

# **CRC Handbook of Chemistry and Physics**

**90<sup>th</sup> Edition**  
**Internet Version 2010**

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## FOREWORD BY THE PUBLISHER

Publishing the 90<sup>th</sup> edition of this landmark reference is a true milestone in the history of CRC Press. Since its first publication in 1913 – as a 116-page pocket-sized book priced at \$2 – the *CRC Handbook of Chemistry and Physics* has developed into a 2800 page tome that no longer fits anyone's pocket but still finds a place on every scientist's bookshelf.

Certainly, the tremendous advances in science and technology over the past 96 years have fuelled the increase in the *Handbook's* contents, but the immense task of data selection, compilation, and organization has been expertly performed by a succession of Editors, Advisory Board members, and Contributors. These people have played a significant role in shaping the *Handbook* that we see today, and it is to them that I wish to pay tribute in this Foreword.

Covering such large subject areas, the Editors have always relied on a team of subject experts from around the world to contribute articles and tables. A cursory glance over the names credited through the years provides an interesting historical roll call of renowned chemists and physicists who have given their time and scientific expertise to the *Handbook*. These contributors include leaders such as Nobel Laureate Glenn T. Seaborg, space science pioneer James Van Allen, and C. S. "Speed" Marvel, considered the father of synthetic polymer chemistry.

Originally conceived by the Ohio-based Chemical Rubber Company as an incentive to encourage sales of their laboratory supplies, the *Handbook* started life as a small booklet of useful mathematical formulae and laboratory data. By 1913, it had grown to 116 pages and was published in its own right as the *Handbook of Chemistry and Physics*. The Editor was William R. Veazey, an Associate Professor of Chemistry at the (then) Case School of Applied Science. Who could have predicted that this pocket book was to become so well known that its users came to refer to it as the 'Rubber Bible' or, simply, the 'CRC'? To paraphrase a review of the 88<sup>th</sup> edition – "if you can't find a copy in your lab, that's because someone in the next lab has stolen it."

Veazey's successor was Charles D. Hodgman, his Assistant Editor for the first edition and an Associate Professor of Physics at Case. Hodgman went on to hold the position of Editor from 1915 to 1963, overseeing 42 editions of the *Handbook*. Under his

Editorship the *Handbook* grew to over 3000 pages and the coverage expanded to include x-ray crystallography, nuclear physics, synthetic polymers, and other fields that did not exist when his first edition appeared.

Following Hodgman's retirement Robert Weast took over the Editorship and published the 45<sup>th</sup> edition in 1964. Noticeably bigger with an 8" by 10" page size, the *Handbook* continued to expand in both scope and magnitude over the next few years. In 1972, The Chemical Rubber Company first published it under the CRC Press imprint, and in the late 1970's sold off its laboratory supply business, moved to new headquarters in Florida, and began building its book publishing business.

David R. Lide became the *Handbook's* fourth Editor in 1989, and took the opportunity to radically overhaul the organization and content to reflect the needs of the modern user. He added, merged, and deleted tables, and during the period of his editorship, updated 100 percent of the content. Staying within the confines of a single volume has always meant difficult decisions on which tables to include – often at the expense of others –but with the advent of electronic media, the *Handbook* is now available electronically and space constraints are less of a problem. Modern production techniques and the move to a larger page size have given the current *Handbook* a cleaner and more user-friendly look.

Publication of the 90<sup>th</sup> edition marks David Lide's final edition as Editor-in-Chief, and the publisher wishes to take this opportunity to thank him for his tremendous expertise and enthusiasm that has helped make the *Handbook* so indispensable to today's scientists.

Starting with the 91<sup>st</sup> edition, the *Handbook* editorship transfers to W.M. "Mickey" Haynes, Editor-in-Chief of the *International Journal of Thermophysics*, Scientist Emeritus at the National Institute of Standards and Technology (NIST), and former Chief of the NIST Physical and Chemical Properties Division. We look forward to a new era in the *Handbook's* long and illustrious history.

**Fiona Macdonald**  
Publisher, CRC Press  
Boca Raton, Florida  
March 2009

## PREFACE

The 90th Edition of the *CRC Handbook of Chemistry and Physics* marks a milestone for this reference work, which first appeared in 1913. For almost a century the *Handbook* has been updated annually, except for a few wartime years, and has served several generations of R&D professionals, engineers, and students. Its aim has always been to provide broad coverage of all types of physical science data commonly encountered by scientists and engineers, with as much depth as can be accommodated in a one-volume format. The data contained in the *Handbook* have been carefully selected by experts in each field; quality control is a high priority and the sources are documented. The annual updates make it possible to add new and improved data in a timely fashion, and references to more detailed data sources have helped to establish the *Handbook* as the first place to look for physical and chemical data.

This edition also marks the retirement of the current Editor-in-Chief after 20 years in that post. The reception to the changes I have made in the book is very gratifying, and I greatly appreciate the suggestions that have come from the Editorial Board, the contributors, and many users. The new Editor will be W. M. "Mickey" Haynes, who has had long experience in providing physical and chemical data through the National Institute of Standards and Technology and through his service as Editor of the *International Journal of Thermophysics*. I am confident that he will continue the tradition of excellence the *Handbook* has achieved.

Many new tables and updates are included in the 90th Edition, especially in the following areas:

Fluid properties (Sec. 6) - new data over a wider temperature and pressure range for

- Water (including D<sub>2</sub>O) and steam
- Air
- Refrigerants and other important industrial fluids

Biochemistry (Sec. 7) – new tables on

- Enzyme catalyzed reactions
- Structure and functions of common drugs
- Chemical constituents of human blood

Analytical chemistry (Sec. 8) – new and expanded tables on

- Proton NMR shifts for solvents and other fluids
- Mass spectral peaks
- Nuclear moments and other data for NMR spectroscopy
- Aqueous solubility of organic compounds

Astronomy and geophysics (Sec. 14) – new data on

- Properties of the planets and their satellites
- Major world earthquakes, 850 AD to 2008
- Interstellar molecules

Other new and expanded tables

- International recommendations for the expression of uncertainty of measurements
- Description of the new IUPAC chemical identifier (InChI)
- Nobel prize winners in physics and chemistry
- Threshold limits for airborne contaminants

In addition to offering the full text of the print edition in searchable pdf format, this Internet Version 2010 presents the major tables of numerical data in the form of interactive tables that can

be sorted, filtered, and combined in various ways. Substances in these tables can be retrieved by searching on name, formula, CAS Registry Number, or chemical structure, and such a search can be combined with a request for a desired property. Thus one can request a specific property of a specific substance (for example, viscosity of benzene) and receive a customized table with exactly that information. In addition, the Internet version includes a section with pdf files of many older tables that have been removed from the print edition to make space for new material.

Suggestions on new topics for the *Handbook* and notification of errors are always appreciated. Input from users plays a key role in keeping the book up to date. Address all comments to Editor-in-Chief, *CRC Handbook of Chemistry and Physics*, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487.

The *Handbook of Chemistry and Physics* is dependent on the efforts of many contributors throughout the world. The list of current contributors follows this Preface. The assistance and support of Dr. Fiona Macdonald, Chemical and Biological Sciences Publisher for CRC Press/Taylor & Francis Books, is greatly appreciated. Finally, I want to thank Mimi Williams, Pam Morrell, Glen Butler, James Yanchak, and Theresa Delforn for their outstanding work in production of the book and Ronel Decius, Robert Morris, and Aviel Alkon for producing the Internet version.

**David R. Lide**  
**June 2009**

**The 90th Edition of the *Handbook of Chemistry and Physics* is dedicated to my wife,  
Bettijoyce Breen Lide, and to the members of my family  
David Alston Lide, Vanessa Lide Whitcomb and David Whitcomb, James Lide and Deborah  
Horowitz, Quentin Lide and Suzanne Romero, Neil and Lizzie Molino, and Van Molino  
and to my grandchildren  
David A. Lide, Jr., Mary Lide, Grace Lide, David A. Whitcomb, Kate Whitcomb, and  
Zoë Lide**

#### **How To Cite this Reference**

The recommended form of citation is: David R. Lide, ed., *CRC Handbook of Chemistry and Physics, 90th Edition (Internet Version 2010)*, CRC Press/Taylor and Francis, Boca Raton, FL. If a specific table is cited, use the format: "Physical Constants of Organic Compounds", in *CRC Handbook of Chemistry and Physics, 90th Edition (Internet Version 2010)*, David R. Lide, ed., CRC Press/Taylor and Francis, Boca Raton, FL.

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# CODATA RECOMMENDED VALUES OF THE FUNDAMENTAL PHYSICAL CONSTANTS: 2006

Peter J. Mohr, Barry N. Taylor, and David B. Newell

These tables give the 2006 self-consistent set of values of the basic constants and conversion factors of physics and chemistry recommended by the Committee on Data for Science and Technology (CODATA) for international use. The 2006 adjustment takes into account the data considered in the 2002 adjustment as well as the data that became available between 31 December 2002, the closing date of that adjustment, and 31 December 2006, the closing date of the new adjustment. The new data has led to a significant reduction in the uncertainties of many recommended values. The 2006 set replaces the previously recommended 2002 CODATA set and may also be found on the World Wide Web at [physics.nist.gov/constants](http://physics.nist.gov/constants).

This report was prepared by the authors under the auspices of the CODATA Task Group on Fundamental Constants. The members of the task group are:

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## References

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2. Yao, W. M., et al., *J. Phys. G* **33**, 1, 2006.

TABLE I: An abbreviated list of the CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
speed of light in vacuum	$c, c_0$	299 792 458	m s <sup>-1</sup>	(exact)
magnetic constant	$\mu_0$	$4\pi \times 10^{-7}$ $= 12.566 370 614... \times 10^{-7}$	N A <sup>-2</sup> N A <sup>-2</sup>	(exact)
electric constant $1/\mu_0 c^2$	$\epsilon_0$	$8.854 187 817... \times 10^{-12}$	F m <sup>-1</sup>	(exact)
Newtonian constant of gravitation	$G$	$6.674 28(67) \times 10^{-11}$	m <sup>3</sup> kg <sup>-1</sup> s <sup>-2</sup>	$1.0 \times 10^{-4}$
Planck constant	$h$	$6.626 068 96(33) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
$h/2\pi$	$\hbar$	$1.054 571 628(53) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
elementary charge	$e$	$1.602 176 487(40) \times 10^{-19}$	C	$2.5 \times 10^{-8}$
magnetic flux quantum $h/2e$	$\Phi_0$	$2.067 833 667(52) \times 10^{-15}$	Wb	$2.5 \times 10^{-8}$
conductance quantum $2e^2/h$	$G_0$	$7.748 091 7004(53) \times 10^{-5}$	S	$6.8 \times 10^{-10}$
electron mass	$m_e$	$9.109 382 15(45) \times 10^{-31}$	kg	$5.0 \times 10^{-8}$
proton mass	$m_p$	$1.672 621 637(83) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
proton-electron mass ratio	$m_p/m_e$	1836.152 672 47(80)		$4.3 \times 10^{-10}$
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	$\alpha$	$7.297 352 5376(50) \times 10^{-3}$		$6.8 \times 10^{-10}$
inverse fine-structure constant	$\alpha^{-1}$	137.035 999 679(94)		$6.8 \times 10^{-10}$
Rydberg constant $\alpha^2 m_e c/2h$	$R_\infty$	10 973 731.568 527(73)	m <sup>-1</sup>	$6.6 \times 10^{-12}$
Avogadro constant	$N_A, L$	$6.022 141 79(30) \times 10^{23}$	mol <sup>-1</sup>	$5.0 \times 10^{-8}$

TABLE I: (Continued.)

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
Faraday constant $N_A e$	$F$	96 485.3399(24)	C mol <sup>-1</sup>	$2.5 \times 10^{-8}$
molar gas constant	$R$	8.314 472(15)	J mol <sup>-1</sup> K <sup>-1</sup>	$1.7 \times 10^{-6}$
Boltzmann constant $R/N_A$	$k$	$1.380 6504(24) \times 10^{-23}$	J K <sup>-1</sup>	$1.7 \times 10^{-6}$
Stefan-Boltzmann constant $(\pi^2/60)k^4/\hbar^3 c^2$	$\sigma$	$5.670 400(40) \times 10^{-8}$	W m <sup>-2</sup> K <sup>-4</sup>	$7.0 \times 10^{-6}$
<i>Non-SI units accepted for use with the SI</i>				
electron volt: $(e/C)$ J	eV	$1.602 176 487(40) \times 10^{-19}$	J	$2.5 \times 10^{-8}$
(unified) atomic mass unit				
$1 \text{ u} = m_{\text{u}} = \frac{1}{12} m(^{12}\text{C}) = 10^{-3} \text{ kg mol}^{-1}/N_A$	u	$1.660 538 782(83) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$

TABLE II: The CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
<b>UNIVERSAL</b>				
speed of light in vacuum	$c, c_0$	299 792 458	m s <sup>-1</sup>	(exact)
magnetic constant	$\mu_0$	$4\pi \times 10^{-7}$ $= 12.566 370 614... \times 10^{-7}$	N A <sup>-2</sup>	(exact)
electric constant $1/\mu_0 c^2$	$\epsilon_0$	$8.854 187 817... \times 10^{-12}$	F m <sup>-1</sup>	(exact)
characteristic impedance of vacuum $\sqrt{\mu_0/\epsilon_0} = \mu_0 c$	$Z_0$	376.730 313 461...	$\Omega$	(exact)
Newtonian constant of gravitation	$G$	$6.674 28(67) \times 10^{-11}$	m <sup>3</sup> kg <sup>-1</sup> s <sup>-2</sup>	$1.0 \times 10^{-4}$
	$G/\hbar c$	$6.708 81(67) \times 10^{-39}$	(GeV/c <sup>2</sup> ) <sup>-2</sup>	$1.0 \times 10^{-4}$
Planck constant	$h$	$6.626 068 96(33) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
in eV s		$4.135 667 33(10) \times 10^{-15}$	eV s	$2.5 \times 10^{-8}$
$\hbar/2\pi$	$\hbar$	$1.054 571 628(53) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
in eV s		$6.582 118 99(16) \times 10^{-16}$	eV s	$2.5 \times 10^{-8}$
$\hbar c$ in MeV fm		197.326 9631(49)	MeV fm	$2.5 \times 10^{-8}$
Planck mass $(\hbar c/G)^{1/2}$	$m_{\text{P}}$	$2.176 44(11) \times 10^{-8}$	kg	$5.0 \times 10^{-5}$
energy equivalent in GeV	$m_{\text{P}} c^2$	$1.220 892(61) \times 10^{19}$	GeV	$5.0 \times 10^{-5}$
Planck temperature $(\hbar c^5/G)^{1/2}/k$	$T_{\text{P}}$	$1.416 785(71) \times 10^{32}$	K	$5.0 \times 10^{-5}$
Planck length $\hbar/m_{\text{P}} c = (\hbar G/c^3)^{1/2}$	$l_{\text{P}}$	$1.616 252(81) \times 10^{-35}$	m	$5.0 \times 10^{-5}$
Planck time $l_{\text{P}}/c = (\hbar G/c^5)^{1/2}$	$t_{\text{P}}$	$5.391 24(27) \times 10^{-44}$	s	$5.0 \times 10^{-5}$
<b>ELECTROMAGNETIC</b>				
elementary charge	$e$	$1.602 176 487(40) \times 10^{-19}$	C	$2.5 \times 10^{-8}$
	$e/h$	$2.417 989 454(60) \times 10^{14}$	A J <sup>-1</sup>	$2.5 \times 10^{-8}$
magnetic flux quantum $h/2e$	$\Phi_0$	$2.067 833 667(52) \times 10^{-15}$	Wb	$2.5 \times 10^{-8}$
conductance quantum $2e^2/h$	$G_0$	$7.748 091 7004(53) \times 10^{-5}$	S	$6.8 \times 10^{-10}$
inverse of conductance quantum	$G_0^{-1}$	12 906.403 7787(88)	$\Omega$	$6.8 \times 10^{-10}$
Josephson constant <sup>1</sup> $2e/h$	$K_{\text{J}}$	$483 597.891(12) \times 10^9$	Hz V <sup>-1</sup>	$2.5 \times 10^{-8}$
von Klitzing constant <sup>2</sup>				
$h/e^2 = \mu_0 c/2\alpha$	$R_{\text{K}}$	25 812.807 557(18)	$\Omega$	$6.8 \times 10^{-10}$
Bohr magneton $e\hbar/2m_e$	$\mu_{\text{B}}$	$927.400 915(23) \times 10^{-26}$	J T <sup>-1</sup>	$2.5 \times 10^{-8}$
in eV T <sup>-1</sup>		$5.788 381 7555(79) \times 10^{-5}$	eV T <sup>-1</sup>	$1.4 \times 10^{-9}$
	$\mu_{\text{B}}/h$	$13.996 246 04(35) \times 10^9$	Hz T <sup>-1</sup>	$2.5 \times 10^{-8}$

<sup>1</sup>See Table IV for the conventional value adopted internationally for realizing representations of the volt using the Josephson effect.<sup>2</sup>See Table IV for the conventional value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
	$\mu_B/hc$	46.686 4515(12)	$\text{m}^{-1} \text{T}^{-1}$	$2.5 \times 10^{-8}$
	$\mu_B/k$	0.671 7131(12)	$\text{K T}^{-1}$	$1.7 \times 10^{-6}$
nuclear magneton $e\hbar/2m_p$ in $\text{eV T}^{-1}$	$\mu_N$	$5.050\,783\,24(13) \times 10^{-27}$ $3.152\,451\,2326(45) \times 10^{-8}$	$\text{J T}^{-1}$ $\text{eV T}^{-1}$	$2.5 \times 10^{-8}$ $1.4 \times 10^{-9}$
	$\mu_N/h$	7.622 593 84(19)	$\text{MHz T}^{-1}$	$2.5 \times 10^{-8}$
	$\mu_N/hc$	$2.542\,623\,616(64) \times 10^{-2}$	$\text{m}^{-1} \text{T}^{-1}$	$2.5 \times 10^{-8}$
	$\mu_N/k$	$3.658\,2637(64) \times 10^{-4}$	$\text{K T}^{-1}$	$1.7 \times 10^{-6}$
<b>ATOMIC AND NUCLEAR</b>				
<b>General</b>				
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	$\alpha$	$7.297\,352\,5376(50) \times 10^{-3}$		$6.8 \times 10^{-10}$
inverse fine-structure constant	$\alpha^{-1}$	137.035 999 679(94)		$6.8 \times 10^{-10}$
Rydberg constant $\alpha^2 m_e c/2h$	$R_\infty$	10 973 731.568 527(73)	$\text{m}^{-1}$	$6.6 \times 10^{-12}$
	$R_\infty c$	$3.289\,841\,960\,361(22) \times 10^{15}$	Hz	$6.6 \times 10^{-12}$
	$R_\infty \hbar c$	$2.179\,871\,97(11) \times 10^{-18}$	J	$5.0 \times 10^{-8}$
$R_\infty \hbar c$ in eV		13.605 691 93(34)	eV	$2.5 \times 10^{-8}$
Bohr radius $\alpha/4\pi R_\infty = 4\pi\epsilon_0\hbar^2/m_e e^2$	$a_0$	$0.529\,177\,208\,59(36) \times 10^{-10}$	m	$6.8 \times 10^{-10}$
Hartree energy $e^2/4\pi\epsilon_0 a_0 = 2R_\infty \hbar c$ $= \alpha^2 m_e c^2$ in eV	$E_h$	$4.359\,743\,94(22) \times 10^{-18}$ 27.211 383 86(68)	J eV	$5.0 \times 10^{-8}$ $2.5 \times 10^{-8}$
quantum of circulation	$h/2m_e$	$3.636\,947\,5199(50) \times 10^{-4}$	$\text{m}^2 \text{s}^{-1}$	$1.4 \times 10^{-9}$
	$h/m_e$	$7.273\,895\,040(10) \times 10^{-4}$	$\text{m}^2 \text{s}^{-1}$	$1.4 \times 10^{-9}$
<b>Electroweak</b>				
Fermi coupling constant <sup>3</sup>	$G_F/(\hbar c)^3$	$1.166\,37(1) \times 10^{-5}$	$\text{GeV}^{-2}$	$8.6 \times 10^{-6}$
weak mixing angle <sup>4</sup> $\theta_W$ (on-shell scheme) $\sin^2 \theta_W = s_W^2 \equiv 1 - (m_W/m_Z)^2$	$\sin^2 \theta_W$	0.222 55(56)		$2.5 \times 10^{-3}$
<b>Electron, <math>e^-</math></b>				
electron mass in u, $m_e = A_r(e)$ u (electron relative atomic mass times u)	$m_e$	$9.109\,382\,15(45) \times 10^{-31}$	kg	$5.0 \times 10^{-8}$
energy equivalent	$m_e c^2$	$5.485\,799\,0943(23) \times 10^{-4}$ $8.187\,104\,38(41) \times 10^{-14}$	u J	$4.2 \times 10^{-10}$ $5.0 \times 10^{-8}$
in MeV		0.510 998 910(13)	MeV	$2.5 \times 10^{-8}$
electron-muon mass ratio	$m_e/m_\mu$	$4.836\,331\,71(12) \times 10^{-3}$		$2.5 \times 10^{-8}$
electron-tau mass ratio	$m_e/m_\tau$	$2.875\,64(47) \times 10^{-4}$		$1.6 \times 10^{-4}$
electron-proton mass ratio	$m_e/m_p$	$5.446\,170\,2177(24) \times 10^{-4}$		$4.3 \times 10^{-10}$
electron-neutron mass ratio	$m_e/m_n$	$5.438\,673\,4459(33) \times 10^{-4}$		$6.0 \times 10^{-10}$
electron-deuteron mass ratio	$m_e/m_d$	$2.724\,437\,1093(12) \times 10^{-4}$		$4.3 \times 10^{-10}$
electron to alpha particle mass ratio	$m_e/m_\alpha$	$1.370\,933\,555\,70(58) \times 10^{-4}$		$4.2 \times 10^{-10}$
electron charge to mass quotient	$-e/m_e$	$-1.758\,820\,150(44) \times 10^{11}$	$\text{C kg}^{-1}$	$2.5 \times 10^{-8}$
electron molar mass $N_A m_e$	$M(e), M_e$	$5.485\,799\,0943(23) \times 10^{-7}$	$\text{kg mol}^{-1}$	$4.2 \times 10^{-10}$
Compton wavelength $h/m_e c$	$\lambda_C$	$2.426\,310\,2175(33) \times 10^{-12}$	m	$1.4 \times 10^{-9}$
$\lambda_C/2\pi = \alpha a_0 = \alpha^2/4\pi R_\infty$	$\tilde{\lambda}_C$	$386.159\,264\,59(53) \times 10^{-15}$	m	$1.4 \times 10^{-9}$
classical electron radius $\alpha^2 a_0$	$r_e$	$2.817\,940\,2894(58) \times 10^{-15}$	m	$2.1 \times 10^{-9}$
Thomson cross section $(8\pi/3)r_e^2$	$\sigma_e$	$0.665\,245\,8558(27) \times 10^{-28}$	$\text{m}^2$	$4.1 \times 10^{-9}$

<sup>3</sup>Value recommended by the Particle Data Group (Yao *et al.*, 2006).<sup>4</sup>Based on the ratio of the masses of the W and Z bosons  $m_W/m_Z$  recommended by the Particle Data Group (Yao *et al.*, 2006). The value for  $\sin^2 \theta_W$  they recommend, which is based on a particular variant of the modified minimal subtraction ( $\overline{\text{MS}}$ ) scheme, is  $\sin^2 \hat{\theta}_W(M_Z) = 0.231\,22(15)$ .

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
electron magnetic moment	$\mu_e$	$-928.476\,377(23) \times 10^{-26}$	$\text{J T}^{-1}$	$2.5 \times 10^{-8}$
to Bohr magneton ratio	$\mu_e/\mu_B$	$-1.001\,159\,652\,181\,11(74)$		$7.4 \times 10^{-13}$
to nuclear magneton ratio	$\mu_e/\mu_N$	$-1838.281\,970\,92(80)$		$4.3 \times 10^{-10}$
electron magnetic moment anomaly $ \mu_e /\mu_B - 1$	$a_e$	$1.159\,652\,181\,11(74) \times 10^{-3}$		$6.4 \times 10^{-10}$
electron $g$ -factor $-2(1 + a_e)$	$g_e$	$-2.002\,319\,304\,3622(15)$		$7.4 \times 10^{-13}$
electron-muon magnetic moment ratio	$\mu_e/\mu_\mu$	$206.766\,9877(52)$		$2.5 \times 10^{-8}$
electron-proton magnetic moment ratio	$\mu_e/\mu_p$	$-658.210\,6848(54)$		$8.1 \times 10^{-9}$
electron to shielded proton magnetic moment ratio (H <sub>2</sub> O, sphere, 25°C)	$\mu_e/\mu'_p$	$-658.227\,5971(72)$		$1.1 \times 10^{-8}$
electron-neutron magnetic moment ratio	$\mu_e/\mu_n$	$960.920\,50(23)$		$2.4 \times 10^{-7}$
electron-deuteron magnetic moment ratio	$\mu_e/\mu_d$	$-2143.923\,498(18)$		$8.4 \times 10^{-9}$
electron to shielded helion magnetic moment ratio (gas, sphere, 25°C)	$\mu_e/\mu'_h$	$864.058\,257(10)$		$1.2 \times 10^{-8}$
electron gyromagnetic ratio $2 \mu_e /\hbar$	$\gamma_e$	$1.760\,859\,770(44) \times 10^{11}$	$\text{s}^{-1} \text{T}^{-1}$	$2.5 \times 10^{-8}$
	$\gamma_e/2\pi$	$28\,024.953\,64(70)$	$\text{MHz T}^{-1}$	$2.5 \times 10^{-8}$
<b>Muon, <math>\mu^-</math></b>				
muon mass	$m_\mu$	$1.883\,531\,30(11) \times 10^{-28}$	kg	$5.6 \times 10^{-8}$
in u, $m_\mu = A_r(\mu)$ u (muon relative atomic mass times u)		$0.113\,428\,9256(29)$	u	$2.5 \times 10^{-8}$
energy equivalent in MeV	$m_\mu c^2$	$1.692\,833\,510(95) \times 10^{-11}$	J	$5.6 \times 10^{-8}$
		$105.658\,3668(38)$	MeV	$3.6 \times 10^{-8}$
muon-electron mass ratio	$m_\mu/m_e$	$206.768\,2823(52)$		$2.5 \times 10^{-8}$
muon-tau mass ratio	$m_\mu/m_\tau$	$5.945\,92(97) \times 10^{-2}$		$1.6 \times 10^{-4}$
muon-proton mass ratio	$m_\mu/m_p$	$0.112\,609\,5261(29)$		$2.5 \times 10^{-8}$
muon-neutron mass ratio	$m_\mu/m_n$	$0.112\,454\,5167(29)$		$2.5 \times 10^{-8}$
muon molar mass $N_A m_\mu$	$M(\mu), M_\mu$	$0.113\,428\,9256(29) \times 10^{-3}$	$\text{kg mol}^{-1}$	$2.5 \times 10^{-8}$
muon Compton wavelength $h/m_\mu c$	$\lambda_{C,\mu}$	$11.734\,441\,04(30) \times 10^{-15}$	m	$2.5 \times 10^{-8}$
$\lambda_{C,\mu}/2\pi$	$\tilde{\lambda}_{C,\mu}$	$1.867\,594\,295(47) \times 10^{-15}$	m	$2.5 \times 10^{-8}$
muon magnetic moment	$\mu_\mu$	$-4.490\,447\,86(16) \times 10^{-26}$	$\text{J T}^{-1}$	$3.6 \times 10^{-8}$
to Bohr magneton ratio	$\mu_\mu/\mu_B$	$-4.841\,970\,49(12) \times 10^{-3}$		$2.5 \times 10^{-8}$
to nuclear magneton ratio	$\mu_\mu/\mu_N$	$-8.890\,597\,05(23)$		$2.5 \times 10^{-8}$
muon magnetic moment anomaly $ \mu_\mu /(e\hbar/2m_\mu) - 1$	$a_\mu$	$1.165\,920\,69(60) \times 10^{-3}$		$5.2 \times 10^{-7}$
muon $g$ -factor $-2(1 + a_\mu)$	$g_\mu$	$-2.002\,331\,8414(12)$		$6.0 \times 10^{-10}$
muon-proton magnetic moment ratio	$\mu_\mu/\mu_p$	$-3.183\,345\,137(85)$		$2.7 \times 10^{-8}$
<b>Tau, <math>\tau^-</math></b>				
tau mass <sup>5</sup>	$m_\tau$	$3.167\,77(52) \times 10^{-27}$	kg	$1.6 \times 10^{-4}$
in u, $m_\tau = A_r(\tau)$ u (tau relative atomic mass times u)		$1.907\,68(31)$	u	$1.6 \times 10^{-4}$

<sup>5</sup>This and all other values involving  $m_\tau$  are based on the value of  $m_\tau c^2$  in MeV recommended by the Particle Data Group (Yao *et al.*, 2006), but with a standard uncertainty of 0.29 MeV rather than the quoted uncertainty of  $-0.26$  MeV,  $+0.29$  MeV.



TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
energy equivalent in MeV	$m_\tau c^2$	$2.847\,05(46) \times 10^{-10}$	J	$1.6 \times 10^{-4}$
		1776.99(29)	MeV	$1.6 \times 10^{-4}$
tau-electron mass ratio	$m_\tau/m_e$	3477.48(57)		$1.6 \times 10^{-4}$
tau-muon mass ratio	$m_\tau/m_\mu$	16.8183(27)		$1.6 \times 10^{-4}$
tau-proton mass ratio	$m_\tau/m_p$	1.893 90(31)		$1.6 \times 10^{-4}$
tau-neutron mass ratio	$m_\tau/m_n$	1.891 29(31)		$1.6 \times 10^{-4}$
tau molar mass $N_A m_\tau$	$M(\tau), M_\tau$	$1.907\,68(31) \times 10^{-3}$	kg mol <sup>-1</sup>	$1.6 \times 10^{-4}$
tau Compton wavelength $h/m_\tau c$ $\lambda_{C,\tau}/2\pi$	$\lambda_{C,\tau}$ $\tilde{\lambda}_{C,\tau}$	$0.697\,72(11) \times 10^{-15}$	m	$1.6 \times 10^{-4}$
		$0.111\,046(18) \times 10^{-15}$	m	$1.6 \times 10^{-4}$
<b>Proton, p</b>				
proton mass	$m_p$	$1.672\,621\,637(83) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_p = A_r(p)$ u (proton relative atomic mass times u)		1.007 276 466 77(10)	u	$1.0 \times 10^{-10}$
energy equivalent in MeV	$m_p c^2$	$1.503\,277\,359(75) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
		938.272 013(23)	MeV	$2.5 \times 10^{-8}$
proton-electron mass ratio	$m_p/m_e$	1836.152 672 47(80)		$4.3 \times 10^{-10}$
proton-muon mass ratio	$m_p/m_\mu$	8.880 243 39(23)		$2.5 \times 10^{-8}$
proton-tau mass ratio	$m_p/m_\tau$	0.528 012(86)		$1.6 \times 10^{-4}$
proton-neutron mass ratio	$m_p/m_n$	0.998 623 478 24(46)		$4.6 \times 10^{-10}$
proton charge to mass quotient	$e/m_p$	$9.578\,833\,92(24) \times 10^7$	C kg <sup>-1</sup>	$2.5 \times 10^{-8}$
proton molar mass $N_A m_p$	$M(p), M_p$	$1.007\,276\,466\,77(10) \times 10^{-3}$	kg mol <sup>-1</sup>	$1.0 \times 10^{-10}$
proton Compton wavelength $h/m_p c$ $\lambda_{C,p}/2\pi$	$\lambda_{C,p}$ $\tilde{\lambda}_{C,p}$	$1.321\,409\,8446(19) \times 10^{-15}$	m	$1.4 \times 10^{-9}$
		$0.210\,308\,908\,61(30) \times 10^{-15}$	m	$1.4 \times 10^{-9}$
proton rms charge radius	$R_p$	$0.8768(69) \times 10^{-15}$	m	$7.8 \times 10^{-3}$
proton magnetic moment to Bohr magneton ratio to nuclear magneton ratio	$\mu_p$	$1.410\,606\,662(37) \times 10^{-26}$	J T <sup>-1</sup>	$2.6 \times 10^{-8}$
	$\mu_p/\mu_B$	$1.521\,032\,209(12) \times 10^{-3}$		$8.1 \times 10^{-9}$
	$\mu_p/\mu_N$	2.792 847 356(23)		$8.2 \times 10^{-9}$
proton $g$ -factor $2\mu_p/\mu_N$	$g_p$	5.585 694 713(46)		$8.2 \times 10^{-9}$
proton-neutron magnetic moment ratio shielded proton magnetic moment (H <sub>2</sub> O, sphere, 25°C)	$\mu_p/\mu_n$	-1.459 898 06(34)		$2.4 \times 10^{-7}$
	$\mu'_p$	$1.410\,570\,419(38) \times 10^{-26}$	J T <sup>-1</sup>	$2.7 \times 10^{-8}$
	$\mu'_p/\mu_B$	$1.520\,993\,128(17) \times 10^{-3}$		$1.1 \times 10^{-8}$
to nuclear magneton ratio	$\mu'_p/\mu_N$	2.792 775 598(30)		$1.1 \times 10^{-8}$
proton magnetic shielding correction $1 - \mu'_p/\mu_p$ (H <sub>2</sub> O, sphere, 25°C)	$\sigma'_p$	$25.694(14) \times 10^{-6}$		$5.3 \times 10^{-4}$
proton gyromagnetic ratio $2\mu_p/\hbar$	$\gamma_p$	$2.675\,222\,099(70) \times 10^8$	s <sup>-1</sup> T <sup>-1</sup>	$2.6 \times 10^{-8}$
	$\gamma_p/2\pi$	42.577 4821(11)	MHz T <sup>-1</sup>	$2.6 \times 10^{-8}$
shielded proton gyromagnetic ratio $2\mu'_p/\hbar$ (H <sub>2</sub> O, sphere, 25°C)	$\gamma'_p$	$2.675\,153\,362(73) \times 10^8$	s <sup>-1</sup> T <sup>-1</sup>	$2.7 \times 10^{-8}$
	$\gamma'_p/2\pi$	42.576 3881(12)	MHz T <sup>-1</sup>	$2.7 \times 10^{-8}$
<b>Neutron, n</b>				
neutron mass	$m_n$	$1.674\,927\,211(84) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_n = A_r(n)$ u (neutron relative atomic mass times u)		1.008 664 915 97(43)	u	$4.3 \times 10^{-10}$
energy equivalent in MeV	$m_n c^2$	$1.505\,349\,505(75) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
		939.565 346(23)	MeV	$2.5 \times 10^{-8}$
neutron-electron mass ratio	$m_n/m_e$	1838.683 6605(11)		$6.0 \times 10^{-10}$

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
neutron-muon mass ratio	$m_n/m_\mu$	8.892 484 09(23)		$2.5 \times 10^{-8}$
neutron-tau mass ratio	$m_n/m_\tau$	0.528 740(86)		$1.6 \times 10^{-4}$
neutron-proton mass ratio	$m_n/m_p$	1.001 378 419 18(46)		$4.6 \times 10^{-10}$
neutron molar mass $N_A m_n$	$M(n), M_n$	$1.008 664 915 97(43) \times 10^{-3}$	kg mol <sup>-1</sup>	$4.3 \times 10^{-10}$
neutron Compton wavelength $h/m_n c$	$\lambda_{C,n}$	$1.319 590 8951(20) \times 10^{-15}$	m	$1.5 \times 10^{-9}$
$\lambda_{C,n}/2\pi$	$\tilde{\lambda}_{C,n}$	$0.210 019 413 82(31) \times 10^{-15}$	m	$1.5 \times 10^{-9}$
neutron magnetic moment	$\mu_n$	$-0.966 236 41(23) \times 10^{-26}$	J T <sup>-1</sup>	$2.4 \times 10^{-7}$
to Bohr magneton ratio	$\mu_n/\mu_B$	$-1.041 875 63(25) \times 10^{-3}$		$2.4 \times 10^{-7}$
to nuclear magneton ratio	$\mu_n/\mu_N$	-1.913 042 73(45)		$2.4 \times 10^{-7}$
neutron $g$ -factor $2\mu_n/\mu_N$	$g_n$	-3.826 085 45(90)		$2.4 \times 10^{-7}$
neutron-electron magnetic moment ratio	$\mu_n/\mu_e$	$1.040 668 82(25) \times 10^{-3}$		$2.4 \times 10^{-7}$
neutron-proton magnetic moment ratio	$\mu_n/\mu_p$	-0.684 979 34(16)		$2.4 \times 10^{-7}$
neutron to shielded proton magnetic moment ratio (H <sub>2</sub> O, sphere, 25°C)	$\mu_n/\mu'_p$	-0.684 996 94(16)		$2.4 \times 10^{-7}$
neutron gyromagnetic ratio $2 \mu_n /\hbar$	$\gamma_n$	$1.832 471 85(43) \times 10^8$	s <sup>-1</sup> T <sup>-1</sup>	$2.4 \times 10^{-7}$
	$\gamma_n/2\pi$	29.164 6954(69)	MHz T <sup>-1</sup>	$2.4 \times 10^{-7}$
<b>Deuteron, d</b>				
deuteron mass	$m_d$	$3.343 583 20(17) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_d = A_r(d)$ u (deuteron relative atomic mass times u)		2.013 553 212 724(78)	u	$3.9 \times 10^{-11}$
energy equivalent	$m_d c^2$	$3.005 062 72(15) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
in MeV		1875.612 793(47)	MeV	$2.5 \times 10^{-8}$
deuteron-electron mass ratio	$m_d/m_e$	3670.482 9654(16)		$4.3 \times 10^{-10}$
deuteron-proton mass ratio	$m_d/m_p$	1.999 007 501 08(22)		$1.1 \times 10^{-10}$
deuteron molar mass $N_A m_d$	$M(d), M_d$	$2.013 553 212 724(78) \times 10^{-3}$	kg mol <sup>-1</sup>	$3.9 \times 10^{-11}$
deuteron rms charge radius	$R_d$	$2.1402(28) \times 10^{-15}$	m	$1.3 \times 10^{-3}$
deuteron magnetic moment	$\mu_d$	$0.433 073 465(11) \times 10^{-26}$	J T <sup>-1</sup>	$2.6 \times 10^{-8}$
to Bohr magneton ratio	$\mu_d/\mu_B$	$0.466 975 4556(39) \times 10^{-3}$		$8.4 \times 10^{-9}$
to nuclear magneton ratio	$\mu_d/\mu_N$	0.857 438 2308(72)		$8.4 \times 10^{-9}$
deuteron $g$ -factor $\mu_d/\mu_N$	$g_d$	0.857 438 2308(72)		$8.4 \times 10^{-9}$
deuteron-electron magnetic moment ratio	$\mu_d/\mu_e$	$-4.664 345 537(39) \times 10^{-4}$		$8.4 \times 10^{-9}$
deuteron-proton magnetic moment ratio	$\mu_d/\mu_p$	0.307 012 2070(24)		$7.7 \times 10^{-9}$
deuteron-neutron magnetic moment ratio	$\mu_d/\mu_n$	-0.448 206 52(11)		$2.4 \times 10^{-7}$
<b>Triton, t</b>				
tritron mass	$m_t$	$5.007 355 88(25) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_t = A_r(t)$ u (tritron relative atomic mass times u)		3.015 500 7134(25)	u	$8.3 \times 10^{-10}$
energy equivalent	$m_t c^2$	$4.500 387 03(22) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
in MeV		2808.920 906(70)	MeV	$2.5 \times 10^{-8}$
tritron-electron mass ratio	$m_t/m_e$	5496.921 5269(51)		$9.3 \times 10^{-10}$
tritron-proton mass ratio	$m_t/m_p$	2.993 717 0309(25)		$8.4 \times 10^{-10}$

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
triton molar mass $N_A m_t$	$M(t), M_t$	$3.015\,500\,7134(25) \times 10^{-3}$	kg mol <sup>-1</sup>	$8.3 \times 10^{-10}$
triton magnetic moment	$\mu_t$	$1.504\,609\,361(42) \times 10^{-26}$	J T <sup>-1</sup>	$2.8 \times 10^{-8}$
to Bohr magneton ratio	$\mu_t/\mu_B$	$1.622\,393\,657(21) \times 10^{-3}$		$1.3 \times 10^{-8}$
to nuclear magneton ratio	$\mu_t/\mu_N$	$2.978\,962\,448(38)$		$1.3 \times 10^{-8}$
triton $g$ -factor $2\mu_t/\mu_N$	$g_t$	$5.957\,924\,896(76)$		$1.3 \times 10^{-8}$
triton-electron magnetic moment ratio	$\mu_t/\mu_e$	$-1.620\,514\,423(21) \times 10^{-3}$		$1.3 \times 10^{-8}$
triton-proton magnetic moment ratio	$\mu_t/\mu_p$	$1.066\,639\,908(10)$		$9.8 \times 10^{-9}$
triton-neutron magnetic moment ratio	$\mu_t/\mu_n$	$-1.557\,185\,53(37)$		$2.4 \times 10^{-7}$
<b>Helion, h</b>				
helion ( <sup>3</sup> He nucleus) mass	$m_h$	$5.006\,411\,92(25) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_h = A_r(h)$ u (helion relative atomic mass times u)		$3.014\,932\,2473(26)$	u	$8.6 \times 10^{-10}$
energy equivalent	$m_h c^2$	$4.499\,538\,64(22) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
in MeV		$2808.391\,383(70)$	MeV	$2.5 \times 10^{-8}$
helion-electron mass ratio	$m_h/m_e$	$5495.885\,2765(52)$		$9.5 \times 10^{-10}$
helion-proton mass ratio	$m_h/m_p$	$2.993\,152\,6713(26)$		$8.7 \times 10^{-10}$
helion molar mass $N_A m_h$	$M(h), M_h$	$3.014\,932\,2473(26) \times 10^{-3}$	kg mol <sup>-1</sup>	$8.6 \times 10^{-10}$
shielded helion magnetic moment (gas, sphere, 25°C)	$\mu'_h$	$-1.074\,552\,982(30) \times 10^{-26}$	J T <sup>-1</sup>	$2.8 \times 10^{-8}$
to Bohr magneton ratio	$\mu'_h/\mu_B$	$-1.158\,671\,471(14) \times 10^{-3}$		$1.2 \times 10^{-8}$
to nuclear magneton ratio	$\mu'_h/\mu_N$	$-2.127\,497\,718(25)$		$1.2 \times 10^{-8}$
shielded helion to proton magnetic moment ratio (gas, sphere, 25°C)	$\mu'_h/\mu_p$	$-0.761\,766\,558(11)$		$1.4 \times 10^{-8}$
shielded helion to shielded proton magnetic moment ratio (gas/H <sub>2</sub> O, spheres, 25°C)	$\mu'_h/\mu'_p$	$-0.761\,786\,1313(33)$		$4.3 \times 10^{-9}$
shielded helion gyromagnetic ratio $2 \mu'_h /\hbar$ (gas, sphere, 25°C)	$\gamma'_h$	$2.037\,894\,730(56) \times 10^8$	s <sup>-1</sup> T <sup>-1</sup>	$2.8 \times 10^{-8}$
	$\gamma'_h/2\pi$	$32.434\,101\,98(90)$	MHz T <sup>-1</sup>	$2.8 \times 10^{-8}$
<b>Alpha particle, <math>\alpha</math></b>				
alpha particle mass	$m_\alpha$	$6.644\,656\,20(33) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
in u, $m_\alpha = A_r(\alpha)$ u (alpha particle relative atomic mass times u)		$4.001\,506\,179\,127(62)$	u	$1.5 \times 10^{-11}$
energy equivalent	$m_\alpha c^2$	$5.971\,919\,17(30) \times 10^{-10}$	J	$5.0 \times 10^{-8}$
in MeV		$3727.379\,109(93)$	MeV	$2.5 \times 10^{-8}$
alpha particle to electron mass ratio	$m_\alpha/m_e$	$7294.299\,5365(31)$		$4.2 \times 10^{-10}$
alpha particle to proton mass ratio	$m_\alpha/m_p$	$3.972\,599\,689\,51(41)$		$1.0 \times 10^{-10}$
alpha particle molar mass $N_A m_\alpha$	$M(\alpha), M_\alpha$	$4.001\,506\,179\,127(62) \times 10^{-3}$	kg mol <sup>-1</sup>	$1.5 \times 10^{-11}$
<b>PHYSICOCHEMICAL</b>				
Avogadro constant	$N_A, L$	$6.022\,141\,79(30) \times 10^{23}$	mol <sup>-1</sup>	$5.0 \times 10^{-8}$
atomic mass constant $m_u = \frac{1}{12}m(^{12}\text{C}) = 1$ u	$m_u$	$1.660\,538\,782(83) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
$= 10^{-3} \text{ kg mol}^{-1}/N_A$ energy equivalent in MeV	$m_u c^2$	$1.492\,417\,830(74) \times 10^{-10}$ 931.494 028(23)	J MeV	$5.0 \times 10^{-8}$ $2.5 \times 10^{-8}$
Faraday constant <sup>6</sup> $N_A e$	$F$	96 485.3399(24)	C mol <sup>-1</sup>	$2.5 \times 10^{-8}$
molar Planck constant	$N_A h$	$3.990\,312\,6821(57) \times 10^{-10}$	J s mol <sup>-1</sup>	$1.4 \times 10^{-9}$
	$N_A h c$	0.119 626 564 72(17)	J m mol <sup>-1</sup>	$1.4 \times 10^{-9}$
molar gas constant	$R$	8.314 472(15)	J mol <sup>-1</sup> K <sup>-1</sup>	$1.7 \times 10^{-6}$
Boltzmann constant $R/N_A$ in eV K <sup>-1</sup>	$k$	$1.380\,6504(24) \times 10^{-23}$ $8.617\,343(15) \times 10^{-5}$	J K <sup>-1</sup> eV K <sup>-1</sup>	$1.7 \times 10^{-6}$ $1.7 \times 10^{-6}$
	$k/h$	$2.083\,6644(36) \times 10^{10}$	Hz K <sup>-1</sup>	$1.7 \times 10^{-6}$
	$k/hc$	69.503 56(12)	m <sup>-1</sup> K <sup>-1</sup>	$1.7 \times 10^{-6}$
molar volume of ideal gas $RT/p$ $T = 273.15 \text{ K}$ , $p = 101.325 \text{ kPa}$	$V_m$	$22.413\,996(39) \times 10^{-3}$	m <sup>3</sup> mol <sup>-1</sup>	$1.7 \times 10^{-6}$
Loschmidt constant $N_A/V_m$ $T = 273.15 \text{ K}$ , $p = 100 \text{ kPa}$	$n_0$	$2.686\,7774(47) \times 10^{25}$	m <sup>-3</sup>	$1.7 \times 10^{-6}$
	$V_m$	$22.710\,981(40) \times 10^{-3}$	m <sup>3</sup> mol <sup>-1</sup>	$1.7 \times 10^{-6}$
Sackur-Tetrode constant (absolute entropy constant) <sup>7</sup> $\frac{5}{2} + \ln[(2\pi m_u k T_1/h^2)^{3/2} k T_1/p_0]$ $T_1 = 1 \text{ K}$ , $p_0 = 100 \text{ kPa}$ $T_1 = 1 \text{ K}$ , $p_0 = 101.325 \text{ kPa}$	$S_0/R$	-1.151 7047(44) -1.164 8677(44)		$3.8 \times 10^{-6}$ $3.8 \times 10^{-6}$
Stefan-Boltzmann constant $(\pi^2/60)k^4/h^3 c^2$	$\sigma$	$5.670\,400(40) \times 10^{-8}$	W m <sup>-2</sup> K <sup>-4</sup>	$7.0 \times 10^{-6}$
first radiation constant $2\pi h c^2$	$c_1$	$3.741\,771\,18(19) \times 10^{-16}$	W m <sup>2</sup>	$5.0 \times 10^{-8}$
first radiation constant for spectral radiance $2hc^2$	$c_{1L}$	$1.191\,042\,759(59) \times 10^{-16}$	W m <sup>2</sup> sr <sup>-1</sup>	$5.0 \times 10^{-8}$
second radiation constant $hc/k$	$c_2$	$1.438\,7752(25) \times 10^{-2}$	m K	$1.7 \times 10^{-6}$
Wien displacement law constants $b = \lambda_{\max} T = c_2/4.965\,114\,231\dots$ $b' = \nu_{\max}/T = 2.821\,439\,372\dots c/c_2$	$b$ $b'$	$2.897\,7685(51) \times 10^{-3}$ $5.878\,933(10) \times 10^{10}$	m K Hz K <sup>-1</sup>	$1.7 \times 10^{-6}$ $1.7 \times 10^{-6}$

TABLE III: The variances, covariances, and correlation coefficients of the values of a selected group of constants based on the 2006 CODATA adjustment. The numbers in bold above the main diagonal are  $10^{16}$  times the numerical values of the relative covariances; the numbers in bold on the main diagonal are  $10^{16}$  times the numerical values of the relative variances; and the numbers in italics below the main diagonal are the correlation coefficients.<sup>1</sup>

	$\alpha$	$h$	$e$	$m_e$	$N_A$	$m_e/m_\mu$	$F$
$\alpha$	<b>0.0047</b>	0.0002	0.0024	-0.0092	0.0092	-0.0092	0.0116
$h$	<i>0.0005</i>	<b>24.8614</b>	<b>12.4308</b>	<b>24.8611</b>	<b>-24.8610</b>	-0.0003	<b>-12.4302</b>
$e$	<i>0.0142</i>	<i>0.9999</i>	<b>6.2166</b>	<b>12.4259</b>	<b>-12.4259</b>	-0.0048	<b>-6.2093</b>
$m_e$	<i>-0.0269</i>	<i>0.9996</i>	<i>0.9992</i>	<b>24.8795</b>	<b>-24.8794</b>	0.0180	<b>-12.4535</b>
$N_A$	<i>0.0269</i>	<i>-0.9996</i>	<i>-0.9991</i>	<i>-1.0000</i>	<b>24.8811</b>	-0.0180	<b>12.4552</b>
$m_e/m_\mu$	<i>-0.0528</i>	<i>0.0000</i>	<i>-0.0008</i>	<i>0.0014</i>	<i>-0.0014</i>	<b>6.4296</b>	<b>-0.0227</b>
$F$	<i>0.0679</i>	<i>-0.9975</i>	<i>-0.9965</i>	<i>-0.9990</i>	<i>0.9991</i>	<i>-0.0036</i>	<b>6.2459</b>

<sup>1</sup> The relative covariance is  $u_r(x_i, x_j) = u(x_i, x_j)/(x_i x_j)$ , where  $u(x_i, x_j)$  is the covariance of  $x_i$  and  $x_j$ ; the relative variance is  $u_r^2(x_i) = u_r(x_i, x_i)$ ; and the correlation coefficient is  $r(x_i, x_j) = u(x_i, x_j)/[u(x_i)u(x_j)]$ .

<sup>6</sup>The numerical value of  $F$  to be used in coulometric chemical measurements is 96 485.3401(48) [ $5.0 \times 10^{-8}$ ] when the relevant current is measured in terms of representations of the volt and ohm based on the Josephson and quantum Hall effects and the internationally adopted conventional values of the Josephson and von Klitzing constants  $K_{J-90}$  and  $R_{K-90}$  given in Table IV.

<sup>7</sup>The entropy of an ideal monoatomic gas of relative atomic mass  $A_r$  is given by  $S = S_0 + \frac{3}{2} R \ln A_r - R \ln(p/p_0) + \frac{5}{2} R \ln(T/K)$ .

TABLE IV: Internationally adopted values of various quantities.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
relative atomic mass <sup>1</sup> of <sup>12</sup> C	$A_r(^{12}\text{C})$	12		(exact)
molar mass constant	$M_u$	$1 \times 10^{-3}$	kg mol <sup>-1</sup>	(exact)
molar mass of <sup>12</sup> C	$M(^{12}\text{C})$	$12 \times 10^{-3}$	kg mol <sup>-1</sup>	(exact)
conventional value of Josephson constant <sup>2</sup>	$K_{\text{J}-90}$	483 597.9	GHz V <sup>-1</sup>	(exact)
conventional value of von Klitzing constant <sup>3</sup>	$R_{\text{K}-90}$	25 812.807	$\Omega$	(exact)
standard atmosphere		101 325	Pa	(exact)

<sup>1</sup> The relative atomic mass  $A_r(X)$  of particle  $X$  with mass  $m(X)$  is defined by  $A_r(X) = m(X)/m_u$ , where  $m_u = m(^{12}\text{C})/12 = M_u/N_A = 1 \text{ u}$  is the atomic mass constant,  $M_u$  is the molar mass constant,  $N_A$  is the Avogadro constant, and  $\text{u}$  is the unified atomic mass unit. Thus the mass of particle  $X$  is  $m(X) = A_r(X) \text{ u}$  and the molar mass of  $X$  is  $M(X) = A_r(X)M_u$ .

<sup>2</sup> This is the value adopted internationally for realizing representations of the volt using the Josephson effect.

<sup>3</sup> This is the value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

TABLE V: Values of some x-ray-related quantities based on the 2006 CODATA adjustment of the values of the constants.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
Cu x unit: $\lambda(\text{CuK}\alpha_1)/1\,537.400$	$x_u(\text{CuK}\alpha_1)$	$1.002\,076\,99(28) \times 10^{-13}$	m	$2.8 \times 10^{-7}$
Mo x unit: $\lambda(\text{MoK}\alpha_1)/707.831$	$x_u(\text{MoK}\alpha_1)$	$1.002\,099\,55(53) \times 10^{-13}$	m	$5.3 \times 10^{-7}$
ångstrom star: $\lambda(\text{WK}\alpha_1)/0.209\,010\,0$	$\text{\AA}^*$	$1.000\,014\,98(90) \times 10^{-10}$	m	$9.0 \times 10^{-7}$
lattice parameter <sup>1</sup> of Si (in vacuum, 22.5°C)	$a$	$543.102\,064(14) \times 10^{-12}$	m	$2.6 \times 10^{-8}$
{220} lattice spacing of Si $a/\sqrt{8}$ (in vacuum, 22.5°C)	$d_{220}$	$192.015\,5762(50) \times 10^{-12}$	m	$2.6 \times 10^{-8}$
molar volume of Si $M(\text{Si})/\rho(\text{Si}) = N_A a^3/8$ (in vacuum, 22.5°C)	$V_m(\text{Si})$	$12.058\,8349(11) \times 10^{-6}$	m <sup>3</sup> mol <sup>-1</sup>	$9.1 \times 10^{-8}$

<sup>1</sup> This is the lattice parameter (unit cell edge length) of an ideal single crystal of naturally occurring Si free of impurities and imperfections, and is deduced from measurements on extremely pure and nearly perfect single crystals of Si by correcting for the effects of impurities.

TABLE VI: The values in SI units of some non-SI units based on the 2006 CODATA adjustment of the values of the constants.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
Non-SI units accepted for use with the SI				
electron volt: $(e/C) \text{ J}$	eV	$1.602\,176\,487(40) \times 10^{-19}$	J	$2.5 \times 10^{-8}$
(unified) atomic mass unit: $1 \text{ u} = m_u = \frac{1}{12} m(^{12}\text{C}) = 10^{-3} \text{ kg mol}^{-1}/N_A$	u	$1.660\,538\,782(83) \times 10^{-27}$	kg	$5.0 \times 10^{-8}$
Natural units (n.u.)				
n.u. of velocity: speed of light in vacuum	$c, c_0$	299 792 458	m s <sup>-1</sup>	(exact)
n.u. of action: reduced Planck constant $(\hbar/2\pi)$	$\hbar$	$1.054\,571\,628(53) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
in eV s		$6.582\,118\,99(16) \times 10^{-16}$	eV s	$2.5 \times 10^{-8}$
in MeV fm	$\hbar c$	197.326 9631(49)	MeV fm	$2.5 \times 10^{-8}$

TABLE VI: (Continued.)

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_r$
n.u. of mass: electron mass	$m_e$	$9.109\,382\,15(45) \times 10^{-31}$	kg	$5.0 \times 10^{-8}$
n.u. of energy in MeV	$m_e c^2$	$8.187\,104\,38(41) \times 10^{-14}$ $0.510\,998\,910(13)$	J MeV	$5.0 \times 10^{-8}$ $2.5 \times 10^{-8}$
n.u. of momentum in MeV/c	$m_e c$	$2.730\,924\,06(14) \times 10^{-22}$ $0.510\,998\,910(13)$	kg m s <sup>-1</sup> MeV/c	$5.0 \times 10^{-8}$ $2.5 \times 10^{-8}$
n.u. of length ( $\hbar/m_e c$ )	$\lambda_C$	$386.159\,264\,59(53) \times 10^{-15}$	m	$1.4 \times 10^{-9}$
n.u. of time	$\hbar/m_e c^2$	$1.288\,088\,6570(18) \times 10^{-21}$	s	$1.4 \times 10^{-9}$
<b>Atomic units (a.u.)</b>				
a.u. of charge: elementary charge	$e$	$1.602\,176\,487(40) \times 10^{-19}$	C	$2.5 \times 10^{-8}$
a.u. of mass: electron mass	$m_e$	$9.109\,382\,15(45) \times 10^{-31}$	kg	$5.0 \times 10^{-8}$
a.u. of action: reduced Planck constant ( $\hbar/2\pi$ )	$\hbar$	$1.054\,571\,628(53) \times 10^{-34}$	J s	$5.0 \times 10^{-8}$
a.u. of length: Bohr radius (bohr) ( $\alpha/4\pi R_\infty$ )	$a_0$	$0.529\,177\,208\,59(36) \times 10^{-10}$	m	$6.8 \times 10^{-10}$
a.u. of energy: Hartree energy (hartree) ( $e^2/4\pi\epsilon_0 a_0 = 2R_\infty \hbar c = \alpha^2 m_e c^2$ )	$E_h$	$4.359\,743\,94(22) \times 10^{-18}$	J	$5.0 \times 10^{-8}$
a.u. of time	$\hbar/E_h$	$2.418\,884\,326\,505(16) \times 10^{-17}$	s	$6.6 \times 10^{-12}$
a.u. of force	$E_h/a_0$	$8.238\,722\,06(41) \times 10^{-8}$	N	$5.0 \times 10^{-8}$
a.u. of velocity ( $\alpha c$ )	$a_0 E_h/\hbar$	$2.187\,691\,2541(15) \times 10^6$	m s <sup>-1</sup>	$6.8 \times 10^{-10}$
a.u. of momentum	$\hbar/a_0$	$1.992\,851\,565(99) \times 10^{-24}$	kg m s <sup>-1</sup>	$5.0 \times 10^{-8}$
a.u. of current	$e E_h/\hbar$	$6.623\,617\,63(17) \times 10^{-3}$	A	$2.5 \times 10^{-8}$
a.u. of charge density	$e/a_0^3$	$1.081\,202\,300(27) \times 10^{12}$	C m <sup>-3</sup>	$2.5 \times 10^{-8}$
a.u. of electric potential	$E_h/e$	27.211 383 86(68)	V	$2.5 \times 10^{-8}$
a.u. of electric field	$E_h/ea_0$	$5.142\,206\,32(13) \times 10^{11}$	V m <sup>-1</sup>	$2.5 \times 10^{-8}$
a.u. of electric field gradient	$E_h/ea_0^2$	$9.717\,361\,66(24) \times 10^{21}$	V m <sup>-2</sup>	$2.5 \times 10^{-8}$
a.u. of electric dipole moment	$ea_0$	$8.478\,352\,81(21) \times 10^{-30}$	C m	$2.5 \times 10^{-8}$
a.u. of electric quadrupole moment	$ea_0^2$	$4.486\,551\,07(11) \times 10^{-40}$	C m <sup>2</sup>	$2.5 \times 10^{-8}$
a.u. of electric polarizability	$e^2 a_0^2/E_h$	$1.648\,777\,2536(34) \times 10^{-41}$	C <sup>2</sup> m <sup>2</sup> J <sup>-1</sup>	$2.1 \times 10^{-9}$
a.u. of 1 <sup>st</sup> hyperpolarizability	$e^3 a_0^3/E_h^2$	$3.206\,361\,533(81) \times 10^{-53}$	C <sup>3</sup> m <sup>3</sup> J <sup>-2</sup>	$2.5 \times 10^{-8}$
a.u. of 2 <sup>nd</sup> hyperpolarizability	$e^4 a_0^4/E_h^3$	$6.235\,380\,95(31) \times 10^{-65}$	C <sup>4</sup> m <sup>4</sup> J <sup>-3</sup>	$5.0 \times 10^{-8}$
a.u. of magnetic flux density	$\hbar/ea_0^2$	$2.350\,517\,382(59) \times 10^5$	T	$2.5 \times 10^{-8}$
a.u. of magnetic dipole moment ( $2\mu_B$ )	$\hbar e/m_e$	$1.854\,801\,830(46) \times 10^{-23}$	J T <sup>-1</sup>	$2.5 \times 10^{-8}$
a.u. of magnetizability	$e^2 a_0^2/m_e$	$7.891\,036\,433(27) \times 10^{-29}$	J T <sup>-2</sup>	$3.4 \times 10^{-9}$
a.u. of permittivity ( $10^7/c^2$ )	$e^2/a_0 E_h$	$1.112\,650\,056 \dots \times 10^{-10}$	F m <sup>-1</sup>	(exact)

TABLE VII: The values of some energy equivalents derived from the relations  $E = mc^2 = hc/\lambda = h\nu = kT$ , and based on the 2006 CODATA adjustment of the values of the constants;  $1 \text{ eV} = (e/C) \text{ J}$ ,  $1 \text{ u} = m_{\text{u}} = \frac{1}{12}m(^{12}\text{C}) = 10^{-3} \text{ kg mol}^{-1}/N_{\text{A}}$ , and  $E_{\text{h}} = 2R_{\infty}hc = \alpha^2m_{\text{e}}c^2$  is the Hartree energy (hartree).

		Relevant unit			
	J	kg	$\text{m}^{-1}$	Hz	
1 J	(1 J) = 1 J	(1 J)/ $c^2$ = $1.112\,650\,056\dots \times 10^{-17} \text{ kg}$	(1 J)/ $hc$ = $5.034\,117\,47(25) \times 10^{24} \text{ m}^{-1}$	(1 J)/ $h$ = $1.509\,190\,450(75) \times 10^{33} \text{ Hz}$	
1 kg	(1 kg) $c^2$ = $8.987\,551\,787\dots \times 10^{16} \text{ J}$	(1 kg) = 1 kg	(1 kg) $c/h$ = $4.524\,439\,15(23) \times 10^{41} \text{ m}^{-1}$	(1 kg) $c^2/h$ = $1.356\,392\,733(68) \times 10^{50} \text{ Hz}$	
1 $\text{m}^{-1}$	(1 $\text{m}^{-1}$ ) $hc$ = $1.986\,445\,501(99) \times 10^{-25} \text{ J}$	(1 $\text{m}^{-1}$ ) $h/c$ = $2.210\,218\,70(11) \times 10^{-42} \text{ kg}$	(1 $\text{m}^{-1}$ ) = 1 $\text{m}^{-1}$	(1 $\text{m}^{-1}$ ) $c$ = 299 792 458 Hz	
1 Hz	(1 Hz) $h$ = $6.626\,068\,96(33) \times 10^{-34} \text{ J}$	(1 Hz) $h/c^2$ = $7.372\,496\,00(37) \times 10^{-51} \text{ kg}$	(1 Hz) $c$ = $3.335\,640\,951\dots \times 10^{-9} \text{ m}^{-1}$	(1 Hz) = 1 Hz	
1 K	(1 K) $k$ = $1.380\,6504(24) \times 10^{-23} \text{ J}$	(1 K) $k/c^2$ = $1.536\,1807(27) \times 10^{-40} \text{ kg}$	(1 K) $k/hc$ = $69.503\,56(12) \text{ m}^{-1}$	(1 K) $k/h$ = $2.083\,6644(36) \times 10^{10} \text{ Hz}$	
1 eV	(1 eV) = $1.602\,176\,487(40) \times 10^{-19} \text{ J}$	(1 eV) $c^2$ = $1.782\,661\,758(44) \times 10^{-36} \text{ kg}$	(1 eV)/ $hc$ = $8.065\,544\,65(20) \times 10^5 \text{ m}^{-1}$	(1 eV)/ $h$ = $2.417\,989\,454(60) \times 10^{14} \text{ Hz}$	
1 u	(1 u) $c^2$ = $1.492\,417\,830(74) \times 10^{-10} \text{ J}$	(1 u) = $1.660\,538\,782(83) \times 10^{-27} \text{ kg}$	(1 u) $c/h$ = $7.513\,006\,671(11) \times 10^{14} \text{ m}^{-1}$	(1 u) $c^2/h$ = $2.252\,342\,7369(32) \times 10^{23} \text{ Hz}$	
1 $E_{\text{h}}$	(1 $E_{\text{h}}$ ) = $4.359\,743\,94(22) \times 10^{-18} \text{ J}$	(1 $E_{\text{h}}$ ) $c^2$ = $4.850\,869\,34(24) \times 10^{-35} \text{ kg}$	(1 $E_{\text{h}}$ ) $hc$ = $2.194\,746\,313\,705(15) \times 10^7 \text{ m}^{-1}$	(1 $E_{\text{h}}$ ) $h$ = $6.579\,683\,920\,722(44) \times 10^{15} \text{ Hz}$	
		K	eV	u	$E_{\text{h}}$
1 J	(1 J)/ $k$ = $7.242\,963(13) \times 10^{22} \text{ K}$	(1 J) = $6.241\,509\,65(16) \times 10^{18} \text{ eV}$	(1 J) $c^2$ = $6.700\,536\,41(33) \times 10^9 \text{ u}$	(1 J) = $2.293\,712\,69(11) \times 10^{17} E_{\text{h}}$	
1 kg	(1 kg) $c^2/k$ = $6.509\,651(11) \times 10^{39} \text{ K}$	(1 kg) $c^2$ = $5.609\,589\,12(14) \times 10^{35} \text{ eV}$	(1 kg) = $6.022\,141\,79(30) \times 10^{26} \text{ u}$	(1 kg) $c^2$ = $2.061\,486\,16(10) \times 10^{34} E_{\text{h}}$	
1 $\text{m}^{-1}$	(1 $\text{m}^{-1}$ ) $hc/k$ = $1.438\,7752(25) \times 10^{-2} \text{ K}$	(1 $\text{m}^{-1}$ ) $hc$ = $1.239\,841\,875(31) \times 10^{-6} \text{ eV}$	(1 $\text{m}^{-1}$ ) $h/c$ = $1.331\,025\,0394(19) \times 10^{-15} \text{ u}$	(1 $\text{m}^{-1}$ ) $hc$ = $4.556\,335\,252\,760(30) \times 10^{-8} E_{\text{h}}$	
1 Hz	(1 Hz) $h/k$ = $4.799\,2374(84) \times 10^{-11} \text{ K}$	(1 Hz) $h$ = $4.135\,667\,33(10) \times 10^{-15} \text{ eV}$	(1 Hz) $h/c^2$ = $4.439\,821\,6294(64) \times 10^{-24} \text{ u}$	(1 Hz) $h$ = $1.519\,829\,846\,006(10) \times 10^{-16} E_{\text{h}}$	
1 K	(1 K) = 1 K	(1 K) $k$ = $8.617\,343(15) \times 10^{-5} \text{ eV}$	(1 K) $k/c^2$ = $9.251\,098(16) \times 10^{-14} \text{ u}$	(1 K) $k$ = $3.166\,8153(55) \times 10^{-6} E_{\text{h}}$	
1 eV	(1 eV)/ $k$ = $1.160\,4505(20) \times 10^4 \text{ K}$	(1 eV) = 1 eV	(1 eV) $c^2$ = $1.073\,544\,188(27) \times 10^{-9} \text{ u}$	(1 eV) = $3.674\,932\,540(92) \times 10^{-2} E_{\text{h}}$	
1 u	(1 u) $c^2/k$ = $1.080\,9527(19) \times 10^{13} \text{ K}$	(1 u) $c^2$ = $931.494\,028(23) \times 10^6 \text{ eV}$	(1 u) = 1 u	(1 u) $c^2$ = $3.423\,177\,7149(49) \times 10^7 E_{\text{h}}$	
1 $E_{\text{h}}$	(1 $E_{\text{h}}$ ) $k$ = $3.157\,7465(55) \times 10^5 \text{ K}$	(1 $E_{\text{h}}$ ) = $27.211\,383\,86(68) \text{ eV}$	(1 $E_{\text{h}}$ ) $c^2$ = $2.921\,262\,2986(42) \times 10^{-8} \text{ u}$	(1 $E_{\text{h}}$ ) = 1 $E_{\text{h}}$	

## STANDARD ATOMIC WEIGHTS (2007)

This table of atomic weights includes the changes made in 2007 by the IUPAC Commission on Isotopic Abundances and Atomic Weights. Those changes affected the following elements: Lu, Mo, Ni, Yb, and Zn.

The Standard Atomic Weights apply to the elements as they exist naturally on Earth, and the uncertainties take into account the isotopic variation found in most laboratory samples. Further comments on the variability are given in the footnotes.

The number in parentheses following the atomic weight value gives the uncertainty in the last digit. An atomic weight entry in brackets indicates that the element that has no stable isotopes; the

value given is the atomic mass in u (or the mass number, if the mass is not accurately known) for the isotope of longest half-life. Thorium, protactinium, and uranium have no stable isotopes, but the terrestrial isotopic composition is sufficiently uniform to permit a standard atomic weight to be specified.

### References

1. Weiser, M. E., "Atomic weights of the elements 2005," *Pure Appl. Chem.* 78, 2051, 2006; *J. Phys. Chem. Ref. Data* 36, 485, 2007.
2. *Chemistry International*, Vol. 29, No. 6, p. 18, 2007.

Name	Symbol	Atomic no.	Atomic weight	Footnotes	Name	Symbol	Atomic no.	Atomic weight	Footnotes
Actinium	Ac	89	[227.0277]	a	Iodine	I	53	126.90447(3)	
Aluminum	Al	13	26.9815386(8)		Iridium	Ir	77	192.227(3)	
Americium	Am	95	[243.0614]	a	Iron	Fe	26	55.845(2)	
Antimony	Sb	51	121.760(1)	g	Krypton	Kr	36	83.798(2)	g m
Argon	Ar	18	39.948(1)	g r	Lanthanum	La	57	138.90547(7)	g
Arsenic	As	33	74.92160(2)		Lawrencium	Lr	103	[262.1097]	a
Astatine	At	85	[209.9871]	a	Lead	Pb	82	207.2(1)	g r
Barium	Ba	56	137.327(7)		Lithium	Li	3	6.941(2)	b g m r
Berkelium	Bk	97	[247.0703]	a	Lutetium	Lu	71	174.9668(1)	g
Beryllium	Be	4	9.012182(3)		Magnesium	Mg	12	24.3050(6)	
Bismuth	Bi	83	208.98040(1)		Manganese	Mn	25	54.938045(5)	
Bohrium	Bh	107	[264.12]	a	Meitnerium	Mt	109	[268.1388]	a
Boron	B	5	10.811(7)	g m r	Mendelevium	Md	101	[258.0984]	a
Bromine	Br	35	79.904(1)		Mercury	Hg	80	200.59(2)	
Cadmium	Cd	48	112.411(8)	g	Molybdenum	Mo	42	95.96(2)	g
Calcium	Ca	20	40.078(4)	g	Neodymium	Nd	60	144.242(3)	g
Californium	Cf	98	[251.0796]	a	Neon	Ne	10	20.1797(6)	g m
Carbon	C	6	12.0107(8)	g r	Neptunium	Np	93	[237.0482]	a
Cerium	Ce	58	140.116(1)	g	Nickel	Ni	28	58.6934(4)	
Cesium	Cs	55	132.9054519(2)		Niobium	Nb	41	92.90638(2)	
Chlorine	Cl	17	35.453(2)	g m r	Nitrogen	N	7	14.0067(2)	g r
Chromium	Cr	24	51.9961(6)		Nobelium	No	102	[259.1010]	a
Cobalt	Co	27	58.933195(5)		Osmium	Os	76	190.23(3)	g
Copper	Cu	29	63.546(3)	r	Oxygen	O	8	15.9994(3)	g r
Curium	Cm	96	[247.0704]	a	Palladium	Pd	46	106.42(1)	g
Darmstadtium	Ds	110	[271]	a	Phosphorus	P	15	30.973762(2)	
Dubnium	Db	105	[262.1141]	a	Platinum	Pt	78	195.084(9)	
Dysprosium	Dy	66	162.500(1)	g	Plutonium	Pu	94	[244.0642]	a
Einsteinium	Es	99	[252.0830]	a	Polonium	Po	84	[208.9824]	a
Erbium	Er	68	167.259(3)	g	Potassium	K	19	39.0983(1)	g
Europium	Eu	63	151.964(1)	g	Praseodymium	Pr	59	140.90765(2)	
Fermium	Fm	100	[257.0951]	a	Promethium	Pm	61	[144.9127]	a
Fluorine	F	9	18.9984032(5)		Protactinium	Pa	91	231.03588(2)	
Francium	Fr	87	[223.0197]	a	Radium	Ra	88	[226.0254]	a
Gadolinium	Gd	64	157.25(3)	g	Radon	Rn	86	[222.0176]	a
Gallium	Ga	31	69.723(1)		Rhenium	Re	75	186.207(1)	
Germanium	Ge	32	72.64(1)		Rhodium	Rh	45	102.90550(2)	
Gold	Au	79	196.966569(4)		Roentgenium	Rg	111	[272.1535]	a
Hafnium	Hf	72	178.49(2)		Rubidium	Rb	37	85.4678(3)	g
Hassium	Hs	108	[277]	a	Ruthenium	Ru	44	101.07(2)	g
Helium	He	2	4.002602(2)	g r	Rutherfordium	Rf	104	[261.1088]	a
Holmium	Ho	67	164.93032(2)		Samarium	Sm	62	150.36(2)	g
Hydrogen	H	1	1.00794(7)	g m r	Scandium	Sc	21	44.955912(6)	
Indium	In	49	114.818(3)		Seaborgium	Sg	106	[266.1219]	a



Name	Symbol	Atomic no.	Atomic weight	Footnotes	Name	Symbol	Atomic no.	Atomic weight	Footnotes
Selenium	Se	34	78.96(3)	r	Tin	Sn	50	118.710(7)	g
Silicon	Si	14	28.0855(3)	r	Titanium	Ti	22	47.867(1)	
Silver	Ag	47	107.8682(2)	g	Tungsten	W	74	183.84(1)	
Sodium	Na	11	22.98976928(2)		Ununbium	Uub	112	[285]	a
Strontium	Sr	38	87.62(1)	g r	Ununhexium	Uuh	116	[289]	a
Sulfur	S	16	32.065(5)	g r	Ununquadium	Uuq	114	[289]	a
Tantalum	Ta	73	180.94788(2)		Uranium	U	92	238.02891(3)	g m
Technetium	Tc	43	[97.9072]	a	Vanadium	V	23	50.9415(1)	
Tellurium	Te	52	127.60(3)	g	Xenon	Xe	54	131.293(6)	g m
Terbium	Tb	65	158.92535(2)		Ytterbium	Yb	70	173.054(5)	g
Thallium	Tl	81	204.3833(2)		Yttrium	Y	39	88.90585(2)	
Thorium	Th	90	232.03806(2)	g	Zinc	Zn	30	65.38(2)	
Thulium	Tm	69	168.93421(2)		Zirconium	Zr	40	91.224(2)	g

<sup>a</sup> No stable isotope exists. The atomic mass in u (or the mass number, if the mass is not accurately known) is given in brackets for the isotope of longest half-life.

<sup>b</sup> Commercially available Li materials have atomic weights that range between 6.939 and 6.996; if a more accurate value is required, it must be determined for the specific material.

<sup>c</sup> Geological specimens are known in which the element has an isotopic composition outside the limits for the normal material. The difference between the atomic weight of the element in such specimens and that given in the table may exceed the stated uncertainty.

<sup>m</sup> Modified isotopic compositions may be found in commercially available material because it has been subject to an undisclosed or inadvertent isotopic fractionation. Substantial deviations in atomic weight of the element from that given in the table can occur.

<sup>r</sup> Range in isotopic composition of normal terrestrial material prevents a more precise atomic weight being given; the tabulated value should be applicable to any normal material.

## ATOMIC MASSES AND ABUNDANCES

This table lists the mass (in atomic mass units, symbol u) and the natural abundance (in percent) of the stable nuclides and a few important radioactive nuclides. A complete table of all nuclides may be found in Section 11 ("Table of the Isotopes").

The atomic masses were taken from the 2003 evaluation of Audi, Wapstra, and Thibault (References 2, 3). The number in parentheses following the mass value is the uncertainty in the last digit(s) given. An asterisk \* after an entry indicates the mass value was derived not purely from experimental data, but at least partly from systematic trends.

Natural abundance values were taken from the IUPAC Technical Report "Atomic Weight of the Elements: Review 2000" (Reference 4); these entries are also followed by uncertainties in the last digit(s) of the stated values. This uncertainty includes both the estimated measurement uncertainty and the reported range of variation in different terrestrial sources of the element (see Reference 4 for full

details and caveats regarding elements whose abundance is variable). The absence of an entry in the Abundance column indicates a radioactive nuclide not present in nature or an element whose isotopic composition varies so widely that a meaningful natural abundance cannot be defined.

### References

1. Holden, N. E., "Table of the Isotopes", in Lide, D. R., Ed., *CRC Handbook of Chemistry and Physics, 86th Ed.*, CRC Press, Boca Raton FL, 2005.
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3. Audi, G., and Wapstra, A. H., Atomic Mass Data Center, World Wide Web site, <<http://www.nndc.bnl.gov/amdc/index.html>>
4. de Laeter, J. R., Böhlke, J. K., De Bièvre, P., Hidaka, H., Peiser, H. S., Rosman, K. J. R., and Taylor, P. D. P., *Pure Appl. Chem.* 75, 683, 2003.

Z	Isotope	Mass in u	Abundance in %
1	<sup>1</sup> H	1.00782503207(10)	99.9885(70)
	<sup>2</sup> H	2.0141017778(4)	0.0115(70)
	<sup>3</sup> H	3.0160492777(25)	
2	<sup>3</sup> He	3.0160293191(26)	0.000134(3)
	<sup>4</sup> He	4.00260325415(6)	99.999866(3)
3	<sup>6</sup> Li	6.015122795(16)	7.59(4)
	<sup>7</sup> Li	7.01600455(8)	92.41(4)
4	<sup>9</sup> Be	9.0121822(4)	100
5	<sup>10</sup> B	10.0129370(4)	19.9(7)
	<sup>11</sup> B	11.0093054(4)	80.1(7)
6	<sup>11</sup> C	11.0114336(10)	
	<sup>12</sup> C	12.0000000(0)	98.93(8)
	<sup>13</sup> C	13.0033548378(10)	1.07(8)
	<sup>14</sup> C	14.003241989(4)	
7	<sup>14</sup> N	14.0030740048(6)	99.636(7)
	<sup>15</sup> N	15.0001088982(7)	0.364(7)
8	<sup>16</sup> O	15.99491461956(16)	99.757(16)
	<sup>17</sup> O	16.99913170(12)	0.038(1)
	<sup>18</sup> O	17.9991610(7)	0.205(14)
9	<sup>18</sup> F	18.0009380(6)	
	<sup>19</sup> F	18.99840322(7)	100
10	<sup>20</sup> Ne	19.9924401754(19)	90.48(3)
	<sup>21</sup> Ne	20.99384668(4)	0.27(1)
	<sup>22</sup> Ne	21.991385114(19)	9.25(3)
11	<sup>22</sup> Na	21.9944364(4)	
	<sup>23</sup> Na	22.9897692809(29)	100
	<sup>24</sup> Na	23.99096278(8)	
12	<sup>24</sup> Mg	23.985041700(14)	78.99(4)
	<sup>25</sup> Mg	24.98583692(3)	10.00(1)
	<sup>26</sup> Mg	25.982592929(30)	11.01(3)
13	<sup>27</sup> Al	26.98153863(12)	100
14	<sup>28</sup> Si	27.9769265325(19)	92.223(19)
	<sup>29</sup> Si	28.976494700(22)	4.685(8)
	<sup>30</sup> Si	29.97377017(3)	3.092(11)
15	<sup>31</sup> P	30.97376163(20)	100
	<sup>32</sup> P	31.97390727(20)	
16	<sup>32</sup> S	31.97207100(15)	94.99(26)
	<sup>33</sup> S	32.97145876(15)	0.75(2)
	<sup>34</sup> S	33.96786690(12)	4.25(24)
	<sup>35</sup> S	34.96903216(11)	
	<sup>36</sup> S	35.96708076(20)	0.01(1)

Z	Isotope	Mass in u	Abundance in %
17	<sup>35</sup> Cl	34.96885268(4)	75.76(10)
	<sup>37</sup> Cl	36.96590259(5)	24.24(10)
18	<sup>36</sup> Ar	35.967545106(29)	0.3365(30)
	<sup>38</sup> Ar	37.9627324(4)	0.0632(5)
	<sup>40</sup> Ar	39.9623831225(29)	99.6003(30)
19	<sup>39</sup> K	38.96370668(20)	93.2581(44)
	<sup>40</sup> K	39.96399848(21)	0.0117(1)
	<sup>41</sup> K	40.96182576(21)	6.7302(44)
	<sup>42</sup> K	41.96240281(24)	
	<sup>43</sup> K	42.960716(10)	
20	<sup>40</sup> Ca	39.96259098(22)	96.941(156)
	<sup>42</sup> Ca	41.95861801(27)	0.647(23)
	<sup>43</sup> Ca	42.9587666(3)	0.135(10)
	<sup>44</sup> Ca	43.9554818(4)	2.086(110)
	<sup>45</sup> Ca	44.9561866(4)	
	<sup>46</sup> Ca	45.9536926(24)	0.004(3)
	<sup>47</sup> Ca	46.9545460(24)	
	<sup>48</sup> Ca	47.952534(4)	0.187(21)
21	<sup>45</sup> Sc	44.9559119(9)	100
22	<sup>46</sup> Ti	45.9526316(9)	8.25(3)
	<sup>47</sup> Ti	46.9517631(9)	7.44(2)
	<sup>48</sup> Ti	47.9479463(9)	73.72(3)
	<sup>49</sup> Ti	48.9478700(9)	5.41(2)
	<sup>50</sup> Ti	49.9447912(9)	5.18(2)
23	<sup>50</sup> V	49.9471585(11)	0.250(4)
	<sup>51</sup> V	50.9439595(11)	99.750(4)
24	<sup>50</sup> Cr	49.9460442(11)	4.345(13)
	<sup>51</sup> Cr	50.9447674(11)	
	<sup>52</sup> Cr	51.9405075(8)	83.789(18)
	<sup>53</sup> Cr	52.9406494(8)	9.501(17)
	<sup>54</sup> Cr	53.9388804(8)	2.365(7)
25	<sup>54</sup> Mn	53.9403589(14)	
	<sup>55</sup> Mn	54.9380451(7)	100
26	<sup>52</sup> Fe	51.948114(7)	
	<sup>54</sup> Fe	53.9396105(7)	5.845(35)
	<sup>55</sup> Fe	54.9382934(7)	
	<sup>56</sup> Fe	55.9349375(7)	91.754(36)
	<sup>57</sup> Fe	56.9353940(7)	2.119(10)
	<sup>58</sup> Fe	57.9332756(8)	0.282(4)
	<sup>59</sup> Fe	58.9348755(8)	
27	<sup>57</sup> Co	56.9362914(8)	

Z	Isotope	Mass in u	Abundance in %	Z	Isotope	Mass in u	Abundance in %
	<sup>58</sup> Co	57.9357528(13)			<sup>96</sup> Zr	95.9082734(30)	2.80(9)
	<sup>59</sup> Co	58.9331950(7)	100	41	<sup>93</sup> Nb	92.9063781(26)	100
	<sup>60</sup> Co	59.9338171(7)		42	<sup>92</sup> Mo	91.906811(4)	14.77(31)
28	<sup>58</sup> Ni	57.9353429(7)	68.0769(89)		<sup>94</sup> Mo	93.9050883(21)	9.23(10)
	<sup>59</sup> Ni	58.9343467(7)			<sup>95</sup> Mo	94.9058421(21)	15.90(9)
	<sup>60</sup> Ni	59.9307864(7)	26.2231(77)		<sup>96</sup> Mo	95.9046795(21)	16.68(1)
	<sup>61</sup> Ni	60.9310560(7)	1.1399(6)		<sup>97</sup> Mo	96.9060215(21)	9.56(5)
	<sup>62</sup> Ni	61.9283451(6)	3.6345(17)		<sup>98</sup> Mo	97.9054082(21)	24.19(26)
	<sup>63</sup> Ni	62.9296694(6)			<sup>99</sup> Mo	98.9077119(21)	
	<sup>64</sup> Ni	63.9279660(7)	0.9256(9)		<sup>100</sup> Mo	99.907477(6)	9.67(20)
29	<sup>63</sup> Cu	62.9295975(6)	69.15(3)	43	<sup>97</sup> Tc	96.906365(5)	
	<sup>64</sup> Cu	63.9297642(6)			<sup>98</sup> Tc	97.907216(4)	
	<sup>65</sup> Cu	64.9277895(7)	30.85(3)		<sup>99</sup> Tc	98.9062547(21)	
30	<sup>64</sup> Zn	63.9291422(7)	48.268(321)	44	<sup>96</sup> Ru	95.907598(8)	5.54(14)
	<sup>65</sup> Zn	64.9292410(7)			<sup>98</sup> Ru	97.905287(7)	1.87(3)
	<sup>66</sup> Zn	65.9260334(10)	27.975(77)		<sup>99</sup> Ru	98.9059393(22)	12.76(14)
	<sup>67</sup> Zn	66.9271273(10)	4.102(21)		<sup>100</sup> Ru	99.9042195(22)	12.60(7)
	<sup>68</sup> Zn	67.9248442(10)	19.024(123)		<sup>101</sup> Ru	100.9055821(22)	17.06(2)
	<sup>70</sup> Zn	69.9253193(21)	0.631(9)		<sup>102</sup> Ru	101.9043493(22)	31.55(14)
31	<sup>67</sup> Ga	66.9282017(14)			<sup>104</sup> Ru	103.905433(3)	18.62(27)
	<sup>68</sup> Ga	67.9279801(16)			<sup>106</sup> Ru	105.907329(8)	
	<sup>69</sup> Ga	68.9255736(13)	60.108(9)	45	<sup>103</sup> Rh	102.905504(3)	100
	<sup>71</sup> Ga	70.9247013(11)	39.892(9)	46	<sup>102</sup> Pd	101.905609(3)	1.02(1)
32	<sup>68</sup> Ge	67.928094(7)			<sup>104</sup> Pd	103.904036(4)	11.14(8)
	<sup>70</sup> Ge	69.9242474(11)	20.38(18)		<sup>105</sup> Pd	104.905085(4)	22.33(8)
	<sup>72</sup> Ge	71.9220758(18)	27.31(26)		<sup>106</sup> Pd	105.903486(4)	27.33(3)
	<sup>73</sup> Ge	72.9234589(18)	7.76(8)		<sup>108</sup> Pd	107.903892(4)	26.46(9)
	<sup>74</sup> Ge	73.9211778(18)	36.72(15)		<sup>110</sup> Pd	109.905153(12)	11.72(9)
	<sup>76</sup> Ge	75.9214026(18)	7.83(7)	47	<sup>107</sup> Ag	106.905097(5)	51.839(8)
33	<sup>75</sup> As	74.9215965(20)	100		<sup>109</sup> Ag	108.904752(3)	48.161(8)
34	<sup>74</sup> Se	73.9224764(18)	0.89(4)	48	<sup>106</sup> Cd	105.906459(6)	1.25(6)
	<sup>75</sup> Se	74.9225234(18)			<sup>108</sup> Cd	107.904184(6)	0.89(3)
	<sup>76</sup> Se	75.9192136(18)	9.37(29)		<sup>110</sup> Cd	109.9030021(29)	12.49(18)
	<sup>77</sup> Se	76.9199140(18)	7.63(16)		<sup>111</sup> Cd	110.9041781(29)	12.80(12)
	<sup>78</sup> Se	77.9173091(18)	23.77(28)		<sup>112</sup> Cd	111.9027578(29)	24.13(21)
	<sup>79</sup> Se	78.9184991(18)			<sup>113</sup> Cd	112.9044017(29)	12.22(12)
	<sup>80</sup> Se	79.9165213(21)	49.61(41)		<sup>114</sup> Cd	113.9033585(29)	28.73(42)
	<sup>82</sup> Se	81.9166994(22)	8.73(22)		<sup>116</sup> Cd	115.904756(3)	7.49(18)
35	<sup>79</sup> Br	78.9183371(22)	50.69(7)	49	<sup>111</sup> In	110.905103(5)	
	<sup>81</sup> Br	80.9162906(21)	49.31(7)		<sup>113</sup> In	112.904058(3)	4.29(5)
36	<sup>78</sup> Kr	77.9203648(12)	0.355(3)		<sup>115</sup> In	114.903878(5)	95.71(5)
	<sup>80</sup> Kr	79.9163790(16)	2.286(10)	50	<sup>112</sup> Sn	111.904818(5)	0.97(1)
	<sup>82</sup> Kr	81.9134836(19)	11.593(31)		<sup>113</sup> Sn	112.905171(4)	
	<sup>83</sup> Kr	82.914136(3)	11.500(19)		<sup>114</sup> Sn	113.902779(3)	0.66(1)
	<sup>84</sup> Kr	83.911507(3)	56.987(15)		<sup>115</sup> Sn	114.903342(3)	0.34(1)
	<sup>86</sup> Kr	85.91061073(11)	17.279(41)		<sup>116</sup> Sn	115.901741(3)	14.54(9)
37	<sup>85</sup> Rb	84.911789738(12)	72.17(2)		<sup>117</sup> Sn	116.902952(3)	7.68(7)
	<sup>86</sup> Rb	85.91116742(21)			<sup>118</sup> Sn	117.901603(3)	24.22(9)
	<sup>87</sup> Rb	86.909180527(13)	27.83(2)		<sup>119</sup> Sn	118.903308(3)	8.59(4)
38	<sup>84</sup> Sr	83.913425(3)	0.56(1)		<sup>120</sup> Sn	119.9021947(27)	32.58(9)
	<sup>85</sup> Sr	84.912933(3)			<sup>122</sup> Sn	121.9034390(29)	4.63(3)
	<sup>86</sup> Sr	85.9092602(12)	9.86(1)		<sup>124</sup> Sn	123.9052739(15)	5.79(5)
	<sup>87</sup> Sr	86.9088771(12)	7.00(1)	51	<sup>121</sup> Sb	120.9038157(24)	57.21(5)
	<sup>88</sup> Sr	87.9056121(12)	82.58(1)		<sup>123</sup> Sb	122.9042140(22)	42.79(5)
	<sup>89</sup> Sr	88.9074507(12)		52	<sup>120</sup> Te	119.904020(10)	0.09(1)
	<sup>90</sup> Sr	89.907738(3)			<sup>122</sup> Te	121.9030439(16)	2.55(12)
39	<sup>89</sup> Y	88.9058483(27)	100		<sup>123</sup> Te	122.9042700(16)	0.89(3)
40	<sup>90</sup> Zr	89.9047044(25)	51.45(40)		<sup>124</sup> Te	123.9028179(16)	4.74(14)
	<sup>91</sup> Zr	90.9056458(25)	11.22(5)		<sup>125</sup> Te	124.9044307(16)	7.07(15)
	<sup>92</sup> Zr	91.9050408(25)	17.15(8)		<sup>126</sup> Te	125.9033117(16)	18.84(25)
	<sup>94</sup> Zr	93.9063152(26)	17.38(28)		<sup>128</sup> Te	127.9044631(19)	31.74(8)

Z	Isotope	Mass in u	Abundance in %	Z	Isotope	Mass in u	Abundance in %	
53	<sup>130</sup> Te	129.9062244(21)	34.08(62)	65	<sup>158</sup> Gd	157.9241039(27)	24.84(7)	
	<sup>123</sup> I	122.905589(4)			<sup>160</sup> Gd	159.9270541(27)	21.86(19)	
	<sup>125</sup> I	124.9046302(16)			<sup>159</sup> Tb	158.9253468(27)	100	
	<sup>127</sup> I	126.904473(4)	100		<sup>156</sup> Dy	155.924283(7)	0.056(3)	
	<sup>129</sup> I	128.904988(3)			<sup>158</sup> Dy	157.924409(4)	0.095(3)	
54	<sup>131</sup> I	130.9061246(12)			<sup>160</sup> Dy	159.9251975(27)	2.329(18)	
	<sup>124</sup> Xe	123.9058930(20)	0.0952(3)		<sup>161</sup> Dy	160.9269334(27)	18.889(42)	
	<sup>126</sup> Xe	125.904274(7)	0.0890(2)		<sup>162</sup> Dy	161.9267984(27)	25.475(36)	
	<sup>128</sup> Xe	127.9035313(15)	1.9102(8)		<sup>163</sup> Dy	162.9287312(27)	24.896(42)	
	<sup>129</sup> Xe	128.9047794(8)	26.4006(82)		<sup>164</sup> Dy	163.9291748(27)	28.260(54)	
	<sup>130</sup> Xe	129.9035080(8)	4.0710(13)		67	<sup>165</sup> Ho	164.9303221(27)	100
	<sup>131</sup> Xe	130.9050824(10)	21.2324(30)			<sup>162</sup> Er	161.928778(4)	0.139(5)
	<sup>132</sup> Xe	131.9041535(10)	26.9086(33)			<sup>164</sup> Er	163.929200(3)	1.601(3)
<sup>134</sup> Xe	133.9053945(9)	10.4357(21)	<sup>166</sup> Er			165.9302931(27)	33.503(36)	
<sup>136</sup> Xe	135.907219(8)	8.8573(44)	<sup>167</sup> Er			166.9320482(27)	22.869(9)	
55	<sup>129</sup> Cs	128.906064(5)		<sup>168</sup> Er		167.9323702(27)	26.978(18)	
	<sup>133</sup> Cs	132.905451933(24)	100	<sup>170</sup> Er		169.9354643(30)	14.910(36)	
	<sup>134</sup> Cs	133.906718475(28)		69		<sup>169</sup> Tm	168.9342133(27)	100
	<sup>136</sup> Cs	135.9073116(20)				<sup>168</sup> Yb	167.933897(5)	0.13(1)
	56	<sup>137</sup> Cs	136.9070895(5)			<sup>169</sup> Yb	168.935190(5)	
<sup>130</sup> Ba		129.9063208(30)	0.106(1)	<sup>170</sup> Yb	169.9347618(26)	3.04(15)		
<sup>132</sup> Ba		131.9050613(11)	0.101(1)	<sup>171</sup> Yb	170.9363258(26)	14.28(57)		
<sup>133</sup> Ba		132.9060075(11)		<sup>172</sup> Yb	171.9363815(26)	21.83(67)		
<sup>134</sup> Ba		133.9045084(4)	2.417(18)	<sup>173</sup> Yb	172.9382108(26)	16.13(27)		
<sup>135</sup> Ba		134.9056886(4)	6.592(12)	<sup>174</sup> Yb	173.9388621(26)	31.83(92)		
<sup>136</sup> Ba		135.9045759(4)	7.854(24)	<sup>176</sup> Yb	175.9425717(28)	12.76(41)		
<sup>137</sup> Ba		136.9058274(5)	11.232(24)	71	<sup>175</sup> Lu	174.9407718(23)	97.41(2)	
<sup>138</sup> Ba		137.9052472(5)	71.698(42)		<sup>176</sup> Lu	175.9426863(23)	2.59(2)	
57		<sup>140</sup> Ba	139.910605(9)		72	<sup>174</sup> Hf	173.940046(3)	0.16(1)
	<sup>138</sup> La	137.907112(4)	0.090(1)	<sup>176</sup> Hf		175.9414086(24)	5.26(7)	
	<sup>139</sup> La	138.9063533(26)	99.910(1)	<sup>177</sup> Hf	176.9432207(23)	18.60(9)		
58	<sup>136</sup> Ce	135.907172(14)	0.185(2)	<sup>178</sup> Hf	177.9436988(23)	27.28(7)		
	<sup>138</sup> Ce	137.905991(11)	0.251(2)	<sup>179</sup> Hf	178.9458161(23)	13.62(2)		
	<sup>140</sup> Ce	139.9054387(26)	88.450(51)	<sup>180</sup> Hf	179.9465500(23)	35.08(16)		
	<sup>141</sup> Ce	140.9082763(26)		73	<sup>180</sup> Ta	179.9474648(24)	0.012(2)	
	<sup>142</sup> Ce	141.909244(3)	11.114(51)		<sup>181</sup> Ta	180.9479958(19)	99.988(2)	
	<sup>144</sup> Ce	143.913647(4)		74	<sup>180</sup> W	179.946704(4)	0.12(1)	
59	<sup>141</sup> Pr	140.9076528(26)	100		<sup>182</sup> W	181.9482042(9)	26.50(16)	
	<sup>142</sup> Nd	141.9077233(25)	27.2(5)		<sup>183</sup> W	182.9502230(9)	14.31(4)	
60	<sup>143</sup> Nd	142.9098143(25)	12.2(2)		<sup>184</sup> W	183.9509312(9)	30.64(2)	
	<sup>144</sup> Nd	143.9100873(25)	23.8(3)		<sup>186</sup> W	185.9543641(19)	28.43(19)	
	<sup>145</sup> Nd	144.9125736(25)	8.3(1)		75	<sup>185</sup> Re	184.9529550(13)	37.40(2)
	<sup>146</sup> Nd	145.9131169(25)	17.2(3)			<sup>187</sup> Re	186.9557531(15)	62.60(2)
	<sup>148</sup> Nd	147.916893(3)	5.7(1)		76	<sup>184</sup> Os	183.9524891(14)	0.02(1)
	<sup>150</sup> Nd	149.920891(3)	5.6(2)			<sup>186</sup> Os	185.9538382(15)	1.59(3)
	61	<sup>145</sup> Pm	144.912749(3)				<sup>187</sup> Os	186.9557505(15)
		<sup>147</sup> Pm	146.9151385(26)			<sup>188</sup> Os	187.9558382(15)	13.24(8)
62	<sup>144</sup> Sm	143.911999(3)	3.07(7)	<sup>189</sup> Os		188.9581475(16)	16.15(5)	
	<sup>147</sup> Sm	146.9148979(26)	14.99(18)	<sup>190</sup> Os		189.9584470(16)	26.26(2)	
	<sup>148</sup> Sm	147.9148227(26)	11.24(10)	<sup>192</sup> Os		191.9614807(27)	40.78(19)	
	<sup>149</sup> Sm	148.9171847(26)	13.82(7)	77		<sup>191</sup> Ir	190.9605940(18)	37.3(2)
	<sup>150</sup> Sm	149.9172755(26)	7.38(1)			<sup>193</sup> Ir	192.9629264(18)	62.7(2)
	<sup>152</sup> Sm	151.9197324(27)	26.75(16)	78		<sup>190</sup> Pt	189.959932(6)	0.014(1)
	<sup>154</sup> Sm	153.9222093(27)	22.75(29)		<sup>192</sup> Pt	191.9610380(27)	0.782(7)	
	63	<sup>151</sup> Eu	150.9198502(26)	47.81(6)	<sup>194</sup> Pt	193.9626803(9)	32.967(99)	
<sup>153</sup> Eu		152.9212303(26)	52.19(6)	<sup>195</sup> Pt	194.9647911(9)	33.832(10)		
64	<sup>152</sup> Gd	151.9197910(27)	0.20(1)	<sup>196</sup> Pt	195.9649515(9)	25.242(41)		
	<sup>154</sup> Gd	153.9208656(27)	2.18(3)	<sup>198</sup> Pt	197.967893(3)	7.163(55)		
	<sup>155</sup> Gd	154.9226220(27)	14.80(12)	79	<sup>197</sup> Au	196.9665687(6)	100	
	<sup>156</sup> Gd	155.9221227(27)	20.47(9)		<sup>198</sup> Au	197.9682423(6)		
	<sup>157</sup> Gd	156.9239601(27)	15.65(2)	80	<sup>196</sup> Hg	195.965833(3)	0.15(1)	

Z	Isotope	Mass in u	Abundance in %	Z	Isotope	Mass in u	Abundance in %
	<sup>197</sup> Hg	196.967213(3)			<sup>236</sup> U	236.0455680(20)	
	<sup>198</sup> Hg	197.9667690(4)	9.97(20)		<sup>238</sup> U	238.0507882(20)	99.2742(10)
	<sup>199</sup> Hg	198.9682799(4)	16.87(22)	93	<sup>237</sup> Np	237.0481734(20)	
	<sup>200</sup> Hg	199.9683260(4)	23.10(19)		<sup>239</sup> Np	239.0529390(22)	
	<sup>201</sup> Hg	200.9703023(6)	13.18(9)	94	<sup>238</sup> Pu	238.0495599(20)	
	<sup>202</sup> Hg	201.9706430(6)	29.86(26)		<sup>239</sup> Pu	239.0521634(20)	
	<sup>203</sup> Hg	202.9728725(18)			<sup>240</sup> Pu	240.0538135(20)	
	<sup>204</sup> Hg	203.9734939(4)	6.87(15)		<sup>241</sup> Pu	241.0568515(20)	
81	<sup>201</sup> Tl	200.970819(16)			<sup>242</sup> Pu	242.0587426(20)	
	<sup>203</sup> Tl	202.9723442(14)	29.52(1)		<sup>244</sup> Pu	244.064204(5)	
	<sup>205</sup> Tl	204.9744275(14)	70.48(1)	95	<sup>241</sup> Am	241.0568291(20)	
82	<sup>204</sup> Pb	203.9730436(13)	1.4(1)		<sup>243</sup> Am	243.0613811(25)	
	<sup>206</sup> Pb	205.9744653(13)	24.1(1)	96	<sup>243</sup> Cm	243.0613891(22)	
	<sup>207</sup> Pb	206.9758969(13)	22.1(1)		<sup>244</sup> Cm	244.0627526(20)	
	<sup>208</sup> Pb	207.9766521(13)	52.4(1)		<sup>245</sup> Cm	245.0654912(22)	
	<sup>210</sup> Pb	209.9841885(16)			<sup>246</sup> Cm	246.0672237(22)	
83	<sup>207</sup> Bi	206.9784707(26)			<sup>247</sup> Cm	247.070354(5)	
	<sup>209</sup> Bi	208.9803987(16)	100		<sup>248</sup> Cm	248.072349(5)	
84	<sup>209</sup> Po	208.9824304(20)		97	<sup>247</sup> Bk	247.070307(6)	
	<sup>210</sup> Po	209.9828737(13)			<sup>249</sup> Bk	249.0749867(28)	
85	<sup>210</sup> At	209.987148(8)		98	<sup>249</sup> Cf	249.0748535(24)	
	<sup>211</sup> At	210.9874963(30)			<sup>250</sup> Cf	250.0764061(22)	
86	<sup>211</sup> Rn	210.990601(7)			<sup>251</sup> Cf	251.079587(5)	
	<sup>220</sup> Rn	220.0113940(24)			<sup>252</sup> Cf	252.081626(5)	
	<sup>222</sup> Rn	222.0175777(25)		99	<sup>252</sup> Es	252.082980(50)	
87	<sup>223</sup> Fr	223.0197359(26)		100	<sup>257</sup> Fm	257.095105(7)	
88	<sup>223</sup> Ra	223.0185022(27)		101	<sup>256</sup> Md	256.094060(60)	
	<sup>224</sup> Ra	224.0202118(24)			<sup>258</sup> Md	258.098431(5)	
	<sup>226</sup> Ra	226.0254098(25)		102	<sup>259</sup> No	259.10103(11)*	
	<sup>228</sup> Ra	228.0310703(26)		103	<sup>262</sup> Lr	262.10963(22)*	
89	<sup>227</sup> Ac	227.0277521(26)		104	<sup>261</sup> Rf	261.108770(30)*	
90	<sup>228</sup> Th	228.0287411(24)		105	<sup>262</sup> Db	262.11408(20)*	
	<sup>230</sup> Th	230.0331338(19)		106	<sup>263</sup> Sg	263.11832(13)*	
	<sup>232</sup> Th	232.0380553(21)	100	107	<sup>264</sup> Bh	264.12460(30)*	
91	<sup>231</sup> Pa	231.0358840(24)	100	108	<sup>265</sup> Hs	265.13009(15)*	
92	<sup>233</sup> U	233.0396352(29)		109	<sup>268</sup> Mt	268.13873(34)*	
	<sup>234</sup> U	234.0409521(20)	0.0054(5)	110	<sup>281</sup> Ds	281.16206(78)*	
	<sup>235</sup> U	235.0439299(20)	0.7204(6)	111	<sup>272</sup> Rg	273.15362(36)*	

# ELECTRON CONFIGURATION AND IONIZATION ENERGY OF NEUTRAL ATOMS IN THE GROUND STATE

William C. Martin

The ground state electron configuration, ground level, and ionization energy of the elements hydrogen through rutherfordium are listed in this table. The electron configurations of elements heavier than neon are shortened by using rare-gas element symbols in brackets to represent the corresponding electrons. See the references for details of the notation for Pa, U, and Np. Ionization energies to higher states (and more precise values of the first ionization energy for certain elements) may be found in the table "Ionization Energies of Atoms and Atomic Ions" in Section 10 of this *Handbook*.

## References

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2. Martin, W. C., and Wiese, W. L., "Atomic Spectroscopy", in *Atomic, Molecular, & Optical Physics Handbook*, ed. by G.W.F. Drake (AIP, Woodbury, NY, 1996) Chapter 10, pp. 135-153.

Z	Element	Ground-state configuration	Ground level	Ionization energy (eV)
1	H Hydrogen	1s	$^2S_{1/2}$	13.5984
2	He Helium	1s <sup>2</sup>	$^1S_0$	24.5874
3	Li Lithium	1s <sup>2</sup> 2s	$^2S_{1/2}$	5.3917
4	Be Beryllium	1s <sup>2</sup> 2s <sup>2</sup>	$^1S_0$	9.3227
5	B Boron	1s <sup>2</sup> 2s <sup>2</sup> 2p	$^2P_{1/2}^o$	8.2980
6	C Carbon	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>2</sup>	$^3P_0$	11.2603
7	N Nitrogen	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>3</sup>	$^4S_{3/2}^o$	14.5341
8	O Oxygen	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>4</sup>	$^3P_2$	13.6181
9	F Fluorine	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>5</sup>	$^2P_{3/2}^o$	17.4228
10	Ne Neon	1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup>	$^1S_0$	21.5645
11	Na Sodium	[Ne] 3s	$^2S_{1/2}$	5.1391
12	Mg Magnesium	[Ne] 3s <sup>2</sup>	$^1S_0$	7.6462
13	Al Aluminum	[Ne] 3s <sup>2</sup> 3p	$^2P_{1/2}^o$	5.9858
14	Si Silicon	[Ne] 3s <sup>2</sup> 3p <sup>2</sup>	$^3P_0$	8.1517
15	P Phosphorus	[Ne] 3s <sup>2</sup> 3p <sup>3</sup>	$^4S_{3/2}^o$	10.4867
16	S Sulfur	[Ne] 3s <sup>2</sup> 3p <sup>4</sup>	$^3P_2$	10.3600
17	Cl Chlorine	[Ne] 3s <sup>2</sup> 3p <sup>5</sup>	$^2P_{3/2}^o$	12.9676
18	Ar Argon	[Ne] 3s <sup>2</sup> 3p <sup>6</sup>	$^1S_0$	15.7596
19	K Potassium	[Ar] 4s	$^2S_{1/2}$	4.3407
20	Ca Calcium	[Ar] 4s <sup>2</sup>	$^1S_0$	6.1132
21	Sc Scandium	[Ar] 3d 4s <sup>2</sup>	$^2D_{3/2}$	6.5615
22	Ti Titanium	[Ar] 3d <sup>2</sup> 4s <sup>2</sup>	$^3F_2$	6.8281
23	V Vanadium	[Ar] 3d <sup>3</sup> 4s <sup>2</sup>	$^4F_{3/2}$	6.7462
24	Cr Chromium	[Ar] 3d <sup>5</sup> 4s	$^7S_3$	6.7665
25	Mn Manganese	[Ar] 3d <sup>5</sup> 4s <sup>2</sup>	$^6S_{5/2}$	7.4340
26	Fe Iron	[Ar] 3d <sup>6</sup> 4s <sup>2</sup>	$^5D_4$	7.9024
27	Co Cobalt	[Ar] 3d <sup>7</sup> 4s <sup>2</sup>	$^4F_{9/2}$	7.8810
28	Ni Nickel	[Ar] 3d <sup>8</sup> 4s <sup>2</sup>	$^3F_4$	7.6398
29	Cu Copper	[Ar] 3d <sup>10</sup> 4s	$^2S_{1/2}$	7.7264
30	Zn Zinc	[Ar] 3d <sup>10</sup> 4s <sup>2</sup>	$^1S_0$	9.3942
31	Ga Gallium	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p	$^2P_{1/2}^o$	5.9993
32	Ge Germanium	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup>	$^3P_0$	7.8994
33	As Arsenic	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup>	$^4S_{3/2}^o$	9.7886
34	Se Selenium	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup>	$^3P_2$	9.7524
35	Br Bromine	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup>	$^2P_{3/2}^o$	11.8138
36	Kr Krypton	[Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup>	$^1S_0$	13.9996
37	Rb Rubidium	[Kr] 5s	$^2S_{1/2}$	4.1771
38	Sr Strontium	[Kr] 5s <sup>2</sup>	$^1S_0$	5.6949
39	Y Yttrium	[Kr] 4d 5s <sup>2</sup>	$^2D_{3/2}$	6.2173
40	Zr Zirconium	[Kr] 4d <sup>2</sup> 5s <sup>2</sup>	$^3F_2$	6.6339
41	Nb Niobium	[Kr] 4d <sup>4</sup> 5s	$^6D_{1/2}$	6.7589
42	Mo Molybdenum	[Kr] 4d <sup>5</sup> 5s	$^7S_3$	7.0924
43	Tc Technetium	[Kr] 4d <sup>5</sup> 5s <sup>2</sup>	$^6S_{5/2}$	7.28
44	Ru Ruthenium	[Kr] 4d <sup>7</sup> 5s	$^5F_5$	7.3605

Z	Element	Ground-state configuration	Ground level	Ionization energy (eV)	
45	Rh	Rhodium	[Kr] $4d^8 5s$	$^4F_{9/2}$	7.4589
46	Pd	Palladium	[Kr] $4d^{10}$	$^1S_0$	8.3369
47	Ag	Silver	[Kr] $4d^{10} 5s$	$^2S_{1/2}$	7.5762
48	Cd	Cadmium	[Kr] $4d^{10} 5s^2$	$^1S_0$	8.9938
49	In	Indium	[Kr] $4d^{10} 5s^2 5p$	$^2P_{1/2}$	5.7864
50	Sn	Tin	[Kr] $4d^{10} 5s^2 5p^2$	$^3P_0$	7.3439
51	Sb	Antimony	[Kr] $4d^{10} 5s^2 5p^3$	$^4S_{3/2}$	8.6084
52	Te	Tellurium	[Kr] $4d^{10} 5s^2 5p^4$	$^3P_2$	9.0096
53	I	Iodine	[Kr] $4d^{10} 5s^2 5p^5$	$^2P_{3/2}^o$	10.4513
54	Xe	Xenon	[Kr] $4d^{10} 5s^2 5p^6$	$^1S_0$	12.1298
55	Cs	Cesium	[Xe] $6s$	$^2S_{1/2}$	3.8939
56	Ba	Barium	[Xe] $6s^2$	$^1S_0$	5.2117
57	La	Lanthanum	[Xe] $5d 6s^2$	$^2D_{3/2}$	5.5769
58	Ce	Cerium	[Xe] $4f 5d 6s^2$	$^1G_4^o$	5.5387
59	Pr	Praseodymium	[Xe] $4f^6 6s^2$	$^4I_{9/2}^o$	5.473
60	Nd	Neodymium	[Xe] $4f^6 6s^2$	$^5I_4$	5.5250
61	Pm	Promethium	[Xe] $4f^6 6s^2$	$^6H_{5/2}^o$	5.582
62	Sm	Samarium	[Xe] $4f^6 6s^2$	$^7F_0$	5.6437
63	Eu	Europium	[Xe] $4f^7 6s^2$	$^8S_{7/2}^o$	5.6704
64	Gd	Gadolinium	[Xe] $4f^7 5d 6s^2$	$^9D_2^o$	6.1498
65	Tb	Terbium	[Xe] $4f^7 6s^2$	$^6H_{15/2}^o$	5.8638
66	Dy	Dysprosium	[Xe] $4f^{10} 6s^2$	$^5I_8$	5.9389
67	Ho	Holmium	[Xe] $4f^{11} 6s^2$	$^4I_{15/2}^o$	6.0215
68	Er	Erbium	[Xe] $4f^{12} 6s^2$	$^3H_6$	6.1077
69	Tm	Thulium	[Xe] $4f^{13} 6s^2$	$^2F_{7/2}^o$	6.1843
70	Yb	Ytterbium	[Xe] $4f^{14} 6s^2$	$^1S_0$	6.2542
71	Lu	Lutetium	[Xe] $4f^{14} 5d 6s^2$	$^2D_{3/2}$	5.4259
72	Hf	Hafnium	[Xe] $4f^{14} 5d^2 6s^2$	$^3F_2$	6.8251
73	Ta	Tantalum	[Xe] $4f^{14} 5d^3 6s^2$	$^4F_{3/2}$	7.5496
74	W	Tungsten	[Xe] $4f^{14} 5d^4 6s^2$	$^5D_0$	7.8640
75	Re	Rhenium	[Xe] $4f^{14} 5d^5 6s^2$	$^6S_{5/2}^o$	7.8335
76	Os	Osmium	[Xe] $4f^{14} 5d^6 6s^2$	$^5D_4$	8.4382
77	Ir	Iridium	[Xe] $4f^{14} 5d^7 6s^2$	$^4F_{9/2}$	8.9670
78	Pt	Platinum	[Xe] $4f^{14} 5d^9 6s$	$^3D_3$	8.9588
79	Au	Gold	[Xe] $4f^{14} 5d^{10} 6s$	$^2S_{1/2}$	9.2255
80	Hg	Mercury	[Xe] $4f^{14} 5d^{10} 6s^2$	$^1S_0$	10.4375
81	Tl	Thallium	[Xe] $4f^{14} 5d^{10} 6s^2 6p$	$^2P_{1/2}$	6.1082
82	Pb	Lead	[Xe] $4f^{14} 5d^{10} 6s^2 6p^2$	$^3P_0$	7.4167
83	Bi	Bismuth	[Xe] $4f^{14} 5d^{10} 6s^2 6p^3$	$^4S_{3/2}$	7.2855
84	Po	Polonium	[Xe] $4f^{14} 5d^{10} 6s^2 6p^4$	$^3P_2$	8.414
85	At	Astatine	[Xe] $4f^{14} 5d^{10} 6s^2 6p^5$	$^2P_{3/2}^o$	
86	Rn	Radon	[Xe] $4f^{14} 5d^{10} 6s^2 6p^6$	$^1S_0$	10.7485
87	Fr	Francium	[Rn] $7s$	$^2S_{1/2}$	4.0727
88	Ra	Radium	[Rn] $7s^2$	$^1S_0$	5.2784
89	Ac	Actinium	[Rn] $6d 7s^2$	$^2D_{3/2}$	5.17
90	Th	Thorium	[Rn] $6d^2 7s^2$	$^3F_2$	6.3067
91	Pa	Protactinium	[Rn] $5f^2(^3H_4) 6d 7s^2$	$(4,3/2)_{11/2}$	5.89
92	U	Uranium	[Rn] $5f^6(^4I_{9/2}^o) 6d 7s^2$	$(9/2,3/2)_6^o$	6.1941
93	Np	Neptunium	[Rn] $5f^6(^6I_4) 6d 7s^2$	$(4,3/2)_{11/2}$	6.2657
94	Pu	Plutonium	[Rn] $5f^6 7s^2$	$^7F_0$	6.0260
95	Am	Americium	[Rn] $5f^7 7s^2$	$^8S_{7/2}^o$	5.9738
96	Cm	Curium	[Rn] $5f^7 6d 7s^2$	$^9D_2^o$	5.9914
97	Bk	Berkelium	[Rn] $5f^9 7s^2$	$^6H_{15/2}^o$	6.1979
98	Cf	Californium	[Rn] $5f^{10} 7s^2$	$^5I_8$	6.2817
99	Es	Einsteinium	[Rn] $5f^{11} 7s^2$	$^4I_{15/2}^o$	6.42
100	Fm	Fermium	[Rn] $5f^{12} 7s^2$	$^3H_6$	6.50
101	Md	Mendelevium	[Rn] $5f^{13} 7s^2$	$^2F_{7/2}^o$	6.58
102	No	Nobelium	[Rn] $5f^{14} 7s^2$	$^1S_0$	6.65
103	Lr	Lawrencium	[Rn] $5f^{14} 7s^2 7p?$	$^2P_{1/2}^o ?$	4.9?
104	Rf	Rutherfordium	[Rn] $5f^{14} 6d^2 7s^2 ?$	$^3F_2 ?$	6.0?

# CONVERSION OF TEMPERATURES FROM THE 1948 AND 1968 SCALES TO ITS-90

This table gives temperature corrections from older scales to the current International Temperature Scale of 1990 (see the preceding table for details on ITS-90). The first part of the table may be used for converting Celsius temperatures in the range  $-180$  to  $4000$  °C from IPTS-68 or IPTS-48 to ITS-90. Within the accuracy of the corrections, the temperature in the first column may be identified with either  $t_{68}$ ,  $t_{48}$ , or  $t_{90}$ . The second part of the table is designed for use at lower temperatures to convert values expressed in kelvins from EPT-76 or IPTS-68 to ITS-90.

The references give analytical equations for expressing these relations. Note that Reference 1 supersedes Reference 2 with respect to corrections in the 630 to 1064 °C range.

## References

1. Burns, G. W. et al., in *Temperature: Its Measurement and Control in Science and Industry*, Vol. 6, Schooley, J. F., Ed., American Institute of Physics, New York, 1993.
2. Goldberg, R. N. and Weir, R. D., *Pure and Appl. Chem.*, 64, 1545, 1992.

$t/^\circ\text{C}$	$t_{90}-t_{68}$	$t_{90}-t_{48}$	$t/^\circ\text{C}$	$t_{90}-t_{68}$	$t_{90}-t_{48}$	$t/^\circ\text{C}$	$t_{90}-t_{68}$	$t_{90}-t_{48}$	$t/^\circ\text{C}$	$t_{90}-t_{68}$	$t_{90}-t_{48}$
-180	0.008	0.020	290	-0.039	0.032	760	0.04	0.60	2400	-1.00	3.2
-170	0.010	0.017	300	-0.039	0.034	770	0.05	0.63	2500	-1.07	3.4
-160	0.012	0.007	310	-0.039	0.035	780	0.05	0.66	2600	-1.15	3.7
-150	0.013	0.000	320	-0.039	0.036	790	0.05	0.69	2700	-1.24	3.8
-140	0.014	0.001	330	-0.040	0.036	800	0.05	0.72	2800	-1.32	4.0
-130	0.014	0.008	340	-0.040	0.037	810	0.05	0.75	2900	-1.41	4.2
-120	0.014	0.017	350	-0.041	0.036	820	0.04	0.76	3000	-1.50	4.4
-110	0.013	0.026	360	-0.042	0.035	830	0.04	0.79	3100	-1.59	4.6
-100	0.013	0.035	370	-0.043	0.034	840	0.03	0.81	3200	-1.69	4.8
-90	0.012	0.041	380	-0.045	0.032	850	0.02	0.83	3300	-1.78	5.1
-80	0.012	0.045	390	-0.046	0.030	860	0.01	0.85	3400	-1.89	5.3
-70	0.011	0.045	400	-0.048	0.028	870	0.00	0.87	3500	-1.99	5.5
-60	0.010	0.042	410	-0.051	0.024	880	-0.02	0.87	3600	-2.10	5.8
-50	0.009	0.038	420	-0.053	0.022	890	-0.03	0.89	3700	-2.21	6.0
-40	0.008	0.032	430	-0.056	0.019	900	-0.05	0.90	3800	-2.32	6.3
-30	0.006	0.024	440	-0.059	0.015	910	-0.06	0.92	3900	-2.43	6.6
-20	0.004	0.016	450	-0.062	0.012	920	-0.08	0.93	4000	-2.55	6.8
-10	0.002	0.008	460	-0.065	0.009	930	-0.10	0.94			
0	0.000	0.000	470	-0.068	0.007	940	-0.11	0.96	$T/\text{K}$	$T_{90}-T_{76}$	$T_{90}-T_{68}$
10	-0.002	-0.006	480	-0.072	0.004	950	-0.13	0.97	5	-0.0001	
20	-0.005	-0.012	490	-0.075	0.002	960	-0.15	0.97	6	-0.0002	
30	-0.007	-0.016	500	-0.079	0.000	970	-0.16	0.99	7	-0.0003	
40	-0.010	-0.020	510	-0.083	-0.001	980	-0.18	1.00	8	-0.0004	
50	-0.013	-0.023	520	-0.087	-0.002	990	-0.19	1.02	9	-0.0005	
60	-0.016	-0.026	530	-0.090	-0.001	1000	-0.20	1.04	10	-0.0006	
70	-0.018	-0.026	540	-0.094	0.000	1010	-0.22	1.05	11	-0.0007	
80	-0.021	-0.027	550	-0.098	0.002	1020	-0.23	1.07	12	-0.0008	
90	-0.024	-0.027	560	-0.101	0.007	1030	-0.23	1.10	13	-0.0010	
100	-0.026	-0.026	570	-0.105	0.011	1040	-0.24	1.12	14	-0.0011	-0.006
110	-0.028	-0.024	580	-0.108	0.018	1050	-0.25	1.14	15	-0.0013	-0.003
120	-0.030	-0.023	590	-0.112	0.025	1060	-0.25	1.17	16	-0.0014	-0.004
130	-0.032	-0.020	600	-0.115	0.035	1070	-0.25	1.19	17	-0.0016	-0.006
140	-0.034	-0.018	610	-0.118	0.047	1080	-0.26	1.20	18	-0.0018	-0.008
150	-0.036	-0.016	620	-0.122	0.060	1090	-0.26	1.20	19	-0.0020	-0.009
160	-0.037	-0.012	630	-0.125	0.075	1100	-0.26	1.2	20	-0.0022	-0.009
170	-0.038	-0.009	640	-0.11	0.12	1200	-0.30	1.4	21	-0.0025	-0.008
180	-0.039	-0.005	650	-0.10	0.15	1300	-0.35	1.5	22	-0.0027	-0.007
190	-0.039	-0.001	660	-0.09	0.19	1400	-0.39	1.6	23	-0.0030	-0.007
200	-0.040	0.003	670	-0.07	0.24	1500	-0.44	1.8	24	-0.0032	-0.006
210	-0.040	0.007	680	-0.05	0.29	1600	-0.49	1.9	25	-0.0035	-0.005
220	-0.040	0.011	690	-0.04	0.32	1700	-0.54	2.1	26	-0.0038	-0.004
230	-0.040	0.014	700	-0.02	0.37	1800	-0.60	2.2	27	-0.0041	-0.004
240	-0.040	0.018	710	-0.01	0.41	1900	-0.66	2.3	28		-0.005
250	-0.040	0.021	720	0.00	0.45	2000	-0.72	2.5	29		-0.006
260	-0.040	0.024	730	0.02	0.49	2100	-0.79	2.7	30		-0.006
270	-0.039	0.028	740	0.03	0.53	2200	-0.85	2.9	31		-0.007
280	-0.039	0.030	750	0.03	0.56	2300	-0.93	3.1	32		-0.008



## Conversion of Temperatures from the 1948 and 1968 Scales to ITS-90

$T/K$	$T_{90}-T_{76}$	$T_{90}-T_{68}$	$T/K$	$T_{90}-T_{76}$	$T_{90}-T_{68}$	$T/K$	$T_{90}-T_{76}$	$T_{90}-T_{68}$	$T/K$	$T_{90}-T_{76}$	$T_{90}-T_{68}$
33		-0.008	57		0.000	81		0.008	150		0.014
34		-0.008	58		0.001	82		0.008	160		0.014
35		-0.007	59		0.002	83		0.008	170		0.013
36		-0.007	60		0.003	84		0.008	180		0.012
37		-0.007	61		0.003	85		0.008	190		0.012
38		-0.006	62		0.004	86		0.008	200		0.011
39		-0.006	63		0.004	87		0.008	210		0.010
40		-0.006	64		0.005	88		0.008	220		0.009
41		-0.006	65		0.005	89		0.008	230		0.008
42		-0.006	66		0.006	90		0.008	240		0.007
43		-0.006	67		0.006	91		0.008	250		0.005
44		-0.006	68		0.007	92		0.008	260		0.003
45		-0.007	69		0.007	93		0.008	270		0.001
46		-0.007	70		0.007	94		0.008	273.16		0.000
47		-0.007	71		0.007	95		0.008	300		-0.006
48		-0.006	72		0.007	96		0.008	400		-0.031
49		-0.006	73		0.007	97		0.009	500		-0.040
50		-0.006	74		0.007	98		0.009	600		-0.040
51		-0.005	75		0.008	99		0.009	700		-0.055
52		-0.005	76		0.008	100		0.009	800		-0.089
53		-0.004	77		0.008	110		0.011	900		-0.124
54		-0.003	78		0.008	120		0.013			
55		-0.002	79		0.008	130		0.014			
56		-0.001	80		0.008	140		0.014			

# INTERNATIONAL SYSTEM OF UNITS (SI)

The International System of Units, abbreviated as SI (from the French name *Le Système International d'Unités*), was established in 1960 by the 11th General Conference on Weights and Measures (CGPM) as the modern metric system of measurement. The core of the SI is the seven base units for the physical quantities length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity. These base units are:

Base quantity	SI base unit	
	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

The SI base units are defined as follows:

**meter:** The meter is the length of the path travelled by light in vacuum during a time interval of  $1/299\,792\,458$  of a second.

**kilogram:** The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram.

**second:** The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom.

**ampere:** The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to  $2 \cdot 10^{-7}$  newton per meter of length.

**kelvin:** The kelvin, unit of thermodynamic temperature, is the fraction  $1/273.16$  of the thermodynamic temperature of the triple point of water.

**mole:** The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

**candela:** The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency  $540 \cdot 10^{12}$  hertz and that has a radiant intensity in that direction of  $1/683$  watt per steradian.

## SI derived units

Derived units are units which may be expressed in terms of base units by means of the mathematical symbols of multiplication and division (and, in the case of °C, subtraction). Certain derived units have been given special names and symbols, and these special names and symbols may themselves be used in combination with those for base and other derived units to express the units of other quantities. The next table lists some examples of derived units expressed directly in terms of base units:

Physical quantity	SI derived unit	
	Name	Symbol
area	square meter	m <sup>2</sup>
volume	cubic meter	m <sup>3</sup>
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s <sup>2</sup>
wave number	reciprocal meter	m <sup>-1</sup>
density, mass density	kilogram per cubic meter	kg/m <sup>3</sup>
specific volume	cubic meter per kilogram	m <sup>3</sup> /kg
current density	ampere per square meter	A/m <sup>2</sup>
magnetic field strength	ampere per meter	A/m
concentration (of amount of substance)	mole per cubic meter	mol/m <sup>3</sup>
luminance	candela per square meter	cd/m <sup>2</sup>
refractive index	(the number) one	1 <sup>(a)</sup>

<sup>(a)</sup> The symbol "1" is generally omitted in combination with a numerical value.

For convenience, certain derived units, which are listed in the next table, have been given special names and symbols. These names and symbols may themselves be used to express other derived units. The special names and symbols are a compact form for the expression of units that are used frequently. The final column shows how the SI units concerned may be expressed in terms of SI base units. In this column, factors such as m<sup>0</sup>, kg<sup>0</sup> ..., which are all equal to 1, are not shown explicitly.

Physical quantity	Name	Symbol	SI derived unit expressed in terms of:	
			Other SI units	SI base units
plane angle	radian <sup>(a)</sup>	rad	$m \cdot m^{-1} = 1^{(b)}$	
solid angle	steradian <sup>(a)</sup>	sr <sup>(c)</sup>	$m^2 \cdot m^{-2} = 1^{(b)}$	
frequency	hertz	Hz	s <sup>-1</sup>	
force	newton	N	$m \cdot kg \cdot s^{-2}$	
pressure, stress	pascal	Pa	N/m <sup>2</sup>	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	N · m	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
electric charge, quantity of electricity	coulomb	C	s · A	
electric potential difference, electromotive force	volt	V	W/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
capacitance	farad	F	C/V	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
electric resistance	ohm	Ω	V/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
electric conductance	siemens	S	A/V	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
magnetic flux	weber	Wb	V · s	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$

magnetic flux density	tesla	T	Wb/m <sup>2</sup>	kg · s <sup>-2</sup> · A <sup>-1</sup>
inductance	henry	H	Wb/A	m <sup>2</sup> · kg · s <sup>-2</sup> · A <sup>-2</sup>
Celsius temperature	degree Celsius <sup>(d)</sup>	°C		K
luminous flux	lumen	lm	cd · sr <sup>(e)</sup>	m <sup>2</sup> · m <sup>-2</sup> · cd = cd
illuminance	lux	lx	lm/m <sup>2</sup>	m <sup>2</sup> · m <sup>-4</sup> · cd = m <sup>-2</sup> · cd
activity (of a radionuclide)	becquerel	Bq		s <sup>-1</sup>
absorbed dose, specific energy (imparted), kerma	gray	Gy	J/kg	m <sup>2</sup> · s <sup>-2</sup>
dose equivalent, ambient dose equivalent, directional dose equivalent, personal dose equivalent, organ equivalent dose	sievert	Sv	J/kg	m <sup>2</sup> · s <sup>-2</sup>
catalytic activity	katal	kat		s <sup>-1</sup> · mol

<sup>(a)</sup> The radian and steradian may be used with advantage in expressions for derived units to distinguish between quantities of different nature but the same dimension. Some examples of their use in forming derived units are given in the next table.

<sup>(b)</sup> In practice, the symbols rad and sr are used where appropriate, but the derived unit “1” is generally omitted in combination with a numerical value.

<sup>(c)</sup> In photometry, the name steradian and the symbol sr are usually retained in expressions for units.

<sup>(d)</sup> It is common practice to express a thermodynamic temperature, symbol  $T$ , in terms of its difference from the reference temperature  $T_0 = 273.15$  K. The numerical value of a Celsius temperature  $t$  expressed in degrees Celsius is given by  $t/°C = T/K - 273.15$ . The unit °C may be used in combination with SI prefixes, e.g., millidegree Celsius, m°C. Note that there should never be a space between the ° sign and the letter C, and that the symbol for kelvin is K, not °K.

The SI derived units with special names may be used in combinations to provide a convenient way to express more complex physical quantities. Examples are given in the next table:

Physical Quantity	SI derived unit		
	Name	Symbol	As SI base units
dynamic viscosity	pascal second	Pa · s	m <sup>-1</sup> · kg · s <sup>-1</sup>
moment of force	newton meter	N · m	m <sup>2</sup> · kg · s <sup>-2</sup>
surface tension	newton per meter	N/m	kg · s <sup>-2</sup>
angular velocity	radian per second	rad/s	m · m <sup>-1</sup> · s <sup>-1</sup> = s <sup>-1</sup>
angular acceleration	radian per second squared	rad/s <sup>2</sup>	m · m <sup>-1</sup> · s <sup>-2</sup> = s <sup>-2</sup>
heat flux density, irradiance	watt per square meter	W/m <sup>2</sup>	kg · s <sup>-3</sup>
heat capacity, entropy	joule per kelvin	J/K	m <sup>-3</sup> · kg · s <sup>-2</sup> · K <sup>-1</sup>
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg · K)	m <sup>2</sup> · s <sup>-2</sup> · K <sup>-1</sup>
specific energy	joule per kilogram	J/kg	m <sup>2</sup> · s <sup>-2</sup>
thermal conductivity	watt per meter kelvin	W/(m · K)	m · kg · s <sup>-3</sup> · K <sup>-1</sup>
energy density	joule per cubic meter	J/m <sup>3</sup>	m <sup>-1</sup> · kg · s <sup>-2</sup>
electric field strength	volt per meter	V/m	m · kg · s <sup>-3</sup> · A <sup>-1</sup>
electric charge density	coulomb per cubic meter	C/m <sup>3</sup>	m <sup>-3</sup> · s · A
electric flux density	coulomb per square meter	C/m <sup>2</sup>	m <sup>-2</sup> · s · A
permittivity	farad per meter	F/m	m <sup>-3</sup> · kg <sup>-1</sup> · s <sup>4</sup> · A <sup>2</sup>
permeability	henry per meter	H/m	m · kg · s <sup>-2</sup> · A <sup>-2</sup>
molar energy	joule per mole	J/mol	m <sup>2</sup> · kg · s <sup>-2</sup> · mol <sup>-1</sup>
molar entropy, molar heat capacity	joule per mole kelvin	J/(mol · K)	m <sup>2</sup> · kg · s <sup>-2</sup> · K <sup>-1</sup> · mol <sup>-1</sup>
exposure (x and γ rays)	coulomb per kilogram	C/kg	kg <sup>-1</sup> · s · A
absorbed dose rate	gray per second	Gy/s	m <sup>2</sup> · s <sup>-3</sup>
radiant intensity	watt per steradian	W/sr	m <sup>4</sup> · m <sup>-2</sup> · kg · s <sup>-3</sup> = m <sup>2</sup> · kg · s <sup>-3</sup>
radiance	watt per square meter steradian	W/(m <sup>2</sup> · sr)	m <sup>2</sup> · m <sup>-2</sup> · kg · s <sup>-3</sup> = kg · s <sup>-3</sup>
catalytic (activity) concentration	katal per cubic meter	kat/m <sup>3</sup>	m <sup>-3</sup> · s <sup>-1</sup> · mol

In practice, with certain quantities preference is given to the use of certain special unit names, or combinations of unit

names, in order to facilitate the distinction between different quantities having the same dimension. For example, the SI unit of frequency is designated the hertz, rather than the reciprocal second, and the SI unit of angular velocity is designated the radian per second rather than the reciprocal second (in this case retaining the word radian emphasizes that angular velocity is equal to  $2\pi$  times the rotational frequency). Similarly the SI unit of moment of force is designated the newton meter rather than the joule.

In the field of ionizing radiation, the SI unit of activity is designated the becquerel rather than the reciprocal second, and the SI units of absorbed dose and dose equivalent the gray and sievert, respectively, rather than the joule per kilogram. In the field of catalysis, the SI unit of catalytic activity is designated the katal rather than the mole per second. The special names becquerel, gray, sievert, and katal were specifically introduced because of the dangers to human health which might arise from mistakes involving the units reciprocal second, joule per kilogram and mole per second.

### Units for dimensionless quantities, quantities of dimension one

Certain quantities are defined as the ratios of two quantities of the same kind, and thus have a dimension which may be expressed by the number one. The unit of such quantities is necessarily a derived unit coherent with the other units of the SI and, since it is formed as the ratio of two identical SI units, the unit also may be expressed by the number one. Thus the SI unit of all quantities having the dimensional product one is the number one. Examples of such quantities are refractive index, relative permeability, and friction factor. Other quantities having the unit 1 include “characteristic numbers” like the Prandtl number and numbers which represent a count, such as a number of molecules, degeneracy (number of energy levels), and partition function in statistical thermodynamics. All of these quantities are described as being dimensionless, or of dimension one, and have the coherent SI unit 1. Their values are simply expressed as numbers and, in general, the unit 1 is not explicitly shown. In a few cases, however, a special name is given to this unit, mainly to avoid confusion between some compound derived units. This is the case for the radian, steradian and neper.

## SI prefixes

The following prefixes have been approved by the CGPM for use with SI units. Only one prefix may be used before a unit. Thus  $10^{-12}$  farad should be designated pF, not  $\mu\mu\text{F}$ .

Factor	Name	Symbol	Factor	Name	Symbol
$10^{24}$	yotta	Y	$10^{-1}$	deci	d
$10^{21}$	zetta	Z	$10^{-2}$	centi	c
$10^{18}$	exa	E	$10^{-3}$	milli	m
$10^{15}$	peta	P	$10^{-6}$	micro	$\mu$
$10^{12}$	tera	T	$10^{-9}$	nano	n
$10^9$	giga	G	$10^{-12}$	pico	p
$10^6$	mega	M	$10^{-15}$	femto	f
$10^3$	kilo	k	$10^{-18}$	atto	a
$10^2$	hecto	h	$10^{-21}$	zepto	z
$10^1$	deka	da	$10^{-24}$	yocto	y

## The kilogram

Among the base units of the International System, the unit of mass is the only one whose name, for historical reasons, contains a prefix. Names and symbols for decimal multiples and submultiples of the unit of mass are formed by attaching prefix names to the unit name “gram” and prefix symbols to the unit symbol “g”.

*Example* :  $10^{-6}$  kg = 1 mg (1 milligram) but not 1  $\mu\text{kg}$  (1 microkilogram).

## Units used with the SI

Many units that are not part of the SI are important and widely used in everyday life. The CGPM has adopted a classification of non-SI units: (1) units accepted for use with the SI (such as the traditional units of time and of angle); (2) units accepted for use with the SI whose values are obtained experimentally; and (3) other units currently accepted for use with the SI to satisfy the needs of special interests.

### (1) Non-SI units accepted for use with the International System

Name	Symbol	Value in SI units
minute	min	1 min = 60 s
hour	h	1 h = 60 min = 3600 s
day	d	1 d = 24 h = 86 400 s
degree	$^\circ$	$1^\circ = (\pi/180)$ rad
minute	'	$1' = (1/60)^\circ = (\pi/10\,800)$ rad
second	"	$1'' = (1/60)' = (\pi/648\,000)$ rad
liter	l, L	1 L = $1\text{ dm}^3 = 10^{-3}\text{ m}^3$
metric ton	t	1 t = $10^3$ kg
neper <sup>(a)</sup>	Np	1 Np = 1
bel <sup>(b)</sup>	B	1 B = $(1/2) \ln 10$ Np

<sup>(a)</sup> The neper is used to express values of such logarithmic quantities as field level, power level, sound pressure level, and logarithmic decrement. Natural logarithms are used to obtain the numerical values of quantities expressed in nepers. The neper is coherent with the SI, but is not yet adopted by the CGPM as an SI unit. In using the neper, it is important to specify the quantity.

<sup>(b)</sup> The bel is used to express values of such logarithmic quantities as field level, power level, sound-pressure level, and attenuation. Logarithms to base ten are used to obtain the numerical values of quantities expressed in bels. The submultiple decibel, dB, is commonly used.

### (2) Non-SI units accepted for use with the International system, whose values in SI units are obtained experimentally

Name	Symbol	Value in SI Units
electronvolt <sup>(b)</sup>	eV	1 eV = 1.602 176 53(14) · $10^{-19}$ J <sup>(a)</sup>
dalton <sup>(c)</sup>	Da	1 Da = 1.660 538 86(28) · $10^{-27}$ kg <sup>(a)</sup>
unified atomic mass unit <sup>(c)</sup>	u	1 u = 1 Da
astronomical unit <sup>(d)</sup>	ua	1 ua = 1.495 978 706 91(06) · $10^{11}$ m <sup>(a)</sup>

<sup>(a)</sup> For the electronvolt and the dalton (unified atomic mass unit), values are quoted from the 2002 CODATA set of the Fundamental Physical Constants (p. 1-1 of this Handbook). The value given for the astronomical unit is quoted from the IERS Conventions 2003 (D.D. McCarthy and G. Petit, eds., IERS Technical Note 32, Frankfurt am Main: Verlag des Bundesamts für Kartographie und Geodäsie, 200). The value of ua in meters comes from the JPL ephemerides DE403 (Standish E.M. 1995, “Report of the IAU WGAS Sub-Group on Numerical Standards”, in “Highlights of Astronomy”, Appenzler ed., pp 180-184, Kluwer Academic Publishers, Dordrecht). It has been determined in “TDB” units using Barycentric Dynamical Time TDB as a time coordinate for the barycentric system.

<sup>(b)</sup> The electronvolt is the kinetic energy acquired by an electron in passing through a potential difference of 1 V in vacuum.

<sup>(c)</sup> The Dalton and unified atomic mass unit are alternative names for the same unit, equal to 1/12 of the mass of an unbound atom of the nuclide  $^{12}\text{C}$ , at rest and in its ground state. The dalton may be combined with SI prefixes to express the masses of large molecules in kilodalton, kDa, or megadalton, MDa.

<sup>(d)</sup> The astronomical unit is a unit of length approximately equal to the mean Earth-Sun distance. It is the radius of an unperturbed circular Newtonian orbit about the Sun of a particle having infinitesimal mass, moving with a mean motion of 0.017 202 098 95 radians/day (known as the Gaussian constant).

### (3) Other non-SI units currently accepted for use with the International System

Name	Symbol	Value in SI Units
nautical mile		1 nautical mile = 1852 m
knot		1 nautical mile per hour = (1852/3600) m/s
are		1 a = $1\text{ dam}^2 = 10^2\text{ m}^2$
hectare	ha	1 ha = $1\text{ hm}^2 = 10^4\text{ m}^2$
bar	bar	1 bar = 0.1 MPa = 100 kPa = $10^5$ Pa
ångström	Å	1 Å = 0.1 nm = $10^{-10}$ m
barn	b	1 b = $100\text{ fm}^2 = 10^{-28}\text{ m}^2$

## Other non-SI units

The SI does not encourage the use of cgs units, but these are frequently found in old scientific texts. The following table gives the relation of some common cgs units to SI units.

Name	Symbol	Value in SI units
erg	erg	1 erg = $10^{-7}$ J
dyne	dyn	1 dyn = $10^{-5}$ N
poise	P	1 P = 1 dyn · s/cm <sup>2</sup> = 0.1 Pa · s
stokes	St	1 St = 1 cm <sup>2</sup> /s = $10^{-4}$ m <sup>2</sup> /s
gauss	G	1 G $\triangleq$ $10^{-4}$ T
oersted	Oe	1 Oe $\triangleq$ (1000/4 $\pi$ ) A/m
maxwell	Mx	1 Mx $\triangleq$ $10^{-8}$ Wb
stilb	sb	1 sb = 1 cd/cm <sup>2</sup> = $10^4$ cd/m <sup>2</sup>
phot	ph	1 ph = $10^4$ lx
gal	Gal	1 Gal = 1 cm/s <sup>2</sup> = $10^{-2}$ m/s <sup>2</sup>

*Note:* The symbol  $\triangleq$  should be read as “corresponds to”; these units cannot strictly be equated because of the different dimensions of the electromagnetic cgs and the SI.

Examples of other non-SI units found in the older literature and their relation to the SI are given below. Use of these units in current texts is discouraged.

Name	Symbol	Value in SI units
curie	Ci	1 Ci = $3.7 \cdot 10^{10}$ Bq
roentgen	R	1 R = $2.58 \cdot 10^{-4}$ C/kg
rad	rad	1 rad = 1 cGy = $10^{-2}$ Gy
rem	rem	1 rem = 1 cSv = $10^{-2}$ Sv
X unit		1 X unit $\approx 1.002 \cdot 10^{-4}$ nm
gamma	$\gamma$	1 $\gamma$ = 1 nT = $10^{-9}$ T
jansky	Jy	1 Jy = $10^{-26}$ W $\cdot$ m <sup>-2</sup> $\cdot$ Hz <sup>-1</sup>
fermi		1 fermi = 1 fm = $10^{-15}$ m
metric carat		1 metric carat = 200 mg = $2 \cdot 10^{-4}$ kg
torr	Torr	1 Torr = (101325/760) Pa
standard atmosphere	atm	1 atm = 101325 Pa
calorie <sup>(a)</sup>	cal	1 cal = 4.184 J
micron	$\mu$	1 $\mu$ = 1 $\mu$ m = $10^{-6}$ m

<sup>(a)</sup> Several types of calorie have been used; the value given here is the so-called "thermochemical calorie".

## References

1. Taylor, B. N., *The International System of Units (SI)*, NIST Special Publication 330, National Institute of Standards and Technology, Gaithersburg, MD, 2001.
2. Bureau International des Poids et Mesures, *Le Système International d'Unités (SI)*, 7th French and English Edition, BIPM, Sèvres, France, 1998; 8th Edition to be published 2006.
3. Taylor, B. N., *Guide for the Use of the International System of Units (SI)*, NIST Special Publication 811, National Institute of Standards and Technology, Gaithersburg, MD, 1995.
4. NIST Physical Reference Data web site, <<http://physics.nist.gov/cuu/Units/index.html>>, October 2004.

## CONVERSION FACTORS

The following table gives conversion factors from various units of measure to SI units. It is reproduced from NIST Special Publication 811, *Guide for the Use of the International System of Units (SI)*. The table gives the factor by which a quantity expressed in a non-SI unit should be multiplied in order to calculate its value in the SI. The SI values are expressed in terms of the base, supplementary, and derived units of SI in order to provide a coherent presentation of the conversion factors and facilitate computations (see the table "International System of Units" in this section). If desired, powers of ten can be avoided by using SI prefixes and shifting the decimal point if necessary.

Conversion from a non-SI unit to a different non-SI unit may be carried out by using this table in two stages, e.g.,

$$1 \text{ cal}_{\text{th}} = 4.184 \text{ J}$$

$$1 \text{ Btu}_{\text{IT}} = 1.055056 \text{ E}+03 \text{ J}$$

Thus,

$$1 \text{ Btu}_{\text{IT}} = (1.055056 \text{ E}+03 \div 4.184) \text{ cal}_{\text{th}} = 252.164 \text{ cal}_{\text{th}}$$

Conversion factors are presented for ready adaptation to computer readout and electronic data transmission. The factors are written as a number equal to or greater than one and less than ten with six or fewer decimal places. This number is followed by the letter E (for exponent), a plus or a minus sign, and two digits that indicate the power of 10 by which the number must be multiplied to obtain the correct value. For example:

$$3.523 \ 907 \ \text{E}-02 \text{ is } 3.523 \ 907 \times 10^{-2}$$

or

$$0.035 \ 239 \ 07$$

Similarly:

$$3.386 \ 389 \ \text{E}+03 \text{ is } 3.386 \ 389 \times 10^3$$

or

$$3 \ 386.389$$

A factor in boldface is exact; i.e., all subsequent digits are zero. All other conversion factors have been rounded to the figures given in accordance with accepted practice. Where less than six digits after the decimal point are shown, more precision is not warranted.

It is often desirable to round a number obtained from a conversion of units in order to retain information on the precision of the value. The following rounding rules may be followed:

1. If the digits to be discarded begin with a digit less than 5, the digit preceding the first discarded digit is not changed.

Example: 6.974 951 5 rounded to 3 digits is 6.97

2. If the digits to be discarded begin with a digit greater than 5, the digit preceding the first discarded digit is increased by one.

Example: 6.974 951 5 rounded to 4 digits is 6.975

3. If the digits to be discarded begin with a 5 and at least one of the following digits is greater than 0, the digit preceding the 5 is increased by 1.

Example: 6.974 851 rounded to 5 digits is 6.974 9

4. If the digits to be discarded begin with a 5 and all of the following digits are 0, the digit preceding the 5 is unchanged if it is even and increased by one if it is odd. (Note that this means that the final digit is always even.)

Examples:

$$6.974 \ 951 \ 5 \text{ rounded to 7 digits is } 6.974 \ 952$$

$$6.974 \ 950 \ 5 \text{ rounded to 7 digits is } 6.974 \ 950$$

## Reference

Taylor, B. N., *Guide for the Use of the International System of Units (SI)*, NIST Special Publication 811, 1995 Edition, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, 1995.

To convert from	Factors in <b>boldface</b> are exact to	Multiply by
abampere.....	ampere (A).....	<b>1.0</b> E+01
abcoulomb.....	coulomb (C).....	<b>1.0</b> E+01
abfarad.....	farad (F).....	<b>1.0</b> E+09
abhenry.....	henry (H).....	<b>1.0</b> E-09
abmho.....	siemens (S).....	<b>1.0</b> E+09
abohm.....	ohm ( $\Omega$ ).....	<b>1.0</b> E-09
abvolt.....	volt (V).....	<b>1.0</b> E-08
acceleration of free fall, standard ( $g_n$ ).....	meter per second squared (m/s <sup>2</sup> ).....	<b>9.806 65</b> E+00
acre (based on U.S. survey foot) <sup>9</sup> .....	square meter (m <sup>2</sup> ).....	4.046 873 E+03
acre foot (based on U.S. survey foot) <sup>9</sup> .....	cubic meter (m <sup>3</sup> ).....	1.233 489 E+03
<i>ampere hour</i> (A · h).....	coulomb (C).....	<b>3.6</b> E+03
ångström (Å).....	meter (m).....	<b>1.0</b> E-10
ångström (Å).....	nanometer (nm).....	<b>1.0</b> E-01
apostilb (asb).....	candela per meter squared (cd/m <sup>2</sup> ).....	3.183 098 E-01
<i>are</i> (a).....	square meter (m <sup>2</sup> ).....	<b>1.0</b> E+02
astronomical unit (ua or AU).....	meter (m).....	1.495 979 E+11
atmosphere, standard (atm).....	pascal (Pa).....	<b>1.013 25</b> E+05
atmosphere, standard (atm).....	kilopascal (kPa).....	<b>1.013 25</b> E+02
atmosphere, technical (at) <sup>10</sup> .....	pascal (Pa).....	<b>9.806 65</b> E+04
atmosphere, technical (at) <sup>10</sup> .....	kilopascal (kPa).....	<b>9.806 65</b> E+01

<sup>9</sup>The U.S. survey foot equals (1200/3937) m. 1 international foot = 0.999998 survey foot.

<sup>10</sup>One technical atmosphere equals one kilogram-force per square centimeter (1 at = 1 kgf/cm<sup>2</sup>).

To convert from	to	Multiply by
bar (bar).....	pascal (Pa) .....	<b>1.0</b> E+05
bar (bar).....	kilopascal (kPa) .....	<b>1.0</b> E+02
barn (b).....	square meter (m <sup>2</sup> ) .....	<b>1.0</b> E-28
barrel [for petroleum, 42 gallons (U.S.)](bbl) .....	cubic meter (m <sup>3</sup> ) .....	1.589 873 E-01
barrel [for petroleum, 42 gallons (U.S.)](bbl) .....	liter (L) .....	1.589 873 E+02
biot (Bi).....	ampere (A) .....	<b>1.0</b> E+01
British thermal unit <sub>IT</sub> (Btu <sub>IT</sub> ) <sup>11</sup> .....	joule (J) .....	1.055 056 E+03
British thermal unit <sub>th</sub> (Btu <sub>th</sub> ) <sup>11</sup> .....	joule (J) .....	1.054 350 E+03
British thermal unit (mean) (Btu).....	joule (J) .....	1.055 87 E+03
British thermal unit (39 °F) (Btu).....	joule (J) .....	1.059 67 E+03
British thermal unit (59 °F) (Btu).....	joule (J) .....	1.054 80 E+03
British thermal unit (60 °F) (Btu).....	joule (J) .....	1.054 68 E+03
British thermal unit <sub>IT</sub> foot per hour square foot degree Fahrenheit [Btu <sub>IT</sub> · ft/(h · ft <sup>2</sup> · °F)].....	watt per meter kelvin [W/(m · K)] .....	1.730 735 E+00
British thermal unit <sub>th</sub> foot per hour square foot degree Fahrenheit [Btu <sub>th</sub> · ft/(h · ft <sup>2</sup> · °F)] .....	watt per meter kelvin [W/(m · K)] .....	1.729 577 E+00
British thermal unit <sub>IT</sub> inch per hour square foot degree Fahrenheit [Btu <sub>IT</sub> · in/(h · ft <sup>2</sup> · °F)].....	watt per meter kelvin [W/(m · K)] .....	1.442 279 E-01
British thermal unit <sub>th</sub> inch per hour square foot degree Fahrenheit [Btu <sub>th</sub> · in/(h · ft <sup>2</sup> · °F)] .....	watt per meter kelvin [W/(m · K)] .....	1.441 314 E-01
British thermal unit <sub>IT</sub> inch per second square foot degree Fahrenheit [Btu <sub>IT</sub> · in/(s · ft <sup>2</sup> · °F)].....	watt per meter kelvin [W/(m · K)] .....	5.192 204 E+02
British thermal unit <sub>th</sub> inch per second square foot degree Fahrenheit [Btu <sub>th</sub> · in/(s · ft <sup>2</sup> · °F)].....	watt per meter kelvin [W/(m · K)] .....	5.188 732 E+02
British thermal unit <sub>IT</sub> per cubic foot (Btu <sub>IT</sub> /ft <sup>3</sup> ).....	joule per cubic meter (J/m <sup>3</sup> ).....	3.725 895 E+04
British thermal unit <sub>th</sub> per cubic foot (Btu <sub>th</sub> /ft <sup>3</sup> ).....	joule per cubic meter (J/m <sup>3</sup> ).....	3.723 403 E+04
British thermal unit <sub>IT</sub> per degree Fahrenheit (Btu <sub>IT</sub> /°F).....	joule per kelvin (J/k) .....	1.899 101 E+03
British thermal unit <sub>th</sub> per degree Fahrenheit (Btu <sub>th</sub> /°F) .....	joule per kelvin (J/k) .....	1.897 830 E+03
British thermal unit <sub>IT</sub> per degree Rankine (Btu <sub>IT</sub> /°R).....	joule per kelvin (J/k) .....	1.899 101 E+03
British thermal unit <sub>th</sub> per degree Rankine (Btu <sub>th</sub> /°R) .....	joule per kelvin (J/k) .....	1.897 830 E+03
British thermal unit <sub>IT</sub> per hour (Btu <sub>IT</sub> /h).....	watt (W) .....	2.930 711 E-01
British thermal unit <sub>th</sub> per hour (Btu <sub>th</sub> /h).....	watt (W) .....	2.928 751 E-01
British thermal unit <sub>IT</sub> per hour square foot degree Fahrenheit [Btu <sub>IT</sub> /(h · ft <sup>2</sup> · °F)].....	watt per square meter kelvin [W/(m <sup>2</sup> · K)] .....	5.678 263 E+00
British thermal unit <sub>th</sub> per hour square foot degree Fahrenheit [Btu <sub>th</sub> /(h · ft <sup>2</sup> · °F)].....	watt per square meter kelvin [W/(m <sup>2</sup> · K)] .....	5.674 466 E+00
British thermal unit <sub>th</sub> per minute (Btu <sub>th</sub> /min).....	watt (W) .....	1.757 250 E+01
British thermal unit <sub>IT</sub> per pound (Btu <sub>IT</sub> /lb) .....	joule per kilogram (J/kg).....	<b>2.326</b> E+03
British thermal unit <sub>th</sub> per pound (Btu <sub>th</sub> /lb).....	joule per kilogram (J/kg).....	2.324 444 E+03
British thermal unit <sub>IT</sub> per pound degree Fahrenheit [Btu <sub>IT</sub> /(lb · °F)].....	joule per kilogram kelvin [J/(kg · K)] .....	<b>4.1868</b> E+03
British thermal unit <sub>th</sub> per pound degree Fahrenheit [Btu <sub>th</sub> /(lb · °F)] .....	joule per kilogram kelvin [J/(kg · K)] .....	<b>4.184</b> E+03
British thermal unit <sub>IT</sub> per pound degree Rankine [Btu <sub>IT</sub> /(lb · °R)] .....	joule per kilogram kelvin [J/(kg · K)] .....	<b>4.1868</b> E+03
British thermal unit <sub>th</sub> per pound degree Rankine [Btu <sub>th</sub> /(lb · °R)].....	joule per kilogram kelvin [J/(kg · K)] .....	<b>4.184</b> E+03
British thermal unit <sub>IT</sub> per second (Btu <sub>IT</sub> /s).....	watt (W) .....	1.055 056 E+03
British thermal unit <sub>th</sub> per second (Btu <sub>th</sub> /s).....	watt (W) .....	1.054 350 E+03

<sup>11</sup> The Fifth International Conference on the Properties of Steam (London, July 1956) defined the International Table calorie as 4.1868 J. Therefore the exact conversion factor for the International Table Btu is 1.055 055 852 62 kJ. Note that the notation for the International Table used in this listing is subscript "IT". Similarly, the notation for thermochemical is subscript "th." Further, the thermochemical Btu, Btu<sub>th</sub>, is based on the thermochemical calorie, cal<sub>th</sub>, where cal<sub>th</sub> = 4.184 J exactly.

To convert from	to	Multiply by
British thermal unit <sub>IT</sub> per second square foot degree Fahrenheit [Btu <sub>IT</sub> /(s · ft <sup>2</sup> · °F)]	watt per square meter kelvin [W/(m <sup>2</sup> · K)]	2.044 175 E+04
British thermal unit <sub>th</sub> per second square foot degree Fahrenheit [Btu <sub>th</sub> /(s · ft <sup>2</sup> · °F)]	watt per square meter kelvin [W/(m <sup>2</sup> · K)]	2.042 808 E+04
British thermal unit <sub>IT</sub> per square foot (Btu <sub>IT</sub> /ft <sup>2</sup> )	joule per square meter (J/m <sup>2</sup> )	1.135 653 E+04
British thermal unit <sub>th</sub> per square foot (Btu <sub>th</sub> /ft <sup>2</sup> )	joule per square meter (J/m <sup>2</sup> )	1.134 893 E+04
British thermal unit <sub>IT</sub> per square foot hour [(Btu <sub>IT</sub> /(ft <sup>2</sup> · h))]	watt per square meter (W/m <sup>2</sup> )	3.154 591 E+00
British thermal unit <sub>th</sub> per square foot hour [Btu <sub>th</sub> /(ft <sup>2</sup> · h)]	watt per square meter (W/m <sup>2</sup> )	3.152 481 E+00
British thermal unit <sub>th</sub> per square foot minute [Btu <sub>th</sub> /(ft <sup>2</sup> · min)]	watt per square meter (W/m <sup>2</sup> )	1.891 489 E+02
British thermal unit <sub>IT</sub> per square foot second [(Btu <sub>IT</sub> /(ft <sup>2</sup> · s))]	watt per square meter (W/m <sup>2</sup> )	1.135 653 E+04
British thermal unit <sub>th</sub> per square foot second [Btu <sub>th</sub> /(ft <sup>2</sup> · s)]	watt per square meter (W/m <sup>2</sup> )	1.134 893 E+04
British thermal unit <sub>th</sub> per square inch second [Btu <sub>th</sub> /(in <sup>2</sup> · s)]	watt per square meter (W/m <sup>2</sup> )	1.634 246 E+06
bushel (U.S.) (bu)	cubic meter (m <sup>3</sup> )	3.523 907 E-02
bushel (U.S.) (bu)	liter (L)	3.523 907 E+01
calorie <sub>IT</sub> (cal <sub>IT</sub> ) <sup>11</sup>	joule (J)	<b>4.1868</b> E+00
calorie <sub>th</sub> (cal <sub>th</sub> ) <sup>11</sup>	joule (J)	<b>4.184</b> E+00
calorie (cal) (mean)	joule (J)	4.190 02 E+00
calorie (15 °C) (cal <sub>15</sub> )	joule (J)	4.185 80 E+00
calorie (20 °C) (cal <sub>20</sub> )	joule (J)	4.181 90 E+00
calorie <sub>IT</sub> , kilogram (nutrition) <sup>12</sup>	joule (J)	<b>4.1868</b> E+03
calorie <sub>th</sub> , kilogram (nutrition) <sup>12</sup>	joule (J)	<b>4.184</b> E+03
calorie (mean), kilogram (nutrition) <sup>12</sup>	joule (J)	4.190 02 E+03
calorie <sub>th</sub> per centimeter second degree Celsius [cal <sub>th</sub> /(cm · s · °C)]	watt per meter kelvin [W/(m · K)]	<b>4.184</b> E+02
calorie <sub>IT</sub> per gram (cal <sub>IT</sub> /g)	joule per kilogram (J/kg)	<b>4.1868</b> E+03
calorie <sub>th</sub> per gram (cal <sub>th</sub> /g)	joule per kilogram (J/kg)	<b>4.184</b> E+03
calorie <sub>IT</sub> per gram degree Celsius [cal <sub>IT</sub> /(g · °C)]	joule per kilogram kelvin [J/(kg · K)]	<b>4.1868</b> E+03
calorie <sub>th</sub> per gram degree Celsius [cal <sub>th</sub> /(g · °C)]	joule per kilogram kelvin [J/(kg · K)]	<b>4.184</b> E+03
calorie <sub>IT</sub> per gram kelvin [cal <sub>IT</sub> /(g · K)]	joule per kilogram kelvin [J/(kg · K)]	<b>4.1868</b> E+03
calorie <sub>th</sub> per gram kelvin [cal <sub>th</sub> /(g · K)]	joule per kilogram kelvin [J/(kg · K)]	<b>4.184</b> E+03
calorie <sub>th</sub> per minute (cal <sub>th</sub> /min)	watt (W)	6.973 333 E-02
calorie <sub>th</sub> per second (cal <sub>th</sub> /s)	watt (W)	<b>4.184</b> E+00
calorie <sub>th</sub> per square centimeter (cal <sub>th</sub> /cm <sup>2</sup> )	joule per square meter (J/m <sup>2</sup> )	<b>4.184</b> E+04
calorie <sub>th</sub> per square centimeter minute [cal <sub>th</sub> /(cm <sup>2</sup> · min)]	watt per square meter (W/m <sup>2</sup> )	6.973 333 E+02
calorie <sub>th</sub> per square centimeter second [cal <sub>th</sub> /(cm <sup>2</sup> · s)]	watt per square meter (W/m <sup>2</sup> )	<b>4.184</b> E+04
candela per square inch (cd/in <sup>2</sup> )	candela per square meter (cd/m <sup>2</sup> )	1.550 003 E+03
carat, metric	kilogram (kg)	<b>2.0</b> E-04
carat, metric	gram (g)	<b>2.0</b> E-01
centimeter of mercury (0 °C) <sup>13</sup>	pascal (Pa)	1.333 22 E+03
centimeter of mercury (0 °C) <sup>13</sup>	kilopascal (kPa)	1.333 22 E+00
centimeter of mercury, conventional (cmHg) <sup>13</sup>	pascal (Pa)	1.333 224 E+03

<sup>12</sup> The kilogram calorie or "large calorie" is an obsolete term used for the kilocalorie, which is the calorie used to express the energy content of foods. However, in practice, the prefix "kilo" is usually omitted.

<sup>13</sup> Conversion factors for mercury manometer pressure units are calculated using the standard value for the acceleration of gravity and the density of mercury at the stated temperature. Additional digits are not justified because the definitions of the units do not take into account the compressibility of mercury or the change in density caused by the revised practical temperature scale, ITS-90. Similar comments also apply to water manometer pressure units. Conversion factors for conventional mercury and water manometer pressure units are based on ISO 31-3.



To convert from	to	Multiply by
centimeter of mercury, conventional (cmHg) <sup>13</sup>	kilopascal (kPa)	1.333 224 E+00
centimeter of water (4 °C) <sup>13</sup>	pascal (Pa)	9.806 38 E+01
centimeter of water, conventional (cmH <sub>2</sub> O) <sup>13</sup>	pascal (Pa)	<b>9.806 65 E+01</b>
centipoise (cP)	pascal second (Pa · s)	<b>1.0 E-03</b>
centistokes (cSt)	meter squared per second (m <sup>2</sup> /s)	<b>1.0 E-06</b>
chain (based on U.S. survey foot) (ch) <sup>9</sup>	meter (m)	2.011 684 E+01
circular mil	square meter (m <sup>2</sup> )	5.067 075 E-10
circular mil	square millimeter (mm <sup>2</sup> )	5.067 075 E-04
clo	square meter kelvin per watt (m <sup>2</sup> · K/W)	1.55 E-01
cord (128 ft <sup>3</sup> )	cubic meter (m <sup>3</sup> )	3.624 556 E+00
cubic foot (ft <sup>3</sup> )	cubic meter (m <sup>3</sup> )	2.831 685 E-02
cubic foot per minute (ft <sup>3</sup> /min)	cubic meter per second (m <sup>3</sup> /s)	4.719 474 E-04
cubic foot per minute (ft <sup>3</sup> /min)	liter per second (L/s)	4.719 474 E-01
cubic foot per second (ft <sup>3</sup> /s)	cubic meter per second (m <sup>3</sup> /s)	2.831 685 E-02
cubic inch (in <sup>3</sup> ) <sup>14</sup>	cubic meter (m <sup>3</sup> )	1.638 706 E-05
cubic inch per minute (in <sup>3</sup> /min)	cubic meter per second (m <sup>3</sup> /s)	2.731 177 E-07
cubic mile (mi <sup>3</sup> )	cubic meter (m <sup>3</sup> )	4.168 182 E+09
cubic yard (yd <sup>3</sup> )	cubic meter (m <sup>3</sup> )	7.645 549 E-01
cubic yard per minute (yd <sup>3</sup> /min)	cubic meter per second (m <sup>3</sup> /s)	1.274 258 E-02
cup (U.S.)	cubic meter (m <sup>3</sup> )	2.365 882 E-04
cup (U.S.)	liter (L)	2.365 882 E-01
cup (U.S.)	milliliter (mL)	2.365 882 E+02
curie (Ci)	becquerel (Bq)	<b>3.7 E+10</b>
darcy <sup>15</sup>	meter squared (m <sup>2</sup> )	9.869 233 E-13
day (d)	second (s)	<b>8.64 E+04</b>
day (sidereal)	second (s)	8.616 409 E+04
debye (D)	coulomb meter (C · m)	3.335 641 E-30
degree (angle) (°)	radian (rad)	1.745 329 E-02
degree Celsius (temperature) (°C)	kelvin (K)	$T/K = t/°C + 273.15$
degree Celsius (temperature interval) (°C)	kelvin (K)	<b>1.0 E+00</b>
degree centigrade (temperature) <sup>16</sup>	degree Celsius (°C)	$t/°C \approx t/\text{deg.cent.}$
degree centigrade (temperature interval) <sup>16</sup>	degree Celsius (°C)	1.0 E+00
degree Fahrenheit (temperature) (°F)	degree Celsius (°C)	$t/°C = (t/°F - 32)/1.8$
degree Fahrenheit (temperature) (°F)	kelvin (K)	$T/K = (t/°F + 459.67)/1.8$
degree Fahrenheit (temperature interval) (°F)	degree Celsius (°C)	5.555 556 E-01
degree Fahrenheit (temperature interval) (°F)	kelvin (K)	5.555 556 E-01
degree Fahrenheit hour per British thermal unit <sub>T</sub> (°F · h/Btu <sub>T</sub> )	kelvin per watt (K/W)	1.895 634 E+00
degree Fahrenheit hour per British thermal unit <sub>th</sub> (°F · h/Btu <sub>th</sub> )	kelvin per watt (K/W)	1.896 903 E+00
degree Fahrenheit hour square foot per British thermal unit <sub>T</sub> (°F · h · ft <sup>2</sup> /Btu <sub>T</sub> )	square meter kelvin per watt (m <sup>2</sup> · K/W)	1.761 102 E-01
degree Fahrenheit hour square foot per British thermal unit <sub>th</sub> (°F · h · ft <sup>2</sup> /Btu <sub>th</sub> )	square meter kelvin per watt (m <sup>2</sup> · K/W)	1.762 280 E-01
degree Fahrenheit hour square foot per British thermal unit <sub>T</sub> inch [°F · h · ft <sup>2</sup> /(Btu <sub>T</sub> · in)]	meter kelvin per watt (m · K/W)	6.933 472 E+00
degree Fahrenheit hour square foot per British thermal unit <sub>th</sub> inch [°F · h · ft <sup>2</sup> /(Btu <sub>th</sub> · in)]	meter kelvin per watt (m · K/W)	6.938 112 E+00
degree Fahrenheit second per British thermal unit <sub>T</sub> (°F · s/Btu <sub>T</sub> )	kelvin per watt (K/W)	5.265 651 E-04
degree Fahrenheit second per British thermal unit <sub>th</sub> (°F · s/Btu <sub>th</sub> )	kelvin per watt (K/W)	5.269 175 E-04
degree Rankine (°R)	kelvin (K)	$T/K = (T/°R)/1.8$
degree Rankine (temperature interval) (°R)	kelvin (K)	5.555 556 E-01
denier	kilogram per meter (kg/m)	1.111 111 E-07
denier	gram per meter (g/m)	1.111 111 E-04
dyne (dyn)	newton (N)	<b>1.0 E-05</b>
dyne centimeter (dyn · cm)	newton meter (N · m)	<b>1.0 E-07</b>
dyne per square centimeter (dyn/cm <sup>2</sup> )	pascal (Pa)	<b>1.0 E-01</b>

<sup>14</sup> The exact conversion factor is 1.638 706 4 E-05.

<sup>15</sup> The darcy is a unit for expressing the permeability of porous solids, not area.

<sup>16</sup> The centigrade temperature scale is obsolete; the degree centigrade is only approximately equal to the degree Celsius.

To convert from	to	Multiply by	
electronvolt (eV)	joule (J)	1.602 177	E-19
EMU of capacitance (abfarad)	farad (F)	<b>1.0</b>	<b>E+09</b>
EMU of current (abampere)	ampere (A)	<b>1.0</b>	<b>E+01</b>
EMU of electric potential (abvolt)	volt (V)	<b>1.0</b>	<b>E-08</b>
EMU of inductance (abhenry)	henry (H)	<b>1.0</b>	<b>E-09</b>
EMU of resistance (abohm)	ohm ( $\Omega$ )	<b>1.0</b>	<b>E-09</b>
erg (erg)	joule (J)	<b>1.0</b>	<b>E-07</b>
erg per second (erg/s)	watt (W)	<b>1.0</b>	<b>E-07</b>
erg per square centimeter second [erg/(cm <sup>2</sup> · s)]	watt per square meter (W/m <sup>2</sup> )	<b>1.0</b>	<b>E-03</b>
ESU of capacitance (statfarad)	farad (F)	1.112 650	E-12
ESU of current (statampere)	ampere (A)	3.335 641	E-10
ESU of electric potential (statvolt)	volt (V)	2.997 925	E+02
ESU of inductance (stathenry)	henry (H)	8.987 552	E+11
ESU of resistance (statohm)	ohm ( $\Omega$ )	8.987 552	E+11
faraday (based on carbon 12)	coulomb (C)	9.648 531	E+04
fathom (based on U.S. survey foot) <sup>9</sup>	meter (m)	1.828 804	E+00
fermi	meter (m)	<b>1.0</b>	<b>E-15</b>
fermi	femtometer (fm)	<b>1.0</b>	<b>E+00</b>
fluid ounce (U.S.) (fl oz)	cubic meter (m <sup>3</sup> )	2.957 353	E-05
fluid ounce (U.S.) (fl oz)	milliliter (mL)	2.957 353	E+01
foot (ft)	meter (m)	<b>3.048</b>	<b>E-01</b>
foot (U.S. survey ft) <sup>9</sup>	meter (m)	3.048 006	E-01
footcandle	lux (lx)	1.076 391	E+01
footlambert	candela per square meter (cd/m <sup>2</sup> )	3.426 259	E+00
foot of mercury, conventional (ftHg) <sup>13</sup>	pascal (Pa)	4.063 666	E+04
foot of mercury, conventional (ftHg) <sup>13</sup>	kilopascal (kPa)	4.063 666	E+01
foot of water (39.2 °F) <sup>13</sup>	pascal (Pa)	2.988 98	E+03
foot of water (39.2 °F) <sup>13</sup>	kilopascal (kPa)	2.988 98	E+00
foot of water, conventional (ftH <sub>2</sub> O) <sup>13</sup>	pascal (Pa)	2.989 067	E+03
foot of water, conventional (ftH <sub>2</sub> O) <sup>13</sup>	kilopascal (kPa)	2.989 067	E+00
foot per hour (ft/h)	meter per second (m/s)	8.466 667	E-05
foot per minute (ft/min)	meter per second (m/s)	<b>5.08</b>	<b>E-03</b>
foot per second (ft/s)	meter per second (m/s)	<b>3.048</b>	<b>E-01</b>
foot per second squared (ft/s <sup>2</sup> )	meter per second squared (m/s <sup>2</sup> )	<b>3.048</b>	<b>E-01</b>
foot poundal	joule (J)	4.214 011	E-02
foot pound-force (ft · lbf)	joule (J)	1.355 818	E+00
foot pound-force per hour (ft · lbf/h)	watt (W)	3.766 161	E-04
foot pound-force per minute (ft · lbf/min)	watt (W)	2.259 697	E-02
foot pound-force per second (ft · lbf/s)	watt (W)	1.355 818	E+00
foot to the fourth power (ft <sup>4</sup> ) <sup>17</sup>	meter to the fourth power (m <sup>4</sup> )	8.630 975	E-03
franklin (Fr)	coulomb (C)	3.335 641	E-10
gal (Gal)	meter per second squared (m/s <sup>2</sup> )	<b>1.0</b>	<b>E-02</b>
gallon [Canadian and U.K. (Imperial)] (gal)	cubic meter (m <sup>3</sup> )	<b>4.546 09</b>	<b>E-03</b>
gallon [Canadian and U.K. (Imperial)] (gal)	liter (L)	<b>4.546 09</b>	<b>E+00</b>
gallon (U.S.) (gal)	cubic meter (m <sup>3</sup> )	3.785 412	E-03
gallon (U.S.) (gal)	liter (L)	3.785 412	E+00
gallon (U.S.) per day (gal/d)	cubic meter per second (m <sup>3</sup> /s)	4.381 264	E-08
gallon (U.S.) per day (gal/d)	liter per second (L/s)	4.381 264	E-05
gallon (U.S.) per horsepower hour [gal/(hp · h)]	cubic meter per joule (m <sup>3</sup> /J)	1.410 089	E-09
gallon (U.S.) per horsepower hour [gal/(hp · h)]	liter per joule (L/J)	1.410 089	E-06
gallon (U.S.) per minute (gpm)(gal/min)	cubic meter per second (m <sup>3</sup> /s)	6.309 020	E-05
gallon (U.S.) per minute (gpm)(gal/min)	liter per second (L/s)	6.309 020	E-02
gamma ( $\gamma$ )	tesla (T)	<b>1.0</b>	<b>E-09</b>
gauss (Gs, G)	tesla (T)	<b>1.0</b>	<b>E-04</b>
gilbert (Gi)	ampere (A)	7.957 747	E-01

<sup>17</sup> This is a unit for the quantity second moment of area, which is sometimes called the "moment of section" or "area moment of inertia" of a plane section about a specified axis.

To convert from	to	Multiply by	
gill [Canadian and U.K. (Imperial)] (gi)	cubic meter (m <sup>3</sup> )	1.420 653	E-04
gill [Canadian and U.K. (Imperial)] (gi)	liter (L)	1.420 653	E-01
gill (U.S.) (gi)	cubic meter (m <sup>3</sup> )	1.182 941	E-04
gill (U.S.) (gi)	liter (L)	1.182 941	E-01
gon (also called grade) (gon)	radian (rad)	1.570 796	E-02
gon (also called grade) (gon)	degree (angle) (°)	<b>9.0</b>	<b>E-01</b>
grain (gr)	kilogram (kg)	<b>6.479 891</b>	<b>E-05</b>
grain (gr)	milligram (mg)	<b>6.479 891</b>	<b>E+01</b>
grain per gallon (U.S.) (gr/gal)	kilogram per cubic meter (kg/m <sup>3</sup> )	1.711 806	E-02
grain per gallon (U.S.) (gr/gal)	milligram per liter (mg/L)	1.711 806	E+01
gram-force per square centimeter (gf/cm <sup>2</sup> )	pascal (Pa)	<b>9.806 65</b>	<b>E+01</b>
gram per cubic centimeter (g/cm <sup>3</sup> )	kilogram per cubic meter (kg/m <sup>3</sup> )	<b>1.0</b>	<b>E+03</b>
hectare (ha)	square meter (m <sup>2</sup> )	<b>1.0</b>	<b>E+04</b>
horsepower (550 ft · lbf/s) (hp)	watt (W)	7.456 999	E+02
horsepower (boiler)	watt (W)	9.809 50	E+03
horsepower (electric)	watt (W)	<b>7.46</b>	<b>E+02</b>
horsepower (metric)	watt (W)	7.354 988	E+02
horsepower (U.K.)	watt (W)	7.4570	E+02
horsepower (water)	watt (W)	7.460 43	E+02
hour (h)	second (s)	<b>3.6</b>	<b>E+03</b>
hour (sidereal)	second (s)	3.590 170	E+03
hundredweight (long, 112 lb)	kilogram (kg)	5.080 235	E+01
hundredweight (short, 100 lb)	kilogram (kg)	4.535 924	E+01
inch (in)	meter (m)	<b>2.54</b>	<b>E-02</b>
inch (in)	centimeter (cm)	<b>2.54</b>	<b>E+00</b>
inch of mercury (32 °F) <sup>13</sup>	pascal (Pa)	3.386 38	E+03
inch of mercury (32 °F) <sup>13</sup>	kilopascal (kPa)	3.386 38	E+00
inch of mercury (60 °F) <sup>13</sup>	pascal (Pa)	3.376 85	E+03
inch of mercury (60 °F) <sup>13</sup>	kilopascal (kPa)	3.376 85	E+00
inch of mercury, conventional (inHg) <sup>13</sup>	pascal (Pa)	3.386 389	E+03
inch of mercury, conventional (inHg) <sup>13</sup>	kilopascal (kPa)	3.386 389	E+00
inch of water (39.2 °F) <sup>13</sup>	pascal (Pa)	2.490 82	E+02
inch of water (60 °F) <sup>13</sup>	pascal (Pa)	2.4884	E+02
inch of water, conventional (inH <sub>2</sub> O) <sup>13</sup>	pascal (Pa)	2.490 889	E+02
inch per second (in/s)	meter per second (m/s)	<b>2.54</b>	<b>E-02</b>
inch per second squared (in/s <sup>2</sup> )	meter per second squared (m/s <sup>2</sup> )	<b>2.54</b>	<b>E-02</b>
inch to the fourth power (in <sup>4</sup> ) <sup>17</sup>	meter to the fourth power (m <sup>4</sup> )	4.162 314	E-07
kayser (K)	reciprocal meter (m <sup>-1</sup> )	<b>1.0</b>	<b>E+02</b>
kelvin (K)	degree Celsius (°C)	$t/°C = T/K - 273.15$	
kilocalorie <sub>IT</sub> (kcal <sub>IT</sub> )	joule (J)	<b>4.1868</b>	<b>E+03</b>
kilocalorie <sub>th</sub> (kcal <sub>th</sub> )	joule (J)	<b>4.184</b>	<b>E+03</b>
kilocalorie (mean) (kcal)	joule (J)	4.190 02	E+03
kilocalorie <sub>th</sub> per minute (kcal <sub>th</sub> /min)	watt (W)	6.973 333	E+01
kilocalorie <sub>th</sub> per second (kcal <sub>th</sub> /s)	watt (W)	<b>4.184</b>	<b>E+03</b>
kilogram-force (kgf)	newton (N)	<b>9.806 65</b>	<b>E+00</b>
kilogram-force meter (kgf · m)	newton meter (N · m)	<b>9.806 65</b>	<b>E+00</b>
kilogram-force per square centimeter (kgf/cm <sup>2</sup> )	pascal (Pa)	<b>9.806 65</b>	<b>E+04</b>
kilogram-force per square centimeter (kgf/cm <sup>2</sup> )	kilopascal (kPa)	<b>9.806 65</b>	<b>E+01</b>
kilogram-force per square meter (kgf/m <sup>2</sup> )	pascal (Pa)	<b>9.806 65</b>	<b>E+00</b>
kilogram-force per square millimeter (kgf/mm <sup>2</sup> )	pascal (Pa)	<b>9.806 65</b>	<b>E+06</b>
kilogram-force per square millimeter (kgf/mm <sup>2</sup> )	megapascal (MPa)	<b>9.806 65</b>	<b>E+00</b>
kilogram-force second squared per meter (kgf · s <sup>2</sup> /m)	kilogram (kg)	<b>9.806 65</b>	<b>E+00</b>
kilometer per hour (km/h)	meter per second (m/s)	2.777 778	E-01
kilopond (kilogram-force) (kp)	newton (N)	<b>9.806 65</b>	<b>E+00</b>
kilowatt hour (kW · h)	joule (J)	<b>3.6</b>	<b>E+06</b>
kilowatt hour (kW · h)	megajoule (MJ)	<b>3.6</b>	<b>E+00</b>

To convert from	to	Multiply by
kip (1 kip=1000 lbf) .....	newton (N).....	4.448 222 E+03
kip (1 kip=1000 lbf) .....	kilonewton (kN).....	4.448 222 E+00
kip per square inch (ksi) (kip/in <sup>2</sup> ) .....	pascal (Pa).....	6.894 757 E+06
kip per square inch (ksi) (kip/in <sup>2</sup> ) .....	kilopascal (kPa).....	6.894 757 E+03
<i>knot</i> (nautical mile per hour) .....	meter per second (m/s) .....	5.144 444 E-01
lambert <sup>18</sup> .....	candela per square meter (cd/m <sup>2</sup> ) .....	3.183 099 E+03
langley (cal <sub>th</sub> /cm <sup>2</sup> ).....	joule per square meter (J/m <sup>2</sup> ).....	<b>4.184 E+04</b>
light year (l.y.) <sup>19</sup> .....	meter (m) .....	9.460 73 E+15
<i>liter</i> (L) <sup>20</sup> .....	cubic meter (m <sup>3</sup> ) .....	<b>1.0 E-03</b>
lumen per square foot (lm/ft <sup>2</sup> ).....	lux (lx).....	1.076 391 E+01
maxwell (Mx).....	weber (Wb).....	<b>1.0 E-08</b>
mho.....	siemens (S) .....	<b>1.0 E+00</b>
microinch.....	meter (m) .....	<b>2.54 E-08</b>
microinch.....	micrometer (μm).....	<b>2.54 E-02</b>
micron (μ).....	meter (m) .....	<b>1.0 E-06</b>
micron (μ).....	micrometer (μm).....	<b>1.0 E+00</b>
mil (0.001 in).....	meter (m) .....	<b>2.54 E-05</b>
mil (0.001 in).....	millimeter (mm) .....	<b>2.54 E-02</b>
mil (angle).....	radian (rad).....	9.817 477 E-04
mil (angle).....	degree (°).....	<b>5.625 E-02</b>
mile (mi).....	meter (m) .....	<b>1.609 344 E+03</b>
mile (mi).....	kilometer (km) .....	<b>1.609 344 E+00</b>
mile (based on U.S. survey foot) (mi) <sup>9</sup> .....	meter (m) .....	1.609 347 E+03
mile (based on U.S. survey foot) (mi) <sup>9</sup> .....	kilometer (km) .....	1.609 347 E+00
<i>mile, nautical</i> <sup>21</sup> .....	meter (m) .....	<b>1.852 E+03</b>
mile per gallon (U.S.) (mpg) (mi/gal).....	meter per cubic meter (m/m <sup>3</sup> ).....	4.251 437 E+05
mile per gallon (U.S.) (mpg) (mi/gal).....	kilometer per liter (km/L).....	4.251 437 E-01
mile per gallon (U.S.) (mpg) (mi/gal) <sup>22</sup> .....	liter per 100 kilometer (L/100 km).....	divide 235.215 by number of miles per gallon
mile per hour (mi/h).....	meter per second (m/s) .....	<b>4.4704 E-01</b>
mile per hour (mi/h).....	kilometer per hour (km/h) .....	<b>1.609 344 E+00</b>
mile per minute (mi/min).....	meter per second (m/s) .....	<b>2.682 24 E+01</b>
mile per second (mi/s).....	meter per second (m/s) .....	<b>1.609 344 E+03</b>
millibar (mbar).....	pascal (Pa).....	<b>1.0 E+02</b>
millibar (mbar).....	kilopascal (kPa).....	<b>1.0 E-01</b>
millimeter of mercury, conventional (mmHg) <sup>13</sup> .....	pascal (Pa).....	1.333 224 E+02
millimeter of water, conventional (mmH <sub>2</sub> O) <sup>13</sup> .....	pascal (Pa).....	<b>9.806 65 E+00</b>
<i>minute</i> (angle) (') .....	radian (rad).....	2.908 882 E-04
<i>minute</i> (min) .....	second (s) .....	<b>6.0 E+01</b>
minute (sidereal).....	second (s) .....	5.983 617 E+01
nit.....	candela per meter squared (cd/m <sup>2</sup> ).....	<b>1.0 E+00</b>
nox.....	lux (lx).....	<b>1.0 E-03</b>
oersted (Oe).....	ampere per meter (A/m).....	7.957 747 E+01
<i>ohm centimeter</i> (Ω · cm).....	ohm meter (Ω · m).....	<b>1.0 E-02</b>
ohm circular-mil per foot.....	ohm meter (Ω · m).....	1.662 426 E-09
ohm circular-mil per foot.....	ohm square millimeter per meter (Ω · mm <sup>2</sup> /m).....	1.662 426 E-03
ounce (avoirdupois) (oz).....	kilogram (kg).....	2.834 952 E-02
ounce (avoirdupois) (oz).....	gram (g).....	2.834 952 E+01
ounce (troy or apothecary) (oz).....	kilogram (kg).....	3.110 348 E-02
ounce (troy or apothecary) (oz).....	gram (g).....	3.110 348 E+01
ounce [Canadian and U.K. fluid (Imperial)] (fl oz).....	cubic meter (m <sup>3</sup> ) .....	2.841 306 E-05

<sup>18</sup> The exact conversion factor is 10<sup>4</sup>/π.

<sup>19</sup> This conversion factor is based on 1 d = 86 400 s; and 1 Julian century = 36 525 d. (See *The Astronomical Almanac for the Year 1995*, page K6, U.S. Government Printing Office, Washington, DC, 1994.)

<sup>20</sup> In 1964 the General Conference on Weights and Measures reestablished the name "liter" as a special name for the cubic decimeter. Between 1901 and 1964 the liter was slightly larger (1.000 028 dm<sup>3</sup>); when one uses high-accuracy volume data of that time, this fact must be kept in mind.

<sup>21</sup> The value of this unit, 1 nautical mile = 1852 m, was adopted by the First International Extraordinary Hydrographic Conference, Monaco, 1929, under the name "International nautical mile."

<sup>22</sup> For converting fuel economy, as used in the U.S., to fuel consumption.

To convert from	to	Multiply by
ounce [Canadian and U.K. fluid (Imperial)] (fl oz).....	milliliter (mL).....	2.841 306 E+01
ounce (U.S. fluid) (fl oz).....	cubic meter (m <sup>3</sup> ).....	2.957 353 E-05
ounce (U.S. fluid) (fl oz).....	milliliter (mL).....	2.957 353 E+01
ounce (avoirdupois)-force (ozf).....	newton (N).....	2.780 139 E-01
ounce (avoirdupois)-force inch (ozf · in).....	newton meter (N · m).....	7.061 552 E-03
ounce (avoirdupois)-force inch (ozf · in).....	millinewton meter (mN · m).....	7.061 552 E+00
ounce (avoirdupois) per cubic inch (oz/in <sup>3</sup> ).....	kilogram per cubic meter (kg/m <sup>3</sup> ).....	1.729 994 E+03
ounce (avoirdupois) per gallon [Canadian and U.K. (Imperial)] (oz/gal).....	kilogram per cubic meter (kg/m <sup>3</sup> ).....	6.236 023 E+00
ounce (avoirdupois) per gallon [Canadian and U.K. (Imperial)] (oz/gal).....	gram per liter (g/L).....	6.236 023 E+00
ounce (avoirdupois) per gallon (U.S.)(oz/gal).....	kilogram per cubic meter (kg/m <sup>3</sup> ).....	7.489 152 E+00
ounce (avoirdupois) per gallon (U.S.)(oz/gal).....	gram per liter (g/L).....	7.489 152 E+00
ounce (avoirdupois) per square foot (oz/ft <sup>2</sup> ).....	kilogram per square meter (kg/m <sup>2</sup> ).....	3.051 517 E-01
ounce (avoirdupois) per square inch (oz/in <sup>2</sup> ).....	kilogram per square meter (kg/m <sup>2</sup> ).....	4.394 185 E+01
ounce (avoirdupois) per square yard(oz/yd <sup>2</sup> ).....	kilogram per square meter (kg/m <sup>2</sup> ).....	3.390 575 E-02
parsec (pc).....	meter (m).....	3.085 678 E+16
peck (U.S.) (pk).....	cubic meter (m <sup>3</sup> ).....	8.809 768 E-03
peck (U.S.) (pk).....	liter (L).....	8.809 768 E+00
pennyweight (dwt).....	kilogram (kg).....	1.555 174 E-03
pennyweight (dwt).....	gram (g).....	1.555 174 E+00
perm (0 °C).....	kilogram per pascal second square meter [kg/(Pa · s · m <sup>2</sup> )].....	5.721 35 E-11
perm (23 °C).....	kilogram per pascal second square meter [kg/(Pa · s · m <sup>2</sup> )].....	5.745 25 E-11
perm inch (0 °C).....	kilogram per pascal second meter [kg/(Pa · s · m)].....	1.453 22 E-12
perm inch (23 °C).....	kilogram per pascal second meter [kg/(Pa · s · m)].....	1.459 29 E-12
phot (ph).....	lux (lx).....	<b>1.0 E+04</b>
pica (computer) (1/6 in).....	meter (m).....	4.233 333 E-03
pica (computer) (1/6 in).....	millimeter (mm).....	4.233 333 E+00
pica (printer's).....	meter (m).....	4.217 518 E-03
pica (printer's).....	millimeter (mm).....	4.217 518 E+00
pint (U.S. dry) (dry pt).....	cubic meter (m <sup>3</sup> ).....	5.506 105 E-04
pint (U.S. dry) (dry pt).....	liter (L).....	5.506 105 E-01
pint (U.S. liquid) (liq pt).....	cubic meter (m <sup>3</sup> ).....	4.731 765 E-04
pint (U.S. liquid) (liq pt).....	liter (L).....	4.731 765 E-01
point (computer) (1/72 in).....	meter (m).....	3.527 778 E-04
point (computer) (1/72 in).....	millimeter (mm).....	3.527 778 E-01
point (printer's).....	meter (m).....	3.514 598 E-04
point (printer's).....	millimeter (mm).....	3.514 598 E-01
poise (P).....	pascal second (Pa · s).....	<b>1.0 E-01</b>
pound (avoirdupois) (lb) <sup>23</sup> .....	kilogram (kg).....	4.535 924 E-01
pound (troy or apothecary) (lb).....	kilogram (kg).....	3.732 417 E-01
poundal.....	newton (N).....	1.382 550 E-01
poundal per square foot.....	pascal (Pa).....	1.488 164 E+00
poundal second per square foot.....	pascal second (Pa · s).....	1.488 164 E+00
pound foot squared (lb · ft <sup>2</sup> ).....	kilogram meter squared (kg · m <sup>2</sup> ).....	4.214 011 E-02
pound-force (lbf) <sup>24</sup> .....	newton (N).....	4.448 222 E+00
pound-force foot (lbf · ft).....	newton meter (N · m).....	1.355 818 E+00
pound-force foot per inch (lbf · ft/in).....	newton meter per meter (N · m/m).....	5.337 866 E+01
pound-force inch (lbf · in).....	newton meter (N · m).....	1.129 848 E-01
pound-force inch per inch (lbf · in/in).....	newton meter per meter (N · m/m).....	4.448 222 E+00
pound-force per foot (lbf/ft).....	newton per meter (N/m).....	1.459 390 E+01
pound-force per inch (lbf/in).....	newton per meter (N/m).....	1.751 268 E+02
pound-force per pound (lbf/lb) (thrust to mass ratio).....	newton per kilogram (N/kg).....	<b>9.806 65 E+00</b>

<sup>23</sup> The exact conversion factor is 4.535 923 7 E-01. All units that contain the pound refer to the avoirdupois pound unless otherwise specified.

<sup>24</sup> If the local value of the acceleration of free fall is taken as  $g_n = 9.806 65 \text{ m/s}^2$  (the standard value), the exact conversion factor is 4.448 221 615 260 5 E+00.



To convert from	to	Multiply by	
pound-force per square foot (lbf/ft <sup>2</sup> )	pascal (Pa)	4.788 026	E+01
pound-force per square inch (psi) (lbf/in <sup>2</sup> )	pascal (Pa)	6.894 757	E+03
pound-force per square inch (psi) (lbf/in <sup>2</sup> )	kilopascal (kPa)	6.894 757	E+00
pound-force second per square foot (lbf · s/ft <sup>2</sup> )	pascal second (Pa · s)	4.788 026	E+01
pound-force second per square inch (lbf · s/in <sup>2</sup> )	pascal second (Pa · s)	6.894 757	E+03
pound inch squared (lb · in <sup>2</sup> )	kilogram meter squared (kg · m <sup>2</sup> )	2.926 397	E−04
pound per cubic foot (lb/ft <sup>3</sup> )	kilogram per cubic meter (kg/m <sup>3</sup> )	1.601 846	E+01
pound per cubic inch (lb/in <sup>3</sup> )	kilogram per cubic meter (kg/m <sup>3</sup> )	2.767 990	E+04
pound per cubic yard (lb/yd <sup>3</sup> )	kilogram per cubic meter (kg/m <sup>3</sup> )	5.932 764	E−01
pound per foot (lb/ft)	kilogram per meter (kg/m)	1.488 164	E+00
pound per foot hour [lb/(ft · h)]	pascal second (Pa · s)	4.133 789	E−04
pound per foot second [lb/(ft · s)]	pascal second (Pa · s)	1.488 164	E+00
pound per gallon [Canadian and U.K. (Imperial)] (lb/gal)	kilogram per cubic meter (kg/m <sup>3</sup> )	9.977 637	E+01
pound per gallon [Canadian and U.K. (Imperial)] (lb/gal)	kilogram per liter (kg/L)	9.977 637	E−02
pound per gallon (U.S.) (lb/gal)	kilogram per cubic meter (kg/m <sup>3</sup> )	1.198 264	E+02
pound per gallon (U.S.) (lb/gal)	kilogram per liter (kg/L)	1.198 264	E−01
pound per horsepower hour [lb/(hp · h)]	kilogram per joule (kg/J)	1.689 659	E−07
pound per hour (lb/h)	kilogram per second (kg/s)	1.259 979	E−04
pound per inch (lb/in)	kilogram per meter (kg/m)	1.785 797	E+01
pound per minute (lb/min)	kilogram per second (kg/s)	7.559 873	E−03
pound per second (lb/s)	kilogram per second (kg/s)	4.535 924	E−01
pound per square foot (lb/ft <sup>2</sup> )	kilogram per square meter (kg/m <sup>2</sup> )	4.882 428	E+00
pound per square inch ( <i>not</i> pound-force) (lb/in <sup>2</sup> )	kilogram per square meter (kg/m <sup>2</sup> )	7.030 696	E+02
pound per yard (lb/yd)	kilogram per meter (kg/m)	4.960 546	E−01
psi (pound-force per square inch) (lbf/in <sup>2</sup> )	pascal (Pa)	6.894 757	E+03
psi (pound-force per square inch) (lbf/in <sup>2</sup> )	kilopascal (kPa)	6.894 757	E+00
quad (10 <sup>15</sup> Btu <sub>T</sub> ) <sup>11</sup>	joule (J)	1.055 056	E+18
quart (U.S. dry) (dry qt)	cubic meter (m <sup>3</sup> )	1.101 221	E−03
quart (U.S. dry) (dry qt)	liter (L)	1.101 221	E+00
quart (U.S. liquid) (liq qt)	cubic meter (m <sup>3</sup> )	9.463 529	E−04
quart (U.S. liquid) (liq qt)	liter (L)	9.463 529	E−01
rad (absorbed dose) (rad)	gray (Gy)	<b>1.0</b>	<b>E−02</b>
rem (rem)	sievert (Sv)	<b>1.0</b>	<b>E−02</b>
revolution (r)	radian (rad)	6.283 185	E+00
revolution per minute (rpm) (r/min)	radian per second (rad/s)	1.047 198	E−01
rhe	reciprocal pascal second [(Pa · s) <sup>−1</sup> ]	<b>1.0</b>	<b>E+01</b>
rod (based on U.S. survey foot) (rd) <sup>9</sup>	meter (m)	5.029 210	E+00
roentgen (R)	coulomb per kilogram (C/kg)	<b>2.58</b>	<b>E−04</b>
rpm (revolution per minute) (r/min)	radian per second (rad/s)	1.047 198	E−01
second (angle) (")	radian (rad)	4.848 137	E−06
second (sidereal)	second (s)	9.972 696	E−01
shake	second (s)	<b>1.0</b>	<b>E−08</b>
shake	nanosecond (ns)	<b>1.0</b>	<b>E+01</b>
skot	candela per meter squared (cd/m <sup>2</sup> )	3.183 098	E−04
slug (slug)	kilogram (kg)	1.459 390	E+01
slug per cubic foot (slug/ft <sup>3</sup> )	kilogram per cubic meter (kg/m <sup>3</sup> )	5.153 788	E+02
slug per foot second [slug/(ft · s)]	pascal second (Pa · s)	4.788 026	E+01
square foot (ft <sup>2</sup> )	square meter (m <sup>2</sup> )	<b>9.290 304</b>	<b>E−02</b>
square foot per hour (ft <sup>2</sup> /h)	square meter per second (m <sup>2</sup> /s)	<b>2.580 64</b>	<b>E−05</b>
square foot per second (ft <sup>2</sup> /s)	square meter per second (m <sup>2</sup> /s)	<b>9.290 304</b>	<b>E−02</b>
square inch (in <sup>2</sup> )	square meter (m <sup>2</sup> )	<b>6.4516</b>	<b>E−04</b>
square inch (in <sup>2</sup> )	square centimeter (cm <sup>2</sup> )	<b>6.4516</b>	<b>E+00</b>
square mile (mi <sup>2</sup> )	square meter (m <sup>2</sup> )	2.589 988	E+06
square mile (mi <sup>2</sup> )	square kilometer (km <sup>2</sup> )	2.589 988	E+00

To convert from	to	Multiply by	mile
square (based on U.S. survey foot) (mi <sup>2</sup> ) <sup>9</sup>	square meter (m <sup>2</sup> )	2.589 998	E+06
square mile (based on U.S. survey foot) (mi <sup>2</sup> ) <sup>9</sup>	square kilometer (km <sup>2</sup> )	2.589 998	E+00
square yard (yd <sup>2</sup> )	square meter (m <sup>2</sup> )	8.361 274	E-01
statampere	ampere (A)	3.335 641	E-10
statcoulomb	coulomb (C)	3.335 641	E-10
statfarad	farad (F)	1.112 650	E-12
stathenry	henry (H)	8.987 552	E+11
statmho	siemens (S)	1.112 650	E-12
statohm	ohm (Ω)	8.987 552	E+11
statvolt	volt (V)	2.997 925	E+02
stere (st)	cubic meter (m <sup>3</sup> )	<b>1.0</b>	<b>E+00</b>
stilb (sb)	candela per square meter (cd/m <sup>2</sup> )	<b>1.0</b>	<b>E+04</b>
stokes (St)	meter squared per second (m <sup>2</sup> /s)	<b>1.0</b>	<b>E-04</b>
tablespoon	cubic meter (m <sup>3</sup> )	1.478 676	E-05
tablespoon	milliliter (mL)	1.478 676	E+01
teaspoon	cubic meter (m <sup>3</sup> )	4.928 922	E-06
teaspoon	milliliter (mL)	4.928 922	E+00
tex	kilogram per meter (kg/m)	<b>1.0</b>	<b>E-06</b>
therm (EC) <sup>25</sup>	joule (J)	<b>1.055 06</b>	<b>E+08</b>
therm (U.S.) <sup>25</sup>	joule (J)	<b>1.054 804</b>	<b>E+08</b>
ton, assay (AT)	kilogram (kg)	2.916 667	E-02
ton, assay (AT)	gram (g)	2.916 667	E+01
ton-force (2000 lbf)	newton (N)	8.896 443	E+03
ton-force (2000 lbf)	kilonewton (kN)	8.896 443	E+00
ton, long (2240 lb)	kilogram (kg)	1.016 047	E+03
ton, long, per cubic yard	kilogram per cubic meter (kg/m <sup>3</sup> )	1.328 939	E+03
ton, metric (t)	kilogram (kg)	<b>1.0</b>	<b>E+03</b>
tonne (called "metric ton" in U.S.) (t)	kilogram (kg)	<b>1.0</b>	<b>E+03</b>
ton of refrigeration (12 000 Btu <sub>IT</sub> /h)	watt (W)	3.516 853	E+03
ton of TNT (energy equivalent) <sup>26</sup>	joule (J)	<b>4.184</b>	<b>E+09</b>
ton, register	cubic meter (m <sup>3</sup> )	2.831 685	E+00
ton, short (2000 lb)	kilogram (kg)	9.071 847	E+02
ton, short, per cubic yard	kilogram per cubic meter (kg/m <sup>3</sup> )	1.186 553	E+03
ton, short, per hour	kilogram per second (kg/s)	2.519 958	E-01
torr (Torr)	pascal (Pa)	1.333 224	E+02
unit pole	weber (Wb)	1.256 637	E-07
watt hour (W · h)	joule (J)	<b>3.6</b>	<b>E+03</b>
watt per square centimeter (W/cm <sup>2</sup> )	watt per square meter (W/m <sup>2</sup> )	<b>1.0</b>	<b>E+04</b>
watt per square inch (W/in <sup>2</sup> )	watt per square meter (W/m <sup>2</sup> )	1.550 003	E+03
watt second (W · s)	joule (J)	<b>1.0</b>	<b>E+00</b>
yard (yd)	meter (m)	<b>9.144</b>	<b>E-01</b>
year (365 days)	second (s)	<b>3.1536</b>	<b>E+07</b>
year (sidereal)	second (s)	3.155 815	E+07
year (tropical)	second (s)	3.155 693	E+07

<sup>25</sup> The therm (EC) is legally defined in the Council Directive of 20 December 1979, Council of the European Communities (now the European Union, EU). The therm (U.S.) is legally defined in the Federal Register of July 27, 1968. Although the therm (EC), which is based on the International Table Btu, is frequently used by engineers in the United States, the therm (U.S.) is the legal unit used by the U.S natural gas industry.

<sup>26</sup> Defined (not measured) value.

## CONVERSION OF TEMPERATURES

<b>From</b>	<b>To</b>	
Celsius	Fahrenheit	$t_F/^{\circ}\text{F} = (9/5) t/^{\circ}\text{C} + 32$
	Kelvin	$T/\text{K} = t/^{\circ}\text{C} + 273.15$
	Rankine	$T/^{\circ}\text{R} = (9/5) (t/^{\circ}\text{C} + 273.15)$
Fahrenheit	Celsius	$t/^{\circ}\text{C} = (5/9) [(t_F/^{\circ}\text{F}) - 32]$
	Kelvin	$T/\text{K} = (5/9) [(t_F/^{\circ}\text{F}) - 32] + 273.15$
	Rankine	$T/^{\circ}\text{R} = t_F/^{\circ}\text{F} + 459.67$
Kelvin	Celsius	$t/^{\circ}\text{C} = T/\text{K} - 273.15$
	Rankine	$T/^{\circ}\text{R} = (9/5) T/\text{K}$
Rankine	Fahrenheit	$t_F/^{\circ}\text{F} = T/^{\circ}\text{R} - 459.67$
	Kelvin	$T/\text{K} = (5/9) T/^{\circ}\text{R}$

Definition of symbols:

$T$  = thermodynamic (absolute) temperature

$t$  = Celsius temperature (the symbol  $\theta$  is also used for Celsius temperature)

$t_F$  = Fahrenheit temperature

### Designation of Large Numbers

	U.S.A.	Other countries
$10^6$	million	million
$10^9$	billion	milliard
$10^{12}$	trillion	billion
$10^{15}$	quadrillion	billiard
$10^{18}$	quintillion	trillion
$100^{100}$	googol	
$10^{\text{googol}}$	googolplex	



## CONVERSION FACTORS FOR ENERGY UNITS

If greater accuracy is required, use the *Energy Equivalents* section of the *Fundamental Physical Constants* table.

	Wavenumber $\bar{\nu}$ cm <sup>-1</sup>	Frequency $\nu$ MHz	Energy $E$ aj	Energy $E$ eV	Energy $E$ $E_h$	Molar energy $E_m$ kJ/mol	Molar energy $E_m$ kcal/mol	Temperature $T$ K
$\bar{\nu}$ : 1 cm <sup>-1</sup>	$\doteq 1$	$2.997925 \times 10^4$	$1.986447 \times 10^{-5}$	$1.239842 \times 10^{-4}$	$4.556335 \times 10^{-6}$	$11.96266 \times 10^{-3}$	$2.85914 \times 10^{-3}$	1.438769
$\nu$ : 1 MHz	$\doteq 3.33564 \times 10^{-5}$	1	$6.626076 \times 10^{-10}$	$4.135669 \times 10^{-9}$	$1.519830 \times 10^{-10}$	$3.990313 \times 10^{-7}$	$9.53708 \times 10^{-8}$	$4.79922 \times 10^{-5}$
1 aj	$\doteq 50341.1$	$1.509189 \times 10^9$	1	6.241506	0.2293710	602.2137	143.9325	$7.24292 \times 10^4$
$E$ : 1 eV	$\doteq 8065.54$	$2.417988 \times 10^8$	0.1602177	1	$3.674931 \times 10^{-2}$	96.4853	23.0605	$1.16045 \times 10^4$
$E_h$	$\doteq 219474.63$	$6.579684 \times 10^9$	4.359748	27.2114	1	2625.500	627.510	$3.15773 \times 10^5$
$E_m$ : 1 kJ/mol	$\doteq 83.5935$	$2.506069 \times 10^6$	$1.660540 \times 10^{-3}$	$1.036427 \times 10^{-2}$	$3.808798 \times 10^{-4}$	1	0.239006	120.272
1 kcal/mol	$\doteq 349.755$	$1.048539 \times 10^7$	$6.947700 \times 10^{-3}$	$4.336411 \times 10^{-2}$	$1.593601 \times 10^{-3}$	4.184	1	503.217
$T$ : 1 K	$\doteq 0.695039$	$2.08367 \times 10^4$	$1.380658 \times 10^{-5}$	$8.61738 \times 10^{-5}$	$3.16683 \times 10^{-6}$	$8.31451 \times 10^{-3}$	$1.98722 \times 10^{-3}$	1

Examples of the use of this table:

$$1 \text{ aj} \doteq 50341 \text{ cm}^{-1}$$

$$1 \text{ eV} \doteq 96.4853 \text{ kJ mol}^{-1}$$

The symbol  $\doteq$  should be read as meaning corresponds to or is equivalent to.

$$E = h\nu = hc\bar{\nu} = kT; E_m = N_A E; E_h \text{ is the Hartree energy}$$

## CONVERSION FACTORS FOR PRESSURE UNITS

	Pa	kPa	MPa	bar	atm	Torr	μmHg	psi
Pa	1	0.001	0.000001	0.00001	$9.8692 \times 10^{-6}$	0.0075006	7.5006	0.0001450377
kPa	1000	1	0.001	0.01	0.0098692	7.5006	7500.6	0.1450377
MPa	1000000	1000	1	10	9.8692	7500.6	7500600	145.0377
bar	100000	100	0.1	1	0.98692	750.06	750060	14.50377
atm	101325	101.325	0.101325	1.01325	1	760	760000	14.69594
Torr	133.322	0.133322	0.000133322	0.00133322	0.00131579	1	1000	0.01933672
μmHg	0.133322	0.000133322	$1.33322 \times 10^{-7}$	$1.33322 \times 10^{-6}$	$1.31579 \times 10^{-6}$	0.001	1	$1.933672 \times 10^{-5}$
psi	6894.757	6.894757	0.006894757	0.06894757	0.068046	51.7151	51715.1	1

To convert a pressure value from a unit in the left-hand column to a new unit, multiply the value by the factor appearing in the column for the new unit. For example:

$$1 \text{ kPa} = 9.8692 \times 10^{-3} \text{ atm}$$

$$1 \text{ Torr} = 1.33322 \times 10^{-4} \text{ MPa}$$

**Notes:** μmHg is often referred to as “micron”  
 Torr is essentially identical to mmHg  
 psi is an abbreviation for the unit pound–force per square inch  
 psia (as a term for a physical quantity) implies the true (absolute) pressure  
 psig implies the true pressure minus the local atmospheric pressure

## CONVERSION FACTORS FOR THERMAL CONDUCTIVITY UNITS

MULTIPLY ↓  
by  
appropriate  
factor to

OBTAIN →	$\text{Btu}_{\text{T}} \text{ft}^{-1} \text{ } ^\circ\text{F}^{-1}$	$\text{Btu}_{\text{T}} \text{in.} \text{ft}^{-2} \text{ } ^\circ\text{F}^{-1}$	$\text{Btu}_{\text{th}} \text{ft}^{-1} \text{ } ^\circ\text{F}^{-1}$	$\text{Btu}_{\text{th}} \text{in.} \text{ft}^{-2} \text{ } ^\circ\text{F}^{-1}$	$\text{cal}_{\text{T}} \text{s}^{-1} \text{cm}^{-1} \text{ } ^\circ\text{C}^{-1}$	$\text{cal}_{\text{th}} \text{s}^{-1} \text{cm}^{-1} \text{ } ^\circ\text{C}^{-1}$	$\text{kcal}_{\text{th}} \text{h}^{-1} \text{m}^{-1} \text{ } ^\circ\text{C}^{-1}$	$\text{J s}^{-1} \text{cm}^{-1} \text{K}^{-1}$	$\text{W cm}^{-1} \text{K}^{-1}$	$\text{W m}^{-1} \text{K}^{-1}$	$\text{mW cm}^{-1} \text{K}^{-1}$
$\text{Btu}_{\text{T}} \text{ft}^{-1} \text{ } ^\circ\text{F}^{-1}$	1	12	1.00067	12.0080	$4.13379 \times 10^{-3}$	$4.13656 \times 10^{-3}$	1.48916	$1.73073 \times 10^{-2}$	$1.73073 \times 10^{-2}$	1.73073	17.3073
$\text{Btu}_{\text{T}} \text{in.} \text{ft}^{-2} \text{ } ^\circ\text{F}^{-1}$	$8.33333 \times 10^{-2}$	1	$8.33891 \times 10^{-2}$	1.00067	$3.44482 \times 10^{-4}$	$3.44713 \times 10^{-4}$	0.124097	$1.44228 \times 10^{-3}$	$1.44228 \times 10^{-3}$	0.144228	1.44228
$\text{Btu}_{\text{th}} \text{ft}^{-1} \text{ } ^\circ\text{F}^{-1}$	0.999331	11.9920	1	12	$4.13102 \times 10^{-3}$	$4.13379 \times 10^{-3}$	1.48816	$1.72958 \times 10^{-2}$	$1.72958 \times 10^{-2}$	1.72958	17.2958
$\text{Btu}_{\text{th}} \text{in.} \text{ft}^{-2} \text{ } ^\circ\text{F}^{-1}$	$8.32776 \times 10^{-2}$	0.999331	$8.33333 \times 10^{-2}$	1	$3.44252 \times 10^{-4}$	$3.44482 \times 10^{-4}$	0.124014	$1.44131 \times 10^{-3}$	$1.44131 \times 10^{-3}$	0.144131	1.44131
$\text{cal}_{\text{T}} \text{s}^{-1} \text{cm}^{-1} \text{ } ^\circ\text{C}^{-1}$	$2.41909 \times 10^2$	$2.90291 \times 10^3$	$2.42071 \times 10^2$	$2.90485 \times 10^3$	1	1.00067	$3.60241 \times 10^2$	4.1868	4.1868	$4.1868 \times 10^2$	$4.1868 \times 10^3$
$\text{cal}_{\text{th}} \text{s}^{-1} \text{cm}^{-1} \text{ } ^\circ\text{C}^{-1}$	$2.41747 \times 10^2$	$2.90096 \times 10^3$	$2.41909 \times 10^2$	$2.90291 \times 10^3$	0.999331	1	$3.6 \times 10^2$	4.184	4.184	$4.184 \times 10^2$	$4.184 \times 10^3$
$\text{kcal}_{\text{th}} \text{h}^{-1} \text{m}^{-1} \text{ } ^\circ\text{C}^{-1}$	0.671520	8.05824	0.671969	8.06363	$2.77592 \times 10^{-3}$	$2.77778 \times 10^{-3}$	1	$1.16222 \times 10^{-2}$	$1.16222 \times 10^{-2}$	1.16222	11.6222
$\text{J s}^{-1} \text{cm}^{-1} \text{K}^{-1}$	57.7789	$6.93347 \times 10^2$	57.8176	$6.93811 \times 10^2$	0.238846	0.239006	86.0421	1	1	$1 \times 10^2$	$1 \times 10^3$
$\text{W cm}^{-1} \text{K}^{-1}$	57.7789	$6.93347 \times 10^2$	57.8176	$6.93811 \times 10^2$	0.238846	0.239006	86.0421	1	1	$1 \times 10^2$	$1 \times 10^3$
$\text{W m}^{-1} \text{K}^{-1}$	0.577789	6.93347	0.578176	6.93811	$2.38846 \times 10^{-3}$	$2.39006 \times 10^{-3}$	0.860421	$1 \times 10^{-2}$	$1 \times 10^{-2}$	1	10
$\text{mW cm}^{-1} \text{K}^{-1}$	$5.77789 \times 10^{-2}$	0.693347	$5.78176 \times 10^{-2}$	0.693811	$2.38846 \times 10^{-4}$	$2.39006 \times 10^{-4}$	$8.60421 \times 10^{-2}$	$1 \times 10^{-3}$	$1 \times 10^{-3}$	0.1	1

## CONVERSION FACTORS FOR ELECTRICAL RESISTIVITY UNITS

To convert FROM ↓ multiply by appropriate factor to OBTAIN →	abΩ cm	μΩ cm	Ω cm	StatΩ cm	Ω m	Ω cir. mil ft <sup>-1</sup>	Ω in.	Ω ft
abohm centimeter	1	$1 \times 10^{-3}$	$10^{-9}$	$1.113 \times 10^{-21}$	$10^{-11}$	$6.015 \times 10^{-3}$	$3.937 \times 10^{-10}$	$3.281 \times 10^{-11}$
microohm centimeter	$10^3$	1	$10^{-6}$	$1.113 \times 10^{-18}$	$10^{-8}$	6.015	$3.937 \times 10^{-7}$	$3.281 \times 10^{-6}$
ohm centimeter	$10^8$	$10^6$	1	$1.113 \times 10^{-12}$	$1 \times 10^{-2}$	$6.015 \times 10^6$	$3.937 \times 10^{-1}$	$3.281 \times 10^{-2}$
statohm centimeter (esu)	$8.987 \times 10^{20}$	$8.987 \times 10^{17}$	$8.987 \times 10^{11}$	1	$8.987 \times 10^9$	$5.406 \times 10^{18}$	$3.538 \times 10^{11}$	$2.949 \times 10^{10}$
ohm meter	$10^{11}$	$10^8$	$10^2$	$1.113 \times 10^{-10}$	1	$6.015 \times 10^8$	$3.937 \times 10^1$	3.281
ohm circular mil per foot	$1.662 \times 10^2$	$1.662 \times 10^{-1}$	$1.662 \times 10^{-7}$	$1.850 \times 10^{-19}$	$1.662 \times 10^{-9}$	1	$6.54 \times 10^{-6}$	$5.45 \times 10^{-9}$
ohm inch	$2.54 \times 10^9$	$2.54 \times 10^6$	2.54	$2.827 \times 10^{-12}$	$2.54 \times 10^{-2}$	$1.528 \times 10^7$	1	$8.3 \times 10^{-2}$
ohm foot	$3.048 \times 10^{10}$	$3.048 \times 10^7$	$3.048 \times 10^{-1}$	$3.3924 \times 10^{-11}$	$3.048 \times 10^{-1}$	$1.833 \times 10^8$	12	1

## CONVERSION FACTORS FOR CHEMICAL KINETICS

### Equivalent Second Order Rate Constants

A \ B	B							
	$\text{cm}^3 \text{mol}^{-1} \text{s}^{-1}$	$\text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$	$\text{m}^3 \text{mol}^{-1} \text{s}^{-1}$	$\text{cm}^3$ $\text{molecule}^{-1} \text{s}^{-1}$	$(\text{mmHg})^{-1} \text{s}^{-1}$	$\text{atm}^{-1} \text{s}^{-1}$	$\text{ppm}^{-1} \text{min}^{-1}$	$\text{m}^2 \text{kN}^{-1} \text{s}^{-1}$
$1 \text{ cm}^3 \text{mol}^{-1} \text{s}^{-1} =$	1	$10^{-3}$	$10^{-6}$	$1.66 \times 10^{-24}$	$1.604 \times 10^{-5} T^{-1}$	$1.219 \times 10^{-2} T^{-1}$	$2.453 \times 10^{-9}$	$1.203 \times 10^{-4} T^{-1}$
$1 \text{ dm}^3 \text{mol}^{-1} \text{s}^{-1} =$	$10^3$	1	$10^{-3}$	$1.66 \times 10^{-21}$	$1.604 \times 10^{-2} T^{-1}$	$12.19 T^{-1}$	$2.453 \times 10^{-6}$	$1.203 \times 10^{-1} T^{-1}$
$1 \text{ m}^3 \text{mol}^{-1} \text{s}^{-1} =$	$10^6$	$10^3$	1	$1.66 \times 10^{-18}$	$16.04 T^{-1}$	$1.219 \times 10^4 T^{-1}$	$2.453 \times 10^{-3}$	$120.3 T^{-1}$
$1 \text{ cm}^3 \text{molecule}^{-1} \text{s}^{-1} =$	$6.023 \times 10^{23}$	$6.023 \times 10^{20}$	$6.023 \times 10^{17}$	1	$9.658 \times 10^{18} T^{-1}$	$7.34 \times 10^{21} T^{-1}$	$1.478 \times 10^{15}$	$7.244 \times 10^{19} T^{-1}$
$1 (\text{mmHg})^{-1} \text{s}^{-1} =$	$6.236 \times 10^4 T$	$62.36 T$	$6.236 \times 10^2 T$	$1.035 \times 10^{-19} T$	1	760	$4.56 \times 10^{-2}$	7.500
$1 \text{ atm}^{-1} \text{s}^{-1} =$	$82.06 T$	$8.206 \times 10^{-2} T$	$8.206 \times 10^{-5} T$	$1.362 \times 10^{-22} T$	$1.316 \times 10^{-3}$	1	$6 \times 10^{-5}$	$9.869 \times 10^{-3}$
$1 \text{ ppm}^{-1} \text{min}^{-1} =$ at 298 K, 1 atm total pressure	$4.077 \times 10^8$	$4.077 \times 10^5$	407.7	$6.76 \times 10^{-16}$	21.93	$1.667 \times 10^4$	1	164.5
$1 \text{ m}^2 \text{kN}^{-1} \text{s}^{-1} =$	$8314 T$	$8.314 T$	$8.314 \times 10^{-3} T$	$1.38 \times 10^{-20} T$	0.1333	101.325	$6.079 \times 10^{-3}$	1

To convert a rate constant from one set of units A to a new set B find the conversion factor for the row A under column B and multiply the old value by it, e.g. to convert  $\text{cm}^3 \text{molecule}^{-1} \text{s}^{-1}$  to  $\text{m}^3 \text{mol}^{-1} \text{s}^{-1}$  multiply by  $6.023 \times 10^{17}$ .

Table adapted from High Temperature Reaction Rate Data No. 5, The University, Leeds (1970).

### Equivalent Third Order Rate Constants

A \ B	B							
	$\text{cm}^6 \text{mol}^{-2} \text{s}^{-1}$	$\text{dm}^6 \text{mol}^{-2} \text{s}^{-1}$	$\text{m}^6 \text{mol}^{-2} \text{s}^{-1}$	$\text{cm}^6$ $\text{molecule}^{-2} \text{s}^{-1}$	$(\text{mmHg})^{-2} \text{s}^{-1}$	$\text{atm}^{-2} \text{s}^{-1}$	$\text{ppm}^{-2} \text{min}^{-1}$	$\text{m}^4 \text{kN}^{-2} \text{s}^{-1}$
$1 \text{ cm}^6 \text{mol}^{-2} \text{s}^{-1} =$	1	$10^{-6}$	$10^{-12}$	$2.76 \times 10^{-48}$	$2.57 \times 10^{-10} T^{-2}$	$1.48 \times 10^{-4} T^{-2}$	$1.003 \times 10^{-19}$	$1.477 \times 10^{-8} T^{-2}$
$1 \text{ dm}^6 \text{mol}^{-2} \text{s}^{-1} =$	$10^6$	1	$10^{-6}$	$2.76 \times 10^{-42}$	$2.57 \times 10^{-4} T^{-2}$	$148 T^{-2}$	$1.003 \times 10^{-13}$	$1.477 \times 10^{-2} T^{-2}$
$1 \text{ m}^6 \text{mol}^{-2} \text{s}^{-1} =$	$10^{12}$	$10^6$	1	$2.76 \times 10^{-36}$	$257 T^{-2}$	$1.48 \times 10^8 T^{-2}$	$1.003 \times 10^{-7}$	$1.477 \times 10^4 T^{-2}$
$1 \text{ cm}^6 \text{molecule}^{-2} \text{s}^{-1} =$	$3.628 \times 10^{47}$	$3.628 \times 10^{41}$	$3.628 \times 10^{35}$	1	$9.328 \times 10^{37} T^{-2}$	$5.388 \times 10^{43} T^{-2}$	$3.64 \times 10^{28}$	$5.248 \times 10^{39} T^{-2}$
$1 (\text{mmHg})^{-2} \text{s}^{-1} =$	$3.89 \times 10^9 T^2$	$3.89 \times 10^3 T^2$	$3.89 \times 10^{-3} T^2$	$1.07 \times 10^{-38} T^2$	1	$5.776 \times 10^5$	$3.46 \times 10^{-5}$	56.25
$1 \text{ atm}^{-2} \text{s}^{-1} =$	$6.733 \times 10^3 T^2$	$6.733 \times 10^{-3} T^2$	$6.733 \times 10^{-9} T^2$	$1.86 \times 10^{-44} T^2$	$1.73 \times 10^{-6}$	1	$6 \times 10^{-11}$	$9.74 \times 10^{-5}$
$1 \text{ ppm}^{-2} \text{min}^{-1} =$ at 298K, 1 atm total pressure	$9.97 \times 10^{18}$	$9.97 \times 10^{12}$	$9.97 \times 10^6$	$2.75 \times 10^{-29}$	$2.89 \times 10^4$	$1.667 \times 10^{10}$	1	$1.623 \times 10^6$
$1 \text{ m}^4 \text{kN}^{-2} \text{s}^{-1} =$	$6.91 \times 10^7 T^2$	$6.91 T^2$	$69.1 \times 10^{-5} T^2$	$1.904 \times 10^{-40} T^2$	0.0178	$1.027 \times 10^4$	$6.16 \times 10^{-7}$	1

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# CONVERSION FACTORS FOR IONIZING RADIATION

## Conversion between SI and Other Units

Quantity	Symbol for quantity	Expression in SI units	Expression in symbols for SI units	Special name for SI units	Symbols using special names		Symbol for conventional unit	Value of conventional unit in SI units
					Conventional units	Conventional units		
Activity	$A$	1 per second	$s^{-1}$	becquerel	Bq	curie	Ci	$3.7 \times 10^{10}$ Bq
Absorbed dose	$D$	joule per kilogram	$J kg^{-1}$	gray	Gy	rad	rad	0.01 Gy
Absorbed dose rate	$\dot{D}$	joule per kilogram second	$J kg^{-1} s^{-1}$		$Gy s^{-1}$	rad	rad $s^{-1}$	0.01 $Gy s^{-1}$
Average energy per ion pair	$W$	joule	J			electronvolt	eV	$1.602 \times 10^{-19}$ J
Dose equivalent	$H$	joule per kilogram	$J kg^{-1}$	sievert	Sv	rem	rem	0.01 Sv
Dose equivalent rate	$\dot{H}$	joule per kilogram second	$J kg^{-1} s^{-1}$		$Sv s^{-1}$	rem per second	rem $s^{-1}$	0.01 $Sv s^{-1}$
Electric current	$I$	ampere	A			ampere	A	1.0 A
Electric potential difference	$U, V$	watt per ampere	$W A^{-1}$	volt	V	volt	V	1.0 V
Exposure	$\dot{X}$	coulomb per kilogram	$C kg^{-1}$			roentgen	R	$2.58 \times 10^{-4}$ C $kg^{-1}$
Exposure rate	$X$	coulomb per kilogram second	$C kg^{-1} s^{-1}$			roentgen per second	$R s^{-1}$	$2.58 \times 10^{-4}$ C $kg^{-1} s^{-1}$
Fluence	$\phi$	1 per meter squared	$m^{-2}$			1 per centimeter squared	$cm^{-2}$	$1.0 \times 10^4 m^{-2}$
Fluence rate	$\Phi$	1 per meter squared second	$m^{-2} s^{-1}$			1 per centimeter squared second	$cm^{-2} s^{-1}$	$1.0 \times 10^4 m^{-2} s^{-1}$
Kerma	$K$	joule per kilogram	$J kg^{-1}$	gray	Gy	rad	rad	0.01 Gy
Kerma rate	$\dot{K}$	joule per kilogram second	$J kg^{-1} s^{-1}$		$Gy s^{-1}$	rad per second	rad $s^{-1}$	0.01 $Gy s^{-1}$
Lineal energy	$y$	joule per meter	$J m^{-1}$			kiloelectron volt per micrometer	keV $\mu m^{-1}$	$1.602 \times 10^{-10}$ J $m^{-1}$
Linear energy transfer	$L$	joule per meter	$J m^{-1}$			kiloelectron volt per micrometer	keV $\mu m^{-1}$	$1.602 \times 10^{-10}$ J $m^{-1}$
Mass attenuation coefficient	$\mu/\rho$	meter squared per kilogram	$m^2 kg^{-1}$			centimeter squared per gram	$cm^2 g^{-1}$	0.1 $m^2 kg^{-1}$
Mass energy transfer coefficient	$\mu_{tr}/\rho$	meter squared per kilogram	$m^2 kg^{-1}$			centimeter squared per gram	$cm^2 g^{-1}$	0.1 $m^2 kg^{-1}$
Mass energy absorption coefficient	$\mu_{en}/\rho$	meter squared per kilogram	$m^2 kg^{-1}$			centimeter squared per gram	$cm^2 g^{-1}$	0.1 $m^2 kg^{-1}$
Mass stopping power	$S/\rho$	joule meter squared per kilogram	$J m^2 kg^{-1}$			MeV centimeter squared per gram	MeV $cm^2 g^{-1}$	$1.602 \times 10^{-14}$ J $m^2 kg^{-1}$
Power	$P$	joule per second	$J s^{-1}$	watt	W	watt	W	1.0 W
Pressure	$p$	newton per meter squared	$N m^{-2}$	pascal	Pa	torr	torr	(101325/760)Pa
Radiation chemical yield	$G$	mole per joule	$mol J^{-1}$			molecules per 100 electron volts	molecules $(100 eV)^{-1}$	$1.04 \times 10^{-7}$ mol $J^{-1}$
Specific energy	$z$	joule per kilogram	$J kg^{-1}$	gray	Gy	rad	rad	0.01 Gy

Conversion of Radioactivity Units from MBq to mCi and  $\mu$ Ci

MBq	mCi	MBq	mCi	MBq	mCi	MBq	mCi	MBq	mCi
7000	189.	700	18.9	70	1.89	7	189	0.7	18.9
6000	162.	600	16.2	60	1.62	6	162	0.6	16.2
5000	135.	500	13.5	50	1.35	5	135	0.5	13.5
4000	108.	400	10.8	40	1.08	4	108	0.4	10.8
3000	81.	300	8.1	30	810	3	81	0.3	8.1
2000	54.	200	5.4	20	540	2	54	0.2	5.4
1000	27.	100	2.7	10	270	1	27	0.1	2.7
900	24.	90	2.4	9	240	0.9	24		
800	21.6	80	2.16	8	220	0.8	21.6		

Conversion of Radioactivity Units from mCi and  $\mu$ Ci to MBq

mCi	MBq	mCi	MBq	mCi	MBq	$\mu$ Ci	MBq	$\mu$ Ci	MBq	$\mu$ Ci	MBq
200	7400	40	1480	5	185	1000	37.0	200	7.4	30	1.11
150	5550	30	1110	4	148	900	33.3	100	3.7	20	0.74
100	3700	20	740	3	111	800	29.6	90	3.33	10	0.37
90	3330	10	370	2	74.0	700	25.9	80	2.96	5	0.185
80	2960	9	333	1	37.0	600	22.2	70	2.59	2	0.074
70	2590	8	296			500	18.5	60	2.22	1	0.037
60	2220	7	259			400	14.8	50	1.85		
50	1850	6	222			300	11.1	40	1.48		

Conversion of Radioactivity Units

100 TBq ( $10^{14}$ Bq)	=	2.7 kCi ( $2.7 \times 10^3$ Ci)	100 kBq ( $10^5$ Bq)	=	2.7 $\mu$ Ci ( $2.7 \times 10^{-6}$ Ci)
10 TBq ( $10^{13}$ Bq)	=	270 Ci ( $2.7 \times 10^2$ Ci)	10 kBq ( $10^4$ Bq)	=	270 nCi ( $2.7 \times 10^{-7}$ Ci)
1 TBq ( $10^{12}$ Bq)	=	27 Ci ( $2.7 \times 10^1$ Ci)	1 kBq ( $10^3$ Bq)	=	27 nCi ( $2.7 \times 10^{-8}$ Ci)
100 GBq ( $10^{11}$ Bq)	=	2.7 Ci ( $2.7 \times 10^0$ Ci)	100 Bq ( $10^2$ Bq)	=	2.7 nCi ( $2.7 \times 10^{-9}$ Ci)
10 GBq ( $10^{10}$ Bq)	=	270 mCi ( $2.7 \times 10^{-1}$ Ci)	10 Bq ( $10^1$ Bq)	=	270 pCi ( $2.7 \times 10^{-10}$ Ci)
1 GBq ( $10^9$ Bq)	=	27 mCi ( $2.7 \times 10^{-2}$ Ci)	1 Bq ( $10^0$ Bq)	=	27 pCi ( $2.7 \times 10^{-11}$ Ci)
100 MBq ( $10^8$ Bq)	=	2.7 mCi ( $2.7 \times 10^{-3}$ Ci)	100 mBq ( $10^{-1}$ Bq)	=	2.7 pCi ( $2.7 \times 10^{-12}$ Ci)
10 MBq ( $10^7$ Bq)	=	270 $\mu$ Ci ( $2.7 \times 10^{-4}$ Ci)	10 mBq ( $10^{-2}$ Bq)	=	270 fCi ( $2.7 \times 10^{-13}$ Ci)
1 MBq ( $10^6$ Bq)	=	27 $\mu$ Ci ( $2.7 \times 10^{-5}$ Ci)	1 mBq ( $10^{-3}$ Bq)	=	27 fCi ( $2.7 \times 10^{-14}$ Ci)

Conversion of Absorbed Dose Units

SI Units	Conventional	SI Units	Conventional
100 Gy ( $10^2$ Gy)	= 10,000 rad ( $10^4$ rad)	100 $\mu$ Gy ( $10^{-4}$ Gy)	= 10 mrad ( $10^{-2}$ rad)
10 Gy ( $10^1$ Gy)	= 1,000 rad ( $10^3$ rad)	10 $\mu$ Gy ( $10^{-5}$ Gy)	= 1 mrad ( $10^{-3}$ rad)
1 Gy ( $10^0$ Gy)	= 100 rad ( $10^2$ rad)	1 $\mu$ Gy ( $10^{-6}$ Gy)	= 100 $\mu$ rad ( $10^{-4}$ rad)
100 mGy ( $10^{-1}$ Gy)	= 10 rad ( $10^1$ rad)	100 nGy ( $10^{-7}$ Gy)	= 10 $\mu$ rad ( $10^{-5}$ rad)
10 mGy ( $10^{-2}$ Gy)	= 1 rad ( $10^0$ rad)	10 nGy ( $10^{-8}$ Gy)	= 1 $\mu$ rad ( $10^{-6}$ rad)
1 mGy ( $10^{-3}$ Gy)	= 100 mrad ( $10^{-1}$ rad)	1 nGy ( $10^{-9}$ Gy)	= 100 nrad ( $10^{-7}$ rad)

Conversion of Dose Equivalent Units

100 Sv ( $10^2$ Sv)	= 10,000 rem ( $10^4$ rem)	100 $\mu$ Sv ( $10^{-4}$ Sv)	= 10 mrem ( $10^{-2}$ rem)
10 Sv ( $10^1$ Sv)	= 1,000 rem ( $10^3$ rem)	10 $\mu$ Sv ( $10^{-5}$ Sv)	= 1 mrem ( $10^{-3}$ rem)
1 Sv ( $10^0$ Sv)	= 100 rem ( $10^2$ rem)	1 $\mu$ Sv ( $10^{-6}$ Sv)	= 100 $\mu$ rem ( $10^{-4}$ rem)
100 mSv ( $10^{-1}$ Sv)	= 10 rem ( $10^1$ rem)	100 nSv ( $10^{-7}$ Sv)	= 10 $\mu$ rem ( $10^{-5}$ rem)
10 mSv ( $10^{-2}$ Sv)	= 1 rem ( $10^0$ rem)	10 nSv ( $10^{-8}$ Sv)	= 1 $\mu$ rem ( $10^{-6}$ rem)
1 mSv ( $10^{-3}$ Sv)	= 100 mrem ( $10^{-1}$ rem)	1 nSv ( $10^{-9}$ Sv)	= 100 nrem ( $10^{-7}$ rem)

## VALUES OF THE GAS CONSTANT IN DIFFERENT UNIT SYSTEMS

In SI units the value of the gas constant,  $R$ , is:

$$\begin{aligned} R &= 8.314472 \text{ Pa m}^3 \text{ K}^{-1} \text{ mol}^{-1} \\ &= 8314.472 \text{ Pa L K}^{-1} \text{ mol}^{-1} \\ &= 0.08314472 \text{ bar L K}^{-1} \text{ mol}^{-1} \end{aligned}$$

$$1 \text{ torr (mmHg)} = 133.322 \text{ Pa [at } 0 \text{ }^\circ\text{C]}$$

$$1 \text{ in Hg} = 3386.38 \text{ Pa [at } 0 \text{ }^\circ\text{C]}$$

$$1 \text{ in H}_2\text{O} = 249.082 \text{ Pa [at } 4 \text{ }^\circ\text{C]}$$

$$1 \text{ ft H}_2\text{O} = 2988.98 \text{ Pa [at } 4 \text{ }^\circ\text{C]}$$

This table gives the appropriate value of  $R$  for use in the ideal gas equation,  $PV = nRT$ , when the variables are expressed in other units. The following conversion factors for pressure units were used in generating the table:

$$1 \text{ atm} = 101325 \text{ Pa}$$

$$1 \text{ psi} = 6894.757 \text{ Pa}$$

### Reference

Mohr, P. J., Taylor, B. N., and Newell, D. B., "CODATA recommended values of the fundamental physical constants: 2006", *J. Phys. Chem. Ref. Data* 37, 1187, 2008.

$V$	Units of $V, T, n$			Units of $P$						
	$T$	$n$		kPa	atm	psi	mmHg	in Hg	in H <sub>2</sub> O	ft H <sub>2</sub> O
ft <sup>3</sup>	K	mol		0.2936228	0.00289784	0.0425864	2.20236	0.0867070	1.17881	0.0982351
		lb-mol		133.1851	1.31443	19.3168	998.973	39.3296	534.704	44.5587
	°R	mol		0.1631238	0.00160990	0.0236591	1.22353	0.0481706	0.654900	0.0545751
		lb-mol		73.99170	0.730242	10.7316	554.984	21.8498	297.058	24.7548
cm <sup>3</sup>	K	mol		8314.472	82.0574	1205.91	62363.8	2455.27	33380.4	2781.71
		lb-mol		3771381	37220.6	546993	282878000	1113690	15141100	1261760
	°R	mol		4619.151	45.5875	669.951	34646.5	1364.03	18544.7	1545.39
		lb-mol		2095211	20678.1	303885	15715400	618717	8411730	700979
L	K	mol		8.314472	0.0820574	1.20591	62.3638	2.45527	33.3804	2.78171
		lb-mol		3771.381	37.2206	546.993	28287.8	1113.69	15141.1	1261.76
	°R	mol		4.619151	0.0455875	0.669951	34.6465	1.36403	18.5447	1.54539
		lb-mol		2095.211	20.6781	303.885	15715.4	618.717	8411.73	700.979
m <sup>3</sup>	K	mol		0.008314472	0.0000820574	0.00120591	0.0623638	0.00245527	0.0333804	0.00278171
		lb-mol		3.771381	0.0372206	0.546993	28.2878	1.11369	15.1411	1.26176
	°R	mol		0.004619151	0.0000455875	0.000669951	0.0346465	0.00136403	0.0185447	0.00154539
		lb-mol		2.095211	0.0206781	0.303885	15.7154	0.618717	8.41173	0.700979



# PERIODIC TABLE OF THE ELEMENTS

1 Group IA		2 IIA		New Notation Previous IUPAC Form CAS Version										13 IIIB IIIA	14 IVB IVA	15 VB VA	16 VIB VIA	17 VIIB VIIA	18 VIIIA	Shell		
1 H 1.00794 1		3 Li 6.941 2-1	4 Be 9.012182 2-2																	2 He 4.002602 2	K	
11 Na 22.989770 2-8-1	12 Mg 24.3050 2-8-2			3 IIIA IIIB	4 IVA IVB	5 VA VB	6 VIA VIB	7 VIIA VIIB	8 VIIIA VIII		9 IB IB	10 IIB IIB	13 Al 26.981538 2-8-3	14 Si 28.0855 2-8-4	15 P 30.973761 2-8-5	16 S 32.065 2-8-6	17 Cl 35.453 2-8-7	18 Ar 39.948 2-8-8				K-L
19 K 39.0983 -8-8-1	20 Ca 40.078 -8-8-2	21 Sc 44.955910 -8-9-2	22 Ti 47.867 -8-10-2	23 V 50.9415 -8-11-2	24 Cr 51.9961 -8-13-1	25 Mn 54.938049 -8-13-2	26 Fe 55.845 -8-14-2	27 Co 58.933200 -8-15-2	28 Ni 58.6934 -8-16-2	29 Cu 63.546 -8-18-1	30 Zn 65.409 -8-18-2	31 Ga 69.723 -8-18-3	32 Ge 72.64 -8-18-4	33 As 74.92160 -8-18-5	34 Se 78.96 -8-18-6	35 Br 79.904 -8-18-7	36 Kr 83.798 -8-18-8					-L-M-N
37 Rb 85.4678 -18-8-1	38 Sr 87.62 -18-8-2	39 Y 88.90585 -18-9-2	40 Zr 91.224 -18-10-2	41 Nb 92.90638 -18-12-1	42 Mo 95.94 -18-13-1	43 Tc (98) -18-13-2	44 Ru 101.07 -18-15-1	45 Rh 102.90550 -18-16-1	46 Pd 106.42 -18-18-0	47 Ag 107.8682 -18-18-1	48 Cd 112.411 -18-18-2	49 In 114.818 -18-18-3	50 Sn 118.710 -18-18-4	51 Sb 121.760 -18-18-5	52 Te 127.60 -18-18-6	53 I 126.90447 -18-18-7	54 Xe 131.293 -18-18-8					-M-N-O
55 Cs 132.90545 -18-8-1	56 Ba 137.327 -18-8-2	57* La 138.9055 -18-9-2	72 Hf 178.49 -32-10-2	73 Ta 180.9479 -32-11-2	74 W 183.84 -32-12-2	75 Re 186.207 -32-13-2	76 Os 190.23 -32-14-2	77 Ir 192.217 -32-15-2	78 Pt 195.078 -32-17-1	79 Au 196.96655 -32-18-1	80 Hg 200.59 -32-18-2	81 Tl 204.3833 -32-18-3	82 Pb 207.2 -32-18-4	83 Bi 208.98038 -32-18-5	84 Po (209) -32-18-6	85 At (210) -32-18-7	86 Rn (222) -32-18-8					-N-O-P
87 Fr (223) -18-8-1	88 Ra (226) -18-8-2	89** Ac (227) -18-9-2	104 Rf (261) -32-10-2	105 Db (262) -32-11-2	106 Sg (266) -32-12-2	107 Bh (264) -32-13-2	108 Hs (277) -32-14-2	109 Mt (268) -32-15-2	110 Ds (271) -32-16-2	111 Rg (272)	112 Uub (285)		114 Uuq (289)		116 Uuh (289)							-O-P-Q
* Lanthanides		58 Ce 140.116 -19-9-2	59 Pr 140.90765 -21-8-2	60 Nd 144.24 -22-8-2	61 Pm (145) -23-8-2	62 Sm 150.36 -24-8-2	63 Eu 151.964 -25-8-2	64 Gd 157.25 -25-9-2	65 Tb 158.92534 -27-8-2	66 Dy 162.500 -28-8-2	67 Ho 164.93032 -29-8-2	68 Er 167.259 -30-8-2	69 Tm 168.93421 -31-8-2	70 Yb 173.04 -32-8-2	71 Lu 174.967 -32-9-2							-N-O-P
** Actinides		90 Th 232.0381 -18-10-2	91 Pa 231.03588 -20-9-2	92 U 238.02891 -21-9-2	93 Np (237) -22-9-2	94 Pu (244) -24-8-2	95 Am (243) -25-8-2	96 Cm (247) -25-9-2	97 Bk (247)	98 Cf (251) -28-8-2	99 Es (252) -29-8-2	100 Fm (257) -30-8-2	101 Md (258) -31-8-2	102 No (259) -32-8-2	103 Lr (262) -32-8-3							-O-P-Q

The new IUPAC format numbers the groups from 1 to 18. The previous IUPAC numbering system and the system used by Chemical Abstracts Service (CAS) are also shown. For radioactive elements that do not occur in nature, the mass number of the most stable isotope is given in parentheses. Elements 112, 114, and 116 have been reported but not confirmed.

## References

1. G. J. Leigh, Editor, *Nomenclature of Inorganic Chemistry*, Blackwell Scientific Publications, Oxford, 1990.
2. *Chemical and Engineering News*, 63(5), 27, 1985.
3. Atomic Weights of the Elements, 2001, *Pure & Appl. Chem.*, 75, 1107, 2003.

	Metallic solids
	Non-metallic solids
	Liquids
	Gases

## UNITS FOR MAGNETIC PROPERTIES

Quantity	Symbol	Gaussian & cgs emu <sup>a</sup>	Conversion factor, C <sup>b</sup>	SI & rationalized mks <sup>c</sup>
Magnetic flux density, magnetic induction	$B$	gauss (G) <sup>d</sup>	$10^{-4}$	tesla (T), Wb/m <sup>2</sup>
Magnetic flux	$\Phi$	maxwell (Mx), G · cm <sup>2</sup>	$10^{-8}$	weber (Wb), volt second (V · s)
Magnetic potential difference, magnetomotive force	$U, F$	gilbert (Gb)	$10/4\pi$	ampere (A)
Magnetic field strength, magnetizing force	$H$	oersted (Oe), <sup>e</sup> Gb/cm	$10^3/4\pi$	A/m <sup>f</sup>
(Volume) magnetization <sup>g</sup>	$M$	emu/cm <sup>3</sup> <sup>h</sup>	$10^3$	A/m
(Volume) magnetization	$4\pi M$	G	$10^3/4\pi$	A/m
Magnetic polarization, intensity of magnetization	$J, I$	emu/cm <sup>3</sup>	$4\pi \times 10^{-4}$	T, Wb/m <sup>2</sup> <sup>i</sup>
(Mass) magnetization	$\sigma, M$	emu/g	1	A · m <sup>2</sup> /kg
			$4\pi \times 10^{-7}$	Wb · m/kg
Magnetic moment	$m$	emu, erg/G	$10^{-3}$	A · m <sup>2</sup> , joule per tesla (J/T)
Magnetic dipole moment	$j$	emu, erg/G	$4\pi \times 10^{-10}$	Wb · m <sup>i</sup>
(Volume) susceptibility	$\chi, \kappa$	dimensionless, emu/cm <sup>3</sup>	$4\pi$	dimensionless
			$(4\pi)^2 \times 10^{-7}$	henry per meter (H/m), Wb/(A · m)
(Mass) susceptibility	$\chi_p, \kappa_p$	cm <sup>3</sup> /g, emu/g	$4\pi \times 10^{-3}$	m <sup>3</sup> /kg
			$(4\pi)^2 \times 10^{-10}$	H · m <sup>2</sup> /kg
(Molar) susceptibility	$\chi_{mol}, \kappa_{mol}$	cm <sup>3</sup> /mol, emu/mol	$4\pi \times 10^{-6}$	m <sup>3</sup> /mol
			$(4\pi)^2 \times 10^{-13}$	H · m <sup>2</sup> /mol
Permeability	$\mu$	dimensionless	$4\pi \times 10^{-7}$	H/m, Wb/(A · m)
Relative permeability <sup>j</sup>	$\mu_r$	not defined		dimensionless
(Volume) energy density, energy product <sup>k</sup>	$W$	erg/cm <sup>3</sup>	$10^{-1}$	J/m <sup>3</sup>
Demagnetization factor	$D, N$	dimensionless	$1/4\pi$	dimensionless

<sup>a</sup>. Gaussian units and cgs emu are the same for magnetic properties. The defining relation is  $B = H + 4\pi M$ .

<sup>b</sup>. Multiply a number in Gaussian units by C to convert it to SI (e.g.,  $1 \text{ G} \times 10^{-4} \text{ T/G} = 10^{-4} \text{ T}$ ).

<sup>c</sup>. SI (*Système International d'Unités*) has been adopted by the National Bureau of Standards. Where two conversion factors are given, the upper one is recognized under, or consistent with, SI and is based on the definition  $B = \mu_0(H + M)$ , where  $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$ . The lower one is not recognized under SI and is based on the definition  $B = \mu_0 H + J$ , where the symbol  $I$  is often used in place of  $J$ .

<sup>d</sup>. 1 gauss =  $10^5$  gamma ( $\gamma$ ).

<sup>e</sup>. Both oersted and gauss are expressed as  $\text{cm}^{-1/2} \cdot \text{g}^{1/2} \cdot \text{s}^{-1}$  in terms of base units.

<sup>f</sup>. A/m was often expressed as "ampere-turn per meter" when used for magnetic field strength.

<sup>g</sup>. Magnetic moment per unit volume.

<sup>h</sup>. The designation "emu" is not a unit.

<sup>i</sup>. Recognized under SI, even though based on the definition  $B = \mu_0 H + J$ . See footnote c.

<sup>j</sup>.  $\mu_r = \mu/\mu_0 = 1 + \chi_r$ , all in SI.  $\mu_r$  is equal to Gaussian  $\mu$ .

<sup>k</sup>.  $B \cdot H$  and  $\mu_0 M \cdot H$  have SI units J/m<sup>3</sup>;  $M \cdot H$  and  $B \cdot H/4\pi$  have Gaussian units erg/cm<sup>3</sup>.

R. B. Goldfarb and F. R. Fickett, U.S. Department of Commerce, National Bureau of Standards, Boulder, Colorado 80303, March 1985, NBS Special Publication 696. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

# SYMBOLS AND TERMINOLOGY FOR PHYSICAL AND CHEMICAL QUANTITIES

The International Organization for Standardization (ISO), International Union of Pure and Applied Chemistry (IUPAC), and the International Union of Pure and Applied Physics (IUPAP) have jointly developed a set of recommended symbols for physical and chemical quantities. Consistent use of these recommended symbols helps assure unambiguous scientific communication. The list below is reprinted from Reference 1 with permission from IUPAC. Full details may be found in the following references:

1. Ian Mills, Ed., *Quantities, Units, and Symbols in Physical Chemistry*, Blackwell Scientific Publications, Oxford, 1988.
2. E. R. Cohen and P. Giacomo, *Symbols, Units, Nomenclature, and Fundamental Constants in Physics*, Document IUPAP-25, 1987; also published in *Physica* 146A, 1-68, 1987.
3. *ISO Standards Handbook 2: Units of Measurement*, International Organization of Standardization, Geneva, 1982.

The symbol for a physical quantity is always given in italic (sloping) type, while symbols for units are given in roman type. Column headings in tables and axis labels on graphs may conveniently be written as the physical quantity symbol divided by the unit symbol, e.g.:

$$\begin{aligned} T/K \\ V/\text{cm}^3 \\ C_p/J \text{ mol}^{-1} \text{ K}^{-1} \end{aligned}$$

The values in the table or graph axis are then pure numbers. Subscripts to symbols for physical quantities should be italic if the subscript refers to another physical quantity or to a number, e.g.:

$$\begin{aligned} C_p - \text{heat capacity at constant pressure} \\ B_n - \text{nth virial coefficient} \end{aligned}$$

Subscripts that have other meanings should be in roman type:

$$\begin{aligned} m_p - \text{mass of the proton} \\ E_k - \text{kinetic energy} \end{aligned}$$

## GENERAL RULES

The value of a physical quantity is expressed as the product of a numerical value and a unit, e.g.:

$$\begin{aligned} T &= 300 \text{ K} \\ V &= 26.2 \text{ cm}^3 \\ C_p &= 45.3 \text{ J mol}^{-1} \text{ K}^{-1} \end{aligned}$$

The following tables give the recommended symbols for the major classes of physical and chemical quantities. The expression in the Definition column is given as an aid in identifying the quantity but is not necessarily the complete or unique definition. The SI Unit gives one (not necessarily unique) expression for the coherent SI unit for the quantity. Other equivalent unit expressions, including those that involve SI prefixes, may be used.

Name	Symbol	Definition	SI unit
<i>Space and Time</i>			
cartesian space coordinates	$x, y, z$		m
spherical polar coordinates	$r, \theta, \phi$		m, 1, 1
generalized coordinate	$q, q_i$		(varies)
position vector	$r$	$r = xi + yj + zk$	m
length	$l$		m
special symbols:			
height	$h$		
breadth	$b$		
thickness	$d, \delta$		
distance	$d$		
radius	$r$		
diameter	$d$		
path length	$s$		
length of arc	$s$		
area	$A, A_x, S$		m <sup>2</sup>
volume	$V, (v)$		m <sup>3</sup>
plane angle	$\alpha, \beta, \gamma, \theta, \phi, \dots$	$\alpha = s/r$	rad, 1
solid angle	$\omega, \Omega$	$\omega = A/r^2$	sr, 1
time	$t$		s
period	$T$	$T = t/N$	s
frequency	$\nu, f$	$\nu = 1/T$	Hz
circular frequency, angular frequency	$\omega$	$\omega = 2\pi\nu$	rad s <sup>-1</sup> , s <sup>-1</sup>
characteristic time interval, relaxation time, time constant	$\tau, T$	$\tau =  dt/d\ln x $	s
angular velocity	$\omega$	$\omega = d\phi/dt$	rad s <sup>-1</sup> , s <sup>-1</sup>
velocity	$v, u, w, c, \dot{r}$	$v = dr/dt$	m s <sup>-1</sup>

Name	Symbol	Definition	SI unit
speed	$v, u, w, c$	$v =  v $	$\text{m s}^{-1}$
acceleration	$\mathbf{a}, (g)$	$\mathbf{a} = d\mathbf{v}/dt$	$\text{m s}^{-2}$
<b>Classical Mechanics</b>			
mass	$m$		kg
reduced mass	$\mu$	$\mu = m_1 m_2 / (m_1 + m_2)$	kg
density, mass density	$\rho$	$\rho = m/V$	$\text{kg m}^{-3}$
relative density	$d$	$d = \rho/\rho$	1
surface density	$\rho_A, \rho_S$	$\rho_A = m/A$	$\text{kg m}^{-2}$
specific volume	$v$	$v = V/m = 1/\rho$	$\text{m}^3 \text{kg}^{-1}$
momentum	$\mathbf{p}$	$\mathbf{p} = m\mathbf{v}$	$\text{kg m s}^{-1}$
angular momentum, action	$\mathbf{L}$	$\mathbf{L} = \mathbf{r} \times \mathbf{p}$	J s
moment of inertia	$I, J$	$I = \sum m_i r_i^2$	$\text{kg m}^2$
force	$\mathbf{F}$	$\mathbf{F} = d\mathbf{p}/dt = m\mathbf{a}$	N
torque, moment of a force	$\mathbf{T}, (\mathcal{M})$	$\mathbf{T} = \mathbf{r} \times \mathbf{F}$	N m
energy	$E$		J
potential energy	$E_p, V, \Phi$	$E_p = \int \mathbf{F} \cdot d\mathbf{s}$	J
kinetic energy	$E_k, T, K$	$E_k = 1/2 m v^2$	J
work	$W, w$	$W = \int \mathbf{F} \cdot d\mathbf{s}$	J
Hamilton function	$H$	$H(q, p) = T(q, p) + V(q)$	J
Lagrange function	$L$	$L(q, \dot{q}) = T(q, \dot{q}) - V(q)$	J
pressure	$p, P$	$p = F/A$	Pa, $\text{N m}^{-2}$
surface tension	$\gamma, \sigma$	$\gamma = dW/dA$	$\text{N m}^{-1}, \text{J m}^{-2}$
weight	$G, (W, P)$	$G = mg$	N
gravitational constant	$G$	$F = G m_1 m_2 / r^2$	$\text{N m}^2 \text{kg}^{-2}$
normal stress	$\sigma$	$\sigma = F/A$	Pa
shear stress	$\tau$	$\tau = F/A$	Pa
linear strain, relative elongation	$\varepsilon, e$	$\varepsilon = \Delta l/l$	1
modulus of elasticity, Young's modulus	$E$	$E = \sigma/\varepsilon$	Pa
shear strain	$\gamma$	$\gamma = \Delta x/d$	1
shear modulus	$G$	$G = \tau/\gamma$	Pa
volume strain, bulk strain	$\theta$	$\theta = \Delta V/V_0$	1
bulk modulus, compression modulus	$K$	$K = -V_0 (dp/dV)$	Pa
viscosity, dynamic viscosity	$\eta, \mu$	$\tau_{x,z} = \eta (dv_x/dz)$	Pa s
fluidity	$\phi$	$\phi = 1/\eta$	$\text{m kg}^{-1} \text{s}$
kinematic viscosity	$\nu$	$\nu = \eta/\rho$	$\text{m}^2 \text{s}^{-1}$
friction coefficient	$\mu, (f)$	$F_{\text{frict}} = \mu F_{\text{norm}}$	1
power	$P$	$P = dW/dt$	W
sound energy flux	$P, P_a$	$P = dE/dt$	W
acoustic factors			
reflection factor	$\rho$	$\rho = P_r/P_0$	1
acoustic absorption factor	$\alpha_a, (\alpha)$	$\alpha_a = 1 - \rho$	1
transmission factor	$\tau$	$\tau = P_{tr}/P_0$	1
dissipation factor	$\delta$	$\delta = \alpha_a - \tau$	1
<b>Electricity and Magnetism</b>			
quantity of electricity, electric charge	$Q$		C
charge density	$\rho$	$\rho = Q/V$	$\text{C m}^{-3}$
surface charge density	$\sigma$	$\sigma = Q/A$	$\text{C m}^{-2}$
electric potential	$V, \phi$	$V = dW/dQ$	V, $\text{J C}^{-1}$
electric potential difference	$U, \Delta V, \Delta \phi$	$U = V_2 - V_1$	V
electromotive force	$E$	$E = \int (\mathbf{F}/Q) \cdot d\mathbf{s}$	V
electric field strength	$\mathbf{E}$	$\mathbf{E} = \mathbf{F}/Q = -\text{grad } V$	$\text{V m}^{-1}$
electric flux	$\Psi$	$\Psi = \int \mathbf{D} \cdot d\mathbf{A}$	C
electric displacement	$\mathbf{D}$	$\mathbf{D} = \varepsilon \mathbf{E}$	$\text{C m}^{-2}$
capacitance	$C$	$C = Q/U$	F, $\text{C V}^{-1}$
permittivity	$\varepsilon$	$\mathbf{D} = \varepsilon \mathbf{E}$	$\text{F m}^{-1}$
permittivity of vacuum	$\varepsilon_0$	$\varepsilon_0 = \mu_0^{-1} c_0^{-2}$	$\text{F m}^{-1}$
relative permittivity	$\varepsilon_r$	$\varepsilon_r = \varepsilon/\varepsilon_0$	1
dielectric polarization (dipole moment per volume)	$\mathbf{P}$	$\mathbf{P} = \mathbf{D} - \varepsilon_0 \mathbf{E}$	$\text{C m}^{-2}$
electric susceptibility	$\chi_e$	$\chi_e = \varepsilon_r - 1$	1
electric dipole moment	$\mathbf{p}, \boldsymbol{\mu}$	$\mathbf{p} = Q\mathbf{r}$	C m

Name	Symbol	Definition	SI unit
electric current	$I$	$I = dQ/dt$	A
electric current density	$j, J$	$I = \int j \cdot dA$	A m <sup>-2</sup>
magnetic flux density, magnetic induction	$B$	$F = Qv \times B$	T
magnetic flux	$\Phi$	$\Phi = \int B \cdot dA$	A m <sup>-2</sup>
magnetic field strength	$H$	$B = \mu H$	A m <sup>-2</sup>
permeability	$\mu$	$B = \mu H$	N A <sup>-2</sup> , H m <sup>-1</sup>
permeability of vacuum	$\mu_0$		H m <sup>-1</sup>
relative permeability	$\mu_r$	$\mu_r = \mu/\mu_0$	1
magnetization (magnetic dipole moment per volume)	$M$	$M = B/\mu_0 - H$	A m <sup>-1</sup>
magnetic susceptibility	$\chi, \kappa, (\chi_m)$	$\chi = \mu_r - 1$	1
molar magnetic susceptibility	$\chi_m$	$\chi_m = V_m \chi$	m <sup>3</sup> mol <sup>-1</sup>
magnetic dipole moment	$m, \mu$	$E_p = -m \cdot B$	A m <sup>2</sup> , J T <sup>-1</sup>
electrical resistance	$R$	$R = U/I$	$\Omega$
conductance	$G$	$G = 1/R$	S
loss angle	$\delta$	$\delta = (\pi/2) + \phi_i - \phi_u$	1, rad
reactance	$X$	$X = (U/I) \sin \delta$	$\Omega$
impedance (complex impedance)	$Z$	$Z = R + iX$	$\Omega$
admittance (complex admittance)	$Y$	$Y = 1/Z$	S
susceptance	$B$	$Y = G + iB$	S
resistivity	$\rho$	$\rho = E/j$	$\Omega$ m
conductivity	$\kappa, \gamma, \sigma$	$\kappa = 1/\rho$	S m <sup>-1</sup>
self-inductance	$L$	$E = -L(dI/dt)$	H
mutual inductance	$M, L_{12}$	$E_1 = L_{12}(dI_2/dt)$	H
magnetic vector potential	$A$	$B = \nabla \times A$	Wb m <sup>-1</sup>
Poynting vector	$S$	$S = E \times H$	W m <sup>-2</sup>
<b>Quantum Mechanics</b>			
momentum operator	$\hat{p}$	$\hat{p} = -i\hbar\nabla$	m <sup>-1</sup> J s
kinetic energy operator	$\hat{T}$	$\hat{T} = -(\hbar^2/2m)\nabla^2$	J
Hamiltonian operator	$\hat{H}$	$\hat{H} = \hat{T} + V$	J
wavefunction, state function	$\Psi, \psi, \phi$	$\hat{H}\psi = E\psi$	(m <sup>-3/2</sup> )
probability density	$P$	$P = \psi^*\psi$	(m <sup>-3</sup> )
charge density of electrons	$\rho$	$\rho = -eP$	(C m <sup>-3</sup> )
probability current density	$S$	$S = -i\hbar(\psi^*\nabla\psi - \psi\nabla\psi^*)/2m_e$	(m <sup>-2</sup> s <sup>-1</sup> )
electric current density of electrons	$j$	$j = -eS$	(A m <sup>-2</sup> )
matrix element of operator $\hat{A}$	$A_{ij} = \langle i \hat{A} j\rangle$	$A_{ij} = \int \psi_i^* \hat{A} \psi_j d\tau$	(varies)
expectation value of operator $\hat{A}$	$\langle A \rangle, \bar{A}$	$\langle A \rangle = \int \psi^* \hat{A} \psi d\tau$	(varies)
hermitian conjugate of $\hat{A}$	$\hat{A}^\dagger$	$(\hat{A}^\dagger)_{ij} = (A_{ji})^*$	(varies)
commutator of $\hat{A}$ and $\hat{B}$	$[\hat{A}, \hat{B}], [\hat{A}, \hat{B}]_-$	$[\hat{A}, \hat{B}] = \hat{A}\hat{B} - \hat{B}\hat{A}$	(varies)
anticommutator	$[\hat{A}, \hat{B}]_+$	$[\hat{A}, \hat{B}]_+ = \hat{A}\hat{B} + \hat{B}\hat{A}$	(varies)
spin wavefunction	$\alpha; \beta$		1
coulomb integral	$H_{AA}$	$H_{AA} = \int \psi_A^* \hat{H} \psi_A d\tau$	J
resonance integral	$H_{AB}$	$H_{AB} = \int \psi_A^* \hat{H} \psi_B d\tau$	J
overlap integral	$S_{AB}$	$S_{AB} = \int \psi_A^* \psi_B d\tau$	1
<b>Atoms and Molecules</b>			
nucleon number, mass number	$A$		1
proton number, atomic number	$Z$		1
neutron number	$N$	$N = A - Z$	1
electron rest mass	$m_e$		kg
mass of atom, atomic mass	$m_a, m$		kg
atomic mass constant	$m_u$	$m_u = m_a(^{12}C)/12$	kg
mass excess	$\Delta$	$\Delta = m_a - Am_u$	kg
elementary charge, proton charge	$e$		C
Planck constant	$h$		J s
Planck constant/2 $\pi$	$\hbar$	$\hbar = h/2\pi$	J s
Bohr radius	$a_0$	$a_0 = 4\pi\epsilon_0 \hbar^2 / m_e e^2$	m
Hartree energy	$E_h$	$E_h = \hbar^2 / m_e a_0^2$	J
Rydberg constant	$R_\infty$	$R_\infty = E_h / 2hc$	m <sup>-1</sup>
fine structure constant	$\alpha$	$\alpha = e^2 / 4\pi\epsilon_0 \hbar c$	1

Name	Symbol	Definition	SI unit
ionization energy	$E_i$		J
electron affinity	$E_{ea}$		J
dissociation energy	$E_d, D$		J
from the ground state	$D_0$		J
from the potential minimum	$D_e$		J
principal quantum number (H atom)	$n$	$E = -hcR/n^2$	1
angular momentum quantum numbers	see under Spectroscopy		
magnetic dipole moment of a molecule	$\mathbf{m}, \boldsymbol{\mu}$	$E_p = -\mathbf{m} \cdot \mathbf{B}$	J T <sup>-1</sup>
magnetizability of a molecule	$\xi$	$\mathbf{m} = \xi \mathbf{B}$	J T <sup>-2</sup>
Bohr magneton	$\mu_B$	$\mu_B = e\hbar/2m_e$	J T <sup>-1</sup>
nuclear magneton	$\mu_N$	$\mu_N = (m_e/m_p)\mu_B$	J T <sup>-1</sup>
magnetogyric ratio (gyromagnetic ratio)	$\gamma$	$\gamma = \mu/L$	C kg <sup>-1</sup>
<i>g</i> factor	$g$		1
Larmor circular frequency	$\omega_L$	$\omega_L = (e/2m)B$	s <sup>-1</sup>
Larmor frequency	$\nu_L$	$\nu_L = \omega_L/2\pi$	Hz
longitudinal relaxation time	$T_1$		s
transverse relaxation time	$T_2$		s
electric dipole moment of a molecule	$\mathbf{p}, \boldsymbol{\mu}$	$E_p = -\mathbf{p} \cdot \mathbf{E}$	C m
quadrupole moment of a molecule	$\mathbf{Q}; \boldsymbol{\Theta}$	$E_p = 1/2\mathbf{Q} \cdot \mathbf{V}'' = 1/3\boldsymbol{\Theta} \cdot \mathbf{V}''$	C m <sup>2</sup>
quadrupole moment of a nucleus	$eQ$	$eQ = 2 \cdot \langle \Theta_{zz} \rangle$	C m <sup>2</sup>
electric field gradient tensor	$\mathbf{q}$	$q_{\alpha\beta} = -\partial^2 V / \partial\alpha\partial\beta$	V m <sup>-2</sup>
quadrupole interaction energy tensor	$\chi$	$\chi_{\alpha\beta} = eQq_{\alpha\beta}$	J
electric polarizability of a molecule	$\alpha$	$p$ (induced) = $\alpha E$	C m <sup>2</sup> V <sup>-1</sup>
activity (of a radioactive substance)	$A$	$A = -dN_B/dt$	Bq
decay (rate) constant, disintegration (rate) constant	$\lambda$	$A = \gamma N_B$	s <sup>-1</sup>
half life	$t_{1/2}, T_{1/2}$		s
mean life	$\tau$		s
level width	$\Gamma$	$\Gamma = \hbar/\tau$	J
disintegration energy	$Q$		J
cross section (of a nuclear reaction)	$\sigma$		m <sup>2</sup>
<b>Spectroscopy</b>			
total term	$T$	$T = E_{tot}/hc$	m <sup>-1</sup>
transition wavenumber	$\tilde{\nu}, (\nu)$	$\tilde{\nu} = T' - T''$	m <sup>-1</sup>
transition frequency	$\nu$	$\nu = (E' - E'')/h$	Hz
electronic term	$T_e$	$T_e = E_e/hc$	m <sup>-1</sup>
vibrational term	$G$	$G = E_{vib}/hc$	m <sup>-1</sup>
rotational term	$F$	$F = E_{rot}/hc$	m <sup>-1</sup>
spin orbit coupling constant	$A$	$T_{s.o.} = A(\hat{\mathbf{L}} \cdot \hat{\mathbf{S}})$	m <sup>-1</sup>
principal moments of inertia	$I_A; I_B; I_C$	$I_A \leq I_B \leq I_C$	kg m <sup>2</sup>
rotational constants,			
in wavenumber	$\tilde{A}; \tilde{B}; \tilde{C}$	$\tilde{A} = h/8\pi^2 c I_A$	m <sup>-1</sup>
in frequency	$A; B; C$	$A = h/8\pi^2 I_A$	Hz
inertial defect	$\Delta$	$\Delta = I_C - I_A - I_B$	kg m <sup>2</sup>
asymmetry parameter	$\kappa$	$\kappa = \frac{(2B - A - C)}{(A - C)}$	1
centrifugal distortion constants,			
S reduction	$D_J; D_{JK}; D_{K^2}; d_1; d_2$		m <sup>-1</sup>
A reduction	$\Delta_J; \Delta_{JK}; \Delta_{K^2}; \delta_J; \delta_K$		m <sup>-1</sup>
harmonic vibration wavenumber	$\omega_e; \omega_r$		m <sup>-1</sup>
vibrational anharmonicity constant	$\omega_e x_e; x_{rs}; g_u'$		m <sup>-1</sup>
vibrational quantum numbers	$v_r; l_t$		1
Coriolis zeta constant	$\zeta_{rs}^a$		1
angular momentum quantum numbers	see additional information below		
degeneracy, statistical weight	$g, d, \beta$		1
electric dipole moment of a molecule	$\mathbf{p}, \boldsymbol{\mu}$	$E_p = -\mathbf{p} \cdot \mathbf{E}$	C m
transition dipole moment of a molecule	$\mathbf{M}, \mathbf{R}$	$\mathbf{M} = \int \psi' \mathbf{p} \psi'' d\tau$	C m
molecular geometry, interatomic distances,			
equilibrium distance	$r_e$		m
zero-point average distance	$r_z$		m

Name	Symbol	Definition	SI unit
ground state distance	$r_0$		m
substitution structure distance	$r_s$		m
vibrational coordinates,			
internal coordinates	$R_i, r_i, \theta_j, \text{etc.}$		(varies)
symmetry coordinates	$S_i$		(varies)
normal coordinates			
mass adjusted	$Q_r$		kg <sup>1/2</sup> m
dimensionless	$q_r$		1
vibrational force constants,			
diatomic	$f, (k)$	$f = \partial^2 V / \partial r^2$	J m <sup>-2</sup>
polyatomic,			
internal coordinates	$f_{ij}$	$f_{ij} = \partial^2 V / \partial r_i \partial r_j$	(varies)
symmetry coordinates	$F_{ij}$	$F_{ij} = \partial^2 V / \partial S_i \partial S_j$	(varies)
dimensionless normal coordinates	$\phi_{rst...}, k_{rst...}$		m <sup>-1</sup>
nuclear magnetic resonance (NMR),			
magnetogyric ratio	$\gamma$	$\gamma = \mu / I \hbar$	C kg <sup>-1</sup>
shielding constant	$\sigma_A$	$B_A = (1 - \sigma_A) B$	1
chemical shift, $\delta$ scale	$\delta$	$\delta = 10^6 (\nu - \nu_0) / \nu_0$	1
(indirect) spin-spin coupling constant	$J_{AB}$	$\hat{H} / \hbar = J_{AB} \hat{I}_A \cdot \hat{I}_B$	Hz
direct (dipolar) coupling constant	$D_{AB}$		Hz
longitudinal relaxation time	$T_1$		s
transverse relaxation time	$T_2$		s
electron spin resonance, electron paramagnetic resonance (ESR, EPR),			
magnetogyric ratio	$\gamma$	$\gamma = \mu / s \hbar$	C kg <sup>-1</sup>
g factor	$g$	$h\nu = g \mu_B B$	1
hyperfine coupling constant,			
in liquids	$a, A$	$\hat{H}_{\text{hs}} / \hbar = a \hat{S} \cdot \hat{I}$	Hz
in solids	$T$	$\hat{H}_{\text{hs}} / \hbar = \hat{S} \cdot T \cdot \hat{I}$	Hz

Angular momentum	Operator symbol	Quantum number symbol		
		Total	Z-axis	z-axis
electron orbital	$\hat{L}$	$L$	$M_L$	$\Lambda$
one electron only	$\hat{l}$	$l$	$m_l$	$\lambda$
electron spin	$\hat{S}$	$S$	$M_S$	$\Sigma$
one electron only	$\hat{s}$	$s$	$m_s$	$\sigma$
electron orbital + spin	$\hat{L} + \hat{S}$			$\Omega = \Lambda + \Sigma$
nuclear orbital (rotational)	$\hat{R}$	$R$		$K_R, k_R$
nuclear spin	$\hat{I}$	$I$	$M_I$	
internal vibrational				
spherical top	$\hat{l}$	$l(l\zeta)$		$K_l$
other	$\hat{j}, \hat{\pi}$			$l(l\zeta)$
sum of $R + L(+j)$	$\hat{N}$	$N$		$K, k$
sum of $N + S$	$\hat{J}$	$J$	$M_J$	$K, k$
sum of $J + I$	$\hat{F}$	$F$	$M_F$	

**Electromagnetic Radiation**

Name	Symbol	Definition	SI unit
wavelength	$\lambda$		m
speed of light			
in vacuum	$c_0$		m s <sup>-1</sup>
in a medium	$c$	$c = c_0 / n$	m s <sup>-1</sup>
wavenumber in vacuum	$\tilde{\nu}$	$\tilde{\nu} = \nu / c_0 = 1 / n \lambda$	m <sup>-1</sup>
wavenumber (in a medium)	$\sigma$	$\sigma = 1 / \lambda$	m <sup>-1</sup>
frequency	$\nu$	$\nu = c / \lambda$	Hz
circular frequency, pulsance	$\omega$	$\omega = 2\pi\nu$	s <sup>-1</sup> , rad s <sup>-1</sup>
refractive index	$n$	$n = c_0 / c$	1
Planck constant	$h$		J s

Name	Symbol	Definition	SI unit
Planck constant/ $2\pi$	$\hbar$	$\hbar = h/2\pi$	J s
radiant energy	$Q, W$		J
radiant energy density	$\rho, w$	$\rho = Q/V$	$\text{J m}^{-3}$
spectral radiant energy density			
in terms of frequency	$\rho_\nu, w_\nu$	$\rho = d\rho/d\nu$	$\text{J m}^{-3} \text{ Hz}^{-1}$
in terms of wavenumber	$\rho_{\bar{\nu}}, w_{\bar{\nu}}$	$\rho_{\bar{\nu}} = d\rho/d\bar{\nu}$	$\text{J m}^{-2}$
in terms of wavelength	$\rho_\lambda, w_\lambda$	$\rho_\lambda = d\rho/d\lambda$	$\text{J m}^{-4}$
Einstein transition probabilities			
spontaneous emission	$A_{nm}$	$dN_n/dt = -A_{nm}N_n$	$\text{s}^{-1}$
stimulated emission	$B_{nm}$	$dN_n/dt = -\rho_\nu(\bar{\nu}_{nm}) \times B_{nm}N_n$	$\text{s kg}^{-1}$
stimulated absorption	$B_{mn}$	$dN_n/dt = -\rho_\nu(\bar{\nu}_{nm}) B_{mn}N_m$	$\text{s kg}^{-1}$
radiant power, radiant energy per time	$\Phi, P$	$\Phi = dQ/dt$	W
radiant intensity	$I$	$I = d\Phi/d\Omega$	$\text{W sr}^{-1}$
radiant exitance (emitted radiant flux)	$M$	$M = d\Phi/dA_{\text{source}}$	$\text{W m}^{-2}$
irradiance (radiant flux received)	$E, (I)$	$E = d\Phi/dA$	$\text{W m}^{-2}$
emittance	$\varepsilon$	$\varepsilon = M/M_{\text{bb}}$	1
Stefan–Boltzmann constant	$\sigma$	$M_{\text{bb}} = \sigma T^4$	$\text{W m}^{-2} \text{ K}^{-4}$
first radiation constant	$c_1$	$c_1 = 2\pi^5 h c_0^2 / 15$	$\text{W m}^2$
second radiation constant	$c_2$	$c_2 = hc_0/k$	K m
transmittance, transmission factor	$\tau, T$	$\tau = \Phi_{\text{tr}}/\Phi_0$	1
absorptance, absorption factor	$\alpha$	$\alpha = \Phi_{\text{abs}}/\Phi_0$	1
reflectance, reflection factor	$\rho$	$\rho = \Phi_{\text{refl}}/\Phi_0$	1
(decadic) absorbance	$A$	$A = -\lg(1 - \alpha_\nu)$	1
napierian absorbance	$B$	$B = -\ln(1 - \alpha_\nu)$	1
absorption coefficient			
(linear) decadic	$a, K$	$a = A/l$	$\text{m}^{-1}$
(linear) napierian	$\alpha$	$\alpha = B/l$	$\text{m}^{-1}$
molar (decadic)	$\varepsilon$	$\varepsilon = a/c = A/cl$	$\text{m}^2 \text{ mol}^{-1}$
molar napierian	$\kappa$	$\kappa = \alpha/c = B/cl$	$\text{m}^2 \text{ mol}^{-1}$
absorption index	$k$	$k = \alpha/4\pi\bar{\nu}$	1
complex refractive index	$\hat{n}$	$\hat{n} = n + ik$	1
molar refraction	$R, R_m$	$R = \frac{(n^2 - 1)}{(n^2 + 2)} V_m$	$\text{m}^3 \text{ mol}^{-1}$
angle of optical rotation	$\alpha$		1, rad
<b>Solid State</b>			
lattice vector	$\mathbf{R}, \mathbf{R}_0$		m
fundamental translation vectors for the crystal lattice	$\mathbf{a}_1; \mathbf{a}_2; \mathbf{a}_3, \mathbf{a}; \mathbf{b}; \mathbf{c}$	$\mathbf{R} = n_1\mathbf{a}_1 + n_2\mathbf{a}_2 + n_3\mathbf{a}_3$	m
(circular) reciprocal lattice vector	$\mathbf{G}$	$\mathbf{G} \cdot \mathbf{R} = 2\pi m$	$\text{m}^{-1}$
(circular) fundamental translation vectors for the reciprocal lattice	$\mathbf{b}_1; \mathbf{b}_2; \mathbf{b}_3, \mathbf{a}^*; \mathbf{b}^*; \mathbf{c}^*$	$\mathbf{a}_i \cdot \mathbf{b}_k = 2\pi\delta_{ik}$	$\text{m}^{-1}$
lattice plane spacing	$d$		m
Bragg angle	$\theta$	$n\lambda = 2d \sin \theta$	1, rad
order of reflection	$n$		1
order parameters			
short range	$\sigma$		1
long range	$s$		1
Burgers vector	$\mathbf{b}$		m
particle position vector	$\mathbf{r}, \mathbf{R}_j$		m
equilibrium position vector of an ion	$\mathbf{R}_0$		m
displacement vector of an ion	$\mathbf{u}$	$\mathbf{u} = \mathbf{R} - \mathbf{R}_0$	m
Debye–Waller factor	$B, D$		1
Debye circular wavenumber	$q_D$		$\text{m}^{-1}$
Debye circular frequency	$\omega_D$		$\text{s}^{-1}$
Grüneisen parameter	$\gamma, \Gamma$	$\gamma = \alpha V/\kappa C_v$	1
Madelung constant	$\alpha, \mathcal{M}$	$E_{\text{coul}} = \frac{\alpha N_A z_+ z_- e^2}{4\pi\epsilon_0 R_0}$	1
density of states	$N_E$	$N_E = dN(E)/dE$	$\text{J}^{-1} \text{ m}^{-3}$
(spectral) density of vibrational modes	$N_\omega, g$	$N_\omega = dN(\omega)/d\omega$	$\text{s m}^{-3}$



Name	Symbol	Definition	SI unit
resistivity tensor	$\rho_{ik}$	$E = \rho \cdot j$	$\Omega \text{ m}$
conductivity tensor	$\sigma_{ik}$	$\sigma = \rho^{-1}$	$\text{S m}^{-1}$
thermal conductivity tensor	$\lambda_{ik}$	$J_q = -\lambda \cdot \text{grad } T$	$\text{W m}^{-1} \text{ K}^{-1}$
residual resistivity	$\rho_R$		$\Omega \text{ m}$
relaxation time	$\tau$	$\tau = l/v_F$	s
Lorenz coefficient	$L$	$L = \lambda/\sigma T$	$\text{V}^2 \text{ K}^{-2}$
Hall coefficient	$A_H, R_H$	$E = \rho \cdot j + R_H(\mathbf{B} \times \mathbf{j})$	$\text{m}^3 \text{ C}^{-1}$
thermoelectric force	$E$		V
Peltier coefficient	$\Pi$		V
Thomson coefficient	$\mu, (\tau)$		$\text{V K}^{-1}$
work function	$\Phi$	$\Phi = E_\infty - E_F$	J
number density, number concentration	$n, (p)$		$\text{m}^{-3}$
gap energy	$E_g$		J
donor ionization energy	$E_d$		J
acceptor ionization energy	$E_a$		J
Fermi energy	$E_F, \varepsilon_F$		J
circular wave vector, propagation vector	$k, \mathbf{q}$	$k = 2\pi/\lambda$	$\text{m}^{-1}$
Bloch function	$u_k(\mathbf{r})$	$\psi(\mathbf{r}) = u_k(\mathbf{r}) \exp(i\mathbf{k} \cdot \mathbf{r})$	$\text{m}^{-3/2}$
charge density of electrons	$\rho$	$\rho(\mathbf{r}) = -e\psi^*(\mathbf{r})\psi(\mathbf{r})$	$\text{C m}^{-3}$
effective mass	$m^*$		kg
mobility	$\mu$	$\mu = v_{\text{drift}}/E$	$\text{m}^2 \text{ V}^{-1} \text{ s}^{-1}$
mobility ratio	$b$	$b = \mu_n/\mu_p$	1
diffusion coefficient	$D$	$dN/dt = -DA(dn/dx)$	$\text{m}^2 \text{ s}^{-1}$
diffusion length	$L$	$L = \sqrt{D\tau}$	m
characteristic (Weiss) temperature	$\theta, \theta_w$		K
Curie temperature	$T_C$		K
Néel temperature	$T_N$		K
<b>Statistical Thermodynamics</b>			
number of entities	$N$		1
number density of entities, number concentration	$n, C$	$n = N/V$	$\text{m}^{-3}$
Avogadro constant	$L, N_A$		$\text{mol}^{-1}$
Boltzmann constant	$k, k_B$		$\text{J K}^{-1}$
gas constant (molar)	$R$	$R = Lk$	$\text{J K}^{-1} \text{ mol}^{-1}$
molecular position vector	$\mathbf{r} (x, y, z)$		m
molecular velocity vector	$\mathbf{c}(c_x, c_y, c_z), \mathbf{u}(u_x, u_y, u_z)$	$\mathbf{c} = d\mathbf{r}/dt$	$\text{m s}^{-1}$
molecular momentum vector	$\mathbf{p}(p_x, p_y, p_z)$	$\mathbf{p} = m\mathbf{c}$	$\text{kg m s}^{-1}$
velocity distribution function (Maxwell)	$f(c_x)$	$f(c_x) = (m/2\pi kT)^{1/2} \times \exp(-mc_x^2/2kT)$	$\text{m}^{-1} \text{ s}$
speed distribution function (Maxwell-Boltzmann)	$F(c)$	$F(c) = (m/2\pi kT)^{3/2} \times 4\pi c^2 \exp(-mc^2/2kT)$	$\text{m}^{-1} \text{ s}$
average speed	$\bar{c}, \bar{u}, \langle c \rangle, \langle u \rangle$	$\bar{c} = \int cF(c)dc$	$\text{m s}^{-1}$
generalized coordinate	$q$		(m)
generalized momentum	$p$	$p = \partial L/\partial \dot{q}$	$(\text{kg m s}^{-1})$
volume in phase space	$\Omega$	$\Omega = (1/h) \int p dq$	1
probability	$P$		1
statistical weight, degeneracy	$g, d, W, \omega, \beta$		1
density of states	$\rho(E)$	$\rho(E) = dN/dE$	$\text{J}^{-1}$
partition function, sum over states, for a single molecule	$q, z$	$q = \sum_i g_i \exp(-\varepsilon_i/kT)$	1
for a canonical ensemble (system, or assembly)	$Q, Z$		1
microcanonical ensemble	$\Omega$		1
grand (canonical ensemble)	$\Xi$		1
symmetry number	$\sigma, s$		1
reciprocal temperature parameter	$\beta$	$\beta = 1/kT$	$\text{J}^{-1}$
characteristic temperature	$\Theta$		K

Name	Symbol	Definition	SI unit
<b>General Chemistry</b>			
number of entities (e.g. molecules, atoms, ions, formula units)	$N$		1
amount (of substance)	$n$	$n_B = N_B/L$	mol
Avogadro constant	$L, N_A$		mol <sup>-1</sup>
mass of atom, atomic mass	$m_a, m$		kg
mass of entity (molecule, or formula unit)	$m_e, m$		kg
atomic mass constant	$m_u$	$m_u = m_a(^{12}\text{C})/12$	kg
molar mass	$M$	$M_B = m/n_B$	kg mol <sup>-1</sup>
relative molecular mass (relative molar mass, molecular weight)	$M_r$	$M_{r,B} = m_B/m_u$	1
molar volume	$V_m$	$V_{m,B} = V/n_B$	m <sup>3</sup> mol <sup>-1</sup>
mass fraction	$w$	$w_B = m_B/\Sigma m_i$	1
volume fraction	$\phi$	$\phi_B = V_B/\Sigma V_i$	1
mole fraction, amount fraction, number fraction	$x, y$	$x_B = n_B/\Sigma n_i$	1
(total) pressure	$p, P$		Pa
partial pressure	$p_B$	$p_B = y_B p$	Pa
mass concentration (mass density)	$\gamma, \rho$	$\gamma_B = m_B/V$	kg m <sup>-3</sup>
number concentration, number density of entities	$C, n$	$C_B = N_B/V$	m <sup>-3</sup>
amount concentration, concentration	$c$	$c_B = n_B/V$	mol m <sup>-3</sup>
solubility	$s$	$s_B = c_B$ (saturated solution)	mol m <sup>-3</sup>
molality (of a solute)	$m, (b)$	$m_B = n_B/m_A$	mol kg <sup>-1</sup>
surface concentration	$\Gamma$	$\Gamma_B = n_B/A$	mol m <sup>-2</sup>
stoichiometric number	$\nu$		1
extent of reaction, advancement	$\xi$	$\Delta\xi = \Delta n_B/\nu_B$	mol
degree of dissociation	$\alpha$		1
<b>Chemical Thermodynamics</b>			
heat	$q, Q$		J
work	$w, W$		J
internal energy	$U$	$\Delta U = q + w$	J
enthalpy	$H$	$H = U + pV$	J
thermodynamic temperature	$T$		K
Celsius temperature	$\theta, t$	$\theta/^{\circ}\text{C} = T/\text{K} - 273.15$	°C
entropy	$S$	$dS \geq dq/T$	J K <sup>-1</sup>
Helmholtz energy (Helmholtz function)	$A$	$A = U - TS$	J
Gibbs energy (Gibbs function)	$G$	$G = H - TS$	J
Massieu function	$J$	$J = -A/T$	J K <sup>-1</sup>
Planck function	$Y$	$Y = -G/T$	J K <sup>-1</sup>
surface tension	$\gamma, \sigma$	$\gamma = (\partial G/\partial A_s)_{T, p}$	J m <sup>-2</sup> , N m <sup>-1</sup>
molar quantity $X$	$X_m$	$X_m = X/n$	(varies)
specific quantity $X$	$x$	$x = X/m$	(varies)
pressure coefficient	$\beta$	$\beta = (\partial p/\partial T)_V$	Pa K <sup>-1</sup>
relative pressure coefficient	$\alpha_p$	$\alpha_p = (1/p)(\partial p/\partial T)_V$	K <sup>-1</sup>
compressibility,			
isothermal	$\kappa_T$	$\kappa_T = -(1/V)(\partial V/\partial p)_T$	Pa <sup>-1</sup>
isentropic	$\kappa_S$	$\kappa_S = -(1/V)(\partial V/\partial p)_S$	Pa <sup>-1</sup>
linear expansion coefficient	$\alpha_l$	$\alpha_l = (1/l)(\partial l/\partial T)$	K <sup>-1</sup>
cubic expansion coefficient	$\alpha, \alpha_V, \gamma$	$\alpha = (1/V)(\partial V/\partial T)_p$	K <sup>-1</sup>
heat capacity,			
at constant pressure	$C_p$	$C_p = (\partial H/\partial T)_p$	J K <sup>-1</sup>
at constant volume	$C_V$	$C_V = (\partial U/\partial T)_V$	J K <sup>-1</sup>
ratio of heat capacities	$\gamma, (\kappa)$	$\gamma = C_p/C_V$	1
Joule–Thomson coefficient	$\mu, \mu_{JT}$	$\mu = (\partial T/\partial p)_H$	K Pa <sup>-1</sup>
second virial coefficient	$B$	$pV_m = RT(1 + B/V_m + \dots)$	m <sup>3</sup> mol <sup>-1</sup>
compression factor (compressibility factor)	$Z$	$Z = pV_m/RT$	1
partial molar quantity $X$	$X_B, (X'_B)$	$X_B = (\partial X/\partial n_B)_{T, p, n_j \neq B}$	(varies)
chemical potential (partial molar Gibbs energy)	$\mu$	$\mu_B = (\partial G/\partial n_B)_{T, p, n_j \neq B}$	J mol <sup>-1</sup>
absolute activity	$\lambda$	$\lambda_B = \exp(\mu_B/RT)$	1

Name	Symbol	Definition	SI unit
standard chemical potential	$\mu^\ominus, \mu^\circ$		J mol <sup>-1</sup>
standard partial molar enthalpy	$H_B^\ominus$	$H_B^\ominus = \mu_B^\ominus + TS_B^\ominus$	J mol <sup>-1</sup>
standard partial molar entropy	$S_B^\ominus$	$S_B^\ominus = -(\partial\mu_B^\ominus/\partial T)_p$	J mol <sup>-1</sup> K <sup>-1</sup>
standard reaction Gibbs energy (function)	$\Delta_r G^\ominus$	$\Delta_r G^\ominus = \sum_B \nu_B \mu_B^\ominus$	J mol <sup>-1</sup>
affinity of reaction	$A, (\mathcal{A})$	$A = -(\partial G / \partial \xi)_{p,T} = -\sum_B \nu_B \mu_B$	J mol <sup>-1</sup>
standard reaction enthalpy	$\Delta_r H^\ominus$	$\Delta_r H^\ominus = \sum_B \nu_B H_B^\ominus$	J mol <sup>-1</sup>
standard reaction entropy	$\Delta_r S^\ominus$	$\Delta_r S^\ominus = \sum_B \nu_B S_B^\ominus$	J mol <sup>-1</sup> K <sup>-1</sup>
equilibrium constant	$K^\ominus, K$	$K^\ominus = \exp(-\Delta_r G^\ominus / RT)$	1
equilibrium constant, pressure basis	$K_p$	$K_p = \prod_B p_B^{\nu_B}$	Pa <sup><math>\sum \nu</math></sup>
concentration basis	$K_c$	$K_c = \prod_B c_B^{\nu_B}$	(mol m <sup>-3</sup> ) <sup><math>\sum \nu</math></sup>
molality basis	$K_m$	$K_m = \prod_B m_B^{\nu_B}$	(mol kg <sup>-1</sup> ) <sup><math>\sum \nu</math></sup>
fugacity	$f, \tilde{p}$	$f_B = \lambda_B \lim_{p \rightarrow 0} (p_B / \lambda_B)_T$	Pa
fugacity coefficient	$\phi$	$\phi_B = f_B / p_B$	1
activity and activity coefficient referenced to Raoult's law, (relative) activity	$a$	$a_B = \exp\left[\frac{\mu_B - \mu_B^*}{RT}\right]$	1
activity coefficient	$f$	$f_B = a_B / x_B$	1
activities and activity coefficients referenced to Henry's law, (relative) activity, molality basis	$a_m$	$a_{m,B} = \exp\left[\frac{\mu_B - \mu_B^\ominus}{RT}\right]$	1
concentration basis	$a_c$	$a_{c,B} = \exp\left[\frac{\mu_B - \mu_B^\ominus}{RT}\right]$	1
mole fraction basis	$a_x$	$a_{x,B} = \exp\left[\frac{\mu_B - \mu_B^\ominus}{RT}\right]$	1
activity coefficient, molality basis	$\gamma_m$	$a_{m,B} = \gamma_{m,B} m_B^\ominus / m^\ominus$	1
concentration basis	$\gamma_c$	$a_{c,B} = \gamma_{c,B} c_B^\ominus / c^\ominus$	1
mole fraction basis	$\gamma_x$	$a_{x,B} = \gamma_{x,B} x_B$	1
ionic strength, molality basis	$I_m, I$	$I_m = \frac{1}{2} \sum m_B z_B^2$	mol kg <sup>-1</sup>
concentration basis	$I_c, I$	$I_c = \frac{1}{2} \sum c_B z_B^2$	mol m <sup>-3</sup>
osmotic coefficient, molality basis	$\phi_m$	$\phi_m = (\mu_A^* - \mu_A) / (RTM_A \sum m_B)$	1
mole fraction basis	$\phi_x$	$\phi_x = (\mu_A - \mu_A^*) / (RT \ln x_A)$	1
osmotic pressure	$\Pi$	$\Pi = c_B RT$ (ideal dilute solution)	Pa

*(i) Symbols used as subscripts to denote a chemical process or reaction*

These symbols should be printed in roman (upright) type, without a full stop (period).

vaporization, evaporation (liquid → gas)	vap
sublimation (solid → gas)	sub
melting, fusion (solid → liquid)	fus
transition (between two phases)	trs
mixing of fluids	mix
solution (of solute in solvent)	sol
dilution (of a solution)	dil
adsorption	ads
displacement	dpl
immersion	imm

reaction in general	r
atomization	at
combustion reaction	c
formation reaction	f

*(ii) Recommended superscripts*

standard	$\ominus, \circ$
pure substance	*
infinite dilution	$\infty$
ideal	id
activated complex, transition state	‡
excess quantity	E

Name	Symbol	Definition	SI unit
<b>Chemical Kinetics</b>			
rate of change of quantity $X$	$\dot{X}$	$\dot{X} = dX/dt$	(varies)
rate of conversion	$\dot{\xi}$	$\dot{\xi} = d\xi/dt$	mol s <sup>-1</sup>
rate of concentration change (due to chemical reaction)	$r_B \nu_B$	$r_B = dc_B/dt$	mol m <sup>-3</sup> s <sup>-1</sup>
rate of reaction (based on amount concentration)	$\nu$	$\nu = \dot{\xi} / V = \nu_B^{-1} dc_B/dt$	mol m <sup>-3</sup> s <sup>-1</sup>
partial order of reaction	$n_B$	$\nu = k \Pi c_B^{n_B}$	1
overall order of reaction	$n$	$n = \sum n_B$	1
rate constant, rate coefficient	$k$	$\nu = k \Pi c_B^{n_B}$	(mol <sup>-1</sup> m <sup>3</sup> ) <sup>n-1</sup> s <sup>-1</sup>
Boltzmann constant	$k, k_B$		J K <sup>-1</sup>
half life	$t_{1/2}$	$c(t_{1/2}) = c_0/2$	s
relaxation time	$\tau$	$\tau = 1/(k_1 + k_{-1})$	s
energy of activation, activation energy	$E_a, E$	$E_a = RT^2 d \ln k/dT$	J mol <sup>-1</sup>
pre-exponential factor	$A$	$k = A \exp(-E_a/RT)$	(mol <sup>-1</sup> m <sup>3</sup> ) <sup>n-1</sup> s <sup>-1</sup>
volume of activation	$\Delta^\ddagger V$	$\Delta^\ddagger V = -RT \times (\partial \ln k / \partial p)_T$	m <sup>3</sup> mol <sup>-1</sup>
collision diameter	$d$	$d_{AB} = r_A + r_B$	m
collision cross-section	$\sigma$	$\sigma_{AB} = \pi d_{AB}^2$	m <sup>2</sup>
collision frequency	$Z_A$		s <sup>-1</sup>
collision number	$Z_{AB}, Z_{AA}$		m <sup>-3</sup> s <sup>-1</sup>
collision frequency factor	$z_{AB}, z_{AA}$	$z_{AB} = Z_{AB} / L c_A c_B$	m <sup>3</sup> mol <sup>-1</sup> s <sup>-1</sup>
standard enthalpy of activation	$\Delta^\ddagger H^\ominus, \Delta H^\ddagger$		J mol <sup>-1</sup>
standard entropy of activation	$\Delta^\ddagger S^\ominus, \Delta S^\ddagger$		J mol <sup>-1</sup> K <sup>-1</sup>
standard Gibbs energy of activation	$\Delta^\ddagger G^\ominus, \Delta G^\ddagger$		J mol <sup>-1</sup>
quantum yield, photochemical yield	$\phi$		1
<b>Electrochemistry</b>			
elementary charge (proton charge)	$e$		C
Faraday constant	$F$	$F = eL$	C mol <sup>-1</sup>
charge number of an ion	$z$	$z_B = Q_B/e$	1
ionic strength	$I_c, I$	$I_c = \frac{1}{2} \sum c_i z_i^2$	mol m <sup>-3</sup>
mean ionic activity	$a_\pm$	$a_\pm = m_\pm \gamma_\pm / m^\ominus$	1
mean ionic molality	$m_\pm$	$m_\pm^{(v_+ + v_-)} = m_+^{v_+} m_-^{v_-}$	mol kg <sup>-1</sup>
mean ionic activity coefficient	$\gamma_\pm$	$\gamma_\pm^{(v_+ + v_-)} = \gamma_+^{v_+} \gamma_-^{v_-}$	1
charge number of electrochemical cell reaction	$n, (z)$		1
electric potential difference (of a galvanic cell)	$\Delta V, E, U$	$\Delta V = V_R - V_L$	V
emf, electromotive force	$E$	$E = \lim_{I \rightarrow 0} \Delta V$	V
standard emf, standard potential of the electrochemical cell reaction	$E^\ominus$	$E^\ominus = -\Delta_r G^\ominus / nF = (RT/nF) \ln K^\ominus$	V
standard electrode potential	$E^\ominus$		V
emf of the cell, potential of the electrochemical cell reaction	$E$	$E = E^\ominus - (RT/nF) \times \sum \nu_i \ln a_i$	V
pH	pH	$\text{pH} \approx -\lg \left[ \frac{c(\text{H}^+)}{\text{mol dm}^{-3}} \right]$	1
inner electric potential	$\phi$	$\nabla \phi = -E$	V
outer electric potential	$\psi$	$\psi = Q/4\pi\epsilon_0 r$	V

Name	Symbol	Definition	SI unit
surface electric potential	$\chi$	$\chi = \phi - \psi$	V
Galvani potential difference	$\Delta\phi$	$\Delta_{\alpha}^{\beta}\phi = \phi^{\beta} - \phi^{\alpha}$	V
volta potential difference	$\Delta\psi$	$\Delta_{\alpha}^{\beta}\psi = \psi^{\beta} - \psi^{\alpha}$	V
electrochemical potential	$\tilde{\mu}$	$\tilde{\mu}_{\text{B}}^{\alpha} = (\partial G/\partial n_{\text{B}}^{\alpha})$	J mol <sup>-1</sup>
electric current	$I$	$I = dQ/dt$	A
(electric) current density	$j$	$j = I/A$	A m <sup>-2</sup>
(surface) charge density	$\sigma$	$\sigma = Q/A$	C m <sup>-2</sup>
electrode reaction rate constant	$k$	$k_{\text{ox}} = I_{\text{a}}/(nFA\prod_i c_i^{n_i})$	(varies)
mass transfer coefficient, diffusion rate constant	$k_{\text{d}}$	$k_{\text{d,B}} =  v_{\text{B}} I_{\text{L,B}}/nFcA$	m s <sup>-1</sup>
thickness of diffusion layer	$\delta$	$\delta_{\text{B}} = D_{\text{B}}/k_{\text{d,B}}$	m
transfer coefficient (electrochemical)	$\alpha$	$\alpha_{\text{c}} = \frac{- v RT\partial \ln I_{\text{c}} }{nF \partial E}$	1
overpotential	$\eta$	$\eta = E_i - E_{i=0} - IR_{\text{u}}$	V
electrokinetic potential (zeta potential)	$\zeta$		V
conductivity	$\kappa, (\sigma)$	$\kappa = j/E$	S m <sup>-1</sup>
conductivity cell constant	$K_{\text{cell}}$	$K_{\text{cell}} = \kappa R$	m <sup>-1</sup>
molar conductivity (of an electrolyte)	$\Lambda$	$\Lambda_{\text{B}} = \kappa/c_{\text{B}}$	S m <sup>2</sup> mol <sup>-1</sup>
ionic conductivity, molar conductivity of an ion	$\lambda$	$\lambda_{\text{B}} =  z_{\text{B}} Fu_{\text{B}}$	S m <sup>2</sup> mol <sup>-1</sup>
electric mobility	$u, (\mu)$	$u_{\text{B}} = v_{\text{B}}/E$	m <sup>2</sup> V <sup>-1</sup> s <sup>-1</sup>
transport number	$t$	$t_{\text{B}} = j_{\text{B}}/\sum_i j_i$	1
reciprocal radius of ionic atmosphere	$\kappa$	$\kappa = (2F^2I/\epsilon RT)^{1/2}$	m <sup>-1</sup>
<b>Colloid and Surface Chemistry</b>			
specific surface area	$a, a_{\text{s}}, s$	$a = A/m$	m <sup>2</sup> kg <sup>-1</sup>
surface amount of B, adsorbed amount of B	$n_{\text{B}}^{\text{s}}, n_{\text{B}}^{\text{a}}$		mol
surface excess of B	$n_{\text{B}}^{\sigma}$		mol
surface excess concentration of B	$\Gamma_{\text{B}}, (\Gamma_{\text{B}}^{\sigma})$	$\Gamma_{\text{B}} = n_{\text{B}}^{\sigma}/A$	mol m <sup>-2</sup>
total surface excess concentration	$\Gamma, (\Gamma^{\sigma})$	$\Gamma = \sum_i \Gamma_i$	mol m <sup>-2</sup>
area per molecule	$a, \sigma$	$a_{\text{B}} = A/N_{\text{B}}^{\sigma}$	m <sup>2</sup>
area per molecule in a filled monolayer	$a_{\text{m}}, \sigma_{\text{m}}$	$a_{\text{m,B}} = A/N_{\text{m,B}}$	m <sup>2</sup>
surface coverage	$\theta$	$\theta = N_{\text{B}}^{\sigma}/N_{\text{m,B}}$	1
contact angle	$\theta$		1, rad
film thickness	$t, h, \delta$		m
thickness of (surface or interfacial) layer	$\tau, \delta, t$		m
surface tension, interfacial tension	$\gamma, \sigma$	$\gamma = (\partial G/\partial A_{\text{s}})_{T,p}$	N m <sup>-1</sup> , J m <sup>-2</sup>
film tension	$\Sigma_{\text{f}}$	$\Sigma_{\text{f}} = 2\gamma_{\text{f}}$	N m <sup>-1</sup>
reciprocal thickness of the double layer	$\kappa$	$\kappa = [2F^2I_{\text{c}}/\epsilon RT]^{1/2}$	m <sup>-1</sup>
average molar masses			
number-average	$M_{\text{n}}$	$M_{\text{n}} = \sum n_i M_i / \sum n_i$	kg mol <sup>-1</sup>
mass-average	$M_{\text{m}}$	$M_{\text{m}} = \sum n_i M_i^2 / \sum n_i M_i$	kg mol <sup>-1</sup>
Z-average	$M_{\text{z}}$	$M_{\text{z}} = \sum n_i M_i^3 / \sum n_i M_i^2$	kg mol <sup>-1</sup>
sedimentation coefficient	$s$	$s = v/a$	s
van der Waals constant	$\lambda$		J
retarded van der Waals constant	$\beta, B$		J
van der Waals–Hamaker constant	$A_{\text{H}}$		J
surface pressure	$\pi^{\text{s}}, \pi$	$\pi^{\text{s}} = \gamma^0 - \gamma$	N m <sup>-1</sup>
<b>Transport Properties</b>			
flux (of a quantity X)	$J_{\text{X}}, J$	$J_{\text{X}} = A^{-1} dX/dt$	(varies)
volume flow rate	$q_{\text{v}}, \dot{V}$	$q_{\text{v}} = dV/dt$	m <sup>3</sup> s <sup>-1</sup>
mass flow rate	$q_{\text{m}}, \dot{m}$	$q_{\text{m}} = dm/dt$	kg s <sup>-1</sup>
mass transfer coefficient	$k_{\text{d}}$		m s <sup>-1</sup>
heat flow rate	$\phi$	$\phi = dq/dt$	W
heat flux	$J_{\text{q}}$	$J_{\text{q}} = \phi/A$	W m <sup>-2</sup>
thermal conductance	$G$	$G = \phi/\Delta T$	W K <sup>-1</sup>
thermal resistance	$R$	$R = 1/G$	K W <sup>-1</sup>
thermal conductivity	$\lambda, k$	$\lambda = J_{\text{q}}/(dT/dl)$	W m <sup>-1</sup> K <sup>-1</sup>

Name	Symbol	Definition	SI unit
coefficient of heat transfer	$h, (k, K, \alpha)$	$h = J_d/\Delta T$	$\text{W m}^{-2} \text{K}^{-1}$
thermal diffusivity	$a$	$a = \lambda/\rho c_p$	$\text{m}^2 \text{s}^{-1}$
diffusion coefficient	$D$	$D = J_d/(dc/dl)$	$\text{m}^2 \text{s}^{-1}$

The following symbols are used in the definitions of the dimensionless quantities: mass ( $m$ ), time ( $t$ ), volume ( $V$ ), area ( $A$ ), density ( $\rho$ ), speed ( $v$ ), length ( $l$ ), viscosity ( $\eta$ ), pressure ( $p$ ), acceleration of free fall ( $g$ ), cubic expansion coefficient ( $\alpha$ ), temperature ( $T$ ), surface tension ( $\gamma$ ), speed of sound ( $c$ ), mean free path ( $\lambda$ ), frequency ( $f$ ), thermal diffusivity ( $a$ ), coefficient of heat transfer ( $h$ ), thermal conductivity ( $k$ ), specific heat capacity at constant pressure ( $c_p$ ), diffusion coefficient ( $D$ ), mole fraction ( $x$ ), mass transfer coefficient ( $k_d$ ), permeability ( $\mu$ ), electric conductivity ( $\kappa$ ), and magnetic flux density ( $B$ ).

Name	Symbol	Definition	SI unit
Reynolds number	$Re$	$Re = \rho v l / \eta$	1
Euler number	$Eu$	$Eu = \Delta p / \rho v^2$	1
Froude number	$Fr$	$Fr = v / (lg)^{1/2}$	1
Grashof number	$Gr$	$Gr = l^3 g \alpha \Delta T \rho^2 / \eta^2$	1
Weber number	$We$	$We = \rho v^2 l / \gamma$	1
Mach number	$Ma$	$Ma = v / c$	1
Knudsen number	$Kn$	$Kn = \lambda / l$	1
Strouhal number	$Sr$	$Sr = lf / v$	1
Fourier number	$Fo$	$Fo = at / l^2$	1
Péclet number	$Pe$	$Pe = vl / a$	1
Rayleigh number	$Ra$	$Ra = l^3 g \alpha \Delta T \rho / \eta a$	1
Nusselt number	$Nu$	$Nu = hl / k$	1
Stanton number	$St$	$St = h / \rho v c_p$	1
Fourier number for mass transfer	$Fo^*$	$Fo^* = Dt / l^2$	1
Péclet number for mass transfer	$Pe^*$	$Pe^* = vl / D$	1
Grashof number for mass transfer	$Gr^*$	$Gr^* = l^3 g \left( \frac{\partial p}{\partial x} \right)_{T,p} \left( \frac{\Delta x p}{\eta} \right)$	1
Nusselt number for mass transfer	$Nu^*$	$Nu^* = k_d l / D$	1
Stanton number for mass transfer	$St^*$	$St^* = k_d / v$	1
Prandtl number	$Pr$	$Pr = \eta / \rho a$	1
Schmidt number	$Sc$	$Sc = \eta / \rho D$	1
Lewis number	$Le$	$Le = a / D$	1
magnetic Reynolds number	$Rm, Re_m$	$Rm = v \mu \kappa l$	1
Alfvén number	$Al$	$Al = v(\rho \mu)^{1/2} / B$	1
Hartmann number	$Ha$	$Ha = Bl (\kappa / \eta)^{1/2}$	1
Cowling number	$Co$	$Co = B^2 / \mu \rho v^2$	1

## NOMENCLATURE FOR CHEMICAL COMPOUNDS

The International Union of Pure and Applied Chemistry (IUPAC) maintains several commissions that deal with the naming of chemical substances. In general, the approach of IUPAC is to present rules for arriving at names in a systematic manner, rather than recommending a unique name for each compound. Thus there are often several alternative "IUPAC names," depending on which nomenclature system is used, each of which may have advantages in specific applications. However, each of these names will be unambiguous.

Organizations such as the Chemical Abstracts Service and the Beilstein Institute that prepare indexes to the chemical literature must adopt a system for selecting unique names in order to avoid excessive cross referencing. Chemical Abstracts Service uses a system which groups together compounds derived from a single parent compound. Thus most index names are inverted (e.g., Benzene, bromo rather than bromobenzene; Acetic acid, sodium salt rather than sodium acetate).

Recommended names for the most common substituent groups, ligands, ions, and organic rings are given in the two following tables, "Nomenclature for Inorganic Ions and Ligands" and "Organic Substituent Groups and Ring Systems." For the basics of macromolecular nomenclature, see "Nomenclature for Organic Polymers" in Section 13.

Some of the most useful recent guides to chemical nomenclature, prepared by IUPAC and other organizations such as the International Union of Biochemistry and Molecular Biology (IUBMB) and the American Chemical Society are listed below. These books contain citations to the more detailed nomenclature documents in each area. Two very useful web sites providing links to nomenclature documents are:

[www.iupac.org/publications/index.html](http://www.iupac.org/publications/index.html)  
[www.chem.qmul.ac.uk/iupac/](http://www.chem.qmul.ac.uk/iupac/)

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Block, B. P., Powell, W. H., and Fernelius, W. C., *Inorganic Chemical Nomenclature, Principles and Practice*, American Chemical Society, Washington, 1990.

*Nomenclature of Inorganic Chemistry - IUPAC Recommendations 2005*. Connelly, N.G., Damhus, T., Hartshorn, R. M., and Hutton, A. T., The Royal Society of Chemistry, 2005.

### Organic Chemistry

International Union of Pure and Applied Chemistry, *A Guide to IUPAC Nomenclature of Organic Compounds, Recommendations 1993*, Panico, R., Powell, W. H., and Richer, J.-C., Eds., Blackwell Scientific Publications, Oxford, 1993.

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### Biochemistry

International Union of Biochemistry and Molecular Biology, *Biochemical Nomenclature and Related Documents, 2nd Edition, 1992*, Portland Press, London, 1993; includes recommendations of the IUPAC-IUBMB Joint Commission on Biochemical Nomenclature.

International Union of Biochemistry and Molecular Biology, *Enzyme Nomenclature, 1992*, Academic Press, Orlando, FL, 1992.

IUPAC-IUBMB Joint Commission on Biochemical Nomenclature, *Nomenclature of Carbohydrates, Recommendations 1996*, McNaught, A. D., Ed., *Pure & Appl. Chem.* 68, 1919, 1996.

### General

Chemical Abstracts Service, *Naming and Indexing Chemical Substances for Chemical Abstracts, Appendix IV, Chemical Abstracts 1994 Index Guide*.

*Principles of Chemical Nomenclature: a Guide to IUPAC Recommendations*, Leigh, G. J., Favre, H. A., and Metanomski, W. V., Blackwell Science, 1998.

# NOMENCLATURE FOR INORGANIC IONS AND LIGANDS

Willem H. Koppenol

The entries below were selected from Table IX of Connelly, N. G., Damhus, T., Hartshorn, R. M. and Hutton, A. T., Eds., *Nomenclature of Inorganic Chemistry. IUPAC Recommendations 2005*, The Royal Society of Chemistry, 2005. Two changes were made: in the case of the hypohalides, the oxidohalogenate names are listed, not the new halooxygenate names. Thus, for BrO<sup>-</sup> the still acceptable name “oxidobromate(1-)” is listed, not the more correct, but less palatable, “bromooxygenate(1-)”. Similarly, and for reasons of consistency, ClO<sup>•</sup> is not named oxygen (mono)chloride, but chlorine mono(o)oxide. The symbol '⊂' is used for dividing names when this is made necessary by a line break. When the name is reconstructed

from the name given in the table, this symbol should be omitted. Thus, all *hyphens* in the table are true parts of the names. The symbols ‘>’ and ‘<’ placed next to an element symbol both denote two single bonds connecting the atom in question to two other atoms. For a given compound, the various systematic names, if applicable, are given in the order: stoichiometric names, substitutive names, additive names and hydrogen names. Acceptable names which are not entirely systematic (or not formed according to any of the systems mentioned above) are given at the end after a semicolon. No order of preference is implied by the order in which formulae and names are listed. Reprinted by permission of IUPAC.

Formula for uncharged atom or group	Name			
	<i>Uncharged atoms or molecules (including zwitterions and radicals) or substituent groups<sup>a</sup></i>	<i>Cations (including cation radicals) or cationic substituent groups<sup>a</sup></i>	<i>Anions (including anion radicals) or anionic substituent groups<sup>b</sup></i>	<i>Ligands<sup>c</sup></i>
H	hydrogen H <sup>•</sup> , hydrogen(●), monohydrogen (natural or unspecified isotopic composition) <sup>1</sup> H <sup>•</sup> , protium(●), monoprotrium <sup>2</sup> H <sup>•</sup> = D <sup>•</sup> , deuterium(●), monodeuterium <sup>3</sup> H <sup>•</sup> = T <sup>•</sup> , tritium(●), monotritium	hydrogen (general) H <sup>+</sup> , hydrogen(1+), hydron (natural or unspecified isotopic composition) <sup>1</sup> H <sup>+</sup> , protium(1+), proton <sup>2</sup> H <sup>+</sup> = D <sup>+</sup> , deuterium(1+), deuteron <sup>3</sup> H <sup>+</sup> = T <sup>+</sup> , tritium(1+), triton	hydride (general) H <sup>-</sup> , hydride (natural or unspecified isotopic composition) <sup>1</sup> H <sup>-</sup> , protide <sup>2</sup> H <sup>-</sup> = D <sup>-</sup> , deuteride <sup>3</sup> H <sup>-</sup> = T <sup>-</sup> , tritide	hydrido   protido deuterido tritido
H <sub>2</sub>	H <sub>2</sub> , dihydrogen D <sub>2</sub> , dideuterium T <sub>2</sub> , ditritium	H <sub>2</sub> <sup>••</sup> , dihydrogen(●1+) <sup>1</sup> H <sub>2</sub> <sup>••</sup> , diprotium(●1+) D <sub>2</sub> <sup>••</sup> , dideuterium(●1+) T <sub>2</sub> <sup>••</sup> , ditritium(●1+)		
D, see H				
D <sub>2</sub> , see H <sub>2</sub>				
T, see H				
T <sub>2</sub> , see H <sub>2</sub>				
F	fluorine F <sup>•</sup> , fluorine(●), monofluorine -F, fluoro	fluorine (general) F <sup>+</sup> , fluorine(1+)	fluoride (general) F <sup>-</sup> , fluoride(1-); fluoride	fluorido (general) F <sup>-</sup> , fluorido(1-); fluorido
F <sub>2</sub>	F <sub>2</sub> , difluorine	F <sub>2</sub> <sup>••</sup> , difluorine(●1+)	F <sub>2</sub> <sup>•-</sup> , difluoride(●1-)	F <sub>2</sub> , difluorine
Cl	chlorine (general) Cl <sup>•</sup> , chlorine(●), monochlorine -Cl, chloro	chlorine (general) Cl <sup>+</sup> , chlorine(1+)	chloride (general) Cl <sup>-</sup> , chloride(1-); chloride	chlorido (general) Cl <sup>-</sup> , chlorido(1-); chlorido
Cl <sub>2</sub>	Cl <sub>2</sub> , dichlorine	Cl <sub>2</sub> <sup>••</sup> , dichlorine(●1+)	Cl <sub>2</sub> <sup>•-</sup> , dichloride(●1-)	Cl <sub>2</sub> , dichlorine Cl <sub>2</sub> <sup>•-</sup> , dichlorido(●1-)
Br	bromine (general) Br <sup>•</sup> , bromine(●), monobromine -Br, bromo	bromine (general) Br <sup>+</sup> , bromine(1+)	bromide (general) Br <sup>-</sup> , bromide(1-); bromide	bromido (general) Br <sup>-</sup> , bromido(1-); bromido
Br <sub>2</sub>	Br <sub>2</sub> , dibromine	Br <sub>2</sub> <sup>••</sup> , dibromine(●1+)	Br <sub>2</sub> <sup>•-</sup> , dibromide(●1-)	Br <sub>2</sub> , dibromine
I	iodine (general) I <sup>•</sup> , iodine(●), monoiodine -I, iodo	iodine (general) I <sup>+</sup> , iodine(1+)	iodide (general) I <sup>-</sup> , iodide(1-); iodide	iodido (general) I <sup>-</sup> , iodido(1-); iodido
I <sub>2</sub>	I <sub>2</sub> , diiodine	I <sub>2</sub> <sup>••</sup> , diiodine(●1+)	I <sub>2</sub> <sup>•-</sup> , diiodide(●1-)	I <sub>2</sub> , diiodine



ClO	ClO, chlorine mon(o)oxide ClO <sup>•</sup> , oxidochlorine(•); chlorosyl –ClO, oxo-λ <sup>3</sup> -chloranyl; chlorosyl –OCl, chlorooxy		ClO <sup>–</sup> , oxidochlorate(1–); hypochlorite	ClO <sup>–</sup> , oxidochlorato(1–); hypochlorito
ClO <sub>2</sub>	ClO <sub>2</sub> , chlorine dioxide ClO <sub>2</sub> <sup>•</sup> , dioxidochlorine(•) ClOO <sup>•</sup> , chloridodioxygen $\curvearrowright$ (O–O) (•), –ClO <sub>2</sub> , dioxo-λ <sup>3</sup> -chloranyl; chloryl –OClO, oxo-λ <sup>3</sup> -chloranyloxy	ClO <sub>2</sub> <sup>+</sup> , dioxidochlorine(1+) (not chloryl)	ClO <sub>2</sub> <sup>–</sup> , dioxidochlorate(1–); chlorite	ClO <sub>2</sub> <sup>–</sup> , dioxidochlorato(1–); chlorito
ClO <sub>3</sub>	ClO <sub>3</sub> , chlorine trioxide ClO <sub>3</sub> <sup>•</sup> , trioxidochlorine(•) –ClO <sub>3</sub> , trioxo-λ <sup>7</sup> -chloranyl; perchloryl –OClO <sub>2</sub> , dioxo-λ <sup>5</sup> -chloranyloxy	ClO <sub>3</sub> <sup>+</sup> , trioxidochlorine(1+) (not perchloryl)	ClO <sub>3</sub> <sup>–</sup> , trioxidochlorate(1–); chlorate	ClO <sub>3</sub> <sup>–</sup> , trioxidochlorato(1–); chlorato
ClO <sub>4</sub>	ClO <sub>4</sub> , chlorine tetraoxide ClO <sub>4</sub> <sup>•</sup> , tetraoxidochlorine(•) –OClO <sub>3</sub> , trioxo-λ <sup>7</sup> -chloranyloxy		ClO <sub>4</sub> <sup>–</sup> , tetraoxidochlorate(1–); perchlorate	ClO <sub>4</sub> <sup>–</sup> , tetraoxidochlorato(1–); perchlorato
IO	IO, iodine mon(o)oxide IO <sup>•</sup> , oxidiodine(•); iodosyl –IO, oxo-λ <sup>3</sup> -iodanyl; iodosyl –OI, iodoxy	IO <sup>+</sup> , oxidiodine(1+) (not iodosyl)	IO <sup>–</sup> , oxidiodate(1–); hypoiodite IO <sup>2–</sup> , oxidiodate(•2–)	IO <sup>–</sup> , oxidiodato(1–); hypoiodito
IO <sub>2</sub>	IO <sub>2</sub> , iodine dioxide IO <sub>2</sub> <sup>•</sup> , dioxidiodine(•) –IO <sub>2</sub> , dioxo-λ <sup>3</sup> -iodanyl; iodyl –OIO, oxo-λ <sup>3</sup> -iodanyloxy	IO <sub>2</sub> <sup>+</sup> , dioxidiodine(1+) (not iodyl)	IO <sub>2</sub> <sup>–</sup> , dioxidiodate(1–); iodite	IO <sub>2</sub> <sup>–</sup> , dioxidiodato(1–); iodito
IO <sub>3</sub>	IO <sub>3</sub> , iodine trioxide IO <sub>3</sub> <sup>•</sup> , trioxidiodine(•) –IO <sub>3</sub> , trioxo-λ <sup>7</sup> -iodanyl; periodyl –OIO <sub>2</sub> , dioxo-λ <sup>5</sup> -iodanyloxy	IO <sub>3</sub> <sup>+</sup> , trioxidiodine(1+) (not periodyl)	IO <sub>3</sub> <sup>–</sup> , trioxidiodate(1–); iodate	IO <sub>3</sub> <sup>–</sup> , trioxidiodato(1–); iodato
IO <sub>4</sub>	IO <sub>4</sub> , iodine tetraoxide IO <sub>4</sub> <sup>•</sup> , tetraoxidiodine(•) –OIO <sub>3</sub> , trioxo-λ <sup>7</sup> -iodanyloxy		IO <sub>4</sub> <sup>–</sup> , tetraoxidiodate(1–); periodate	IO <sub>4</sub> <sup>–</sup> , tetraoxidiodato(1–); periodato
O	oxygen (general) O, monooxygen O <sup>2•</sup> , oxidanylidene, monooxygen(2•) >O, oxy, epoxy (in rings) =O, oxo	oxygen (general) O <sup>•+</sup> , oxygen(•1+)	oxide (general) O <sup>•–</sup> , oxidanidyl, oxide(•1–) O <sup>2–</sup> , oxide(2–); oxide –O <sup>•</sup> , oxido	O <sup>2•</sup> , oxido
O <sub>2</sub>	O <sub>2</sub> , dioxygen O <sub>2</sub> <sup>2•</sup> , dioxidanediyl, dioxygen(2•) –OO–, dioxidanediyl; peroxy	O <sub>2</sub> <sup>•+</sup> , dioxidanilyumyl, dioxygen(•1+) O <sub>2</sub> <sup>2+</sup> , dioxidanebis(ylum), dioxygen(2+)	O <sub>2</sub> <sup>•–</sup> , dioxidanidyl, dioxide(•1–); superoxide (not hyperoxide) O <sub>2</sub> <sup>2–</sup> , dioxidanediide, dioxide(2–); peroxide	dioxido (general) O <sub>2</sub> , dioxygen O <sub>2</sub> <sup>•–</sup> , dioxido(•1–); superoxido O <sub>2</sub> <sup>2–</sup> , dioxidanediido, dioxido(2–); peroxido
O <sub>3</sub>	O <sub>3</sub> , trioxygen; ozone –OOO–, trioxidanediyl		O <sub>3</sub> <sup>•–</sup> , trioxidanidyl, trioxide(•1–); ozonide	O <sub>3</sub> , trioxygen; ozone O <sub>3</sub> <sup>•–</sup> , trioxido(•1–); ozonido
HO	HO <sup>•</sup> , oxidanyl, hydridooxygen(•); hydroxyl –OH, oxidanyl; hydroxy	HO <sup>+</sup> , oxidanylium, hydridooxygen(1+); hydroxylum	HO <sup>–</sup> , oxidanide, hydroxide	HO <sup>–</sup> , oxidanido; hydroxido
HO <sub>2</sub>	HO <sub>2</sub> <sup>•</sup> , dioxidanyl, hydridodioxygen(•) hydrogen dioxide –OOH, dioxidanyl; hydroperoxy	HO <sub>2</sub> <sup>+</sup> , dioxidanilyum, hydridodioxygen(1+)	HO <sub>2</sub> <sup>–</sup> , dioxidanide, hydrogen(peroxide)(1–)	HO <sub>2</sub> <sup>–</sup> , dioxidanido, hydrogen(peroxido)(1–)
S	sulfur (general) S, monosulfur =S, sulfanylidene; thioxo –S–, sulfanediyl	sulfur (general) S <sup>•+</sup> , sulfur(1+)	sulfide (general) S <sup>•–</sup> , sulfanidyl, sulfide(•1–) S <sup>2–</sup> , sulfanediide, sulfide(2–); sulfide –S <sup>•</sup> , sulfido	sulfido (general) S <sup>•–</sup> , sulfanidyl, sulfido(•1–) S <sup>2–</sup> , sulfanediido, sulfido(2–)

S <sub>2</sub>	S <sub>2</sub> , disulfur –SS–, disulfanediyl >S=S, sulfanylidene-λ <sup>4</sup> -sulfanediyl; sulfinothioyl	S <sub>2</sub> <sup>•+</sup> , disulfur(•1+)	S <sub>2</sub> <sup>•-</sup> , disulfanidyl, disulfide(•1-) S <sub>2</sub> <sup>2-</sup> , disulfide(2-), disulfanediide –SS <sup>-</sup> , disulfanidyl	S <sub>2</sub> <sup>2-</sup> , disulfido(2-), disulfanediido
HS	HS <sup>•</sup> , sulfanyl, hydridosulfur(•) –SH, sulfanyl	HS <sup>+</sup> , sulfanylium, hydridosulfur(1+)	HS <sup>-</sup> , sulfanide, hydrogen(sulfide)(1-)	HS <sup>-</sup> , sulfanido, hydrogen(sulfido)(1-)
SO	SO, sulfur mon(o)oxide [SO], oxidosulfur >SO, oxo-λ <sup>4</sup> -sulfanediyl; sulfinyl	SO <sup>•+</sup> , oxidosulfur(•1+) ( <i>not</i> sulfinyl or thionyl)	SO <sup>•-</sup> , oxidosulfate(•1-)	[SO], oxidosulfur
SO <sub>2</sub>	SO <sub>2</sub> , sulfur dioxide [SO <sub>2</sub> ], dioxidosulfur >SO <sub>2</sub> , dioxo-λ <sup>6</sup> -sulfanediyl; sulfuryl, sulfonyl		SO <sub>2</sub> <sup>•-</sup> , dioxidosulfate(•1-) SO <sub>2</sub> <sup>2-</sup> , dioxidosulfate(2-), sulfanediolate	[SO <sub>2</sub> ], dioxidosulfur SO <sub>2</sub> <sup>2-</sup> , dioxidosulfato(2-), sulfanediolato
SO <sub>3</sub>	SO <sub>3</sub> , sulfur trioxide		SO <sub>3</sub> <sup>•-</sup> , trioxidosulfate(•1-) SO <sub>3</sub> <sup>2-</sup> , trioxidosulfate(2-); sulfite –S(O) <sub>2</sub> (O), oxidodioxo-λ <sup>6</sup> -sulfanyl; sulfonato	SO <sub>3</sub> <sup>2-</sup> , trioxidosulfato(2-); sulfito
SO <sub>4</sub>	–OS(O) <sub>2</sub> O–, sulfonylbis(oxy)		SO <sub>4</sub> <sup>•-</sup> , tetraoxidosulfate(•1-) SO <sub>4</sub> <sup>2-</sup> , tetraoxidosulfate(2-); sulfate	SO <sub>4</sub> <sup>2-</sup> , tetraoxidosulfato(2-); sulfato
S <sub>2</sub> O <sub>3</sub>			S <sub>2</sub> O <sub>3</sub> <sup>•-</sup> = SO <sub>3</sub> S <sup>•-</sup> , trioxido-1κ <sup>3</sup> O-disulfate(S–S)(•1-), trioxidosulfidosulfate(•1-) S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> = SO <sub>3</sub> S <sup>2-</sup> , trioxido-1κ <sup>3</sup> O-disulfate(S–S)(2-), trioxidosulfidosulfate(2-); thiosulfate, sulfurothioate	S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> = SO <sub>3</sub> S <sup>2-</sup> , trioxido-1κ <sup>3</sup> O-disulfato(S–S)(2-), trioxidosulfidosulfato(2-); thiosulfato, sulfurothioato
Se	Se (general) Se, monoselenium >Se, selanediyl =Se, selanylidene; selenoxo	selenium	selenide (general) Se <sup>•-</sup> , selanidyl, selenide(•1-) Se <sup>2-</sup> , selanediide, selenide(2-); selenide	selenido (general) Se <sup>•-</sup> , selanidyl, selenido(•1-) Se <sup>2-</sup> , selanediido, selenido(2-)
SeO	SeO, selenium mon(o)oxide [SeO], oxidoselenium >SeO, seleninyl			[SeO], oxidoselenium
SeO <sub>2</sub>	SeO <sub>2</sub> , selenium dioxide [SeO <sub>2</sub> ], dioxidoselenium >SeO <sub>2</sub> , selenonyl		SeO <sub>2</sub> <sup>2-</sup> , dioxidoselenate(2-)	[SeO <sub>2</sub> ], dioxidoselenium SeO <sub>2</sub> <sup>2-</sup> , dioxidoselenato(2-)
SeO <sub>3</sub>	SeO <sub>3</sub> , selenium trioxide		SeO <sub>3</sub> <sup>•-</sup> , trioxidoselenate(•1-) SeO <sub>3</sub> <sup>2-</sup> , trioxidoselenate(2-); selenite	SeO <sub>3</sub> <sup>2-</sup> , trioxidoselenato(2-); selenito
SeO <sub>4</sub>			SeO <sub>4</sub> <sup>2-</sup> , tetraoxidoselenate(2-); selenate	SeO <sub>4</sub> <sup>2-</sup> , tetraoxidoselenato(2-); selenato
Te	tellurium >Te, tellanediyl =Te, tellanylidene; telluroxo	tellurium	telluride (general) Te <sup>•-</sup> , tellanidyl, telluride(•1-) Te <sup>2-</sup> , tellanediide, telluride(2-); telluride	tellurido (general) Te <sup>•-</sup> , tellanidyl, tellurido(•1-) Te <sup>2-</sup> , tellanediido, tellurido(2-)
CrO <sub>2</sub>	CrO <sub>2</sub> , chromium dioxide, chromium(IV) oxide			
UO <sub>2</sub>	UO <sub>2</sub> , uranium dioxide	UO <sub>2</sub> <sup>+</sup> , dioxidouranium(1+) [ <i>not</i> uranyl(1+)] UO <sub>2</sub> <sup>2+</sup> , dioxidouranium(2+) [ <i>not</i> uranyl(2+)]		

NpO <sub>2</sub>	NpO <sub>2</sub> , neptunium dioxide	NpO <sub>2</sub> <sup>+</sup> , dioxidoneptunium(1+) [not neptunyl(1+)] NpO <sub>2</sub> <sup>2+</sup> , dioxidoneptunium(2+) [not neptunyl(2+)]		
PuO <sub>2</sub>	PuO <sub>2</sub> , plutonium dioxide	PuO <sub>2</sub> <sup>+</sup> , dioxidoplutonium(1+) [not plutonyl(1+)] PuO <sub>2</sub> <sup>2+</sup> , dioxidoplutonium(2+) [not plutonyl(2+)]		
N	nitrogen N <sup>•</sup> , nitrogen(•), mononitrogen –N<, azanetriyl; nitrilo –N=, azanylylidene ≡N, azanylidyne	nitrogen (general) N <sup>+</sup> , nitrogen(1+)	nitride (general) N <sup>3-</sup> , nitride(3–), azanetriide; nitride =N <sup>–</sup> , azanidyldene; amidylidene –N <sup>2-</sup> , azanediidyl	N <sup>3-</sup> , nitrido(3–), azanetriido
N <sub>2</sub>	N <sub>2</sub> , dinitrogen =N <sup>+</sup> =N <sup>–</sup> , (azanidyldene)azani mylidene; diazo –N=N–, diazane-1,2-diylidene; hydrazinediylidene =NN=, diazene-1,2-diyl; azo	N <sub>2</sub> <sup>•+</sup> , dinitrogen(1+) N <sub>2</sub> <sup>2+</sup> , dinitrogen(2+) –N <sup>+</sup> ≡N, diazyn-1-ium-1-yl	N <sub>2</sub> <sup>2-</sup> , dinitride(2–) N <sub>2</sub> <sup>4-</sup> , dinitride(4–), diazanetraide; hydrazinetetraide	N <sub>2</sub> , dinitrogen N <sub>2</sub> <sup>2-</sup> , dinitrido(2–) N <sub>2</sub> <sup>4-</sup> , dinitrido(4–), diazanetraido; hydrazinetetraido
N <sub>3</sub>	N <sub>3</sub> <sup>•</sup> , trinitrogen(•) –N=N <sup>+</sup> =N <sup>–</sup> , azido		N <sub>3</sub> <sup>–</sup> , trinitride(1–); azide	N <sub>3</sub> <sup>–</sup> , trinitrido(1–); azido
NH	NH <sup>+</sup> , azanylidene, hydridonitrogen(2•); nitrene >NH, azanediyl =NH, azanylidene; imino	NH <sup>+</sup> , azanyliumdiyl, hydridonitrogen(1+) NH <sup>2+</sup> , azanebis(ylum), hydridonitrogen(2+)	NH <sup>–</sup> , azanidyl, hydridonitrate(1–) NH <sup>2-</sup> , azanediide, hydridonitrate(2–); imide –NH <sup>–</sup> , azanidyl; amidyl	NH <sup>2-</sup> , azanediido, hydridonitrato(2–); imido
NH <sub>2</sub>	NH <sub>2</sub> <sup>+</sup> , azanyl, dihydridonitrogen(•); aminyl –NH <sub>2</sub> , azanyl; amino	NH <sub>2</sub> <sup>+</sup> , azanylium, dihydridonitrogen(1+)	NH <sub>2</sub> <sup>–</sup> , azanide, dihydridonitrate(1–); amide	NH <sub>2</sub> <sup>–</sup> , azanido, dihydridonitrato(1–), amido
NH <sub>3</sub>	NH <sub>3</sub> , azane (parent hydride name), amine (parent name for certain organic derivatives), trihydridonitrogen; ammonia	NH <sub>3</sub> <sup>•+</sup> , azaniumyl, trihydridonitrogen(•1+) –NH <sub>3</sub> <sup>+</sup> , azaniumyl; ammonio	NH <sub>3</sub> <sup>–</sup> , azanuidyl, trihydridonitrate(•1–)	NH <sub>3</sub> , ammiane
NH <sub>4</sub>	NH <sub>4</sub> <sup>+</sup> , λ <sup>5</sup> -azanyl, tetrahydridonitrogen(•)	NH <sub>4</sub> <sup>+</sup> , azanium; ammonium		
H <sub>2</sub> NO	H <sub>2</sub> NO <sup>+</sup> , aminooxidanyl, dihydridooxidonitrogen(•); aminoxyl HONH <sup>+</sup> , hydroxyazanyl, hydridohydroxidonitrogen(•) –NH(OH), hydroxyazanyl, hydroxyamino –ONH <sub>2</sub> , aminooxy –NH <sub>2</sub> (O), oxo-λ <sup>5</sup> -azanyl; azinoyl		HONH <sup>–</sup> , hydroxyazanide, hydridohydroxidonitrate(1–) H <sub>2</sub> NO <sup>–</sup> , azanolate, aminooxidamide, dihydridooxidonitrate(1–)	NHOH <sup>–</sup> , hydroxyazanido, hydridohydroxidonitrato(1–) H <sub>2</sub> NO <sup>–</sup> , azanolato, aminooxidamido, dihydridooxidonitrato(1–)
N <sub>2</sub> H <sub>2</sub>	HN=NH, diazene –N=NH <sub>2</sub> <sup>+</sup> , diazen-2-ium-1-ide H <sub>2</sub> NN <sup>•</sup> , diazanylidene, hydrazinylidene =NNH <sub>2</sub> , diazanylidene; hydrazinylidene •HNNH <sup>•</sup> , diazane-1,2-diyl; hydrazine-1,2-diyl –HNNH–, diazane-1,2-diyl; hydrazine-1,2-diyl	HNNH <sup>2+</sup> , diazanylium	HNNH <sup>2-</sup> , diazane-1,2-diide, hydrazine-1,2-diide H <sub>2</sub> NN <sup>2-</sup> , diazane-1,1-diide, hydrazine-1,1-diide	HN=NH, diazene –N=NH <sub>2</sub> <sup>+</sup> , diazen-2-ium-1-ido HNNH <sup>2-</sup> , diazane-1,2-diido, hydrazine-1,2-diido H <sub>2</sub> NN <sup>2-</sup> , diazane-1,1-diido, hydrazine-1,1-diido

$N_2H_3$	$H_2NNH^+$ , diazanyl, trihydrido $\subset$ dinitrogen( $N-N$ )( $\bullet$ ); hydrazinyl - $NHNH_2$ , diazanyl; hydrazinyl $^2-NNH_3^+$ , diazan-2-ium-1,1-diide	$H_2N=NH^+$ , diazenium	$H_2NNH^-$ , diazanide, hydrazinide	$^2-NNH_3^+$ , diazan-2-ium-1,1-diido $H_2NNH^-$ , diazanido, hydrazinido
$N_2H_4$	$H_2NNH_2$ , diazane (parent hydride name), hydrazine (parent name for organic derivatives) - $NHNH_3^+$ , diazan-2-ium-1-ide	$H_2NNH_2^{2+}$ , diazaniumyl, bis(dihydridonitrogen) $\subset$ ( $N-N$ )( $\bullet 1+$ ); hydraziniumyl $H_2N=NH_2^{2+}$ , diazenediium		$H_2NNH_2$ , diazane, hydrazine - $NHNH_3^+$ , diazan-2-ium-1-ido
NO	NO, nitrogen mon(o)oxide ( <i>not</i> nitric oxide) NO $^+$ , oxoazanyl, oxidonitrogen( $\bullet$ ); nitrosyl -N=O, oxoazanyl; nitroso >N(O) $^-$ , oxo- $\lambda^5$ -azanyl; azoryl =N(O) $^-$ , oxo- $\lambda^5$ -azanylidene; azorylidene $\equiv$ N(O), oxo- $\lambda^5$ -azanylidyne; azorylidyne -O $^+$ =N $^-$ , azanidyldeneoxidaniumyl	NO $^+$ , oxidonitrogen(1+) ( <i>not</i> nitrosyl) NO $^{2+}$ , oxidonitrogen(2+)	NO $^-$ , oxidonitrate(1-) NO $^{2-}$ , oxidonitrate(2 $\bullet$ 1-)	NO, oxidonitrogen (general); nitrosyl = oxidonitrogen- $\kappa N$ (general) NO $^+$ , oxidonitrogen(1+) NO $^-$ , oxidonitrato(1-)
NO $_2$	NO $_2$ , nitrogen dioxide NO $_2^+$ = ONO $^+$ , nitrosooxidanyl, dioxidonitrogen( $\bullet$ ); nitryl -NO $_2$ , nitro -ONO, nitrosooxy	NO $_2^+$ , dioxidonitrogen(1+) ( <i>not</i> nitryl)	NO $_2^-$ , dioxidonitrate(1-); nitrite NO $_2^{2-}$ , dioxidonitrate( $\bullet$ 2-)	NO $_2^-$ , dioxidonitrato(1-); nitrito NO $_2^{2-}$ , dioxidonitrato( $\bullet$ 2-)
NO $_3$	NO $_3$ , nitrogen trioxide NO $_3^+$ = O $_2$ NO $^+$ , nitrooxidanyl, trioxidonitrogen( $\bullet$ ) ONOO $^+$ , nitrosodioxidanyl, (dioxido)oxidonitrogen( $\bullet$ ) -ONO $_2$ , nitrooxy		NO $_3^-$ , trioxidonitrate(1-); nitrate NO $_3^{2-}$ , trioxidonitrate( $\bullet$ 2-) [NO(OO)] $^-$ , (dioxido)oxidonitrate(1-); peroxy nitrite	NO $_3^-$ , trioxidonitrato(1-); nitrato NO $_3^{2-}$ , trioxidonitrato( $\bullet$ 2-) [NO(OO)] $^-$ , oxidoperoxidonitrato(1-); peroxy nitrito
N $_2$ O	N $_2$ O, dinitrogen oxide ( <i>not</i> nitrous oxide) NNO, oxidodinitrogen( $N-N$ ) -N(O)=N $^-$ , azoxy		N $_2$ O $^-$ , oxidodinitrate( $\bullet$ 1-)	N $_2$ O, dinitrogen oxide (general) NNO, oxidodinitrogen( $N-N$ ) N $_2$ O $^-$ , oxidodinitrato( $\bullet$ 1-)
N $_2$ O $_3$	N $_2$ O $_3$ , dinitrogen trioxide O $_2$ NNO, trioxido-1 $\kappa^2$ O,2 $\kappa$ O- dinitrogen( $N-N$ ) NO $^+$ NO $_2^-$ , oxidonitrogen(1+) dioxidonitrate(1-) ONONO, dinitrosooxidane, $\mu$ -oxidobis(oxidonitrogen)		N $_2$ O $_3^{2-}$ = [O $_2$ NNO] $^{2-}$ , trioxido-1 $\kappa_2$ O,2 $\kappa$ O- dinitrate( $N-N$ )(2-)	
N $_2$ O $_4$	N $_2$ O $_4$ , dinitrogen tetraoxide O $_2$ NNO $_2$ , bis(dioxidonitrogen) $\subset$ ( $N-N$ ) ONOONO, 1,2-dinitrosodioxidane, 2,5-diazy-1,3,4,6-tetraoxy- [6]catena NO $^+$ NO $_3^-$ , oxidonitrogen(1+) trioxidonitrate(1-)			
N $_2$ O $_5$	N $_2$ O $_5$ , dinitrogen pentaoxide O $_2$ NONO $_2$ , dinitrooxidane, NO $_2^+$ NO $_3^-$ , dioxidonitrogen(1+) trioxidonitrate(1-)			
NS	NS, nitrogen monosulfide NS $^+$ , sulfidonitrogen( $\bullet$ ) -N=S, sulfanylideneazanyl; thionitroso	NS $^+$ , sulfidonitrogen(1+) ( <i>not</i> thionitrosyl)	NS $^-$ , sulfidonitrate(1-)	NS, sulfidonitrogen, sulfidonitrato, thionitrosyl (general) NS $^+$ , sulfidonitrogen(1+) NS $^-$ , sulfidonitrato(1-)

P	phosphorus (general) P*, phosphorus(●), monophosphorus >P-, phosphanetriyl	phosphorus (general) P <sup>+</sup> , phosphorus(1+)	phosphide (general) P <sup>-</sup> , phosphide(1-) P <sup>3-</sup> , phosphide(3-), phosphanetriide; phosphide	P <sup>3-</sup> , phosphido, phosphanetriido
PO	PO*, oxophosphanyl, oxidophosphorus(●), phosphorus mon(o)oxide; phosphoryl >P(O)-, oxo-λ <sup>5</sup> -phosphanetriyl; phosphoryl =P(O)-, oxo-λ <sup>5</sup> -phosphanylidene; phosphorylidene ≡P(O), oxo-λ <sup>5</sup> -phosphanylidyne; phosphorylidyne	PO <sup>+</sup> , oxidophosphorus(1+) ( <i>not</i> phosphoryl)	PO <sup>-</sup> , oxidophosphate(1-)	
PO <sub>2</sub>	-P(O) <sub>2</sub> , dioxo-λ <sup>5</sup> -phosphanyl		PO <sub>2</sub> <sup>-</sup> , dioxidophosphate(1-)	PO <sub>2</sub> <sup>-</sup> , dioxidophosphato(1-)
PO <sub>3</sub>			PO <sub>3</sub> <sup>-</sup> , trioxidophosphate(1-) PO <sub>3</sub> <sup>•2-</sup> , trioxidophosphate(●2-) PO <sub>3</sub> <sup>3-</sup> , trioxidophosphate(3-); phosphite (PO <sub>3</sub> <sup>-</sup> ) <sub>n</sub> = {P(O) <sub>2</sub> O} <sub>n</sub> <sup>n-</sup> , <i>catena</i> -poly[(dioxidophosphate- μ-oxido)(1-)]; metaphosphate -P(O)(O <sup>-</sup> ) <sub>2</sub> , dioxidooxo-λ <sup>5</sup> - phosphanyl; phosphonato	PO <sub>3</sub> <sup>-</sup> , trioxidophosphato(1-) PO <sub>3</sub> <sup>•2-</sup> , trioxidophosphato(●2-) PO <sub>3</sub> <sup>3-</sup> , trioxidophosphato(3-); phosphito
PO <sub>4</sub>			PO <sub>4</sub> <sup>•2-</sup> , tetraoxidophosphate(●2-) PO <sub>4</sub> <sup>3-</sup> , tetraoxidophosphate(3-); phosphate	PO <sub>4</sub> <sup>3-</sup> , tetraoxidophosphato(3-); phosphato
PS	PS*, sulfidophosphorus(●); -PS, thiophosphoryl	PS <sup>+</sup> , sulfidophosphorus(1+) ( <i>not</i> thiophosphoryl)		
AsO <sub>3</sub>			AsO <sub>3</sub> <sup>3-</sup> , trioxidoarsenate(3-); arsenite, arsorite -As(=O)(O <sup>-</sup> ) <sub>2</sub> , dioxidooxo-λ <sup>5</sup> -arsanyl; arsonato	AsO <sub>3</sub> <sup>3-</sup> , trioxidoarsenato(3-); arsenito, arsorito
AsO <sub>4</sub>			AsO <sub>4</sub> <sup>3-</sup> , tetraoxidoarsenate(3-); arsenate, arsorato	AsO <sub>4</sub> <sup>3-</sup> , tetraoxidoarsenato(3-); arsenato, arsorato
VO	VO, vanadium(II) oxide, vanadium mon(o)oxide	VO <sup>2+</sup> , oxidovanadium(2+) ( <i>not</i> vanadyl)		
CO	CO, carbon mon(o)oxide >C=O, carbonyl =C=O, carbonylidene	CO <sup>+</sup> , oxidocarbon(●1+) CO <sup>2+</sup> , oxidocarbon(2+)	CO <sup>-</sup> , oxidocarbonate(●1-)	CO, oxidocarbon, oxidocarbonato (general); carbonyl = oxidocarbon-κC (general) CO <sup>+</sup> , oxidocarbon(●1+) CO <sup>-</sup> , oxidocarbonato(●1-)
CO <sub>2</sub>	CO <sub>2</sub> , carbon dioxide, dioxidocarbon		CO <sub>2</sub> <sup>•+</sup> , oxidooxomethyl, dioxidocarbonate(●1-)	CO <sub>2</sub> , dioxidocarbon CO <sub>2</sub> <sup>•+</sup> , oxidooxomethyl, dioxidocarbonato(●1-)
CO <sub>3</sub>			CO <sub>3</sub> <sup>•+</sup> , trioxidocarbonate(●1-), OCOO <sup>•+</sup> , (dioxido)oxidocarbonate(●1-), oxidoperoxidocarbonate(●1-) CO <sub>3</sub> <sup>2-</sup> , trioxidocarbonate(2-); carbonate	CO <sub>3</sub> <sup>2-</sup> , trioxidocarbonato(2-); carbonato
CS	carbon monosulfide >C=S, carbonothioyl; thiocarbonyl =C=S, carbonothioylidene	CS <sup>+</sup> , sulfidocarbon(●1+)	CS <sup>-</sup> , sulfidocarbonate(●1-)	CS, sulfidocarbon, sulfidocarbonato, thiocarbonyl (general); CS <sup>+</sup> , sulfidocarbon(●1+) CS <sup>-</sup> , sulfidocarbonato(●1-)
CS <sub>2</sub>	CS <sub>2</sub> , disulfidocarbon, carbon disulfide		CS <sub>2</sub> <sup>•+</sup> , sulfidothioxomethyl, disulfidocarbonate(●1-)	CS <sub>2</sub> , disulfidocarbon CS <sub>2</sub> <sup>•+</sup> , sulfidothioxomethyl, disulfidocarbonato(●1-)

CN	CN <sup>•</sup> , nitridocarbon(•); cyanyl –CN, cyano –NC, isocyano	CN <sup>+</sup> , azanylidynemethylum, nitridocarbon(1+)	CN <sup>–</sup> , nitridocarbonato(1–); cyanide	nitridocarbonato (general) CN <sup>–</sup> , nitridocarbonato(1–); cyanido = [nitridocarbonato(1–)-κC]
CNO	OCN <sup>•</sup> , nitridooidocarbon(•) –OCN, cyanato –NCO, isocyanato –ONC, λ <sup>2</sup> -methylidene ☉ azanylylideneoxy –CNO, (oxo-λ <sup>5</sup> - azanylidynemethyl		OCN <sup>–</sup> , nitridooidocarbonato(1–); cyanate ONC <sup>–</sup> , carbidooidonitrato(1–); fulminate OCN <sup>•2–</sup> , nitridooidocarbonato(•2–)	OCN <sup>–</sup> , nitridooidocarbonato(1–); cyanato ONC <sup>–</sup> , carbidooidonitrato(1–); fulminato
CNS	SCN <sup>•</sup> , nitridosulfidocarbon(•) –SCN, thiocyanato –NCS, isothiocyanato –SNC, λ <sup>2</sup> -methylidene ☉ azanylylidenesulfanediyyl –CNS, (sulfanylidene-λ <sup>5</sup> - azanylidynemethyl		SCN <sup>–</sup> , nitridosulfidocarbonato(1–); thiocyanate SNC <sup>–</sup> , carbidosulfidonitrato(1–)	SCN <sup>–</sup> , nitridosulfidocarbonato(1–); thiocyanato SNC <sup>–</sup> , carbidosulfidonitrato(1–)
CNSe	SeCN <sup>•</sup> , nitridoselenidocarbon(•) –SeCN, selenocyanato –NCSe, isoselenocyanato –SeNC, λ <sup>2</sup> -methylidene ☉ azanylylideneselanediyyl –CNSe, (selanylidene-λ <sup>5</sup> - azanylidynemethyl		SeCN <sup>–</sup> , nitridoselenidocarbonato(1–); selenocyanate SeNC <sup>–</sup> , carbidoselenidonitrato(1–)	SeCN <sup>–</sup> , nitridoselenidocarbonato(1–); selenocyanato SeNC <sup>–</sup> , carbidoselenidonitrato(1–)

<sup>a</sup> Where an element symbol occurs in the first column, the unmodified element name is listed in the second and third columns. The unmodified name is generally used when the element appears as an electropositive constituent in the construction of a stoichiometric name (Sections IR-5.2 and IR-5.4). Names of homoatomic cations consisting of the element are also constructed using the element name, adding multiplicative prefixes and charge numbers as applicable (Sections IR-5.3.2.1 to IR-5.3.2.3). The sections mentioned refer to parts of Nomenclature of Inorganic Chemistry, IUPAC Recommendations 2005, see above.

<sup>b</sup> Where an element symbol occurs in the first column, the fourth column gives the element name appropriately modified with the ending 'ide' (hydride, nitride, etc.). The 'ide' form of the element name is generally used when the element appears as an electronegative constituent in the construction of a stoichiometric name (Sections IR-5.2 and IR-5.4). Names of homoatomic anions consisting of the element in question are also constructed using this modified form, adding multiplicative prefixes and charge numbers as applicable (Sections IR-5.3.3.1 to IR-5.3.3.3). Examples are given in the Table of names of some specific anions, e.g. chloride(1–), oxide(2–), dioxide(2–). In certain cases, a particular anion has the 'ide' form itself as an accepted short name, e.g. chloride, oxide. If specific anions are named, the 'ide' form of the element name with no further modification is given as the first entry in the fourth column, with the qualifier '(general)'. The sections mentioned refer to parts of Nomenclature of Inorganic Chemistry, IUPAC Recommendations 2005, see above.

<sup>c</sup> Ligand names must be placed within enclosing marks whenever necessary to avoid ambiguity, cf. Section IR-9.2.2.3. Some ligand names must always be enclosed. For example, if 'dioxido' is cited as is, it must be enclosed so as to distinguish it from two 'oxido' ligands; if combined with a multiplicative prefix it must be enclosed because it starts with a multiplicative prefix itself. A ligand name such as 'nitridocarbonato' must always be enclosed to avoid interpreting it as two separate ligand names, 'nitrido' and 'carbonato'. In this table, however, these enclosing marks are omitted for the sake of clarity. Note that the ligand names given here with a charge number can generally also be used without if it is not desired to make any implication regarding the charge of the ligand. For example, the ligand name '[dioxido(•1–)]' may be used if one wishes explicitly to consider the ligand to be the species dioxide(•1–), whereas the ligand name '(dioxido)' can be used if no such implications are desirable. The section mentioned refer to parts of Nomenclature of Inorganic Chemistry, IUPAC Recommendations 2005, see above.

## ORGANIC SUBSTITUENT GROUPS AND RING SYSTEMS

The first part of this table lists substituent groups and their line formulas. A substituent group is defined by IUPAC as a group that replaces one or more hydrogen atoms attached to a parent structure. Such groups are sometimes called radicals, but IUPAC now reserves the term radical for a free molecular species with unpaired electrons. IUPAC does not recommend some of these names, which are marked here with asterisks (e.g., *amyl*\*), but they are included in this list because they are often encountered in the older literature. Substituent group names which are formed

by systematic rules (e.g., methyl from methane, ethyl from ethane, etc.) are included here only for the first few members of a homologous series.

In the second part of the table a number of common organic ring compounds are shown, with the conventional numbering of the ring positions indicated.

The help of Warren H. Powell in preparing this table is greatly appreciated. Pertinent references may be found in the table "Nomenclature of Chemical Compounds."

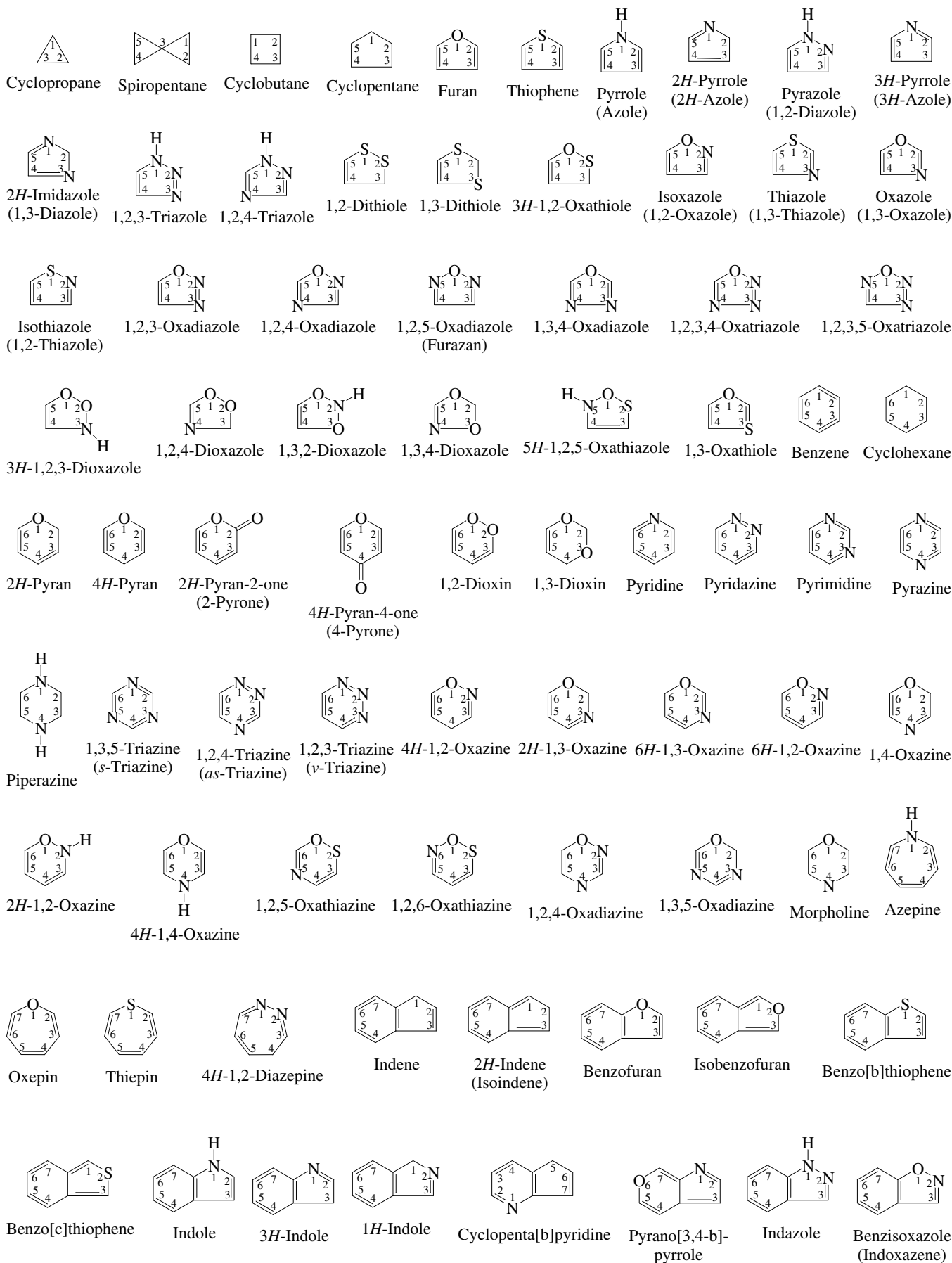
### Substituent Groups

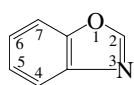
acetamido (acetylamino)	$\text{CH}_3\text{CONH-}$	cinnamoyl	$\text{C}_6\text{H}_5\text{CH=CHCO-}$
acetoacetyl	$\text{CH}_3\text{COCH}_2\text{CO-}$	cinnamyl (3-phenyl-2-propenyl)	$\text{C}_6\text{H}_5\text{CH=CHCH}_2\text{-}$
acetonyl	$\text{CH}_3\text{COCH}_2\text{-}$	cinnamylidene	$\text{C}_6\text{H}_5\text{CH=CHCH=}$
acetyl	$\text{CH}_3\text{CO-}$	cresyl* (hydroxymethylphenyl)	$\text{HO}(\text{CH}_2)\text{C}_6\text{H}_4\text{-}$
acryloyl* (1-oxo-2-propenyl)	$\text{CH}_2=\text{CHCO-}$	crotonoyl	$\text{CH}_3\text{CH=CHCO-}$
alanyl (from alanine)	$\text{CH}_3\text{CH}(\text{NH}_2)\text{CO-}$	crotyl (2-butenyl)	$\text{CH}_3\text{CH=CHCH}_2\text{-}$
$\beta$ -alanyl	$\text{H}_2\text{N}(\text{CH}_2)_2\text{CO-}$	cyanamido (cyanoamino)	$\text{NCNH-}$
allyl (2-propenyl)	$\text{CH}_2=\text{CHCH}_2\text{-}$	cyanato	$\text{NCO-}$
allylidene (2-propenylidene)	$\text{CH}_2=\text{CHCH=}$	cyano	$\text{NC-}$
amidino (aminoiminomethyl)	$\text{H}_2\text{NC(=NH)-}$	decanedioyl	$-\text{OC}(\text{CH}_2)_8\text{CO-}$
amino	$\text{H}_2\text{N-}$	decanoyl	$\text{CH}_3(\text{CH}_2)_8\text{CO-}$
amyl* (pentyl)	$\text{CH}_3(\text{CH}_2)_4\text{-}$	dialzo	$\text{N}_2=$
anilino (phenylamino)	$\text{C}_6\text{H}_5\text{NH-}$	diazooamino	$-\text{NHN=N-}$
anisidino	$\text{CH}_3\text{OC}_6\text{H}_4\text{NH-}$	disilanyl	$\text{H}_3\text{SiSiH}_2\text{-}$
anthranoyl (2-aminobenzoyl)	$2\text{-H}_2\text{NC}_6\text{H}_4\text{CO-}$	disiloxanyloxy	$\text{H}_3\text{SiOSiH}_2\text{O-}$
arsino	$\text{AsH}_2\text{-}$	disulfinyl	$-\text{S}(\text{O})\text{S}(\text{O})\text{-}$
azelaoyl (from azelaic acid)	$-\text{OC}(\text{CH}_2)_7\text{CO-}$	dithio	$-\text{SS-}$
azido	$\text{N}_3\text{-}$	enantioyl* (heptanoyl)	$\text{CH}_3(\text{CH}_2)_5\text{CO-}$
azino	$=\text{N=N=}$	epoxy	$-\text{O-}$
azo	$-\text{N=N-}$	ethenyl (vinyl)	$\text{CH}_2=\text{CH-}$
azoxy	$-\text{N}(\text{O})=\text{N-}$	ethynyl	$\text{HC}\equiv\text{C-}$
benzal* (benzylidene)	$\text{C}_6\text{H}_5\text{CH=}$	ethoxy	$\text{C}_2\text{H}_5\text{O-}$
benzamido (benzoylamino)	$\text{C}_6\text{H}_5\text{CONH-}$	ethyl	$\text{CH}_3\text{CH}_2\text{-}$
benzhydryl (diphenylmethyl)	$(\text{C}_6\text{H}_5)_2\text{CH-}$	ethylene	$-\text{CH}_2\text{CH}_2\text{-}$
benzoxy* (benzoyloxy)	$\text{C}_6\text{H}_5\text{COO-}$	ethylidene	$\text{CH}_3\text{CH=}$
benzoyl	$\text{C}_6\text{H}_5\text{CO-}$	ethylthio	$\text{C}_2\text{H}_5\text{S-}$
benzyl	$\text{C}_6\text{H}_5\text{CH}_2\text{-}$	formamido (formylamino)	$\text{HCONH-}$
benzylidene	$\text{C}_6\text{H}_5\text{CH=}$	formyl	$\text{HCO-}$
benzylidyne	$\text{C}_6\text{H}_5\text{C=}$	furmaroyl (from fumaric acid)	$-\text{OCCH=CHCO-}$
biphenyl	$\text{C}_6\text{H}_5\text{C}_6\text{H}_5\text{-}$	furfuryl (2-furanylmethyl)	$\text{OC}_4\text{H}_3\text{CH}_2\text{-}$
biphenylene	$-\text{C}_6\text{H}_4\text{-C}_6\text{H}_4\text{-}$	furfurylidene (2-furanylmethylene)	$\text{OC}_4\text{H}_3\text{CH=}$
butoxy	$\text{C}_4\text{H}_9\text{O-}$	glutamoyl (from glutamic acid)	$-\text{OC}(\text{CH}_2)_2\text{CH}(\text{NH}_2)\text{CO-}$
<i>sec</i> -butoxy (1-methylpropoxy)	$\text{C}_2\text{H}_5\text{CH}(\text{CH}_3)\text{O-}$	glutaryl (from glutaric acid)	$-\text{OC}(\text{CH}_2)_3\text{CO-}$
<i>tert</i> -butoxy (1,1-dimethylethoxy)	$(\text{CH}_3)_3\text{CO-}$	glycylamino	$\text{H}_2\text{NCH}_2\text{CONH-}$
butyl	$\text{CH}_3(\text{CH}_2)_3\text{-}$	glycoloyl; glycolyl (hydroxyacetyl)	$\text{HOCH}_2\text{CO-}$
<i>sec</i> -butyl (1-methylpropyl)	$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{-}$	glycyl (aminoacetyl)	$\text{H}_2\text{NCH}_2\text{CO-}$
<i>tert</i> -butyl (1,1-dimethylethyl)	$(\text{CH}_3)_3\text{C-}$	glyoxyloyl; glyoxylyl (oxoacetyl)	$\text{HCOCO-}$
butyryl (1-oxobutyl)	$\text{CH}_3(\text{CH}_2)_2\text{CO-}$	guanidino	$\text{H}_2\text{NC(=NH)NH-}$
caproyl* (hexanoyl)	$\text{CH}_3(\text{CH}_2)_4\text{CO-}$	guanyl (aminoiminomethyl)	$\text{H}_2\text{NC(=NH)-}$
capryl* (decanoyl)	$\text{CH}_3(\text{CH}_2)_8\text{CO-}$	heptadecanoyl	$\text{CH}_3(\text{CH}_2)_{15}\text{CO-}$
capryloyl* (octanoyl)	$\text{CH}_3(\text{CH}_2)_6\text{CO-}$	heptanamido	$\text{CH}_3(\text{CH}_2)_5\text{CONH-}$
carbamido (carbamoylamino)	$\text{H}_2\text{NCONH-}$	heptanedioyl	$-\text{OC}(\text{CH}_2)_5\text{CO-}$
carbamoyl (aminocarbonyl)	$\text{H}_2\text{NCO-}$	heptanoyl	$\text{CH}_3(\text{CH}_2)_5\text{CO-}$
carbamyl (aminocarbonyl)	$\text{H}_2\text{NCO-}$	hexadecanoyl	$\text{CH}_3(\text{CH}_2)_{14}\text{CO-}$
carbazoyl (hydrazinocarbonyl)	$\text{H}_2\text{NNHCO-}$	hexamethylene (1,6-hexanediyl)	$-(\text{CH}_2)_6\text{-}$
carbethoxy (ethoxycarbonyl)	$\text{C}_2\text{H}_5\text{OCO-}$	hexanedioyl	$-\text{OC}(\text{CH}_2)_4\text{CO-}$
carbonyl	$=\text{C=O}$	hippuryl (N-benzoylglycyl)	$\text{C}_6\text{H}_5\text{CONHCH}_2\text{CO-}$
carboxy	$\text{HOOC-}$	hydrazino	$\text{H}_2\text{NNH-}$
cetyl* (hexadecyl)	$\text{CH}_3(\text{CH}_2)_{15}\text{-}$	hydrazo	$-\text{HNNH-}$
chloroformyl (chlorocarbonyl)	$\text{ClCO-}$	hydrocinnamoyl	$\text{C}_6\text{H}_5(\text{CH}_2)_2\text{CO-}$

hydroperoxy	HOO-	phenylene (benzenediyl)	-C <sub>6</sub> H <sub>4</sub> -
hydroxyamino	HONH-	phosphino* (phosphanyl)	H <sub>2</sub> P-
hydroxy	HO-	phosphinyl* (phosphinoyl)	H <sub>2</sub> P(O)-
imino	HN=	phospho	O <sub>2</sub> P-
iodoso* (iodosyl)	OI-	phosphono	(HO) <sub>2</sub> P(O)-
iodyl	O <sub>2</sub> I-	phthaloyl (from phthalic acid)	1,2-C <sub>6</sub> H <sub>4</sub> (CO) <sub>2</sub>
isoamyl* (isopentyl; 3-methylbutyl)	(CH <sub>3</sub> ) <sub>2</sub> CH(CH <sub>2</sub> ) <sub>2</sub> -	picryl (2,4,6-trinitrophenyl)	2,4,6-(NO <sub>2</sub> ) <sub>3</sub> C <sub>6</sub> H <sub>2</sub> -
isobutenyl (2-methyl-1-propenyl)	(CH <sub>3</sub> ) <sub>2</sub> C=CH-	pimeloyl (from pimelic acid)	-OC(CH <sub>2</sub> ) <sub>5</sub> CO-
isobutoxy (2-methylpropoxy)	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> O-	piperidino (1-piperidinyl)	C <sub>5</sub> H <sub>10</sub> N-
isobutyl (2-methylpropyl)	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> -	pivaloyl (from pivalic acid)	(CH <sub>3</sub> ) <sub>3</sub> CCO-
isobutylidene (3-methylpropylidene)	(CH <sub>3</sub> ) <sub>2</sub> CHCH=	prenyl (3-methyl-2-butenyl)	(CH <sub>3</sub> ) <sub>2</sub> C=CHCH <sub>2</sub> -
isobutyryl (2-methyl-1-oxopropyl)	(CH <sub>3</sub> ) <sub>2</sub> CHCO-	propargyl (2-propynyl)	HC≡CCH <sub>2</sub> -
isocyanato	OCN-	1-propenyl	-CH=CHCH <sub>2</sub>
isocyano	CN-	2-propenyl (allyl)	CH <sub>2</sub> =CHCH <sub>2</sub> -
isohexyl (4-methylpentyl)	(CH <sub>3</sub> ) <sub>2</sub> CH(CH <sub>2</sub> ) <sub>3</sub> -	propionyl* (propanyl)	CH <sub>3</sub> CH <sub>2</sub> CO-
isoleucyl (from isoleucine)	C <sub>2</sub> H <sub>5</sub> CH(CH <sub>3</sub> )CH(NH <sub>2</sub> )CO-	propoxy	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> O-
isonitroso* (hydroxyamino)	HON=	propyl	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> -
isopentyl (3-methylbutyl)	(CH <sub>3</sub> ) <sub>2</sub> CH(CH <sub>2</sub> ) <sub>2</sub> -	propylidene	CH <sub>3</sub> CH <sub>2</sub> CH=
isopentylidene (3-methylbutylidene)	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CH=	pyrryl (pyrrolyl)	C <sub>4</sub> H <sub>4</sub> N-
isopropenyl (1-methylethenyl)	CH <sub>2</sub> =C(CH <sub>3</sub> )-	salicyloyl (2-hydroxybenzoyl)	2-HOC <sub>6</sub> H <sub>4</sub> CO-
isopropoxy (1-methylethoxy)	(CH <sub>3</sub> ) <sub>2</sub> CHO-	selenyl* (selanyl; hydroseleno)	HS-
isopropyl (1-methylethyl)	(CH <sub>3</sub> ) <sub>2</sub> CH-	seryl (from serine)	HOCH <sub>2</sub> CH(NH <sub>2</sub> )CO-
isopropylidene (1-methylethylidene)	(CH <sub>3</sub> ) <sub>2</sub> C=	siloxyl	H <sub>3</sub> SiO-
isothiocyanato (isothiocyano)	SCN-	silyl	H <sub>3</sub> Si-
isovaleryl* (3-methyl-1-oxobutyl)	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CO-	silylene	H <sub>2</sub> Si=
lactoyl (from lactic acid)	CH <sub>3</sub> CH(OH)CO-	sorbonyl (from sorbic acid)	CH <sub>2</sub> CH=CHCH=CHCO-
lauroyl (from lauric acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>10</sub> CO-	stearoyl (from stearic acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>14</sub> CO-
lauryl (dodecyl)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>11</sub> -	stearyl (octadecyl)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>17</sub> -
leucyl (from leucine)	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CH(NH <sub>2</sub> )CO-	styryl (2-phenylethenyl)	C <sub>6</sub> H <sub>5</sub> CH=CH-
levulinoyl (from levulinic acid)	CH <sub>3</sub> CO(CH <sub>2</sub> ) <sub>2</sub> CO-	suberoyl (from suberic acid)	-OC(CH <sub>2</sub> ) <sub>6</sub> CO-
malonyl (from malonic acid)	-OCCH <sub>2</sub> CO-	succinyl (from succinic acid)	-OCCH <sub>2</sub> CH <sub>2</sub> CO-
mandeloyl (from mandelic acid)	C <sub>6</sub> H <sub>5</sub> CH(OH)CO-	sulfamino (sulfoamino)	HOSO <sub>2</sub> NH-
mercapto	HS-	sulfamoyl (sulfamyl)	H <sub>2</sub> NSO <sub>2</sub> -
mesityl	2,4,6-(CH <sub>3</sub> ) <sub>3</sub> C <sub>6</sub> H <sub>2</sub> -	sulfanilyl [(4-aminophenyl)sulfonyl]	4-H <sub>2</sub> NC <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> -
methacryloyl (from methacrylic acid)	CH <sub>2</sub> =C(CH <sub>3</sub> )CO-	sulfeno	HOS-
methallyl (2-methyl-2-propenyl)	CH <sub>2</sub> =C(CH <sub>3</sub> )CH <sub>2</sub> -	sulfhydryl (mercapto)	HS-
methionyl (from methionine)	CH <sub>3</sub> SCH <sub>2</sub> CH <sub>2</sub> CH(NH <sub>2</sub> )CO-	sulfinyl	OS=
methoxy	CH <sub>3</sub> O-	sulfo	HO <sub>3</sub> S-
methyl	H <sub>3</sub> C-	sulfonyl (sulfuryl)	-SO <sub>2</sub> -
methylene	H <sub>2</sub> C=	terephthaloyl	1,4-C <sub>6</sub> H <sub>4</sub> (CO) <sub>2</sub>
methylthio	CH <sub>3</sub> S-	tetramethylene	-(CH <sub>2</sub> ) <sub>4</sub> -
myristoyl (from myristic acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>12</sub> CO-	thienyl (from thiophene)	(C <sub>4</sub> H <sub>3</sub> S)-
myristyl (tetradecyl)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>13</sub> -	thiocarbonyl (carbothionyl)	=CS
naphthyl	(C <sub>10</sub> H <sub>7</sub> )-	thiocarboxy	HOSC-
naphthylene	-(C <sub>10</sub> H <sub>6</sub> )-	thiocyanato (thiocyano)	NCS-
neopentyl (2,2-dimethylpropyl)	(CH <sub>3</sub> ) <sub>3</sub> CCH <sub>2</sub> -	thionyl* (sulfinyl)	-SO-
nitramino (nitroamino)	O <sub>2</sub> NNH-	threonyl (from threonine)	CH <sub>3</sub> CH(OH)CH(NH <sub>2</sub> )CO-
nitro	O <sub>2</sub> N-	toluidino [(methylphenyl)amino]	CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> NH-
nitrosamino (nitrosoamino)	ONNH-	toluoyl (methylbenzoyl)	CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> CO-
nitrosimino (nitrosoimino)	ONN=	tolyl (methylphenyl)	CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> -
nitroso	ON-	α-tolyl (benzyl)	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -
nonanoyl (from nonanoic acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CO-	tolyene (methylphenylene)	-(CH <sub>2</sub> C <sub>6</sub> H <sub>3</sub> )-
oleoyl (from oleic acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> CH=CH(CH <sub>2</sub> ) <sub>7</sub> CO-	tosyl [(4-methylphenyl) sulfonyl]	4-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> -
oxalyl (from oxalic acid)	-OCCO-	triazano	H <sub>2</sub> NNHNH-
oxo	O=	trimethylene (1,3-propanediyl)	-(CH <sub>2</sub> ) <sub>3</sub> -
palmitoyl (from palmitic acid)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>14</sub> CO-	trityl (triphenylmethyl)	(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub> C-
pentamethylene (1,5-pentanediy)	-(CH <sub>2</sub> ) <sub>5</sub> -	valeryl* (pentanoyl)	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> CO-
pentyl	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>4</sub> -	valyl (from valine)	(CH <sub>3</sub> ) <sub>2</sub> CHCH(NH <sub>2</sub> )CO-
tert-pentyl	CH <sub>3</sub> CH <sub>2</sub> C(CH <sub>3</sub> ) <sub>2</sub> -	vinyl (ethenyl)	CH <sub>2</sub> =CH-
phenacyl	C <sub>6</sub> H <sub>5</sub> COCH <sub>2</sub> -	vinylidene (ethenylidene)	CH <sub>2</sub> =C=
phenacylidene	C <sub>6</sub> H <sub>5</sub> COCH=	xylydino [(dimethylphenyl)amino]	(CH <sub>3</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>3</sub> NH-
phenethyl (2-phenylethyl)	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> CH <sub>2</sub> -	xylyl (dimethylphenyl)	(CH <sub>3</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>3</sub> -
phenoxy	C <sub>6</sub> H <sub>5</sub> O-	xylylene [phenylenebis(methylene)]	-CH <sub>2</sub> C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> -
phenyl	C <sub>6</sub> H <sub>5</sub> -		

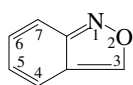


## Organic Ring Compounds

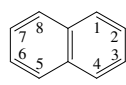




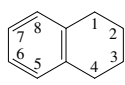
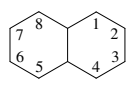
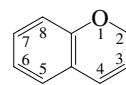
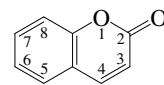
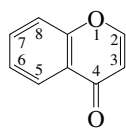
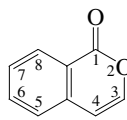
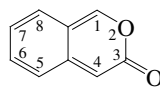
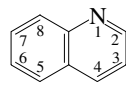
Benzoxazole



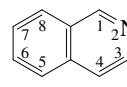
2,1-Benzisoxazole



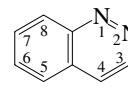
Naphthalene

1,2,3,4-Tetrahydronaphthalene  
(Tetralin)Octahydronaphthalene  
(Decalin)2H-1-Benzopyran  
(2H-Chromene)2H-1-Benzopyran-2-one  
(Coumarin)4H-1-Benzopyran-4-one  
(Chromen-4-one)1H-2-Benzopyran-1-one  
(Isocoumarin)3H-2-Benzopyran-1-one  
(Isochromen-3-one)

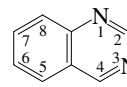
Quinoline



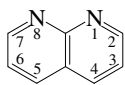
Isoquinoline



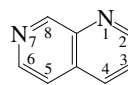
Cinnoline



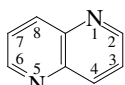
Quinazoline



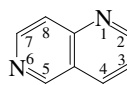
1,8-Naphthyridine



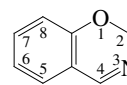
1,7-Naphthyridine



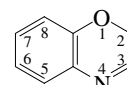
1,5-Naphthyridine



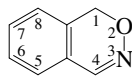
1,6-Naphthyridine



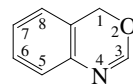
2H-1,3-Benzoxazine



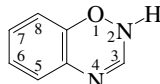
2H-1,4-Benzoxazine



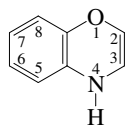
1H-2,3-Benzoxazine



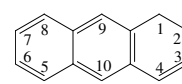
4H-3,1-Benzoxazine



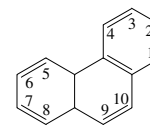
2H-1,2-Benzoxazine



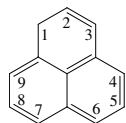
4H-1,4-Benzoxazine



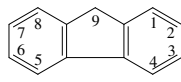
Anthracene



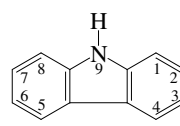
Phenanthrene



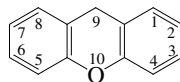
Phenalene



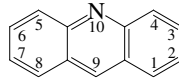
Fluorene



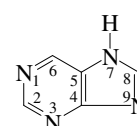
Carbazole



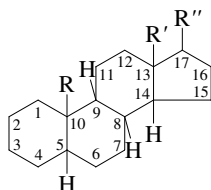
Xanthene



Acridine

Norpinane  
(Bicyclo[3.1.1]heptane)

7H-Purine



Steroid ring system

R = Nearly always methyl  
 R' = Usually methyl  
 R'' = Various groups

## SCIENTIFIC ABBREVIATIONS, ACRONYMS, AND SYMBOLS

This table lists some abbreviations, acronyms, and symbols encountered in the physical sciences. Most entries in italic type are symbols for physical quantities; for more details on these, see the table “Symbols and Terminology for Physical and Chemical Quantities” in this section. Additional information on units may be found in the table “International System of Units (SI)” in Section 1. Many of the terms to which these abbreviations refer are included in the tables “Definitions of Scientific Terms” in Section 2 and “Techniques for Materials Characterization” in Section 12. Useful references for further information are given below.

Publication practices vary with regard to the use of capital or lower case letters for many abbreviations. An effort has been made to follow the most common practices in this table, but much variation is found in the literature. Likewise, policies on the use of periods in an abbreviation vary considerably. Periods are generally omitted in this table unless they are necessary for clarity. Periods should never appear in SI units. The SI prefixes (m, k, M, etc.) are included here, but they should never be used alone. Selected combinations of these prefixes with SI units (e.g., mg, kV, MW) are also included.

Abbreviations are listed in alphabetical order without regard to case. Entries beginning with Greek letters fall at the end of the table.

A	ampere; alanine; adenine (in genetic code)
Å	ångström
A	absorbance; area; Helmholtz energy; mass number
$A_H$	Hall coefficient
$A_r$	atomic weight (relative atomic mass)
a	atto (SI prefix for $10^{-18}$ )
$\alpha$	absorption coefficient; acceleration; activity; van der Waals constant
$a_0$	Bohr radius
A/D	analog to digital
AAA	acetoacetanilide
Aad	2-aminoadipic acid
AAO	acetaldehyde oxime
AAS	atomic absorption spectroscopy
ABA	abscisic acid
Abe	abequose
ABL	$\alpha$ -acetylbutyrolactone
abs	absolute
Abu	2-aminobutanoic acid
Ac	acetyl; acetate
ac, AC	alternating current
Aces	2-[(2-amino-2-oxoethyl)amino]ethanesulfonic acid
ACT	activated complex theory
ACTH	adrenocorticotrophic hormone
Ad	adamantyl
Ada	[(carbamoylmethyl)imino]diacetic acid
Ade	adenine
ADI	acceptable daily intake
Ado	adenosine
ADP	adenosine diphosphate; ammonium dihydrogen phosphate
ads	adsorption
AE	appearance energy

## References

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2. Kotyk, A., *Quantities, Symbols, Units, and Abbreviations in the Life Sciences*, Humana Press, Totawa, NJ, 1999.
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9. *Acronyms and Symbols*, <www3.interscience.wiley.com/stasa/>.
10. *IUPAC Compendium of Chemical Terminology (Gold Book)*, <gold-book.iupac.org>.
11. IUPAC-IUB Joint Commission on Biochemical Nomenclature, *Pure & Appl. Chem.* 56, 595, 1984.

ae	eon ( $10^9$ years)
AEP	1-(2-aminoethyl)piperazine
AES	atomic emission spectroscopy; Auger electron spectroscopy
AF	audio frequency
AFM	atomic force microscopy
Ahx	2-aminohexanoic acid
AI	artificial intelligence
AIBN	2,2'-azobis[isobutyronitrile]
AICA	5-amino-1H-imidazole-4-carboxamide
AIM	atoms in molecules (method)
AIP	aluminum isopropoxide
Al	Alfén number
Ala	alanine
alc	alcohol
ALE	atomic layer epitaxy
aliph.	aliphatic
alk.	alkaline
All	allose
Alt	altrose
AM	amplitude modulation
Am	amyl
am	amorphous solid
AMP	adenosine monophosphate
AMPD	2-amino-2-methyl-1,3-propanediol
AMTCS	amyltrichlorosilane [trichloropentylsilane]
AMS	accelerator mass spectrometry
amu	atomic mass unit (recommended symbol is u)
AN	acetonitrile
anh, anhyd	anhydrous
ANOVA	analysis of variance
antilog	antilogarithm
ANTU	1-naphthalenylthiourea

AO	atomic orbital	Bé	Baumé
AOM	angular overlap model	BEBO	bond energy bond order (method)
APAD	3-acetylpyridine adenine dinucleotide	BEI	biological exposure index
Ape	2-aminopentanoic acid	BEM	biological effect monitoring
API	atmospheric pressure ionization	Bes	2-[bis(2-hydroxyethyl)amino]ethanesulfonic acid
Api	apiose	BET	Brunauer–Emmett–Teller (isotherm)
APM	atomic probe microanalysis	BeV	billion electronvolt
Apm	2-aminopimelic acid	BGE	butyl glycidyl ether
APPI	atmospheric pressure photoionization	BHA	<i>tert</i> -butyl-4-hydroxyanisole
APS	appearance potential spectroscopy; adenosine phosphosulfate	BHC	benzene hexachloride [hexachlorobenzene]
APW	augmented plane wave	Bhn	Brinell hardness number
aq	aqueous	BHT	butylated hydroxytoluene [2,6-di- <i>tert</i> -butyl-4-methylphenol]
Ar	aryl	Bi	biot
Ara	arabinose	Bicine	<i>N,N</i> -bis(2-hydroxyethyl)glycine
Ara-ol	arabinitol	BIRD	blackbody infrared radiative dissociation
Arg	arginine	Bistris	2-[bis(2-hydroxyethyl)amino]-2-(hydroxymethyl)propane-1,3-diol
ARPES	angular resolved photoelectron spectroscopy	Bistris-propane	1,3-bis[tris(hydroxymethyl)methylamino]propane
ASC	4-(acetylamino)benzenesulfonyl chloride	BLO	$\gamma$ -butyrolactone
ASCII	American National Standard Code for Information Interchange	BN	bond number; benzonitrile
ASE	aromatic stabilization model	BNS	nuclear backscattering spectroscopy
Asn	asparagine	BO	Born–Oppenheimer (approximation); bond order
Asp	aspartic acid	BOD	biochemical oxygen demand
at	atomization	BON	$\beta$ -hydroxynaphthoic acid
ATEE	<i>N</i> -acetyl- <i>L</i> -tyrosine ethyl ester	BP	base peak (in mass spectrometry)
ATLC	adsorption thin layer chromatography	bp	boiling point; base pair
atm	standard atmosphere	BPB	bromophenol blue
ATP	adenosine triphosphate	BPG	2,3-bis(phospho)- <i>D</i> -glycerate
ATR	attenuated total internal reflection	bpy	2,2'-bipyridine
at.wt.	atomic weight	Bq	becquerel
AU	astronomical unit (ua is also used)	Br	butyryl
AUC	area under the time-concentration curve	BRE	bond resonance energy
av	average	BrUrd	5-bromouridine
avdp	avoidrupois	BS	Birge–Sponer extrapolation
B	bel; asparagine or aspartic acid (unspecified)	BSE	back scattered electron(s)
<i>B</i>	magnetic flux density; second virial coefficient; susceptibility	BSSE	basis set superposition error
b	barn	BTMSA	1,2-bis(trimethylsilyl)acetylene
<i>b</i>	van der Waals constant; molality	Btu	British thermal unit
BA	benzyladenine	BTX	benzene, toluene, and xylene
BAL	British anti-Lewisite [2,3-dimercapto-1-propanol]	Bu	butyl
BAP, BaP	benzo[a]pyrene	bu	bushel
bar	bar (pressure unit)	Bz	benzoyl
bb1	barrel	Bzl	benzyl
BBP	benzyl butyl phthalate	C	coulomb; cysteine; cytosine (in genetic code)
BCB	bromocresol blue	°C	degree Celsius
bcc	body centered cubic	C	capacitance; heat capacity; number concentration
BCF	bioconcentration factor	c	centi (SI prefix for 10 <sup>-2</sup> ); combustion reaction
BCG	bromocresol green	<i>c</i>	amount concentration; specific heat; velocity
BCNU	<i>N,N'</i> -bis(2-chloroethyl)- <i>N</i> -nitrosourea	<i>c</i> <sub>0</sub>	speed of light in vacuum
BCP	bromocresol purple	CA	collisional activation
BCPB	bromochlorophenol blue	ca.	approximately
BCS	Bardeen–Cooper–Schrieffer (theory)	CADD	computer-assisted drug design
BDE	bond dissociation energy	cal	calorie
BDEA	butyldiethanolamine	calc	calculated
BDMA	benzyl dimethylamine	cAMP	adenosine cyclic 3',5'-(hydrogen phosphate)

CAN	ceric ammonium nitrate	COSY	correlation spectroscopy
CARS	coherent anti-Stokes Raman spectroscopy	COT	1,3,5,7-cyclooctatetraene
CAS	complete active space	cot	cotangent
CASRN	Chemical Abstracts Service Registry Number	coth	hyperbolic cotangent
CAT	computerized axial tomography; clear air turbulence	CP	chemically pure
CBE	chemical beam epitaxy	Cp	cyclopentadienyl
CBS	complete basis set (of orbitals)	Cp*	pentamethylcyclopentadienyl
CC	coupled cluster; combustion calorimetry	cP	centipoise
cc	cubic centimeter	cp	candle power
CCD	charge-coupled device	CPA	coherent potential approximation
CD	circular dichroism	CPC	centrifugal partition chromatography
cd	candela; condensed (phase)	cpd	contact potential difference
CDNO	complete neglect of differential overlap	CPL	circular polarization of luminescence
CDP	cytidine 5'-diphosphate	CPR	chlorophenol red
CDT	1,5,9-cyclododecatriene	cps	cycles per second
CDTA	(1,2-cyclohexylenedinitrilo)tetraacetic acid monohydrate	CPT	charge conjugation/space inversion/time inversion (theorem)
CDW	charge density waves	CPU	central processing unit
CEM	channel electron multiplier	cr, cryst	crystalline (phase)
CEP	counter electrophoresis	CRF	charge remote fragmentation
CEPA	coupled electron-pair approximation	CRU	constitutional repeating unit (in polymer nomenclature)
cf.	compare	CSA	camphorsulfonic acid
CFC	chlorofluorocarbon compound	csc	cosecant
cfm	cubic feet per minute	CSR	charge stripping reaction
cgs	centimeter-gram-second system	CT	charge transfer
Chaps	3-[3-(cholamidopropyl)dimethylammonio]-1-propanesulfonic acid	ct	carat
Ches	2-( <i>N</i> -cyclohexylamino)ethanesulfonic acid	CTEM	conventional transmission electron microscopy
CHF	coupled Hartree-Fock (method)	CTP	cytidine 5'-triphosphate
Chl	chlorophyll	CTR	controlled thermonuclear reaction
Cho	choline	cu	cubic
CHT	1,3,5-cycloheptatriene	CV	cyclic voltammetry
Ci	curie	CVD	chemical vapor deposition
CI	configuration interaction; chemical ionization; color index	cw	continuous wave
CID	charge-injection device; collision-induced dissociation	cwt	hundredweight (112 pounds)
CIDEP	chemically induced dynamic electron polarization	Cy	cyclohexyl
CIDNP	chemically induced dynamic nuclear polarization	Cya	cysteic acid
CIE	countercurrent immunoelectrophoresis	Cyd	cytidine
cir	circular	cyl	cylinder
CKFF	Cotton-Kraihanzel force field	Cys	cysteine
CL	cathode luminescence (spectroscopy)	Cyt	cytosine
CLT	central limit theorem	D	debye unit; aspartic acid
cm	centimeter	<i>D</i>	diffusion coefficient; dissociation energy; electric displacement
c.m.	center of mass	d	day; deuteron; deci (SI prefix for 10 <sup>-1</sup> )
c.m.c.	critical micelle concentration	<i>d</i>	distance; density; dextrorotatory
CMO	canonical molecular orbital	2,4-D	2,4-dichlorophenoxyacetic acid
CMP	cytidine 5'-monophosphate; chemical measurement process	D/A	digital to analog
CN	coordination number	Da	dalton
CNDO	complete neglect of differential overlap	DA	donor-acceptor (complex)
<i>Co</i>	Cowling number	da	deka (SI prefix for 10 <sup>1</sup> )
COD	chemical oxygen demand; 1,4-cyclooctadiene	DAA	diacetone alcohol
conc	concentrated; concentration	DAB	4-(dimethylamino)azobenzene
const	constant	Dab	2,4-diaminobutanoic acid
COOP	crystal orbital overlap population	DACH	<i>trans</i> -1,2-diaminocyclohexane
cos	cosine	DAP	diammonium phosphate
cosh	hyperbolic cosine	DART	direct analysis in real-time mass spectrometry

dB	decibel	DRE	Dewar resonance energy
DBA	dibenz[a,h]anthracene	dRib	2-deoxyribose
DBCP	1,2-dibromo-3-chloropropane	DRIFT	diffuse reflectance infrared Fourier transform
DBMS	database management system	DRP	dynamic reaction path
DBP	dibutyl phthalate	DRS	diffuse reflectance spectroscopy
DBPC	2,6-di- <i>tert</i> -butyl- <i>p</i> -cresol	DSC	differential scanning calorimetry
dc, DC	direct current	DTA	differential thermal analysis
DCB	dicyanobenzene	DTBP	di- <i>tert</i> -butyl peroxide
DCEE	dichloroethyl ether	DVB	divinylbenzene
DCHA	dicyclohexylamine	dyn	dyne
DCM	dichloromethane	DZ	double-zeta (type of basis set)
DCPD	dicyclopentadiene	E	exa (SI prefix for 10 <sup>18</sup> ); glutamic acid
DE	delocalization energy; delayed extraction	<i>E</i>	electric field strength; electromotive force; energy; modulus of elasticity; entgegen ( <i>trans</i> configuration)
Dec	decyl	<i>E<sub>h</sub></i>	Hartree energy
dec	decomposes	e	electron; base of natural logarithms
DEET	diethyltoluamide [ <i>N,N</i> -diethyl-3-methylbenzamide]	<i>e</i>	elementary charge; linear strain
deg	degree	EA	electron affinity
den	density	EAN	effective atomic number
DESI	desorption electrospray ionization (in mass spectrometry)	ECD	electron capture dissociation
det	determinant	ECP	effective core potential
dev	deviation	ECR	electron cyclotron resonance
DFT	density functional theory	ED	electron diffraction
dGlc	2-deoxyglucose	EDAX	energy dispersive analysis by x-rays
DHH	dehydroheliotridine	EDB	ethylene dibromide [1,2-dibromoethane]
DHU	dihydrouridine	EDC	ethylene dichloride [1,2-dichloroethane]
DHR	dehydroretroecine	EDI	estimated daily intake
DI	desorption ionization	EDS	energy-dispersive x-ray spectroscopy
diam	diameter	EDTA	ethylenediaminetetraacetic acid
dil	dilute; dilution	EEDQ	ethyl 2-ethoxy-1-(2 <i>H</i> )-quinolinecarboxylate
DIM	diatomics in molecules (method); digital imaging microscopy	EEL	environmental exposure level
dm	decimeter	EELS	electron energy loss spectroscopy
DMA	<i>N,N</i> -dimethylaniline	EES	excitation emission spectrum
DMAC	<i>N,N</i> -dimethylacetamide	EFF	empirical force field
DBMC	2,4-di- <i>tert</i> -butyl-5-methylphenol	EFFF	energy factored force field
DBP	2,3-dibromo-1-propanol	EG	equilibrium in the gas phase
DMF	<i>N,N</i> -dimethylformamide	EGA	evolved gas analysis
DMP	dimethyl phthalate	EHMO, EHT	extended Hückel molecular orbital (theory)
DMS	dimethyl sulfide	EIMS	electron impact mass spectrometry
DMSO	dimethyl sulfoxide	EIS	electron impact spectroscopy; electrochemical impedance spectroscopy
DMT	dimethyl terephthalate; dimethyl tartrate	ELISA	enzyme-linked immunosorbent assay
DN	donor number	ELS	energy loss spectroscopy
DNA	deoxyribonucleic acid	EM	extended molarity; electron microscopy
DNase	deoxyribonuclease	emf	electromotive force
DNMR	dynamic NMR spectroscopy	EMPA, EMA	electron probe microanalysis
DNP	dinitropyrene	emu	electromagnetic unit system
Dod	dodecyl	en	ethylenediamine
DOP	dioctyl phthalate	ENDOR	electron-nuclear double resonance
DOS	density of states; digital operating system	EOS	equation of state
doz	dozen	EPDS	electron photodetachment spectroscopy
d.p.	degree of polymerization	EPR	electron paramagnetic resonance
dpl	displacement	EPT-76	provisional low temperature scale of 1976
Dpm	2,6-diaminopimelic acid	EPTC	dipropylcarbamoithioic acid, <i>S</i> -ethyl ester
dpm	disintegrations per minute	EPXMA	electron probe x-ray microanalysis
dps	disintegrations per second	eq, eqn	equation
dr	dram		

<i>eqQ</i>	quadrupole coupling constant	ft	foot
erf	error function	ft-lb	foot pound
erg	erg (energy unit)	FTIR	Fourier transform infrared spectroscopy
ES	equilibrium in solution	FTMS	Fourier transform mass spectrometry
ESA	electrostatic energy analyzer	FTNMR	Fourier transform nuclear magnetic resonance
ESCA	electron spectroscopy for chemical analysis	fus	fusion (melting)
ESD	electron stimulated desorption	FVP	flash vacuum pyrolysis
e.s.d.	estimated standard deviation	FWHM	full width at half maximum
ESI	electrospray ionization	G	Gauss; guanine (in genetic code); giga (SI prefix for 10 <sup>9</sup> ); glycine
ESR	electron spin resonance	<i>G</i>	electrical conductance; Gibbs energy; gravitational constant; sheer modulus
est	estimated	g	gram; gas (phase)
esu	electrostatic unit system	<i>g</i>	acceleration due to gravity; degeneracy; Landé <i>g</i> -factor; statistical weight
ET	ephemeris time; electron transfer	GABA	γ-aminobutyric acid
Et	ethyl	Gal	gal; galactose
Etn	ethanolamine	gal	gallon
ETS	electron tunneling spectroscopy	GalN	galactosamine
<i>Eu</i>	Euler number	GB	gas-phase basicity
e.u.	entropy unit	GC	gas chromatography
eV	electronvolt	GC-MS	gas chromatography-mass spectrometry
EXAFS	extended x-ray absorption fine structure (spectroscopy)	GDMS	glow discharge mass spectroscopy
EXELFS	extended energy loss fine structure	GDP	guanosine 5'-diphosphate
exp	exponential function	<i>gem</i>	geminal (on the same carbon atom)
expt	experimental	GeV	gigaelectronvolt
ext	external	GIAO	gauge invariant atomic orbital
F	farad; phenylalanine	GIBMS	guided ion beam mass spectrometry
°F	degree Fahrenheit	gl	glacial
<i>F</i>	Faraday constant; force; angular momentum	Gla	4-carboxyglutamic acid
<i>f</i>	formation reaction; femto (SI prefix for 10 <sup>-15</sup> )	GLC	gas-liquid chromatography
<i>f</i>	activity coefficient; aperture ratio; focal length; force constant; frequency; fugacity	Glc	glucose
FAB	fast atom bombardment	GlcA	gluconic acid
FAD	flavine adenine dinucleotide	GlcN	glucosamine
FAIMS	high-field asymmetric waveform ion mobility spectrometry	GlcNAc	<i>N</i> -acetylglucosamine
FA-SIFT	flowing afterglow – selected ion-flow tube	GLP	good laboratory practice
fcc	face centered cubic	GlcU	glucuronic acid
FD	field desorption	Gln	glutamine
FEL	free electron laser	Glu	glutamic acid
FEM	field emission microscopy	Gly	glycine
FEMO	free electron molecular orbital	Glx	glutamine or glutamic acid (unspecified)
FET	field effect transistor	GMP	guanosine 5'-monophosphate
fid	free induction decay	GMT	Greenwich mean time
FI	field ionization	GPC	gel-permeation chromatography
FIM	field ion microscopy	gpm	gallons per minute
FIR	far infrared	gps	gallon per second
fl	fluid (phase)	<i>Gr</i>	Grashof number
FM	frequency modulation	gr	grain
<i>Fo</i>	Fourier number	Gra	glyceraldehyde
fp	freezing point	Gri	glyceric acid
fpm	feet per minute	Grn	glycerone [dihydroxyacetone]
fps	feet per second; foot-pound-second system	Gro	glycerol
Fr	franklin	GTO	Gaussian-type orbital
<i>Fr</i>	Froude number	GTP	guanosine 5'-triphosphate
Fru	fructose	Gua	guanine
FSGO	floating spherical Gaussian orbitals	Gul	gulose
FT	Fourier transform	Guo	guanosine



GUT	grand unified theory	I/O	input/output
GVB	generalized valence bond (method)	IAT	international atomic time
GWS	Glashow–Weinberg–Salam (theory)	IC	integrated circuit
Gy	gray; gigayear	ICD	induced circular dichroism
H	henry; histidine	ICP	inductive-coupled plasma
<i>H</i>	enthalpy; Hamiltonian function; magnetic field	ICR	ion cyclotron resonance
$H_0$	Hubble constant	ICVTST	improved canonical variational transition-state theory
h	helion; hour; hecto (SI prefix for $10^2$ )	ID	inside diameter
<i>h</i>	Planck constant	id	ideal (solution)
<i>Ha</i>	Hartmann number	Ido	iodose
ha	hectare	IdoA	iduronic acid
HAM	hydrogenic atoms in molecules	IDP	inosine 5'-diphosphate
hav	haversine	IE	ionization energy
Hb	hemoglobin	i.e.p.	isoelectric point
HCA	heterocyclic amine	IEPA	independent electron pair approximation
hcp	hexagonal closed packed	IF	intermediate frequency
Hcy	homocysteine	IGLO	individual gauge for localized orbitals
HDL	high-density lipoprotein	IKES	ion kinetic energy spectrometry
HDS	hydrodesulfurization	Ile	isoleucine
HEIS	high-energy ion scattering	Im	imaginary part
HEP	high energy physics	IMFP	inelastic mean free path (of electrons)
Hepes	4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid	imm	immersion
Hepps	4-(2-hydroxyethyl)-1-piperazinepropanesulfonic acid	IMP	inosine 5'-monophosphate
HF	high frequency; Hartree–Fock (method)	IMPATT	impact ionization avalanche transit time
HFA	hexafluoroacetone	IMS	ion mobility spectrometry
HFO	Hartree–Fock orbital	in.	inch
hfs	hyperfine structure	InChI	IUPAC International Chemical Identifier
His	histidine	INDO	immediate neglect of differential overlap
HMO	Hückel molecular orbital	Ino	inosine
HMX	cyclotetramethylenetetranitramine	INS	inelastic neutron scattering; ion neutralization spectroscopy
HN1	2-chloro- <i>N</i> -(2-chloroethyl)- <i>N</i> -ethylethanamine	Ins	<i>myo</i> -inositol
HOAc	acetic acid	int	internal
HOC	halogenated organic compound(s)	IP	ionization potential
HOMAS	harmonic oscillator model of aromatic stabilization	IPA	isopropyl alcohol
HOMO	highest occupied molecular orbital	IPMA	ion probe microanalysis
HOSE	harmonic oscillator stabilization energy	IPN	interpenetrating polymer network
Hp	heptyl	IPR	isotope perturbation of resonance
hp	horsepower	IPTS	International Practical Temperature Scale
HPLC	high-performance liquid chromatography	IQ	2-amino-3-methyl-3 <i>H</i> -imidazo(4,5- <i>f</i> )quinoline
HPMS	high pressure mass spectrometry	IR	infrared
HQ	<i>p</i> -hydroquinone	IRAS	infrared reflection-absorption spectroscopy
hr	hour	IRC	intrinsic reaction coordinate
HRE	Hückel resonance energy	IRMPD	infrared multiphoton dissociation
HREELS	high resolution electron energy loss spectroscopy	IRMS	isotope ratio mass spectrometry
HREM	high resolution electron microscopy	IRS	infrared spectroscopy
HSAB	hard-soft acid-base (theory)	isc	intersystem crossing
HSE	homodesmotic stabilization energy	ISE	ion-selective electrode;isodesmic stabilization energy
Hse	homoserine	ISS	ion scattering spectroscopy
Hx	hexyl	IT	ion trap; information technology
Hyl	5-hydroxylysine	ITP	inosine 5'-triphosphate
Hyp	hypoxanthine; 4-hydroxyproline	ITS	International Temperature Scale (1990)
Hz	hertz	IU	international unit
I	isoleucine; inositol	J	joule; leucine or isoleucine (unspecified)
<i>I</i>	electric current; ionic strength; moment of inertia; nuclear spin angular momentum; radiant intensity	<i>J</i>	angular momentum; electric current density; flux; Massieu function
<i>i</i>	square root of minus one	<i>j</i>	angular momentum; electric current density
<i>i</i>	electric current		



JT	Jahn–Teller (effect)	LI	laser ionization
K	kelvin; lysine	lim	limit
<i>K</i>	absorption coefficient; bulk modulus; equilibrium constant; kinetic energy	LIMS	laser ionization mass spectroscopy; laboratory information management system
k	kilo (SI prefix for 10 <sup>3</sup> )	liq	liquid
<i>k</i>	absorption index; Boltzmann constant; rate constant; thermal conductivity; wave vector	LIT	linear ion trap
kat	katal (unit of catalytic activity)	LLCT	ligand to ligand charge transfer
kb	kilobar; kilobases (DNA or RNA)	lm	lumen
KC-MS	Knudson cell mass spectrometry	LMCT	ligand to metal charge transfer
kcal	kilocalorie	LMMS	laser microprobe mass spectrometry
KDP	potassium dihydrogen phosphate	LMO	localized molecular orbital
KE	kinetic energy	LMR	laser magnetic resonance
KERD	kinetic energy release distributions	ln	logarithm (natural)
keV	kiloelectronvolt	LNDO	local neglect of differential overlap
KG	kinetics in the gas phase	log	logarithm (common)
kg	kilogram	LOMO	lowest occupied molecular orbital
kgf	kilogram force	long.	longitude
KIE	kinetic isotope effect	LPG	liquid petroleum gas
kJ	kilojoule	LPHP	laser-powered homogeneous pyrolysis
km	kilometer	LPU	law of propagation of uncertainty
<i>Kn</i>	Knudsen number	LSFE	linear field stabilization energy
kPa	kilopascal	LSI	liquid secondary ionization
KS	kinetics in solution	LST	local sidereal time
kt	karat	LT	local time
KTP	potassium titanium phosphate	LTE	local thermodynamic equilibrium
kV	kilovolt	LUMO	lowest unoccupied molecular orbital
kva	kilovolt ampere	lx	lux
kW	kilowatt	ly	langley
kwh	kilowatt hour	l.y.	light year
L	liter; lambert; leucine	Lys	lysine
<i>L</i>	Avogadro constant; inductance; Lagrange function; angular momentum	Lyx	lyxose
l	liter; liquid (phase)	M	molar (as in 0.1 M solution); mega (SI prefix for 10 <sup>6</sup> ); methionine
<i>l</i>	angular momentum; length; mean free path; levorotatory	<i>M</i>	magnetization; molar mass; mutual inductance; torque; angular momentum component; median
Lac	lactose	<i>M<sub>r</sub></i>	molecular weight (relative molar mass)
LAH	lithium aluminum hydride	m	meter; molal (as in 0.1 m solution); metastable (isotope); milli (SI prefix for 10 <sup>-3</sup> )
lat.	latitude	<i>m</i>	magnetic dipole moment; mass; molality; angular momentum component; <i>meta</i> (locant on aromatic ring)
lb	pound	<i>Ma</i>	Mach number
lbf	pound force	MA	maleic anhydride
LC	liquid chromatography	Mal	maltose
LC-MS	liquid chromatography–mass spectrometry	Man	mannose
lc	liquid crystal (phase)	MASNMR	magic angle spinning nuclear magnetic resonance
LCAO	linear combination of atomic orbitals	max	maximum
LD	lethal dose; laser desorption	Mb	myoglobin
LDA	local density approximation; lithium diisopropylamide	MBE	molecular beam epitaxy
LDL	low-density lipoprotein	MBER	molecular beam electron resonance
LDV	laser-Doppler velocimetry	MBPT	many body perturbation theory
<i>Le</i>	Lewis function	MC	Monte Carlo (method)
LE	localization energy	MCAA	monochloroacetic acid
LEC	liquid exchange chromatography	MCD	magnetic circular dichroism
LED	light emitting diode	MCP	microchannel plate
LEED	low-energy electron diffraction	MCPA	(4-chloro-2-methylphenoxy)acetic acid
LEIS	low-energy ion scattering	MCPF	modified coupled pair functional
Leu	leucine	MCS	Monte Carlo simulation
LFER	linear free energy relationships		
LFL	lower flammable limit		

MCSCF	multiconfigurational self-consistent field (approximation)	MSDS	Material Safety Data Sheet
MD	molecular dynamics (method)	MS-K	mass spectroscopy – kinetic method
Me	methyl	MSL	mean sea level
MeCCNU	1-(2-chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	MTBE	methyl <i>tert</i> -butyl ether
MeIQ	2-amino-3,4-dimethylimidazo[4,5-f]quinoline	MTD	maximum tolerable dose
MeIQx	2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline	Mur	muramic acid
MEK	methyl ethyl ketone	mV	millivolt
MEP	molecular electrostatic potential	MVK	methyl vinyl ketone
MERP	minimum energy reaction path	MW	megawatt; microwave; molecular weight
Mes	4-morpholineethanesulfonic acid	mW	milliwatt
MESFET	metal-semiconductor field-effect transistor	Mx	maxwell
Met	methionine	N	newton; asparagine
MeV	megaelectronvolt	<i>N</i>	angular momentum; neutron number; number density
meV	millielectronvolt	<i>N<sub>A</sub></i>	Avogadro constant
MF	molecular formula	<i>n</i>	neutron; nano (SI prefix for 10 <sup>-9</sup> )
mg	milligram	<i>n</i>	amount of substance; number density; principal quantum number; refractive index; normal (in chemical formulas)
MHD	magnetohydrodynamics	NAA	nuclear activation analysis
mi	mile	NAAD	nicotinic acid adenine dinucleotide
MIAK	methyl isoamyl ketone	NAD	nicotinamide adenine dinucleotide
MIKES	mass-analyzed ion kinetic energy spectrometry	NADH	reduced NAD
min	minimum; minute	NADP	NAD phosphate
MINDO	modified INDO (method)	NANA	<i>N</i> -acetylneuraminic acid
MIPK	methyl isopropyl ketone	NAO	natural atomic orbital
MIR	mid infrared	NBO	natural bond orbital
misc	miscible	nbp	normal boiling point
MKS	meter–kilogram–second system	NEDOR	nuclear electron double resonance
MKSA	meter–kilogram–second–ampere system	Neu	neuraminic acid
mL, ml	milliliter	NEXAFS	near-edge x-ray absorption fine structure
MM	molecular mechanics	ng	nanogram
mm	millimeter	NHO	natural hybrid orbital
MMDR	microwave-microwave double resonance	NHOMO	next-to-highest occupied molecular orbital
mmf	magnetomotive force	NICI	negative ion chemical ionization
mmHg	millimeter of mercury	NICS	nuclear independent chemical shift
MNDO	modified neglect of diatomic overlap	NIR	near infrared; ribosylnicotinamide
MO	molecular orbital; methyl orange	nm	nanometer
MODR	microwave-optical double resonance	NMN	β-nicotinamide mononucleotide
mol	mole	NMR	nuclear magnetic resonance
mol.wt.	molecular weight	Nn	nonyl
mon	monomeric form	NNDO	neglect of nonbonded differential overlap
Mops	4-morpholinepropanesulfonic acid	NO	natural orbital
MOS	metal-oxide semiconductor	NOE	nuclear Overhauser effect
MOSFET	metal-oxide semiconductor field-effect transistor	NOEL	no-observed-effect level
mp	melting point	NOx	nitrogen oxides
MPa	megapascal	NP	nitropyrene
MPA	Mulliken population analysis	NPA	natural population analysis
Mpc	megaparsec	NQR	nuclear quadrupole resonance
MPI	multiphoton ionization	NRA	nuclear reaction analysis
MPTP	1,2,3,6-tetrahydro-1-methyl-4-phenylpyridine	ns	nanosecond
MR	methyl red	NSE	neutron spin echo
MRD	multireference double substitution (method)	NTP	normal temperature and pressure
MRI	magnetic resonance imaging	Nu	nucleophile
mRNA	messenger RNA	<i>Nu</i>	Nusselt number
MS	mass spectroscopy	<i>o</i>	<i>ortho</i> (locant on aromatic ring)
ms	millisecond	obs, obsd	observed
MSA	methanesulfonic acid	Oc	octyl
		OD	optical density; outside diameter

ODMR	optically detected magnetic resonance	PIV	particle-image velocimetry
Oe	oersted	PIXE	particle induced x-ray emission
OFGF	outer valence Green's function (method)	pK	negative log of ionization constant
ORD	optical rotatory dispersion	PLM	principle of least motion
Oro	orotate; orotidine	PLOT	porous-layer open-tabular (column)
oz	ounce	PLS	partial least squares
P	poise; peta (SI prefix for 10 <sup>15</sup> ); proline	pm	picometer
<i>P</i>	power; pressure; probability; sound energy flux	PMA	poly(methyl acrylate)
p	proton; pico (SI prefix for 10 <sup>-12</sup> )	PMMA	poly(methyl methacrylate)
<i>p</i>	dielectric polarization; electric dipole moment; momentum; pressure; bond order; <i>para</i> (as aromatic ring locant)	PMO	perturbation MO (theory)
Pa	pascal	PNDO	partial neglect of differential overlap
PA	proton affinity; pyrrolizidine alkaloid	PNO	pair natural orbitals
PABA	<i>p</i> -aminobenzoic acid	PNRA	prompt nuclear reaction analysis
PAC	photoacoustic calorimetry	POAV	$\pi$ -orbital axis vector
PAH	polycyclic aromatic hydrocarbon(s)	pol	polymeric form
PAM	polyacrylamide	POx	phosphorus oxides
PAN	1-(2-pyridylazo)-2-naphthol; polyacrylonitrile	ppb	parts per billion
PAR	4-(2'-pyridylazo)resorcinol	ppm	parts per million
PAS	photoacoustic spectroscopy	PPO	poly(phenylene oxide)
PBA	poly(butyl acrylate)	PPP	Pariser-Parr-Pople (method)
PBB	polybrominated biphenyl	ppt	parts per thousand; precipitate
PBD	poly(1,3-butadiene)	Pr	propyl
PBMA	poly(butyl methacrylate)	<i>Pr</i>	Prandtl number
PBT	poly(butylene terephthalate)	PRDDO	partial retention of diatomic differential overlap
PC	paper chromatography; photocalorimetry	Pro	proline
pc	parsec	PS	photoelectron spectroscopy
PCB	polychlorinated biphenyl	ps	picosecond
PCM	polarizable continuum model	PSD	photon stimulated desorption
PCR	polymerase chain reaction	psi	pounds per square inch
PD	potential difference	psia	pounds per square inch absolute
pdl	poundal	psig	pounds per square inch gage
PDMS	poly(dimethylsiloxane)	PT	perturbation theory
Pe	pentyl	PTFE	poly(tetrafluoroethylene)
<i>Pe</i>	Péclet number	pt	pint
pe	probable error	PTMS	propyltrimethoxysilane
PEA	poly(ethyl acrylate)	Pu	purine
PEG	poly(ethylene glycol)	PVA	poly(vinyl alcohol)
PEL	permissible exposure limit	PVAc	poly(vinyl acetate)
PES	photoelectron spectroscopy; potential energy surface	PVC	poly(vinyl chloride)
PET	positron emission tomography; poly(ethylene terephthalate)	PVD	physical vapor deposition
peth	petroleum ether	PVDF	poly(vinylidene fluoride)
pf	power factor	PVME	poly(methyl vinyl ether)
PFOA	perfluorooctanoic acid	PVT	pressure-volume-temperature
pg	picogram	Py	pyrimidine
Ph	phenyl	PyMS	pyrolysis mass spectrometry
pH	negative log of hydrogen ion concentration	p.z.c.	point of zero charge
Phe	phenylalanine	Q	electric charge; heat; partition function; quadrupole moment; radiant energy; vibrational normal coordinate; glutamine
PhIP	2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine	<i>q</i>	electric field gradient; flow rate; heat; wave vector (phonons)
PHPMS	pulsed high pressure mass spectrometry	QCD	quantum chromodynamics
pI	isoelectric point	QCI	quadratic configuration interaction
PIB	polyisobutylene	QCT	quasi-classical trajectory (method)
PIMS	photoionization mass spectrometry	QED	quantum electrodynamics
PIN	p-intrinsic-n (diode)	Q.E.D.	<i>quod erat demonstrandum</i> (which was to be proved)
Pipes	1,4-piperazinediethanesulfonic acid	QIT	quadrupole ion trap

QMRE	quantum mechanical resonance energy	S	siemens; serine
QMS	quadrupole mass spectrometry	S	area; entropy; probability current density; Poynting vector; symmetry coordinate; spin angular momentum
QSAR	quantitative structure–activity relations	s	second; solid (phase)
QSO	quasi-stellar object	s	path length; spin angular momentum; symmetry number; sedimentation coefficient; solubility; symmetrical (as stereochemical descriptor)
qt	quart	SAED	selected area electron diffraction
quad	quadrillion BTU (=1.055•10 <sup>18</sup> joules)	SALC	symmetry adapted linear combinations
Qui	quinovose	SALI	surface analysis by laser ionization
q.v.	<i>quod vide</i> (which you should see)	SAM	scanning Auger microscopy
R	roentgen; arginine; alkyl radical (in chemical formulas)	SAMS	self-assembled monolayers
°R	degree Rankine	SANS	small angle neutron scattering
R	electrical resistance; gas constant; molar refraction; Rydberg constant; coefficient of multiple correlation	SAR	structure–activity relationship
r	reaction (as in $\Delta_r H$ )	Sar	sarcosine
r	position vector; radius	sat, satd	saturated
RA	right ascension	SAXS	small angle x-ray scattering
rad	radian	Sc	Schmidt number
RAIRS	reflection-absorption infrared spectroscopy	SC	spin-coupled (method)
RAM	random access memory	SCD	state correlation diagram
RBS	Rutherford back scattering	SCE	saturated calomel electrode
Rbu, Rul	ribulose	SCF	self-consistent field (method); supercritical fluid
RCI	ring current index	SCP	single cell protein
RDA	rubidium dihydrogen arsenate	SCR	silicon-controlled rectifier
RDS	rate determining step	SCRf	self-consistent reaction field (method)
Re	real part	sd	standard deviation
RE	resonance energy	SDW	spin density wave
RED	radial electron distribution	SE	strain energy
REELS	reflection electron energy loss spectroscopy	SEC	size exclusion chromatography
REM	reflection electron microscopy	sec	secant; second
rem	roentgen equivalent man	sec	secondary (in chemical name)
REMPI	resonance-enhanced multiphoton ionization	SECSY	spin-echo correlated spectroscopy
REPE	resonance energy per electron	Sed	sedoheptulose
RF	radiofrequency	SEELFS	surface extended energy loss fine structure
RGA	residual gas analyzer	SEM	scanning electron microscopy; standard error of the mean
Rha	rhamnose	sepn	separation
RHEED	reflection high-energy electron diffraction	Ser	serine
RHF	restricted Hartree–Fock (theory)	SERS	surface-enhanced Raman spectroscopy
RI	resonance ionization	SET	single electron transfer
RIA	radioimmunoassay	SEXAF	surface extended x-ray absorption fine structure
Rib	ribose	SFC	supercritical fluid chromatography
Ribulo	ribulose	Sh	Sherwood number
rms	root–mean–square	Shy	thiohypoxanthine
RNA	ribonucleic acid	SI	International System of Units; surface ionization
RNase	ribonuclease	SID	surface-induced dissociation
ROHF	restricted open shell Hartree–Fock	SILAR	successive ionic layer adsorption and reaction
ROM	read only memory	SIM	selected ion monitoring
RPA	random phase approximation	SIMS	secondary-ion spectroscopy
RPH	reaction path Hamiltonian	sin	sine
RPLC	reversed-phase liquid chromatography	sinh	hyperbolic sine
rpm	revolutions per minute	SIPN	semi-interpenetrating polymer network
rps	revolutions per second	SLAM	scanning laser acoustic microscopy
RRK	Rice–Ramsperger–Kassel (theory)	SLUMO	second lowest unoccupied molecular orbital
RRKM	Rice–Ramsperger–Kassel–Marcus (theory)	SMILES	simplified molecular input line entry system
rRNA	ribosomal RNA	SMO	semiempirical molecular orbital
RRS	resonance Raman spectroscopy	SMOW	Standard Mean Ocean Water (Vienna)
RS	Raman spectroscopy		
RSC	reaction-solution calorimetry		
Ry	rydberg		

SNMS	sputtered neutral mass spectroscopy	TEELS	transmission electron energy loss spectroscopy
Sno	thiouridine	TEM	transverse electromagnetic; transmission electron microscope
SNU	solar neutrino unit	temp	temperature
SOJT	second-order Jahn–Teller (effect)	<i>tert</i>	tertiary (in chemical name)
sol	soluble; solution	Tes	2-{{[2-hydroxy-1,1-bis(hydroxymethyl)ethyl]amino}-1-propanesulfonic acid
soln, sln	solution	TFD	Thomas–Fermi–Dirac (method)
SOMO	singly occupied molecular orbital	TGA	thermogravimetric analysis
Sor	sorbose	Thd	ribosylthymine
sp gr	specific gravity	THEED	transmission high energy electron diffraction
SPM	scanned probe microscopy	theor	theoretical
SPST	single-pulse shock tubes	thf, THF	tetrahydrofuran
sq	square	Thr	threonine
<i>Sr</i>	Strouhal number	Thy	thymine
sr	steradian	TI	thermal ionization
Srd	6-thioinosine	TL	thermoluminescence
SSMS	source spark mass spectroscopy	TLC	thin-layer chromatography
St	stoke	TLV	threshold limit value
<i>St</i>	Stanton number	TM	transverse magnetic
std, stnd	standard (state)	TMAB	tetrabutylammonium bromide
STEL	short-term exposure limit	TMS	tetramethylsilane
STEM	scanning transmission electron microscope	TOF	turnover frequency
STM	scanning tunneling microscopy	TOF-MS	time-of-flight mass spectrometer
STO	Slater-type orbital	tol	tolyl
STP	standard temperature and pressure	TON	turnover number
sub, subl	sublimes; sublimation	TOPO	trioctylphosphine oxide
Suc, Sac	sucrose	Torr	torr (pressure unit)
Sur	thiouracil	Tre	trehalose
Sv	sievert	TRE	topological resonance energy
SWIFT	stored waveform inverse Fourier transform	Tricine	<i>N</i> -[2-hydroxy-1,1-bis(hydroxymethyl)ethyl]glycine
T	tesla; tera (SI prefix for 10 <sup>12</sup> ); threonine	Tris	2-amino-2-(hydroxymethyl)-1,3-propanediol
<i>T</i>	kinetic energy; period; term value; temperature (thermodynamic); torque; transmittance	TRMC	time-resolved microwave conductivity
t	metric tonne; triton	tRNA	transfer RNA
<i>t</i>	Celsius temperature; thickness; time; transport number	Trp	tryptophan
TAC	time-to-amplitude converter	trs	transition
TAI	International Atomic Time	TS	transition state
Tal	talose	TSS	transition state spectroscopy
tan	tangent	TST	generalized transition-state theory
tanh	hyperbolic tangent	TTF	tetrathiofulvalene
Taps	3-{{[2-hydroxy-1,1-bis(hydroxymethyl)ethyl]amino}-1-propanesulfonic acid	Tyr	tyrosine
TBE	1,1,2,2-tetrabromoethane	U	uracil (in genetic code)
TBP	tributyl phosphate	<i>U</i>	electric potential difference; internal energy
TC	titration calorimetry	u	unified atomic mass unit
TCA	trichloroacetic acid	<i>u</i>	Bloch function; electric mobility; velocity
TCE	trichloroethylene	ua	astronomical unit (AU is also used)
TCG	Geocentric Coordinated Time	UBFF	Urey–Bradley force field
TCNE	tetracyanoethylene	UDMH	1,1-dimethylhydrazine
TCNQ	tetracyanoquinodimethane	UDP	uridine 5′-diphosphate
TCP	tricresyl phosphate	UHF	ultrahigh frequency; unrestricted Hartree–Fock (method)
TCSCF	two configuration self-consistent field	UMP	uridine 5′-monophosphate
TDI	toluene diisocyanate	<i>uns</i> ,	unsymmetrical (as chemical descriptor)
tDNA	transfer DNA	<i>unsym</i>	
TE	transverse electric	UPS,	ultraviolet photoelectron spectroscopy
TEA	triethanolamine; triethylamine	UPES	
TED	transferred electron device; transmission electron diffraction	Ura	uracil
		Urd	uridine

USP	<i>United States Pharmacopeia</i>	Xyl	xylose
UT	universal time	Y	yotta (SI prefix for 10 <sup>24</sup> ); tyrosine
UTC	coordinated universal time	Y	admittance; Planck function; Young's modulus
UTP	uridine 5'-triphosphate	y	yocto (SI prefix for 10 <sup>-24</sup> )
UV	ultraviolet	y	mole fraction for gas (when <i>x</i> refers to liquid phase)
V	volt; valine	y, yr	year
V	electric potential; potential energy; volume	YAG	yttrium aluminum garnet
<i>v</i>	reaction rate; specific volume; velocity; vibrational quantum number; vicinal (as chemical descriptor)	yd	yard
v/v	volume per volume (volume of solute divided by volume of solution, expressed as percent)	YIG	yttrium iron garnet
Val	valine	Z	zetta (SI prefix for 10 <sup>21</sup> ); glutamine or glutamic acid (unspecified)
vap	vaporization	Z	atomic number; compression factor; collision number; impedance; partition function; zusammen ( <i>cis</i> -configuration)
VAT	vibration assisted tunneling	z	zepto (SI prefix for 10 <sup>-21</sup> )
VB	valence band; valence bond (theory)	z	charge number (of an ion); collision frequency factor
VCD	vibrational circular dichroism	ZDO	zero differential overlap
VDW	van der Waals interaction	ZINDO	Zerner's INDO method
VHF	very high frequency	ZPE, ZPVE	zero point vibrational energy
<i>vic</i>	vicinal (on adjacent carbon atom)	ZULU	Greenwich mean time
VIS	visible region of the spectrum	α	alpha particle
vit	vitreous (phase)	α	absorption coefficient; degree of dissociation; electric polarizability; expansion coefficient; fine structure constant
VLPP	very low pressure pyrolysis	β	beta particle
VOC	volatile organic compound(s)	β	reciprocal temperature parameter (= 1/ <i>kT</i> )
VOFF	valence orbital force field	γ	photon; gamma (obsolete mass unit = μg)
VPC	vapor phase chromatography	γ	activity coefficient; conductivity; magnetogyric ratio; mass concentration; ratio of heat capacities; surface tension
VSEPR	valence shell electron-pair repulsion (method)	Γ	Grüneisen parameter; level width; surface concentration
VSIP	valence state ionization potential	δ	chemical shift; Dirac delta function; Kronecker delta; loss angle
VSLI	very large scale integrated (circuit)	Δ	inertial defect; mass excess
VSMOW	Vienna Standard Mean Ocean Water	ε	emittance; Levi-Civita symbol; linear strain; molar absorption coefficient; permittivity
VUV	vacuum ultraviolet	ζ	Coriolis coupling constant; electrokinetic potential
W	watt; tryptophan	η	overpotential; viscosity
W	radiant energy; statistical weight; work	κ	compressibility; conductivity; magnetic susceptibility; molar absorption coefficient
<i>w</i>	energy density; mass fraction; velocity; work	λ	absolute activity; radioactive decay constant; thermal conductivity; wavelength
w/v	weight per volume (mass of solute divided by volume of solution, usually expressed as g/100 mL)	Λ	angular momentum; ionic conductivity
w/w	weight per weight (mass of solute divided by mass of solution, expressed as percent)	μ	muon; micro (SI prefix for 10 <sup>-6</sup> )
WAXS	wide angle x-ray scattering	μ	chemical potential; electric dipole moment; electric mobility; friction coefficient; Joule-Thompson coefficient; magnetic dipole moment; mobility; permeability
Wb	weber	μF	microfarad
<i>We</i>	Weber number	μg	microgram
WKB	Wentzel-Kramers-Brillouin (approximation)	μm	micrometer
WLF	Williams-Landel-Ferry (equation)	μs	microsecond
WLN	Wisswesser line notation	<i>v</i>	frequency; kinematic velocity; stoichiometric number
wt	weight	<i>v</i> <sub>e</sub>	neutrino
X	X unit; halogen (in chemical formula)	<i>v</i>	wavenumber
<i>X</i>	reactance	π	pion
<i>x</i>	mole fraction	Π	osmotic pressure; Peltier coefficient
X, Xaa	unspecified amino acid	ρ	density; reflectance; resistivity
XAFS	x-ray absorption fine structure		
Xan	xanthine		
XANES	x-ray absorption near-edge structure		
Xao	xanthosine		
Xle	leucine or isoleucine (unspecified)		
Xlu, Xul	xylulose		
XPS, XPES	x-ray photoelectron spectroscopy		
XRD	x-ray diffraction		
XRF	x-ray fluorescence		
XRS	x-ray spectroscopy		



$\sigma$	electrical conductivity; cross section; normal stress; shielding constant (NMR); Stefan–Boltzmann constant; surface tension; standard deviation	$\chi$	magnetic susceptibility
$\tau$	transmittance; chemical shift; shear stress; relaxation time	$\chi_e$	electric susceptibility
$\phi$	electrical potential; fugacity coefficient; osmotic coefficient; quantum yield; wavefunction	$\psi$	wavefunction
$\Phi$	magnetic flux; potential energy; radiant power; work function	$\omega$	circular frequency; angular velocity; harmonic vibration wavenumber; statistical weight
		$\Omega$	ohm
		$\Omega$	axial angular momentum; solid angle

## GREEK, RUSSIAN, AND HEBREW ALPHABETS

The following table presents the Hebrew, Greek, and Russian alphabets, their letters, the names of the letters, and the English equivalents.

	Hebrew <sup>1,3</sup>	Greek <sup>4</sup>	Russian
א	aleph ' 2	Α α alpha a	А а a
ב	beth b, bh	Β β beta b	Б б b
ג	gimel g, gh	Γ γ gamma g, n	В в v
ד	daleth d, dh	Δ δ delta d	Г г g
ה	he h	Ε ε epsilon e	Д д d
ו	waw w	Ζ ζ zeta z	Е е e
ז	zayin z	Η η eta ē	Ж ж zh
ח	heth ḥ	Θ θ theta th	З з z
ט	teth ṭ	Ι ι iota i	И и Й й i, ĭ
י	yodh y	Κ κ kappa k	К к k
כ	kaph k, kh	Λ λ lambda l	Л л l
ל	lamedh l	Μ μ mu m	М м m
מ	mem m	Ν ν nu n	Н н n
נ	nun n	Ξ ξ xi x	О о o
ס	samekh s	Ο ο omicron o	П п p
ש	ayin ʿ	Π π pi p	Р р r
פ	pe p, ph	Ρ ρ rho r, rh	С с s
צ	sadhe ṣ	Σ σ ς sigma s	Т т t
ק	qoph q	Τ τ tau t	У у u
ר	resh r	Υ υ upsilon y, u	Ф ф f
שׁ	sin ś	Φ φ phi ph	Х х kh
שׂ	shin sh	Χ χ chi ch	Ц ц ts
ת	taw t, th	Ψ ψ psi ps	Ч ч ch
		Ω ω omega ō	Ш ш sh
			Щ щ shch
			Ъ ъ <sup>5</sup> ”
			Ы ы y
			Ь ь <sup>6</sup> ’
			Э э e
			Ю ю yu
			Я я ya

<sup>1</sup> Where two forms of a letter are given, the second one is the form used at the end of a word.

<sup>2</sup> Not represented in transliteration when initial.

<sup>3</sup> The Hebrew letters are primarily consonants; a few of them are also used secondarily to represent certain vowels, when provided at all, by means of a system of dots or strokes adjacent to the consonated characters.

<sup>4</sup> The letter gamma is transliterated “n” only before velars; the letter upsilon is transliterated “u” only as the final element in diphthongs.

<sup>5</sup> This sign indicates that the immediately preceding consonant is not palatized even though immediately followed by a palatized vowel.

<sup>6</sup> This sign indicates that the immediately preceding consonant is palatized even though not immediately followed by a palatized vowel.



## DEFINITIONS OF SCIENTIFIC TERMS

Brief definitions of selected terms of importance in chemistry, physics, and related fields of science are given in this section. The selection process emphasizes the following types of terms:

- ◆ Physical quantities
- ◆ Units of measure
- ◆ Classes of chemical compounds and materials
- ◆ Important theories, laws, and basic concepts.

Individual chemical compounds are not included.

Definitions have taken wherever possible from the recommendations of international or national bodies, especially the International Union of Pure and Applied Chemistry (IUPAC) and International Organization for Standardization (ISO). For physical quantities and units, the recommended symbol is also given. The source of such definitions is indicated by the reference number in brackets following the definition. In many cases these official definitions have been edited in the interest of stylistic consistency and economy of space. The user is referred to the original source for further details.

An asterisk (\*) following a term indicates that further information can be found by consulting the index of this handbook under the entry for that term.

**Ab initio method** - An approach to quantum-mechanical calculations on molecules which starts with the Schrödinger equation and carries out a complete integration, without introducing empirical factors derived from experimental measurement.

**Absorbance (A)** - Defined as  $-\log(1-\alpha) = \log(1/\tau)$ , where  $\alpha$  is the absorbance and  $\tau$  the transmittance of a medium through which a light beam passes. [2]

**Absorbed dose (D)** - For any ionizing radiation, the mean energy imparted to an element of irradiated matter divided by the mass of that element. [1]

**Absorbance ( $\alpha$ )** - Ratio of the radiant or luminous flux in a given spectral interval absorbed in a medium to that of the incident radiation. Also called absorption factor. [1]

**Absorption coefficient ( $a$ )** - The relative decrease in the intensity of a collimated beam of electromagnetic radiation, as a result of absorption by a medium, during traversal of an infinitesimal layer of the medium, divided by the length traversed. [1]

**Absorption coefficient, molar ( $\epsilon$ )** - Absorption coefficient divided by amount-of-substance concentration of the absorbing material in the sample solution ( $\epsilon = a/c$ ). The SI unit is  $\text{m}^2/\text{mol}$ . Also called extinction coefficient, but usually in units of  $\text{mol}^{-1}\text{dm}^3\text{cm}^{-1}$ . [2]

**Acceleration** - Rate of change of velocity with respect to time.

**Acceleration due to gravity ( $g$ )\*** - The standard value ( $9.80665 \text{ m/s}^2$ ) of the acceleration experienced by a body in the earth's gravitational field. [1]

**Acenens** - Polycyclic aromatic hydrocarbons consisting of fused benzene rings in a rectilinear arrangement. [5]

**Acid** - Historically, a substance that yields an  $\text{H}^+$  ion when it dissociates in solution, resulting in a  $\text{pH} < 7$ . In the Brønsted definition, an acid is a substance that donates a proton in any type of reaction. The most general definition, due to G.N. Lewis,

classifies any chemical species capable of accepting an electron pair as an acid.

**Acid dissociation constant ( $K_a$ )\*** - The equilibrium constant for the dissociation of an acid HA through the reaction  $\text{HA} + \text{H}_2\text{O} \rightleftharpoons \text{A}^- + \text{H}_3\text{O}^+$ . The quantity  $\text{p}K_a = -\log K_a$  is often used to express the acid dissociation constant.

**Actinides** - The elements of atomic number 89 through 103, e.g., Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr. [7]

**Activation energy\*** - In general, the energy that must be added to a system in order for a process to occur, even though the process may already be thermodynamically possible. In chemical kinetics, the activation energy is the height of the potential barrier separating the products and reactants. It determines the temperature dependence of the reaction rate.

**Activity** - For a mixture of substances, the absolute activity  $\lambda$  of chemical B is defined as  $\lambda_B = \exp(\mu_B/RT)$ , where  $\mu_B$  is the chemical potential of substance B,  $R$  the gas constant, and  $T$  the thermodynamic temperature. The relative activity  $a$  is defined as  $a_B = \exp[(\mu_B - \mu_B^\circ)/RT]$ , where  $\mu_B^\circ$  designates the chemical potential in the standard state. [2]

**Activity coefficient ( $\gamma$ )\*** - Ratio of the activity  $a_B$  of component B of a mixture to the concentration of that component. The value of  $\gamma$  depends on the method of stating the composition. For mole fraction  $x_B$ , the relation is  $a_B = \gamma_B x_B$ ; for molarity  $c_B$ , it is  $a_B = \gamma_B c_B/c^\circ$ , where  $c^\circ$  is the standard state composition (typically chosen as 1 mol/L); for molality  $m_B$ , it is  $a_B = \gamma_B m_B/m^\circ$ , where  $m^\circ$  is the standard state molality (typically 1 mol/kg). [2]

**Activity, of radioactive substance (A)** - The average number of spontaneous nuclear transitions from a particular energy state occurring in an amount of a radionuclide in a small time interval divided by that interval. [1]

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- Acyl groups** - Groups formed by removing the hydroxy groups from oxoacids that have the general structure  $\text{RC}(=\text{O})(\text{OH})$  and replacement analogues of such acyl groups. [5]
- Adiabatic process** - A thermodynamic process in which no heat enters or leaves the system.
- Admittance ( $Y$ )** - Reciprocal of impedance.  $Y = G + iB$ , where  $G$  is conductance and  $B$  is susceptance. [1]
- Adsorption** - A process in which molecules of gas, of dissolved substances in liquids, or of liquids adhere in an extremely thin layer to surfaces of solid bodies with which they are in contact. [10]
- Albedo\*** - The ratio of the light reflected or scattered from a surface to the intensity of incident light. The term is often used in reference to specific types of terrain or to entire planets.
- Alcohols** - Compounds in which a hydroxy group,  $-\text{OH}$ , is attached to a saturated carbon atom. [5]
- Aldehydes** - Compounds  $\text{RC}(=\text{O})\text{H}$ , in which a carbonyl group is bonded to one hydrogen atom and to one R group. [5]
- Aldoses** - Aldehydic parent sugars (polyhydroxyaldehydes  $\text{H}[\text{CH}(\text{OH})]_n\text{C}(=\text{O})\text{H}$ ,  $n > 1$ ) and their intramolecular hemiacetals. [5]
- Aldoximes** - Oximes of aldehydes:  $\text{RCH}=\text{NOH}$ . [5]
- Alfvén number ( $Al$ )** - A dimensionless quantity used in plasma physics, defined by  $Al = v(\rho\mu)^{1/2}/B$ , where  $\rho$  is density,  $v$  is velocity,  $\mu$  is permeability, and  $B$  is magnetic flux density. [2]
- Alfvén waves** - Very low frequency waves which can exist in a plasma in the presence of a uniform magnetic field. Also called magnetohydrodynamic waves.
- Alicyclic compounds** - Aliphatic compounds having a carbocyclic ring structure which may be saturated or unsaturated, but may not be a benzenoid or other aromatic system. [5]
- Aliphatic compounds** - Acyclic or cyclic, saturated or unsaturated carbon compounds, excluding aromatic compounds. [5]
- Alkali metals** - The elements lithium, sodium, potassium, rubidium, cesium, and francium.
- Alkaline earth metals** - The elements calcium, strontium, barium, and radium. [7]
- Alkaloids** - Basic nitrogen compounds (mostly heterocyclic) occurring mostly in the plant kingdom (but not excluding those of animal origin). Amino acids, peptides, proteins, nucleotides, nucleic acids, and amino sugars are not normally regarded as alkaloids. [5]
- Alkanes** - Acyclic branched or unbranched hydrocarbons having the general formula  $\text{C}_n\text{H}_{2n+2}$ , and therefore consisting entirely of hydrogen atoms and saturated carbon atoms. [5]
- Alkenes** - Acyclic branched or unbranched hydrocarbons having one carbon-carbon double bond and the general formula  $\text{C}_n\text{H}_{2n}$ . Acyclic branched or unbranched hydrocarbons having more than one double bond are alkadienes, alkatrienes, etc. [5]
- Alkoxides** - Compounds, ROM, derivatives of alcohols, ROH, in which R is saturated at the site of its attachment to oxygen and M is a metal or other cationic species. [5]
- Alkyl groups** - Univalent groups derived from alkanes by removal of a hydrogen atom from any carbon atom:  $\text{C}_n\text{H}_{2n+1}$ -. The groups derived by removal of a hydrogen atom from a terminal carbon atom of unbranched alkanes form a subclass of normal alkyl ( $n$ -alkyl) groups. The groups  $\text{RCH}_2$ -,  $\text{R}_2\text{CH}$ -, and  $\text{R}_3\text{C}$ - (R not equal to H) are primary, secondary, and tertiary alkyl groups, respectively. [5]
- Alkynes** - Acyclic branched or unbranched hydrocarbons having a carbon-carbon triple bond and the general formula  $\text{C}_n\text{H}_{2n-2}$ .  $\text{RC}\equiv\text{CR}$ -. Acyclic branched or unbranched hydrocarbons having more than one triple bond are known as alkadiynes, alkatriynes, etc. [5]
- Allotropy** - The occurrence of an element in two or more crystalline forms.
- Allylic groups** - The group  $\text{CH}_2=\text{CHCH}_2$ - (allyl) and derivatives formed by substitution. The term 'allylic position' or 'allylic site' refers to the saturated carbon atom. A group, such as  $-\text{OH}$ , attached at an allylic site is sometimes described as "allylic". [5]
- Amagat volume unit** - A non-SI unit previously used in high pressure science. It is defined as the molar volume of a real gas at one atmosphere pressure and 273.15 K. The approximate value is 22.4 L/mol.
- Amides** - Derivatives of oxoacids  $\text{R}(\text{C}=\text{O})(\text{OH})$  in which the hydroxy group has been replaced by an amino or substituted amino group. [5]
- Amine oxides** - Compounds derived from tertiary amines by the attachment of one oxygen atom to the nitrogen atom:  $\text{R}_3\text{N}^+-\text{O}^-$ . By extension the term includes the analogous derivatives of primary and secondary amines. [5]
- Amines** - Compounds formally derived from ammonia by replacing one, two, or three hydrogen atoms by hydrocarbyl groups, and having the general structures  $\text{RNH}_2$  (primary amines),  $\text{R}_2\text{NH}$  (secondary amines),  $\text{R}_3\text{N}$  (tertiary amines). [5]
- Amino acids\*** - Compounds containing both a carboxylic acid group ( $-\text{COOH}$ ) and an amino group ( $-\text{NH}_2$ ). The most important are the  $\alpha$ -amino acids, in which the  $-\text{NH}_2$  group is attached to the C atom adjacent to the  $-\text{COOH}$  group. In the  $\beta$ -amino acids, there is an intervening carbon atom. [4]
- Ampere (A)\*** - The SI base unit of electric current. [1]
- Ampere's law** - The defining equation for the magnetic induction  $B$ , viz.,  $dF = Idl \times B$ , where  $dF$  is the force produced by a current  $I$  flowing in an element of the conductor  $dl$  pointing in the direction of the current.
- Ångström (Å)** - A unit of length used in spectroscopy, crystallography, and molecular structure, equal to  $10^{-10}$  m.
- Angular momentum ( $L$ )** - The angular momentum of a particle about a point is the vector product of the radius vector from this point to the particle and the momentum of the particle; i.e.,  $L = r \times p$ . [1]
- Angular velocity ( $\omega$ )** - The angle through which a body rotates per unit time.
- Anilides** - Compounds derived from oxoacids  $\text{R}(\text{C}=\text{O})(\text{OH})$  by replacing the  $-\text{OH}$  group by the  $-\text{NHPh}$  group or derivative formed by ring substitution. Also used for salts formed by replacement of a nitrogen-bound hydrogen of aniline by a metal. [5]
- Anion** - A negatively charged atomic or molecular particle.
- Antiferroelectricity\*** - An effect analogous to antiferromagnetism in which electric dipoles in a crystal are ordered in two sublattices that are polarized in opposite directions, leading to zero net polarization. The effect vanishes above a critical temperature.
- Antiferromagnetism\*** - A type of magnetism in which the magnetic moments of atoms in a solid are ordered into two antiparallel aligned sublattices. Antiferromagnets are characterized by a zero or small positive magnetic susceptibility. The

susceptibility increases with temperature up to a critical value, the Néel temperature, above which the material becomes paramagnetic.

**Antiparticle** - A particle having the same mass as a given elementary particle and a charge equal in magnitude but opposite in sign.

**Appearance potential\*** - The lowest energy which must be imparted to the parent molecule to cause it to produce a particular specified parent ion. This energy, usually stated in eV, may be imparted by electron impact, photon impact, or in other ways. More properly called appearance energy. [3]

**Appearance potential spectroscopy (APS)** - See Techniques for Materials Characterization, page 12-1.

**Are (a)** - A unit of area equal to 100 m<sup>2</sup>. [1]

**Arenes** - Monocyclic and polycyclic aromatic hydrocarbons. See aromatic compounds. [5]

**Aromatic compounds** - Compounds whose structure includes a cyclic delocalized  $\pi$ -electron system. Historical use of the term implies a ring containing only carbon (e.g., benzene, naphthalene), but it is often generalized to include heterocyclic structures such as pyridine and thiophene. [5]

**Arrhenius equation** - A key equation in chemical kinetics which expresses the rate constant  $k$  as  $k = A \exp(-E_a/RT)$ , where  $E_a$  is the activation energy,  $R$  the molar gas constant, and  $T$  the temperature.  $A$  is called the preexponential factor and, for simple gas phase reactions, may be identified with the collision frequency.

**Arsines** - AsH<sub>3</sub> and compounds derived from it by substituting one, two or three hydrogen atoms by hydrocarbyl groups. RAsH<sub>2</sub>, R<sub>2</sub>AsH, R<sub>3</sub>As (R not equal to H) are called primary, secondary and tertiary arsines, respectively. [5]

**Aryl groups** - Groups derived from arenes by removal of a hydrogen atom from a ring carbon atom. Groups similarly derived from heteroarenes are sometimes subsumed in this definition. [5]

**Astronomical unit (AU)\*** - The mean distance of the earth from the sun, equal to  $1.49597870 \times 10^{11}$  m.

**Atomic absorption spectroscopy (AAS)** - See Techniques for Materials Characterization, page 12-1.

**Atomic emission spectroscopy (AES)** - See Techniques for Materials Characterization, page 12-1.

**Atomic force microscopy (AFM)** - See Techniques for Materials Characterization, page 12-1.

**Atomic mass\*** - The mass of a nuclide, normally expressed in unified atomic mass units (u).

**Atomic mass unit (u)\*** - A unit of mass used in atomic, molecular, and nuclear science, defined as the mass of one atom of <sup>12</sup>C divided by 12. Its approximate value is  $1.66054 \times 10^{-27}$  kg. Also called the unified atomic mass unit. [1]

**Atomic number (Z)** - A characteristic property of an element, equal to the number of protons in the nucleus.

**Atomic weight (A<sub>r</sub>)\*** - The ratio of the average mass per atom of an element to 1/12 of the mass of nuclide <sup>12</sup>C. An atomic weight can be defined for a sample of any given isotopic composition. The standard atomic weight refers to a sample of normal terrestrial isotopic composition. The term relative atomic mass is synonymous with atomic weight. [2]

**Attenuated total reflection (ATR)** - See Techniques for Materials Characterization, page 12-1.

**Auger effect** - An atomic process in which an electron from a higher energy level fills a vacancy in an inner shell, transferring the released energy to another electron which is ejected.

**Aurora** - An atmospheric phenomenon in which streamers of light are produced when electrons from the sun are guided into the thermosphere by the earth's magnetic field. It occurs in the polar regions at altitudes of 95—300 km.

**Avogadro constant (N<sub>A</sub>)\*** - The number of elementary entities in one mole of a substance.

**Azeotrope** - A liquid mixture in a state where the variation of vapor pressure with composition at constant temperature (or, alternatively, the variation of normal boiling point with composition) shows either a maximum or a minimum. Thus when an azeotrope boils the vapor has the same composition as the liquid.

**Azides** - Compounds bearing the group -N<sub>3</sub>, viz. -N=N<sup>+</sup>=N<sup>-</sup>; usually attached to carbon, e.g. PhN<sub>3</sub>, phenyl azide or azidobenzene. Also used for salts of hydrazoic acid, HN<sub>3</sub>, e.g. NaN<sub>3</sub>, sodium azide. [5]

**Azines** - Condensation products, R<sub>2</sub>C=NN=CR<sub>2</sub>, of two moles of a carbonyl compound with one mole of hydrazine. [5]

**Azo compounds** - Derivatives of diazene (diimide), HN=NH, wherein both hydrogens are substituted by hydrocarbyl groups, e.g., PhN=NPh, azobenzene or diphenyldiazene. [5]

**Balmer series** - The series of lines in the spectrum of the hydrogen atom which corresponds to transitions between the state with principal quantum number  $n = 2$  and successive higher states. The wavelengths are given by  $1/\lambda = R_H(1/4 - 1/n^2)$ , where  $n = 3, 4, \dots$  and  $R_H$  is the Rydberg constant for hydrogen. The first member of the series ( $n = 2 \rightleftharpoons 3$ ), which is often called the H $\alpha$  line, falls at a wavelength of 6563 Å.

**Bar (bar)** - A unit of pressure equal to 10<sup>5</sup> Pa.

**Bardeen-Cooper-Schrieffer (BCS) theory** - A theory of superconductivity which is based upon the formation of electron pairs as a result of an electron-lattice interaction. The theory relates the superconducting transition temperature to the density of states and the Debye temperature.

**Barn (b)** - A unit used for expressing cross sections of nuclear processes, equal to 10<sup>-28</sup> m<sup>2</sup>.

**Barrel** - A unit of volume equal to 158.9873 L.

**Baryon** - Any elementary particle built up from three quarks. Examples are the proton, neutron, and various short-lived hyperons. Baryons have odd half-integer spins.

**Base** - Historically, a substance that yields an OH<sup>-</sup> ion when it dissociates in solution, resulting in a pH > 7. In the Brønsted definition, a base is a substance capable of accepting a proton in any type of reaction. The more general definition, due to G.N. Lewis, classifies any chemical species capable of donating an electron pair as a base.

**Becquerel (Bq)\*** - The SI unit of radioactivity (disintegrations per unit time), equal to s<sup>-1</sup>. [1]

**Beer's law** - An approximate expression for the change in intensity of a light beam that passes through an absorbing medium, viz.,  $\log(I/I_0) = -\epsilon cl$ , where  $I_0$  is the incident intensity,  $I$  is the final intensity,  $\epsilon$  is the molar (decadic) absorption coefficient,  $c$  is the molar concentration of the absorbing substance, and  $l$  is the path length. Also called the Beer-Lambert law

**Binding energy\*** - A generic term for the energy required to decompose a system into two or more of its constituent parts. In nuclear physics, the binding energy is the energy differ-



ence between a nucleus and the separated nucleons of which it is composed (the energy equivalent of the mass defect). In atomic physics, it is the energy required to remove an electron from an atom.

**Biot (Bi)** - A name sometimes used for the unit of current in the emu system.

**Birefringence** - A property of certain crystals in which two refracted rays result from a single incident light ray. One, the ordinary ray, follows the normal laws of refraction, while the other, the extraordinary ray, exhibits a variable refractive index which depends on the direction in the crystal.

**Black body radiation\*** - The radiation emitted by a perfect black body, i.e., a body which absorbs all radiation incident on it and reflects none. The wavelength dependence of the radiated energy density  $\rho$  (energy per unit volume per unit wavelength range) is given by the Planck formula

$$\rho = \frac{8\pi hc}{\lambda^5 (e^{hc/\lambda kT} - 1)}$$

where  $\lambda$  is the wavelength,  $h$  is Planck's constant,  $c$  is the speed of light,  $k$  is the Boltzmann constant, and  $T$  is the temperature.

**Black hole** - A very dense object, formed in a supernova explosion, whose gravitational field is so large that no matter or radiation can escape from the object.

**Bloch wave function** - A solution of the Schrödinger equation for an electron moving in a spatially periodic potential; used in the band theory of solids.

**Bohr magneton ( $\mu_B$ )\*** - The atomic unit of magnetic moment, defined as  $eh/4\pi m_e$ , where  $h$  is Planck's constant,  $m_e$  the electron mass, and  $e$  the elementary charge. It is the moment associated with a single electron spin.

**Bohr, bohr radius ( $a_0$ )\*** - The radius of the lowest orbit in the Bohr model of the hydrogen atom, defined as  $\epsilon_0 h^2 / \pi m_e e^2$ , where  $\epsilon_0$  is the permittivity of a vacuum,  $h$  is Planck's constant,  $m_e$  the electron mass, and  $e$  the elementary charge. It is customarily taken as the unit of length when using atomic units.

**Boiling point** - The temperature at which the liquid and gas phases of a substance are in equilibrium at a specified pressure. The normal boiling point is the boiling point at normal atmospheric pressure (101.325 kPa).

**Boltzmann constant ( $k$ )\*** - The molar gas constant  $R$  divided by Avogadro's constant.

**Boltzmann distribution** - An expression for the equilibrium distribution of molecules as a function of their energy, in which the number of molecules in a state of energy  $E$  is proportional to  $\exp(-E/kT)$ , where  $k$  is the Boltzmann constant and  $T$  is the temperature.

**Bond strength** - See Dissociation energy.

**Born-Haber cycle\*** - A thermodynamic cycle in which a crystalline solid is converted to gaseous ions and then reconverted to the solid. The cycle permits calculation of the lattice energy of the crystal.

**Bose-Einstein distribution** - A modification of the Boltzmann distribution which applies to a system of particles that are bosons. The number of particles of energy  $E$  is proportional to  $[e^{(E-\mu)/kT} - 1]^{-1}$ , where  $\mu$  is a normalization constant,  $k$  is the Boltzmann constant, and  $T$  is the temperature.

**Boson** - A particle that obeys Bose-Einstein Statistics; specifically, any particle with spin equal to zero or an integer. This includes

the photon, pion, deuteron, and all nuclei of even mass number.

**Boyle's law** - The empirical law, exact only for an ideal gas, which states that the volume of a gas is inversely proportional to its pressure at constant temperature.

**Bragg angle ( $\theta$ )** - Defined by the equation  $n\lambda = 2d\sin\theta$ , which relates the angle  $\theta$  between a crystal plane and the diffracted x-ray beam, the wavelength  $\lambda$  of the x-rays, the crystal plane spacing  $d$ , and the diffraction order  $n$  (any integer).

**Bravais lattices\*** - The 14 distinct crystal lattices that can exist in three dimensions. They include three in the cubic crystal system, two in the tetragonal, four in the orthorhombic, two in the monoclinic, and one each in the triclinic, hexagonal, and trigonal systems.

**Breakdown voltage** - The potential difference at which an insulating substance undergoes a physical or chemical change that causes it to become a conductor, thus allowing current to flow through the sample.

**Bremsstrahlung** - Electromagnetic radiation generated when the velocity of a charged particle is reduced (literally, "braking radiation"). An example is the x-ray continuum resulting from collisions of electrons with the target in an x-ray tube.

**Brewster angle** - The angle of incidence for which the maximum degree of plane polarization occurs when a beam of unpolarized light is incident on the surface of a medium of refractive index  $n$ . At this angle, the angle between the reflected and refracted beams is  $90^\circ$ . The value of the Brewster angle is  $\tan^{-1}n$ .

**Brillouin scattering** - The scattering of light by acoustic phonons in a solid or liquid.

**Brillouin zone** - A region of allowed wave vectors and energy levels in a crystalline solid, which plays a part in the propagation of waves through the lattice.

**British thermal unit (Btu)** - A non-SI unit of energy, equal to approximately 1055 J. Several values of the Btu, defined in slightly different ways, have been used.

**Brownian motion** - The random movements of small particles suspended in a fluid, which arise from collisions with the fluid molecules.

**Brunauer-Emmett-Teller method (BET)** - See Techniques for Materials Characterization, page 12-1.

**Buffer\*** - A solution designed to maintain a constant pH when small amounts of a strong acid or base are added. Buffers usually consist of a fairly weak acid and its salt with a strong base. Suitable concentrations are chosen so that the pH of the solution remains close to the  $pK_a$  of the weak acid.

**Calorie (cal)** - A non-SI unit of energy, originally defined as the heat required to raise the temperature of 1 g of water by  $1^\circ\text{C}$ . Several calories of slightly different values have been used. The thermochemical calorie is now defined as 4.184 J.

**Candela (cd)\*** - The SI base unit of luminous intensity. [1]

**Capacitance (C)** - Ratio of the charge acquired by a body to the change in potential. [1]

**Carbamates** - Salts or esters of carbamic acid,  $\text{H}_2\text{NC}(=\text{O})\text{OH}$ , or of N-substituted carbamic acids:  $\text{R}_2\text{NC}(=\text{O})\text{OR}'$ , ( $\text{R}' = \text{hydrocarbyl}$  or a cation). The esters are often called urethanes or urethans, a usage that is strictly correct only for the ethyl esters. [5]

**Carbenes** - The electrically neutral species  $\text{H}_2\text{C}$ : and its derivatives, in which the carbon is covalently bonded to two univa-

lent groups of any kind or a divalent group and bears two non-bonding electrons, which may be spin-paired (singlet state) or spin-non-paired (triplet state). [5]

**Carbinols** - An obsolete term for substituted methanols, in which the name carbinol is synonymous with methanol. [5]

**Carbohydrates** - Originally, compounds such as aldoses and ketoses, having the stoichiometric formula  $C_n(H_2O)_n$  (hence "hydrates of carbon"). The generic term carbohydrate now includes mono-, oligo-, and polysaccharides, as well as their reaction products and derivatives. [5]

**Carboranes** - A contraction of carboranes. Compounds in which a boron atom in a polyboron hydride is replaced by a carbon atom with maintenance of the skeletal structure. [5]

**Carboxylic acids** - Oxoacids having the structure  $RC(=O)OH$ . The term is used as a suffix in systematic name formation to denote the  $-C(=O)OH$  group including its carbon atom. [5]

**Carnot cycle** - A sequence of reversible changes in a heat engine using a perfect gas as the working substance, which is used to demonstrate that entropy is a state function. The Carnot cycle also provides a means to calculate the efficiency of a heat engine.

**Catalyst** - A substance that participates in a particular chemical reaction and thereby increases its rate but without a net change in the amount of that substance in the system. [3]

**Catenanes, catena compounds** - Hydrocarbons having two or more rings connected in the manner of links of a chain, without a covalent bond. More generally, the class catena compounds embraces functional derivatives and hetero analogues. [5]

**Cation** - A positively charged atomic or molecular particle.

**Centipoise (cP)** - A common non-SI unit of viscosity, equal to mPa s.

**Centrifugal distortion** - An effect in molecular spectroscopy in which rotational levels are lowered in energy, relative to the values of a rigid rotor, as the rotational angular momentum increases. The effect may be understood classically as a stretching of the bonds in the molecule as it rotates faster, thus increasing the moment of inertia.

**Ceramic** - A nonmetallic material of very high melting point.

**Cerenkov radiation** - Light emitted when a beam of charged particles travels through a medium at a speed greater than the speed of light in the medium. It is typically blue in color.

**Cgs system of units** - A system of units based upon the centimeter, gram, and second. The cgs system has been supplanted by the International System (SI).

**Chalcogens** - The Group VIA elements (oxygen, sulfur, selenium, tellurium, and polonium). Compounds of these elements are called chalcogenides. [7]

**Chaotic system** - A complex system whose behavior is governed by deterministic laws but whose evolution can vary drastically when small changes are made in the initial conditions.

**Charge** - See Electric charge.

**Charles' law** - The empirical law, exact only for an ideal gas, which states that the volume of a gas is directly proportional to its temperature at constant pressure.

**Charm** - A quantum number introduced in particle physics to account for certain properties of elementary particles and their reactions.

**Chelate** - A compound characterized by the presence of bonds from two or more bonding sites within the same ligand to a central metal atom. [3]

**Chemical potential** - For a mixture of substances, the chemical potential of constituent B is defined as the partial derivative of the Gibbs energy  $G$  with respect to the amount (number of moles) of B, with temperature, pressure, and amounts of all other constituents held constant. Also called partial molar Gibbs energy. [2]

**Chemical shift\*** - A small change in the energy levels (and hence in the spectra associated with these levels) resulting from the effects of chemical binding in a molecule. The term is used in fields such as NMR, Mössbauer, and photoelectron spectroscopy, where the energy levels are determined primarily by nuclear or atomic effects.

**Chiral molecule** - A molecule which cannot be superimposed on its mirror image. A common example is an organic molecule containing a carbon atom to which four different atoms or groups are attached. Such molecules exhibit optical activity, i.e., they rotate the plane of a polarized light beam.

**Chlorocarbons** - Compounds consisting solely of chlorine and carbon. [5]

**Chromatography\*** - A method for separation of the components of a sample in which the components are distributed between two phases, one of which is stationary while the other moves. In gas chromatography the gas moves over a liquid or solid stationary phase. In liquid chromatography the liquid mixture moves through another liquid, a solid, or a gel. The mechanism of separation of components may be adsorption, differential solubility, ion-exchange, permeation, or other mechanisms. [6]

**Clapeyron equation** - A relation between pressure and temperature of two phases of a pure substance that are in equilibrium, viz.,  $dp/dT = \Delta_{\text{trs}} S / \Delta_{\text{trs}} V$ , where  $\Delta_{\text{trs}} S$  is the difference in entropy between the phases and  $\Delta_{\text{trs}} V$  the corresponding difference in volume.

**Clathrates** - Inclusion compounds in which the guest molecule is in a cage formed by the host molecule or by a lattice of host molecules. [5]

**Clausius (Cl)** - A non-SI unit of entropy or heat capacity defined as cal/K = 4.184 J/K. [2]

**Clausius-Clapeyron equation** - An approximation to the Clapeyron equation applicable to liquid-gas and solid-gas equilibrium, in which one assumes an ideal gas with volume much greater than the condensed phase volume. For the liquid-gas case, it takes the form  $d(\ln p)/dT = \Delta_{\text{vap}} H / RT^2$ , where  $R$  is the molar gas constant and  $\Delta_{\text{vap}} H$  is the molar enthalpy of vaporization. For the solid-gas case,  $\Delta_{\text{vap}} H$  is replaced by the molar enthalpy of sublimation,  $\Delta_{\text{sub}} H$ .

**Clausius-Mosotti equation** - A relation between the dielectric constant  $\epsilon_r$  at optical frequencies and the polarizability  $\alpha$ :

$$\frac{\epsilon_r - 1}{\epsilon_r + 2} = \frac{\rho N_A \alpha}{3M\epsilon_0}$$

where  $\rho$  is density,  $N_A$  is Avogadro's number,  $M$  is molar mass, and  $\epsilon_0$  is the permittivity of a vacuum.

**Clebsch-Gordon coefficients** - A set of coefficients used to describe the vector coupling of angular momenta in atomic and nuclear physics.

**Codon** - A set of three bases, chosen from the four primary bases found in the DNA molecule (uracil, cytosine, adenine, and guanine), which specifies the production of a particular amino

acid or carries some other genetic instruction. For example, the codon UCA specifies the amino acid serine, CAG specifies glutamine, etc. There are a total of 64 codons.

**Coercive force** - The magnetizing force at which the magnetic flux density is equal to zero. [10]

**Coercivity\*** - The maximum value of coercive force that can be attained when a magnetic material is symmetrically magnetized to saturation induction. [10]

**Coherent anti-Stokes Raman spectroscopy (CARS)** - See Techniques for Materials Characterization, page 12-1.

**Colloid** - Molecules or polymolecular particles dispersed in a medium that have, at least in one direction, a dimension roughly between 1 nm and 1  $\mu$ m. [3]

**Color center** - A defect in a crystal that gives rise to optical absorption, thus changing the color of the material. A common type is the F-center, which results when an electron occupies the site of a negative ion.

**Compressibility ( $\kappa$ )\*** - The fractional change of volume as pressure is increased, viz.,  $\kappa = -(1/V)(dV/dp)$ . [1]

**Compton wavelength ( $\lambda_c$ )\*** - In the scattering of electromagnetic radiation by a free particle (e.g., electron, proton),  $\lambda_c = h/mc$  is the increase in wavelength, at a 90° scattering angle, corresponding to the transfer of energy from radiation to particle. Here  $h$  is Planck's constant,  $c$  the speed of light, and  $m$  the mass of the particle.

**Conductance ( $G$ )\*** - For direct current, the reciprocal of resistance. More generally, the real part of admittance. [1]

**Conductivity, electrical ( $\sigma$ )\*** - The reciprocal of the resistivity. [1]

**Conductivity, thermal** - See Thermal conductivity.

**Congruent transformation** - A phase transition (melting, vaporization, etc.) in which the substance preserves its exact chemical composition.

**Constitutional repeating unit (CRU)** - In polymer science, the smallest constitutional unit, the repetition of which constitutes a regular macromolecule, i.e., a macromolecule with all units connected identically with respect to directional sense. [8]

**Copolymer** - A polymer derived from more than one species of monomer. [8]

**Coriolis effect** - The deviation from simple trajectories when a mechanical system is described in a rotating coordinate system. It affects the motion of projectiles on the earth and in molecular spectroscopy leads to an important interaction between the rotational and vibrational motions. The effect may be described by an additional term in the equations of motion, called the Coriolis force.

**Cosmic rays\*** - High energy nuclear particles, electrons, and photons, originating mostly outside the solar system, which continually bombard the earth's atmosphere.

**Coulomb (C)\*** - The SI unit of electric charge, equal to A s. [1]

**Coulomb's law** - The statement that the force  $F$  between two electrical charges  $q_1$  and  $q_2$  separated by a distance  $r$  is  $F = (4\pi\epsilon_0)^{-1} q_1 q_2 / r^2$ , where  $\epsilon_0$  is the permittivity of a vacuum.

**Covalent bond** - A chemical bond between two atoms whose stability results from the sharing of two electrons, one from each atom.

**Cowling number (Co)** - A dimensionless quantity used in plasma physics, defined by  $Co = B^2 / \mu \rho v^2$ , where  $\rho$  is density,  $v$  is velocity,  $\mu$  is permeability, and  $B$  is magnetic flux density. [2]

**CPT theorem** - A theorem in particle physics which states that any local Lagrangian theory that is invariant under proper

Lorentz transformations is also invariant under the combined operations of charge conjugation, C, space inversion, P, and time reversal, T, taken in any order.

**Critical point\*** - In general, the point on the phase diagram of a two-phase system at which the two coexisting phases have identical properties and therefore represent a single phase. At the liquid-gas critical point of a pure substance, the distinction between liquid and gas vanishes, and the vapor pressure curve ends. The coordinates of this point are called the critical temperature and critical pressure. Above the critical temperature, it is not possible to liquefy the substance.

**Cross section ( $\sigma$ )\*** - A measure of the probability of collision (or other interaction) between a beam of particles and a target which it encounters. In rough terms it is the effective area the target particles present to the incident ones; however, the precise definition depends on the nature of the interaction. A general definition of  $\sigma$  is the number of encounters per unit time divided by  $n\nu$ , where  $n$  is the concentration of incident particles and  $\nu$  their velocity.

**Crosslink** - In polymer science, a small region in a macromolecule from which at least four chains emanate, and formed by reactions involving sites or groups on existing macromolecules or by interactions between existing macromolecules. [8]

**Crown compounds** - Macrocyclic polydentate compounds, usually uncharged, in which three or more coordinating ring atoms (usually oxygen or nitrogen) are or may become suitably close for easy formation of chelate complexes with metal ions or other cationic species. [5]

**Crust\*** - The outer layer of the solid earth, above the Mohorovicic discontinuity. Its thickness averages about 35 km on the continents and about 7 km below the ocean floor.

**Cryoscopic constant ( $E_f$ )\*** - The constant that expresses the amount by which the freezing point  $T_f$  of a solvent is lowered by a non-dissociating solute, through the relation  $\Delta T_f = E_f m$ , where  $m$  is the molality of the solute.

**Curie (Ci)** - A non-SI unit of radioactivity (disintegrations per unit time), equal to  $3.7 \times 10^{10} \text{ s}^{-1}$ .

**Curie temperature ( $T_c$ )\*** - For a ferromagnetic material, the critical temperature above which the material becomes paramagnetic. Also applied to the temperature at which the spontaneous polarization disappears in a ferroelectric solid. [1]

**Cyanohydrins** - Alcohols substituted by a cyano group, most commonly, but not limited to, examples having a CN and an OH group attached to the same carbon atom. They are formally derived from aldehydes or ketones by the addition of hydrogen cyanide. [5]

**Cycloalkanes** - Saturated monocyclic hydrocarbons (with or without side chains). See alicyclic compounds. Unsaturated monocyclic hydrocarbons having one endocyclic double or one triple bond are called cycloalkenes and cycloalkynes, respectively. [5]

**Cyclotron resonance** - The resonant absorption of energy from a system in which electrons or ions that are orbiting in a uniform magnetic field are subjected to radiofrequency or microwave radiation. The resonance frequency is given by  $\nu = eH/2\pi m^* c$ , where  $e$  is the elementary charge,  $H$  is the magnetic field strength,  $m^*$  is the effective mass of the charged particle, and  $c$  is the speed of light. The effect occurs in both solids (involving electrons or holes) and in low pressure gases (involving ions)



**Dalton (Da)** - A name sometimes used in biochemistry for the unified atomic mass unit (u).

**De Broglie wavelength** - The wavelength associated with the wave representation of a moving particle, given by  $h/mv$ , where  $h$  is Planck's constant,  $m$  the particle mass, and  $v$  the velocity.

**De Haas-Van Alphen effect** - An effect observed in certain metals and semiconductors at low temperatures and high magnetic fields, characterized by a periodic variation of magnetic susceptibility with field strength.

**Debye equation\*** - The relation between the relative permittivity (dielectric constant)  $\epsilon_r$ , polarizability  $\alpha$ , and permanent dipole moment  $\mu$  in a dielectric material whose molecules are free to rotate. It takes the form

$$\frac{\epsilon_r - 1}{\epsilon_r + 2} = \frac{\rho N_A}{3M\epsilon_0} \left( \alpha + \frac{\mu^2}{3kT} \right)$$

where  $\rho$  is density,  $N_A$  is Avogadro's number,  $M$  is molar mass, and  $\epsilon_0$  is the permittivity of a vacuum.

**Debye length** - In the Debye-Hückel theory of ionic solutions, the effective thickness of the cloud of ions of opposite charge which surrounds each given ion and shields the Coulomb potential produced by that ion.

**Debye temperature ( $\theta_D$ )\*** - In the Debye model of the heat capacity of a crystalline solid,  $\theta_D = hv_D/k$ , where  $h$  is Planck's constant,  $k$  is the Boltzmann constant, and  $v_D$  is the maximum vibrational frequency the crystal can support. For  $T \ll \theta_D$ , the heat capacity is proportional to  $T^3$ .

**Debye unit (D)** - A non-SI unit of electric dipole moment used in molecular physics, equal to  $3.335641 \times 10^{-30}$  C m.

**Debye-Waller factor (D)** - The factor by which the intensity of a diffraction line is reduced because of lattice vibrations. [1]

**Defect** - Any departure from the regular structure of a crystal lattice. A Frenkel defect results when an atom or ion moves to an interstitial position and leaves behind a vacancy. A Schottky defect involves either a vacancy where the atom has moved to the surface or a structure where a surface atom has moved to an interstitial position.

**Degree of polymerization** - The number of monomeric units in a macromolecule or an oligomer molecule. [8]

**Dendrite** - A tree-like crystalline pattern often observed, for example, in ice crystals and alloys in which the crystal growth branches repeatedly.

**Density ( $\rho$ )\*** - In the most common usage, mass density or mass per unit volume. More generally, the amount of some quantity (mass, charge, energy, etc.) divided by a length, area, or volume.

**Density of states ( $N_E, \rho$ )** - The number of one-electron states in an infinitesimal interval of energy, divided by the range of that interval and by volume. [1]

**Dew point\*** - The temperature at which liquid begins to condense as the temperature of a gas mixture is lowered. In meteorology, it is the temperature at which moisture begins to condense on a surface in contact with the air.

**Diamagnetism** - A type of magnetism characterized by a negative magnetic susceptibility, so that the material, when placed in an external magnetic field, becomes weakly magnetized in the direction opposite to the field. This magnetization is independent of temperature.

**Diazo compounds** - Compounds having the divalent diazo group,  $=N^+=N^-$ , attached to a carbon atom, e.g.,  $CH_2=N_2$  diazomethane. [5]

**Dielectric constant ( $\epsilon$ )\*** - Ratio of the electric displacement in a medium to the electric field strength. Also called permittivity. [1]

**Dienes** - Compounds that contain two fixed double bonds (usually assumed to be between carbon atoms). Dienes in which the two double-bond units are linked by one single bond are termed conjugated. [5]

**Differential scanning calorimetry (DSC)** - See Techniques for Materials Characterization, page 12-1.

**Differential thermal analysis (DTA)** - See Techniques for Materials Characterization, page 12-1.

**Diffusion\*** - The migration of atoms, molecules, ions, or other particles as a result of some type of gradient (concentration, temperature, etc.).

**Dioptr** - A unit used in optics, formally equal to  $m^{-1}$ . It is used in expressing dioptric power, which is the reciprocal of the focal length of a lens.

**Dipole moment, electric ( $p, \mu$ )\*** - For a distribution of equal positive and negative charge, the magnitude of the dipole moment vector is the positive charge multiplied by the distance between the centers of positive and negative charge distribution. The direction is given by the line from the center of negative charge to the center of positive charge.

**Dipole moment, magnetic ( $m, \mu$ )** - Formally defined in electromagnetic theory as a vector quantity whose vector product with the magnetic flux density equals the torque. The magnetic dipole generated by a current  $I$  flowing in a small loop of area  $A$  has a magnetic moment of magnitude  $IA$ . In atomic and nuclear physics, a magnetic moment is associated with the angular momentum of a particle; e.g., an electron with orbital angular momentum  $l$  exhibits a magnetic moment of  $-el/2m_e$  where  $e$  is the elementary charge and  $m_e$  the mass of the electron. [1]

**Disaccharides** - Compounds in which two monosaccharides are joined by a glycosidic bond. [5]

**Dislocation** - An extended displacement of a crystal from a regular lattice. An edge dislocation results when one portion of the crystal has partially slipped with respect to the other, resulting in an extra plane of atoms extending through part of the crystal. A screw dislocation transforms successive atomic planes into the surface of a helix.

**Dispersion** - Splitting of a beam of light (or other electromagnetic radiation) of mixed wavelengths into the constituent wavelengths as a result of the variation of refractive index of the medium with wavelength.

**Dissociation constant\*** - The equilibrium constant for a chemical reaction in which a compound dissociates into its constituent parts.

**Dissociation energy ( $D_0$ )\*** - For a diatomic molecule, the difference between the energies of the free atoms at rest and the minimum in the potential energy curve. The term bond dissociation energy ( $D_0$ ), which can be applied to polyatomic molecules as well, is used for the difference between the energies of the fragments resulting when a bond is broken and the energy of the original molecule in its lowest energy state. The term bond strength implies differences in enthalpy rather than energy.

- Domain** - A small region of a solid in which the magnetic or electric moments of the individual units (atoms, molecules, or ions) are aligned in the same direction.
- Domain wall** - The transition region between adjacent ferromagnetic domains, generally a layer with a thickness of a few hundred ångström units. Also called Bloch wall.
- Doppler effect** - The change in the apparent frequency of a wave (sound, light, or other) when the source of the wave is moving relative to the observer.
- Dose equivalent ( $H$ )** - The product of the absorbed dose of radiation at a point of interest in tissue and various modifying factors which depend on the type of tissue and radiation. [1]
- Drift velocity** - The velocity of charge carriers (electrons, ions, etc.) moving under the influence of an electric field in a medium which subjects the carriers to some frictional force.
- Dyne (dyn)** - A non-SI (cgs) unit of force, equal to  $10^{-5}$  N.
- Ebullioscopic constant ( $E_b$ )\*** - The constant that expresses the amount by which the boiling point  $T_b$  of a solvent is raised by a non-dissociating solute, through the relation  $\Delta T_b = E_b m$ , where  $m$  is the molality of the solute.
- Eddy currents** - Circulating currents set up in conducting bulk materials or sheets by varying magnetic fields.
- Effinghausen effect** - The appearance of a temperature gradient in a current carrying conductor that is placed in a transverse magnetic field. The direction of the gradient is perpendicular to the current and the field.
- Eigenvalue** - An allowed value of the constant  $a$  in the equation  $Au = au$ , where  $A$  is an operator acting on a function  $u$  (which is called an eigenfunction). In quantum mechanics, the outcome of any observation is an eigenvalue of the corresponding operator. Also called characteristic value.
- Einstein** - A non-SI unit used in photochemistry, equal to one mole of photons.
- Einstein temperature ( $\theta_v$ )** - In the Einstein theory of the heat capacity of a crystalline solid,  $\theta_v = hv/k$ , where  $h$  is Planck's constant,  $k$  is the Boltzmann constant, and  $v$  is the vibrational frequency of the crystal.
- Einstein transition probability** - A constant in the Einstein relation  $A_{ij} + B_{ij}\rho$  for the probability of a transition between two energy levels  $i$  and  $j$  in a radiation field of energy density  $\rho$ . The  $A_{ij}$  coefficient describes the probability of spontaneous emission, while  $B_{ij}$  and  $B_{ji}$  govern the probability of stimulated emission and absorption, respectively ( $B_{ij} = B_{ji}$ ).
- Elastic limit** - The greatest stress which a material is capable of sustaining without any permanent strain remaining after complete release of the stress. [10]
- Elastic modulus** - See Young's modulus.
- Electric charge ( $Q$ )** - The quantity of electricity; i.e., the property that controls interactions between bodies through electrical forces.
- Electric current ( $I$ )** - The charge passing through a circuit per unit time. [1]
- Electric displacement ( $D$ )** - A vector quantity whose magnitude equals the electric field strength multiplied by the permittivity of the medium and whose direction is the same as that of the field strength.
- Electric field strength ( $E$ )** - The force exerted by an electric field on a point charge divided by the electric charge. [1]
- Electric potential ( $V$ )** - A scalar quantity whose gradient is equal to the negative of the electric field strength.
- Electrical conductance** - See Conductance.
- Electrical resistance** - See Resistance.
- Electrical resistivity** - See Resistivity.
- Electrochemical series\*** - An arrangement of reactions which produce or consume electrons in an order based on standard electrode potentials. A common arrangement places metals in decreasing order of their tendency to give up electrons.
- Electrode potential\*** - The electromotive force of a cell in which the electrode on the left is the standard hydrogen electrode and that on the right is the electrode in question. [2]
- Electrolysis** - The decomposition of a substance as a result of passing an electric current between two electrodes immersed in the sample.
- Electromotive force (emf)** - The energy supplied by a source divided by the charge transported through the source. [1]
- Electron\*** - An elementary particle in the family of leptons, with negative charge and spin of  $1/2$ .
- Electron affinity\*** - The energy difference between the ground state of a gas-phase atom or molecule and the lowest state of the corresponding negative ion.
- Electron cyclotron resonance (ECR)** - See Techniques for Materials Characterization, page 12-1.
- Electron energy loss spectroscopy (EELS)** - See Techniques for Materials Characterization, page 12-1.
- Electron nuclear double resonance (ENDOR)** - See Techniques for Materials Characterization, page 12-1.
- Electron paramagnetic resonance (EPR)** - See Techniques for Materials Characterization, page 12-1.
- Electron probe microanalysis (EPMA)** - See Techniques for Materials Characterization, page 12-1.
- Electron spectroscopy for chemical analysis (ESCA)** - See Techniques for Materials Characterization, page 12-1.
- Electron spin ( $s$ )** - The quantum number, equal to  $1/2$ , that specifies the intrinsic angular momentum of the electron.
- Electron stimulated desorption (ESD)** - See Techniques for Materials Characterization, page 12-1.
- Electron volt (eV)\*** - A non-SI unit of energy used in atomic and nuclear physics, equal to approximately  $1.602177 \times 10^{-19}$  J. The electron volt is defined as the kinetic energy acquired by an electron upon acceleration through a potential difference of 1 V. [1]
- Electronegativity\*** - A parameter originally introduced by Pauling which describes, on a relative basis, the power of an atom or group of atoms to attract electrons from the same molecular entity. [3]
- Electrophoresis** - The motion of macromolecules or colloidal particles in an electric field. [3]
- Emissivity ( $\epsilon$ )\*** - Ratio of the radiant flux emitted per unit area to that of an ideal black body at the same temperature. Also called emittance. [1]
- Emu** - The electromagnetic system of units, based upon the cm, g, and s plus the emu of current (sometimes called the abampere).
- Enantiomers** - A chiral molecule and its non-superposable mirror image. The two forms rotate the plane of polarized light by equal amounts in opposite directions. Also called optical isomers.
- Energy ( $E, U$ )\*** - The characteristic of a system that enables it to do work.



**Energy gap\*** - In the theory of solids, the region between two energy bands, in which no bound states can occur.

**Enols, alkenols** - The term refers specifically to vinylic alcohols, which have the structure  $\text{HO-CR}'=\text{CR}_2$ . Enols are tautomeric with aldehydes ( $\text{R}' = \text{H}$ ) or ketones ( $\text{R}'$  not equal to  $\text{H}$ ). [5]

**Enthalpy ( $H$ )\*** - A thermodynamic function, especially useful when dealing with constant-pressure processes, defined by  $H = E + PV$ , where  $E$  is energy,  $P$  pressure, and  $V$  volume. [1]

**Enthalpy of combustion\*** - The enthalpy change in a combustion reaction. Its negative is the heat released in combustion.

**Enthalpy of formation, standard\*** - The enthalpy change for the reaction in which a substance is formed from its constituent elements, each in its standard reference state (normally refers to 1 mol, sometimes to 1 g, of the substance).

**Enthalpy of fusion\*** - The enthalpy change in the transition from solid to liquid state.

**Enthalpy of sublimation** - The enthalpy change in the transition from solid to gas state.

**Enthalpy of vaporization\*** - The enthalpy change in the transition from liquid to gas state.

**Entropy ( $S$ )\*** - A thermodynamic function defined such that when a small quantity of heat  $dQ$  is received by a system at temperature  $T$ , the entropy of the system is increased by  $dQ/T$ , provided that no irreversible change takes place in the system. [1]

**Entropy unit (e.u.)** - A non-SI unit of entropy, equal to 4.184 J/K mol.

**Ephemeris time** - Time measured in tropical years from January 1, 1900.

**Epoxy compounds** - Compounds in which an oxygen atom is directly attached to two adjacent or non-adjacent carbon atoms of a carbon chain or ring system; thus cyclic ethers. [5]

**Equation of continuity** - Any of a class of equations that express the fact that some quantity (mass, charge, energy, etc.) cannot be created or destroyed. Such equations typically specify that the rate of increase of the quantity in a given region of space equals the net current of the quantity flowing into the region.

**Equation of state\*** - An equation relating the pressure, volume, and temperature of a substance or system.

**Equilibrium constant ( $K$ )\*** - For a chemical reaction  $aA + bB \rightleftharpoons cC + dD$ , the equilibrium constant is defined by:

$$K = \frac{a_C^c \cdot a_D^d}{a_A^a \cdot a_B^b}$$

where  $a_i$  is the activity of component  $i$ . To a certain approximation, the activities can be replaced by concentrations. The equilibrium constant is related to  $\Delta_r G^\circ$ , the standard Gibbs energy change in the reaction, by  $RT \ln K = -\Delta_r G^\circ$ .

**Equivalent conductance** - See Conductivity, electrical

**Erg (erg)** - A non-SI (cgs) unit of energy, equal to  $10^{-7}$  J.

**Esters** - Compounds formally derived from an oxoacid  $\text{RC}(=\text{O})(\text{OH})$  and an alcohol, phenol, heteroarenol, or enol by linking, with formal loss of water from an acidic hydroxy group of the former and a hydroxy group of the latter. [5]

**Esu** - The electrostatic system of units, based upon the cm, g, and s plus the esu of charge (sometimes called the statcoulomb or franklin).

**Ethers** - Compounds with formula  $\text{ROR}$ , where  $\text{R}$  is not equal to  $\text{H}$ . [5]

**Euler number ( $Eu$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Eu = \Delta p / \rho v^2$ , where  $p$  is pressure,  $\rho$  is density, and  $v$  is velocity. [2]

**Eutectic** - The point on a two-component solid-liquid phase diagram which represents the lowest melting point of any possible mixture. A liquid having the eutectic composition will freeze at a single temperature without change of composition.

**Excitance ( $M$ )** - Radiant energy flux leaving an element of a surface divided by the area of that element. [1]

**Exciton** - A localized excited state consisting of a bound electron-hole pair in a molecular or ionic crystal. The exciton can propagate through the crystal.

**Exosphere** - The outermost part of the earth's atmosphere, beginning at about 500 to 1000 km above the surface. It is characterized by densities so low that air molecules can escape into outer space.

**Expansion coefficient** - See thermal expansion coefficient.

**Extended electron energy loss fine structure (EXELFS)** - See Techniques for Materials Characterization, page 12-1.

**Extended x-ray absorption fine structure (EXAFS)** - See Techniques for Materials Characterization, page 12-1.

**Extinction coefficient** - See Absorption coefficient, molar.

**F-Center** - See Color center.

**Fahrenheit temperature ( $^\circ\text{F}$ )** - The temperature scale based on the assignment of  $32^\circ\text{F} = 0^\circ\text{C}$  and a temperature interval of  $^\circ\text{F} = (5/9)^\circ\text{C}$ ; i.e.,  $t/^\circ\text{F} = (9/5)t/^\circ\text{C} + 32$ .

**Farad ( $\text{F}$ )\*** - The SI unit of electric capacitance, equal to  $\text{C/V}$ . [1]

**Faraday constant ( $F$ )\*** - The electric charge of 1 mol of singly charged positive ions; i.e.,  $F = N_A e$ , where  $N_A$  is Avogadro's constant and  $e$  is the elementary charge. [1]

**Faraday effect\*** - The rotation of the plane of plane-polarized light by a medium placed in a magnetic field parallel to the direction of the light beam. The effect can be observed in solids, liquids, and gasses.

**Fatty acids** - Aliphatic monocarboxylic acids derived from or contained in esterified form in an animal or vegetable fat, oil, or wax. Natural fatty acids commonly have a chain of 4 to 28 carbons (usually unbranched and even-numbered), which may be saturated or unsaturated. By extension, the term is sometimes used to embrace all acyclic aliphatic carboxylic acids. [5]

**Fermat's principle** - The law that a ray of light traversing one or more media will follow a path which minimizes the time required to pass between two given points.

**Fermi (f)** - Name sometimes used in nuclear physics for the femtometer.

**Fermi level** - The highest energy of occupied states in a solid at zero temperature. Sometimes called Fermi energy. The Fermi surface is the surface in momentum space formed by electrons occupying the Fermi level.

**Fermi resonance** - An effect observed in vibrational spectroscopy when an overtone of one fundamental vibration closely coincides in energy with another fundamental of the same symmetry species. It leads to a splitting of vibrational bands.

**Fermi-Dirac distribution** - A modification of the Boltzmann distribution which takes into account the Pauli exclusion principle. The number of particles of energy  $E$  is proportional to  $[e^{(E-\mu)/kT} + 1]^{-1}$ , where  $\mu$  is a normalization constant,  $k$  the Boltzmann constant, and  $T$  the temperature. The distribution is applicable to a system of fermions.

**Fermion** - A particle that obeys Fermi-Dirac statistics. Specifically, any particle with spin equal to an odd multiple of  $1/2$ . Examples are the electron, proton, neutron, muon, etc.

**Ferrimagnetism\*** - A type of magnetism in which the magnetic moments of atoms in a solid are ordered into two nonequivalent sublattices with unequal magnetic moments, leading to a nonzero magnetic susceptibility.

**Ferrite** - A ferrimagnetic material of nominal formula  $MFe_2O_4$ , where  $M$  is a divalent metal; widely used in microwave switches and other solid state devices.

**Ferroelectricity\*** - The retention of electric polarization by certain materials after the external field that produced the polarization has been removed.

**Ferromagnetism\*** - A type of magnetism in which the magnetic moments of atoms in a solid are aligned within domains which can in turn be aligned with each other by a weak magnetic field. Some ferromagnetic materials can retain their magnetization when the external field is removed, as long as the temperature is below a critical value, the Curie temperature. They are characterized by a large positive magnetic susceptibility.

**Fick's law** - The statement that the flux  $J$  of a diffusing substance is proportional to the concentration gradient, i.e.,  $J = -D(dc/dx)$ , where  $D$  is called the diffusion coefficient.

**Field** - A mathematical construct which describes the interaction between particles resulting from gravity, electromagnetism, or other physical phenomena. In classical physics a field is described by equations. Quantum field theory introduces operators to represent the physical observables.

**Field emission microscopy (FEM)** - See Techniques for Materials Characterization, page 12-1.

**Field ion microscopy (FIM)** - See Techniques for Materials Characterization, page 12-1.

**Fine structure** - The splitting in spectral lines that results from interactions of the electron spin with the orbital angular momentum.

**Fine structure constant ( $\alpha$ )\*** - Defined as  $e^2/2hc\epsilon_0$ , where  $e$  is the elementary charge,  $h$  Planck's constant,  $c$  the speed of light, and  $\epsilon_0$  the permittivity of a vacuum. It is a measure of the strength of the electromagnetic interaction between particles.

**First radiation constant ( $c_1$ )\*** - Constant ( $= 2\pi hc^2$ ) in the equation for the radiant exitance  $M_\lambda$  of a black body:

$$M_\lambda = \frac{c_1 \lambda^{-5} \Delta\lambda}{e^{c_2/\lambda T} - 1}$$

where  $\lambda$  is the wavelength,  $T$  is the temperature, and  $c_2 = hc/k$  is the second radiation constant.

**Flash point** - The lowest temperature at which vapors above a volatile combustible substance will ignite in air when exposed to a flame. [10]

**Fluence ( $F$ )** - Term used in photochemistry to specify the energy per unit area delivered in a given time interval, for example by a laser pulse. [2]

**Fluorocarbons** - Compounds consisting solely of fluorine and carbon. [5]

**Fluxoid** - The quantum of magnetic flux in superconductivity theory, equal to  $hc/2e$ , where  $h$  is Planck's constant,  $c$  the velocity of light, and  $e$  the elementary charge.

**Force ( $F$ )** - The rate of change of momentum with time. [1]

**Force constants ( $f, k$ )\*** - In molecular vibrations, the coefficients in the expression of the potential energy in terms of atom displacements from their equilibrium positions. In a diatomic molecule,  $f = d^2V/dr^2$ , where  $V(r)$  is the potential energy and  $r$  is the interatomic distance. [2]

**Fourier number ( $Fo$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Fo = at/l^2$ , where  $a$  is thermal diffusivity,  $t$  is time, and  $l$  is length. [2]

**Fourier transform infrared spectroscopy (FTIR)** - A technique for obtaining an infrared spectrum by use of an interferometer in which the path length of one of the beams is varied. A Fourier transformation of the resulting interferogram yields the actual spectrum. The technique is also used for NMR and other types of spectroscopy.

**Fractals** - Geometrical objects that are self-similar under a change of scale; i.e., they appear similar at all levels of magnification. They can be considered to have fractional dimensionality. Examples occur in diverse fields such as geography (rivers and shorelines), biology (trees), and solid state physics (amorphous materials).

**Franck-Condon principle** - An important principle in molecular spectroscopy which states that the nuclei in a molecule remain essentially stationary while an electronic transition is taking place. The physical interpretation rests on the fact that the electrons move much more rapidly than the nuclei because of their much smaller mass.

**Franklin (Fr)** - Name sometimes given to the unit of charge in the esu system.

**Fraunhofer diffraction** - Diffraction of light in situations where the source and observation point are so far removed that the wave surfaces may be considered planar.

**Fraunhofer lines** - Sharp absorption lines in the spectrum of sunlight, caused by absorption of the solar blackbody radiation by atoms near the sun's surface.

**Free radical** - See Radicals. The term "free radical" is often used more broadly for molecules that have a paramagnetic ground state (e.g.,  $O_2$ ) and sometimes for any transient or highly reactive molecular species.

**Freezing point** - See Melting point.

**Frequency ( $\nu$ )\*** - Number of cycles of a periodic phenomenon divided by time. [1]

**Fresnel diffraction** - Diffraction of light in a situation where the source and observation point are sufficiently close together that the curvature of the wave surfaces must be taken into account.

**Froude number ( $Fr$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Fr = v/(lg)^{1/2}$ , where  $v$  is velocity,  $l$  is length, and  $g$  is acceleration due to gravity. [2]

**Fugacity ( $f_B$ )** - For a gas mixture, the fugacity of component B is defined as the absolute activity  $\lambda_B$  times the limit, as the pressure  $p$  approaches zero at constant temperature, of  $p_B/\lambda_B$ . [2]

**Fullerenes** - Compounds composed solely of an even number of carbon atoms, which form a cage-like fused-ring polycyclic system with twelve five-membered rings and the rest six-membered rings. The archetypal example is [60]fullerene, where the atoms and bonds delineate a truncated icosahedron. The term has been broadened to include any closed cage structure consisting entirely of three-coordinate carbon atoms. [5]

**Fulvalenes** - The hydrocarbon fulvalene and its derivatives formed by substitution (and by extension, analogues formed

by replacement of one or more carbon atoms of the fulvalene skeleton by a heteroatom). [5]

**Fulvenes** - The hydrocarbon fulvene and its derivatives formed by substitution (and by extension, analogues formed by replacement of one or more carbon atoms of the fulvene skeleton by a heteroatom). [5]

**Fundamental vibrational frequencies\*** - In molecular spectroscopy, the characteristic vibrational frequencies obtained when the vibrational energy is expressed in normal coordinates. They determine the primary features of the infrared and Raman spectra of the molecule.

$\gamma$  - Name sometimes used for microgram.

**$\gamma$ -rays\*** - Electromagnetic radiation (photons) with energy greater than about 0.1 MeV (wavelength less than about 1 pm).

**$g$ -Factor of the electron\*** - The proportionality factor in the equation relating the magnetic moment  $\mu$  of an electron to its total angular momentum quantum number  $J$ , i.e.,  $\mu = -g\mu_B J$ , where  $\mu_B$  is the Bohr magneton. Also called Landé factor.

**Gal** - A non-SI unit of acceleration, equal to 0.01 m/s. Also called galileo.

**Gallon (US)** - A unit of volume equal to 3.785412 L.

**Gallon (UK, Imperial)** - A unit of volume equal to 4.546090 L.

**Gauss (G)** - A non-SI unit of magnetic flux density ( $B$ ) equal to  $10^{-4}$  T.

**Gaussian system of units** - A hybrid system used in electromagnetic theory, which combines features of both the esu and emu systems.

**Gel** - A colloidal system with a finite, but usually rather small, yield stress (the shear stress at which yielding starts abruptly). [3]

**Genetic code\*** - The set of relations between each of the 64 codons of DNA and a specific amino acid (or other genetic instruction).

**Gibbs energy ( $G$ )\*** - An important function in chemical thermodynamics, defined by  $G = H - TS$ , where  $H$  is the enthalpy,  $S$  the entropy, and  $T$  the thermodynamic temperature. Sometimes called Gibbs free energy and, in older literature, simply "free energy". [2]

**Gibbs phase rule** - The relation  $F = C - P + 2$ , where  $C$  is the number of components in a mixture,  $P$  is the number of phases, and  $F$  is the degrees of freedom, i.e., the number of intensive variables that can be changed independently without affecting the number of phases.

**Glass transition temperature\*** - The temperature at which an amorphous polymer is transformed, in a reversible way, from a viscous or rubbery condition to a hard and relatively brittle one. [10]

**Glow discharge mass spectroscopy (GDMS)** - See Techniques for Materials Characterization, page 12-1.

**Glueon** - A hypothetical particle postulated to take part in the binding of quarks, in analogy to the role of the photon in electromagnetic interactions.

**Glycerides** - Esters of glycerol (propane-1,2,3-triol) with fatty acids, widely distributed in nature. They are by long-established custom subdivided into triglycerides, 1,2- or 1,3-diglycerides, and 1- or 2-monoglycerides, according to the number and positions of acyl groups. [5]

**Glycols** - Dihydric alcohols in which two hydroxy groups are on different carbon atoms, usually but not necessarily adjacent. Also called diols. [5]

**Grain (gr)** - A non-SI unit of mass, equal to 64.79891 mg.

**Grain boundary** - The interface between two regions of different crystal orientation.

**Grashof number ( $Gr$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Gr = l^3 g \alpha \Delta T \rho^2 / \eta^2$ , where  $T$  is temperature,  $\rho$  is density,  $l$  is length,  $\eta$  is viscosity,  $\alpha$  is cubic expansion coefficient, and  $g$  is acceleration of gravity. [2]

**Gravitational constant ( $G$ )\*** - The universal constant in the equation for the gravitational force between two particles,  $F = G m_1 m_2 / r^2$ , where  $r$  is the distance between the particles and  $m_1$  and  $m_2$  are their masses. [1]

**Gray (Gy)\*** - The SI unit of absorbed dose of radiation, equal to J/kg. [1]

**Gregorian calendar** - The modification of the Julian calendar introduced in 1582 by Pope Gregory XII which specified that a year divisible by 100 is a leap year only if divisible by 400.

**Grignard reagents** - Organomagnesium halides,  $RMgX$ , having a carbon-magnesium bond (or their equilibrium mixtures in solution with  $R_2Mg + MgX_2$ ). [5]

**Gruneisen parameter ( $\gamma$ )** - Defined by  $\gamma = \alpha_v / \kappa c_v \rho$ , where  $\alpha_v$  is the cubic thermal expansion coefficient,  $\kappa$  is the isothermal compressibility,  $c_v$  is the specific heat capacity at constant volume, and  $\rho$  is the mass density.  $\gamma$  is independent of temperature for most crystalline solids. [1]

**Gyromagnetic ratio ( $\gamma$ )** - Ratio of the magnetic moment of a particle to its angular momentum. Also called magnetogyric ratio.

**Hadron** - Any elementary particle that can take part in the strong interaction. Hadrons are subdivided into baryons, with odd half integer spins, and mesons, which have zero or integral spin.

**Hall effect\*** - The development of a transverse potential difference  $V$  in a conducting material when subjected to a magnetic field  $H$  perpendicular to the direction of the current. The potential difference is given by  $V = R_H B J t$ , where  $B$  is the magnetic induction,  $J$  the current density,  $t$  the thickness of the specimen in the direction of the potential difference, and  $R_H$  is called the Hall coefficient.

**Halocarbon** - A compound containing no elements other than carbon, hydrogen, and one or more halogens. In common practice, the term is used mainly for compounds of no more than four or five carbon atoms.

**Halogens** - The elements F, Cl, Br, I, and At. Compounds of these elements are called halogenides or halides. [7]

**Hamiltonian ( $H$ )** - An expression for the total energy of a mechanical system in terms of the momenta and positions of constituent particles. In quantum mechanics, the Hamiltonian operator appears in the eigenvalue equation  $H\psi = E\psi$ , where  $E$  is an energy eigenvalue and  $\psi$  the corresponding eigenfunction.

**Hardness\*** - The resistance of a material to deformation, indentation, or scratching. Hardness is measured on various scales, such as Mohs, Brinell, Knoop, Rockwell, and Vickers. [10]

**Hartmann number ( $Ha$ )** - A dimensionless quantity used in plasma physics, defined by  $Ha = Bl(\kappa/\eta)^{1/2}$ , where  $B$  is magnetic flux density,  $l$  is length,  $\kappa$  is electric conductivity, and  $\eta$  is viscosity. [2]

**Hartree ( $E_h$ )\*** - An energy unit used in atomic and molecular science, equal to approximately  $4.3597482 \times 10^{-18}$  J.

**Hartree-Fock method** - A iterative procedure for solving the Schrödinger equation for an atom or molecule in which the equation is solved for each electron in an initial assumed po-



tential from all the other electrons. The new potential that results is used to repeat the calculation and the procedure continued until convergence is reached. Also called self-consistent field (SCF) method.

**Heat capacity\*** - Defined in general as  $dQ/dT$ , where  $dQ$  is the amount of heat that must be added to a system to increase its temperature by a small amount  $dT$ . The heat capacity at constant pressure is  $C_p = (\partial H/\partial T)_p$ ; that at constant volume is  $C_v = (\partial E/\partial T)_v$ , where  $H$  is enthalpy,  $E$  is internal energy,  $p$  is pressure,  $V$  is volume, and  $T$  is temperature. An upper case  $C$  normally indicates the molar heat capacity, while a lower case  $c$  is used for the specific (per unit mass) heat capacity. [1]

**Heat of formation, vaporization, etc.** - See corresponding terms under Enthalpy.

**Hectare (ha)** - A unit of area equal to  $10^4$  m<sup>2</sup>. [1]

**Heisenberg uncertainty principle** - The statement that two observable properties of a system that are complementary, in the sense that their quantum-mechanical operators do not commute, cannot be specified simultaneously with absolute precision. An example is the position and momentum of a particle; according to this principle, the uncertainties in position  $\Delta q$  and momentum  $\Delta p$  must satisfy the relation  $\Delta p \Delta q \geq h/4\pi$ , where  $h$  is Planck's constant.

**Heitler-London model** - An early quantum-mechanical model of the hydrogen atom which introduced the concept of the exchange interaction between electrons as the primary reason for stability of the chemical bond.

**Helicon** - A low-frequency wave generated when a metal at low temperature is exposed to a uniform magnetic field and a circularly polarized electric field.

**Helmholz energy (A)** - A thermodynamic function defined by  $A = E - TS$ , where  $E$  is the energy,  $S$  the entropy, and  $T$  the thermodynamic temperature. [2]

**Hemiacetals** - Compounds having the general formula  $R_2C(OH)OR'$  ( $R'$  not equal to H). [5]

**Henry (H)\*** - The SI unit of inductance, equal to Wb/A. [1]

**Henry's law\*** - An expression which applies to an ideal dilute solution in which one or more gasses are dissolved, viz.,  $p_i = H_i x_i$ , where  $p_i$  is the partial pressure of component  $i$  above the solution,  $x_i$  is its mole fraction in the solution, and  $H_i$  is the Henry's law constant (a characteristic of the given gas and solvent, as well as the temperature).

**Hermitian operator** - An operator  $A$  that satisfies the relation  $\int u_m^* A u_n dx = (\int u_n^* A u_m dx)^*$ , where  $*$  indicates the complex conjugate. The eigenvalues of Hermitian operators are real, and eigenfunctions belonging to different eigenvalues are orthogonal.

**Hertz (Hz)** - The SI unit of frequency, equal to s<sup>-1</sup>. [1]

**Heterocyclic compounds** - Cyclic compounds having as ring members atoms of at least two different elements, e.g., quinine, 1,2-thiazole, bicyclo[3.3.1]tetrasiloxane. [5]

**Heusler alloys** - Alloys of manganese, copper, aluminum, nickel, and sometimes other metals which find important uses as permanent magnets.

**Holography** - A technique for creating a three-dimensional image of a object by recording the interference pattern between a light beam diffracted from the object and a reference beam. The image can be reconstructed from this pattern by a suitable optical system.

**Homopolymer** - A polymer derived from one species of (real, implicit, or hypothetical) monomer. [8]

**Hooke's law** - The statement that the ratio of stress to strain is a constant in a totally elastic medium.

**Horse power** - A non-SI unit of energy, equal to approximately 746 W.

**Hubble constant** - The ratio of the recessional velocity of an extragalactic object to the distance of that object. Its value is about  $2 \times 10^{-18}$  s<sup>-1</sup>.

**Huckel theory** - A simple approximation for calculating the energy of conjugated molecules in which only the resonance integrals between neighboring bonds are considered. Also called CNDO method (complete neglect of differential overlap).

**Hume-Rothery rules** - A set of empirical rules for predicting the occurrence of solid solutions in metallic systems. The rules involve size, crystal structure, and electronegativity.

**Hund's rules** - A series of rules for predicting the sequence of energy states in atoms and molecules. One of the important results is that when two electrons exist in different orbitals, the state with their spins parallel (triplet state) lies at lower energy than the state with antiparallel spins (singlet).

**Hydrazines** - Hydrazine (diazane),  $H_2NNH_2$ , and its hydrocarbyl derivatives. When one or more substituents are acyl groups, the compound is a hydrazide. [5]

**Hydrocarbon** - A compound containing only carbon and hydrogen. [5]

**Hydrolysis** - A reaction occurring in water in which a chemical bond is cleaved and a new bond formed with the oxygen atom of water.

**Hyperfine structure** - Splitting of energy levels and spectral lines into several closely spaced components as a result of interaction of nuclear spin angular momentum with other angular momenta in the atom or molecule.

**Hysteresis\*** - An irreversible response of a system (parameter  $A$ ) as a function of an external force (parameter  $F$ ), usually symmetric with respect to the origin of the  $A$  vs.  $F$  graph after the initial application of the force. A common example is magnetic induction vs. magnetic field strength in a ferromagnet.

**Ideal gas law** - The equation of state  $pV = RT$ , which defines an ideal gas, where  $p$  is pressure,  $V$  molar volume,  $T$  temperature, and  $R$  the molar gas constant.

**Ideal solution** - A solution in which solvent-solvent and solvent-solute interactions are identical, so that properties such as volume and enthalpy are exactly additive. Ideal solutions follow Raoult's law, which states that the vapor pressure  $p_i$  of component  $i$  is  $p_i = x_i p_i^*$ , where  $x_i$  is the mole fraction of component  $i$  and  $p_i^*$  the vapor pressure of the pure substance  $i$ .

**Ignition temperature\*** - The lowest temperature at which combustion of a material will occur spontaneously under specified conditions. Sometimes called autoignition temperature, kindling point. [10]

**Imides** - Diacyl derivatives of ammonia or primary amines, especially those cyclic compounds derived from diacids. Also used for salts having the anion  $RN_2^-$ . [5]

**Impedance (Z)** - The complex representation of potential difference divided by the complex representation of current. In terms of reactance  $X$  and resistance  $R$ , the impedance is given by  $Z = R + iX$ . [1]

**Index of refraction (n)\*** - For a non-absorbing medium, the ratio of the velocity of electromagnetic radiation *in vacuo* to the phase velocity of radiation of a specified frequency in the medium. [1]

- Inductance** - The ratio of the electromagnetic force induced in a coil by a current to the rate of change of the current.
- Inductive coupled plasma mass spectroscopy (ICPMS)** - See Techniques for Materials Characterization, page 12-1.
- Inertial defect** - In molecular spectroscopy, the quantity  $I_c - I_a - I_b$  for a molecule whose equilibrium configuration is planar, where  $I_a$ ,  $I_b$ , and  $I_c$  are the effective principal moments of inertia. The inertial defect for a rigid planar molecule would be zero, but vibration-rotation interactions in a real molecule lead to a positive inertial defect.
- Insulator** - A material in which the highest occupied energy band (valence band) is completely filled with electrons, while the next higher band (conduction band) is empty. Solids with an energy gap of 5 eV or more are generally considered as insulators at room temperature. Their conductivity is less than  $10^{-6}$  S/m and increases with temperature.
- Intercalation compounds** - Compounds resulting from reversible inclusion, without covalent bonding, of one kind of molecule in a solid matrix of another compound, which has a laminar structure. The host compound, a solid, may be macromolecular, crystalline, or amorphous. [5]
- International System of Units (SI)\*** - The unit system adopted by the General Conference on Weights and Measures in 1960. It consists of seven base units (meter, kilogram, second, ampere, kelvin, mole, candela), plus derived units and prefixes. [1]
- International Temperature Scale (ITS-90)\*** - The official international temperature scale adopted in 1990. It consists of a set of fixed points and equations which enable the thermodynamic temperature to be determined from operational measurements. [9]
- Ion** - An atomic or molecular particle having a net electric charge. [3]
- Ion exchange** - A process involving the adsorption of one or several ionic species accompanied by the simultaneous desorption (displacement) of one or more other ionic species. [3]
- Ion neutralization spectroscopy (INS)** - See Techniques for Materials Characterization, page 12-1.
- Ionic strength ( $I$ )** - A measure of the total concentration of ions in a solution, defined by  $I = 1/2 \sum_i z_i^2 m_i$ , where  $z_i$  is the charge of ionic species  $i$  and  $m_i$  is its molality. For a 1-1 electrolyte at molality  $m$ ,  $I = m$ .
- Ionization constant\*** - The equilibrium constant for a reaction in which a substance in solution dissociates into ions.
- Ionization potential\*** - The minimum energy required to remove an electron from an isolated atom or molecule (in its vibrational ground state) in the gaseous phase. More properly called ionization energy. [3]
- Irradiance ( $E$ )** - The radiant energy flux incident on an element of a surface, divided by the area of that element. [1]
- Isentropic process** - A thermodynamic process in which the entropy of the system does not change.
- Ising model** - A model describing the coupling between two atoms in a ferromagnetic lattice, in which the interaction energy is proportional to the negative of the product of the spin components along a specified axis.
- Isobar** - A line connecting points of equal pressure on a graphical representation of a physical system.
- Isochore** - A line or surface of constant volume on a graphical representation of a physical system.
- Isoelectric point\*** - The pH of a solution or dispersion at which the net charge on the macromolecules or colloidal particles is zero. In electrophoresis there is no motion of the particles in an electric field at the isoelectric point.
- Isomers** - In chemistry, compounds that have identical molecular formulas but differ in the nature or sequence of bonding of their atoms or in the arrangement of their atoms in space. In physics, nuclei of the same atomic number  $Z$  and mass number  $A$  but in different energy states. [3]
- Isomorphs** - Substances of different chemical nature but having the same crystal structure.
- Isotactic macromolecule** - A tactic macromolecule, essentially comprising only one species of repeating unit which has chiral or prochiral atoms in the main chain in a unique arrangement with respect to its adjacent constitutional units. [8]
- Isotherm** - A line connecting points of equal temperature on a graphical representation of a physical system.
- Isothermal process** - A thermodynamic process in which the temperature of the system does not change.
- Isotones** - Nuclides having the same neutron number  $N$  but different atomic number  $Z$ . [3]
- Isotopes** - Two or more nuclides with the same atomic number  $Z$  but different mass number  $A$ . The term is sometimes used synonymously with nuclide, but it is preferable to reserve the word nuclide for a species of specific  $Z$  and  $A$ . [3]
- Jahn-Teller effect** - An interaction of vibrational and electronic motions in a nonlinear molecule which removes the degeneracy of certain electronic energy levels. It can influence the spectrum, crystal structure, and magnetic properties of the substance.
- Johnson noise** - Electrical noise generated by random thermal motion of electrons in a conductor or semiconductor. Also called thermal noise.
- Josephson effect** - The tunneling of electron pairs through a thin insulating layer which separates two superconductors. When a potential difference is applied to the superconductors, an alternating current is generated whose frequency is precisely proportional to the potential difference. This effect has important applications in metrology and determination of fundamental physical constants.
- Joule (J)\*** - The SI unit of energy, equal to N m. [1]
- Joule-Thomson coefficient ( $\mu$ )** - A parameter which describes the temperature change when a gas expands adiabatically through a nozzle from a high pressure to a low pressure region. It is defined by  $\mu = (\partial T / \partial p)_H$ , where  $H$  is enthalpy.
- Julian calendar** - The calendar introduced by Julius Caesar in 46 B.C. which divided the year into 365 days with a leap year of 366 days every fourth year.
- Julian date (JD)** - The number of days elapsed since noon Greenwich Mean Time on January 1, 4713 B.C. Thus January 1, 2000, 0h (midnight) will be JD 2,451,543.5. This dating system was introduced by Joseph Scaliger in 1582.
- Kaon** - One of the elementary particles in the family of mesons. Kaons have a spin of zero and may be neutral or charged.
- Kelvin (K)\*** - The SI base unit of thermodynamic temperature. [1]
- Kepler's laws** - The three laws of planetary motion, which established the elliptical shape of planetary orbits and the relation between orbital dimensions and the period of rotation.

- Kerr effect\*** - An electrooptical effect in which birefringence is induced in a liquid or gas when a strong electric field is applied perpendicular to the direction of an incident light beam. The Kerr constant  $k$  is given by  $n_1 - n_2 = k\lambda E^2$ , where  $\lambda$  is the wavelength,  $E$  is the electric field strength, and  $n_1$  and  $n_2$  are the indices of refraction of the ordinary and extraordinary rays, respectively.
- Ketenes** - Compounds in which a carbonyl group is connected by a double bond to an alkylidene group:  $R_2C=C=O$ . [5]
- Ketones** - Compounds in which a carbonyl group is bonded to two carbon atoms:  $R_1R_2C=O$  (neither R may be H). [5]
- Kilogram (kg)\*** - The SI base unit of mass. [1]
- Kinetic energy ( $E_k$ ,  $T$ )** - The energy associated with the motion of a system of particles in a specified reference frame. For a single particle of mass  $m$  moving at velocity  $v$ ,  $E_k = 1/2mv^2$ .
- Kirchhoff's laws** - Basic rules for electric circuits, which state (a) the algebraic sum of the currents at a network node is zero and (b) the algebraic sum of the voltage drops around a closed path is zero.
- Klein-Gordon equation** - A relativistic extension of the Schrödinger equation.
- Klein-Nishima formula** - An expression for the scattering cross section of a photon by an unbound electron, based upon the Dirac electron theory.
- Knight shift** - The change in magnetic resonance frequency of a nucleus in a metal relative to the same nucleus in a diamagnetic solid. The effect is due to the polarization of the conduction electrons in the metal.
- Knudsen number ( $Kn$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Kn = \lambda/l$ , where  $\lambda$  is mean free path and  $l$  is length. [2]
- Kondo effect** - A large increase in electrical resistance observed at low temperatures in certain dilute alloys of a magnetic metal in a nonmagnetic material.
- Kramers-Kronig relation** - A set of equations relating the real and imaginary parts of the index of refraction of a medium
- Lactams** - Cyclic amides of amino carboxylic acids, having a 1-azacycloalkan-2-one structure, or analogues having unsaturation or heteroatoms replacing one or more carbon atoms of the ring. [5]
- Lactones** - Cyclic esters of hydroxy carboxylic acids, containing a 1-oxacycloalkan-2-one structure, or analogues having unsaturation or heteroatoms replacing one or more carbon atoms of the ring. [5]
- Lagrangian function ( $L$ )** - A function used in classical mechanics, defined as the kinetic energy minus the potential energy for a system of particles.
- Lamb shift** - The small energy difference between the  $^2S_{1/2}$  and  $^2P_{1/2}$  levels in the hydrogen atom, which results from interactions between the electron and the radiation field.
- Laminar flow** - Smooth, uniform, non-turbulent flow of a gas or liquid in parallel layers, with little mixing between layers. It is characterized by small values of the Reynolds number.
- Landé g-factor** - See g-Factor of the electron
- Langevin function** - The mathematical function  $L(x) = (e^x + e^{-x}) / (e^x - e^{-x}) - 1/x$ , which occurs in the expression for the average dipole moment of a group of rotating polar molecules in an electric field:  $\mu_{av} = \mu L(\mu E/kT)$ , where  $\mu$  is the electric dipole moment of a single molecule,  $E$  is the electric field strength,  $k$  is the Boltzmann constant, and  $T$  is the temperature.
- Lanthanides** - The elements of atomic number 57 through 71, which share common chemical properties: La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu. [7]
- Larmor frequency ( $\nu_1$ )** - The precession frequency of a magnetic dipole in an applied magnetic field. In particular, a nucleus in a magnetic field of strength  $B$  has a Larmor frequency of  $\gamma B/2\pi$ , where  $\gamma$  is the magnetogyric ratio of the nucleus.
- Laser\*** - A device in which an optical cavity is filled with a medium where a population inversion can be produced by some means. When the resonant frequency of the cavity bears the proper relation to the separation of the inverted energy levels, stimulated emission occurs, producing a highly monochromatic, coherent beam of light.
- Laser ionization mass spectroscopy (LIMS)** - See Techniques for Materials Characterization, page 12-1.
- Lattice constants\*** - Parameters specifying the dimensions of a unit cell in a crystal lattice, specifically the lengths of the cell edges and the angles between them.
- Lattice energy\*** - The energy per ion pair required to separate completely the ions in a crystal lattice at a temperature of absolute zero.
- Laue diagram** - A diffraction pattern produced when an x-ray beam passes through a thin slice of a crystal and impinges on a detector behind the crystal.
- Lenz's law** - The statement that the current induced in a circuit by a change in magnetic flux is so directed as to oppose the change in flux
- Leonard-Jones potential** - A simple but useful function for approximating the interaction between two neutral atoms or molecules separated by a distance  $r$  by writing the potential energy as  $U(r) = 4\epsilon\{(r_0/r)^{12} - (r_0/r)^6\}$ , where  $\epsilon$  and  $r_0$  are adjustable parameters. In this form the depth of the potential well is  $\epsilon$  and the minimum occurs at  $2^{1/6}r_0$ . The  $(1/r)^{12}$  term is often replaced by other powers of  $1/r$ .
- Lepton** - One of the class of elementary particles that do not take part in the strong interaction. Included are the electron, muon, and neutrino. All leptons have a spin of  $1/2$ .
- Lewis number ( $Le$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Le = a/D$ , where  $a$  is thermal diffusivity and  $D$  is diffusion coefficient. [2]
- Ligand field theory** - A description of the structure of crystals containing a transition metal ion surrounded by nonmetallic ions (ligands). It is based on construction of molecular orbitals involving the  $d$ -orbitals of the central metal ion and combinations of atomic orbitals of the ligands.
- Light year (l.y.)** - A unit of distance used in astronomy, defined as the distance light travels in one year in a vacuum. Its approximate value is  $9.46073 \times 10^{15}$  m.
- Lignins** - Macromolecular constituents of wood related to lignans, composed of phenolic propylbenzene skeletal units, linked at various sites and apparently randomly. [5]
- Ligroin** - The petroleum fraction consisting mostly of  $C_7$  and  $C_8$  hydrocarbons and boiling in the range 90-140 °C; commonly used as a laboratory solvent.
- Lipids** - A loosely defined term for substances of biological origin that are soluble in nonpolar solvents. They consist of saponifiable lipids, such as glycerides (fats and oils) and phospholipids, as well as nonsaponifiable lipids, principally steroids. [5]
- Lipoproteins** - Clathrate complexes consisting of a lipid enwrapped in a protein host without covalent binding, in such a way that



the complex has a hydrophilic outer surface consisting of all the protein and the polar ends of any phospholipids. [5]

**Liter (L)\*** - A synonym for cubic decimeter. [1]

**Lithosphere\*** - The outer layer of the solid earth, extending from the base of the mantle to the surface of the crust.

**Lorentz contraction** - The reduction in length of a moving body in the direction of motion, given by the factor  $(1-v^2/c^2)^{1/2}$ , where  $v$  is the velocity of the body and  $c$  the velocity of light. Also known as the FitzGerald-Lorentz contraction.

**Lorentz force** - The force exerted on a point charge  $Q$  moving at velocity  $v$  in the presence of external fields  $E$  and  $B$ . It is given (in SI units) by  $F = Q(E + v \times B)$ .

**Loss angle ( $\delta$ )** - For a dielectric material in an alternating electromagnetic field,  $\delta$  is the phase difference between the current and the potential difference. The function  $\tan \delta$  is a measure of the ratio of the power dissipated in the dielectric to the power stored.

**Low energy electron diffraction (LEED)** - See Techniques for Materials Characterization, page 12-1.

**Lumen (lm)\*** - The SI unit of luminous flux, equal to cd sr. [1]

**Luminous flux ( $\Phi$ )** - The intensity of light from a source multiplied by the solid angle. The SI unit is lumen. [1]

**Lux (lx)\*** - The SI unit of illuminance, equal to cd sr m<sup>-2</sup>. [1]

**Lyddane-Sachs-Teller relation** - A relation between the phonon frequencies and dielectric constants of an ionic crystal which states that  $(\omega_T/\omega_L)^2 = \epsilon(\infty)/\epsilon(0)$ , where  $\omega_T$  is the angular frequency of transverse optical phonons,  $\omega_L$  that of longitudinal optical phonons,  $\epsilon(0)$  is the static dielectric constant, and  $\epsilon(\infty)$  the dielectric constant at optical frequencies.

**Lyman series** - The series of lines in the spectrum of the hydrogen atom which corresponds to transitions between the ground state (principal quantum number  $n = 1$ ) and successive excited states. The wavelengths are given by  $1/\lambda = R_H(1-1/n^2)$ , where  $n = 2, 3, 4, \dots$  and  $R_H$  is the Rydberg constant for hydrogen. The first member of the series ( $n = 1 \leftrightarrow 2$ ), which is often called the Lyman- $\alpha$  line, falls at a wavelength of 1216 Å, and the series converges at 912 Å, the ionization limit of hydrogen.

**Mach number ( $Ma$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Ma = v/c$ , where  $v$  is velocity and  $c$  is the speed of sound. [2]

**Macromolecule** - A molecule of high relative molecular mass (molecular weight), the structure of which essentially comprises the multiple repetition of units derived, actually or conceptually, from molecules of low relative molecular mass. [8]

**Madelung constant\*** - A constant characteristic of a particular crystalline material which gives a measure of the electrostatic energy binding the ions in the crystal.

**Magnetic field strength ( $H$ )** - An axial vector quantity, the curl of which is equal to the current density, including the displacement current. [1]

**Magnetic induction ( $B$ )** - An axial vector quantity such that the force exerted on an element of current is equal to the vector product of this element and the magnetic induction. [1]

**Magnetic moment** - See Dipole moment, magnetic.

**Magnetic susceptibility ( $\chi_m, \kappa$ )\*** - Defined by  $\chi_m = (\mu - \mu_0)/\mu_0$ , where  $\mu$  is the permeability of the medium and  $\mu_0$  the permeability of a vacuum. [1]

**Magnetization ( $M$ )** - Defined by  $M = (B/\mu_0) - H$ , where  $B$  is magnetic induction,  $H$  magnetic field strength, and  $\mu_0$  the permeability of a vacuum. [1]

**Magnetogyric ratio ( $\gamma$ )** - Ratio of the magnetic moment of a particle to its angular momentum. Also called gyromagnetic ratio.

**Magneton** - See Bohr magneton, Nuclear magneton.

**Magnetostriction\*** - The change in dimensions of a solid sample when it is placed in a magnetic field.

**Magnon** - A quantum of magnetic energy associated with a spin wave in a ferromagnetic or antiferromagnetic crystal.

**Mantle** - The layer of the earth between the crust and the liquid outer core, which begins about 2900 km below the Earth's surface.

**Maser** - A device in which a microwave cavity is filled with a medium where a population inversion can be produced by some means. When the resonant frequency of the cavity bears the proper relation to the separation of the inverted energy levels, the device can serve as an amplifier or oscillator at that frequency.

**Mass ( $m$ )\*** - Quantity of matter. Mass can also be defined as "resistance to acceleration".

**Mass defect ( $B$ )** - Defined by  $B = Zm(^1\text{H}) + Nm_n - m_a$ , where  $Z$  is the atomic number,  $m(^1\text{H})$  is the mass of the hydrogen atom,  $N$  is the neutron number,  $m_n$  is the rest mass of the neutron, and  $m_a$  is the mass of the atom in question. Thus  $Bc^2$  can be equated to the binding energy of the nucleus if the binding energy of atomic electrons is neglected. [1]

**Mass excess ( $\Delta$ )** - Defined by  $\Delta = m_a - Am_u$ , where  $m_a$  is the mass of the atom,  $A$  the number of nucleons, and  $m_u$  the unified atomic mass constant ( $m_u = 1$  u). [1]

**Mass fraction ( $w_B$ )** - The ratio of the mass of substance B to the total mass of a mixture. [1]

**Mass number ( $A$ )** - A characteristic property of a specific isotope of an element, equal to the sum of the number of protons and neutrons in the nucleus.

**Mass spectrometry** - An analytical technique in which ions are separated according to the mass/charge ratio and detected by a suitable detector. The ions may be produced by electron impact on a gas, a chemical reaction, energetic vaporization of a solid, etc. [6]

**Massieu function** - A thermodynamic function defined by  $J = -A/T$ , where  $A$  is the Helmholtz energy and  $T$  the thermodynamic temperature. [2]

**Matthiessen's rule** - The statement that the electrical resistivity  $\rho$  of a metal can be written as  $\rho = \rho_L + \rho_i$ , where  $\rho_L$  is due to scattering of conduction electrons by lattice vibrations and  $\rho_i$  to scattering by impurities and imperfections. If the impurity concentration is small,  $\rho_i$  is temperature independent.

**Maxwell (Mx)\*** - A non-SI unit of magnetic field strength ( $H$ ) equal to  $10^{-8}$  Wb. [1]

**Maxwell's equations** - The fundamental equations of electromagnetism. In a form appropriate to SI units, they are:

$$\begin{aligned}\text{curl } H &= \partial D / \partial t + j \\ \text{div } B &= 0 \\ \text{curl } E &= -\partial B / \partial t \\ \text{div } D &= \rho\end{aligned}$$

where  $H$  is the magnetic field strength,  $B$  the magnetic induction,  $E$  the electric field strength,  $D$  the electric displacement,  $j$  the current density,  $\rho$  the charge density, and  $t$  is time.

**Maxwell-Boltzmann distribution** - An expression for the fraction of molecules  $f(v)$  in a gas that have velocity  $v$  within a specified interval. It takes the form

$$f(v) = 4\pi(M/2\pi RT)^{3/2} v^2 e^{-Mv^2/2RT}$$

where  $M$  is the molar mass,  $R$  the molar gas constant, and  $T$  the temperature.

**Mean free path\*** - The average distance a gas molecule travels between collisions.

**Meissner effect** - The complete exclusion of magnetic induction from the interior of a superconductor.

**Melting point\*** - The temperature at which the solid and liquid phases of a substance are in equilibrium at a specified pressure (normally taken to be atmospheric unless stated otherwise).

**Mercaptans** - A traditional term abandoned by IUPAC, synonymous with thiols. This term is still widely used. [5]

**Meson** - Any elementary particle that has zero or integral spin. Mesons are responsible for the forces between protons and neutrons in the nucleus.

**Mesosphere** - The part of the Earth's atmosphere extending from the top of the stratosphere (about 50 km above the surface) to 80–90 km. It is characterized by a decrease in temperature with increasing altitude.

**Metal** - A material in which the highest occupied energy band (conduction band) is only partially filled with electrons. The electrical conductivity of metals generally decreases with temperature.

**Metalloenes** - Organometallic coordination compounds in which one atom of a transition metal such as iron, ruthenium or osmium is bonded to and only to the face of two cyclopentadienyl ligands which lie in parallel planes. [5]

**Meter (m)\*** - The SI base unit of length. [1]

**Methine group** - In organic compounds, the  $-C=$  group. [5]

**Mho** - An archaic name for the SI unit siemens (reciprocal ohm).

**Micelle** - A particle formed by the aggregation of surfactant molecules (typically, 10 to 100 molecules) in solution. For aqueous solutions, the hydrophilic end of the molecule is on the surface of the micelle, while the hydrophobic end (often a hydrocarbon chain) points toward the center. At the critical micelle concentration (cmc) the previously dissolved molecules aggregate into a micelle.

**Micron ( $\mu$ )** - An obsolete name for micrometer.

**Mie scattering** - The scattering of light by spherical dielectric particles whose diameter is comparable to the wavelength of the light.

**Milky way** - The band of light in the night sky resulting from the stars in the galactic plane. The term is also used to denote the galaxy in which the sun is located.

**Miller indices ( $hkl$ )** - A set of indices used to label planes in a crystal lattice. [2]

**Millimeter of mercury (mmHg)** - A non-SI unit of pressure, equal to 133.322 Pa. The name is generally considered interchangeable with torr.

**Mobility ( $\mu$ )\*** - In solid state physics, the drift velocity of electrons or holes in a solid divided by the applied electric field strength. The term is used in a similar sense in other fields.

**Molality ( $m$ )** - A measure of concentration of a solution in which one states the amount of substance (i.e., number of moles) of solute per kilogram of solvent. Thus a 0.1 molal solution (often written as 0.1 m) has  $m = 0.1$  mol/kg.

**Molar mass** - The mass of one mole of a substance. It is normally expressed in units of g/mol, in which case its numerical value is identical with the molecular weight (relative molecular mass). [1]

**Molar quantity** - It is often convenient to express an extensive quantity (e.g., volume, enthalpy, heat capacity, etc.) as the actual value divided by amount of substance (number of moles). The resulting quantity is called molar volume, molar enthalpy, etc.

**Molar refraction ( $R$ )** - A property of a dielectric defined by the equation  $R = V_m [(n^2 - 1)/(n^2 + 2)]$ , where  $n$  is the index of refraction of the medium (at optical wavelengths) and  $V_m$  the molar volume. It is related to the polarizability  $\alpha$  of the molecules that make up the medium by the Lorenz-Lorentz equation,  $R = N_A \alpha / 3\epsilon_0$ , where  $N_A$  is Avogadro's constant and  $\epsilon_0$  is the permittivity of a vacuum.

**Molarity ( $c$ )** - A measure of concentration of a solution in which one states the amount of substance (i.e., number of moles) of solute per liter of solution. Thus a 0.1 molar solution (often referred to as 0.1 M) has a concentration  $c = 0.1$  mol/L.

**Mole (mol)\*** - The SI base unit of amount of substance. [1]

**Mole fraction ( $x_B$ )** - The ratio of the amount of substance (number of moles) of substance B to the total amount of substance in a mixture. [1]

**Molecular orbital** - See Orbital.

**Molecular weight ( $M_r$ )\*** - The ratio of the average mass per molecule or specified entity of a substance to 1/12 of the mass of nuclide  $^{12}\text{C}$ . Also called relative molar (or molecular) mass. [1]

**Moment of inertia ( $I$ )** - The moment of inertia of a body about an axis is the sum (or integral) of the products of its elements of mass and the squares of their distances from the axis. [1]

**Momentum ( $p$ )** - The product of mass and velocity. [1]

**Monomer** - A substance consisting of molecules which can undergo polymerization, thereby contributing constitutional units to the essential structure of a macromolecule. [8]

**Monosaccharides** - A term which includes aldoses, ketoses, and a wide variety of derivatives. [5]

**Mössbauer effect** - The recoilless emission of  $\gamma$ -rays from nuclei bound in a crystal under conditions where the recoil energy associated with the  $\gamma$  emission is taken up by the crystal as a whole. This results in a very narrow line width, which can be exploited in various types of precise measurements.

**Muon\*** - An unstable elementary particle of spin 1/2 and mass about 200 times that of the electron.

**Naphtha** - The petroleum fraction consisting mostly of  $C_6$  to  $C_8$  hydrocarbons and boiling in the range 80–120 °C. Solvents derived from this fraction include ligroin and petroleum ether.

**Nautical mile** - A non-SI unit of length, equal to exactly 1852 m.

**Navier-Stokes equations** - A set of complex equations for the motion of a viscous fluid subject to external forces.

**Néel temperature ( $T_N$ )\*** - The critical temperature above which an antiferromagnetic substance becomes paramagnetic. [1]

**Nernst effect** - The production of an electric field in a conductor subject to an applied magnetic field and containing a transverse temperature gradient. The electric field is perpendicular to the magnetic field and the temperature gradient.

**Network** - In polymer science, a highly ramified macromolecule in which essentially each constitutional unit is connected to each other constitutional unit and to the macroscopic phase boundary by many permanent paths through the macromolecule, the number of such paths increasing with the number of intervening bonds. The paths must on the average be coextensive with the macromolecule. [8]



**Neutrino** - A stable elementary particle in the lepton family. Neutrinos have zero (or at least near-zero) rest mass and spin 1/2.

**Neutron\*** - An elementary particle on spin 1/2 and zero charge. The free neutron has a mean lifetime of 887 seconds. Neutrons and protons, which are collectively called nucleons, are the constituents of the nucleus.

**Neutron activation analysis (NAA)** - See Techniques for Materials Characterization, page 12-1.

**Neutron number (N)** - A characteristic property of a specific isotope of an element, equal to the number of neutrons in the nucleus.

**Newton (N)\*** - The SI unit of force, equal to  $\text{m kg s}^{-2}$ . [1]

**Nitriles** - Compounds having the structure  $\text{RC}\equiv\text{N}$ ; thus C-substituted derivatives of hydrocyanic acid,  $\text{HC}\equiv\text{N}$ . [5]

**Nitrosamines** - N-Nitroso amines: compounds of the structure  $\text{R}_2\text{NNO}$ . Compounds  $\text{RNHNO}$  are not ordinarily isolatable, but they, too, are nitrosamines. The name is a contraction of N-nitrosoamine and, as such, does not require the N locant. [5]

**Nuclear magnetic resonance (NMR)\*** - A widely used technique in which the resonant absorption of radiofrequency radiation by magnetic nuclei in a magnetic field is measured. The results give important information on the local environment of each nucleus.

**Nuclear magneton ( $\mu_N$ )\*** - The unit of nuclear magnetic moment, defined as  $eh/4\pi m_p$ , where  $h$  is Planck's constant,  $m_p$  the proton mass, and  $e$  the elementary charge.

**Nuclear quadrupole resonance (NQR)** - See Techniques for Materials Characterization, page 12-1.

**Nuclear reaction analysis (NRA)** - See Techniques for Materials Characterization, page 12-1.

**Nuclear spin (I)** - The quantum number that specifies the intrinsic angular momentum of a particular nucleus. The magnitude of the angular momentum is given by  $[I(I+1)]^{1/2} h/2\pi$ , where  $h$  is Planck's constant.

**Nucleic acids\*** - Macromolecules, the major organic matter of the nuclei of biological cells, made up of nucleotide units, and hydrolyzable into certain pyrimidine or purine bases (usually adenine, cytosine, guanine, thymine, uracil), D-ribose or 2-deoxy-D-ribose. [5]

**Nucleon** - A collective term for the proton and neutron.

**Nucleosides** - Ribosyl or deoxyribosyl derivatives (rarely, other glycosyl derivatives) of certain pyrimidine or purine bases. They are thus glycosylamines or N-glycosides related to nucleotides by the lack of phosphorylation. [5]

**Nucleotides** - Compounds formally obtained by esterification of the 3' or 5' hydroxy group of nucleosides with phosphoric acid. They are the monomers of nucleic acids and are formed from them by hydrolytic cleavage. [5]

**Nuclide** - A species of atoms in which each atom has identical atomic number  $Z$  and identical mass number  $A$ . [3]

**Nusselt number (Nu)** - A dimensionless quantity used in fluid mechanics, defined by  $Nu = hl/k$ , where  $h$  is coefficient of heat transfer,  $l$  is length, and  $k$  is thermal conductivity. [2]

**Nyquist theorem** - An expression for the mean square thermal noise voltage across a resistor, given by  $4RkT\Delta f$  where  $R$  is the resistance,  $k$  the Boltzmann constant,  $T$  the temperature, and  $\Delta f$  the frequency band within which the voltage is measured.

**Octanol-water partition coefficient (P)\*** - A measure of the way in which a compound will partition itself between the octanol and water phases in the two-phase octanol-water system, and thus an indicator of certain types of biological activity. Specifically,  $P$  is the ratio of the concentration (in moles per liter) of the compound in the octanol phase to that in the water phase at infinite dilution. The quantity normally reported is  $\log P$ .

**Oersted (Oe)** - A non-SI unit of magnetic field ( $H$ ), equal to 79.57747 A/m.

**Ohm ( $\Omega$ )\*** - The SI unit of electric resistance, equal to V/A. [1]

**Ohm's law** - A relation among electric current  $I$ , potential difference  $V$ , and resistance  $R$ , viz.,  $I = V/R$ . At constant temperature the resistance for many materials is constant to high precision.

**Olefins** - Acyclic and cyclic hydrocarbons having one or more carbon-carbon double bonds, apart from the formal ones in aromatic compounds. The class olefins subsumes alkenes and cycloalkenes and the corresponding polyenes. [5]

**Oligomer** - A substance consisting of molecules of intermediate relative molecular mass (molecular weight), the structure of which essentially comprises the multiple repetition of units derived, actually or conceptually, from molecules of low relative molecular mass. In contrast to a polymer, the properties of an oligomer can vary significantly with the removal of one or a few of its units. [8]

**Oligopeptides** - Peptides containing from three to nine amino groups. [5]

**Onsager relations** - An important set of equations in the thermodynamics of irreversible processes. They express the symmetry between the transport coefficients describing reciprocal processes in systems with a linear dependence of flux on driving forces.

**Optical rotary power** - Angle by which the plane of polarization of a light beam is rotated by an optically active medium, divided by path length and by concentration of the active constituent. Depending on whether mass or molar concentration is used, the modifier "specific" or "molar" is attached. [2]

**Orbital** - A one-electron wavefunction. Atomic orbitals are classified as  $s$ -,  $p$ -,  $d$ -, or  $f$ -orbitals according to whether the angular momentum quantum number  $l = 0, 1, 2,$  or  $3$ . Molecular orbitals, which are usually constructed as linear combinations of atomic orbitals, describe the distribution of electrons over the entire molecule.

**Oscillator strength (f)** - A measure of the intensity of a spectroscopic transition, defined by

$$f = \frac{8\pi^2 M e v}{3 h e^2} |\mu_{ij}|^2$$

where  $\nu$  is the frequency,  $\mu_{ij}$  the transition dipole moment,  $m_e$  the mass of the electron,  $e$  the elementary charge, and  $h$  Planck's constant.

**Osmosis** - The flow of a solvent in a system in which two solutions of different concentration are separated by a semipermeable membrane which cannot pass solute molecules. The solvent will flow from the side of lower concentration to that of higher concentration, thus tending to equalize the concentrations. The pressure that must be applied to the more concentrated side to stop the flow is called the osmotic pressure.

**Osmotic coefficient ( $\phi$ )** - Defined by  $\phi = \ln a_A / (M_A \sum m_B)$ , where  $M_A$  is the molar mass of substance A (normally the solvent),  $a_A$  is its activity, and the  $m_B$  are molalities of the solutes. [1]

**Osmotic pressure ( $\Pi$ )** - The excess pressure necessary to maintain osmotic equilibrium between a solution and the pure solvent separated by a membrane permeable only to the solvent. In an ideal dilute solution  $\Pi = c_B RT$ , where  $c_B$  is the amount-of-substance concentration of the solute,  $R$  is the molar gas constant, and  $T$  the temperature. [1,2]

**Ostwald dilution law** - A relation for the concentration dependence of the molar conductivity  $\Lambda$  of an electrolyte solution, viz.,

$$\frac{1}{\Lambda} = \frac{1}{\Lambda^\circ} + \frac{\Lambda c}{K(\Lambda^\circ)^2}$$

where  $c$  is the solute concentration,  $K$  is the equilibrium constant for dissociation of the solute, and  $\Lambda^\circ$  is the conductivity at  $c\Lambda = 0$ .

**Ounce (oz)** - A non-SI unit of mass. The avoirdupois ounce equals 28.34952 g, while the troy ounce equals 31.10348 g.

**Overpotential ( $\eta$ )** - In an electrochemical cell, the difference between the potential of an electrode and its zero-current value.

**Oximes** - Compounds of structure  $R_2C=NOH$  derived from condensation of aldehydes or ketones with hydroxylamine. Oximes from aldehydes may be called aldioximes; those from ketones may be called ketoximes. [5]

**Oxo compounds** - Compounds containing an oxygen atom, =O, doubly bonded to carbon or another element. The term thus embraces aldehydes, carboxylic acids, ketones, sulfonic acids, amides and esters. [5]

**Ozonides** - The 1,2,4-trioxolanes formed by the reaction of ozone at a carbon-carbon double bond, or the analogous compounds derived from acetylenic compounds. [5]

**Pair production** - A process in which a photon is converted into a particle and its antiparticle (e.g., an electron and positron) in the electromagnetic field of a nucleus.

**Paraffins** - Obsolescent term for saturated hydrocarbons, commonly but not necessarily acyclic. Still widely used in the petrochemical industry, where the term designates acyclic saturated hydrocarbons, and stands in contradistinction to naphthenes. [5]

**Paramagnetism\*** - A type of magnetism characterized by a positive magnetic susceptibility, so that the material becomes weakly magnetized in the direction of an external field. The magnetization disappears when the field is removed. In the simplest approximation (Curie's law) the susceptibility is inversely proportional to temperature.

**Parity** - The property of a quantum-mechanical wave function that describes its behavior under the symmetry operation of coordinate inversion. A parity of +1 (or even) is assigned if the wave function does not change sign when the signs of all the coordinates are changed; the parity is -1 (or odd) if the wave function changes sign under this operation.

**Parsec (pc)** - A unit of distance defined as the distance at which 1 astronomical unit (AU) subtends an angle of 1 second of arc. It is equal to 206264.806 AU or  $3.085678 \times 10^{16}$  m.

**Particle induced x-ray emission (PIXE)** - See Techniques for Materials Characterization, page 12-1.

**Partition function ( $q, z$ )** - For a single molecule,  $q = \sum_i g_i \exp(\epsilon_i/kT)$ , where  $\epsilon_i$  is an energy level of degeneracy  $g_i$ ,  $k$  the Boltzmann constant, and  $T$  the absolute temperature; the summation extends over all energy states. For a system of  $N$  non-interacting molecules which are indistinguishable, as in an ideal gas, the canonical partition function  $Q = qN/N!$ .

**Pascal (Pa)\*** - The SI unit of pressure, equal to  $N/m^2$ . [1]

**Paschen series** - The series of lines in the spectrum of the hydrogen atom which corresponds to transitions between the state with principal quantum number  $n = 3$  and successive higher states. The wavelengths are given by  $1/\lambda = R_H(1/9 - 1/n^2)$ , where  $n = 4, 5, 6, \dots$  and  $R_H$  is the Rydberg constant. The first member of the series ( $n = 3 \leftrightarrow 4$ ), which is often called the  $P_\alpha$  line, falls in the infrared at a wavelength of 1.875  $\mu m$ .

**Paschen-Back effect** - In atomic spectroscopy, the decoupling of electron spin from orbital angular momentum as the strength of an external magnetic field is increased.

**Pauli exclusion principle** - The statement that two electrons in an atom cannot have identical quantum numbers; thus if there are two electrons in the same orbital, their spin quantum numbers must be of opposite sign.

**Pearson symbol** - A code for designating crystallographic information, including the crystal system, the lattice type, and the number of atoms per unit cell.

**Péclet number ( $Pe$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Pe = vl/a$ , where  $v$  is velocity,  $l$  is length, and  $a$  is thermal diffusivity. [2]

**Peltier effect** - The absorption or generation of heat (depending on the current direction) which occurs when an electric current is passed through a junction between two materials.

**Peptides** - Amides derived from two or more amino carboxylic acid molecules (the same or different) by formation of a covalent bond from the carbonyl carbon of one to the nitrogen atom of another with formal loss of water. [5]

**Permeability ( $\mu$ )** - Magnetic induction divided by magnetic field strength; i.e.  $\mu = B/H$ . The relative permeability  $\mu_r = \mu/\mu_0$ , where  $\mu_0$  is the permeability of a vacuum. [1]

**Permittivity ( $\epsilon$ )** - Ratio of the electric displacement in a medium to the electric field strength. Also called dielectric constant. [1]

**Peroxides** - Compounds of structure ROOR in which R may be any organic group. In inorganic chemistry, salts of the anion  $O_2^{-2}$  [5]

**Peroxy acids** - Acids in which an acidic -OH group has been replaced by an -OOH group; e.g.,  $CH_3C(=O)OOH$  peroxyacetic acid,  $PhS(=O)_2OOH$  benzeneperoxy sulfonic acid. [5]

**Petroleum ether** - The petroleum fraction consisting of  $C_5$  and  $C_6$  hydrocarbons and boiling in the range 35–60 °C; commonly used as a laboratory solvent.

**pH\*** - A convenient measure of the acid-base character of a solution, usually defined by  $pH = -\log [c(H^+)/mol L^{-1}]$ , where  $c(H^+)$  is the concentration of hydrogen ions. The more precise definition is in terms of activity rather than concentration. [2]

**Phenols** - Compounds having one or more hydroxy groups attached to a benzene or other arene ring. [5]

**Phonon** - A quantum of energy associated with a vibrational mode of a crystal lattice.

**Phosphines** -  $PH_3$  and compounds derived from it by substituting one, two or three hydrogen atoms by hydrocarbyl groups.

$\text{RPH}_2$ ,  $\text{R}_2\text{PH}$  and  $\text{R}_3\text{P}$  (R not equal to H) are called primary, secondary and tertiary phosphines, respectively. [5]

**Phosphonium compounds** - Salts (and hydroxides)  $[\text{R}_4\text{P}]^+\text{X}^-$  containing tetracoordinate phosphonium ion and the associated anion. [5]

**Phosphonium ylides** - Compounds having the structure  $\text{R}_3\text{P}^+-\text{C}=\text{R}_2 \rightleftharpoons \text{R}_3\text{P}=\text{CR}_2$ . Also known as Wittig reagents. [5]

**Phosphorescence** - The process by which a molecule is excited by light to a higher electronic state and then undergoes a radiationless transition to a state of different multiplicity from which it decays, after some delay, to the ground state. The emitted light is normally of longer wavelength than the exciting light because vibrational energy has been dissipated.

**Photoelectric effect** - The complete absorption of a photon by a solid with the emission of an electron.

**Photon** - An elementary particle of zero mass and spin 1/2. The photon is involved in electromagnetic interactions and is the quantum of electromagnetic radiation.

**Photon stimulated desorption (PSD)** - See Techniques for Materials Characterization, page 12-1.

**Pinacols** - Tetra(hydrocarbyl)ethane-1,2-diols,  $\text{R}_2\text{C}(\text{OH})\text{C}(\text{OH})\text{R}_2$ , of which the tetramethyl example is the simplest one and is itself commonly known as pinacol. [5]

**Pion** - An elementary particle in the family of mesons. Pions have zero spin and may be neutral or charged. They participate in the strong interaction which holds the nucleus together.

**pK\*** - The negative logarithm (base 10) of an equilibrium constant  $K$ . For  $\text{pK}_a$ , see Acid dissociation constant.

**Planck constant ( $h$ )\*** - The elementary quantum of action, which relates energy to frequency through the equation  $E = h\nu$ .

**Planck distribution** - See Black body radiation

**Planck function** - A thermodynamic function defined by  $Y = -G/T$ , where  $G$  is Gibbs energy and  $T$  thermodynamic temperature. [2]

**Plasma** - A highly ionized gas in which the charge of the electrons is balanced by the charge of the positive ions, so that the system as a whole is electrically neutral.

**Plasmon** - A quantum associated with a plasma oscillation in the electron gas of a solid.

**Point group\*** - A group of symmetry operations (rotations, reflections, etc.) that leave a molecule invariant. Every molecular conformation can be assigned to a specific point group, which plays a major role in determining the spectrum of the molecule.

**Poise (P)** - A non-SI unit of viscosity, equal to 0.1 Pa s.

**Poiseuille's equation** - A formula for the rate of flow of a viscous fluid through a tube:

$$\frac{dV}{dt} = \frac{(p_1^2 - p_2^2)\pi r^4}{16l\eta p_0}$$

where  $V$  is the volume as measured at pressure  $p_0$ ;  $p_1$  and  $p_2$  are the pressures at each end of the tube;  $r$  is the radius and  $l$  the length of the tube; and  $\eta$  is the viscosity.

**Poisson ratio ( $\mu$ )** - The absolute value of the ratio of the transverse strain to the corresponding axial strain resulting from uniformly distributed axial stress below the proportional limit (i.e., where Hooke's law is valid). [10]

**Polariton** - A quantum associated with the coupled modes of photons and optical phonons in an ionic crystal.

**Polarizability ( $\alpha$ )\*** - The change in dipole moment of a molecule produced by an external electric field; specifically,  $\alpha_{ab} = \partial p_a / \partial E_b$ , where  $p_a$  is the dipole moment component on the  $a$  axis and  $E_b$  is the component of the electric field strength along the  $b$  axis. [2]

**Polymer** - A substance composed of molecules of high relative molecular mass (molecular weight), the structure of which essentially comprises the multiple repetition of units derived, actually or conceptually, from molecules of low relative molecular mass. A single molecule of a polymer is called a macromolecule. [8]

**Polypeptides** - Peptides containing 10 or more amino acid residues. See also Peptides. [5]

**Polysaccharides** - Compounds consisting of a large number of monosaccharides linked glycosidically. This term is commonly used only for those containing more than ten monosaccharide residues. Also called glycans. [5]

**Porphyryns** - Natural pigments containing a fundamental skeleton of four pyrrole nuclei united through the  $\alpha$ -positions by four methine groups to form a macrocyclic structure (porphyrin is designated porphine in Chemical Abstracts indexes). [5]

**Positron** - The antiparticle of the electron. It has the same mass and spin as an electron, and an equal but opposite charge.

**Positronium** - The hydrogen-like "atom" formed from a positron nucleus and an electron. Its lifetime is very short because of annihilation of the positron and electron.

**Potential** - See Electric potential.

**Potential energy ( $E_p$ ,  $V$ ,  $U$ )** - The portion of the energy of a system that is associated with its position in a force field.

**Pound (lb)** - A non-SI unit of mass, equal to 0.4535924 kg.

**Power (P)** - Rate of energy transfer. For electrical circuits, this is equal to the product of current and potential difference,  $P = IV$ . [1]

**Poynting vector (S)** - For electromagnetic radiation, the vector product of the electric field strength and the magnetic field strength. [1]

**Prandtl number (Pr)** - A dimensionless quantity used in fluid mechanics, defined by  $Pr = \eta/\rho a$ , where  $\eta$  is viscosity,  $\rho$  is density, and  $a$  is thermal diffusivity. [2]

**Pressure\*** - Force divided by area. [1]

**Proteins** - Naturally occurring and synthetic polypeptides having molecular weights greater than about 10,000 (the limit is not precise). See also Peptides. [5]

**Proton\*** - A stable elementary particle of unit positive charge and spin 1/2. Protons and neutrons, which are collectively called nucleons, are the constituents of the nucleus.

**Pulsar** - A neutron star which rotates rapidly and emits electromagnetic radiation in regular pulses at a frequency related to the rotation period.

**Purine bases\*** - Purine and its substitution derivatives, especially naturally occurring examples. [5]

**Pyrimidine bases\*** - Pyrimidine and its substitution derivatives, especially naturally occurring examples. [5]

**Q-switching** - A technique for obtaining very high power from a laser by keeping the  $Q$  factor of the laser cavity low while the population inversion builds up, then suddenly increasing the  $Q$  to initiate the stimulated emission.

**Quad** - A unit of energy defined as  $10^{15}$  Btu, equal to approximately  $1.055056 \times 10^{18}$  J.



- Quadrupole moment** - A coefficient of the third term (after monopole and dipole) in the power series expansion of the electric potential of an array of charges. A nucleus of spin greater than 1/2 has a non-vanishing nuclear quadrupole moment which can interact with the electric field gradient of the surrounding electrons. Molecular quadrupole moments have an influence on intermolecular forces.
- Quality factor (Q)** - The ratio of the absolute value of the reactance of an electrical system to the resistance; thus a measure of the energy stored per cycle relative to the energy dissipated.
- Quantum yield** - In photochemistry, the number of moles transformed in a specific process, either physically (e.g., by emission of photons) or chemically, per mole of photons absorbed by the system. [3]
- Quark** - An elementary entity which has not been directly observed but is considered a constituent of protons, neutrons, and other hadrons.
- Quasar** - An extragalactic object emitting electromagnetic radiation at a very high power level and showing a very large red shift, thus indicating that the object is receding at a speed approaching the speed of light.
- Quasicrystal** - A solid having conventional crystalline properties but whose lattice does not display translational periodicity.
- Quaternary ammonium compounds** - Derivatives of ammonium compounds,  $\text{NH}_4^+ \text{Y}^-$ , in which all four of the hydrogens bonded to nitrogen have been replaced with hydrocarbyl groups. Compounds having a carbon-nitrogen double bond (i.e.  $\text{R}_2\text{C}=\text{N}^+\text{R}_2\text{Y}^-$ ) are more accurately called iminium compounds. [5]
- Quinones** - Compounds having a fully conjugated cyclic dione structure, such as that of benzoquinones, derived from aromatic compounds by conversion of an even number of  $-\text{CH}=\text{}$  groups into  $-\text{C}(=\text{O})-$  groups with any necessary rearrangement of double bonds. [5]
- Racemic mixture** - A mixture of equal amounts of a pair of enantiomers (optical isomers); such a mixture is not optically active.
- Rad** - A non-SI unit of absorbed dose of radiation, equal to 0.01 Gy.
- Radiance (L)** - The radiant intensity in a given direction from an element of a surface, divided by the area of the orthogonal projection of this element on a plane perpendicular to the given direction. [1]
- Radiant intensity (I)** - The radiant energy flux leaving an element of a source within an element of solid angle, divided by that element of solid angle. [1]
- Radicals** - Molecular entities possessing an unpaired electron, such as  $\cdot\text{CH}_3$ ,  $\cdot\text{SnH}_3$ ,  $\cdot\text{Cl}$ . (In these formulas the dot, symbolizing the unpaired electron, should be placed so as to indicate the atom of highest spin density, if this is possible). [5]
- Raman effect** - The inelastic scattering of light by a molecule, in which the incident photon either gives up to, or receives energy from, one of the internal vibrational modes of the molecule. The scattered light thus has either a lower frequency (Stokes radiation) or higher frequency (anti-Stokes radiation) than the incident light. These shifts provide a measure of the normal vibrational frequencies of the molecule.
- Rankine cycle** - A thermodynamic cycle which can be used to calculate the ideal performance of a heat engine that uses a condensable vapor as the working fluid (e.g., a steam engine or a heat pump).
- Rankine temperature** - A thermodynamic temperature scale based on a temperature interval  $^\circ\text{R} = (5/9) \text{K}$ ; i.e.,  $T/^\circ\text{R} = (9/5)T/\text{K} = t/^\circ\text{F} + 459.67$ .
- Raoult's law** - The expression for the vapor pressure  $p_i$  of component  $i$  in an ideal solution, viz.,  $p_i = x_i p_{i0}$ , where  $x_i$  is the mole fraction of component  $i$  and  $p_{i0}$  the vapor pressure of the pure substance  $i$ .
- Rare earth elements** - The elements Sc, Y, and the lanthanides (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu). [7]
- Rayleigh number (Ra)** - A dimensionless quantity used in fluid mechanics, defined by  $Ra = \beta g \alpha \Delta T \rho / \eta a$ , where  $l$  is length,  $g$  is acceleration of gravity,  $\alpha$  is cubic expansion coefficient,  $T$  is temperature,  $\rho$  is density,  $\eta$  is viscosity, and  $a$  is thermal diffusivity. [2]
- Rayleigh scattering** - The scattering of light by particles which are much smaller than the wavelength of the light. It is characterized by a scattered intensity which varies as the inverse fourth power of the wavelength.
- Rayleigh wave** - A guided elastic wave along the surface of a solid; also called surface acoustic wave.
- Reactance (X)** - The imaginary part of impedance. For an inductive reactance  $L$  and a capacitive reactance  $C$  in series, the reactance is  $X = L\omega - 1/(C\omega)$ , where  $\omega$  is  $2\pi$  times the frequency of the current. [1]
- Red shift** - A displacement of a spectral line toward longer wavelengths. This can occur through the Doppler effect (e.g., in the light from receding galaxies) or, in the general theory of relativity, from the effects of a star's gravitational field.
- Reflectance (p)** - Ratio of the radiant or luminous flux at a given wavelength that is reflected to that of the incident radiation. Also called reflection factor. [1]
- Reflection high energy electron diffraction (RHEED)** - See Techniques for Materials Characterization, page 12-1.
- Relative humidity\*** - The ratio of the partial pressure of water vapor in air to the saturation vapor pressure of water at the same temperature, expressed as a percentage. [10]
- Relative molar mass** - See Molecular weight.
- Rem** - A non-SI unit of dose equivalent, equal to 0.01 Sv.
- Resistance (R)** - Electric potential difference divided by current when there is no electromotive force in the conductor. This definition applies to direct current. More generally, resistance is defined as the real part of impedance. [1]
- Resistivity (p)** - Electric field strength divided by current density when there is no electromotive force in the conductor. Resistivity is an intrinsic property of a material. For a conductor of uniform cross section with area  $A$  and length  $L$ , and whose resistance is  $R$ , the resistivity is given by  $\rho = RA/L$ . [1]
- Reynolds number (Re)** - A dimensionless quantity used in fluid mechanics, defined by  $Re = \rho v l / \eta$ , where  $\rho$  is density,  $v$  is velocity,  $l$  is length, and  $\eta$  is viscosity. [2]
- Rheology** - The study of the flow of liquids and deformation of solids. Rheology addresses such phenomena as creep, stress relaxation, anelasticity, nonlinear stress deformation, and viscosity.
- Ribonucleic acids (RNA)** - Naturally occurring polyribonucleotides. See also nucleic acids, nucleosides, nucleotides, ribonucleotides. [5]
- Ribonucleotides** - Nucleotides in which the glycosyl group is a ribosyl group. See also nucleotides. [5]

**Roentgen (R)** - A unit used for expressing the charge (positive or negative) liberated by x-ray or  $\gamma$  radiation in air, divided by the mass of air. A roentgen is defined as  $2.58 \times 10^{-4}$  C/kg.

**Rotational constants** - In molecular spectroscopy, the constants appearing in the expression for the rotational energy levels as a function of the angular momentum quantum numbers. These constants are proportional to the reciprocals of the principal moments of inertia, averaged over the vibrational motion.

**Rutherford back scattering (RBS)** - See Techniques for Materials Characterization, page 12-1.

**Rydberg constant ( $R_\infty$ )**\* - The fundamental constant which appears in the equation for the energy levels of hydrogen-like atoms; i.e.,  $E_n = hcR_\infty Z^2\mu/n^2$ , where  $h$  is Planck's constant,  $c$  the speed of light,  $Z$  the atomic number,  $\mu$  the reduced mass of nucleus and electron, and  $n$  the principal quantum number ( $n = 1, 2, \dots$ ).

**Rydberg series** - A regular series of lines in the spectrum of an atom or molecule, with the spacing between successive lines becoming smaller as the frequency increases (wavelength decreases). The series eventually converges to a limit which usually corresponds to the complete removal of an electron from the atom or molecule.

**Sackur-Tetrode equation**\* - An equation for the molar entropy  $S_m$  of an ideal monatomic gas:  $S_m = R \ln(e^{5/2} V/N_A \Lambda^3)$ , where  $R$  is the molar gas constant,  $V$  is the volume, and  $N_A$  is Avogadro's number. The constant  $\Lambda$  is given by  $\Lambda = h/(2\pi mkT)^{1/2}$ , where  $h$  is Planck's constant,  $m$  the atomic mass,  $k$  the Boltzmann constant, and  $T$  the temperature.

**Salinity (S)**\* - A parameter used in oceanography to describe the concentration of dissolved salts in seawater. It is defined in terms of electrical conductivity relative to a standard solution of KCl. When expressed in units of parts per thousand,  $S$  may be roughly equated to the concentration of dissolved material in grams per kilogram of seawater.

**Salt** - An ionic compound formed by the reaction of an acid and a base.

**Scanned probe microscopy (SPM)** - See Techniques for Materials Characterization, page 12-1.

**Scanning electron microscopy (SEM)** - See Techniques for Materials Characterization, page 12-1.

**Scanning laser acoustic microscopy (SLAM)** - See Techniques for Materials Characterization, page 12-1.

**Scanning transmission electron microscopy (STEM)** - See Techniques for Materials Characterization, page 12-1.

**Scanning tunneling microscopy (STM)** - See Techniques for Materials Characterization, page 12-1.

**Schiff bases** - Imines bearing a hydrocarbyl group on the nitrogen atom:  $R_2C=NR'$  ( $R'$  not equal to H). Considered by many to be synonymous with azomethines. [5]

**Schmidt number (Sc)** - A dimensionless quantity used in fluid mechanics, defined by  $Sc = \eta/\rho D$ , where  $\eta$  is viscosity,  $\rho$  is density, and  $D$  is diffusion coefficient. [2]

**Schottky barrier** - A potential barrier associated with a metal-semiconductor contact. It forms the basis for the rectifying device known as the Schottky diode.

**Schrödinger equation** - The basic equation of wave mechanics which, for systems not dependent on time, takes the form:

$$-(\hbar/2m)\nabla^2\psi + V\psi = E\psi$$

where  $\psi$  is the wavefunction,  $V$  is the potential energy expressed as a function of the spatial coordinates,  $E$  is an energy eigenvalue,  $\nabla^2$  is the Laplacian operator,  $\hbar$  is Planck's constant divided by  $2\pi$ , and  $m$  is the mass.

**Second (s)**\* - The SI base unit of time. [1]

**Second radiation constant ( $c_2$ )**\* - See First radiation constant.

**Secondary ion mass spectroscopy (SIMS)** - See Techniques for Materials Characterization, page 12-1.

**Seebeck effect** - The development of a potential difference in a circuit where two different metals or semiconductors are joined and their junctions maintained at different temperatures. It is the basis of the thermocouple.

**Selenides** - Compounds having the structure RSeR (R not equal to H). They are thus selenium analogues of ethers. Also used for metal salts of  $H_2Se$ . [5]

**Semicarbazones** - Compounds having the structure  $R_2C=NNHC(=O)NH_2$ , formally derived by condensation of aldehydes or ketones with semicarbazide  $[NH_2NHC(=O)NH_2]$ . [5]

**Semiconductor** - A material in which the highest occupied energy band (valence band) is completely filled with electrons at  $T = 0$  K, and the energy gap to the next highest band (conduction band) ranges from 0 to 4 or 5 eV. With increasing temperature electrons are excited into the conduction band, leading to an increase in the electrical conductivity.

**Semiquinones** - Radical anions having the structure -O-Z-O- where Z is an ortho- or para-arylene group or analogous heteroarylene group; they are formally generated by the addition of an electron to a quinone. [5]

**SI units**\* - The International System of Units adopted in 1960 and recommended for use in all scientific and technical fields. [1]

**Siemens (S)**\* - The SI unit of electric conductance, equal to  $\Omega^{-1}$ . [1]

**Sievert (Sv)**\* - The SI unit of dose equivalent (of radiation), equal to J/kg. [1]

**Silanes** - Saturated silicon hydrides, analogues of the alkanes; i.e., compounds of the general formula  $Si_nH_{2n+2}$ . Silanes may be subdivided into silane, oligosilanes, and polysilanes. Hydrocarbyl derivatives are often referred to loosely as silanes. [5]

**Silicones** - Polymeric or oligomeric siloxanes, usually considered unbranched, of general formula  $[-OSiR_2-]_n$  (R not equal to H). [5]

**Siloxanes** - Saturated silicon-oxygen hydrides with unbranched or branched chains of alternating silicon and oxygen atoms (each silicon atom is separated from its nearest silicon neighbors by single oxygen atoms). [5]

**Skin effect** - The concentration of high frequency alternating currents near the surface of a conductor.

**Slater orbital** - A particular mathematical expression for the radial part of the wave function of a single electron, which is used in quantum-mechanical calculations of the energy and other properties of atoms and molecules.

**Small angle neutron scattering (SANS)** - See Techniques for Materials Characterization, page 12-1.

**Snell's law** - The relation between the angle of incidence  $i$  and the angle of refraction  $r$  of a light beam which passes from a medium of refractive index  $n_0$  to a medium of index  $n_1$ , viz.,  $\sin i/\sin r = n_1/n_0$ .

**Solar constant**\* - The mean radiant energy flux from the sun on a unit surface normal to the direction of the rays at the mean

distance of the earth from the sun. The value is approximately  $1373 \text{ W/m}^2$ .

**Solar wind** - The stream of high velocity hydrogen and helium ions emitted by the sun which flows through the solar system and beyond.

**Soliton** - A spatially localized wave in a solid or liquid that can interact strongly with other solitons but will afterwards regain its original form.

**Solubility\*** - A quantity expressing the maximum concentration of some material (the solute) that can exist in another liquid or solid material (the solvent) at thermodynamic equilibrium at specified temperature and pressure. Common measures of solubility include the mass of solute per unit mass of solution (mass fraction), mole fraction of solute, molality, molarity, and others.

**Solubility product constant ( $K_{sp}$ )\*** - The equilibrium constant for the dissolution of a sparsely soluble salt into its constituent ions.

**Space group\*** - A group of symmetry operations (reflections, rotations, etc.) that leave a crystal invariant. A total of 230 space groups have been identified.

**Spark source mass spectroscopy (SSMS)** - See Techniques for Materials Characterization, page 12-1.

**Specific gravity** - Ratio of the mass density of a material to that of water. Since one must specify the temperature of both the sample and the water to have a precisely defined quantity, the use of this term is now discouraged.

**Specific heat** - Heat capacity divided by mass. See Heat capacity.

**Specific quantity** - It is often convenient to express an extensive quantity (e.g., volume, enthalpy, heat capacity, etc.) as the actual value divided by mass. The resulting quantity is called specific volume, specific enthalpy, etc.

**Specific rotation  $[\alpha]_D^\theta$**  - For an optically active substance, defined by  $[\alpha]_D^\theta = \alpha/\gamma l$ , where  $\alpha$  is the angle through which plane polarized light is rotated by a solution of mass concentration  $\gamma$  and path length  $l$ . Here  $\theta$  is the Celsius temperature and  $\lambda$  the wavelength of the light at which the measurement is carried out. Also called specific optical rotatory power. [2]

**Spin ( $s, I$ )\*** - A measure of the intrinsic angular momentum of a particle, which it possesses independent of its orbital motion. The symbol  $s$  is used for the spin quantum number of an electron, while  $I$  is generally used for nuclear spin.

**Spiro compounds** - Compounds having one atom (usually a quaternary carbon) as the only common member of two rings. [5]

**Stacking fault** - An error in the normal sequence of layer growth in a crystal.

**Standard mean ocean water (SMOW)** - A standard sample of pure water of accurately known isotopic composition which is maintained by the International Atomic Energy Agency. It is used for precise calibration of density and isotopic composition measurements.

**Standard reduction potential ( $E^\circ$ )** - The zero-current potential of a cell in which the specified reduction reaction occurs at the right-hand electrode and the left-hand electrode is the standard hydrogen electrode. Also called Standard electrode potential.

**Standard state** - A defined state (specified temperature, pressure, concentration, etc.) for tabulating thermodynamic functions and carrying out thermodynamic calculations. The standard

state pressure is usually taken as  $100,000 \text{ Pa}$  (1 bar), but various standard state temperatures are used. [2]

**Stanton number ( $St$ )** - A dimensionless quantity used in fluid mechanics, defined by  $St = h/\rho v c_p$ , where  $h$  is coefficient of heat transfer,  $\rho$  is density,  $v$  is velocity, and  $c_p$  is specific heat capacity at constant pressure. [2]

**Stark effect** - The splitting of an energy level of an atom or molecule, and hence a splitting of spectral lines arising from that level, as a result of the application of an external electric field.

**Statistical weight ( $g$ )** - The number of distinct states corresponding to the same energy level. Also called degeneracy.

**Stefan-Boltzmann constant ( $\sigma$ )\*** - Constant in the equation for the radiant exitance  $M$  (radiant energy flux per unit area) from a black body at thermodynamic temperature  $T$ , viz.  $M = \sigma T^4$ . [1]

**Stibines** -  $\text{SbH}_3$  and compounds derived from it by substituting one, two or three hydrogen atoms by hydrocarbyl groups:  $\text{R}_3\text{Sb}$ ,  $\text{RSbH}_2$ ,  $\text{R}_2\text{SbH}$ , and  $\text{R}_3\text{Sb}$  (R not equal to H) are called primary, secondary and tertiary stibines, respectively. [5]

**Stochastic process** - A process which involves random variables and whose outcome can thus be described only in terms of probabilities.

**Stoichiometric number ( $\nu$ )** - The number appearing before the symbol for each compound in the equation for a chemical reaction. By convention, it is negative for reactants and positive for products. [2]

**Stokes (St)** - A non-SI unit of kinematic viscosity, equal to  $10^{-4} \text{ m}^2/\text{s}$ .

**Stokes' law** - The statement, valid under certain conditions, that the viscous force  $F$  experienced by a sphere of radius  $a$  moving at velocity  $v$  in a medium of viscosity  $\eta$  is given by  $F = -6\pi\eta av$ .

**Strain** - The deformation of a body that results from an applied stress.

**Stratosphere** - The part of the earth's atmosphere extending from the top of the troposphere (typically 10 to 15 km above the surface) to about 50 km. It is characterized by an increase in temperature with increasing altitude.

**Stress** - Force per unit area (pressure) applied to a body. Tensile stress tends to stretch or compress the body in the direction of the applied force. Shear stress results from a tangential force which tends to twist the body.

**Strong interaction** - The short range (order of 1 fm) attractive forces between protons, neutrons, and other hadrons which are responsible for the stability of the nucleus.

**Strouhal number ( $Sr$ )** - A dimensionless quantity used in fluid mechanics, defined by  $Sr = lf/v$ , where  $l$  is length,  $f$  is frequency, and  $v$  is velocity. [2]

**Structure factor** - In x-ray crystallography, the sum of the scattering factors of all the atoms in a unit cell, weighted by an appropriate phase factor. The intensity of a given reflection is proportional to the square of the structure factor.

**Sublimation pressure** - The pressure of a gas in equilibrium with a solid at a specified temperature.

**Sulfides** - Compounds having the structure  $\text{RSR}$  (R not equal to H). Such compounds were once called thioethers. In an inorganic sense, salts or other derivatives of hydrogen sulfide. [5]

**Sulfones** - Compounds having the structure,  $\text{RS(=O)}_2\text{R}$  (R not equal to H), e.g.  $\text{C}_2\text{H}_5\text{S(=O)}_2\text{CH}_3$ , ethyl methyl sulfone. [5]



**Sulfonic acids** -  $\text{HS(=O)}_2\text{OH}$ , sulfonic acid, and its *S*-hydrocarbyl derivatives. [5]

**Sulfoxides** - Compounds having the structure  $\text{R}_2\text{S=O}$  (R not equal to H), e.g.,  $\text{Ph}_2\text{S=O}$ , diphenyl sulfoxide. [5]

**Superconductor** - A material that experiences a nearly total loss of electrical resistivity below a critical temperature  $T_c$ . The effect can occur in pure metals, alloys, semiconductors, organic compounds, and certain inorganic solids.

**Superfluid** - A fluid with near-zero viscosity and extremely high thermal conductivity. Liquid helium exhibits these properties below 2.186 K (the  $\lambda$  point).

**Supernova** - A star in the process of exploding because of instabilities which follow the exhaustion of its nuclear fuel.

**Surface analysis by laser ionization (SALI)** - See Techniques for Materials Characterization, page 12-1.

**Surface tension ( $\gamma, \sigma$ )\*** - The force per unit length in the plane of the interface between a liquid and a gas, which resists an increase in the area of that surface. It can also be equated to the surface Gibbs energy per unit area.

**Surfactant** - A substance which lowers the surface tension of the medium in which it is dissolved, and/or the interfacial tension with other phases, and accordingly is positively adsorbed at the liquid-vapor or other interfaces. [3]

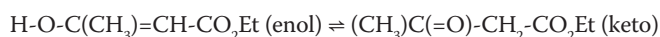
**Susceptance ( $B$ )** - Imaginary part of admittance. [1]

**Svedberg** - A non-SI unit of time, used to express sedimentation coefficients, equal to  $10^{-13}$  s.

**Syndiotactic macromolecule** - A tactic macromolecule, essentially comprising alternating enantiomeric configurational base units which have chiral or prochiral atoms in the main chain in a unique arrangement with respect to their adjacent constitutional units. In this case the repeating unit consists of two configurational base units that are enantiomeric. [8]

**Tacticity** - The orderliness of the succession of configurational repeating units of a macromolecule or oligomer molecule. In a tactic macromolecule essentially all the configurational repeating units are identical with respect to directional sense. See Configurational repeating unit, Isotactic, Syndiotactic. [8]

**Tautomerism** - Isomerism of the general form  $\text{G-X-Y=Z} \rightleftharpoons \text{X=Y-Z-G}$ , where the isomers (called tautomers) are readily interconvertible; the atoms connecting the groups X, Y, Z are typically any of C, H, O, or S, and G is a group which becomes an electrofuge (i.e., a group that does not carry away the bonding electron pair when it leaves its position in the molecule) or nucleofuge (a group that does carry away the bonding electrons when leaving) during isomerization. The commonest case, when the electrofuge is  $\text{H}^+$ , is also known as prototropy. A common example, written so as to illustrate the general pattern given above, is keto-enol tautomerism, such as



In some cases the interconversion rate between tautomers is slow enough to permit isolation of the separate keto and enol forms. [5]

**Tensile strength\*** - In tensile testing, the ratio of maximum load a body can bear before breaking to original cross-sectional area. Also called ultimate strength. [11]

**Terpenes** - Hydrocarbons of biological origin having carbon skeletons formally derived from isoprene [ $\text{CH}_2=\text{C(CH}_3\text{)CH=CH}_2$ ]. [5]

**Terpenoids** - Natural products and related compounds formally derived from isoprene units. They contain oxygen in various functional groups. The skeleton of terpenoids may differ from strict additivity of isoprene units by the loss or shift of a methyl (or other) group. [5]

**Tesla (T)\*** - The SI unit of magnetic flux density ( $B$ ), equal to  $\text{Vs/m}^2$ . [1]

**Thermal conductivity\*** - Rate of heat flow divided by area and by temperature gradient. [1]

**Thermal diffusivity** - Thermal conductivity divided by density and by specific heat capacity at constant pressure. [1]

**Thermal expansion coefficient ( $\alpha$ )\*** - The linear expansion coefficient is defined by  $\alpha_l = (1/l)(dl/dT)$ ; the volume expansion coefficient by  $\alpha_v = (1/V)(dV/dT)$ . [1]

**Thermionic emission** - The emission of electrons from a solid as a result of heat. The effect requires a high enough temperature to impart sufficient kinetic energy to the electrons to exceed the work function of the solid.

**Thermodynamic laws** - The foundation of the science of thermodynamics:

**First law:** The internal energy of an isolated system is constant; if energy is supplied to the system in the form of heat  $dq$  and work  $dw$ , then the change in energy  $dU = dq + dw$ .

**Second law:** No process is possible in which the only result is the transfer of heat from a reservoir and its complete conversion to work.

**Third law:** The entropy of a perfect crystal approaches zero as the thermodynamic temperature approaches zero.

**Thermoelectric power** - For a bar of a pure material whose ends are at different temperatures, the potential difference divided by the difference in temperature of the ends. See also Seebeck effect.

**Thermogravimetric analysis (TGA)** - See Techniques for Materials Characterization, page 12-1.

**Thermosphere** - The layer of the Earth's atmosphere extending from the top of the mesosphere (typically 80–90 km above the surface) to about 500 km. It is characterized by a rapid increase in temperature with increasing altitude up to about 200 km, followed by a leveling off in the 300–500 km region.

**Thiols** - Compounds having the structure  $\text{RSH}$  (R not equal to H). Also known by the term mercaptans (abandoned by IUPAC); e.g.,  $\text{CH}_3\text{CH}_2\text{SH}$ , ethanethiol. [5]

**Thomson coefficient ( $\mu, \tau$ )** - The heat power developed in the Thomson effect (whereby heat is evolved in a conductor when a current is flowing in the presence of a temperature gradient), divided by the current and the temperature difference. [1]

**Tonne (t)** - An alternative name for megagram (1000 kg). [1]

**Torque ( $T$ )** - For a force  $F$  that produces a torsional motion,  $T = r \times F$ , where  $r$  is a vector from some reference point to the point of application of the force.

**Torr** - A non-SI unit of pressure, equal to 133.322 Pa. The name is generally considered interchangeable with millimeter of mercury.

**Townsend coefficient** - In a radiation counter, the number of ionizing collisions by an electron per unit path length in the direction of an applied electric field.

**Transducer** - Any device that converts a signal from acoustical, optical, or some other form of energy into an electrical signal (or vice versa) while preserving the information content of the original signal.

**Transistor** - A voltage amplifier using controlled electron currents inside a semiconductor.

**Transition metals** - Elements characterized by a partially filled  $d$  subshell. The First Transition Series comprises Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu. The Second and Third Transition Series include the lanthanides and actinides, respectively. [7]

**Transition probability\*** - See Einstein transition probability.

**Transmittance ( $\tau$ )** - Ratio of the radiant or luminous flux at a given wavelength that is transmitted to that of the incident radiation. Also called transmission factor. [1]

**Tribology** - The study of frictional forces between solid surfaces.

**Triple point\*** - The point in  $p, T$  space where the solid, liquid, and gas phases of a substance are in thermodynamic equilibrium. The corresponding temperature and pressure are called the triple point temperature and triple point pressure.

**Troposphere** - The lowest part of the earth's atmosphere, extending to 10–15 km above the surface. It is characterized by a decrease in temperature with increasing altitude. The exact height varies with latitude and season.

**Tunnel diode** - A device involving a p-n junction in which both sides are so heavily doped that the Fermi level on the p-side lies in the valence band and on the n-side in the conduction band. This leads to a current-voltage curve with a maximum, so that the device exhibits a negative resistance in some regions.

**Ultraviolet photoelectron spectroscopy (UPS)** - See Techniques for Materials Characterization, page 12-1.

**Umklapp process** - A process involving the interaction of three or more waves (lattice or electron) in a solid in which the sum of the wave vectors does not equal zero.

**Unified atomic mass unit ( $u$ )\*** - A unit of mass used in atomic, molecular, and nuclear science, defined as the mass of one atom of  $^{12}\text{C}$  divided by 12. Its approximate value is  $1.66054 \times 10^{-27}$  kg. [1]

**Universal time ( $t_U$ , UT)** - Mean solar time counted from midnight at the Greenwich meridian. Also called Greenwich mean time (GMT). The interval of mean solar time is based on the average, over one year, of the time between successive transits of the sun across the observer's meridian.

**Vacancy** - A missing atom or ion in a crystal lattice.

**Van Allen belts** - Two toroidal regions above the earth's atmosphere containing protons and electrons. The outer belt at about 25,000 km above the surface is probably of solar origin. The inner belt at about 3000 km contains more energetic particles from outside the solar system.

**Van der Waals' equation\*** - An equation of state for fluids which takes the form:

$$pV_m = RT \left( \frac{1}{V_m - b} - \frac{a}{V_m^2} \right)$$

where  $p$  is pressure,  $V_m$  is molar volume,  $T$  is temperature,  $R$  is the molar gas constant, and  $a$  and  $b$  are characteristic parameters of the substance which describe the effect of attractive and repulsive intermolecular forces, respectively.

**Van der Waals' force** - The weak attractive force between two molecules which arises from electric dipole interactions. It can lead to the formation of stable but weakly bound dimer molecules or clusters.

**Van't Hoff equation** - The equation expressing the temperature dependence of the equilibrium constant  $K$  of a chemical reaction:

$$\frac{d \ln K}{dT} = \frac{\Delta_r H^\circ}{RT^2}$$

where  $\Delta_r H^\circ$  is the standard enthalpy of reaction,  $R$  the molar gas constant, and  $T$  the temperature. Also called van't Hoff isochore.

**Vapor pressure\*** - The pressure of a gas in equilibrium with a liquid (or, in some usage, a solid) at a specified temperature.

**Varistor** - A device that utilizes the properties of certain metal oxides with small amounts of impurities, which show abrupt nonlinearities at specific voltages where the material changes from a semiconductor to an insulator.

**Velocity ( $v$ )** - Rate of change of distance with time.

**Verdet constants ( $V$ )\*** - Angle of rotation of a plane polarized light beam passing through a medium in a magnetic field, divided by the field strength and by the path length.

**Virial equation of state\*** - An equation relating the pressure  $p$ , molar volume  $V_m$ , and temperature  $T$  of a real gas in the form of an expansion in powers of the molar volume, viz.,  $pV_m = RT(1 + BV_m^{-1} + CV_m^{-2} + \dots)$ , where  $R$  is the molar gas constant.  $B$  is called the second virial coefficient,  $C$  the third virial coefficient, etc. The virial coefficients are functions of temperature.

**Viscosity ( $\eta$ )\*** - The proportionality factor between sheer rate and sheer stress, defined through the equation  $F = \eta A(dv/dx)$ , where  $F$  is the tangential force required to move a planar surface of area  $A$  at velocity  $v$  relative to a parallel surface separated from the first by a distance  $x$ . Sometimes called dynamic or absolute viscosity. The term kinematic viscosity (symbol  $\nu$ ) is defined as  $\eta$  divided by the mass density.

**Volt ( $V$ )\*** - The SI unit of electric potential, equal to W/A. [1]

**Volume fraction ( $\phi$ )** - Defined as  $V_j/\sum_i V_i$ , where  $V_j$  is the volume of the specified component and the  $V_i$  are the volumes of all the components of a mixture prior to mixing. [2]

**Watt ( $W$ )\*** - The SI unit of power, equal to J/s. [1]

**Wave function** - A function of the coordinates of all the particles in a quantum mechanical system (and, in general, of time) which fully describes the state of the system. The product of the wave function and its complex conjugate is proportional to the probability of finding a particle at a particular point in space.

**Weak interaction** - The weak forces (order of  $10^{-12}$  of the strong interaction) between elementary particles which are responsible for beta decay and other nuclear effects.

**Weber ( $Wb$ )\*** - The SI unit of magnetic flux, equal to V s. [1]

**Weber number ( $We$ )** - A dimensionless quantity used in fluid mechanics, defined by  $We = \rho v^2 l / \gamma$ , where  $\rho$  is density,  $v$  is velocity,  $l$  is length, and  $\gamma$  is surface tension. [2]

**Weight** - That force which, when applied to a body, would give it an acceleration equal to the local acceleration of gravity. [1]

**Wiedeman-Franz law** - The law stating that the thermal conductivity  $k$  and electrical conductivity  $\sigma$  of a pure metal are related by  $k = L\sigma T$ , where  $T$  is the temperature and  $L$  (called the Lorenz ratio) has the approximate value  $2.45 \times 10^{-8}$  V<sup>2</sup>/K<sup>2</sup>.

**Wien displacement law** - The relation, which can be derived from the Planck formula for black body radiation, that



$\lambda_{\max} T = 0.0028978 \text{ m K}$ , where  $\lambda_{\max}$  is the wavelength of maximum radiance at temperature  $T$ .

**Wigner-Seitz method** - A method of calculating electron energy levels in a solid using a model in which each electron is subject to a spherically symmetric potential.

**Wittig reagents** - See phosphonium ylides.

**Work (W)** - Force multiplied by the displacement in the direction of the force. [1]

**Work function ( $\Phi$ )\*** - The energy difference between an electron at rest at infinity and an electron at the Fermi level in the interior of a substance. It is thus the minimum energy required to remove an electron from the interior of a solid to a point just outside the surface. [1]

**X unit (X)** - A unit of length used in x-ray crystallography, equal to approximately  $1.002 \times 10^{-13} \text{ m}$ .

**X-ray photoelectron spectroscopy (XPS)** - See Techniques for Materials Characterization, page 12-1.

**Yield strength** - The stress at which a material exhibits a specified deviation (often chosen as 0.2% for metals) from proportionality of stress and strain. [11]

**Young's modulus (E)** - In tension or compression of a body below its elastic limit, the ratio of stress to corresponding strain. Since strain is normally expressed on a fractional basis, Young's modulus has dimensions of pressure. Also called elastic modulus. [11]

**Zeeman effect** - The splitting of an energy level of an atom or molecule, and hence a splitting of spectral lines arising from that level, as a result of the application of an external magnetic field.

**Zener diode** - A control device utilizing a p-n junction with a well defined reverse-bias avalanche breakdown voltage.

**Zeotrope** - A liquid mixture that shows no maximum or minimum when vapor pressure is plotted against composition at constant temperature. See Azeotrope.

**Zero-point energy** - The energy possessed by a quantum mechanical system as a result of the uncertainty principle even when it is in its lowest energy state; e.g., the difference between the lowest energy level of a harmonic oscillator and the minimum in the potential well.

**Zeta potential ( $\zeta$ )** - The electric potential at the surface of a colloidal particle relative to the potential in the bulk medium at a long distance. Also called electrokinetic potential.

**Zwitterions** - Neutral compounds having formal unit electrical charges of opposite sign. Some chemists restrict the term to compounds with the charges on non-adjacent atoms. Sometimes referred to as inner salts, dipolar ions (a misnomer). [5]

## THERMODYNAMIC FUNCTIONS AND RELATIONS

$p$  = pressure       $V$  = volume       $T$  = temperature

$n_i$  = amount of substance  $i$

$x_i = n_i / \sum_j n_j$  = mole fraction of substance  $i$

Energy	$U$
Entropy	$S$
Enthalpy	$H = U + pV$
Helmholtz energy	$A = U - TS$
Gibbs energy	$G = U + pV - TS$
Isobaric heat capacity	$C_p = (\partial H / \partial T)_p$
Isochoric heat capacity	$C_v = (\partial U / \partial T)_v$
Isobaric expansivity	$\alpha = V^{-1}(\partial V / \partial T)_p$
Isothermal compressibility	$\kappa_T = -V^{-1}(\partial V / \partial p)_T$
Isentropic compressibility	$\kappa_S = -V^{-1}(\partial V / \partial p)_S$
	$\kappa_T - \kappa_S = T\alpha^2 V / C_p$
	$C_p - C_v = T\alpha^2 V / \kappa_T$
Gibbs-Helmholtz equation	$H = G - T(\partial G / \partial T)_p$
Maxwell relations	$(\partial S / \partial p)_T = -(\partial V / \partial T)_p$
	$(\partial S / \partial V)_T = -(\partial p / \partial T)_v$
Joule-Thomson expansion	$\mu_{JT} = (\partial T / \partial p)_H = -\{V - T(\partial V / \partial T)_p\} / C_p$
	$\Phi_{JT} = (\partial H / \partial p)_T = V - T(\partial V / \partial T)_p$
Partial molar quantity	$X_i = (\partial X / \partial n_i)_{T,p,n_j \neq i}$
Chemical potential	$\mu_i = (\partial G / \partial n_i)_{T,p,n_j \neq i}$
Perfect gas [symbol <sup>pg</sup> ]	$pV = (\sum_i n_i)RT$
	$\mu_i^{pg} = \mu_i^\theta + RT \ln(x_i p / p^\theta)$
Fugacity	$f_i = (x_i p) \exp\{(\mu_i - \mu_i^{pg}) / RT\}$
Activity coefficient	$\gamma_i = f_i / (x_i f_i^\theta)$
Gibbs-Duhem relation	$0 = SdT - Vdp + \sum_i n_i d\mu_i$

[Superscript  $\theta$  in above equations indicates standard state]

Notation for chemical and physical changes ( $X = H, S, G$ , etc.):

Chemical reaction	$\Delta_r X$
Formation from elements	$\Delta_f X$
Combustion	$\Delta_c X$
Fusion (cry $\rightarrow$ liq)	$\Delta_{fus} X$
Vaporization (liq $\rightarrow$ gas)	$\Delta_{vap} X$
Sublimation (cry $\rightarrow$ gas)	$\Delta_{sub} X$
Phase transition	$\Delta_{trs} X$
Solution	$\Delta_{sol} X$
Mixing	$\Delta_{mix} X$
Dilution	$\Delta_{dil} X$

# REPRESENTATION OF CHEMICAL STRUCTURES WITH THE IUPAC INTERNATIONAL CHEMICAL IDENTIFIER (INCHI)

Stephen R. Heller and Alan D. McNaught

The IUPAC International Chemical Identifier (InChI) is a freely available, non-proprietary identifier for chemical substances that can be used in both printed and electronic data sources. It is generated from a computerized representation of a molecular structure diagram, which can be produced by chemical structure-drawing software. Its use enables linking of diverse data compilations and unambiguous identification of chemical substances. A full description of the Identifier and software for its generation are available from the IUPAC Web site (Ref. 1), and a helpful compilation of answers to frequently asked questions has been put together at the Unilever Centre for Molecular Science Informatics (Ref. 2). Commercial structure-drawing software that will generate the Identifier is available from several organizations, listed on the IUPAC Web site.

The conversion of structural information to the Identifier is based on a set of IUPAC structure conventions, and rules for normalization and canonicalization (conversion to a single, predictable sequence) of an input structure representation. The resulting InChI is simply a series of characters that serve to uniquely identify the structure from which it was derived. The InChI uses a layered format to represent all available structural information relevant to compound identity. InChI layers are listed below. Each layer in an InChI representation contains a specific type of structural information. These layers, automatically extracted from the input structure, are designed so that each successive layer adds additional detail to the Identifier. The specific layers generated depend on the level of structural detail available and whether or not allowance is made for tautomerism. Of course, any ambiguities or uncertainties in the original structure will remain in the InChI.

This layered structure design offers a number of advantages. If two structures for the same substance are drawn at different levels of detail, the one with the lower level of detail will, in effect, be contained within the other. Specifically, if one substance is drawn with stereo-bonds and the other without, the layers in the latter will be a subset of the former. The same will hold for compounds treated by one author as tautomers and by another as exact structures with all H-atoms fixed. This can work at a finer level. For example, if one author includes double bond and tetrahedral stereochemistry, but another omits stereochemistry, the latter InChI will be contained in the former.

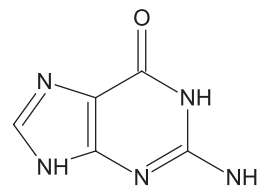
The InChI layers are

1. Formula
2. Connectivity (no formal bond orders)
  - a. disconnected metals
  - b. connected metals
3. Isotopes
4. Stereochemistry
  - a. double bond (Z/E)
  - b. tetrahedral (sp<sup>3</sup>)
5. Tautomers (on or off)

Charges are not part of the basic InChI, but rather are added at the end of the InChI string.

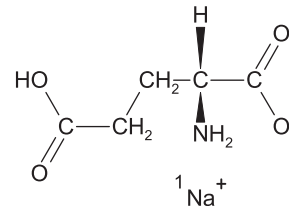
Two examples of InChI representations are given below. It is important to recognize, however, that InChI strings are intended for use by computers and end users need not understand any of their

details. In fact, the open nature of InChI and its flexibility of representation, after implementation into software systems, may allow chemists to be even less concerned with the details of structure representation by computers.



guanine

InChI=1/C5H5N5O/c6-5-9-3-2(4(11)10-5)7-1-8-3/h1H,(H4,6,7,8,9,10,11)/f/h8,10H,6H2



monosodium glutamate

InChI=1/C5H9NO4.Na/c6-3(5(9)10)1-2-4(7)8;/h3H,1-2,6H2,(H,7,8)(H,9,10);/q;+1/p-1/t3-;/m1./s1/fC5H8NO4.Na/h7H;/q-1;m

The layers in the InChI string are separated by the '/' character followed by a lowercase letter (except for the first layer, the chemical formula), with the layers arranged in predefined order. In the examples the following segments are included

InChI version number

/- chemical formula

/c connectivity-1.1 (excluding terminal H)

/h connectivity-1.2 (locations of terminal H, including mobile H attachment points)

/q charge

/p proton balance

/t sp<sup>3</sup> (tetrahedral) parity

/m parity inverted to obtain relative stereo (1 = inverted, 0 = not inverted)

/s stereo type (1 = absolute, 2 = relative, 3 = racemic)

/f chemical formula of the fixed-H structure if it is different

/h connectivity-2 (locations of fixed mobile H)

/q charge

/t sp<sup>3</sup> (tetrahedral) parity

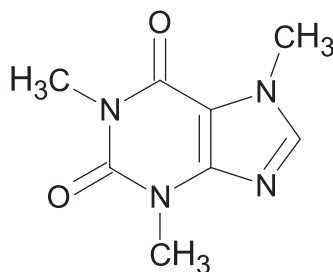
/m parity inverted to obtain relative stereo (1 = inverted, 0 = not inverted, . = inversion does not affect the parity)

/s stereo type (1 = absolute, 2 = relative, 3 = racemic)

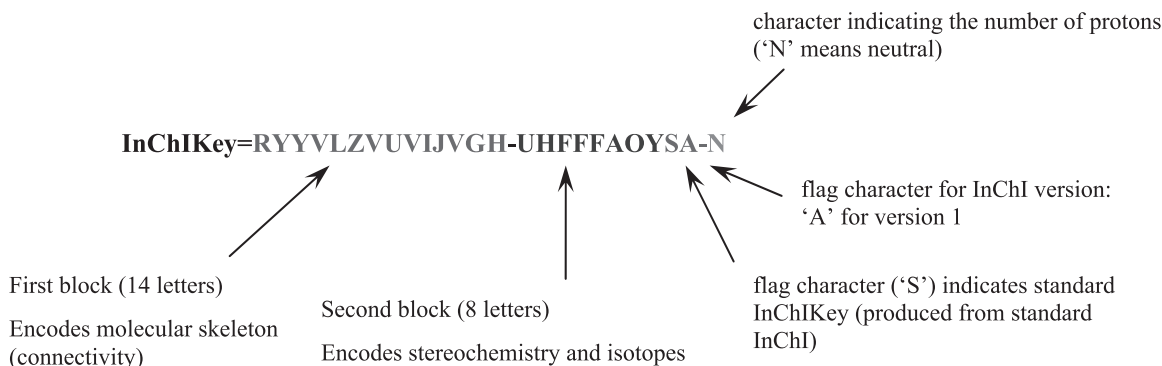
One of the most important applications of InChI is the facility to locate mention of a chemical substance using Internet-based search

engines. This is made easier by using a shorter (compressed) form of InChI, known as InChIKey. The InChIKey is a 27-character representation that, because it is compressed, cannot be reconverted into the original structure, but it is not subject to the undesirable and unpredictable breaking of longer character strings by some search en-

gines. The usefulness of the InChIKey as a search tool is enhanced by its derivation from a "standard" InChI. i.e., an InChI produced with standard option settings for features such as tautomerism and stereochemistry. An example is shown below; the "standard" InChI is denoted by the letter "S" after the version number.



InChI=1S/C8H10N4O2/c1-10-4-9-6-5(10)7(13)12(3)8(14)11(6)2/h4H,1-3H3 (caffeine)



Use of InChIKey also allows searches based solely on atomic connectivity (first 14 characters). Software for generating InChIKey is available from the IUPAC Web site (Ref. 1).

The enormous databases compiled by organizations such as PubChem (Ref. 4), the U.S. National Cancer Institute (NCI), and ChemSpider (Ref. 5) contain millions of InChIs and InChIKeys, which allow sophisticated searching of these collections. PubChem provides InChI-based structure-search facilities for both identical and similar structures (Ref. 6), and ChemSpider offers both search facilities and Web services enabling a variety of InChI and InChIKey conversions (Ref. 7). The NCI Chemical Structure Lookup Service (Ref. 8) provides InChI-based search access to over 39 million chemical structures from over 80 different public and commercial data sources.

## References

1. <http://www.iupac.org/inchi>
2. <http://wwmm.ch.cam.ac.uk/inchifaq/>
3. *Pure Appl. Chem.*, in preparation.
4. <http://pubchem.ncbi.nlm.nih.gov>
5. <http://www.chemspider.com>
6. <http://pubchem.ncbi.nlm.nih.gov/search>
7. <http://www.chemspider.com/InChI.aspx>
8. <http://cholla.chemnavigator.com/cgi-bin/lookup/new/search>

## EXPRESSION OF UNCERTAINTY OF MEASUREMENTS

In general, the result of a measurement is only an approximation or estimate of the true value of the quantity subject to measurement, and thus the result is of limited value unless accompanied by a statement of its uncertainty. Much (but not all) of the scientific data appearing in the literature does include some indication of the uncertainty, but this may be stated in many different ways and is often explained poorly. In an effort to encourage consistency in uncertainty statements, the International Committee for Weights and Measures (CIPM) initiated a project, in collaboration with several other international organizations, to prepare a set of guidelines expressing international consensus on the recommended method of stating uncertainties. This project resulted in the publication of the *Guide to the Expression of Uncertainty in Measurement* (Reference 1), which is often referred to as *GUM*. The recommendations of *GUM* have been summarized by the National Institute of Standards and Technology in *NIST Technical Note 1297, Guidelines for Evaluating the Uncertainty of NIST Measurement Results* (Reference 2).

In the notation of *GUM*, we are concerned with the **measurand**, i.e., the quantity that is being measured. In physics and chemistry this is usually called a **physical quantity** and represents some inherent characteristic of a material, system, or process that can be expressed in numerical terms — specifically as the product of a number and a reference, commonly called a **unit**. Thus the density of water at room temperature is (approximately) 0.998 g/mL (grams per milliliter) or, alternatively 998 kg m<sup>-3</sup> (kilograms per meter cubed). This statement gives the most likely value of the measurand, to this level of precision, but gives no information on how much the stated value might differ from the true value.

It is important to differentiate between the terms **error** and **uncertainty**. The error in a measurement is the difference between the measured value and the true value; the error can be stated if the true value is known (to some level of accuracy). The uncertainty is an estimate of the maximum reasonable extent to which the measured value is believed to deviate from the true value, in a situation where the true value is not known (most often the case). The result of a measurement can unknowably be very close to the true value, and thus have negligible error, even though its uncertainty is large.

The uncertainty of the result of a measurement generally consists of several components, which may be grouped in two types according to the method used to estimate their numerical values:

**Type A. Those which are evaluated by statistical methods**

**Type B. Those which are evaluated by other means**

The terms “random uncertainty” and “systematic uncertainty” are often used, but these terms do not always correspond in a simple way to the A and B categories. This is because the nature of an uncertainty component is conditioned by how the quantity appears in the mathematical model that describes the current measurement process. An uncertainty component arising from a systematic effect may in some cases be evaluated by methods of Type A while in other cases by methods of Type B.

In the *GUM* formulation, each component of uncertainty, whether in the A or B category, is represented by an estimated standard deviation, termed **standard uncertainty**, symbol  $u_j$ , and equal to the positive square root of the estimated variance  $u_j^2$ .

For an uncertainty component of Type A,  $u_i = s_i$ , where  $s_i$  is the statistically estimated standard deviation, as determined from a

series of observations by appropriate statistical analysis. Any valid statistical method may be used. Examples are calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to data in order to estimate parameters of the curve and their standard deviations; and carrying out an analysis of variance (ANOVA) in order to identify and quantify random effects in certain types of measurements. Details of statistical analysis are given in References 4–7 and many other places.

In a similar manner, each uncertainty component of Type B is represented by a quantity  $u_j$ , which is obtained from an assumed probability distribution based on all the available information about the measurement process. Since  $u_j$  is treated like a standard deviation, the standard uncertainty in each Type B component is simply  $u_j$ . The evaluation of  $u_j$  is usually based on scientific judgment using all the relevant information available, which may include

- previous measurement data
- experience with, or general knowledge of, the behavior and properties of relevant materials and instruments
- manufacturer’s specifications
- data provided in calibrations and other reports
- uncertainties assigned to reference data taken from handbooks.

The specific approach to evaluating the standard uncertainty  $u_j$  of a Type B uncertainty will depend on the detailed model of the measurement process. The following are examples of steps that may be used:

1. Convert a quoted uncertainty (for example, in a calibration factor) that is a stated multiple of an estimated standard deviation to a standard uncertainty by dividing the quoted uncertainty by the multiplier.
2. Convert a quoted uncertainty that defines a “confidence interval” having a stated level of confidence, such as 95% or 99%, to a standard uncertainty by treating the quoted uncertainty as if a normal distribution had been used to calculate it (unless otherwise indicated) and dividing it by the appropriate factor for such a distribution. These factors are 1.960 and 2.576 for the two levels of confidence given.
3. Model knowledge of the quantity in question by a normal distribution and estimate lower and upper limits  $a_-$  and  $a_+$  such that the best estimated value of the quantity is  $(a_- + a_+)/2$  (i.e., the midpoint of the limits) and there is 1 chance out of 2 (i.e., a 50 percent probability) that the value of the quantity lies in the interval  $a_-$  to  $a_+$ . Then  $u_j \approx 1.48 a$ , where  $a = (a_+ - a_-)/2$  is the half-width of the interval.
4. Model knowledge of the quantity in question by a normal distribution and estimate lower and upper limits  $a_-$  and  $a_+$  such that the best estimated value of the quantity is  $(a_- + a_+)/2$  and there is about a 2 out of 3 chance (i.e., a 67 percent probability) that the value of the quantity lies in the interval  $a_-$  to  $a_+$ . Then  $u_j \approx a$ , where  $a = (a_+ - a_-)/2$ .
5. Estimate lower and upper limits  $a_-$  and  $a_+$  for the value of the quantity in question such that the probability that the value lies in the interval  $a_-$  to  $a_+$  is, for all practical purposes, 100 percent. Provided that there is no contradictory information, treat the quantity as if it is equally probable for its value to lie anywhere within the interval  $a_-$  to  $a_+$ ;

that is, model it by a uniform or rectangular probability distribution. The best estimate of the value of the quantity is then  $(a_+ + a_-)/2$  with  $u_j = a/\sqrt{3}$  where  $a = (a_+ - a_-)/2$ . If the distribution used to model the quantity is triangular rather than rectangular, then  $u_j = a/\sqrt{6}$ . The rectangular distribution is a reasonable default model in the absence of any other information. But if it is known that values of the quantity in question near the center of the limits are more likely than values close to the limits, a triangular or a normal distribution may be a better model.

When all the standard uncertainties of Type A and Type B have been determined in this way, they should be combined to produce the **combined standard uncertainty** (suggested symbol  $u_c$ ), which may be regarded as the estimated standard deviation of the measurement result. This process, often called the *law of propagation of uncertainty* or “root-sum-of-squares,” involves taking the square root of the sum of the squares of all the  $u_i$ . In many practical measurement situations, the probability distribution characterized by the measurement result  $y$  and its combined standard uncertainty  $u_c(y)$  is approximately normal (Gaussian). When this is the case,  $u_c(y)$  defines an interval  $y - u_c(y)$  to  $y + u_c(y)$  about the measurement result  $y$  within which the value of the measurand  $Y$  estimated by  $y$  is believed to lie with a level of confidence of approximately 68 percent. That is, it is believed with an approximate level of confidence of 68 percent that  $y - u_c(y) \leq Y \leq y + u_c(y)$ , which is commonly written as  $Y = y \pm u_c(y)$ .

In fundamental metrological research (involving physical constants, calibration standards, and the like) the combined standard uncertainty  $u_c$  is normally used as the statement of uncertainty in a measurement. In most cases, however, it is desirable to use a measure of uncertainty that defines an interval about the measurement result  $y$  within which the value of the measurand  $Y$  is confidently believed to lie. The measure of uncertainty intended to meet this requirement is termed **expanded uncertainty**, suggested symbol  $U$ , and is obtained by multiplying  $u_c(y)$  by a **coverage factor**, suggested symbol  $k$ . Thus  $U = ku_c(y)$  and it is believed with high confidence that  $y - U \leq Y \leq y + U$ , which is commonly written as  $Y = y \pm U$ . The value of the coverage factor  $k$  is chosen on the basis of the desired level of confidence to be associated with the interval defined by  $U = ku_c$ . Typically,  $k$  is in the range 2 to 3. When the normal distribution applies,  $U = 2u_c$  (i.e.,  $k = 2$ ) defines an interval having a level of confidence of approximately 95 percent, and  $U = 3u_c$  defines an interval having a confidence level greater than 99 percent. In current international practice it is most common to use  $k = 2$ , corresponding to about 95 percent confidence, but the

value of  $k$  should be stated in each case to avoid confusion. See References 1 and 2 for methods of calculating  $k$  when a value other than  $k = 2$  is needed for a specific requirement.

## Summary of Key Steps

- Group the uncertainty components into Type A (can be evaluated by statistical methods) and Type B (must be evaluated by other means).
- Determine the standard uncertainty for each component of Type A by statistical methods and for each component of Type B by other suitable methods, based on modeling the measurement process.
- Take the square root of the sum of the squares of all the standard uncertainties to get the combined standard uncertainty  $u_c$ .
- Specify a coverage factor  $k$  which, when multiplied by  $u_c$ , gives the expanded uncertainty  $U$ . In fundamental metrological research  $k = 1$  is usually chosen; in other cases,  $k = 2$  (corresponding to a confidence level of about 95%) is the most common choice.

## References

1. ISO, *Guide to the Expression of Uncertainty in Measurement*, International Organization for Standardization, Geneva, Switzerland, 1993. Several supplements have been published; see Bich, W., Cox, M. C., and Harris, P. M., “Evolution of the *Guide to the Expression of Uncertainty in Measurement*,” *Metrologia* 43, S161, 2006.
2. Taylor, B. N., and Kuyatt, C. E., *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, NIST Technical Note 1297, National Institute of Standards and Technology, Gaithersburg, MD, 1994; available for free download at <physics.nist.gov/cuu/Uncertainty/bibliography.html>.
3. Bell, S., *A Beginner’s Guide to Uncertainty of Measurement*, National Physical Laboratory, Teddington, Middlesex, UK, 2001; available on the Internet through <www.npl.co.uk/server.php?show=ConWebDoc.1785>.
4. Eisenhart, C., “Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems,” *J. Res. Natl. Bur. Stand. (U.S.)* 67C, 161, 1963.
5. Mandel, J., *The Statistical Analysis of Experimental Data*, Dover Publishers, New York, 1984.
6. Nantrella, M. G., *Experimental Statistics*, NBS Handbook 91, U.S. Government Printing Office, Washington, DC, 1966.
7. Box, G. E. P., Hunter, J. S., and Hunter, W. G., *Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition*, John Wiley & Sons, Hoboken, NJ, 2005.



## NOBEL LAUREATES IN CHEMISTRY AND PHYSICS

Full details on nationality and basis of the awards can be found at <[nobelprize.org/](http://nobelprize.org/)>.

### Chemistry

2008	Martin Chalfie, Osamu Shimomura, Roger Y. Tsien	1954	Linus Pauling
2007	Gerhard Ertl	1953	Hermann Staudinger
2006	Roger D. Kornberg	1952	Archer J.P. Martin, Richard L.M. Synge
2005	Yves Chauvin, Robert H. Grubbs, Richard R. Schrock	1951	Edwin M. McMillan, Glenn T. Seaborg
2004	Aaron Ciechanover, Avram Hershko, Irwin Rose	1950	Otto Diels, Kurt Alder
2003	Peter Agre, Roderick MacKinnon	1949	William F. Giauque
2002	John B. Fenn, Koichi Tanaka, Kurt Wüthrich	1948	Arne Tiselius
2001	William S. Knowles, Ryoji Noyori, K. Barry Sharpless	1947	Sir Robert Robinson
2000	Alan Heeger, Alan G. MacDiarmid, Hideki Shirakawa	1946	James B. Sumner, John H. Northrop, Wendell M. Stanley
1999	Ahmed Zewail	1945	Artturi Virtanen
1998	Walter Kohn, John Pople	1944	Otto Hahn
1997	Paul D. Boyer, John E. Walker, Jens C. Skou	1943	George de Hevesy
1996	Robert F. Curl Jr., Sir Harold Kroto, Richard E. Smalley	1942	<i>No prize awarded</i>
1995	Paul J. Crutzen, Mario J. Molina, F. Sherwood Rowland	1941	<i>No prize awarded</i>
1994	George A. Olah	1940	<i>No prize awarded</i>
1993	Kary B. Mullis, Michael Smith	1939	Adolf Butenandt, Leopold Ruzicka
1992	Rudolph A. Marcus	1938	Richard Kuhn
1991	Richard R. Ernst	1937	Norman Haworth, Paul Karrer
1990	Elias James Corey	1936	Peter Debye
1989	Sidney Altman, Thomas R. Cech	1935	Frédéric Joliot, Irène Joliot-Curie
1988	Johann Deisenhofer, Robert Huber, Hartmut Michel	1934	Harold C. Urey
1987	Donald J. Cram, Jean-Marie Lehn, Charles J. Pedersen	1933	<i>No prize awarded</i>
1986	Dudley R. Herschbach, Yuan T. Lee, John C. Polanyi	1932	Irving Langmuir
1985	Herbert A. Hauptman, Jerome Karle	1931	Carl Bosch, Friedrich Bergius
1984	Bruce Merrifield	1930	Hans Fischer
1983	Henry Taube	1929	Arthur Harden, Hans von Euler-Chelpin
1982	Aaron Klug	1928	Adolf Windaus
1981	Kenichi Fukui, Roald Hoffmann	1927	Heinrich Wieland
1980	Paul Berg, Walter Gilbert, Frederick Sanger	1926	The Svedberg
1979	Herbert C. Brown, Georg Wittig	1925	Richard Zsigmondy
1978	Peter Mitchell	1924	<i>No prize awarded</i>
1977	Ilya Prigogine	1923	Fritz Pregl
1976	William Lipscomb	1922	Francis W. Aston
1975	John Cornforth, Vladimir Prelog	1921	Frederick Soddy
1974	Paul J. Flory	1920	Walther Nernst
1973	Ernst Otto Fischer, Geoffrey Wilkinson	1919	<i>No prize awarded</i>
1972	Christian Anfinsen, Stanford Moore, William H. Stein	1918	Fritz Haber
1971	Gerhard Herzberg	1917	<i>No prize awarded</i>
1970	Luis Leloir	1916	<i>No prize awarded</i>
1969	Derek Barton, Odd Hassel	1915	Richard Willstätter
1968	Lars Onsager	1914	Theodore W. Richards
1967	Manfred Eigen, Ronald G.W. Norrish, George Porter	1913	Alfred Werner
1966	Robert S. Mulliken	1912	Victor Grignard, Paul Sabatier
1965	Robert B. Woodward	1911	Marie Curie
1964	Dorothy Crowfoot Hodgkin	1910	Otto Wallach
1963	Karl Ziegler, Giulio Natta	1909	Wilhelm Ostwald
1962	Max F. Perutz, John C. Kendrew	1908	Ernest Rutherford
1961	Melvin Calvin	1907	Eduard Buchner
1960	Willard F. Libby	1906	Henri Moissan
1959	Jaroslav Heyrovsky	1905	Adolf von Baeyer
1958	Frederick Sanger	1904	Sir William Ramsay
1957	Lord Todd	1903	Svante Arrhenius
1956	Sir Cyril Hinshelwood, Nikolay Semenov	1902	Emil Fischer
1955	Vincent du Vigneaud	1901	Jacobus H. van't Hoff

## Physics

2008	Makoto Kobayashi, Toshihide Maskawa, Yoichiro Nambu	1957	Chen Ning Yang, Tsung-Dao Lee
2007	Albert Fert, Peter Grünberg	1956	William B. Shockley, John Bardeen, Walter H. Brattain
2006	John C. Mather, George F. Smoot	1955	Willis E. Lamb, Polykarp Kusch
2005	Roy J. Glauber, John L. Hall, Theodor W. Hänsch	1954	Max Born, Walther Bothe
2004	David J. Gross, H. David Politzer, Frank Wilczek	1953	Frits Zernike
2003	Alexei A. Abrikosov, Vitaly L. Ginzburg, Anthony J. Leggett	1952	Felix Bloch, E. M. Purcell
2002	Raymond Davis Jr., Masatoshi Koshihira, Riccardo Giacconi	1951	John Cockcroft, Ernest T.S. Walton
2001	Eric A. Cornell, Wolfgang Ketterle, Carl E. Wieman	1950	Cecil Powell
2000	Zhores I. Alferov, Herbert Kroemer, Jack S. Kilby	1949	Hideki Yukawa
1999	Gerardus't Hooft, Martinus J.G. Veltman	1948	Patrick M.S. Blackett
1998	Robert B. Laughlin, Daniel C. Tsui	1947	Edward V. Appleton
1997	Steven Chu, Claude Cohen-Tannoudji, William D. Phillips	1946	Percy W. Bridgman
1996	David M. Lee, Douglas D. Osheroff, Robert C. Richardson	1945	Wolfgang Pauli
1995	Martin L. Perl, Frederick Reines	1944	Isidor Isaac Rabi
1994	Bertram N. Brockhouse, Clifford G. Shull	1943	Otto Stern
1993	Russell A. Hulse, Joseph H. Taylor Jr.	1942	<i>No prize awarded</i>
1992	Georges Charpak	1941	<i>No prize awarded</i>
1991	Pierre-Gilles de Gennes	1940	<i>No prize awarded</i>
1990	Jerome I. Friedman, Henry W. Kendall, Richard E. Taylor	1939	Ernest Lawrence
1989	Norman F. Ramsey, Hans G. Dehmelt, Wolfgang Paul	1938	Enrico Fermi
1988	Leon M. Lederman, Melvin Schwartz, Jack Steinberger	1937	Clinton Davisson, George Paget Thomson
1987	J. Georg Bednorz, K. Alex Müller	1936	Victor F. Hess, Carl D. Anderson
1986	Ernst Ruska, Gerd Binnig, Heinrich Rohrer	1935	James Chadwick
1985	Klaus von Klitzing	1934	<i>No prize awarded</i>
1984	Carlo Rubbia, Simon van der Meer	1933	Erwin Schrödinger, Paul A.M. Dirac
1983	Subramanyan Chandrasekhar, William A. Fowler	1932	Werner Heisenberg
1982	Kenneth G. Wilson	1931	<i>No prize awarded</i>
1981	Nicolaas Bloembergen, Arthur L. Schawlow, Kai M. Siegbahn	1930	Sir Venkata Raman
1980	James Cronin, Val Fitch	1929	Louis de Broglie
1979	Sheldon Glashow, Abdus Salam, Steven Weinberg	1928	Owen Willans Richardson
1978	Pyotr Kapitsa, Arno Penzias, Robert Woodrow Wilson	1927	Arthur H. Compton, C.T.R. Wilson
1977	Philip W. Anderson, Sir Nevill F. Mott, John H. van Vleck	1926	Jean Baptiste Perrin
1976	Burton Richter, Samuel C.C. Ting	1925	James Franck, Gustav Hertz
1975	Aage N. Bohr, Ben R. Mottelson, James Rainwater	1924	Manne Siegbahn
1974	Martin Ryle, Antony Hewish	1923	Robert A. Millikan
1973	Leo Esaki, Ivar Giaever, Brian D. Josephson	1922	Niels Bohr
1972	John Bardeen, Leon N. Cooper, Robert Schrieffer	1921	Albert Einstein
1971	Dennis Gabor	1920	Charles Edouard Guillaume
1970	Hannes Alfvén, Louis Néel	1919	Johannes Stark
1969	Murray Gell-Mann	1918	Max Planck
1968	Luis Alvarez	1917	Charles Glover Barkla
1967	Hans Bethe	1916	<i>No prize awarded</i>
1966	Alfred Kastler	1915	William Bragg, Lawrence Bragg
1965	Sin-Itiro Tomonaga, Julian Schwinger, Richard P. Feynman	1914	Max von Laue
1964	Charles H. Townes, Nicolay G. Basov, Aleksandr M. Prokhorov	1913	Heike Kamerlingh Onnes
1963	Eugene Wigner, Maria Goeppert-Mayer, J. Hans D. Jensen	1912	Gustaf Dalén
1962	Lev Landau	1911	Wilhelm Wien
1961	Robert Hofstadter, Rudolf Mössbauer	1910	Johannes Diderik van der Waals
1960	Donald A. Glaser	1909	Guglielmo Marconi, Ferdinand Braun
1959	Emilio Segrè, Owen Chamberlain	1908	Gabriel Lippmann
1958	Pavel A. Cherenkov, Il'ja M. Frank, Igor Y. Tamm	1907	Albert A. Michelson
		1906	J.J. Thomson
		1905	Philipp Lenard
		1904	Lord Rayleigh
		1903	Henri Becquerel, Pierre Curie, Marie Curie
		1902	Hendrik A. Lorentz, Pieter Zeeman
		1901	Wilhelm Conrad Röntgen



## PHYSICAL CONSTANTS OF ORGANIC COMPOUNDS

The basic physical constants and structure diagrams for about 10,900 organic compounds are presented in this table. An effort has been made to include the compounds most frequently encountered in the laboratory, the workplace, and the environment. Particular emphasis has been given to substances that are considered environmental or human health hazards. In making the selection of compounds for the table, added weight was assigned to the appearance of a compound in various lists or reference sources such as:

- Laboratory reagent lists, e.g., the *ACS Reagent Chemicals* volume (Ref. 1)
- The DIPPR list of industrially important compounds (Ref. 2) and the (much larger) TSCA inventory of chemicals used in commerce
- The *Hazardous Substances Data Bank* (Ref. 3)
- The UNEP list *Persistent Organic Pollutants* (Ref. 4)
- Chemicals on Reporting Rules (CORR), a database of about 7500 regulated compounds prepared by the Environmental Protection Agency (Ref. 5)
- The EPA Integrated Risk Information System (IRIS), a database of human health effects of exposure to chemicals in the environment (Ref. 6)
- Compendia of chemicals of biochemical or medical importance, such as *The Merck Index* (Ref. 10)
- Specialized tables in this *Handbook*

It should be noted that the above lists vary widely in their choice of chemical names, and even in the use of Chemical Abstracts Registry Numbers. To the extent possible, we have attempted to systematize the names and registry numbers for this table.

Clearly, criteria of this type are somewhat subjective, and compounds considered important by some users have undoubtedly been omitted. Suggestions for additional compounds or other improvements are welcomed.

The data in the table have been derived from many sources, including both the primary literature and evaluated compilations. The *Handbook of Data on Organic Compounds, Third Edition* (Ref. 7) and the *Chapman & Hall/CRC Combined Chemical Dictionary* (Ref. 8) were important sources. Other useful compilations of physical property data for organic compounds are listed in Refs. 9–19. Many boiling point values (and some melting point and density values) were taken from recent physical chemistry literature dealing with fluid properties. Where conflicts were found, the value deemed most reliable was chosen.

The table is arranged alphabetically by substance name, which generally is either an IUPAC systematic name or, in the case of pesticides, pharmaceuticals, and other complex compounds, a simple trivial name. Names in ubiquitous use, such as acetic acid and formaldehyde, are adopted rather than their systematic equivalents. Synonyms are given in the column following the primary name, and structure diagrams are given on the page facing the data listing. The explanation of the data columns follows:

- **No.:** An identification number used in the indexes.
- **Name:** Primary name of the substance.
- **Synonym:** A synonym in common use. When the primary name is non-systematic, a systematic name may appear here.
- **Mol. Form.:** The molecular formula written in the Hill convention.

- **CAS RN:** The Chemical Abstracts Service Registry Number for the compound.
- **Mol. Wt:** Molecular weight (relative molar mass) as calculated with the 2001 IUPAC Standard Atomic Weights.
- **Physical Form:** A notation of the physical phase, color, crystal type, or other features of the compound at ambient temperature. Abbreviations are given below.
- **mp:** Normal melting point in °C. A value is sometimes followed by “dec,” indicating decomposition is observed at the stated temperature (so that it is probably not a true melting point). The notation “tp” indicates a triple point, where solid, liquid, and gas are in equilibrium.
- **bp:** Normal boiling point in °C, if it is available. This is the temperature at which the liquid phase is in equilibrium with the vapor at a pressure of 760 mmHg (101.325 kPa). A notation “sp” following the value indicates a sublimation point, where the vapor pressure of the solid phase reaches 760 mmHg. When a notation such as “dec” or “exp” (explodes) follows the value, the temperature may not be a true boiling point. A simply entry “sub” indicates the solid has a significant sublimation pressure at ambient temperatures. The boiling point at reduced pressure is listed in some cases, with or without the normal boiling point. Here the superscript indicates the pressure in mmHg.
- **den:** Density (mass per unit volume) in g/cm<sup>3</sup>. The temperature in °C is indicated by a superscript. Values refer to the liquid or solid phase, and all values are true densities, not specific gravities. The number of decimal places gives a rough estimate of the accuracy of the value.
- **n<sub>D</sub>:** Refractive index, at the temperature in °C indicated by the superscript. Unless otherwise indicated, all values refer to a wavelength of 589 nm (sodium D line). Values are given only for liquids and solids.
- **Solubility:** Qualitative indication of solubility in common solvents. Abbreviations are:

i	insoluble
sl	slightly soluble
s	soluble
vs	very soluble
msc	miscible
dec	decomposes

Abbreviations for solvents are given below.

In order to facilitate the location of compounds in the table, three indexes are provided:

- **Synonym Index:** Includes common synonyms, but not the primary name by which the table is arranged.
- **Molecular Formula Index:** Lists compounds by molecular formula in the Hill Order (see Preface to this *Handbook*).
- **CAS Registry Number Index:** Lists compounds by Chemical Abstracts Service Registry Number. Note there is some redundancy in this index, because many compounds have several Registry Numbers associated with them. Thus the CAS RN in a table entry may differ from the CAS RN that points to it in the index. For example, CAS RN 1319-77-3 in the index points to all three cresol isomers, each of which has its own specific CAS RN.

The assistance of Fiona Macdonald in checking names and formulas is gratefully acknowledged, as well as the efforts of Janice

Shackleton, Trupti Desai, Nazila Kamaly, Matt Griffiths, and Lawrence Braschi in preparing the structure diagrams.

## List of Abbreviations

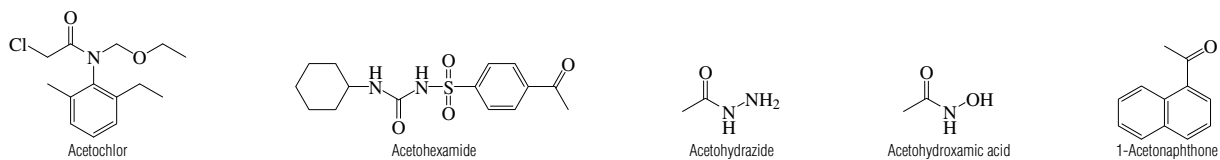
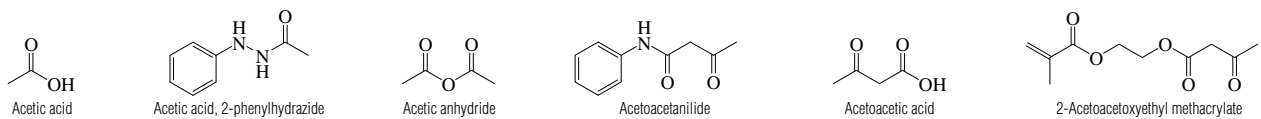
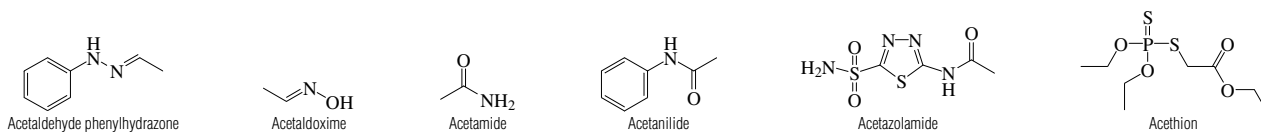
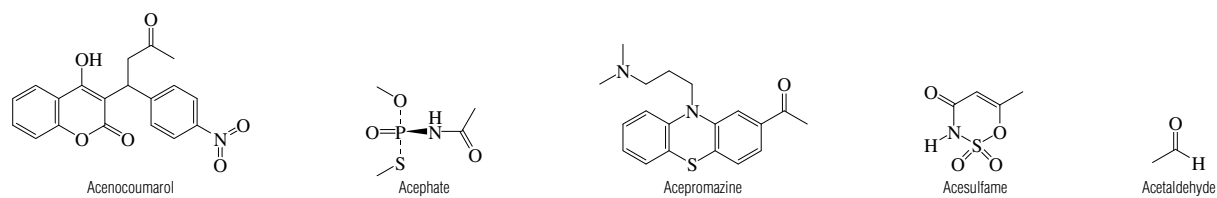
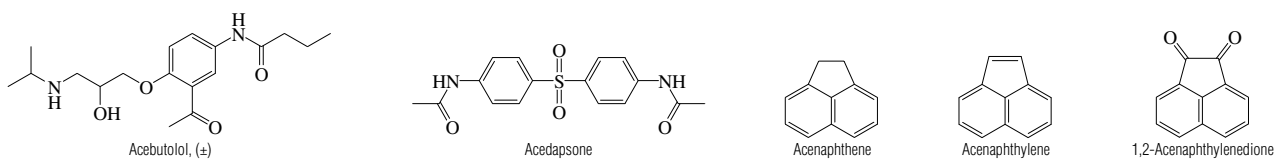
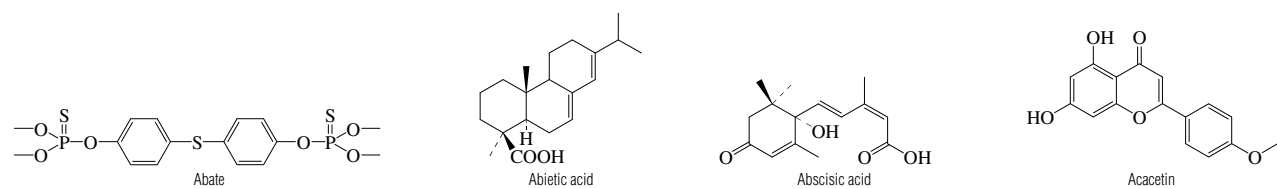
Ac	acetyl	mcl	monoclinic
Ac <sub>2</sub> O	acetic anhydride	Me	methyl
AcOEt	ethyl acetate	MeCN	acetonitrile
ac	acid	MeOH	methanol
ace	acetone	misc, msc	miscible
al	alcohol (ethanol)	mp	melting point
alk	alkali	n	refractive index
amor	amorphous	nd	needles
anh	anhydrous	oct	octahedra, octahedral
aq	aqueous	oran	orange
bipym	bipyramidal	orth	orthorhombic
bl	blue	os	organic solvents
blk	black	pa	pale
bp	boiling point	peth	petroleum ether
br	brown	Ph	phenyl
bt	bright	PhCl	chlorobenzene
Bu	butyl	PhNH <sub>2</sub>	aniline
BuOH	1-butanol	PhNO <sub>2</sub>	nitrobenzene
bz	benzene	pl	plates
chl	chloroform	pow	powder
col	colorless	Pr	propyl
con, conc	concentrated	PrOH	1-propanol
cry	crystals	pr	prisms
ctc	carbon tetrachloride	purp	purple
cy, cyhex	cyclohexane	py	pyridine
dec	decomposes	pym	pyramids, pyramidal
den	density	reac	reacts
dil	dilute	rhom	rhombic
diox	dioxane	s	soluble
dk	dark	sat	saturated
DMF	dimethylformamide	sc	scales
DMSO	dimethyl sulfoxide	sl	slightly soluble
efflor	efflorescent	soln	solution
Et	ethyl	sp	sublimation point
EtOH	ethanol	stab	stable
eth	diethyl ether	sub	sublimes
exp	explodes	sulf	sulfuric acid
fl	flakes	syr	syrup
fir	fluorescent	tab	tablets
fum	fumes, fuming	tcl	triclinic
gl	glacial	tetr	tetragonal
gr	gray	tfa	trifluoroacetic acid
gran	granular	thf, THF	tetrahydrofuran
grn	green	tol	toluene
hex	hexagonal	tp	triple point
HOAc	acetic acid	trg	trigonal
hp	heptane	unstab	unstable
hx	hexane	vap	vapor
hyd	hydrate	viol	violet
hyg	hygroscopic	visc	viscous
i	insoluble	vol	volatile
i-	iso-	vs	very soluble
iso	isooctane	w	water
lf	leaves	wh	white
lig	ligroin	xyl	xylene
liq	liquid	ye	yellow
lo	long		

## References

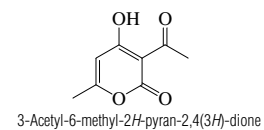
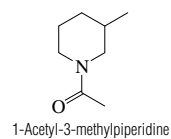
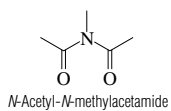
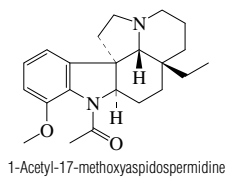
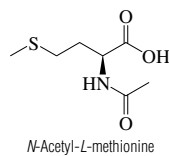
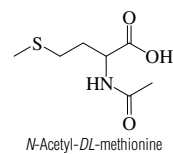
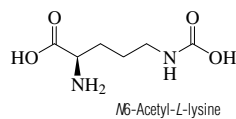
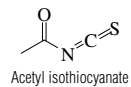
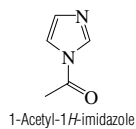
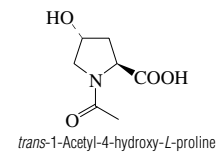
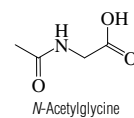
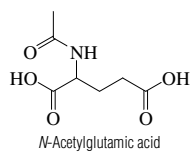
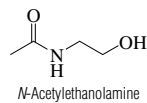
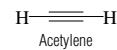
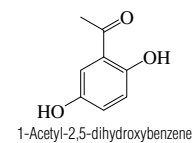
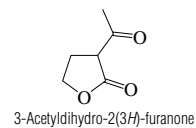
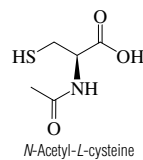
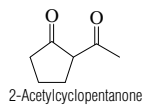
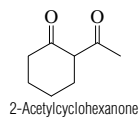
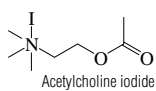
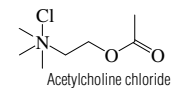
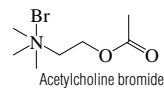
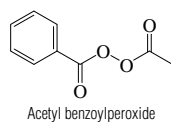
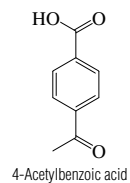
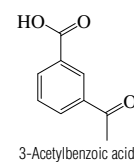
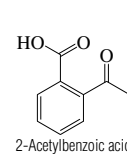
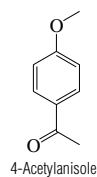
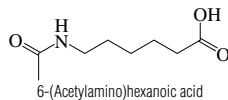
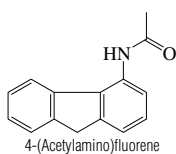
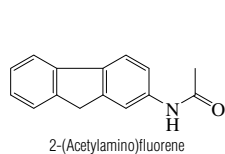
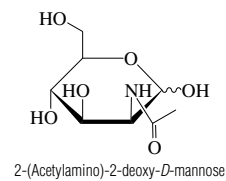
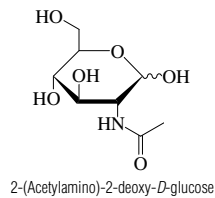
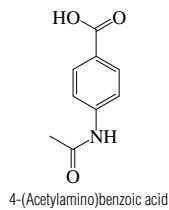
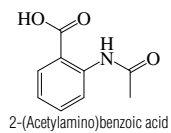
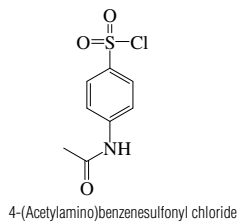
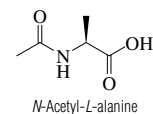
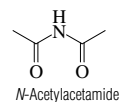
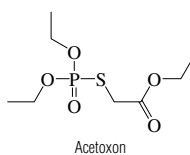
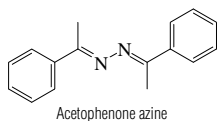
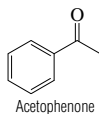
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No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1	Abate	Temephos	C <sub>16</sub> H <sub>20</sub> O <sub>6</sub> P <sub>2</sub> S <sub>3</sub>	3383-96-8	466.469		30		1.32		
2	Abietic acid		C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	514-10-3	302.451	mcl pl (al-w)	173.5	250 <sup>9</sup>			vs ace, bz, eth, EtOH
3	Abscisic acid		C <sub>15</sub> H <sub>20</sub> O <sub>4</sub>	21293-29-8	264.318	cry (chl-peth)	160	sub 120			vs ace, eth, chl
4	Acacetin	5,7-Dihydroxy-2-(4-methoxyphenyl)-4 <i>H</i> -1-benzopyran-4-one	C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	480-44-4	284.263	ye nd (95% al)	263				vs EtOH
5	Acebutolol, (±)		C <sub>18</sub> H <sub>28</sub> N <sub>2</sub> O <sub>4</sub>	37517-30-9	336.426	cry	121				
6	Acedapsone		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S	77-46-3	332.374	pa ye nd (eth) lf (dil al)	290				sl H <sub>2</sub> O
7	Acenaphthene	1,2-Dihydroacenaphthylene	C <sub>12</sub> H <sub>10</sub>	83-32-9	154.207		93.4	279	1.222 <sup>20</sup>	1.6048 <sup>85</sup>	i H <sub>2</sub> O; sl EtOH, chl; vs bz; s HOAc
8	Acenaphthylene	Acenaphthalene	C <sub>12</sub> H <sub>8</sub>	208-96-8	152.192		91.8	280	0.8987 <sup>16</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz; sl chl
9	1,2-Acenaphthylenedione		C <sub>12</sub> H <sub>6</sub> O <sub>2</sub>	82-86-0	182.175	ye nd (HOAc)	261	sub	1.4800 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, bz, HOAc; s lig
10	Acenocoumarol	Nicoumalone	C <sub>19</sub> H <sub>16</sub> NO <sub>6</sub>	152-72-7	353.325	cry (ace aq)	198				i H <sub>2</sub> O
11	Acephate	Phosphoramidothioic acid, acetyl-, <i>O,S</i> -dimethyl ester	C <sub>4</sub> H <sub>10</sub> NO <sub>3</sub> PS	30560-19-1	183.166		88		1.35 <sup>20</sup>		
12	Acepromazine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> OS	61-00-7	326.455	oran oil		230 <sup>0.5</sup>			
13	Acesulfame		C <sub>4</sub> H <sub>5</sub> NO <sub>4</sub> S	33665-90-6	163.153	nd (bz)	123.2				s bz, chl
14	Acetaldehyde	Ethanal	C <sub>2</sub> H <sub>4</sub> O	75-07-0	44.052	vol liq or gas	-123.37	20.1	0.7834 <sup>18</sup>	1.3316 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, bz; sl chl
15	Acetaldehyde phenylhydrazone		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub>	935-07-9	134.178		99.5	150 <sup>40</sup> , 135 <sup>21</sup>			vs EtOH
16	Acetaldoxime	Acetaldehyde oxime	C <sub>2</sub> H <sub>5</sub> NO	107-29-9	59.067	nd	45	115	0.9656 <sup>20</sup>	1.4264 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
17	Acetamide	Ethanamide	C <sub>2</sub> H <sub>5</sub> NO	60-35-5	59.067	trg mcl (al-eth)	80.16	222.0	0.9986 <sup>85</sup>	1.4278	vs H <sub>2</sub> O, EtOH
18	Acetanilide	<i>N</i> -Phenylacetamide	C <sub>8</sub> H <sub>9</sub> NO	103-84-4	135.163		114.3	304	1.2190 <sup>15</sup>		sl H <sub>2</sub> O; vs EtOH, ace; s eth, s bz, tol
19	Acetazolamide	<i>N</i> -[5-(Aminosulfonyl)-1,3,4-thiadiazol-2-yl]acetamide	C <sub>8</sub> H <sub>8</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	59-66-5	222.246		260.5				sl H <sub>2</sub> O
20	Acethion		C <sub>8</sub> H <sub>17</sub> O <sub>4</sub> PS <sub>2</sub>	919-54-0	272.322	liq		137 <sup>1.5</sup>	1.18 <sup>20</sup>		
21	Acetic acid	Ethanoic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	64-19-7	60.052		16.64	117.9	1.0446 <sup>25</sup>	1.3720 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz; s chl, CS <sub>2</sub>
22	Acetic acid, 2-phenylhydrazide		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O	114-83-0	150.177	hex pr (eth)	130.0				vs H <sub>2</sub> O, EtOH; sl eth, chl, tfa; s bz
23	Acetic anhydride		C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	108-24-7	102.089	liq	-74.1	139.5	1.082 <sup>20</sup>	1.3901 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, bz; msc eth; sl ctc
24	Acetoacetanilide		C <sub>10</sub> H <sub>11</sub> NO <sub>2</sub>	102-01-2	177.200	pr or nd (bz or lig)	86				sl H <sub>2</sub> O; s EtOH, eth, bz, chl, acid, lig
25	Acetoacetic acid		C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	541-50-4	102.089	cry (eth)	36.5	dec 100			vs H <sub>2</sub> O, eth, EtOH
26	2-Acetoacetoxyethyl methacrylate	2-(Methacryloyloxy)ethyl acetoacetate	C <sub>10</sub> H <sub>14</sub> O <sub>5</sub>	21282-97-3	214.215	liq		100 <sup>0.8</sup>	1.122	1.4560 <sup>20</sup>	
27	Acetochlor		C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	34256-82-1	269.768	ye liq		134 <sup>0.4</sup>		1.5272 <sup>20</sup>	sl H <sub>2</sub> O
28	Acetohexamide		C <sub>15</sub> H <sub>20</sub> N <sub>2</sub> O <sub>4</sub> S	968-81-0	324.396	cry (EtOH aq)	188				i H <sub>2</sub> O, eth; sl EtOH, chl; s py
29	Acetohydrazide		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	1068-57-1	74.081		67	137 <sup>25</sup>			s H <sub>2</sub> O, EtOH; sl eth
30	Acetohydroxamic acid	<i>N</i> -Hydroxyacetamide	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	546-88-3	75.067	hyg cry	90				
31	1-Acetonaphthone		C <sub>12</sub> H <sub>10</sub> O	941-98-0	170.206		34	297	1.1171 <sup>21</sup>	1.6280 <sup>22</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl
32	2-Acetonaphthone		C <sub>12</sub> H <sub>10</sub> O	93-08-3	170.206	nd (lig, dil al)	56	302			sl EtOH, ctc
33	Acetone	2-Propanone	C <sub>3</sub> H <sub>6</sub> O	67-64-1	58.079	liq	-94.7	56.05	0.7845 <sup>25</sup>	1.3588 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz, chl
34	Acetone cyanohydrin		C <sub>4</sub> H <sub>7</sub> NO	75-86-5	85.105		-19	82 <sup>23</sup>	0.932 <sup>19</sup>	1.3992 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s ace, bz, chl; i peth
35	Acetone (2,4-dinitrophenyl) hydrazone		C <sub>9</sub> H <sub>10</sub> N <sub>4</sub> O <sub>4</sub>	1567-89-1	238.200	ye nd or pl (al)	128				i H <sub>2</sub> O; s EtOH, eth, bz, chl, AcOEt
36	Acetone (1-methylethylidene) hydrazone	Dimethyl ketazine	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	627-70-3	112.172	liq	-12.5	133	0.8390 <sup>20</sup>	1.4535 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace
37	Acetone thiosemicarbazide		C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> S	1752-30-3	131.199	ye cry	176				s ace

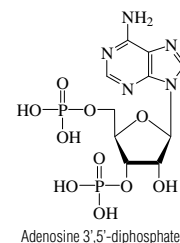
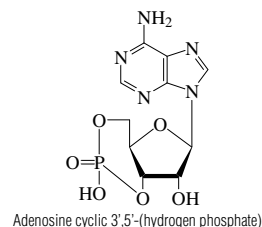
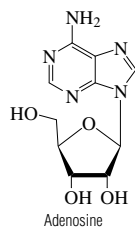
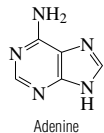
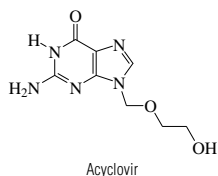
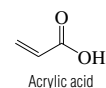
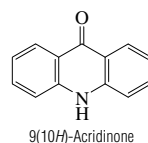
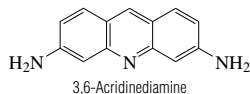
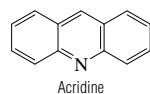
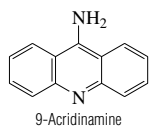
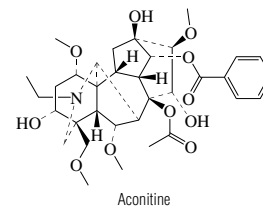
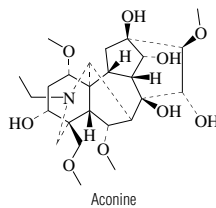
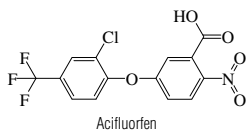
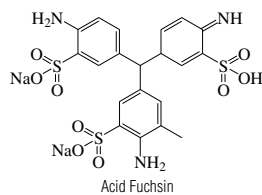
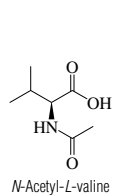
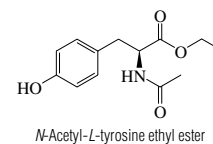
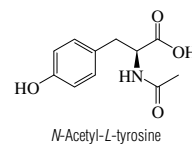
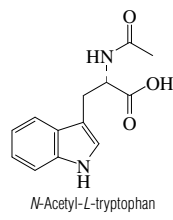
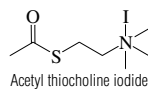
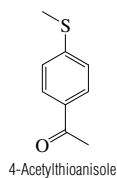
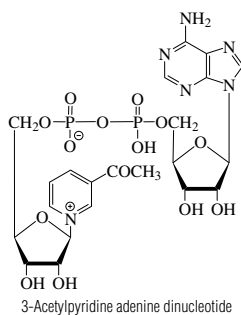
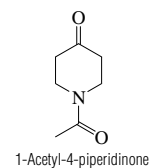
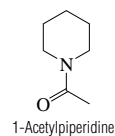
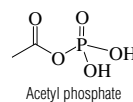
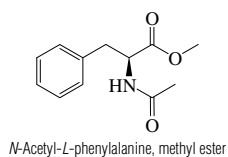
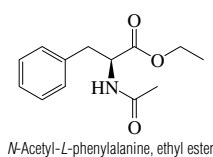
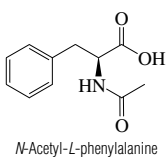
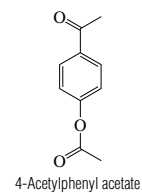
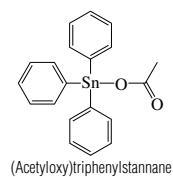
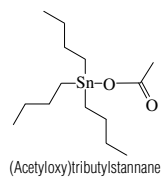
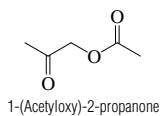
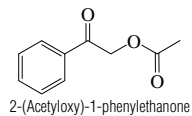
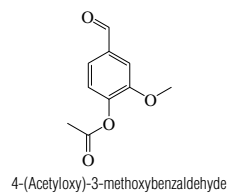
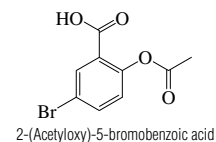
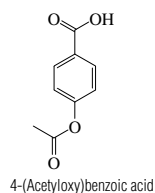
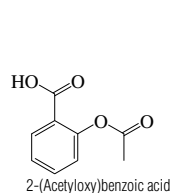
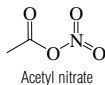
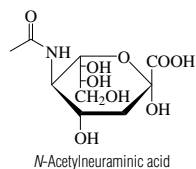
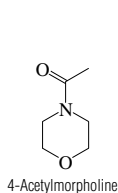


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
38	Acetonitrile	Methyl cyanide	C <sub>2</sub> H <sub>3</sub> N	75-05-8	41.052	liq	-43.82	81.65	0.7857 <sup>20</sup>	1.3442 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz, ctc
39	Acetophenone	Methyl phenyl ketone	C <sub>8</sub> H <sub>8</sub> O	98-86-2	120.149	mcl pr or pl	20.5	202	1.0281 <sup>20</sup>	1.5372 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, con sulf, chl
40	Acetophenone azine	Methylphenyl ketazine	C <sub>16</sub> H <sub>16</sub> N <sub>2</sub>	729-43-1	236.311		120				
41	Acetoxon	Acetophos	C <sub>8</sub> H <sub>17</sub> O <sub>5</sub> PS	2425-25-4	256.257	liq		73 <sup>0.005</sup>			
42	<i>N</i> -Acetylacetamide		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	625-77-4	101.105	nd (eth)	79	223.5			s H <sub>2</sub> O, EtOH, eth, chl, lig
43	<i>N</i> -Acetyl- <i>L</i> -alanine		C <sub>7</sub> H <sub>9</sub> NO <sub>3</sub>	97-69-8	131.130		125				
44	4-(Acetylamino)benzenesulfonyl chloride	Acetylsulfanilyl chloride	C <sub>8</sub> H <sub>9</sub> ClNO <sub>3</sub> S	121-60-8	233.673	nd (bz), pr (bz-chl)	149				vs EtOH, eth; s bz, chl
45	2-(Acetylamino)benzoic acid		C <sub>9</sub> H <sub>9</sub> NO <sub>3</sub>	89-52-1	179.172	nd (HOAc)	187.5				sl H <sub>2</sub> O; s EtOH; vs eth, ace, bz, HOAc
46	4-(Acetylamino)benzoic acid		C <sub>9</sub> H <sub>9</sub> NO <sub>3</sub>	556-08-1	179.172	nd (HOAc)	256.5				i H <sub>2</sub> O; s EtOH; sl eth, tfa
47	2-(Acetylamino)-2-deoxy- <i>D</i> -glucose	<i>N</i> -Acetyl- <i>D</i> -glucosamine	C <sub>8</sub> H <sub>15</sub> NO <sub>6</sub>	7512-17-6	221.208		205				
48	2-(Acetylamino)-2-deoxy- <i>D</i> -mannose	<i>N</i> -Acetyl- <i>D</i> -mannosamine	C <sub>8</sub> H <sub>15</sub> NO <sub>6</sub>	3615-17-6	221.208	cry (ace aq)	128				dec alk
49	2-(Acetylamino)fluorene		C <sub>15</sub> H <sub>13</sub> NO	53-96-3	223.270	cry (dil al)	193				i H <sub>2</sub> O; s EtOH, eth, HOAc
50	4-(Acetylamino)fluorene		C <sub>15</sub> H <sub>13</sub> NO	28322-02-3	223.270	br cry (bz)	200				
51	6-(Acetylamino)hexanoic acid	$\epsilon$ -Acetamidocaproic acid	C <sub>8</sub> H <sub>15</sub> NO <sub>3</sub>	57-08-9	173.210	cry (ace)	104.5				
52	4-Acetylanisole		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	100-06-1	150.174	pl (peth)	38.5	258	1.0818 <sup>41</sup>	1.547 <sup>41</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, chl
53	2-Acetylbenzoic acid		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	577-56-0	164.158	nd (w), pr (bz)	114.5	111 <sup>2</sup>			vs H <sub>2</sub> O, eth, EtOH
54	3-Acetylbenzoic acid		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	586-42-5	164.158		172	111 <sup>2</sup>			s H <sub>2</sub> O; msc EtOH
55	4-Acetylbenzoic acid		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	586-89-0	164.158	nd (w)	208	sub			vs H <sub>2</sub> O
56	Acetyl benzoylperoxide	Acetozone	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	644-31-5	180.158	wh nd (lig)	37	130 <sup>19</sup>			vs eth
57	Acetyl bromide	Ethanoyl bromide	C <sub>2</sub> H <sub>3</sub> BrO	506-96-7	122.948	liq	-96	76	1.6625 <sup>16</sup>	1.4486 <sup>20</sup>	msc eth, bz, chl; s ace
58	Acetyl chloride	Ethanoyl chloride	C <sub>2</sub> H <sub>3</sub> ClO	75-36-5	78.497	liq	-112.8	50.7	1.1051 <sup>20</sup>	1.3886 <sup>20</sup>	msc eth, ace, bz, chl; s ctc
59	Acetylcholine bromide		C <sub>7</sub> H <sub>16</sub> BrNO <sub>2</sub>	66-23-9	226.112	hyg cry	146				vs H <sub>2</sub> O
60	Acetylcholine chloride		C <sub>7</sub> H <sub>16</sub> ClNO <sub>2</sub>	60-31-1	181.661		150				s H <sub>2</sub> O, EtOH; i eth
61	Acetylcholine iodide		C <sub>7</sub> H <sub>16</sub> INO <sub>2</sub>	2260-50-6	273.112	hyg	163				
62	2-Acetylcyclohexanone		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	874-23-7	140.180		-11	112 <sup>18</sup> , 101 <sup>14</sup>	1.0782 <sup>25</sup>	1.5138 <sup>20</sup>	s ctc
63	2-Acetylcyclopentanone		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	1670-46-8	126.153			73 <sup>20</sup>	1.0431 <sup>25</sup>	1.4906 <sup>20</sup>	
64	<i>N</i> -Acetyl- <i>L</i> -cysteine	Acetylcysteine	C <sub>7</sub> H <sub>13</sub> NO <sub>3</sub> S	616-91-1	163.195	cry (w)	109.5				
65	3-Acetyldihydro-2(3 <i>H</i> )-furanone	$\alpha$ -Acetylbutyrolactone	C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	517-23-7	128.126			107 <sup>5</sup>	1.1846 <sup>20</sup>	1.4585 <sup>20</sup>	vs H <sub>2</sub> O
66	1-Acetyl-2,5-dihydroxybenzene	2,5-Dihydroxyacetophenone	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	490-78-8	152.148	ye grn nd (dil al or w)	205.3				sl H <sub>2</sub> O, eth, bz; s EtOH
67	Acetylene	Ethyne	C <sub>2</sub> H <sub>2</sub>	74-86-2	26.037	col gas	-80.7 (triple point)	-84.7 sp	0.377 <sup>25</sup> (p>1 atm)		sl H <sub>2</sub> O, EtOH, CS <sub>2</sub> ; s ace, bz, chl
68	<i>N</i> -Acetyethanolamine		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	142-26-7	103.120		63.5	166 <sup>8</sup>	1.1079 <sup>25</sup>	1.4674 <sup>20</sup>	msc H <sub>2</sub> O; s ace; sl bz, lig
69	Acetyl fluoride	Ethanoyl fluoride	C <sub>2</sub> H <sub>3</sub> FO	557-99-3	62.042	vol liq or gas	-84	20.8	1.032 <sup>25</sup>		msc EtOH, eth; s bz, chl; sl CS <sub>2</sub>
70	<i>N</i> -Acetylglutamic acid		C <sub>7</sub> H <sub>11</sub> NO <sub>5</sub>	1188-37-0	189.166	pr (w)	199				s H <sub>2</sub> O, EtOH
71	<i>N</i> -Acetylglycine	Aceturic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>3</sub>	543-24-8	117.104	lo nd (w, MeOH)	206				vs H <sub>2</sub> O, ace, EtOH
72	<i>trans</i> -1-Acetyl-4-hydroxy- <i>L</i> -proline	Oxaceprol	C <sub>7</sub> H <sub>11</sub> NO <sub>4</sub>	33996-33-7	173.167	cry (Ac)	132				vs H <sub>2</sub> O, MeOH
73	1-Acetyl-1 <i>H</i> -imidazole		C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> O	2466-76-4	110.114		104.5				sl H <sub>2</sub> O; s EtOH, eth, chl, THF
74	Acetyl iodide	Ethanoyl iodide	C <sub>2</sub> H <sub>3</sub> IO	507-02-8	169.948			108	2.0673 <sup>20</sup>	1.5491 <sup>20</sup>	vs eth
75	Acetyl isothiocyanate		C <sub>3</sub> H <sub>3</sub> NOS	13250-46-9	101.127			132.5	1.1523 <sup>13</sup>	1.5231 <sup>18</sup>	s eth, CS <sub>2</sub>
76	<i>N</i> 6-Acetyl- <i>L</i> -lysine		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	692-04-6	188.224		265 dec				
77	<i>N</i> -Acetyl- <i>DL</i> -methionine		C <sub>7</sub> H <sub>13</sub> NO <sub>3</sub> S	1115-47-5	191.248		114.5				
78	<i>N</i> -Acetyl- <i>L</i> -methionine	Methionamine	C <sub>7</sub> H <sub>13</sub> NO <sub>3</sub> S	65-82-7	191.248		105.5				
79	1-Acetyl-17-methoxyaspidospermidine	Aspidospermine	C <sub>22</sub> H <sub>30</sub> N <sub>2</sub> O <sub>2</sub>	466-49-9	354.485	nd or pr (al) nd (peth)	208	220 <sup>2</sup>			sl H <sub>2</sub> O, eth; s EtOH, bz, chl
80	<i>N</i> -Acetyl- <i>N</i> -methylacetamide		C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	1113-68-4	115.131	liq	-25	195; 114.5 <sup>61</sup>	1.0663 <sup>25</sup>	1.4502 <sup>25</sup>	msc H <sub>2</sub> O; i eth
81	1-Acetyl-3-methylpiperidine		C <sub>8</sub> H <sub>15</sub> NO	4593-16-2	141.211	liq	-13.6	239	0.9684 <sup>25</sup>	1.4731 <sup>25</sup>	vs H <sub>2</sub> O
82	3-Acetyl-6-methyl-2 <i>H</i> -pyran-2,4(3 <i>H</i> )-dione	Dehydroacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	520-45-6	168.148		109	270			vs H <sub>2</sub> O, eth; sl EtOH, chl

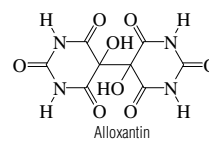
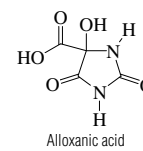
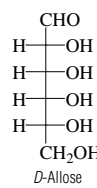
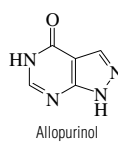
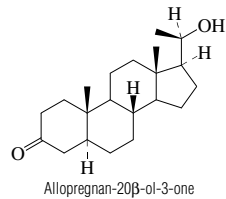
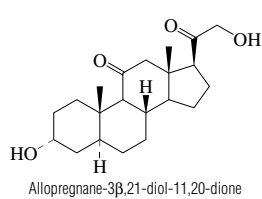
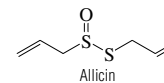
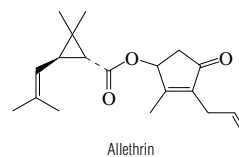
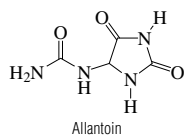
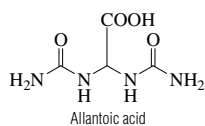
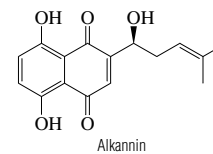
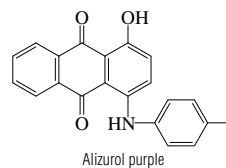
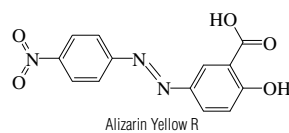
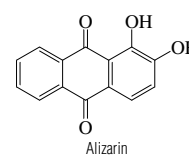
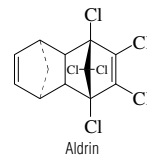
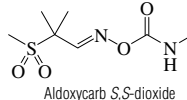
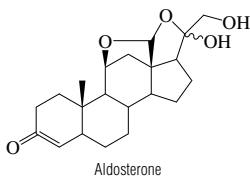
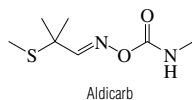
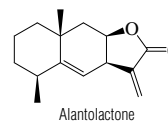
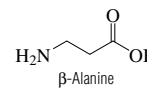
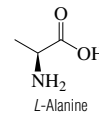
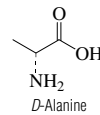
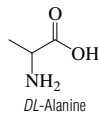
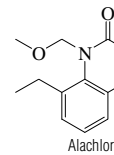
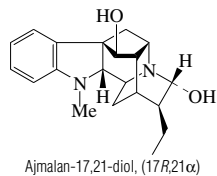
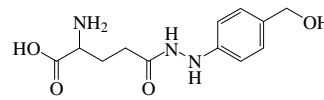
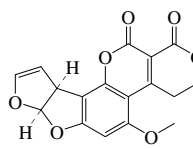
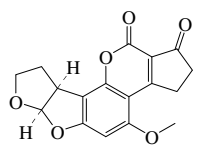
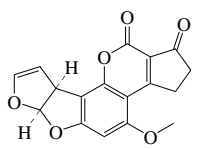
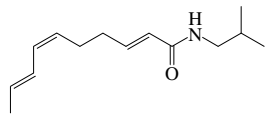
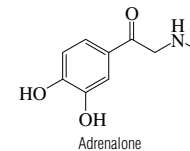
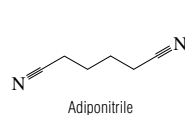
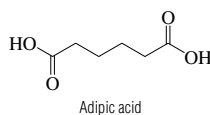
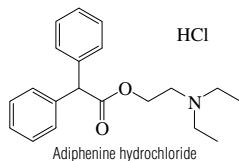
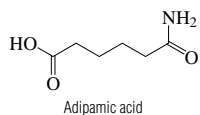
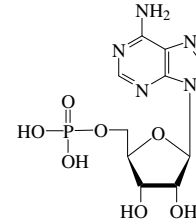
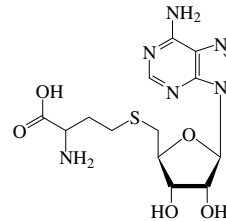
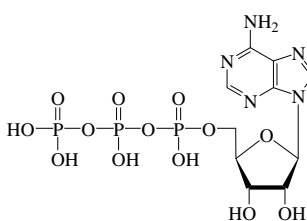
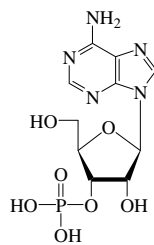
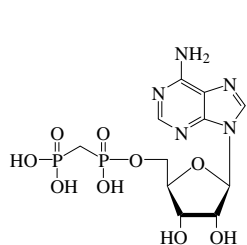


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
83	4-Acetylmorpholine		C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	1696-20-4	129.157		14.5	152 <sup>50</sup> , 118 <sup>12</sup>	1.1145 <sup>20</sup>	1.4827 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, ace, ctc
84	<i>N</i> -Acetylneuraminic acid	Aceneuramic acid	C <sub>11</sub> H <sub>19</sub> NO <sub>9</sub>	131-48-6	309.271		186				
85	Acetyl nitrate		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	591-09-3	105.050			exp 60; 22 <sup>70</sup>	1.24 <sup>15</sup>		
86	2-(Acetyloxy)benzoic acid	Acetylsalicylic acid	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	50-78-2	180.158	nd (w), mcl tab (w)	135				s H <sub>2</sub> O, eth, chl; vs EtOH; sl bz
87	4-(Acetyloxy)benzoic acid		C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	2345-34-8	180.158		188.5				
88	2-(Acetyloxy)-5-bromobenzoic acid	5-Bromoacetylsalicylic acid	C <sub>9</sub> H <sub>7</sub> BrO <sub>4</sub>	1503-53-3	259.054	nd (al)	60				i H <sub>2</sub> O; vs EtOH, eth
89	4-(Acetyloxy)-3-methoxybenzaldehyde		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	881-68-5	194.184		78				sl H <sub>2</sub> O; vs EtOH, eth
90	2-(Acetyloxy)-1-phenylethanol		C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	2243-35-8	178.184	orth pl	49	270	1.1169 <sup>65</sup>	1.5036 <sup>65</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl; sl bz, lig
91	1-(Acetyloxy)-2-propanone	Acetoxyacetone	C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	592-20-1	116.116			171; 63 <sup>11</sup>	1.0757 <sup>20</sup>	1.4141 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
92	(Acetyloxy)tributylstannane	Tributyltin acetate	C <sub>14</sub> H <sub>30</sub> O <sub>2</sub> Sn	56-36-0	349.097		84.7				
93	(Acetyloxy)triphenylstannane	Triphenyltin acetate	C <sub>20</sub> H <sub>18</sub> O <sub>2</sub> Sn	900-95-8	409.066		121.5				
94	4-Acetylphenyl acetate		C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	13031-43-1	178.184						s ctc, CS <sub>2</sub>
95	<i>N</i> -Acetyl- <i>L</i> -phenylalanine		C <sub>11</sub> H <sub>13</sub> NO <sub>3</sub>	2018-61-3	207.226		173.5				s EtOH
96	<i>N</i> -Acetyl- <i>L</i> -phenylalanine, ethyl ester		C <sub>13</sub> H <sub>17</sub> NO <sub>3</sub>	2361-96-8	235.279	cry (EtOH aq)	93				
97	<i>N</i> -Acetyl- <i>L</i> -phenylalanine, methyl ester		C <sub>12</sub> H <sub>15</sub> NO <sub>3</sub>	3618-96-0	221.252	nd (peth) or visc oil (chl)	91				
98	Acetyl phosphate		C <sub>2</sub> H <sub>3</sub> O <sub>5</sub> P	590-54-5	140.032	unstab in soln					
99	1-Acetylpyperidine		C <sub>7</sub> H <sub>13</sub> NO	618-42-8	127.184	liq	-13.4	226.5	1.011 <sup>9</sup>	1.4790 <sup>25</sup>	vs H <sub>2</sub> O, EtOH
100	1-Acetyl-4-piperidinone		C <sub>7</sub> H <sub>11</sub> NO <sub>2</sub>	32161-06-1	141.168			218; 124 <sup>02</sup>	1.146 <sup>25</sup>	1.5026 <sup>20</sup>	
101	3-Acetylpyridine adenine dinucleotide	3-Acetyl NAD	C <sub>22</sub> H <sub>28</sub> N <sub>6</sub> O <sub>14</sub> P <sub>2</sub>	86-08-8	662.436	solid					
102	4-Acetylthioanisole		C <sub>9</sub> H <sub>10</sub> OS	1778-09-2	166.239		81.5				
103	Acetyl thiocholine iodide		C <sub>7</sub> H <sub>16</sub> INOS	1866-15-5	289.177		205				
104	<i>N</i> -Acetyl- <i>L</i> -tryptophan		C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	1218-34-4	246.261	nd (dil MeOH)	189.5				s H <sub>2</sub> O, EtOH, alk
105	<i>N</i> -Acetyl- <i>L</i> -tyrosine		C <sub>11</sub> H <sub>13</sub> NO <sub>4</sub>	537-55-3	223.226	cry (w); pl (diox)	153				
106	<i>N</i> -Acetyl- <i>L</i> -tyrosine ethyl ester		C <sub>13</sub> H <sub>17</sub> NO <sub>4</sub>	840-97-1	251.279		80.5				
107	<i>N</i> -Acetyl- <i>L</i> -valine		C <sub>7</sub> H <sub>13</sub> NO <sub>3</sub>	96-81-1	159.183		164				
108	Acid Fuchsin	Fuchsin, acid	C <sub>20</sub> H <sub>17</sub> N <sub>3</sub> Na <sub>2</sub> O <sub>9</sub> S <sub>3</sub>	3244-88-0	585.539						sl H <sub>2</sub> O, EtOH
109	Acifluorten	5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid	C <sub>14</sub> H <sub>7</sub> ClF <sub>3</sub> NO <sub>3</sub>	50594-66-6	361.658		150				
110	Aconine		C <sub>25</sub> H <sub>41</sub> NO <sub>9</sub>	509-20-6	499.596	amor	132				s H <sub>2</sub> O, EtOH, chl; sl eth, lig
111	Aconitine		C <sub>34</sub> H <sub>47</sub> NO <sub>11</sub>	302-27-2	645.737	orth lf	204				vs bz, EtOH, chl
112	9-Acridinamine	Aminacrine	C <sub>13</sub> H <sub>10</sub> N <sub>2</sub>	90-45-9	194.231	ye nd (ace or al)	241				s EtOH, ace; sl DMSO; vs dil HCl
113	Acridine	Dibenzo[e,b]pyridine	C <sub>13</sub> H <sub>9</sub> N	260-94-6	179.217	orth nd or pr (al)	106(form a); 110(form b)	344.86	1.005 <sup>20</sup>		i H <sub>2</sub> O; sl ctc; vs EtOH, eth, bz
114	3,6-Acridinediamine	Proflavine	C <sub>13</sub> H <sub>11</sub> N <sub>3</sub>	92-62-6	209.246	ye nd (al or w)	285				s H <sub>2</sub> O; vs EtOH; sl eth, bz
115	9(10 <i>H</i> )-Acridinone		C <sub>13</sub> H <sub>9</sub> NO	578-95-0	195.216	ye lf (al)	>300				i H <sub>2</sub> O, eth, bz; sl EtOH; s HOAc, alk
116	Acrolein	2-Propenal	C <sub>3</sub> H <sub>4</sub> O	107-02-8	56.063	liq	-87.7	52.6	0.840 <sup>20</sup>	1.4017 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth, ace; sl chl
117	Acrylamide	2-Propenamamide	C <sub>3</sub> H <sub>5</sub> NO	79-06-1	71.078	lf (bz)	84.5	192.6			vs H <sub>2</sub> O, chl; s EtOH, eth, ace
118	Acrylic acid	2-Propenoic acid	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	79-10-7	72.063		12.5	141	1.0511 <sup>20</sup>	1.4224 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, bz, ctc
119	Acrylonitrile	Propenenitrile	C <sub>3</sub> H <sub>3</sub> N	107-13-1	53.063	liq	-83.48	77.3	0.8007 <sup>25</sup>	1.3911 <sup>20</sup>	s H <sub>2</sub> O; vs ace, bz, eth, EtOH
120	Acyclovir		C <sub>8</sub> H <sub>11</sub> N <sub>5</sub> O <sub>3</sub>	59277-89-3	225.205	cry (EtOH)	225				
121	Adenine	1 <i>H</i> -Purin-6-amine	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	73-24-5	135.128	orth nd (+3w)	360 dec	sub 220			s H <sub>2</sub> O; sl EtOH; i eth, chl
122	Adenosine	β- <i>D</i> -Ribofuranoside, adenine-9	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	58-61-7	267.242	n(w+3/2)	235.5				sl H <sub>2</sub> O; i EtOH
123	Adenosine cyclic 3',5'-(hydrogen phosphate)	cAMP	C <sub>10</sub> H <sub>12</sub> N <sub>5</sub> O <sub>6</sub> P	60-92-4	329.206	cry	219				
124	Adenosine 3',5'-diphosphate	3'-Adenylic acid, 5'-(dihydrogen phosphate)	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>10</sub> P <sub>2</sub>	1053-73-2	427.202	amor pow					

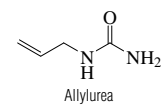
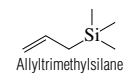
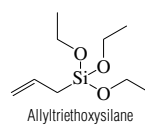
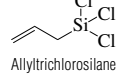
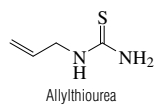
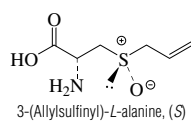
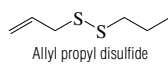
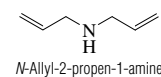
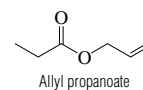
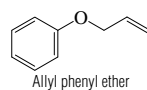
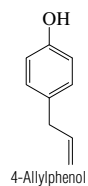
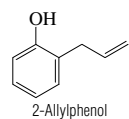
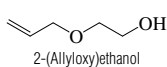
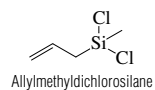
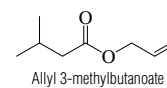
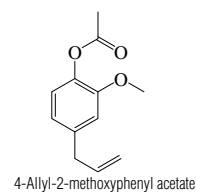
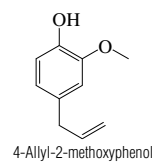
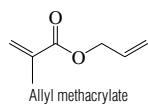
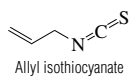
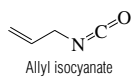
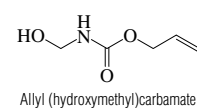
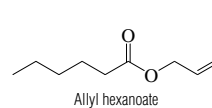
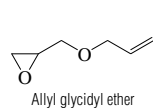
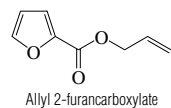
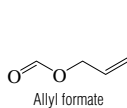
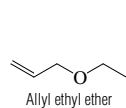
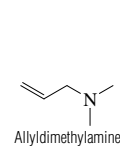
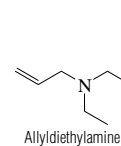
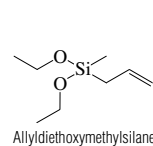
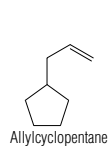
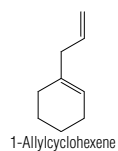
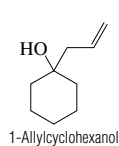
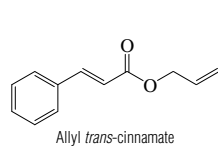
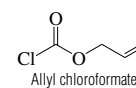
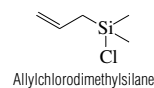
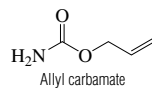
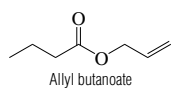
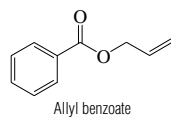
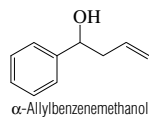
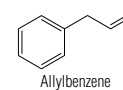
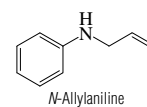
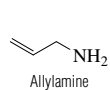
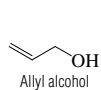
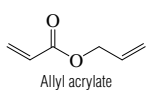
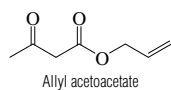
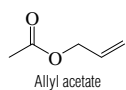




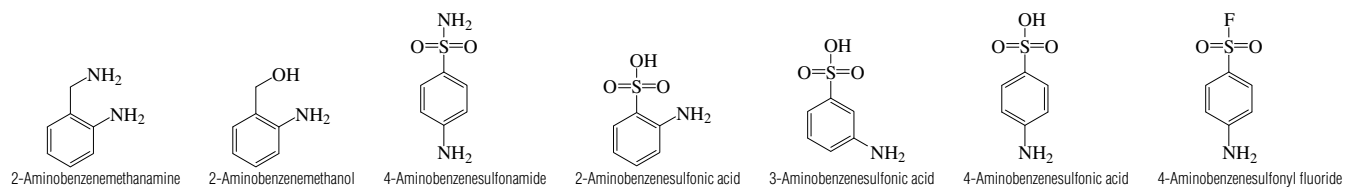
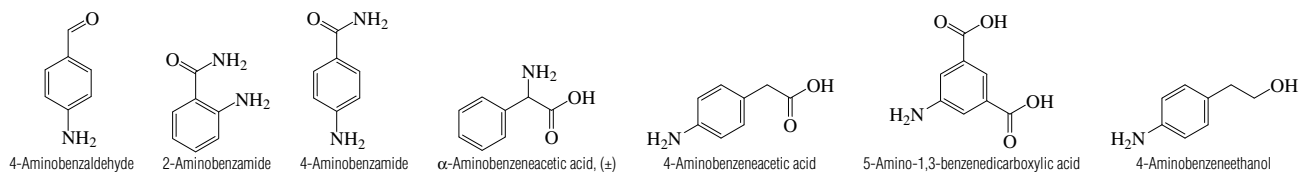
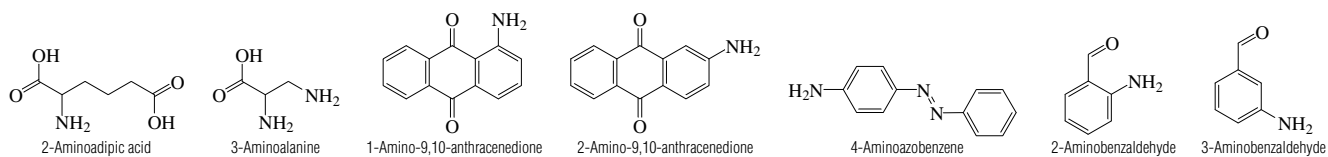
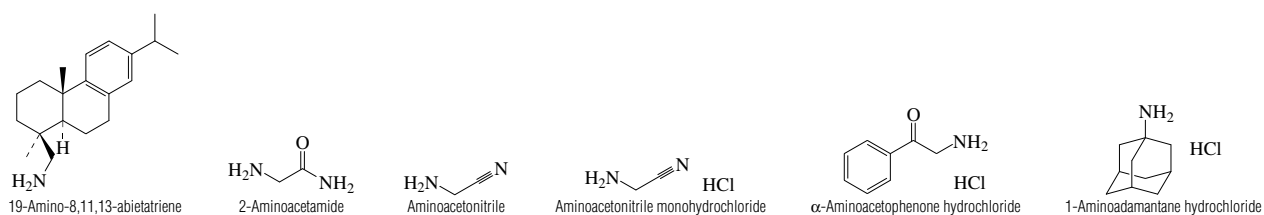
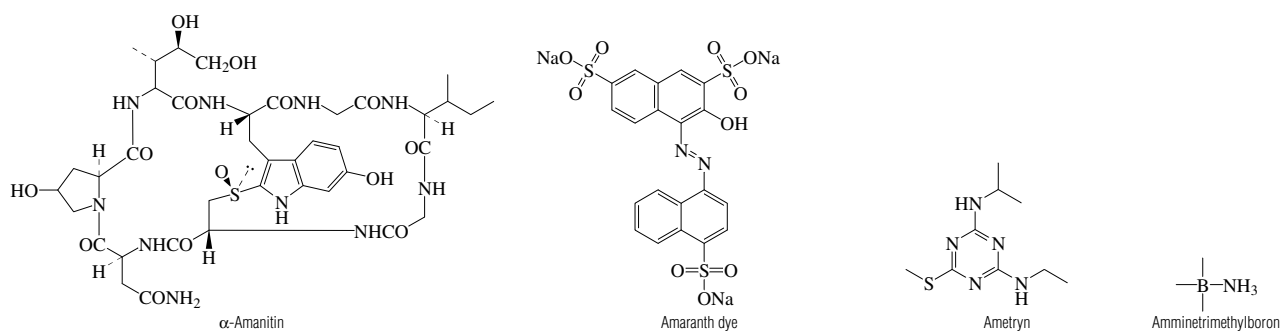
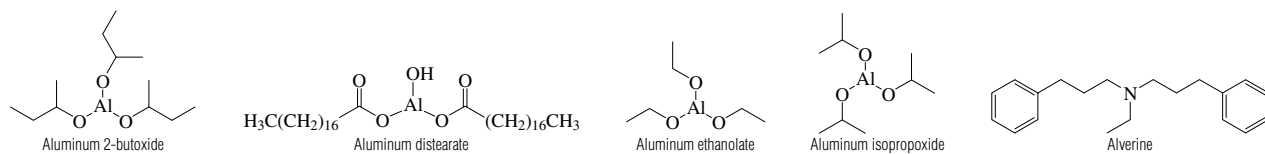
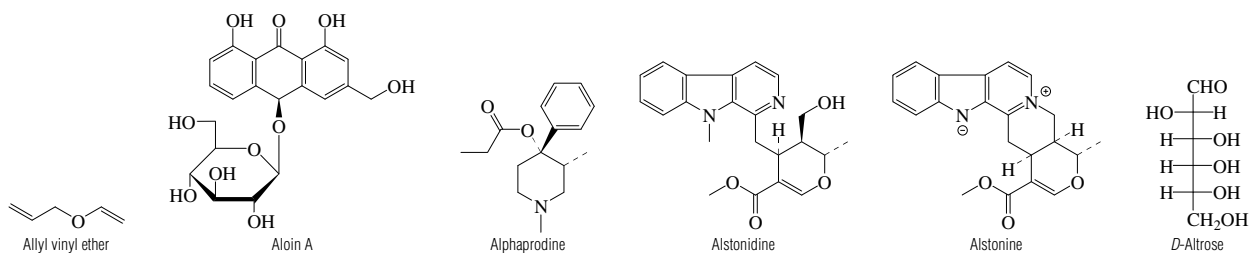
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
125	Adenosine 5'-methylenediphosphonate	Adenosine, 5'-[hydrogen (phosphonomethyl) phosphonate]	C <sub>11</sub> H <sub>17</sub> N <sub>5</sub> O <sub>9</sub> P <sub>2</sub>	3768-14-7	425.229	cry (w)	204				s H <sub>2</sub> O
126	Adenosine 3'-phosphate	3'-Adenylic acid	C <sub>10</sub> H <sub>14</sub> N <sub>5</sub> O <sub>7</sub> P	84-21-9	347.222	col nd	195 dec				
127	Adenosine 5'-triphosphate	ATP	C <sub>10</sub> H <sub>16</sub> N <sub>5</sub> O <sub>13</sub> P <sub>3</sub>	56-65-5	507.181		144 dec				
128	S-Adenosyl-L-homocysteine		C <sub>14</sub> H <sub>20</sub> N <sub>6</sub> O <sub>5</sub> S	979-92-0	384.411		210 dec				
129	5'-Adenylic acid	Adenosine 5'-monophosphate	C <sub>10</sub> H <sub>14</sub> N <sub>5</sub> O <sub>7</sub> P	61-19-8	347.222		195 dec				vs H <sub>2</sub> O; s EtOH, 10% HCl
130	Adipamic acid		C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	334-25-8	145.156	nd (w)	161.5				
131	Adiphenine hydrochloride		C <sub>20</sub> H <sub>26</sub> ClNO <sub>2</sub>	50-42-0	347.879	cry	113.5				vs H <sub>2</sub> O; sl EtOH, eth
132	Adipic acid	1,6-Hexanedioic acid	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	124-04-9	146.141	mcl pr (w, ace, lig)	152.5	337.5	1.360 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH; s eth; i HOAc, lig
133	Adiponitrile	Hexanedinitrile	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	111-69-3	108.141	nd (eth)	1	295	0.9676 <sup>20</sup>	1.4380 <sup>20</sup>	sl H <sub>2</sub> O, eth; s chl, EtOH
134	Adrenalone		C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	99-45-6	181.188	nd	235 dec				sl H <sub>2</sub> O, EtOH, eth
135	Affinin	N-(2-Methylpropyl)-2,6,8-decatrienamamide	C <sub>14</sub> H <sub>23</sub> NO	25394-57-4	221.339	ye oil	23	162 <sup>0.5</sup>		1.5134 <sup>25</sup>	i H <sub>2</sub> O
136	Aflatoxin B1		C <sub>17</sub> H <sub>12</sub> O <sub>6</sub>	1162-65-8	312.273	cry	268				
137	Aflatoxin B2		C <sub>17</sub> H <sub>14</sub> O <sub>6</sub>	7220-81-7	314.289		287.5				
138	Aflatoxin G1		C <sub>17</sub> H <sub>12</sub> O <sub>7</sub>	1165-39-5	328.273	cry	245				
139	Agaritine	L-Glutamic acid, 5-[2-[4-(hydroxymethyl)phenyl]hydrazide]	C <sub>12</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub>	2757-90-6	267.281	cry (dil al)	207 dec				vs H <sub>2</sub> O
140	Ajmalan-17,21-diol, (17R,21α)	Ajmaline	C <sub>20</sub> H <sub>26</sub> N <sub>2</sub> O <sub>2</sub>	4360-12-7	326.432	pl (+3.5w) (aq AcOEt)	206				i H <sub>2</sub> O; s EtOH, chl; sl eth, bz
141	Alachlor		C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	15972-60-8	269.768		40	100 <sup>0.02</sup>	1.133 <sup>25</sup>		
142	DL-Alanine	DL-2-Aminopropanoic acid	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	302-72-7	89.094	orth pr or nd (w)	300 dec	sub 250	1.424 <sup>25</sup>		s H <sub>2</sub> O; vs EtOH
143	D-Alanine	2-Aminopropanoic acid, (R)	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	338-69-2	89.094	nd (w, al)	314 dec	sub			s H <sub>2</sub> O; sl EtOH; i eth
144	L-Alanine	2-Aminopropanoic acid, (S)	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	56-41-7	89.094	orth (w)	297 dec	sub 250	1.432 <sup>22</sup>		s H <sub>2</sub> O; sl EtOH, py; i eth, ace
145	β-Alanine	3-Aminopropanoic acid	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	107-95-9	89.094	nd, orth pr (al)	200 dec		1.437 <sup>19</sup>		s H <sub>2</sub> O; sl EtOH; i eth, ace
146	Alantolactone		C <sub>15</sub> H <sub>20</sub> O <sub>2</sub>	546-43-0	232.319	nd	76	275			vs bz, eth, EtOH, chl
147	Aldicarb		C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	116-06-3	190.263		99		1.195 <sup>25</sup>		
148	Aldosterone		C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	52-39-1	360.444	cry (HOAc)	166.5				
149	Aldoxycarb S,S-dioxide		C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub> S	1646-88-4	222.262	cry	141				sl H <sub>2</sub> O
150	Aldrin		C <sub>12</sub> H <sub>6</sub> Cl <sub>6</sub>	309-00-2	364.910		104				i H <sub>2</sub> O; s EtOH, eth, ace, bz
151	Alizarin	1,2-Dihydroxy-9,10-anthracenedione	C <sub>14</sub> H <sub>6</sub> O <sub>4</sub>	72-48-0	240.212	oran or red tcl nd or pr (al)	289.5				sl H <sub>2</sub> O; s EtOH, eth, ace, bz; i chl
152	Alizarin Red S	Sodium alizarinesulfonate	C <sub>14</sub> H <sub>7</sub> NaO <sub>7</sub> S	130-22-3	342.257						vs H <sub>2</sub> O; s EtOH
153	Alizarin Yellow R		C <sub>13</sub> H <sub>6</sub> N <sub>3</sub> O <sub>5</sub>	2243-76-7	287.227	oran-br nd (dil HOAc)	253 dec				vs H <sub>2</sub> O, EtOH
154	Alizuroil purple	1-Hydroxy-4-[(4-methylphenyl)amino]-9,10-anthracenedione	C <sub>21</sub> H <sub>15</sub> NO <sub>3</sub>	81-48-1	329.349	flat viol nd					s H <sub>2</sub> SO <sub>4</sub>
155	Alkannin		C <sub>16</sub> H <sub>16</sub> O <sub>5</sub>	23444-65-7	288.295	br-red pr (bz)	149	sub 140			vs EtOH
156	Allantoic acid	Bis(aminocarbonyl)amino acetic acid	C <sub>4</sub> H <sub>8</sub> N <sub>4</sub> O <sub>4</sub>	99-16-1	176.132	nd	170 dec				sl H <sub>2</sub> O, os, dil acid
157	Allantoin		C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>3</sub>	97-59-6	158.116	mcl pl or	239				sl H <sub>2</sub> O; s EtOH, NaOH; i eth, MeOH
158	Allene		C <sub>3</sub> H <sub>4</sub>	463-49-0	40.064	col gas	-136.6	-34.4	0.584 <sup>25</sup> (p>1 atm)	1.4168	vs bz, peth
159	Allethrin		C <sub>19</sub> H <sub>26</sub> O <sub>3</sub>	584-79-2	302.407				1.010 <sup>20</sup>		
160	Allicin		C <sub>6</sub> H <sub>10</sub> OS <sub>2</sub>	539-86-6	162.272			dec	1.112 <sup>20</sup>	1.561 <sup>20</sup>	vs H <sub>2</sub> O
161	Allopregnane-3β,21-diol-11,20-dione		C <sub>21</sub> H <sub>32</sub> O <sub>4</sub>	566-02-9	348.477	cry (aq, ac, +w) nd (bz, ac)	190				
162	Allopregnan-20β-ol-3-one	5α-Pregnan-20β-ol-3-one	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub>	516-58-5	318.494		185				
163	Allopurinol	1,5-Dihydro-4H-pyrazolo[3,4-d]pyrimidin-4-one	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	315-30-0	136.112	cry	350				
164	D-Allose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	2595-97-3	180.155	cry (w)	128				vs H <sub>2</sub> O
165	Alloxanic acid		C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	470-44-0	160.085	tcl pr (eth)	162 dec				vs H <sub>2</sub> O, EtOH
166	Alloxantin		C <sub>8</sub> H <sub>8</sub> N <sub>4</sub> O <sub>8</sub>	76-24-4	286.156	orth pr (w+2)	254 dec				sl H <sub>2</sub> O, EtOH, eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
167	Allyl acetate		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	591-87-7	100.117			103.5	0.9275 <sup>20</sup>	1.4049 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
168	Allyl acetoacetate		C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	1118-84-9	142.152	liq	-85	196; 66.5 <sup>14</sup>	1.0366 <sup>20</sup>	1.4398 <sup>20</sup>	s H <sub>2</sub> O, lig; msc EtOH, bz
169	Allyl acrylate		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	999-55-3	112.127			121	0.9441 <sup>20</sup>	1.4320 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, acid
170	Allyl alcohol	2-Propen-1-ol	C <sub>3</sub> H <sub>6</sub> O	107-18-6	58.079	liq	-129	97.4	0.8540 <sup>20</sup>	1.4135 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
171	Allylamine	2-Propen-1-amine	C <sub>3</sub> H <sub>7</sub> N	107-11-9	57.095	liq	-88.2	53.3	0.758 <sup>20</sup>	1.4205 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
172	<i>N</i> -Allylaniline	Allylphenylamine	C <sub>9</sub> H <sub>11</sub> N	589-09-3	133.190			219; 106 <sup>12</sup>	0.9736 <sup>25</sup>	1.563 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace; msc eth
173	Allylbenzene	2-Propenylbenzene	C <sub>9</sub> H <sub>10</sub>	300-57-2	118.175	liq	-40	156	0.8920 <sup>20</sup>	1.5131 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
174	$\alpha$ -Allylbenzenemethanol		C <sub>10</sub> H <sub>12</sub> O	936-58-3	148.201			228.5	1.004 <sup>18</sup>	1.5289 <sup>21</sup>	
175	Allyl benzoate		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	583-04-0	162.185				1.0569 <sup>15</sup>	1.5178 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, MeOH
176	Allyl butanoate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	2051-78-7	128.169			142; 44.5 <sup>15</sup>	0.9017 <sup>20</sup>	1.4158 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
177	Allyl carbamate		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	2114-11-6	101.105						sl ctc
178	Allylchlorodimethylsilane		C <sub>6</sub> H <sub>11</sub> ClSi	4028-23-3	134.680			111	0.8964 <sup>20</sup>	1.4195 <sup>20</sup>	
179	Allyl chloroformate		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	2937-50-0	120.535	hyg liq		109.5	1.136	1.422 <sup>20</sup>	
180	Allyl <i>trans</i> -cinnamate	Allyl <i>trans</i> -3-phenyl-2-propenoate	C <sub>12</sub> H <sub>12</sub> O <sub>2</sub>	1866-31-5	188.222			dec 268; 163 <sup>17</sup>	1.048 <sup>23</sup>	1.530 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth; sl ctc
181	1-Allylcyclohexanol		C <sub>9</sub> H <sub>16</sub> O	1123-34-8	140.222			190	0.9341 <sup>22</sup>	1.4756 <sup>22</sup>	
182	1-Allylcyclohexene	1-(2-Propenyl)cyclohexene	C <sub>9</sub> H <sub>14</sub>	13511-13-2	122.207	liq		156			
183	Allylcyclopentane		C <sub>8</sub> H <sub>14</sub>	3524-75-2	110.197	liq	-110.7	125	0.793 <sup>25</sup>	1.4412 <sup>20</sup>	s chl
184	Allyldiethoxymethylsilane		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub> Si	18388-45-9	174.314			155	0.8572 <sup>25</sup>	1.4104 <sup>20</sup>	
185	Allyldiethylamine	<i>N,N</i> -Diethyl-2-propen-1-amine	C <sub>7</sub> H <sub>15</sub> N	5666-17-1	113.201			110	0.7477 <sup>25</sup>	1.4209 <sup>20</sup>	
186	Allyldimethylamine	<i>N,N</i> -Dimethyl-2-propen-1-amine	C <sub>5</sub> H <sub>11</sub> N	2155-94-4	85.148			63.5	0.7094 <sup>25</sup>	1.4010 <sup>20</sup>	
187	Allyl ethyl ether		C <sub>5</sub> H <sub>10</sub> O	557-31-3	86.132			67.6	0.7651 <sup>20</sup>	1.3881 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
188	Allyl formate		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	1838-59-1	86.090			83.6	0.9460 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH; msc eth
189	Allyl 2-furancarboxylate	Allyl 2-furanoate	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	4208-49-5	152.148			207.5	1.115 <sup>25</sup>	1.4945 <sup>20</sup>	s eth, ace; sl ctc
190	Allyl glycidyl ether		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	106-92-3	114.142			154	0.9698 <sup>20</sup>	1.4332 <sup>20</sup>	
191	Allyl hexanoate		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	123-68-2	156.222			186	0.8869 <sup>20</sup>		
192	Allyl (hydroxymethyl)carbamate		C <sub>6</sub> H <sub>10</sub> NO <sub>3</sub>	24935-97-5	131.130	cry (tol)	57				
193	Allyl isocyanate		C <sub>4</sub> H <sub>7</sub> NO	1476-23-9	83.089			88			
194	Allyl isothiocyanate		C <sub>4</sub> H <sub>7</sub> NS	57-06-7	99.155	liq	-80	152	1.0126 <sup>20</sup>	1.5306 <sup>20</sup>	vs bz, eth, EtOH
195	Allyl methacrylate		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	96-05-9	126.153			67 <sup>90</sup> , 55 <sup>90</sup>	0.9335 <sup>20</sup>	1.4360 <sup>20</sup>	
196	4-Allyl-2-methoxyphenol	Eugenol	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	97-53-0	164.201	liq	-7.5	253.2	1.0652 <sup>20</sup>	1.5405 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl, HOAc, oils
197	4-Allyl-2-methoxyphenyl acetate	1,3,4-Eugenol acetate	C <sub>12</sub> H <sub>14</sub> O <sub>3</sub>	93-28-7	206.237	pr (al)	30.5	281; 127 <sup>6</sup>	1.0806 <sup>20</sup>	1.5205 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; sl ctc
198	Allyl 3-methylbutanoate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	2835-39-4	142.196			154			
199	Allylmethylchlorosilane		C <sub>3</sub> H <sub>7</sub> Cl <sub>2</sub> Si	1873-92-3	155.099			119.5	1.0758 <sup>20</sup>	1.4419 <sup>20</sup>	
200	2-(Allyloxy)ethanol	Ethylene glycol monoallyl ether	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	111-45-5	102.132			158.5	0.9580 <sup>20</sup>	1.4358 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH; s bz, ctc, MeOH
201	2-Allylphenol		C <sub>9</sub> H <sub>10</sub> O	1745-81-9	134.174	liq	-6	220	1.0246 <sup>15</sup>	1.5181 <sup>20</sup>	vs eth
202	4-Allylphenol	Chavicol	C <sub>9</sub> H <sub>10</sub> O	501-92-8	134.174		15.8	238	1.0203 <sup>15</sup>	1.5441 <sup>18</sup>	vs eth, EtOH, chl
203	Allyl phenyl ether		C <sub>9</sub> H <sub>10</sub> O	1746-13-0	134.174			191.7	0.9811 <sup>20</sup>	1.5223 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth; sl ctc
204	Allyl propanoate	2-Propenyl propanoate	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	2408-20-0	114.142			123	0.9140 <sup>20</sup>	1.4105 <sup>20</sup>	s EtOH, eth, ace
205	<i>N</i> -Allyl-2-propen-1-amine	Diallylamine	C <sub>7</sub> H <sub>11</sub> N	124-02-7	97.158			111		1.4387 <sup>20</sup>	s EtOH, eth
206	Allyl propyl disulfide		C <sub>8</sub> H <sub>12</sub> S <sub>2</sub>	2179-59-1	148.289			79 <sup>13</sup>		1.5219 <sup>20</sup>	
207	3-(Allylsulfanyl)- <i>L</i> -alanine, (S)	Alliin	C <sub>6</sub> H <sub>11</sub> NO <sub>3</sub> S	556-27-4	177.221	nd (dil ac)	165				vs H <sub>2</sub> O
208	Allylthiourea	Thiosinamine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> S	109-57-9	116.185	mcl or orth pr (w)	78		1.217 <sup>20</sup>	1.5936 <sup>78</sup>	s H <sub>2</sub> O, EtOH; sl eth; i bz
209	Allyltrichlorosilane	Trichloro-2-propenylsilane	C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> Si	107-37-9	175.517		35	117.5	1.2011 <sup>20</sup>	1.4460 <sup>20</sup>	
210	Allyltriethoxysilane		C <sub>9</sub> H <sub>20</sub> O <sub>3</sub> Si	2550-04-1	204.339			100 <sup>50</sup> , 82 <sup>28</sup>	0.9030 <sup>20</sup>	1.4072 <sup>20</sup>	
211	Allyltrimethylsilane		C <sub>6</sub> H <sub>14</sub> Si	762-72-1	114.261			85	0.7158 <sup>25</sup>	1.4074 <sup>20</sup>	i H <sub>2</sub> O
212	Allylurea		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O	557-11-9	100.119	nd (al)	85				msc H <sub>2</sub> O, EtOH; sl eth, chl; i peth

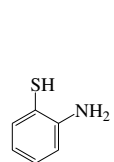


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub> <sup>20</sup>	Solubility
213	Allyl vinyl ether	3-(Ethenyloxy)-1-propene	C <sub>6</sub> H <sub>8</sub> O	3917-15-5	84.117			66	0.7900 <sup>20</sup>	1.4062 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, chl
214	Aloin A		C <sub>21</sub> H <sub>22</sub> O <sub>9</sub>	1415-73-2	418.395		149.3				s H <sub>2</sub> O, EtOH, ace; sl eth, bz; i chl
215	Alphaprodine		C <sub>16</sub> H <sub>23</sub> NO <sub>2</sub>	15867-21-7	261.360	cry	103				
216	Alstonidine		C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	25394-75-6	380.437	cry (eth)	189				vs ace, EtOH
217	Alstonine		C <sub>21</sub> H <sub>20</sub> N <sub>2</sub> O <sub>3</sub>	642-18-2	348.395	ye nd (ace)	207 dec				
218	D-Altrose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	1990-29-0	180.155	pr (MeOH,al)	103.5				vs H <sub>2</sub> O
219	Aluminum 2-butoxide	2-Butanol, aluminum salt	C <sub>12</sub> H <sub>27</sub> AlO <sub>3</sub>	2269-22-9	246.322			197 <sup>20</sup>			
220	Aluminum distearate	Hydroxyaluminum distearate	C <sub>36</sub> H <sub>71</sub> AlO <sub>5</sub>	300-92-5	610.928	wh pow	145				i H <sub>2</sub> O
221	Aluminum ethanolate	Aluminum ethoxide	C <sub>6</sub> H <sub>15</sub> AlO <sub>3</sub>	555-75-9	162.163	liq/wh solid	140	200 <sup>7</sup>			dec H <sub>2</sub> O; sl xyl
222	Aluminum isopropoxide		C <sub>9</sub> H <sub>21</sub> AlO <sub>3</sub>	555-31-7	204.243	hyg wh solid	119	135 <sup>10</sup> , 94 <sup>05</sup>			reac H <sub>2</sub> O; s EtOH, bz, peth, chl
223	Alverine	N-Ethyl-bis(3-phenylpropyl) amine	C <sub>20</sub> H <sub>27</sub> N	150-59-4	281.435	oil		166 <sup>03</sup>			
224	α-Amanitin		C <sub>39</sub> H <sub>54</sub> N <sub>10</sub> O <sub>14</sub> S	23109-05-9	918.970	nd	254 dec				
225	Amaranth dye		C <sub>20</sub> H <sub>11</sub> N <sub>2</sub> Na <sub>3</sub> O <sub>10</sub> S <sub>3</sub>	915-67-3	604.472	dk red pow					s H <sub>2</sub> O
226	Ametryn		C <sub>9</sub> H <sub>17</sub> N <sub>5</sub> S	834-12-8	227.330		88				
227	Aminetrimethylboron		C <sub>3</sub> H <sub>12</sub> BN	1830-95-1	72.945		73.5				
228	19-Amino-8,11,13-abietatriene		C <sub>20</sub> H <sub>31</sub> N	1446-61-3	285.467	cry	44.5				
229	2-Aminoacetamide		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	598-41-4	74.081	hyg nd (chl)	67.5				vs H <sub>2</sub> O, EtOH; sl eth, bz; s ace, chl
230	Aminoacetonitrile		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub>	540-61-4	56.066			58 <sup>15</sup>			vs EtOH
231	Aminoacetonitrile monohydrochloride		C <sub>2</sub> H <sub>5</sub> ClN <sub>2</sub>	6011-14-9	92.527	hyg cry (al)	165 dec				
232	α-Aminoacetophenone hydrochloride		C <sub>8</sub> H <sub>10</sub> ClNO	5468-37-1	171.624		194 dec				
233	1-Aminoadamantane hydrochloride	Adamantanamine hydrochloride	C <sub>10</sub> H <sub>16</sub> ClN	665-66-7	187.710	cry (al-eth)	360 dec				vs H <sub>2</sub> O, EtOH
234	2-Amino adipic acid		C <sub>6</sub> H <sub>11</sub> NO <sub>4</sub>	626-71-1	161.156	pl (w)	207.0				sl H <sub>2</sub> O, EtOH, eth
235	3-Aminoalanine	2,3-Diaminopropionic acid	C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	515-94-6	104.108	hyg rosettes	110				vs H <sub>2</sub> O
236	1-Amino-9,10-anthracenedione	1-Aminoanthraquinone	C <sub>14</sub> H <sub>9</sub> NO <sub>2</sub>	82-45-1	223.227	red nd (al)	253.5	sub			vs ace, bz, EtOH, chl
237	2-Amino-9,10-anthracenedione	2-Aminoanthraquinone	C <sub>14</sub> H <sub>9</sub> NO <sub>2</sub>	117-79-3	223.227	red nd (al, HOAc)	304.5	sub			i H <sub>2</sub> O, eth; sl EtOH; s ace, bz, chl
238	4-Aminoazobenzene		C <sub>12</sub> H <sub>11</sub> N <sub>3</sub>	60-09-3	197.235	oran mcl nd (al)	127	>360			sl H <sub>2</sub> O, lig; s EtOH, eth, bz, chl
239	2-Aminobenzaldehyde		C <sub>7</sub> H <sub>7</sub> NO	529-23-7	121.137	silv lf	40.5	80 <sup>2</sup>			sl H <sub>2</sub> O; vs EtOH, eth; s bz, chl; i lig
240	3-Aminobenzaldehyde		C <sub>7</sub> H <sub>7</sub> NO	1709-44-0	121.137	nd (AcOEt)	29				s eth, acid
241	4-Aminobenzaldehyde		C <sub>7</sub> H <sub>7</sub> NO	556-18-3	121.137	pl (w)	71.5				s H <sub>2</sub> O, EtOH, eth, acid
242	2-Aminobenzamide		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	88-68-6	136.151		110.5 dec				s H <sub>2</sub> O, EtOH; sl eth, bz; vs AcOEt
243	4-Aminobenzamide		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	2835-68-9	136.151	ye cry (+1/4w)	183				sl H <sub>2</sub> O; s EtOH, eth
244	α-Aminobenzeneacetic acid, (±)	α-Phenylglycine	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	2835-06-5	151.163	pl	292 dec	sub 255			s alk; sl os
245	4-Aminobenzeneacetic acid	p-Aminophenylacetic acid	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	1197-55-3	151.163	pl (w)	200 dec				i H <sub>2</sub> O; sl EtOH, DMSO
246	5-Amino-1,3-benzenedicarboxylic acid		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	99-31-0	181.147	pr(al), pl(w)	360	sub			i H <sub>2</sub> O; sl EtOH
247	4-Aminobenzeneethanol		C <sub>8</sub> H <sub>11</sub> NO	104-10-9	137.179	nd (al)	108				
248	2-Aminobenzenemethanamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	4403-69-4	122.167		61	269			vs EtOH
249	2-Aminobenzenemethanol		C <sub>7</sub> H <sub>9</sub> NO	5344-90-1	123.152		83.5	273			s H <sub>2</sub> O, EtOH, eth, HOAc; vs bz, chl
250	4-Aminobenzeneulfonamide	Sulfanilamide	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub> S	63-74-1	172.205	lf (dil al)	165.5		1.08 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth, ace; sl chl, peth
251	2-Aminobenzeneulfonic acid	Orthanilic acid	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	88-21-1	173.190	pr (+ 1/2w)	>320 dec				sl H <sub>2</sub> O; i EtOH, eth
252	3-Aminobenzeneulfonic acid	Metanilic acid	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	121-47-1	173.190	nd, pr (w +1)	dec				sl H <sub>2</sub> O, EtOH; i eth
253	4-Aminobenzeneulfonic acid	Sulfanilic acid	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	121-57-3	173.190	orth pl or mcl (w+2)	288		1.485 <sup>25</sup>		sl H <sub>2</sub> O; i EtOH, eth
254	4-Aminobenzeneulfonyl fluoride	p-Sulfanilyl fluoride	C <sub>6</sub> H <sub>6</sub> FNO <sub>2</sub> S	98-62-4	175.181		68.5				

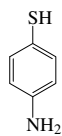




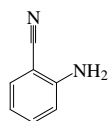
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
255	2-Aminobenzenethiol		C <sub>6</sub> H <sub>7</sub> NS	137-07-5	125.192		26	234		1.4606 <sup>20</sup>	s EtOH, eth
256	4-Aminobenzenethiol		C <sub>6</sub> H <sub>7</sub> NS	1193-02-8	125.192		46	143 <sup>17</sup>			s H <sub>2</sub> O, EtOH
257	2-Aminobenzonitrile		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1885-29-6	118.136	ye pr (CS <sub>2</sub> ) nd (peth)	51	263			sl H <sub>2</sub> O; vs EtOH, eth, ace, bz; i peth
258	3-Aminobenzonitrile		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	2237-30-1	118.136	nd (dil al or CCl <sub>4</sub> )	54.3	289			sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
259	4-Aminobenzonitrile		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	873-74-5	118.136	pr or pl (w)	87.0				sl H <sub>2</sub> O, ctc; vs EtOH, eth, ace, bz
260	4-Aminobenzophenone		C <sub>13</sub> H <sub>11</sub> NO	1137-41-3	197.232	lf (dil al)	124	246 <sup>13</sup>			sl H <sub>2</sub> O, tfa; s EtOH, eth, HOAc
261	<i>N</i> -(4-Aminobenzoyl)- <i>L</i> -glutamic acid		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	4271-30-1	266.249	cry (w)	173				
262	<i>N</i> -(4-Aminobenzoyl)glycine	<i>p</i> -Aminohippuric acid	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	61-78-9	194.186	pr or nd (w)	198.5				vs ace, bz, EtOH
263	2-Aminobiphenyl		C <sub>12</sub> H <sub>11</sub> N	90-41-5	169.222	lf (dil al)	51	299			i H <sub>2</sub> O; s EtOH, eth, bz; sl DMSO, peth
264	3-Aminobiphenyl		C <sub>12</sub> H <sub>11</sub> N	2243-47-2	169.222	nd	31.5				sl H <sub>2</sub> O; s EtOH, eth, ace, bz
265	4-Aminobiphenyl	<i>p</i> -Biphenylamine	C <sub>12</sub> H <sub>11</sub> N	92-67-1	169.222	lf (dil al)	53.5	302			sl H <sub>2</sub> O; s EtOH, eth, ace, chl
266	2-Amino-5-bromobenzoic acid	5-Bromoanthranilic acid	C <sub>7</sub> H <sub>6</sub> BrNO <sub>2</sub>	5794-88-7	216.033	nd	219.5				s DMSO
267	1-Amino-4-bromo-9,10-dihydro-9,10-dioxo-2-anthracenesulfonic acid	1-Amino-4-bromoanthraquinone-2-sulfonic acid	C <sub>14</sub> H <sub>8</sub> BrNO <sub>5</sub> S	116-81-4	382.187	red nd (w)					
268	<i>DL</i> -2-Aminobutanoic acid		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	2835-81-6	103.120	lf (w)	304 dec	sub	1.2300 <sup>20</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, bz
269	<i>L</i> -2-Aminobutanoic acid		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	1492-24-6	103.120	lf (dil al), cry (al)	292 dec				s H <sub>2</sub> O; sl EtOH, eth; i bz
270	<i>DL</i> -3-Aminobutanoic acid		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	2835-82-7	103.120	nd (al)	194.3				vs H <sub>2</sub> O; i EtOH, eth, bz
271	4-Aminobutanoic acid	<i>γ</i> -Aminobutyric acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	56-12-2	103.120	pr or nd (al) lf (MeOH- eth)	203 dec				vs H <sub>2</sub> O; sl EtOH, ace; i eth, bz
272	2-Amino-1-butanol, (±)		C <sub>4</sub> H <sub>11</sub> NO	13054-87-0	89.136	liq	-1.0	178	0.9162 <sup>20</sup>	1.4489 <sup>25</sup>	msc H <sub>2</sub> O, EtOH, eth; sl chl
273	4-Amino-1-butanol		C <sub>4</sub> H <sub>11</sub> NO	13325-10-5	89.136			205; 125 <sup>34</sup>	0.967 <sup>12</sup>	1.4625 <sup>20</sup>	s H <sub>2</sub> O, EtOH; i eth
274	4-Amino- <i>N</i> -[(butylamino)carbonyl]benzenesulfonamide	Carbutamide	C <sub>11</sub> H <sub>17</sub> N <sub>3</sub> O <sub>3</sub> S	339-43-5	271.336		144.5				
275	Aminocarb		C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	2032-59-9	208.257	cry	94				sl H <sub>2</sub> O, bz; s ace
276	<i>N</i> -(Aminocarbonyl)acetamide		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	591-07-1	102.092		218	sub 180			sl H <sub>2</sub> O, eth; s EtOH
277	[4-[(Aminocarbonyl)amino]phenyl]arsonic acid	Carbarsone	C <sub>7</sub> H <sub>9</sub> AsN <sub>2</sub> O <sub>4</sub>	121-59-5	260.079	nd (w)	174				sl H <sub>2</sub> O, DMSO, EtOH; i eth, chl; s alk
278	<i>N</i> -(Aminocarbonyl)-2-bromo-2-ethylbutanamide	Carbromal	C <sub>7</sub> H <sub>13</sub> BrN <sub>2</sub> O <sub>2</sub>	77-65-6	237.094	orth (dil al)	118		1.544 <sup>25</sup>		sl H <sub>2</sub> O, chl; s ace, bz
279	<i>N</i> -(Aminocarbonyl)-2-bromo-3-methylbutanamide	Bromisovalum	C <sub>6</sub> H <sub>11</sub> BrN <sub>2</sub> O <sub>2</sub>	496-67-3	223.067	nd or lf (to)	154	sub	1.56 <sup>15</sup>		vs ace, bz, eth, EtOH
280	[2-(Aminocarbonyl)phenoxy]acetic acid	Salicylamide <i>O</i> -acetic acid	C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	25395-22-6	195.172		221				s alk
281	7-Aminocephalosporanic acid		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub> S	957-68-6	272.277	cry					
282	1-Amino-5-chloro-9,10-anthracenedione	1-Amino-5-chloroanthraquinone	C <sub>14</sub> H <sub>8</sub> ClNO <sub>2</sub>	117-11-3	257.673		212				
283	4-Amino-6-chloro-1,3-benzenedisulfonamide	Chloraminophenamide	C <sub>6</sub> H <sub>8</sub> ClN <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	121-30-2	285.729		254.5				
284	5-Amino-2-chlorobenzenesulfonic acid	6-Chlorometanilic acid	C <sub>6</sub> H <sub>6</sub> ClNO <sub>3</sub> S	88-43-7	207.635	nd (w)	280 dec				
285	2-Amino-5-chlorobenzoic acid		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	635-21-2	171.582		211				
286	5-Amino-2-chlorobenzoic acid		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	89-54-3	171.582		188		1.519 <sup>15</sup>		vs EtOH
287	2-Amino-5-chlorobenzophenone	2-Benzoyl-4-chloroaniline	C <sub>13</sub> H <sub>10</sub> ClNO	719-59-5	231.677	ye nd	100.5				vs H <sub>2</sub> O, EtOH, peth, chl
288	2-Amino-4-chloro-5-methylbenzenesulfonic acid	2-Chloro- <i>p</i> -toluidine-5-sulfonic acid	C <sub>7</sub> H <sub>8</sub> ClNO <sub>3</sub> S	88-51-7	221.662	short nd (w)					
289	2-Amino-4-chlorophenol	2-Hydroxy-5-chloroaniline	C <sub>6</sub> H <sub>6</sub> ClNO	95-85-2	143.571		140				sl DMSO
290	1-Aminocyclopentanecarboxylic acid	Cycloleucine	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	52-52-8	129.157	cry (al-w)	330 dec				
291	7-Aminodeacetoxycephalosporanic acid		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>5</sub> S	22252-43-3	214.241		241 dec				
292	1-Amino-1-deoxy- <i>D</i> -glucitol	Glucamine	C <sub>6</sub> H <sub>15</sub> NO <sub>5</sub>	488-43-7	181.187	cry (MeOH)	127				vs H <sub>2</sub> O, EtOH
293	2-Amino-2-deoxy- <i>D</i> -glucose	<i>D</i> -Glucosamine	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	3416-24-8	179.171						vs H <sub>2</sub> O



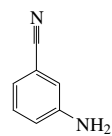
2-Aminobenzenethiol



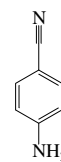
4-Aminobenzenethiol



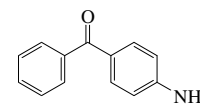
2-Aminobenzonitrile



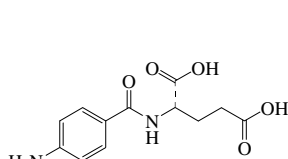
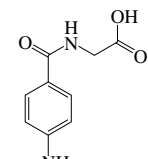
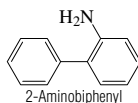
3-Aminobenzonitrile



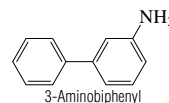
4-Aminobenzonitrile



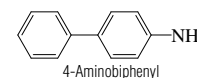
4-Aminobenzophenone

*N*-(4-Aminobenzoyl)-L-glutamic acid*N*-(4-Aminobenzoyl)glycine

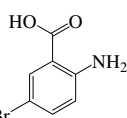
2-Aminobiphenyl



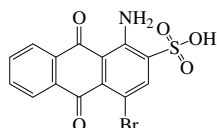
3-Aminobiphenyl



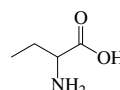
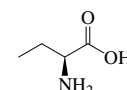
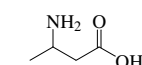
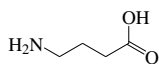
4-Aminobiphenyl



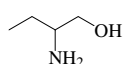
2-Amino-5-bromobenzoic acid



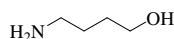
1-Amino-4-bromo-9,10-dihydro-9,10-dioxo-2-anthracenesulfonic acid

*DL*-2-Aminobutanoic acid*L*-2-Aminobutanoic acid*DL*-3-Aminobutanoic acid

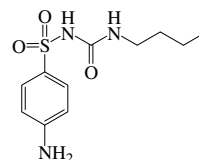
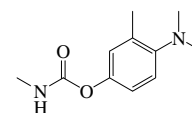
4-Aminobutanoic acid



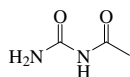
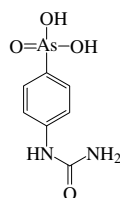
2-Amino-1-butanol, (±)



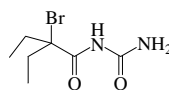
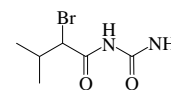
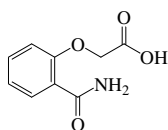
4-Amino-1-butanol

4-Amino-*N*-[(butylamino)carbonyl]benzenesulfonamide

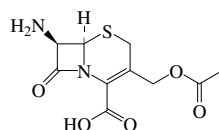
Aminocarb

*N*-(Aminocarbonyl)acetamide

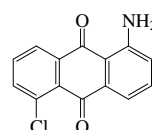
[4-((Aminocarbonyl)amino)phenyl]arsonic acid

*N*-(Aminocarbonyl)-2-bromo-2-ethylbutanamide*N*-(Aminocarbonyl)-2-bromo-3-methylbutanamide

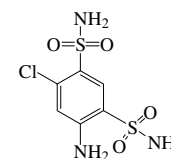
[2-(Aminocarbonyl)phenoxy]acetic acid



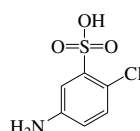
7-Aminocephalosporanic acid



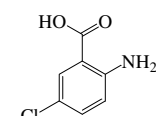
1-Amino-5-chloro-9,10-anthracenedione



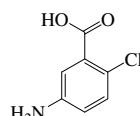
4-Amino-6-chloro-1,3-benzenedisulfonamide



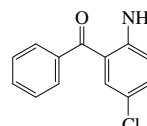
5-Amino-2-chlorobenzenesulfonic acid



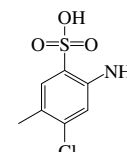
2-Amino-5-chlorobenzoic acid



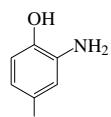
5-Amino-2-chlorobenzoic acid



2-Amino-5-chlorobenzophenone



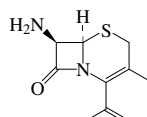
2-Amino-4-chloro-5-methylbenzenesulfonic acid



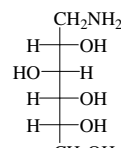
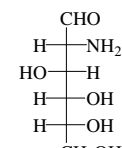
2-Amino-4-chlorophenol



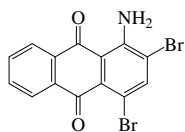
1-Aminocyclopentanecarboxylic acid



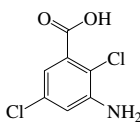
7-Aminodeacetoxycephalosporanic acid

1-Amino-1-deoxy-*D*-glucitol2-Amino-2-deoxy-*D*-glucose

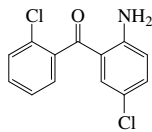
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
294	1-Amino-2,4-dibromo-9,10-anthracenedione		C <sub>14</sub> H <sub>7</sub> Br <sub>2</sub> NO <sub>2</sub>	81-49-2	381.020	red nd (xyl)	226				
295	3-Amino-2,5-dichlorobenzoic acid	Chloramben	C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	133-90-4	206.027		200				sl DMSO
296	2-Amino-2',5'-dichlorobenzophenone		C <sub>13</sub> H <sub>9</sub> Cl <sub>2</sub> NO	2958-36-3	266.122		≈80				
297	2-Amino-4,6-dichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO	527-62-8	178.016	long nd (CS <sub>2</sub> )	95.5	sub 70			
298	4-Amino-2,6-dichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO	5930-28-9	178.016	nd or lf (w, bz)	168	sub			i H <sub>2</sub> O; vs EtOH, eth; s ace; sl bz, HOAc
299	2-Amino-1,7-dihydro-7-methyl-6 <i>H</i> -purin-6-one	7-Methylguanine	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> O	578-76-7	165.153		370				
300	5-Amino-2,3-dihydro-1,4-phthalazinedione	Luminol	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	521-31-3	177.161	ye nd (al)	330.5				i H <sub>2</sub> O; sl EtOH, eth; vs alk; s HOAc
301	2-Amino-1,7-dihydro-6 <i>H</i> -purine-6-thione	Thioguanine	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> S	154-42-7	167.193		>360				
302	6-Amino-1,3-dihydro-2 <i>H</i> -purin-2-one	Isoguanine	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> O	3373-53-3	151.127		>360				i H <sub>2</sub> O
303	2-Amino-3,4-dimethylimidazo[4,5-f]quinoline	Me-IQ	C <sub>12</sub> H <sub>12</sub> N <sub>4</sub>	77094-11-2	212.250	cry	297				
304	2-Amino-4,6-dinitrophenol	Picramic acid	C <sub>6</sub> H <sub>3</sub> N <sub>2</sub> O <sub>5</sub>	96-91-3	199.121	dk red nd (al) pr (chl)	169				vs bz, EtOH
305	2-Aminoethanesulfonic acid	Taurine	C <sub>2</sub> H <sub>7</sub> NO <sub>3</sub> S	107-35-7	125.147	mcl pr (w)	328				vs H <sub>2</sub> O
306	1-Aminoethanol	Acetaldehyde ammonia	C <sub>2</sub> H <sub>7</sub> NO	75-39-8	61.083	orth (eth-al)	97	dec 110			s H <sub>2</sub> O; sl eth
307	2-(2-Aminoethoxy)ethanol	Diglycolamine	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	929-06-6	105.136		-12.5	221	1.0572 <sup>20</sup>		
308	<i>N</i> -(2-Aminoethyl)acetamide		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	1001-53-2	102.134		51				s H <sub>2</sub> O, EtOH, bz; i eth
309	6-Amino-3-ethyl-1-allyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	Aminometradine	C <sub>9</sub> H <sub>13</sub> N <sub>3</sub> O <sub>2</sub>	642-44-4	195.218	cry (+1w, w)	143				
310	1-[(2-Aminoethyl)amino]-2-propanol	<i>N</i> -(2-Hydroxypropyl)ethylenediamine	C <sub>8</sub> H <sub>14</sub> N <sub>2</sub> O	123-84-2	118.177			94 <sup>3</sup>	0.9837 <sup>25</sup>	1.4738 <sup>20</sup>	
311	4-(2-Aminoethyl)-1,2-benzenediol, hydrochloride	Dopamine hydrochloride	C <sub>8</sub> H <sub>12</sub> ClNO <sub>2</sub>	62-31-7	189.640	nd (w)	241 dec				vs H <sub>2</sub> O, MeOH
312	$\alpha$ -(1-Aminoethyl)benzenemethanol, [ <i>S</i> -( <i>R</i> *, <i>R</i> *)]-		C <sub>8</sub> H <sub>13</sub> NO	492-39-7	151.205	pl(MeOH)	77.5				vs eth, EtOH, chl
313	$\alpha$ -(1-Aminoethyl)benzenemethanol, hydrochloride		C <sub>8</sub> H <sub>14</sub> ClNO	53631-70-2	187.666		198.5				s H <sub>2</sub> O
314	<i>N</i> -(2-Aminoethyl)ethanolamine		C <sub>4</sub> H <sub>12</sub> N <sub>2</sub> O	111-41-1	104.150			239; 105 <sup>10</sup>	1.0286 <sup>20</sup>	1.4863 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s ace; sl bz, lig
315	4-(2-Aminoethyl)phenol	Tyramine	C <sub>8</sub> H <sub>11</sub> NO	51-67-2	137.179	pl or nd (bz, w), cry (al)	164.5	206 <sup>25</sup>			sl H <sub>2</sub> O, bz, DMSO; s EtOH, xyl; i tol
316	<i>N</i> -(2-Aminoethyl)-1,3-propanediamine	<i>N</i> -(3-Aminopropyl)ethylenediamine	C <sub>8</sub> H <sub>15</sub> N <sub>3</sub>	13531-52-7	117.193			87 <sup>3</sup>		1.4805 <sup>25</sup>	
317	2-Amino-2-ethyl-1,3-propanediol		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	115-70-8	119.163		37.5	152 <sup>10</sup>	1.099 <sup>20</sup>	1.490 <sup>20</sup>	msc H <sub>2</sub> O
318	<i>L</i> -2-Aminohexanedioic acid	2-Aminoadipic acid	C <sub>6</sub> H <sub>11</sub> NO <sub>4</sub>	542-32-5	161.156	cry (EtOH, w)	205 dec				sl H <sub>2</sub> O, EtOH, eth
319	6-Aminohexanenitrile	5-Cyano-1-pentylamine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	2432-74-8	112.172	liq		118 <sup>16</sup>			vs H <sub>2</sub> O; i EtOH; sl MeOH
320	6-Aminohexanoic acid	$\epsilon$ -Aminocaproic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	60-32-2	131.173	lf (eth)	205				
321	6-Amino-1-hexanol		C <sub>6</sub> H <sub>13</sub> NO	4048-33-3	117.189		57	137 <sup>30</sup>			
322	1-Amino-4-hydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>9</sub> NO <sub>3</sub>	116-85-8	239.226		216.5				s EtOH, ace
323	3-Amino-4-hydroxybenzenesulfonic acid		C <sub>6</sub> H <sub>7</sub> NO <sub>4</sub> S	98-37-3	189.190	orth (w+1)	>300				sl H <sub>2</sub> O; i EtOH, eth
324	4-Amino-2-hydroxybenzohydrazide	<i>p</i> -Aminosalicylic acid hydrazide	C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	6946-29-8	167.165	nd (al)	195				vs EtOH
325	2-Amino-3-hydroxybenzoic acid		C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	548-93-6	153.136	lf (w)	253.5				sl H <sub>2</sub> O; s EtOH, eth, chl
326	4-Amino-2-hydroxybenzoic acid	<i>p</i> -Aminosalicylic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	65-49-6	153.136	nd, pl (al-eth)	150 dec				s H <sub>2</sub> O, EtOH, eth, ace; i bz, peth, chl
327	5-Amino-2-hydroxybenzoic acid	Mesalamine	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	89-57-6	153.136		283				sl H <sub>2</sub> O; i EtOH
328	3-Amino-4-hydroxybutanoic acid	$\gamma$ -Hydroxy- $\beta$ -aminobutyric acid	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	589-44-6	119.119	pr	216				vs H <sub>2</sub> O; sl EtOH, chl, eth, AcOEt
329	4-Amino-3-hydroxybutanoic acid, ( $\pm$ )		C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	924-49-2	119.119	pr (w), cry (dil al)	218				vs H <sub>2</sub> O
330	4-(2-Amino-1-hydroxyethyl)-1,2-benzenediol, ( $\pm$ )		C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	138-65-8	169.178		189 dec				
331	1-Amino-4-hydroxy-2-methoxy-9,10-anthracenedione		C <sub>15</sub> H <sub>11</sub> NO <sub>4</sub>	2379-90-0	269.253						sl chl
332	4-Amino-5-(hydroxymethyl)-2(1 <i>H</i> )-pyrimidinone	5-Hydroxymethylcytosine	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	1123-95-1	141.129		>300 dec				



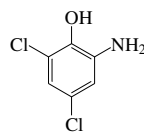
1-Amino-2,4-dibromo-9,10-anthracenedione



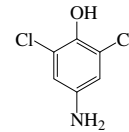
3-Amino-2,5-dichlorobenzoic acid



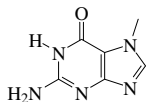
2-Amino-2',5'-dichlorobenzophenone



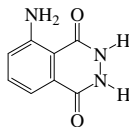
2-Amino-4,6-dichlorophenol



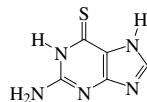
4-Amino-2,6-dichlorophenol



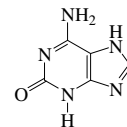
2-Amino-1,7-dihydro-7-methyl-6H-purin-6-one



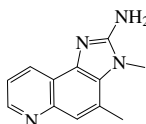
5-Amino-2,3-dihydro-1,4-phthalazinedione



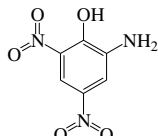
2-Amino-1,7-dihydro-6H-purine-6-thione



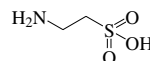
6-Amino-1,3-dihydro-2H-purin-2-one



2-Amino-3,4-dimethylimidazo[4,5-f]quinoline



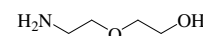
2-Amino-4,6-dinitrophenol



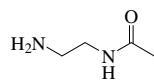
2-Aminoethanesulfonic acid



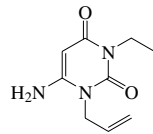
1-Aminoethanol



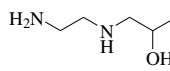
2-(2-Aminoethoxy)ethanol



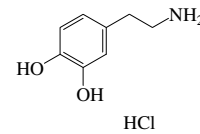
N-(2-Aminoethyl)acetamide



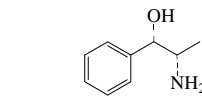
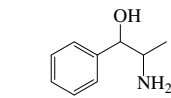
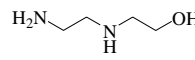
6-Amino-3-ethyl-1-allyl-2,4-(1H,3H)-pyrimidinedione



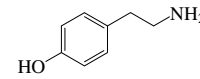
1-[(2-Aminoethyl)amino]-2-propanol



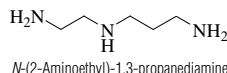
4-(2-Aminoethyl)-1,2-benzenediol, hydrochloride

 $\alpha$ -(1-Aminoethyl)benzenemethanol, [S-(R\*,R\*)]- $\alpha$ -(1-Aminoethyl)benzenemethanol, hydrochloride

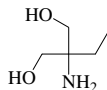
N-(2-Aminoethyl)ethanolamine



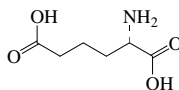
4-(2-Aminoethyl)phenol



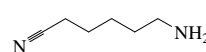
N-(2-Aminoethyl)-1,3-propanediamine



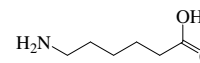
2-Amino-2-ethyl-1,3-propanediol



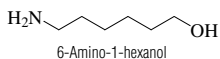
L-2-Aminohexanedioic acid



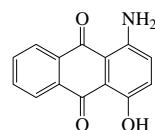
6-Aminohexanenitrile



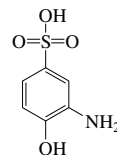
6-Aminohexanoic acid



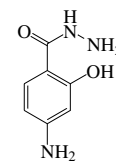
6-Amino-1-hexanol



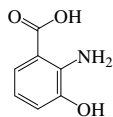
1-Amino-4-hydroxy-9,10-anthracenedione



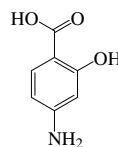
3-Amino-4-hydroxybenzenesulfonic acid



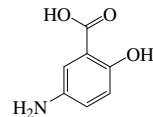
4-Amino-2-hydroxybenzohydrazide



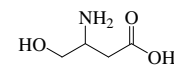
2-Amino-3-hydroxybenzoic acid



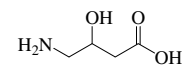
4-Amino-2-hydroxybenzoic acid



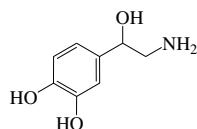
5-Amino-2-hydroxybenzoic acid



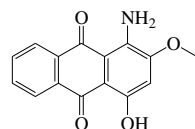
3-Amino-4-hydroxybutanoic acid



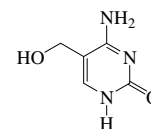
4-Amino-3-hydroxybutanoic acid, (±)



4-(2-Amino-1-hydroxyethyl)-1,2-benzenediol, (±)

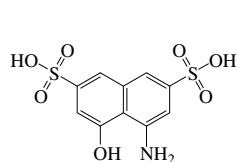


1-Amino-4-hydroxy-2-methoxy-9,10-anthracenedione

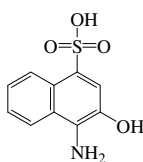


4-Amino-5-(hydroxymethyl)-2(1H)-pyrimidinone

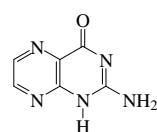
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
333	4-Amino-5-hydroxy-2,7-naphthalenedisulfonic acid	1-Naphthol-8-amino-3,6-disulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>7</sub> S <sub>2</sub>	90-20-0	319.311						sl H <sub>2</sub> O, EtOH, eth
334	4-Amino-3-hydroxy-1-naphthalenesulfonic acid	1-Amino-2-naphthol-4-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>4</sub> S	116-63-2	239.248	gray nd					i H <sub>2</sub> O, EtOH, bz; s alk
335	2-Amino-4-hydroxypteridine		C <sub>6</sub> H <sub>6</sub> N <sub>4</sub> O	2236-60-4	163.137	ye cry	>360				
336	5-Amino-1 <i>H</i> -imidazole-4-carboxamide		C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O	360-97-4	126.117	cry (EtOH)	170				
337	<i>O</i> -[(Aminoiminomethyl)amino]- <i>L</i> -homoserine	Canavanine	C <sub>5</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub>	543-38-4	176.174	cry (al)					vs H <sub>2</sub> O
338	(Aminoiminomethyl)urea		C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> O	141-83-3	102.095	pr	105	dec 160			s H <sub>2</sub> O, py; sl EtOH; i eth, bz, chl, CS <sub>2</sub>
339	2-Amino-5-iodobenzoic acid		C <sub>7</sub> H <sub>6</sub> INO <sub>2</sub>	5326-47-6	263.033		220 dec				sl H <sub>2</sub> O, tfa; vs EtOH, eth, ace; s bz
340	4-Amino-1 <i>H</i> -isindole-1,3(2 <i>H</i> )-dione		C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	2518-24-3	162.146		269.5				
341	4-Amino-3-isoxazolidinone, ( <i>R</i> )	Cycloserine	C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	68-41-7	102.092		155 dec				s H <sub>2</sub> O; sl MeOH
342	1-Amino-2-methyl-9,10-anthracenedione	1-Amino-2-methylanthraquinone	C <sub>15</sub> H <sub>11</sub> NO <sub>2</sub>	82-28-0	237.254		205.5				i H <sub>2</sub> O; s EtOH, bz, chl; sl eth
343	$\alpha$ -(Aminomethyl)benzenemethanol	Phenylethanamine	C <sub>8</sub> H <sub>11</sub> NO	7568-93-6	137.179		56.5	160 <sup>17</sup>			vs H <sub>2</sub> O; s EtOH
344	$\beta$ -(Aminomethyl)benzenepropanoic acid	4-Amino-3-phenylbutyric acid	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	1078-21-3	179.216			252 dec			
345	2-Amino-5-methylbenzenesulfonic acid		C <sub>7</sub> H <sub>9</sub> NO <sub>3</sub> S	88-44-8	187.216	lt ye nd	132 dec				vs H <sub>2</sub> O
346	<i>trans</i> -4-(Aminomethyl)cyclohexanecarboxylic acid	Tranexamic acid	C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	1197-18-8	157.211		>300				vs H <sub>2</sub> O
347	4-Amino-4-methyl-2-pentanone	Diacetonamine	C <sub>8</sub> H <sub>13</sub> NO	625-04-7	115.173			25 <sup>9,14</sup>			s H <sub>2</sub> O; msc EtOH, eth
348	2-Amino-4-methylphenol		C <sub>7</sub> H <sub>9</sub> NO	95-84-1	123.152	cry (w), orth (bz), lf or nd	136	sub			sl H <sub>2</sub> O, bz; s EtOH, eth, chl; i lig
349	4-Amino-2-methylphenol		C <sub>7</sub> H <sub>9</sub> NO	2835-96-3	123.152	nd or lf (bz)	176.5	sub			sl H <sub>2</sub> O, bz; s EtOH, eth
350	4-Amino-3-methylphenol		C <sub>7</sub> H <sub>9</sub> NO	2835-99-6	123.152	pr (dil al) cry (bz)	179				sl H <sub>2</sub> O; vs EtOH, eth; s DMSO
351	(Aminomethyl)phosphonic acid		CH <sub>2</sub> NO <sub>3</sub> P	1066-51-9	111.038	cry	309				
352	2-Amino-2-methyl-1,3-propanediol		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	115-69-5	105.136		110	151 <sup>10</sup>			vs H <sub>2</sub> O; s EtOH
353	<i>L</i> -3-Amino-2-methylpropanoic acid		C <sub>6</sub> H <sub>9</sub> NO <sub>2</sub>	144-90-1	103.120	cry (w)	182				
354	2-Amino-2-methyl-1-propanol	2-Aminoisobutanol	C <sub>4</sub> H <sub>11</sub> NO	124-68-5	89.136		25.5	165.5	0.934 <sup>20</sup>	1.449 <sup>20</sup>	msc H <sub>2</sub> O; s ctc
355	4-Amino-5-methyl-2(1 <i>H</i> )-pyrimidinone	5-Methylcytosine	C <sub>8</sub> H <sub>9</sub> N <sub>3</sub> O	554-01-8	125.129	pr (w+1/2)	270 dec				s H <sub>2</sub> O, acid; sl EtOH; i eth
356	3-(Aminomethyl)-3,5,5-trimethylcyclohexanol	1-Hydroxy-3-aminomethyl-3,5,5-trimethylcyclohexane	C <sub>10</sub> H <sub>21</sub> NO	15647-11-7	171.280		45.5	265	0.969 <sup>25</sup>	1.4904 <sup>20</sup>	
357	3-Amino-2-naphthalenecarboxylic acid	3-Amino-2-naphthoic acid	C <sub>11</sub> H <sub>9</sub> NO <sub>2</sub>	5959-52-4	187.195	ye lf (dil al)	216.5				s EtOH, eth
358	2-Amino-1,4-naphthalenedione		C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	2348-81-4	173.169		207				i H <sub>2</sub> O, alk; s EtOH, eth, HOAc
359	7-Amino-1,3-naphthalenedisulfonic acid	Amido-G-Acid	C <sub>10</sub> H <sub>9</sub> NO <sub>6</sub> S <sub>2</sub>	86-65-7	303.311	mcl pr or nd (w+4)	274				vs H <sub>2</sub> O, EtOH
360	2-Amino-1,5-naphthalenedisulfonic acid	2-Naphthylamine-1,5-disulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>6</sub> S <sub>2</sub>	117-62-4	303.311		>300				
361	4-Amino-1,6-naphthalenedisulfonic acid	1-Naphthylamine-4,7-disulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>6</sub> S <sub>2</sub>	85-75-6	303.311						vs H <sub>2</sub> O
362	4-Amino-1,7-naphthalenedisulfonic acid	1-Naphthylamine-4,6-disulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>6</sub> S <sub>2</sub>	85-74-5	303.311						vs H <sub>2</sub> O, EtOH
363	2-Amino-1-naphthalenesulfonic acid	2-Naphthylamine-1-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	81-16-3	223.248	sc(hot w)					s DMSO
364	4-Amino-1-naphthalenesulfonic acid	1-Naphthylamine-4-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	84-86-6	223.248	wh nd (w+1/2) red-br cry	dec		1.6703 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH; s MeOH, py
365	5-Amino-1-naphthalenesulfonic acid	1-Naphthylamine-5-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	84-89-9	223.248	wh cry					s H <sub>2</sub> O; i eth
366	6-Amino-1-naphthalenesulfonic acid	2-Naphthylamine-5-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	81-05-0	223.248	nd(w)					i H <sub>2</sub> O, EtOH, eth
367	7-Amino-1-naphthalenesulfonic acid	Badische acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	86-60-2	223.248	nd (w+1), pl (aq ace)					vs HOAc
368	8-Amino-1-naphthalenesulfonic acid	1-Naphthylamine-8-sulfonic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	82-75-7	223.248						vs gl HOAc
369	6-Amino-2-naphthalenesulfonic acid	Bronner acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	93-00-5	223.248	lf					i cold H <sub>2</sub> O; sl hot H <sub>2</sub> O



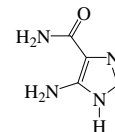
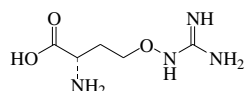
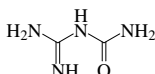
4-Amino-5-hydroxy-2,7-naphthalenedisulfonic acid



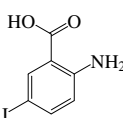
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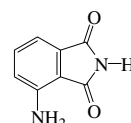
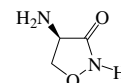
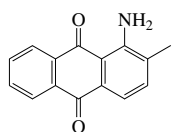
2-Amino-4-hydroxypteridine

5-Amino-1*H*-imidazole-4-carboxamide*O*-((Aminoiminomethyl)amino)-*L*-homoserine

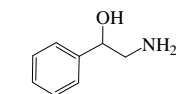
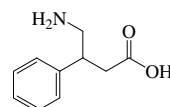
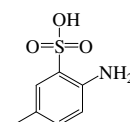
(Aminoiminomethyl)urea



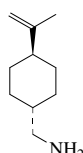
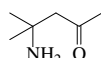
2-Amino-5-iodobenzoic acid

4-Amino-1*H*-isoindole-1,3(2*H*)-dione4-Amino-3-isoxazolidinone, (*R*)

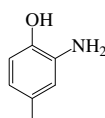
1-Amino-2-methyl-9,10-anthracenedione

 $\alpha$ -(Aminomethyl)benzenemethanol $\beta$ -(Aminomethyl)benzenepropanoic acid

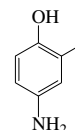
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*trans*-4-(Aminomethyl)cyclohexanecarboxylic acid

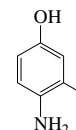
4-Amino-4-methyl-2-pentanone



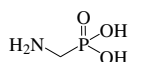
2-Amino-4-methylphenol



4-Amino-2-methylphenol



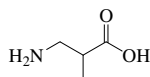
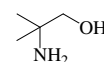
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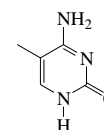
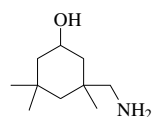
(Aminomethyl)phosphonic acid



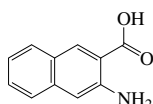
2-Amino-2-methyl-1,3-propanediol

*L*-3-Amino-2-methylpropanoic acid

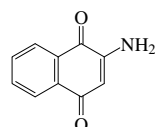
2-Amino-2-methyl-1-propanol

4-Amino-5-methyl-2(1*H*)-pyrimidinone

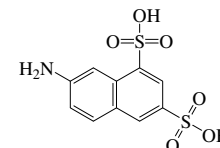
3-(Aminomethyl)-3,5,5-trimethylcyclohexanol



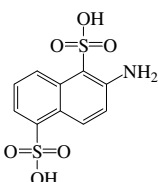
3-Amino-2-naphthalenecarboxylic acid



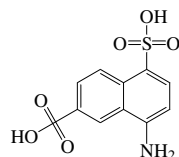
2-Amino-1,4-naphthalenedione



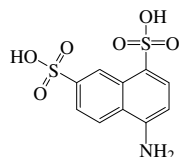
7-Amino-1,3-naphthalenedisulfonic acid



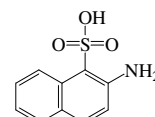
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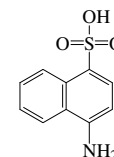
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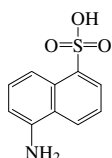
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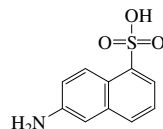
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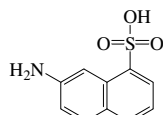
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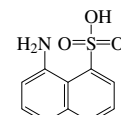
5-Amino-1-naphthalenesulfonic acid



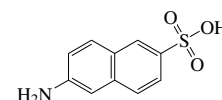
6-Amino-1-naphthalenesulfonic acid



7-Amino-1-naphthalenesulfonic acid



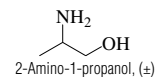
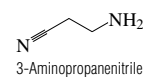
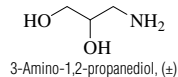
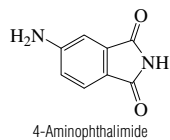
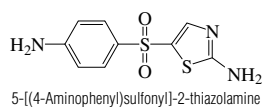
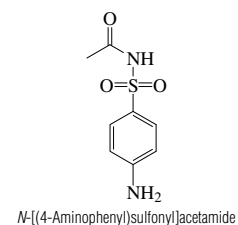
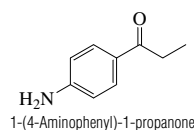
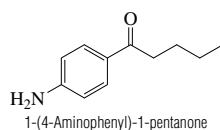
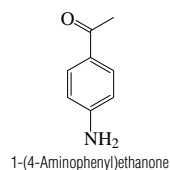
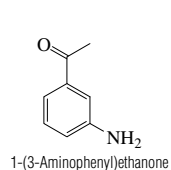
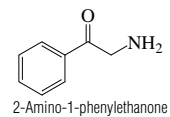
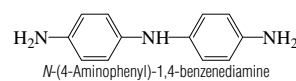
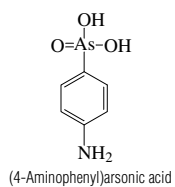
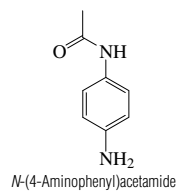
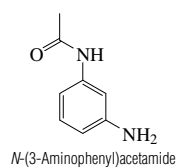
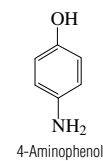
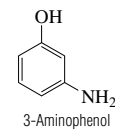
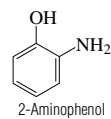
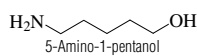
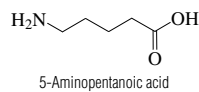
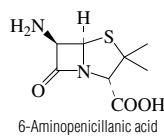
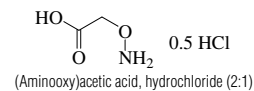
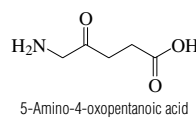
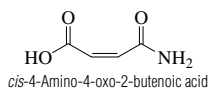
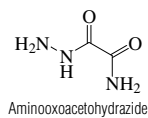
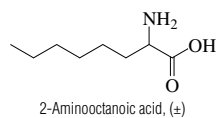
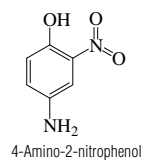
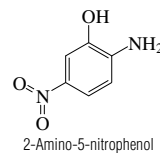
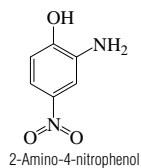
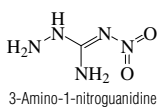
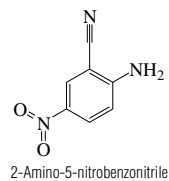
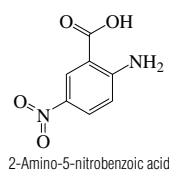
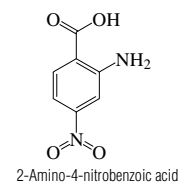
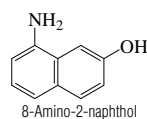
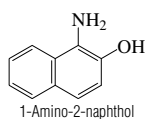
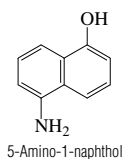
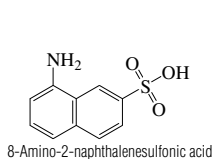
8-Amino-1-naphthalenesulfonic acid



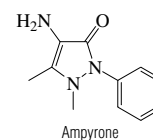
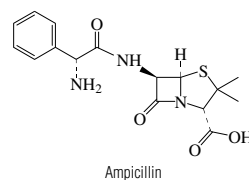
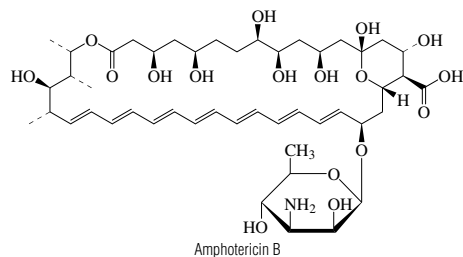
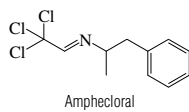
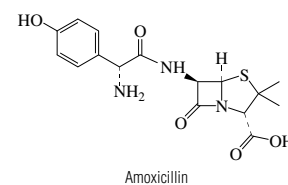
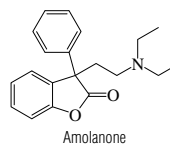
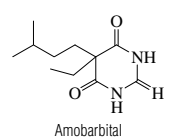
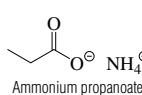
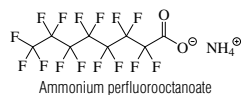
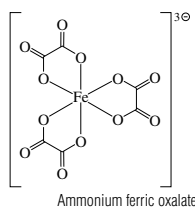
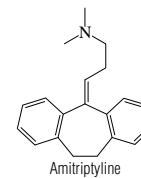
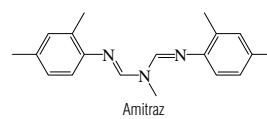
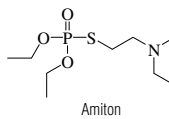
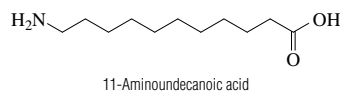
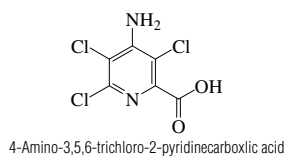
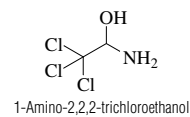
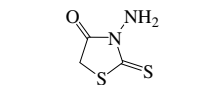
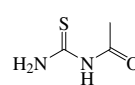
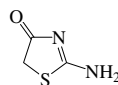
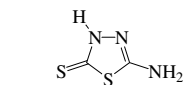
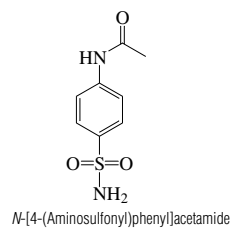
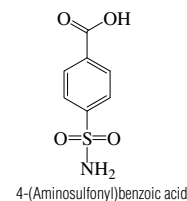
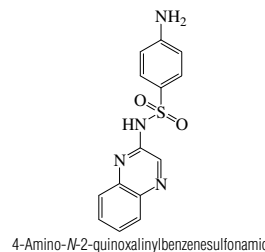
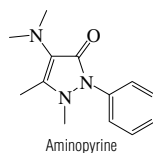
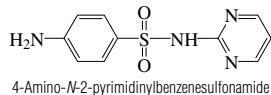
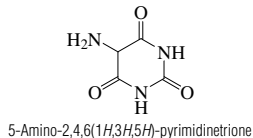
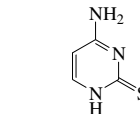
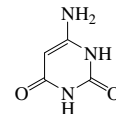
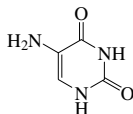
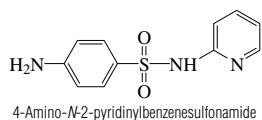
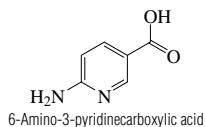
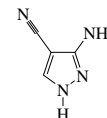
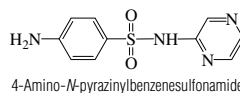
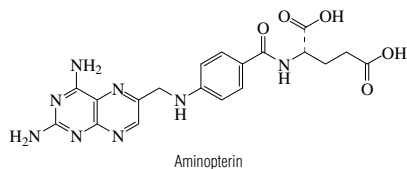
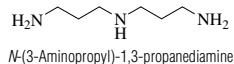
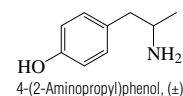
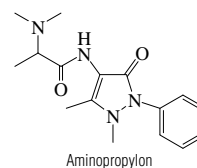
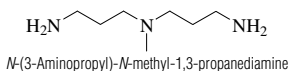
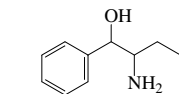
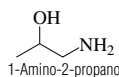
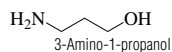
6-Amino-2-naphthalenesulfonic acid

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
370	8-Amino-2-naphthalenesulfonic acid	1,7-Cleve's acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub> S	119-28-8	223.248	nd or pr (w)					sl EtOH; s eth
371	5-Amino-1-naphthol	1-Amino-6-hydroxynaphthalene	C <sub>10</sub> H <sub>9</sub> NO	83-55-6	159.184		170				sl DMSO
372	1-Amino-2-naphthol		C <sub>10</sub> H <sub>9</sub> NO	2834-92-6	159.184	silvery lf (bz, eth)	150 dec				sl H <sub>2</sub> O, eth; s EtOH; vs dil alk, acid
373	8-Amino-2-naphthol	8-Amino-β-naphthol	C <sub>10</sub> H <sub>9</sub> NO	118-46-7	159.184	nd (w, al)	206	sub			s H <sub>2</sub> O, eth; vs EtOH; sl bz, lig
374	2-Amino-4-nitrobenzoic acid		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	619-17-0	182.134	oran pr (dil al)	269				i H <sub>2</sub> O; vs EtOH, eth, ace; s xyl
375	2-Amino-5-nitrobenzoic acid		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	616-79-5	182.134	lf (al), ye nd (w, dil al)	269				i H <sub>2</sub> O, bz, chl, xyl; s EtOH, eth
376	2-Amino-5-nitrobenzotrile		C <sub>7</sub> H <sub>6</sub> N <sub>3</sub> O <sub>2</sub>	17420-30-3	163.134		203.5				sl DMSO
377	3-Amino-1-nitroguanidine		CH <sub>2</sub> N <sub>4</sub> O <sub>2</sub>	18264-75-0	119.084		187.8				sl H <sub>2</sub> O
378	2-Amino-4-nitrophenol		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	99-57-0	154.123	oran pr (+w)	146				sl H <sub>2</sub> O, ace; vs EtOH; s eth, bz, HOAc
379	2-Amino-5-nitrophenol		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	121-88-0	154.123		205.8				s H <sub>2</sub> O, EtOH, bz
380	4-Amino-2-nitrophenol		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	119-34-6	154.123	dk red pl or nd (w, al)	131	110 <sup>12</sup>			s H <sub>2</sub> O, EtOH, eth; sl DMSO
381	2-Aminooctanoic acid, (±)		C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	644-90-6	159.227	lf (w)	270	sub			sl H <sub>2</sub> O, EtOH, eth, bz; s HOAc
382	Aminooxoacetohydrazide	Semioxamzide	C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	515-96-8	103.080		221 dec				sl H <sub>2</sub> O; i EtOH, eth; vs alk, acid
383	<i>cis</i> -4-Amino-4-oxo-2-butenic acid	Maleamic acid	C <sub>4</sub> H <sub>5</sub> NO <sub>3</sub>	557-24-4	115.088	cry (al)	172.5				vs H <sub>2</sub> O, EtOH
384	5-Amino-4-oxopentanoic acid	5-Aminolevulinic acid	C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	106-60-5	131.130	cry (EtOH)	118				
385	(Aminoxy)acetic acid, hydrochloride (2:1)		C <sub>4</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>6</sub>	2921-14-4	218.592		152.5				
386	6-Aminopenicillanic acid	Penicilin	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub> S	551-16-6	216.257	cry (w)	208				s H <sub>2</sub> O; sl EtOH; i eth, bz, lig
387	5-Aminopentanoic acid		C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	660-88-8	117.147	lf (dil al)	157 dec	dec			
388	5-Amino-1-pentanol		C <sub>5</sub> H <sub>13</sub> NO	2508-29-4	103.163		38.5	221.5	0.9488 <sup>17</sup>	1.4618 <sup>17</sup>	msc H <sub>2</sub> O, EtOH, ace
389	2-Aminophenol		C <sub>6</sub> H <sub>7</sub> NO	95-55-6	109.126	wh orth bipym nd (bz)	174	sub 153	1.328 <sup>25</sup>		s H <sub>2</sub> O, eth; vs EtOH; sl bz, tfa
390	3-Aminophenol		C <sub>6</sub> H <sub>7</sub> NO	591-27-5	109.126	pr (to)	123	164 <sup>11</sup>			s H <sub>2</sub> O, tol; vs EtOH, eth; sl bz, DMSO
391	4-Aminophenol		C <sub>6</sub> H <sub>7</sub> NO	123-30-8	109.126	wh pl (w)	187.5	110 <sup>0.3</sup>			sl H <sub>2</sub> O, tfa; vs EtOH; i bz, chl; s alk
392	<i>N</i> -(3-Aminophenyl)acetamide		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O	102-28-3	150.177	nd or pl (bz)	88				vs H <sub>2</sub> O, EtOH, ace; sl eth, bz
393	<i>N</i> -(4-Aminophenyl)acetamide	<i>p</i> -Aminoacetanilide	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O	122-80-5	150.177	nd (w)	166.5	267			s H <sub>2</sub> O; vs EtOH, eth
394	(4-Aminophenyl)arsonic acid	Arsanilic acid	C <sub>6</sub> H <sub>6</sub> AsNO <sub>3</sub>	98-50-0	217.055	mcl nd (w, al)	232		1.9571 <sup>10</sup>		s H <sub>2</sub> O, eth; sl EtOH, DMSO; i ace, bz
395	<i>N</i> -(4-Aminophenyl)-1,4-benzenediamine	4,4'-Diaminodiphenylamine	C <sub>12</sub> H <sub>13</sub> N <sub>3</sub>	537-65-5	199.251	lf (w)	158	dec			vs eth, EtOH
396	2-Amino-1-phenylethanone	Phenacylamine	C <sub>8</sub> H <sub>9</sub> NO	613-89-8	135.163	ye cry	20	251		1.6160 <sup>20</sup>	i H <sub>2</sub> O; s eth; sl ctc
397	1-(3-Aminophenyl)ethanone	<i>m</i> -Aminoacetophenone	C <sub>8</sub> H <sub>9</sub> NO	99-03-6	135.163	pa ye pl (al), lf (eth)	98.5	289.5			sl H <sub>2</sub> O; s EtOH
398	1-(4-Aminophenyl)ethanone	<i>p</i> -Aminoacetophenone	C <sub>8</sub> H <sub>9</sub> NO	99-92-3	135.163	ye mcl pr (al)	106	294; 195 <sup>15</sup>			vs eth, EtOH
399	1-(4-Aminophenyl)-1-pentanone		C <sub>11</sub> H <sub>15</sub> NO	38237-74-0	177.243	cry (bz-peth)	74.5	161 <sup>3</sup>			i H <sub>2</sub> O; s EtOH, eth
400	1-(4-Aminophenyl)-1-propanone	<i>p</i> -Aminopropiophenone	C <sub>9</sub> H <sub>11</sub> NO	70-69-9	149.189	pl (al, w), nd (w)	140				s DMSO
401	<i>N</i> -[(4-Aminophenyl)sulfonyl]acetamide	Sulfacetamide	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub> S	144-80-9	214.241		183				sl H <sub>2</sub> O; s EtOH; i eth; vs ace, alk
402	5-[(4-Aminophenyl)sulfonyl]-2-thiazolamine	Thiazolsulfone	C <sub>9</sub> H <sub>9</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	473-30-3	255.316	nd (al)	220 dec				vs ace, eth, EtOH, diox
403	4-Aminophthalimide	5-Amino-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	3676-85-5	162.146			224 <sup>0.5</sup>			
404	3-Amino-1,2-propanediol, (±)		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	13552-31-3	91.109			dec 265; 145 <sup>9</sup>	1.1752 <sup>20</sup>	1.4910 <sup>25</sup>	s H <sub>2</sub> O, EtOH; i eth, bz
405	3-Aminopropanenitrile	3-Aminopropionitrile	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	151-18-8	70.093			185; 88 <sup>20</sup>	0.9584 <sup>20</sup>	1.4396 <sup>20</sup>	
406	2-Amino-1-propanol, (±)		C <sub>3</sub> H <sub>9</sub> NO	6168-72-5	75.109			174.5		1.4502 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; sl chl

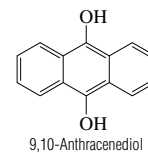
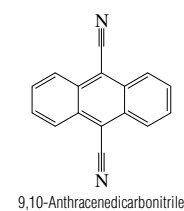
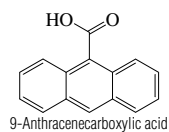
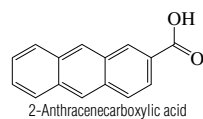
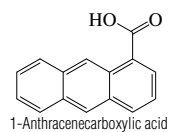
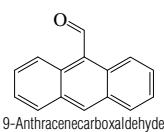
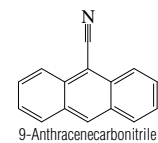
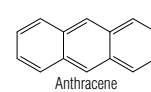
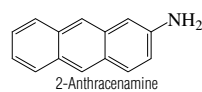
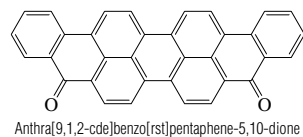
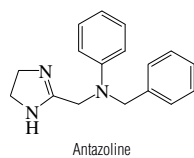
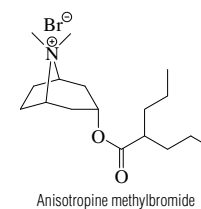
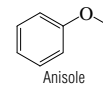
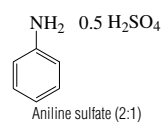
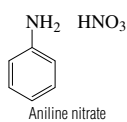
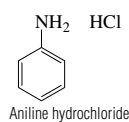
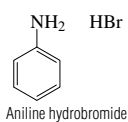
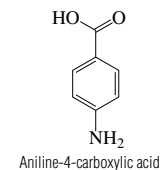
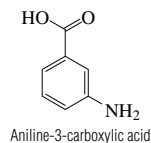
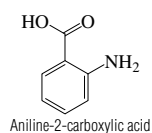
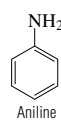
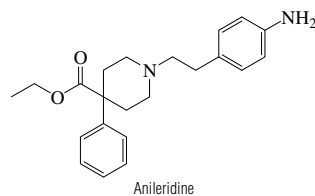
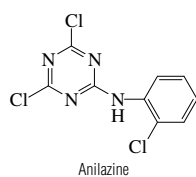
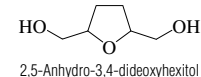
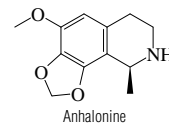
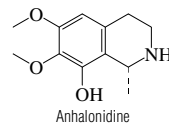
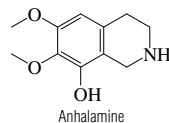
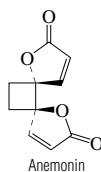
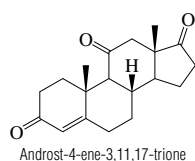
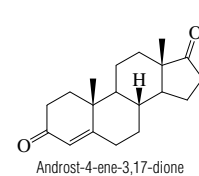
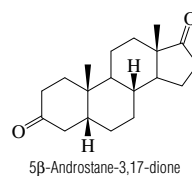
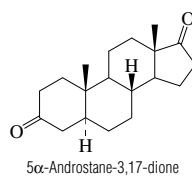
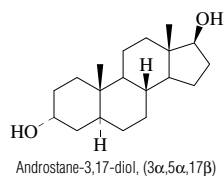
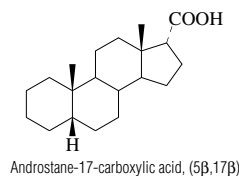
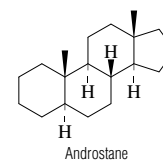
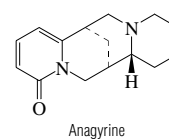
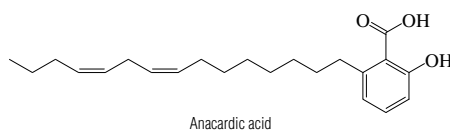
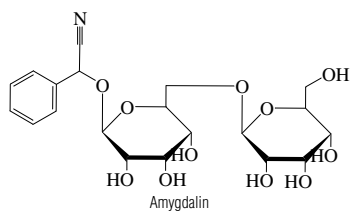




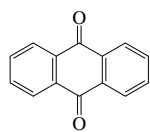
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
407	3-Amino-1-propanol	Propanolamine	C <sub>3</sub> H <sub>9</sub> NO	156-87-6	75.109		12.4	187.5	0.9824 <sup>26</sup>	1.4617 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
408	1-Amino-2-propanol	Isopropanolamine	C <sub>3</sub> H <sub>9</sub> NO	1674-56-2	75.109		0.9	159.4	0.9611 <sup>20</sup>	1.4479 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz, ctc
409	$\alpha$ -(1-Aminopropyl)benzenemethanol	$\alpha$ -( $\alpha$ -Aminopropyl)benzyl alcohol	C <sub>10</sub> H <sub>13</sub> NO	5897-76-7	165.232	pl (bz-eth)	79.5				
410	<i>N</i> -(3-Aminopropyl)- <i>N</i> -methyl-1,3-propanediamine		C <sub>7</sub> H <sub>13</sub> N <sub>3</sub>	105-83-9	145.246			232.5; 112 <sup>6</sup>	0.9023 <sup>20</sup>	1.4705 <sup>25</sup>	
411	Aminopropylon		C <sub>16</sub> H <sub>22</sub> N <sub>4</sub> O <sub>2</sub>	3690-04-8	302.372	pr (bz)	181				vs H <sub>2</sub> O
412	4-(2-Aminopropyl)phenol, ( $\pm$ )	Hydroxyamphetamine	C <sub>9</sub> H <sub>13</sub> NO	1518-86-1	151.205	cry (bz)	125.5				s H <sub>2</sub> O, EtOH, bz, chl, AcOEt
413	<i>N</i> -(3-Aminopropyl)-1,3-propanediamine	Bis(3-aminopropyl)amine	C <sub>6</sub> H <sub>17</sub> N <sub>3</sub>	56-18-8	131.219		-14	151 <sup>50</sup>	0.938 <sup>25</sup>	1.4810 <sup>20</sup>	s chl
414	Aminopterin		C <sub>19</sub> H <sub>20</sub> N <sub>8</sub> O <sub>5</sub>	54-62-6	440.413	ye cry	262 dec				
415	4-Amino- <i>N</i> -pyrazinylbenzenesulfonamide	Sulfapyrazine	C <sub>10</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S	116-44-9	250.277	nd (PhNO <sub>2</sub> )	251				i H <sub>2</sub> O, EtOH, eth, bz, chl; s py; sl ace
416	3-Amino-1 <i>H</i> -pyrazole-4-carbonitrile	3-Amino-4-cyanopyrazole	C <sub>4</sub> H <sub>4</sub> N <sub>4</sub>	16617-46-2	108.102	cry (w)	173				
417	2-Amino-3-pyridinecarboxylic acid		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	5345-47-1	138.124			296 dec			sl H <sub>2</sub> O
418	6-Amino-3-pyridinecarboxylic acid	6-Aminonicotinic acid	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	3167-49-5	138.124	cry (dil HOAc, +2w)	312				
419	4-Amino- <i>N</i> -2-pyridinylbenzenesulfonamide	Sulfapyridine	C <sub>11</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub> S	144-83-2	249.289	ye oran (al)	192				i H <sub>2</sub> O, bz, ctc; s EtOH
420	5-Amino-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	5-Aminouracil	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	932-52-5	127.102	nd (w)	dec				i H <sub>2</sub> O; s alk, acid
421	6-Amino-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione		C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	873-83-6	127.102	cry (w)	dec				vs H <sub>2</sub> O
422	4-Amino-2(1 <i>H</i> )-pyrimidinethione	2-Thiocytosine	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> S	333-49-3	127.168						sl DMSO
423	5-Amino-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetriene	Uramil	C <sub>4</sub> H <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	118-78-5	143.101	nd or pl (w)	>400				s H <sub>2</sub> O, chl; i eth, bz
424	4-Amino- <i>N</i> -2-pyrimidinylbenzenesulfonamide	Sulfadiazine	C <sub>10</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S	68-35-9	250.277	cry (w), wh pow	255 dec				sl H <sub>2</sub> O, EtOH, ace, DMSO
425	Aminopyrine		C <sub>13</sub> H <sub>17</sub> N <sub>3</sub> O	58-15-1	231.293	pr or pl (lig or AcOEt)	134.5				vs H <sub>2</sub> O, bz, EtOH
426	4-Amino- <i>N</i> -2-quinoxalinybenzenesulfonamide	Sulfaquinoxaline	C <sub>14</sub> H <sub>12</sub> N <sub>4</sub> O <sub>2</sub> S	59-40-5	300.336		247.5				sl H <sub>2</sub> O, EtOH, ace; s aq alk
427	4-(Aminosulfonyl)benzoic acid	Carzenide	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub> S	138-41-0	201.201	pr or lf (w)	291 dec				i H <sub>2</sub> O; vs EtOH; sl eth; i bz
428	<i>N</i> -[4-(Aminosulfonyl)phenyl]acetamide	Acetyl-sulfanilamide	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub> S	121-61-9	214.241	nd (HOAc)	219.5				s H <sub>2</sub> O, EtOH, ace
429	5-Amino-1,3,4-thiadiazole-2(3 <i>H</i> )-thione		C <sub>2</sub> H <sub>3</sub> N <sub>3</sub> S <sub>2</sub>	2349-67-9	133.195		243.0				
430	2-Amino-4(5 <i>H</i> )-thiazolone		C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> OS	556-90-1	116.141	pr or nd (w)	256 dec				sl H <sub>2</sub> O; i EtOH, eth
431	<i>N</i> -(Aminothioxomethyl)acetamide	Acetylthiourea	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> OS	591-08-2	118.157	pr (w), orth (al)	165				sl H <sub>2</sub> O, eth; s DMSO, EtOH
432	<i>N</i> -Amino-2-thioxo-4-thiazolidinone	3-Aminorhodanine	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> OS <sub>2</sub>	1438-16-0	148.206		101.5				s DMSO
433	1-Amino-2,2,2-trichloroethanol	Chloral ammonia	C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> NO	507-47-1	164.418	nd (al)	73	dec 100			vs bz, eth, EtOH
434	4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid	Picloram	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	1918-02-1	241.459		218.5				
435	11-Aminoundecanoic acid		C <sub>11</sub> H <sub>23</sub> NO <sub>2</sub>	2432-99-7	201.307		189.0				
436	Amiton		C <sub>10</sub> H <sub>24</sub> NO <sub>3</sub> PS	78-53-5	269.342	liq		76 <sup>901</sup>		1.4655 <sup>27</sup>	
437	Amitraz	<i>N</i> -Methylbis(2,4-xylilyliminomethyl)amine	C <sub>19</sub> H <sub>23</sub> N <sub>3</sub>	33089-61-1	293.406		86		1.128 <sup>20</sup>		
438	Amitriptyline		C <sub>20</sub> H <sub>23</sub> N	50-48-6	277.404	cry	196 (HCl)				
439	Ammonium ferric oxalate		C <sub>6</sub> H <sub>12</sub> FeN <sub>3</sub> O <sub>12</sub>	14221-47-7	374.017		165 dec		1.78 <sup>17.5</sup>		vs H <sub>2</sub> O; i EtOH
440	Ammonium perfluorooctanoate		C <sub>8</sub> H <sub>4</sub> F <sub>13</sub> NO <sub>2</sub>	3825-26-1	431.100	solid					
441	Ammonium propanoate		C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	17496-08-1	91.109	hyg cry	45				s H <sub>2</sub> O
442	Amobarbital	5-Ethyl-5-isopentyl-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetriene	C <sub>11</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	57-43-2	226.272		157				vs bz, EtOH, chl
443	Amolanone	3-[2-(Diethylamino)ethyl]-3-phenyl-2(3 <i>H</i> )-benzofuranone	C <sub>20</sub> H <sub>23</sub> NO <sub>2</sub>	76-65-3	309.403	cry (peth)	43.4	193 <sup>20</sup>		1.5614 <sup>25</sup>	
444	Amoxicillin		C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>5</sub> S	26787-78-0	365.404	cry (w)					s H <sub>2</sub> O
445	Ampechloral		C <sub>11</sub> H <sub>12</sub> Cl <sub>3</sub> N	5581-35-1	264.579			96 <sup>9.5</sup>		1.530	
446	Amphotericin B		C <sub>47</sub> H <sub>73</sub> NO <sub>17</sub>	1397-89-3	924.080	ye pr (DMF)	170 dec				i H <sub>2</sub> O; sl DMF; s DMSO
447	Ampicillin		C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>4</sub> S	69-53-4	349.405	cry	200 dec				sl H <sub>2</sub> O
448	Ampyrone		C <sub>11</sub> H <sub>13</sub> N <sub>3</sub> O	83-07-8	203.240	pa ye cry (bz)	109				s H <sub>2</sub> O, EtOH, bz, chl; sl eth



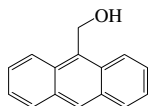
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
449	Amygdalin		C <sub>20</sub> H <sub>27</sub> NO <sub>11</sub>	29883-15-6	457.428		224.5				vs H <sub>2</sub> O; sl EtOH; i eth, chl
450	Anacardic acid		C <sub>22</sub> H <sub>32</sub> O <sub>3</sub>	11034-77-8	344.487	cry (ace)	35.5				vs eth, EtOH, peth
451	Anagyrene		C <sub>15</sub> H <sub>20</sub> N <sub>2</sub> O	486-89-5	244.332	pe ye glass		265 <sup>12</sup> , 212 <sup>4</sup>			s H <sub>2</sub> O, eth, bz; vs EtOH, chl; i lig
452	Androstane		C <sub>19</sub> H <sub>32</sub>	24887-75-0	260.457	lf (ace-MeOH)	50	60 <sup>0.003</sup>			vs ace, eth, EtOH, peth
453	Androstane-17-carboxylic acid, (5β,17β)	Etiocolanic acid	C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	438-08-4	304.467	nd (gl HOAc)	228.5	sub 160			
454	Androstane-3,17-diol, (3α,5α,17β)	Epiandrostanediol	C <sub>19</sub> H <sub>32</sub> O <sub>2</sub>	1852-53-5	292.456	nd (ace aq)	223				
455	5α-Androstane-3,17-dione		C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	846-46-8	288.424	cry (MeOH)	135				
456	5β-Androstane-3,17-dione		C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	1229-12-5	288.424	cry (ace-hx)	135				
457	Androst-4-ene-3,17-dione	4-Androstene-3,17-dione	C <sub>19</sub> H <sub>26</sub> O <sub>2</sub>	63-05-8	286.408		143(form a); 173(form b)				
458	Androst-4-ene-3,11,17-trione	Adrenosterone	C <sub>19</sub> H <sub>24</sub> O <sub>3</sub>	382-45-6	300.392	nd (al)	222	sub			sl H <sub>2</sub> O; s EtOH, eth, ace, chl
459	Anemonin	<i>trans</i> -1,7-Dioxadispiro[4.0.4.2]dodeca-3,9-diene-2,8-dione	C <sub>10</sub> H <sub>6</sub> O <sub>4</sub>	508-44-1	192.169	orth pl (chl) nd (al or bz)	158				vs chl
460	Anhalamine		C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	643-60-7	209.242	nd (al)	187.5				vs eth, EtOH
461	Anhalonidine		C <sub>12</sub> H <sub>17</sub> NO <sub>3</sub>	17627-77-9	223.268	oct cry (bz, eth)	160.5				vs H <sub>2</sub> O, EtOH
462	Anhalonine		C <sub>12</sub> H <sub>15</sub> NO <sub>3</sub>	519-04-0	221.252	rhomb nd	86	140 <sup>0.02</sup>			vs EtOH, bz, chl, eth, peth
463	2,5-Anhydro-3,4-dideoxyhexitol	Tetrahydro-2,5-furandimethanol	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	104-80-3	132.157		<-50	265	1.154 <sup>20</sup>		vs H <sub>2</sub> O, ace, bz, EtOH
464	Anilazine	2,4-Dichloro-6-( <i>o</i> -chloroanilino)- <i>s</i> -triazine	C <sub>9</sub> H <sub>5</sub> Cl <sub>3</sub> N <sub>4</sub>	101-05-3	275.522		160		1.8 <sup>20</sup>		
465	Anileridine		C <sub>22</sub> H <sub>28</sub> N <sub>2</sub> O <sub>2</sub>	144-14-9	352.469	cry	83				s H <sub>2</sub> O
466	Aniline	Benzenamine	C <sub>6</sub> H <sub>7</sub> N	62-53-3	93.127	oily liq	-6.02	184.17	1.0217 <sup>20</sup>	1.5863 <sup>20</sup>	s H <sub>2</sub> O, ctc, liq; msc EtOH, eth, ace, bz
467	Aniline-2-carboxylic acid	<i>o</i> -Anthranilic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	118-92-3	137.137	lf (al)	146.5	sub	1.412 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth; sl bz, tfa; vs chl, py
468	Aniline-3-carboxylic acid	<i>m</i> -Anthranilic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	99-05-8	137.137		173		1.51 <sup>25</sup>		sl H <sub>2</sub> O, EtOH; s eth, tfa; vs ace; i bz
469	Aniline-4-carboxylic acid	<i>p</i> -Anthranilic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	150-13-0	137.137	mcl pr (w)	188.2		1.374 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth; sl ace; i bz, chl
470	Aniline hydrobromide		C <sub>6</sub> H <sub>7</sub> BrN	542-11-0	174.039		286				
471	Aniline hydrochloride	Benzenamine hydrochloride	C <sub>6</sub> H <sub>7</sub> ClN	142-04-1	129.588	lf or nd	198		1.2215 <sup>4</sup>		vs H <sub>2</sub> O, EtOH; i eth, chl; sl DMSO
472	Aniline nitrate		C <sub>6</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	542-15-4	156.139	orth	190 dec		1.356 <sup>4</sup>		vs H <sub>2</sub> O, eth, EtOH
473	Aniline sulfate (2:1)		C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S	542-16-5	284.331				1.377 <sup>4</sup>		s H <sub>2</sub> O; sl EtOH, tfa; i eth
474	Anisole	Methoxybenzene	C <sub>7</sub> H <sub>8</sub> O	100-66-3	108.138	liq	-37.13	153.7	0.9940 <sup>20</sup>	1.5174 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; vs ace, bz
475	Anisotropine methylbromide	Oclatropine methylbromide	C <sub>17</sub> H <sub>32</sub> BrNO <sub>2</sub>	80-50-2	362.346	cry (ace)	329				
476	Antazoline		C <sub>17</sub> H <sub>19</sub> N <sub>3</sub>	91-75-8	265.353	cry	122				
477	Anthra[9,1,2-cde]benzo[rs]t]pentaphene-5,10-dione		C <sub>34</sub> H <sub>16</sub> O <sub>2</sub>	116-71-2	456.490	viol-bl or blk nd (PhNO <sub>2</sub> )	492 dec				i EtOH, bz, HOAc; s xyl, py, sulf
478	2-Anthracenamine		C <sub>14</sub> H <sub>11</sub> N	613-13-8	193.244	ye lf (al)	238.8	sub			i H <sub>2</sub> O; s EtOH; i con sulf
479	Anthracene		C <sub>14</sub> H <sub>10</sub>	120-12-7	178.229	tab or mcl pr (al)	215.76	339.9	1.28 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth, ace, bz, chl, ctc
480	9-Anthracenecarbonitrile		C <sub>15</sub> H <sub>9</sub> N	1210-12-4	203.239		177.5		1.3000 <sup>20</sup>		
481	9-Anthracenecarboxaldehyde		C <sub>15</sub> H <sub>10</sub> O	642-31-9	206.239	oran nd (dil HOAc)	104.5				i H <sub>2</sub> O; s bz, HOAc
482	1-Anthracenecarboxylic acid	1-Anthroic acid	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	607-42-1	222.239	ye nd (HOAc) ye pr (al)	251.5	sub			i H <sub>2</sub> O; s EtOH, eth; sl bz, chl
483	2-Anthracenecarboxylic acid	2-Anthroic acid	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	613-08-1	222.239	ye lf (al) nd, lf (sub)	281	sub			vs HOAc
484	9-Anthracenecarboxylic acid	9-Anthroic acid	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	723-62-6	222.239		217 dec	sub			i H <sub>2</sub> O; s EtOH
485	9,10-Anthracenedicarbonitrile		C <sub>16</sub> H <sub>8</sub> N <sub>2</sub>	1217-45-4	228.248		337 dec				
486	9,10-Anthracenediol		C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	4981-66-2	210.228	br or ye nd	180				vs eth, EtOH



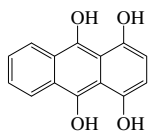
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
487	9,10-Anthracenedione	Anthraquinone	C <sub>14</sub> H <sub>8</sub> O <sub>2</sub>	84-65-1	208.213	ye orth nd (al, bz)	286	377	1.438 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, eth, bz, chl
488	9-Anthracenemethanol		C <sub>15</sub> H <sub>12</sub> O	1468-95-7	208.255		160.5				
489	1,4,9,10-Anthracenetetrol		C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	476-60-8	242.227		148				
490	1,2,10-Anthracenetriol	Anthrarobin	C <sub>14</sub> H <sub>10</sub> O <sub>3</sub>	577-33-3	226.227	ye lf, nd (al- w)	208				sl H <sub>2</sub> O; vs EtOH, eth, ace; s bz
491	1,8,9-Anthracenetriol	Anthralin	C <sub>14</sub> H <sub>10</sub> O <sub>3</sub>	1143-38-0	226.227	ye pl or nd (lig)	179				i H <sub>2</sub> O; s EtOH, ace, bz; sl eth; vs py
492	1-Anthracenol		C <sub>14</sub> H <sub>10</sub> O	610-50-4	194.228	cry (bz), br nd or lf (al)	158	234 <sup>13</sup>			i H <sub>2</sub> O; vs EtOH, eth; s NaOH
493	9-Anthracenol	Anthranol	C <sub>14</sub> H <sub>10</sub> O	529-86-2	194.228	ye red lf (dil al)	152				
494	9(10 <i>H</i> )-Anthracenone	Anthrone	C <sub>14</sub> H <sub>10</sub> O	90-44-8	194.228	nd (bz-lig, HOAc)	155				s ace, bz, con sulf, dil alk
495	Antimony potassium tartrate trihydrate	Tartar emetic	C <sub>8</sub> H <sub>10</sub> K <sub>2</sub> O <sub>15</sub> Sb <sub>2</sub>	28300-74-5	667.873	col cry			2.6		sl H <sub>2</sub> O
496	Apholate		C <sub>12</sub> H <sub>24</sub> N <sub>6</sub> P <sub>3</sub>	52-46-0	387.300		148				
497	Aphylline		C <sub>15</sub> H <sub>24</sub> N <sub>2</sub> O	577-37-7	248.364	cry	52.5	200 <sup>4</sup>			vs ace, bz, eth, EtOH
498	Apigenin	5,7-Dihydroxy-2-(4-hydroxyphenyl)-4 <i>H</i> -1-benzopyran-4-one	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	520-36-5	270.237	ye nd (aq py)	347.5				i H <sub>2</sub> O; s EtOH, py; vs dil alk
499	Apoatropine		C <sub>17</sub> H <sub>21</sub> NO <sub>2</sub>	500-55-0	271.355	pr (chl)	62				sl H <sub>2</sub> O, lig; vs EtOH, eth, ace, bz
500	Apocodeine		C <sub>18</sub> H <sub>19</sub> NO <sub>2</sub>	641-36-1	281.350	pr (MeOH)	123.5				sl EtOH; s eth, ace, bz, lig
501	Apomorphine		C <sub>17</sub> H <sub>17</sub> NO <sub>2</sub>	58-00-4	267.323	hex pl (chl- peth) rods (eth)	195 dec				sl H <sub>2</sub> O; s EtOH, eth, ace, bz, alk
502	Apomorphine, hydrochloride		C <sub>17</sub> H <sub>18</sub> ClNO <sub>2</sub>	314-19-2	303.784	grn in air mcl pr	205 dec				
503	Aprobarbital	5-Isopropyl-5-allyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	77-02-1	210.229	cry	141				vs ace, eth, EtOH, chl
504	L-Arabinitol		C <sub>5</sub> H <sub>12</sub> O <sub>5</sub>	7643-75-6	152.146		102.5				vs H <sub>2</sub> O; sl EtOH; i eth
505	α-D-Arabinopyranose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	608-45-7	150.130	cry (MeOH)	155.5		1.585 <sup>25</sup>		
506	6-D-α-L-Arabinopyranosyl-D-Glucose	Vicianose	C <sub>11</sub> H <sub>20</sub> O <sub>10</sub>	14116-69-9	312.271	nd (dil al)	210 dec				vs H <sub>2</sub> O
507	DL-Arabinose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	20235-19-2	150.130	pr, nd (al)	164.5		1.585 <sup>20</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, bz
508	α-D-Arabinose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	31178-68-4	150.130		156		1.585 <sup>25</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, ace, MeOH
509	β-D-Arabinose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	31178-69-5	150.130		156		1.625 <sup>25</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, ace, MeOH
510	Aramite		C <sub>15</sub> H <sub>23</sub> ClO <sub>4</sub> S	140-57-8	334.860		-37.3	195 <sup>2</sup>	1.143 <sup>20</sup>	1.5100 <sup>20</sup>	vs ace, bz, eth, EtOH
511	Arecaidine	1,2,5,6-Tetrahydro-1-methyl-3-pyridinecarboxylic acid	C <sub>7</sub> H <sub>11</sub> NO <sub>2</sub>	499-04-7	141.168	pl (dil al) tab (dil al +1w)	232 dec				vs H <sub>2</sub> O; i EtOH, eth, bz, chl
512	Arecoline		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	63-75-2	155.195			209	1.0485 <sup>20</sup>	1.486 <sup>-20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
513	D-Arginine		C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	7200-25-1	174.201		217 dec				i H <sub>2</sub> O, EtOH, eth, bz
514	L-Arginine		C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	74-79-3	174.201		244 dec				s H <sub>2</sub> O; sl EtOH; i eth
515	L-Arginine, monohydrochloride		C <sub>6</sub> H <sub>15</sub> ClN <sub>4</sub> O <sub>2</sub>	1119-34-2	210.662		219				
516	Artemisin	8-Hydroxysantonin	C <sub>15</sub> H <sub>18</sub> O <sub>4</sub>	481-05-0	262.302	cry	203	260 <sup>0.1</sup>			sl H <sub>2</sub> O, chl; s AcOEt; i peth
517	Ascaridole	1-Methyl-4-isopropyl-2,3-dioxabicyclo[2.2.2]oct-5-ene	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	512-85-6	168.233	liq	3.3	exp; 115 <sup>15</sup> , 39 <sup>0.2</sup>	1.0103 <sup>20</sup>	1.4769 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz, tol; sl chl
518	L-Ascorbic acid	Vitamin C	C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	50-81-7	176.124		191 dec		1.65 <sup>25</sup>		vs H <sub>2</sub> O; s EtOH; i eth, bz, chl, peth
519	Ascorbyl palmitate	6-Hexadecanoylascorbic acid	C <sub>22</sub> H <sub>38</sub> O <sub>7</sub>	137-66-6	414.533		112				
520	L-Asparagine	α-Aminosuccinamic acid	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	70-47-3	132.118	orth (w+1)	235		1.543 <sup>15</sup>		s H <sub>2</sub> O; i EtOH, eth, MeOH
521	D-Asparagine, monohydrate		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	5794-24-1	150.133		215		1.523 <sup>15</sup>		sl H <sub>2</sub> O; i EtOH, eth, bz, MeOH
522	L-Asparagine, monohydrate		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	5794-13-8	150.133		234		1.543 <sup>15</sup>		sl H <sub>2</sub> O; i EtOH, eth, bz, MeOH



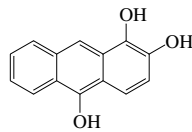
9,10-Anthracenedione



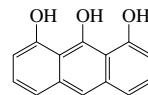
9-Anthracenemethanol



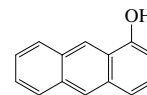
1,4,9,10-Anthracenetetrol



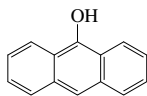
1,2,10-Anthracenetriol



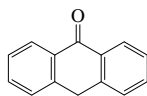
1,8,9-Anthracenetriol



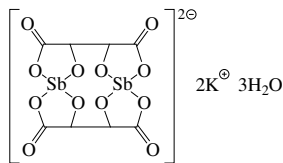
1-Anthracenol



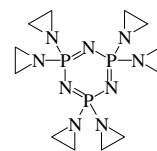
9-Anthracenol



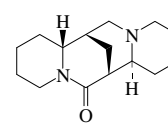
9(10H)-Anthracenone



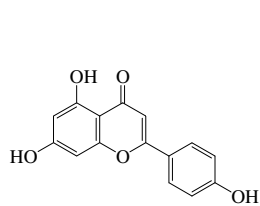
Antimony potassium tartrate trihydrate



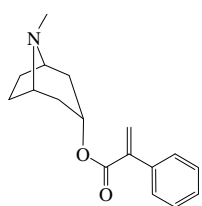
Aphotale



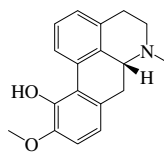
Aphylline



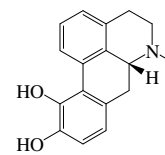
Apigenin



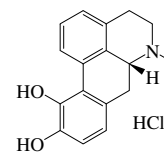
Apotropine



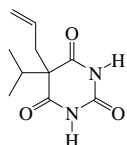
Apocodeine



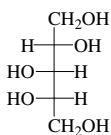
Apomorphine



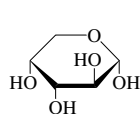
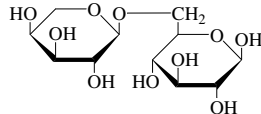
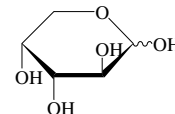
Apomorphine, hydrochloride



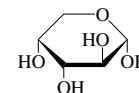
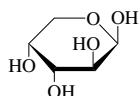
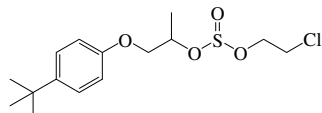
Aprobarbital



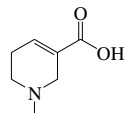
L-Arabinitol

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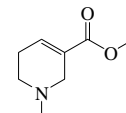
DL-Arabinose

 $\alpha$ -D-Arabinose $\beta$ -D-Arabinose

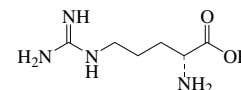
Aramite



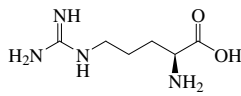
Arecaidine



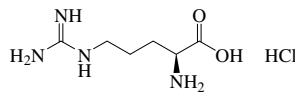
Arecoline



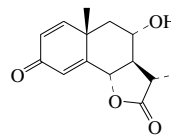
D-Arginine



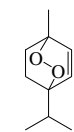
L-Arginine



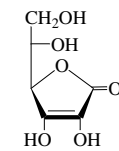
L-Arginine, monohydrochloride



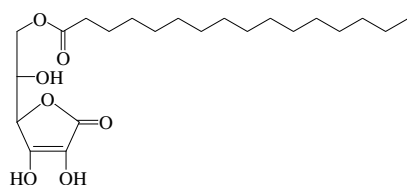
Artemisin



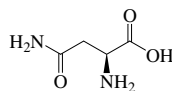
Ascaridole



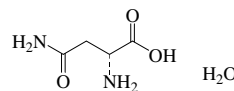
L-Ascorbic acid



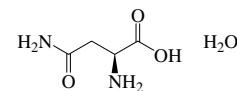
Ascorbyl palmitate



L-Asparagine



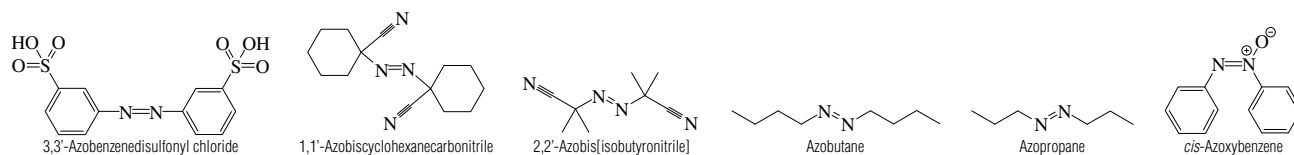
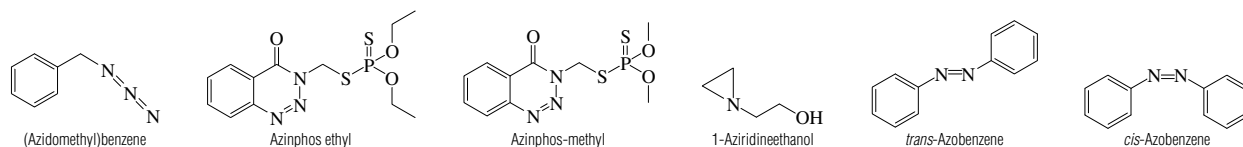
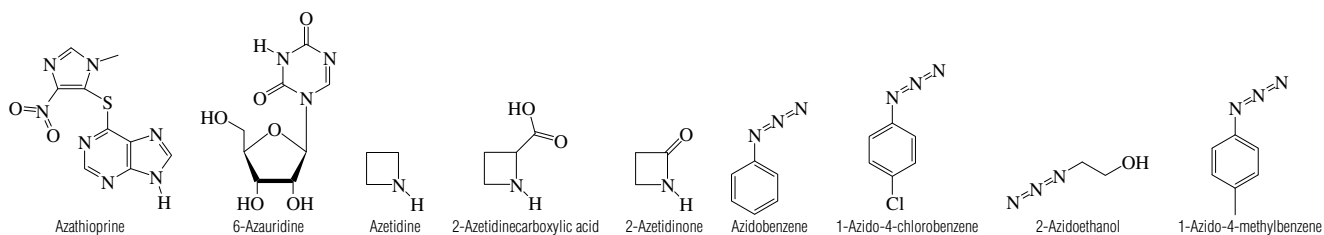
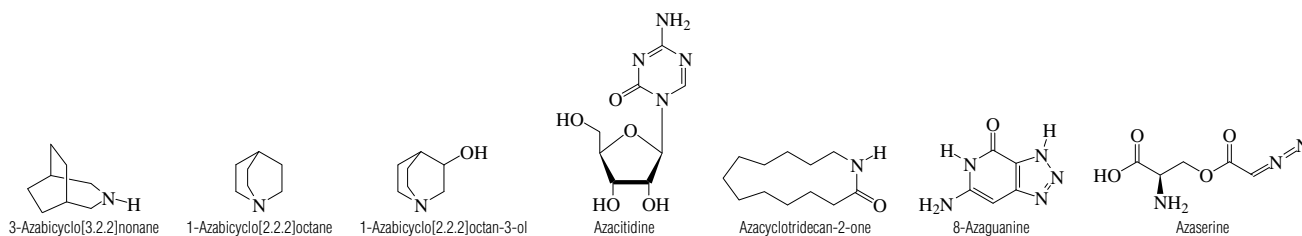
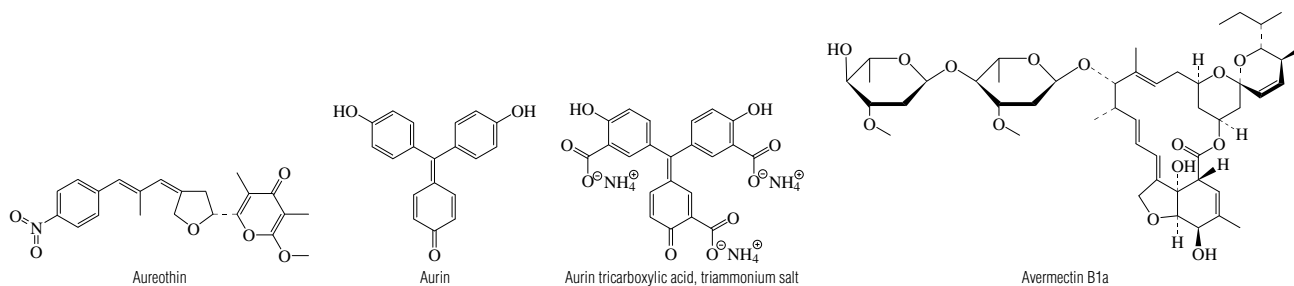
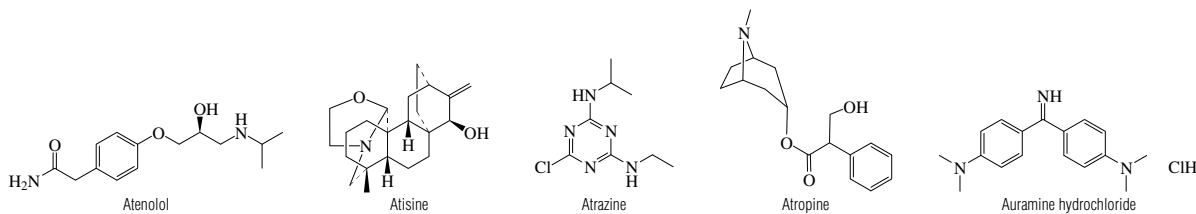
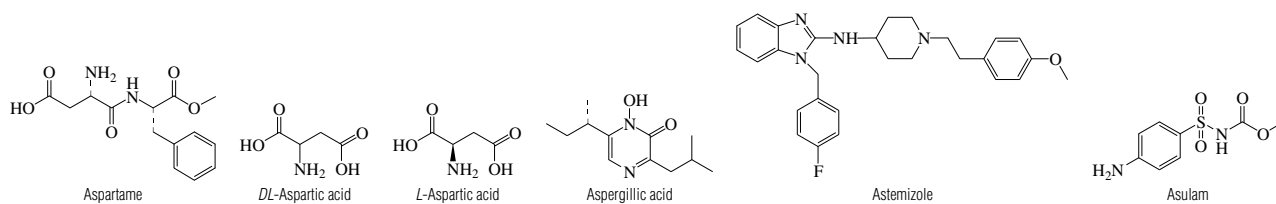
D-Asparagine, monohydrate



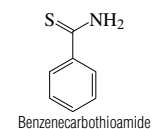
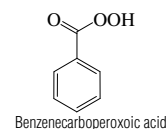
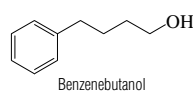
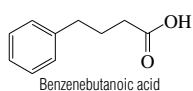
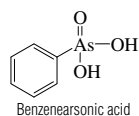
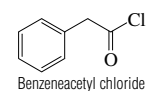
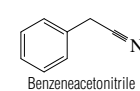
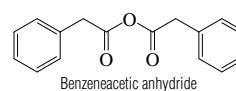
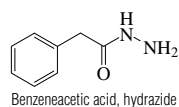
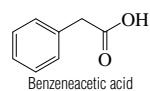
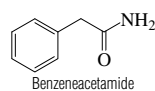
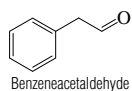
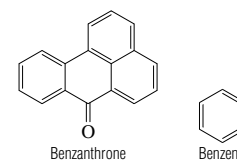
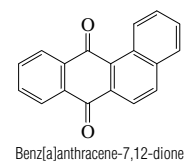
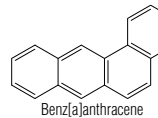
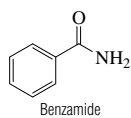
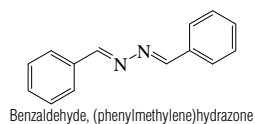
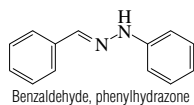
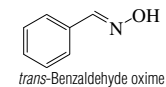
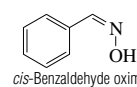
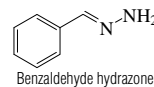
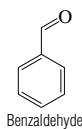
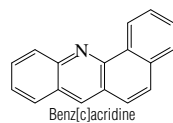
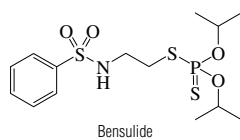
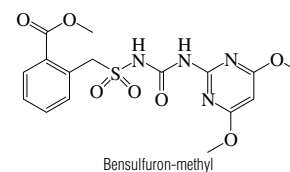
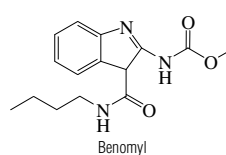
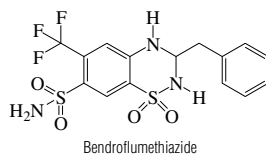
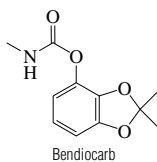
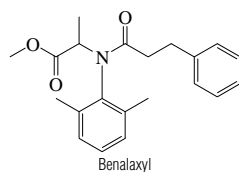
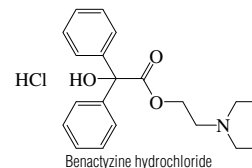
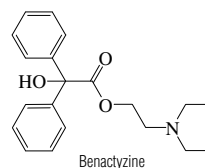
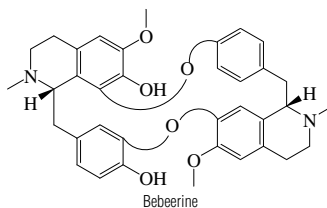
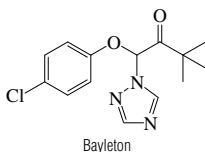
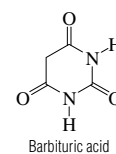
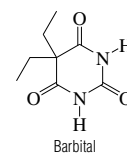
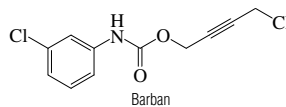
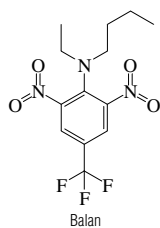
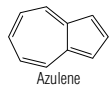
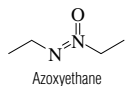
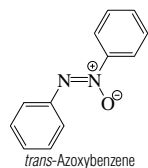
L-Asparagine, monohydrate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
523	Aspartame	<i>L</i> -α-Aspartyl- <i>L</i> -phenylalanine, 2-methyl ester	C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> O <sub>5</sub>	22839-47-0	294.303	nd (w)	246.5				
524	<i>DL</i> -Aspartic acid		C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	617-45-8	133.104	mcl pr (w)	277.5		1.6622 <sup>13</sup>		sl H <sub>2</sub> O; i EtOH, eth, bz, py
525	<i>L</i> -Aspartic acid	<i>L</i> -Aminosuccinic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	56-84-8	133.104	orth lf (w)	270		1.6603 <sup>13</sup>		sl H <sub>2</sub> O; i EtOH, eth, bz; s dil HCl, py
526	Aspergillilic acid		C <sub>12</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	490-02-8	224.299	pa ye rods	98				vs bz, eth, EtOH
527	Astemizole		C <sub>28</sub> H <sub>31</sub> N <sub>4</sub> O	68844-77-9	458.570	wh cry	149.1				i H <sub>2</sub> O; s os
528	Asulam	Methyl [(4-aminophenyl)sulfonyl]carbamate	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> S	3337-71-1	230.241		144				
529	Atenolol		C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O <sub>3</sub>	29122-68-7	266.336	cry (AcOEt)	147				sl H <sub>2</sub> O, diox, ace; i chl; s MeOH, HOAc
530	Atisine	Anthorine	C <sub>22</sub> H <sub>33</sub> NO <sub>2</sub>	466-43-3	343.503	orth bipym	58.5				vs eth, EtOH, chl
531	Atrazine		C <sub>6</sub> H <sub>14</sub> ClN <sub>5</sub>	1912-24-9	215.684		173				
532	Atropine		C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub>	51-55-8	289.370	orth nd (dil al)	118.5	sub 95			vs H <sub>2</sub> O, EtOH; i eth; sl chl
533	Auramine hydrochloride		C <sub>17</sub> H <sub>24</sub> ClN <sub>3</sub> O	2465-27-2	321.845	ye nd (w)	267				sl H <sub>2</sub> O
534	Aureothin		C <sub>22</sub> H <sub>23</sub> NO <sub>6</sub>	2825-00-5	397.421	ye pr	158				vs ace, EtOH, chl
535	Aurin		C <sub>19</sub> H <sub>14</sub> O <sub>3</sub>	603-45-2	290.312	dk red lf or orth	309 dec				i H <sub>2</sub> O, bz; s EtOH, alk; sl eth, chl
536	Aurin tricarboxylic acid, triammonium salt	Aluminon	C <sub>22</sub> H <sub>23</sub> N <sub>3</sub> O <sub>9</sub>	569-58-4	473.433	red-br pow					s H <sub>2</sub> O; sl EtOH; i peth
537	Avermectin B1a	Abamectin	C <sub>48</sub> H <sub>72</sub> O <sub>14</sub>	71751-41-2	873.078		152				
538	3-Azabicyclo[3.2.2]nonane		C <sub>8</sub> H <sub>15</sub> N	283-24-9	125.212			166 <sup>500</sup>			
539	1-Azabicyclo[2.2.2]octane	Quinuclidine	C <sub>7</sub> H <sub>13</sub> N	100-76-5	111.185	cry (eth)	158				vs H <sub>2</sub> O, ace, eth, EtOH
540	1-Azabicyclo[2.2.2]octan-3-ol	3-Quinuclidinol	C <sub>7</sub> H <sub>13</sub> NO	1619-34-7	127.184	cry (bz)	221	sub 120			s ace
541	Azacididine	4-Amino-1-β- <i>D</i> -ribofuranosyl-1,3,5-triazine-2(1 <i>H</i> )-one	C <sub>8</sub> H <sub>12</sub> N <sub>4</sub> O <sub>5</sub>	320-67-2	244.205	cry	229				
542	Azacyclotridecan-2-one		C <sub>12</sub> H <sub>23</sub> NO	947-04-6	197.317		152.5				
543	8-Azaguanine		C <sub>4</sub> H <sub>4</sub> N <sub>6</sub> O	134-58-7	152.114		300				
544	Azaserine		C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O <sub>4</sub>	115-02-6	173.128	ye-grn orth cry	150 dec				vs H <sub>2</sub> O; sl EtOH, ace, MeOH
545	Azathioprine	6-[(1-Methyl-4-nitro-1 <i>H</i> -imidazol-5-yl)thio]-1 <i>H</i> -purine	C <sub>9</sub> H <sub>7</sub> N <sub>7</sub> O <sub>2</sub> S	446-86-6	277.263	ye cry	243 dec				sl H <sub>2</sub> O, EtOH, chl
546	6-Azauridine	2-β- <i>D</i> -Ribofuranosyl-1,2,4-triazine-3,5(2 <i>H</i> ,4 <i>H</i> )-dione	C <sub>8</sub> H <sub>11</sub> N <sub>3</sub> O <sub>6</sub>	54-25-1	245.189		158				s H <sub>2</sub> O
547	Azetidine		C <sub>3</sub> H <sub>7</sub> N	503-29-7	57.095	liq	-70.0	63	0.8436 <sup>20</sup>	1.4287 <sup>25</sup>	vs ace, bz, eth, EtOH
548	2-Azetidinecarboxylic acid		C <sub>4</sub> H <sub>7</sub> NO <sub>2</sub>	2517-04-6	101.105	cry (95% MeOH)	217 dec				
549	2-Azetidinone		C <sub>3</sub> H <sub>5</sub> NO	930-21-2	71.078		73.5	106 <sup>15</sup>			vs eth, EtOH, chl
550	Azidobenzene		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub>	622-37-7	119.124	pa ye oil	-27.5	70 <sup>11</sup>	1.0860 <sup>20</sup>	1.5589 <sup>25</sup>	i H <sub>2</sub> O; sl EtOH, eth
551	1-Azido-4-chlorobenzene		C <sub>6</sub> H <sub>4</sub> ClN <sub>3</sub>	3296-05-7	153.569		20	96 <sup>20</sup>	1.2634 <sup>25</sup>		i H <sub>2</sub> O; s eth
552	2-Azidoethanol		C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O	1517-05-1	87.080			75 <sup>40</sup>	1.146 <sup>24</sup>		vs H <sub>2</sub> O
553	1-Azido-4-methylbenzene		C <sub>7</sub> H <sub>7</sub> N <sub>3</sub>	2101-86-2	133.151		-29.0	dec 180; 80 <sup>10</sup>	1.0527 <sup>23</sup>		vs eth, EtOH
554	(Azidomethyl)benzene		C <sub>7</sub> H <sub>7</sub> N <sub>3</sub>	622-79-7	133.151			108 <sup>23</sup> , 78 <sup>12</sup>	1.0730 <sup>19</sup>	1.5341 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth
555	Azinphos ethyl		C <sub>12</sub> H <sub>16</sub> N <sub>3</sub> O <sub>3</sub> PS <sub>2</sub>	2642-71-9	345.377	nd	53	1110 <sup>001</sup>	1.284 <sup>20</sup>		reac alk
556	Azinphos-methyl		C <sub>10</sub> H <sub>12</sub> N <sub>3</sub> O <sub>3</sub> PS <sub>2</sub>	86-50-0	317.324		73		1.44 <sup>20</sup>		
557	1-Aziridineethanol		C <sub>4</sub> H <sub>7</sub> NO	1072-52-2	87.120			168	1.088 <sup>25</sup>	1.4560 <sup>20</sup>	
558	<i>trans</i> -Azobenzene	<i>trans</i> -Diphenyldiazene	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	17082-12-1	182.220	oran-red mcl lf (al)	67.88	293	1.203 <sup>20</sup>	1.6266 <sup>78</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, chl; vs py
559	<i>cis</i> -Azobenzene	<i>cis</i> -Diphenyldiazene	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	1080-16-6	182.220	oran-red pl (peth)	71				sl H <sub>2</sub> O; s EtOH, eth, bz, HOAc, lig
560	3,3'-Azobenzenedisulfonyl chloride		C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	104115-88-0	379.239	red nd (eth)	166.5				vs eth
561	1,1'-Azobiscyclohexanecarbonitrile		C <sub>14</sub> H <sub>20</sub> N <sub>4</sub>	2094-98-6	244.336		100				i H <sub>2</sub> O; s lig
562	2,2'-Azobis[isobutyronitrile]	2,2'-Azobis[2-methylpropionitrile]	C <sub>8</sub> H <sub>12</sub> N <sub>4</sub>	78-67-1	164.208						i H <sub>2</sub> O; sl EtOH, eth
563	Azobutane		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub>	2159-75-3	142.242			60 <sup>18</sup>			
564	Azopropane		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	821-67-0	114.188			114			
565	<i>cis</i> -Azoxybenzene	Diphenyldiazene 1-oxide, ( <i>E</i> )	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	21650-65-7	198.219		87		1.166 <sup>20</sup>	1.633 <sup>20</sup>	

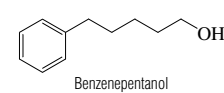
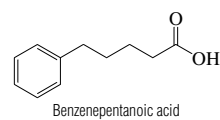
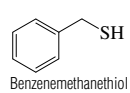
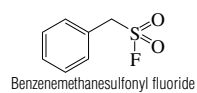
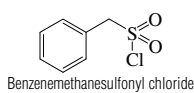
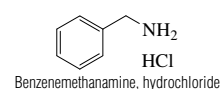
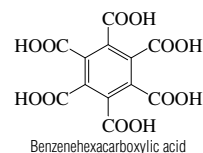
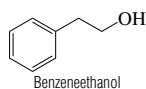
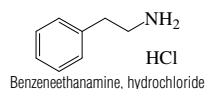
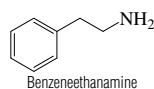
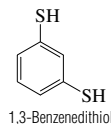
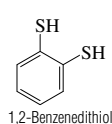
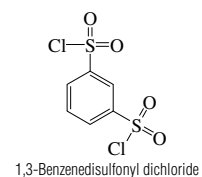
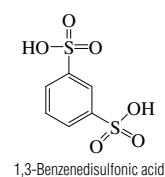
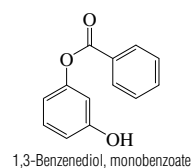
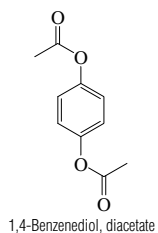
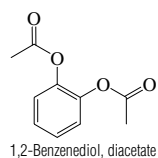
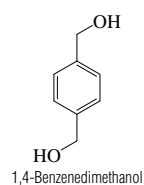
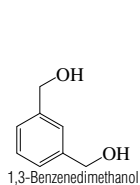
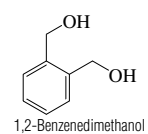
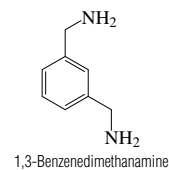
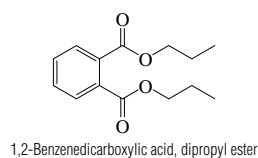
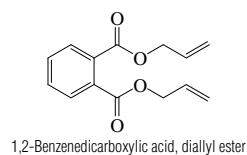
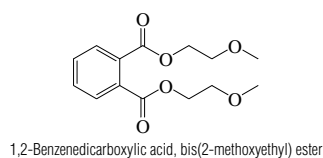
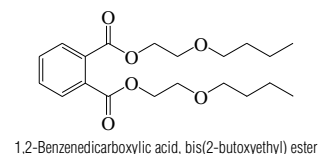
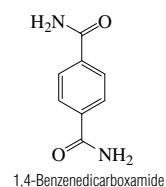
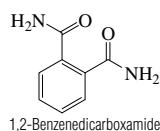
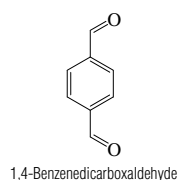
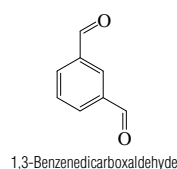
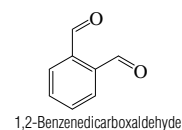
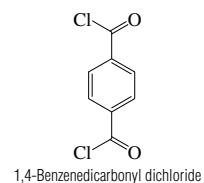
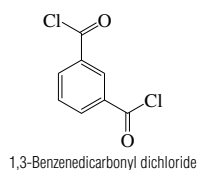
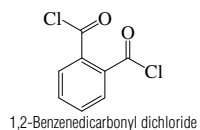
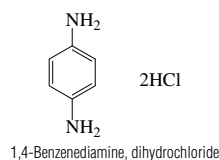
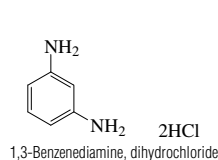
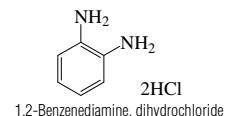
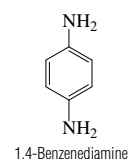
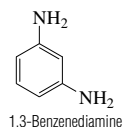
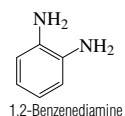
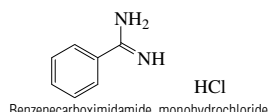
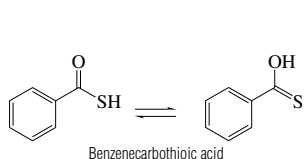




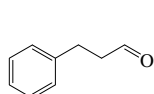
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
566	<i>trans</i> -Azoxybenzene	Diphenyldiazene 1-oxide, ( <i>Z</i> )	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	20972-43-4	198.219		34.6		1.1590 <sup>26</sup>		i H <sub>2</sub> O; s EtOH, eth
567	Azoxyethane	Diethyldiazene 1-oxide	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	16301-26-1	102.134	liq		46			
568	Azulene	Bicyclo[5.3.0]decapentaene	C <sub>10</sub> H <sub>8</sub>	275-51-4	128.171	bl or gr-blk lf (al)	99	dec 270; 125 <sup>10</sup>			i H <sub>2</sub> O; s EtOH, eth, ace, acid; sl chl
569	Balan	<i>N</i> -Butyl- <i>N</i> -ethyl-2,6-dinitro-4-(trifluoromethyl)aniline	C <sub>13</sub> H <sub>16</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	1861-40-1	335.279		66	121 <sup>0.5</sup> , 148 <sup>7</sup>			
570	Barban		C <sub>11</sub> H <sub>2</sub> Cl <sub>2</sub> NO <sub>2</sub>	101-27-9	258.101		75				
571	Barbital	5,5-Diethylbarbituric acid	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	57-44-3	184.192	nd (w)	190		1.220 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace, chl, lig, tfa
572	Barbituric acid		C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	67-52-7	128.086	orth pr (w +2)	248	dec 260			s H <sub>2</sub> O, eth; sl EtOH
573	Bayleton	Triadimefon	C <sub>14</sub> H <sub>16</sub> ClN <sub>2</sub> O <sub>2</sub>	43121-43-3	293.749		82		1.22 <sup>20</sup>		
574	Bebeerine		C <sub>36</sub> H <sub>38</sub> N <sub>2</sub> O <sub>6</sub>	477-60-1	594.696	cry (bz, eth, chl-MeOH)	221				s EtOH, MeOH, eth; vs ace, chl
575	Benactyzine	2-(Diethylamino)ethyl benzilate	C <sub>20</sub> H <sub>25</sub> NO <sub>3</sub>	302-40-9	327.418	cry	51				
576	Benactyzine hydrochloride	2-Diethylaminoethyl benzilate hydrochloride	C <sub>20</sub> H <sub>26</sub> ClNO <sub>3</sub>	57-37-4	363.878		177.5				s H <sub>2</sub> O; i eth
577	Benalaxyl		C <sub>20</sub> H <sub>22</sub> NO <sub>3</sub>	71626-11-4	325.402		79		1.27 <sup>25</sup>		
578	Bendiocarb	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methylcarbamate	C <sub>11</sub> H <sub>13</sub> NO <sub>4</sub>	22781-23-3	223.226		130		1.25 <sup>20</sup>		
579	Bendroflumethiazide		C <sub>15</sub> H <sub>14</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	73-48-3	421.415	cry	225				i H <sub>2</sub> O, bz, eth; s EtOH, ace
580	Benomyl		C <sub>14</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub>	17804-35-2	290.318			dec			
581	Bensulfuron-methyl		C <sub>16</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub> S	83055-99-6	410.402		187				
582	Bensulide		C <sub>14</sub> H <sub>24</sub> NO <sub>4</sub> PS <sub>3</sub>	741-58-2	397.514		34.4		1.224 <sup>20</sup>		
583	Bentazon		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub> S	25057-89-0	240.278		138				
584	Benz[C]acridine	12-Azabenz[ <i>a</i> ]anthracene	C <sub>17</sub> H <sub>11</sub> N	225-51-4	229.276	nd (dil al)	132				vs bz, eth, EtOH
585	Benzaldehyde	Benzenecarboxaldehyde	C <sub>7</sub> H <sub>6</sub> O	100-52-7	106.122	liq	-57.1	178.8	1.0401 <sup>25</sup>	1.5463 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace, bz
586	Benzaldehyde hydrazone	Benzyldiene hydrazine	C <sub>7</sub> H <sub>8</sub> N <sub>2</sub>	5281-18-5	120.152	lf	16	140 <sup>14</sup>			s EtOH
587	<i>cis</i> -Benzaldehyde oxime		C <sub>7</sub> H <sub>9</sub> NO	622-32-2	121.137	pr	36.5	200	1.1111 <sup>20</sup>	1.5908 <sup>20</sup>	vs bz, eth, EtOH
588	<i>trans</i> -Benzaldehyde oxime		C <sub>7</sub> H <sub>9</sub> NO	622-31-1	121.137	nd (eth)	35	119 <sup>10</sup>	1.145 <sup>20</sup>		s H <sub>2</sub> O; vs EtOH, eth
589	Benzaldehyde, phenylhydrazone		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub>	588-64-7	196.247	nd (lig), pr	157.0				sl EtOH, eth; s ace, bz, liq NH <sub>3</sub>
590	Benzaldehyde, (phenylmethylene) hydrazone		C <sub>14</sub> H <sub>12</sub> N <sub>2</sub>	588-68-1	208.258	ye pr (al)	93				i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl; sl ctc
591	Benzamide	Benzoic acid amide	C <sub>7</sub> H <sub>7</sub> NO	55-21-0	121.137	mcl pr or pl (w)	127.3	290	1.0792 <sup>30</sup>		sl H <sub>2</sub> O, eth, bz; vs EtOH, ctc, CS <sub>2</sub>
592	Benz[ <i>a</i> ]anthracene	1,2-Benzanthracene	C <sub>18</sub> H <sub>12</sub>	56-55-3	228.288	lf (al)	160.5	438			i H <sub>2</sub> O; vs EtOH
593	Benz[ <i>a</i> ]anthracene-7,12-dione		C <sub>18</sub> H <sub>10</sub> O <sub>2</sub>	2498-66-0	258.271		170.5				sl EtOH, eth, lig; s ace; vs bz, chl
594	Benzanthrone		C <sub>17</sub> H <sub>10</sub> O	82-05-3	230.260		170				sl bz
595	Benzene	[6]Annulene	C <sub>6</sub> H <sub>6</sub>	71-43-2	78.112	orth pr or liq	5.49	80.09	0.8765 <sup>20</sup>	1.5011 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, chl; s ctc
596	Benzeneacetaldehyde	Phenylacetaldehyde	C <sub>8</sub> H <sub>8</sub> O	122-78-1	120.149		33.5	195	1.0272 <sup>20</sup>	1.5255 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
597	Benzeneacetamide	$\alpha$ -Phenylacetamide	C <sub>8</sub> H <sub>9</sub> NO	103-81-1	135.163		157				sl H <sub>2</sub> O, eth, bz; s EtOH
598	Benzeneacetic acid	Phenylacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	103-82-2	136.149	lf, pl (peth)	76.5	265.5	1.228 <sup>6</sup>		sl H <sub>2</sub> O, chl; vs EtOH, eth; s ace; i lig
599	Benzeneacetic acid, hydrazide		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O	937-39-3	150.177		115.5				
600	Benzeneacetic anhydride		C <sub>16</sub> H <sub>14</sub> O <sub>3</sub>	1555-80-2	254.280	pr or nd (eth)	73.3	195 <sup>12</sup>			vs eth, chl
601	Benzeneacetonitrile	Benzyl cyanide	C <sub>8</sub> H <sub>7</sub> N	140-29-4	117.149	liq	-23.8	233.5	1.0205 <sup>15</sup>	1.5211 <sup>25</sup>	
602	Benzeneacetyl chloride	Phenylacetyl chloride	C <sub>8</sub> H <sub>7</sub> ClO	103-80-0	154.594			170 <sup>20</sup> , 105 <sup>24</sup>	1.1682 <sup>20</sup>	1.5325 <sup>20</sup>	vs eth
603	Benzenearsonic acid		C <sub>6</sub> H <sub>7</sub> AsO <sub>3</sub>	98-05-5	202.040	cry (w)	158 dec				vs H <sub>2</sub> O, EtOH
604	Benzeneboronic acid		C <sub>6</sub> H <sub>7</sub> BO <sub>2</sub>	98-80-6	121.930		219				sl H <sub>2</sub> O; s EtOH, eth, bz
605	Benzenebutanoic acid		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	1821-12-1	164.201	lf (w)	52	290			s H <sub>2</sub> O, EtOH, eth
606	Benzenebutanol		C <sub>10</sub> H <sub>14</sub> O	3360-41-6	150.217			140 <sup>14</sup>		1.5214 <sup>20</sup>	
607	Benzenecarboxoperoxoic acid	Perbenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	93-59-4	138.121	mcl pl (peth)	42	100 <sup>14</sup>			vs ace, bz, eth, EtOH
608	Benzenecarbothioamide		C <sub>7</sub> H <sub>7</sub> NS	2227-79-4	137.203		117				



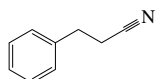
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
609	Benzenecarbothioic acid		C <sub>6</sub> H <sub>6</sub> OS	98-91-9	138.187	ye pl (HOAc)	24	86 <sup>10</sup>	1.28 <sup>20</sup>	1.6040 <sup>20</sup>	vs ace, bz, eth, EtOH
610	Benzenecarboximidamide, monohydrochloride		C <sub>7</sub> H <sub>9</sub> ClN <sub>2</sub>	1670-14-0	156.612	orth pr (w +2)	169				s H <sub>2</sub> O, EtOH; sl tfa
611	1,2-Benzenediamine	<i>o</i> -Phenylenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	95-54-5	108.141	brsh ye lf (w pl (chl))	102.1	257			s H <sub>2</sub> O, eth, bz, chl; vs EtOH
612	1,3-Benzenediamine	<i>m</i> -Phenylenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108-45-2	108.141	orth (al)	66.0	285	1.0096 <sup>58</sup>	1.6339 <sup>58</sup>	vs H <sub>2</sub> O; s EtOH, eth, bz
613	1,4-Benzenediamine	<i>p</i> -Phenylenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	106-50-3	108.141	wh pl (bz, eth)	141.1	267			sl H <sub>2</sub> O; s EtOH, eth, bz, chl
614	1,2-Benzenediamine, dihydrochloride		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	615-28-1	181.062		250 dec				
615	1,3-Benzenediamine, dihydrochloride		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	541-69-5	181.062						s H <sub>2</sub> O
616	1,4-Benzenediamine, dihydrochloride		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	624-18-0	181.062						s H <sub>2</sub> O
617	1,2-Benzenedicarbonyl dichloride	Phthaloyl chloride	C <sub>8</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	88-95-9	203.023		15.5	281.1	1.4089 <sup>20</sup>	1.5684 <sup>20</sup>	
618	1,3-Benzenedicarbonyl dichloride		C <sub>8</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	99-63-8	203.023	pr(eth)	43.5	276	1.3880 <sup>17</sup>	1.570 <sup>47</sup>	sl H <sub>2</sub> O, EtOH; s eth
619	1,4-Benzenedicarbonyl dichloride		C <sub>8</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	100-20-9	203.023	nd or pl (lig)	83.5	258; 125 <sup>9</sup>			s eth
620	1,2-Benzenedicarboxaldehyde		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	643-79-8	134.133	ye cry or nd (lig)	55.8	83 <sup>3,8</sup>			vs eth, EtOH
621	1,3-Benzenedicarboxaldehyde		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	626-19-7	134.133	nd (dil al)	89.5	246; 136 <sup>13</sup>			sl H <sub>2</sub> O, eth, chl; vs EtOH; s ace, bz
622	1,4-Benzenedicarboxaldehyde		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	623-27-8	134.133	nd (w)	117	246			sl H <sub>2</sub> O; vs EtOH; s eth, chl, alk
623	1,2-Benzenedicarboxamide	Phthalamide	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	88-96-0	164.162	cry	222	dec			sl H <sub>2</sub> O, EtOH; i eth
624	1,4-Benzenedicarboxamide		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	3010-82-0	164.162	nd (w), pl (HOAc)	322.3				
625	1,2-Benzenedicarboxylic acid, bis(2-butoxyethyl) ester	Bis(2-butoxyethyl) phthalate	C <sub>20</sub> H <sub>30</sub> O <sub>6</sub>	117-83-9	366.448			270			
626	1,2-Benzenedicarboxylic acid, bis(2-methoxyethyl) ester	Bis(2-methoxyethyl) phthalate	C <sub>14</sub> H <sub>18</sub> O <sub>6</sub>	117-82-8	282.289		-60.0	230 <sup>10</sup>	1.1596 <sup>20</sup>		
627	1,2-Benzenedicarboxylic acid, diallyl ester	Diallyl phthalate	C <sub>14</sub> H <sub>14</sub> O <sub>4</sub>	131-17-9	246.259			161 <sup>4</sup>			
628	1,2-Benzenedicarboxylic acid, dipropyl ester	Dipropyl phthalate	C <sub>14</sub> H <sub>18</sub> O <sub>4</sub>	131-16-8	250.291	liq	-31.0	304.5	1.0767 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth
629	1,3-Benzenedimethanamine	<i>m</i> -Xylene diamine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	1477-55-0	136.194			247	1.052 <sup>20</sup>		vs H <sub>2</sub> O, eth, EtOH
630	1,2-Benzenedimethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	612-14-6	138.164	pl (eth, peth)	64.8	145 <sup>3</sup>			s H <sub>2</sub> O, EtOH; vs eth; sl bz
631	1,3-Benzenedimethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	626-18-6	138.164	nd (bz)	57	156 <sup>13</sup>	1.1610 <sup>16</sup>		vs H <sub>2</sub> O, eth, EtOH
632	1,4-Benzenedimethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	589-29-7	138.164	nd (w)	117.5	140 <sup>1</sup>			vs H <sub>2</sub> O, ace, eth, EtOH
633	1,2-Benzenediol, diacetate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	635-67-6	194.184	nd (al)	64.5	142 <sup>9</sup>			i H <sub>2</sub> O; vs EtOH, eth, chl; s peth
634	1,4-Benzenediol, diacetate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	1205-91-0	194.184	pl (w, al)	123.5		0.8731 <sup>25</sup>		s H <sub>2</sub> O; vs EtOH, eth, chl, lig
635	1,3-Benzenediol, monobenzoate		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	136-36-7	214.216		134.5				
636	1,3-Benzenedisulfonic acid		C <sub>6</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	98-48-6	238.238	hyg cry					
637	1,3-Benzenedisulfonyl dichloride		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	585-47-7	275.130		61.8	195 <sup>10,5</sup>			
638	1,2-Benzenedithiol		C <sub>6</sub> H <sub>6</sub> S <sub>2</sub>	17534-15-5	142.242		28.5	238.5			vs EtOH, eth, bz; s AcOEt
639	1,3-Benzenedithiol		C <sub>6</sub> H <sub>6</sub> S <sub>2</sub>	626-04-0	142.242	lf	27	245			vs bz, eth, EtOH
640	Benzenethanamine	1-Amino-2-phenylethane	C <sub>8</sub> H <sub>11</sub> N	64-04-0	121.180	liq	<0	195	0.9640 <sup>25</sup>	1.5290 <sup>25</sup>	s H <sub>2</sub> O, etc; vs EtOH, eth
641	Benzenethanamine, hydrochloride		C <sub>8</sub> H <sub>12</sub> ClN	156-28-5	157.641	pl or lf (al)	218.5				vs H <sub>2</sub> O, EtOH
642	Benzenethanol	Phenethyl alcohol	C <sub>8</sub> H <sub>10</sub> O	60-12-8	122.164	liq	-27	218.8	1.0202 <sup>20</sup>	1.5325 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
643	Benzenehexacarboxylic acid	Mellitic acid	C <sub>12</sub> H <sub>6</sub> O <sub>12</sub>	517-60-2	342.169	nd (al)	287 dec				vs H <sub>2</sub> O; s EtOH, sulf
644	Benzenemethanamine, hydrochloride		C <sub>7</sub> H <sub>10</sub> ClN	3287-99-8	143.614		258.3				vs H <sub>2</sub> O, EtOH
645	Benzenemethanesulfonyl chloride		C <sub>7</sub> H <sub>7</sub> ClO <sub>2</sub> S	1939-99-7	190.648	pr (eth), nd (bz)	93				vs eth, bz
646	Benzenemethanesulfonyl fluoride		C <sub>7</sub> H <sub>7</sub> FO <sub>2</sub> S	329-98-6	174.193		92.0				
647	Benzenemethanethiol	Thiobenzyl alcohol	C <sub>7</sub> H <sub>8</sub> S	100-53-8	124.204	liq	-30	194.5	1.058 <sup>20</sup>	1.5151 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl etc; s CS <sub>2</sub>
648	Benzenepentanoic acid	5-Phenylvaleric acid	C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	2270-20-4	178.228	pl (w), pr (peth)	57.5	190 <sup>30</sup>			sl H <sub>2</sub> O; vs EtOH; s os
649	Benzenepentanol		C <sub>11</sub> H <sub>16</sub> O	10521-91-2	164.244			155 <sup>20</sup> , 150 <sup>18</sup>	0.9725 <sup>20</sup>	1.5156 <sup>20</sup>	vs eth, EtOH



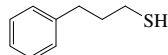
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
650	Benzenepropanal	Hydrocinnamic aldehyde	C <sub>9</sub> H <sub>10</sub> O	104-53-0	134.174	mcl	47	224; 117 <sup>2b</sup>	1.0190 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH; msc eth
651	Benzenepropanenitrile	Hydrocinnamonitrile	C <sub>9</sub> H <sub>9</sub> N	645-59-0	131.174	liq	-1	261; 141 <sup>25</sup>	1.0016 <sup>20</sup>	1.5266 <sup>28</sup>	s EtOH, eth; sl chl
652	Benzenepropanethiol		C <sub>9</sub> H <sub>12</sub> S	24734-68-7	152.256			121 <sup>23</sup> , 109 <sup>10</sup>	1.01 <sup>25</sup>	1.5494 <sup>20</sup>	
653	Benzenepropanoic acid	Hydrocinnamic acid	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	501-52-0	150.174	nd (w)	48	279.8	1.0712 <sup>49</sup>		s H <sub>2</sub> O, EtOH, eth, ctc, CS <sub>2</sub> ; vs bz
654	Benzenepropanol	Hydrocinnamyl alcohol	C <sub>9</sub> H <sub>12</sub> O	122-97-4	136.190		<-18	235	0.995 <sup>25</sup>	1.5357 <sup>25</sup>	s H <sub>2</sub> O, ctc; msc EtOH, eth
655	Benzenepropanol carbamate	Phenprobamate	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	673-31-4	179.216		102				i H <sub>2</sub> O; s EtOH, chl
656	Benzenepropanoyl chloride		C <sub>9</sub> H <sub>9</sub> ClO	645-45-4	168.619			dec 225; 105 <sup>10</sup>	1.135 <sup>21</sup>		s eth, CS <sub>2</sub>
657	Benzeneseleninic acid	Phenylseleninic acid	C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> Se	6996-92-5	189.07		124.5		1.93 <sup>20</sup>		sl H <sub>2</sub> O; i bz; vs alk
658	Benzeneselenol		C <sub>6</sub> H <sub>6</sub> Se	645-96-5	157.07			183.6; 84 <sup>25</sup>	1.4865 <sup>15</sup>		i H <sub>2</sub> O; s EtOH; vs eth, ctc
659	Benzenesulfonic acid		C <sub>6</sub> H <sub>6</sub> O <sub>2</sub> S	618-41-7	142.176	pr (w)	84	dec			sl H <sub>2</sub> O; s EtOH, eth, bz; i peth
660	Benzenesulfinyl chloride		C <sub>6</sub> H <sub>5</sub> ClOS	4972-29-6	160.621	pl (peth)	38	71 <sup>15</sup>	1.3469 <sup>25</sup>	1.3470 <sup>25</sup>	s eth, chl
661	Benzenesulfonamide		C <sub>6</sub> H <sub>7</sub> NO <sub>2</sub> S	98-10-2	157.191	lf, nd (w)	156				sl H <sub>2</sub> O, tfa; s EtOH, eth
662	Benzenesulfonic acid	Besyllic acid	C <sub>6</sub> H <sub>5</sub> O <sub>3</sub> S	98-11-3	158.175	nd (bz)	65				vs H <sub>2</sub> O, EtOH; i eth; sl bz; s HOAc
663	Benzenesulfonyl chloride	Phenylsulfonyl chloride	C <sub>6</sub> H <sub>5</sub> ClO <sub>2</sub> S	98-09-9	176.621		14.5	dec 251	1.3470 <sup>15</sup>		i H <sub>2</sub> O; vs EtOH; s eth, ctc
664	Benzenesulfonyl fluoride	Phenylsulfonyl fluoride	C <sub>6</sub> H <sub>5</sub> FO <sub>2</sub> S	368-43-4	160.166			203.5	1.3286 <sup>20</sup>	1.4932 <sup>18</sup>	s EtOH, eth
665	1,2,4,5-Benzenetetracarboxylic acid	Pyromellitic acid	C <sub>10</sub> H <sub>6</sub> O <sub>8</sub>	89-05-4	254.150	tcl pr (w+2)	276				sl H <sub>2</sub> O; s EtOH
666	Benzenethiol	Phenyl mercaptan	C <sub>6</sub> H <sub>6</sub> S	108-98-5	110.177	liq	-14.93	169.1	1.0775 <sup>20</sup>	1.5893 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl ctc
667	1,3,5-Benzenetricarbonyl trichloride		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>3</sub>	4422-95-1	265.477		36.3	180 <sup>16</sup>			s chl
668	1,2,3-Benzenetricarboxylic acid	Hemimellitic acid	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	569-51-7	210.140	pr (al)	200		1.546 <sup>20</sup>		vs eth, EtOH
669	1,2,4-Benzenetricarboxylic acid	Trimellitic acid	C <sub>9</sub> H <sub>6</sub> O <sub>6</sub>	528-44-9	210.140	nd (w) cry (al) cry (HOAc)	219				vs H <sub>2</sub> O, eth, EtOH
670	1,3,5-Benzenetricarboxylic acid		C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	554-95-0	210.140	pr or nd (w+1)	380				sl H <sub>2</sub> O; vs EtOH, eth
671	1,2,4-Benzenetricarboxylic acid 1,2-anhydride, 4-chloride	4-(Chloroformyl)phthalic anhydride	C <sub>9</sub> H <sub>5</sub> ClO <sub>4</sub>	1204-28-0	210.571		66				
672	1,2,4-Benzenetricarboxylic acid, triallyl ester		C <sub>18</sub> H <sub>18</sub> O <sub>6</sub>	2694-54-4	330.332		<-30		1.164 <sup>20</sup>		
673	1,2,3-Benzenetriol	Pyrogallol	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	87-66-1	126.110	lf or nd (bz)	133	309	1.453 <sup>4</sup>	1.561 <sup>134</sup>	vs H <sub>2</sub> O, EtOH, eth, NH <sub>3</sub> ; s ace; i bz
674	1,2,4-Benzenetriol	Hydroxyhydroquinone	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	533-73-3	126.110	pl (eth), lf or pl (w)	140.5				vs H <sub>2</sub> O, EtOH, eth; i bz, chl
675	1,3,5-Benzenetriol	Phloroglucinol	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	108-73-6	126.110	lf or pl (w+2)	218.5	sub	1.46 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth, bz, py; s ace
676	1,2,4-Benzenetriol triacetate		C <sub>12</sub> H <sub>12</sub> O <sub>6</sub>	613-03-6	252.219		99	300			s EtOH, chl, MeOH
677	Benzestrol		C <sub>20</sub> H <sub>26</sub> O <sub>2</sub>	85-95-0	298.419	cry (al)	164				vs ace, eth, EtOH, HOAc
678	Benzethonium chloride		C <sub>27</sub> H <sub>42</sub> ClNO <sub>2</sub>	121-54-0	448.081	pl (chl/eth)	165 (hyd)				vs H <sub>2</sub> O; s ace, chl, EtOH
679	Benzidine-3,3'-dicarboxylic acid	3,3'-Dicarboxybenzidine	C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub>	2130-56-5	272.256	nd	300	dec			
680	<i>p</i> -Benzidine	[1,1'-Biphenyl]-4,4'-diamine	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	92-87-5	184.236	nd (w)	120	401			sl H <sub>2</sub> O, eth, DMSO; s EtOH
681	Benzil	Diphenylethanedione	C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	134-81-6	210.228	ye pr (al)	94.87	347	1.084 <sup>102</sup>		i H <sub>2</sub> O; vs EtOH, eth; s ace; sl ctc
682	1 <i>H</i> -Benzimidazol-2-amine		C <sub>7</sub> H <sub>7</sub> N <sub>3</sub>	934-32-7	133.151	pl (w)	224				s H <sub>2</sub> O, EtOH, ace; sl eth, bz, DMSO
683	1 <i>H</i> -Benzimidazole	<i>N,N'</i> -Methenyl- <i>o</i> -phenylenediamine	C <sub>7</sub> H <sub>7</sub> N <sub>2</sub>	51-17-2	118.136	orth bipym pl (w)	170.5	>360			sl H <sub>2</sub> O, eth; vs EtOH; i bz; s dil alk
684	1 <i>H</i> -Benzimidazole-2-acetonitrile		C <sub>9</sub> H <sub>7</sub> N <sub>3</sub>	4414-88-4	157.172		208.4				
685	1 <i>H</i> -Benz[de]isoquinoline-1,3(2 <i>H</i> )-dione		C <sub>12</sub> H <sub>7</sub> NO <sub>2</sub>	81-83-4	197.190	nd (chl-al)	300				
686	Benzo[ <i>c</i> ]chrysene		C <sub>22</sub> H <sub>14</sub>	194-69-4	278.346	nd (AcOH)	126.5				
687	Benzo[ <i>g</i> ]chrysene	Benzo[ <i>a</i> ]triphenylene	C <sub>22</sub> H <sub>14</sub>	196-78-1	278.346	nd (AcOH)	114.5				



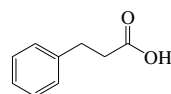
Benzenepropanal



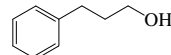
Benzenepropanenitrile



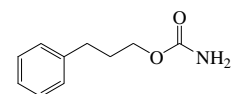
Benzenepropanethiol



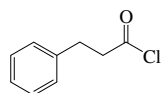
Benzenepropanoic acid



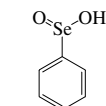
Benzenepropanol



Benzenepropanol carbamate



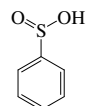
Benzenepropanoyl chloride



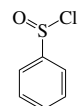
Benzeneseleninic acid



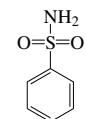
Benzeneselenol



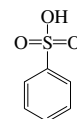
Benzenesulfinic acid



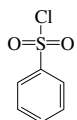
Benzenesulfinyl chloride



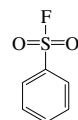
Benzenesulfonamide



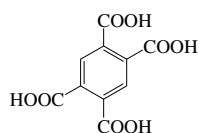
Benzenesulfonic acid



Benzenesulfonyl chloride



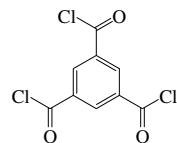
Benzenesulfonyl fluoride



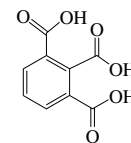
1,2,4,5-Benzenetetracarboxylic acid



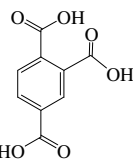
Benzenethiol



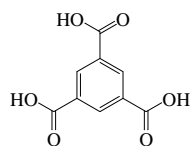
1,3,5-Benzenetricarbonyl trichloride



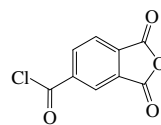
1,2,3-Benzenetricarboxylic acid



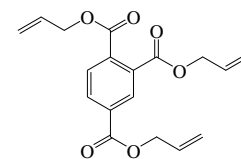
1,2,4-Benzenetricarboxylic acid



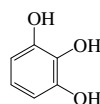
1,3,5-Benzenetricarboxylic acid



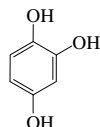
1,2,4-Benzenetricarboxylic acid 1,2-anhydride, 4-chloride



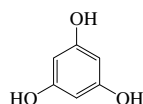
1,2,4-Benzenetricarboxylic acid, triallyl ester



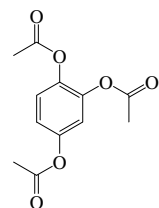
1,2,3-Benzenetriol



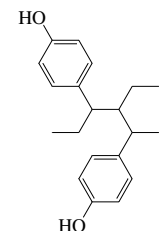
1,2,4-Benzenetriol



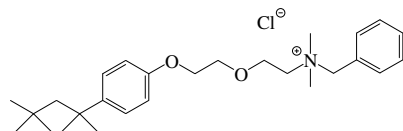
1,3,5-Benzenetriol



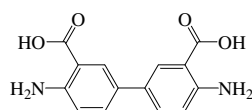
1,2,4-Benzenetriol triacetate



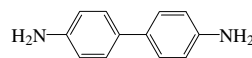
Benzenestrol



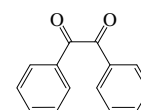
Benzethonium chloride



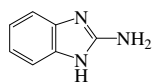
Benzidine-3,3'-dicarboxylic acid



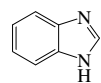
p-Benzidine



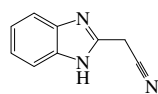
Benzil



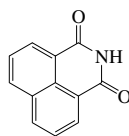
1H-Benzimidazol-2-amine



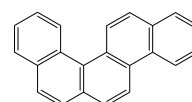
1H-Benzimidazole



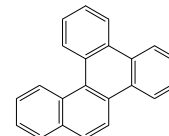
1H-Benzimidazole-2-acetonitrile



1H-Benz[de]isoquinoline-1,3(2H)-dione



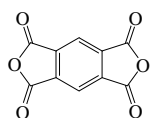
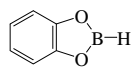
Benzo[c]chrysene



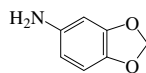
Benzo[g]chrysene

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
688	1 <i>H</i> ,3 <i>H</i> -Benzo[1,2- <i>c</i> :4,5- <i>c'</i> ]difuran-1,3,5,7-tetrone		C <sub>10</sub> H <sub>2</sub> O <sub>6</sub>	89-32-7	218.119		285.3				
689	1,3,2-Benzodioxaborole		C <sub>6</sub> H <sub>5</sub> BO <sub>2</sub>	274-07-7	119.914		12	88 <sup>156</sup> , 50 <sup>50</sup>	1.2700 <sup>20</sup>	1.5070 <sup>20</sup>	
690	1,3-Benzodioxol-5-amine		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	14268-66-7	137.137		42	144 <sup>16</sup>			
691	1,3-Benzodioxole		C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	274-09-9	122.122			172.5; 77 <sup>27</sup>	1.064 <sup>25</sup>	1.5398 <sup>20</sup>	
692	1,3-Benzodioxole-5-carboxaldehyde	Piperonal	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	120-57-0	150.132		37	263			sl H <sub>2</sub> O; vs EtOH; msc eth; s ace, chl
693	1,3-Benzodioxole-5-carboxylic acid	Piperonylic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	94-53-1	166.132		229				
694	1,3-Benzodioxole-5-ethanamine		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	1484-85-1	165.189			166 <sup>20</sup> , 101 <sup>1</sup>	1.225 <sup>20</sup>	1.5620 <sup>20</sup>	
695	1,3-Benzodioxole-5-methanamine		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	2620-50-0	151.163			139 <sup>13</sup> , 100 <sup>0,07</sup>	1.214 <sup>25</sup>	1.5635 <sup>20</sup>	
696	1,3-Benzodioxole-5-methanol		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	495-76-1	152.148	nd (peth)	58	157 <sup>16</sup>			sl H <sub>2</sub> O; s EtOH, eth, bz, chl; i lig
697	1,3-Benzodioxol-5-ol		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	533-31-3	138.121		64.9				
698	<i>trans,trans</i> -5-(1,3-Benzodioxol-5-yl)-2,4-pentadienoic acid	Piperinic acid	C <sub>12</sub> H <sub>10</sub> O <sub>4</sub>	136-72-1	218.205	nd (al), ye nd (sub)	215.8	sub			vs EtOH
699	7,8-Benzoflavone	2-Phenyl-4 <i>H</i> -naphtho[1,2- <i>b</i> ]pyran-4-one	C <sub>19</sub> H <sub>12</sub> O <sub>2</sub>	604-59-1	272.297	ye pl (al)	157				sl EtOH, chl; s sulf
700	Benzo[ <i>b</i> ]fluoranthene	Benzo[ <i>e</i> ]acephenanthrylene	C <sub>20</sub> H <sub>12</sub>	205-99-2	252.309	nd (bz)	168				i H <sub>2</sub> O; msc bz
701	Benzo[ <i>j</i> ]fluoranthene	Dibenzo[ <i>a</i> , <i>k</i> ]fluorene	C <sub>20</sub> H <sub>12</sub>	205-82-3	252.309	ye pl (al) nd (HOAc)	166				i H <sub>2</sub> O; sl EtOH, HOAc
702	Benzo[ <i>k</i> ]fluoranthene	2,3,1',8'-Binaphthylene	C <sub>20</sub> H <sub>12</sub>	207-08-9	252.309	pa ye nd (bz)	217	480			i H <sub>2</sub> O; s EtOH, bz, HOAc
703	1 <i>H</i> -Benzo[ <i>a</i> ]fluorene		C <sub>17</sub> H <sub>12</sub>	238-84-6	216.277	pl (ace or HOAc)	189.5	405			i H <sub>2</sub> O; sl EtOH; s eth, bz, chl
704	1 <i>H</i> -Benzo[ <i>b</i> ]fluorene		C <sub>17</sub> H <sub>12</sub>	243-17-4	216.277		212	401			i H <sub>2</sub> O
705	Benzofuran	Coumarone	C <sub>8</sub> H <sub>6</sub> O	271-89-6	118.133		<-18	174	1.0913 <sup>25</sup>	1.5615 <sup>17</sup>	i H <sub>2</sub> O; s EtOH, eth
706	2-Benzofurancarboxylic acid	Coumarilic acid	C <sub>9</sub> H <sub>6</sub> O <sub>3</sub>	496-41-3	162.142	nd (w)	192.5	312.5			vs EtOH
707	2(3 <i>H</i> )-Benzofuranone		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	553-86-6	134.133		50	249	1.2236 <sup>14</sup>		
708	3(2 <i>H</i> )-Benzofuranone		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	7169-34-8	134.133	red nd (al)	102.5	152 <sup>15</sup>			vs bz
709	1-(2-Benzofuranyl)ethanone		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	1646-26-0	160.170		76	126 <sup>11</sup>			s H <sub>2</sub> O
710	Benzofurazan, 1-oxide		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	480-96-6	136.108		71.5		1.280 <sup>80</sup>		
711	Benzohydrazide	Benzoic acid, hydrazide	C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O	613-94-5	136.151	pl (w)	115	dec 267			s H <sub>2</sub> O, EtOH; sl eth, ace, chl
712	Benzoic acid	Benzenecarboxylic acid	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	65-85-0	122.122	mcl lf or nd	122.35	249.2	1.2659 <sup>15</sup>	1.504 <sup>132</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz, chl
713	Benzoic anhydride		C <sub>14</sub> H <sub>10</sub> O <sub>3</sub>	93-97-0	226.227	pr (eth)	42.5	360	1.989 <sup>15</sup>	1.5767 <sup>15</sup>	i H <sub>2</sub> O, lig; s EtOH, eth; sl chl
714	Benzoin	2-Hydroxy-1,2-diphenylethanone, (±)	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	579-44-2	212.244		137	344; 194 <sup>12</sup>	1.310 <sup>20</sup>		vs EtOH, chl
715	Benzonitrile	Phenyl cyanide	C <sub>7</sub> H <sub>5</sub> N	100-47-0	103.122	liq	-13.99	191.1	1.0093 <sup>15</sup>	1.5289 <sup>30</sup>	sl H <sub>2</sub> O; msc EtOH; vs ace, bz; s ctc
716	Benzo[ <i>ghi</i> ]perylene	1,12-Benzperylene	C <sub>22</sub> H <sub>12</sub>	191-24-2	276.330	ye-grn lf (bz)	272.5				i H <sub>2</sub> O
717	Benzo[ <i>c</i> ]phenanthrene	Tetrahalicene	C <sub>18</sub> H <sub>12</sub>	195-19-7	228.288		68				i H <sub>2</sub> O; sl EtOH, lig
718	Benzophenone	Diphenyl ketone	C <sub>13</sub> H <sub>10</sub> O	119-61-9	182.217	(α) orth pr (al); (β) mcl pr	47.9 (α); 26 (β)	305.4	1.111 <sup>18</sup>	1.6077 <sup>19</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl, ace; s bz
719	Benzophenone hydrazone		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub>	5350-57-2	196.247		97.3	227 <sup>55</sup>			
720	Benzophenone, oxime	Diphenyl ketoxime	C <sub>13</sub> H <sub>11</sub> NO	574-66-3	197.232	nd (al)	144				i H <sub>2</sub> O; vs EtOH, eth, chl, ace; s bz
721	3,3',4,4'-Benzophenonetetracarboxylic acid dianhydride	4,4'-Carbonyldiphthalic anhydride	C <sub>17</sub> H <sub>6</sub> O <sub>7</sub>	2421-28-5	322.226		216				
722	Benzo-2-phenylhydrazide		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	532-96-7	212.246	pr (al), nd (w)	168	314			sl H <sub>2</sub> O, eth; s EtOH, bz, chl
723	Benzopurpurine 4B	C.I. Direct Red 2, disodium salt	C <sub>34</sub> H <sub>26</sub> N <sub>6</sub> Na <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	992-59-6	724.716	br pow					s H <sub>2</sub> O, EtOH, ac, H <sub>2</sub> SO <sub>4</sub>
724	2 <i>H</i> -1-Benzopyran	1,2-Chromene	C <sub>9</sub> H <sub>8</sub> O	254-04-6	132.159			132 <sup>102</sup> , 91 <sup>13</sup>	1.0993 <sup>16</sup>	1.5869 <sup>24</sup>	i H <sub>2</sub> O
725	[2]Benzopyrano[6,5,4- <i>def</i> ][2]benzopyran-1,3,6,8-tetrone	1,4,5,8-Naphthalenetetracarboxylic acid anhydride	C <sub>14</sub> H <sub>4</sub> O <sub>6</sub>	81-30-1	268.178	nd (al)	450	sub 320			i H <sub>2</sub> O; s Na <sub>2</sub> CO <sub>3</sub> , HOAc
726	1 <i>H</i> -2-Benzopyran-1-one	Isocoumarin	C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	491-31-6	146.143	pl (bz)	47	286			i H <sub>2</sub> O; vs EtOH, eth, bz, CS <sub>2</sub>
727	2 <i>H</i> -1-Benzopyran-2-one	Coumarin	C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	91-64-5	146.143	orth pym (eth)	71	301.7	0.935 <sup>20</sup>		s H <sub>2</sub> O, EtOH, alk; vs eth, chl, py



1*H*,3*H*-Benzo[1,2-*c*:4,5-*c'*]difuran-1,3,5,7-tetrone

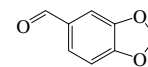
1,3,2-Benzodioxaborole



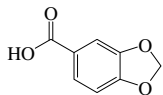
1,3-Benzodioxol-5-amine



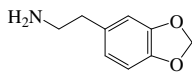
1,3-Benzodioxole



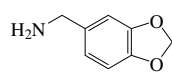
1,3-Benzodioxole-5-carboxaldehyde



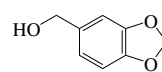
1,3-Benzodioxole-5-carboxylic acid



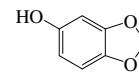
1,3-Benzodioxole-5-ethanamine



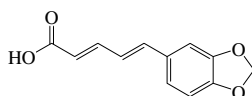
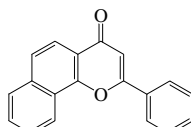
1,3-Benzodioxole-5-methanamine



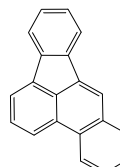
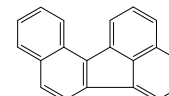
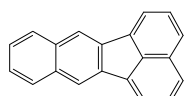
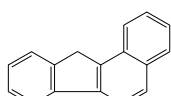
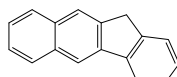
1,3-Benzodioxole-5-methanol



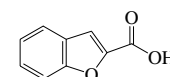
1,3-Benzodioxol-5-ol

*trans,trans*-5-(1,3-Benzodioxol-5-yl)-2,4-pentadienoic acid

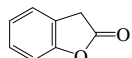
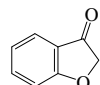
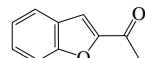
7,8-Benzoflavone

Benzo[*b*]fluorantheneBenzo[*j*]fluorantheneBenzo[*k*]fluoranthene11*H*-Benzo[*a*]fluorene11*H*-Benzo[*b*]fluorene

Benzofuran



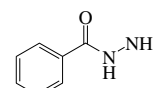
2-Benzofurancarboxylic acid

2(3*H*)-Benzofuranone3(2*H*)-Benzofuranone

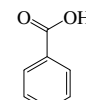
1-(2-Benzofuranyl)ethanone



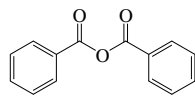
Benzofurazan, 1-oxide



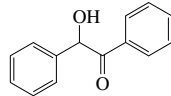
Benzohydrazide



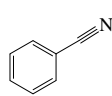
Benzoic acid



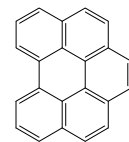
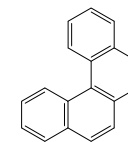
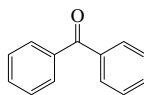
Benzoic anhydride



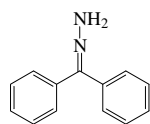
Benzoin



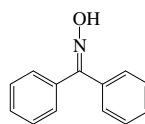
Benzonitrile

Benzo[*ghi*]peryleneBenzo[*c*]phenanthrene

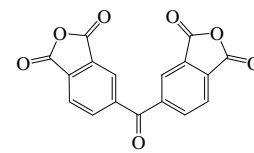
Benzophenone



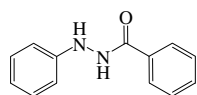
Benzophenone hydrazone



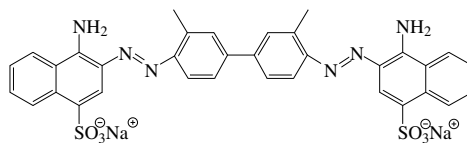
Benzophenone, oxime



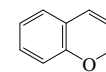
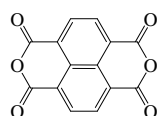
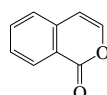
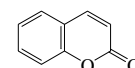
3,3',4,4'-Benzophenonetetracarboxylic acid dianhydride



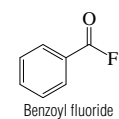
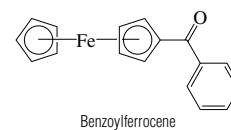
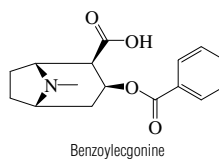
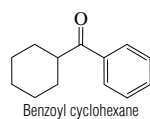
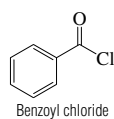
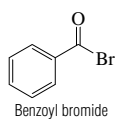
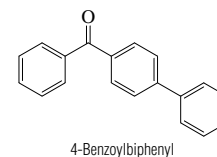
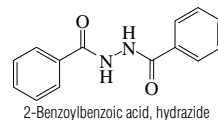
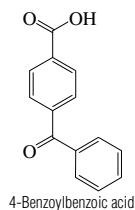
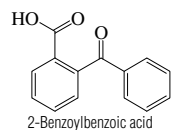
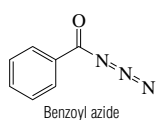
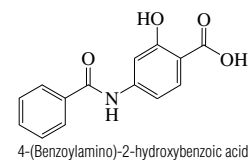
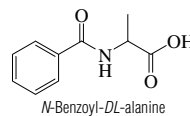
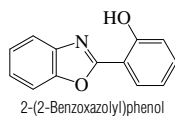
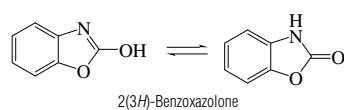
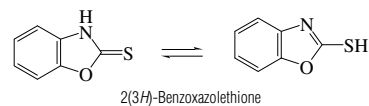
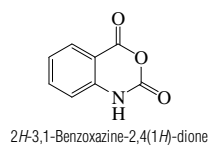
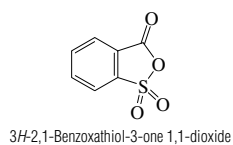
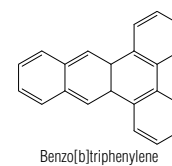
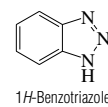
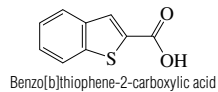
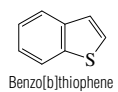
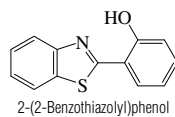
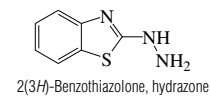
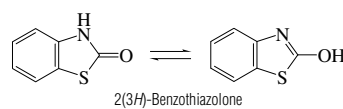
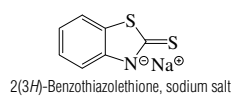
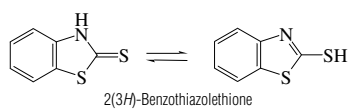
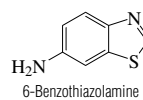
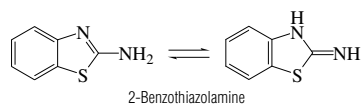
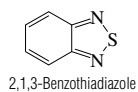
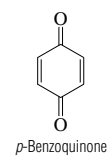
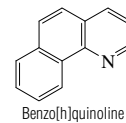
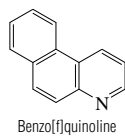
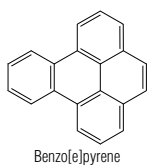
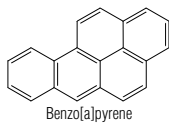
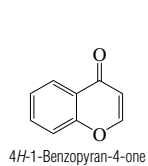
Benzo-2-phenylhydrazide



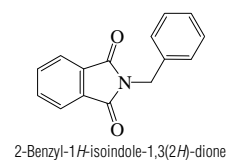
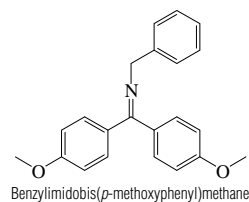
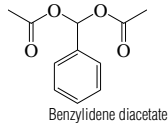
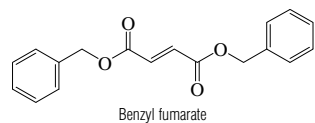
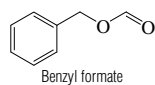
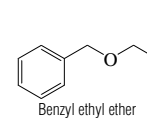
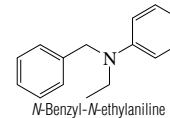
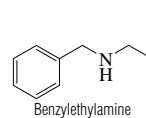
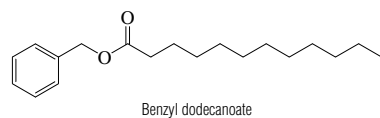
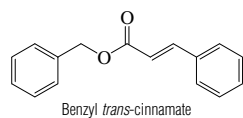
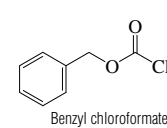
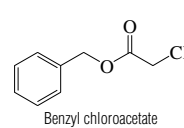
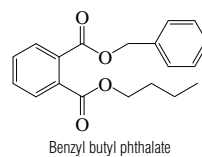
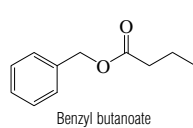
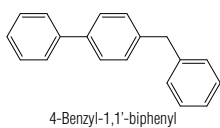
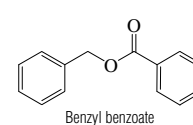
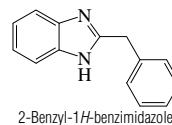
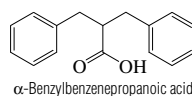
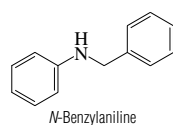
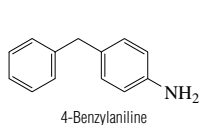
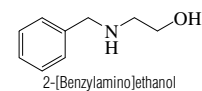
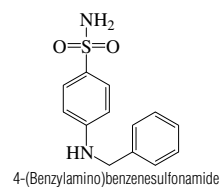
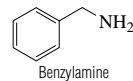
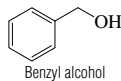
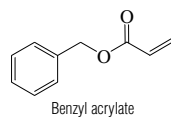
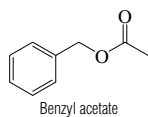
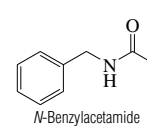
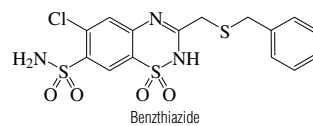
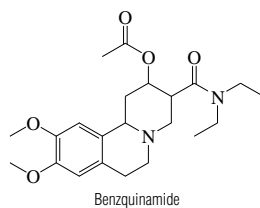
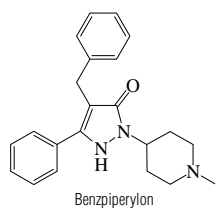
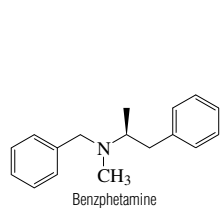
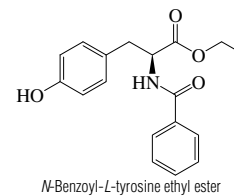
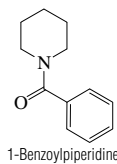
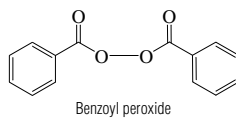
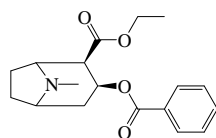
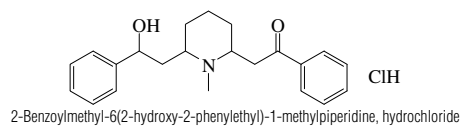
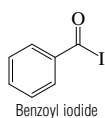
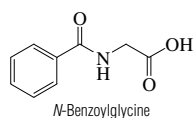
Benzopurpurine 4B

2*H*-1-Benzopyran[2]Benzopyrano[6,5,4-*def*][2]benzopyran-1,3,6,8-tetrone1*H*-2-Benzopyran-1-one2*H*-1-Benzopyran-2-one

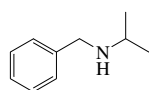
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
728	4 <i>H</i> -1-Benzopyran-4-one		C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	491-38-3	146.143	nd (peth w)	59	sub	1.2900 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz, chl
729	Benzo[a]pyrene	2,3-Benzopyrene	C <sub>20</sub> H <sub>12</sub>	50-32-8	252.309		181.1				i H <sub>2</sub> O; vs chl
730	Benzo[e]pyrene	1,2-Benzopyrene	C <sub>20</sub> H <sub>12</sub>	192-97-2	252.309	pa ye nd (bz-MeOH)	181.4	311			i H <sub>2</sub> O
731	Benzo[f]quinoline	β-Naphthoquinoline	C <sub>13</sub> H <sub>9</sub> N	85-02-9	179.217	lf (peth or w)	94	352; 203 <sup>8</sup>			sl H <sub>2</sub> O; vs EtOH, bz, eth; s ace
732	Benzo[h]quinoline		C <sub>13</sub> H <sub>9</sub> N	230-27-3	179.217	lf (eth), pl (peth)	52	339; 233 <sup>47</sup>	1.2340 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
733	<i>p</i> -Benzoquinone	2,5-Cyclohexadiene-1,4-dione	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	106-51-4	108.095	ye mcl pr (w)	115	sub	1.318 <sup>20</sup>		sl H <sub>2</sub> O, peth; s EtOH, eth, chl
734	2,1,3-Benzothiadiazole		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> S	273-13-2	136.174		43	206			
735	2-Benzothiazolamine	2-Aminobenzothiazole	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> S	136-95-8	150.201	pl (w), lf (w)	132				sl H <sub>2</sub> O; s EtOH, eth, chl, con HCl
736	6-Benzothiazolamine	6-Aminobenzothiazole	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> S	533-30-2	150.201	pr (w)	87				i H <sub>2</sub> O, eth; s EtOH
737	Benzothiazole	Benzosulfonazole	C <sub>7</sub> H <sub>6</sub> NS	95-16-9	135.187		1.0	231	1.2460 <sup>20</sup>	1.6379 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, CS <sub>2</sub> ; s ace
738	2(3 <i>H</i> )-Benzothiazolethione	2-Mercaptobenzothiazole	C <sub>7</sub> H <sub>6</sub> NS <sub>2</sub>	149-30-4	167.252	pa ye mcl nd(al, MeOH)	181		1.42 <sup>20</sup>		i H <sub>2</sub> O; s EtOH; sl eth, bz, DMSO
739	2(3 <i>H</i> )-Benzothiazolethione, sodium salt		C <sub>7</sub> H <sub>4</sub> NNaS <sub>2</sub>	2492-26-4	189.234						sl H <sub>2</sub> O
740	2(3 <i>H</i> )-Benzothiazolone		C <sub>7</sub> H <sub>6</sub> NOS	934-34-9	151.186	pr (dil al), nd	139	360			i H <sub>2</sub> O; vs EtOH, eth
741	2(3 <i>H</i> )-Benzothiazolone, hydrazone		C <sub>7</sub> H <sub>6</sub> N <sub>3</sub> S	615-21-4	165.216		202.8				
742	2-(2-Benzothiazolyl)phenol		C <sub>13</sub> H <sub>9</sub> NOS	3411-95-8	227.281	nd or lf (al)	131	179 <sup>3</sup>			s EtOH
743	Benzo[b]thiophene	Thianaphthene	C <sub>8</sub> H <sub>6</sub> S	95-15-8	134.199	lf	32	221	1.1484 <sup>32</sup>	1.6374 <sup>37</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace, bz; sl chl
744	Benzo[b]thiophene-2-carboxylic acid	Thionaphthene-2-carboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>2</sub> S	6314-28-9	178.208	nd (w)	240.5				vs eth
745	1 <i>H</i> -Benzotriazole	1,2,3-Triaza-1 <i>H</i> -indene	C <sub>6</sub> H <sub>5</sub> N <sub>3</sub>	95-14-7	119.124	nd (chl or bz)	100	204 <sup>15</sup>			sl H <sub>2</sub> O; s EtOH, bz, chl, tol, DMF
746	Benzo[b]triphenylene		C <sub>22</sub> H <sub>14</sub>	215-58-7	278.346	nd (al, HOAc)	205				i H <sub>2</sub> O; vs bz
747	3 <i>H</i> -2,1-Benzoxathiol-3-one 1,1-dioxide		C <sub>7</sub> H <sub>4</sub> O <sub>3</sub> S	81-08-3	184.170	nd or pr (bz)	129.5	184 <sup>16</sup>			vs bz, chl
748	2 <i>H</i> -3,1-Benzoxazine-2,4(1 <i>H</i> )-dione		C <sub>8</sub> H <sub>6</sub> NO <sub>3</sub>	118-48-9	163.131	pr (al, gl HOAc) cry (al)	243 dec				sl H <sub>2</sub> O, EtOH, ace; i eth, bz, chl
749	Benzoxazole	1-Oxa-3-azaindene	C <sub>7</sub> H <sub>6</sub> NO	273-53-0	119.121	pr (dil al)	31	182.5	1.1754 <sup>20</sup>	1.5594 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, sulf
750	2(3 <i>H</i> )-Benzoxazolethione		C <sub>7</sub> H <sub>6</sub> NOS	2382-96-9	151.186	nd (w)	196				sl H <sub>2</sub> O, ace, EtOH; vs eth, HOAc
751	2(3 <i>H</i> )-Benzoxazolone		C <sub>7</sub> H <sub>6</sub> NO <sub>2</sub>	59-49-4	135.121		138	335; 230 <sup>30</sup>			sl H <sub>2</sub> O; s EtOH, eth, tfa
752	2-(2-Benzoxazolyl)phenol		C <sub>13</sub> H <sub>9</sub> NO <sub>2</sub>	835-64-3	211.216	pink nd (al, HOAc)	123.5	338			sl H <sub>2</sub> O; vs EtOH; s eth, ace, bz
753	<i>N</i> -Benzoyl- <i>DL</i> -alanine		C <sub>10</sub> H <sub>11</sub> NO <sub>3</sub>	1205-02-3	193.199	pl, pr or lf (eth)	165.5	dec			s H <sub>2</sub> O, EtOH; sl eth, DMSO
754	4-(Benzoylamino)-2-hydroxybenzoic acid	Benzoylpas	C <sub>14</sub> H <sub>11</sub> NO <sub>4</sub>	13898-58-3	257.242		260.5				
755	Benzoyl azide	Benzazide	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O	582-61-6	147.134	pl (ace)	32	exp	1.1680 <sup>35</sup>		vs eth, EtOH
756	2-Benzoylbenzoic acid		C <sub>14</sub> H <sub>10</sub> O <sub>3</sub>	85-52-9	226.227	tcl nd (w+1)	129.0				vs EtOH, eth; s bz; sl chl
757	4-Benzoylbenzoic acid		C <sub>14</sub> H <sub>10</sub> O <sub>3</sub>	611-95-0	226.227	nd (HOAc), pl (al) mcl lf (w)	199	sub			sl H <sub>2</sub> O, tfa, bz; s EtOH, eth, HOAc
758	2-Benzoylbenzoic acid, hydrazide		C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	787-84-8	240.257	nd (al)	242.3				sl H <sub>2</sub> O; i EtOH, eth, chl; s MeOH
759	4-Benzoylbiphenyl	4-Phenylbenzophenone	C <sub>19</sub> H <sub>14</sub> O	2128-93-0	258.313		101.5	420; 156 <sup>0.1</sup>			
760	Benzoyl bromide	Benzoic acid, bromide	C <sub>7</sub> H <sub>5</sub> BrO	618-32-6	185.018	liq	-24	218.5	1.570 <sup>15</sup>	1.5868 <sup>25</sup>	msc eth
761	Benzoyl chloride	Benzoic acid, chloride	C <sub>7</sub> H <sub>5</sub> ClO	98-88-4	140.567	liq	-0.4	197.2; 71 <sup>9</sup>	1.2120 <sup>20</sup>	1.5537 <sup>20</sup>	msc eth; s bz, ctc, CS <sub>2</sub>
762	Benzoyl cyclohexane	Cyclohexyl phenyl ketone	C <sub>13</sub> H <sub>16</sub> O	712-50-5	188.265	nd (peth)	59.5	164 <sup>16</sup>			
763	Benzoylecgonine		C <sub>16</sub> H <sub>16</sub> NO <sub>4</sub>	519-09-5	289.327	nd (w)	195				vs bz, EtOH
764	Benzoylferrocene		C <sub>17</sub> H <sub>14</sub> FeO	1272-44-2	290.137		110.0				
765	Benzoyl fluoride	Benzoic acid, fluoride	C <sub>7</sub> H <sub>5</sub> FO	455-32-3	124.112	liq	-28	154.5	1.1400 <sup>20</sup>		vs EtOH, eth; s ctc



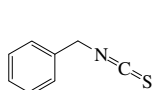
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
766	<i>N</i> -Benzoylglycine	Hippuric acid	C <sub>9</sub> H <sub>9</sub> NO <sub>3</sub>	495-69-2	179.172	pr (w or al)	191.5		1.371 <sup>20</sup>		s H <sub>2</sub> O, EtOH; sl eth, bz, chl; i peth
767	Benzoyl iodide	Benzoic acid, iodide	C <sub>7</sub> H <sub>5</sub> IO	618-38-2	232.018	nd	1.5	128 <sup>20</sup>	1.746 <sup>18</sup>		vs eth, EtOH
768	2-Benzoylmethyl-6-(2-hydroxy-2-phenylethyl)-1-methylpiperidine, hydrochloride		C <sub>22</sub> H <sub>28</sub> ClNO <sub>2</sub>	63990-84-1	373.916		183.5				sl H <sub>2</sub> O; s EtOH; vs chl
769	3-(Benzoyloxy)-8-methyl-8-azabicyclo[3.2.1]octane-2-carboxylic acid, ethyl ester, [1 <i>R</i> -( <i>exo,exo</i> )]	Cocaethylene	C <sub>18</sub> H <sub>23</sub> NO <sub>4</sub>	529-38-4	317.381	pr (eth)	109				vs eth, EtOH
770	Benzoyl peroxide		C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	94-36-0	242.227	orth (eth), pr	105	exp		1.543	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, CS <sub>2</sub>
771	1-Benzoylpiperidine		C <sub>12</sub> H <sub>15</sub> NO	776-75-0	189.253	tcl	49	320.5			i H <sub>2</sub> O; s EtOH, eth; sl ctc
772	<i>N</i> -Benzoyl- <i>L</i> -tyrosine ethyl ester		C <sub>18</sub> H <sub>19</sub> NO <sub>4</sub>	3483-82-7	313.349		119.5				
773	Benzphetamine		C <sub>17</sub> H <sub>21</sub> N	156-08-1	239.356			127 <sup>0.02</sup>		1.5515 <sup>19</sup>	vs eth, EtOH, MeOH, chl
774	Benzpiperylon		C <sub>22</sub> H <sub>25</sub> N <sub>3</sub> O	53-89-4	347.453	cry (al)	182 dec				
775	Benzquinamide		C <sub>22</sub> H <sub>32</sub> N <sub>2</sub> O <sub>5</sub>	63-12-7	404.499	cry	131				
776	Benzthiazide		C <sub>15</sub> H <sub>14</sub> ClN <sub>2</sub> O <sub>4</sub> S <sub>3</sub>	91-33-8	431.938	cry (EtOH)	236				i H <sub>2</sub> O; s alk
777	<i>N</i> -Benzylacetamide		C <sub>9</sub> H <sub>11</sub> NO	588-46-5	149.189		61	157 <sup>2</sup>			vs EtOH, eth
778	Benzyl acetate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	140-11-4	150.174	liq	-51.3	213	1.0550 <sup>20</sup>	1.5232 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; s eth, ace, chl
779	Benzyl acrylate		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	2495-35-4	162.185			228	1.0573 <sup>20</sup>	1.5143 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc
780	Benzyl alcohol	Benzenemethanol	C <sub>7</sub> H <sub>8</sub> O	100-51-6	108.138	liq	-15.4	205.31	1.0419 <sup>24</sup>	1.5396 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz, MeOH, chl
781	Benzylamine	Benzenemethanamine	C <sub>7</sub> H <sub>9</sub> N	100-46-9	107.153			185; 90 <sup>12</sup>	0.9813 <sup>20</sup>	1.5401 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace; s bz; sl chl
782	4-(Benzylamino)benzenesulfonamide	<i>N</i> -(Benzylsulfanyl)aniline	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	104-22-3	262.327		171				
783	2-(Benzylamino)ethanol		C <sub>9</sub> H <sub>13</sub> NO	104-63-2	151.205			225; 154 <sup>12</sup>	1.065 <sup>25</sup>	1.5430 <sup>20</sup>	
784	4-Benzylaniline		C <sub>13</sub> H <sub>13</sub> N	1135-12-2	183.249	mcl (lig)	34.5	300	1.038 <sup>25</sup>		vs eth, EtOH, lig
785	<i>N</i> -Benzylaniline	<i>N</i> -Phenylbenzenemethanamine	C <sub>13</sub> H <sub>13</sub> N	103-32-2	183.249	pr	37.5	306.5	1.0298 <sup>65</sup>	1.6118 <sup>25</sup>	vs eth, EtOH
786	$\alpha$ -Benzylbenzenepropanoic acid		C <sub>16</sub> H <sub>16</sub> O <sub>2</sub>	618-68-8	240.297	pl (peth HOAc) nd (w)	90	235 <sup>18</sup>			vs bz, eth, EtOH
787	2-Benzyl-1 <i>H</i> -benzimidazole	Benzadazol	C <sub>14</sub> H <sub>12</sub> N <sub>2</sub>	621-72-7	208.258	nd (bz)	187				vs bz, EtOH, gl HOAc
788	Benzyl benzoate		C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	120-51-4	212.244	nd or lf	21	323.5	1.1121 <sup>25</sup>	1.5680 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, MeOH, chl
789	4-Benzyl-1,1'-biphenyl		C <sub>19</sub> H <sub>16</sub>	613-42-3	244.330	lf	85	285 <sup>110</sup>	1.171 <sup>0</sup>		i H <sub>2</sub> O; s EtOH, ctc; vs eth, bz
790	Benzyl butanoate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	103-37-7	178.228			239	1.0111 <sup>20</sup>	1.4920 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
791	Benzyl butyl phthalate	Butyl benzyl phthalate	C <sub>19</sub> H <sub>20</sub> O <sub>4</sub>	85-68-7	312.360	liq		370	1.119 <sup>25</sup>		i H <sub>2</sub> O
792	Benzyl chloroacetate		C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	140-18-1	184.619			147 <sup>9</sup> , 85 <sup>0.4</sup>	1.2223 <sup>4</sup>	1.5426 <sup>18</sup>	vs eth, EtOH
793	Benzyl chloroformate	Carbobenzoxy chloride	C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	501-53-1	170.594	oily liq		103 <sup>20</sup>	1.195 <sup>25</sup>	1.5190 <sup>20</sup>	s eth, ace, bz
794	Benzyl <i>trans</i> -cinnamate	Benzyl <i>trans</i> -3-phenyl-2-propenoate	C <sub>16</sub> H <sub>14</sub> O <sub>2</sub>	78277-23-3	238.281	pr	39	dec 350; 244 <sup>5</sup>	1.109 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth; sl bz
795	Benzyl dodecanoate	Benzyl laurate	C <sub>19</sub> H <sub>30</sub> O <sub>2</sub>	140-25-0	290.440		8.5	210 <sup>12</sup>	0.9429 <sup>25</sup>	1.4812 <sup>24</sup>	vs bz, eth, EtOH, peth
796	Benzylethylamine	<i>N</i> -Ethylbenzenemethanamine	C <sub>9</sub> H <sub>13</sub> N	14321-27-8	135.206			194	0.9342 <sup>17</sup>	1.5117 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz, chl
797	<i>N</i> -Benzyl- <i>N</i> -ethylaniline	Ethylbenzylaniline	C <sub>15</sub> H <sub>17</sub> N	92-59-1	211.303	pa ye oil	35	288; 185 <sup>22</sup>	1.001 <sup>55</sup>	1.5943 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
798	Benzyl ethyl ether		C <sub>9</sub> H <sub>12</sub> O	539-30-0	136.190			186	0.9478 <sup>20</sup>	1.4955 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
799	Benzyl formate		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	104-57-4	136.149			203; 84 <sup>10</sup>	1.081 <sup>20</sup>	1.5154 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace; msc eth; sl ctc
800	Benzyl fumarate		C <sub>18</sub> H <sub>16</sub> O <sub>4</sub>	538-64-7	296.318	cry pow	59	210 <sup>5</sup>			vs eth, EtOH, chl
801	Benzylidene diacetate	Toluene- $\alpha$ , $\alpha$ -diol, diacetate	C <sub>11</sub> H <sub>12</sub> O <sub>4</sub>	581-55-5	208.211	pl (eth)	46	220	1.11 <sup>20</sup>		vs bz, eth, EtOH
802	Benzylimidobis( <i>p</i> -methoxyphenyl)methane		C <sub>22</sub> H <sub>21</sub> NO <sub>2</sub>	524-96-9	331.408	pa ye cry	90				vs eth, chl
803	2-Benzyl-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione		C <sub>15</sub> H <sub>11</sub> NO <sub>2</sub>	2142-01-0	237.254	ye nd (al)	116		1.343 <sup>18</sup>		s EtOH, HOAc; sl DMSO



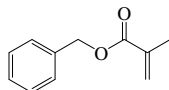
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
804	Benzylisopropylamine	<i>N</i> -Isopropylbenzenemethanamine	C <sub>10</sub> H <sub>15</sub> N	102-97-6	149.233			200; 93 <sup>10</sup>	0.892 <sup>25</sup>	1.5025 <sup>20</sup>	
805	Benzyl isothiocyanate	(Isothiocyanatomethyl)benzene	C <sub>8</sub> H <sub>7</sub> NS	622-78-6	149.214	ye oil		243	1.1246 <sup>16</sup>	1.6049 <sup>15</sup>	i H <sub>2</sub> O; msc EtOH; s eth
806	Benzyl methacrylate		C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	2495-37-6	176.212			144 <sup>50</sup>			
807	Benzyl 3-methylbutanoate		C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	103-38-8	192.254			245; 136 <sup>25</sup>	0.9983 <sup>15</sup>	1.4884 <sup>20</sup>	
808	Benzyl methyl ether		C <sub>8</sub> H <sub>10</sub> O	538-86-3	122.164	liq	-52.6	170	0.9634 <sup>20</sup>	1.5008 <sup>20</sup>	i H <sub>2</sub> O, liq; vs EtOH, eth; s bz
809	1-Benzyl-2-methylhydrazine	1-Methyl-2-phenylmethylhydrazine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	10309-79-2	136.194	liq		117 <sup>20</sup>			
810	Benzyl 2-methylpropanoate	Benzyl isobutyrate	C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	103-28-6	178.228			228; 114 <sup>20</sup>	1.0159 <sup>18</sup>	1.4883 <sup>20</sup>	
811	Benzyl nitrite		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	935-05-7	137.137	oil		81 <sup>35</sup>	1.075 <sup>25</sup>	1.4989 <sup>25</sup>	
812	<i>N</i> -Benzoyloxycarbonylaspartame		C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>7</sub>	33605-72-0	428.435	cry	122				
813	Benzoyloxycarbonyl-L-glutamine		C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>5</sub>	2650-64-8	280.276		134.5				s DMSO
814	Benzoyloxycarbonylglycine		C <sub>10</sub> H <sub>11</sub> NO <sub>4</sub>	1138-80-3	209.199		121				s ace
815	Benzoyloxycarbonylglycyl-L-leucine		C <sub>16</sub> H <sub>22</sub> N <sub>2</sub> O <sub>5</sub>	1421-69-8	322.356		100				
816	Benzoyloxycarbonylglycyl-L-phenylalanine		C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O <sub>5</sub>	1170-76-9	356.372		126				
817	2-(Benzoyloxy)ethanol	Ethylene glycol monobenzyl ether	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	622-08-2	152.190	oil	<-75	256	1.0640 <sup>20</sup>	1.5233 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
818	Benzylpenicillin sodium		C <sub>16</sub> H <sub>17</sub> N <sub>2</sub> NaO <sub>4</sub> S	69-57-8	356.372	nd (BuOH aq)	215		1.41		vs H <sub>2</sub> O; s MeOH; i ace, eth, chl
819	2-Benzylphenol	<i>o</i> -Benzylphenol	C <sub>13</sub> H <sub>12</sub> O	28994-41-4	184.233		21	312		1.5994 <sup>20</sup>	vs ace, bz, EtOH
820	4-Benzylphenol	<i>p</i> -Benzylphenol	C <sub>13</sub> H <sub>12</sub> O	101-53-1	184.233		84	322			s H <sub>2</sub> O, EtOH, eth, bz, ctc, HOAc, chl
821	Benzyl phenyl ether		C <sub>13</sub> H <sub>12</sub> O	946-80-5	184.233	lf (al)	40	286.5			
822	1-Benzylpiperazine		C <sub>11</sub> H <sub>16</sub> N <sub>2</sub>	2759-28-6	176.258			146 <sup>12</sup>		1.5430 <sup>28</sup>	s H <sub>2</sub> O, EtOH, eth; sl chl
823	1-Benzylpiperidine		C <sub>12</sub> H <sub>17</sub> N	2905-56-8	175.270			245	0.9625 <sup>16</sup>	1.5227 <sup>20</sup>	
824	4-Benzylpiperidine		C <sub>12</sub> H <sub>17</sub> N	31252-42-3	175.270		16.8	270; 150 <sup>17</sup>	0.9970 <sup>20</sup>	1.5337 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
825	Benzyl propanoate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	122-63-4	164.201			221	1.0335 <sup>20</sup>		
826	2-Benzylpyridine		C <sub>12</sub> H <sub>11</sub> N	101-82-6	169.222	nd	12.5	277; 149 <sup>16</sup>	1.067 <sup>0</sup>	1.5785 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
827	4-Benzylpyridine		C <sub>12</sub> H <sub>11</sub> N	2116-65-6	169.222		12.4	288; 180 <sup>31</sup>	1.0612 <sup>20</sup>	1.5818 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc; vs eth
828	Benzyl 3-pyridinecarboxylate	Benzyl nicotinate	C <sub>13</sub> H <sub>11</sub> NO <sub>2</sub>	94-44-0	213.232			170 <sup>3</sup>			
829	1-Benzyl-1 <i>H</i> -pyrrole		C <sub>11</sub> H <sub>11</sub> N	2051-97-0	157.212		15	247	1.0183 <sup>20</sup>	1.5655 <sup>24</sup>	i H <sub>2</sub> O; vs EtOH, eth
830	Benzyl 1,2-pyrrolidinedicarboxylate, (S)	<i>N</i> -(Benzoyloxycarbonyl)- <i>L</i> -proline	C <sub>13</sub> H <sub>15</sub> NO <sub>4</sub>	1148-11-4	249.263		78.5			1.5310 <sup>20</sup>	sl chl
831	Benzyl salicylate		C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	118-58-1	228.243			320	1.1799 <sup>20</sup>	1.5805 <sup>20</sup>	sl EtOH; s EtOH, eth, ctc
832	<i>O</i> -Benzyl-L-serine	3-(Benzoyloxy)- <i>L</i> -alanine	C <sub>10</sub> H <sub>13</sub> NO <sub>3</sub>	4726-96-9	195.215		218 dec				
833	Benzylsulfonic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub> S	100-87-8	172.202	hyg cry					
834	4-[(Benzylsulfonyl)amino]benzoic acid	<i>p</i> -(Benzylsulfonamido)benzoic acid	C <sub>14</sub> H <sub>13</sub> NO <sub>4</sub> S	536-95-8	291.323		229.5				vs EtOH
835	(Benzylsulfonyl)benzene		C <sub>13</sub> H <sub>12</sub> O <sub>2</sub> S	3112-88-7	232.298	nd (al)	146		1.1261 <sup>153</sup>		i H <sub>2</sub> O; sl EtOH, eth, bz
836	(Benzylthio)benzene		C <sub>13</sub> H <sub>12</sub> S	831-91-4	200.299	lf (al)	43.5	197 <sup>27</sup>			i H <sub>2</sub> O; s EtOH, eth, con sulf
837	Benzyl thiocyanate	$\alpha$ -Thiocyanatotoluene	C <sub>8</sub> H <sub>7</sub> NS	3012-37-1	149.214	pr (al)	43	232			i H <sub>2</sub> O; s EtOH, eth, chl, CS <sub>2</sub>
838	Benzyltrimethylammonium chloride		C <sub>10</sub> H <sub>16</sub> ClN	56-93-9	185.694		243				vs H <sub>2</sub> O; s ace
839	Benzylurea		C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O	538-32-9	150.177	nd (al)	148	dec 200			vs ace, EtOH
840	Bephonium chloride		C <sub>17</sub> H <sub>22</sub> ClNO	13928-81-9	291.816	cry (ace)	135				
841	Berberine		C <sub>20</sub> H <sub>19</sub> NO <sub>5</sub>	2086-83-1	353.369	red-ye nd (w+6) cry (chl)	145				vs eth, EtOH
842	Berberine chloride dihydrate		C <sub>20</sub> H <sub>22</sub> ClNO <sub>6</sub>	633-65-8	407.845	ye cry					
843	Bergenin		C <sub>14</sub> H <sub>16</sub> O <sub>9</sub>	477-90-7	328.272	cry (MeOH)	238				vs H <sub>2</sub> O, EtOH
844	Beryllium 2,4-pentanedioate	Beryllium acetylacetonate	C <sub>10</sub> H <sub>14</sub> BeO <sub>4</sub>	10210-64-7	207.228		108	270	1.168 <sup>20</sup>		
845	Betaine	1-Carboxy- <i>N,N,N</i> -trimethylmethanaminium, inner salt	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	107-43-7	117.147	pr or lf (al)	293 dec				vs H <sub>2</sub> O, MeOH; s EtOH; sl eth, chl
846	Betaine, hydrochloride		C <sub>5</sub> H <sub>12</sub> ClNO <sub>2</sub>	590-46-5	153.608	mcl cry (al)	227.5				vs H <sub>2</sub> O
847	Betamethasone		C <sub>22</sub> H <sub>26</sub> FO <sub>5</sub>	378-44-9	392.460	cry (AcOMe)	232 dec				
848	Bethanidine		C <sub>10</sub> H <sub>13</sub> N <sub>3</sub>	55-73-2	177.246	cry (aq MeOH)	196				



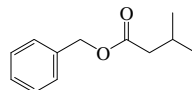
Benzylisopropylamine



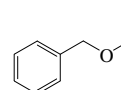
Benzyl isothiocyanate



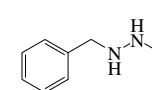
Benzyl methacrylate



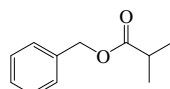
Benzyl 3-methylbutanoate



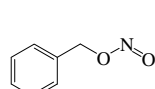
Benzyl methyl ether



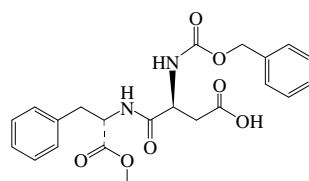
1-Benzyl-2-methylhydrazine



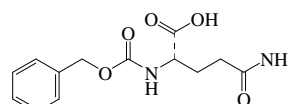
Benzyl 2-methylpropanoate



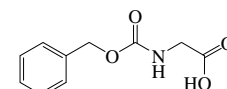
Benzyl nitrite



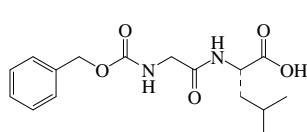
N-Benzylloxycarbonylaspartame



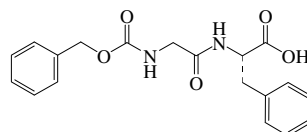
Benzylloxycarbonyl-L-glutamine



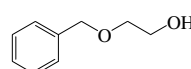
Benzylloxycarbonylglycine



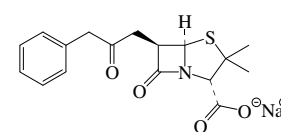
Benzylloxycarbonylglycyl-L-leucine



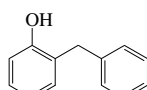
Benzylloxycarbonylglycyl-L-phenylalanine



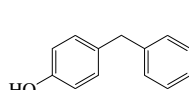
2-(Benzylloxy)ethanol



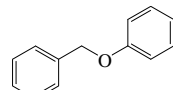
Benzylpenicillin sodium



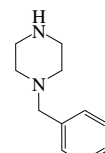
2-Benzylphenol



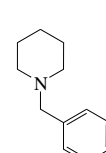
4-Benzylphenol



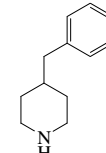
Benzyl phenyl ether



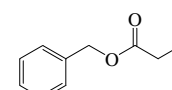
1-Benzylpiperazine



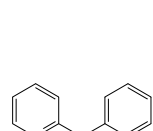
1-Benzylpiperidine



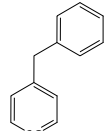
4-Benzylpiperidine



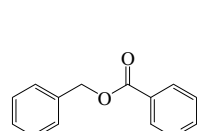
Benzyl propanoate



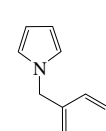
2-Benzylpyridine



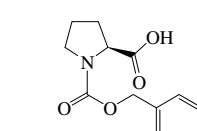
4-Benzylpyridine



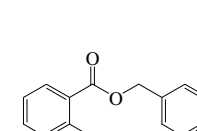
Benzyl 3-pyridinecarboxylate



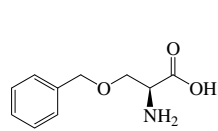
1-Benzyl-1H-pyrrole



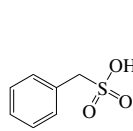
Benzyl 1,2-pyrrolidinedicarboxylate, (S)



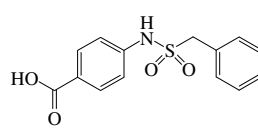
Benzyl salicylate



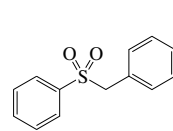
O-Benzyl-L-serine



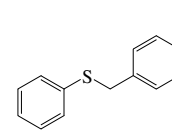
Benzylsulfonic acid



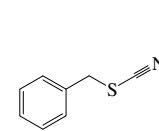
4-[(Benzylsulfonyl)amino]benzoic acid



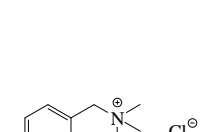
(Benzylsulfonyl)benzene



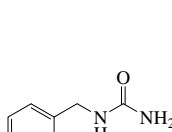
(Benzylthio)benzene



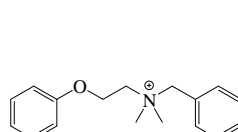
Benzyl thiocyanate



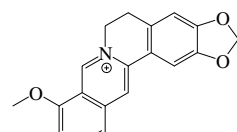
Benzyltrimethylammonium chloride



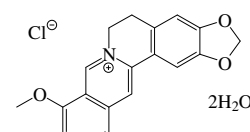
Benzylurea



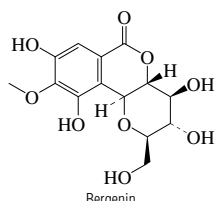
Bephenium chloride



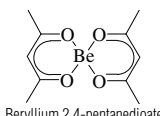
Berberine



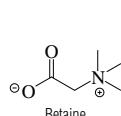
Berberine chloride dihydrate



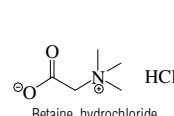
Bergenin



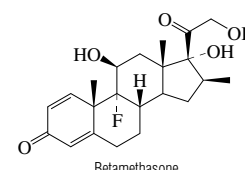
Beryllium 2,4-pentanedioate



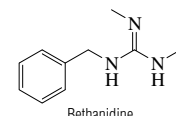
Betaine



Betaine, hydrochloride



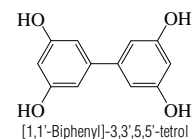
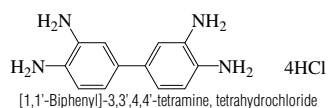
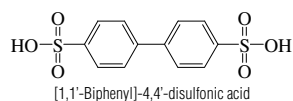
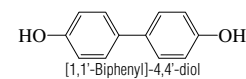
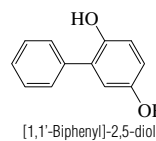
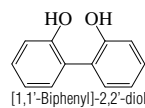
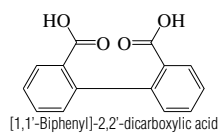
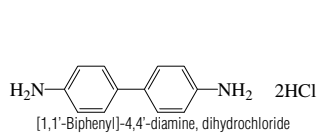
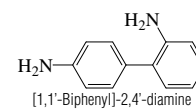
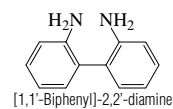
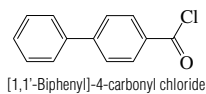
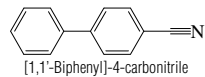
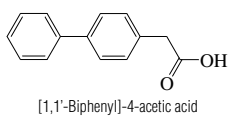
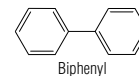
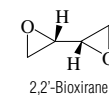
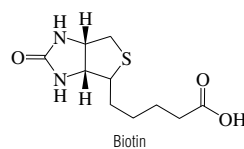
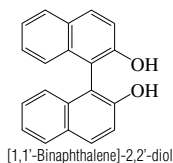
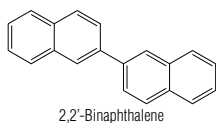
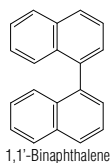
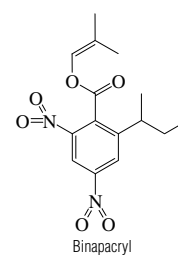
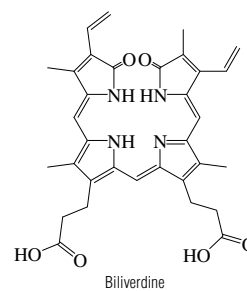
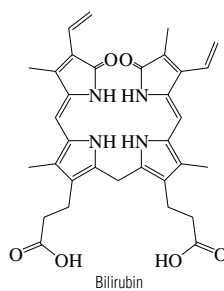
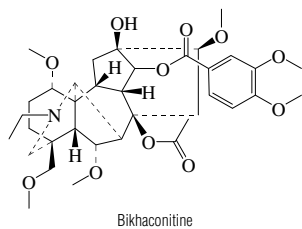
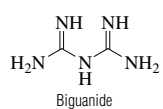
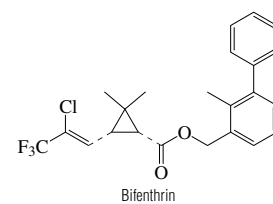
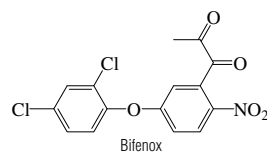
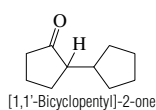
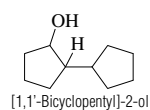
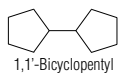
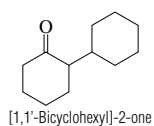
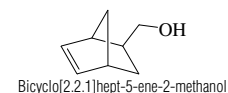
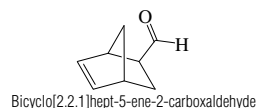
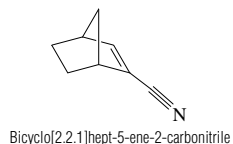
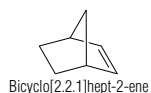
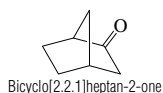
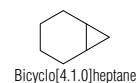
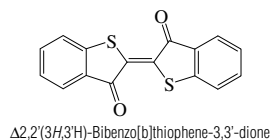
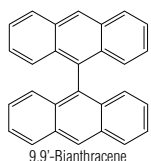
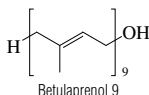
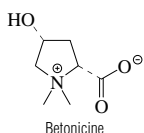
Betamethasone



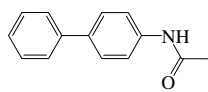
Bethanidine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
849	Betonidine		C <sub>7</sub> H <sub>13</sub> NO <sub>3</sub>	515-25-3	159.183	pr (dil al, +1w)	252 dec				vs EtOH
850	Betulaprenol 9	Nonaisoprenol	C <sub>45</sub> H <sub>74</sub> O	13190-97-1	631.069	oil or cry	41				s chl
851	9,9'-Bianthracene		C <sub>28</sub> H <sub>18</sub>	1055-23-8	354.443		321.3				
852	Δ <sup>2,2'</sup> (3 <i>H</i> ,3' <i>H</i> )-Bibenzo[b]thiophene-3,3'-dione	Durindone Red	C <sub>16</sub> H <sub>6</sub> O <sub>2</sub> S <sub>2</sub>	522-75-8	296.364	br nd (xyl) red mcl nd (bz)	359	sub			i H <sub>2</sub> O, EtOH; sl chl, CS <sub>2</sub> ; s bz, xyl
853	Bicyclo[2.2.1]heptane		C <sub>7</sub> H <sub>12</sub>	279-23-2	96.170		87.5	105.3			vs ace, bz, eth, EtOH
854	Bicyclo[4.1.0]heptane	Norcarane	C <sub>7</sub> H <sub>12</sub>	286-08-8	96.170			116.5	0.853 <sup>25</sup>	1.4564 <sup>20</sup>	
855	Bicyclo[2.2.1]heptan-2-one		C <sub>7</sub> H <sub>10</sub> O	497-38-1	110.153		89.5	170			
856	Bicyclo[2.2.1]hept-2-ene		C <sub>7</sub> H <sub>10</sub>	498-66-8	94.154		45	96			
857	Bicyclo[2.2.1]hept-5-ene-2-carbonitrile		C <sub>8</sub> H <sub>9</sub> N	95-11-4	119.164		13	84 <sup>10</sup>	0.999 <sup>25</sup>	1.4885 <sup>20</sup>	
858	Bicyclo[2.2.1]hept-5-ene-2-carboxaldehyde		C <sub>8</sub> H <sub>10</sub> O	5453-80-5	122.164			71 <sup>20</sup>	1.018 <sup>25</sup>	1.4893 <sup>20</sup>	
859	Bicyclo[2.2.1]hept-5-ene-2-methanol		C <sub>8</sub> H <sub>12</sub> O	95-12-5	124.180			103 <sup>20</sup>			
860	[1,1'-Bicyclohexyl]-2-one	2-Cyclohexylcyclohexanone	C <sub>12</sub> H <sub>20</sub> O	90-42-6	180.286	liq	-32	264	0.9696 <sup>25</sup>	1.4877 <sup>25</sup>	
861	1,1'-Bicyclopentyl		C <sub>10</sub> H <sub>18</sub>	1636-39-1	138.250						s ctc, CS <sub>2</sub>
862	[1,1'-Bicyclopentyl]-2-ol	2-Hydroxybicyclopentyl	C <sub>10</sub> H <sub>18</sub> O	4884-25-7	154.249		20	235.5	0.9785 <sup>15</sup>	1.4884 <sup>17</sup>	
863	[1,1'-Bicyclopentyl]-2-one		C <sub>10</sub> H <sub>16</sub> O	4884-24-6	152.233	liq	-13	232.5	0.9745 <sup>21</sup>	1.4763	
864	Bifenox	Methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate	C <sub>14</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>5</sub>	42576-02-3	342.131		85				
865	Bifenthrin		C <sub>23</sub> H <sub>22</sub> ClF <sub>3</sub> O <sub>2</sub>	82657-04-3	422.868		69		1.2 <sup>125</sup>		
866	Biguanide	Imidodicarbonimidic diamide	C <sub>2</sub> H <sub>4</sub> N <sub>5</sub>	56-03-1	101.111	pr or nd (al)	136	dec 142			vs H <sub>2</sub> O; s EtOH; i bz, chl
867	Bikhaconitine	3-Deoxyseudaconitine	C <sub>36</sub> H <sub>51</sub> NO <sub>11</sub>	6078-26-8	673.790		164				vs eth, EtOH, chl
868	Bilirubin		C <sub>33</sub> H <sub>36</sub> N <sub>4</sub> O <sub>6</sub>	635-65-4	584.662	red mcl pr or pl (chl)					i H <sub>2</sub> O; sl EtOH, eth; s bz, chl
869	Biliverdine	Dehydrobilirubin	C <sub>33</sub> H <sub>34</sub> N <sub>4</sub> O <sub>6</sub>	114-25-0	582.646	dk grn pl or pr (MeOH)	>300				i H <sub>2</sub> O; s EtOH, bz; sl eth, chl, CS <sub>2</sub>
870	Binapacryl		C <sub>15</sub> H <sub>18</sub> N <sub>2</sub> O <sub>6</sub>	485-31-4	322.313		70		1.27 <sup>20</sup>		
871	1,1'-Binaphthalene	1,1'-Binaphthyl	C <sub>20</sub> H <sub>14</sub>	604-53-5	254.325	(i) pl (HOAc) (ii) orth (peth)	160	>360; 240 <sup>12</sup>	1.3000 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, CS <sub>2</sub>
872	2,2'-Binaphthalene		C <sub>20</sub> H <sub>14</sub>	612-78-2	254.325	bl flr pl (al)	187.9	452			i H <sub>2</sub> O; sl EtOH; s eth, bz, CS <sub>2</sub>
873	[1,1'-Binaphthalene]-2,2'-diol		C <sub>20</sub> H <sub>16</sub> O <sub>2</sub>	602-09-5	286.324	nd (al), cry (w)	220				i H <sub>2</sub> O; s EtOH, eth, alk; sl chl
874	Biotin	Coenzyme R	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub> S	58-85-5	244.310	nd (w)	232 dec				s H <sub>2</sub> O, EtOH; sl eth, chl
875	2,2'-Bioxirane	Diepoxybutane	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	1464-53-5	86.090		2.0	144	1.113 <sup>20</sup>	1.435 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
876	Biphenyl	Diphenyl	C <sub>12</sub> H <sub>10</sub>	92-52-4	154.207	lf (dil al)	68.93	256.1	1.04 <sup>20</sup>	1.588 <sup>77</sup>	i H <sub>2</sub> O; s EtOH, eth; vs bz, ctc, MeOH
877	[1,1'-Biphenyl]-4-acetic acid	Felbinac	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	5728-52-9	212.244		160.5				
878	[1,1'-Biphenyl]-4-carbonitrile		C <sub>13</sub> H <sub>9</sub> N	2920-38-9	179.217		88	190 <sup>20</sup>			i H <sub>2</sub> O; vs EtOH, eth
879	[1,1'-Biphenyl]-4-carbonyl chloride		C <sub>13</sub> H <sub>9</sub> ClO	14002-51-8	216.662		111	160 <sup>2</sup>			
880	[1,1'-Biphenyl]-2,2'-diamine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	1454-80-4	184.236	pr or nd (al)	81	162 <sup>4</sup>	1.3090 <sup>20</sup>		s H <sub>2</sub> O, ace, bz
881	[1,1'-Biphenyl]-2,4'-diamine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	492-17-1	184.236	nd (dil al)	54.5	363			i H <sub>2</sub> O; s EtOH, eth
882	[1,1'-Biphenyl]-4,4'-diamine, dihydrochloride		C <sub>12</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub>	531-85-1	257.158		>300				
883	[1,1'-Biphenyl]-2,2'-dicarboxylic acid	<i>o,o'</i> -Diphenic acid	C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	482-05-3	242.227	mcl pr or lf (w) cry (HOAc)	233.5	sub			i H <sub>2</sub> O; s EtOH, eth
884	[1,1'-Biphenyl]-2,2'-diol		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	1806-29-7	186.206		109	320	1.3420 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth, ace, bz; sl peth, chl
885	[1,1'-Biphenyl]-2,5'-diol		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	1079-21-6	186.206	nd (dil al)	97.5				vs EtOH
886	[1,1'-Biphenyl]-4,4'-diol		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	92-88-6	186.206		278 dec				sl H <sub>2</sub> O, bz, DMSO; s EtOH, eth
887	[1,1'-Biphenyl]-4,4'-disulfonic acid		C <sub>12</sub> H <sub>10</sub> O <sub>6</sub> S <sub>2</sub>	5314-37-4	314.333	pr	72.5	>200			vs H <sub>2</sub> O
888	[1,1'-Biphenyl]-3,3',4,4'-tetramine, tetrahydrochloride		C <sub>12</sub> H <sub>16</sub> Cl <sub>4</sub> N <sub>4</sub>	7411-49-6	360.110		245 dec				
889	[1,1'-Biphenyl]-3,3',5,5'-tetrol	Diresorcinol	C <sub>12</sub> H <sub>10</sub> O <sub>4</sub>	531-02-2	218.205	pl or nd (w+2)	310				vs H <sub>2</sub> O, eth, EtOH

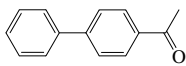




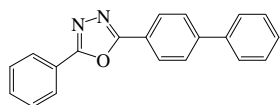
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
890	<i>N</i> -[1,1'-Biphenyl]-4-ylacetamide		C <sub>14</sub> H <sub>13</sub> NO	4075-79-0	211.259	cry (dil MeOH)	172.8				i H <sub>2</sub> O; vs EtOH, ace, MeOH
891	1-[1,1'-Biphenyl]-4-ylethanone		C <sub>14</sub> H <sub>12</sub> O	92-91-1	196.244	pr (ace), cry (al)	121	326	1.2510 <sup>9</sup>		i H <sub>2</sub> O; vs EtOH, ace; sl chl
892	2-[1,1'-Biphenyl]-4-yl-5-phenyl-1,3,4-oxadiazole		C <sub>20</sub> H <sub>14</sub> N <sub>2</sub> O	852-38-0	298.337		168				
893	2,2'-Bipyridine	α,α'-Dipyridyl	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	366-18-7	156.184	pr (peth)	72	273.5			sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
894	2,3'-Bipyridine	2,3'-Bipyridyl	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	581-50-0	156.184			295.5	1.140 <sup>20</sup>	1.6223 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, chl; sl peth
895	2,4'-Bipyridine	2,4'-Bipyridyl	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	581-47-5	156.184		61.5	281			sl H <sub>2</sub> O; vs EtOH, eth, chl
896	3,3'-Bipyridine	3,3'-Bipyridyl	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	581-46-4	156.184		68	291.5	1.1614 <sup>20</sup>		vs H <sub>2</sub> O, EtOH; sl eth
897	4,4'-Bipyridine	γ,γ'-Dipyridyl	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	553-26-4	156.184	nd (w+2)	114	305			sl H <sub>2</sub> O; vs EtOH, bz, chl; s eth
898	2,2'-Biquinoline		C <sub>18</sub> H <sub>12</sub> N <sub>2</sub>	119-91-5	256.301	pl or lf (al)	196				i H <sub>2</sub> O; vs EtOH; s eth, ace, bz
899	4,4-Bis(acetoacetamido)-3,3'-dimethyl-1,1'-biphenyl	<i>N,N</i> -Bis(acetoacetyl)-3,3'-dimethylbenzidine	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	91-96-3	380.437		212				sl DMSO
900	Bisacodyl		C <sub>22</sub> H <sub>16</sub> NO <sub>4</sub>	603-50-9	361.391		133.5				
901	Bis(4-amino-3-chlorophenyl)methane	4,4'-Methylene-bis(2-chloroaniline)	C <sub>13</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub>	101-14-4	267.153						s ctc
902	Bis(4-aminocyclohexyl)methane		C <sub>13</sub> H <sub>26</sub> N <sub>2</sub>	1761-71-3	210.358		15	320	0.92 <sup>75</sup>		
903	Bis(2-aminoethyl)amine	Diethylenetriamine	C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	111-40-0	103.166	ye hyg liq	-39	207	0.9569 <sup>20</sup>	1.4810 <sup>25</sup>	msc H <sub>2</sub> O, EtOH; i eth; s lig
904	<i>N,N</i> -Bis(2-aminoethyl)-1,2-ethanediamine	Triethylenetetramine	C <sub>6</sub> H <sub>18</sub> N <sub>4</sub>	112-24-3	146.234		12	266.5		1.4971 <sup>20</sup>	s H <sub>2</sub> O, EtOH, acid
905	Bis(2-aminophenyl)disulfide		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> S <sub>2</sub>	1141-88-4	248.366		93				i H <sub>2</sub> O; vs EtOH, eth
906	Bis(4-aminophenyl)disulfide		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> S <sub>2</sub>	722-27-0	248.366		85				s H <sub>2</sub> O; vs EtOH, eth, chl; sl bz, lig
907	1,2-Bis(4-aminophenyl)ethane		C <sub>14</sub> H <sub>16</sub> N <sub>2</sub>	621-95-4	212.290	pl (w)	137	sub			i H <sub>2</sub> O; vs EtOH
908	Bis(4-aminophenyl) sulfone	Dapsone	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub> S	80-08-0	248.300	cry (95% al)	175.5				s EtOH; sl DMSO
909	Bis(4-aminophenyl) sulfoxide	4,4'-Sulfinyldianiline	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> OS	119-59-5	232.300	pr (w, al)	175 dec				s H <sub>2</sub> O, EtOH
910	1,4-Bis(3-aminopropoxy)butane	1,4-Butanediol bis(3-aminopropyl) ether	C <sub>10</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	7300-34-7	204.310	liq		135 <sup>3</sup>	0.96 <sup>20</sup>	1.4619 <sup>20</sup>	
911	<i>N,N</i> -Bis(3-aminopropyl)-1,4-butanediamine	Spermine	C <sub>10</sub> H <sub>26</sub> N <sub>4</sub>	71-44-3	202.340		29	150 <sup>5</sup>			
912	<i>N,N</i> -Bis(3-aminopropyl)-1,4-butanediamine, tetrahydrochloride		C <sub>10</sub> H <sub>30</sub> Cl <sub>4</sub> N <sub>4</sub>	306-67-2	348.184		301.5				s H <sub>2</sub> O
913	Bis(2-bromoethyl) ether	Bromex	C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub> O	5414-19-7	231.914			115 <sup>32</sup> , 92 <sup>12</sup>	1.8452 <sup>20</sup>	1.5131 <sup>27</sup>	
914	1,2-Bis(bromomethyl)benzene		C <sub>6</sub> H <sub>8</sub> Br <sub>2</sub>	91-13-4	263.958	orth (chl)	95	129 <sup>4,5</sup>	1.988 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, ctc, chl, peth, lig
915	1,3-Bis(bromomethyl)benzene		C <sub>6</sub> H <sub>8</sub> Br <sub>2</sub>	626-15-3	263.958	nd (chl), pr (ace)	77	137 <sup>20</sup>	1.959 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, chl, lig
916	1,4-Bis(bromomethyl)benzene		C <sub>6</sub> H <sub>8</sub> Br <sub>2</sub>	623-24-5	263.958	mcl pr (al), cry (chl, bz)	144.5	245	2.012 <sup>25</sup>		i H <sub>2</sub> O; vs EtOH, chl; sl eth; s bz
917	2,2-Bis(bromomethyl)-1,3-propanediol	Pentaerythritol dibromide	C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub> O <sub>2</sub>	3296-90-0	261.940	nd (bz)	113				
918	1,3-Bis(bromomethyl)tetramethyldisiloxane		C <sub>6</sub> H <sub>16</sub> Br <sub>2</sub> OSi <sub>2</sub>	2351-13-5	320.169			233; 103 <sup>15</sup>	1.3918 <sup>25</sup>	1.4719 <sup>25</sup>	
919	Bis(4-bromophenyl) ether		C <sub>12</sub> H <sub>8</sub> Br <sub>2</sub> O	2050-47-7	327.999	lf (al)	60.5	339	1.8 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, bz; vs eth; sl chl
920	Bis(2-(2-butoxyethoxy)ethyl) adipate		C <sub>22</sub> H <sub>42</sub> O <sub>6</sub>	141-17-3	434.563	liq			1.1 <sup>25</sup>		
921	1,4-Bis(α-( <i>tert</i> -butyldioxy)isopropyl)benzene		C <sub>20</sub> H <sub>34</sub> O <sub>4</sub>	2781-00-2	338.482	cry	79				
922	Bis(3- <i>tert</i> -butyl-5-ethyl-2-hydroxyphenyl)methane		C <sub>25</sub> H <sub>36</sub> O <sub>2</sub>	88-24-4	368.553	cry	123				
923	Bis(4-chlorobenzoyl) peroxide		C <sub>14</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>4</sub>	94-17-7	311.118	pr cry (bz)	141				
924	1,2-Bis(2-chloroethoxy)ethane		C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>2</sub>	112-26-5	187.064			232	1.195 <sup>20</sup>	1.4592 <sup>25</sup>	s ctc
925	Bis(2-chloroethoxy)methane		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	111-91-1	173.037			215.0			
926	<i>N,N</i> -Bis(2-chloroethyl)aniline	Aniline mustard	C <sub>10</sub> H <sub>13</sub> Cl <sub>2</sub> N	553-27-5	218.123	pr	45	164 <sup>14</sup>			sl eth; s EtOH, MeOH
927	Bis(2-chloroethyl) carbonate		C <sub>6</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>3</sub>	623-97-2	187.021		8	241	1.3506 <sup>20</sup>	1.461 <sup>20</sup>	i H <sub>2</sub> O
928	Bis(2-chloroethyl) 2-chloroethylphosphonate		C <sub>6</sub> H <sub>12</sub> Cl <sub>3</sub> O <sub>3</sub> P	6294-34-4	269.490			170.2 <sup>5</sup>		1.488 <sup>25</sup>	



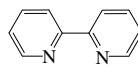
N-[1,1'-Biphenyl]-4-ylacetamide



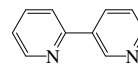
1-[1,1'-Biphenyl]-4-ylethanone



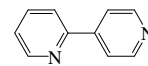
2-[1,1'-Biphenyl]-4-yl-5-phenyl-1,3,4-oxadiazole



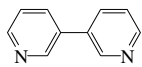
2,2'-Bipyridine



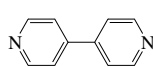
2,3'-Bipyridine



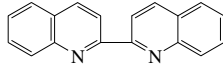
2,4'-Bipyridine



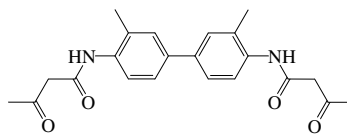
3,3'-Bipyridine



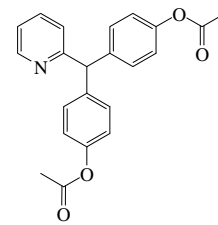
4,4'-Bipyridine



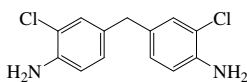
2,2'-Biquinoline



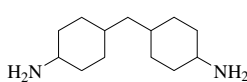
4,4'-Bis(acetoacetamido)-3,3'-dimethyl-1,1'-biphenyl



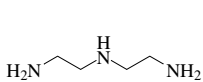
Bisacodyl



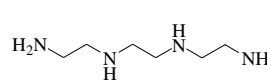
Bis(4-amino-3-chlorophenyl)methane



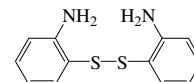
Bis(4-aminocyclohexyl)methane



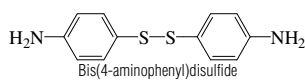
Bis(2-aminoethyl)amine



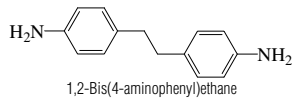
N,N'-Bis(2-aminoethyl)-1,2-ethanediamine



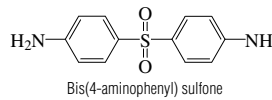
Bis(2-aminophenyl)disulfide



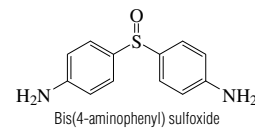
Bis(4-aminophenyl)disulfide



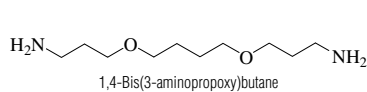
1,2-Bis(4-aminophenyl)ethane



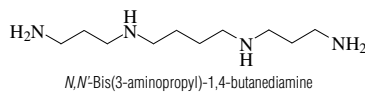
Bis(4-aminophenyl) sulfone



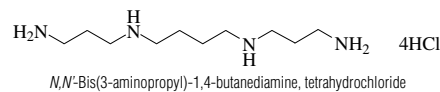
Bis(4-aminophenyl) sulfoxide



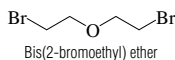
1,4-Bis(3-aminopropoxy)butane



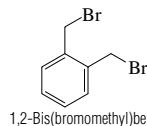
N,N'-Bis(3-aminopropyl)-1,4-butanediamine



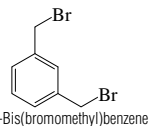
N,N'-Bis(3-aminopropyl)-1,4-butanediamine, tetrahydrochloride



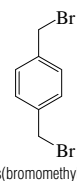
Bis(2-bromoethyl) ether



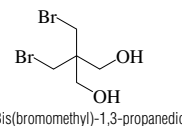
1,2-Bis(bromomethyl)benzene



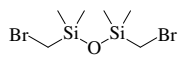
1,3-Bis(bromomethyl)benzene



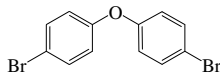
1,4-Bis(bromomethyl)benzene



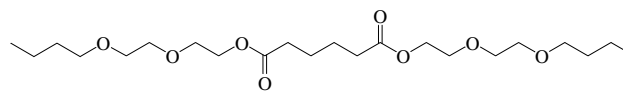
2,2-Bis(bromomethyl)-1,3-propanediol



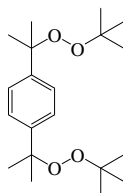
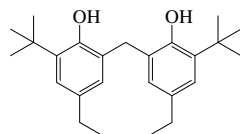
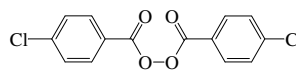
1,3-Bis(bromomethyl)tetramethyldisiloxane



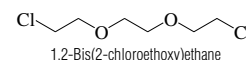
Bis(4-bromophenyl) ether



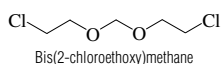
Bis(2-(2-butoxyethoxy)ethyl) adipate

1,4-Bis( $\alpha$ -*tert*-butyl-dioxy)isopropylbenzeneBis(3-*tert*-butyl-5-ethyl-2-hydroxyphenyl)methane

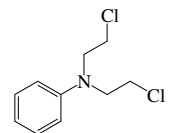
Bis(4-chlorobenzoyl) peroxide



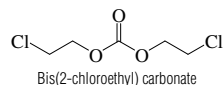
1,2-Bis(2-chloroethoxy)ethane



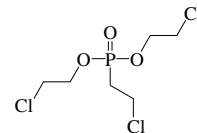
Bis(2-chloroethoxy)methane



N,N-Bis(2-chloroethyl)aniline

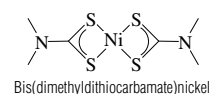
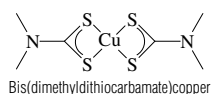
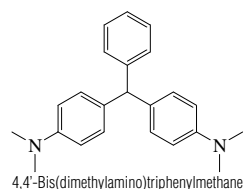
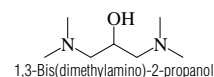
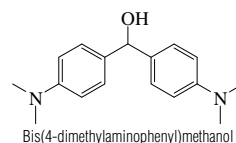
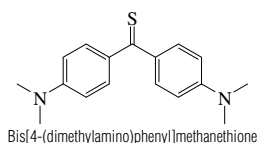
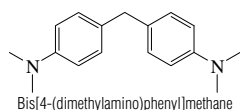
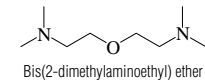
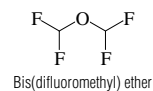
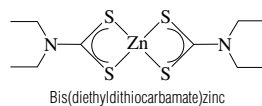
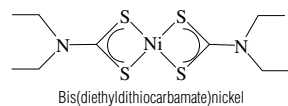
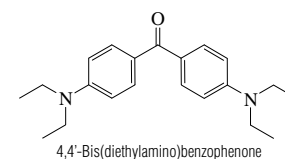
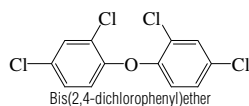
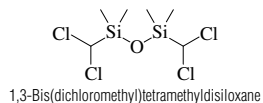
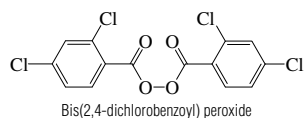
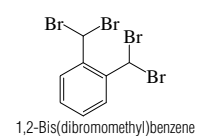
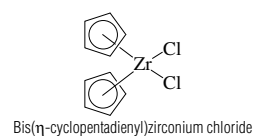
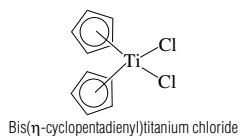
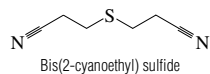
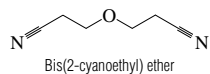
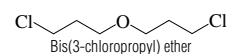
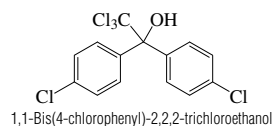
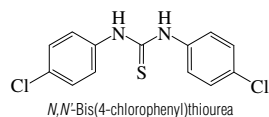
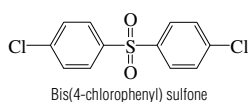
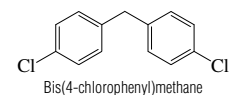
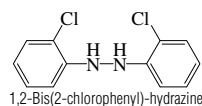
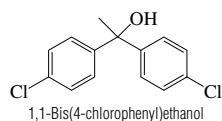
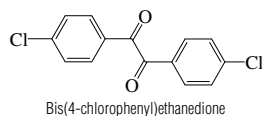
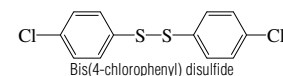
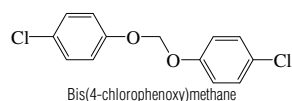
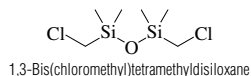
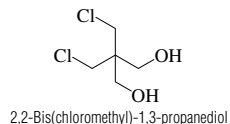
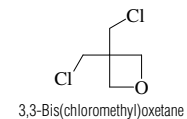
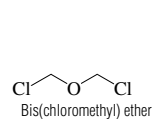
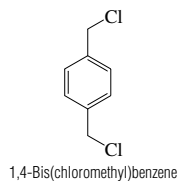
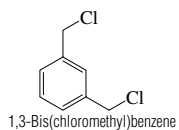
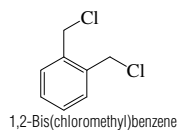
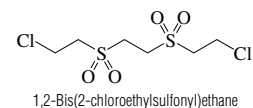
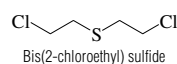
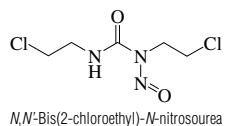
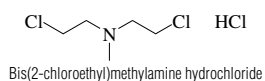
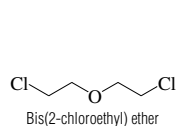


Bis(2-chloroethyl) carbonate

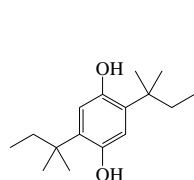


Bis(2-chloroethyl) 2-chloroethylphosphonate

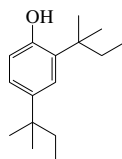
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
929	Bis(2-chloroethyl) ether	Dichloroethyl ether	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	111-44-4	143.012	liq	-51.9	178.5	1.22 <sup>20</sup>	1.451 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; msc bz
930	Bis(2-chloroethyl)methylamine hydrochloride	Nitrogen mustard hydrochloride	C <sub>6</sub> H <sub>12</sub> Cl <sub>3</sub> N	55-86-7	192.515	hyg nd	111.5				
931	<i>N,N'</i> -Bis(2-chloroethyl)- <i>N</i> -nitrosourea	Carmustine	C <sub>6</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>2</sub>	154-93-8	214.049	lt ye pow	31				vs H <sub>2</sub> O, EtOH
932	Bis(2-chloroethyl) sulfide	Mustard gas	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> S	505-60-2	159.078		13.5	216	1.2741 <sup>20</sup>	1.5313 <sup>20</sup>	
933	1,2-Bis(2-chloroethylsulfonyl) ethane		C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	3944-87-4	283.193	cry (MeOH/HOAc)	205				
934	1,2-Bis(chloromethyl)benzene		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub>	612-12-4	175.056	mcl (lig)	55	239.5	1.393 <sup>25</sup>		i H <sub>2</sub> O; vs EtOH, eth, chl; s ctc
935	1,3-Bis(chloromethyl)benzene		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub>	626-16-4	175.056	cry	34.2	251.5	1.302 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth; sl chl
936	1,4-Bis(chloromethyl)benzene		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub>	623-25-6	175.056	pl (al)	100	dec 245; 135 <sup>16</sup>	1.417 <sup>25</sup>		i H <sub>2</sub> O; vs EtOH, eth, ace, chl; sl HOAc
937	Bis(chloromethyl) ether		C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	542-88-1	114.958	liq	-41.5	106	1.323 <sup>15</sup>	1.435 <sup>21</sup>	msc EtOH, eth
938	3,3-Bis(chloromethyl)oxetane		C <sub>6</sub> H <sub>8</sub> Cl <sub>2</sub> O	78-71-7	155.022	liq	18.7	101 <sup>27</sup>	1.295 <sup>25</sup>		
939	2,2-Bis(chloromethyl)-1,3-propanediol	Pentaerythritol dichlorohydrin	C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	2209-86-1	173.037	cry	83	159 <sup>12</sup>			
940	1,3-Bis(chloromethyl) tetramethyldisiloxane		C <sub>6</sub> H <sub>16</sub> Cl <sub>2</sub> OSi <sub>2</sub>	2362-10-9	231.267	liq	-90	204; 92 <sup>21</sup>	1.045 <sup>20</sup>	1.4398 <sup>20</sup>	
941	Bis(4-chlorophenoxy)methane	Di(4-chlorophenoxy)methane	C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	555-89-5	269.123	cry (peth)	70.5	191 <sup>6</sup>			vs ace, bz
942	Bis(4-chlorophenyl) disulfide		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub> S <sub>2</sub>	1142-19-4	287.228		72.8				s chl
943	Bis(4-chlorophenyl)ethanedione		C <sub>14</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>2</sub>	3457-46-3	279.119		197.8				
944	1,1-Bis(4-chlorophenyl)ethanol		C <sub>14</sub> H <sub>12</sub> Cl <sub>2</sub> O	80-06-8	267.150		70				i H <sub>2</sub> O, EtOH; s eth, bz
945	1,2-Bis(2-chlorophenyl)-hydrazine	2,2-Dichlorohydrazobenzene	C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	782-74-1	253.126		87				
946	Bis(4-chlorophenyl)methane		C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub>	101-76-8	237.124		55.5	188 <sup>18</sup>	1.365 <sup>17</sup>		s EtOH
947	Bis(4-chlorophenyl) sulfone		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>2</sub> S	80-07-9	287.162		147.9	250 <sup>10</sup>			sl H <sub>2</sub> O; s EtOH, chl
948	<i>N,N'</i> -Bis(4-chlorophenyl)thiourea	Di( <i>p</i> -chlorophenyl)thiourea	C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> S	1220-00-4	297.202	nd	176				
949	1,1-Bis(4-chlorophenyl)-2,2,2-trichloroethanol		C <sub>14</sub> H <sub>8</sub> Cl <sub>5</sub> O	115-32-2	370.485	cry (petr)	77.5	180 <sup>0.1</sup>			i H <sub>2</sub> O, os
950	Bis(3-chloropropyl) ether	3-Chloropropyl ether	C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> O	629-36-7	171.064			216; 90.5 <sup>11</sup>	1.136 <sup>20</sup>	1.4158 <sup>20</sup>	s EtOH, eth
951	Bis(2-cyanoethyl) ether		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	1656-48-0	124.140			161 <sup>5</sup> , 111 <sup>0.5</sup>	1.0504 <sup>20</sup>	1.4405 <sup>20</sup>	
952	Bis(2-cyanoethyl) sulfide		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> S	111-97-7	140.206			163 <sup>1.5</sup>		1.5047 <sup>20</sup>	
953	Bis( $\eta$ -cyclopentadienyl)titanium chloride		C <sub>10</sub> H <sub>10</sub> Cl <sub>2</sub> Ti	1271-19-8	248.959	red cry	289	258 <sup>10</sup>	1.60		sl H <sub>2</sub> O, bz; s chl, EtOH, tol
954	Bis( $\eta$ -cyclopentadienyl)zirconium chloride		C <sub>10</sub> H <sub>10</sub> Cl <sub>2</sub> Zr	1291-32-3	292.316			180 <sup>0.5</sup>			
955	1,2-Bis(dibromomethyl)benzene		C <sub>8</sub> H <sub>8</sub> Br <sub>4</sub>	13209-15-9	421.750	mcl	116.5				sl H <sub>2</sub> O; vs chl; i lig
956	Bis(2,4-dichlorobenzoyl) peroxide		C <sub>14</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>4</sub>	133-14-2	380.008		106				
957	1,3-Bis(dichloromethyl) tetramethyldisiloxane		C <sub>6</sub> H <sub>14</sub> Cl <sub>2</sub> OSi <sub>2</sub>	2943-70-6	300.157			149 <sup>50</sup> , 117 <sup>11</sup>	1.2213 <sup>20</sup>	1.4660 <sup>20</sup>	
958	Bis(2,4-dichlorophenyl)ether	2,2',4,4'-Tetrachlorodiphenyl ether	C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub> O	28076-73-5	307.987	cry (eth)	71				
959	4,4'-Bis(diethylamino) benzophenone	Michler's ethyl ketone	C <sub>21</sub> H <sub>28</sub> N <sub>2</sub> O	90-93-7	324.459	lf (al)	95.3				
960	Bis(diethyldithiocarbamate)nickel		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> NiS <sub>4</sub>	14267-17-5	355.232			202 <sup>0.02</sup>			
961	Bis(diethyldithiocarbamate)zinc		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> S <sub>4</sub> Zn	14324-55-1	361.948			178 <sup>0.05</sup>			
962	Bis(difluoromethyl) ether	Difluoromethyl ether	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> O	1691-17-4	118.030	col gas		2	1.43 <sup>20</sup>		
963	Bis(2-dimethylaminoethyl) ether	2,2'-Oxybis[ <i>N,N</i> -dimethylethanamine]	C <sub>8</sub> H <sub>20</sub> N <sub>2</sub> O	3033-62-3	160.257	liq		80 <sup>15</sup>			
964	Bis[4-(dimethylamino)phenyl] methane	Michler's Base	C <sub>17</sub> H <sub>22</sub> N <sub>2</sub>	101-61-1	254.370	pl or tab (al, lig)	91.5	dec 390; 183 <sup>3</sup>			i H <sub>2</sub> O; sl EtOH; vs eth, bz; s acid
965	Bis[4-(dimethylamino)phenyl] methanethione	4,4'-Bis(dimethylamino) thiobenzophenone	C <sub>17</sub> H <sub>20</sub> N <sub>2</sub> S	1226-46-6	284.419	pl	204				i H <sub>2</sub> O, EtOH, lig; sl eth; s bz, chl, HOAc
966	Bis(4-dimethylaminophenyl) methanol	4,4'-Bis(dimethylamino) benzhydrol	C <sub>17</sub> H <sub>22</sub> N <sub>2</sub> O	119-58-4	270.369		102.0				i H <sub>2</sub> O; vs EtOH; s eth, bz, HOAc
967	1,3-Bis(dimethylamino)-2-propanol		C <sub>7</sub> H <sub>18</sub> N <sub>2</sub> O	5966-51-8	146.230			181.5	0.8788 <sup>20</sup>	1.4418 <sup>20</sup>	vs H <sub>2</sub> O
968	4,4'-Bis(dimethylamino) triphenylmethane		C <sub>23</sub> H <sub>28</sub> N <sub>2</sub>	129-73-7	330.465	nd or lf (al, bz)	102				vs bz, eth
969	Bis(dimethyldithiocarbamate) copper		C <sub>6</sub> H <sub>12</sub> CuN <sub>2</sub> S <sub>4</sub>	137-29-1	303.978			206 <sup>0.01</sup>			
970	Bis(dimethyldithiocarbamate) nickel		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> NiS <sub>4</sub>	15521-65-0	299.125			208 <sup>0.002</sup>			



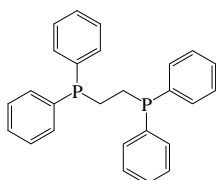
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
971	2,5-Bis(1,1-dimethylpropyl)-1,4-benzenediol	2,5-Di- <i>tert</i> -pentyhydroquinone	C <sub>16</sub> H <sub>26</sub> O <sub>2</sub>	79-74-3	250.376		180				
972	2,4-Bis(1,1-dimethylpropyl)phenol		C <sub>16</sub> H <sub>26</sub> O	120-95-6	234.376		26.0	169 <sup>22</sup>			
973	1,2-Bis(diphenylphosphino)ethane	Diphos	C <sub>26</sub> H <sub>24</sub> P <sub>2</sub>	1663-45-2	398.417		143.5				
974	1,3-Bis(2,3-epoxypropoxy)benzene	Diglycidyl resorcinol ether	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	101-90-6	222.237		42.5	147 <sup>0.4</sup>	1.2183 <sup>30</sup>	1.5408 <sup>20</sup>	
975	Bis(2-ethoxyethyl) phthalate		C <sub>16</sub> H <sub>22</sub> O <sub>6</sub>	605-54-9	310.342		34	345	1.1229 <sup>21</sup>		
976	Bis(ethoxymethyl) ether		C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	5648-29-3	134.173			140.6			
977	<i>N,N</i> -Bis(4-ethoxyphenyl)ethanimidamide monohydrochloride	Phenacaine hydrochloride	C <sub>18</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>2</sub>	620-99-5	334.841	cry (w+1)	191				vs H <sub>2</sub> O, EtOH, chl
978	Bis(ethylenediamine)copper dichloride	Cupriethylenediamine dichloride	C <sub>4</sub> H <sub>16</sub> Cl <sub>2</sub> CuN <sub>4</sub>	15243-01-3	254.649	dk bl cry					s EtOH
979	Bis(2-ethylhexyl) adipate		C <sub>22</sub> H <sub>42</sub> O <sub>4</sub>	103-23-1	370.566		-67.8	214 <sup>5</sup>	0.922 <sup>25</sup>	1.4474 <sup>20</sup>	vs ace, eth, EtOH
980	Bis(2-ethylhexyl)amine		C <sub>16</sub> H <sub>36</sub> N	106-20-7	241.456			161 <sup>21</sup>			
981	Bis(2-ethylhexyl) azelate		C <sub>25</sub> H <sub>46</sub> O <sub>4</sub>	103-24-2	412.647		-78	237 <sup>5</sup>	0.915 <sup>25</sup>	1.446 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, ace, bz, sl ctc
982	Bis(2-ethylhexyl) ether	2,2'-Diethyldihexyl ether	C <sub>16</sub> H <sub>34</sub> O	10143-60-9	242.440			269; 144 <sup>13</sup>		1.4325 <sup>20</sup>	sl ctc
983	Bis(2-ethylhexyl) phosphate		C <sub>16</sub> H <sub>35</sub> O <sub>4</sub> P	298-07-7	322.420	visc liq		155 <sup>0.015</sup>	0.975 <sup>25</sup>		sl H <sub>2</sub> O; s bz, hx
984	Bis(2-ethylhexyl) phosphonate	Bis(2-ethylhexyl) phosphite	C <sub>16</sub> H <sub>35</sub> O <sub>3</sub> P	3658-48-8	306.421	liq		150 <sup>1</sup>	0.93 <sup>25</sup>	1.4420 <sup>20</sup>	
985	Bis(2-ethylhexyl) phosphorodithioate		C <sub>16</sub> H <sub>35</sub> O <sub>2</sub> PS <sub>2</sub>	5810-88-8	354.552	cry					s bz, hp, chl
986	Bis(2-ethylhexyl) phthalate	Di- <i>sec</i> -octyl phthalate	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	117-81-7	390.557	liq	-55	384	0.981 <sup>25</sup>	1.4853 <sup>20</sup>	sl ctc
987	Bis(2-ethylhexyl) sebacate		C <sub>26</sub> H <sub>50</sub> O <sub>4</sub>	122-62-3	426.673		-48	256 <sup>5</sup>	0.912 <sup>25</sup>	1.451 <sup>25</sup>	vs ace, bz, EtOH
988	Bis(2-ethylhexyl) sodium sulfosuccinate	Docusate sodium	C <sub>20</sub> H <sub>37</sub> NaO <sub>7</sub> S	577-11-7	444.559	waxy solid					s peth, ctc, eth, ace
989	Bis(2-ethylhexyl) terephthalate		C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	6422-86-2	390.557			383			
990	2,2-Bis(ethylsulfonyl)butane	Sulfonethylmethane	C <sub>8</sub> H <sub>18</sub> O <sub>4</sub> S <sub>2</sub>	76-20-0	242.357	pl (w)	76	dec	1.199 <sup>85</sup>		s chl
991	Bis[4-(hexyloxy)phenyl]diazene, 1-oxide		C <sub>24</sub> H <sub>36</sub> N <sub>2</sub> O <sub>3</sub>	2587-42-0	398.538						s chl
992	<i>N,N</i> -Bis(2-hydroxybenzylidene)-1,2-ethylenediamine	Disalicylidene-1,2-ethanediamine	C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	94-93-9	268.310		125.5				sl EtOH, eth; s bz, chl
993	Bis(2-hydroxy-3- <i>tert</i> -butyl-5-methylphenyl)methane		C <sub>23</sub> H <sub>32</sub> O <sub>2</sub>	119-47-1	340.499	nd (peth)	131				
994	Bis(2-hydroxy-5-chlorophenyl) sulfide	Fenticlor	C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub> S	97-24-5	287.162		174				i H <sub>2</sub> O; s EtOH, eth, gl HOAc
995	2-[Bis(2-hydroxyethyl)amino] ethanol hydrochloride	Triethanolamine hydrochloride	C <sub>8</sub> H <sub>16</sub> ClNO <sub>3</sub>	637-39-8	185.649	cry (al)	179.5				vs H <sub>2</sub> O
996	<i>N,N</i> -Bis(2-hydroxyethyl) butylamine	Butylbis(2-hydroxyethyl)amine	C <sub>8</sub> H <sub>19</sub> NO <sub>2</sub>	102-79-4	161.243			275; 80 <sup>35</sup>	0.9681 <sup>20</sup>	1.4625 <sup>20</sup>	s chl
997	Bis(2-hydroxyethyl) disulfide		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S <sub>2</sub>	1892-29-1	154.251		26	160 <sup>3.5</sup>			
998	<i>N,N</i> -Bis(2-hydroxyethyl) dodecanamide		C <sub>16</sub> H <sub>33</sub> NO <sub>3</sub>	120-40-1	287.438	waxy solid	38.7				
999	<i>N,N</i> -Bis(2-hydroxyethyl) ethylamine	<i>N</i> -Ethyl-diethanolamine	C <sub>6</sub> H <sub>15</sub> NO <sub>2</sub>	139-87-7	133.189	ye liq	-50	247	1.0135 <sup>20</sup>	1.4663 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; sl eth
1000	<i>N,N</i> -Bis(2-hydroxyethyl) ethylenediamine		C <sub>6</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	4439-20-7	148.203		97.5	136 <sup>1</sup>			s H <sub>2</sub> O
1001	<i>N,N</i> -Bis(2-hydroxyethyl)glycine	Bicine	C <sub>6</sub> H <sub>13</sub> NO <sub>4</sub>	150-25-4	163.172	nd (al)	194 dec				vs H <sub>2</sub> O; i EtOH
1002	Bis(2-hydroxyethyl)methylamine	Methyldiethanolamine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	105-59-9	119.163	liq	-21	247	1.043 <sup>25</sup>	1.4685 <sup>20</sup>	vs H <sub>2</sub> O
1003	<i>N,N</i> -Bis(2-hydroxyethyl)-3-methylaniline	Diethanol- <i>m</i> -toluidine	C <sub>11</sub> H <sub>17</sub> NO <sub>2</sub>	91-99-6	195.259		64.5	160 <sup>1</sup>			sl chl
1004	<i>N,N</i> -Bis(2-hydroxyethyl)-1,3-propanediamine	3-(Aminopropyl)diethanolamine	C <sub>7</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	4985-85-7	162.230			160 <sup>1</sup>			
1005	Bis(2-hydroxyethyl) sulfide	2,2'-Thiodiethanol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S	111-48-8	122.186	liq	-10.2	282	1.1793 <sup>25</sup>	1.5211 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, chl, AcOEt; s eth; sl bz
1006	Bis(2-hydroxyethyl) terephthalate	Bis(2-hydroxyethyl) 1,4-benzenedicarboxylate	C <sub>12</sub> H <sub>14</sub> O <sub>6</sub>	959-26-2	254.235	cry (w)	109.5				
1007	1,2-Bis(2-hydroxyethylthio)ethane		C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> S <sub>2</sub>	5244-34-8	182.304		64.8	170 <sup>0.5</sup>			s H <sub>2</sub> O, EtOH, bz, peth
1008	Bis(2-hydroxy-4-methoxyphenyl) methanone	2,2'-Dihydroxy-4,4'-dimethoxybenzophenone	C <sub>15</sub> H <sub>14</sub> O <sub>5</sub>	131-54-4	274.269		139.5				
1009	1,3-Bis(hydroxymethyl)-2-imidazolidone	1,3-Dimethylolthyleneurea	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	136-84-5	146.144	cry (MeOH)	101				
1010	2,2-Bis(4-hydroxy-3-methylphenyl)propane	Bisphenol C	C <sub>17</sub> H <sub>20</sub> O <sub>2</sub>	79-97-0	256.340	nd (xyl)	140				
1011	2,2-Bis(hydroxymethyl)-1,3-propanediol, tetra(2-propenyl) ester	Pentaerythritol tetraacrylate	C <sub>17</sub> H <sub>20</sub> O <sub>8</sub>	4986-89-4	352.336		17.3		1.185 <sup>25</sup>		
1012	2,2-Bis(hydroxymethyl)-1,3-propanediol, tri(2-propenyl) ester	Pentaerythritol triacrylate	C <sub>14</sub> H <sub>16</sub> O <sub>7</sub>	3524-68-3	298.289				1.180 <sup>20</sup>		



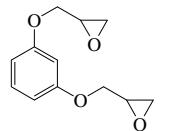
2,5-Bis(1,1-dimethylpropyl)-1,4-benzenediol



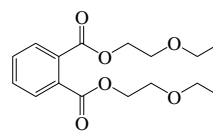
2,4-Bis(1,1-dimethylpropyl)phenol



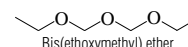
1,2-Bis(diphenylphosphino)ethane



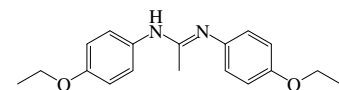
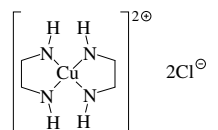
1,3-Bis(2,3-epoxypropoxy)benzene



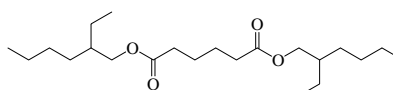
Bis(2-ethoxyethyl) phthalate



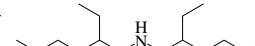
Bis(ethoxymethyl) ether

*N,N'*-Bis(4-ethoxyphenyl)ethanimidamide monohydrochloride

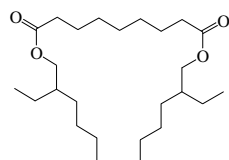
Bis(ethylenediamine)copper dichloride



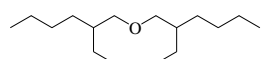
Bis(2-ethylhexyl) adipate



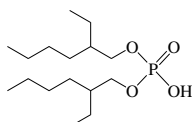
Bis(2-ethylhexyl)amine



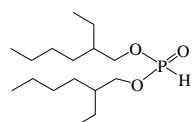
Bis(2-ethylhexyl) azelate



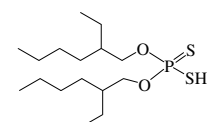
Bis(2-ethylhexyl) ether



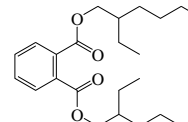
Bis(2-ethylhexyl) phosphate



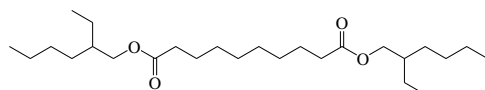
Bis(2-ethylhexyl) phosphonate



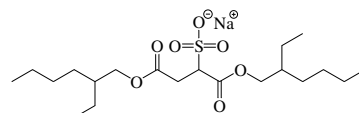
Bis(2-ethylhexyl) phosphorodithioate



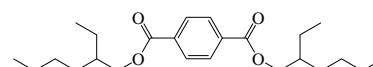
Bis(2-ethylhexyl) phthalate



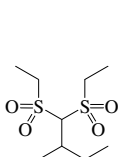
Bis(2-ethylhexyl) sebacate



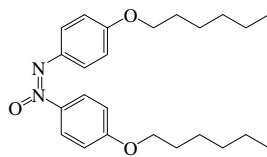
Bis(2-ethylhexyl) sodium sulfosuccinate



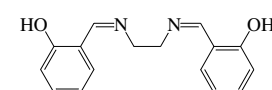
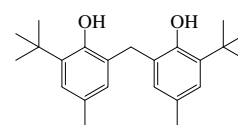
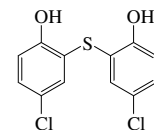
Bis(2-ethylhexyl) terephthalate



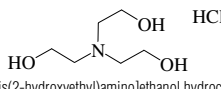
2,2-Bis(ethylsulfonyl)butane



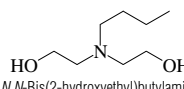
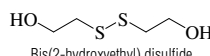
Bis[4-(hexyloxy)phenyl]diazene, 1-oxide

*N,N'*-Bis(2-hydroxybenzylidene)-1,2-ethylenediamineBis(2-hydroxy-3-*tert*-butyl-5-methylphenyl)methane

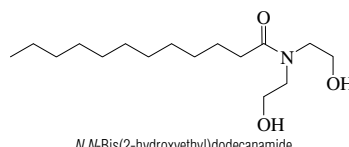
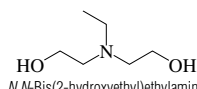
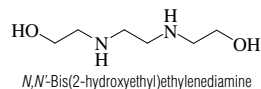
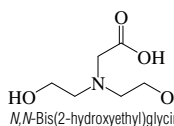
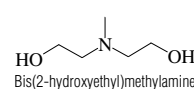
Bis(2-hydroxy-5-chlorophenyl) sulfide



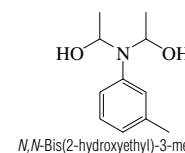
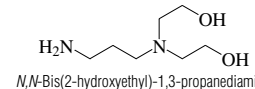
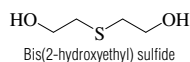
2-Bis(2-hydroxyethyl)aminoethanol hydrochloride

*N,N*-Bis(2-hydroxyethyl)butylamine

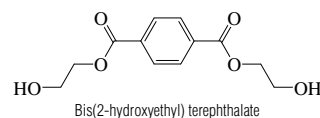
Bis(2-hydroxyethyl) disulfide

*N,N*-Bis(2-hydroxyethyl)dodecanamide*N,N*-Bis(2-hydroxyethyl)ethylamine*N,N'*-Bis(2-hydroxyethyl)ethylenediamine*N,N*-Bis(2-hydroxyethyl)glycine

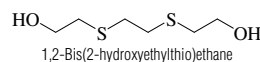
Bis(2-hydroxyethyl)methylamine

*N,N*-Bis(2-hydroxyethyl)-3-methylaniline*N,N*-Bis(2-hydroxyethyl)-1,3-propanediamine

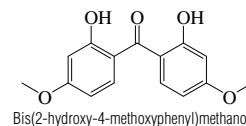
Bis(2-hydroxyethyl) sulfide



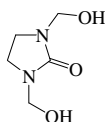
Bis(2-hydroxyethyl) terephthalate



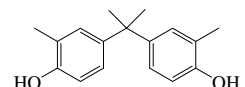
1,2-Bis(2-hydroxyethylthio)ethane



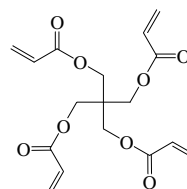
Bis(2-hydroxy-4-methoxyphenyl)methanone



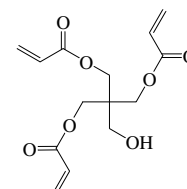
1,3-Bis(hydroxymethyl)-2-imidazolidone



2,2-Bis(4-hydroxy-3-methylphenyl)propane



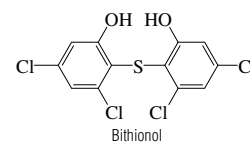
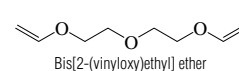
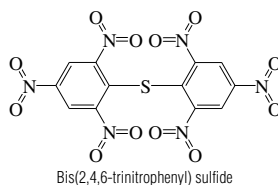
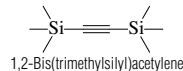
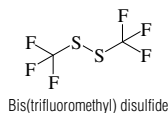
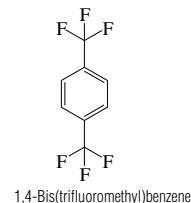
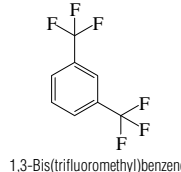
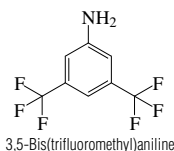
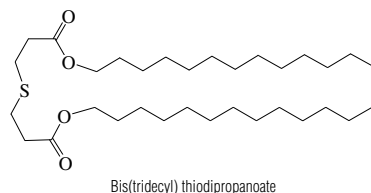
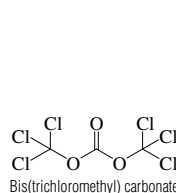
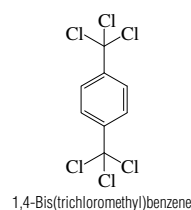
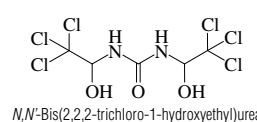
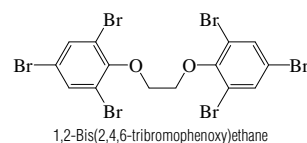
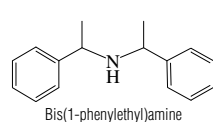
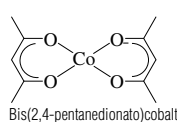
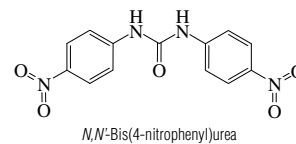
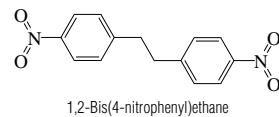
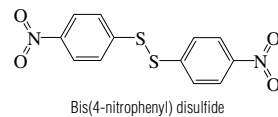
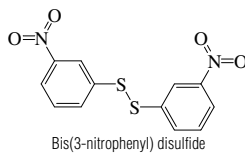
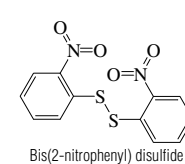
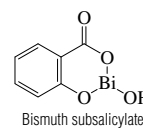
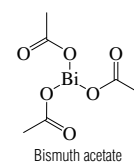
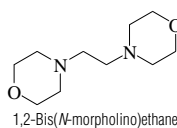
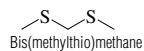
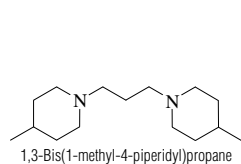
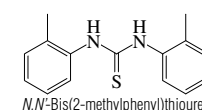
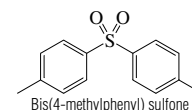
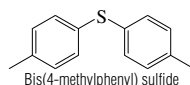
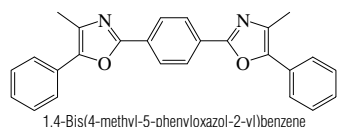
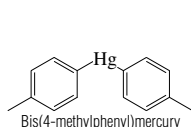
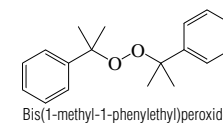
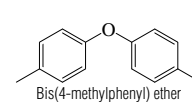
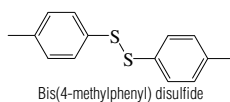
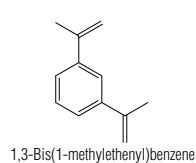
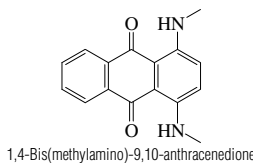
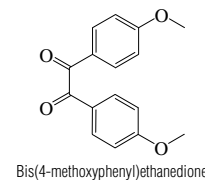
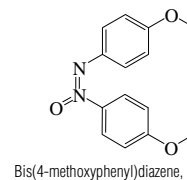
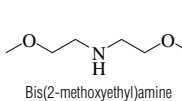
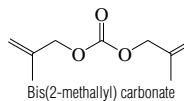
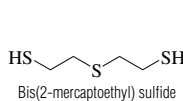
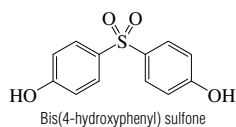
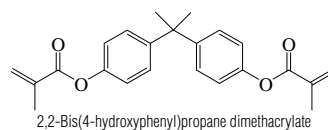
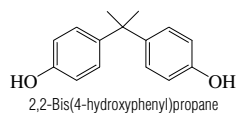
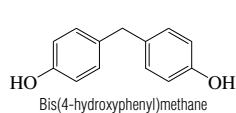
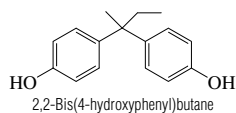
2,2-Bis(hydroxymethyl)-1,3-propanediol, tetra(2-propenyl) ester



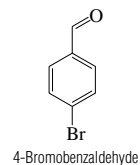
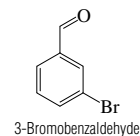
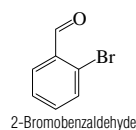
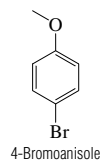
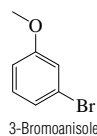
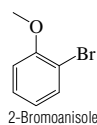
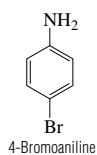
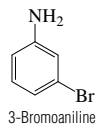
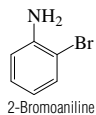
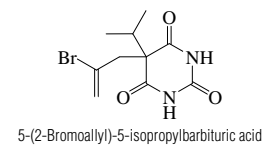
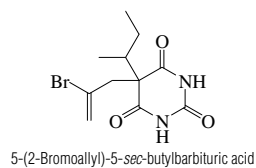
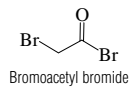
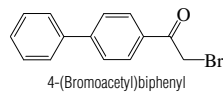
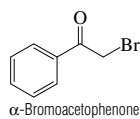
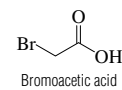
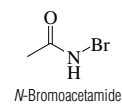
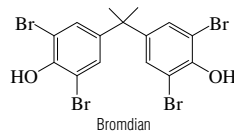
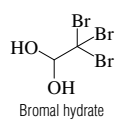
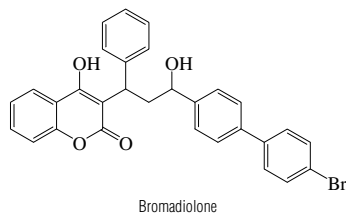
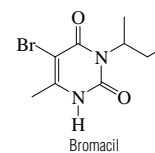
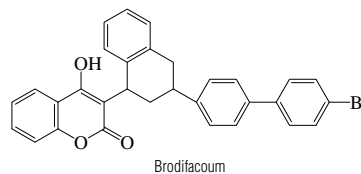
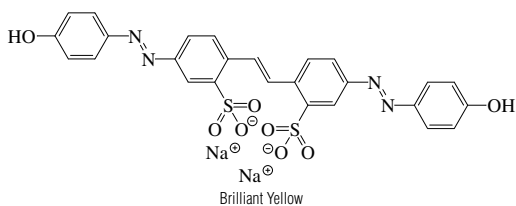
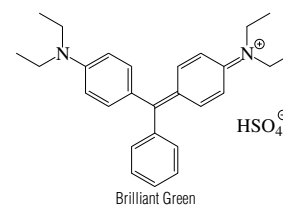
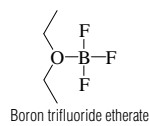
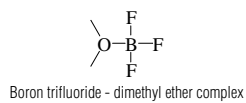
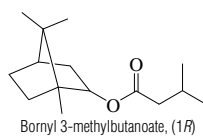
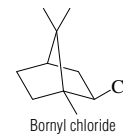
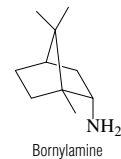
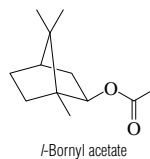
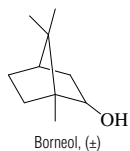
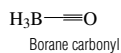
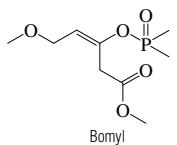
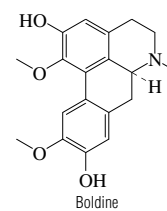
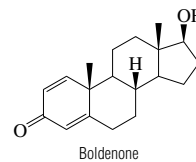
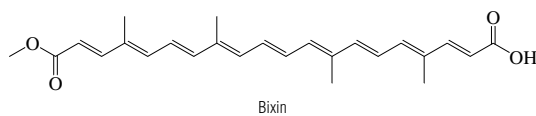
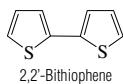
2,2-Bis(hydroxymethyl)-1,3-propanediol, tri(2-propenyl) ester

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1013	2,2-Bis(4-hydroxyphenyl)butane	Bisphenol B	C <sub>16</sub> H <sub>18</sub> O <sub>2</sub>	77-40-7	242.313		120.5				vs ace, MeOH
1014	Bis(4-hydroxyphenyl)methane	Bisphenol AD	C <sub>13</sub> H <sub>12</sub> O <sub>2</sub>	620-92-8	200.233		162.5	sub			s EtOH, eth, chl, alk; sl DMSO; i CS <sub>2</sub>
1015	2,2-Bis(4-hydroxyphenyl)propane	Bisphenol A	C <sub>15</sub> H <sub>16</sub> O <sub>2</sub>	80-05-7	228.287	cry or fl	153	220 <sup>4</sup> , 222 <sup>3</sup>			i H <sub>2</sub> O; vs EtOH, eth, bz, alk; s HOAc
1016	2,2-Bis(4-hydroxyphenyl)propane dimethacrylate	Bisphenol A dimethacrylate	C <sub>23</sub> H <sub>24</sub> O <sub>4</sub>	3253-39-2	364.435		73				
1017	Bis(4-hydroxyphenyl) sulfone	Bisphenol S	C <sub>12</sub> H <sub>10</sub> O <sub>4</sub> S	80-09-1	250.270	nd (w), orth bipym	240.5		1.3663 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth; sl bz, DMSO
1018	Bis(2-mercaptoethyl) sulfide	2,2'-Dimercaptodiethyl sulfide	C <sub>4</sub> H <sub>10</sub> S <sub>3</sub>	3570-55-6	154.317		-11	135 <sup>18</sup>	1.183 <sup>25</sup>	1.598 <sup>20</sup>	
1019	Bis(2-methylallyl) carbonate		C <sub>9</sub> H <sub>14</sub> O <sub>3</sub>	64057-79-0	170.205		201.3	66 <sup>3</sup>	0.943 <sup>25</sup>	1.437 <sup>120</sup>	
1020	Bis(2-methoxyethyl)amine	2-Methoxy- <i>N</i> -(2-methoxyethyl) ethanamine	C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	111-95-5	133.189						s ctc
1021	Bis(4-methoxyphenyl)diazene, 1-oxide		C <sub>14</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	1562-94-3	258.272	ye nd (al)			1.1711 <sup>11</sup>		s EtOH, ace, bz; sl chl
1022	Bis(4-methoxyphenyl)ethanedione		C <sub>16</sub> H <sub>14</sub> O <sub>4</sub>	1226-42-2	270.280		133				sl EtOH, chl
1023	1,4-Bis(methylamino)-9,10-anthracenedione		C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	2475-44-7	266.294						sl chl
1024	1,3-Bis(1-methylethenyl)benzene	1,3-Diisopropenylbenzene	C <sub>12</sub> H <sub>14</sub>	3748-13-8	158.239	liq		231	0.925	1.5570 <sup>20</sup>	
1025	Bis(4-methylphenyl) disulfide	Di- <i>p</i> -Tolyl disulfide	C <sub>14</sub> H <sub>14</sub> S <sub>2</sub>	103-19-5	246.391	nd or lf (al)	47.5	212 <sup>20</sup>	1.114 <sup>51</sup>		i H <sub>2</sub> O; s EtOH, ace; vs eth
1026	Bis(4-methylphenyl) ether	<i>p</i> -Tolyl ether	C <sub>14</sub> H <sub>14</sub> O	1579-40-4	198.260		51	285			vs bz, eth, EtOH
1027	Bis(1-methyl-1-phenylethyl) peroxide	Dicumyl peroxide	C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>	80-43-3	270.367	cry (EtOH)	40	100 <sup>9,2</sup>			
1028	Bis(4-methylphenyl)mercury	Di- <i>p</i> -tolylmercury	C <sub>14</sub> H <sub>14</sub> Hg	537-64-4	382.85		245.7				
1029	1,4-Bis(4-methyl-5-phenyloxazol-2-yl)benzene	2,2'- <i>p</i> -Phenylenebis(4-methyl-5-phenyloxazole)	C <sub>26</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	3073-87-8	392.449			232			sl chl
1030	Bis(4-methylphenyl) sulfide	Di- <i>p</i> -tolyl sulfide	C <sub>14</sub> H <sub>14</sub> S	620-94-0	214.326	nd (al)	57.3	>300; 175 <sup>16</sup>			i H <sub>2</sub> O; s EtOH, ace, bz, HOAc; sl chl
1031	Bis(4-methylphenyl) sulfone	Di- <i>p</i> -tolyl sulfone	C <sub>14</sub> H <sub>14</sub> O <sub>2</sub> S	599-66-6	246.325	pr(bz), nd(w,al)	159	406			sl H <sub>2</sub> O, eth; s EtOH, bz, chl, CS <sub>2</sub>
1032	<i>N,N'</i> -Bis(2-methylphenyl)thiourea		C <sub>15</sub> H <sub>16</sub> N <sub>2</sub> S	137-97-3	256.366	nd (al, sub)					vs bz, EtOH, chl
1033	1,3-Bis(1-methyl-4-piperidyl) propane		C <sub>15</sub> H <sub>30</sub> N <sub>2</sub>	64168-11-2	238.412		13.7	215 <sup>50</sup>	0.8962 <sup>25</sup>	1.4804 <sup>25</sup>	
1034	Bis(methylthio)methane		C <sub>3</sub> H <sub>6</sub> S <sub>2</sub>	1618-26-4	108.226			148			
1035	1,2-Bis( <i>N</i> -morpholino)ethane		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	1723-94-0	200.278	wh-ye (eth, liq)	75	285; 160 <sup>25</sup>			vs H <sub>2</sub> O, ace, bz, EtOH
1036	Bismuth acetate		C <sub>6</sub> H <sub>9</sub> BiO <sub>6</sub>	22306-37-2	386.111	col tablets	250				i H <sub>2</sub> O
1037	Bismuth subsalicylate		C <sub>7</sub> H <sub>5</sub> BiO <sub>4</sub>	14882-18-9	362.093	pr					i H <sub>2</sub> O, EtOH; reac alk
1038	Bis(2-nitrophenyl) disulfide		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	1155-00-6	308.333			198.5			i H <sub>2</sub> O, eth; sl EtOH, ace, bz, HOAc
1039	Bis(3-nitrophenyl) disulfide	Nitrophenide	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	537-91-7	308.333			84			sl EtOH, chl; s eth
1040	Bis(4-nitrophenyl) disulfide		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	100-32-3	308.333			182	255 <sup>0,1</sup>		sl EtOH, HOAc
1041	1,2-Bis(4-nitrophenyl)ethane	4,4'-Dinitrobenzyl	C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub>	736-30-1	272.256	ye nd (al,bz)	181.8				i EtOH; sl eth, bz, chl, HOAc
1042	<i>N,N'</i> -Bis(4-nitrophenyl)urea	4,4'-Dinitrocarbanilide	C <sub>13</sub> H <sub>10</sub> N <sub>4</sub> O <sub>3</sub>	587-90-6	302.242			312 dec			
1043	Bis(2,4-pentanedionato)cobalt	Cobalt(II) bis(acetylacetonate)	C <sub>10</sub> H <sub>14</sub> CoO <sub>4</sub>	14024-48-7	257.149	bl-viol cry	167				
1044	Bis(1-phenylethyl)amine		C <sub>16</sub> H <sub>18</sub> N	10024-74-5	225.329			296.5	1.018 <sup>15</sup>	1.573	
1045	1,2-Bis(2,4,6-tribromophenoxy) ethane		C <sub>14</sub> H <sub>6</sub> Br <sub>6</sub> O <sub>2</sub>	37853-59-1	687.637	nd (bz/EtOH)	222				
1046	<i>N,N'</i> -Bis(2,2,2-trichloro-1-hydroxyethyl)urea		C <sub>8</sub> H <sub>6</sub> Cl <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	116-52-9	354.831			196			vs ace, EtOH
1047	1,4-Bis(trichloromethyl)benzene		C <sub>6</sub> H <sub>4</sub> Cl <sub>6</sub>	68-36-0	312.836	cry (bz, eth)	109				s chl
1048	Bis(trichloromethyl) carbonate	Triphosgene	C <sub>3</sub> Cl <sub>6</sub> O <sub>3</sub>	32315-10-9	296.748	cry (eth, peth)	79	203	1.6290 <sup>90</sup>		
1049	Bis(tridecyl) thiodipropionate	Ditridecyl thiodipropionate	C <sub>32</sub> H <sub>62</sub> O <sub>4</sub> S	10595-72-9	542.897			265 <sup>0,25</sup>			vs EtOH
1050	3,5-Bis(trifluoromethyl)aniline		C <sub>8</sub> H <sub>6</sub> F <sub>6</sub> N	328-74-5	229.123			85 <sup>15</sup> , 76 <sup>10</sup>	1.487 <sup>25</sup>	1.4335 <sup>20</sup>	
1051	1,3-Bis(trifluoromethyl)benzene		C <sub>8</sub> H <sub>4</sub> F <sub>6</sub>	402-31-3	214.108			116	1.3790 <sup>25</sup>	1.3916 <sup>25</sup>	i H <sub>2</sub> O
1052	1,4-Bis(trifluoromethyl)benzene		C <sub>8</sub> H <sub>4</sub> F <sub>6</sub>	433-19-2	214.108	liq		115			
1053	Bis(trifluoromethyl) disulfide		C <sub>2</sub> F <sub>6</sub> S <sub>2</sub>	372-64-5	202.141			34.6			vs EtOH, peth
1054	1,2-Bis(trimethylsilyl)acetylene		C <sub>6</sub> H <sub>18</sub> Si <sub>2</sub>	14630-40-1	170.400		26	134	0.770 <sup>20</sup>	1.413 <sup>20</sup>	
1055	Bis(2,4,6-trinitrophenyl) sulfide	Dipicryl sulfide	C <sub>12</sub> H <sub>4</sub> N <sub>6</sub> O <sub>12</sub> S	2217-06-3	456.258	ye cry	230	exp			
1056	Bis[2-(vinylloxy)ethyl] ether	Diethylene glycol divinyl ether	C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	764-99-8	158.195			81 <sup>10</sup>			
1057	Bithionol		C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub> S	97-18-7	356.052		188		1.73 <sup>25</sup>		vs ace

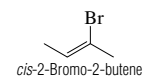
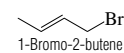
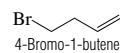
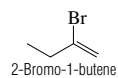
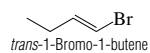
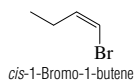
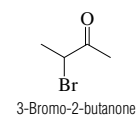
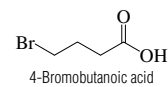
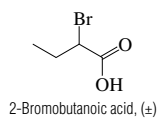
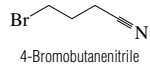
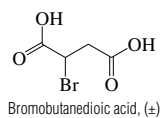
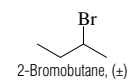
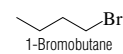
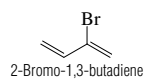
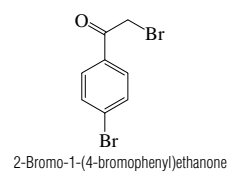
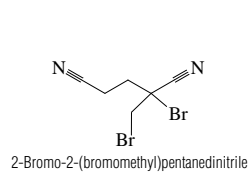
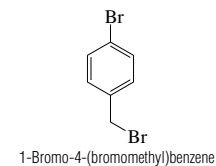
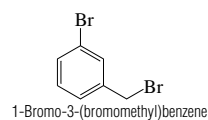
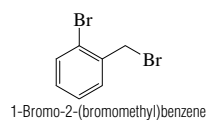
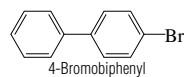
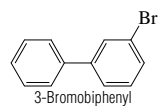
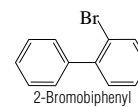
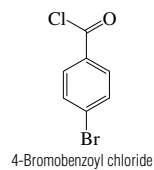
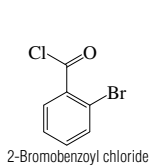
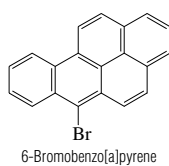
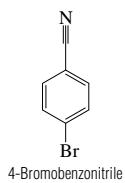
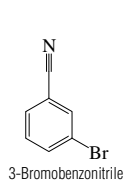
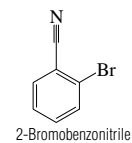
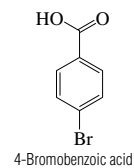
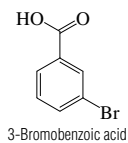
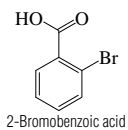
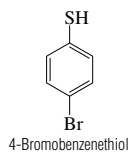
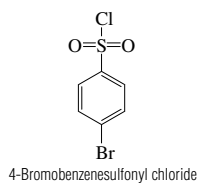
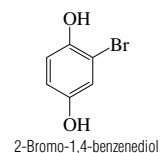
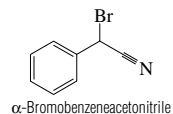
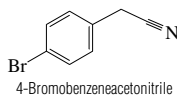
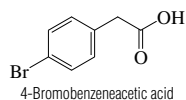
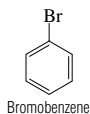




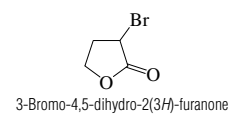
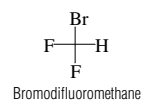
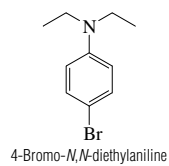
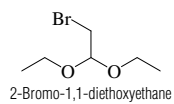
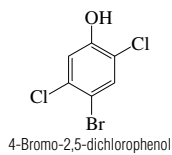
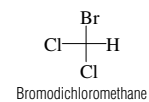
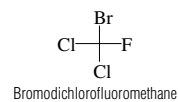
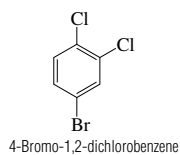
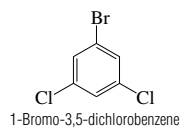
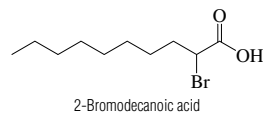
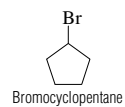
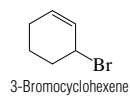
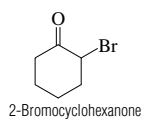
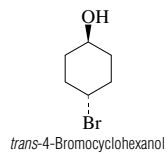
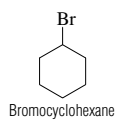
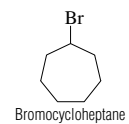
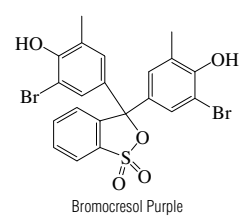
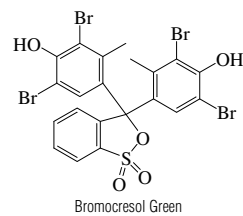
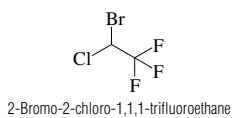
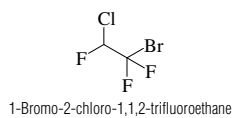
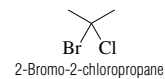
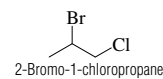
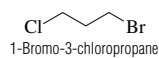
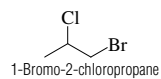
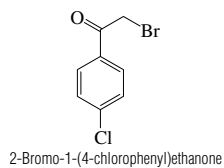
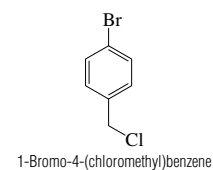
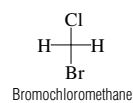
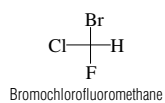
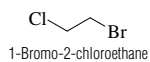
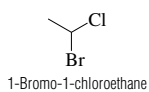
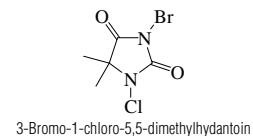
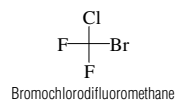
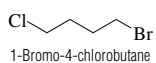
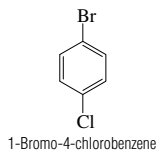
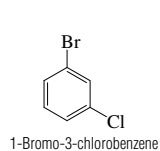
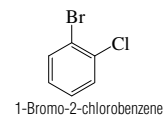
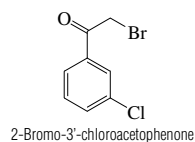
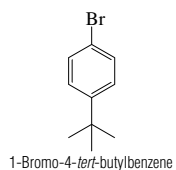
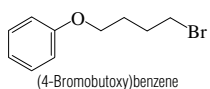
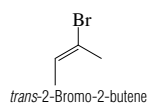
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1058	2,2'-Bithiophene		C <sub>8</sub> H <sub>6</sub> S <sub>2</sub>	492-97-7	166.264		33	260			i H <sub>2</sub> O; vs EtOH; s eth, ctc, HOAc
1059	Bixin		C <sub>25</sub> H <sub>30</sub> O <sub>4</sub>	6983-79-5	394.504	viol pr (ace)	198				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz, HOAc
1060	Boldenone	Dehydrotestosterone	C <sub>19</sub> H <sub>26</sub> O <sub>2</sub>	846-48-0	286.408		165				vs EtOH, chl
1061	Boldine		C <sub>19</sub> H <sub>21</sub> NO <sub>4</sub>	476-70-0	327.375	cry (eth)	163				vs EtOH, chl
1062	Bornyl		C <sub>9</sub> H <sub>15</sub> O <sub>8</sub> P	122-10-1	282.184	ye oil		160 <sup>17</sup>			sl H <sub>2</sub> O; vs ace, EtOH, xyl
1063	Borane carbonyl		CH <sub>3</sub> BO	13205-44-2	41.845	col gas	-137	-64			dec H <sub>2</sub> O
1064	Borneol, (±)		C <sub>10</sub> H <sub>18</sub> O	6627-72-1	154.249	lf (lig)	208	sub	1.011 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz
1065	<i>l</i> -Bornyl acetate		C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	5655-61-8	196.286		27	223.5	0.982 <sup>25</sup>	1.4626 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
1066	Bornylamine		C <sub>10</sub> H <sub>19</sub> N	32511-34-5	153.265		163				vs ace, bz, eth, EtOH
1067	Bornyl chloride	2-Chloro-1,7,7-trimethylbicyclo[2.2.1]heptane, <i>endo</i>	C <sub>10</sub> H <sub>17</sub> Cl	464-41-5	172.695	nd	132	207.5			vs bz, eth, EtOH, peth
1068	Bornyl 3-methylbutanoate, (1 <i>R</i> )	<i>d</i> -Bornyl isovalerate	C <sub>15</sub> H <sub>26</sub> O <sub>2</sub>	53022-14-3	238.366			257.5	0.955 <sup>25</sup>		vs eth, EtOH
1069	Boron trifluoride - dimethyl ether complex		C <sub>2</sub> H <sub>6</sub> BF <sub>3</sub> O	353-42-4	113.874		-14	dec 127	1.2410 <sup>20</sup>	1.302 <sup>20</sup>	
1070	Boron trifluoride etherate		C <sub>4</sub> H <sub>10</sub> BF <sub>3</sub> O	109-63-7	141.927	liq	-60.4	125.5	1.125 <sup>25</sup>	1.348 <sup>20</sup>	dec H <sub>2</sub> O; vs eth, EtOH
1071	Brilliant Green		C <sub>27</sub> H <sub>34</sub> N <sub>2</sub> O <sub>4</sub> S	633-03-4	482.635	small gold cry					vs H <sub>2</sub> O, EtOH
1072	Brilliant Yellow		C <sub>26</sub> H <sub>20</sub> N <sub>4</sub> Na <sub>2</sub> O <sub>8</sub> S <sub>2</sub>	3051-11-4	626.569	ye cry (w)					s H <sub>2</sub> O, EtOH; sl ace
1073	Brodifacoum		C <sub>31</sub> H <sub>23</sub> BrO <sub>3</sub>	56073-10-0	523.417	off-wh pow	230				i H <sub>2</sub> O; sl EtOH, bz; s ace, chl
1074	Bromacil	5-Bromo-3- <i>sec</i> -butyl-6-methyluracil	C <sub>9</sub> H <sub>13</sub> BrN <sub>2</sub> O <sub>2</sub>	314-40-9	261.115		158		1.55 <sup>25</sup>		
1075	Bromadiolone		C <sub>30</sub> H <sub>23</sub> BrO <sub>4</sub>	28772-56-7	527.406	ye-wh pow	205				vs DMF; sl ace, chl, EtOH, eth; i hx
1076	Bromal hydrate		C <sub>2</sub> H <sub>2</sub> Br <sub>3</sub> O <sub>2</sub>	507-42-6	298.756	mcl pr (w+1)	53.5	dec	2.5661 <sup>40</sup>		vs eth, EtOH
1077	Bromdian	Tetrabromobisphenol A	C <sub>15</sub> H <sub>12</sub> Br <sub>4</sub> O <sub>2</sub>	79-94-7	543.871		179				s EtOH, eth, bz, chl
1078	<i>N</i> -Bromoacetamide		C <sub>2</sub> H <sub>4</sub> BrNO	79-15-2	137.963	nd (chl-hx)	103.5				vs eth
1079	Bromoacetic acid		C <sub>2</sub> H <sub>3</sub> BrO <sub>2</sub>	79-08-3	138.948	hex or orth cry	50	208	1.9335 <sup>50</sup>	1.4804 <sup>50</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, bz; sl chl
1080	Bromoacetone		C <sub>3</sub> H <sub>5</sub> BrO	598-31-2	136.975	liq	-36.5	138; 31.5 <sup>8</sup>	1.634 <sup>23</sup>	1.4697 <sup>15</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
1081	$\alpha$ -Bromoacetophenone	$\omega$ -Bromoacetophenone	C <sub>8</sub> H <sub>7</sub> BrO	70-11-1	199.045	nd (al) orth pr (al) pl(peth)	50.5	135 <sup>16</sup>	1.647 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, peth; vs eth, bz, chl
1082	4-(Bromoacetyl)biphenyl	2-Bromo-4'-phenylacetophenone	C <sub>14</sub> H <sub>11</sub> BrO	135-73-9	275.140	nd (95% al)	127				
1083	Bromoacetyl bromide		C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> O	598-21-0	201.844			148.5	2.312 <sup>22</sup>	1.5449 <sup>20</sup>	s ace, ctc
1084	Bromoacetylene		C <sub>2</sub> HBr	593-61-3	104.933	col gas		4.7			vs eth
1085	5-(2-Bromoallyl)-5- <i>sec</i> -butylbarbituric acid	Butallylonal	C <sub>11</sub> H <sub>15</sub> BrN <sub>2</sub> O <sub>3</sub>	1142-70-7	303.152		131.5				vs eth, EtOH
1086	5-(2-Bromoallyl)-5-isopropylbarbituric acid	Propallylonal	C <sub>10</sub> H <sub>13</sub> BrN <sub>2</sub> O <sub>3</sub>	545-93-7	289.125	cry (dil HOAc, dil al)	181				sl H <sub>2</sub> O, eth, bz; vs EtOH, ace, HOAc
1087	2-Bromoaniline		C <sub>6</sub> H <sub>6</sub> BrN	615-36-1	172.023		32	229	1.578 <sup>20</sup>	1.6113 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
1088	3-Bromoaniline		C <sub>6</sub> H <sub>6</sub> BrN	591-19-5	172.023		18.5	251	1.5793 <sup>20</sup>	1.6260 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
1089	4-Bromoaniline		C <sub>6</sub> H <sub>6</sub> BrN	106-40-1	172.023	orth bipym nd (60% al)	66.4	dec	1.4970 <sup>100</sup>		i H <sub>2</sub> O; s EtOH, eth; sl chl
1090	2-Bromoanisole		C <sub>7</sub> H <sub>7</sub> BrO	578-57-4	187.034		1.3	216	1.5018 <sup>20</sup>	1.5727 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1091	3-Bromoanisole		C <sub>7</sub> H <sub>7</sub> BrO	2398-37-0	187.034			211; 105 <sup>16</sup>		1.5635 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub>
1092	4-Bromoanisole		C <sub>7</sub> H <sub>7</sub> BrO	104-92-7	187.034		13.5	215	1.4564 <sup>20</sup>	1.5642 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, chl; s ctc
1093	2-Bromobenzaldehyde		C <sub>7</sub> H <sub>5</sub> BrO	6630-33-7	185.018		21.5	230		1.5925 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, bz; sl ctc
1094	3-Bromobenzaldehyde		C <sub>7</sub> H <sub>5</sub> BrO	3132-99-8	185.018			234		1.5935 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
1095	4-Bromobenzaldehyde		C <sub>7</sub> H <sub>5</sub> BrO	1122-91-4	185.018	lf (dil al)	58	67 <sup>2</sup>			i H <sub>2</sub> O; vs EtOH, bz; sl chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1096	Bromobenzene	Phenyl bromide	C <sub>6</sub> H <sub>5</sub> Br	108-86-1	157.008	liq	-30.72	156.06	1.4950 <sup>20</sup>	1.5597 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; s ctc
1097	4-Bromobenzenoacetic acid		C <sub>8</sub> H <sub>7</sub> BrO <sub>2</sub>	1878-68-8	215.045	nd (w)	116	sub			sl H <sub>2</sub> O; vs EtOH, eth, CS <sub>2</sub>
1098	4-Bromobenzenoacetonitrile		C <sub>8</sub> H <sub>6</sub> BrN	16532-79-9	196.045	pa ye cry (al)	48.0				vs bz, EtOH
1099	α-Bromobenzenoacetonitrile	α-Bromobenzyl cyanide	C <sub>8</sub> H <sub>6</sub> BrN	5798-79-8	196.045	ye cry (dil al)	29	dec 242; 133 <sup>12</sup>	1.539 <sup>29</sup>		i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
1100	2-Bromo-1,4-benzenediol		C <sub>6</sub> H <sub>3</sub> BrO <sub>2</sub>	583-69-7	189.007	lf (lig), cry (chl)	111.5	sub			vs H <sub>2</sub> O, EtOH, eth, bz; sl chl, lig; s HOAc
1101	4-Bromobenzenesulfonyl chloride	p-Brosyl chloride	C <sub>6</sub> H <sub>4</sub> BrClO <sub>2</sub> S	98-58-8	255.517	tcl or mcl pl (eth)	76	153 <sup>15</sup>			i H <sub>2</sub> O; vs eth; s chl
1102	4-Bromobenzenethiol		C <sub>6</sub> H <sub>4</sub> BrS	106-53-6	189.073	lf (al)	73	230.5	1.5260 <sup>83</sup>		sl H <sub>2</sub> O, EtOH; vs eth, ctc, chl
1103	2-Bromobenzoic acid		C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	88-65-3	201.018	mcl pr (w), nd	150	sub	1.929 <sup>25</sup>		sl H <sub>2</sub> O, DMSO; s EtOH, eth, ace, chl
1104	3-Bromobenzoic acid		C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	585-76-2	201.018	mcl nd (dil al)	155	>280	1.845 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth
1105	4-Bromobenzoic acid		C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	586-76-5	201.018	nd (eth), lf (w), mcl pr	254.5		1.894 <sup>20</sup>		sl H <sub>2</sub> O, DMSO; s EtOH, eth
1106	2-Bromobenzonitrile		C <sub>7</sub> H <sub>5</sub> BrN	2042-37-7	182.018	nd (w)	55.5	252			s H <sub>2</sub> O; vs EtOH; sl chl
1107	3-Bromobenzonitrile		C <sub>7</sub> H <sub>5</sub> BrN	6952-59-6	182.018		39.5	225			vs EtOH, eth; sl chl
1108	4-Bromobenzonitrile		C <sub>7</sub> H <sub>5</sub> BrN	623-00-7	182.018	nd (w, al)	114	236			s H <sub>2</sub> O, EtOH, eth, chl
1109	6-Bromobenzo[a]pyrene		C <sub>20</sub> H <sub>11</sub> Br	21248-00-0	331.205	cry (ace/MeOH)	223				
1110	2-Bromobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> BrClO	7154-66-7	219.463	nd	11	243		1.5963 <sup>20</sup>	sl ctc
1111	4-Bromobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> BrClO	586-75-4	219.463	nd (peth)	42	246; 181 <sup>125</sup>			vs EtOH, eth, bz, lig
1112	2-Bromobiphenyl		C <sub>12</sub> H <sub>9</sub> Br	2052-07-5	233.103		0.8	297	1.2175 <sup>26</sup>	1.6248 <sup>25</sup>	vs eth, EtOH
1113	3-Bromobiphenyl		C <sub>12</sub> H <sub>9</sub> Br	2113-57-7	233.103			300; 171 <sup>17</sup>		1.6411 <sup>20</sup>	i H <sub>2</sub> O
1114	4-Bromobiphenyl		C <sub>12</sub> H <sub>9</sub> Br	92-66-0	233.103	pl (al)	91.5	310	0.9327 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, HOAc; sl chl
1115	1-Bromo-2-(bromomethyl) benzene		C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	3433-80-5	249.931	cry (al, lig)	31	129 <sup>19</sup>			vs eth, EtOH, HOAc
1116	1-Bromo-3-(bromomethyl) benzene		C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	823-78-9	249.931	nd or lf	42	122 <sup>12</sup>			s chl
1117	1-Bromo-4-(bromomethyl) benzene	p-Bromobenzyl bromide	C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	589-15-1	249.931	nd (al)	63				sl H <sub>2</sub> O; s EtOH, bz, chl; vs eth, CS <sub>2</sub>
1118	2-Bromo-2-(bromomethyl) pentanedinitrile	1,2-Dibromo-2,4-dicyanobutane	C <sub>6</sub> H <sub>6</sub> Br <sub>2</sub> N <sub>2</sub>	35691-65-7	265.933		52				i H <sub>2</sub> O; vs ace, bz, DMF
1119	2-Bromo-1-(4-bromophenyl) ethanone	p-Bromophenacyl bromide	C <sub>8</sub> H <sub>7</sub> Br <sub>2</sub> O	99-73-0	277.941	nd (al)	111				i H <sub>2</sub> O; s EtOH, eth, chl
1120	2-Bromo-1,3-butadiene		C <sub>4</sub> H <sub>5</sub> Br	1822-86-2	132.987			42 <sup>165</sup>	1.397 <sup>20</sup>	1.4988 <sup>20</sup>	vs eth, EtOH
1121	1-Bromobutane	Butyl bromide	C <sub>4</sub> H <sub>9</sub> Br	109-65-9	137.018	liq	-112.6	101.6	1.2758 <sup>20</sup>	1.4401 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; sl ctc; s chl
1122	2-Bromobutane, (±)	(±)-sec-Butyl bromide	C <sub>4</sub> H <sub>9</sub> Br	5787-31-5	137.018	liq	-112.65	91.3	1.2585 <sup>20</sup>	1.4366 <sup>20</sup>	vs ace, eth, chl
1123	Bromobutanedioic acid, (±)	Bromosuccinic acid	C <sub>4</sub> H <sub>5</sub> BrO <sub>4</sub>	584-98-5	196.985		161		2.073 <sup>25</sup>		s H <sub>2</sub> O, EtOH; sl HOAc
1124	4-Bromobutanenitrile		C <sub>4</sub> H <sub>6</sub> BrN	5332-06-9	148.002			206	1.4967 <sup>20</sup>	1.4818 <sup>20</sup>	s EtOH, eth, chl
1125	2-Bromobutanoic acid, (±)	DL-α-Bromobutyric acid	C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	2385-70-8	167.002		-2.0	dec 217; 127 <sup>25</sup>	1.5641 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth
1126	4-Bromobutanoic acid		C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	2623-87-2	167.002		33	142 <sup>25</sup> , 125 <sup>7</sup>			
1127	3-Bromo-2-butanone		C <sub>4</sub> H <sub>7</sub> BrO	814-75-5	151.002			36 <sup>11</sup>			
1128	cis-1-Bromo-1-butene		C <sub>4</sub> H <sub>7</sub> Br	31849-78-2	135.003			86.1	1.3265 <sup>15</sup>	1.4536 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl; sl ctc
1129	trans-1-Bromo-1-butene		C <sub>4</sub> H <sub>7</sub> Br	32620-08-9	135.003	liq	-100.3	94.7	1.3209 <sup>15</sup>	1.4527 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl; sl ctc
1130	2-Bromo-1-butene		C <sub>4</sub> H <sub>7</sub> Br	23074-36-4	135.003	liq	-133.4	88	1.3209 <sup>15</sup>	1.4527 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl; sl ctc
1131	4-Bromo-1-butene		C <sub>4</sub> H <sub>7</sub> Br	5162-44-7	135.003			98.5	1.3230 <sup>20</sup>	1.4622 <sup>20</sup>	sl H <sub>2</sub> O; vs bz, eth, EtOH
1132	1-Bromo-2-butene		C <sub>4</sub> H <sub>7</sub> Br	4784-77-4	135.003			104.5	1.3371 <sup>25</sup>	1.4822 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; vs chl, bz
1133	cis-2-Bromo-2-butene		C <sub>4</sub> H <sub>7</sub> Br	3017-68-3	135.003	liq	-111.5	93.9	1.3416 <sup>15</sup>	1.4631 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; vs chl, bz

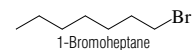
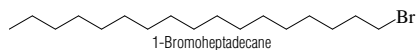
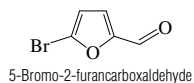
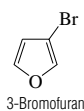
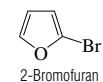
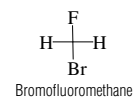
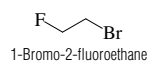
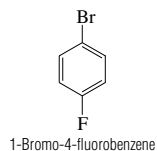
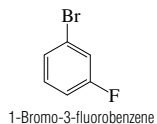
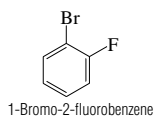
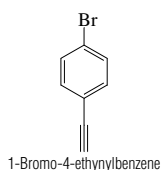
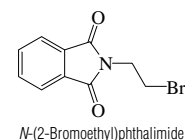
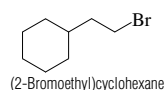
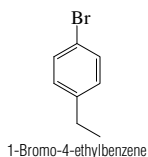
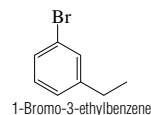
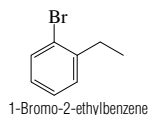
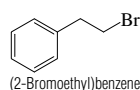
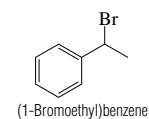
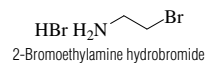
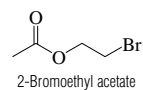
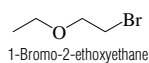
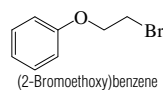
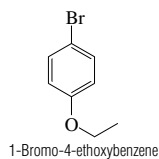
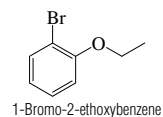
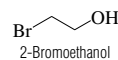
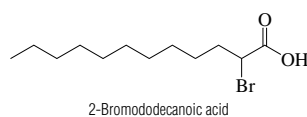
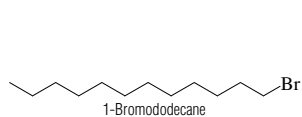
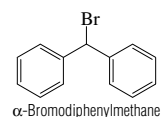
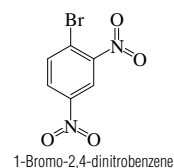
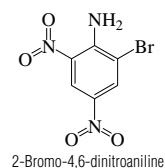
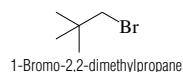
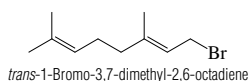
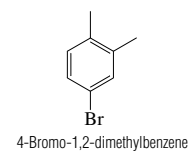
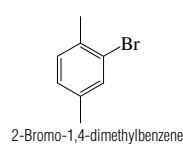
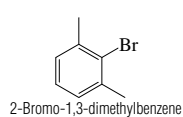
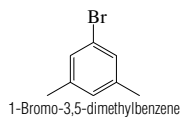
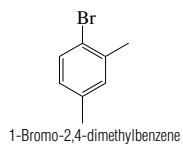
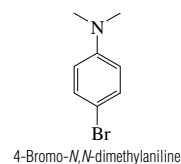
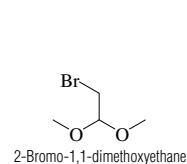
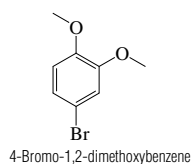
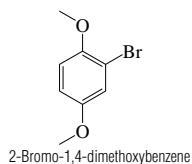
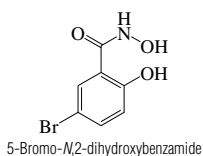


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1134	<i>trans</i> -2-Bromo-2-butene		C <sub>4</sub> H <sub>7</sub> Br	3017-71-8	135.003	liq	-114.6	85.6	1.3323 <sup>15</sup>	1.4602 <sup>16</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; vs chl, bz
1135	(4-Bromobutoxy)benzene		C <sub>10</sub> H <sub>13</sub> BrO	1200-03-9	229.113	cry (al)	41	154 <sup>18</sup>			sl EtOH, ctc
1136	1-Bromo-4- <i>tert</i> -butylbenzene		C <sub>10</sub> H <sub>13</sub> Br	3972-65-4	213.114		19	231.5	1.2286 <sup>20</sup>	1.5436 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
1137	2-Bromo-3'-chloroacetophenone	3-Chlorophenacyl bromide	C <sub>8</sub> H <sub>6</sub> BrClO	41011-01-2	233.490	nd	40	397.5			vs EtOH
1138	1-Bromo-2-chlorobenzene		C <sub>6</sub> H <sub>4</sub> BrCl	694-80-4	191.453	liq	-12.3	204	1.6387 <sup>25</sup>	1.5809 <sup>20</sup>	i H <sub>2</sub> O; vs bz; sl ctc
1139	1-Bromo-3-chlorobenzene		C <sub>6</sub> H <sub>4</sub> BrCl	108-37-2	191.453	liq	-21.5	196	1.6302 <sup>20</sup>	1.5771 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1140	1-Bromo-4-chlorobenzene		C <sub>6</sub> H <sub>4</sub> BrCl	106-39-8	191.453	nd or pl (al, eth)	68	196	1.576 <sup>71</sup>	1.5531 <sup>70</sup>	i H <sub>2</sub> O; sl EtOH; s eth, bz, ctc, chl
1141	1-Bromo-4-chlorobutane		C <sub>4</sub> H <sub>8</sub> BrCl	6940-78-9	171.464			175; 63 <sup>10</sup>	1.489 <sup>20</sup>	1.4885 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; sl ctc
1142	Bromochlorodifluoromethane	Halon 1211	CBrClF <sub>2</sub>	353-59-3	165.365	col gas	-159.5	-3.7			
1143	3-Bromo-1-chloro-5,5-dimethylhydantoin		C <sub>8</sub> H <sub>8</sub> BrClN <sub>2</sub> O <sub>2</sub>	126-06-7	241.471		162				
1144	1-Bromo-1-chloroethane		C <sub>2</sub> H <sub>4</sub> BrCl	593-96-4	143.410			83	1.667 <sup>10</sup>	1.4660 <sup>20</sup>	
1145	1-Bromo-2-chloroethane		C <sub>2</sub> H <sub>4</sub> BrCl	107-04-0	143.410	liq	-16.7	107	1.7392 <sup>20</sup>	1.4908 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
1146	Bromochlorofluoromethane		CHBrClF	593-98-6	147.374	liq	-115	36	1.9771 <sup>10</sup>	1.4144 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace, chl
1147	Bromochloromethane	Halon 1011	CH <sub>2</sub> BrCl	74-97-5	129.384	liq	-87.9	68.0	1.9344 <sup>20</sup>	1.4838 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1148	1-Bromo-4-(chloromethyl)benzene	<i>p</i> -Bromobenzyl chloride	C <sub>7</sub> H <sub>6</sub> BrCl	589-17-3	205.480	nd (al, peth)	50	236			i H <sub>2</sub> O; vs EtOH, eth; s peth
1149	2-Bromo-1-(4-chlorophenyl)ethanone	<i>p</i> -Chlorophenacyl bromide	C <sub>8</sub> H <sub>6</sub> BrClO	536-38-9	233.490	nd	96.5				
1150	1-Bromo-2-chloropropane		C <sub>3</sub> H <sub>6</sub> BrCl	3017-96-7	157.437			118	1.531 <sup>20</sup>	1.4745 <sup>20</sup>	vs ace, bz, eth, EtOH
1151	1-Bromo-3-chloropropane		C <sub>3</sub> H <sub>6</sub> BrCl	109-70-6	157.437	liq	-58.9	143.3	1.5969 <sup>20</sup>	1.4864 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl
1152	2-Bromo-1-chloropropane		C <sub>3</sub> H <sub>6</sub> BrCl	3017-95-6	157.437			117	1.537 <sup>20</sup>	1.4795 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz
1153	2-Bromo-2-chloropropane		C <sub>3</sub> H <sub>6</sub> BrCl	2310-98-7	157.437			95	1.495 <sup>20</sup>	1.4575 <sup>20</sup>	vs ace, bz, eth, EtOH
1154	1-Bromo-2-chloro-1,1,2-trifluoroethane		C <sub>2</sub> HBrClF <sub>3</sub>	354-06-3	197.381			52.5	1.8574 <sup>25</sup>	1.3738 <sup>20</sup>	
1155	2-Bromo-2-chloro-1,1,1-trifluoroethane	Halothane	C <sub>2</sub> HBrClF <sub>3</sub>	151-67-7	197.381			50.2; 20 <sup>243</sup>	1.8563 <sup>25</sup>	1.3697 <sup>10</sup>	sl H <sub>2</sub> O; s peth
1156	Bromocresol Green	Bromocresol Green	C <sub>21</sub> H <sub>14</sub> Br <sub>4</sub> O <sub>3</sub> S	76-60-8	698.014	wh or red (+7w) ye (HOAc)	218.5				sl H <sub>2</sub> O; vs EtOH, eth, AcOEt; s bz
1157	Bromocresol Purple	Bromocresol Purple	C <sub>21</sub> H <sub>16</sub> Br <sub>2</sub> O <sub>3</sub> S	115-40-2	540.222		241.5				
1158	Bromocycloheptane	Cycloheptyl bromide	C <sub>7</sub> H <sub>13</sub> Br	2404-35-5	177.082			101 <sup>40</sup> ; 75 <sup>12</sup>	1.3080 <sup>20</sup>	1.4996 <sup>20</sup>	i H <sub>2</sub> O; vs eth, chl
1159	Bromocyclohexane	Cyclohexyl bromide	C <sub>6</sub> H <sub>11</sub> Br	108-85-0	163.055	liq	-56.5	166.2	1.3359 <sup>20</sup>	1.4957 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
1160	<i>trans</i> -4-Bromocyclohexanol		C <sub>6</sub> H <sub>11</sub> BrO	32388-22-0	179.054	pl (hx)	81.5				
1161	2-Bromocyclohexanone		C <sub>6</sub> H <sub>9</sub> BrO	822-85-5	177.038			114 <sup>32</sup> ; 90 <sup>14</sup>	1.340 <sup>25</sup>	1.5085 <sup>25</sup>	
1162	3-Bromocyclohexene		C <sub>6</sub> H <sub>9</sub> Br	1521-51-3	161.039			81 <sup>40</sup> ; 56 <sup>11</sup>	1.3890 <sup>20</sup>	1.5320 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
1163	Bromocyclopentane	Cyclopentyl bromide	C <sub>5</sub> H <sub>9</sub> Br	137-43-9	149.029			137.5	1.3873 <sup>20</sup>	1.4886 <sup>20</sup>	sl ctc
1164	1-Bromodecane		C <sub>10</sub> H <sub>21</sub> Br	112-29-8	221.178	liq	-29.2	240.6	1.0702 <sup>20</sup>	1.4557 <sup>20</sup>	i H <sub>2</sub> O; vs eth, chl; s ctc
1165	2-Bromodecanoic acid		C <sub>10</sub> H <sub>19</sub> BrO <sub>2</sub>	2623-95-2	251.161		2.0	140 <sup>2</sup>	1.1912 <sup>24</sup>	1.4595 <sup>24</sup>	vs eth
1166	1-Bromo-3,5-dichlorobenzene		C <sub>6</sub> H <sub>3</sub> BrCl <sub>2</sub>	19752-55-7	225.898	pr (al)	83	232			i H <sub>2</sub> O; s EtOH, eth, chl; vs bz
1167	4-Bromo-1,2-dichlorobenzene		C <sub>6</sub> H <sub>3</sub> BrCl <sub>2</sub>	18282-59-2	225.898	pr	25	237			i H <sub>2</sub> O; sl EtOH; vs eth, bz, chl
1168	Bromodichlorofluoromethane	Halon 1121	CBrCl <sub>2</sub> F	353-58-2	181.819	liq		52.8	1.95 <sup>22</sup>		
1169	Bromodichloromethane		CHBrCl <sub>2</sub>	75-27-4	163.829	liq	-57	90	1.980 <sup>20</sup>	1.4964 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz; sl ctc
1170	4-Bromo-2,5-dichlorophenol		C <sub>6</sub> H <sub>3</sub> BrCl <sub>2</sub> O	1940-42-7	241.897	nd	71.5				
1171	2-Bromo-1,1-diethoxyethane		C <sub>6</sub> H <sub>13</sub> BrO <sub>2</sub>	2032-35-1	197.070			170; 66 <sup>18</sup>	1.283 <sup>20</sup>	1.4387 <sup>20</sup>	s EtOH, eth
1172	4-Bromo- <i>N,N</i> -diethylaniline		C <sub>10</sub> H <sub>14</sub> BrN	2052-06-4	228.129	nd or pr	38	270			i H <sub>2</sub> O; vs EtOH, eth
1173	Bromodifluoromethane		CHBrF <sub>2</sub>	1511-62-2	130.920		-145	-14.6	1.55 <sup>16</sup>		s H <sub>2</sub> O; vs EtOH
1174	3-Bromo-4,5-dihydro-2(3 <i>H</i> )-furanone	$\alpha$ -Bromo- $\gamma$ -butyrolactone	C <sub>4</sub> H <sub>5</sub> BrO <sub>2</sub>	5061-21-2	164.986			130 <sup>20</sup>	1.8 <sup>20</sup>	1.5059 <sup>20</sup>	

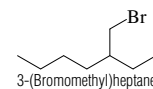
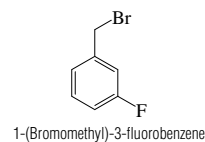
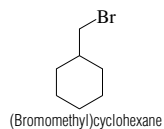
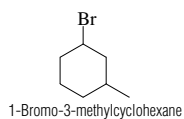
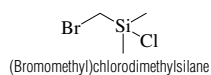
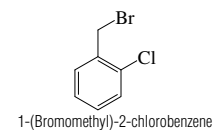
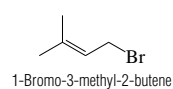
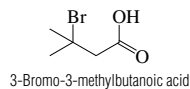
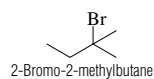
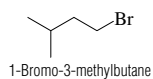
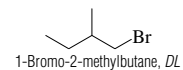
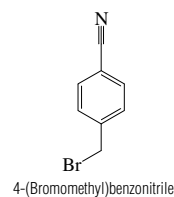
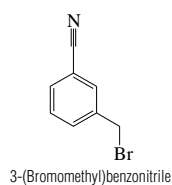
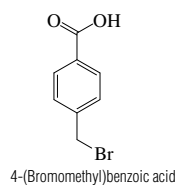
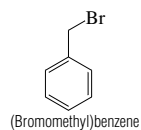
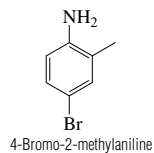
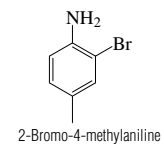
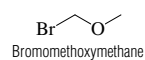
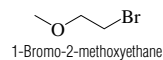
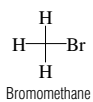
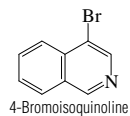
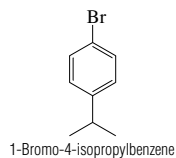
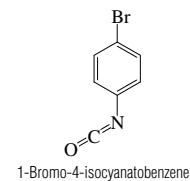
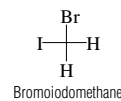
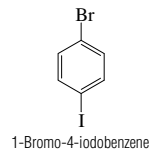
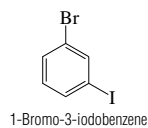
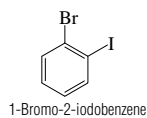
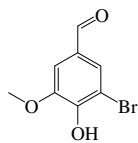
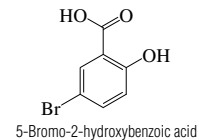
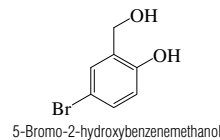
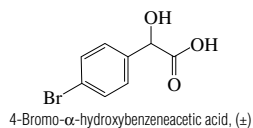
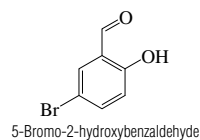
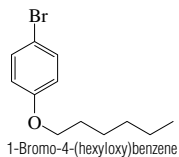
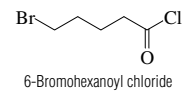
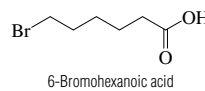
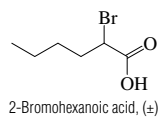
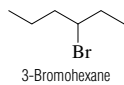
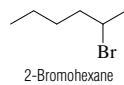
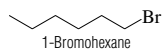
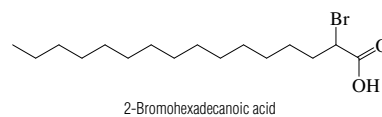
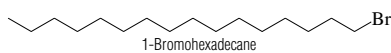
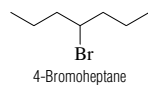
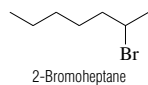


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1175	5-Bromo- <i>N</i> ,2-dihydroxybenzamide	5-Bromosalicylhydroxamic acid	C <sub>7</sub> H <sub>6</sub> BrNO <sub>3</sub>	5798-94-7	232.032	cry (al)	232 dec				
1176	2-Bromo-1,4-dimethoxybenzene		C <sub>8</sub> H <sub>8</sub> BrO <sub>2</sub>	25245-34-5	217.060	oil		262; 130 <sup>10</sup>	1.445	1.5700 <sup>20</sup>	
1177	4-Bromo-1,2-dimethoxybenzene		C <sub>8</sub> H <sub>8</sub> BrO <sub>2</sub>	2859-78-1	217.060			254.5	1.702 <sup>25</sup>	1.5743 <sup>20</sup>	
1178	2-Bromo-1,1-dimethoxyethane		C <sub>4</sub> H <sub>8</sub> BrO <sub>2</sub>	7252-83-7	169.017			149	1.430 <sup>20</sup>	1.4450 <sup>20</sup>	s eth, ace, chl
1179	4-Bromo- <i>N,N</i> -dimethylaniline		C <sub>8</sub> H <sub>10</sub> BrN	586-77-6	200.076		55	264	1.3220 <sup>100</sup>		i H <sub>2</sub> O; s EtOH; vs eth
1180	1-Bromo-2,4-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	583-70-0	185.061	liq	-17	205	1.3419 <sup>20</sup>	1.5501 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace
1181	1-Bromo-3,5-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	556-96-7	185.061			204	1.362 <sup>20</sup>	1.5462 <sup>22</sup>	vs eth; s ace, bz
1182	2-Bromo-1,3-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	576-22-7	185.061			203.5; 100 <sup>20</sup>		1.5552 <sup>20</sup>	vs eth; s ace, bz
1183	2-Bromo-1,4-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	553-94-6	185.061	lf or pl	9	199; 88 <sup>13</sup>	1.3582 <sup>18</sup>	1.5514 <sup>18</sup>	i H <sub>2</sub> O; vs EtOH; s bz
1184	4-Bromo-1,2-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	583-71-1	185.061	liq	-0.2	214.5	1.3708 <sup>20</sup>	1.5530 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1185	<i>trans</i> -1-Bromo-3,7-dimethyl-2,6-octadiene	<i>trans</i> -Geranyl bromide	C <sub>10</sub> H <sub>17</sub> Br	6138-90-5	217.146			101 <sup>12</sup> ; 470 <sup>005</sup>	1.0940 <sup>22</sup>	1.5027 <sup>20</sup>	
1186	1-Bromo-2,2-dimethylpropane		C <sub>5</sub> H <sub>11</sub> Br	630-17-1	151.045			106	1.1997 <sup>20</sup>	1.4370 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; vs chl
1187	2-Bromo-4,6-dinitroaniline		C <sub>6</sub> H <sub>3</sub> BrN <sub>3</sub> O <sub>4</sub>	1817-73-8	262.018	ye nd (al or HOAc)	153.5	sub			vs EtOH, ace; s HOAc
1188	1-Bromo-2,4-dinitrobenzene		C <sub>6</sub> H <sub>3</sub> BrN <sub>2</sub> O <sub>4</sub>	584-48-5	247.003	ye nd (al)	75				vs EtOH
1189	$\alpha$ -Bromodiphenylmethane		C <sub>13</sub> H <sub>11</sub> Br	776-74-9	247.130		45	184 <sup>20</sup> ; 152 <sup>2</sup>			s EtOH, chl; vs bz
1190	1-Bromododecane	Lauryl bromide	C <sub>12</sub> H <sub>25</sub> Br	143-15-7	249.231	liq	-9.5	276	1.0399 <sup>20</sup>	1.4583 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; msc ace
1191	2-Bromododecanoic acid		C <sub>12</sub> H <sub>23</sub> BrO <sub>2</sub>	111-56-8	279.214	pl	32	158 <sup>2</sup>	1.1474 <sup>74</sup>	1.4585 <sup>24</sup>	vs bz, eth, EtOH, lig
1192	Bromoethane	Ethyl bromide	C <sub>2</sub> H <sub>5</sub> Br	74-96-4	108.965	liq	-118.6	38.5	1.4604 <sup>20</sup>	1.4239 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, chl
1193	2-Bromoethanol	Ethylene bromohydrin	C <sub>2</sub> H <sub>5</sub> BrO	540-51-2	124.964			150; 51 <sup>4</sup>	1.7629 <sup>20</sup>	1.4915 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl lig
1194	Bromoethene	Vinyl bromide	C <sub>2</sub> H <sub>3</sub> Br	593-60-2	106.949	vol liq or gas	-139.54	15.8	1.4933 <sup>20</sup>	1.4380 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
1195	1-Bromo-2-ethoxybenzene		C <sub>8</sub> H <sub>9</sub> BrO	583-19-7	201.060			223	1.4223 <sup>20</sup>		vs eth, EtOH
1196	1-Bromo-4-ethoxybenzene		C <sub>8</sub> H <sub>9</sub> BrO	588-96-5	201.060		2.0	231	1.4071 <sup>25</sup>	1.5517 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s chl
1197	(2-Bromoethoxy)benzene		C <sub>8</sub> H <sub>9</sub> BrO	589-10-6	201.060		39	dec 240; 128 <sup>20</sup>	1.3555 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth
1198	1-Bromo-2-ethoxyethane	2-Bromoethyl ethyl ether	C <sub>6</sub> H <sub>9</sub> BrO	592-55-2	153.017			127.5	1.3852 <sup>0</sup>	1.4447 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
1199	2-Bromoethyl acetate		C <sub>6</sub> H <sub>9</sub> BrO <sub>2</sub>	927-68-4	167.002	liq	-13.8	162.5	1.514 <sup>20</sup>	1.457 <sup>23</sup>	vs H <sub>2</sub> O, chl; msc EtOH, eth
1200	2-Bromoethylamine hydrobromide	2-Bromoethanamine hydrobromide	C <sub>2</sub> H <sub>7</sub> Br <sub>2</sub> N	2576-47-8	204.892		174.0				
1201	(1-Bromoethyl)benzene		C <sub>8</sub> H <sub>9</sub> Br	585-71-7	185.061			219; 92 <sup>11</sup>	1.3535 <sup>25</sup>	1.5543 <sup>25</sup>	
1202	(2-Bromoethyl)benzene		C <sub>8</sub> H <sub>9</sub> Br	103-63-9	185.061	liq	-55.9	219; 105 <sup>18</sup>	1.3643 <sup>20</sup>	1.5372 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz; sl ctc
1203	1-Bromo-2-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	1973-22-4	185.061	liq	-67.9	199.3	1.3548 <sup>20</sup>	1.5472 <sup>20</sup>	vs ace, bz, eth, EtOH
1204	1-Bromo-3-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	2725-82-8	185.061			202	1.3493 <sup>20</sup>	1.5465 <sup>20</sup>	
1205	1-Bromo-4-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Br	1585-07-5	185.061	liq	-43.5	204	1.3423 <sup>20</sup>	1.5445 <sup>20</sup>	vs ace, bz, eth, EtOH
1206	(2-Bromoethyl)cyclohexane		C <sub>8</sub> H <sub>15</sub> Br	1647-26-3	191.109	liq	-57	212	1.2357 <sup>20</sup>	1.4899 <sup>20</sup>	
1207	<i>N</i> -(2-Bromoethyl)phthalimide		C <sub>10</sub> H <sub>9</sub> BrNO <sub>2</sub>	574-98-1	254.081	nd (w)	83				vs eth; sl chl
1208	1-Bromo-4-ethynylbenzene		C <sub>8</sub> H <sub>7</sub> Br	766-96-1	181.030		64.5	89 <sup>16</sup>			s chl
1209	1-Bromo-2-fluorobenzene		C <sub>6</sub> H <sub>4</sub> BrF	1072-85-1	174.998			154	1.0738 <sup>21</sup>	1.5337 <sup>20</sup>	
1210	1-Bromo-3-fluorobenzene		C <sub>6</sub> H <sub>4</sub> BrF	1073-06-9	174.998			150	1.7081 <sup>20</sup>	1.5257 <sup>20</sup>	s ctc
1211	1-Bromo-4-fluorobenzene		C <sub>6</sub> H <sub>4</sub> BrF	460-00-4	174.998	liq	-17.4	151.5	1.593 <sup>15</sup>	1.5310 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
1212	1-Bromo-2-fluoroethane		C <sub>2</sub> H <sub>4</sub> BrF	762-49-2	126.955			71.5	1.7044 <sup>25</sup>	1.4236 <sup>20</sup>	vs eth, EtOH
1213	Bromofluoromethane		CH <sub>2</sub> BrF	373-52-4	112.929	vol liq or gas		19			s EtOH; vs chl
1214	2-Bromofuran		C <sub>4</sub> H <sub>3</sub> BrO	584-12-3	146.970			103	1.6500 <sup>20</sup>	1.4980 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz
1215	3-Bromofuran		C <sub>4</sub> H <sub>3</sub> BrO	22037-28-1	146.970			103	1.6606 <sup>20</sup>	1.4958 <sup>20</sup>	vs ace, bz, eth, EtOH
1216	5-Bromo-2-furancarboxaldehyde		C <sub>5</sub> H <sub>3</sub> BrO <sub>2</sub>	1899-24-7	174.981	cry (50% al)	83.5	201; 112 <sup>16</sup>			vs eth, EtOH
1217	1-Bromoheptadecane		C <sub>17</sub> H <sub>35</sub> Br	3508-00-7	319.364		29.6	349	0.9916 <sup>20</sup>	1.4625 <sup>20</sup>	i H <sub>2</sub> O; vs chl
1218	1-Bromoheptane	Heptyl bromide	C <sub>7</sub> H <sub>15</sub> Br	629-04-9	179.098	liq	-56.1	178.9	1.1400 <sup>20</sup>	1.4502 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc; s chl

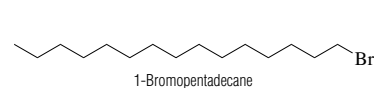
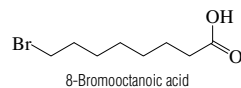
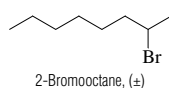
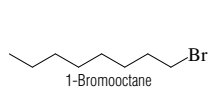
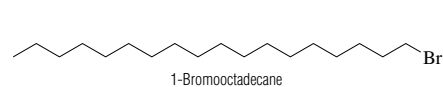
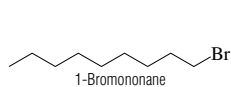
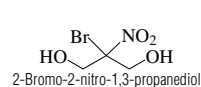
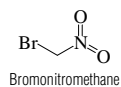
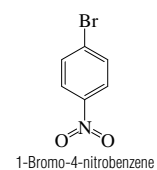
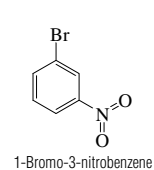
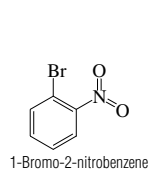
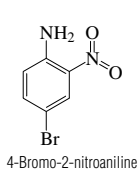
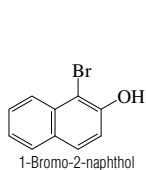
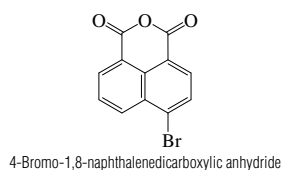
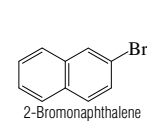
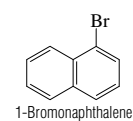
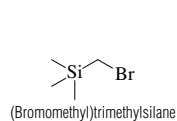
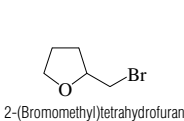
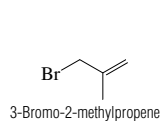
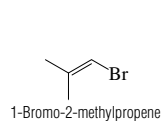
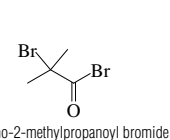
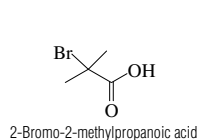
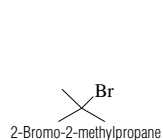
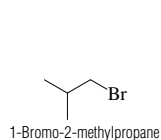
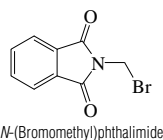
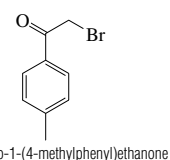
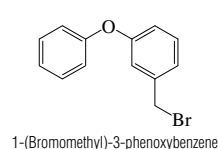
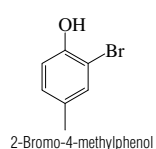
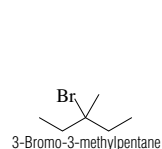
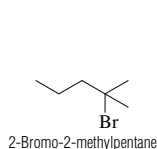
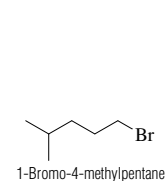
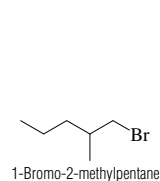
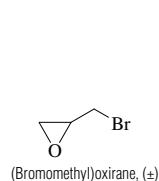
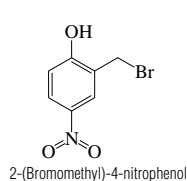
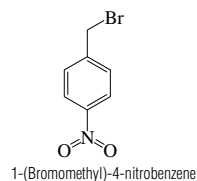
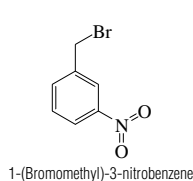
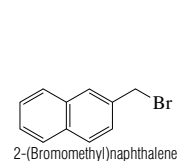
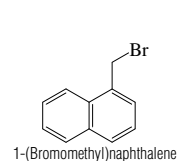
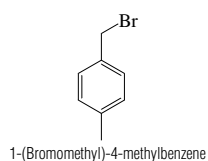
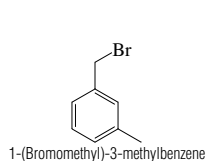
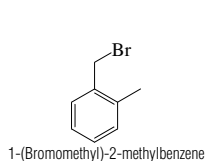




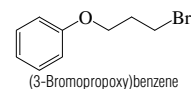
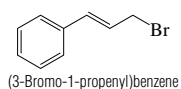
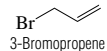
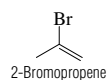
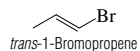
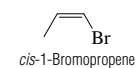
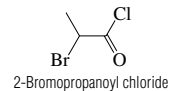
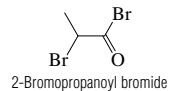
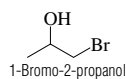
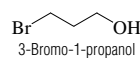
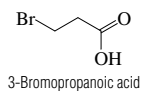
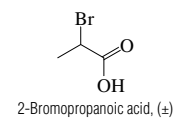
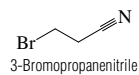
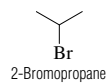
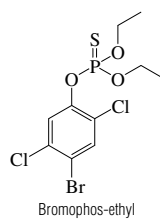
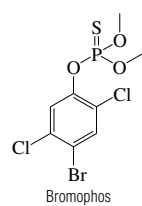
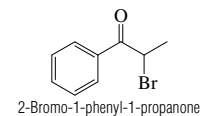
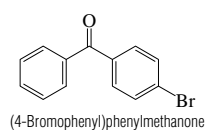
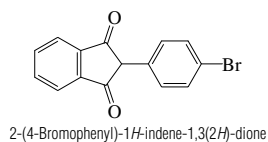
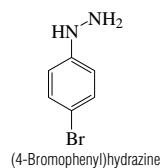
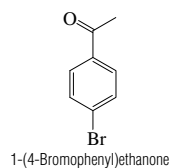
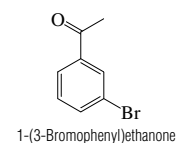
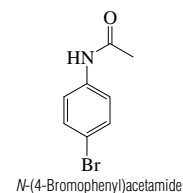
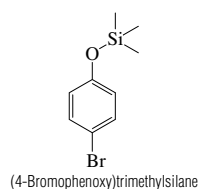
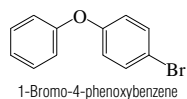
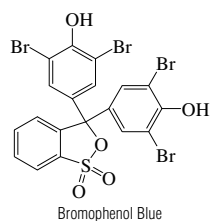
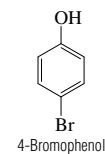
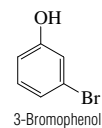
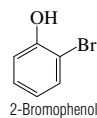
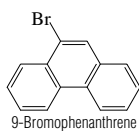
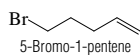
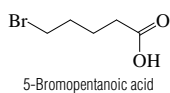
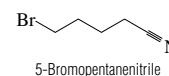
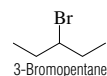
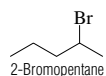
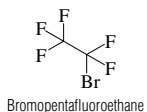
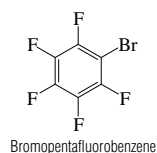
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1219	2-Bromoheptane	2-Heptyl bromide	C <sub>7</sub> H <sub>15</sub> Br	1974-04-5	179.098		47	166	1.1277 <sup>20</sup>	1.4503 <sup>20</sup>	i H <sub>2</sub> O; vs bz; s ctc, chl
1220	4-Bromoheptane	4-Heptyl bromide	C <sub>7</sub> H <sub>15</sub> Br	998-93-6	179.098			161; 84 <sup>72</sup>	1.1351 <sup>20</sup>	1.4495 <sup>20</sup>	i H <sub>2</sub> O; s bz, ctc, chl
1221	1-Bromohexadecane		C <sub>16</sub> H <sub>33</sub> Br	112-82-3	305.337		18	336	0.9991 <sup>20</sup>	1.4618 <sup>25</sup>	i H <sub>2</sub> O; s eth
1222	2-Bromohexadecanoic acid		C <sub>16</sub> H <sub>31</sub> BrO <sub>2</sub>	18263-25-7	335.320		52.8				
1223	1-Bromohexane	Hexyl bromide	C <sub>6</sub> H <sub>13</sub> Br	111-25-1	165.071	liq	-83.7	155.3	1.1744 <sup>20</sup>	1.4478 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace; vs chl
1224	2-Bromohexane		C <sub>6</sub> H <sub>13</sub> Br	3377-86-4	165.071			143; 78 <sup>90</sup>	1.1658 <sup>20</sup>	1.4832 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace; sl ctc
1225	3-Bromohexane		C <sub>6</sub> H <sub>13</sub> Br	3377-87-5	165.071			142	1.1799 <sup>20</sup>	1.4472 <sup>20</sup>	vs ace, eth, EtOH, chl
1226	2-Bromohexanoic acid, (±)		C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	2681-83-6	195.054		2.0	240; 140 <sup>23</sup>	1.2810 <sup>33</sup>		s EtOH, eth
1227	6-Bromohexanoic acid		C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	4224-70-8	195.054	cry (peth)	35	167 <sup>20</sup>			vs peth
1228	6-Bromohexanoyl chloride		C <sub>6</sub> H <sub>10</sub> BrClO	22809-37-6	213.499			101 <sup>6</sup>			
1229	1-Bromo-4-(hexyloxy)benzene		C <sub>12</sub> H <sub>17</sub> BrO	30752-19-3	257.166			156 <sup>13</sup>	1.2306 <sup>20</sup>	1.5262 <sup>20</sup>	
1230	5-Bromo-2-hydroxybenzaldehyde		C <sub>7</sub> H <sub>6</sub> BrO <sub>2</sub>	1761-61-1	201.018	nd (al), lf (eth)	105.5				i H <sub>2</sub> O; s EtOH, eth; sl chl
1231	4-Bromo-α-hydroxybenzeneacetic acid, (±)	p-Bromomandelic acid	C <sub>8</sub> H <sub>7</sub> BrO <sub>3</sub>	7021-04-7	231.044		119				vs H <sub>2</sub> O, EtOH, eth, bz, chl
1232	5-Bromo-2-hydroxybenzenemethanol	Bromosaligenin	C <sub>7</sub> H <sub>7</sub> BrO <sub>2</sub>	2316-64-5	203.034	lf (bz)	113				vs bz, eth, EtOH, chl
1233	5-Bromo-2-hydroxybenzoic acid		C <sub>7</sub> H <sub>5</sub> BrO <sub>3</sub>	89-55-4	217.017	nd (w, dil al)	169.8	sub 100			sl H <sub>2</sub> O, ace; vs EtOH, eth
1234	3-Bromo-4-hydroxy-5-methoxybenzaldehyde		C <sub>9</sub> H <sub>7</sub> BrO <sub>3</sub>	2973-76-4	231.044	pl (HOAc), nd, pl (al)	167.0				i H <sub>2</sub> O; s EtOH, DMSO; sl eth, bz
1235	1-Bromo-2-iodobenzene		C <sub>6</sub> H <sub>4</sub> BrI	583-55-1	282.904		9.5	257; 120 <sup>15</sup>	2.2570 <sup>25</sup>	1.6618 <sup>25</sup>	i H <sub>2</sub> O; sl EtOH, HOAc; s ace
1236	1-Bromo-3-iodobenzene		C <sub>6</sub> H <sub>4</sub> BrI	591-18-4	282.904	liq	-9.3	252; 120 <sup>18</sup>			i H <sub>2</sub> O; sl EtOH, HOAc
1237	1-Bromo-4-iodobenzene		C <sub>6</sub> H <sub>4</sub> BrI	589-87-7	282.904	pr or pl (eth-al)	92	252			i H <sub>2</sub> O; sl EtOH, chl; s eth
1238	Bromiodomethane		CH <sub>2</sub> BrI	557-68-6	220.835			139.5	2.926 <sup>17</sup>	1.6410 <sup>20</sup>	vs chl
1239	1-Bromo-4-isocyanatobenzene	p-Bromophenyl isocyanate	C <sub>7</sub> H <sub>4</sub> BrNO	2493-02-9	198.017	nd		226			vs eth
1240	1-Bromo-4-isopropylbenzene		C <sub>9</sub> H <sub>11</sub> Br	586-61-8	199.087	liq	-22.5	218.7	1.3145 <sup>20</sup>	1.5569 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl; sl ctc
1241	4-Bromoisquinoline		C <sub>9</sub> H <sub>6</sub> BrN	1532-97-4	208.055	cry (peth)	41.5	282.5			vs eth
1242	Bromomethane	Methyl bromide	CH <sub>3</sub> Br	74-83-9	94.939	col gas	-93.68	3.5	1.6755 <sup>20</sup>	1.4218 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, chl, CS <sub>2</sub>
1243	1-Bromo-2-methoxyethane		C <sub>3</sub> H <sub>7</sub> BrO	6482-24-2	138.991			110	1.4623 <sup>20</sup>	1.44753 <sup>20</sup>	
1244	Bromomethoxymethane		C <sub>2</sub> H <sub>5</sub> BrO	13057-17-5	124.964			87	1.5976 <sup>20</sup>	1.4562 <sup>20</sup>	
1245	2-Bromo-4-methylaniline		C <sub>7</sub> H <sub>8</sub> BrN	583-68-6	186.050	lf	26	240	1.510 <sup>20</sup>	1.5999 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
1246	4-Bromo-2-methylaniline		C <sub>7</sub> H <sub>8</sub> BrN	583-75-5	186.050	cry (al)	59.5	240			sl H <sub>2</sub> O, chl; s EtOH; vs eth, HOAc
1247	(Bromomethyl)benzene	Benzyl bromide	C <sub>7</sub> H <sub>7</sub> Br	100-39-0	171.035	liq	-1.5	201	1.4380 <sup>25</sup>	1.5752 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
1248	4-(Bromomethyl)benzoic acid		C <sub>8</sub> H <sub>7</sub> BrO <sub>2</sub>	6232-88-8	215.045		226.3				
1249	3-(Bromomethyl)benzotrile		C <sub>8</sub> H <sub>6</sub> BrN	28188-41-2	196.045		96.5	130 <sup>4</sup>			
1250	4-(Bromomethyl)benzotrile		C <sub>8</sub> H <sub>6</sub> BrN	17201-43-3	196.045		114				
1251	1-Bromo-2-methylbutane, DL		C <sub>6</sub> H <sub>11</sub> Br	5973-11-5	151.045			119	1.2205 <sup>20</sup>	1.4452 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs chl
1252	1-Bromo-3-methylbutane	Isopentyl bromide	C <sub>6</sub> H <sub>11</sub> Br	107-82-4	151.045	liq	-112	120.4	1.2071 <sup>20</sup>	1.4420 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc; vs chl
1253	2-Bromo-2-methylbutane	tert-Pentyl bromide	C <sub>6</sub> H <sub>11</sub> Br	507-36-8	151.045			108	1.197 <sup>18</sup>	1.4421	
1254	3-Bromo-3-methylbutanoic acid	β-Bromoisovaleric acid	C <sub>6</sub> H <sub>9</sub> BrO <sub>2</sub>	5798-88-9	181.028	nd (lig)	74				vs bz, eth, EtOH
1255	1-Bromo-3-methyl-2-butene		C <sub>6</sub> H <sub>9</sub> Br	870-63-3	149.029			dec 131; 50 <sup>40</sup>	1.2930 <sup>15</sup>	1.4930 <sup>15</sup>	vs ace, bz, eth, EtOH
1256	1-(Bromomethyl)-2-chlorobenzene		C <sub>7</sub> H <sub>6</sub> BrCl	611-17-6	205.480			109 <sup>10</sup>			
1257	(Bromomethyl)chlorodimethylsilane		C <sub>3</sub> H <sub>8</sub> BrClSi	16532-02-8	187.539			131	1.375 <sup>25</sup>	1.4630 <sup>25</sup>	
1258	1-Bromo-3-methylcyclohexane	3-Methylcyclohexyl bromide	C <sub>7</sub> H <sub>13</sub> Br	13905-48-1	177.082			181; 60 <sup>11</sup>	1.2676 <sup>15</sup>	1.4979 <sup>20</sup>	i H <sub>2</sub> O; vs eth; s bz
1259	(Bromomethyl)cyclohexane		C <sub>7</sub> H <sub>13</sub> Br	2550-36-9	177.082			76 <sup>26</sup>	1.283 <sup>20</sup>	1.4907 <sup>20</sup>	vs bz, eth, chl
1260	1-(Bromomethyl)-3-fluorobenzene		C <sub>7</sub> H <sub>6</sub> BrF	456-41-7	189.025			88 <sup>20</sup>		1.5474 <sup>20</sup>	
1261	3-(Bromomethyl)heptane		C <sub>8</sub> H <sub>17</sub> Br	18908-66-2	193.125			67 <sup>10</sup>			



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1262	1-(Bromomethyl)-2-methylbenzene		C <sub>8</sub> H <sub>9</sub> Br	89-92-9	185.061	pr	21	217; 108 <sup>16</sup>	1.3811 <sup>23</sup>	1.5730 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1263	1-(Bromomethyl)-3-methylbenzene		C <sub>8</sub> H <sub>9</sub> Br	620-13-3	185.061			212.5	1.3711 <sup>23</sup>	1.5660 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1264	1-(Bromomethyl)-4-methylbenzene		C <sub>8</sub> H <sub>9</sub> Br	104-81-4	185.061	nd (al)	35	220	1.324 <sup>25</sup>		i H <sub>2</sub> O; s EtOH; vs eth, chl
1265	1-(Bromomethyl)naphthalene		C <sub>11</sub> H <sub>9</sub> Br	3163-27-7	221.093	cry (peth, al)	56	183 <sup>16</sup> , 167 <sup>10</sup>			vs ace, bz, eth, EtOH
1266	2-(Bromomethyl)naphthalene		C <sub>11</sub> H <sub>9</sub> Br	939-26-4	221.093	lf (al)	56	213 <sup>100</sup> , 167 <sup>14</sup>			s EtOH, eth, chl, HOAc
1267	1-(Bromomethyl)-3-nitrobenzene		C <sub>7</sub> H <sub>6</sub> BrNO <sub>2</sub>	3958-57-4	216.033	nd or pl (al)	59.3	162 <sup>13</sup>			i H <sub>2</sub> O; s EtOH
1268	1-(Bromomethyl)-4-nitrobenzene		C <sub>7</sub> H <sub>6</sub> BrNO <sub>2</sub>	100-11-8	216.033	nd (al)	99.5				sl H <sub>2</sub> O, chl; vs EtOH, eth; s HOAc
1269	2-(Bromomethyl)-4-nitrophenol		C <sub>7</sub> H <sub>6</sub> BrNO <sub>3</sub>	772-33-8	232.032		148				
1270	(Bromomethyl)oxirane, (±)		C <sub>3</sub> H <sub>5</sub> BrO	82584-73-4	136.975	liq	-40	137	1.615 <sup>14</sup>	1.4841 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
1271	1-Bromo-2-methylpentane	2-Methylpentyl bromide	C <sub>6</sub> H <sub>13</sub> Br	25346-33-2	165.071			141	1.1624 <sup>20</sup>	1.4495 <sup>20</sup>	vs eth, chl
1272	1-Bromo-4-methylpentane		C <sub>6</sub> H <sub>13</sub> Br	626-88-0	165.071			145	1.1683 <sup>20</sup>	1.4490	vs eth, chl
1273	2-Bromo-2-methylpentane		C <sub>6</sub> H <sub>13</sub> Br	4283-80-1	165.071			142.5; 70 <sup>100</sup>		1.442 <sup>23</sup>	vs eth, chl
1274	3-Bromo-3-methylpentane		C <sub>6</sub> H <sub>13</sub> Br	25346-31-0	165.071			130; 76 <sup>100</sup>	1.1835 <sup>20</sup>	1.4525 <sup>20</sup>	vs eth, chl
1275	2-Bromo-4-methylphenol		C <sub>7</sub> H <sub>7</sub> BrO	6627-55-0	187.034	nd (peth)	56.5	213.5	1.5422 <sup>25</sup>	1.5772 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, bz, chl
1276	1-(Bromomethyl)-3-phenoxybenzene	3-Phenoxybenzyl bromide	C <sub>13</sub> H <sub>11</sub> BrO	51632-16-7	263.129	oil					
1277	2-Bromo-1-(4-methylphenyl)ethanone		C <sub>9</sub> H <sub>9</sub> BrO	619-41-0	213.070	nd or lf (al)	51	157 <sup>14</sup>			vs eth, EtOH
1278	<i>N</i> -(Bromomethyl)phthalimide	2-(Bromomethyl)-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione	C <sub>9</sub> H <sub>6</sub> BrNO <sub>2</sub>	5332-26-3	240.054	pr (chl, bz)	151.5				s ace; sl bz, chl; vs AcOEt
1279	1-Bromo-2-methylpropane	Isobutyl bromide	C <sub>4</sub> H <sub>9</sub> Br	78-77-3	137.018	liq	-119	91.1	1.272 <sup>15</sup>	1.4348 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, chl, bz; s ctc
1280	2-Bromo-2-methylpropane	<i>tert</i> -Butyl bromide	C <sub>4</sub> H <sub>9</sub> Br	507-19-7	137.018	liq	-16.2	73.3	1.4278 <sup>20</sup>	1.4278 <sup>20</sup>	i H <sub>2</sub> O; sl ctc
1281	2-Bromo-2-methylpropanoic acid	$\alpha$ -Bromoisobutyric acid	C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	2052-01-9	167.002	cry (peth)	48.5	199; 115 <sup>24</sup>	1.4969 <sup>60</sup>		
1282	2-Bromo-2-methylpropanoyl bromide		C <sub>4</sub> H <sub>6</sub> Br <sub>2</sub> O	20769-85-1	229.898			163	1.4067 <sup>14</sup>		vs ace, CS <sub>2</sub>
1283	1-Bromo-2-methylpropene		C <sub>4</sub> H <sub>7</sub> Br	3017-69-4	135.003			91	1.336 <sup>20</sup>		
1284	3-Bromo-2-methylpropene		C <sub>4</sub> H <sub>7</sub> Br	1458-98-6	135.003			95	1.313 <sup>20</sup>		
1285	2-(Bromomethyl)tetrahydrofuran		C <sub>5</sub> H <sub>9</sub> BrO	1192-30-9	165.028			170; 70 <sup>22</sup>	1.4679 <sup>20</sup>	1.4850 <sup>20</sup>	s EtOH, eth
1286	(Bromomethyl)trimethylsilane		C <sub>4</sub> H <sub>11</sub> BrSi	18243-41-9	167.120			116.5	1.170 <sup>25</sup>	1.4460 <sup>20</sup>	
1287	1-Bromonaphthalene	1-Naphthyl bromide	C <sub>10</sub> H <sub>7</sub> Br	90-11-9	207.067	oily liq	6.1	281	1.4785 <sup>20</sup>	1.658 <sup>20</sup>	s H <sub>2</sub> O, ace; msc EtOH, eth, bz; sl ctc
1288	2-Bromonaphthalene		C <sub>10</sub> H <sub>7</sub> Br	580-13-2	207.067	pl or orth lf (al)	55.9	281.5	1.605 <sup>25</sup>	1.6382 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> ; sl ctc
1289	4-Bromo-1,8-naphthalenedicarboxylic anhydride		C <sub>12</sub> H <sub>6</sub> BrO <sub>3</sub>	81-86-7	277.070		222				
1290	1-Bromo-2-naphthol	1-Bromo- $\beta$ -naphthol	C <sub>10</sub> H <sub>7</sub> BrO	573-97-7	223.066	orth pr (bz-lig) nd (HOAc)	84	130			i H <sub>2</sub> O; s EtOH, eth, bz; sl chl; vs HOAc
1291	4-Bromo-2-nitroaniline		C <sub>6</sub> H <sub>6</sub> BrN <sub>2</sub> O <sub>2</sub>	875-51-4	217.020	oran-ye nd (w)	111.5	sub			vs EtOH
1292	1-Bromo-2-nitrobenzene		C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	577-19-5	202.006	pa ye (al)	43	258	1.6245 <sup>60</sup>		i H <sub>2</sub> O; vs EtOH; s eth, ace, bz; sl chl
1293	1-Bromo-3-nitrobenzene		C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	585-79-5	202.006	orth	56	265	1.7036 <sup>20</sup>	1.5979 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz
1294	1-Bromo-4-nitrobenzene	<i>p</i> -Nitrobromobenzene	C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	586-78-7	202.006	orth or mcl pr (al)	127	256	1.948 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, bz; sl chl
1295	Bromonitromethane		CH <sub>2</sub> BrNO <sub>2</sub>	563-70-2	139.937			149; 71 <sup>40</sup>		1.4880 <sup>20</sup>	vs EtOH
1296	2-Bromo-2-nitro-1,3-propanediol	Bronopol	C <sub>3</sub> H <sub>5</sub> BrNO <sub>4</sub>	52-51-7	199.989		131.5				
1297	1-Bromononane		C <sub>9</sub> H <sub>19</sub> Br	693-58-3	207.151	liq	-29.0	221.4; 88 <sup>4</sup>	1.0845 <sup>25</sup>	1.4522 <sup>25</sup>	
1298	1-Bromooctadecane		C <sub>18</sub> H <sub>37</sub> Br	112-89-0	333.391	cry (al)	28.2	362; 210 <sup>10</sup>	0.9848 <sup>20</sup>	1.4631 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
1299	1-Bromooctane	Octyl bromide	C <sub>8</sub> H <sub>17</sub> Br	111-83-1	193.125	liq	-55.0	200.8	1.1072 <sup>25</sup>	1.4503 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
1300	2-Bromooctane, (±)		C <sub>8</sub> H <sub>17</sub> Br	60251-57-2	193.125			188.5	1.0878 <sup>25</sup>	1.4442 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth
1301	8-Bromooctanoic acid		C <sub>8</sub> H <sub>15</sub> BrO <sub>2</sub>	17696-11-6	223.108	nd (peth)	38.5	147 <sup>2</sup>			vs bz, eth, EtOH
1302	1-Bromopentadecane		C <sub>15</sub> H <sub>31</sub> Br	629-72-1	291.311		19	322	1.0675 <sup>20</sup>	1.4611 <sup>20</sup>	i H <sub>2</sub> O; s ace; vs chl

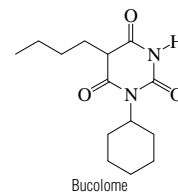
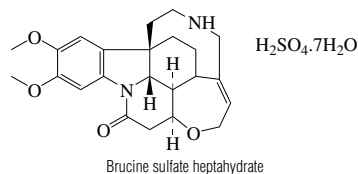
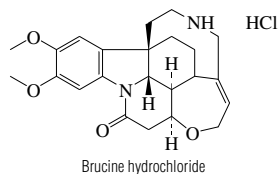
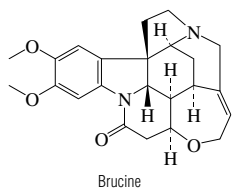
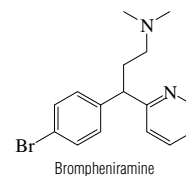
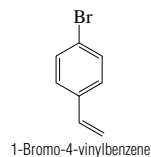
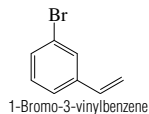
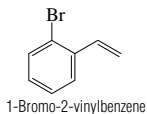
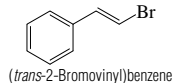
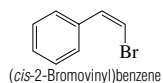
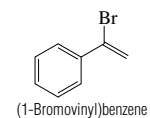
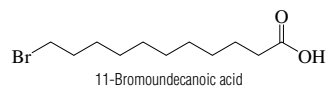
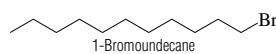
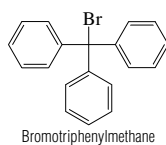
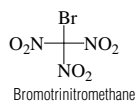
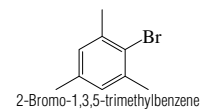
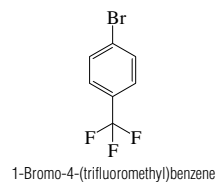
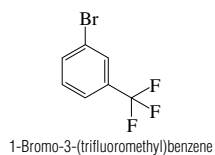
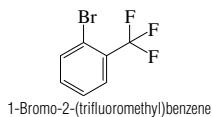
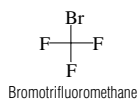
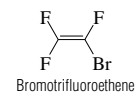
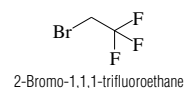
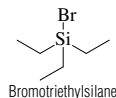
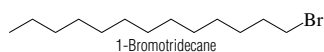
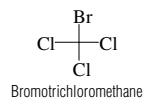
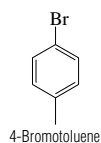
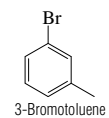
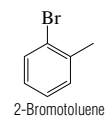
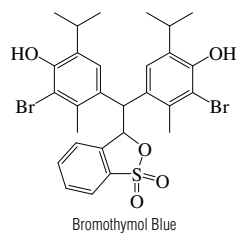
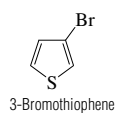
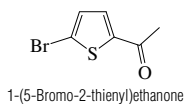
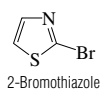
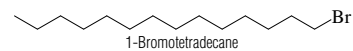
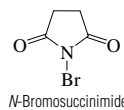
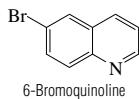
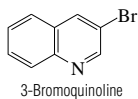
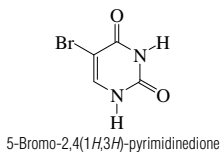
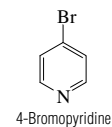
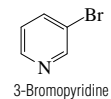
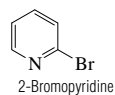
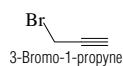
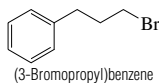
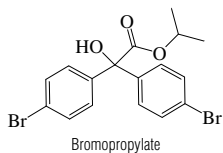


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1303	Bromopentafluorobenzene		C <sub>6</sub> BrF <sub>5</sub>	344-04-7	246.960	liq	-31	137	1.981 <sup>25</sup>	1.4490 <sup>20</sup>	
1304	Bromopentafluoroethane		C <sub>2</sub> BrF <sub>5</sub>	354-55-2	198.917	col gas		-21	1.8098 <sup>25</sup>		
1305	1-Bromopentane	Pentyl bromide	C <sub>5</sub> H <sub>11</sub> Br	110-53-2	151.045	liq	-88.0	129.8	1.2182 <sup>20</sup>	1.4447 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl; sl ctc; msc eth
1306	2-Bromopentane		C <sub>5</sub> H <sub>11</sub> Br	107-81-3	151.045	liq	-95.5	117.4	1.2075 <sup>20</sup>	1.4413 <sup>20</sup>	vs bz, eth, EtOH, chl
1307	3-Bromopentane		C <sub>5</sub> H <sub>11</sub> Br	1809-10-5	151.045	liq	-126.2	118.6	1.214 <sup>20</sup>	1.4441 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
1308	5-Bromopentanenitrile		C <sub>5</sub> H <sub>9</sub> BrN	5414-21-1	162.029			111 <sup>12</sup> , 103 <sup>10</sup>	1.3989 <sup>20</sup>	1.4780 <sup>20</sup>	
1309	5-Bromopentanoic acid		C <sub>5</sub> H <sub>9</sub> BrO <sub>2</sub>	2067-33-6	181.028		40.0	142 <sup>13</sup>			s chl
1310	5-Bromo-1-pentene		C <sub>5</sub> H <sub>9</sub> Br	1119-51-3	149.029			125.5	1.2581 <sup>20</sup>	1.4640 <sup>20</sup>	
1311	9-Bromophenanthrene	9-Phenanthryl bromide	C <sub>14</sub> H <sub>9</sub> Br	573-17-1	257.125	pr (al)	64.5	>360	1.4093 <sup>10</sup>		i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub> ; sl chl
1312	2-Bromophenol		C <sub>6</sub> H <sub>6</sub> BrO	95-56-7	173.007		5.6	194.5	1.4924 <sup>20</sup>	1.589 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, alk
1313	3-Bromophenol		C <sub>6</sub> H <sub>6</sub> BrO	591-20-8	173.007		33	236.5			sl H <sub>2</sub> O, ctc; vs EtOH, eth; s chl, alk
1314	4-Bromophenol		C <sub>6</sub> H <sub>6</sub> BrO	106-41-2	173.007		66.4	238	1.840 <sup>15</sup>		s H <sub>2</sub> O, chl; vs EtOH, eth
1315	Bromophenol Blue	Bromphenol Blue	C <sub>19</sub> H <sub>10</sub> Br <sub>4</sub> O <sub>5</sub> S	115-39-9	669.960	hex pr (HOAc-ace)	279 dec				sl H <sub>2</sub> O; s EtOH, bz, HOAc
1316	1-Bromo-4-phenoxybenzene	4-Bromophenyl phenyl ether	C <sub>12</sub> H <sub>9</sub> BrO	101-55-3	249.102		18.72	126 <sup>3,5</sup>	1.6088 <sup>20</sup>	1.6084 <sup>20</sup>	i H <sub>2</sub> O; s eth, ctc
1317	(4-Bromophenoxy)trimethylsilane		C <sub>9</sub> H <sub>13</sub> BrOSi	17878-44-3	245.188			126 <sup>25</sup>	1.2619 <sup>20</sup>	1.5145 <sup>20</sup>	
1318	<i>N</i> -(4-Bromophenyl)acetamide	<i>p</i> -Bromoacetanilide	C <sub>8</sub> H <sub>8</sub> BrNO	103-88-8	214.060	nd (60% al)	168		1.717 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, chl; sl eth, bz
1319	1-(3-Bromophenyl)ethanone		C <sub>8</sub> H <sub>7</sub> BrO	2142-63-4	199.045		7.5	133 <sup>19</sup>		1.5755 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz
1320	1-(4-Bromophenyl)ethanone	<i>p</i> -Bromoacetophenone	C <sub>8</sub> H <sub>7</sub> BrO	99-90-1	199.045	lf (al)	50.5	257; 130 <sup>11</sup>	1.647 <sup>25</sup>	1.647	i H <sub>2</sub> O; s EtOH, eth, bz, ctc, HOAc
1321	(4-Bromophenyl)hydrazine	( <i>p</i> -Bromophenyl)hydrazine	C <sub>8</sub> H <sub>8</sub> BrN <sub>2</sub>	589-21-9	187.037	nd (w), lf (lig), cry (al)	108				vs eth, EtOH, lig
1322	2-(4-Bromophenyl)-1 <i>H</i> -indene-1,3(2 <i>H</i> )-dione	Bromindione	C <sub>15</sub> H <sub>9</sub> BrO <sub>2</sub>	1146-98-1	301.135	cry (lig)	138				
1323	(4-Bromophenyl)phenylmethanone		C <sub>13</sub> H <sub>9</sub> BrO	90-90-4	261.113	lf (al)	82.5	350			i H <sub>2</sub> O; sl EtOH, eth, bz, peth
1324	2-Bromo-1-phenyl-1-propanone		C <sub>9</sub> H <sub>9</sub> BrO	2114-00-3	213.070			247.5	1.4298 <sup>20</sup>	1.5720 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
1325	Bromophos		C <sub>8</sub> H <sub>8</sub> BrCl <sub>2</sub> PS	2104-96-3	317.999	ye cry	54	141 <sup>0,01</sup>			sl H <sub>2</sub> O; s eth, ctc, tol
1326	Bromophos-ethyl		C <sub>10</sub> H <sub>12</sub> BrCl <sub>2</sub> O <sub>3</sub> PS	4824-78-6	394.049	pale-ye liq		122 <sup>0,004</sup>			
1327	1-Bromopropane	Propyl bromide	C <sub>3</sub> H <sub>7</sub> Br	106-94-5	122.992	liq	-110.3	71.1	1.3537 <sup>20</sup>	1.4343 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, chl, ctc
1328	2-Bromopropane	Isopropyl bromide	C <sub>3</sub> H <sub>7</sub> Br	75-26-3	122.992	liq	-89.0	59.5	1.3140 <sup>20</sup>	1.4251 <sup>20</sup>	sl H <sub>2</sub> O; s ace, bz, chl; msc EtOH, eth
1329	3-Bromopropanenitrile		C <sub>3</sub> H <sub>5</sub> BrN	2417-90-5	133.975			92 <sup>25</sup> , 69 <sup>7</sup>	1.6152 <sup>20</sup>	1.4800 <sup>20</sup>	vs EtOH, eth; sl ctc
1330	2-Bromopropanoic acid, (±)		C <sub>3</sub> H <sub>5</sub> BrO <sub>2</sub>	10327-08-9	152.975	pr	25.7	203.5	1.7000 <sup>20</sup>	1.4753 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; sl chl
1331	3-Bromopropanoic acid	<i>β</i> -Bromopropionic acid	C <sub>3</sub> H <sub>5</sub> BrO <sub>2</sub>	590-92-1	152.975	pl (CCl <sub>4</sub> )	62.5	141 <sup>45</sup>	1.48 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth, bz, chl
1332	3-Bromo-1-propanol		C <sub>3</sub> H <sub>7</sub> BrO	627-18-9	138.991			105 <sup>185</sup> , 80 <sup>22</sup>	1.5374 <sup>20</sup>	1.4834 <sup>25</sup>	s H <sub>2</sub> O; msc EtOH, eth
1333	1-Bromo-2-propanol		C <sub>3</sub> H <sub>7</sub> BrO	19686-73-8	138.991			146.5	1.5585 <sup>30</sup>	1.4801 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth
1334	2-Bromopropanoyl bromide		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub> O	563-76-8	215.871			153	2.0611 <sup>16</sup>		
1335	2-Bromopropanoyl chloride		C <sub>3</sub> H <sub>4</sub> BrClO	7148-74-5	171.420			132	1.697 <sup>11</sup>	1.4780 <sup>20</sup>	s eth, chl; sl ctc
1336	<i>cis</i> -1-Bromopropene		C <sub>3</sub> H <sub>5</sub> Br	590-13-6	120.976	liq	-113	57.8	1.4291 <sup>20</sup>	1.4560 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, chl
1337	<i>trans</i> -1-Bromopropene		C <sub>3</sub> H <sub>5</sub> Br	590-15-8	120.976			63.2			
1338	2-Bromopropene		C <sub>3</sub> H <sub>5</sub> Br	557-93-7	120.976	liq	-126	48.4	1.3965 <sup>16</sup>	1.4467 <sup>16</sup>	i H <sub>2</sub> O; s eth, ace, chl
1339	3-Bromopropene	Allyl bromide	C <sub>3</sub> H <sub>5</sub> Br	106-95-6	120.976	liq	-119	70.1	1.398 <sup>20</sup>	1.4697 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc, chl, CS <sub>2</sub>
1340	(3-Bromo-1-propenyl)benzene		C <sub>9</sub> H <sub>9</sub> Br	4392-24-9	197.071	nd (al, eth)	34	130 <sup>10</sup>	1.3428 <sup>30</sup>	1.613 <sup>20</sup>	vs EtOH
1341	(3-Bromopropoxy)benzene		C <sub>9</sub> H <sub>11</sub> BrO	588-63-6	215.086		10.7	127 <sup>18</sup>	1.364 <sup>16</sup>		vs eth
1342	3-Bromopropylamine hydrobromide	3-Bromo-1-propanamine hydrobromide	C <sub>3</sub> H <sub>8</sub> Br <sub>2</sub> N	5003-71-4	218.918		171.5				

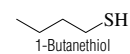
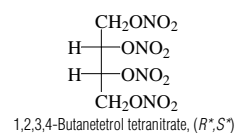
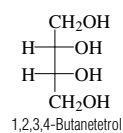
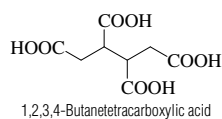
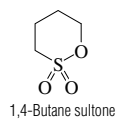
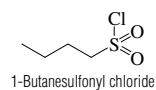
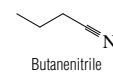
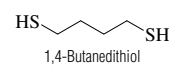
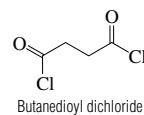
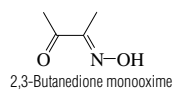
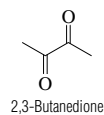
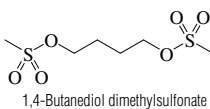
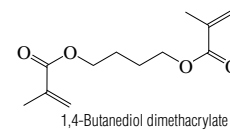
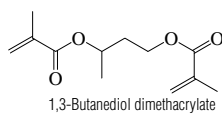
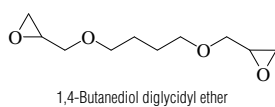
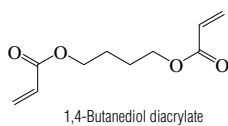
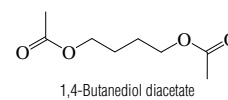
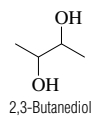
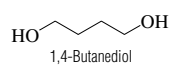
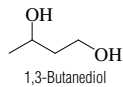
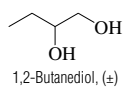
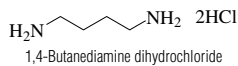
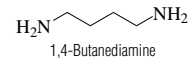
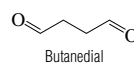
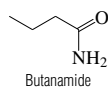
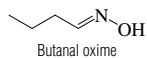
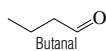
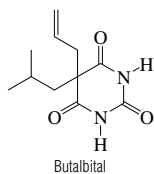
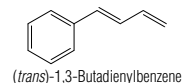
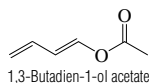
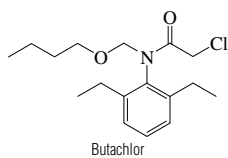
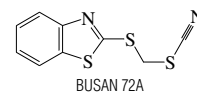
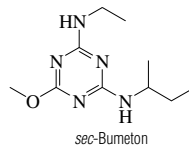
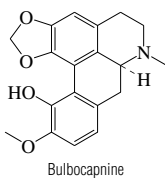
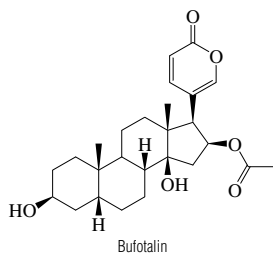


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1343	Bromopropylate	4,4'-Dibromobenzilic acid isopropyl ester	C <sub>17</sub> H <sub>16</sub> Br <sub>2</sub> O <sub>3</sub>	18181-80-1	428.115		77		1.59 <sup>20</sup>		
1344	(3-Bromopropyl)benzene		C <sub>9</sub> H <sub>11</sub> Br	637-59-2	199.087			219.5; 117 <sup>25</sup>	1.3106 <sup>25</sup>	1.5440 <sup>25</sup>	i H <sub>2</sub> O; vs eth
1345	3-Bromo-1-propyne	Propargyl bromide	C <sub>3</sub> H <sub>3</sub> Br	106-96-7	118.960			89	1.579 <sup>19</sup>	1.4922 <sup>20</sup>	s EtOH, eth, bz, ctc, chl
1346	2-Bromopyridine		C <sub>5</sub> H <sub>4</sub> BrN	109-04-6	157.997	liq	-40.1	193; 75 <sup>13</sup>	1.6337 <sup>20</sup>	1.5734 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
1347	3-Bromopyridine		C <sub>5</sub> H <sub>4</sub> BrN	626-55-1	157.997	liq	-27.3	173; 69 <sup>18</sup>	1.645 <sup>0</sup>	1.5694 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth
1348	4-Bromopyridine		C <sub>5</sub> H <sub>4</sub> BrN	1120-87-2	157.997		0.5	29 <sup>9,4</sup>	1.6450 <sup>0</sup>	1.5694 <sup>20</sup>	s ace, bz
1349	5-Bromo-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	5-Bromouracil	C <sub>4</sub> H <sub>3</sub> BrN <sub>2</sub> O <sub>2</sub>	51-20-7	190.983		310				
1350	3-Bromoquinoline		C <sub>8</sub> H <sub>6</sub> BrN	5332-24-1	208.055	ye oil	13.3	275		1.6641 <sup>20</sup>	s chl; vs HOAc
1351	6-Bromoquinoline		C <sub>8</sub> H <sub>6</sub> BrN	5332-25-2	208.055		24	281			s EtOH, eth, acid
1352	<i>N</i> -Bromosuccinimide		C <sub>4</sub> H <sub>4</sub> BrNO <sub>2</sub>	128-08-5	177.985	cry (bz)	174		2.098 <sup>25</sup>		sl H <sub>2</sub> O, AcOEt, eth; vs ace; i hx
1353	1-Bromotetradecane		C <sub>14</sub> H <sub>28</sub> Br	112-71-0	277.284		5.6	307	1.0170 <sup>20</sup>	1.4603 <sup>20</sup>	vs ace, bz, EtOH
1354	2-Bromothiazole		C <sub>3</sub> H <sub>2</sub> BrNS	3034-53-5	164.024			171	1.82 <sup>25</sup>	1.5927 <sup>20</sup>	
1355	1-(5-Bromo-2-thienyl)ethanone		C <sub>8</sub> H <sub>6</sub> BrOS	5370-25-2	205.072	nd (al)	94.5	103 <sup>4</sup>			sl EtOH; s ctc
1356	2-Bromothiophene	2-Thienyl bromide	C <sub>4</sub> H <sub>3</sub> BrS	1003-09-4	163.036			150	1.684 <sup>20</sup>	1.5868 <sup>20</sup>	i H <sub>2</sub> O; vs eth, ace; s ctc
1357	3-Bromothiophene		C <sub>4</sub> H <sub>3</sub> BrS	872-31-1	163.036			159.5	1.735 <sup>20</sup>	1.5919 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz; sl chl
1358	Bromothymol Blue	Bromthymol Blue	C <sub>27</sub> H <sub>26</sub> Br <sub>2</sub> O <sub>5</sub> S	76-59-5	624.381		201				vs eth, EtOH
1359	2-Bromotoluene		C <sub>7</sub> H <sub>7</sub> Br	95-46-5	171.035	liq	-27.8	181.7	1.4232 <sup>20</sup>	1.5565 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, msc ctc
1360	3-Bromotoluene		C <sub>7</sub> H <sub>7</sub> Br	591-17-3	171.035	liq	-39.8	183.7	1.4099 <sup>20</sup>	1.5510 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, chl; msc eth; sl ctc
1361	4-Bromotoluene		C <sub>7</sub> H <sub>7</sub> Br	106-38-7	171.035	cry (al)	28.5	184.3	1.3959 <sup>35</sup>	1.5477 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl; sl ctc
1362	Bromotrichloromethane		CBrCl <sub>3</sub>	75-62-7	198.274	liq	-5.65	105	2.012 <sup>25</sup>	1.5065 <sup>20</sup>	vs eth, EtOH
1363	1-Bromotridecane		C <sub>13</sub> H <sub>27</sub> Br	765-09-3	263.257		6.2	292	1.0234 <sup>25</sup>	1.4574 <sup>25</sup>	i H <sub>2</sub> O; vs chl
1364	Bromotriethylsilane		C <sub>6</sub> H <sub>15</sub> BrSi	1112-48-7	195.173	liq	-49.3	163; 66 <sup>24</sup>	1.143 <sup>20</sup>	1.4561 <sup>20</sup>	
1365	2-Bromo-1,1,1-trifluoroethane		C <sub>2</sub> H <sub>2</sub> BrF <sub>3</sub>	421-06-7	162.936	vol liq or gas	-93.9	26	1.7881 <sup>20</sup>	1.3331 <sup>20</sup>	
1366	Bromotrifluoroethane		C <sub>2</sub> BrF <sub>3</sub>	598-73-2	160.920	col gas		-2.5			
1367	Bromotrifluoromethane		CBrF <sub>3</sub>	75-63-8	148.910	col gas	-172	-57.8	1.5800 <sup>20</sup>		i H <sub>2</sub> O; vs chl
1368	1-Bromo-2-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	392-83-6	225.006			167.5	1.652 <sup>25</sup>	1.4817 <sup>20</sup>	
1369	1-Bromo-3-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	401-78-5	225.006		1	151.5	1.613 <sup>25</sup>	1.4716 <sup>20</sup>	
1370	1-Bromo-4-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	402-43-7	225.006			160	1.607 <sup>25</sup>	1.4705 <sup>25</sup>	
1371	2-Bromo-1,3,5-trimethylbenzene		C <sub>9</sub> H <sub>11</sub> Br	576-83-0	199.087	liq	-1	225	1.3191 <sup>10</sup>	1.5510 <sup>20</sup>	i H <sub>2</sub> O; vs eth; s bz; sl ctc
1372	Bromotrinitromethane		CBrN <sub>3</sub> O <sub>6</sub>	560-95-2	229.931		17.5	56 <sup>10</sup>	2.0312 <sup>20</sup>	1.4808 <sup>20</sup>	vs EtOH, chl
1373	Bromotriphenylmethane	Triphenylmethyl bromide	C <sub>19</sub> H <sub>15</sub> Br	596-43-0	323.226		153	230 <sup>15</sup>	1.5500 <sup>20</sup>		
1374	1-Bromoundecane		C <sub>11</sub> H <sub>23</sub> Br	693-67-4	235.205	liq	-9.7	258.8	1.0494 <sup>25</sup>	1.4552 <sup>25</sup>	sl ctc
1375	11-Bromoundecanoic acid		C <sub>11</sub> H <sub>21</sub> BrO <sub>2</sub>	2834-05-1	265.188	nd (liq)	57	188 <sup>18</sup>			vs ace, bz, eth, EtOH
1376	(1-Bromovinyl)benzene		C <sub>8</sub> H <sub>7</sub> Br	98-81-7	183.046		-44	86 <sup>14</sup> , 71 <sup>3</sup>	1.4025 <sup>23</sup>	1.5881 <sup>20</sup>	
1377	<i>cis</i> -2-Bromovinyl)benzene		C <sub>8</sub> H <sub>7</sub> Br	588-73-8	183.046		-7	55 <sup>2</sup>	1.4322 <sup>10</sup>	1.5990 <sup>22</sup>	
1378	<i>trans</i> -2-Bromovinyl)benzene		C <sub>8</sub> H <sub>7</sub> Br	588-72-7	183.046		7	dec 219; 108 <sup>20</sup>	1.4269 <sup>16</sup>	1.6093 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
1379	1-Bromo-2-vinylbenzene		C <sub>8</sub> H <sub>7</sub> Br	2039-88-5	183.046	liq	-52.8	209.2; 98 <sup>20</sup>	1.4160 <sup>20</sup>	1.5927 <sup>20</sup>	
1380	1-Bromo-3-vinylbenzene		C <sub>8</sub> H <sub>7</sub> Br	2039-86-3	183.046			92 <sup>20</sup>	1.4059 <sup>20</sup>	1.5933 <sup>20</sup>	
1381	1-Bromo-4-vinylbenzene		C <sub>8</sub> H <sub>7</sub> Br	2039-82-9	183.046		7.7	212; 103 <sup>20</sup>	1.3984 <sup>20</sup>	1.5947 <sup>20</sup>	i H <sub>2</sub> O; vs chl; s HOAc
1382	Brompheniramine		C <sub>16</sub> H <sub>16</sub> BrN <sub>2</sub>	86-22-6	319.239	ye oily liq		150 <sup>0,5</sup>			s dil acid
1383	Brucine		C <sub>23</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub>	357-57-3	394.463	mcl pr (w +4)	178				sl H <sub>2</sub> O, eth, bz; vs EtOH, chl
1384	Brucine hydrochloride	2,3-Dimethoxystrychnidin-10-one, monohydrochloride	C <sub>23</sub> H <sub>27</sub> ClN <sub>2</sub> O <sub>4</sub>	5786-96-9	430.924	pr					vs H <sub>2</sub> O, EtOH
1385	Brucine sulfate heptahydrate	2,3-Dimethoxystrychnidin-10-one, sulfate, heptahydrate	C <sub>46</sub> H <sub>68</sub> N <sub>4</sub> O <sub>19</sub> S	60583-39-3	1013.113	nd (w)					s H <sub>2</sub> O; sl EtOH, chl, tta; vs MeOH; i bz
1386	Bucolome	5-Butyl-1-cyclohexyl-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O <sub>3</sub>	841-73-6	266.336	nd (MeOH)	84	186 <sup>0,8</sup>			

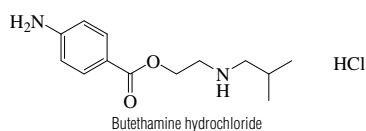
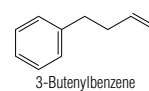
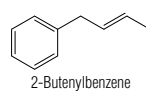
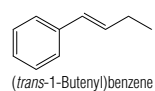
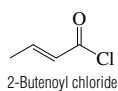
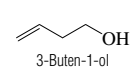
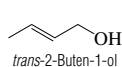
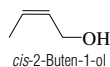
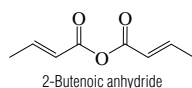
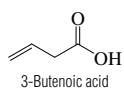
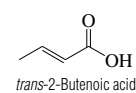
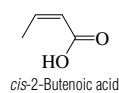
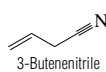
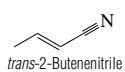
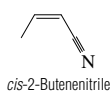
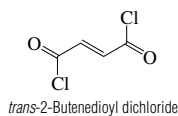
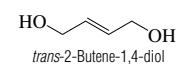
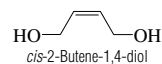
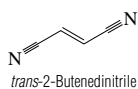
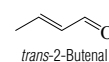
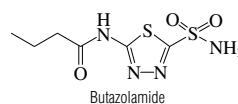
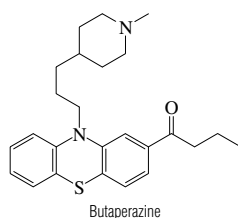
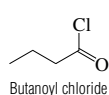
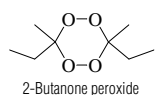
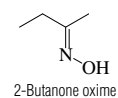
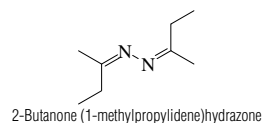
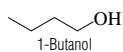
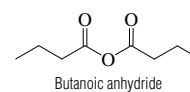
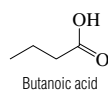
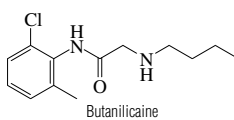
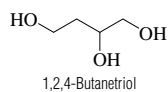




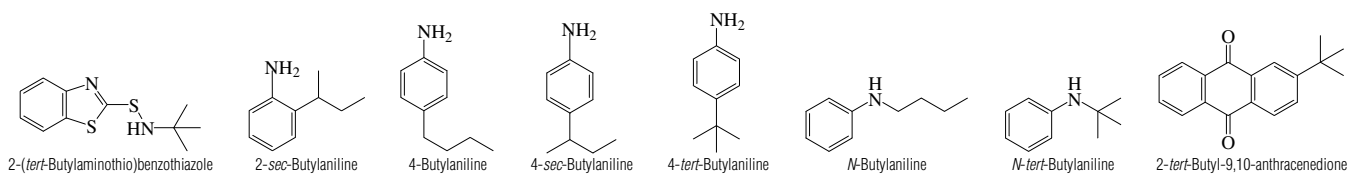
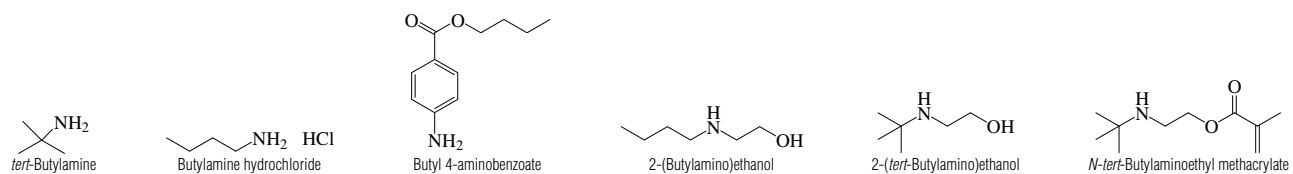
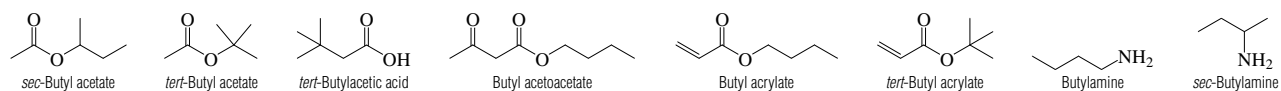
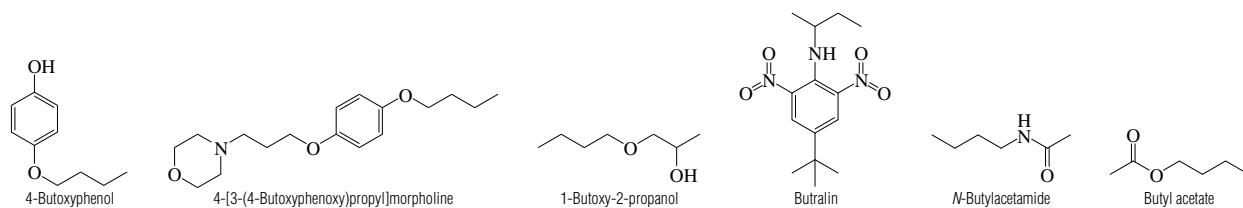
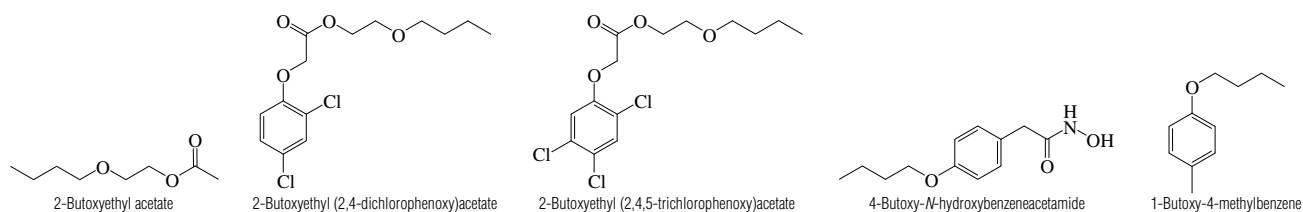
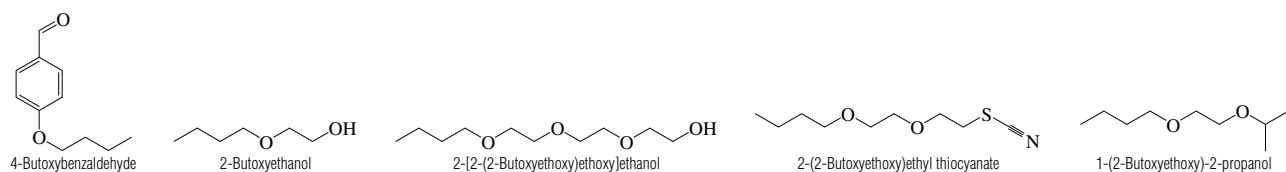
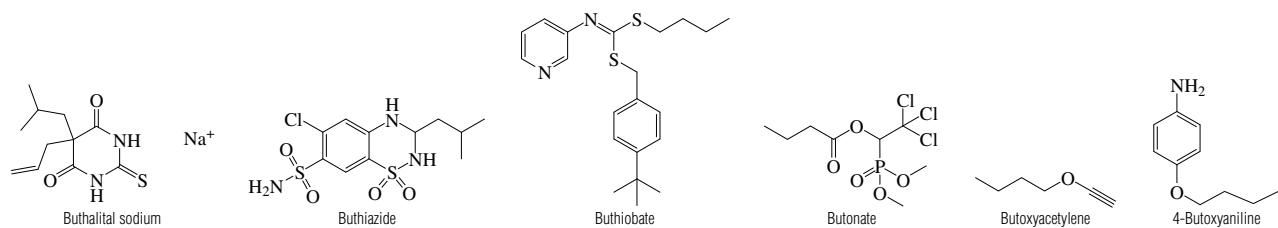
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1387	Bufotalin		C <sub>26</sub> H <sub>36</sub> O <sub>6</sub>	471-95-4	444.560	cry (+1 al)	223 dec				i H <sub>2</sub> O; s EtOH, chl
1388	Bulbocapnine		C <sub>19</sub> H <sub>19</sub> NO <sub>4</sub>	298-45-3	325.359	pr (al)	199.5				i H <sub>2</sub> O; s EtOH; vs chl
1389	sec-Bumeton	<i>N</i> -sec-Butyl- <i>N'</i> -ethyl-6-methoxy-1,3,5-triazine-2,4-diamine	C <sub>10</sub> H <sub>19</sub> N <sub>5</sub> O	26259-45-0	225.291		87				
1390	BUSAN 72A	(2-Benzothiazolylthio)methyl thiocyanate	C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> S <sub>3</sub>	21564-17-0	238.352	liq		dec			
1391	Butachlor		C <sub>17</sub> H <sub>26</sub> ClNO <sub>2</sub>	23184-66-9	311.847		<-5	156 <sup>5</sup>	1.070 <sup>25</sup>		
1392	1,2-Butadiene	Methylallene	C <sub>4</sub> H <sub>6</sub>	590-19-2	54.091	vol liq or gas	-136.2	10.9	0.676 <sup>0</sup>	1.4205 <sup>1</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs bz
1393	1,3-Butadiene	Divinyl	C <sub>4</sub> H <sub>6</sub>	106-99-0	54.091	col gas	-108.91	-4.41	0.6149 <sup>25</sup> (p>1 atm)	1.4292 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; vs ace
1394	1,3-Butadien-1-ol acetate		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1515-76-0	112.127			58 <sup>40</sup>	0.945 <sup>25</sup>	1.4690 <sup>20</sup>	
1395	( <i>trans</i> )-1,3-Butadienylbenzene		C <sub>10</sub> H <sub>10</sub>	16939-57-4	130.186		2.3	76 <sup>11</sup>	0.9286 <sup>20</sup>	1.6089 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1396	1,3-Butadiyne	Diacetylene	C <sub>4</sub> H <sub>2</sub>	460-12-8	50.059	vol liq or gas	-36.4	10.3	0.7364 <sup>0</sup>	1.4189 <sup>5</sup>	vs H <sub>2</sub> O, eth, ace; s chl, EtOH
1397	Butalbitol	5-Isobutyl-5-allyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	77-26-9	224.256	pr	138.5				s H <sub>2</sub> O; s EtOH, eth, ace, chl; i lig
1398	Butanal	Butyraldehyde	C <sub>4</sub> H <sub>8</sub> O	123-72-8	72.106	liq	-96.86	74.8	0.8016 <sup>20</sup>	1.3843 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH; vs ace, bz; sl chl
1399	Butanal oxime		C <sub>4</sub> H <sub>9</sub> NO	110-69-0	87.120	liq	-29.5	154	0.923 <sup>20</sup>		vs H <sub>2</sub> O, ace, bz; msc EtOH, eth; s chl
1400	Butanamide	Butyramide	C <sub>4</sub> H <sub>9</sub> NO	541-35-5	87.120	lf (bz)	114.8	216	0.8850 <sup>20</sup>	1.4087 <sup>30</sup>	sl H <sub>2</sub> O, eth; i bz; s EtOH
1401	Butane		C <sub>4</sub> H <sub>10</sub>	106-97-8	58.122	col gas	-138.3	-0.5	0.573 <sup>25</sup> (p>1 atm)	1.3326 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl
1402	Butanedial		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	638-37-9	86.090			dec 170; 58 <sup>9</sup>	1.065 <sup>20</sup>	1.4262 <sup>18</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
1403	1,4-Butanediamine	Putrescine	C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	110-60-1	88.151	lf	21.91	158.5	0.877 <sup>25</sup>	1.4969 <sup>20</sup>	s H <sub>2</sub> O
1404	1,4-Butanediamine dihydrochloride		C <sub>4</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub>	333-93-7	161.073	nd or lf (al, w)	280 dec	sub			vs H <sub>2</sub> O, EtOH; i eth, bz, MeOH
1405	1,2-Butanediol, (±)		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	26171-83-5	90.121			190.5	1.0024 <sup>20</sup>	1.4378 <sup>20</sup>	s H <sub>2</sub> O, EtOH, ace
1406	1,3-Butanediol	1,3-Butylene glycol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	107-88-0	90.121		<-50	207.5	1.0053 <sup>20</sup>	1.4401 <sup>20</sup>	
1407	1,4-Butanediol	Tetramethylene glycol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	110-63-4	90.121		20.4	235	1.0171 <sup>20</sup>	1.4460 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, DMSO; sl eth
1408	2,3-Butanediol		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	6982-25-8	90.121	cry (eth)	7.6	182.5	1.0033 <sup>20</sup>	1.4310 <sup>25</sup>	msc H <sub>2</sub> O, EtOH; s eth, ace, chl
1409	1,4-Butanediol diacetate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	628-67-1	174.195		12	229	1.0479 <sup>15</sup>	1.4251 <sup>15</sup>	
1410	1,4-Butanediol diacrylate		C <sub>10</sub> H <sub>14</sub> O <sub>4</sub>	1070-70-8	198.216			83 <sup>3,3</sup>	1.105 <sup>25</sup>		
1411	1,4-Butanediol diglycidyl ether	1,4-Bis(2,3-epoxypropoxy) butane	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	2425-79-8	202.248			266; 155 <sup>11</sup>	1.1 <sup>25</sup>	1.4611 <sup>20</sup>	
1412	1,3-Butanediol dimethacrylate		C <sub>12</sub> H <sub>18</sub> O <sub>4</sub>	1189-08-8	226.269			290		1.4495 <sup>25</sup>	vs ace, eth, EtOH, lig
1413	1,4-Butanediol dimethacrylate		C <sub>12</sub> H <sub>18</sub> O <sub>4</sub>	2082-81-7	226.269	liq		133 <sup>4</sup> , 76 <sup>0,027</sup>	1.025 <sup>20</sup>	1.4560 <sup>20</sup>	sl H <sub>2</sub> O
1414	1,4-Butanediol dimethylsulfonate	Busulfan	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub> S <sub>2</sub>	55-98-1	246.301	cry	116				i H <sub>2</sub> O; sl EtOH, ace
1415	2,3-Butanedione	Diacetyl	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	431-03-8	86.090	liq	-1.2	88	0.9808 <sup>18</sup>	1.3951 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s bz, ctc
1416	2,3-Butanedione monooxime		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	57-71-6	101.105	pr (chl), lf (w)	76.8	185.5			sl H <sub>2</sub> O; vs EtOH, eth, chl; s alk
1417	Butanedioyl dichloride	Succinyl chloride	C <sub>4</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	543-20-4	154.980	pl or lf	20	193.3	1.3748 <sup>20</sup>	1.4683 <sup>20</sup>	s eth, ace, bz
1418	1,4-Butanedithiol	Tetramethylenedithiol	C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	1191-08-8	122.252	liq	-53.9	195.5	1.0021 <sup>0</sup>	1.5290 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; sl ctc
1419	Butanenitrile	Propyl cyanide	C <sub>4</sub> H <sub>7</sub> N	109-74-0	69.106	liq	-111.9	117.6	0.7936 <sup>20</sup>	1.3842 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s bz
1420	1-Butanesulfonyl chloride		C <sub>4</sub> H <sub>9</sub> ClO <sub>2</sub> S	2386-60-9	156.631			75 <sup>10</sup>		1.4559 <sup>20</sup>	
1421	1,4-Butane sultone	1,2-Oxathiane 2,2-dioxide	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	1633-83-6	136.170	liq	13.5	135 <sup>4</sup>	1.331 <sup>20</sup>	1.4640 <sup>20</sup>	
1422	1,2,3,4-Butanetetra-carboxylic acid		C <sub>8</sub> H <sub>10</sub> O <sub>8</sub>	1703-58-8	234.160	lf (w) cry (ace)	236.5				vs H <sub>2</sub> O, EtOH
1423	1,2,3,4-Butanetetrol	Erythritol	C <sub>4</sub> H <sub>10</sub> O <sub>4</sub>	149-32-6	122.120	bipym tetr pr	121.5	330.5	1.451 <sup>20</sup>		s H <sub>2</sub> O; i eth, bz
1424	1,2,3,4-Butanetetrol tetranitrate, ( <i>R</i> <sup>*</sup> , <i>S</i> <sup>*</sup> )	Erythrityl tetranitrate	C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>12</sub>	7297-25-8	302.111		61				vs EtOH
1425	1-Butanethiol	Butyl mercaptan	C <sub>4</sub> H <sub>10</sub> S	109-79-5	90.187	liq	-115.7	98.5	0.8416 <sup>20</sup>	1.4440 <sup>20</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1426	2-Butanethiol	sec-Butyl mercaptan	C <sub>4</sub> H <sub>10</sub> S	91840-99-2	90.187	liq	-165	85.0	0.8295 <sup>20</sup>	1.4366 <sup>20</sup>	s EtOH, eth, bz, peth; sl ctc
1427	1,2,4-Butanetriol		C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	3068-00-6	106.120			190 <sup>18</sup> , 172 <sup>12</sup>	1.18 <sup>20</sup>	1.4688 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
1428	Butanilcaine	2-(Butylamino)-N-(2-chloro-6-methylphenyl)acetamide	C <sub>13</sub> H <sub>19</sub> ClN <sub>2</sub> O	3785-21-5	254.755	cry	46	145 <sup>0.001</sup>			
1429	Butanoic acid	Butyric acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	107-92-6	88.106	liq	-5.1	163.75	0.9528 <sup>25</sup>	1.3980 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl ctc
1430	Butanoic anhydride	Butyric anhydride	C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	106-31-0	158.195	liq	-75	200	0.9668 <sup>20</sup>	1.4070 <sup>20</sup>	s eth; sl ctc
1431	1-Butanol	Butyl alcohol	C <sub>4</sub> H <sub>10</sub> O	71-36-3	74.121	liq	-88.6	117.73	0.8095 <sup>20</sup>	1.3988 <sup>20</sup>	s H <sub>2</sub> O, bz; msc EtOH, eth; vs ace
1432	2-Butanol	sec-Butyl alcohol	C <sub>4</sub> H <sub>10</sub> O	78-92-2	74.121	liq	-88.5	99.51	0.8063 <sup>20</sup>	1.3978 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s bz, ctc
1433	2-Butanone	Methyl ethyl ketone	C <sub>4</sub> H <sub>8</sub> O	78-93-3	72.106	liq	-86.64	79.59	0.7999 <sup>25</sup>	1.3788 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl
1434	2-Butanone (1-methylpropylidene) hydrazone		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub>	5921-54-0	140.226			171.5	0.8404 <sup>20</sup>	1.4511 <sup>20</sup>	
1435	2-Butanone oxime		C <sub>4</sub> H <sub>9</sub> NO	96-29-7	87.120	liq	-29.5	152.5	0.9232 <sup>20</sup>	1.4410 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
1436	2-Butanone peroxide	Methyl ethyl ketone peroxide	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	1338-23-4	176.211	col liq		exp 110			sl H <sub>2</sub> O; misc os
1437	Butanoyl chloride	n-Butyryl chloride	C <sub>4</sub> H <sub>7</sub> ClO	141-75-3	106.551	liq	-89	102	1.0277 <sup>20</sup>	1.4121 <sup>20</sup>	msc eth
1438	Butaperazine		C <sub>24</sub> H <sub>31</sub> N <sub>3</sub> OS	653-03-2	409.587			275 <sup>0.05</sup>			
1439	Butazolamide	N-[5-(Aminosulfonyl)-1,3,4-thiadiazol-2-yl]butanamide	C <sub>8</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S <sub>2</sub>	16790-49-1	250.298	cry	261 dec				
1440	trans-2-Butenal	trans-Crotonaldehyde	C <sub>4</sub> H <sub>6</sub> O	123-73-9	70.090	liq	-76	102.2	0.8516 <sup>20</sup>	1.4366 <sup>20</sup>	s H <sub>2</sub> O, chl; vs EtOH, eth, ace; msc bz
1441	1-Butene	1-Butylene	C <sub>4</sub> H <sub>8</sub>	106-98-9	56.107	col gas	-185.34	-6.26	0.588 <sup>25</sup> (p>1 atm)	1.3962 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
1442	cis-2-Butene		C <sub>4</sub> H <sub>8</sub>	590-18-1	56.107	col gas	-138.88	3.71	0.616 <sup>25</sup> (p>1 atm)	1.3931 <sup>-25</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
1443	trans-2-Butene		C <sub>4</sub> H <sub>8</sub>	624-64-6	56.107	col gas	-105.52	0.88	0.599 <sup>25</sup> (p>1 atm)	1.3848 <sup>-25</sup>	s bz
1444	trans-2-Butenedinitrile		C <sub>4</sub> H <sub>2</sub> N <sub>2</sub>	764-42-1	78.072	nd (bz-peth)	96.8	186	0.9416 <sup>111</sup>	1.4349 <sup>111</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz, chl; sl peth
1445	cis-2-Butene-1,4-diol		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	6117-80-2	88.106		2.0	235	1.0698 <sup>20</sup>	1.4782 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH
1446	trans-2-Butene-1,4-diol		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	821-11-4	88.106		25	131 <sup>13</sup>	1.0700 <sup>20</sup>	1.4755 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
1447	trans-2-Butenediyl dichloride	Fumaric acid dichloride	C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	627-63-4	152.964	pa ye lig		159	1.408 <sup>20</sup>	1.5004 <sup>18</sup>	
1448	cis-2-Butenenitrile	Isocrotonitrile	C <sub>4</sub> H <sub>7</sub> N	1190-76-7	67.090	liq		107.4			
1449	trans-2-Butenenitrile	Crotonitrile	C <sub>4</sub> H <sub>7</sub> N	627-26-9	67.090	liq	-51.5	120	0.8239 <sup>20</sup>	1.4225 <sup>20</sup>	s eth, ace
1450	3-Butenenitrile	Allyl cyanide	C <sub>4</sub> H <sub>7</sub> N	109-75-1	67.090	liq	-87	119	0.8341 <sup>20</sup>	1.4060 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
1451	cis-2-Butenoic acid	Isocrotonic acid	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	503-64-0	86.090	nd or pr (peth)	15	169	1.0267 <sup>20</sup>	1.4450 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH
1452	trans-2-Butenoic acid	Crotonic acid	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	107-93-7	86.090	mcl pr or nd (w, lig)	71.5	184.7	0.9604 <sup>77</sup>	1.4249 <sup>77</sup>	vs H <sub>2</sub> O, EtOH; s eth, ace, lig
1453	3-Butenoic acid		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	625-38-7	86.090	liq	-35	169	1.0091 <sup>20</sup>	1.4239 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth
1454	2-Butenoic anhydride	Crotonic acid anhydride	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	623-68-7	154.163			247; 129 <sup>19</sup>	1.0397 <sup>20</sup>	1.4745 <sup>20</sup>	vs eth
1455	cis-2-Buten-1-ol	cis-Crotyl alcohol	C <sub>4</sub> H <sub>8</sub> O	4088-60-2	72.106			123	0.8662 <sup>20</sup>	1.4342 <sup>25</sup>	s H <sub>2</sub> O
1456	trans-2-Buten-1-ol	trans-Crotyl alcohol	C <sub>4</sub> H <sub>8</sub> O	504-61-0	72.106		<-30	121.2	0.8521 <sup>20</sup>	1.4288 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s chl
1457	3-Buten-1-ol		C <sub>4</sub> H <sub>8</sub> O	627-27-0	72.106			113.5	0.8424 <sup>20</sup>	1.4224 <sup>20</sup>	s H <sub>2</sub> O, ace; msc EtOH, eth; sl chl
1458	3-Buten-2-ol		C <sub>4</sub> H <sub>8</sub> O	598-32-3	72.106			97			
1459	3-Buten-2-one	Methyl vinyl ketone	C <sub>4</sub> H <sub>6</sub> O	78-94-4	70.090			81.4	0.864 <sup>20</sup>	1.4081 <sup>20</sup>	s H <sub>2</sub> O, EtOH, bz; vs eth, ace; sl ctc
1460	2-Butenoyl chloride		C <sub>4</sub> H <sub>7</sub> ClO	10487-71-5	104.535			124.5	1.0905 <sup>20</sup>	1.460 <sup>18</sup>	vs ace
1461	(trans-1-Butenyl)benzene		C <sub>10</sub> H <sub>12</sub>	1005-64-7	132.202	liq	-43.1	198.7	0.9019 <sup>20</sup>	1.5420 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
1462	2-Butenylbenzene		C <sub>10</sub> H <sub>12</sub>	1560-06-1	132.202			176	0.8831 <sup>20</sup>	1.5101 <sup>20</sup>	
1463	3-Butenylbenzene		C <sub>10</sub> H <sub>12</sub>	768-56-9	132.202	liq	-70	177	0.8831 <sup>20</sup>	1.5059 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
1464	1-Buten-3-yne	Vinylacetylene	C <sub>4</sub> H <sub>4</sub>	689-97-4	52.075	col gas		5.1	0.7094 <sup>0</sup>	1.4161 <sup>1</sup>	i H <sub>2</sub> O; s bz
1465	Butethamine hydrochloride	2-Isobutylaminoethyl 4-aminobenzoate	C <sub>13</sub> H <sub>21</sub> ClN <sub>2</sub> O <sub>2</sub>	553-68-4	272.771	cry	194				s H <sub>2</sub> O; sl EtOH, bz, chl; i eth

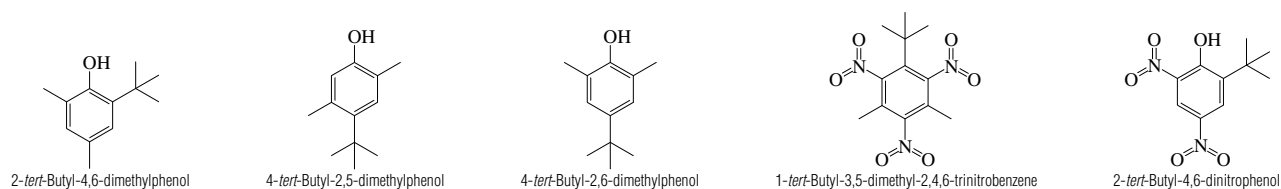
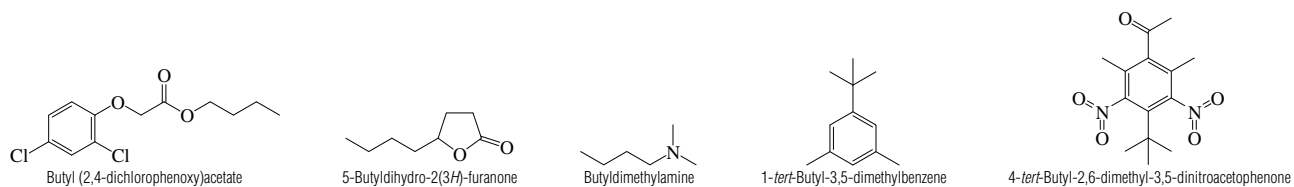
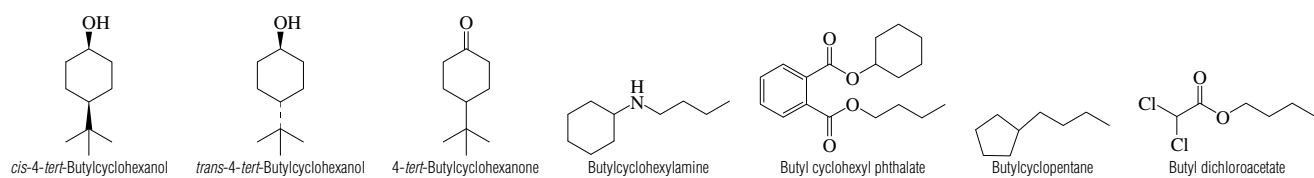
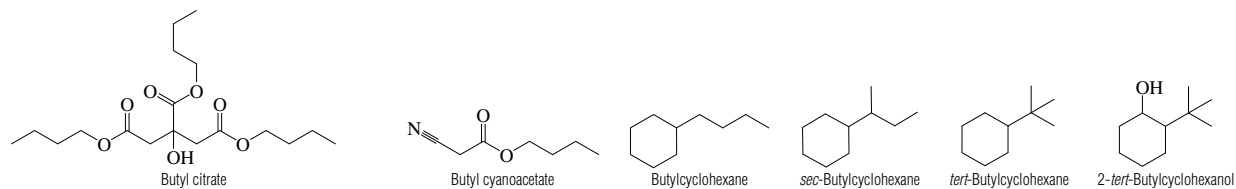
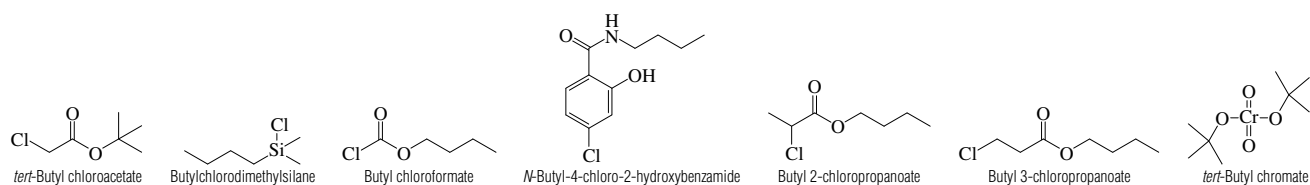
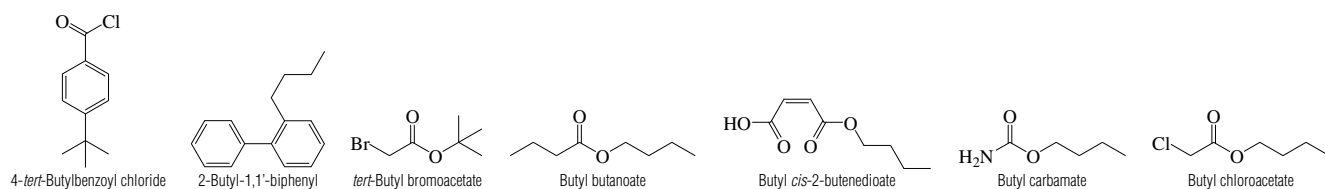
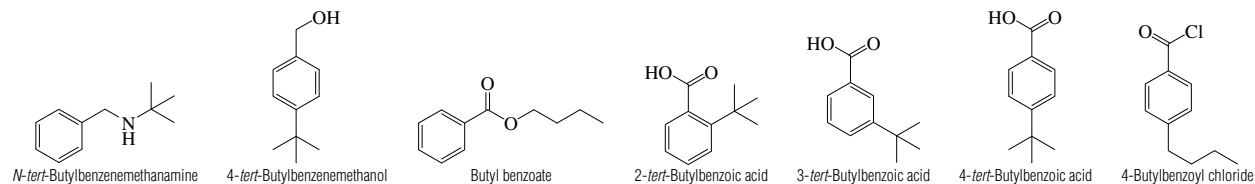
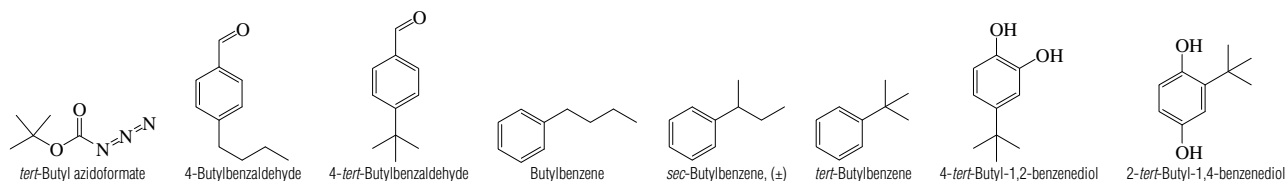


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1466	Buthalital sodium		C <sub>11</sub> H <sub>15</sub> N <sub>2</sub> NaO <sub>2</sub> S	510-90-7	262.304						vs H <sub>2</sub> O; sl EtOH; i eth, bz
1467	Buthiazide		C <sub>11</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	2043-38-1	353.846		221.5				
1468	Buthiobate	Denmert	C <sub>21</sub> H <sub>28</sub> N <sub>2</sub> S <sub>2</sub>	51308-54-4	372.590	ye oil	32		1.0865 <sup>25</sup>	1.596 <sup>26</sup>	i H <sub>2</sub> O; s os
1469	Butonate		C <sub>8</sub> H <sub>14</sub> Cl <sub>3</sub> O <sub>3</sub> P	126-22-7	327.527			129 <sup>0.5</sup>			
1470	Butoxyacetylene		C <sub>6</sub> H <sub>10</sub> O	3329-56-4	98.142			104	0.8200 <sup>20</sup>	1.4067	vs eth, EtOH
1471	4-Butoxyaniline		C <sub>10</sub> H <sub>12</sub> NO	4344-55-2	165.232			132 <sup>4</sup>			
1472	4-Butoxybenzaldehyde		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	5736-88-9	178.228			148 <sup>10</sup>			
1473	2-Butoxyethanol	Ethylene glycol monobutyl ether	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	111-76-2	118.174	liq	-74.8	168.4	0.9015 <sup>20</sup>	1.4198 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl ctc
1474	2-[2-(2-Butoxyethoxy)ethoxy] ethanol		C <sub>10</sub> H <sub>22</sub> O <sub>4</sub>	143-22-6	206.280			278	0.9890 <sup>20</sup>	1.4389 <sup>20</sup>	vs EtOH, MeOH
1475	2-(2-Butoxyethoxy)ethyl thiocyanate	Lethane 384	C <sub>9</sub> H <sub>17</sub> NO <sub>2</sub> S	112-56-1	203.302	liq		122 <sup>0.25</sup>			i H <sub>2</sub> O; vs os
1476	1-(2-Butoxyethoxy)-2-propanol		C <sub>9</sub> H <sub>20</sub> O <sub>3</sub>	124-16-3	176.253	col liq	-90	230	0.931 <sup>20</sup>		s H <sub>2</sub> O
1477	2-Butoxyethyl acetate	Ethylene glycol monobutyl ether acetate	C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	112-07-2	160.211	liq		192			
1478	2-Butoxyethyl (2,4- dichlorophenoxy)acetate	2,4-D 2-Butoxyethyl ester	C <sub>14</sub> H <sub>18</sub> Cl <sub>2</sub> O <sub>4</sub>	1929-73-3	321.197			159 <sup>1</sup>	1.232 <sup>20</sup>		
1479	2-Butoxyethyl (2,4,5- trichlorophenoxy)acetate	2,4,5-T Butoxyethyl ester	C <sub>14</sub> H <sub>17</sub> Cl <sub>3</sub> O <sub>4</sub>	2545-59-7	355.642			164 <sup>1</sup>	1.280 <sup>20</sup>		s ctc
1480	4-Butoxy- <i>N</i> - hydroxybenzeneacetamide	Bufexamac	C <sub>12</sub> H <sub>17</sub> NO <sub>3</sub>	2438-72-4	223.268	nd (ace)	154				
1481	1-Butoxy-4-methylbenzene		C <sub>11</sub> H <sub>16</sub> O	10519-06-9	164.244			229.5	0.9205 <sup>25</sup>	1.4970 <sup>20</sup>	s eth
1482	4-Butoxyphenol		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	122-94-1	166.217		65.5	125 <sup>4</sup>			vs ace, bz, eth, EtOH
1483	4-[3-(4-Butoxyphenoxy)propyl] morpholine	Pramoxine	C <sub>17</sub> H <sub>27</sub> NO <sub>3</sub>	140-65-8	293.401			196 <sup>6</sup>			
1484	1-Butoxy-2-propanol		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	5131-66-8	132.201			171.5; 71 <sup>20</sup>	0.882 <sup>20</sup>	1.4168 <sup>20</sup>	s EtOH, eth, bz, ctc, MeOH
1485	Butralin	4- <i>tert</i> -Butyl- <i>N</i> - <i>sec</i> -butyl-2,6- dinitroaniline	C <sub>14</sub> H <sub>21</sub> N <sub>2</sub> O <sub>4</sub>	33629-47-9	295.335		60	135 <sup>0.5</sup>			
1486	<i>N</i> -Butylacetamide		C <sub>8</sub> H <sub>13</sub> NO	1119-49-9	115.173			229	0.8960 <sup>25</sup>	1.4388 <sup>25</sup>	
1487	Butyl acetate		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	123-86-4	116.158	liq	-78	126.1	0.8825 <sup>20</sup>	1.3941 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, chl
1488	<i>sec</i> -Butyl acetate		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	105-46-4	116.158	liq	-98.9	112	0.8748 <sup>20</sup>	1.3888 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
1489	<i>tert</i> -Butyl acetate		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	540-88-5	116.158			95.1	0.8665 <sup>20</sup>	1.3855 <sup>20</sup>	s EtOH, eth, chl, HOAc
1490	<i>tert</i> -Butylacetic acid		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	1070-83-3	116.158		6.5	190	0.9124 <sup>20</sup>	1.4096 <sup>20</sup>	s EtOH, eth
1491	Butyl acetoacetate		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	591-60-6	158.195		-35.6	127 <sup>50</sup> , 85 <sup>6</sup>	0.9671 <sup>25</sup>	1.4137 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, bz, lig
1492	Butyl acrylate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	141-32-2	128.169	liq	-64.6	145	0.8898 <sup>20</sup>	1.4185 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; sl ctc
1493	<i>tert</i> -Butyl acrylate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	1663-39-4	128.169	liq		120; 62 <sup>60</sup>	0.879 <sup>25</sup>	1.4110 <sup>20</sup>	
1494	Butylamine	1-Butanamine	C <sub>4</sub> H <sub>11</sub> N	109-73-9	73.137	liq	-49.1	77.00	0.7414 <sup>20</sup>	1.4031 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth
1495	<i>sec</i> -Butylamine	2-Butanamine, (±)-	C <sub>4</sub> H <sub>11</sub> N	33966-50-6	73.137		<-72	62.73	0.7246 <sup>20</sup>	1.3932 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth; vs ace
1496	<i>tert</i> -Butylamine	2-Methyl-2-propanamine	C <sub>4</sub> H <sub>11</sub> N	75-64-9	73.137	liq	-66.94	44.04	0.6958 <sup>20</sup>	1.3784 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
1497	Butylamine hydrochloride	1-Butanamine hydrochloride	C <sub>4</sub> H <sub>12</sub> ClN	3858-78-4	109.598			213	0.982 <sup>20</sup>		sl H <sub>2</sub> O, EtOH
1498	Butyl 4-aminobenzoate	Butamben	C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub>	94-25-7	193.243	cry (al or bz)	58	173 <sup>8</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, chl
1499	2-(Butylamino)ethanol		C <sub>8</sub> H <sub>15</sub> NO	111-75-1	117.189			199; 91 <sup>11</sup>	0.8907 <sup>20</sup>	1.4437 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth
1500	2-( <i>tert</i> -Butylamino)ethanol		C <sub>8</sub> H <sub>15</sub> NO	4620-70-6	117.189		44	176.5; 72 <sup>14</sup>	0.8818 <sup>20</sup>		
1501	<i>N</i> - <i>tert</i> -Butylaminoethyl methacrylate		C <sub>10</sub> H <sub>19</sub> NO <sub>2</sub>	3775-90-4	185.264			102 <sup>12</sup>			s chl
1502	2-( <i>tert</i> -Butylaminothio) benzothiazole	<i>N</i> - <i>tert</i> -Butyl-2- benzothiazolesulfenamide	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> S <sub>2</sub>	95-31-8	238.372		108				
1503	2- <i>sec</i> -Butylaniline		C <sub>10</sub> H <sub>13</sub> N	55751-54-7	149.233			120 <sup>16</sup>	0.9574 <sup>20</sup>		s EtOH, ace, bz; sl ctc
1504	4-Butylaniline		C <sub>10</sub> H <sub>13</sub> N	104-13-2	149.233	pa ye		261	0.945 <sup>20</sup>		sl ctc
1505	4- <i>sec</i> -Butylaniline		C <sub>10</sub> H <sub>13</sub> N	30273-11-1	149.233			238; 118 <sup>15</sup>	0.9491 <sup>15</sup>	1.5360 <sup>20</sup>	vs bz, eth
1506	4- <i>tert</i> -Butylaniline		C <sub>10</sub> H <sub>13</sub> N	769-92-6	149.233	ye rd (peth)	17	241	0.9525 <sup>15</sup>	1.5380 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs bz; s ctc
1507	<i>N</i> -Butylaniline		C <sub>10</sub> H <sub>13</sub> N	1126-78-9	149.233	liq	-14.4	243.5	0.9323 <sup>20</sup>	1.5341 <sup>20</sup>	vs eth, EtOH
1508	<i>N</i> - <i>tert</i> -Butylaniline		C <sub>10</sub> H <sub>13</sub> N	937-33-7	149.233			215; 95 <sup>19</sup>		1.5270 <sup>20</sup>	s EtOH; vs ace, bz, chl
1509	2- <i>tert</i> -Butyl-9,10-anthracenedione		C <sub>18</sub> H <sub>16</sub> O <sub>2</sub>	84-47-9	264.319		99				s ctc, CS <sub>2</sub>

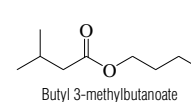
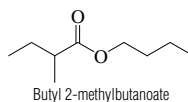
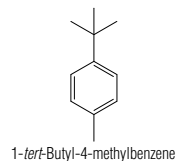
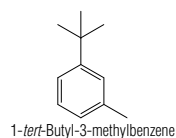
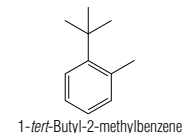
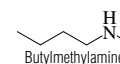
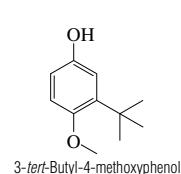
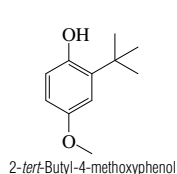
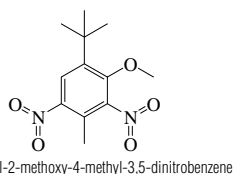
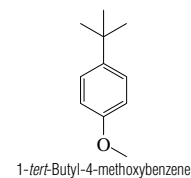
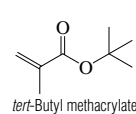
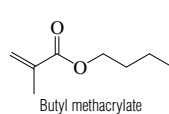
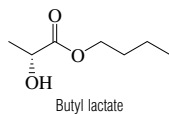
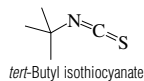
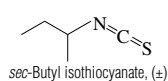
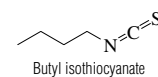
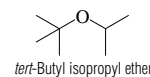
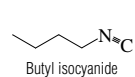
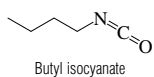
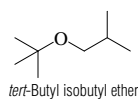
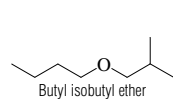
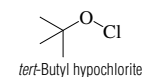
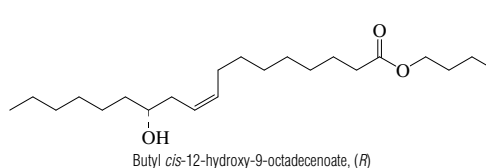
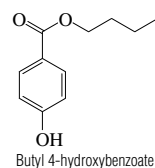
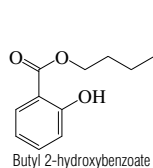
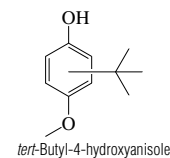
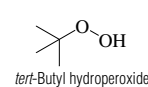
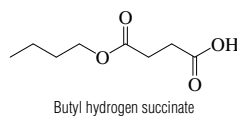
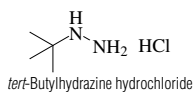
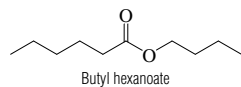
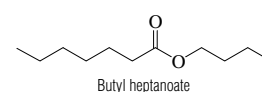
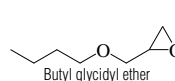
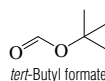
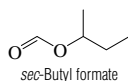
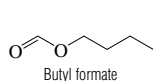
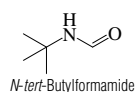
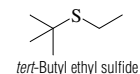
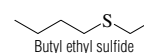
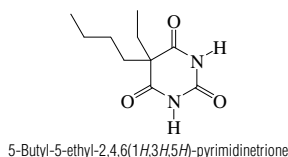
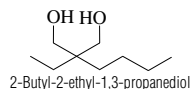
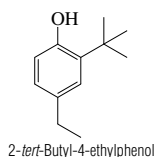
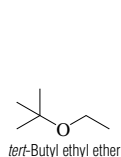
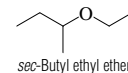
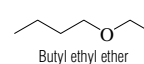
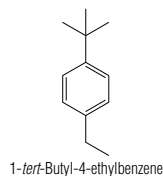
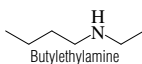
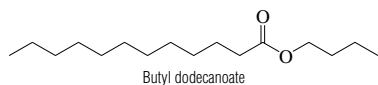
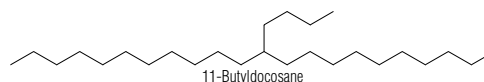
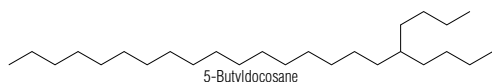


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1510	<i>tert</i> -Butyl azidoformate	<i>tert</i> -Butyl carbonazidate	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	1070-19-5	143.144	unstab >80		73 <sup>70</sup>			
1511	4-Butylbenzaldehyde		C <sub>11</sub> H <sub>14</sub> O	1200-14-2	162.228			123 <sup>7</sup>		1.5265	
1512	4- <i>tert</i> -Butylbenzaldehyde		C <sub>11</sub> H <sub>14</sub> O	939-97-9	162.228	liq		107 <sup>11</sup> , 130 <sup>25</sup>	0.970	1.5270 <sup>20</sup>	
1513	Butylbenzene		C <sub>10</sub> H <sub>14</sub>	104-51-8	134.218	liq	-87.85	183.31	0.8601 <sup>20</sup>	1.4898 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
1514	<i>sec</i> -Butylbenzene, (±)	2-Phenylbutane	C <sub>10</sub> H <sub>14</sub>	36383-15-0	134.218	liq	-82.7	173.3	0.8621 <sup>20</sup>	1.4902 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
1515	<i>tert</i> -Butylbenzene		C <sub>10</sub> H <sub>14</sub>	98-06-6	134.218	liq	-57.8	169.1	0.8665 <sup>20</sup>	1.4927 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc ace, bz
1516	4- <i>tert</i> -Butyl-1,2-benzenediol		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	98-29-3	166.217		54.3	285; 160 <sup>22</sup>			s tfa
1517	2- <i>tert</i> -Butyl-1,4-benzenediol		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	1948-33-0	166.217		128				
1518	<i>N</i> - <i>tert</i> -Butylbenzenemethanamine		C <sub>11</sub> H <sub>17</sub> N	3378-72-1	163.260			75 <sup>9</sup>		1.4951 <sup>25</sup>	
1519	4- <i>tert</i> -Butylbenzenemethanol		C <sub>11</sub> H <sub>16</sub> O	877-65-6	164.244			236; 140 <sup>20</sup>	0.928 <sup>25</sup>	1.5179 <sup>20</sup>	
1520	Butyl benzoate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	136-60-7	178.228	liq	-22.4	250.3	1.000 <sup>20</sup>	1.4940 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace; sl ctc
1521	2- <i>tert</i> -Butylbenzoic acid		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	1077-58-3	178.228	pl (dil al)	80.5				vs EtOH
1522	3- <i>tert</i> -Butylbenzoic acid		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	7498-54-6	178.228	nd (peth)	128.8				vs EtOH, peth
1523	4- <i>tert</i> -Butylbenzoic acid		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	98-73-7	178.228	nd (dil al)	164.5				i H <sub>2</sub> O; vs EtOH, bz; s chl
1524	4-Butylbenzoyl chloride		C <sub>11</sub> H <sub>13</sub> ClO	28788-62-7	196.673			155 <sup>26</sup>	1.051 <sup>25</sup>	1.5351 <sup>20</sup>	
1525	4- <i>tert</i> -Butylbenzoyl chloride		C <sub>11</sub> H <sub>13</sub> ClO	1710-98-1	196.673			266; 135 <sup>20</sup>	1.007 <sup>25</sup>	1.5364 <sup>20</sup>	
1526	2-Butyl-1,1'-biphenyl		C <sub>16</sub> H <sub>18</sub>	54532-97-7	210.314	liq	-9.65	291.2	0.9676 <sup>20</sup>	1.5604 <sup>20</sup>	
1527	<i>tert</i> -Butyl bromoacetate		C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	5292-43-3	195.054			73 <sup>25</sup>		1.4430 <sup>20</sup>	vs eth, EtOH
1528	Butyl butanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	109-21-7	144.212	liq	-91.5	166	0.8700 <sup>20</sup>	1.4075 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
1529	Butyl <i>cis</i> -2-butenedioate	Monobutyl maleate	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	925-21-3	172.179	oil			1.09 <sup>25</sup>		
1530	Butyl carbamate		C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	592-35-8	117.147	pr	53	dec 204; 108 <sup>14</sup>			vs EtOH; sl chl
1531	Butyl chloroacetate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	590-02-3	150.603			183	1.0704 <sup>20</sup>	1.4297 <sup>20</sup>	vs eth, EtOH
1532	<i>tert</i> -Butyl chloroacetate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	107-59-5	150.603			150; 50 <sup>10</sup>		1.4260 <sup>20</sup>	dec H <sub>2</sub> O
1533	Butylchlorodimethylsilane		C <sub>6</sub> H <sub>15</sub> ClSi	1000-50-6	150.722			139	0.876 <sup>20</sup>	1.5145 <sup>20</sup>	
1534	Butyl chloroformate		C <sub>2</sub> H <sub>5</sub> ClO <sub>2</sub>	592-34-7	136.577			142	1.074 <sup>25</sup>	1.4114 <sup>20</sup>	msc eth; s ace; sl ctc
1535	<i>N</i> -Butyl-4-chloro-2-hydroxybenzamide	Buclosamide	C <sub>11</sub> H <sub>14</sub> ClNO <sub>2</sub>	575-74-6	227.688		91.5				
1536	Butyl 2-chloropropanoate		C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	54819-86-2	164.630			184	1.0253 <sup>20</sup>	1.4263 <sup>20</sup>	vs eth
1537	Butyl 3-chloropropanoate		C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	27387-79-7	164.630			104 <sup>22</sup> , 92 <sup>6</sup>	1.0370 <sup>20</sup>	1.4321 <sup>20</sup>	vs H <sub>2</sub> O, eth
1538	<i>tert</i> -Butyl chromate		C <sub>8</sub> H <sub>16</sub> CrO <sub>4</sub>	1189-85-1	230.223	red cry (peth)	-5				reac H <sub>2</sub> O
1539	Butyl citrate		C <sub>18</sub> H <sub>32</sub> O <sub>7</sub>	77-94-1	360.443		-20	233 <sup>22</sup>	1.043 <sup>20</sup>	1.4460 <sup>20</sup>	
1540	Butyl cyanoacetate		C <sub>7</sub> H <sub>11</sub> NO <sub>2</sub>	5459-58-5	141.168			231; 115 <sup>15</sup>	1.0010 <sup>20</sup>	1.4200 <sup>20</sup>	
1541	Butylcyclohexane		C <sub>10</sub> H <sub>20</sub>	1678-93-9	140.266	liq	-74.73	180	0.7902 <sup>20</sup>	1.4408 <sup>20</sup>	i H <sub>2</sub> O
1542	<i>sec</i> -Butylcyclohexane		C <sub>10</sub> H <sub>20</sub>	7058-01-7	140.266			179.3	0.8131 <sup>20</sup>	1.4467 <sup>20</sup>	i H <sub>2</sub> O; s ace
1543	<i>tert</i> -Butylcyclohexane		C <sub>10</sub> H <sub>20</sub>	3178-22-1	140.266	liq	-41.2	171.5	0.8127 <sup>20</sup>	1.4469 <sup>20</sup>	i H <sub>2</sub> O
1544	2- <i>tert</i> -Butylcyclohexanol		C <sub>10</sub> H <sub>20</sub> O	13491-79-7	156.265		45	139 <sup>95</sup>	0.902 <sup>25</sup>		
1545	<i>cis</i> -4- <i>tert</i> -Butylcyclohexanol		C <sub>10</sub> H <sub>20</sub> O	937-05-3	156.265		83	112 <sup>15</sup>			
1546	<i>trans</i> -4- <i>tert</i> -Butylcyclohexanol		C <sub>10</sub> H <sub>20</sub> O	21862-63-5	156.265		83	112 <sup>15</sup>			
1547	4- <i>tert</i> -Butylcyclohexanone		C <sub>10</sub> H <sub>18</sub> O	98-53-3	154.249		48	90 <sup>9</sup>			
1548	Butylcyclohexylamine	<i>N</i> -Butylcyclohexylamine	C <sub>10</sub> H <sub>21</sub> N	10108-56-2	155.281		208.3				sl H <sub>2</sub> O, ctc; vs EtOH, eth
1549	Butyl cyclohexyl phthalate		C <sub>18</sub> H <sub>24</sub> O <sub>4</sub>	84-64-0	304.382	col liq		≈205 <sup>9</sup>	1.076 <sup>25</sup>		sl H <sub>2</sub> O; misc os
1550	Butylcyclopentane		C <sub>9</sub> H <sub>18</sub>	2040-95-1	126.239	liq	-108	156.6	0.7846 <sup>20</sup>	1.4316 <sup>20</sup>	vs ace, bz, eth, EtOH
1551	Butyl dichloroacetate		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	29003-73-4	185.048			193.5	1.1820 <sup>20</sup>	1.4420 <sup>20</sup>	vs eth, EtOH
1552	Butyl (2,4-dichlorophenoxy) acetate	2,4-D Butyl ester	C <sub>12</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>3</sub>	94-80-4	277.143		9	133 <sup>1</sup>			
1553	5-Butyldihydro-2(3 <i>H</i> )-furanone		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	104-50-7	142.196			132 <sup>20</sup>	0.9796 <sup>19</sup>	1.4451 <sup>19</sup>	s EtOH; sl ctc
1554	Butyldimethylamine	<i>N,N</i> -Dimethyl-1-butanamine	C <sub>6</sub> H <sub>15</sub> N	927-62-8	101.190			95	0.7206 <sup>20</sup>	1.3970 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz
1555	1- <i>tert</i> -Butyl-3,5-dimethylbenzene		C <sub>12</sub> H <sub>18</sub>	98-19-1	162.271	liq	-18	207	0.8668 <sup>20</sup>		s ctc
1556	4- <i>tert</i> -Butyl-2,6-dimethyl-3,5-dinitroacetophenone	Musk ketone	C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> O <sub>5</sub>	81-14-1	294.303	ye cry	135.5				vs chl
1557	2- <i>tert</i> -Butyl-4,6-dimethylphenol		C <sub>12</sub> H <sub>18</sub> O	1879-09-0	178.270		22.3	249	0.917 <sup>80</sup>	1.5183 <sup>20</sup>	i alk
1558	4- <i>tert</i> -Butyl-2,5-dimethylphenol		C <sub>12</sub> H <sub>18</sub> O	17696-37-6	178.270		71.2	264	0.939 <sup>80</sup>	1.5311 <sup>20</sup>	s alk
1559	4- <i>tert</i> -Butyl-2,6-dimethylphenol		C <sub>12</sub> H <sub>18</sub> O	879-97-0	178.270		82.4	248	0.916 <sup>80</sup>		s alk
1560	1- <i>tert</i> -Butyl-3,5-dimethyl-2,4,6-trinitrobenzene		C <sub>12</sub> H <sub>15</sub> N <sub>3</sub> O <sub>6</sub>	81-15-2	297.263	pl, nd (al)	110				i H <sub>2</sub> O; sl EtOH; s eth, chl
1561	2- <i>tert</i> -Butyl-4,6-dinitrophenol		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub>	1420-07-1	240.212	ye solid	126				

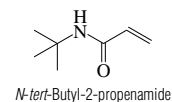
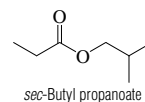
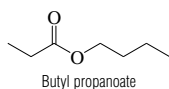
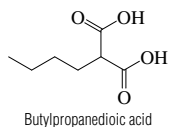
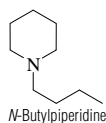
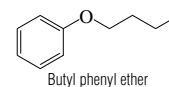
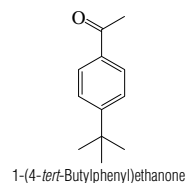
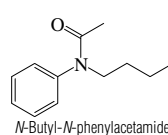
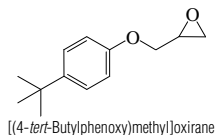
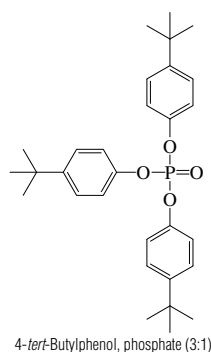
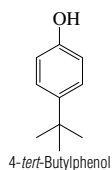
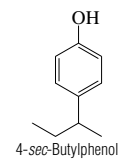
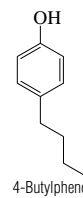
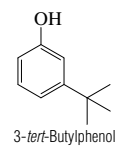
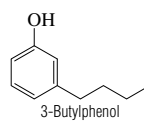
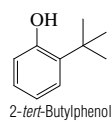
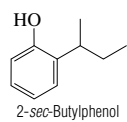
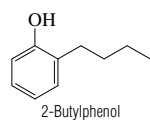
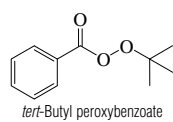
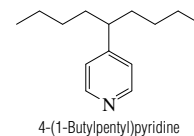
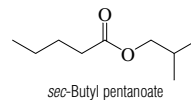
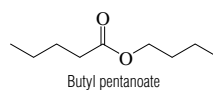
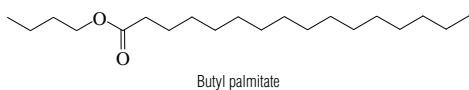
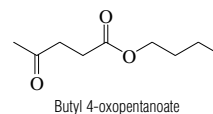
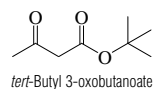
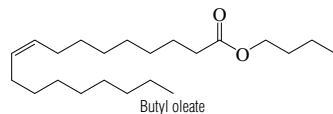
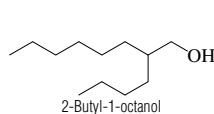
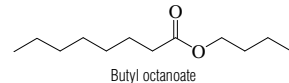
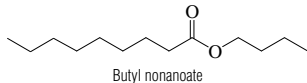
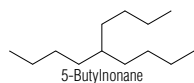
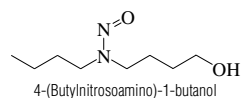
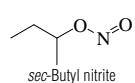
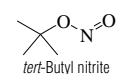
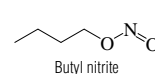
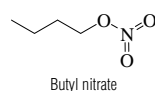
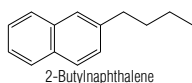
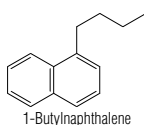
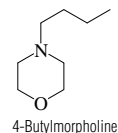
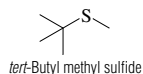
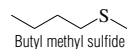
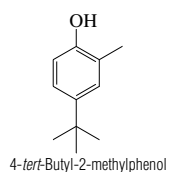
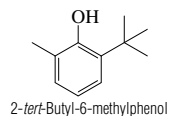
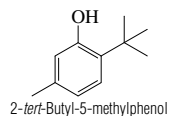
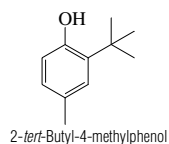
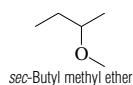
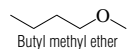




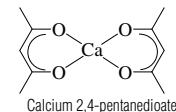
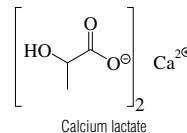
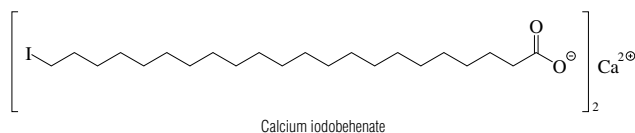
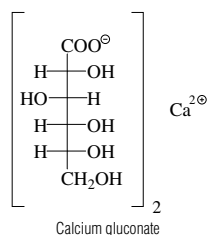
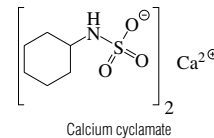
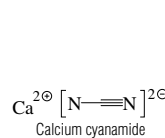
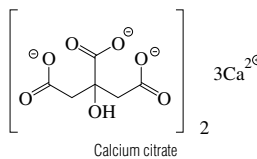
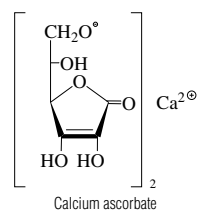
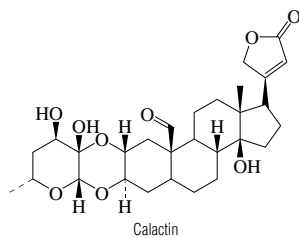
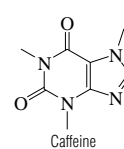
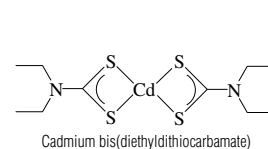
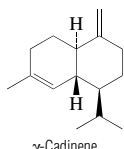
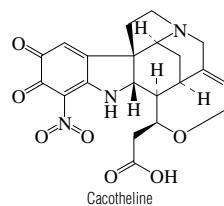
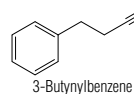
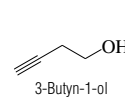
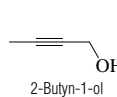
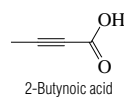
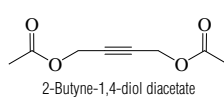
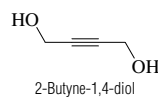
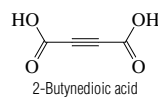
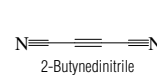
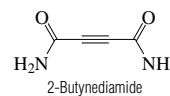
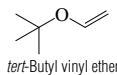
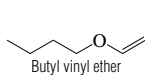
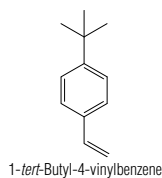
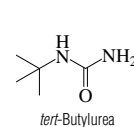
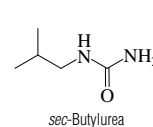
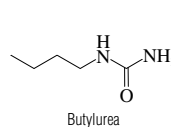
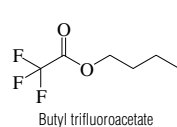
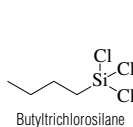
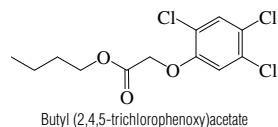
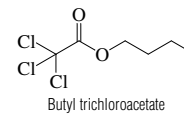
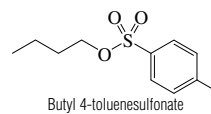
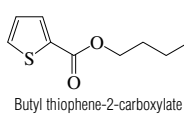
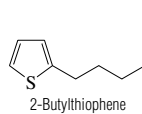
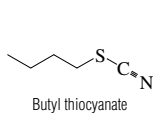
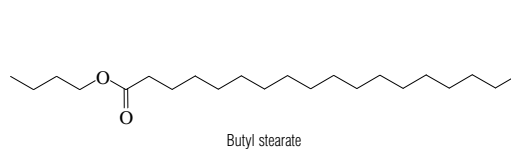
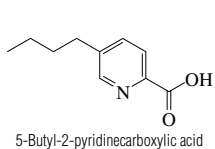
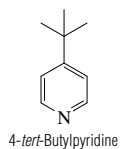
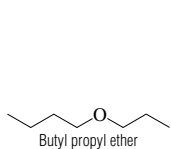
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1562	5-Butyldocosane		C <sub>26</sub> H <sub>54</sub>	55282-16-1	366.707		208	244 <sup>10</sup>	0.8058 <sup>20</sup>	1.4503 <sup>20</sup>	
1563	11-Butyldocosane		C <sub>26</sub> H <sub>54</sub>	13475-76-8	366.707			242.5 <sup>10</sup>	0.8041 <sup>20</sup>	1.4499 <sup>20</sup>	
1564	Butyl dodecanoate		C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	106-18-3	256.424			180 <sup>18</sup>			
1565	Butylethylamine	<i>N</i> -Ethyl-1-butanamine	C <sub>6</sub> H <sub>15</sub> N	13360-63-9	101.190			107.5	0.7398 <sup>20</sup>	1.4040 <sup>20</sup>	msc EtOH, eth, ace, bz
1566	1- <i>tert</i> -Butyl-4-ethylbenzene		C <sub>12</sub> H <sub>18</sub>	7364-19-4	162.271	liq	-38.4	211	0.8641 <sup>20</sup>		
1567	Butyl ethyl ether		C <sub>8</sub> H <sub>18</sub> O	628-81-9	102.174	liq	-124	92.3	0.7495 <sup>20</sup>	1.3818 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace
1568	<i>sec</i> -Butyl ethyl ether		C <sub>8</sub> H <sub>18</sub> O	2679-87-0	102.174			81	0.7503 <sup>20</sup>	1.3802 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1569	<i>tert</i> -Butyl ethyl ether	Ethyl <i>tert</i> -butyl ether	C <sub>8</sub> H <sub>18</sub> O	637-92-3	102.174	liq	-94	72.6	0.736 <sup>25</sup>	1.3756 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
1570	2- <i>tert</i> -Butyl-4-ethylphenol		C <sub>12</sub> H <sub>16</sub> O	96-70-8	178.270		23	250			
1571	2-Butyl-2-ethyl-1,3-propanediol		C <sub>9</sub> H <sub>20</sub> O <sub>2</sub>	115-84-4	160.254	wh cry	43.8	262	0.927 <sup>50</sup>	1.4587 <sup>25</sup>	sl H <sub>2</sub> O, ace; s EtOH
1572	5-Butyl-5-ethyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	Butethal	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	77-28-1	212.245			128.5			
1573	Butyl ethyl sulfide		C <sub>6</sub> H <sub>14</sub> S	638-46-0	118.240	liq	-95.1	144.3	0.8376 <sup>20</sup>	1.4492 <sup>10</sup>	vs EtOH; s chl
1574	<i>tert</i> -Butyl ethyl sulfide	2-Methyl-2-propanethiol	C <sub>6</sub> H <sub>14</sub> S	14290-92-7	118.240	liq	-88.9	120.4; 56 <sup>109</sup>			
1575	<i>N-tert</i> -Butylformamide		C <sub>5</sub> H <sub>11</sub> NO	2425-74-3	101.147	liq	16	202	0.903	1.4330 <sup>20</sup>	
1576	Butyl formate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	592-84-7	102.132	liq	-91.5	106.1	0.8958 <sup>20</sup>	1.3887 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
1577	<i>sec</i> -Butyl formate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	589-40-2	102.132			97	0.8846 <sup>20</sup>	1.3865 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
1578	<i>tert</i> -Butyl formate	1,1-Dimethylethyl formate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	762-75-4	102.132	liq		82	0.872	1.3790 <sup>20</sup>	
1579	Butyl glycidyl ether		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	2426-08-6	130.185			169; 75 <sup>26</sup>	0.918 <sup>20</sup>		
1580	Butyl heptanoate	Butyl enanthate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	5454-28-4	186.292	liq	-67.5	226.2	0.8638 <sup>20</sup>	1.4204 <sup>20</sup>	vs ace, bz, eth, EtOH
1581	Butyl hexanoate	Butyl caproate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	626-82-4	172.265	liq	-64.3	208	0.8653 <sup>20</sup>	1.4152 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth
1582	<i>tert</i> -Butylhydrazine hydrochloride		C <sub>4</sub> H <sub>13</sub> ClN <sub>2</sub>	7400-27-3	124.612			192.5			
1583	Butyl hydrogen succinate	Monobutyl succinate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	5150-93-6	174.195		8.6	136.5 <sup>3</sup>	1.0732 <sup>20</sup>	1.4360 <sup>20</sup>	
1584	<i>tert</i> -Butyl hydroperoxide		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	75-91-2	90.121		6	dec 89; 36 <sup>17</sup>	0.8960 <sup>20</sup>	1.4015 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ctc, chl
1585	<i>tert</i> -Butyl-4-hydroxyanisole	Butylated hydroxyanisole	C <sub>11</sub> H <sub>16</sub> O <sub>2</sub>	25013-16-5	180.244	wax	51	268			i H <sub>2</sub> O; s peth, EtOH
1586	Butyl 2-hydroxybenzoate		C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	2052-14-4	194.227	liq	-5.9	271	1.0728 <sup>20</sup>	1.5115 <sup>20</sup>	sl ctc
1587	Butyl 4-hydroxybenzoate	Butylparaben	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	94-26-8	194.227		68.5				sl H <sub>2</sub> O, ctc; s EtOH
1588	Butyl <i>cis</i> -12-hydroxy-9-octadecenoate, ( <i>A</i> )	Butyl ricinoleate	C <sub>22</sub> H <sub>42</sub> O <sub>3</sub>	151-13-3	354.566			275 <sup>13</sup>	0.9058 <sup>22</sup>	1.4566 <sup>22</sup>	vs eth
1589	<i>tert</i> -Butyl hypochlorite		C <sub>4</sub> H <sub>9</sub> ClO	507-40-4	108.566	ye liq		77.5	0.9583 <sup>18</sup>	1.403 <sup>20</sup>	i H <sub>2</sub> O; vs eth, bz; s ace
1590	Butyl isobutyl ether		C <sub>8</sub> H <sub>18</sub> O	17071-47-5	130.228	liq		151	0.763 <sup>15</sup>	1.4077 <sup>21</sup>	vs ace, eth, EtOH
1591	<i>tert</i> -Butyl isobutyl ether		C <sub>8</sub> H <sub>18</sub> O	33021-02-2	130.228	liq		112.0			
1592	Butyl isocyanate		C <sub>5</sub> H <sub>9</sub> NO	111-36-4	99.131			115	0.880 <sup>20</sup>	1.4060 <sup>20</sup>	
1593	Butyl isocyanide		C <sub>5</sub> H <sub>9</sub> N	2769-64-4	83.132			120	0.78 <sup>20</sup>		vs eth, EtOH
1594	<i>tert</i> -Butyl isopropyl ether		C <sub>7</sub> H <sub>16</sub> O	17348-59-3	116.201	liq	-88	87.6	0.7365 <sup>25</sup>		s chl
1595	Butyl isothiocyanate	1-Isothiocyanatobutane	C <sub>5</sub> H <sub>9</sub> NS	592-82-5	115.197			168	0.9546 <sup>20</sup>	1.501 <sup>20</sup>	vs eth, EtOH
1596	<i>sec</i> -Butyl isothiocyanate, (±)	2-Isothiocyanatobutane, (±)	C <sub>5</sub> H <sub>9</sub> NS	116724-11-9	115.197			159.5	0.944 <sup>12</sup>		vs eth, EtOH
1597	<i>tert</i> -Butyl isothiocyanate	2-Isothiocyanato-2-methylpropane	C <sub>5</sub> H <sub>9</sub> NS	590-42-1	115.197		10.5	140	0.9187 <sup>10</sup>		
1598	Butyl lactate		C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	34451-18-8	146.184			77 <sup>10</sup>	0.9744 <sup>27</sup>		vs eth, EtOH
1599	Butyl methacrylate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	97-88-1	142.196			160	0.8936 <sup>20</sup>	1.4240 <sup>20</sup>	vs eth, EtOH
1600	<i>tert</i> -Butyl methacrylate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	585-07-9	142.196			135.2			
1601	1- <i>tert</i> -Butyl-4-methoxybenzene		C <sub>11</sub> H <sub>16</sub> O	5396-38-3	164.244		19.0	238	0.9383 <sup>20</sup>	1.5039 <sup>20</sup>	
1602	1- <i>tert</i> -Butyl-2-methoxy-4-methyl-3,5-dinitrobenzene		C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O <sub>5</sub>	83-66-9	268.265	pa ye lf (al)	85	185 <sup>16</sup>			i H <sub>2</sub> O; sl EtOH; s eth, chl
1603	2- <i>tert</i> -Butyl-4-methoxyphenol		C <sub>11</sub> H <sub>16</sub> O <sub>2</sub>	121-00-6	180.244			184 <sup>50</sup>			
1604	3- <i>tert</i> -Butyl-4-methoxyphenol		C <sub>11</sub> H <sub>16</sub> O <sub>2</sub>	88-32-4	180.244		65				
1605	Butylmethylamine	<i>N</i> -Methyl-1-butanamine	C <sub>7</sub> H <sub>15</sub> N	110-68-9	87.164			91	0.7637 <sup>15</sup>		
1606	1- <i>tert</i> -Butyl-2-methylbenzene	2- <i>tert</i> -Butyltoluene	C <sub>11</sub> H <sub>16</sub>	1074-92-6	148.245	liq	-50.3	200.4	0.8897 <sup>20</sup>	1.5076 <sup>20</sup>	vs ace, bz, eth, EtOH
1607	1- <i>tert</i> -Butyl-3-methylbenzene	3- <i>tert</i> -Butyltoluene	C <sub>11</sub> H <sub>16</sub>	1075-38-3	148.245	liq	-41.4	189.3	0.8657 <sup>20</sup>	1.4944 <sup>20</sup>	vs ace, bz, eth, EtOH
1608	1- <i>tert</i> -Butyl-4-methylbenzene	4- <i>tert</i> -Butyltoluene	C <sub>11</sub> H <sub>16</sub>	98-51-1	148.245	liq	-52	190	0.8612 <sup>20</sup>	1.4918 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, chl; s ace, bz
1609	Butyl 2-methylbutanoate	Butyl <i>o</i> -toluate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	15706-73-7	158.238			179	0.8620 <sup>20</sup>	1.4135 <sup>20</sup>	
1610	Butyl 3-methylbutanoate	Butyl <i>p</i> -toluate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	109-19-3	158.238						



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1611	Butyl methyl ether		C <sub>8</sub> H <sub>18</sub> O	628-28-4	88.148	liq	-115.7	70.16	0.7392 <sup>25</sup>	1.3736 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
1612	sec-Butyl methyl ether		C <sub>8</sub> H <sub>18</sub> O	116783-23-4	88.148			59.1	0.7415 <sup>20</sup>	1.3680 <sup>25</sup>	vs ace, eth, EtOH
1613	2-tert-Butyl-4-methylphenol		C <sub>11</sub> H <sub>16</sub> O	2409-55-4	164.244		51.5	237	0.9247 <sup>75</sup>	1.4969 <sup>75</sup>	sl H <sub>2</sub> O; s ace, bz, chl
1614	2-tert-Butyl-5-methylphenol		C <sub>11</sub> H <sub>16</sub> O	88-60-8	164.244		46.5	127 <sup>11</sup>	0.922 <sup>80</sup>	1.5250 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
1615	2-tert-Butyl-6-methylphenol		C <sub>11</sub> H <sub>16</sub> O	2219-82-1	164.244		31	230	0.9240 <sup>80</sup>	1.5195 <sup>20</sup>	
1616	4-tert-Butyl-2-methylphenol		C <sub>11</sub> H <sub>16</sub> O	98-27-1	164.244		27.5	237; 132 <sup>20</sup>	0.965 <sup>20</sup>	1.5230 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz
1617	Butyl methyl sulfide		C <sub>8</sub> H <sub>18</sub> S	628-29-5	104.214	liq	-97.8	123.4	0.8426 <sup>20</sup>	1.4477 <sup>20</sup>	vs EtOH, MeOH
1618	tert-Butyl methyl sulfide		C <sub>8</sub> H <sub>18</sub> S	6163-64-0	104.214	liq		98.9			
1619	4-Butylmorpholine		C <sub>8</sub> H <sub>17</sub> NO	1005-67-0	143.227	liq	-57.1	213.5	0.9068 <sup>20</sup>	1.4451 <sup>20</sup>	vs H <sub>2</sub> O, ace, bz, EtOH
1620	1-Butylnaphthalene		C <sub>14</sub> H <sub>16</sub>	1634-09-9	184.277	liq	-19.8	289.3	0.9738 <sup>20</sup>	1.5819 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1621	2-Butylnaphthalene		C <sub>14</sub> H <sub>16</sub>	1134-62-9	184.277	liq	-2.5	292	0.9673 <sup>20</sup>	1.5777 <sup>20</sup>	vs ace, bz, EtOH
1622	Butyl nitrate		C <sub>8</sub> H <sub>15</sub> NO <sub>3</sub>	928-45-0	119.119			133	1.0228 <sup>30</sup>	1.4013 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
1623	Butyl nitrite		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	544-16-1	103.120			78	0.9114 <sup>25</sup>	1.3762 <sup>20</sup>	msc EtOH, eth
1624	tert-Butyl nitrite		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	540-80-7	103.120	pa ye liq		63	0.8670 <sup>20</sup>	1.368 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl, CS <sub>2</sub>
1625	sec-Butyl nitrite		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	924-43-6	103.120			68.5	0.8726 <sup>20</sup>	1.3710 <sup>20</sup>	vs eth, EtOH, chl
1626	4-(Butylnitrosoamino)-1-butanol	N-Butyl-N-(4-hydroxybutyl) nitrosamine	C <sub>8</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	3817-11-6	174.241			115 <sup>0.01</sup>			
1627	5-Butylnonane		C <sub>13</sub> H <sub>28</sub>	17312-63-9	184.361			217.5	0.7635 <sup>18</sup>	1.4273 <sup>18</sup>	
1628	Butyl nonanoate	Butyl pelargonate	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	50623-57-9	214.344		-38	123 <sup>20</sup>	0.8520 <sup>25</sup>	1.4262 <sup>25</sup>	
1629	Butyl octanoate		C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	589-75-3	200.318	liq	-42.9	240.5	0.8628 <sup>20</sup>	1.4232 <sup>25</sup>	vs ace, eth, EtOH
1630	2-Butyl-1-octanol		C <sub>12</sub> H <sub>26</sub> O	3913-02-8	186.333			246.5; 132 <sup>15</sup>	0.891 <sup>20</sup>		
1631	Butyl oleate	Butyl cis-9-octadecenoate	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	142-77-8	338.567	ye cry	-26.4	227 <sup>15</sup>	0.8704 <sup>15</sup>	1.4480 <sup>25</sup>	vs EtOH
1632	tert-Butyl 3-oxobutanoate		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	1694-31-1	158.195			71.5 <sup>11</sup>	0.9756 <sup>20</sup>	1.4180 <sup>20</sup>	
1633	Butyl 4-oxopentanoate	Butyl levulinate	C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	2052-15-5	172.221			237.5	0.9735 <sup>20</sup>	1.4290 <sup>20</sup>	sl chl
1634	Butyl palmitate	Butyl hexadecanoate	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	111-06-8	312.531	cry (dil al)	16.9			1.4312 <sup>50</sup>	i H <sub>2</sub> O; s EtOH, eth
1635	Butyl pentanoate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	591-68-4	158.238	liq	-92.8	185.8	0.8710 <sup>15</sup>	1.4128 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
1636	sec-Butyl pentanoate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	116836-32-9	158.238			174.5	0.8605 <sup>20</sup>	1.4070 <sup>20</sup>	vs bz, eth, py, EtOH
1637	4-(1-Butylpentyl)pyridine		C <sub>14</sub> H <sub>23</sub> N	2961-47-9	205.340			265; 181 <sup>50</sup>	0.8878 <sup>25</sup>	1.4846 <sup>25</sup>	
1638	tert-Butyl peroxybenzoate	Benzoyl tert-butyl peroxide	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	614-45-9	194.227			75 <sup>0.2</sup>	1.021 <sup>25</sup>	1.4990 <sup>20</sup>	
1639	2-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	3180-09-4	150.217	liq	-20	235	0.975 <sup>20</sup>	1.5180 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, alk
1640	2-sec-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	89-72-5	150.217		16	228; 116 <sup>21</sup>	0.9804 <sup>25</sup>	1.5200 <sup>25</sup>	
1641	2-tert-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	88-18-6	150.217	liq	-6.8	223	0.9783 <sup>20</sup>	1.5160 <sup>20</sup>	s EtOH, ctc, alk; vs eth
1642	3-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	4074-43-5	150.217			248	0.974 <sup>20</sup>		vs eth, EtOH
1643	3-tert-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	585-34-2	150.217	nd (peth)	42.3	240			s EtOH, alk; vs eth
1644	4-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	1638-22-8	150.217		22	248	0.976 <sup>22</sup>	1.5165 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, alk; sl ctc
1645	4-sec-Butylphenol	4-(1-Methylpropyl)phenol	C <sub>10</sub> H <sub>14</sub> O	99-71-8	150.217		61.5	241	0.986 <sup>20</sup>	1.5182 <sup>21</sup>	i H <sub>2</sub> O; s EtOH, alk; vs eth
1646	4-tert-Butylphenol		C <sub>10</sub> H <sub>14</sub> O	98-54-4	150.217	nd (lig)	98	237	0.908 <sup>80</sup>	1.4787 <sup>14</sup>	s H <sub>2</sub> O, EtOH, eth, chl, alk
1647	4-tert-Butylphenol, phosphate (3:1)		C <sub>30</sub> H <sub>39</sub> O <sub>4</sub> P	78-33-1	494.602						i EtOH; sl eth, bz
1648	[(4-tert-Butylphenoxy)methyl] oxirane		C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	3101-60-8	206.281			167 <sup>14</sup> ; 145 <sup>0.5</sup>	1.036 <sup>25</sup>	1.5145 <sup>20</sup>	
1649	N-Butyl-N-phenylacetamide		C <sub>12</sub> H <sub>17</sub> NO	91-49-6	191.269		24.5	281	0.9912 <sup>20</sup>	1.5146 <sup>20</sup>	sl chl
1650	1-(4-tert-Butylphenyl)ethanone		C <sub>12</sub> H <sub>16</sub> O	943-27-1	176.254		17.7	263; 137 <sup>20</sup>	0.9635 <sup>20</sup>	1.518 <sup>15</sup>	
1651	Butyl phenyl ether	Butoxybenzene	C <sub>10</sub> H <sub>14</sub> O	1126-79-0	150.217	liq	-19.4	210	0.9351 <sup>20</sup>	1.4969 <sup>20</sup>	s eth, ace
1652	N-Butylpiperidine		C <sub>9</sub> H <sub>19</sub> N	4945-48-6	141.254			176	0.8245 <sup>20</sup>	1.4467 <sup>20</sup>	
1653	Butylpropanedioic acid	Butylmalonic acid	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	534-59-8	160.168	pr (w)	104.5				vs H <sub>2</sub> O; s EtOH, eth
1654	Butyl propanoate	Butyl propionate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	590-01-2	130.185	liq	-89	146.8	0.8754 <sup>20</sup>	1.4014 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
1655	sec-Butyl propanoate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	591-34-4	130.185			133	0.8657 <sup>20</sup>	1.3952 <sup>20</sup>	s EtOH, eth
1656	N-tert-Butyl-2-propenamide	N-tert-Butylacrylamide	C <sub>7</sub> H <sub>13</sub> NO	107-58-4	127.184	cry (bz)	128				sl H <sub>2</sub> O; i peth

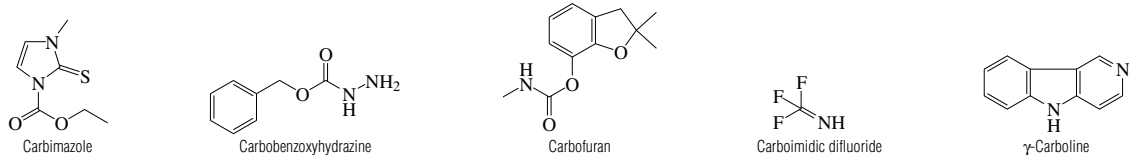
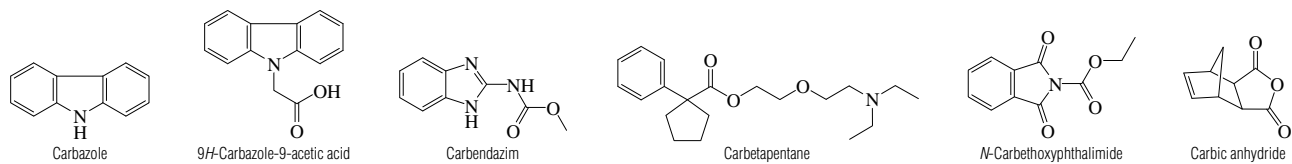
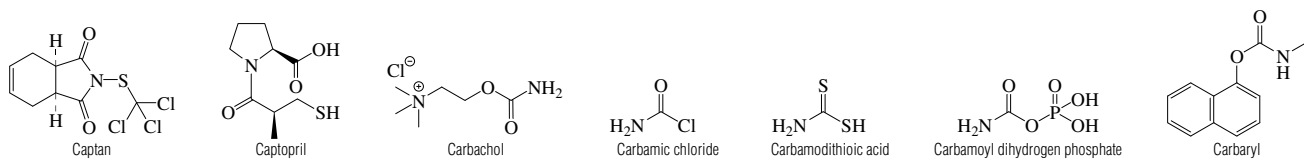
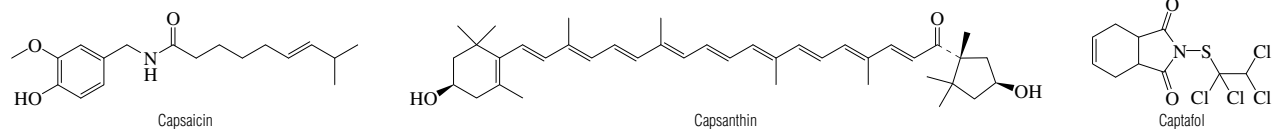
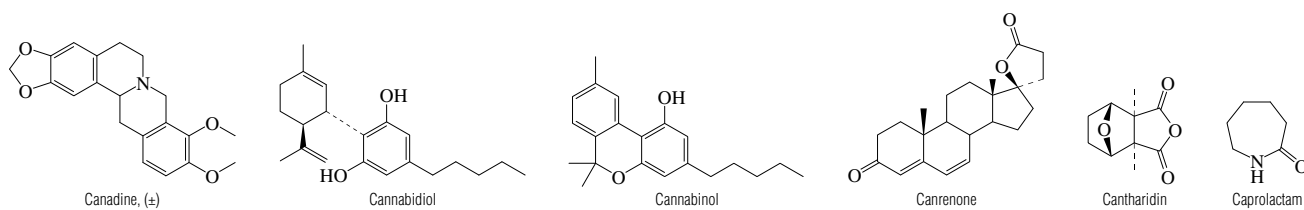
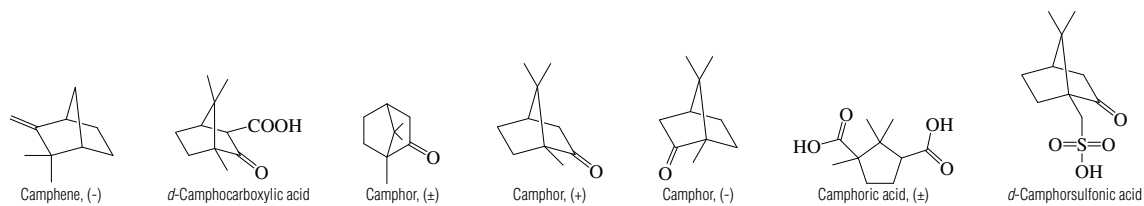
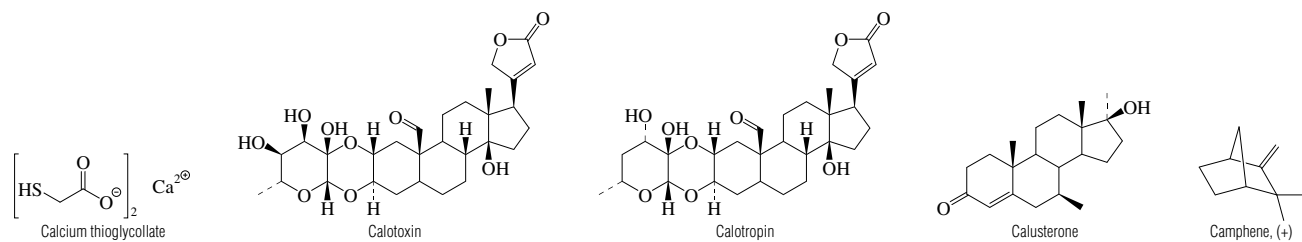


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1657	Butyl propyl ether		C <sub>7</sub> H <sub>16</sub> O	3073-92-5	116.201			118.1	0.7772 <sup>9</sup>		i H <sub>2</sub> O; vs EtOH, eth
1658	4- <i>tert</i> -Butylpyridine		C <sub>9</sub> H <sub>13</sub> N	3978-81-2	135.206	liq	-41	196.5	0.915 <sup>25</sup>	1.4958 <sup>20</sup>	s ctc, CS <sub>2</sub>
1659	5-Butyl-2-pyridinecarboxylic acid	Fusaric acid	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	536-69-6	179.216		97				
1660	Butyl stearate		C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	123-95-5	340.583		27	343	0.854 <sup>25</sup>	1.4328 <sup>50</sup>	i H <sub>2</sub> O; s EtOH; vs ace
1661	Butyl thiocyanate	1-Thiocyanobutane	C <sub>5</sub> H <sub>9</sub> NS	628-83-1	115.197			186	0.9563 <sup>15</sup>	1.4360 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
1662	2-Butylthiophene		C <sub>8</sub> H <sub>12</sub> S	1455-20-5	140.246			181.5	0.9537 <sup>20</sup>	1.5090 <sup>20</sup>	
1663	Butyl thiophene-2-carboxylate	Butyl 2-thiophenecarboxylate	C <sub>9</sub> H <sub>12</sub> O <sub>2</sub> S	56053-84-0	184.255			58 <sup>9</sup> , 15			
1664	Butyl 4-toluenesulfonate		C <sub>11</sub> H <sub>16</sub> O <sub>3</sub> S	778-28-9	228.308			165 <sup>6</sup>	1.1319 <sup>20</sup>	1.5050 <sup>20</sup>	i H <sub>2</sub> O; s eth; sl ctc
1665	Butyl trichloroacetate		C <sub>8</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	3657-07-6	219.493			204	1.2778 <sup>20</sup>	1.4525 <sup>25</sup>	s ctc
1666	Butyl (2,4,5-trichlorophenoxy)acetate	2,4,5-T Butyl ester	C <sub>12</sub> H <sub>13</sub> Cl <sub>3</sub> O <sub>3</sub>	93-79-8	311.588		28.5	337			
1667	Butyltrichlorosilane	Trichlorobutylsilane	C <sub>4</sub> H <sub>9</sub> Cl <sub>3</sub> Si	7521-80-4	191.559			148.5	1.1606 <sup>20</sup>	1.4363 <sup>20</sup>	s eth, bz, tol, AcOEt
1668	Butyl trifluoroacetate		C <sub>8</sub> H <sub>9</sub> F <sub>3</sub> O <sub>2</sub>	367-64-6	170.129			102	1.0268 <sup>22</sup>	1.353 <sup>22</sup>	s chl
1669	Butylurea		C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	592-31-4	116.161	tab (w), nd (bz)	97.0				vs H <sub>2</sub> O, EtOH; sl chl
1670	<i>sec</i> -Butylurea	(1-Methylpropyl)urea	C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	689-11-2	116.161	pr (w)	169				
1671	<i>tert</i> -Butylurea		C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	1118-12-3	116.161		176 dec				s H <sub>2</sub> O; vs EtOH; sl bz
1672	1- <i>tert</i> -Butyl-4-vinylbenzene	<i>p-tert</i> -Butylstyrene	C <sub>12</sub> H <sub>16</sub>	1746-23-2	160.255	liq	-36.9	99 <sup>14</sup>	0.89 <sup>20</sup>		
1673	Butyl vinyl ether	1-(Ethenyloxy)butane	C <sub>6</sub> H <sub>12</sub> O	111-34-2	100.158	liq	-92	94	0.7888 <sup>20</sup>	1.4026 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, ace; msc eth; s bz
1674	<i>tert</i> -Butyl vinyl ether	2-(Ethenyloxy)-2-methylpropane	C <sub>6</sub> H <sub>12</sub> O	926-02-3	100.158	liq	-112	75	0.7691 <sup>20</sup>	1.3922 <sup>20</sup>	
1675	1-Butyne	Ethylacetylene	C <sub>4</sub> H <sub>6</sub>	107-00-6	54.091	col gas	-125.7	8.08	0.6783 <sup>9</sup>	1.3962 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
1676	2-Butyne	Dimethylacetylene	C <sub>4</sub> H <sub>6</sub>	503-17-3	54.091	vol liq or gas	-32.2	26.9	0.6910 <sup>20</sup>	1.3921 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
1677	2-Butylenediamide	Cellocidin	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	543-21-5	112.087	cry (dil MeOH)	217 dec				sl H <sub>2</sub> O, chl, EtOH, eth, gl HOAc
1678	2-Butylenedinitrile		C <sub>4</sub> N <sub>2</sub>	1071-98-3	76.056		20.5	76.5	0.9708 <sup>25</sup>	1.4647 <sup>25</sup>	
1679	2-Butylenedioic acid		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	142-45-0	114.057		183 dec				vs H <sub>2</sub> O, EtOH, eth
1680	2-Butyne-1,4-diol	Bis(hydroxymethyl)acetylene	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	110-65-6	86.090	pl (bz, AcOEt)	50	238		1.4804 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, ace; sl eth; i bz, peth
1681	2-Butyne-1,4-diol diacetate	1,4-Diacetoxy-2-butyne	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	1573-17-7	170.163			122 <sup>10</sup>		1.4611 <sup>20</sup>	s ctc
1682	2-Butynoic acid		C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	590-93-2	84.074	pl (eth, peth)	78	203	0.9641 <sup>20</sup>		vs H <sub>2</sub> O, eth, EtOH, chl
1683	2-Butyn-1-ol		C <sub>4</sub> H <sub>6</sub> O	764-01-2	70.090	liq	-1.1	148	0.9370 <sup>20</sup>	1.4530 <sup>20</sup>	vs eth, EtOH
1684	3-Butyn-1-ol		C <sub>4</sub> H <sub>6</sub> O	927-74-2	70.090	liq	-63.6	129	0.9257 <sup>20</sup>	1.4409 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
1685	3-Butyn-2-ol		C <sub>4</sub> H <sub>6</sub> O	2028-63-9	70.090	liq	-1.5	106.5	0.8618 <sup>20</sup>	1.4207 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
1686	3-Butyn-2-one	Ethynyl methyl ketone	C <sub>4</sub> H <sub>6</sub> O	1423-60-5	68.074			84	0.8793 <sup>20</sup>	1.4070 <sup>20</sup>	
1687	3-Butynylbenzene		C <sub>10</sub> H <sub>10</sub>	16520-62-0	130.186			190	0.9258 <sup>20</sup>	1.5208 <sup>20</sup>	
1688	$\gamma$ -Butyrolactone	Oxolan-2-one	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	96-48-0	86.090	liq	-43.61	204	1.1296 <sup>20</sup>	1.4341 <sup>20</sup>	vs ace, bz, eth, EtOH
1689	Cacotheline		C <sub>21</sub> H <sub>21</sub> N <sub>3</sub> O <sub>7</sub>	561-20-6	427.408	ye cry	>300				sl H <sub>2</sub> O
1690	$\gamma$ -Cadinene		C <sub>15</sub> H <sub>24</sub>	39029-41-9	204.352			126 <sup>12</sup>	0.9182 <sup>15</sup>	1.3166 <sup>20</sup>	
1691	Cadmium bis(diethylthiocarbamate)		C <sub>10</sub> H <sub>20</sub> CdN <sub>2</sub> S <sub>4</sub>	14239-68-0	408.950	wh cry	255				
1692	Caffeine		C <sub>8</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub>	58-08-2	194.191	wh nd (w+1), hex pr (sub)	238	sub 90	1.23 <sup>19</sup>		sl H <sub>2</sub> O, EtOH; i eth, ctc; s chl, py
1693	Calactin	19-Oxogomphoside	C <sub>28</sub> H <sub>40</sub> O <sub>9</sub>	20304-47-6	532.623	small pr (ace)	271				
1694	Calcium ascorbate		C <sub>12</sub> H <sub>14</sub> CaO <sub>12</sub>	5743-27-1	390.310	tricl cry (w)					s H <sub>2</sub> O; i MeOH, EtOH
1695	Calcium citrate		C <sub>12</sub> H <sub>10</sub> Ca <sub>3</sub> O <sub>14</sub>	7693-13-2	498.433	cry (w)	$\approx$ 100 dec (hyd)				sl H <sub>2</sub> O; i EtOH
1696	Calcium cyanamide	Calcium carbimide	CCa <sub>2</sub> N <sub>2</sub>	156-62-7	80.102	col hex cry	$\approx$ 1340	sub	2.29		dec H <sub>2</sub> O
1697	Calcium cyclamate		C <sub>12</sub> H <sub>24</sub> CaN <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	139-06-0	396.535	cry					vs H <sub>2</sub> O
1698	Calcium gluconate		C <sub>12</sub> H <sub>22</sub> CaO <sub>14</sub>	299-28-5	430.373	cry					i EtOH, os
1699	Calcium iodobenzenate	Iodobenzenoic acid, calcium salt	C <sub>44</sub> H <sub>84</sub> CaI <sub>2</sub> O <sub>4</sub>	1319-91-1	971.023	wh-ye pow					i H <sub>2</sub> O, EtOH, eth; s chl
1700	Calcium lactate		C <sub>6</sub> H <sub>10</sub> CaO <sub>6</sub>	814-80-2	218.217	wh pow (w)					s H <sub>2</sub> O; i EtOH
1701	Calcium 2,4-pentanedioate	Calcium acetylacetonate	C <sub>10</sub> H <sub>14</sub> CaO <sub>4</sub>	19372-44-2	238.294	col cry (MeOH)	dec				

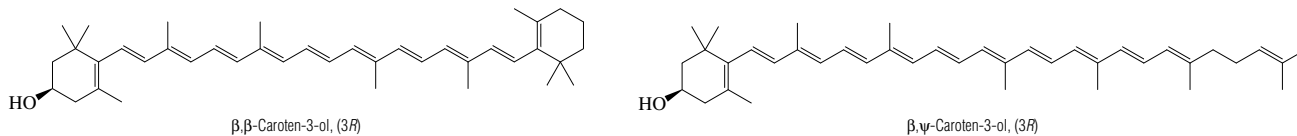
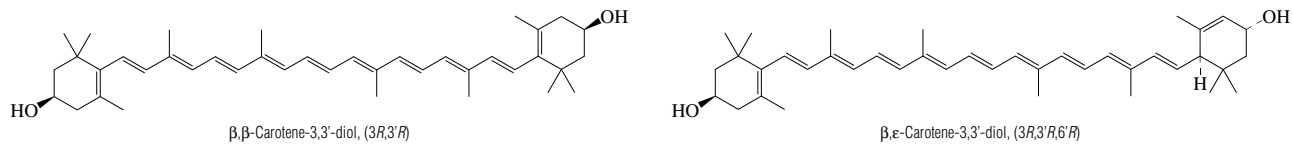
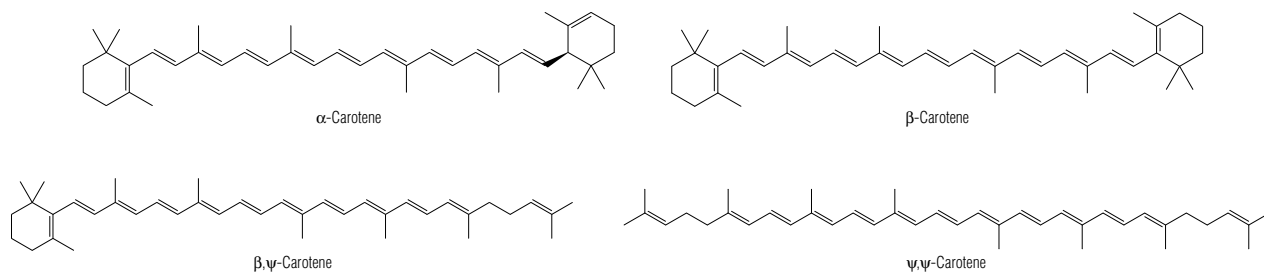
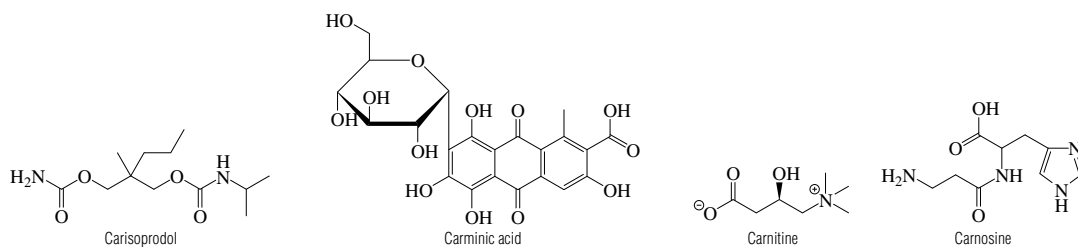
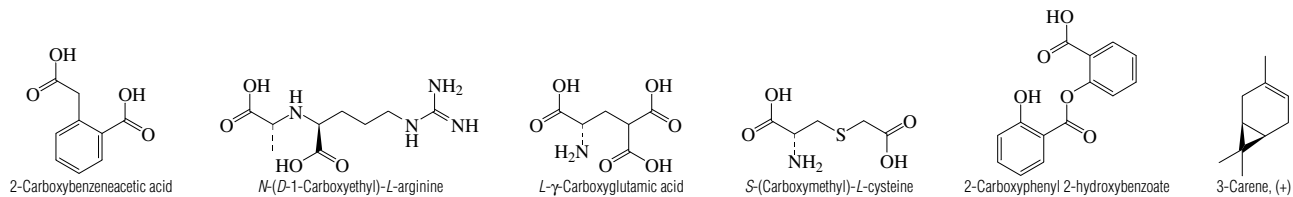
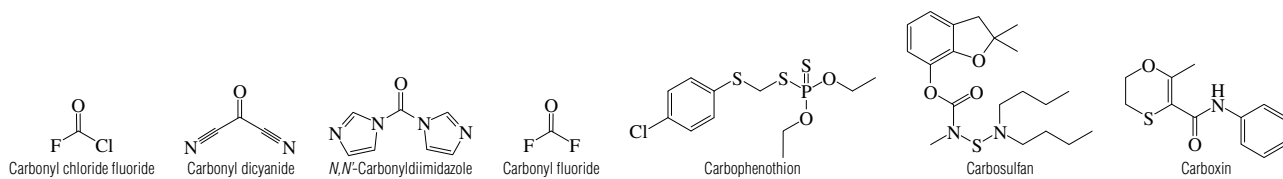
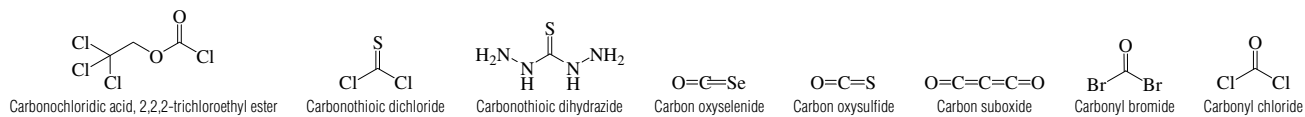
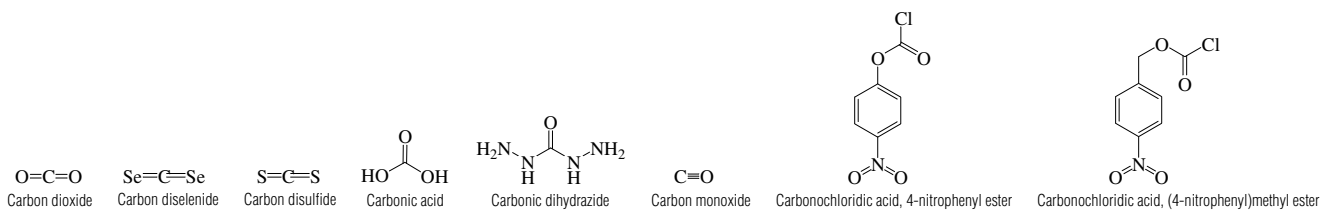


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1702	Calcium thioglycollate		C <sub>4</sub> H <sub>6</sub> CaO <sub>4</sub> S <sub>2</sub>	814-71-1	222.297	pr (w)	220 dec				s H <sub>2</sub> O, chl; sl EtOH; i eth, bz
1703	Calotoxin	4β-Hydroxy-19-oxogomphoside	C <sub>29</sub> H <sub>40</sub> O <sub>10</sub>	20304-49-8	548.622	cry (EtOH)	268				
1704	Calotropin		C <sub>29</sub> H <sub>40</sub> O <sub>9</sub>	1986-70-5	532.623	pl (EtOH)	221				s H <sub>2</sub> O, EtOH; i eth
1705	Calusterone		C <sub>28</sub> H <sub>48</sub> O	17021-26-0	400.680	cry (ace)	157.5				
1706	Camphene, (+)	2,2-Dimethyl-3-methylenebicyclo[2.2.1]heptane, (1R)-	C <sub>10</sub> H <sub>16</sub>	5794-03-6	136.234	nd	52	161	0.8950 <sup>50</sup>	1.4570 <sup>25</sup>	vs eth
1707	Camphene, (-)	2,2-Dimethyl-3-methylenebicyclo[2.2.1]heptane, (1S)-	C <sub>10</sub> H <sub>16</sub>	5794-04-7	136.234		52	158	0.8446 <sup>50</sup>	1.4564 <sup>54</sup>	vs eth
1708	d-Camphocarboxylic acid		C <sub>11</sub> H <sub>16</sub> O <sub>3</sub>	18530-30-8	196.243	pr (eth, 50% al)	127.5				vs bz, eth, EtOH
1709	Camphor, (±)	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one, (±)	C <sub>10</sub> H <sub>16</sub> O	21368-68-3	152.233	wh rhom cry (EtOH)	178.3	sub			i H <sub>2</sub> O; vs EtOH, eth; s ace, bz, ctc
1710	Camphor, (+)	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one, (1R)	C <sub>10</sub> H <sub>16</sub> O	464-49-3	152.233	pl	178.8	207.4	0.990 <sup>25</sup>	1.5462	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz
1711	Camphor, (-)	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one, (1S)	C <sub>10</sub> H <sub>16</sub> O	464-48-2	152.233		178.6		0.9853 <sup>18</sup>		i H <sub>2</sub> O; vs EtOH, eth, HOAc; s ace, bz
1712	Camphoric acid, (±)	1,2,2-Trimethyl-1,3-cyclopentenedicarboxylic acid, (1R, 3SR)	C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	5394-83-2	200.232	pr, lf	202		1.186		sl H <sub>2</sub> O; s chl, eth, EtOH
1713	d-Camphorsulfonic acid		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub> S	3144-16-9	232.297	pr (HOAc)	195 dec				vs H <sub>2</sub> O; i eth; sl HOAc
1714	Canadine, (±)	DL-Tetrahydroberberine	C <sub>20</sub> H <sub>21</sub> NO <sub>4</sub>	29074-38-2	339.386	mcl nd (al)	134				vs EtOH, chl
1715	Cannabidiol		C <sub>21</sub> H <sub>30</sub> O <sub>2</sub>	13956-29-1	314.462	rods (peth)	67	188 <sup>2</sup>	1.040 <sup>40</sup>	1.5404 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
1716	Cannabinol	6,6,9-Trimethyl-3-pentyl-6H-dibenzof[b,d]pyran-1-ol	C <sub>21</sub> H <sub>26</sub> O <sub>2</sub>	521-35-7	310.430	pl, lf (peth)	77	185 <sup>0.05</sup>			i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth, alk
1717	Canrenone		C <sub>22</sub> H <sub>28</sub> O <sub>3</sub>	976-71-6	340.455	cry (AcOEt)	150				
1718	Cantharidin		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	56-25-7	196.200	orth pl	218	sub 84			i H <sub>2</sub> O; sl EtOH, eth, ace, bz; s HOAc
1719	Caprolactam	6-Hexanelactam	C <sub>6</sub> H <sub>11</sub> NO	105-60-2	113.157	lf (lig)	69.3	270			vs H <sub>2</sub> O, bz, EtOH, chl
1720	Capsaicin		C <sub>18</sub> H <sub>27</sub> NO <sub>3</sub>	404-86-4	305.412	mcl pl or sc (peth)	65	215 <sup>0.01</sup>			i H <sub>2</sub> O; vs EtOH; s eth, bz, peth; sl con HCl
1721	Capsanthin	3,3'-Dihydroxy-β,κ-caroten-6'-one, (3R,3'S,5'R)	C <sub>40</sub> H <sub>56</sub> O <sub>3</sub>	465-42-9	584.871		176				
1722	Captafol		C <sub>10</sub> H <sub>9</sub> Cl <sub>4</sub> NO <sub>2</sub> S	2425-06-1	349.061	cry	161				
1723	Captan		C <sub>9</sub> H <sub>8</sub> Cl <sub>3</sub> NO <sub>2</sub> S	133-06-2	300.590	cry (CCl <sub>4</sub> )	172.5		1.74 <sup>25</sup>		vs chl
1724	Captopril	1-(3-Mercapto-2-methyl-1-oxypropyl)proline	C <sub>9</sub> H <sub>15</sub> NO <sub>3</sub> S	62571-86-2	217.285	cry (AcOEt)	105				s H <sub>2</sub> O, EtOH, chl
1725	Carbachol		C <sub>6</sub> H <sub>15</sub> ClN <sub>2</sub> O <sub>2</sub>	51-83-2	182.648		210 dec				vs H <sub>2</sub> O, MeOH; sl EtOH; i eth, chl
1726	Carbamic chloride	Carbamyl chloride	CH <sub>2</sub> ClNO	463-72-9	79.486			dec 62			
1727	Carbamodithioic acid		CH <sub>2</sub> NS <sub>2</sub>	594-07-0	93.172						vs EtOH, eth
1728	Carbamoyl dihydrogen phosphate		CH <sub>4</sub> NO <sub>5</sub> P	590-55-6	141.021	unstab in soln					
1729	Carbaryl		C <sub>12</sub> H <sub>11</sub> NO <sub>2</sub>	63-25-2	201.221		145		1.228 <sup>25</sup>		vs ace, DMF
1730	Carbazole	Dibenzopyrrole	C <sub>12</sub> H <sub>9</sub> N	86-74-8	167.206	pl or lf	246.3	354.69			i H <sub>2</sub> O; sl EtOH, eth, bz, chl; s ace
1731	9H-Carbazole-9-acetic acid		C <sub>14</sub> H <sub>11</sub> NO <sub>2</sub>	524-80-1	225.243	lf (AcOEt)	215				vs eth, EtOH, chl, HOAc
1732	Carbendazim	Carbamic acid, 1H-benzimidazol-2-yl-, methyl ester	C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	10605-21-7	191.186		300 dec		1.45		
1733	Carbetapentane	Pentoxyverine	C <sub>20</sub> H <sub>31</sub> NO <sub>3</sub>	77-23-6	333.465			165 <sup>0.01</sup>			
1734	N-Carboethoxyphthalimide	N-(Ethoxycarbonyl)phthalimide	C <sub>11</sub> H <sub>9</sub> NO <sub>4</sub>	22509-74-6	219.194		91				
1735	Carbic anhydride		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	129-64-6	164.158	orth cry (peth)	164.5		1.417 <sup>25</sup>		vs ace, bz, EtOH, chl
1736	Carbimazole		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> S	22232-54-8	186.231	cry, pow	123.5				vs ace, chl
1737	Carbobenzoylhydrazine	Benzyl carbazate	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	5331-43-1	166.177		69.5				
1738	Carbofuran		C <sub>12</sub> H <sub>15</sub> NO <sub>3</sub>	1563-66-2	221.252		151		1.18		
1739	Carboimide difluoride		CHF <sub>2</sub> N	2712-98-3	65.023	gas	-90	-13 dec			

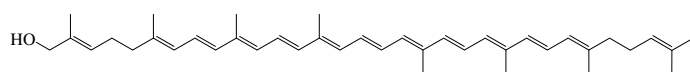
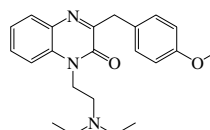




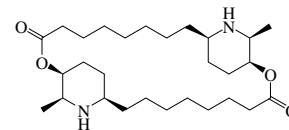
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1740	γ-Carboline	5 <i>H</i> -Pyrido[4,3- <i>b</i> ]indole	C <sub>11</sub> H <sub>8</sub> N <sub>2</sub>	244-69-9	168.195	nd	225		1.352		sl H <sub>2</sub> O, bz; vs MeOH; s EtOH
1741	Carbon dioxide	Carbonic anhydride	CO <sub>2</sub>	124-38-9	44.010	col gas	-56.56 tp	-78.5 sp	0.720 <sup>25</sup> (p>1 atm)		sl H <sub>2</sub> O
1742	Carbon diselenide	Carbon selenide	CSe <sub>2</sub>	506-80-9	169.93	ye liq	-43.7	125.5	2.6823 <sup>20</sup>	1.8454 <sup>20</sup>	
1743	Carbon disulfide	Carbon bisulfide	CS <sub>2</sub>	75-15-0	76.141	col liq	-112.1	46	1.2632 <sup>20</sup>	1.6319 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
1744	Carbonic acid		CH <sub>2</sub> O <sub>3</sub>	463-79-6	62.025						Aq. soln. of CO <sub>2</sub>
1745	Carbonic dihydrazide	Carbohydrazide	CH <sub>2</sub> N <sub>4</sub> O	497-18-7	90.085	nd (dil al)	154		1.616 <sup>20</sup>		vs H <sub>2</sub> O, EtOH
1746	Carbon monoxide	Carbon oxide	CO	630-08-0	28.010	col gas	-205.02	-191.5	0.7909 <sup>19</sup>		sl H <sub>2</sub> O; s bz, HOAc
1747	Carbonochloridic acid, 4-nitrophenyl ester		C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	7693-46-1	201.565		80	160 <sup>19</sup>			
1748	Carbonochloridic acid, (4-nitrophenyl)methyl ester		C <sub>8</sub> H <sub>6</sub> ClNO <sub>4</sub>	4457-32-3	215.592		32.8				
1749	Carbonochloridic acid, 2,2,2-trichloroethyl ester		C <sub>3</sub> H <sub>2</sub> Cl <sub>4</sub> O <sub>2</sub>	17341-93-4	211.859			63 <sup>11</sup>			
1750	Carbonyl dichloride	Thiophosgene	CCl <sub>2</sub> S	463-71-8	114.982	red liq		73	1.508 <sup>15</sup>	1.5442 <sup>20</sup>	dec H <sub>2</sub> O, EtOH; s eth
1751	Carbonyl dihydrazide	1,3-Diamino-2-thiourea	CH <sub>6</sub> N <sub>4</sub> S	2231-57-4	106.151	nd, pl (w) nd, pl (w)	170 dec				vs H <sub>2</sub> O
1752	Carbon oxyselenide	Carbonyl selenide	COSe	1603-84-5	106.97	col gas; unstab	-122	-21.5			dec H <sub>2</sub> O
1753	Carbon oxysulfide	Carbonyl sulfide	COS	463-58-1	60.075	col gas	-138.8	-50	1.028 <sup>17</sup>	1.24 <sup>87</sup>	sl H <sub>2</sub> O; s EtOH; vs KOH
1754	Carbon suboxide	1,2-Propadiene-1,3-dione	C <sub>3</sub> O <sub>2</sub>	504-64-3	68.031	col gas	-107	6.8	1.114 <sup>0</sup>	1.4538 <sup>0</sup>	s eth, bz, CS <sub>2</sub>
1755	Carbonyl bromide	Bromophosgene	CBr <sub>2</sub> O	593-95-3	187.818			64.5	2.52 <sup>15</sup>		
1756	Carbonyl chloride	Phosgene	CCl <sub>2</sub> O	75-44-5	98.916	col gas	-127.78	8	1.3719 <sup>25</sup> (p>1 atm)		s bz, ctc, chl, tol, HOAc
1757	Carbonyl chloride fluoride	Carbonic chloride fluoride	CClFO	353-49-1	82.461	col gas	-148	-47.2			reac H <sub>2</sub> O
1758	Carbonyl dicyanide		C <sub>2</sub> N <sub>2</sub> O	1115-12-4	80.044	liq	-36	65.5	1.124 <sup>20</sup>	1.3919 <sup>20</sup>	s eth, ace, ctc, chl
1759	<i>N,N'</i> -Carbonyldiimidazole		C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O	530-62-1	162.149	cry (bz)	119				
1760	Carbonyl fluoride		CF <sub>2</sub> O	353-50-4	66.007	col gas	-111.2	-84.5	1.139 <sup>25</sup>		
1761	Carbophenothion		C <sub>11</sub> H <sub>16</sub> ClO <sub>2</sub> PS <sub>3</sub>	786-19-6	342.866			82 <sup>0,01</sup>	1.271 <sup>20</sup>		
1762	Carbosulfan		C <sub>20</sub> H <sub>32</sub> N <sub>2</sub> O <sub>3</sub> S	55285-14-8	380.544			126	1.056 <sup>20</sup>		
1763	Carboxin		C <sub>12</sub> H <sub>12</sub> NO <sub>2</sub> S	5234-68-4	235.302		94				
1764	2-Carboxybenzeneacetic acid		C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	89-51-0	180.158		184.5		1.4100 <sup>20</sup>		s H <sub>2</sub> O, EtOH; sl eth; i bz, chl
1765	<i>N</i> -( <i>D</i> -1-Carboxyethyl)- <i>L</i> -arginine	Octopine	C <sub>9</sub> H <sub>18</sub> N <sub>4</sub> O <sub>4</sub>	34522-32-2	246.264	nd (w)	281				
1766	<i>L</i> -γ-Carboxyglutamic acid		C <sub>8</sub> H <sub>9</sub> NO <sub>6</sub>	53861-57-7	191.138	cry	167				
1767	<i>S</i> -(Carboxymethyl)- <i>L</i> -cysteine	Carbocysteine	C <sub>6</sub> H <sub>9</sub> NO <sub>3</sub> S	638-23-3	179.195	nd	206				
1768	2-Carboxyphenyl 2-hydroxybenzoate	Salsalate	C <sub>14</sub> H <sub>10</sub> O <sub>5</sub>	552-94-3	258.226		147				sl ace
1769	3-Carene, (+)		C <sub>10</sub> H <sub>16</sub>	498-15-7	136.234			171; 123 <sup>200</sup>	0.8549 <sup>30</sup>	1.469 <sup>3</sup>	vs ace, bz, eth
1770	Carisoprodol		C <sub>12</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	78-44-4	260.330	cry	92				s os
1771	Carminic acid		C <sub>22</sub> H <sub>20</sub> O <sub>13</sub>	1260-17-9	492.386	red mcl pr (aq, MeOH)	136 dec				s H <sub>2</sub> O, EtOH; sl eth; i bz, chl
1772	Carnitine	4-Amino-3-hydroxybutanoic acid trimethylbetaine	C <sub>7</sub> H <sub>15</sub> NO <sub>3</sub>	541-15-1	161.199	cry (al-ace), hyg	197 dec				vs H <sub>2</sub> O, EtOH
1773	Carnosine	<i>N</i> -β-Alanyl- <i>L</i> -histidine	C <sub>9</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub>	305-84-0	226.232		260				vs H <sub>2</sub> O
1774	α-Carotene		C <sub>40</sub> H <sub>56</sub>	7488-99-5	536.873	red pl or pr (peth, bz-MeOH)	187.5		1.00 <sup>20</sup>		vs bz, eth, chl
1775	β-Carotene		C <sub>40</sub> H <sub>56</sub>	7235-40-7	536.873	red br hex pr (bz-MeOH)	183		1.00 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, chl; s eth, ace, bz
1776	β,ψ-Carotene	γ-Carotene	C <sub>40</sub> H <sub>56</sub>	472-93-5	536.873	red pr (bz-MeOH), viol pr (eth)	153				i H <sub>2</sub> O, EtOH; sl eth, peth; s bz, chl
1777	ψ,ψ-Carotene	<i>trans</i> -Lycopene	C <sub>40</sub> H <sub>56</sub>	502-65-8	536.873	red pr or nd (peth)	175				sl EtOH, peth; s eth; vs bz, chl, CS <sub>2</sub>
1778	β,β-Carotene-3,3'-diol, (3 <i>R</i> ,3' <i>R</i> )	Zeaxanthin	C <sub>40</sub> H <sub>56</sub> O <sub>2</sub>	144-68-3	568.872	ye pr (MeOH) orth (chl-eth)	215.5	227 <sup>0,06</sup>			i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, py, chl
1779	β,ε-Carotene-3,3'-diol, (3 <i>R</i> ,3' <i>R</i> ,6' <i>R</i> )	Xanthophyll	C <sub>40</sub> H <sub>56</sub> O <sub>2</sub>	127-40-2	568.872	ye or viol pr (eth-MeOH)	196				vs bz, eth, EtOH, peth
1780	β,β-Caroten-3-ol, (3 <i>R</i> )	Cryptoxanthin	C <sub>40</sub> H <sub>56</sub> O	472-70-8	552.872	garnet red pr (bz-MeOH)	160				vs bz, chl



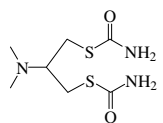
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1781	β,ψ-Caroten-3-ol, (3 <i>R</i> )	Rubixanthin	C <sub>40</sub> H <sub>56</sub> O	3763-55-1	552.872	dk red nd (bz-MeOH) oran-red (bz-peth)	160				sl EtOH, peth; s bz, chl
1782	ψ,ψ-Caroten-16-ol	Lycoxanthin	C <sub>40</sub> H <sub>56</sub> O	19891-74-8	552.872	red pl (bz- MeOH)	168				i H <sub>2</sub> O; sl EtOH; s bz, CS <sub>2</sub>
1783	Caroverine		C <sub>22</sub> H <sub>27</sub> N <sub>3</sub> O <sub>2</sub>	23465-76-1	365.468	cry	69	202 <sup>0.01</sup>			sl i-PrOH
1784	Carpaine		C <sub>28</sub> H <sub>50</sub> N <sub>2</sub> O <sub>4</sub>	3463-92-1	478.708	mcl pr (al, ace)	121				vs ace, bz, eth, EtOH
1785	Cartap hydrochloride		C <sub>7</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	22042-59-7	273.804	cry	180				s H <sub>2</sub> O; sl EtOH, MeOH
1786	Carvenone, (S)		C <sub>10</sub> H <sub>16</sub> O	10395-45-6	152.233			233	0.9289 <sup>20</sup>	1.4805 <sup>20</sup>	i H <sub>2</sub> O; s ace
1787	( <i>R</i> )-Carvone	<i>ρ</i> -Mentha-1,8-dien-6-one, ( <i>R</i> )	C <sub>10</sub> H <sub>14</sub> O	6485-40-1	150.217		25.2	231	0.9593 <sup>20</sup>	1.4988 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH; s eth, ctc, chl
1788	( <i>S</i> )-Carvone	<i>ρ</i> -Mentha-1,8-dien-6-one, ( <i>S</i> )	C <sub>10</sub> H <sub>14</sub> O	2244-16-8	150.217		<15	231	0.965 <sup>20</sup>	1.4989 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH; s eth, chl
1789	Caryophyllene		C <sub>15</sub> H <sub>24</sub>	87-44-5	204.352			122 <sup>13.5</sup>	0.9075 <sup>20</sup>	1.4986 <sup>20</sup>	vs bz
1790	Casimiroin	6-Methoxy-9-methyl-1,3-dioxolo[4,5- <i>h</i> ]quinolin-8(9 <i>H</i> )-one	C <sub>12</sub> H <sub>11</sub> NO <sub>4</sub>	477-89-4	233.220						sl chl
1791	Cassaine		C <sub>24</sub> H <sub>33</sub> NO <sub>4</sub>	468-76-8	405.572	fl (eth)	142.5				s EtOH, ace, chl, eth, bz, MeOH
1792	Caulophylline		C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O	486-86-2	204.267	cry (w+2), nd (al, bz)	137				vs H <sub>2</sub> O, ace, bz, EtOH
1793	α-Cedrene		C <sub>15</sub> H <sub>24</sub>	469-61-4	204.352	oil		262.5; 125 <sup>12</sup>			
1794	Cedrol		C <sub>15</sub> H <sub>26</sub> O	77-53-2	222.366		86		0.9479 <sup>90</sup>	1.4824 <sup>90</sup>	
1795	Cefazolin		C <sub>14</sub> H <sub>14</sub> N <sub>6</sub> O <sub>4</sub> S <sub>3</sub>	25953-19-9	454.508	nd (ace aq)	200 dec				s DMF, py; sl MeOH; i chl, bz, eth
1796	β-Cellobiose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	13360-52-6	342.296	cry (dil al)	225 dec				s H <sub>2</sub> O; i EtOH, eth, ace, bz
1797	Cellotriose		C <sub>18</sub> H <sub>32</sub> O <sub>16</sub>	33404-34-1	504.437		208				
1798	Cephalexin		C <sub>16</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub> S	15686-71-2	347.389	cry					
1799	Cephaloglycin	Kafocin	C <sub>18</sub> H <sub>19</sub> N <sub>3</sub> O <sub>6</sub> S	3577-01-3	405.425	cry (w)	≈220 dec				
1800	Cephaloridine		C <sub>19</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	50-59-9	415.486	cry					s H <sub>2</sub> O
1801	Cephalothin		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	153-61-7	396.437		160				
1802	Cephapirin		C <sub>17</sub> H <sub>17</sub> N <sub>3</sub> O <sub>6</sub> S <sub>2</sub>	21593-23-7	423.463	cry (ace aq)	155				
1803	Cepharanthine		C <sub>37</sub> H <sub>38</sub> N <sub>2</sub> O <sub>6</sub>	481-49-2	606.707	ye amor pow	150				
1804	Cephadrine		C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>4</sub> S	38821-53-3	349.405	col cry (w)	141 dec				
1805	Cerulenin	2,3-Epoxy-4-oxo-7,10-dodecadienamide, (2 <i>R</i> ,3 <i>S</i> )-	C <sub>12</sub> H <sub>17</sub> NO <sub>3</sub>	17397-89-6	223.268	wh nd	94				sl H <sub>2</sub> O; s bz, EtOH, ace; i peth
1806	Cevadine		C <sub>22</sub> H <sub>40</sub> NO <sub>3</sub>	62-59-9	591.733	flat nd (eth)	213 dec				
1807	Chavicine		C <sub>17</sub> H <sub>19</sub> NO <sub>3</sub>	495-91-0	285.338						vs eth, EtOH, peth
1808	Cheirolin		C <sub>9</sub> H <sub>9</sub> NO <sub>2</sub> S <sub>2</sub>	505-34-0	179.261	cry (eth)	47.5	200 <sup>3</sup>			vs EtOH, chl
1809	Chelerythrine		C <sub>21</sub> H <sub>19</sub> NO <sub>5</sub>	34316-15-9	365.380	cry (chl- MeOH)		207			vs chl
1810	Chelidonine	Stylophorine	C <sub>20</sub> H <sub>19</sub> NO <sub>5</sub>	476-32-4	353.369	mcl pr (al)	135.5	220 <sup>0.002</sup>			i H <sub>2</sub> O; s EtOH, eth, chl
1811	Chinomethionat		C <sub>10</sub> H <sub>6</sub> N <sub>2</sub> OS <sub>2</sub>	2439-01-2	234.297		170				
1812	Chloral hydrate		C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	302-17-0	165.403		57	dec 96	1.9081 <sup>20</sup>		vs H <sub>2</sub> O, bz, eth, EtOH
1813	Chlorambucil		C <sub>14</sub> H <sub>15</sub> Cl <sub>2</sub> NO <sub>2</sub>	305-03-3	304.213		65				
1814	Chloramine B	<i>N</i> -Chlorobenzenesulfonamide sodium	C <sub>6</sub> H <sub>5</sub> ClNNaO <sub>2</sub> S	127-52-6	213.618	pr (w)	190				sl EtOH; i chl, eth
1815	Chloramine T	<i>N</i> -Chloro-4-methylbenzenesulfonamide sodium	C <sub>7</sub> H <sub>7</sub> ClNNaO <sub>2</sub> S	127-65-1	227.645	pr (hyd)	180 (hyd)				s H <sub>2</sub> O; i bz, chl, eth
1816	Chloramphenicol		C <sub>11</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>5</sub>	56-75-7	323.129	pa ye pl or nd (w)	150.5	sub			vs ace, EtOH, chl
1817	Chloramphenicol palmitate		C <sub>27</sub> H <sub>42</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>6</sub>	530-43-8	561.537	cry (bz)	90				vs bz, eth, EtOH
1818	Chloranilic acid	2,5-Dichloro-3,6-dihydroxy-2,5-cyclohexadiene-1,4-dione	C <sub>6</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>4</sub>	87-88-7	208.984	red lf (w+2)	283.5				s H <sub>2</sub> O
1819	Chlorbenside	1-Chloro-4[[[4-chlorophenyl)methyl]thio]benzene	C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub> S	103-17-3	269.189		75		1.4210 <sup>20</sup>		
1820	Chlorbicyclen		C <sub>9</sub> H <sub>8</sub> Cl <sub>6</sub>	2550-75-6	397.768	pow	105	174 <sup>2</sup>			
1821	Chlorbromuron	<i>N</i> -(4-Bromo-3-chlorophenyl)- <i>N</i> -methoxy- <i>N</i> -methylurea	C <sub>9</sub> H <sub>10</sub> BrClN <sub>2</sub> O <sub>2</sub>	13360-45-7	293.544		96		1.69 <sup>20</sup>		
1822	Chlorbutam	1-Methyl-2-propynyl(3-chlorophenyl)carbamate	C <sub>11</sub> H <sub>10</sub> ClNO <sub>2</sub>	1967-16-4	223.656	cry	45.5				sl H <sub>2</sub> O; s MeOH, EtOH, ace
1823	Chlorcyclizine		C <sub>18</sub> H <sub>21</sub> ClN <sub>2</sub>	82-93-9	300.826	oil		140 <sup>0.12</sup>			
1824	Chlordane		C <sub>10</sub> H <sub>6</sub> Cl <sub>6</sub>	57-74-9	409.779		106	175 <sup>1</sup>	1.60 <sup>25</sup>		

 $\psi,\psi$ -Caroten-16-ol

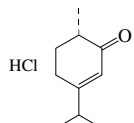
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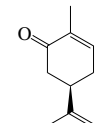
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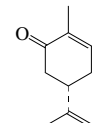
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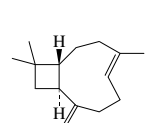
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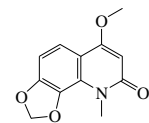
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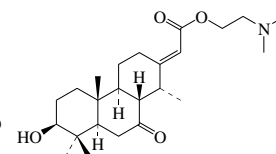
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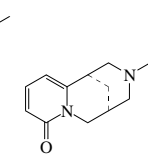
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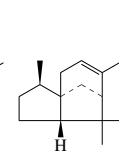
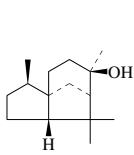
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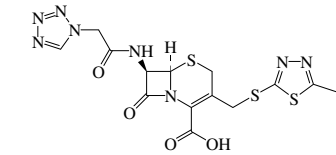
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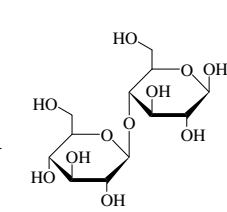
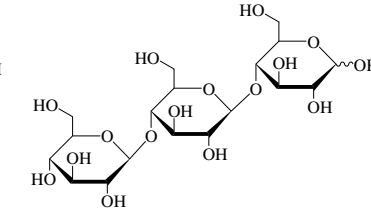
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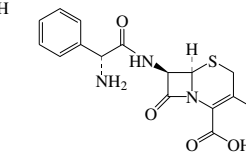
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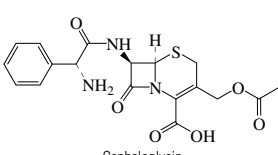
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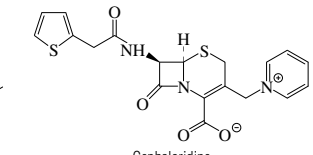
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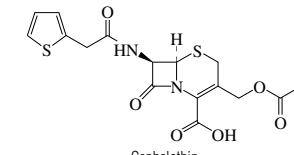
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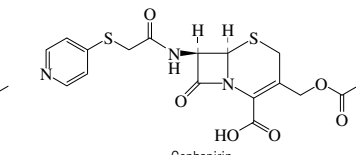
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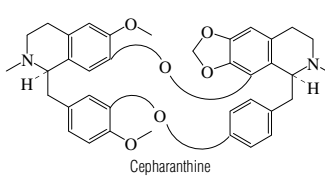
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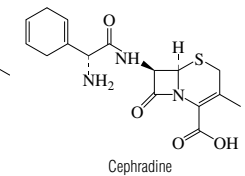
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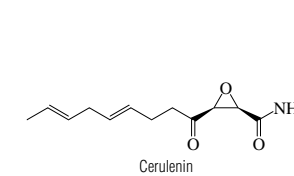
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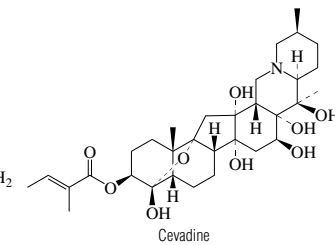
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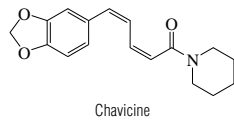
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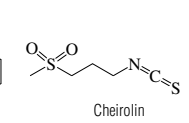
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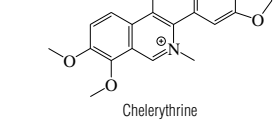
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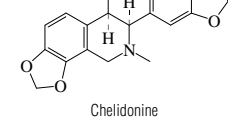
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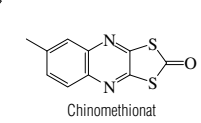
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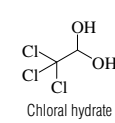
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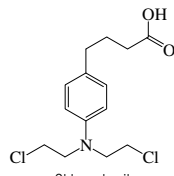
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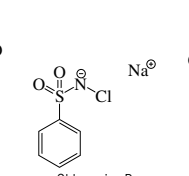
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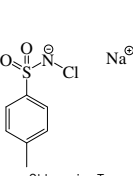
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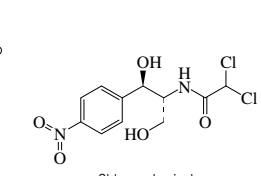
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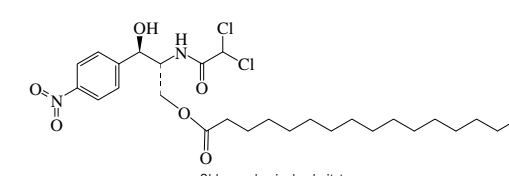
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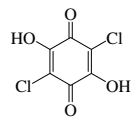
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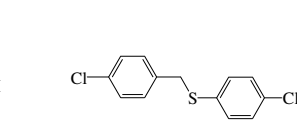
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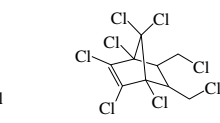
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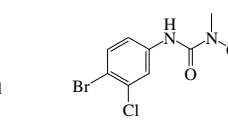
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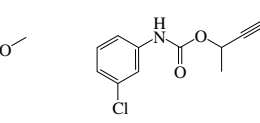
Chlorbenside



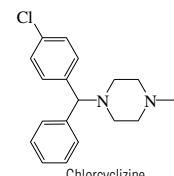
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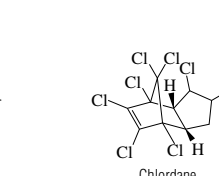
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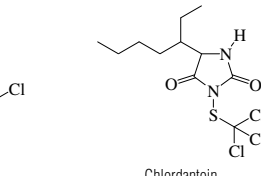
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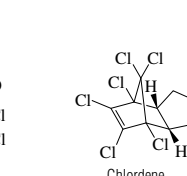
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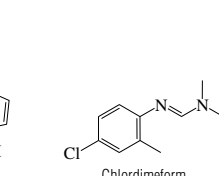
Chlordane



Chlordantoin

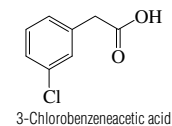
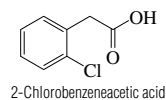
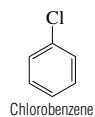
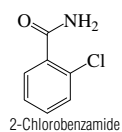
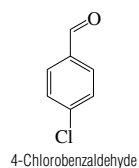
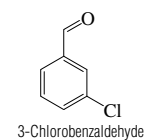
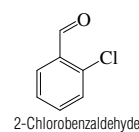
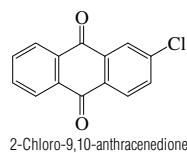
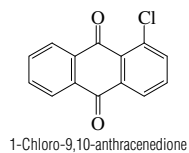
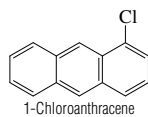
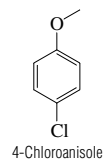
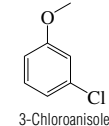
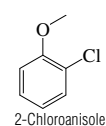
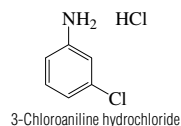
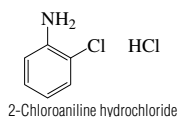
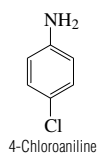
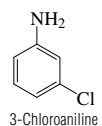
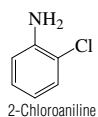
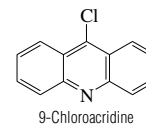
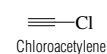
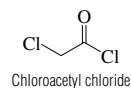
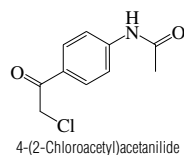
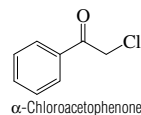
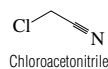
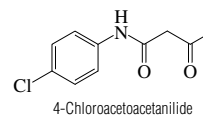
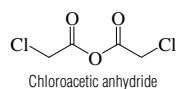
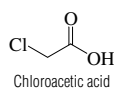
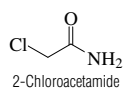
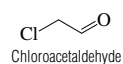
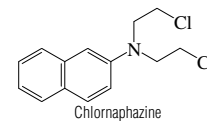
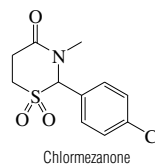
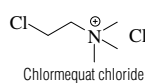
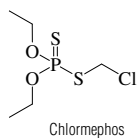
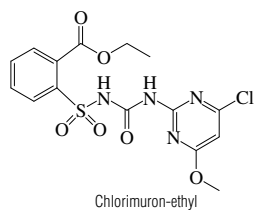
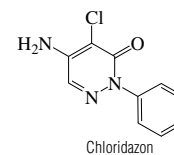
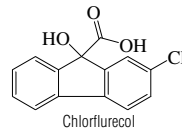
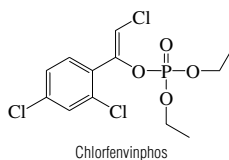
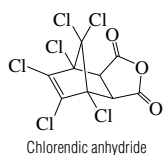
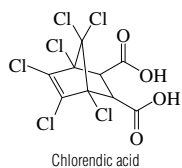


Chlordene



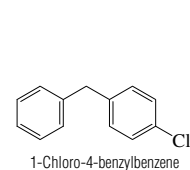
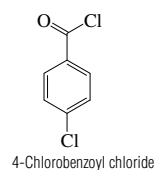
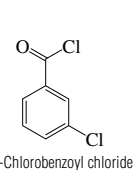
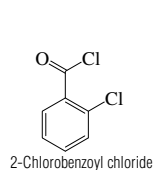
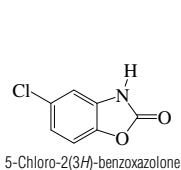
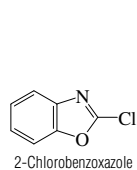
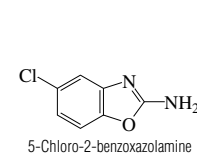
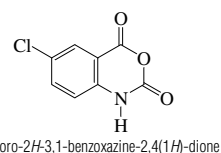
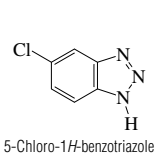
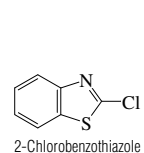
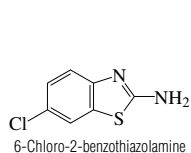
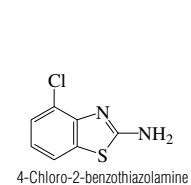
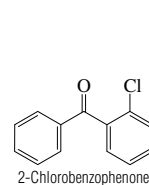
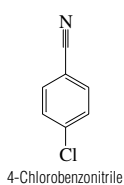
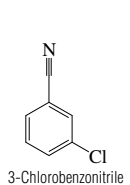
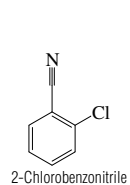
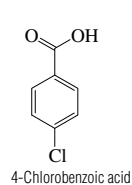
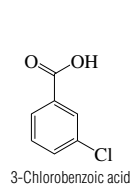
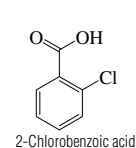
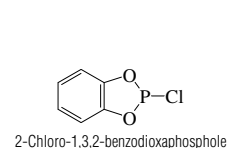
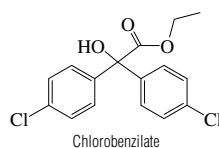
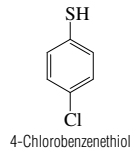
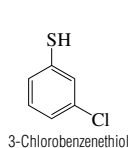
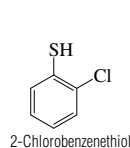
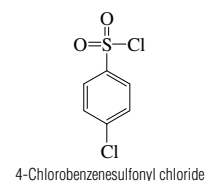
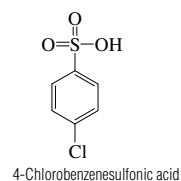
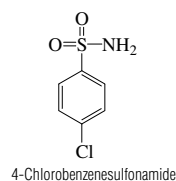
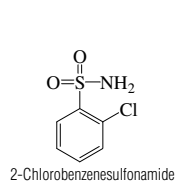
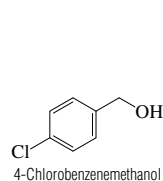
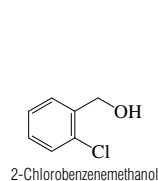
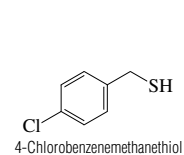
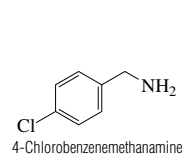
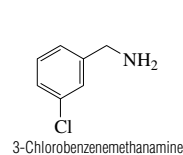
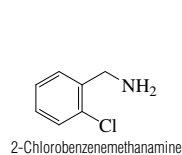
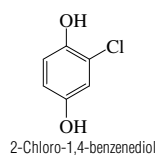
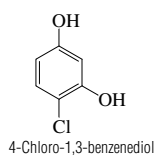
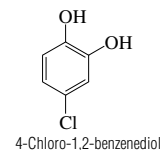
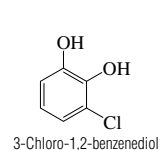
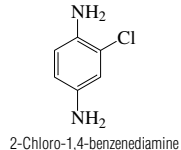
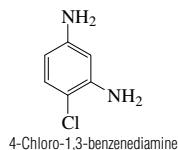
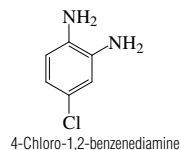
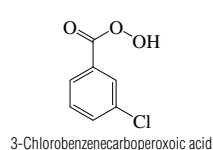
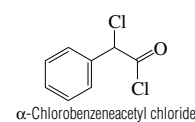
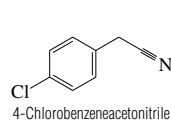
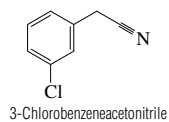
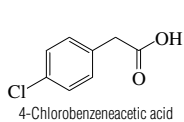
Chlordimeform

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1825	Chlordantoin		C <sub>11</sub> H <sub>17</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub> S	5588-20-5	347.689						s CS <sub>2</sub>
1826	Chlordene		C <sub>10</sub> H <sub>6</sub> Cl <sub>6</sub>	3734-48-3	338.873	cry (EtOH)	155				
1827	Chlordimeform		C <sub>10</sub> H <sub>13</sub> ClN <sub>2</sub>	6164-98-3	196.676		35	156 <sup>0.4</sup>	1.105 <sup>25</sup>	1.5885 <sup>25</sup>	vs bz, eth, EtOH
1828	Chlorendic acid	1,4,5,6,7,7-Hexachloro-5-norbornene-2,3-dicarboxylic acid	C <sub>8</sub> H <sub>4</sub> Cl <sub>6</sub> O <sub>4</sub>	115-28-6	388.844	cry (w)	232				
1829	Chlorendic anhydride		C <sub>8</sub> H <sub>2</sub> Cl <sub>6</sub> O <sub>3</sub>	115-27-5	370.828		235				
1830	Chlorfenvinphos		C <sub>12</sub> H <sub>14</sub> Cl <sub>3</sub> O <sub>4</sub> P	470-90-6	359.569			170 <sup>0.05</sup>			
1831	Chlorflurecol	9 <i>H</i> -Fluorene-9-carboxylic acid, 2-chloro-9-hydroxy-	C <sub>14</sub> H <sub>9</sub> ClO <sub>3</sub>	2464-37-1	260.672				1.496 <sup>20</sup>		
1832	Chloridazon	3(2 <i>H</i> )-Pyridazinone, 5-amino-4-chloro-2-phenyl-	C <sub>10</sub> H <sub>6</sub> ClN <sub>3</sub> O	1698-60-8	221.643		205				
1833	Chlorimuron-ethyl		C <sub>15</sub> H <sub>15</sub> ClN <sub>4</sub> O <sub>6</sub> S	90982-32-4	414.821		186				
1834	Chlormephos	Chloromethyl <i>O,O</i> -diethyl dithiophosphate	C <sub>6</sub> H <sub>12</sub> ClO <sub>2</sub> PS <sub>2</sub>	24934-91-6	234.705	oil		83 <sup>0.1</sup>		1.5244	sl H <sub>2</sub> O; misc os
1835	Chlormequat chloride		C <sub>3</sub> H <sub>3</sub> Cl <sub>2</sub> N	999-81-5	158.069		239 dec				
1836	Chlormezanone		C <sub>11</sub> H <sub>12</sub> ClNO <sub>3</sub> S	80-77-3	273.736	cry	117				sl EtOH
1837	Chlornaphazine		C <sub>14</sub> H <sub>15</sub> Cl <sub>2</sub> N	494-03-1	268.182	pl (peth)	55	210 <sup>5</sup>			vs ace, bz, eth, EtOH
1838	Chloroacetaldehyde		C <sub>2</sub> H <sub>3</sub> ClO	107-20-0	78.497	liq	-16.3	85.5	1.19		s eth
1839	2-Chloroacetamide		C <sub>2</sub> H <sub>4</sub> ClNO	79-07-2	93.512		121	225			s H <sub>2</sub> O; vs EtOH; sl eth
1840	Chloroacetic acid		C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	79-11-8	94.497	mcl pl	63	189.3	1.4043 <sup>40</sup>	1.4351 <sup>55</sup>	vs H <sub>2</sub> O; s EtOH, eth, bz, chl; sl ctc
1841	Chloroacetic anhydride		C <sub>4</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>3</sub>	541-88-8	170.979	pr (bz)	46	203		1.5497 <sup>20</sup>	
1842	4-Chloroacetoacetanilide	<i>N</i> -Acetoacetyl-4-chloroaniline	C <sub>10</sub> H <sub>10</sub> ClNO <sub>2</sub>	101-92-8	211.645		132				
1843	Chloroacetone		C <sub>3</sub> H <sub>3</sub> ClO	78-95-5	92.524	liq	-44.5	119	1.15 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth, chl
1844	Chloroacetonitrile	Chloromethyl cyanide	C <sub>2</sub> H <sub>2</sub> ClN	107-14-2	75.497			126.5	1.1930 <sup>20</sup>	1.4202 <sup>25</sup>	vs eth, EtOH
1845	α-Chloroacetophenone	ω-Chloroacetophenone	C <sub>8</sub> H <sub>7</sub> ClO	532-27-4	154.594	pl (dil al), rhom, lf (peth)	56.5	247	1.324 <sup>15</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz; s ace, peth
1846	4-(2-Chloroacetyl)acetanilide		C <sub>10</sub> H <sub>10</sub> ClNO <sub>2</sub>	140-49-8	211.645		218				
1847	Chloroacetyl chloride		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	79-04-9	112.942	liq	-22	106	1.4202 <sup>20</sup>	1.4530 <sup>20</sup>	msc eth; s ace, ctc
1848	Chloroacetylene		C <sub>2</sub> HCl	593-63-5	60.482	col gas	-126	-30			sl EtOH
1849	9-Chloroacridine		C <sub>13</sub> H <sub>9</sub> ClN	1207-69-8	213.663	nd (al)	121	sub			vs H <sub>2</sub> O, EtOH
1850	2-Chloroaniline		C <sub>6</sub> H <sub>6</sub> ClN	95-51-2	127.572	liq	-1.9	208.8		1.5895 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth, ace
1851	3-Chloroaniline		C <sub>6</sub> H <sub>6</sub> ClN	108-42-9	127.572	liq	-10.28	230.5	1.2161 <sup>20</sup>	1.5941 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl
1852	4-Chloroaniline		C <sub>6</sub> H <sub>6</sub> ClN	106-47-8	127.572	orth pr	70.5	232	1.429 <sup>19</sup>	1.5546 <sup>67</sup>	s H <sub>2</sub> O, EtOH, eth, chl
1853	2-Chloroaniline hydrochloride		C <sub>6</sub> H <sub>7</sub> Cl <sub>2</sub> N	137-04-2	164.033	pl (w, aq al)	235		1.505 <sup>18</sup>		vs H <sub>2</sub> O
1854	3-Chloroaniline hydrochloride		C <sub>6</sub> H <sub>7</sub> Cl <sub>2</sub> N	141-85-5	164.033	pl	222				vs H <sub>2</sub> O, EtOH
1855	2-Chloroanisole	1-Chloro-2-methoxybenzene	C <sub>7</sub> H <sub>7</sub> ClO	766-51-8	142.583	liq	-26.8	198.5	1.1911 <sup>20</sup>	1.5480 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
1856	3-Chloroanisole	1-Chloro-3-methoxybenzene	C <sub>7</sub> H <sub>7</sub> ClO	2845-89-8	142.583			193.5	1.1759 <sup>12</sup>	1.5365 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
1857	4-Chloroanisole	1-Chloro-4-methoxybenzene	C <sub>7</sub> H <sub>7</sub> ClO	623-12-1	142.583		<-18	197.5	1.201 <sup>20</sup>	1.5390 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl; s ctc
1858	1-Chloroanthracene		C <sub>14</sub> H <sub>9</sub> Cl	4985-70-0	212.674	lf (HOAc)	83.5		1.1707 <sup>100</sup>	1.6959 <sup>100</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
1859	1-Chloro-9,10-anthracenedione		C <sub>14</sub> H <sub>7</sub> ClO <sub>2</sub>	82-44-0	242.658	ye nd (to or al)	163	sub			i H <sub>2</sub> O; sl EtOH, ctc; msc eth; s bz
1860	2-Chloro-9,10-anthracenedione		C <sub>14</sub> H <sub>7</sub> ClO <sub>2</sub>	131-09-9	242.658	pa ye nd (al, HOAc)	211	sub			i H <sub>2</sub> O, eth; sl EtOH, bz; vs tol; s PhNO <sub>2</sub>
1861	2-Chlorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> ClO	89-98-5	140.567	nd	12.4	211.9	1.2483 <sup>20</sup>	1.5662 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
1862	3-Chlorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> ClO	587-04-2	140.567	pr	17.5	213.5	1.2410 <sup>20</sup>	1.5650 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, ace, bz
1863	4-Chlorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> ClO	104-88-1	140.567	pl	47.5	213.5	1.196 <sup>61</sup>	1.555 <sup>61</sup>	s H <sub>2</sub> O, ace, chl; vs EtOH, eth, bz
1864	2-Chlorobenzamide		C <sub>7</sub> H <sub>6</sub> ClNO	609-66-5	155.582	orth nd (w)	141.8				s H <sub>2</sub> O, EtOH, eth
1865	Chlorobenzene	Phenyl chloride	C <sub>6</sub> H <sub>5</sub> Cl	108-90-7	112.557	liq	-45.31	131.72	1.1058 <sup>20</sup>	1.5241 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs bz, ctc

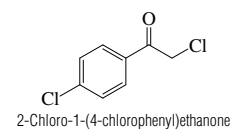
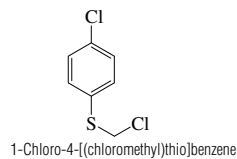
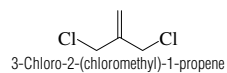
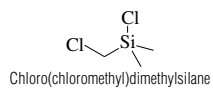
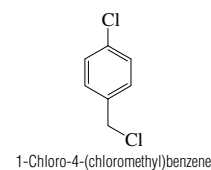
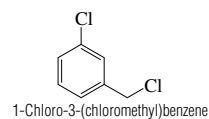
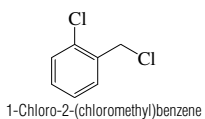
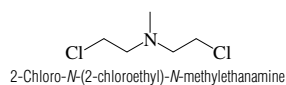
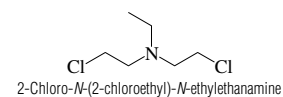
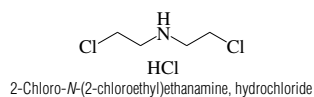
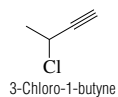
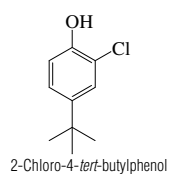
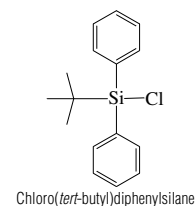
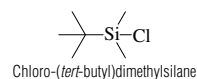
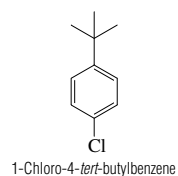
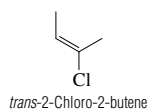
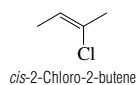
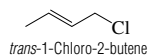
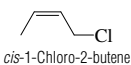
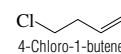
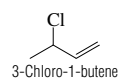
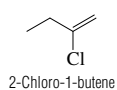
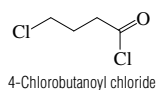
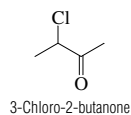
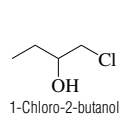
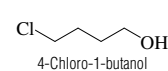
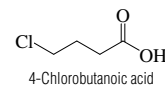
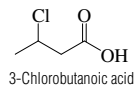
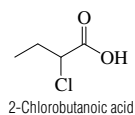
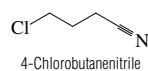
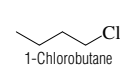
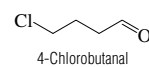
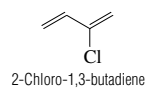
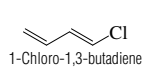
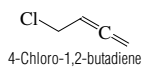
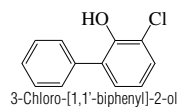
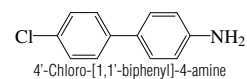
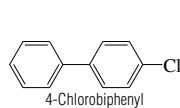
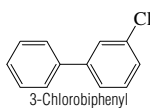
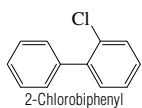
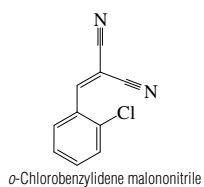


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1866	2-Chlorobenzeneacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	2444-36-2	170.594	nd (w)	96				sl H <sub>2</sub> O; vs EtOH
1867	3-Chlorobenzeneacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	1878-65-5	170.594	pl (dil al), nd (lig)	77.5				sl H <sub>2</sub> O, bz, ctc, EtOH; msc eth
1868	4-Chlorobenzeneacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	1878-66-6	170.594	nd (w)	105.5				s H <sub>2</sub> O, EtOH, eth, bz
1869	2-Chlorobenzeneacetonitrile		C <sub>8</sub> H <sub>6</sub> ClN	2856-63-5	151.594		24	251	1.1737 <sup>18</sup>		
1870	3-Chlorobenzeneacetonitrile		C <sub>8</sub> H <sub>6</sub> ClN	1529-41-5	151.594		11.5	261; 135 <sup>10</sup>	1.1806 <sup>30</sup>	1.5437 <sup>20</sup>	
1871	4-Chlorobenzeneacetonitrile		C <sub>8</sub> H <sub>6</sub> ClN	140-53-4	151.594		29	265.0	1.1778 <sup>30</sup>		s ctc
1872	α-Chlorobenzeneacetyl chloride		C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O	2912-62-1	189.039			120 <sup>23</sup> , 110 <sup>14</sup>	1.196 <sup>25</sup>	1.5440 <sup>20</sup>	
1873	3-Chlorobenzeneperoxydicarboxylic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>3</sub>	937-14-4	172.566		92 dec				
1874	4-Chloro-1,2-benzenediamine	4-Chloro- <i>o</i> -phenylenediamine	C <sub>6</sub> H <sub>7</sub> ClN <sub>2</sub>	95-83-0	142.586	pl (bz-lig) lf (w)	76				sl H <sub>2</sub> O; vs EtOH, eth; s bz, lig
1875	4-Chloro-1,3-benzenediamine		C <sub>6</sub> H <sub>7</sub> ClN <sub>2</sub>	5131-60-2	142.586	pl or nd	91				vs EtOH
1876	2-Chloro-1,4-benzenediamine	2-Chloro- <i>p</i> -phenylenediamine	C <sub>6</sub> H <sub>7</sub> ClN <sub>2</sub>	615-66-7	142.586	nd	64				
1877	3-Chloro-1,2-benzenediol		C <sub>6</sub> H <sub>6</sub> ClO <sub>2</sub>	4018-65-9	144.556	cry (lig)	48.5	110 <sup>11</sup>			vs lig
1878	4-Chloro-1,2-benzenediol		C <sub>6</sub> H <sub>6</sub> ClO <sub>2</sub>	2138-22-9	144.556	lf (bz-peth)	90.5	139 <sup>10,5</sup>			vs H <sub>2</sub> O, ace, eth, EtOH
1879	4-Chloro-1,3-benzenediol		C <sub>6</sub> H <sub>6</sub> ClO <sub>2</sub>	95-88-5	144.556			257			vs H <sub>2</sub> O, EtOH, eth, ace, bz, CS <sub>2</sub>
1880	2-Chloro-1,4-benzenediol		C <sub>6</sub> H <sub>6</sub> ClO <sub>2</sub>	615-67-8	144.556	red lf (chl), nd (bz)	108	263			vs H <sub>2</sub> O, chl; s EtOH, eth; vs bz
1881	2-Chlorobenzeneethanamine		C <sub>7</sub> H <sub>8</sub> ClN	89-97-4	141.599			72 <sup>2</sup>		1.5594 <sup>25</sup>	
1882	3-Chlorobenzeneethanamine		C <sub>7</sub> H <sub>8</sub> ClN	4152-90-3	141.599			89 <sup>2</sup>		1.5570 <sup>25</sup>	
1883	4-Chlorobenzeneethanamine		C <sub>7</sub> H <sub>8</sub> ClN	104-86-9	141.599			109 <sup>13</sup>		1.5566 <sup>25</sup>	
1884	4-Chlorobenzeneethanethiol		C <sub>7</sub> H <sub>8</sub> ClS	6258-66-8	158.649		19.5	113 <sup>17</sup>	1.202 <sup>25</sup>	1.5893 <sup>20</sup>	
1885	2-Chlorobenzeneethanol		C <sub>7</sub> H <sub>7</sub> ClO	17849-38-6	142.583	lf or nd (dil al)	73	230			sl H <sub>2</sub> O; vs EtOH, eth, lig
1886	4-Chlorobenzeneethanol		C <sub>7</sub> H <sub>7</sub> ClO	873-76-7	142.583	nd (w), pl (bz or bz-lig)	75	235			vs bz, eth, EtOH
1887	2-Chlorobenzeneethanesulfonamide		C <sub>8</sub> H <sub>8</sub> ClNO <sub>2</sub> S	6961-82-6	191.636	lf (al)	188				vs EtOH
1888	4-Chlorobenzeneethanesulfonamide		C <sub>8</sub> H <sub>8</sub> ClNO <sub>2</sub> S	98-64-6	191.636	pr or pl (eth)	146				vs bz, eth
1889	4-Chlorobenzeneethanesulfonic acid	<i>p</i> -Chlorobenzeneethanesulfonic acid	C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub> S	98-66-8	192.620	nd (w+1)	67	147 <sup>25</sup>			s H <sub>2</sub> O, EtOH; i eth, bz
1890	4-Chlorobenzeneethanesulfonyl chloride		C <sub>8</sub> H <sub>7</sub> Cl <sub>2</sub> O <sub>2</sub> S	98-60-2	211.066		51	141 <sup>15</sup>			vs eth, bz
1891	2-Chlorobenzeneethiol		C <sub>7</sub> H <sub>7</sub> ClS	6320-03-2	144.622			205.5	1.2752 <sup>10</sup>		sl H <sub>2</sub> O, EtOH
1892	3-Chlorobenzeneethiol		C <sub>7</sub> H <sub>7</sub> ClS	2037-31-2	144.622			206	1.2637 <sup>13</sup>		i H <sub>2</sub> O; s EtOH, eth, chl, peth
1893	4-Chlorobenzeneethiol		C <sub>7</sub> H <sub>7</sub> ClS	106-54-7	144.622		61	206	1.1911 <sup>20</sup>	1.5480 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; sl chl
1894	Chlorobenzilate		C <sub>16</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>3</sub>	510-15-6	325.186		37	157 <sup>0,07</sup>	1.2816 <sup>20</sup>		
1895	2-Chloro-1,3,2-benzodioxaphosphole		C <sub>6</sub> H <sub>4</sub> ClO <sub>2</sub> P	1641-40-3	174.522		30	80 <sup>20</sup>	1.4650 <sup>20</sup>	1.5712 <sup>20</sup>	
1896	2-Chlorobenzoic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	118-91-2	156.567	mcl pr (w)	140.2	sub	1.544 <sup>20</sup>		s H <sub>2</sub> O, bz; vs EtOH, eth, ace; sl CS <sub>2</sub>
1897	3-Chlorobenzoic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	535-80-8	156.567	pr (w)	158	sub	1.496 <sup>25</sup>		sl H <sub>2</sub> O, bz, ctc, CS <sub>2</sub> ; s EtOH, eth
1898	4-Chlorobenzoic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	74-11-3	156.567	tcl pr (al-eth)	243				i H <sub>2</sub> O, bz, ctc; vs EtOH; sl eth, ace
1899	2-Chlorobenzonitrile		C <sub>7</sub> H <sub>5</sub> ClN	873-32-5	137.567	nd	46.3	232			sl H <sub>2</sub> O; s EtOH, eth, chl
1900	3-Chlorobenzonitrile		C <sub>7</sub> H <sub>5</sub> ClN	766-84-7	137.567		41	100 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, eth
1901	4-Chlorobenzonitrile		C <sub>7</sub> H <sub>5</sub> ClN	623-03-0	137.567	nd (al)	95	223; 95 <sup>5</sup>	1.1133 <sup>17</sup>		sl H <sub>2</sub> O, lig; s EtOH, eth, bz, chl
1902	2-Chlorobenzophenone	2-Chlorophenyl phenyl ketone	C <sub>13</sub> H <sub>9</sub> ClO	5162-03-8	216.662	pl (chl-lig)	54	330			
1903	4-Chloro-2-benzothiazolamine		C <sub>7</sub> H <sub>6</sub> ClN <sub>2</sub> S	19952-47-7	184.646		204				
1904	6-Chloro-2-benzothiazolamine		C <sub>7</sub> H <sub>6</sub> ClN <sub>2</sub> S	95-24-9	184.646		200				
1905	2-Chlorobenzothiazole		C <sub>7</sub> H <sub>4</sub> ClNS	615-20-3	169.632		24	248	1.3715 <sup>10</sup>	1.6338 <sup>10</sup>	vs ace, eth, EtOH
1906	5-Chloro-1 <i>H</i> -benzotriazole		C <sub>6</sub> H <sub>4</sub> ClN <sub>3</sub>	94-97-3	153.569		158				
1907	6-Chloro-2 <i>H</i> -3,1-benzoxazine-2,4(1 <i>H</i> )-dione	5-Chloroisatoic anhydride	C <sub>8</sub> H <sub>4</sub> ClNO <sub>3</sub>	4743-17-3	197.576		280 dec				
1908	5-Chloro-2-benzoxazolamine	Zoxazolamine	C <sub>7</sub> H <sub>6</sub> ClN <sub>2</sub> O	61-80-3	168.580	pl (bz)	184.5				vs EtOH
1909	2-Chlorobenzoxazole		C <sub>7</sub> H <sub>4</sub> ClNO	615-18-9	153.566		7	201.5	1.3453 <sup>18</sup>	1.5678 <sup>20</sup>	
1910	5-Chloro-2(3 <i>H</i> )-benzoxazolone	Chloroxazone	C <sub>7</sub> H <sub>4</sub> ClNO <sub>2</sub>	95-25-0	169.566	cry (ace)	191.5				vs EtOH, MeOH
1911	2-Chlorobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	609-65-4	175.012	liq	-4	238		1.5726 <sup>16</sup>	s ctc

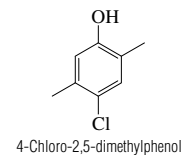
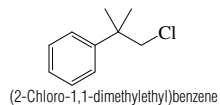
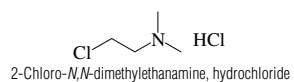
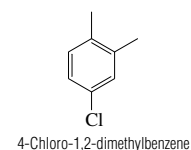
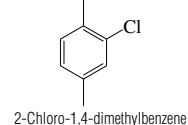
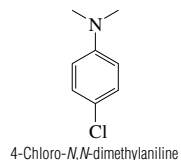
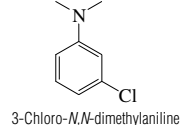
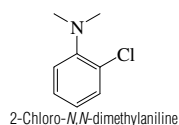
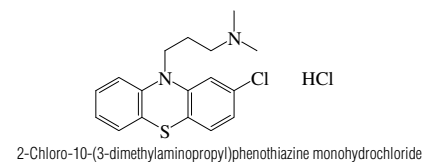
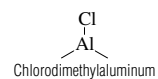
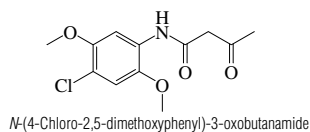
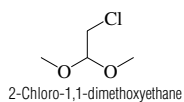
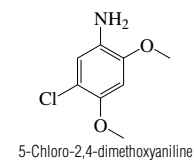
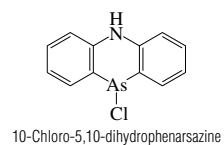
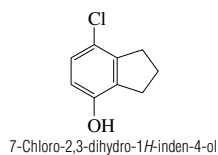
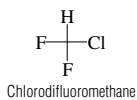
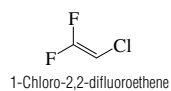
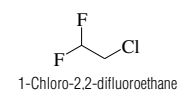
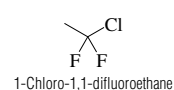
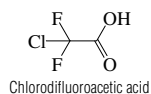
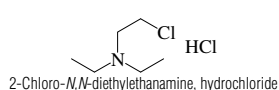
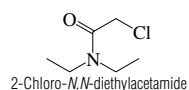
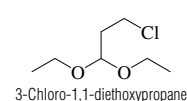
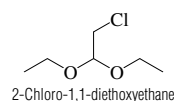
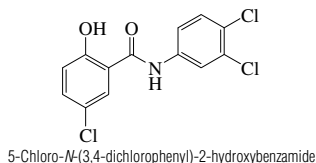
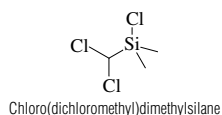
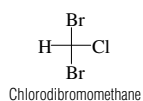
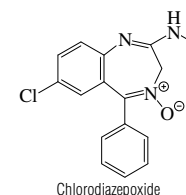
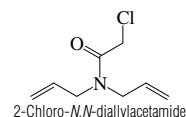
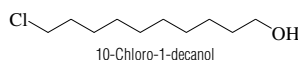
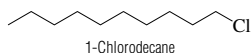
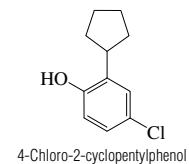
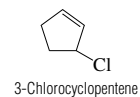
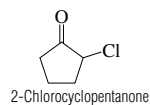
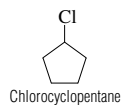
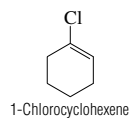
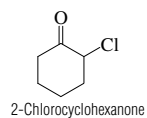
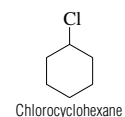
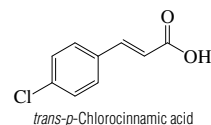
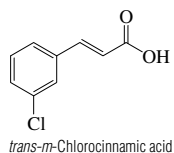
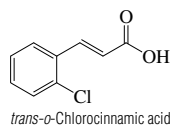
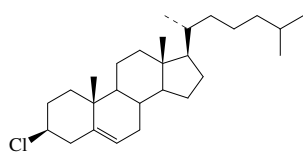




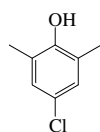
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1912	3-Chlorobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> O	618-46-2	175.012			225		1.5677 <sup>20</sup>	
1913	4-Chlorobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> O	122-01-0	175.012		16	222	1.3770 <sup>20</sup>	1.5756 <sup>20</sup>	sl chl
1914	1-Chloro-4-benzylbenzene		C <sub>13</sub> H <sub>11</sub> Cl	831-81-2	202.679		7.5	299; 147 <sup>8</sup>	1.1247 <sup>20</sup>		vs ace
1915	<i>o</i> -Chlorobenzylidene malononitrile		C <sub>10</sub> H <sub>5</sub> CIN <sub>2</sub>	2698-41-1	188.613	wh cry	96	312			sl H <sub>2</sub> O; s bz, diox, EtOAc, ace
1916	2-Chlorobiphenyl		C <sub>12</sub> H <sub>9</sub> Cl	2051-60-7	188.652	mcl (dil al)	34	274	1.1499 <sup>32</sup>		i H <sub>2</sub> O; vs eth, EtOH, lig
1917	3-Chlorobiphenyl		C <sub>12</sub> H <sub>9</sub> Cl	2051-61-8	188.652		16	284.5	1.1579 <sup>25</sup>	1.6181 <sup>25</sup>	vs ace, eth, EtOH
1918	4-Chlorobiphenyl		C <sub>12</sub> H <sub>9</sub> Cl	2051-62-9	188.652	lf (lig or al)	78.8	292.9; 146 <sup>10</sup>			i H <sub>2</sub> O; s EtOH, eth, lig
1919	4'-Chloro-[1,1'-biphenyl]-4-amine	4-Amino-4'-chlorodiphenyl	C <sub>12</sub> H <sub>10</sub> CIN	135-68-2	203.667	cry (peth)	134				vs ace, bz, eth
1920	3-Chloro-[1,1'-biphenyl]-2-ol	2-Phenyl-6-chlorophenol	C <sub>12</sub> H <sub>9</sub> ClO	85-97-2	204.651		6	dec 317	1.24 <sup>25</sup>	1.6237 <sup>30</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1921	4-Chloro-1,2-butadiene		C <sub>4</sub> H <sub>5</sub> Cl	25790-55-0	88.536			88	0.9891 <sup>20</sup>	1.4775 <sup>20</sup>	vs ace, bz, eth
1922	1-Chloro-1,3-butadiene		C <sub>4</sub> H <sub>5</sub> Cl	627-22-5	88.536			68	0.9606 <sup>20</sup>	1.4712 <sup>20</sup>	vs eth, EtOH, chl
1923	2-Chloro-1,3-butadiene	Chloroprene	C <sub>4</sub> H <sub>5</sub> Cl	126-99-8	88.536	liq	-130	59.4	0.956 <sup>20</sup>	1.4583 <sup>20</sup>	sl H <sub>2</sub> O; msc eth, ace, bz
1924	4-Chlorobutanal		C <sub>4</sub> H <sub>7</sub> ClO	6139-84-0	106.551			51 <sup>13</sup>	1.106 <sup>8</sup>	1.4466 <sup>8</sup>	vs ace, eth, EtOH
1925	1-Chlorobutane	Butyl chloride	C <sub>4</sub> H <sub>9</sub> Cl	109-69-3	92.567	liq	-123.1	78.4	0.8857 <sup>20</sup>	1.4023 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
1926	2-Chlorobutane	(±)- <i>sec</i> -Butyl chloride	C <sub>4</sub> H <sub>9</sub> Cl	53178-20-4	92.567	liq	-131.3	68.2	0.8732 <sup>20</sup>	1.3971 <sup>20</sup>	vs bz, eth, EtOH, chl
1927	4-Chlorobutanenitrile		C <sub>4</sub> H <sub>6</sub> CIN	628-20-6	103.551			192	1.0934 <sup>15</sup>	1.4413 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
1928	2-Chlorobutanoic acid		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	4170-24-5	122.551			189 <sup>627</sup> , 101 <sup>15</sup>	1.1796 <sup>20</sup>	1.441 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
1929	3-Chlorobutanoic acid		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	625-68-3	122.551	cry (eth)	16	116 <sup>22</sup>	1.1898 <sup>20</sup>	1.4221 <sup>20</sup>	s EtOH; vs eth; sl ctc
1930	4-Chlorobutanoic acid		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	627-00-9	122.551		16	196 <sup>22</sup> , 68 <sup>0.2</sup>	1.2236 <sup>20</sup>	1.4642 <sup>20</sup>	vs EtOH
1931	4-Chloro-1-butanol		C <sub>4</sub> H <sub>9</sub> ClO	928-51-8	108.566			84 <sup>16</sup>	1.0883 <sup>20</sup>	1.4518 <sup>20</sup>	vs eth, EtOH
1932	1-Chloro-2-butanol	α-Butylene chlorohydrin	C <sub>4</sub> H <sub>9</sub> ClO	1873-25-2	108.566			141	1.068 <sup>25</sup>	1.4400 <sup>20</sup>	s EtOH, eth
1933	3-Chloro-2-butanone		C <sub>4</sub> H <sub>7</sub> ClO	4091-39-8	106.551			115	1.0554 <sup>25</sup>	1.4219 <sup>20</sup>	
1934	4-Chlorobutanoyl chloride		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O	4635-59-0	140.996			173.5	1.2581 <sup>20</sup>	1.4616 <sup>20</sup>	s eth
1935	2-Chloro-1-butene		C <sub>4</sub> H <sub>7</sub> Cl	2211-70-3	90.552			58.5	0.9107 <sup>15</sup>	1.4165 <sup>21</sup>	vs ace, bz, eth, EtOH
1936	3-Chloro-1-butene		C <sub>4</sub> H <sub>7</sub> Cl	563-52-0	90.552			64.5	0.8978 <sup>20</sup>	1.4149 <sup>20</sup>	vs eth, ace; s chl
1937	4-Chloro-1-butene		C <sub>4</sub> H <sub>7</sub> Cl	927-73-1	90.552			75	0.9211 <sup>20</sup>	1.4233 <sup>20</sup>	vs ace, eth, chl
1938	<i>cis</i> -1-Chloro-2-butene		C <sub>4</sub> H <sub>7</sub> Cl	4628-21-1	90.552			84.1	0.9426 <sup>20</sup>	1.4390 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, chl
1939	<i>trans</i> -1-Chloro-2-butene		C <sub>4</sub> H <sub>7</sub> Cl	4894-61-5	90.552			85	0.9295 <sup>20</sup>	1.4350 <sup>20</sup>	i H <sub>2</sub> O; s ace, chl
1940	<i>cis</i> -2-Chloro-2-butene		C <sub>4</sub> H <sub>7</sub> Cl	2211-69-0	90.552	liq	-117.3	70.6	0.9239 <sup>20</sup>	1.4240 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s ace, chl
1941	<i>trans</i> -2-Chloro-2-butene		C <sub>4</sub> H <sub>7</sub> Cl	2211-68-9	90.552	liq	-105.8	62.8	0.9138 <sup>20</sup>	1.4190 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s ace, chl
1942	1-Chloro-4- <i>tert</i> -butylbenzene		C <sub>10</sub> H <sub>13</sub> Cl	3972-56-3	168.663			213	1.0075 <sup>18</sup>	1.5123 <sup>20</sup>	
1943	Chloro-( <i>tert</i> -butyl)dimethylsilane		C <sub>6</sub> H <sub>15</sub> ClSi	18162-48-6	150.722		89.5	125			
1944	Chloro( <i>tert</i> -butyl)diphenylsilane		C <sub>18</sub> H <sub>19</sub> ClSi	58479-61-1	274.861			120 <sup>0.06</sup>	1.07 <sup>20</sup>	1.5675 <sup>20</sup>	
1945	2-Chloro-4- <i>tert</i> -butylphenol		C <sub>10</sub> H <sub>13</sub> ClO	98-28-2	184.662			114 <sup>8</sup>			
1946	3-Chloro-1-butyne		C <sub>4</sub> H <sub>5</sub> Cl	21020-24-6	88.536			68.5	1.4218 <sup>25</sup>	1.4218 <sup>25</sup>	
1947	2-Chloro- <i>N</i> -(2-chloroethyl)ethanamine, hydrochloride		C <sub>4</sub> H <sub>10</sub> Cl <sub>2</sub> N	821-48-7	178.488		215.0				
1948	2-Chloro- <i>N</i> -(2-chloroethyl)- <i>N</i> -ethylethanamine	HN1	C <sub>6</sub> H <sub>13</sub> Cl <sub>2</sub> N	538-07-8	170.080	col liq	-34	66 <sup>12</sup>	1.0861 <sup>23</sup>	1.4653 <sup>25</sup>	i H <sub>2</sub> O
1949	2-Chloro- <i>N</i> -(2-chloroethyl)- <i>N</i> -methylethanamine	Mechlorethamine	C <sub>5</sub> H <sub>11</sub> Cl <sub>2</sub> N	51-75-2	156.053		-60	87 <sup>18</sup> , 64 <sup>8</sup>			sl H <sub>2</sub> O; msc ctc, DMF
1950	1-Chloro-2-(chloromethyl)benzene	2-Chlorobenzyl chloride	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	611-19-8	161.029	liq	-17	217	1.2699 <sup>0</sup>	1.5530 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, ctc; vs eth, bz
1951	1-Chloro-3-(chloromethyl)benzene	3-Chlorobenzyl chloride	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	620-20-2	161.029			216; 110 <sup>25</sup>	1.2695 <sup>15</sup>	1.5554 <sup>20</sup>	vs EtOH
1952	1-Chloro-4-(chloromethyl)benzene	4-Chlorobenzyl chloride	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	104-83-6	161.029	nd (dil al)	31	223			sl ctc
1953	Chloro(chloromethyl)dimethylsilane		C <sub>3</sub> H <sub>8</sub> Cl <sub>2</sub> Si	1719-57-9	143.088			115.5	1.0865 <sup>20</sup>	1.4360 <sup>20</sup>	
1954	3-Chloro-2-(chloromethyl)-1-propene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	1871-57-4	124.997	liq	-14	138	1.1782 <sup>20</sup>	1.4753	vs EtOH, chl



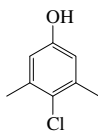
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1955	1-Chloro-4-[(chloromethyl)thio]benzene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> S	7205-90-5	193.094		21.5	128 <sup>12</sup>	1.346 <sup>25</sup>	1.6055 <sup>20</sup>	
1956	2-Chloro-1-(4-chlorophenyl)ethanone		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	937-20-2	189.039	nd (al)	101.5	270			s EtOH, bz, MeOH
1957	3-Chlorocholest-5-ene, (3β)		C <sub>27</sub> H <sub>46</sub> Cl	910-31-6	405.099	nd (al, ace)	96				i H <sub>2</sub> O; s EtOH, ace, bz, chl; vs CS <sub>2</sub>
1958	<i>trans</i> -o-Chlorocinnamic acid		C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	939-58-2	182.604		212				vs eth, EtOH
1959	<i>trans</i> -m-Chlorocinnamic acid		C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	14473-90-6	182.604		165				s EtOH, eth
1960	<i>trans</i> -p-Chlorocinnamic acid		C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	940-62-5	182.604		249.5				vs ace, eth, EtOH
1961	Chlorocyclohexane	Cyclohexyl chloride	C <sub>6</sub> H <sub>11</sub> Cl	542-18-7	118.604	liq	-43.81	142	1.000 <sup>20</sup>	1.4626 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; vs chl
1962	2-Chlorocyclohexanone		C <sub>6</sub> H <sub>9</sub> ClO	822-87-7	132.587		23	82 <sup>15</sup>	1.160 <sup>20</sup>	1.4825 <sup>20</sup>	s eth, bz, diox; sl ctc
1963	1-Chlorocyclohexene		C <sub>6</sub> H <sub>9</sub> Cl	930-66-5	116.588			142.5	1.0361 <sup>19</sup>	1.4797 <sup>20</sup>	s eth, ace, ctc, chl
1964	Chlorocyclopentane	Cyclopentyl chloride	C <sub>5</sub> H <sub>9</sub> Cl	930-28-9	104.578			114	1.0051 <sup>20</sup>	1.4510 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, ctc
1965	2-Chlorocyclopentanone		C <sub>5</sub> H <sub>9</sub> ClO	694-28-0	118.562			87 <sup>19</sup> , 73 <sup>12</sup>	1.185 <sup>25</sup>	1.4750 <sup>20</sup>	
1966	3-Chlorocyclopentene		C <sub>5</sub> H <sub>7</sub> Cl	96-40-2	102.563			40 <sup>40</sup> , 27 <sup>40</sup>	1.0388 <sup>25</sup>	1.4708 <sup>25</sup>	vs eth, EtOH, chl
1967	4-Chloro-2-cyclopentylphenol	Dowicide 9	C <sub>11</sub> H <sub>13</sub> ClO	13347-42-7	196.673			183 <sup>18</sup>			
1968	1-Chlorodecane		C <sub>10</sub> H <sub>21</sub> Cl	1002-69-3	176.727	liq	-31.3	225.9	0.8696 <sup>20</sup>	1.4380 <sup>20</sup>	i H <sub>2</sub> O; vs eth, chl; s ctc
1969	10-Chloro-1-decanol		C <sub>10</sub> H <sub>21</sub> ClO	51309-10-5	192.726		12.5	187 <sup>15</sup>	0.9630 <sup>25</sup>	1.4578 <sup>20</sup>	vs eth, EtOH
1970	2-Chloro- <i>N,N</i> -diallylacetamide	Allidochlor	C <sub>8</sub> H <sub>12</sub> ClNO	93-71-0	173.640	liq		116 <sup>1</sup> , 92 <sup>0.7</sup>	1.088 <sup>25</sup>	1.4932 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH
1971	Chlorodiazepoxide		C <sub>16</sub> H <sub>16</sub> ClN <sub>3</sub> O	58-25-3	299.754			236.2			
1972	Chlorodibromomethane		CHBr <sub>2</sub> Cl	124-48-1	208.280	liq	-20	120	2.451 <sup>20</sup>	1.5482 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
1973	Chloro(dichloromethyl)dimethylsilane	(Dichloromethyl)dimethylchlorosilane	C <sub>2</sub> H <sub>4</sub> Cl <sub>3</sub> Si	18171-59-0	177.533	liq	-48	149	1.2369 <sup>20</sup>	1.461 <sup>20</sup>	
1974	5-Chloro- <i>N</i> -(3,4-dichlorophenyl)-2-hydroxybenzamide	3',4',5-Trichlorosalicylanilide	C <sub>13</sub> H <sub>6</sub> Cl <sub>3</sub> NO <sub>2</sub>	642-84-2	316.568			247			
1975	2-Chloro-1,1-diethoxyethane		C <sub>6</sub> H <sub>13</sub> ClO <sub>2</sub>	621-62-5	152.619			157.4	1.0180 <sup>20</sup>	1.4170 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
1976	3-Chloro-1,1-diethoxypropane		C <sub>7</sub> H <sub>15</sub> ClO <sub>2</sub>	35573-93-4	166.646			84 <sup>25</sup>	0.9951 <sup>19</sup>	1.4268 <sup>20</sup>	vs ace, bz
1977	2-Chloro- <i>N,N</i> -diethylacetamide		C <sub>8</sub> H <sub>12</sub> ClNO	2315-36-8	149.618			192 <sup>25</sup>			
1978	2-Chloro- <i>N,N</i> -diethylethanamine, hydrochloride		C <sub>8</sub> H <sub>15</sub> Cl <sub>2</sub> N	869-24-9	172.096		200				sl H <sub>2</sub> O
1979	Chlorodifluoroacetic acid		C <sub>2</sub> HClF <sub>2</sub> O <sub>2</sub>	76-04-0	130.478	hyg	25	122		1.3559 <sup>20</sup>	s chl
1980	1-Chloro-1,1-difluoroethane	Refrigerant 142b	C <sub>2</sub> H <sub>2</sub> ClF <sub>2</sub>	75-68-3	100.495	col gas	-130.8	-9.1	1.107 <sup>25</sup>		i H <sub>2</sub> O; s bz
1981	1-Chloro-2,2-difluoroethane		C <sub>2</sub> H <sub>2</sub> ClF <sub>2</sub>	338-65-8	100.495			35.1			
1982	1-Chloro-2,2-difluoroethene	1-Chloro-2,2-difluoroethylene	C <sub>2</sub> HClF <sub>2</sub>	359-10-4	98.479	col gas	-138.5	-18.5			
1983	Chlorodifluoromethane	Refrigerant 22	CHClF <sub>2</sub>	75-45-6	86.469	col gas	-157.42	-40.7	1.4909 <sup>69</sup>		sl H <sub>2</sub> O; s eth, ace, chl
1984	7-Chloro-2,3-dihydro-1 <i>H</i> -inden-4-ol	Chlorindanol	C <sub>9</sub> H <sub>9</sub> ClO	145-94-8	168.619	nd (peth)	92				
1985	10-Chloro-5,10-dihydrophenarsazine	Phenarsazine chloride	C <sub>12</sub> H <sub>6</sub> AsClN	578-94-9	277.581	ye cry	195		1.65		i H <sub>2</sub> O; sl ctc, bz, xyl
1986	5-Chloro-2,4-dimethoxyaniline		C <sub>8</sub> H <sub>10</sub> ClNO <sub>2</sub>	97-50-7	187.624		91				
1987	2-Chloro-1,1-dimethoxyethane		C <sub>4</sub> H <sub>9</sub> ClO <sub>2</sub>	97-97-2	124.566			127.5	1.068 <sup>20</sup>	1.4150 <sup>20</sup>	sl EtOH, eth, bz, ctc
1988	<i>N</i> -(4-Chloro-2,5-dimethoxyphenyl)-3-oxobutanamide		C <sub>12</sub> H <sub>14</sub> ClNO <sub>4</sub>	4433-79-8	271.697		107				s chl
1989	Chlorodimethylaluminum	Dimethylaluminum chloride	C <sub>2</sub> H <sub>6</sub> AlCl	1184-58-3	92.504	hyg liq	-21	126	0.996		rac H <sub>2</sub> O; s hx
1990	2-Chloro-10-(3-dimethylaminopropyl)phenothiazine monohydrochloride	Aminazin hydrochloride	C <sub>17</sub> H <sub>26</sub> Cl <sub>2</sub> N <sub>2</sub> S	69-09-0	355.325		195 dec				s H <sub>2</sub> O; i eth, bz; vs chl, EtOH
1991	2-Chloro- <i>N,N</i> -dimethylaniline		C <sub>8</sub> H <sub>10</sub> ClN	698-01-1	155.625			205	1.1067 <sup>20</sup>	1.5578 <sup>20</sup>	vs bz, EtOH
1992	3-Chloro- <i>N,N</i> -dimethylaniline		C <sub>8</sub> H <sub>10</sub> ClN	6848-13-1	155.625			232			sl H <sub>2</sub> O; s EtOH, ace, bz
1993	4-Chloro- <i>N,N</i> -dimethylaniline		C <sub>8</sub> H <sub>10</sub> ClN	698-69-1	155.625	nd (al)	35.5	231	1.0480 <sup>100</sup>		s EtOH
1994	2-Chloro-1,4-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	95-72-7	140.610		0.8	187	1.0589 <sup>15</sup>		i H <sub>2</sub> O; s ace, ctc; vs bz
1995	4-Chloro-1,2-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	615-60-1	140.610	liq	-6	194	1.0682 <sup>15</sup>		i H <sub>2</sub> O; s ace, ctc; vs bz
1996	2-Chloro- <i>N,N</i> -dimethylethanamine, hydrochloride		C <sub>4</sub> H <sub>11</sub> Cl <sub>2</sub> N	4584-46-7	144.043		201.0				sl H <sub>2</sub> O
1997	(2-Chloro-1,1-dimethylethyl)benzene	Neophyl chloride	C <sub>10</sub> H <sub>13</sub> Cl	515-40-2	168.663			223; 105 <sup>18</sup>	1.047 <sup>20</sup>	1.5247 <sup>20</sup>	vs ace, bz, eth, EtOH



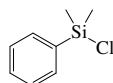
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
1998	4-Chloro-2,5-dimethylphenol		C <sub>8</sub> H <sub>9</sub> ClO	1124-06-7	156.609	silv-grn nd (lig)	74.5				sl H <sub>2</sub> O; vs bz, EtOH, peth
1999	4-Chloro-2,6-dimethylphenol		C <sub>8</sub> H <sub>9</sub> ClO	1123-63-3	156.609	nd (w)	83				sl H <sub>2</sub> O; vs bz, EtOH, HOAc
2000	4-Chloro-3,5-dimethylphenol	Chloroxylenol	C <sub>8</sub> H <sub>9</sub> ClO	88-04-0	156.609		115	246			sl H <sub>2</sub> O, bz, peth; s EtOH, eth
2001	Chlorodimethylphenylsilane		C <sub>8</sub> H <sub>11</sub> ClSi	768-33-2	170.712			195; 82 <sup>16</sup>	1.032 <sup>20</sup>	1.5082 <sup>20</sup>	
2002	1-Chloro- <i>N,N</i> -dimethyl-2-propanamine, hydrochloride		C <sub>5</sub> H <sub>13</sub> Cl <sub>2</sub> N	17256-39-2	158.069						s chl
2003	1-Chloro-2,2-dimethylpropane		C <sub>5</sub> H <sub>11</sub> Cl	753-89-9	106.594	liq	-20	84.3	0.8660 <sup>20</sup>	1.4044 <sup>20</sup>	vs bz, eth, EtOH, chl
2004	3-Chloro-2,2-dimethylpropanoic acid		C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	13511-38-1	136.577		41.5	110 <sup>10</sup>			vs ctc
2005	Chlorodimethylsilane		C <sub>2</sub> H <sub>6</sub> ClSi	1066-35-9	94.616	liq	-111	34.7	0.852	1.3830 <sup>20</sup>	
2006	2-Chloro-4,6-dinitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>4</sub>	3531-19-9	217.567	ye cry (DMF aq)	157				
2007	4-Chloro-2,6-dinitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>4</sub>	5388-62-5	217.567	oran-ye nd (al)	147				s EtOH
2008	1-Chloro-2,4-dinitrobenzene		C <sub>6</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>4</sub>	97-00-7	202.552	ye orth (eth) nd (al) ye cry	53	315	1.4982 <sup>75</sup>	1.5857 <sup>60</sup>	i H <sub>2</sub> O; sl EtOH; s eth, bz, CS <sub>2</sub>
2009	2-Chloro-1,3-dinitrobenzene		C <sub>6</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>4</sub>	606-21-3	202.552	ye nd (al, HOAc)	88	315	1.6867 <sup>16</sup>		i H <sub>2</sub> O; s EtOH, eth, tol; sl chl
2010	1-Chloro-2,4-dinitronaphthalene		C <sub>10</sub> H <sub>5</sub> ClN <sub>2</sub> O <sub>4</sub>	2401-85-6	252.611	ye nd (bz)	146.5				
2011	4-Chloro-2,6-dinitrophenol		C <sub>6</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>5</sub>	88-87-9	218.551	pa ye cry	81		1.74 <sup>22</sup>		vs eth, EtOH, chl
2012	2-Chloro-3,5-dinitropyridine		C <sub>5</sub> H <sub>2</sub> ClN <sub>2</sub> O <sub>4</sub>	2578-45-2	203.541		66.5				
2013	2-Chloro-1,3-dinitro-5-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>2</sub> ClF <sub>3</sub> N <sub>2</sub> O <sub>4</sub>	393-75-9	270.550		57				
2014	4-Chloro-1,3-dioxolan-2-one	Chloroethylene carbonate	C <sub>3</sub> H <sub>3</sub> ClO <sub>3</sub>	3967-54-2	122.507	liq	110	213; 122 <sup>18</sup>	1.504	1.4540 <sup>20</sup>	
2015	2-Chloro-1,2-diphenylethane		C <sub>14</sub> H <sub>11</sub> ClO	447-31-4	230.689	nd (al)	68.5	dec			s EtOH; sl chl; i alk
2016	Chlorodiphenylmethane		C <sub>13</sub> H <sub>11</sub> Cl	90-99-3	202.679		16	140 <sup>3</sup>	1.140 <sup>25</sup>	1.5951 <sup>20</sup>	s chl
2017	1-Chlorododecane	Lauryl chloride	C <sub>12</sub> H <sub>25</sub> Cl	112-52-7	204.780	liq	-9.3	263.2	0.8673 <sup>20</sup>	1.4434 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc ace, ctc; s bz
2018	Chloroethane	Ethyl chloride	C <sub>2</sub> H <sub>5</sub> Cl	75-00-3	64.514	vol liq or gas	-138.4	12.3	0.8902 <sup>25</sup> (p>1 atm)	1.3676 <sup>20</sup>	sl EtOH, chl; vs EtOH; msc eth
2019	2-Chloroethanesulfonyl chloride		C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> O <sub>2</sub> S	1622-32-8	163.023			201.5	1.555 <sup>20</sup>	1.4920 <sup>20</sup>	
2020	2-Chloroethanol	Ethylene chlorohydrin	C <sub>2</sub> H <sub>5</sub> ClO	107-07-3	80.513	liq	-67.5	128.6	1.2019 <sup>20</sup>	1.4419 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth; s chl
2021	2-Chloroethanol, 4-methylbenzenesulfonate		C <sub>9</sub> H <sub>11</sub> ClO <sub>3</sub> S	80-41-1	234.699			210 <sup>21</sup>			i H <sub>2</sub> O; s ctc
2022	Chloroethene	Vinyl chloride	C <sub>2</sub> H <sub>3</sub> Cl	75-01-4	62.498	col gas	-153.84	-13.8	0.9106 <sup>20</sup>	1.3700 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH; vs eth
2023	1-Chloro-4-ethoxybenzene		C <sub>8</sub> H <sub>9</sub> ClO	622-61-7	156.609		21	213	1.1254 <sup>20</sup>	1.5252 <sup>20</sup>	s EtOH, eth, HOAc; vs bz; sl ctc
2024	(2-Chloroethoxy)benzene		C <sub>8</sub> H <sub>9</sub> ClO	622-86-6	156.609		28	218.5			i H <sub>2</sub> O; vs EtOH, eth, ace, bz; sl ctc
2025	1-Chloro-1-ethoxyethane		C <sub>4</sub> H <sub>9</sub> ClO	7081-78-9	108.566			93.5	0.9655 <sup>20</sup>	1.4053 <sup>20</sup>	
2026	2-(2-Chloroethoxy)ethanol		C <sub>4</sub> H <sub>9</sub> ClO <sub>2</sub>	628-89-7	124.566			180; 80 <sup>9</sup>	1.18 <sup>25</sup>	1.4529 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth
2027	2-Chloroethyl acetate	β-Chloroethyl acetate	C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	542-58-5	122.551			145	1.178 <sup>20</sup>	1.4234 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
2028	2-Chloroethyl acetoacetate		C <sub>6</sub> H <sub>9</sub> ClO <sub>3</sub>	54527-68-3	164.586			198; 120 <sup>19</sup>	1.2055 <sup>21</sup>	1.4430 <sup>20</sup>	vs bz, eth, EtOH
2029	2-Chloroethylamine hydrochloride	2-Chloroethanamine hydrochloride	C <sub>2</sub> H <sub>5</sub> Cl <sub>2</sub> N	870-24-6	115.990		146.3				vs H <sub>2</sub> O, ace, EtOH
2030	(1-Chloroethyl)benzene		C <sub>8</sub> H <sub>9</sub> Cl	672-65-1	140.610			105 <sup>50</sup>			
2031	(2-Chloroethyl)benzene		C <sub>8</sub> H <sub>9</sub> Cl	622-24-2	140.610			197.5, 92 <sup>20</sup>	1.069 <sup>25</sup>	1.5276 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, CS <sub>2</sub>
2032	1-Chloro-2-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	89-96-3	140.610	liq	-82.7	178.4	1.0569 <sup>20</sup>	1.5218 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz, ctc, chl
2033	1-Chloro-3-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	620-16-6	140.610	liq	-55	183.8	1.0529 <sup>20</sup>	1.5195 <sup>20</sup>	vs ace, bz, eth, EtOH
2034	1-Chloro-4-ethylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	622-98-0	140.610	liq	-62.6	184.4	1.0455 <sup>20</sup>	1.5175 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, peth; s HOAc
2035	2-Chloroethyl chloroformate		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	627-11-2	142.969			155	1.3847 <sup>20</sup>	1.4483 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; sl ctc



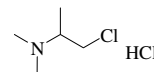
4-Chloro-2,6-dimethylphenol



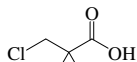
4-Chloro-3,5-dimethylphenol



Chlorodimethylphenylsilane

1-Chloro-*N,N*-dimethyl-2-propanamine, hydrochloride

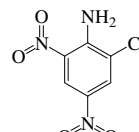
1-Chloro-2,2-dimethylpropane



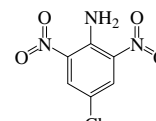
3-Chloro-2,2-dimethylpropanoic acid



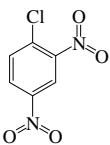
Chlorodimethylsilane



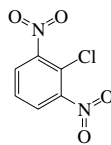
2-Chloro-4,6-dinitroaniline



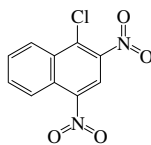
4-Chloro-2,6-dinitroaniline



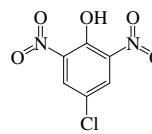
1-Chloro-2,4-dinitrobenzene



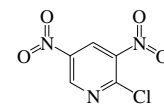
2-Chloro-1,3-dinitrobenzene



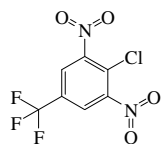
1-Chloro-2,4-dinitronaphthalene



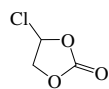
4-Chloro-2,6-dinitrophenol



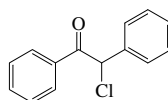
2-Chloro-3,5-dinitropyridine



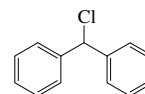
2-Chloro-1,3-dinitro-5-(trifluoromethyl)benzene



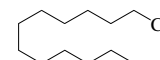
4-Chloro-1,3-dioxolan-2-one



2-Chloro-1,2-diphenylethanone



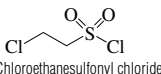
Chlorodiphenylmethane



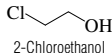
1-Chlorododecane



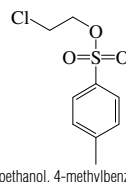
Chloroethane



2-Chloroethanesulfonyl chloride



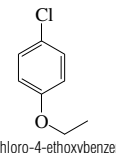
2-Chloroethanol



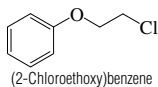
2-Chloroethanol, 4-methylbenzenesulfonate



Chloroethene



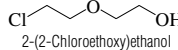
1-Chloro-4-ethoxybenzene



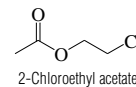
(2-Chloroethoxy)benzene



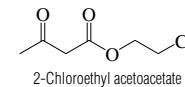
1-Chloro-1-ethoxyethane



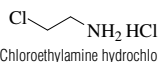
2-(2-Chloroethoxy)ethanol



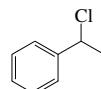
2-Chloroethyl acetate



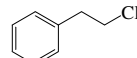
2-Chloroethyl acetoacetate



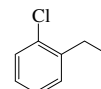
2-Chloroethylamine hydrochloride



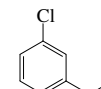
(1-Chloroethyl)benzene



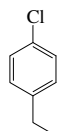
(2-Chloroethyl)benzene



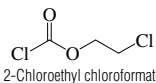
1-Chloro-2-ethylbenzene



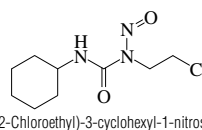
1-Chloro-3-ethylbenzene



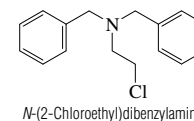
1-Chloro-4-ethylbenzene



2-Chloroethyl chloroformate

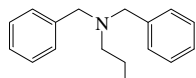


1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea

*N*-(2-Chloroethyl)dibenzylamine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2036	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea	Lomustine	C <sub>9</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>2</sub>	13010-47-4	233.695	ye pow	90				i H <sub>2</sub> O; s EtOH
2037	<i>N</i> -(2-Chloroethyl)dibenzylamine	Dibenamine	C <sub>16</sub> H <sub>18</sub> ClN	51-50-3	259.774	oily liq		169 <sup>3</sup>			
2038	<i>N</i> -(2-Chloroethyl)dibenzylamine hydrochloride	Dibenamine hydrochloride	C <sub>16</sub> H <sub>15</sub> Cl <sub>2</sub> N	55-43-6	296.235	cry	194				i H <sub>2</sub> O; s EtOH, dil acid
2039	Chloroethyldimethylsilane		C <sub>4</sub> H <sub>11</sub> ClSi	6917-76-6	122.669			89.5	0.8675 <sup>20</sup>	1.4105 <sup>20</sup>	
2040	2-Chloroethyl ethyl ether		C <sub>4</sub> H <sub>9</sub> ClO	628-34-2	108.566			107.5	0.9895 <sup>20</sup>	1.4113 <sup>20</sup>	sl H <sub>2</sub> O; msc eth; s chl
2041	2-Chloroethyl isocyanate		C <sub>3</sub> H <sub>5</sub> ClNO	1943-83-5	105.523					44 <sup>17</sup>	
2042	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	Semustine	C <sub>10</sub> H <sub>18</sub> ClN <sub>3</sub> O <sub>2</sub>	13909-09-6	247.722	cry	64 dec				
2043	5-(2-Chloroethyl)-4-methylthiazole	Clomethiazole	C <sub>8</sub> H <sub>9</sub> ClNS	533-45-9	161.653	oil		92 <sup>7</sup>	1.233 <sup>25</sup>		
2044	<i>N</i> -(2-Chloroethyl)morpholine		C <sub>8</sub> H <sub>12</sub> ClNO	3240-94-6	149.618					42 <sup>1</sup>	
2045	4-(2-Chloroethyl)morpholine, hydrochloride		C <sub>8</sub> H <sub>13</sub> Cl <sub>2</sub> NO	3647-69-6	186.079		185				
2046	1-Chloro-2-(ethylthio)ethane		C <sub>4</sub> H <sub>9</sub> ClS	693-07-2	124.632			157	1.0663 <sup>25</sup>		
2047	2-Chloroethyl vinyl ether		C <sub>4</sub> H <sub>7</sub> ClO	110-75-8	106.551	liq	-70	108	1.0495 <sup>20</sup>	1.4378 <sup>20</sup>	vs EtOH, eth; sl chl
2048	3-Chloro-4-fluoroaniline		C <sub>6</sub> H <sub>6</sub> ClFN	367-21-5	145.562		45.0	227.0			
2049	1-Chloro-2-fluorobenzene		C <sub>6</sub> H <sub>4</sub> ClF	348-51-6	130.547	liq	-43	137.6	1.2233 <sup>20</sup>	1.4918 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz
2050	1-Chloro-3-fluorobenzene		C <sub>6</sub> H <sub>4</sub> ClF	625-98-9	130.547			127.6	1.221 <sup>25</sup>	1.4911	
2051	1-Chloro-4-fluorobenzene		C <sub>6</sub> H <sub>4</sub> ClF	352-33-0	130.547	liq	-26.8	130	1.4990 <sup>15</sup>	1.4990 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
2052	1-Chloro-1-fluoroethane		C <sub>2</sub> H <sub>4</sub> ClF	1615-75-4	82.504	vol liq or gas		16.2			
2053	1-Chloro-2-fluoroethane		C <sub>2</sub> H <sub>4</sub> ClF	762-50-5	82.504			52.8	1.1747 <sup>20</sup>	1.3775 <sup>20</sup>	vs eth, EtOH
2054	Chlorofluoromethane		CH <sub>2</sub> ClF	593-70-4	68.478	col gas	-135.1	-9.1			sl H <sub>2</sub> O; vs chl
2055	1-Chloro-3-fluoro-2-methylbenzene		C <sub>7</sub> H <sub>6</sub> ClF	443-83-4	144.574			154	1.191 <sup>25</sup>	1.5026 <sup>20</sup>	
2056	2-Chloro-1-fluoro-4-nitrobenzene	3-Chloro-4-fluoronitrobenzene	C <sub>6</sub> H <sub>3</sub> ClFNO <sub>2</sub>	350-30-1	175.545		41.5	229.5			
2057	4-Chloro-1-(4-fluorophenyl)-1-butanone		C <sub>10</sub> H <sub>10</sub> ClFO	3874-54-2	200.636			136 <sup>6</sup>	1.22 <sup>25</sup>	1.5255 <sup>20</sup>	
2058	3-Chloro-2,5-furandione		C <sub>4</sub> HClO <sub>3</sub>	96-02-6	132.502		33	196	1.5375 <sup>25</sup>	1.4980 <sup>20</sup>	
2059	1-Chloro-1,2,2,3,3,4,4-heptafluorocyclobutane	Refrigerant C317	C <sub>4</sub> ClF <sub>7</sub>	377-41-3	216.485	liq or gas	-39.1	25	1.602 <sup>15</sup>		
2060	1-Chloroheptane	Heptyl chloride	C <sub>7</sub> H <sub>15</sub> Cl	629-06-1	134.647	liq	-69.5	160.4	0.8762 <sup>20</sup>	1.4264 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc; s chl
2061	2-Chloroheptane		C <sub>7</sub> H <sub>15</sub> Cl	1001-89-4	134.647			61 <sup>32</sup> , 46 <sup>19</sup>	0.8672 <sup>20</sup>	1.4221 <sup>20</sup>	i H <sub>2</sub> O; vs eth; s bz, chl, HOAc
2062	3-Chloroheptane		C <sub>7</sub> H <sub>15</sub> Cl	999-52-0	134.647			144; 48 <sup>20</sup>	0.8690 <sup>20</sup>	1.4228 <sup>20</sup>	vs bz, eth
2063	4-Chloroheptane		C <sub>7</sub> H <sub>15</sub> Cl	998-95-8	134.647			144	0.8710 <sup>20</sup>	1.4237 <sup>20</sup>	vs bz, eth
2064	7-Chloro-1-heptanol	Heptamethylene chlorohydrin	C <sub>7</sub> H <sub>15</sub> ClO	55944-70-2	150.646	cry (peth, bz)	11	150 <sup>20</sup>	0.9998 <sup>15</sup>	1.4537 <sup>25</sup>	vs EtOH, peth
2065	1-Chlorohexadecane		C <sub>16</sub> H <sub>33</sub> Cl	4860-03-1	260.886		17.9	326.6	0.8635 <sup>20</sup>	1.4503 <sup>20</sup>	i H <sub>2</sub> O
2066	1-Chlorohexane	Hexyl chloride	C <sub>6</sub> H <sub>13</sub> Cl	544-10-5	120.620	liq	-94.0	135.1	0.8738 <sup>25</sup>	1.4200 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; vs chl; sl ctc
2067	2-Chlorohexane	2-Hexyl chloride	C <sub>6</sub> H <sub>13</sub> Cl	638-28-8	120.620			122.5	0.8694 <sup>21</sup>	1.4142 <sup>22</sup>	vs ace, bz, eth, EtOH
2068	3-Chlorohexane	3-Hexyl chloride	C <sub>6</sub> H <sub>13</sub> Cl	2346-81-8	120.620			123	0.8684 <sup>20</sup>	1.4163 <sup>20</sup>	vs ace, bz, eth, EtOH
2069	6-Chloro-1-hexanol		C <sub>6</sub> H <sub>13</sub> ClO	2009-83-8	136.619			107 <sup>12</sup>	1.0241 <sup>20</sup>	1.4550 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
2070	4-Chloro-17-hydroxyandrost-4-en-3-one, (17β)	Clostebol	C <sub>19</sub> H <sub>27</sub> ClO <sub>2</sub>	1093-58-9	322.869		189				
2071	5-Chloro-2-hydroxybenzaldehyde		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	635-93-8	156.567	pl (al)	100.3	105 <sup>12</sup>			i H <sub>2</sub> O; vs EtOH; s eth, alk
2072	4-Chloro-α-hydroxybenzeneacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	492-86-4	186.593		120.3				vs bz, EtOH
2073	3-Chloro-4-hydroxybenzoic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>3</sub>	3964-58-7	172.566	nd (w)	171	sub			sl H <sub>2</sub> O, bz, chl; vs EtOH, eth, ace
2074	5-Chloro-2-hydroxybenzoic acid		C <sub>7</sub> H <sub>5</sub> ClO <sub>3</sub>	321-14-2	172.566	nd (w, al)	174.8				s H <sub>2</sub> O, eth; vs EtOH, bz; sl ace
2075	2-Chloro-5-hydroxybenzophenone		C <sub>13</sub> H <sub>9</sub> ClO <sub>2</sub>	85-19-8	232.662		95.3				i H <sub>2</sub> O
2076	3-Chloro-4-hydroxy-5-methoxybenzaldehyde		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	19463-48-0	186.593	tetr	165				i H <sub>2</sub> O; s EtOH, HOAc
2077	1-Chloro-2-iodobenzene		C <sub>6</sub> H <sub>4</sub> ClI	615-41-8	238.453		0.7	234.5	1.9515 <sup>25</sup>	1.6331 <sup>25</sup>	i H <sub>2</sub> O; s ace; sl ctc
2078	1-Chloro-3-iodobenzene		C <sub>6</sub> H <sub>4</sub> ClI	625-99-0	238.453			230	1.9255 <sup>20</sup>		i H <sub>2</sub> O; s ace
2079	1-Chloro-4-iodobenzene		C <sub>6</sub> H <sub>4</sub> ClI	637-87-6	238.453	lf (ace, al)	57	227	1.886 <sup>27</sup>		i H <sub>2</sub> O; s EtOH, PhNO <sub>2</sub> ; sl chl
2080	1-Chloro-4-iodobutane		C <sub>4</sub> H <sub>9</sub> ClI	10297-05-9	218.464	liq		116; 89 <sup>19</sup>	1.785	1.5400 <sup>20</sup>	
2081	Chloriodomethane		CH <sub>2</sub> ClI	593-71-5	176.384			109	2.422 <sup>20</sup>	1.5822 <sup>20</sup>	vs ace, bz, eth, EtOH

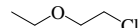




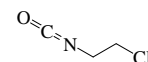
N-(2-Chloroethyl)dibenzylamine hydrochloride



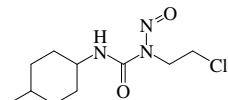
Chloroethyl dimethylsilane



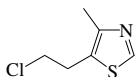
2-Chloroethyl ethyl ether



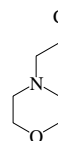
2-Chloroethyl isocyanate



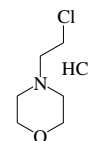
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea



5-(2-Chloroethyl)-4-methylthiazole



N-(2-Chloroethyl)morpholine



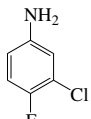
4-(2-Chloroethyl)morpholine, hydrochloride



1-Chloro-2-(ethylthio)ethane



2-Chloroethyl vinyl ether



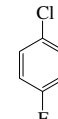
3-Chloro-4-fluoroaniline



1-Chloro-2-fluorobenzene



1-Chloro-3-fluorobenzene



1-Chloro-4-fluorobenzene



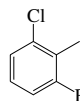
1-Chloro-1-fluoroethane



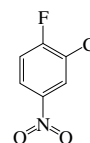
1-Chloro-2-fluoroethane



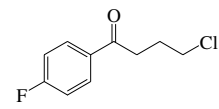
Chlorofluoromethane



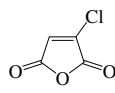
1-Chloro-3-fluoro-2-methylbenzene



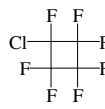
2-Chloro-1-fluoro-4-nitrobenzene



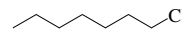
4-Chloro-1-(4-fluorophenyl)-1-butanone



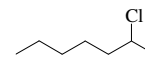
3-Chloro-2,5-furandione



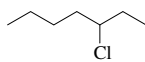
1-Chloro-1,2,2,3,3,4,4-heptafluorocyclobutane



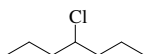
1-Chloroheptane



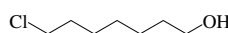
2-Chloroheptane



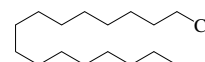
3-Chloroheptane



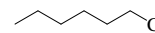
4-Chloroheptane



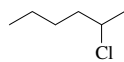
7-Chloro-1-heptanol



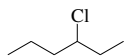
1-Chlorohexadecane



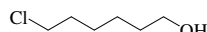
1-Chlorohexane



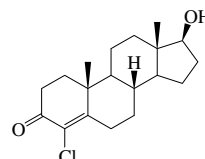
2-Chlorohexane



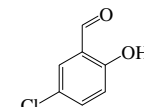
3-Chlorohexane



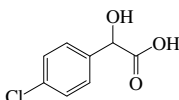
6-Chloro-1-hexanol



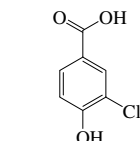
4-Chloro-17-hydroxyandrost-4-en-3-one, (17β)



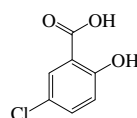
5-Chloro-2-hydroxybenzaldehyde



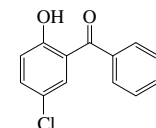
4-Chloro-α-hydroxybenzeneacetic acid



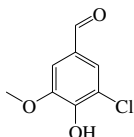
3-Chloro-4-hydroxybenzoic acid



5-Chloro-2-hydroxybenzoic acid



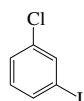
2-Chloro-5-hydroxybenzophenone



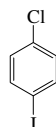
3-Chloro-4-hydroxy-5-methoxybenzaldehyde



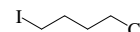
1-Chloro-2-iodobenzene



1-Chloro-3-iodobenzene



1-Chloro-4-iodobenzene

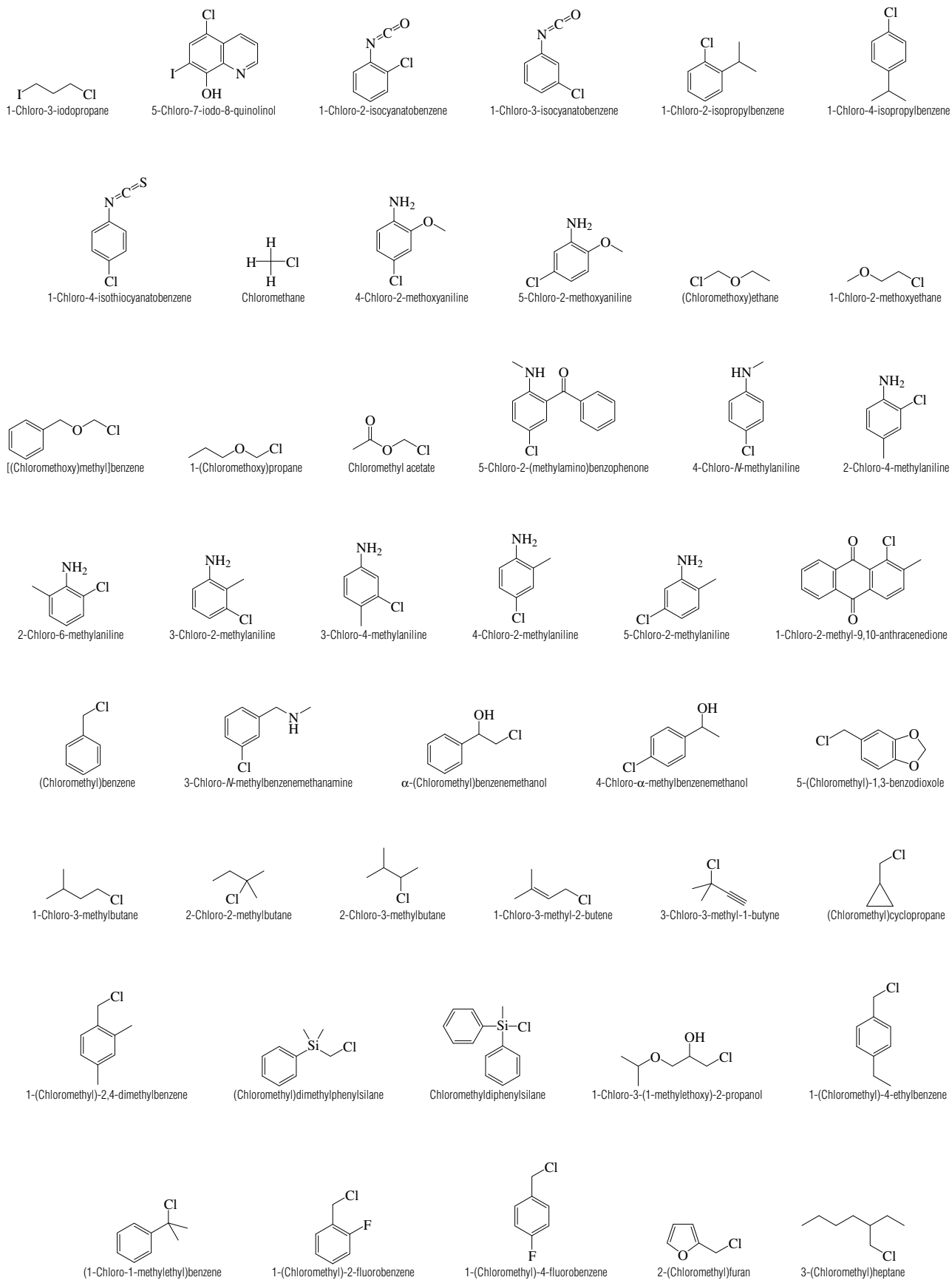


1-Chloro-4-iodobutane

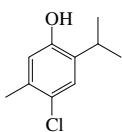


Chloriodomethane

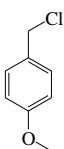
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2082	1-Chloro-3-iodopropane		C <sub>3</sub> H <sub>6</sub> ClI	6940-76-7	204.437			171	1.904 <sup>20</sup>	1.5472 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl; sl ctc
2083	5-Chloro-7-iodo-8-quinolinol	Iodochlorhydroxyquin	C <sub>9</sub> H <sub>6</sub> ClINO	130-26-7	305.499	ye br nd (al)	178.5				sl EtOH; s HOAc
2084	1-Chloro-2-isocyanatobenzene		C <sub>7</sub> H <sub>5</sub> ClNO	3320-83-0	153.566		30.5	200; 115 <sup>43</sup>			sl ctc
2085	1-Chloro-3-isocyanatobenzene		C <sub>7</sub> H <sub>5</sub> ClNO	2909-38-8	153.566			113 <sup>43</sup>			sl chl
2086	1-Chloro-2-isopropylbenzene		C <sub>9</sub> H <sub>11</sub> Cl	2077-13-6	154.636	liq	-74.4	191.1	1.0341 <sup>20</sup>	1.5168 <sup>20</sup>	vs ace, bz, eth, EtOH
2087	1-Chloro-4-isopropylbenzene		C <sub>9</sub> H <sub>11</sub> Cl	2621-46-7	154.636	liq	-12.3	198.3	1.0208 <sup>20</sup>	1.5117 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, ctc; vs bz
2088	1-Chloro-4-isothiocyanatobenzene		C <sub>7</sub> H <sub>5</sub> ClNS	2131-55-7	169.632	nd (al)	46	249.5			i H <sub>2</sub> O; s EtOH
2089	Chloromethane	Methyl chloride	CH <sub>3</sub> Cl	74-87-3	50.488	col gas	-97.7	-24.09	0.911 <sup>25</sup> (p>1 atm)	1.3389 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH; msc eth, ace, bz, chl
2090	4-Chloro-2-methoxyaniline	4-Chloro-2-anisidine	C <sub>7</sub> H <sub>8</sub> ClNO	93-50-5	157.598	nd or pr (dil al)	52	260			s EtOH, eth, bz, chl
2091	5-Chloro-2-methoxyaniline		C <sub>7</sub> H <sub>8</sub> ClNO	95-03-4	157.598	nd (dil al)	84				s EtOH; sl lig
2092	(Chloromethoxy)ethane	Chloromethyl ethyl ether	C <sub>3</sub> H <sub>7</sub> ClO	3188-13-4	94.540			83	1.0188 <sup>15</sup>	1.4040 <sup>20</sup>	
2093	1-Chloro-2-methoxyethane		C <sub>3</sub> H <sub>7</sub> ClO	627-42-9	94.540			92.5	1.0345 <sup>20</sup>	1.4111 <sup>20</sup>	vs H <sub>2</sub> O, eth
2094	[(Chloromethoxy)methyl]benzene		C <sub>8</sub> H <sub>9</sub> ClO	3587-60-8	156.609			103 <sup>13</sup>	1.1350 <sup>20</sup>	1.5192 <sup>20</sup>	
2095	1-(Chloromethoxy)propane		C <sub>3</sub> H <sub>7</sub> ClO	3587-57-3	108.566			109	0.9884 <sup>20</sup>	1.4125 <sup>20</sup>	vs eth, EtOH
2096	Chloromethyl acetate		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	625-56-9	108.524			116	1.194 <sup>20</sup>	1.409 <sup>20</sup>	vs eth, EtOH
2097	5-Chloro-2-(methylamino)benzophenone	<i>N</i> -Methyl-2-amino-5-chlorobenzophenone	C <sub>14</sub> H <sub>12</sub> ClNO	1022-13-5	245.704		92				
2098	4-Chloro- <i>N</i> -methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	932-96-7	141.599			240	1.169 <sup>11</sup>	1.5835 <sup>20</sup>	s EtOH, ace, bz
2099	2-Chloro-4-methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	615-65-6	141.599		7	220	1.151 <sup>20</sup>	1.5748 <sup>22</sup>	sl EtOH, bz
2100	2-Chloro-6-methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	87-63-8	141.599			215; 97 <sup>10</sup>			
2101	3-Chloro-2-methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	87-60-5	141.599		1	245		1.5880 <sup>20</sup>	s H <sub>2</sub> O, EtOH; i eth, bz
2102	3-Chloro-4-methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	95-74-9	141.599		26	243			s EtOH; sl ctc
2103	4-Chloro-2-methylaniline	<i>p</i> -Chloro- <i>o</i> -toluidine	C <sub>7</sub> H <sub>8</sub> ClN	95-69-2	141.599	lf (al)	30.3	244			s EtOH; sl ctc
2104	5-Chloro-2-methylaniline		C <sub>7</sub> H <sub>8</sub> ClN	95-79-4	141.599		26	239; 140 <sup>38</sup>			vs EtOH
2105	1-Chloro-2-methyl-9,10-anthracenedione		C <sub>15</sub> H <sub>9</sub> ClO <sub>2</sub>	129-35-1	256.684		170.5				i EtOH, eth; sl py
2106	(Chloromethyl)benzene	Benzyl chloride	C <sub>7</sub> H <sub>7</sub> Cl	100-44-7	126.584	liq	-45	179	1.1004 <sup>20</sup>	1.5391 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, chl; sl ctc
2107	3-Chloro- <i>N</i> -methylbenzenemethanamine		C <sub>8</sub> H <sub>10</sub> ClN	39191-07-6	155.625			88 <sup>4</sup>		1.5350 <sup>25</sup>	s chl
2108	$\alpha$ -(Chloromethyl)benzenemethanol		C <sub>8</sub> H <sub>9</sub> ClO	1674-30-2	156.609			128 <sup>17</sup> , 121 <sup>11</sup>	1.1926 <sup>20</sup>	1.5523 <sup>20</sup>	s EtOH; vs eth
2109	4-Chloro- $\alpha$ -methylbenzenemethanol		C <sub>8</sub> H <sub>9</sub> ClO	3391-10-4	156.609			121 <sup>15</sup>		1.5505 <sup>20</sup>	s ctc
2110	5-(Chloromethyl)-1,3-benzodioxole		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	20850-43-5	170.594		20.5	134 <sup>14</sup>	1.312 <sup>25</sup>	1.5660 <sup>20</sup>	
2111	1-Chloro-3-methylbutane	Isopentyl chloride	C <sub>5</sub> H <sub>11</sub> Cl	107-84-6	106.594	liq	-104.4	98.9	0.8750 <sup>20</sup>	1.4084 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs chl
2112	2-Chloro-2-methylbutane		C <sub>5</sub> H <sub>11</sub> Cl	594-36-5	106.594	liq	-73.5	85.6	0.8653 <sup>20</sup>	1.4055 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
2113	2-Chloro-3-methylbutane		C <sub>5</sub> H <sub>11</sub> Cl	631-65-2	106.594			91.5	0.878 <sup>20</sup>		
2114	1-Chloro-3-methyl-2-butene		C <sub>5</sub> H <sub>9</sub> Cl	503-60-6	104.578			109	0.9273 <sup>20</sup>	1.4485 <sup>20</sup>	vs ace, eth, EtOH, chl
2115	3-Chloro-3-methyl-1-butene		C <sub>5</sub> H <sub>9</sub> Cl	1111-97-3	102.563	liq	-61	76	0.9061 <sup>20</sup>		
2116	(Chloromethyl)cyclopropane		C <sub>3</sub> H <sub>5</sub> Cl	5911-08-0	90.552	liq	-90.9	88	0.98 <sup>25</sup>	1.4350 <sup>20</sup>	
2117	1-(Chloromethyl)-2,4-dimethylbenzene		C <sub>9</sub> H <sub>11</sub> Cl	824-55-5	154.636			215.5; 110 <sup>20</sup>	1.0580 <sup>19</sup>		vs bz, eth, EtOH
2118	(Chloromethyl)dimethylphenylsilane		C <sub>9</sub> H <sub>13</sub> ClSi	1833-51-8	184.738			225	1.0240 <sup>25</sup>		s ctc, CS <sub>2</sub>
2119	Chloromethyldiphenylsilane		C <sub>13</sub> H <sub>13</sub> ClSi	144-79-6	232.781			295	1.1277 <sup>20</sup>	1.5742 <sup>20</sup>	
2120	1-Chloro-3-(1-methylethoxy)-2-propanol		C <sub>6</sub> H <sub>13</sub> ClO <sub>2</sub>	4288-84-0	152.619			182; 87 <sup>20</sup>	1.0910 <sup>20</sup>	1.4370 <sup>25</sup>	s EtOH, eth
2121	1-(Chloromethyl)-4-ethylbenzene		C <sub>9</sub> H <sub>11</sub> Cl	1467-05-6	154.636			95 <sup>15</sup>		1.5290 <sup>25</sup>	vs bz, EtOH, chl
2122	(1-Chloro-1-methylethyl)benzene		C <sub>9</sub> H <sub>11</sub> Cl	934-53-2	154.636			98 <sup>1</sup>	1.192 <sup>25</sup>	1.5290 <sup>25</sup>	
2123	1-(Chloromethyl)-2-fluorobenzene		C <sub>7</sub> H <sub>6</sub> ClF	345-35-7	144.574			172; 86 <sup>40</sup>	1.216 <sup>25</sup>	1.5150 <sup>20</sup>	
2124	1-(Chloromethyl)-4-fluorobenzene		C <sub>7</sub> H <sub>6</sub> ClF	352-11-4	144.574			82 <sup>26</sup> , 76 <sup>20</sup>	1.2143 <sup>20</sup>	1.5130	
2125	2-(Chloromethyl)furan		C <sub>6</sub> H <sub>7</sub> ClO	617-88-9	116.546			49 <sup>26</sup>	1.1783 <sup>20</sup>	1.4941 <sup>20</sup>	vs bz, eth, EtOH
2126	3-(Chloromethyl)heptane		C <sub>8</sub> H <sub>17</sub> Cl	123-04-6	148.674			172	0.8769 <sup>20</sup>	1.4319 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; sl ctc



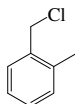
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2127	4-Chloro-5-methyl-2-isopropylphenol	Chlorothymol	C <sub>10</sub> H <sub>13</sub> ClO	89-68-9	184.662		63	258.5			vs H <sub>2</sub> O; s EtOH, eth, bz, ctc, peth, alk
2128	1-(Chloromethyl)-4-methoxybenzene		C <sub>8</sub> H <sub>9</sub> ClO	824-94-2	156.609	nd	24.5	262.5	1.261 <sup>20</sup>	1.580 <sup>20</sup>	vs ace, bz, eth
2129	1-(Chloromethyl)-2-methylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	552-45-4	140.610			198; 90 <sup>20</sup>	1.063 <sup>25</sup>	1.5410 <sup>25</sup>	vs eth, EtOH
2130	1-(Chloromethyl)-3-methylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	620-19-9	140.610			195.5	1.064 <sup>20</sup>	1.5345 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2131	1-(Chloromethyl)-4-methylbenzene		C <sub>8</sub> H <sub>9</sub> Cl	104-82-5	140.610			201; 90 <sup>20</sup>	1.0512 <sup>20</sup>	1.5380	i H <sub>2</sub> O; s EtOH; msc eth
2132	Chloromethyl methyl ether		C <sub>2</sub> H <sub>5</sub> ClO	107-30-2	80.513	liq	-103.5	59.5	1.063 <sup>10</sup>	1.397 <sup>20</sup>	s EtOH, eth, ace, chl
2133	2-(Chloromethyl)-2-methyloxirane		C <sub>4</sub> H <sub>7</sub> ClO	598-09-4	106.551			122	1.1011 <sup>20</sup>	1.4310 <sup>20</sup>	vs H <sub>2</sub> O, eth
2134	1-(Chloromethyl)naphthalene		C <sub>11</sub> H <sub>9</sub> Cl	86-52-2	176.642	pr	32	291.5	1.1813 <sup>20</sup>	1.6380 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc, peth
2135	2-(Chloromethyl)naphthalene		C <sub>11</sub> H <sub>9</sub> Cl	2506-41-4	176.642	lf (al)	48.5	169 <sup>20</sup>			i H <sub>2</sub> O; s EtOH, peth
2136	1-(Chloromethyl)-2-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	612-23-7	171.582	cry (lig)	50.0	125 <sup>4</sup>		1.5557 <sup>62</sup>	i H <sub>2</sub> O; s EtOH, eth, HOAc; vs ace, bz
2137	1-(Chloromethyl)-3-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	619-23-8	171.582	pa ye nd (lig)	46	173 <sup>34</sup>		1.5577 <sup>62</sup>	vs ace, bz, eth, EtOH
2138	1-(Chloromethyl)-4-nitrobenzene	4-Nitrobenzyl chloride	C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	100-14-1	171.582	pl or nd (al)	71			1.5647 <sup>62</sup>	i H <sub>2</sub> O; s EtOH, eth; vs ace, bz, AcOEt
2139	1-Chloro-2-methyl-3-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	83-42-1	171.582	nd (dil al)	37.8	238		1.5377 <sup>69</sup>	i H <sub>2</sub> O; s EtOH
2140	1-Chloro-2-methyl-4-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	13290-74-9	171.582	ye cry	42.5	249			vs eth
2141	1-Chloro-4-methyl-2-nitrobenzene	4-Chloro-3-nitrotoluene	C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	89-60-1	171.582		7	261; 118 <sup>11</sup>		1.5572 <sup>20</sup>	i H <sub>2</sub> O; s ctc
2142	2-Chloro-1-methyl-4-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	121-86-8	171.582	nd (al)	66.5	260		1.5470 <sup>69</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, HOAc
2143	4-Chloro-1-methyl-2-nitrobenzene		C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	89-59-8	171.582	mcl nd	38	242; 115.5 <sup>11</sup>	1.2559 <sup>60</sup>		i H <sub>2</sub> O; s EtOH, eth; sl chl
2144	2-Chloro-4-methylpentane		C <sub>8</sub> H <sub>13</sub> Cl	25346-32-1	120.620			113	0.8610 <sup>20</sup>	1.4113 <sup>20</sup>	vs eth
2145	3-(Chloromethyl)pentane		C <sub>8</sub> H <sub>13</sub> Cl	4737-41-1	120.620			126; 83 <sup>202</sup>	0.8914 <sup>20</sup>	1.4222 <sup>20</sup>	vs bz, eth, chl
2146	2-Chloro-4-methylphenol	2-Chloro- <i>p</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	6640-27-3	142.583			195.5	1.1785 <sup>27</sup>	1.5200 <sup>27</sup>	vs bz, eth, EtOH
2147	2-Chloro-5-methylphenol	6-Chloro- <i>m</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	615-74-7	142.583	pr (peth)	45.5	196	1.215 <sup>15</sup>		vs H <sub>2</sub> O, EtOH
2148	2-Chloro-6-methylphenol	6-Chloro- <i>o</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	87-64-9	142.583			189; 80 <sup>20</sup>		1.5449 <sup>20</sup>	sl H <sub>2</sub> O; s eth
2149	3-Chloro-4-methylphenol	3-Chloro- <i>p</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	615-62-3	142.583	nd (al)	55.5	228			vs bz, eth, EtOH
2150	4-Chloro-2-methylphenol	4-Chloro- <i>o</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	1570-64-5	142.583	nd (peth)	51	223			sl H <sub>2</sub> O; s peth
2151	4-Chloro-3-methylphenol	4-Chloro- <i>m</i> -cresol	C <sub>7</sub> H <sub>7</sub> ClO	59-50-7	142.583	nd (peth)	67	235			sl H <sub>2</sub> O, chl; s EtOH, eth, peth
2152	(4-Chloro-2-methylphenoxy)acetic acid	MCPA	C <sub>8</sub> H <sub>9</sub> ClO <sub>3</sub>	94-74-6	200.618	pl (bz, to)	120				sl H <sub>2</sub> O; vs EtOH, eth; s bz, ctc
2153	4-(4-Chloro-2-methylphenoxy)butanoic acid		C <sub>11</sub> H <sub>13</sub> ClO <sub>3</sub>	94-81-5	228.672		100				
2154	Chloromethylphenylsilane		C <sub>7</sub> H <sub>7</sub> ClSi	1631-82-9	156.685			113 <sup>100</sup>	1.043 <sup>20</sup>	1.5171 <sup>20</sup>	
2155	(Chloromethyl)phosphonic acid		CH <sub>2</sub> ClO <sub>3</sub> P	2565-58-4	130.468	nd (bz/MeNO <sub>2</sub> )	90				
2156	<i>N</i> -Chloromethylphthalimide		C <sub>9</sub> H <sub>6</sub> ClNO <sub>2</sub>	17564-64-6	195.603		135.5				
2157	2-Chloro-2-methylpropanal		C <sub>4</sub> H <sub>7</sub> ClO	917-93-1	106.551			90	1.053 <sup>15</sup>	1.4160 <sup>16</sup>	vs eth, EtOH
2158	1-Chloro-2-methylpropane	Isobutyl chloride	C <sub>4</sub> H <sub>9</sub> Cl	513-36-0	92.567	liq	-130.3	68.5	0.8773 <sup>20</sup>	1.3984 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s eth, ace, chl
2159	2-Chloro-2-methylpropane	<i>tert</i> -Butyl chloride	C <sub>4</sub> H <sub>9</sub> Cl	507-20-0	92.567	liq	-25.60	50.9	0.8420 <sup>20</sup>	1.3857 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, ctc, chl
2160	1-Chloro-2-methylpropene	Dimethylvinyl chloride	C <sub>4</sub> H <sub>7</sub> Cl	513-37-1	90.552			68	0.9186 <sup>20</sup>	1.4221 <sup>20</sup>	sl H <sub>2</sub> O; s chl
2161	3-Chloro-2-methylpropene		C <sub>4</sub> H <sub>7</sub> Cl	563-47-3	90.552			71.5	0.9165 <sup>20</sup>	1.4291 <sup>20</sup>	msc EtOH, eth; s ace; vs chl
2162	3-(Chloromethyl)pyridine, hydrochloride		C <sub>6</sub> H <sub>7</sub> Cl <sub>2</sub> N	6959-48-4	164.033	hyg	143.8				
2163	Chloromethylsilane		CH <sub>2</sub> ClSi	993-00-0	80.590	col gas	-135	7; -45 <sup>63</sup>			
2164	1-Chloro-4-(methylsulfonyl)benzene	4-Chlorobenzenethiol, <i>S</i> -methyl, <i>S,S</i> -dioxide	C <sub>7</sub> H <sub>7</sub> ClO <sub>2</sub> S	98-57-7	190.648		98				
2165	1-Chloro-4-(methylthio)benzene		C <sub>7</sub> H <sub>7</sub> ClS	123-09-1	158.649			105 <sup>10</sup>			
2166	1-Chloro-2-(methylthio)ethane		C <sub>3</sub> H <sub>7</sub> ClS	542-81-4	110.606			140; 60 <sup>30</sup>	1.123 <sup>20</sup>	1.4902 <sup>20</sup>	s EtOH, eth, ace
2167	Chloro(methylthio)methane		C <sub>2</sub> H <sub>5</sub> ClS	2373-51-5	96.579			105	1.153 <sup>25</sup>	1.4963 <sup>20</sup>	
2168	(Chloromethyl)trimethylsilane		C <sub>4</sub> H <sub>11</sub> ClSi	2344-80-1	122.669			98.5	0.879 <sup>25</sup>	1.4175 <sup>20</sup>	



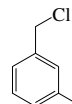
4-Chloro-5-methyl-2-isopropylphenol



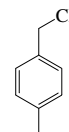
1-(Chloromethyl)-4-methoxybenzene



1-(Chloromethyl)-2-methylbenzene



1-(Chloromethyl)-3-methylbenzene



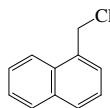
1-(Chloromethyl)-4-methylbenzene



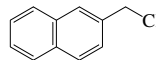
Chloromethyl methyl ether



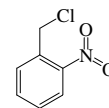
2-(Chloromethyl)-2-methyloxirane



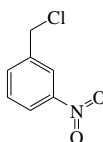
1-(Chloromethyl)naphthalene



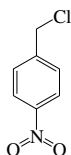
2-(Chloromethyl)naphthalene



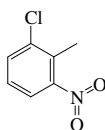
1-(Chloromethyl)-2-nitrobenzene



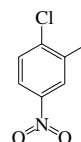
1-(Chloromethyl)-3-nitrobenzene



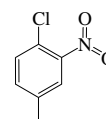
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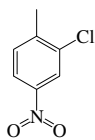
1-Chloro-2-methyl-3-nitrobenzene



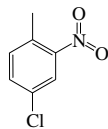
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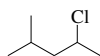
1-Chloro-4-methyl-2-nitrobenzene



2-Chloro-1-methyl-4-nitrobenzene



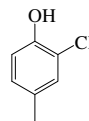
4-Chloro-1-methyl-2-nitrobenzene



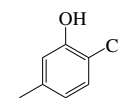
2-Chloro-4-methylpentane



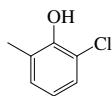
3-(Chloromethyl)pentane



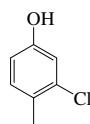
2-Chloro-4-methylphenol



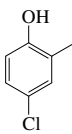
2-Chloro-5-methylphenol



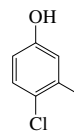
2-Chloro-6-methylphenol



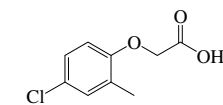
3-Chloro-4-methylphenol



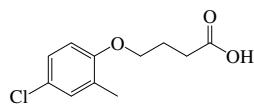
4-Chloro-2-methylphenol



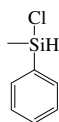
4-Chloro-3-methylphenol



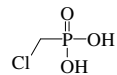
(4-Chloro-2-methylphenoxy)acetic acid



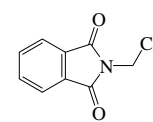
4-(4-Chloro-2-methylphenoxy)butanoic acid



Chloromethylphenylsilane



(Chloromethyl)phosphonic acid



N-Chloromethylphthalimide



2-Chloro-2-methylpropanal



1-Chloro-2-methylpropane



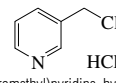
2-Chloro-2-methylpropane



1-Chloro-2-methylpropene



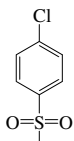
3-Chloro-2-methylpropene



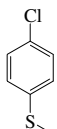
3-(Chloromethyl)pyridine, hydrochloride



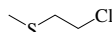
Chloromethylsilane



1-Chloro-4-(methylsulfonyl)benzene



1-Chloro-4-(methylthio)benzene



1-Chloro-2-(methylthio)ethane

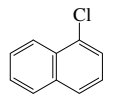


Chloro(methylthio)methane



(Chloromethyl)trimethylsilane

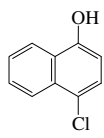
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2169	1-Chloronaphthalene	1-Naphthyl chloride	C <sub>10</sub> H <sub>7</sub> Cl	90-13-1	162.616	oily liq	-2.5	259; 106.5 <sup>5</sup>	1.1880 <sup>25</sup>	1.6326 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> ; sl ctc
2170	2-Chloronaphthalene		C <sub>10</sub> H <sub>7</sub> Cl	91-58-7	162.616	pl (dil al), lf	58.0	256	1.1377 <sup>71</sup>	1.6079 <sup>13</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
2171	4-Chloro-1-naphthol		C <sub>10</sub> H <sub>7</sub> ClO	604-44-4	178.615	nd (chl, aq al)	120.5				s EtOH, eth, ace, bz, chl
2172	Chloroneb	1,4-Dichloro-2,5-dimethoxybenzene	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	2675-77-6	207.055		134	268			
2173	2-Chloro-4-nitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub>	121-87-9	172.569	ye nd (w)	108				vs eth, EtOH, HOAc
2174	2-Chloro-5-nitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub>	6283-25-6	172.569	ye nd (lig)	121				vs eth, EtOH, HOAc
2175	4-Chloro-2-nitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub>	89-63-4	172.569	dk oran-ye pr (dil al)	116.5				vs EtOH, eth, HOAc; sl ace, lig
2176	4-Chloro-3-nitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub>	635-22-3	172.569	ye nd or pr (w) nd (peth)	103				s H <sub>2</sub> O, eth, chl; vs EtOH; sl lig
2177	5-Chloro-2-nitroaniline		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub>	1635-61-6	172.569	ye nd (CS <sub>2</sub> ) ye lf (al, bz)	127.8	sub			vs eth, EtOH
2178	1-Chloro-5-nitro-9,10-anthracenedione		C <sub>14</sub> H <sub>6</sub> ClNO <sub>4</sub>	129-40-8	287.656		315.3				i H <sub>2</sub> O, EtOH, eth, lig; sl bz; s py
2179	2-Chloro-5-nitrobenzaldehyde		C <sub>7</sub> H <sub>4</sub> ClNO <sub>3</sub>	6361-21-3	185.565	cry (al)	81.3				vs EtOH, chl
2180	4-Chloro-3-nitrobenzaldehyde		C <sub>7</sub> H <sub>4</sub> ClNO <sub>3</sub>	16588-34-4	185.565		64.5				sl H <sub>2</sub> O; s chl
2181	1-Chloro-2-nitrobenzene	<i>o</i> -Chloronitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	88-73-3	157.555	mcl nd	32.1	245.5	1.368 <sup>242</sup>		i H <sub>2</sub> O; s EtOH, eth, bz; vs ace, tol, py
2182	1-Chloro-3-nitrobenzene	<i>m</i> -Chloronitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	121-73-3	157.555	pa ye orth pr (al)	44.4	235.5	1.343 <sup>50</sup>	1.5374 <sup>80</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
2183	1-Chloro-4-nitrobenzene	<i>p</i> -Chloronitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	100-00-5	157.555	mcl pr	82	242	1.2979 <sup>80</sup>	1.5376 <sup>100</sup>	i H <sub>2</sub> O; sl EtOH; s eth, chl, CS <sub>2</sub>
2184	5-Chloro-3-nitro-1,2-benzenediamine		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O	42389-30-0	187.584		167				
2185	4-Chloro-3-nitrobenzenesulfonamide		C <sub>6</sub> H <sub>4</sub> ClN <sub>2</sub> O <sub>2</sub> S	97-09-6	236.633	ye cry (EtOH)	175				
2186	4-Chloro-3-nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub> S	97-08-5	256.064		60.8				
2187	2-Chloro-4-nitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	99-60-5	201.565	nd (w)	141.8				s H <sub>2</sub> O, EtOH, eth, bz
2188	2-Chloro-5-nitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	2516-96-3	201.565	nd or pr (w)	166.5		1.608 <sup>18</sup>		sl H <sub>2</sub> O, ace; s EtOH, eth, bz
2189	4-Chloro-3-nitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	96-99-1	201.565	nd or pl (w)	182.8		1.645 <sup>18</sup>		i H <sub>2</sub> O; sl EtOH, ace
2190	1-Chloro-1-nitroethane		C <sub>2</sub> H <sub>4</sub> ClNO <sub>2</sub>	598-92-5	109.512			124.5	1.2837 <sup>20</sup>	1.4224 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc, alk
2191	2-Chloro-4-nitrophenol		C <sub>6</sub> H <sub>4</sub> ClNO <sub>3</sub>	619-08-9	173.554	wh nd (50% al)	111				s H <sub>2</sub> O, EtOH, eth, chl; sl bz
2192	4-Chloro-2-nitrophenol		C <sub>6</sub> H <sub>4</sub> ClNO <sub>3</sub>	89-64-5	173.554	ye mcl pr (al)	88.5				i H <sub>2</sub> O; s EtOH, eth, chl; sl ace
2193	5-Chloro-2-nitrophenol		C <sub>6</sub> H <sub>4</sub> ClNO <sub>3</sub>	611-07-4	173.554	ye pr or nd (w)	41	sub			sl H <sub>2</sub> O; s EtOH, eth, HOAc
2194	1-Chloro-1-nitropropane		C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	600-25-9	123.539			142	1.207 <sup>20</sup>	1.4251 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, oils
2195	2-Chloro-2-nitropropane		C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	594-71-8	123.539		-21.5	dec 134; 57 <sup>50</sup>	1.2 <sup>20</sup>	1.4378 <sup>19</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc, oils; i KOH
2196	2-Chloro-3-nitropyridine		C <sub>5</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>2</sub>	5470-18-8	158.543	nd (w)	104.0				
2197	1-Chloro-2-nitro-4-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>3</sub> ClF <sub>3</sub> NO <sub>2</sub>	121-17-5	225.553	liq	-1.3	222; 95 <sup>10</sup>	1.511 <sup>25</sup>	1.4893 <sup>30</sup>	
2198	1-Chloro-4-nitro-2-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>3</sub> ClF <sub>3</sub> NO <sub>2</sub>	777-37-7	225.553		22	232	1.527 <sup>25</sup>	1.5083 <sup>35</sup>	
2199	1-Chlorononane		C <sub>9</sub> H <sub>19</sub> Cl	2473-01-0	162.700	liq	-39.4	205.2	0.8674 <sup>25</sup>	1.4343 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl
2200	9-Chloro-1-nonanol		C <sub>9</sub> H <sub>19</sub> ClO	51308-99-7	178.699		28	147 <sup>14</sup>		1.4575 <sup>20</sup>	vs eth, EtOH
2201	1-Chlorooctadecane		C <sub>18</sub> H <sub>37</sub> Cl	3386-33-2	288.940		28.6	352	0.8616 <sup>20</sup>	1.4524 <sup>20</sup>	i H <sub>2</sub> O; sl ctc
2202	1-Chlorooctane	Octyl chloride	C <sub>8</sub> H <sub>17</sub> Cl	111-85-3	148.674	liq	-57.8	183.5	0.8734 <sup>20</sup>	1.4309 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
2203	2-Chlorooctane		C <sub>8</sub> H <sub>17</sub> Cl	628-61-5	148.674			172; 75 <sup>28</sup>	0.8658 <sup>17</sup>	1.4273 <sup>21</sup>	i H <sub>2</sub> O; vs EtOH, eth
2204	8-Chloro-1-octanol		C <sub>8</sub> H <sub>17</sub> ClO	23144-52-7	164.673			139 <sup>19</sup>		1.4563 <sup>25</sup>	vs eth, EtOH
2205	Chloropentafluoroacetone		C <sub>2</sub> ClF <sub>5</sub> O	79-53-8	182.476	col gas	-133	8			
2206	Chloropentafluorobenzene		C <sub>6</sub> ClF <sub>5</sub>	344-07-0	202.509			117.96	1.568 <sup>25</sup>	1.4256 <sup>20</sup>	



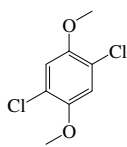
1-Chloronaphthalene



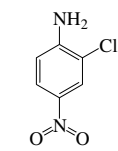
2-Chloronaphthalene



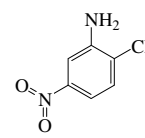
4-Chloro-1-naphthol



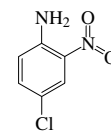
Chloroneb



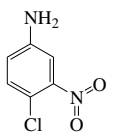
2-Chloro-4-nitroaniline



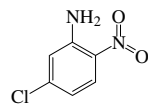
2-Chloro-5-nitroaniline



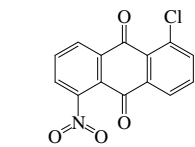
4-Chloro-2-nitroaniline



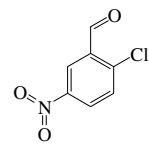
4-Chloro-3-nitroaniline



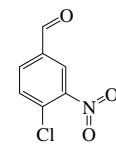
5-Chloro-2-nitroaniline



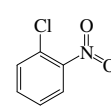
1-Chloro-5-nitro-9,10-anthracenedione



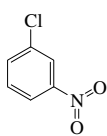
2-Chloro-5-nitrobenzaldehyde



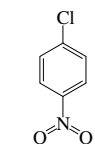
4-Chloro-3-nitrobenzaldehyde



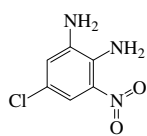
1-Chloro-2-nitrobenzene



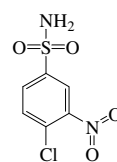
1-Chloro-3-nitrobenzene



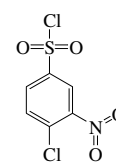
1-Chloro-4-nitrobenzene



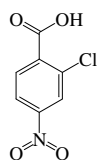
5-Chloro-3-nitro-1,2-benzenediamine



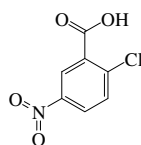
4-Chloro-3-nitrobenzenesulfonamide



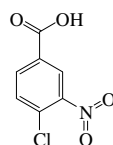
4-Chloro-3-nitrobenzenesulfonyl chloride



2-Chloro-4-nitrobenzoic acid



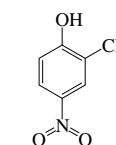
2-Chloro-5-nitrobenzoic acid



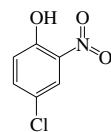
4-Chloro-3-nitrobenzoic acid



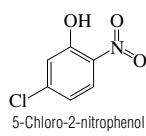
1-Chloro-1-nitroethane



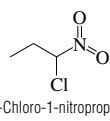
2-Chloro-4-nitrophenol



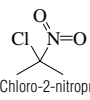
4-Chloro-2-nitrophenol



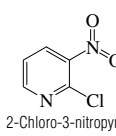
5-Chloro-2-nitrophenol



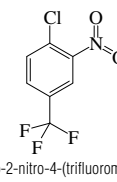
1-Chloro-1-nitropropane



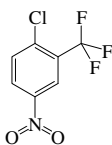
2-Chloro-2-nitropropane



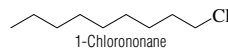
2-Chloro-1-nitropyridine



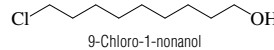
1-Chloro-2-nitro-4-(trifluoromethyl)benzene



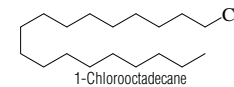
1-Chloro-4-nitro-2-(trifluoromethyl)benzene



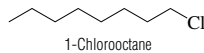
1-Chlorononane



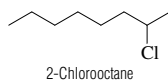
9-Chloro-1-nonanol



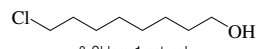
1-Chlorooctadecane



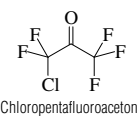
1-Chlorooctane



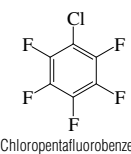
2-Chlorooctane



8-Chloro-1-octanol



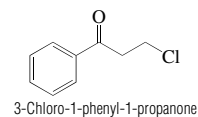
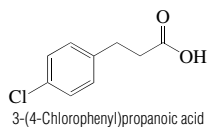
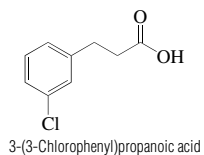
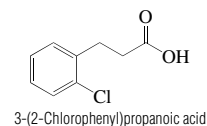
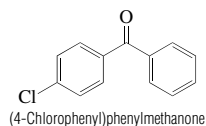
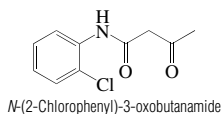
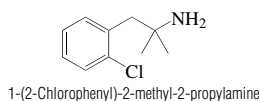
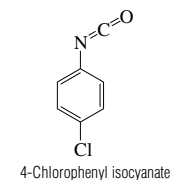
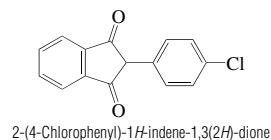
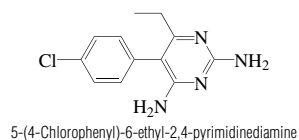
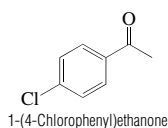
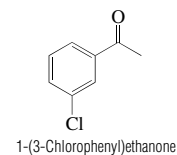
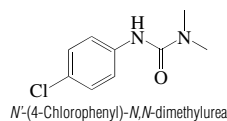
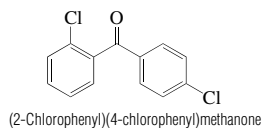
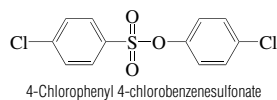
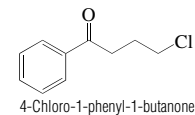
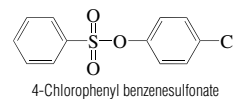
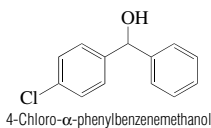
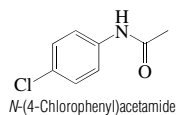
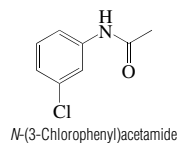
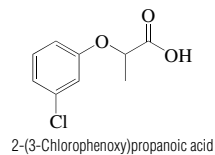
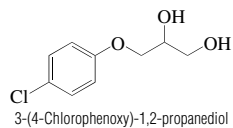
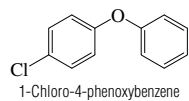
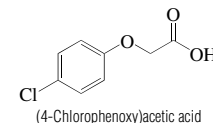
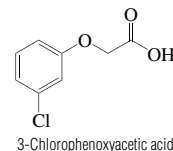
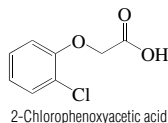
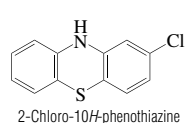
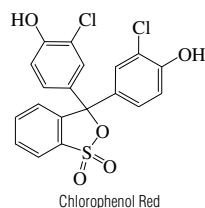
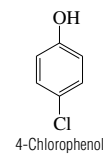
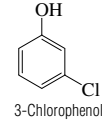
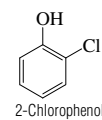
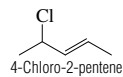
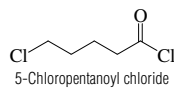
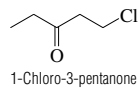
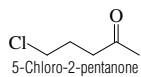
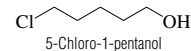
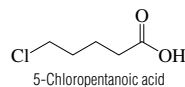
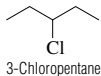
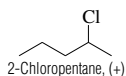
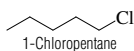
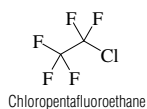
Chloropentafluoroacetone



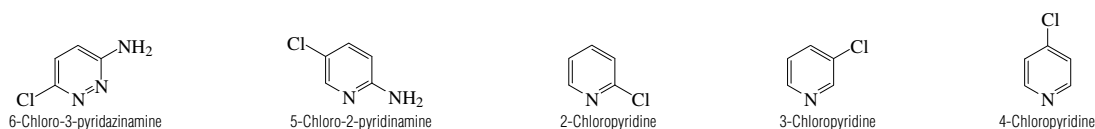
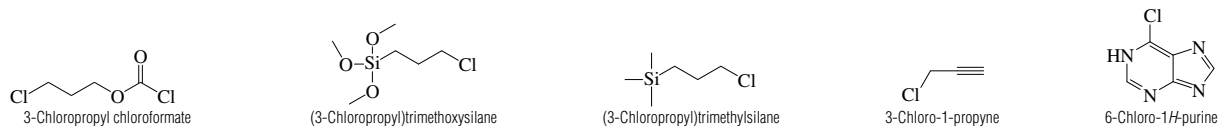
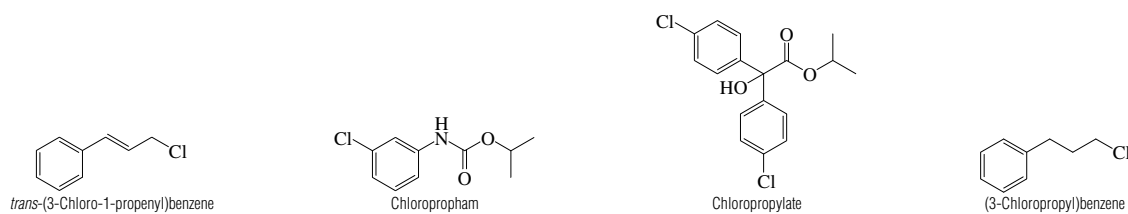
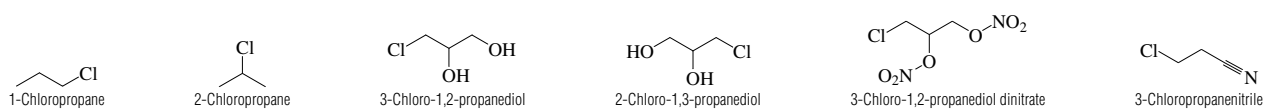
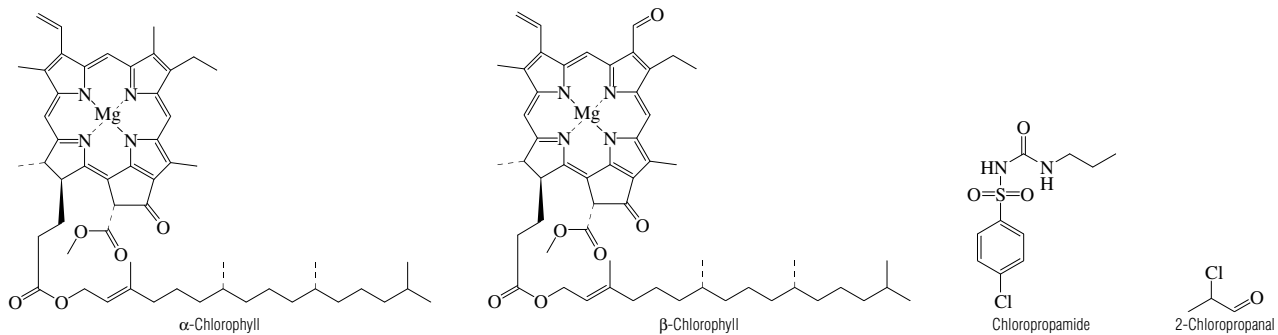
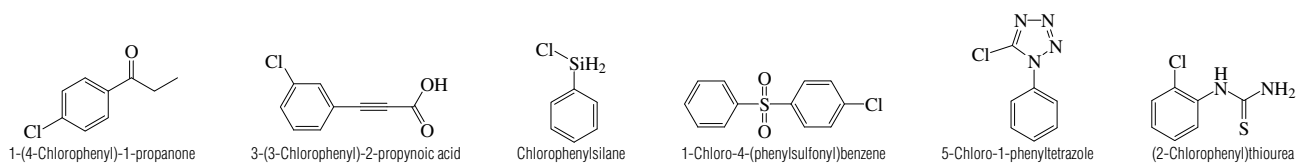
Chloropentafluorobenzene

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2207	Chloropentafluoroethane	Refrigerant 115	C <sub>2</sub> ClF <sub>5</sub>	76-15-3	154.466	col gas	-99.4	-39.1	1.5678 <sup>42</sup>	1.2678 <sup>42</sup>	i H <sub>2</sub> O; s EtOH, eth
2208	1-Chloropentane	Pentyl chloride	C <sub>5</sub> H <sub>11</sub> Cl	543-59-9	106.594	liq	-99.0	108.4	0.8820 <sup>20</sup>	1.4126 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, ctc; vs chl
2209	2-Chloropentane, (+)	sec-Pentyl chloride	C <sub>5</sub> H <sub>11</sub> Cl	29882-57-3	106.594	liq	-137	97.0	0.8698 <sup>20</sup>	1.4063 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; vs chl
2210	3-Chloropentane		C <sub>5</sub> H <sub>11</sub> Cl	616-20-6	106.594	liq	-105	97.5	0.8731 <sup>20</sup>	1.4082 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl ace
2211	5-Chloropentanoic acid		C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	1119-46-6	136.577		18	230	1.3416 <sup>25</sup>	1.4555 <sup>20</sup>	vs eth, EtOH
2212	5-Chloro-1-pentanol		C <sub>5</sub> H <sub>11</sub> ClO	5259-98-3	122.593			112 <sup>12</sup>		1.4518 <sup>20</sup>	vs eth, EtOH
2213	5-Chloro-2-pentanone		C <sub>5</sub> H <sub>9</sub> ClO	5891-21-4	120.577			106 <sup>110</sup> , 76 <sup>34</sup>	1.0523 <sup>20</sup>	1.4375 <sup>20</sup>	s eth, ace; sl ctc
2214	1-Chloro-3-pentanone		C <sub>5</sub> H <sub>9</sub> ClO	32830-97-0	120.577			68 <sup>20</sup>		1.4361 <sup>20</sup>	vs eth, EtOH
2215	5-Chloropentanoyl chloride		C <sub>5</sub> H <sub>9</sub> Cl <sub>2</sub> O	1575-61-7	155.022			83 <sup>12</sup>	1.210 <sup>18</sup>	1.4639 <sup>20</sup>	vs eth
2216	4-Chloro-2-pentene		C <sub>5</sub> H <sub>9</sub> Cl	1458-99-7	104.578			103; 47 <sup>25</sup>	0.8988 <sup>20</sup>	1.4322 <sup>20</sup>	vs ace, eth, chl
2217	2-Chlorophenol		C <sub>6</sub> H <sub>5</sub> ClO	95-57-8	128.556		9.4	174.9	1.2634 <sup>20</sup>	1.5524 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth; vs bz
2218	3-Chlorophenol		C <sub>6</sub> H <sub>5</sub> ClO	108-43-0	128.556		32.6	214	1.245 <sup>45</sup>	1.5565 <sup>40</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth; vs bz
2219	4-Chlorophenol		C <sub>6</sub> H <sub>5</sub> ClO	106-48-9	128.556		42.8	220	1.2651 <sup>40</sup>	1.5579 <sup>40</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz; s alk
2220	Chlorophenol Red		C <sub>19</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>5</sub> S	4430-20-0	423.266	grn-br cry	261				sl H <sub>2</sub> O; s EtOH
2221	2-Chloro-10 <i>H</i> -phenothiazine		C <sub>12</sub> H <sub>8</sub> CINS	92-39-7	233.717		198.5				
2222	2-Chlorophenoxyacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	614-61-9	186.593	nd (w, al)	148.5				s H <sub>2</sub> O, EtOH
2223	3-Chlorophenoxyacetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	588-32-9	186.593	cry (w)	110				i H <sub>2</sub> O
2224	(4-Chlorophenoxy)acetic acid		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	122-88-3	186.593	pr or nd (w)	156.5				vs H <sub>2</sub> O; sl chl
2225	1-Chloro-4-phenoxybenzene	4-Chlorophenyl phenyl ether	C <sub>12</sub> H <sub>9</sub> ClO	7005-72-3	204.651			284.5	1.2026 <sup>15</sup>	1.599	
2226	3-(4-Chlorophenoxy)-1,2-propanediol	Chlorphenesin	C <sub>9</sub> H <sub>11</sub> ClO <sub>3</sub>	104-29-0	202.634	cry	78	214 <sup>19</sup>			i H <sub>2</sub> O; vs EtOH, eth; s bz, con sulf
2227	2-(3-Chlorophenoxy)propanoic acid	Cloprop	C <sub>9</sub> H <sub>7</sub> ClO <sub>3</sub>	101-10-0	200.618	cry	113	100 <sup>15</sup>			
2228	2-Chloro- <i>N</i> -phenylacetamide		C <sub>8</sub> H <sub>8</sub> ClNO	587-65-5	169.609	nd (dil HOAc)		sub			vs bz, eth, EtOH
2229	<i>N</i> -(2-Chlorophenyl)acetamide		C <sub>8</sub> H <sub>8</sub> ClNO	533-17-5	169.609		88.3				i H <sub>2</sub> O; s EtOH, bz, chl; vs eth
2230	<i>N</i> -(3-Chlorophenyl)acetamide		C <sub>8</sub> H <sub>8</sub> ClNO	588-07-8	169.609	nd	79	333			sl H <sub>2</sub> O; vs EtOH, eth, bz, CS <sub>2</sub> ; s chl
2231	<i>N</i> -(4-Chlorophenyl)acetamide		C <sub>8</sub> H <sub>8</sub> ClNO	539-03-7	169.609		179	333	1.385 <sup>22</sup>		i H <sub>2</sub> O; s EtOH; vs eth; sl ctc
2232	4-Chloro- $\alpha$ -phenylbenzenemethanol		C <sub>13</sub> H <sub>11</sub> ClO	119-56-2	218.678		59				sl chl
2233	4-Chlorophenyl benzenesulfonate		C <sub>12</sub> H <sub>9</sub> ClO <sub>3</sub> S	80-38-6	268.715	col cry	62		1.33		sl H <sub>2</sub> O
2234	4-Chloro-1-phenyl-1-butanone		C <sub>10</sub> H <sub>11</sub> ClO	939-52-6	182.646		19.5	131 <sup>4</sup>	1.137 <sup>25</sup>	1.5459 <sup>20</sup>	
2235	4-Chlorophenyl 4-chlorobenzenesulfonate	Ovex	C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub> S	80-33-1	303.161		86.5				i H <sub>2</sub> O; sl EtOH; s ace
2236	(2-Chlorophenyl)(4-chlorophenyl) methanone	2,4'-Dichlorodiphenyl ketone	C <sub>13</sub> H <sub>8</sub> Cl <sub>2</sub> O	85-29-0	251.108	pr (al)	67	214 <sup>22</sup>	1.393 <sup>14</sup>		s EtOH; sl chl
2237	<i>N</i> -(4-Chlorophenyl)- <i>N,N</i> -dimethylurea	Monuron	C <sub>9</sub> H <sub>11</sub> ClN <sub>2</sub> O	150-68-5	198.648	wh pl (MeOH)	170.5				i H <sub>2</sub> O; sl EtOH, ace
2238	1-(3-Chlorophenyl)ethanone	<i>m</i> -Chloroacetophenone	C <sub>8</sub> H <sub>7</sub> ClO	99-02-5	154.594			244; 129 <sup>30</sup>	1.2130 <sup>40</sup>	1.5494 <sup>20</sup>	s EtOH, eth, ace
2239	1-(4-Chlorophenyl)ethanone	<i>p</i> -Chloroacetophenone	C <sub>8</sub> H <sub>7</sub> ClO	99-91-2	154.594		20	232	1.1922 <sup>20</sup>	1.5550 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
2240	5-(4-Chlorophenyl)-6-ethyl-2,4-pyrimidinediamine	Pyrimethamine	C <sub>12</sub> H <sub>13</sub> ClN <sub>4</sub>	58-14-0	248.711		233.5				
2241	2-(4-Chlorophenyl)-1 <i>H</i> -indene-1,3(2 <i>H</i> )-dione	Clorindione	C <sub>15</sub> H <sub>9</sub> ClO <sub>2</sub>	1146-99-2	256.684	dk red nd (al)	145.5				vs bz, eth, EtOH
2242	4-Chlorophenyl isocyanate		C <sub>7</sub> H <sub>4</sub> ClNO	104-12-1	153.566		31.3	116 <sup>45</sup>			
2243	1-(2-Chlorophenyl)-2-methyl-2-propylamine	Clortermine	C <sub>10</sub> H <sub>14</sub> ClN	10389-73-8	183.678	liq		117 <sup>16</sup>			
2244	<i>N</i> -(2-Chlorophenyl)-3-oxobutanamide		C <sub>10</sub> H <sub>10</sub> ClNO <sub>2</sub>	93-70-9	211.645		106.5				s EtOH; i eth, lig
2245	(4-Chlorophenyl) phenylmethanone		C <sub>13</sub> H <sub>9</sub> ClO	134-85-0	216.662	nd (al)	77.5	332			s EtOH, eth, ace; sl ctc
2246	3-(2-Chlorophenyl)propanoic acid		C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	1643-28-3	184.619	nd or lf (w)	102				
2247	3-(3-Chlorophenyl)propanoic acid		C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	21640-48-2	184.619	lf (peth)	77				
2248	3-(4-Chlorophenyl)propanoic acid		C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	2019-34-3	184.619		126				
2249	3-Chloro-1-phenyl-1-propanone	2-Chloroethyl phenyl ketone	C <sub>9</sub> H <sub>9</sub> ClO	936-59-4	168.619	lf (eth), cry (al, peth)	49.5	113 <sup>4</sup>			

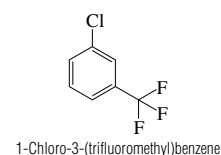
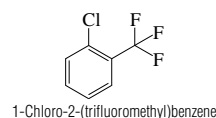
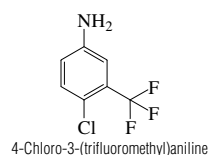
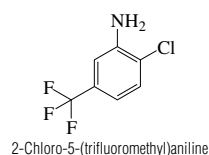
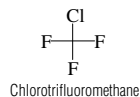
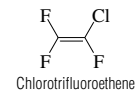
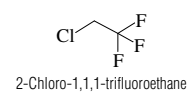
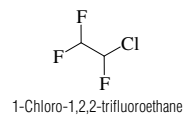
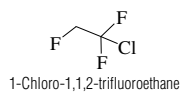
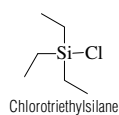
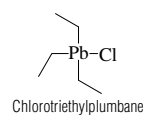
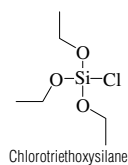
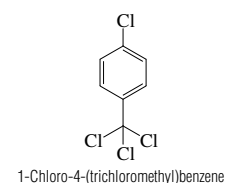
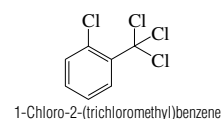
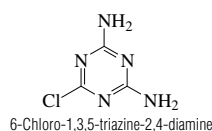
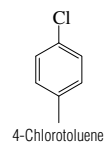
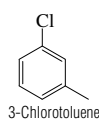
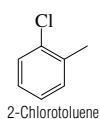
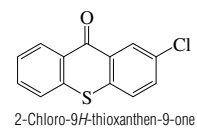
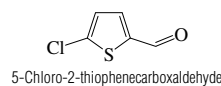
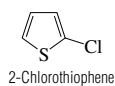
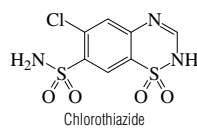
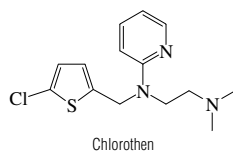
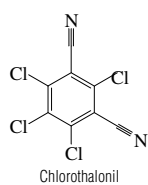
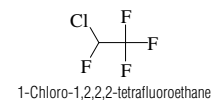
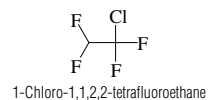
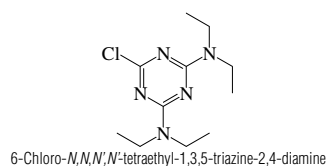
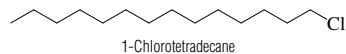
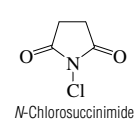
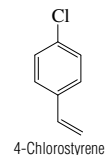
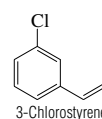
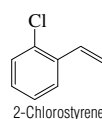
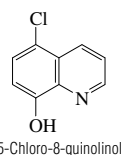
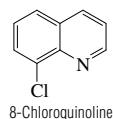
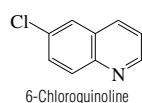
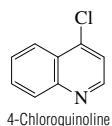
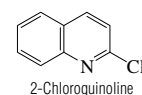
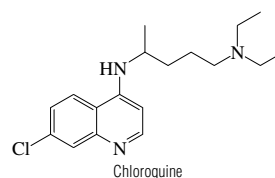
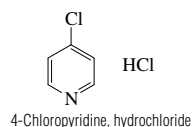
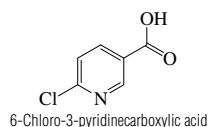
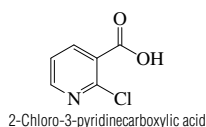




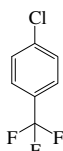
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2250	1-(4-Chlorophenyl)-1-propanone		C <sub>9</sub> H <sub>9</sub> ClO	6285-05-8	168.619		37.3	135 <sup>31</sup> , 114 <sup>2</sup>			i H <sub>2</sub> O; s EtOH; CS <sub>2</sub> ; sl chl
2251	3-(3-Chlorophenyl)-2-propynoic acid		C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	7396-28-3	180.588	cry (HOAc, bz-peth)	144.5				vs HOAc
2252	Chlorophenylsilane	Phenylchlorosilane	C <sub>6</sub> H <sub>5</sub> ClSi	4206-75-1	142.659			162.5	1.0683 <sup>20</sup>	1.5340 <sup>20</sup>	
2253	1-Chloro-4-(phenylsulfonyl)benzene	Sulphenone	C <sub>12</sub> H <sub>9</sub> ClO <sub>2</sub> S	80-00-2	252.716		94				i H <sub>2</sub> O; sl EtOH; s eth; vs ace, bz
2254	5-Chloro-1-phenyltetrazole		C <sub>7</sub> H <sub>5</sub> ClN <sub>4</sub>	14210-25-4	180.595		123				
2255	(2-Chlorophenyl)thiourea		C <sub>7</sub> H <sub>7</sub> ClN <sub>2</sub> S	5344-82-1	186.662	nd or pl	146				vs bz, EtOH
2256	α-Chlorophyll		C <sub>55</sub> H <sub>72</sub> MgN <sub>4</sub> O <sub>5</sub>	479-61-8	893.490	bl blk hex pl	152.3				i H <sub>2</sub> O; vs EtOH, eth; s lig
2257	β-Chlorophyll		C <sub>55</sub> H <sub>70</sub> MgN <sub>4</sub> O <sub>6</sub>	519-62-0	907.473	bl-blk or grn pow	125				i H <sub>2</sub> O; vs EtOH, eth, py; s MeOH
2258	Chloropropamide	4-Chloro-N[(propylamino)carbonyl]benzenesulfonamide	C <sub>10</sub> H <sub>13</sub> ClN <sub>2</sub> O <sub>3</sub> S	94-20-2	276.739	cry (EtOH)	128				i H <sub>2</sub> O; s EtOH; sl eth, bz
2259	2-Chloropropanal		C <sub>3</sub> H <sub>5</sub> ClO	683-50-1	92.524			86	1.182 <sup>15</sup>	1.431 <sup>17</sup>	vs bz, eth
2260	1-Chloropropane	Propyl chloride	C <sub>3</sub> H <sub>7</sub> Cl	540-54-5	78.541	liq	-122.9	46.5	0.8899 <sup>20</sup>	1.3879 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s bz, chl
2261	2-Chloropropane	Isopropyl chloride	C <sub>3</sub> H <sub>7</sub> Cl	75-29-6	78.541	liq	-117.18	35.7	0.8617 <sup>20</sup>	1.3777 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, ctc, chl
2262	3-Chloro-1,2-propanediol	α-Chlorohydrin	C <sub>3</sub> H <sub>7</sub> ClO <sub>2</sub>	96-24-2	110.540	ye liq		dec 213; 116 <sup>11</sup>	1.325 <sup>18</sup>	1.4809 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
2263	2-Chloro-1,3-propanediol	Glycerol β-chlorohydrin	C <sub>3</sub> H <sub>7</sub> ClO <sub>2</sub>	497-04-1	110.540			146 <sup>18</sup> , 124 <sup>14</sup>	1.3219 <sup>20</sup>	1.4831 <sup>20</sup>	vs H <sub>2</sub> O, ace, EtOH
2264	3-Chloro-1,2-propanediol dinitrate	Clonitrate	C <sub>3</sub> H <sub>5</sub> ClN <sub>2</sub> O <sub>6</sub>	2612-33-1	200.534	sl ye liq		192.5	1.5112 <sup>9</sup>		vs ace, EtOH, chl
2265	3-Chloropropanenitrile	β-Chloropropionitrile	C <sub>3</sub> H <sub>5</sub> ClN	542-76-7	89.524	liq	-51	175.5	1.1573 <sup>20</sup>	1.4360 <sup>20</sup>	sl ctc
2266	2-Chloropropanoic acid	2-Chloropropionic acid	C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	598-78-7	108.524			185	1.2585 <sup>20</sup>	1.4380 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace
2267	3-Chloropropanoic acid	β-Chloropropionic acid	C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	107-94-8	108.524	lf (w), hyg cry (liq)	41	dec 204			s H <sub>2</sub> O, EtOH, chl; msc eth
2268	2-Chloro-1-propanol	Propylene chlorohydrin	C <sub>3</sub> H <sub>7</sub> ClO	78-89-7	94.540			133.5	1.103 <sup>20</sup>	1.4390 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
2269	3-Chloro-1-propanol		C <sub>3</sub> H <sub>7</sub> ClO	627-30-5	94.540			165	1.1309 <sup>20</sup>	1.4459 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth; sl ctc
2270	1-Chloro-2-propanol	sec-Propylene chlorohydrin	C <sub>3</sub> H <sub>7</sub> ClO	127-00-4	94.540			127	1.113 <sup>20</sup>	1.4392 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl ctc
2271	3-Chloropropanoyl chloride		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O	625-36-5	126.969			144	1.3307 <sup>13</sup>	1.4549 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, chl
2272	cis-1-Chloropropene		C <sub>3</sub> H <sub>5</sub> Cl	16136-84-8	76.525	liq	-134.8	32.8	0.9347 <sup>20</sup>	1.4055 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
2273	trans-1-Chloropropene		C <sub>3</sub> H <sub>5</sub> Cl	16136-85-9	76.525	liq	-99	37.4	0.9349 <sup>20</sup>	1.4054 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
2274	2-Chloropropene	Isopropenyl chloride	C <sub>3</sub> H <sub>5</sub> Cl	557-98-2	76.525	vol liq or gas	-137.4	22.6	0.9017 <sup>20</sup>	1.3973 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
2275	3-Chloropropene	Allyl chloride	C <sub>3</sub> H <sub>5</sub> Cl	107-05-1	76.525	liq	-134.5	45.1	0.9376 <sup>20</sup>	1.4157 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig; sl ctc
2276	2-Chloro-2-propenenitrile		C <sub>3</sub> H <sub>3</sub> ClN	920-37-6	87.508	liq	-65	88.5	1.096 <sup>25</sup>	1.4290 <sup>20</sup>	
2277	2-Chloropropenoic acid	2-Chloroacrylic acid	C <sub>3</sub> H <sub>3</sub> ClO <sub>2</sub>	598-79-8	106.508			66	sub		
2278	trans-(3-Chloro-1-propenyl)benzene		C <sub>9</sub> H <sub>9</sub> Cl	21087-29-6	152.620		8.5	106 <sup>13</sup>	1.0926 <sup>20</sup>	1.5851 <sup>20</sup>	vs ace, bz, eth, EtOH
2279	Chloroprotham		C <sub>10</sub> H <sub>12</sub> ClNO <sub>2</sub>	101-21-3	213.661		41	149 <sup>2</sup>	1.18 <sup>30</sup>	1.5388 <sup>20</sup>	
2280	Chloropropylate		C <sub>17</sub> H <sub>16</sub> Cl <sub>2</sub> O <sub>3</sub>	5836-10-2	339.213	pow	73				sl H <sub>2</sub> O; s os
2281	(3-Chloropropyl)benzene		C <sub>9</sub> H <sub>11</sub> Cl	104-52-9	154.636			219.5	1.056 <sup>21</sup>	1.5160 <sup>25</sup>	sl ctc
2282	3-Chloropropyl chloroformate		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	628-11-5	156.996			177	1.2926 <sup>25</sup>	1.4456 <sup>20</sup>	i H <sub>2</sub> O
2283	(3-Chloropropyl)trimethoxysilane		C <sub>6</sub> H <sub>15</sub> ClO <sub>3</sub> Si	2530-87-2	198.720			91	1.077 <sup>25</sup>	1.4183 <sup>25</sup>	
2284	(3-Chloropropyl)trimethylsilane		C <sub>6</sub> H <sub>15</sub> ClSi	2344-83-4	150.722			151	0.8789 <sup>20</sup>	1.4319 <sup>20</sup>	
2285	3-Chloro-1-propyne	Propargyl chloride	C <sub>3</sub> H <sub>3</sub> Cl	624-65-7	74.509		-78	58	1.030 <sup>25</sup>	1.4349 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz; s ctc
2286	6-Chloro-1H-purine	6-Chloropurine	C <sub>5</sub> H <sub>4</sub> ClN <sub>4</sub>	87-42-3	154.558	nd (w)	176 dec				
2287	6-Chloro-3-pyridazinamine		C <sub>6</sub> H <sub>6</sub> ClN <sub>3</sub>	5469-69-2	129.548		220				
2288	5-Chloro-2-pyridinamine		C <sub>6</sub> H <sub>6</sub> ClN <sub>2</sub>	1072-98-6	128.560	pl	137	127 <sup>11</sup>			s H <sub>2</sub> O, EtOH; sl DMSO; i peth, lig
2289	2-Chloropyridine		C <sub>6</sub> H <sub>6</sub> ClN	109-09-1	113.546	oil		170	1.205 <sup>15</sup>	1.5320 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
2290	3-Chloropyridine		C <sub>6</sub> H <sub>6</sub> ClN	626-60-8	113.546			148; 86 <sup>100</sup>		1.5304 <sup>20</sup>	sl H <sub>2</sub> O
2291	4-Chloropyridine		C <sub>6</sub> H <sub>6</sub> ClN	626-61-9	113.546	liq	-43.5	147.5	1.2000 <sup>25</sup>		s H <sub>2</sub> O; msc EtOH



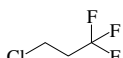
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2292	2-Chloro-3-pyridinecarboxylic acid		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	2942-59-8	157.555		>175 dec				
2293	6-Chloro-3-pyridinecarboxylic acid		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	5326-23-8	157.555		198 dec				
2294	4-Chloropyridine, hydrochloride		C <sub>5</sub> H <sub>5</sub> Cl <sub>2</sub> N	7379-35-3	150.006			sub 210			
2295	Chloroquine		C <sub>18</sub> H <sub>26</sub> ClN <sub>3</sub>	54-05-7	319.872		90				
2296	2-Chloroquinoline		C <sub>9</sub> H <sub>6</sub> ClN	612-62-4	163.604	nd (aq al)	38	266; 153 <sup>22</sup>	1.2464 <sup>25</sup>	1.6342 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, chl
2297	4-Chloroquinoline		C <sub>9</sub> H <sub>6</sub> ClN	611-35-8	163.604	cry	34.5	262; 130 <sup>15</sup>	1.251 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s dil HCl
2298	6-Chloroquinoline		C <sub>9</sub> H <sub>6</sub> ClN	612-57-7	163.604	pr (eth), nd (al)	43.8	263		1.6110 <sup>56</sup>	
2299	8-Chloroquinoline		C <sub>9</sub> H <sub>6</sub> ClN	611-33-6	163.604	liq	-20	288.5	1.2834 <sup>14</sup>	1.6408 <sup>14</sup>	s H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
2300	5-Chloro-8-quinolinol	Cloxyquin	C <sub>9</sub> H <sub>6</sub> ClNO	130-16-5	179.603	cry (al)	130				
2301	2-Chlorostyrene		C <sub>8</sub> H <sub>7</sub> Cl	2039-87-4	138.595	liq	-63.1	188.7	1.1000 <sup>20</sup>	1.5649 <sup>20</sup>	s EtOH, eth, ace, ctc, HOAc; msc peth
2302	3-Chlorostyrene		C <sub>8</sub> H <sub>7</sub> Cl	2039-85-2	138.595			63 <sup>6</sup>	1.1033 <sup>20</sup>	1.5625 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2303	4-Chlorostyrene		C <sub>8</sub> H <sub>7</sub> Cl	1073-67-2	138.595		15.9	192	1.0868 <sup>20</sup>	1.5660 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, ctc
2304	<i>N</i> -Chlorosuccinimide		C <sub>4</sub> H <sub>4</sub> ClNO <sub>2</sub>	128-09-6	133.534	pl (CCl <sub>4</sub> )	150		1.65 <sup>25</sup>		sl H <sub>2</sub> O, EtOH, bz, lig; s ace, HOAc
2305	1-Chlorotetradecane		C <sub>14</sub> H <sub>29</sub> Cl	2425-54-9	232.833		4.9	296.8	0.8654 <sup>20</sup>	1.4474 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, chl; vs ace, bz; sl ctc
2306	6-Chloro- <i>N,N,N',N'</i> -tetraethyl-1,3,5-triazine-2,4-diamine		C <sub>11</sub> H <sub>20</sub> ClN <sub>3</sub>	580-48-3	257.764	oily liq	27	155 <sup>9</sup>	1.0956 <sup>20</sup>	1.5320 <sup>20</sup>	vs bz, chl, EtOH, lig
2307	1-Chloro-1,1,2,2-tetrafluoroethane		C <sub>2</sub> HClF <sub>4</sub>	354-25-6	136.476	col gas	-117	-11.7			
2308	1-Chloro-1,2,2,2-tetrafluoroethane		C <sub>2</sub> HClF <sub>4</sub>	2837-89-0	136.476	col gas		-12			
2309	Chlorothalonil		C <sub>8</sub> Cl <sub>4</sub> N <sub>2</sub>	1897-45-6	265.911		250	350	1.7 <sup>25</sup>		i H <sub>2</sub> O; sl ace, cyhex
2310	Chlorothen	Chloromethapyrilene	C <sub>14</sub> H <sub>16</sub> ClN <sub>2</sub> S	148-65-2	295.831			155 <sup>10</sup> , 192 <sup>5</sup>	1.1751 <sup>25</sup>		
2311	Chlorothiazide		C <sub>7</sub> H <sub>6</sub> ClN <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	58-94-6	295.724		350 dec				
2312	2-Chlorothiophene	2-Thienyl chloride	C <sub>4</sub> H <sub>3</sub> ClS	96-43-5	118.585	liq	-71.9	128.3	1.2863 <sup>20</sup>	1.5487 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl chl
2313	5-Chloro-2-thiophenecarboxaldehyde		C <sub>6</sub> H <sub>3</sub> ClOS	7283-96-7	146.595			77.5 <sup>5</sup>		1.6036 <sup>25</sup>	sl chl
2314	2-Chloro-9 <i>H</i> -thioxanthen-9-one		C <sub>13</sub> H <sub>7</sub> ClOS	86-39-5	246.712		153.5				
2315	2-Chlorotoluene		C <sub>7</sub> H <sub>7</sub> Cl	95-49-8	126.584	liq	-35.8	159.0	1.0825 <sup>20</sup>	1.5268 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz; msc eth, ace, chl
2316	3-Chlorotoluene		C <sub>7</sub> H <sub>7</sub> Cl	108-41-8	126.584	liq	-47.8	161.8	1.075 <sup>20</sup>	1.5214 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc, chl; msc eth
2317	4-Chlorotoluene		C <sub>7</sub> H <sub>7</sub> Cl	106-43-4	126.584		7.5	162.4	1.0697 <sup>20</sup>	1.5150 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc, chl; msc eth
2318	6-Chloro-1,3,5-triazine-2,4-diamine		C <sub>3</sub> H <sub>4</sub> ClN <sub>3</sub>	3397-62-4	145.551		>330				
2319	1-Chloro-2-(trichloromethyl)benzene		C <sub>7</sub> H <sub>4</sub> Cl <sub>4</sub>	2136-89-2	229.919		29.4	264.3	1.5187 <sup>20</sup>	1.5836 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace; sl ctc
2320	1-Chloro-4-(trichloromethyl)benzene		C <sub>7</sub> H <sub>4</sub> Cl <sub>4</sub>	5216-25-1	229.919			245	1.4463 <sup>20</sup>		vs ace, eth
2321	Chlorotriethoxysilane		C <sub>6</sub> H <sub>15</sub> ClO <sub>3</sub> Si	4667-99-6	198.720	liq	-51	156	1.030 <sup>20</sup>	1.3999 <sup>20</sup>	vs EtOH
2322	Chlorotriethylplumbane	Lead triethyl chloride	C <sub>6</sub> H <sub>15</sub> ClPb	1067-14-7	329.8		123 dec				s H <sub>2</sub> O
2323	Chlorotriethylsilane		C <sub>6</sub> H <sub>15</sub> ClSi	994-30-9	150.722			144.5	0.8967 <sup>20</sup>	1.4314 <sup>20</sup>	
2324	1-Chloro-1,1,2-trifluoroethane		C <sub>2</sub> H <sub>2</sub> ClF <sub>3</sub>	421-04-5	118.485	vol liq or gas		12			
2325	1-Chloro-1,2,2-trifluoroethane		C <sub>2</sub> H <sub>2</sub> ClF <sub>3</sub>	431-07-2	118.485	vol liq or gas		17.3			
2326	2-Chloro-1,1,1-trifluoroethane		C <sub>2</sub> H <sub>2</sub> ClF <sub>3</sub>	75-88-7	118.485	col gas	-105.5	6.1	1.389 <sup>0</sup>	1.3090 <sup>0</sup>	
2327	Chlorotrifluoroethene	Chlorotrifluoroethylene	C <sub>2</sub> ClF <sub>3</sub>	79-38-9	116.469	col gas	-158.2	-27.8	1.54 <sup>60</sup>	1.38 <sup>0</sup>	s bz, chl
2328	Chlorotrifluoromethane	Refrigerant 13	CClF <sub>3</sub>	75-72-9	104.459	col gas	-181.2	-81.4			i H <sub>2</sub> O
2329	2-Chloro-5-(trifluoromethyl)aniline		C <sub>7</sub> H <sub>5</sub> ClF <sub>3</sub> N	121-50-6	195.570			103 <sup>25</sup>	1.428 <sup>25</sup>	1.4975 <sup>20</sup>	
2330	4-Chloro-3-(trifluoromethyl)aniline		C <sub>7</sub> H <sub>5</sub> ClF <sub>3</sub> N	320-51-4	195.570		36.5	132 <sup>27</sup>			
2331	1-Chloro-2-(trifluoromethyl)benzene	<i>o</i> -Chlorobenzotrifluoride	C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	88-16-4	180.555	liq	-6	152.2	1.2540 <sup>30</sup>	1.4513 <sup>25</sup>	s chl
2332	1-Chloro-3-(trifluoromethyl)benzene	<i>m</i> -Chlorobenzotrifluoride	C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	98-15-7	180.555	liq	-56	137.5	1.3311 <sup>25</sup>	1.4438 <sup>25</sup>	



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2333	1-Chloro-4-(trifluoromethyl)benzene	<i>p</i> -Chlorobenzotrifluoride	C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	98-56-6	180.555	liq	-33	138.5	1.3340 <sup>25</sup>	1.4431 <sup>30</sup>	
2334	3-Chloro-1,1,1-trifluoropropane		C <sub>3</sub> H <sub>2</sub> ClF <sub>3</sub>	460-35-5	132.512	liq	-106.5	45.1	1.3253 <sup>20</sup>	1.3350 <sup>20</sup>	i H <sub>2</sub> O
2335	2-Chloro-2,4,4-trimethylpentane		C <sub>9</sub> H <sub>17</sub> Cl	6111-88-2	148.674		-26	dec 147; 44 <sup>16</sup>	0.8746 <sup>20</sup>	1.4308 <sup>20</sup>	vs EtOH
2336	Chlorotrimethylstannane		C <sub>3</sub> H <sub>9</sub> ClSn	1066-45-1	199.266		38.5	148			s H <sub>2</sub> O, chl, os
2337	2-Chloro-1,3,5-trinitrobenzene	Picryl chloride	C <sub>6</sub> H <sub>2</sub> ClN <sub>3</sub> O <sub>6</sub>	88-88-0	247.549	wh nd or pl (chl, al-lig)	83		1.797 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, bz, sl eth; vs ace, tol
2338	Chlorotrinitromethane		CClN <sub>3</sub> O <sub>6</sub>	1943-16-4	185.480		2.3	dec 134; 56 <sup>40</sup>	1.6769 <sup>20</sup>	1.4500 <sup>20</sup>	vs eth, EtOH, chl
2339	Chlorotriphenylmethane		C <sub>19</sub> H <sub>15</sub> Cl	76-83-5	278.775	nd or pr (bz- peth)	113.5	310			i H <sub>2</sub> O; sl EtOH; vs eth, bz, chl; s ace
2340	Chlorotriphenylsilane		C <sub>18</sub> H <sub>15</sub> ClSi	76-86-8	294.851			241 <sup>35</sup>			
2341	Chlorotriphenylstannane	Triphenyltin chloride	C <sub>18</sub> H <sub>15</sub> ClSn	639-58-7	385.475		103.5				s chl
2342	Chlorotripropylstannane		C <sub>9</sub> H <sub>21</sub> ClSn	2279-76-7	283.426		-23.5	123 <sup>13</sup>	1.2678 <sup>28</sup>	1.49102 <sup>28</sup>	s ctc, os
2343	Chlorovinyl dimethylsilane		C <sub>4</sub> H <sub>9</sub> ClSi	1719-58-0	120.653			83.5	0.8744 <sup>20</sup>	1.4141 <sup>20</sup>	
2344	Chloroxuron	<i>N</i> '-[4-(4-Chlorophenoxy)phenyl]- <i>N,N</i> -dimethylurea	C <sub>15</sub> H <sub>13</sub> ClN <sub>2</sub> O <sub>2</sub>	1982-47-4	290.745		151				
2345	Chlorozotocin		C <sub>9</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>7</sub>	54749-90-5	313.692	cry	147	dec			s H <sub>2</sub> O
2346	Chlorphenesin carbamate		C <sub>10</sub> H <sub>12</sub> ClNO <sub>4</sub>	886-74-8	245.660	cry (bz)	90				vs ace, EtOH, diox
2347	Chlorpheniramine		C <sub>16</sub> H <sub>19</sub> ClN <sub>2</sub>	132-22-9	274.788	oily liq		142 <sup>1</sup>			
2348	Chlorpheniramine maleate	Chloroprophenpyridamine	C <sub>20</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>4</sub>	113-92-8	390.861		132.5				
2349	Chlorphentermine	2-(4-Chlorobenzyl)-2-propylamine	C <sub>10</sub> H <sub>14</sub> ClN	461-78-9	183.678	liq		231; 101 <sup>2</sup>			
2350	Chlorpromazine	2-Chloro- <i>N,N</i> -dimethyl-10 <i>H</i> -phenothiazine-10-propanamine	C <sub>17</sub> H <sub>19</sub> ClN <sub>2</sub> S	50-53-3	318.864			202 <sup>0,8</sup>			i H <sub>2</sub> O; vs EtOH, eth, bz, chl; s dil HCl
2351	Chlorprothixene		C <sub>18</sub> H <sub>18</sub> ClNS	113-59-7	315.861	pale ye cry	97				i H <sub>2</sub> O, EtOH, eth, chl
2352	Chlorpyrifos		C <sub>9</sub> H <sub>11</sub> Cl <sub>3</sub> NO <sub>3</sub> PS	2921-88-2	350.586		42				
2353	Chlorpyrifos-methyl		C <sub>7</sub> H <sub>7</sub> Cl <sub>3</sub> NO <sub>3</sub> PS	5598-13-0	322.534		43				
2354	Chlorsulfuron		C <sub>12</sub> H <sub>12</sub> ClN <sub>2</sub> O <sub>4</sub> S	64902-72-3	357.773		176				
2355	Chlortetracycline		C <sub>22</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>6</sub>	57-62-5	478.879	gold-ye	168.5				i H <sub>2</sub> O, eth; sl EtOH, ace, bz; s diox
2356	Chlorthalidone		C <sub>14</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>4</sub> S	77-36-1	338.765	wh pow or cry	225	dec			s alk, EtOH; sl eth
2357	Chlorthion		C <sub>8</sub> H <sub>9</sub> ClNO <sub>3</sub> PS	500-28-7	297.653	ye cry	21	125 <sup>0,1</sup>	1.437 <sup>20</sup>	1.5661 <sup>20</sup>	i H <sub>2</sub> O; vs bz, eth, EtOH
2358	Chlorthiophos		C <sub>11</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>3</sub> PS <sub>2</sub>	21923-23-9	361.245			150 <sup>0,001</sup>			
2359	Chlortoluron	<i>N</i> '-(3-Chloro-4-methylphenyl)- <i>N,N</i> -dimethylurea	C <sub>10</sub> H <sub>13</sub> ClN <sub>2</sub> O	15545-48-9	212.675	cry	147				sl H <sub>2</sub> O; s os
2360	Cholane		C <sub>24</sub> H <sub>42</sub>	548-98-1	330.590	pr (al)	90	190 <sup>0,001</sup>			
2361	Cholan-24-oic acid	Cholanic acid	C <sub>24</sub> H <sub>40</sub> O <sub>2</sub>	25312-65-6	360.574	nd (al), cry (HOAc)	163.5				s EtOH, chl, HOAc
2362	Cholesta-3,5-diene		C <sub>27</sub> H <sub>44</sub>	747-90-0	368.638	wh nd (al)	80	260 <sup>13</sup>	0.925 <sup>100</sup>		i H <sub>2</sub> O; s EtOH; msc eth, bz, chl; vs lig
2363	Cholesta-5,7-dien-3-ol, (3β)	7-Dehydrocholesterol	C <sub>27</sub> H <sub>44</sub> O	434-16-2	384.637	pl (+1w), (eth- MeOH)	150.5				i H <sub>2</sub> O; sl EtOH; s eth, ace
2364	Cholesta-8,24-dien-3-ol, (3β,5α)		C <sub>27</sub> H <sub>44</sub> O	128-33-6	384.637	pl (MeOH) ,nd	110	160 <sup>0,001</sup>			s ace, chl, MeOH
2365	Cholestane, (5α)	28,29,30-Trinorlanostane	C <sub>27</sub> H <sub>48</sub>	481-21-0	372.670	sc or pl (eth- al, ace)	80	250 <sup>1</sup>	0.9090 <sup>88</sup>	1.4887 <sup>88</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, bz, chl
2366	Cholestane, (5β)	Coprostanane	C <sub>27</sub> H <sub>48</sub>	481-20-9	372.670	orth nd (al, ace)	72		0.9119 <sup>87</sup>	1.4884 <sup>88</sup>	vs eth, chl
2367	Cholestanol	Dihydrocholesterol	C <sub>27</sub> H <sub>48</sub> O	80-97-7	388.669	sc (al,+1w)	141.5				vs eth, chl
2368	Cholestan-3-ol, (3α,5α)	Epicholestanol	C <sub>27</sub> H <sub>48</sub> O	516-95-0	388.669	nd (al)	185.5				s chl
2369	Cholest-4-en-3-ol, (3β)	Allocholesterol	C <sub>27</sub> H <sub>46</sub> O	517-10-2	386.653	nd (eth- MeOH)	132				i H <sub>2</sub> O; s EtOH; vs eth, ace, bz, chl
2370	Cholest-5-en-3-ol, (3α)	Epicholesterol	C <sub>27</sub> H <sub>46</sub> O	474-77-1	386.653	cry (al, chl- MeOH)	141.5				sl EtOH
2371	Cholest-5-en-3-ol (3β), acetate		C <sub>29</sub> H <sub>48</sub> O <sub>2</sub>	604-35-3	428.690	wh nd (ace, al)	115.5				vs bz, eth, chl
2372	Cholest-5-en-3-ol (3β), benzoate		C <sub>34</sub> H <sub>50</sub> O <sub>2</sub>	604-32-0	490.760	wh nd	151.3		0.9413 <sup>200</sup>		i EtOH; s eth, chl
2373	Cholest-5-en-3-ol (3β)-, hexadecanoate		C <sub>43</sub> H <sub>76</sub> O <sub>2</sub>	601-34-3	625.062	wh nd (eth al)	79.3				vs bz, chl
2374	Cholest-5-en-3-ol (3β)-, <i>cis</i> -9-octadecenoate		C <sub>45</sub> H <sub>78</sub> O <sub>2</sub>	303-43-5	651.100		46.3				s chl



1-Chloro-4-(trifluoromethyl)benzene



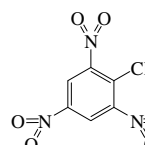
3-Chloro-1,1,1-trifluoropropane



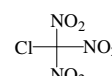
2-Chloro-2,4,4-trimethylpentane



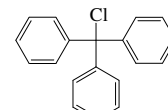
Chlorotrimethylstannane



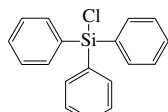
2-Chloro-1,3,5-trinitrobenzene



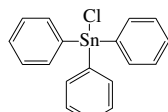
Chlorotrinitromethane



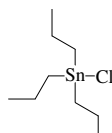
Chlorotriphenylmethane



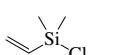
Chlorotriphenylsilane



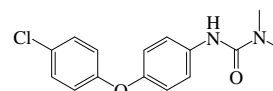
Chlorotriphenylstannane



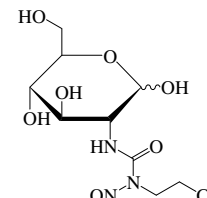
Chlorotripropylstannane



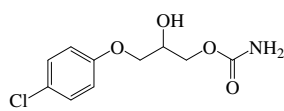
Chlorovinylidimethylsilane



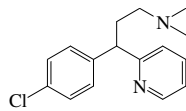
Chloroxuron



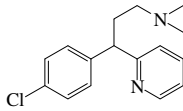
Chlorozotocin



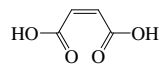
Chlorphenesin carbamate



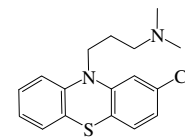
Chlorpheniramine



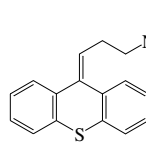
Chlorpheniramine maleate



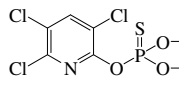
Chlorphentermine



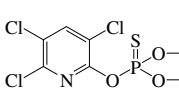
Chlorpromazine



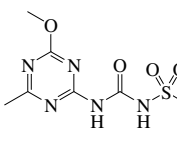
Chlorprothixene



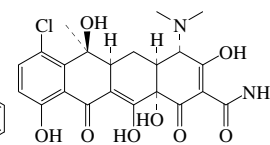
Chlorpyrifos



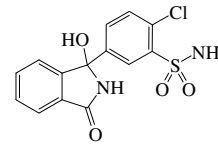
Chlorpyrifos-methyl



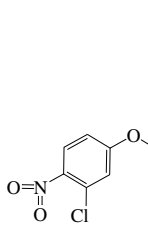
Chlorsulfuron



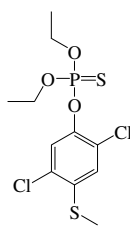
Chlortetracycline



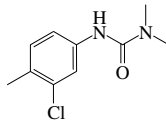
Chlorthalidone



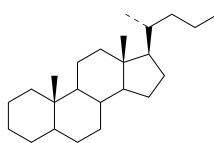
Chlorthion



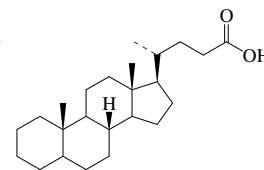
Chlorthiophos



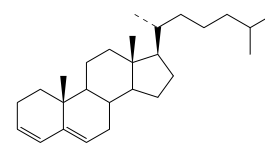
Chlortoluron



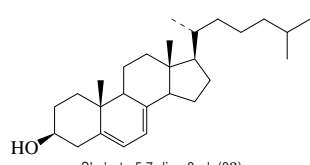
Cholane



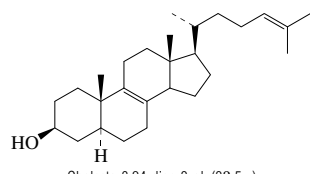
Cholan-24-oic acid



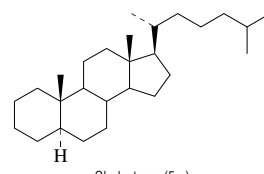
Cholesta-3,5-diene



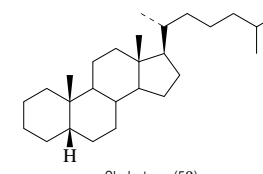
Cholesta-5,7-dien-3-ol, (3β)



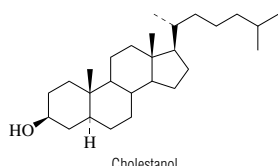
Cholesta-8,24-dien-3-ol, (3β,5α)



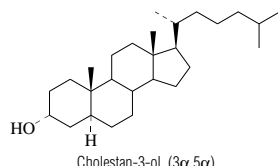
Cholestane, (5α)



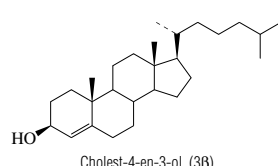
Cholestane, (3β)



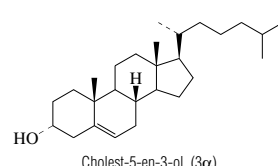
Cholestanol



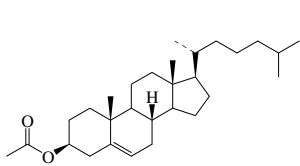
Cholestan-3-ol, (3α,5α)



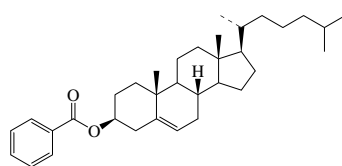
Cholest-4-en-3-ol, (3β)



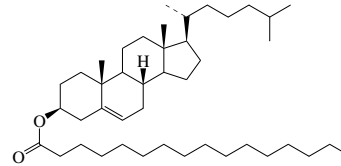
Cholest-5-en-3-ol, (3α)



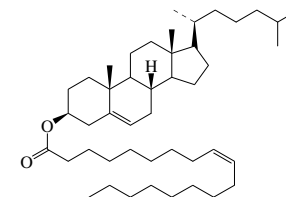
Cholest-5-en-3-ol (3β), acetate



Cholest-5-en-3-ol (3β), benzoate



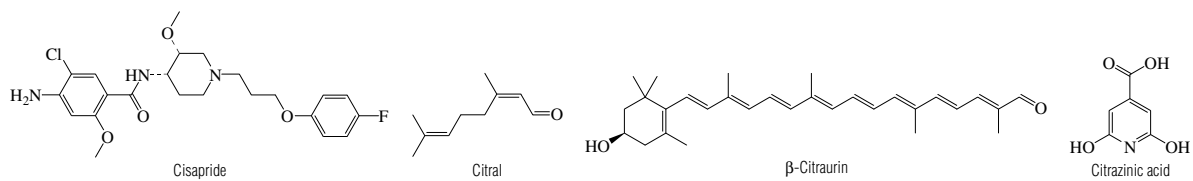
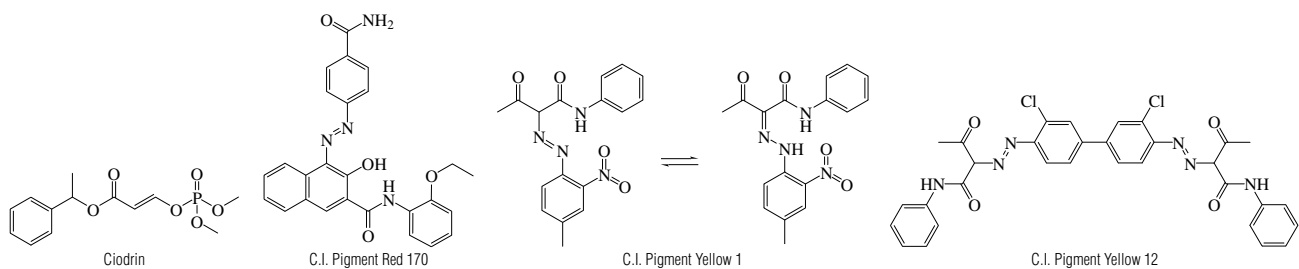
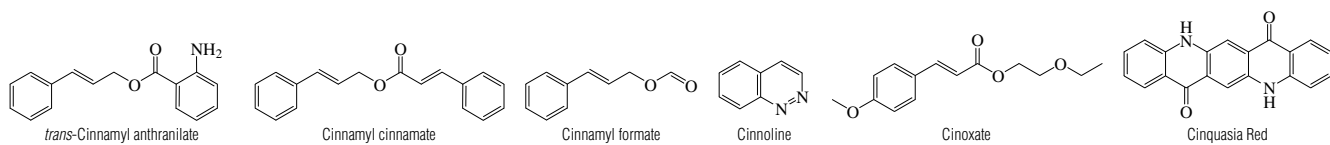
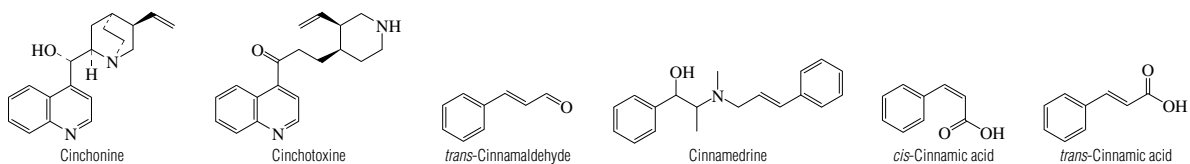
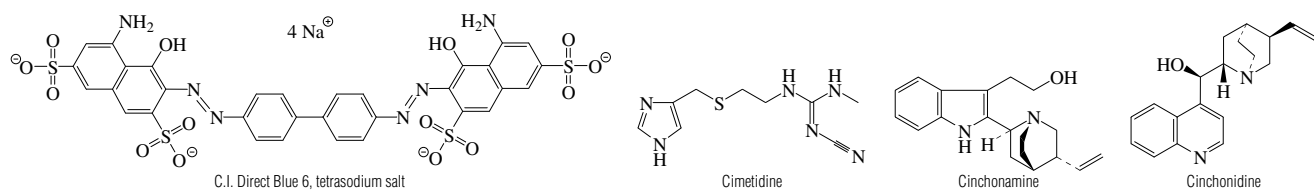
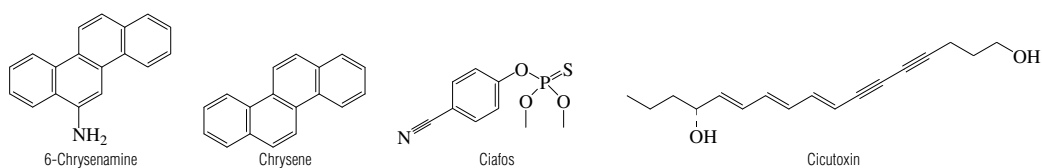
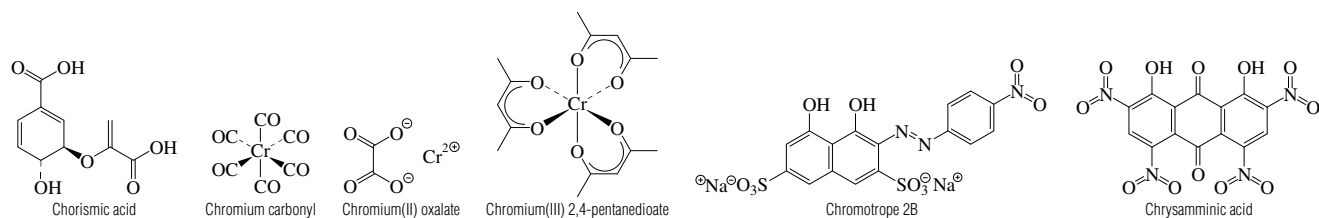
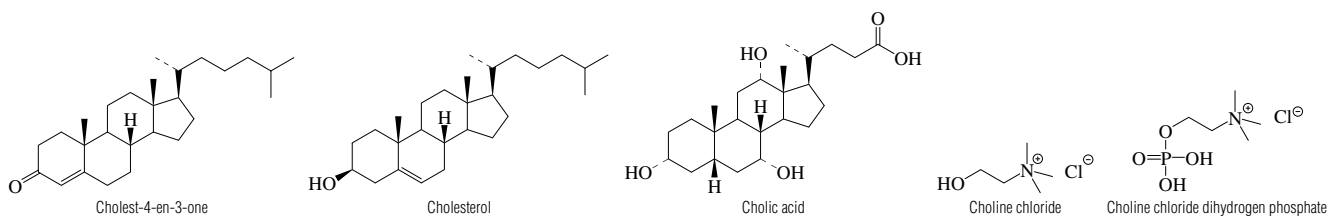
Cholest-5-en-3-ol (3β)-, hexadecanoate



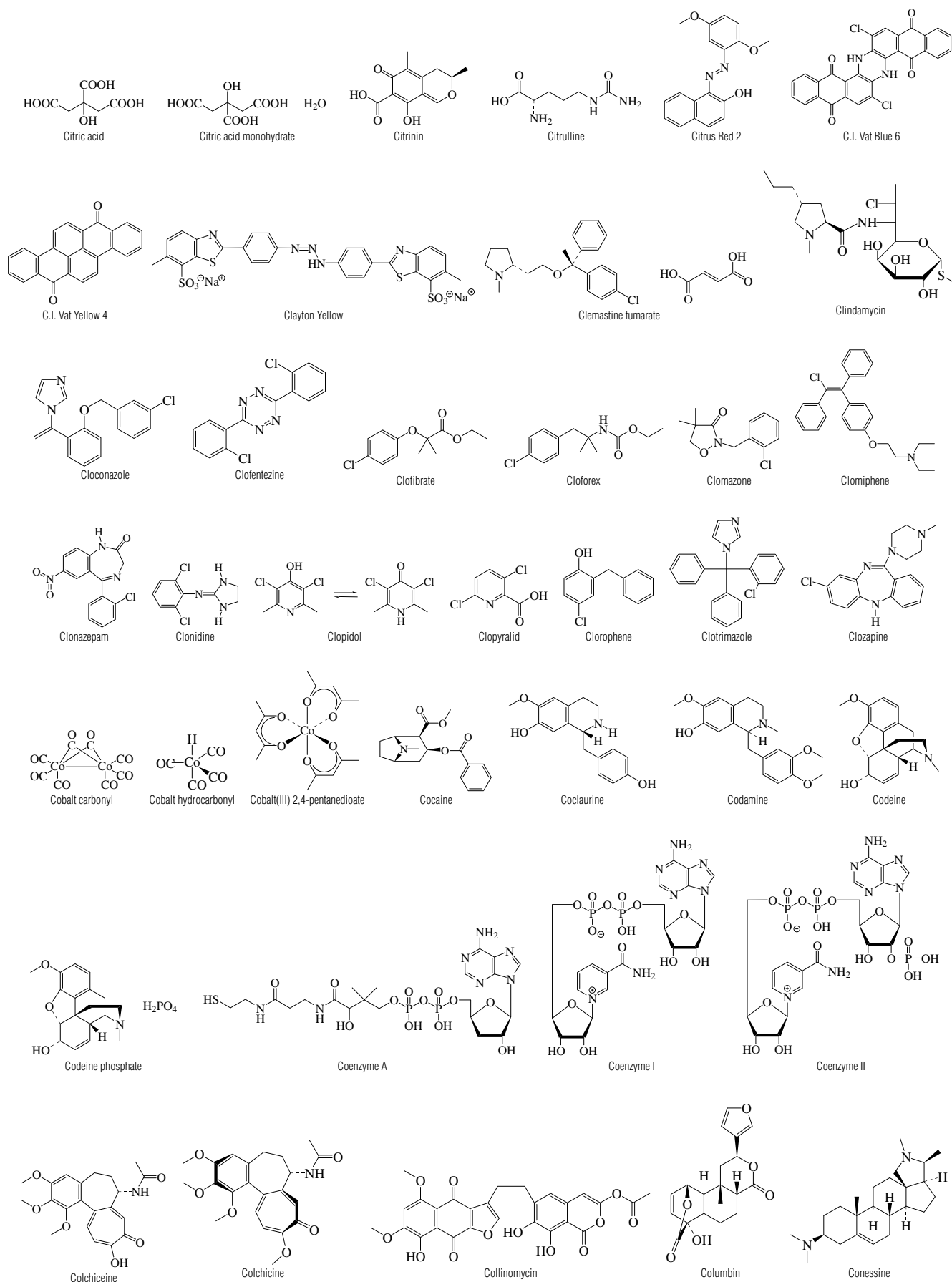
Cholest-5-en-3-ol (3β)-, cis-9-octadecenoate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2375	Cholest-4-en-3-one		C <sub>27</sub> H <sub>44</sub> O	601-57-0	384.637	nd or pl (al)	81.5	245 <sup>0.03</sup>			
2376	Cholesterol		C <sub>27</sub> H <sub>46</sub> O	57-88-5	386.653	orth or tcl lf (al) nd (eth)	148.5	dec 360; 233 <sup>0.5</sup>	1.067 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, ace; s bz, HOAc; vs diox
2377	Cholic acid	3,7,12-Trihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,7 $\alpha$ ,12 $\alpha$ )	C <sub>24</sub> H <sub>40</sub> O <sub>5</sub>	81-25-4	408.572		198				sl H <sub>2</sub> O; s EtOH, ace, alk; vs eth, chl
2378	Choline chloride		C <sub>5</sub> H <sub>14</sub> ClNO	67-48-1	139.624	hyg cry	305 dec				vs H <sub>2</sub> O, EtOH
2379	Choline chloride dihydrogen phosphate	Phosphorylcholine	C <sub>5</sub> H <sub>15</sub> ClNO <sub>4</sub> P	107-73-3	219.605	visc liq					
2380	Chorismic acid		C <sub>10</sub> H <sub>10</sub> O <sub>6</sub>	617-12-9	226.182	cry	148				s H <sub>2</sub> O
2381	Chromium carbonyl		C <sub>6</sub> CrO <sub>6</sub>	13007-92-6	220.056	col orth cry	dec 130	sub	1.77		i H <sub>2</sub> O, EtOH; s eth, chl
2382	Chromium(II) oxalate		C <sub>2</sub> CrO <sub>4</sub>	814-90-4	140.015	ye-grn pow (hyd)					i H <sub>2</sub> O, EtOH; s dil acid
2383	Chromium(III) 2,4-pentanedioate	Chromium acetylacetonate	C <sub>15</sub> H <sub>21</sub> CrO <sub>6</sub>	21679-31-2	349.320	red mcl cry	208	345	1.34		i H <sub>2</sub> O; s bz
2384	Chromotrope 2B		C <sub>16</sub> H <sub>13</sub> N <sub>3</sub> Na <sub>2</sub> O <sub>10</sub> S <sub>2</sub>	548-80-1	513.366	red-br pow	300				s H <sub>2</sub> O; i EtOH
2385	Chrysaminic acid	1,8-Dihydroxy-2,4,5,7-tetranitro-9,10-anthracenedione	C <sub>14</sub> H <sub>4</sub> N <sub>4</sub> O <sub>12</sub>	517-92-0	420.202	ye pl or lf	exp	dec			vs eth, EtOH
2386	6-Chrysenamine	6-Aminochrysene	C <sub>18</sub> H <sub>13</sub> N	2642-98-0	243.303	lf (al)	210.5				
2387	Chrysene	Benzo[a]phenanthrene	C <sub>18</sub> H <sub>12</sub>	218-01-9	228.288	red bl fl or orth pl (bz, HOAc)	255.5	448	1.274 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, eth, ace, bz, CS <sub>2</sub> ; s tol
2388	Ciafos		C <sub>9</sub> H <sub>10</sub> NO <sub>3</sub> PS	2636-26-2	243.219	ye to red-ye liq	15	120 <sup>0.09</sup> dec		1.5404 <sup>32</sup>	sl H <sub>2</sub> O; vs chl, EtOH, ace, MeOH
2389	Cicutoxin	8,10,12-Heptadecatriene-4,6-diyne-1,14-diol	C <sub>17</sub> H <sub>22</sub> O <sub>2</sub>	505-75-9	258.356	pr (eth/peth)	54				s hot H <sub>2</sub> O, EtOH, eth, chl
2390	C.I. Direct Blue 6, tetrasodium salt	Direct Blue 6	C <sub>32</sub> H <sub>20</sub> N <sub>6</sub> Na <sub>4</sub> O <sub>14</sub> S <sub>4</sub>	2602-46-2	932.752	dk bronze pow					
2391	Cimetidine		C <sub>10</sub> H <sub>16</sub> N <sub>6</sub> S	51481-61-9	252.339	cry	142				
2392	Cinchonamine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O	482-28-0	296.406	orth nd (al) orth pr (MeOH)	186				i H <sub>2</sub> O; vs EtOH, eth; s bz, chl
2393	Cinchonidine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O	485-71-2	294.390	or pl or pr (al)	210.5	sub			i H <sub>2</sub> O, bz; s EtOH, chl, py; sl eth
2394	Cinchonine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O	118-10-5	294.390	pr nd (al, eth)	265				
2395	Cinchotoxine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O	69-24-9	294.390	nd or pr (eth)	59				i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
2396	trans-Cinnamaldehyde	3-Phenyl-2-propenal, (E)-	C <sub>9</sub> H <sub>8</sub> O	14371-10-9	132.159	ye liq	-7.5	246	1.0497 <sup>20</sup>	1.6195 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl; i lig
2397	Cinnamedrine	$\alpha$ -[1-[Methyl(3-phenylallyl)amino]ethyl]benzenemethanol	C <sub>19</sub> H <sub>23</sub> NO	90-86-8	281.392		75				
2398	cis-Cinnamic acid	3-Phenyl-2-propenoic acid, (Z)	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	102-94-3	148.159	mcl pr (w)	42				vs EtOH, HOAc, lig
2399	trans-Cinnamic acid	3-Phenyl-2-propenoic acid, (E)	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	140-10-3	148.159	mcl pr (dil al)	133	300	1.2475 <sup>4</sup>		i H <sub>2</sub> O, lig; vs EtOH; s eth, ace, bz
2400	trans-Cinnamyl anthranilate		C <sub>16</sub> H <sub>16</sub> NO <sub>2</sub>	87-29-6	253.296	cry	64				
2401	Cinnamyl cinnamate		C <sub>18</sub> H <sub>16</sub> O <sub>2</sub>	122-69-0	264.319	nd (al)	44		1.1565 <sup>4</sup>		i H <sub>2</sub> O; s EtOH, chl; vs eth
2402	Cinnamyl formate	3-Phenyl-2-propen-1-ol, formate	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	104-65-4	162.185		0	252	1.086 <sup>25</sup>		
2403	Cinnoline	1,2-Benzodiazine	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	253-66-7	130.147	pa ye cry (lig)	38	114 <sup>0.3</sup>			vs eth, EtOH
2404	Cinoxate	3-(4-Methoxyphenyl)-2-propenoic acid, 2-ethoxyethyl ester	C <sub>14</sub> H <sub>18</sub> O <sub>4</sub>	104-28-9	250.291	col liq	-25	185 <sup>2</sup>	1.102 <sup>25</sup>	1.567 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH
2405	Cinquasia Red	Quinacridone	C <sub>20</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	1047-16-1	312.321	red-viol cry	390				i H <sub>2</sub> O, os
2406	Ciodrin		C <sub>14</sub> H <sub>19</sub> O <sub>6</sub> P	7700-17-6	314.271			135 <sup>0.03</sup>	1.19 <sup>25</sup>		
2407	C.I. Pigment Red 170		C <sub>26</sub> H <sub>22</sub> N <sub>4</sub> O <sub>4</sub>	2786-76-7	454.478	red solid					
2408	C.I. Pigment Yellow 1		C <sub>17</sub> H <sub>16</sub> N <sub>4</sub> O <sub>4</sub>	2512-29-0	340.334	ye cry	256				
2409	C.I. Pigment Yellow 12		C <sub>22</sub> H <sub>26</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>4</sub>	6358-85-6	629.492	ye cry	317				
2410	Cisapride		C <sub>23</sub> H <sub>25</sub> ClFN <sub>3</sub> O <sub>4</sub>	81098-60-4	465.945	cry (hp)	132				
2411	Citral	3,7-Dimethyl-2,6-octadienal	C <sub>10</sub> H <sub>16</sub> O	5392-40-5	152.233			228.3	0.8888 <sup>20</sup>	1.4898 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
2412	$\beta$ -Citral		C <sub>30</sub> H <sub>40</sub> O <sub>2</sub>	650-69-1	432.638	pl (bz-peth), cry (al)	147				i H <sub>2</sub> O; vs EtOH, eth, ace, bz; sl lig
2413	Citrazinic acid	1,2-Dihydro-6-hydroxy-2-oxo-4-pyridinecarboxylic acid	C <sub>6</sub> H <sub>5</sub> NO <sub>4</sub>	99-11-6	155.109	ye pow	>300 dec				s H <sub>2</sub> O, alk; sl HCl

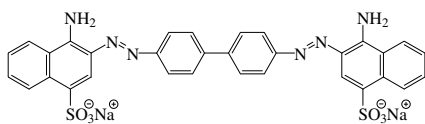




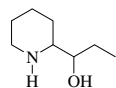
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2414	Citric acid	2-Hydroxy-1,2,3-propanetricarboxylic acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	77-92-9	192.124	orth (w+1)	153	dec	1.665 <sup>20</sup>		vs H <sub>2</sub> O, EtOH; s eth, AcOEt; i bz, chl
2415	Citric acid monohydrate	2-Hydroxy-1,2,3-propanetricarboxylic acid, monohydrate	C <sub>6</sub> H <sub>10</sub> O <sub>8</sub>	5949-29-1	210.138	cry (w)	135		1.542		vs H <sub>2</sub> O; vs EtOH, eth
2416	Citrinin	Antimycin	C <sub>13</sub> H <sub>14</sub> O <sub>5</sub>	518-75-2	250.247	ye nd (MeOH)	178	dec			i H <sub>2</sub> O; sl EtOH, eth; s ace, bz
2417	Citrulline	MS-(Aminocarbonyl)-L-ornithine	C <sub>6</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub>	372-75-8	175.185	pr (aq MeOH)	222				s H <sub>2</sub> O; i EtOH, MeOH
2418	Citrus Red 2		C <sub>18</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	6358-53-8	308.331	cry	156				sl H <sub>2</sub> O; s EtOH
2419	C.I. Vat Blue 6	7,16-Dichloro-6,15-dihydro-5,9,14,18-anthrazinetetrone	C <sub>28</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	130-20-1	511.312	viol-bl pow					
2420	C.I. Vat Yellow 4	Anthanthrone	C <sub>24</sub> H <sub>12</sub> O <sub>2</sub>	128-66-5	332.351	ye cry					
2421	Clayton Yellow	Thiazol Yellow G	C <sub>28</sub> H <sub>18</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>6</sub> S <sub>4</sub>	1829-00-1	695.721	ye-br pow					s H <sub>2</sub> O, EtOH, H <sub>2</sub> SO <sub>4</sub>
2422	Clemastine fumarate		C <sub>25</sub> H <sub>30</sub> ClNO <sub>5</sub>	14976-57-9	459.963			181			
2423	Clindamycin		C <sub>18</sub> H <sub>33</sub> ClN <sub>2</sub> O <sub>5</sub> S	18323-44-9	424.983	ye amorp solid					s EtOAc
2424	Cloconazole		C <sub>18</sub> H <sub>15</sub> ClN <sub>2</sub> O	77175-51-0	310.777		73				
2425	Clofentazine	3,6-Bis(2-chlorophenyl)-1,2,4,5-tetrazine	C <sub>14</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>4</sub>	74115-24-5	303.147		182				
2426	Clofibrate		C <sub>12</sub> H <sub>15</sub> ClO <sub>3</sub>	637-07-0	242.698			149 <sup>20</sup>			
2427	Cloforex		C <sub>13</sub> H <sub>18</sub> ClNO <sub>2</sub>	14261-75-7	255.741	cry	52.8	89 <sup>005</sup>			
2428	Clomazone	2-(2-Chlorobenzyl)-4,4-dimethyl-1,2-oxazolidin-3-one	C <sub>12</sub> H <sub>14</sub> ClNO <sub>2</sub>	81777-89-1	239.698				1.192 <sup>20</sup>		
2429	Clomiphene		C <sub>26</sub> H <sub>28</sub> ClNO	911-45-5	405.959		117				
2430	Clonazepam		C <sub>15</sub> H <sub>10</sub> ClN <sub>3</sub> O <sub>3</sub>	1622-61-3	315.711	wh cry	237.5				i H <sub>2</sub> O, bz; sl ace, MeOH, chl
2431	Clonidine		C <sub>9</sub> H <sub>9</sub> Cl <sub>2</sub> N <sub>3</sub>	4205-90-7	230.093	cry	137				
2432	Clopidol		C <sub>7</sub> H <sub>7</sub> Cl <sub>2</sub> NO	2971-90-6	192.043	pow	>320				i H <sub>2</sub> O
2433	Clopyralid	3,6-Dichloro-2-pyridinecarboxylic acid	C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	1702-17-6	192.000		151				
2434	Clorophene		C <sub>13</sub> H <sub>11</sub> ClO	120-32-1	218.678		48.5	161 <sup>3.5</sup>	1.185 <sup>58</sup>		s ctc, CS <sub>2</sub>
2435	Clotrimazole		C <sub>22</sub> H <sub>17</sub> ClN <sub>2</sub>	23593-75-1	344.836	cry	148				sl H <sub>2</sub> O, bz; s ace, chl, AcOEt, DMF
2436	Clozapine	Clozaril	C <sub>18</sub> H <sub>19</sub> ClN <sub>4</sub>	5786-21-0	326.824	ye cry	183.5				
2437	Cobalt carbonyl	Dicobalt octacarbonyl	C <sub>8</sub> Co <sub>2</sub> O <sub>8</sub>	10210-68-1	341.947	oran cry	51	dec	1.78		i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
2438	Cobalt hydrocarbonyl	Tetracarbonylhydrocobalt	C <sub>4</sub> HCoO <sub>4</sub>	16842-03-8	171.982	ye liq or gas	≈-30	10			s os
2439	Cobalt(III) 2,4-pentanedioate	Cobalt(III) acetylacetonate	C <sub>15</sub> H <sub>21</sub> CoO <sub>6</sub>	21679-46-9	356.257		240				
2440	Cocaine		C <sub>17</sub> H <sub>21</sub> NO <sub>4</sub>	50-36-2	303.354	mcl pr (al)	98	187 <sup>0.1</sup>		1.5022 <sup>98</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz, py; s CS <sub>2</sub>
2441	Coclaurine		C <sub>17</sub> H <sub>19</sub> NO <sub>3</sub>	486-39-5	285.338	pl (al)	220.5				
2442	Codamine		C <sub>20</sub> H <sub>28</sub> NO <sub>4</sub>	21040-59-5	343.418	pr (bz, eth)	127				vs eth, EtOH, chl
2443	Codeine		C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	76-57-3	299.365	orth cry (w, dil al, eth)	157.5	250 <sup>22</sup> , 140 <sup>1.5</sup>	1.32 <sup>25</sup>		s H <sub>2</sub> O, eth, bz, chl, tol; vs EtOH; i peth
2444	Codeine phosphate		C <sub>18</sub> H <sub>24</sub> NO <sub>7</sub> P	52-28-8	397.361	lf or pr (dil al)	227	dec			vs EtOH, chl
2445	Coenzyme A		C <sub>21</sub> H <sub>36</sub> N <sub>7</sub> O <sub>16</sub> P <sub>3</sub> S	85-61-0	767.535	pow; unstab in air					s H <sub>2</sub> O
2446	Coenzyme I	Nicotinamide adenine dinucleotide	C <sub>21</sub> H <sub>27</sub> N <sub>7</sub> O <sub>14</sub> P <sub>2</sub>	53-84-9	663.425	hyg pow					s H <sub>2</sub> O
2447	Coenzyme II	Nicotinamide adenine dinucleotide phosphate	C <sub>21</sub> H <sub>28</sub> N <sub>7</sub> O <sub>17</sub> P <sub>3</sub>	53-59-8	743.405	gray-wh pow					s H <sub>2</sub> O
2448	Colchicine		C <sub>21</sub> H <sub>23</sub> NO <sub>6</sub>	477-27-0	385.411	pa ye nd (diox)	178.5		1.24 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, chl; i eth, bz
2449	Colchicine		C <sub>22</sub> H <sub>25</sub> NO <sub>6</sub>	64-86-8	399.437	ye pl (w + 1/2) ye cry (bz)	156				vs H <sub>2</sub> O, EtOH
2450	Colistin A		C <sub>53</sub> H <sub>100</sub> N <sub>16</sub> O <sub>13</sub>	7722-44-3	1169.47	amorp pow					sl H <sub>2</sub> O, EtOH, hx; s acids, MeOH
2451	Collinomycin		C <sub>27</sub> H <sub>20</sub> O <sub>12</sub>	27267-69-2	536.441	oran pr (chl-MeOH)	281				vs ace, diox, chl
2452	Columbin		C <sub>20</sub> H <sub>22</sub> O <sub>6</sub>	546-97-4	358.385	nd (MeOH)	195.5				i H <sub>2</sub> O; sl ace, AcOEt, MeOH; s chl
2453	Conessine		C <sub>24</sub> H <sub>40</sub> N <sub>2</sub>	546-06-5	356.588	lf or pl (ace)	125.5	166 <sup>0.1</sup>			sl H <sub>2</sub> O; s chl, HOAc



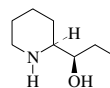
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2454	Congo Red		C <sub>32</sub> H <sub>22</sub> N <sub>6</sub> Na <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	573-58-0	696.663	pow	>360				sl H <sub>2</sub> O; s EtOH; i eth
2455	Conhydrine		C <sub>8</sub> H <sub>17</sub> NO	3238-62-8	143.227	nd (peth)	121	226			sl H <sub>2</sub> O; vs bz, eth, EtOH
2456	Conhydrine, (+)	2-( $\alpha$ -Hydroxypropyl)piperidine	C <sub>8</sub> H <sub>17</sub> NO	495-20-5	143.227	lf (eth)	121	226			sl H <sub>2</sub> O; vs eth, EtOH, chl
2457	Coniferin		C <sub>16</sub> H <sub>22</sub> O <sub>8</sub>	531-29-3	342.341	nd (w+2)	186				s H <sub>2</sub> O, py; sl EtOH; i eth
2458	Conquinamine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	464-86-8	312.406	ye tetr	123				sl H <sub>2</sub> O; s EtOH, eth, chl
2459	Convallatoxin		C <sub>29</sub> H <sub>42</sub> O <sub>10</sub>	508-75-8	550.637	pr (eth/MeOH)	238				s EtOH, ace; sl chl; i eth
2460	Copaene		C <sub>15</sub> H <sub>24</sub>	3856-25-5	204.352			248.5	0.8996 <sup>20</sup>	1.4894 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, HOAc, lig
2461	Copper(II) ethylacetoacetate	Bis(ethylacetoacetato)copper	C <sub>12</sub> H <sub>16</sub> CuO <sub>6</sub>	14284-06-1	321.813	grn cry (EtOH)	192				s EtOH, chl
2462	Copper(II) gluconate	Cupric gluconate	C <sub>12</sub> H <sub>22</sub> CuO <sub>14</sub>	527-09-3	453.841	bl-grn cry	156				sl EtOH; i os
2463	Copper(II) 2,4-pentanedioate	Copper(II) acetylacetonate	C <sub>10</sub> H <sub>14</sub> CuO <sub>4</sub>	13395-16-9	261.762	bl pow	284 dec	sub			sl H <sub>2</sub> O; s chl
2464	Copper phthalocyanine	Pigment Blue 15	C <sub>32</sub> H <sub>16</sub> CuN <sub>8</sub>	147-14-8	576.069	bl-purp cry					i H <sub>2</sub> O, EtOH; s conc H <sub>2</sub> SO <sub>4</sub>
2465	Coronene		C <sub>24</sub> H <sub>12</sub>	191-07-1	300.352	ye nd (bz)	437.4	525	1.371 <sup>25</sup>		i H <sub>2</sub> O, con sulf; sl bz
2466	Corticosterone		C <sub>21</sub> H <sub>30</sub> O <sub>4</sub>	50-22-6	346.461	nd (al, pl) (ace)	181				i H <sub>2</sub> O; s EtOH, eth, ace
2467	Corybulbine		C <sub>21</sub> H <sub>25</sub> NO <sub>4</sub>	518-77-4	355.429	nd (al)	237.5				i H <sub>2</sub> O; sl EtOH, eth; s ace, bz, HCl
2468	Corycavamine		C <sub>21</sub> H <sub>21</sub> NO <sub>5</sub>	521-85-7	367.396	pr (eth, al)	149				vs EtOH, chl
2469	Corydaline		C <sub>22</sub> H <sub>27</sub> NO <sub>4</sub>	518-69-4	369.454	pr (al)	136				vs bz, eth, EtOH, chl
2470	Corydine		C <sub>20</sub> H <sub>23</sub> NO <sub>4</sub>	476-69-7	341.402	tetr pr (eth)	149				vs eth, EtOH, chl
2471	Corynantheine		C <sub>22</sub> H <sub>26</sub> N <sub>2</sub> O <sub>3</sub>	18904-54-6	366.452		165.5				vs EtOH
2472	Cotarnine		C <sub>12</sub> H <sub>15</sub> NO <sub>4</sub>	82-54-2	237.252	nd (bz), cry (eth)	132 dec				sl H <sub>2</sub> O; s EtOH, eth, bz, chl, NH <sub>4</sub> OH
2473	Coumaphos		C <sub>14</sub> H <sub>16</sub> ClO <sub>5</sub> PS	56-72-4	362.766		93		1.474		
2474	Coumestrol	3,9-Dihydroxy-6H-benzofuro[3,2-c][1]benzopyran-6-one	C <sub>15</sub> H <sub>8</sub> O <sub>5</sub>	479-13-0	268.222	cry rods	385 dec				i H <sub>2</sub> O; sl EtOH, ace; i eth
2475	Creatine		C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	57-00-1	131.133	mcl pr (w+1)	303 dec		1.33 <sup>25</sup>		s H <sub>2</sub> O; sl EtOH; i eth
2476	Creatinine		C <sub>4</sub> H <sub>7</sub> N <sub>3</sub> O	60-27-5	113.118	orth pr (w+2) lf (w)	300 dec				s H <sub>2</sub> O; sl EtOH; i eth, ace, chl
2477	<i>o</i> -Cresol	2-Methylphenol	C <sub>7</sub> H <sub>8</sub> O	95-48-7	108.138		31.03	191.04	1.0327 <sup>35</sup>	1.5386 <sup>35</sup>	s H <sub>2</sub> O; vs EtOH, eth; msc ace, bz, ctc
2478	<i>m</i> -Cresol	3-Methylphenol	C <sub>7</sub> H <sub>8</sub> O	108-39-4	108.138		12.24	202.27	1.0339 <sup>20</sup>	1.5401 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
2479	<i>p</i> -Cresol	4-Methylphenol	C <sub>7</sub> H <sub>8</sub> O	106-44-5	108.138	pr	34.77	201.98	1.0185 <sup>40</sup>	1.5312 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
2480	<i>o</i> -Cresolphthalein		C <sub>22</sub> H <sub>18</sub> O <sub>4</sub>	596-27-0	346.376	cry (al)	223				vs EtOH
2481	<i>o</i> -Cresolphthalein complexone	Metalphthalein	C <sub>32</sub> H <sub>32</sub> N <sub>2</sub> O <sub>12</sub>	2411-89-4	636.602	ye cry pow	186				i H <sub>2</sub> O; s EtOH, ace, alk
2482	Cresol Red	<i>o</i> -Cresolsulfonphthalein	C <sub>21</sub> H <sub>16</sub> O <sub>5</sub> S	1733-12-6	382.430	red-br cry pow	>300				vs H <sub>2</sub> O, EtOH
2483	<i>p</i> -Cresyl diphenyl phosphate		C <sub>19</sub> H <sub>17</sub> O <sub>4</sub> P	78-31-9	340.309	col liq	-40		1.208 <sup>25</sup>		i H <sub>2</sub> O; s os
2484	Crimidine		C <sub>7</sub> H <sub>10</sub> CIN <sub>3</sub>	535-89-7	171.627	br wax	87	143 <sup>4</sup>			vs EtOH
2485	Cromolyn	Cromoglicic acid	C <sub>23</sub> H <sub>16</sub> O <sub>11</sub>	16110-51-3	468.366	col cry	241 dec				
2486	Cruformate		C <sub>12</sub> H <sub>16</sub> ClNO <sub>3</sub> P	299-86-5	291.711		60	118 <sup>0,01</sup>			
2487	Cryptopine	Cryptocavine	C <sub>21</sub> H <sub>23</sub> NO <sub>5</sub>	482-74-6	369.412	pr or pl (bz) nd (chl-MeOH)	223		1.315 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, eth, bz; s chl, HOAc
2488	Crystal Violet	Gentian violet	C <sub>25</sub> H <sub>30</sub> CIN <sub>3</sub>	548-62-9	407.979	grn pow	215 dec				vs H <sub>2</sub> O, chl
2489	Cubebin		C <sub>20</sub> H <sub>20</sub> O <sub>6</sub>	18423-69-3	356.369	nd (al, bz)	131.5				vs eth, EtOH, chl
2490	Cucurbitacin B		C <sub>32</sub> H <sub>46</sub> O <sub>8</sub>	6199-67-3	558.702	cry (EtOH)	181				
2491	Cucurbitacin C		C <sub>32</sub> H <sub>46</sub> O <sub>8</sub>	5988-76-1	560.718	cry (AcOEt)	207.5				
2492	Cupferron		C <sub>8</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	135-20-6	155.154		163.5				sl DMSO
2493	Cupreine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	524-63-0	310.390	pr (eth)	202				vs EtOH
2494	Curan-17-ol, (16 $\alpha$ )	Geissoschizoline	C <sub>19</sub> H <sub>28</sub> N <sub>2</sub> O	18397-07-4	298.421	pa ye amor pow	135 dec				i H <sub>2</sub> O; vs EtOH, eth, chl



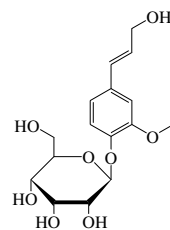
Congo Red



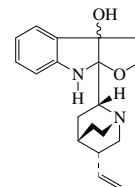
Conhydrine



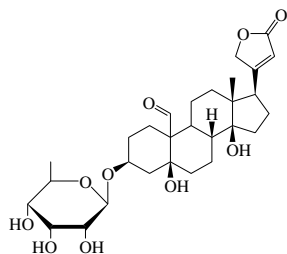
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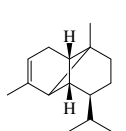
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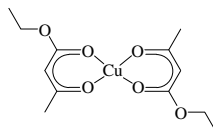
Conquinamine



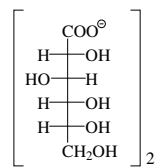
Convallatoxin



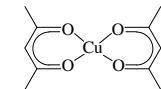
Copaene



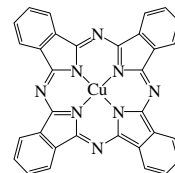
Copper(II) ethylacetoacetate



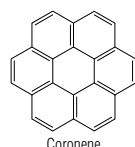
Copper(II) gluconate



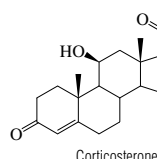
Copper(II) 2,4-pentanedioate



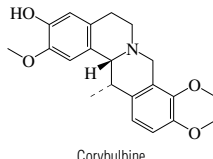
Copper phthalocyanine



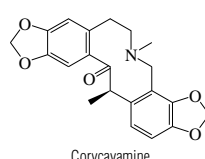
Coronene



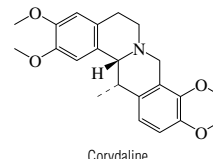
Corticosterone



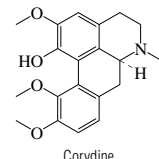
Corybulbine



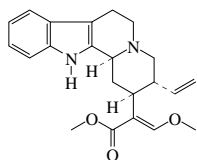
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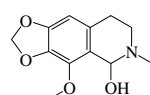
Corydaline



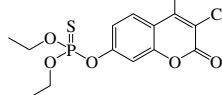
Corydine



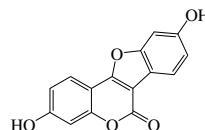
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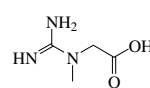
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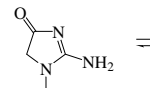
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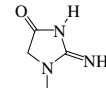
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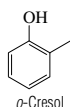
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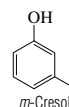
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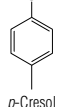
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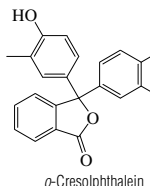
o-Cresol



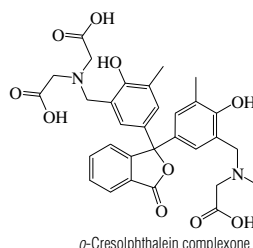
m-Cresol



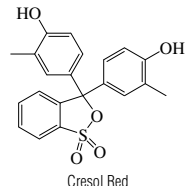
p-Cresol



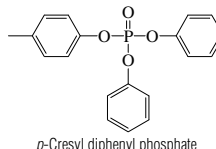
alpha-Cresolphthalein



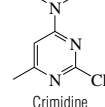
alpha-Cresolphthalein complexone



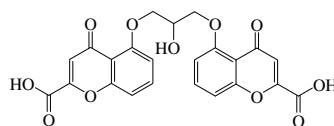
Cresol Red



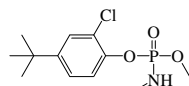
p-Cresyl diphenyl phosphate



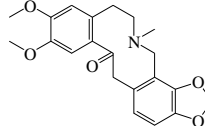
Crimidine



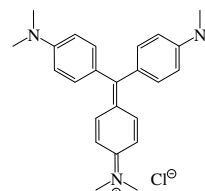
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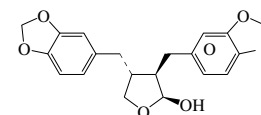
Crufomate



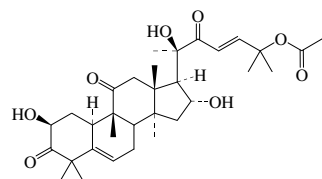
Cryptopine



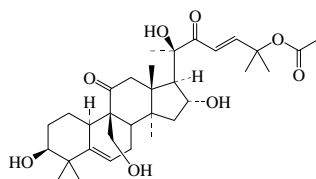
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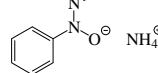
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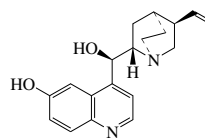
Cucurbitacin B



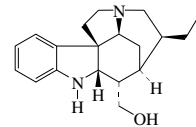
Cucurbitacin C



Cupferron

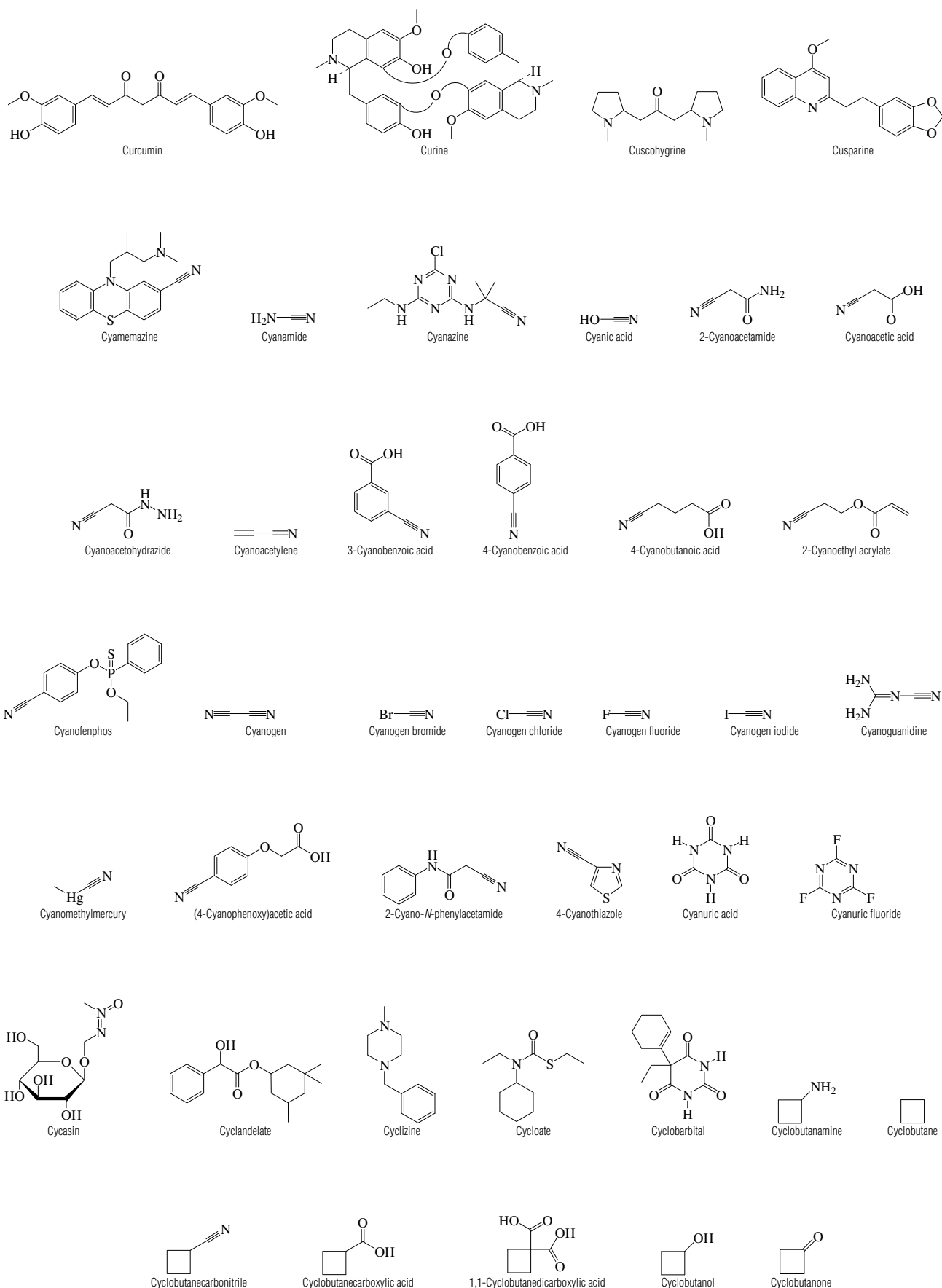


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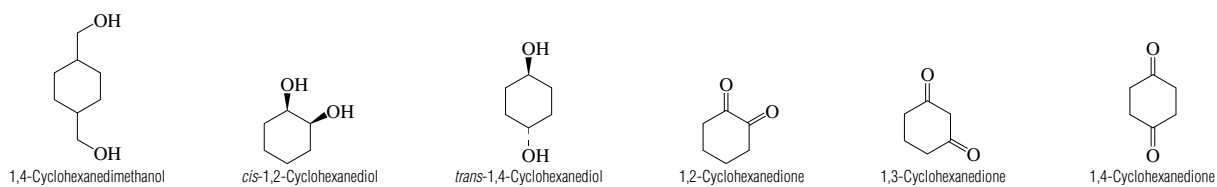
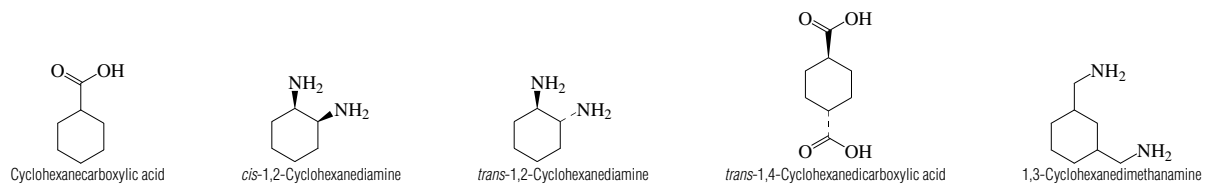
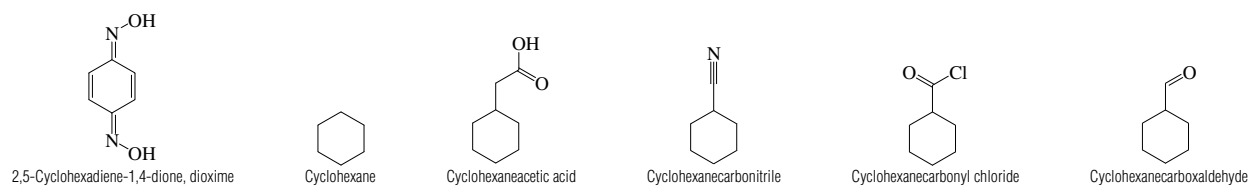
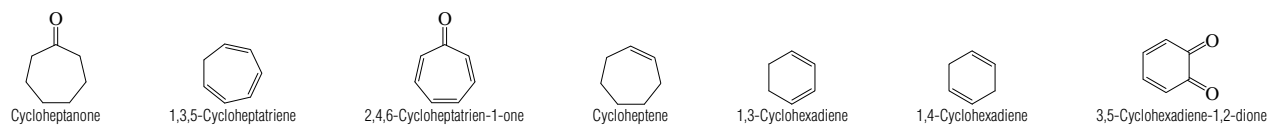
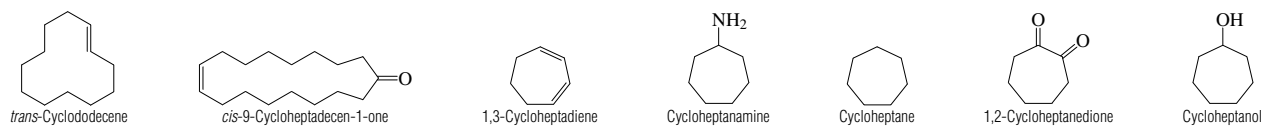
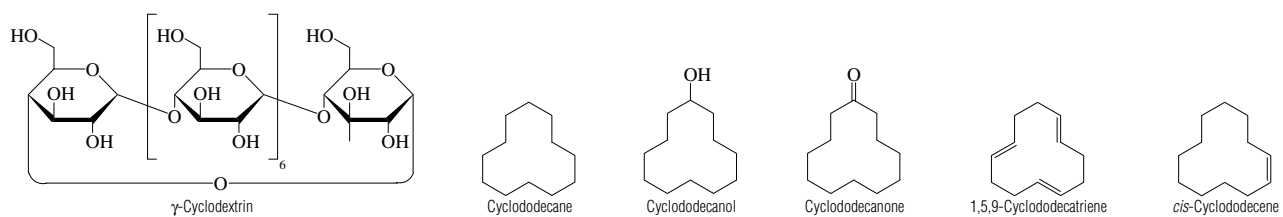
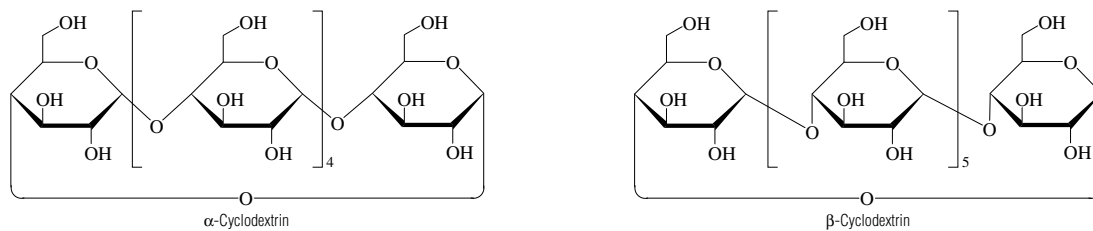
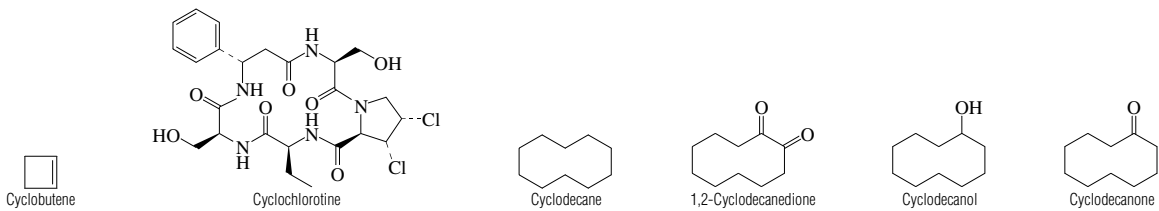
Curan-17-ol, (16alpha)

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2495	Curcumin	Turmeric	C <sub>21</sub> H <sub>20</sub> O <sub>6</sub>	458-37-7	368.380	oran ye pr, orth pr (MeOH)	183				vs EtOH, HOAc
2496	Curine		C <sub>36</sub> H <sub>38</sub> N <sub>2</sub> O <sub>6</sub>	436-05-5	594.696	pr, nd (chl- MeOH)	221				vs ace, bz, py
2497	Cuscohygrine		C <sub>13</sub> H <sub>24</sub> N <sub>2</sub> O	454-14-8	224.342	oil		169 <sup>23</sup> , 122 <sup>2</sup>	0.9733 <sup>20</sup>	1.4832 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
2498	Cusparine	2-[2-(1,3-Benzodioxol-5-yl) ethyl]-4-methoxyquinoline	C <sub>19</sub> H <sub>17</sub> NO <sub>3</sub>	529-92-0	307.343	(α) wh or ye nd (peth); (β) amber pr	92(α form); 111(β form)				i H <sub>2</sub> O; vs ace, bz, eth, EtOH
2499	Cyanemazine		C <sub>19</sub> H <sub>21</sub> N <sub>3</sub> S	3546-03-0	323.455	ye pow	92	212 <sup>20,25</sup>			i H <sub>2</sub> O; s EtOH
2500	Cyanamide	Cyanogenamide	CH <sub>2</sub> N <sub>2</sub>	420-04-2	42.040	nd	45.56	140 <sup>19</sup>	1.282 <sup>20</sup>	1.4418 <sup>48</sup>	vs H <sub>2</sub> O, EtOH; s eth, ace, bz; sl CS <sub>2</sub>
2501	Cyanazine		C <sub>3</sub> H <sub>3</sub> CIN <sub>6</sub>	21725-46-2	240.692		168				
2502	Cyanic acid	Hydrogen cyanate	CHNO	420-05-3	43.025	unstab liq or gas	-86	23	1.140 <sup>20</sup>		vs H <sub>2</sub> O, bz, eth, chl
2503	2-Cyanoacetamide		C <sub>3</sub> H <sub>5</sub> N <sub>2</sub> O	107-91-5	84.076	pl (w)	121.5				vs H <sub>2</sub> O
2504	Cyanoacetic acid		C <sub>3</sub> H <sub>3</sub> NO <sub>2</sub>	372-09-8	85.062		66	dec 160; 108 <sup>15</sup>			s H <sub>2</sub> O, EtOH, eth; sl chl, HOAc
2505	Cyanoacetohydrazide	Cyacetacide	C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O	140-87-4	99.091	pr (al)	114.5				vs H <sub>2</sub> O, EtOH
2506	Cyanoacetylene		C <sub>2</sub> HN	1070-71-9	51.047		5	42.5	0.8167 <sup>17</sup>	1.3868 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH
2507	3-Cyanobenzoic acid		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	1877-72-1	147.132	nd (w)	219	sub			sl H <sub>2</sub> O; s EtOH, eth
2508	4-Cyanobenzoic acid		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	619-65-8	147.132		219				s H <sub>2</sub> O, EtOH, eth, HOAc; sl tfa
2509	4-Cyanobutanoic acid		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	39201-33-7	113.116	hyg cry	45				s H <sub>2</sub> O, EtOH, eth, bz
2510	2-Cyanoethyl acrylate		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	106-71-8	125.126			108 <sup>12</sup>	1.062 <sup>20</sup>		
2511	Cyanofenphos		C <sub>15</sub> H <sub>14</sub> NO <sub>2</sub> PS	13067-93-1	303.317		83			1.5839 <sup>25</sup>	sl H <sub>2</sub> O
2512	Cyanogen	Ethane dinitrile	C <sub>2</sub> N <sub>2</sub>	460-19-5	52.034	col gas	-27.83	-21.1	0.9537 <sup>21</sup>		s H <sub>2</sub> O, EtOH, eth
2513	Cyanogen bromide	Bromine cyanide	CBrN	506-68-3	105.922	nd	52	61.5	2.015 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth
2514	Cyanogen chloride	Chlorine cyanide	CCIN	506-77-4	61.471	col vol liq or gas	-6.5	13	1.186 <sup>20</sup>		s H <sub>2</sub> O, EtOH; vs eth
2515	Cyanogen fluoride	Fluorine cyanide	CFN	1495-50-7	45.016	col gas	-82	-46			
2516	Cyanogen iodide	Iodine cyanide	CIN	506-78-5	152.922	nd (al, eth)	146.7	sub	2.84 <sup>18</sup>		vs eth, EtOH
2517	Cyanoguanidine	Dicyanodiamide	C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	461-58-5	84.080		211		1.404 <sup>14</sup>		s H <sub>2</sub> O, EtOH, ace; i eth, bz, chl
2518	Cyanomethylmercury	Methylmercurynitrile	C <sub>2</sub> H <sub>2</sub> HgN	2597-97-9	241.64	cry (chl)	92	subl			vs H <sub>2</sub> O, EtOH, bz; s eth
2519	(4-Cyanophenoxy)acetic acid		C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	1878-82-6	177.157	cry (w)	178				
2520	2-Cyano- <i>M</i> -phenylacetamide		C <sub>9</sub> H <sub>9</sub> N <sub>2</sub> O	621-03-4	160.172	nd (al)	199.5				
2521	4-Cyanothiazole		C <sub>4</sub> H <sub>3</sub> N <sub>2</sub> S	1452-15-9	110.137	nd	58				
2522	Cyanuric acid	1,3,5-Triazine-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )- trione	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	108-80-5	129.074	wh cry	>330	sub	1.75 <sup>25</sup>		sl hot H <sub>2</sub> O, ace, bz, EtOH; s conc HCl
2523	Cyanuric fluoride	2,4,6-Trifluoro-1,3,5-triazine	C <sub>3</sub> F <sub>3</sub> N <sub>3</sub>	675-14-9	135.047			72.8			
2524	Cycasin		C <sub>9</sub> H <sub>16</sub> N <sub>2</sub> O <sub>7</sub>	14901-08-7	252.222	nd (ace aq)	154 dec				
2525	Cyclandelate		C <sub>17</sub> H <sub>24</sub> O <sub>3</sub>	456-59-7	276.371		52	193 <sup>14</sup>			i H <sub>2</sub> O
2526	Cyclizine		C <sub>18</sub> H <sub>22</sub> N <sub>2</sub>	82-92-8	266.381	cry (peth)	106				i H <sub>2</sub> O; s chl; sl EtOH
2527	Cycloate	Carbamothioic acid, cyclohexylethyl-, <i>S</i> -ethyl ester	C <sub>11</sub> H <sub>21</sub> NOS	1134-23-2	215.356		11.5	145 <sup>10</sup>	1.0156 <sup>30</sup>		
2528	Cyclobarbitol		C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	52-31-3	236.266	lf (w)	173				i H <sub>2</sub> O; vs EtOH; s eth, dil alk; sl HOAc
2529	Cyclobutanamine	Aminocyclobutane	C <sub>4</sub> H <sub>9</sub> N	2516-34-9	71.121			82	0.8328 <sup>20</sup>	1.4363 <sup>19</sup>	
2530	Cyclobutane	Tetramethylene	C <sub>4</sub> H <sub>8</sub>	287-23-0	56.107	vol liq or gas	-90.7	12.6	0.7038 <sup>9</sup>	1.375 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, ace; msc eth; s bz
2531	Cyclobutanecarbonitrile	Cyanocyclobutane	C <sub>5</sub> H <sub>7</sub> N	4426-11-3	81.117			149.6			
2532	Cyclobutanecarboxylic acid		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	3721-95-7	100.117	liq	-1.0	190; 74 <sup>2</sup>	1.0599 <sup>20</sup>	1.4400 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
2533	1,1-Cyclobutanedicarboxylic acid		C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	5445-51-2	144.126	pr (w, eth)	158.0				vs H <sub>2</sub> O; s EtOH, eth, bz; sl liq
2534	Cyclobutanol	Hydroxycyclobutane	C <sub>4</sub> H <sub>8</sub> O	2919-23-5	72.106			124	0.9218 <sup>15</sup>	1.4371 <sup>20</sup>	
2535	Cyclobutanone		C <sub>4</sub> H <sub>6</sub> O	1191-95-3	70.090	liq	-50.9	99	0.9547 <sup>9</sup>	1.4215 <sup>20</sup>	s H <sub>2</sub> O, eth, bz, chl, tol; vs EtOH; i peth

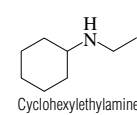
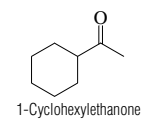
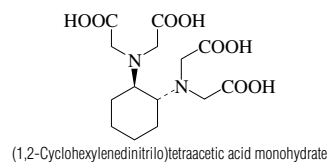
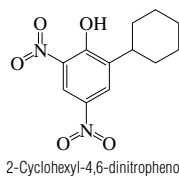
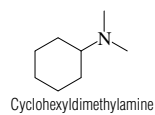
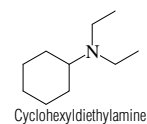
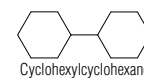
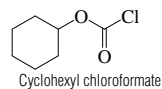
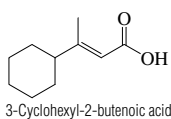
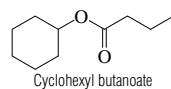
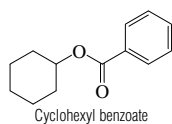
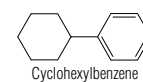
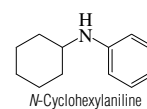
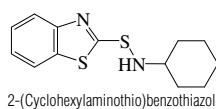
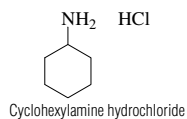
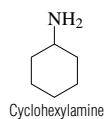
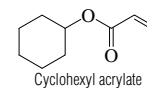
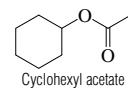
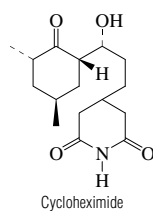
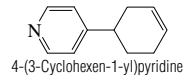
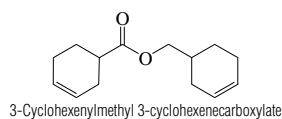
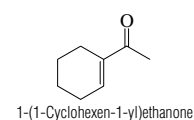
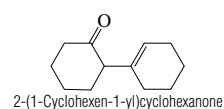
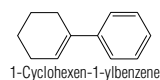
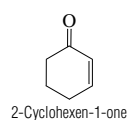
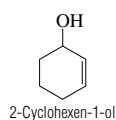
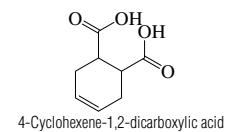
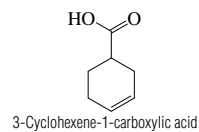
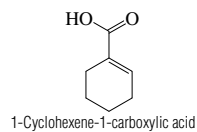
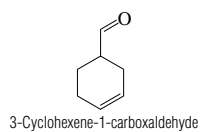
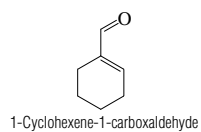
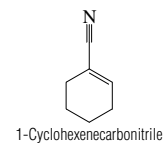
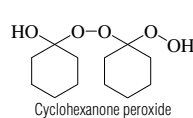
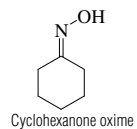
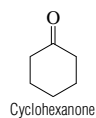
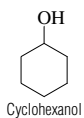
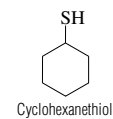
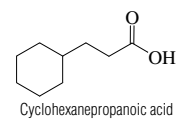
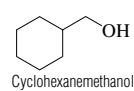
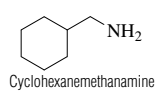
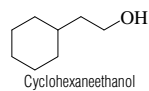
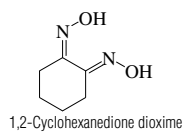


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2536	Cyclobutene		C <sub>4</sub> H <sub>6</sub>	822-35-5	54.091	col gas		2	0.733 <sup>0</sup>		vs ace; s bz, peth
2537	Cyclochlorotene		C <sub>24</sub> H <sub>31</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>7</sub>	12663-46-6	572.439	nd (MeOH)	255 dec				
2538	Cyclodecane		C <sub>10</sub> H <sub>20</sub>	293-96-9	140.266		10	202	0.8538 <sup>25</sup>	1.4716 <sup>20</sup>	
2539	1,2-Cyclodecanedione	Sebacil	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	96-01-5	168.233		40.5	104 <sup>10</sup>			
2540	Cyclodecanol		C <sub>10</sub> H <sub>20</sub> O	1502-05-2	156.265		40.5	125 <sup>12</sup>	0.9606 <sup>20</sup>	1.4926 <sup>20</sup>	s EtOH
2541	Cyclodecanone		C <sub>10</sub> H <sub>18</sub> O	1502-06-3	154.249	amor pow	28	106 <sup>13</sup>	0.9654 <sup>20</sup>	1.4806 <sup>20</sup>	vs bz, eth, chl
2542	α-Cyclodextrin	Cyclomaltohexaose	C <sub>36</sub> H <sub>60</sub> O <sub>30</sub>	10016-20-3	972.843	hx pl or nd					vs cold H <sub>2</sub> O; i hot H <sub>2</sub> O
2543	β-Cyclodextrin	Cyclomaltoheptaose	C <sub>42</sub> H <sub>70</sub> O <sub>35</sub>	7585-39-9	1134.984	mcl cry (w)	260 dec				
2544	γ-Cyclodextrin	Cyclomaltooctaose	C <sub>48</sub> H <sub>80</sub> O <sub>40</sub>	17465-86-0	1297.125	sq pl or rods					
2545	Cyclododecane		C <sub>12</sub> H <sub>24</sub>	294-62-2	168.319	nd (al)	60.4	247	0.82 <sup>90</sup>		
2546	Cyclododecanol		C <sub>12</sub> H <sub>24</sub> O	1724-39-6	184.318			286			
2547	Cyclododecanone		C <sub>12</sub> H <sub>22</sub> O	830-13-7	182.302		59	127 <sup>12</sup>	0.9059 <sup>66</sup>	1.4571 <sup>60</sup>	
2548	1,5,9-Cyclododecatriene	CDT	C <sub>12</sub> H <sub>18</sub>	4904-61-4	162.271	liq	-17	240	0.84 <sup>100</sup>		
2549	cis-Cyclododecene		C <sub>12</sub> H <sub>22</sub>	1129-89-1	166.303			133 <sup>35</sup> , 71 <sup>2</sup>		1.4840 <sup>20</sup>	vs bz, chl
2550	trans-Cyclododecene		C <sub>12</sub> H <sub>22</sub>	1486-75-5	166.303			113 <sup>17</sup>		1.4850 <sup>20</sup>	vs bz, chl
2551	cis-9-Cycloheptadecen-1-one	Civetone	C <sub>17</sub> H <sub>30</sub> O	542-46-1	250.419		32.5	343; 159 <sup>2</sup>			
2552	1,3-Cycloheptadiene		C <sub>7</sub> H <sub>10</sub>	4054-38-0	94.154	liq	-110.4	120.5	0.868 <sup>25</sup>	1.4978 <sup>20</sup>	
2553	Cycloheptanamine		C <sub>7</sub> H <sub>15</sub> N	5452-35-7	113.201			54 <sup>11</sup>		1.4724 <sup>20</sup>	
2554	Cycloheptane		C <sub>7</sub> H <sub>14</sub>	291-64-5	98.186	liq	-8.46	118.4	0.8098 <sup>20</sup>	1.4436 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, chl
2555	1,2-Cycloheptanedione		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	3008-39-7	126.153		-40	108 <sup>17</sup>	1.0583 <sup>22</sup>	1.4689 <sup>22</sup>	s EtOH
2556	Cycloheptanol		C <sub>7</sub> H <sub>14</sub> O	502-41-0	114.185		7.2	185	0.9554 <sup>20</sup>	1.40705 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
2557	Cycloheptanone	Suberone	C <sub>7</sub> H <sub>12</sub> O	502-42-1	112.169			178.5	0.9508 <sup>20</sup>	1.4608 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
2558	1,3,5-Cycloheptatriene	Tropilidene	C <sub>7</sub> H <sub>8</sub>	544-25-2	92.139	liq; cub cry (-80°C)	-79.5	117; 60.5 <sup>122</sup>	0.8875 <sup>19</sup>	1.5343 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs bz, chl
2559	2,4,6-Cycloheptatrien-1-one		C <sub>7</sub> H <sub>6</sub> O	539-80-0	106.122		-7	113 <sup>15</sup> , 84 <sup>6</sup>	1.095 <sup>22</sup>	1.6172 <sup>22</sup>	vs bz, chl
2560	Cycloheptene		C <sub>7</sub> H <sub>12</sub>	628-92-2	96.170	liq	-56	115	0.8228 <sup>20</sup>	1.4552 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; sl ctc
2561	1,3-Cyclohexadiene		C <sub>6</sub> H <sub>8</sub>	592-57-4	80.128	liq	-89	80.5	0.8405 <sup>20</sup>	1.4755 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, peth; vs eth
2562	1,4-Cyclohexadiene	1,4-Dihydrobenzene	C <sub>6</sub> H <sub>8</sub>	628-41-1	80.128	liq	-49.2	85.5	0.8471 <sup>20</sup>	1.4725 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, chl, peth
2563	3,5-Cyclohexadiene-1,2-dione		C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	583-63-1	108.095	red pl or pr	≈65 dec				s eth, ace, bz; i peth
2564	2,5-Cyclohexadiene-1,4-dione, dioxime		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	105-11-3	138.124	pa ye nd (w)	240 dec				s H <sub>2</sub> O
2565	Cyclohexane	Hexahydrobenzene	C <sub>6</sub> H <sub>12</sub>	110-82-7	84.159		6.59	80.73	0.7739 <sup>25</sup>	1.4235 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
2566	Cyclohexaneacetic acid		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	5292-21-7	142.196	nd (HCO <sub>2</sub> H)	33	245	1.0423 <sup>18</sup>	1.4775 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace
2567	Cyclohexanecarbonitrile	Cyclohexyl cyanide	C <sub>7</sub> H <sub>11</sub> N	766-05-2	109.169	liq	11	184; 76 <sup>16</sup>	0.919	1.4505 <sup>20</sup>	
2568	Cyclohexanecarbonyl chloride		C <sub>7</sub> H <sub>11</sub> ClO	2719-27-9	146.614			180	1.0962 <sup>15</sup>	1.4711 <sup>29</sup>	
2569	Cyclohexanecarboxaldehyde		C <sub>7</sub> H <sub>12</sub> O	2043-61-0	112.169			159.3	0.9035 <sup>20</sup>	1.4496 <sup>20</sup>	s H <sub>2</sub> O, eth
2570	Cyclohexanecarboxylic acid	Hexahydrobenzoic acid	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	98-89-5	128.169	mcl pr	31.5	232.5	1.0334 <sup>22</sup>	1.4530 <sup>20</sup>	sl H <sub>2</sub> O, ctc; vs EtOH, bz, chl
2571	cis-1,2-Cyclohexanediamine	cis-1,2-Diaminocyclohexane	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	1436-59-5	114.188	liq		40 <sup>2</sup>	0.952 <sup>20</sup>	1.4951 <sup>20</sup>	
2572	trans-1,2-Cyclohexanediamine	trans-1,2-Diaminocyclohexane	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	1121-22-8	114.188		14.8	80 <sup>15</sup> , 41 <sup>2</sup>	0.951 <sup>20</sup>		
2573	trans-1,4-Cyclohexanedicarboxylic acid		C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	619-82-9	172.179	pr (w)	312.5	sub 300			sl H <sub>2</sub> O, eth; vs EtOH; s ace; i chl
2574	1,3-Cyclohexanedimethanamine		C <sub>8</sub> H <sub>18</sub> N <sub>2</sub>	2579-20-6	142.242		<-70	220	0.945 <sup>20</sup>		vs H <sub>2</sub> O, eth, EtOH
2575	1,4-Cyclohexanedimethanol		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	105-08-8	144.212		43	283; 167 <sup>10</sup>			
2576	cis-1,2-Cyclohexanediol		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	1792-81-0	116.158		100	120 <sup>15</sup>	1.0297 <sup>101</sup>		s EtOH, ace, bz; sl chl
2577	trans-1,4-Cyclohexanediol		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	6995-79-5	116.158	mcl pr (ace)	143		1.18 <sup>20</sup>		s H <sub>2</sub> O, EtOH, MeOH; i eth; sl ace
2578	1,2-Cyclohexanedione	1,2-Dioxocyclohexane	C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	765-87-7	112.127	cry (peth)	40	194	1.1187 <sup>21</sup>	1.4995 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, bz
2579	1,3-Cyclohexanedione	Dihydroresorcinol	C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	504-02-9	112.127	pr (bz)	105.5		1.0861 <sup>91</sup>	1.4576 <sup>102</sup>	s H <sub>2</sub> O, EtOH, ace, chl; sl eth, bz
2580	1,4-Cyclohexanedione	Tetrahydroquinone	C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	637-88-7	112.127	mcl pl (w),nd (peth)	78	132 <sup>20</sup>	1.0861 <sup>91</sup>		s H <sub>2</sub> O, EtOH, eth, ace, bz, chl

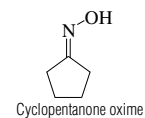
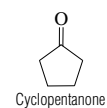
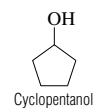
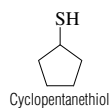
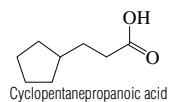
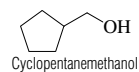
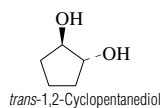
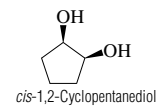
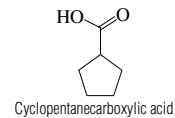
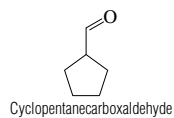
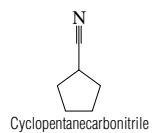
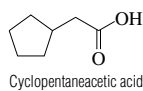
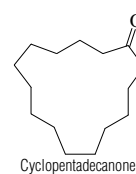
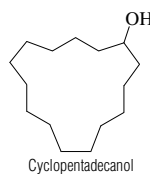
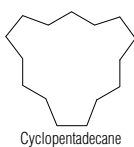
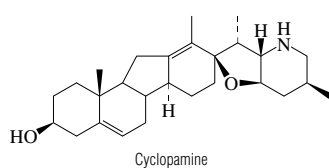
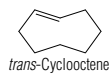
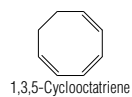
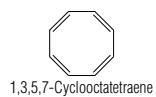
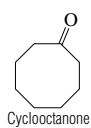
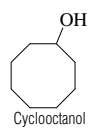
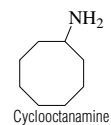
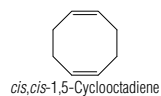
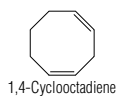
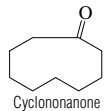
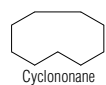
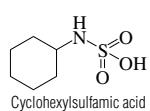
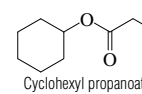
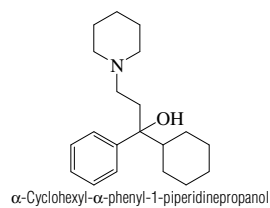
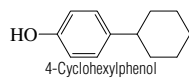
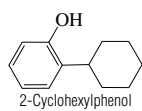
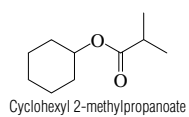
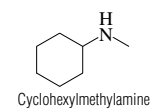
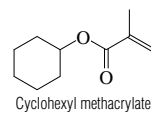
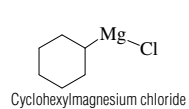
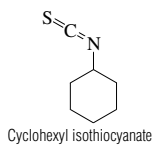
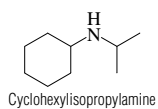
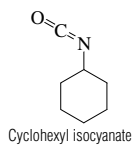
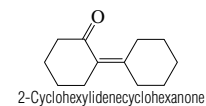
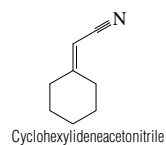
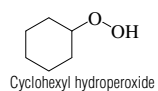
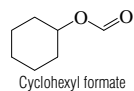
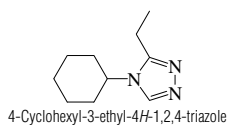




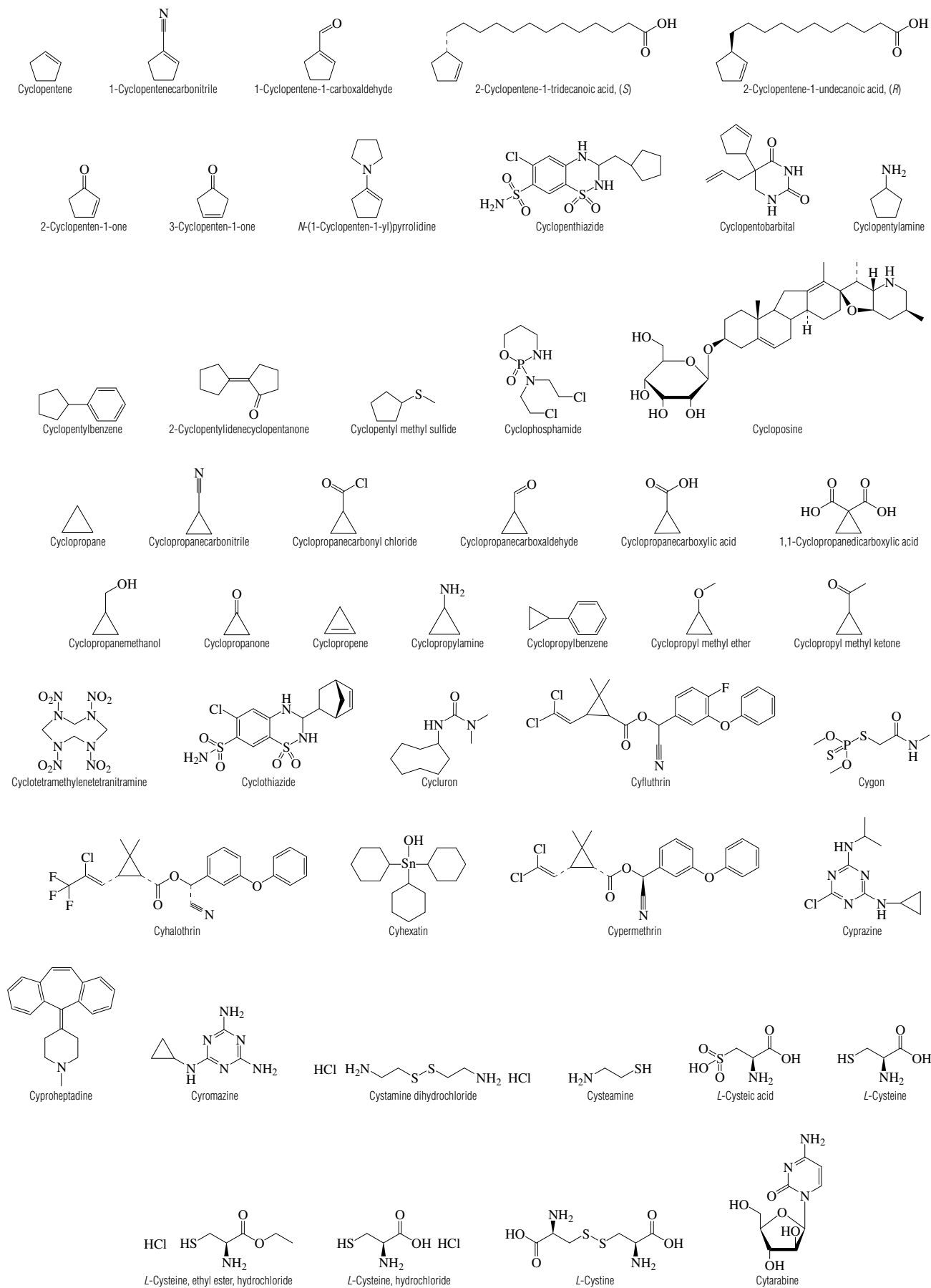
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2581	1,2-Cyclohexanedione dioxime	Nioxime	C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	492-99-9	142.155	nd (w, HOAc)	192				s H <sub>2</sub> O, ace, chl; sl tfa
2582	Cyclohexaneethanol		C <sub>8</sub> H <sub>16</sub> O	4442-79-9	128.212			208	0.9229 <sup>20</sup>	1.4641 <sup>20</sup>	s EtOH, eth, bz
2583	Cyclohexanemethanamine		C <sub>7</sub> H <sub>13</sub> N	3218-02-8	113.201			160	0.87 <sup>25</sup>	1.4630 <sup>20</sup>	
2584	Cyclohexanemethanol	Cyclohexylcarbinol	C <sub>7</sub> H <sub>14</sub> O	100-49-2	114.185	liq	-43	183	0.9297 <sup>20</sup>	1.4644 <sup>20</sup>	vs eth, EtOH
2585	Cyclohexanepropanoic acid		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	701-97-3	156.222		16	276.5	0.912 <sup>25</sup>	1.4638 <sup>20</sup>	s H <sub>2</sub> O, eth; sl ctc
2586	Cyclohexanethiol	Cyclohexyl mercaptan	C <sub>6</sub> H <sub>12</sub> S	1569-69-3	116.224			158.8	0.9782 <sup>20</sup>	1.4921 <sup>20</sup>	vs ace, bz, eth, EtOH
2587	Cyclohexanol	Cyclohexyl alcohol	C <sub>6</sub> H <sub>12</sub> O	108-93-0	100.158	hyg nd	25.93	160.84	0.9624 <sup>20</sup>	1.4641 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace; msc bz; sl chl
2588	Cyclohexanone	Pimelic ketone	C <sub>6</sub> H <sub>10</sub> O	108-94-1	98.142	liq	-27.9	155.43	0.9478 <sup>20</sup>	1.4507 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz, chl, ctc
2589	Cyclohexanone oxime		C <sub>6</sub> H <sub>11</sub> NO	100-64-1	113.157	hex pr (lig)	90	206			s H <sub>2</sub> O, EtOH, eth, MeOH; sl chl
2590	Cyclohexanone peroxide		C <sub>12</sub> H <sub>22</sub> O <sub>5</sub>	78-18-2	246.300	cry or long nd	79				
2591	Cyclohexene	Tetrahydrobenzene	C <sub>6</sub> H <sub>10</sub>	110-83-8	82.143	liq	-103.5	82.98	0.8110 <sup>20</sup>	1.4465 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
2592	1-Cyclohexenecarbonitrile	1-Cyanocyclohexene	C <sub>7</sub> H <sub>9</sub> N	1855-63-6	107.153			81 <sup>12</sup>			
2593	1-Cyclohexene-1-carboxaldehyde		C <sub>7</sub> H <sub>10</sub> O	1192-88-7	110.153			69 <sup>18</sup>	0.9694 <sup>20</sup>	1.5005 <sup>20</sup>	s EtOH, eth
2594	3-Cyclohexene-1-carboxaldehyde		C <sub>7</sub> H <sub>10</sub> O	100-50-5	110.153		1.0	105	0.9692 <sup>20</sup>	1.4745 <sup>20</sup>	s ace, MeOH; sl ctc
2595	1-Cyclohexene-1-carboxylic acid		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	636-82-8	126.153		38	241	1.109 <sup>20</sup>	1.4902 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace
2596	3-Cyclohexene-1-carboxylic acid		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	4771-80-6	126.153		17	234.5	1.0820 <sup>20</sup>	1.4814 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, ace
2597	4-Cyclohexene-1,2-dicarboxylic acid		C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	88-98-2	170.163	pr (w)	173.0				
2598	2-Cyclohexen-1-ol		C <sub>6</sub> H <sub>10</sub> O	822-67-3	98.142			164	0.9923 <sup>15</sup>	1.4790 <sup>25</sup>	s EtOH, ace
2599	2-Cyclohexen-1-one		C <sub>6</sub> H <sub>8</sub> O	930-68-7	96.127	liq	-53	170	0.9620 <sup>25</sup>	1.4883 <sup>20</sup>	vs EtOH; s ace
2600	1-Cyclohexen-1-ylbenzene		C <sub>12</sub> H <sub>14</sub>	771-98-2	158.239	liq	-11	252	0.9939 <sup>20</sup>	1.5718 <sup>20</sup>	vs MeOH
2601	2-(1-Cyclohexen-1-yl)cyclohexanone		C <sub>12</sub> H <sub>18</sub> O	1502-22-3	178.270			116 <sup>3</sup>		1.5070 <sup>20</sup>	
2602	1-(1-Cyclohexen-1-yl)ethanone		C <sub>8</sub> H <sub>12</sub> O	932-66-1	124.180		73	201.5	0.9655 <sup>20</sup>	1.4881 <sup>20</sup>	s EtOH, eth
2603	3-Cyclohexenylmethyl 3-cyclohexenecarboxylate		C <sub>14</sub> H <sub>20</sub> O <sub>2</sub>	2611-00-9	220.308	liq		153 <sup>7</sup> , 109 <sup>16</sup>			
2604	4-(3-Cyclohexen-1-yl)pyridine		C <sub>11</sub> H <sub>13</sub> N	70644-46-1	159.228		22.1	226	1.0222 <sup>25</sup>	1.5466 <sup>25</sup>	
2605	Cycloheximide		C <sub>15</sub> H <sub>23</sub> NO <sub>4</sub>	66-81-9	281.349	pl (al)	119				vs EtOH
2606	Cyclohexyl acetate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	622-45-7	142.196			173; 96 <sup>15</sup>	0.968 <sup>20</sup>	1.442 <sup>20</sup>	vs eth, EtOH
2607	Cyclohexyl acrylate		C <sub>9</sub> H <sub>14</sub> O <sub>2</sub>	3066-71-5	154.206			183; 88 <sup>20</sup>	1.0275 <sup>20</sup>	1.4673 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
2608	Cyclohexylamine	Cyclohexanamine	C <sub>6</sub> H <sub>13</sub> N	108-91-8	99.174	liq	-17.8	134	0.8191 <sup>20</sup>	1.4625 <sup>15</sup>	s H <sub>2</sub> O, ctc; vs EtOH; msc eth, ace, bz
2609	Cyclohexylamine hydrochloride	Cyclohexanamine hydrochloride	C <sub>6</sub> H <sub>14</sub> ClN	4998-76-9	135.635	nd (w, al-eth)	206.5				vs H <sub>2</sub> O, EtOH
2610	2-(Cyclohexylaminothio)benzothiazole		C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> S <sub>2</sub>	95-33-0	264.409		103				
2611	<i>N</i> -Cyclohexylaniline		C <sub>12</sub> H <sub>17</sub> N	1821-36-9	175.270	mcl pr	16	279; 192 <sup>73</sup>	1.0155 <sup>20</sup>	1.5610 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
2612	Cyclohexylbenzene		C <sub>12</sub> H <sub>16</sub>	827-52-1	160.255	pl	7.07	240.1	0.9427 <sup>20</sup>	1.5329 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth; sl ctc
2613	Cyclohexyl benzoate		C <sub>13</sub> H <sub>16</sub> O <sub>2</sub>	2412-73-9	204.265		<-10	285	1.0429 <sup>20</sup>	1.5200 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2614	Cyclohexyl butanoate		C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	1551-44-6	170.249			213	0.9572 <sup>20</sup>		i H <sub>2</sub> O; s EtOH; sl ctc
2615	3-Cyclohexyl-2-butenic acid	Cicrotoic acid	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	25229-42-9	168.233	pr (aq-MeOH)	85.5				
2616	Cyclohexyl chloroformate		C <sub>7</sub> H <sub>11</sub> ClO <sub>2</sub>	13248-54-9	162.614			87.5 <sup>27</sup>			vs eth
2617	Cyclohexylcyclohexane		C <sub>12</sub> H <sub>22</sub>	92-51-3	166.303		4	238			sl H <sub>2</sub> O; s EtOH, eth
2618	Cyclohexyldiethylamine	<i>N,N</i> -Diethylcyclohexanamine	C <sub>10</sub> H <sub>21</sub> N	91-65-6	155.281			192; 85 <sup>20</sup>	0.8443 <sup>25</sup>		s EtOH; sl ctc
2619	Cyclohexyldimethylamine	<i>N,N</i> -Dimethylcyclohexanamine	C <sub>8</sub> H <sub>17</sub> N	98-94-2	127.228			162			
2620	2-Cyclohexyl-4,6-dinitrophenol		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	131-89-5	266.249	cry	104				sl H <sub>2</sub> O; s bz, DMF
2621	(1,2-Cyclohexylenedinitrilo) tetraacetic acid monohydrate	CDTA	C <sub>14</sub> H <sub>24</sub> N <sub>2</sub> O <sub>5</sub>	13291-61-7	364.349	cry (w)	215				
2622	1-Cyclohexylethanone		C <sub>8</sub> H <sub>14</sub> O	823-76-7	126.196			180.5	0.9176 <sup>20</sup>	1.4565 <sup>16</sup>	i H <sub>2</sub> O; s eth
2623	Cyclohexylethylamine	<i>N</i> -Ethylcyclohexanamine	C <sub>8</sub> H <sub>17</sub> N	5459-93-8	127.228			164	0.868 <sup>9</sup>		sl H <sub>2</sub> O, ctc; msc EtOH, eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2624	4-Cyclohexyl-3-ethyl-4 <i>H</i> -1,2,4-triazole	Hexazole	C <sub>10</sub> H <sub>17</sub> N <sub>3</sub>	4671-03-8	179.262	pr (eth)	89.5	227 <sup>10</sup>			vs H <sub>2</sub> O, bz, chl
2625	Cyclohexyl formate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	4351-54-6	128.169			162	1.0057 <sup>9</sup>	1.4430 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, HOAc, HCOOH; vs eth
2626	Cyclohexyl hydroperoxide		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	766-07-4	116.158		-20	42 <sup>21</sup>	1.019 <sup>20</sup>	1.4645 <sup>25</sup>	vs eth, EtOH, HOAc
2627	Cyclohexylideneacetone		C <sub>8</sub> H <sub>11</sub> N	4435-18-1	121.180			107 <sup>22</sup>	0.9483 <sup>15</sup>	1.4382 <sup>25</sup>	vs eth, EtOH
2628	2-Cyclohexylidene-cyclohexanone		C <sub>12</sub> H <sub>18</sub> O	1011-12-7	178.270	cry (MeOH aq)	56.5				
2629	Cyclohexyl isocyanate	Isocyanatocyclohexane	C <sub>7</sub> H <sub>11</sub> NO	3173-53-3	125.168			172	0.98 <sup>25</sup>	1.4551 <sup>20</sup>	
2630	Cyclohexylisopropylamine	<i>N</i> -Isopropylcyclohexanamine	C <sub>9</sub> H <sub>19</sub> N	1195-42-2	141.254			62 <sup>12</sup>	0.859 <sup>25</sup>	1.4480 <sup>20</sup>	
2631	Cyclohexyl isothiocyanate	Isothiocyanatocyclohexane	C <sub>7</sub> H <sub>11</sub> NS	1122-82-3	141.234			221	1.0339 <sup>20</sup>	1.5375 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
2632	Cyclohexylmagnesium chloride		C <sub>6</sub> H <sub>11</sub> ClMg	931-51-1	142.909	hyg liq					s eth
2633	Cyclohexyl methacrylate		C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	101-43-9	168.233			210	0.9626 <sup>20</sup>	1.4578 <sup>20</sup>	
2634	Cyclohexylmethylamine	<i>N</i> -Methylcyclohexanamine	C <sub>7</sub> H <sub>15</sub> N	100-60-7	113.201			147	0.8660 <sup>23</sup>	1.4560 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH; msc eth; s chl
2635	Cyclohexyl 2-methylpropanoate		C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	1129-47-1	170.249			204	0.9489 <sup>9</sup>		vs eth, EtOH
2636	2-Cyclohexylphenol		C <sub>12</sub> H <sub>16</sub> O	119-42-6	176.254	nd (lig)	56.5				vs EtOH, HOAc
2637	4-Cyclohexylphenol		C <sub>12</sub> H <sub>16</sub> O	1131-60-8	176.254	nd (bz)	133	294; 133 <sup>4</sup>			i H <sub>2</sub> O; vs EtOH, eth; s bz; sl lig
2638	$\alpha$ -Cyclohexyl- $\alpha$ -phenyl-1-piperidinepropanol	Trihexphenidyl	C <sub>20</sub> H <sub>31</sub> NO	144-11-6	301.466		114				
2639	Cyclohexyl propanoate		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	6222-35-1	156.222			193; 93 <sup>25</sup>	0.9359 <sup>20</sup>	1.4403 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc
2640	Cyclohexylsulfamic acid	Cyclamic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>3</sub> S	100-88-9	179.237		169.5				vs alk
2641	Cyclononane		C <sub>9</sub> H <sub>18</sub>	293-55-0	126.239			11	0.8463 <sup>25</sup>	1.4666 <sup>20</sup>	
2642	Cyclononane		C <sub>9</sub> H <sub>16</sub> O	3350-30-9	140.222		34	148 <sup>24</sup> , 94 <sup>12</sup>	0.9560 <sup>20</sup>	1.4729 <sup>20</sup>	s EtOH
2643	1,4-Cyclooctadiene		C <sub>8</sub> H <sub>12</sub>	1073-07-0	108.181	liq	-53	145	0.8754 <sup>20</sup>		
2644	<i>cis,cis</i> -1,5-Cyclooctadiene		C <sub>8</sub> H <sub>12</sub>	111-78-4	108.181	liq	-56.4	150.5	0.883 <sup>20</sup>	1.4905 <sup>25</sup>	vs bz
2645	Cyclooctanamine	Aminocyclooctane	C <sub>8</sub> H <sub>17</sub> N	5452-37-9	127.228	liq	-48	190	0.928 <sup>25</sup>	1.4804 <sup>20</sup>	
2646	Cyclooctane		C <sub>8</sub> H <sub>16</sub>	292-64-8	112.213		14.59	149	0.8349 <sup>20</sup>	1.4586 <sup>20</sup>	i H <sub>2</sub> O; s bz, lig
2647	Cyclooctanol		C <sub>8</sub> H <sub>16</sub> O	696-71-9	128.212		25.1	99 <sup>16</sup>	0.9740 <sup>20</sup>	1.4871 <sup>20</sup>	s EtOH
2648	Cyclooctanone		C <sub>8</sub> H <sub>14</sub> O	502-49-8	126.196		29	196	0.9581 <sup>20</sup>	1.4694 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; sl ctc
2649	1,3,5,7-Cyclooctatetraene	[8]Annulene	C <sub>8</sub> H <sub>8</sub>	629-20-9	104.150	liq	-2.4	140.5	0.9206 <sup>20</sup>	1.5381 <sup>20</sup>	s EtOH, eth, ace, bz
2650	1,3,5-Cyclooctatriene		C <sub>8</sub> H <sub>10</sub>	1871-52-9	106.165	liq	-83	145.5	0.8971 <sup>25</sup>	1.5035 <sup>25</sup>	
2651	<i>cis</i> -Cyclooctene		C <sub>8</sub> H <sub>14</sub>	931-87-3	110.197	liq	-12	138	0.8472 <sup>20</sup>	1.4698 <sup>20</sup>	s EtOH, eth, ctc
2652	<i>trans</i> -Cyclooctene		C <sub>8</sub> H <sub>14</sub>	931-89-5	110.197	liq	-59	143	0.8483 <sup>20</sup>	1.4741 <sup>25</sup>	s EtOH, chl; sl ctc
2653	Cyclooctyne		C <sub>8</sub> H <sub>12</sub>	1781-78-8	108.181			158	0.868 <sup>20</sup>	1.4850 <sup>20</sup>	
2654	Cycloamine	11-Deoxojervine	C <sub>27</sub> H <sub>41</sub> NO <sub>2</sub>	4449-51-8	411.621	nd (EtOH)	237				
2655	Cyclopentadecane		C <sub>15</sub> H <sub>30</sub>	295-48-7	210.399	nd (MeOH)	61.3		0.8364 <sup>51</sup>	1.4592 <sup>61</sup>	
2656	Cyclopentadecanol	Exaltol	C <sub>15</sub> H <sub>30</sub> O	4727-17-7	226.398	cry (MeOH)	80.5	177 <sup>11</sup> , 145 <sup>3</sup>	0.930 <sup>20</sup>	1.4555 <sup>98</sup>	
2657	Cyclopentadecanone		C <sub>15</sub> H <sub>28</sub> O	502-72-7	224.382		63	120 <sup>9,3</sup>	0.8895 <sup>25</sup>	1.4637 <sup>60</sup>	sl H <sub>2</sub> O; s EtOH, ace
2658	1,3-Cyclopentadiene	Pyropentylene	C <sub>5</sub> H <sub>6</sub>	542-92-7	66.102	liq	-85	41	0.8021 <sup>20</sup>	1.4440 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz; s ace
2659	Cyclopentane	Pentamethylene	C <sub>5</sub> H <sub>10</sub>	287-92-3	70.133	liq	-93.4	49.3	0.7457 <sup>20</sup>	1.4065 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
2660	Cyclopentaneacetic acid		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	1123-00-8	128.169	pl	13.5	228	1.0216 <sup>18</sup>	1.4523 <sup>18</sup>	
2661	Cyclopentanecarbonitrile	Cyanocyclopentane	C <sub>6</sub> H <sub>9</sub> N	4254-02-8	95.142	liq	-76	170; 67 <sup>10</sup>	0.912	1.4410 <sup>20</sup>	
2662	Cyclopentanecarboxaldehyde		C <sub>6</sub> H <sub>10</sub> O	872-53-7	98.142			133.5	0.9371 <sup>20</sup>	1.4432 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
2663	Cyclopentanecarboxylic acid	Cyclopentanoic acid	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	3400-45-1	114.142	liq	-7	212; 104 <sup>11</sup>	1.0527 <sup>20</sup>	1.4532 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s MeOH
2664	<i>cis</i> -1,2-Cyclopentanediol		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	5057-98-7	102.132		30	124 <sup>29</sup> , 100 <sup>10</sup>			
2665	<i>trans</i> -1,2-Cyclopentanediol		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	5057-99-8	102.132		54.7	226; 136 <sup>21</sup>			
2666	Cyclopentanemethanol		C <sub>6</sub> H <sub>12</sub> O	3637-61-4	100.158			163	0.9332 <sup>20</sup>	1.4579 <sup>20</sup>	
2667	Cyclopentanepropanoic acid		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	140-77-2	142.196			158 <sup>26</sup> , 131 <sup>12</sup>	1.0100 <sup>17</sup>	1.4570 <sup>20</sup>	
2668	Cyclopentanethiol	Cyclopentyl mercaptan	C <sub>5</sub> H <sub>10</sub> S	1679-07-8	102.198			132.1	0.9550 <sup>20</sup>		
2669	Cyclopentanol	Cyclopentyl alcohol	C <sub>5</sub> H <sub>10</sub> O	96-41-3	86.132	liq	-17.5	140.42	0.9488 <sup>20</sup>	1.4530 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace
2670	Cyclopentanone	Adipic ketone	C <sub>5</sub> H <sub>8</sub> O	120-92-3	84.117	liq	-51.90	130.57	0.9487 <sup>20</sup>	1.4366 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, ctc, hx; msc eth
2671	Cyclopentanone oxime		C <sub>5</sub> H <sub>9</sub> NO	1192-28-5	99.131		57.8	196			vs H <sub>2</sub> O, bz

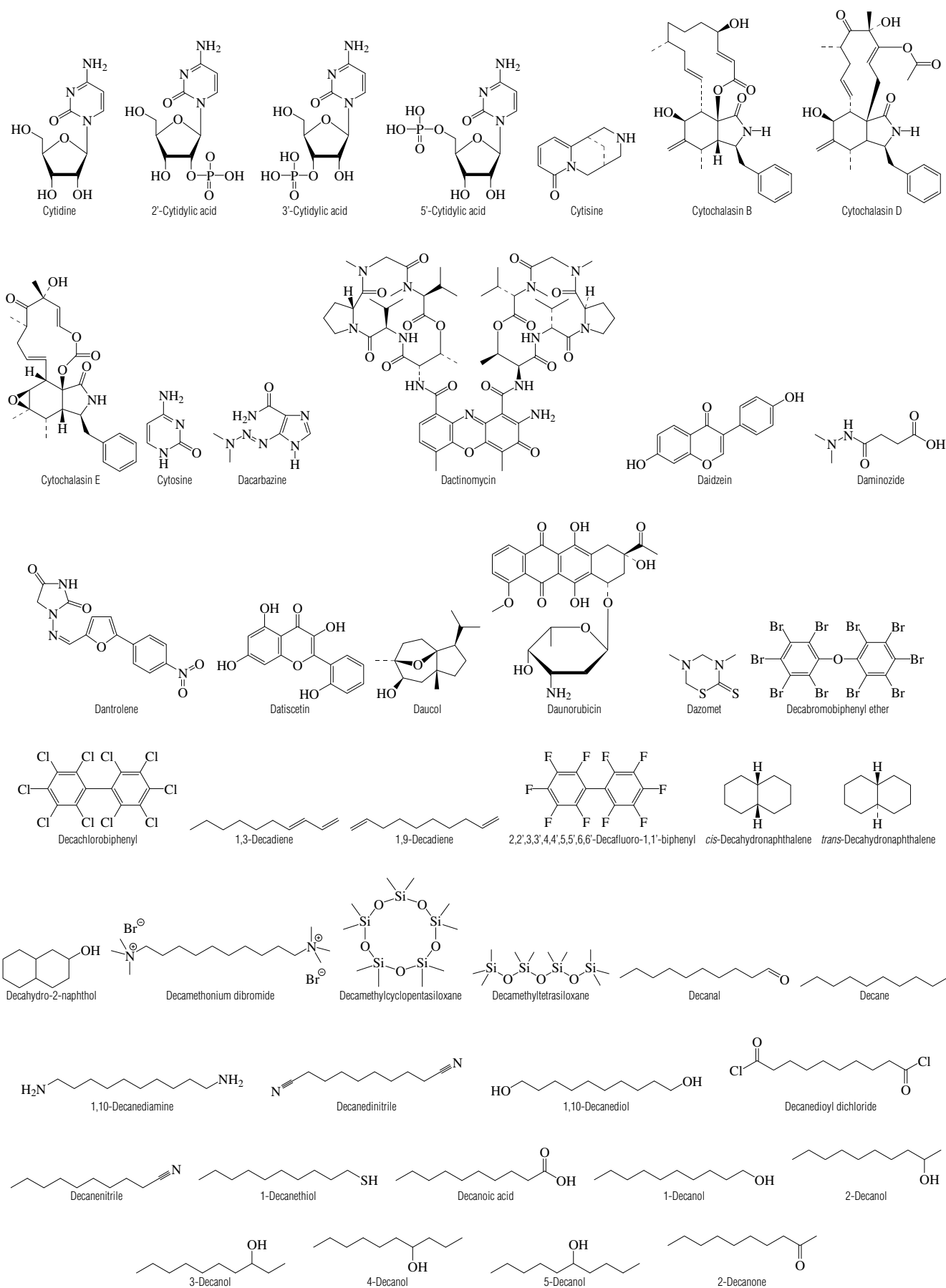


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2672	Cyclopentene		C <sub>5</sub> H <sub>8</sub>	142-29-0	68.118	liq	-135.0	44.2	0.7720 <sup>20</sup>	1.4225 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc, peth
2673	1-Cyclopentenecarbonitrile	1-Cyanocyclopentene	C <sub>6</sub> H <sub>7</sub> N	3047-38-9	93.127	liq		81 <sup>30</sup>			
2674	1-Cyclopentene-1-carboxaldehyde		C <sub>6</sub> H <sub>8</sub> O	6140-65-4	96.127	liq	-32	146	0.970 <sup>21</sup>	1.4872 <sup>17</sup>	
2675	2-Cyclopentene-1-tridecanoic acid, (S)	Chaulmoogric acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	29106-32-9	280.446	pl or lf (al, HOAc)	68.5	247 <sup>20</sup>			vs eth, chl
2676	2-Cyclopentene-1-undecanoic acid, (R)	Hydnocarpic acid	C <sub>16</sub> H <sub>28</sub> O <sub>2</sub>	459-67-6	252.392		60.5				vs EtOH, chl, peth
2677	2-Cyclopenten-1-one		C <sub>6</sub> H <sub>8</sub> O	930-30-3	82.101			136; 40 <sup>12</sup>	0.989 <sup>15</sup>	1.4629 <sup>15</sup>	vs eth, EtOH
2678	3-Cyclopenten-1-one		C <sub>6</sub> H <sub>8</sub> O	14320-37-7	82.101	liq		28 <sup>17</sup>			
2679	N-(1-Cyclopenten-1-yl)pyrrolidine	1-Pyrrolidinylcyclopentene	C <sub>9</sub> H <sub>13</sub> N	7148-07-4	137.222			105 <sup>15</sup>		1.5128 <sup>20</sup>	
2680	Cyclopenthiiazide		C <sub>13</sub> H <sub>18</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	742-20-1	379.883			238			
2681	Cyclopentobarbital		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	76-68-6	234.250	cry (w, dil al)	139.5				sl H <sub>2</sub> O; vs EtOH
2682	Cyclopentylamine	Cyclopentanamine	C <sub>5</sub> H <sub>11</sub> N	1003-03-8	85.148	liq	-82.7	108	0.8689 <sup>20</sup>	1.4728 <sup>25</sup>	s ace, bz, chl
2683	Cyclopentylbenzene		C <sub>11</sub> H <sub>14</sub>	700-88-9	146.229			219	0.9462 <sup>20</sup>	1.5280 <sup>20</sup>	vs eth
2684	2-Cyclopentylidenecyclopentanone		C <sub>10</sub> H <sub>14</sub> O	825-25-2	150.217			135 <sup>25</sup>	1.0179 <sup>18</sup>	1.5215 <sup>18</sup>	
2685	Cyclopentyl methyl sulfide		C <sub>6</sub> H <sub>12</sub> S	7133-36-0	116.224			156.2			
2686	Cyclophosphamide	Cyclophosphane	C <sub>7</sub> H <sub>15</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub> P	50-18-0	261.086		43				vs H <sub>2</sub> O; sl bz, chl, diox, EtOH
2687	Cycloposine		C <sub>33</sub> H <sub>51</sub> NO <sub>7</sub>	23185-94-6	573.761		268				
2688	Cyclopropane	Trimethylene	C <sub>3</sub> H <sub>6</sub>	75-19-4	42.080	col gas	-127.58	-32.81	0.617 <sup>25</sup> (p>1 atm)	1.3799 <sup>42</sup>	s H <sub>2</sub> O, bz, peth; vs EtOH, eth
2689	Cyclopropanecarbonitrile	Cyclopropyl cyanide	C <sub>4</sub> H <sub>5</sub> N	5500-21-0	67.090			135.1	0.8946 <sup>20</sup>	1.4229 <sup>20</sup>	s eth, hx; sl ctc
2690	Cyclopropanecarbonyl chloride		C <sub>3</sub> H <sub>5</sub> ClO	4023-34-1	104.535			119	1.1516 <sup>20</sup>		
2691	Cyclopropanecarboxaldehyde	Formylcyclopropane	C <sub>4</sub> H <sub>6</sub> O	1489-69-6	70.090	liq		100	0.938	1.4298 <sup>20</sup>	
2692	Cyclopropanecarboxylic acid		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	1759-53-1	86.090		18.5	183	1.0885 <sup>20</sup>	1.4390 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
2693	1,1-Cyclopropanedicarboxylic acid		C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	598-10-7	130.100	pr or nd (chl) pr (w +1)	140.5				vs H <sub>2</sub> O, eth
2694	Cyclopropanemethanol		C <sub>3</sub> H <sub>6</sub> O	2516-33-8	72.106			124	0.911 <sup>25</sup>		sl ctc
2695	Cyclopropanone		C <sub>3</sub> H <sub>4</sub> O	5009-27-8	56.063		stable only at low temp.				
2696	Cyclopropene		C <sub>3</sub> H <sub>4</sub>	2781-85-3	40.064	gas		dec -36			
2697	Cyclopropylamine	Cyclopropanamine	C <sub>3</sub> H <sub>7</sub> N	765-30-0	57.095	liq	-35.39	50.5	0.8240 <sup>20</sup>	1.4210 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, chl
2698	Cyclopropylbenzene		C <sub>9</sub> H <sub>10</sub>	873-49-4	118.175	liq	-31	173.6; 80 <sup>37</sup>	0.9317 <sup>20</sup>	1.5285 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, chl
2699	Cyclopropyl methyl ether		C <sub>4</sub> H <sub>8</sub> O	540-47-6	72.106	liq	-119	44.7	0.8100 <sup>20</sup>	1.3802 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
2700	Cyclopropyl methyl ketone		C <sub>5</sub> H <sub>8</sub> O	765-43-5	84.117	liq	-68.3	111.3	0.8984 <sup>20</sup>	1.4251 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
2701	Cyclotetramethylenetetranitramine	HMX	C <sub>4</sub> H <sub>8</sub> N <sub>4</sub> O <sub>8</sub>	2691-41-0	296.156	cry	286	exp			
2702	Cyclothiazide		C <sub>14</sub> H <sub>18</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	2259-96-3	389.878		234				
2703	Cycluron	N'-Cyclooctyl-N,N-dimethylurea	C <sub>11</sub> H <sub>22</sub> N <sub>2</sub> O	2163-69-1	198.305	cry	138				sl H <sub>2</sub> O; s bz, ace; vs MeOH
2704	Cyfluthrin		C <sub>22</sub> H <sub>18</sub> Cl <sub>2</sub> FNO <sub>3</sub>	68359-37-5	434.287		60				
2705	Cygon		C <sub>6</sub> H <sub>12</sub> NO <sub>3</sub> PS <sub>2</sub>	60-51-5	229.258		52	1170 <sup>1</sup>	1.277 <sup>65</sup>		
2706	Cyhalothrin	2,2-Dimethylcyclopropanecarboxylate	C <sub>23</sub> H <sub>19</sub> ClF <sub>3</sub> NO <sub>3</sub>	91465-08-6	449.850		49.2				
2707	Cyhexatin	Stannane, tricyclohexylhydroxy-	C <sub>18</sub> H <sub>34</sub> OSn	13121-70-5	385.172		196				
2708	Cypermethrin		C <sub>22</sub> H <sub>19</sub> Cl <sub>2</sub> NO <sub>3</sub>	52315-07-8	416.297		70		1.25 <sup>20</sup>		
2709	Cyprazine		C <sub>9</sub> H <sub>14</sub> ClN <sub>5</sub>	22936-86-3	227.694		167				
2710	Cyproheptadine		C <sub>21</sub> H <sub>21</sub> N	129-03-3	287.399	cry (EtOH aq)	113				
2711	Cyromazine	N-Cyclopropyl-1,3,5-triazine-2,4,6-triamine	C <sub>6</sub> H <sub>10</sub> N <sub>6</sub>	66215-27-8	166.183	cry	220				
2712	Cystamine dihydrochloride		C <sub>4</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub> S <sub>2</sub>	56-17-7	225.203	nd (MeOH)	218 dec				vs H <sub>2</sub> O, EtOH
2713	Cysteamine		C <sub>2</sub> H <sub>7</sub> NS	60-23-1	77.149	cry (sub)	99.5	dec			vs H <sub>2</sub> O, EtOH
2714	L-Cysteic acid		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub> S	13100-82-8	169.157	cry	260 dec				s H <sub>2</sub> O; i EtOH
2715	L-Cysteine	Propanoic acid, 2-amino-3-mercapto-, (R)-	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub> S	52-90-4	121.159	cry (w)	240 dec				vs H <sub>2</sub> O, ace, EtOH
2716	L-Cysteine, ethyl ester, hydrochloride		C <sub>5</sub> H <sub>12</sub> ClNO <sub>2</sub> S	868-59-7	185.673		125.8				vs H <sub>2</sub> O
2717	L-Cysteine, hydrochloride		C <sub>3</sub> H <sub>7</sub> ClNO <sub>2</sub> S	52-89-1	157.620	cry	175 dec				s H <sub>2</sub> O
2718	L-Cystine	3,3'-Dithiobis(2-aminopropanoic acid)	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	56-89-3	240.300	hex pl or pr (w)	260 dec		1.677 <sup>25</sup>		sl H <sub>2</sub> O; i EtOH, eth, bz; s acid, alk
2719	Cytarabine	Cytosine arabinoside	C <sub>9</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub>	147-94-4	243.216	pr (EtOH aq)	212				s H <sub>2</sub> O

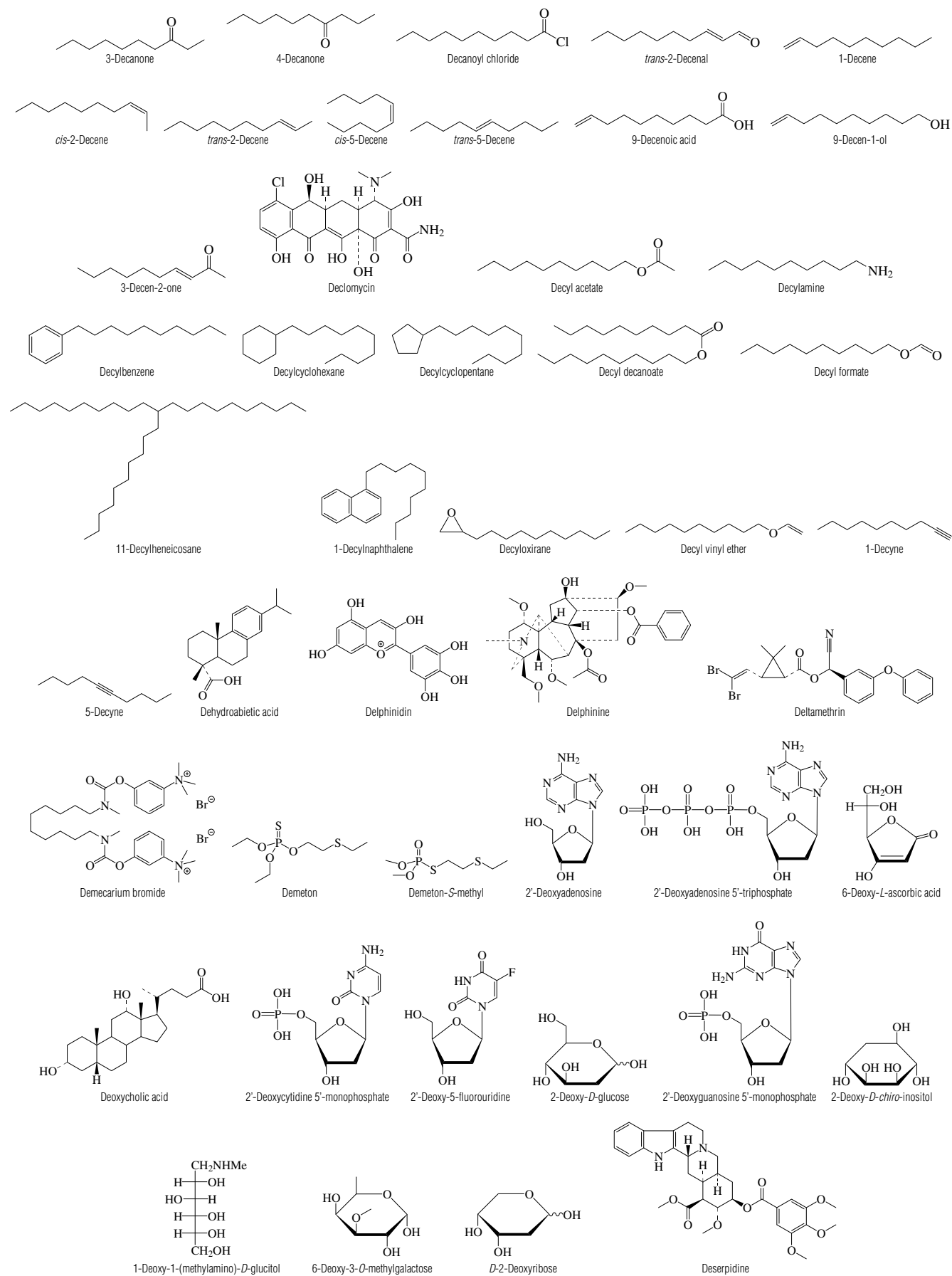


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2720	Cytidine	4-Amino-1-β-D-ribofuranosyl-2(1H)-pyrimidinone	C <sub>9</sub> H <sub>13</sub> N <sub>3</sub> O <sub>5</sub>	65-46-3	243.216	nd (dil al)	230 dec				vs H <sub>2</sub> O; sl EtOH
2721	2'-Cytidylic acid	Cytidine 2'-monophosphate	C <sub>9</sub> H <sub>14</sub> N <sub>3</sub> O <sub>8</sub> P	85-94-9	323.196		239 dec				
2722	3'-Cytidylic acid	Cytidine 3'-monophosphate	C <sub>9</sub> H <sub>14</sub> N <sub>3</sub> O <sub>8</sub> P	84-52-6	323.196		233 dec				s H <sub>2</sub> O, EtOH
2723	5'-Cytidylic acid	Cytidine 5'-monophosphate	C <sub>9</sub> H <sub>14</sub> N <sub>3</sub> O <sub>8</sub> P	63-37-6	323.196	orth nd	233 dec				vs H <sub>2</sub> O, EtOH
2724	Cytisine	Sophorine	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O	485-35-8	190.241	pr	153	218 <sup>2</sup>			vs H <sub>2</sub> O, EtOH, MeOH; s bz, ace
2725	Cytochalasin B		C <sub>29</sub> H <sub>37</sub> NO <sub>5</sub>	14930-96-2	479.608	nd (ace)	219				
2726	Cytochalasin D	Zygosporin A	C <sub>30</sub> H <sub>37</sub> NO <sub>6</sub>	22144-77-0	507.618	nd (ace/peth)	270				
2727	Cytochalasin E		C <sub>28</sub> H <sub>33</sub> NO <sub>7</sub>	36011-19-5	495.565		207				
2728	Cytosine		C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O	71-30-7	111.102	mcl or tcl pl (w+1)	322 dec				s H <sub>2</sub> O; sl EtOH, chl; i eth
2729	Dacarbazine	5-(3,3-Dimethyl-1-triazenyl)-1H-imidazole-4-carboxamide	C <sub>6</sub> H <sub>8</sub> N <sub>6</sub> O	4342-03-4	182.182	cry	205				
2730	Dactinomycin		C <sub>62</sub> H <sub>86</sub> N <sub>12</sub> O <sub>16</sub>	50-76-0	1255.416		245 dec				
2731	Daidzein	7-Hydroxy-3-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	C <sub>15</sub> H <sub>10</sub> O <sub>4</sub>	486-66-8	254.238	pa ye pr (50% al)	323 dec	sub			s EtOH, eth
2732	Daminozide	Butanedioic acid, mono(2,2-dimethylhydrazide)	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	1596-84-5	160.170		154.5				
2733	Dantrolene		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>5</sub>	7261-97-4	314.253	cry (DMF aq)	280				
2734	Datiscetin		C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>	480-15-9	286.236	pa ye nd (al, aq HOAc)	277.5				vs ace, eth, EtOH
2735	Daucol		C <sub>15</sub> H <sub>26</sub> O <sub>2</sub>	887-08-1	238.366	cry	114	128 <sup>2</sup>			
2736	Daunorubicin		C <sub>27</sub> H <sub>29</sub> NO <sub>10</sub>	20830-81-3	527.520	red nd	208				
2737	Dazomet		C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> S <sub>2</sub>	533-74-4	162.276	nd (bz)	106				reac H <sub>2</sub> O; s EtOH
2738	Decabromobiphenyl ether	Bis(pentabromophenyl) ether	C <sub>12</sub> Br <sub>10</sub> O	1163-19-5	959.167	ye pr (tol)	305				i H <sub>2</sub> O
2739	Decachlorobiphenyl		C <sub>12</sub> Cl <sub>10</sub>	2051-24-3	498.658	cry (bz)	309				i H <sub>2</sub> O
2740	1,3-Decadiene	1-Hexyl-1,3-butadiene	C <sub>10</sub> H <sub>18</sub>	2051-25-4	138.250			169	0.752 <sup>30</sup>		vs bz
2741	1,9-Decadiene		C <sub>10</sub> H <sub>18</sub>	1647-16-1	138.250			167	0.75 <sup>25</sup>	1.4325 <sup>20</sup>	
2742	2,2',3,3',4,4',5,5',6,6'-Decafluoro-1,1'-biphenyl		C <sub>12</sub> F <sub>10</sub>	434-90-2	334.112		67.5	206	1.785 <sup>20</sup>		
2743	cis-Decahydronaphthalene	cis-Decalin	C <sub>10</sub> H <sub>18</sub>	493-01-6	138.250	liq	-42.9	195.8	0.8965 <sup>20</sup>	1.4810 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; vs eth, ace, chl
2744	trans-Decahydronaphthalene	trans-Decalin	C <sub>10</sub> H <sub>18</sub>	493-02-7	138.250	liq	-30.4	187.3	0.8659 <sup>25</sup>	1.4695 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace; msc bz; sl MeOH
2745	Decahydro-2-naphthol	Decahydro-β-naphthol	C <sub>10</sub> H <sub>18</sub> O	825-51-4	154.249			109 <sup>14</sup>	0.996 <sup>25</sup>	1.4992 <sup>20</sup>	
2746	Decamethonium dibromide		C <sub>16</sub> H <sub>38</sub> Br <sub>2</sub> N <sub>2</sub>	541-22-0	418.294	cry (MeOH/ace)	269 dec				i eth
2747	Decamethylcyclopentasiloxane		C <sub>10</sub> H <sub>30</sub> O <sub>5</sub> Si <sub>5</sub>	541-02-6	370.770	liq	-38	210	0.9593 <sup>20</sup>	1.3982 <sup>20</sup>	i H <sub>2</sub> O
2748	Decamethyltetrasiloxane		C <sub>10</sub> H <sub>30</sub> O <sub>3</sub> Si <sub>4</sub>	141-62-8	310.685	liq	-76	194	0.8536 <sup>25</sup>	1.3895 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s bz, peth
2749	Decanal	Capraldehyde	C <sub>10</sub> H <sub>20</sub> O	112-31-2	156.265	liq	-4.0	208.5	0.830 <sup>15</sup>	1.4287 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; sl ctc
2750	Decane		C <sub>10</sub> H <sub>22</sub>	124-18-5	142.282	liq	-29.6	174.15	0.7266 <sup>25</sup>	1.4090 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH; s eth; sl ctc
2751	1,10-Decanediamine		C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>	646-25-3	172.311		59.73	140 <sup>12</sup>			
2752	Decanedinitrile		C <sub>10</sub> H <sub>16</sub> N <sub>2</sub>	1871-96-1	164.247		7.6	204 <sup>16</sup>	0.913 <sup>20</sup>	1.4474 <sup>20</sup>	i H <sub>2</sub> O; s chl
2753	1,10-Decanediol	Decamethylene glycol	C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	112-47-0	174.281	nd (w, dil al)	74	192 <sup>20</sup>			sl H <sub>2</sub> O, eth; vs EtOH; s DMSO; i lig
2754	Decanedioyl dichloride		C <sub>10</sub> H <sub>16</sub> Cl <sub>2</sub> O <sub>2</sub>	111-19-3	239.139		-1.3	220 <sup>75</sup> , 165 <sup>11</sup>	1.1212 <sup>20</sup>	1.4684 <sup>18</sup>	
2755	Decanenitrile	Caprinitrile	C <sub>10</sub> H <sub>19</sub> N	1975-78-6	153.265	liq	-17.9	243; 106 <sup>10</sup>	0.8199 <sup>20</sup>	1.4296 <sup>20</sup>	vs ace, eth, EtOH, chl
2756	1-Decanethiol	Decyl mercaptan	C <sub>10</sub> H <sub>22</sub> S	143-10-2	174.347	liq	-26	240.6	0.8443 <sup>20</sup>	1.4509 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2757	Decanoic acid	Capric acid	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	334-48-5	172.265	nd	31.4	268.7	0.8858 <sup>40</sup>	1.4288 <sup>40</sup>	i H <sub>2</sub> O; vs ace, bz, eth, EtOH
2758	1-Decanol	Capric alcohol	C <sub>10</sub> H <sub>22</sub> O	112-30-1	158.281		6.9	231.1	0.8297 <sup>20</sup>	1.4372 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl; s ctc
2759	2-Decanol		C <sub>10</sub> H <sub>22</sub> O	74742-10-2	158.281	liq	-1.2	211	0.8250 <sup>20</sup>	1.4326 <sup>25</sup>	s EtOH, bz; msc eth, ace; sl ctc
2760	3-Decanol		C <sub>10</sub> H <sub>22</sub> O	1565-81-7	158.281	liq	-7.5	213; 101 <sup>12</sup>	0.827 <sup>20</sup>	1.434 <sup>20</sup>	
2761	4-Decanol	1-Propylheptyl alcohol	C <sub>10</sub> H <sub>22</sub> O	2051-31-2	158.281	liq	-11	210.5	0.8261 <sup>20</sup>	1.4320 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc
2762	5-Decanol		C <sub>10</sub> H <sub>22</sub> O	5205-34-5	158.281	liq	8.7	201	0.824 <sup>20</sup>	1.4333 <sup>20</sup>	
2763	2-Decanone	Methyl octyl ketone	C <sub>10</sub> H <sub>20</sub> O	693-54-9	156.265	nd	14	210; 96 <sup>12</sup>	0.8248 <sup>20</sup>	1.4255 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc

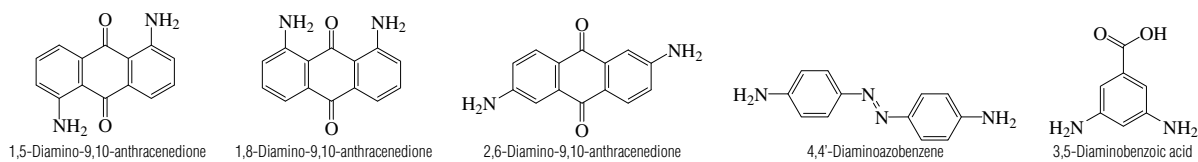
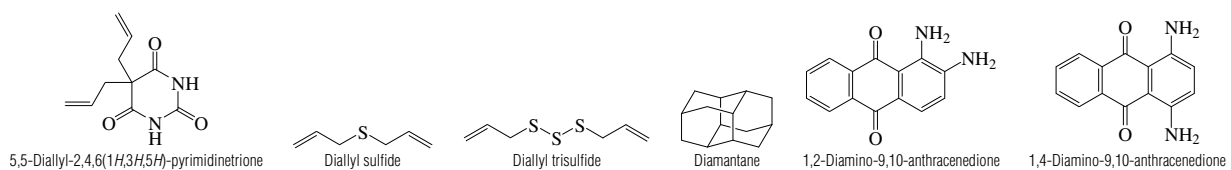
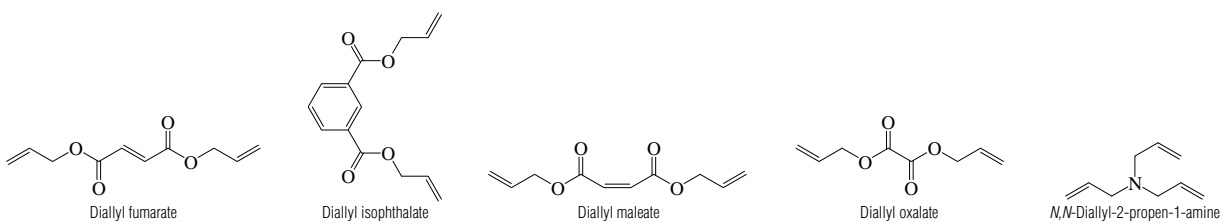
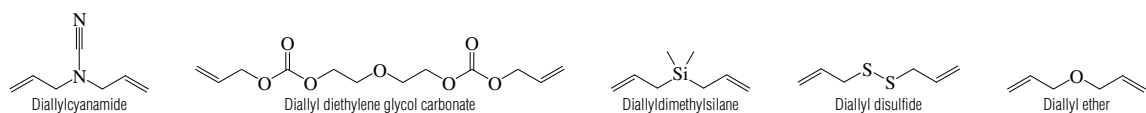
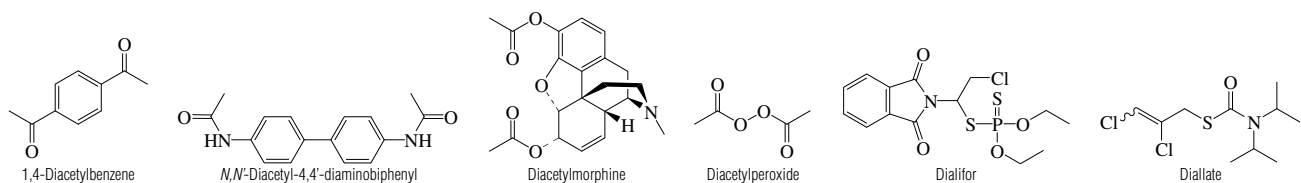
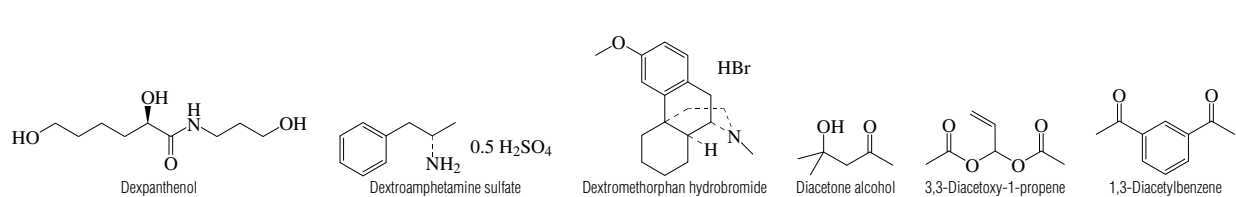
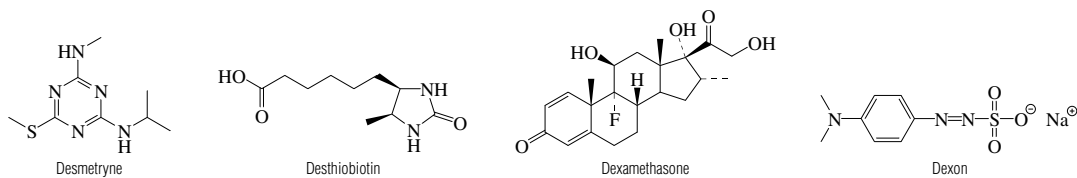
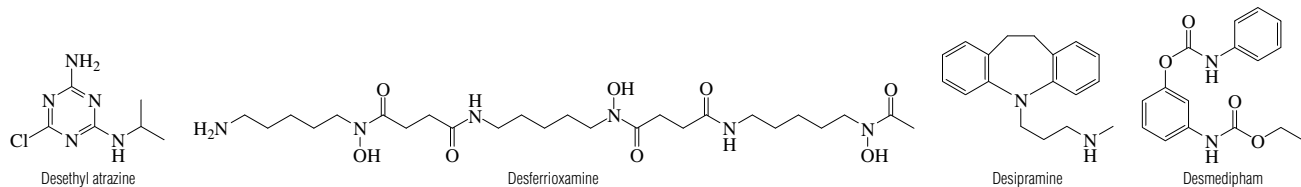




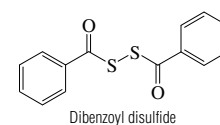
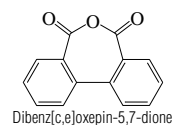
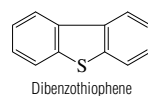
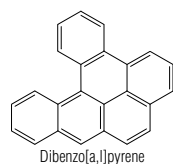
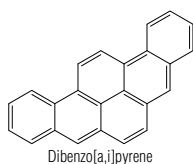
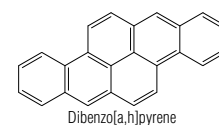
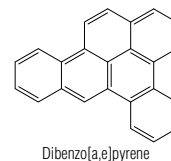
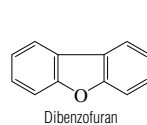
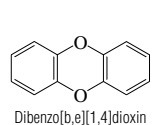
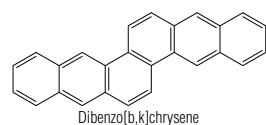
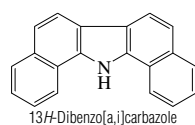
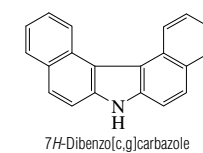
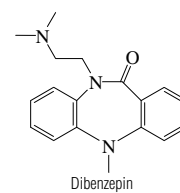
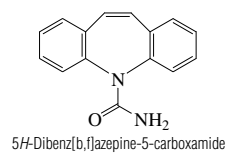
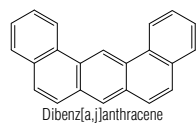
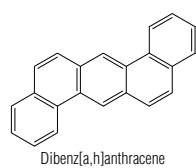
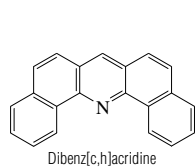
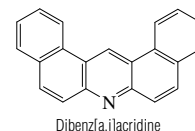
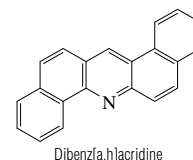
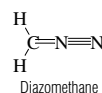
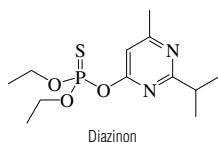
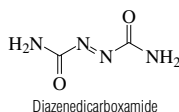
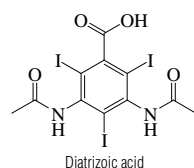
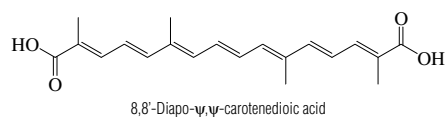
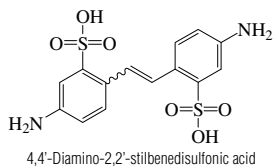
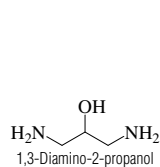
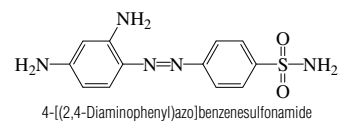
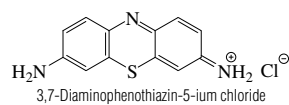
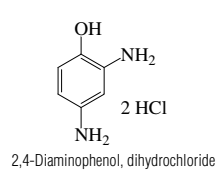
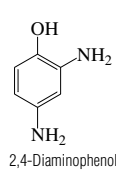
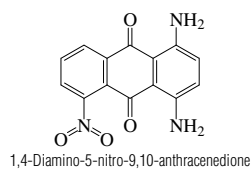
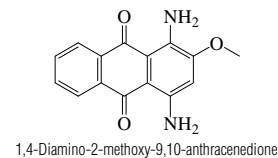
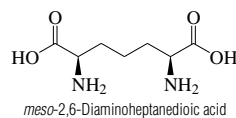
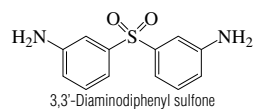
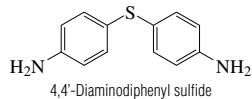
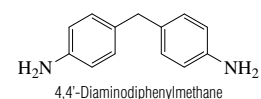
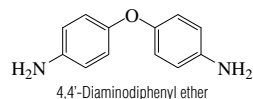
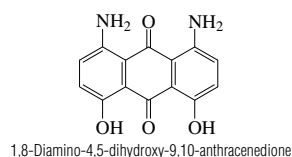
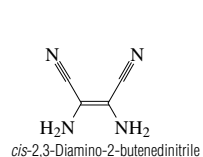
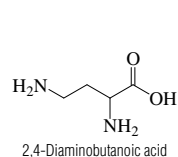
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2764	3-Decanone	Ethyl heptyl ketone	C <sub>10</sub> H <sub>20</sub> O	928-80-3	156.265	liq	1.3	203	0.8251 <sup>20</sup>	1.4252 <sup>20</sup>	s EtOH, eth, ctc
2765	4-Decanone	Hexyl propyl ketone	C <sub>10</sub> H <sub>20</sub> O	624-16-8	156.265	liq	-9	206.5	0.824 <sup>20</sup>	1.4240 <sup>21</sup>	i H <sub>2</sub> O; msc EtOH, eth
2766	Decanoyl chloride	Caprinoyl chloride	C <sub>10</sub> H <sub>19</sub> ClO	112-13-0	190.710	liq	-34.5	95	0.919 <sup>25</sup>	1.4410 <sup>20</sup>	s eth, ctc
2767	<i>trans</i> -2-Decenal		C <sub>10</sub> H <sub>18</sub> O	3913-81-3	154.249			230; 107 <sup>11</sup>			
2768	1-Decene		C <sub>10</sub> H <sub>20</sub>	872-05-9	140.266	liq	-66.3	170.5	0.7408 <sup>20</sup>	1.4215 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
2769	<i>cis</i> -2-Decene		C <sub>10</sub> H <sub>20</sub>	20348-51-0	140.266	col liq		174.2			
2770	<i>trans</i> -2-Decene		C <sub>10</sub> H <sub>20</sub>	20063-97-2	140.266	col liq		173.3			
2771	<i>cis</i> -5-Decene		C <sub>10</sub> H <sub>20</sub>	7433-78-5	140.266	col liq	-112	171; 73 <sup>20</sup>	0.7445 <sup>20</sup>	1.4258 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
2772	<i>trans</i> -5-Decene		C <sub>10</sub> H <sub>20</sub>	7433-56-9	140.266	col liq	-73	171	0.7401 <sup>20</sup>	1.4243 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
2773	9-Decenoic acid	Caproic acid	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	14436-32-9	170.249		26.5	158 <sup>21</sup> , 142 <sup>4</sup>	0.9238 <sup>15</sup>	1.4507 <sup>15</sup>	vs eth, EtOH
2774	9-Decen-1-ol	Decylenic alcohol	C <sub>10</sub> H <sub>20</sub> O	13019-22-2	156.265			236	0.876 <sup>25</sup>	1.4480 <sup>20</sup>	
2775	3-Decen-2-one	Heptylidene acetone	C <sub>10</sub> H <sub>18</sub> O	10519-33-2	154.249			102 <sup>15,3</sup>	0.8473 <sup>20</sup>	1.4480 <sup>20</sup>	
2776	Declomycin	Demeclocycline	C <sub>21</sub> H <sub>21</sub> ClN <sub>2</sub> O <sub>6</sub>	127-33-3	464.853	cry	176 dec				
2777	Decyl acetate		C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	112-17-4	200.318	liq	-15	244	0.8671 <sup>20</sup>	1.4273 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc, HOAc
2778	Decylamine	1-Decanamine	C <sub>10</sub> H <sub>23</sub> N	2016-57-1	157.297		17	220.5	0.7936 <sup>20</sup>	1.4369 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl
2779	Decylbenzene		C <sub>16</sub> H <sub>26</sub>	104-72-3	218.377	liq	-14.4	293	0.8555 <sup>20</sup>	1.4832 <sup>20</sup>	vs ace, bz, eth, EtOH
2780	Decylcyclohexane		C <sub>16</sub> H <sub>32</sub>	1795-16-0	224.425	liq	-0.9	299	0.8186 <sup>20</sup>	1.4534 <sup>20</sup>	
2781	Decylcyclopentane		C <sub>15</sub> H <sub>30</sub>	1795-21-7	210.399	liq	-22	279	0.8110 <sup>20</sup>	1.4486 <sup>20</sup>	vs ace, bz, eth, EtOH
2782	Decyl decanoate		C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	1654-86-0	312.531		9.7	219 <sup>15</sup>	0.8586 <sup>20</sup>	1.4423 <sup>20</sup>	vs eth
2783	Decyl formate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	5451-52-5	186.292	liq		243			
2784	11-Decylheneicosane		C <sub>31</sub> H <sub>64</sub>	55320-06-4	436.840		10.0	282.0 <sup>10</sup>	0.8116 <sup>20</sup>	1.4540 <sup>20</sup>	
2785	1-Decylnaphthalene		C <sub>20</sub> H <sub>28</sub>	26438-27-7	268.436		15	379	0.9322 <sup>20</sup>	1.5435 <sup>20</sup>	
2786	Decyloxirane		C <sub>12</sub> H <sub>24</sub> O	2855-19-8	184.318					1.4347 <sup>25</sup>	sl ctc
2787	Decyl vinyl ether	1-(Ethenyloxy)decane	C <sub>12</sub> H <sub>24</sub> O	765-05-9	184.318		-41	101 <sup>10</sup>	0.812 <sup>20</sup>	1.4346 <sup>20</sup>	
2788	1-Decyne	Octylacetylene	C <sub>10</sub> H <sub>18</sub>	764-93-2	138.250	liq	-44	174	0.7655 <sup>20</sup>	1.4265 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2789	5-Decyne	Dibutylacetylene	C <sub>10</sub> H <sub>18</sub>	1942-46-7	138.250	liq	-73	177; 78.8 <sup>25</sup>	0.7690 <sup>20</sup>	1.4331 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
2790	Dehydroabietic acid	8,11,13-Abietatrien-18-oic acid	C <sub>20</sub> H <sub>28</sub> O <sub>2</sub>	1740-19-8	300.435	cry (EtOH aq)	172				
2791	Delphinidin		C <sub>15</sub> H <sub>11</sub> ClO <sub>7</sub>	528-53-0	338.697		>350				vs H <sub>2</sub> O, EtOH, MeOH; s AcOEt
2792	Delphinine		C <sub>33</sub> H <sub>45</sub> NO <sub>9</sub>	561-07-9	599.712	orth (al)	199				i H <sub>2</sub> O; s chl, ace, eth; vs EtOH
2793	Deltamethrin		C <sub>22</sub> H <sub>19</sub> Br <sub>2</sub> NO <sub>3</sub>	52918-63-5	505.199		99				
2794	Demecarium bromide		C <sub>32</sub> H <sub>52</sub> Br <sub>2</sub> N <sub>4</sub> O <sub>4</sub>	56-94-0	716.588	hyg pow	165 dec				vs H <sub>2</sub> O; sl ace; i ace, eth
2795	Demeton	Systox	C <sub>8</sub> H <sub>19</sub> O <sub>3</sub> PS <sub>2</sub>	8065-48-3	258.339	oily liq		134 <sup>2</sup>			i H <sub>2</sub> O; s EtOH, tol
2796	Demeton-S-methyl		C <sub>8</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	919-86-8	230.285	ye liq		89 <sup>15</sup> , 118 <sup>1</sup>	1.20 <sup>20</sup>	1.5063 <sup>20</sup>	i H <sub>2</sub> O; s os
2797	2'-Deoxyadenosine		C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub>	958-09-8	251.242						sl H <sub>2</sub> O
2798	2'-Deoxyadenosine 5'-triphosphate		C <sub>10</sub> H <sub>16</sub> N <sub>5</sub> O <sub>12</sub> P <sub>3</sub>	1927-31-7	491.182	cry (EtOH aq)					
2799	6-Deoxy-L-ascorbic acid		C <sub>6</sub> H <sub>8</sub> O <sub>5</sub>	528-81-4	160.125	pr (AcOEt)	168	sub 160			vs H <sub>2</sub> O, ace, EtOH
2800	Deoxycholic acid	3,12-Dihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,12 $\alpha$ )	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	83-44-3	392.573	cry (al)	177				
2801	2'-Deoxycytidine 5'-monophosphate	2'-Deoxy-5'-cytidylic acid	C <sub>9</sub> H <sub>14</sub> N <sub>3</sub> O <sub>7</sub> P	1032-65-1	307.197	pow	183 dec				
2802	2'-Deoxy-5-fluorouridine	Floxuridine	C <sub>9</sub> H <sub>11</sub> FN <sub>2</sub> O <sub>5</sub>	50-91-9	246.191	cry	150				
2803	2-Deoxy-D-glucose		C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	154-17-6	164.156		146.5				
2804	2'-Deoxyguanosine 5'-monophosphate	2'-Deoxy-5'-guanylic acid	C <sub>10</sub> H <sub>14</sub> N <sub>5</sub> O <sub>7</sub> P	902-04-5	347.222						s H <sub>2</sub> O
2805	2-Deoxy-D-chiro-inositol	D-Quercitol	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	488-73-3	164.156	pr (w, dil al)	236		1.5845 <sup>13</sup>		vs H <sub>2</sub> O
2806	1-Deoxy-1-(methylamino)-D-glucitol	N-Methylglucamine	C <sub>7</sub> H <sub>17</sub> NO <sub>5</sub>	6284-40-8	195.214	cry (MeOH)	128.5				s H <sub>2</sub> O
2807	6-Deoxy-3-O-methylgalactose	Digitalose	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	4481-08-7	178.183	nd (AcOEt)	119				vs H <sub>2</sub> O
2808	D-2-Deoxyribose		C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	533-67-5	134.131		90				
2809	Deserpidine		C <sub>32</sub> H <sub>38</sub> N <sub>2</sub> O <sub>6</sub>	131-01-1	578.652	nd or pr	230.5				i H <sub>2</sub> O; s EtOH, chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2810	Desethyl atrazine	6-Chloro- <i>N</i> -isopropyl-1,3,5-triazine-2,4-diamine	C <sub>8</sub> H <sub>10</sub> ClN <sub>5</sub>	6190-65-4	187.630	cry	136				
2811	Desferrioxamine	Deferoxamine	C <sub>25</sub> H <sub>48</sub> N <sub>6</sub> O <sub>8</sub>	70-51-9	560.684	cry (EtOH aq)	139				
2812	Desipramine		C <sub>18</sub> H <sub>22</sub> N <sub>2</sub>	50-47-5	266.381			173 <sup>0.02</sup>			
2813	Desmedipham		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub>	13684-56-5	300.309		120				
2814	Desmetryne		C <sub>8</sub> H <sub>15</sub> N <sub>5</sub> S	1014-69-3	213.304	cry	85				
2815	Desthiobiotin		C <sub>10</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	533-48-2	214.261	lo nd (H <sub>2</sub> O)	157				s H <sub>2</sub> O
2816	Dexamethasone		C <sub>22</sub> H <sub>26</sub> FO <sub>5</sub>	50-02-2	392.460		262				
2817	Dexon	Sodium dimethylaminobenzenediazosulfonate	C <sub>8</sub> H <sub>10</sub> N <sub>3</sub> NaO <sub>3</sub> S	140-56-7	251.238	ye-br pow					sl H <sub>2</sub> O; s DMF
2818	Dexpanthenol		C <sub>9</sub> H <sub>19</sub> NO <sub>4</sub>	81-13-0	205.252	hyg oil		dec	1.20 <sup>20</sup>	1.497 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, MeOH; sl eth
2819	Dextroamphetamine sulfate		C <sub>18</sub> H <sub>28</sub> N <sub>2</sub> O <sub>4</sub> S	51-63-8	368.491		>300		1.15 <sup>25</sup>		vs H <sub>2</sub> O
2820	Dextromethorphan hydrobromide		C <sub>18</sub> H <sub>26</sub> BrNO	125-69-9	352.309	wh cry pow	123				s EtOH, chl; i eth
2821	Diacetone alcohol	4-Hydroxy-4-methyl-2-pentanone	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	123-42-2	116.158	liq	-44	167.9	0.9387 <sup>20</sup>	1.4213 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
2822	3,3-Diacetoxy-1-propene		C <sub>7</sub> H <sub>10</sub> O <sub>4</sub>	869-29-4	158.152	liq	-37.6	180	1.0760 <sup>20</sup>	1.4193 <sup>20</sup>	vs ace, bz, eth, EtOH
2823	1,3-Diacetylbenzene		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	6781-42-6	162.185		32	152 <sup>15</sup>			sl H <sub>2</sub> O, peth; s EtOH, bz, chl, HOAc
2824	1,4-Diacetylbenzene	4-Acetylacetophenone	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	1009-61-6	162.185		113.0	128 <sup>3</sup>			vs EtOH; sl chl
2825	<i>N,N'</i> -Diacetyl-4,4'-diaminobiphenyl		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	613-35-4	268.310	nd (HOAc)	328.3				
2826	Diacetylmorphine		C <sub>21</sub> H <sub>23</sub> NO <sub>5</sub>	561-27-3	369.412	orth	173	273 <sup>12</sup>	1.56 <sup>25</sup>		vs bz, chl
2827	Diacetylperoxide	Acetyl peroxide	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	110-22-5	118.089	nd (eth) lf	30	63 <sup>21</sup>			vs eth, EtOH
2828	Dialifor		C <sub>14</sub> H <sub>17</sub> ClNO <sub>4</sub> PS <sub>2</sub>	10311-84-9	393.846		68				
2829	Diallate		C <sub>10</sub> H <sub>17</sub> Cl <sub>2</sub> NOS	2303-16-4	270.219			150 <sup>9</sup>			
2830	Diallylcyanamide		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	538-08-9	122.167			142 <sup>90</sup> , 95 <sup>9</sup>			s EtOH; sl eth, ctc
2831	Diallyl diethylene glycol carbonate	Diethylene glycol bis(allyl carbonate)	C <sub>12</sub> H <sub>18</sub> O <sub>7</sub>	142-22-3	274.267	col liq	-4	161 <sup>2</sup>	1.14 <sup>20</sup>		i H <sub>2</sub> O; s os
2832	Diallyldimethylsilane		C <sub>8</sub> H <sub>16</sub> Si	1113-12-8	140.299			137; 68 <sup>20</sup>	0.7679 <sup>20</sup>	1.4420 <sup>20</sup>	
2833	Diallyl disulfide		C <sub>6</sub> H <sub>10</sub> S <sub>2</sub>	2179-57-9	146.273			100 <sup>48</sup> , 79 <sup>16</sup>	1.0237 <sup>15</sup>		
2834	Diallyl ether	Allyl ether	C <sub>6</sub> H <sub>10</sub> O	557-40-4	98.142	liq	-6	94	0.8260 <sup>20</sup>	1.4163 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace; s chl
2835	Diallyl fumarate		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	2807-54-7	196.200			140 <sup>3</sup>	1.0768 <sup>20</sup>	1.4670 <sup>25</sup>	vs ace, bz, eth, EtOH
2836	Diallyl isophthalate	Di-2-propenyl 1,3-benzenedicarboxylate	C <sub>14</sub> H <sub>14</sub> O <sub>4</sub>	1087-21-4	246.259			176 <sup>5</sup>			
2837	Diallyl maleate		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	999-21-3	196.200			129 <sup>10</sup> , 109 <sup>3</sup>	1.075 <sup>20</sup>	1.4699 <sup>20</sup>	s chl
2838	Diallyl oxalate		C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	615-99-6	170.163			217	1.1582 <sup>20</sup>	1.4481 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; sl chl
2839	<i>N,N</i> -Diallyl-2-propen-1-amine	Triallylamine	C <sub>9</sub> H <sub>15</sub> N	102-70-5	137.222		94	155.5	0.809 <sup>20</sup>	1.4502 <sup>20</sup>	s EtOH, eth, ace, bz, acid
2840	5,5-Diallyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	Allobarbital	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	52-43-7	208.213	lf	172				sl H <sub>2</sub> O, DMSO; s EtOH, eth, bz
2841	Diallyl sulfide		C <sub>6</sub> H <sub>10</sub> S	592-88-1	114.208	liq	-85	138.6	0.8877 <sup>27</sup>	1.4870 <sup>25</sup>	vs eth, EtOH
2842	Diallyl trisulfide		C <sub>6</sub> H <sub>10</sub> S <sub>3</sub>	2050-87-5	178.338			117 <sup>16</sup>	1.0845 <sup>15</sup>		vs eth
2843	Diamantane	Congressane	C <sub>14</sub> H <sub>20</sub>	2292-79-7	188.309	cry	236				
2844	1,2-Diamino-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	1758-68-5	238.241	viol nd	303.5				sl EtOH, eth, chl, xyl; s py, con sulf
2845	1,4-Diamino-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	128-95-0	238.241	dk viol nd (py)	268				sl H <sub>2</sub> O; s EtOH, bz, PhNO <sub>2</sub> ; vs py
2846	1,5-Diamino-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	129-44-2	238.241	dk red nd (al, HOAc)	319	sub			i H <sub>2</sub> O; sl EtOH, eth, ace, bz; s PhNO <sub>2</sub>
2847	1,8-Diamino-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	129-42-0	238.241	red nd (al, HOAc)	265				i H <sub>2</sub> O; s EtOH, py; sl eth, HOAc
2848	2,6-Diamino-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	131-14-6	238.241	red-br pr (aq-py)	320	dec			sl H <sub>2</sub> O; s EtOH, chl, con sulf, xyl, py
2849	4,4'-Diaminoazobenzene		C <sub>12</sub> H <sub>12</sub> N <sub>4</sub>	538-41-0	212.250	ye nd (al), oran-ye pr (al)	250.5				sl H <sub>2</sub> O, lig; s EtOH; vs bz, chl
2850	3,5-Diaminobenzoic acid		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	535-87-5	152.151	nd (+1w)	228				sl H <sub>2</sub> O, tta; s EtOH; vs eth

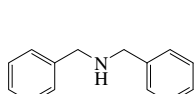


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2851	2,4-Diaminobutanoic acid		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	305-62-4	118.134	hyg cry					s H <sub>2</sub> O; sl EtOH, MeOH
2852	<i>cis</i> -2,3-Diamino-2-butenedinitrile		C <sub>4</sub> H <sub>4</sub> N <sub>4</sub>	1187-42-4	108.102		178.5		1.41 <sup>20</sup>		
2853	1,8-Diamino-4,5-dihydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	128-94-9	270.240	bl nd (xyl)					i H <sub>2</sub> O; s bz, xyl, EtOH
2854	4,4'-Diaminodiphenyl ether	4,4'-Oxydianiline	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O	101-80-4	200.235		189 dec	>300			
2855	4,4'-Diaminodiphenylmethane	4,4'-Methylenedianiline	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub>	101-77-9	198.263	pl or nd (w) pl (bz)	92.5	398; 257 <sup>18</sup>			sl H <sub>2</sub> O; vs EtOH, eth, bz
2856	4,4'-Diaminodiphenyl sulfide	4,4'-Thiodianiline	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> S	139-65-1	216.301	nd (w)	108.5				sl H <sub>2</sub> O; vs EtOH, eth, bz; s tfa
2857	3,3'-Diaminodiphenyl sulfone	3,3'-Sulfonyldianiline	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub> S	599-61-1	248.300		168.5				vs H <sub>2</sub> O, EtOH
2858	<i>meso</i> -2,6-Diaminoheptanedioic acid	2,6-Diaminopimelic acid	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub>	922-54-3	190.197	nd (w)	314 dec				s H <sub>2</sub> O
2859	1,4-Diamino-2-methoxy-9,10-anthracenedione		C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	2872-48-2	268.267		235				
2860	1,4-Diamino-5-nitro-9,10-anthracenedione		C <sub>14</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	82-33-7	283.239		278				
2861	2,4-Diaminophenol		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	95-86-3	124.140	lf	79 dec				vs H <sub>2</sub> O, ace, EtOH
2862	2,4-Diaminophenol, dihydrochloride		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O	137-09-7	197.061	nd	235 dec				vs H <sub>2</sub> O
2863	3,7-Diaminophenothiazin-5-ium chloride	Thionine	C <sub>12</sub> H <sub>10</sub> ClN <sub>2</sub> S	581-64-6	263.745						sl H <sub>2</sub> O, EtOH, eth; s bz, chl, acid
2864	4-[(2,4-Diaminophenyl)azo]benzenesulfonamide	Prontosil	C <sub>12</sub> H <sub>14</sub> ClN <sub>5</sub> O <sub>2</sub> S	103-12-8	327.790		249.5				sl H <sub>2</sub> O; s EtOH, ace, oils, fats
2865	1,3-Diamino-2-propanol		C <sub>3</sub> H <sub>10</sub> N <sub>2</sub> O	616-29-5	90.123	cry	42.8				i eth, bz
2866	4,4'-Diamino-2,2'-stilbenedisulfonic acid	Amsonic acid	C <sub>14</sub> H <sub>14</sub> N <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	81-11-8	370.400	ye nd	300				sl H <sub>2</sub> O
2867	4,6-Diamino-1,3,5-triazin-2(1 <i>H</i> )-one		C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O	645-92-1	127.105	nd (aq Na <sub>2</sub> CO <sub>3</sub> )	dec				i H <sub>2</sub> O, EtOH, eth, bz, HOAc; s acid, alk
2868	8,8'-Diapo- $\psi,\psi$ -carotenedioic acid	Crocetin	C <sub>20</sub> H <sub>24</sub> O <sub>4</sub>	27876-94-4	328.403	brick red orth	286				sl H <sub>2</sub> O, EtOH; i eth, bz; s py; vs NaOH
2869	Diatrizoic acid	<i>N,N'</i> -Diacetyl-3,5-diamino-2,4,6-triiodobenzoic acid	C <sub>11</sub> H <sub>9</sub> I <sub>3</sub> N <sub>2</sub> O <sub>4</sub>	117-96-4	613.913	cry (EtOH aq)	300				
2870	Diazenedicarboxamide	Azodicarbonamide	C <sub>2</sub> H <sub>2</sub> N <sub>4</sub> O <sub>2</sub>	123-77-3	116.079		212 dec				
2871	Diazinon		C <sub>12</sub> H <sub>21</sub> N <sub>2</sub> O <sub>3</sub> PS	333-41-5	304.345			87 <sup>0.05</sup>	1.1088 <sup>20</sup>	1.4922 <sup>20</sup>	
2872	Diazomethane		CH <sub>2</sub> N <sub>2</sub>	334-88-3	42.040	ye gas	-145	-23			vs eth, diox
2873	Dibenz[ <i>a,h</i> ]acridine		C <sub>21</sub> H <sub>13</sub> N	226-36-8	279.335	ye cry	228				
2874	Dibenz[ <i>a,j</i> ]acridine	7-Azadibenz[ <i>a,j</i> ]anthracene	C <sub>21</sub> H <sub>13</sub> N	224-42-0	279.335		216				i H <sub>2</sub> O
2875	Dibenz[ <i>c,h</i> ]acridine		C <sub>21</sub> H <sub>13</sub> N	224-53-3	279.335	ye cry (EtOH)	189				
2876	Dibenz[ <i>a,h</i> ]anthracene	1,2:5,6-Dibenzanthracene	C <sub>22</sub> H <sub>14</sub>	53-70-3	278.346	pl (dil ace)	269.5				i H <sub>2</sub> O; sl EtOH; s ace, bz, CS <sub>2</sub>
2877	Dibenz[ <i>a,j</i> ]anthracene		C <sub>22</sub> H <sub>14</sub>	224-41-9	278.346	oran lf or nd (bz)	197.5				i H <sub>2</sub> O, HOAc; sl EtOH, eth, bz; s peth
2878	5 <i>H</i> -Dibenz[ <i>b,f</i> ]azepine-5-carboxamide	Carbamazepine	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O	298-46-4	236.268		190.2				
2879	Dibenzepin		C <sub>18</sub> H <sub>21</sub> N <sub>3</sub> O	4498-32-2	295.379		117	185 <sup>0.01</sup>			
2880	7 <i>H</i> -Dibenzo[ <i>c,g</i> ]carbazole		C <sub>20</sub> H <sub>13</sub> N	194-59-2	267.324	cry (EtOH)	158				
2881	13 <i>H</i> -Dibenzo[ <i>a,i</i> ]carbazole		C <sub>20</sub> H <sub>13</sub> N	239-64-5	267.324		221.3				i H <sub>2</sub> O
2882	Dibenzo[ <i>b,k</i> ]chrysene		C <sub>26</sub> H <sub>16</sub>	217-54-9	328.405		400				
2883	Dibenzo[ <i>b,e</i> ][1,4]dioxin	Diphenylene dioxide	C <sub>12</sub> H <sub>6</sub> O <sub>2</sub>	262-12-4	184.191	nd (MeOH)	120.5				
2884	Dibenzofuran	2,2'-Biphenylene oxide	C <sub>12</sub> H <sub>8</sub> O	132-64-9	168.191	lf or nd (al)	86.5	287	1.0886 <sup>99</sup>	1.6079 <sup>99</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; vs eth, HOAc
2885	Dibenzo[ <i>a,e</i> ]pyrene	Naphtho[1,2,3,4- <i>def</i> ]chrysene	C <sub>24</sub> H <sub>14</sub>	192-65-4	302.368	pa ye nd (xyl)	233.5				sl EtOH, ace, bz, HOAc; s tol, con sulf
2886	Dibenzo[ <i>a,h</i> ]pyrene	Dibenzo[ <i>bst</i> ]chrysene	C <sub>24</sub> H <sub>14</sub>	189-64-0	302.368	oran pl	315				
2887	Dibenzo[ <i>a,i</i> ]pyrene	Benzo[ <i>rst</i> ]pentaphene	C <sub>24</sub> H <sub>14</sub>	189-55-9	302.368		281.5	275 <sup>0.05</sup>			
2888	Dibenzo[ <i>a,l</i> ]pyrene	Dibenzo[ <i>def,p</i> ]chrysene	C <sub>24</sub> H <sub>14</sub>	191-30-0	302.368	ye pl (bz/ EtOH)	164.5				
2889	Dibenzothiophene		C <sub>12</sub> H <sub>6</sub> S	132-65-0	184.257	nd (dil al, lig)	98.2	332.5			i H <sub>2</sub> O; s chl, MeOH; vs EtOH, bz
2890	Dibenz[ <i>c,e</i> ]oxepin-5,7-dione		C <sub>14</sub> H <sub>6</sub> O <sub>3</sub>	6050-13-1	224.212	nd (HOAc or bz)	217	sub			i H <sub>2</sub> O; sl eth
2891	Dibenzoyl disulfide	Benzoyl disulfide	C <sub>14</sub> H <sub>10</sub> O <sub>2</sub> S <sub>2</sub>	644-32-6	274.358	pr(al), sc(chl-peth)	134.5	dec			i H <sub>2</sub> O; sl EtOH, eth; s CS <sub>2</sub>

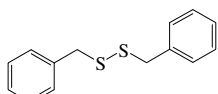


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2892	Dibenzylamine	<i>N</i> -Benzylbenzenemethanamine	C <sub>14</sub> H <sub>15</sub> N	103-49-1	197.276		-26	dec 300; 270 <sup>250</sup>	1.0256 <sup>22</sup>	1.5781 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
2893	Dibenzyl disulfide		C <sub>14</sub> H <sub>14</sub> S <sub>2</sub>	150-60-7	246.391	lf (al)	71.5				sl H <sub>2</sub> O; s EtOH, eth, bz, MeOH
2894	<i>N,N'</i> -Dibenzyl-1,2-ethanediamine	Benzathine	C <sub>16</sub> H <sub>20</sub> N <sub>2</sub>	140-28-3	240.343	oily lig	26	195 <sup>4</sup>	1.024 <sup>20</sup>	1.5635 <sup>20</sup>	vs bz, eth, EtOH
2895	Dibenzyl ether	Benzyl ether	C <sub>14</sub> H <sub>14</sub> O	103-50-4	198.260		1.8	298	1.0428 <sup>20</sup>	1.5168 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
2896	2,6-Dibenzylidene-cyclohexanone		C <sub>20</sub> H <sub>18</sub> O	897-78-9	274.356		117.5	190 <sup>20</sup>			sl EtOH; s bz, HOAc
2897	Dibenzyl malonate		C <sub>17</sub> H <sub>16</sub> O <sub>4</sub>	15014-25-2	284.307			187 <sup>2</sup>	1.137 <sup>25</sup>	1.5447 <sup>20</sup>	
2898	Dibenzyl phosphite		C <sub>14</sub> H <sub>15</sub> O <sub>3</sub> P	17176-77-1	262.241		-2.5	162 <sup>20,1</sup>		1.5521 <sup>18</sup>	
2899	Dibenzyl sulfide	Benzyl sulfide	C <sub>14</sub> H <sub>14</sub> S	538-74-9	214.326	pl (eth or chl)	49.5	dec	1.0583 <sup>50</sup>		i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
2900	Dibenzyl sulfone		C <sub>14</sub> H <sub>14</sub> O <sub>2</sub> S	620-32-6	246.325	nd (al-bz)	152	dec 290			i H <sub>2</sub> O; sl EtOH; vs ace; s bz, HOAc
2901	Dibenzyl sulfoxide		C <sub>14</sub> H <sub>14</sub> OS	621-08-9	230.325	lf (al, w)	134	dec 210			i H <sub>2</sub> O; vs EtOH, eth
2902	1,3-Dibenzylurea		C <sub>15</sub> H <sub>16</sub> N <sub>2</sub> O	1466-67-7	240.300	nd (al)	169.5				vs EtOH, HOAc
2903	Dibromoacetic acid		C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> O <sub>2</sub>	631-64-1	217.844	hyg cry	49	195 <sup>250</sup> , 130 <sup>16</sup>			vs H <sub>2</sub> O; vs EtOH, eth
2904	Dibromoacetonitrile		C <sub>2</sub> HBr <sub>2</sub> N	3252-43-5	198.844			169; 68 <sup>24</sup>	2.369 <sup>20</sup>	1.5393 <sup>20</sup>	
2905	2,4-Dibromoaniline		C <sub>6</sub> H <sub>3</sub> Br <sub>2</sub> N	615-57-6	250.919	orth bipym (chl) nd or lf (al)	79.5	156 <sup>74</sup>	2.260 <sup>20</sup>		s EtOH, eth, chl, HOAc
2906	3,5-Dibromoaniline		C <sub>6</sub> H <sub>3</sub> Br <sub>2</sub> N	626-40-4	250.919	nd (dil al)	57				vs EtOH, eth, bz
2907	9,10-Dibromoanthracene		C <sub>14</sub> H <sub>8</sub> Br <sub>2</sub>	523-27-3	336.022	ye nd (to or xyl)	226	sub			i H <sub>2</sub> O; sl EtOH, eth, bz; s chl
2908	<i>o</i> -Dibromobenzene	1,2-Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	583-53-9	235.904		7.1	225	1.9843 <sup>20</sup>	1.6155 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth, ace, bz, ctc
2909	<i>m</i> -Dibromobenzene	1,3-Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	108-36-1	235.904	liq	-7	218	1.9523 <sup>20</sup>	1.6083 <sup>17</sup>	i H <sub>2</sub> O; s EtOH; msc eth
2910	<i>p</i> -Dibromobenzene	1,4-Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	106-37-6	235.904	pl	87.43	218.5	2.261 <sup>17</sup>	1.5742	i H <sub>2</sub> O; s EtOH, bz; vs eth, ace, CS <sub>2</sub>
2911	4,4'-Dibromobenzophenone	Bis(4-bromophenyl) ketone	C <sub>13</sub> H <sub>8</sub> Br <sub>2</sub> O	3988-03-2	340.010	pl (al)	177	395			vs bz, HOAc, chl
2912	4,4'-Dibromo-1,1'-biphenyl		C <sub>12</sub> H <sub>8</sub> Br <sub>2</sub>	92-86-4	312.000	mcl pr (MeOH)	164	357.5			i H <sub>2</sub> O; sl EtOH; s bz
2913	1,3-Dibromo-2,2-bis(bromomethyl)propane	Pentaerythritol tetrabromide	C <sub>3</sub> H <sub>8</sub> Br <sub>4</sub>	3229-00-3	387.734	cry (ace), nd (lig)	163	305.5	2.596 <sup>15</sup>		s EtOH, bz, tol; sl eth, chl
2914	3,5-Dibromo- <i>N</i> -(4-bromophenyl)-2-hydroxybenzamide	Tribromsalan	C <sub>13</sub> H <sub>8</sub> Br <sub>3</sub> NO <sub>2</sub>	87-10-5	449.921		227				
2915	1,1-Dibromobutane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	62168-25-6	215.915			158; 91 <sup>101</sup>	1.784 <sup>25</sup>	1.4988 <sup>25</sup>	
2916	1,2-Dibromobutane	$\alpha$ -Butylene dibromide	C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	533-98-2	215.915	liq	-65.4	166.3	1.7915 <sup>20</sup>	1.4025 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl
2917	1,3-Dibromobutane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	107-80-2	215.915			174	1.800 <sup>20</sup>	1.507 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl; sl ctc
2918	1,4-Dibromobutane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	110-52-1	215.915	liq	-16.5	197	1.8199 <sup>25</sup>	1.5167 <sup>25</sup>	i H <sub>2</sub> O; sl ctc; s chl
2919	2,3-Dibromobutane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	5408-86-6	215.915	liq	-24	161	1.7893 <sup>22</sup>	1.5133 <sup>22</sup>	i H <sub>2</sub> O; s eth
2920	<i>trans</i> -1,4-Dibromo-2-butene		C <sub>4</sub> H <sub>6</sub> Br <sub>2</sub>	821-06-7	213.899	pl (peth)	53.4	203; 74 <sup>14</sup>			sl H <sub>2</sub> O, chl; vs EtOH, peth; s ace
2921	1,4-Dibromo-2-butyne		C <sub>4</sub> H <sub>2</sub> Br <sub>2</sub>	2219-66-1	211.883			92 <sup>15</sup>	2.014 <sup>18</sup>	1.588 <sup>18</sup>	s eth, ace; vs chl
2922	$\alpha,\alpha'$ -Dibromo- <i>d</i> -camphor		C <sub>10</sub> H <sub>14</sub> Br <sub>2</sub> O	514-12-5	310.025		61		1.854 <sup>21</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz, chl; s AcOEt
2923	Dibromochlorofluoromethane		CB <sub>2</sub> ClF	353-55-9	226.270			80.3	2.3173 <sup>22</sup>	1.4570 <sup>20</sup>	
2924	1,2-Dibromo-3-chloropropane		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub> Cl	96-12-8	236.333			196	2.093 <sup>14</sup>	1.553 <sup>14</sup>	i H <sub>2</sub> O
2925	1,2-Dibromo-1-chloro-1,2,2-trifluoroethane		C <sub>2</sub> Br <sub>2</sub> ClF <sub>3</sub>	354-51-8	276.277		50	93			
2926	2,2-Dibromo-2-cyanoacetamide		C <sub>3</sub> H <sub>2</sub> Br <sub>2</sub> N <sub>2</sub> O	10222-01-2	241.868	cry (bz)	126				
2927	<i>trans</i> -1,2-Dibromocyclohexane, ( $\pm$ )		C <sub>6</sub> H <sub>10</sub> Br <sub>2</sub>	5183-77-7	241.951		-2.0	145 <sup>100</sup> , 105 <sup>20</sup>	1.7759 <sup>20</sup>	1.5445 <sup>19</sup>	vs ace, bz, eth, EtOH
2928	1,10-Dibromodecane	Decamethylene dibromide	C <sub>10</sub> H <sub>20</sub> Br <sub>2</sub>	4101-68-2	300.074	pl (al)	28	161 <sup>9</sup> , 128 <sup>4</sup>	1.335 <sup>30</sup>	1.4927 <sup>25</sup>	i H <sub>2</sub> O; sl EtOH; s eth
2929	1,2-Dibromo-1,1-dichloroethane		C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	75-81-0	256.751	liq	-26	195	2.135 <sup>20</sup>	1.5662 <sup>20</sup>	vs ace, bz, eth, EtOH
2930	1,2-Dibromo-1,2-dichloroethane		C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	683-68-1	256.751	liq	-26	195	2.135 <sup>20</sup>	1.5662 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
2931	Dibromodichloromethane		CB <sub>2</sub> Cl <sub>2</sub>	594-18-3	242.725		38	150.2	2.42 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz
2932	1,2-Dibromo-1,1-difluoroethane	Genetron 132b-B2	C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> F <sub>2</sub>	75-82-1	223.842	liq	-61.3	92.5	2.2238 <sup>20</sup>	1.4456 <sup>20</sup>	

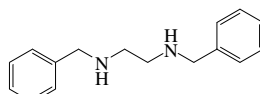
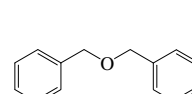




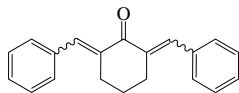
Dibenzylamine



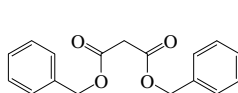
Dibenzyl disulfide

*N,N'*-Dibenzyl-1,2-ethanediamine

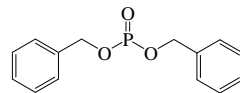
Dibenzyl ether



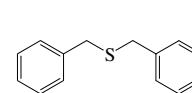
2,6-Dibenzylidenecyclohexanone



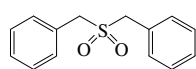
Dibenzyl malonate



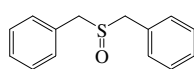
Dibenzyl phosphite



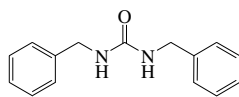
Dibenzyl sulfide



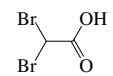
Dibenzyl sulfone



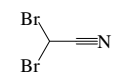
Dibenzyl sulfoxide



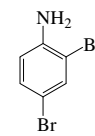
1,3-Dibenzylurea



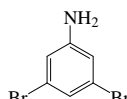
Dibromoacetic acid



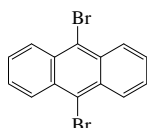
Dibromoacetonitrile



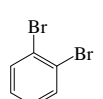
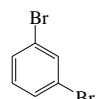
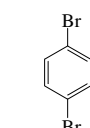
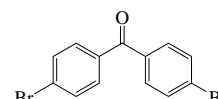
2,4-Dibromoaniline



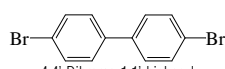
3,5-Dibromoaniline



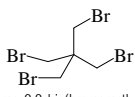
9,10-Dibromoanthracene

*o*-Dibromobenzene*m*-Dibromobenzene*p*-Dibromobenzene

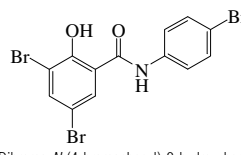
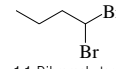
4,4'-Dibromobenzophenone



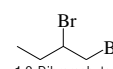
4,4'-Dibromo-1,1'-biphenyl



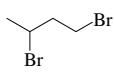
1,3-Dibromo-2,2-bis(bromomethyl)propane

3,5-Dibromo-*N*-(4-bromophenyl)-2-hydroxybenzamide

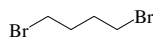
1,1-Dibromobutane



1,2-Dibromobutane



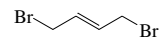
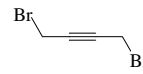
1,3-Dibromobutane



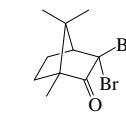
1,4-Dibromobutane



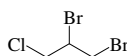
2,3-Dibromobutane

*trans*-1,4-Dibromo-2-butene

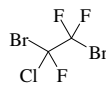
1,4-Dibromo-2-butyne

 $\alpha, \alpha'$ -Dibromo-*d*-camphor

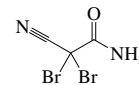
Dibromochlorofluoromethane



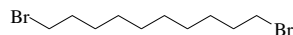
1,2-Dibromo-3-chloropropane



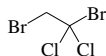
1,2-Dibromo-1-chloro-1,2,2-trifluoroethane



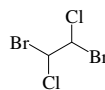
2,2-Dibromo-2-cyanoacetamide

*trans*-1,2-Dibromocyclohexane, ( $\pm$ )

1,10-Dibromodecane



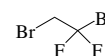
1,2-Dibromo-1,1-dichloroethane



1,2-Dibromo-1,2-dichloroethane

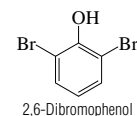
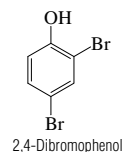
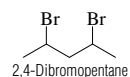
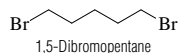
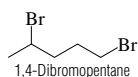
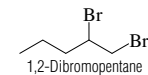
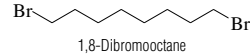
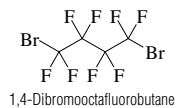
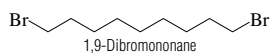
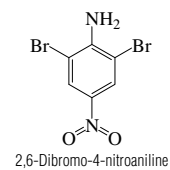
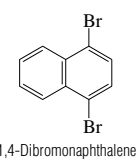
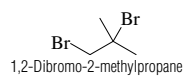
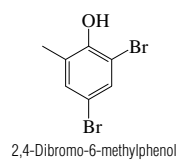
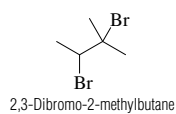
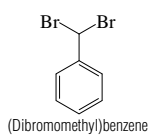
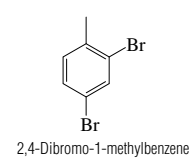
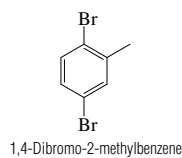
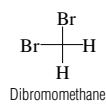
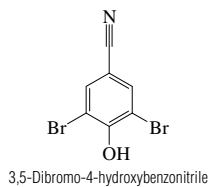
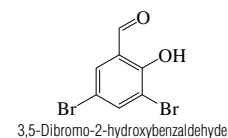
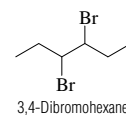
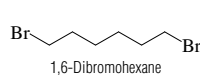
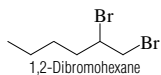
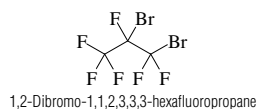
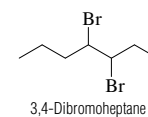
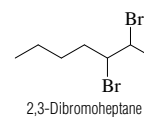
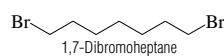
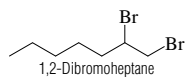
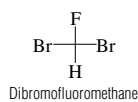
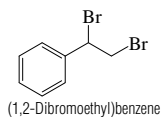
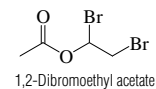
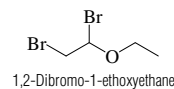
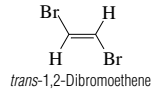
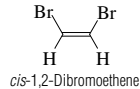
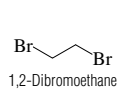
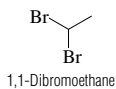
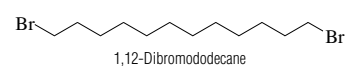
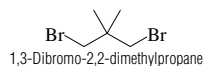
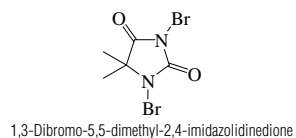
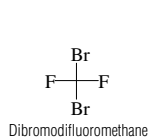


Dibromodichloromethane

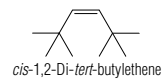
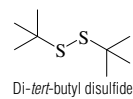
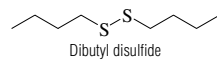
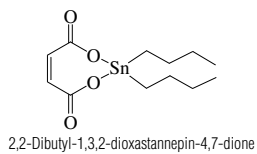
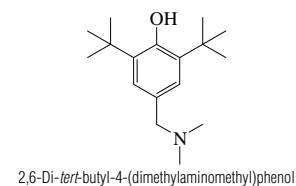
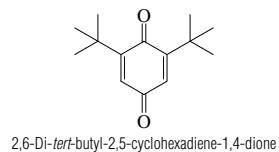
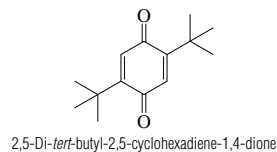
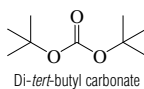
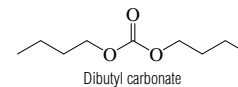
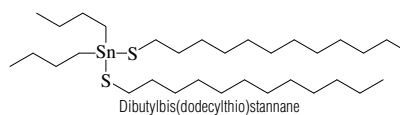
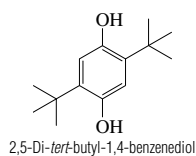
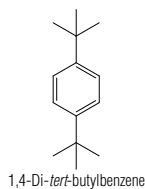
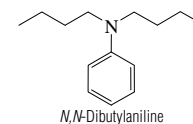
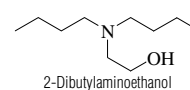
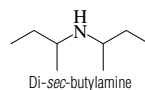
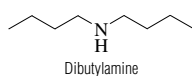
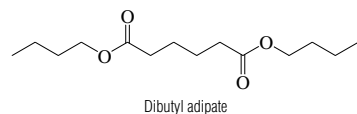
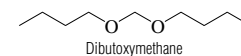
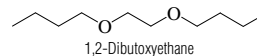
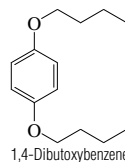
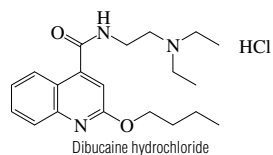
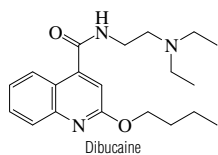
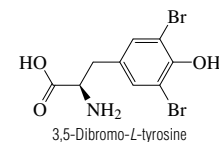
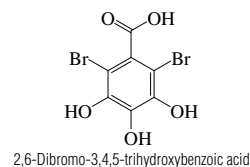
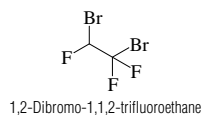
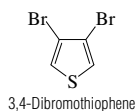
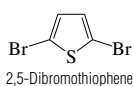
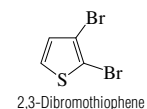
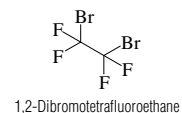
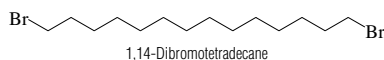
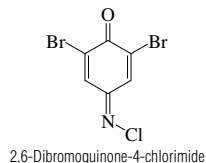
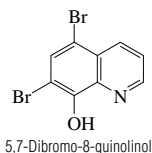
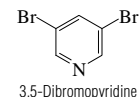
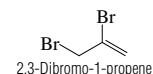
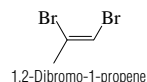
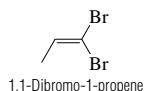
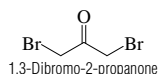
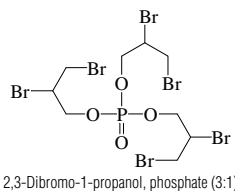
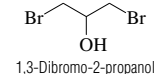
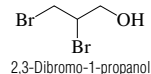
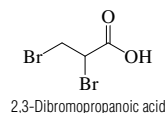
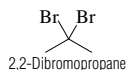
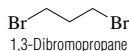
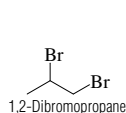


1,2-Dibromo-1,1-difluoroethane

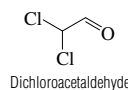
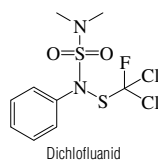
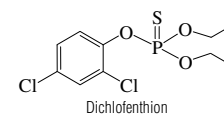
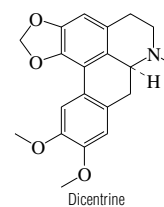
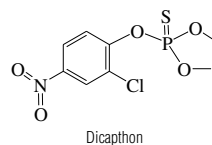
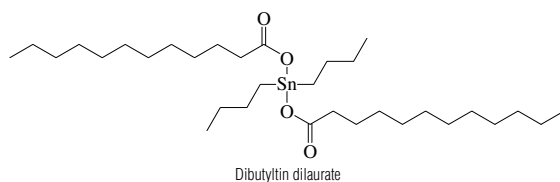
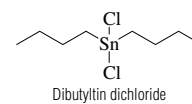
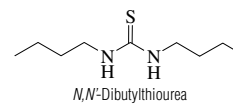
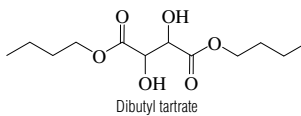
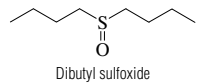
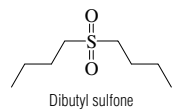
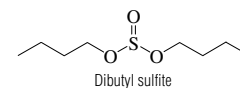
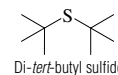
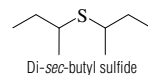
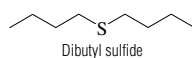
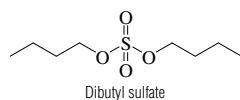
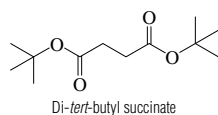
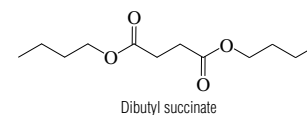
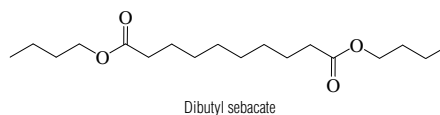
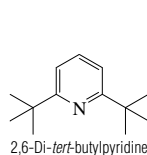
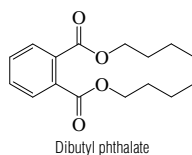
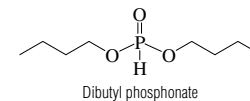
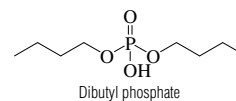
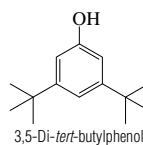
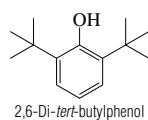
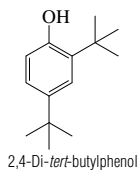
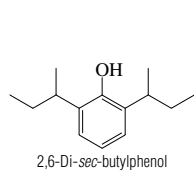
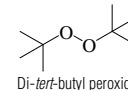
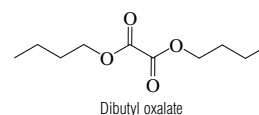
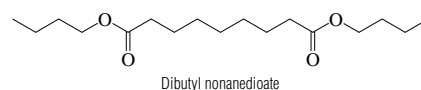
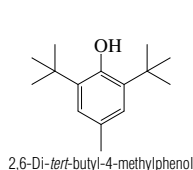
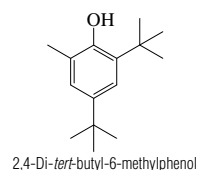
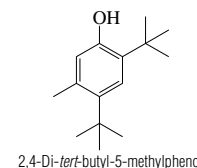
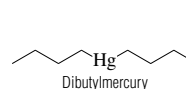
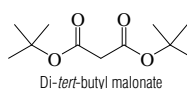
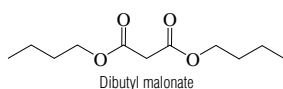
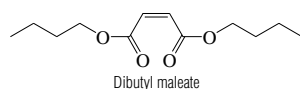
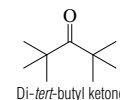
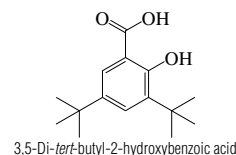
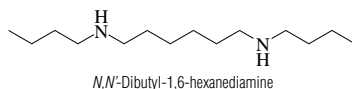
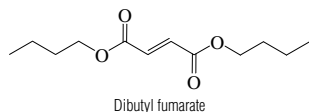
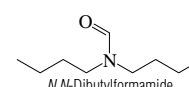
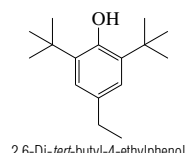
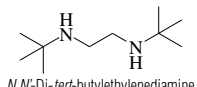
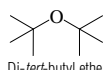
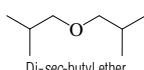
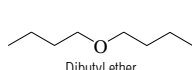
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2933	Dibromodifluoromethane		CBr <sub>2</sub> F <sub>2</sub>	75-61-6	209.816	vol liq or gas	-110.1	22.76			s H <sub>2</sub> O, eth, ace, bz
2934	1,3-Dibromo-5,5-dimethyl-2,4-imidazolidinedione	Dibromantine	C <sub>8</sub> H <sub>8</sub> Br <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	77-48-5	285.922		198 dec				
2935	1,3-Dibromo-2,2-dimethylpropane		C <sub>8</sub> H <sub>10</sub> Br <sub>2</sub>	5434-27-5	229.941			184; 80 <sup>26</sup>	1.6775 <sup>20</sup>	1.5090	
2936	1,12-Dibromododecane		C <sub>12</sub> H <sub>24</sub> Br <sub>2</sub>	3344-70-5	328.127	nd (al,HOAc)	41	215 <sup>15</sup>			i H <sub>2</sub> O; vs EtOH, chl; s eth, HOAc
2937	1,1-Dibromoethane	Ethylidene dibromide	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	557-91-5	187.861	liq	-63	108.0	2.0555 <sup>20</sup>	1.5128 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, ace, bz; sl chl; vs eth
2938	1,2-Dibromoethane	Ethylene dibromide	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	106-93-4	187.861		9.84	131.6	2.1683 <sup>25</sup>	1.5356 <sup>25</sup>	vs ace, bz, eth, EtOH
2939	<i>cis</i> -1,2-Dibromoethene	<i>cis</i> -1,2-Dibromoethylene	C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	590-11-4	185.845	liq	-53	112.5	2.2464 <sup>20</sup>	1.5428 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz, chl
2940	<i>trans</i> -1,2-Dibromoethene	<i>trans</i> -1,2-Dibromoethylene	C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	590-12-5	185.845	liq	-6.5	108	2.2308 <sup>20</sup>	1.5505 <sup>18</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz, chl
2941	1,2-Dibromo-1-ethoxyethane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub> O	2983-26-8	231.914			80 <sup>20</sup>	1.7320 <sup>20</sup>	1.5044 <sup>20</sup>	vs EtOH, chl
2942	1,2-Dibromoethyl acetate		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub> O <sub>2</sub>	24442-57-7	245.898	liq		89.5 <sup>16</sup>	1.91 <sup>20</sup>		
2943	(1,2-Dibromoethyl)benzene		C <sub>8</sub> H <sub>8</sub> Br <sub>2</sub>	93-52-7	263.958		75	133 <sup>19</sup>			s EtOH, eth, bz, chl, HOAc, MeOH, lig
2944	Dibromofluoromethane		CHBr <sub>2</sub> F	1868-53-7	191.825	liq	-78	64.9	2.421 <sup>20</sup>	1.4685 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
2945	1,2-Dibromoheptane		C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	42474-21-5	257.994			228	1.5086 <sup>20</sup>	1.4986 <sup>20</sup>	
2946	1,7-Dibromoheptane	Heptamethylene dibromide	C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	4549-31-9	257.994		41.7	263	1.5306 <sup>20</sup>	1.5034 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, ctc, chl
2947	2,3-Dibromoheptane		C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	21266-88-6	257.994			101 <sup>17</sup>	1.5139 <sup>20</sup>	1.4992 <sup>20</sup>	
2948	3,4-Dibromoheptane		C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	21266-90-0	257.994			107 <sup>24</sup>	1.5182 <sup>20</sup>	1.5010 <sup>20</sup>	
2949	1,2-Dibromo-1,1,2,3,3,3-hexafluoropropane		C <sub>3</sub> Br <sub>2</sub> F <sub>6</sub>	661-95-0	309.830			72.8	2.1630 <sup>20</sup>		i H <sub>2</sub> O
2950	1,2-Dibromohexane		C <sub>6</sub> H <sub>12</sub> Br <sub>2</sub>	624-20-4	243.967			103 <sup>36</sup>	1.5774 <sup>20</sup>	1.5024 <sup>20</sup>	vs bz, eth, chl
2951	1,6-Dibromohexane		C <sub>6</sub> H <sub>12</sub> Br <sub>2</sub>	629-03-8	243.967	liq	-1.2	245.5	1.6025 <sup>25</sup>	1.5054 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace, chl; sl ctc
2952	3,4-Dibromohexane		C <sub>6</sub> H <sub>12</sub> Br <sub>2</sub>	89583-12-0	243.967			80 <sup>13</sup>	1.6027 <sup>20</sup>	1.5043 <sup>20</sup>	
2953	3,5-Dibromo-2-hydroxybenzaldehyde	3,5-Dibromosalicylaldehyde	C <sub>7</sub> H <sub>6</sub> Br <sub>2</sub> O <sub>2</sub>	90-59-5	279.914	pa ye pr	86	sub			vs bz, eth, chl
2954	3,5-Dibromo-2-hydroxybenzoic acid	3,5-Dibromosalicylic acid	C <sub>7</sub> H <sub>4</sub> Br <sub>2</sub> O <sub>3</sub>	3147-55-5	295.913	nd	228				s ace
2955	3,5-Dibromo-4-hydroxybenzotrile	Bromoxynil	C <sub>7</sub> H <sub>5</sub> Br <sub>2</sub> NO	1689-84-5	276.913		190				
2956	Dibromomethane	Methylene bromide	CH <sub>2</sub> Br <sub>2</sub>	74-95-3	173.835	liq	-52.5	97	2.4969 <sup>20</sup>	1.5420 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; s ctc
2957	1,4-Dibromo-2-methylbenzene	2,5-Dibromotoluene	C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	615-59-8	249.931		5.6	236	1.8127 <sup>17</sup>	1.5982 <sup>18</sup>	i H <sub>2</sub> O
2958	2,4-Dibromo-1-methylbenzene		C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	31543-75-6	249.931		-9.7	103 <sup>11</sup>	1.8176 <sup>25</sup>	1.5964 <sup>25</sup>	
2959	(Dibromomethyl)benzene		C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub>	618-31-5	249.931		1.0	156 <sup>23</sup>	1.8365 <sup>28</sup>	1.6147 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
2960	2,3-Dibromo-2-methylbutane		C <sub>8</sub> H <sub>10</sub> Br <sub>2</sub>	594-51-4	229.941		7	62 <sup>17</sup>	1.6717 <sup>20</sup>	1.5729 <sup>25</sup>	
2961	2,4-Dibromo-6-methylphenol		C <sub>7</sub> H <sub>8</sub> Br <sub>2</sub> O	609-22-3	265.930	nd (peth)	58	dec 265; 105 <sup>4</sup>			s chl
2962	1,2-Dibromo-2-methylpropane		C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	594-34-3	215.915		10.5	150	1.7827 <sup>20</sup>	1.5119 <sup>20</sup>	s EtOH, eth, chl
2963	1,4-Dibromonaphthalene		C <sub>10</sub> H <sub>6</sub> Br <sub>2</sub>	83-53-4	285.963		83	310			i H <sub>2</sub> O; s EtOH, eth; sl HOAc
2964	2,6-Dibromo-4-nitroaniline		C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	827-94-1	295.916	ye nd (al, HOAc)	207				sl H <sub>2</sub> O; s HOAc
2965	2,6-Dibromo-4-nitrophenol		C <sub>6</sub> H <sub>3</sub> Br <sub>2</sub> NO <sub>3</sub>	99-28-5	296.901	pa ye pr or lf (al)	145 dec				i H <sub>2</sub> O; vs EtOH, eth; sl ace, bz, HOAc
2966	1,9-Dibromononane		C <sub>9</sub> H <sub>18</sub> Br <sub>2</sub>	4549-33-1	286.047	liq	-22.5	285; 154 <sup>10</sup>	1.4229 <sup>20</sup>		
2967	1,4-Dibromooctylfluorobutane		C <sub>8</sub> Br <sub>2</sub> F <sub>8</sub>	335-48-8	359.838			97			
2968	1,8-Dibromooctane	Octamethylene dibromide	C <sub>8</sub> H <sub>16</sub> Br <sub>2</sub>	4549-32-0	272.021		15.5	271	1.4594 <sup>25</sup>	1.4971 <sup>25</sup>	i H <sub>2</sub> O; s eth, ctc, chl
2969	1,2-Dibromopentane		C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	3234-49-9	229.941			184	1.668 <sup>18</sup>		
2970	1,4-Dibromopentane		C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	626-87-9	229.941		-34.4	146 <sup>150</sup> , 99 <sup>14</sup>	1.6222 <sup>20</sup>	1.5086 <sup>20</sup>	
2971	1,5-Dibromopentane		C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	111-24-0	229.941	liq	-39.5	222.3	1.6928 <sup>25</sup>	1.5102 <sup>25</sup>	i H <sub>2</sub> O; s bz, chl; sl ctc
2972	2,4-Dibromopentane		C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	19398-53-9	229.941			75 <sup>21</sup> , 60 <sup>12</sup>	1.6659 <sup>20</sup>	1.4987 <sup>20</sup>	
2973	2,4-Dibromophenol		C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> O	615-58-7	251.903	nd (peth)	38	238.5	2.0700 <sup>20</sup>		sl H <sub>2</sub> O, ctc; vs EtOH, eth, bz
2974	2,6-Dibromophenol		C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> O	608-33-3	251.903	nd (w)	56.5	255; 162 <sup>21</sup>			s H <sub>2</sub> O; vs EtOH, eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
2975	1,2-Dibromopropane	Propylene dibromide	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	78-75-1	201.888	liq	-55.49	141.9	1.9324 <sup>20</sup>	1.5201 <sup>20</sup>	s EtOH, eth, chl; sl ctc
2976	1,3-Dibromopropane		C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	109-64-8	201.888	liq	-34.5	167.3	1.9701 <sup>25</sup>	1.5204 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; sl ctc
2977	2,2-Dibromopropane		C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	594-16-1	201.888			113	1.880 <sup>20</sup>		vs eth, EtOH, chl
2978	2,3-Dibromopropanoic acid		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub> O <sub>2</sub>	600-05-5	231.871		66.5	160 <sup>20</sup> , 138 <sup>12</sup>			vs bz, eth, EtOH
2979	2,3-Dibromo-1-propanol		C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub> O	96-13-9	217.887			219	2.120 <sup>20</sup>		
2980	1,3-Dibromo-2-propanol		C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub> O	96-21-9	217.887	ye liq		dec 219; 105 <sup>16</sup>	2.1364 <sup>20</sup>	1.5495 <sup>25</sup>	vs ace, eth, EtOH
2981	2,3-Dibromo-1-propanol, phosphate (3:1)	Tris(2,3-dibromopropyl) phosphate	C <sub>9</sub> H <sub>15</sub> Br <sub>6</sub> O <sub>4</sub> P	126-72-7	697.610						s chl
2982	1,3-Dibromo-2-propanone	1,3-Dibromoacetone	C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub> O	816-39-7	215.871	nd	26	97 <sup>22</sup>	2.1670 <sup>18</sup>		vs eth, CS <sub>2</sub>
2983	1,1-Dibromo-1-propene		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub>	13195-80-7	199.872			125	1.9767 <sup>20</sup>	1.5260 <sup>20</sup>	sl H <sub>2</sub> O; s bz, ctc, chl
2984	1,2-Dibromo-1-propene		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub>	26391-16-2	199.872			131.5	2.0076 <sup>20</sup>		
2985	2,3-Dibromo-1-propene		C <sub>3</sub> H <sub>4</sub> Br <sub>2</sub>	513-31-5	199.872			141; 37.7 <sup>11</sup>	2.0345 <sup>25</sup>	1.5416 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace, chl
2986	3,5-Dibromopyridine		C <sub>5</sub> H <sub>4</sub> Br <sub>2</sub> N	625-92-3	236.893	nd (al)	112	222			sl H <sub>2</sub> O; s EtOH, eth
2987	5,7-Dibromo-8-quinolinol	Broxyquinoline	C <sub>8</sub> H <sub>6</sub> Br <sub>2</sub> NO	521-74-4	302.950	nd (al)	196	sub			i H <sub>2</sub> O; s EtOH, ace, bz, chl, HOAc; sl eth
2988	2,6-Dibromoquinone-4-chlorimide	2,6-Dibromo-4-(chloroimino)-2,5-cyclohexadien-1-one	C <sub>8</sub> H <sub>6</sub> Br <sub>2</sub> ClNO	537-45-1	299.347	ye pr (al or HOAc)	83				vs EtOH
2989	1,14-Dibromotetradecane	Tetradecamethylene dibromide	C <sub>14</sub> H <sub>28</sub> Br <sub>2</sub>	37688-96-3	356.180	lf (al-eth) cry (al)	50.4	190 <sup>8</sup>			vs eth, EtOH, chl
2990	1,2-Dibromotetrafluoroethane	Refrigerant 114B2	C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	124-73-2	259.823	liq	-110.32	47.35	2.149 <sup>25</sup>	1.361 <sup>25</sup>	i H <sub>2</sub> O
2991	2,3-Dibromothiophene		C <sub>4</sub> H <sub>2</sub> Br <sub>2</sub> S	3140-93-0	241.932	liq	-17.5	218.5; 89 <sup>13</sup>		1.6304 <sup>22</sup>	
2992	2,5-Dibromothiophene		C <sub>4</sub> H <sub>2</sub> Br <sub>2</sub> S	3141-27-3	241.932	liq	-6	210.3	2.142 <sup>23</sup>	1.6288 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
2993	3,4-Dibromothiophene		C <sub>4</sub> H <sub>2</sub> Br <sub>2</sub> S	3141-26-2	241.932		4.5	221.5			
2994	1,2-Dibromo-1,1,2-trifluoroethane	Halon 2302	C <sub>2</sub> HBr <sub>2</sub> F <sub>3</sub>	354-04-1	241.832			76	2.274 <sup>27</sup>	1.4191 <sup>24</sup>	
2995	2,6-Dibromo-3,4,5-trihydroxybenzoic acid	Dibromogallic acid	C <sub>7</sub> H <sub>4</sub> Br <sub>2</sub> O <sub>5</sub>	602-92-6	327.912	nd, pr or lf (w+1)	150				vs H <sub>2</sub> O, eth, EtOH
2996	3,5-Dibromo-L-tyrosine		C <sub>9</sub> H <sub>8</sub> Br <sub>2</sub> NO <sub>3</sub>	300-38-9	338.980	nd or pl	245				sl H <sub>2</sub> O, EtOH; i eth; s alk, acid
2997	Dibucaine	Cinchocaine	C <sub>20</sub> H <sub>29</sub> N <sub>3</sub> O <sub>2</sub>	85-79-0	343.463	hyg cry	64				
2998	Dibucaine hydrochloride		C <sub>20</sub> H <sub>30</sub> ClN <sub>3</sub> O <sub>2</sub>	61-12-1	379.924			94 dec			s chl
2999	1,4-Dibutoxybenzene		C <sub>14</sub> H <sub>22</sub> O <sub>2</sub>	104-36-9	222.324			45.5	158 <sup>15</sup>		s ctc
3000	1,2-Dibutoxyethane	Ethylene glycol dibutyl ether	C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	112-48-1	174.281	liq	-69.1	203.3	0.8319 <sup>25</sup>	1.4112 <sup>25</sup>	
3001	Dibutoxymethane	Butylal	C <sub>8</sub> H <sub>20</sub> O <sub>2</sub>	2568-90-3	160.254	liq	-58.1	179.2	0.8339 <sup>20</sup>	1.4072 <sup>17</sup>	
3002	Dibutyl adipate		C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	105-99-7	258.354		-32.4	165 <sup>10</sup>	0.9613 <sup>20</sup>	1.4369 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
3003	Dibutylamine	<i>N</i> -Butylbutanamine	C <sub>8</sub> H <sub>19</sub> N	111-92-2	129.244	liq	-62	159.6	0.7670 <sup>20</sup>	1.4177 <sup>20</sup>	s H <sub>2</sub> O, ace, bz; vs EtOH, eth
3004	Di- <i>sec</i> -butylamine	<i>N-sec</i> -Butyl-2-butanamine	C <sub>8</sub> H <sub>19</sub> N	626-23-3	129.244			134	0.7534 <sup>20</sup>	1.4162 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH
3005	2-Dibutylaminoethanol		C <sub>10</sub> H <sub>23</sub> NO	102-81-8	173.296			114 <sup>16</sup>			
3006	<i>N,N</i> -Dibutylaniline		C <sub>14</sub> H <sub>23</sub> N	613-29-6	205.340	liq	-32.2	274.8	0.9037 <sup>20</sup>	1.5186 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace, bz; s ctc
3007	1,4-Di- <i>tert</i> -butylbenzene		C <sub>14</sub> H <sub>22</sub>	1012-72-2	190.325	nd (MeOH)	79.5	238; 109 <sup>15</sup>	0.9850 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth
3008	2,5-Di- <i>tert</i> -butyl-1,4-benzenediol		C <sub>14</sub> H <sub>22</sub> O <sub>2</sub>	88-58-4	222.324	cry (aq HOAc)	213.5				
3009	Dibutylbis(dodecylthio)stannane	Dibutyltin bis(dodecyl sulfide)	C <sub>32</sub> H <sub>66</sub> S <sub>2</sub> Sn	1185-81-5	635.722	col liq		122 <sup>0.3</sup>	1.05 <sup>20</sup>		s tol, hp
3010	Dibutyl carbonate		C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	542-52-9	174.237			207	0.9251 <sup>20</sup>	1.4117 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3011	Di- <i>tert</i> -butyl carbonate		C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	34619-03-9	174.237	cry (al)	40	158			vs EtOH
3012	2,5-Di- <i>tert</i> -butyl-2,5-cyclohexadiene-1,4-dione		C <sub>14</sub> H <sub>20</sub> O <sub>2</sub>	2460-77-7	220.308	ye cry (al)	152.5				i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
3013	2,6-Di- <i>tert</i> -butyl-2,5-cyclohexadiene-1,4-dione		C <sub>14</sub> H <sub>20</sub> O <sub>2</sub>	719-22-2	220.308		69	60 <sup>0.01</sup>			
3014	2,6-Di- <i>tert</i> -butyl-4-(dimethylaminomethyl)phenol		C <sub>17</sub> H <sub>29</sub> NO	88-27-7	263.418	pl (EtOH)	94	179 <sup>40</sup>			
3015	2,2-Dibutyl-1,3,2-dioxastannepin-4,7-dione		C <sub>12</sub> H <sub>20</sub> O <sub>4</sub> Sn	78-04-6	346.995	ye solid	110				
3016	Dibutyl disulfide		C <sub>8</sub> H <sub>18</sub> S <sub>2</sub>	629-45-8	178.359	oil		226; 117 <sup>20</sup>	0.938 <sup>20</sup>	1.4923 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
3017	Di- <i>tert</i> -butyl disulfide		C <sub>8</sub> H <sub>18</sub> S <sub>2</sub>	110-06-5	178.359		-2.5	88 <sup>21</sup>	0.9226 <sup>20</sup>	1.4899 <sup>20</sup>	
3018	<i>cis</i> -1,2-Di- <i>tert</i> -butylethene	<i>cis</i> -2,2,5,5-Tetramethyl-3-hexene	C <sub>10</sub> H <sub>20</sub>	692-47-7	140.266	liq		144	0.744 <sup>20</sup>	1.4270 <sup>20</sup>	

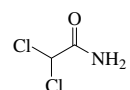


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3019	Dibutyl ether		C <sub>8</sub> H <sub>18</sub> O	142-96-1	130.228	liq	-95.2	140.28	0.7684 <sup>20</sup>	1.3992 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace; sl ctc
3020	Di- <i>sec</i> -butyl ether		C <sub>8</sub> H <sub>18</sub> O	6863-58-7	130.228	liq		121.1	0.756 <sup>25</sup>		
3021	Di- <i>tert</i> -butyl ether		C <sub>8</sub> H <sub>18</sub> O	6163-66-2	130.228	liq		107.23	0.7658 <sup>20</sup>	1.3949 <sup>20</sup>	
3022	<i>N,N'</i> -Di- <i>tert</i> -butylethylenediamine	<i>N,N'</i> -Di- <i>tert</i> -butylethanediamine	C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>	4062-60-6	172.311	cry	53.3	189	0.69		
3023	2,6-Di- <i>tert</i> -butyl-4-ethylphenol		C <sub>16</sub> H <sub>26</sub> O	4130-42-1	234.376		44	272			i alk
3024	<i>N,N</i> -Dibutylformamide		C <sub>9</sub> H <sub>19</sub> NO	761-65-9	157.253						s ctc, CS <sub>2</sub>
3025	Dibutyl fumarate		C <sub>12</sub> H <sub>20</sub> O <sub>4</sub>	105-75-9	228.285	liq	-13.5	285; 150 <sup>4</sup>	0.9775 <sup>20</sup>	1.4469 <sup>20</sup>	i H <sub>2</sub> O; s ace, chl
3026	<i>N,N'</i> -Dibutyl-1,6-hexanediamine		C <sub>14</sub> H <sub>32</sub> N <sub>2</sub>	4835-11-4	228.417			138 <sup>3,5</sup>		1.4470 <sup>25</sup>	
3027	3,5-Di- <i>tert</i> -butyl-2-hydroxybenzoic acid		C <sub>15</sub> H <sub>22</sub> O <sub>3</sub>	19715-19-6	250.334		163.3				s chl
3028	Di- <i>tert</i> -butyl ketone		C <sub>9</sub> H <sub>18</sub> O	815-24-7	142.238	liq	-25.2	152	0.8240 <sup>18</sup>	1.4194 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl, HOAc
3029	Dibutyl maleate		C <sub>12</sub> H <sub>20</sub> O <sub>4</sub>	105-76-0	228.285		<-80	280; 142 <sup>10</sup>			
3030	Dibutyl malonate		C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	1190-39-2	216.275	liq	-83	251.5	0.9824 <sup>20</sup>	1.4262 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc, ctc
3031	Di- <i>tert</i> -butyl malonate		C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	541-16-2	216.275		-6	113 <sup>31</sup> , 66 <sup>2</sup>	1.4184 <sup>20</sup>	1.4184 <sup>29</sup>	s ace, chl
3032	Dibutylmercury		C <sub>8</sub> H <sub>18</sub> Hg	629-35-6	314.82			223; 105 <sup>10</sup>	1.7779 <sup>20</sup>	1.5057 <sup>20</sup>	
3033	2,4-Di- <i>tert</i> -butyl-5-methylphenol	DBMC	C <sub>15</sub> H <sub>24</sub> O	497-39-2	220.351		62.1	282	0.912 <sup>60</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
3034	2,4-Di- <i>tert</i> -butyl-6-methylphenol		C <sub>15</sub> H <sub>24</sub> O	616-55-7	220.351		51	269	0.891 <sup>60</sup>		i alk
3035	2,6-Di- <i>tert</i> -butyl-4-methylphenol		C <sub>15</sub> H <sub>24</sub> O	128-37-0	220.351		71	265	0.8937 <sup>75</sup>	1.4859 <sup>75</sup>	i H <sub>2</sub> O; s EtOH, ace, bz, peth; i alk
3036	Dibutyl nonanedioate		C <sub>17</sub> H <sub>32</sub> O <sub>4</sub>	2917-73-9	300.434			170 <sup>2</sup>			sl chl
3037	Dibutyl oxalate		C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	2050-60-4	202.248	liq	-30.5	241; 96 <sup>2</sup>	0.9873 <sup>20</sup>	1.4234 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3038	Di- <i>tert</i> -butyl peroxide	DTBP	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	110-05-4	146.228	liq	-40	111	0.704 <sup>20</sup>	1.3890 <sup>20</sup>	i H <sub>2</sub> O; msc ace; s ctc, lig
3039	2,6-Di- <i>sec</i> -butylphenol		C <sub>14</sub> H <sub>22</sub> O	5510-99-6	206.324	liq	-42	257.5		1.5080 <sup>20</sup>	
3040	2,4-Di- <i>tert</i> -butylphenol		C <sub>14</sub> H <sub>22</sub> O	96-76-4	206.324		56.5	263.5		1.5080 <sup>20</sup>	sl ctc; i alk
3041	2,6-Di- <i>tert</i> -butylphenol		C <sub>14</sub> H <sub>22</sub> O	128-39-2	206.324	pr (al)	39	161 <sup>50</sup> , 133 <sup>20</sup>		1.5001 <sup>20</sup>	sl EtOH; s ctc; i alk
3042	3,5-Di- <i>tert</i> -butylphenol		C <sub>14</sub> H <sub>22</sub> O	1138-52-9	206.324		88				
3043	Dibutyl phosphate		C <sub>8</sub> H <sub>19</sub> O <sub>4</sub> P	107-66-4	210.208	oil		136 <sup>0,5</sup>	1.06 <sup>20</sup>		s ctc, BuOH
3044	Dibutyl phosphonate		C <sub>8</sub> H <sub>19</sub> O <sub>3</sub> P	1809-19-4	194.209	oil		230; 131 <sup>19</sup>	0.985 <sup>25</sup>	1.4220 <sup>20</sup>	
3045	Dibutyl phthalate		C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	84-74-2	278.344	liq	-35	340	1.0465 <sup>20</sup>	1.4911 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz; s ctc
3046	2,6-Di- <i>tert</i> -butylpyridine		C <sub>13</sub> H <sub>21</sub> N	585-48-8	191.313			120 <sup>20</sup>			
3047	Dibutyl sebacate		C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	109-43-3	314.461	liq	-10	344.5	0.9405 <sup>15</sup>	1.4433 <sup>15</sup>	i H <sub>2</sub> O; s eth, ctc
3048	Dibutyl succinate		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	141-03-7	230.301	liq	-29.2	274.5	0.9752 <sup>20</sup>	1.4299 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
3049	Di- <i>tert</i> -butyl succinate		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	926-26-1	230.301		36.5	109 <sup>9</sup>			
3050	Dibutyl sulfate	Butyl sulfate	C <sub>8</sub> H <sub>18</sub> O <sub>4</sub> S	625-22-9	210.292	liq		115 <sup>6</sup>			
3051	Dibutyl sulfide		C <sub>8</sub> H <sub>18</sub> S	544-40-1	146.294	liq	-79.7	185	0.8386 <sup>20</sup>	1.4530 <sup>20</sup>	vs eth, EtOH, chl
3052	Di- <i>sec</i> -butyl sulfide		C <sub>8</sub> H <sub>18</sub> S	626-26-6	146.294			165	0.8348 <sup>20</sup>	1.4506 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
3053	Di- <i>tert</i> -butyl sulfide		C <sub>8</sub> H <sub>18</sub> S	107-47-1	146.294	liq	-9.0	149.1	0.815 <sup>25</sup>	1.4506 <sup>20</sup>	
3054	Dibutyl sulfite	Butyl sulfite	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub> S	626-85-7	194.292			230	0.9957 <sup>20</sup>	1.4310 <sup>20</sup>	s EtOH, eth
3055	Dibutyl sulfone		C <sub>8</sub> H <sub>18</sub> O <sub>2</sub> S	598-04-9	178.293		45	291	0.9885 <sup>47</sup>		i H <sub>2</sub> O; s EtOH, eth
3056	Dibutyl sulfoxide		C <sub>8</sub> H <sub>18</sub> OS	2168-93-6	162.293	nd (dil al)	32.6	dec	0.8317 <sup>23</sup>	1.4669 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3057	Dibutyl tartrate		C <sub>12</sub> H <sub>22</sub> O <sub>6</sub>	87-92-3	262.299	pr	22	320	1.0909 <sup>20</sup>	1.4451 <sup>20</sup>	vs H <sub>2</sub> O, ace, EtOH
3058	<i>N,N'</i> -Dibutylthiourea		C <sub>9</sub> H <sub>20</sub> N <sub>2</sub> S	109-46-6	188.333	nd (al)	78				
3059	Dibutyltin dichloride	Dibutyltin dichlorostannane	C <sub>8</sub> H <sub>18</sub> Cl <sub>2</sub> Sn	683-18-1	303.845	solid	43	135 <sup>10</sup>			s hx, eth, thf
3060	Dibutyltin dilaurate		C <sub>32</sub> H <sub>64</sub> O <sub>4</sub> Sn	77-58-7	631.558	ye liq or cry	23				i H <sub>2</sub> O, MeOH; s eth, bz, ctc
3061	Dicapthon		C <sub>8</sub> H <sub>9</sub> ClNO <sub>3</sub> PS	2463-84-5	297.653	cry (MeOH)	53				i H <sub>2</sub> O; s ace, tol, xyl, AcOEt
3062	Dicentrine		C <sub>20</sub> H <sub>21</sub> NO <sub>4</sub>	517-66-8	339.386						s chl
3063	Dichlofenthion		C <sub>10</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>3</sub> PS	97-17-6	315.153						s ctc, CS <sub>2</sub>
3064	Dichlofluand		C <sub>9</sub> H <sub>11</sub> Cl <sub>2</sub> FN <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	1085-98-9	333.229	wh pow	105.3				i H <sub>2</sub> O; s ace, MeOH, xyl
3065	Dichloroacetaldehyde		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	79-02-7	112.942			90.5	1.436 <sup>25</sup>		sl EtOH

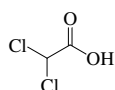


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3066	2,2-Dichloroacetamide		C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> NO	683-72-7	127.957		99.4	234			s H <sub>2</sub> O, EtOH, eth; sl ace
3067	Dichloroacetic acid		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	79-43-6	128.942		13.5	194; 102 <sup>20</sup>	1.5634 <sup>20</sup>	1.4658 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace; sl ctc
3068	Dichloroacetic anhydride		C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub> O <sub>3</sub>	4124-30-5	239.869		18.0	dec 215; 100 <sup>10</sup>	1.574 <sup>24</sup>		
3069	1,1-Dichloroacetone		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O	513-88-2	126.969			120	1.304 <sup>18</sup>		sl H <sub>2</sub> O; s EtOH; msc eth
3070	1,3-Dichloroacetone		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O	534-07-6	126.969	pr or nd	45	173.4	1.3826 <sup>16</sup>	1.4716 <sup>40</sup>	s H <sub>2</sub> O, EtOH, eth
3071	Dichloroacetonitrile		C <sub>2</sub> HCl <sub>2</sub> N	3018-12-0	109.942			112.5	1.369 <sup>20</sup>	1.4391 <sup>25</sup>	s MeOH
3072	Dichloroacetyl chloride		C <sub>2</sub> HCl <sub>3</sub> O	79-36-7	147.387			108	1.5315 <sup>16</sup>	1.4591 <sup>20</sup>	dec H <sub>2</sub> O, EtOH; msc eth
3073	Dichloroacetylene		C <sub>2</sub> Cl <sub>2</sub>	7572-29-4	94.927	liq	-66	33	1.261 <sup>20</sup>	1.42790 <sup>20</sup>	s EtOH, eth, ace
3074	4-[(Dichloroamino)sulfonyl]benzoic acid	Halazone	C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>4</sub> S	80-13-7	270.091	pr (HOAc)	195 dec				sl H <sub>2</sub> O, chl; vs HOAc; i peth
3075	2,3-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	608-27-5	162.017	nd (lig)	24	252			s EtOH, ace; vs eth; sl bz, ctc, lig
3076	2,4-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	554-00-7	162.017	pr (ace) nd (dil al) (lig)	63.5	245	1.567 <sup>20</sup>		sl H <sub>2</sub> O, chl; s EtOH, eth
3077	2,5-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	95-82-9	162.017	nd (lig)	50	251			sl H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
3078	2,6-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	608-31-1	162.017		39				sl H <sub>2</sub> O; s EtOH, eth
3079	3,4-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	95-76-1	162.017	nd (lig)	72	272			s EtOH, eth; sl bz, chl
3080	3,5-Dichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N	626-43-7	162.017	nd (lig, dil al)	52	261			i H <sub>2</sub> O; s EtOH, eth, ctc, lig
3081	9,10-Dichloroanthracene		C <sub>14</sub> H <sub>8</sub> Cl <sub>2</sub>	605-48-1	247.120	ye nd (MeCOEt or CCl <sub>4</sub> )	213.5				sl EtOH, eth, chl; s bz
3082	1,5-Dichloro-9,10-anthracenedione		C <sub>14</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	82-46-2	277.103	ye nd (to)	252				i H <sub>2</sub> O; sl EtOH, ace; s bz, HOAc
3083	1,8-Dichloro-9,10-anthracenedione		C <sub>14</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	82-43-9	277.103	ye nd (HOAc)	202.5				i H <sub>2</sub> O; sl EtOH; s bz, tol, PhNO <sub>2</sub>
3084	<i>trans</i> -4,4'-Dichloroazobenzene		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>2</sub>	1602-00-2	251.111	ye nd (ace)	189				
3085	4,4'-Dichloroazoxybenzene		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>2</sub> O	614-26-6	267.110	ye nd (EtOH)	158				
3086	2,3-Dichlorobenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	6334-18-5	175.012	cry (dil al)	66				vs eth, EtOH
3087	2,4-Dichlorobenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	874-42-0	175.012	pr	73.3	105 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
3088	2,6-Dichlorobenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	83-38-5	175.012	nd (lig)	71.8				vs eth, EtOH, lig
3089	3,4-Dichlorobenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	6287-38-3	175.012		44	247.5			i H <sub>2</sub> O; s EtOH, eth; sl ctc
3090	3,5-Dichlorobenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	10203-08-4	175.012	nd or lf (dil HOAc)	65	240			vs ace, bz, eth, EtOH
3091	2,6-Dichlorobenzamide		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> NO	2008-58-4	190.027	cry	198				
3092	<i>o</i> -Dichlorobenzene	1,2-Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	95-50-1	147.002	liq	-17.0	180	1.3059 <sup>20</sup>	1.5515 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, ctc
3093	<i>m</i> -Dichlorobenzene	1,3-Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	541-73-1	147.002	liq	-24.8	173	1.2884 <sup>20</sup>	1.5459 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; msc ace
3094	<i>p</i> -Dichlorobenzene	1,4-Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	106-46-7	147.002	mcl pr, lf (ace)	53.09	174	1.2475 <sup>55</sup>	1.5285 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, ace, bz; s eth, ctc
3095	2,5-Dichloro-1,4-benzenediamine		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N <sub>2</sub>	20103-09-7	177.031	pr (w)	170				
3096	2,6-Dichloro-1,4-benzenediamine		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N <sub>2</sub>	609-20-1	177.031	nd, pr (dil al)	125				s EtOH, eth, ace, bz
3097	3,5-Dichloro-1,2-benzenediol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> O <sub>2</sub>	13673-92-2	179.001	pr	83.5				sl H <sub>2</sub> O; s EtOH; vs ace
3098	4,5-Dichloro-1,2-benzenediol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> O <sub>2</sub>	3428-24-8	179.001	pr(chl-CS <sub>2</sub> ) nd(bz-peth)	116.5				s H <sub>2</sub> O; vs EtOH, bz
3099	4,6-Dichloro-1,3-benzenediol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> O <sub>2</sub>	137-19-9	179.001		113	254			vs H <sub>2</sub> O, EtOH, eth, ace; sl lig
3100	2,5-Dichloro-1,4-benzenediol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> O <sub>2</sub>	824-69-1	179.001	nd or pr w, ace, bz)	172.5		1.8150 <sup>24</sup>		s H <sub>2</sub> O; vs EtOH, eth, ace
3101	4,5-Dichloro-1,3-benzenedisulfonamide	Dichlorphenamide	C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	120-97-8	305.159		228.7				
3102	2,4-Dichlorobenzenemethanamine		C <sub>7</sub> H <sub>7</sub> Cl <sub>2</sub> N	95-00-1	176.044			125 <sup>13</sup>		1.5762 <sup>25</sup>	s chl
3103	2,4-Dichlorobenzenemethanol	2,4-Dichlorobenzyl alcohol	C <sub>7</sub> H <sub>7</sub> Cl <sub>2</sub> O	1777-82-8	177.028		59.5	150 <sup>25</sup>			s chl
3104	<i>N,N</i> -Dichlorobenzenesulfonamide		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> NO <sub>2</sub> S	473-29-0	226.081	ye mcl or pl	76				s EtOH; sl ctc

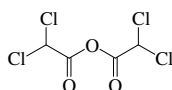




2,2-Dichloroacetamide



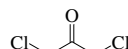
Dichloroacetic acid



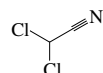
Dichloroacetic anhydride



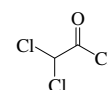
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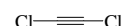
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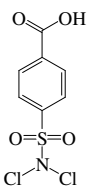
Dichloroacetonitrile



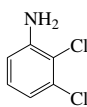
Dichloroacetyl chloride



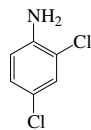
Dichloroacetylene



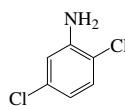
4-[(Dichloroamino)sulfonyl]benzoic acid



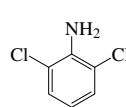
2,3-Dichloroaniline



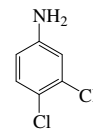
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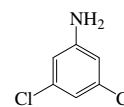
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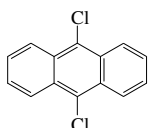
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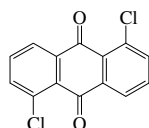
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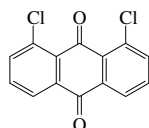
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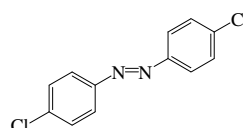
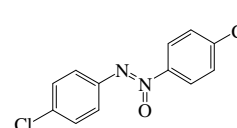
9,10-Dichloroanthracene



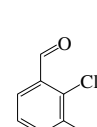
1,5-Dichloro-9,10-anthracenedione



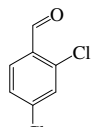
1,8-Dichloro-9,10-anthracenedione

*trans*-4,4'-Dichloroazobenzene

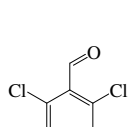
4,4'-Dichloroazoxybenzene



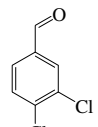
2,3-Dichlorobenzaldehyde



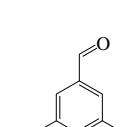
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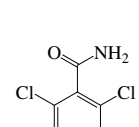
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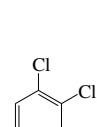
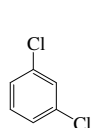
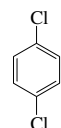
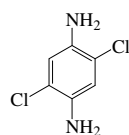
3,4-Dichlorobenzaldehyde



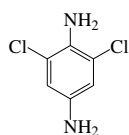
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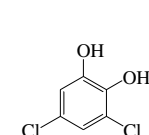
2,6-Dichlorobenzamide

*o*-Dichlorobenzene*m*-Dichlorobenzene*p*-Dichlorobenzene

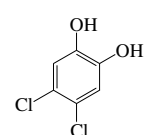
2,5-Dichloro-1,4-benzenediamine



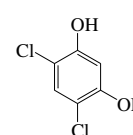
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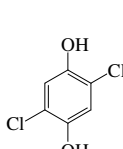
3,5-Dichloro-1,2-benzenediol



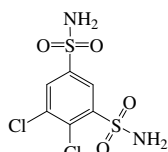
4,5-Dichloro-1,2-benzenediol



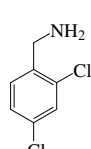
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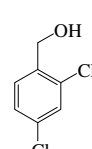
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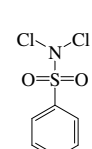
4,5-Dichloro-1,3-benzenedisulfonamide



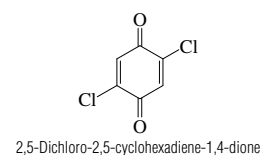
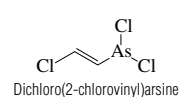
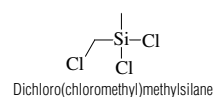
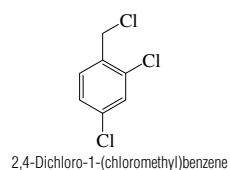
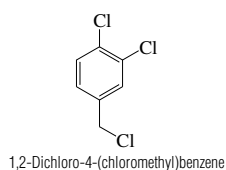
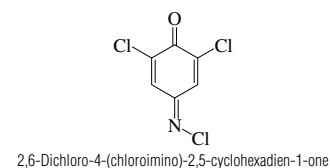
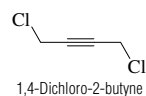
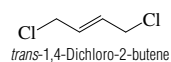
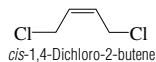
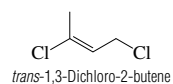
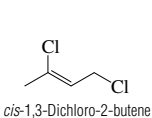
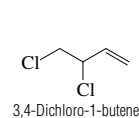
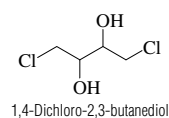
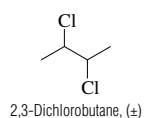
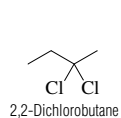
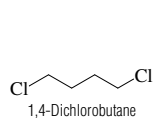
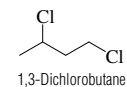
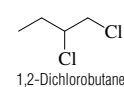
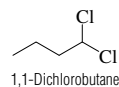
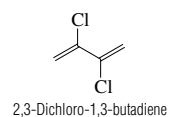
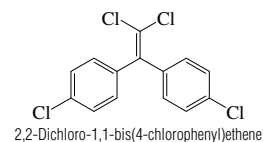
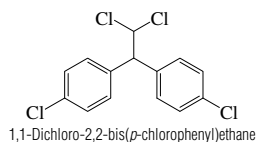
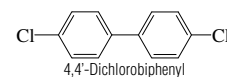
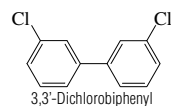
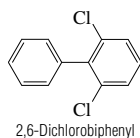
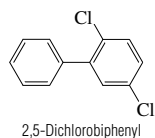
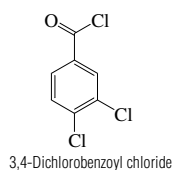
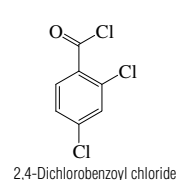
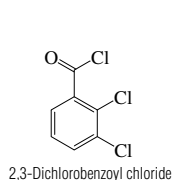
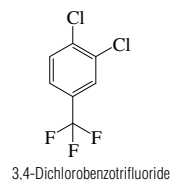
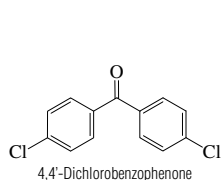
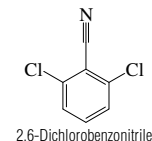
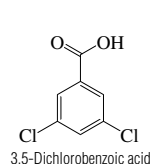
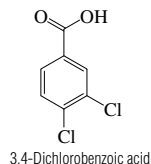
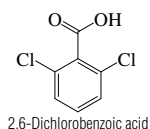
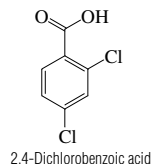
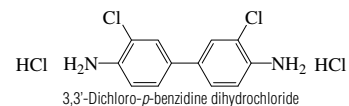
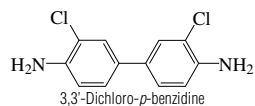
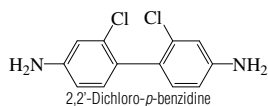
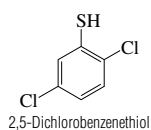
2,4-Dichlorobenzenemethanamine



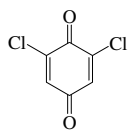
2,4-Dichlorobenzenemethanol

*N,N*-Dichlorobenzenesulfonamide

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3105	2,5-Dichlorobenzenethiol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> S	5858-18-4	179.067			115 <sup>50</sup>			
3106	2,2'-Dichloro- <i>p</i> -benzidine	[1,1'-Biphenyl]-4,4'-diamine, 2,2'-dichloro-	C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	84-68-4	253.126	nd (w), pr (al)	165				vs eth, EtOH
3107	3,3'-Dichloro- <i>p</i> -benzidine	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-	C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	91-94-1	253.126	nd	132.5				i H <sub>2</sub> O; s EtOH, bz, HOAc
3108	3,3'-Dichloro- <i>p</i> -benzidine dihydrochloride		C <sub>12</sub> H <sub>12</sub> Cl <sub>4</sub> N <sub>2</sub>	612-83-9	326.048						i H <sub>2</sub> O; vs EtOH
3109	2,4-Dichlorobenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	50-84-0	191.012	nd (w or bz)	164.2	sub			s H <sub>2</sub> O, EtOH, eth, bz, chl; sl ace
3110	2,5-Dichlorobenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	50-79-3	191.012	nd (w)	154.4	301			sl H <sub>2</sub> O, DMSO; s EtOH, eth
3111	2,6-Dichlorobenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	50-30-6	191.012	nd (al), pr (w)	144	sub			s H <sub>2</sub> O, EtOH, eth, bz, chl
3112	3,4-Dichlorobenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	51-44-5	191.012	nd (w, al, bz)	208.5				s H <sub>2</sub> O, eth; vs EtOH; sl DMSO
3113	3,5-Dichlorobenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	51-36-5	191.012	nd (al, w)	188	sub			sl H <sub>2</sub> O, lig, DMSO; s EtOH, eth
3114	2,6-Dichlorobenzonitrile	Dichlobenil	C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> N	1194-65-6	172.012	cry (peth)	144.5	270			
3115	4,4'-Dichlorobenzophenone	Bis(4-chlorophenyl) ketone	C <sub>13</sub> H <sub>8</sub> Cl <sub>2</sub> O	90-98-2	251.108	pl (al)	147.5	353	1.4500 <sup>20</sup>		i H <sub>2</sub> O; s EtOH; vs eth, chl; sl ace
3116	3,4-Dichlorobenzotrifluoride	1,2-Dichloro-4-(trifluoromethyl) benzene	C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> F <sub>3</sub>	328-84-7	215.000	liq		173.5; 64 <sup>14</sup>	1.4729 <sup>25</sup>		
3117	2,3-Dichlorobenzoyl chloride		C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> O	2905-60-4	209.457	liq		140 <sup>14</sup>			
3118	2,4-Dichlorobenzoyl chloride		C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> O	89-75-8	209.457		16.5	150 <sup>34</sup> , 111 <sup>7.5</sup>	1.5895 <sup>20</sup>		s ctc
3119	2,5-Dichlorobenzoyl chloride		C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> O	2905-61-5	209.457	liq		95.4 <sup>1</sup>			
3120	3,4-Dichlorobenzoyl chloride		C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> O	3024-72-4	209.457		25	242			sl ctc
3121	2,5-Dichlorobiphenyl		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	34883-39-1	223.098			182 <sup>30</sup> , 171 <sup>15</sup>			i H <sub>2</sub> O
3122	2,6-Dichlorobiphenyl		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	33146-45-1	223.098	cry	35.5				i H <sub>2</sub> O
3123	3,3'-Dichlorobiphenyl		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	2050-67-1	223.098	nd (dil al)	29	320			vs bz, eth, EtOH
3124	4,4'-Dichlorobiphenyl		C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	2050-68-2	223.098	pr or nd (al, to-peth)	149.3	317	1.4420 <sup>9</sup>		i H <sub>2</sub> O; sl EtOH, chl; s bz
3125	1,1-Dichloro-2,2-bis( <i>p</i> -chlorophenyl)ethane		C <sub>14</sub> H <sub>10</sub> Cl <sub>4</sub>	72-54-8	320.041		109.5	193 <sup>1</sup>			sl chl
3126	2,2-Dichloro-1,1-bis(4-chlorophenyl)ethene		C <sub>14</sub> H <sub>8</sub> Cl <sub>4</sub>	72-55-9	318.026		89				
3127	2,3-Dichloro-1,3-butadiene		C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub>	1653-19-6	122.981			98	1.1829 <sup>20</sup>	1.4890 <sup>20</sup>	vs chl
3128	1,1-Dichlorobutane	Butylidene chloride	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	541-33-3	127.013			113.8	1.0863 <sup>20</sup>	1.4355 <sup>20</sup>	i H <sub>2</sub> O; s chl
3129	1,2-Dichlorobutane		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	616-21-7	127.013			124.1	1.1116 <sup>25</sup>	1.4450 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl; sl ctc
3130	1,3-Dichlorobutane		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1190-22-3	127.013			134	1.1158 <sup>20</sup>	1.4445 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl; sl ctc
3131	1,4-Dichlorobutane		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	110-56-5	127.013	liq	-37.3	161	1.1331 <sup>25</sup>	1.4522 <sup>25</sup>	i H <sub>2</sub> O; vs chl
3132	2,2-Dichlorobutane		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	4279-22-5	127.013	liq	-74	104	1.1048 <sup>25</sup>	1.4295	i H <sub>2</sub> O; s chl
3133	2,3-Dichlorobutane, (±)		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	2211-67-8	127.013	liq	-80	119; 53 <sup>30</sup>	1.105 <sup>25</sup>	1.4409 <sup>25</sup>	i H <sub>2</sub> O
3134	1,4-Dichloro-2,3-butanediol		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>2</sub>	2419-73-0	159.012			126.5	150 <sup>30</sup>		vs EtOH
3135	3,4-Dichloro-1-butene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	760-23-6	124.997	liq	-61	116	1.1170 <sup>20</sup>	1.4641 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; vs chl, bz
3136	<i>cis</i> -1,3-Dichloro-2-butene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	10075-38-4	124.997			130; 34 <sup>20</sup>	1.1605 <sup>20</sup>	1.4735 <sup>20</sup>	vs ace, bz, eth, EtOH
3137	<i>trans</i> -1,3-Dichloro-2-butene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	7415-31-8	124.997			132; 53 <sup>20</sup>	1.160 <sup>20</sup>	1.4719 <sup>20</sup>	vs ace, bz, eth, EtOH
3138	<i>cis</i> -1,4-Dichloro-2-butene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	1476-11-5	124.997	liq	-48	152.5	1.188 <sup>25</sup>	1.4887 <sup>25</sup>	vs ace, bz, eth, EtOH
3139	<i>trans</i> -1,4-Dichloro-2-butene		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	110-57-6	124.997		1.0	155.4	1.183 <sup>25</sup>	1.4871 <sup>25</sup>	vs ace, bz, eth, EtOH
3140	1,4-Dichloro-2-butyne		C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub>	821-10-3	122.981			165.5	1.258 <sup>20</sup>	1.5058 <sup>20</sup>	s eth, ace; sl ctc; vs chl
3141	2,6-Dichloro-4-(chloroimino)-2,5-cyclohexadien-1-one	Gibbs' reagent	C <sub>6</sub> H <sub>2</sub> Cl <sub>3</sub> NO	101-38-2	210.445		66				
3142	1,2-Dichloro-4-(chloromethyl) benzene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	102-47-6	195.474		37.5	241			i H <sub>2</sub> O; s EtOH, ctc
3143	2,4-Dichloro-1-(chloromethyl) benzene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	94-99-5	195.474			120 <sup>13</sup>			
3144	Dichloro(chloromethyl) methylsilane		C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> Si	1558-33-4	163.506			121.5	1.2858 <sup>20</sup>	1.4500 <sup>20</sup>	
3145	Dichloro(2-chlorovinyl)arsine		C <sub>2</sub> H <sub>2</sub> AsCl <sub>3</sub>	541-25-3	207.318	liq	0.1	190	1.888 <sup>20</sup>		
3146	2,5-Dichloro-2,5-cyclohexadiene-1,4-dione		C <sub>6</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	615-93-0	176.985	pa ye mcl pr (al)	162.3				i H <sub>2</sub> O; sl EtOH; s eth, chl



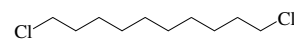
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3147	2,6-Dichloro-2,5-cyclohexadiene-1,4-dione		C <sub>6</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	697-91-6	176.985	ye orth (liq, bz)	121.8				sl H <sub>2</sub> O, EtOH; s chl
3148	1,1-Dichlorocyclohexane		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub>	2108-92-1	153.049	liq	-47	171	1.1559 <sup>20</sup>	1.4803 <sup>20</sup>	
3149	<i>cis</i> -1,2-Dichlorocyclohexane		C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub>	10498-35-8	153.049	liq	-1.5	206.9	1.2021 <sup>20</sup>	1.4967 <sup>20</sup>	vs bz
3150	1,10-Dichlorodecane		C <sub>10</sub> H <sub>20</sub> Cl <sub>2</sub>	2162-98-3	211.172		15.6	167 <sup>28</sup>	0.9945 <sup>25</sup>	1.4586 <sup>25</sup>	
3151	2,7-Dichlorodibenzo- <i>p</i> -dioxin		C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	33857-26-0	253.081	cry	201				
3152	1,2-Dichloro-4-(dichloromethyl)benzene		C <sub>7</sub> H <sub>4</sub> Cl <sub>4</sub>	56961-84-3	229.919			257	1.515 <sup>22</sup>		vs bz, eth, EtOH
3153	Dichloro(dichloromethyl)methylsilane		C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> Si	1558-31-2	197.951			149	1.4116 <sup>20</sup>	1.4700 <sup>20</sup>	
3154	2,3-Dichloro-5,6-dicyanobenzoquinone		C <sub>8</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	84-58-2	227.004	ye-oran cry	214.5				vs bz, HOAc, diox
3155	Dichlorodiethylsilane		C <sub>4</sub> H <sub>10</sub> Cl <sub>2</sub> Si	1719-53-5	157.114		-96.5	dec 129	1.0504 <sup>20</sup>	1.4309 <sup>20</sup>	
3156	1,1-Dichloro-1,2-difluoroethane		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	25915-78-0	134.940	col liq		48.4			
3157	1,2-Dichloro-1,1-difluoroethane		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	1649-08-7	134.940	liq	-101.2	46.2	1.4163 <sup>20</sup>	1.36193 <sup>20</sup>	sl H <sub>2</sub> O
3158	1,2-Dichloro-1,2-difluoroethane		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	431-06-1	134.940	liq	-101.2	59.6	1.4163 <sup>20</sup>	1.3619 <sup>20</sup>	
3159	1,1-Dichloro-2,2-difluoroethene	1,1-Dichloro-2,2-difluoroethylene	C <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	79-35-6	132.924	vol liq or gas	-116	19	1.555 <sup>-20</sup>	1.383 <sup>-20</sup>	
3160	<i>cis</i> -1,2-Dichloro-1,2-difluoroethene	Fluorocarbon 1112	C <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	311-81-9	132.924	vol liq	-119.6	21.1	1.495 <sup>0</sup>		
3161	<i>trans</i> -1,2-Dichloro-1,2-difluoroethene		C <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	381-71-5	132.924	vol liq	-93.3	22	1.494 <sup>0</sup>		
3162	Dichlorodifluoromethane	Refrigerant 12	CCl <sub>2</sub> F <sub>2</sub>	75-71-8	120.914	col gas	-157.1	-29.8			sl H <sub>2</sub> O; s EtOH, eth, HOAc
3163	2,2-Dichloro-1,1-difluoro-1-methoxyethane	Methoxyflurane	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> F <sub>2</sub> O	76-38-0	164.966	col liq	-35	105	1.43 <sup>20</sup>	1.3861 <sup>20</sup>	
3164	2,2'-Dichlorodisopropyl ether		C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> O	108-60-1	171.064			187	1.103 <sup>20</sup>	1.4505 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; vs bz
3165	1,4-Dichloro-2,5-dimethylbenzene		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub>	1124-05-6	175.056		71	222			s chl
3166	2,5-Dichloro-2,5-dimethylhexane		C <sub>8</sub> H <sub>16</sub> Cl <sub>2</sub>	6223-78-5	183.119	lf, nd	67.5		0.9543 <sup>20</sup>		vs bz, eth, EtOH, chl
3167	1,3-Dichloro-5,5-dimethylhydantoin		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	118-52-5	197.019	pr	132		1.5 <sup>20</sup>		sl H <sub>2</sub> O; s chl, ctc, bz
3168	2,4-Dichloro-3,5-dimethylphenol	Dichloroxylenol	C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	133-53-9	191.055		83				vs eth
3169	Dichlorodimethylsilane		C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	75-78-5	129.061	liq	-16	70.3	1.064 <sup>25</sup>	1.4038 <sup>20</sup>	dec H <sub>2</sub> O, EtOH
3170	2,3-Dichloro-1,4-dioxane		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	95-59-0	156.996		30	81 <sup>10</sup>	1.468 <sup>20</sup>	1.4928 <sup>20</sup>	i H <sub>2</sub> O; vs eth, ace, bz, ctc, diox
3171	Dichlorodiphenylmethane		C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub>	2051-90-3	237.124			dec 305; 190 <sup>21</sup>	1.235 <sup>18</sup>		s eth, bz, ctc
3172	Dichlorodiphenylsilane		C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> Si	80-10-4	253.199			305	1.204 <sup>25</sup>	1.5800 <sup>20</sup>	s EtOH, eth, ace, bz, ctc
3173	1,1-Dichloroethane	Ethylidene dichloride	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	75-34-3	98.959	liq	-96.9	57.3	1.1757 <sup>20</sup>	1.4164 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz
3174	1,2-Dichloroethane	Ethylene dichloride	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	107-06-2	98.959	liq	-35.7	83.5	1.2454 <sup>25</sup>	1.4422 <sup>25</sup>	sl H <sub>2</sub> O; vs EtOH; msc eth; s ace, bz, chl
3175	2,2-Dichloroethanol		C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	598-38-9	114.958			146	1.4040 <sup>25</sup>	1.4626 <sup>25</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
3176	1,1-Dichloroethene	Vinylidene chloride	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	75-35-4	96.943	liq	-122.56	31.6	1.213 <sup>20</sup>	1.4249 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; vs eth, chl
3177	<i>cis</i> -1,2-Dichloroethene	<i>cis</i> -1,2-Dichloroethylene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	156-59-2	96.943	liq	-80.0	60.1	1.2837 <sup>20</sup>	1.4490 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; vs bz, chl
3178	<i>trans</i> -1,2-Dichloroethene	<i>trans</i> -1,2-Dichloroethylene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	156-60-5	96.943	liq	-49.8	48.7	1.2565 <sup>20</sup>	1.4454 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; vs bz, chl
3179	1,2-Dichloro-1-ethoxyethane		C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	623-46-1	143.012			145	1.1370 <sup>20</sup>	1.4435 <sup>20</sup>	sl chl
3180	1,2-Dichloroethyl acetate		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	10140-87-1	156.996	liq		79 <sup>33</sup> , 32 <sup>10</sup>			
3181	Dichloroethylaluminum	Ethylaluminum chloride	C <sub>2</sub> H <sub>4</sub> AlCl <sub>2</sub>	563-43-9	126.949	hyg solid or liq	32	115 <sup>50</sup>	1.207		reac H <sub>2</sub> O
3182	Dichloroethylmethylsilane		C <sub>3</sub> H <sub>8</sub> Cl <sub>2</sub> Si	4525-44-4	143.088			101	1.0047 <sup>20</sup>	1.4197 <sup>20</sup>	
3183	2',7'-Dichlorofluorescein	2',7'-Dichloro-3,6-fluorandiols	C <sub>20</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>5</sub>	76-54-0	401.196						sl DMSO
3184	1,1-Dichloro-1-fluoroethane		C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	1717-00-6	116.949	liq	-103.5	32.0	1.250 <sup>10</sup>	1.3600 <sup>10</sup>	i H <sub>2</sub> O
3185	1,2-Dichloro-1-fluoroethane		C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	430-57-9	116.949	liq	-60	73.8	1.3814 <sup>20</sup>	1.4132 <sup>20</sup>	
3186	1,1-Dichloro-2-fluoroethane	1,1-Dichloro-2-fluoroethylene	C <sub>2</sub> HCl <sub>2</sub> F	359-02-4	114.933	liq	-108.8	37.5	1.3732 <sup>16</sup>	1.4031 <sup>16</sup>	
3187	Dichlorofluoromethane	Refrigerant 21	CHCl <sub>2</sub> F	75-43-4	102.923	col gas	-130.4	8.9	1.405 <sup>9</sup>	1.3724 <sup>9</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, chl, HOAc
3188	(Dichlorofluoromethyl)benzene		C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> F	498-67-9	179.019	liq	-26.8	179	1.3138 <sup>11</sup>	1.5180 <sup>11</sup>	vs EtOH
3189	1,1-Dichloro-2-fluoropropene		C <sub>3</sub> H <sub>3</sub> Cl <sub>2</sub> F	430-95-5	128.960			78	1.3026 <sup>25</sup>	1.4196 <sup>25</sup>	
3190	1,7-Dichloroheptane		C <sub>7</sub> H <sub>14</sub> Cl <sub>2</sub>	821-76-1	169.092			124 <sup>35</sup>	1.0408 <sup>25</sup>	1.4565 <sup>25</sup>	



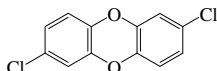
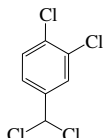
2,6-Dichloro-2,5-cyclohexadiene-1,4-dione



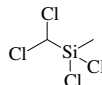
1,1-Dichlorocyclohexane

*cis*-1,2-Dichlorocyclohexane

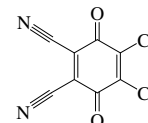
1,10-Dichlorodecane

2,7-Dichlorodibenzo-*p*-dioxin

1,2-Dichloro-4-(dichloromethyl)benzene



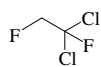
Dichloro(dichloromethyl)methylsilane



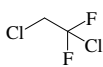
2,3-Dichloro-5,6-dicyanobenzoquinone



Dichlorodiethylsilane



1,1-Dichloro-1,2-difluoroethane



1,2-Dichloro-1,1-difluoroethane



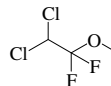
1,2-Dichloro-1,2-difluoroethane



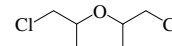
1,1-Dichloro-2,2-difluoroethene

*cis*-1,2-Dichloro-1,2-difluoroethene*trans*-1,2-Dichloro-1,2-difluoroethene

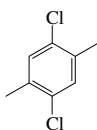
Dichlorodifluoromethane



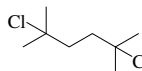
2,2-Dichloro-1,1-difluoro-1-methoxyethane



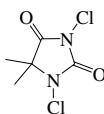
2,2'-Dichlorodiisopropyl ether



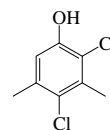
1,4-Dichloro-2,5-dimethylbenzene



2,5-Dichloro-2,5-dimethylhexane



1,3-Dichloro-5,5-dimethyl hydantoin



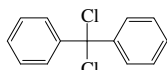
2,4-Dichloro-3,5-dimethylphenol



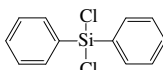
Dichlorodimethylsilane



2,3-Dichloro-1,4-dioxane



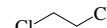
Dichlorodiphenylmethane



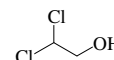
Dichlorodiphenylsilane



1,1-Dichloroethane



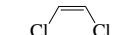
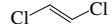
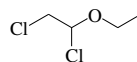
1,2-Dichloroethane



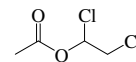
2,2-Dichloroethanol



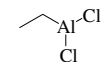
1,1-Dichloroethene

*cis*-1,2-Dichloroethene*trans*-1,2-Dichloroethene

1,2-Dichloro-1-ethoxyethane



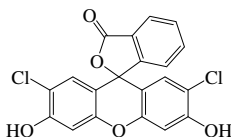
1,2-Dichloroethyl acetate



Dichloroethylaluminum



Dichloroethylmethylsilane



2,7-Dichlorofluorescein



1,1-Dichloro-1-fluoroethane



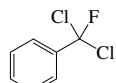
1,2-Dichloro-1-fluoroethane



1,1-Dichloro-2-fluoroethene



Dichlorodifluoromethane



(Dichlorofluoromethyl)benzene

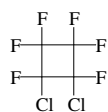


1,1-Dichloro-2-fluoropropene

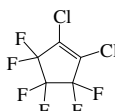


1,7-Dichloroheptane

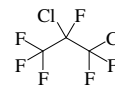
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3191	1,2-Dichloro-1,2,3,3,4,4-hexafluorocyclobutane		C <sub>4</sub> Cl <sub>2</sub> F <sub>6</sub>	356-18-3	232.939	liq	-24.2	59.5			
3192	1,2-Dichloro-3,3,4,4,5,5-hexafluorocyclopentane		C <sub>5</sub> Cl <sub>2</sub> F <sub>6</sub>	706-79-6	244.949	liq	-105.8	90.7	1.6546 <sup>20</sup>	1.3676 <sup>20</sup>	
3193	1,2-Dichloro-1,1,2,3,3,3-hexafluoropropane		C <sub>3</sub> Cl <sub>2</sub> F <sub>6</sub>	661-97-2	220.928			34.1			i H <sub>2</sub> O
3194	1,3-Dichloro-1,1,2,2,3,3-hexafluoropropane	Refrigerant 216	C <sub>3</sub> Cl <sub>2</sub> F <sub>6</sub>	662-01-1	220.928	liq	-125.4	35.7	1.573 <sup>20</sup>	1.3030 <sup>20</sup>	
3195	1,5-Dichloro-1,1,3,3,5,5-hexamethyltrisiloxane		C <sub>6</sub> H <sub>18</sub> Cl <sub>2</sub> O <sub>2</sub> Si <sub>3</sub>	3582-71-6	277.369	liq	-53	184	1.018 <sup>20</sup>		dec H <sub>2</sub> O
3196	1,2-Dichlorohexane		C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub>	2162-92-7	155.065			173	1.085 <sup>15</sup>		vs eth, chl
3197	1,6-Dichlorohexane		C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub>	2163-00-0	155.065			204	1.0676 <sup>25</sup>	1.4555 <sup>25</sup>	i H <sub>2</sub> O; s eth, ctc, chl
3198	3,5-Dichloro-2-hydroxybenzaldehyde		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	90-60-8	191.012	ye orth (HOAc)	95				i H <sub>2</sub> O
3199	3,5-Dichloro-2-hydroxybenzoic acid		C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>3</sub>	320-72-9	207.011	nd (dil al) orth pr	220.5	sub			sl H <sub>2</sub> O; vs EtOH, eth
3200	2,6-Dichloroindophenol, sodium salt	Tillman's reagent	C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> NNaO <sub>2</sub>	620-45-1	290.078	dk grn cry					s H <sub>2</sub> O, EtOH, ace
3201	5,6-Dichloro-1,3-isobenzofurandione	4,5-Dichlorophthalic anhydride	C <sub>8</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>3</sub>	942-06-3	217.006	tab or pr (to)	188	313			vs eth, EtOH, tol
3202	Dichloromethane	Methylene chloride	CH <sub>2</sub> Cl <sub>2</sub>	75-09-2	84.933	liq	-97.2	40	1.3266 <sup>20</sup>	1.4242 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
3203	1,2-Dichloro-3-methoxybenzene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	1984-59-4	177.028		32				
3204	1,3-Dichloro-2-methoxybenzene	2,6-Dichloroanisole	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	1984-65-2	177.028	liq	10	105 <sup>20</sup>	1.291	1.5430 <sup>20</sup>	
3205	2,4-Dichloro-1-methoxybenzene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	553-82-2	177.028	pr	28.5	232; 125 <sup>10</sup>			sl chl
3206	3,6-Dichloro-2-methoxybenzoic acid	Dicamba	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	1918-00-9	221.038	cry (pent)	115		1.57 <sup>25</sup>		
3207	(Dichloromethyl)benzene	Benzal chloride	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	98-87-3	161.029	liq	-17	205	1.26 <sup>25</sup>	1.5502 <sup>20</sup>	i H <sub>2</sub> O; vs eth, EtOH
3208	<i>N,N</i> -Dichloro-4-methylbenzenesulfonamide	Dichloramine-T	C <sub>7</sub> H <sub>7</sub> Cl <sub>2</sub> NO <sub>2</sub> S	473-34-7	240.108	pr(chl-peth)	83				i H <sub>2</sub> O; s EtOH, eth, bz, ctc, HOAc
3209	Dichloromethylborane	Methylchloroborane	CH <sub>2</sub> BCl <sub>2</sub>	7318-78-7	96.752	col gas		11			
3210	2,3-Dichloro-2-methylbutane	Amylene dichloride	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	507-45-9	141.038			129	1.0696 <sup>15</sup>	1.4450 <sup>18</sup>	i H <sub>2</sub> O; vs eth, EtOH
3211	1,1-Dichloromethyl methyl ether	Methoxydichloromethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	4885-02-3	114.958			85	1.271 <sup>25</sup>	1.4300 <sup>20</sup>	
3212	2,4-Dichloro-3-methylphenol		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	17788-00-0	177.028	pr (peth)	58	236; 77 <sup>4</sup>			vs eth, chl
3213	2,4-Dichloro-6-methylphenol		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	1570-65-6	177.028	nd (w, peth)	55				sl H <sub>2</sub> O; vs EtOH, eth, chl, CS <sub>2</sub>
3214	2,6-Dichloro-4-methylphenol		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	2432-12-4	177.028	nd (lig)	39	231; 138 <sup>28</sup>			i H <sub>2</sub> O; vs eth, EtOH, HOAc
3215	Dichloromethylphenylsilane		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> Si	149-74-6	191.131			206.5	1.1866 <sup>20</sup>	1.5180 <sup>20</sup>	
3216	Dichloromethylphosphine	Methylphosphonous dichloride	CH <sub>2</sub> Cl <sub>2</sub> P	676-83-5	116.915			12 <sup>20</sup>	1.304 <sup>20</sup>	1.4940 <sup>20</sup>	
3217	1,2-Dichloro-2-methylpropane	1,2-Dichloroisobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	594-37-6	127.013			106.5	1.093 <sup>20</sup>	1.4370 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
3218	2,4-Dichloro-5-methylpyrimidine		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> N <sub>2</sub>	1780-31-0	163.004	pl (al)	26	235			sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
3219	2,4-Dichloro-6-methylpyrimidine		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> N <sub>2</sub>	5424-21-5	163.004	nd (lig)	46.5	219			vs bz, eth, EtOH, chl
3220	Dichloromethylsilane		CH <sub>2</sub> Cl <sub>2</sub> Si	75-54-7	115.035	liq	-93	41	1.105 <sup>25</sup>		
3221	1,2-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2050-69-3	197.061	pl (al)	36	296.5	1.3147 <sup>49</sup>	1.5338 <sup>49</sup>	s EtOH, eth
3222	1,3-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2198-75-6	197.061	nd or pr (al)	62.3	291			s EtOH
3223	1,4-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	1825-31-6	197.061	nd or pr (al, ace)	67.5	288; 147 <sup>12</sup>	1.2997 <sup>76</sup>	1.6228 <sup>76</sup>	i H <sub>2</sub> O; sl EtOH; s eth, bz, HOAc; vs ace
3224	1,5-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	1825-30-5	197.061	nd or lf (al) pr (sub)	107	sub	1.4900 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth
3225	1,6-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2050-72-8	197.061	nd or pr (al, peth)	49	sub			
3226	1,7-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2050-73-9	197.061	nd or pr (al, HOAc)	63.5	285.5	1.2611 <sup>100</sup>	1.6092 <sup>100</sup>	s EtOH, eth, bz, HOAc
3227	1,8-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2050-74-0	197.061	orth pl (hx) nd (al, sub)	89	sub	1.2924 <sup>100</sup>	1.6236 <sup>100</sup>	s EtOH, peth
3228	2,3-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2050-75-1	197.061	orth lf (al)	120				i H <sub>2</sub> O; sl EtOH; vs eth
3229	2,6-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2065-70-5	197.061	nd or lf (al) pl (eth, bz)	140.5	285			sl EtOH; s eth, bz, chl, HOAc
3230	2,7-Dichloronaphthalene		C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub>	2198-77-8	197.061	pl or lf (al)	115.0				vs EtOH; s hx, HOAc
3231	2,3-Dichloro-1,4-naphthalenedione	Dichlone	C <sub>10</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	117-80-6	227.044	ye nd (al)	195				i H <sub>2</sub> O; sl EtOH, eth, bz; s chl



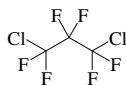
1,2-Dichloro-1,2,3,3,4,4-hexafluorocyclobutane



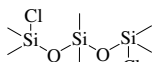
1,2-Dichloro-3,3,4,4,5,5-hexafluorocyclopentene



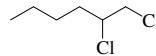
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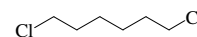
1,3-Dichloro-1,1,2,2,3,3-hexafluoropropane



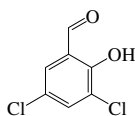
1,5-Dichloro-1,1,3,3,5,5-hexamethyltrisiloxane



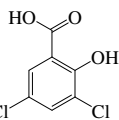
1,2-Dichlorohexane



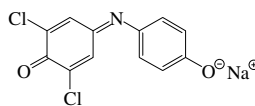
1,6-Dichlorohexane



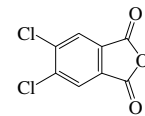
3,5-Dichloro-2-hydroxybenzaldehyde



3,5-Dichloro-2-hydroxybenzoic acid



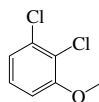
2,6-Dichloroindophenol, sodium salt



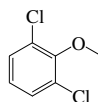
5,6-Dichloro-1,3-isobenzofurandione



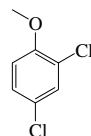
Dichloromethane



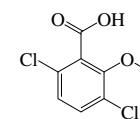
1,2-Dichloro-3-methoxybenzene



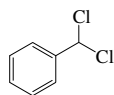
1,3-Dichloro-2-methoxybenzene



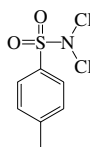
2,4-Dichloro-1-methoxybenzene



3,6-Dichloro-2-methoxybenzoic acid



(Dichloromethyl)benzene



N,N-Dichloro-4-methylbenzenesulfonamide



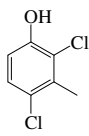
Dichloromethylborane



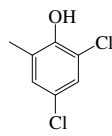
2,3-Dichloro-2-methylbutane



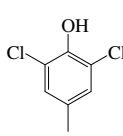
1,1-Dichloromethyl methyl ether



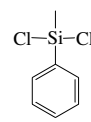
2,4-Dichloro-3-methylphenol



2,4-Dichloro-6-methylphenol



2,6-Dichloro-4-methylphenol



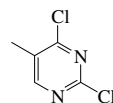
Dichloromethylphenylsilane



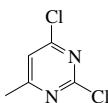
Dichloromethylphosphine



1,2-Dichloro-2-methylpropane



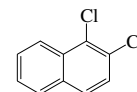
2,4-Dichloro-5-methylpyrimidine



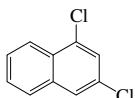
2,4-Dichloro-6-methylpyrimidine



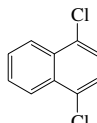
Dichloromethylsilane



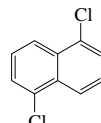
1,2-Dichloronaphthalene



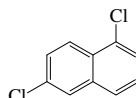
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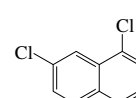
1,4-Dichloronaphthalene



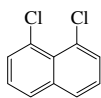
1,5-Dichloronaphthalene



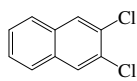
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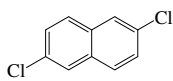
1,7-Dichloronaphthalene



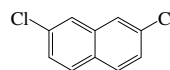
1,8-Dichloronaphthalene



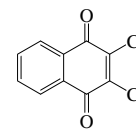
2,3-Dichloronaphthalene



2,6-Dichloronaphthalene



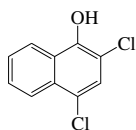
2,7-Dichloronaphthalene



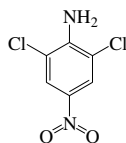
2,3-Dichloro-1,4-naphthalenedione

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3232	2,4-Dichloro-1-naphthol	2,4-Dichloro- $\alpha$ -naphthol	C <sub>10</sub> H <sub>6</sub> Cl <sub>2</sub> O	2050-76-2	213.060	nd (al, bz)	107.5	180			vs bz, eth, EtOH
3233	2,6-Dichloro-4-nitroaniline		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	99-30-9	207.014	ye nd (al, HOAc)	191				s EtOH, acid; sl DMSO
3234	1,2-Dichloro-3-nitrobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	3209-22-1	192.000	mcl nd (peth, HOAc)	61.5	257.5	1.721 <sup>14</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth; sl chl
3235	1,2-Dichloro-4-nitrobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	99-54-7	192.000	nd (al)	43	255.5	1.4558 <sup>75</sup>		i H <sub>2</sub> O; s EtOH, eth; sl ctc
3236	1,3-Dichloro-5-nitrobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	618-62-2	192.000	mcl pr or lf (HOAc, al)	65.4		1.4000 <sup>100</sup>		i H <sub>2</sub> O; s EtOH, eth
3237	1,4-Dichloro-2-nitrobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	89-61-2	192.000	pl or pr (al) pl (AcOEt)	56	267	1.439 <sup>75</sup>	1.4390 <sup>75</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> ; sl ctc
3238	2,4-Dichloro-1-nitrobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	611-06-3	192.000	nd (al)	34	258.5	1.4790 <sup>80</sup>	1.5512 <sup>70</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
3239	1,1-Dichloro-1-nitroethane	Ethide	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	594-72-9	143.957			123.5			s ctc
3240	2,6-Dichloro-4-nitrophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>3</sub>	618-80-4	207.999	br nd (w)	127 exp		1.822 <sup>25</sup>		vs eth, chl
3241	1,1-Dichloro-1-nitropropane		C <sub>3</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	595-44-8	157.984			145	1.312 <sup>20</sup>		s ctc
3242	1,9-Dichlorononane		C <sub>9</sub> H <sub>19</sub> Cl <sub>2</sub>	821-99-8	197.145			260; 138 <sup>17</sup>	1.0173 <sup>25</sup>	1.4586 <sup>25</sup>	
3243	1,8-Dichlorooctane		C <sub>8</sub> H <sub>16</sub> Cl <sub>2</sub>	2162-99-4	183.119			241	1.0248 <sup>25</sup>	1.4572 <sup>25</sup>	
3244	1,3-Dichloro-1,1,2,2,3-pentafluoropropane		C <sub>3</sub> HCl <sub>2</sub> F <sub>5</sub>	507-55-1	202.938	liq		52	1.55 <sup>25</sup>		
3245	3,3-Dichloro-1,1,1,2,2-pentafluoropropane	Refrigerant 225ca	C <sub>3</sub> HCl <sub>2</sub> F <sub>5</sub>	422-56-0	202.938	liq		45.5	1.54 <sup>25</sup>		
3246	1,2-Dichloropentane		C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	1674-33-5	141.038			148.3	1.0872 <sup>20</sup>	1.4485 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs chl
3247	1,5-Dichloropentane		C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	628-76-2	141.038	liq	-72.8	179	1.0956 <sup>25</sup>	1.4545 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
3248	2,3-Dichloropentane		C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	600-11-3	141.038	liq	-77.3	139	1.0789 <sup>20</sup>	1.4464 <sup>20</sup>	i H <sub>2</sub> O
3249	Dichlorophene		C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	97-23-4	269.123	cry (bz, peth)	177.5				i H <sub>2</sub> O; s EtOH, ace
3250	2,3-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	576-24-9	163.001	cry (lig, bz)	58				s EtOH, eth, bz, lig
3251	2,4-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	120-83-2	163.001	hex nd (bz)	45	210			sl H <sub>2</sub> O; s EtOH, eth, bz, chl
3252	2,5-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	583-78-8	163.001	pr (bz, peth)	59	211			sl H <sub>2</sub> O; vs EtOH, eth; s bz, peth
3253	2,6-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	87-65-0	163.001	nd (peth)	68.5	220; 82 <sup>4</sup>	1.653 <sup>20</sup>		vs EtOH, eth; s bz, peth
3254	3,4-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	95-77-2	163.001	nd (bz-peth)	68	253			sl H <sub>2</sub> O; vs EtOH, eth; s bz, peth
3255	3,5-Dichlorophenol		C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	591-35-5	163.001	pr (peth)	68	233			sl H <sub>2</sub> O; vs EtOH, eth; s peth
3256	(2,4-Dichlorophenoxy)acetic acid	2,4-D	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	94-75-7	221.038	cry (bz)	140.5	160 <sup>9,4</sup>			i H <sub>2</sub> O; s EtOH; sl bz, DMSO
3257	4-(2,4-Dichlorophenoxy)butanoic acid	Butyrac 118 acid	C <sub>10</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>3</sub>	94-82-6	249.090		118				
3258	2-(2,4-Dichlorophenoxy)propanoic acid	Dichlorprop	C <sub>9</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>3</sub>	120-36-5	235.064		117.5				sl H <sub>2</sub> O, lig; s EtOH, eth
3259	Dichlorophenylarsine		C <sub>6</sub> H <sub>4</sub> AsCl <sub>2</sub>	696-28-6	222.932	liq	-19	255	1.6516 <sup>20</sup>	1.6386 <sup>15</sup>	vs bz, eth, EtOH
3260	2,4-Dichlorophenyl benzenesulfonate	Genite	C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>3</sub> S	97-16-5	303.161		45.5				s ctc, CS <sub>2</sub>
3261	2,2-Dichloro-1-phenylethanone		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	2648-61-5	189.039	amor	20.5	249	1.340 <sup>16</sup>	1.5686 <sup>20</sup>	s EtOH, bz, ctc
3262	1-(2,4-Dichlorophenyl)ethanone		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	2234-16-4	189.039		33.5			1.5640 <sup>20</sup>	i H <sub>2</sub> O
3263	1-(2,5-Dichlorophenyl)ethanone		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	2476-37-1	189.039		12	118 <sup>12</sup>	1.321 <sup>30</sup>	1.5595 <sup>30</sup>	
3264	1-(3,4-Dichlorophenyl)ethanone		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> O	2642-63-9	189.039	nd (peth)	76	135 <sup>12</sup>			i H <sub>2</sub> O; s ctc, lig
3265	3,4-Dichlorophenyl isocyanate	1,2-Dichloro-5-isocyanatobenzene	C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> NO	102-36-3	188.011	cry	42	112 <sup>12</sup>			
3266	3,5-Dichlorophenyl isocyanate	1,3-Dichloro-5-isocyanatobenzene	C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> NO	34893-92-0	188.011		33		1.380		
3267	<i>N</i> -(3,4-Dichlorophenyl)-2-methyl-2-propenamide	Dicryl	C <sub>10</sub> H <sub>9</sub> Cl <sub>2</sub> NO	2164-09-2	230.090	cry (al-peth)	128				vs ace, EtOH
3268	3-(2,4-Dichlorophenyl)-2-propenoic acid		C <sub>9</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	1201-99-6	217.049		234				s DMSO
3269	Dichlorophenylsilane	Phenyldichlorosilane	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> Si	1631-84-1	177.104			181	1.221 <sup>25</sup>		dec H <sub>2</sub> O
3270	1,1-Dichloropropane	Propylidene chloride	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	78-99-9	112.986			88.1	1.1321 <sup>20</sup>	1.4289 <sup>20</sup>	s EtOH, eth, bz, chl
3271	1,2-Dichloropropane, ( $\pm$ )	Propylene dichloride	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	26198-63-0	112.986	liq	-100.53	96.4	1.1560 <sup>20</sup>	1.4394 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, chl
3272	1,3-Dichloropropane		C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	142-28-9	112.986	liq	-99.5	120.9	1.1785 <sup>25</sup>	1.4455 <sup>25</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s bz, chl
3273	2,2-Dichloropropane		C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	594-20-7	112.986	liq	-33.9	69.3	1.1136 <sup>20</sup>	1.4148 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl; msc eth

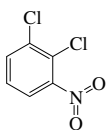




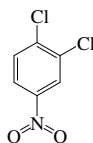
2,4-Dichloro-1-naphthol



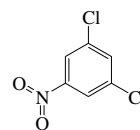
2,6-Dichloro-4-nitroaniline



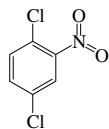
1,2-Dichloro-3-nitrobenzene



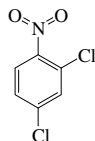
1,2-Dichloro-4-nitrobenzene



1,3-Dichloro-5-nitrobenzene



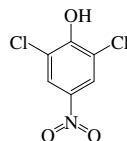
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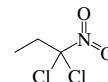
2,4-Dichloro-1-nitrobenzene



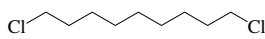
1,1-Dichloro-1-nitroethane



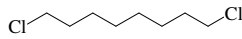
2,6-Dichloro-4-nitrophenol



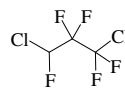
1,1-Dichloro-1-nitropropane



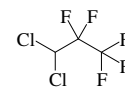
1,9-Dichlorononane



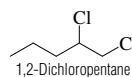
1,8-Dichlorooctane



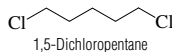
1,3-Dichloro-1,1,2,2,3-pentafluoropropane



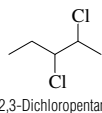
3,3-Dichloro-1,1,1,2,2-pentafluoropropane



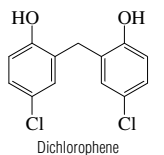
1,2-Dichloropentane



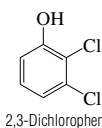
1,5-Dichloropentane



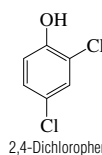
2,3-Dichloropentane



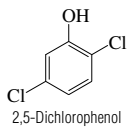
Dichlorophene



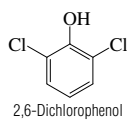
2,3-Dichlorophenol



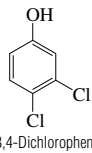
2,4-Dichlorophenol



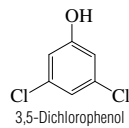
2,5-Dichlorophenol



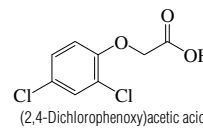
2,6-Dichlorophenol



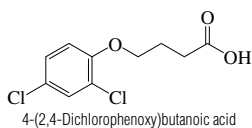
3,4-Dichlorophenol



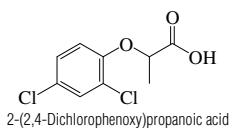
3,5-Dichlorophenol



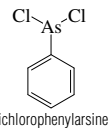
(2,4-Dichlorophenoxy)acetic acid



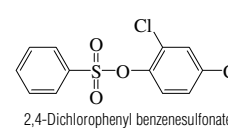
4-(2,4-Dichlorophenoxy)butanoic acid



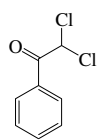
2-(2,4-Dichlorophenoxy)propanoic acid



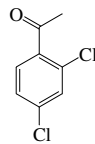
Dichlorophenylarsine



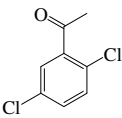
2,4-Dichlorophenyl benzenesulfonate



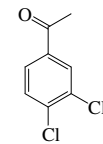
2,2-Dichloro-1-phenylethanone



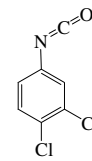
1-(2,4-Dichlorophenyl)ethanone



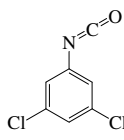
1-(2,5-Dichlorophenyl)ethanone



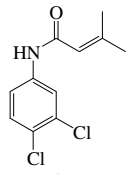
1-(3,4-Dichlorophenyl)ethanone



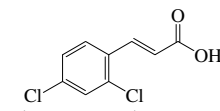
3,4-Dichlorophenyl isocyanate



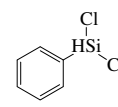
3,5-Dichlorophenyl isocyanate



N-(3,4-Dichlorophenyl)-2-methyl-2-propenamide



3-(2,4-Dichlorophenyl)-2-propenoic acid



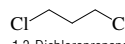
Dichlorophenylsilane



1,1-Dichloropropane



1,2-Dichloropropane, (±)

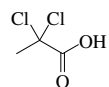


1,3-Dichloropropane

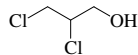


2,2-Dichloropropane

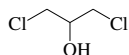
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3274	2,2-Dichloropropanoic acid	2,2-Dichloropropionic acid	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	75-99-0	142.969			187.5; 92 <sup>14</sup>	1.389 <sup>12</sup>		vs H <sub>2</sub> O, alk, EtOH; s eth, ctc
3275	2,3-Dichloro-1-propanol		C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub> O	616-23-9	128.985	visc		184	1.3607 <sup>20</sup>	1.4819 <sup>20</sup>	sl H <sub>2</sub> O, lig; msc EtOH, eth, ace, bz
3276	1,3-Dichloro-2-propanol		C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub> O	96-23-1	128.985			176	1.3506 <sup>17</sup>	1.4837 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; msc eth; s ace, chl
3277	2,3-Dichloro-1-propanol, phosphate (3:1)		C <sub>9</sub> H <sub>15</sub> Cl <sub>6</sub> O <sub>4</sub> P	78-43-3	430.904			190 <sup>0,1</sup>	1.517 <sup>22</sup>		
3278	2,3-Dichloropropanoyl chloride		C <sub>3</sub> H <sub>3</sub> Cl <sub>3</sub> O	7623-13-4	161.414			53 <sup>17</sup>	1.4757 <sup>20</sup>	1.4764 <sup>20</sup>	
3279	1,1-Dichloropropene		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	563-58-6	110.970			76.5	1.1864 <sup>25</sup>	1.4430 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace, chl
3280	<i>cis</i> -1,2-Dichloropropene		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	6923-20-2	110.970			93		1.4549 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz, chl
3281	<i>trans</i> -1,2-Dichloropropene		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	7069-38-7	110.970			77	1.1818 <sup>20</sup>	1.4471 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, ctc, MeOH
3282	<i>cis</i> -1,3-Dichloropropene	<i>cis</i> -1,3-Dichloropropylene	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	10061-01-5	110.970			104.3	1.224 <sup>20</sup>	1.4682 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
3283	<i>trans</i> -1,3-Dichloropropene	<i>trans</i> -1,3-Dichloropropylene	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	10061-02-6	110.970			112	1.217 <sup>20</sup>	1.4730 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
3284	2,3-Dichloropropene		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	78-88-6	110.970		10	94	1.211 <sup>20</sup>	1.4603 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth, bz, chl
3285	3,6-Dichloropyridazine		C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> N <sub>2</sub>	141-30-0	148.978		68.8	89 <sup>0,2</sup>			s chl
3286	2,6-Dichloropyridine		C <sub>5</sub> H <sub>3</sub> Cl <sub>2</sub> N	2402-78-0	147.990		87	211			
3287	4,6-Dichloro-2-pyrimidinamine		C <sub>4</sub> H <sub>3</sub> Cl <sub>2</sub> N <sub>3</sub>	56-05-3	163.993		215				s DMSO
3288	2,4-Dichloropyrimidine		C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> N <sub>2</sub>	3934-20-1	148.978		59	198; 101 <sup>23</sup>			
3289	4,7-Dichloroquinoline		C <sub>9</sub> H <sub>5</sub> Cl <sub>2</sub> N	86-98-6	198.049	cry (MeOH), nd (80% al)	93	148 <sup>10</sup>			sl chl
3290	5,7-Dichloro-8-quinolinol	Chloroxine	C <sub>9</sub> H <sub>5</sub> Cl <sub>2</sub> NO	773-76-2	214.048	cry (al)	179.5				sl EtOH, ace, chl, DMSO; s alk, bz, peth
3291	2,3-Dichloroquinoxaline		C <sub>8</sub> H <sub>4</sub> Cl <sub>2</sub> N <sub>2</sub>	2213-63-0	199.037	cry (al, bz)	152				i H <sub>2</sub> O; vs EtOH, bz, chl, HOAc
3292	2,5-Dichlorostyrene		C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub>	1123-84-8	173.040		8.0	93 <sup>5</sup> , 74 <sup>3</sup>	1.246 <sup>20</sup>	1.5798 <sup>20</sup>	
3293	1,2-Dichloro-3,4,5,6-tetrafluorobenzene		C <sub>6</sub> Cl <sub>2</sub> F <sub>4</sub>	1198-59-0	218.964			157.7			
3294	1,1-Dichloro-1,2,2,2-tetrafluoroethane	Refrigerant 114a	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	374-07-2	170.921	col gas	-56.6	3.4	1.455 <sup>25</sup> (p>1 atm)	1.3092 <sup>0</sup>	vs bz, eth, EtOH
3295	1,2-Dichloro-1,1,2,2-tetrafluoroethane	Refrigerant 114	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	76-14-2	170.921	col gas	-92.53	3.5	1.455 <sup>25</sup> (p>1 atm)	1.3092 <sup>0</sup>	i H <sub>2</sub> O; vs eth, EtOH
3296	1,2-Dichloro-1,1,2,2-tetramethyldisilane		C <sub>4</sub> H <sub>12</sub> Cl <sub>2</sub> Si <sub>2</sub>	4342-61-4	187.215			148; 49 <sup>18</sup>	1.010 <sup>20</sup>	1.4548 <sup>20</sup>	
3297	1,3-Dichloro-1,1,3,3-tetramethyldisiloxane		C <sub>4</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>2</sub> Si <sub>2</sub>	2401-73-2	203.214	liq	-37.5	138	1.038 <sup>20</sup>		
3298	2,5-Dichlorothiophene		C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> S	3172-52-9	153.030	liq	-40.5	162	1.4422 <sup>20</sup>	1.5626 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
3299	2,3-Dichlorotoluene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	32768-54-0	161.029		6	207.5	1.2458 <sup>20</sup>	1.5511 <sup>20</sup>	vs bz
3300	2,4-Dichlorotoluene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	95-73-8	161.029	liq	-13.5	201	1.2476 <sup>20</sup>	1.5511 <sup>20</sup>	i H <sub>2</sub> O; s ctc
3301	2,5-Dichlorotoluene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	19398-61-9	161.029		2.5	200	1.2535 <sup>20</sup>	1.5449 <sup>20</sup>	i H <sub>2</sub> O; s bz
3302	2,6-Dichlorotoluene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	118-69-4	161.029		25.8	198	1.2686 <sup>20</sup>	1.5507 <sup>20</sup>	i H <sub>2</sub> O; s chl
3303	3,4-Dichlorotoluene		C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	95-75-0	161.029	liq	-15.2	208.9	1.2564 <sup>20</sup>	1.5471 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
3304	1,3-Dichloro-1,3,5-triazine-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-trione	Dichlorocyanuric acid	C <sub>3</sub> HCl <sub>2</sub> N <sub>3</sub> O <sub>3</sub>	2782-57-2	197.964	cry	226.6				
3305	1,2-Dichloro-4-(trichloromethyl)benzene		C <sub>7</sub> H <sub>3</sub> Cl <sub>5</sub>	13014-24-9	264.364		25.8	283.1	1.5913 <sup>20</sup>	1.5886 <sup>20</sup>	
3306	1,2-Dichloro-1,1,2-trifluoroethane	Refrigerant 123a	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	354-23-4	152.930	vol liq or gas	-78	29.5	1.50 <sup>25</sup>		
3307	2,2-Dichloro-1,1,1-trifluoroethane		C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	306-83-2	152.930	vol liq or gas	-107	27.82	1.4638 <sup>25</sup>		sl H <sub>2</sub> O
3308	2,2-Dichloro-1,1,2-trifluoroethane	Refrigerant 123b	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	812-04-4	152.930			30.2			
3309	2,4-Dichloro-1-(trifluoromethyl)benzene	2,4-Dichlorobenzotrifluoride	C <sub>7</sub> H <sub>3</sub> Cl <sub>2</sub> F <sub>3</sub>	320-60-5	215.000					1.4802 <sup>20</sup>	
3310	4,5-Dichloro-2-(trifluoromethyl)-1 <i>H</i> -benzimidazole	Chloroflurazole	C <sub>8</sub> H <sub>3</sub> Cl <sub>2</sub> F <sub>3</sub> N <sub>2</sub>	3615-21-2	255.024		213.5				
3311	Dichlorovinylmethylsilane		C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub> Si	124-70-9	141.072			92.5	1.0868 <sup>20</sup>	1.4270 <sup>20</sup>	dec H <sub>2</sub> O
3312	Dichlorvos	Phosphoric acid, 2,2-dichloroethyl dimethyl ester	C <sub>4</sub> H <sub>7</sub> Cl <sub>2</sub> O <sub>4</sub> P	62-73-7	220.976			140 <sup>20</sup> , 84 <sup>1</sup>	1.415 <sup>25</sup>		



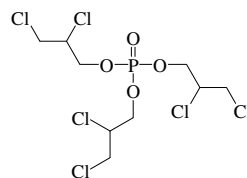
2,2-Dichloropropanoic acid



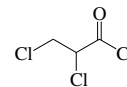
2,3-Dichloro-1-propanol



1,3-Dichloro-2-propanol



2,3-Dichloro-1-propanol, phosphate (3:1)



2,3-Dichloropropanoyl chloride



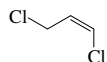
1,1-Dichloropropene



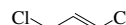
cis-1,2-Dichloropropene



trans-1,2-Dichloropropene



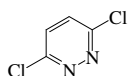
cis-1,3-Dichloropropene



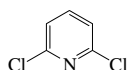
trans-1,3-Dichloropropene



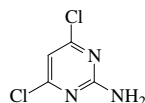
2,3-Dichloropropene



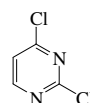
3,6-Dichloropyridazine



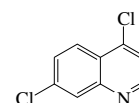
2,6-Dichloropyridine



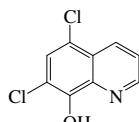
4,6-Dichloro-2-pyrimidinamine



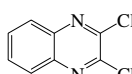
2,4-Dichloropyrimidine



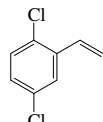
4,7-Dichloroquinoline



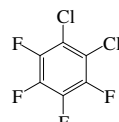
5,7-Dichloro-8-quinolinol



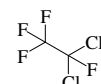
2,3-Dichloroquinoxaline



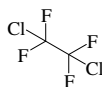
2,5-Dichlorostyrene



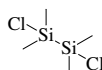
1,2-Dichloro-3,4,5,6-tetrafluorobenzene



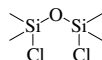
1,1-Dichloro-1,2,2,2-tetrafluoroethane



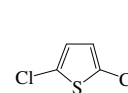
1,2-Dichloro-1,1,2,2-tetrafluoroethane



1,2-Dichloro-1,1,2,2-tetramethyldisilane



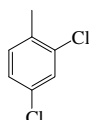
1,3-Dichloro-1,1,3,3-tetramethyldisiloxane



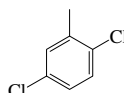
2,5-Dichlorothiophene



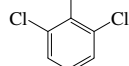
2,3-Dichlorotoluene



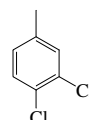
2,4-Dichlorotoluene



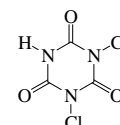
2,5-Dichlorotoluene



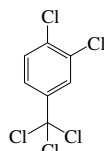
2,6-Dichlorotoluene



3,4-Dichlorotoluene



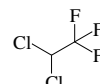
1,3-Dichloro-1,3,5-triazine-2,4,6(1H,3H,5H)-trione



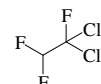
1,2-Dichloro-4-(trichloromethyl)benzene



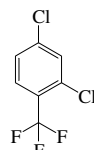
1,2-Dichloro-1,1,2-trifluoroethane



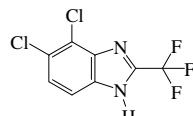
2,2-Dichloro-1,1,1-trifluoroethane



2,2-Dichloro-1,1,2-trifluoroethane



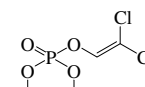
2,4-Dichloro-1-(trifluoromethyl)benzene



4,5-Dichloro-2-(trifluoromethyl)-1H-benzimidazole

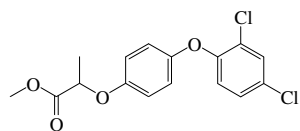


Dichlorovinylmethylsilane

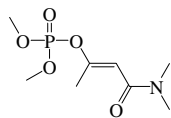


Dichlorvos

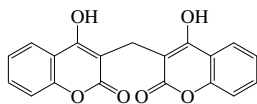
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3313	Diclofop-methyl	Methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]propanoate	C <sub>16</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>4</sub>	51338-27-3	341.186		40	176 <sup>0.1</sup>			
3314	Dicrotophos		C <sub>8</sub> H <sub>16</sub> NO <sub>5</sub> P	141-66-2	237.191			400; 130 <sup>0.1</sup>	1.216 <sup>15</sup>		
3315	Dicumarol		C <sub>19</sub> H <sub>12</sub> O <sub>6</sub>	66-76-2	336.294	nd	290				
3316	Dicyanamide	Cyanocyanamide	C <sub>2</sub> H <sub>2</sub> N <sub>3</sub>	504-66-5	67.049	aq soln only					
3317	<i>o</i> -Dicyanobenzene	<i>o</i> -Phthalodinitrile	C <sub>8</sub> H <sub>4</sub> N <sub>2</sub>	91-15-6	128.131	nd (w, lig)	141	150 <sup>10</sup>	1.1250 <sup>25</sup>		sl H <sub>2</sub> O, lig; vs EtOH, bz; s eth, ace
3318	<i>m</i> -Dicyanobenzene	<i>m</i> -Phthalodinitrile	C <sub>8</sub> H <sub>4</sub> N <sub>2</sub>	626-17-5	128.131	nd(al)	162	sub	0.992 <sup>40</sup>		sl H <sub>2</sub> O; vs EtOH; s eth, bz, chl; i peth
3319	<i>p</i> -Dicyanobenzene	<i>p</i> -Phthalodinitrile	C <sub>8</sub> H <sub>4</sub> N <sub>2</sub>	623-26-7	128.131	nd (w, MeOH)	224	sub			i H <sub>2</sub> O; sl EtOH, eth; s bz; vs HOAc
3320	Dicyclohexyl adipate		C <sub>18</sub> H <sub>30</sub> O <sub>4</sub>	849-99-0	310.429		35				s chl
3321	Dicyclohexylamine	<i>N</i> -Cyclohexylcyclohexanamine	C <sub>12</sub> H <sub>23</sub> N	101-83-7	181.318		-0.1	dec 256; 114 <sup>9</sup>	0.9123 <sup>20</sup>	1.4842 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz
3322	Dicyclohexylamine nitrite	<i>N</i> -Cyclohexylcyclohexanamine, nitrite	C <sub>12</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	3129-91-7	228.331	cry	182 dec				
3323	Dicyclohexylcarbodiimide		C <sub>13</sub> H <sub>22</sub> N <sub>2</sub>	538-75-0	206.327		34.5	123 <sup>6</sup> , 99 <sup>0.5</sup>			
3324	Dicyclohexyl disulfide		C <sub>12</sub> H <sub>22</sub> S <sub>2</sub>	2550-40-5	230.433	liq		195 <sup>20</sup>			
3325	Dicyclohexyl ether		C <sub>12</sub> H <sub>22</sub> O	4645-15-2	182.302	liq	-36	242.5	0.9227 <sup>20</sup>	1.4741 <sup>20</sup>	
3326	Dicyclohexylmethanone		C <sub>13</sub> H <sub>22</sub> O	119-60-8	194.313		57	159 <sup>20</sup>	0.986 <sup>0</sup>	1.4860 <sup>20</sup>	s eth, ace, ctc
3327	Dicyclohexylphosphine		C <sub>12</sub> H <sub>23</sub> P	829-84-5	198.285			281; 129 <sup>8</sup>	0.904 <sup>25</sup>	1.5163 <sup>20</sup>	
3328	Dicyclohexyl phthalate		C <sub>20</sub> H <sub>26</sub> O <sub>4</sub>	84-61-7	330.418	pr (al)	66	225 <sup>4</sup>	1.383 <sup>20</sup>	1.431 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
3329	<i>N,N'</i> -Dicyclohexylthiourea		C <sub>13</sub> H <sub>24</sub> N <sub>2</sub> S	1212-29-9	240.408	cry (MeOH)	180				
3330	1,3-Dicyclohexylurea		C <sub>13</sub> H <sub>24</sub> N <sub>2</sub> O	2387-23-7	224.342		233.8				
3331	Dicyclomine hydrochloride	Dicycloverine hydrochloride	C <sub>19</sub> H <sub>36</sub> ClNO <sub>2</sub>	67-92-5	345.948	cry	165				
3332	Dicyclopentadiene		C <sub>10</sub> H <sub>12</sub>	1755-01-7	132.202		32	dec 170; 65 <sup>14</sup>	0.9302 <sup>35</sup>	1.5050 <sup>35</sup>	vs eth, EtOH
3333	Dicyclopentyl ether	Cyclopentyl ether	C <sub>10</sub> H <sub>18</sub> O	10137-73-2	154.249	liq		80 <sup>13</sup>			
3334	Dicyclopropyl ketone		C <sub>7</sub> H <sub>10</sub> O	1121-37-5	110.153			161	0.977 <sup>25</sup>	1.4670 <sup>20</sup>	
3335	Didecylamine	<i>N</i> -Decyl-1-decanamine	C <sub>20</sub> H <sub>43</sub> N	1120-49-6	297.562			359.0			
3336	Didecyl ether		C <sub>20</sub> H <sub>42</sub> O	2456-28-2	298.546		16	196 <sup>15.5</sup>	0.8187 <sup>20</sup>		
3337	Didecyl phthalate		C <sub>28</sub> H <sub>46</sub> O <sub>4</sub>	84-77-5	446.663		2.5	240 <sup>3</sup>	0.9639 <sup>20</sup>		
3338	3',4'-Didehydro-β,ψ-caroten-16'-oic acid	Torularhodin	C <sub>40</sub> H <sub>52</sub> O <sub>2</sub>	514-92-1	564.840	purp nd (MeOH-eth)	211				vs py, chl, CS <sub>2</sub>
3339	2',3'-Dideoxyinosine	Didanosine	C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub>	69655-05-6	236.227	wh cry (EtOH aq)	162				
3340	2,6-Dideoxy-3- <i>O</i> -methyl- <i>ribo</i> -hexose	Cymarose	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	579-04-4	162.184	pr (eth-peth) nd (ace)	101				vs H <sub>2</sub> O, ace, EtOH
3341	Didodecanoyl peroxide	Lauroyl peroxide	C <sub>24</sub> H <sub>46</sub> O <sub>4</sub>	105-74-8	398.620	wh pl	49				i H <sub>2</sub> O; s chl
3342	Didodecylamine	<i>N</i> -Dodecyl-1-dodecanamine	C <sub>24</sub> H <sub>51</sub> N	3007-31-6	353.669		53.7	263 <sup>27</sup>			vs bz, eth, EtOH, chl
3343	Didodecyl phosphate		C <sub>24</sub> H <sub>51</sub> O <sub>4</sub> P	7057-92-3	434.633	cry (MeOH)	59				
3344	Didodecyl phthalate	1,2-Benzenedicarboxylic acid, didodecyl ester	C <sub>32</sub> H <sub>54</sub> O <sub>4</sub>	2432-90-8	502.769		22.0	256 <sup>1</sup>	0.9389 <sup>20</sup>		
3345	Dieldrin		C <sub>12</sub> H <sub>6</sub> Cl <sub>6</sub> O	60-57-1	380.909		175.5		1.75 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH; s ace, bz
3346	Dienestrol		C <sub>18</sub> H <sub>18</sub> O <sub>2</sub>	84-17-3	266.335	cry (dil al)	227.5	sub 130			vs ace, eth, EtOH
3347	1,2,8,9-Diepoxy- <i>p</i> -menthane	Limonene diepoxide	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	96-08-2	168.233		242				
3348	Diethanolamine	Bis(2-hydroxyethyl)amine	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	111-42-2	105.136		28	268.8	1.0966 <sup>20</sup>	1.4776 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; sl eth, bz
3349	Diethyl, ethyl ester		C <sub>16</sub> H <sub>22</sub> ClNO <sub>3</sub>	38727-55-8	311.804	cry	49.5				
3350	4,4'-Diethoxyazobenzene		C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	588-52-3	270.326	ye lf (al)	162	dec			i H <sub>2</sub> O; sl EtOH; s eth, bz, chl; vs HOAc
3351	3,4-Diethoxybenzaldehyde		C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	2029-94-9	194.227		22	279; 200 <sup>50</sup>	1.0100 <sup>22</sup>		vs EtOH
3352	1,2-Diethoxybenzene		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	2050-46-6	166.217	pr (peth, dil al)	44	219	1.0075 <sup>20</sup>	1.5083 <sup>25</sup>	s EtOH, ctc; vs eth
3353	1,4-Diethoxybenzene		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	122-95-2	166.217	pl (dil al)	72	246			vs EtOH; s eth, bz, ctc, chl
3354	4,4-Diethoxy-1-butanamine		C <sub>8</sub> H <sub>19</sub> NO <sub>2</sub>	6346-09-4	161.243			196	0.933 <sup>25</sup>	1.4275 <sup>20</sup>	
3355	1,1-Diethoxy- <i>N,N</i> -dimethylmethanamine		C <sub>7</sub> H <sub>17</sub> NO <sub>2</sub>	1188-33-6	147.216			129	0.859 <sup>25</sup>	1.4007 <sup>20</sup>	
3356	Diethoxydimethylsilane	Dimethyldiethoxysilane	C <sub>6</sub> H <sub>16</sub> O <sub>2</sub> Si	78-62-6	148.276	liq	-87	114	0.865 <sup>25</sup>	1.3811 <sup>20</sup>	s ctc
3357	Diethoxydiphenylsilane		C <sub>16</sub> H <sub>20</sub> O <sub>2</sub> Si	2553-19-7	272.415			302; 167 <sup>15</sup>	1.0329 <sup>20</sup>	1.5269 <sup>20</sup>	
3358	2,2-Diethoxyethanamine		C <sub>6</sub> H <sub>15</sub> NO <sub>2</sub>	645-36-3	133.189	liq	-78	163	0.9159 <sup>25</sup>	1.4123 <sup>25</sup>	vs H <sub>2</sub> O, eth, EtOH, chl



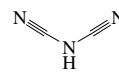
Diclafop-methyl



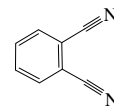
Dicrotophos



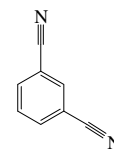
Dicumarol



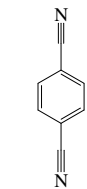
Dicyanamide



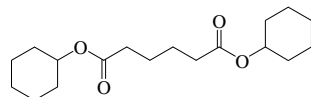
o-Dicyanobenzene



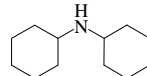
m-Dicyanobenzene



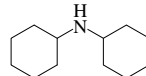
p-Dicyanobenzene



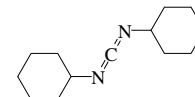
Dicyclohexyl adipate



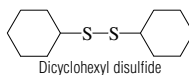
Dicyclohexylamine



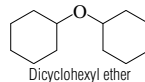
Dicyclohexylamine nitrite

HNO<sub>2</sub>

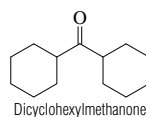
Dicyclohexylcarbodiimide



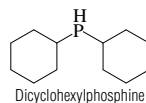
Dicyclohexyl disulfide



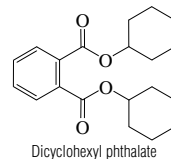
Dicyclohexyl ether



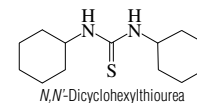
Dicyclohexylmethanone



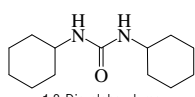
Dicyclohexylphosphine



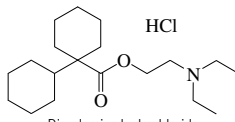
Dicyclohexyl phthalate



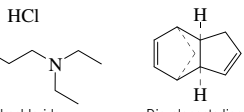
N,N'-Dicyclohexylthiourea



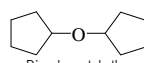
1,3-Dicyclohexylurea



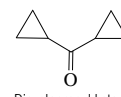
Dicyclimine hydrochloride



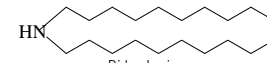
Dicyclopentadiene



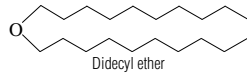
Dicyclopentyl ether



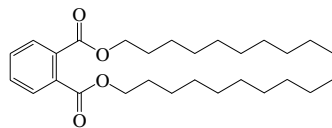
Dicyclopropyl ketone



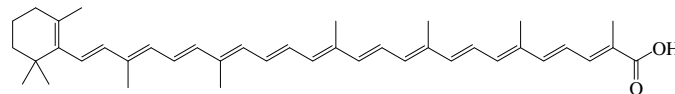
Didecylamine



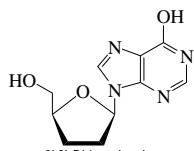
Didecyl ether



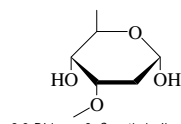
Didecyl phthalate



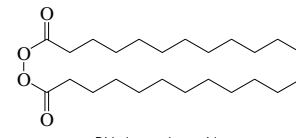
3',4'-Didehydro-β,ψ-caroten-16'-oic acid



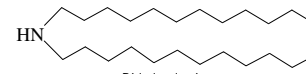
2',3'-Dideoxyinosine



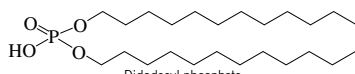
2,6-Dideoxy-3-O-methyl-ribo-hexose



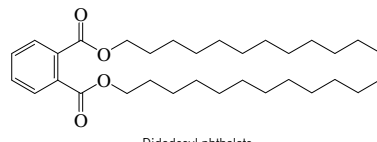
Didodecanoyl peroxide



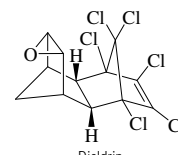
Didodecylamine



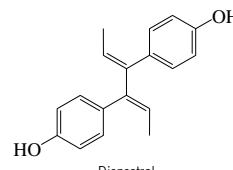
Didodecyl phosphate



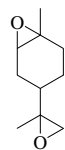
Didodecyl phthalate



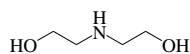
Dieldrin



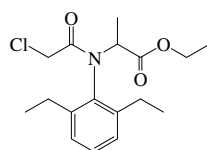
Dienestrol



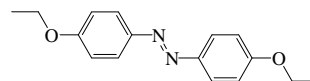
1,2:8,9-Diepoxy-p-menthane



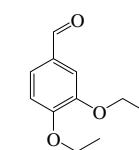
Diethanolamine



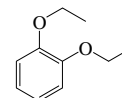
Diethyl, ethyl ester



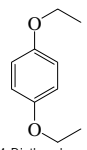
4,4'-Diethoxyazobenzene



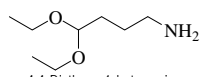
3,4-Diethoxybenzaldehyde



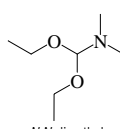
1,2-Diethoxybenzene



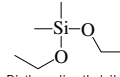
1,4-Diethoxybenzene



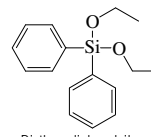
4,4-Diethoxy-1-butanamine



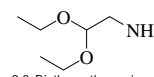
1,1-Diethoxy-N,N-dimethylmethanamine



Diethoxydimethylsilane

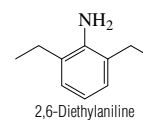
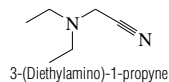
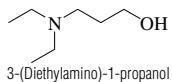
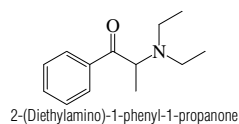
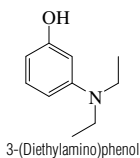
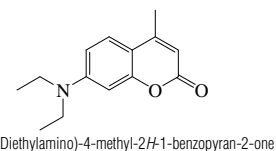
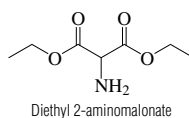
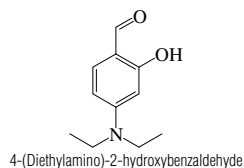
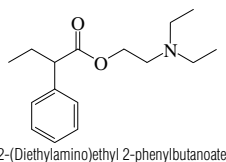
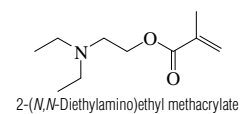
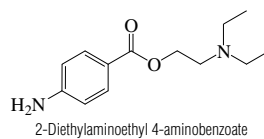
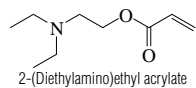
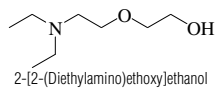
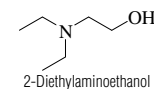
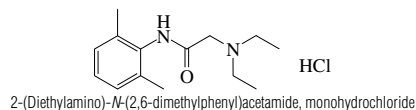
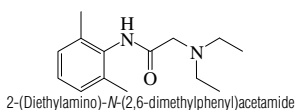
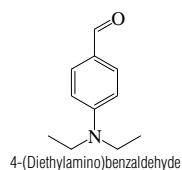
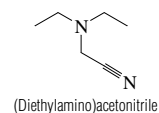
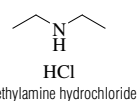
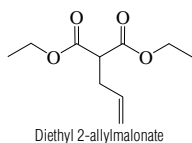
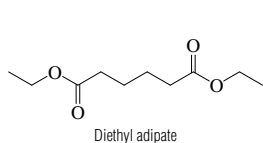
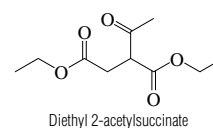
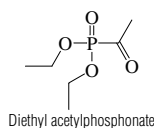
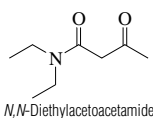
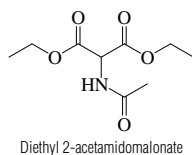
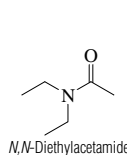
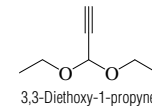
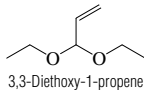
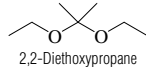
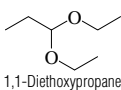
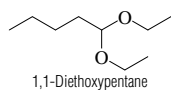
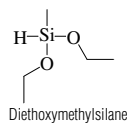
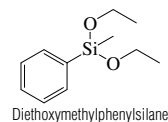
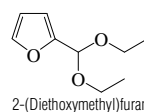
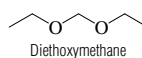
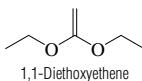
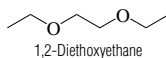
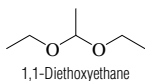


Diethoxydiphenylsilane



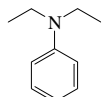
2,2-Diethoxyethanamine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3359	1,1-Diethoxyethane	Acetal	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	105-57-7	118.174	liq	-100	102.25	0.8254 <sup>20</sup>	1.3834 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth; vs ace
3360	1,2-Diethoxyethane	Ethylene glycol diethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	629-14-1	118.174	liq	-74.0	121.2	0.8351 <sup>25</sup>	1.3898 <sup>25</sup>	vs ace, bz, eth, EtOH
3361	1,1-Diethoxyethane		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	2678-54-8	116.158			68 <sup>100</sup>	0.7932 <sup>20</sup>	1.3643 <sup>21</sup>	
3362	Diethoxymethane		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	462-95-3	104.148	liq	-66.5	88	0.8319 <sup>20</sup>	1.3748 <sup>18</sup>	s H <sub>2</sub> O; msc EtOH; vs ace, bz; sl chl
3363	2-(Diethoxymethyl)furan		C <sub>9</sub> H <sub>14</sub> O <sub>3</sub>	13529-27-6	170.205			191.5	0.9976 <sup>20</sup>	1.4451 <sup>20</sup>	vs EtOH
3364	Diethoxymethylphenylsilane		C <sub>11</sub> H <sub>16</sub> O <sub>2</sub> Si	775-56-4	210.346			218	0.9627 <sup>20</sup>	1.4690 <sup>20</sup>	
3365	Diethoxymethylsilane		C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> Si	2031-62-1	134.250			98	0.829 <sup>25</sup>		
3366	1,1-Diethoxypentane		C <sub>9</sub> H <sub>20</sub> O <sub>2</sub>	3658-79-5	160.254			59 <sup>12</sup>	0.829 <sup>22</sup>	1.4029 <sup>22</sup>	
3367	1,1-Diethoxypropane		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	4744-08-5	132.201			123	0.825 <sup>20</sup>	1.3924 <sup>19</sup>	s H <sub>2</sub> O, ace, bz; vs EtOH, eth
3368	2,2-Diethoxypropane		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	126-84-1	132.201			114	0.8200 <sup>21</sup>	1.3891 <sup>20</sup>	s EtOH, ace, bz; vs eth; sl ctc
3369	3,3-Diethoxy-1-propene	Acrolein, diethyl acetal	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	3054-95-3	130.185			123.5	0.8543 <sup>15</sup>	1.4000 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
3370	3,3-Diethoxy-1-propyne		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	10160-87-9	128.169			139	0.8942 <sup>22</sup>	1.4140 <sup>20</sup>	vs ace, eth, EtOH, chl
3371	<i>N,N</i> -Diethylacetamide		C <sub>8</sub> H <sub>13</sub> NO	685-91-6	115.173			185.5	0.9130 <sup>17</sup>	1.4374 <sup>17</sup>	s H <sub>2</sub> O, EtOH; msc eth, ace, bz; sl ctc
3372	Diethyl 2-acetamidomalate		C <sub>9</sub> H <sub>15</sub> NO <sub>5</sub>	1068-90-2	217.219	cry (al, bz-peth)	96.3	185 <sup>20</sup>			sl H <sub>2</sub> O, eth; s tfa, EtOH
3373	<i>N,N</i> -Diethylacetacetamide		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	2235-46-3	157.211	liq		76 <sup>13</sup>			
3374	Diethyl acetylphosphonate		C <sub>8</sub> H <sub>13</sub> O <sub>4</sub> P	919-19-7	180.138			114 <sup>20</sup>	1.1005 <sup>20</sup>	1.4200 <sup>26</sup>	
3375	Diethyl 2-acetylsuccinate		C <sub>10</sub> H <sub>16</sub> O <sub>5</sub>	1115-30-6	216.231			255; 133 <sup>17</sup>	1.081 <sup>20</sup>	1.4346 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl chl
3376	Diethyl adipate		C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	141-28-6	202.248	liq	-19.8	245	1.0076 <sup>20</sup>	1.4272 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3377	Diethyl 2-allylmalonate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	2049-80-1	200.232			222.5; 93 <sup>6</sup>	1.0098 <sup>20</sup>	1.4305 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
3378	Diethylamine	<i>N</i> -Ethylethanamine	C <sub>6</sub> H <sub>11</sub> N	109-89-7	73.137	liq	-49.8	55.5	0.7056 <sup>20</sup>	1.3864 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH; s eth, ctc
3379	Diethylamine hydrochloride	<i>N</i> -Ethylethanamine hydrochloride	C <sub>6</sub> H <sub>12</sub> ClN	660-68-4	109.598	lf (al-eth)	228.5		1.0477 <sup>22</sup>		vs H <sub>2</sub> O, EtOH
3380	(Diethylamino)acetonitrile		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	3010-02-4	112.172			170	0.8660 <sup>20</sup>	1.4260 <sup>20</sup>	s H <sub>2</sub> O
3381	4-(Diethylamino)benzaldehyde		C <sub>11</sub> H <sub>15</sub> NO	120-21-8	177.243	ye nd (w)	41	172 <sup>10</sup>			vs H <sub>2</sub> O; s EtOH, eth, bz, ctc
3382	2-(Diethylamino)- <i>N</i> -(2,6-dimethylphenyl)acetamide	Lidocaine	C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O	137-58-6	234.337	nd (bz, al)	68.5	181 <sup>4</sup>			vs bz, eth, EtOH, chl
3383	2-(Diethylamino)- <i>N</i> -(2,6-dimethylphenyl)acetamide, monohydrochloride		C <sub>14</sub> H <sub>23</sub> ClN <sub>2</sub> O	73-78-9	270.798			128			vs H <sub>2</sub> O
3384	2-Diethylaminoethanol		C <sub>8</sub> H <sub>15</sub> NO	100-37-8	117.189	hyg		163	0.8921 <sup>20</sup>	1.4412 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, ace, bz, peth; sl ctc
3385	2-[2-(Diethylamino)ethoxy]ethanol		C <sub>8</sub> H <sub>19</sub> NO <sub>2</sub>	140-82-9	161.243			221.5; 92 <sup>7</sup>	0.9421 <sup>25</sup>	1.4480 <sup>20</sup>	
3386	2-(Diethylamino)ethyl acrylate		C <sub>9</sub> H <sub>17</sub> NO <sub>2</sub>	2426-54-2	171.237		<-60	81 <sup>10</sup>	0.937 <sup>20</sup>	1.4376 <sup>25</sup>	
3387	2-Diethylaminoethyl 4-aminobenzoate	Procaine	C <sub>13</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	59-46-1	236.310	nd (w+2) pl (lig or eth)	61				sl H <sub>2</sub> O; s EtOH, eth, bz, chl
3388	2-( <i>N,N</i> -Diethylamino)ethyl methacrylate		C <sub>10</sub> H <sub>19</sub> NO <sub>2</sub>	105-16-8	185.264			80 <sup>10</sup>	0.92 <sup>30</sup>		
3389	2-(Diethylamino)ethyl 2-phenylbutanoate	Butethamate	C <sub>16</sub> H <sub>25</sub> NO <sub>2</sub>	14007-64-8	263.376			168 <sup>11</sup>		1.4909 <sup>20</sup>	
3390	4-(Diethylamino)-2-hydroxybenzaldehyde		C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	17754-90-4	193.243		65.0				
3391	Diethyl 2-aminomalate		C <sub>7</sub> H <sub>13</sub> NO <sub>4</sub>	6829-40-9	175.183			122 <sup>16</sup> , 116 <sup>12</sup>	1.100 <sup>16</sup>	1.4353 <sup>16</sup>	vs H <sub>2</sub> O, EtOH, eth; s ace, bz; i lig
3392	7-(Diethylamino)-4-methyl-2 <i>H</i> -1-benzopyran-2-one		C <sub>14</sub> H <sub>17</sub> NO <sub>2</sub>	91-44-1	231.291	cry (al, bz-lig)					sl H <sub>2</sub> O; s EtOH, eth, ace
3393	3-(Diethylamino)phenol		C <sub>10</sub> H <sub>15</sub> NO	91-68-9	165.232	orth bipym (CS <sub>2</sub> -lig)	78	276; 170 <sup>15</sup>			s H <sub>2</sub> O, EtOH, eth, CS <sub>2</sub> ; sl lig
3394	2-(Diethylamino)-1-phenyl-1-propanone	Diethylpropion	C <sub>13</sub> H <sub>19</sub> NO	90-84-6	205.296	liq		111 <sup>14</sup>			
3395	3-(Diethylamino)-1-propanol		C <sub>7</sub> H <sub>17</sub> NO	622-93-5	131.216			189.5	0.8600 <sup>20</sup>	1.4439 <sup>20</sup>	s EtOH; s eth, ace, bz; sl chl
3396	3-(Diethylamino)-1-propyne	<i>N,N</i> -Diethyl-2-propargylamine	C <sub>7</sub> H <sub>13</sub> N	4079-68-9	111.185	liq		120			
3397	2,6-Diethylaniline		C <sub>10</sub> H <sub>13</sub> N	579-66-8	149.233		1.5	243	0.906 <sup>25</sup>	1.5452 <sup>20</sup>	



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3398	<i>N,N</i> -Diethylaniline		C <sub>10</sub> H <sub>15</sub> N	91-66-7	149.233	ye oil	-38.8	216.3	0.9307 <sup>20</sup>	1.5409 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace, ctc; vs eth, chl
3399	Diethylarsine		C <sub>4</sub> H <sub>11</sub> As	692-42-2	134.052			105	1.1338 <sup>24</sup>	1.4709	vs ace, bz, eth, EtOH
3400	<i>N,N</i> -Diethylbenzamide		C <sub>11</sub> H <sub>15</sub> NO	1696-17-9	177.243			132 <sup>5</sup>			
3401	<i>o</i> -Diethylbenzene	1,2-Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	135-01-3	134.218	liq	-31.2	184	0.8800 <sup>20</sup>	1.5035 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
3402	<i>m</i> -Diethylbenzene	1,3-Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	141-93-5	134.218	liq	-83.9	181.1	0.8602 <sup>20</sup>	1.4955 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
3403	<i>p</i> -Diethylbenzene	1,4-Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	105-05-5	134.218	liq	-42.83	183.7	0.8620 <sup>20</sup>	1.4967 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
3404	<i>N,N</i> -Diethyl-1,4-benzenediamine		C <sub>10</sub> H <sub>16</sub> N <sub>2</sub>	93-05-0	164.247			261			vs bz
3405	Diethyl benzylidenemalonate	Diethyl benzalmalonate	C <sub>14</sub> H <sub>16</sub> O <sub>4</sub>	5292-53-5	248.275		32	216 <sup>30</sup> , 196 <sup>14</sup>	1.1045 <sup>20</sup>	1.5389 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
3406	Diethyl benzylmalonate		C <sub>14</sub> H <sub>18</sub> O <sub>4</sub>	607-81-8	250.291			300	1.076 <sup>15</sup>	1.4872 <sup>20</sup>	i H <sub>2</sub> O; sl chl
3407	Diethyl benzylphosphonate		C <sub>11</sub> H <sub>17</sub> O <sub>3</sub> P	1080-32-6	228.225			110 <sup>2</sup>		1.4930 <sup>20</sup>	s ctc
3408	Diethylbromoacetamide	2-Bromo-2-ethylbutanamide	C <sub>8</sub> H <sub>12</sub> BrNO	511-70-6	194.069		67				sl H <sub>2</sub> O, chl; vs EtOH, eth, bz
3409	Diethyl 2-bromomalonate	Ethyl bromomalonate	C <sub>7</sub> H <sub>11</sub> BrO <sub>4</sub>	685-87-0	239.064		-54	dec 254	1.4022 <sup>25</sup>	1.4521 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
3410	<i>N,N</i> -Diethylbutanamide		C <sub>8</sub> H <sub>17</sub> NO	1114-76-7	143.227			206	0.8884 <sup>20</sup>	1.4403 <sup>25</sup>	vs H <sub>2</sub> O, EtOH
3411	Diethyl 2-butylmalonate	Pentane-1,1-dicarboxylic acid, diethyl ester	C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	133-08-4	216.275			238	0.9764 <sup>20</sup>	1.4250 <sup>20</sup>	vs EtOH, eth
3412	Diethyl 2-butyndioate		C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	762-21-0	170.163		0.8	184 <sup>200</sup>	1.0075 <sup>20</sup>	1.4425 <sup>20</sup>	s EtOH, eth, ctc
3413	Diethylcarbamazine citrate		C <sub>16</sub> H <sub>26</sub> N <sub>2</sub> O <sub>6</sub>	1642-54-2	391.416	cry	138				
3414	Diethylcarbamid chloride		C <sub>6</sub> H <sub>10</sub> CINO	88-10-8	135.592			186			
3415	<i>N,N</i> -Diethylcarbanilide		C <sub>17</sub> H <sub>20</sub> N <sub>2</sub> O	85-98-3	268.353	cry (al)	79				i H <sub>2</sub> O; vs EtOH; s chl
3416	Diethyl carbonate	Ethyl carbonate	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	105-58-8	118.131	liq	-43	126	0.9692 <sup>25</sup>	1.3845 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
3417	<i>O,O</i> -Diethyl chloridothionophosphate	Diethyl thiophosphoryl chloride	C <sub>4</sub> H <sub>10</sub> ClO <sub>2</sub> PS	2524-04-1	188.613			45 <sup>3</sup>			s ctc
3418	Diethylchloroaluminum		C <sub>4</sub> H <sub>10</sub> AlCl	96-10-6	120.557			134 <sup>70</sup>			
3419	Diethyl chloromalonate	Ethyl chloromalonate	C <sub>7</sub> H <sub>11</sub> ClO <sub>4</sub>	14064-10-9	194.613			222	1.2040 <sup>20</sup>	1.4327 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, chl; s CS <sub>2</sub>
3420	Diethyl chlorophosphonate	Diethoxyphosphoryl chloride	C <sub>4</sub> H <sub>10</sub> ClO <sub>3</sub> P	814-49-3	172.547			93.5	1.205 <sup>19</sup>	1.4170 <sup>20</sup>	
3421	Diethylcyanamide		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	617-83-4	98.146	liq	-80.6	188	0.854 <sup>20</sup>	1.4126 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
3422	Diethyl 1,1-cyclobutanedicarboxylate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	3779-29-1	200.232			224	1.0456 <sup>20</sup>	1.4330 <sup>26</sup>	vs EtOH; sl ctc
3423	1,1-Diethylcyclohexane		C <sub>10</sub> H <sub>20</sub>	78-01-3	140.266			179.5			
3424	Diethyl 1,1-cyclopropanedicarboxylate		C <sub>9</sub> H <sub>14</sub> O <sub>4</sub>	1559-02-0	186.205			215; 100 <sup>12</sup>	1.055 <sup>25</sup>	1.4345 <sup>18</sup>	vs EtOH, eth
3425	Diethyl dibutylmalonate		C <sub>15</sub> H <sub>28</sub> O <sub>4</sub>	596-75-8	272.381			150 <sup>12</sup>	0.9457 <sup>20</sup>	1.4341 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
3426	Diethyl dicarbonate	Pyrocarbonic acid diethyl ester	C <sub>6</sub> H <sub>10</sub> O <sub>5</sub>	1609-47-8	162.140			93 <sup>18</sup>	1.120 <sup>20</sup>	1.3960 <sup>20</sup>	vs ace, EtOH, liq
3427	Diethyl [(diethanolamino)methyl] phosphonate		C <sub>8</sub> H <sub>22</sub> NO <sub>5</sub> P	2781-11-5	255.249	liq		150 <sup>01</sup>			
3428	5,5-Diethyldihydro-2 <i>H</i> -1,3-oxazine-2,4(3 <i>H</i> )-dione	Diethadione	C <sub>8</sub> H <sub>13</sub> NO <sub>3</sub>	702-54-5	171.194	cry (eth)	97.5				
3429	Diethyl 1,4-dihydro-2,4,6-trimethyl-3,5-pyridinedicarboxylate	3,5-Diethoxycarbonyl-1,4-dihydrocollidine	C <sub>14</sub> H <sub>21</sub> NO <sub>4</sub>	632-93-9	267.322	lt bl flr pl (al)	131				sl H <sub>2</sub> O, EtOH, eth, CS <sub>2</sub> ; vs chl
3430	Diethyldimethyllead	Diethyldimethylplumbane	C <sub>6</sub> H <sub>16</sub> Pb	1762-27-2	295.4	col liq		51 <sup>13</sup>	1.79 <sup>20</sup>		
3431	Diethyl 2,6-dimethyl-3,5-pyridinedicarboxylate		C <sub>13</sub> H <sub>17</sub> NO <sub>4</sub>	1149-24-2	251.279		71	301; 208 <sup>40</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, chl, liq
3432	Diethyl 3,5-dimethylpyrrole-2,4-dicarboxylate		C <sub>12</sub> H <sub>17</sub> NO <sub>4</sub>	2436-79-5	239.268	nd (dil al)	137.8				i H <sub>2</sub> O; sl EtOH, eth; s ace, bz, HOAc
3433	Diethyl disulfide		C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	110-81-6	122.252	liq	-101.5	154.0	0.9931 <sup>20</sup>	1.5073 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
3434	<i>N,N</i> -Diethyldodecanamide		C <sub>16</sub> H <sub>32</sub> NO	3352-87-2	255.439			166 <sup>2</sup>	0.847 <sup>25</sup>	1.4545 <sup>20</sup>	s chl
3435	Diethylene glycol	Diglycol	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	111-46-6	106.120	liq	-10.4	245.8	1.1197 <sup>15</sup>	1.4472 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, chl
3436	Diethylene glycol, bischloroformate	Oxydi-2,1-ethanediy carbonochloridate	C <sub>6</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>5</sub>	106-75-2	231.031	liq		126 <sup>5</sup>	1.39 <sup>20</sup>	1.4542 <sup>20</sup>	
3437	Diethylene glycol diacetate		C <sub>8</sub> H <sub>14</sub> O <sub>5</sub>	628-68-2	190.194		18	200	1.1068 <sup>15</sup>	1.4348 <sup>20</sup>	vs EtOH
3438	Diethylene glycol dibenzoate		C <sub>18</sub> H <sub>18</sub> O <sub>5</sub>	120-55-8	314.333		33.5	280 <sup>24</sup> , 250 <sup>1</sup>	1.1690 <sup>15</sup>		vs H <sub>2</sub> O, EtOH

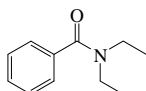




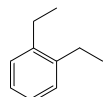
N,N-Diethylaniline



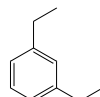
Diethylarsine



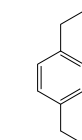
N,N-Diethylbenzamide



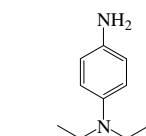
o-Diethylbenzene



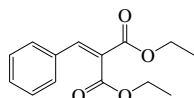
m-Diethylbenzene



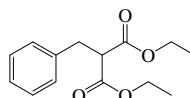
p-Diethylbenzene



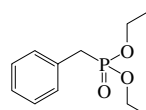
N,N-Diethyl-1,4-benzenediamine



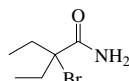
Diethyl benzylidenemalonate



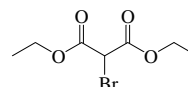
Diethyl benzylmalonate



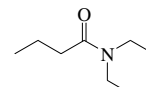
Diethyl benzylphosphonate



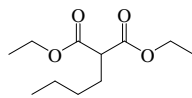
Diethylbromoacetamide



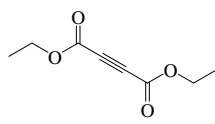
Diethyl 2-bromomalonate



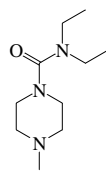
N,N-Diethylbutanamide



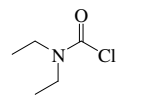
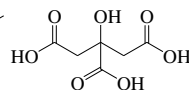
Diethyl 2-butylmalonate



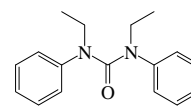
Diethyl 2-butynedioate



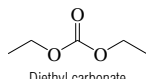
Diethylcarbamazine citrate



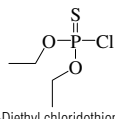
Diethylcarbamoyl chloride



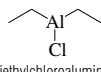
N,N'-Diethylcarbanilide



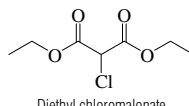
Diethyl carbonate



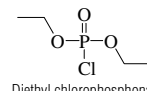
O,O-Diethyl chloridothionophosphate



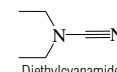
Diethylchloroaluminum



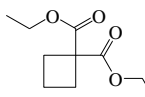
Diethyl chloromalonate



Diethyl chlorophosphonate



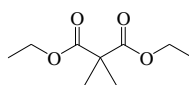
Diethylcyanamide



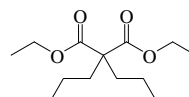
Diethyl 1,1-cyclobutanedicarboxylate



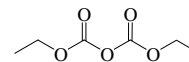
1,1-Diethylcyclohexane



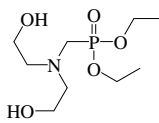
Diethyl 1,1-cyclopropanedicarboxylate



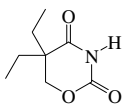
Diethyl dibutylmalonate



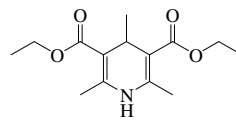
Diethyl dicarbonate



Diethyl ((diethanolamino)methyl)phosphonate



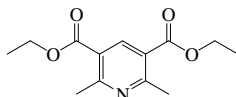
5,5-Diethyl-2H-1,3-oxazine-2,4(3H)-dione



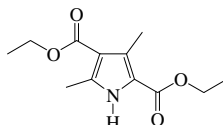
Diethyl 1,4-dihydro-2,4,6-trimethyl-3,5-pyridinedicarboxylate



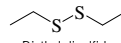
Diethyl dimethyllead



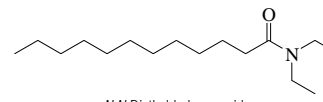
Diethyl 2,6-dimethyl-3,5-pyridinedicarboxylate



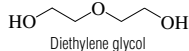
Diethyl 3,5-dimethylpyrrole-2,4-dicarboxylate



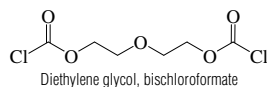
Diethyl disulfide



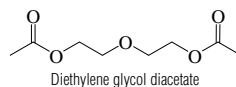
N,N-Diethyldodecanamide



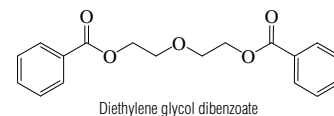
Diethylene glycol



Diethylene glycol, bischloroformate

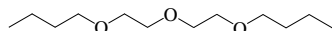


Diethylene glycol diacetate

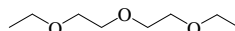


Diethylene glycol dibenzoate

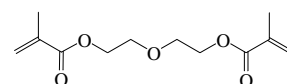
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3439	Diethylene glycol dibutyl ether	Bis(2-butoxyethyl) ether	C <sub>12</sub> H <sub>26</sub> O <sub>3</sub>	112-73-2	218.332	liq	-60	256	0.885 <sup>25</sup>	1.4235 <sup>20</sup>	
3440	Diethylene glycol diethyl ether	Bis(2-ethoxyethyl) ether	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	112-36-7	162.227	liq	-45	188	0.9063 <sup>20</sup>	1.4115 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, s eth
3441	Diethylene glycol dimethacrylate	Oxydiethylene methacrylate	C <sub>12</sub> H <sub>18</sub> O <sub>5</sub>	2358-84-1	242.268			>200; 150 <sup>9</sup>	1.0821 <sup>20</sup>	1.4571 <sup>25</sup>	
3442	Diethylene glycol dimethyl ether	Diglyme	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	111-96-6	134.173	liq	-68	162	0.9434 <sup>20</sup>	1.4097 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
3443	Diethylene glycol dinitrate	2,2'-Oxybisethanol, dinitrate	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>7</sub>	693-21-0	196.116			44 <sup>0.01</sup>			
3444	Diethylene glycol monobutyl ether		C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	112-34-5	162.227	liq	-68	231	0.9553 <sup>20</sup>	1.4306 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, eth, ace; s bz
3445	Diethylene glycol monobutyl ether acetate	2-(2-Butoxyethoxy)ethyl acetate	C <sub>10</sub> H <sub>20</sub> O <sub>4</sub>	124-17-4	204.264	liq	-32	245	0.985 <sup>20</sup>	1.4262 <sup>20</sup>	vs ace, eth, EtOH
3446	Diethylene glycol monododecanoate	2-(2-Hydroxyethoxy)ethyl laurate	C <sub>16</sub> H <sub>32</sub> O <sub>4</sub>	141-20-8	288.423	lt ye	17.5	>270	0.96 <sup>25</sup>		msc EtOH, eth, ace; s bz, tol
3447	Diethylene glycol monoethyl ether	Carbitol	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	111-90-0	134.173	hyg liq		196	0.9885 <sup>20</sup>	1.4300 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, ace, bz; vs eth
3448	Diethylene glycol monoethyl ether acetate	Carbitol acetate	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	112-15-2	176.211	liq	-25	218.5	1.0096 <sup>20</sup>	1.4213 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
3449	Diethylene glycol monoethyl ether	2-[2-(Hexyloxy)ethoxy]ethanol	C <sub>10</sub> H <sub>22</sub> O <sub>3</sub>	112-59-4	190.280	col liq	-28	258; 192 <sup>100</sup>			
3450	Diethylene glycol monomethyl ether	2-(2-Methoxyethoxy)ethanol	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	111-77-3	120.147			193	1.035 <sup>20</sup>	1.4264 <sup>20</sup>	msc H <sub>2</sub> O, ace; vs EtOH, eth
3451	Diethylene glycol monopropyl ether		C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	6881-94-3	148.200	liq	-53.3	213; 124 <sup>4</sup>			
3452	<i>N,N</i> -Diethyl-1,2-ethanediamine	<i>N,N</i> -Diethylethylenediamine	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	100-36-7	116.204			144	0.8280 <sup>20</sup>	1.4340 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, ctc, tol
3453	<i>N,N</i> -Diethyl-1,2-ethanediamine		C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	111-74-0	116.204			146	0.8280 <sup>20</sup>	1.4340 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH, tol
3454	Diethyl ether	Ethyl ether	C <sub>4</sub> H <sub>10</sub> O	60-29-7	74.121	liq	-116.2	34.5	0.7138 <sup>20</sup>	1.3526 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, bz, eth; vs ace
3455	Diethyl (ethoxymethylene) malonate	2-Ethoxy-1,1-bis(ethoxycarbonyl)ethene	C <sub>10</sub> H <sub>16</sub> O <sub>5</sub>	87-13-8	216.231			dec 280; 165 <sup>19</sup>		1.4600 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
3456	Diethyl ethylenemalonate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	1462-12-0	186.205			116 <sup>17</sup> ; 86 <sup>3</sup>	1.0404 <sup>20</sup>	1.4308 <sup>17</sup>	vs eth, EtOH
3457	Diethyl ethylmalonate		C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	133-13-1	188.221			208; 98 <sup>12</sup>	1.006 <sup>20</sup>	1.4166 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
3458	Diethyl ethylphenylmalonate		C <sub>15</sub> H <sub>20</sub> O <sub>4</sub>	76-67-5	264.318			170 <sup>19</sup>	1.071 <sup>20</sup>	1.4896 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
3459	Diethyl ethylphosphonate		C <sub>8</sub> H <sub>15</sub> O <sub>3</sub> P	78-38-6	166.155			198; 90 <sup>16</sup>	1.0259 <sup>20</sup>	1.4163 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
3460	<i>N,N</i> -Diethylformamide		C <sub>5</sub> H <sub>11</sub> NO	617-84-5	101.147			177.5	0.9080 <sup>19</sup>	1.4321 <sup>25</sup>	msc H <sub>2</sub> O, ace, bz; vs EtOH, eth
3461	Diethyl fumarate		C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	623-91-6	172.179		0.8	214	1.0452 <sup>20</sup>	1.4412 <sup>20</sup>	i H <sub>2</sub> O; s ace, chl
3462	Diethyl glutarate		C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	818-38-2	188.221	syr liq	-24.1	236.5	1.0220 <sup>20</sup>	1.4241 <sup>20</sup>	vs eth
3463	3,4-Diethylhexane		C <sub>10</sub> H <sub>22</sub>	19398-77-7	142.282			163.9	0.7472 <sup>25</sup>	1.4190 <sup>20</sup>	
3464	Di-2-ethylhexyl maleate		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	142-16-5	340.498			156 <sup>7</sup>	0.94 <sup>20</sup>		
3465	1,2-Diethylhydrazine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	1615-80-1	88.151			85.5	0.797 <sup>25</sup>	1.4204 <sup>20</sup>	vs bz, eth, EtOH
3466	Diethyl 1,2-hydrazinedicarboxylate	Diethyl bicarbamate	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub>	4114-28-7	176.170	nd (chl), pr (w)	135	dec 250	1.324 <sup>8</sup>		vs eth, EtOH
3467	Diethyl hydrogen phosphate	Diethyl phosphate	C <sub>4</sub> H <sub>11</sub> O <sub>4</sub> P	598-02-7	154.101	syr		dec 203; 87 <sup>0.0001</sup>	1.1800 <sup>20</sup>	1.4170 <sup>20</sup>	vs eth
3468	<i>N,N</i> -Diethyl-4-hydroxy-3-methoxybenzamide	Ethamivan	C <sub>12</sub> H <sub>17</sub> NO <sub>3</sub>	304-84-7	223.268		95				s chl
3469	Diethyl iminodiacetate		C <sub>8</sub> H <sub>15</sub> NO <sub>4</sub>	6290-05-7	189.210	orth cry	247 dec				
3470	Diethyl isobutylmalonate		C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	10203-58-4	216.275				0.9804 <sup>20</sup>	1.4236 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s chl
3471	Diethyl isophthalate		C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	636-53-3	222.237		11.5	302	1.1239 <sup>17</sup>	1.508 <sup>18</sup>	i H <sub>2</sub> O
3472	Diethyl isopropylidene malonate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	6802-75-1	200.232			176.5; 116 <sup>14</sup>	1.0282 <sup>18</sup>	1.4486 <sup>17</sup>	vs ace, EtOH
3473	Diethyl isopropylmalonate	Ethyl isopropylmalonate	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	759-36-4	202.248			215	0.9961 <sup>20</sup>	1.4188 <sup>21</sup>	sl H <sub>2</sub> O, ctc; vs EtOH, eth; s chl
3474	Diethyl ketomalonate	Ethyl mesoxalate	C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	609-09-6	174.151	pa ye grn oil	-30	210; 105 <sup>19</sup>	1.1419 <sup>16</sup>	1.4310 <sup>22</sup>	vs H <sub>2</sub> O; s EtOH, eth, chl; i CS <sub>2</sub>
3475	Diethyl malate	Diethyl hydroxybutanedioate	C <sub>8</sub> H <sub>14</sub> O <sub>5</sub>	7554-12-3	190.194			253; 124 <sup>13</sup>	1.1290 <sup>20</sup>		
3476	Diethyl maleate		C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	141-05-9	172.179	liq	-8.8	223	1.0662 <sup>20</sup>	1.4416 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
3477	Diethyl malonate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	105-53-3	160.168	liq	-50	200	1.0551 <sup>20</sup>	1.4139 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace, bz
3478	Diethyl mercury		C <sub>4</sub> H <sub>10</sub> Hg	627-44-1	258.71			159; 57 <sup>16</sup>	2.43 <sup>20</sup>		s eth; sl EtOH
3479	Diethylmethylaniline	<i>N</i> -Ethyl- <i>N</i> -methylethanamine	C <sub>8</sub> H <sub>13</sub> N	616-39-7	87.164	liq	-196	66	0.703 <sup>25</sup>	1.3879 <sup>25</sup>	vs H <sub>2</sub> O, EtOH, eth



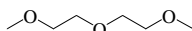
Diethylene glycol dibutyl ether



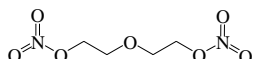
Diethylene glycol diethyl ether



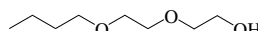
Diethylene glycol dimethacrylate



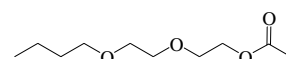
Diethylene glycol dimethyl ether



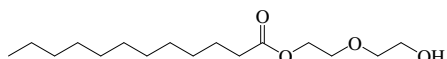
Diethylene glycol dinitrate



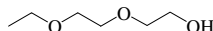
Diethylene glycol monobutyl ether



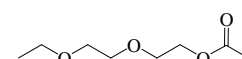
Diethylene glycol monobutyl ether acetate



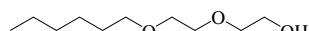
Diethylene glycol monododecanoate



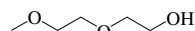
Diethylene glycol monoethyl ether



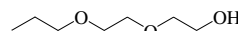
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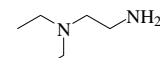
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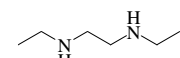
Diethylene glycol monomethyl ether



Diethylene glycol monopropyl ether



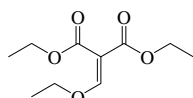
N,N-Diethyl-1,2-ethanediamine



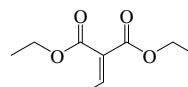
N,N-Diethyl-1,2-ethanediamine



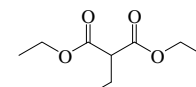
Diethyl ether



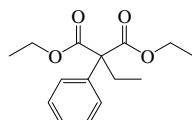
Diethyl (ethoxymethylene)malonate



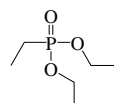
Diethyl ethylenemalonate



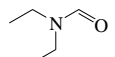
Diethyl ethylmalonate



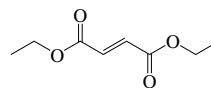
Diethyl ethylphenylmalonate



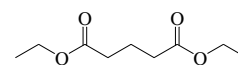
Diethyl ethylphosphonate



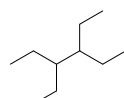
N,N-Diethylformamide



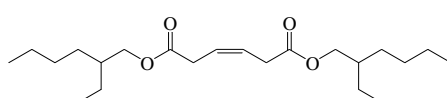
Diethyl fumarate



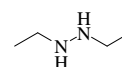
Diethyl glutarate



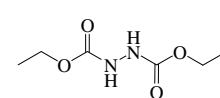
3,4-Diethylhexane



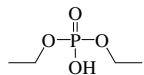
Di-2-ethylhexyl maleate



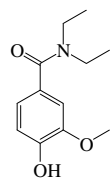
1,2-Diethylhydrazine



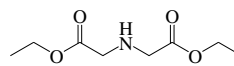
Diethyl 1,2-hydrazinedicarboxylate



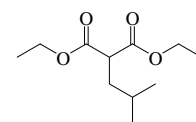
Diethyl hydrogen phosphate



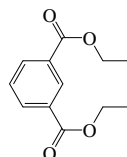
N,N-Diethyl-4-hydroxy-3-methoxybenzamide



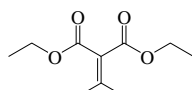
Diethyl iminodiacetate



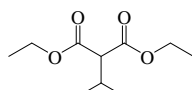
Diethyl isobutylmalonate



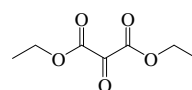
Diethyl isophthalate



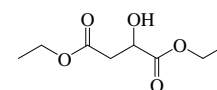
Diethyl isopropylidenemalonate



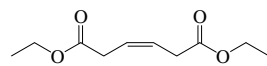
Diethyl isopropylmalonate



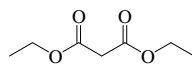
Diethyl ketomalonate



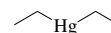
Diethyl malate



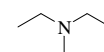
Diethyl maleate



Diethyl malonate

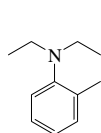
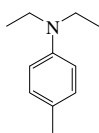
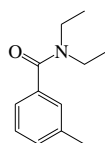
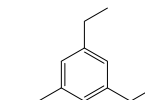


Diethyl mercury

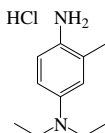
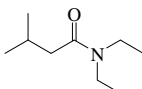
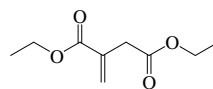


Diethylmethylamine

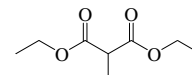
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3480	<i>N,N</i> -Diethyl-2-methylaniline		C <sub>11</sub> H <sub>17</sub> N	606-46-2	163.260	liq	-60	209	0.9286 <sup>20</sup>	1.5153 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
3481	<i>N,N</i> -Diethyl-4-methylaniline		C <sub>11</sub> H <sub>17</sub> N	613-48-9	163.260			229	0.9242 <sup>16</sup>		sl H <sub>2</sub> O; msc EtOH, eth
3482	<i>N,N</i> -Diethyl-3-methylbenzamide	DEET	C <sub>12</sub> H <sub>17</sub> NO	134-62-3	191.269			160 <sup>19</sup> , 111 <sup>1</sup>	0.996 <sup>20</sup>	1.5212 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
3483	1,3-Diethyl-5-methylbenzene		C <sub>11</sub> H <sub>16</sub>	2050-24-0	148.245	liq	-74.1	205	0.8748 <sup>20</sup>	1.5027 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
3484	<i>N,N,N',N'</i> -Diethyl-2-methyl-1,4-benzenediamine, monohydrochloride	4- <i>N,N</i> -Diethyl-1,4-diamino-2-methylbenzene, hydrochloride	C <sub>11</sub> H <sub>15</sub> ClN <sub>2</sub>	2051-79-8	214.735	cry	250 dec				
3485	<i>N,N</i> -Diethyl-3-methylbutanamide	Isovaleryl diethylamide	C <sub>9</sub> H <sub>19</sub> NO	533-32-4	157.253			211	0.8764 <sup>20</sup>	1.4422 <sup>20</sup>	vs eth, EtOH
3486	Diethyl methylenesuccinate		C <sub>9</sub> H <sub>14</sub> O <sub>4</sub>	2409-52-1	186.205		58.5	228	1.0467 <sup>20</sup>	1.4377 <sup>20</sup>	msc EtOH; s eth, bz; vs ace
3487	Diethyl methylmalonate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	609-08-5	174.195			201	1.0225 <sup>20</sup>	1.4126 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
3488	Diethyl methylphosphonate		C <sub>8</sub> H <sub>13</sub> O <sub>3</sub> P	683-08-9	152.129			194	1.0406 <sup>20</sup>	1.4101 <sup>30</sup>	s H <sub>2</sub> O, EtOH, eth; i bz
3489	<i>N,N</i> -Diethyl-4-methyl-1-piperazinecarboxamide	Diethylcarbamazine	C <sub>10</sub> H <sub>21</sub> N <sub>3</sub> O	90-89-1	199.293		48	110 <sup>3</sup>			
3490	3,3-Diethyl-5-methyl-2,4-piperidinedione		C <sub>10</sub> H <sub>17</sub> NO <sub>2</sub>	125-64-4	183.248		75.5				s H <sub>2</sub> O, bz, chl, EtOH
3491	<i>N,N</i> -Diethyl-1-naphthalenamine		C <sub>14</sub> H <sub>17</sub> N	84-95-7	199.292			285	1.013 <sup>20</sup>	1.5961 <sup>20</sup>	s EtOH, eth, bz; sl ctc
3492	<i>N,N</i> -Diethyl-4-nitroaniline		C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	2216-15-1	194.230	ye nd (lig) pl (al)	77.5		1.225 <sup>25</sup>		s EtOH; sl lig
3493	<i>N,N</i> -Diethyl-4-nitrosoaniline		C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O	120-22-9	178.230	grn mcl pr (eth) grn lf (ace)	87.5		1.24 <sup>15</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace, chl
3494	Diethyl nonanedioate	Diethyl azelate	C <sub>13</sub> H <sub>24</sub> O <sub>4</sub>	624-17-9	244.328	liq	-18.5	291.5	0.9729 <sup>20</sup>	1.4351 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3495	Diethyl oxalate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	95-92-1	146.141	liq	-40.6	185.7	1.0785 <sup>20</sup>	1.4101 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; s ctc
3496	Diethyl oxobutanedioate	Diethyl oxalacetate	C <sub>8</sub> H <sub>12</sub> O <sub>5</sub>	108-56-5	188.178			131 <sup>24</sup>	1.131 <sup>20</sup>	1.4561 <sup>17</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz; vs ace
3497	Diethyl 3-oxo-1,5-pentanedioate	Diethyl 1,3-acetonedicarboxylate	C <sub>8</sub> H <sub>14</sub> O <sub>5</sub>	105-50-0	202.204			250	1.113 <sup>20</sup>		sl H <sub>2</sub> O; msc EtOH
3498	3,3-Diethylpentane	Tetraethylmethane	C <sub>8</sub> H <sub>20</sub>	1067-20-5	128.255	liq	-33.1	146.3	0.7536 <sup>20</sup>	1.4206 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
3499	<i>N,N'</i> -Diethyl-1,4-pentanediamine	Novoldiamine	C <sub>9</sub> H <sub>22</sub> N <sub>2</sub>	140-80-7	158.284			201	0.814 <sup>20</sup>	1.4429 <sup>20</sup>	
3500	2,2-Diethyl-4-pentenamide	Novonal	C <sub>9</sub> H <sub>17</sub> NO	512-48-1	155.237	wh pow	75.5				vs eth, EtOH
3501	Diethyl 2-pentenedioate	Diethyl glutaconate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	2049-67-4	186.205			237	1.0496 <sup>20</sup>	1.4411 <sup>20</sup>	vs eth, EtOH
3502	Diethylperoxide		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	628-37-5	90.121	liq	-70	65	0.8240 <sup>19</sup>	1.3715 <sup>17</sup>	sl H <sub>2</sub> O; msc EtOH, eth
3503	<i>N,N</i> -Diethyl-10 <i>H</i> -phenothiazine-10-ethanamine	Diethazine	C <sub>18</sub> H <sub>22</sub> N <sub>2</sub> S	60-91-3	298.446	oil		167 <sup>0.5</sup>			i H <sub>2</sub> O; s dil HCl
3504	<i>N,N</i> -Diethyl- $\alpha$ -phenylbenzenemethanamine	<i>N,N</i> -Diethylbenzhydramine	C <sub>17</sub> H <sub>21</sub> N	519-72-2	239.356		58.5	170 <sup>17</sup>			
3505	Diethyl phenylmalonate		C <sub>13</sub> H <sub>16</sub> O <sub>4</sub>	83-13-6	236.264		16.5	dec 205; 168 <sup>12</sup>	1.0950 <sup>20</sup>	1.4977 <sup>20</sup>	vs ace, EtOH
3506	Diethyl phenylphosphonite		C <sub>10</sub> H <sub>15</sub> O <sub>2</sub> P	1638-86-4	198.199			235; 62 <sup>1</sup>	1.032 <sup>16</sup>		
3507	5,5-Diethyl-1-phenyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	Phenetharbital	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	357-67-5	260.288		178				vs EtOH
3508	Diethylphosphine		C <sub>4</sub> H <sub>11</sub> P	627-49-6	90.104			85	0.786 <sup>20</sup>		
3509	Diethyl phosphonate		C <sub>4</sub> H <sub>11</sub> O <sub>3</sub> P	762-04-9	138.102			54 <sup>6</sup>			s ctc
3510	<i>O,O</i> -Diethyl phosphorodithionate		C <sub>4</sub> H <sub>11</sub> O <sub>2</sub> PS <sub>2</sub>	298-06-6	186.233						s H <sub>2</sub> O
3511	Diethyl phthalate		C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	84-66-2	222.237	liq	-40.5	295	1.232 <sup>14</sup>	1.5000 <sup>21</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, bz, ctc
3512	3,3-Diethyl-2,4-piperidinedione	Piperidione	C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	77-03-2	169.221	nd (w)	104				vs H <sub>2</sub> O, EtOH, chl, MeOH
3513	<i>N,N</i> -Diethylpropanamide		C <sub>8</sub> H <sub>15</sub> NO	1114-51-8	129.200			191	0.8972 <sup>20</sup>	1.4425 <sup>20</sup>	vs EtOH
3514	<i>N,N</i> -Diethyl-1,3-propanediamine		C <sub>7</sub> H <sub>15</sub> N <sub>2</sub>	104-78-9	130.231			168.5	0.822 <sup>20</sup>	1.443 <sup>20</sup>	
3515	Diethylpropanedioic acid	Diethylmalonic acid	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	510-20-3	160.168	pr (w,bz)	127 dec				vs H <sub>2</sub> O, EtOH, eth; sl bz, chl
3516	2,2-Diethyl-1,3-propanediol		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	115-76-4	132.201		61.5	240.5	1.050 <sup>20</sup>	1.4574 <sup>25</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
3517	Diethyl 2-propylmalonate		C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	2163-48-6	202.248			221; 114 <sup>22</sup>	0.989 <sup>20</sup>	1.4197 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
3518	<i>N,N</i> -Diethyl-3-pyridinecarboxamide	Nikethamide	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O	59-26-7	178.230	ye solid or visc liq	25	dec 280; 175 <sup>25</sup>	1.060 <sup>25</sup>	1.525 <sup>20</sup>	sl DMSO

*N,N*-Diethyl-2-methylaniline*N,N*-Diethyl-4-methylaniline*N,N*-Diethyl-3-methylbenzamide

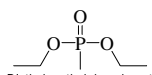
1,3-Diethyl-5-methylbenzene

*M4,M4*-Diethyl-2-methyl-1,4-benzenediamine, monohydrochloride*N,N*-Diethyl-3-methylbutanamide

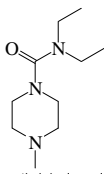
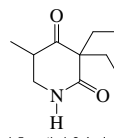
Diethyl methylenesuccinate



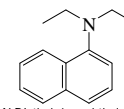
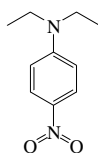
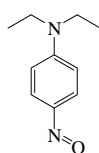
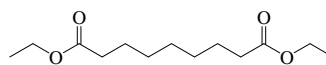
Diethyl methylmalonate



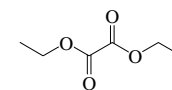
Diethyl methylphosphonate

*N,N*-Diethyl-4-methyl-1-piperazinecarboxamide

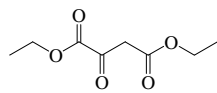
3,3-Diethyl-5-methyl-2,4-piperidinedione

*N,N*-Diethyl-1-naphthalenamine*N,N*-Diethyl-4-nitroaniline*N,N*-Diethyl-4-nitrosaniline

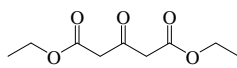
Diethyl nonanedioate



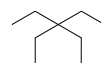
Diethyl oxalate



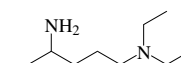
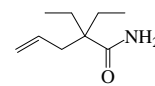
Diethyl oxobutanedioate



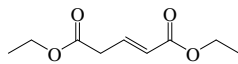
Diethyl 3-oxo-1,5-pentanedioate



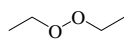
3,3-Diethylpentane

*N,N*-Diethyl-1,4-pentanediamine

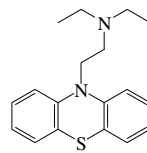
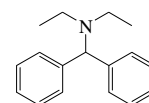
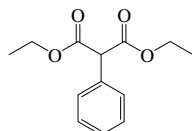
2,2-Diethyl-4-pentanamide



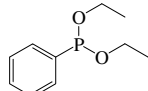
Diethyl 2-pentenedioate



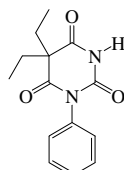
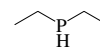
Diethylperoxide

*N,N*-Diethyl-10*H*-phenothiazine-10-ethanamine*N,N*-Diethyl- $\alpha$ -phenylbenzenemethanamine

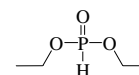
Diethyl phenylmalonate



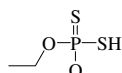
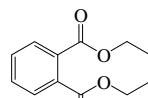
Diethyl phenylphosphonite

5,5-Diethyl-1-phenyl-2,4,6-(1*H*,3*H*,5*H*)-pyrimidinetrione

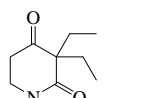
Diethylphosphine



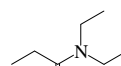
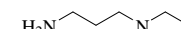
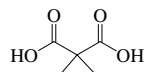
Diethyl phosphonate

*O,O*-Diethyl phosphorodithionate

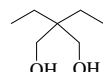
Diethyl phthalate



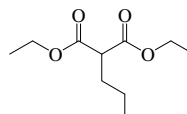
3,3-Diethyl-2,4-piperidinedione

*N,N*-Diethylpropanamide*N,N*-Diethyl-1,3-propanediamine

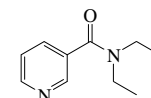
Diethylpropanedioic acid



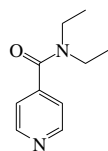
2,2-Diethyl-1,3-propanediol



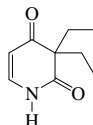
Diethyl 2-propylmalonate

*N,N*-Diethyl-3-pyridinecarboxamide

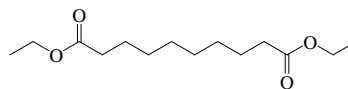
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3519	<i>N,N</i> -Diethyl-4-pyridinecarboxamide	Isonicotinic acid diethylamide	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O	530-40-5	178.230			119 <sup>1</sup>		1.525 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
3520	3,3-Diethyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyridinedione	Pyrrithyldione	C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	77-04-3	167.205		90.7				
3521	Diethyl sebacate		C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	110-40-7	258.354		2.5	305; 188 <sup>19</sup>	0.9646 <sup>20</sup>	1.4306 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, ace; i bz
3522	Diethyl selenide		C <sub>4</sub> H <sub>10</sub> Se	627-53-2	137.08	pa ye	55	108	1.2300 <sup>20</sup>	1.4768 <sup>20</sup>	
3523	Diethylsilane		C <sub>4</sub> H <sub>12</sub> Si	542-91-6	88.224	liq	-134.3	57	0.6843 <sup>20</sup>	1.3921 <sup>20</sup>	i H <sub>2</sub> O
3524	<i>trans</i> -Diethylstilbestrol		C <sub>18</sub> H <sub>20</sub> O <sub>2</sub>	56-53-1	268.351	pl (bz)	170.5				vs eth, EtOH, chl
3525	<i>trans</i> -Diethylstilbestrol dipropionate	Clinestrol	C <sub>24</sub> H <sub>28</sub> O <sub>4</sub>	130-80-3	380.477	pr (MeOH)	104				vs bz, eth, EtOH
3526	<i>trans</i> -Diethylstilbestrol monomethyl ether	Mestilbol	C <sub>19</sub> H <sub>22</sub> O <sub>2</sub>	18839-90-2	282.377	nd (bz-peth)	117.5	190 <sup>3</sup>			vs ace, eth, EtOH
3527	Diethyl succinate	Ethyl succinate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	123-25-1	174.195	liq	-21	217.7	1.0402 <sup>20</sup>	1.4201 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, chl
3528	Diethyl sulfate		C <sub>4</sub> H <sub>10</sub> O <sub>4</sub> S	64-67-5	154.185	oil	-24	208	1.172 <sup>25</sup>	1.3989 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
3529	Diethyl sulfide		C <sub>4</sub> H <sub>10</sub> S	352-93-2	90.187	liq	-103.91	92.1	0.8362 <sup>20</sup>	1.4430 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
3530	Diethyl sulfite	Ethyl sulfite	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub> S	623-81-4	138.185			158; 51 <sup>13</sup>	1.1 <sup>20</sup>	1.4310 <sup>20</sup>	s EtOH, eth
3531	Diethyl sulfone	Ethyl sulfone	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S	597-35-3	122.186	orth pl	73.5	248	1.357 <sup>20</sup>		s H <sub>2</sub> O, eth; vs bz; i peth
3532	Diethyl sulfoxide		C <sub>4</sub> H <sub>10</sub> OS	70-29-1	106.186	syr	14	104 <sup>25</sup> , 90 <sup>15</sup>	1.0092 <sup>22</sup>		vs H <sub>2</sub> O, eth, EtOH
3533	Diethyl <i>DL</i> -tartrate		C <sub>8</sub> H <sub>14</sub> O <sub>6</sub>	57968-71-5	206.193		18.7	281; 158 <sup>14</sup>	1.2046 <sup>20</sup>	1.4438 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
3534	Diethyl telluride		C <sub>4</sub> H <sub>10</sub> Te	627-54-3	185.72	red-ye		137.5	1.599 <sup>15</sup>	1.5182 <sup>15</sup>	vs EtOH
3535	Diethyl terephthalate		C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	636-09-9	222.237	mcl pr (al, peth)	44	302	1.0989 <sup>45</sup>		i H <sub>2</sub> O; vs EtOH, eth
3536	Diethyl thiodipropionate		C <sub>10</sub> H <sub>18</sub> O <sub>2</sub> S	673-79-0	234.313			174 <sup>15</sup> , 121 <sup>2</sup>	1.1034 <sup>20</sup>	1.4655 <sup>20</sup>	
3537	<i>N,N</i> -Diethylthiourea		C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> S	105-55-5	132.227		78	dec			s H <sub>2</sub> O, EtOH; vs eth; sl ctc
3538	<i>N,N</i> -Diethyl-1,1,1-trimethylsilanamine	(Diethylamino)trimethylsilane	C <sub>7</sub> H <sub>19</sub> NSi	996-50-9	145.319			126.3	0.7627 <sup>20</sup>	1.4112 <sup>20</sup>	
3539	Diethyltrisulfide		C <sub>4</sub> H <sub>10</sub> S <sub>3</sub>	3600-24-6	154.317		-72.6	85 <sup>26</sup>	1.1082 <sup>20</sup>	1.5689 <sup>13</sup>	
3540	<i>N,N</i> -Diethylurea		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O	634-95-7	116.161	pl, nd (eth)	75	95 <sup>0,02</sup>			vs H <sub>2</sub> O, EtOH, bz, lig; s eth
3541	<i>N,N'</i> -Diethylurea		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O	623-76-7	116.161	tab (lig), hyg nd (al)	112.5	263	1.0415 <sup>25</sup>	1.4616 <sup>40</sup>	vs H <sub>2</sub> O, EtOH, eth
3542	Diethyl vinylphosphonate		C <sub>6</sub> H <sub>13</sub> O <sub>3</sub> P	682-30-4	164.139			110 <sup>2</sup>	1.068 <sup>25</sup>	1.4290 <sup>20</sup>	
3543	Diethyl zinc	Zinc diethyl	C <sub>4</sub> H <sub>10</sub> Zn	557-20-0	123.531	col liq	-28	118; 80 <sup>200</sup>	1.2065 <sup>20</sup>	1.4936 <sup>20</sup>	dec H <sub>2</sub> O; msc eth, peth, bz
3544	Difenoconazole		C <sub>19</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub>	119446-68-3	406.262		76	220 <sup>0,03</sup>			
3545	Difenzoquat methyl sulfate	1 <i>H</i> -Pyrazolium, 1,2-dimethyl-3,5-diphenyl-, methyl sulfate	C <sub>18</sub> H <sub>20</sub> N <sub>2</sub> O <sub>4</sub> S	43222-48-6	360.428		157				
3546	Diflubenzuron	<i>N</i> -[[[4-Chlorophenyl]amino]carbonyl]-2,6-difluorobenzamide	C <sub>14</sub> H <sub>9</sub> ClF <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	35367-38-5	310.683		239				
3547	Difluoroacetic acid		C <sub>2</sub> H <sub>2</sub> F <sub>2</sub> O <sub>2</sub>	381-73-7	96.033	liq	-1	133	1.526 <sup>25</sup>	1.3470 <sup>20</sup>	
3548	2,4-Difluoroaniline		C <sub>6</sub> H <sub>6</sub> F <sub>2</sub> N	367-25-9	129.108	liq	-7.5	170	1.268 <sup>25</sup>	1.5063 <sup>20</sup>	
3549	<i>o</i> -Difluorobenzene	1,2-Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	367-11-3	114.093	liq	-47.1	94	1.1599 <sup>18</sup>	1.4451 <sup>18</sup>	i H <sub>2</sub> O; s ace, bz, chl
3550	<i>m</i> -Difluorobenzene	1,3-Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	372-18-9	114.093	liq	-69.12	82.6	1.1572 <sup>20</sup>	1.4374 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz
3551	<i>p</i> -Difluorobenzene	1,4-Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	540-36-3	114.093	liq	-23.55	89	1.1701 <sup>20</sup>	1.4422 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz; sl ctc
3552	4,4'-Difluoro-1,1'-biphenyl	4,4'-Difluorodiphenyl	C <sub>12</sub> H <sub>8</sub> F <sub>2</sub>	398-23-2	190.189	mcl pr (al) lf (w)	94.5	254.5			i H <sub>2</sub> O; vs EtOH, bz, chl; s eth, ace
3553	1,1-Difluorocyclohexane		C <sub>6</sub> H <sub>10</sub> F <sub>2</sub>	371-90-4	120.140	liq		99.5			
3554	3,3-Difluorocyclopropene		C <sub>3</sub> H <sub>2</sub> F <sub>2</sub>	56830-75-2	76.045	liq		34			
3555	Difluorodimethylsilane		C <sub>2</sub> H <sub>6</sub> F <sub>2</sub> Si	353-66-2	96.152	col gas	-87.5	2.5			
3556	1,5-Difluoro-2,4-dinitrobenzene		C <sub>6</sub> H <sub>2</sub> F <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	327-92-4	204.088		75.5	132 <sup>2</sup>			sl EtOH
3557	Difluorodiphenylsilane		C <sub>12</sub> H <sub>10</sub> F <sub>2</sub> Si	312-40-3	220.290			246; 157 <sup>50</sup>	1.145 <sup>17</sup>	1.5221 <sup>25</sup>	
3558	1,1-Difluoroethane	Ethylidene difluoride	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	75-37-6	66.050	col gas	-118.6	-24.05	0.896 <sup>25</sup> (p>1 atm)	1.3011 <sup>-72</sup>	
3559	1,2-Difluoroethane	Ethylene difluoride	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	624-72-6	66.050	vol liq		26			vs bz, eth, chl
3560	1,1-Difluoroethene	Vinylidene fluoride	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	75-38-7	64.034	col gas	-144	-85.7			vs eth, EtOH
3561	<i>cis</i> -1,2-Difluoroethene	<i>cis</i> -1,2-Difluoroethylene	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1630-77-9	64.034	col gas		-26			
3562	<i>trans</i> -1,2-Difluoroethene	<i>trans</i> -1,2-Difluoroethylene	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1630-78-0	64.034	col gas		-53.1			
3563	Difluoromethane	Methylene fluoride	CH <sub>2</sub> F <sub>2</sub>	75-10-5	52.024	col gas	-136.8 tp	-51.6	1.2139 <sup>-52</sup>		i H <sub>2</sub> O; s EtOH



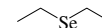
N,N-Diethyl-4-pyridinecarboxamide



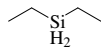
3,3-Diethyl-2,4(1H,3H)-pyridinedione



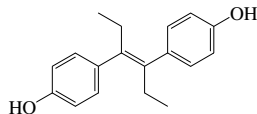
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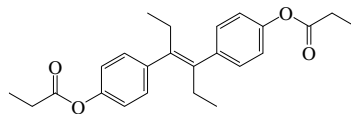
Diethyl selenide



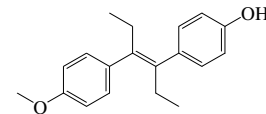
Diethylsilane



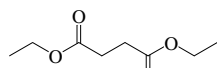
trans-Diethylstilbestrol



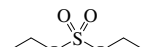
trans-Diethylstilbestrol dipropionate



trans-Diethylstilbestrol monomethyl ether



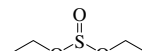
Diethyl succinate



Diethyl sulfate



Diethyl sulfide



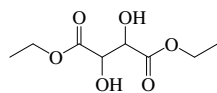
Diethyl sulfite



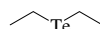
Diethyl sulfone



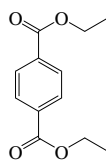
Diethyl sulfoxide



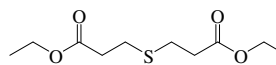
Diethyl DL-tartrate



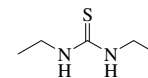
Diethyl telluride



Diethyl terephthalate



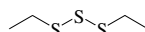
Diethyl thiodipropionate



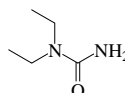
N,N-Diethylthiourea



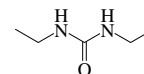
N,N-Diethyl-1,1,1-trimethylsilanamine



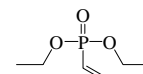
Diethyltrisulfide



N,N-Diethylurea



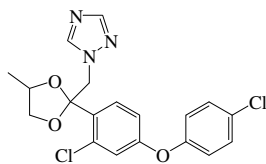
N,N'-Diethylurea



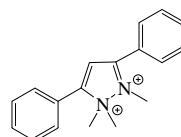
Diethyl vinylphosphonate



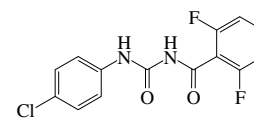
Diethyl zinc



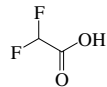
Difenoconazole



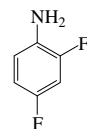
Difenzoquat methyl sulfate



Diflubenzuron



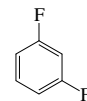
Difluoroacetic acid



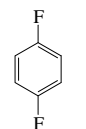
2,4-Difluoroaniline



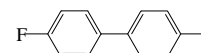
o-Difluorobenzene



m-Difluorobenzene



p-Difluorobenzene



4,4'-Difluoro-1,1'-biphenyl



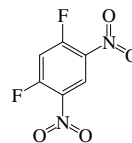
1,1-Difluorocyclohexane



3,3-Difluorocyclopropene



Difluorodimethylsilane



1,5-Difluoro-2,4-dinitrobenzene



Difluorodiphenylsilane



1,1-Difluoroethane



1,2-Difluoroethane



1,1-Difluoroethene



cis-1,2-Difluoroethene



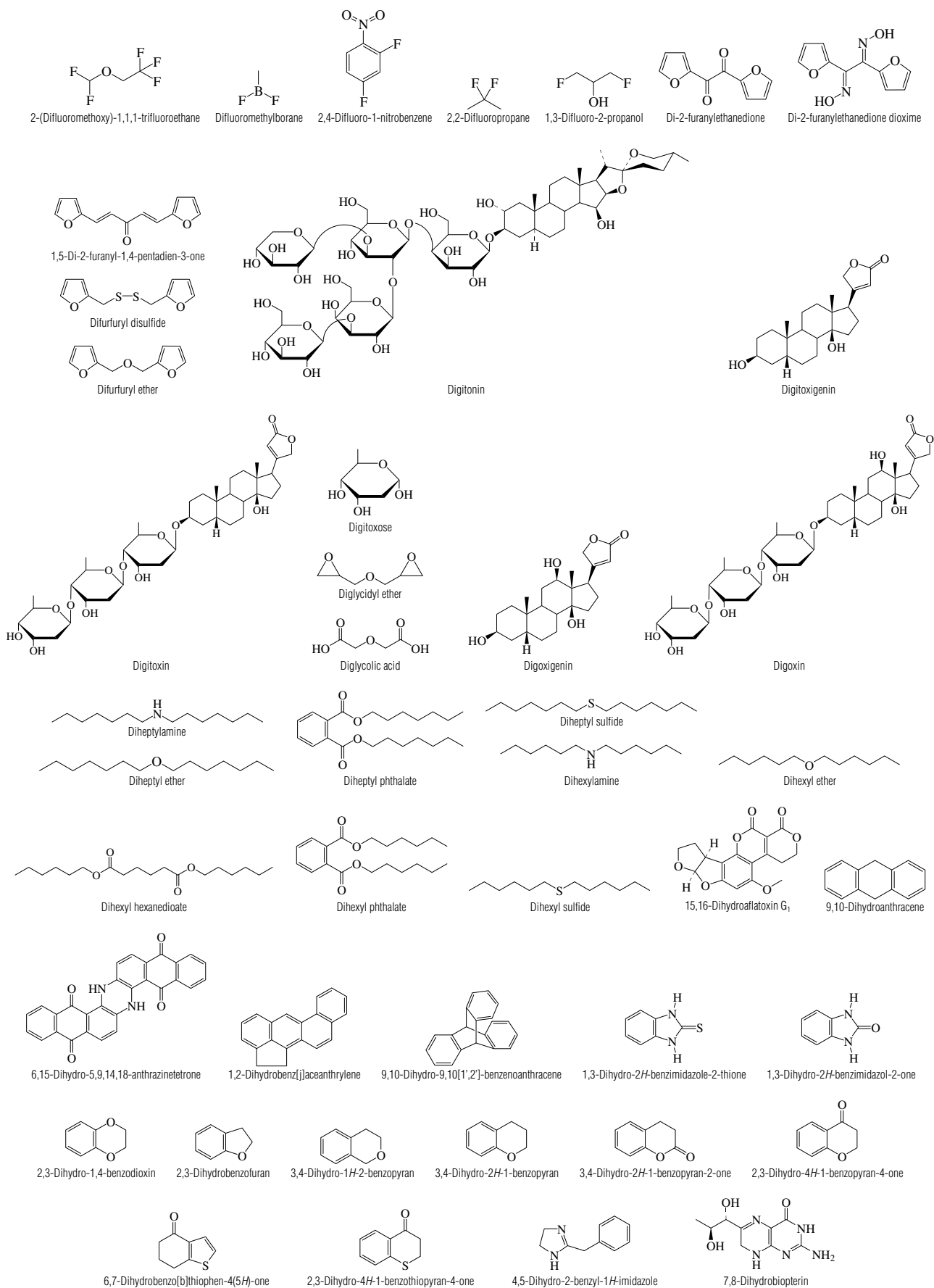
trans-1,2-Difluoroethene



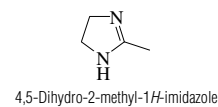
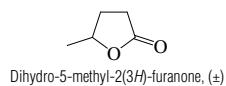
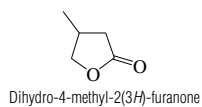
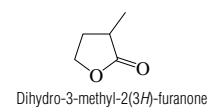
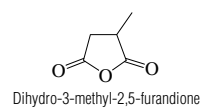
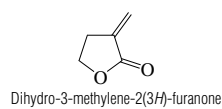
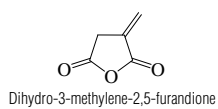
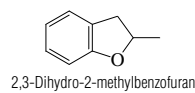
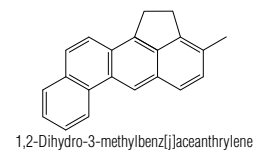
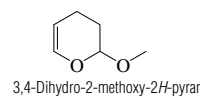
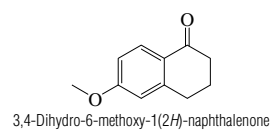
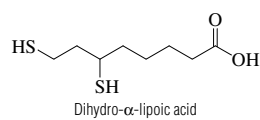
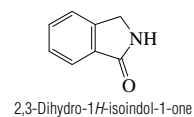
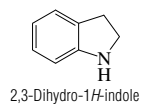
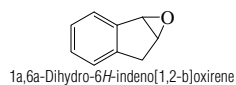
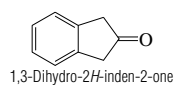
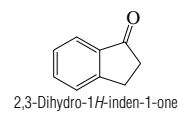
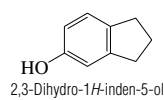
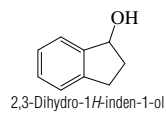
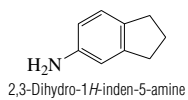
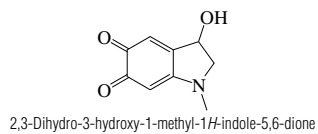
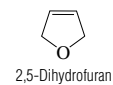
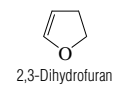
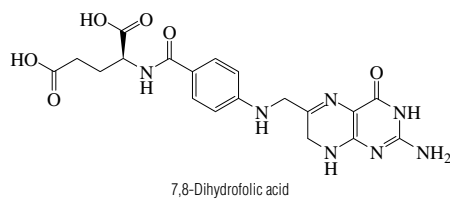
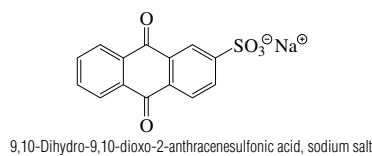
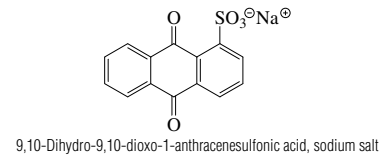
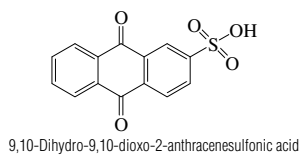
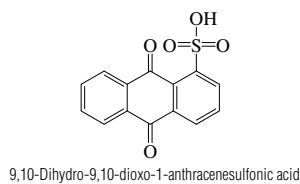
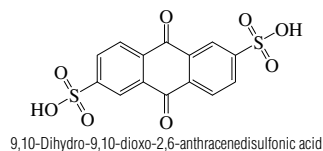
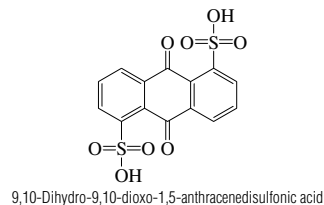
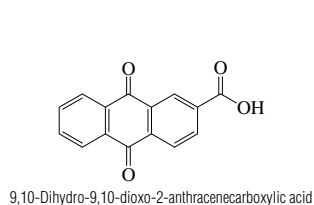
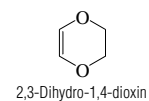
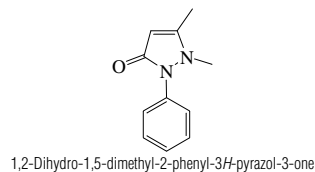
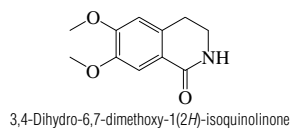
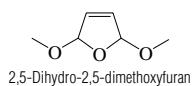
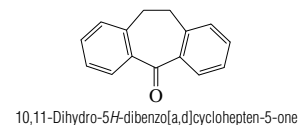
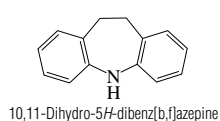
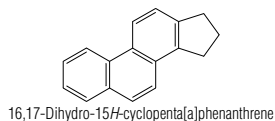
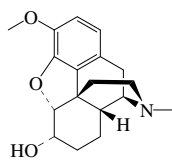
Difluoromethane

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3564	2-(Difluoromethoxy)-1,1,1-trifluoroethane	Difluoromethyl 2,2,2-trifluoroethyl ether	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> O	1885-48-9	150.047	col liq		29			
3565	Difluoromethylborane		CH <sub>2</sub> BF <sub>2</sub>	373-64-8	63.843	gas		-78.5 <sup>287</sup>			reac H <sub>2</sub> O
3566	2,4-Difluoro-1-nitrobenzene		C <sub>6</sub> H <sub>4</sub> F <sub>2</sub> NO <sub>2</sub>	446-35-5	159.091		9.8	207	1.4571 <sup>14</sup>	1.5149 <sup>14</sup>	sl chl
3567	2,2-Difluoropropane		C <sub>3</sub> H <sub>6</sub> F <sub>2</sub>	420-45-1	80.077	col gas	-104.8	-0.4	0.9205 <sup>20</sup>	1.2904 <sup>20</sup>	(p>1 atm)
3568	1,3-Difluoro-2-propanol		C <sub>3</sub> H <sub>6</sub> F <sub>2</sub> O	453-13-4	96.076			127; 55 <sup>34</sup>	1.24 <sup>25</sup>	1.3725 <sup>20</sup>	
3569	Di-2-furanylethanedione		C <sub>10</sub> H <sub>6</sub> O <sub>4</sub>	492-94-4	190.153	ye nd (al), cry (bz)	166.3				sl H <sub>2</sub> O; s EtOH, eth, bz, chl
3570	Di-2-furanylethanedione dioxime	α-Furildioxime	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	522-27-0	220.182		167				sl EtOH, eth, bz, lig
3571	1,5-Di-2-furanyl-1,4-pentadien-3-one		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	886-77-1	214.216	hyg pr (peth) ye pr (lig)	60.5	181 <sup>4</sup>			vs eth, EtOH, chl
3572	Difurfuryl disulfide	Furfuryl disulfide	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub> S <sub>2</sub>	4437-20-1	226.315		10	167 <sup>13</sup> , 112 <sup>9.5</sup>			vs EtOH
3573	Difurfuryl ether	Furfuryl ether	C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	4437-22-3	178.184			101 <sup>2</sup>	1.1405 <sup>20</sup>	1.5088 <sup>20</sup>	i H <sub>2</sub> O
3574	Digitonin		C <sub>55</sub> H <sub>92</sub> O <sub>29</sub>	11024-24-1	1229.312		237.5				
3575	Digitoxigenin		C <sub>23</sub> H <sub>34</sub> O <sub>4</sub>	143-62-4	374.514		253				s EtOH; vs MeOH
3576	Digitoxin		C <sub>41</sub> H <sub>64</sub> O <sub>13</sub>	71-63-6	764.939	pr (dil al)	255.5				sl H <sub>2</sub> O; vs EtOH; s eth, chl, MeOH, py
3577	Digitoxose		C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	527-52-6	148.157	cry (MeOH+eth)	112				vs H <sub>2</sub> O, ace; s py, AcOEt
3578	Diglycidyl ether	Bis(2,3-epoxypropyl) ether	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	2238-07-5	130.141			260	1.1195 <sup>20</sup>		
3579	Diglycolic acid	2,2'-Oxydiacetic acid	C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	110-99-6	134.088	mcl pr (w + 1)	148	dec			vs H <sub>2</sub> O, eth, EtOH
3580	Digoxigenin		C <sub>23</sub> H <sub>34</sub> O <sub>5</sub>	1672-46-4	390.513	pr (AcOEt)	222				vs EtOH, MeOH; sl chl
3581	Digoxin		C <sub>41</sub> H <sub>64</sub> O <sub>14</sub>	20830-75-5	780.939	trc pl (dil al, py)	249 dec				vs EtOH
3582	Diheptylamine	N-Heptyl-1-heptanamine	C <sub>14</sub> H <sub>31</sub> N	2470-68-0	213.403	nd	31.5	271; 135 <sup>9</sup>	0.7956 <sup>21</sup>		sl H <sub>2</sub> O; s EtOH; vs eth
3583	Diheptyl ether	Heptyl ether	C <sub>14</sub> H <sub>30</sub> O	629-64-1	214.387			258.5	0.8008 <sup>20</sup>	1.4275 <sup>20</sup>	vs eth, EtOH
3584	Diheptyl phthalate		C <sub>22</sub> H <sub>34</sub> O <sub>4</sub>	3648-21-3	362.503			360			
3585	Diheptyl sulfide	Heptyl sulfide	C <sub>14</sub> H <sub>30</sub> S	629-65-2	230.453		70	298	0.8416 <sup>20</sup>	1.4606 <sup>20</sup>	i H <sub>2</sub> O; s eth
3586	Dihexylamine	N-Hexyl-1-hexanamine	C <sub>12</sub> H <sub>27</sub> N	143-16-8	185.349	liq	-13.1	236; 75 <sup>1</sup>	0.7889 <sup>20</sup>	1.4339 <sup>20</sup>	s EtOH, eth
3587	Dihexyl ether	Hexyl ether	C <sub>12</sub> H <sub>26</sub> O	112-58-3	186.333			226	0.7936 <sup>20</sup>	1.4204 <sup>20</sup>	i H <sub>2</sub> O; s eth; sl ctc
3588	Dihexyl hexanedioate		C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	110-33-8	314.461	liq	-9	348; 182.5 <sup>4</sup>	0.941 <sup>20</sup>		
3589	Dihexyl phthalate		C <sub>20</sub> H <sub>30</sub> O <sub>4</sub>	84-75-3	334.450			210 <sup>5</sup>			
3590	Dihexyl sulfide	Hexyl sulfide	C <sub>12</sub> H <sub>26</sub> S	6294-31-1	202.399			230; 136 <sup>20</sup>	0.8411 <sup>20</sup>	1.4586 <sup>20</sup>	
3591	15,16-Dihydroaflatoxin G <sub>1</sub>	Aflatoxin G <sub>2</sub>	C <sub>17</sub> H <sub>14</sub> O <sub>7</sub>	7241-98-7	330.289		239.3				
3592	9,10-Dihydroanthracene		C <sub>14</sub> H <sub>12</sub>	613-31-0	180.245	tab or pr	111	305	1.215 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, chl
3593	6,15-Dihydro-5,9,14,18-anthrazinetetrone	Indanthrene	C <sub>28</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub>	81-77-6	442.422	bl nd	485 dec				i H <sub>2</sub> O, EtOH, eth, ace, bz; s PhNO <sub>2</sub> , dil alk
3594	1,2-Dihydrobenz[ <i>j</i> ]aceanthrylene	Cholanthrene	C <sub>20</sub> H <sub>14</sub>	479-23-2	254.325	pa ye lf (bz- al)	170.4				i H <sub>2</sub> O; s EtOH, bz, HOAc, lig, tol
3595	9,10-Dihydro-9,10[1',2']-benzoanthracene	Triptycene	C <sub>20</sub> H <sub>14</sub>	477-75-8	254.325	cry (cyhex)	256				
3596	1,3-Dihydro-2 <i>H</i> -benzimidazole-2-thione	2-Benzimidazolethiol	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> S	583-39-1	150.201	pl (dil al or NH <sub>3</sub> )	298				vs EtOH
3597	1,3-Dihydro-2 <i>H</i> -benzimidazol-2-one		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O	615-16-7	134.135	lf (w or al)	318 dec				sl H <sub>2</sub> O, eth, bz; s ace; vs EtOH
3598	2,3-Dihydro-1,4-benzodioxin		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	493-09-4	136.149			212; 103 <sup>6</sup>	1.180 <sup>20</sup>	1.5485 <sup>20</sup>	
3599	2,3-Dihydrobenzofuran	Coumaran	C <sub>8</sub> H <sub>8</sub> O	496-16-2	120.149	liq	-21.5	188.5	1.058 <sup>25</sup>	1.5497 <sup>20</sup>	vs eth, EtOH, chl
3600	3,4-Dihydro-1 <i>H</i> -2-benzopyran	Isochroman	C <sub>9</sub> H <sub>10</sub> O	493-05-0	134.174		4	110 <sup>25</sup> , 90 <sup>12</sup>	1.067 <sup>25</sup>	1.5444 <sup>20</sup>	
3601	3,4-Dihydro-2 <i>H</i> -1-benzopyran		C <sub>9</sub> H <sub>10</sub> O	493-08-3	134.174		4.8	215; 98 <sup>18</sup>	1.072 <sup>20</sup>	1.5444 <sup>20</sup>	s H <sub>2</sub> O; msc os
3602	3,4-Dihydro-2 <i>H</i> -1-benzopyran-2-one		C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	119-84-6	148.159	lf	25	272	1.169 <sup>18</sup>	1.5563 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, eth, ctc; s chl
3603	2,3-Dihydro-4 <i>H</i> -1-benzopyran-4-one	4-Chromanone	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	491-37-2	148.159		36.5	160 <sup>50</sup> , 127 <sup>13</sup>	1.1291 <sup>100</sup>	1.5750	s EtOH; vs eth, ace, bz, chl; sl ctc
3604	6,7-Dihydrobenzo[ <i>b</i> ]thiophen-4(5 <i>H</i> )-one	4,5,6,7-Tetrahydro-4-benzothiophenone	C <sub>9</sub> H <sub>8</sub> OS	13414-95-4	152.214						sl chl
3605	2,3-Dihydro-4 <i>H</i> -1-benzothiopyran-4-one		C <sub>9</sub> H <sub>8</sub> OS	3528-17-4	164.224		29	154 <sup>12</sup>	1.2487 <sup>14</sup>	1.6395 <sup>20</sup>	
3606	4,5-Dihydro-2-benzyl-1 <i>H</i> -imidazole	Tolazoline	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub>	59-98-3	160.215	cry (peth)	67				
3607	7,8-Dihydrobiopterin		C <sub>9</sub> H <sub>13</sub> N <sub>5</sub> O <sub>3</sub>	6779-87-9	239.231	hyg nd (w)					s H <sub>2</sub> O

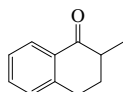
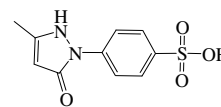
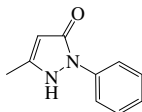
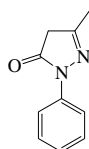




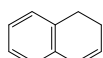
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3608	Dihydrocodeine		C <sub>18</sub> H <sub>23</sub> NO <sub>3</sub>	125-28-0	301.381	cry (aq, MeOH)	112.5	248 <sup>15</sup>			
3609	16,17-Dihydro-15H-cyclopenta[a]phenanthrene	1,2-Cyclopentenophenanthrene	C <sub>17</sub> H <sub>14</sub>	482-66-6	218.293	nd (al, petr)	135.5				i H <sub>2</sub> O; s EtOH, peth
3610	10,11-Dihydro-5H-dibenz[b,f]azepine		C <sub>14</sub> H <sub>13</sub> N	494-19-9	195.260						s chl
3611	10,11-Dihydro-5H-dibenzo[a,d]cyclohepten-5-one		C <sub>15</sub> H <sub>12</sub> O	1210-35-1	208.255		30	203 <sup>7</sup>	1.1635 <sup>20</sup>	1.6324 <sup>20</sup>	
3612	2,5-Dihydro-2,5-dimethoxyfuran		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	332-77-4	130.141			161	1.073 <sup>25</sup>	1.4339 <sup>20</sup>	
3613	3,4-Dihydro-6,7-dimethoxy-1(2H)-isoquinolinone	Corydaldine	C <sub>11</sub> H <sub>13</sub> NO <sub>3</sub>	493-49-2	207.226	mcl pr (w, al)	175				vs H <sub>2</sub> O, bz, eth, EtOH
3614	1,2-Dihydro-1,5-dimethyl-2-phenyl-3H-pyrazol-3-one	Antipyrine	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O	60-80-0	188.225	lf or sc (eth, bz)	114	319			vs H <sub>2</sub> O, EtOH
3615	2,3-Dihydro-1,4-dioxin		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	543-75-9	86.090			94.1	1.0836 <sup>20</sup>	1.4372 <sup>20</sup>	s ctc
3616	9,10-Dihydro-9,10-dioxo-2-anthracenecarboxylic acid		C <sub>15</sub> H <sub>8</sub> O <sub>4</sub>	117-78-2	252.223	ye nd (HOAc)	291	sub			sl EtOH, HOAc; i eth, bz; s ace
3617	9,10-Dihydro-9,10-dioxo-1,5-anthracenedisulfonic acid		C <sub>14</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	117-14-6	368.339	ye nd (HCl +4w) pl (dil HOAc)	310 dec				vs H <sub>2</sub> O, EtOH, HOAc
3618	9,10-Dihydro-9,10-dioxo-2,6-anthracenedisulfonic acid		C <sub>14</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	84-50-4	368.339						vs H <sub>2</sub> O; s EtOH; i eth, bz
3619	9,10-Dihydro-9,10-dioxo-1-anthracenesulfonic acid		C <sub>14</sub> H <sub>6</sub> O <sub>5</sub> S	82-49-5	288.276	lf (HOAc) ye lf (conc HCl, +3w)	216.0				vs H <sub>2</sub> O, HOAc; s EtOH
3620	9,10-Dihydro-9,10-dioxo-2-anthracenesulfonic acid		C <sub>14</sub> H <sub>6</sub> O <sub>5</sub> S	84-48-0	288.276	ye lf (+3w)					vs H <sub>2</sub> O; s EtOH; i eth
3621	9,10-Dihydro-9,10-dioxo-1-anthracenesulfonic acid, sodium salt	Sodium anthraquinone-1-sulfonate	C <sub>14</sub> H <sub>7</sub> NaO <sub>5</sub> S	128-56-3	310.258	ye lf (w)					sl H <sub>2</sub> O
3622	9,10-Dihydro-9,10-dioxo-2-anthracenesulfonic acid, sodium salt		C <sub>14</sub> H <sub>7</sub> NaO <sub>5</sub> S	131-08-8	310.258						sl DMSO
3623	7,8-Dihydrofolic acid		C <sub>19</sub> H <sub>21</sub> N <sub>7</sub> O <sub>6</sub>	4033-27-6	443.413	ye cry					
3624	2,3-Dihydrofuran		C <sub>4</sub> H <sub>6</sub> O	1191-99-7	70.090			54.5	0.927 <sup>25</sup>	1.4239 <sup>20</sup>	
3625	2,5-Dihydrofuran		C <sub>4</sub> H <sub>6</sub> O	1708-29-8	70.090					1.4311 <sup>20</sup>	
3626	2,3-Dihydro-3-hydroxy-1-methyl-1H-indole-5,6-dione	Adrenochrome	C <sub>9</sub> H <sub>8</sub> NO <sub>3</sub>	54-06-8	179.172		125 dec				vs H <sub>2</sub> O, EtOH; i eth, bz
3627	2,3-Dihydro-1H-inden-5-amine		C <sub>9</sub> H <sub>11</sub> N	24425-40-9	133.190	nd (peth)	37.5	248; 131 <sup>15</sup>			sl H <sub>2</sub> O, chl; s eth, ace, bz
3628	2,3-Dihydro-1H-inden-1-ol		C <sub>9</sub> H <sub>10</sub> O	6351-10-6	134.174	pl (peth)	54.8	220; 128 <sup>12</sup>			vs bz, EtOH, chl
3629	2,3-Dihydro-1H-inden-5-ol		C <sub>9</sub> H <sub>10</sub> O	1470-94-6	134.174		58	253			sl H <sub>2</sub> O, peth; vs EtOH, eth; s sulf
3630	2,3-Dihydro-1H-inden-1-one		C <sub>9</sub> H <sub>8</sub> O	83-33-0	132.159	ta, nd (w + 3)	42	243; 129 <sup>12</sup>	1.0943 <sup>40</sup>	1.561 <sup>25</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
3631	1,3-Dihydro-2H-inden-2-one	2-Indanone	C <sub>9</sub> H <sub>8</sub> O	615-13-4	132.159	nd (al, eth)	59	dec 218	1.0712 <sup>69</sup>	1.538 <sup>67</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, chl
3632	1a,6a-Dihydro-6H-indeno[1,2-b]oxirene		C <sub>9</sub> H <sub>8</sub> O	768-22-9	132.159		24.5	113 <sup>20</sup> , 98 <sup>6</sup>	1.1255 <sup>24</sup>		s chl
3633	2,3-Dihydro-1H-indole		C <sub>8</sub> H <sub>9</sub> N	496-15-1	119.164			229	1.069 <sup>20</sup>	1.5923 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace, bz
3634	1,3-Dihydro-2H-indol-2-one		C <sub>8</sub> H <sub>7</sub> NO	59-48-3	133.148	nd (w)	128	227 <sup>23</sup> , 195 <sup>17</sup>			s H <sub>2</sub> O, EtOH, eth
3635	2,3-Dihydro-1H-isoindol-1-one		C <sub>8</sub> H <sub>7</sub> NO	480-91-1	133.148	nd (w)	151	338; 103 <sup>18</sup>			vs eth, EtOH, chl
3636	Dihydro-α-lipoic acid	6,8-Dimercaptooctanoic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub> S <sub>2</sub>	462-20-4	208.342	ye liq		145 <sup>0.2</sup>			
3637	3,4-Dihydro-6-methoxy-1(2H)-naphthalenone	6-Methoxy-α-tetralone	C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	1078-19-9	176.212	cry (MeOH, lig)	78	171 <sup>11</sup>			
3638	3,4-Dihydro-2-methoxy-2H-pyran		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	4454-05-1	114.142	liq		128	1.006	1.4420 <sup>20</sup>	
3639	1,2-Dihydro-3-methylbenz[j]aceanthrylene	3-Methylcholanthrene	C <sub>21</sub> H <sub>16</sub>	56-49-5	268.352	ye nd (bz)	180	280 <sup>80</sup>	1.28 <sup>20</sup>		i H <sub>2</sub> O
3640	2,3-Dihydro-2-methylbenzofuran		C <sub>9</sub> H <sub>10</sub> O	1746-11-8	134.174			197.5	1.061 <sup>25</sup>	1.5308	
3641	Dihydro-3-methylene-2,5-furandione		C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	2170-03-8	112.084	orth bipym pr (eth, chl)	69	139 <sup>30</sup> , 114 <sup>18</sup>			sl eth; vs chl
3642	Dihydro-3-methylene-2(3H)-furanone	α-Methylene butyrolactone	C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	547-65-9	98.101			85 <sup>10</sup>	1.1206 <sup>20</sup>	1.4650 <sup>20</sup>	s H <sub>2</sub> O, eth, ace, bz; sl ctc; vs EtOH
3643	Dihydro-3-methyl-2,5-furandione		C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	4100-80-5	114.100		34	239	1.22 <sup>25</sup>		
3644	Dihydro-3-methyl-2(3H)-furanone	2-Methyl-γ-butyrolactone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1679-47-6	100.117	liq		200; 79 <sup>10</sup>	1.0570 <sup>20</sup>	1.4325 <sup>20</sup>	
3645	Dihydro-4-methyl-2(3H)-furanone	3-Methyl-γ-butyrolactone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1679-49-8	100.117	liq		76 <sup>11</sup>	1.058 <sup>20</sup>	1.4339 <sup>20</sup>	
3646	Dihydro-5-methyl-2(3H)-furanone, (±)	(±)-γ-Valerolactone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	57129-69-8	100.117	liq	-31	206	1.0551 <sup>20</sup>	1.4328 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, ace; sl ctc
3647	4,5-Dihydro-2-methyl-1H-imidazole	Lysidine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	534-26-9	84.120	hyg	107	196.5			vs H <sub>2</sub> O, EtOH; i eth; s chl



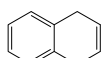
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3648	1,3-Dihydro-1-methyl-2 <i>H</i> -imidazole-2-thione	Methimazole	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> S	60-56-0	114.169	lf (al)	146	dec 280			vs H <sub>2</sub> O; s EtOH, chf; sl eth, bz, lig
3649	2,3-Dihydro-1-methyl-1 <i>H</i> -indene		C <sub>10</sub> H <sub>12</sub>	767-58-8	132.202			190.6	0.938 <sup>25</sup>	1.5266 <sup>20</sup>	i H <sub>2</sub> O
3650	3,4-Dihydro-2-methyl-1(2 <i>H</i> )-naphthalene		C <sub>11</sub> H <sub>12</sub> O	1590-08-5	160.212		15	136 <sup>16</sup>	1.057 <sup>25</sup>	1.5535 <sup>20</sup>	
3651	4-(4,5-Dihydro-3-methyl-5-oxo-1 <i>H</i> -pyrazol-1-yl)benzenesulfonic acid		C <sub>10</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub> S	89-36-1	254.262	nd (w+1)	≈300 dec				
3652	1,2-Dihydro-5-methyl-2-phenyl-3 <i>H</i> -pyrazol-3-one	5-Hydroxy-3-methyl-1-phenylpyrazole	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub> O	19735-89-8	174.198		128	287 <sup>105</sup> , 191 <sup>17</sup>	1.2600 <sup>20</sup>	1.637	s H <sub>2</sub> O, EtOH; sl bz; i peth
3653	2,4-Dihydro-5-methyl-2-phenyl-3 <i>H</i> -pyrazol-3-one		C <sub>10</sub> H <sub>10</sub> N <sub>2</sub> O	89-25-8	174.198	mcl pr (w)	127	287 <sup>105</sup> , 191 <sup>17</sup>		1.637	
3654	3,6-Dihydro-4-methyl-2 <i>H</i> -pyran		C <sub>6</sub> H <sub>10</sub> O	16302-35-5	98.142			117.5	0.912 <sup>25</sup>	1.4495 <sup>20</sup>	
3655	4,5-Dihydro-2-methylthiazole		C <sub>4</sub> H <sub>6</sub> NS	2346-00-1	101.171	liq	-101	145	1.067 <sup>25</sup>	1.5200 <sup>20</sup>	
3656	1,2-Dihydronaphthalene		C <sub>10</sub> H <sub>10</sub>	447-53-0	130.186	liq	-8	206.5	0.9974 <sup>20</sup>	1.5814 <sup>20</sup>	
3657	1,4-Dihydronaphthalene	Δ 2-Dialin	C <sub>10</sub> H <sub>10</sub>	612-17-9	130.186	pl	25	211.5	0.9928 <sup>33</sup>	1.5577 <sup>20</sup>	
3658	3,4-Dihydro-2(1 <i>H</i> )-naphthalene		C <sub>10</sub> H <sub>10</sub> O	530-93-8	146.185		18	237	1.1055 <sup>27</sup>	1.5598 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
3659	1,2-Dihydro-5-nitroacenaphthylene		C <sub>12</sub> H <sub>8</sub> NO <sub>2</sub>	602-87-9	199.205		103				s H <sub>2</sub> O, EtOH, eth, lig
3660	1,6-Dihydro-6-oxo-3-pyridinecarboxylic acid		C <sub>6</sub> H <sub>6</sub> NO <sub>3</sub>	5006-66-6	139.109	nd(w)	310 dec	sub			sl H <sub>2</sub> O, tfa; i EtOH, eth, bz, chl
3661	Dihydro-5-pentyl-2(3 <i>H</i> )-furanone	4-Hydroxynonanoic acid lactone	C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	104-61-0	156.222	oil		134 <sup>12</sup>			
3662	9,10-Dihydrophenanthrene		C <sub>14</sub> H <sub>12</sub>	776-35-2	180.245	nd (MeOH)	34.5	168 <sup>15</sup>	1.0757 <sup>40</sup>	1.6415 <sup>20</sup>	s chl
3663	2,3-Dihydro-2-phenyl-4 <i>H</i> -1-benzopyran-4-one		C <sub>15</sub> H <sub>12</sub> O <sub>2</sub>	487-26-3	224.255	nd (lig)	76				i H <sub>2</sub> O; s ace, bz; sl ctc
3664	4,5-Dihydro-2-(phenylmethyl)-1 <i>H</i> -imidazole, monohydrochloride		C <sub>10</sub> H <sub>13</sub> ClN <sub>2</sub>	59-97-2	196.676		174				
3665	4,5-Dihydro-5-phenyl-2-oxazolamine	Aminorex	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O	2207-50-3	162.187	cry (bz)	137				
3666	1,4-Dihydro-1-phenyl-5 <i>H</i> -tetrazole-5-thione	1-Phenyl-5-mercapto-1 <i>H</i> -tetrazole	C <sub>7</sub> H <sub>6</sub> N <sub>4</sub> S	86-93-1	178.215		145				
3667	Dihydro-5-propyl-2(3 <i>H</i> )-furanone	γ-Propyl-γ-butyrolactone	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	105-21-5	128.169			84 <sup>5</sup>		1.4385 <sup>25</sup>	
3668	2,3-Dihydro-6-propyl-2-thioxo-4(1 <i>H</i> )-pyrimidinone	Propylthiouracil	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> OS	51-52-5	170.231	w pow (w)	219				sl H <sub>2</sub> O, chl, DMSO, EtOH; i eth, bz
3669	1,7-Dihydro-6 <i>H</i> -purine-6-thione	6-Mercaptopurine	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> S	50-44-2	152.178	ye pr (w, + l w)	313 dec				i H <sub>2</sub> O; s alk
3670	3,4-Dihydro-2 <i>H</i> -pyran		C <sub>6</sub> H <sub>8</sub> O	110-87-2	84.117			86	0.921 <sup>19</sup>	1.4402 <sup>19</sup>	s H <sub>2</sub> O, EtOH; sl chl
3671	3,6-Dihydro-2 <i>H</i> -pyran		C <sub>6</sub> H <sub>8</sub> O	3174-74-1	84.117	liq		95	0.94 <sup>19</sup>		
3672	Dihydro-2 <i>H</i> -pyran-2,6(3 <i>H</i> )-dione		C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	108-55-4	114.100		56.3	158 <sup>15</sup>	1.4110 <sup>20</sup>		
3673	4,5-Dihydro-1 <i>H</i> -pyrazole	2-Pyrazoline	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	109-98-8	70.093			144	1.0200 <sup>17</sup>	1.4796 <sup>17</sup>	vs H <sub>2</sub> O, eth, EtOH
3674	1,2-Dihydro-3,6-pyridazinedione	Maleic hydrazide	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	123-33-1	112.087	cry (w)	307				sl H <sub>2</sub> O, EtOH, tfa
3675	Dihydro-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	5,6-Dihydrouracil	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	504-07-4	114.103	nd (w)	275.5				vs H <sub>2</sub> O; s EtOH, chl, MeOH
3676	2,5-Dihydro-1 <i>H</i> -pyrrole	3-Pyrroline	C <sub>4</sub> H <sub>5</sub> N	109-96-6	69.106			90.5	0.9097 <sup>20</sup>	1.4664 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
3677	3,4-Dihydro-2(1 <i>H</i> )-quinolinone	Hydrocarbostyryl	C <sub>8</sub> H <sub>8</sub> NO	553-03-7	147.173	pr (al, eth)	163.5	201 <sup>45</sup>			vs eth, EtOH
3678	1,4-Dihydro-2,3-quinoxalinedione	2,3-Quinoxalinediol	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	15804-19-0	162.146	nd (w)	410				vs H <sub>2</sub> O; sl EtOH, eth; s bz, DMSO, HOAc
3679	Dihydrotachysterol		C <sub>28</sub> H <sub>46</sub> O	67-96-9	398.664	cry (MeOH)	131				i H <sub>2</sub> O; s os
3680	Dihydrothebaine		C <sub>19</sub> H <sub>23</sub> NO <sub>3</sub>	561-25-1	313.391		162.5				i H <sub>2</sub> O; s EtOH, bz, AcOEt
3681	4,5-Dihydro-2-thiazolamine		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> S	1779-81-3	102.158	nd or lf (bz)	85.3	dec			vs H <sub>2</sub> O, EtOH, bz, chl
3682	2,3-Dihydrothiophene		C <sub>4</sub> H <sub>6</sub> S	1120-59-8	86.156			112.1			
3683	2,5-Dihydrothiophene		C <sub>4</sub> H <sub>6</sub> S	1708-32-3	86.156			122.4			
3684	2,5-Dihydrothiophene 1,1-dioxide	3-Sulfolene	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub> S	77-79-2	118.155		64.5				s chl
3685	Dihydro-2(3 <i>H</i> )-thiophenone		C <sub>4</sub> H <sub>6</sub> OS	1003-10-7	102.155			111 <sup>52</sup> , 39 <sup>1</sup>	1.18 <sup>25</sup>	1.5230 <sup>20</sup>	
3686	Dihydro-2-thioxo-4,6(1 <i>H</i> ,5 <i>H</i> )-pyrimidinedione	2-Thiobarbituric acid	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub> S	504-17-6	144.152	pl (w)	235 dec				sl H <sub>2</sub> O; s EtOH, dil alk, dil HCl
3687	2,3-Dihydro-2-thioxo-4(1 <i>H</i> )-pyrimidinone	2-Thiouracil	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> OS	141-90-2	128.152	pr (w, al)	>340 dec				sl H <sub>2</sub> O, EtOH, DMSO; s anh HF
3688	1,2-Dihydro-3 <i>H</i> -1,2,4-triazole-3-thione		C <sub>2</sub> H <sub>3</sub> N <sub>3</sub> S	3179-31-5	101.130		222.5				s DMSO
3689	(1,3-Dihydro-1,3,3-trimethyl-2 <i>H</i> -indol-2-ylidene)acetaldehyde		C <sub>13</sub> H <sub>12</sub> NO	84-83-3	201.264						s chl

1,3-Dihydro-1-methyl-2*H*-imidazole-2-thione2,3-Dihydro-1-methyl-1*H*-indene3,4-Dihydro-2-methyl-1(2*H*)-naphthalenone4-(4,5-Dihydro-3-methyl-5-oxo-1*H*-pyrazol-1-yl)benzenesulfonic acid1,2-Dihydro-5-methyl-2-phenyl-3*H*-pyrazol-3-one2,4-Dihydro-5-methyl-2-phenyl-3*H*-pyrazol-3-one3,6-Dihydro-4-methyl-2*H*-pyran

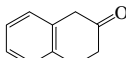
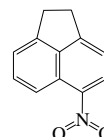
4,5-Dihydro-2-methylthiazole



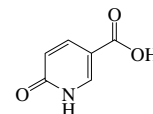
1,2-Dihydronaphthalene



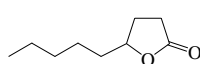
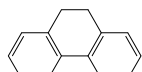
1,4-Dihydronaphthalene

3,4-Dihydro-2(1*H*)-naphthalenone

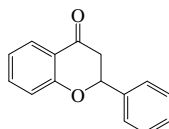
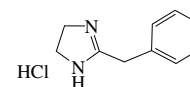
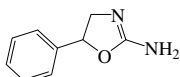
1,2-Dihydro-5-nitroacenaphthylene



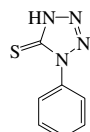
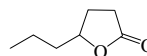
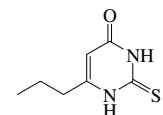
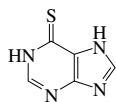
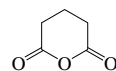
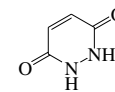
1,6-Dihydro-6-oxo-3-pyridinecarboxylic acid

Dihydro-5-pentyl-2(3*H*)-furanone

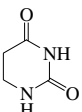
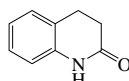
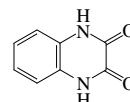
9,10-Dihydrophenanthrene

2,3-Dihydro-2-phenyl-4*H*-1-benzopyran-4-one4,5-Dihydro-2-(phenylmethyl)-1*H*-imidazole, monohydrochloride

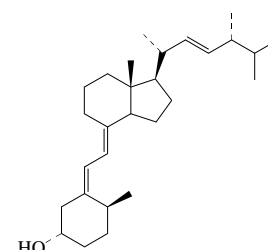
4,5-Dihydro-5-phenyl-2-oxazolamine

1,4-Dihydro-1-phenyl-5*H*-tetrazole-5-thioneDihydro-5-propyl-2(3*H*)-furanone2,3-Dihydro-6-propyl-2-thioxo-4(1*H*)-pyrimidinone1,7-Dihydro-6*H*-purine-6-thione3,4-Dihydro-2*H*-pyran3,6-Dihydro-2*H*-pyranDihydro-2*H*-pyran-2,6(3*H*)-dione4,5-Dihydro-1*H*-pyrazole

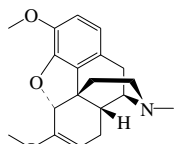
1,2-Dihydro-3,6-pyridazinedione

Dihydro-2,4(1*H*,3*H*)-pyrimidinedione2,5-Dihydro-1*H*-pyrrole3,4-Dihydro-2(1*H*)-quinolinone

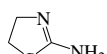
1,4-Dihydro-2,3-quinoxalinedione



Dihydrotachysterol



Dihydrothebaine



4,5-Dihydro-2-thiazolamine



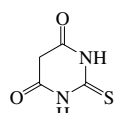
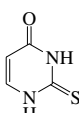
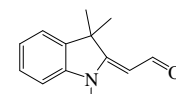
2,3-Dihydrothiophene



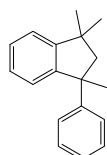
2,5-Dihydrothiophene



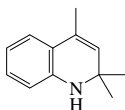
2,5-Dihydrothiophene 1,1-dioxide

Dihydro-2(3*H*)-thiophenoneDihydro-2-thioxo-4,6(1*H*,5*H*)-pyrimidinedione2,3-Dihydro-2-thioxo-4(1*H*)-pyrimidinone1,2-Dihydro-3*H*-1,2,4-triazole-3-thione(1,3-Dihydro-1,3,3-trimethyl-2*H*-indol-2-ylidene)acetaldehyde

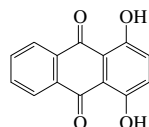
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3690	2,3-Dihydro-1,1,3-trimethyl-3-phenyl-1 <i>H</i> -indene		C <sub>18</sub> H <sub>20</sub>	3910-35-8	236.352	tcl pr (al)	52.5	308.5	1.0009 <sup>20</sup>	1.5681 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, MeOH
3691	1,2-Dihydro-2,2,4-trimethylquinoline		C <sub>12</sub> H <sub>15</sub> N	147-47-7	173.254		26.5	260; 132 <sup>13</sup>			
3692	1,4-Dihydroxy-9,10-anthracenedione	Quinizarin	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	81-64-1	240.212	ye red lf (eth) dk red nd	200				s H <sub>2</sub> O, EtOH, eth, bz, KOH, sulf
3693	1,5-Dihydroxy-9,10-anthracenedione	Anthrarufin	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	117-12-4	240.212	pa ye pl (gl HOAc)	280	sub			i H <sub>2</sub> O; sl EtOH, eth, ace, CS <sub>2</sub> ; s bz
3694	1,8-Dihydroxy-9,10-anthracenedione	Danthron	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	117-10-2	240.212	red or red-ye nd or lf (al)	193	sub			i H <sub>2</sub> O; sl EtOH, eth; s ace, HOAc, alk
3695	2,6-Dihydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	84-60-6	240.212	ye nd (al)	360 dec				sl H <sub>2</sub> O, EtOH; i eth, bz, chl; s alk
3696	2,7-Dihydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	572-93-0	240.212	ye nd (+1w, dil al) nd (sub)	353.8	sub			i H <sub>2</sub> O; s EtOH; sl eth, bz, chl
3697	2,2'-Dihydroxyazobenzene		C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	2050-14-8	214.219	gold-ye lf (bz), nd (al)	173	140 <sup>0.001</sup>			i H <sub>2</sub> O; sl EtOH, bz; vs eth; s con alk
3698	2,3-Dihydroxybenzaldehyde		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	24677-78-9	138.121	ye nd	108	235; 120 <sup>16</sup>			vs ace, EtOH, HOAc
3699	2,4-Dihydroxybenzaldehyde	β-Resorcyllaldehyde	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	95-01-2	138.121	nd (eth-lig)	135	226 <sup>22</sup>			s H <sub>2</sub> O, HOAc; vs EtOH, eth, chl; sl bz
3700	2,5-Dihydroxybenzaldehyde		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	1194-98-5	138.121	ye nd (bz)	100.0				vs H <sub>2</sub> O, EtOH, chl
3701	3,4-Dihydroxybenzaldehyde	Protocatechualdehyde	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	139-85-5	138.121	lf (w, to)	153 dec				s H <sub>2</sub> O; vs EtOH, eth
3702	<i>N</i> ,2'-Dihydroxybenzamide	Salicylhydroxamic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	89-73-6	153.136	nd (HOAc)	168	sub			sl H <sub>2</sub> O, DMSO; vs EtOH, eth; s HOAc
3703	2,5-Dihydroxybenzeneacetic acid	Homogentisic acid	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	451-13-8	168.148	pr (w+1), lf (al-chl)	153				vs H <sub>2</sub> O, EtOH, eth; i bz, chl
3704	2,3-Dihydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	303-38-8	154.121	pr or nd (w+1)	205.5		1.542 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth; sl ace
3705	2,4-Dihydroxybenzoic acid	β-Resorcylic acid	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	89-86-1	154.121	cry (+w)	226 dec				s H <sub>2</sub> O, EtOH, eth, bz; i CS <sub>2</sub>
3706	2,5-Dihydroxybenzoic acid	Gentisic acid	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	490-79-9	154.121	nd or pr (w)	199.5				vs H <sub>2</sub> O, EtOH, eth; s ace; i bz, chl, CS <sub>2</sub>
3707	2,6-Dihydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	303-07-1	154.121	nd (+w)	167 dec				s H <sub>2</sub> O, EtOH, eth; i chl; sl tfa
3708	3,4-Dihydroxybenzoic acid	Protocatechuic acid	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	99-50-3	154.121	mcl nd (w+1)	201 dec		1.524 <sup>4</sup>		sl H <sub>2</sub> O; vs EtOH; s eth; i bz
3709	3,5-Dihydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	99-10-5	154.121	pr or nd	239				sl H <sub>2</sub> O, ace; vs EtOH, eth
3710	2,2'-Dihydroxybenzophenone	Bis(2-hydroxyphenyl) ketone	C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	835-11-0	214.216		59.5	333			i H <sub>2</sub> O; s EtOH, eth, chl
3711	4,4'-Dihydroxybenzophenone	Bis(4-hydroxyphenyl) ketone	C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	611-99-4	214.216	nd (lig), cry (w)	210		1.133 <sup>131</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace; i bz, CS <sub>2</sub>
3712	6,7-Dihydroxy-2 <i>H</i> -1-benzopyran-2-one	Esculetin	C <sub>9</sub> H <sub>6</sub> O <sub>4</sub>	305-01-1	178.142	nd (w), pr (HOAc) lf (sub)	276	sub			sl H <sub>2</sub> O, eth; s EtOH, ace, chl, AcOEt
3713	7,8-Dihydroxy-2 <i>H</i> -1-benzopyran-2-one	Daphnetin	C <sub>9</sub> H <sub>6</sub> O <sub>4</sub>	486-35-1	178.142	ye nd (dil al)	262	sub			s H <sub>2</sub> O, EtOH; sl eth, bz, chl, CS <sub>2</sub>
3714	2,4-Dihydroxybutanoic acid		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	1518-62-3	120.105	liq		96 <sup>3</sup>			
3715	3,6-Dihydroxycholan-24-oic acid, (3α,5β,6α)	Hydoxycholeic acid	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	83-49-8	392.573	cry (AcOEt)	198.5				sl H <sub>2</sub> O, eth, ace, bz; s EtOH, HOAc
3716	3,7-Dihydroxycholan-24-oic acid, (3α,5β,7β)	Ursodiol	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	128-13-2	392.573	pl (al)	203				vs EtOH; sl eth
3717	3,7-Dihydroxycholan-24-oic acid, (3α,5β,7α)	Chenodiol	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	474-25-9	392.573	nd (EtOAc+he p)	119				i H <sub>2</sub> O, bz; vs EtOH, ace; s eth, HOAc
3718	1,25-Dihydroxycholecalciferol	Calcitriol	C <sub>27</sub> H <sub>44</sub> O <sub>3</sub>	32222-06-3	416.636	wh cry pow	115				sl EtOH, MeOH, thf, AcOEt
3719	2,5-Dihydroxy-2,5-cyclohexadiene-1,4-dione		C <sub>6</sub> H <sub>4</sub> O <sub>4</sub>	615-94-1	140.094	dk ye nd	211				sl H <sub>2</sub> O, ace, DMSO; s EtOH, HOAc; i eth



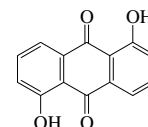
2,3-Dihydro-1,1,3-trimethyl-3-phenyl-1H-indene



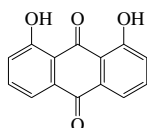
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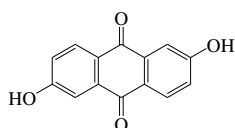
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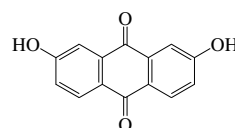
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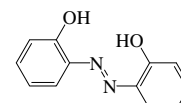
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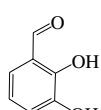
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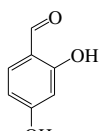
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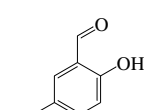
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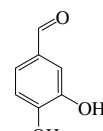
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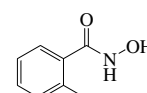
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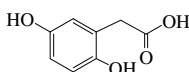
2,5-Dihydroxybenzaldehyde



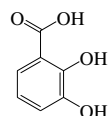
3,4-Dihydroxybenzaldehyde



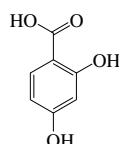
N,2-Dihydroxybenzamide



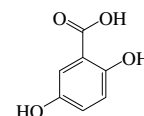
2,5-Dihydroxybenzeneacetic acid



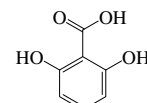
2,3-Dihydroxybenzoic acid



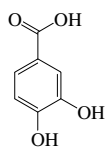
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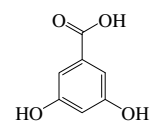
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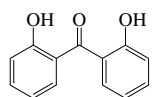
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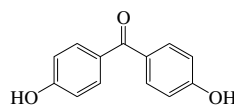
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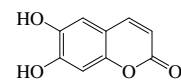
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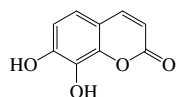
2,2'-Dihydroxybenzophenone



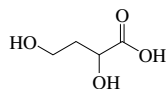
4,4'-Dihydroxybenzophenone



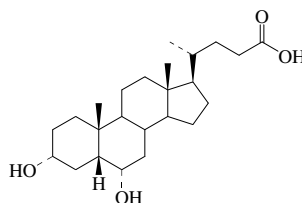
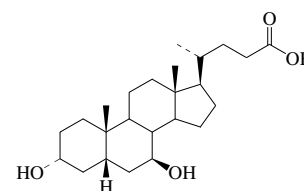
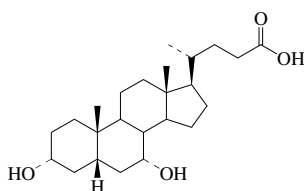
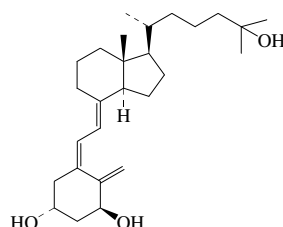
6,7-Dihydroxy-2H-1-benzopyran-2-one



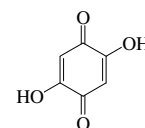
7,8-Dihydroxy-2H-1-benzopyran-2-one



2,4-Dihydroxybutanoic acid

3,6-Dihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,6 $\alpha$ )3,7-Dihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,7 $\beta$ )3,7-Dihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,7 $\alpha$ )

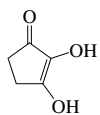
1,25-Dihydroxycholecalciferol



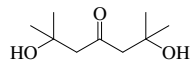
2,5-Dihydroxy-2,5-cyclohexadiene-1,4-dione

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3720	2,3-Dihydroxy-2-cyclopenten-1-one	Reductic acid	C <sub>5</sub> H <sub>6</sub> O <sub>3</sub>	80-72-8	114.100		212				s H <sub>2</sub> O, EtOH; sl eth, ace, AcOEt; i bz
3721	2,6-Dihydroxy-2,6-dimethyl-4-heptanone	Di(2-hydroxy-2-methylpropyl) ketone	C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	3682-91-5	174.237	pale ye cry					
3722	2,2'-Dihydroxydiphenylmethane	2,2'-Methylenebisphenol	C <sub>13</sub> H <sub>12</sub> O <sub>2</sub>	2467-02-9	200.233		118.3	363	1.280 <sup>25</sup>		
3723	4,4'-Dihydroxydiphenyl sulfide	4,4'-Thiobisphenol	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub> S	2664-63-3	218.271	mcl pr or lf (al)	151				sl H <sub>2</sub> O, EtOH, eth, CS <sub>2</sub>
3724	1,8-Dihydroxy-3-(hydroxymethyl)-9,10-anthracenedione	Aloe-emodol	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	481-72-1	270.237	oran ye nd (to, al)	223.5	sub			vs bz, eth, EtOH
3725	2,3-Dihydroxymaleic acid	Dihydroxymaleic acid	C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	526-84-1	148.071	pl (w+2)	155 dec				sl H <sub>2</sub> O, eth, MeOH; s EtOH
3726	α,4-Dihydroxy-3-methoxybenzeneacetic acid	Vanilmandelic acid	C <sub>9</sub> H <sub>10</sub> O <sub>5</sub>	55-10-7	198.172	sc (bz-eth)	132 dec				vs H <sub>2</sub> O, ace, eth
3727	7,8-Dihydroxy-6-methoxy-2 <i>H</i> -1-benzopyran-2-one	Fraxetin	C <sub>10</sub> H <sub>6</sub> O <sub>5</sub>	574-84-5	208.168	pl (dil al)	231				vs EtOH
3728	5,7-Dihydroxy-3-(4-methoxyphenyl)-4 <i>H</i> -1-benzopyran-4-one		C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	491-80-5	284.263		214.8				
3729	(2,6-Dihydroxy-4-methoxyphenyl) phenylmethanone	Cotoin	C <sub>14</sub> H <sub>12</sub> O <sub>4</sub>	479-21-0	244.243	ye pr (chl) lf or nd (w)	130.5				vs ace, bz, eth, EtOH
3730	1,7-Dihydroxy-3-methoxy-9 <i>H</i> -xanthen-9-one	Gentisin	C <sub>14</sub> H <sub>10</sub> O <sub>5</sub>	437-50-3	258.226	ye orth	266.5				i H <sub>2</sub> O; vs EtOH; i ace; s py
3731	1,8-Dihydroxy-3-methyl-9,10-anthracenedione	Chrysophanic acid	C <sub>15</sub> H <sub>10</sub> O <sub>4</sub>	481-74-3	254.238	ye hex or mcl nd (sub)	196	sub	0.92 <sup>25</sup>		vs bz, HOAc
3732	2,4-Dihydroxy-6-methylbenzoic acid	<i>o</i> -Orsellinic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	480-64-8	168.148	nd (dil HOAc, +1w)	176 dec				s EtOH, eth
3733	5,7-Dihydroxy-4-methyl-2 <i>H</i> -1-benzopyran-2-one		C <sub>10</sub> H <sub>6</sub> O <sub>4</sub>	2107-76-8	192.169	nd (al), lf (HOAc)	283				sl H <sub>2</sub> O, eth, bz, chl; vs EtOH, alk
3734	6,7-Dihydroxy-4-methyl-2 <i>H</i> -1-benzopyran-2-one		C <sub>10</sub> H <sub>6</sub> O <sub>4</sub>	529-84-0	192.169	ye nd (dil al)	275				s H <sub>2</sub> O, EtOH, HOAc
3735	5,8-Dihydroxy-1,4-naphthalenedione		C <sub>10</sub> H <sub>6</sub> O <sub>4</sub>	475-38-7	190.153	dk red mcl pr (bz) red-br nd (al)	232	sub			sl H <sub>2</sub> O, EtOH, eth; s HOAc
3736	4,5-Dihydroxy-2,7-naphthalenedisulfonic acid	Chromotropic acid	C <sub>10</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	148-25-4	320.296	nd or lf (w+2)					s H <sub>2</sub> O, alk; i EtOH, eth
3737	5,6-Dihydroxynaphtho[2,3- <i>f</i> ]quinoline-7,12-dione	Alizarin Blue	C <sub>17</sub> H <sub>9</sub> NO <sub>4</sub>	568-02-5	291.258	br-viol nd (bz)	269				vs bz, gl HOAc
3738	1,2-Dihydroxy-3-nitro-9,10-anthracenedione	Alizarin Orange	C <sub>14</sub> H <sub>7</sub> NO <sub>6</sub>	568-93-4	285.209	oran nd or pl (HOAc)	244 dec	sub			sl H <sub>2</sub> O; s EtOH, bz, chl, sulf, HOAc
3739	9,10-Dihydroxyoctadecanedioic acid, ( <i>R</i> *, <i>R</i> ')-(±)	Phloionic acid	C <sub>18</sub> H <sub>34</sub> O <sub>6</sub>	23843-52-9	346.459	cry (al)	126				
3740	9,10-Dihydroxyoctadecanoic acid	9,10-Dihydroxystearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>4</sub>	120-87-6	316.477		90				i H <sub>2</sub> O; sl EtOH, eth
3741	5,7-Dihydroxy-2-phenyl-4 <i>H</i> -1-benzopyran-4-one	Chrysin	C <sub>15</sub> H <sub>10</sub> O <sub>4</sub>	480-40-0	254.238	lf ye pr (MeOH)	285.5				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz, CS <sub>2</sub>
3742	1-(2,4-Dihydroxyphenyl)ethanone	Resacetophenone	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	89-84-9	152.148	nd or lf	146		1.18 <sup>141</sup>		i H <sub>2</sub> O, chl; s EtOH, py; sl eth, bz
3743	(2,4-Dihydroxyphenyl) phenylmethanone	Benzoescorcinol	C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	131-56-6	214.216	nd (w)	144				i H <sub>2</sub> O; s EtOH; vs eth; sl bz, chl
3744	3-(3,4-Dihydroxyphenyl)-2-propenoic acid	Caffeic acid	C <sub>9</sub> H <sub>6</sub> O <sub>4</sub>	331-39-5	180.158	ye pr, pl (w)	225 dec				vs EtOH
3745	Dihydroxyphenylstibine oxide	Benzenestibonic acid	C <sub>6</sub> H <sub>4</sub> O <sub>3</sub> Sb	535-46-6	248.878	nd (HOAc)	139				
3746	17,21-Dihydroxypregna-1,4-diene-3,11,20-trione	Prednisone	C <sub>21</sub> H <sub>26</sub> O <sub>5</sub>	53-03-2	358.428		234 dec				
3747	17,21-Dihydroxypregna-4-ene-3,20-dione	11-Deoxy-17-hydrocorticosterone	C <sub>21</sub> H <sub>30</sub> O <sub>4</sub>	152-58-9	346.461		215				vs ace, EtOH, chl
3748	17,21-Dihydroxypregna-4-ene-3,11,20-trione	Cortisone	C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	53-06-5	360.444		222				sl H <sub>2</sub> O, eth, bz, chl; s EtOH, ace
3749	2,3-Dihydroxypropanal, (±)		C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	56-82-6	90.078	nd or pr (40% MeOH)	145	145 <sup>0,8</sup>	1.453 <sup>18</sup>		s H <sub>2</sub> O; sl EtOH, eth; i bz, peth, lig
3750	2,3-Dihydroxypropanoic acid, ( <i>R</i> )	Glyceric acid	C <sub>3</sub> H <sub>6</sub> O <sub>4</sub>	6000-40-4	106.078	thick gum		dec			
3751	1,3-Dihydroxy-2-propanone	Dihydroxyacetone	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	96-26-4	90.078		90				s H <sub>2</sub> O, EtOH, eth, ace; i lig
3752	2,3-Dihydroxypropyl decanoate	Decanoic acid glycerol monoester	C <sub>13</sub> H <sub>26</sub> O <sub>4</sub>	2277-23-8	246.343	pr (peth)	53				
3753	2,3-Dihydroxypropyl octanoate	Octanoic acid glycerol monoester	C <sub>11</sub> H <sub>22</sub> O <sub>4</sub>	26402-26-6	218.291	cry (peth)	40				

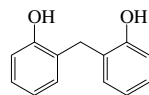




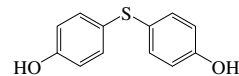
2,3-Dihydroxy-2-cyclopenten-1-one



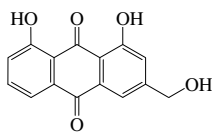
2,6-Dihydroxy-2,6-dimethyl-4-heptanone



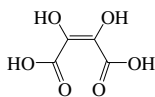
2,2'-Dihydroxydiphenylmethane



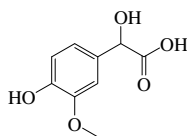
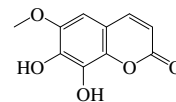
4,4'-Dihydroxydiphenyl sulfide



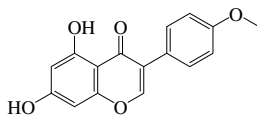
1,8-Dihydroxy-3-(hydroxymethyl)-9,10-anthracenedione



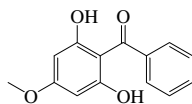
2,3-Dihydroxymaleic acid

 $\alpha$ ,4-Dihydroxy-3-methoxybenzeneacetic acid

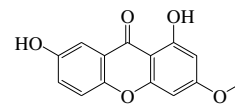
7,8-Dihydroxy-6-methoxy-2H-1-benzopyran-2-one



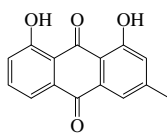
5,7-Dihydroxy-3-(4-methoxyphenyl)-4H-1-benzopyran-4-one



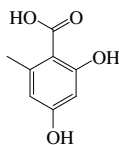
(2,6-Dihydroxy-4-methoxyphenyl)phenylmethanone



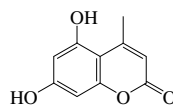
1,7-Dihydroxy-3-methoxy-9H-xanthen-9-one



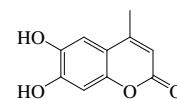
1,8-Dihydroxy-3-methyl-9,10-anthracenedione



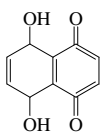
2,4-Dihydroxy-6-methylbenzoic acid



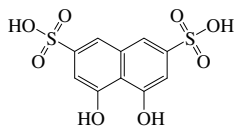
5,7-Dihydroxy-4-methyl-2H-1-benzopyran-2-one



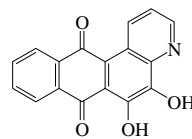
6,7-Dihydroxy-4-methyl-2H-1-benzopyran-2-one



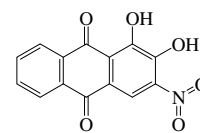
5,8-Dihydroxy-1,4-naphthalenedione



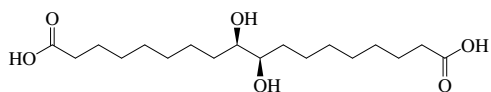
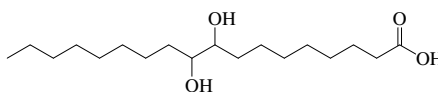
4,5-Dihydroxy-2,7-naphthalenedisulfonic acid



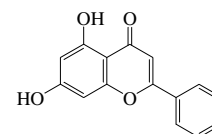
5,6-Dihydroxynaphtho[2,3-f]quinoline-7,12-dione



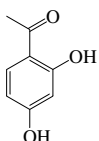
1,2-Dihydroxy-3-nitro-9,10-anthracenedione

9,10-Dihydroxyoctadecanedioic acid, (*R*\*, *R*\*)-(±)

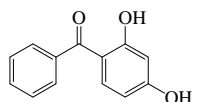
9,10-Dihydroxyoctadecanoic acid



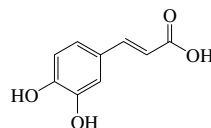
5,7-Dihydroxy-2-phenyl-4H-1-benzopyran-4-one



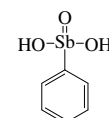
1-(2,4-Dihydroxyphenyl)ethanone



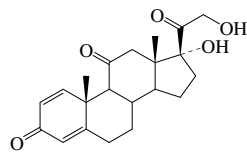
(2,4-Dihydroxyphenyl)phenylmethanone



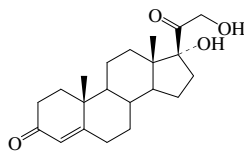
3-(3,4-Dihydroxyphenyl)-2-propenoic acid



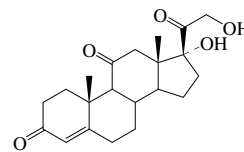
Dihydroxyphenylstibine oxide



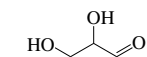
17,21-Dihydroxypregna-1,4-diene-3,11,20-trione



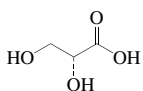
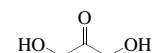
17,21-Dihydroxypregn-4-ene-3,20-dione



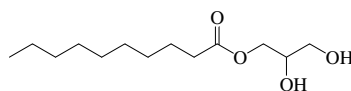
17,21-Dihydroxypregn-4-ene-3,11,20-trione



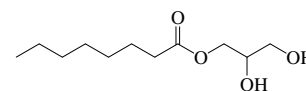
2,3-Dihydroxypropanal, (±)

2,3-Dihydroxypropanoic acid, (*R*)

1,3-Dihydroxy-2-propanone

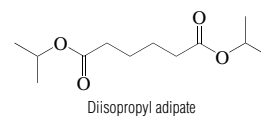
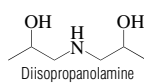
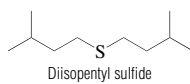
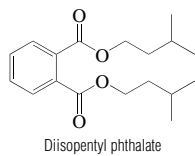
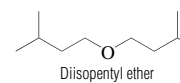
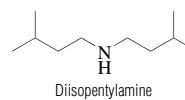
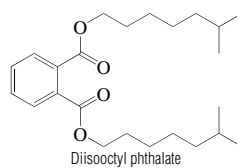
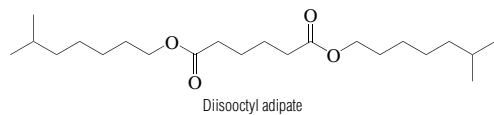
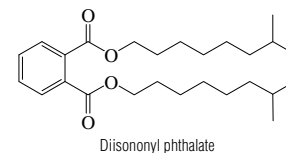
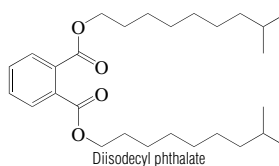
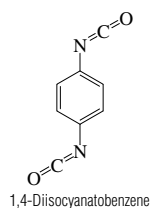
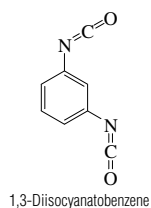
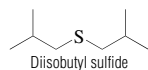
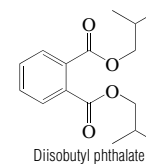
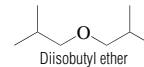
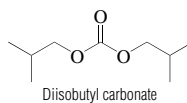
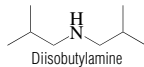
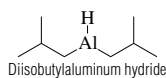
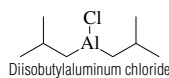
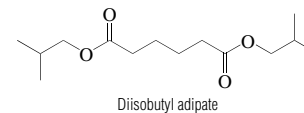
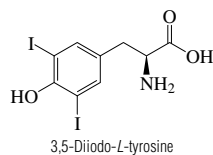
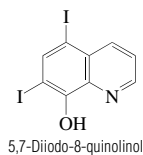
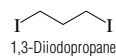
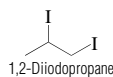
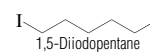
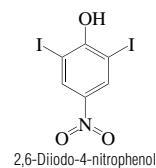
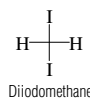
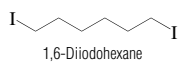
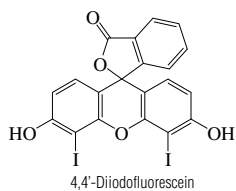
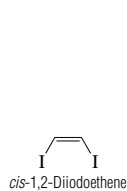
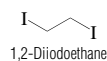
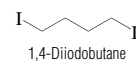
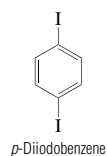
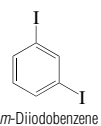
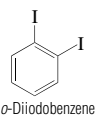
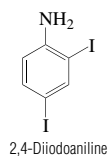
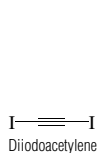
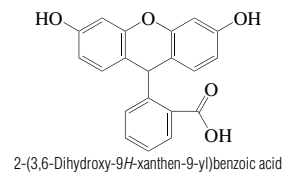
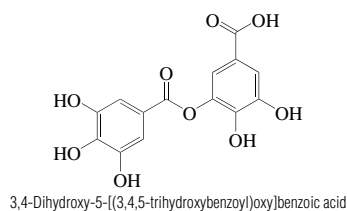
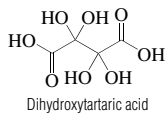
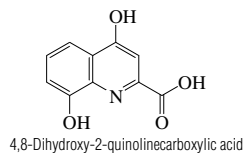


2,3-Dihydroxypropyl decanoate

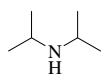


2,3-Dihydroxypropyl octanoate

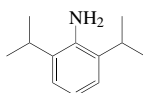
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3754	4,8-Dihydroxy-2-quinolinecarboxylic acid	Xanthurenic acid	C <sub>10</sub> H <sub>7</sub> NO <sub>4</sub>	59-00-7	205.168	ye micry cry (w)	289				i H <sub>2</sub> O; s EtOH, dil HCl; sl eth, bz
3755	Dihydroxytartaric acid		C <sub>4</sub> H <sub>6</sub> O <sub>8</sub>	76-30-2	182.086		114.5				
3756	3,4-Dihydroxy-5-[(3,4,5-trihydroxybenzoyl)oxy]benzoic acid	Digallic acid	C <sub>14</sub> H <sub>10</sub> O <sub>9</sub>	536-08-3	322.224	nf (dil al + 1w)	269 dec				vs ace, EtOH
3757	2-(3,6-Dihydroxy-9H-xanthen-9-yl)benzoic acid	Fluorescein	C <sub>20</sub> H <sub>14</sub> O <sub>5</sub>	518-44-5	334.322	col or ye nd (eth), pl (bz)	126				i H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc
3758	Diiodoacetylene		C <sub>2</sub> I <sub>2</sub>	624-74-8	277.830	orth nd (lig)	81.5	exp			vs ace, bz, eth, EtOH
3759	2,4-Diiodoaniline		C <sub>6</sub> H <sub>3</sub> I <sub>2</sub> N	533-70-0	344.920	br nd or orth cry (al)	95.5		2.748 <sup>25</sup>		vs ace, bz, eth, EtOH
3760	<i>o</i> -Diiodobenzene	1,2-Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	615-42-9	329.905	pl or pr (lig)	27	287; 100 <sup>3</sup>	2.54 <sup>20</sup>	1.7179 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH
3761	<i>m</i> -Diiodobenzene	1,3-Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	626-00-6	329.905	orth pl or pr (eth-al)	40.4	285	2.47 <sup>25</sup>		i H <sub>2</sub> O; vs eth, EtOH, chl
3762	<i>p</i> -Diiodobenzene	1,4-Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	624-38-4	329.905	orth lf (al)	131.5	285			i H <sub>2</sub> O; s EtOH; vs eth; sl chl
3763	1,4-Diiodobutane		C <sub>4</sub> H <sub>8</sub> I <sub>2</sub>	628-21-7	309.916		5.8	125 <sup>15</sup> dec	2.3494 <sup>25</sup>	1.6184 <sup>25</sup>	i H <sub>2</sub> O; sl ctc; s os
3764	1,2-Diiodoethane		C <sub>2</sub> H <sub>4</sub> I <sub>2</sub>	624-73-7	281.862	ye mcl pr or orth (eth)	83	200	3.325 <sup>20</sup>	1.871 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, chl
3765	<i>cis</i> -1,2-Diiodoethene	<i>cis</i> -1,2-Diiodoethylene	C <sub>2</sub> H <sub>2</sub> I <sub>2</sub>	590-26-1	279.846		-14	72.5 <sup>16</sup>	3.0625 <sup>20</sup>		i H <sub>2</sub> O; s eth, chl
3766	4,4'-Diiodofluorescein		C <sub>20</sub> H <sub>10</sub> I <sub>2</sub> O <sub>5</sub>	38577-97-8	584.099	oran-red pow					sl H <sub>2</sub> O; s alk, EtOH
3767	1,6-Diiodohexane	Hexamethylene diiodide	C <sub>6</sub> H <sub>12</sub> I <sub>2</sub>	629-09-4	337.968	nd	9.5	163 <sup>17</sup> , 141 <sup>10</sup>	2.0342 <sup>25</sup>	1.5837 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, eth
3768	Diiodomethane	Methylene iodide	CH <sub>2</sub> I <sub>2</sub>	75-11-6	267.836	ye nd or lf	6.1	182	3.3211 <sup>20</sup>	1.7411 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz, chl
3769	2,6-Diiodo-4-nitrophenol	Disophenol	C <sub>6</sub> H <sub>3</sub> I <sub>2</sub> NO <sub>3</sub>	305-85-1	390.902	lt ye cry (gl HOAc)	157				vs EtOH
3770	1,5-Diiodopentane	Pentamethylene diiodide	C <sub>5</sub> H <sub>10</sub> I <sub>2</sub>	628-77-3	323.942		9	149 <sup>20</sup> , 101 <sup>3</sup>	2.1692 <sup>25</sup>	1.5987 <sup>25</sup>	i H <sub>2</sub> O; s eth, chl
3771	1,2-Diiodopropane		C <sub>3</sub> H <sub>6</sub> I <sub>2</sub>	598-29-8	295.889				2.490 <sup>18</sup>		vs eth, EtOH
3772	1,3-Diiodopropane	Trimethylene diiodide	C <sub>3</sub> H <sub>6</sub> I <sub>2</sub>	627-31-6	295.889		-20	dec 227; 110 <sup>19</sup>	2.5612 <sup>25</sup>	1.6391 <sup>25</sup>	i H <sub>2</sub> O; s eth, ctc, chl
3773	5,7-Diiodo-8-quinolinol	Iodoquinol	C <sub>9</sub> H <sub>5</sub> I <sub>2</sub> NO	83-73-8	396.951	ye nd (HOAc, xyl)	210				sl H <sub>2</sub> O, bz, chl, eth; vs EtOH; s alk
3774	3,5-Diiodo- <i>L</i> -tyrosine		C <sub>9</sub> H <sub>9</sub> I <sub>2</sub> NO <sub>3</sub>	300-39-0	432.981	ye nd (w, 70% al)	213				sl H <sub>2</sub> O; i EtOH, eth, bz
3775	Diisobutyl adipate		C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	141-04-8	258.354			293; 187 <sup>15</sup>	0.9543 <sup>19</sup>	1.4301 <sup>20</sup>	
3776	Diisobutylaluminum chloride		C <sub>8</sub> H <sub>16</sub> AlCl	1779-25-5	176.664	hyg col liq	-40	152 <sup>10</sup>	0.905	1.4506 <sup>20</sup>	s eth, hx
3777	Diisobutylaluminum hydride		C <sub>8</sub> H <sub>16</sub> Al	1191-15-7	142.219	liq		140 <sup>4</sup> , 85 <sup>0.5</sup>			s cyhex, eth, bz, tol
3778	Diisobutylamine	2-Methyl- <i>N</i> -(2-methylpropyl)-1-propanamine	C <sub>8</sub> H <sub>17</sub> N	110-96-3	129.244	liq	-73.5	139.6		1.4090 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace, bz
3779	Diisobutyl carbonate		C <sub>9</sub> H <sub>18</sub> O <sub>3</sub>	539-92-4	174.237			190	0.9138 <sup>20</sup>	1.4072 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
3780	Diisobutyl ether	1,1'-Oxybis[2-methylpropane]	C <sub>8</sub> H <sub>18</sub> O	628-55-7	130.228			122.6	0.761 <sup>15</sup>		i H <sub>2</sub> O; msc EtOH, eth
3781	Diisobutyl phthalate		C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	84-69-5	278.344			296.5; 159 <sup>4</sup>	1.0490 <sup>15</sup>		s ctc
3782	Diisobutyl sulfide		C <sub>8</sub> H <sub>18</sub> S	592-65-4	146.294	liq	-105.5	171	0.8363 <sup>10</sup>		
3783	1,3-Diisocyanatobenzene		C <sub>8</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	123-61-5	160.130	cry	51	103 <sup>8</sup>			
3784	1,4-Diisocyanatobenzene		C <sub>8</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	104-49-4	160.130	cry	95	117 <sup>14</sup>			
3785	Diisodecyl phthalate	Bis(8-methylnonyl)phthalate	C <sub>28</sub> H <sub>46</sub> O <sub>4</sub>	26761-40-0	446.663	liq	-50	253 <sup>4</sup>	0.966 <sup>20</sup>		i H <sub>2</sub> O; s os
3786	Diisononyl phthalate	Bis(7-methyloctyl)phthalate	C <sub>26</sub> H <sub>42</sub> O <sub>4</sub>	28553-12-0	418.609	col liq					i H <sub>2</sub> O; s ace, MeOH; bz, eth
3787	Diisoctyl adipate		C <sub>22</sub> H <sub>42</sub> O <sub>4</sub>	1330-86-5	370.566			210 <sup>4</sup>			
3788	Diisoctyl phthalate		C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	27554-26-3	390.557			370			
3789	Diisopentylamine	3-Methyl- <i>N</i> -isopentyl-1-butanamine	C <sub>10</sub> H <sub>23</sub> N	544-00-3	157.297	liq	-44	188	0.7672 <sup>21</sup>	1.4235 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth
3790	Diisopentyl ether	Diisoamyl ether	C <sub>10</sub> H <sub>22</sub> O	544-01-4	158.281			172.5	0.7777 <sup>20</sup>	1.4085 <sup>20</sup>	i H <sub>2</sub> O; vs ace, EtOH, chl
3791	Diisopentyl phthalate	Diisoamyl phthalate	C <sub>18</sub> H <sub>26</sub> O <sub>4</sub>	605-50-5	306.397			dec 334	1.0209 <sup>16</sup>	1.4871 <sup>20</sup>	vs EtOH
3792	Diisopentyl sulfide		C <sub>10</sub> H <sub>22</sub> S	544-02-5	174.347	liq	-74.6	211	0.8323 <sup>20</sup>	1.4520 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; vs eth
3793	Diisopropanolamine	1,1'-Iminobis-2-propanol	C <sub>6</sub> H <sub>15</sub> NO <sub>2</sub>	110-97-4	133.189	cry	44.5	250; 151 <sup>23</sup>	0.989 <sup>20</sup>		s H <sub>2</sub> O, EtOH; sl eth
3794	Diisopropyl adipate		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	6938-94-9	230.301		-0.6	120 <sup>6.5</sup>	0.9569 <sup>20</sup>	1.4247 <sup>20</sup>	vs ace, eth, EtOH



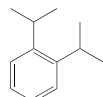
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3795	Diisopropylamine	<i>N</i> -Isopropyl-2-propanamine	C <sub>6</sub> H <sub>15</sub> N	108-18-9	101.190	liq	-61	83.9	0.7153 <sup>20</sup>	1.3924 <sup>20</sup>	vs ace, bz, eth, EtOH
3796	2,6-Diisopropylaniline		C <sub>12</sub> H <sub>19</sub> N	24544-04-5	177.286	liq	-45	257	0.94 <sup>25</sup>	1.5332 <sup>20</sup>	
3797	1,2-Diisopropylbenzene		C <sub>12</sub> H <sub>18</sub>	577-55-9	162.271	liq	-57	204	0.8701 <sup>20</sup>	1.4960 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
3798	1,3-Diisopropylbenzene		C <sub>12</sub> H <sub>18</sub>	99-62-7	162.271	liq	-63.1	203.2	0.8559 <sup>20</sup>	1.4883 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
3799	1,4-Diisopropylbenzene		C <sub>12</sub> H <sub>18</sub>	100-18-5	162.271	liq	-17	210.3	0.8568 <sup>20</sup>	1.4898 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, ctc
3800	<i>p</i> -Diisopropylbenzene hydroperoxide		C <sub>12</sub> H <sub>18</sub> O <sub>2</sub>	98-49-7	194.270	waxy cry	30.1	123 <sup>1</sup>	0.9932 <sup>20</sup>		i H <sub>2</sub> O
3801	<i>N,N</i> -Diisopropyl-2-benzothiazolesulfenamide		C <sub>13</sub> H <sub>18</sub> N <sub>2</sub> S <sub>2</sub>	95-29-4	266.425		59.0				
3802	<i>N,N'</i> -Diisopropylcarbodiimide		C <sub>7</sub> H <sub>14</sub> N <sub>2</sub>	693-13-0	126.199			147	0.806 <sup>25</sup>	1.4320 <sup>20</sup>	
3803	Diisopropyl disulfide		C <sub>6</sub> H <sub>14</sub> S <sub>2</sub>	4253-89-8	150.305	liq	-69	177	0.9435 <sup>20</sup>	1.4916 <sup>20</sup>	
3804	<i>N,N</i> -Diisopropylethanolamine	<i>N,N</i> -Diisopropyl-2-aminoethanol	C <sub>8</sub> H <sub>19</sub> NO	96-80-0	145.243			190	0.826 <sup>25</sup>	1.4417 <sup>20</sup>	
3805	Diisopropyl ether	Isopropyl ether	C <sub>6</sub> H <sub>14</sub> O	108-20-3	102.174	liq	-85.4	68.4	0.7192 <sup>25</sup>	1.3658 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
3806	Diisopropyl methylphosphonate		C <sub>7</sub> H <sub>17</sub> O <sub>3</sub> P	1445-75-6	180.182			66 <sup>3</sup>		1.4120 <sup>18</sup>	
3807	2,6-Diisopropylphthalene		C <sub>16</sub> H <sub>20</sub>	24157-81-1	212.330	cry (MeOH)	70				
3808	Diisopropyl oxalate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	615-81-6	174.195			190	1.002 <sup>20</sup>	1.4100 <sup>20</sup>	vs eth, EtOH
3809	Diisopropyl phosphonate		C <sub>6</sub> H <sub>13</sub> O <sub>3</sub> P	1809-20-7	166.155			97 <sup>40</sup> , 76 <sup>10</sup>	0.9970 <sup>18</sup>		
3810	<i>O,O</i> -Diisopropyl phosphorodithioate		C <sub>6</sub> H <sub>15</sub> O <sub>2</sub> PS <sub>2</sub>	107-56-2	214.286	liq		71 <sup>3</sup>	1.09 <sup>20</sup>		s EtOH, bz, ace, ctc, chl
3811	Diisopropyl phthalate	1,2-Benzenedicarboxylic acid, diisopropyl ester	C <sub>14</sub> H <sub>18</sub> O <sub>4</sub>	605-45-8	250.291			130 <sup>12</sup>	1.0615 <sup>15</sup>	1.4900 <sup>20</sup>	
3812	Diisopropyl sulfide		C <sub>6</sub> H <sub>14</sub> S	625-80-9	118.240	liq	-78.1	120.0	0.8142 <sup>20</sup>	1.4438 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3813	Diisopropyl tartrate, (±)		C <sub>10</sub> H <sub>18</sub> O <sub>6</sub>	58167-01-4	234.246		34	275; 154 <sup>12</sup>	1.1166 <sup>20</sup>		vs ace, eth, EtOH
3814	Diisopropyl thioperoxydicarbonate	Diisopropyl dioxanthogen	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub> S <sub>4</sub>	105-65-7	270.456		52				s chl
3815	1,4-Diisothiocyanatobenzene	Bitoscanate	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> S <sub>2</sub>	4044-65-9	192.261	nd (ace, HOAc)	132				
3816	Diketene		C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	674-82-8	84.074	liq	-6.5	126.1	1.0877 <sup>20</sup>	1.4379 <sup>20</sup>	
3817	Dilactic acid	2,2'-Oxybispropanoic acid	C <sub>6</sub> H <sub>10</sub> O <sub>5</sub>	19201-34-4	162.140	orth	112.5				vs H <sub>2</sub> O, eth
3818	Dimetline		C <sub>20</sub> H <sub>21</sub> NO <sub>3</sub>	1165-48-6	323.386		109.5				s chl
3819	Dimetfox	Tetramethylphosphorodiamidic fluoride	C <sub>4</sub> H <sub>12</sub> FN <sub>2</sub> OP	115-26-4	154.122	liq		86 <sup>15</sup>	1.1151 <sup>20</sup>	1.4267 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth
3820	Dimemorfan	3,17-Dimethylmorphinan, (9α,13α,14α)-	C <sub>18</sub> H <sub>25</sub> N	36309-01-0	255.399	ye oil	92	133 <sup>0,3</sup>			
3821	2,3-Dimercaptobutanedioic acid		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub> S <sub>2</sub>	2418-14-6	182.219	wh cry (MeOH)	193				
3822	1,4-Dimercapto-2,3-butanediol		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S <sub>2</sub>	7634-42-6	154.251		42.5				s chl
3823	2,2'-Dimercaptodiethyl ether	2-Mercaptoethyl ether	C <sub>6</sub> H <sub>10</sub> OS <sub>2</sub>	2150-02-9	138.251	liq	-80	217; 64 <sup>2</sup>	1.114 <sup>20</sup>		
3824	2,3-Dimercapto-1-propanol	Dimercaprol	C <sub>3</sub> H <sub>8</sub> OS <sub>2</sub>	59-52-9	124.225			83 <sup>0,8</sup>	1.2463 <sup>20</sup>	1.5749 <sup>20</sup>	s EtOH, eth, oils; sl chl
3825	Dimetan®		C <sub>11</sub> H <sub>17</sub> NO <sub>3</sub>	122-15-6	211.258	cry	46	175 <sup>11</sup>			s H <sub>2</sub> O, cyhex; vs EtOH, eth, ace
3826	Dimethipin	2,3-Dihydro-5,6-dimethyl-1,4-dithiin, 1,1,4,4-tetraoxide	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub> S <sub>2</sub>	55290-64-7	210.271		165				
3827	Dimethirimol	5-Butyl-2-(dimethylamino)-6-methylpyrimidin-4(1 <i>H</i> )-one	C <sub>11</sub> H <sub>19</sub> N <sub>3</sub> O	5221-53-4	209.288	nd	102				sl H <sub>2</sub> O; vs chl, xyl; s EtOH, ace
3828	Dimethisoquin	2-[(3-Butyl-1-isoquinolinyl)oxy]- <i>N,N</i> -dimethylethanamine	C <sub>17</sub> H <sub>24</sub> N <sub>2</sub> O	86-80-6	272.385		146	156 <sup>3</sup>		1.5486 <sup>20</sup>	s H <sub>2</sub> O, EtOH
3829	Dimethoxane	2,6-Dimethyl-1,3-dioxan-4-ol acetate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	828-00-2	174.195	liq		86 <sup>10</sup>	1.0655 <sup>20</sup>	1.4310 <sup>20</sup>	msc H <sub>2</sub> O; s os
3830	2',5'-Dimethoxyacetophenone		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	1201-38-3	180.200	cry	21	156 <sup>14</sup>	1.139	1.5441 <sup>20</sup>	
3831	1,2-Dimethoxy-4-allylbenzene		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	93-15-2	178.228	liq	-2.0	254.7	1.0396 <sup>20</sup>	1.5340 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
3832	4,7-Dimethoxy-5-allyl-1,3-benzodioxole	Apiole	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	523-80-8	222.237	nd	29.5	294; 179 <sup>35</sup>	1.015 <sup>20</sup>	1.5360 <sup>20</sup>	vs ace, bz, EtOH, lig
3833	2,4-Dimethoxyaniline		C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	2735-04-8	153.179	pl (lig)	33.5	262.0			sl H <sub>2</sub> O, chl; s EtOH, eth, bz, lig
3834	2,5-Dimethoxyaniline		C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	102-56-7	153.179		82.5	270			s H <sub>2</sub> O, EtOH, chl, lig
3835	3,4-Dimethoxyaniline		C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	6315-89-5	153.179	lf (eth)	87.5	159 <sup>14</sup>			s eth, chl



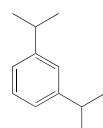
Diisopropylamine



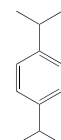
2,6-Diisopropylaniline



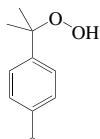
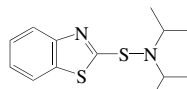
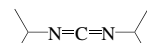
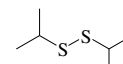
1,2-Diisopropylbenzene



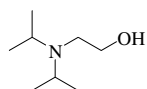
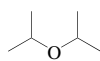
1,3-Diisopropylbenzene



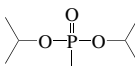
1,4-Diisopropylbenzene

*p*-Diisopropylbenzene hydroperoxide*N,N*-Diisopropyl-2-benzothiazolesulfenamide*N,N'*-Diisopropylcarbodiimide

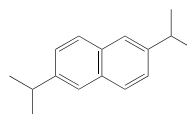
Diisopropyl disulfide

*N,N*-Diisopropylethanolamine

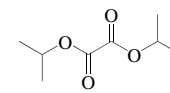
Diisopropyl ether



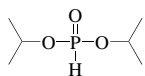
Diisopropyl methylphosphonate



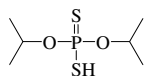
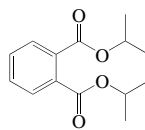
2,6-Diisopropyl-naphthalene



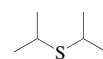
Diisopropyl oxalate



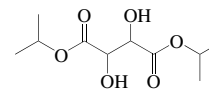
Diisopropyl phosphonate

*O,O*-Diisopropyl phosphorodithioate

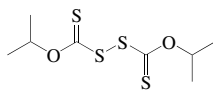
Diisopropyl phthalate



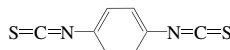
Diisopropyl sulfide



Diisopropyl tartrate, (+)



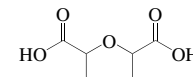
Diisopropyl thioperoxydicarbonate



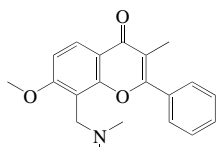
1,4-Diisothiocyanatobenzene



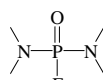
Diketene



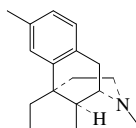
Dilactic acid



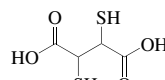
Dimetiline



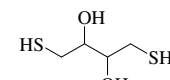
Dimetox



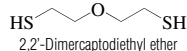
Dimormoran



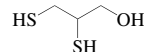
2,3-Dimercaptobutanedioic acid



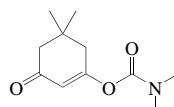
1,4-Dimercapto-2,3-butanediol



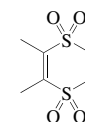
2,2'-Dimercaptodiethyl ether



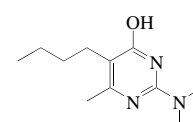
2,3-Dimercapto-1-propanol



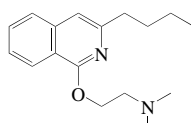
Dimetan®



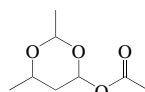
Dimethipin



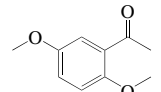
Dimethirimol



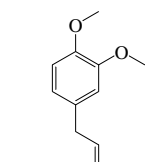
Dimethisoquin



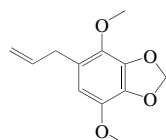
Dimethoxane



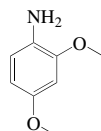
2',5'-Dimethoxyacetophenone



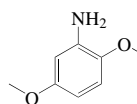
1,2-Dimethoxy-4-allylbenzene



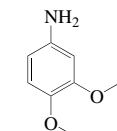
4,7-Dimethoxy-5-allyl-1,3-benzodioxole



2,4-Dimethoxyaniline

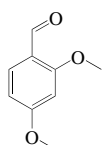


2,5-Dimethoxyaniline

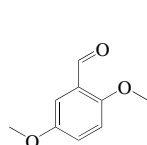


3,4-Dimethoxyaniline

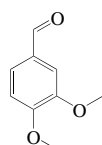
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3836	2,4-Dimethoxybenzaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	613-45-6	166.173	nd (al or lig)	72	290; 165 <sup>10</sup>			i H <sub>2</sub> O; s EtOH, eth, bz; sl chl
3837	2,5-Dimethoxybenzaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	93-02-7	166.173		52	270; 146 <sup>10</sup>			sl H <sub>2</sub> O; s EtOH, eth
3838	3,4-Dimethoxybenzaldehyde	Veratraldehyde	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	120-14-9	166.173	nd (eth, lig, to)	43	281; 155 <sup>10</sup>			sl H <sub>2</sub> O, chl; vs EtOH, eth
3839	3,5-Dimethoxybenzaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	7311-34-4	166.173		46.3	151 <sup>16</sup>			sl H <sub>2</sub> O, peth; s EtOH, bz
3840	1,2-Dimethoxybenzene	Veratrole	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	91-16-7	138.164		22.5	206	1.0810 <sup>25</sup>	1.5827 <sup>21</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
3841	1,3-Dimethoxybenzene		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	151-10-0	138.164	liq	-52	217.5	1.0521 <sup>25</sup>	1.5231 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, ctc, sulf
3842	1,4-Dimethoxybenzene		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	150-78-7	138.164	lf (w)	59	212.6	1.0375 <sup>55</sup>		sl H <sub>2</sub> O; s EtOH, chl; vs eth, bz
3843	3,4-Dimethoxybenzeneacetic acid		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	93-40-3	196.200	cry (bz-peth) nd (w+1)	98				s H <sub>2</sub> O, chl; vs EtOH, eth
3844	3,4-Dimethoxybenzeneethanamine		C <sub>10</sub> H <sub>12</sub> NO <sub>2</sub>	120-20-7	181.232			164 <sup>14</sup>		1.5464 <sup>20</sup>	s ctc
3845	3,4-Dimethoxybenzenemethanamine		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	5763-61-1	167.205			156 <sup>12</sup> , 120 <sup>3</sup>	1.143 <sup>25</sup>		s chl
3846	3,4-Dimethoxybenzenemethanol		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	93-03-8	168.189	visc oil		298; 172 <sup>12</sup>	1.178 <sup>17</sup>	1.555 <sup>17</sup>	s H <sub>2</sub> O, EtOH
3847	3,3'-Dimethoxybenzidine	Dianisidine	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	119-90-4	244.289	lf or nd (w)	137				i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
3848	3,3'-Dimethoxybenzidine-4,4'-diisocyanate		C <sub>16</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub>	91-93-0	296.277	cry	112				
3849	2,4-Dimethoxybenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	91-52-1	182.173			108.5			sl H <sub>2</sub> O; s EtOH, eth, chl, HOAc
3850	2,6-Dimethoxybenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	1466-76-8	182.173			186 dec			
3851	3,4-Dimethoxybenzoic acid	Veratric acid	C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	93-07-2	182.173	nd (w or HOAc) orth (sub)	181	sub			i H <sub>2</sub> O; vs EtOH, eth; sl chl
3852	3,5-Dimethoxybenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	1132-21-4	182.173	nd (w), pr (al)	185.5	sub			vs eth, EtOH
3853	4,4'-Dimethoxybenzoin	<i>p</i> -Anisoin	C <sub>16</sub> H <sub>16</sub> O <sub>4</sub>	119-52-8	272.296	pr (dil al)	114.0				sl H <sub>2</sub> O, chl, EtOH, eth; s ace
3854	5,7-Dimethoxy-2 <i>H</i> -1-benzopyran-2-one	Limettin	C <sub>11</sub> H <sub>10</sub> O <sub>4</sub>	487-06-9	206.195	pr or nd (al)	149	dec 200			sl H <sub>2</sub> O; vs EtOH, ace, chl; i eth, lig
3855	4,4'-Dimethoxy-1,1'-biphenyl		C <sub>14</sub> H <sub>14</sub> O <sub>2</sub>	2132-80-1	214.260	lf (bz)	175	sub			i H <sub>2</sub> O, peth; vs EtOH, bz, chl; sl eth
3856	Dimethoxyborane		C <sub>2</sub> H <sub>2</sub> BO <sub>2</sub>	4542-61-4	73.887	vol liq or gas	-130.6	25.9			dec H <sub>2</sub> O
3857	4,4-Dimethoxy-2-butanone		C <sub>8</sub> H <sub>12</sub> O <sub>3</sub>	5436-21-5	132.157			50 <sup>5</sup>			s ctc
3858	2,6-Dimethoxy-2,5-cyclohexadiene-1,4-dione	2,6-Dimethoxy- <i>p</i> -quinone	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	530-55-2	168.148	ye mcl pr (HOAc)	256	sub			sl H <sub>2</sub> O, EtOH, eth; s tfa; vs alk, HOAc
3859	Dimethoxydimethylsilane		C <sub>4</sub> H <sub>12</sub> O <sub>2</sub> Si	1112-39-6	120.223			82	0.8646 <sup>20</sup>	1.3708 <sup>20</sup>	dec H <sub>2</sub> O
3860	Dimethoxydiphenylsilane		C <sub>14</sub> H <sub>16</sub> O <sub>2</sub> Si	6843-66-9	244.362			286; 161 <sup>15</sup>	1.0771 <sup>20</sup>	1.5447 <sup>20</sup>	
3861	1,1-Dimethoxydodecane	Lauraldehyde, dimethyl acetal	C <sub>14</sub> H <sub>30</sub> O <sub>2</sub>	14620-52-1	230.387			133 <sup>5</sup>		1.4310 <sup>25</sup>	vs eth, EtOH
3862	2,2-Dimethoxyethanamine		C <sub>3</sub> H <sub>11</sub> NO <sub>2</sub>	22483-09-6	105.136		-78	137 <sup>95</sup>	0.966 <sup>25</sup>	1.4170 <sup>20</sup>	
3863	1,2-Dimethoxyethane	Ethylene glycol dimethyl ether	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	110-71-4	90.121	liq	-69.20	84.50	0.8637 <sup>25</sup>	1.3770 <sup>25</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz, chl, ctc
3864	(2,2-Dimethoxyethyl)benzene		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	101-48-4	166.217			193.5			
3865	4,8-Dimethoxyfuro[2,3- <i>b</i> ]quinoline	Fagarine	C <sub>13</sub> H <sub>11</sub> NO <sub>3</sub>	524-15-2	229.231	pr (al)	142				sl H <sub>2</sub> O, peth; s EtOH, eth, bz, chl
3866	1,1-Dimethoxyhexadecane	Palmitaldehyde, dimethyl acetal	C <sub>18</sub> H <sub>38</sub> O <sub>2</sub>	2791-29-9	286.494		10	144 <sup>2</sup>	0.8542 <sup>20</sup>	1.4382 <sup>25</sup>	vs ace, eth, EtOH
3867	2,4-Dimethoxy-6-hydroxyacetophenone	Xanthoxylin	C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	90-24-4	196.200	cry (al)	82	185 <sup>20</sup>			vs eth, EtOH
3868	5,6-Dimethoxy-1-indanone		C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	2107-69-9	192.211			119.5			sl ctc
3869	6,7-Dimethoxy-1(3 <i>H</i> )-isobenzofuranone	Meconin	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	569-31-3	194.184	wh nd (w)	102.5				sl H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc, chl
3870	Dimethoxymethane	Methylal	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	109-87-5	76.095	liq	-105.1	42	0.8593 <sup>20</sup>	1.3513 <sup>20</sup>	s H <sub>2</sub> O; vs ace, bz, eth, EtOH
3871	1,2-Dimethoxy-4-methylbenzene		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	494-99-5	152.190	pr (eth)	24	220	1.0509 <sup>25</sup>	1.5257 <sup>25</sup>	i H <sub>2</sub> O; sl ctc; vs os
3872	1,3-Dimethoxy-5-methylbenzene		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	4179-19-5	152.190			244	1.0478 <sup>15</sup>	1.5234 <sup>20</sup>	vs bz, eth, EtOH
3873	1,4-Dimethoxy-2-methylbenzene		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	24599-58-4	152.190		21	214.0			
3874	<i>N</i> -(Dimethoxymethyl)dimethylamine	Dimethylformamide dimethyl acetal	C <sub>5</sub> H <sub>13</sub> NO <sub>2</sub>	4637-24-5	119.163			104	0.897 <sup>25</sup>	1.3972 <sup>20</sup>	



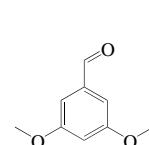
2,4-Dimethoxybenzaldehyde



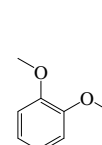
2,5-Dimethoxybenzaldehyde



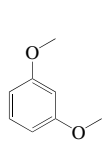
3,4-Dimethoxybenzaldehyde



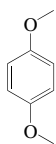
3,5-Dimethoxybenzaldehyde



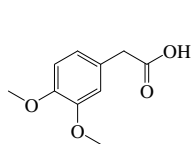
1,2-Dimethoxybenzene



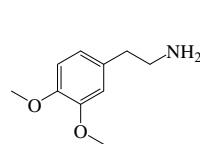
1,3-Dimethoxybenzene



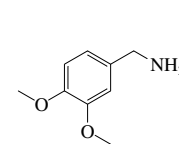
1,4-Dimethoxybenzene



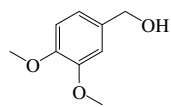
3,4-Dimethoxybenzeneacetic acid



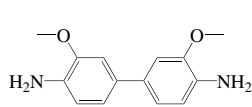
3,4-Dimethoxybenzeneethanamine



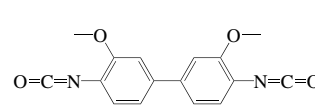
3,4-Dimethoxybenzenemethanamine



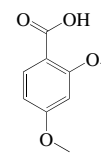
3,4-Dimethoxybenzenemethanol



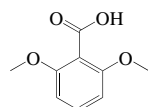
3,3'-Dimethoxybiphenyl



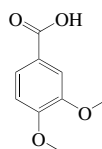
3,3'-Dimethoxybiphenyl-4,4'-diisocyanate



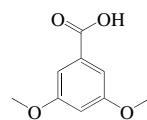
2,4-Dimethoxybenzoic acid



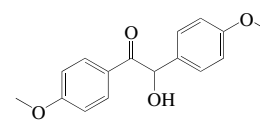
2,6-Dimethoxybenzoic acid



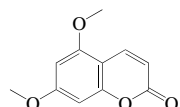
3,4-Dimethoxybenzoic acid



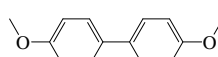
3,5-Dimethoxybenzoic acid



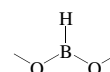
4,4'-Dimethoxybenzoin



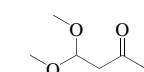
5,7-Dimethoxy-2H-1-benzopyran-2-one



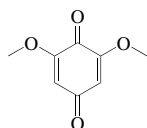
4,4'-Dimethoxy-1,1'-biphenyl



Dimethoxyborane



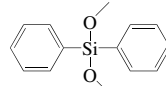
4,4-Dimethoxy-2-butanone



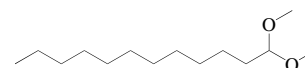
2,6-Dimethoxy-2,5-cyclohexadiene-1,4-dione



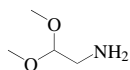
Dimethoxydimethylsilane



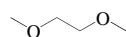
Dimethoxydiphenylsilane



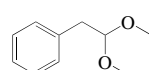
1,1-Dimethoxydodecane



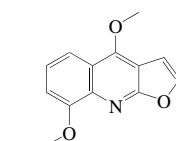
2,2-Dimethoxyethanamine



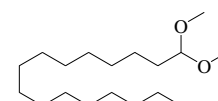
1,2-Dimethoxyethane



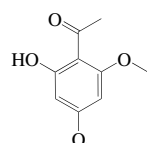
(2,2-Dimethoxyethyl)benzene



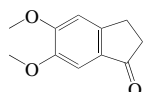
4,8-Dimethoxyfuro[2,3-b]quinoline



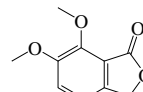
1,1-Dimethoxyhexadecane



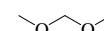
2,4-Dimethoxy-6-hydroxyacetophenone



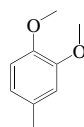
5,6-Dimethoxy-1-indanone



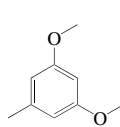
6,7-Dimethoxy-1(3H)-isobenzofuranone



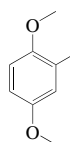
Dimethoxymethane



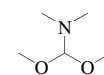
1,2-Dimethoxy-4-methylbenzene



1,3-Dimethoxy-5-methylbenzene



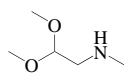
1,4-Dimethoxy-2-methylbenzene



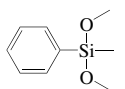
N-(Dimethoxymethyl)dimethylamine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3875	2,2-Dimethoxy- <i>N</i> -methylethanamine		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	122-07-6	119.163			140	0.928 <sup>25</sup>	1.4115 <sup>20</sup>	
3876	Dimethoxymethylphenylsilane		C <sub>9</sub> H <sub>14</sub> O <sub>2</sub> Si	3027-21-2	182.292			129 <sup>79</sup>		1.4795 <sup>20</sup>	
3877	1,2-Dimethoxy-4-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>4</sub>	709-09-1	183.162	ye nd (al-w)	98	230 <sup>15</sup>	1.1888 <sup>133</sup>		i H <sub>2</sub> O; vs EtOH, eth; s chl; sl lig
3878	1,4-Dimethoxy-2-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>4</sub>	89-39-4	183.162	gold-ye nd (dil al)	72.5		1.1666 <sup>132</sup>		i H <sub>2</sub> O; vs EtOH, bz, chl, sulf
3879	2,6-Dimethoxyphenol		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	91-10-1	154.163	mcl pr (w)	56.5	261			vs eth, EtOH
3880	3,5-Dimethoxyphenol		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	500-99-2	154.163		37	199 <sup>35</sup> , 170 <sup>10</sup>			s eth, bz; sl lig
3881	1-(3,4-Dimethoxyphenyl)ethanone		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	1131-62-0	180.200	pr (dil al)	51	287			vs H <sub>2</sub> O, bz, EtOH, chl
3882	1,1-Dimethoxypropane		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	4744-10-9	104.148			86	0.8648 <sup>20</sup>		
3883	2,2-Dimethoxypropane		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	77-76-9	104.148	liq	-47	83	0.847 <sup>25</sup>	1.3780 <sup>20</sup>	
3884	3,3-Dimethoxy-1-propene		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	6044-68-4	102.132			88	0.862 <sup>25</sup>	1.3954 <sup>20</sup>	
3885	1,2-Dimethoxy-4-(1-propenyl)benzene		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	93-16-3	178.228		18	270.5	1.0521 <sup>20</sup>	1.5616 <sup>20</sup>	
3886	4,5-Dimethoxy-6-(2-propenyl)-1,3-benzodioxole	Apiole (Dill)	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	484-31-1	222.237	oil	29.5	285	1.1598 <sup>15</sup>	1.5305 <sup>17</sup>	
3887	1,2-Dimethoxy-4-vinylbenzene		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	6380-23-0	164.201					1.5711 <sup>20</sup>	s chl
3888	Dimethylacetal		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	534-15-6	90.121	liq	-113.2	64.5	0.8501 <sup>20</sup>	1.3668 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ctc, chl; vs ace
3889	<i>N,N</i> -Dimethylacetamide	<i>N,N</i> -Dimethylethanamide	C <sub>4</sub> H <sub>9</sub> NO	127-19-5	87.120	liq	-18.59	165	0.9372 <sup>25</sup>	1.4341 <sup>25</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz, chl
3890	2,7-Dimethyl-3,6-acridinediamine, monohydrochloride	Acridine Yellow	C <sub>15</sub> H <sub>16</sub> ClN <sub>3</sub>	135-49-9	273.761	red cry pow					s hot H <sub>2</sub> O, EtOH
3891	Dimethyl adipate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	627-93-0	174.195	cry	10.3	115 <sup>13</sup>	1.0600 <sup>20</sup>	1.4283 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, HOAc
3892	3,3-Dimethylallyl diphosphate	3-Methyl-2-butenyl pyrophosphate	C <sub>8</sub> H <sub>12</sub> O <sub>7</sub> P <sub>2</sub>	358-72-5	246.092	cry (MeOH)					
3893	Dimethylamine	<i>N</i> -Methylmethanamine	C <sub>2</sub> H <sub>7</sub> N	124-40-3	45.084	col gas	-92.18	6.88	0.6804 <sup>0</sup>	1.3501 <sup>17</sup>	vs H <sub>2</sub> O; s EtOH, eth
3894	Dimethylamine hydrochloride	<i>N</i> -Methylmethanamine hydrochloride	C <sub>2</sub> H <sub>8</sub> ClN	506-59-2	81.545	orth nd (al)	171				vs H <sub>2</sub> O, EtOH, chl
3895	(Dimethylamino)acetonitrile		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	926-64-7	84.120			137.5	0.8649 <sup>20</sup>	1.4095 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
3896	4-(Dimethylamino)acetophenone	4-Acetyl- <i>N,N</i> -dimethylaniline	C <sub>10</sub> H <sub>13</sub> NO	2124-31-4	163.216	nd (w, peth)	105.5				vs H <sub>2</sub> O, eth, lig; sl chl
3897	10-[(Dimethylamino)acetyl]-10 <i>H</i> -phenothiazine	Ahistan	C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> OS	518-61-6	284.375	cry	144.5				
3898	<i>p</i> -(Dimethylamino)azobenzene		C <sub>14</sub> H <sub>15</sub> N <sub>3</sub>	60-11-7	225.289	ye lf (al)	117	dec			i H <sub>2</sub> O; vs EtOH, py; s eth; sl chl, lig
3899	2',3'-Dimethyl-4-aminoazobenzene	4- <i>o</i> -Tolylazo- <i>o</i> -toluidine	C <sub>14</sub> H <sub>15</sub> N <sub>3</sub>	97-56-3	225.289	ye lf (al)	102				vs eth, EtOH
3900	4-(Dimethylamino)benzaldehyde	Ehrlich's reagent	C <sub>9</sub> H <sub>11</sub> NO	100-10-7	149.189	lf (w)	74.5	176 <sup>17</sup>	1.0254 <sup>100</sup>		sl H <sub>2</sub> O, chl; s EtOH, eth, ace, bz
3901	<i>p</i> -(Dimethylamino)benzalrhodanine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> OS <sub>2</sub>	536-17-4	264.365	dp red nd (xyl)	270 dec				i H <sub>2</sub> O; sl EtOH, bz; vs eth, ctc; s ace
3902	2-(Dimethylamino)benzoic acid		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	610-16-2	165.189	pr, nd (eth)	72	sub			vs H <sub>2</sub> O, eth, EtOH
3903	3-(Dimethylamino)benzoic acid		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	99-64-9	165.189	nd (w)	152.5				sl H <sub>2</sub> O, chl; s EtOH, eth
3904	4-(Dimethylamino)benzoic acid		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	619-84-1	165.189	nd (al)	242.5				s EtOH; sl eth
3905	4,4'-Dimethylaminobenzophenonimide	Brilliant Oil Yellow	C <sub>17</sub> H <sub>21</sub> N <sub>3</sub>	492-80-8	267.369	ye or col pl (al)	136				i H <sub>2</sub> O; s EtOH; sl eth
3906	(Dimethylamino)dimethylborane		C <sub>4</sub> H <sub>12</sub> BN	1113-30-0	84.956	liq	-92	65			vs eth, ace
3907	6-(Dimethylamino)-4,4-diphenyl-3-heptanone		C <sub>21</sub> H <sub>27</sub> NO	76-99-3	309.445			99.5			vs EtOH
3908	6-(Dimethylamino)-4,4-diphenyl-3-hexanone	Normethadone	C <sub>20</sub> H <sub>26</sub> NO	467-85-6	295.419	oily liq		165 <sup>3</sup>			
3909	2-(Dimethylamino)ethyl acrylate		C <sub>7</sub> H <sub>13</sub> NO <sub>2</sub>	2439-35-2	143.184		<-60	95 <sup>30</sup>	0.938 <sup>20</sup>		
3910	3-[2-(Dimethylamino)ethyl]-1 <i>H</i> -indol-5-ol	Bufotenine	C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O	487-93-4	204.267	pr (EtOAc)	146.5	320 <sup>0,1</sup>			vs eth, EtOH
3911	2-(Dimethylamino)ethyl methacrylate		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	2867-47-2	157.211			63 <sup>9</sup>			
3912	4-[2-(Dimethylamino)ethyl]phenol	Hordeanine	C <sub>10</sub> H <sub>15</sub> NO	539-15-1	165.232	orth pr (al), nd (w)	117.5	173 <sup>11</sup>			vs eth, EtOH, chl
3913	<i>N</i> -(2-(Dimethylamino)ethyl)- <i>N,N,N'</i> -trimethyl-1,2-ethanediamine		C <sub>9</sub> H <sub>23</sub> N <sub>3</sub>	3030-47-5	173.299			84 <sup>12</sup>		1.4413 <sup>25</sup>	
3914	5-(Dimethylamino)-1-naphthalenesulfonyl chloride	Dansyl chloride	C <sub>12</sub> H <sub>12</sub> ClNO <sub>2</sub> S	605-65-2	269.747		70				

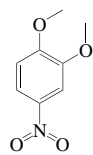




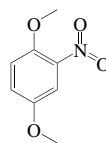
2,2-Dimethoxy-N-methylethanamine



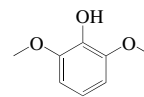
Dimethoxymethylphenylsilane



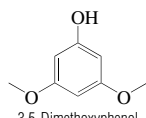
1,2-Dimethoxy-4-nitrobenzene



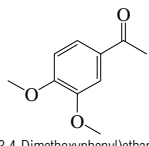
1,4-Dimethoxy-2-nitrobenzene



2,6-Dimethoxyphenol



3,5-Dimethoxyphenol



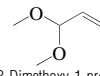
1-(3,4-Dimethoxyphenyl)ethanone



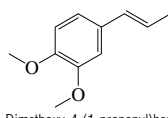
1,1-Dimethoxypropane



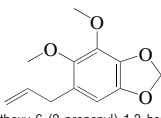
2,2-Dimethoxypropane



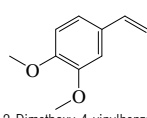
3,3-Dimethoxy-1-propene



1,2-Dimethoxy-4-(1-propenyl)benzene



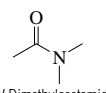
4,5-Dimethoxy-6-(2-propenyl)-1,3-benzodioxole



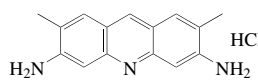
1,2-Dimethoxy-4-vinylbenzene



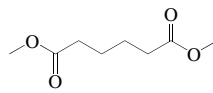
Dimethylacetal



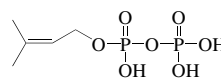
N,N-Dimethylacetamide



2,7-Dimethyl-3,6-acridinediamine, monohydrochloride



Dimethyl adipate



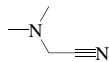
3,3-Dimethylallyl diphosphate



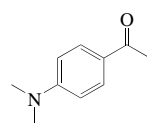
Dimethylamine



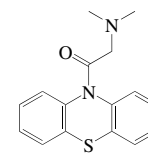
Dimethylamine hydrochloride



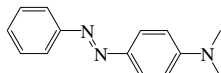
(Dimethylamino)acetonitrile



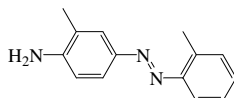
4-(Dimethylamino)acetophenone



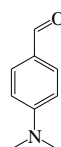
10-[(Dimethylamino)acetyl]-10H-phenothiazine



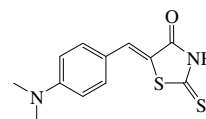
p-(Dimethylamino)azobenzene



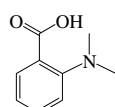
2',3-Dimethyl-4-aminoazobenzene



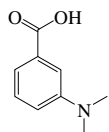
4-(Dimethylamino)benzaldehyde



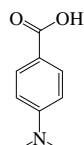
p-(Dimethylamino)benzalrhodanine



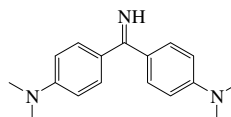
2-(Dimethylamino)benzoic acid



3-(Dimethylamino)benzoic acid



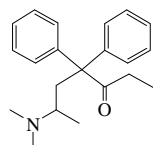
4-(Dimethylamino)benzoic acid



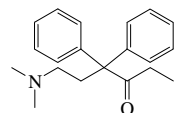
4,4'-Dimethylaminobenzophenonimide



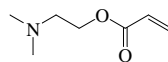
(Dimethylamino)dimethylborane



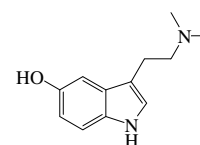
6-(Dimethylamino)-4,4-diphenyl-3-heptanone



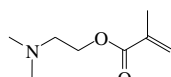
6-(Dimethylamino)-4,4-diphenyl-3-hexanone



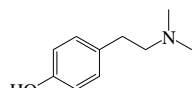
2-(Dimethylamino)ethyl acrylate



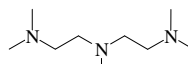
3-[2-(Dimethylamino)ethyl]-1H-indol-5-ol



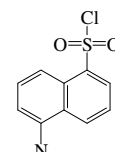
2-(Dimethylamino)ethyl methacrylate



4-[2-(Dimethylamino)ethyl]phenol

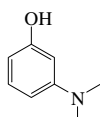


N-[2-(Dimethylamino)ethyl]-N,N'-trimethyl-1,2-ethanediamine

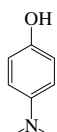


5-(Dimethylamino)-1-naphthalenesulfonyl chloride

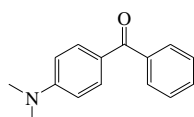
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3915	3-(Dimethylamino)phenol		C <sub>8</sub> H <sub>11</sub> NO	99-07-0	137.179	nd (lig)	86	266.5		1.5895 <sup>26</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, CS <sub>2</sub>
3916	4-(Dimethylamino)phenol		C <sub>8</sub> H <sub>11</sub> NO	619-60-3	137.179		77	165 <sup>30</sup>			sl H <sub>2</sub> O; s EtOH, eth
3917	[4-(Dimethylamino)phenyl]phenylmethanone	4-(Dimethylamino)benzophenone	C <sub>15</sub> H <sub>15</sub> NO	530-44-9	225.286	ye lf (al) nd (peth)	92.5				i H <sub>2</sub> O; sl EtOH; vs eth; s chl, peth
3918	3-(Dimethylamino)-1-phenyl-1-propanone, hydrochloride		C <sub>11</sub> H <sub>16</sub> ClNO	879-72-1	213.704			153.5			
3919	3-[4-(Dimethylamino)phenyl]-2-propenal	4-(Dimethylamino)cinnamaldehyde	C <sub>11</sub> H <sub>13</sub> NO	6203-18-5	175.227			139.5			
3920	3-(Dimethylamino)propanenitrile		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	1738-25-6	98.146			173	0.8705 <sup>20</sup>		
3921	2-(Dimethylamino)-1-propanol		C <sub>6</sub> H <sub>13</sub> NO	15521-18-3	103.163			150.3	0.8820 <sup>26</sup>		s H <sub>2</sub> O
3922	3-(Dimethylamino)-1-propanol		C <sub>6</sub> H <sub>13</sub> NO	3179-63-3	103.163			163.5	0.872 <sup>25</sup>	1.4360 <sup>20</sup>	s ctc
3923	1-(Dimethylamino)-2-propanol		C <sub>6</sub> H <sub>13</sub> NO	108-16-7	103.163			124.5	0.837 <sup>25</sup>	1.4193 <sup>20</sup>	s ctc
3924	3-(Dimethylamino)-1-propyne	<i>N,N</i> -Dimethyl-2-propargylamine	C <sub>5</sub> H <sub>9</sub> N	7223-38-3	83.132			80	0.7792 <sup>20</sup>	1.4195 <sup>20</sup>	
3925	2-Dimethylaminopurine	<i>N,N</i> -Dimethyl-1 <i>H</i> -purin-6-amine	C <sub>7</sub> H <sub>9</sub> N <sub>5</sub>	938-55-6	163.180		263				
3926	2-( <i>p</i> -Dimethylaminostyryl)benzothiazole		C <sub>17</sub> H <sub>16</sub> N <sub>2</sub> S	1628-58-6	280.387	ye nd (MeOH)	207 dec				
3927	2,3-Dimethylaniline	2,3-Xylidine	C <sub>8</sub> H <sub>11</sub> N	87-59-2	121.180		<-15	221.5	0.9931 <sup>20</sup>	1.5684 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ctc
3928	2,4-Dimethylaniline	2,4-Xylidine	C <sub>8</sub> H <sub>11</sub> N	95-68-1	121.180	liq	-14.3	214	0.9723 <sup>20</sup>	1.5569 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz
3929	2,5-Dimethylaniline	2,5-Xylidine	C <sub>8</sub> H <sub>11</sub> N	95-78-3	121.180	ye lf (lig)	15.5	214	0.9790 <sup>21</sup>	1.5591 <sup>21</sup>	sl H <sub>2</sub> O; s eth, ctc
3930	2,6-Dimethylaniline	2,6-Xylidine	C <sub>8</sub> H <sub>11</sub> N	87-62-7	121.180		11.2	215	0.9842 <sup>20</sup>	1.5610 <sup>20</sup>	vs eth, EtOH
3931	3,4-Dimethylaniline	3,4-Xylidine	C <sub>8</sub> H <sub>11</sub> N	95-64-7	121.180	pl or pr (lig)	51	228	1.076 <sup>18</sup>		sl H <sub>2</sub> O, chl; s eth; vs lig
3932	3,5-Dimethylaniline	3,5-Xylidine	C <sub>8</sub> H <sub>11</sub> N	108-69-0	121.180		9.8	220.5	0.9706 <sup>20</sup>	1.5581 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ctc
3933	<i>N</i> ,2-Dimethylaniline		C <sub>8</sub> H <sub>11</sub> N	611-21-2	121.180			207.5	0.9709 <sup>20</sup>	1.5649 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
3934	<i>N</i> ,3-Dimethylaniline		C <sub>8</sub> H <sub>11</sub> N	696-44-6	121.180			206.5	0.9660 <sup>20</sup>	1.5557 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
3935	<i>N</i> ,4-Dimethylaniline		C <sub>8</sub> H <sub>11</sub> N	623-08-5	121.180			210	0.9348 <sup>65</sup>	1.5568 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
3936	<i>N,N</i> -Dimethylaniline		C <sub>8</sub> H <sub>11</sub> N	121-69-7	121.180	pa ye	2.42	194.15	0.9557 <sup>20</sup>	1.5582 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz; vs chl
3937	<i>N,N</i> -Dimethylaniline hydrochloride		C <sub>8</sub> H <sub>12</sub> ClN	5882-44-0	157.641	hyg pl (w, bz)	90		1.1156 <sup>19</sup>		vs H <sub>2</sub> O, EtOH, chl
3938	2,6-Dimethylanisole		C <sub>9</sub> H <sub>12</sub> O	1004-66-6	136.190			182.5	0.9619 <sup>14</sup>	1.5053 <sup>14</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
3939	3,5-Dimethylanisole		C <sub>9</sub> H <sub>12</sub> O	874-63-5	136.190			194; 89 <sup>15</sup>	0.9627 <sup>15</sup>	1.5110 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> ; sl ctc
3940	9,10-Dimethylanthracene		C <sub>16</sub> H <sub>14</sub>	781-43-1	206.282		183.6	360.0			i H <sub>2</sub> O
3941	1,4-Dimethyl-9,10-anthracenedione		C <sub>16</sub> H <sub>12</sub> O <sub>2</sub>	1519-36-4	236.265	ye nd (al, sub)	140.5	sub			i H <sub>2</sub> O; sl EtOH; s bz, xyl, HOAc
3942	Dimethylarsine		C <sub>2</sub> H <sub>4</sub> As	593-57-7	105.999	liq, ign in air	-136.1	36	1.208 <sup>29</sup>		vs ace, bz, eth, EtOH
3943	Dimethylarsinic acid	Cacodylic acid	C <sub>2</sub> H <sub>4</sub> AsO <sub>2</sub>	75-60-5	137.998		195	>200			vs H <sub>2</sub> O; s EtOH; i eth
3944	2,4-Dimethylbenzaldehyde		C <sub>9</sub> H <sub>10</sub> O	15764-16-6	134.174	liq	-9	218			s EtOH; s eth, ace, bz; sl chl
3945	2,5-Dimethylbenzaldehyde	Isoxylaldehyde	C <sub>9</sub> H <sub>10</sub> O	5779-94-2	134.174			220	0.9500 <sup>20</sup>		vs EtOH; s eth, ace, bz, ctc
3946	3,5-Dimethylbenzaldehyde		C <sub>9</sub> H <sub>10</sub> O	5779-95-3	134.174		9	221			vs ace, bz, eth, EtOH
3947	<i>N,N</i> -Dimethylbenzamide		C <sub>9</sub> H <sub>11</sub> NO	611-74-5	149.189		44.8	272.0			
3948	7,12-Dimethylbenz[ <i>a</i> ]anthracene	9,10-Dimethyl-1,2-benzanthracene	C <sub>20</sub> H <sub>16</sub>	57-97-6	256.341	pa ye pl (al, HOAc)	122.5				vs ace, bz
3949	4,5-Dimethyl-1,2-benzenediamine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	3171-45-7	136.194		128				
3950	<i>N,N</i> -Dimethyl-1,2-benzenediamine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	2836-03-5	136.194	oil		218; 90 <sup>22</sup>	0.995 <sup>22</sup>		sl H <sub>2</sub> O; vs EtOH, eth, ace, bz
3951	<i>N,N</i> -Dimethyl-1,3-benzenediamine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	2836-04-6	136.194		<-20	270; 138 <sup>10</sup>	0.995 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth
3952	<i>N,N</i> -Dimethyl-1,4-benzenediamine	Dimethyl- <i>p</i> -phenylenediamine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	99-98-9	136.194	nd (bz)	53	263	1.036 <sup>20</sup>		s H <sub>2</sub> O, chl; vs EtOH, eth, bz; sl lig
3953	2,5-Dimethyl-1,3-benzenediol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	488-87-9	138.164	nd (bz), pr (w)	163	278.5			s H <sub>2</sub> O, EtOH, eth



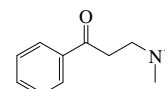
3-(Dimethylamino)phenol



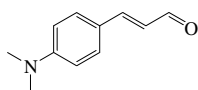
4-(Dimethylamino)phenol



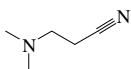
[4-(Dimethylamino)phenyl]phenylmethanone



3-(Dimethylamino)-1-phenyl-1-propanone, hydrochloride



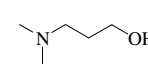
3-[4-(Dimethylamino)phenyl]-2-propenal



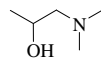
3-(Dimethylamino)propanenitrile



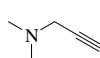
2-(Dimethylamino)-1-propanol



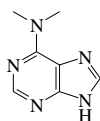
3-(Dimethylamino)-1-propanol



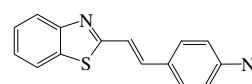
1-(Dimethylamino)-2-propanol



3-(Dimethylamino)-1-propyne



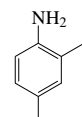
2-Dimethylaminopurine



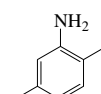
2-(p-Dimethylaminostyryl)benzothiazole



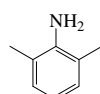
2,3-Dimethylaniline



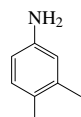
2,4-Dimethylaniline



2,5-Dimethylaniline



2,6-Dimethylaniline



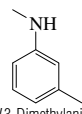
3,4-Dimethylaniline



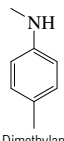
3,5-Dimethylaniline



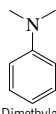
N,2-Dimethylaniline



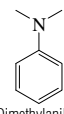
N,3-Dimethylaniline



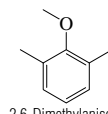
N,4-Dimethylaniline



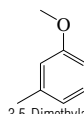
N,N-Dimethylaniline



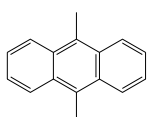
N,N-Dimethylaniline hydrochloride



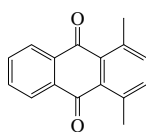
2,6-Dimethylanisole



3,5-Dimethylanisole



9,10-Dimethylantracene



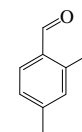
1,4-Dimethyl-9,10-anthracenedione



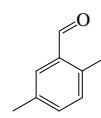
Dimethylarsine



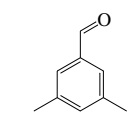
Dimethylarsinic acid



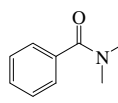
2,4-Dimethylbenzaldehyde



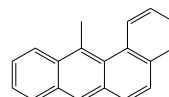
2,5-Dimethylbenzaldehyde



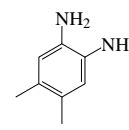
3,5-Dimethylbenzaldehyde



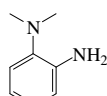
N,N-Dimethylbenzamide



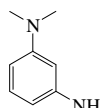
7,12-Dimethylbenz[a]anthracene



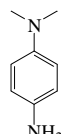
4,5-Dimethyl-1,2-benzenediamine



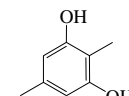
N,N-Dimethyl-1,2-benzenediamine



N,N-Dimethyl-1,3-benzenediamine

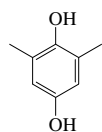


N,N-Dimethyl-1,4-benzenediamine

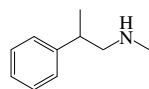
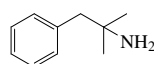
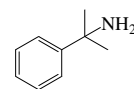
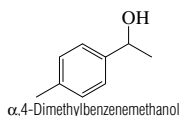
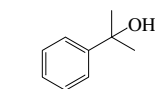
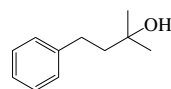
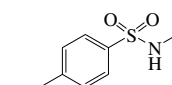
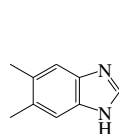
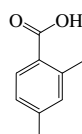


2,5-Dimethyl-1,3-benzenediol

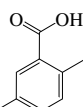
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3954	2,6-Dimethyl-1,4-benzenediol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	654-42-2	138.164	nd (xyl), cry (w)	152.3				vs eth, EtOH
3955	<i>N</i> ,β-Dimethylbenzeneethanamine	Phenylpropylmethylamine	C <sub>10</sub> H <sub>15</sub> N	93-88-9	149.233			207.5	0.915 <sup>25</sup>		vs bz, eth, EtOH
3956	α,α-Dimethylbenzeneethanamine	Phentermine	C <sub>10</sub> H <sub>15</sub> N	122-09-8	149.233	oily liq		205; 100 <sup>21</sup>			
3957	α,α-Dimethylbenzenemethanamine		C <sub>9</sub> H <sub>13</sub> N	585-32-0	135.206			196.5	0.9423 <sup>20</sup>	1.5181 <sup>25</sup>	
3958	α,4-Dimethylbenzenemethanol	1-(4-Methylphenyl)ethanol	C <sub>9</sub> H <sub>12</sub> O	536-50-5	136.190			219	0.9668 <sup>25</sup>	1.5246 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
3959	α,α-Dimethylbenzenemethanol	α-Cumyl alcohol	C <sub>9</sub> H <sub>12</sub> O	617-94-7	136.190	pr	36	202	0.9735 <sup>20</sup>	1.5325 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, HOAc
3960	α,α-Dimethylbenzenepropanol	Benzyl- <i>tert</i> -butanol	C <sub>11</sub> H <sub>16</sub> O	103-05-9	164.244	nd	24.5	121 <sup>13</sup>	0.9626 <sup>21</sup>	1.5077 <sup>21</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz
3961	<i>N</i> ,4-Dimethylbenzenesulfonamide		C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub> S	640-61-9	185.244	pl (dil al)	78.5		1.340 <sup>25</sup>		vs eth, EtOH
3962	5,6-Dimethyl-1 <i>H</i> -benzimidazole	Dimedazole	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub>	582-60-5	146.188	cry (eth)	205.5	sub			s H <sub>2</sub> O, EtOH, eth, chl, DMSO
3963	2,4-Dimethylbenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	611-01-8	150.174	mcl or tcl nd (w)	90	268			sl H <sub>2</sub> O; s EtOH, ace, bz, chl, HOAc, tol
3964	2,5-Dimethylbenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	610-72-0	150.174	nd (al)	132	sub	1.069 <sup>21</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz
3965	2,6-Dimethylbenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	632-46-2	150.174	nd (lig)	116	274.5; 155 <sup>17</sup>			sl H <sub>2</sub> O, lig; s EtOH, eth
3966	3,4-Dimethylbenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	619-04-5	150.174	pr (al)	167.3				i H <sub>2</sub> O; s EtOH, eth, bz
3967	3,5-Dimethylbenzoic acid	Mesitylenic acid	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	499-06-9	150.174	nd (w, al)	171.1	sub			sl H <sub>2</sub> O; vs EtOH, eth
3968	4,4-Dimethylbenzophenone	Bis(4-methylphenyl) ketone	C <sub>15</sub> H <sub>14</sub> O	611-97-2	210.271	orth (al)	96.5	334			vs ace, bz, eth, EtOH
3969	7,8-Dimethylbenzo[ <i>g</i> ]pteridine-2,4(1 <i>H</i> ,3 <i>H</i> )-dione	Lumichrome	C <sub>12</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub>	1086-80-2	242.233	ye cry (chl)	300				sl H <sub>2</sub> O, EtOH, chl
3970	2,5-Dimethylbenzoxazole		C <sub>9</sub> H <sub>7</sub> NO	5676-58-4	147.173			218.5	1.0880 <sup>18</sup>	1.5412 <sup>20</sup>	s ctc
3971	<i>N,N</i> -Dimethylbenzylamine	Dimethylbenzylamine	C <sub>9</sub> H <sub>13</sub> N	103-83-3	135.206			181	0.915 <sup>50</sup>	1.5011 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
3972	<i>N,N</i> -Dimethyl- <i>N'</i> -benzyl-1,2-ethanediamine	<i>N</i> -Benzyl- <i>N'</i> , <i>N'</i> -dimethyl-1,2-ethanediamine	C <sub>11</sub> H <sub>18</sub> N <sub>2</sub>	103-55-9	178.274			145 <sup>30</sup> , 123 <sup>11</sup>	0.9343 <sup>20</sup>	1.5089 <sup>20</sup>	
3973	<i>N,N</i> -Dimethyl- <i>N'</i> -benzyl- <i>N'</i> -2-pyridinyl-1,2-ethanediamine	Tripelennamine	C <sub>16</sub> H <sub>21</sub> N <sub>3</sub>	91-81-6	255.358	ye oil		140 <sup>0.1</sup>		1.576 <sup>25</sup>	misc H <sub>2</sub> O
3974	6,6-Dimethylbicyclo[3.1.1]heptan-2-one, (1 <i>R</i> )		C <sub>9</sub> H <sub>14</sub> O	38651-65-9	138.206	liq	-1	209	0.9807 <sup>20</sup>	1.4787 <sup>20</sup>	vs eth, EtOH
3975	2,3-Dimethylbicyclo[2.2.1]hept-2-ene	2,3-Dimethyl-2-norbornene	C <sub>9</sub> H <sub>14</sub>	529-16-8	122.207			140.5	0.8698 <sup>17</sup>	1.4688 <sup>17</sup>	s eth, ace, bz
3976	6,6-Dimethylbicyclo[3.1.1]hept-2-ene-2-ethanol		C <sub>11</sub> H <sub>18</sub> O	128-50-7	166.260			235; 110 <sup>10</sup>	0.973 <sup>25</sup>	1.4930 <sup>20</sup>	s chl
3977	2,2'-Dimethylbiphenyl		C <sub>14</sub> H <sub>14</sub>	605-39-0	182.261	cry (al)	19.5	256	0.9906 <sup>20</sup>	1.5752 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; s ace
3978	3,3'-Dimethylbiphenyl		C <sub>14</sub> H <sub>14</sub>	612-75-9	182.261		9	280	0.9995 <sup>20</sup>	1.5946 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; s ace
3979	4,4'-Dimethylbiphenyl		C <sub>14</sub> H <sub>14</sub>	613-33-2	182.261	mcl pr (eth)	125	295	0.917 <sup>121</sup>		i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, CS <sub>2</sub>
3980	4,4'-Dimethyl-2,2'-bipyridine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	1134-35-6	184.236		171.5				s chl
3981	2,3-Dimethyl-1,3-butadiene	Diisopropenyl	C <sub>6</sub> H <sub>10</sub>	513-81-5	82.143	liq	-76	68.8	0.7222 <sup>25</sup>	1.4394 <sup>20</sup>	s ctc
3982	<i>N,N</i> -Dimethylbutanamide		C <sub>8</sub> H <sub>13</sub> NO	760-79-2	115.173	liq	-40	186; 125 <sup>100</sup>	0.9064 <sup>25</sup>	1.4391 <sup>25</sup>	vs ace, bz, eth, EtOH
3983	3,3-Dimethyl-2-butanamine		C <sub>8</sub> H <sub>15</sub> N	3850-30-4	101.190	liq	-20	102	0.7668 <sup>20</sup>	1.4105 <sup>25</sup>	vs H <sub>2</sub> O
3984	2,2-Dimethylbutane	Neohexane	C <sub>6</sub> H <sub>14</sub>	75-83-2	86.175	liq	-98.8	49.73	0.6444 <sup>25</sup>	1.3688 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs ace, bz, peth, ctc
3985	2,3-Dimethylbutane		C <sub>6</sub> H <sub>14</sub>	79-29-8	86.175	liq	-128.10	57.93	0.6616 <sup>20</sup>	1.3750 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs ace, bz, peth, ctc
3986	2,3-Dimethyl-2,3-butanediol	Pinacol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	76-09-5	118.174	nd (al,eth)	43.32	174.4			sl H <sub>2</sub> O, CS <sub>2</sub> ; vs EtOH, eth
3987	2,3-Dimethyl-2-butanethiol		C <sub>6</sub> H <sub>14</sub> S	1639-01-6	118.240	liq		126.1			
3988	2,2-Dimethylbutanoic acid		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	595-37-9	116.158	liq	-14	186	0.9276 <sup>20</sup>	1.4145 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
3989	2,2-Dimethyl-1-butanol		C <sub>6</sub> H <sub>14</sub> O	1185-33-7	102.174		<-15	136.5	0.8283 <sup>20</sup>	1.4208 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
3990	3,3-Dimethyl-1-butanol		C <sub>6</sub> H <sub>14</sub> O	624-95-3	102.174	liq	-60	143	0.844 <sup>15</sup>	1.4323 <sup>15</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
3991	2,3-Dimethyl-2-butanol		C <sub>6</sub> H <sub>14</sub> O	594-60-5	102.174	liq	-14	118.4	0.8236 <sup>20</sup>	1.4176 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth
3992	3,3-Dimethyl-2-butanol, (±)		C <sub>6</sub> H <sub>14</sub> O	20281-91-8	102.174		5.6	120.4	0.8122 <sup>25</sup>	1.4148 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth



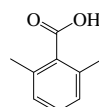
2,6-Dimethyl-1,4-benzenediol

*N,β*-Dimethylbenzeneethanamine $\alpha,\alpha$ -Dimethylbenzeneethanamine $\alpha,\alpha$ -Dimethylbenzenemethanamine $\alpha,4$ -Dimethylbenzenemethanol $\alpha,\alpha$ -Dimethylbenzenemethanol $\alpha,\alpha$ -Dimethylbenzenepropanol*N,4*-Dimethylbenzenesulfonamide5,6-Dimethyl-1*H*-benzimidazole

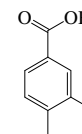
2,4-Dimethylbenzoic acid



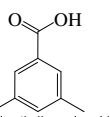
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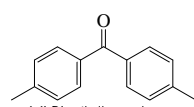
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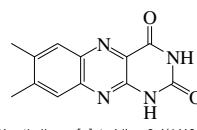
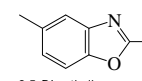
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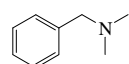
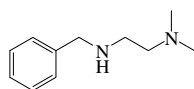
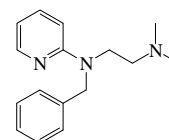
3,5-Dimethylbenzoic acid



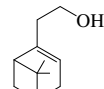
4,4'-Dimethylbenzophenone

7,8-Dimethylbenzo[*g*]pteridine-2,4(1*H*,3*H*)-dione

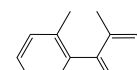
2,5-Dimethylbenzoxazole

*N,N*-Dimethylbenzylamine*N,N*-Dimethyl-*N'*-benzyl-1,2-ethanediamine*N,N*-Dimethyl-*N'*-benzyl-*N'*-2-pyridinyl-1,2-ethanediamine6,6-Dimethylbicyclo[3.1.1]heptan-2-one, (1*R*)

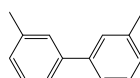
2,3-Dimethylbicyclo[2.2.1]hept-2-ene



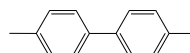
6,6-Dimethylbicyclo[3.1.1]hept-2-ene-2-ethanol



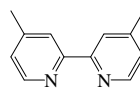
2,2'-Dimethylbiphenyl



3,3'-Dimethylbiphenyl



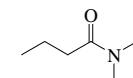
4,4'-Dimethylbiphenyl



4,4'-Dimethyl-2,2'-bipyridine



2,3-Dimethyl-1,3-butadiene

*N,N*-Dimethylbutanamide

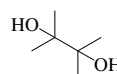
3,3-Dimethyl-2-butanamine



2,2-Dimethylbutane



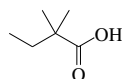
2,3-Dimethylbutane



2,3-Dimethyl-2,3-butanediol



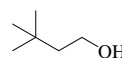
2,3-Dimethyl-2-butanethiol



2,2-Dimethylbutanoic acid



2,2-Dimethyl-1-butanol



3,3-Dimethyl-1-butanol

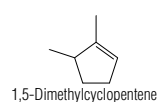
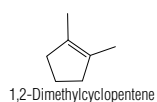
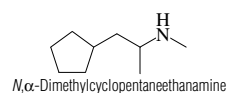
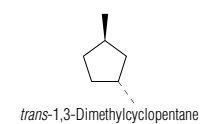
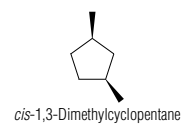
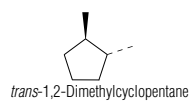
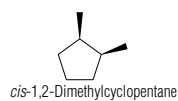
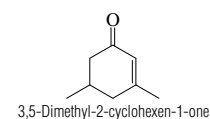
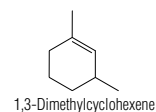
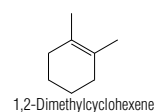
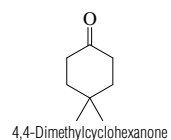
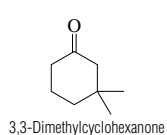
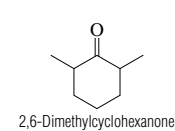
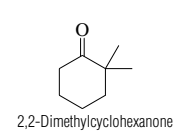
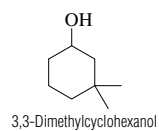
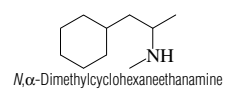
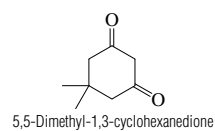
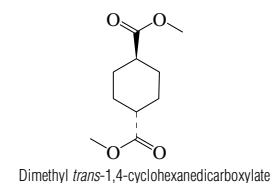
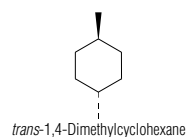
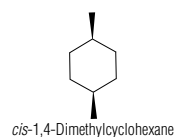
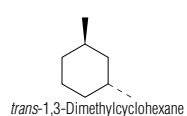
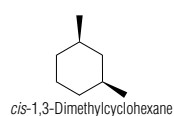
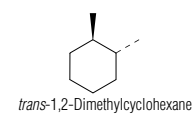
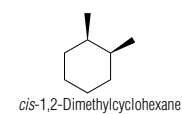
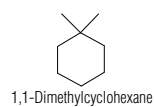
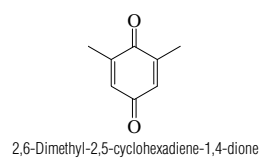
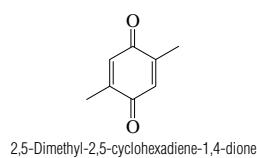
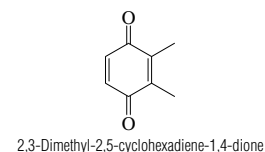
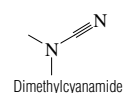
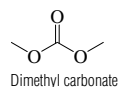
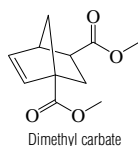
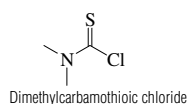
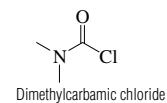
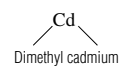
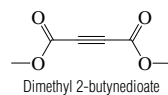
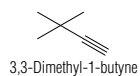
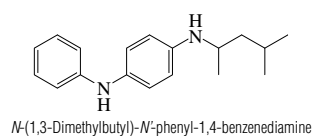
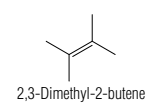
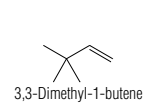
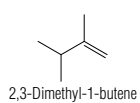
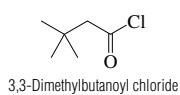
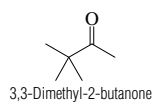


2,3-Dimethyl-2-butanol



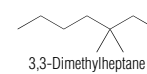
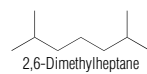
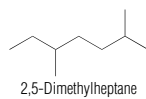
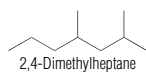
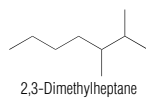
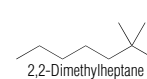
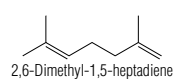
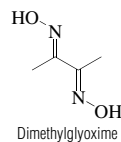
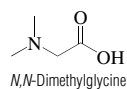
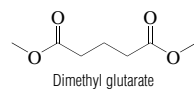
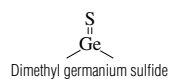
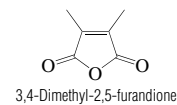
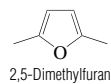
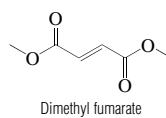
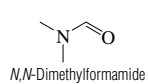
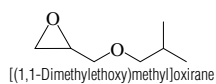
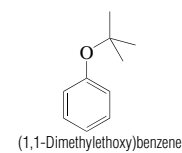
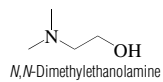
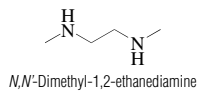
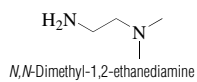
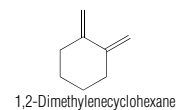
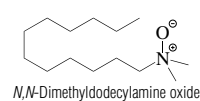
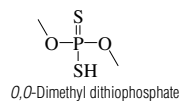
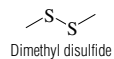
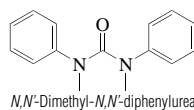
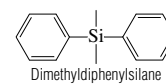
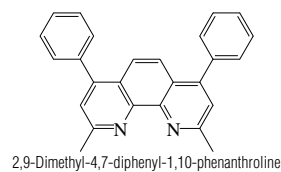
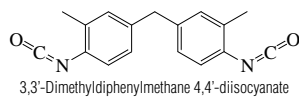
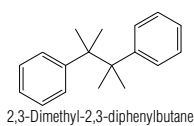
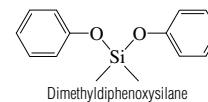
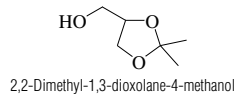
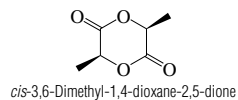
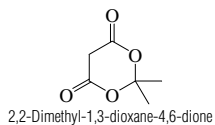
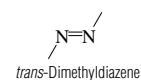
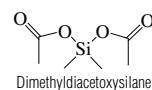
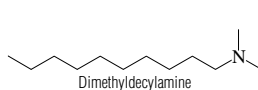
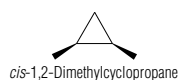
3,3-Dimethyl-2-butanol, (±)

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
3993	3,3-Dimethyl-2-butanone	Pinacolone	C <sub>8</sub> H <sub>12</sub> O	75-97-8	100.158	liq	-52.5	106.1	0.7229 <sup>25</sup>	1.395 <sup>20</sup>	s H <sub>2</sub> O; s EtOH, eth, ace, ctc
3994	3,3-Dimethylbutanoyl chloride		C <sub>8</sub> H <sub>11</sub> ClO	7065-46-5	134.603			130; 68 <sup>100</sup>	0.969 <sup>20</sup>	1.4210 <sup>20</sup>	vs eth
3995	2,3-Dimethyl-1-butene		C <sub>8</sub> H <sub>12</sub>	563-78-0	84.159	liq	-157.3	55.6	0.6803 <sup>20</sup>	1.3995 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc, CS <sub>2</sub>
3996	3,3-Dimethyl-1-butene		C <sub>8</sub> H <sub>12</sub>	558-37-2	84.159	liq	-115.2	41.2	0.6529 <sup>20</sup>	1.3763 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, chl
3997	2,3-Dimethyl-2-butene		C <sub>8</sub> H <sub>12</sub>	563-79-1	84.159	liq	-74.19	73.3	0.7080 <sup>20</sup>	1.4122 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl
3998	<i>N</i> -(1,3-Dimethylbutyl)- <i>N'</i> -phenyl-1,4-benzenediamine		C <sub>18</sub> H <sub>24</sub> N <sub>2</sub>	793-24-8	268.397		46	164 <sup>1</sup>			
3999	3,3-Dimethyl-1-butyne	<i>tert</i> -Butylacetylene	C <sub>8</sub> H <sub>10</sub>	917-92-0	82.143	liq	-78.2	37.7	0.6623 <sup>25</sup>	1.3736 <sup>20</sup>	
4000	Dimethyl 2-butyndioate		C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	762-42-5	142.110			dec 197; 98 <sup>20</sup>	1.1564 <sup>20</sup>	1.4434 <sup>20</sup>	s EtOH, eth, ctc
4001	Dimethyl cadmium		C <sub>2</sub> H <sub>6</sub> Cd	506-82-1	142.480		-4.5	105.5 (exp 150)	1.9846 <sup>18</sup>	1.5488	s peth
4002	Dimethylcarbamoyl chloride	Dimethylcarbamoyl chloride	C <sub>3</sub> H <sub>6</sub> CINO	79-44-7	107.539	liq	-33	167	1.168 <sup>25</sup>	1.4540 <sup>20</sup>	
4003	Dimethylcarbamothioic chloride		C <sub>3</sub> H <sub>6</sub> CINS	16420-13-6	123.605	pr	42.5	98 <sup>10</sup>			vs eth; s chl, peth
4004	Dimethyl carbate		C <sub>11</sub> H <sub>14</sub> O <sub>4</sub>	39589-98-5	210.227	cry	38	137 <sup>12.5</sup>	1.164 <sup>21</sup>	1.4852 <sup>20</sup>	i H <sub>2</sub> O
4005	Dimethyl carbonate	Methyl carbonate	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	616-38-6	90.078		0.5	90.5	1.0636 <sup>25</sup>	1.3687 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
4006	Dimethylcyanamide		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	1467-79-4	70.093			163.5		1.4089 <sup>19</sup>	vs ace, eth, EtOH
4007	2,3-Dimethyl-2,5-cyclohexadiene-1,4-dione		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	526-86-3	136.149	ye nd	55	sub			sl H <sub>2</sub> O; s EtOH, eth, chl
4008	2,5-Dimethyl-2,5-cyclohexadiene-1,4-dione		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	137-18-8	136.149	ye nd (al)	126.0				sl H <sub>2</sub> O, EtOH; s eth, bz, chl
4009	2,6-Dimethyl-2,5-cyclohexadiene-1,4-dione		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	527-61-7	136.149	ye nd	72.5	sub	1.0479 <sup>28</sup>		s chl
4010	1,1-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	590-66-9	112.213	liq	-33.3	119.6	0.7809 <sup>20</sup>	1.4290 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; msc ctc
4011	<i>cis</i> -1,2-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	2207-01-4	112.213	liq	-49.8	129.8	0.7963 <sup>20</sup>	1.4360 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc; msc eth, ace
4012	<i>trans</i> -1,2-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	6876-23-9	112.213	liq	-88.15	123.5	0.7760 <sup>20</sup>	1.4270 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz; vs lig
4013	<i>cis</i> -1,3-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	638-04-0	112.213	liq	-75.53	120.1	0.7660 <sup>20</sup>	1.4229 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
4014	<i>trans</i> -1,3-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	2207-03-6	112.213	liq	-90.07	124.5	0.79 <sup>15</sup>	1.4284 <sup>25</sup>	
4015	<i>cis</i> -1,4-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	624-29-3	112.213	liq	-87.39	124.4	0.7829 <sup>20</sup>	1.4230 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
4016	<i>trans</i> -1,4-Dimethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	2207-04-7	112.213	liq	-36.93	119.4	0.77 <sup>15</sup>	1.4185 <sup>25</sup>	i H <sub>2</sub> O
4017	Dimethyl <i>trans</i> -1,4-cyclohexanedicarboxylate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	3399-22-2	200.232	ndl (eth)	71				s eth
4018	5,5-Dimethyl-1,3-cyclohexanedione	5,5-Dimethyldihydroresorcinol	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	126-81-8	140.180	nd (w)	150	dec			sl H <sub>2</sub> O, eth; s ace, ctc; vs chl, HOAc
4019	<i>N</i> , $\alpha$ -Dimethylcyclohexaneethanamine	Propylhexedrine	C <sub>10</sub> H <sub>21</sub> N	101-40-6	155.281			205; 82 <sup>10</sup>	0.8501 <sup>20</sup>	1.4600 <sup>20</sup>	vs EtOH
4020	3,3-Dimethylcyclohexanol		C <sub>8</sub> H <sub>16</sub> O	767-12-4	128.212		11.5	185; 99.5 <sup>35</sup>	0.9128 <sup>14</sup>	1.4606 <sup>15</sup>	
4021	2,2-Dimethylcyclohexanone		C <sub>8</sub> H <sub>14</sub> O	1193-47-1	126.196	liq	-20.5	172	0.9145 <sup>20</sup>	1.4486 <sup>20</sup>	
4022	2,6-Dimethylcyclohexanone		C <sub>8</sub> H <sub>14</sub> O	2816-57-1	126.196			175	0.925 <sup>25</sup>	1.4460 <sup>20</sup>	
4023	3,3-Dimethylcyclohexanone		C <sub>8</sub> H <sub>14</sub> O	2979-19-3	126.196			180; 72 <sup>25</sup>	0.909 <sup>15</sup>	1.4482 <sup>17</sup>	
4024	4,4-Dimethylcyclohexanone		C <sub>8</sub> H <sub>14</sub> O	4255-62-3	126.196		39	73 <sup>14</sup>	0.932 <sup>20</sup>	1.4537 <sup>24</sup>	
4025	1,2-Dimethylcyclohexene		C <sub>8</sub> H <sub>14</sub>	1674-10-8	110.197	liq	-84.1	138	0.8220 <sup>25</sup>	1.4620 <sup>20</sup>	
4026	1,3-Dimethylcyclohexene		C <sub>8</sub> H <sub>14</sub>	2808-76-6	110.197			127	0.799 <sup>25</sup>	1.449 <sup>20</sup>	
4027	3,5-Dimethyl-2-cyclohexen-1-one		C <sub>8</sub> H <sub>12</sub> O	1123-09-7	124.180			208.5	0.9400 <sup>20</sup>	1.4812 <sup>20</sup>	s EtOH, eth
4028	1,1-Dimethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	1638-26-2	98.186	liq	-69.8	87.5	0.7499 <sup>25</sup>	1.4136 <sup>20</sup>	
4029	<i>cis</i> -1,2-Dimethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	1192-18-3	98.186	liq	-54	99.5	0.7680 <sup>25</sup>	1.4222 <sup>20</sup>	
4030	<i>trans</i> -1,2-Dimethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	822-50-4	98.186	liq	-117.6	91.9	0.7468 <sup>25</sup>	1.4120 <sup>20</sup>	
4031	<i>cis</i> -1,3-Dimethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	2532-58-3	98.186	liq	-133.7	90.8	0.7402 <sup>25</sup>	1.4089 <sup>20</sup>	
4032	<i>trans</i> -1,3-Dimethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	1759-58-6	98.186	liq	-134	91.7	0.7443 <sup>25</sup>	1.4107 <sup>20</sup>	
4033	<i>N</i> , $\alpha$ -Dimethylcyclopentaneethanamine	Cyclopentamine	C <sub>9</sub> H <sub>19</sub> N	102-45-4	141.254			171		1.4500 <sup>20</sup>	
4034	1,2-Dimethylcyclopentene		C <sub>7</sub> H <sub>12</sub>	765-47-9	96.170	liq	-90.4	105.8	0.7928 <sup>25</sup>	1.4448 <sup>20</sup>	
4035	1,5-Dimethylcyclopentene		C <sub>7</sub> H <sub>12</sub>	16491-15-9	96.170	liq	-118	99	0.780 <sup>20</sup>	1.4331 <sup>20</sup>	
4036	1,1-Dimethylcyclopropane		C <sub>5</sub> H <sub>10</sub>	1630-94-0	70.133	vol liq or gas	-109	20.6	0.6604 <sup>20</sup>	1.3668 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, vs eth, sulf

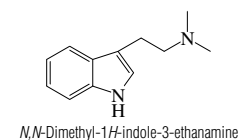
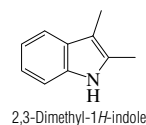
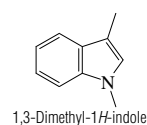
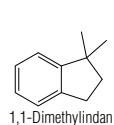
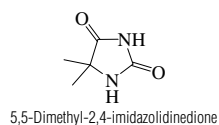
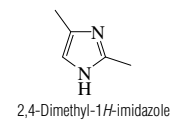
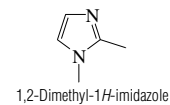
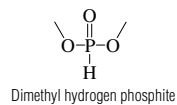
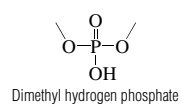
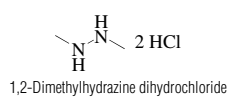
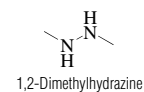
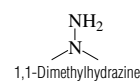
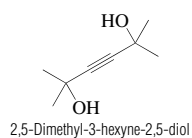
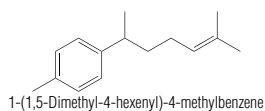
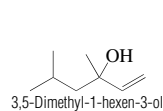
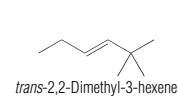
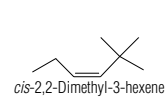
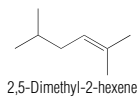
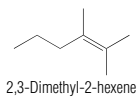
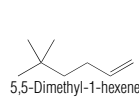
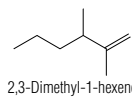
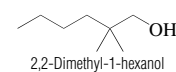
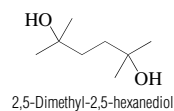
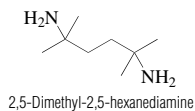
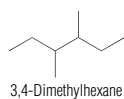
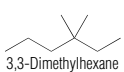
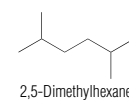
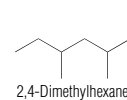
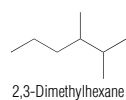
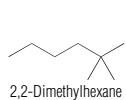
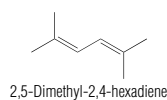
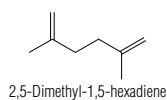
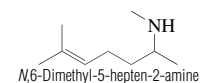
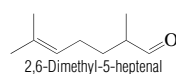
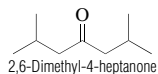
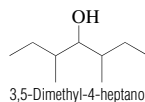
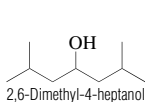
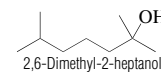
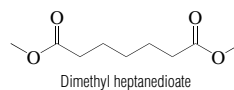
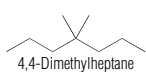
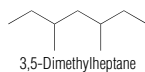
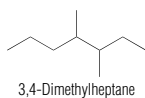


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4037	<i>cis</i> -1,2-Dimethylcyclopropane		C <sub>5</sub> H <sub>10</sub>	930-18-7	70.133	liq	-140.9	37.0	0.6889 <sup>25</sup>	1.3829 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth; sl ctc
4038	<i>trans</i> -1,2-Dimethylcyclopropane		C <sub>5</sub> H <sub>10</sub>	2402-06-4	70.133	vol liq or gas	-149.6	28.2	0.6648 <sup>25</sup>	1.3713 <sup>20</sup>	vs eth, EtOH
4039	Dimethyldecylamine	<i>N,N</i> -Dimethyl-1-decanamine	C <sub>12</sub> H <sub>27</sub> N	1120-24-7	185.349			234.5			
4040	Dimethyldiacetoxysilane	Bis(acetyloxy)dimethylsilane	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub> Si	2182-66-3	176.243	liq	-12.5	165	1.0540 <sup>20</sup>	1.4030 <sup>20</sup>	
4041	<i>trans</i> -Dimethyldiazene	Azomethane	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	4143-41-3	58.082	gas	-78	1.5	0.743 <sup>0</sup>	1.4199 <sup>19</sup>	vs ace, EtOH, eth; s ctc, hp
4042	2,2-Dimethyl-1,3-dioxane-4,6-dione	Meldrum's acid	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	2033-24-1	144.126		94				
4043	<i>cis</i> -3,6-Dimethyl-1,4-dioxane-2,5-dione		C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	4511-42-6	144.126	orth (eth)	96.8	150 <sup>25</sup>			
4044	2,2-Dimethyl-1,3-dioxolane-4-methanol	Isopropylidene glycerol	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	100-79-8	132.157			82 <sup>10</sup>	1.064 <sup>20</sup>	1.4383 <sup>20</sup>	
4045	Dimethyldiphenoxysilane		C <sub>14</sub> H <sub>16</sub> O <sub>2</sub> Si	3440-02-6	244.362		-23	131 <sup>5</sup>	1.0599 <sup>25</sup>	1.5330 <sup>20</sup>	
4046	2,3-Dimethyl-2,3-diphenylbutane	Dicumene	C <sub>18</sub> H <sub>22</sub>	1889-67-4	238.368	cry (MeOH)	119.5				
4047	3,3'-Dimethyldiphenylmethane 4,4'-diisocyanate		C <sub>17</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	139-25-3	278.305						s chl
4048	2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline		C <sub>26</sub> H <sub>20</sub> N <sub>2</sub>	4733-39-5	360.450		280 dec				
4049	Dimethyldiphenylsilane		C <sub>14</sub> H <sub>16</sub> Si	778-24-5	212.363			277; 173 <sup>45</sup>	0.9867 <sup>20</sup>	1.5644 <sup>20</sup>	
4050	<i>N,N'</i> -Dimethyl- <i>N,N'</i> -diphenylurea		C <sub>15</sub> H <sub>16</sub> N <sub>2</sub> O	611-92-7	240.300	pl (al)	122	350			vs H <sub>2</sub> O, EtOH, ace; sl eth, bz, CS <sub>2</sub>
4051	Dimethyl disulfide	Methyl disulfide	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	624-92-0	94.199	liq	-84.67	109.74	1.0625 <sup>20</sup>	1.5289 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
4052	<i>O,O</i> -Dimethyl dithiophosphate	<i>O,O</i> -Dimethyl phosphorodithionate	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> PS <sub>2</sub>	756-80-9	158.180	liq		56 <sup>4</sup>	1.29 <sup>20</sup>		
4053	<i>N,N</i> -Dimethyldodecylamine oxide		C <sub>14</sub> H <sub>31</sub> NO	1643-20-5	229.402	hyg nd (tol)	130.5				
4054	1,2-Dimethylenecyclohexane		C <sub>8</sub> H <sub>12</sub>	2819-48-9	108.181			127; 60 <sup>90</sup>	0.8361 <sup>20</sup>	1.4718 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; vs ace
4055	<i>N,N</i> -Dimethyl-1,2-ethanediamine		C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	108-00-9	88.151			104	0.803 <sup>25</sup>	1.4260 <sup>20</sup>	
4056	<i>N,N'</i> -Dimethyl-1,2-ethanediamine		C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	110-70-3	88.151			120	0.828 <sup>15</sup>		s EtOH, eth, dil HCl
4057	<i>N,N</i> -Dimethylethanolamine	Deanol	C <sub>4</sub> H <sub>11</sub> NO	108-01-0	89.136	liq	-59	134	0.8866 <sup>20</sup>	1.4300 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl
4058	Dimethyl ether	Methyl ether	C <sub>2</sub> H <sub>6</sub> O	115-10-6	46.068	col gas	-141.5	-24.8			s H <sub>2</sub> O, EtOH, eth, ace, chl; sl bz
4059	(1,1-Dimethylethoxy)benzene		C <sub>10</sub> H <sub>14</sub> O	6669-13-2	150.217	liq	-24	185.5	0.9214 <sup>20</sup>		
4060	[(1,1-Dimethylethoxy)methyl]oxirane		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	7665-72-7	130.185	liq	-70	152	0.898 <sup>20</sup>		
4061	<i>N,N</i> -Dimethylformamide	DMF	C <sub>3</sub> H <sub>7</sub> NO	68-12-2	73.094	liq	-60.48	153	0.9445 <sup>25</sup>	1.4305 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz; sl liq
4062	Dimethyl fumarate		C <sub>6</sub> H <sub>6</sub> O <sub>4</sub>	624-49-7	144.126		103.5	193	1.37 <sup>20</sup>	1.4062 <sup>111</sup>	i H <sub>2</sub> O; s ace, chl
4063	2,5-Dimethylfuran		C <sub>6</sub> H <sub>8</sub> O	625-86-5	96.127	liq	-62.8	93	0.8883 <sup>20</sup>	1.4363 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc, chl
4064	3,4-Dimethyl-2,5-furandione		C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	766-39-2	126.110	pl or lf (dil al)	96	223	1.107 <sup>100</sup>		sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
4065	Dimethyl germanium sulfide		C <sub>2</sub> H <sub>6</sub> GeS	16090-49-6	134.77	col cry	54.5	302			
4066	Dimethyl glutarate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	1119-40-0	160.168	liq	-42.5	214; 109 <sup>21</sup>	1.0876 <sup>20</sup>	1.4242 <sup>20</sup>	vs EtOH, eth; s chl
4067	<i>N,N</i> -Dimethylglycine		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	1118-68-9	103.120	hyg nd (PrOH)	185.5				vs H <sub>2</sub> O, MeOH; s EtOH, eth, ace
4068	Dimethylglyoxime		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	95-45-4	116.119	nd (to or dil al)	245.5	sub 234			i H <sub>2</sub> O; vs EtOH, eth; sl bz, tol
4069	2,6-Dimethyl-1,5-heptadiene		C <sub>9</sub> H <sub>16</sub>	6709-39-3	124.223	liq	-70	143	0.7648 <sup>25</sup>		
4070	2,2-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	1071-26-7	128.255	liq	-113	132.7	0.7105 <sup>20</sup>	1.4016 <sup>20</sup>	i H <sub>2</sub> O; s eth, ctc; vs ace, chl; msc bz
4071	2,3-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	3074-71-3	128.255	liq	-116	140.5	0.7260 <sup>20</sup>	1.4088 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, chl
4072	2,4-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	2213-23-2	128.255			132.9	0.7115 <sup>25</sup>	1.4034 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl, peth
4073	2,5-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	2216-30-0	128.255			136	0.7198 <sup>20</sup>	1.4033 <sup>20</sup>	vs ace, bz, eth, EtOH
4074	2,6-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	1072-05-5	128.255	liq	-102.9	135.2	0.7089 <sup>20</sup>	1.4011 <sup>20</sup>	sl chl
4075	3,3-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	4032-86-4	128.255			137.3	0.7254 <sup>20</sup>	1.4087 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth; vs ace, bz

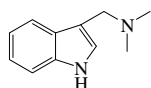
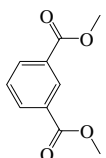




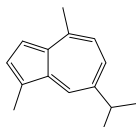
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4076	3,4-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	922-28-1	128.255			140.6	0.7314 <sup>20</sup>	1.4108 <sup>20</sup>	i H <sub>2</sub> O; s eth, ctc; vs ace, chl; msc bz
4077	3,5-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	926-82-9	128.255			136	0.7225 <sup>20</sup>	1.4083 <sup>20</sup>	i H <sub>2</sub> O; s eth, ctc; vs ace, chl; msc bz
4078	4,4-Dimethylheptane		C <sub>9</sub> H <sub>20</sub>	1068-19-5	128.255			135.2	0.7221 <sup>20</sup>	1.4076 <sup>20</sup>	i H <sub>2</sub> O; s eth, ctc; vs ace, chl; msc bz
4079	Dimethyl heptanedioate	Dimethyl pimelate	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	1732-08-7	188.221		-21	120 <sup>10</sup> , 80 <sup>1</sup>	1.0625 <sup>20</sup>	1.4309 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz
4080	2,6-Dimethyl-2-heptanol		C <sub>9</sub> H <sub>20</sub> O	13254-34-7	144.254			173	0.8186 <sup>20</sup>	1.4242 <sup>20</sup>	
4081	2,6-Dimethyl-4-heptanol	Diisobutylcarbinol	C <sub>9</sub> H <sub>20</sub> O	108-82-7	144.254			174.5	0.8114 <sup>20</sup>	1.4242 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
4082	3,5-Dimethyl-4-heptanol		C <sub>9</sub> H <sub>20</sub> O	19549-79-2	144.254			186	0.836 <sup>18</sup>	1.4283 <sup>20</sup>	sl H <sub>2</sub> O
4083	2,6-Dimethyl-4-heptanone	Diisobutyl ketone	C <sub>9</sub> H <sub>18</sub> O	108-83-8	142.238	liq	-41.5	169.4	0.8062 <sup>20</sup>	1.412 <sup>21</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
4084	2,6-Dimethyl-5-heptenal		C <sub>9</sub> H <sub>16</sub> O	106-72-9	140.222	oil		120 <sup>100</sup>			
4085	N,6-Dimethyl-5-hepten-2-amine	Isometheptene	C <sub>9</sub> H <sub>19</sub> N	503-01-5	141.254			177			vs eth, EtOH
4086	2,5-Dimethyl-1,5-hexadiene		C <sub>8</sub> H <sub>14</sub>	627-58-7	110.197	liq	-75.6	114.3	0.743 <sup>20</sup>	1.43995 <sup>21</sup>	i H <sub>2</sub> O; s ace, chl
4087	2,5-Dimethyl-2,4-hexadiene		C <sub>8</sub> H <sub>14</sub>	764-13-6	110.197		14	134.5	0.7577 <sup>25</sup>	1.4785 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4088	2,2-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	590-73-8	114.229	liq	-121.1	106.86	0.6953 <sup>20</sup>	1.3935 <sup>20</sup>	vs ace, bz, eth, EtOH
4089	2,3-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	584-94-1	114.229			115.62	0.6912 <sup>25</sup>	1.4011 <sup>20</sup>	vs ace, bz, EtOH, lig
4090	2,4-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	589-43-5	114.229			109.5	0.6962 <sup>25</sup>	1.3929 <sup>25</sup>	
4091	2,5-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	592-13-2	114.229	liq	-91	109.12	0.6901 <sup>25</sup>	1.3925 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, ace, bz; s eth
4092	3,3-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	563-16-6	114.229	liq	-126.1	111.97	0.7100 <sup>20</sup>	1.4001 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; vs eth, ace, bz
4093	3,4-Dimethylhexane		C <sub>8</sub> H <sub>18</sub>	583-48-2	114.229			117.73	0.7151 <sup>25</sup>	1.4041 <sup>20</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz
4094	2,5-Dimethyl-2,5-hexanediamine		C <sub>8</sub> H <sub>20</sub> N <sub>2</sub>	23578-35-0	144.258			184; 63 <sup>8</sup>	0.8485 <sup>15</sup>	1.4459 <sup>20</sup>	
4095	2,5-Dimethyl-2,5-hexanediol	1,1,4,4-Tetramethyl-1,4-butanediol	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	110-03-2	146.228	pr (AcOEt) fl (peth)	88.50	214	0.898 <sup>20</sup>		s H <sub>2</sub> O; vs EtOH, bz, chl
4096	2,2-Dimethyl-1-hexanol		C <sub>8</sub> H <sub>18</sub> O	2370-13-0	130.228			95 <sup>29</sup>			
4097	2,3-Dimethyl-1-hexene		C <sub>8</sub> H <sub>16</sub>	16746-86-4	112.213			110.5	0.7172 <sup>25</sup>	1.4113 <sup>20</sup>	
4098	5,5-Dimethyl-1-hexene		C <sub>8</sub> H <sub>16</sub>	7116-86-1	112.213			104	0.705 <sup>25</sup>	1.4049 <sup>20</sup>	
4099	2,3-Dimethyl-2-hexene		C <sub>8</sub> H <sub>16</sub>	7145-20-2	112.213	liq	-115.1	121.8	0.7366 <sup>25</sup>	1.4268 <sup>20</sup>	
4100	2,5-Dimethyl-2-hexene		C <sub>8</sub> H <sub>16</sub>	3404-78-2	112.213			112.2	0.7182 <sup>20</sup>	1.4140 <sup>20</sup>	
4101	cis-2,2-Dimethyl-3-hexene		C <sub>8</sub> H <sub>16</sub>	690-92-6	112.213	liq	-137.4	105.5	0.7086 <sup>25</sup>	1.4099 <sup>20</sup>	
4102	trans-2,2-Dimethyl-3-hexene		C <sub>8</sub> H <sub>16</sub>	690-93-7	112.213			100.8	0.6995 <sup>25</sup>	1.4063 <sup>20</sup>	
4103	3,5-Dimethyl-1-hexen-3-ol		C <sub>8</sub> H <sub>16</sub> O	3329-48-4	128.212			146.5	0.8382 <sup>20</sup>	1.4342 <sup>20</sup>	
4104	1-(1,5-Dimethyl-4-hexenyl)-4-methylbenzene	α-Curcumene	C <sub>15</sub> H <sub>22</sub>	644-30-4	202.336			140 <sup>19</sup>	0.8805 <sup>20</sup>	1.4989 <sup>20</sup>	i H <sub>2</sub> O; s bz
4105	2,5-Dimethyl-3-hexyne-2,5-diol		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	142-30-3	142.196		95	205	0.947 <sup>20</sup>		s H <sub>2</sub> O, chl; vs EtOH, eth, ace, bz
4106	1,1-Dimethylhydrazine		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	57-14-7	60.098	liq, fumes in air	-57.20	63.9	0.791 <sup>22</sup>	1.4075 <sup>22</sup>	vs H <sub>2</sub> O, EtOH, eth, MeOH
4107	1,2-Dimethylhydrazine		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	540-73-8	60.098	fumes (air)	-8.9	81	0.8274 <sup>20</sup>	1.4209 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
4108	1,2-Dimethylhydrazine dihydrochloride		C <sub>2</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	306-37-6	133.019	pr (w)	170 dec				vs H <sub>2</sub> O, EtOH
4109	Dimethyl hydrogen phosphate	Dimethyl phosphate	C <sub>2</sub> H <sub>4</sub> O <sub>4</sub> P	813-78-5	126.048			dec 174	1.3225 <sup>20</sup>	1.408 <sup>25</sup>	vs H <sub>2</sub> O, ace, EtOH
4110	Dimethyl hydrogen phosphite		C <sub>2</sub> H <sub>4</sub> O <sub>3</sub> P	868-85-9	110.049			170.5	1.2002 <sup>20</sup>	1.4036 <sup>20</sup>	s EtOH, py; sl ctc
4111	1,2-Dimethyl-1H-imidazole		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1739-84-0	96.131			206	1.0051 <sup>11</sup>		vs H <sub>2</sub> O, eth, EtOH
4112	2,4-Dimethyl-1H-imidazole		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	930-62-1	96.131		92	267			
4113	5,5-Dimethyl-2,4-imidazolidinedione		C <sub>5</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	77-71-4	128.130	pr (dil al)	178	sub			vs H <sub>2</sub> O, EtOH, eth, ace, bz, chl; s DMSO
4114	1,1-Dimethylindan		C <sub>11</sub> H <sub>14</sub>	4912-92-9	146.229			191	0.919 <sup>20</sup>	1.5135 <sup>25</sup>	
4115	1,3-Dimethyl-1H-indole		C <sub>10</sub> H <sub>11</sub> N	875-30-9	145.201	nd	142	258.5			s eth
4116	2,3-Dimethyl-1H-indole		C <sub>10</sub> H <sub>11</sub> N	91-55-4	145.201		107.5	287			
4117	N,N-Dimethyl-1H-indole-3-ethanamine	N,N-Dimethyltryptamine	C <sub>12</sub> H <sub>16</sub> N <sub>2</sub>	61-50-7	188.268		46				



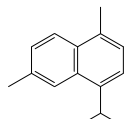
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4118	<i>N,N</i> -Dimethyl-1- <i>H</i> -indole-3-methanamine	Gramine	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub>	87-52-5	174.242	nd or pl (ace)	138.5				i H <sub>2</sub> O; s EtOH, eth, chl; i peth
4119	Dimethyl isophthalate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	1459-93-4	194.184	nd(dil al)	67.5	282	1.194 <sup>20</sup>	1.5168 <sup>20</sup>	sl H <sub>2</sub> O
4120	1,4-Dimethyl-7-isopropylazulene	Guaiazulene	C <sub>15</sub> H <sub>18</sub>	489-84-9	198.304	bl-viol pl (al)	31.5	167 <sup>12</sup>	0.973 <sup>20</sup>		s EtOH, eth, AcOEt
4121	1,6-Dimethyl-4-isopropyl-naphthalene	Cadalene	C <sub>15</sub> H <sub>18</sub>	483-78-3	198.304			294; 149 <sup>10</sup>	0.9667 <sup>25</sup>	1.5785 <sup>25</sup>	vs oils
4122	2,4-Dimethyl-3-isopropylpentane		C <sub>10</sub> H <sub>22</sub>	13475-79-1	142.282	liq	-81.7	157.1	0.7545 <sup>25</sup>	1.4246 <sup>20</sup>	
4123	3,5-Dimethylisoxazole		C <sub>5</sub> H <sub>6</sub> NO	300-87-8	97.116			143	0.99 <sup>25</sup>	1.4421 <sup>20</sup>	
4124	Dimethylmagnesium	Magnesium dimethyl	C <sub>2</sub> H <sub>5</sub> Mg	2999-74-8	54.374	solid	220 dec	subl			
4125	Dimethyl maleate	Methyl <i>cis</i> -butenedioate	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	624-48-6	144.126	liq	-19	202	1.1606 <sup>20</sup>	1.4416 <sup>20</sup>	sl H <sub>2</sub> O, lig; s eth, ctc
4126	Dimethyl malonate	Methyl malonate	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	108-59-8	132.116	liq	-61.9	181.4	1.528 <sup>20</sup>	1.4135 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; vs ace, bz; s chl
4127	Dimethylmalonic acid	Dimethylpropanedioic acid	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	595-46-0	132.116	pr (bz/peth)	192.5	subl			s hot H <sub>2</sub> O
4128	Dimethyl mercury		C <sub>2</sub> H <sub>6</sub> Hg	593-74-8	230.66			93	3.17 <sup>25</sup>	1.5452 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
4129	Dimethyl <i>cis</i> -2-methyl-2-butenedioate	Dimethyl citraconate	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	617-54-9	158.152			210.5	1.1153 <sup>20</sup>	1.4473 <sup>20</sup>	vs ace, eth, EtOH
4130	Dimethyl methylenesuccinate		C <sub>7</sub> H <sub>10</sub> O <sub>4</sub>	617-52-7	158.152	hyg mcl (MeOH)	38	208	1.1241 <sup>18</sup>	1.4457 <sup>20</sup>	s EtOH, eth, MeOH; vs ace
4131	Dimethyl methylmalonate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	609-02-9	146.141			174	1.0977 <sup>20</sup>	1.4128 <sup>20</sup>	vs ace, eth, EtOH, chl
4132	Dimethyl methylphosphonate		C <sub>3</sub> H <sub>7</sub> O <sub>3</sub> P	756-79-6	124.075			181; 79.5 <sup>20</sup>	1.1684 <sup>20</sup>	1.4099 <sup>30</sup>	s H <sub>2</sub> O; EtOH, eth
4133	<i>trans</i> -2,2-Dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylic acid		C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	4638-92-0	168.233	pr	20.0	245			vs eth, EtOH, chl
4134	Dimethyl 2-methylsuccinate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	1604-11-1	160.168			196	1.076 <sup>25</sup>	1.4200 <sup>20</sup>	
4135	Dimethyl <i>p</i> -(methylthio)phenyl phosphate		C <sub>9</sub> H <sub>13</sub> O <sub>4</sub> PS	3254-63-5	248.235	liq			1.273 <sup>21</sup>		sl H <sub>2</sub> O; s ace, EtOH, diox, ctc, xyl
4136	2,6-Dimethylmorpholine		C <sub>6</sub> H <sub>13</sub> NO	141-91-3	115.173	liq	-88	146.6	0.9329 <sup>20</sup>	1.4460 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, bz, lig; s ace; sl chl
4137	Dimethyl morpholinophosphoramidate	Dimethyl 4-morpholinylphosphonate	C <sub>6</sub> H <sub>14</sub> NO <sub>4</sub> P	597-25-1	195.153	liq		96 <sup>1</sup>			
4138	1,2-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	573-98-8	156.223		0.8	266.5	1.0179 <sup>20</sup>	1.6166 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
4139	1,3-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	575-41-7	156.223	liq	-6	263	1.0144 <sup>20</sup>	1.6140 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
4140	1,4-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	571-58-4	156.223		7.6	268	1.0166 <sup>20</sup>	1.6127 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, ace, bz, ctc
4141	1,5-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	571-61-9	156.223		82	265			i H <sub>2</sub> O; vs bz, eth
4142	1,6-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	575-43-9	156.223	liq	-16.9	264	1.0021 <sup>20</sup>	1.6166 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
4143	1,7-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	575-37-1	156.223	liq	-13.9	263	1.0115 <sup>20</sup>	1.6083 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz
4144	1,8-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	569-41-5	156.223		65	270	1.003 <sup>20</sup>		i H <sub>2</sub> O; s eth, bz
4145	2,3-Dimethylnaphthalene	Guajen	C <sub>12</sub> H <sub>12</sub>	581-40-8	156.223	lf (al)	105	268	1.003 <sup>20</sup>	1.5060 <sup>20</sup>	i H <sub>2</sub> O; vs bz, eth
4146	2,6-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	581-42-0	156.223		112	262	1.003 <sup>20</sup>		i H <sub>2</sub> O
4147	2,7-Dimethylnaphthalene		C <sub>12</sub> H <sub>12</sub>	582-16-1	156.223		97	265	1.003 <sup>20</sup>		
4148	<i>N,N</i> -Dimethyl-1-naphthylamine		C <sub>12</sub> H <sub>13</sub> N	86-56-6	171.238	viol flr cry		250; 140 <sup>13</sup>	1.0423 <sup>20</sup>	1.624 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
4149	<i>N,N</i> -Dimethyl-2-naphthylamine		C <sub>12</sub> H <sub>13</sub> N	2436-85-3	171.238	dk red nd	52.5	305	1.0279 <sup>20</sup>	1.6443 <sup>33</sup>	i H <sub>2</sub> O; s EtOH, eth
4150	<i>N,N</i> -Dimethyl-2-nitroaniline		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	610-17-3	166.177	ye-oran	-20	146 <sup>20</sup>	1.1794 <sup>20</sup>	1.6102 <sup>20</sup>	s H <sub>2</sub> O, eth; vs EtOH, chl
4151	<i>N,N</i> -Dimethyl-3-nitroaniline		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	619-31-8	166.177	red mcl pr (eth)	60.5	282.5	1.313 <sup>17</sup>		i H <sub>2</sub> O; s EtOH, eth
4152	<i>N,N</i> -Dimethyl-4-nitroaniline		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	100-23-2	166.177	ye nd (al)	164.5				i H <sub>2</sub> O; s EtOH, eth, HOAc
4153	1,2-Dimethyl-3-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	83-41-0	151.163	nd (al)	15	240	1.1402 <sup>20</sup>	1.5441 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc
4154	1,2-Dimethyl-4-nitrobenzene	4-Nitro- <i>o</i> -xylene	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	99-51-4	151.163	ye pr (al)	30.5	251; 143 <sup>21</sup>	1.112 <sup>15</sup>	1.5202 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH
4155	1,3-Dimethyl-2-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	81-20-9	151.163		15	226	1.112 <sup>15</sup>	1.5202 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s ctc
4156	1,3-Dimethyl-5-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	99-12-7	151.163	nd (al)	75	274			i H <sub>2</sub> O; vs EtOH, eth
4157	1,4-Dimethyl-2-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	89-58-7	151.163	pa ye liq	-25	240.5	1.132 <sup>15</sup>	1.5413 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
4158	2,4-Dimethyl-1-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	89-87-2	151.163		9	247; 122 <sup>18</sup>	1.135 <sup>15</sup>	1.5473 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
4159	1,2-Dimethyl-5-nitro-1- <i>H</i> -imidazole	Dimetridazole	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	551-92-8	141.129	nd (w)	138.5				vs eth, EtOH
4160	<i>N,N</i> -Dimethyl-4-[2-(4-nitrophenyl)ethenyl]aniline		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	4584-57-0	268.310		258.3				

*N,N*-Dimethyl-1*H*-indole-3-methanamine

Dimethyl isophthalate



1,4-Dimethyl-7-isopropylazulene



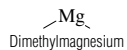
1,6-Dimethyl-4-isopropyl-naphthalene



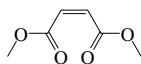
2,4-Dimethyl-3-isopropyl-pentane



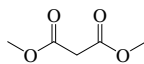
3,5-Dimethylisoxazole



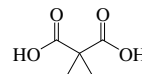
Dimethylmagnesium



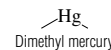
Dimethyl maleate



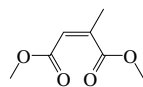
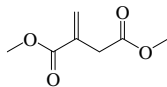
Dimethyl malonate



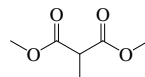
Dimethylmalonic acid



Dimethyl mercury

Dimethyl *cis*-2-methyl-2-butenedioate

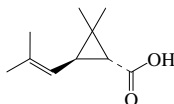
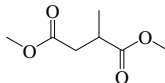
Dimethyl methylenesuccinate



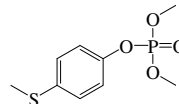
Dimethyl methylmalonate



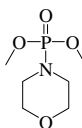
Dimethyl methylphosphonate

*trans*-2,2-Dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylic acid

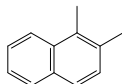
Dimethyl 2-methylsuccinate

Dimethyl *p*-(methylthio)phenyl phosphate

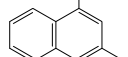
2,6-Dimethylmorpholine



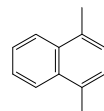
Dimethyl morpholinophosphoramidate



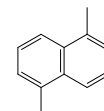
1,2-Dimethylnaphthalene



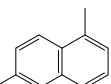
1,3-Dimethylnaphthalene



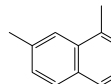
1,4-Dimethylnaphthalene



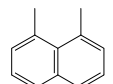
1,5-Dimethylnaphthalene



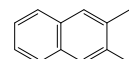
1,6-Dimethylnaphthalene



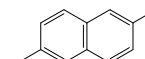
1,7-Dimethylnaphthalene



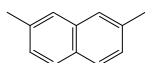
1,8-Dimethylnaphthalene



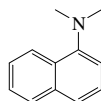
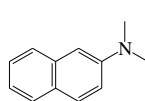
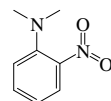
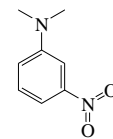
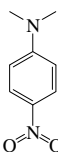
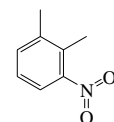
2,3-Dimethylnaphthalene



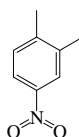
2,6-Dimethylnaphthalene



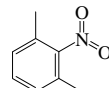
2,7-Dimethylnaphthalene

*N,N*-Dimethyl-1-naphthylamine*N,N*-Dimethyl-2-naphthylamine*N,N*-Dimethyl-2-nitroaniline*N,N*-Dimethyl-3-nitroaniline*N,N*-Dimethyl-4-nitroaniline

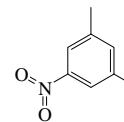
1,2-Dimethyl-3-nitrobenzene



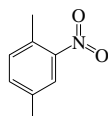
1,2-Dimethyl-4-nitrobenzene



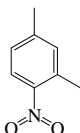
1,3-Dimethyl-2-nitrobenzene



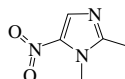
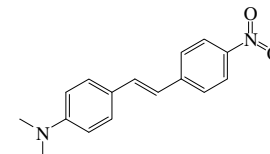
1,3-Dimethyl-5-nitrobenzene



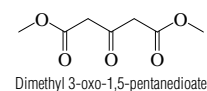
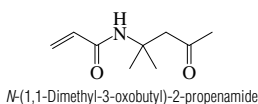
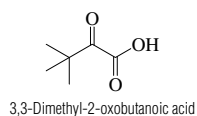
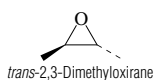
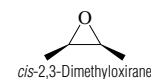
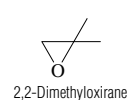
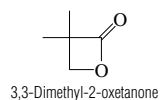
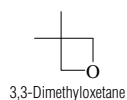
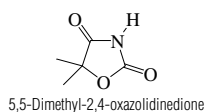
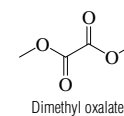
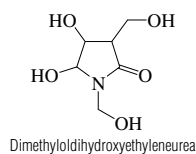
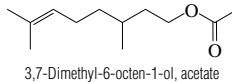
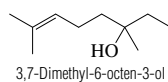
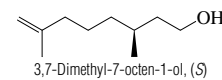
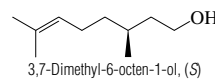
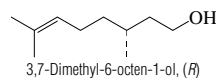
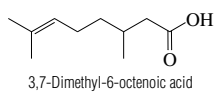
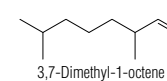
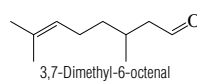
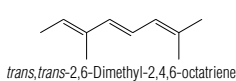
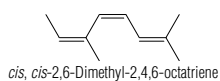
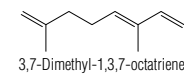
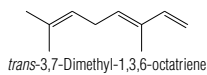
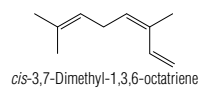
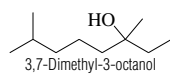
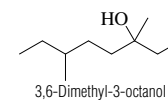
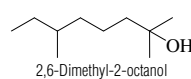
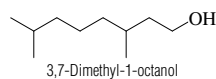
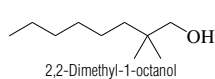
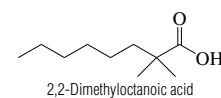
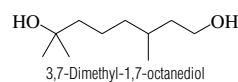
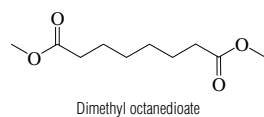
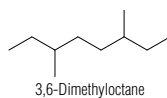
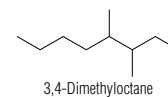
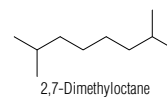
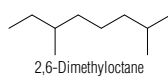
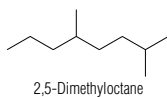
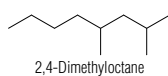
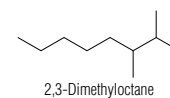
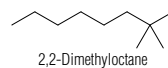
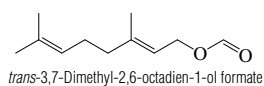
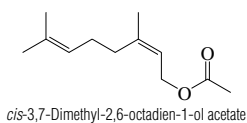
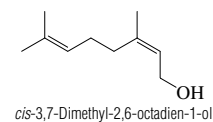
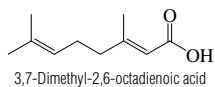
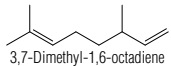
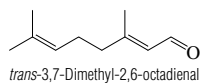
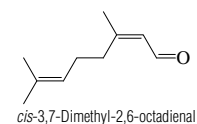
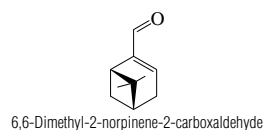
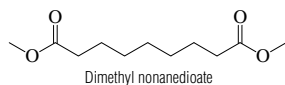
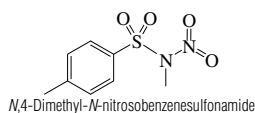
1,4-Dimethyl-2-nitrobenzene



2,4-Dimethyl-1-nitrobenzene

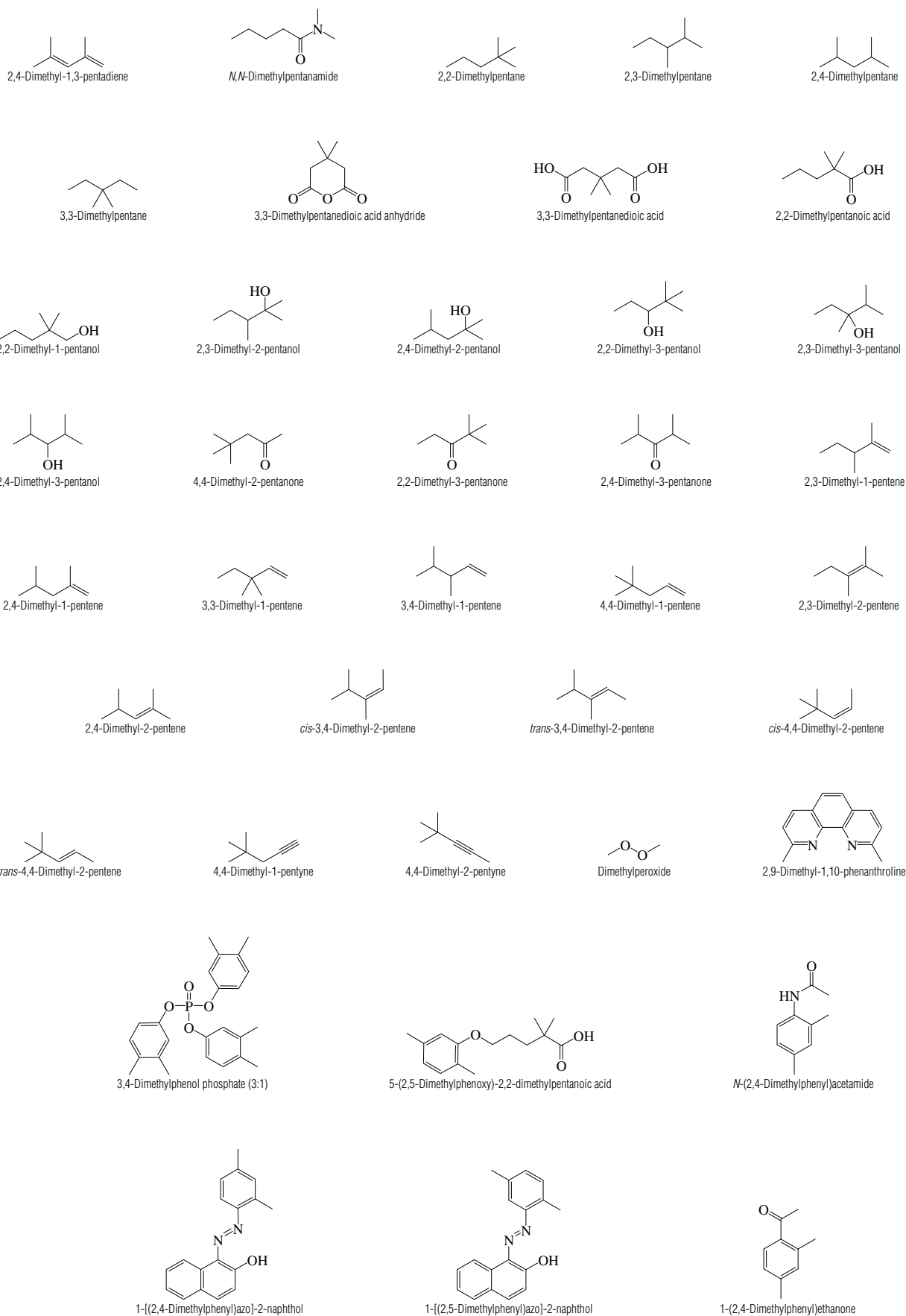
1,2-Dimethyl-5-nitro-1*H*-imidazole*N,N*-Dimethyl-4-[2-(4-nitrophenyl)ethenyl]aniline

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4161	<i>N,N</i> -Dimethyl- <i>N</i> -nitrosobenzenesulfonamide	<i>p</i> -Tolylsulfonilylmethylnitrosamide	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub> S	80-11-5	214.241	cry	60				i H <sub>2</sub> O; vs EtOH, eth
4162	Dimethyl nonanedioate	Methyl azelate	C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	1732-10-1	216.275		-0.8	156 <sup>20</sup>	1.0082 <sup>20</sup>	1.4367 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz, ctc
4163	6,6-Dimethyl-2-norpinene-2-carboxaldehyde	Myrtenal	C <sub>10</sub> H <sub>14</sub> O	564-94-3	150.217	unstab oil		99 <sup>15</sup>			
4164	<i>cis</i> -3,7-Dimethyl-2,6-octadienal		C <sub>10</sub> H <sub>16</sub> O	106-26-3	152.233			120 <sup>20</sup>	0.8869 <sup>20</sup>	1.4869 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
4165	<i>trans</i> -3,7-Dimethyl-2,6-octadienal		C <sub>10</sub> H <sub>16</sub> O	141-27-5	152.233			229	0.8888 <sup>20</sup>	1.4898 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
4166	3,7-Dimethyl-1,6-octadiene	Citronellene	C <sub>10</sub> H <sub>18</sub>	2436-90-0	138.250				0.7601 <sup>20</sup>	1.4362 <sup>20</sup>	
4167	3,7-Dimethyl-2,6-octadienoic acid	Geranic acid	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	459-80-3	168.233	oil					
4168	<i>cis</i> -3,7-Dimethyl-2,6-octadien-1-ol	Nerol	C <sub>10</sub> H <sub>18</sub> O	106-25-2	154.249		<-15	225; 125 <sup>25</sup>	0.8756 <sup>20</sup>	1.4746 <sup>20</sup>	vs EtOH
4169	<i>cis</i> -3,7-Dimethyl-2,6-octadien-1-ol acetate		C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	141-12-8	196.286			134 <sup>25</sup> , 93 <sup>3</sup>	0.905 <sup>15</sup>	1.452 <sup>20</sup>	
4170	<i>trans</i> -3,7-Dimethyl-2,6-octadien-1-ol formate		C <sub>11</sub> H <sub>18</sub> O <sub>2</sub>	105-86-2	182.260			dec 229; 113 <sup>25</sup>	0.9086 <sup>25</sup>	1.4659 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace
4171	2,2-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	15869-87-1	142.282			155	0.7208 <sup>25</sup>	1.4082 <sup>20</sup>	
4172	2,3-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	7146-60-3	142.282			164.3	0.7377 <sup>20</sup>	1.4146 <sup>20</sup>	
4173	2,4-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	4032-94-4	142.282			156	0.7226 <sup>25</sup>	1.4091 <sup>20</sup>	
4174	2,5-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	15869-89-3	142.282			158.5	0.7264 <sup>25</sup>	1.4112 <sup>20</sup>	
4175	2,6-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	2051-30-1	142.282			160.4	0.7313 <sup>20</sup>	1.4097 <sup>20</sup>	
4176	2,7-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	1072-16-8	142.282	liq	-54.9	159.9	0.7202 <sup>25</sup>	1.4086 <sup>20</sup>	s eth, HOAc
4177	3,4-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	15869-92-8	142.282			163.4	0.7410 <sup>25</sup>	1.4182 <sup>20</sup>	
4178	3,6-Dimethyloctane		C <sub>10</sub> H <sub>22</sub>	15869-94-0	142.282			160.8	0.7324 <sup>25</sup>	1.4139 <sup>20</sup>	
4179	Dimethyl octanedioate	Dimethyl suberate	C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	1732-09-8	202.248	liq	-1.6	268	1.0217 <sup>20</sup>	1.4341 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; sl ctc
4180	3,7-Dimethyl-1,7-octanediol		C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	107-74-4	174.281			265	0.937 <sup>20</sup>	1.4599 <sup>20</sup>	sl bz, tol
4181	2,2-Dimethyloctanoic acid		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	29662-90-6	172.265			140 <sup>13</sup>			
4182	2,2-Dimethyl-1-octanol		C <sub>10</sub> H <sub>22</sub> O	2370-14-1	158.281	liq		97	0.84 <sup>20</sup>		
4183	3,7-Dimethyl-1-octanol		C <sub>10</sub> H <sub>22</sub> O	106-21-8	158.281			212.5	0.832 <sup>25</sup>	1.438 <sup>25</sup>	s eth
4184	2,6-Dimethyl-2-octanol	Tetrahydromyrcenol	C <sub>10</sub> H <sub>22</sub> O	18479-57-7	158.281			80.5 <sup>10</sup>	0.8023 <sup>25</sup>	1.422 <sup>25</sup>	
4185	3,6-Dimethyl-3-octanol		C <sub>10</sub> H <sub>22</sub> O	151-19-9	158.281	liq	-67.5	202.2	0.8347 <sup>22</sup>	1.4370 <sup>20</sup>	
4186	3,7-Dimethyl-3-octanol		C <sub>10</sub> H <sub>22</sub> O	78-69-3	158.281			205.1	0.826 <sup>25</sup>	1.433 <sup>25</sup>	
4187	<i>cis</i> -3,7-Dimethyl-1,3,6-octatriene	<i>cis</i> -β-Ocimene	C <sub>10</sub> H <sub>16</sub>	3338-55-4	136.234				0.799 <sup>20</sup>		
4188	<i>trans</i> -3,7-Dimethyl-1,3,6-octatriene	<i>trans</i> -β-Ocimene	C <sub>10</sub> H <sub>16</sub>	3779-61-1	136.234				0.799 <sup>20</sup>		
4189	3,7-Dimethyl-1,3,7-octatriene	α-Ocimene	C <sub>10</sub> H <sub>16</sub>	502-99-8	136.234			dec 177	0.8000 <sup>20</sup>	1.4862 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl, HOAc
4190	<i>cis</i> , <i>cis</i> -2,6-Dimethyl-2,4,6-octatriene	<i>cis</i> - <i>allo</i> -Ocimene	C <sub>10</sub> H <sub>16</sub>	17202-20-9	136.234	liq					
4191	<i>trans</i> , <i>trans</i> -2,6-Dimethyl-2,4,6-octatriene	<i>trans</i> - <i>allo</i> -Ocimene	C <sub>10</sub> H <sub>16</sub>	3016-19-1	136.234	liq	-35.4	188; 91 <sup>20</sup>	0.8118 <sup>20</sup>	1.5446 <sup>20</sup>	
4192	3,7-Dimethyl-6-octenal	Citronellal	C <sub>10</sub> H <sub>18</sub> O	106-23-0	154.249	nd or orth cry		207.5	0.853 <sup>20</sup>	1.4473 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH
4193	3,7-Dimethyl-1-octene		C <sub>10</sub> H <sub>20</sub>	4984-01-4	140.266	col liq		154	0.7396 <sup>20</sup>	1.4212 <sup>20</sup>	
4194	3,7-Dimethyl-6-octenoic acid	Citronellic acid	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	502-47-6	170.249			257; 157 <sup>23</sup>	0.9234 <sup>21</sup>		
4195	3,7-Dimethyl-6-octen-1-ol, ( <i>R</i> )	Citronellol, (+)	C <sub>10</sub> H <sub>20</sub> O	1117-61-9	156.265	oil		224; 108 <sup>10</sup>	0.8550 <sup>20</sup>	1.4565 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
4196	3,7-Dimethyl-6-octen-1-ol, ( <i>S</i> )	Citronellol, (-)	C <sub>10</sub> H <sub>20</sub> O	7540-51-4	156.265	oil		224; 108 <sup>10</sup>	0.8591 <sup>18</sup>	1.4576 <sup>18</sup>	vs eth, EtOH
4197	3,7-Dimethyl-7-octen-1-ol, ( <i>S</i> )	Rhodinol	C <sub>10</sub> H <sub>20</sub> O	6812-78-8	156.265			114 <sup>12</sup>	0.8549 <sup>20</sup>	1.4556 <sup>20</sup>	vs eth, EtOH
4198	3,7-Dimethyl-6-octen-3-ol		C <sub>10</sub> H <sub>20</sub> O	18479-51-1	156.265			94 <sup>14</sup>	0.8695 <sup>15</sup>	1.4569 <sup>15</sup>	
4199	3,7-Dimethyl-6-octen-1-ol, acetate	Citronellol acetate	C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	150-84-5	198.302			115 <sup>10</sup>			
4200	Dimethyloldihydroxyethyleneurea	4,5-Dihydroxy-1,3-bis(hydroxymethyl)-2-imidazolidinone	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>5</sub>	1854-26-8	178.143	hyg cry					
4201	Dimethyl oxalate		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	553-90-2	118.089	mcl tab	54.8	163.5	1.1716 <sup>60</sup>	1.379 <sup>82</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, chl
4202	5,5-Dimethyl-2,4-oxazolidinedione	Dimethadione	C <sub>6</sub> H <sub>8</sub> NO <sub>3</sub>	695-53-4	129.115			76.5			
4203	3,3-Dimethyloxetane		C <sub>6</sub> H <sub>10</sub> O	6921-35-3	86.132			80.6	0.834 <sup>25</sup>	1.3965 <sup>20</sup>	
4204	3,3-Dimethyl-2-oxetanone		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1955-45-9	100.117			58 <sup>15</sup>			
4205	2,2-Dimethyloxirane	2-Methyl-1,2-epoxypropane	C <sub>4</sub> H <sub>8</sub> O	558-30-5	72.106			52	0.8112 <sup>20</sup>	1.3712 <sup>22</sup>	s EtOH, eth
4206	<i>cis</i> -2,3-Dimethyloxirane		C <sub>4</sub> H <sub>8</sub> O	1758-33-4	72.106	liq	-80	60	0.8226 <sup>25</sup>	1.3802 <sup>20</sup>	vs eth, ace, bz
4207	<i>trans</i> -2,3-Dimethyloxirane		C <sub>4</sub> H <sub>8</sub> O	6189-41-9	72.106	liq	-85	56.5	0.8010 <sup>25</sup>	1.3736 <sup>20</sup>	vs eth, ace, bz
4208	3,3-Dimethyl-2-oxobutanoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	815-17-8	130.141			90.5	189; 80 <sup>15</sup>		sl H <sub>2</sub> O; s eth, bz, chl, CS <sub>2</sub>
4209	<i>N</i> -(1,1-Dimethyl-3-oxobutyl)-2-propenamide	Diacetone acrylamide	C <sub>9</sub> H <sub>15</sub> NO <sub>2</sub>	2873-97-4	169.221						s chl
4210	Dimethyl 3-oxo-1,5-pentanedioate	Dimethyl 1,3-acetonedicarboxylate	C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	1830-54-2	174.151			150 <sup>25</sup> , 77 <sup>0.6</sup>	1.185 <sup>25</sup>	1.4434 <sup>20</sup>	

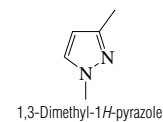
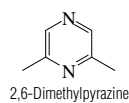
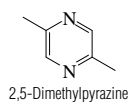
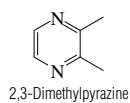
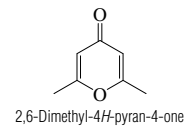
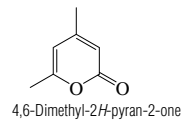
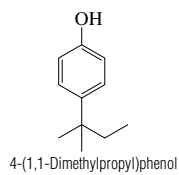
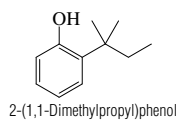
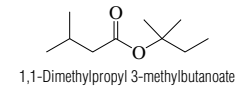
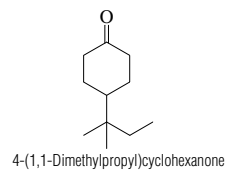
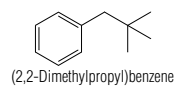
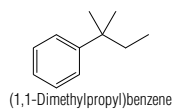
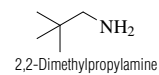
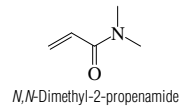
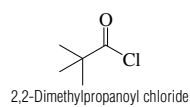
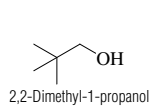
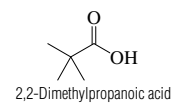
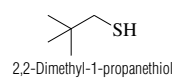
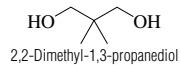
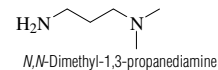
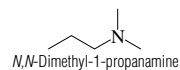
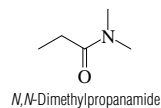
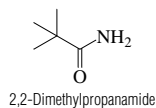
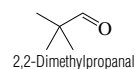
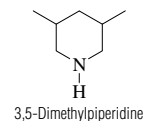
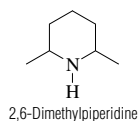
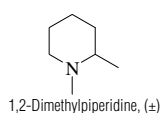
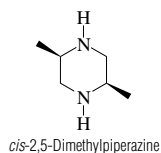
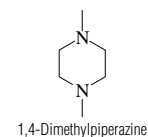
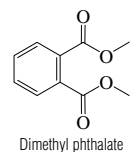
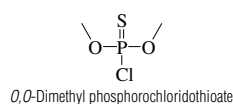
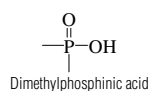
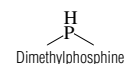
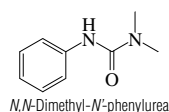
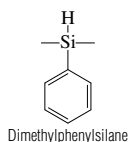
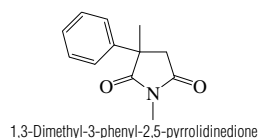
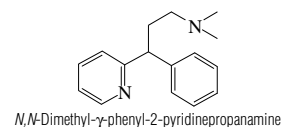
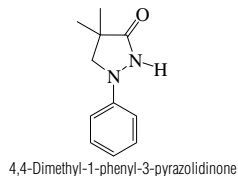
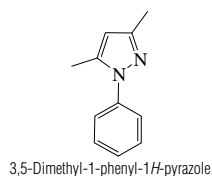
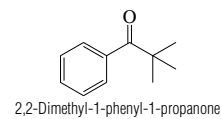
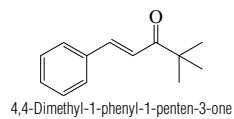
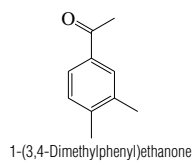
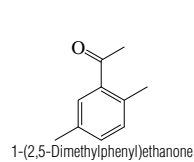


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4211	2,4-Dimethyl-1,3-pentadiene		C <sub>7</sub> H <sub>12</sub>	1000-86-8	96.170	liq	-114	93.2	0.7343 <sup>23</sup>	1.4390 <sup>23</sup>	
4212	<i>N,N</i> -Dimethylpentanamide		C <sub>7</sub> H <sub>15</sub> NO	6225-06-5	129.200		-51	141 <sup>100</sup>	0.8962 <sup>25</sup>	1.4419 <sup>25</sup>	vs H <sub>2</sub> O, eth, EtOH
4213	2,2-Dimethylpentane		C <sub>7</sub> H <sub>16</sub>	590-35-2	100.202	liq	-123.7	79.2	0.6739 <sup>20</sup>	1.3822 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, hp, chl
4214	2,3-Dimethylpentane		C <sub>7</sub> H <sub>16</sub>	565-59-3	100.202			89.78	0.6908 <sup>25</sup>	1.3894 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, chl
4215	2,4-Dimethylpentane		C <sub>7</sub> H <sub>16</sub>	108-08-7	100.202	liq	-119.2	80.49	0.6727 <sup>20</sup>	1.3815 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, chl, hp
4216	3,3-Dimethylpentane		C <sub>7</sub> H <sub>16</sub>	562-49-2	100.202	liq	-134.4	86.06	0.6936 <sup>20</sup>	1.3909 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, hp, chl
4217	3,3-Dimethylpentanedioic anhydride	Dihydro-4,4-dimethyl-2 <i>H</i> -pyran-2,6(3 <i>H</i> )-dione	C <sub>7</sub> H <sub>10</sub> O <sub>3</sub>	4160-82-1	142.152		125.8	181 <sup>25</sup> , 156 <sup>20</sup>			
4218	3,3-Dimethylpentanedioic acid		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	4839-46-7	160.168	mcl pl, nd (bz)	103.5	126 <sup>415</sup> , 89 <sup>2</sup>	1.4278 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, eth; sl bz; i lig
4219	2,2-Dimethylpentanoic acid		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	1185-39-3	130.185	liq		98 <sup>a</sup>	0.9189 <sup>20</sup>		
4220	2,2-Dimethyl-1-pentanol		C <sub>7</sub> H <sub>16</sub> O	2370-12-9	116.201						s chl
4221	2,3-Dimethyl-2-pentanol		C <sub>7</sub> H <sub>16</sub> O	4911-70-0	116.201				0.804 <sup>20</sup>		sl H <sub>2</sub> O
4222	2,4-Dimethyl-2-pentanol		C <sub>7</sub> H <sub>16</sub> O	625-06-9	116.201		<-20	133.1	0.8103 <sup>20</sup>	1.4172 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
4223	2,2-Dimethyl-3-pentanol		C <sub>7</sub> H <sub>16</sub> O	3970-62-5	116.201	liq	-2.5	135	0.8253 <sup>20</sup>	1.4223 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4224	2,3-Dimethyl-3-pentanol		C <sub>7</sub> H <sub>16</sub> O	595-41-5	116.201		<-30	139.7	0.833 <sup>20</sup>	1.4287 <sup>20</sup>	sl H <sub>2</sub> O, bz; s EtOH, eth
4225	2,4-Dimethyl-3-pentanol		C <sub>7</sub> H <sub>16</sub> O	600-36-2	116.201		<-70	138.7	0.8288 <sup>20</sup>	1.4250 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
4226	4,4-Dimethyl-2-pentanone		C <sub>7</sub> H <sub>14</sub> O	590-50-1	114.185	liq	-64	126	0.809 <sup>25</sup>	1.4036 <sup>20</sup>	
4227	2,2-Dimethyl-3-pentanone		C <sub>7</sub> H <sub>14</sub> O	564-04-5	114.185	liq	-45	125.6	0.8125 <sup>20</sup>	1.4065 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, chl
4228	2,4-Dimethyl-3-pentanone	Diisopropyl ketone	C <sub>7</sub> H <sub>14</sub> O	565-80-0	114.185	liq	-69	125.4	0.8108 <sup>20</sup>	1.3999 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz; sl ctc
4229	2,3-Dimethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	3404-72-6	98.186	liq	-134.3	84.3	0.7051 <sup>20</sup>	1.4033 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs dil sulf
4230	2,4-Dimethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	2213-32-3	98.186	liq	-124.1	81.6	0.6943 <sup>20</sup>	1.3986 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, ctc, chl
4231	3,3-Dimethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	3404-73-7	98.186	liq	-134.3	77.5	0.6974 <sup>20</sup>	1.3984 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, chl
4232	3,4-Dimethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	7385-78-6	98.186			80.8	0.6934 <sup>25</sup>	1.3992 <sup>20</sup>	
4233	4,4-Dimethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	762-62-9	98.186	liq	-136.6	72.5	0.6827 <sup>20</sup>	1.3818 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, ctc, chl
4234	2,3-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	10574-37-5	98.186	liq	-118.3	97.5	0.7277 <sup>20</sup>	1.4208 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4235	2,4-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	625-65-0	98.186	liq	-127.7	83.4	0.6954 <sup>20</sup>	1.4040 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
4236	<i>cis</i> -3,4-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	4914-91-4	98.186	liq	-113.4	89.3	0.7092 <sup>25</sup>	1.4104 <sup>20</sup>	
4237	<i>trans</i> -3,4-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	4914-92-5	98.186	liq	-124.2	91.5	0.7124 <sup>25</sup>	1.4128 <sup>20</sup>	
4238	<i>cis</i> -4,4-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	762-63-0	98.186	liq	-135.4	80.4	0.6951 <sup>25</sup>	1.4026 <sup>20</sup>	
4239	<i>trans</i> -4,4-Dimethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	690-08-4	98.186	liq	-115.2	76.7	0.6889 <sup>20</sup>	1.3982 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4240	4,4-Dimethyl-1-pentyne		C <sub>7</sub> H <sub>12</sub>	13361-63-2	96.170	liq	-75.7	76.1	0.7142 <sup>20</sup>	1.3983 <sup>20</sup>	vs bz, eth, chl
4241	4,4-Dimethyl-2-pentyne		C <sub>7</sub> H <sub>12</sub>	999-78-0	96.170	liq	-82.4	83	0.7176 <sup>20</sup>	1.4071 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl; sl ctc
4242	Dimethylperoxide		C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	690-02-8	62.068	vol liq or gas	-100	14	0.8677 <sup>9</sup>	1.3503 <sup>9</sup>	sl EtOH, eth; s tol, HOAc
4243	2,9-Dimethyl-1,10-phenanthroline	Neocuproine	C <sub>14</sub> H <sub>12</sub> N <sub>2</sub>	484-11-7	208.258	cry, 1/2w (w, lig)	159.5				
4244	3,4-Dimethylphenol phosphate (3:1)		C <sub>24</sub> H <sub>27</sub> O <sub>4</sub> P	3862-11-1	410.442		72	261 <sup>7</sup>			i H <sub>2</sub> O; sl EtOH, chl, hx; s bz
4245	5-(2,5-Dimethylphenoxy)-2,2-dimethylpentanoic acid	Gemfibrozil	C <sub>15</sub> H <sub>22</sub> O <sub>3</sub>	25812-30-0	250.334	cry	62	159 <sup>02</sup>			
4246	<i>N</i> -(2,4-Dimethylphenyl)acetamide		C <sub>10</sub> H <sub>13</sub> NO	2050-43-3	163.216	nd (al)	129.3	170 <sup>10</sup>			vs EtOH, chl
4247	1-[(2,4-Dimethylphenyl)azo]-2-naphthol	1-(2,4-Xylylazo)-2-naphthol	C <sub>18</sub> H <sub>16</sub> N <sub>2</sub> O	3118-97-6	276.332	red nd (al)	166				vs eth, EtOH
4248	1-[(2,5-Dimethylphenyl)azo]-2-naphthol	1-(2,5-Xylylazo)-2-naphthol	C <sub>18</sub> H <sub>16</sub> N <sub>2</sub> O	85-82-5	276.332	nd (al)	153				
4249	1-(2,4-Dimethylphenyl)ethanone	2,4-Dimethylacetophenone	C <sub>10</sub> H <sub>12</sub> O	89-74-7	148.201			228	1.0121 <sup>15</sup>	1.5340 <sup>20</sup>	vs eth, EtOH

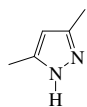
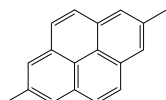




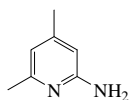
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4250	1-(2,5-Dimethylphenyl)ethanone	2,5-Dimethylacetophenone	C <sub>10</sub> H <sub>12</sub> O	2142-73-6	148.201	liq	-18.1	232.5	0.9963 <sup>19</sup>	1.5291 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, CS <sub>2</sub>
4251	1-(3,4-Dimethylphenyl)ethanone	3,4-Dimethylacetophenone	C <sub>10</sub> H <sub>12</sub> O	3637-01-2	148.201	liq	-1.5	246.5	1.0090 <sup>14</sup>	1.5413 <sup>15</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; s ctc, HOAc
4252	4,4-Dimethyl-1-phenyl-1-penten-3-one		C <sub>13</sub> H <sub>16</sub> O	538-44-3	188.265		43	154 <sup>25</sup>	0.9508 <sup>16</sup>	1.5523 <sup>25</sup>	
4253	2,2-Dimethyl-1-phenyl-1-propanone		C <sub>11</sub> H <sub>14</sub> O	938-16-9	162.228			220	0.9632 <sup>26</sup>	1.5086 <sup>19</sup>	s ace
4254	3,5-Dimethyl-1-phenyl-1H-pyrazole		C <sub>11</sub> H <sub>12</sub> N <sub>2</sub>	1131-16-4	172.226			272; 145 <sup>12,5</sup>	1.0566 <sup>20</sup>	1.5738 <sup>19</sup>	vs eth, EtOH, chl
4255	4,4-Dimethyl-1-phenyl-3-pyrazolidinone	4,4-Dimethylphenidone	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O	2654-58-2	190.241		176				
4256	N,N-Dimethyl-γ-phenyl-2-pyridinepropanamine	Pheniramine	C <sub>16</sub> H <sub>20</sub> N <sub>2</sub>	86-21-5	240.343			181 <sup>13</sup> ; 135 <sup>0,5</sup>	1.0081 <sup>25</sup>	1.5519 <sup>25</sup>	vs bz, eth, EtOH, chl
4257	1,3-Dimethyl-3-phenyl-2,5-pyrrolidinedione	Methsuximide	C <sub>12</sub> H <sub>13</sub> NO <sub>2</sub>	77-41-8	203.237		52.5	121 <sup>0,1</sup>			
4258	Dimethylphenylsilane		C <sub>8</sub> H <sub>12</sub> Si	766-77-8	136.267			156.5	0.8891 <sup>20</sup>	1.4995 <sup>20</sup>	i H <sub>2</sub> O
4259	N,N-Dimethyl-N'-phenylurea	Fenuron	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O	101-42-8	164.203	cry (hx)	132				
4260	Dimethylphosphine		C <sub>2</sub> H <sub>4</sub> P	676-59-5	62.051	vol liq or gas		25			i H <sub>2</sub> O; s EtOH, eth
4261	Dimethylphosphinic acid		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> P	3283-12-3	94.050	cry (bz)	92	377			vs H <sub>2</sub> O, EtOH, eth; s bz
4262	O,O-Dimethyl phosphorochlorodithioate	Dimethyl chlorothiophosphate	C <sub>2</sub> H <sub>6</sub> ClO <sub>2</sub> PS	2524-03-0	160.560	hyg liq		68 <sup>12</sup>	1.322	1.4820 <sup>20</sup>	
4263	Dimethyl phthalate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	131-11-3	194.184	pa ye	5.5	283.7	1.1905 <sup>20</sup>	1.5138 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz; sl ctc
4264	1,4-Dimethylpiperazine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	106-58-1	114.188	liq	-0.59	131	0.8600 <sup>20</sup>	1.4474 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth
4265	cis-2,5-Dimethylpiperazine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	6284-84-0	114.188	orth bipym nd or pr (chl)	114	162		1.4720 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, chl; sl eth, bz
4266	1,2-Dimethylpiperidine, (±)		C <sub>7</sub> H <sub>15</sub> N	2512-81-4	113.201			127.5	0.824 <sup>15</sup>	1.4395 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
4267	2,6-Dimethylpiperidine		C <sub>7</sub> H <sub>15</sub> N	504-03-0	113.201			127	0.8158 <sup>25</sup>	1.4377 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl ctc; s acid
4268	3,5-Dimethylpiperidine	3,5-Lupetidine	C <sub>7</sub> H <sub>15</sub> N	35794-11-7	113.201			144	0.853 <sup>25</sup>	1.4454 <sup>20</sup>	
4269	2,2-Dimethylpropanal	Pivaldehyde	C <sub>5</sub> H <sub>10</sub> O	630-19-3	86.132		6	77.5	0.7923 <sup>17</sup>	1.3791 <sup>20</sup>	s EtOH, eth
4270	2,2-Dimethylpropanamide		C <sub>5</sub> H <sub>11</sub> NO	754-10-9	101.147						s tfa
4271	N,N-Dimethylpropanamide		C <sub>5</sub> H <sub>11</sub> NO	758-96-3	101.147	liq	-45	175	0.9269 <sup>20</sup>		
4272	N,N-Dimethyl-1-propanamine	Dimethylpropylamine	C <sub>5</sub> H <sub>13</sub> N	926-63-6	87.164			66	0.7152 <sup>20</sup>	1.3860 <sup>20</sup>	vs bz, eth, EtOH
4273	N,N-Dimethyl-1,3-propanediamine		C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	109-55-7	102.178			132	0.8272 <sup>20</sup>		
4274	2,2-Dimethyl-1,3-propanediol	Neopentyl glycol	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	126-30-7	104.148	nd (bz)	129.13	208			s H <sub>2</sub> O, bz, chl; vs EtOH, eth
4275	2,2-Dimethylpropanenitrile	tert-Butyl cyanide	C <sub>5</sub> H <sub>9</sub> N	630-18-2	83.132		15	106.1	0.7586 <sup>25</sup>	1.3774 <sup>20</sup>	
4276	2,2-Dimethyl-1-propanethiol	Neopentyl mercaptan	C <sub>5</sub> H <sub>12</sub> S	1679-08-9	104.214	liq		103.7			
4277	2,2-Dimethylpropanoic acid	Trimethylacetic acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	75-98-9	102.132	nd	35	164	0.905 <sup>50</sup>	1.3931 <sup>30</sup>	sl H <sub>2</sub> O; vs EtOH, eth
4278	2,2-Dimethyl-1-propanol	Neopentyl alcohol	C <sub>5</sub> H <sub>12</sub> O	75-84-3	88.148		52.5	113.5	0.812 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s ctc
4279	2,2-Dimethylpropanoyl chloride	Pivalic acid chloride	C <sub>5</sub> H <sub>9</sub> ClO	3282-30-2	120.577			107	1.003 <sup>20</sup>	1.4139 <sup>20</sup>	vs eth
4280	N,N-Dimethyl-2-propanamide	N,N-Dimethylacrylamide	C <sub>5</sub> H <sub>9</sub> NO	2680-03-7	99.131	liq		81 <sup>20</sup>	0.962 <sup>25</sup>	1.4730 <sup>20</sup>	
4281	2,2-Dimethylpropylamine	2,2-Dimethyl-1-propanamine	C <sub>5</sub> H <sub>13</sub> N	5813-64-9	87.164			82	0.7455 <sup>20</sup>	1.4023 <sup>20</sup>	vs eth
4282	(1,1-Dimethylpropyl)benzene		C <sub>11</sub> H <sub>16</sub>	2049-95-8	148.245			192.4	0.8748 <sup>20</sup>	1.4958 <sup>20</sup>	
4283	(2,2-Dimethylpropyl)benzene		C <sub>11</sub> H <sub>16</sub>	1007-26-7	148.245			185	0.8581 <sup>18</sup>	1.4884 <sup>18</sup>	
4284	4-(1,1-Dimethylpropyl)cyclohexanone		C <sub>11</sub> H <sub>20</sub> O	16587-71-6	168.276		96	125 <sup>16</sup> ; 109 <sup>11</sup>	0.920 <sup>25</sup>	1.4677 <sup>20</sup>	
4285	1,1-Dimethylpropyl 3-methylbutanoate	tert-Pentyl isopentanoate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	542-37-0	172.265			173.5	0.8729 <sup>0</sup>		vs EtOH
4286	2-(1,1-Dimethylpropyl)phenol		C <sub>11</sub> H <sub>16</sub> O	3279-27-4	164.244						sl ctc
4287	4-(1,1-Dimethylpropyl)phenol	p-tert-Pentylphenol	C <sub>11</sub> H <sub>16</sub> O	80-46-6	164.244		95	262.5			
4288	4,6-Dimethyl-2H-pyran-2-one		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	675-09-2	124.138	lf (eth)	51.5	245			vs H <sub>2</sub> O, eth, EtOH
4289	2,6-Dimethyl-4H-pyran-4-one		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	1004-36-0	124.138	pl, nd (sub)	132	251; 140 <sup>25</sup>	0.9953 <sup>17</sup>		s H <sub>2</sub> O, EtOH, eth, ace
4290	2,3-Dimethylpyrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	5910-89-4	108.141			156	1.0281 <sup>0</sup>		s H <sub>2</sub> O, EtOH, eth
4291	2,5-Dimethylpyrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	123-32-0	108.141		15	155	0.9887 <sup>20</sup>	1.4980 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, chl
4292	2,6-Dimethylpyrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108-50-9	108.141	pr	47.5	155.6	0.9647 <sup>50</sup>		s H <sub>2</sub> O, EtOH, eth; sl ctc
4293	1,3-Dimethyl-1H-pyrazole		C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	694-48-4	96.131			137	0.9561 <sup>17</sup>	1.4734 <sup>15</sup>	vs H <sub>2</sub> O



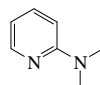
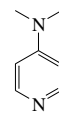
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4294	3,5-Dimethyl-1 <i>H</i> -pyrazole		C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	67-51-6	96.131	cry (peth, al)	107.5	218	0.8839 <sup>16</sup>		s H <sub>2</sub> O, ace; vs EtOH, eth, bz, MeOH
4295	2,7-Dimethylpyrene		C <sub>18</sub> H <sub>14</sub>	15679-24-0	230.304		230				
4296	4,6-Dimethyl-2-pyridinamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	5407-87-4	122.167		61	235			
4297	<i>N,N</i> -Dimethyl-2-pyridinamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	5683-33-0	122.167		182	196	1.0149 <sup>14</sup>	1.5663 <sup>20</sup>	s EtOH, eth, bz
4298	<i>N,N</i> -Dimethyl-4-pyridinamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	1122-58-3	122.167	pl (eth)	114				vs H <sub>2</sub> O, EtOH, bz, chl; s eth
4299	2,3-Dimethylpyridine	2,3-Lutidine	C <sub>7</sub> H <sub>9</sub> N	583-61-9	107.153			161.12	0.9319 <sup>25</sup>	1.5057 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
4300	2,4-Dimethylpyridine	2,4-Lutidine	C <sub>7</sub> H <sub>9</sub> N	108-47-4	107.153	liq	-64	158.38	0.9309 <sup>20</sup>	1.5010 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s ace
4301	2,5-Dimethylpyridine	2,5-Lutidine	C <sub>7</sub> H <sub>9</sub> N	589-93-5	107.153	liq	-16	156.98	0.9297 <sup>20</sup>	1.5006 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH; msc eth; s ace
4302	2,6-Dimethylpyridine	2,6-Lutidine	C <sub>7</sub> H <sub>9</sub> N	108-48-5	107.153	liq	-6.1	144.01	0.9226 <sup>20</sup>	1.4953 <sup>20</sup>	msc H <sub>2</sub> O; sl EtOH; s eth, ace, chl
4303	3,4-Dimethylpyridine	3,4-Lutidine	C <sub>7</sub> H <sub>9</sub> N	583-58-4	107.153	liq	-11	179.10	0.9281 <sup>20</sup>	1.5096 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace, chl
4304	3,5-Dimethylpyridine	3,5-Lutidine	C <sub>7</sub> H <sub>9</sub> N	591-22-0	107.153	liq	-6.6	171.84	0.9419 <sup>20</sup>	1.5061 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace; sl ctc
4305	2,6-Dimethylpyridine-1-oxide		C <sub>7</sub> H <sub>9</sub> NO	1073-23-0	123.152	hyg	35	133 <sup>22</sup>	1.073 <sup>25</sup>	1.5706 <sup>20</sup>	
4306	4,6-Dimethyl-2-pyrimidinamine		C <sub>6</sub> H <sub>8</sub> N <sub>3</sub>	767-15-7	123.155		153.5				s H <sub>2</sub> O, EtOH, ace, bz; i eth; vs chl
4307	2,6-Dimethyl-4-pyrimidinamine	Kyanmethin	C <sub>6</sub> H <sub>8</sub> N <sub>3</sub>	461-98-3	123.155	nd (al), pl (bz)	183	sub			sl H <sub>2</sub> O, EtOH, bz, chl
4308	4,6-Dimethylpyrimidine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1558-17-4	108.141		25	159		1.4880 <sup>20</sup>	vs H <sub>2</sub> O
4309	1,3-Dimethyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	874-14-6	140.140		123.5				sl EtOH; s eth, chl
4310	2,4-Dimethylpyrrole		C <sub>6</sub> H <sub>8</sub> N	625-82-1	95.142	pa bl flr cry		168	0.9236 <sup>20</sup>	1.5048 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz; s chl
4311	2,5-Dimethylpyrrole		C <sub>6</sub> H <sub>8</sub> N	625-84-3	95.142		6.5	171; 51 <sup>4</sup>	0.9353 <sup>20</sup>	1.5036 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
4312	1,2-Dimethylpyrrolidine		C <sub>6</sub> H <sub>13</sub> N	765-48-0	99.174	oil		99	0.799 <sup>20</sup>		s H <sub>2</sub> O
4313	2,4-Dimethylquinoline	4-Methylquinaldine	C <sub>11</sub> H <sub>11</sub> N	1198-37-4	157.212	orth pr (eth)		265	1.0611 <sup>15</sup>	1.6075 <sup>20</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth
4314	2,6-Dimethylquinoline		C <sub>11</sub> H <sub>11</sub> N	877-43-0	157.212	orth pr (eth)	60	266.5			sl H <sub>2</sub> O, EtOH, eth, chl; vs bz
4315	2,7-Dimethylquinoline	<i>m</i> -Toluquinaldine	C <sub>11</sub> H <sub>11</sub> N	93-37-8	157.212		61	264.5			sl H <sub>2</sub> O; s EtOH, eth, chl
4316	2,3-Dimethylquinoxaline		C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	2379-55-7	158.199	nd (w+3, ace)	106				s EtOH, eth, ace, bz, chl, acid
4317	Dimethyl sebacate		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	106-79-6	230.301	lo pr	38	175 <sup>20</sup> , 144 <sup>5</sup>	0.9882 <sup>28</sup>	1.4355 <sup>28</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc
4318	Dimethyl selenide	Methyl selenide	C <sub>2</sub> H <sub>6</sub> Se	593-79-3	109.03			57	1.4077 <sup>15</sup>		vs eth, EtOH, chl
4319	Dimethylsilane	2-Silapropane	C <sub>2</sub> H <sub>6</sub> Si	1111-74-6	60.171	col gas	-150	-20	0.68 <sup>80</sup>		
4320	Dimethylstearylamine	Dymanthine	C <sub>20</sub> H <sub>43</sub> N	124-28-7	297.562		22.9				
4321	Dimethyl succinate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	106-65-0	146.141		19	196.4	1.1198 <sup>20</sup>	1.4197 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, ace; vs eth
4322	Dimethylsulfamoyl chloride	Dimethylaminosulfonyl chloride	C <sub>2</sub> H <sub>6</sub> ClNO <sub>2</sub> S	13360-57-1	143.593			80 <sup>16</sup>			
4323	Dimethyl sulfate		C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	77-78-1	126.132		-27	dec 188; 76 <sup>15</sup>	1.3322 <sup>20</sup>	1.3874 <sup>20</sup>	s H <sub>2</sub> O, eth, bz, ctc; msc EtOH; i CS <sub>2</sub>
4324	Dimethyl sulfide		C <sub>2</sub> H <sub>6</sub> S	75-18-3	62.134	liq	-98.24	37.33	0.8483 <sup>20</sup>	1.4438 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
4325	Dimethyl sulfite		C <sub>2</sub> H <sub>6</sub> O <sub>3</sub> S	616-42-2	110.132			126	1.2129 <sup>20</sup>	1.4083 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
4326	2,4-Dimethylsulfolane		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub> S	1003-78-7	148.223	liq	-1.5	281	1.1362 <sup>20</sup>	1.4732 <sup>20</sup>	vs lig
4327	Dimethyl sulfone		C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	67-71-0	94.133	pr	108.9	238	1.1700 <sup>10</sup>	1.4226	s H <sub>2</sub> O, EtOH, bz
4328	Dimethyl sulfoxide	DMSO	C <sub>2</sub> H <sub>6</sub> OS	67-68-5	78.133		17.89	189	1.1010 <sup>25</sup>	1.4793 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, ctc, AcOEt
4329	Dimethyl <i>L</i> -tartrate	Dimethyl 2,3-dihydroxybutanedioate, [ <i>R</i> -( <i>R</i> *, <i>R</i> *)]-	C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	608-68-4	178.139	(i) cry (bz) (ii) cry (w)	50(form a); 61(form b)	280	1.306 <sup>45</sup>		vs H <sub>2</sub> O, ace, eth, EtOH
4330	Dimethyl telluride		C <sub>2</sub> H <sub>6</sub> Te	593-80-6	157.67	pa ye		94			vs EtOH
4331	Dimethyl terephthalate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	120-61-6	194.184		141	288	1.075 <sup>141</sup>		sl H <sub>2</sub> O, EtOH, MeOH; s eth, chl
4332	Dimethyl tetrachloroterephthalate		C <sub>10</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>4</sub>	1861-32-1	331.965		155				
4333	2,7-Dimethylthiachromine-8-ethanol		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> OS	92-35-3	262.330	ye pr (chl)	228.8	sub			s H <sub>2</sub> O, MeOH; sl EtOH, eth, ace, chl

3,5-Dimethyl-1*H*-pyrazole

2,7-Dimethylpyrene



4,6-Dimethyl-2-pyridinamine

*N,N*-Dimethyl-2-pyridinamine*N,N*-Dimethyl-4-pyridinamine

2,3-Dimethylpyridine



2,4-Dimethylpyridine



2,5-Dimethylpyridine



2,6-Dimethylpyridine



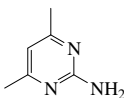
3,4-Dimethylpyridine



3,5-Dimethylpyridine



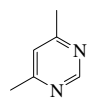
2,6-Dimethylpyridine-1-oxide



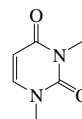
4,6-Dimethyl-2-pyrimidinamine



2,6-Dimethyl-4-pyrimidinamine



4,6-Dimethylpyrimidine

1,3-Dimethyl-2,4(1*H*,3*H*)-pyrimidinedione

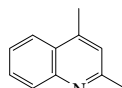
2,4-Dimethylpyrrole



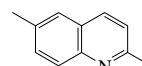
2,5-Dimethylpyrrole



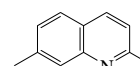
1,2-Dimethylpyrrolidine



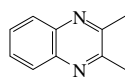
2,4-Dimethylquinoline



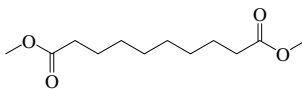
2,6-Dimethylquinoline



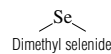
2,7-Dimethylquinoline



2,3-Dimethylquinoxaline



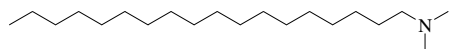
Dimethyl sebacate



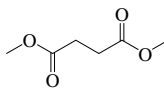
Dimethyl selenide



Dimethylsilane



Dimethylstearylamine



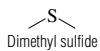
Dimethyl succinate



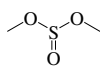
Dimethylsulfamoyl chloride



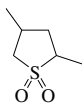
Dimethyl sulfate



Dimethyl sulfide



Dimethyl sulfite



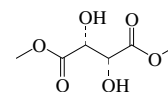
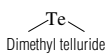
2,4-Dimethylsulfolane



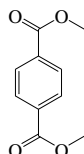
Dimethyl sulfone



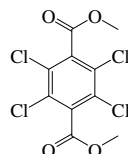
Dimethyl sulfoxide

Dimethyl *L*-tartrate

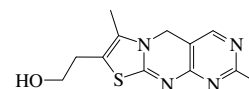
Dimethyl telluride



Dimethyl terephthalate

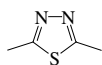


Dimethyl tetrachloroterephthalate

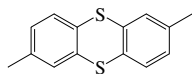


2,7-Dimethylthiachromine-8-ethanol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4334	2,5-Dimethyl-1,3,4-thiadiazole		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> S	27464-82-0	114.169		65	202.5			sl H <sub>2</sub> O, EtOH, eth
4335	2,7-Dimethylthianthrene	Mesulphen	C <sub>14</sub> H <sub>12</sub> S <sub>2</sub>	135-58-0	244.375	nd (HOAc,al)	123	184 <sup>3</sup>			vs ace, eth, peth, chl
4336	2,4-Dimethylthiazole		C <sub>6</sub> H <sub>8</sub> NS	541-58-2	113.182			146; 71 <sup>50</sup>	1.0562 <sup>15</sup>	1.5091 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
4337	4,5-Dimethylthiazole		C <sub>6</sub> H <sub>8</sub> NS	3581-91-7	113.182		83.5	158	1.0699 <sup>20</sup>		vs eth, EtOH
4338	<i>N,N</i> -Dimethylthioacetamide		C <sub>6</sub> H <sub>8</sub> NS	631-67-4	103.186		74.5				
4339	Dimethyl thiodipropionate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub> S	4131-74-2	206.260			162 <sup>18</sup> , 148 <sup>18</sup>	1.1559 <sup>20</sup>	1.4740 <sup>20</sup>	
4340	2,3-Dimethylthiophene		C <sub>6</sub> H <sub>8</sub> S	632-16-6	112.193	liq	-49	141.6	1.0021 <sup>20</sup>	1.5192 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
4341	2,4-Dimethylthiophene		C <sub>6</sub> H <sub>8</sub> S	638-00-6	112.193			140.7	0.9938 <sup>20</sup>	1.5104 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
4342	2,5-Dimethylthiophene		C <sub>6</sub> H <sub>8</sub> S	638-02-8	112.193	liq	-62.6	136.5	0.9850 <sup>20</sup>	1.5129 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
4343	3,4-Dimethylthiophene		C <sub>6</sub> H <sub>8</sub> S	632-15-5	112.193			145	0.9932 <sup>25</sup>	1.5206 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth
4344	<i>N,N</i> -Dimethylthiourea		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> S	6972-05-0	104.174	cry (w)	161.5				
4345	<i>N,N'</i> -Dimethylthiourea		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> S	534-13-4	104.174	hyg pl	62				vs H <sub>2</sub> O, EtOH, ace; sl eth, bz; i CS <sub>2</sub>
4346	2,6-Dimethyl-4-tridecylmorpholine	Tridemorph	C <sub>19</sub> H <sub>35</sub> NO	24602-86-6	297.519			141 <sup>1,3</sup>	0.86		
4347	<i>N,N</i> -Dimethyl- <i>N'</i> -[3-(trifluoromethyl)phenyl]urea	Fluometuron	C <sub>10</sub> H <sub>11</sub> F <sub>3</sub> N <sub>2</sub> O	2164-17-2	232.201		164				vs ace, EtOH
4348	Dimethyl trisulfide		C <sub>2</sub> H <sub>6</sub> S <sub>3</sub>	3658-80-8	126.264			41 <sup>6</sup>			
4349	6,10-Dimethyl-3,5,9-undecatrien-2-one	Pseudoionone	C <sub>13</sub> H <sub>20</sub> O	141-10-6	192.297	pa ye oil		144 <sup>12</sup>	0.8984 <sup>20</sup>	1.5335 <sup>20</sup>	s EtOH, eth, chl, MeOH
4350	<i>N,N</i> -Dimethylurea		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O	598-94-7	88.108	mcl pr (al, chl)	182.1		1.2555 <sup>25</sup>		s H <sub>2</sub> O; sl EtOH, tfa; i eth
4351	<i>N,N'</i> -Dimethylurea		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O	96-31-1	88.108	orth bipym (chl-eth)	106.6	269	1.142 <sup>25</sup>		vs H <sub>2</sub> O, EtOH; i eth; sl chl
4352	Dimethyl zinc		C <sub>2</sub> H <sub>6</sub> Zn	544-97-8	95.478	liq, ign in air	-43.0	46	1.386 <sup>10</sup>		s eth; msc peth
4353	Dimetilan		C <sub>10</sub> H <sub>16</sub> N <sub>4</sub> O <sub>3</sub>	644-64-4	240.259	col solid	69	205 <sup>13</sup>			s H <sub>2</sub> O, chl, EtOH, ace, xyl
4354	Dimorpholamine		C <sub>20</sub> H <sub>38</sub> N <sub>4</sub> O <sub>4</sub>	119-48-2	398.541	cry (peth)	41.5	229 <sup>0,4</sup>			vs H <sub>2</sub> O
4355	<i>N,N'</i> -Di-2-naphthyl-1,4-benzenediamine		C <sub>26</sub> H <sub>20</sub> N <sub>2</sub>	93-46-9	360.450		235				i EtOH, eth, bz
4356	Di-2-naphthyl disulfide		C <sub>20</sub> H <sub>14</sub> S <sub>2</sub>	5586-15-2	318.455	nd	139.5		1.144 <sup>145</sup>	1.4555 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; i lig
4357	<i>N,N'</i> -Di-1-naphthylurea		C <sub>21</sub> H <sub>16</sub> N <sub>2</sub> O	607-56-7	312.364	nd (py, HOAc)	296	sub			vs py
4358	Diniconazole		C <sub>15</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O	83657-24-3	326.221	cry	149				s H <sub>2</sub> O, ace, MeOH, xyl
4359	Dinitramine		C <sub>11</sub> H <sub>13</sub> F <sub>3</sub> N <sub>4</sub> O <sub>4</sub>	29091-05-2	322.241		98				
4360	2,3-Dinitroaniline		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	602-03-9	183.122		128		1.646 <sup>50</sup>		i H <sub>2</sub> O; s EtOH; sl eth
4361	2,4-Dinitroaniline		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	97-02-9	183.122	ye nd (ace) grn ye tab (al)	180.0		1.615 <sup>14</sup>		i H <sub>2</sub> O; sl EtOH, ace, HCl
4362	2,5-Dinitroaniline		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	619-18-1	183.122	oran nd (al)	138.0				vs EtOH
4363	2,6-Dinitroaniline		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	606-22-4	183.122	gold lf (HOAc) ye nd (al)	141.5				i H <sub>2</sub> O, lig; sl EtOH; s eth, bz
4364	3,5-Dinitroaniline		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	618-87-1	183.122	ye nd (dil al)	163		1.601 <sup>50</sup>		i H <sub>2</sub> O; s EtOH, eth; sl ace, bz
4365	1,5-Dinitro-9,10-anthracenedione		C <sub>14</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	82-35-9	298.207	pa ye nd (xyl)	385	sub			i H <sub>2</sub> O; sl EtOH, eth, bz; vs PhNO <sub>2</sub>
4366	1,8-Dinitro-9,10-anthracenedione		C <sub>14</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	129-39-5	298.207		312				
4367	2,4-Dinitrobenzaldehyde		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	528-75-6	196.117	pa ye pr (al), pl (bz)	72	200 <sup>15</sup>			sl H <sub>2</sub> O, chl, lig; s EtOH, eth, bz
4368	3,5-Dinitrobenzamide	Nitromide	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>5</sub>	121-81-3	211.132	lf (w)	184				vs H <sub>2</sub> O
4369	1,2-Dinitrobenzene	<i>o</i> -Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	528-29-0	168.107	nd (bz), pl (al)	116.5	318; 194 <sup>30</sup>	1.3119 <sup>120</sup>	1.565 <sup>17</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, AcOEt; sl DMSO
4370	1,3-Dinitrobenzene	<i>m</i> -Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	99-65-0	168.107	orth pl (al)	90.3	291; 167 <sup>14</sup>	1.5751 <sup>18</sup>		sl H <sub>2</sub> O; vs EtOH, ace, py; s eth, tol
4371	1,4-Dinitrobenzene	<i>p</i> -Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	100-25-4	168.107	nd (al)	173.5	297; 183 <sup>34</sup>	1.625 <sup>18</sup>		i H <sub>2</sub> O; sl EtOH, chl; s ace, bz, tol
4372	2,4-Dinitro-1,3-benzenediol	2,4-Dinitroresorcinol	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	519-44-8	200.105	ye lf (al)	147.5				sl H <sub>2</sub> O, EtOH
4373	2,4-Dinitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>4</sub> S	528-76-7	234.617	ye pr (bz-peth)	99				vs bz, chl, HOAc; sl peth



2,5-Dimethyl-1,3,4-thiadiazole



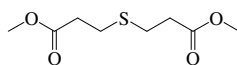
2,7-Dimethylthianthrene



2,4-Dimethylthiazole



4,5-Dimethylthiazole

*N,N*-Dimethylthioacetamide

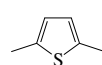
Dimethyl thiodipropionate



2,3-Dimethylthiophene



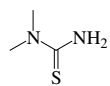
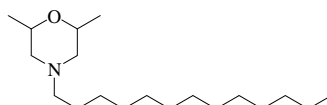
2,4-Dimethylthiophene



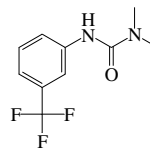
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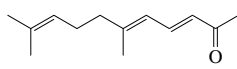
3,4-Dimethylthiophene

*N,N*-Dimethylthiourea*N,N'*-Dimethylthiourea

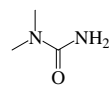
2,6-Dimethyl-4-tridecylmorpholine

*N,N*-Dimethyl-*N'*-[3-(trifluoromethyl)phenyl]urea

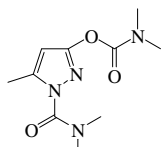
Dimethyl trisulfide



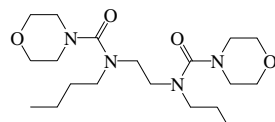
6,10-Dimethyl-3,5,9-undecatrien-2-one

*N,N*-Dimethylurea*N,N'*-Dimethylurea

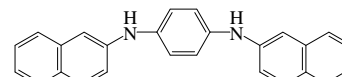
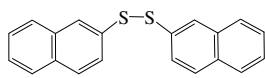
Dimethyl zinc



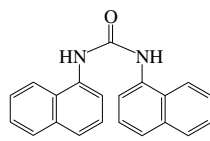
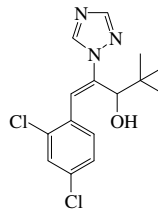
Dimetilan



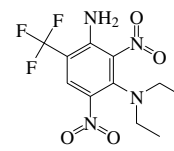
Dimorpholamine

*N,N*-Di-2-naphthyl-1,4-benzenediamine

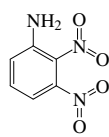
Di-2-naphthyl disulfide

*N,N'*-Di-1-naphthylurea

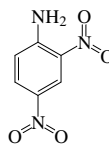
Diniconazole



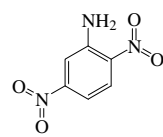
Dinitramine



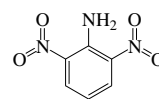
2,3-Dinitroaniline



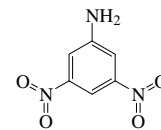
2,4-Dinitroaniline



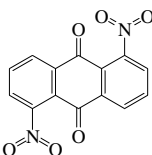
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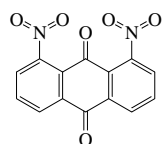
2,6-Dinitroaniline



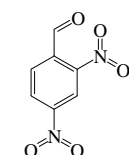
3,5-Dinitroaniline



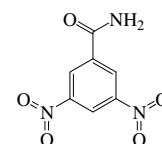
1,5-Dinitro-9,10-anthracenedione



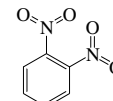
1,8-Dinitro-9,10-anthracenedione



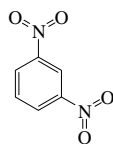
2,4-Dinitrobenzaldehyde



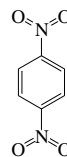
3,5-Dinitrobenzamide



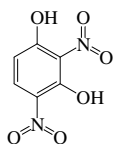
1,2-Dinitrobenzene



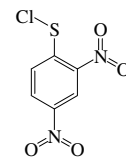
1,3-Dinitrobenzene



1,4-Dinitrobenzene



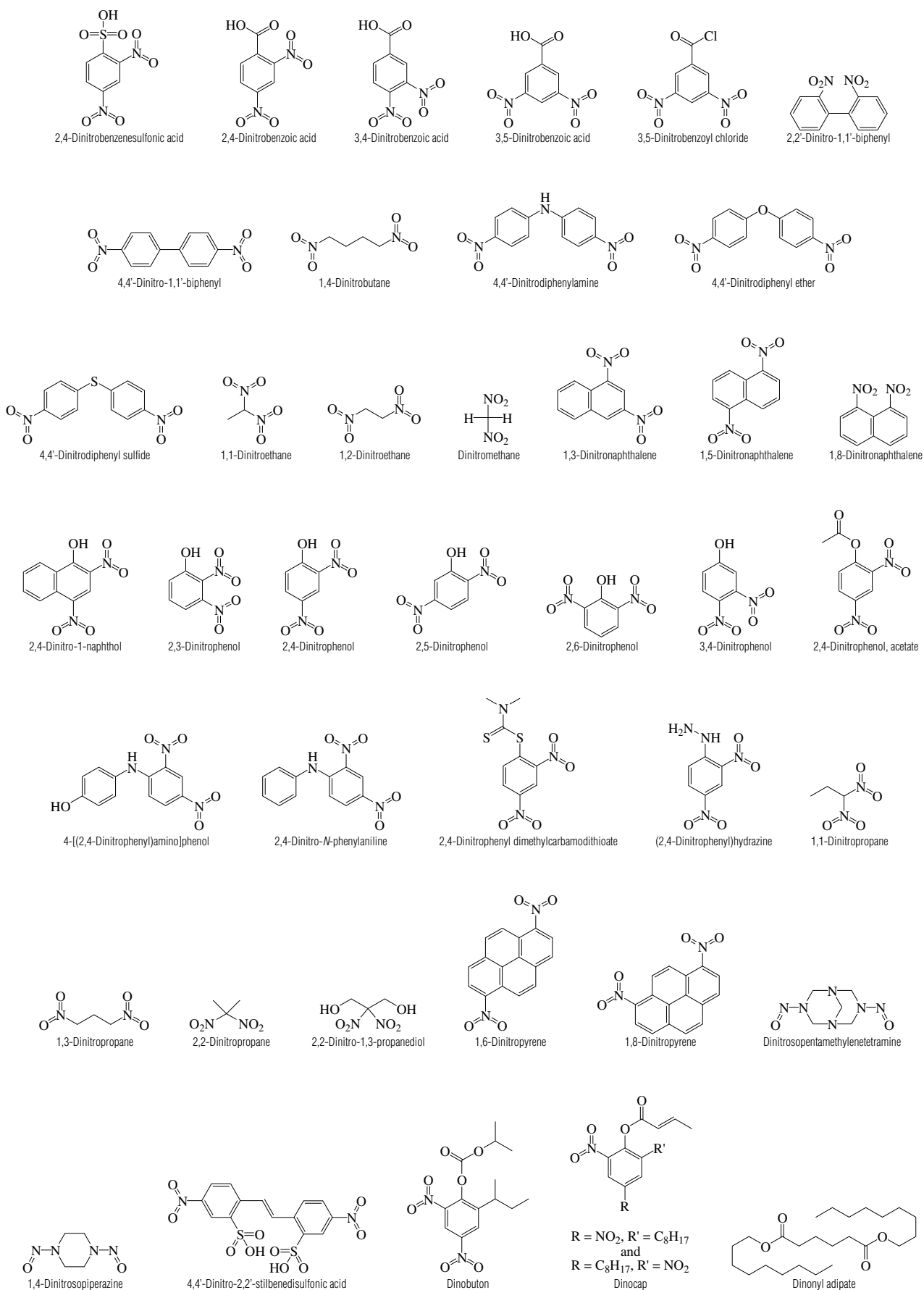
2,4-Dinitro-1,3-benzenediol



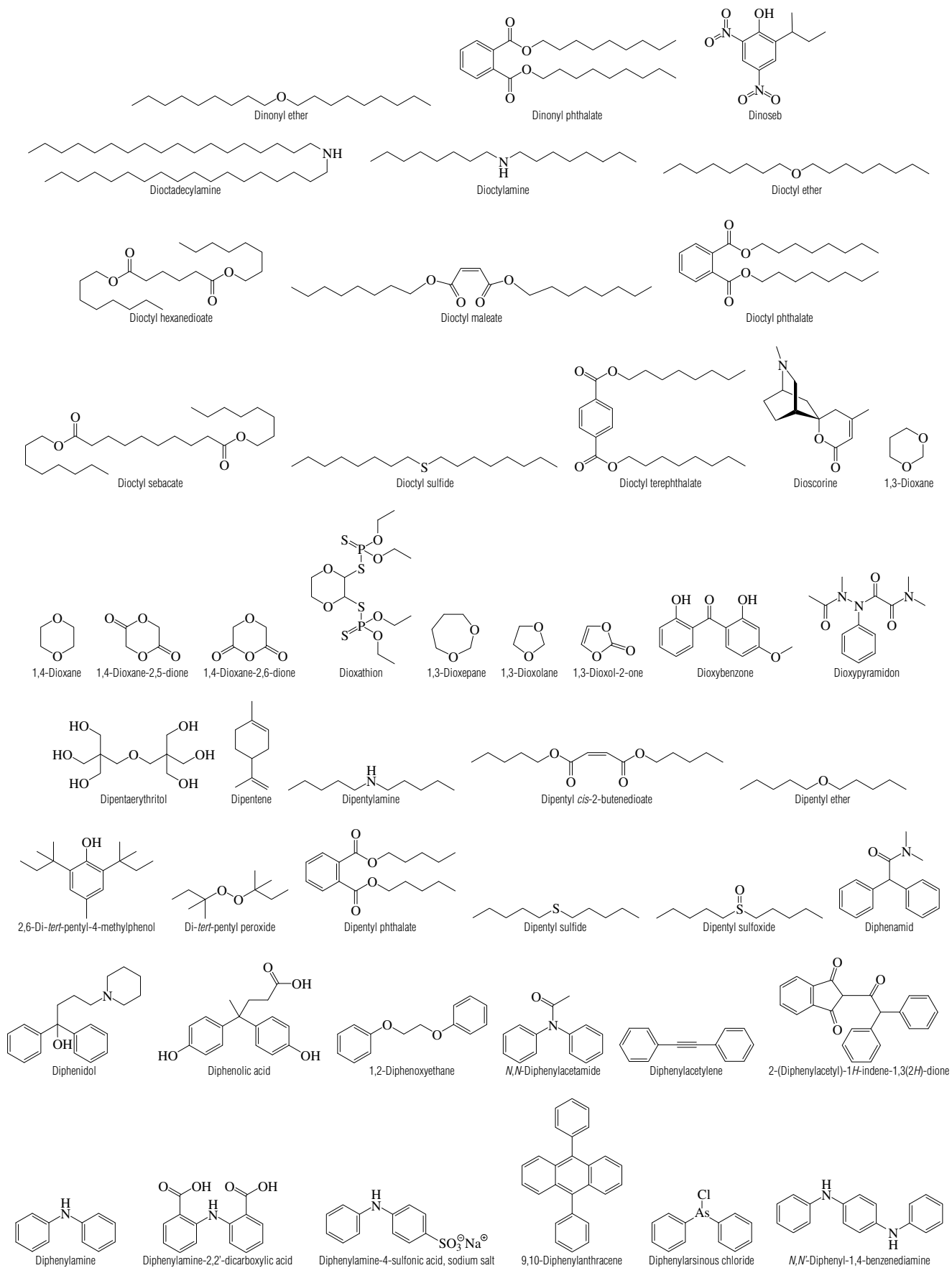
2,4-Dinitrobenzenesulfonyl chloride

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4374	2,4-Dinitrobenzenesulfonic acid		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>7</sub> S	89-02-1	248.170	nd (w+3)	108				vs H <sub>2</sub> O, EtOH; sl eth; i bz, peth
4375	2,4-Dinitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	610-30-0	212.116	nd (w)	183		1.672 <sup>20</sup>		sl H <sub>2</sub> O, EtOH, bz
4376	3,4-Dinitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	528-45-0	212.116	cry (dil al)	166				sl H <sub>2</sub> O; vs EtOH, eth
4377	3,5-Dinitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	99-34-3	212.116	mcl pr (al)	205				sl H <sub>2</sub> O; vs EtOH, HOAc
4378	3,5-Dinitrobenzoyl chloride		C <sub>7</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>5</sub>	99-33-2	230.562	ye nd (bz)	74	196 <sup>12</sup>			s eth, chl
4379	2,2'-Dinitro-1,1'-biphenyl		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	2436-96-6	244.203	ye mcl pr or nd (al)	126	305	1.45 <sup>25</sup>		i H <sub>2</sub> O; vs EtOH; s eth, bz; sl ace, lig
4380	4,4'-Dinitro-1,1'-biphenyl		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	1528-74-1	244.203	nd (al)	242.3				i H <sub>2</sub> O; sl EtOH; s bz, HOAc
4381	1,4-Dinitrobutane		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	4286-49-1	148.118	pl (al)	33.5	176 <sup>13</sup>			i H <sub>2</sub> O; sl EtOH; s eth, bz, MeOH
4382	4,4'-Dinitrodiphenylamine	4-Nitro- <i>N</i> -(4-nitrophenyl)aniline	C <sub>12</sub> H <sub>9</sub> N <sub>3</sub> O <sub>4</sub>	1821-27-8	259.217	ye nd(al)	217.5				i H <sub>2</sub> O, tol; sl EtOH, bz; s ace, HOAc
4383	4,4'-Dinitrodiphenyl ether	Bis(4-nitrophenyl) ether	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>5</sub>	101-63-3	260.202		146.0				i H <sub>2</sub> O; sl EtOH, eth; s bz, HOAc
4384	4,4'-Dinitrodiphenyl sulfide	Bis(4-nitrophenyl) sulfide	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub> S	1223-31-0	276.268	oran pl (HOAc)	160.5				i H <sub>2</sub> O; sl EtOH; s con sulf
4385	1,1-Dinitroethane		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	600-40-8	120.064	ye mcl (bz, MeOH)		185.5	1.349 <sup>24</sup>		sl H <sub>2</sub> O; s EtOH, eth
4386	1,2-Dinitroethane		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	7570-26-5	120.064		39.5	95 <sup>5</sup>	1.4597 <sup>20</sup>	1.4468 <sup>20</sup>	vs eth, EtOH
4387	Dinitromethane		CH <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	625-76-3	106.038	ye nd	<-15	exp 100			i H <sub>2</sub> O; s EtOH, eth
4388	1,3-Dinitronaphthalene		C <sub>10</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	606-37-1	218.166	ye nd (bz, py-w)	148	sub			i H <sub>2</sub> O; s EtOH, ace
4389	1,5-Dinitronaphthalene		C <sub>10</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	605-71-0	218.166	hex nd (ace, HOAc)	219	sub	1.5860 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, ace; s bz, py; vs eth
4390	1,8-Dinitronaphthalene		C <sub>10</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	602-38-0	218.166	ye orth pl (chl)	173	dec 445			i H <sub>2</sub> O; sl EtOH, bz; s ace, chl, py
4391	2,4-Dinitro-1-naphthol		C <sub>10</sub> H <sub>6</sub> N <sub>2</sub> O <sub>5</sub>	605-69-6	234.165	ye nd (al, chl)	138.8				
4392	2,3-Dinitrophenol		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	66-56-8	184.106	ye nd (w)	144.5		1.681 <sup>20</sup>		sl H <sub>2</sub> O, DMSO; vs EtOH, eth; s bz
4393	2,4-Dinitrophenol		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	51-28-5	184.106	pa ye pl or lf (w)	114.8	sub	1.683 <sup>24</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace, bz, tol, chl, py
4394	2,5-Dinitrophenol		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	329-71-5	184.106	ye mcl pr or nd (w, lig)	108				vs bz, eth
4395	2,6-Dinitrophenol		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	573-56-8	184.106	pa ye orth nd or lf (dil al)	63.5				i H <sub>2</sub> O; vs EtOH, eth; s bz, chl; sl ctc
4396	3,4-Dinitrophenol		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	577-71-9	184.106	tcl nd (w)	134		1.672 <sup>25</sup>		vs bz, eth, EtOH
4397	2,4-Dinitrophenol, acetate		C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	4232-27-3	226.143	cry (MeOH)	72.5				
4398	4-[(2,4-Dinitrophenyl)amino]phenol		C <sub>12</sub> H <sub>9</sub> N <sub>3</sub> O <sub>5</sub>	119-15-3	275.216	red lf	195.5				s alk
4399	2,4-Dinitro- <i>N</i> -phenylaniline		C <sub>12</sub> H <sub>9</sub> N <sub>3</sub> O <sub>4</sub>	961-68-2	259.217	ye red nd (al)	157.8				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz, DMSO
4400	2,4-Dinitrophenyl dimethylcarbamodithioate		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	89-37-2	287.315		152.5		1.54 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, ace, bz
4401	(2,4-Dinitrophenyl)hydrazine		C <sub>6</sub> H <sub>6</sub> N <sub>4</sub> O <sub>4</sub>	119-26-6	198.137	blsh-red (al)	194				i H <sub>2</sub> O; s EtOH; sl eth, bz, chl, DMSO
4402	1,1-Dinitropropane		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	601-76-3	134.091	liq	-42	184	1.2610 <sup>25</sup>	1.4339 <sup>20</sup>	s alk
4403	1,3-Dinitropropane		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	6125-21-9	134.091		-21.4	103 <sup>1</sup>	1.353 <sup>26</sup>	1.4654 <sup>20</sup>	i H <sub>2</sub> O; s eth
4404	2,2-Dinitropropane		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	595-49-3	134.091		53	185.5	1.30 <sup>25</sup>		sl H <sub>2</sub> O
4405	2,2-Dinitro-1,3-propanediol		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	2736-80-3	166.089	wh pl (bz)	142				
4406	1,6-Dinitropyrene		C <sub>16</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	42397-64-8	292.246		>300				
4407	1,8-Dinitropyrene		C <sub>16</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	42397-65-9	292.246		300				
4408	Dinitrosopentamethylenetetramine		C <sub>5</sub> H <sub>10</sub> N <sub>6</sub> O <sub>2</sub>	101-25-7	186.172	cry (MeOH)	207				
4409	1,4-Dinitrosopiperazine		C <sub>4</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	140-79-4	144.133	pa ye pl (w)	159.0				vs EtOH
4410	4,4'-Dinitro-2,2'-stilbenedisulfonic acid		C <sub>14</sub> H <sub>10</sub> N <sub>2</sub> O <sub>10</sub> S <sub>2</sub>	128-42-7	430.366	cry (AcOH)	266				
4411	Dinobuton	Dessin	C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> O <sub>7</sub>	973-21-7	326.302	ye cry (EtOH)	60				
4412	Dinocap		C <sub>18</sub> H <sub>24</sub> N <sub>2</sub> O <sub>6</sub>	6119-92-2	364.393				136 <sup>01</sup>		
4413	Dinonyl adipate		C <sub>24</sub> H <sub>46</sub> O <sub>4</sub>	151-32-6	398.620				205 <sup>1</sup>		

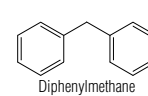
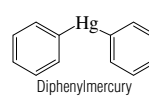
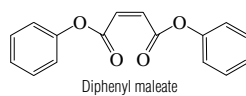
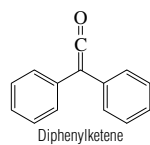
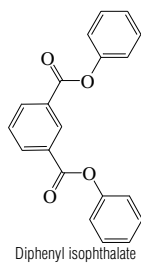
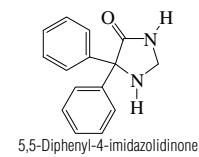
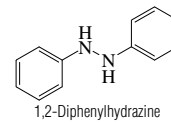
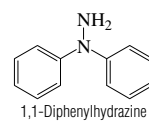
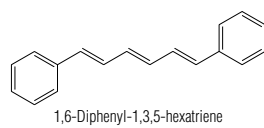
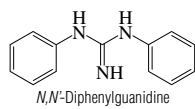
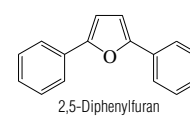
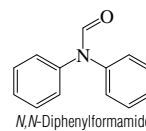
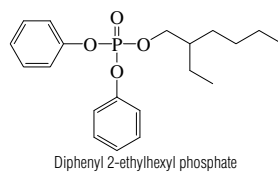
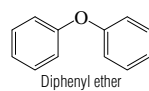
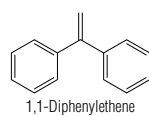
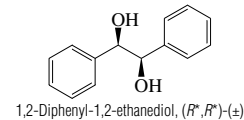
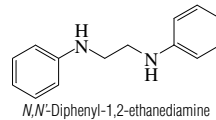
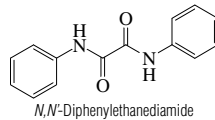
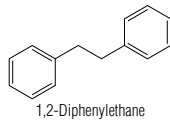
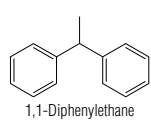
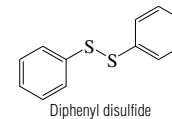
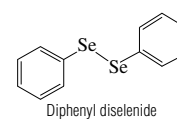
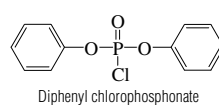
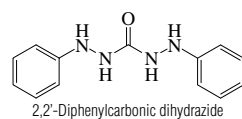
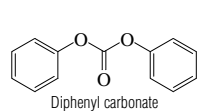
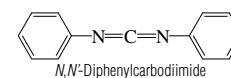
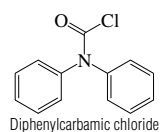
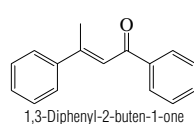
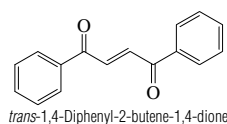
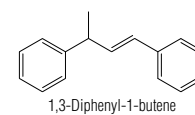
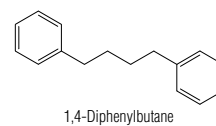
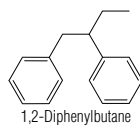
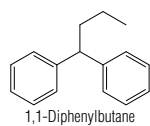
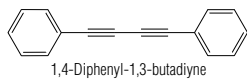
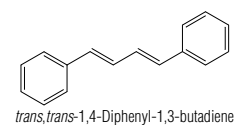
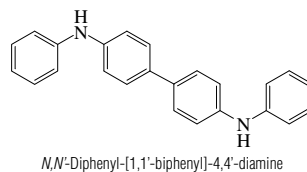
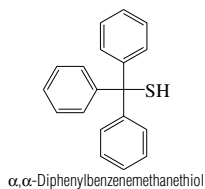
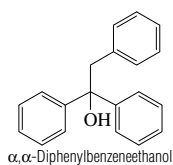




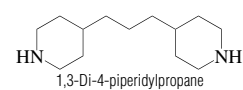
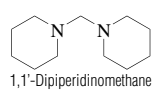
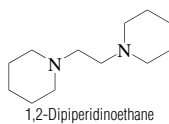
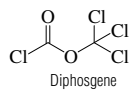
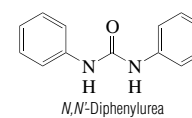
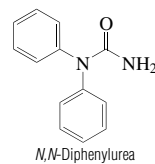
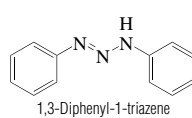
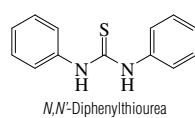
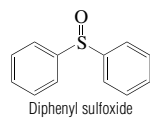
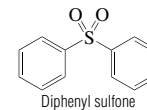
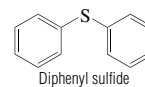
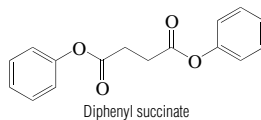
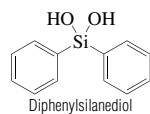
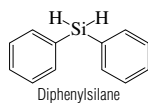
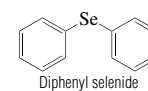
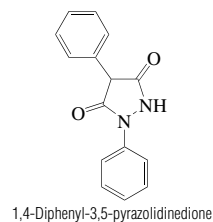
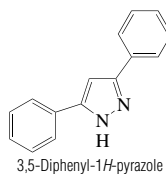
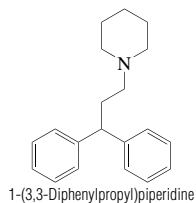
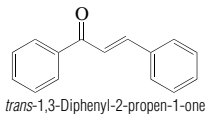
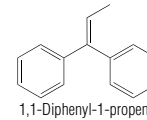
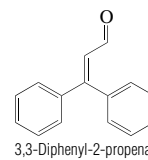
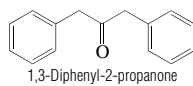
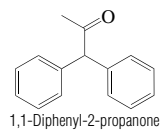
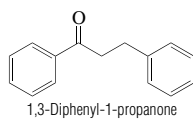
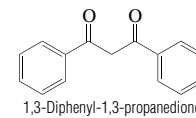
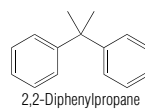
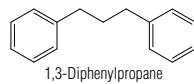
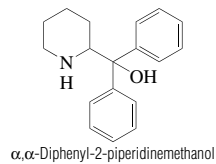
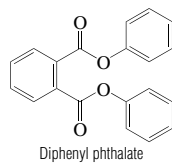
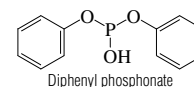
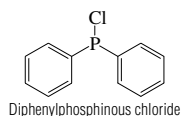
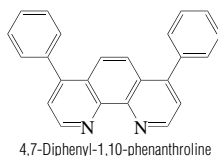
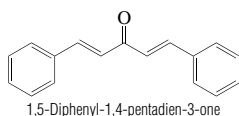
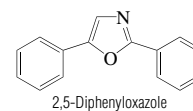
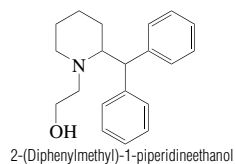
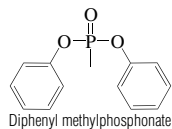
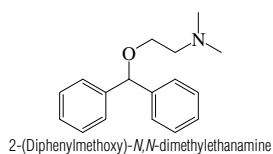
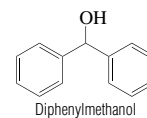
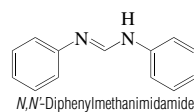
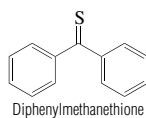
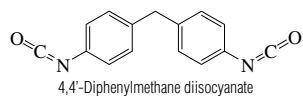
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4414	Dinonyl ether		C <sub>18</sub> H <sub>38</sub> O	2456-27-1	270.494	liq		318	0.81	1.4356 <sup>20</sup>	
4415	Dinonyl phthalate		C <sub>26</sub> H <sub>42</sub> O <sub>4</sub>	84-76-4	418.609			413			
4416	Dinoseb	Phenol, 2-(1-methylpropyl)-4,6-dinitro-	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub>	88-85-7	240.212		40		1.265 <sup>45</sup>		
4417	Diocetadecylamine	Distearylamine	C <sub>36</sub> H <sub>72</sub> N	112-99-2	521.988		72.9	268 <sup>2</sup>			vs chl
4418	Diocetylamine	<i>N</i> -Octyl-1-octanamine	C <sub>16</sub> H <sub>32</sub> N	1120-48-5	241.456	nd	35.5	297.5	0.7963 <sup>26</sup>	1.4415 <sup>26</sup>	vs eth, EtOH
4419	Diocetyl ether		C <sub>16</sub> H <sub>34</sub> O	629-82-3	242.440	liq	-7.6	283	0.8063 <sup>20</sup>	1.4327 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, etc
4420	Diocetyl hexanedioate		C <sub>22</sub> H <sub>42</sub> O <sub>4</sub>	123-79-5	370.566		9.6	191 <sup>2</sup>	0.922 <sup>25</sup>		
4421	Diocetyl maleate		C <sub>20</sub> H <sub>36</sub> O <sub>4</sub>	2915-53-9	340.498	liq		242 <sup>0.002</sup>	0.94 <sup>20</sup>	1.4539 <sup>20</sup>	
4422	Diocetyl phthalate		C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	117-84-0	390.557		25	220 <sup>4</sup>			
4423	Diocetyl sebacate	Diocetyl decanedioate	C <sub>26</sub> H <sub>50</sub> O <sub>4</sub>	2432-87-3	426.673		18	218 <sup>0.5</sup>	0.9074 <sup>25</sup>		s etc
4424	Diocetyl sulfide	Octyl sulfide	C <sub>16</sub> H <sub>34</sub> S	2690-08-6	258.506			202 <sup>29</sup> , 180 <sup>10</sup>	0.842 <sup>25</sup>	1.4610 <sup>20</sup>	
4425	Diocetyl terephthalate		C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	4654-26-6	390.557	cry		425	1.21 <sup>62</sup>		
4426	Dioscorine		C <sub>13</sub> H <sub>19</sub> NO <sub>2</sub>	3329-91-7	221.296	grn-ye pr (eth)	34				s H <sub>2</sub> O, ace, chl, EtOH; sl eth, bz
4427	1,3-Dioxane	1,3-Dioxacyclohexane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	505-22-6	88.106	liq	-45	106.1	1.0286 <sup>25</sup>	1.4165 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz
4428	1,4-Dioxane	1,4-Dioxacyclohexane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	123-91-1	88.106		11.85	101.5	1.0337 <sup>20</sup>	1.4224 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz; s etc
4429	1,4-Dioxane-2,5-dione		C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	502-97-6	116.073	lf (al, al-chl)	85.4				vs ace
4430	1,4-Dioxane-2,6-dione	Diglycollic anhydride	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	4480-83-5	116.073	cry (bz)	92.5	240.5; 120 <sup>12</sup>			
4431	Dioxathion		C <sub>12</sub> H <sub>26</sub> O <sub>6</sub> P <sub>2</sub> S <sub>4</sub>	78-34-2	456.538		-20		1.257 <sup>26</sup>		
4432	1,3-Dioxepane		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	505-65-7	102.132						s chl
4433	1,3-Dioxolane	1,3-Dioxacyclopentane	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	646-06-0	74.079	liq	-97.22	78	1.060 <sup>20</sup>	1.3974 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, ace
4434	1,3-Dioxol-2-one		C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	872-36-6	86.046	liq	22	162; 73 <sup>32</sup>	1.35 <sup>25</sup>		
4435	Dioxybenzone	(2-Hydroxy-4-methoxyphenyl)(2-hydroxyphenyl)methanone	C <sub>14</sub> H <sub>12</sub> O <sub>4</sub>	131-53-3	244.243			172 <sup>1</sup>			
4436	Dioxypyrimidon		C <sub>13</sub> H <sub>17</sub> N <sub>3</sub> O <sub>3</sub>	519-65-3	263.292	pr	105.5	197 <sup>2</sup>			s H <sub>2</sub> O, EtOH
4437	Dipentaerythritol		C <sub>10</sub> H <sub>22</sub> O <sub>7</sub>	126-58-9	254.278	cry (w)	221		1.366 <sup>15</sup>		s hot H <sub>2</sub> O
4438	Dipentene	<i>p</i> -Menthadiene	C <sub>10</sub> H <sub>16</sub>	7705-14-8	136.234	liq	-95.5	178	0.8402 <sup>21</sup>	1.4727 <sup>20</sup>	
4439	Dipentylamine	Diamylamine	C <sub>10</sub> H <sub>23</sub> N	2050-92-2	157.297			202.5	0.7771 <sup>20</sup>	1.4272 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH; msc eth; s ace
4440	Dipentyl <i>cis</i> -2-butenedioate	Dipentyl maleate	C <sub>14</sub> H <sub>24</sub> O <sub>4</sub>	10099-71-5	256.339	liq		161 <sup>10</sup>	0.974 <sup>20</sup>		
4441	Dipentyl ether	Amyl ether	C <sub>10</sub> H <sub>22</sub> O	693-65-2	158.281	liq	-69	190	0.7833 <sup>20</sup>	1.4119 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
4442	2,6-Di- <i>tert</i> -pentyl-4-methylphenol	2,6-Bis(1,1-dimethylpropyl)-4-methylphenol	C <sub>17</sub> H <sub>28</sub> O	56103-67-4	248.403			283	0.931 <sup>25</sup>	1.4950 <sup>20</sup>	
4443	Di- <i>tert</i> -pentyl peroxide		C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	10508-09-5	174.281		-55	58 <sup>14</sup> , 38 <sup>9</sup>	0.808 <sup>20</sup>	1.4095 <sup>20</sup>	
4444	Dipentyl phthalate		C <sub>18</sub> H <sub>26</sub> O <sub>4</sub>	131-18-0	306.397			205 <sup>11</sup>			s etc, CS <sub>2</sub>
4445	Dipentyl sulfide		C <sub>10</sub> H <sub>22</sub> S	872-10-6	174.347		-51.3	86 <sup>3.7</sup>	0.8407 <sup>20</sup>	1.4561 <sup>20</sup>	i H <sub>2</sub> O; s eth
4446	Dipentyl sulfoxide		C <sub>10</sub> H <sub>22</sub> OS	1986-90-9	190.346		58	120 <sup>1</sup>			
4447	Diphenamid	Benzeneacetamide, <i>N,N</i> -dimethyl- $\alpha$ -phenyl-	C <sub>16</sub> H <sub>17</sub> NO	957-51-7	239.312		135		1.17 <sup>23.3</sup>		
4448	Diphenidol	1,1-Diphenyl-4-piperidinyl-1-butanol	C <sub>21</sub> H <sub>27</sub> NO	972-02-1	309.445	nd (peth)	104.5				
4449	Diphenolic acid		C <sub>17</sub> H <sub>16</sub> O <sub>4</sub>	126-00-1	286.323	cry (w)	171.5				vs H <sub>2</sub> O, ace, EtOH
4450	1,2-Diphenoxyethane	Ethylene glycol diphenyl ether	C <sub>14</sub> H <sub>14</sub> O <sub>2</sub>	104-66-5	214.260	lf (al)	98	182 <sup>12</sup>			i H <sub>2</sub> O; sl EtOH; s eth, chl
4451	<i>N,N</i> -Diphenylacetamide		C <sub>14</sub> H <sub>13</sub> NO	519-87-9	211.259	wh cry pow	103	sub			sl H <sub>2</sub> O, eth, chl; s EtOH
4452	Diphenylacetylene		C <sub>14</sub> H <sub>10</sub>	501-65-5	178.229	mcl pr or pl (al)	62.5	300	0.9657 <sup>100</sup>		i H <sub>2</sub> O; sl EtOH, chl; vs eth
4453	2-(Diphenylacetyl)-1 <i>H</i> -indene-1,3(2 <i>H</i> )-dione	Diphenadione	C <sub>23</sub> H <sub>16</sub> O <sub>3</sub>	82-66-6	340.371	pa ye mcl (al)	146.5			1.670	vs ace, HOAc
4454	Diphenylamine	<i>N</i> -Phenylbenzenamine	C <sub>12</sub> H <sub>11</sub> N	122-39-4	169.222	mcl lf(dil al)	53.2	302	1.158 <sup>22</sup>		i H <sub>2</sub> O; vs EtOH, ace; s eth; sl chl
4455	Diphenylamine-2,2'-dicarboxylic acid		C <sub>14</sub> H <sub>11</sub> NO <sub>4</sub>	579-92-0	257.242	ye cry (al)	296 dec				
4456	Diphenylamine-4-sulfonic acid, sodium salt	Sodium diphenylamine-4-sulfonate	C <sub>12</sub> H <sub>10</sub> NNaO <sub>3</sub> S	6152-67-6	271.267	ye cry					
4457	9,10-Diphenylanthracene		C <sub>26</sub> H <sub>18</sub>	1499-10-1	330.421			246.5			
4458	Diphenylarsinous chloride	Chlorodiphenylarsine	C <sub>12</sub> H <sub>10</sub> AsCl	712-48-1	264.582	orth pl (peth)	44	337	1.4820 <sup>16</sup>	1.6332 <sup>26</sup>	vs ace, bz, eth, EtOH
4459	<i>N,N'</i> -Diphenyl-1,4-benzenediamine	<i>N,N'</i> -Diphenyl- <i>p</i> -phenylenediamine	C <sub>18</sub> H <sub>16</sub> N <sub>2</sub>	74-31-7	260.333		150	222 <sup>0.5</sup>			sl EtOH, eth, bz, chl; i acid



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4460	$\alpha,\alpha$ -Diphenylbenzeneethanol		C <sub>20</sub> H <sub>18</sub> O	4428-13-1	274.356	nd(bz-lig) pr (peth)	89.5	222 <sup>11</sup>			i H <sub>2</sub> O; vs EtOH; sl eth, chl, peth
4461	$\alpha,\alpha$ -Diphenylbenzenemethanethiol	Triphenylmethyl mercaptan	C <sub>19</sub> H <sub>16</sub> S	3695-77-0	276.395		105.8				
4462	<i>N,N'</i> -Diphenyl-[1,1'-biphenyl]-4,4'-diamine	<i>N,N'</i> -Diphenylbenzidine	C <sub>24</sub> H <sub>20</sub> N <sub>2</sub>	531-91-9	336.429	lf or pl	247				i H <sub>2</sub> O; sl EtOH, eth, bz; vs tol, HOAc
4463	<i>trans,trans</i> -1,4-Diphenyl-1,3-butadiene		C <sub>16</sub> H <sub>14</sub>	538-81-8	206.282	lf (al, HOAc)	154.3	352			vs bz, eth, EtOH, peth
4464	1,4-Diphenyl-1,3-butadiyne	Diphenyldiacetylene	C <sub>16</sub> H <sub>10</sub>	886-66-8	202.250		86.5				
4465	1,1-Diphenylbutane		C <sub>16</sub> H <sub>18</sub>	719-79-9	210.314		27	287	0.9928 <sup>20</sup>	1.5664 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4466	1,2-Diphenylbutane		C <sub>16</sub> H <sub>18</sub>	5223-59-6	210.314			291; 152 <sup>11</sup>	0.9673 <sup>20</sup>	1.5554 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4467	1,4-Diphenylbutane		C <sub>16</sub> H <sub>18</sub>	1083-56-3	210.314		52.5	317	0.9880 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, chl
4468	1,3-Diphenyl-1-butene		C <sub>16</sub> H <sub>16</sub>	7614-93-9	208.298		47.5	311	0.9996 <sup>20</sup>	1.590 <sup>15</sup>	
4469	<i>trans</i> -1,4-Diphenyl-2-butene-1,4-dione		C <sub>16</sub> H <sub>12</sub> O <sub>2</sub>	959-28-4	236.265	ye nd (al, bz)	111				sl EtOH; s bz, HOAc; vs chl; i lig
4470	1,3-Diphenyl-2-buten-1-one	Dyprone	C <sub>16</sub> H <sub>14</sub> O	495-45-4	222.281			342.5	1.1080 <sup>15</sup>	1.6343 <sup>20</sup>	vs eth, EtOH
4471	Diphenylcarbamic chloride		C <sub>13</sub> H <sub>10</sub> ClNO	83-01-2	231.677	lf (al)	84.5				
4472	Diphenylcarbazon		C <sub>13</sub> H <sub>12</sub> N <sub>4</sub> O	538-62-5	240.260	oran oran nd (bz) pr (al)	157 dec				i H <sub>2</sub> O; vs EtOH, bz, chl
4473	<i>N,N'</i> -Diphenylcarbodiimide		C <sub>13</sub> H <sub>10</sub> N <sub>2</sub>	622-16-2	194.231		169	331; 175 <sup>20</sup>			sl H <sub>2</sub> O, EtOH, eth; s bz
4474	Diphenyl carbonate	Phenyl carbonate	C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	102-09-0	214.216	nd (al, bz)	83	306	1.1215 <sup>67</sup>		i H <sub>2</sub> O; s EtOH, eth, ctc, HOAc
4475	2,2'-Diphenylcarbonic dihydrazide	<i>sym</i> -Diphenylcarbazine	C <sub>13</sub> H <sub>14</sub> N <sub>4</sub> O	140-22-7	242.276	cry (al + 1) cry (HOAc)	170	dec			sl H <sub>2</sub> O, eth; s EtOH, ace, bz
4476	Diphenyl chlorophosphonate		C <sub>12</sub> H <sub>10</sub> ClO <sub>3</sub> P	2524-64-3	268.632			314 <sup>272</sup>	1.296 <sup>25</sup>	1.5500 <sup>20</sup>	s tfa
4477	Diphenyl diselenide	Phenyl diselenide	C <sub>12</sub> H <sub>10</sub> Se <sub>2</sub>	1666-13-3	312.13	ye nd	63.5	202 <sup>11</sup>	1.557 <sup>80</sup>	1.743 <sup>20</sup>	s EtOH, eth, xyl, MeOH
4478	Diphenyl disulfide	Phenyl disulfide	C <sub>12</sub> H <sub>10</sub> S <sub>2</sub>	882-33-7	218.337	nd(al) or orth	62	310	1.353 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub>
4479	1,1-Diphenylethane		C <sub>14</sub> H <sub>14</sub>	612-00-0	182.261	liq	-17.9	272.6	0.9997 <sup>20</sup>	1.5756 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz
4480	1,2-Diphenylethane	Dibenzyl	C <sub>14</sub> H <sub>14</sub>	103-29-7	182.261	mcl pr (MeOH)	52.5	284	0.9780 <sup>25</sup>	1.5476 <sup>60</sup>	i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
4481	<i>N,N'</i> -Diphenylethanediarnide		C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	620-81-5	240.257	lf (bz)	254	>360			vs bz
4482	<i>N,N'</i> -Diphenyl-1,2-ethanediarnine	1,2-Dianilinoethane	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub>	150-61-8	212.290	cry (dil al)	74	229 <sup>12</sup> , 178 <sup>2</sup>			i H <sub>2</sub> O; s EtOH, eth; sl tfa
4483	1,2-Diphenyl-1,2-ethanediol, ( <i>R*,R*</i> )-(±)		C <sub>14</sub> H <sub>14</sub> O <sub>2</sub>	655-48-1	214.260	nd (w,al),tab (eth)	122.5	>300			i H <sub>2</sub> O, lig; vs EtOH, eth; s ace
4484	1,1-Diphenylethene		C <sub>14</sub> H <sub>12</sub>	530-48-3	180.245		8.2	277	1.0232 <sup>20</sup>	1.6085 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl
4485	Diphenyl ether		C <sub>12</sub> H <sub>10</sub> O	101-84-8	170.206		26.87	258.0	1.0661 <sup>30</sup>	1.5787 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, HOAc; sl chl
4486	Diphenyl 2-ethylhexyl phosphate		C <sub>20</sub> H <sub>27</sub> O <sub>4</sub> P	1241-94-7	362.399			232 <sup>5</sup>	1.090 <sup>25</sup>	1.510 <sup>25</sup>	
4487	<i>N,N'</i> -Diphenylformamide		C <sub>13</sub> H <sub>11</sub> NO	607-00-1	197.232	orth (dil al)	73.5	337.5; 189 <sup>13</sup>			i H <sub>2</sub> O; s EtOH, eth, bz; sl ctc
4488	2,5-Diphenylfuran		C <sub>16</sub> H <sub>12</sub> O	955-83-9	220.265	nd or lf (dil al)	91	344			i H <sub>2</sub> O; vs EtOH, eth; s ace, bz
4489	<i>N,N'</i> -Diphenylguanidine	1,3-Diphenylguanidine	C <sub>13</sub> H <sub>13</sub> N <sub>3</sub>	102-06-7	211.262	mcl nd (al, to)	150	dec 170	1.13 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, ctc chl, tol; vs eth
4490	1,6-Diphenyl-1,3,5-hexatriene		C <sub>18</sub> H <sub>16</sub>	1720-32-7	232.320	lf (ace)	202.3				i H <sub>2</sub> O, EtOH, eth, HOAc; s ace; sl bz, chl
4491	1,1-Diphenylhydrazine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	530-50-7	184.236	tab (lig)	50.5	220 <sup>40</sup>	1.190 <sup>16</sup>		vs bz, eth, EtOH, chl
4492	1,2-Diphenylhydrazine	Hydrazobenzene	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	122-66-7	184.236	tab (al-eth)	131		1.158 <sup>16</sup>		vs EtOH; sl bz, DMSO; i HOAc
4493	5,5-Diphenyl-4-imidazolidinone	Doxenitoin	C <sub>15</sub> H <sub>14</sub> N <sub>2</sub> O	3254-93-1	238.284	pl (MeOH)	183				
4494	Diphenyl isophthalate		C <sub>20</sub> H <sub>16</sub> O <sub>4</sub>	744-45-6	318.323		138				s chl
4495	Diphenylketene	Diphenylethenone	C <sub>14</sub> H <sub>10</sub> O	525-06-4	194.228	red-ye liq		267.5	1.1107 <sup>13</sup>	1.615 <sup>14</sup>	
4496	Diphenyl maleate		C <sub>16</sub> H <sub>12</sub> O <sub>4</sub>	7242-17-3	268.264	pl (lig)	73	226 <sup>15</sup>			vs ace, bz, eth, EtOH
4497	Diphenylmercury	Mercuriodibenzene	C <sub>12</sub> H <sub>10</sub> Hg	587-85-9	354.80			204 <sup>10</sup>	2.318 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth; s bz, chl
4498	Diphenylmethane		C <sub>13</sub> H <sub>12</sub>	101-81-5	168.234	pr nd	25.4	265.0	1.001 <sup>26</sup>	1.5753 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl

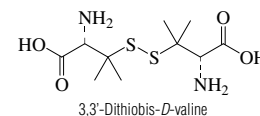
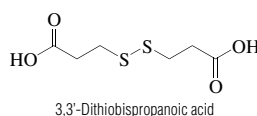
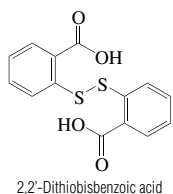
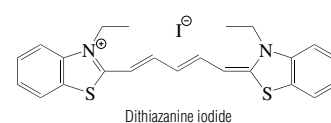
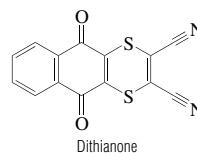
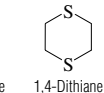
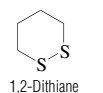
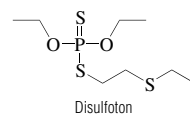
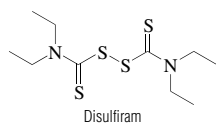
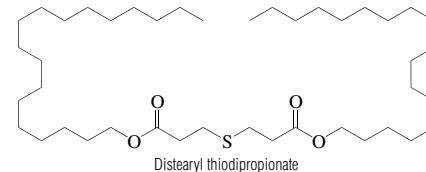
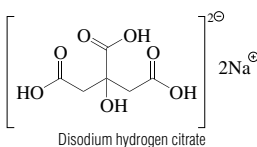
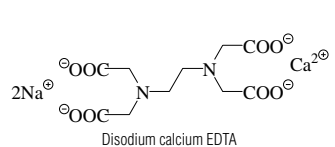
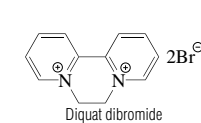
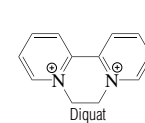
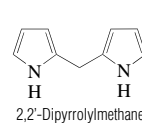
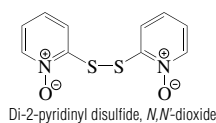
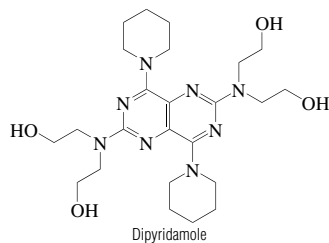
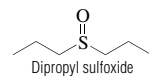
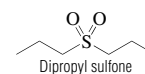
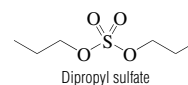
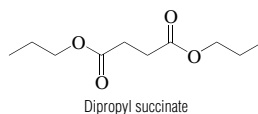
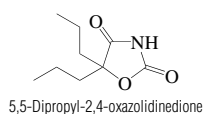
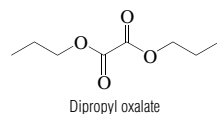
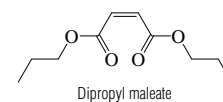
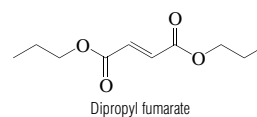
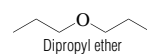
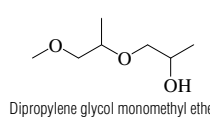
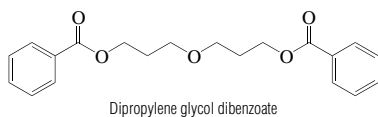
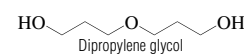
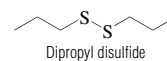
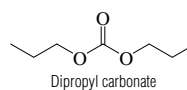
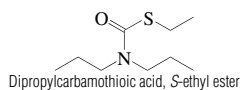
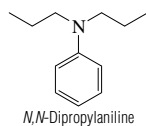
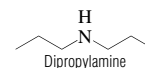
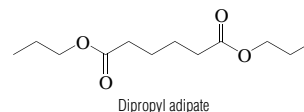
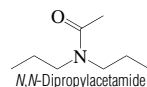
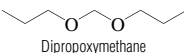
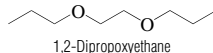
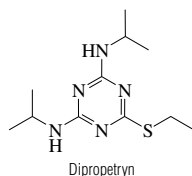
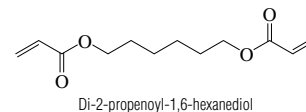
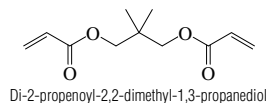
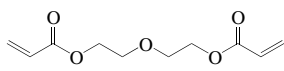
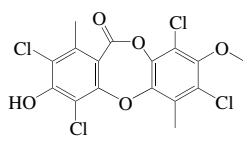


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4499	4,4'-Diphenylmethane diisocyanate	Methylene diphenyl diisocyanate	C <sub>15</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	101-68-8	250.252		37	196 <sup>5</sup>	1.197 <sup>70</sup>	1.5906 <sup>50</sup>	s ace, bz, PhNO <sub>2</sub>
4500	Diphenylmethanethione		C <sub>13</sub> H <sub>10</sub> S	1450-31-3	198.283		53.5	174 <sup>14</sup>			sl EtOH, eth, peth; vs bz, chl
4501	<i>N,N'</i> -Diphenylmethanimidamide		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub>	622-15-1	196.247	nd (al)	142	>250			sl H <sub>2</sub> O, peth; s EtOH, ace, bz; vs eth
4502	Diphenylmethanol	Benzohydrol	C <sub>13</sub> H <sub>12</sub> O	91-01-0	184.233	nd (lig)	69	298; 180 <sup>20</sup>			sl H <sub>2</sub> O; vs EtOH, eth, ctc, chl; s HOAc
4503	2-(Diphenylmethoxy)- <i>N,N</i> -dimethylethanamine	Diphenhydramine	C <sub>17</sub> H <sub>21</sub> NO	58-73-1	255.355	oil		165 <sup>3</sup>			
4504	Diphenyl methylphosphonate		C <sub>13</sub> H <sub>13</sub> O <sub>3</sub> P	7526-26-3	248.214		35	205 <sup>13</sup>	1.2051 <sup>20</sup>		i H <sub>2</sub> O
4505	2-(Diphenylmethyl)-1-piperidineethanol	Diphemethoxidine	C <sub>20</sub> H <sub>26</sub> NO	13862-07-2	295.419		106.5	180 <sup>11</sup>			
4506	2,5-Diphenyloxazole		C <sub>15</sub> H <sub>11</sub> NO	92-71-7	221.254	nd (lig)	74	360	1.0940 <sup>100</sup>	1.6231 <sup>100</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl chl
4507	1,5-Diphenyl-1,4-pentadien-3-one	Dibenzalacetone	C <sub>17</sub> H <sub>14</sub> O	538-58-9	234.292	pl or lf (ace, AcOEt)	113 dec	dec			i H <sub>2</sub> O; sl EtOH, eth; s ace, chl
4508	4,7-Diphenyl-1,10-phenanthroline		C <sub>24</sub> H <sub>16</sub> N <sub>2</sub>	1662-01-7	332.397		220 dec				
4509	Diphenylphosphinichloride	Chlorodiphenylphosphine	C <sub>12</sub> H <sub>10</sub> ClP	1079-66-9	220.634	hyg ye liq		320; 174 <sup>5</sup>	1.229	1.6360 <sup>20</sup>	
4510	Diphenyl phosphonate		C <sub>12</sub> H <sub>11</sub> O <sub>3</sub> P	4712-55-4	234.187		12	218 <sup>26</sup>	1.223 <sup>25</sup>	1.5575 <sup>20</sup>	
4511	Diphenyl phthalate	Phenyl phthalate	C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	84-62-8	318.323	pr (al, lig)	73	253 <sup>14</sup>			i H <sub>2</sub> O; sl EtOH, eth, ctc
4512	$\alpha,\alpha$ -Diphenyl-2-piperidinemethanol	Pipradrol	C <sub>18</sub> H <sub>21</sub> NO	467-60-7	267.366	cry (hx)	97.5				
4513	1,3-Diphenylpropane		C <sub>15</sub> H <sub>16</sub>	1081-75-0	196.288	liq	6	300; 123 <sup>1,7</sup>	1.007 <sup>20</sup>	1.5760 <sup>20</sup>	
4514	2,2-Diphenylpropane		C <sub>15</sub> H <sub>16</sub>	778-22-3	196.288		29	282.5	0.9980 <sup>20</sup>		
4515	1,3-Diphenyl-1,3-propanedione	Dibenzoylmethane	C <sub>15</sub> H <sub>12</sub> O <sub>2</sub>	120-46-7	224.255		70.5				s EtOH, eth, chl, dil NaOH
4516	1,3-Diphenyl-1-propanone	Phenethyl phenyl ketone	C <sub>15</sub> H <sub>14</sub> O	1083-30-3	210.271	lf (EtOH)	72.5	360			
4517	1,1-Diphenyl-2-propanone	1,1-Diphenylacetone	C <sub>15</sub> H <sub>14</sub> O	781-35-1	210.271		46	307; 174 <sup>10</sup>		1.5361 <sup>16</sup>	s EtOH, eth, bz, chl, lig
4518	1,3-Diphenyl-2-propanone	Dibenzyl ketone	C <sub>15</sub> H <sub>14</sub> O	102-04-5	210.271	cry (al, peth)	35	331	1.195 <sup>0</sup>		i H <sub>2</sub> O; s EtOH, eth, peth
4519	3,3-Diphenyl-2-propenal	$\beta$ -Phenylcinnamaldehyde	C <sub>15</sub> H <sub>12</sub> O	1210-39-5	208.255	pa ye pr (lig)	44.8	205 <sup>14</sup>			
4520	1,1-Diphenyl-1-propene		C <sub>15</sub> H <sub>14</sub>	778-66-5	194.272		52	280; 149 <sup>11</sup>	1.0250 <sup>20</sup>	1.5880 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz
4521	<i>trans</i> -1,3-Diphenyl-2-propen-1-one	Chalcone	C <sub>15</sub> H <sub>12</sub> O	614-47-1	208.255	pa ye lf, pr, nd (peth)	59	dec 346	1.0712 <sup>62</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz, chl, CS <sub>2</sub>
4522	1-(3,3-Diphenylpropyl)piperidine	Fenpiprane	C <sub>20</sub> H <sub>25</sub> N	3540-95-2	279.420		41.5	215 <sup>8</sup>			
4523	3,5-Diphenyl-1 <i>H</i> -pyrazole		C <sub>15</sub> H <sub>12</sub> N <sub>2</sub>	1145-01-3	220.269	cry (al)	200				
4524	1,4-Diphenyl-3,5-pyrazolidinedione	Phenopyrazone	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	3426-01-5	252.268	cry (EtOAc, Diox)	233.5				
4525	Diphenyl selenide		C <sub>12</sub> H <sub>10</sub> Se	1132-39-4	233.17	ye nd (bz)	1.3	301.5	1.351 <sup>20</sup>	1.5500 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, xyl
4526	Diphenylsilane		C <sub>12</sub> H <sub>12</sub> Si	775-12-2	184.309			134 <sup>16</sup> , 96 <sup>13</sup>	0.9969 <sup>20</sup>	1.5800 <sup>20</sup>	s ctc, CS <sub>2</sub>
4527	Diphenylsilanediol		C <sub>12</sub> H <sub>12</sub> O <sub>2</sub> Si	947-42-2	216.308						sl DMSO
4528	Diphenyl succinate		C <sub>16</sub> H <sub>14</sub> O <sub>4</sub>	621-14-7	270.280	lf (al)	121	330; 222.5 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, eth, ace, bz
4529	Diphenyl sulfide	Phenyl sulfide	C <sub>12</sub> H <sub>10</sub> S	139-66-2	186.272	liq	-25.9	296	1.1136 <sup>20</sup>	1.6334 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc; msc eth, bz, CS <sub>2</sub>
4530	Diphenyl sulfone		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub> S	127-63-9	218.271	mcl pr(bz) pl(al)	128.5	379	1.252 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz
4531	Diphenyl sulfoxide		C <sub>12</sub> H <sub>10</sub> OS	945-51-7	202.271	pr(lig)	71.2	340 <sup>16</sup>			vs EtOH, eth, bz, HOAc; sl chl; i peth
4532	<i>N,N'</i> -Diphenylthiourea	<i>sym</i> -Diphenylthiourea	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> S	102-08-9	228.312		154.5		1.32 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth, chl, oils
4533	1,3-Diphenyl-1-triazene	Diazoaminobenzene	C <sub>12</sub> H <sub>11</sub> N <sub>3</sub>	136-35-6	197.235	ye lf or pr (al)	98				i H <sub>2</sub> O; vs EtOH, eth, bz, py
4534	<i>N,N</i> -Diphenylurea		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	603-54-3	212.246	tab (al)	189	dec	1.276 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH, eth, chl
4535	<i>N,N'</i> -Diphenylurea	Carbanilide	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	102-07-8	212.246	orth pr (al)	239	260 dec	1.239 <sup>25</sup>		sl H <sub>2</sub> O, EtOH; s eth, py, HOAc; i bz
4536	Diphosgene	Carbonochloridic acid, trichloromethyl ester	C <sub>2</sub> Cl <sub>4</sub> O <sub>2</sub>	503-38-8	197.832	liq	-57	128	1.6525 <sup>14</sup>	1.4566 <sup>22</sup>	vs eth, EtOH
4537	1,2-Dipiperidinoethane		C <sub>12</sub> H <sub>24</sub> N <sub>2</sub>	1932-04-3	196.332	liq	-0.5	265	0.9160 <sup>25</sup>	1.4853 <sup>25</sup>	
4538	1,1'-Dipiperidinomethane	1,1'-Methylenedipiperidine	C <sub>11</sub> H <sub>22</sub> N <sub>2</sub>	880-09-1	182.306			230; 122 <sup>15</sup>	0.9269 <sup>20</sup>	1.4820 <sup>20</sup>	
4539	1,3-Di-4-piperidylpropane	4,4'-Trimethylenedipiperidine	C <sub>13</sub> H <sub>26</sub> N <sub>2</sub>	16898-52-5	210.358		67.1	329			vs H <sub>2</sub> O

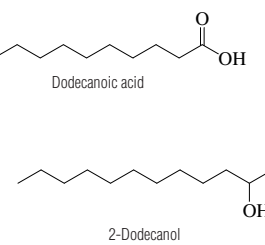
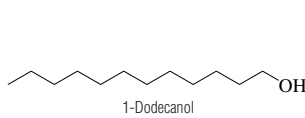
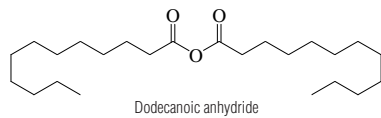
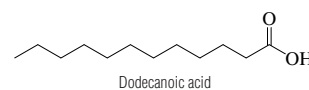
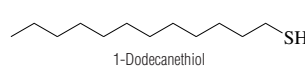
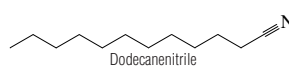
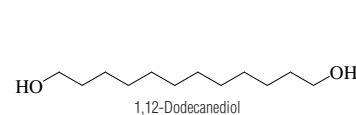
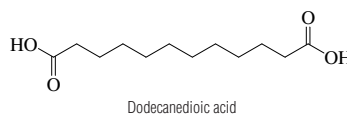
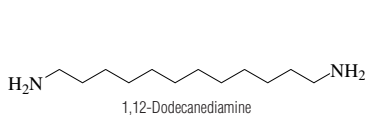
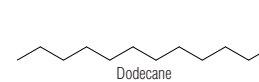
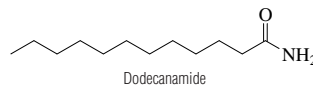
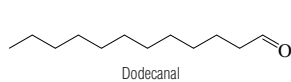
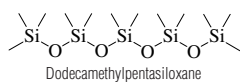
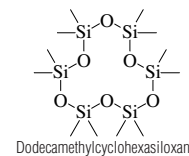
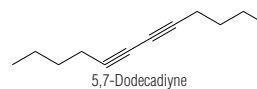
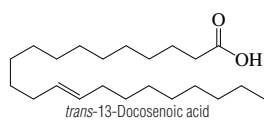
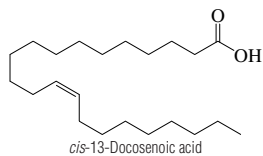
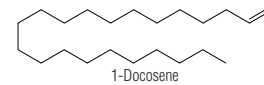
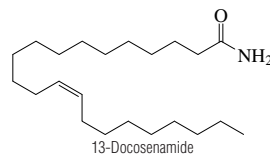
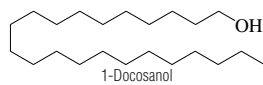
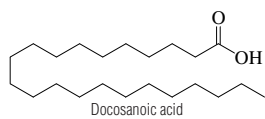
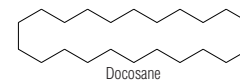
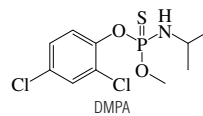
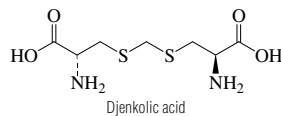
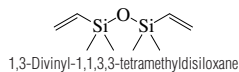
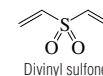
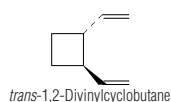
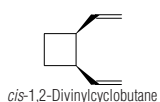
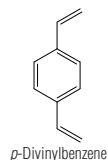
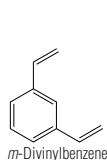
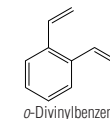
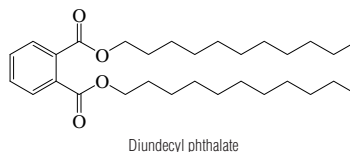
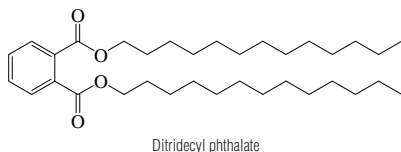
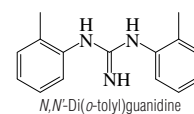
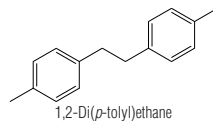
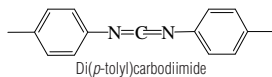
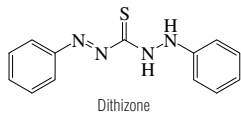
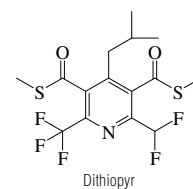
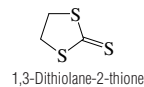
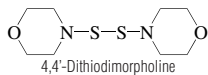
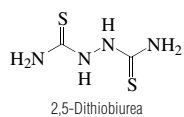


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4540	Diploicin		C <sub>16</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>5</sub>	527-93-5	424.059		232				
4541	Di-2-propenoyldiethyleneglycol		C <sub>10</sub> H <sub>14</sub> O <sub>5</sub>	4074-88-8	214.215			200	1.1110 <sup>25</sup>	1.4595 <sup>25</sup>	
4542	Di-2-propenoyl-2,2-dimethyl-1,3-propanediol	2-Propenoic acid, 2,2-dimethyl-1,3-propanediyl ester	C <sub>11</sub> H <sub>16</sub> O <sub>4</sub>	2223-82-7	212.243					1.4542 <sup>25</sup>	
4543	Di-2-propenoyl-1,6-hexanediol	2-Propenoic acid, 1,6-hexanediyl ester	C <sub>12</sub> H <sub>18</sub> O <sub>4</sub>	13048-33-4	226.269				1.010 <sup>25</sup>		
4544	Dipropetryn	6-(Ethylthio)- <i>N,N'</i> -diisopropyl-1,3,5-triazine-2,4-diamine	C <sub>11</sub> H <sub>21</sub> N <sub>3</sub> S	4147-51-7	255.384		105				
4545	1,2-Dipropoxyethane		C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	18854-56-3	146.228	liq		163.2 dec	0.8312 <sup>25</sup>	1.4013 <sup>25</sup>	
4546	Dipropoxymethane	Formaldehyde, dipropyl acetal	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	505-84-0	132.201	liq	-97.3	140.5	0.8345 <sup>20</sup>	1.3939 <sup>19</sup>	vs ace, bz, eth, EtOH
4547	<i>N,N</i> -Dipropylacetamide		C <sub>9</sub> H <sub>17</sub> NO	1116-24-1	143.227			209.5	0.8992 <sup>17</sup>	1.4419 <sup>17</sup>	vs EtOH
4548	Dipropyl adipate		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	106-19-4	230.301		-15.7	151 <sup>11</sup>	0.9790 <sup>20</sup>	1.4314 <sup>20</sup>	vs eth, EtOH, chl
4549	Dipropylamine	<i>N</i> -Propyl-1-propanamine	C <sub>6</sub> H <sub>13</sub> N	142-84-7	101.190	liq	-63	109.3	0.7400 <sup>20</sup>	1.4050 <sup>20</sup>	s H <sub>2</sub> O, EtOH; msc eth; vs ace, bz
4550	4-[(Dipropylamino)sulfonyl]benzoic acid	Probenecid	C <sub>13</sub> H <sub>19</sub> NO <sub>2</sub> S	57-66-9	285.360		195				
4551	<i>N,N</i> -Dipropylaniline		C <sub>12</sub> H <sub>15</sub> N	2217-07-4	177.286	ye lf		242	0.9104 <sup>20</sup>	1.5271 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; sl ctc
4552	Dipropylcarbamoithioic acid, <i>S</i> -ethyl ester	EPTC	C <sub>9</sub> H <sub>19</sub> NOS	759-94-4	189.318			127 <sup>20</sup>	0.9546 <sup>30</sup>		
4553	Dipropyl carbonate		C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	623-96-1	146.184			168	0.9435 <sup>20</sup>	1.4008 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
4554	Dipropyl disulfide		C <sub>6</sub> H <sub>14</sub> S <sub>2</sub>	629-19-6	150.305	liq	-85.6	195.8	0.9599 <sup>20</sup>	1.4981 <sup>20</sup>	
4555	Dipropylene glycol		C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	25265-71-8	134.173			230.5	1.0206 <sup>20</sup>		msc H <sub>2</sub> O; s EtOH
4556	Dipropylene glycol dibenzoate		C <sub>20</sub> H <sub>22</sub> O <sub>5</sub>	27138-31-4	342.386			197 <sup>1</sup>			
4557	Dipropylene glycol monomethyl ether	1-(2-Methoxyisopropoxy)-2-propanol	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	34590-94-8	148.200	liq	-80	188.3	0.95	1.4190 <sup>20</sup>	
4558	Dipropyl ether	Propyl ether	C <sub>6</sub> H <sub>14</sub> O	111-43-3	102.174	liq	-114.8	90.08	0.7466 <sup>20</sup>	1.3809 <sup>20</sup>	sl H <sub>2</sub> O; vs eth, EtOH
4559	Dipropyl fumarate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	14595-35-8	200.232			110 <sup>5</sup>	1.0129 <sup>20</sup>	1.4435 <sup>20</sup>	s EtOH, eth
4560	Dipropyl maleate		C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	2432-63-5	200.232			126 <sup>12</sup>	1.0245 <sup>20</sup>	1.4434 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
4561	Dipropyl oxalate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	615-98-5	174.195	liq	-44.3	211	1.0188 <sup>20</sup>	1.4158 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; s eth
4562	5,5-Dipropyl-2,4-oxazolidinedione		C <sub>9</sub> H <sub>15</sub> NO <sub>3</sub>	512-12-9	185.220		42.5	149 <sup>3</sup>			
4563	Dipropyl succinate		C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	925-15-5	202.248	liq	-5.9	250.8	1.0020 <sup>20</sup>	1.4250 <sup>20</sup>	vs ace, bz, eth
4564	Dipropyl sulfate		C <sub>6</sub> H <sub>14</sub> O <sub>4</sub> S	598-05-0	182.238			120 <sup>20</sup>	1.1064 <sup>20</sup>	1.4135 <sup>20</sup>	vs peth
4565	Dipropyl sulfide		C <sub>6</sub> H <sub>14</sub> S	111-47-7	118.240	liq	-102.5	142.9	0.814 <sup>17</sup>	1.4487 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4566	Dipropyl sulfone		C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> S	598-03-8	150.239	cry	29.5		1.0278 <sup>20</sup>	1.4456 <sup>30</sup>	sl H <sub>2</sub> O; s EtOH, eth
4567	Dipropyl sulfoxide		C <sub>6</sub> H <sub>14</sub> OS	4253-91-2	134.239	nd	22.5	80 <sup>2</sup>	0.9654 <sup>20</sup>	1.4663 <sup>20</sup>	vs eth, EtOH
4568	Dipyridamole		C <sub>24</sub> H <sub>40</sub> N <sub>6</sub> O <sub>4</sub>	58-32-2	504.627			163			
4569	Di-2-pyridinyl disulfide, <i>N,N'</i> -dioxide	Dipyriothione	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	3696-28-4	252.313	cry (MeOH)	205				
4570	2,2'-Dipyrrylmethane		C <sub>9</sub> H <sub>10</sub> N <sub>2</sub>	21211-65-4	146.188	lf or nd (al)	73	164 <sup>12</sup>			vs bz, eth, EtOH
4571	Diquat		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	2764-72-9	184.236	Cation					
4572	Diquat dibromide		C <sub>12</sub> H <sub>12</sub> Br <sub>2</sub> N <sub>2</sub>	85-00-7	344.044			337	1.24 <sup>20</sup>		
4573	Disodium calcium EDTA	Edetate calcium disodium	C <sub>10</sub> H <sub>12</sub> CaNa <sub>2</sub> O <sub>8</sub>	62-33-9	374.268	pow					s H <sub>2</sub> O
4574	Disodium hydrogen citrate	Sodium acid citrate	C <sub>6</sub> H <sub>8</sub> Na <sub>2</sub> O <sub>7</sub>	144-33-2	236.088	wh pow (w)	149 dec				vs H <sub>2</sub> O
4575	Disperse Blue No. 1	1,4,5,8-Tetraamino-9,10-anthracenedione	C <sub>14</sub> H <sub>12</sub> N <sub>4</sub> O <sub>2</sub>	2475-45-8	268.271	red-br nd	331				
4576	Distearyl thiodipropionate	Dioctadecyl thioisopropanoate	C <sub>42</sub> H <sub>82</sub> O <sub>4</sub> S	693-36-7	683.163	cry	61				
4577	Disulfiram		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> S <sub>4</sub>	97-77-8	296.539		71.5	117 <sup>17</sup>			i H <sub>2</sub> O; s EtOH; sl eth; vs chl
4578	Disulfoton		C <sub>8</sub> H <sub>19</sub> O <sub>2</sub> PS <sub>3</sub>	298-04-4	274.405		-25	108 <sup>01</sup> , 128 <sup>1</sup>	1.144 <sup>20</sup>		
4579	1,2-Dithiane		C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	505-20-4	120.237	nd	32.5	80 <sup>14</sup> , 60 <sup>5</sup>		1.5981 <sup>25</sup>	s eth, bz, chl
4580	1,3-Dithiane		C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	505-23-7	120.237		54	89 <sup>14</sup>		1.5981 <sup>25</sup>	vs bz, eth, chl
4581	1,4-Dithiane		C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	505-29-3	120.237	mcl pr	112.3	199.5			sl H <sub>2</sub> O; s EtOH, eth, ctc, CS <sub>2</sub> , HOAc
4582	Dithianone		C <sub>14</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	3347-22-6	296.324	nd (ace)	220				
4583	Dithiazanine iodide		C <sub>23</sub> H <sub>23</sub> IN <sub>2</sub> S <sub>2</sub>	514-73-8	518.476	grn nd (MeOH)	248 dec				i H <sub>2</sub> O
4584	2,2'-Dithiobisbenzoic acid	Diphenyl disulfide-2,2'-dicarboxylic acid	C <sub>14</sub> H <sub>10</sub> O <sub>4</sub> S <sub>2</sub>	119-80-2	306.357			289.5			i H <sub>2</sub> O; s EtOH, eth
4585	3,3'-Dithiobispropanoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub> S <sub>2</sub>	1119-62-6	210.271			158			
4586	3,3'-Dithiobis- <i>D</i> -valine		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	20902-45-8	296.407			204.5			

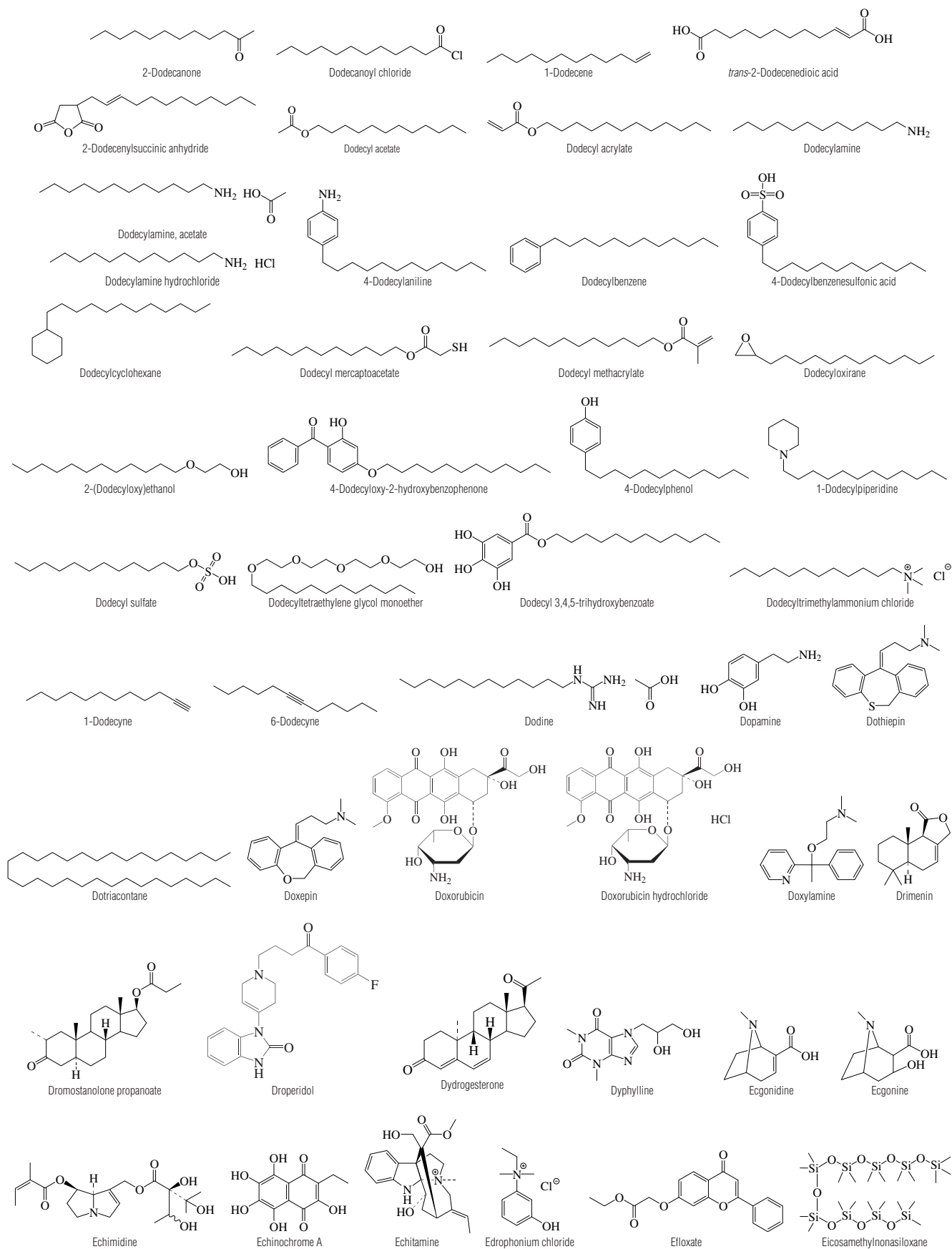




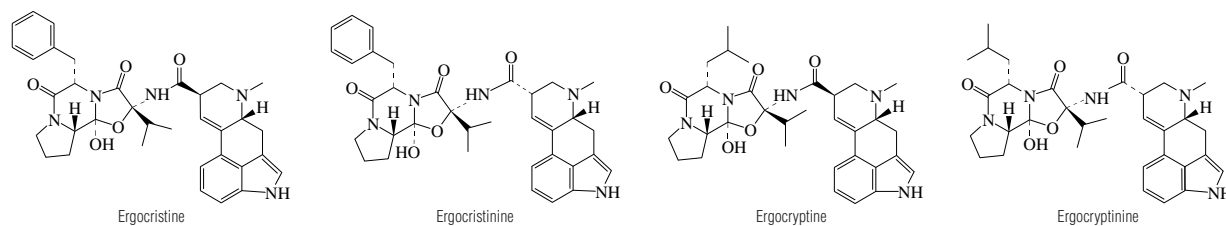
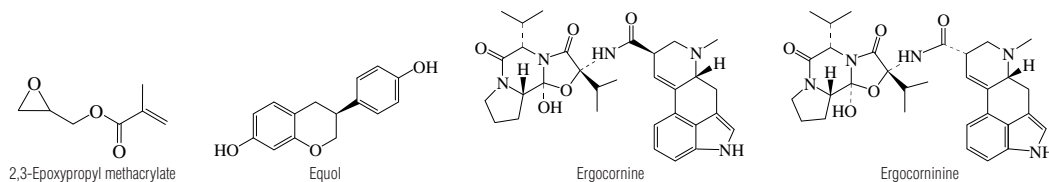
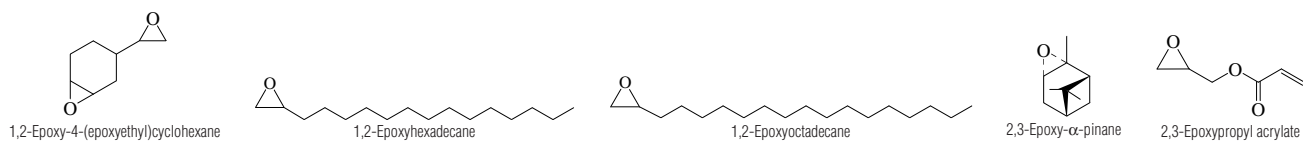
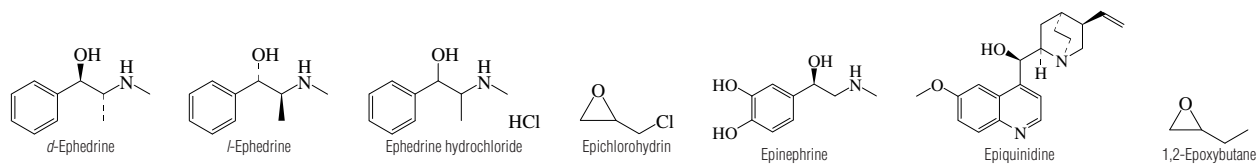
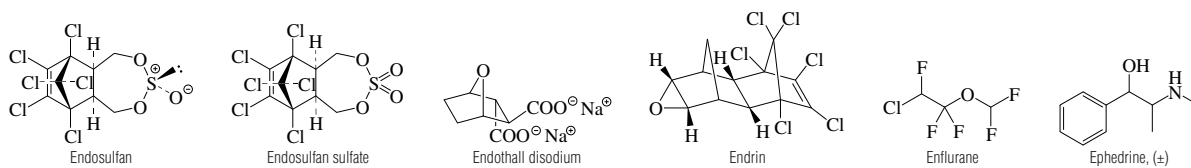
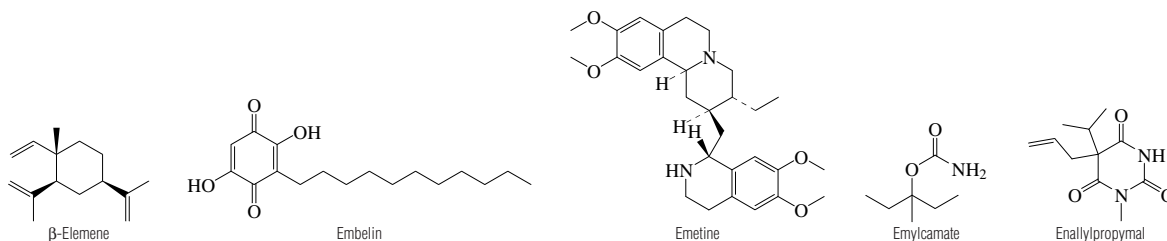
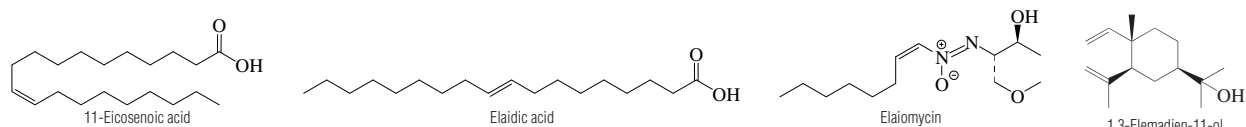
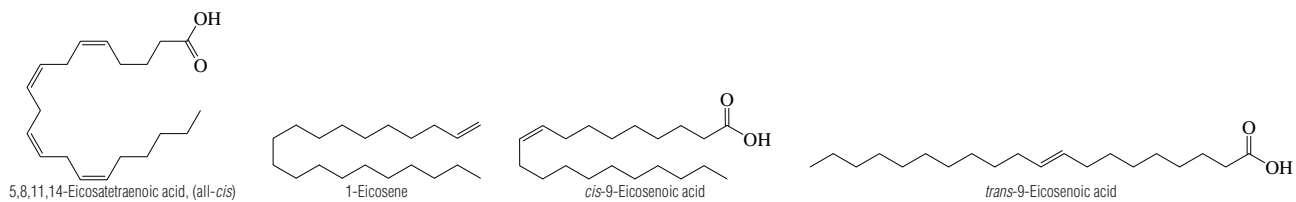
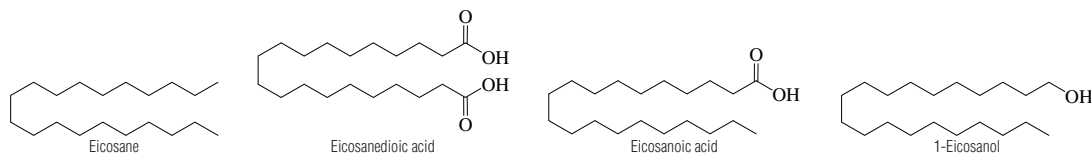
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4587	2,5-Dithiobiurea	1,2-Hydrazinedicarbthioamide	C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> S <sub>2</sub>	142-46-1	150.226	nd (w)	214				
4588	4,4'-Dithiodimorpholine		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	103-34-4	236.355		124.5				s chl
4589	1,2-Dithiolane		C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	557-22-2	106.210		77	90 <sup>27</sup>			
4590	1,3-Dithiolane	1,3-Dithiacyclopentane	C <sub>3</sub> H <sub>6</sub> S <sub>2</sub>	4829-04-3	106.210	liq	-50	175	1.259 <sup>17</sup>	1.5975 <sup>15</sup>	s EtOH, eth, xyl
4591	1,3-Dithiolane-2-thione		C <sub>2</sub> H <sub>4</sub> S <sub>3</sub>	822-38-8	136.259		35	307			
4592	Dithiopyr		C <sub>15</sub> H <sub>16</sub> F <sub>5</sub> NO <sub>2</sub> S <sub>2</sub>	97886-45-8	401.416		65				
4593	Dithizone		C <sub>13</sub> H <sub>12</sub> N <sub>4</sub> S	60-10-6	256.326	bl-blk (chl-al)	167 dec				i H <sub>2</sub> O; sl EtOH, eth; s chl, alk
4594	Di( <i>p</i> -tolyl)carbodiimide		C <sub>15</sub> H <sub>14</sub> N <sub>2</sub>	726-42-1	222.285		58.5	221 <sup>20</sup>	1.1500 <sup>20</sup>		
4595	1,2-Di( <i>p</i> -tolyl)ethane	1,2-Bis( <i>p</i> -tolyl)ethane	C <sub>16</sub> H <sub>18</sub>	538-39-6	210.314	lf (al)	85	178 <sup>18</sup>			i H <sub>2</sub> O; sl EtOH; s bz, peth
4596	<i>N,N'</i> -Di( <i>o</i> -tolyl)guanidine		C <sub>15</sub> H <sub>17</sub> N <sub>3</sub>	97-39-2	239.316	cry (dil al)	179		1.10 <sup>20</sup>		sl H <sub>2</sub> O, tfa, EtOH; vs eth; s chl
4597	Ditridecyl phthalate		C <sub>34</sub> H <sub>58</sub> O <sub>4</sub>	119-06-2	530.823	liq		285 <sup>3,5</sup>	0.952 <sup>25</sup>		
4598	Diundecyl phthalate		C <sub>30</sub> H <sub>50</sub> O <sub>4</sub>	3648-20-2	474.716	cry (EtOH)	35.5				
4599	Diuron		C <sub>7</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O	330-54-1	233.093		158				
4600	<i>o</i> -Divinylbenzene	1,2-Divinylbenzene	C <sub>10</sub> H <sub>10</sub>	91-14-5	130.186			82 <sup>14</sup>	0.9325 <sup>22</sup>	1.5767 <sup>20</sup>	s ace, bz
4601	<i>m</i> -Divinylbenzene	1,3-Divinylbenzene	C <sub>10</sub> H <sub>10</sub>	108-57-6	130.186		-52.3	121 <sup>76</sup> , 52 <sup>3</sup>	0.9294 <sup>20</sup>	1.5760 <sup>20</sup>	s ace, bz
4602	<i>p</i> -Divinylbenzene	1,4-Divinylbenzene	C <sub>10</sub> H <sub>10</sub>	105-06-6	130.186		31	95 <sup>18</sup> , 34 <sup>02</sup>	0.913 <sup>40</sup>	1.5835 <sup>25</sup>	s ace, bz
4603	<i>cis</i> -1,2-Divinylcyclobutane		C <sub>8</sub> H <sub>12</sub>	16177-46-1	108.181			38 <sup>28</sup>	0.8010 <sup>20</sup>	1.4563 <sup>20</sup>	
4604	<i>trans</i> -1,2-Divinylcyclobutane		C <sub>8</sub> H <sub>12</sub>	6553-48-6	108.181			112.5	0.7817 <sup>20</sup>	1.4451 <sup>20</sup>	
4605	Divinyl ether		C <sub>4</sub> H <sub>6</sub> O	109-93-3	70.090	vol liq or gas	-100.6	28.3	0.773 <sup>20</sup>	1.3989 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, chl
4606	Divinyl sulfide	Vinyl sulfide	C <sub>4</sub> H <sub>6</sub> S	627-51-0	86.156		20	84	0.9174 <sup>15</sup>		sl H <sub>2</sub> O; s ace; msc EtOH, eth
4607	Divinyl sulfone	Vinyl sulfone	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub> S	77-77-0	118.155	liq	-26	234.5	1.177 <sup>25</sup>	1.4765 <sup>20</sup>	
4608	1,3-Divinyl-1,1,3,3-tetramethyldisiloxane		C <sub>8</sub> H <sub>16</sub> OSi <sub>2</sub>	2627-95-4	186.399	liq	-99.7	39	0.811 <sup>20</sup>	1.4123 <sup>20</sup>	
4609	Djenkolic acid		C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	498-59-9	254.327	nd(w)	≈325 dec				
4610	DMPA		C <sub>10</sub> H <sub>14</sub> Cl <sub>2</sub> NO <sub>2</sub> PS	299-85-4	314.169	solid	51.4	150 <sup>2</sup>			sl H <sub>2</sub> O; vs bz, ctc, ace
4611	Docosane		C <sub>22</sub> H <sub>46</sub>	629-97-0	310.600	pl(to), cry (eth)	43.6	368.6	0.7944 <sup>20</sup>	1.4455 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, chl; vs eth
4612	Docosanoic acid	Behenic acid	C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	112-85-6	340.583	nd	81.5	306 <sup>60</sup>	0.8223 <sup>90</sup>	1.4270 <sup>100</sup>	sl H <sub>2</sub> O, EtOH, eth
4613	1-Docosanol		C <sub>22</sub> H <sub>46</sub> O	661-19-8	326.599	cry (ace, chl)	72.5	180 <sup>9,22</sup>			sl H <sub>2</sub> O, eth; vs EtOH, MeOH; s chl
4614	13-Docosenamide	Erucamide	C <sub>22</sub> H <sub>43</sub> NO	112-84-5	337.582	cry	94				
4615	1-Docosene		C <sub>22</sub> H <sub>44</sub>	1599-67-3	308.584		38	367	0.794 <sup>25</sup>		
4616	<i>cis</i> -13-Docosenoic acid	Erucic acid	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	112-86-7	338.567	nd (al)	34.7	265 <sup>15</sup>	0.860 <sup>55</sup>	1.4758 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc; vs eth, MeOH
4617	<i>trans</i> -13-Docosenoic acid	Brassicic acid	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	506-33-2	338.567	pl (al)	61.9	282 <sup>30</sup> , 256 <sup>10</sup>	0.8585 <sup>57</sup>	1.4347 <sup>100</sup>	
4618	5,7-Dodecadiyne	Dibutylbutadiyne	C <sub>12</sub> H <sub>18</sub>	1120-29-2	162.271			103 <sup>8</sup>			
4619	Dodecamethylcyclohexasiloxane		C <sub>12</sub> H <sub>36</sub> O <sub>6</sub> Si <sub>6</sub>	540-97-6	444.923	liq	-1.5	245	0.9672 <sup>25</sup>	1.4015 <sup>20</sup>	i H <sub>2</sub> O
4620	Dodecamethylpentasiloxane		C <sub>12</sub> H <sub>36</sub> O <sub>5</sub> Si <sub>5</sub>	141-63-9	384.840	liq	-80	232; 105 <sup>12</sup>	0.8755 <sup>20</sup>	1.3925 <sup>20</sup>	s ctc, CS <sub>2</sub>
4621	Dodecanal	Lauraldehyde	C <sub>12</sub> H <sub>24</sub> O	112-54-9	184.318	lf	44.5	185 <sup>100</sup> , 100 <sup>2,5</sup>	0.8352 <sup>15</sup>	1.435 <sup>22</sup>	i H <sub>2</sub> O; sl EtOH; s eth
4622	Dodecanamide		C <sub>12</sub> H <sub>25</sub> NO	1120-16-7	199.333	nd	110	199 <sup>12</sup>		1.4287 <sup>110</sup>	i H <sub>2</sub> O; s EtOH, ace, ctc; sl eth, bz
4623	Dodecane		C <sub>12</sub> H <sub>26</sub>	112-40-3	170.334	liq	-9.57	216.32	0.7495 <sup>20</sup>	1.4210 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, ctc, chl
4624	1,12-Dodecanediamine		C <sub>12</sub> H <sub>28</sub> N <sub>2</sub>	2783-17-7	200.363		67.38	135 <sup>3</sup>			
4625	Dodecanedioic acid		C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	693-23-2	230.301		128	222 <sup>25</sup>	1.15 <sup>25</sup>		s tfa
4626	1,12-Dodecanediol		C <sub>12</sub> H <sub>26</sub> O <sub>2</sub>	5675-51-4	202.333	cry (bz, dil al)	81.3	189 <sup>12</sup>			s tfa
4627	Dodecanenitrile	Lauronitrile	C <sub>12</sub> H <sub>23</sub> N	2437-25-4	181.318		4	277; 198 <sup>100</sup>	0.8240 <sup>20</sup>	1.4361 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl
4628	1-Dodecanethiol		C <sub>12</sub> H <sub>26</sub> S	112-55-0	202.399	liq	-6.7	277; 143 <sup>15</sup>	0.844 <sup>20</sup>	1.4589 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
4629	Dodecanoic acid	Lauric acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	143-07-7	200.318	nd (al)	43.8	225 <sup>100</sup>	0.8679 <sup>50</sup>	1.4183 <sup>82</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace; msc bz
4630	Dodecanoic anhydride		C <sub>24</sub> H <sub>46</sub> O <sub>3</sub>	645-66-9	382.620	lf (al, eth)	41.8		0.8533 <sup>70</sup>	1.4292 <sup>70</sup>	vs EtOH
4631	1-Dodecanol	Lauryl alcohol	C <sub>12</sub> H <sub>26</sub> O	112-53-8	186.333	lf (dil al)	23.9	260	0.8309 <sup>24</sup>		i H <sub>2</sub> O; s EtOH, eth; sl bz
4632	2-Dodecanol		C <sub>12</sub> H <sub>26</sub> O	10203-28-8	186.333		19	252	0.8286 <sup>20</sup>	1.4400 <sup>20</sup>	



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4633	2-Dodecanone	Decyl methyl ketone	C <sub>12</sub> H <sub>24</sub> O	6175-49-1	184.318		21	246.5	0.8198 <sup>20</sup>	1.4330 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; sl ctc
4634	Dodecanoyl chloride		C <sub>12</sub> H <sub>23</sub> ClO	112-16-3	218.763		-17	145 <sup>18</sup>	0.9169 <sup>25</sup>	1.4458 <sup>20</sup>	vs eth
4635	1-Dodecene		C <sub>12</sub> H <sub>24</sub>	112-41-4	168.319	liq	-35.2	213.8	0.7584 <sup>20</sup>	1.4300 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc, peth
4636	<i>trans</i> -2-Dodecenedioic acid	Traumatic acid	C <sub>12</sub> H <sub>20</sub> O <sub>4</sub>	6402-36-4	228.285	cry (al,ace)	165.5				vs eth, EtOH, chl
4637	2-Dodecenylsuccinic anhydride		C <sub>18</sub> H <sub>28</sub> O <sub>3</sub>	19780-11-1	266.375	hyg cry	42	181 <sup>5</sup>			
4638	Dodecyl acetate		C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	112-66-3	228.371		0.7	265; 180 <sup>40</sup>	0.8652 <sup>22</sup>	1.4439 <sup>20</sup>	
4639	Dodecyl acrylate	Lauryl 2-propenoate	C <sub>15</sub> H <sub>28</sub> O <sub>2</sub>	2156-97-0	240.382		4	120 <sup>0.8</sup>	0.8727 <sup>20</sup>		
4640	Dodecylamine	1-Dodecanamine	C <sub>12</sub> H <sub>27</sub> N	124-22-1	185.349		28.3	259	0.8015 <sup>20</sup>	1.4421 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz, chl
4641	Dodecylamine, acetate	1-Dodecanamine, acetate	C <sub>14</sub> H <sub>31</sub> NO <sub>2</sub>	2016-56-0	245.402		69.5				vs H <sub>2</sub> O, EtOH
4642	Dodecylamine hydrochloride	Lauryl amine hydrochloride	C <sub>12</sub> H <sub>25</sub> ClN	929-73-7	221.810		186				vs H <sub>2</sub> O, EtOH
4643	4-Dodecylaniline		C <sub>18</sub> H <sub>31</sub> N	104-42-7	261.446		41.5	211 <sup>10</sup>			
4644	Dodecylbenzene	Laurylbenzene	C <sub>18</sub> H <sub>30</sub>	123-01-3	246.431		3	328	0.8551 <sup>20</sup>	1.4824 <sup>20</sup>	i H <sub>2</sub> O
4645	4-Dodecylbenzenesulfonic acid		C <sub>18</sub> H <sub>30</sub> O <sub>3</sub> S	121-65-3	326.494			>205			
4646	Dodecylcyclohexane		C <sub>18</sub> H <sub>36</sub>	1795-17-1	252.479		12.5	331	0.8223 <sup>20</sup>	1.4559 <sup>20</sup>	
4647	Dodecyl mercaptoacetate		C <sub>14</sub> H <sub>28</sub> O <sub>2</sub> S	3746-39-2	260.436		1.5	171 <sup>3</sup>			
4648	Dodecyl methacrylate		C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	142-90-5	254.408			142 <sup>4</sup>	0.866 <sup>20</sup>		
4649	Dodecyloxirane	1,2-Epoxytetradecane	C <sub>14</sub> H <sub>28</sub> O	3234-28-4	212.371	oil		95 <sup>0.4</sup>	0.845	1.4408 <sup>20</sup>	
4650	2-(Dodecyloxy)ethanol		C <sub>14</sub> H <sub>30</sub> O <sub>2</sub>	4536-30-5	230.387			143 <sup>0.8</sup>			
4651	4-Dodecyloxy-2-hydroxybenzophenone		C <sub>25</sub> H <sub>34</sub> O <sub>3</sub>	2985-59-3	382.536		43.5				
4652	4-Dodecylphenol		C <sub>18</sub> H <sub>30</sub> O	104-43-8	262.430	nd (bz)	66	175 <sup>2</sup>			
4653	1-Dodecylpiperidine		C <sub>17</sub> H <sub>35</sub> N	5917-47-5	253.467	pa ye		161 <sup>5</sup> , 115 <sup>0.6</sup>	0.8378 <sup>20</sup>	1.4588 <sup>20</sup>	
4654	Dodecyl sulfate	Lauryl sulfate	C <sub>12</sub> H <sub>25</sub> O <sub>4</sub> S	151-41-7	266.397	cry					s H <sub>2</sub> O
4655	Dodecyltetraethylene glycol monoether	3,6,9,12-Tetraoxatetracosan-1-ol	C <sub>20</sub> H <sub>42</sub> O <sub>5</sub>	5274-68-0	362.544			247 <sup>10</sup>			
4656	Dodecyl 3,4,5-trihydroxybenzoate		C <sub>19</sub> H <sub>30</sub> O <sub>5</sub>	1166-52-5	338.438		96.5				s ace
4657	Dodecyltrimethylammonium chloride		C <sub>15</sub> H <sub>34</sub> ClN	112-00-5	263.891		246 dec				vs H <sub>2</sub> O, ace, EtOH, chl
4658	1-Dodecyne	Decylacetylene	C <sub>12</sub> H <sub>22</sub>	765-03-7	166.303	liq	-19	215	0.7788 <sup>20</sup>	1.4340 <sup>20</sup>	
4659	6-Dodecyne		C <sub>12</sub> H <sub>22</sub>	6975-99-1	166.303			210; 100 <sup>14</sup>	0.785 <sup>20</sup>	1.4442 <sup>20</sup>	vs ace, eth, EtOH
4660	Dodine	Dodecylguanidine, monoacetate	C <sub>15</sub> H <sub>33</sub> N <sub>3</sub> O <sub>2</sub>	2439-10-3	287.442		136				
4661	Dopamine	4(2-Aminoethyl)-1,2-benzenediol	C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	51-61-6	153.179	pr					
4662	Dothiepin		C <sub>19</sub> H <sub>21</sub> NS	113-53-1	295.442		56	172 <sup>0.05</sup>			
4663	Dotriacontane	Bicetyl	C <sub>32</sub> H <sub>66</sub>	544-85-4	450.866	pl (bz,chl,HO Ac,eth)	69.4	467	0.8124 <sup>20</sup>	1.4550 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, chl; s eth, ctc; vs bz
4664	Doxepin		C <sub>19</sub> H <sub>21</sub> NO	1668-19-5	279.376	oily liq		155 <sup>0.03</sup> , 265 <sup>0.2</sup>			
4665	Doxorubicin	Adriamycin	C <sub>27</sub> H <sub>29</sub> NO <sub>11</sub>	23214-92-8	543.519	cry	230				
4666	Doxorubicin hydrochloride	Adriamycin hydrochloride	C <sub>27</sub> H <sub>30</sub> ClNO <sub>11</sub>	25316-40-9	579.980	oran-red nd	204 dec				s H <sub>2</sub> O, MeOH; i ace, bz, chl, eth, peth
4667	Doxylamine		C <sub>17</sub> H <sub>22</sub> N <sub>2</sub> O	469-21-6	270.369	liq		139 <sup>0.5</sup>			
4668	Drimenin		C <sub>15</sub> H <sub>22</sub> O <sub>2</sub>	2326-89-8	234.335	cry	133	110 <sup>0.1</sup>			i H <sub>2</sub> O
4669	Dromostanolone propanoate	2-Methyl-17-(1-oxopropoxy)androstan-3-one, (2 $\alpha$ ,5 $\alpha$ ,17 $\beta$ )	C <sub>23</sub> H <sub>36</sub> O <sub>3</sub>	521-12-0	360.530		128				
4670	Droperidol	Dehydrobenzperidol	C <sub>22</sub> H <sub>22</sub> FN <sub>3</sub> O <sub>2</sub>	548-73-2	379.427	cry (w)	146 (hyd)				i H <sub>2</sub> O; sl EtOH, eth, bz; s chl, DMF
4671	Dyrogesterone		C <sub>21</sub> H <sub>28</sub> O <sub>2</sub>	152-62-5	312.446	cry (ace/hx)	170				
4672	Dyphylline		C <sub>10</sub> H <sub>14</sub> N <sub>4</sub> O <sub>4</sub>	479-18-5	254.243			161.5			
4673	Ecgonidine		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	484-93-5	167.205	cry (MeOH) (MeOH-eth)	228 dec				vs H <sub>2</sub> O
4674	Ecgonine		C <sub>9</sub> H <sub>15</sub> NO <sub>3</sub>	481-37-8	185.220	mcl pr	205				vs H <sub>2</sub> O, EtOH
4675	Echimidine		C <sub>20</sub> H <sub>31</sub> NO <sub>7</sub>	520-68-3	397.463	glass					
4676	Echinochrome A	2-Ethyl-3,5,6,7,8-pentahydroxy-1,4-naphthalenedione	C <sub>12</sub> H <sub>10</sub> O <sub>7</sub>	517-82-8	266.203	red nd (Diox-w)	220 dec	sub 120			sl H <sub>2</sub> O; s EtOH, ace; vs eth, bz
4677	Echitamine		C <sub>22</sub> H <sub>30</sub> N <sub>2</sub> O <sub>5</sub>	6871-44-9	402.483		206				s H <sub>2</sub> O, EtOH, eth, chl, con sulf; i peth
4678	Edrophonium chloride		C <sub>10</sub> H <sub>16</sub> ClNO	116-38-1	201.693	cry	162				vs H <sub>2</sub> O; s EtOH; i eth, chl
4679	Efloxate	Ethyl [(4-oxo-2-phenyl-4 <i>H</i> -1-benzopyran-7-yl)oxy]acetate	C <sub>19</sub> H <sub>16</sub> O <sub>5</sub>	119-41-5	324.327		123.7				s chl
4680	Eicosamethylnonasiloxane		C <sub>20</sub> H <sub>60</sub> O <sub>8</sub> Si <sub>9</sub>	2652-13-3	681.455			307.5; 198 <sup>16</sup>	0.9173 <sup>20</sup>	1.3980 <sup>20</sup>	vs bz

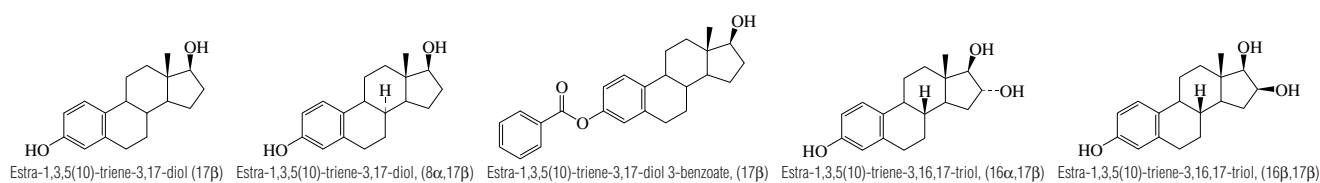
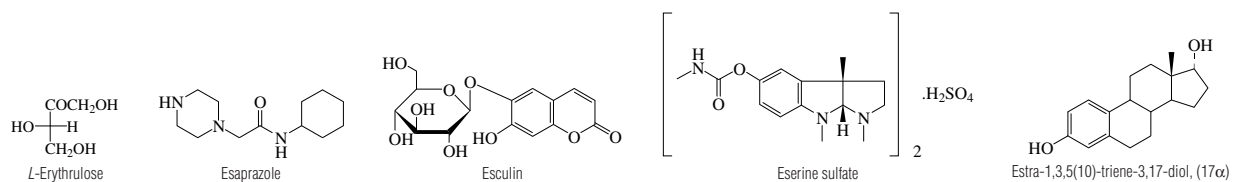
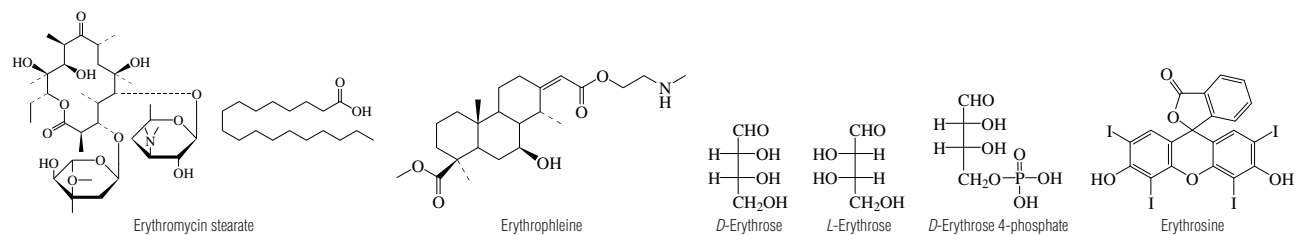
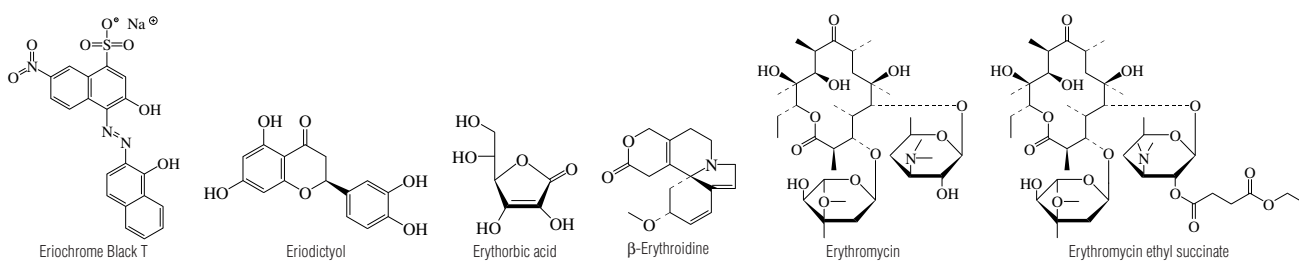
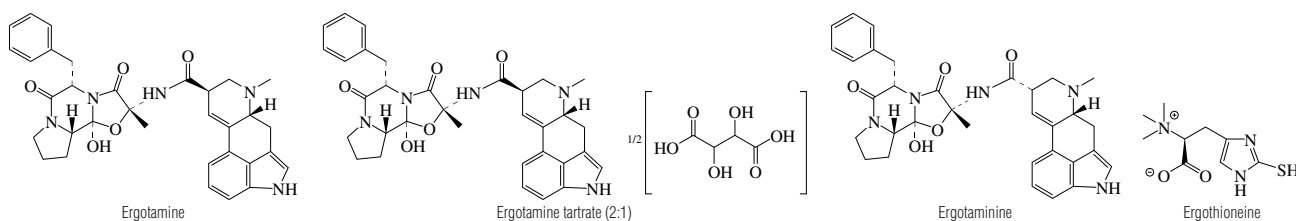
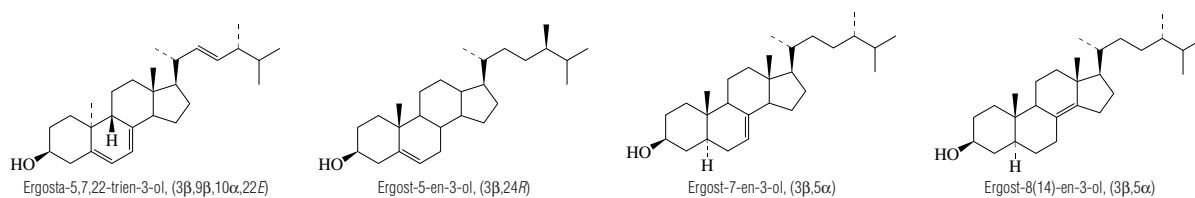
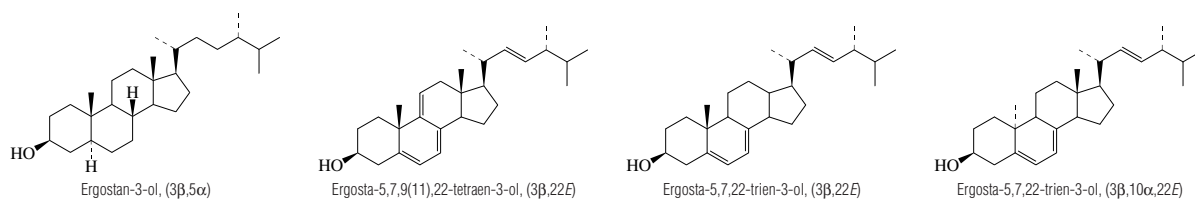
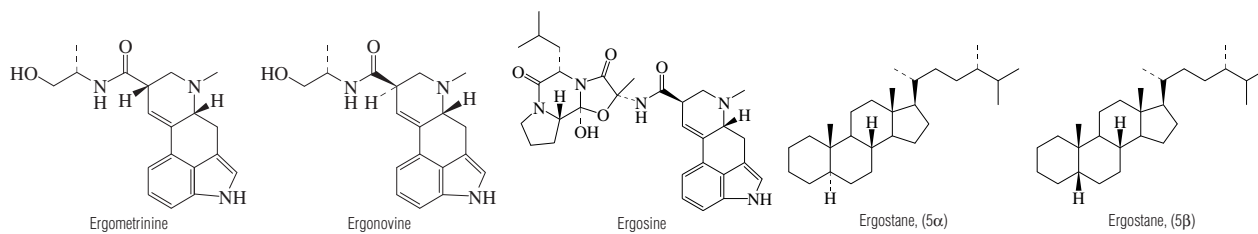


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4681	Eicosane	Icosane	C <sub>20</sub> H <sub>42</sub>	112-95-8	282.547	lf (al)	36.6	343	0.7886 <sup>20</sup>	1.4425 <sup>20</sup>	i H <sub>2</sub> O; s eth, peth, bz; sl chl; vs ace
4682	Eicosanedioic acid	1,18-Octadecanedicarboxylic acid	C <sub>20</sub> H <sub>38</sub> O <sub>4</sub>	2424-92-2	342.514	cry (bz,al)	125.5	233 <sup>2</sup>			s eth
4683	Eicosanoic acid	Arachidic acid	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	506-30-9	312.531	pl (al)	76.5	dec 328; 204 <sup>1</sup>	0.8240 <sup>100</sup>	1.425 <sup>100</sup>	i H <sub>2</sub> O; sl EtOH; vs eth; s bz, chl
4684	1-Eicosanol	Arachic alcohol	C <sub>20</sub> H <sub>42</sub> O	629-96-9	298.546	wax (al), cry (chl)	65.4	356; 222 <sup>3</sup>	0.8405 <sup>20</sup>	1.4350 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, chl; vs ace; s bz, peth
4685	5,8,11,14-Eicosatetraenoic acid, (all- <i>cis</i> )	Arachidonic acid	C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	506-32-1	304.467		-49.5	163 <sup>1</sup>	0.9082 <sup>20</sup>	1.4824 <sup>20</sup>	i H <sub>2</sub> O; vs ace, eth, EtOH, peth
4686	1-Eicosene		C <sub>20</sub> H <sub>40</sub>	3452-07-1	280.532		28.5	341; 151 <sup>2</sup>	0.7882 <sup>30</sup>	1.4440 <sup>30</sup>	i H <sub>2</sub> O; s bz, peth
4687	<i>cis</i> -9-Eicosenoic acid		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	29204-02-2	310.515		24.5	220 <sup>6</sup>	0.8882 <sup>25</sup>		
4688	<i>trans</i> -9-Eicosenoic acid		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	506-31-0	310.515		54				
4689	11-Eicosenoic acid		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	2462-94-4	310.515		24	267 <sup>15</sup>	0.8826 <sup>25</sup>		vs EtOH, MeOH
4690	Elaidic acid	<i>trans</i> -9-Octadecenoic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	112-79-8	282.462	pl (al)	45	288 <sup>100</sup> , 234 <sup>15</sup>	0.8734 <sup>45</sup>	1.4499 <sup>45</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
4691	Elaiomycin		C <sub>13</sub> H <sub>26</sub> N <sub>2</sub> O <sub>3</sub>	23315-05-1	258.356	ye oil				1.4798 <sup>25</sup>	sl H <sub>2</sub> O; s os
4692	1,3-Elemadien-11-ol	Elemol	C <sub>13</sub> H <sub>26</sub> O	639-99-6	222.366	cry (al)	52.5	142 <sup>12</sup>	0.9345 <sup>18</sup>	1.4980 <sup>18</sup>	
4693	β-Elementene		C <sub>13</sub> H <sub>24</sub>	33880-83-0	204.352			120 <sup>16</sup> , 104 <sup>11</sup>	0.8749 <sup>20</sup>	1.4935 <sup>20</sup>	
4694	Embelin	2,5-Dihydroxy-3-undecyl-2,5-cyclohexadiene-1,4-dione	C <sub>17</sub> H <sub>26</sub> O <sub>4</sub>	550-24-3	294.386	oran pl (al)	142.5				vs bz, eth, EtOH
4695	Emetine	6',7',10,11-Tetramethoxyemetan	C <sub>29</sub> H <sub>40</sub> N <sub>2</sub> O <sub>4</sub>	483-18-1	480.639	amor pow	74				i H <sub>2</sub> O; s EtOH, eth, ace; sl bz, chl
4696	Emylcamate	3-Methyl-3-pentanol, carbamate	C <sub>7</sub> H <sub>15</sub> NO <sub>2</sub>	78-28-4	145.200	nd	57	35 <sup>1</sup>			sl H <sub>2</sub> O; vs bz, eth, EtOH
4697	Enallylpropymal		C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	1861-21-8	224.256	cry (w, dil al)	56.5	177 <sup>12</sup>			vs bz, eth, EtOH, chl
4698	Endosulfan		C <sub>9</sub> H <sub>6</sub> Cl <sub>6</sub> O <sub>3</sub> S	115-29-7	406.925		106	106 <sup>9,7</sup>	1.745 <sup>20</sup>		
4699	Endosulfan sulfate		C <sub>9</sub> H <sub>6</sub> Cl <sub>6</sub> O <sub>4</sub> S	1031-07-8	422.925	cry (cyhex)	181				
4700	Endothall disodium		C <sub>8</sub> H <sub>10</sub> Na <sub>2</sub> O <sub>3</sub>	145-73-3	232.142		144		1.431 <sup>20</sup>		
4701	Endrin		C <sub>12</sub> H <sub>6</sub> Cl <sub>6</sub> O	72-20-8	380.909	cry	dec 245				vs ace, bz, xyl; s ctc, hx
4702	Enflurane		C <sub>3</sub> H <sub>2</sub> ClF <sub>2</sub> O	13838-16-9	184.492	liq		56.5	1.5121 <sup>25</sup>	1.3025 <sup>20</sup>	vs os
4703	Ephedrine, (±)	α-[1-(Methylamino)ethyl]benzenemethanol, ( <i>R</i> *, <i>S</i> *)-(±)-	C <sub>10</sub> H <sub>15</sub> NO	90-81-3	165.232	nd (eth, peth)	76.5	135 <sup>12</sup>	1.1220 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth, bz, chl
4704	<i>d</i> -Ephedrine	α-[1-(Methylamino)ethyl]benzenemethanol, [ <i>S</i> -( <i>R</i> *, <i>S</i> *)]-	C <sub>10</sub> H <sub>15</sub> NO	321-98-2	165.232	pl (w)	40	225			s H <sub>2</sub> O, EtOH, eth, bz, chl
4705	<i>l</i> -Ephedrine	α-[1-(Methylamino)ethyl]benzenemethanol, [ <i>R</i> -( <i>R</i> *, <i>S</i> *)]-	C <sub>10</sub> H <sub>15</sub> NO	299-42-3	165.232	pl (w + 1)	40	225	1.0085 <sup>22</sup>		s H <sub>2</sub> O, EtOH, eth, bz, chl
4706	Ephedrine hydrochloride	2-(Methylamino)-1-phenyl-1-propanol, hydrochloride	C <sub>10</sub> H <sub>16</sub> ClNO	50-98-6	201.693	orth nd	219		1.0208 <sup>20</sup>		
4707	Epichlorohydrin	(Chloromethyl)oxirane	C <sub>3</sub> H <sub>5</sub> ClO	13403-37-7	92.524	liq	-26	118; 62 <sup>100</sup>	1.1812 <sup>20</sup>	1.4358 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, ctc
4708	Epinephrine	<i>D</i> -Adrenaline	C <sub>9</sub> H <sub>13</sub> NO <sub>3</sub>	51-43-4	183.204	br (in air)	211.5				sl H <sub>2</sub> O; i EtOH; s HOAc, acid
4709	Epiquinidine		C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	572-59-8	324.417	cry (AcOEt) lf (eth)	113				vs EtOH; s eth
4710	1,2-Epoxybutane	Ethyloxirane	C <sub>4</sub> H <sub>8</sub> O	106-88-7	72.106	liq	-150	63.4	0.8297 <sup>20</sup>	1.3851 <sup>20</sup>	vs EtOH, ace; msc eth
4711	1,2-Epoxy-4-(epoxyethyl)cyclohexane	4-Vinyl-1-cyclohexene dioxide	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	106-87-6	140.180		<-55	227	1.0966 <sup>20</sup>	1.4787 <sup>20</sup>	vs H <sub>2</sub> O
4712	1,2-Epoxyhexadecane	Tetradecyloxirane	C <sub>16</sub> H <sub>32</sub> O	7320-37-8	240.424	hyg cry or liq	24.1	178 <sup>12</sup>	0.846	1.2240	
4713	1,2-Epoxyoctadecane	Hexadecyloxirane	C <sub>18</sub> H <sub>36</sub> O	7390-81-0	268.478	hyg cry	26.1	137 <sup>70,5</sup>			
4714	2,3-Epoxy-α-pinane		C <sub>10</sub> H <sub>16</sub> O	1686-14-2	152.233			85 <sup>24</sup>			
4715	2,3-Epoxypropyl acrylate	Glycidyl acrylate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	106-90-1	128.126			53 <sup>10</sup>	1.1109 <sup>20</sup>	1.4490 <sup>20</sup>	vs bz
4716	2,3-Epoxypropyl methacrylate	Glycidyl methacrylate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	106-91-2	142.152			189; 75 <sup>10</sup>	1.042 <sup>20</sup>	1.448 <sup>25</sup>	vs bz, eth, EtOH
4717	Equol		C <sub>14</sub> H <sub>14</sub> O <sub>3</sub>	531-95-3	230.259	cry (aq, al)	189.5				
4718	Ergocornine		C <sub>31</sub> H <sub>59</sub> N <sub>5</sub> O <sub>3</sub>	564-36-3	561.673	cry (MeOH)	183 dec				i H <sub>2</sub> O; s EtOH, ace, bz, chl, AcOEt
4719	Ergocorninine		C <sub>31</sub> H <sub>59</sub> N <sub>5</sub> O <sub>3</sub>	564-37-4	561.673	lo pr (al)	228 dec				vs ace, bz, EtOH, chl
4720	Ergocristine		C <sub>35</sub> H <sub>59</sub> N <sub>5</sub> O <sub>3</sub>	511-08-0	609.716	orth (bz)	175 dec				i H <sub>2</sub> O; s EtOH, ace, chl
4721	Ergocristinine		C <sub>35</sub> H <sub>59</sub> N <sub>5</sub> O <sub>3</sub>	511-07-9	609.716	pr (al)	237 dec				i H <sub>2</sub> O; sl EtOH, ace, chl
4722	Ergocryptine		C <sub>32</sub> H <sub>41</sub> N <sub>5</sub> O <sub>3</sub>	511-09-1	575.699	pr (al)	213 dec				i H <sub>2</sub> O; s EtOH, chl
4723	Ergocryptinine		C <sub>33</sub> H <sub>41</sub> N <sub>5</sub> O <sub>3</sub>	511-10-4	587.710	lo pr (al)	245 dec				vs ace, chl

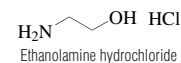
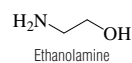
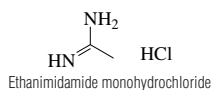
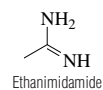
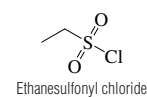
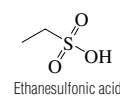
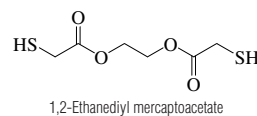
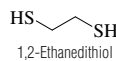
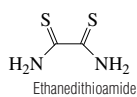
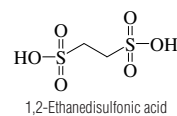
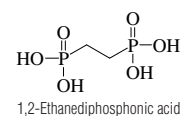
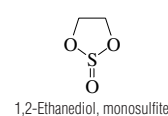
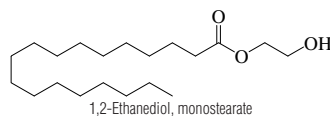
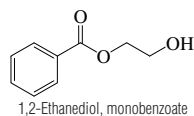
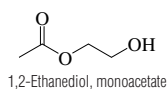
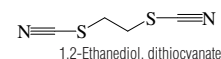
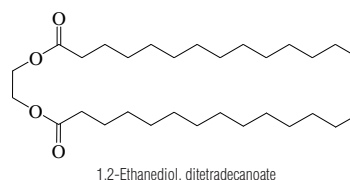
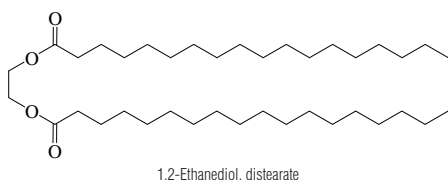
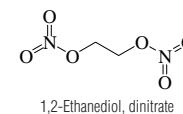
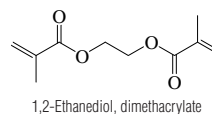
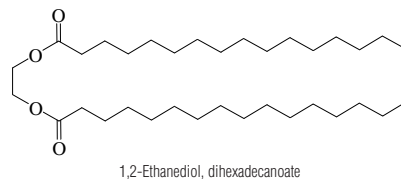
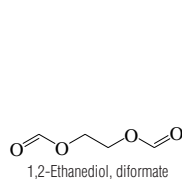
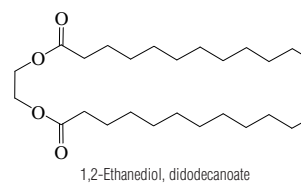
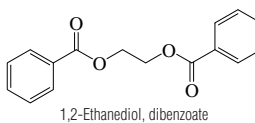
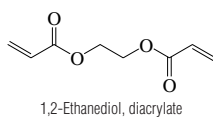
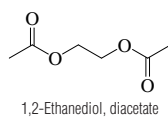
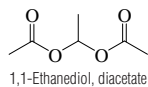
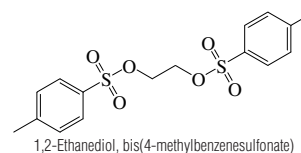
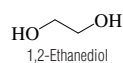
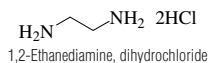
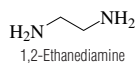
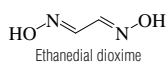
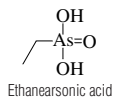
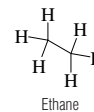
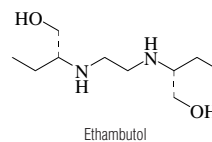
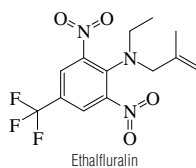
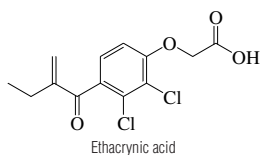
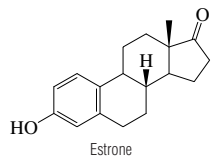


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4724	Ergometrinine		C <sub>19</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub>	479-00-5	325.405	pr (ace)	196 dec				vs chl
4725	Ergonovine	Ergometrine	C <sub>19</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub>	60-79-7	325.405	pl or nd	162 dec				s H <sub>2</sub> O, ace; vs EtOH; sl chl
4726	Ergosine		C <sub>30</sub> H <sub>37</sub> N <sub>5</sub> O <sub>5</sub>	561-94-4	547.646	pr (MeOH, AcOEt)	228 dec				s ace, chl; sl MeOH
4727	Ergostane, (5α)		C <sub>28</sub> H <sub>50</sub>	511-20-6	386.697	lf or pl (ace, eth- MeOH)	85				vs ace, eth, chl
4728	Ergostane, (5β)	Coproergostane	C <sub>28</sub> H <sub>50</sub>	511-21-7	386.697	nd (ace)	64				vs eth, chl
4729	Ergostan-3-ol, (3β,5α)	Ergostanol	C <sub>28</sub> H <sub>50</sub> O	6538-02-9	402.696	nd (MeOH-eth)	144.5				i H <sub>2</sub> O; s eth, chl
4730	Ergosta-5,7,9(11),22-tetraen-3-ol, (3β,22E)	Dehydroergosterol	C <sub>28</sub> H <sub>42</sub> O	516-85-8	394.632	lf (al) nd (eth), pl (al)	146	230 <sup>0.5</sup>			vs ace, bz, eth, EtOH
4731	Ergosta-5,7,22-trien-3-ol, (3β,22E)	Ergosterol	C <sub>28</sub> H <sub>44</sub> O	57-87-4	396.648	pl (+w, al) nd (eth)	170	250 <sup>0.01</sup>			i H <sub>2</sub> O; sl EtOH, eth, peth; s bz, chl
4732	Ergosta-5,7,22-trien-3-ol, (3β,10α,22E)	Pyrocalciferol	C <sub>28</sub> H <sub>44</sub> O	128-27-8	396.648	nd (MeOH)	94				i H <sub>2</sub> O; s EtOH, chl, MeOH
4733	Ergosta-5,7,22-trien-3-ol, (3β,9β,10α,22E)	Lumisterol	C <sub>28</sub> H <sub>44</sub> O	474-69-1	396.648	nd (ace-MeOH)	118				i H <sub>2</sub> O; s EtOH, HOAc; vs eth, ace, chl
4734	Ergost-5-en-3-ol, (3β,24β)	Campesterol	C <sub>28</sub> H <sub>48</sub> O	474-62-4	400.680	cry (ace)	157.5				
4735	Ergost-7-en-3-ol, (3β,5α)	γ-Ergosterol	C <sub>28</sub> H <sub>48</sub> O	516-78-9	400.680	nd (MeOH) cry (PROH)	146				s eth
4736	Ergost-8(14)-en-3-ol, (3β,5α)	α-Ergosterol	C <sub>28</sub> H <sub>48</sub> O	632-32-6	400.680	lf or nd (MeOH)	131				sl EtOH; s eth, bz, chl
4737	Ergotamine		C <sub>33</sub> H <sub>55</sub> N <sub>5</sub> O <sub>5</sub>	113-15-5	601.821	nd (al), pr (bz) pl (ace)	213 dec				vs bz, eth, chl
4738	Ergotamine tartrate (2:1)	Gynergen	C <sub>35</sub> H <sub>58</sub> N <sub>5</sub> O <sub>8</sub>	379-79-3	656.706		192 dec				
4739	Ergotaminine		C <sub>33</sub> H <sub>55</sub> N <sub>5</sub> O <sub>5</sub>	639-81-6	581.662	orth pl (MeOH) pl (al)	252 dec				i H <sub>2</sub> O; sl EtOH, ace, bz; s chl; vs py
4740	Ergothioneine		C <sub>9</sub> H <sub>15</sub> N <sub>3</sub> O <sub>2</sub> S	497-30-3	229.299	nd or lf (dil EtOH)	290 dec				vs H <sub>2</sub> O; sl EtOH, ace; i eth, bz, chl
4741	Eriochrome Black T		C <sub>20</sub> H <sub>12</sub> N <sub>3</sub> NaO <sub>7</sub> S	1787-61-7	461.380	br-blk pow					s H <sub>2</sub> O, EtOH, MeOH
4742	Eriodictyol	3',4',5',7-Tetrahydroxyflavanone, (S)	C <sub>15</sub> H <sub>12</sub> O <sub>6</sub>	552-58-9	288.252	pl or nd (EtOH)	267 dec				vs EtOH, HOAc
4743	Erythorbic acid	Isoascorbic acid	C <sub>8</sub> H <sub>8</sub> O <sub>6</sub>	89-65-6	176.124	gran cry	168				s H <sub>2</sub> O, py; sl ace
4744	β-Erythroidine		C <sub>16</sub> H <sub>19</sub> NO <sub>3</sub>	466-81-9	273.327	cry (al)	99.5				s H <sub>2</sub> O, eth, chl; vs EtOH, bz
4745	Erythromycin	Propiicine	C <sub>37</sub> H <sub>67</sub> NO <sub>13</sub>	114-07-8	733.927	cry (w)	191				vs ace, eth, EtOH, chl
4746	Erythromycin ethyl succinate		C <sub>43</sub> H <sub>75</sub> NO <sub>16</sub>	1264-62-6	862.053	cry (ace aq)	222				
4747	Erythromycin stearate		C <sub>55</sub> H <sub>103</sub> NO <sub>15</sub>	643-22-1	1018.405	cry	92				i H <sub>2</sub> O; sl EtOH, eth, chl
4748	Erythrophleine	Norcassamidine	C <sub>24</sub> H <sub>38</sub> NO <sub>5</sub>	36150-73-9	421.571	glass	115				s H <sub>2</sub> O, EtOH
4749	D-Erythrose		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	583-50-6	120.105	syr					s H <sub>2</sub> O; vs EtOH
4750	L-Erythrose		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	533-49-3	120.105	syr					vs H <sub>2</sub> O, EtOH
4751	D-Erythrose 4-phosphate	2,3-Dihydroxy-4-(phosphonoxy)butanal	C <sub>4</sub> H <sub>8</sub> O <sub>7</sub> P	585-18-2	200.084	stab in aq soln only					s H <sub>2</sub> O
4752	Erythrosine		C <sub>20</sub> H <sub>16</sub> I <sub>4</sub> O <sub>5</sub>	15905-32-5	835.893	br pow (Na salt)					s H <sub>2</sub> O; vs eth, EtOH
4753	L-Erythrulose		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	533-50-6	120.105	syr	dec	dec			vs H <sub>2</sub> O, EtOH
4754	Esaprazole	N-Cyclohexyl-1-piperazineacetamide	C <sub>12</sub> H <sub>23</sub> N <sub>3</sub> O	64204-55-3	225.330		112	190 <sup>0.5</sup>			
4755	Esculin	6-(β-D-Glucopyranosyloxy)-7-hydroxy-2H-1-benzopyran-2-one	C <sub>15</sub> H <sub>16</sub> O <sub>9</sub>	531-75-9	340.283	pr (w+2)	205 (pentahydrate)				sl H <sub>2</sub> O, EtOH, eth; s chl, py, HOAc
4756	Eserine sulfate	Physostigmine sulfate	C <sub>30</sub> H <sub>44</sub> N <sub>6</sub> O <sub>8</sub> S	64-47-1	648.770	hyg cry (ace-eth)	141				vs ace, EtOH
4757	Estra-1,3,5(10)-triene-3,17-diol, (17α)	α-Estradiol	C <sub>18</sub> H <sub>24</sub> O <sub>2</sub>	57-91-0	272.383	nd (+1/2 w) (80% al)	221.5				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz
4758	Estra-1,3,5(10)-triene-3,17-diol (17β)	β-Estradiol	C <sub>18</sub> H <sub>24</sub> O <sub>2</sub>	50-28-2	272.383	pr (80% al),	178.5				vs ace, EtOH, Diox
4759	Estra-1,3,5(10)-triene-3,17-diol, (8α,17β)	Isoestradiol	C <sub>18</sub> H <sub>24</sub> O <sub>2</sub>	517-04-4	272.383	cry (dil MeOH-chl)	181				s EtOH, diox
4760	Estra-1,3,5(10)-triene-3,17-diol 3-benzoate, (17β)	Estradiol benzoate	C <sub>25</sub> H <sub>28</sub> O <sub>3</sub>	50-50-0	376.488		196				
4761	Estra-1,3,5(10)-triene-3,16,17-triol, (16α,17β)	Estriol	C <sub>18</sub> H <sub>24</sub> O <sub>3</sub>	50-27-1	288.382	lf (al), mcl (dil al)	288 dec		1.27 <sup>25</sup>		s EtOH; sl eth, bz, tfa; vs py
4762	Estra-1,3,5(10)-triene-3,16,17-triol, (16β,17β)	16-Epiestriol	C <sub>18</sub> H <sub>24</sub> O <sub>3</sub>	547-81-9	288.382	cry (MeOH-bz)	290				

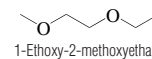
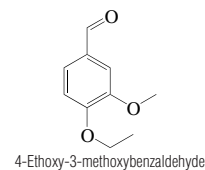
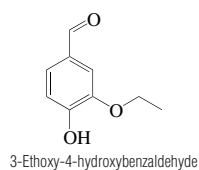
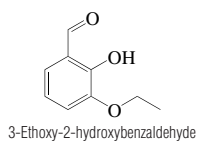
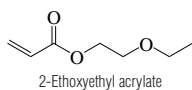
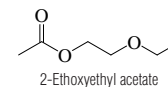
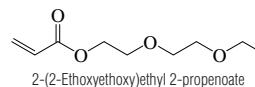
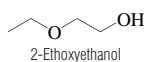
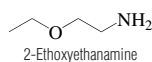
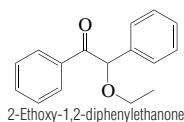
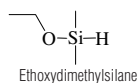
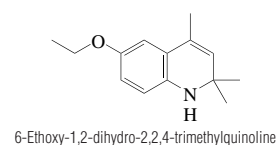
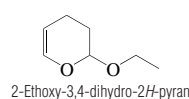
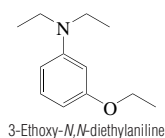
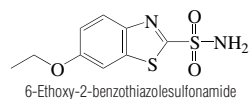
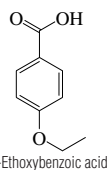
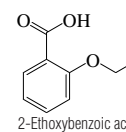
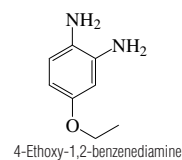
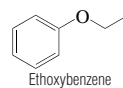
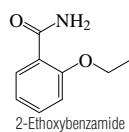
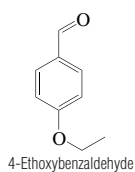
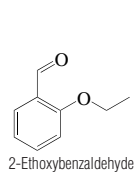
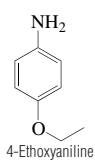
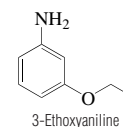
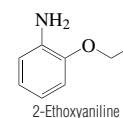
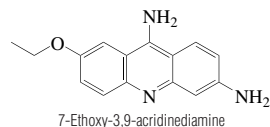
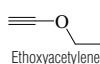
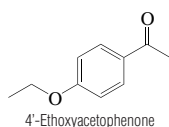
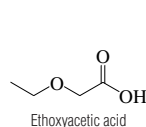
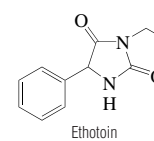
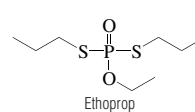
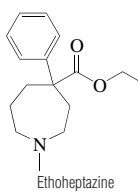
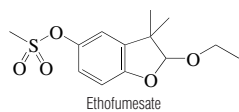
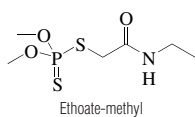
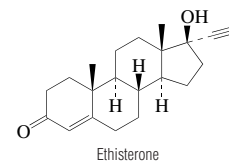
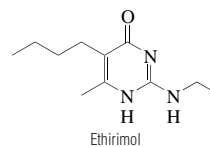
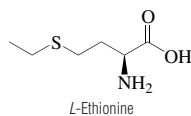
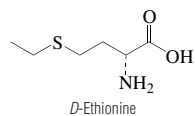
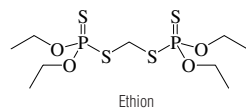
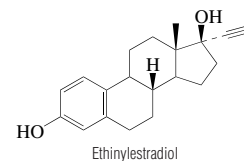
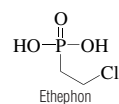
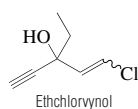
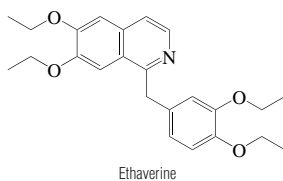
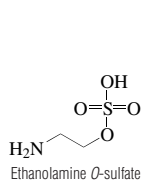




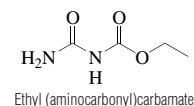
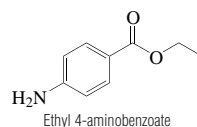
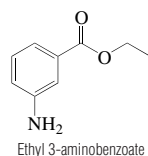
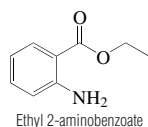
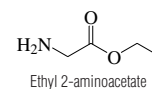
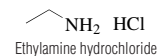
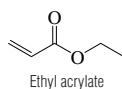
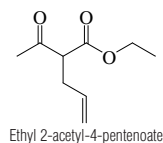
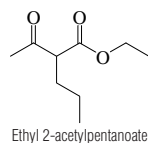
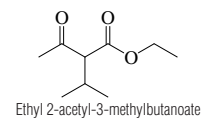
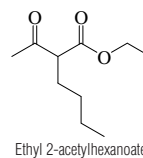
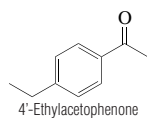
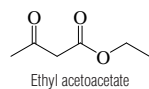
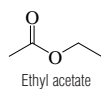
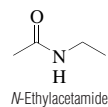
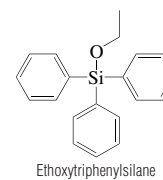
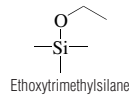
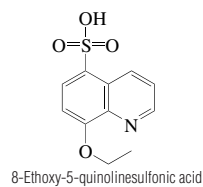
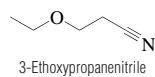
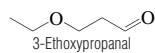
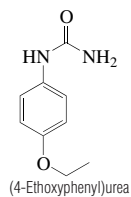
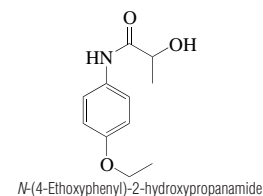
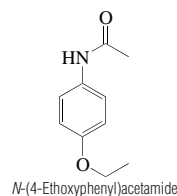
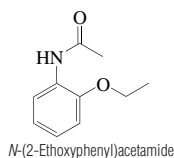
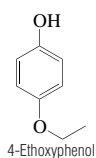
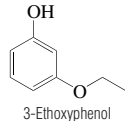
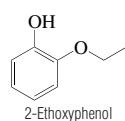
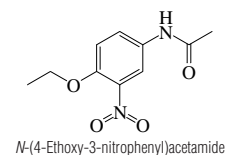
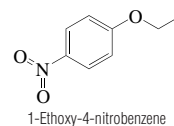
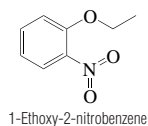
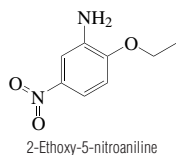
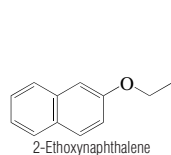
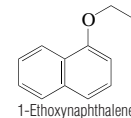
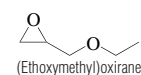
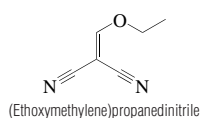
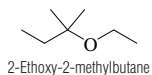
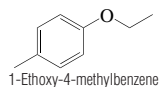
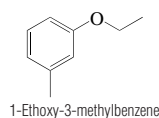
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4763	Estrone		C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>	53-16-7	270.367	mcl, orth (al)	260.2		1.236 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth, bz; s ace, diox
4764	Ethacrynic acid		C <sub>13</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>4</sub>	58-54-8	303.138		122.5				
4765	Ethalfuralin		C <sub>13</sub> H <sub>14</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	55283-68-6	333.263		57	dec 256			
4766	Ethambutol		C <sub>10</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	74-55-5	204.310	cry	89				sl H <sub>2</sub> O; s bz, chl
4767	Ethane		C <sub>2</sub> H <sub>6</sub>	74-84-0	30.069	col gas	-182.79	-88.6	0.5446 <sup>89</sup>		i H <sub>2</sub> O; vs bz
4768	Ethane arsonic acid		C <sub>2</sub> H <sub>7</sub> AsO <sub>3</sub>	507-32-4	153.997	nd (al), orth nd (w)	99.5	210 <sup>12</sup>			vs H <sub>2</sub> O, EtOH
4769	Ethanedial dioxime		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	557-30-2	88.065	orth pl (w)	178 dec	sub			vs H <sub>2</sub> O, EtOH, eth
4770	1,2-Ethanediamine	Ethylenediamine	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	107-15-3	60.098		11.14	117	0.8979 <sup>20</sup>	1.4565 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH; i eth, bz; s ctc
4771	1,2-Ethanediamine, dihydrochloride	Ethylenediamine dihydrochloride	C <sub>2</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	333-18-6	133.019					1.633	vs H <sub>2</sub> O
4772	1,2-Ethanediol	Ethylene glycol	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	107-21-1	62.068	liq	-12.69	197.3	1.1135 <sup>20</sup>	1.4318 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, ace; s eth, chl; sl bz
4773	1,2-Ethanediol, bis(4-methylbenzenesulfonate)		C <sub>16</sub> H <sub>18</sub> O <sub>6</sub> S <sub>2</sub>	6315-52-2	370.440	cry (bz)	128				
4774	1,1-Ethanediol, diacetate	Ethylidene diacetate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	542-10-9	146.141		18.9	169	1.070 <sup>25</sup>	1.3985 <sup>25</sup>	vs eth, EtOH
4775	1,2-Ethanediol, diacetate	Ethylene glycol diacetate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	111-55-7	146.141	liq	-31	190	1.1043 <sup>20</sup>	1.4159 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth, ace, bz, CS <sub>2</sub>
4776	1,2-Ethanediol, diacrylate	Ethylene glycol diacrylate	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	2274-11-5	170.163	liq		55 <sup>0,6</sup>	1.0935 <sup>26</sup>		
4777	1,2-Ethanediol, dibenzoate	Ethylene glycol dibenzoate	C <sub>16</sub> H <sub>14</sub> O <sub>4</sub>	94-49-5	270.280	orth pr (eth)	73.5	dec 360			i H <sub>2</sub> O; s eth, chl
4778	1,2-Ethanediol, didodecanoate	Ethylene glycol didodecanoate	C <sub>26</sub> H <sub>50</sub> O <sub>4</sub>	624-04-4	426.673	pl (al)	56.6	188 <sup>20</sup>			vs eth, EtOH
4779	1,2-Ethanediol, diformate	Ethylene glycol diformate	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	629-15-2	118.089			174	1.193 <sup>0</sup>	1.3580	sl H <sub>2</sub> O; s EtOH, eth
4780	1,2-Ethanediol, dihexadecanoate	Ethylene glycol dipalmitate	C <sub>34</sub> H <sub>66</sub> O <sub>4</sub>	624-03-3	538.886	lf or nd (al-chl)	72		0.8594 <sup>78</sup>		i H <sub>2</sub> O, EtOH; s eth; vs ace
4781	1,2-Ethanediol, dimethacrylate	Ethylene glycol dimethacrylate	C <sub>10</sub> H <sub>14</sub> O <sub>4</sub>	97-90-5	198.216	liq	-40	260	1.053 <sup>20</sup>	1.4532 <sup>25</sup>	vs bz, EtOH, lig
4782	1,2-Ethanediol, dinitrate	Ethylene glycol dinitrate	C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	628-96-6	152.062	ye liq	-22.3	198.5	1.4918 <sup>20</sup>		vs eth, EtOH
4783	1,2-Ethanediol, distearate	Ethylene glycol distearate	C <sub>38</sub> H <sub>74</sub> O <sub>4</sub>	627-83-8	594.993	lf	79	241 <sup>20</sup>	0.8581 <sup>78</sup>		i H <sub>2</sub> O, EtOH; vs eth, ace
4784	1,2-Ethanediol, ditetradecanoate	Ethylene glycol ditetradecanoate	C <sub>30</sub> H <sub>58</sub> O <sub>4</sub>	627-84-9	482.780	cry (eth, ace)	65	208 <sup>20</sup>	0.8600 <sup>90</sup>		i H <sub>2</sub> O, EtOH; s eth; vs ace, bz, ctc
4785	1,2-Ethanediol, dithiocyanate	Ethylene glycol dithiocyanate	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> S <sub>2</sub>	629-17-4	144.218	orth pl or nd (w)	90	dec	1.4200 <sup>9</sup>		sl H <sub>2</sub> O, bz; s EtOH, eth; vs ace
4786	1,2-Ethanediol, monoacetate	Ethylene glycol monoacetate	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	542-59-6	104.105			188	1.108 <sup>15</sup>		msc H <sub>2</sub> O, EtOH, eth
4787	1,2-Ethanediol, monobenzoate	Ethylene glycol monobenzoate	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	94-33-7	166.173		45	150 <sup>10</sup>	1.1101 <sup>30</sup>		vs EtOH
4788	1,2-Ethanediol, monostearate	Ethylene glycol monostearate	C <sub>20</sub> H <sub>40</sub> O <sub>3</sub>	111-60-4	328.530	cry (peth)	60.5	190 <sup>3</sup>	0.8780 <sup>20</sup>	1.4310 <sup>60</sup>	sl EtOH; s eth
4789	1,2-Ethanediol, monosulfite	Ethylene glycol monosulfite	C <sub>2</sub> H <sub>4</sub> O <sub>3</sub> S	3741-38-6	108.116	liq	-11	173	1.4402 <sup>20</sup>	1.4463 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth, ace, bz, AcOEt; sl chl
4790	1,2-Ethanediphosphonic acid	1,2-Diphosphonoethane	C <sub>2</sub> H <sub>6</sub> O <sub>6</sub> P <sub>2</sub>	6145-31-9	190.029	nd (EtOH/eth)	223				
4791	1,2-Ethanedisulfonic acid	Ethylene disulfonic acid	C <sub>2</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	110-04-3	190.195		173				vs diox
4792	Ethanedithioamide	Rubeanic acid	C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> S <sub>2</sub>	79-40-3	120.196	red cry	170 dec				sl H <sub>2</sub> O, EtOH; s con sulf
4793	1,2-Ethanedithiol	Ethylene dimercaptan	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	540-63-6	94.199	liq	-41.2	146.1	1.234 <sup>20</sup>	1.5590 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; vs alk
4794	1,2-Ethanediy mercaptoacetate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub> S <sub>2</sub>	123-81-9	210.271			138 <sup>1,5</sup>			
4795	Ethanesulfonic acid	Ethylsulfonic acid	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	594-45-6	110.132	hyg	-17	123 <sup>1</sup>	1.3341 <sup>25</sup>	1.4335 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
4796	Ethanesulfonyl chloride		C <sub>2</sub> H <sub>4</sub> ClO <sub>2</sub> S	594-44-5	128.578	pa ye		174	1.357 <sup>22</sup>	1.4531 <sup>20</sup>	vs eth; s CS <sub>2</sub>
4797	Ethanethiol	Ethyl mercaptan	C <sub>2</sub> H <sub>6</sub> S	75-08-1	62.134	liq	-147.88	35.0	0.8315 <sup>25</sup>	1.4310 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, dil alk
4798	Ethanimidamide		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	143-37-3	58.082		-35				sl H <sub>2</sub> O; s EtOH, acid
4799	Ethanimidamide monohydrochloride	Acetamidine hydrochloride	C <sub>2</sub> H <sub>7</sub> ClN <sub>2</sub>	124-42-5	94.543	nd or pr (al) hyg lo pr (al)	177.5				vs H <sub>2</sub> O, EtOH
4800	Ethanol	Ethyl alcohol	C <sub>2</sub> H <sub>6</sub> O	64-17-5	46.068	liq	-114.14	78.29	0.7893 <sup>20</sup>	1.3611 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, chl; s bz
4801	Ethanolamine	Glycinol	C <sub>2</sub> H <sub>7</sub> NO	141-43-5	61.083		10.5	171	1.0180 <sup>20</sup>	1.4541 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth, lig, bz; s chl
4802	Ethanolamine hydrochloride	2-Aminoethanol hydrochloride	C <sub>2</sub> H <sub>8</sub> ClNO	2002-24-6	97.544	hyg cry (EtOH)	85				



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4803	Ethanolamine <i>O</i> -sulfate	2-Aminoethyl sulfate	C <sub>2</sub> H <sub>7</sub> NO <sub>3</sub> S	926-39-6	141.147		230 dec				s H <sub>2</sub> O; i EtOH
4804	Ethaverine	1-[(3,4-Diethoxyphenyl)methyl]-6,7-dioxyisoquinoline	C <sub>24</sub> H <sub>29</sub> NO <sub>4</sub>	486-47-5	395.492		100				i H <sub>2</sub> O; s EtOH; sl eth, chl
4805	Ethchlorvynol	1-Chloro-3-ethyl-1-penten-4-yn-ol	C <sub>7</sub> H <sub>9</sub> ClO	113-18-8	144.598	liq		181; 30 <sup>0.1</sup>	1.07 <sup>25</sup>	1.474 <sup>25</sup>	i H <sub>2</sub> O; s os
4806	Ethephon	Phosphonic acid, (2-chloroethyl)-	C <sub>2</sub> H <sub>5</sub> ClO <sub>3</sub> P	16672-87-0	144.494		74		1.2		
4807	Ethinylestradiol	19-Norpregna-1,3,5(10)-trien-20-yne-3,17-diol, (17 $\alpha$ )-	C <sub>20</sub> H <sub>24</sub> O <sub>2</sub>	57-63-6	296.404						sl chl
4808	Ethion		C <sub>8</sub> H <sub>22</sub> O <sub>4</sub> P <sub>2</sub> S <sub>4</sub>	563-12-2	384.476		-13	165 <sup>0.3</sup>	1.22 <sup>20</sup>		
4809	<i>D</i> -Ethionine	3-Ethylhomocysteine, ( <i>R</i> )	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub> S	535-32-0	163.238	cry (H <sub>2</sub> O)	278 dec				
4810	<i>L</i> -Ethionine	3-Ethylhomocysteine, ( <i>S</i> )	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub> S	13073-35-3	163.238	cry (H <sub>2</sub> O)	273 dec				
4811	Ethirimol	4(1 <i>H</i> )-Pyrimidinone, 5-butyl-2-(ethylamino)-6-methyl-	C <sub>11</sub> H <sub>19</sub> N <sub>3</sub> O	23947-60-6	209.288		160		1.21 <sup>25</sup>		
4812	Ethisterone		C <sub>21</sub> H <sub>28</sub> O <sub>2</sub>	434-03-7	312.446		272				
4813	Ethoate-methyl		C <sub>6</sub> H <sub>14</sub> NO <sub>3</sub> PS <sub>2</sub>	116-01-8	243.284	cry (tol/hp)	67				
4814	Ethofumesate		C <sub>13</sub> H <sub>16</sub> O <sub>5</sub> S	26225-79-6	286.344		71		1.14		
4815	Ethoheptazine	4-Carboethoxymethyl-4-phenylazacycloheptane	C <sub>16</sub> H <sub>23</sub> NO <sub>2</sub>	77-15-6	261.360	liq		134 <sup>1</sup>	1.038 <sup>26</sup>	1.5210 <sup>26</sup>	
4816	Ethoprop	Phosphorodithioic acid, <i>O</i> -ethyl <i>S,S</i> -dipropyl ester	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub> PS <sub>2</sub>	13194-48-4	242.340			88 <sup>0.2</sup>	1.094 <sup>20</sup>		
4817	Ethotoin		C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	86-35-1	204.225	pr (w)	94				s hot H <sub>2</sub> O; vs EtOH, bz, eth
4818	Ethoxyacetic acid		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	627-03-2	104.105			206.5	1.1021 <sup>20</sup>	1.4194 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
4819	4'-Ethoxyacetophenone		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	1676-63-7	164.201	pl (eth)	39	268			vs eth, EtOH
4820	Ethoxyacetylene		C <sub>4</sub> H <sub>6</sub> O	927-80-0	70.090			50	0.8000 <sup>20</sup>	1.3796 <sup>20</sup>	
4821	7-Ethoxy-3,9-acridinediamine	Ethacridine	C <sub>15</sub> H <sub>15</sub> N <sub>3</sub> O	442-16-0	253.299	ye nd	226				
4822	2-Ethoxyaniline	<i>o</i> -Phenetidine	C <sub>8</sub> H <sub>9</sub> NO	94-70-2	137.179		<-21	232.5		1.5560 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
4823	3-Ethoxyaniline	<i>m</i> -Phenetidine	C <sub>8</sub> H <sub>9</sub> NO	621-33-0	137.179			248			vs eth, EtOH
4824	4-Ethoxyaniline	<i>p</i> -Phenetidine	C <sub>8</sub> H <sub>9</sub> NO	156-43-4	137.179		1.2	254	1.0652 <sup>16</sup>	1.5528 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
4825	2-Ethoxybenzaldehyde		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	613-69-4	150.174		21	248			msc EtOH, eth; sl chl
4826	4-Ethoxybenzaldehyde		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	10031-82-0	150.174		13.5	249	1.08 <sup>21</sup>		vs EtOH, eth, bz
4827	2-Ethoxybenzamide	Ethenzamide	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	938-73-8	165.189	nd (w, al)	133				sl H <sub>2</sub> O, chl; vs EtOH, eth
4828	Ethoxybenzene	Phenetole	C <sub>8</sub> H <sub>10</sub> O	103-73-1	122.164	liq	-29.43	169.81	0.9651 <sup>20</sup>	1.5076 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
4829	4-Ethoxy-1,2-benzenediamine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O	1197-37-1	152.193		71.5	295			vs H <sub>2</sub> O; s EtOH, eth, chl
4830	2-Ethoxybenzoic acid		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	134-11-2	166.173		20.7	211 <sup>39</sup>			sl H <sub>2</sub> O, EtOH, ctc
4831	4-Ethoxybenzoic acid		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	619-86-3	166.173	nd (w)	198.5				sl H <sub>2</sub> O, tfa; s EtOH, eth, bz
4832	6-Ethoxy-2-benzothiazolesulfonamide	Ethoxzolamide	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub> S <sub>2</sub>	452-35-7	258.316		189				
4833	3-Ethoxy- <i>N,N</i> -diethylaniline		C <sub>12</sub> H <sub>19</sub> NO	1864-92-2	193.285			286; 97 <sup>0.6</sup>		1.5325 <sup>25</sup>	s EtOH, bz, HOAc
4834	2-Ethoxy-3,4-dihydro-2 <i>H</i> -pyran		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	103-75-3	128.169			132; 42 <sup>16</sup>	0.9658 <sup>25</sup>	1.4394 <sup>20</sup>	
4835	6-Ethoxy-1,2-dihydro-2,2,4-trimethylquinoline	Ethoxyquin	C <sub>14</sub> H <sub>19</sub> NO	91-53-2	217.307			124 <sup>2</sup>	1.026 <sup>25</sup>	1.569 <sup>25</sup>	
4836	Ethoxydimethylsilane	Dimethylethoxysilane	C <sub>4</sub> H <sub>12</sub> OSi	14857-34-2	104.223	liq		54	0.76 <sup>20</sup>		
4837	2-Ethoxy-1,2-diphenylethanone		C <sub>16</sub> H <sub>16</sub> O <sub>2</sub>	574-09-4	240.297	nd (lig)	62	194 <sup>20</sup>	1.1016 <sup>17</sup>	1.5727 <sup>17</sup>	vs bz, eth, EtOH, lig
4838	2-Ethoxyethanamine		C <sub>4</sub> H <sub>11</sub> NO	110-76-9	89.136			107	0.8512 <sup>20</sup>	1.4101 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, bz; sl chl
4839	2-Ethoxyethanol	Ethylene glycol monoethyl ether	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	110-80-5	90.121	liq	-70	135	0.9253 <sup>25</sup>	1.4054 <sup>25</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
4840	2-(2-Ethoxyethoxy)ethyl 2-propenoate	Diethylene glycol ethyl ether acrylate	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	7328-17-8	188.221				1.13 <sup>25</sup>		
4841	2-Ethoxyethyl acetate	Ethylene glycol monoethyl ether acetate	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	111-15-9	132.157	liq	-61.7	156.4	0.9740 <sup>20</sup>	1.4054 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
4842	2-Ethoxyethyl acrylate	Ethylene glycol monoethyl ether acrylate	C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	106-74-1	144.168	liq	-47	174	0.983 <sup>20</sup>	1.4274 <sup>20</sup>	
4843	3-Ethoxy-2-hydroxybenzaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	492-88-6	166.173		65.3	264			
4844	3-Ethoxy-4-hydroxybenzaldehyde	Ethyl vanillin	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	121-32-4	166.173		77.5	285			sl H <sub>2</sub> O; s EtOH, eth, bz, chl
4845	4-Ethoxy-3-methoxybenzaldehyde		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	120-25-2	180.200	mcl pr	64.5	168 <sup>13</sup>			sl H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
4846	1-Ethoxy-2-methoxyethane		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	5137-45-1	104.148	liq		103.5	0.8460 <sup>25</sup>	1.3843 <sup>25</sup>	

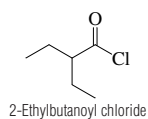
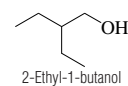
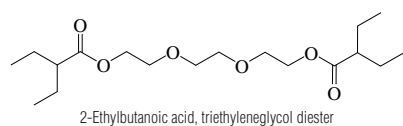
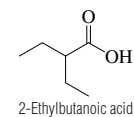
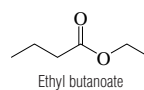
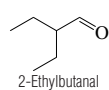
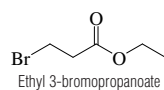
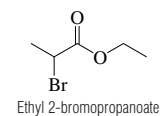
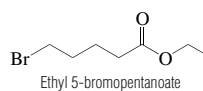
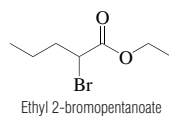
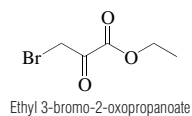
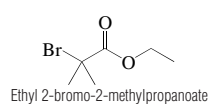
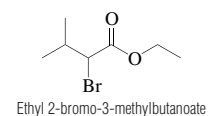
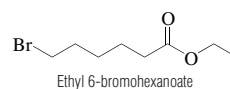
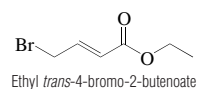
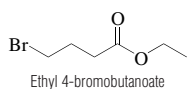
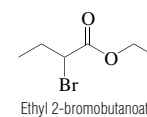
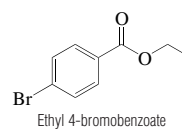
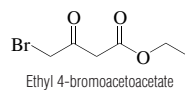
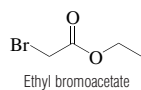
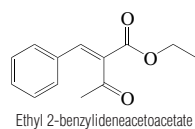
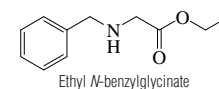
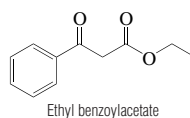
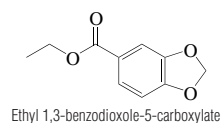
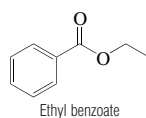
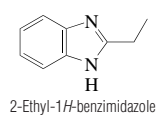
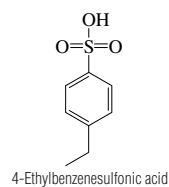
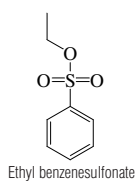
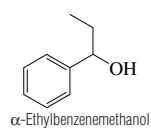
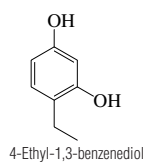
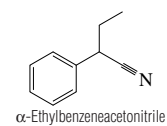
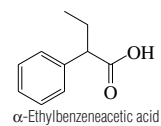
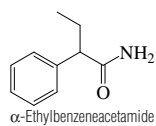
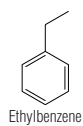
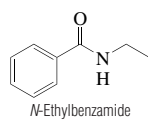
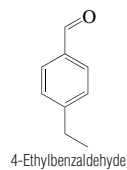
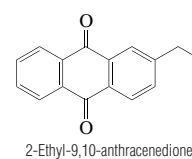
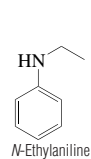
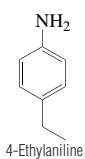
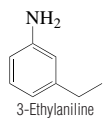
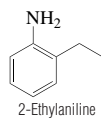
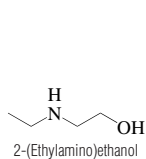


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4847	1-Ethoxy-3-methylbenzene		C <sub>9</sub> H <sub>12</sub> O	621-32-9	136.190			192	0.949 <sup>20</sup>	1.513 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4848	1-Ethoxy-4-methylbenzene		C <sub>9</sub> H <sub>12</sub> O	622-60-6	136.190			188.5	0.9509 <sup>18</sup>	1.5058 <sup>18</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
4849	2-Ethoxy-2-methylbutane	Ethyl <i>tert</i> -pentyl ether	C <sub>7</sub> H <sub>16</sub> O	919-94-8	116.201			101.4	0.7606 <sup>25</sup>	1.3886 <sup>25</sup>	vs eth, EtOH
4850	(Ethoxymethylene)propanedinitrile		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	123-06-8	122.124		66	160 <sup>12</sup>			s EtOH, eth; sl chl
4851	(Ethoxymethyl)oxirane	2,3-Epoxypropyl ethyl ether	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	4016-11-9	102.132			128	0.9700 <sup>20</sup>	1.4320 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
4852	1-Ethoxynaphthalene		C <sub>12</sub> H <sub>12</sub> O	5328-01-8	172.222	nd	5.5	280.5	1.060 <sup>20</sup>	1.5953 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, eth
4853	2-Ethoxynaphthalene		C <sub>12</sub> H <sub>12</sub> O	93-18-5	172.222	pl (al)	37.5	282	1.0640 <sup>20</sup>	1.5975 <sup>36</sup>	i H <sub>2</sub> O; s EtOH, eth, tol, lig, CS <sub>2</sub>
4854	2-Ethoxy-5-nitroaniline	5-Nitro- <i>o</i> -phenetidine	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	136-79-8	182.176	ye nd (dil al)	96.5	205 <sup>14</sup>			vs eth, EtOH
4855	1-Ethoxy-2-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	610-67-3	167.162	br ye	1.1	267	1.1903 <sup>15</sup>	1.5425 <sup>20</sup>	vs eth, EtOH
4856	1-Ethoxy-4-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	100-29-8	167.162	pr (dil al, eth)	60	283	1.1176 <sup>100</sup>		sl H <sub>2</sub> O, EtOH; vs eth; msc ace, bz; s peth
4857	<i>N</i> -(4-Ethoxy-3-nitrophenyl)acetamide		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub>	1777-84-0	224.213	nd (dil al)	124.0				vs ace, bz, EtOH
4858	2-Ethoxyphenol	Catechol monoethyl ether	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	94-71-3	138.164		29	217	1.0903 <sup>25</sup>		sl H <sub>2</sub> O, ctc; msc EtOH, eth
4859	3-Ethoxyphenol	Resorcinol monoethyl ether	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	621-34-1	138.164			246; 131 <sup>10</sup>	1.105 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth, bz; sl chl
4860	4-Ethoxyphenol	Hydroquinone monoethyl ether	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	622-62-8	138.164	pr or lf (w)	66.5	246.5			sl H <sub>2</sub> O; vs EtOH, eth; s chl
4861	<i>N</i> -(2-Ethoxyphenyl)acetamide		C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	581-08-8	179.216	lf (dil al)	79	>240			i H <sub>2</sub> O; s EtOH, eth, chl
4862	<i>N</i> -(4-Ethoxyphenyl)acetamide	Phenacetin	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	62-44-2	179.216	mcl pr	137.5			1.571	sl H <sub>2</sub> O, eth, bz; s EtOH, ace; vs py
4863	<i>N</i> -(4-Ethoxyphenyl)-2-hydroxypropanamide	<i>p</i> -Lactophenetide	C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	539-08-2	209.242		118				s H <sub>2</sub> O; vs EtOH; sl eth, bz, chl, peth
4864	(4-Ethoxyphenyl)urea	Dulcin	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	150-69-6	180.203	lf (dil al), pl (w)	173.5	dec			sl H <sub>2</sub> O; s EtOH; vs AcOEt
4865	3-Ethoxypropanal		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	2806-85-1	102.132			135.2	0.9165 <sup>20</sup>		
4866	3-Ethoxypropanenitrile		C <sub>5</sub> H <sub>9</sub> NO	2141-62-0	99.131			171	0.9285 <sup>15</sup>	1.4068 <sup>20</sup>	vs eth, EtOH
4867	8-Ethoxy-5-quinolinesulfonic acid	Actinoquinol	C <sub>11</sub> H <sub>11</sub> NO <sub>4</sub> S	15301-40-3	253.275	br nd (w)	286 dec				s alk
4868	Ethoxytrimethylsilane		C <sub>5</sub> H <sub>14</sub> OSi	1825-62-3	118.250			76	0.7573 <sup>20</sup>	1.3741 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
4869	Ethoxytriphenylsilane		C <sub>20</sub> H <sub>26</sub> O <sub>2</sub> Si	1516-80-9	304.458		65	344			s chl
4870	<i>N</i> -Ethylacetamide		C <sub>4</sub> H <sub>9</sub> NO	625-50-3	87.120			205; 104 <sup>18</sup>	0.942 <sup>4</sup>	1.4338 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s chl, HOAc
4871	Ethyl acetate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	141-78-6	88.106	liq	-83.8	77.11	0.9003 <sup>20</sup>	1.3723 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth; vs ace, bz
4872	Ethyl acetoacetate		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	141-97-9	130.141	liq	-45	180.8	1.0368 <sup>10</sup>	1.4171 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth; s bz, chl
4873	4'-Ethylacetophenone		C <sub>10</sub> H <sub>12</sub> O	937-30-4	148.201			114 <sup>11</sup>			
4874	Ethyl 2-acetylhexanoate		C <sub>10</sub> H <sub>18</sub> O <sub>3</sub>	1540-29-0	186.248			221.5	0.9523 <sup>20</sup>	1.4301 <sup>20</sup>	vs ace, eth
4875	Ethyl 2-acetyl-3-methylbutanoate		C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	1522-46-9	172.221			201; 97 <sup>20</sup>	0.9648 <sup>18</sup>	1.4256 <sup>18</sup>	i H <sub>2</sub> O; msc EtOH, eth
4876	Ethyl 2-acetylpentanoate		C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	1540-28-9	172.221			224; 90 <sup>15</sup>	0.9661 <sup>20</sup>	1.4255 <sup>20</sup>	vs eth, EtOH
4877	Ethyl 2-acetyl-4-pentenoate	Ethyl 2-allylacetate	C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	610-89-9	170.205			208	0.9898 <sup>20</sup>	1.4388 <sup>18</sup>	msc EtOH, eth, bz
4878	Ethyl acrylate	Ethyl propenoate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	140-88-5	100.117	liq	-71.2	99.4	0.9234 <sup>20</sup>	1.4068 <sup>20</sup>	sl H <sub>2</sub> O, DMSO; msc EtOH, eth; s chl
4879	Ethylamine	Ethanamine	C <sub>2</sub> H <sub>7</sub> N	75-04-7	45.084	vol liq or gas	-80.5	16.5	0.677 <sup>25</sup> ( <i>p</i> >1 atm)	1.3663 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
4880	Ethylamine hydrochloride	Ethanamine hydrochloride	C <sub>2</sub> H <sub>8</sub> ClN	557-66-4	81.545	mcl pl (al)	109.5		1.2160 <sup>20</sup>		vs H <sub>2</sub> O, EtOH
4881	Ethyl 2-aminoacetate	Glycine, ethyl ester	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	459-73-4	103.120			149; 58 <sup>18</sup>	1.0275 <sup>10</sup>	1.4242 <sup>10</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz; vs lig
4882	Ethyl 2-aminobenzoate		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	87-25-2	165.189		13	268	1.1174 <sup>20</sup>	1.5646 <sup>20</sup>	vs eth, EtOH
4883	Ethyl 3-aminobenzoate		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	582-33-2	165.189			294; 160 <sup>5</sup>	1.171 <sup>20</sup>	1.5600 <sup>22</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ctc
4884	Ethyl 4-aminobenzoate	Ethyl aminobenzoate	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	94-09-7	165.189	nd (w), orth (eth)	92	310			i H <sub>2</sub> O; vs EtOH, eth; s chl, acid
4885	Ethyl (aminocarbonyl)carbamate		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	626-36-8	132.118	nd (w, bz)	196.5	dec			i H <sub>2</sub> O, eth; sl EtOH, bz, tfa

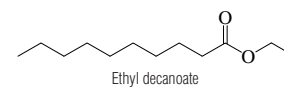
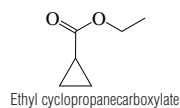
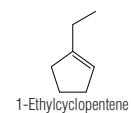
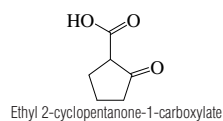
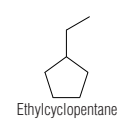
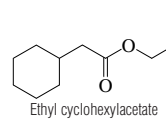
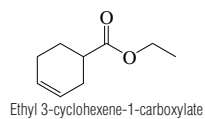
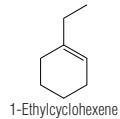
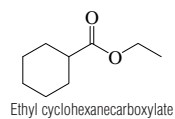
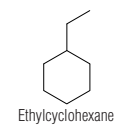
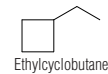
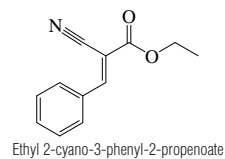
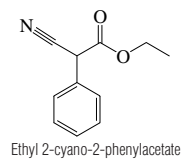
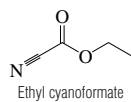
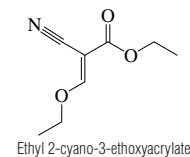
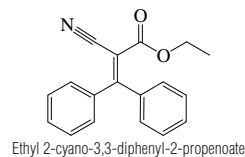
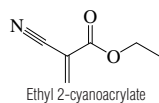
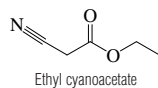
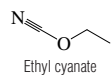
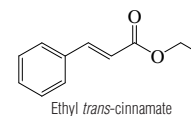
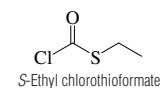
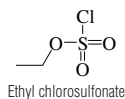
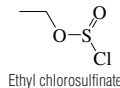
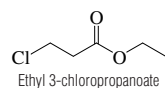
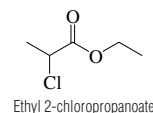
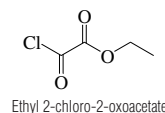
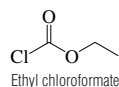
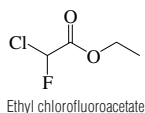
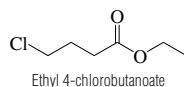
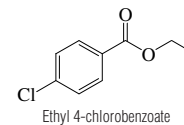
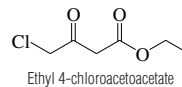
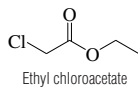
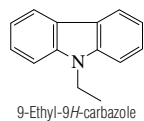
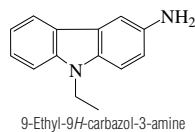
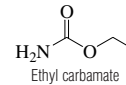
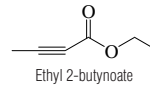
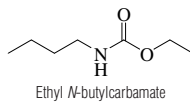
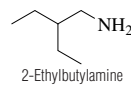
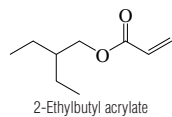
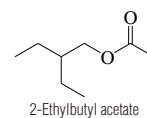
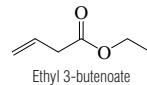
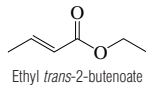
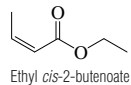
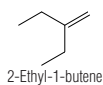


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4886	2-(Ethylamino)ethanol		C <sub>8</sub> H <sub>11</sub> NO	110-73-6	89.136			169.5	0.914 <sup>20</sup>	1.444 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
4887	2-Ethylaniline		C <sub>8</sub> H <sub>9</sub> N	578-54-1	121.180	liq	-43	209.5	0.983 <sup>22</sup>	1.5584 <sup>22</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth
4888	3-Ethylaniline		C <sub>8</sub> H <sub>9</sub> N	587-02-0	121.180	liq	-64	214; 94 <sup>6</sup>	0.9896 <sup>25</sup>		vs eth, EtOH
4889	4-Ethylaniline		C <sub>8</sub> H <sub>9</sub> N	589-16-2	121.180	liq	-2.4	217.5	0.9679 <sup>20</sup>	1.5554 <sup>20</sup>	sl H <sub>2</sub> O, ctc; vs EtOH, eth
4890	<i>N</i> -Ethylaniline		C <sub>8</sub> H <sub>9</sub> N	103-69-5	121.180	liq	-63.5	203.0	0.9625 <sup>20</sup>	1.5559 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace, bz; s ctc
4891	2-Ethyl-9,10-anthracenedione		C <sub>16</sub> H <sub>12</sub> O <sub>2</sub>	84-51-5	236.265		108.8				
4892	4-Ethylbenzaldehyde		C <sub>9</sub> H <sub>10</sub> O	4748-78-1	134.174			221	0.9790 <sup>20</sup>		
4893	<i>N</i> -Ethylbenzamide		C <sub>9</sub> H <sub>11</sub> NO	614-17-5	149.189	nd (w)	70.5				
4894	Ethylbenzene	Phenylethane	C <sub>8</sub> H <sub>10</sub>	100-41-4	106.165	liq	-94.96	136.16	0.8626 <sup>25</sup>	1.4959 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl chl
4895	$\alpha$ -Ethylbenzeneacetamide	$\alpha$ -Phenylbutyramide	C <sub>10</sub> H <sub>13</sub> NO	90-26-6	163.216	cry	86	185 <sup>16</sup>			s H <sub>2</sub> O, ctc; sl ace
4896	$\alpha$ -Ethylbenzeneacetic acid		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	90-27-7	164.201	pl (eth)	47.5	271			s eth, bz, ctc
4897	$\alpha$ -Ethylbenzeneacetonitrile		C <sub>10</sub> H <sub>11</sub> N	769-68-6	145.201			241	0.977 <sup>14</sup>		i H <sub>2</sub> O; s EtOH, eth, bz
4898	4-Ethyl-1,3-benzenediol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	2896-60-8	138.164	pr (chl, bz)	98.5	160 <sup>24</sup> , 131 <sup>15</sup>			sl H <sub>2</sub> O, EtOH, eth
4899	$\alpha$ -Ethylbenzenemethanol	$\alpha$ -Ethylbenzyl alcohol	C <sub>9</sub> H <sub>12</sub> O	93-54-9	136.190			219	0.9915 <sup>25</sup>	1.5169 <sup>23</sup>	vs bz, eth, EtOH, MeOH
4900	Ethyl benzenesulfonate		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub> S	515-46-8	186.228			156 <sup>15</sup>	1.2167 <sup>20</sup>	1.5081 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH; vs eth, chl
4901	4-Ethylbenzenesulfonic acid		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub> S	98-69-1	186.228				1.23		
4902	2-Ethyl-1 <i>H</i> -benzimidazole		C <sub>9</sub> H <sub>10</sub> N <sub>2</sub>	1848-84-6	146.188		176.5				sl chl
4903	Ethyl benzoate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	93-89-0	150.174	liq	-34	212	1.0415 <sup>25</sup>	1.5007 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; msc eth; sl ctc
4904	Ethyl 1,3-benzodioxole-5-carboxylate		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	6951-08-2	194.184	pr	18.5	285.5; 135 <sup>6</sup>			vs eth, EtOH, peth
4905	Ethyl benzoylacetate		C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	94-02-0	192.211		<0	dec 267; 167 <sup>20</sup>	1.1202 <sup>15</sup>	1.5317 <sup>15</sup>	sl H <sub>2</sub> O; s EtOH, eth
4906	Ethyl <i>N</i> -benzylglycinate		C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub>	6436-90-4	193.243			177 <sup>50</sup>		1.5041 <sup>20</sup>	vs EtOH, eth, bz
4907	Ethyl 2-benzylideneacetoacetate		C <sub>13</sub> H <sub>14</sub> O <sub>3</sub>	620-80-4	218.248	orth pl (dial)	60.5	296; 180 <sup>17</sup>			i H <sub>2</sub> O; sl EtOH, eth, bz; vs chl
4908	Ethyl bromoacetate		C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	105-36-2	167.002			168.5	1.5032 <sup>20</sup>	1.4489 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace; sl ctc
4909	Ethyl 4-bromoacetoacetate		C <sub>6</sub> H <sub>9</sub> BrO <sub>3</sub>	13176-46-0	209.037			115 <sup>14</sup> , 110 <sup>10</sup>	1.5278 <sup>18</sup>	1.5281 <sup>20</sup>	vs eth, EtOH
4910	Ethyl 4-bromobenzoate		C <sub>9</sub> H <sub>9</sub> BrO <sub>2</sub>	5798-75-4	229.070	liq	-18	263; 125 <sup>15</sup>	1.4332 <sup>17</sup>	1.5438 <sup>17</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz
4911	Ethyl 2-bromobutanoate		C <sub>8</sub> H <sub>11</sub> BrO <sub>2</sub>	533-68-6	195.054			177; 43 <sup>9</sup>	1.3273 <sup>20</sup>	1.4475 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
4912	Ethyl 4-bromobutanoate		C <sub>8</sub> H <sub>11</sub> BrO <sub>2</sub>	2969-81-5	195.054			192; 82 <sup>10</sup>	1.3540 <sup>20</sup>	1.4559 <sup>20</sup>	
4913	Ethyl <i>trans</i> -4-bromo-2-butenolate		C <sub>8</sub> H <sub>9</sub> BrO <sub>2</sub>	37746-78-4	193.038			100 <sup>14</sup>	1.402 <sup>16</sup>	1.4925 <sup>20</sup>	vs EtOH
4914	Ethyl 6-bromohexanoate	Ethyl 6-bromocaproate	C <sub>8</sub> H <sub>15</sub> BrO <sub>2</sub>	25542-62-5	223.108	cry (peth)	33	126 <sup>21</sup>	1.238 <sup>23</sup>	1.4566 <sup>21</sup>	
4915	Ethyl 2-bromo-3-methylbutanoate		C <sub>7</sub> H <sub>13</sub> BrO <sub>2</sub>	609-12-1	209.081			186	1.2760 <sup>20</sup>	1.4496 <sup>20</sup>	vs eth, EtOH
4916	Ethyl 2-bromo-2-methylpropanoate		C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	600-00-0	195.054			163	1.3263 <sup>20</sup>	1.4446 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth
4917	Ethyl 3-bromo-2-oxopropanoate	Ethyl 3-bromopyruvate	C <sub>6</sub> H <sub>9</sub> BrO <sub>3</sub>	70-23-5	195.012			87 <sup>9</sup>			
4918	Ethyl 2-bromopentanoate		C <sub>7</sub> H <sub>13</sub> BrO <sub>2</sub>	615-83-8	209.081			191	1.226 <sup>18</sup>	1.4496 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4919	Ethyl 5-bromopentanoate		C <sub>7</sub> H <sub>13</sub> BrO <sub>2</sub>	14660-52-7	209.081			129 <sup>35</sup> , 107 <sup>20</sup>	1.3085 <sup>20</sup>	1.4543 <sup>20</sup>	sl ctc
4920	Ethyl 2-bromopropanoate	Ethyl $\alpha$ -bromopropionate	C <sub>5</sub> H <sub>9</sub> BrO <sub>2</sub>	535-11-5	181.028			dec 160; 71 <sup>26</sup>	1.4135 <sup>20</sup>	1.4490 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
4921	Ethyl 3-bromopropanoate		C <sub>5</sub> H <sub>9</sub> BrO <sub>2</sub>	539-74-2	181.028			179; 65 <sup>15</sup>	1.4123 <sup>18</sup>	1.4516 <sup>20</sup>	s EtOH, eth, ace; sl ctc
4922	2-Ethylbutanal	Diethylacetaldehyde	C <sub>6</sub> H <sub>12</sub> O	97-96-1	100.158			118 <sup>60</sup>	0.8110 <sup>20</sup>	1.4025 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
4923	Ethyl butanoate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	105-54-4	116.158	liq	-98	121.3	0.8735 <sup>25</sup>	1.3898 <sup>25</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
4924	2-Ethylbutanoic acid	Diethylacetic acid	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	88-09-5	116.158	liq	-31.8	194	0.9239 <sup>20</sup>	1.4132 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
4925	2-Ethylbutanoic acid, triethyleneglycol diester		C <sub>18</sub> H <sub>34</sub> O <sub>6</sub>	95-08-9	346.459			181 <sup>3,5</sup>			
4926	2-Ethyl-1-butanol		C <sub>6</sub> H <sub>14</sub> O	97-95-0	102.174		<-15	147	0.8326 <sup>20</sup>	1.4220 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
4927	2-Ethylbutanoyl chloride		C <sub>6</sub> H <sub>11</sub> ClO	2736-40-5	134.603			140	0.9825 <sup>20</sup>	1.4234 <sup>20</sup>	vs eth

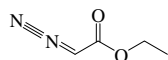




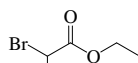
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4928	2-Ethyl-1-butene		C <sub>6</sub> H <sub>12</sub>	760-21-4	84.159	liq	-131.5	64.7	0.6894 <sup>20</sup>	1.3969 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
4929	Ethyl <i>cis</i> -2-butenolate	Ethyl isocrotonate	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	6776-19-8	114.142			136	0.9182 <sup>20</sup>	1.4242 <sup>20</sup>	vs ace, eth, EtOH
4930	Ethyl <i>trans</i> -2-butenolate	Ethyl crotonate	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	623-70-1	114.142			138	0.9175 <sup>20</sup>	1.4243 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4931	Ethyl 3-butenolate		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1617-18-1	114.142			119	0.9122 <sup>20</sup>	1.4105 <sup>20</sup>	s EtOH
4932	2-Ethylbutyl acetate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	10031-87-5	144.212		<-100	162.5	0.8790 <sup>20</sup>	1.4109 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
4933	2-Ethylbutyl acrylate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	3953-10-4	156.222	liq		80 <sup>20</sup>			
4934	2-Ethylbutylamine	2-Ethyl-1-butanamine	C <sub>6</sub> H <sub>15</sub> N	617-79-8	101.190	liq	125				
4935	Ethyl <i>N</i> -butylcarbamate		C <sub>7</sub> H <sub>15</sub> NO <sub>2</sub>	591-62-8	145.200	liq	-22	202; 100 <sup>15</sup>	0.9434 <sup>26</sup>	1.4278 <sup>26</sup>	
4936	Ethyl 2-butyrate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4341-76-8	112.127			163	0.9641 <sup>20</sup>	1.4372 <sup>20</sup>	
4937	Ethyl carbamate	Urethane	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	51-79-6	89.094	pr (bz, to)	49	185	0.9862 <sup>21</sup>	1.4144 <sup>51</sup>	vs H <sub>2</sub> O, EtOH, eth, bz, chl, py; sl lig
4938	9-Ethyl-9 <i>H</i> -carbazol-3-amine		C <sub>14</sub> H <sub>14</sub> N <sub>2</sub>	132-32-1	210.274		99				
4939	9-Ethyl-9 <i>H</i> -carbazole		C <sub>14</sub> H <sub>13</sub> N	86-28-2	195.260	nd (al)	68	190 <sup>10</sup>	1.059 <sup>80</sup>	1.6394 <sup>80</sup>	i H <sub>2</sub> O; vs EtOH, eth
4940	Ethyl chloroacetate		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	105-39-5	122.551	liq	-21	144.3	1.1585 <sup>20</sup>	1.4215 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; s bz
4941	Ethyl 4-chloroacetoacetate		C <sub>6</sub> H <sub>9</sub> ClO <sub>3</sub>	638-07-3	164.586		-8	dec 220; 115 <sup>14</sup>	1.218 <sup>25</sup>	1.4520 <sup>20</sup>	
4942	Ethyl 4-chlorobenzoate		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	7335-27-5	184.619			237.5	1.1873 <sup>14</sup>		vs EtOH
4943	Ethyl 4-chlorobutanoate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	3153-36-4	150.603			184	1.0756 <sup>20</sup>	1.4311 <sup>20</sup>	vs ace, eth, EtOH
4944	Ethyl chlorofluoroacetate		C <sub>4</sub> H <sub>6</sub> ClFO <sub>2</sub>	401-56-9	140.541			129	1.225 <sup>20</sup>	1.3927 <sup>20</sup>	
4945	Ethyl chloroformate		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	541-41-3	108.524	liq	-80.6	95	1.1352 <sup>20</sup>	1.3974 <sup>20</sup>	vs bz, eth, chl
4946	Ethyl 2-chloro-2-oxoacetate	Ethyl oxalyl chloride	C <sub>4</sub> H <sub>5</sub> ClO <sub>3</sub>	4755-77-5	136.534	hyg		137	1.2226 <sup>20</sup>		vs bz, eth
4947	Ethyl 2-chloropropanoate	Ethyl $\alpha$ -chloropropionate	C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	535-13-7	136.577			147	1.0793 <sup>20</sup>	1.4178 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
4948	Ethyl 3-chloropropanoate		C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	623-71-2	136.577			162	1.1086 <sup>20</sup>	1.4254 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
4949	Ethyl chlorosulfinate		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub> S	6378-11-6	128.578			52.5 <sup>44</sup> ; 32 <sup>16</sup>	1.2837 <sup>20</sup>	1.4550 <sup>25</sup>	vs eth
4950	Ethyl chlorosulfonate		C <sub>3</sub> H <sub>5</sub> ClO <sub>3</sub> S	625-01-4	144.577			152.5; 93 <sup>100</sup>	1.3502 <sup>25</sup>	1.416 <sup>20</sup>	vs eth, chl, lig
4951	<i>S</i> -Ethyl chlorothioformate		C <sub>3</sub> H <sub>5</sub> ClOS	2941-64-2	124.589	liq		136	1.195 <sup>20</sup>	1.4820 <sup>20</sup>	
4952	Ethyl <i>trans</i> -cinnamate	Ethyl <i>trans</i> -3-phenyl-2-propenoate	C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	4192-77-2	176.212		10	271.5	1.0491 <sup>20</sup>	1.5598 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace; s bz, ctc
4953	Ethyl cyanate		C <sub>3</sub> H <sub>5</sub> NO	627-48-5	71.078			dec 162; 30 <sup>12</sup>	0.89 <sup>20</sup>	1.3788 <sup>25</sup>	vs eth, EtOH
4954	Ethyl cyanoacetate		C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	105-56-6	113.116	liq	-22.5	205	1.0654 <sup>20</sup>	1.4175 <sup>20</sup>	s H <sub>2</sub> O; vs eth, EtOH
4955	Ethyl 2-cyanoacrylate	Ethyl 2-cyano-2-propenoate	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	7085-85-0	125.126	liq		55 <sup>3</sup>			
4956	Ethyl 2-cyano-3,3-diphenyl-2-propenoate	Etocrilene	C <sub>18</sub> H <sub>15</sub> NO <sub>2</sub>	5232-99-5	277.318		110.5	195 <sup>3</sup>			
4957	Ethyl 2-cyano-3-ethoxyacrylate		C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	94-05-3	169.178		52	190.5			
4958	Ethyl cyanoformate		C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	623-49-4	99.089			115.5	1.003 <sup>25</sup>	1.3820 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
4959	Ethyl 2-cyano-2-phenylacetate		C <sub>11</sub> H <sub>11</sub> NO <sub>2</sub>	4553-07-5	189.211	oil		dec 275; 165 <sup>20</sup>	1.091 <sup>20</sup>	1.5012 <sup>25</sup>	vs ace, bz, eth, EtOH
4960	Ethyl 2-cyano-3-phenyl-2-propenoate	Ethyl 2-benzylidene-2-cyanoacetate	C <sub>12</sub> H <sub>11</sub> NO <sub>2</sub>	2025-40-3	201.221	(i) nd (al) (ii) oil	51	188 <sup>15</sup>	1.1076 <sup>25</sup>	1.5033	vs ace, chl
4961	Ethylcyclobutane		C <sub>6</sub> H <sub>12</sub>	4806-61-5	84.159	liq	-142.9	70.8	0.7284 <sup>20</sup>	1.4020 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, bz, peth
4962	Ethylcyclohexane		C <sub>8</sub> H <sub>16</sub>	1678-91-7	112.213	liq	-111.3	131.9	0.7880 <sup>20</sup>	1.4330 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; vs lig; msc ctc
4963	Ethyl cyclohexanecarboxylate		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	3289-28-9	156.222			196	0.9362 <sup>20</sup>	1.4501 <sup>15</sup>	vs ace, eth, EtOH, chl
4964	1-Ethylcyclohexene		C <sub>8</sub> H <sub>14</sub>	1453-24-3	110.197	liq	-109.9	137	0.8176 <sup>25</sup>	1.4567 <sup>20</sup>	
4965	Ethyl 3-cyclohexene-1-carboxylate		C <sub>9</sub> H <sub>14</sub> O <sub>2</sub>	15111-56-5	154.206			194.5	0.9688 <sup>20</sup>	1.4578 <sup>20</sup>	
4966	Ethyl cyclohexylacetate		C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	5452-75-5	170.249			211	0.9537 <sup>14</sup>	1.451 <sup>14</sup>	
4967	Ethylcyclopentane		C <sub>7</sub> H <sub>14</sub>	1640-89-7	98.186	liq	-138.4	103.5	0.7665 <sup>20</sup>	1.4198 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; s bz, tol
4968	Ethyl 2-cyclopentanone-1-carboxylate		C <sub>8</sub> H <sub>12</sub> O <sub>3</sub>	611-10-9	156.179			221; 110 <sup>16</sup>	1.0781 <sup>21</sup>	1.4519 <sup>20</sup>	s eth, bz
4969	1-Ethylcyclopentene		C <sub>7</sub> H <sub>12</sub>	2146-38-5	96.170	liq	-118.5	106.3	0.7936 <sup>25</sup>	1.4412 <sup>20</sup>	
4970	Ethylcyclopropane		C <sub>5</sub> H <sub>10</sub>	1191-96-4	70.133	liq	-149.2	35.9	0.6790 <sup>25</sup>	1.3786 <sup>20</sup>	
4971	Ethyl cyclopropanecarboxylate		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	4606-07-9	114.142			134	0.9608 <sup>15</sup>	1.4190 <sup>20</sup>	
4972	Ethyl decanoate	Ethyl caprate	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	110-38-3	200.318	liq	-20	241.5	0.8650 <sup>20</sup>	1.4256 <sup>20</sup>	i H <sub>2</sub> O; vs eth, EtOH, chl



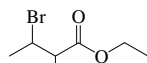
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
4973	Ethyl diazoacetate	Diazoacetic ester	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	623-73-4	114.103	ye orth cry	-22	dec 140	1.0852 <sup>18</sup>	1.4605 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz, lig
4974	Ethyl dibromoacetate		C <sub>4</sub> H <sub>6</sub> Br <sub>2</sub> O <sub>2</sub>	617-33-4	245.898			194	1.8991 <sup>20</sup>	1.5017 <sup>13</sup>	i H <sub>2</sub> O; msc EtOH, eth
4975	Ethyl 2,3-dibromobutanoate		C <sub>6</sub> H <sub>10</sub> Br <sub>2</sub> O <sub>2</sub>	609-11-0	273.950	nd	58.5	113 <sup>30</sup>	1.6800 <sup>20</sup>		sl H <sub>2</sub> O, ctc; s EtOH, eth
4976	Ethyl 2,4-dibromobutanoate		C <sub>6</sub> H <sub>10</sub> Br <sub>2</sub> O <sub>2</sub>	36847-51-5	273.950			149 <sup>52</sup>	1.6987 <sup>20</sup>	1.4960 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
4977	Ethyl 2,3-dibromopropanoate		C <sub>5</sub> H <sub>8</sub> Br <sub>2</sub> O <sub>2</sub>	3674-13-3	259.925			214.5	1.7966 <sup>20</sup>	1.5007 <sup>20</sup>	s EtOH, eth
4978	Ethyl 3,6-di( <i>tert</i> -butyl)-1-naphthalenesulfonate	Ethyl dibunate	C <sub>20</sub> H <sub>28</sub> O <sub>3</sub> S	5560-69-0	348.499						s chl
4979	Ethyl dichloroacetate		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	535-15-9	156.996			155; 56 <sup>10</sup>	1.2827 <sup>20</sup>	1.4386 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, chl
4980	Ethyl dichloroarsine	Dichloroethylarsine	C <sub>2</sub> H <sub>4</sub> AsCl <sub>2</sub>	598-14-1	174.889			155.3; 74 <sup>50</sup>	1.66 <sup>20</sup>		s H <sub>2</sub> O; misc EtOH, bz
4981	Ethyl dichlorocarbamate		C <sub>3</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	13698-16-3	157.984			66 <sup>18</sup> , 55 <sup>15</sup>	1.304 <sup>30</sup>	1.4595 <sup>20</sup>	
4982	Ethyl 2,3-dichloropropanoate		C <sub>3</sub> H <sub>5</sub> Cl <sub>2</sub> O <sub>2</sub>	6628-21-3	171.022			183.5	1.2401 <sup>20</sup>	1.4482 <sup>20</sup>	vs eth, EtOH
4983	Ethyl diethoxyacetate		C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	6065-82-3	176.211			199	0.985 <sup>25</sup>	1.4100 <sup>20</sup>	
4984	Ethyl diethylmalonate		C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	77-25-8	216.275			230	0.9643 <sup>30</sup>	1.4240 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
4985	Ethyl difluoroacetate		C <sub>4</sub> H <sub>6</sub> F <sub>2</sub> O <sub>2</sub>	454-31-9	124.087			100	1.1765 <sup>20</sup>		i H <sub>2</sub> O
4986	Ethyl difluoroarsine		C <sub>2</sub> H <sub>4</sub> AsF <sub>2</sub>	430-40-0	141.980	liq, fumes in air	-38.7	94.3	1.708 <sup>17</sup>		
4987	5-Ethylidihydro-5- <i>sec</i> -butyl-2-thioxo-4,6(1 <i>H</i> ,5 <i>H</i> )-pyrimidinedione	Thiobutabarbital	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S	2095-57-0	228.311		169				
4988	5-Ethylidihydro-2(3 <i>H</i> )-furanone		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	695-06-7	114.142	liq	-18	215.5	1.0261 <sup>20</sup>	1.4495 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
4989	Ethyl dihydrogen phosphate		C <sub>2</sub> H <sub>4</sub> O <sub>4</sub> P	1623-14-9	126.048	hyg cry		dec	1.430 <sup>25</sup>	1.427	vs H <sub>2</sub> O, ace, eth, EtOH
4990	5-Ethylidihydro-5-phenyl-4,6(1 <i>H</i> ,5 <i>H</i> )-pyrimidinedione	Primidone	C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	125-33-7	218.251		281.5				
4991	Ethyl 2,4-dihydroxy-6-methylbenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	2524-37-0	196.200	lf (HOAc), pr (al)	132	sub			vs eth, EtOH
4992	<i>O</i> -Ethyl <i>S</i> -[2-(diisopropylamino)ethyl]methylphosphonothioate	VX Nerve agent	C <sub>11</sub> H <sub>26</sub> NO <sub>2</sub> PS	50782-69-9	267.369	very toxic liq					
4993	Ethylidimethylamine	<i>N,N</i> -Dimethylethanamine	C <sub>4</sub> H <sub>11</sub> N	598-56-1	73.137	liq	-140	36.5	0.675 <sup>20</sup>	1.3705 <sup>25</sup>	
4994	Ethyl 4-(dimethylamino)benzoate		C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	10287-53-3	193.243		66.5	190 <sup>14</sup>	1.0099 <sup>100</sup>		
4995	1-Ethyl-2,4-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	874-41-9	134.218	liq	-62.9	188.4	0.8763 <sup>20</sup>	1.5038 <sup>20</sup>	vs ace, bz, eth, EtOH
4996	1-Ethyl-3,5-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	934-74-7	134.218	liq	-84.3	183.6	0.8608 <sup>25</sup>	1.4981 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s peth, ctc
4997	2-Ethyl-1,3-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	2870-04-4	134.218	liq	-16.2	190	0.8864 <sup>25</sup>	1.5107 <sup>20</sup>	
4998	2-Ethyl-1,4-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	1758-88-9	134.218	liq	-53.7	186.9	0.8732 <sup>25</sup>	1.5043 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s peth, ctc
4999	3-Ethyl-1,2-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	933-98-2	134.218	liq	-49.5	194	0.8881 <sup>25</sup>	1.5117 <sup>20</sup>	
5000	4-Ethyl-1,2-dimethylbenzene		C <sub>10</sub> H <sub>14</sub>	934-80-5	134.218	liq	-66.9	189.5	0.8706 <sup>25</sup>	1.5031 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s peth, ctc
5001	<i>N'</i> -Ethyl- <i>N,N</i> -dimethyl-1,2-ethanediamine		C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	123-83-1	116.204			134.5	0.738 <sup>25</sup>	1.4222 <sup>20</sup>	
5002	Ethyl 4,4-dimethyl-3-oxopentanoate	Ethyl pivaloylacetate	C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	17094-34-7	172.221	liq		83 <sup>17</sup>	0.97 <sup>18</sup>		
5003	3-Ethyl-2,2-dimethylpentane		C <sub>9</sub> H <sub>20</sub>	16747-32-3	128.255	liq	-99.3	133.8	0.7438 <sup>20</sup>	1.4123 <sup>20</sup>	
5004	3-Ethyl-2,3-dimethylpentane		C <sub>9</sub> H <sub>20</sub>	16747-33-4	128.255			144.7	0.7508 <sup>25</sup>	1.4221 <sup>20</sup>	
5005	3-Ethyl-2,4-dimethylpentane		C <sub>9</sub> H <sub>20</sub>	1068-87-7	128.255	liq	-122.4	136.7	0.7365 <sup>20</sup>	1.4131 <sup>20</sup>	
5006	Ethyl 2,2-dimethylpropanoate	Ethyl 2,2-dimethylpropionate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	3938-95-2	130.185	liq	-89.5	118.4	0.856 <sup>20</sup>	1.3906 <sup>20</sup>	s EtOH, eth
5007	3-Ethyl-2,5-dimethylpyrazine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	13360-65-1	136.194			180.5	0.9657 <sup>24</sup>	1.5014 <sup>24</sup>	sl H <sub>2</sub> O, EtOH, eth
5008	3-Ethyl-2,4-dimethyl-1 <i>H</i> -pyrrole		C <sub>8</sub> H <sub>13</sub> N	517-22-6	123.196	pr	0	199; 96 <sup>16</sup>	0.913 <sup>20</sup>	1.4961 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, chl
5009	Ethyl 3,5-dimethylpyrrole-2-carboxylate		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	2199-44-2	167.205	cry (al)	125	135 <sup>10.5</sup>			s EtOH, ace
5010	Ethyl 2,4-dimethylpyrrole-3-carboxylate		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	2199-51-1	167.205	cry (eth-liq, peth)	78.5	291			vs eth, EtOH
5011	Ethyl 2,5-dimethylpyrrole-3-carboxylate		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	2199-52-2	167.205	orth (al)	117.5	291; 130 <sup>15</sup>			vs EtOH
5012	Ethyl 4,5-dimethylpyrrole-3-carboxylate		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	2199-53-3	167.205	cry (dil al)	111.3				vs eth, EtOH, chl
5013	Ethyl 2,4-dioxopentanoate		C <sub>7</sub> H <sub>10</sub> O <sub>4</sub>	615-79-2	158.152		18	214	1.1251 <sup>20</sup>	1.4757 <sup>17</sup>	vs eth, EtOH



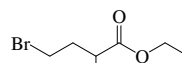
Ethyl diazoacetate



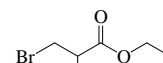
Ethyl dibromoacetate



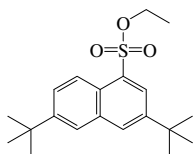
Ethyl 2,3-dibromobutanoate



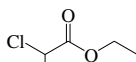
Ethyl 2,4-dibromobutanoate



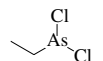
Ethyl 2,3-dibromopropanoate



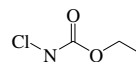
Ethyl 3,6-di(tert-butyl)-1-naphthalenesulfonate



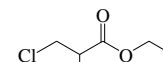
Ethyl dichloroacetate



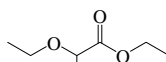
Ethyldichloroarsine



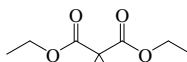
Ethyl dichlorocarbamate



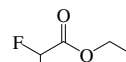
Ethyl 2,3-dichloropropanoate



Ethyl diethoxyacetate



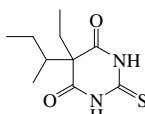
Ethyl diethylmalonate



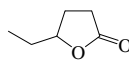
Ethyl difluoroacetate



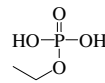
Ethyldifluoroarsine



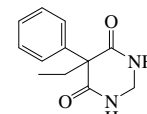
5-Ethylidihydro-5-sac-butyl-2-thioxo-4,6(1H,5H)-pyrimidinedione



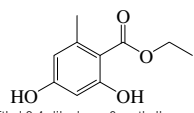
5-Ethylidihydro-2(3H)-furanone



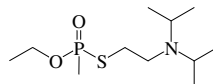
Ethyl dihydrogen phosphate



5-Ethylidihydro-5-phenyl-4,6(1H,5H)-pyrimidinedione



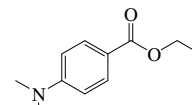
Ethyl 2,4-dihydroxy-6-methylbenzoate



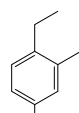
O-Ethyl S-[2-(diisopropylamino)ethyl] methylphosphonothioate



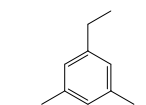
Ethyldimethylamine



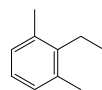
Ethyl 4-(dimethylamino)benzoate



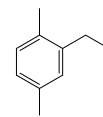
1-Ethyl-2,4-dimethylbenzene



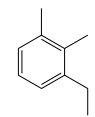
1-Ethyl-3,5-dimethylbenzene



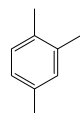
2-Ethyl-1,3-dimethylbenzene



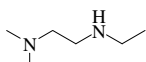
2-Ethyl-1,4-dimethylbenzene



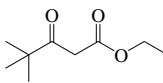
3-Ethyl-1,2-dimethylbenzene



4-Ethyl-1,2-dimethylbenzene



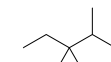
N'-Ethyl-N,N-dimethyl-1,2-ethanediamine



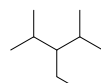
Ethyl 4,4-dimethyl-3-oxopentanoate



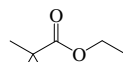
3-Ethyl-2,2-dimethylpentane



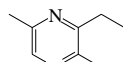
3-Ethyl-2,3-dimethylpentane



3-Ethyl-2,4-dimethylpentane



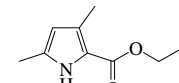
Ethyl 2,2-dimethylpropanoate



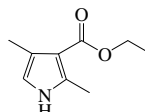
3-Ethyl-2,5-dimethylpyrazine



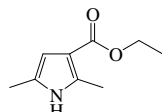
3-Ethyl-2,4-dimethyl-1H-pyrrole



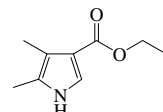
Ethyl 3,5-dimethylpyrrole-2-carboxylate



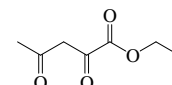
Ethyl 2,4-dimethylpyrrole-3-carboxylate



Ethyl 2,5-dimethylpyrrole-3-carboxylate

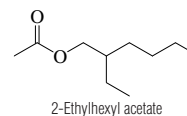
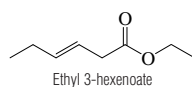
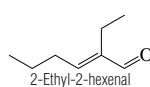
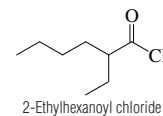
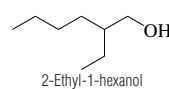
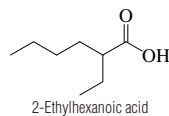
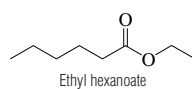
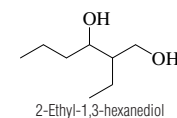
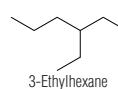
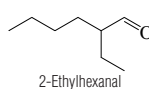
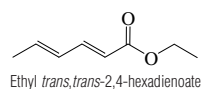
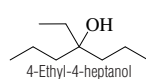
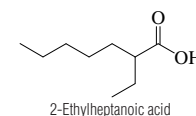
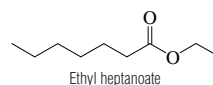
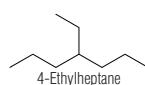
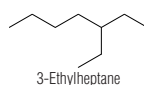
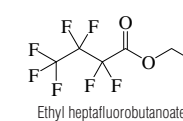
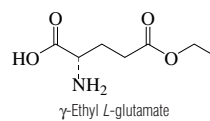
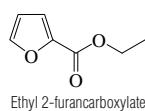
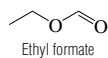
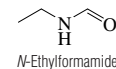
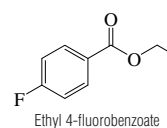
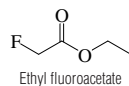
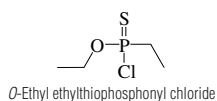
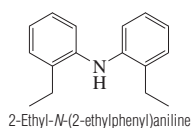
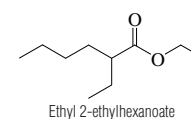
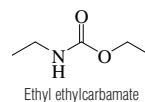
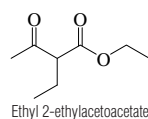
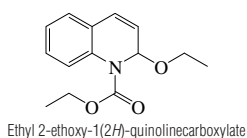
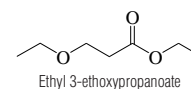
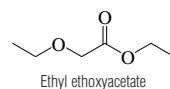
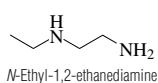
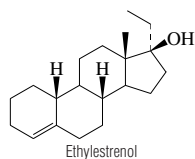
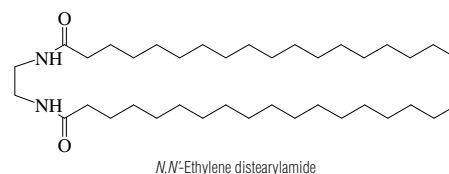
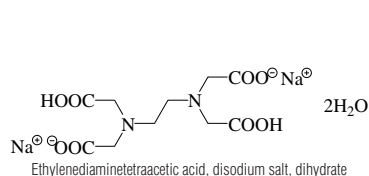
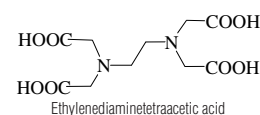
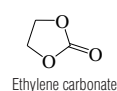
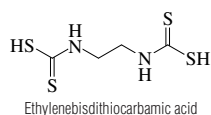
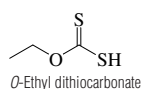


Ethyl 4,5-dimethylpyrrole-3-carboxylate



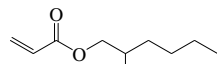
Ethyl 2,4-dioxopentanoate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5014	<i>O</i> -Ethyl dithiocarbonate	Xanthogenic acid	C <sub>3</sub> H <sub>6</sub> OS <sub>2</sub>	151-01-9	122.209	unstab liq	-53	25			
5015	Ethylene	Ethene	C <sub>2</sub> H <sub>4</sub>	74-85-1	28.053	col gas	-169.15	-103.77	0.5678 <sup>104</sup>	1.363 <sup>100</sup>	i H <sub>2</sub> O; sl EtOH, bz, ace; s eth
5016	Ethylenebisdithiocarbamic acid		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> S <sub>4</sub>	111-54-6	212.380	unstab liq					
5017	Ethylene carbonate	Vinylene carbonate	C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	96-49-1	88.062	mcl pl (al)	36.4	248	1.3214 <sup>99</sup>	1.4148 <sup>50</sup>	msc H <sub>2</sub> O, EtOH, eth, bz, chl, AcOEt
5018	Ethylenediaminetetraacetic acid	EDTA	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>8</sub>	60-00-4	292.242	cry (w)	245 dec				
5019	Ethylenediaminetetraacetic acid, disodium salt, dihydrate	EDTA disodium	C <sub>10</sub> H <sub>18</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>10</sub>	6381-92-6	372.237		242 dec				
5020	<i>N,N'</i> -Ethylene distearylamine	<i>N,N'</i> -Dioctadecanoyl ethanediamine	C <sub>38</sub> H <sub>76</sub> N <sub>2</sub> O <sub>2</sub>	110-30-5	593.022	cry (EtOH)	149				
5021	Ethyleneimine	Aziridine	C <sub>2</sub> H <sub>3</sub> N	151-56-4	43.068	liq	-77.9	56	0.832 <sup>25</sup>		msc H <sub>2</sub> O; s EtOH; vs eth; sl chl
5022	Ethylestrenol		C <sub>20</sub> H <sub>32</sub> O	965-90-2	288.467	cry	77				
5023	<i>N</i> -Ethyl-1,2-ethanediamine		C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	110-72-5	88.151			129	0.837 <sup>25</sup>	1.4385 <sup>20</sup>	
5024	Ethyl ethoxyacetate		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	817-95-8	132.157			158	0.9702 <sup>20</sup>	1.4039 <sup>20</sup>	s EtOH, eth, ace
5025	Ethyl 3-ethoxypropanoate		C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	763-69-9	146.184			166; 48 <sup>5</sup>	0.9490 <sup>20</sup>	1.4065 <sup>20</sup>	
5026	Ethyl 2-ethoxy-1(2 <i>H</i> )-quinolinecarboxylate	EEDQ	C <sub>14</sub> H <sub>17</sub> NO <sub>3</sub>	16357-59-8	247.290		56.5	126 <sup>0.1</sup>			s chl
5027	Ethyl 2-ethylacetoacetate		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	607-97-6	158.195			198.0; 80 <sup>10</sup>	0.9847 <sup>16</sup>	1.4214 <sup>25</sup>	msc EtOH, eth
5028	Ethyl ethylcarbamate		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	623-78-9	117.147			176	0.9813 <sup>20</sup>	1.4215 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5029	Ethyl 2-ethylhexanoate	Ethyl 2-ethylcaproate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2983-37-1	172.265			90 <sup>28</sup>	0.8586 <sup>25</sup>	1.4123 <sup>25</sup>	
5030	2-Ethyl- <i>N</i> -(2-ethylphenyl)aniline		C <sub>16</sub> H <sub>19</sub> N	64653-59-4	225.329		29	336 <sup>603</sup> , 173 <sup>10</sup>		1.5550 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl chl; s acid
5031	<i>O</i> -Ethyl ethylthiophosphonyl chloride		C <sub>4</sub> H <sub>10</sub> ClOPS	1497-68-3	172.613	liq		35 <sup>0.7</sup>	1.15 <sup>20</sup>		
5032	Ethyl fluoroacetate		C <sub>4</sub> H <sub>7</sub> FO <sub>2</sub>	459-72-3	106.096			120	1.0912 <sup>20</sup>	1.3755 <sup>20</sup>	vs H <sub>2</sub> O
5033	Ethyl 4-fluorobenzoate		C <sub>9</sub> H <sub>9</sub> FO <sub>2</sub>	451-46-7	168.164	mcl pr (w)	26	210	1.146 <sup>25</sup>	1.4864 <sup>20</sup>	vs eth, EtOH
5034	<i>N</i> -Ethylformamide		C <sub>3</sub> H <sub>7</sub> NO	627-45-2	73.094			198	0.9552 <sup>20</sup>	1.4320 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
5035	Ethyl formate		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	109-94-4	74.079	liq	-79.6	54.4	0.9208 <sup>20</sup>	1.3609 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth; vs ace; sl ctc
5036	2-Ethylfuran		C <sub>6</sub> H <sub>8</sub> O	3208-16-0	96.127			92.5	0.9018 <sup>20</sup>	1.4403 <sup>20</sup>	s EtOH, eth, ace, bz
5037	Ethyl 2-furancarboxylate	Ethyl 2-furanoate	C <sub>7</sub> H <sub>8</sub> O <sub>3</sub>	614-99-3	140.137	lf or pr	34.5	196.8	1.1174 <sup>21</sup>	1.4797 <sup>21</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; s bz
5038	γ-Ethyl <i>L</i> -glutamate		C <sub>7</sub> H <sub>13</sub> NO <sub>4</sub>	1119-33-1	175.183		191				sl H <sub>2</sub> O
5039	Ethyl heptafluorobutanoate		C <sub>6</sub> H <sub>9</sub> F <sub>7</sub> O <sub>2</sub>	356-27-4	242.092			95	1.394 <sup>20</sup>	1.3011 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace
5040	3-Ethylheptane		C <sub>9</sub> H <sub>20</sub>	15869-80-4	128.255	liq	-114.9	143.0	0.7225 <sup>25</sup>	1.4093 <sup>20</sup>	
5041	4-Ethylheptane		C <sub>9</sub> H <sub>20</sub>	2216-32-2	128.255			141.2	0.7241 <sup>25</sup>	1.4096 <sup>20</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz
5042	Ethyl heptanoate	Ethyl oenanthane	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	106-30-9	158.238	liq	-66.1	187	0.8817 <sup>20</sup>	1.4100 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
5043	2-Ethylheptanoic acid		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	3274-29-1	158.238	liq		153 <sup>31</sup>		1.4255 <sup>27</sup>	
5044	4-Ethyl-4-heptanol		C <sub>9</sub> H <sub>20</sub> O	597-90-0	144.254			182	0.8350 <sup>20</sup>	1.4332 <sup>20</sup>	vs eth, EtOH
5045	Ethyl <i>trans,trans</i> -2,4-hexadienoate	Ethyl sorbate	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	2396-84-1	140.180			195.5	0.9506 <sup>20</sup>	1.4951 <sup>20</sup>	vs eth, EtOH, chl
5046	2-Ethylhexanal		C <sub>8</sub> H <sub>16</sub> O	123-05-7	128.212		<-100	163	0.8540 <sup>20</sup>	1.4142 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
5047	3-Ethylhexane		C <sub>8</sub> H <sub>18</sub>	619-99-8	114.229			118.6	0.7136 <sup>20</sup>	1.4018 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl; s ctc
5048	2-Ethyl-1,3-hexanediol	Ethohexadiol	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	94-96-2	146.228	liq	-40	244	0.9325 <sup>22</sup>	1.4497 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
5049	Ethyl hexanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	123-66-0	144.212	liq	-67	167	0.873 <sup>20</sup>	1.4073 <sup>20</sup>	sl H <sub>2</sub> O; vs eth, EtOH
5050	2-Ethylhexanoic acid		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	149-57-5	144.212			228; 120 <sup>13</sup>	0.9031 <sup>25</sup>	1.4241 <sup>20</sup>	s H <sub>2</sub> O, eth, ctc; sl EtOH
5051	2-Ethyl-1-hexanol		C <sub>8</sub> H <sub>18</sub> O	104-76-7	130.228	liq	-70	184.6	0.8319 <sup>25</sup>	1.4300 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
5052	2-Ethylhexanoyl chloride		C <sub>8</sub> H <sub>15</sub> ClO	760-67-8	162.657			101 <sup>40</sup> , 67 <sup>11</sup>	0.939 <sup>25</sup>	1.4335 <sup>20</sup>	
5053	2-Ethyl-2-hexenal		C <sub>8</sub> H <sub>14</sub> O	645-62-5	126.196			175	0.8554 <sup>20</sup>		
5054	Ethyl 3-hexenoate	Ethyl hydrosorbate	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	2396-83-0	142.196			166.5	0.8957 <sup>20</sup>	1.4255 <sup>20</sup>	
5055	2-Ethylhexyl acetate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	103-09-3	172.265	liq	-80	199	0.8718 <sup>20</sup>	1.4204 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth

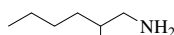


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5056	2-Ethylhexyl acrylate		C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	103-11-7	184.276		-90	125 <sup>60</sup>	0.880 <sup>25</sup>	1.4332 <sup>25</sup>	
5057	2-Ethylhexylamine	2-Ethyl-1-hexanamine	C <sub>8</sub> H <sub>19</sub> N	104-75-6	129.244			169.2			sl H <sub>2</sub> O
5058	2-Ethylhexyl butyl phthalate	Butyl 2-ethylhexyl phthalate	C <sub>20</sub> H <sub>36</sub> O <sub>4</sub>	85-69-8	334.450	col liq					sl H <sub>2</sub> O
5059	2-Ethylhexyl dihydrogen phosphate	Mono(2-ethylhexyl) phosphate	C <sub>8</sub> H <sub>19</sub> O <sub>4</sub> P	1070-03-7	210.208	liq					s H <sub>2</sub> O, bz
5060	2-Ethylhexyl diphenyl phosphite	Forstab	C <sub>20</sub> H <sub>27</sub> O <sub>3</sub> P	15647-08-2	346.400			152 <sup>0.15</sup>	1.054 <sup>20</sup>	1.5207 <sup>27</sup>	
5061	Ethyl hexyl ether	1-Ethoxyhexane	C <sub>8</sub> H <sub>18</sub> O	5756-43-4	130.228			143	0.7722 <sup>20</sup>	1.4008 <sup>20</sup>	vs eth, EtOH
5062	2-Ethylhexyl 2-hydroxybenzoate	Octisalate	C <sub>15</sub> H <sub>22</sub> O <sub>3</sub>	118-60-5	250.334	liq		190 <sup>21</sup>	1.01		
5063	2-Ethylhexyl methacrylate		C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	688-84-6	198.302			120 <sup>18</sup> , 110 <sup>14</sup>	0.880 <sup>25</sup>	1.436 <sup>25</sup>	
5064	2-[(2-Ethylhexyl)oxy]ethanol	Ethylene glycol mono(2-ethylhexyl) ether	C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	1559-35-9	174.281			227.7			
5065	Ethylhydrazine		C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	624-80-6	60.098			101			vs H <sub>2</sub> O, ace, eth, EtOH
5066	Ethyl hydrazinecarboxylate	Ethyl carbazate	C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	4114-31-2	104.108	cry	46	dec 198; 93 <sup>9</sup>			s EtOH, eth; sl chl
5067	Ethyl hydrogen adipate		C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	626-86-8	174.195	hyg cry (eth, peth)	29	285	0.9796 <sup>20</sup>	1.4311 <sup>20</sup>	s EtOH, eth, peth
5068	Ethyl hydrogen fumarate		C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	2459-05-4	144.126		70	147 <sup>16</sup>	1.1109 <sup>97</sup>		s EtOH, ace; sl chl
5069	Ethyl hydrogen succinate	Butanedioic acid, monoethyl ester	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	1070-34-4	146.141	pr or nd	8	172 <sup>42</sup> , 119 <sup>3</sup>	1.1466 <sup>20</sup>	1.4327 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5070	Ethyl hydroperoxide	Ethyl hydrogen peroxide	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	3031-74-1	62.068	liq	-100	95	0.9332 <sup>20</sup>	1.3800 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
5071	Ethyl hydroxyacetate		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	623-50-7	104.105			160	1.0826 <sup>23</sup>	1.4180 <sup>20</sup>	vs eth, EtOH
5072	Ethyl 3-hydroxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	7781-98-8	166.173	pl (bz)	74		1.0680 <sup>131</sup>		sl H <sub>2</sub> O, chl; s EtOH, eth
5073	Ethyl 4-hydroxybenzoate	Ethylparaben	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	120-47-8	166.173	cry (dil al)	117	297.5			sl H <sub>2</sub> O, chl, tfa; vs EtOH, eth; i CS <sub>2</sub>
5074	Ethyl 3-hydroxybutanoate, (±)		C <sub>8</sub> H <sub>12</sub> O <sub>3</sub>	35608-64-1	132.157			185; 76 <sup>15</sup>	1.017 <sup>20</sup>	1.4182 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl ctc
5075	Ethyl 2-hydroxy-3-butenate		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	91890-87-8	130.141			dec 173; 68 <sup>15</sup>	1.0470 <sup>15</sup>	1.436 <sup>13</sup>	vs H <sub>2</sub> O, eth, EtOH
5076	α-Ethyl-1-hydroxycyclohexanecetic acid	Cyclobutylol	C <sub>10</sub> H <sub>18</sub> O <sub>3</sub>	512-16-3	186.248	cry (eth-peth)	81.5	164 <sup>24</sup>	1.0010 <sup>18</sup>	1.4680 <sup>18</sup>	vs ace, eth, EtOH, chl
5077	N-Ethyl-N-hydroxyethanamine	N,N-Diethylhydroxylamine	C <sub>4</sub> H <sub>11</sub> NO	3710-84-7	89.136		10	133	0.8669 <sup>20</sup>	1.4195 <sup>20</sup>	
5078	2-Ethyl-3-hydroxyhexanal		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	496-03-7	144.212			138 <sup>50</sup> , 101 <sup>9</sup>			
5079	Ethyl 4-hydroxy-3-methoxybenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	617-05-0	196.200	nd (dil al)	44	292			i H <sub>2</sub> O; vs EtOH, eth; s chl
5080	Ethyl cis-12-hydroxy-9-octadecenoate, (R)	Ethyl ricinoleate	C <sub>20</sub> H <sub>38</sub> O <sub>3</sub>	55066-53-0	326.514			258 <sup>13</sup>	0.9180 <sup>20</sup>	1.4618 <sup>22</sup>	
5081	Ethylidene-cyclohexane		C <sub>8</sub> H <sub>14</sub>	1003-64-1	110.197			136	0.822 <sup>25</sup>	1.4618 <sup>20</sup>	
5082	5-Ethylidene-2-norbornene	5-Ethylidenebicyclo[2.2.1]hept-2-ene	C <sub>9</sub> H <sub>12</sub>	16219-75-3	120.191	liq		146	0.893	1.4900 <sup>20</sup>	
5083	1-Ethyl-1H-imidazole		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	7098-07-9	96.131			208	0.999 <sup>25</sup>		msc H <sub>2</sub> O
5084	Ethyl iodoacetate		C <sub>4</sub> H <sub>7</sub> I O <sub>2</sub>	623-48-3	214.002	oil		179	1.8173 <sup>13</sup>	1.5079 <sup>13</sup>	s EtOH, eth
5085	Ethyl isobutylcarbamate	Isobutyl urethane	C <sub>7</sub> H <sub>15</sub> NO <sub>2</sub>	539-89-9	145.200		<-65	110 <sup>30</sup>	0.9432 <sup>20</sup>	1.4288 <sup>20</sup>	vs eth, EtOH
5086	Ethyl isocyanate		C <sub>3</sub> H <sub>5</sub> NO	109-90-0	71.078			60	0.9031 <sup>20</sup>	1.3808 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
5087	Ethyl isocyanide		C <sub>3</sub> H <sub>5</sub> N	624-79-3	55.079		<-66	79	0.7402 <sup>20</sup>	1.3622 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s ace
5088	N-Ethyl-1H-isoindole-1,3(2H)-dione		C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	5022-29-7	175.184	nd (al)	79	285.5			s EtOH, eth
5089	Ethyl isopentyl ether		C <sub>7</sub> H <sub>16</sub> O	628-04-6	116.201			112.5	0.7688 <sup>21</sup>		vs eth, EtOH
5090	Ethylisopropylamine	N-Ethyl-2-propanamine	C <sub>5</sub> H <sub>13</sub> N	19961-27-4	87.164			69.6		1.3872 <sup>25</sup>	
5091	1-Ethyl-2-isopropylbenzene		C <sub>11</sub> H <sub>16</sub>	18970-44-0	148.245			193	0.889 <sup>20</sup>	1.508 <sup>20</sup>	vs ace, bz, eth, EtOH
5092	Ethyl isopropyl ether		C <sub>6</sub> H <sub>12</sub> O	625-54-7	88.148			54.1	0.720 <sup>25</sup>	1.3698 <sup>25</sup>	s H <sub>2</sub> O, ace, chl; msc EtOH, eth
5093	N-Ethyl-N-isopropyl-2-propanamine		C <sub>8</sub> H <sub>19</sub> N	7087-68-5	129.244			126.5	0.742 <sup>25</sup>	1.4138 <sup>20</sup>	s ctc
5094	Ethyl isopropyl sulfide		C <sub>6</sub> H <sub>12</sub> S	5145-99-3	104.214	liq	-122.2	107.5	0.8246 <sup>20</sup>		
5095	Ethyl isothiocyanate		C <sub>3</sub> H <sub>5</sub> NS	542-85-8	87.144	liq	-5.9	131.5	0.9990 <sup>20</sup>	1.5130 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
5096	Ethyl lactate	Ethyl 2-hydroxypropionate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	2676-33-7	118.131	liq	-26	154.5	1.0328 <sup>20</sup>	1.4124 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5097	Ethyl laurate		C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	106-33-2	228.371	liq	-10	271; 154 <sup>15</sup>	0.8618 <sup>20</sup>	1.4311 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth; sl ctc
5098	Ethyl levulinate		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	539-88-8	144.168			205.8	1.0111 <sup>20</sup>	1.4229 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
5099	Ethyl mercaptoacetate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	623-51-8	120.171			157	1.0964 <sup>15</sup>	1.4582 <sup>20</sup>	s EtOH, eth; sl ctc
5100	Ethyl methacrylate		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	97-63-2	114.142			117	0.9135 <sup>20</sup>	1.4147 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH, eth

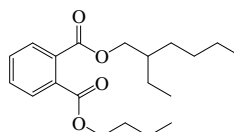




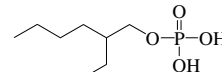
2-Ethylhexyl acrylate



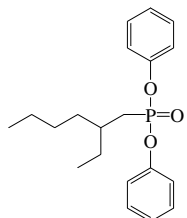
2-Ethylhexylamine



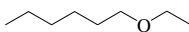
2-Ethylhexyl butyl phthalate



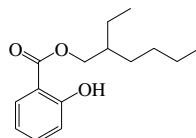
2-Ethylhexyl dihydrogen phosphate



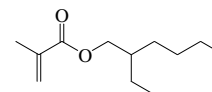
2-Ethylhexyl diphenyl phosphite



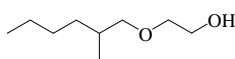
Ethyl hexyl ether



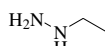
2-Ethylhexyl 2-hydroxybenzoate



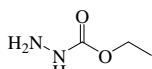
2-Ethylhexyl methacrylate



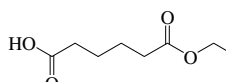
2-[(2-Ethylhexyl)oxy]ethanol



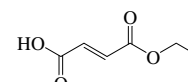
Ethylhydrazine



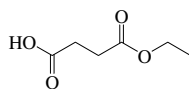
Ethyl hydrazinecarboxylate



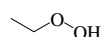
Ethyl hydrogen adipate



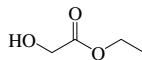
Ethyl hydrogen fumarate



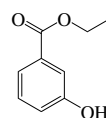
Ethyl hydrogen succinate



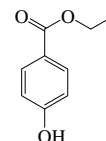
Ethyl hydroperoxide



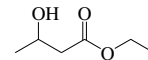
Ethyl hydroxyacetate



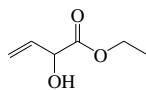
Ethyl 3-hydroxybenzoate



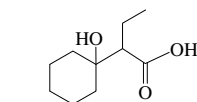
Ethyl 4-hydroxybenzoate



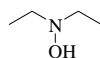
Ethyl 3-hydroxybutanoate, (±)



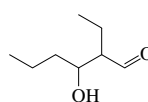
Ethyl 2-hydroxy-3-butenoate



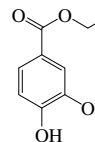
α-Ethyl-1-hydroxycyclohexaneacetic acid



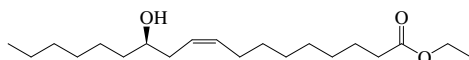
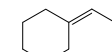
N-Ethyl-N-hydroxyethanamine



2-Ethyl-3-hydroxyhexanal



Ethyl 4-hydroxy-3-methoxybenzoate

Ethyl *cis*-12-hydroxy-9-octadecenoate, (R)

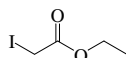
Ethylidenecyclohexane



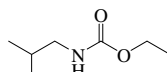
5-Ethylidene-2-norbornene



1-Ethyl-1H-imidazole



Ethyl iodoacetate



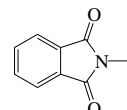
Ethyl isobutylcarbamate



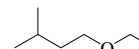
Ethyl isocyanate



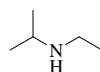
Ethyl isocyanide



N-Ethyl-1H-isoindole-1,3(2H)-dione



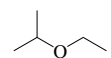
Ethyl isopentyl ether



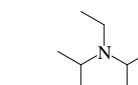
Ethylisopropylamine



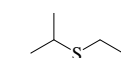
1-Ethyl-2-isopropylbenzene



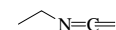
Ethyl isopropyl ether



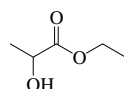
N-Ethyl-N-isopropyl-2-propanamine



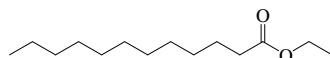
Ethyl isopropyl sulfide



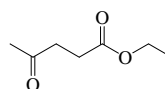
Ethyl isothiocyanate



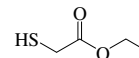
Ethyl lactate



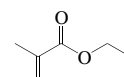
Ethyl laurate



Ethyl levulinate

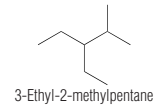
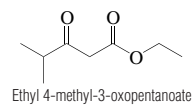
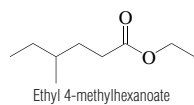
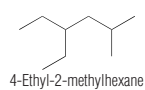
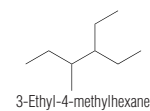
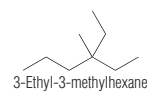
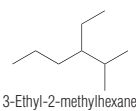
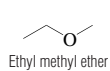
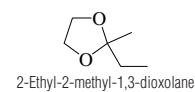
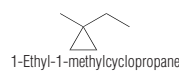
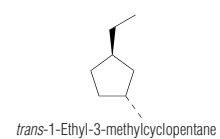
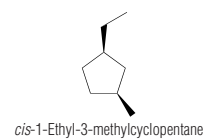
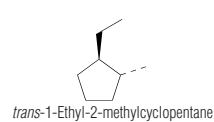
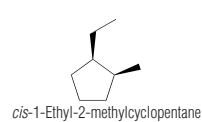
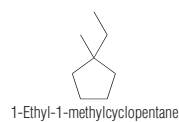
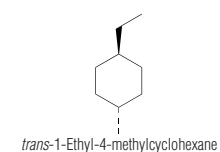
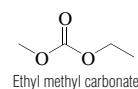
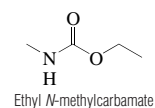
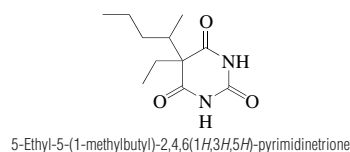
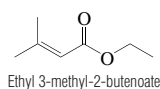
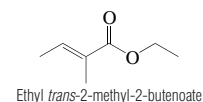
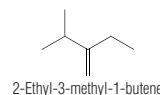
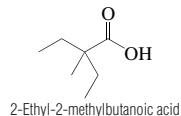
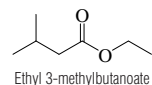
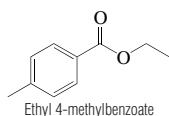
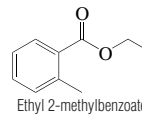
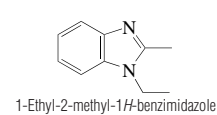
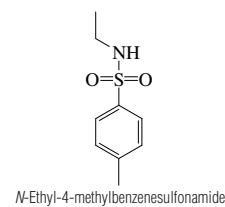
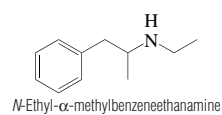
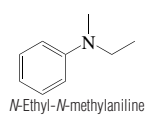
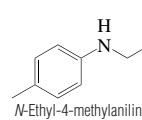
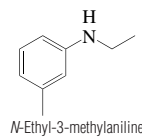
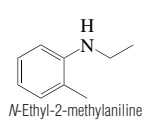
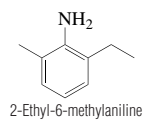
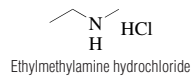
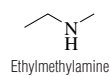
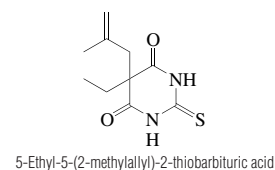
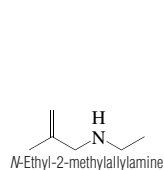
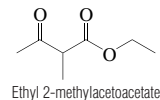
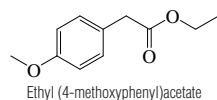
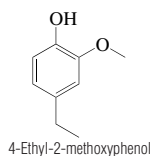
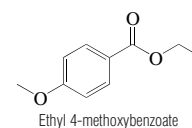
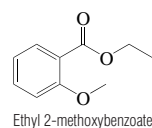
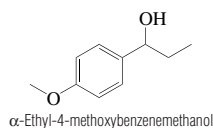
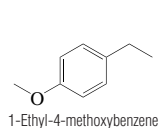
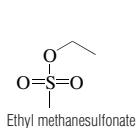


Ethyl mercaptoacetate

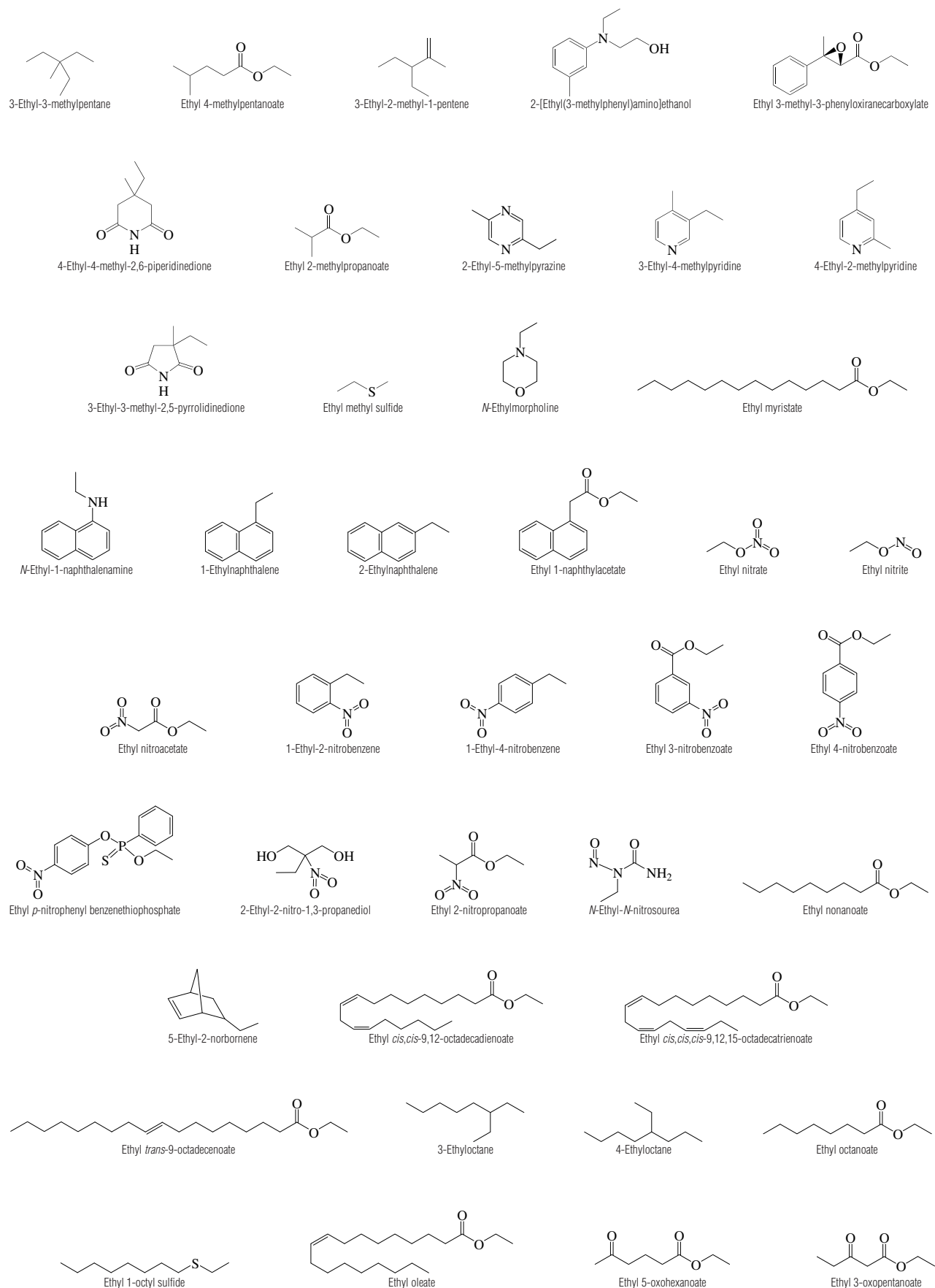


Ethyl methacrylate

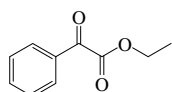
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5101	Ethyl methanesulfonate		C <sub>3</sub> H <sub>8</sub> O <sub>3</sub> S	62-50-0	124.159			86 <sup>10</sup>			
5102	1-Ethyl-4-methoxybenzene		C <sub>9</sub> H <sub>12</sub> O	1515-95-3	136.190			198	0.9624 <sup>15</sup>	1.5120 <sup>20</sup>	vs bz, eth
5103	α-Ethyl-4-methoxybenzenemethanol		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	5349-60-0	166.217			143 <sup>20</sup>		1.5277 <sup>20</sup>	s ctc
5104	Ethyl 2-methoxybenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	7335-26-4	180.200			261	1.1124 <sup>20</sup>	1.5224 <sup>20</sup>	vs eth, EtOH
5105	Ethyl 4-methoxybenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	94-30-4	180.200		7.5	269.5	1.1038 <sup>20</sup>	1.5254 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5106	4-Ethyl-2-methoxyphenol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	2785-89-9	152.190	liq	-7	236.5	1.0931 <sup>18</sup>		
5107	Ethyl (4-methoxyphenyl)acetate		C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	14062-18-1	194.227			139 <sup>70</sup>	1.097 <sup>25</sup>	1.5075 <sup>20</sup>	
5108	Ethyl 2-methylacetoacetate		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	609-14-3	144.168			187	0.9941 <sup>20</sup>	1.4185 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth; vs ace
5109	<i>N</i> -Ethyl-2-methylallylamine	<i>N</i> -Ethyl-2-methyl-2-propen-1-amine	C <sub>6</sub> H <sub>13</sub> N	18328-90-0	99.174	liq		104.7	0.753	1.4221 <sup>20</sup>	msc H <sub>2</sub> O
5110	5-Ethyl-5-(2-methylallyl)-2-thiobarbituric acid	Methallatal	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	115-56-0	226.295		160.5				
5111	Ethylmethylaniline	<i>N</i> -Methylethanamine	C <sub>8</sub> H <sub>9</sub> N	624-78-2	59.110			36.7			vs H <sub>2</sub> O, ace, eth, EtOH
5112	Ethylmethylaniline hydrochloride	<i>N</i> -Methylethanamine hydrochloride	C <sub>8</sub> H <sub>10</sub> ClN	624-60-2	95.571	pl (al-eth)	128		1.0874 <sup>20</sup>		vs H <sub>2</sub> O, EtOH; i eth; s chl
5113	2-Ethyl-6-methylaniline		C <sub>9</sub> H <sub>13</sub> N	24549-06-2	135.206	liq	-33	231	0.968 <sup>25</sup>	1.5525 <sup>20</sup>	
5114	<i>N</i> -Ethyl-2-methylaniline		C <sub>9</sub> H <sub>13</sub> N	94-68-8	135.206		<-15	216	0.948 <sup>25</sup>	1.5456 <sup>20</sup>	s EtOH, eth
5115	<i>N</i> -Ethyl-3-methylaniline		C <sub>9</sub> H <sub>13</sub> N	102-27-2	135.206			221	0.9263 <sup>15</sup>	1.5451 <sup>20</sup>	s EtOH, eth
5116	<i>N</i> -Ethyl-4-methylaniline	<i>N</i> -Ethyl-4-toluidine	C <sub>9</sub> H <sub>13</sub> N	622-57-1	135.206			217	0.9391 <sup>16</sup>		s EtOH, eth
5117	<i>N</i> -Ethyl- <i>N</i> -methylaniline		C <sub>9</sub> H <sub>13</sub> N	613-97-8	135.206			204	0.92 <sup>55</sup>		i H <sub>2</sub> O; msc EtOH, eth; s ctc
5118	<i>N</i> -Ethyl-α-methylbenzeneethanamine	<i>N</i> -Ethylamphetamine	C <sub>11</sub> H <sub>17</sub> N	457-87-4	163.260			105 <sup>14</sup>		1.4986 <sup>25</sup>	
5119	<i>N</i> -Ethyl-4-methylbenzenesulfonamide		C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub> S	80-39-7	199.270		64				s EtOH
5120	1-Ethyl-2-methyl-1 <i>H</i> -benzimidazole		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub>	5805-76-5	160.215		51	296	1.073 <sup>25</sup>		
5121	Ethyl 2-methylbenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	87-24-1	164.201		<-10	227; 113 <sup>18</sup>	1.0325 <sup>21</sup>	1.507 <sup>22</sup>	i H <sub>2</sub> O; msc EtOH, eth
5122	Ethyl 4-methylbenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	94-08-6	164.201			232	1.0269 <sup>18</sup>	1.5089 <sup>18</sup>	i H <sub>2</sub> O; msc EtOH, eth
5123	Ethyl 3-methylbutanoate	Ethyl isovalerate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	108-64-5	130.185	liq	-99.3	135.0	0.8656 <sup>20</sup>	1.3962 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
5124	2-Ethyl-2-methylbutanoic acid		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	19889-37-3	130.185		<-20	207		1.4250 <sup>20</sup>	vs EtOH
5125	2-Ethyl-3-methyl-1-butene		C <sub>7</sub> H <sub>14</sub>	7357-93-9	98.186			89	0.7150 <sup>20</sup>	1.410 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl
5126	Ethyl <i>trans</i> -2-methyl-2-butenolate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	5837-78-5	128.169			156	0.9200 <sup>20</sup>	1.4340 <sup>20</sup>	
5127	Ethyl 3-methyl-2-butenolate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	638-10-8	128.169			153.5	0.9199 <sup>21</sup>	1.4345 <sup>20</sup>	
5128	5-Ethyl-5-(1-methylbutyl)-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione		C <sub>11</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	76-74-4	226.272		130				sl H <sub>2</sub> O; s EtOH, eth
5129	Ethyl <i>N</i> -methylcarbamate		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	105-40-8	103.120			170	1.0115 <sup>20</sup>	1.4183 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
5130	Ethyl methyl carbonate		C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	623-53-0	104.105	liq	-14	107.5	1.012 <sup>20</sup>	1.3778 <sup>20</sup>	vs eth, EtOH
5131	<i>trans</i> -1-Ethyl-4-methylcyclohexane		C <sub>8</sub> H <sub>18</sub>	6236-88-0	126.239	liq	-80.8	149	0.7798 <sup>20</sup>	1.4304 <sup>20</sup>	
5132	1-Ethyl-1-methylcyclopentane		C <sub>8</sub> H <sub>16</sub>	16747-50-5	112.213	liq	-143.8	121.6	0.7767 <sup>25</sup>	1.4272 <sup>20</sup>	vs ace, bz, eth, EtOH
5133	<i>cis</i> -1-Ethyl-2-methylcyclopentane		C <sub>8</sub> H <sub>16</sub>	930-89-2	112.213	liq	-106	128	0.7852 <sup>20</sup>	1.4293 <sup>20</sup>	
5134	<i>trans</i> -1-Ethyl-2-methylcyclopentane		C <sub>8</sub> H <sub>16</sub>	930-90-5	112.213	liq	-105.9	121.2	0.7649 <sup>25</sup>	1.4219 <sup>20</sup>	
5135	<i>cis</i> -1-Ethyl-3-methylcyclopentane		C <sub>8</sub> H <sub>16</sub>	2613-66-3	112.213			121	0.7724 <sup>20</sup>	1.4203 <sup>20</sup>	vs ace, bz, eth, EtOH
5136	<i>trans</i> -1-Ethyl-3-methylcyclopentane		C <sub>8</sub> H <sub>16</sub>	2613-65-2	112.213	liq	-108	121	0.7619 <sup>20</sup>	1.4186 <sup>20</sup>	
5137	1-Ethyl-1-methylcyclopropane		C <sub>6</sub> H <sub>12</sub>	53778-43-1	84.159	liq	-130.2	56.8	0.6968 <sup>25</sup>	1.3887 <sup>20</sup>	
5138	2-Ethyl-2-methyl-1,3-dioxolane		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	126-39-6	116.158			118	0.9360 <sup>20</sup>		
5139	Ethyl methyl ether		C <sub>3</sub> H <sub>8</sub> O	540-67-0	60.095	col gas	-113	7.4	0.7251 <sup>10</sup>	1.3420 <sup>4</sup>	s H <sub>2</sub> O, ace, chl; msc EtOH, eth
5140	3-Ethyl-2-methylhexane		C <sub>9</sub> H <sub>20</sub>	16789-46-1	128.255			138	0.7310 <sup>20</sup>	1.4106 <sup>20</sup>	
5141	3-Ethyl-3-methylhexane		C <sub>9</sub> H <sub>20</sub>	3074-76-8	128.255			140.6	0.7371 <sup>25</sup>	1.4140 <sup>20</sup>	
5142	3-Ethyl-4-methylhexane	2,3-Diethylpentane	C <sub>9</sub> H <sub>20</sub>	3074-77-9	128.255			140	0.7420 <sup>20</sup>	1.4134 <sup>20</sup>	
5143	4-Ethyl-2-methylhexane		C <sub>9</sub> H <sub>20</sub>	3074-75-7	128.255			133.8	0.7195 <sup>25</sup>	1.4063 <sup>20</sup>	
5144	Ethyl 4-methylhexanoate	Ethyl 4-methylcaproate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	1561-10-0	158.238			180	0.8708 <sup>20</sup>	1.4051 <sup>20</sup>	
5145	Ethyl 4-methyl-3-oxopentanoate		C <sub>9</sub> H <sub>16</sub> O <sub>3</sub>	7152-15-0	158.195	liq	-9	173	0.98 <sup>25</sup>	1.250 <sup>20</sup>	
5146	3-Ethyl-2-methylpentane		C <sub>8</sub> H <sub>18</sub>	609-26-7	114.229	liq	-114.9	115.66	0.7193 <sup>20</sup>	1.4040 <sup>20</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz



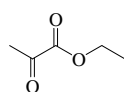
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5147	3-Ethyl-3-methylpentane		C <sub>8</sub> H <sub>18</sub>	1067-08-9	114.229	liq	-90.9	118.27	0.7274 <sup>20</sup>	1.4078 <sup>20</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz
5148	Ethyl 4-methylpentanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	25415-67-2	144.212			163; 52 <sup>10</sup>	0.8705 <sup>20</sup>	1.4050 <sup>20</sup>	
5149	3-Ethyl-2-methyl-1-pentene		C <sub>8</sub> H <sub>16</sub>	19780-66-6	112.213	liq	-112.9	109.5	0.7262 <sup>20</sup>	1.4140 <sup>20</sup>	
5150	2-[Ethyl(3-methylphenyl)amino] ethanol		C <sub>11</sub> H <sub>17</sub> NO	91-88-3	179.259			118 <sup>1.5</sup>		1.5540 <sup>20</sup>	s ctc
5151	Ethyl 3-methyl-3-phenyloxiranecarboxylate	Ethyl 3-methyl-3-phenylglycidate	C <sub>12</sub> H <sub>14</sub> O <sub>3</sub>	77-83-8	206.237			273.5	1.044 <sup>20</sup>	1.5182 <sup>20</sup>	
5152	4-Ethyl-4-methyl-2,6-piperidinedione	Bemegrade	C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	64-65-3	155.195	pl (w. ace-eth)	126.5	sub 100			s chl
5153	Ethyl 2-methylpropanoate	Ethyl isobutanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	97-62-1	116.158	liq	-88.2	110.1	0.868 <sup>20</sup>	1.3869 <sup>18</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
5154	2-Ethyl-5-methylpyrazine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	13360-64-0	122.167	liq		79 <sup>25</sup>			
5155	3-Ethyl-4-methylpyridine	3-Ethyl-4-picoline	C <sub>8</sub> H <sub>11</sub> N	529-21-5	121.180			198	0.9286 <sup>17</sup>		sl H <sub>2</sub> O; s EtOH, eth, chl; vs ace
5156	4-Ethyl-2-methylpyridine	4-Ethyl-2-picoline	C <sub>8</sub> H <sub>11</sub> N	536-88-9	121.180			179	0.9130 <sup>25</sup>		vs ace, bz, eth, EtOH
5157	3-Ethyl-3-methyl-2,5-pyrrolidinedione	Ethosuximide	C <sub>7</sub> H <sub>11</sub> NO <sub>2</sub>	77-67-8	141.168	cry (ace-eth)	64.5				vs H <sub>2</sub> O
5158	Ethyl methyl sulfide		C <sub>3</sub> H <sub>8</sub> S	624-89-5	76.161	liq	-105.93	66.7	0.8422 <sup>20</sup>	1.4404 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth, chl
5159	<i>N</i> -Ethylmorpholine		C <sub>6</sub> H <sub>13</sub> NO	100-74-3	115.173			138.5	0.8996 <sup>20</sup>	1.4400 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, bz
5160	Ethyl myristate		C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	124-06-1	256.424		12.3	295	0.8573 <sup>25</sup>	1.4362 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc, lig; sl eth
5161	<i>N</i> -Ethyl-1-naphthalenamine		C <sub>12</sub> H <sub>13</sub> N	118-44-5	171.238			305; 191 <sup>16</sup>	1.0652 <sup>15</sup>	1.6477 <sup>15</sup>	vs eth, EtOH
5162	1-Ethynaphthalene		C <sub>12</sub> H <sub>12</sub>	1127-76-0	156.223	liq	-13.9	258.6	1.0082 <sup>20</sup>	1.6062 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
5163	2-Ethynaphthalene		C <sub>12</sub> H <sub>12</sub>	939-27-5	156.223	liq	-7.4	258	0.9922 <sup>20</sup>	1.5999 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl chl
5164	Ethyl 1-naphthylacetate		C <sub>14</sub> H <sub>16</sub> O <sub>2</sub>	2122-70-5	214.260	oil	88.5	222 <sup>20</sup> , 118 <sup>13</sup>			s EtOH, eth
5165	Ethyl nitrate		C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	625-58-1	91.066	liq	-94.6	87.2	1.1084 <sup>20</sup>	1.3852 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth
5166	Ethyl nitrite		C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	109-95-5	75.067	ye vol liq or gas		18	0.899 <sup>15</sup>	1.3418 <sup>10</sup>	msc EtOH, eth
5167	Ethyl nitroacetate		C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	626-35-7	133.104			106 <sup>25</sup> , 83 <sup>6</sup>	1.1953 <sup>20</sup>	1.4250 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; vs eth; s dil alk
5168	1-Ethyl-2-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	612-22-6	151.163	liq	-12.3	232.5	1.1207 <sup>20</sup>	1.5356 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace; sl ctc
5169	1-Ethyl-4-nitrobenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	100-12-9	151.163	liq	-12.3	245.5	1.1192 <sup>20</sup>	1.5455 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace; sl ctc
5170	Ethyl 3-nitrobenzoate		C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	618-98-4	195.172		47	297			i H <sub>2</sub> O; vs EtOH, eth
5171	Ethyl 4-nitrobenzoate		C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	99-77-4	195.172		57	186.3; 153 <sup>8</sup>			i H <sub>2</sub> O; s EtOH, eth
5172	Ethyl <i>p</i> -nitrophenyl benzenethiophosphate		C <sub>14</sub> H <sub>14</sub> NO <sub>4</sub> PS	2104-64-5	323.304		36		1.27 <sup>25</sup>	1.5978 <sup>30</sup>	vs bz, eth, EtOH
5173	2-Ethyl-2-nitro-1,3-propanediol		C <sub>5</sub> H <sub>11</sub> NO <sub>4</sub>	597-09-1	149.146	nd (w)	57.5	dec			vs H <sub>2</sub> O, eth, EtOH
5174	Ethyl 2-nitropropanoate		C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	2531-80-8	147.130			190.5		1.4210 <sup>20</sup>	vs bz, eth, EtOH
5175	<i>N</i> -Ethyl- <i>N</i> -nitroso- <i>N</i> -ethylurea	<i>N</i> -Nitroso- <i>N</i> -ethylurea	C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	759-73-9	117.107		100	dec			s chl
5176	Ethyl nonanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	123-29-5	186.292	liq	-36.7	227.0	0.8657 <sup>20</sup>	1.4220 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc
5177	5-Ethyl-2-norbornene		C <sub>9</sub> H <sub>14</sub>	15403-89-1	122.207	liq		143.6	0.86	1.4630 <sup>20</sup>	
5178	Ethyl <i>cis,cis</i> -9,12-octadecadienoate	Ethyl linoleate	C <sub>20</sub> H <sub>36</sub> O <sub>2</sub>	544-35-4	308.499	ye or col		272 <sup>180</sup> , 212 <sup>12</sup>	0.8865 <sup>20</sup>		vs eth, EtOH
5179	Ethyl <i>cis,cis,cis</i> -9,12,15-octadecatrienoate	Ethyl linolenate	C <sub>20</sub> H <sub>34</sub> O <sub>2</sub>	1191-41-9	306.483			218 <sup>15</sup>	0.8919 <sup>20</sup>	1.4694 <sup>20</sup>	vs eth, EtOH
5180	Ethyl <i>trans</i> -9-octadecenoate		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	6114-18-7	310.515		5.8	218 <sup>15</sup>	0.8664 <sup>25</sup>	1.4480 <sup>25</sup>	vs eth, EtOH
5181	3-Ethyl-octane		C <sub>10</sub> H <sub>22</sub>	5881-17-4	142.282			166.5	0.7359 <sup>25</sup>	1.4156 <sup>20</sup>	
5182	4-Ethyl-octane		C <sub>10</sub> H <sub>22</sub>	15869-86-0	142.282			163.7	0.7343 <sup>25</sup>	1.4151 <sup>20</sup>	
5183	Ethyl octanoate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	106-32-1	172.265	liq	-43.1	208.5	0.866 <sup>18</sup>	1.4178 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
5184	Ethyl 1-octyl sulfide	1-(Ethylthio)octane	C <sub>10</sub> H <sub>22</sub> S	3698-94-0	174.347	liq		109 <sup>14</sup>			
5185	Ethyl oleate	Ethyl <i>cis</i> -9-octadecenoate	C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	111-62-6	310.515			216 <sup>15</sup> , 207 <sup>13</sup>	0.8720 <sup>20</sup>	1.4515 <sup>20</sup>	vs eth, EtOH
5186	Ethyl 5-oxohexanoate		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	13984-57-1	158.195			221.5	0.989 <sup>25</sup>	1.4277 <sup>20</sup>	
5187	Ethyl 3-oxopentanoate		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	4949-44-4	144.168			191	1.0120 <sup>20</sup>	1.4230 <sup>20</sup>	vs bz, eth, EtOH



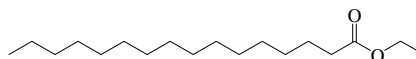
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5188	Ethyl 2-oxo-2-phenylacetate	Ethyl phenylglyoxylate	C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	1603-79-8	178.184			256.5	1.1222 <sup>25</sup>	1.5190 <sup>25</sup>	
5189	Ethyl 2-oxopropanoate	Ethyl pyruvate	C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	617-35-6	116.116	liq	-50	155	1.0596 <sup>15</sup>	1.4052 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
5190	Ethyl palmitate		C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	628-97-7	284.478	nd	24	191 <sup>10</sup>	0.8577 <sup>25</sup>	1.4347 <sup>34</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
5191	3-Ethylpentane		C <sub>7</sub> H <sub>16</sub>	617-78-7	100.202	liq	-118.55	93.5	0.6982 <sup>20</sup>	1.3934 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, hp, chl
5192	3-Ethyl-2,4-pentanedione		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	1540-34-7	128.169			178.5	0.9531 <sup>19</sup>	1.4408 <sup>19</sup>	vs eth, EtOH, chl
5193	Ethyl pentanoate	Ethyl valerate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	539-82-2	130.185	liq	-91.2	146.1	0.8770 <sup>20</sup>	1.4120 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
5194	3-Ethyl-3-pentanol		C <sub>7</sub> H <sub>16</sub> O	597-49-9	116.201	liq	-12.5	142	0.8407 <sup>22</sup>	1.4294 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
5195	2-Ethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	3404-71-5	98.186			94	0.7079 <sup>20</sup>	1.405 <sup>20</sup>	vs bz, eth, EtOH
5196	3-Ethyl-1-pentene		C <sub>7</sub> H <sub>14</sub>	4038-04-4	98.186	liq	-127.5	84.1	0.6917 <sup>25</sup>	1.3982 <sup>20</sup>	
5197	3-Ethyl-2-pentene		C <sub>7</sub> H <sub>14</sub>	816-79-5	98.186			96	0.7204 <sup>20</sup>	1.4148 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
5198	Ethyl pentyl ether		C <sub>7</sub> H <sub>16</sub> O	17952-11-3	116.201			117.6	0.7622 <sup>20</sup>	1.3927 <sup>20</sup>	vs eth, EtOH
5199	Ethyl 2-pentynoate		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	55314-57-3	126.153			67 <sup>18</sup>	0.962 <sup>25</sup>		
5200	2-Ethylphenol		C <sub>8</sub> H <sub>10</sub> O	90-00-6	122.164		18	204.5	1.0146 <sup>25</sup>	1.5367 <sup>20</sup>	vs ace, bz, eth, EtOH
5201	3-Ethylphenol		C <sub>8</sub> H <sub>10</sub> O	620-17-7	122.164	liq	-4	218.4	1.0283 <sup>20</sup>		sl H <sub>2</sub> O, chl; vs EtOH, eth
5202	4-Ethylphenol		C <sub>8</sub> H <sub>10</sub> O	123-07-9	122.164	nd	45.0	217.9		1.5239 <sup>25</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth, bz; s ace
5203	Ethyl phenoxyacetate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	2555-49-9	180.200			247; 110 <sup>3</sup>	1.0958 <sup>30</sup>	1.5080 <sup>20</sup>	
5204	<i>N</i> -Ethyl- <i>N</i> -phenylacetamide		C <sub>10</sub> H <sub>13</sub> NO	529-65-7	163.216		55	260	0.9938 <sup>60</sup>		s H <sub>2</sub> O, eth, ctc
5205	Ethyl phenylacetate	Benzeneacetic acid, ethyl ester	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	101-97-3	164.201	liq	-29.4	227	1.0333 <sup>20</sup>	1.4980 <sup>20</sup>	vs eth, EtOH
5206	2-(Ethylphenylamino)ethanol		C <sub>10</sub> H <sub>15</sub> NO	92-50-2	165.232						s chl
5207	Ethyl phenylcarbamate	Phenylurethane	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	101-99-5	165.189	wh nd (w) pl (dil al)	53	dec 237	1.1064 <sup>30</sup>	1.5376 <sup>30</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz; sl ctc
5208	Ethyl <i>N</i> -phenylformimidate		C <sub>9</sub> H <sub>11</sub> NO	6780-49-0	149.189			214; 87 <sup>10</sup>	1.0051 <sup>20</sup>	1.5279 <sup>20</sup>	s eth, bz
5209	Ethyl <i>N</i> -phenylglycinate		C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	2216-92-4	179.216	lf (dil al)	58	273.5			vs eth, EtOH
5210	1-(4-Ethylphenyl)-2-phenylethane		C <sub>16</sub> H <sub>18</sub>	7439-15-8	210.314	cry		294	1.028 <sup>50</sup>		
5211	Ethyl 3-phenylpropanoate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	2021-28-5	178.228			247.2	1.0147 <sup>20</sup>	1.4954 <sup>20</sup>	vs eth, EtOH
5212	Ethyl 3-phenylpropynoate	Ethyl phenylacetylenecarboxylate	C <sub>11</sub> H <sub>10</sub> O <sub>2</sub>	2216-94-6	174.196			265; 128 <sup>1,6</sup>	1.055 <sup>25</sup>	1.5520 <sup>20</sup>	s eth
5213	Ethyl phenyl sulfone		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub> S	599-70-2	170.229	lf (dil al)	42	160 <sup>12</sup>	1.1410 <sup>20</sup>		vs bz, eth, EtOH, chl
5214	Ethylphosphonic acid		C <sub>2</sub> H <sub>5</sub> O <sub>3</sub> P	6779-09-5	110.049	hyg pl or nd	61.5	335 <sup>8</sup>			vs H <sub>2</sub> O, eth, EtOH
5215	Ethyl phosphorodichloridate	Ethylphosphoric acid dichloride	C <sub>2</sub> H <sub>5</sub> Cl <sub>2</sub> O <sub>2</sub> P	1498-51-7	162.940			62 <sup>10</sup>		1.4338 <sup>20</sup>	
5216	5-Ethyl-2-picoline		C <sub>8</sub> H <sub>11</sub> N	104-90-5	121.180			178.3	0.9202 <sup>20</sup>	1.4971 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz; vs ace
5217	Ethyl 1-piperazinecarboxylate	1-Carboxypiperazine	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	120-43-4	158.198			237		1.4760 <sup>25</sup>	vs H <sub>2</sub> O, eth, EtOH
5218	1-Ethylpiperidine		C <sub>7</sub> H <sub>15</sub> N	766-09-6	113.201			130.8	0.8237 <sup>20</sup>	1.4480 <sup>20</sup>	
5219	Ethyl 4-piperidinecarboxylate		C <sub>8</sub> H <sub>15</sub> NO <sub>2</sub>	1126-09-6	157.211	col oil		100 <sup>10</sup>		1.4591 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
5220	Ethyl 1-piperidinepropanoate		C <sub>10</sub> H <sub>19</sub> NO <sub>2</sub>	19653-33-9	185.264			217; 139 <sup>50</sup>	0.9627 <sup>25</sup>	1.4525 <sup>25</sup>	vs H <sub>2</sub> O
5221	1-Ethyl-3-piperidinol		C <sub>7</sub> H <sub>15</sub> NO	13444-24-1	129.200			94 <sup>15</sup>		1.4777 <sup>14</sup>	
5222	<i>N</i> -Ethyl-1-propanamine		C <sub>6</sub> H <sub>13</sub> N	20193-20-8	87.164			81	0.7204 <sup>17</sup>	1.3858 <sup>25</sup>	sl H <sub>2</sub> O; vs ace, EtOH
5223	Ethylpropanedioic acid		C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	601-75-2	132.116	pr (w+1)	114	180 <sup>0,15</sup>			vs H <sub>2</sub> O; s EtOH, eth, bz; i ace; sl tfa
5224	Ethyl propanoate	Ethyl propionate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	105-37-3	102.132	liq	-73.9	99.1	0.8843 <sup>25</sup>	1.3839 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
5225	Ethyl propyl ether		C <sub>5</sub> H <sub>12</sub> O	628-32-0	88.148	liq	-127.5	63.21	0.7386 <sup>20</sup>	1.3695 <sup>20</sup>	vs eth, EtOH, HOAc
5226	2-(1-Ethylpropyl)pyridine		C <sub>10</sub> H <sub>15</sub> N	7399-50-0	149.233			195.4	0.8981 <sup>20</sup>	1.4850 <sup>25</sup>	
5227	4-(1-Ethylpropyl)pyridine		C <sub>10</sub> H <sub>15</sub> N	35182-51-5	149.233		125.5	217; 80 <sup>12</sup>	0.9085 <sup>25</sup>	1.40905 <sup>25</sup>	
5228	Ethyl propyl sulfide		C <sub>5</sub> H <sub>12</sub> S	4110-50-3	104.214	liq	-117	118.6	0.8370 <sup>20</sup>	1.4462 <sup>20</sup>	s EtOH
5229	Ethyl 2-propynoate	(Ethoxycarbonyl)acetylene	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	623-47-2	98.101			120	0.9645 <sup>16</sup>	1.4105 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl
5230	2-Ethylpyrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	13925-00-3	108.141			112 <sup>200</sup>			
5231	2-Ethylpyridine		C <sub>7</sub> H <sub>9</sub> N	100-71-0	107.153	liq	-63.1	148.6	0.9502 <sup>25</sup>	1.4964 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH; vs eth, ace; sl ctc



Ethyl 2-oxo-2-phenylacetate



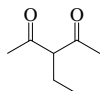
Ethyl 2-oxopropanoate



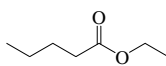
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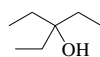
3-Ethylpentane



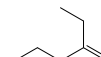
3-Ethyl-2,4-pentanedione



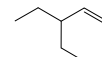
Ethyl pentanoate



3-Ethyl-3-pentanol



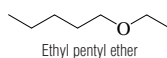
2-Ethyl-1-pentene



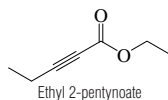
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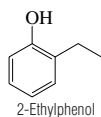
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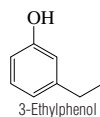
Ethyl pentyl ether



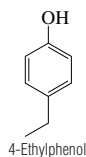
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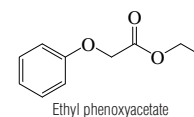
2-Ethylphenol



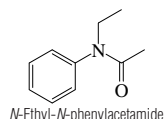
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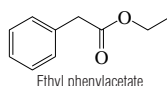
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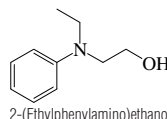
Ethyl phenoxyacetate



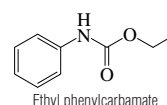
N-Ethyl-N-phenylacetamide



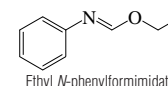
Ethyl phenylacetate



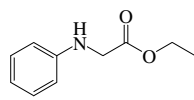
2-(Ethylphenylamino)ethanol



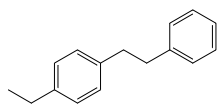
Ethyl phenylcarbamate



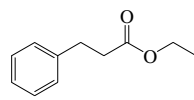
Ethyl N-phenylformimidate



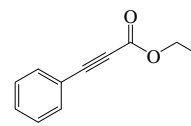
Ethyl N-phenylglycinate



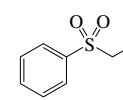
1-(4-Ethylphenyl)-2-phenylethane



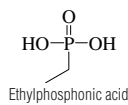
Ethyl 3-phenylpropanoate



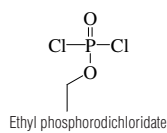
Ethyl 3-phenylpropynoate



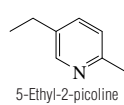
Ethyl phenyl sulfone



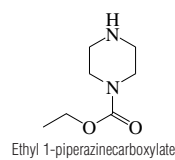
Ethylphosphonic acid



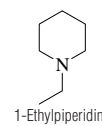
Ethyl phosphorodichloridate



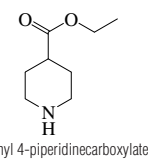
5-Ethyl-2-picoline



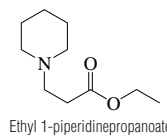
Ethyl 1-piperazinecarboxylate



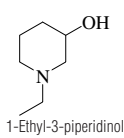
1-Ethylpiperidine



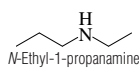
Ethyl 4-piperidinecarboxylate



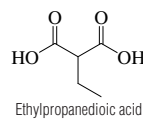
Ethyl 1-piperidinepropanoate



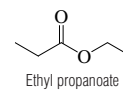
1-Ethyl-3-piperidinol



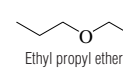
N-Ethyl-1-propanamine



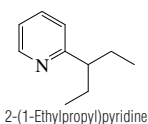
Ethylpropanedioic acid



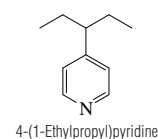
Ethyl propanoate



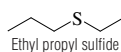
Ethyl propyl ether



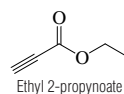
2-(1-Ethylpropyl)pyridine



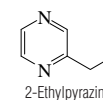
4-(1-Ethylpropyl)pyridine



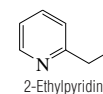
Ethyl propyl sulfide



Ethyl 2-propynoate



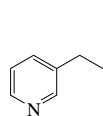
2-Ethylpyrazine



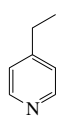
2-Ethylpyridine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5232	3-Ethylpyridine		C <sub>7</sub> H <sub>9</sub> N	536-78-7	107.153	liq	-76.9	165	0.9539 <sup>25</sup>	1.5021 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; vs ace; sl ctc
5233	4-Ethylpyridine		C <sub>7</sub> H <sub>9</sub> N	536-75-4	107.153	liq	-90.5	168.3	0.9417 <sup>20</sup>	1.5009 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; vs ace; sl ctc
5234	2-Ethyl-4-pyridinecarbothioamide	Ethionamide	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> S	536-33-4	166.243		163				
5235	Ethyl 2-pyridinecarboxylate	Ethyl 2-picolinate	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	2524-52-9	151.163	ye cry in air	1	243	1.1194 <sup>20</sup>	1.5104 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5236	Ethyl 3-pyridinecarboxylate	Ethyl nicotinate	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	614-18-6	151.163		8.5	224	1.1070 <sup>20</sup>	1.5024 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth, bz; sl ctc
5237	Ethyl 4-pyridinecarboxylate		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	1570-45-2	151.163		23	219.5	1.0091 <sup>15</sup>	1.5017 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, bz; vs eth, chl
5238	<i>N</i> -Ethylpyridinium bromide		C <sub>7</sub> H <sub>10</sub> BrN	1906-79-2	188.065	cry (al)	111.5				s H <sub>2</sub> O, EtOH; i eth
5239	1-Ethyl-1 <i>H</i> -pyrrole		C <sub>6</sub> H <sub>9</sub> N	617-92-5	95.142			129.5	0.9009 <sup>20</sup>	1.4841 <sup>20</sup>	vs EtOH
5240	1-Ethyl-1 <i>H</i> -pyrrole-2,5-dione	<i>N</i> -Ethylmaleimide	C <sub>6</sub> H <sub>7</sub> NO <sub>2</sub>	128-53-0	125.126	cry (bz)	45.5				sl H <sub>2</sub> O; vs EtOH, eth; s chl
5241	1-Ethyl-2-pyrrolidinemethanamine		C <sub>7</sub> H <sub>13</sub> N <sub>2</sub>	26116-12-1	128.215			59 <sup>16</sup> , 40 <sup>10</sup>	0.887 <sup>25</sup>	1.4665 <sup>20</sup>	
5242	Ethyl Red	2-(4-Diethylaminophenylazo) benzoic acid	C <sub>17</sub> H <sub>19</sub> N <sub>3</sub> O <sub>2</sub>	76058-33-8	297.352		135				
5243	Ethyl salicylate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	118-61-6	166.173		45	150 <sup>10</sup>	1.1326 <sup>20</sup>	1.5296 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; vs eth; s ctc
5244	Ethyl silicate		C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si	78-10-4	208.329	liq	-82.5	168.8	0.9320 <sup>20</sup>	1.3928 <sup>20</sup>	dec H <sub>2</sub> O
5245	Ethyl stearate	Ethyl octadecanoate	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	111-61-5	312.531		33	199 <sup>10</sup>	1.057 <sup>20</sup>	1.4349 <sup>40</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; vs ace
5246	2-Ethylstyrene		C <sub>10</sub> H <sub>12</sub>	7564-63-8	132.202	liq	-75.5	187.3; 68 <sup>12</sup>	0.9017 <sup>25</sup>	1.5380 <sup>20</sup>	
5247	3-Ethylstyrene		C <sub>10</sub> H <sub>12</sub>	7525-62-4	132.202	liq	-101	190.0	0.8945 <sup>20</sup>	1.5351 <sup>20</sup>	
5248	4-Ethylstyrene		C <sub>10</sub> H <sub>12</sub>	3454-07-7	132.202	liq	-49.7	192.3; 86 <sup>20</sup>	0.8884 <sup>25</sup>	1.5376 <sup>20</sup>	
5249	Ethyl sulfate		C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	540-82-9	126.132			dec 280	1.3657 <sup>20</sup>	1.4105 <sup>20</sup>	vs H <sub>2</sub> O
5250	2-(Ethylsulfonyl)ethanol	Ethylsulfonylethyl alcohol	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub> S	513-12-2	138.185						sl chl
5251	2-Ethyl-5-(3-sulfophenyl)isoxazolium hydroxide, inner salt	Woodward's Reagent K	C <sub>11</sub> H <sub>11</sub> NO <sub>4</sub> S	4156-16-5	253.275		dec 207				
5252	Ethyl tartrate	Ethyl tartrate, acid	C <sub>8</sub> H <sub>10</sub> O <sub>6</sub>	608-89-9	178.139		90				vs H <sub>2</sub> O, EtOH
5253	2-Ethyltetrahydrofuran		C <sub>6</sub> H <sub>12</sub> O	1003-30-1	100.158			109	0.8570 <sup>19</sup>	1.4147 <sup>19</sup>	vs ace, bz, eth, EtOH
5254	5-Ethyl-1,3,4-thiadiazol-2-amine		C <sub>4</sub> H <sub>6</sub> N <sub>3</sub> S	14068-53-2	129.184		200.8				
5255	<i>S</i> -Ethyl thioacetate		C <sub>4</sub> H <sub>8</sub> OS	625-60-5	104.171			116.4	0.9792 <sup>20</sup>	1.4583 <sup>21</sup>	i H <sub>2</sub> O; vs EtOH, eth
5256	(Ethylthio)acetic acid		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	627-04-3	120.171		-8.5	164 <sup>83</sup> , 109 <sup>5</sup>	1.1497 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, eth
5257	(Ethylthio)benzene	Thiophenetole	C <sub>8</sub> H <sub>10</sub> S	622-38-8	138.230			205	1.0211 <sup>20</sup>	1.5670 <sup>20</sup>	s EtOH
5258	Ethyl thiocyanate		C <sub>3</sub> H <sub>5</sub> NS	542-90-5	87.144	liq	-85.5	146	1.007 <sup>23</sup>	1.4684 <sup>15</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
5259	2-(Ethylthio)ethanol		C <sub>4</sub> H <sub>10</sub> OS	110-77-0	106.186	liq	-100	184	1.0166 <sup>20</sup>	1.4867 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH; vs ace
5260	1-(Ethylthio)-4-methylbenzene		C <sub>9</sub> H <sub>12</sub> S	622-63-9	152.256			220	0.9996 <sup>20</sup>	1.555 <sup>20</sup>	
5261	2-Ethylthiophene		C <sub>6</sub> H <sub>8</sub> S	872-55-9	112.193			134	0.9930 <sup>20</sup>	1.5122 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
5262	Ethyl thiophene-2-carboxylate		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub> S	2810-04-0	156.203			218	1.1623 <sup>16</sup>	1.5248 <sup>20</sup>	s EtOH, ace; sl ctc
5263	3-Ethyl-2-thioxo-4-thiazolidinone	3-Ethylrhodanine	C <sub>8</sub> H <sub>9</sub> NOS <sub>2</sub>	7648-01-3	161.246		35.5				
5264	2-Ethyltoluene		C <sub>9</sub> H <sub>12</sub>	611-14-3	120.191	liq	-79.83	165.2	0.8807 <sup>20</sup>	1.5046 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
5265	3-Ethyltoluene		C <sub>9</sub> H <sub>12</sub>	620-14-4	120.191	liq	-95.6	161.3	0.8645 <sup>20</sup>	1.4966 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc ace, bz
5266	4-Ethyltoluene		C <sub>9</sub> H <sub>12</sub>	622-96-8	120.191	liq	-62.35	162	0.8614 <sup>20</sup>	1.4959 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc ace, bz
5267	Ethyl <i>p</i> -toluenesulfonate		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub> S	80-40-0	200.254		34.5	173 <sup>15</sup>	1.166 <sup>48</sup>		i H <sub>2</sub> O; s EtOH, eth, AcOEt; sl ctc
5268	Ethyl trichloroacetate		C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>2</sub>	515-84-4	191.441			167.5	1.3836 <sup>20</sup>	1.4505 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl chl
5269	Ethyl trifluoroacetate		C <sub>4</sub> H <sub>5</sub> F <sub>3</sub> O <sub>2</sub>	383-63-1	142.077			61	1.194 <sup>20</sup>	1.308 <sup>20</sup>	
5270	Ethyl 4,4,4-trifluoroacetate		C <sub>6</sub> H <sub>7</sub> F <sub>3</sub> O <sub>3</sub>	372-31-6	184.113	liq	-39.1	132	1.2586 <sup>15</sup>	1.3783 <sup>15</sup>	s EtOH, eth
5271	Ethyl trifluoromethanesulfonate		C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> O <sub>3</sub> S	425-75-2	178.130			115	1.3740 <sup>9</sup>		s eth
5272	Ethyl 3,4,5-trihydroxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>5</sub>	831-61-8	198.172	mcl pr (w+2 1/2) nd (chl)	163.0				sl H <sub>2</sub> O, chl; s EtOH, eth, AcOEt

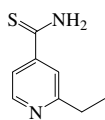




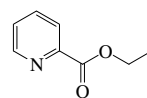
3-Ethylpyridine



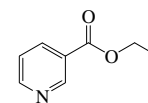
4-Ethylpyridine



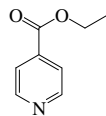
2-Ethyl-4-pyridinecarbothioamide



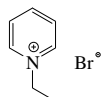
Ethyl 2-pyridinecarboxylate



Ethyl 3-pyridinecarboxylate



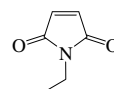
Ethyl 4-pyridinecarboxylate



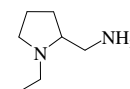
N-Ethylpyridinium bromide



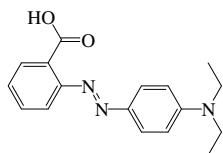
1-Ethyl-1H-pyrrole



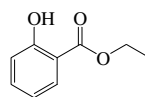
1-Ethyl-1H-pyrrole-2,5-dione



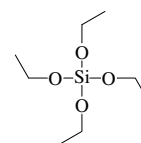
1-Ethyl-2-pyrrolidinemethanamine



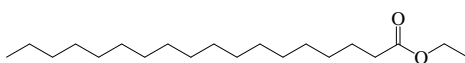
Ethyl Red



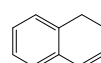
Ethyl salicylate



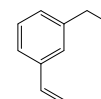
Ethyl silicate



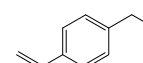
Ethyl stearate



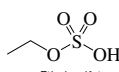
2-Ethylstyrene



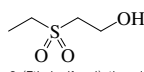
3-Ethylstyrene



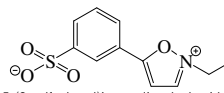
4-Ethylstyrene



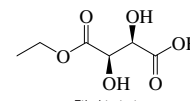
Ethyl sulfate



2-(Ethylsulfonyl)ethanol



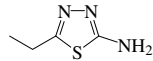
2-Ethyl-5-(3-sulfonylphenyl)isoxazolium hydroxide, inner salt



Ethyl tartrate



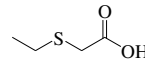
2-Ethyltetrahydrofuran



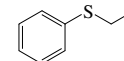
5-Ethyl-1,3,4-thiadiazol-2-amine



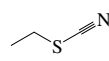
S-Ethyl thioacetate



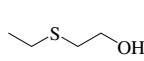
(Ethylthio)acetic acid



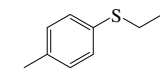
(Ethylthio)benzene



Ethyl thiocyanate



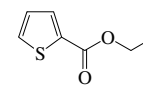
2-(Ethylthio)ethanol



1-(Ethylthio)-4-methylbenzene



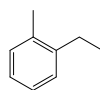
2-Ethylthiophene



Ethyl thiophene-2-carboxylate



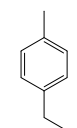
3-Ethyl-2-thioxo-4-thiazolidinone



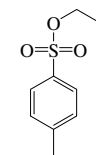
2-Ethyltoluene



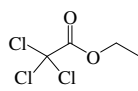
3-Ethyltoluene



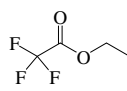
4-Ethyltoluene



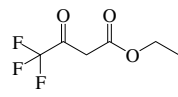
Ethyl p-toluenesulfonate



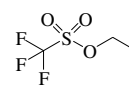
Ethyl trichloroacetate



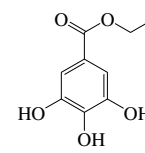
Ethyl trifluoroacetate



Ethyl 4,4,4-trifluoroacetoacetate

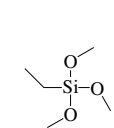


Ethyl trifluoromethanesulfonate

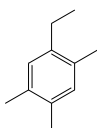


Ethyl 3,4,5-trihydroxybenzoate

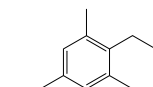
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5273	Ethyltrimethoxysilane		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub> Si	5314-55-6	150.249			124.3	0.9488 <sup>20</sup>	1.3838 <sup>20</sup>	vs EtOH
5274	1-Ethyl-2,4,5-trimethylbenzene		C <sub>11</sub> H <sub>16</sub>	17851-27-3	148.245	liq	-13.5	213	0.883 <sup>20</sup>	1.5075 <sup>20</sup>	vs ace, bz, eth, EtOH
5275	2-Ethyl-1,3,5-trimethylbenzene		C <sub>11</sub> H <sub>16</sub>	3982-67-0	148.245	liq	-15.5	212.4	0.883 <sup>20</sup>	1.5074 <sup>20</sup>	vs ace, bz, eth, EtOH
5276	Ethyltrimethyllead	Ethyltrimethylplumbane	C <sub>5</sub> H <sub>14</sub> Pb	1762-26-1	281.4	col liq		27 <sup>10.5</sup>	1.88 <sup>20</sup>		
5277	3-Ethyl-2,4,5-trimethylpyrrole		C <sub>9</sub> H <sub>15</sub> N	520-69-4	137.222	lf (eth)	66.5	214; 110 <sup>35</sup>			
5278	4-Ethyl-2,6,7-trioxa-1-phosphabicyclo[2.2.2]octane	Trimethylolpropane phosphite	C <sub>6</sub> H <sub>11</sub> O <sub>3</sub> P	824-11-3	162.123		53.7				s chl
5279	Ethyl undecanoate	Ethyl undecylate	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	627-90-7	214.344		-15	131 <sup>14</sup>	0.8633 <sup>20</sup>	1.4285 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
5280	Ethyl 10-undecenoate		C <sub>13</sub> H <sub>24</sub> O <sub>2</sub>	692-86-4	212.329	liq	-38	264.5	0.8827 <sup>15</sup>	1.4449 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, HOAc; sl ctc
5281	<i>N</i> -Ethylurea		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O	625-52-5	88.108	nd (bz, al-eth)	92.5	dec	1.2130 <sup>18</sup>		vs H <sub>2</sub> O, EtOH, bz; s eth; i CS <sub>2</sub>
5282	Ethyl vinyl ether		C <sub>4</sub> H <sub>8</sub> O	109-92-2	72.106	liq	-115.8	35.5	0.7589 <sup>20</sup>	1.3767 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH; msc eth
5283	Ethyl Violet		C <sub>21</sub> H <sub>26</sub> ClN <sub>3</sub>	2390-59-2	492.138	gray-viol cry					s H <sub>2</sub> O, EtOH
5284	$\alpha$ -Ethynylbenzenemethanol	1-Phenylpropargyl alcohol	C <sub>9</sub> H <sub>8</sub> O	4187-87-5	132.159	pr	22	114 <sup>12</sup>	1.0655 <sup>20</sup>	1.5508 <sup>20</sup>	
5285	$\alpha$ -Ethynylbenzenemethanol carbamate	Carbimate	C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	3567-38-2	175.184	cry (al)	86.5				
5286	1-Ethynylcyclohexanamine		C <sub>8</sub> H <sub>13</sub> N	30389-18-5	123.196			65 <sup>20</sup>	0.913 <sup>25</sup>	1.4817 <sup>20</sup>	
5287	1-Ethynylcyclohexanol		C <sub>8</sub> H <sub>12</sub> O	78-27-3	124.180	cry (peth)	31.5	174	0.9873 <sup>20</sup>	1.4822 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, peth; sl chl
5288	1-Ethynylcyclohexanol, carbamate	Ethinamate	C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	126-52-3	167.205	nd	97	120 <sup>3</sup>		1.4441 <sup>21</sup>	sl H <sub>2</sub> O; vs EtOH; s hx
5289	1-Ethynylcyclopentanol		C <sub>7</sub> H <sub>10</sub> O	17356-19-3	110.153		27	157.5	0.962 <sup>25</sup>	1.4751 <sup>20</sup>	
5290	$\alpha$ -Ethynyl- $\alpha$ -methylbenzenemethanol		C <sub>10</sub> H <sub>10</sub> O	127-66-2	146.185		52.3	217.5; 102 <sup>12</sup>	1.0314 <sup>20</sup>		
5291	Ethynylsilane	Silylacetylene	C <sub>2</sub> H <sub>4</sub> Si	1066-27-9	56.139	col gas		-22.5			
5292	Etioporphyrin		C <sub>32</sub> H <sub>38</sub> N <sub>4</sub>	448-71-5	478.671		362				
5293	Etofylline		C <sub>9</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub>	519-37-9	224.216		158				vs H <sub>2</sub> O; s EtOH; sl eth, bz
5294	Eto glucid	Oxirane, 2,2'-(2,5,8,11-tetraoxadodecane-1,12-diyl) bis-	C <sub>12</sub> H <sub>22</sub> O <sub>6</sub>	1954-28-5	262.299	col liq	-13	196 <sup>2</sup>	1.1312 <sup>20</sup>	1.4622 <sup>20</sup>	
5295	Etoposide		C <sub>29</sub> H <sub>32</sub> O <sub>13</sub>	33419-42-0	588.556	cry (MeOH)	≈243				s MeOH
5296	Etrimos		C <sub>10</sub> H <sub>17</sub> N <sub>2</sub> O <sub>4</sub> PS	38260-54-7	292.291		-1.7		1.195 <sup>20</sup>		
5297	Eucalyptol	Cineole	C <sub>10</sub> H <sub>18</sub> O	470-82-6	154.249		0.8	176.4	0.9267 <sup>20</sup>	1.4586 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; sl ctc
5298	Euparin	1-[6-Hydroxy-2-(1-methylvinyl)-5-benzofuranyl]ethanone	C <sub>13</sub> H <sub>12</sub> O <sub>3</sub>	532-48-9	216.232		121.5				s eth, bz, chl; sl NaOH
5299	Evan's Blue		C <sub>34</sub> H <sub>24</sub> N <sub>6</sub> Na <sub>4</sub> O <sub>14</sub> S <sub>4</sub>	314-13-6	960.806						s H <sub>2</sub> O, EtOH, acid
5300	Evodiamine		C <sub>19</sub> H <sub>17</sub> N <sub>3</sub> O	518-17-2	303.357	ye lf (al)	28				
5301	Famotidine		C <sub>8</sub> H <sub>15</sub> N <sub>7</sub> O <sub>2</sub> S <sub>3</sub>	76824-35-6	337.446	cry	163				i EtOH, chl; vs DMF; s HOAc; sl MeOH
5302	Famphur		C <sub>10</sub> H <sub>16</sub> NO <sub>3</sub> PS <sub>2</sub>	52-85-7	325.342		53				
5303	$\alpha$ -Farnesene		C <sub>15</sub> H <sub>24</sub>	502-61-4	204.352			130 <sup>12</sup>	0.8410 <sup>20</sup>	1.4836 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace; msc peth, lig
5304	$\beta$ -Farnesene		C <sub>15</sub> H <sub>24</sub>	18794-84-8	204.352			121 <sup>9</sup>	0.8363 <sup>20</sup>	1.4899 <sup>20</sup>	vs ace, eth, chl
5305	Farnesic acid		C <sub>15</sub> H <sub>24</sub> O <sub>2</sub>	7548-13-2	236.351	oil		204 <sup>16</sup>			
5306	2- <i>cis</i> ,6- <i>trans</i> -Farnesol		C <sub>15</sub> H <sub>26</sub> O	3790-71-4	222.366	oil		156 <sup>12</sup> , 120 <sup>9,3</sup>	0.8908 <sup>20</sup>	1.4877 <sup>20</sup>	vs ace, eth, EtOH
5307	2- <i>trans</i> ,6- <i>trans</i> -Farnesol		C <sub>15</sub> H <sub>26</sub> O	106-28-5	222.366	oil		160 <sup>10</sup> , 137 <sup>3</sup>	0.888 <sup>20</sup>	1.4877 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace
5308	Farnesol acetate		C <sub>17</sub> H <sub>28</sub> O <sub>2</sub>	29548-30-9	264.403			168 <sup>10</sup>			
5309	Fenadiazole	2-(1,2,4-Oxadiazol-2-yl)phenol	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	1008-65-7	194.145	cry	112	180 <sup>0.1</sup>			
5310	Fenamiphos		C <sub>13</sub> H <sub>22</sub> NO <sub>3</sub> PS	22224-92-6	303.358		49		1.15 <sup>20</sup>		
5311	Fenarimol		C <sub>17</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub> O	60168-88-9	331.195		118				
5312	Fenbuconazole		C <sub>20</sub> H <sub>19</sub> ClN <sub>4</sub>	114369-43-6	350.845		125				
5313	Fenbutatin oxide	Distannoxane, hexakis(2-methyl-2-phenylpropyl)-	C <sub>60</sub> H <sub>78</sub> O <sub>6</sub> Sn <sub>2</sub>	13356-08-6	1052.680		138				
5314	$\alpha$ -Fenchol, ( $\pm$ )	1,3,3-Trimethylbicyclo[2.2.1]heptan-2-ol, <i>endo</i> -( $\pm$ )	C <sub>10</sub> H <sub>18</sub> O	36386-49-9	154.249		39	199.5	0.9420 <sup>40</sup>		vs eth, EtOH
5315	( $\pm$ )-Fenchone		C <sub>10</sub> H <sub>16</sub> O	18492-37-0	152.233	oily liq	6.1	193.5	0.9492 <sup>15</sup>	1.4702 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace
5316	Fenfluramine		C <sub>12</sub> H <sub>16</sub> F <sub>3</sub> N	458-24-2	231.257	cry (AcOEt)		110 <sup>12</sup>			
5317	Fenitrothion		C <sub>9</sub> H <sub>12</sub> NO <sub>3</sub> PS	122-14-5	277.234			118 <sup>0.05</sup> , 164 <sup>1</sup>	1.3227 <sup>25</sup>		
5318	Fenoxprop-ethyl		C <sub>18</sub> H <sub>16</sub> ClNO <sub>5</sub>	82110-72-3	361.777		85	200 <sup>0.001</sup>			sl H <sub>2</sub> O, hx; s eth; vs ace, tol



Ethyltrimethoxysilane



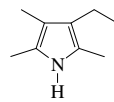
1-Ethyl-2,4,5-trimethylbenzene



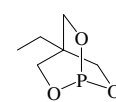
2-Ethyl-1,3,5-trimethylbenzene



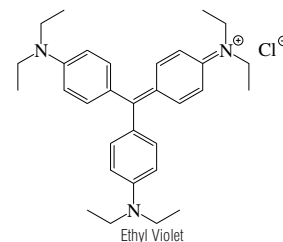
Ethyltrimethyllead



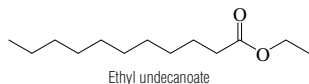
3-Ethyl-2,4,5-trimethylpyrrole



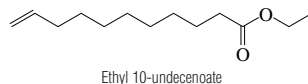
4-Ethyl-2,6,7-trioxa-1-phosphabicyclo[2.2.2]octane



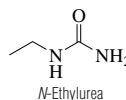
Ethyl Violet



Ethyl undecanoate



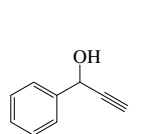
Ethyl 10-undecenoate



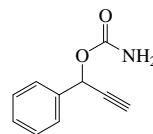
N-Ethylurea



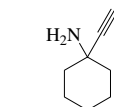
Ethyl vinyl ether



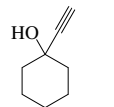
alpha-Ethynylbenzenemethanol



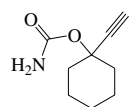
alpha-Ethynylbenzenemethanol carbamate



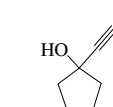
1-Ethynylcyclohexanamine



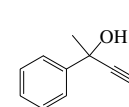
1-Ethynylcyclohexanol



1-Ethynylcyclohexanol, carbamate



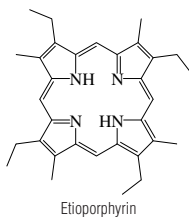
1-Ethynylcyclopentanol



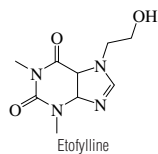
alpha-Ethynyl-alpha-methylbenzenemethanol



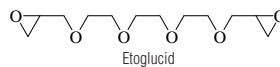
Ethynylsilane



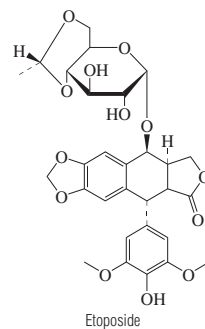
Etioporphyrin



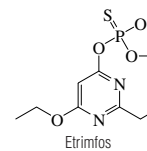
Etoflyline



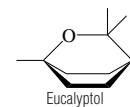
Eto glucid



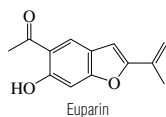
Etoposide



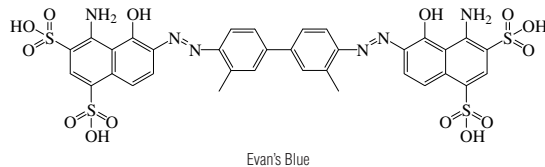
Etrimos



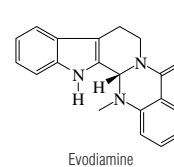
Eucalyptol



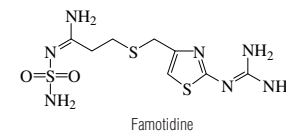
Euparin



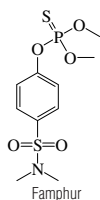
Evan's Blue



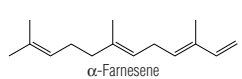
Evodiamine



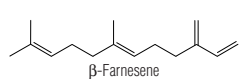
Famotidine



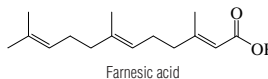
Famphur



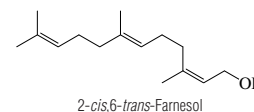
alpha-Farnesene



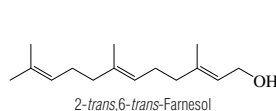
beta-Farnesene



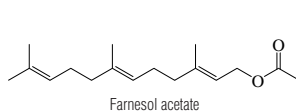
Farnesic acid



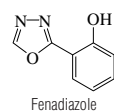
2-cis,6-trans-Farnesol



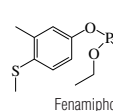
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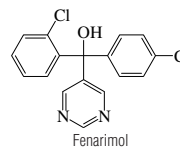
Farnesol acetate



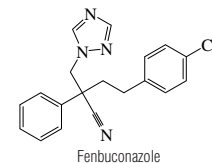
Fenadiazole



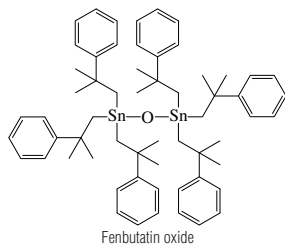
Fenamiphos



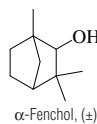
Fenarimol



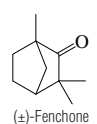
Fenbuconazole



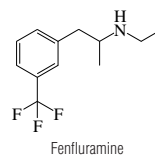
Fenbutatin oxide



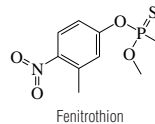
alpha-Fenchol, (±)



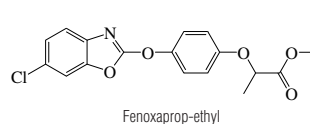
(±)-Fenchone



Fenfluramine

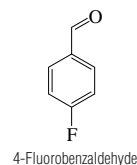
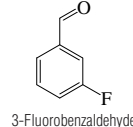
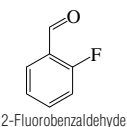
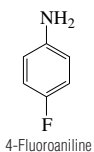
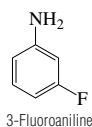
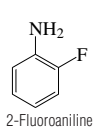
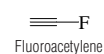
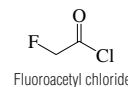
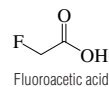
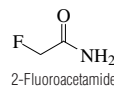
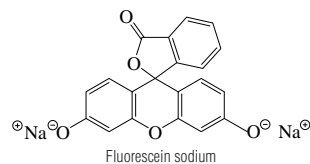
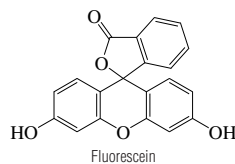
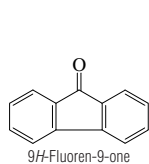
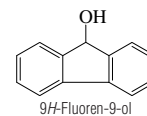
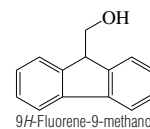
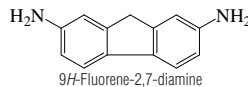
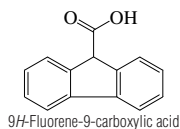
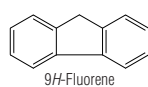
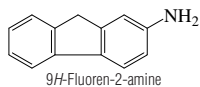
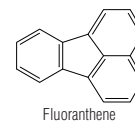
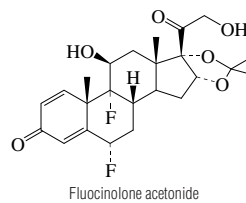
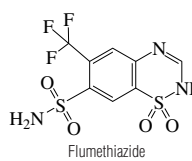
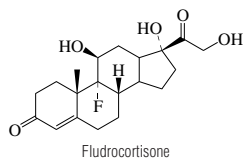
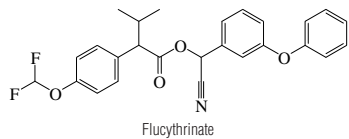
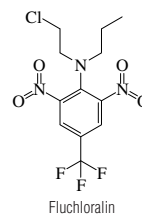
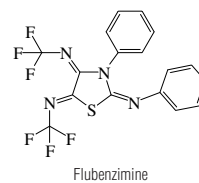
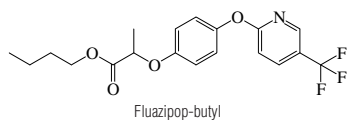
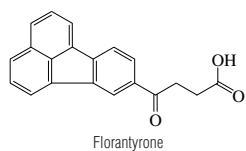
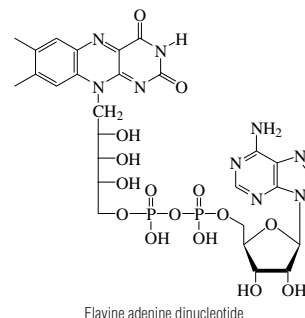
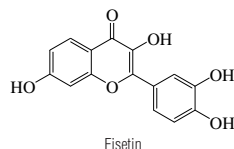
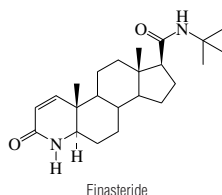
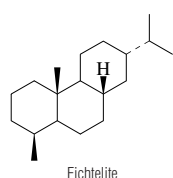
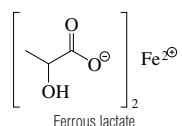
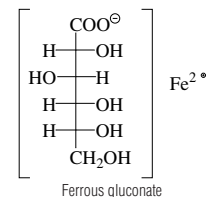
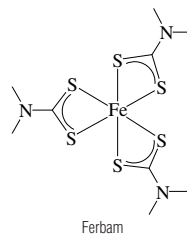
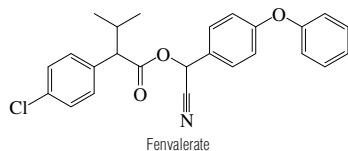
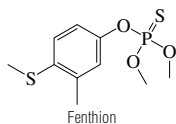
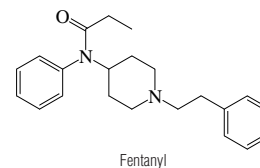
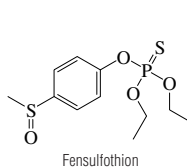
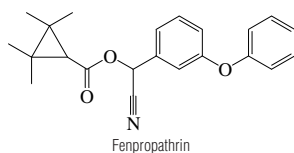
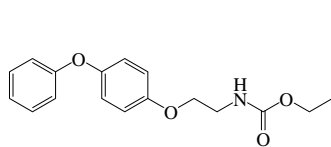


Fenitrothion



Fenoxaprop-ethyl

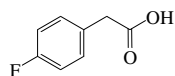
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5319	Fenoxycarb	Ethyl 2-(4-phenoxyphenoxy) ethylcarbamate	C <sub>17</sub> H <sub>19</sub> NO <sub>4</sub>	79127-80-3	301.338		53				
5320	Fenpropathrin		C <sub>22</sub> H <sub>23</sub> NO <sub>3</sub>	64257-84-7	349.423		47		1.15 <sup>25</sup>		
5321	Fensulfothion		C <sub>11</sub> H <sub>17</sub> O <sub>4</sub> PS <sub>2</sub>	115-90-2	308.354			140 <sup>0.01</sup>	1.202 <sup>20</sup>		
5322	Fentanyl		C <sub>22</sub> H <sub>28</sub> N <sub>2</sub> O	437-38-7	336.469		87.5				
5323	Fenthion		C <sub>10</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	55-38-9	278.328		7.5	87 <sup>0.01</sup>	1.246 <sup>20</sup>		
5324	Fenvalerate		C <sub>22</sub> H <sub>22</sub> ClNO <sub>3</sub>	51630-58-1	419.901			dec	1.15 <sup>25</sup>		
5325	Ferbam	Iron, tris(dimethylcarbamodithioato-S,S)-, (OC-6-11)-	C <sub>9</sub> H <sub>18</sub> FeN <sub>3</sub> S <sub>6</sub>	14484-64-1	416.494		180 dec				
5326	Ferrocene	Dicyclopentadienyl iron	C <sub>10</sub> H <sub>10</sub> Fe	102-54-5	186.031		172.5	249			i H <sub>2</sub> O
5327	Ferrous gluconate		C <sub>12</sub> H <sub>22</sub> FeO <sub>14</sub>	299-29-6	446.140	ye-gray pow (w)					s H <sub>2</sub> O; i EtOH
5328	Ferrous lactate		C <sub>6</sub> H <sub>10</sub> FeO <sub>6</sub>	5905-52-2	233.984	grn-wh pow (hyd)					s H <sub>2</sub> O; i EtOH
5329	Fichtelite	18-Norabietane	C <sub>19</sub> H <sub>34</sub>	2221-95-6	262.473	cry	46	236 <sup>43</sup>	0.9380 <sup>22</sup>	1.5052 <sup>20</sup>	
5330	Finasteride	Proscar	C <sub>23</sub> H <sub>36</sub> N <sub>2</sub> O <sub>2</sub>	98319-26-7	372.544	wh cry	252				sl H <sub>2</sub> O; s chl, EtOH, MeOH, DMSO
5331	Fisetin		C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>	528-48-3	286.236	lt ye nd (dil al, + 1 w)	330				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz, peth
5332	Flavine adenine dinucleotide	FAD	C <sub>27</sub> H <sub>33</sub> N <sub>9</sub> O <sub>15</sub> P <sub>2</sub>	146-14-5	785.550	ye cry (w)					
5333	Florantyrone		C <sub>20</sub> H <sub>14</sub> O <sub>3</sub>	519-95-9	302.323	ye cry (HOAc)	208				s EtOH, MeOH
5334	Fluazipop-butyl		C <sub>19</sub> H <sub>26</sub> F <sub>3</sub> NO <sub>4</sub>	79241-46-6	383.362	pale ye liq	5				
5335	Flubenzimine		C <sub>17</sub> H <sub>10</sub> F <sub>6</sub> N <sub>4</sub> S	37893-02-0	416.343	ye cry	119				sl H <sub>2</sub> O
5336	Fluchloralin		C <sub>12</sub> H <sub>12</sub> ClF <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	33245-39-5	355.697		42				
5337	Flucythrinate	Cythrín	C <sub>26</sub> H <sub>23</sub> F <sub>2</sub> NO <sub>4</sub>	70124-77-5	451.463			108 <sup>0.35</sup>	1.189 <sup>22</sup>		
5338	Fludrocortisone		C <sub>21</sub> H <sub>29</sub> FO <sub>5</sub>	127-31-1	380.450	cry (EtOH)	261 dec				
5339	Flumethiazide	Trifluoromethylthiazide	C <sub>8</sub> H <sub>6</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	148-56-1	329.277	cry	306				sl H <sub>2</sub> O; i bz, tol; s MeOH, EtOH, DMF
5340	Fluocinolone acetonide		C <sub>24</sub> H <sub>30</sub> F <sub>2</sub> O <sub>6</sub>	67-73-2	452.488	cry (ace/hx)	266 dec				
5341	Fluoranthene	1,2-(1,8-Naphthylene)benzene	C <sub>16</sub> H <sub>10</sub>	206-44-0	202.250	pa ye nd or pl (al)	110.19	384	1.252 <sup>0</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
5342	9H-Fluoren-2-amine		C <sub>13</sub> H <sub>11</sub> N	153-78-6	181.233	pl or nd (dil al)	130.3				i H <sub>2</sub> O; s EtOH, eth, ctc, CS <sub>2</sub>
5343	9H-Fluorene	2,2'-Methylenebiphenyl	C <sub>13</sub> H <sub>10</sub>	86-73-7	166.218	lf (al)	114.77	295	1.203 <sup>0</sup>		i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, CS <sub>2</sub>
5344	9H-Fluorene-9-carboxylic acid		C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	1989-33-9	210.228		226				
5345	9H-Fluorene-2,7-diamine	2,7-Diaminofluorene	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub>	525-64-4	196.247	nd (w), pr (bz), pl (eth)	166				i H <sub>2</sub> O; s EtOH, chl
5346	9H-Fluorene-9-methanol		C <sub>14</sub> H <sub>12</sub> O	24324-17-2	196.244		105.0				
5347	9H-Fluoren-9-ol		C <sub>13</sub> H <sub>10</sub> O	1689-64-1	182.217	hex nd (w, peth)	156.0				sl H <sub>2</sub> O, peth, EtOH; s eth, ace; vs bz
5348	9H-Fluoren-9-one		C <sub>13</sub> H <sub>8</sub> O	486-25-9	180.202	ye orth bipym (al, bz-peth)	84	341.5	1.1300 <sup>99</sup>	1.6309 <sup>99</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; vs tol; sl ctc
5349	Fluorescein		C <sub>20</sub> H <sub>12</sub> O <sub>5</sub>	2321-07-5	332.306	red orth pr	315 dec				sl H <sub>2</sub> O, EtOH, eth; vs ace; s py, MeOH
5350	Fluorescein sodium	Cl Acid Yellow 73	C <sub>20</sub> H <sub>10</sub> Na <sub>2</sub> O <sub>5</sub>	518-47-8	376.270	ye pow					s H <sub>2</sub> O, EtOH, glycerol, dil acid
5351	2-Fluoroacetamide	Fluoroacetic acid amide	C <sub>2</sub> H <sub>4</sub> FNO	640-19-7	77.057		108	sub			s H <sub>2</sub> O, ace; sl chl
5352	Fluoroacetic acid	Fluoroethanoic acid	C <sub>2</sub> H <sub>3</sub> FO <sub>2</sub>	144-49-0	78.042	nd	35.2	168	1.3693 <sup>36</sup>		s H <sub>2</sub> O, EtOH
5353	Fluoroacetyl chloride		C <sub>2</sub> H <sub>2</sub> ClFO	359-06-8	96.487	liq		72; 23 <sup>105</sup>			
5354	Fluoroacetylene	Fluoroethyne	C <sub>2</sub> HF	2713-09-9	44.027	gas	-196	-105 exp			
5355	2-Fluoroaniline		C <sub>6</sub> H <sub>6</sub> FN	348-54-9	111.117	pa ye liq	-34.6	175; 55 <sup>12</sup>	1.1513 <sup>21</sup>	1.5421 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
5356	3-Fluoroaniline		C <sub>6</sub> H <sub>6</sub> FN	372-19-0	111.117			188	1.1561 <sup>19</sup>	1.5436 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth
5357	4-Fluoroaniline		C <sub>6</sub> H <sub>6</sub> FN	371-40-4	111.117	pa ye liq	-0.8	182; 85 <sup>19</sup>	1.1725 <sup>20</sup>	1.5195 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
5358	2-Fluorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> FO	446-52-6	124.112	liq	-44.5	175	1.178 <sup>25</sup>	1.5234 <sup>20</sup>	
5359	3-Fluorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> FO	456-48-4	124.112			173	1.17 <sup>25</sup>	1.5206 <sup>20</sup>	
5360	4-Fluorobenzaldehyde		C <sub>7</sub> H <sub>5</sub> FO	459-57-4	124.112	liq	-10	181.5	1.1810 <sup>19</sup>		



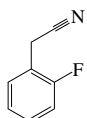
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5361	Fluorobenzene		C <sub>6</sub> H <sub>5</sub> F	462-06-6	96.102	liq	-42.18	84.73	1.0225 <sup>20</sup>	1.4684 <sup>30</sup>	sl H <sub>2</sub> O; vs bz, eth, EtOH, liq
5362	4-Fluorobenzeneacetic acid		C <sub>8</sub> H <sub>7</sub> FO <sub>2</sub>	405-50-5	154.139	cry (chl)	86	164 <sup>2</sup>			
5363	2-Fluorobenzeneacetonitrile		C <sub>8</sub> H <sub>6</sub> FN	326-62-5	135.139			232; 102 <sup>10</sup>	1.059 <sup>25</sup>	1.5009 <sup>20</sup>	
5364	4-Fluorobenzeneacetonitrile		C <sub>8</sub> H <sub>6</sub> FN	459-22-3	135.139		86.0	228; 119 <sup>18</sup>	1.1390 <sup>20</sup>	1.5002 <sup>20</sup>	
5365	4-Fluorobenzeneethanamine		C <sub>7</sub> H <sub>8</sub> FN	140-75-0	125.144			183		1.5139 <sup>20</sup>	
5366	4-Fluorobenzeneethanol		C <sub>7</sub> H <sub>7</sub> FO	459-56-3	126.128		23	210		1.5080 <sup>20</sup>	
5367	4-Fluorobenzene sulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClFO <sub>2</sub> S	349-88-2	194.611	pl or nd	30	106 <sup>9</sup>			vs bz, eth, chl
5368	2-Fluorobenzoic acid		C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	445-29-4	140.112	nd (a)	126.5		1.460 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth; i bz; s chl
5369	3-Fluorobenzoic acid		C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	455-38-9	140.112	lf (w)	124		1.474 <sup>25</sup>		sl H <sub>2</sub> O; s eth
5370	4-Fluorobenzoic acid		C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	456-22-4	140.112	pr (w), mcl pr (w)	185		1.479 <sup>25</sup>		sl H <sub>2</sub> O, ace; s EtOH, eth
5371	2-Fluorobenzonitrile		C <sub>7</sub> H <sub>5</sub> FN	394-47-8	121.112			93 <sup>22</sup>			
5372	4-Fluorobenzonitrile		C <sub>7</sub> H <sub>5</sub> FN	1194-02-1	121.112	nd (peth)	34.8	188.8	1.1070 <sup>55</sup>	1.4925 <sup>55</sup>	sl chl; s peth
5373	2-Fluorobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> ClFO	393-52-2	158.557		2.0	91 <sup>15</sup>	1.328 <sup>25</sup>	1.5365 <sup>20</sup>	
5374	3-Fluorobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> ClFO	1711-07-5	158.557	liq	-30	189	1.304 <sup>25</sup>	1.5285 <sup>20</sup>	
5375	4-Fluorobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> ClFO	403-43-0	158.557		9	82 <sup>20</sup>	1.342 <sup>25</sup>	1.5296 <sup>20</sup>	
5376	2-Fluoro-1,1'-biphenyl		C <sub>12</sub> H <sub>9</sub> F	321-60-8	172.197		73.5	248	1.2452 <sup>25</sup>		s EtOH, eth, chl, peth; sl liq
5377	4-Fluoro-1,1'-biphenyl		C <sub>12</sub> H <sub>9</sub> F	324-74-3	172.197	pr	74.2	253	1.247 <sup>25</sup>		sl EtOH; s eth, gl HOAc
5378	1-Fluorobutane	Butyl fluoride	C <sub>4</sub> H <sub>9</sub> F	2366-52-1	76.112	liq	-134	32.5	0.7789 <sup>20</sup>	1.3396 <sup>20</sup>	vs EtOH
5379	2-Fluorobutane	sec-Butyl fluoride	C <sub>4</sub> H <sub>9</sub> F	359-01-3	76.112	vol liq or gas	-121.4	25.1	0.7559 <sup>25</sup>		
5380	Fluorocyclohexane	Cyclohexyl fluoride	C <sub>6</sub> H <sub>11</sub> F	372-46-3	102.149		13	101	0.9279 <sup>20</sup>	1.4146 <sup>20</sup>	i H <sub>2</sub> O; s py
5381	1-Fluorocyclohexene		C <sub>6</sub> H <sub>9</sub> F	694-51-9	100.133			96.5		1.4441 <sup>25</sup>	
5382	5-Fluorocytosine	4-Amino-5-fluoro-2-hydroxypyrimidine	C <sub>4</sub> H <sub>4</sub> FN <sub>3</sub> O	2022-85-7	129.092	wh cry	296 dec				
5383	1-Fluorodecane	Decyl fluoride	C <sub>10</sub> H <sub>21</sub> F	334-56-5	160.272	liq	-35	186.2	0.8194 <sup>20</sup>	1.4085	vs eth
5384	Fluorodifen	2-Nitro-1-(4-nitrophenoxy)-4-(trifluoromethyl)benzene	C <sub>13</sub> H <sub>7</sub> F <sub>3</sub> N <sub>2</sub> O <sub>5</sub>	15457-05-3	328.200		94				
5385	1-Fluoro-2,4-dinitrobenzene	2,4-Dinitrophenyl fluoride	C <sub>6</sub> H <sub>3</sub> FN <sub>2</sub> O <sub>4</sub>	70-34-8	186.097		25.8	296	1.4718 <sup>54</sup>	1.5690 <sup>20</sup>	s EtOH; sl chl
5386	Fluoroethane	Ethyl fluoride	C <sub>2</sub> H <sub>5</sub> F	353-36-6	48.059	col gas	-143.2	-37.7	0.7182 <sup>20</sup> (p>1 atm)	1.2656 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
5387	2-Fluoroethanol	Ethylene fluorohydrin	C <sub>2</sub> H <sub>5</sub> FO	371-62-0	64.058	liq	-26.4	103.5	1.1040 <sup>20</sup>	1.3647 <sup>18</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace; sl chl
5388	Fluoroethene	Vinyl fluoride	C <sub>2</sub> H <sub>3</sub> F	75-02-5	46.043	col gas	-160.5	-72			i H <sub>2</sub> O; s EtOH, ace
5389	1-Fluoroheptane		C <sub>7</sub> H <sub>15</sub> F	661-11-0	118.192	liq	-73	117.9	0.8062 <sup>20</sup>	1.3854 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz; vs peth
5390	1-Fluorohexane	Hexyl fluoride	C <sub>6</sub> H <sub>13</sub> F	373-14-8	104.165	liq	-103	91.5	0.7995 <sup>20</sup>	1.3738 <sup>20</sup>	s eth, bz
5391	1-Fluoro-2-iodobenzene		C <sub>6</sub> H <sub>4</sub> FI	348-52-7	221.998	liq	-41.5	188.6		1.5910 <sup>20</sup>	s ace, bz, chl
5392	1-Fluoro-4-iodobenzene		C <sub>6</sub> H <sub>4</sub> FI	352-34-1	221.998	liq	-27	183	1.9523 <sup>15</sup>	1.5270 <sup>22</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
5393	1-Fluoro-3-isothiocyanatobenzene		C <sub>7</sub> H <sub>4</sub> FNS	404-72-8	153.177			227	1.27 <sup>25</sup>	1.6186 <sup>20</sup>	
5394	1-Fluoro-4-isothiocyanatobenzene		C <sub>7</sub> H <sub>4</sub> FNS	1544-68-9	153.177		27	228			
5395	Fluoromethane	Methyl fluoride	CH <sub>3</sub> F	593-53-3	34.033	col gas	-143.3	-78.4	0.557 <sup>25</sup> (p>1 atm)	1.1674 <sup>25</sup>	sl H <sub>2</sub> O, bz, chl; vs EtOH, eth
5396	1-Fluoro-2-methoxybenzene		C <sub>7</sub> H <sub>7</sub> FO	321-28-8	126.128	liq	-39	154.5	1.5489 <sup>17</sup>	1.4969 <sup>17</sup>	i H <sub>2</sub> O; s eth, ctc
5397	1-Fluoro-3-methoxybenzene		C <sub>7</sub> H <sub>7</sub> FO	456-49-5	126.128	liq	-35	159; 51 <sup>14</sup>	1.104 <sup>25</sup>	1.4876 <sup>20</sup>	
5398	1-Fluoro-4-methoxybenzene		C <sub>7</sub> H <sub>7</sub> FO	459-60-9	126.128	liq	-45	157	1.1781 <sup>18</sup>	1.4886 <sup>18</sup>	s eth
5399	4-Fluoro-2-methylaniline		C <sub>7</sub> H <sub>8</sub> FN	452-71-1	125.144		14.2	94 <sup>16</sup>	1.1263 <sup>18</sup>	1.5363 <sup>18</sup>	s eth, ace, bz, ctc
5400	(Fluoromethyl)benzene		C <sub>7</sub> H <sub>7</sub> F	350-50-5	110.129	liq	-35	140; 40 <sup>14</sup>	1.0228 <sup>25</sup>	1.4892 <sup>25</sup>	s ctc
5401	2-Fluoro-4-methyl-1-nitrobenzene	3-Fluoro-4-nitrotoluene	C <sub>7</sub> H <sub>8</sub> FNO <sub>2</sub>	446-34-4	155.127	nd (al)	53.2	97 <sup>3</sup>	1.4380 <sup>25</sup>		
5402	2-Fluoro-2-methylpropane	tert-Butyl fluoride	C <sub>4</sub> H <sub>9</sub> F	353-61-7	76.112	col gas		12.1			
5403	1-Fluoronaphthalene		C <sub>10</sub> H <sub>7</sub> F	321-38-0	146.161	liq	-9	215; 80 <sup>11</sup>	1.1322 <sup>20</sup>	1.5939 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
5404	2-Fluoronaphthalene		C <sub>10</sub> H <sub>7</sub> F	323-09-1	146.161	nd (al)	61	212; 90 <sup>16</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
5405	1-Fluoro-2-nitrobenzene	<i>o</i> -Fluoronitrobenzene	C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	1493-27-2	141.100	ye liq	-6	dec 215	1.3285 <sup>18</sup>	1.5489 <sup>17</sup>	vs eth, EtOH
5406	1-Fluoro-3-nitrobenzene	<i>m</i> -Fluoronitrobenzene	C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	402-67-5	141.100	ye cry	41	199; 86 <sup>19</sup>	1.3254 <sup>19</sup>	1.5262 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth; sl bz
5407	1-Fluoro-4-nitrobenzene	<i>p</i> -Fluoronitrobenzene	C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	350-46-9	141.100	ye nd	21	205	1.3300 <sup>20</sup>	1.5316 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
5408	1-Fluorooctane	Octyl fluoride	C <sub>8</sub> H <sub>17</sub> F	463-11-6	132.219	liq	-64	142.3	0.8116 <sup>20</sup>	1.3946 <sup>20</sup>	
5409	1-Fluoropentane	Pentyl fluoride	C <sub>5</sub> H <sub>11</sub> F	592-50-7	90.139	liq	-120	62.8	0.7907 <sup>20</sup>	1.3591 <sup>2-</sup>	vs eth, EtOH
5410	2-Fluorophenol		C <sub>6</sub> H <sub>5</sub> FO	367-12-4	112.101		16.1	151.5	1.120 <sup>25</sup>	1.5144 <sup>20</sup>	s H <sub>2</sub> O



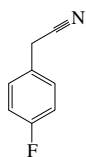
Fluorobenzene



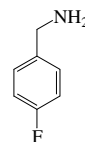
4-Fluorobenzeneacetic acid



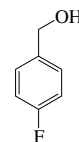
2-Fluorobenzeneacetonitrile



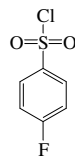
4-Fluorobenzeneacetonitrile



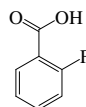
4-Fluorobenzenemethanamine



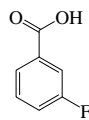
4-Fluorobenzenemethanol



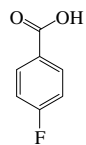
4-Fluorobenzenesulfonyl chloride



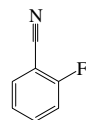
2-Fluorobenzoic acid



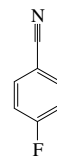
3-Fluorobenzoic acid



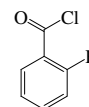
4-Fluorobenzoic acid



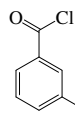
2-Fluorobenzonitrile



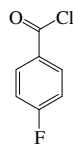
4-Fluorobenzonitrile



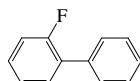
2-Fluorobenzoyl chloride



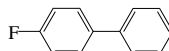
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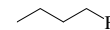
4-Fluorobenzoyl chloride



2-Fluoro-1,1'-biphenyl



4-Fluoro-1,1'-biphenyl



1-Fluorobutane



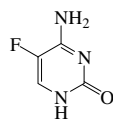
2-Fluorobutane



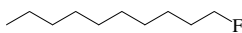
Fluorocyclohexane



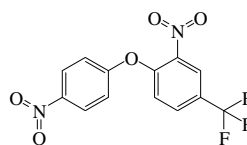
1-Fluorocyclohexene



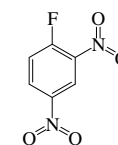
5-Fluorocytosine



1-Fluorodecane



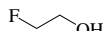
Fluorodifen



1-Fluoro-2,4-dinitrobenzene



Fluoroethane



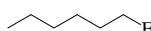
2-Fluoroethanol



Fluoroethene



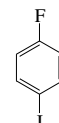
1-Fluoroheptane



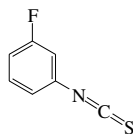
1-Fluorohexane



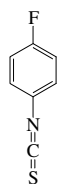
1-Fluoro-2-iodobenzene



1-Fluoro-4-iodobenzene



1-Fluoro-3-isothiocyanatobenzene



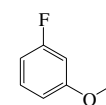
1-Fluoro-4-isothiocyanatobenzene



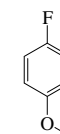
Fluoromethane



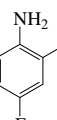
1-Fluoro-2-methoxybenzene



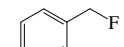
1-Fluoro-3-methoxybenzene



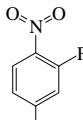
1-Fluoro-4-methoxybenzene



4-Fluoro-2-methylaniline



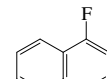
(Fluoromethyl)benzene



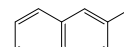
2-Fluoro-4-methyl-1-nitrobenzene



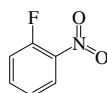
2-Fluoro-2-methylpropane



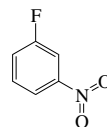
1-Fluoronaphthalene



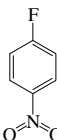
2-Fluoronaphthalene



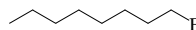
1-Fluoro-2-nitrobenzene



1-Fluoro-3-nitrobenzene



1-Fluoro-4-nitrobenzene



1-Fluorooctane



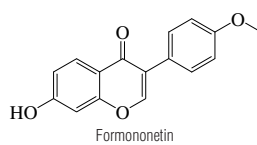
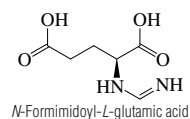
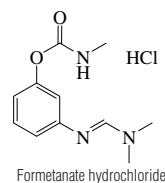
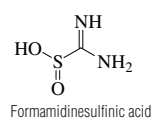
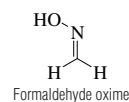
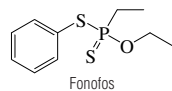
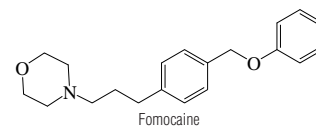
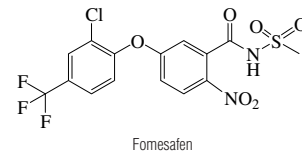
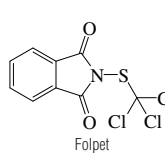
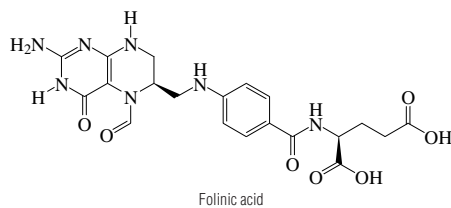
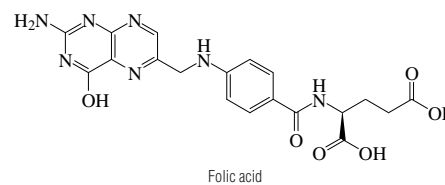
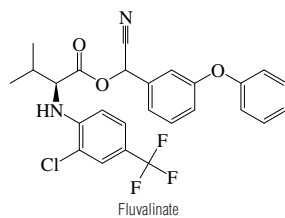
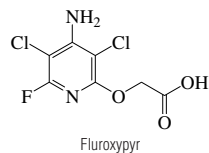
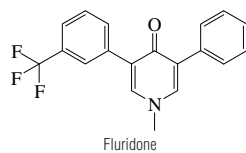
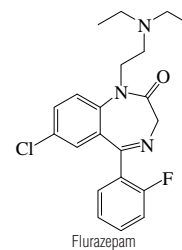
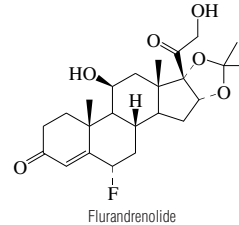
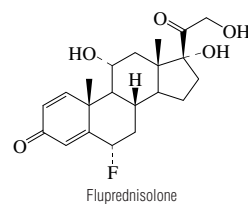
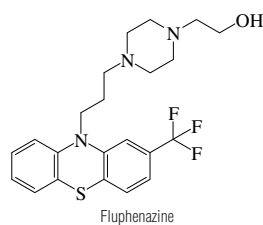
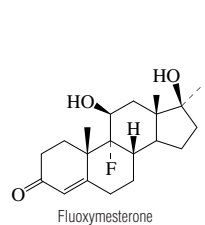
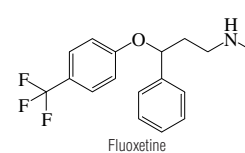
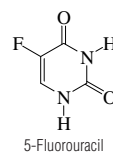
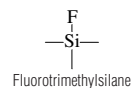
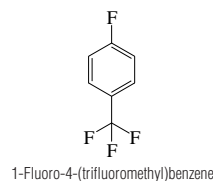
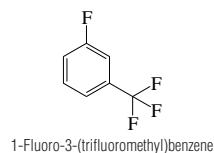
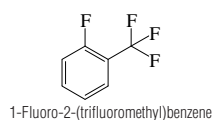
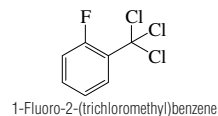
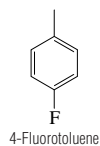
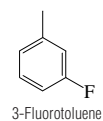
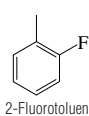
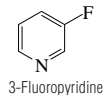
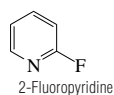
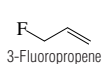
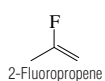
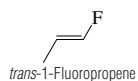
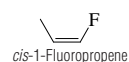
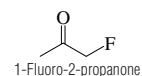
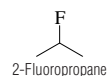
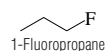
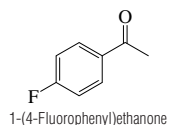
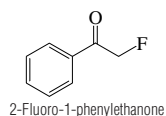
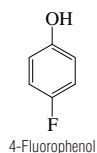
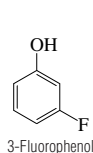
1-Fluoropentane



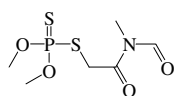
2-Fluorophenol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5411	3-Fluorophenol		C <sub>6</sub> H <sub>5</sub> FO	372-20-3	112.101		13.7	178	1.238 <sup>25</sup>	1.5140 <sup>20</sup>	
5412	4-Fluorophenol		C <sub>6</sub> H <sub>5</sub> FO	371-41-5	112.101		48	185.5	1.1889 <sup>56</sup>		sl H <sub>2</sub> O; s ace, peth
5413	2-Fluoro-1-phenylethanone		C <sub>9</sub> H <sub>9</sub> FO	450-95-3	138.139	pl	29	90 <sup>12</sup>	1.152 <sup>20</sup>	1.5200 <sup>20</sup>	
5414	1-(4-Fluorophenyl)ethanone		C <sub>9</sub> H <sub>9</sub> FO	403-42-9	138.139	liq	-45	196	1.1382 <sup>25</sup>	1.5081 <sup>25</sup>	i H <sub>2</sub> O; s bz, chl
5415	1-Fluoropropane	Propyl fluoride	C <sub>3</sub> H <sub>7</sub> F	460-13-9	62.086	col gas	-159	-2.5	0.7596 <sup>20</sup> (p>1 atm)	1.3115 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
5416	2-Fluoropropane	Isopropyl fluoride	C <sub>3</sub> H <sub>7</sub> F	420-26-8	62.086	gas		-9.4			sl H <sub>2</sub> O
5417	1-Fluoro-2-propanone	Fluoroacetone	C <sub>3</sub> H <sub>5</sub> FO	430-51-3	76.069			77	1.0288 <sup>20</sup>	1.3700 <sup>20</sup>	
5418	<i>cis</i> -1-Fluoropropene		C <sub>3</sub> H <sub>5</sub> F	19184-10-2	60.070	col gas		≈-20			
5419	<i>trans</i> -1-Fluoropropene		C <sub>3</sub> H <sub>5</sub> F	20327-65-5	60.070	col gas	≈-20				
5420	2-Fluoropropene		C <sub>3</sub> H <sub>5</sub> F	1184-60-7	60.070	col gas		-24			
5421	3-Fluoropropene		C <sub>3</sub> H <sub>5</sub> F	818-92-8	60.070	col gas		-3			sl H <sub>2</sub> O; vs EtOH, eth; s chl
5422	2-Fluoropyridine		C <sub>5</sub> H <sub>4</sub> FN	372-48-5	97.091			125	1.1280 <sup>20</sup>	1.4574 <sup>20</sup>	
5423	3-Fluoropyridine		C <sub>5</sub> H <sub>4</sub> FN	372-47-4	97.091	liq		107	1.130	1.4720 <sup>20</sup>	
5424	2-Fluorotoluene		C <sub>7</sub> H <sub>7</sub> F	95-52-3	110.129	liq	-62	115	1.0041 <sup>13</sup>	1.4704 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
5425	3-Fluorotoluene		C <sub>7</sub> H <sub>7</sub> F	352-70-5	110.129	liq	-87	115	0.9974 <sup>20</sup>	1.4691 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
5426	4-Fluorotoluene		C <sub>7</sub> H <sub>7</sub> F	352-32-9	110.129	liq	-56	116.6	0.9975 <sup>20</sup>	1.4699 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
5427	1-Fluoro-2-(trichloromethyl)benzene		C <sub>7</sub> H <sub>4</sub> Cl <sub>3</sub> F	488-98-2	213.464			95 <sup>12</sup> , 75 <sup>5</sup>	1.453 <sup>25</sup>	1.5432 <sup>20</sup>	
5428	1-Fluoro-2-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> F <sub>4</sub>	392-85-8	164.101			114.5	1.293 <sup>25</sup>	1.4040 <sup>25</sup>	
5429	1-Fluoro-3-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> F <sub>4</sub>	401-80-9	164.101	liq	-81.5	101.5	1.3021 <sup>17</sup>		
5430	1-Fluoro-4-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> F <sub>4</sub>	402-44-8	164.101	liq	-41.7	103.5	1.293 <sup>25</sup>	1.4025 <sup>20</sup>	
5431	Fluorotrimethylsilane		C <sub>3</sub> H <sub>9</sub> FSi	420-56-4	92.187	vol liq or gas		16.4			
5432	5-Fluorouracil	5-Fluoro-2,4(1 <i>H</i> ,3 <i>H</i> )-Pyrimidinedione	C <sub>4</sub> H <sub>3</sub> FN <sub>2</sub> O <sub>2</sub>	51-21-8	130.077	cry (w, MeOH-eth)	283	sub 190			
5433	Fluoxetine		C <sub>17</sub> H <sub>18</sub> F <sub>3</sub> NO	54910-89-3	309.326	oil					
5434	Fluoxymesterone		C <sub>20</sub> H <sub>28</sub> FO <sub>3</sub>	76-43-7	336.440		270				
5435	Fluphenazine		C <sub>22</sub> H <sub>26</sub> F <sub>3</sub> N <sub>3</sub> OS	69-23-8	437.520			251 <sup>10.3</sup>			
5436	Fluprednisolone		C <sub>21</sub> H <sub>27</sub> FO <sub>5</sub>	53-34-9	378.434		210				
5437	Flurandrenolide	Fludrocortide	C <sub>24</sub> H <sub>33</sub> FO <sub>6</sub>	1524-88-5	436.513	cry (ace/hx)	251				
5438	Flurazepam		C <sub>21</sub> H <sub>23</sub> ClFN <sub>3</sub> O	17617-23-1	387.878	wh rods (eth/peth)	80				
5439	Fluridone		C <sub>19</sub> H <sub>14</sub> F <sub>3</sub> NO	59756-60-4	329.315		155				
5440	Fluroxypyr	[(4-Amino-3,5-dichloro-6-fluoro-2-pyridyl)oxy]acetic acid	C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> FN <sub>2</sub> O <sub>3</sub>	69377-81-7	255.030		232				
5441	Fluvalinate		C <sub>28</sub> H <sub>22</sub> ClF <sub>3</sub> N <sub>2</sub> O <sub>3</sub>	102851-06-9	502.912			>450	1.29 <sup>25</sup>		
5442	Folic acid	Vitamin B <sub>c</sub>	C <sub>19</sub> H <sub>19</sub> N <sub>7</sub> O <sub>6</sub>	59-30-3	441.397	ye-oran nd (w)	250 dec				vs py, EtOH, HOAc
5443	Folinic acid	5-Formyl-5,6,7,8-tetrahydrofolic acid	C <sub>20</sub> H <sub>23</sub> N <sub>7</sub> O <sub>7</sub>	58-05-9	473.440	cry (w + 3)	245 dec				sl H <sub>2</sub> O
5444	Folpet	1 <i>H</i> -Isoindole-1,3(2 <i>H</i> )-dione, 2-[(trichloromethyl)thio]-	C <sub>9</sub> H <sub>4</sub> Cl <sub>3</sub> NO <sub>2</sub> S	133-07-3	296.558		177				
5445	Fomesafen		C <sub>15</sub> H <sub>10</sub> ClF <sub>3</sub> N <sub>2</sub> O <sub>6</sub> S	72178-02-0	438.762		220		1.28 <sup>20</sup>		
5446	Fomocaine	4-[3-[4-(Phenoxymethyl)phenyl]propyl]morpholine	C <sub>20</sub> H <sub>25</sub> NO <sub>2</sub>	17692-39-6	311.419	col cry	53	2391 <sup>1</sup>			
5447	Fonofos	Phosphonodithioic acid, ethyl-, <i>O</i> -ethyl <i>S</i> -phenyl ester	C <sub>10</sub> H <sub>15</sub> OPS <sub>2</sub>	944-22-9	246.329			130 <sup>0.1</sup>	1.16 <sup>25</sup>		
5448	Formaldehyde	Methanal	CH <sub>2</sub> O	50-00-0	30.026	col gas	-92	-19.1	0.815 <sup>-20</sup>		s H <sub>2</sub> O, EtOH, chl; msc eth, ace, bz
5449	Formaldehyde oxime		CH <sub>3</sub> NO	75-17-2	45.041		1.3	109 <sup>15</sup>	1.133 <sup>25</sup>		s H <sub>2</sub> O; vs EtOH, eth
5450	Formamide	Methanamide	CH <sub>3</sub> NO	75-12-7	45.041		2.49	220	1.1334 <sup>20</sup>	1.4472 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth; s ace; i bz, chl
5451	Formamidesulfonic acid	Aminoiminomethanesulfonic acid	CH <sub>4</sub> N <sub>2</sub> O <sub>2</sub> S	1758-73-2	108.120	nd (al)	144 dec				vs H <sub>2</sub> O; i eth, bz
5452	Formetate hydrochloride		C <sub>11</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>2</sub>	23422-53-9	257.717	pow	201 dec				vs H <sub>2</sub> O; s MeOH; sl ace, hx, chl
5453	Formic acid	Methanoic acid	CH <sub>2</sub> O <sub>2</sub>	64-18-6	46.026		8.3	101	1.220 <sup>20</sup>	1.3714 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace; s bz, tol
5454	<i>N</i> -Formimidoyl- <i>L</i> -glutamic acid	<i>N</i> -(Iminomethyl)- <i>L</i> -glutamic acid	C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	816-90-0	174.154		90				
5455	Formononetin	7-Hydroxy-3-(4-methoxyphenyl)-4 <i>H</i> -1-benzopyran-4-one	C <sub>16</sub> H <sub>12</sub> O <sub>4</sub>	485-72-3	268.264		256.5				

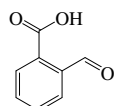




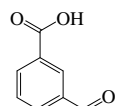
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5456	Formothion		C <sub>6</sub> H <sub>12</sub> NO <sub>4</sub> PS <sub>2</sub>	2540-82-1	257.267	visc ye oil	25.5	dec	1.361 <sup>20</sup>	1.5541 <sup>20</sup>	sl H <sub>2</sub> O; misc os
5457	2-Formylbenzoic acid		C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	119-67-5	150.132		98		1.404 <sup>25</sup>		s H <sub>2</sub> O; vs EtOH, eth
5458	3-Formylbenzoic acid		C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	619-21-6	150.132	nd (w)	175				vs H <sub>2</sub> O, eth, EtOH
5459	4-Formylbenzoic acid		C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	619-66-9	150.132		247				sl H <sub>2</sub> O; vs EtOH; s eth, chl
5460	3-Formylbenzotrile		C <sub>8</sub> H <sub>5</sub> NO	24964-64-5	131.132		76.5	210			vs H <sub>2</sub> O, EtOH, eth, chl
5461	4-Formylbenzotrile		C <sub>8</sub> H <sub>5</sub> NO	105-07-7	131.132		100.5	133 <sup>12</sup>			s H <sub>2</sub> O; vs EtOH, eth, chl
5462	6-Formyl-2,3-dimethoxybenzoic acid	Opianic acid	C <sub>10</sub> H <sub>10</sub> O <sub>5</sub>	519-05-1	210.183	nd (w)	150				s EtOH, eth
5463	Formylferrocene		C <sub>11</sub> H <sub>10</sub> FeO	12093-10-6	214.041		118.5	70 <sup>0.1</sup>			
5464	Formyl fluoride	Fluoroformaldehyde	CHFO	1493-02-3	48.016	col gas	-142.2	-26.5	1.1950 <sup>30</sup>		
5465	<i>N</i> -(4-Formylphenyl)acetamide		C <sub>9</sub> H <sub>9</sub> NO <sub>2</sub>	122-85-0	163.173	pr (w)	158.0				vs H <sub>2</sub> O, bz
5466	Fosetyl-Al	Aluminum tris( <i>O</i> -ethylphosphonate)	C <sub>6</sub> H <sub>18</sub> AlO <sub>9</sub> P <sub>3</sub>	39148-24-8	354.105		>300				
5467	Fosthietan		C <sub>6</sub> H <sub>12</sub> NO <sub>3</sub> PS <sub>2</sub>	21548-32-3	241.268	ye oil			1.3 <sup>25</sup>	1.5348 <sup>25</sup>	s ace, chl, MeOH, tol
5468	Fraxin		C <sub>16</sub> H <sub>18</sub> O <sub>10</sub>	524-30-1	370.308	ye nd (al)	205				
5469	<i>DL</i> -Fructose	$\alpha$ -Acrose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	6035-50-3	180.155	nd	130		1.665 <sup>16</sup>		
5470	<i>L</i> -Fructose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	7776-48-9	180.155	wh cry	102				s H <sub>2</sub> O
5471	$\beta$ - <i>D</i> -Fructose	$\beta$ -Levulose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	53188-23-1	180.155	pr or nd (w) orth pr (al)	103 dec		1.60 <sup>20</sup>		vs H <sub>2</sub> O, ace; s EtOH, MeOH, py
5472	<i>D</i> -Fructose 6-phosphate	Hexose monophosphate	C <sub>6</sub> H <sub>13</sub> O <sub>9</sub> P	643-13-0	260.135						vs H <sub>2</sub> O
5473	Fucoxanthin		C <sub>42</sub> H <sub>58</sub> O <sub>6</sub>	3351-86-8	658.905	red pl (eth) hex pl (dil al)	168				vs eth, EtOH
5474	Fulminic acid	Carbyloxime	CHNO	506-85-4	43.025			unstable in pure form			s eth
5475	Fulvene		C <sub>6</sub> H <sub>6</sub>	497-20-1	78.112			7 <sup>56</sup>	0.8241 <sup>20</sup>	1.4920 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl
5476	Fumaric acid	<i>trans</i> -2-Butenedioic acid	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	110-17-8	116.073	nd, mcl pr or lf (w)	287 dec	sub 165	1.635 <sup>20</sup>		sl H <sub>2</sub> O, eth, ace; s EtOH, con sulf
5477	Fumigatin	3-Hydroxy-2-methoxy-5-methyl-2,5-cyclohexadiene-1,4-dione	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	484-89-9	168.148	br nd or pl (peth)	116				vs ace, bz, eth, EtOH
5478	Furan	Oxacyclopentadiene	C <sub>4</sub> H <sub>4</sub> O	110-00-9	68.074	liq	-85.61	31.5	0.9514 <sup>20</sup>	1.4214 <sup>20</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth; s ace, bz
5479	2-Furanacetic acid		C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	2745-26-8	126.110	lf(peth)	68.5	102 <sup>0.4</sup>			s H <sub>2</sub> O, bz, MeOH, peth
5480	2-Furancarboxitrile		C <sub>5</sub> H <sub>3</sub> NO	617-90-3	93.084			147	1.0822 <sup>20</sup>	1.4798 <sup>20</sup>	s EtOH, eth
5481	2-Furancarboxyl chloride		C <sub>5</sub> H <sub>3</sub> ClO <sub>2</sub>	527-69-5	130.530	liq	-1.0	173	1.324 <sup>25</sup>	1.5310 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl; sl ctc
5482	3-Furancarboxaldehyde		C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	498-60-2	96.085			145; 71 <sup>43</sup>	1.110 <sup>20</sup>	1.4945 <sup>20</sup>	
5483	2-Furancarboxylic acid	2-Furoic acid	C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	88-14-2	112.084	mcl nd or lf (w)	133.5	231			s H <sub>2</sub> O, EtOH; vs eth; sl ace
5484	3-Furancarboxylic acid		C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	488-93-7	112.084	nd (w)	122.5	sub 105			sl H <sub>2</sub> O; s EtOH, AcOEt; vs eth
5485	2,5-Furandicarboxylic acid	Dehydromucic acid	C <sub>6</sub> H <sub>4</sub> O <sub>5</sub>	3238-40-2	156.093	nd (w), lf (al)	342	sub	1.7400 <sup>20</sup>		sl H <sub>2</sub> O, EtOH
5486	2-Furanmethanamine	Furfurylamine	C <sub>5</sub> H <sub>7</sub> NO	617-89-0	97.116			145.5	1.0995 <sup>20</sup>	1.4908 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth, chl
5487	2-Furanmethanediol diacetate		C <sub>9</sub> H <sub>10</sub> O <sub>5</sub>	613-75-2	198.172	nd or pl (eth-peth)	53.3	220			vs bz, eth, EtOH
5488	2-Furanmethanethiol		C <sub>5</sub> H <sub>6</sub> OS	98-02-2	114.166			157	1.1319 <sup>20</sup>	1.5329 <sup>20</sup>	i H <sub>2</sub> O; sl chl
5489	2-Furanmethanol acetate		C <sub>7</sub> H <sub>8</sub> O <sub>3</sub>	623-17-6	140.137			179	1.1175 <sup>20</sup>	1.4327 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5490	4-(2-Furanyl)-2-butanone		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	699-17-2	138.164	oil		203	1.0361 <sup>19</sup>	1.4696 <sup>17</sup>	
5491	4-(2-Furanyl)-3-buten-2-one		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	623-15-4	136.149		39.5	dec 229; 113 <sup>10</sup>	1.0496 <sup>57</sup>	1.5788 <sup>45</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl; s peth
5492	1-(2-Furanyl)ethanone		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	1192-62-7	110.111	cry (lig)	33	175	1.098 <sup>20</sup>	1.5017 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5493	2-Furanylmethyl pentanoate	Furfuryl valerate	C <sub>10</sub> H <sub>14</sub> O <sub>3</sub>	36701-01-6	182.216			228; 82 <sup>1</sup>	1.0284 <sup>20</sup>		vs eth, EtOH
5494	3-(2-Furanyl)-1-phenyl-2-propen-1-one		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	717-21-5	198.217		47	317	1.1140 <sup>20</sup>		s EtOH, eth
5495	1-(2-Furanyl)-1-propanone		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	3194-15-8	124.138	cry	28	88 <sup>14</sup>	1.0626 <sup>28</sup>	1.4922 <sup>25</sup>	s eth; sl ctc
5496	1-(2-Furanyl)-2-propanone	2-Furfuryl methyl ketone	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	6975-60-6	124.138		29	179.5	1.104 <sup>20</sup>	1.5035 <sup>20</sup>	
5497	3-(2-Furanyl)-2-propenal		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	623-30-3	122.122		54	135 <sup>14</sup>			i H <sub>2</sub> O; msc EtOH; s eth; sl chl
5498	3-(2-Furanyl)-2-propenenitrile	2-Furanacrylonitrile	C <sub>7</sub> H <sub>7</sub> NO	7187-01-1	119.121		38	96		1.5824 <sup>25</sup>	vs tol



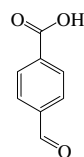
Formothion



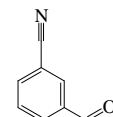
2-Formylbenzoic acid



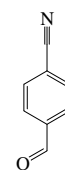
3-Formylbenzoic acid



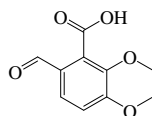
4-Formylbenzoic acid



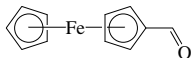
3-Formylbenzotrile



4-Formylbenzotrile



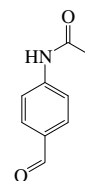
6-Formyl-2,3-dimethoxybenzoic acid



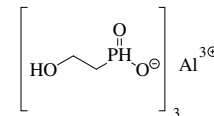
Formylferrocene



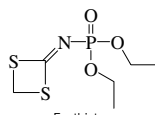
Formyl fluoride



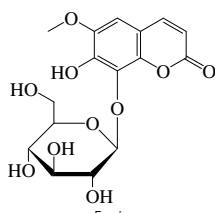
N-(4-Formylphenyl)acetamide



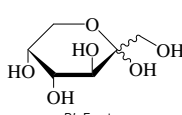
Fosetyl-Al



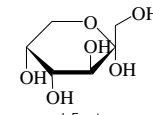
Fosthietan



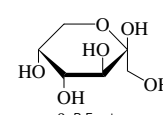
Fraxin



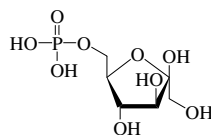
DL-Fructose



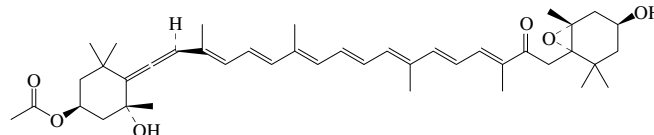
L-Fructose



β-D-Fructose



D-Fructose 6-phosphate



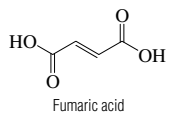
Fucoxanthin



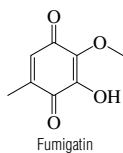
Fulminic acid



Fulvene



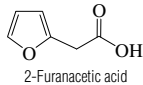
Fumaric acid



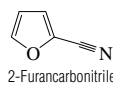
Fumigatin



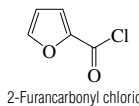
Furan



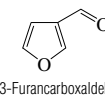
2-Furanacetic acid



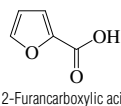
2-Furancarboxitrile



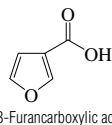
2-Furancarboxyl chloride



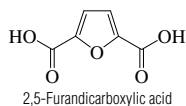
3-Furancarboxaldehyde



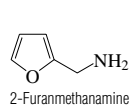
2-Furancarboxylic acid



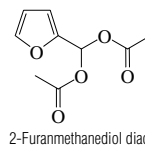
3-Furancarboxylic acid



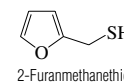
2,5-Furandicarboxylic acid



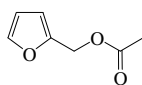
2-Furanmethanamine



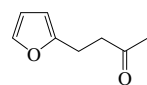
2-Furanmethanediol diacetate



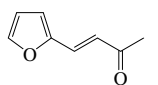
2-Furanmethanethiol



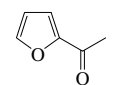
2-Furanmethanol acetate



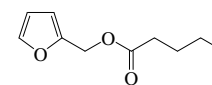
4-(2-Furanyl)-2-butanone



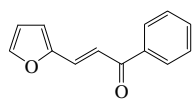
4-(2-Furanyl)-3-buten-2-one



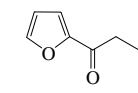
1-(2-Furanyl)ethanone



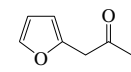
2-Furanylmethyl pentanoate



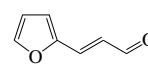
3-(2-Furanyl)-1-phenyl-2-propen-1-one



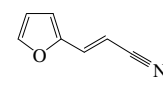
1-(2-Furanyl)-1-propanone



1-(2-Furanyl)-2-propanone

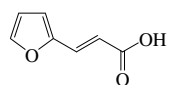


3-(2-Furanyl)-2-propenal

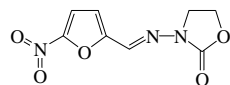


3-(2-Furanyl)-2-propenenitrile

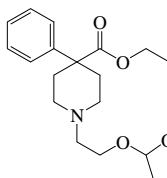
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5499	3-(2-Furanyl)-2-propenoic acid	2-Furanacrylic acid	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	539-47-9	138.121	nd (w)	141	286			vs eth, EtOH
5500	Furazolidone	3-[[[(5-Nitro-2-furanyl)methylene]amino]-2-oxazolidinone	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> O <sub>5</sub>	67-45-8	225.159		255				
5501	Furethidine		C <sub>21</sub> H <sub>31</sub> NO <sub>4</sub>	2385-81-1	361.476		28	210 <sup>0.5</sup>		1.5219 <sup>20</sup>	
5502	Furfural	2-Furaldehyde	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	98-01-1	96.085	liq	-38.1	161.7	1.1594 <sup>20</sup>	1.5261 <sup>20</sup>	s H <sub>2</sub> O, bz, chl; vs EtOH, ace; msc eth
5503	Furfuryl alcohol	2-Furanmethanol	C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	98-00-0	98.101	col-ye liq	-14.6	171	1.1296 <sup>20</sup>	1.4869 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, eth; s chl
5504	Furfuryl propanoate	2-Furanmethanol, propanoate	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	623-19-8	154.163			195	1.1085 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, ace; msc eth
5505	Furoin	1,2-Di-2-furanyl-2-hydroxyethanone	C <sub>10</sub> H <sub>8</sub> O <sub>4</sub>	552-86-3	192.169	nd (al)	138.5				sl H <sub>2</sub> O, EtOH, chl; s eth, MeOH
5506	Furonazide		C <sub>12</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	3460-67-1	229.234		202.3				
5507	Furosemide		C <sub>12</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>5</sub> S	54-31-9	330.743		204 dec				
5508	Fursultiamine		C <sub>17</sub> H <sub>26</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	804-30-8	398.543	col pr	132 dec		1.29		sl H <sub>2</sub> O
5509	Furylfuramide, (E)	2-(2-Furanyl)-3-(5-nitro-2-furanyl)-2-propenamamide	C <sub>11</sub> H <sub>8</sub> N <sub>2</sub> O <sub>5</sub>	18819-45-9	248.192	cry	154				
5510	Fusarenen X		C <sub>17</sub> H <sub>22</sub> O <sub>8</sub>	23255-69-8	354.352	cry	182				
5511	Galactaric acid	Mucic acid	C <sub>8</sub> H <sub>10</sub> O <sub>6</sub>	526-99-8	210.138	pr (w)	255 dec				
5512	Galactitol	Dulcose	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	608-66-2	182.171	cry (dil MeOH)	189.5	277 <sup>1</sup>	1.47 <sup>20</sup>		s H <sub>2</sub> O; sl EtOH, py; i eth, bz
5513	D-Galactonic acid, γ-lactone		C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	2782-07-2	178.139	nd (w+1), nd (al)	112				vs H <sub>2</sub> O
5514	α-D-Galactopyranose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	3646-73-9	180.155		167				
5515	4-O-β-D-Galactopyranosyl-D-gluconic acid	Lactobionic acid	C <sub>12</sub> H <sub>22</sub> O <sub>12</sub>	96-82-2	358.296	syr					vs H <sub>2</sub> O; sl EtOH, MeOH, HOAc; i eth
5516	D-Galactose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	59-23-4	180.155	pl or pr (al)pr or nd (w+1)	170				vs H <sub>2</sub> O; sl EtOH; i eth, bz; s py
5517	D-Galacturonic acid		C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	685-73-4	194.139	nd (w)	166 (β)				s H <sub>2</sub> O, EtOH; i eth
5518	Galanthamine	Lycoremine	C <sub>17</sub> H <sub>21</sub> NO <sub>3</sub>	357-70-0	287.354	cry (bz)	126.5				vs ace, EtOH, chl
5519	Galipine	2-[2-(3,4-Dimethoxyphenyl)ethyl]-4-methoxyquinoline	C <sub>20</sub> H <sub>21</sub> NO <sub>3</sub>	525-68-8	323.386	pr (al, eth) nd (peth)	115.5				vs ace, bz, eth, EtOH
5520	Gallamine triethiodide		C <sub>30</sub> H <sub>60</sub> I <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	65-29-2	891.528		147.5				vs H <sub>2</sub> O, EtOH; sl eth, ace, bz, chl
5521	Gallein		C <sub>20</sub> H <sub>12</sub> O <sub>5</sub>	2103-64-2	332.306	br-red pow (+1.5w) red (anh)	>300				vs ace, EtOH
5522	Ganciclovir		C <sub>8</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	82410-32-0	255.231	cry (MeOH)	250 dec				
5523	Gardol		C <sub>15</sub> H <sub>26</sub> NNaO <sub>3</sub>	137-16-6	293.378						sl H <sub>2</sub> O
5524	Gelsemine		C <sub>20</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	509-15-9	322.401	cry (ace)	178				vs ace, bz, eth, EtOH
5525	Gelsemine, monohydrochloride		C <sub>20</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>2</sub>	35306-33-3	358.862		326				s H <sub>2</sub> O; sl EtOH
5526	Genistein	5,7-Dihydroxy-3-(4-hydroxyphenyl)-4H-1-benzopyran-4-one	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	446-72-0	270.237	nd(eth), pr(dil al)	301 dec				
5527	β-Gentiobiose	6-O-β-D-Glucopyranosyl-D-glucose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	554-91-6	342.296	cry (EtOH)	192				s hot H <sub>2</sub> O, hot MeOH
5528	trans-Geraniol		C <sub>10</sub> H <sub>18</sub> O	106-24-1	154.249		<-15	230	0.8894 <sup>20</sup>	1.4766 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl
5529	Geranyl 2-methylpropanoate		C <sub>14</sub> H <sub>24</sub> O <sub>2</sub>	2345-26-8	224.340			136 <sup>13</sup>	0.8997 <sup>15</sup>	1.4576 <sup>20</sup>	
5530	Geranyl acetate		C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	16409-44-2	196.286			115 <sup>12</sup>	0.9163 <sup>15</sup>	1.4624 <sup>20</sup>	
5531	Germin		C <sub>27</sub> H <sub>43</sub> NO <sub>8</sub>	508-65-6	509.632	pr or cry (MeOH)	220				s bz, MeOH, alk, acid
5532	Gibberellic acid		C <sub>19</sub> H <sub>22</sub> O <sub>6</sub>	77-06-5	346.374	cry (EtOAc)	234				vs ace, EtOH, MeOH
5533	Gitoxigenin		C <sub>23</sub> H <sub>34</sub> O <sub>5</sub>	545-26-6	390.513	pr (AcOEt) pr (+w, dil al)	234				i H <sub>2</sub> O; sl eth; s chl
5534	Gitoxin		C <sub>41</sub> H <sub>64</sub> O <sub>14</sub>	4562-36-1	780.939	pr (chl-MeOH)	285 dec				
5535	α-Glaucine		C <sub>21</sub> H <sub>25</sub> NO <sub>4</sub>	475-81-0	355.429	pl, pr (eth, AcOEt)	120				vs ace, EtOH, chl
5536	D-Glucaric acid	D-Tetrahydroxyadipic acid	C <sub>6</sub> H <sub>10</sub> O <sub>8</sub>	87-73-0	210.138	nd (45% al)	125.5				vs H <sub>2</sub> O, EtOH; sl eth, chl
5537	D-Glucitol	Sorbitol	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	50-70-4	182.171	nd (w)	111	295 <sup>3.5</sup>	1.489 <sup>20</sup>	1.3330 <sup>20</sup>	vs H <sub>2</sub> O, ace
5538	D-Glucitol, hexaacetate	Sorbitol hexaacetate	C <sub>18</sub> H <sub>26</sub> O <sub>12</sub>	7208-47-1	434.392	pr (w)	100.8		1.30 <sup>20</sup>		sl H <sub>2</sub> O, eth; vs EtOH; s chl, AcOEt



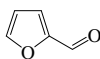
3-(2-Furanyl)-2-propenoic acid



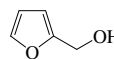
Furazolidone



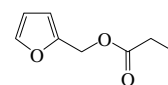
Furethidine



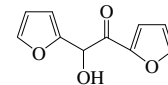
Furfural



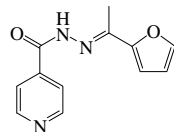
Furfuryl alcohol



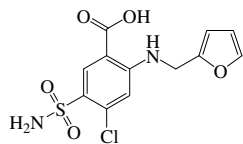
Furfuryl propanoate



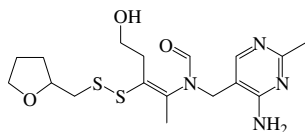
Furoin



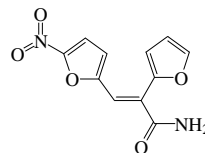
Furonazide



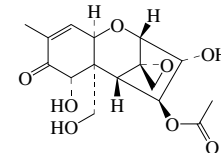
Furosemide



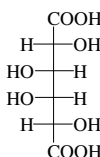
Fursultiamine



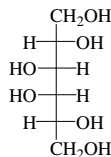
Furfurylamide, (E)



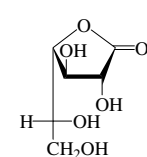
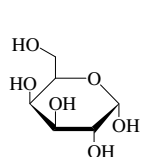
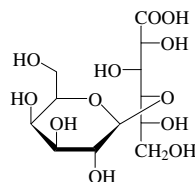
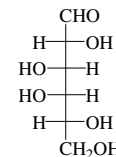
Fusarenon X



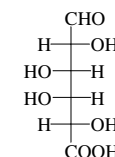
Galactaric acid



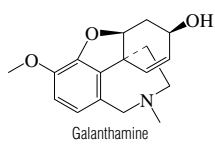
Galactitol

D-Galactonic acid,  $\gamma$ -lactone $\alpha$ -D-Galactopyranose4-O- $\beta$ -D-Galactopyranosyl-D-gluconic acid

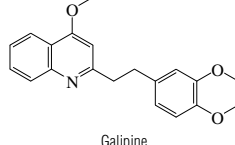
D-Galactose



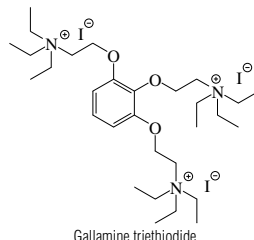
D-Galacturonic acid



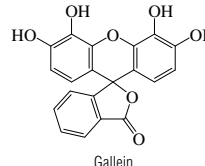
Galanthamine



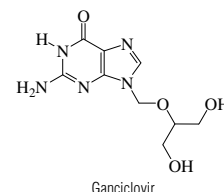
Galipine



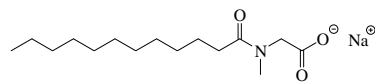
Gallamine triethiodide



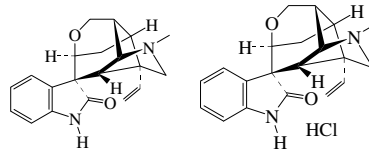
Gallein



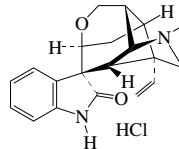
Ganciclovir



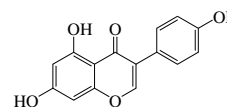
Gardol



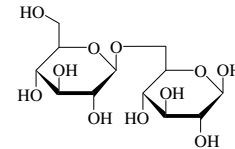
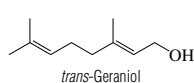
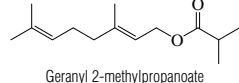
Gelsemine



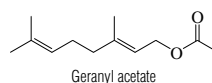
Gelsemine, monohydrochloride



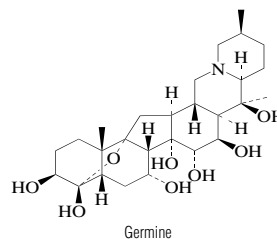
Genistein

 $\beta$ -Gentiobiose*trans*-Geraniol

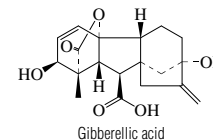
Geranyl 2-methylpropanoate



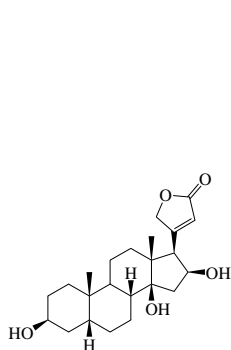
Geranyl acetate



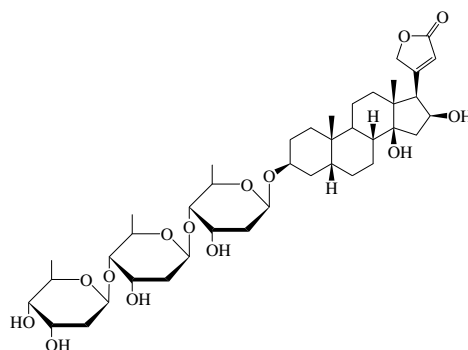
Germine



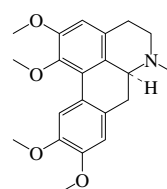
Gibberellic acid



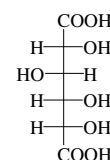
Gitoxigenin



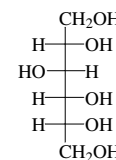
Gitoxin



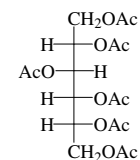
d-Glucine



D-Glucaric acid

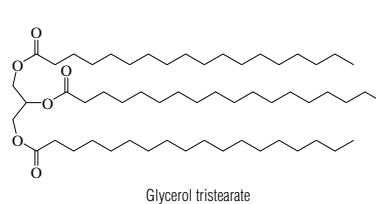
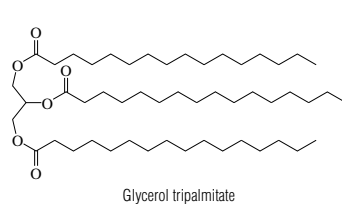
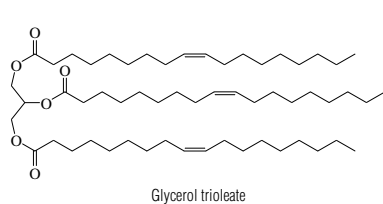
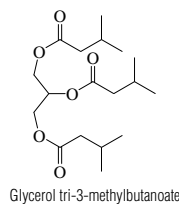
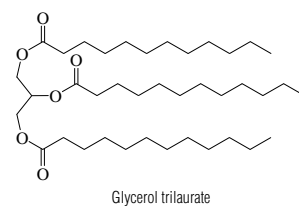
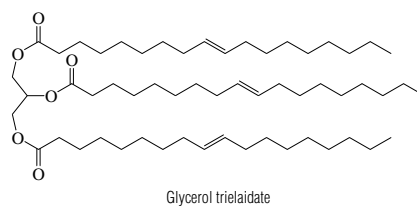
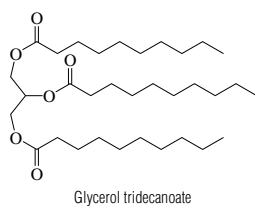
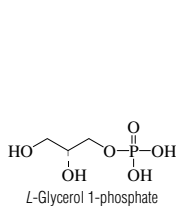
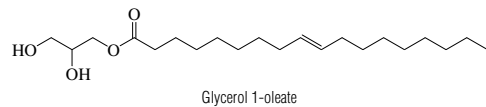
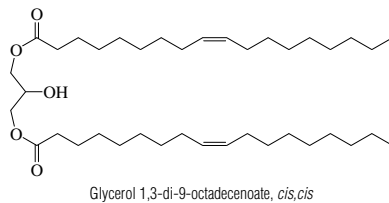
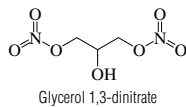
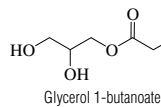
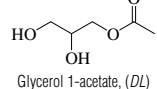
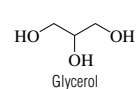
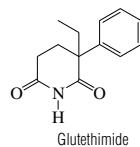
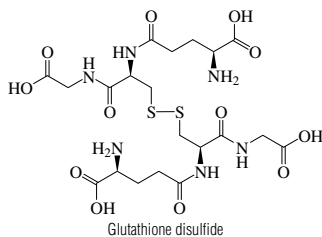
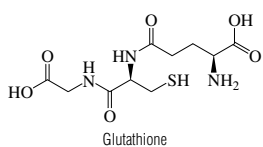
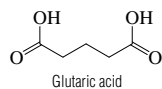
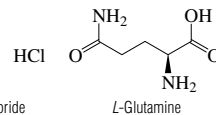
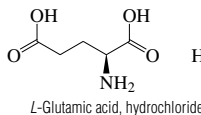
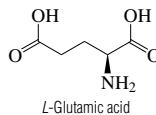
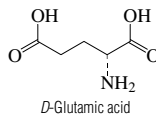
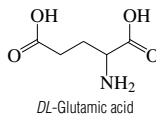
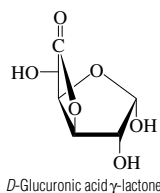
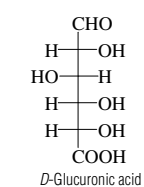
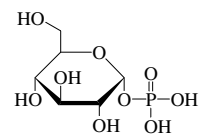
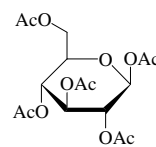
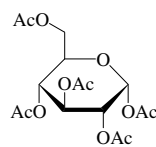
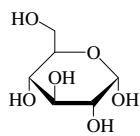
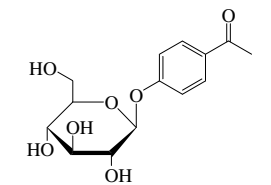
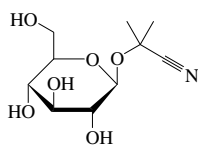
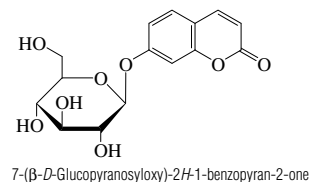
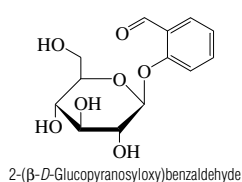
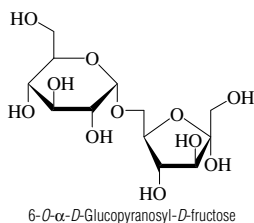
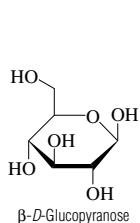
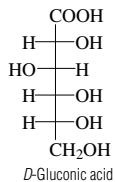


D-Glucitol



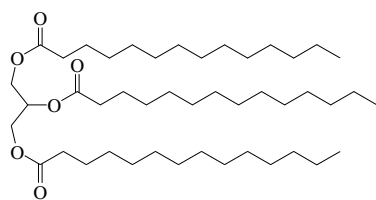
D-Glucitol, hexaacetate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5539	<i>D</i> -Gluconic acid		C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	526-95-4	196.155	nd (al-eth)	131				s H <sub>2</sub> O; sl EtOH; i eth, bz
5540	β- <i>D</i> -Glucopyranose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	492-61-5	180.155	cry (hot EtOH)	149				
5541	6- <i>O</i> -α- <i>D</i> -Glucopyranosyl- <i>D</i> -fructose	Palatinose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	13718-94-0	342.296						s H <sub>2</sub> O
5542	2-(β- <i>D</i> -Glucopyranosyloxy) benzaldehyde	Helicin	C <sub>13</sub> H <sub>16</sub> O <sub>7</sub>	618-65-5	284.262	nd (w)	175				vs H <sub>2</sub> O, EtOH
5543	7-(β- <i>D</i> -Glucopyranosyloxy)-2 <i>H</i> -1-benzopyran-2-one	Skimmin	C <sub>15</sub> H <sub>16</sub> O <sub>6</sub>	93-39-0	324.283	cry (w + 1)	220				s H <sub>2</sub> O, EtOH; i eth, chl
5544	2-(β- <i>D</i> -Glucopyranosyloxy)-2-methylpropanenitrile	Linamarin	C <sub>10</sub> H <sub>17</sub> NO <sub>6</sub>	554-35-8	247.245	nd (w, al)	145				vs ace
5545	1-[4-(β- <i>D</i> -Glucopyranosyloxy) phenyl]ethanone	Picein	C <sub>14</sub> H <sub>16</sub> O <sub>7</sub>	530-14-3	298.289	nd (w+1), nd (MeOH)	195.5				sl H <sub>2</sub> O; s EtOH, eth, HOAc; i chl
5546	α- <i>D</i> -Glucose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	26655-34-5	180.155		146 dec		1.5620 <sup>18</sup>		vs H <sub>2</sub> O; sl EtOH; i ace, AcOEt; s py
5547	α- <i>D</i> -Glucose pentaacetate		C <sub>16</sub> H <sub>22</sub> O <sub>11</sub>	604-68-2	390.339	pl or nd (al)	113.3	sub			sl H <sub>2</sub> O, EtOH, CS <sub>2</sub> ; s eth, chl, HOAc
5548	β- <i>D</i> -Glucose pentaacetate		C <sub>16</sub> H <sub>22</sub> O <sub>11</sub>	604-69-3	390.339	nd (al)	134	sub	1.2740 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, peth, eth; s bz; msc chl
5549	α- <i>D</i> -Glucose 1-phosphate		C <sub>6</sub> H <sub>13</sub> O <sub>8</sub> P	59-56-3	260.135						vs H <sub>2</sub> O
5550	<i>D</i> -Glucuronic acid		C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	6556-12-3	194.139	nd (al)	165				vs H <sub>2</sub> O, EtOH
5551	<i>D</i> -Glucuronic acid γ-lactone	<i>D</i> -Glucuronolactone	C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	32449-92-6	176.124	mcl pl (w) cry (al)	177.5		1.76 <sup>20</sup>		s H <sub>2</sub> O; sl EtOH, DMSO, MeOH; i bz
5552	<i>DL</i> -Glutamic acid		C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	617-65-2	147.130	orth (al,w)	199 dec		1.4601 <sup>20</sup>		sl H <sub>2</sub> O, eth; i EtOH, CS <sub>2</sub> , lig
5553	<i>D</i> -Glutamic acid		C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	6893-26-1	147.130	lf (w)	213 dec		1.538 <sup>20</sup>		sl H <sub>2</sub> O; i EtOH, eth, ace, bz, HOAc, MeOH
5554	<i>L</i> -Glutamic acid	( <i>S</i> )-2-Aminopentanedioic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	56-86-0	147.130	orth (dil al)	160 dec	sub 175	1.538 <sup>20</sup>		sl H <sub>2</sub> O
5555	<i>L</i> -Glutamic acid, hydrochloride		C <sub>5</sub> H <sub>10</sub> ClNO <sub>4</sub>	138-15-8	183.591	orth pl (w)	214 dec				vs H <sub>2</sub> O, EtOH
5556	<i>L</i> -Glutamine	2-Aminoglutaric acid	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	56-85-9	146.144	nd (w, dil al)	185 dec				s H <sub>2</sub> O; i EtOH, eth, bz, MeOH
5557	Glutaric acid	Pentanedioic acid	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	110-94-1	132.116	nd (bz)	97.8	dec 303	1.429 <sup>15</sup>	1.4188 <sup>106</sup>	vs H <sub>2</sub> O, EtOH, eth; i bz; s chl, lig
5558	Glutathione	<i>L</i> -γ-Glutamyl- <i>L</i> -cysteinylglycine	C <sub>10</sub> H <sub>17</sub> N <sub>3</sub> O <sub>6</sub> S	70-18-8	307.323	cry (50% al)	195				vs H <sub>2</sub> O; i EtOH, eth; s DMF
5559	Glutathione disulfide	<i>L</i> -γ-Glutamyl- <i>L</i> -cysteinylglycine disulfide	C <sub>20</sub> H <sub>32</sub> N <sub>6</sub> O <sub>12</sub> S <sub>2</sub>	27025-41-8	612.631	cry (EtOH aq)	179				
5560	Glutethimide		C <sub>13</sub> H <sub>15</sub> NO <sub>2</sub>	77-21-4	217.264	cry (eth)	84				i H <sub>2</sub> O; s EtOH; vs eth, ace
5561	Glycerol	1,2,3-Propanetriol	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	56-81-5	92.094	syr, orth pl	18.1	290	1.2613 <sup>20</sup>	1.4746 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth; i bz, ctc, chl
5562	Glycerol 1-acetate, ( <i>DL</i> )	1,2,3-Propanetriol 1-acetate, (±)	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	93713-40-7	134.131			158 <sup>165</sup> , 130 <sup>3</sup>	1.2060 <sup>20</sup>	1.4157 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl eth; i bz
5563	Glycerol 1-butanoate		C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	557-25-5	162.184			280; 117 <sup>10</sup>	1.129 <sup>18</sup>	1.4531 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
5564	Glycerol 1,3-dinitrate	1,2,3-Propanetriol, 1,3-dinitrate	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>7</sub>	623-87-0	182.089	pr (w), cry (eth)	26	148 <sup>15</sup> , 116 <sup>9,6</sup>	1.523 <sup>20</sup>	1.4715 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5565	Glycerol 1,3-di-9-octadecenoate, <i>cis,cis</i>		C <sub>39</sub> H <sub>72</sub> O <sub>3</sub>	2465-32-9	620.986	cry (eth/ EtOH)	50.1				
5566	Glycerol 1-oleate	1-Monoolein	C <sub>21</sub> H <sub>40</sub> O <sub>4</sub>	111-03-5	356.541	pl (al)	35	239 <sup>3</sup>	0.9420 <sup>20</sup>	1.4626 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
5567	<i>L</i> -Glycerol 1-phosphate	α-Glycerophosphoric acid	C <sub>3</sub> H <sub>5</sub> O <sub>8</sub> P	5746-57-6	172.073	syr		dec			dec H <sub>2</sub> O
5568	Glycerol tridecanoate	Decanoic acid glycerol triester	C <sub>33</sub> H <sub>62</sub> O <sub>6</sub>	621-71-6	554.841	cry (peth)	32				
5569	Glycerol trielaidate	Trielaidin	C <sub>57</sub> H <sub>104</sub> O <sub>6</sub>	537-39-3	885.432						vs bz, eth, chl
5570	Glycerol trilaurate	Trilaurin	C <sub>39</sub> H <sub>74</sub> O <sub>6</sub>	538-24-9	639.001	nd (al)			0.8986 <sup>55</sup>	1.4404 <sup>60</sup>	i H <sub>2</sub> O; s EtOH, eth, peth; vs ace, bz
5571	Glycerol tri-3-methylbutanoate	Triisovalerin	C <sub>18</sub> H <sub>32</sub> O <sub>6</sub>	620-63-3	344.443			332.5	0.9984 <sup>20</sup>	1.4354 <sup>20</sup>	vs eth, EtOH
5572	Glycerol trioleate	Triolein	C <sub>57</sub> H <sub>104</sub> O <sub>6</sub>	122-32-7	885.432	col-ye oil	-4	237 <sup>18</sup>	0.915 <sup>15</sup>	1.4676 <sup>15</sup>	i H <sub>2</sub> O; sl EtOH; vs eth; s chl, peth
5573	Glycerol tripalmitate	Tripalmitin	C <sub>51</sub> H <sub>98</sub> O <sub>6</sub>	555-44-2	807.320	nd (eth)	66.5	315	0.8752 <sup>70</sup>	1.4381 <sup>80</sup>	i H <sub>2</sub> O; sl EtOH; vs eth; s bz, chl
5574	Glycerol tristearate	Tristearin	C <sub>57</sub> H <sub>110</sub> O <sub>6</sub>	555-43-1	891.479				0.8559 <sup>90</sup>	1.4395 <sup>80</sup>	i H <sub>2</sub> O, EtOH; sl bz, ctc; s ace, chl

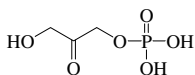


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5575	Glycerol tritridecanoate	Trimyristin	C <sub>45</sub> H <sub>86</sub> O <sub>6</sub>	555-45-3	723.161	wh-ye solid	58.5	311	0.8848 <sup>60</sup>	1.4428 <sup>60</sup>	i H <sub>2</sub> O; sl EtOH, lig; s eth, ace, bz
5576	Glycerone phosphate	1-Hydroxy-3-(phosphonoxy)-2-propanone	C <sub>3</sub> H <sub>4</sub> O <sub>6</sub> P	57-04-5	170.058						dec H <sub>2</sub> O
5577	Glycine	Aminoacetic acid	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	56-40-6	75.067	mcl or trg pr (dil al)	290 dec		1.161 <sup>20</sup>		vs H <sub>2</sub> O; i EtOH, eth; sl ace, py
5578	Glycine, ethyl ester, hydrochloride	Ethyl aminoacetate hydrochloride	C <sub>4</sub> H <sub>10</sub> ClNO <sub>2</sub>	623-33-6	139.581		144				vs H <sub>2</sub> O, EtOH
5579	Glycine, hydrochloride		C <sub>2</sub> H <sub>6</sub> ClNO <sub>2</sub>	6000-43-7	111.528	hyg orth nd (w)	200.5				vs H <sub>2</sub> O
5580	Glycocholic acid		C <sub>26</sub> H <sub>43</sub> NO <sub>6</sub>	475-31-0	465.622	nd (w)	166.5				sl H <sub>2</sub> O, eth; vs EtOH
5581	Glycocyanine		C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	352-97-6	117.107	pl or nd (w)	282				sl H <sub>2</sub> O, EtOH, eth
5582	Glycogen		(C <sub>6</sub> H <sub>10</sub> O <sub>5</sub> ) <sub>x</sub>	9005-79-2	162.140	wh pow					vs H <sub>2</sub> O; i EtOH, eth
5583	Glycolaldehyde		C <sub>2</sub> H <sub>2</sub> O <sub>2</sub>	141-46-8	60.052	pl	97		1.366 <sup>100</sup>	1.4772 <sup>19</sup>	s chl
5584	Glycolic acid		C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	79-14-1	76.051	orth nd (w) lf (eth)	79.5	100			s H <sub>2</sub> O, EtOH, eth
5585	<i>N</i> -Glycolylneuraminic acid	<i>N</i> -(Hydroxyacetyl)neuraminic acid	C <sub>11</sub> H <sub>19</sub> NO <sub>10</sub>	1113-83-3	325.270		186				
5586	Glycopyrrolate		C <sub>19</sub> H <sub>28</sub> BrNO <sub>3</sub>	596-51-0	398.334		192.5				
5587	Glycylalanine	<i>N</i> -Alanylglycine	C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	1188-01-8	146.144		237 dec				s H <sub>2</sub> O; i EtOH, eth
5588	<i>L</i> -Glycylasparagine		C <sub>8</sub> H <sub>11</sub> N <sub>3</sub> O <sub>4</sub>	1999-33-3	189.169	nd (EtOH aq)	216				s H <sub>2</sub> O; sl EtOH
5589	<i>N</i> -Glycylglycine	2-(Aminoacetamido)acetic acid	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	556-50-3	132.118		263 dec				s H <sub>2</sub> O
5590	<i>N</i> -( <i>N</i> -Glycylglycyl)glycine		C <sub>8</sub> H <sub>11</sub> N <sub>3</sub> O <sub>4</sub>	556-33-2	189.169	nd (dil al)	246 dec				s H <sub>2</sub> O; i EtOH, eth
5591	<i>N</i> -Glycyl- <i>L</i> -leucine		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	869-19-2	188.224	pl (dil al) pl (dil al)	256 dec				vs H <sub>2</sub> O; i EtOH
5592	<i>N</i> -Glycyl- <i>L</i> -phenylalanine		C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	3321-03-7	222.240		266				s H <sub>2</sub> O
5593	<i>N</i> -Glycylserine, ( <i>DL</i> )		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	687-38-7	162.144		198 dec				
5594	Glycyrrhizic acid		C <sub>42</sub> H <sub>62</sub> O <sub>16</sub>	1405-86-3	822.931	pl or pr (HOAc)	220 dec				vs H <sub>2</sub> O, EtOH; i eth
5595	Glyodin	1 <i>H</i> -Imidazole, 2-heptadecyl-4,5-dihydro-, monoacetate	C <sub>22</sub> H <sub>44</sub> N <sub>2</sub> O <sub>2</sub>	556-22-9	368.596				1.035 <sup>20</sup>		
5596	Glyoxal		C <sub>2</sub> H <sub>2</sub> O <sub>2</sub>	107-22-2	58.036	ye pr	15	50.4	1.14 <sup>20</sup>	1.3826 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth
5597	Glyoxal bis(2-hydroxyanil)	2,2'-Benzoxazoline	C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	1149-16-2	240.257		202				s DMSO
5598	Glyoxylic acid		C <sub>2</sub> H <sub>2</sub> O <sub>3</sub>	298-12-4	74.035	orth pr (w+1/2)	98				vs H <sub>2</sub> O; sl EtOH, eth, bz
5599	Glyphosate	Glycine, <i>N</i> -(phosphonomethyl)-	C <sub>3</sub> H <sub>8</sub> NO <sub>3</sub> P	1071-83-6	169.074		230 dec				
5600	Glyphosate isopropylamine salt		C <sub>6</sub> H <sub>17</sub> N <sub>2</sub> O <sub>3</sub> P	38641-94-0	228.183	cry					vs H <sub>2</sub> O
5601	Glyphosine	Glycine, <i>N,N</i> -bis(phosphonomethyl)-	C <sub>4</sub> H <sub>11</sub> NO <sub>8</sub> P <sub>2</sub>	2439-99-8	263.080	wh cry					s H <sub>2</sub> O
5602	Grayanotoxin I		C <sub>22</sub> H <sub>36</sub> O <sub>7</sub>	4720-09-6	412.517	cry (AcOEt/ C <sub>3</sub> H <sub>12</sub> )	268				
5603	Griseofulvin, (+)		C <sub>17</sub> H <sub>17</sub> ClO <sub>6</sub>	126-07-8	352.766	oct or orth cry (bz)	220				i H <sub>2</sub> O; sl EtOH, eth, ace, bz, AcOEt, chl
5604	Guaioil		C <sub>15</sub> H <sub>26</sub> O	489-86-1	222.366	trg pr (al)	91	dec 288; 165 <sup>17</sup>	0.9074 <sup>100</sup>	1.4716 <sup>100</sup>	i H <sub>2</sub> O; s EtOH, eth
5605	Guanabenz		C <sub>9</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>4</sub>	5051-62-7	231.083	wh solid	228 dec				
5606	Guanadrel sulfate (2:1)		C <sub>20</sub> H <sub>40</sub> N <sub>6</sub> O <sub>8</sub> S	22195-34-2	524.632	cry (MeOH/ EtOH)	214				
5607	Guanethidine		C <sub>10</sub> H <sub>22</sub> N <sub>4</sub>	55-65-2	198.309	wh cry (MeOH)	226				
5608	Guanidine	Aminomethanamide	CH <sub>5</sub> N <sub>3</sub>	113-00-8	59.071	cry	50				vs H <sub>2</sub> O, EtOH
5609	Guanidine monohydrochloride		CH <sub>6</sub> ClN <sub>3</sub>	50-01-1	95.532	orth bipym (al)	182.3		1.354 <sup>20</sup>		vs H <sub>2</sub> O, EtOH
5610	Guanidine mononitrate		CH <sub>5</sub> N <sub>3</sub> O <sub>3</sub>	506-93-4	122.084	lf (w)	217	dec			vs H <sub>2</sub> O, EtOH
5611	Guanidine, sulfate (2:1)		C <sub>2</sub> H <sub>12</sub> N <sub>6</sub> O <sub>2</sub> S	594-14-9	216.219		292 dec				
5612	2-Guanidinoethanesulfonic acid	Taurocyamine	C <sub>3</sub> H <sub>9</sub> N <sub>3</sub> O <sub>3</sub> S	543-18-0	167.186	cry (EtOH, ace)	227				
5613	3-Guanidinopropanoic acid	<i>N</i> -Amidino-β-alanine	C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	353-09-3	131.133	cry (EtOH)	210				
5614	Guanine		C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	73-40-5	151.127	nd or pl (aq NH <sub>3</sub> )	360 dec	sub			i H <sub>2</sub> O, HOAc; sl EtOH, eth; s alk, acid
5615	Guanosine	2-Amino-1,9-dihydro-9-β- <i>D</i> -ribofuranosyl-6 <i>H</i> -purin-6-one	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub>	118-00-3	283.241	nd (w)	239 dec				sl H <sub>2</sub> O; i EtOH, eth; vs HOAc
5616	Guanosine 5'-diphosphate	Guanosine 5'-(trihydrogen diphosphate)	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>11</sub> P <sub>2</sub>	146-91-8	443.201	amorp solid					
5617	Guanosine 5'-monophosphate	5'-Guanylic acid	C <sub>10</sub> H <sub>14</sub> N <sub>5</sub> O <sub>8</sub> P	85-32-5	363.221	hyg cry	190 dec				sl H <sub>2</sub> O

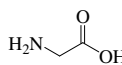




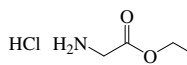
Glycerol tritridecanoate



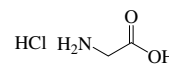
Glycerone phosphate



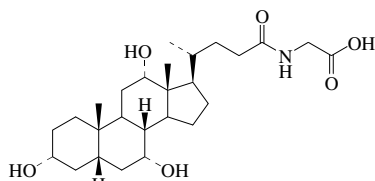
Glycine



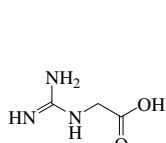
Glycine, ethyl ester, hydrochloride



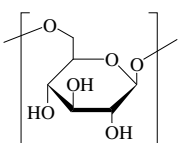
Glycine, hydrochloride



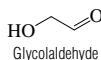
Glycocholic acid



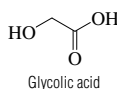
Glycocyanine



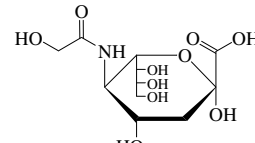
Glycogen



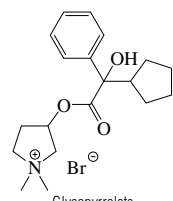
Glycolaldehyde



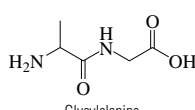
Glycolic acid



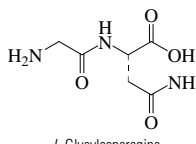
N-Glycolylneuraminic acid



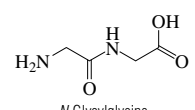
Glycopyrrolate



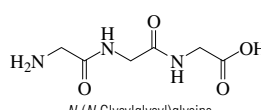
Glycylalanine



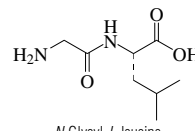
L-Glycylasparagine



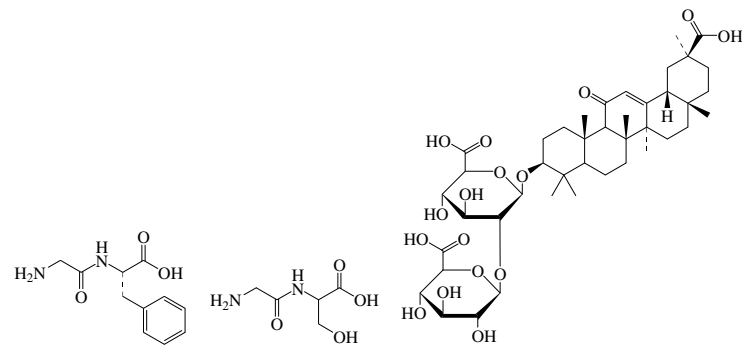
N-Glycylglycine



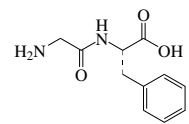
N-(N-glycylglycyl)glycine



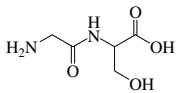
N-Glycyl-L-leucine



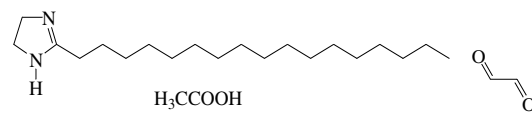
Glycyrrhizic acid



N-Glycyl-L-phenylalanine



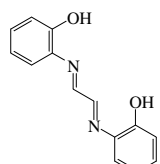
N-Glycylserine, (DL)

H<sub>3</sub>CCOOH

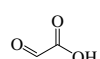
Glyodin



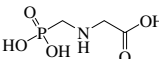
Glyoxal



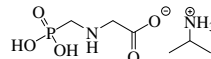
Glyoxal bis(2-hydroxyanil)



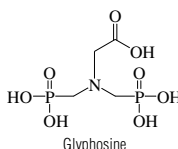
Glyoxylic acid



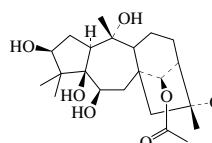
Glyphosate



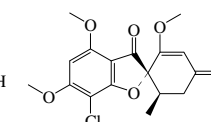
Glyphosate isopropylamine salt



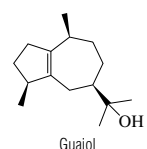
Glyphosine



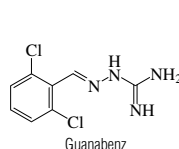
Grayanotoxin I



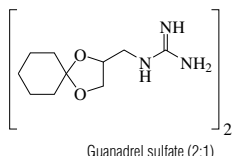
Griseofulvin, (+)



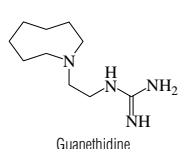
Guaiol



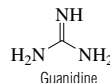
Guanabenz



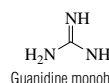
Guanadrel sulfate (2:1)

H<sub>2</sub>SO<sub>4</sub>

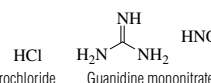
Guanethidine



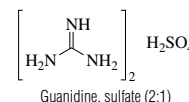
Guanidine



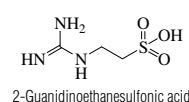
Guanidine monohydrochloride



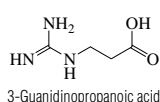
Guanidine mononitrate



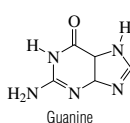
Guanidine, sulfate (2:1)



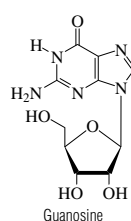
2-Guanidinoethanesulfonic acid



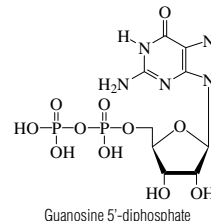
3-Guanidinopropanoic acid



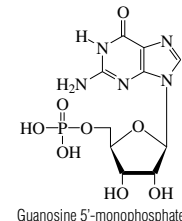
Guanine



Guanosine

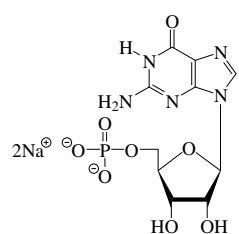


Guanosine 5'-diphosphate

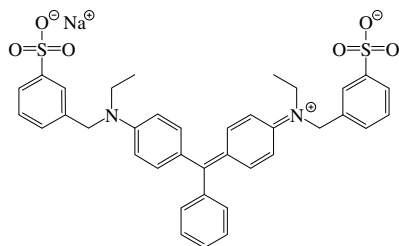


Guanosine 5'-monophosphate

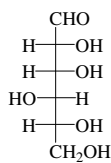
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5618	Guanosine 5'-monophosphate, disodium salt	5'-Guanylic acid, disodium salt	C <sub>10</sub> H <sub>12</sub> N <sub>5</sub> Na <sub>2</sub> O <sub>8</sub> P	5550-12-9	407.185		195 dec				sl H <sub>2</sub> O
5619	Guinea Green B	C.I. Acid Green 3	C <sub>37</sub> H <sub>35</sub> N <sub>7</sub> NaO <sub>6</sub> S <sub>2</sub>	4680-78-8	690.803	dk grn pow					s H <sub>2</sub> O; sl EtOH
5620	D-Gulose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	4205-23-6	180.155	syr		dec			vs H <sub>2</sub> O
5621	L-Gulose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	6027-89-0	180.155	syr		dec			vs H <sub>2</sub> O
5622	Haloperidol		C <sub>21</sub> H <sub>23</sub> ClFNO <sub>2</sub>	52-86-8	375.865		151.5				
5623	Harmaline	4,9-Dihydro-7-methoxy-1-methyl-3H-pyrido[3,4-b]indole	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O	304-21-2	214.262	tab (MeOH) orth pr (al)	230				sl H <sub>2</sub> O, EtOH, eth; s chl, py
5624	Harman	1-Methyl-9H-pyrido[3,4-b]indole	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	486-84-0	182.220	bl flr orth cry (hp)	236.5				
5625	Harmine	7-Methoxy-1-methyl-9H-pyrido[3,4-b]indole	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	442-51-3	212.246	orth (al), pr (MeOH)	273	sub			sl H <sub>2</sub> O, chl, EtOH, eth; s py
5626	HC Blue No. 1		C <sub>11</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub>	2784-94-3	255.271	blk cry	100				
5627	HC Blue No. 2		C <sub>12</sub> H <sub>19</sub> N <sub>3</sub> O <sub>5</sub>	33229-34-4	285.296	dk bl-blk cry	110				
5628	Hectane		C <sub>100</sub> H <sub>202</sub>	6703-98-6	1404.67		117				
5629	Hederagenin		C <sub>30</sub> H <sub>48</sub> O <sub>4</sub>	465-99-6	472.700	pr (al)	333				
5630	Helenalin		C <sub>15</sub> H <sub>16</sub> O <sub>4</sub>	6754-13-8	262.302	cry (EtOH)	226				sl H <sub>2</sub> O; s EtOH, chl
5631	Helminthosporal		C <sub>15</sub> H <sub>22</sub> O <sub>2</sub>	723-61-5	234.335		58	1170.015			
5632	Helvolic acid		C <sub>33</sub> H <sub>44</sub> O <sub>8</sub>	29400-42-8	568.697	nd (dil HOAc)	212 dec				sl H <sub>2</sub> O, EtOH; s eth, ace, bz, diox
5633	Hematein		C <sub>16</sub> H <sub>12</sub> O <sub>6</sub>	475-25-2	300.262	red-br cry	250 dec				i H <sub>2</sub> O, eth, bz, chl; sl EtOH, HOAc
5634	Hematin		C <sub>34</sub> H <sub>33</sub> FeN <sub>4</sub> O <sub>5</sub>	15489-90-4	633.495	br pow (py)	>200				i H <sub>2</sub> O, eth; s EtOH, alk; sl py, HOAc
5635	Hematoporphyrin		C <sub>34</sub> H <sub>38</sub> N <sub>4</sub> O <sub>6</sub>	14459-29-1	598.689	deep red cry	172.5				i H <sub>2</sub> O; s EtOH; sl eth, chl
5636	Hematoxylin		C <sub>16</sub> H <sub>14</sub> O <sub>6</sub>	517-28-2	302.278	ye cry	140				sl H <sub>2</sub> O, eth; s alk, EtOH
5637	Hemin		C <sub>34</sub> H <sub>32</sub> ClFeN <sub>4</sub> O <sub>4</sub>	16009-13-5	651.941	long blades (gl HOAc)	>300				
5638	Heneicosane		C <sub>21</sub> H <sub>44</sub>	629-94-7	296.574	cry (w)	40.01	356.5	0.7919 <sup>20</sup>	1.4441 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s peth
5639	Hentriacontane	Untriacontane	C <sub>31</sub> H <sub>64</sub>	630-04-6	436.840	lf (AcOEt)	67.9	458	0.781 <sup>68</sup>	1.4278 <sup>60</sup>	sl EtOH, eth, bz, chl; s peth
5640	Heptachlor		C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub>	76-44-8	373.318	wh cry	95.5		1.57 <sup>9</sup>		vs bz, eth, EtOH, lig
5641	Heptachlor epoxide		C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub> O	1024-57-3	389.317		160				
5642	2,2',3,3',4,4',6-Heptachlorobiphenyl		C <sub>12</sub> H <sub>3</sub> Cl <sub>7</sub>	52663-71-5	395.323	cry	117.5				i H <sub>2</sub> O
5643	1,1,1,2,3,3,3-Heptachloropropane		C <sub>3</sub> HCl <sub>7</sub>	3849-33-0	285.211		11	249	1.7921 <sup>34</sup>	1.5427 <sup>21</sup>	vs chl
5644	Heptacontane		C <sub>70</sub> H <sub>142</sub>	7719-93-9	983.876		107	647			
5645	Heptacosane		C <sub>27</sub> H <sub>56</sub>	593-49-7	380.734	cry (al, bz) lf (AcOEt)	59.23	442	0.7796 <sup>60</sup>	1.4345 <sup>65</sup>	i H <sub>2</sub> O, EtOH; sl eth
5646	Heptadecanal	Margaric aldehyde	C <sub>17</sub> H <sub>34</sub> O	629-90-3	254.451	nd (peth), cry (al)	36	204 <sup>26</sup>			vs bz, eth
5647	1-Heptadecanamine		C <sub>17</sub> H <sub>37</sub> N	4200-95-7	255.483		49	336	0.8510 <sup>20</sup>	1.4510 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5648	Heptadecane		C <sub>17</sub> H <sub>36</sub>	629-78-7	240.468	hex lf	22.0	302.0	0.7780 <sup>20</sup>	1.4369 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, ctc; s eth
5649	Heptadecanenitrile		C <sub>17</sub> H <sub>33</sub> N	5399-02-0	251.451	cry (al)	34	349	0.8315 <sup>20</sup>	1.4467 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, chl; vs eth
5650	Heptadecanoic acid	Margaric acid	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	506-12-7	270.451	pl (peth)	61.3	227 <sup>100</sup>	0.8532 <sup>60</sup>	1.4342 <sup>60</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, chl
5651	1-Heptadecanol	Margaryl alcohol	C <sub>17</sub> H <sub>36</sub> O	1454-85-9	256.467	lf (al), cry (ace)	53.9	324	0.8475 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth
5652	2-Heptadecanone	Pentadecyl methyl ketone	C <sub>17</sub> H <sub>34</sub> O	2922-51-2	254.451	pl (dil al)	48	320	0.8049 <sup>48</sup>		i H <sub>2</sub> O; sl EtOH; s ace, peth; vs bz, eth
5653	9-Heptadecanone		C <sub>17</sub> H <sub>34</sub> O	540-08-9	254.451	pl (MeOH)	53	251.5; 1421.5	0.8140 <sup>48</sup>		sl EtOH; s MeOH
5654	1-Heptadecene	Hexahydroaplotaxene	C <sub>17</sub> H <sub>34</sub>	6765-39-5	238.452		11.5	300	0.7852 <sup>20</sup>	1.4432 <sup>20</sup>	i H <sub>2</sub> O; vs eth; s bz; msc lig
5655	Heptadecylbenzene	1-Phenylheptadecane	C <sub>23</sub> H <sub>40</sub>	14752-75-1	316.564		32	397	0.8546 <sup>20</sup>	1.4810 <sup>20</sup>	
5656	trans,trans-2,4-Heptadienal		C <sub>7</sub> H <sub>10</sub> O	4313-03-5	110.153			84.5	0.881 <sup>25</sup>	1.5315 <sup>20</sup>	
5657	1,6-Heptadiene		C <sub>7</sub> H <sub>12</sub>	3070-53-9	96.170	liq		90			
5658	1,6-Heptadiyne		C <sub>7</sub> H <sub>8</sub>	2396-63-6	92.139	liq	-85	112	0.8164 <sup>17</sup>	1.4511 <sup>17</sup>	i H <sub>2</sub> O; s bz, HOAc
5659	Heptafluorobutanoic acid		C <sub>4</sub> HF <sub>7</sub> O <sub>2</sub>	375-22-4	214.039	liq	-17.5	121	1.651 <sup>20</sup>	1.295 <sup>25</sup>	s H <sub>2</sub> O, eth, tol; i peth



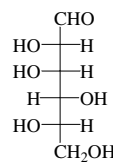
Guanosine 5'-monophosphate, disodium salt



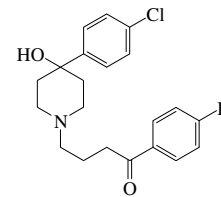
Guinea Green B



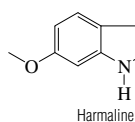
D-Gulose



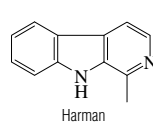
L-Gulose



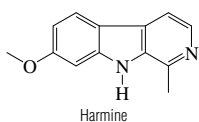
Haloperidol



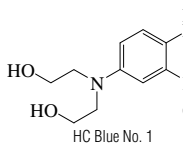
Harmaline



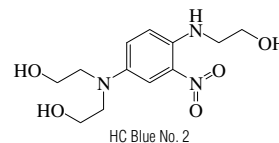
Harman



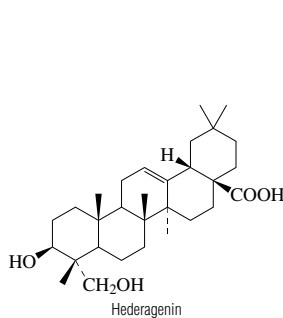
Harmine



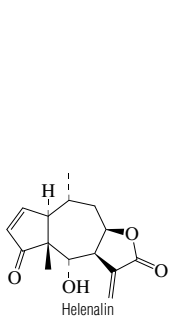
HC Blue No. 1



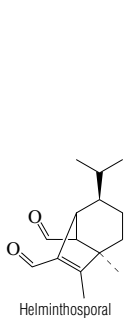
HC Blue No. 2

 $\text{H}_3\text{C}(\text{CH}_2)_{98}\text{CH}_3$   
Hectane


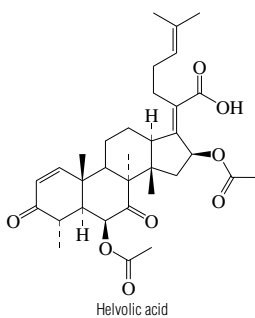
Hederagenin



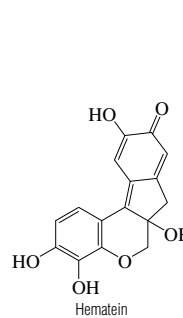
Helenalin



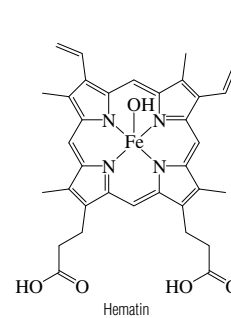
Helminthosporal



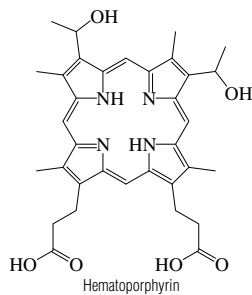
Helvolic acid



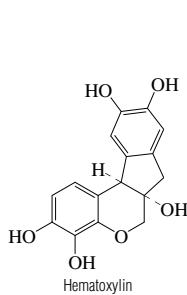
Hematein



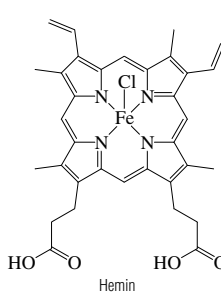
Hematin



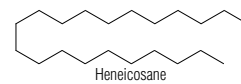
Hematoporphyrin



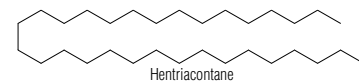
Hematoxylin



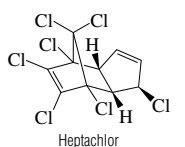
Hemin



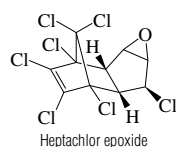
Heneicosane



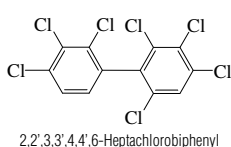
Hentriacontane



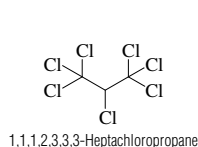
Heptachlor



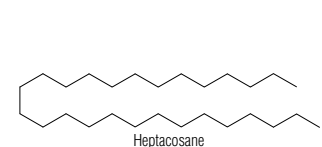
Heptachlor epoxide



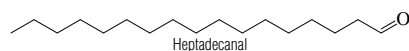
2,2',3,3',4,4',6-Heptachlorobiphenyl



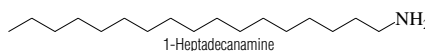
1,1,1,2,3,3,3-Heptachloropropane

 $\text{H}_3\text{C}(\text{CH}_2)_{68}\text{CH}_3$   
Heptacontane


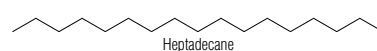
Heptacosane



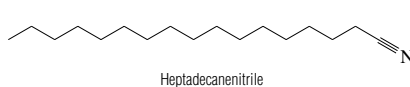
Heptadecanal



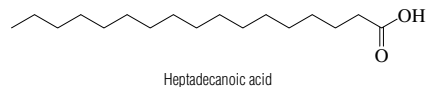
1-Heptadecanamine



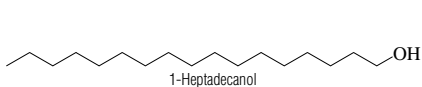
Heptadecane



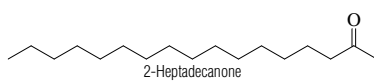
Heptadecanenitrile



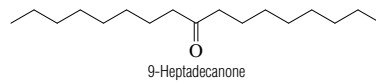
Heptadecanoic acid



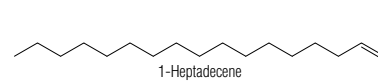
1-Heptadecanol



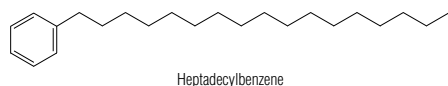
2-Heptadecanone



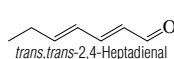
9-Heptadecanone



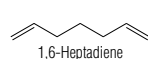
1-Heptadecene



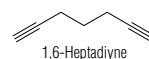
Heptadecylbenzene



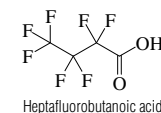
trans,trans-2,4-Heptadienal



1,6-Heptadiene

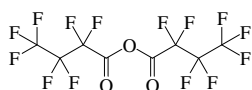


1,6-Heptadiyne

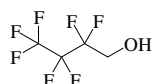


Heptafluorobutanoic acid

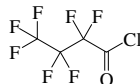
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5660	Heptafluorobutanoic anhydride		C <sub>8</sub> F <sub>14</sub> O <sub>3</sub>	336-59-4	410.062	liq	-43	106.5	1.665 <sup>20</sup>	1.285 <sup>20</sup>	
5661	2,2,3,3,4,4,4-Heptafluoro-1-butanol		C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	375-01-9	200.055			95	1.600 <sup>20</sup>	1.294 <sup>20</sup>	s EtOH, ace
5662	Heptafluorobutanyl chloride		C <sub>4</sub> ClF <sub>7</sub> O	375-16-6	232.484			38.5	1.55 <sup>20</sup>	1.288 <sup>20</sup>	
5663	6,6,7,7,8,8,8-Heptafluoro-2,2-dimethyl-3,5-octanedione		C <sub>10</sub> H <sub>11</sub> F <sub>7</sub> O <sub>2</sub>	17587-22-3	296.182		38	46 <sup>5</sup>	1.273 <sup>25</sup>	1.3766 <sup>20</sup>	
5664	Heptafluoro-2-iodopropane	Perfluoroisopropyl iodide	C <sub>3</sub> F <sub>7</sub> I	677-69-0	295.925			38	1.3298 <sup>20</sup>		
5665	1,1,1,2,3,3,3-Heptafluoropropane	Refrigerant 227ea	C <sub>3</sub> HF <sub>7</sub>	431-89-0	170.029	col gas	-126.8	-16.34			
5666	2,2,4,4,6,8,8-Heptamethylnonane		C <sub>16</sub> H <sub>34</sub>	4390-04-9	226.441			246.3			
5667	1,1,1,3,5,5,5-Heptamethyltrisiloxane		C <sub>7</sub> H <sub>22</sub> O <sub>2</sub> Si <sub>3</sub>	1873-88-7	222.506			142	0.8194 <sup>20</sup>	1.3818 <sup>20</sup>	
5668	Heptanal	Heptaldehyde	C <sub>7</sub> H <sub>14</sub> O	111-71-7	114.185	liq	-43.4	152.8	0.8132 <sup>25</sup>	1.4113 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
5669	Heptanal oxime	Enanthaldoxime	C <sub>7</sub> H <sub>15</sub> NO	629-31-2	129.200	pl (al)	57.5	195	0.8583 <sup>25</sup>	1.4210 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
5670	2-Heptanamine	Tuaminoheptane	C <sub>7</sub> H <sub>17</sub> N	123-82-0	115.217			142	0.7665 <sup>19</sup>	1.4199 <sup>19</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, peth
5671	4-Heptanamine		C <sub>7</sub> H <sub>17</sub> N	16751-59-0	115.217			139.5	0.767 <sup>20</sup>	1.4172 <sup>20</sup>	
5672	Heptane		C <sub>7</sub> H <sub>16</sub>	142-82-5	100.202	liq	-90.55	98.4	0.6795 <sup>25</sup>	1.3855 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, bz, chl; s ctc
5673	1,7-Heptanediamine		C <sub>7</sub> H <sub>18</sub> N <sub>2</sub>	646-19-5	130.231		25.32	224			s EtOH, eth, ace
5674	Heptanedinitrile		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	646-20-8	122.167		-31.4	155 <sup>14</sup>	0.949 <sup>18</sup>	1.4472 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, chl
5675	Heptanedioic acid	Pimelic acid	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	111-16-0	160.168	pr (w)	106	342.0; 272 <sup>100</sup>	1.329 <sup>15</sup>		s H <sub>2</sub> O, EtOH, eth; i bz
5676	1,7-Heptanediol		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	629-30-1	132.201		22.5	262	0.9569 <sup>25</sup>	1.4520 <sup>25</sup>	vs eth, EtOH
5677	2,3-Heptanedione	Acetyl valeryl	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	96-04-8	128.169			144; 46 <sup>13</sup>	0.919 <sup>18</sup>	1.4150 <sup>18</sup>	
5678	3,5-Heptanedione	Dipropionylmethane	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	7424-54-6	128.169			175; 79 <sup>30</sup>	0.945 <sup>20</sup>		
5679	Heptanedioyl dichloride		C <sub>7</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	142-79-0	197.059			137 <sup>15</sup>			
5680	Heptanenitrile		C <sub>7</sub> H <sub>13</sub> N	629-08-3	111.185	liq	-64	183; 71 <sup>10</sup>	0.8106 <sup>20</sup>	1.4104 <sup>30</sup>	i H <sub>2</sub> O; s eth, ace, bz, HOAc
5681	1-Heptanethiol	Heptyl mercaptan	C <sub>7</sub> H <sub>16</sub> S	1639-09-4	132.267	liq	-43	176.9	0.8427 <sup>20</sup>	1.4521 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
5682	2,4,6-Heptanetrione		C <sub>7</sub> H <sub>10</sub> O <sub>3</sub>	626-53-9	142.152	lf	49	121 <sup>10</sup>	1.0599 <sup>30</sup>	1.4930 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
5683	Heptanoic acid	Enanthic acid	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	111-14-8	130.185	liq	-7.17	222.2	0.9124 <sup>25</sup>	1.4170 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace
5684	Heptanoic anhydride		C <sub>14</sub> H <sub>26</sub> O <sub>3</sub>	626-27-7	242.354	liq	-12.4	269.5	0.9321 <sup>20</sup>	1.4335 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth
5685	1-Heptanol	Heptyl alcohol	C <sub>7</sub> H <sub>16</sub> O	111-70-6	116.201	liq	-33.2	176.45	0.8219 <sup>20</sup>	1.4249 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
5686	2-Heptanol, (±)		C <sub>7</sub> H <sub>16</sub> O	52390-72-4	116.201			159	0.8167 <sup>20</sup>	1.4210 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
5687	3-Heptanol, (S)		C <sub>7</sub> H <sub>16</sub> O	26549-25-7	116.201	liq	-70	157; 66 <sup>18</sup>	0.8227 <sup>20</sup>	1.4201 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
5688	4-Heptanol	Dipropylcarbinol	C <sub>7</sub> H <sub>16</sub> O	589-55-9	116.201	liq	-41.2	156	0.8183 <sup>20</sup>	1.4205 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
5689	2-Heptanone	Methyl pentyl ketone	C <sub>7</sub> H <sub>14</sub> O	110-43-0	114.185	liq	-35	151.05	0.8111 <sup>20</sup>	1.4088 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth
5690	3-Heptanone	Ethyl butyl ketone	C <sub>7</sub> H <sub>14</sub> O	106-35-4	114.185	liq	-39	147	0.8183 <sup>20</sup>	1.4057 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
5691	4-Heptanone	Dipropyl ketone	C <sub>7</sub> H <sub>14</sub> O	123-19-3	114.185	liq	-33	144	0.8174 <sup>20</sup>	1.4069 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
5692	Heptanoyl chloride		C <sub>7</sub> H <sub>13</sub> ClO	2528-61-2	148.630	liq	-83.8	125.2	0.9590 <sup>20</sup>	1.4345 <sup>18</sup>	s eth; sl ctc; vs lig
5693	2-Heptenal	Butylacrolein	C <sub>7</sub> H <sub>12</sub> O	2463-63-0	112.169			166	0.864 <sup>17</sup>	1.4468 <sup>17</sup>	
5694	1-Heptene		C <sub>7</sub> H <sub>14</sub>	592-76-7	98.186	liq	-118.9	93.64	0.6970 <sup>20</sup>	1.3998 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
5695	cis-2-Heptene		C <sub>7</sub> H <sub>14</sub>	6443-92-1	98.186			98.4	0.708 <sup>20</sup>	1.406 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl; sl ctc
5696	trans-2-Heptene		C <sub>7</sub> H <sub>14</sub>	14686-13-6	98.186	liq	-109.5	98	0.7012 <sup>20</sup>	1.4045 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth, chl
5697	cis-3-Heptene		C <sub>7</sub> H <sub>14</sub>	7642-10-6	98.186	liq	-136.6	95.8	0.7030 <sup>20</sup>	1.4059 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth, chl
5698	trans-3-Heptene		C <sub>7</sub> H <sub>14</sub>	14686-14-7	98.186	liq	-136.6	95.7	0.6981 <sup>20</sup>	1.4043 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl; sl ctc
5699	6-Heptenoic acid		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	1119-60-4	128.169	liq	-6.5	226	0.9515 <sup>14</sup>	1.4404 <sup>14</sup>	
5700	1-Hepten-4-ol		C <sub>7</sub> H <sub>14</sub> O	3521-91-3	114.185			152.1	0.8384 <sup>22</sup>	1.4347 <sup>20</sup>	



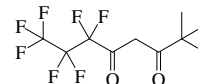
Heptafluorobutanoic anhydride



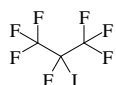
2,2,3,3,4,4,4-Heptafluoro-1-butanol



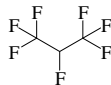
Heptafluorobutanoyl chloride



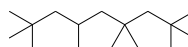
6,6,7,7,8,8,8-Heptafluoro-2,2-dimethyl-3,5-octanedione



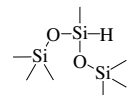
Heptafluoro-2-iodopropane



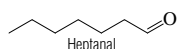
1,1,1,2,3,3,3-Heptafluoropropane



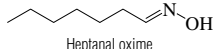
2,2,4,4,6,8,8-Heptamethylnonane



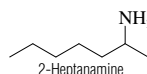
1,1,1,3,5,5,5-Heptamethyltrisiloxane



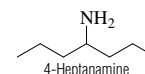
Heptanal



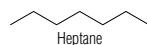
Heptanal oxime



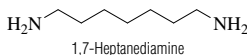
2-Heptanamine



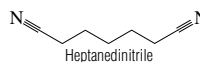
4-Heptanamine



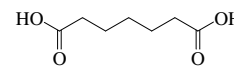
Heptane



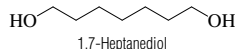
1,7-Heptanediamine



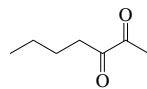
Heptanedinitrile



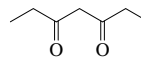
Heptanedioic acid



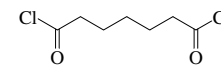
1,7-Heptanediol



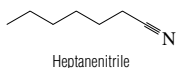
2,3-Heptanedione



3,5-Heptanedione



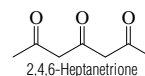
Heptanedioyl dichloride



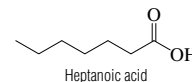
Heptanenitrile



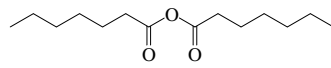
1-Heptanethiol



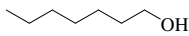
2,4,6-Heptanetrione



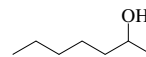
Heptanoic acid



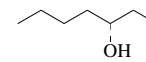
Heptanoic anhydride



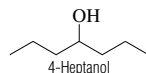
1-Heptanol



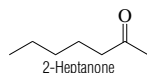
2-Heptanol, (±)



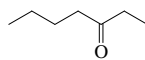
3-Heptanol, (S)



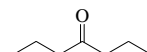
4-Heptanol



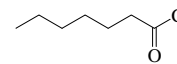
2-Heptanone



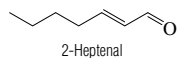
3-Heptanone



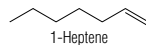
4-Heptanone



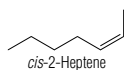
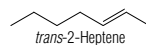
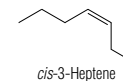
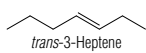
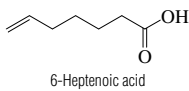
Heptanoyl chloride



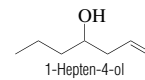
2-Heptenal



1-Heptene

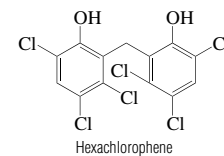
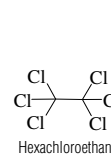
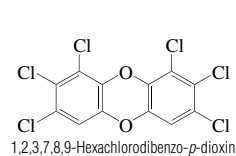
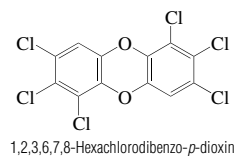
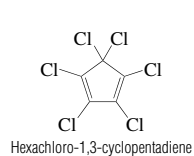
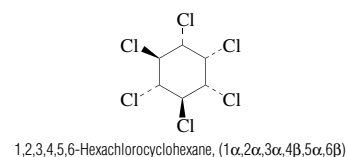
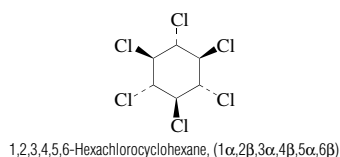
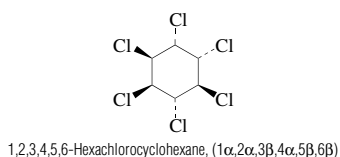
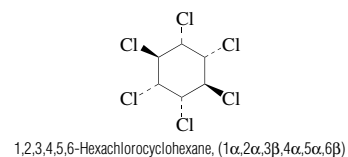
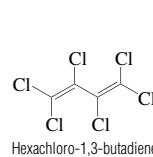
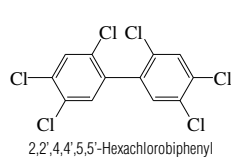
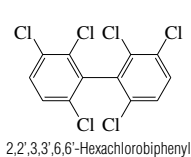
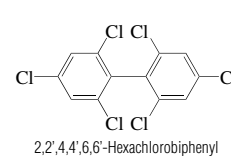
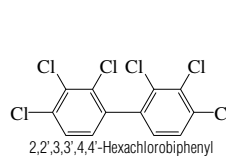
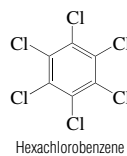
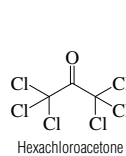
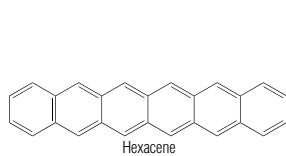
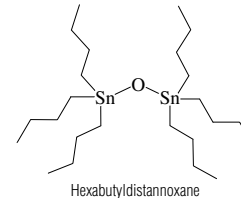
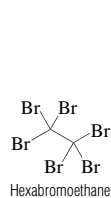
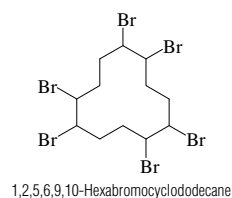
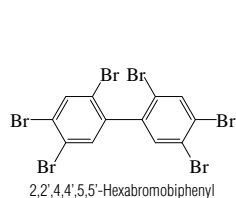
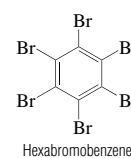
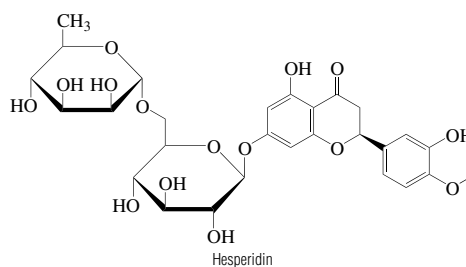
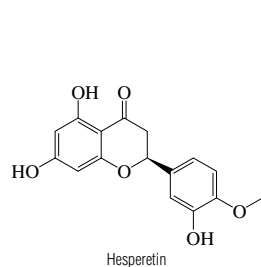
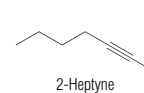
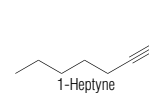
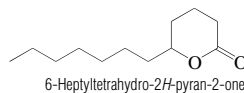
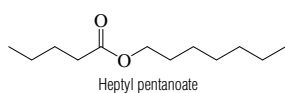
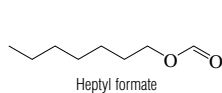
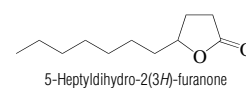
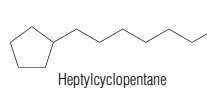
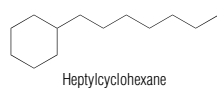
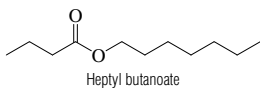
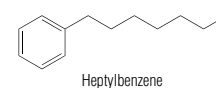
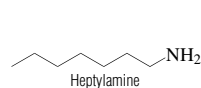
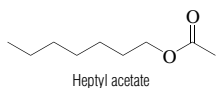
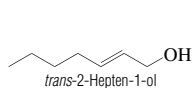
*cis*-2-Heptene*trans*-2-Heptene*cis*-3-Heptene*trans*-3-Heptene

6-Heptenoic acid



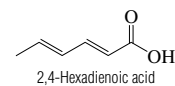
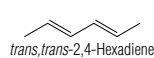
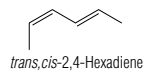
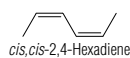
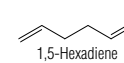
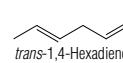
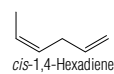
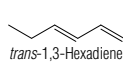
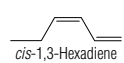
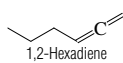
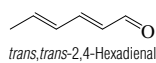
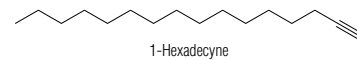
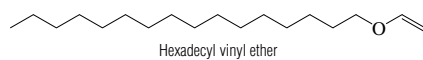
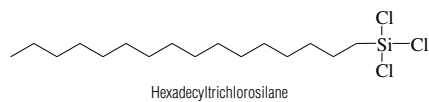
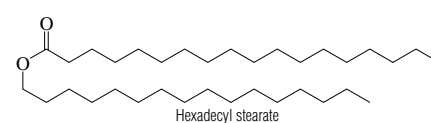
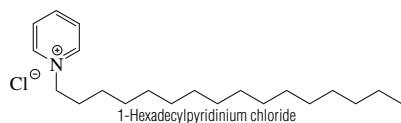
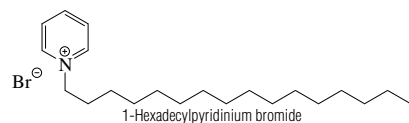
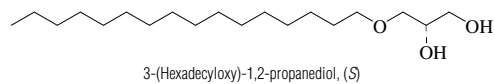
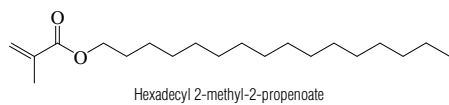
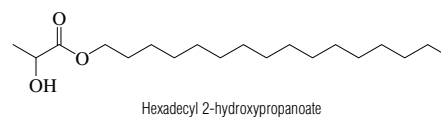
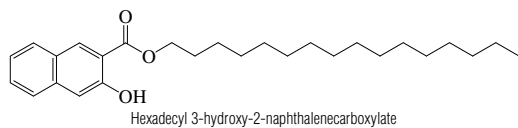
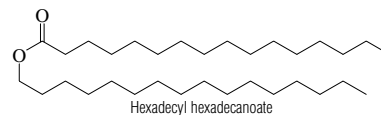
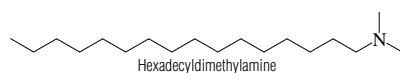
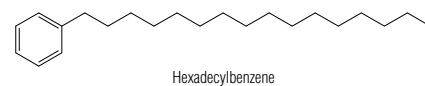
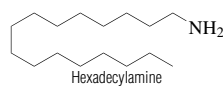
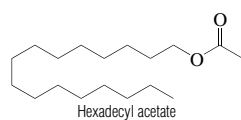
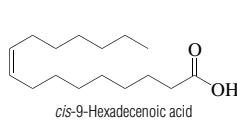
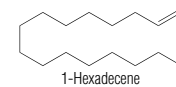
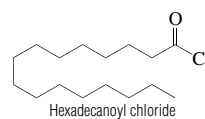
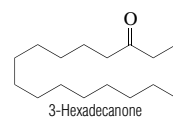
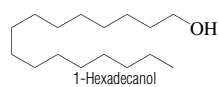
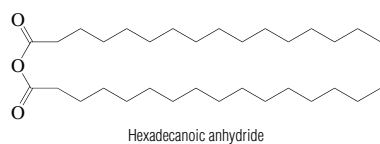
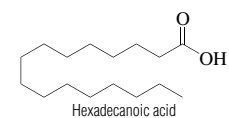
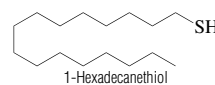
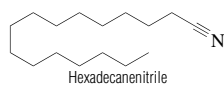
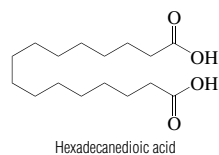
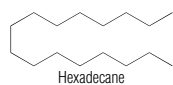
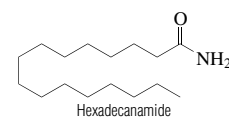
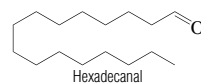
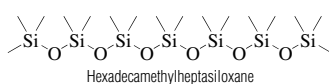
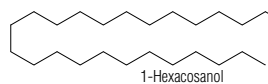
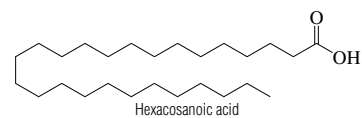
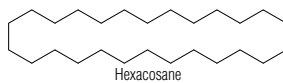
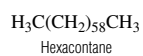
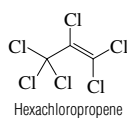
1-Hepten-4-ol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5701	<i>trans</i> -2-Hepten-1-ol		C <sub>7</sub> H <sub>14</sub> O	33467-76-4	114.185			178; 75 <sup>10</sup>	0.8516 <sup>20</sup>	1.4460 <sup>20</sup>	s EtOH, ace
5702	Heptyl acetate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	112-06-1	158.238	liq	-50.2	193	0.8750 <sup>15</sup>	1.4150 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
5703	Heptylamine	1-Heptanamine	C <sub>7</sub> H <sub>17</sub> N	111-68-2	115.217	liq	-18	156	0.7754 <sup>20</sup>	1.4251 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH, eth
5704	Heptylbenzene		C <sub>13</sub> H <sub>20</sub>	1078-71-3	176.298	liq	-48	240; 109 <sup>10</sup>	0.8567 <sup>20</sup>	1.4865 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl
5705	Heptyl butanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	5870-93-9	186.292	liq	-57.5	225.8	0.8637 <sup>20</sup>	1.4231 <sup>20</sup>	vs EtOH
5706	Heptylcyclohexane		C <sub>13</sub> H <sub>26</sub>	5617-41-4	182.345	liq	-30	244	0.8109 <sup>20</sup>	1.4484 <sup>20</sup>	
5707	Heptylcyclopentane		C <sub>12</sub> H <sub>24</sub>	5617-42-5	168.319	liq	-53	224	0.8010 <sup>20</sup>	1.4421 <sup>20</sup>	vs ace, bz, eth, EtOH
5708	5-Heptyldihydro-2(3 <i>H</i> )-furanone	4-Hydroxyundecanoic acid lactone	C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	104-67-6	184.276			286	0.9494 <sup>20</sup>	1.4512 <sup>20</sup>	vs EtOH
5709	Heptyl formate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	112-23-2	144.212			178.1	0.8784 <sup>20</sup>	1.4140 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
5710	Heptyl pentanoate		C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	5451-80-9	200.318	liq	-46.4	245.2	0.8623 <sup>20</sup>	1.4254 <sup>15</sup>	vs ace, eth, EtOH
5711	6-Heptyltetrahydro-2 <i>H</i> -pyran-2-one	5-Dodecanolide	C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	713-95-1	198.302	liq	-12	101 <sup>03</sup>			
5712	1-Heptyne		C <sub>7</sub> H <sub>12</sub>	628-71-7	96.170	liq	-81	99.7	0.7328 <sup>20</sup>	1.4087 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, chl, peth
5713	2-Heptyne	1-Methyl-2-butylacetylene	C <sub>7</sub> H <sub>12</sub>	1119-65-9	96.170			112	0.744 <sup>25</sup>	1.4230 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, chl, peth
5714	3-Heptyne	1-Ethyl-2-propylacetylene	C <sub>7</sub> H <sub>12</sub>	2586-89-2	96.170	liq	-130.5	107.2	0.7336 <sup>25</sup>	1.4189 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, chl, peth
5715	Hesperetin		C <sub>16</sub> H <sub>14</sub> O <sub>6</sub>	520-33-2	302.278	pl (dil al + 1/2 w)	227.5	sub 205			vs eth, EtOH
5716	Hesperidin		C <sub>28</sub> H <sub>34</sub> O <sub>15</sub>	520-26-3	610.561	wh nd (dil MeOH, HOAc)	262				vs py, EtOH, HOAc
5717	Hexabromobenzene		C <sub>6</sub> Br <sub>6</sub>	87-82-1	551.488	mcl nd (bz)	327				i H <sub>2</sub> O; sl EtOH, eth; s bz, chl
5718	2,2',4,4',5,5'-Hexabromobiphenyl		C <sub>12</sub> H <sub>6</sub> Br <sub>6</sub>	59080-40-9	627.584	cry (ctc)	160				
5719	1,2,5,6,9,10-Hexabromocyclododecane		C <sub>12</sub> H <sub>18</sub> Br <sub>6</sub>	3194-55-6	641.695	cry	167				
5720	Hexabromoethane		C <sub>2</sub> Br <sub>6</sub>	594-73-0	503.445	orth pr (bz)		dec 200	3.823 <sup>20</sup>	1.863	sl EtOH, eth, CS <sub>2</sub>
5721	Hexabutyl-distannoxane	Bis(tributyltin) oxide	C <sub>24</sub> H <sub>54</sub> OSn <sub>2</sub>	56-35-9	596.105	liq	-45	225 <sup>10</sup>	1.17 <sup>20</sup>	1.4870	
5722	Hexacene		C <sub>26</sub> H <sub>16</sub>	258-31-1	328.405	dk bl-grn cry (sub)	380	sub			i H <sub>2</sub> O, EtOH
5723	Hexachloroacetone		C <sub>2</sub> Cl <sub>6</sub> O	116-16-5	264.749	liq	-1.0	203	1.7434 <sup>12</sup>	1.5112 <sup>20</sup>	sl H <sub>2</sub> O; s ace
5724	Hexachlorobenzene	Perchlorobenzene	C <sub>6</sub> Cl <sub>6</sub>	118-74-1	284.782	nd (sub)	228.83	325	2.044 <sup>23</sup>	1.5691 <sup>23</sup>	i H <sub>2</sub> O; sl EtOH; s eth, chl; vs bz
5725	2,2',3,3',4,4'-Hexachlorobiphenyl		C <sub>12</sub> H <sub>2</sub> Cl <sub>6</sub>	38380-07-3	360.878	cry	151				i H <sub>2</sub> O
5726	2,2',4,4',6,6'-Hexachlorobiphenyl		C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	33979-03-2	360.878	cry	112.5				i H <sub>2</sub> O
5727	2,2',3,3',6,6'-Hexachlorobiphenyl		C <sub>12</sub> H <sub>2</sub> Cl <sub>6</sub>	38411-22-2	360.878	cry (hx)	114.2				i H <sub>2</sub> O
5728	2,2',4,4',5,5'-Hexachlorobiphenyl		C <sub>12</sub> H <sub>2</sub> Cl <sub>6</sub>	35065-27-1	360.878	cry	103.5				
5729	Hexachloro-1,3-butadiene		C <sub>4</sub> Cl <sub>6</sub>	87-68-3	260.761	liq	-21	215	1.556 <sup>25</sup>	1.5542 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5730	1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\alpha$ ,6 $\beta$ )	Lindane	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	58-89-9	290.830	nd (al)	112.5	323.4			vs ace, bz
5731	1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\beta$ ,6 $\beta$ )	$\alpha$ -Hexachlorocyclohexane	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	319-84-6	290.830	cry	158				
5732	1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\beta$ ,3 $\alpha$ ,4 $\beta$ ,5 $\alpha$ ,6 $\beta$ )	$\beta$ -Hexachlorocyclohexane	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	319-85-7	290.830	cry (bz, al, xyl)		60 <sup>050</sup>	1.89 <sup>19</sup>		i H <sub>2</sub> O; sl EtOH, bz, chl, HOAc
5733	1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\alpha$ ,4 $\beta$ ,5 $\alpha$ ,6 $\beta$ )	$\delta$ -Lindane	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	319-86-8	290.830	pl	141.5	60 <sup>036</sup>			
5734	Hexachloro-1,3-cyclopentadiene	Perchlorocyclopentadiene	C <sub>5</sub> Cl <sub>6</sub>	77-47-4	272.772	ye grn liq	-9	239; 48 <sup>03</sup>	1.7019 <sup>25</sup>	1.5658 <sup>20</sup>	
5735	1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin		C <sub>12</sub> H <sub>2</sub> Cl <sub>6</sub> O <sub>2</sub>	57653-85-7	390.861	cry	285				
5736	1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin		C <sub>12</sub> H <sub>2</sub> Cl <sub>6</sub> O <sub>2</sub>	19408-74-3	390.861	cry	243				
5737	Hexachloroethane	Perchloroethane	C <sub>2</sub> Cl <sub>6</sub>	67-72-1	236.739	orth (al-eth)	186.8 tp	184.7 sp	2.091 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth; s bz; sl liq HF
5738	Hexachlorophene		C <sub>13</sub> H <sub>6</sub> Cl <sub>6</sub> O <sub>2</sub>	70-30-4	406.904	nd (bz)	166.5				i H <sub>2</sub> O; s EtOH, eth, ace, chl, dil alk

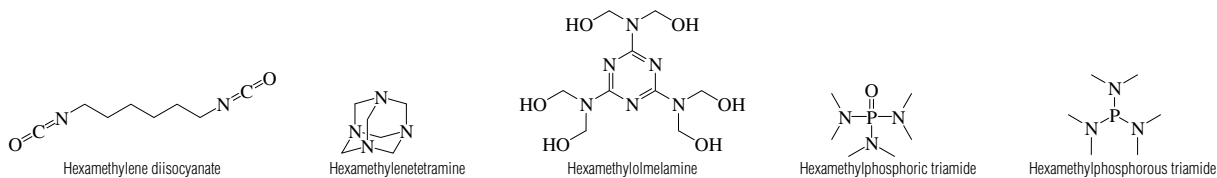
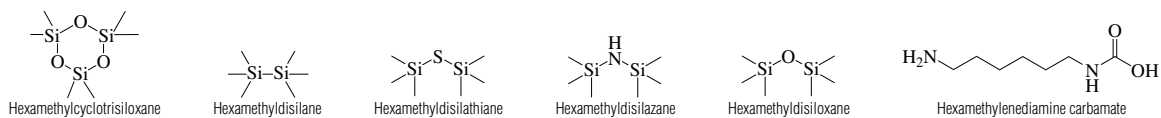
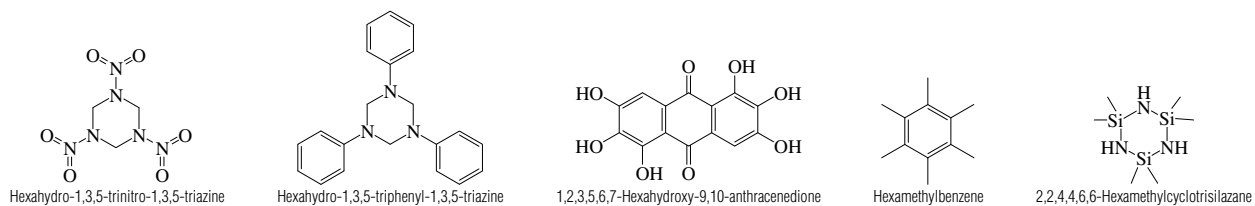
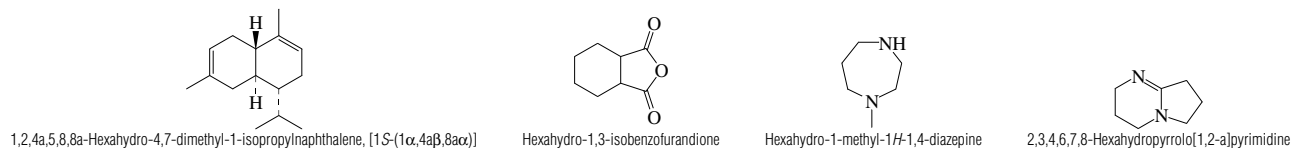
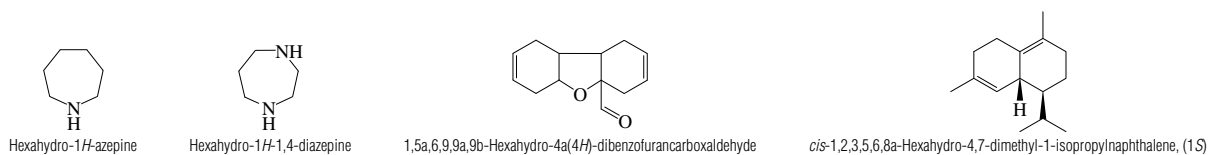
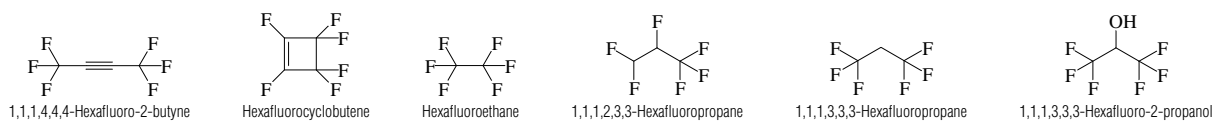
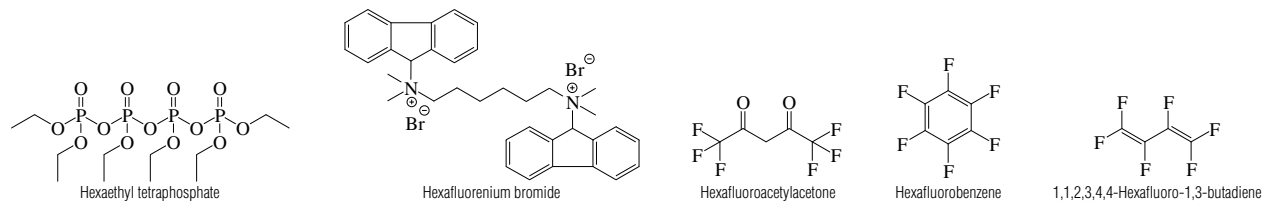
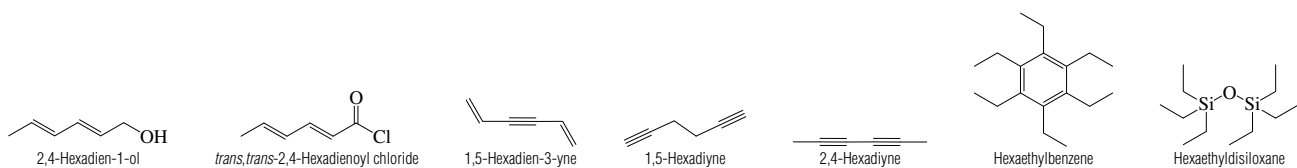


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5739	Hexachloropropene		C <sub>3</sub> Cl <sub>6</sub>	1888-71-7	248.750	liq	-72.9	209.5	1.7632 <sup>20</sup>	1.5091 <sup>20</sup>	i H <sub>2</sub> O; s ctc, chl
5740	Hexacontane		C <sub>60</sub> H <sub>122</sub>	7667-80-3	843.611		99.3				
5741	Hexacosane		C <sub>26</sub> H <sub>54</sub>	630-01-3	366.707	mcl, tcl or orth (bz) cry (eth)	56.1	412.2	0.7783 <sup>60</sup>	1.4357 <sup>60</sup>	vs bz, lig, chl
5742	Hexacosanoic acid	Cerotic acid	C <sub>26</sub> H <sub>52</sub> O <sub>2</sub>	506-46-7	396.690		88.5		0.8198 <sup>100</sup>	1.4301 <sup>100</sup>	i H <sub>2</sub> O; vs EtOH, eth
5743	1-Hexacosanol		C <sub>26</sub> H <sub>54</sub> O	506-52-5	382.706	orth pl (dil al)	80	305 <sup>20</sup> dec			i H <sub>2</sub> O; s EtOH, eth
5744	Hexadecamethylheptasiloxane		C <sub>16</sub> H <sub>48</sub> O <sub>6</sub> Si <sub>7</sub>	541-01-5	533.147	liq	-78	270	0.9012 <sup>20</sup>	1.3965 <sup>20</sup>	vs bz, lig
5745	Hexadecanal		C <sub>16</sub> H <sub>32</sub> O	629-80-1	240.424	pl (eth), nd (peth)	35	200 <sup>29</sup>			i H <sub>2</sub> O; s EtOH, eth, ace, bz
5746	Hexadecanamide		C <sub>16</sub> H <sub>33</sub> NO	629-54-9	255.439	lf	107	236 <sup>12</sup>	1.0000 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, bz, ace, eth
5747	Hexadecane	Cetane	C <sub>16</sub> H <sub>34</sub>	544-76-3	226.441	lf (HOAc)	18.12	286.86	0.7701 <sup>25</sup>	1.4329 <sup>25</sup>	i H <sub>2</sub> O; sl EtOH; msc eth; s ctc
5748	Hexadecanedioic acid		C <sub>16</sub> H <sub>30</sub> O <sub>4</sub>	505-54-4	286.407	pl (al)	126.6				vs ace, EtOH
5749	Hexadecanenitrile		C <sub>16</sub> H <sub>31</sub> N	629-79-8	237.424	hex	31	333	0.8303 <sup>20</sup>	1.4450 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
5750	1-Hexadecanethiol	Cetyl mercaptan	C <sub>16</sub> H <sub>34</sub> S	2917-26-2	258.506	cry (lig)	19	125 <sup>0.5</sup>			i H <sub>2</sub> O; sl EtOH, ctc; s eth
5751	Hexadecanoic acid	Palmitic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	57-10-3	256.424	nd (al)	62.5	351.5	0.8527 <sup>62</sup>	1.43345 <sup>60</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; msc eth; vs chl
5752	Hexadecanoic anhydride		C <sub>32</sub> H <sub>62</sub> O <sub>3</sub>	623-65-4	494.832	lf (peth)	64		0.8388 <sup>63</sup>	1.4364 <sup>68</sup>	vs eth
5753	1-Hexadecanol	Cetyl alcohol	C <sub>16</sub> H <sub>34</sub> O	36653-82-4	242.440	fl (AcOEt)	49.2	312	0.8187 <sup>50</sup>	1.4283 <sup>79</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, bz, chl; s ace
5754	3-Hexadecanone		C <sub>16</sub> H <sub>32</sub> O	18787-64-9	240.424	lf (peth)	43	184 <sup>17</sup> , 140 <sup>2</sup>			s chl
5755	Hexadecanoyl chloride		C <sub>16</sub> H <sub>31</sub> ClO	112-67-4	274.869		12	199 <sup>20</sup>	0.9016 <sup>25</sup>	1.4514 <sup>20</sup>	vs eth
5756	1-Hexadecene	1-Cetene	C <sub>16</sub> H <sub>32</sub>	629-73-2	224.425	lf	2.1	284.9	0.7811 <sup>20</sup>	1.4412 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, peth
5757	<i>cis</i> -9-Hexadecenoic acid	Palmitoleic acid	C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	373-49-9	254.408		0.5	182 <sup>1</sup>			
5758	Hexadecyl acetate		C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	629-70-9	284.478		-18.5	222 <sup>205</sup>	0.8574 <sup>25</sup>	1.4438 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s ctc
5759	Hexadecylamine	1-Hexadecanamine	C <sub>16</sub> H <sub>35</sub> N	143-27-1	241.456	lf	46.8	322.5	0.8129 <sup>20</sup>	1.4496 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz; s ace
5760	Hexadecylbenzene		C <sub>22</sub> H <sub>38</sub>	1459-09-2	302.537		27	385	0.8547 <sup>20</sup>	1.4813 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, bz, CS <sub>2</sub>
5761	Hexadecyldimethylamine	<i>N,N</i> -Dimethyl-1-hexadecanamine	C <sub>18</sub> H <sub>39</sub> N	112-69-6	269.510			330.0			
5762	Hexadecyl hexadecanoate	Cetyl palmitate	C <sub>32</sub> H <sub>64</sub> O <sub>2</sub>	540-10-3	480.849	mcl lf	54		0.989 <sup>20</sup>	1.4398 <sup>70</sup>	vs eth, EtOH
5763	Hexadecyl 3-hydroxy-2-naphthalenecarboxylate	Hexadecyl 3-hydroxy-2-naphthoate	C <sub>27</sub> H <sub>46</sub> O <sub>3</sub>	531-84-0	412.605	grn-wh fl	72.5				vs bz, HOAc
5764	Hexadecyl 2-hydroxypropanoate	Cetyl lactate	C <sub>19</sub> H <sub>38</sub> O <sub>3</sub>	35274-05-6	314.503	wax	41	219 <sup>10</sup> , 170 <sup>1</sup>		1.4410 <sup>40</sup>	
5765	Hexadecyl 2-methyl-2-propenoate		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	2495-27-4	310.515		24	183 <sup>2</sup>	0.87 <sup>20</sup>		
5766	3-(Hexadecyloxy)-1,2-propanediol, ( <i>S</i> )	Chimyl alcohol	C <sub>19</sub> H <sub>40</sub> O <sub>3</sub>	506-03-6	316.519	lf (hx)	64	120 <sup>0.005</sup>			vs ace, peth, chl
5767	1-Hexadecylpyridinium bromide		C <sub>21</sub> H <sub>38</sub> BrN	140-72-7	384.438		61				
5768	1-Hexadecylpyridinium chloride	Cetylpyridinium chloride	C <sub>21</sub> H <sub>38</sub> ClN	123-03-5	339.987	wh pow	80				vs H <sub>2</sub> O, chl
5769	Hexadecyl stearate	Cetyl stearate	C <sub>34</sub> H <sub>68</sub> O <sub>2</sub>	1190-63-2	508.903	lf or pl (eth, HOAc)	57			1.4410 <sup>70</sup>	vs ace, eth, chl
5770	Hexadecyltrichlorosilane		C <sub>16</sub> H <sub>33</sub> Cl <sub>3</sub> Si	5894-60-0	359.878			269			
5771	Hexadecyl vinyl ether	1-(Ethenyloxy)hexadecane	C <sub>18</sub> H <sub>36</sub> O	822-28-6	268.478		16	160 <sup>2</sup>	0.821 <sup>27</sup>	1.4444 <sup>25</sup>	
5772	1-Hexadecyne		C <sub>16</sub> H <sub>30</sub>	629-74-3	222.409		15	284	0.7965 <sup>20</sup>	1.4440 <sup>20</sup>	vs bz
5773	<i>trans,trans</i> -2,4-Hexadienal	Sorbinaldehyde	C <sub>8</sub> H <sub>8</sub> O	142-83-6	96.127	liq	-16.5	174; 76 <sup>30</sup>	0.898 <sup>20</sup>	1.5384 <sup>20</sup>	
5774	1,2-Hexadiene	Propylallene	C <sub>6</sub> H <sub>10</sub>	592-44-9	82.143			76	0.7149 <sup>20</sup>	1.4282 <sup>20</sup>	vs eth, chl
5775	<i>cis</i> -1,3-Hexadiene		C <sub>6</sub> H <sub>10</sub>	14596-92-0	82.143			73.1	0.7033 <sup>25</sup>	1.4379 <sup>20</sup>	
5776	<i>trans</i> -1,3-Hexadiene		C <sub>6</sub> H <sub>10</sub>	20237-34-7	82.143	liq	-102.4	73.2	0.6995 <sup>25</sup>	1.4406 <sup>20</sup>	
5777	<i>cis</i> -1,4-Hexadiene		C <sub>6</sub> H <sub>10</sub>	7318-67-4	82.143			66.3	0.695 <sup>25</sup>	1.4049 <sup>20</sup>	vs eth
5778	<i>trans</i> -1,4-Hexadiene		C <sub>6</sub> H <sub>10</sub>	7319-00-8	82.143	liq	-138.7	65.0	0.695 <sup>25</sup>	1.4104 <sup>20</sup>	
5779	1,5-Hexadiene	Biallyl	C <sub>6</sub> H <sub>10</sub>	592-42-7	82.143	liq	-140.7	59.4	0.6878 <sup>25</sup>	1.4042 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; sl ctc
5780	<i>cis,cis</i> -2,4-Hexadiene		C <sub>6</sub> H <sub>10</sub>	6108-61-8	82.143	liq		85	0.7298 <sup>25</sup>	1.4606 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
5781	<i>trans,cis</i> -2,4-Hexadiene		C <sub>6</sub> H <sub>10</sub>	5194-50-3	82.143	liq	-96.1	83.5	0.7185 <sup>25</sup>	1.4560 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
5782	<i>trans,trans</i> -2,4-Hexadiene		C <sub>6</sub> H <sub>10</sub>	5194-51-4	82.143	liq	-44.9	82.2	0.7101 <sup>25</sup>	1.4510 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
5783	2,4-Hexadienoic acid	Sorbic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	110-44-1	112.127	nd (dil al) nd (w)	134.5	dec 228; 153 <sup>50</sup>	1.204 <sup>19</sup>		s H <sub>2</sub> O, EtOH, chl; vs eth

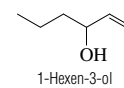
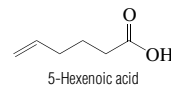
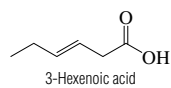
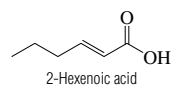
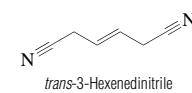
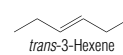
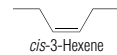
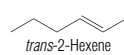
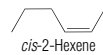
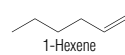
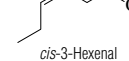
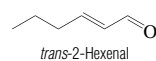
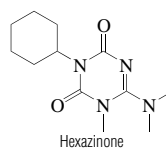
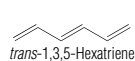
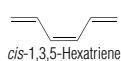
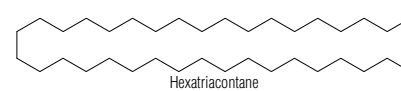
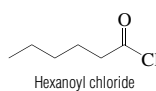
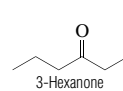
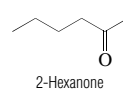
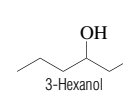
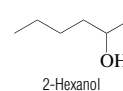
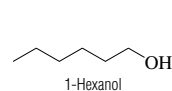
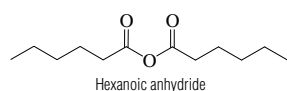
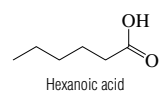
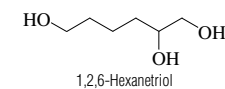
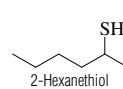
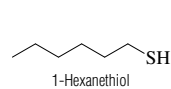
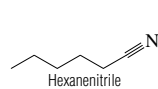
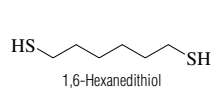
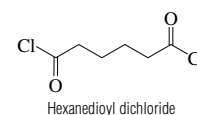
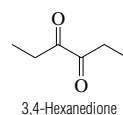
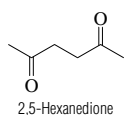
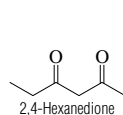
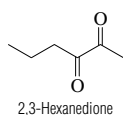
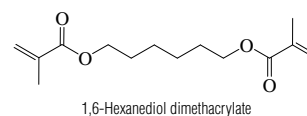
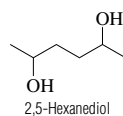
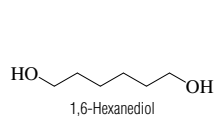
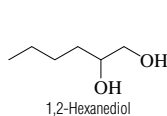
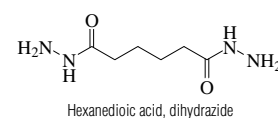
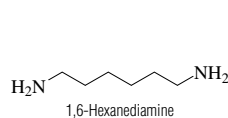
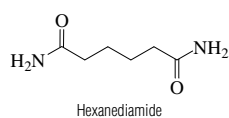
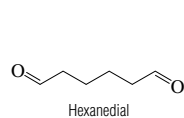
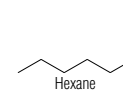
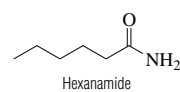
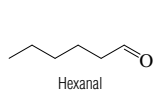
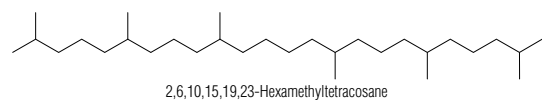




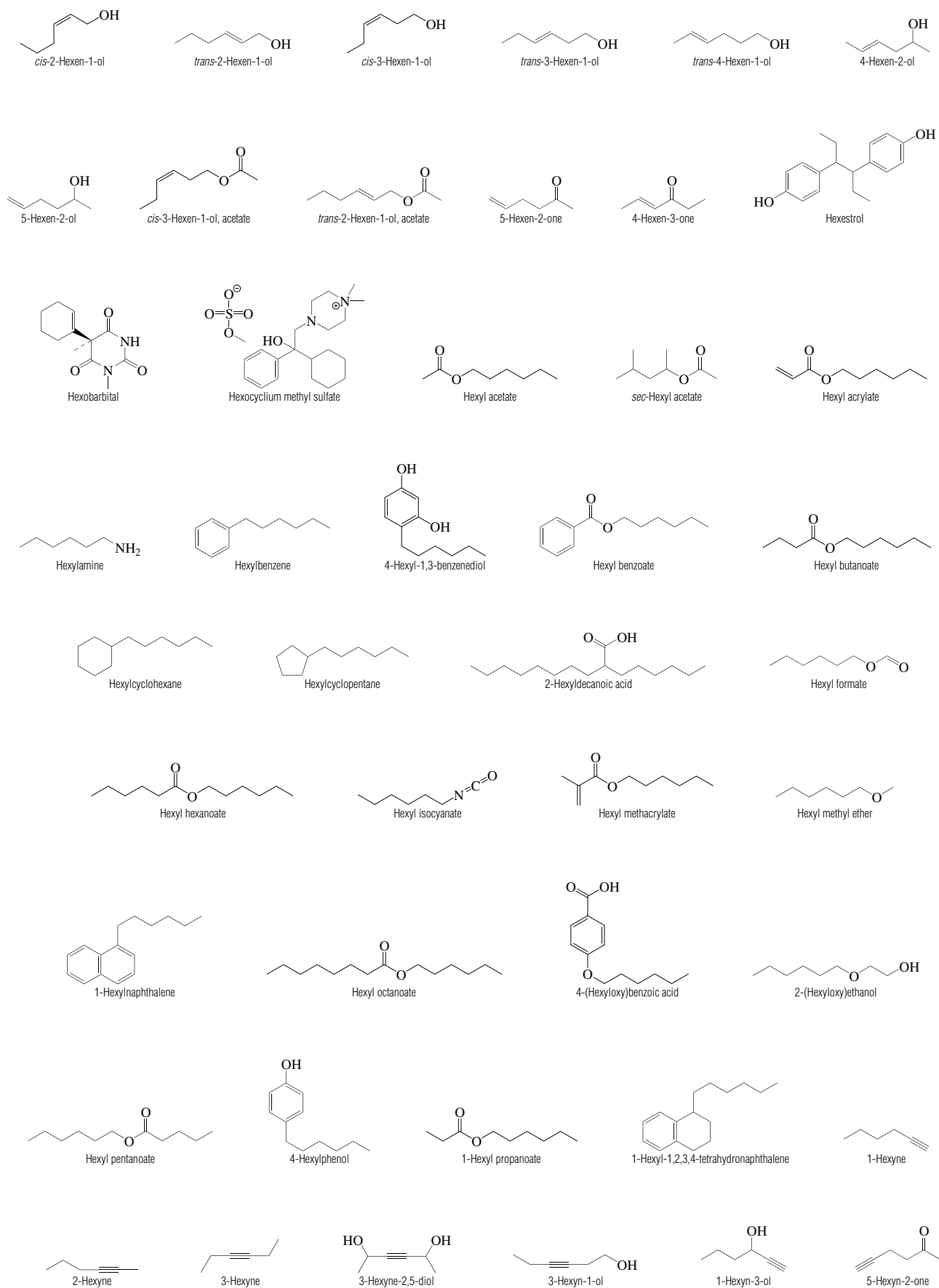
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5784	2,4-Hexadien-1-ol	Sorbic alcohol	C <sub>6</sub> H <sub>10</sub> O	111-28-4	98.142	nd	30.5	76 <sup>12</sup>	0.8967 <sup>23</sup>	1.4981 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
5785	<i>trans,trans</i> -2,4-Hexadienoyl chloride		C <sub>6</sub> H <sub>7</sub> ClO	2614-88-2	130.572			82 <sup>22</sup>	1.0666 <sup>19</sup>	1.5545 <sup>20</sup>	vs ace
5786	1,5-Hexadien-3-yne	Divinylacetylene	C <sub>6</sub> H <sub>6</sub>	821-08-9	78.112	liq	-88	85	0.7851 <sup>20</sup>	1.5035 <sup>20</sup>	i H <sub>2</sub> O; s bz
5787	1,5-Hexadiyne	Bipropargyl	C <sub>6</sub> H <sub>6</sub>	628-16-0	78.112	liq	-6	86	0.8049 <sup>20</sup>	1.4380 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
5788	2,4-Hexadiyne	Dimethyldiacetylene	C <sub>6</sub> H <sub>6</sub>	2809-69-0	78.112	pr (sub)	67.8	129.5			vs EtOH, eth
5789	Hexaethylbenzene		C <sub>18</sub> H <sub>30</sub>	604-88-6	246.431	mcl pr (al or bz)	129	298	0.8305 <sup>130</sup>	1.4736 <sup>130</sup>	i H <sub>2</sub> O; s EtOH, sulf; vs eth, bz
5790	Hexaethyldisiloxane		C <sub>12</sub> H <sub>30</sub> OSi <sub>2</sub>	994-49-0	246.536			233; 129 <sup>30</sup>	0.8457 <sup>20</sup>	1.4340 <sup>20</sup>	
5791	Hexaethyl tetraphosphate	Ethyl tetraphosphate	C <sub>12</sub> H <sub>30</sub> O <sub>13</sub> P <sub>4</sub>	757-58-4	506.253	hyg	-40	dec 150	1.2917 <sup>27</sup>	1.4273 <sup>27</sup>	vs ace, bz, EtOH
5792	Hexafluoronium bromide		C <sub>36</sub> H <sub>42</sub> Br <sub>2</sub> N <sub>2</sub>	317-52-2	662.539	cry (PrOH)	188				
5793	Hexafluoroacetylacetone		C <sub>6</sub> H <sub>2</sub> F <sub>6</sub> O <sub>2</sub>	1522-22-1	208.059			54.15	1.485 <sup>20</sup>	1.3333 <sup>20</sup>	
5794	Hexafluorobenzene	Perfluorobenzene	C <sub>6</sub> F <sub>6</sub>	392-56-3	186.054		5.03	80.32	1.6175 <sup>20</sup>	1.3777 <sup>20</sup>	
5795	1,1,2,3,4,4-Hexafluoro-1,3-butadiene		C <sub>4</sub> F <sub>6</sub>	685-63-2	162.033	col gas	-132	5.47	1.553 <sup>20</sup>	1.378 <sup>20</sup>	
5796	1,1,1,4,4,4-Hexafluoro-2-butyne		C <sub>4</sub> F <sub>6</sub>	692-50-2	162.033	col gas	-117.4	-24.6			s EtOH, eth, ace, ctc, HOAc
5797	Hexafluorocyclobutene		C <sub>4</sub> F <sub>6</sub>	697-11-0	162.033	col gas	-60	5.5	1.602 <sup>20</sup>	1.298 <sup>20</sup>	
5798	Hexafluoroethane	Perfluoroethane	C <sub>2</sub> F <sub>6</sub>	76-16-4	138.011	col gas	-100.05	-78.1	1.590 <sup>78</sup>		i H <sub>2</sub> O; sl EtOH, eth
5799	1,1,1,2,3,3-Hexafluoropropane	Refrigerant 236ea	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	431-63-0	152.038	col gas		6.2	1.5026 <sup>9</sup>		
5800	1,1,1,3,3,3-Hexafluoropropane	Refrigerant 236fa	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	690-39-1	152.038	col gas	-93.6	-1.0	1.4343 <sup>9</sup>		
5801	1,1,1,3,3,3-Hexafluoro-2-propanol		C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	920-66-1	168.037	liq	-2.0	59	1.4600 <sup>21</sup>		
5802	Hexahydro-1 <i>H</i> -azepine	Hexamethylenimine	C <sub>6</sub> H <sub>13</sub> N	111-49-9	99.174			138	0.8643 <sup>22</sup>	1.4631 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth
5803	Hexahydro-1 <i>H</i> -1,4-diazepine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	505-66-8	100.162	hyg	40.5	169			
5804	1,5a,6,9,9a,9b-Hexahydro-4a(4 <i>H</i> )-dibenzofurancarboxaldehyde		C <sub>13</sub> H <sub>16</sub> O <sub>2</sub>	126-15-8	204.265	liq	-80	307	1.10 <sup>20</sup>	1.5254 <sup>20</sup>	i H <sub>2</sub> O
5805	<i>cis</i> -1,2,3,5,6,8a-Hexahydro-4,7-dimethyl-1-isopropyl-naphthalene, (1 <i>S</i> )		C <sub>15</sub> H <sub>24</sub>	483-76-1	204.352			125 <sup>12</sup>	0.9160 <sup>15</sup>	1.5089 <sup>15</sup>	
5806	1,2,4a,5,8,8a-Hexahydro-4,7-dimethyl-1-isopropyl-naphthalene, [1 <i>S</i> -(1 <i>α</i> ,4 <i>α</i> β,8 <i>α</i> )]		C <sub>15</sub> H <sub>24</sub>	523-47-7	204.352			274; 136 <sup>11</sup>	0.9230 <sup>20</sup>	1.5059 <sup>20</sup>	vs eth, lig
5807	Hexahydro-1,3-isobenzofurandione	Hexahydrophthalic anhydride	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	85-42-7	154.163		32	145 <sup>18</sup>			
5808	Hexahydro-1-methyl-1 <i>H</i> -1,4-diazepine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	4318-37-0	114.188			154	0.9111 <sup>20</sup>	1.4769 <sup>20</sup>	
5809	2,3,4,6,7,8-Hexahydropyrrolo[1,2- <i>a</i> ]pyrimidine		C <sub>7</sub> H <sub>12</sub> N <sub>2</sub>	3001-72-7	124.183			96 <sup>1</sup> , 81 <sup>2</sup>	1.005 <sup>25</sup>	1.5190 <sup>20</sup>	
5810	Hexahydro-1,3,5-trinitro-1,3,5-triazine	Cyclonite	C <sub>3</sub> H <sub>3</sub> N <sub>6</sub> O <sub>6</sub>	121-82-4	222.116	orth cry (ace)	205.5		1.82 <sup>20</sup>		i H <sub>2</sub> O, EtOH, bz; sl eth, MeOH; s ace, HOAc
5811	Hexahydro-1,3,5-triphenyl-1,3,5-triazine		C <sub>21</sub> H <sub>21</sub> N <sub>3</sub>	91-78-1	315.412		144	185; 60 <sup>29</sup>			i H <sub>2</sub> O; sl EtOH; s eth, ace, bz, tol
5812	1,2,3,5,6,7-Hexahydroxy-9,10-anthracenedione	Rufigallol	C <sub>14</sub> H <sub>6</sub> O <sub>8</sub>	82-12-2	304.209	red rhom, red-ye nd (sub)		sub			i H <sub>2</sub> O; sl EtOH, eth; s ace, alk
5813	Hexamethylbenzene	Mellitene	C <sub>12</sub> H <sub>18</sub>	87-85-4	162.271	orth pr or nd (al)	165.5	263.4	1.0630 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc, chl
5814	2,2,4,4,6,6-Hexamethylcyclotrisilazane		C <sub>6</sub> H <sub>21</sub> N <sub>3</sub> Si <sub>3</sub>	1009-93-4	219.508	liq	-10	188	0.9196 <sup>20</sup>	1.448 <sup>20</sup>	
5815	Hexamethylcyclotrisiloxane	Dimethylsiloxane cyclic trimer	C <sub>6</sub> H <sub>18</sub> O <sub>3</sub> Si <sub>3</sub>	541-05-9	222.462		64.5	134	1.1200 <sup>20</sup>		i H <sub>2</sub> O
5816	Hexamethyldisilane		C <sub>6</sub> H <sub>18</sub> Si <sub>2</sub>	1450-14-2	146.378		13.5	113.5	0.7247 <sup>22</sup>	1.4229 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz; dec alk
5817	Hexamethyldisilathiane		C <sub>6</sub> H <sub>18</sub> SSi <sub>2</sub>	3385-94-2	178.443			162.5	0.851 <sup>20</sup>		
5818	Hexamethyldisilazane		C <sub>6</sub> H <sub>19</sub> NSi <sub>2</sub>	999-97-3	161.393			125	0.7741 <sup>25</sup>	1.4090 <sup>20</sup>	
5819	Hexamethyldisiloxane		C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	107-46-0	162.377	liq	-66	99	0.7638 <sup>20</sup>	1.3774 <sup>20</sup>	i H <sub>2</sub> O
5820	Hexamethylenediamine carbamate	(6-Aminoethyl)carbamic acid	C <sub>7</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	143-06-6	160.214	cry	150				
5821	Hexamethylene diisocyanate		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	822-06-0	168.193			122 <sup>10</sup> , 94 <sup>1</sup>	1.0528 <sup>20</sup>	1.4585 <sup>20</sup>	
5822	Hexamethylenetetramine	Methenamine	C <sub>6</sub> H <sub>12</sub> N <sub>4</sub>	100-97-0	140.186	orth (al)	>250	sub	1.331 <sup>-5</sup>		vs H <sub>2</sub> O; s EtOH, ace, chl; sl eth, bz
5823	Hexamethylolmelamine		C <sub>6</sub> H <sub>18</sub> N <sub>6</sub> O <sub>6</sub>	531-18-0	306.275		137				vs H <sub>2</sub> O
5824	Hexamethylphosphoric triamide	Tris(dimethylamino)phosphine oxide	C <sub>6</sub> H <sub>18</sub> N <sub>3</sub> OP	680-31-9	179.200			232.5	1.03 <sup>20</sup>	1.4579 <sup>20</sup>	s EtOH, eth
5825	Hexamethylphosphorous triamide	Tris(dimethylamino)phosphine	C <sub>6</sub> H <sub>18</sub> N <sub>3</sub> P	1608-26-0	163.201						s chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5826	2,6,10,15,19,23-Hexamethyltetracosane	Squalane	C <sub>30</sub> H <sub>62</sub>	111-01-3	422.813	liq	-38	350	0.8115 <sup>15</sup>	1.4530 <sup>15</sup>	i H <sub>2</sub> O; sl EtOH, ace; s eth, chl; msc bz
5827	Hexanal	Caproaldehyde	C <sub>6</sub> H <sub>12</sub> O	66-25-1	100.158	liq	-56	131	0.8335 <sup>20</sup>	1.4039 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz
5828	Hexanamide		C <sub>6</sub> H <sub>13</sub> NO	628-02-4	115.173	cry (ace)	101	255	0.999 <sup>20</sup>	1.4200 <sup>110</sup>	vs bz, eth, EtOH, chl
5829	Hexane		C <sub>6</sub> H <sub>14</sub>	110-54-3	86.175	liq	-95.35	68.73	0.6606 <sup>25</sup>	1.3727 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH; s eth, chl
5830	Hexanedial		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1072-21-5	114.142		-8	93 <sup>a</sup>	1.003 <sup>19</sup>	1.4350 <sup>20</sup>	vs bz, eth, EtOH
5831	Hexanediamide		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	628-94-4	144.171	pl	220				vs EtOH
5832	1,6-Hexanediamine	Hexamethylenediamine	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	124-09-4	116.204	orth bipym pl	39.13	204.6			vs H <sub>2</sub> O; s EtOH, bz
5833	Hexanedioic acid, dihydrazide		C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	1071-93-8	174.201		181.8				
5834	1,2-Hexanediol		C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	6920-22-5	118.174		45	224; 87 <sup>15</sup>		1.4431 <sup>20</sup>	
5835	1,6-Hexanediol	Hexamethylene glycol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	629-11-8	118.174		41.5	208		1.4579 <sup>25</sup>	s H <sub>2</sub> O, EtOH, ace; sl eth; i bz
5836	2,5-Hexanediol	Diisopropanol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	2935-44-6	118.174	cry (eth)	43	218; 86 <sup>1</sup>	0.9610 <sup>20</sup>	1.4475 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
5837	1,6-Hexanediol dimethacrylate	Hexamethylene methacrylate	C <sub>14</sub> H <sub>22</sub> O <sub>4</sub>	6606-59-3	254.323				0.998 <sup>25</sup>		
5838	2,3-Hexanedione	Acetylbutyryl	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	3848-24-6	114.142			128	0.934 <sup>19</sup>		
5839	2,4-Hexanedione	Propionylacetone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	3002-24-2	114.142	oil		160	0.959 <sup>20</sup>	1.4516 <sup>20</sup>	
5840	2,5-Hexanedione	Acetylacetone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	110-13-4	114.142	liq	-5.5	194	0.7370 <sup>20</sup>	1.4232 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
5841	3,4-Hexanedione	Bipropionyl	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	4437-51-8	114.142	liq	-10	130	0.941 <sup>21</sup>	1.4130 <sup>21</sup>	
5842	Hexanedioyl dichloride		C <sub>6</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>2</sub>	111-50-2	183.033			126 <sup>12</sup>			sl chl
5843	1,6-Hexanedithiol		C <sub>6</sub> H <sub>14</sub> S <sub>2</sub>	1191-43-1	150.305	liq	-21	237; 118 <sup>15</sup>	0.9886 <sup>25</sup>	1.5110 <sup>20</sup>	
5844	Hexanenitrile	Capronitrile	C <sub>6</sub> H <sub>11</sub> N	628-73-9	97.158	liq	-80.3	163.65	0.8051 <sup>20</sup>	1.4068 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
5845	1-Hexanethiol	Hexyl mercaptan	C <sub>6</sub> H <sub>14</sub> S	111-31-9	118.240	liq	-81	152.7	0.8424 <sup>20</sup>	1.4496 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
5846	2-Hexanethiol		C <sub>6</sub> H <sub>14</sub> S	1679-06-7	118.240	liq	-147	142	0.8345 <sup>20</sup>	1.4451 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
5847	1,2,6-Hexanetriol	1,2,6-Trihydroxyhexane	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	106-69-4	134.173			170 <sup>3</sup> , 161 <sup>1</sup>	1.1049 <sup>20</sup>	1.58 <sup>20</sup>	
5848	Hexanoic acid	Caproic acid	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	142-62-1	116.158	liq	-3	205.2	0.9212 <sup>25</sup>	1.4163 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
5849	Hexanoic anhydride		C <sub>12</sub> H <sub>22</sub> O <sub>3</sub>	2051-49-2	214.301		-41	dec 255	0.9240 <sup>15</sup>	1.4297 <sup>20</sup>	vs eth, EtOH
5850	1-Hexanol	Caproyl alcohol	C <sub>6</sub> H <sub>14</sub> O	111-27-3	102.174	liq	-47.4	157.6	0.8136 <sup>20</sup>	1.4178 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace, chl; msc eth, bz
5851	2-Hexanol		C <sub>6</sub> H <sub>14</sub> O	20281-86-1	102.174			140	0.8159 <sup>20</sup>	1.4144 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth
5852	3-Hexanol		C <sub>6</sub> H <sub>14</sub> O	17015-11-1	102.174			135	0.8182 <sup>20</sup>	1.4167 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace; msc eth
5853	2-Hexanone	Butyl methyl ketone	C <sub>6</sub> H <sub>12</sub> O	591-78-6	100.158	liq	-55.5	127.6	0.8113 <sup>20</sup>	1.4007 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
5854	3-Hexanone	Ethyl propyl ketone	C <sub>6</sub> H <sub>12</sub> O	589-38-8	100.158	liq	-55.4	123.5	0.8118 <sup>20</sup>	1.4004 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
5855	Hexanoyl chloride	Caproyl chloride	C <sub>6</sub> H <sub>11</sub> ClO	142-61-0	134.603	liq	-87	153	0.9784 <sup>20</sup>	1.4264 <sup>20</sup>	s eth, ace
5856	Hexatriacontane		C <sub>36</sub> H <sub>74</sub>	630-06-8	506.973		75.8	298.4 <sup>3</sup>	0.7803 <sup>80</sup>	1.4397 <sup>80</sup>	
5857	<i>cis</i> -1,3,5-Hexatriene		C <sub>6</sub> H <sub>8</sub>	2612-46-6	80.128	liq	-12	78	0.7175 <sup>20</sup>	1.4577 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, chl, peth
5858	<i>trans</i> -1,3,5-Hexatriene		C <sub>6</sub> H <sub>8</sub>	821-07-8	80.128	liq	-12	78.5	0.7369 <sup>15</sup>	1.5135 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, chl, peth
5859	Hexazinone		C <sub>12</sub> H <sub>20</sub> N <sub>4</sub> O <sub>2</sub>	51235-04-2	252.313		99	dec	1.25		
5860	<i>trans</i> -2-Hexenal		C <sub>6</sub> H <sub>10</sub> O	6728-26-3	98.142			146.5; 50 <sup>20</sup>	0.8491 <sup>20</sup>	1.4480 <sup>20</sup>	
5861	<i>cis</i> -3-Hexenal		C <sub>6</sub> H <sub>10</sub> O	6789-80-6	98.142			121	0.8533 <sup>22</sup>	1.4300 <sup>21</sup>	
5862	1-Hexene		C <sub>6</sub> H <sub>12</sub>	592-41-6	84.159	liq	-139.76	63.48	0.6685 <sup>25</sup>	1.3852 <sup>25</sup>	i H <sub>2</sub> O; vs bz, eth, EtOH, peth
5863	<i>cis</i> -2-Hexene		C <sub>6</sub> H <sub>12</sub>	7688-21-3	84.159	liq	-141.11	68.8	0.6824 <sup>25</sup>	1.3979 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, lig
5864	<i>trans</i> -2-Hexene		C <sub>6</sub> H <sub>12</sub>	4050-45-7	84.159	liq	-133	67.9	0.6733 <sup>25</sup>	1.3936 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, lig
5865	<i>cis</i> -3-Hexene		C <sub>6</sub> H <sub>12</sub>	7642-09-3	84.159	liq	-137.8	66.4	0.6778 <sup>20</sup>	1.3947 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, lig
5866	<i>trans</i> -3-Hexene		C <sub>6</sub> H <sub>12</sub>	13269-52-8	84.159	liq	-115.4	67.1	0.6772 <sup>20</sup>	1.3943 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, lig
5867	<i>trans</i> -3-Hexenedinitrile	<i>trans</i> -1,4-Dicyano-2-butene	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1119-85-3	106.125	cry	76				
5868	2-Hexenoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1191-04-4	114.142	nd (w, al)	36.5	216.5	0.965 <sup>20</sup>	1.4460 <sup>40</sup>	vs eth
5869	3-Hexenoic acid	Hydrosorbic acid	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	4219-24-3	114.142		12	208	0.9640 <sup>23</sup>	1.4935 <sup>20</sup>	
5870	5-Hexenoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1577-22-6	114.142	liq	-37	203	0.9610 <sup>20</sup>	1.4343 <sup>20</sup>	vs eth, EtOH
5871	1-Hexen-3-ol		C <sub>6</sub> H <sub>12</sub> O	4798-44-1	100.158			134	0.834 <sup>22</sup>	1.4297 <sup>18</sup>	sl H <sub>2</sub> O; vs ace, eth, EtOH

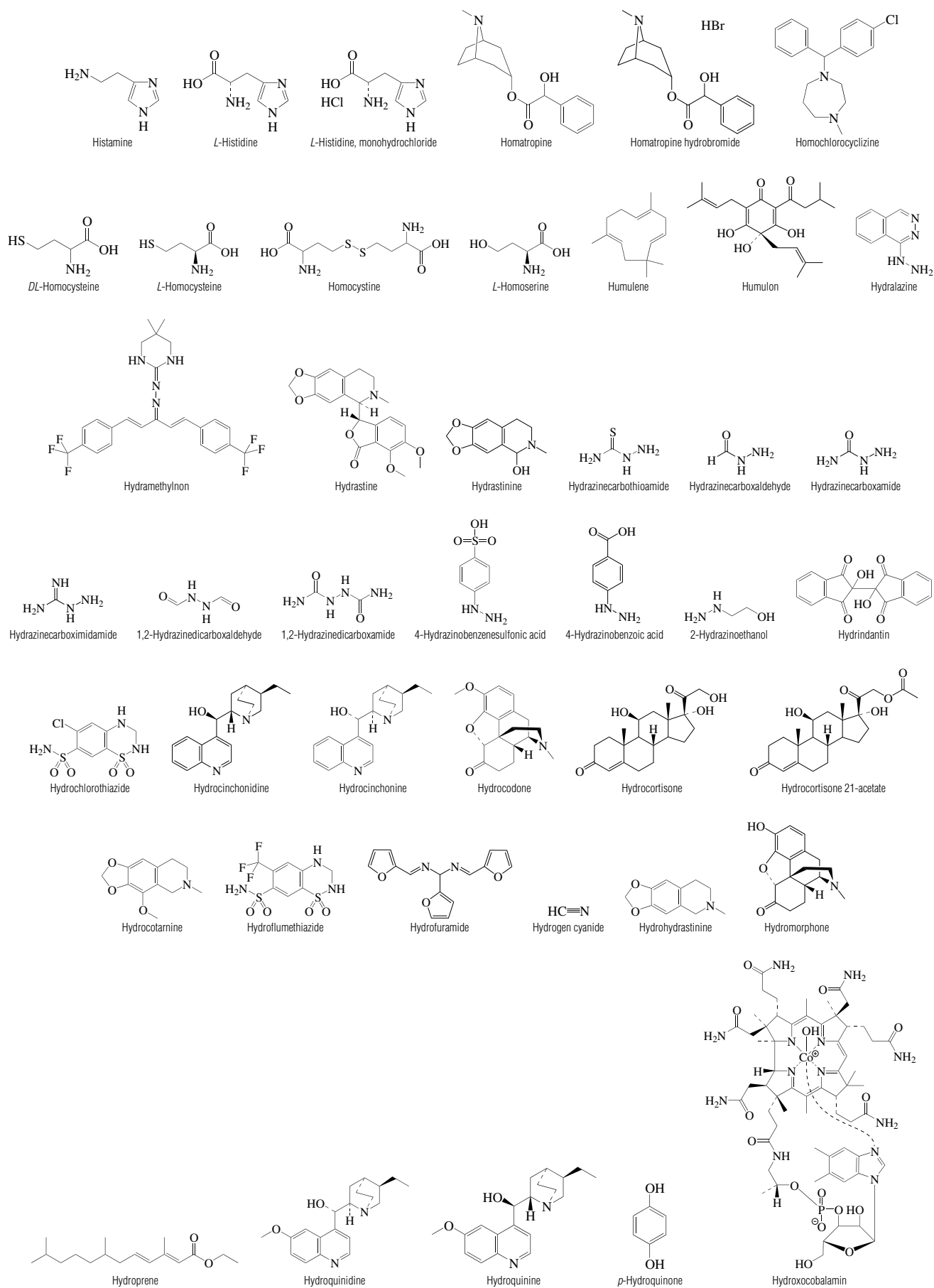


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5872	<i>cis</i> -2-Hexen-1-ol		C <sub>6</sub> H <sub>12</sub> O	928-94-9	100.158			157	0.8472 <sup>20</sup>	1.4397 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH; s eth, ace; sl ctc
5873	<i>trans</i> -2-Hexen-1-ol		C <sub>6</sub> H <sub>12</sub> O	928-95-0	100.158			157	0.8490 <sup>16</sup>	1.4340 <sup>20</sup>	
5874	<i>cis</i> -3-Hexen-1-ol		C <sub>6</sub> H <sub>12</sub> O	928-96-1	100.158			156.5	0.8478 <sup>22</sup>	1.4380 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth
5875	<i>trans</i> -3-Hexen-1-ol		C <sub>6</sub> H <sub>12</sub> O	928-97-2	100.158			154.5		1.4374 <sup>20</sup>	
5876	<i>trans</i> -4-Hexen-1-ol		C <sub>6</sub> H <sub>12</sub> O	928-92-7	100.158			159	0.8513 <sup>20</sup>	1.4402 <sup>20</sup>	
5877	4-Hexen-2-ol		C <sub>6</sub> H <sub>12</sub> O	52387-50-5	100.158			137.5	0.8405 <sup>18</sup>	1.4392 <sup>20</sup>	sl H <sub>2</sub> O
5878	5-Hexen-2-ol		C <sub>6</sub> H <sub>12</sub> O	626-94-8	100.158			139	0.842 <sup>15</sup>		sl H <sub>2</sub> O
5879	<i>cis</i> -3-Hexen-1-ol, acetate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	3681-71-8	142.196	liq		66 <sup>12</sup>			
5880	<i>trans</i> -2-Hexen-1-ol, acetate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	2497-18-9	142.196	liq		166; 68 <sup>15</sup>	0.898	1.4270 <sup>20</sup>	
5881	5-Hexen-2-one		C <sub>6</sub> H <sub>10</sub> O	109-49-9	98.142			129.5	0.833 <sup>27</sup>	1.4178 <sup>27</sup>	
5882	4-Hexen-3-one		C <sub>6</sub> H <sub>10</sub> O	2497-21-4	98.142			138.5	0.8559 <sup>20</sup>	1.4388 <sup>20</sup>	s EtOH, eth; vs ace
5883	Hexestrol		C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>	84-16-2	270.367	nd (bz)	186.5				vs ace, eth, EtOH
5884	Hexobarbital		C <sub>12</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	56-29-1	236.266		146.5				
5885	Hexocyclium methyl sulfate		C <sub>21</sub> H <sub>36</sub> N <sub>2</sub> O <sub>5</sub> S	115-63-9	428.586	cry	205				sl chl; i eth
5886	Hexyl acetate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	142-92-7	144.212	liq	-80.9	171.5	0.8779 <sup>15</sup>	1.4092 <sup>20</sup>	i H <sub>2</sub> O; vs eth, EtOH
5887	<i>sec</i> -Hexyl acetate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	108-84-9	144.212			147.5	0.8805 <sup>25</sup>	1.3980 <sup>20</sup>	sl H <sub>2</sub> O; vs eth, EtOH
5888	Hexyl acrylate		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	2499-95-8	156.222		-45	40 <sup>1</sup>	0.878 <sup>20</sup>		
5889	Hexylamine	1-Hexanamine	C <sub>6</sub> H <sub>15</sub> N	111-26-2	101.190	liq	-22.9	132.8	0.7660 <sup>20</sup>	1.4180 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s chl
5890	Hexylbenzene		C <sub>12</sub> H <sub>18</sub>	1077-16-3	162.271	liq	-61	226.1	0.8575 <sup>20</sup>	1.4864 <sup>20</sup>	i H <sub>2</sub> O; msc eth; s bz, peth
5891	4-Hexyl-1,3-benzenediol	4-Hexylresorcinol	C <sub>12</sub> H <sub>18</sub> O <sub>2</sub>	136-77-6	194.270	nd (bz)	68	334			vs ace, eth, EtOH, chl
5892	Hexyl benzoate		C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	6789-88-4	206.281			272; 139 <sup>8</sup>	0.9793 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, ace
5893	Hexyl butanoate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2639-63-6	172.265	liq	-78	208	0.8652 <sup>20</sup>	1.4160 <sup>15</sup>	i H <sub>2</sub> O; s EtOH; sl chl
5894	Hexylcyclohexane		C <sub>12</sub> H <sub>24</sub>	4292-75-5	168.319	liq	-43	224	0.8076 <sup>20</sup>	1.4462 <sup>20</sup>	
5895	Hexylcyclopentane		C <sub>11</sub> H <sub>22</sub>	4457-00-5	154.293	liq	-73	203	0.7965 <sup>20</sup>	1.4392 <sup>20</sup>	vs ace, bz, eth, EtOH
5896	2-Hexyldecanoic acid		C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	25354-97-6	256.424	visc oil		145 <sup>0.02</sup>		1.4432 <sup>24</sup>	
5897	Hexyl formate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	629-33-4	130.185	liq	-62.6	155.5	0.8813 <sup>20</sup>	1.4071 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
5898	Hexyl hexanoate	Hexyl caproate	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	6378-65-0	200.318	liq	-55	246	0.865 <sup>18</sup>	1.4264 <sup>15</sup>	vs ace, bz, eth, EtOH
5899	Hexyl isocyanate		C <sub>7</sub> H <sub>13</sub> NO	2525-62-4	127.184			44 <sup>7</sup>			
5900	Hexyl methacrylate		C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	142-09-6	170.249			162; 86 <sup>17</sup>	0.880 <sup>25</sup>	1.429 <sup>25</sup>	vs ace, bz, eth, EtOH
5901	Hexyl methyl ether		C <sub>7</sub> H <sub>16</sub> O	4747-07-3	116.201			126.1			
5902	1-Hexylnaphthalene		C <sub>16</sub> H <sub>20</sub>	2876-53-1	212.330	liq	-18	322	0.9566 <sup>20</sup>	1.5647 <sup>20</sup>	
5903	Hexyl octanoate		C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	1117-55-1	228.371	liq	-30.6	277.4	0.8603 <sup>20</sup>	1.4323 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
5904	4-(Hexyloxy)benzoic acid		C <sub>13</sub> H <sub>18</sub> O <sub>3</sub>	1142-39-8	222.280	cry	106				
5905	2-(Hexyloxy)ethanol	Ethylene glycol monohexyl ether	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	112-25-4	146.228	liq	-45.1	208	0.8878 <sup>20</sup>	1.4291 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
5906	Hexyl pentanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	1117-59-5	186.292	liq	-63.1	226.3	0.8635 <sup>20</sup>	1.4228 <sup>15</sup>	vs ace, eth, EtOH
5907	4-Hexylphenol		C <sub>12</sub> H <sub>18</sub> O	2446-69-7	178.270			148 <sup>9</sup>			
5908	1-Hexyl propanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	2445-76-3	158.238	liq	-57.5	190	0.8698 <sup>20</sup>	1.4162 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, AcOEt
5909	1-Hexyl-1,2,3,4-tetrahydronaphthalene		C <sub>16</sub> H <sub>24</sub>	66325-11-9	216.362	liq		305	0.9176 <sup>25</sup>	1.5127 <sup>25</sup>	
5910	1-Hexyne	Butylacetylene	C <sub>6</sub> H <sub>10</sub>	693-02-7	82.143	liq	-131.9	71.3	0.7155 <sup>25</sup>	1.3989 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; sl ctc
5911	2-Hexyne	1-Methyl-2-propylacetylene	C <sub>6</sub> H <sub>10</sub>	764-35-2	82.143	liq	-89.6	84.5	0.7315 <sup>20</sup>	1.4138 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, chl, peth
5912	3-Hexyne	Diethylacetylene	C <sub>6</sub> H <sub>10</sub>	928-49-4	82.143	liq	-103	81	0.7231 <sup>20</sup>	1.4115 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, peth
5913	3-Hexyne-2,5-diol		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	3031-66-1	114.142			121 <sup>15</sup>	1.0180 <sup>20</sup>	1.4691 <sup>20</sup>	
5914	3-Hexyn-1-ol	3-Hexynol	C <sub>6</sub> H <sub>10</sub> O	1002-28-4	98.142			162; 65 <sup>12</sup>	0.8982 <sup>20</sup>	1.4530 <sup>20</sup>	
5915	1-Hexyn-3-ol		C <sub>6</sub> H <sub>10</sub> O	105-31-7	98.142	liq	-80	142	0.8704 <sup>20</sup>	1.4340 <sup>25</sup>	s ctc
5916	5-Hexyn-2-one		C <sub>6</sub> H <sub>8</sub> O	2550-28-9	96.127			149	0.9065 <sup>20</sup>	1.4366 <sup>20</sup>	

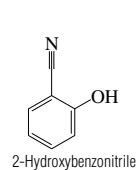
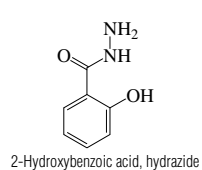
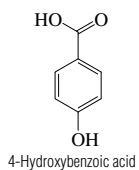
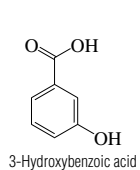
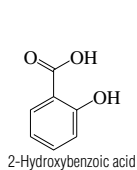
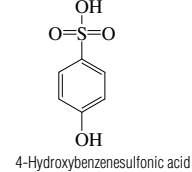
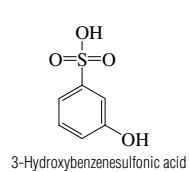
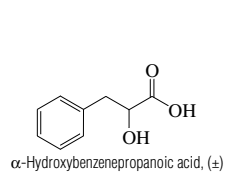
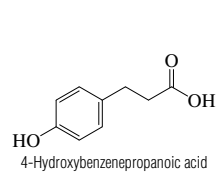
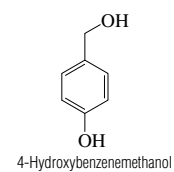
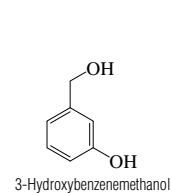
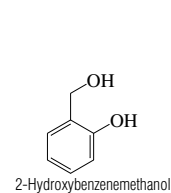
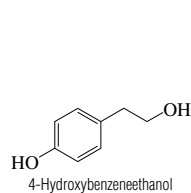
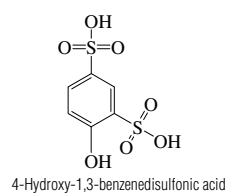
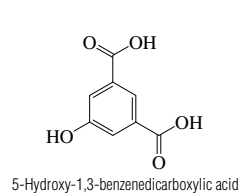
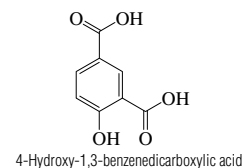
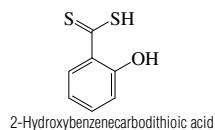
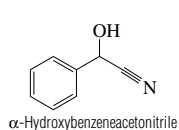
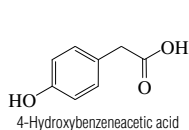
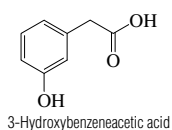
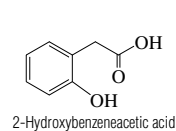
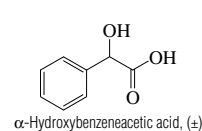
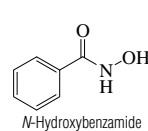
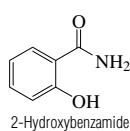
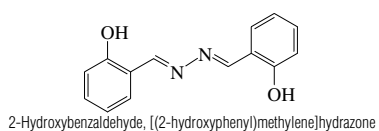
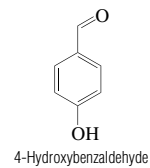
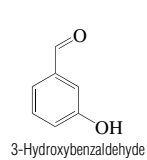
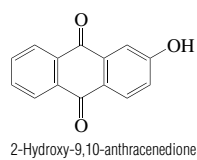
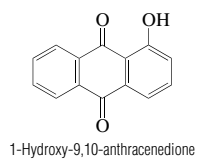
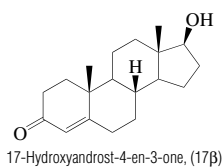
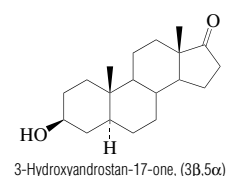
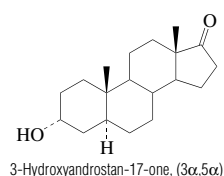
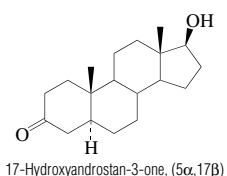
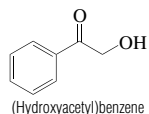
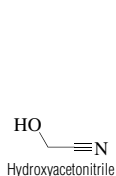


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5917	Histamine		C <sub>6</sub> H <sub>9</sub> N <sub>3</sub>	51-45-6	111.145	wh nd (chl)	83	209 <sup>18</sup>			s H <sub>2</sub> O, EtOH, chl; sl eth
5918	L-Histidine	Glyoxaline-5-alanine	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	71-00-1	155.154	nd or pl (dil al)	287 dec				s H <sub>2</sub> O; sl EtOH; l eth, ace, bz, chl
5919	L-Histidine, monohydrochloride		C <sub>6</sub> H <sub>10</sub> ClN <sub>3</sub> O <sub>2</sub>	645-35-2	191.615		245 dec				s H <sub>2</sub> O
5920	Homatropine		C <sub>16</sub> H <sub>21</sub> NO <sub>3</sub>	87-00-3	275.343	pr (al, eth)	99.5				sl H <sub>2</sub> O, bz; s EtOH, eth, ace, chl
5921	Homatropine hydrobromide	Tropanol mandelate	C <sub>16</sub> H <sub>22</sub> BrNO <sub>3</sub>	51-56-9	356.255	orth pym or pl (w)	217 dec				vs H <sub>2</sub> O, EtOH
5922	Homochlorocyclizine		C <sub>19</sub> H <sub>23</sub> ClN <sub>2</sub>	848-53-3	314.852	oil		177 <sup>0.8</sup>			
5923	DL-Homocysteine	DL-2-Amino-4-mercaptobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub> S	454-29-5	135.185		272 dec				s H <sub>2</sub> O; i eth, bz
5924	L-Homocysteine	L-2-Amino-4-mercaptobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub> S	6027-13-0	135.185	platelets	232				
5925	Homocystine		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	870-93-9	268.354		264				sl H <sub>2</sub> O; i eth, bz
5926	L-Homoserine	2-Amino-4-hydroxybutanoic acid, (S)	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	672-15-1	119.119	pr (90% al)	203 dec				vs H <sub>2</sub> O; sl EtOH; i eth, bz
5927	Humulene		C <sub>15</sub> H <sub>24</sub>	6753-98-6	204.352			123 <sup>10</sup>	0.8905 <sup>20</sup>	1.5038 <sup>20</sup>	
5928	Humulon		C <sub>21</sub> H <sub>30</sub> O <sub>5</sub>	26472-41-3	362.460	ye cry (eth)	66.5				sl H <sub>2</sub> O; s EtOH, eth, ace, bz, alk
5929	Hydralazine	1-Hydrazinophthalazine	C <sub>8</sub> H <sub>8</sub> N <sub>4</sub>	86-54-4	160.177	ye cry (MeOH)	172				s acid
5930	Hydramethylnon		C <sub>25</sub> H <sub>24</sub> F <sub>6</sub> N <sub>4</sub>	67485-29-4	494.476		190				
5931	Hydrastine		C <sub>21</sub> H <sub>21</sub> NO <sub>6</sub>	118-08-1	383.395	ye pr (al)	132				i H <sub>2</sub> O; s ace, bz
5932	Hydrastinine		C <sub>11</sub> H <sub>13</sub> NO <sub>3</sub>	6592-85-4	207.226	nd (lig), cry (eth)	116.5				s H <sub>2</sub> O; vs EtOH, eth, chl
5933	Hydrazinecarbothioamide	Thiosemicarbazide	CH <sub>3</sub> N <sub>3</sub> S	79-19-6	91.136	lo nd (w)	183				vs H <sub>2</sub> O, EtOH
5934	Hydrazinecarboxaldehyde		CH <sub>2</sub> N <sub>2</sub> O	624-84-0	60.055	ye lf or nd (al)	54				vs bz, eth, EtOH, chl
5935	Hydrazinecarboxamide		CH <sub>3</sub> N <sub>3</sub> O	57-56-7	75.070	pr (al)	96		1.484 <sup>8</sup>		vs H <sub>2</sub> O; s EtOH; i eth, bz, chl
5936	Hydrazinecarboximidamide	Aminoguanidine	CH <sub>5</sub> N <sub>4</sub>	79-17-4	74.086	cry	dec				vs H <sub>2</sub> O, EtOH
5937	1,2-Hydrazinedicarboxaldehyde		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	628-36-4	88.065	pr (al)	161.0				vs H <sub>2</sub> O; sl EtOH, DMSO; i eth
5938	1,2-Hydrazinedicarboxamide		C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	110-21-4	118.095	pl (w)	258		1.604 <sup>17</sup>		
5939	4-Hydrazinobenzenesulfonic acid	Phenylhydrazine-4-sulfonic acid	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub> S	98-71-5	188.204	nd, lf (w)	286				sl H <sub>2</sub> O, EtOH
5940	4-Hydrazinobenzoic acid		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	619-67-0	152.151	ye nd or pl (w)	221 dec				sl H <sub>2</sub> O; i eth
5941	2-Hydrazinoethanol		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	109-84-2	76.097	liq	-70	219; 120 <sup>17.5</sup>	1.119 <sup>25</sup>		vs H <sub>2</sub> O, EtOH, MeOH
5942	Hydrindantin		C <sub>18</sub> H <sub>10</sub> O <sub>6</sub>	5103-42-4	322.268	pr (ace)	250 dec				
5943	Hydrochlorothiazide		C <sub>7</sub> H <sub>7</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	58-93-5	297.740		274				
5944	Hydrocinchonidine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O	485-64-3	296.406	lf (al)	229				vs EtOH
5945	Hydrocinchonine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O	485-65-4	296.406	pr	268.5				s H <sub>2</sub> O; sl EtOH; i eth
5946	Hydrocodone		C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	125-29-1	299.365		198				i H <sub>2</sub> O; s EtOH
5947	Hydrocortisone		C <sub>21</sub> H <sub>30</sub> O <sub>5</sub>	50-23-7	362.460	pl (al or i-PrOH)	220				sl H <sub>2</sub> O; s EtOH, diox, HOAc
5948	Hydrocortisone 21-acetate	Cortisol acetate	C <sub>23</sub> H <sub>32</sub> O <sub>6</sub>	50-03-3	404.496		223 dec		1.289 <sup>20</sup>		
5949	Hydrocotarnine		C <sub>12</sub> H <sub>19</sub> NO <sub>3</sub>	550-10-7	221.252		56				i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
5950	Hydroflumethiazide		C <sub>8</sub> H <sub>8</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	135-09-1	331.293		270.5				
5951	Hydrofuramide		C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	494-47-3	268.267	nd (al)	117				i H <sub>2</sub> O; vs EtOH, eth
5952	Hydrogen cyanide	Hydrocyanic acid	HCN	74-90-8	27.026	vol liq or gas	-13.29	26	0.6876 <sup>20</sup>	1.2614 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
5953	Hydrohydrastinine		C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub>	494-55-3	191.227	nd (lig), cry (peth)	66	303			vs ace, bz, eth, EtOH
5954	Hydromorphone	7,8-Dihydromorphin-6-one	C <sub>17</sub> H <sub>19</sub> NO <sub>3</sub>	466-99-9	285.338	cry (EtOH)	266.5				
5955	Hydroprene		C <sub>17</sub> H <sub>30</sub> O <sub>2</sub>	41096-46-2	266.419			174 <sup>19</sup>	0.8955 <sup>20</sup>		
5956	Hydroquinidine		C <sub>20</sub> H <sub>26</sub> N <sub>2</sub> O <sub>2</sub>	1435-55-8	326.432	nd (al)	168.5				s EtOH, eth, ace, chl
5957	Hydroquinine		C <sub>20</sub> H <sub>28</sub> N <sub>2</sub> O <sub>2</sub>	522-66-7	326.432	nd (eth, chl)	172.5				vs ace, eth, EtOH, chl
5958	p-Hydroquinone	1,4-Benzenediol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	123-31-9	110.111	mcl pr (sub) nd(w) pr (MeOH)	172.4	285	1.330 <sup>20</sup>	1.632 <sup>25</sup>	s H <sub>2</sub> O, eth; vs EtOH, ace; i bz
5959	Hydroxocobalamin	Vitamin B-12a	C <sub>62</sub> H <sub>88</sub> CoN <sub>13</sub> O <sub>15</sub> P	13422-51-0	1346.355	red cry (ace aq)	200 dec				s H <sub>2</sub> O, EtOH; i ace, eth, bz

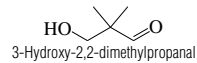
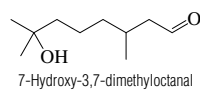
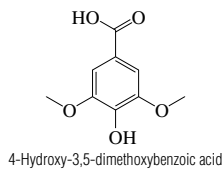
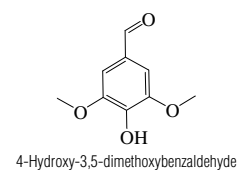
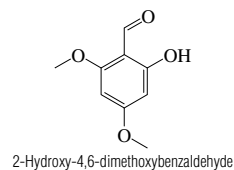
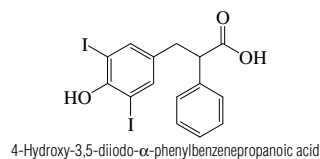
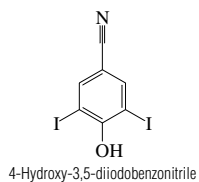
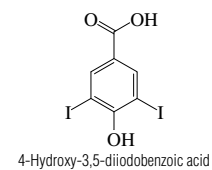
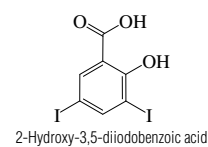
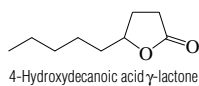
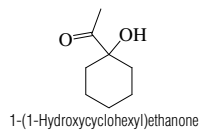
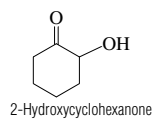
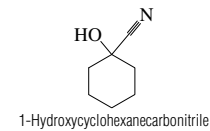
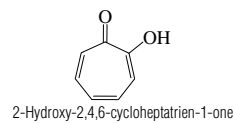
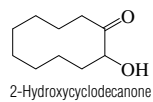
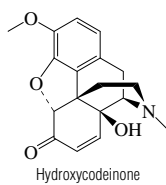
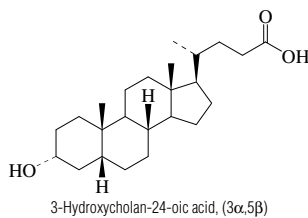
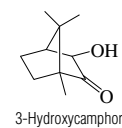
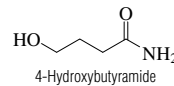
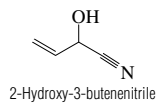
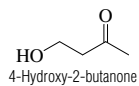
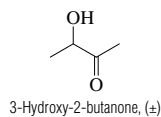
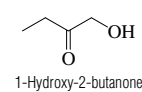
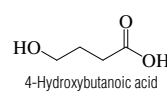
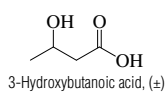
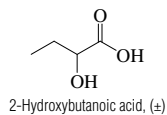
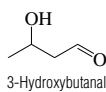
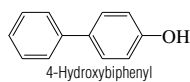
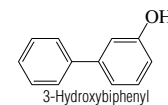
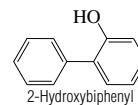
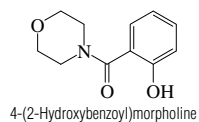
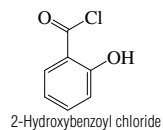
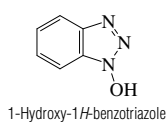
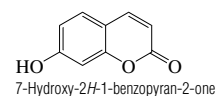
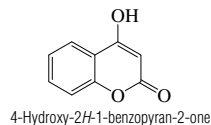
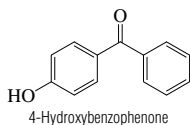
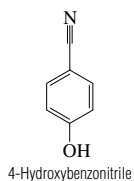
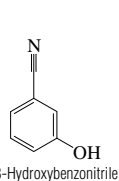




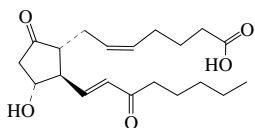
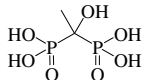
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5960	Hydroxyacetonitrile	Glyconitrile	C <sub>2</sub> H <sub>3</sub> NO	107-16-4	57.051		<-72	dec 183; 119 <sup>24</sup>		1.4117 <sup>19</sup>	vs H <sub>2</sub> O, EtOH, eth; i bz, chl
5961	(Hydroxyacetyl)benzene		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	582-24-1	136.149	hex pl (al), pl (w or dil al)	90	125 <sup>12</sup> , 56 <sup>1</sup>	1.0963 <sup>99</sup>		s H <sub>2</sub> O, EtOH, eth, chl; sl lig
5962	17-Hydroxyandrost-3-one, (5 $\alpha$ ,17 $\beta$ )	Stanolone	C <sub>19</sub> H <sub>30</sub> O <sub>2</sub>	521-18-6	290.440		181	sub 135			
5963	3-Hydroxyandrost-17-one, (3 $\alpha$ ,5 $\alpha$ )	Androsterone	C <sub>19</sub> H <sub>30</sub> O <sub>2</sub>	53-41-8	290.440	lf or nd (al, ace)	185				sl H <sub>2</sub> O, chl; s EtOH, eth, ace, bz
5964	3-Hydroxyandrost-17-one, (3 $\beta$ ,5 $\alpha$ )	Epiandrosterone	C <sub>19</sub> H <sub>30</sub> O <sub>2</sub>	481-29-8	290.440	cry (bz-peth, ace)	178				
5965	17-Hydroxyandrost-4-en-3-one, (17 $\beta$ )	Testosterone	C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	58-22-0	288.424	nd (dil ace)	155				i H <sub>2</sub> O; s EtOH, eth, ace
5966	1-Hydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>8</sub> O <sub>3</sub>	129-43-1	224.212	red-oran nd (al)	193.8	sub			i H <sub>2</sub> O; s EtOH, eth, bz; sl liq NH <sub>3</sub>
5967	2-Hydroxy-9,10-anthracenedione		C <sub>14</sub> H <sub>8</sub> O <sub>3</sub>	605-32-3	224.212	ye pl or nd (al or HOAc)	306	sub			i H <sub>2</sub> O; s EtOH, eth, aq NH <sub>3</sub> , KOH
5968	3-Hydroxybenzaldehyde	3-Formylphenol	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	100-83-4	122.122	nd (w)	108	240	1.1179 <sup>130</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace, bz; i lig
5969	4-Hydroxybenzaldehyde	4-Formylphenol	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	123-08-0	122.122	nd (w)	117		1.129 <sup>130</sup>	1.5705 <sup>130</sup>	sl H <sub>2</sub> O, ace; vs EtOH, eth; s bz
5970	2-Hydroxybenzaldehyde, [(2-hydroxyphenyl)methylene]hydrazone		C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	959-36-4	240.257		214				i H <sub>2</sub> O; s EtOH, chl; vs bz, alk
5971	2-Hydroxybenzamide	Salicylamide	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	65-45-2	137.137		142	181.5 <sup>14</sup>	1.175 <sup>140</sup>		sl H <sub>2</sub> O, eth, DMSO; s EtOH
5972	<i>N</i> -Hydroxybenzamide		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	495-18-1	137.137	orth ta, lf (eth)	131 exp				s H <sub>2</sub> O, EtOH; sl eth, bz
5973	$\alpha$ -Hydroxybenzeneacetic acid, ( $\pm$ )	<i>DL</i> -Mandelic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	611-72-3	152.148	orth pl	119		1.2890 <sup>20</sup>		s H <sub>2</sub> O, eth, EtOH, <i>i</i> -PROH
5974	2-Hydroxybenzeneacetic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	614-75-5	152.148		148	240			sl H <sub>2</sub> O, chl; s eth
5975	3-Hydroxybenzeneacetic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	621-37-4	152.148	nd (bz-lig)	132	190 <sup>11</sup>			vs H <sub>2</sub> O, EtOH, eth; s bz; sl lig
5976	4-Hydroxybenzeneacetic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	156-38-7	152.148	nd (w)	152	sub			sl H <sub>2</sub> O; vs EtOH, eth
5977	$\alpha$ -Hydroxybenzeneacetonitrile	Mandelonitrile	C <sub>8</sub> H <sub>7</sub> NO	532-28-5	133.148	ye oily liq	-10		1.12		i H <sub>2</sub> O; vs chl, eth, EtOH
5978	2-Hydroxybenzenecarbothioic acid	Dithiosalicylic acid	C <sub>7</sub> H <sub>6</sub> OS <sub>2</sub>	527-89-9	170.252	oran-ye nd	49				vs bz, eth, EtOH
5979	4-Hydroxy-1,3-benzenedicarboxylic acid	4-Hydroxyisophthalic acid	C <sub>8</sub> H <sub>6</sub> O <sub>5</sub>	636-46-4	182.131	nd(w), lf (dil al)	310				i H <sub>2</sub> O, chl; vs EtOH, eth; s HOAc
5980	5-Hydroxy-1,3-benzenedicarboxylic acid		C <sub>8</sub> H <sub>6</sub> O <sub>5</sub>	618-83-7	182.131	nd(w+2) cr(aq-al)		sub			vs bz, eth, EtOH
5981	4-Hydroxy-1,3-benzenedisulfonic acid	Phenoldisulfonic acid	C <sub>6</sub> H <sub>4</sub> O <sub>7</sub> S <sub>2</sub>	96-77-5	254.238	nd (w)	>100 dec				vs H <sub>2</sub> O, EtOH
5982	4-Hydroxybenzeneethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	501-94-0	138.164		91.8	310.0			
5983	2-Hydroxybenzenemethanol	Salicyl alcohol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	90-01-7	124.138	lf (bz), nd or pl (w, eth)	87	sub	1.1613 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth, bz; vs chl
5984	3-Hydroxybenzenemethanol	3-Hydroxybenzyl alcohol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	620-24-6	124.138	nd (bz), cry (CCl <sub>4</sub> )	73	dec 300	1.161 <sup>25</sup>		vs H <sub>2</sub> O, EtOH, eth; sl chl
5985	4-Hydroxybenzenemethanol	4-Hydroxybenzyl alcohol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	623-05-2	124.138	pr or nd (w)	124.5	252			vs H <sub>2</sub> O, EtOH, bz, chl; s eth; sl DMSO
5986	4-Hydroxybenzenepropanoic acid	<i>p</i> -Hydroxyhydrocinnamic acid	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	501-97-3	166.173		130.8	209 <sup>14</sup>			s H <sub>2</sub> O, EtOH, eth, bz; i CS <sub>2</sub>
5987	$\alpha$ -Hydroxybenzenepropanoic acid, ( $\pm$ )	( $\pm$ )-3-Phenyllactic acid	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	828-01-3	166.173	cry (chl, bz), pr (w)	98	149 <sup>15</sup>			vs H <sub>2</sub> O, ace, eth, EtOH
5988	3-Hydroxybenzenesulfonic acid	<i>m</i> -Phenolsulfonic acid	C <sub>6</sub> H <sub>4</sub> O <sub>3</sub> S	585-38-6	174.175	nd (w+2)					
5989	4-Hydroxybenzenesulfonic acid	<i>p</i> -Phenolsulfonic acid	C <sub>6</sub> H <sub>4</sub> O <sub>3</sub> S	98-67-9	174.175	nd					vs H <sub>2</sub> O, EtOH
5990	2-Hydroxybenzoic acid	Salicylic acid	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	69-72-7	138.121	nd (w), mcl pr (al)	159.0	211 <sup>20</sup>	1.443 <sup>20</sup>	1.565	sl H <sub>2</sub> O, bz, chl, ctc; vs EtOH, eth, ace
5991	3-Hydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	99-06-9	138.121	nd (w) pl, pr (al)	202.5		1.485 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace; i bz
5992	4-Hydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	99-06-7	138.121	pr or pl (w, al) cry (ace)	214.5		1.46 <sup>25</sup>		sl H <sub>2</sub> O, bz; vs EtOH; s eth, ace
5993	2-Hydroxybenzoic acid, hydrazide		C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	936-02-7	152.151		148				vs bz, EtOH
5994	2-Hydroxybenzonitrile		C <sub>7</sub> H <sub>5</sub> NO	611-20-1	119.121		98	149 <sup>14</sup>	1.1052 <sup>100</sup>	1.5372 <sup>100</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz, chl



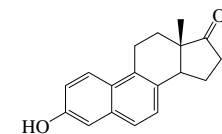
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
5995	3-Hydroxybenzotrile		C <sub>7</sub> H <sub>7</sub> NO	873-62-1	119.121	pr (al, eth) lf (w)	82.8				vs H <sub>2</sub> O, EtOH, eth, bz, chl
5996	4-Hydroxybenzotrile		C <sub>7</sub> H <sub>7</sub> NO	767-00-0	119.121	lf (w)	113	148 <sup>1</sup>			sl H <sub>2</sub> O, DMSO; vs EtOH, eth, chl
5997	4-Hydroxybenzophenone	4-Hydroxyphenyl phenyl ketone	C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	1137-42-4	198.217	nd (al), pr (dil al)	135		1.133 <sup>172</sup>		sl H <sub>2</sub> O; vs EtOH, eth, HOAc
5998	4-Hydroxy-2 <i>H</i> -1-benzopyran-2-one		C <sub>9</sub> H <sub>6</sub> O <sub>3</sub>	1076-38-6	162.142	nd (w)	213.5				s H <sub>2</sub> O, EtOH, eth; sl DMSO
5999	7-Hydroxy-2 <i>H</i> -1-benzopyran-2-one	Umbelliferone	C <sub>9</sub> H <sub>6</sub> O <sub>3</sub>	93-35-6	162.142	nd (w)	230.5	sub			vs EtOH, HOAc, chl
6000	1-Hydroxy-1 <i>H</i> -benzotriazole		C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O	2592-95-2	135.123		157.8				
6001	2-Hydroxybenzoyl chloride		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	1441-87-8	156.567		19	92 <sup>15</sup>	1.3112 <sup>20</sup>	1.5812 <sup>20</sup>	vs eth
6002	4-(2-Hydroxybenzoyl)morpholine	4-Salicyloylmorpholine	C <sub>11</sub> H <sub>10</sub> NO <sub>3</sub>	3202-84-4	204.202						s DMSO
6003	2-Hydroxybiphenyl	[1,1'-Biphenyl]-2-ol	C <sub>12</sub> H <sub>10</sub> O	90-43-7	170.206		57.5	286	1.213 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, ace, bz; vs eth, py
6004	3-Hydroxybiphenyl	[1,1'-Biphenyl]-3-ol	C <sub>12</sub> H <sub>10</sub> O	580-51-8	170.206		78	>300			sl H <sub>2</sub> O; vs EtOH, eth, bz, py; s chl
6005	4-Hydroxybiphenyl	[1,1'-Biphenyl]-4-ol	C <sub>12</sub> H <sub>10</sub> O	92-69-3	170.206		166	305			sl H <sub>2</sub> O, DMSO; vs EtOH, eth, chl, py
6006	3-Hydroxybutanal	Aldol	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	107-89-1	88.106			83 <sup>20</sup>	1.103 <sup>20</sup>	1.4238 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth; vs ace
6007	2-Hydroxybutanoic acid, (±)		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	600-15-7	104.105		44.2	dec 260; 140 <sup>14</sup>	1.125 <sup>20</sup>		s H <sub>2</sub> O, EtOH, eth
6008	3-Hydroxybutanoic acid, (±)		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	625-71-8	104.105		49	130 <sup>12</sup> , 94 <sup>0.1</sup>		1.4424 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; i bz
6009	4-Hydroxybutanoic acid		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	591-81-1	104.105		<-17	dec 180			
6010	1-Hydroxy-2-butanone		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	5077-67-8	88.106			160; 78 <sup>60</sup>	1.0272 <sup>20</sup>	1.4189 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth
6011	3-Hydroxy-2-butanone, (±)	Acetoin	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	52217-02-4	88.106		15	148	1.0044 <sup>20</sup>	1.4171 <sup>20</sup>	msc H <sub>2</sub> O; sl EtOH, eth; s ace, chl; i lig
6012	4-Hydroxy-2-butanone		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	590-90-9	88.106			182; 90 <sup>11</sup>	1.0233 <sup>20</sup>	1.4585 <sup>14</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace
6013	2-Hydroxy-3-butenitrile		C <sub>4</sub> H <sub>7</sub> NO	5809-59-6	83.089	liq		94 <sup>17</sup>			
6014	4-Hydroxybutyramide		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	927-60-6	103.120		52				
6015	3-Hydroxycamphor	3-Hydroxy-1,7,7-trimethylbicyclo[2.2.1]heptan-2-one	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	10373-81-6	168.233	nd (bz-peth)	205.5				vs eth, EtOH, chl
6016	3-Hydroxycholelan-24-oic acid, (3α,5β)	Lithocholic acid	C <sub>24</sub> H <sub>40</sub> O <sub>3</sub>	434-13-9	376.573	hex lf (al) pr (dil al)	186				i H <sub>2</sub> O, lig; s EtOH, chl, HOAc; sl eth
6017	Hydroxycodone		C <sub>18</sub> H <sub>19</sub> NO <sub>4</sub>	508-54-3	313.349			275 dec			
6018	2-Hydroxycyclodecanone	Sebacoin	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	96-00-4	170.249	cry (peth)	38.5	136 <sup>14</sup>			
6019	2-Hydroxy-2,4,6-cycloheptatrien-1-one		C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	533-75-5	122.122	nd	50.8	sub 40			s H <sub>2</sub> O, eth, ace
6020	1-Hydroxycyclohexanecarbonitrile		C <sub>7</sub> H <sub>11</sub> NO	931-97-5	125.168		35	132 <sup>20</sup>	1.0172 <sup>20</sup>	1.4693 <sup>20</sup>	vs H <sub>2</sub> O, eth
6021	2-Hydroxycyclohexanone		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	533-60-8	114.142	nd (al)				1.4785 <sup>21</sup>	vs H <sub>2</sub> O, EtOH; i eth, bz, peth
6022	1-(1-Hydroxycyclohexyl)ethanone		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	1123-27-9	142.196			125.5; 91 <sup>11</sup>	1.0248 <sup>25</sup>	1.4670 <sup>25</sup>	vs eth, EtOH
6023	4-Hydroxydecanoic acid γ-lactone	5-Hexyldihydro-2(3 <i>H</i> )-furanone	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	706-14-9	170.249	liq		281			
6024	2-Hydroxy-3,5-diiodobenzoic acid	3,5-Diiodosalicylic acid	C <sub>7</sub> H <sub>4</sub> I <sub>2</sub> O <sub>3</sub>	133-91-5	389.914	nd (al)	235.5				sl H <sub>2</sub> O; vs EtOH, eth; i bz, chl
6025	4-Hydroxy-3,5-diiodobenzoic acid		C <sub>7</sub> H <sub>4</sub> I <sub>2</sub> O <sub>3</sub>	618-76-8	389.914		237	dec 260			i H <sub>2</sub> O; vs EtOH, eth; sl bz, chl, lig
6026	4-Hydroxy-3,5-diiodobenzotrile		C <sub>7</sub> H <sub>3</sub> I <sub>2</sub> NO	1689-83-4	370.914			201 dec			
6027	4-Hydroxy-3,5-diiodo-α-phenylbenzenepropanoic acid	Iodoalphonic acid	C <sub>15</sub> H <sub>12</sub> I <sub>2</sub> O <sub>3</sub>	577-91-3	494.063		164				i H <sub>2</sub> O; s EtOH, eth; sl bz, chl
6028	2-Hydroxy-4,6-dimethoxybenzaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	708-76-9	182.173		70	193 <sup>25</sup> , 165 <sup>10</sup>			i H <sub>2</sub> O; vs EtOH, eth, bz, chl, HOAc
6029	4-Hydroxy-3,5-dimethoxybenzaldehyde	Syringaldehyde	C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	134-96-3	182.173	br nd (lig)	113	192 <sup>14</sup>			sl H <sub>2</sub> O, lig; vs EtOH, eth, bz, chl
6030	4-Hydroxy-3,5-dimethoxybenzoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>5</sub>	530-57-4	198.172	nd (w)	204.5				sl H <sub>2</sub> O; vs EtOH
6031	7-Hydroxy-3,7-dimethyloctanal		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	107-75-5	172.265			103 <sup>3</sup>	0.9220 <sup>20</sup>	1.4494 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace
6032	3-Hydroxy-2,2-dimethylpropanal	Hydroxypivaldehyde	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	597-31-9	102.132	nd (w)	89.5	173; 68 <sup>14</sup>			
6033	2-Hydroxy-3,5-dinitrobenzoic acid		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>7</sub>	609-99-4	228.116	ye nd or pl (+1w)	182				s H <sub>2</sub> O, EtOH, eth, bz



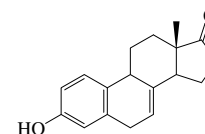
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6034	11-Hydroxy-9,15-dioxoprostano-5,13-dien-1-oic acid, (5Z,11α,13E)	15-Oxo-prostaglandin E2	C <sub>20</sub> H <sub>30</sub> O <sub>5</sub>	26441-05-4	350.449	cry					
6035	1-Hydroxy-1,1-diphosphonoethane	Etidronic acid	C <sub>2</sub> H <sub>6</sub> O <sub>7</sub> P <sub>2</sub>	2809-21-4	206.028	cry (w)	105				s H <sub>2</sub> O, EtOH, MeOH
6036	3-Hydroxyestra-1,3,5,7,9-pentaen-17-one	Equilenin	C <sub>18</sub> H <sub>18</sub> O <sub>2</sub>	517-09-9	266.335		258.5	sub 170			sl EtOH, ace, chl
6037	3-Hydroxyestra-1,3,5(10),7-tetraen-17-one	Equilin	C <sub>18</sub> H <sub>20</sub> O <sub>2</sub>	474-86-2	268.351	pl (AcOEt)	239	sub 170			sl H <sub>2</sub> O; s EtOH, ace, diox, AcOEt
6038	2-Hydroxyethyl acrylate	2-Hydroxyethyl 2-propenoate	C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	818-61-1	116.116	liq		191; 91 <sup>12</sup>	1.011 <sup>23</sup>		
6039	<i>N</i> -(2-Hydroxyethyl)dodecanamide		C <sub>14</sub> H <sub>29</sub> NO <sub>2</sub>	142-78-9	243.386		88.5				
6040	<i>N</i> -(2-Hydroxyethyl)ethylenediaminetriacetic acid		C <sub>10</sub> H <sub>18</sub> N <sub>2</sub> O <sub>7</sub>	150-39-0	278.259	cry	165	dec			
6041	2-Hydroxyethyl 2-hydroxybenzoate	Glycol salicylate	C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	87-28-5	182.173		37	173 <sup>15</sup>	1.2526 <sup>15</sup>		sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
6042	2-Hydroxyethyl methacrylate	Ethylene glycol monomethacrylate	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	868-77-9	130.141			103 <sup>13</sup> , 67 <sup>3</sup>	1.079 <sup>20</sup>	1.4515 <sup>20</sup>	
6043	<i>N</i> -(2-Hydroxyethyl)phthalimide		C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub>	3891-07-4	191.183	nd (al), lf (w)	130.3				sl H <sub>2</sub> O
6044	1-(2-Hydroxyethyl)-2-pyrrolidione		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	3445-11-2	129.157		20	295	1.1435 <sup>20</sup>		
6045	4-Hydroxy-4 <i>H</i> -furo[3,2- <i>c</i> ]pyran-2(6 <i>H</i> )-one	Patulin	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	149-29-1	154.121	pl or pr (eth, chl)	111				s H <sub>2</sub> O, EtOH, eth, ace, bz; i peth
6046	16-Hydroxyhexadecanoic acid	16-Hydroxypalmitic acid	C <sub>16</sub> H <sub>32</sub> O <sub>3</sub>	506-13-8	272.423		96.5				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz
6047	2-Hydroxyhexanoic acid		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	6064-63-7	132.157	pr (eth)	60				vs H <sub>2</sub> O
6048	6-Hydroxyhexanoic acid		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	1191-25-9	132.157	liq					
6049	3-Hydroxy-2-(hydroxymethyl)-2-methylpropanoic acid	Dimethylolpropionic acid	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	4767-03-7	134.131		190				
6050	5-Hydroxy-2-(hydroxymethyl)-4 <i>H</i> -pyran-4-one	Kojic acid	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub>	501-30-4	142.110	pr nd (ace)	153.5				sl H <sub>2</sub> O, bz; s EtOH, eth, ace, DMSO
6051	8-Hydroxy-7-iodo-5-quinolinesulfonic acid	Ferron	C <sub>9</sub> H <sub>6</sub> INO <sub>3</sub> S	547-91-1	351.118	ye pr, lf (al)	260	dec			sl H <sub>2</sub> O, EtOH; i eth, bz, chl; s con sulf
6052	2-Hydroxy-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione		C <sub>8</sub> H <sub>8</sub> NO <sub>3</sub>	524-38-9	163.131		232				s DMSO
6053	2-Hydroxy-4-isopropyl-2,4,6-cycloheptatrien-1-one		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	499-44-5	164.201	pa ye (peth)	51.5	137 <sup>10</sup>	1.0606 <sup>65</sup>		sl H <sub>2</sub> O, bz, lig; s ctc
6054	Hydroxylupanine		C <sub>15</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	15358-48-2	264.364	cry (ace)	169.5				vs H <sub>2</sub> O, EtOH, chl
6055	<i>N</i> -Hydroxymethanamine	<i>N</i> -Methylhydroxylamine	CH <sub>3</sub> NO	593-77-1	47.057	hyg nd	87.5	62.5 <sup>15</sup>	1.0003 <sup>20</sup>	1.4164 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
6056	2-Hydroxy-3-methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	148-53-8	152.148	lt ye lf, grn nd (w, lig)	44.5	265.5			sl H <sub>2</sub> O, lig; vs EtOH, eth, ctc
6057	2-Hydroxy-4-methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	673-22-3	152.148	nd (w), cry (al)	42.0				s EtOH, eth, bz, lig
6058	2-Hydroxy-5-methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	672-13-9	152.148	ye liq (w)	4	247.5			vs eth, EtOH
6059	3-Hydroxy-4-methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	621-59-0	152.148		114	179 <sup>15</sup>	1.196 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz, HOAc; vs chl
6060	4-Hydroxy-3-methoxybenzaldehyde	Vanillin	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	121-33-5	152.148	tetr (w, lig)	81.5	285	1.056 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth, ace; s bz, lig
6061	4-Hydroxy-3-methoxybenzeneacetic acid	Homovanillic acid	C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	306-08-1	182.173		143.5				
6062	4-Hydroxy-3-methoxybenzenemethanol		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	498-00-0	154.163	pr (w), nd (bz)	115	dec			s H <sub>2</sub> O, EtOH, eth, bz
6063	4-Hydroxy-3-methoxybenzenepropanol		C <sub>10</sub> H <sub>14</sub> O <sub>3</sub>	2305-13-7	182.216		65	197 <sup>15</sup>		1.5545 <sup>25</sup>	vs eth, EtOH
6064	2-Hydroxy-5-methoxybenzoic acid		C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	2612-02-4	168.148		142				
6065	4-Hydroxy-3-methoxybenzoic acid	Vanillic acid	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	121-34-6	168.148	wh nd	211.5	sub			sl H <sub>2</sub> O; vs EtOH; s eth, DMSO
6066	7-Hydroxy-6-methoxy-2 <i>H</i> -1-benzopyran-2-one	Scopoletin	C <sub>10</sub> H <sub>8</sub> O <sub>4</sub>	92-61-5	192.169	nd or pr (al)	204				sl H <sub>2</sub> O, EtOH; s chl; i bz, CS <sub>2</sub>
6067	4-(4-Hydroxy-3-methoxyphenyl)-2-butanone	Zingerone	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	122-48-5	194.227	cry (ace, eth)	40.5	187 <sup>14</sup>			vs eth
6068	1-(2-Hydroxy-4-methoxyphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	552-41-0	166.173	nd (al)	52.5	158 <sup>20</sup>	1.3102 <sup>61</sup>	1.5452 <sup>61</sup>	vs bz, eth, EtOH, chl
6069	1-(4-Hydroxy-3-methoxyphenyl)ethanone	Apocynin	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	498-02-2	166.173	pr (w)	115	297; 234 <sup>15</sup>			sl H <sub>2</sub> O; s EtOH, ace, bz; vs eth, chl
6070	(2-Hydroxy-4-methoxyphenyl)phenylmethanone	Oxybenzone	C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	131-57-7	228.243		65.5				s ctc

11-Hydroxy-9,15-dioxoprost-5,13-dien-1-oic acid, (5Z,11 $\alpha$ ,13E)

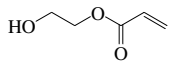
1-Hydroxy-1,1-diphosphoethane



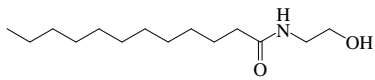
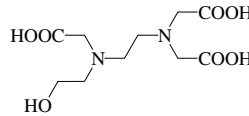
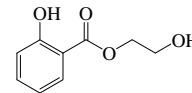
3-Hydroxyestra-1,3,5,7,9-pentaen-17-one



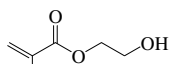
3-Hydroxyestra-1,3,5(10),7-tetraen-17-one



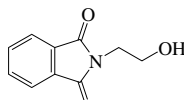
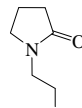
2-Hydroxyethyl acrylate

*N*-(2-Hydroxyethyl)dodecanamide*N*-(2-Hydroxyethyl)ethylenediaminetriacetic acid

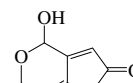
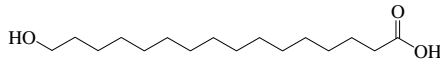
2-Hydroxyethyl 2-hydroxybenzoate



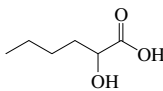
2-Hydroxyethyl methacrylate

*N*-(2-Hydroxyethyl)phthalimide

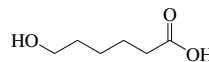
1-(2-Hydroxyethyl)-2-pyrrolidinone

4-Hydroxy-4*H*-furo[3,2-*c*]pyran-2(6*H*)-one

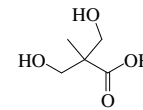
16-Hydroxyhexadecanoic acid



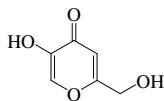
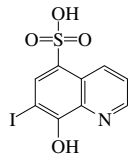
2-Hydroxyhexanoic acid



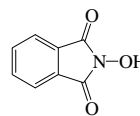
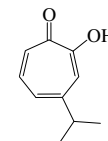
6-Hydroxyhexanoic acid



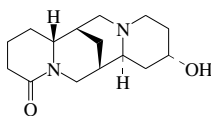
3-Hydroxy-2-(hydroxymethyl)-2-methylpropanoic acid

5-Hydroxy-2-(hydroxymethyl)-4*H*-pyran-4-one

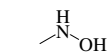
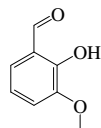
8-Hydroxy-7-iodo-5-quinolinesulfonic acid

2-Hydroxy-1*H*-isoindole-1,3(2*H*)-dione

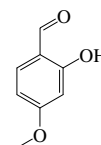
2-Hydroxy-4-isopropyl-2,4,6-cycloheptatrien-1-one



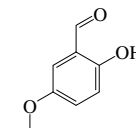
Hydroxylupanine

*N*-Hydroxymethanamine

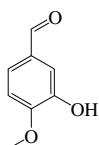
2-Hydroxy-3-methoxybenzaldehyde



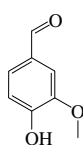
2-Hydroxy-4-methoxybenzaldehyde



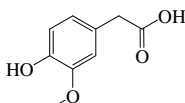
2-Hydroxy-5-methoxybenzaldehyde



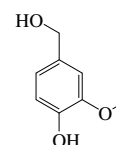
3-Hydroxy-4-methoxybenzaldehyde



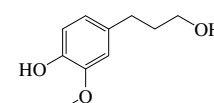
4-Hydroxy-3-methoxybenzaldehyde



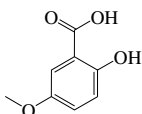
4-Hydroxy-3-methoxybenzeneacetic acid



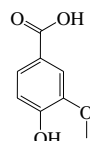
4-Hydroxy-3-methoxybenzenemethanol



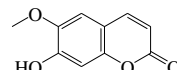
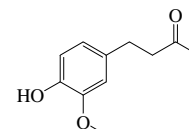
4-Hydroxy-3-methoxybenzenepropanol



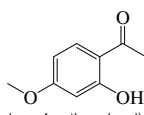
2-Hydroxy-5-methoxybenzoic acid



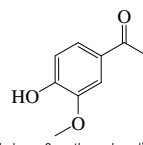
4-Hydroxy-3-methoxybenzoic acid

7-Hydroxy-6-methoxy-2*H*-1-benzopyran-2-one

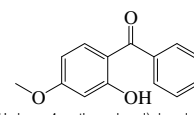
4-(4-Hydroxy-3-methoxyphenyl)-2-butanone



1-(2-Hydroxy-4-methoxyphenyl)ethanone



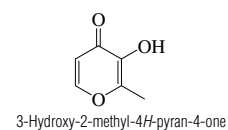
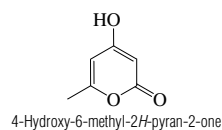
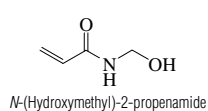
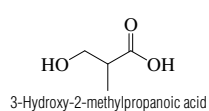
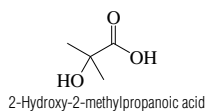
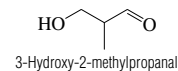
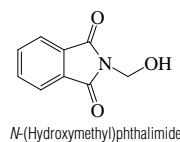
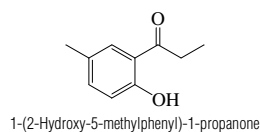
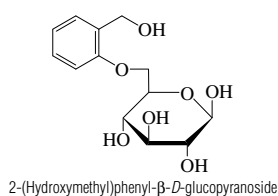
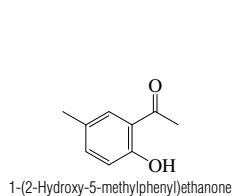
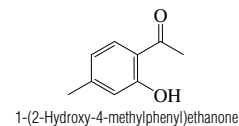
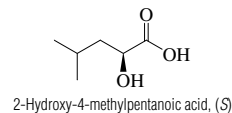
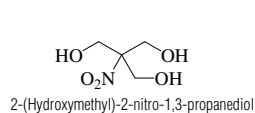
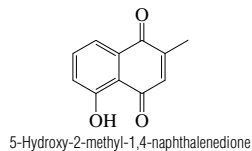
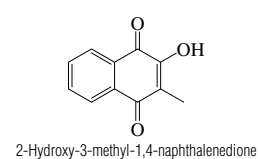
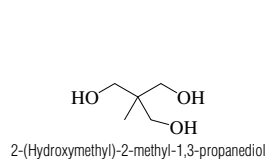
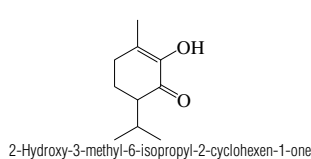
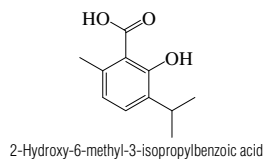
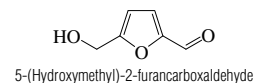
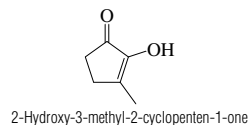
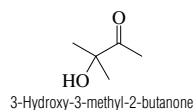
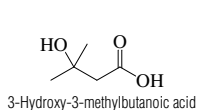
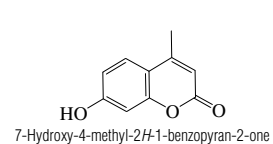
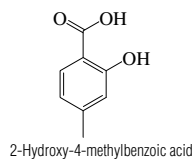
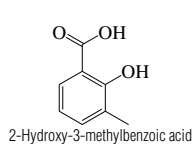
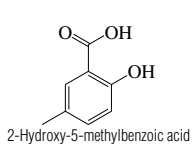
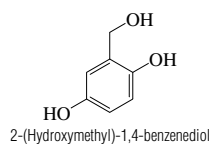
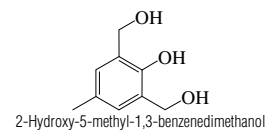
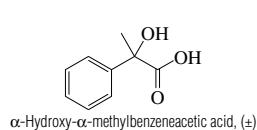
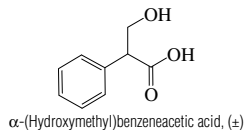
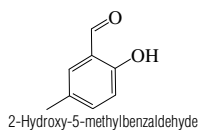
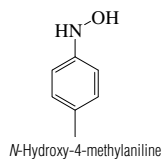
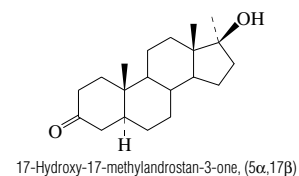
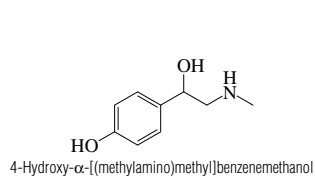
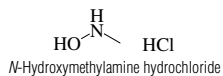
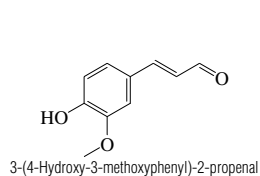
1-(4-Hydroxy-3-methoxyphenyl)ethanone



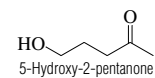
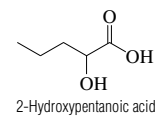
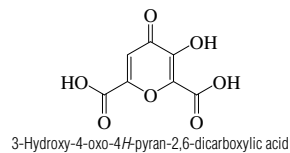
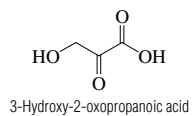
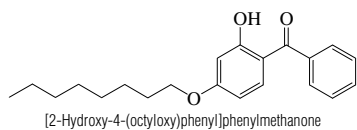
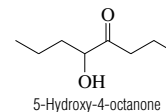
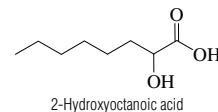
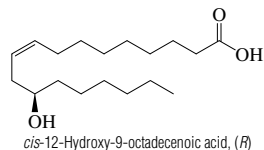
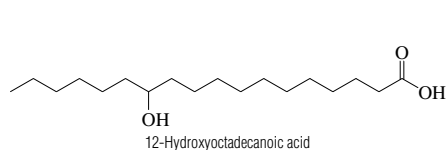
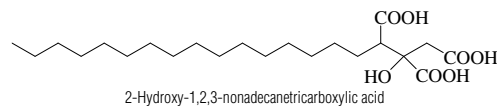
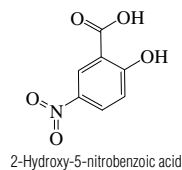
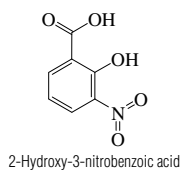
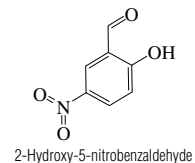
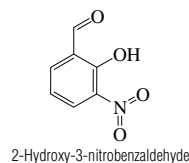
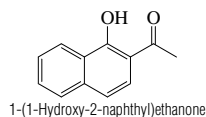
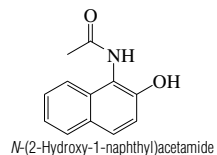
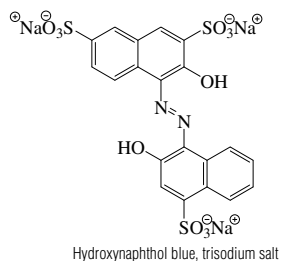
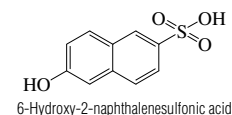
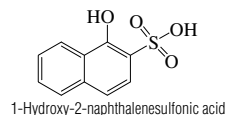
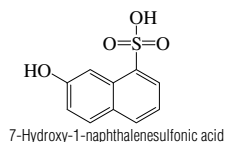
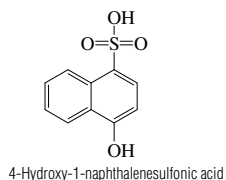
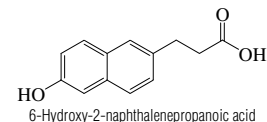
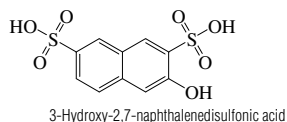
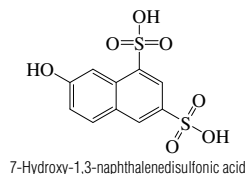
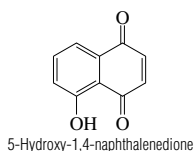
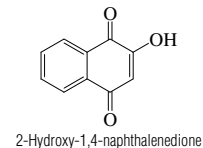
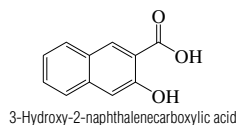
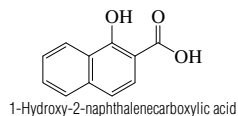
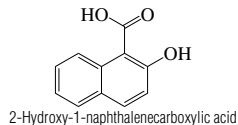
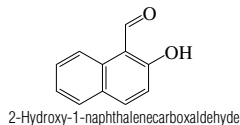
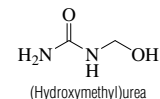
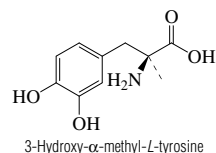
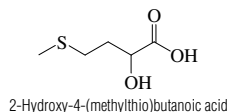
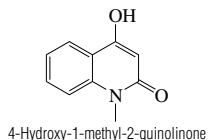
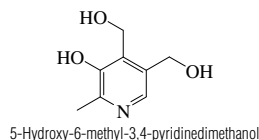
(2-Hydroxy-4-methoxyphenyl)phenylmethanone

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6071	3-(4-Hydroxy-3-methoxyphenyl)-2-propenal		C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	458-36-6	178.184	cry (bz)	84		1.1562 <sup>102</sup>		vs bz, eth, EtOH
6072	<i>N</i> -Hydroxymethylamine hydrochloride	<i>N</i> -Methylhydroxylamine hydrochloride	CH <sub>6</sub> ClNO	4229-44-1	83.518		83.5				
6073	4-Hydroxy- $\alpha$ -[(methylamino)methyl]benzenemethanol	Synephrine	C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	94-07-5	167.205		184.5				
6074	17-Hydroxy-17-methylandrostan-3-one, (5 $\alpha$ ,17 $\beta$ )	Mestanolone	C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	521-11-9	304.467		192.5				sl AcOEt
6075	<i>N</i> -Hydroxy-4-methylaniline		C <sub>7</sub> H <sub>9</sub> NO	623-10-9	123.152	lf (bz)	96	dec 117			vs eth, EtOH, chl
6076	2-Hydroxy-5-methylbenzaldehyde		C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	613-84-3	136.149	pl (aq, al)	56	217.5	1.0913 <sup>99</sup>	1.547 <sup>99</sup>	vs eth, EtOH, chl
6077	$\alpha$ -(Hydroxymethyl)benzeneacetic acid, ( $\pm$ )	Tropic acid	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	552-63-6	166.173	nd, pl (al, bz, w)	118	dec			vs H <sub>2</sub> O, eth, EtOH
6078	$\alpha$ -Hydroxy- $\alpha$ -methylbenzeneacetic acid, ( $\pm$ )	Atrolactic acid	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	4607-38-9	166.173	nd, pl (lig)	94				vs ace, bz
6079	2-Hydroxy-5-methyl-1,3-benzenedimethanol		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	91-04-3	168.189		130.5				
6080	2-(Hydroxymethyl)-1,4-benzenediol	Gentisyl alcohol	C <sub>7</sub> H <sub>8</sub> O <sub>3</sub>	495-08-9	140.137	nd (chl)	100	sub 75			vs H <sub>2</sub> O, EtOH, chl
6081	2-Hydroxy-5-methylbenzoic acid	<i>p</i> -Cresotic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	89-56-5	152.148		151				sl H <sub>2</sub> O; s EtOH, eth, bz, chl; i CS <sub>2</sub>
6082	2-Hydroxy-3-methylbenzoic acid	<i>o</i> -Cresotic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	83-40-9	152.148		165.5				sl H <sub>2</sub> O; s EtOH, eth, bz, chl
6083	2-Hydroxy-4-methylbenzoic acid	<i>m</i> -Cresotic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	50-85-1	152.148	cry, lf	177				sl H <sub>2</sub> O; s EtOH, bz, chl; vs eth
6084	7-Hydroxy-4-methyl-2 <i>H</i> -1-benzopyran-2-one	Hymecromone	C <sub>10</sub> H <sub>8</sub> O <sub>3</sub>	90-33-5	176.169	nd (al)	194.5				sl H <sub>2</sub> O, eth, chl; s EtOH, alk, HOAc
6085	3-Hydroxy-3-methylbutanoic acid		C <sub>7</sub> H <sub>10</sub> O <sub>3</sub>	625-08-1	118.131		<-32	162 <sup>12</sup>	0.9384 <sup>20</sup>	1.5081 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
6086	3-Hydroxy-3-methyl-2-butanone		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	115-22-0	102.132			140	0.9526 <sup>20</sup>		s chl
6087	2-Hydroxy-3-methyl-2-cyclopenten-1-one		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	80-71-7	112.127		104.8				
6088	5-(Hydroxymethyl)-2-furancarboxaldehyde	5-(Hydroxymethyl)-2-furaldehyde	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	67-47-0	126.110	nd (eth-peth)	31.5	115 <sup>1</sup>	1.2062 <sup>25</sup>	1.5627 <sup>18</sup>	s H <sub>2</sub> O, EtOH, bz, chl; sl eth, ctc
6089	2-Hydroxy-6-methyl-3-isopropylbenzoic acid	<i>o</i> -Thymotic acid	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	548-51-6	194.227	nd (w, bz, lig)	127	sub			vs bz, eth, EtOH
6090	2-Hydroxy-3-methyl-6-isopropyl-2-cyclohexen-1-one	Diosphenol	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	490-03-9	168.233		83	109 <sup>10</sup>			
6091	2-(2-Hydroxymethyl)-2-methyl-1,3-propanediol		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	77-85-0	120.147	wh pow or nd (al)	204	136 <sup>15</sup>			msc H <sub>2</sub> O, EtOH; i eth, bz; vs HOAc
6092	2-Hydroxy-3-methyl-1,4-naphthalenedione	Phthiocol	C <sub>11</sub> H <sub>8</sub> O <sub>3</sub>	483-55-6	188.180	ye pr (eth-peth)	173.5	sub			vs ace, eth
6093	5-Hydroxy-2-methyl-1,4-naphthalenedione	Plumbagin	C <sub>11</sub> H <sub>8</sub> O <sub>3</sub>	481-42-5	188.180	gold pr or oran-ye nd (dil al)	78.5	sub			vs ace, bz, eth, EtOH
6094	2-(Hydroxymethyl)-2-nitro-1,3-propanediol	Tris(hydroxymethyl)nitromethane	C <sub>4</sub> H <sub>8</sub> NO <sub>3</sub>	126-11-4	151.118	nd or pr	165	dec			vs H <sub>2</sub> O, eth, EtOH
6095	2-Hydroxy-4-methylpentanoic acid, (S)	<i>L</i> -Leucic acid	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	13748-90-8	132.157	orth (eth)	81.5				vs H <sub>2</sub> O, eth, EtOH
6096	1-(2-Hydroxy-4-methylphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	6921-64-8	150.174		21	245	1.1012 <sup>10</sup>	1.5527 <sup>13</sup>	
6097	1-(2-Hydroxy-5-methylphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	1450-72-2	150.174	pr (lig)	50	210; 120 <sup>20</sup>	1.0797 <sup>53</sup>		vs bz, eth, EtOH, chl
6098	2-(Hydroxymethyl)phenyl- $\beta$ - <i>D</i> -glucopyranoside	Salicin	C <sub>13</sub> H <sub>16</sub> O <sub>7</sub>	138-52-3	286.278	orth nd or lf (w)	207	dec 240	1.434 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, HOAc
6099	1-(2-Hydroxy-5-methylphenyl)-1-propanone		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	938-45-4	164.201		1.0	129 <sup>16,5</sup>	1.0841 <sup>14</sup>	1.549 <sup>13</sup>	s chl
6100	<i>N</i> -(Hydroxymethyl)phthalimide		C <sub>9</sub> H <sub>7</sub> NO <sub>3</sub>	118-29-6	177.157	lf, pr (to)	141.5				i H <sub>2</sub> O, eth, ctc; sl EtOH, bz; s tol
6101	3-Hydroxy-2-methylpropanal		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	38433-80-6	88.106	oil					
6102	2-Hydroxy-2-methylpropanoic acid		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	594-61-6	104.105	hyg pr (eth) nd (bz)	82.5	212			vs H <sub>2</sub> O, EtOH, eth; sl bz
6103	3-Hydroxy-2-methylpropanoic acid		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	2068-83-9	104.105	oil					
6104	<i>N</i> -(Hydroxymethyl)-2-propenamide	<i>N</i> -(Hydroxymethyl)acrylamide	C <sub>4</sub> H <sub>7</sub> NO <sub>2</sub>	924-42-5	101.105	cry	76				
6105	4-Hydroxy-6-methyl-2 <i>H</i> -pyran-2-one	Triacetic acid lactone	C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	675-10-5	126.110		189	dec			
6106	3-Hydroxy-2-methyl-4 <i>H</i> -pyran-4-one	Maltol	C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	118-71-8	126.110	mcl pr (chl)	161.5	sub 93			sl H <sub>2</sub> O, eth, bz; vs chl; s alk; peth

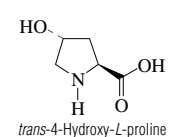
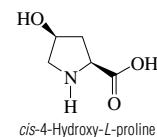
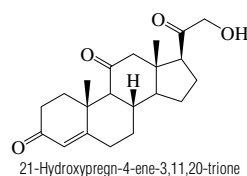
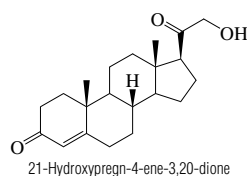
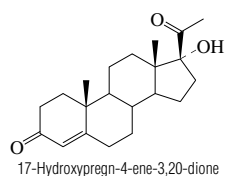
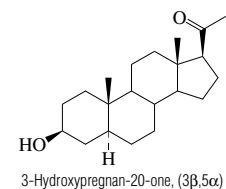
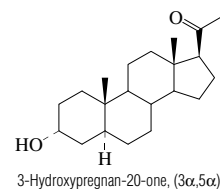
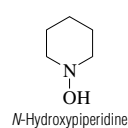
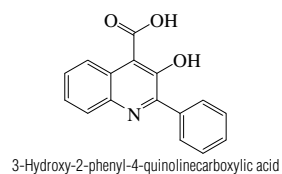
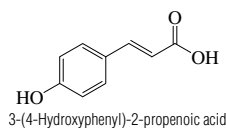
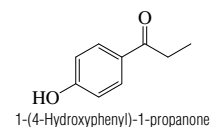
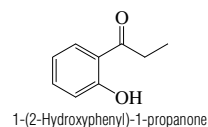
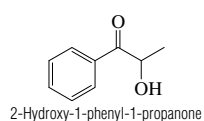
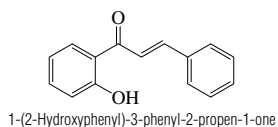
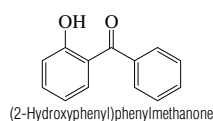
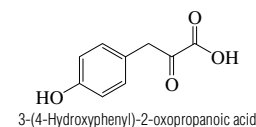
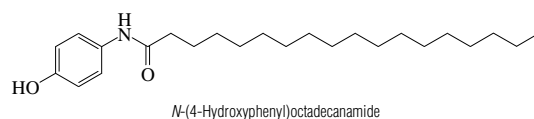
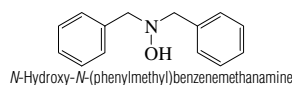
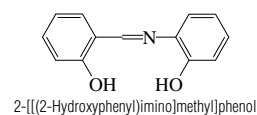
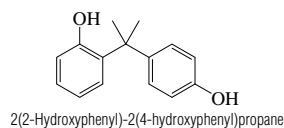
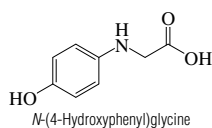
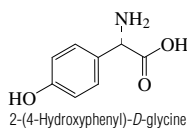
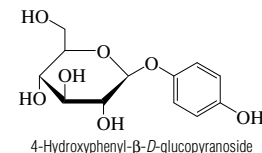
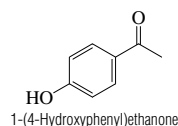
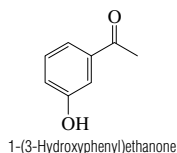
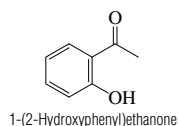
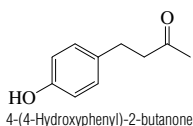
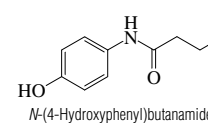
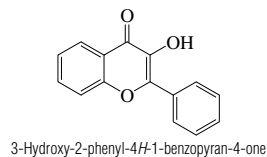
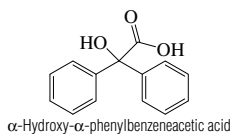
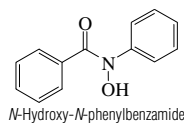
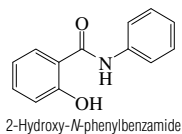
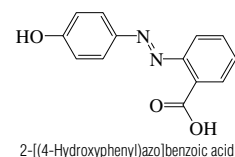
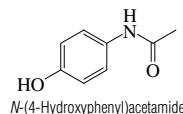
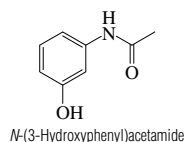
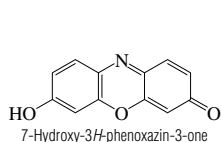




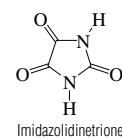
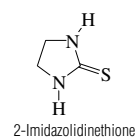
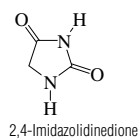
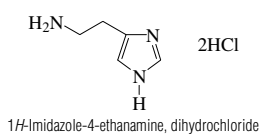
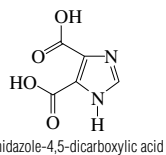
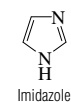
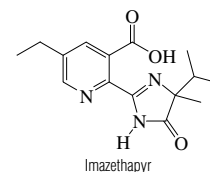
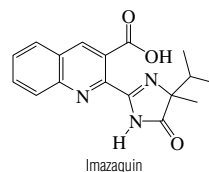
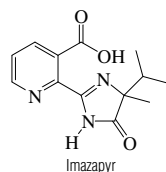
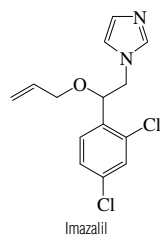
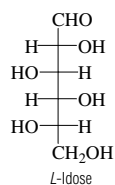
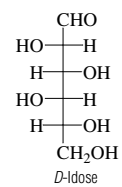
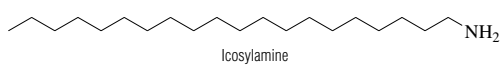
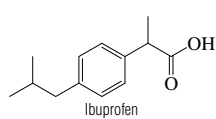
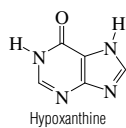
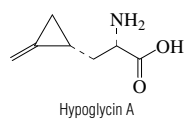
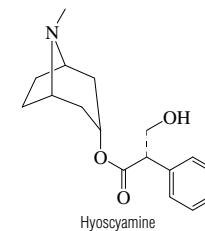
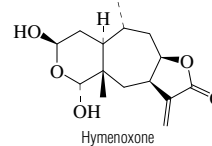
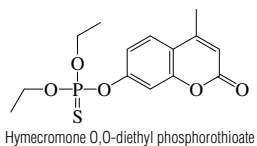
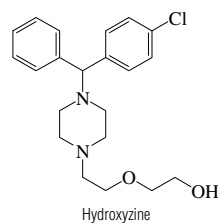
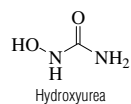
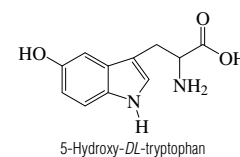
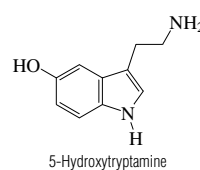
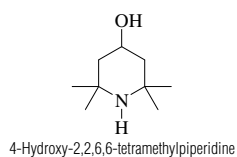
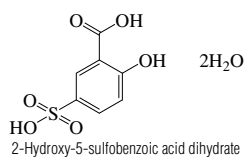
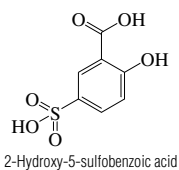
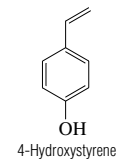
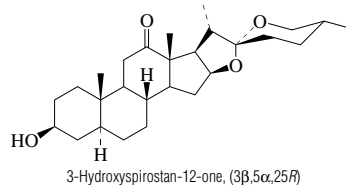
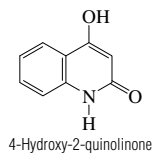
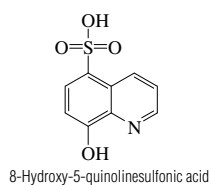
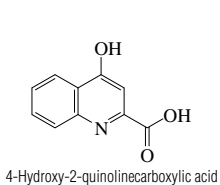
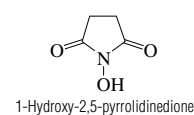
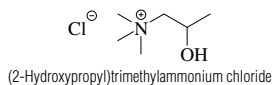
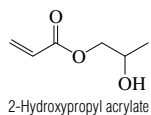
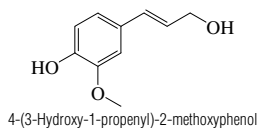
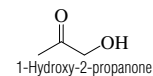
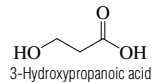
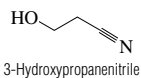
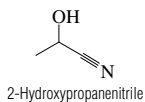
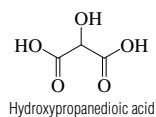
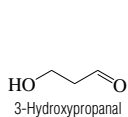
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6107	5-Hydroxy-6-methyl-3,4-pyridinedimethanol	Pyridoxin	C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	65-23-6	169.178	nd (HOAc)	160	140 <sup>0.001</sup>			
6108	4-Hydroxy-1-methyl-2-quinolinone	4-Hydroxy- <i>N</i> -methylcarbostyryl	C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	1677-46-9	175.184		265				sl DMSO
6109	2-Hydroxy-4-(methylthio)butanoic acid	Methionine hydroxy analog	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub> S	583-91-5	150.196	oil					
6110	3-Hydroxy- $\alpha$ -methyl- <i>L</i> -tyrosine	Methyl dopa	C <sub>10</sub> H <sub>13</sub> NO <sub>4</sub>	555-30-6	211.215	cry (MeOH)	300 dec				
6111	(Hydroxymethyl)urea		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	1000-82-4	90.081	pr (al)	111				vs H <sub>2</sub> O; s EtOH, MeOH, HOAc; i eth
6112	2-Hydroxy-1-naphthalenecarboxaldehyde		C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	708-06-5	172.181	pr (al), nd (AcOEt)	83	192 <sup>27</sup>			i H <sub>2</sub> O; s EtOH, eth, aq alk, sulf, peth
6113	2-Hydroxy-1-naphthalenecarboxylic acid	2-Hydroxy-1-naphthoic acid	C <sub>11</sub> H <sub>8</sub> O <sub>3</sub>	2283-08-1	188.180		157.3				sl H <sub>2</sub> O; vs EtOH; s eth, ace, bz, lig, chl
6114	1-Hydroxy-2-naphthalenecarboxylic acid	1-Hydroxy-2-naphthoic acid	C <sub>11</sub> H <sub>8</sub> O <sub>3</sub>	86-48-6	188.180	cry (al) nd (al, eth, bz)	195				sl H <sub>2</sub> O; vs EtOH, eth; s bz
6115	3-Hydroxy-2-naphthalenecarboxylic acid	3-Hydroxy-2-naphthoic acid	C <sub>11</sub> H <sub>8</sub> O <sub>3</sub>	92-70-6	188.180	nd (dil al) ye lf (dil al)	222.5				sl H <sub>2</sub> O; vs EtOH, eth; s bz, chl, tol
6116	2-Hydroxy-1,4-naphthalenedione	Lawsone	C <sub>10</sub> H <sub>6</sub> O <sub>3</sub>	83-72-7	174.153	ye pr (HOAc)	195 dec				vs EtOH; i eth, bz, chl; s HOAc
6117	5-Hydroxy-1,4-naphthalenedione	Juglone	C <sub>10</sub> H <sub>6</sub> O <sub>3</sub>	481-39-0	174.153	ye nd (bz) peth)	155	sub			i H <sub>2</sub> O; s EtOH, eth, bz; vs chl; sl lig
6118	7-Hydroxy-1,3-naphthalenedisulfonic acid	2-Naphthol-6,8-disulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>7</sub> S <sub>2</sub>	118-32-1	304.297						s H <sub>2</sub> O
6119	3-Hydroxy-2,7-naphthalenedisulfonic acid	2-Naphthol-3,6-disulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>7</sub> S <sub>2</sub>	148-75-4	304.297	hyg nd	dec				vs H <sub>2</sub> O, EtOH
6120	6-Hydroxy-2-naphthalenepropanoic acid	Allenolic acid	C <sub>13</sub> H <sub>12</sub> O <sub>3</sub>	553-39-9	216.232	cry (dil MeOH)	180.5				vs py, EtOH, MeOH
6121	4-Hydroxy-1-naphthalenesulfonic acid	1-Naphthol-4-sulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>4</sub> S	84-87-7	224.234	tab or pl (w)	170 dec				vs H <sub>2</sub> O; i eth
6122	7-Hydroxy-1-naphthalenesulfonic acid	Croceic acid	C <sub>10</sub> H <sub>6</sub> O <sub>4</sub> S	132-57-0	224.234						s H <sub>2</sub> O
6123	1-Hydroxy-2-naphthalenesulfonic acid	1-Naphthol-2-sulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>4</sub> S	567-18-0	224.234	pl (w)	>250				sl H <sub>2</sub> O, dil HCl; s EtOH; i eth
6124	6-Hydroxy-2-naphthalenesulfonic acid	2-Naphthol-6-sulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>4</sub> S	93-01-6	224.234	lf, cry (w+1)	125				vs H <sub>2</sub> O, EtOH; i eth; s HOAc
6125	Hydroxynaphthol blue, trisodium salt		C <sub>20</sub> H <sub>14</sub> N <sub>2</sub> Na <sub>3</sub> O <sub>11</sub> S <sub>3</sub>	63451-35-4	623.495	dk red cry					
6126	<i>N</i> -(2-Hydroxy-1-naphthyl)acetamide		C <sub>12</sub> H <sub>11</sub> NO <sub>2</sub>	117-93-1	201.221	lf (w, dil al)	235 dec	sub			vs ace, bz, eth, EtOH
6127	1-(1-Hydroxy-2-naphthyl)ethanone		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	711-79-5	186.206	pr (bz, lig) gm-ye nd (al)	101	dec 325			vs bz, HOAc
6128	2-Hydroxy-3-nitrobenzaldehyde		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	5274-70-4	167.120	nd (HOAc)	109.5				vs bz, EtOH
6129	2-Hydroxy-5-nitrobenzaldehyde		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	97-51-8	167.120	cry (dil HOAc)	127.0				s ace
6130	2-Hydroxy-3-nitrobenzoic acid	3-Nitrosalicylic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	85-38-1	183.119	ye nd (HOAc, w+1)	148				sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz, chl
6131	2-Hydroxy-5-nitrobenzoic acid	5-Nitrosalicylic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	96-97-9	183.119	nd (w)	229.5		1.650 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth, ace, bz; s chl
6132	2-Hydroxy-1,2,3-nonadecanetricarboxylic acid	Agaricic acid	C <sub>22</sub> H <sub>40</sub> O <sub>7</sub>	666-99-9	416.549	cry pow	142 dec				s H <sub>2</sub> O; sl EtOH, eth; i bz, chl
6133	12-Hydroxyoctadecanoic acid	12-Hydroxysteric acid	C <sub>18</sub> H <sub>36</sub> O <sub>3</sub>	106-14-9	300.477	cry (al)	82				i H <sub>2</sub> O; s EtOH, eth, chl
6134	<i>cis</i> -12-Hydroxy-9-octadecenoic acid, ( <i>R</i> )	Ricinoleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>	141-22-0	298.461	visc liq	5.5	227 <sup>10</sup>	0.9450 <sup>21</sup>	1.4716 <sup>21</sup>	i H <sub>2</sub> O; vs eth, EtOH
6135	2-Hydroxyoctanoic acid		C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	617-73-2	160.211	pl	70	162 <sup>10</sup>			sl H <sub>2</sub> O, chl; vs EtOH, eth
6136	5-Hydroxy-4-octanone	Butyrolin	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	496-77-5	144.212	liq	-10	185	0.9107 <sup>16</sup>	1.4345 <sup>16</sup>	
6137	[2-Hydroxy-4-(octyloxy)phenyl]phenylmethanone	Octabenzone	C <sub>21</sub> H <sub>26</sub> O <sub>3</sub>	1843-05-6	326.429		48.5				
6138	3-Hydroxy-2-oxopropanoic acid	Hydroxypyruvic acid	C <sub>3</sub> H <sub>4</sub> O <sub>4</sub>	1113-60-6	104.062		81 dec				
6139	3-Hydroxy-4-oxo-4 <i>H</i> -pyran-2,6-dicarboxylic acid	Meconic acid	C <sub>7</sub> H <sub>4</sub> O <sub>7</sub>	497-59-6	200.103	orth pl (w, dil HCl) (+3w)	120 dec				sl H <sub>2</sub> O, MeOH, ace, eth; s EtOH, bz
6140	2-Hydroxypentanoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	617-31-2	118.131	hyg pl	34	sub			s H <sub>2</sub> O, EtOH, eth
6141	5-Hydroxy-2-pentanone		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1071-73-4	102.132			209; 117 <sup>33</sup>	1.0071 <sup>20</sup>	1.4390 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6142	7-Hydroxy-3 <i>H</i> -phenoxazin-3-one	Resorufine	C <sub>12</sub> H <sub>7</sub> NO <sub>3</sub>	635-78-9	213.189	br nd (PhNO <sub>2</sub> ) pr (HCl)					i H <sub>2</sub> O; sl EtOH; i eth; vs alk
6143	<i>N</i> -(2-Hydroxyphenyl)acetamide		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	614-80-2	151.163	pl (dil al)	209				sl H <sub>2</sub> O; vs EtOH, eth, bz; s DMSO
6144	<i>N</i> -(3-Hydroxyphenyl)acetamide		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	621-42-1	151.163	nd (w)	148.5				vs H <sub>2</sub> O, EtOH; sl eth, bz, chl, DMSO
6145	<i>N</i> -(4-Hydroxyphenyl)acetamide	Acetaminophen	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	103-90-2	151.163	mcl pr (w)	170		1.293 <sup>21</sup>		i H <sub>2</sub> O; vs EtOH
6146	2-[(4-Hydroxyphenyl)azo]benzoic acid		C <sub>13</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	1634-82-8	242.229		206				sl DMSO
6147	2-Hydroxy- <i>N</i> -phenylbenzamide	Salicylanilide	C <sub>13</sub> H <sub>11</sub> NO <sub>2</sub>	87-17-2	213.232	pr (w, al)	136.5				s H <sub>2</sub> O; sl EtOH, eth, bz, chl
6148	<i>N</i> -Hydroxy- <i>N</i> -phenylbenzamide		C <sub>13</sub> H <sub>11</sub> NO <sub>2</sub>	304-88-1	213.232		120.3				
6149	$\alpha$ -Hydroxy- $\alpha$ -phenylbenzeneacetic acid	Benzilic acid	C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	76-93-7	228.243	mcl nd (w)	150	dec 180			sl H <sub>2</sub> O, ace; vs EtOH, eth; s con sulf
6150	3-Hydroxy-2-phenyl-4 <i>H</i> -1-benzopyran-4-one		C <sub>15</sub> H <sub>10</sub> O <sub>3</sub>	577-85-5	238.238	pa ye nd (al)	169.5				s EtOH
6151	<i>N</i> -(4-Hydroxyphenyl)butanamide	4-Hydroxybutyrilide	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	101-91-7	179.216	nd (w)	139.5				vs H <sub>2</sub> O, EtOH
6152	4-(4-Hydroxyphenyl)-2-butanone		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	5471-51-2	164.201		82.5				
6153	1-(2-Hydroxyphenyl)ethanone		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	118-93-4	136.149		2.5	218	1.1307 <sup>20</sup>	1.5584 <sup>20</sup>	vs eth, EtOH, HOAc
6154	1-(3-Hydroxyphenyl)ethanone		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	121-71-1	136.149	nd or lf	96	296; 153 <sup>5</sup>	1.0992 <sup>109</sup>	1.5348 <sup>109</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz, chl; i lig
6155	1-(4-Hydroxyphenyl)ethanone		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	99-93-4	136.149	nd (eth, dil al)	109.5	147 <sup>3</sup>	1.1090 <sup>109</sup>	1.5577 <sup>109</sup>	sl H <sub>2</sub> O, DMSO; vs EtOH, eth
6156	4-Hydroxyphenyl- $\beta$ - <i>D</i> -glucopyranoside	Arbutin	C <sub>12</sub> H <sub>16</sub> O <sub>7</sub>	497-76-7	272.251	nd (w+1)	199.5				vs H <sub>2</sub> O; s EtOH; sl eth; i bz, chl, CS <sub>2</sub>
6157	2-(4-Hydroxyphenyl)- <i>D</i> -glycine	Oxfenicine	C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	22818-40-2	167.162	cry	240 dec				
6158	<i>N</i> -(4-Hydroxyphenyl)glycine		C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	122-87-2	167.162	lf (w) pl (w)	246 dec				sl H <sub>2</sub> O, EtOH; i eth; s AcOEt, chl
6159	2(2-Hydroxyphenyl)-2(4-hydroxyphenyl)propane	2,4'-Isopropylidenediphenol	C <sub>15</sub> H <sub>16</sub> O <sub>2</sub>	837-08-1	228.287	cry (bz)	111				
6160	2-[[2(2-Hydroxyphenyl)imino]methyl]phenol	<i>N</i> -Salicylidene- <i>o</i> -aminophenol	C <sub>13</sub> H <sub>11</sub> NO <sub>2</sub>	1761-56-4	213.232		185				
6161	<i>N</i> -Hydroxy- <i>N</i> -(phenylmethyl)benzenemethanamine		C <sub>14</sub> H <sub>15</sub> NO	621-07-8	213.275		122.5				s chl
6162	<i>N</i> -(4-Hydroxyphenyl)octadecanamide		C <sub>24</sub> H <sub>41</sub> NO <sub>2</sub>	103-99-1	375.589		133.8	239.5 <sup>10</sup>			i H <sub>2</sub> O; sl eth, bz, chl; s ace
6163	3-(4-Hydroxyphenyl)-2-oxopropanoic acid	4-Hydroxy- $\alpha$ -oxobenzenepranoic acid	C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	156-39-8	180.158	cry (w)	220 dec				s H <sub>2</sub> O; dec alk
6164	(2-Hydroxyphenyl)phenylmethanone		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	117-99-7	198.217	pl (dil al)	40	250 <sup>60</sup>			i H <sub>2</sub> O; vs EtOH, eth, bz; sl chl, peth
6165	1-(2-Hydroxyphenyl)-3-phenyl-2-propen-1-one	2'-Hydroxychalcone	C <sub>15</sub> H <sub>12</sub> O <sub>2</sub>	1214-47-7	224.255		90				
6166	2-Hydroxy-1-phenyl-1-propanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	5650-40-8	150.174	ye oil		251	1.1085 <sup>18</sup>	1.536 <sup>23</sup>	
6167	1-(2-Hydroxyphenyl)-1-propanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	610-99-1	150.174			150 <sup>80</sup> , 115 <sup>15</sup>		1.5501 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc, alk
6168	1-(4-Hydroxyphenyl)-1-propanone	Paroxypropione	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	70-70-2	150.174	wh nd or pl (w)	149				sl H <sub>2</sub> O, ace; s EtOH, eth, alk
6169	3-(4-Hydroxyphenyl)-2-propenoic acid	<i>p</i> -Coumaric acid	C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	7400-08-0	164.158	nd	211.5				vs eth, EtOH
6170	3-Hydroxy-2-phenyl-4-quinolinecarboxylic acid	Oxycinchophen	C <sub>16</sub> H <sub>11</sub> NO <sub>3</sub>	485-89-2	265.263	ye pr (al)	206 dec				vs bz, EtOH, HOAc
6171	<i>N</i> -Hydroxypiperidine	1-Piperidinol	C <sub>6</sub> H <sub>11</sub> NO	4801-58-5	101.147	hyg	39.3	110 <sup>65</sup>			
6172	3-Hydroxypregnan-20-one, (3 $\alpha$ ,5 $\alpha$ )	Allopregnan-3 $\alpha$ -ol-20-one	C <sub>21</sub> H <sub>34</sub> O <sub>2</sub>	516-54-1	318.494	cry (al)	177				
6173	3-Hydroxypregnan-20-one, (3 $\beta$ ,5 $\alpha$ )	Allopregnan-3 $\beta$ -ol-20-one	C <sub>21</sub> H <sub>34</sub> O <sub>2</sub>	516-55-2	318.494		189.5				
6174	17-Hydroxypregnan-4-ene-3,20-dione	17 $\alpha$ -Hydroxyprogesterone	C <sub>21</sub> H <sub>30</sub> O <sub>3</sub>	68-96-2	330.461						sl chl
6175	21-Hydroxypregnan-4-ene-3,20-dione	Deoxycorticosterone	C <sub>21</sub> H <sub>30</sub> O <sub>3</sub>	64-85-7	330.461	pl (eth)	141.5				sl H <sub>2</sub> O, eth; vs EtOH, ace; s chl
6176	21-Hydroxypregnan-4-ene-3,11,20-trione	11-Dehydrocorticosterone	C <sub>21</sub> H <sub>28</sub> O <sub>4</sub>	72-23-1	344.445	pr (ace-w, al, ace-eth)	183.5				i H <sub>2</sub> O; s EtOH, ace, bz
6177	<i>cis</i> -4-Hydroxy- <i>L</i> -proline		C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	618-27-9	131.130	nd (w+1)	239.5				vs H <sub>2</sub> O
6178	<i>trans</i> -4-Hydroxy- <i>L</i> -proline		C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	51-35-4	131.130	lf (dil al) pr (w)	274				vs H <sub>2</sub> O; sl EtOH

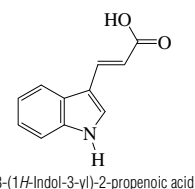
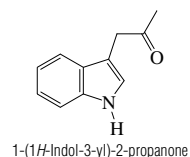
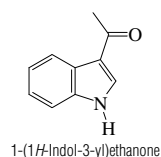
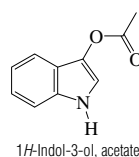
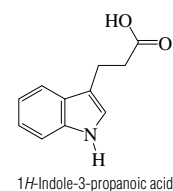
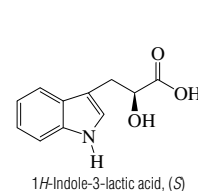
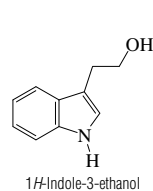
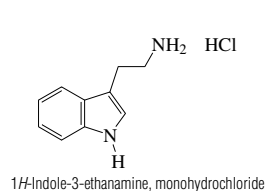
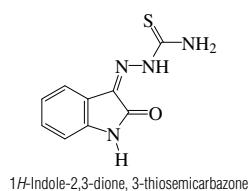
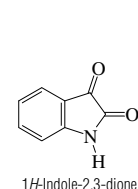
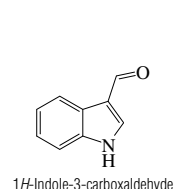
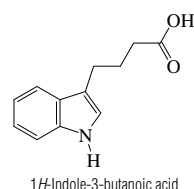
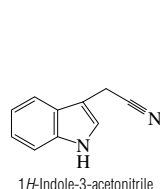
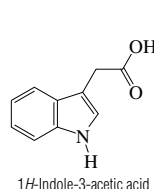
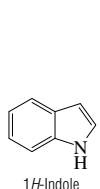
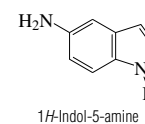
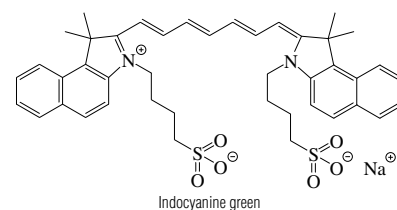
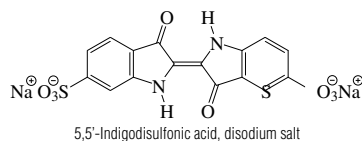
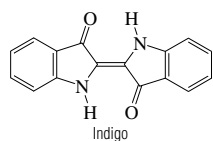
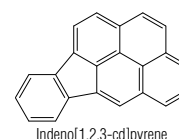
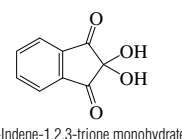
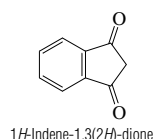
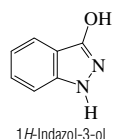
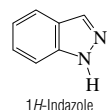
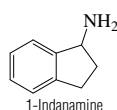
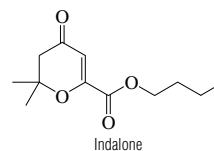
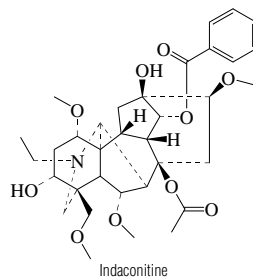
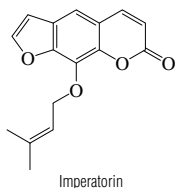
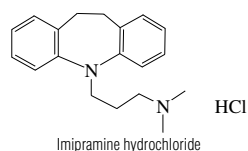
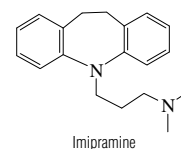
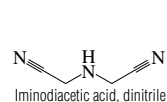
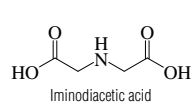
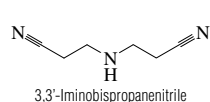
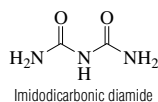
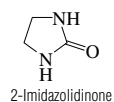


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6179	3-Hydroxypropanal	Hydracrolein	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	2134-29-4	74.079			90 <sup>18</sup> , 38 <sup>92</sup>			vs ace, eth, EtOH
6180	Hydroxypropanedioic acid	Tartronic acid	C <sub>3</sub> H <sub>4</sub> O <sub>5</sub>	80-69-3	120.061	pr (w+1)	157	sub			s H <sub>2</sub> O, EtOH; sl eth
6181	2-Hydroxypropanenitrile	Acetaldehyde cyanohydrin	C <sub>3</sub> H <sub>5</sub> NO	78-97-7	71.078	liq	-40	183	0.9877 <sup>20</sup>	1.4058 <sup>18</sup>	msc H <sub>2</sub> O, EtOH; s eth, chl; i CS <sub>2</sub> , peth
6182	3-Hydroxypropanenitrile	Hydracrylonitrile	C <sub>3</sub> H <sub>5</sub> NO	109-78-4	71.078	liq	-46	221	1.0404 <sup>25</sup>	1.4248 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth; s chl; i CS <sub>2</sub>
6183	3-Hydroxypropanoic acid	Hydracrylic acid	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	503-66-2	90.078	syr		dec		1.4489 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH; msc eth
6184	1-Hydroxy-2-propanone	Acetone alcohol	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	116-09-6	74.079	hyg liq	-17	145.5	1.0805 <sup>20</sup>	1.4295 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth
6185	4-(3-Hydroxy-1-propenyl)-2-methoxyphenol	Coniferyl alcohol	C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	458-35-5	180.200	pr (eth-lig)	74	164 <sup>3</sup>			i H <sub>2</sub> O; s EtOH, alk; vs eth
6186	2-Hydroxypropyl acrylate		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	999-61-1	130.141	liq		70 <sup>2</sup>			
6187	(2-Hydroxypropyl) trimethylammonium chloride		C <sub>6</sub> H <sub>16</sub> ClNO	2382-43-6	153.650	pr (Bu OH)	165	dec			vs H <sub>2</sub> O, EtOH
6188	3-Hydroxy-1H-pyridin-2-one		C <sub>5</sub> H <sub>5</sub> NO <sub>2</sub>	16867-04-2	111.100			245 dec			
6189	1-Hydroxy-2,5-pyrrolidinedione	N-Hydroxysuccinimide	C <sub>4</sub> H <sub>5</sub> NO <sub>3</sub>	6066-82-6	115.088	hyg	96.3				sl DMSO
6190	4-Hydroxy-2-quinolinecarboxylic acid	Kynurenic acid	C <sub>10</sub> H <sub>7</sub> NO <sub>3</sub>	492-27-3	189.168	ye nd (+w, dil al)	282.5				sl H <sub>2</sub> O; s EtOH; i eth; vs alk
6191	8-Hydroxy-5-quinolinesulfonic acid		C <sub>9</sub> H <sub>7</sub> NO <sub>4</sub> S	84-88-8	225.222	ye lf, nd (+1w) (dil HCl)	322.5				sl H <sub>2</sub> O
6192	4-Hydroxy-2-quinolinone	2,4-Quinolinediol	C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	86-95-3	161.158			360 dec			sl EtOH, PhNO <sub>2</sub> , gl HOAc
6193	3-Hydroxyspirostan-12-one, (3β,5α,25R)	Hecogenin	C <sub>27</sub> H <sub>42</sub> O <sub>4</sub>	467-55-0	430.620	pl (eth)	266.5				vs ace, eth, EtOH
6194	4-Hydroxystyrene	4-Vinylphenol	C <sub>8</sub> H <sub>8</sub> O	2628-17-3	120.149		73.5				
6195	2-Hydroxy-5-sulfobenzoic acid	5-Sulfosalicylic acid	C <sub>7</sub> H <sub>6</sub> O <sub>5</sub> S	97-05-2	218.184	hyg nd	120				vs H <sub>2</sub> O; vs EtOH, eth
6196	2-Hydroxy-5-sulfobenzoic acid dihydrate	5-Sulfosalicylic acid dihydrate	C <sub>7</sub> H <sub>10</sub> O <sub>8</sub> S	5965-83-3	254.214	wh cry (w)					vs H <sub>2</sub> O; vs EtOH, eth
6197	4-Hydroxy-2,2,6,6-tetramethylpiperidine	2,2,6,6-Tetramethyl-4-piperidinol	C <sub>8</sub> H <sub>18</sub> NO	2403-88-5	157.253		130	213.5			
6198	5-Hydroxytryptamine	3-(2-Aminoethyl)indol-5-ol	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O	50-67-9	176.214						s H <sub>2</sub> O
6199	5-Hydroxy-DL-tryptophan		C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	114-03-4	220.224	rod or nd (al)	300 dec				
6200	Hydroxyurea		CH <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	127-07-1	76.055	nd (al)	141	dec			vs H <sub>2</sub> O
6201	Hydroxyzine		C <sub>21</sub> H <sub>27</sub> ClN <sub>2</sub> O <sub>2</sub>	68-88-2	374.904	oil		220 <sup>0.5</sup>			
6202	Hymecromone 0,0-diethyl phosphorothioate		C <sub>14</sub> H <sub>17</sub> O <sub>3</sub> PS	299-45-6	328.321	nd	38	210 <sup>1.0</sup> dec	1.260 <sup>38</sup>	1.5685 <sup>37</sup>	vs H <sub>2</sub> O; sl peth
6203	Hymenoxone		C <sub>15</sub> H <sub>22</sub> O <sub>3</sub>	57377-32-9	282.333	cry					
6204	Hyoscyamine		C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub>	101-31-5	289.370	tetr nd (dil al)	108.5				sl H <sub>2</sub> O, eth, bz; vs EtOH, chl
6205	Hypoglycin A		C <sub>7</sub> H <sub>11</sub> NO <sub>2</sub>	156-56-9	141.168	ye pl (Me aq)	282				
6206	Hypoxanthine		C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	68-94-0	136.112	oct nd (w)	150 dec				sl H <sub>2</sub> O; s alk, dil acid
6207	Ibuprofen	2-(4-Isobutylphenyl)propanoic acid	C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	15687-27-1	206.281	col cry	76				sl H <sub>2</sub> O; s os
6208	Icosylamine	1-Eicosanamine	C <sub>20</sub> H <sub>42</sub> N	10525-37-8	297.562			372.4			
6209	D-Idose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	5978-95-0	180.155	syr					vs H <sub>2</sub> O
6210	L-Idose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	5934-56-5	180.155	syr					vs H <sub>2</sub> O
6211	Imazalil		C <sub>14</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub> O	35554-44-0	297.179		50	dec	1.243 <sup>23</sup>		
6212	Imazapyr		C <sub>13</sub> H <sub>15</sub> N <sub>3</sub> O <sub>3</sub>	81334-34-1	261.276		171				
6213	Imazaquin		C <sub>17</sub> H <sub>17</sub> N <sub>3</sub> O <sub>3</sub>	81335-37-7	311.335		221				
6214	Imazethapyr		C <sub>15</sub> H <sub>15</sub> N <sub>3</sub> O <sub>3</sub>	81335-77-5	289.330		173				
6215	Imidazole	1,3-Diazole	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	288-32-4	68.077	mcl pr (bz)	89.5	257	1.0303 <sup>101</sup>	1.4801 <sup>101</sup>	vs H <sub>2</sub> O, EtOH; s eth, ace, py; sl bz
6216	1H-Imidazole-4,5-dicarboxylic acid		C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	570-22-9	156.097	pr	290 dec		1.749 <sup>25</sup>		sl H <sub>2</sub> O, py; i EtOH, eth, bz
6217	1H-Imidazole-4-ethanamine, dihydrochloride		C <sub>6</sub> H <sub>11</sub> Cl <sub>2</sub> N <sub>3</sub>	56-92-8	184.066	pl (eth-HOAc), pr (w)	251.3		1.43 <sup>20</sup>		vs H <sub>2</sub> O, MeOH
6218	2,4-Imidazolidinedione	Hydantoin	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	461-72-3	100.076	nd (MeOH), lf (w)	220				s H <sub>2</sub> O, EtOH, alk; sl eth; i peth
6219	2-Imidazolidinethione	Ethylene thiourea	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> S	96-45-7	102.158	nd (al), pr (al)	203				vs H <sub>2</sub> O; s EtOH; i eth, bz, chl; sl DMSO
6220	Imidazolidinetrione	Parabanic acid	C <sub>3</sub> H <sub>2</sub> N <sub>2</sub> O <sub>3</sub>	120-89-8	114.059	mcl nd (w)	244 dec	sub 100			s H <sub>2</sub> O; vs EtOH

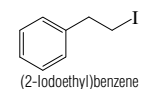
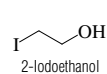
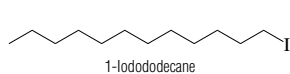
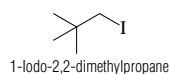
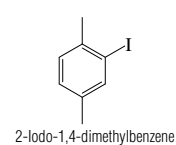
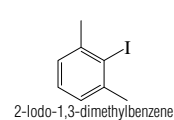
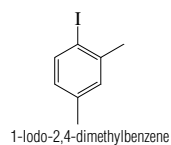
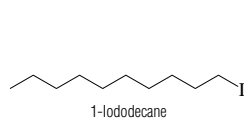
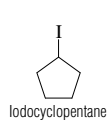
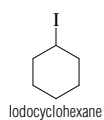
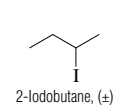
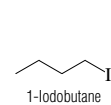
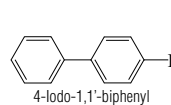
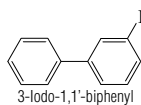
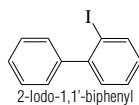
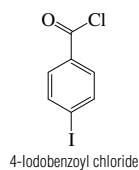
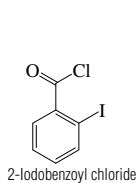
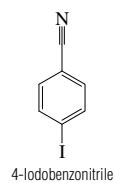
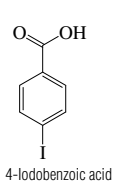
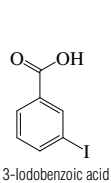
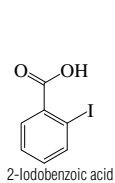
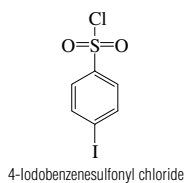
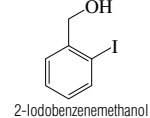
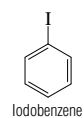
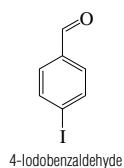
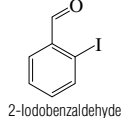
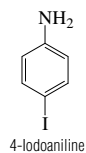
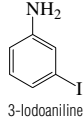
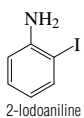
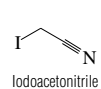
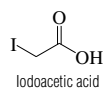
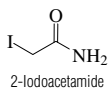
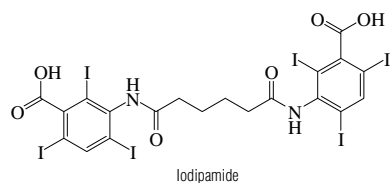
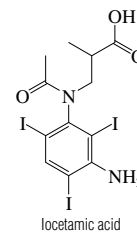
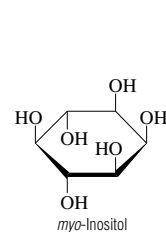
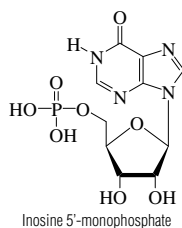
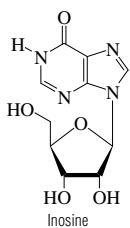
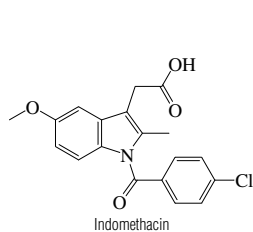


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6221	2-Imidazolidinone	Ethylene urea	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O	120-93-4	86.092		131				vs H <sub>2</sub> O; EtOH; sl eth, chl
6222	Imidodicarbonic diamide	Biuret	C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	108-19-0	103.080	pl (al), nd (w+1)	190 dec				sl H <sub>2</sub> O; vs EtOH; l eth
6223	3,3'-Iminobispropanenitrile	Bis(2-cyanoethyl)amine	C <sub>6</sub> H <sub>8</sub> N <sub>3</sub>	111-94-4	123.155		-6	162 <sup>5</sup>	1.0165 <sup>20</sup>		
6224	Iminodiacetic acid		C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	142-73-4	133.104	orth pr	247.5				sl H <sub>2</sub> O; i EtOH, eth
6225	Iminodiacetic acid, dinitrile	2,2'-Iminobisacetoneitrile	C <sub>4</sub> H <sub>5</sub> N <sub>3</sub>	628-87-5	95.103		78				s H <sub>2</sub> O, EtOH; sl eth, bz, chl
6226	Imipramine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub>	50-49-7	280.407			160 <sup>0.1</sup>			
6227	Imipramine hydrochloride	Tofranil	C <sub>19</sub> H <sub>25</sub> ClN <sub>2</sub>	113-52-0	316.868		174.5				vs H <sub>2</sub> O; s EtOH; sl ace
6228	Imperatorin		C <sub>16</sub> H <sub>14</sub> O <sub>4</sub>	482-44-0	270.280	cry (al)	102				sl H <sub>2</sub> O; s EtOH, eth, bz, peth; vs chl
6229	Indaconitine		C <sub>34</sub> H <sub>47</sub> NO <sub>10</sub>	4491-19-4	629.738	cry	202 dec				vs eth, EtOH, chl
6230	Indalone	Butopyronoxyl	C <sub>12</sub> H <sub>18</sub> O <sub>4</sub>	532-34-3	226.269	ye-red liq		263	1.057 <sup>20</sup>	1.475 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl
6231	Indan		C <sub>9</sub> H <sub>10</sub>	496-11-7	118.175	liq	-51.38	177.97	0.9639 <sup>20</sup>	1.5378 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl chl
6232	1-Indanamine	1-Aminoindane	C <sub>9</sub> H <sub>11</sub> N	34698-41-4	133.190			221; 96 <sup>9</sup>	1.038 <sup>15</sup>	1.5613 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace, bz
6233	1 <i>H</i> -Indazole	1 <i>H</i> -Benzopyrazole	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	271-44-3	118.136	nd (al, w)	148	269			s H <sub>2</sub> O, EtOH, eth
6234	1 <i>H</i> -Indazol-3-ol	1,2-Dihydro-3 <i>H</i> -indazol-3-one	C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	7364-25-2	134.135	nd or lf (MeOH) pl or nd (al)	252.5				sl H <sub>2</sub> O, eth; s MeOH, EtOH
6235	Indene	Indonaphthene	C <sub>9</sub> H <sub>8</sub>	95-13-6	116.160	liq	-1.5	182	0.9960 <sup>25</sup>	1.5768 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, bz, py; sl chl
6236	1 <i>H</i> -Indene-1,3(2 <i>H</i> )-dione		C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	606-23-5	146.143	nd (eth, lig)	131 dec		1.37 <sup>21</sup>		sl H <sub>2</sub> O, ctc; vs EtOH; s eth, bz, alk
6237	1 <i>H</i> -Indene-1,2,3-trione monohydrate	Ninhydrin	C <sub>9</sub> H <sub>6</sub> O <sub>4</sub>	485-47-2	178.142	pa ye pr (w, al)	242 dec				vs H <sub>2</sub> O; s EtOH, alk; sl eth
6238	Indeno[1,2,3- <i>cd</i> ]pyrene	1,10-(1,2-Phenylene)pyrene	C <sub>22</sub> H <sub>12</sub>	193-39-5	276.330	ye cry (cy)	162				
6239	Indigo		C <sub>16</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	482-89-3	262.262	dk bl pow	390 dec	sub 300			
6240	5,5'-Indigodisulfonic acid, disodium salt	Indigo Carmine	C <sub>16</sub> H <sub>6</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>8</sub> S <sub>2</sub>	860-22-0	466.353	dk-bl pow					sl H <sub>2</sub> O, EtOH; i os
6241	Indocyanine green		C <sub>43</sub> H <sub>47</sub> N <sub>2</sub> NaO <sub>6</sub> S <sub>2</sub>	3599-32-4	774.962	grn pow	244 dec				
6242	1 <i>H</i> -Indol-5-amine		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	5192-03-0	132.163		132				
6243	1 <i>H</i> -Indole	2,3-Benzopyrrole	C <sub>8</sub> H <sub>7</sub> N	120-72-9	117.149	lf (w, peth) cry (eth)	52.5	253.6	1.22 <sup>25</sup>		s H <sub>2</sub> O, bz; vs EtOH, eth, tol; sl ctc
6244	1 <i>H</i> -Indole-3-acetic acid	Indoleacetic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	87-51-4	175.184	lf (bz), pl (chl)	168.5				i H <sub>2</sub> O; vs EtOH; s eth, ace, bz; sl chl
6245	1 <i>H</i> -Indole-3-acetonitrile		C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	771-51-7	156.184		36	160 <sup>0.2</sup>			
6246	1 <i>H</i> -Indole-3-butyric acid	Indolebutyric acid	C <sub>12</sub> H <sub>13</sub> NO <sub>2</sub>	133-32-4	203.237		124.5				vs bz; s DMSO; l peth
6247	1 <i>H</i> -Indole-3-carboxaldehyde		C <sub>9</sub> H <sub>7</sub> NO	487-89-8	145.158		197.8				
6248	1 <i>H</i> -Indole-2,3-dione	Isatin	C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	91-56-5	147.132	oran mcl pr	203 dec				s H <sub>2</sub> O, ace, bz; vs EtOH; sl eth
6249	1 <i>H</i> -Indole-2,3-dione, 3-thiosemicarbazone	Isatin, 3-thiosemicarbazone	C <sub>9</sub> H <sub>8</sub> N <sub>4</sub> OS	487-16-1	220.251		283				
6250	1 <i>H</i> -Indole-3-ethanamine, monohydrochloride	Tryptamine hydrochloride	C <sub>10</sub> H <sub>13</sub> ClN <sub>2</sub>	343-94-2	196.676	nd (al-bz or lig)	255				vs ace, EtOH
6251	1 <i>H</i> -Indole-3-ethanol	Tryptophol	C <sub>10</sub> H <sub>11</sub> NO	526-55-6	161.200	pr (bz-peth)	59	174 <sup>2</sup>			vs ace, eth, EtOH, chl
6252	1 <i>H</i> -Indole-3-lactic acid, ( <i>S</i> )	α-Hydroxy-1 <i>H</i> -indole-3-propanoic acid	C <sub>11</sub> H <sub>11</sub> NO <sub>3</sub>	7417-65-4	205.210	cry (peth)	100				
6253	1 <i>H</i> -Indole-3-propanoic acid		C <sub>11</sub> H <sub>11</sub> NO <sub>2</sub>	830-96-6	189.211		134.5				sl H <sub>2</sub> O, DMSO; vs EtOH, eth, ace, bz
6254	Indolizine		C <sub>8</sub> H <sub>7</sub> N	274-40-8	117.149	pl	75	205			i H <sub>2</sub> O; s EtOH
6255	1 <i>H</i> -Indol-3-ol, acetate		C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	608-08-2	175.184		129				
6256	1-(1 <i>H</i> -Indol-3-yl)ethanone		C <sub>10</sub> H <sub>9</sub> NO	703-80-0	159.184	nd (bz)	192.3	144 <sup>10</sup>			vs EtOH
6257	1-(1 <i>H</i> -Indol-3-yl)-2-propanone	3-Indolylacetone	C <sub>11</sub> H <sub>11</sub> NO	1201-26-9	173.211	br orth (bz), nd (aq MeOH)	116				
6258	3-(1 <i>H</i> -Indol-3-yl)-2-propenoic acid	3-Indolylacrylic acid	C <sub>11</sub> H <sub>9</sub> NO <sub>2</sub>	1204-06-4	187.195		185 dec				

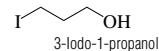
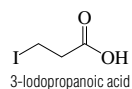
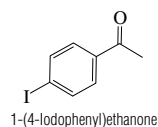
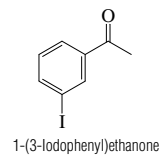
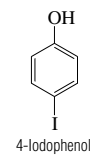
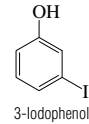
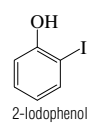
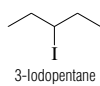
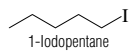
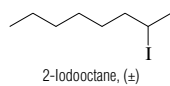
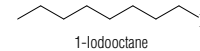
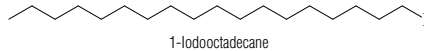
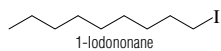
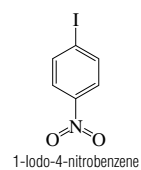
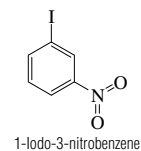
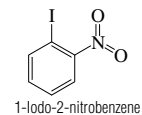
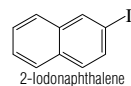
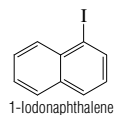
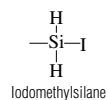
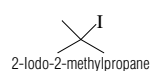
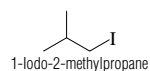
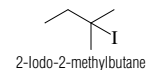
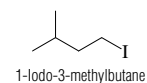
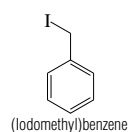
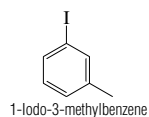
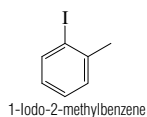
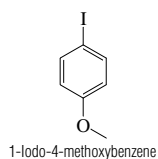
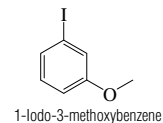
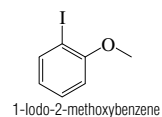
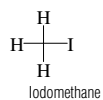
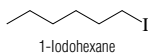
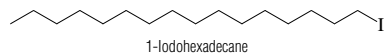
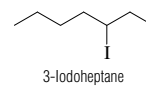
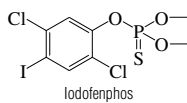
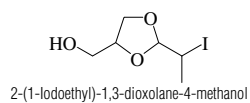




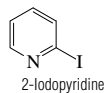
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6259	Indomethacin		C <sub>19</sub> H <sub>16</sub> ClNO <sub>4</sub>	53-86-1	357.788		155 (form a); 162 (form b)				
6260	Inosine	Hypoxanthine riboside	C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> O <sub>5</sub>	58-63-9	268.226	pl (w + 2), nd (80% al)	218 dec				sl H <sub>2</sub> O; vs EtOH
6261	Inosine 5'-monophosphate	5'-Inosinic acid	C <sub>10</sub> H <sub>13</sub> N <sub>4</sub> O <sub>8</sub> P	131-99-7	348.206	visc liq or glass					vs H <sub>2</sub> O; sl EtOH, eth
6262	myo-Inositol	(1α,2α,3α,4β,5α,6β)- Cyclohexanehexol	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	87-89-8	180.155	cry (w)	225		1.752		s H <sub>2</sub> O
6263	locetamic acid		C <sub>12</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub>	16034-77-8	613.955	wh-ye pow	225				i H <sub>2</sub> O; sl EtOH, bz, eth, ace
6264	Iodipamide		C <sub>20</sub> H <sub>14</sub> N <sub>2</sub> O <sub>6</sub>	606-17-7	1139.761		307 dec				i H <sub>2</sub> O, bz; sl EtOH, eth, ace
6265	2-Iodoacetamide		C <sub>2</sub> H <sub>4</sub> IINO	144-48-9	184.963		93.0				s H <sub>2</sub> O; sl tfa
6266	Iodoacetic acid		C <sub>2</sub> H <sub>3</sub> IO <sub>2</sub>	64-69-7	185.948		82.5	dec			s H <sub>2</sub> O, EtOH, peth; sl eth, chl
6267	Iodoacetone		C <sub>3</sub> H <sub>5</sub> IO	3019-04-3	183.975			62 <sup>12</sup>	2.17 <sup>15</sup>		s EtOH
6268	Iodoacetoneitrile		C <sub>2</sub> H <sub>3</sub> IIN	624-75-9	166.948			185	2.307 <sup>25</sup>	1.5744 <sup>20</sup>	
6269	Iodoacetylene		C <sub>2</sub> HI	14545-08-5	151.933			32			
6270	2-Iodoaniline		C <sub>6</sub> H <sub>6</sub> IIN	615-43-0	219.023	nd (dil al)	60.5				sl H <sub>2</sub> O; vs EtOH, eth, ace
6271	3-Iodoaniline		C <sub>6</sub> H <sub>6</sub> IIN	626-01-7	219.023	lf	33	145 <sup>15</sup>		1.6811 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, chl
6272	4-Iodoaniline		C <sub>6</sub> H <sub>6</sub> IIN	540-37-4	219.023	nd (w)	67.5				sl H <sub>2</sub> O, peth; s EtOH, eth
6273	2-Iodobenzaldehyde		C <sub>7</sub> H <sub>5</sub> IO	26260-02-6	232.018		37	129 <sup>14</sup>			sl H <sub>2</sub> O; s ace
6274	4-Iodobenzaldehyde		C <sub>7</sub> H <sub>5</sub> IO	15164-44-0	232.018		77.5	265			sl H <sub>2</sub> O; s EtOH, bz
6275	Iodobenzene		C <sub>6</sub> H <sub>5</sub> I	591-50-4	204.008	liq	-31.3	188.4	1.8308 <sup>20</sup>	1.6200 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth, ace, bz, ctc
6276	2-Iodobenzenemethanol		C <sub>7</sub> H <sub>7</sub> IO	5159-41-1	234.034		92	148 <sup>32</sup>		1.6349 <sup>20</sup>	
6277	4-Iodobenzenesulfonyl chloride	Pipsyl chloride	C <sub>6</sub> H <sub>4</sub> ClIO <sub>2</sub> S	98-61-3	302.517		85				
6278	2-Iodobenzoic acid		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	88-67-5	248.018	nd (w)	163	exp 233	2.25 <sup>25</sup>		sl H <sub>2</sub> O, ace; vs EtOH, eth
6279	3-Iodobenzoic acid		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	618-51-9	248.018	mcl pr (ace)	188.3	sub			sl H <sub>2</sub> O, eth; vs EtOH
6280	4-Iodobenzoic acid		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	619-58-9	248.018	mcl pr (dil al) lf (sub)	270	sub	2.184 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth, DMSO
6281	4-Iodobenzonitrile		C <sub>7</sub> H <sub>4</sub> IIN	3058-39-7	229.018		127.5				
6282	2-Iodobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> ClIO	609-67-6	266.463		38.3	159 <sup>27</sup> , 135 <sup>19</sup>			
6283	4-Iodobenzoyl chloride		C <sub>7</sub> H <sub>4</sub> ClIO	1711-02-0	266.463		65.5	164 <sup>32</sup>			
6284	2-Iodo-1,1'-biphenyl		C <sub>12</sub> H <sub>9</sub> I	2113-51-1	280.103			190 <sup>36</sup> , 169 <sup>17</sup>	1.5511 <sup>25</sup>	1.6620 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, HOAc
6285	3-Iodo-1,1'-biphenyl		C <sub>12</sub> H <sub>9</sub> I	20442-79-9	280.103		26.5	188 <sup>16</sup>	1.5967 <sup>25</sup>		
6286	4-Iodo-1,1'-biphenyl		C <sub>12</sub> H <sub>9</sub> I	1591-31-7	280.103	nd (al, HOAc)	113.5	320; 183 <sup>11</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, HOAc
6287	1-Iodobutane	Butyl iodide	C <sub>4</sub> H <sub>9</sub> I	542-69-8	184.018	liq	-103	130.5	1.6154 <sup>20</sup>	1.5001 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs chl
6288	2-Iodobutane, (±)	(±)-sec-Butyl iodide	C <sub>4</sub> H <sub>9</sub> I	52152-71-3	184.018	liq	-104.2	120.1	1.5920 <sup>20</sup>	1.4991 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs chl
6289	Iodocyclohexane	Cyclohexyl iodide	C <sub>6</sub> H <sub>11</sub> I	626-62-0	210.055			dec 180; 81 <sup>20</sup>	1.6244 <sup>20</sup>	1.5477 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
6290	Iodocyclopentane	Cyclopentyl iodide	C <sub>5</sub> H <sub>9</sub> I	1556-18-9	196.029			166.5	1.7096 <sup>20</sup>	1.5447 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz; sl ctc
6291	1-Iododecane		C <sub>10</sub> H <sub>21</sub> I	2050-77-3	268.178	liq	-16.3	263.7; 132 <sup>15</sup>	1.2546 <sup>20</sup>	1.4858 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
6292	1-Iodo-2,4-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> I	4214-28-2	232.061			dec 231; 111 <sup>14</sup>	1.6282 <sup>16</sup>	1.6008 <sup>16</sup>	i H <sub>2</sub> O; s ace, bz
6293	2-Iodo-1,3-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> I	608-28-6	232.061	oil	11.2	229.5	1.6158 <sup>20</sup>	1.6035 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz
6294	2-Iodo-1,4-dimethylbenzene		C <sub>8</sub> H <sub>9</sub> I	1122-42-5	232.061			dec 227	1.6168 <sup>17</sup>	1.5992 <sup>17</sup>	i H <sub>2</sub> O; s ace, bz
6295	1-Iodo-2,2-dimethylpropane		C <sub>5</sub> H <sub>11</sub> I	15501-33-4	198.045			dec 128	1.4940 <sup>20</sup>	1.4890 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
6296	1-Iodododecane	Lauryl iodide	C <sub>12</sub> H <sub>25</sub> I	4292-19-7	296.231		0.3	298.2	1.1999 <sup>20</sup>	1.4840 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, MeOH; msc eth, ace, ctc
6297	Iodoethane	Ethyl iodide	C <sub>2</sub> H <sub>5</sub> I	75-03-6	155.965	liq	-111.1	72.3	1.9357 <sup>20</sup>	1.5133 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; s eth, chl
6298	2-Iodoethanol		C <sub>2</sub> H <sub>5</sub> IO	624-76-0	171.964			dec 176	2.1967 <sup>20</sup>	1.5713 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
6299	Iodoethene	Vinyl iodide	C <sub>2</sub> H <sub>3</sub> I	593-66-8	153.949			56	2.037 <sup>20</sup>	1.5385 <sup>20</sup>	vs eth, EtOH
6300	(2-Iodoethyl)benzene		C <sub>8</sub> H <sub>9</sub> I	17376-04-4	232.061	liq		122 <sup>13</sup>	1.603	1.6010 <sup>20</sup>	



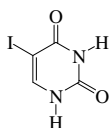
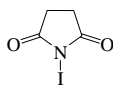
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6301	2-(1-Iodoethyl)-1,3-dioxolane-4-methanol	Iodinated glycerol	C <sub>6</sub> H <sub>11</sub> IO <sub>3</sub>	5634-39-9	258.053	pale ye liq			1.797	1.547	s eth, chl, thf, AcOEt
6302	Iodofenphos		C <sub>8</sub> H <sub>8</sub> Cl <sub>2</sub> IO <sub>3</sub> PS	18181-70-9	412.997	wh cry	76				i H <sub>2</sub> O; s ace, xyl; sl EtOH
6303	1-Iodoheptane		C <sub>7</sub> H <sub>15</sub> I	4282-40-0	226.098	liq	-48.2	204.0	1.3719 <sup>25</sup>	1.4904 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl; sl ctc
6304	3-Iodoheptane		C <sub>7</sub> H <sub>15</sub> I	31294-92-5	226.098			89 <sup>30</sup>	1.3676 <sup>20</sup>		
6305	1-Iodohexadecane		C <sub>16</sub> H <sub>33</sub> I	544-77-4	352.337	pa ye liq	24.7	357; 212 <sup>15</sup>	1.1213 <sup>25</sup>	1.4797 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace; msc bz; vs chl
6306	1-Iodohexane	Hexyl iodide	C <sub>6</sub> H <sub>13</sub> I	638-45-9	212.071	liq	-74.2	181.3	1.4305 <sup>25</sup>	1.4928 <sup>20</sup>	i H <sub>2</sub> O
6307	Iodomethane	Methyl iodide	CH <sub>3</sub> I	74-88-4	141.939	liq	-66.4	42.43	2.2789 <sup>20</sup>	1.5308 <sup>20</sup>	sl H <sub>2</sub> O; s ace, bz, chl; msc EtOH, eth
6308	1-Iodo-2-methoxybenzene	<i>o</i> -Iodoanisole	C <sub>7</sub> H <sub>7</sub> IO	529-28-2	234.034			241; 91 <sup>2</sup>	1.8 <sup>20</sup>		vs EtOH, eth, ace, bz, chl, lig
6309	1-Iodo-3-methoxybenzene	<i>m</i> -Iodoanisole	C <sub>7</sub> H <sub>7</sub> IO	766-85-8	234.034			244.5	1.9650 <sup>20</sup>		vs EtOH, eth
6310	1-Iodo-4-methoxybenzene	<i>p</i> -Iodoanisole	C <sub>7</sub> H <sub>7</sub> IO	696-62-8	234.034	lf (al), nd (MeOH)	53	238; 138 <sup>25</sup>			s EtOH, eth, chl
6311	1-Iodo-2-methylbenzene		C <sub>7</sub> H <sub>7</sub> I	615-37-2	218.035			211.5	1.713 <sup>20</sup>	1.6079 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6312	1-Iodo-3-methylbenzene		C <sub>7</sub> H <sub>7</sub> I	625-95-6	218.035	liq	-27.2	213	1.705 <sup>20</sup>	1.6053 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6313	(Iodomethyl)benzene		C <sub>7</sub> H <sub>7</sub> I	620-05-3	218.035	col or ye nd (MeOH)	24.5	93 <sup>10</sup>	1.7335 <sup>25</sup>	1.6334 <sup>25</sup>	vs bz, eth, EtOH
6314	1-Iodo-3-methylbutane	Isopentyl iodide	C <sub>7</sub> H <sub>11</sub> I	541-28-6	198.045			147	1.5118 <sup>20</sup>	1.4939 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
6315	2-Iodo-2-methylbutane		C <sub>7</sub> H <sub>11</sub> I	594-38-7	198.045			124.5	1.4937 <sup>20</sup>	1.4981 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6316	1-Iodo-2-methylpropane	Isobutyl iodide	C <sub>4</sub> H <sub>9</sub> I	513-38-2	184.018			121.1	1.6035 <sup>20</sup>	1.4959 <sup>20</sup>	
6317	2-Iodo-2-methylpropane	<i>tert</i> -Butyl iodide	C <sub>4</sub> H <sub>9</sub> I	558-17-8	184.018	liq	-38.2	100.1	1.571 <sup>25</sup>	1.4918 <sup>20</sup>	msc EtOH, eth
6318	Iodomethylsilane		CH <sub>3</sub> ISi	18089-64-0	172.041	col liq	-109.5	71.8			
6319	1-Iodonaphthalene		C <sub>10</sub> H <sub>7</sub> I	90-14-2	254.067		2.1	302	1.7399 <sup>20</sup>	1.7026 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz, CS <sub>2</sub>
6320	2-Iodonaphthalene		C <sub>10</sub> H <sub>7</sub> I	612-55-5	254.067	lf (dil al)	54.5	308	1.6319 <sup>99</sup>	1.6662 <sup>99</sup>	i H <sub>2</sub> O; vs EtOH, eth, HOAc
6321	1-Iodo-2-nitrobenzene		C <sub>6</sub> H <sub>4</sub> INO <sub>2</sub>	609-73-4	249.006	ye orth nd (al)	54	290; 162 <sup>18</sup>	1.9186 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth
6322	1-Iodo-3-nitrobenzene		C <sub>6</sub> H <sub>4</sub> INO <sub>2</sub>	645-00-1	249.006	mcl pr	38.5	280	1.9477 <sup>50</sup>		i H <sub>2</sub> O; s EtOH, eth
6323	1-Iodo-4-nitrobenzene		C <sub>6</sub> H <sub>4</sub> INO <sub>2</sub>	636-98-6	249.006	ye nd (al)	174.7	288	1.8090 <sup>155</sup>		i H <sub>2</sub> O; s EtOH, HOAc; sl DMSO
6324	1-Iodononane		C <sub>9</sub> H <sub>19</sub> I	4282-42-2	254.151	col liq	-20	245.0	1.2836 <sup>25</sup>	1.4848 <sup>25</sup>	
6325	1-Iodooctadecane		C <sub>18</sub> H <sub>37</sub> I	629-93-6	380.391	lf (lig), nd (ace, al-ace)	34.0	383	1.0994 <sup>20</sup>	1.4810 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, eth
6326	1-Iodooctane		C <sub>8</sub> H <sub>17</sub> I	629-27-6	240.125	liq	-45.7	225.1	1.3298 <sup>20</sup>	1.4885 <sup>20</sup>	s EtOH, eth
6327	2-Iodooctane, (±)	2-Octyl iodide, (±)	C <sub>8</sub> H <sub>17</sub> I	36049-78-2	240.125			210; 95 <sup>16</sup>	1.3251 <sup>20</sup>	1.4896 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, lig
6328	1-Iodopentane	Pentyl iodide	C <sub>5</sub> H <sub>11</sub> I	628-17-1	198.045	liq	-85.6	157.0	1.5161 <sup>20</sup>	1.4959 <sup>20</sup>	s chl
6329	3-Iodopentane		C <sub>5</sub> H <sub>11</sub> I	1809-05-8	198.045			145.5	1.5176 <sup>20</sup>	1.4974 <sup>20</sup>	vs ace, bz, eth
6330	2-Iodophenol		C <sub>6</sub> H <sub>5</sub> IO	533-58-4	220.007	nd	43	186 <sup>160</sup> ; 91 <sup>2</sup>	1.8757 <sup>90</sup>		s H <sub>2</sub> O; vs EtOH, eth, CS <sub>2</sub>
6331	3-Iodophenol		C <sub>6</sub> H <sub>5</sub> IO	626-02-8	220.007	nd (lig)	118	186 <sup>100</sup>			sl H <sub>2</sub> O; s EtOH, eth
6332	4-Iodophenol		C <sub>6</sub> H <sub>5</sub> IO	540-38-5	220.007	nd (w or sub)	93.5	139 <sup>5</sup> dec	1.8573 <sup>112</sup>		sl H <sub>2</sub> O; vs EtOH, eth
6333	1-(3-Iodophenyl)ethanone	3-Iodoacetophenone	C <sub>8</sub> H <sub>7</sub> IO	14452-30-3	246.045			129 <sup>8</sup> ; 117 <sup>4</sup>		1.622 <sup>20</sup>	s bz
6334	1-(4-Iodophenyl)ethanone	4-Iodoacetophenone	C <sub>8</sub> H <sub>7</sub> IO	13329-40-3	246.045		86	153 <sup>18</sup>			s EtOH, bz, CS <sub>2</sub> , HOAc; sl lig, eth
6335	1-Iodopropane	Propyl iodide	C <sub>3</sub> H <sub>7</sub> I	107-08-4	169.992	liq	-101.3	102.5	1.7489 <sup>20</sup>	1.5058 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
6336	2-Iodopropane	Isopropyl iodide	C <sub>3</sub> H <sub>7</sub> I	75-30-9	169.992	liq	-90	89.5	1.7042 <sup>20</sup>	1.5028 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz, chl
6337	3-Iodopropanoic acid		C <sub>3</sub> H <sub>5</sub> IO <sub>2</sub>	141-76-4	199.975	lf (w)	85				sl H <sub>2</sub> O, chl; vs EtOH; s eth, ace
6338	3-Iodo-1-propanol		C <sub>3</sub> H <sub>7</sub> IO	627-32-7	185.991	visc oil		226; 115 <sup>38</sup>	1.9976 <sup>20</sup>	1.5585 <sup>20</sup>	
6339	3-Iodopropene	Allyl iodide	C <sub>3</sub> H <sub>5</sub> I	556-56-9	167.976	ye liq	-99.3	103	1.848 <sup>12</sup>	1.5540 <sup>21</sup>	i H <sub>2</sub> O; s EtOH, eth, chl



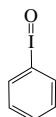
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6340	2-Iodopyridine		C <sub>5</sub> H <sub>4</sub> IN	5029-67-4	204.997			100 <sup>15</sup> , 93 <sup>13</sup>	1.928 <sup>25</sup>	1.6366 <sup>20</sup>	s EtOH, eth, ace, bz
6341	5-Iodo-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	5-Iodouracil	C <sub>4</sub> H <sub>3</sub> IN <sub>2</sub> O <sub>2</sub>	696-07-1	237.983		275 dec				
6342	1-Iodo-2,5-pyrrolidinedione	<i>N</i> -Iodosuccinimide	C <sub>4</sub> H <sub>4</sub> INO <sub>2</sub>	516-12-1	224.985	cry (ace)	200.5		2.245 <sup>25</sup>		vs H <sub>2</sub> O; s EtOH, ace; sl eth, DMSO
6343	Iodosylbenzene		C <sub>6</sub> H <sub>5</sub> IO	536-80-1	220.007	ye pow	210 exp				s H <sub>2</sub> O, EtOH; i eth, ace, bz, peth
6344	2-Iodothiophene		C <sub>4</sub> H <sub>3</sub> IS	3437-95-4	210.036	liq	-40	181	2.0595 <sup>25</sup>	1.6465 <sup>25</sup>	vs EtOH, eth; sl chl
6345	4-Iodotoluene		C <sub>7</sub> H <sub>7</sub> I	624-31-7	218.035	lf (al)	36.5	211	1.678 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub> ; sl chl
6346	<i>L</i> -3-Iodotyrosine		C <sub>9</sub> H <sub>10</sub> INO <sub>3</sub>	70-78-0	307.084	cry (w)	205 dec				
6347	<i>trans</i> - $\alpha$ -Iionone, ( $\pm$ )		C <sub>13</sub> H <sub>20</sub> O	30685-95-1	192.297			146 <sup>28</sup>	0.9298 <sup>21</sup>	1.5041 <sup>20</sup>	vs ace, eth, EtOH
6348	<i>trans</i> - $\beta$ -Iionone		C <sub>13</sub> H <sub>20</sub> O	79-77-6	192.297			124 <sup>10</sup> , 73 <sup>0.1</sup>	0.945 <sup>20</sup>	1.5198 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s chl
6349	Iopanoic acid		C <sub>11</sub> H <sub>19</sub> INO <sub>2</sub>	96-83-3	570.932	wh solid	156				i H <sub>2</sub> O; s dil alk, EtOH
6350	Iophendylate	Ethyl 10-(4-iodophenyl)undecanoate	C <sub>19</sub> H <sub>29</sub> IO <sub>2</sub>	99-79-6	416.336	visc liq		197 <sup>1</sup>	1.25 <sup>20</sup>	1.525 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH, bz, chl
6351	Iopodic acid	Ipodate	C <sub>12</sub> H <sub>13</sub> N <sub>3</sub> O <sub>2</sub>	5587-89-3	597.956	cry	168				i H <sub>2</sub> O; vs EtOH, MeOH, chl, ace
6352	Iprodione		C <sub>13</sub> H <sub>13</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub>	36734-19-7	330.166		136				
6353	Iridomyrmecin	Hexahydro-4,7-dimethylcyclopenta[c]pyran-3(1 <i>H</i> )-one	C <sub>10</sub> H <sub>16</sub> O <sub>2</sub>	485-43-8	168.233	pr	61	106 <sup>1.5</sup>		1.4607 <sup>65</sup>	sl H <sub>2</sub> O; s eth
6354	$\alpha$ -Irone	4-(2,5,6,6-Tetramethyl-2-cyclohexen-1-yl)-3-buten-2-one	C <sub>14</sub> H <sub>22</sub> O	79-69-6	206.324			90 <sup>0.4</sup>	0.9362 <sup>20</sup>	1.5002 <sup>20</sup>	
6355	$\beta$ -Irone	4-(2,5,6,6-Tetramethyl-1-cyclohexen-1-yl)-3-buten-2-one	C <sub>14</sub> H <sub>22</sub> O	79-70-9	206.324			125 <sup>11</sup>	0.9434 <sup>21</sup>	1.5162 <sup>25</sup>	sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
6356	Iron hydrocarbonyl	Hydrogen tetracarboxylferrate(II)	C <sub>4</sub> H <sub>2</sub> FeO <sub>4</sub>	17440-90-3	169.902	col liq; unstab	-70	dec			s alk
6357	Iron noncarbonyl	Diiron noncarbonyl	C <sub>8</sub> Fe <sub>2</sub> O <sub>9</sub>	15321-51-4	363.781	oran-ye cry	100 dec		2.85		
6358	Iron(III) NTA	Nitrioltriacetatoiron(III)	C <sub>8</sub> H <sub>8</sub> FeNO <sub>6</sub>	16448-54-7	243.960	solid					s H <sub>2</sub> O
6359	Iron pentacarbonyl		C <sub>5</sub> FeO <sub>5</sub>	13463-40-6	195.896	col to ye oily liq	-20	103	1.5 <sup>20</sup>	1.453 <sup>22</sup>	i H <sub>2</sub> O; sl EtOH; s bz, ace, ctc
6360	Iron(III) 2,4-pentanedioate	Ferric acetylacetonate	C <sub>15</sub> H <sub>21</sub> FeO <sub>8</sub>	14024-18-1	353.169		179		5.24		
6361	Isanic acid	17-Octadecene-9,11-diyonic acid	C <sub>18</sub> H <sub>26</sub> O <sub>2</sub>	506-25-2	274.398	cry	39.5		0.9309 <sup>45</sup>	1.49148 <sup>50</sup>	s ace, EtOH, i-PrOH; sl peth
6362	Isatidine	Retrorsine <i>N</i> -oxide	C <sub>18</sub> H <sub>28</sub> NO <sub>7</sub>	15503-86-3	367.395	cry	145				
6363	Isaxonine	<i>N</i> -Isopropyl-2-pyrimidineamine	C <sub>7</sub> H <sub>11</sub> N <sub>3</sub>	4214-72-6	137.182		28	93 <sup>12</sup>			
6364	Isazophos		C <sub>9</sub> H <sub>17</sub> ClN <sub>3</sub> O <sub>3</sub> PS	67329-04-8	313.741			170; 100 <sup>0.001</sup>	1.22 <sup>20</sup>		
6365	Isobenzan		C <sub>9</sub> H <sub>8</sub> Cl <sub>6</sub> O	297-78-9	411.751	cry (hp)	121				s eth, bz, xyl, tol
6366	1(3 <i>H</i> )-Isobenzofuranone		C <sub>8</sub> H <sub>6</sub> O <sub>2</sub>	87-41-2	134.133	nd or pl (w)	75	290	1.1636 <sup>99</sup>	1.536 <sup>99</sup>	s H <sub>2</sub> O; vs EtOH, eth; sl chl
6367	Isoborneol	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-ol, <i>exo</i> -( $\pm$ )	C <sub>10</sub> H <sub>18</sub> O	24393-70-2	154.249	tab (peth)	212	sub	1.10 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth, chl; sl bz
6368	Isobornyl thiocanoacetate		C <sub>13</sub> H <sub>19</sub> NO <sub>2</sub> S	115-31-1	253.361	ye oily liq		95 <sup>0.06</sup>	1.1465 <sup>25</sup>	1.512 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, bz, chl, peth
6369	6-Isobornyl-3,4-xyleneol	Xibornol	C <sub>18</sub> H <sub>26</sub> O	13741-18-9	258.398	cry	95	167 <sup>3</sup>	1.0240 <sup>20</sup>	1.5382 <sup>20</sup>	
6370	Isobutanal	2-Methyl-1-propanal	C <sub>4</sub> H <sub>8</sub> O	78-84-2	72.106	liq	-65.9	64.5	0.7891 <sup>20</sup>	1.3730 <sup>20</sup>	s H <sub>2</sub> O, eth, ace, chl; sl ctc
6371	Isobutane	2-Methylpropane	C <sub>4</sub> H <sub>10</sub>	75-28-5	58.122	col gas	-159.4	-11.73	0.5510 <sup>25</sup> ( <i>p</i> >1 atm)	1.3518 <sup>-25</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
6372	Isobutene		C <sub>4</sub> H <sub>8</sub>	115-11-7	56.107	col gas	-140.7	-6.9	0.589 <sup>25</sup> ( <i>p</i> >1 atm)	1.3926 <sup>-25</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, sulf
6373	Isobutyl acetate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	110-19-0	116.158	liq	-98.8	116.5	0.8712 <sup>20</sup>	1.3902 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
6374	Isobutyl acrylate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	106-63-8	128.169	liq	-61	132	0.8896 <sup>20</sup>	1.4150 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, MeOH
6375	5-Isobutyl-3-allyl-2-thioxo-4-imidazolidinone	Albutoin	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> OS	830-89-7	212.311		210.5				
6376	Isobutylamine	2-Methyl-1-propanamine	C <sub>4</sub> H <sub>11</sub> N	78-81-9	73.137	liq	-86.7	67.75	0.724 <sup>25</sup>	1.3988 <sup>19</sup>	
6377	Isobutyl 4-aminobenzoate	Isobutyl <i>p</i> -aminobenzoate	C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	94-14-4	193.243		64.5				



2-iodopyridine

5-iodo-2,4(1*H*,3*H*)-pyrimidinedione

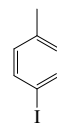
1-iodo-2,5-pyrrolidinedione



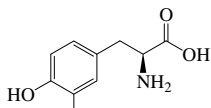
Iodosylbenzene



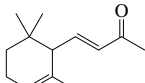
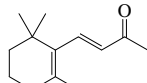
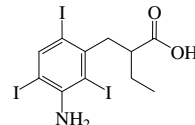
2-iodothiophene



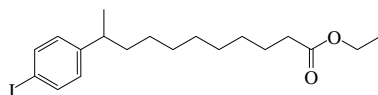
4-iodotoluene



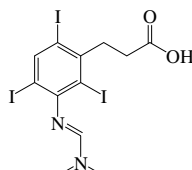
L-3-iodotyrosine

*trans*-α-ionone, (±)*trans*-β-ionone

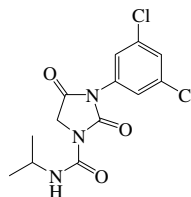
Iopanoic acid



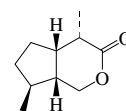
Iophendylate



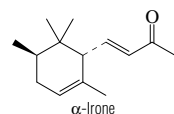
Iopodic acid



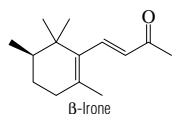
Iprodione



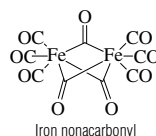
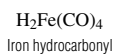
Iridomyrmecin



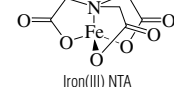
α-Irone



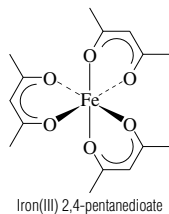
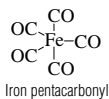
β-Irone



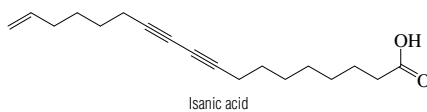
Iron nonacarbonyl



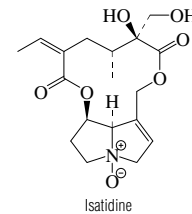
Iron(III) NTA



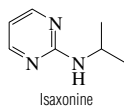
Iron(III) 2,4-pentanedioate



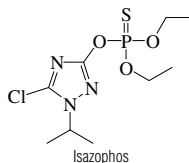
Isanic acid



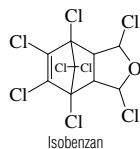
Isatidine



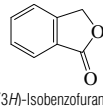
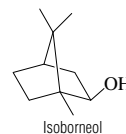
Isaxonine



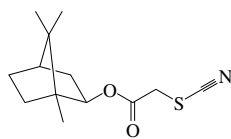
Isazophos



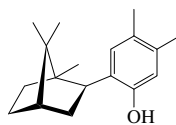
Isobenzan

1(3*H*)-Isobenzofuranone

Isoborneol



Isobornyl thiocynoacetate



6-Isobornyl-3,4-xyleneol



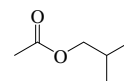
Isobutanal



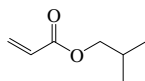
Isobutane



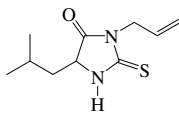
Isobutene



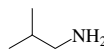
Isobutyl acetate



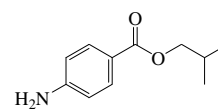
Isobutyl acrylate



5-Isobutyl-3-allyl-2-thioxo-4-imidazolidinone



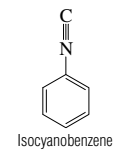
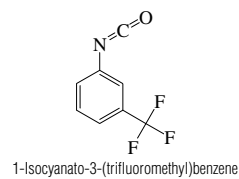
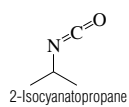
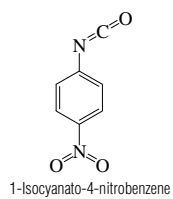
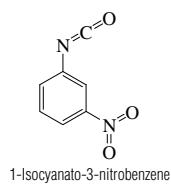
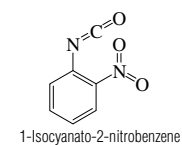
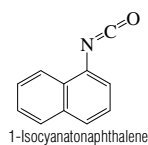
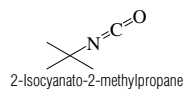
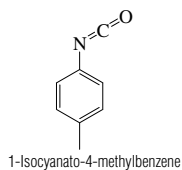
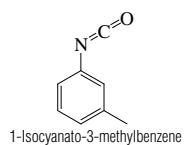
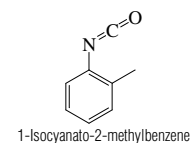
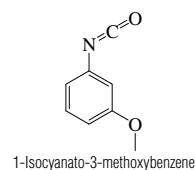
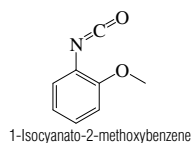
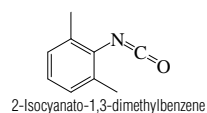
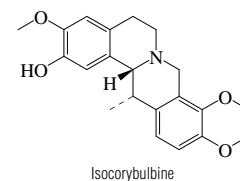
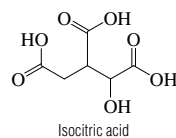
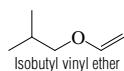
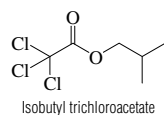
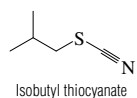
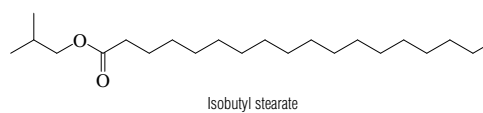
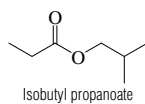
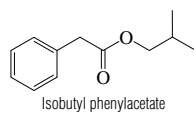
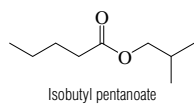
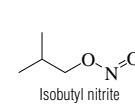
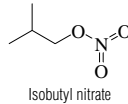
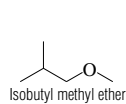
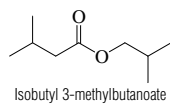
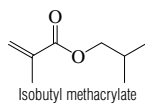
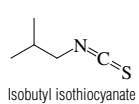
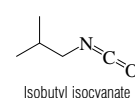
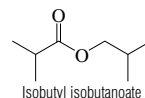
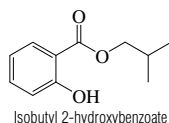
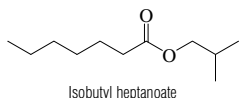
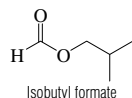
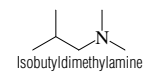
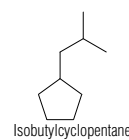
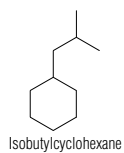
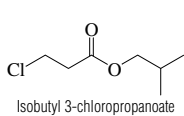
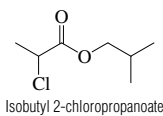
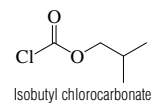
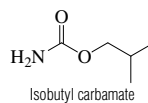
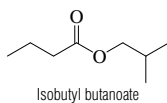
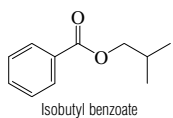
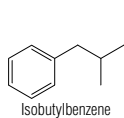
Isobutylamine



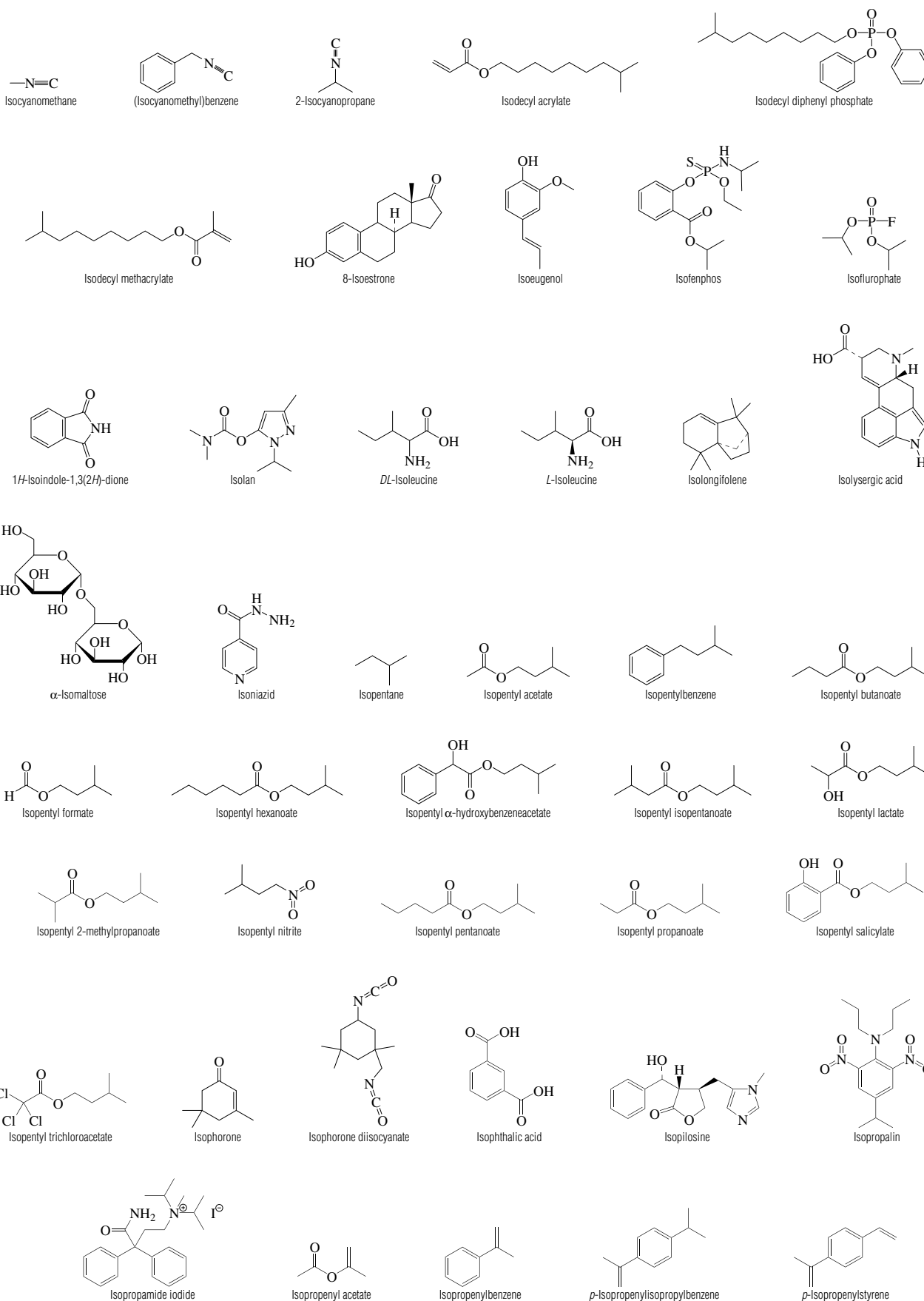
Isobutyl 4-aminobenzoate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6378	Isobutylbenzene		C <sub>10</sub> H <sub>14</sub>	538-93-2	134.218	liq	-51.4	172.79	0.8532 <sup>20</sup>	1.4866 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
6379	Isobutyl benzoate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	120-50-3	178.228			242	0.9990 <sup>20</sup>		i H <sub>2</sub> O; msc EtOH, eth; s ace, chl
6380	Isobutyl butanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	539-90-2	144.212			156.9	0.8364 <sup>18</sup>	1.4032 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
6381	Isobutyl carbamate		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	543-28-2	117.147	lf	67	207		1.4098 <sup>78</sup>	vs eth, EtOH
6382	Isobutyl chlorocarbonate		C <sub>6</sub> H <sub>9</sub> ClO <sub>2</sub>	543-27-1	136.577			128.8	1.0426 <sup>18</sup>	1.4071 <sup>18</sup>	s EtOH, bz, chl; msc eth
6383	Isobutyl 2-chloropropanoate		C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	114489-96-2	164.630			176	1.0312 <sup>20</sup>	1.4247 <sup>20</sup>	
6384	Isobutyl 3-chloropropanoate		C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	62108-68-3	164.630			191.3	1.0323 <sup>20</sup>	1.4295 <sup>20</sup>	vs eth, EtOH
6385	Isobutylcyclohexane		C <sub>10</sub> H <sub>20</sub>	1678-98-4	140.266	liq	-95	171.3	0.7952 <sup>20</sup>	1.4386 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, chl; vs eth, bz
6386	Isobutylcyclopentane		C <sub>9</sub> H <sub>18</sub>	3788-32-7	126.239	liq	-115.2	148	0.7769 <sup>25</sup>	1.4298 <sup>20</sup>	
6387	Isobutyldimethylamine	<i>N,N</i> ,2-Trimethyl-1-propanamine	C <sub>6</sub> H <sub>15</sub> N	7239-24-9	101.190			80.5	0.7097 <sup>20</sup>	1.3907 <sup>20</sup>	vs H <sub>2</sub> O
6388	Isobutyl formate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	542-55-2	102.132	liq	-95.8	98.2	0.8776 <sup>20</sup>	1.3857 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH, eth; vs ace
6389	Isobutyl heptanoate	Isobutyl enanthate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	7779-80-8	186.292			208	0.8593 <sup>20</sup>		vs ace, bz, eth, EtOH
6390	Isobutyl 2-hydroxybenzoate	Isobutyl salicylate	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	87-19-4	194.227		5.9	261	1.0639 <sup>20</sup>	1.5087 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
6391	Isobutyl isobutanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	97-85-8	144.212	liq	-80.7	148.6	0.8542 <sup>20</sup>	1.3999 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, ace; msc eth
6392	Isobutyl isocyanate		C <sub>5</sub> H <sub>9</sub> NO	1873-29-6	99.131			106			
6393	Isobutyl isothiocyanate	1-Isothiocyano-2-methylpropane	C <sub>5</sub> H <sub>9</sub> NS	591-82-2	115.197			160	0.9631 <sup>14</sup>	1.5005 <sup>14</sup>	
6394	Isobutyl methacrylate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	97-86-9	142.196			155	0.8858 <sup>20</sup>	1.4199 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6395	Isobutyl 3-methylbutanoate	Isobutyl isovalerate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	589-59-3	158.238			168.5	0.853 <sup>20</sup>	1.4057 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace; s chl
6396	Isobutyl methyl ether		C <sub>5</sub> H <sub>12</sub> O	625-44-5	88.148			58.6	0.7311 <sup>20</sup>		vs eth, EtOH
6397	Isobutyl nitrate		C <sub>6</sub> H <sub>13</sub> NO <sub>3</sub>	543-29-3	119.119			123.4	1.0152 <sup>20</sup>	1.4028 <sup>20</sup>	
6398	Isobutyl nitrite		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	542-56-3	103.120	col liq		67	0.8699 <sup>22</sup>	1.3715 <sup>22</sup>	sl H <sub>2</sub> O; s EtOH, eth
6399	Isobutyl pentanoate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	10588-10-0	158.238			179	0.8625 <sup>25</sup>	1.4046 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth, ace
6400	Isobutyl phenylacetate		C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	102-13-6	192.254			247	0.999 <sup>18</sup>		i H <sub>2</sub> O; s EtOH, eth
6401	Isobutyl propanoate	Isobutyl propionate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	540-42-1	130.185	liq	-71.4	137	0.888 <sup>0</sup>	1.3973 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz, chl, ctc
6402	Isobutyl stearate		C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	646-13-9	340.583	wax	28.9	223 <sup>15</sup>	0.8498 <sup>20</sup>		vs eth
6403	Isobutyl thiocyanate		C <sub>5</sub> H <sub>9</sub> NS	591-84-4	115.197	liq	-59	175.4			vs eth, EtOH
6404	Isobutyl trichloroacetate		C <sub>6</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	33560-15-5	219.493			188	1.2636 <sup>20</sup>	1.4483 <sup>20</sup>	vs bz, eth, EtOH
6405	Isobutyl vinyl ether		C <sub>6</sub> H <sub>12</sub> O	109-53-5	100.158	liq	-112	83	0.7645 <sup>20</sup>	1.3966 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, ace, bz; msc eth
6406	Isocitric acid		C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	320-77-4	192.124	ye syr	105				
6407	Isocorybulbine		C <sub>21</sub> H <sub>28</sub> NO <sub>4</sub>	22672-74-8	355.429	lf (al)	187.5		1.045 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, chl, acid
6408	Isocorydine		C <sub>20</sub> H <sub>23</sub> NO <sub>4</sub>	475-67-2	341.402	pl	185				vs chl
6409	2-Isocyanato-1,3-dimethylbenzene	2,6-Dimethylphenyl isocyanate	C <sub>9</sub> H <sub>9</sub> NO	28556-81-2	147.173	liq		100 <sup>13</sup>			
6410	1-Isocyanato-2-methoxybenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	700-87-8	149.148			94 <sup>17</sup>			
6411	1-Isocyanato-3-methoxybenzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	18908-07-1	149.148			102 <sup>15</sup>			
6412	1-Isocyanato-2-methylbenzene	2-Tolyl isocyanate	C <sub>8</sub> H <sub>9</sub> NO	614-68-6	133.148			185		1.5282 <sup>20</sup>	i H <sub>2</sub> O; s eth
6413	1-Isocyanato-3-methylbenzene	3-Tolyl isocyanate	C <sub>8</sub> H <sub>9</sub> NO	621-29-4	133.148			196.5	1.0330 <sup>20</sup>		vs bz, eth
6414	1-Isocyanato-4-methylbenzene	4-Tolyl isocyanate	C <sub>8</sub> H <sub>9</sub> NO	622-58-2	133.148			187			vs bz, eth
6415	2-Isocyanato-2-methylpropane	<i>tert</i> -Butyl isocyanate	C <sub>5</sub> H <sub>9</sub> NO	1609-86-5	99.131		85.5		0.8670 <sup>7</sup>	1.4061 <sup>20</sup>	
6416	1-Isocyanatonaphthalene	1-Naphthyl isocyanate	C <sub>11</sub> H <sub>7</sub> NO	86-84-0	169.180			269	1.1774 <sup>20</sup>		s eth, bz
6417	1-Isocyanato-2-nitrobenzene	2-Nitrophenyl isocyanate	C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	3320-86-3	164.118	wh nd (peth)	41	137 <sup>18</sup>			vs bz, eth, chl
6418	1-Isocyanato-3-nitrobenzene	3-Nitrophenyl isocyanate	C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	3320-87-4	164.118	wh lf (lig)	51	130 <sup>11</sup>			vs bz, eth, chl
6419	1-Isocyanato-4-nitrobenzene	4-Nitrophenyl isocyanate	C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	100-28-7	164.118	pa ye nd	57	162 <sup>20</sup> , 137 <sup>11</sup>			vs bz, eth, chl
6420	2-Isocyanatopropane	Isopropyl isocyanate	C <sub>4</sub> H <sub>7</sub> NO	1795-48-8	85.105			74.5	0.866 <sup>25</sup>	1.3825 <sup>20</sup>	
6421	1-Isocyanato-3-(trifluoromethyl)benzene	3-(Trifluoromethyl)phenyl isocyanate	C <sub>8</sub> H <sub>4</sub> F <sub>3</sub> NO	329-01-1	187.119			54 <sup>11</sup>	1.3455 <sup>20</sup>	1.4690 <sup>20</sup>	
6422	Isocyanobenzene	Phenyl isocyanide	C <sub>7</sub> H <sub>5</sub> N	931-54-4	103.122	unstab liq		80 <sup>40</sup>	0.98 <sup>15</sup>		

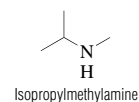
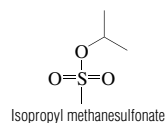
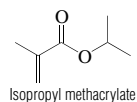
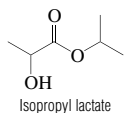
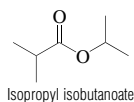
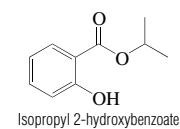
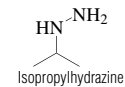
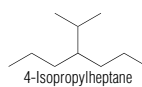
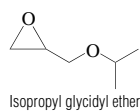
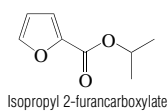
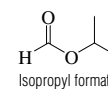
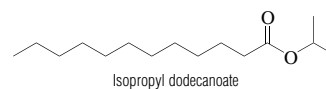
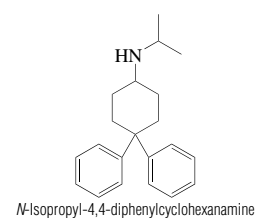
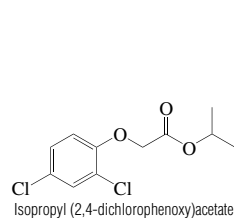
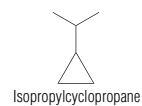
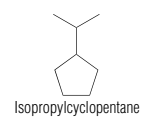
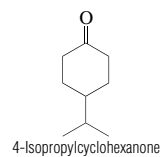
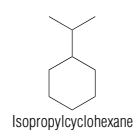
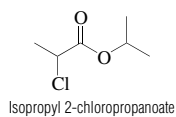
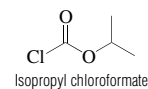
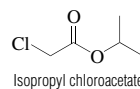
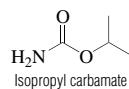
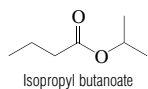
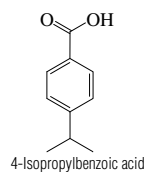
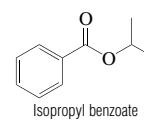
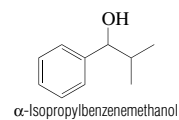
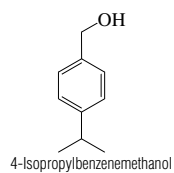
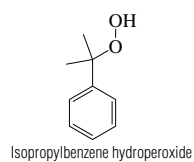
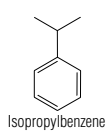
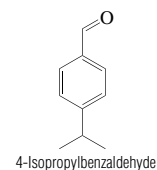
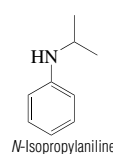
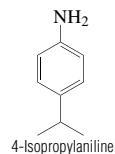
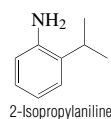
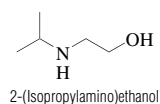
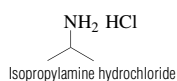
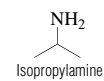
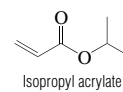
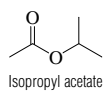
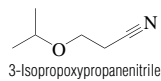
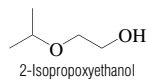
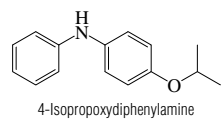




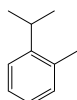
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6423	Isocyanomethane	Methyl isocyanide	C <sub>2</sub> H <sub>3</sub> N	593-75-9	41.052		-45	exp 59.6	0.756 <sup>4</sup>		
6424	(Isocyanomethyl)benzene	Benzyl isocyanide	C <sub>8</sub> H <sub>7</sub> N	10340-91-7	117.149			dec 199; 93 <sup>55</sup>	0.972 <sup>15</sup>	1.5193 <sup>20</sup>	
6425	2-Isocyanopropane	Isopropyl isocyanide	C <sub>4</sub> H <sub>7</sub> N	598-45-8	69.106			87	0.7596 <sup>25</sup>		i H <sub>2</sub> O; msc EtOH, eth
6426	Isodecyl acrylate		C <sub>13</sub> H <sub>24</sub> O <sub>2</sub>	1330-61-6	212.329		-100	158 <sup>50</sup>	0.885 <sup>20</sup>	1.4416 <sup>20</sup>	
6427	Isodecyl diphenyl phosphate		C <sub>22</sub> H <sub>31</sub> O <sub>4</sub> P	29761-21-5	390.452			249 <sup>10</sup> dec			
6428	Isodecyl methacrylate		C <sub>14</sub> H <sub>26</sub> O <sub>2</sub>	29964-84-9	226.355			126 <sup>10</sup>	0.876 <sup>20</sup>		
6429	8-Isoestrone		C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>	517-06-6	270.367	pr (MeOH)	254				vs eth, Diox
6430	Isoeugenol		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	97-54-1	164.201			266	1.080 <sup>25</sup>	1.5739 <sup>19</sup>	vs eth, EtOH
6431	Isofenphos		C <sub>15</sub> H <sub>24</sub> NO <sub>4</sub> PS	25311-71-1	345.395		<-12	120 <sup>0.01</sup>	1.134 <sup>20</sup>		
6432	Isoflurophate		C <sub>6</sub> H <sub>14</sub> FO <sub>3</sub> P	55-91-4	184.145			62 <sup>9</sup>	1.055 <sup>25</sup>	1.3830 <sup>25</sup>	sl H <sub>2</sub> O, lig; s eth; vs oils
6433	1 <i>H</i> -Isoindole-1,3(2 <i>H</i> )-dione	Phthalimide	C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	85-41-6	147.132	nd (w), pr (HOAc) if (sub)	238				vs bz
6434	Isolan		C <sub>10</sub> H <sub>17</sub> N <sub>3</sub> O <sub>2</sub>	119-38-0	211.261	col liq		118 <sup>2.5</sup>	1.07 <sup>20</sup>		msc H <sub>2</sub> O; s EtOH, xyl
6435	<i>DL</i> -Isoleucine		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	443-79-8	131.173		292 dec				
6436	<i>L</i> -Isoleucine	2-Amino-3-methylpentanoic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	73-32-5	131.173		284 dec				s H <sub>2</sub> O; i EtOH
6437	Isolongifolene		C <sub>15</sub> H <sub>24</sub>	1135-66-6	204.352	liq		82 <sup>0.4</sup>			
6438	Isolysergic acid		C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	478-95-5	268.310	cry (w+2)	218 dec				sl H <sub>2</sub> O, EtOH; s py
6439	$\alpha$ -Isomaltose	6- <i>O</i> - $\alpha$ - <i>D</i> -Glucopyranosyl- <i>D</i> -glucose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	499-40-1	342.296		120				
6440	Isoniazid	4-Pyridinecarboxylic acid hydrazide	C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O	54-85-3	137.139	cry (al)	171.4				vs H <sub>2</sub> O, EtOH
6441	Isopentane	2-Methylbutane	C <sub>5</sub> H <sub>12</sub>	78-78-4	72.149	vol liq or gas	-159.77	27.88	0.6201 <sup>20</sup>	1.3537 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6442	Isopentyl acetate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	123-92-2	130.185	liq	-78.5	142.5	0.876 <sup>15</sup>	1.4000 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, chl
6443	Isopentylbenzene		C <sub>11</sub> H <sub>16</sub>	2049-94-7	148.245			195	0.856 <sup>20</sup>	1.4867 <sup>10</sup>	i H <sub>2</sub> O; s EtOH, eth; vs bz
6444	Isopentyl butanoate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	106-27-4	158.238			179	0.865 <sup>19</sup>	1.4110 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
6445	Isopentyl formate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	110-45-2	116.158	liq	-93.5	123.5	0.877 <sup>20</sup>	1.3967 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH; msc eth
6446	Isopentyl hexanoate	Isopentyl caproate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	2198-61-0	186.292			225.5	0.861 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth
6447	Isopentyl $\alpha$ -hydroxybenzeneacetate	Isopentyl mandelate	C <sub>13</sub> H <sub>18</sub> O <sub>3</sub>	5421-04-5	222.280	oily liq		172 <sup>11</sup>			
6448	Isopentyl isopentanoate	Isoamyl isovalerate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	659-70-1	172.265			190.4	0.8583 <sup>19</sup>	1.4130 <sup>19</sup>	
6449	Isopentyl lactate		C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	19329-89-6	160.211			202.4	0.9589 <sup>25</sup>	1.4240 <sup>25</sup>	vs eth, EtOH
6450	Isopentyl 2-methylpropanoate	Isopentyl isobutyrate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	2050-01-3	158.238			168.5	0.8627 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, ace
6451	Isopentyl nitrite	Isoamyl nitrite	C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	110-46-3	117.147			99.2	0.8828 <sup>20</sup>	1.3918 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
6452	Isopentyl pentanoate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2050-09-1	172.265			193			
6453	Isopentyl propanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	105-68-0	144.212			160.2	0.8697 <sup>20</sup>	1.4069 <sup>20</sup>	vs eth, EtOH
6454	Isopentyl salicylate		C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	87-20-7	208.253			278; 151 <sup>15</sup>	1.0535 <sup>20</sup>	1.5080 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth, chl; sl ctc
6455	Isopentyl trichloroacetate		C <sub>7</sub> H <sub>11</sub> Cl <sub>3</sub> O <sub>2</sub>	57392-55-9	233.520			217	1.2314 <sup>20</sup>	1.4521 <sup>20</sup>	vs eth, EtOH
6456	Isophorone	3,5,5-Trimethyl-2-cyclohexen-1-one	C <sub>9</sub> H <sub>14</sub> O	78-59-1	138.206	liq	-8.1	215.2	0.9255 <sup>20</sup>	1.4766 <sup>18</sup>	
6457	Isophorone diisocyanate		C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	4098-71-9	222.283		60	217 <sup>100</sup>	1.062 <sup>20</sup>		
6458	Isophthalic acid	1,3-Benzenedicarboxylic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	121-91-5	166.132	nd (w, al)	347	sub			sl H <sub>2</sub> O; s EtOH, HOAc; i eth, bz, lig
6459	Isopilosine		C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	491-88-3	286.325	pl (al), pr (w, dil al)	187				vs EtOH
6460	Isopropalin	Benzenamine, 4-(1-methylethyl)-2,6-dinitro- <i>N,N</i> -dipropyl-	C <sub>15</sub> H <sub>23</sub> N <sub>3</sub> O <sub>4</sub>	33820-53-0	309.362	red-oran liq					i H <sub>2</sub> O; s os
6461	Isopropamide iodide		C <sub>23</sub> H <sub>33</sub> IN <sub>2</sub> O	71-81-8	480.424	cry or pow	190				s H <sub>2</sub> O, EtOH, MeOH; i chl
6462	Isopropenyl acetate		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	108-22-5	100.117	liq	-92.9	94	0.9090 <sup>20</sup>	1.4033 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, chl, ace; vs eth
6463	Isopropenylbenzene	$\alpha$ -Methyl styrene	C <sub>9</sub> H <sub>10</sub>	98-83-9	118.175	liq	-23.2	165.4	0.9106 <sup>20</sup>	1.5386 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, ctc
6464	<i>p</i> -Isopropenylisopropylbenzene		C <sub>12</sub> H <sub>16</sub>	2388-14-9	160.255	liq	-30.6	220.8	0.8936 <sup>20</sup>	1.5238 <sup>20</sup>	vs ace, bz, eth, EtOH
6465	<i>p</i> -Isopropenylstyrene		C <sub>11</sub> H <sub>12</sub>	16262-48-9	144.213	liq		242	0.93	1.5684 <sup>20</sup>	



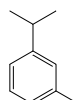
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6466	4-Isopropoxydiphenylamine	4-Isopropoxy- <i>N</i> -phenylaniline	C <sub>15</sub> H <sub>17</sub> NO	101-73-5	227.302		83				
6467	2-Isopropoxyethanol		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	109-59-1	104.148			145	0.9030 <sup>20</sup>	1.4095 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace
6468	3-Isopropoxypropanenitrile	1-Cyano-2-isopropoxyethane	C <sub>5</sub> H <sub>11</sub> NO	110-47-4	113.157			65 <sup>10</sup>			s chl
6469	Isopropyl acetate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	108-21-4	102.132	liq	-73.4	88.7	0.8718 <sup>20</sup>	1.3773 <sup>20</sup>	s H <sub>2</sub> O, EtOH, ace, chl; msc eth
6470	Isopropyl acrylate	Isopropyl 2-propenoate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	689-12-3	114.142	liq		51 <sup>103</sup>			
6471	Isopropylamine	2-Propanamine	C <sub>3</sub> H <sub>9</sub> N	75-31-0	59.110	liq	-95.13	31.76	0.6891 <sup>20</sup>	1.3742 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace; s bz, chl
6472	Isopropylamine hydrochloride	2-Propanamine hydrochloride	C <sub>3</sub> H <sub>10</sub> ClN	15572-56-2	95.571		164				s DMSO
6473	2-(Isopropylamino)ethanol		C <sub>6</sub> H <sub>13</sub> NO	109-56-8	103.163		128.5	173	0.8970 <sup>20</sup>	1.4395 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
6474	2-Isopropylaniline		C <sub>9</sub> H <sub>13</sub> N	643-28-7	135.206			221; 95 <sup>13</sup>	0.9760 <sup>12</sup>		i H <sub>2</sub> O; s eth, bz, ctc
6475	4-Isopropylaniline	Cumidine	C <sub>9</sub> H <sub>13</sub> N	99-88-7	135.206			225	0.953 <sup>20</sup>		
6476	<i>N</i> -Isopropylaniline		C <sub>9</sub> H <sub>13</sub> N	768-52-5	135.206			203	0.9526 <sup>25</sup>	1.5380 <sup>20</sup>	s EtOH, eth, ace, bz
6477	4-Isopropylbenzaldehyde	Cuminaldehyde	C <sub>10</sub> H <sub>12</sub> O	122-03-2	148.201			235.5	0.9755 <sup>20</sup>	1.5301 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
6478	Isopropylbenzene	Cumene	C <sub>9</sub> H <sub>12</sub>	98-82-8	120.191	liq	-96.02	152.41	0.8640 <sup>25</sup>	1.4915 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
6479	Isopropylbenzene hydroperoxide	Cumene hydroperoxide	C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	80-15-9	152.190	liq		153; 84 <sup>9</sup>	1.03 <sup>20</sup>		
6480	4-Isopropylbenzenemethanol	Cumic alcohol	C <sub>10</sub> H <sub>14</sub> O	536-60-7	150.217		28	249	0.9818 <sup>20</sup>	1.5210 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs bz
6481	$\alpha$ -Isopropylbenzenemethanol	1-Phenyl-2-methylpropyl alcohol	C <sub>10</sub> H <sub>14</sub> O	611-69-8	150.217			223	0.9869 <sup>14</sup>	1.5193 <sup>14</sup>	i H <sub>2</sub> O; s EtOH, ace
6482	Isopropyl benzoate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	939-48-0	164.201			216	1.0163 <sup>15</sup>	1.4890 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
6483	4-Isopropylbenzoic acid	Cumic acid	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	536-66-3	164.201	tcl pl (al)	117.5	sub	1.162 <sup>4</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s peth
6484	Isopropyl butanoate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	638-11-9	130.185			130.5	0.8588 <sup>20</sup>	1.3936 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
6485	Isopropyl carbamate		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	1746-77-6	103.120	nd	93	183	0.9951 <sup>66</sup>		
6486	Isopropyl chloroacetate		C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	105-48-6	136.577			150.5	1.0888 <sup>20</sup>	1.4382 <sup>20</sup>	vs eth
6487	Isopropyl chloroformate		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	108-23-6	122.551			105	1.4013 <sup>30</sup>		vs eth
6488	Isopropyl 2-chloropropanoate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	40058-87-5	150.603			151.5	1.0315 <sup>20</sup>	1.4149 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
6489	Isopropylcyclohexane		C <sub>9</sub> H <sub>18</sub>	696-29-7	126.239	liq	-89.4	154.8	0.8023 <sup>20</sup>	1.4410 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc ace, bz
6490	4-Isopropylcyclohexanone		C <sub>9</sub> H <sub>16</sub> O	5432-85-9	140.222			214; 139 <sup>100</sup>	0.9099 <sup>30</sup>	1.4552 <sup>25</sup>	
6491	Isopropylcyclopentane		C <sub>8</sub> H <sub>16</sub>	3875-51-2	112.213	liq	-111.4	126.5	0.7765 <sup>20</sup>	1.4258 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, ace, ctc; s eth, bz
6492	Isopropylcyclopropane		C <sub>6</sub> H <sub>12</sub>	3638-35-5	84.159	liq	-112.9	58.3	0.6936 <sup>25</sup>	1.3865 <sup>20</sup>	
6493	Isopropyl (2,4-dichlorophenoxy) acetate		C <sub>11</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>3</sub>	94-11-1	263.117		5	140 <sup>1</sup>	1.26 <sup>25</sup>	1.5209 <sup>25</sup>	
6494	<i>N</i> -Isopropyl-4,4-diphenylcyclohexanamine	Pramiverin	C <sub>21</sub> H <sub>27</sub> N	14334-40-8	293.446		70	165 <sup>0.05</sup>			
6495	Isopropyl dodecanoate	Isopropyl laurate	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	10233-13-3	242.398			196 <sup>60</sup> , 105 <sup>0.8</sup>	0.8536 <sup>20</sup>	1.4280 <sup>25</sup>	vs eth, EtOH
6496	Isopropyl formate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	625-55-8	88.106			68.2	0.8728 <sup>20</sup>	1.3678 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace; s chl
6497	Isopropyl 2-furancarboxylate	Isopropyl 2-furanoate	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	6270-34-4	154.163			198.5	1.0655 <sup>24</sup>	1.4682 <sup>24</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
6498	Isopropyl glycidyl ether	(1-Methylethoxy)methyloxirane	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4016-14-2	116.158			137	0.9186 <sup>20</sup>		s H <sub>2</sub> O, ace, EtOH
6499	4-Isopropylheptane		C <sub>10</sub> H <sub>22</sub>	52896-87-4	142.282			158.9	0.7354 <sup>25</sup>	1.4153 <sup>20</sup>	
6500	Isopropylhydrazine		C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	2257-52-5	74.124	liq		107			s H <sub>2</sub> O, bz, EtOH; sl eth
6501	Isopropyl 2-hydroxybenzoate	Isopropyl salicylate	C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	607-85-2	180.200			238	1.0729 <sup>20</sup>	1.5065 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
6502	Isopropyl isobutanoate	Isopropyl isobutyrate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	617-50-5	130.185			120.7	0.8471 <sup>21</sup>		i H <sub>2</sub> O; s EtOH, eth, ace
6503	Isopropyl lactate		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	617-51-6	132.157			167	0.9980 <sup>20</sup>	1.4082 <sup>25</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
6504	Isopropyl methacrylate	Isopropyl 2-methyl-2-propenoate	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	4655-34-9	128.169			125	0.8847 <sup>20</sup>	1.4122 <sup>20</sup>	vs ace, bz, eth, EtOH
6505	Isopropyl methanesulfonate		C <sub>4</sub> H <sub>10</sub> O <sub>3</sub> S	926-06-7	138.185			82 <sup>6</sup>			
6506	Isopropylmethylamine	Methylisopropylamine	C <sub>4</sub> H <sub>11</sub> N	4747-21-1	73.137			50.4			



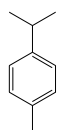
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6507	1-Isopropyl-2-methylbenzene	<i>o</i> -Cymene	C <sub>10</sub> H <sub>14</sub>	527-84-4	134.218	liq	-71.5	178.1	0.8766 <sup>20</sup>	1.5006 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
6508	1-Isopropyl-3-methylbenzene	<i>m</i> -Cymene	C <sub>10</sub> H <sub>14</sub>	535-77-3	134.218	liq	-63.7	175.1	0.8610 <sup>20</sup>	1.4930 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
6509	1-Isopropyl-4-methylbenzene	<i>p</i> -Cymene	C <sub>10</sub> H <sub>14</sub>	99-87-6	134.218	liq	-67.94	177.1	0.8573 <sup>20</sup>	1.4909 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
6510	Isopropyl 3-methylbutanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	32665-23-9	144.212			142; 70 <sup>25</sup>	0.8538 <sup>17</sup>	1.3960 <sup>20</sup>	vs ace, eth, EtOH
6511	5-Isopropyl-2-methyl-1,3-cyclohexadiene, ( <i>R</i> )		C <sub>10</sub> H <sub>16</sub>	4221-98-1	136.234			173	0.8421 <sup>20</sup>	1.4772 <sup>19</sup>	
6512	5-Isopropyl-3-methyl-2-cyclohexen-1-one, (±)	Homocamfin	C <sub>10</sub> H <sub>16</sub> O	535-86-4	152.233	pa ye		244; 121 <sup>15</sup>	0.9340 <sup>21</sup>	1.4865 <sup>21</sup>	vs ace, EtOH
6513	6-Isopropyl-3-methyl-2-cyclohexen-1-one, (±)	(±)-Piperitone	C <sub>10</sub> H <sub>16</sub> O	6091-52-7	152.233	liq	-19	232.5	0.9331 <sup>20</sup>	1.4845 <sup>20</sup>	vs ace, EtOH
6514	Isopropyl methyl ether	2-Methoxypropane	C <sub>4</sub> H <sub>10</sub> O	598-53-8	74.121			30.77	0.7237 <sup>15</sup>	1.3576 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
6515	5-Isopropyl-2-methylphenol	Carvacrol	C <sub>10</sub> H <sub>14</sub> O	499-75-2	150.217	nd	1	237.7	0.9772 <sup>20</sup>	1.5230 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc; vs ace
6516	2-Isopropyl-6-methyl-4-pyrimidinol		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O	2814-20-2	152.193	cry		173			
6517	Isopropyl methyl sulfide		C <sub>4</sub> H <sub>10</sub> S	1551-21-9	90.187	liq	-101.5	84.8	0.8291 <sup>20</sup>	1.4932 <sup>20</sup>	s EtOH, eth, ace
6518	1-Isopropyl-naphthalene		C <sub>13</sub> H <sub>14</sub>	6158-45-8	170.250	liq	-16	268	0.9956 <sup>20</sup>	1.5952 <sup>20</sup>	
6519	2-Isopropyl-naphthalene		C <sub>13</sub> H <sub>14</sub>	2027-17-0	170.250		14.5	268.2	0.9753 <sup>20</sup>	1.5848 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
6520	Isopropyl nitrate		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	1712-64-7	105.093			100	1.034 <sup>19</sup>	1.3912 <sup>16</sup>	s EtOH, eth
6521	Isopropyl nitrite		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	541-42-4	89.094	pa ye oil		40	0.8684 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth
6522	1-Isopropyl-4-nitrobenzene		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	1817-47-6	165.189	pa ye oil		122 <sup>9</sup>	1.084 <sup>20</sup>	1.5367 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz, lig
6523	<i>N</i> -Isopropyl- <i>N</i> -nitroso-2-propanamine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O	601-77-4	130.187	cry (eth,w)	48	194.5	0.9422 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz
6524	Isopropyl 3-oxobutanoate	Isopropyl acetoacetate	C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	542-08-5	144.168	liq	-27.3	186	0.9835 <sup>20</sup>	1.4173 <sup>20</sup>	vs eth, EtOH, lig
6525	Isopropyl palmitate	Isopropyl hexadecanoate	C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	142-91-6	298.504		13.5	160 <sup>2</sup>	0.8404 <sup>28</sup>	1.4364 <sup>25</sup>	vs ace, bz, eth, EtOH
6526	Isopropyl pentanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	18362-97-5	144.212				0.8579 <sup>20</sup>	1.4061 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
6527	2-Isopropylphenol		C <sub>9</sub> H <sub>12</sub> O	88-69-7	136.190		15.5	213.5	1.012 <sup>20</sup>	1.5315 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, ctc
6528	3-Isopropylphenol		C <sub>9</sub> H <sub>12</sub> O	618-45-1	136.190		26	228		1.5261 <sup>20</sup>	vs eth
6529	4-Isopropylphenol		C <sub>9</sub> H <sub>12</sub> O	99-89-8	136.190	nd (peth)	62.3	230; 110 <sup>10</sup>	0.990 <sup>20</sup>	1.5228 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, chl
6530	<i>N</i> -Isopropyl- <i>N</i> '-phenyl-1,4-benzenediamine		C <sub>15</sub> H <sub>18</sub> N <sub>2</sub>	101-72-4	226.317		72.5	148 <sup>2</sup>			
6531	Isopropyl phenylcarbamate	Propham	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	122-42-9	179.216	wh nd (al)	90		1.09 <sup>20</sup>	1.4989 <sup>91</sup>	vs bz, EtOH
6532	1-(4-Isopropylphenyl)ethanone		C <sub>11</sub> H <sub>14</sub> O	645-13-6	162.228			254	0.9753 <sup>15</sup>	1.5235 <sup>20</sup>	
6533	Isopropyl propanoate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	637-78-5	116.158			109.5	0.8660 <sup>20</sup>	1.3872 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
6534	<i>N</i> -Isopropyl-2-propenamide		C <sub>8</sub> H <sub>11</sub> NO	2210-25-5	113.157		64.5	110 <sup>15</sup>			
6535	Isopropylpropylamine	<i>N</i> -Propyl-2-propanamine	C <sub>8</sub> H <sub>15</sub> N	21968-17-2	101.190			96.9			
6536	Isopropyl propyl sulfide		C <sub>6</sub> H <sub>14</sub> S	5008-73-1	118.240			132.1	0.8269 <sup>20</sup>		
6537	4-Isopropylpyridine		C <sub>8</sub> H <sub>11</sub> N	696-30-0	121.180	liq	-54.9	178	0.9382 <sup>25</sup>	1.4962 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace
6538	Isopropyl 3-pyridinecarboxylate	Isopropyl nicotine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	553-60-6	165.189			126 <sup>30</sup> , 92.5 <sup>5</sup>	1.0624 <sup>20</sup>	1.4926 <sup>20</sup>	
6539	Isopropyl silicate	Tetra(isopropoxy)silane	C <sub>12</sub> H <sub>26</sub> O <sub>4</sub> Si	1992-48-9	264.434			184	0.8770 <sup>20</sup>		s ctc, CS <sub>2</sub>
6540	Isopropyl stearate		C <sub>21</sub> H <sub>42</sub> O <sub>2</sub>	112-10-7	326.557		28	207 <sup>6</sup>	0.8403 <sup>28</sup>		vs ace, eth, EtOH, chl
6541	4-Isopropylstyrene		C <sub>11</sub> H <sub>14</sub>	2055-40-5	146.229	liq	-44.7	204.1	0.8850 <sup>20</sup>	1.5289 <sup>20</sup>	vs ace, bz, eth, EtOH
6542	Isopropyl tetradecanoate	Isopropyl myristate	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	110-27-0	270.451			193 <sup>20</sup> , 140 <sup>2</sup>	0.8532 <sup>20</sup>	1.4325 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; vs ace, bz
6543	(Isopropylthio)benzene		C <sub>8</sub> H <sub>12</sub> S	3019-20-3	152.256			208	0.9852 <sup>20</sup>	1.5464 <sup>20</sup>	
6544	Isopropyl trichloroacetate		C <sub>3</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>2</sub>	3974-99-0	205.468			175; 66 <sup>15</sup>	1.2911 <sup>25</sup>	1.4428 <sup>20</sup>	vs bz, eth, EtOH
6545	Isopropylurea		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	691-60-1	102.134	nd		103 <sup>0.1</sup>			s H <sub>2</sub> O, EtOH, chl, ace; sl eth
6546	Isopropyl vinyl ether	2-(Ethenyloxy)propane	C <sub>5</sub> H <sub>10</sub> O	926-65-8	86.132	liq	-140	55.5	0.7534 <sup>20</sup>	1.3840 <sup>20</sup>	vs ace, bz, eth, EtOH
6547	Isoproterenol	4-[1-Hydroxy-2-[isopropylamino]ethyl]-1,2-benzenediol	C <sub>11</sub> H <sub>17</sub> NO <sub>3</sub>	7683-59-2	211.258		170.5				



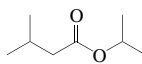
1-Isopropyl-2-methylbenzene



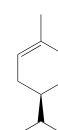
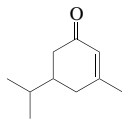
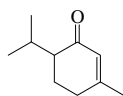
1-Isopropyl-3-methylbenzene



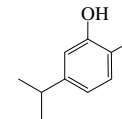
1-Isopropyl-4-methylbenzene



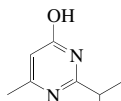
Isopropyl 3-methylbutanoate

5-Isopropyl-2-methyl-1,3-cyclohexadiene, (*R*)5-Isopropyl-3-methyl-2-cyclohexen-1-one, ( $\pm$ )6-Isopropyl-3-methyl-2-cyclohexen-1-one, ( $\pm$ )

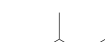
Isopropyl methyl ether



5-Isopropyl-2-methylphenol



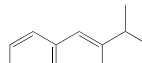
2-Isopropyl-6-methyl-4-pyrimidinol



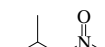
Isopropyl methyl sulfide



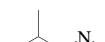
1-Isopropyl-naphthalene



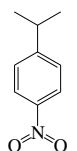
2-Isopropyl-naphthalene



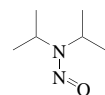
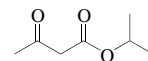
Isopropyl nitrate



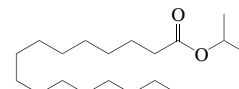
Isopropyl nitrite



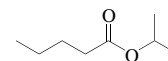
1-Isopropyl-4-nitrobenzene

*N*-Isopropyl-*N*-nitroso-2-propanamine

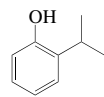
Isopropyl 3-oxobutanoate



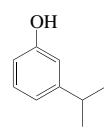
Isopropyl palmitate



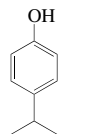
Isopropyl pentanoate



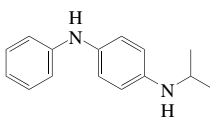
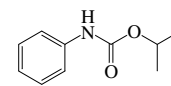
2-Isopropylphenol



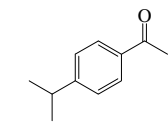
3-Isopropylphenol



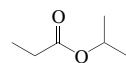
4-Isopropylphenol

*N*-Isopropyl-*N*'-phenyl-1,4-benzenediamine

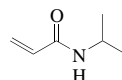
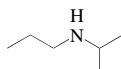
Isopropyl phenylcarbamate



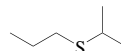
1-(4-Isopropylphenyl)ethanone



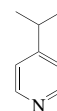
Isopropyl propanoate

*N*-Isopropyl-2-propenamide

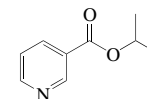
Isopropylpropylamine



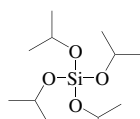
Isopropyl propyl sulfide



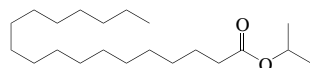
4-Isopropylpyridine



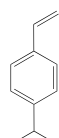
Isopropyl 3-pyridinecarboxylate



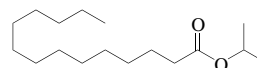
Isopropyl silicate



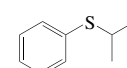
Isopropyl stearate



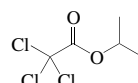
4-Isopropylstyrene



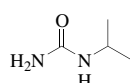
Isopropyl tetradecanoate



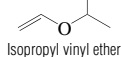
(Isopropylthio)benzene



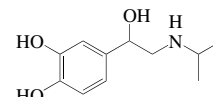
Isopropyl trichloroacetate



Isopropylurea



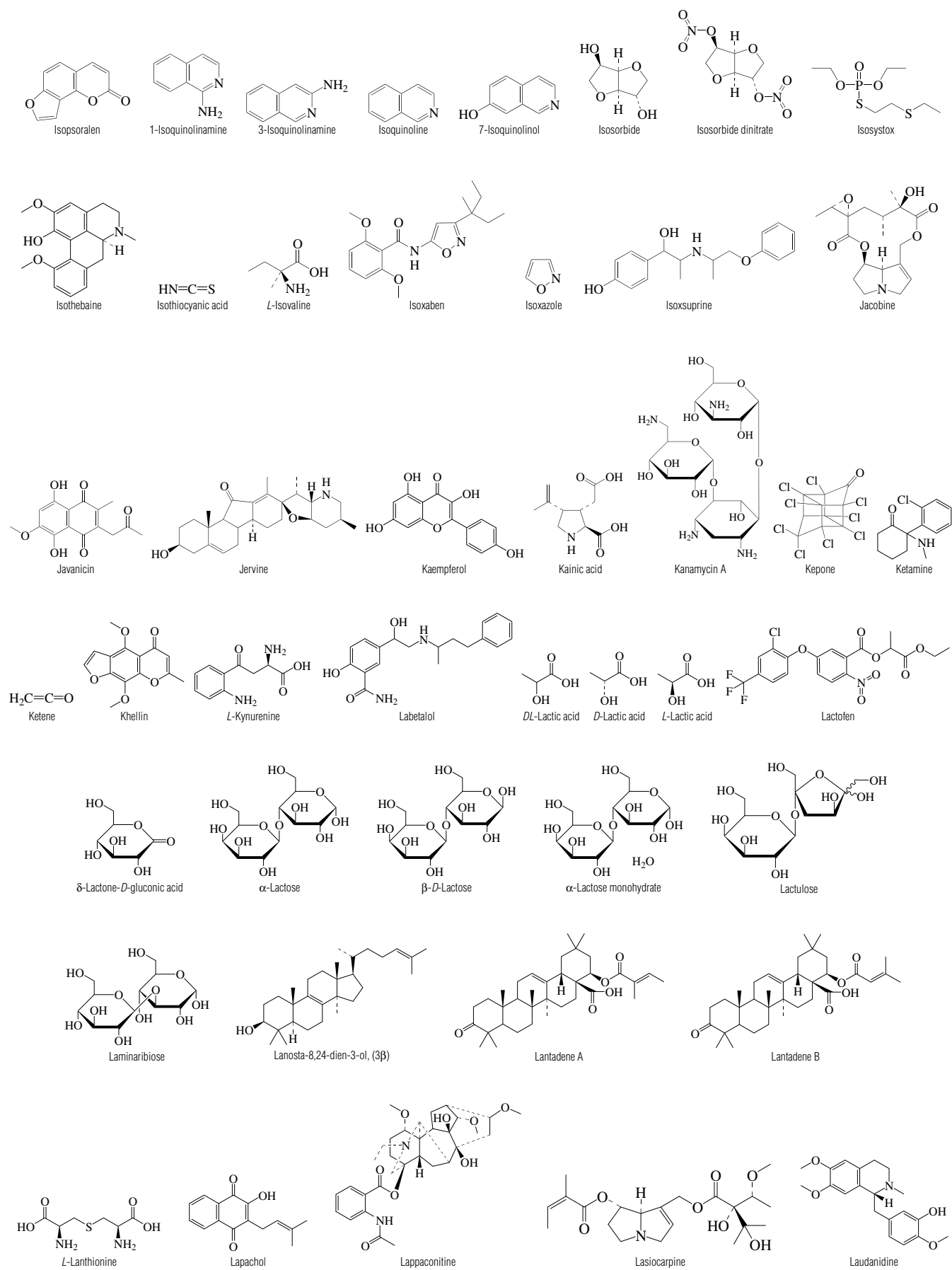
Isopropyl vinyl ether



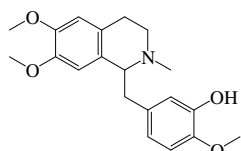
Isoproterenol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6548	Isopsoralen		C <sub>11</sub> H <sub>6</sub> O <sub>3</sub>	523-50-2	186.164		139				
6549	1-Isoquinolinamine		C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	1532-84-9	144.173	pl(w)	123	164 <sup>8</sup>			sl H <sub>2</sub> O, eth; vs EtOH
6550	3-Isoquinolinamine		C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	25475-67-6	144.173		178.5				
6551	Isoquinoline	Benzo[c]pyridine	C <sub>9</sub> H <sub>7</sub> N	119-65-3	129.159	hyg pl	26.47	243.22	1.0910 <sup>90</sup>	1.6148 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, chl; msc eth, bz
6552	7-Isoquinolinol		C <sub>9</sub> H <sub>9</sub> NO	7651-83-4	145.158		230				sl H <sub>2</sub> O, eth; s EtOH
6553	Isosorbide		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	652-67-5	146.141		63	170 <sup>2</sup>			
6554	Isosorbide dinitrate	1,4:3,6-Dianhydroglucitol	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>8</sub>	87-33-2	236.136	col cry	52				vs EtOH, eth, ace
6555	Isosystox	Demeton-S	C <sub>8</sub> H <sub>19</sub> O <sub>3</sub> PS <sub>2</sub>	126-75-0	258.339	liq		133 <sup>2</sup>	1.132 <sup>21</sup>		s H <sub>2</sub> O
6556	Isothobaine		C <sub>19</sub> H <sub>21</sub> NO <sub>3</sub>	568-21-8	311.375	orth cry (al)	203.5				i H <sub>2</sub> O; msc EtOH, chl; sl eth; s MeOH
6557	Isothiocyanic acid		CHNS	3129-90-6	59.091	unstab gas					
6558	L-Isovaline	2-Amino-2-methylbutyric acid	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	595-40-4	117.147	nd (w)	≈300				s EtOH; sl eth
6559	Isoxaben		C <sub>18</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	82558-50-7	332.395	wh cry	173				s EtOAc, MeCN, MeOH
6560	Isoxazole	1-Oxa-2-azacyclopentadiene	C <sub>3</sub> H <sub>3</sub> NO	288-14-2	69.062			95	1.078 <sup>20</sup>	1.4298 <sup>17</sup>	s H <sub>2</sub> O
6561	Isoxsuprine		C <sub>18</sub> H <sub>25</sub> NO <sub>3</sub>	395-28-8	301.381	cry	103.0				
6562	Jacobine		C <sub>18</sub> H <sub>25</sub> NO <sub>6</sub>	6870-67-3	351.395	pl (EtOH)	228				
6563	Javanicin		C <sub>15</sub> H <sub>14</sub> O <sub>6</sub>	476-45-9	290.268	red cry (al)	208 dec				s alk
6564	Jervine		C <sub>27</sub> H <sub>35</sub> NO <sub>3</sub>	469-59-0	425.604		243 dec				i H <sub>2</sub> O; s EtOH, ace, chl; sl eth
6565	Kaempferol		C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>	520-18-3	286.236	ye nd (al, + 1 w)	277				sl H <sub>2</sub> O, chl; vs EtOH, eth, ace; i bz
6566	Kainic acid		C <sub>10</sub> H <sub>15</sub> NO <sub>4</sub>	487-79-6	213.231	cry (EtOH aq)	253 dec				s H <sub>2</sub> O; i EtOH
6567	Kanamycin A		C <sub>18</sub> H <sub>36</sub> N <sub>6</sub> O <sub>11</sub>	59-01-8	484.499	cry (EtOH)					
6568	Kepone	Chlordecone	C <sub>10</sub> Cl <sub>10</sub> O	143-50-0	490.636		350 dec		1.61 <sup>25</sup>		
6569	Ketamine	2-(2-Chlorophenyl)-2-(methylamino)cyclohexanone, (±)	C <sub>13</sub> H <sub>16</sub> ClNO	6740-88-1	237.725	cry (eth-pentane)	92.5				
6570	Ketene		C <sub>2</sub> H <sub>2</sub> O	463-51-4	42.036	col gas	-151	-49.8			sl eth, ace
6571	Khellin	4,9-Dimethoxy-7-methyl-5H-furo[3,2-g][1]benzopyran-5-one	C <sub>14</sub> H <sub>12</sub> O <sub>5</sub>	82-02-0	260.242	eth, al	154 dec	190 <sup>0.05</sup>			i H <sub>2</sub> O; s EtOH, ace; sl eth, chl
6572	L-Kynurenine	Benzenebutanoic acid, α,2-diamino-γ-oxo-	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	343-65-7	208.213	lf (+/2w)	191 dec				sl H <sub>2</sub> O
6573	Labetalol		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O <sub>3</sub>	36894-69-6	328.405	cry (MeOH)	164				
6574	DL-Lactic acid	2-Hydroxypropanoic acid, (±)	C <sub>3</sub> H <sub>5</sub> O <sub>3</sub>	598-82-3	90.078	ye cry		122 <sup>15</sup>	1.2060 <sup>21</sup>	1.4392 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; sl eth
6575	D-Lactic acid	D-2-Hydroxypropanoic acid	C <sub>3</sub> H <sub>5</sub> O <sub>3</sub>	10326-41-7	90.078	pl (chl)	53	103 <sup>2</sup>			vs H <sub>2</sub> O, EtOH
6576	L-Lactic acid	L-2-Hydroxypropanoic acid	C <sub>3</sub> H <sub>5</sub> O <sub>3</sub>	79-33-4	90.078	hyg pr (eth)	53				vs H <sub>2</sub> O, EtOH
6577	Lactofen		C <sub>19</sub> H <sub>15</sub> ClF <sub>3</sub> NO <sub>7</sub>	77501-63-4	461.773	ye pow (bz)	93				
6578	δ-Lactone-D-gluconic acid	δ-D-Gluconolactone	C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	90-80-2	178.139	nd (al)					
6579	α-Lactose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	14641-93-1	342.296	wh pow	222.8				vs H <sub>2</sub> O; sl EtOH; i eth, chl
6580	β-D-Lactose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	5965-66-2	342.296		254		1.59 <sup>20</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, chl
6581	α-Lactose monohydrate		C <sub>12</sub> H <sub>24</sub> O <sub>12</sub>	5989-81-1	360.312	mcl (w)	201 dec		1.547 <sup>20</sup>		vs H <sub>2</sub> O; i EtOH, eth, chl, MeOH
6582	Lactulose	4-O-β-D-Galactopyranosyl-D-fructose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	4618-18-2	342.296	hx pl (MeOH)	169				vs H <sub>2</sub> O
6583	Laminaribiose	3-O-β-D-Glucopyranosyl-D-glucose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	34980-39-7	342.296		205				
6584	Lanosta-8,24-dien-3-ol, (3β)	Lanosterol	C <sub>30</sub> H <sub>50</sub> O	79-63-0	426.717	nd (eth), cry (MeOH-ace)	140.5				vs eth, EtOH, chl
6585	Lantadene A	Rehmannic acid	C <sub>35</sub> H <sub>52</sub> O <sub>5</sub>	467-81-2	552.785	cry (MeOH)	297				
6586	Lantadene B		C <sub>35</sub> H <sub>52</sub> O <sub>5</sub>	467-82-3	552.785	cry (EtOH)	302				
6587	L-Lanthionine	L-Cysteine, S-(2-amino-2-carboxyethyl)-, (R)-	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S	922-55-4	208.235	hex pl	294 dec				sl H <sub>2</sub> O
6588	Lapachol	2-Hydroxy-3-(3-methyl-2-butenyl)-1,4-naphthalenedione	C <sub>15</sub> H <sub>14</sub> O <sub>3</sub>	84-79-7	242.270	ye pr (eth, bz) pl (al)	139.5				i H <sub>2</sub> O; s EtOH, eth, bz, chl; vs HOAc
6589	Lappaconitine		C <sub>32</sub> H <sub>44</sub> N <sub>2</sub> O <sub>8</sub>	32854-75-4	584.699	hex pl (al)	217.5				i H <sub>2</sub> O; sl EtOH, eth; s bz, chl
6590	Lasiocarpine		C <sub>21</sub> H <sub>33</sub> NO <sub>7</sub>	303-34-4	411.490	col pl (peth)	95.5				sl H <sub>2</sub> O; s EtOH, bz, eth
6591	Laudanidine		C <sub>20</sub> H <sub>25</sub> NO <sub>4</sub>	301-21-3	343.418	hex pr (al)	184.5				vs H <sub>2</sub> O, bz

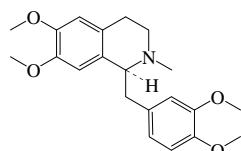




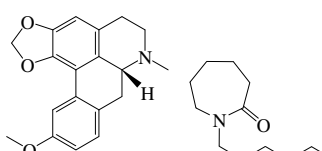
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6592	Laudanine		C <sub>20</sub> H <sub>25</sub> NO <sub>4</sub>	85-64-3	343.418	ye wh pr (dil al, al-chl)	167		1.26 <sup>20</sup>		sl H <sub>2</sub> O, EtOH, eth; s bz, chl
6593	Laudanosine		C <sub>21</sub> H <sub>27</sub> NO <sub>4</sub>	2688-77-9	357.444	nd (peth), pr (al)	89				vs ace, eth, EtOH, chl
6594	Laureline		C <sub>19</sub> H <sub>19</sub> NO <sub>3</sub>	81-38-9	309.359	tab (al) cubes (peth)	114				i H <sub>2</sub> O; s EtOH, eth, dil acid, con sulf
6595	Laurocapram	1-Dodecylhexahydro-2 <i>H</i> -azepin-2-one	C <sub>18</sub> H <sub>35</sub> NO	59227-89-3	281.477	col liq	-7	160 <sup>50</sup>	0.91	1.4701	i H <sub>2</sub> O
6596	Lead bis(dimethyldithiocarbamate)		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> PbS <sub>4</sub>	19010-66-3	447.6	pale ye nd	258				
6597	Ledol		C <sub>15</sub> H <sub>26</sub> O	577-27-5	222.366	nd (al)	105	292	0.9078 <sup>100</sup>	1.4667 <sup>110</sup>	vs ace, eth, EtOH
6598	Lenacil		C <sub>13</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	2164-08-1	234.294		290		1.32 <sup>25</sup>		vs py
6599	Leptophos		C <sub>13</sub> H <sub>10</sub> BrCl <sub>2</sub> O <sub>2</sub> PS	21609-90-5	412.066	tan waxy solid	71		1.53 <sup>25</sup>		i H <sub>2</sub> O; vs bz; s ace, 2-PrOH, xyl
6600	<i>DL</i> -Leucine		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	328-39-2	131.173	lf (w)	293	sub	1.293 <sup>18</sup>		s H <sub>2</sub> O; sl EtOH; i eth
6601	<i>D</i> -Leucine		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	328-38-1	131.173	pl (al)	293	sub			sl H <sub>2</sub> O
6602	<i>L</i> -Leucine	2-Amino-4-methylpentanoic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	61-90-5	131.173	hex pl (dil al)	293	sub	1.293 <sup>18</sup>		sl H <sub>2</sub> O; i EtOH, eth
6603	<i>N</i> -Leucylglycine		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	686-50-0	188.224		248 dec				s H <sub>2</sub> O; sl EtOH, eth; i ace, bz, chl
6604	Leuprolide		C <sub>39</sub> H <sub>84</sub> N <sub>16</sub> O <sub>12</sub>	53714-56-0	1209.398	fluffy solid					
6605	Leurosine		C <sub>46</sub> H <sub>56</sub> N <sub>4</sub> O <sub>9</sub>	23360-92-1	808.959	cry	203				
6606	Levallorphan	17-Allylmorphinan-3-ol	C <sub>19</sub> H <sub>25</sub> NO	152-02-3	283.408	cry (EtOH aq)	181				
6607	Levodopa	<i>L</i> -3,4-Dihydroxyphenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>4</sub>	59-92-7	197.188	pl (dil al) pr or nd (w+SO <sub>2</sub> )	277 dec				s H <sub>2</sub> O; i EtOH, eth, ace, bz; s alk, MeOH
6608	Levopimaric acid		C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	79-54-9	302.451	orth cry	150				
6609	Levorphanol	17-Methylmorphinan-3-ol	C <sub>17</sub> H <sub>23</sub> NO	77-07-6	257.371	cry	198				
6610	<i>α</i> -Limonene	<i>ρ</i> -Mentha-1,8-diene, ( <i>R</i> )	C <sub>10</sub> H <sub>16</sub>	5989-27-5	136.234	oil	-74.0	178	0.8411 <sup>20</sup>	1.4730 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
6611	<i>β</i> -Limonene	<i>ρ</i> -Mentha-1,8-diene, ( <i>S</i> )	C <sub>10</sub> H <sub>16</sub>	5989-54-8	136.234	oil		178; 64.4 <sup>15</sup>	0.843 <sup>20</sup>	1.4746 <sup>20</sup>	i H <sub>2</sub> O; vs eth, EtOH
6612	Linalol	3,7-Dimethyl-1,6-octadien-3-ol, (±)-	C <sub>10</sub> H <sub>18</sub> O	22564-99-4	154.249			198; 86 <sup>13</sup>	0.870 <sup>15</sup>	1.4627	
6613	Linalyl acetate	3,7-Dimethyl-1,6-octadien-3-yl acetate	C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	115-95-7	196.286	liq		220; 44 <sup>02</sup>	0.895 <sup>20</sup>	1.4460 <sup>20</sup>	i H <sub>2</sub> O; misc EtOH, eth
6614	Lincomycin		C <sub>18</sub> H <sub>34</sub> N <sub>2</sub> O <sub>6</sub> S	154-21-2	406.537	amor solid					sl H <sub>2</sub> O; s EtOH, ace, chl
6615	Linoleic acid	<i>cis,cis</i> -9,12-Octadecadienoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	60-33-3	280.446		-7	229 <sup>16</sup>	0.9022 <sup>20</sup>	1.4699 <sup>20</sup>	vs ace, bz, eth, EtOH
6616	Linolenic acid	<i>cis,cis,cis</i> -9,12,15-Octadecatrienoic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	463-40-1	278.430		-11	231 <sup>17</sup> , 129 <sup>05</sup>	0.9164 <sup>20</sup>	1.4800 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl bz
6617	Linuron	<i>N</i> -(3,4-Dichlorophenyl)- <i>N'</i> -methoxy- <i>N'</i> -methylurea	C <sub>9</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	330-55-2	249.093		93				
6618	Liothyronine		C <sub>15</sub> H <sub>12</sub> I <sub>3</sub> NO <sub>4</sub>	6893-02-3	650.974	cry	236 dec				i H <sub>2</sub> O, EtOH; s dil alk
6619	Lipoamide	1,2-Dithiolane-3-pentanamide	C <sub>8</sub> H <sub>15</sub> NOS <sub>2</sub>	940-69-2	205.341	cry	128				
6620	<i>α</i> -Lipoic acid	1,2-Dithiolane-3-pentanoic acid	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub> S <sub>2</sub>	1077-28-7	206.326	ye pl (cy)	60	87 <sup>25</sup>			i H <sub>2</sub> O
6621	Lisinopril		C <sub>21</sub> H <sub>35</sub> N <sub>3</sub> O <sub>7</sub>	83915-83-7	441.519	wh cry pow	159				i EtOH, chl, ace; sl MeOH
6622	Lithium oxalate		C <sub>2</sub> Li <sub>2</sub> O <sub>4</sub>	30903-87-8	101.901		dec		2.121 <sup>17</sup>		s H <sub>2</sub> O; i EtOH, eth
6623	Lobelanidine		C <sub>22</sub> H <sub>29</sub> NO <sub>2</sub>	552-72-7	339.471	sc (al, eth)	150				i H <sub>2</sub> O; s EtOH; sl eth; vs ace, bz, py
6624	Lobelanine		C <sub>22</sub> H <sub>29</sub> NO <sub>2</sub>	579-21-5	335.440	nd (eth, peth)	99				vs ace, bz, EtOH, chl
6625	Lobeline		C <sub>22</sub> H <sub>27</sub> NO <sub>2</sub>	90-69-7	337.455	nd (al, bz)	130.5				sl H <sub>2</sub> O; s EtOH, eth, bz, chl; vs ace
6626	Loflucarban		C <sub>13</sub> H <sub>2</sub> Cl <sub>2</sub> FN <sub>2</sub> S	790-69-2	315.192		163.5				
6627	Longifolene	Kuromatsuene	C <sub>15</sub> H <sub>24</sub>	475-20-7	204.352			258; 126 <sup>15</sup>	0.9319 <sup>18</sup>	1.5040 <sup>20</sup>	i H <sub>2</sub> O; s bz
6628	Loratadine	Claritin	C <sub>22</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>2</sub>	79794-75-5	382.883	cry (MeCN)	132				
6629	Lovastatin	Mevacor	C <sub>24</sub> H <sub>36</sub> O <sub>5</sub>	75330-75-5	404.540	wh cry (ace aq)	174				i H <sub>2</sub> O; vs chl; s DMF; sl ace, EtOH
6630	Lovoal		C <sub>15</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	14255-88-0	375.130	ye cry	103				s ace, diox
6631	Loxapine		C <sub>18</sub> H <sub>18</sub> ClN <sub>2</sub> O	1977-10-2	327.808	ye cry (peth)	109.5				



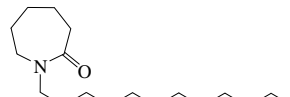
Laudanine



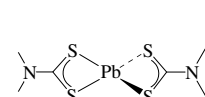
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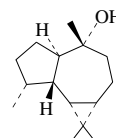
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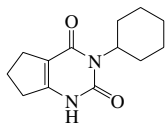
Laurocapram



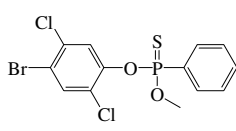
Lead bis(dimethyldithiocarbamate)



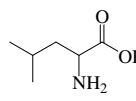
Ledol



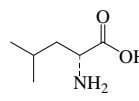
Lenacil



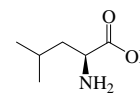
Leptophos



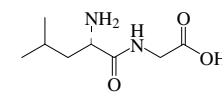
DL-Leucine



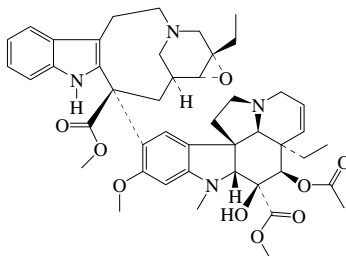
D-Leucine



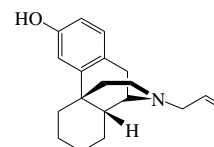
L-Leucine



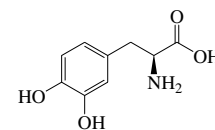
N-Leucylglycine

H-5-oxoPro-His-Trp-Ser-Tyr-D-Leu-Leu-Arg-Pro-NHEt  
Leuprolide

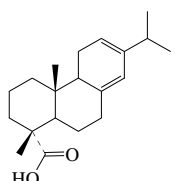
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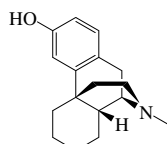
Levallorphan



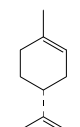
Levodopa



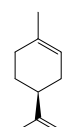
Levopimaric acid



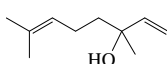
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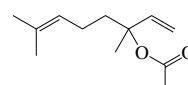
d-Limonene



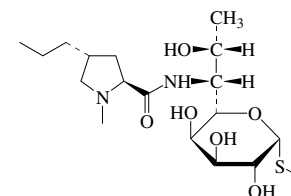
l-Limonene



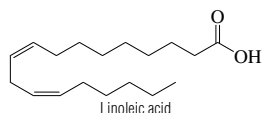
Linalol



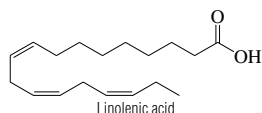
Linalyl acetate



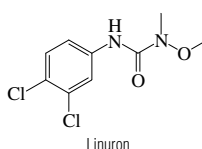
Lincosycin



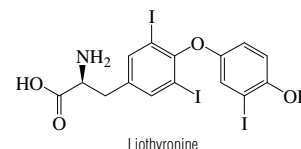
Linoleic acid



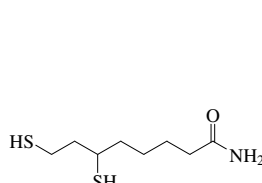
Linolenic acid



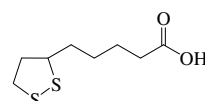
Linuron



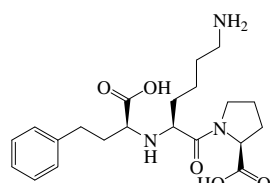
Liothyronine



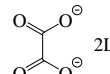
Lipoamide



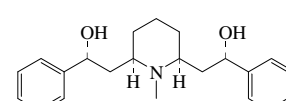
α-Lipoic acid



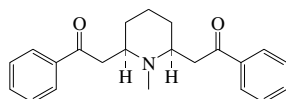
Lisinopril



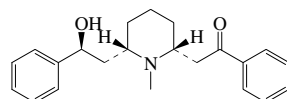
Lithium oxalate



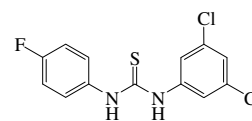
Lobelanidine



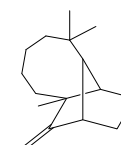
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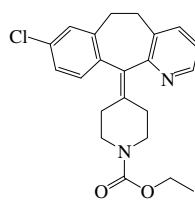
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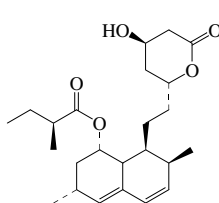
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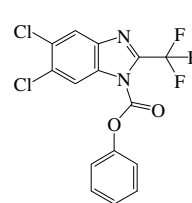
Longifolene



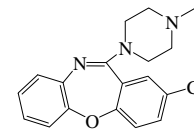
Loratadine



Lovastatin

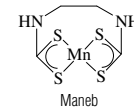
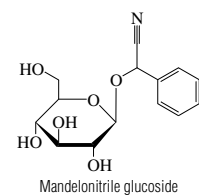
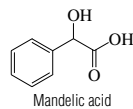
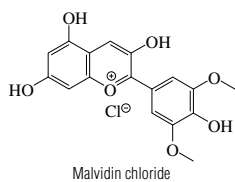
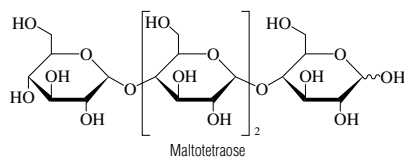
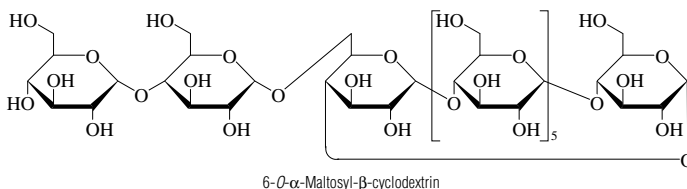
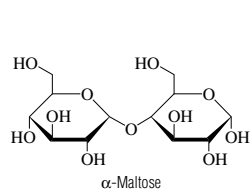
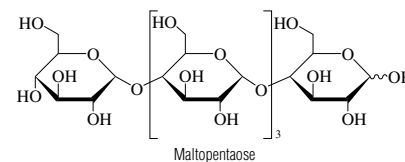
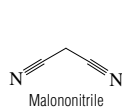
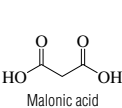
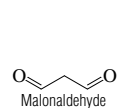
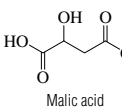
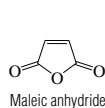
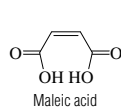
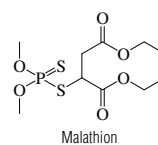
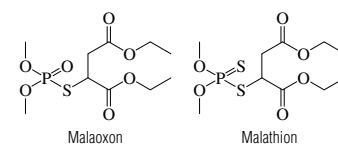
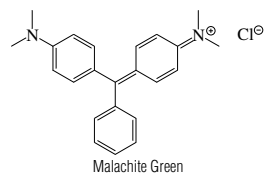
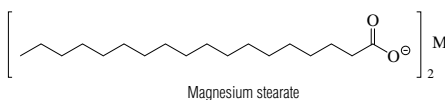
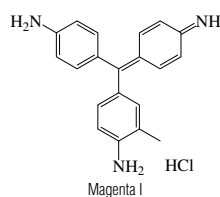
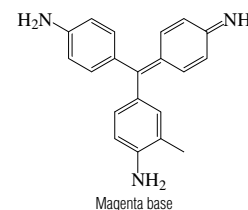
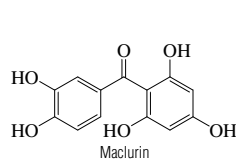
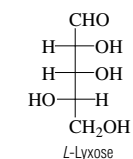
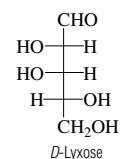
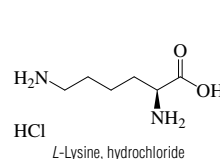
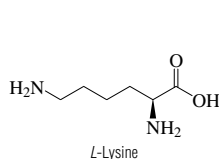
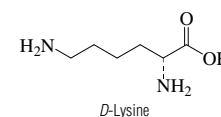
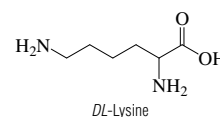
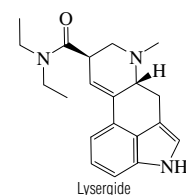
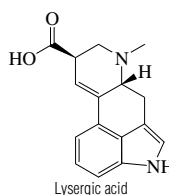
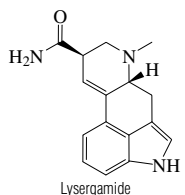
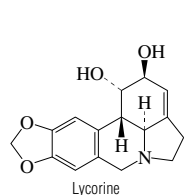
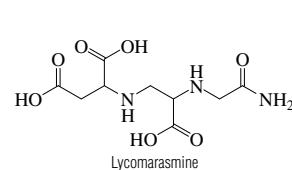
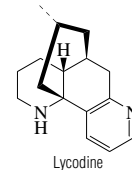
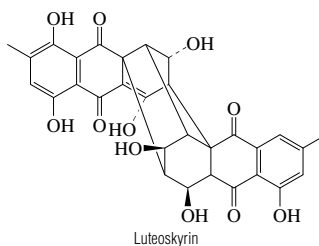
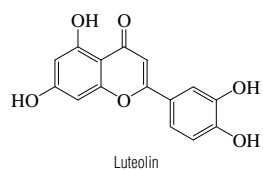
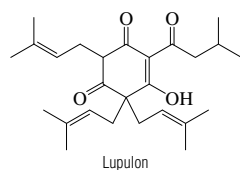
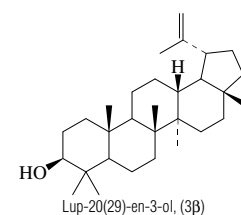
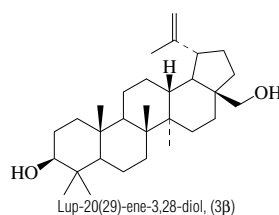
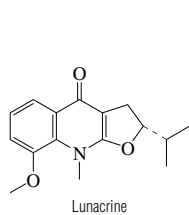
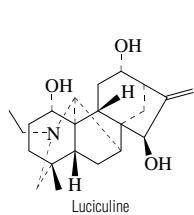
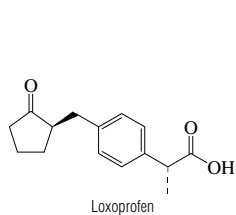


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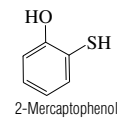
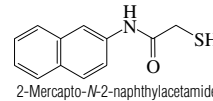
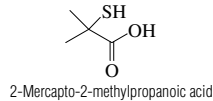
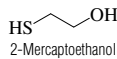
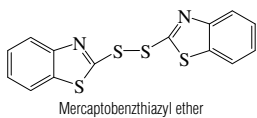
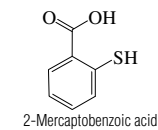
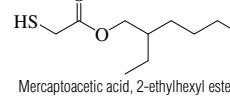
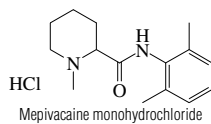
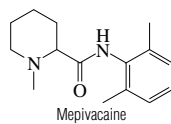
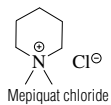
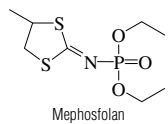
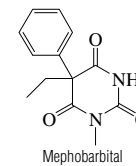
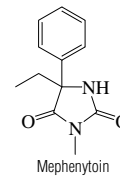
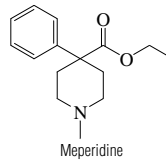
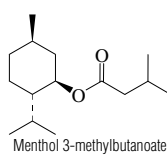
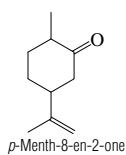
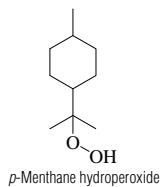
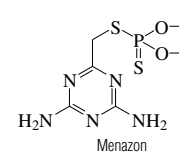
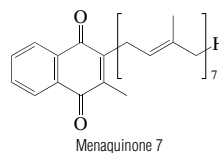
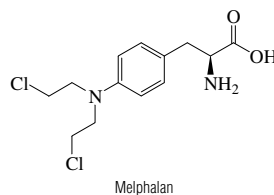
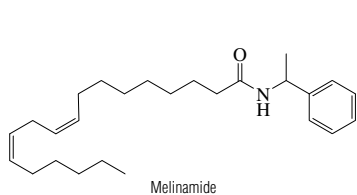
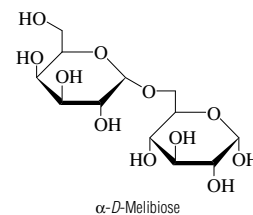
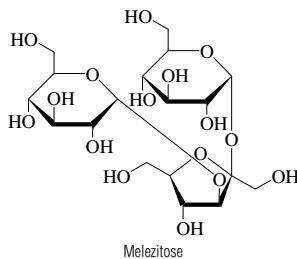
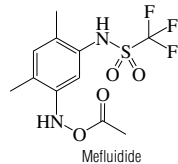
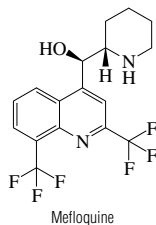
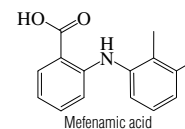
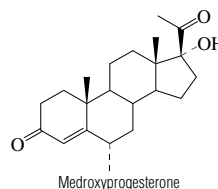
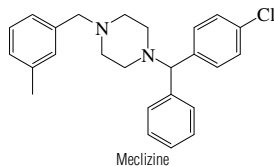
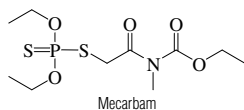
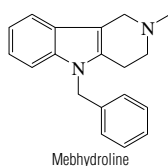
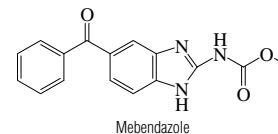
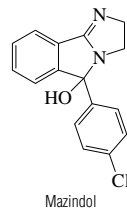
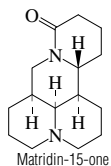
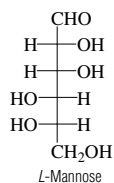
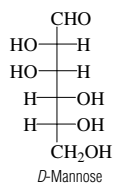
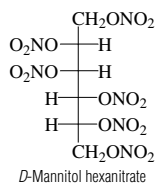
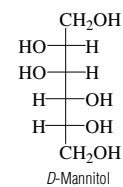
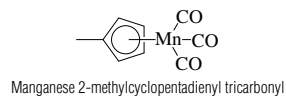
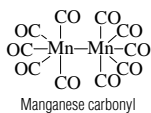
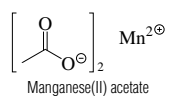


Loxapine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6632	Loxoprofen	$\alpha$ -Methyl-4-[(2-oxocyclopentyl)methyl]benzeneacetic acid	C <sub>15</sub> H <sub>18</sub> O <sub>3</sub>	68767-14-6	246.302	col oil	110	192 <sup>0.3</sup>			
6633	Luciculine	Napelline	C <sub>22</sub> H <sub>35</sub> NO <sub>3</sub>	5008-52-6	361.518	cry (+1w, ace)	149	165 <sup>0.02</sup>			vs EtOH
6634	Lunacrine		C <sub>16</sub> H <sub>19</sub> NO <sub>3</sub>	82-40-6	273.327						s chl
6635	Lup-20(29)-ene-3,28-diol, (3 $\beta$ )	Betulin	C <sub>30</sub> H <sub>50</sub> O <sub>2</sub>	473-98-3	442.717	nd (al +1)	250	sub 240			i H <sub>2</sub> O; sl EtOH, bz; s eth, AcOEt, lig
6636	Lup-20(29)-en-3-ol, (3 $\beta$ )	Lupeol	C <sub>30</sub> H <sub>50</sub> O	545-47-1	426.717	nd (al, ace)	216		0.9457 <sup>218</sup>	1.4910 <sup>218</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
6637	Lupulon		C <sub>26</sub> H <sub>38</sub> O <sub>4</sub>	468-28-0	414.578	pr (MeOH)	93				i H <sub>2</sub> O; s EtOH, peth, hx
6638	Luteolin		C <sub>15</sub> H <sub>10</sub> O <sub>6</sub>	491-70-3	286.236	ye nd (dil al, + 1 w)	329 dec				sl H <sub>2</sub> O; s EtOH, eth, alk, con sulf
6639	Luteoskyrin	8,8'-Dihydroxyrugulosin	C <sub>30</sub> H <sub>22</sub> O <sub>12</sub>	21884-44-6	574.489	ye nd (EtOH)	278 dec				
6640	Lycodine		C <sub>16</sub> H <sub>22</sub> N <sub>2</sub>	20316-18-1	242.359	orth pr	99	190 <sup>1.0</sup>			s H <sub>2</sub> O, chl, eth, EtOH; i peth
6641	Lycomarasmine		C <sub>9</sub> H <sub>15</sub> N <sub>3</sub> O <sub>7</sub>	7611-43-0	277.231		228 dec				
6642	Lycorine		C <sub>16</sub> H <sub>17</sub> NO <sub>4</sub>	476-28-8	287.311	pr (al, py)	280	sub			i H <sub>2</sub> O; sl EtOH, eth, chl
6643	Lysergamide		C <sub>16</sub> H <sub>17</sub> N <sub>3</sub> O	478-94-4	267.325	cry (MeOH), pr (aq, ace)	137.5				sl EtOH, ace, os
6644	Lysergic acid		C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	82-58-6	268.310	lf or hex sc (w)	240 dec				sl H <sub>2</sub> O, eth, bz; s EtOH, py
6645	Lysergide		C <sub>20</sub> H <sub>25</sub> N <sub>3</sub> O	50-37-3	323.432		82				
6646	DL-Lysine	2,6-Diaminohexanoic acid, ( $\pm$ )	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	70-54-2	146.187		224				sl H <sub>2</sub> O
6647	D-Lysine	2,6-Diaminohexanoic acid, (D)	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	923-27-3	146.187		218 dec				s H <sub>2</sub> O
6648	L-Lysine	2,6-Diaminohexanoic acid, (L)	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	56-87-1	146.187	nd (w, dil al)	224 dec				s H <sub>2</sub> O; i EtOH, eth, ace, bz
6649	L-Lysine, hydrochloride		C <sub>6</sub> H <sub>15</sub> ClN <sub>2</sub> O <sub>2</sub>	10098-89-2	182.648		263 dec				
6650	D-Lyxose		C <sub>6</sub> H <sub>10</sub> O <sub>5</sub>	1114-34-7	150.130		108		1.545 <sup>20</sup>		
6651	L-Lyxose		C <sub>6</sub> H <sub>10</sub> O <sub>5</sub>	1949-78-6	150.130		110				
6652	Maclurin	(3,4-Dihydroxyphenyl)(2,4,6-trihydroxyphenyl)methanone	C <sub>13</sub> H <sub>10</sub> O <sub>6</sub>	519-34-6	262.214	ye nd (al)	222.5				vs eth, EtOH
6653	Magenta base	Rosaniline	C <sub>20</sub> H <sub>19</sub> N <sub>3</sub>	3248-93-9	301.385	br-red cry	186 dec				
6654	Magenta I	Rosaniline hydrochloride	C <sub>20</sub> H <sub>20</sub> ClN <sub>3</sub>	632-99-5	337.846	grn cry	200 dec				sl H <sub>2</sub> O, EtOH; i eth
6655	Magnesium stearate	Magnesium octadecanoate	C <sub>36</sub> H <sub>70</sub> MgO <sub>4</sub>	557-04-0	591.244	wh pow	132				i H <sub>2</sub> O; reac acid
6656	Malachite Green		C <sub>23</sub> H <sub>25</sub> ClN <sub>2</sub>	569-64-2	364.911	grn cry					vs H <sub>2</sub> O, EtOH, MeOH
6657	Malaoxon	(Dimethoxyphosphinythio)butanedioic acid	C <sub>10</sub> H <sub>15</sub> O <sub>7</sub> PS	1634-78-2	314.293	liq		132 <sup>0.1</sup>			
6658	Malathion		C <sub>10</sub> H <sub>19</sub> O <sub>6</sub> PS <sub>2</sub>	121-75-5	330.358	ye-br liq	1.4	156 <sup>0.7</sup> dec	1.2076 <sup>20</sup>	1.4960 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz
6659	Maleic acid	cis-2-Butenedioic acid	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	110-16-7	116.073	mcl pr (w)	139		1.590 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, ace; s eth; i bz, chl
6660	Maleic anhydride		C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	108-31-6	98.057	nd (chl, eth)	52.56	202	1.314 <sup>60</sup>		s H <sub>2</sub> O; s eth, ace, chl; sl lig
6661	Maleonitrile	cis-Butenedinitrile	C <sub>4</sub> H <sub>2</sub> N <sub>2</sub>	928-53-0	78.072	pr (EtOH)	31.5	111 <sup>20</sup>			
6662	Malic acid	Hydroxybutanedioic acid	C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	617-48-1	134.088		132		1.601 <sup>20</sup>		s H <sub>2</sub> O; vs eth, EtOH, MeOH
6663	Malonaldehyde	1,3-Propanedial	C <sub>3</sub> H <sub>2</sub> O <sub>2</sub>	542-78-9	72.063	hyg nd	73				
6664	Malonic acid		C <sub>3</sub> H <sub>4</sub> O <sub>4</sub>	141-82-2	104.062	tcl (al)	135 dec	sub	1.619 <sup>10</sup>		vs H <sub>2</sub> O, py; s EtOH, eth; i bz
6665	Malononitrile		C <sub>3</sub> H <sub>2</sub> N <sub>2</sub>	109-77-3	66.061		32	218.5	1.1910 <sup>20</sup>	1.4146 <sup>34</sup>	s H <sub>2</sub> O, ace, bz, chl; vs EtOH, eth
6666	Maltopentaose		C <sub>30</sub> H <sub>52</sub> O <sub>26</sub>	34620-76-3	828.718	cry (w)	78 (hyd)				
6667	$\alpha$ -Maltose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	4482-75-1	342.296	nd (al)	162.5		1.546 <sup>20</sup>		vs H <sub>2</sub> O
6668	6-O- $\alpha$ -Maltosyl- $\beta$ -cyclodextrin		C <sub>54</sub> H <sub>90</sub> O <sub>45</sub>	104723-60-6	1459.266	cry (MeOH)					
6669	Maltotetraose		C <sub>24</sub> H <sub>42</sub> O <sub>21</sub>	34612-38-9	666.577	amorp solid	170 dec				
6670	Malvidin chloride		C <sub>17</sub> H <sub>15</sub> ClO <sub>7</sub>	643-84-5	366.750		>300				sl H <sub>2</sub> O; s EtOH, MeOH
6671	Mandelic acid	$\alpha$ -Hydroxybenzeneacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	90-64-2	152.148	orth pl	119		1.2890 <sup>20</sup>		s H <sub>2</sub> O, eth, EtOH, i-PROH
6672	Mandelonitrile glucoside		C <sub>14</sub> H <sub>17</sub> NO <sub>6</sub>	138-53-4	295.288	wh nd or pl (al)	122				vs H <sub>2</sub> O, EtOH
6673	Maneb	Manganese, [[1,2-ethanediy]bis(carbamodithioato)](2-)-	C <sub>4</sub> H <sub>6</sub> MnN <sub>2</sub> S <sub>4</sub>	12427-38-2	265.302		dec 200				

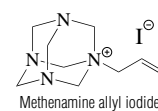
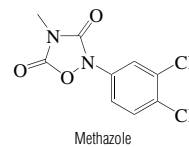
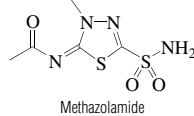
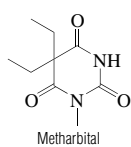
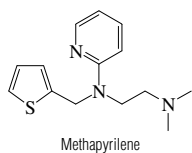
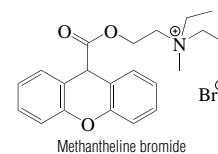
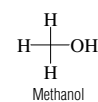
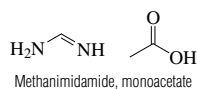
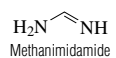
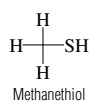
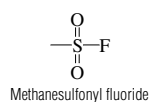
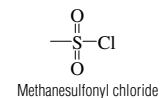
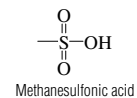
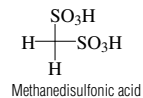
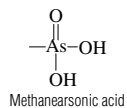
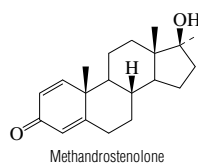
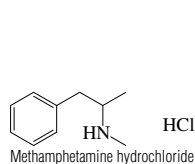
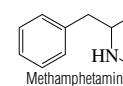
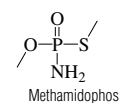
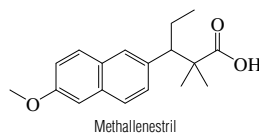
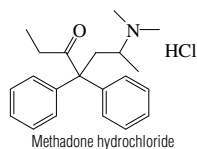
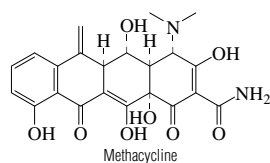
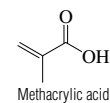
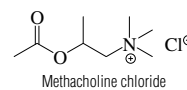
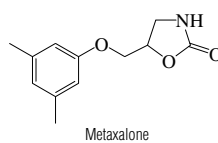
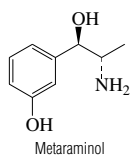
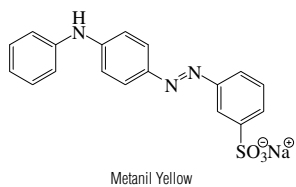
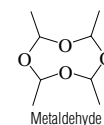
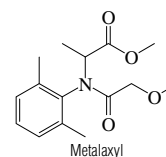
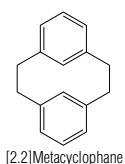
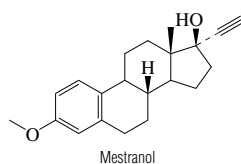
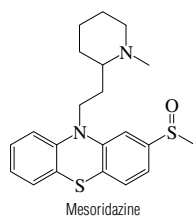
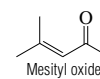
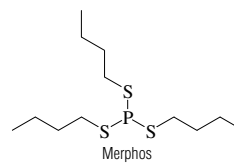
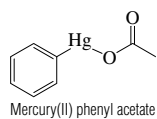
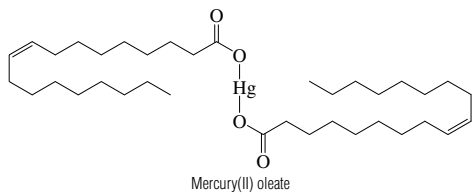
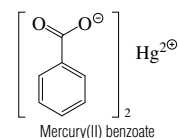
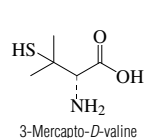
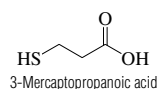
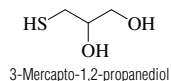
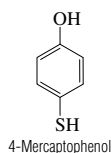


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6674	Manganese(II) acetate		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub> Mn	638-38-0	173.027	red cry (w)	210				s H <sub>2</sub> O, MeOH, HOAc; i ace
6675	Manganese carbonyl	Dimanganese decacarbonyl	C <sub>10</sub> Mn <sub>2</sub> O <sub>10</sub>	10170-69-1	389.977	ye mcl cry	154		1.75		i H <sub>2</sub> O; s os
6676	Manganese cyclopentadienyl tricarbonyl		C <sub>8</sub> H <sub>5</sub> MnO <sub>3</sub>	12079-65-1	204.062	pale ye cry	77.0	subl			s os
6677	Manganese 2-methylcyclopentadienyl tricarbonyl		C <sub>9</sub> H <sub>7</sub> MnO <sub>3</sub>	12108-13-3	218.088	ye liq	1.5	233; 102 <sup>10</sup>	1.388 <sup>20</sup>		i H <sub>2</sub> O; misc bz
6678	D-Mannitol	Cordycepic acid	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	69-65-8	182.171	orth nd or pr (w)	168	295 <sup>3,5</sup>	1.489 <sup>20</sup>	1.3330	vs H <sub>2</sub> O; sl EtOH, py; i eth
6679	D-Mannitol hexanitrate		C <sub>6</sub> H <sub>6</sub> N <sub>6</sub> O <sub>18</sub>	15825-70-4	452.157	nd (al)	107	exp	1.8 <sup>20</sup>		vs bz, eth, EtOH
6680	D-Mannose	Seminose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	3458-28-4	180.155	nd or orth pr (al)	132 dec		1.539 <sup>20</sup>		vs H <sub>2</sub> O; sl EtOH, MeOH; i eth, bz
6681	L-Mannose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	10030-80-5	180.155	cry (al)	132				vs H <sub>2</sub> O
6682	Matridin-15-one	Matrine	C <sub>15</sub> H <sub>24</sub> N <sub>2</sub> O	519-02-8	248.364	α-nd or pl; β-orth pr,		223 <sup>6</sup>		1.5286 <sup>25</sup>	s H <sub>2</sub> O, eth, ace; vs EtOH, bz; sl peth
6683	Mazindol		C <sub>16</sub> H <sub>13</sub> ClN <sub>2</sub> O	22232-71-9	284.739	cry (ace/hx)	198				i H <sub>2</sub> O; s EtOH
6684	Mebendazole		C <sub>16</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub>	31431-39-7	295.292	cry (HOAc/MeOH)	288.5				i H <sub>2</sub> O, EtOH, eth, chl
6685	Mebhydroline		C <sub>19</sub> H <sub>20</sub> N <sub>2</sub>	524-81-2	276.375	cry	95	211 <sup>1</sup>			i H <sub>2</sub> O; sl eth; vs EtOH, ace, MeOH
6686	Mecarbam		C <sub>10</sub> H <sub>20</sub> NO <sub>3</sub> PS <sub>2</sub>	2595-54-2	329.374	ye oil		144 <sup>0,02</sup>	1.223 <sup>20</sup>		sl H <sub>2</sub> O
6687	Meclizine		C <sub>25</sub> H <sub>27</sub> ClN <sub>2</sub>	569-65-3	390.948			230			s CS <sub>2</sub>
6688	Medroxyprogesterone		C <sub>22</sub> H <sub>32</sub> O <sub>3</sub>	520-85-4	344.487		214.5				vs chl
6689	Mefenamic acid	2-[(2,3-Dimethylphenyl)amino] benzoic acid	C <sub>15</sub> H <sub>15</sub> NO <sub>2</sub>	61-68-7	241.286	hyg cry	230 dec				s alk; sl eth, chl
6690	Mefloquine		C <sub>17</sub> H <sub>16</sub> F <sub>6</sub> N <sub>2</sub> O	53230-10-7	378.311	cry (MeOH aq)	178.2				
6691	Mefluidide		C <sub>11</sub> H <sub>13</sub> F <sub>3</sub> N <sub>2</sub> O <sub>3</sub> S	53780-34-0	310.292		184				
6692	Melezitose		C <sub>18</sub> H <sub>32</sub> O <sub>16</sub>	597-12-6	504.437	cry (w+2)	153		1.5565 <sup>25</sup>		vs H <sub>2</sub> O
6693	α-D-Melibiose	6-O-α-D-Galactopyranosyl-D-glucose	C <sub>12</sub> H <sub>20</sub> O <sub>11</sub>	585-99-9	342.296						vs H <sub>2</sub> O; sl EtOH; dec acid
6694	Melinamide	N-(1-Phenylethyl)-9,12-octadecadieneamide, (Z,Z)-	C <sub>26</sub> H <sub>41</sub> NO	14417-88-0	383.610	oil	<4	202 <sup>0,07</sup>		1.5050 <sup>23</sup>	
6695	Melphalan	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-	C <sub>13</sub> H <sub>18</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	148-82-3	305.200	nd	183 dec				i H <sub>2</sub> O; s EtOH
6696	Menaquinone 7	Vitamin K <sub>2</sub> (35)	C <sub>46</sub> H <sub>64</sub> O <sub>2</sub>	2124-57-4	648.999	cry	54				
6697	Menazon		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub> PS <sub>2</sub>	78-57-9	281.296	cry (MeOH)	160				sl H <sub>2</sub> O; s thf
6698	p-Menthane hydroperoxide	1-Methyl-1-(4-methylcyclohexyl)ethyl hydroperoxide	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	80-47-7	172.265			259	0.92		
6699	p-Menth-8-en-2-one	2-Methyl-5-(1-methylethyl)cyclohexanone	C <sub>10</sub> H <sub>18</sub> O	7764-50-3	152.233			223.0			
6700	Menthol 3-methylbutanoate	Menthol, isovalerate	C <sub>15</sub> H <sub>26</sub> O <sub>2</sub>	16409-46-4	240.382			129 <sup>9</sup>	0.908 <sup>15</sup>	1.4486 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace
6701	Meperidine	Pethidine	C <sub>15</sub> H <sub>21</sub> NO <sub>2</sub>	57-42-1	247.334		30	155 <sup>5</sup>			
6702	Mephentoin		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	50-12-4	218.251		136				
6703	Mephobarbital		C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	115-38-8	246.261	wh cry (w)	176				sl H <sub>2</sub> O, eth, chl; vs EtOH
6704	Mephosolan		C <sub>8</sub> H <sub>16</sub> NO <sub>3</sub> PS <sub>2</sub>	950-10-7	269.322	ye liq		120 <sup>0,001</sup>		1.5354 <sup>26</sup>	s ace, EtOH, bz
6705	Mepiquat chloride	Piperidinium, 1,1-dimethyl-, chloride	C <sub>7</sub> H <sub>16</sub> CIN	24307-26-4	149.662		223				
6706	Mepivacaine	N-(2,6-Dimethylphenyl)-1-methyl-2-piperidinecarboxamide	C <sub>15</sub> H <sub>22</sub> N <sub>2</sub> O	96-88-8	246.348	cry (eth)	150.5				s CS <sub>2</sub>
6707	Mepivacaine monohydrochloride	Carbocaine hydrochloride	C <sub>15</sub> H <sub>23</sub> CIN <sub>2</sub> O	1722-62-9	282.809	cry	263				s H <sub>2</sub> O
6708	Mercaptoacetic acid, 2-ethylhexyl ester		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub> S	7659-86-1	204.330			133.5	0.97 <sup>20</sup>		
6709	2-Mercaptobenzoic acid	o-Thiosalicic acid	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub> S	147-93-3	154.187	lf or nd (al, w, HOAc)	168.5	sub			s H <sub>2</sub> O, EtOH, eth; sl DMSO, lig
6710	Mercaptobenzthiazyl ether	2,2'-Dithiobis[benzothiazole]	C <sub>14</sub> H <sub>8</sub> N <sub>2</sub> S <sub>4</sub>	120-78-5	332.487	ye nd	180		1.50		i H <sub>2</sub> O; sl EtOH, bz, ctc, ace
6711	2-Mercaptoethanol		C <sub>2</sub> H <sub>6</sub> OS	60-24-2	78.133			158; 55 <sup>13</sup>	1.1143 <sup>20</sup>	1.4996 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, bz
6712	2-Mercapto-2-methylpropanoic acid		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	4695-31-2	120.171		47	101 <sup>15</sup>			vs H <sub>2</sub> O
6713	2-Mercapto-N-2-naphthylacetamide	Thionalide	C <sub>12</sub> H <sub>11</sub> NOS	93-42-5	217.286		111.5				i H <sub>2</sub> O; vs EtOH, os
6714	2-Mercaptophenol		C <sub>6</sub> H <sub>6</sub> OS	1121-24-0	126.176	oil	5.5	217; 89 <sup>8</sup>	1.2371 <sup>0</sup>		vs bz, eth, EtOH

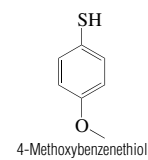
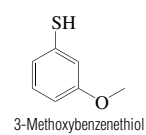
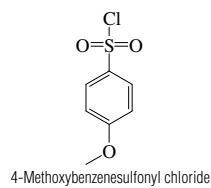
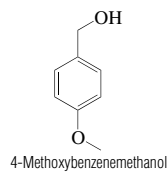
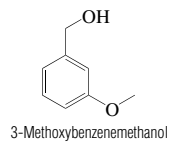
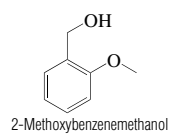
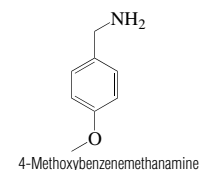
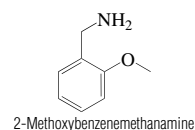
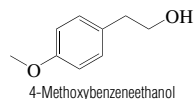
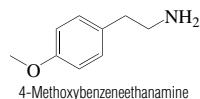
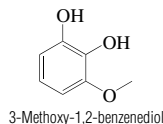
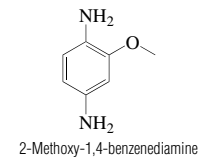
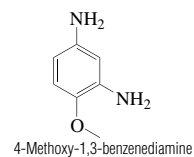
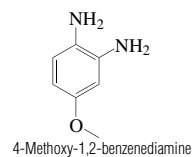
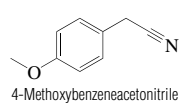
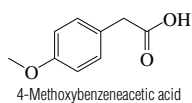
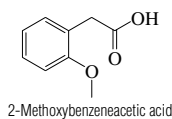
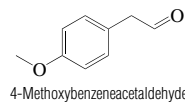
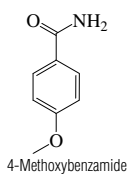
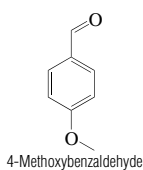
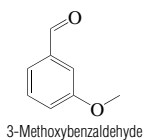
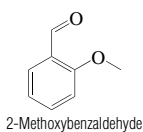
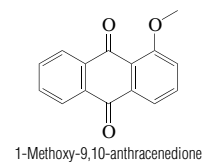
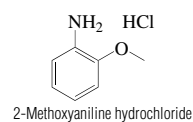
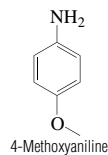
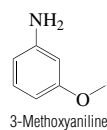
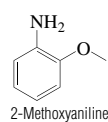
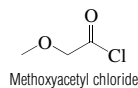
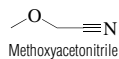
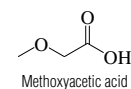
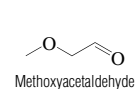
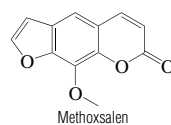
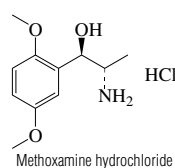
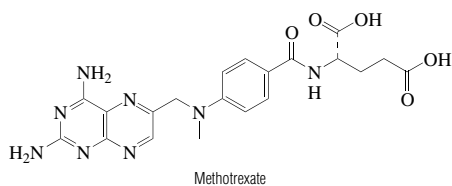
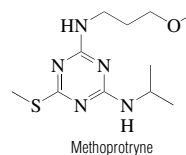
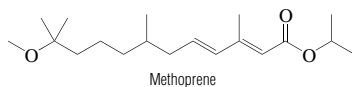
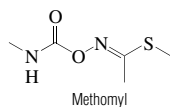
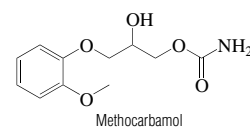
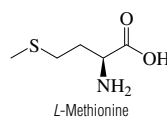
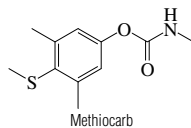
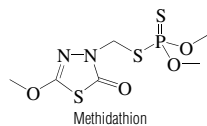
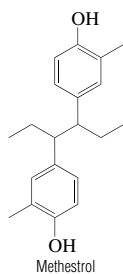


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6715	4-Mercaptophenol		C <sub>6</sub> H <sub>6</sub> OS	637-89-8	126.176	cry	29.5	167 <sup>45</sup> , 135 <sup>11</sup>	1.1285 <sup>25</sup>	1.5101 <sup>25</sup>	s H <sub>2</sub> O, EtOH, alk, con sulf
6716	3-Mercapto-1,2-propanediol	Thioglycerol	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	96-27-5	108.160	visc		100 <sup>1</sup>	1.2455 <sup>20</sup>	1.5268 <sup>20</sup>	sl H <sub>2</sub> O, eth, bz, chl; msc EtOH; vs ace
6717	3-Mercaptopropanoic acid		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	107-96-0	106.144	amor	18	111 <sup>15</sup> , 86 <sup>3</sup>	1.218 <sup>21</sup>	1.494 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ctc
6718	3-Mercapto-D-valine	Penicillamine	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub> S	52-67-5	149.212		198.5				
6719	Mercury(II) benzoate	Mercuric benzoate	C <sub>14</sub> H <sub>10</sub> HgO <sub>4</sub>	583-15-3	442.81	cry pow (w)	≈125				i EtOH
6720	Mercury(II) oleate	Mercuric oleate	C <sub>36</sub> H <sub>66</sub> HgO <sub>4</sub>	1191-80-6	763.35	ye-br solid					i H <sub>2</sub> O; sl EtOH, eth
6721	Mercury(II) phenyl acetate	Phenylmercuric acetate	C <sub>8</sub> H <sub>8</sub> HgO <sub>2</sub>	62-38-4	336.74		153				i H <sub>2</sub> O; s chl
6722	Merphos	Phosphorotrithious acid, S,S,S-tributyl ester	C <sub>12</sub> H <sub>27</sub> PS <sub>3</sub>	150-50-5	298.511		100	137 <sup>0.7</sup> , 176 <sup>15</sup>	1.02 <sup>20</sup>		
6723	Mesityl oxide	Isobutenyl methyl ketone	C <sub>8</sub> H <sub>10</sub> O	141-79-7	98.142	liq	-59	130	0.8653 <sup>20</sup>	1.4440 <sup>20</sup>	s H <sub>2</sub> O, ace; msc EtOH, eth
6724	Mesoridazine		C <sub>21</sub> H <sub>26</sub> N <sub>2</sub> OS <sub>2</sub>	5588-33-0	386.573	oil					
6725	Mestranol		C <sub>21</sub> H <sub>26</sub> O <sub>2</sub>	72-33-3	310.430	cry	151				i H <sub>2</sub> O; s diox, eth, EtOH, chl
6726	[2.2]Metacyclopentane	Tricyclo[9.3.1.1]hexadeca-1(15),4,6,8(16),11,13-hexaene	C <sub>16</sub> H <sub>16</sub>	2319-97-3	208.298	orth pr	132.5	290			sl EtOH; s bz, eth
6727	Metalaxyl		C <sub>15</sub> H <sub>21</sub> NO <sub>4</sub>	57837-19-1	279.333		71				
6728	Metaldehyde	Metacetaldehyde (polymer)	(C <sub>2</sub> H <sub>4</sub> O) <sub>x</sub>	37273-91-9		tetr nd or pr (al)	246	sub 115			i H <sub>2</sub> O, ace; sl EtOH, eth, bz, chl
6729	Metanil Yellow		C <sub>18</sub> H <sub>14</sub> N <sub>2</sub> NaO <sub>3</sub> S	587-98-4	375.377	br-ye pow					vs H <sub>2</sub> O, EtOH; s bz, eth; sl ace
6730	Metaraminol	2-Amino-1-(3-hydroxyphenyl)-1-propanol, (1 <i>R</i> ,2 <i>S</i> )	C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	54-49-9	167.205	hyg cry (HCl)					s H <sub>2</sub> O
6731	Metaxalone		C <sub>12</sub> H <sub>19</sub> NO <sub>3</sub>	1665-48-1	221.252	cry (AcOEt)	122	223 <sup>1.5</sup>			
6732	Methacholine chloride		C <sub>8</sub> H <sub>10</sub> ClNO <sub>2</sub>	62-51-1	195.688	hyg cry	172				vs H <sub>2</sub> O, EtOH, chl
6733	Methacrylic acid	2-Methylpropenoic acid	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	79-41-4	86.090	pr	16	162.5	1.0153 <sup>20</sup>	1.4314 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
6734	Methacycline		C <sub>22</sub> H <sub>22</sub> N <sub>2</sub> O <sub>8</sub>	914-00-1	442.418	cry	205 dec				
6735	Methadone hydrochloride	6-(Dimethylamino)-4,4-diphenyl-3-heptanone hydrochloride	C <sub>21</sub> H <sub>28</sub> ClNO	1095-90-5	345.906	pl (al-eth)	235				vs H <sub>2</sub> O, EtOH
6736	Methallenestril		C <sub>18</sub> H <sub>22</sub> O <sub>3</sub>	517-18-0	286.366	cry (MeOH aq)	139				s eth
6737	Methamidophos	Phosphoramidothioic acid, O,S-dimethyl ester	C <sub>2</sub> H <sub>6</sub> NO <sub>2</sub> PS	10265-92-6	141.130		46		1.31 <sup>20</sup>		
6738	Methamphetamine		C <sub>10</sub> H <sub>15</sub> N	537-46-2	149.233			212			
6739	Methamphetamine hydrochloride	N,α-Dimethylbenzeneethanamine, hydrochloride, (S)-	C <sub>10</sub> H <sub>16</sub> ClN	51-57-0	185.694		173.8				vs H <sub>2</sub> O, EtOH, chl
6740	Methandrostenolone		C <sub>20</sub> H <sub>28</sub> O <sub>2</sub>	72-63-9	300.435		166				
6741	Methane		CH <sub>4</sub>	74-82-8	16.043	col gas	-182.47	-161.48	0.4228 <sup>162</sup>		sl H <sub>2</sub> O, ace; s EtOH, eth, bz, tol, MeOH
6742	Methanearsonic acid		CH <sub>2</sub> AsO <sub>3</sub>	124-58-3	139.971		160.5				s H <sub>2</sub> O, EtOH
6743	Methanedisulfonic acid	Methiononic acid	CH <sub>4</sub> O <sub>2</sub> S <sub>2</sub>	503-40-2	176.169		98				i H <sub>2</sub> O; s HNO <sub>3</sub>
6744	Methanesulfonic acid	Methylsulfonic acid	CH <sub>3</sub> O <sub>2</sub> S	75-75-2	96.106		20	167 <sup>10</sup>	1.4812 <sup>18</sup>	1.4317 <sup>18</sup>	s H <sub>2</sub> O
6745	Methanesulfonyl chloride		CH <sub>3</sub> ClO <sub>2</sub> S	124-63-0	114.552			162; 55 <sup>11</sup>	1.4805 <sup>18</sup>	1.4573 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
6746	Methanesulfonyl fluoride		CH <sub>3</sub> FO <sub>2</sub> S	558-25-8	98.097			123.5			
6747	Methanethiol	Methyl mercaptan	CH <sub>3</sub> S	74-93-1	48.108	col gas	-123	5.9	0.8665 <sup>20</sup>		sl H <sub>2</sub> O, chl; vs EtOH, eth
6748	Methanimidamide	Formamidine	CH <sub>3</sub> N <sub>2</sub>	463-52-5	44.056	pr	81	dec			vs H <sub>2</sub> O, EtOH
6749	Methanimidamide, monoacetate	Formamidine acetate	C <sub>2</sub> H <sub>5</sub> N <sub>2</sub> O <sub>2</sub>	3473-63-0	104.108		161.5				vs H <sub>2</sub> O
6750	Methanol	Methyl alcohol	CH <sub>3</sub> O	67-56-1	32.042	liq	-97.53	64.6	0.7914 <sup>20</sup>	1.3288 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace; vs bz; s chl
6751	Methantheline bromide		C <sub>21</sub> H <sub>26</sub> BrNO <sub>3</sub>	53-46-3	420.340	cry (i-PrOH)	174.5				s H <sub>2</sub> O, EtOH, chl; i eth
6752	Methapyrilene		C <sub>14</sub> H <sub>19</sub> N <sub>3</sub> S	91-80-5	261.386			174 <sup>3</sup>		1.5915 <sup>20</sup>	
6753	Metharbital	5,5-Diethyl-1-methyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	C <sub>9</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	50-11-3	198.218	nd	150.5				s H <sub>2</sub> O; sl chl
6754	Methazolamide		C <sub>8</sub> H <sub>8</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	554-57-4	236.273	cry (w)	213 dec				
6755	Methazole		C <sub>4</sub> H <sub>4</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>3</sub>	20354-26-1	261.061		123		1.24 <sup>25</sup>		
6756	Methanamine allyl iodide	Allylhexamethylenetetramine iodide	C <sub>9</sub> H <sub>17</sub> IN <sub>4</sub>	36895-62-2	308.162	cry	148 dec				vs H <sub>2</sub> O; i chl, eth

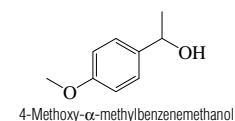
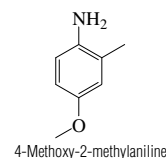
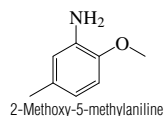
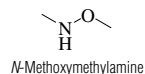
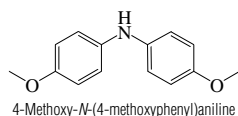
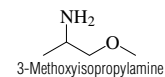
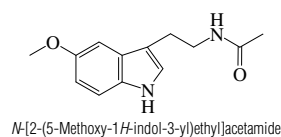
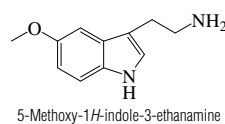
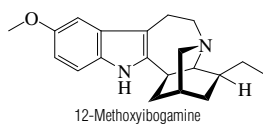
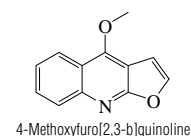
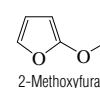
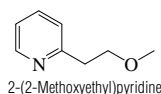
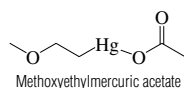
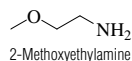
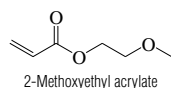
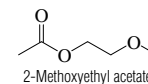
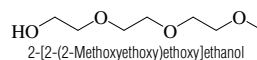
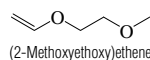
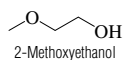
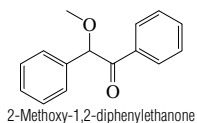
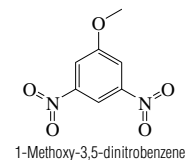
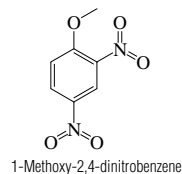
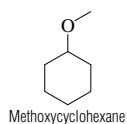
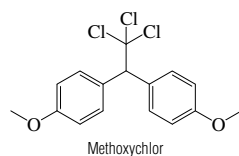
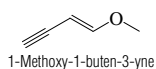
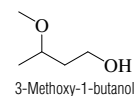
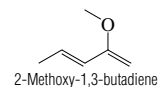
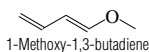
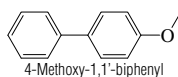
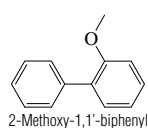
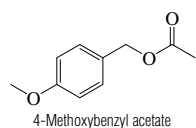
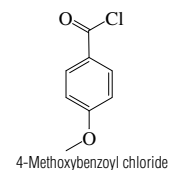
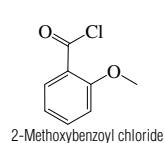
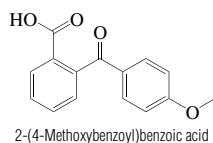
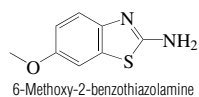
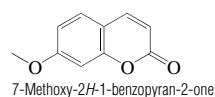
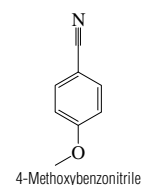
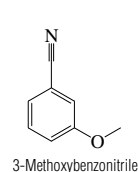
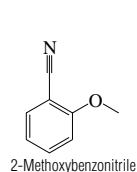
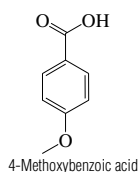
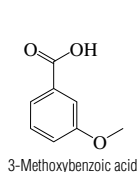
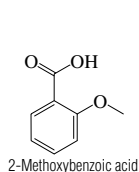




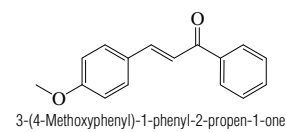
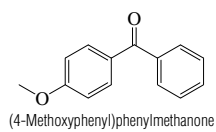
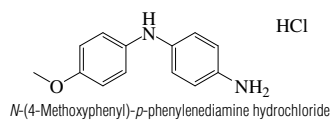
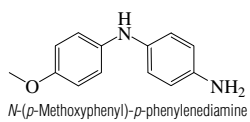
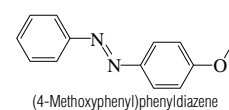
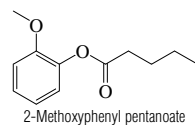
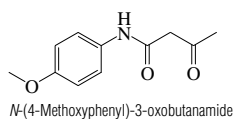
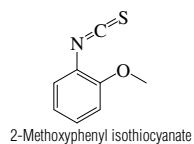
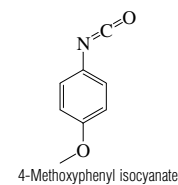
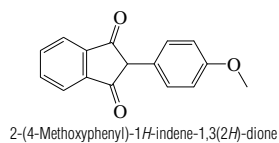
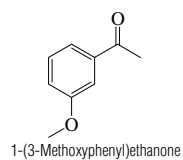
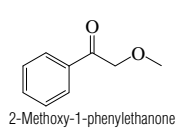
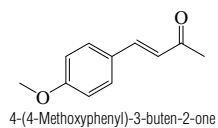
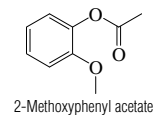
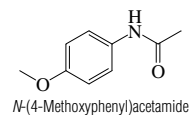
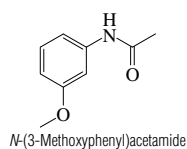
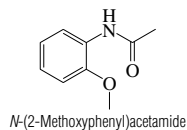
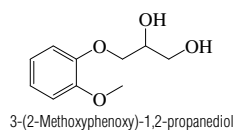
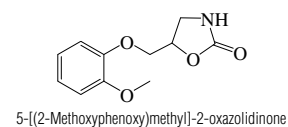
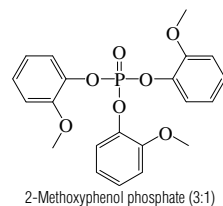
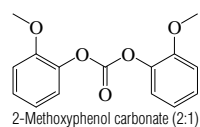
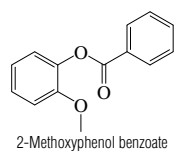
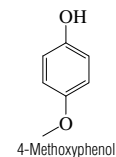
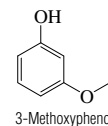
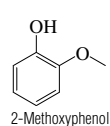
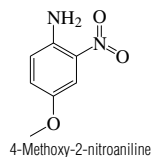
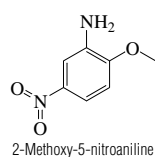
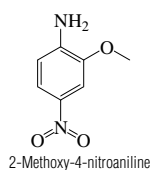
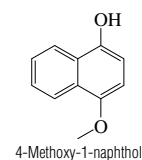
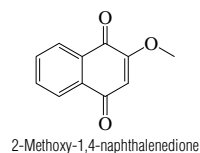
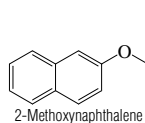
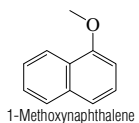
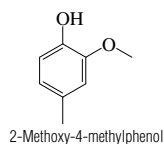
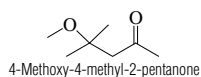
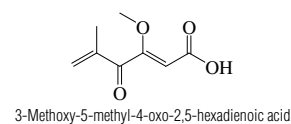
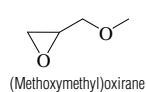
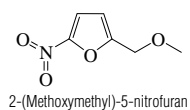
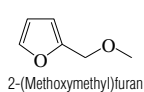
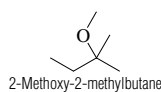
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6757	Methestrol		C <sub>20</sub> H <sub>26</sub> O <sub>2</sub>	130-73-4	298.419	cry (dil HOAc)	145				
6758	Methidathion		C <sub>8</sub> H <sub>11</sub> N <sub>2</sub> O <sub>4</sub> PS <sub>3</sub>	950-37-8	302.330		39				
6759	Methiocarb	Phenol, 3,5-dimethyl-4-(methylthio)-, methylcarbamate	C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub> S	2032-65-7	225.308		120				
6760	L-Methionine		C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	63-68-3	149.212	hex pl (dil al)	281 dec				s H <sub>2</sub> O; i EtOH, eth, ace, bz, peth; sl HOAc
6761	Methocarbamol	Guaifenesin-1-carbamate	C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	532-03-6	241.241	cry (bz)	93				s EtOH
6762	Methomyl		C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> S	16752-77-5	162.210		78		1.2946 <sup>24</sup>		
6763	Methoprene		C <sub>19</sub> H <sub>34</sub> O <sub>3</sub>	40596-69-8	310.471			100 <sup>0.05</sup>	0.926 <sup>20</sup>		
6764	Methoprotrotryne		C <sub>11</sub> H <sub>21</sub> N <sub>3</sub> O <sub>5</sub>	841-06-5	271.383	cry	69				sl H <sub>2</sub> O; s os
6765	Methotrexate		C <sub>20</sub> H <sub>22</sub> N <sub>6</sub> O <sub>5</sub>	59-05-2	454.440	ye cry (w)	190 dec				
6766	Methoxamine hydrochloride		C <sub>11</sub> H <sub>18</sub> ClNO <sub>3</sub>	61-16-5	247.719	cry	214				vs H <sub>2</sub> O; i eth, bz, chl
6767	Methoxsalen	9-Methoxy-7H-furo[3,2-g][1]benzopyran-7-one	C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	298-81-7	216.190	pr (dil al) nd (peth)	148				sl H <sub>2</sub> O, eth, ace, peth; vs EtOH
6768	Methoxyacetaldehyde		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	10312-83-1	74.079			92	1.005 <sup>25</sup>	1.3950 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
6769	Methoxyacetic acid		C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	625-45-6	90.078	hyg		203.5	1.1768 <sup>20</sup>	1.4168 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
6770	Methoxyacetonitrile		C <sub>3</sub> H <sub>5</sub> NO	1738-36-9	71.078			119	0.9492 <sup>20</sup>	1.3831 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, chl, alk, acid
6771	Methoxyacetyl chloride		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	38870-89-2	108.524			112.5	1.1871 <sup>20</sup>	1.4199 <sup>20</sup>	s eth, ace, ctc; vs chl
6772	2-Methoxyaniline	<i>o</i> -Anisidine	C <sub>7</sub> H <sub>9</sub> NO	90-04-0	123.152		6.2	224	1.0923 <sup>20</sup>	1.5715 <sup>10</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz
6773	3-Methoxyaniline	<i>m</i> -Anisidine	C <sub>7</sub> H <sub>9</sub> NO	536-90-3	123.152	liq	-1	251	1.096 <sup>20</sup>	1.5794 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace, bz
6774	4-Methoxyaniline	<i>p</i> -Anisidine	C <sub>7</sub> H <sub>9</sub> NO	104-94-9	123.152	orth pl	57.2	243	1.071 <sup>57</sup>	1.5559 <sup>60</sup>	s H <sub>2</sub> O, ace, bz; vs EtOH, eth
6775	2-Methoxyaniline hydrochloride	<i>o</i> -Anisidine hydrochloride	C <sub>7</sub> H <sub>10</sub> ClNO	134-29-2	159.613	nd	225				
6776	1-Methoxy-9,10-anthracenedione		C <sub>15</sub> H <sub>10</sub> O <sub>3</sub>	82-39-3	238.238			170.3			sl EtOH; vs bz, chl
6777	2-Methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	135-02-4	136.149	pr	37.5	243.5	1.1326 <sup>20</sup>	1.5600 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc; vs eth, ace, chl
6778	3-Methoxybenzaldehyde		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	591-31-1	136.149			231	1.1187 <sup>20</sup>	1.5530 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz; vs eth, ace, chl
6779	4-Methoxybenzaldehyde	<i>p</i> -Anisaldehyde	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	123-11-5	136.149		0	248; 134 <sup>12</sup>	1.119 <sup>15</sup>	1.5730 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace, chl; s bz
6780	4-Methoxybenzamide		C <sub>9</sub> H <sub>9</sub> NO <sub>2</sub>	3424-93-9	151.163	nd or tab (w)	166.5	295			vs H <sub>2</sub> O, EtOH
6781	4-Methoxybenzeneacetaldehyde		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	5703-26-4	150.174			255.5	1.096 <sup>20</sup>	1.5359 <sup>20</sup>	
6782	2-Methoxybenzeneacetic acid		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	93-25-4	166.173	nd (w)	124	100 <sup>2</sup>			s H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
6783	4-Methoxybenzeneacetic acid		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	104-01-8	166.173	pl (w)	87	138 <sup>2</sup>			i H <sub>2</sub> O; vs EtOH; s eth, bz; sl chl, lig
6784	4-Methoxybenzeneacetonitrile		C <sub>9</sub> H <sub>9</sub> NO	104-47-2	147.173			286.5	1.0845 <sup>20</sup>	1.5309 <sup>20</sup>	s EtOH, eth, chl
6785	4-Methoxy-1,2-benzenediamine	4-Methoxy- <i>o</i> -phenylenediamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> O	102-51-2	138.166	grn pl	51	200 <sup>21</sup> , 168 <sup>11</sup>			vs eth
6786	4-Methoxy-1,3-benzenediamine	4-Methoxy- <i>m</i> -phenylenediamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> O	615-05-4	138.166	nd (eth)	67.5				s EtOH, eth; sl DMSO
6787	2-Methoxy-1,4-benzenediamine	2,5-Diaminoanisole	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> O	5307-02-8	138.166	cry	107				
6788	3-Methoxy-1,2-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>3</sub>	934-00-9	140.137	nd	42.8	163 <sup>48</sup> , 129 <sup>10</sup>			s chl
6789	4-Methoxybenzenemethanamine		C <sub>9</sub> H <sub>13</sub> NO	55-81-2	151.205			139 <sup>20</sup>		1.5379 <sup>20</sup>	
6790	4-Methoxybenzenethanol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	702-23-8	152.190		29	335			
6791	2-Methoxybenzenemethanamine		C <sub>8</sub> H <sub>11</sub> NO	6850-57-3	137.179			228	1.051 <sup>25</sup>	1.5475 <sup>20</sup>	
6792	4-Methoxybenzenemethanamine		C <sub>8</sub> H <sub>11</sub> NO	2393-23-9	137.179			236.5	1.050 <sup>15</sup>	1.5462 <sup>20</sup>	sl H <sub>2</sub> O, EtOH, eth
6793	2-Methoxybenzenemethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	612-16-8	138.164			249	1.0386 <sup>25</sup>	1.5455 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth
6794	3-Methoxybenzenemethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	6971-51-3	138.164		30	252	1.112 <sup>25</sup>	1.5440 <sup>20</sup>	
6795	4-Methoxybenzenemethanol	Anise alcohol	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	105-13-5	138.164	nd	25	259.1	1.109 <sup>26</sup>	1.5420 <sup>25</sup>	s H <sub>2</sub> O, ctc; vs EtOH, eth
6796	4-Methoxybenzenesulfonyl chloride		C <sub>7</sub> H <sub>7</sub> ClO <sub>3</sub> S	98-68-0	206.647	nd or pr (bz)	42.5	103 <sup>0.25</sup>			s EtOH, eth, bz
6797	3-Methoxybenzenethiol		C <sub>7</sub> H <sub>8</sub> OS	15570-12-4	140.203			224.5; 114 <sup>20</sup>		1.5874 <sup>20</sup>	s chl
6798	4-Methoxybenzenethiol		C <sub>7</sub> H <sub>8</sub> OS	696-63-9	140.203			228	1.1313 <sup>25</sup>	1.5801 <sup>25</sup>	s EtOH, eth, bz; sl chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6799	2-Methoxybenzoic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	579-75-9	152.148	pl (w)	101	200			sl H <sub>2</sub> O; vs EtOH, eth, chl; s bz, ctc
6800	3-Methoxybenzoic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	586-38-9	152.148	nd (w)	107	170 <sup>10</sup>			sl H <sub>2</sub> O, ctc; s EtOH, eth, bz; vs chl
6801	4-Methoxybenzoic acid	<i>p</i> -Anisic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	100-09-4	152.148		185	276.5			i H <sub>2</sub> O; vs EtOH, MeOH, eth; s chl
6802	2-Methoxybenzotrile		C <sub>8</sub> H <sub>7</sub> NO	6609-56-9	133.148		24.5	255.5	1.1063 <sup>20</sup>		s EtOH; vs eth
6803	3-Methoxybenzotrile		C <sub>8</sub> H <sub>7</sub> NO	1527-89-5	133.148			140 <sup>34</sup> , 111 <sup>13</sup>	1.089 <sup>25</sup>	1.5402 <sup>20</sup>	
6804	4-Methoxybenzotrile		C <sub>8</sub> H <sub>7</sub> NO	874-90-8	133.148	nd (w) lf (al)	61.5	256.5			i H <sub>2</sub> O; vs EtOH, eth; s bz
6805	7-Methoxy-2 <i>H</i> -1-benzopyran-2-one		C <sub>10</sub> H <sub>8</sub> O <sub>3</sub>	531-59-9	176.169	lf (w, MeOH)	118.3				sl H <sub>2</sub> O; s EtOH, eth, con sulf, alk
6806	6-Methoxy-2-benzothiazolamine		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> OS	1747-60-0	180.227		166				
6807	2-(4-Methoxybenzoyl)benzoic acid	<i>o</i> -( <i>p</i> -Anisoyl)benzoic acid	C <sub>15</sub> H <sub>12</sub> O <sub>4</sub>	1151-15-1	256.254	lf (w), cry (al, to)	146				vs eth, EtOH, tol
6808	2-Methoxybenzoyl chloride		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	21615-34-9	170.594			254			
6809	4-Methoxybenzoyl chloride	<i>p</i> -Anisoyl chloride	C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	100-07-2	170.594	nd	24.5	262.5	1.261 <sup>20</sup>	1.580 <sup>20</sup>	s eth, ace; vs bz; sl ctc
6810	4-Methoxybenzyl acetate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	104-21-2	180.200		84	270; 150 <sup>23</sup>	1.105 <sup>25</sup>		s ctc
6811	2-Methoxy-1,1'-biphenyl		C <sub>13</sub> H <sub>12</sub> O	86-26-0	184.233	pr (peth)	29	274	1.0233 <sup>99</sup>	1.5641 <sup>99</sup>	i H <sub>2</sub> O; s EtOH, peth; sl ctc
6812	4-Methoxy-1,1'-biphenyl		C <sub>13</sub> H <sub>12</sub> O	613-37-6	184.233	pl (al)	90	157 <sup>10</sup>	1.0278 <sup>100</sup>	1.5744 <sup>100</sup>	i H <sub>2</sub> O; s EtOH, eth
6813	1-Methoxy-1,3-butadiene		C <sub>6</sub> H <sub>8</sub> O	3036-66-6	84.117			91.5	0.8296 <sup>20</sup>	1.4594 <sup>20</sup>	s H <sub>2</sub> O, EtOH
6814	2-Methoxy-1,3-butadiene		C <sub>6</sub> H <sub>8</sub> O	3588-30-5	84.117			75	0.8272 <sup>20</sup>	1.4442 <sup>20</sup>	vs ace, bz, eth, EtOH
6815	3-Methoxy-1-butanol		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	2517-43-3	104.148			157	0.923 <sup>23</sup>	1.4148 <sup>25</sup>	vs EtOH, ace; s eth; sl chl
6816	1-Methoxy-1-buten-3-yne		C <sub>6</sub> H <sub>8</sub> O	2798-73-4	82.101			dec 123; 39 <sup>23</sup>	0.906 <sup>20</sup>	1.4818 <sup>20</sup>	i H <sub>2</sub> O; s chl
6817	Methoxychlor		C <sub>16</sub> H <sub>15</sub> Cl <sub>3</sub> O <sub>2</sub>	72-43-5	345.648	cry (dil al)	87		1.41 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, ctc; vs eth, bz
6818	Methoxycyclohexane		C <sub>7</sub> H <sub>14</sub> O	931-56-6	114.185	liq	-74.4	133	0.8756 <sup>20</sup>	1.4355 <sup>20</sup>	vs eth, EtOH
6819	1-Methoxy-2,4-dinitrobenzene		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>5</sub>	119-27-7	198.133	nd (al or w)	94.5	206 <sup>12</sup>	1.3364 <sup>131</sup>	1.546 <sup>15</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz; vs py
6820	1-Methoxy-3,5-dinitrobenzene	3,5-Dinitroanisole	C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>5</sub>	5327-44-6	198.133	nd (al)	105.3		1.558 <sup>12</sup>		vs ace, bz, MeOH
6821	2-Methoxy-1,2-diphenylethanone		C <sub>15</sub> H <sub>14</sub> O <sub>2</sub>	3524-62-7	226.271	nd (lig)	49.5	188 <sup>15</sup>	1.1278 <sup>14</sup>		vs bz, eth, EtOH
6822	2-Methoxyethanol	Ethylene glycol monomethyl ether	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	109-86-4	76.095	liq	-85.1	124.1	0.9647 <sup>20</sup>	1.4024 <sup>20</sup>	msc H <sub>2</sub> O, eth, bz; vs EtOH; s ace; sl chl
6823	(2-Methoxyethoxy)ethene		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	1663-35-0	102.132			107			
6824	2-[2-(2-Methoxyethoxy)ethoxy] ethanol	Triethyleneglycol monomethyl ether	C <sub>7</sub> H <sub>16</sub> O <sub>4</sub>	112-35-6	164.200			246			
6825	2-Methoxyethyl acetate	Ethylene glycol monomethyl ether acetate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	110-49-6	118.131	liq	-70	143	1.0074 <sup>19</sup>	1.4002 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
6826	2-Methoxyethyl acrylate	2-Methoxyethyl 2-propenoate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	3121-61-7	130.141			67 <sup>16</sup> , 56 <sup>12</sup>	1.012 <sup>20</sup>		
6827	2-Methoxyethylamine	1-Amino-2-methoxyethane	C <sub>3</sub> H <sub>8</sub> NO	109-85-3	75.109			95			vs H <sub>2</sub> O, EtOH; sl chl
6828	Methoxyethylmercuric acetate		C <sub>6</sub> H <sub>10</sub> HgO <sub>3</sub>	151-38-2	318.72	nd (peth)	42				
6829	2-(2-Methoxyethyl)pyridine	Metyridine	C <sub>8</sub> H <sub>11</sub> NO	114-91-0	137.179			203; 96 <sup>17</sup>	0.988 <sup>20</sup>	1.4975 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
6830	2-Methoxyfuran		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	25414-22-6	98.101			110.5	1.0646 <sup>25</sup>	1.4468 <sup>25</sup>	
6831	4-Methoxyfuro[2,3- <i>b</i> ]quinoline	Dictamnine	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	484-29-7	199.205	pr (al)	133.5				sl H <sub>2</sub> O; vs EtOH; s eth, chl, AcOEt
6832	12-Methoxyibogamine	Ibogaine	C <sub>20</sub> H <sub>26</sub> N <sub>2</sub> O	83-74-9	310.432		148				s chl
6833	5-Methoxy-1 <i>H</i> -indole-3-ethanamine	5-Methoxytryptamine	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O	608-07-1	190.241	cry (al)	121.5				
6834	<i>N</i> -[2-(5-Methoxy-1 <i>H</i> -indol-3-yl)ethyl]acetamide	Melatonin	C <sub>13</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	73-31-4	232.278	pa ye lf (bz)	117				
6835	3-Methoxyisopropylamine	1-Methoxy-2-propanamine	C <sub>4</sub> H <sub>11</sub> NO	37143-54-7	89.136			97		1.4031 <sup>25</sup>	
6836	4-Methoxy- <i>N</i> -(4-methoxyphenyl)aniline	4,4'-Dimethoxydiphenylamine	C <sub>14</sub> H <sub>15</sub> NO <sub>2</sub>	101-70-2	229.275	lf (EtOH)	103				
6837	<i>N</i> -Methoxymethylamine	<i>N</i> -Methoxymethanamine	C <sub>2</sub> H <sub>7</sub> NO	1117-97-1	61.083	liq		42.4			
6838	2-Methoxy-5-methylaniline	5-Methyl- <i>o</i> -anisidine	C <sub>8</sub> H <sub>11</sub> NO	120-71-8	137.179		53	235			sl H <sub>2</sub> O, chl; s EtOH, eth, bz, peth
6839	4-Methoxy-2-methylaniline		C <sub>8</sub> H <sub>11</sub> NO	102-50-1	137.179	cry (lig)	29.5	248.5	1.065 <sup>25</sup>	1.5647 <sup>20</sup>	vs EtOH
6840	4-Methoxy- $\alpha$ -methylbenzenemethanol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	3319-15-1	152.190			dec 310; 140 <sup>17</sup>	1.0794 <sup>20</sup>	1.5310 <sup>25</sup>	s ctc

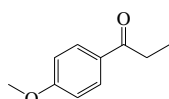


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6841	2-Methoxy-2-methylbutane	Methyl <i>tert</i> -pentyl ether	C <sub>8</sub> H <sub>14</sub> O	994-05-8	102.174			86.1	0.7660 <sup>25</sup>	1.3862 <sup>25</sup>	sl H <sub>2</sub> O; vs eth, EtOH
6842	2-(Methoxymethyl)furan		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	13679-46-4	112.127			132	1.0163 <sup>20</sup>	1.4570 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth
6843	2-(Methoxymethyl)-5-nitrofuran		C <sub>6</sub> H <sub>7</sub> NO <sub>4</sub>	586-84-5	157.125			104 <sup>3</sup>	1.281 <sup>20</sup>	1.5325 <sup>20</sup>	vs EtOH
6844	(Methoxymethyl)oxirane		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	930-37-0	88.106			113	0.9890 <sup>20</sup>	1.4320 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
6845	3-Methoxy-5-methyl-4-oxo-2,5-hexadienoic acid	Penicillic acid	C <sub>8</sub> H <sub>10</sub> O <sub>4</sub>	90-65-3	170.163	orth or hex pl (+ 1w)	83				s H <sub>2</sub> O, ace; vs EtOH, eth, bz; sl peth
6846	4-Methoxy-4-methyl-2-pentanone	Pentoxone	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	107-70-0	130.185			160	0.8980 <sup>25</sup>	1.418 <sup>20</sup>	
6847	2-Methoxy-4-methylphenol	Creosol	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	93-51-6	138.164	pr	5.5	221	1.098 <sup>20</sup>	1.5353 <sup>25</sup>	vs eth, EtOH
6848	1-Methoxynaphthalene		C <sub>11</sub> H <sub>10</sub> O	2216-69-5	158.196		<-10	269	1.0963 <sup>14</sup>	1.6940 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; vs CS <sub>2</sub>
6849	2-Methoxynaphthalene		C <sub>11</sub> H <sub>10</sub> O	93-04-9	158.196	lf (eth), pl (peth)	73.5	274			vs bz, eth, chl
6850	2-Methoxy-1,4-naphthalenedione		C <sub>11</sub> H <sub>6</sub> O <sub>3</sub>	2348-82-5	188.180		183.0				
6851	4-Methoxy-1-naphthol		C <sub>11</sub> H <sub>10</sub> O <sub>2</sub>	84-85-5	174.196		129.8				
6852	2-Methoxy-4-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	97-52-9	168.150		141.0				s DMSO
6853	2-Methoxy-5-nitroaniline	5-Nitro- <i>o</i> -anisidine	C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	99-59-2	168.150		118		1.2068 <sup>15</sup>		s H <sub>2</sub> O, eth; vs EtOH, ace, bz; sl lig
6854	4-Methoxy-2-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	96-96-8	168.150	dk red pr (w or al)	129				vs H <sub>2</sub> O, ace, eth, EtOH
6855	2-Methoxyphenol	Guaiacol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	90-05-1	124.138	hex pr	32	205	1.1287 <sup>21</sup>	1.5429 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc, chl
6856	3-Methoxyphenol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	150-19-6	124.138		<-17	114 <sup>5</sup>	1.131 <sup>25</sup>	1.5510 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH, eth
6857	4-Methoxyphenol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	150-76-5	124.138	pl	57	243			s H <sub>2</sub> O, bz, ctc; vs EtOH, eth
6858	2-Methoxyphenol benzoate	Guaiacol benzoate	C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	531-37-3	228.243		57.5				vs eth, chl
6859	2-Methoxyphenol carbonate (2:1)	Guaiacol carbonate	C <sub>15</sub> H <sub>14</sub> O <sub>3</sub>	553-17-3	274.269	cry (al)	89				i H <sub>2</sub> O; sl EtOH; s eth; vs chl
6860	2-Methoxyphenol phosphate (3:1)	Guaiacol phosphate	C <sub>21</sub> H <sub>21</sub> O <sub>7</sub> P	563-03-1	416.362		91	277 <sup>3</sup>			vs ace, tol, chl
6861	5-[(2-Methoxyphenoxy)methyl]-2-oxazolidinone	Mephenoxalone	C <sub>11</sub> H <sub>13</sub> NO <sub>4</sub>	70-07-5	223.226		144				
6862	3-(2-Methoxyphenoxy)-1,2-propanediol	Guafenesin	C <sub>10</sub> H <sub>14</sub> O <sub>4</sub>	93-14-1	198.216	orth pr (eth, eth-peth)	78.5	215 <sup>19</sup> , 127 <sup>0,2</sup>			s H <sub>2</sub> O, bz, chl; vs EtOH; i peth
6863	<i>N</i> -(2-Methoxyphenyl)acetamide	<i>o</i> -Acetanisidine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	93-26-5	165.189	nd (w)	87.5	304			vs H <sub>2</sub> O, EtOH; s eth, ace, HOAc
6864	<i>N</i> -(3-Methoxyphenyl)acetamide	<i>m</i> -Acetanisidine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	588-16-9	165.189	nd or pl (w)	81				vs H <sub>2</sub> O, EtOH; s eth, ace
6865	<i>N</i> -(4-Methoxyphenyl)acetamide	<i>p</i> -Acetanisidine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	51-66-1	165.189	pl (w)	131				vs ace, EtOH, chl
6866	2-Methoxyphenyl acetate	2-Acetoxyanisole	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	613-70-7	166.173		31.5	123 <sup>13</sup>	1.1285 <sup>25</sup>	1.5101 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
6867	4-(4-Methoxyphenyl)-3-buten-2-one		C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	943-88-4	176.212	lf (al, eth, HOAc)	74.0	187.5 <sup>19</sup>			i H <sub>2</sub> O; vs EtOH, eth; s bz, HOAc, sulf
6868	2-Methoxy-1-phenylethanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	4079-52-1	150.174	ye liq	8	245; 125 <sup>19</sup>	1.0897 <sup>20</sup>	1.5393 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace
6869	1-(3-Methoxyphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	586-37-8	150.174		95.5	240	1.0343 <sup>19</sup>	1.5410 <sup>20</sup>	s H <sub>2</sub> O, EtOH, ace, ctc
6870	2-(4-Methoxyphenyl)-1 <i>H</i> -indene-1,3(2 <i>H</i> )-dione	Anisindione	C <sub>16</sub> H <sub>12</sub> O <sub>3</sub>	117-37-3	252.264	pa ye cry (HOAc, al)	156.5				
6871	4-Methoxyphenyl isocyanate		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	5416-93-3	149.148			110 <sup>10</sup>			
6872	2-Methoxyphenyl isothiocyanate	1-Isouthiocyanato-2-methoxybenzene	C <sub>8</sub> H <sub>7</sub> NOS	3288-04-8	165.213			264; 131 <sup>11</sup>	1.1878 <sup>20</sup>	1.6458 <sup>20</sup>	
6873	<i>N</i> -(4-Methoxyphenyl)-3-oxobutanamide		C <sub>11</sub> H <sub>13</sub> NO <sub>3</sub>	5437-98-9	207.226		117.3				s EtOH, chl; sl eth
6874	2-Methoxyphenyl pentanoate	Guaiacol valerate	C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	531-39-5	208.253			265	1.05 <sup>25</sup>		vs bz, eth, EtOH
6875	(4-Methoxyphenyl)phenyldiazene		C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	2396-60-3	212.246	oran-red pl, lf (al, peth)	56	340	1.12 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, ace
6876	<i>N</i> -( <i>p</i> -Methoxyphenyl)- <i>p</i> -phenylenediamine	<i>N</i> -(4-Methoxyphenyl)-1,4-benzenediamine	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O	101-64-4	214.262	nd	102	238 <sup>12</sup>			sl H <sub>2</sub> O, peth; vs bz, eth, EtOH
6877	<i>N</i> -(4-Methoxyphenyl)- <i>p</i> -phenylenediamine hydrochloride		C <sub>13</sub> H <sub>15</sub> ClN <sub>2</sub> O	3566-44-7	250.723	cry	245 dec				
6878	(4-Methoxyphenyl)phenylmethanone		C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	611-94-9	212.244	pr (eth)	61.5	355; 168 <sup>12</sup>			i H <sub>2</sub> O; vs EtOH, eth; s ace, bz, HOAc
6879	3-(4-Methoxyphenyl)-1-phenyl-2-propen-1-one		C <sub>16</sub> H <sub>14</sub> O <sub>2</sub>	959-33-1	238.281	ye nd (al)	79	187 <sup>19</sup>			i H <sub>2</sub> O; vs EtOH; s eth, ctc, chl, HOAc

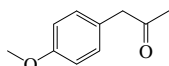


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6880	1-(4-Methoxyphenyl)-1-propanone	Ethyl 4-methoxyphenyl ketone	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	121-97-1	164.201		25.5	266	1.0798 <sup>16</sup>		s ctc
6881	1-(4-Methoxyphenyl)-2-propanone	Anisyl methyl ketone	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	122-84-9	164.201		<-15	268	1.0694 <sup>17</sup>	1.5253 <sup>20</sup>	vs eth, EtOH
6882	<i>trans</i> -3-(4-Methoxyphenyl)-2-propenoic acid	<i>trans</i> -4-Methoxycinnamic acid	C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	943-89-5	178.184		173.5				sl H <sub>2</sub> O, EtOH, bz, DMSO; s ctc, HOAc
6883	<i>trans</i> -1-Methoxy-4-(2-phenylvinyl)benzene		C <sub>15</sub> H <sub>14</sub> O	1694-19-5	210.271		136.5	142.5 <sup>15</sup>			i H <sub>2</sub> O; vs EtOH, eth, ace, bz; s peth
6884	1-Methoxy-1,2-propadiene	Methoxyallene	C <sub>4</sub> H <sub>6</sub> O	13169-00-1	70.090	oil		51.5			
6885	3-Methoxy-1-propanamine		C <sub>4</sub> H <sub>11</sub> NO	5332-73-0	89.136			117.5	0.8727 <sup>20</sup>	1.4391 <sup>20</sup>	s H <sub>2</sub> O, ace, bz, ctc, chl, MeOH
6886	3-Methoxy-1,2-propanediol	Glycerol 3-methyl ether	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	623-39-2	106.120	hyg liq		220	1.114 <sup>20</sup>	1.442 <sup>25</sup>	vs H <sub>2</sub> O, EtOH, ace; s eth
6887	3-Methoxypropanenitrile		C <sub>4</sub> H <sub>7</sub> NO	110-67-8	85.105			163	0.9379 <sup>20</sup>	1.4043 <sup>20</sup>	s EtOH, eth, chl
6888	2-Methoxy-1-propanol		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1589-47-5	90.121			130	0.938 <sup>20</sup>	1.4070 <sup>20</sup>	
6889	1-Methoxy-2-propanone	Methoxyacetone	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	5878-19-3	88.106			116	0.957 <sup>25</sup>	1.3970 <sup>20</sup>	
6890	2-Methoxy-1-propene		C <sub>4</sub> H <sub>8</sub> O	116-11-0	72.106			38	0.7372 <sup>20</sup>		
6891	3-Methoxy-1-propene		C <sub>4</sub> H <sub>8</sub> O	627-40-7	72.106			44	0.77 <sup>11</sup>	1.3778 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace
6892	<i>trans</i> -1-Methoxy-4-(1-propenyl)benzene	Anethole	C <sub>10</sub> H <sub>12</sub> O	4180-23-8	148.201	col oily liq	22.5	235; 81 <sup>23</sup>	0.9882 <sup>20</sup>	1.5615 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace; vs bz
6893	1-Methoxy-4-(2-propenyl)benzene	Estragole	C <sub>10</sub> H <sub>12</sub> O	140-67-0	148.201			215.5	0.965 <sup>25</sup>	1.5195 <sup>20</sup>	vs EtOH, chl
6894	<i>cis</i> -2-Methoxy-4-(1-propenyl)phenol		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	5912-86-7	164.201			134 <sup>13</sup>	1.0837 <sup>20</sup>	1.5726 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
6895	<i>trans</i> -2-Methoxy-4-(1-propenyl)phenol		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	5932-68-3	164.201		33.5	141 <sup>13</sup>	1.0852 <sup>20</sup>	1.5784 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
6896	1-Methoxy-4-propylbenzene		C <sub>10</sub> H <sub>14</sub> O	104-45-0	150.217			211.5	0.9472 <sup>20</sup>	1.5045 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace, bz, chl; vs eth
6897	2-Methoxy-4-propylphenol		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	2785-87-7	166.217			121 <sup>10</sup>			
6898	3-Methoxy-1-propyne		C <sub>4</sub> H <sub>6</sub> O	627-41-8	70.090			63	0.83 <sup>12</sup>	1.5035 <sup>20</sup>	vs eth, EtOH
6899	5-Methoxypsoralen	Bergaptene	C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	484-20-8	216.190	nd (EtOH)	188				i H <sub>2</sub> O; sl EtOH, bz, chl
6900	6-Methoxy-3-pyridinamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	6628-77-9	124.140		30	125 <sup>10</sup> , 87 <sup>1</sup>		1.5745 <sup>20</sup>	
6901	2-Methoxypyridine		C <sub>6</sub> H <sub>8</sub> NO	1628-89-3	109.126			142.5	1.0457 <sup>20</sup>	1.5042 <sup>20</sup>	
6902	3-Methoxypyridine		C <sub>6</sub> H <sub>8</sub> NO	7295-76-3	109.126	liq		178.5; 65 <sup>15</sup>	1.083	1.5180 <sup>20</sup>	
6903	4-Methoxypyridine		C <sub>6</sub> H <sub>8</sub> NO	620-08-6	109.126			192; 95 <sup>45</sup>			msc H <sub>2</sub> O
6904	6-Methoxyquinoline		C <sub>10</sub> H <sub>8</sub> NO	5263-87-6	159.184	hyg lf	26.5	306; 153 <sup>12</sup>	1.152 <sup>20</sup>		s EtOH, eth, chl, dil HCl
6905	6-Methoxy-4-quinolinecarboxylic acid	Quinic acid	C <sub>11</sub> H <sub>9</sub> NO <sub>3</sub>	86-68-0	203.194	pa ye pr (dil al)	285 dec	sub			sl H <sub>2</sub> O, eth, bz, tfa; i chl; s EtOH
6906	2-Methoxy-1,3,5-trinitrobenzene	Methyl picrate	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>7</sub>	606-35-9	243.131	nd (dil MeOH)	69		1.4947 <sup>80</sup>		i H <sub>2</sub> O; vs EtOH, chl, bz; s eth
6907	(2-Methoxyvinyl)benzene		C <sub>9</sub> H <sub>10</sub> O	4747-15-3	134.174			211.5	0.9894 <sup>23</sup>	1.5620 <sup>24</sup>	
6908	Methscopolamine bromide	Scopolamine methobromide	C <sub>18</sub> H <sub>24</sub> BrNO <sub>4</sub>	155-41-9	398.293	cry (EtOH)	215 dec				s H <sub>2</sub> O; sl EtOH
6909	Methyl abietate		C <sub>21</sub> H <sub>32</sub> O <sub>2</sub>	127-25-3	316.478	pa ye lf (liq)		225 <sup>16</sup>	1.049 <sup>20</sup>	1.5344	i H <sub>2</sub> O; s EtOH, HOAc
6910	<i>N</i> -Methylacetamide		C <sub>3</sub> H <sub>7</sub> NO	79-16-3	73.094		28	205	0.9371 <sup>25</sup>	1.4301 <sup>20</sup>	vs ace, bz, eth, EtOH
6911	4-Methylacetanilide		C <sub>9</sub> H <sub>11</sub> NO	103-89-9	149.189	mcl cry or nd (dil al)	152	307	1.2120 <sup>15</sup>		vs eth, EtOH
6912	Methyl acetate		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	79-20-9	74.079	liq	-98.25	56.87	0.9342 <sup>20</sup>	1.3614 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
6913	Methyl acetoacetate		C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	105-45-3	116.116		27.5	171.7	1.0762 <sup>20</sup>	1.4184 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s ctc
6914	4-Methylacetophenone		C <sub>9</sub> H <sub>10</sub> O	122-00-9	134.174	nd	28	226; 93.5 <sup>7</sup>	1.0051 <sup>20</sup>	1.5335 <sup>20</sup>	vs bz, eth, EtOH, chl
6915	Methyl 2-(acetyloxy)benzoate	Methyl <i>o</i> -acetylsalicylate	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	580-02-9	194.184	pl (peth)	51.5	135 <sup>9</sup>			vs eth, EtOH, chl
6916	Methyl acrylate	Methyl propenoate	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	96-33-3	86.090	liq	<-75	80.7	0.9535 <sup>20</sup>	1.4040 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
6917	2-Methylacrylonitrile	2-Methylpropenenitrile	C <sub>4</sub> H <sub>5</sub> N	126-98-7	67.090	liq	-35.8	90.3	0.8001 <sup>20</sup>	1.4003 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH, eth, ace, tol
6918	2-Methylalanine	$\alpha$ -Aminoisobutyric acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	62-57-7	103.120	mcl pr	335	sub 280			vs H <sub>2</sub> O; sl EtOH; i eth
6919	5-Methyl-3-allyl-2,4-oxazolinedione	Aloxidone	C <sub>7</sub> H <sub>9</sub> NO <sub>3</sub>	526-35-2	155.151			138 <sup>35</sup> , 86 <sup>0.5</sup>		1.4688 <sup>25</sup>	

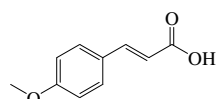
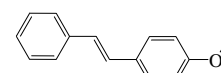
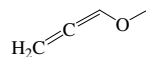




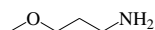
1-(4-Methoxyphenyl)-1-propanone



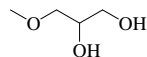
1-(4-Methoxyphenyl)-2-propanone

*trans*-3-(4-Methoxyphenyl)-2-propenoic acid*trans*-1-Methoxy-4-(2-phenylvinyl)benzene

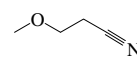
1-Methoxy-1,2-propadiene



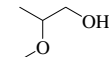
3-Methoxy-1-propanamine



3-Methoxy-1,2-propanediol



3-Methoxypropanenitrile



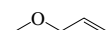
2-Methoxy-1-propanol



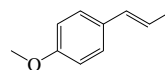
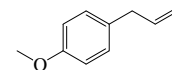
1-Methoxy-2-propanone



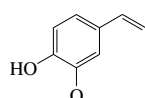
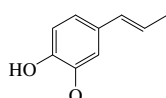
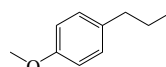
2-Methoxy-1-propene



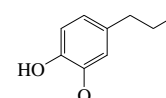
3-Methoxy-1-propene

*trans*-1-Methoxy-4-(1-propenyl)benzene

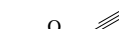
1-Methoxy-4-(2-propenyl)benzene

*cis*-2-Methoxy-4-(1-propenyl)phenol*trans*-2-Methoxy-4-(1-propenyl)phenol

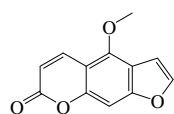
1-Methoxy-4-propylbenzene



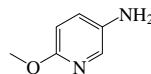
2-Methoxy-4-propylphenol



3-Methoxy-1-propyne



5-Methoxypsoralen



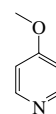
6-Methoxy-3-pyridinamine



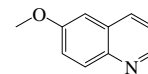
2-Methoxypyridine



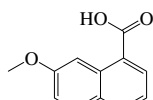
3-Methoxypyridine



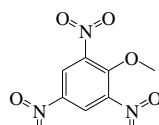
4-Methoxypyridine



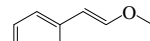
6-Methoxyquinoline



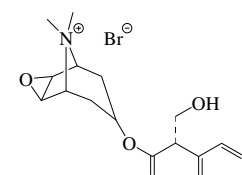
6-Methoxy-4-quinolinecarboxylic acid



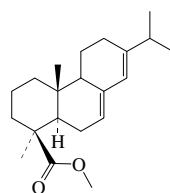
2-Methoxy-1,3,5-trinitrobenzene



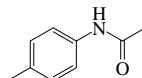
(2-Methoxyvinyl)benzene



Methscopolamine bromide



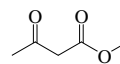
Methyl abietate

*N*-Methylacetamide

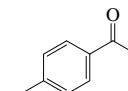
4-Methylacetanilide



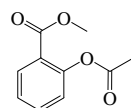
Methyl acetate



Methyl acetoacetate



4-Methylacetophenone



Methyl 2-(acetyloxy)benzoate



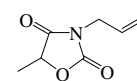
Methyl acrylate



2-Methylacrylonitrile

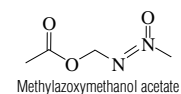
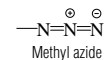
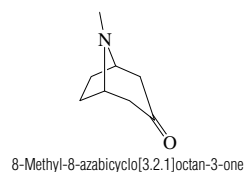
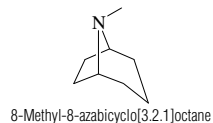
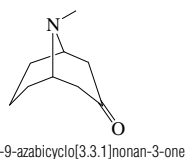
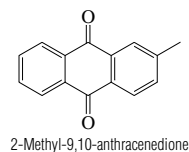
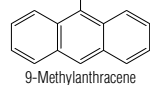
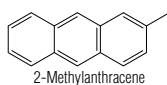
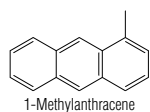
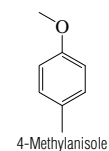
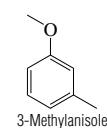
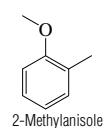
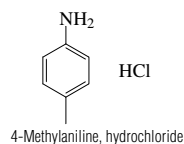
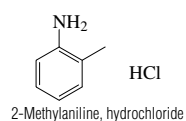
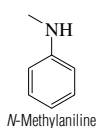
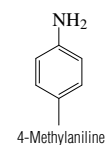
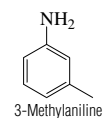
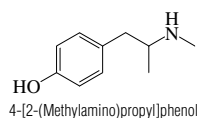
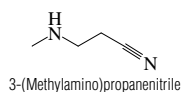
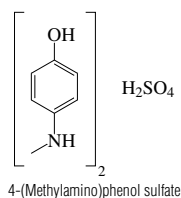
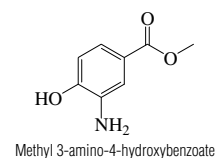
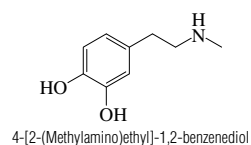
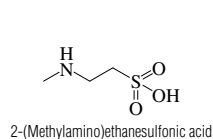
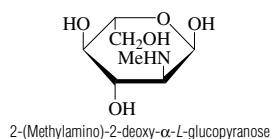
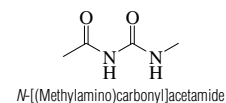
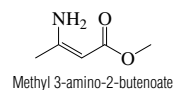
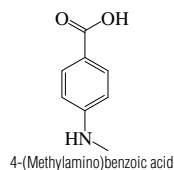
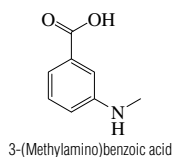
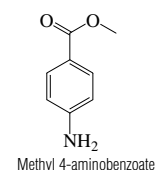
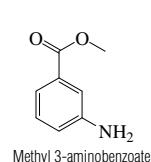
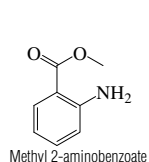
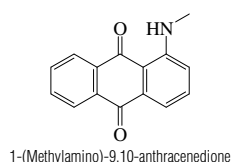
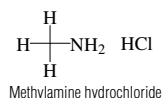
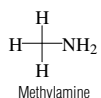


2-Methylalanine

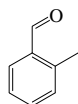


5-Methyl-3-allyl-2,4-oxazolindione

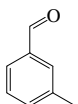
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6920	Methylamine	Methanamine	CH <sub>5</sub> N	74-89-5	31.058	col gas	-93.5	-6.32	0.656 <sup>25</sup> (p>1 atm)		vs H <sub>2</sub> O; s EtOH, ace, bz, msc eth
6921	Methylamine hydrochloride	Methanamine hydrochloride	CH <sub>5</sub> ClN	593-51-1	67.519	hyg tetr tab (al)	227.5	227 <sup>15</sup>			s H <sub>2</sub> O, EtOH; i chl, ace
6922	1-(Methylamino)-9,10-anthracenedione		C <sub>15</sub> H <sub>11</sub> NO <sub>2</sub>	82-38-2	237.254	ye-red nd	171.0				s EtOH, bz, chl, HOAc
6923	Methyl 2-aminobenzoate	Methyl anthranilate	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	134-20-3	151.163		24.5	256	1.1682 <sup>10</sup>	1.5810	sl H <sub>2</sub> O; vs EtOH, eth
6924	Methyl 3-aminobenzoate		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	4518-10-9	151.163		39	152 <sup>11</sup>	1.232 <sup>20</sup>		vs EtOH, eth, bz, chl; s lig; sl peth
6925	Methyl 4-aminobenzoate		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	619-45-4	151.163	lf or nd (aq MeOH)	113.0				s chl
6926	2-(Methylamino)benzoic acid		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	119-68-6	151.163	pl (al or lig)	180.5	80 <sup>01</sup>			sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
6927	3-(Methylamino)benzoic acid		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	51524-84-6	151.163	pl (peth)	127				vs ace, bz, EtOH, chl
6928	4-(Methylamino)benzoic acid		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	10541-83-0	151.163	nd (bz, w, dil al)	168				s H <sub>2</sub> O, bz, AcOEt; vs EtOH, eth; sl tfa
6929	Methyl 3-amino-2-butenoate		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	14205-39-1	115.131						s chl
6930	<i>N</i> -[(Methylamino)carbonyl]acetamide		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	623-59-6	116.119	tcl (w, al), pr (w)	180.5	dec			s H <sub>2</sub> O, chl; sl EtOH, eth
6931	2-(Methylamino)-2-deoxy- $\alpha$ - <i>L</i> -glucopyranose	<i>N</i> -Methyl- $\alpha$ - <i>L</i> -glucosamine	C <sub>7</sub> H <sub>15</sub> NO <sub>5</sub>	42852-95-9	193.198	glass					s MeOH
6932	2-(Methylamino)ethanesulfonic acid	<i>N</i> -Methyltaurine	C <sub>3</sub> H <sub>9</sub> NO <sub>3</sub> S	107-68-6	139.173		241.5				vs H <sub>2</sub> O; i EtOH, eth
6933	4-[2-(Methylamino)ethyl]-1,2-benzenediol	Deoxyepinephrine	C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	501-15-5	167.205		188.5				
6934	Methyl 3-amino-4-hydroxybenzoate	Orthocaine	C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	536-25-4	167.162	nd (bz or HOAc)	143				i H <sub>2</sub> O; vs EtOH; s eth, alk; sl bz
6935	4-(Methylamino)phenol sulfate		C <sub>14</sub> H <sub>20</sub> N <sub>2</sub> O <sub>6</sub> S	1936-57-8	344.383	cry	260	dec			sl EtOH; i eth
6936	3-(Methylamino)propanenitrile		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	693-05-0	84.120			102 <sup>49</sup> , 74 <sup>16</sup>	0.8992 <sup>20</sup>	1.4320 <sup>20</sup>	s H <sub>2</sub> O, ace, bz, chl, MeOH
6937	4-[2-(Methylamino)propyl]phenol	Pholedrine	C <sub>10</sub> H <sub>15</sub> NO	370-14-9	165.232	cry (MeOH)	161				vs eth, EtOH
6938	2-Methylaniline	<i>o</i> -Toluidine	C <sub>7</sub> H <sub>9</sub> N	95-53-4	107.153	liq	-14.41	200.3	0.9984 <sup>20</sup>	1.5725 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ctc
6939	3-Methylaniline	<i>m</i> -Toluidine	C <sub>7</sub> H <sub>9</sub> N	108-44-1	107.153	liq	-31.3	203.3	0.9889 <sup>20</sup>	1.5681 <sup>20</sup>	vs ace, bz, eth, EtOH
6940	4-Methylaniline	<i>p</i> -Toluidine	C <sub>7</sub> H <sub>9</sub> N	106-49-0	107.153	lf (w+1)	43.6	200.4	0.9619 <sup>20</sup>	1.5534 <sup>45</sup>	sl H <sub>2</sub> O; vs EtOH, py; s eth, ace, ctc
6941	<i>N</i> -Methylaniline		C <sub>7</sub> H <sub>9</sub> N	100-61-8	107.153	liq	-57	196.2	0.9891 <sup>20</sup>	1.5684 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, chl
6942	2-Methylaniline, hydrochloride	<i>o</i> -Toluidine, hydrochloride	C <sub>7</sub> H <sub>10</sub> ClN	636-21-5	143.614	mcl pr (w)	215				vs H <sub>2</sub> O, EtOH
6943	4-Methylaniline, hydrochloride		C <sub>7</sub> H <sub>10</sub> ClN	540-23-8	143.614	mcl nd (eth-HOAc)	244.5	258	1.1930 <sup>18</sup>		vs H <sub>2</sub> O, EtOH, HOAc
6944	2-Methylanisole		C <sub>8</sub> H <sub>10</sub> O	578-58-5	122.164	liq	-34.1	171	0.985 <sup>25</sup>	1.5161 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, ctc
6945	3-Methylanisole		C <sub>8</sub> H <sub>10</sub> O	100-84-5	122.164	liq	-47	175.5	0.969 <sup>25</sup>	1.5130 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; sl ctc
6946	4-Methylanisole		C <sub>8</sub> H <sub>10</sub> O	104-93-8	122.164	liq	-32	175.5	0.969 <sup>25</sup>	1.5112 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
6947	1-Methylanthracene		C <sub>15</sub> H <sub>12</sub>	610-48-0	192.256	bl nd (MeOH) lf (al)	85.5	199.5	1.0471 <sup>99</sup>	1.6802 <sup>99</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, sulf
6948	2-Methylanthracene		C <sub>15</sub> H <sub>12</sub>	613-12-7	192.256	grn bl flr lf (sub)	209	sub	1.80 <sup>0</sup>		i H <sub>2</sub> O, ace; sl EtOH, eth; s bz, CS <sub>2</sub>
6949	9-Methylanthracene		C <sub>15</sub> H <sub>12</sub>	779-02-2	192.256	ye nd (dil al) pr (bz, al)	81.5	196 <sup>12</sup>	1.065 <sup>99</sup>	1.6959 <sup>99</sup>	s EtOH, eth, ace, bz, chl
6950	2-Methyl-9,10-anthracenedione	2-Methylanthraquinone	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	84-54-8	222.239	ye nd (al, HOAc)	177	sub			vs bz, EtOH, HOAc
6951	Methylarsine		CH <sub>3</sub> As	593-52-2	91.973	col gas	-143	2			vs ace, eth, EtOH
6952	9-Methyl-9-azabicyclo[3.3.1]nonan-3-one	Pseudopelletierine	C <sub>9</sub> H <sub>15</sub> NO	552-70-5	153.221	orth pr (peth)	54	246	1.001 <sup>100</sup>	1.4760 <sup>100</sup>	vs H <sub>2</sub> O, eth, EtOH
6953	8-Methyl-8-azabicyclo[3.2.1]octane	Tropane	C <sub>8</sub> H <sub>15</sub> N	529-17-9	125.212			166	0.9251 <sup>15</sup>		
6954	8-Methyl-8-azabicyclo[3.2.1]octan-3-one		C <sub>8</sub> H <sub>13</sub> NO	532-24-1	139.195		43	227; 113 <sup>25</sup>	1.9872 <sup>100</sup>	1.4598 <sup>100</sup>	s EtOH, eth, ace, bz, peth; sl chl
6955	Methyl azide		CH <sub>3</sub> N <sub>3</sub>	624-90-8	57.055			exp 20.5	0.869 <sup>15</sup>		
6956	Methylazoxymethanol acetate		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	592-62-1	132.118			191; 49 <sup>945</sup>			



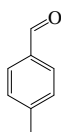
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6957	2-Methylbenzaldehyde	<i>o</i> -Tolualdehyde	C <sub>8</sub> H <sub>8</sub> O	529-20-4	120.149			200; 94 <sup>10</sup>	1.0328 <sup>20</sup>	1.5462 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz; vs ace
6958	3-Methylbenzaldehyde	<i>m</i> -Tolualdehyde	C <sub>8</sub> H <sub>8</sub> O	620-23-5	120.149			199	1.0189 <sup>21</sup>	1.5413 <sup>21</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace; s bz, chl
6959	4-Methylbenzaldehyde	<i>p</i> -Tolualdehyde	C <sub>8</sub> H <sub>8</sub> O	104-87-0	120.149			204; 106 <sup>10</sup>	1.0194 <sup>17</sup>	1.5454 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; vs chl
6960	2-Methylbenzamide	<i>o</i> -Toluamide	C <sub>8</sub> H <sub>9</sub> NO	527-85-5	135.163		147				sl H <sub>2</sub> O, eth, tfa, bz; vs EtOH
6961	4-Methylbenzamide	<i>p</i> -Toluamide	C <sub>8</sub> H <sub>9</sub> NO	619-55-6	135.163		162.5				sl H <sub>2</sub> O, bz, chl; vs EtOH, eth; s tfa
6962	<i>N</i> -Methylbenzamide		C <sub>8</sub> H <sub>9</sub> NO	613-93-4	135.163		82	291; 167 <sup>12</sup>			s EtOH, ace
6963	7-Methylbenz[a]anthracene		C <sub>19</sub> H <sub>14</sub>	2541-69-7	242.314	ye pl (al)	141				i H <sub>2</sub> O; s EtOH, eth, ace, ctc, HOAc, CS <sub>2</sub>
6964	8-Methylbenz[a]anthracene		C <sub>19</sub> H <sub>14</sub>	2381-31-9	242.314	pl (bz-al), nd (bz-lig)	156.5	272 <sup>3</sup> , 160 <sup>0,1</sup>	1.2310 <sup>0</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, xyl
6965	9-Methylbenz[a]anthracene		C <sub>19</sub> H <sub>14</sub>	2381-16-0	242.314	nd (al)	152.5				i H <sub>2</sub> O; s EtOH, eth, ctc, chl, CS <sub>2</sub> , xyl
6966	10-Methylbenz[a]anthracene		C <sub>19</sub> H <sub>14</sub>	2381-15-9	242.314		184				i H <sub>2</sub> O; s EtOH, HOAc
6967	12-Methylbenz[a]anthracene		C <sub>19</sub> H <sub>14</sub>	2422-79-9	242.314	pl (al)	150.5				i H <sub>2</sub> O; s EtOH, CS <sub>2</sub> , HOAc
6968	2-Methylbenzeneacetaldehyde		C <sub>9</sub> H <sub>10</sub> O	10166-08-2	134.174			221; 92 <sup>10</sup>	1.0241 <sup>10</sup>		vs eth, EtOH, chl
6969	4-Methylbenzeneacetaldehyde		C <sub>9</sub> H <sub>10</sub> O	104-09-6	134.174		40	221.5	1.0052 <sup>20</sup>	1.5255 <sup>20</sup>	vs eth, EtOH, chl
6970	$\alpha$ -Methylbenzeneacetaldehyde		C <sub>9</sub> H <sub>10</sub> O	93-53-8	134.174			203.5	1.0089 <sup>20</sup>	1.5176 <sup>20</sup>	vs EtOH
6971	2-Methylbenzeneacetic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	644-36-0	150.174	nd (w)	89				s H <sub>2</sub> O, chl
6972	3-Methylbenzeneacetic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	621-36-3	150.174	nd (w)	62	121 <sup>26</sup>			s H <sub>2</sub> O, chl
6973	4-Methylbenzeneacetic acid		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	622-47-9	150.174	nd or pl (al, w)	93	265			vs bz, eth, EtOH
6974	$\alpha$ -Methylbenzeneacetic acid, ( $\pm$ )		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	2328-24-7	150.174		<-20	263	1.1 <sup>0</sup>	1.5237 <sup>20</sup>	
6975	4-Methylbenzeneacetonitrile		C <sub>9</sub> H <sub>9</sub> N	2947-61-7	131.174		18	242.5	0.992 <sup>25</sup>	1.5190 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
6976	$\alpha$ -Methylbenzeneacetonitrile		C <sub>9</sub> H <sub>9</sub> N	1823-91-2	131.174			231	0.9854 <sup>20</sup>	1.5095 <sup>25</sup>	vs eth, EtOH
6977	3-Methyl-1,2-benzenediamine	Toluene-2,3-diamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	2687-25-4	122.167		63.5	255			vs ace, bz, EtOH
6978	4-Methyl-1,2-benzenediamine	Toluene-3,4-diamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	496-72-0	122.167	pl (liq)	89.5	265			vs H <sub>2</sub> O; s lig
6979	2-Methyl-1,3-benzenediamine	Toluene-2,6-diamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	823-40-5	122.167	pr (bz, w)	106				s H <sub>2</sub> O, EtOH, bz
6980	2-Methyl-1,4-benzenediamine	Toluene-2,5-diamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	95-70-5	122.167	pl (bz)	64	273.5			s H <sub>2</sub> O, EtOH, eth; sl bz, HOAc
6981	3-Methyl-1,2-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	488-17-5	124.138	lf (bz)	68	248			s H <sub>2</sub> O, EtOH, bz, chl
6982	4-Methyl-1,2-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	452-86-8	124.138	lf (bz-lig), pr (bz)	65	258	1.1287 <sup>74</sup>	1.5425 <sup>74</sup>	s H <sub>2</sub> O, EtOH, eth, ace, chl; sl lig
6983	2-Methyl-1,3-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	608-25-3	124.138	pr (bz)	120	265			vs H <sub>2</sub> O, bz, eth, EtOH
6984	4-Methyl-1,3-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	496-73-1	124.138	cry (bz-peth)	105	270			s H <sub>2</sub> O, EtOH, eth; sl bz, peth
6985	5-Methyl-1,3-benzenediol	Orcinol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	504-15-4	124.138	pr(w+1), lf(chl)	107	287	1.290 <sup>4</sup>		s H <sub>2</sub> O, EtOH, eth, bz; sl lig, peth
6986	2-Methyl-1,4-benzenediol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	95-71-6	124.138		125	283; 163 <sup>11</sup>			vs H <sub>2</sub> O, EtOH, eth; s ace; sl bz, lig
6987	4-Methyl-1,2-benzenedithiol	Toluene-3,4-dithiol	C <sub>7</sub> H <sub>8</sub> S <sub>2</sub>	496-74-2	156.269		29				s chl
6988	$\beta$ -Methylbenzeneethanamine		C <sub>8</sub> H <sub>13</sub> N	582-22-9	135.206			210	0.9433 <sup>4</sup>	1.5255 <sup>20</sup>	vs bz, eth, EtOH
6989	<i>N</i> -Methylbenzeneethanamine		C <sub>8</sub> H <sub>13</sub> N	589-08-2	135.206			206	0.93 <sup>25</sup>	1.5162 <sup>20</sup>	
6990	2-Methylbenzeneethanol		C <sub>8</sub> H <sub>12</sub> O	19819-98-8	136.190		1.0	243.5	1.016 <sup>25</sup>	1.5355 <sup>20</sup>	
6991	4-Methylbenzeneethanol		C <sub>8</sub> H <sub>12</sub> O	699-02-5	136.190			244.5; 94 <sup>6</sup>	1.0028 <sup>20</sup>	1.5267 <sup>20</sup>	
6992	2-Methylbenzenemethanamine		C <sub>8</sub> H <sub>11</sub> N	89-93-0	121.180	liq	-30	206; 81 <sup>15</sup>	0.9766 <sup>19</sup>	1.5436 <sup>19</sup>	
6993	3-Methylbenzenemethanamine		C <sub>8</sub> H <sub>11</sub> N	100-81-2	121.180			203.5	0.966 <sup>25</sup>	1.5360 <sup>20</sup>	
6994	4-Methylbenzenemethanamine		C <sub>8</sub> H <sub>11</sub> N	104-84-7	121.180		12.5	195	0.952 <sup>20</sup>	1.5340 <sup>20</sup>	
6995	<i>N</i> -Methylbenzenemethanamine		C <sub>8</sub> H <sub>11</sub> N	103-67-3	121.180			180.5	0.9442 <sup>18</sup>		vs H <sub>2</sub> O
6996	$\alpha$ -Methylbenzenemethanol	1-Phenylethanol	C <sub>8</sub> H <sub>10</sub> O	98-85-1	122.164		20	205	1.013 <sup>25</sup>	1.5265 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
6997	2-Methylbenzenemethanol	<i>o</i> -Tolyl alcohol	C <sub>8</sub> H <sub>10</sub> O	89-95-2	122.164	nd (peth-eth)	38	224; 118 <sup>20</sup>	1.023 <sup>40</sup>		vs eth, EtOH, chl



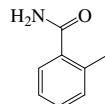
2-Methylbenzaldehyde



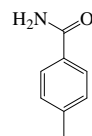
3-Methylbenzaldehyde



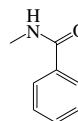
4-Methylbenzaldehyde



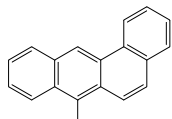
2-Methylbenzamide



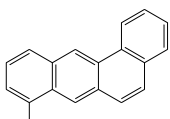
4-Methylbenzamide



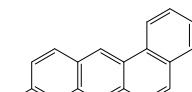
N-Methylbenzamide



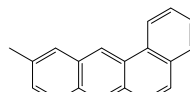
7-Methylbenz[a]anthracene



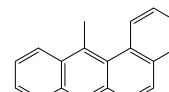
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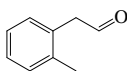
9-Methylbenz[a]anthracene



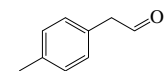
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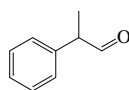
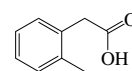
12-Methylbenz[a]anthracene



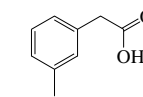
2-Methylbenzeneacetaldehyde



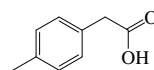
4-Methylbenzeneacetaldehyde

 $\alpha$ -Methylbenzeneacetaldehyde

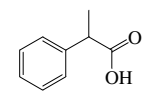
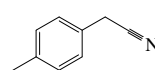
2-Methylbenzeneacetic acid



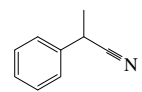
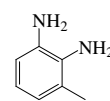
3-Methylbenzeneacetic acid



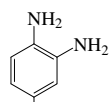
4-Methylbenzeneacetic acid

 $\alpha$ -Methylbenzeneacetic acid, ( $\pm$ )

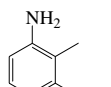
4-Methylbenzeneacetonitrile

 $\alpha$ -Methylbenzeneacetonitrile

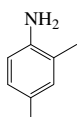
3-Methyl-1,2-benzenediamine



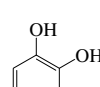
4-Methyl-1,2-benzenediamine



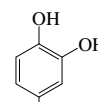
2-Methyl-1,3-benzenediamine



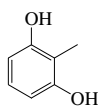
2-Methyl-1,4-benzenediamine



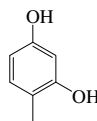
3-Methyl-1,2-benzenediol



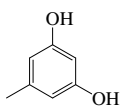
4-Methyl-1,2-benzenediol



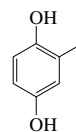
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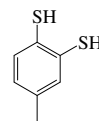
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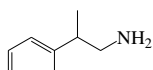
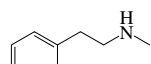
5-Methyl-1,3-benzenediol



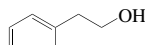
2-Methyl-1,4-benzenediol



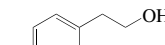
4-Methyl-1,2-benzenedithiol

 $\beta$ -Methylbenzeneethanamine

N-Methylbenzeneethanamine



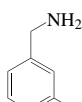
2-Methylbenzeneethanol



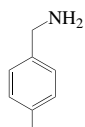
4-Methylbenzeneethanol



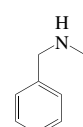
2-Methylbenzenemethanamine



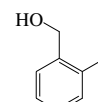
3-Methylbenzenemethanamine



4-Methylbenzenemethanamine

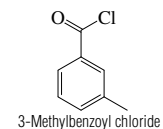
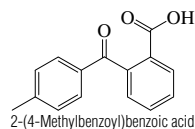
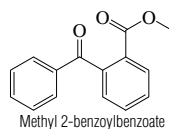
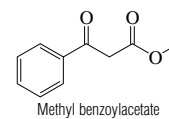
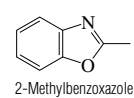
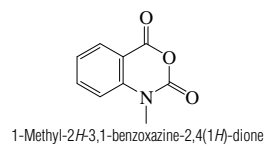
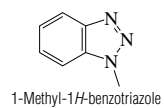
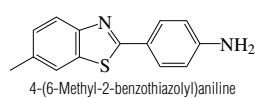
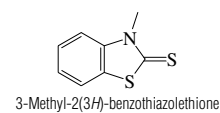
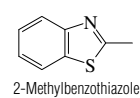
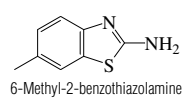
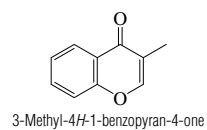
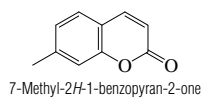
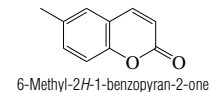
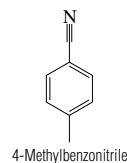
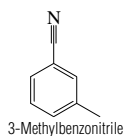
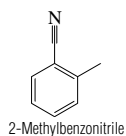
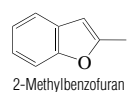
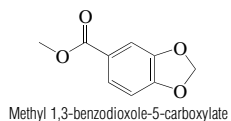
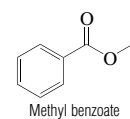
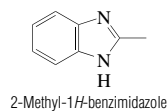
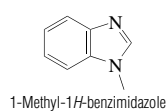
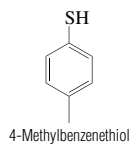
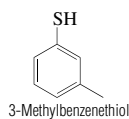
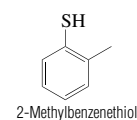
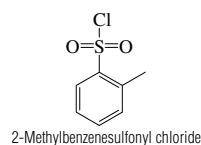
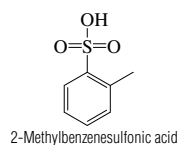
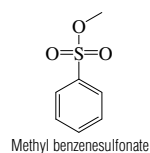
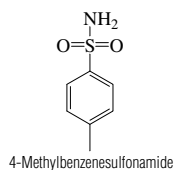
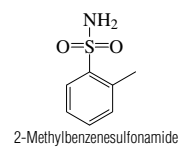
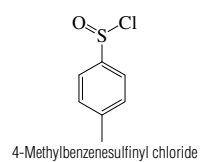
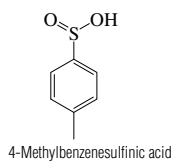
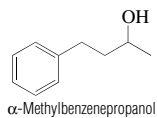
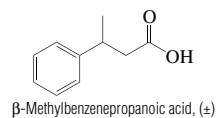
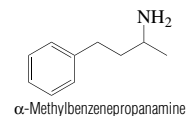
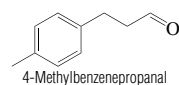
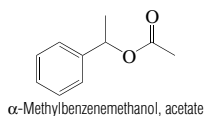
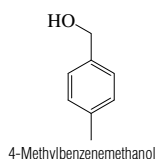
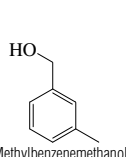


N-Methylbenzenemethanamine

 $\alpha$ -Methylbenzenemethanol

2-Methylbenzenemethanol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
6998	3-Methylbenzenemethanol	<i>m</i> -Tolyl alcohol	C <sub>8</sub> H <sub>10</sub> O	587-03-1	122.164		<-20	215.5	0.9157 <sup>17</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s chl
6999	4-Methylbenzenemethanol	<i>p</i> -Tolyl alcohol	C <sub>8</sub> H <sub>10</sub> O	589-18-4	122.164	nd (lig)	61.5	217	0.978 <sup>22</sup>		vs eth, EtOH
7000	$\alpha$ -Methylbenzenemethanol, acetate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	93-92-5	164.201	oil		109 <sup>18</sup>			
7001	4-Methylbenzenepropanal		C <sub>10</sub> H <sub>12</sub> O	5406-12-2	148.201			223	0.999 <sup>14</sup>	1.525 <sup>14</sup>	
7002	$\alpha$ -Methylbenzenepropanamine	1-Methyl-3-phenylpropylamine	C <sub>10</sub> H <sub>13</sub> N	22374-89-6	149.233		143	223; 101 <sup>14</sup>	0.9289 <sup>15</sup>	1.5152 <sup>20</sup>	vs EtOH
7003	$\beta$ -Methylbenzenepropanoic acid, ( $\pm$ )		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	772-17-8	164.201		46.5	168 <sup>14</sup>	1.0701 <sup>20</sup>	1.5155 <sup>20</sup>	sl H <sub>2</sub> O; s peth
7004	$\alpha$ -Methylbenzenepropanol		C <sub>10</sub> H <sub>14</sub> O	2344-70-9	150.217			239; 123 <sup>15</sup>	0.9899 <sup>16</sup>	1.517 <sup>16</sup>	
7005	4-Methylbenzenesulfonic acid	<i>p</i> -Toluenesulfonic acid	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub> S	536-57-2	156.203	orth pl or nd (w)	86.5				s H <sub>2</sub> O; vs EtOH, eth; sl bz
7006	4-Methylbenzenesulfonyl chloride		C <sub>7</sub> H <sub>6</sub> ClOS	10439-23-3	174.648	nd	57	113 <sup>3,5</sup>			vs chl
7007	2-Methylbenzenesulfonamide		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub> S	88-19-7	171.217	oct cry (al), pr (w)	158.7	214 <sup>10</sup>			sl H <sub>2</sub> O, eth, DMSO; s EtOH
7008	4-Methylbenzenesulfonamide	<i>p</i> -Toluenesulfonamide	C <sub>7</sub> H <sub>9</sub> NO <sub>2</sub> S	70-55-3	171.217	mcl pl (w+2)	138	214 <sup>10</sup>			sl H <sub>2</sub> O, eth; s EtOH
7009	Methyl benzenesulfonate		C <sub>7</sub> H <sub>8</sub> O <sub>3</sub> S	80-18-2	172.202		4.5	150 <sup>15</sup>	1.2730 <sup>17</sup>	1.5151 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, chl
7010	2-Methylbenzenesulfonic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub> S	88-20-0	172.202	hyg pl (w+2)	67.5	128.8 <sup>25</sup>			vs H <sub>2</sub> O; s EtOH; i eth
7011	2-Methylbenzenesulfonyl chloride	<i>o</i> -Toluenesulfonyl chloride	C <sub>7</sub> H <sub>7</sub> ClO <sub>2</sub> S	133-59-5	190.648		10.2	154 <sup>36</sup>	1.3383 <sup>20</sup>	1.5656 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
7012	2-Methylbenzenethiol		C <sub>7</sub> H <sub>8</sub> S	137-06-4	124.204		15	195	1.041 <sup>20</sup>	1.570 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth
7013	3-Methylbenzenethiol		C <sub>7</sub> H <sub>8</sub> S	108-40-7	124.204	liq	-20	195	1.044 <sup>20</sup>	1.572 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth
7014	4-Methylbenzenethiol		C <sub>7</sub> H <sub>8</sub> S	106-45-6	124.204		43	195	1.0220 <sup>51</sup>		i H <sub>2</sub> O; s EtOH, chl; vs eth
7015	1-Methyl-1 <i>H</i> -benzimidazole		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	1632-83-3	132.163	nd (peth), pl (al)	66	286	1.1254 <sup>20</sup>	1.6013 <sup>7</sup>	s peth
7016	2-Methyl-1 <i>H</i> -benzimidazole		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	615-15-6	132.163	pr or nd (w)	177.8				s H <sub>2</sub> O; sl EtOH, eth; i bz
7017	Methyl benzoate		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	93-58-3	136.149	liq	-12.4	199	1.0837 <sup>25</sup>	1.5164 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc, MeOH; msc eth
7018	Methyl 1,3-benzodioxole-5-carboxylate		C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	326-56-7	180.158	nd or lf (peth)	53	dec 273			vs eth, EtOH
7019	2-Methylbenzofuran		C <sub>9</sub> H <sub>8</sub> O	4265-25-2	132.159			197.5	1.0540 <sup>20</sup>	1.5495 <sup>22</sup>	vs eth, EtOH
7020	2-Methylbenzotrile	<i>o</i> -Tolunitrile	C <sub>8</sub> H <sub>7</sub> N	529-19-1	117.149	liq	-13.5	205	0.9955 <sup>20</sup>	1.5279 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
7021	3-Methylbenzotrile	<i>m</i> -Tolunitrile	C <sub>8</sub> H <sub>7</sub> N	620-22-4	117.149	liq	-23	213	1.0316 <sup>20</sup>	1.5252 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; sl ctc
7022	4-Methylbenzotrile	<i>p</i> -Tolunitrile	C <sub>8</sub> H <sub>7</sub> N	104-85-8	117.149		29.5	217.0	0.9762 <sup>30</sup>		i H <sub>2</sub> O; vs EtOH, eth; sl ctc
7023	6-Methyl-2 <i>H</i> -1-benzopyran-2-one		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	92-48-8	160.170		76.5	304; 174 <sup>14</sup>			vs EtOH, eth, bz; sl chl, peth
7024	7-Methyl-2 <i>H</i> -1-benzopyran-2-one	7-Methylcoumarin	C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	2445-83-2	160.170	nd, (pl) (aq al)	128	171.5 <sup>11</sup>			sl H <sub>2</sub> O; vs EtOH, HOAc; s eth
7025	3-Methyl-4 <i>H</i> -1-benzopyran-4-one	Tricromyl	C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	85-90-5	160.170						s chl
7026	6-Methyl-2-benzothiazolamine		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> S	2536-91-6	164.228	nd (w) pr (dil al)	142				sl H <sub>2</sub> O; s EtOH
7027	2-Methylbenzothiazole		C <sub>8</sub> H <sub>7</sub> NS	120-75-2	149.214		14	238	1.1763 <sup>19</sup>	1.6092 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, chl
7028	3-Methyl-2(3 <i>H</i> )-benzothiazolethione		C <sub>8</sub> H <sub>7</sub> NS <sub>2</sub>	2254-94-6	181.279	nd (al), pr (HOAc)	90	335			i H <sub>2</sub> O; sl EtOH, eth; vs bz, chl
7029	4-(6-Methyl-2-benzothiazolyl)aniline		C <sub>14</sub> H <sub>12</sub> N <sub>2</sub> S	92-36-4	240.323		194.8	434			sl EtOH, eth, bz, HOAc
7030	1-Methyl-1 <i>H</i> -benzotriazole		C <sub>7</sub> H <sub>7</sub> N <sub>3</sub>	13351-73-0	133.151	pl (bz-lig)	64.5	270.5			vs bz, EtOH, HOAc
7031	1-Methyl-2 <i>H</i> -3,1-benzoxazine-2,4(1 <i>H</i> )-dione		C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	10328-92-4	177.157		180				
7032	2-Methylbenzoxazole		C <sub>8</sub> H <sub>7</sub> NO	95-21-6	133.148		9.5	200.5	1.1211 <sup>20</sup>	1.5497 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth
7033	Methyl benzoylacetate		C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	614-27-7	178.184	pa ye		dec 265; 151 <sup>12</sup>	1.158 <sup>29</sup>	1.537 <sup>20</sup>	vs ace, eth, EtOH
7034	Methyl 2-benzoylbenzoate		C <sub>15</sub> H <sub>12</sub> O <sub>3</sub>	606-28-0	240.254	pl or mcl pr (dil al)	52	351	1.1903 <sup>19</sup>	1.591 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s sulf
7035	2-(4-Methylbenzoyl)benzoic acid	2-( <i>p</i> -Toluoyl)benzoic acid	C <sub>15</sub> H <sub>12</sub> O <sub>3</sub>	85-55-2	240.254		146				sl H <sub>2</sub> O, DMSO; vs EtOH, eth, ace, bz
7036	2-Methylbenzoyl chloride		C <sub>8</sub> H <sub>7</sub> ClO	933-88-0	154.594			213.5		1.5549 <sup>20</sup>	vs eth, EtOH
7037	3-Methylbenzoyl chloride		C <sub>8</sub> H <sub>7</sub> ClO	1711-06-4	154.594	liq	-23	219.5	1.0265 <sup>21</sup>	1.505 <sup>22</sup>	vs eth, EtOH

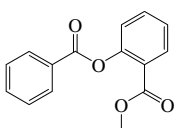


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7038	4-Methylbenzoyl chloride		C <sub>8</sub> H <sub>9</sub> ClO	874-60-2	154.594	liq	-1.5	226	1.1686 <sup>20</sup>	1.5547 <sup>20</sup>	s ctc
7039	Methyl benzoylsalicylate	2-(Benzoyloxy)benzoic acid, methyl ester	C <sub>15</sub> H <sub>12</sub> O <sub>4</sub>	610-60-6	256.254	cry	85	385			i H <sub>2</sub> O; s bz, chl, eth, EtOH
7040	α-Methylbenzylamine, (±)	1-Amino-1-phenylethane	C <sub>9</sub> H <sub>11</sub> N	618-36-0	121.180		32	187	0.9395 <sup>15</sup>	1.5238 <sup>25</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
7041	1-Methyl-2-benzylbenzene		C <sub>14</sub> H <sub>14</sub>	713-36-0	182.261		6.6	280.5	1.0020 <sup>20</sup>	1.5763 <sup>20</sup>	
7042	1-Methyl-4-benzylbenzene		C <sub>14</sub> H <sub>14</sub>	620-83-7	182.261	liq	-30	286	0.9976 <sup>20</sup>	1.5712 <sup>20</sup>	vs eth, bz, EtOH, chl
7043	α-Methylbenzyl formate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	7775-38-4	150.174	liq					
7044	1-Methyl-2-benzyl-4(1 <i>H</i> )-quinazolinone	Glycosine	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O	6873-15-0	250.294		161.5				
7045	1-Methylbicyclo[3.1.0]hexane		C <sub>7</sub> H <sub>12</sub>	4625-24-5	96.170			93.1			
7046	2-Methylbiphenyl		C <sub>13</sub> H <sub>12</sub>	643-58-3	168.234	liq	-0.2	255.3	1.0113 <sup>20</sup>	1.5914 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7047	3-Methylbiphenyl		C <sub>13</sub> H <sub>12</sub>	643-93-6	168.234		2.3	272.7	1.0182 <sup>17</sup>	1.5972 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
7048	4-Methylbiphenyl		C <sub>13</sub> H <sub>12</sub>	644-08-6	168.234	pl (liq, MeOH)	49.5	267.5	1.015 <sup>27</sup>		i H <sub>2</sub> O; s EtOH, eth; sl ctc
7049	4-Methyl- <i>N,N</i> -bis(4-methylphenyl)aniline		C <sub>21</sub> H <sub>21</sub> N	1159-53-1	287.399	cry (HOAc)	117				vs ace, bz, eth, chl
7050	Methyl bromoacetate		C <sub>3</sub> H <sub>5</sub> BrO <sub>2</sub>	96-32-2	152.975			132	1.6350 <sup>20</sup>	1.4520 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
7051	Methyl 2-bromobenzoate		C <sub>8</sub> H <sub>7</sub> BrO <sub>2</sub>	610-94-6	215.045			244			i H <sub>2</sub> O; s EtOH
7052	Methyl 3-bromobenzoate		C <sub>8</sub> H <sub>7</sub> BrO <sub>2</sub>	618-89-3	215.045	pl	32	125 <sup>15</sup>			sl H <sub>2</sub> O; s EtOH, eth
7053	Methyl 4-bromobenzoate		C <sub>8</sub> H <sub>7</sub> BrO <sub>2</sub>	619-42-1	215.045	lf (dil al), nd (eth)	81		1.689 <sup>25</sup>		s EtOH, eth, ace, peth; vs bz, chl
7054	Methyl 2-bromobutanoate		C <sub>8</sub> H <sub>9</sub> BrO <sub>2</sub>	3196-15-4	181.028			168	1.4528 <sup>20</sup>	1.4029 <sup>25</sup>	vs EtOH
7055	Methyl 4-bromobutanoate		C <sub>8</sub> H <sub>9</sub> BrO <sub>2</sub>	4897-84-1	181.028			186.5	1.4 <sup>25</sup>	1.4567 <sup>25</sup>	vs EtOH
7056	Methyl 4-bromo-2-butenate		C <sub>8</sub> H <sub>9</sub> BrO <sub>2</sub>	1117-71-1	179.013			84 <sup>12</sup>	1.490 <sup>19</sup>	1.498 <sup>19</sup>	
7057	Methyl 5-bromopentanoate		C <sub>8</sub> H <sub>11</sub> BrO <sub>2</sub>	5454-83-1	195.054	liq		101 <sup>14</sup>	1.363	1.4630 <sup>20</sup>	
7058	Methyl 3-bromopropanoate		C <sub>7</sub> H <sub>9</sub> BrO <sub>2</sub>	3395-91-3	167.002			105 <sup>60</sup> , 62 <sup>12</sup>	1.4123 <sup>18</sup>	1.4542 <sup>20</sup>	s EtOH, eth, ace
7059	3-Methyl-1,2-butadiene		C <sub>5</sub> H <sub>8</sub>	598-25-4	68.118	liq	-113.6	40.83	0.6806 <sup>25</sup>	1.4203 <sup>20</sup>	vs ace, bz, eth, EtOH
7060	2-Methyl-1,3-butadiene	Isoprene	C <sub>5</sub> H <sub>8</sub>	78-79-5	68.118	liq	-145.9	34.0	0.679 <sup>20</sup>	1.4219 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz
7061	3-Methylbutanal	Isovaleraldehyde	C <sub>6</sub> H <sub>10</sub> O	590-86-3	86.132	liq	-51	92.5	0.7977 <sup>20</sup>	1.3902 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7062	3-Methylbutanamide	Isovaleramide	C <sub>6</sub> H <sub>11</sub> NO	541-46-8	101.147	mcl lf (al)	137	226			s H <sub>2</sub> O, EtOH, eth; vs peth
7063	3-Methyl-1-butanamine	Isopentylamine	C <sub>6</sub> H <sub>13</sub> N	107-85-7	87.164			96	0.7505 <sup>20</sup>	1.4083 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, chl
7064	2-Methyl-2-butanamine		C <sub>6</sub> H <sub>13</sub> N	594-39-8	87.164	liq	-105	77	0.731 <sup>25</sup>	1.3954 <sup>25</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
7065	3-Methyl-2-butanamine		C <sub>6</sub> H <sub>13</sub> N	598-74-3	87.164	liq	-50	85.5	0.7574 <sup>19</sup>	1.4096 <sup>18</sup>	vs H <sub>2</sub> O; s EtOH
7066	3-Methyl-1,3-butanediol		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	2568-33-4	104.148			202.5	0.9448 <sup>20</sup>	1.4452 <sup>20</sup>	s H <sub>2</sub> O, EtOH
7067	2-Methylbutanenitrile		C <sub>6</sub> H <sub>9</sub> N	18936-17-9	83.132			125	0.7913 <sup>15</sup>	1.3933 <sup>20</sup>	vs eth, EtOH
7068	3-Methylbutanenitrile	Isobutyl cyanide	C <sub>6</sub> H <sub>9</sub> N	625-28-5	83.132	liq	-101	127.5	0.7914 <sup>20</sup>	1.3927 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace
7069	2-Methyl-1-butanethiol, (+)		C <sub>6</sub> H <sub>12</sub> S	20089-07-0	104.214	liq		119.1	0.8420 <sup>20</sup>	1.4440 <sup>20</sup>	
7070	3-Methyl-1-butanethiol	Isopentyl mercaptan	C <sub>6</sub> H <sub>12</sub> S	541-31-1	104.214	liq		116	0.8350 <sup>20</sup>	1.4412 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
7071	2-Methyl-2-butanethiol		C <sub>6</sub> H <sub>12</sub> S	1679-09-0	104.214	liq		99.1	0.8120 <sup>20</sup>	1.4385 <sup>20</sup>	
7072	3-Methyl-2-butanethiol		C <sub>6</sub> H <sub>12</sub> S	2084-18-6	104.214	liq	-127.1	109.8			
7073	Methyl butanoate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	623-42-7	102.132	liq	-85.8	102.8	0.8984 <sup>20</sup>	1.3878 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
7074	2-Methylbutanoic acid	(±)-2-Methylbutyric acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	600-07-7	102.132		<-80	177	0.934 <sup>20</sup>	1.4051 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s chl
7075	3-Methylbutanoic acid	Isovaleric acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	503-74-2	102.132	liq	-29.3	176.5	0.931 <sup>20</sup>	1.4033 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth, chl
7076	3-Methylbutanoic anhydride		C <sub>10</sub> H <sub>18</sub> O <sub>3</sub>	1468-39-9	186.248			215	0.9327 <sup>20</sup>	1.4043 <sup>20</sup>	vs eth
7077	2-Methyl-1-butanol, (±)		C <sub>5</sub> H <sub>12</sub> O	34713-94-5	88.148			127.5	0.8152 <sup>25</sup>	1.4092 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace
7078	3-Methyl-1-butanol	Isopentyl alcohol	C <sub>5</sub> H <sub>12</sub> O	123-51-3	88.148	liq	-117.2	131.1	0.8104 <sup>20</sup>	1.4053 <sup>20</sup>	sl H <sub>2</sub> O; vs ace, eth, EtOH
7079	2-Methyl-2-butanol	<i>tert</i> -Pentyl alcohol	C <sub>5</sub> H <sub>12</sub> O	75-85-4	88.148	liq	-9.1	102.4	0.8096 <sup>20</sup>	1.4052 <sup>20</sup>	s H <sub>2</sub> O, bz, chl; msc EtOH, eth; vs ace

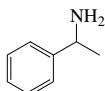
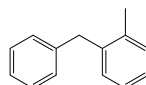




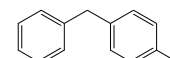
4-Methylbenzoyl chloride



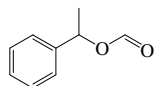
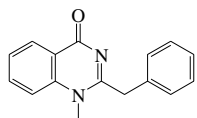
Methyl benzoysalicylate

 $\alpha$ -Methylbenzylamine, ( $\pm$ )

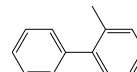
1-Methyl-2-benzylbenzene



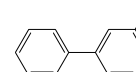
1-Methyl-4-benzylbenzene

 $\alpha$ -Methylbenzyl formate1-Methyl-2-benzyl-4(1*H*)-quinazolinone

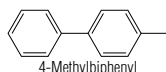
1-Methylbicyclo[3.1.0]hexane



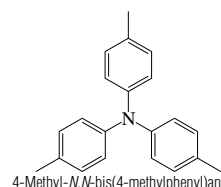
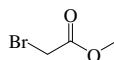
2-Methylbiphenyl



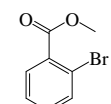
3-Methylbiphenyl



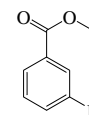
4-Methylbiphenyl

4-Methyl-*N,N*-bis(4-methylphenyl)aniline

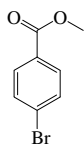
Methyl bromoacetate



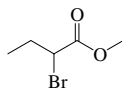
Methyl 2-bromobenzoate



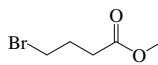
Methyl 3-bromobenzoate



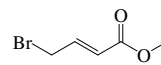
Methyl 4-bromobenzoate



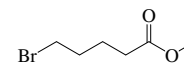
Methyl 2-bromobutanoate



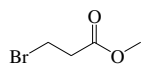
Methyl 4-bromobutanoate



Methyl 4-bromo-2-butenate



Methyl 5-bromopentanoate



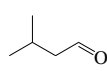
Methyl 3-bromopropanoate



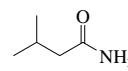
3-Methyl-1,2-butadiene



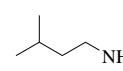
2-Methyl-1,3-butadiene



3-Methylbutanal



3-Methylbutanamide



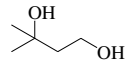
3-Methyl-1-butanamine



2-Methyl-2-butanamine



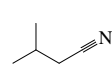
3-Methyl-2-butanamine



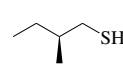
3-Methyl-1,3-butanediol



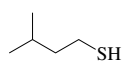
2-Methylbutanenitrile



3-Methylbutanenitrile



2-Methyl-1-butanethiol, (+)



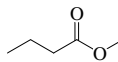
3-Methyl-1-butanethiol



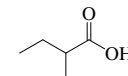
2-Methyl-2-butanethiol



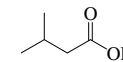
3-Methyl-2-butanethiol



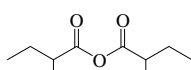
Methyl butanoate



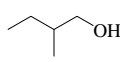
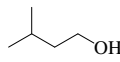
2-Methylbutanoic acid



3-Methylbutanoic acid



3-Methylbutanoic anhydride

2-Methyl-1-butanol, ( $\pm$ )

3-Methyl-1-butanol

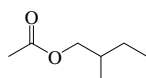


2-Methyl-2-butanol

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7080	3-Methyl-2-butanol, (±)		C <sub>5</sub> H <sub>12</sub> O	70116-68-6	88.148			112.9	0.8180 <sup>20</sup>	1.4089 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace; s bz, ctc
7081	2-Methyl-1-butanol acetate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	624-41-9	130.185			140	0.8740 <sup>20</sup>	1.4040 <sup>20</sup>	vs ace, eth, EtOH
7082	3-Methyl-2-butanone	Methyl isopropyl ketone	C <sub>5</sub> H <sub>10</sub> O	563-80-4	86.132	liq	-93.1	94.33	0.8051 <sup>20</sup>	1.3880 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace; s ctc
7083	2-Methylbutanoyl chloride, (±)		C <sub>5</sub> H <sub>9</sub> ClO	57526-28-0	120.577			116	0.9917 <sup>20</sup>	1.4170 <sup>20</sup>	
7084	3-Methylbutanoyl chloride	Isovaleryl chloride	C <sub>5</sub> H <sub>9</sub> ClO	108-12-3	120.577			114	0.9844 <sup>20</sup>	1.4149 <sup>20</sup>	s eth
7085	<i>trans</i> -2-Methyl-2-butenal	Tiglic aldehyde	C <sub>5</sub> H <sub>8</sub> O	497-03-0	84.117	liq		117; 64 <sup>119</sup>	0.8710 <sup>20</sup>	1.4475 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH
7086	3-Methyl-2-butenal	Senecialdehyde	C <sub>5</sub> H <sub>8</sub> O	107-86-8	84.117			134	0.8722 <sup>20</sup>	1.4528 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
7087	2-Methyl-1-butene		C <sub>5</sub> H <sub>10</sub>	563-46-2	70.133	liq	-137.53	31.2	0.6504 <sup>20</sup>	1.3778 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
7088	3-Methyl-1-butene		C <sub>5</sub> H <sub>10</sub>	563-45-1	70.133	vol liq or gas	-168.43	20.1	0.6213 <sup>25</sup>	1.3643 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz
7089	2-Methyl-2-butene		C <sub>5</sub> H <sub>10</sub>	513-35-9	70.133	liq	-133.72	38.56	0.6623 <sup>20</sup>	1.3874 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc; vs lig
7090	<i>cis</i> -2-Methyl-2-butenedioic acid	Citraconic acid	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	498-23-7	130.100	nd (eth-liq) tcl pr (eth-bz)	93.5		1.617 <sup>25</sup>		vs H <sub>2</sub> O; sl eth, chl; i bz, CS <sub>2</sub>
7091	3-Methyl-2-butenitrile		C <sub>5</sub> H <sub>8</sub> N	4786-24-7	81.117	liq		141			
7092	Methyl <i>cis</i> -2-butenate	Methyl isocrotonate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	4358-59-2	100.117			118		1.4175 <sup>20</sup>	
7093	Methyl <i>trans</i> -2-butenate	Methyl crotonate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	623-43-8	100.117	liq	-42	121	0.9444 <sup>20</sup>	1.4242 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
7094	<i>cis</i> -2-Methyl-2-butenic acid	Angelic acid	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	565-63-9	100.117	mcl pr or nd	45.5	185	0.9834 <sup>49</sup>	1.4434 <sup>47</sup>	sl H <sub>2</sub> O; s EtOH; vs eth
7095	<i>trans</i> -2-Methyl-2-butenic acid	Tiglic acid	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-59-1	100.117	tab (w)	64.5	198.5	0.9641 <sup>76</sup>	1.4330 <sup>76</sup>	s H <sub>2</sub> O; vs EtOH, eth
7096	3-Methyl-2-butenic acid		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	541-47-9	100.117		69.5	197	1.0062 <sup>24</sup>		
7097	3-Methyl-2-buten-1-ol		C <sub>5</sub> H <sub>10</sub> O	556-82-1	86.132			140	0.848 <sup>25</sup>	1.4412 <sup>20</sup>	
7098	3-Methyl-3-buten-1-ol		C <sub>5</sub> H <sub>10</sub> O	763-32-6	86.132			129.9			
7099	2-Methyl-3-buten-2-ol		C <sub>5</sub> H <sub>10</sub> O	115-18-4	86.132	liq	-28	97	0.82 <sup>20</sup>		
7100	3-Methyl-3-buten-2-ol		C <sub>5</sub> H <sub>10</sub> O	10473-14-0	86.132			114	0.8531 <sup>17</sup>	1.4288 <sup>17</sup>	
7101	3-Methyl-3-buten-2-one	Isopropenyl methyl ketone	C <sub>5</sub> H <sub>8</sub> O	814-78-8	84.117	liq	-54	98	0.8527 <sup>20</sup>	1.4220 <sup>20</sup>	vs EtOH
7102	3-Methyl-2-butenoyl chloride		C <sub>5</sub> H <sub>9</sub> ClO	3350-78-5	118.562			146	1.065 <sup>25</sup>	1.4770 <sup>20</sup>	
7103	(3-Methyl-2-butenyl)guanidine	Galegine	C <sub>5</sub> H <sub>13</sub> N <sub>3</sub>	543-83-9	127.187	hyg	62.5	dec			vs H <sub>2</sub> O, EtOH
7104	2-Methyl-1-buten-3-yne	Isopropenylacetylene	C <sub>5</sub> H <sub>6</sub>	78-80-8	66.102	liq	-113	32	0.6801 <sup>11</sup>	1.4140 <sup>20</sup>	s chl
7105	[(3-Methylbutoxy)methyl]benzene		C <sub>12</sub> H <sub>18</sub> O	122-73-6	178.270			236; 118 <sup>19</sup>	0.909 <sup>20</sup>	1.4792 <sup>20</sup>	vs eth, EtOH
7106	1-[2-(3-Methylbutoxy)-2-phenylethyl]pyrrolidine	Amixetrine	C <sub>17</sub> H <sub>27</sub> NO	24622-72-8	261.402			121 <sup>2</sup>		1.4978 <sup>22</sup>	
7107	2-Methylbutyl acrylate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	44914-03-6	142.196			160; 45 <sup>10</sup>	0.8936 <sup>20</sup>	1.4240 <sup>20</sup>	vs eth, EtOH
7108	3-Methylbutyl benzoate	Isopentyl benzoate	C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	94-46-2	192.254			261	0.993 <sup>15</sup>		vs EtOH
7109	3-Methylbutyl 2-chloropropanoate		C <sub>8</sub> H <sub>15</sub> ClO <sub>2</sub>	62108-69-4	178.657			208	1.0050 <sup>20</sup>	1.4289 <sup>20</sup>	
7110	3-Methylbutyl 3-chloropropanoate		C <sub>8</sub> H <sub>15</sub> ClO <sub>2</sub>	62108-70-7	178.657			208; 87 <sup>12</sup>	1.0171 <sup>20</sup>	1.4343 <sup>20</sup>	vs eth, EtOH
7111	Methyl <i>tert</i> -butyl ether	<i>tert</i> -Butyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	1634-04-4	88.148	liq	-108.6	55.0	0.7353 <sup>25</sup>	1.3664 <sup>25</sup>	s H <sub>2</sub> O; vs EtOH, eth
7112	3-Methylbutyl nitrate	Isopentyl nitrate	C <sub>8</sub> H <sub>17</sub> NO <sub>3</sub>	543-87-3	133.146			148	0.996 <sup>22</sup>	1.4122 <sup>21</sup>	
7113	2-Methyl-3-butyln-2-amine		C <sub>6</sub> H <sub>13</sub> N	2978-58-7	83.132		18	79.5	0.79 <sup>25</sup>	1.4235 <sup>20</sup>	
7114	3-Methyl-1-butyne		C <sub>5</sub> H <sub>8</sub>	598-23-2	68.118	vol liq or gas	-89.7	26.3	0.6660 <sup>20</sup>	1.3723 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
7115	2-Methyl-3-butyln-2-ol	1,1-Dimethylpropargyl alcohol	C <sub>6</sub> H <sub>8</sub> O	115-19-5	84.117		1.5	104	0.8618 <sup>20</sup>	1.4207 <sup>20</sup>	
7116	Methyl carbamate		C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	598-55-0	75.067	nd	54	177	1.1361 <sup>56</sup>	1.4125 <sup>56</sup>	vs H <sub>2</sub> O; vs EtOH, eth
7117	3-Methyl-9 <i>H</i> -carbazole		C <sub>13</sub> H <sub>11</sub> N	4630-20-0	181.233	pl (HOAc)	208.5	365			vs bz, eth
7118	9-Methyl-9 <i>H</i> -carbazole		C <sub>13</sub> H <sub>11</sub> N	1484-12-4	181.233	nd, lf (al)	89.34	343.64; 195 <sup>12</sup>			vs eth
7119	Methyl chloroacetate		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	96-34-4	108.524	liq	-32.1	129.5	1.236 <sup>20</sup>	1.4218 <sup>20</sup>	vs ace, bz, eth, EtOH
7120	Methyl 2-chloroacrylate		C <sub>4</sub> H <sub>5</sub> ClO <sub>2</sub>	80-63-7	120.535			52 <sup>51</sup>	1.189 <sup>20</sup>	1.4420 <sup>20</sup>	vs eth
7121	Methyl 2-chlorobenzoate		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	610-96-8	170.594			234			s EtOH
7122	Methyl 3-chlorobenzoate		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	2905-65-9	170.594		21	229			
7123	Methyl 4-chlorobenzoate		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	1126-46-1	170.594	nd or mcl pr	43.5		1.382 <sup>20</sup>		vs EtOH
7124	Methyl 4-chlorobutanoate		C <sub>6</sub> H <sub>9</sub> ClO <sub>2</sub>	3153-37-5	136.577			174; 55 <sup>4</sup>	1.1293 <sup>20</sup>	1.4321 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace
7125	Methyl chlorocarbonate		C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	79-22-1	94.497			70.5	1.2231 <sup>20</sup>	1.3868 <sup>20</sup>	msc EtOH, eth; s bz, ctc, chl
7126	Methyl 5-chloro-2-hydroxybenzoate		C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	4068-78-4	186.593	nd (al)	50	dec 249; 120 <sup>12</sup>			vs EtOH
7127	Methyl 5-chloro-2-nitrobenzoate		C <sub>8</sub> H <sub>6</sub> ClNO <sub>4</sub>	51282-49-6	215.592	pl (MeOH)	48.5		1.453 <sup>18</sup>		vs MeOH
7128	Methyl chlorooxacetate		C <sub>3</sub> H <sub>4</sub> ClO <sub>3</sub>	5781-53-3	122.507			119	1.3316 <sup>20</sup>	1.4189 <sup>20</sup>	
7129	Methyl 2-chloropropanoate		C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	17639-93-9	122.551			132.5	1.0750 <sup>25</sup>		



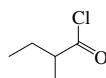
3-Methyl-2-butanol, (±)



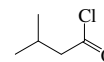
2-Methyl-1-butanol acetate



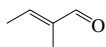
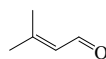
3-Methyl-2-butanone



2-Methylbutanoyl chloride, (±)



3-Methylbutanoyl chloride

*trans*-2-Methyl-2-butenal

3-Methyl-2-butenal



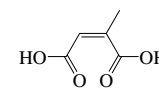
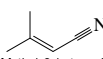
2-Methyl-1-butene



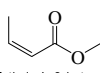
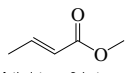
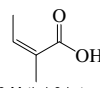
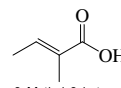
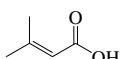
3-Methyl-1-butene



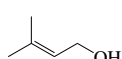
2-Methyl-2-butene

*cis*-2-Methyl-2-butenedioic acid

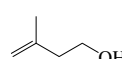
3-Methyl-2-butenenitrile

Methyl *cis*-2-butenateMethyl *trans*-2-butenate*cis*-2-Methyl-2-butenic acid*trans*-2-Methyl-2-butenic acid

3-Methyl-2-butenic acid



3-Methyl-2-buten-1-ol



3-Methyl-3-buten-1-ol



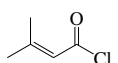
2-Methyl-3-buten-2-ol



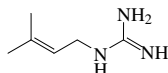
3-Methyl-3-buten-2-ol



3-Methyl-3-buten-2-one



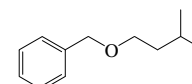
3-Methyl-2-butenoyl chloride



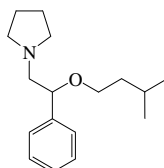
(3-Methyl-2-butenyl)guanidine



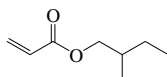
2-Methyl-1-buten-3-yne



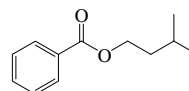
[(3-Methylbutoxy)methyl]benzene



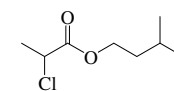
1-[2-(3-Methylbutoxy)-2-phenylethyl]pyrrolidine



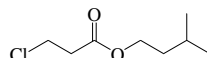
2-Methylbutyl acrylate



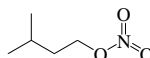
3-Methylbutyl benzoate



3-Methylbutyl 2-chloropropanoate



3-Methylbutyl 3-chloropropanoate

Methyl *tert*-butyl ether

3-Methylbutyl nitrate



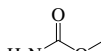
2-Methyl-3-butyne-2-amine



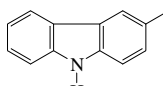
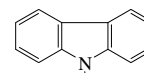
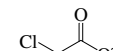
3-Methyl-1-butyne



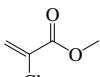
2-Methyl-3-butyne-2-ol



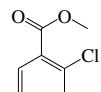
Methyl carbamate

3-Methyl-9*H*-carbazole9-Methyl-9*H*-carbazole

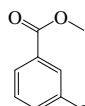
Methyl chloroacetate



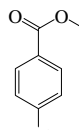
Methyl 2-chloroacrylate



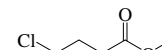
Methyl 2-chlorobenzoate



Methyl 3-chlorobenzoate



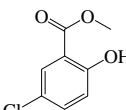
Methyl 4-chlorobenzoate



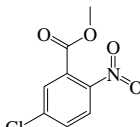
Methyl 4-chlorobutanoate



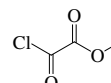
Methyl chlorocarbonate



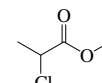
Methyl 5-chloro-2-hydroxybenzoate



Methyl 5-chloro-2-nitrobenzoate

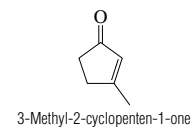
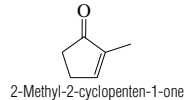
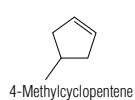
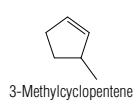
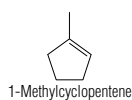
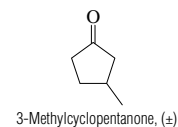
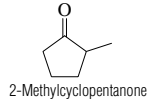
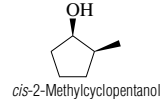
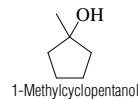
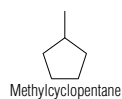
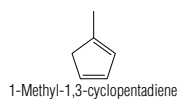
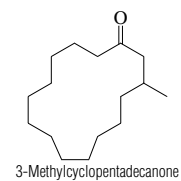
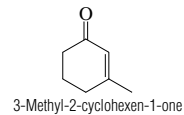
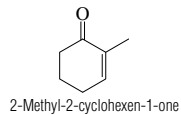
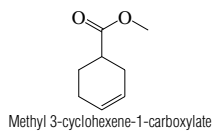
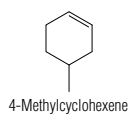
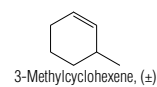
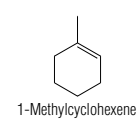
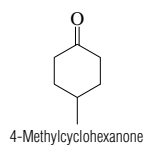
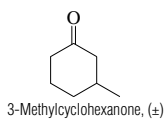
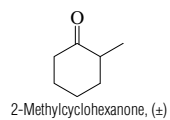
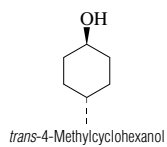
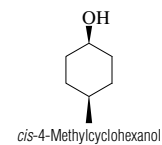
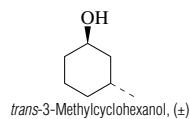
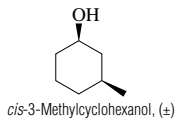
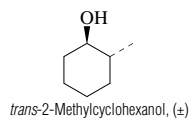
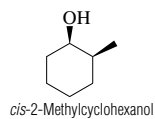
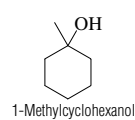
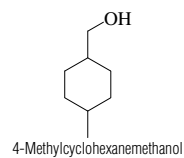
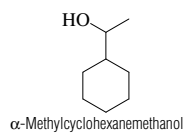
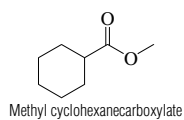
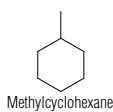
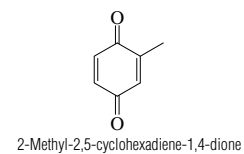
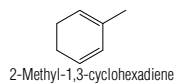
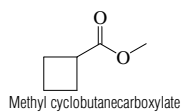
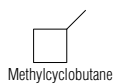
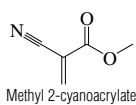
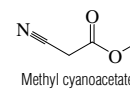
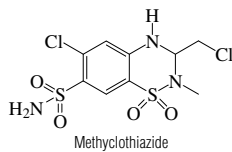
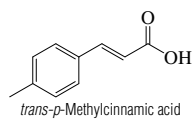
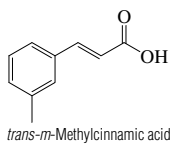
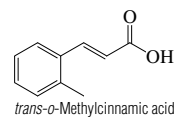
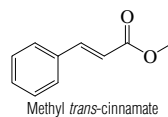
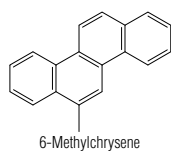
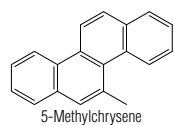
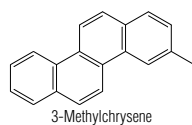


Methyl chlorooxacetate

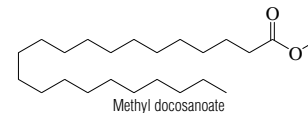
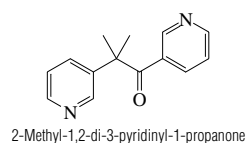
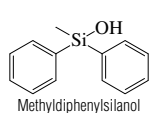
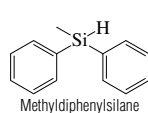
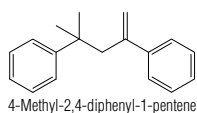
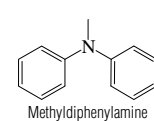
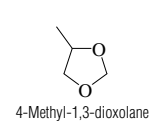
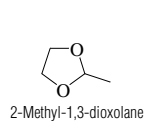
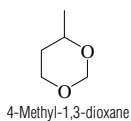
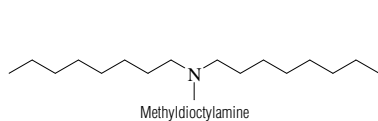
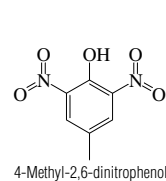
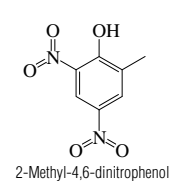
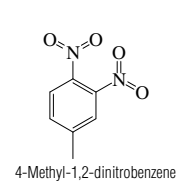
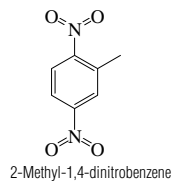
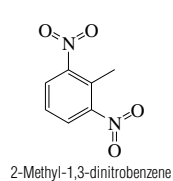
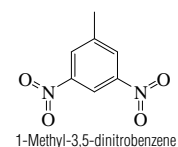
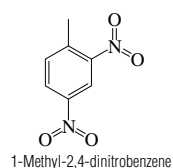
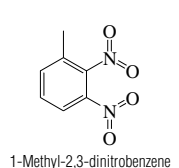
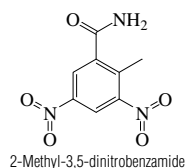
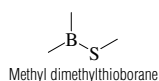
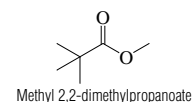
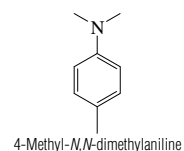
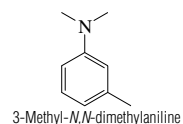
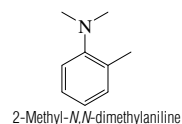
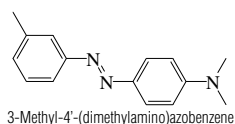
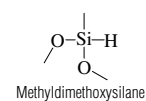
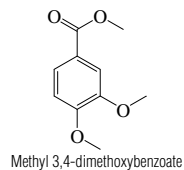
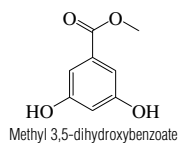
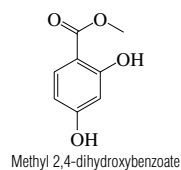
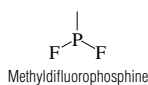
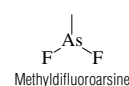
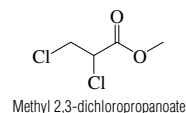
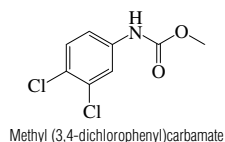
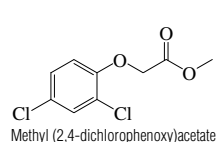
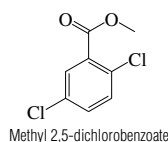
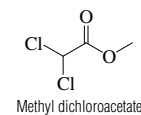
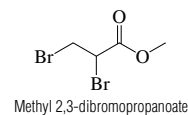
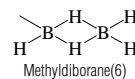
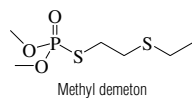
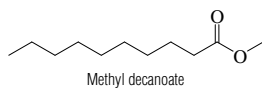
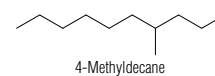
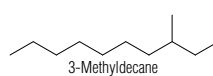
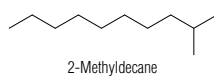
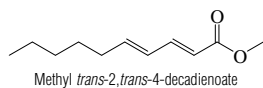
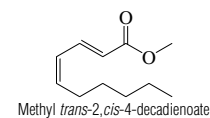
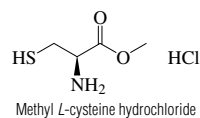
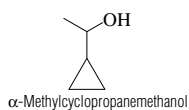
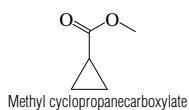


Methyl 2-chloropropanoate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7130	3-Methylchrysene		C <sub>19</sub> H <sub>14</sub>	3351-31-3	242.314	lf (bz-peth)	173.3				vs EtOH
7131	5-Methylchrysene		C <sub>19</sub> H <sub>14</sub>	3697-24-3	242.314		118.3				i H <sub>2</sub> O
7132	6-Methylchrysene		C <sub>19</sub> H <sub>14</sub>	1705-85-7	242.314		161				
7133	Methyl <i>trans</i> -cinnamate	Methyl <i>trans</i> -3-phenyl-2-propenoate	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	1754-62-7	162.185	cry (peth, dil al)	36.5	261.9	1.042 <sup>36</sup>	1.5766 <sup>22</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz; sl chl
7134	<i>trans</i> -o-Methylcinnamic acid		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	2373-76-4	162.185	cry (EtOH)	175				
7135	<i>trans</i> -m-Methylcinnamic acid		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	3029-79-6	162.185	cry (w)	115				
7136	<i>trans</i> -p-Methylcinnamic acid		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	1866-39-3	162.185		198.5				
7137	Methylthiazide		C <sub>9</sub> H <sub>11</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	135-07-9	360.237	cry (EtOH aq)	225				i H <sub>2</sub> O, bz, chl; sl MeOH; vs ace, py
7138	Methyl cyanate		C <sub>2</sub> H <sub>3</sub> NO	1768-34-9	57.051	unstab gas	-30	exp			
7139	Methyl cyanoacetate		C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	105-34-0	99.089	liq	-22.5	200.5	1.1225 <sup>25</sup>	1.4176 <sup>20</sup>	vs eth, EtOH
7140	Methyl 2-cyanoacrylate	Mecrylate	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	137-05-3	111.100			47 <sup>2</sup>	1.1012 <sup>20</sup>	1.4430	
7141	Methylcyclobutane		C <sub>5</sub> H <sub>10</sub>	598-61-8	70.133	liq	-161.5	36.3	0.6884 <sup>20</sup>	1.3866 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, bz, peth
7142	Methyl cyclobutanecarboxylate		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	765-85-5	114.142			135.5			
7143	2-Methyl-1,3-cyclohexadiene	4,5-Dihydrotoluene	C <sub>7</sub> H <sub>10</sub>	1489-57-2	94.154			107.5	0.8260 <sup>18</sup>	1.4662 <sup>18</sup>	
7144	2-Methyl-2,5-cyclohexadiene-1,4-dione		C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	553-97-9	122.122	ye pl or nd	69	sub	1.08 <sup>75</sup>		sl H <sub>2</sub> O; s EtOH, eth
7145	Methylcyclohexane		C <sub>7</sub> H <sub>14</sub>	108-87-2	98.186	liq	-126.6	100.93	0.7694 <sup>20</sup>	1.4231 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, lig
7146	Methyl cyclohexanecarboxylate		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	4630-82-4	142.196			183	0.9954 <sup>15</sup>	1.4433 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl
7147	α-Methylcyclohexanemethanol		C <sub>8</sub> H <sub>16</sub> O	1193-81-3	128.212			189	0.928 <sup>25</sup>	1.4656 <sup>20</sup>	vs EtOH, eth; sl ctc
7148	4-Methylcyclohexanemethanol		C <sub>8</sub> H <sub>16</sub> O	34885-03-5	128.212			75 <sup>2,5</sup>	0.9074 <sup>20</sup>	1.4617 <sup>20</sup>	
7149	1-Methylcyclohexanol		C <sub>7</sub> H <sub>14</sub> O	590-67-0	114.185		25	155; 70 <sup>25</sup>	0.9194 <sup>20</sup>	1.4595 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl
7150	<i>cis</i> -2-Methylcyclohexanol		C <sub>7</sub> H <sub>14</sub> O	615-38-3	114.185		7	165	0.9360 <sup>20</sup>	1.4640 <sup>20</sup>	vs EtOH
7151	<i>trans</i> -2-Methylcyclohexanol, (±)		C <sub>7</sub> H <sub>14</sub> O	615-39-4	114.185	liq	-2.0	167.5	0.9247 <sup>20</sup>	1.4616 <sup>20</sup>	vs eth, EtOH
7152	<i>cis</i> -3-Methylcyclohexanol, (±)		C <sub>7</sub> H <sub>14</sub> O	5454-79-5	114.185	liq	-5.5	168; 94 <sup>12</sup>	0.9155 <sup>20</sup>	1.4752 <sup>20</sup>	vs eth, EtOH
7153	<i>trans</i> -3-Methylcyclohexanol, (±)		C <sub>7</sub> H <sub>14</sub> O	7443-55-2	114.185	liq	-0.5	167; 84 <sup>13</sup>	0.9214 <sup>20</sup>	1.4580 <sup>20</sup>	vs eth, EtOH
7154	<i>cis</i> -4-Methylcyclohexanol		C <sub>7</sub> H <sub>14</sub> O	7731-28-4	114.185	liq	-9.2	173	0.9170 <sup>20</sup>	1.4614 <sup>20</sup>	vs eth, EtOH
7155	<i>trans</i> -4-Methylcyclohexanol		C <sub>7</sub> H <sub>14</sub> O	7731-29-5	114.185			174	0.9118 <sup>21</sup>	1.4561 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; s eth
7156	2-Methylcyclohexanone, (±)		C <sub>7</sub> H <sub>12</sub> O	24965-84-2	112.169	liq	-13.9	165	0.9250 <sup>20</sup>	1.4483 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
7157	3-Methylcyclohexanone, (±)		C <sub>7</sub> H <sub>12</sub> O	625-96-7	112.169	liq	-73.5	169; 65 <sup>15</sup>	0.9136 <sup>20</sup>	1.4456 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7158	4-Methylcyclohexanone		C <sub>7</sub> H <sub>12</sub> O	589-92-4	112.169	liq	-40.6	170	0.9138 <sup>20</sup>	1.4451 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
7159	1-Methylcyclohexene		C <sub>7</sub> H <sub>12</sub>	591-49-1	96.170	liq	-120.4	110.3	0.8102 <sup>20</sup>	1.4503 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, ctc
7160	3-Methylcyclohexene, (±)		C <sub>7</sub> H <sub>12</sub>	56688-75-6	96.170	liq	-115.5	104	0.7990 <sup>20</sup>	1.4414 <sup>20</sup>	vs bz, eth, chl, peth
7161	4-Methylcyclohexene		C <sub>7</sub> H <sub>12</sub>	591-47-9	96.170	liq	-115.5	102.7	0.7991 <sup>20</sup>	1.4414 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7162	Methyl 3-cyclohexene-1-carboxylate		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	6493-77-2	140.180			182; 80 <sup>20</sup>	1.0130 <sup>20</sup>	1.4610 <sup>20</sup>	
7163	2-Methyl-2-cyclohexen-1-one		C <sub>7</sub> H <sub>10</sub> O	1121-18-2	110.153			178.5	0.966 <sup>20</sup>	1.4833 <sup>20</sup>	s bz
7164	3-Methyl-2-cyclohexen-1-one		C <sub>7</sub> H <sub>10</sub> O	1193-18-6	110.153	liq	-21	201	0.9693 <sup>20</sup>	1.49475 <sup>20</sup>	msc H <sub>2</sub> O; s bz
7165	3-Methylcyclopentadecanone	Muscone	C <sub>16</sub> H <sub>30</sub> O	541-91-3	238.408	oily liq		329; 130 <sup>0,5</sup>	0.9221 <sup>17</sup>	1.4802 <sup>17</sup>	vs ace, eth, EtOH
7166	1-Methyl-1,3-cyclopentadiene		C <sub>6</sub> H <sub>8</sub>	96-39-9	80.128	liq		73	0.81 <sup>20</sup>	1.4512 <sup>20</sup>	
7167	Methylcyclopentane		C <sub>6</sub> H <sub>12</sub>	96-37-7	84.159	liq	-142.42	71.8	0.7486 <sup>20</sup>	1.4097 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, lig, ctc
7168	1-Methylcyclopentanol		C <sub>6</sub> H <sub>12</sub> O	1462-03-9	100.158	nd	36	136; 53 <sup>30</sup>	0.9044 <sup>23</sup>	1.4429 <sup>23</sup>	
7169	<i>cis</i> -2-Methylcyclopentanol		C <sub>6</sub> H <sub>12</sub> O	25144-05-2	100.158			148.5	0.9379 <sup>16</sup>	1.4504 <sup>16</sup>	
7170	2-Methylcyclopentanone		C <sub>6</sub> H <sub>10</sub> O	1120-72-5	98.142	liq	-75	139.5	0.9139 <sup>20</sup>	1.4364 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth, ace
7171	3-Methylcyclopentanone, (±)		C <sub>6</sub> H <sub>10</sub> O	6195-92-2	98.142	liq	-58.4	144	0.913 <sup>22</sup>	1.4329 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth, ace, HOAc
7172	1-Methylcyclopentene		C <sub>6</sub> H <sub>10</sub>	693-89-0	82.143	liq	-126.5	75.5	0.7748 <sup>25</sup>	1.4322 <sup>20</sup>	
7173	3-Methylcyclopentene		C <sub>6</sub> H <sub>10</sub>	1120-62-3	82.143			64.9	0.7572 <sup>25</sup>	1.4216 <sup>20</sup>	
7174	4-Methylcyclopentene		C <sub>6</sub> H <sub>10</sub>	1759-81-5	82.143	liq	-160.8	65.7	0.7634 <sup>25</sup>	1.4209 <sup>20</sup>	
7175	2-Methyl-2-cyclopenten-1-one		C <sub>6</sub> H <sub>8</sub> O	1120-73-6	96.127			157	0.9808 <sup>16</sup>	1.4762 <sup>15</sup>	
7176	3-Methyl-2-cyclopenten-1-one		C <sub>6</sub> H <sub>8</sub> O	2758-18-1	96.127			157.5	0.9712 <sup>20</sup>	1.4714 <sup>20</sup>	

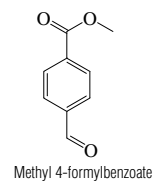
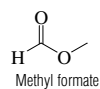
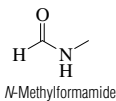
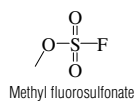
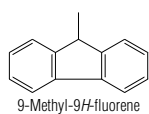
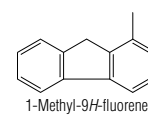
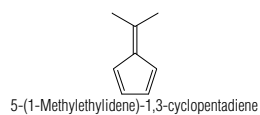
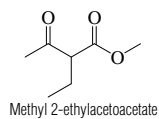
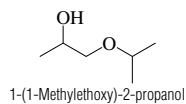
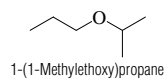
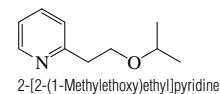
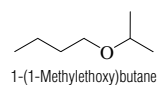
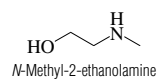
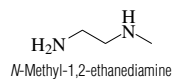
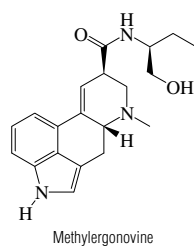
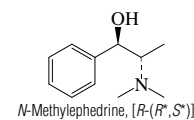
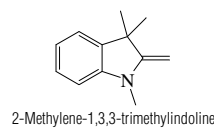
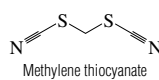
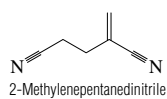
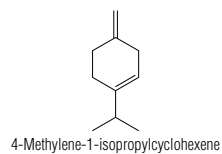
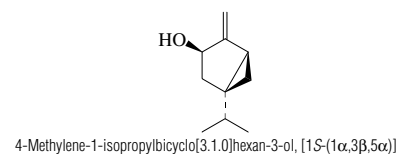
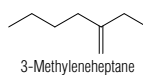
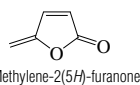
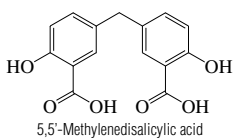
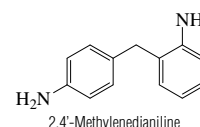
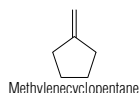
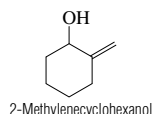
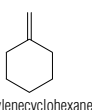
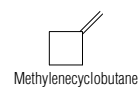
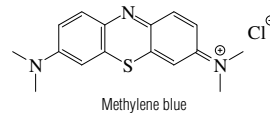
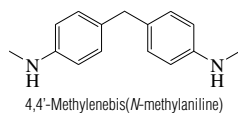
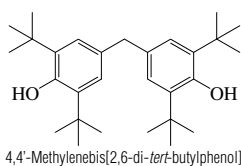
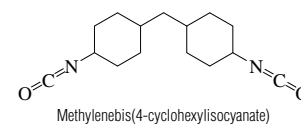
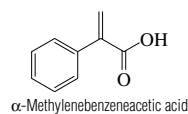
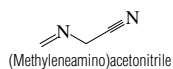
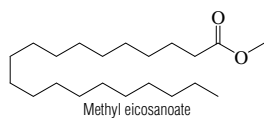
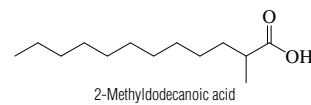
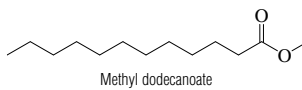
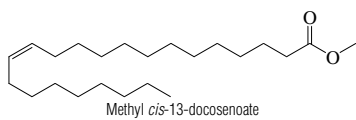


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7177	Methylcyclopropane		C <sub>4</sub> H <sub>8</sub>	594-11-6	56.107	col gas	-177.6	0.7	0.6912 <sup>20</sup>		vs eth, EtOH
7178	Methyl cyclopropanecarboxylate		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2868-37-3	100.117			114.9	0.9848 <sup>20</sup>	1.4144 <sup>19</sup>	s ace, chl
7179	α-Methylcyclopropanemethanol		C <sub>5</sub> H <sub>10</sub> O	765-42-4	86.132	liq	-32.1	123.5	0.8805 <sup>20</sup>	1.4316 <sup>20</sup>	
7180	Methyl L-cysteine hydrochloride		C <sub>4</sub> H <sub>10</sub> ClNO <sub>2</sub> S	18598-63-5	171.646	cry (MeOH)	140.5				
7181	Methyl <i>trans</i> -2, <i>cis</i> -4-decadienoate		C <sub>11</sub> H <sub>18</sub> O <sub>2</sub>	4493-42-9	182.260			71 <sup>0,15</sup>	0.9128 <sup>22</sup>	1.4874 <sup>22</sup>	
7182	Methyl <i>trans</i> -2, <i>trans</i> -4-decadienoate		C <sub>11</sub> H <sub>18</sub> O <sub>2</sub>	7328-33-8	182.260			87 <sup>13</sup> , 70 <sup>2</sup>	0.9082 <sup>22</sup>	1.4918 <sup>22</sup>	
7183	2-Methyldecane		C <sub>11</sub> H <sub>24</sub>	6975-98-0	156.309	liq	-48.9	189.3	0.7368 <sup>20</sup>	1.4154 <sup>20</sup>	
7184	3-Methyldecane		C <sub>11</sub> H <sub>24</sub>	13151-34-3	156.309	liq	-92.9	188.1	0.7422 <sup>20</sup>	1.4177 <sup>20</sup>	
7185	4-Methyldecane		C <sub>11</sub> H <sub>24</sub>	2847-72-5	156.309	liq	-77.5	187		1.4352 <sup>20</sup>	
7186	Methyl decanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	110-42-9	186.292	liq	-18	224	0.8730 <sup>20</sup>	1.4259 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc; msc chl
7187	Methyl demeton		C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	8022-00-2	230.285	ye liq		89 <sup>15</sup> , 118 <sup>1</sup>	1.20 <sup>20</sup>	1.5063 <sup>20</sup>	i H <sub>2</sub> O; s os
7188	Methyldiborane(6)		CH <sub>6</sub> B <sub>2</sub>	23777-55-1	41.697	unstab gas					s eth
7189	Methyl 2,3-dibromopropanoate		C <sub>4</sub> H <sub>6</sub> Br <sub>2</sub> O <sub>2</sub>	1729-67-5	245.898			206	1.9333 <sup>20</sup>	1.5127 <sup>20</sup>	s EtOH
7190	Methyl dichloroacetate		C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	116-54-1	142.969	liq	-51.9	142.9	1.3774 <sup>20</sup>	1.4429 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc
7191	Methyl 2,5-dichlorobenzoate		C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	2905-69-3	205.039	cry	38				
7192	Methyl (2,4-dichlorophenoxy) acetate	2,4-D methyl ester	C <sub>9</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	1928-38-7	235.064		119	141 <sup>18</sup>			
7193	Methyl (3,4-dichlorophenyl) carbamate	Swep	C <sub>9</sub> H <sub>7</sub> Cl <sub>2</sub> NO <sub>2</sub>	1918-18-9	220.054	nd	114				
7194	Methyl 2,3-dichloropropanoate		C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	3674-09-7	156.996			92 <sup>20</sup> , 63 <sup>10</sup>	1.3282 <sup>20</sup>		vs ace, eth, EtOH
7195	Methyldifluoroarsine		CH <sub>3</sub> AsF <sub>2</sub>	420-24-6	127.954	liq, fumes in air	-29.7	76.5	1.924 <sup>18</sup>		
7196	Methyldifluorophosphine	(Difluoro)methylphosphine	CH <sub>2</sub> F <sub>2</sub> P	753-59-3	84.006	gas	-110	-28			sl EtOH, ace
7197	Methyl 2,4-dihydroxybenzoate		C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	2150-47-2	168.148		116.5				
7198	Methyl 3,5-dihydroxybenzoate		C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	2150-44-9	168.148		165				
7199	Methyl 3,4-dimethoxybenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	2150-38-1	196.200	nd (dil al)	60.8	283			vs bz, eth, EtOH
7200	Methyldimethoxysilane		C <sub>3</sub> H <sub>10</sub> O <sub>2</sub> Si	16881-77-9	106.196			61			
7201	3-Methyl-4'-(dimethylamino) azobenzene		C <sub>15</sub> H <sub>17</sub> N <sub>3</sub>	55-80-1	239.316	oran cry	122				
7202	2-Methyl- <i>N,N</i> -dimethylaniline	<i>N,N</i> -Dimethyl- <i>o</i> -toluidine	C <sub>9</sub> H <sub>13</sub> N	609-72-3	135.206	liq	-60	194.1	0.9286 <sup>20</sup>	1.5152 <sup>20</sup>	vs eth, EtOH
7203	3-Methyl- <i>N,N</i> -dimethylaniline	<i>N,N</i> -Dimethyl- <i>m</i> -toluidine	C <sub>9</sub> H <sub>13</sub> N	121-72-2	135.206			212	0.9410 <sup>20</sup>	1.5492 <sup>20</sup>	msc EtOH, eth
7204	4-Methyl- <i>N,N</i> -dimethylaniline	<i>N,N</i> -Dimethyl- <i>p</i> -toluidine	C <sub>9</sub> H <sub>13</sub> N	99-97-8	135.206			211	0.9366 <sup>20</sup>	1.5366 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
7205	Methyl 2,2-dimethylpropanoate	Methyl 2,2-dimethylpropionate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	598-98-1	116.158			101.1	0.891 <sup>0</sup>	1.3905 <sup>20</sup>	vs eth, EtOH
7206	Methyl dimethylthioborane	Dimethyl(methylthio)borane	C <sub>3</sub> H <sub>6</sub> BS	19163-05-4	87.979	liq	-84	71			vs ace, eth
7207	2-Methyl-3,5-dinitrobenzamide	Dinitolmide	C <sub>8</sub> H <sub>7</sub> N <sub>3</sub> O <sub>5</sub>	148-01-6	225.159	cry	181				
7208	1-Methyl-2,3-dinitrobenzene	2,3-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	602-01-7	182.134		63				i H <sub>2</sub> O; s EtOH, eth; sl chl
7209	1-Methyl-2,4-dinitrobenzene	2,4-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	121-14-2	182.134	ye nd or mcl pr (CS <sub>2</sub> )	70.5	dec 300	1.3208 <sup>71</sup>	1.442	i H <sub>2</sub> O; s EtOH, eth, chl, bz; vs ace, py
7210	1-Methyl-3,5-dinitrobenzene	3,5-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	618-85-9	182.134	ye orth nd (HOAc)	93	sub	1.2772 <sup>111</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
7211	2-Methyl-1,3-dinitrobenzene	2,6-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	606-20-2	182.134	orth nd (al)	66.0	285	1.2833 <sup>111</sup>	1.479	s EtOH, chl
7212	2-Methyl-1,4-dinitrobenzene	2,5-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	619-15-8	182.134	nd (al)	52.5		1.282 <sup>111</sup>		s EtOH, bz; vs CS <sub>2</sub>
7213	4-Methyl-1,2-dinitrobenzene	3,4-Dinitrotoluene	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	610-39-9	182.134	ye nd (CS <sub>2</sub> )	59.0		1.2594 <sup>111</sup>		i H <sub>2</sub> O; s EtOH, CS <sub>2</sub> ; sl chl
7214	2-Methyl-4,6-dinitrophenol	4,6-Dinitro- <i>o</i> -cresol	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>5</sub>	534-52-1	198.133	ye pr or nd (al)	86.5				sl H <sub>2</sub> O, peth; s EtOH, eth, ace, chl
7215	4-Methyl-2,6-dinitrophenol	2,6-Dinitro- <i>p</i> -cresol	C <sub>7</sub> H <sub>9</sub> N <sub>2</sub> O <sub>5</sub>	609-93-8	198.133	ye nd (eth, peth)	85				i H <sub>2</sub> O; s EtOH, eth, bz
7216	Methyldioctylamine	<i>N</i> -Methyl- <i>N</i> -octyl-1-octanamine	C <sub>17</sub> H <sub>37</sub> N	4455-26-9	255.483		-30.1	158 <sup>10</sup>		1.4424 <sup>20</sup>	
7217	4-Methyl-1,3-dioxane		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	1120-97-4	102.132	liq	-44.5	114	0.9758 <sup>20</sup>	1.4159 <sup>20</sup>	sl H <sub>2</sub> O; vs os
7218	2-Methyl-1,3-dioxolane		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	497-26-7	88.106			81.5	0.9811 <sup>20</sup>	1.4035 <sup>17</sup>	vs H <sub>2</sub> O; msc EtOH, eth
7219	4-Methyl-1,3-dioxolane		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1072-47-5	88.106	liq		85	0.99 <sup>20</sup>	1.3980 <sup>20</sup>	
7220	Methyldiphenylamine	<i>N</i> -Methyl- <i>N</i> -phenylbenzenamine	C <sub>13</sub> H <sub>13</sub> N	552-82-9	183.249	liq	-7.5	293.5	1.0476 <sup>20</sup>	1.6193 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, MeOH; s ctc
7221	4-Methyl-2,4-diphenyl-1-pentene		C <sub>18</sub> H <sub>20</sub>	6362-80-7	236.352	liq		172 <sup>8</sup> , 102 <sup>0,2</sup>	0.99 <sup>25</sup>		
7222	Methyldiphenylsilane		C <sub>13</sub> H <sub>14</sub> Si	776-76-1	198.336			93.5 <sup>1</sup>	0.996 <sup>20</sup>	1.5694 <sup>20</sup>	s ctc
7223	Methyldiphenylsilanol		C <sub>13</sub> H <sub>14</sub> O <sub>2</sub> Si	778-25-6	214.335		167	184 <sup>24</sup> , 148 <sup>3</sup>	1.0840 <sup>25</sup>		s ctc, CS <sub>2</sub>
7224	2-Methyl-1,2-di-3-pyridinyl-1-propanone	Metrypone	C <sub>14</sub> H <sub>14</sub> N <sub>2</sub> O	54-36-4	226.273		50.5				
7225	Methyl docosanoate	Methyl behenate	C <sub>23</sub> H <sub>46</sub> O <sub>2</sub>	929-77-1	354.610	nd (ace)	54			1.4339 <sup>60</sup>	vs eth, EtOH



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7226	Methyl <i>cis</i> -13-docosenoate		C <sub>23</sub> H <sub>44</sub> O <sub>2</sub>	1120-34-9	352.594		-1.2	220 <sup>5</sup>			
7227	Methyl dodecanoate	Methyl laurate	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	111-82-0	214.344		5.2	267	0.8702 <sup>20</sup>	1.4319 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl, ctc
7228	2-Methyldodecanoic acid		C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	2874-74-0	214.344	pl	22	153 <sup>1</sup>	0.890 <sup>18</sup>		
7229	Methyl eicosanoate	Methyl arachidate	C <sub>21</sub> H <sub>42</sub> O <sub>2</sub>	1120-28-1	326.557	lf (MeOH)	54.5	215 <sup>10</sup>		1.4317 <sup>60</sup>	vs bz, eth, EtOH, chl
7230	(Methyleneamino)acetonitrile		C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	109-82-0	68.077		129				
7231	α-Methylenebenzeneacetic acid	Atropic acid	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	492-38-6	148.159	lf (al), nd (w)	106.5	dec 267			sl H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
7232	Methylenebis(4-cyclohexylisocyanate)		C <sub>15</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	5124-30-1	262.348	liq			1.066	1.4970 <sup>20</sup>	
7233	4,4'-Methylenebis[2,6-di- <i>tert</i> -butylphenol]	Bis(3,5-di- <i>tert</i> -butyl-4-hydroxyphenyl)methane	C <sub>28</sub> H <sub>44</sub> O <sub>2</sub>	118-82-1	424.658		154	289 <sup>40</sup> , 250 <sup>10</sup>			
7234	4,4'-Methylenebis( <i>N</i> -methylaniline)	<i>N,N'</i> -Dimethyl-4,4'-diaminodiphenylmethane	C <sub>15</sub> H <sub>18</sub> N <sub>2</sub>	1807-55-2	226.317						s ctc, CS <sub>2</sub>
7235	Methylene blue		C <sub>16</sub> H <sub>18</sub> ClN <sub>3</sub> S	61-73-4	319.852	dk grn cry or pow (chl-eth)					s H <sub>2</sub> O, EtOH, chl; i eth; sl py
7236	Methylenecyclobutane		C <sub>4</sub> H <sub>8</sub>	1120-56-5	68.118	liq	-134.7	42.2	0.7401 <sup>20</sup>	1.4210 <sup>20</sup>	
7237	Methylenecyclohexane		C <sub>6</sub> H <sub>12</sub>	1192-37-6	96.170	liq	-106.7	102.5	0.8074 <sup>20</sup>	1.4523 <sup>30</sup>	i H <sub>2</sub> O; s eth, bz, chl
7238	2-Methylenecyclohexanol		C <sub>7</sub> H <sub>12</sub> O	4065-80-9	112.169			83 <sup>13</sup>	0.955 <sup>20</sup>	1.4843 <sup>30</sup>	
7239	Methylenecyclopentane		C <sub>6</sub> H <sub>10</sub>	1528-30-9	82.143			75.5	0.7787 <sup>20</sup>	1.4355 <sup>20</sup>	s bz, chl
7240	Methylenecyclopropene		C <sub>4</sub> H <sub>4</sub>	4095-06-1	52.075	solid stab at -196					
7241	2,4'-Methylenedianiline	2,4'-Diaminodiphenylmethane	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub>	1208-52-2	198.263	lf (bz)	88.5	222 <sup>9</sup>			
7242	5,5'-Methylenedisalicylic acid		C <sub>15</sub> H <sub>12</sub> O <sub>6</sub>	122-25-8	288.252	nd (bz)	243.5				vs ace, eth, EtOH
7243	5-Methylene-2(5 <i>H</i> )-furanone	Protoanemonin	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	108-28-1	96.085	pa ye oil		73 <sup>11</sup>			sl H <sub>2</sub> O; s chl
7244	3-Methyleneheptane		C <sub>8</sub> H <sub>16</sub>	1632-16-2	112.213			120	0.7270 <sup>20</sup>	1.4157 <sup>20</sup>	i H <sub>2</sub> O; vs eth, bz, peth
7245	4-Methylene-1-isopropylbicyclo[3.1.0]hexan-3-ol, [1 <i>S</i> -(1α,3β,5α)]	4(10)-Thujene-3-ol	C <sub>10</sub> H <sub>16</sub> O	471-16-9	152.233			208	0.9488 <sup>19</sup>	1.4871 <sup>25</sup>	s eth
7246	4-Methylene-1-isopropylcyclohexene		C <sub>10</sub> H <sub>16</sub>	99-84-3	136.234			173.5	0.838 <sup>22</sup>	1.4754 <sup>22</sup>	
7247	2-Methylenepentanedinitrile	2,4-Dicyano-1-butene	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1572-52-7	106.125			103 <sup>5</sup>		1.4561 <sup>20</sup>	s chl
7248	Methylene thiocyanate	Dithiocyanatomethane	C <sub>3</sub> H <sub>2</sub> N <sub>2</sub> S <sub>2</sub>	6317-18-6	130.191	solid	102				
7249	2-Methylene-1,3,3-trimethylindoline	Fischer's base	C <sub>12</sub> H <sub>15</sub> N	118-12-7	173.254			244			sl H <sub>2</sub> O; s EtOH, eth, bz, chl
7250	<i>N</i> -Methylephedrine, [ <i>R</i> -( <i>R</i> *, <i>S</i> *)]	(1 <i>R</i> ,2 <i>S</i> )- <i>N</i> -Methylephedrine	C <sub>11</sub> H <sub>17</sub> NO	552-79-4	179.259	nd or pl (al, eth)	87.5				i H <sub>2</sub> O; s EtOH, eth, MeOH
7251	Methylergonovine	Methylergometrine	C <sub>20</sub> H <sub>25</sub> N <sub>3</sub> O <sub>2</sub>	113-42-8	339.432	pr (MeOH, ace)	172				i H <sub>2</sub> O; s EtOH, ace
7252	<i>N</i> -Methyl-1,2-ethanediamine		C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	109-81-9	74.124			115	0.841 <sup>25</sup>	1.4395 <sup>20</sup>	
7253	<i>N</i> -Methyl-2-ethanolamine		C <sub>3</sub> H <sub>9</sub> NO	109-83-1	75.109			158	0.937 <sup>20</sup>	1.4385 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
7254	1-(1-Methylethoxy)butane	Butyl isopropyl ether	C <sub>7</sub> H <sub>16</sub> O	1860-27-1	116.201			108	0.7594 <sup>15</sup>	1.3870 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, con sulf
7255	2-[2-(1-Methylethoxy)ethyl]pyridine		C <sub>10</sub> H <sub>15</sub> NO	70715-19-4	165.232			133 <sup>50</sup>	0.9502 <sup>25</sup>	1.4820 <sup>25</sup>	vs H <sub>2</sub> O
7256	1-(1-Methylethoxy)propane		C <sub>6</sub> H <sub>14</sub> O	627-08-7	102.174			83	0.7370 <sup>20</sup>	1.376 <sup>21</sup>	sl H <sub>2</sub> O; vs EtOH; s eth, ace
7257	1-(1-Methylethoxy)-2-propanol	1-Isopropoxy-2-propanol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	3944-36-3	118.174			137.5	0.879 <sup>20</sup>	1.4070 <sup>20</sup>	
7258	Methyl 2-ethylacetoacetate		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	51756-08-2	144.168			182	0.995 <sup>14</sup>		vs ace, eth, EtOH
7259	5-(1-Methylethylidene)-1,3-cyclopentadiene		C <sub>8</sub> H <sub>10</sub>	2175-91-9	106.165		1.4	155; 49 <sup>11</sup>	0.881 <sup>20</sup>	1.5474 <sup>20</sup>	
7260	1-Methyl-9 <i>H</i> -fluorene		C <sub>14</sub> H <sub>12</sub>	1730-37-6	180.245		87				
7261	9-Methyl-9 <i>H</i> -fluorene		C <sub>14</sub> H <sub>12</sub>	2523-37-7	180.245	pr	46.5	155 <sup>15</sup>	1.0263 <sup>66</sup>	1.610 <sup>66</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
7262	Methyl fluorosulfonate		CH <sub>3</sub> FO <sub>3</sub> S	421-20-5	114.096	col liq	-95	93	1.412	1.3326 <sup>20</sup>	
7263	<i>N</i> -Methylformamide		C <sub>2</sub> H <sub>5</sub> NO	123-39-7	59.067	liq	-3.8	199.51	1.011 <sup>19</sup>	1.4319 <sup>20</sup>	vs H <sub>2</sub> O, ace, EtOH
7264	Methyl formate		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	107-31-3	60.052	liq	-99	31.7	0.9713 <sup>20</sup>	1.3419 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH; s eth, chl, MeOH
7265	Methyl 4-formylbenzoate		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	1571-08-0	164.158	nd (w)	63	265			
7266	2-Methylfuran		C <sub>5</sub> H <sub>6</sub> O	534-22-5	82.101	liq	-91.3	64.7	0.9132 <sup>20</sup>	1.4342 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth

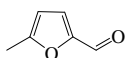




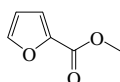
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7267	3-Methylfuran		C <sub>5</sub> H <sub>6</sub> O	930-27-8	82.101			65.5	0.923 <sup>18</sup>	1.4330 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, eth
7268	5-Methyl-2-furancarboxaldehyde		C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	620-02-0	110.111			187; 89 <sup>26</sup>	1.1072 <sup>18</sup>	1.5264 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH; msc eth; sl ctc
7269	Methyl 2-furancarboxylate	Methyl 2-furanoate	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	611-13-2	126.110			181.3	1.1786 <sup>21</sup>	1.4860 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
7270	3-Methyl-2,5-furandione		C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	616-02-4	112.084		7.5	213.5	1.2469 <sup>16</sup>	1.4710 <sup>21</sup>	vs ace, eth, EtOH
7271	<i>N</i> -Methyl-2-furanmethanamine		C <sub>6</sub> H <sub>9</sub> NO	4753-75-7	111.141			149	0.989 <sup>25</sup>	1.4729 <sup>20</sup>	
7272	5-Methyl-2-furanmethanol		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	3857-25-8	112.127			dec 195; 81 <sup>23</sup>	1.0769 <sup>20</sup>	1.4853 <sup>20</sup>	vs eth, EtOH
7273	$\alpha$ -Methyl-2-furanmethanol		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	4208-64-4	112.127			162.5	1.0739 <sup>25</sup>	1.4827 <sup>15</sup>	
7274	5-Methyl-2(3 <i>H</i> )-furanone		C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	591-12-8	98.101	nd	18	56 <sup>12</sup>	1.084 <sup>20</sup>	1.4476 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, CS <sub>2</sub> ; sl ctc
7275	5-Methyl-2(5 <i>H</i> )-furanone		C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	591-11-7	98.101		<-17	209; 98 <sup>15</sup>	1.0810 <sup>20</sup>	1.4454 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth
7276	Methylgermane		CH <sub>3</sub> Ge	1449-65-6	90.70	col gas	-158	-23			
7277	Methyl $\beta$ - <i>D</i> -glucopyranoside		C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	709-50-2	194.182			109			s H <sub>2</sub> O
7278	Methyl $\alpha$ - <i>D</i> -glucopyranoside	$\alpha$ -Methylglucoside	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	97-30-3	194.182	orth nd (al)	168	200 <sup>9,2</sup>	1.46 <sup>30</sup>		vs H <sub>2</sub> O
7279	3-Methylglutaric acid	3-Methylpentanedioic acid	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	626-51-7	146.141			87	166 <sup>0,5</sup>		s H <sub>2</sub> O, EtOH, eth; sl bz, chl; i lig
7280	Methyl Green		C <sub>27</sub> H <sub>35</sub> BrClN <sub>3</sub>	14855-76-6	516.944	grn pow (al)					vs H <sub>2</sub> O
7281	Methyl heptadecanoate		C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	1731-92-6	284.478	pl (al)	30	185 <sup>9</sup> , 152 <sup>0,5</sup>			i H <sub>2</sub> O; s EtOH, ace, ctc; vs eth, bz
7282	Methyl heptafluorobutanoate		C <sub>5</sub> H <sub>3</sub> F <sub>7</sub> O <sub>2</sub>	356-24-1	228.066	liq	-86	80	1.483 <sup>20</sup>	1.295 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace
7283	6-Methyl-2-heptanamine, ( $\pm$ )	Octodrine	C <sub>8</sub> H <sub>19</sub> N	5984-58-7	129.244	visc liq		155	0.767 <sup>25</sup>	1.4209 <sup>20</sup>	
7284	<i>N</i> -Methyl-2-heptanamine		C <sub>8</sub> H <sub>19</sub> N	540-43-2	129.244			155			
7285	2-Methylheptane		C <sub>8</sub> H <sub>18</sub>	592-27-8	114.229	liq	-109.02	117.66	0.6980 <sup>20</sup>	1.3949 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, ace, bz; s eth, ctc
7286	3-Methylheptane		C <sub>8</sub> H <sub>18</sub>	589-81-1	114.229	col liq	-120.48	118.9	0.7017 <sup>25</sup>	1.3961 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, chl
7287	4-Methylheptane		C <sub>8</sub> H <sub>18</sub>	589-53-7	114.229	liq	-121.0	117.72	0.7046 <sup>20</sup>	1.3979 <sup>20</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz
7288	Methyl heptanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	106-73-0	144.212	liq	-56	174	0.8815 <sup>20</sup>	1.4152 <sup>20</sup>	sl H <sub>2</sub> O, ctc, ace; s EtOH, eth
7289	2-Methyl-1-heptanol, ( $\pm$ )		C <sub>8</sub> H <sub>18</sub> O	111675-77-5	130.228	col liq	-112	175.6	0.8022 <sup>20</sup>	1.424 <sup>20</sup>	
7290	3-Methyl-1-heptanol		C <sub>8</sub> H <sub>18</sub> O	1070-32-2	130.228	liq	-90	186; 101 <sup>20</sup>	0.824 <sup>24</sup>	1.4295 <sup>25</sup>	
7291	4-Methyl-1-heptanol		C <sub>8</sub> H <sub>18</sub> O	817-91-4	130.228			188	0.8065 <sup>25</sup>	1.4253 <sup>25</sup>	vs EtOH
7292	5-Methyl-1-heptanol, ( $\pm$ )		C <sub>8</sub> H <sub>18</sub> O	111767-95-4	130.228	col liq	-104	186.6	0.8153 <sup>25</sup>	1.4272 <sup>25</sup>	
7293	6-Methyl-1-heptanol	Isooctyl alcohol	C <sub>8</sub> H <sub>18</sub> O	1653-40-3	130.228	liq	-106	188; 95.8 <sup>20</sup>	0.8176 <sup>25</sup>	1.4251 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
7294	2-Methyl-2-heptanol		C <sub>8</sub> H <sub>18</sub> O	625-25-2	130.228	liq	-50.4	156	0.8142 <sup>20</sup>	1.4250 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7295	3-Methyl-2-heptanol		C <sub>8</sub> H <sub>18</sub> O	31367-46-1	130.228			166.1	0.8177 <sup>25</sup>	1.4199 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
7296	4-Methyl-2-heptanol		C <sub>8</sub> H <sub>18</sub> O	56298-90-9	130.228	col liq	-102	171.6	0.8027 <sup>20</sup>	1.424 <sup>20</sup>	
7297	5-Methyl-2-heptanol		C <sub>8</sub> H <sub>18</sub> O	54630-50-1	130.228	liq	-61	170	0.8174 <sup>21</sup>		
7298	6-Methyl-2-heptanol		C <sub>8</sub> H <sub>18</sub> O	4730-22-7	130.228	liq	-105	174	0.8218 <sup>20</sup>	1.4238 <sup>10</sup>	
7299	2-Methyl-3-heptanol, ( $\pm$ )		C <sub>8</sub> H <sub>18</sub> O	100296-26-2	130.228	liq	-85	167.5	0.8235 <sup>20</sup>	1.4265 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
7300	3-Methyl-3-heptanol	2-Ethyl-2-hexanol	C <sub>8</sub> H <sub>18</sub> O	5582-82-1	130.228	liq	-83	163	0.8282 <sup>20</sup>	1.4279 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
7301	4-Methyl-3-heptanol		C <sub>8</sub> H <sub>18</sub> O	14979-39-6	130.228	liq	-123	170	0.827 <sup>25</sup>	1.4300 <sup>20</sup>	
7302	5-Methyl-3-heptanol		C <sub>8</sub> H <sub>18</sub> O	18720-65-5	130.228	liq	-91.2	172	0.8425 <sup>25</sup>	1.433 <sup>24</sup>	
7303	6-Methyl-3-heptanol, ( $\pm$ )		C <sub>8</sub> H <sub>18</sub> O	100295-85-0	130.228	col liq	-61	169	0.8220 <sup>20</sup>	1.4254 <sup>20</sup>	
7304	2-Methyl-4-heptanol		C <sub>8</sub> H <sub>18</sub> O	21570-35-4	130.228	liq	-81	164	0.8207 <sup>20</sup>	1.4203	vs eth, EtOH
7305	3-Methyl-4-heptanol		C <sub>8</sub> H <sub>18</sub> O	1838-73-9	130.228	liq		164.7	0.8329 <sup>25</sup>	1.4211 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
7306	4-Methyl-4-heptanol		C <sub>8</sub> H <sub>18</sub> O	598-01-6	130.228	liq	-82	161	0.8248 <sup>20</sup>	1.4258 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
7307	6-Methyl-2-heptanol acetate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	67952-57-2	172.265			187	0.8474 <sup>20</sup>	1.413 <sup>20</sup>	vs EtOH
7308	6-Methyl-2-heptanone		C <sub>8</sub> H <sub>16</sub> O	928-68-7	128.212			167	0.8151 <sup>20</sup>	1.4162 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; msc ace, bz, chl
7309	5-Methyl-3-heptanone		C <sub>8</sub> H <sub>16</sub> O	541-85-5	128.212	liq		161			
7310	6-Methyl-3-heptanone		C <sub>8</sub> H <sub>16</sub> O	624-42-0	128.212			164	0.8304 <sup>20</sup>	1.4209 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
7311	2-Methyl-4-heptanone	Isobutyl propyl ketone	C <sub>8</sub> H <sub>16</sub> O	626-33-5	128.212			154	0.813 <sup>22</sup>		i H <sub>2</sub> O; s EtOH, eth



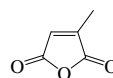
3-Methylfuran



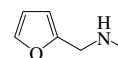
5-Methyl-2-furancarboxaldehyde



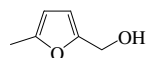
Methyl 2-furancarboxylate



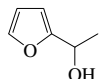
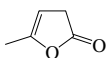
3-Methyl-2,5-furandione



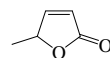
N-Methyl-2-furanmethanamine



5-Methyl-2-furanmethanol

 $\alpha$ -Methyl-2-furanmethanol

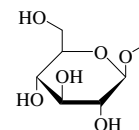
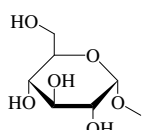
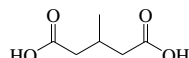
5-Methyl-2(3H)-furanone



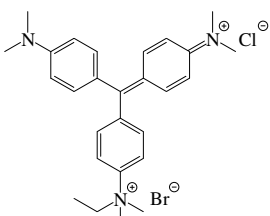
5-Methyl-2(5H)-furanone



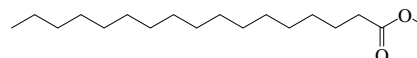
Methylgermane

Methyl  $\beta$ -D-glucopyranosideMethyl  $\alpha$ -D-glucopyranoside

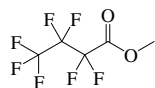
3-Methylglutaric acid



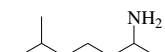
Methyl Green



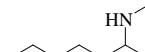
Methyl heptadecanoate



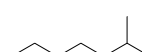
Methyl heptafluorobutanoate



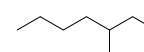
6-Methyl-2-heptanamine, (+)



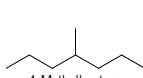
N-Methyl-2-heptanamine



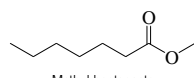
2-Methylheptane



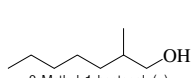
3-Methylheptane



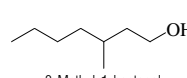
4-Methylheptane



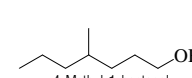
Methyl heptanoate



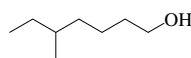
2-Methyl-1-heptanol, (+)



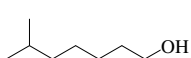
3-Methyl-1-heptanol



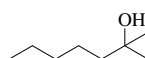
4-Methyl-1-heptanol



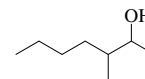
5-Methyl-1-heptanol, (+)



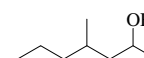
6-Methyl-1-heptanol



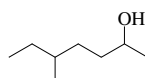
2-Methyl-2-heptanol



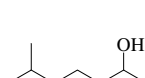
3-Methyl-2-heptanol



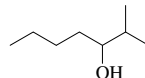
4-Methyl-2-heptanol



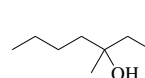
5-Methyl-2-heptanol



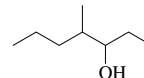
6-Methyl-2-heptanol



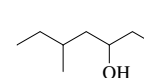
2-Methyl-3-heptanol, (+)



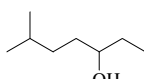
3-Methyl-3-heptanol



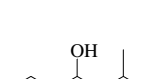
4-Methyl-3-heptanol



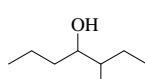
5-Methyl-3-heptanol



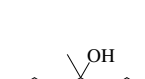
6-Methyl-3-heptanol, (+)



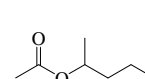
2-Methyl-4-heptanol



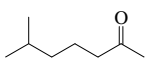
3-Methyl-4-heptanol



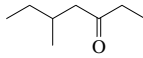
4-Methyl-4-heptanol



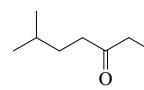
6-Methyl-2-heptanol acetate



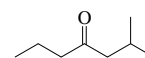
6-Methyl-2-heptanone



5-Methyl-3-heptanone

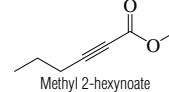
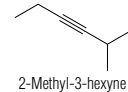
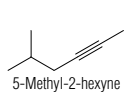
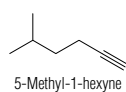
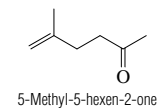
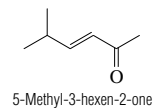
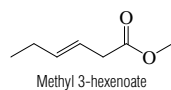
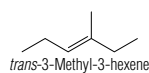
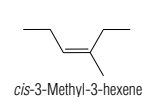
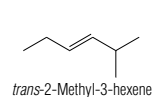
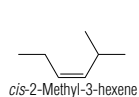
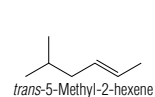
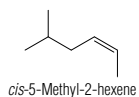
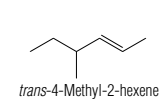
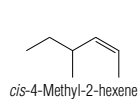
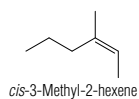
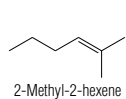
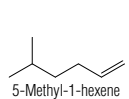
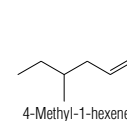
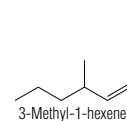
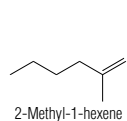
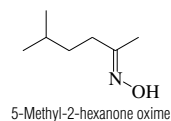
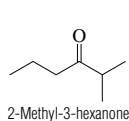
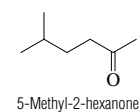
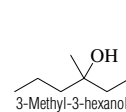
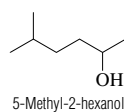
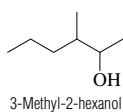
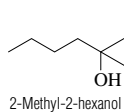
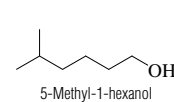
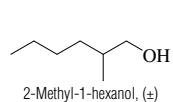
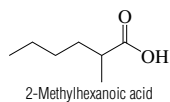
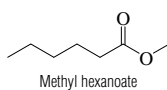
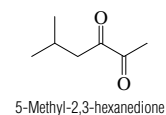
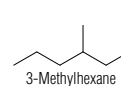
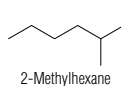
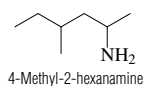
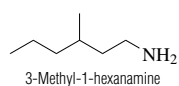
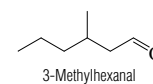
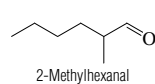
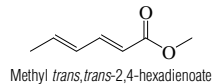
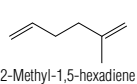
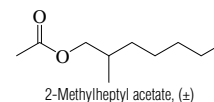
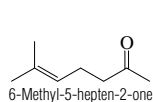
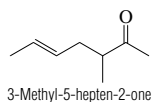
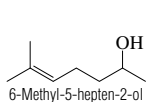
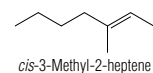
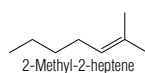
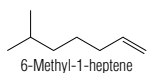
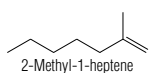


6-Methyl-3-heptanone

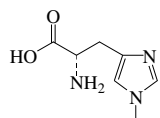


2-Methyl-4-heptanone

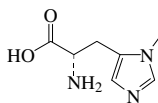
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7312	2-Methyl-1-heptene		C <sub>8</sub> H <sub>16</sub>	15870-10-7	112.213	liq	-90	119.3	0.7104 <sup>25</sup>	1.4123 <sup>20</sup>	
7313	6-Methyl-1-heptene		C <sub>8</sub> H <sub>16</sub>	5026-76-6	112.213			113.2	0.7079 <sup>25</sup>	1.4070 <sup>20</sup>	
7314	2-Methyl-2-heptene		C <sub>8</sub> H <sub>16</sub>	627-97-4	112.213			122.6	0.7200 <sup>25</sup>	1.4170 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, ctc, chl
7315	<i>cis</i> -3-Methyl-2-heptene		C <sub>8</sub> H <sub>16</sub>	22768-19-0	112.213			122	0.725 <sup>25</sup>	1.419 <sup>20</sup>	
7316	6-Methyl-5-hepten-2-ol		C <sub>8</sub> H <sub>16</sub> O	1569-60-4	128.212			175	0.8545 <sup>20</sup>	1.4505 <sup>20</sup>	
7317	3-Methyl-5-hepten-2-one		C <sub>8</sub> H <sub>14</sub> O	38552-72-6	126.196			63 <sup>20</sup>	0.8463 <sup>18</sup>	1.4345 <sup>18</sup>	
7318	6-Methyl-5-hepten-2-one		C <sub>8</sub> H <sub>14</sub> O	110-93-0	126.196		173.5		0.8546 <sup>16</sup>	1.4445 <sup>20</sup>	vs eth, EtOH
7319	2-Methylheptyl acetate, (±)		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	74112-36-0	172.265			195	0.8626 <sup>14</sup>	1.4146 <sup>20</sup>	vs eth, EtOH
7320	2-Methyl-1,5-hexadiene		C <sub>7</sub> H <sub>12</sub>	4049-81-4	96.170	liq	-128.8	88.1	0.7153 <sup>25</sup>	1.4183 <sup>20</sup>	
7321	Methyl <i>trans,trans</i> -2,4-hexadienoate	Methyl sorbate	C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	689-89-4	126.153	lf	15	180; 70 <sup>20</sup>	0.9777 <sup>20</sup>	1.5025 <sup>22</sup>	i H <sub>2</sub> O; s EtOH, eth
7322	2-Methylhexanal		C <sub>7</sub> H <sub>14</sub> O	925-54-2	114.185	liq		141; 132 <sup>60</sup>			
7323	3-Methylhexanal	3-Methylcaproaldehyde	C <sub>7</sub> H <sub>14</sub> O	19269-28-4	114.185			143	0.8203 <sup>20</sup>	1.4122 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7324	3-Methyl-1-hexanamine		C <sub>7</sub> H <sub>17</sub> N	65530-93-0	115.217			149; 67 <sup>45</sup>	0.772 <sup>26</sup>	1.4249 <sup>25</sup>	
7325	4-Methyl-2-hexanamine		C <sub>7</sub> H <sub>17</sub> N	105-41-9	115.217			132.5	0.7655 <sup>20</sup>	1.4150 <sup>25</sup>	sl H <sub>2</sub> O; vs EtOH, eth, chl, dil acid
7326	2-Methylhexane		C <sub>7</sub> H <sub>16</sub>	591-76-4	100.202	liq	-118.2	90.04	0.6787 <sup>20</sup>	1.3848 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth, ace, bz, lig, chl
7327	3-Methylhexane		C <sub>7</sub> H <sub>16</sub>	78918-91-9	100.202	liq	-119.4	92	0.687 <sup>21</sup>	1.3854 <sup>25</sup>	i H <sub>2</sub> O; s EtOH; msc eth, ace, bz, lig, chl
7328	5-Methyl-2,3-hexanedione	2-Methylhexa-4,5-dione	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	13706-86-0	128.169			138	0.908 <sup>22</sup>	1.4119 <sup>20</sup>	
7329	Methyl hexanoate	Methyl caproate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	106-70-7	130.185	liq	-71	149.5	0.8846 <sup>20</sup>	1.4049 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz, ctc
7330	2-Methylhexanoic acid		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	4536-23-6	130.185			215.5	0.918 <sup>20</sup>	1.4193 <sup>20</sup>	vs ace, bz, eth, EtOH
7331	2-Methyl-1-hexanol, (±)		C <sub>7</sub> H <sub>16</sub> O	111768-04-8	116.201			164; 71 <sup>15</sup>	0.826 <sup>20</sup>	1.4226 <sup>20</sup>	vs eth, EtOH
7332	5-Methyl-1-hexanol		C <sub>7</sub> H <sub>16</sub> O	627-98-5	116.201			169; 54 <sup>15</sup>	0.8192 <sup>24</sup>	1.4175 <sup>20</sup>	vs eth, EtOH
7333	2-Methyl-2-hexanol		C <sub>7</sub> H <sub>16</sub> O	625-23-0	116.201			143	0.8119 <sup>20</sup>	1.4175 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
7334	3-Methyl-2-hexanol		C <sub>7</sub> H <sub>16</sub> O	2313-65-7	116.201			151; 80 <sup>32</sup>	0.8220 <sup>25</sup>	1.4198 <sup>18</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace
7335	5-Methyl-2-hexanol		C <sub>7</sub> H <sub>16</sub> O	627-59-8	116.201			151; 78 <sup>28</sup>	0.814 <sup>20</sup>	1.4180 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7336	3-Methyl-3-hexanol		C <sub>7</sub> H <sub>16</sub> O	597-96-6	116.201			143	0.8233 <sup>20</sup>	1.4231 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
7337	5-Methyl-2-hexanone	Methyl isopentyl ketone	C <sub>7</sub> H <sub>14</sub> O	110-12-3	114.185			144	0.888 <sup>20</sup>	1.4062 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH; vs ace, bz; s ctc
7338	2-Methyl-3-hexanone	Propyl isopropyl ketone	C <sub>7</sub> H <sub>14</sub> O	7379-12-6	114.185			135	0.8091 <sup>20</sup>	1.4042 <sup>20</sup>	s EtOH, eth, chl; vs ace
7339	5-Methyl-2-hexanone oxime		C <sub>7</sub> H <sub>15</sub> NO	624-44-2	129.200			195.5	0.8881 <sup>20</sup>	1.4448 <sup>20</sup>	sl chl
7340	2-Methyl-1-hexene		C <sub>7</sub> H <sub>14</sub>	6094-02-6	98.186	liq	-102.8	92	0.7000 <sup>20</sup>	1.4035 <sup>20</sup>	
7341	3-Methyl-1-hexene		C <sub>7</sub> H <sub>14</sub>	3404-61-3	98.186			83.9	0.6871 <sup>25</sup>	1.3965 <sup>20</sup>	
7342	4-Methyl-1-hexene		C <sub>7</sub> H <sub>14</sub>	3769-23-1	98.186	liq	-141.5	86.7	0.6942 <sup>25</sup>	1.4000 <sup>20</sup>	
7343	5-Methyl-1-hexene		C <sub>7</sub> H <sub>14</sub>	3524-73-0	98.186			85.3	0.6877 <sup>25</sup>	1.3967 <sup>20</sup>	
7344	2-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	2738-19-4	98.186	liq	-130.4	95.4	0.7038 <sup>25</sup>	1.4106 <sup>20</sup>	
7345	<i>cis</i> -3-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	10574-36-4	98.186	liq	-118.5	95.6	0.712 <sup>20</sup>	1.4126 <sup>20</sup>	
7346	<i>cis</i> -4-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	3683-19-0	98.186			86.3	0.6952 <sup>25</sup>	1.4026 <sup>20</sup>	
7347	<i>trans</i> -4-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	3683-22-5	98.186	liq	-125.7	87.6	0.6925 <sup>25</sup>	1.4025 <sup>20</sup>	
7348	<i>cis</i> -5-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	13151-17-2	98.186			89.5	0.697 <sup>25</sup>	1.404 <sup>20</sup>	
7349	<i>trans</i> -5-Methyl-2-hexene		C <sub>7</sub> H <sub>14</sub>	7385-82-2	98.186	liq	-124.3	88.1	0.6883 <sup>25</sup>	1.4006 <sup>20</sup>	
7350	<i>cis</i> -2-Methyl-3-hexene		C <sub>7</sub> H <sub>14</sub>	15840-60-5	98.186			86	0.690 <sup>25</sup>	1.401 <sup>20</sup>	
7351	<i>trans</i> -2-Methyl-3-hexene		C <sub>7</sub> H <sub>14</sub>	692-24-0	98.186	liq	-141.6	85.9	0.6853 <sup>25</sup>	1.4001 <sup>20</sup>	
7352	<i>cis</i> -3-Methyl-3-hexene		C <sub>7</sub> H <sub>14</sub>	4914-89-0	98.186			95.4	0.7079 <sup>25</sup>	1.4126 <sup>20</sup>	
7353	<i>trans</i> -3-Methyl-3-hexene		C <sub>7</sub> H <sub>14</sub>	3899-36-3	98.186			93.5	0.7050 <sup>25</sup>	1.4109 <sup>20</sup>	
7354	Methyl 3-hexenoate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	2396-78-3	128.169			67 <sup>34</sup>	0.9132 <sup>25</sup>	1.4240 <sup>23</sup>	
7355	5-Methyl-3-hexen-2-one	2-Oxo-5-methylhex-3-ene	C <sub>7</sub> H <sub>12</sub> O	5166-53-0	112.169			77 <sup>30</sup> , 65 <sup>13</sup>	0.8549 <sup>28</sup>	1.4395 <sup>22</sup>	
7356	5-Methyl-5-hexen-2-one		C <sub>7</sub> H <sub>12</sub> O	3240-09-3	112.169			150	0.8460 <sup>20</sup>	1.4348 <sup>20</sup>	vs ace, eth, EtOH
7357	5-Methyl-1-hexyne		C <sub>7</sub> H <sub>12</sub>	2203-80-7	96.170	liq	-125	92	0.7274 <sup>20</sup>	1.4059 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, peth
7358	5-Methyl-2-hexyne		C <sub>7</sub> H <sub>12</sub>	53566-37-3	96.170	liq	-92.9	102.5	0.7378 <sup>20</sup>	1.4176 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz, chl, peth
7359	2-Methyl-3-hexyne		C <sub>7</sub> H <sub>12</sub>	36566-80-0	96.170	liq	-116.7	95.2	0.7263 <sup>20</sup>	1.4120 <sup>20</sup>	vs bz, eth, chl, peth
7360	Methyl 2-hexynoate		C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	18937-79-6	126.153			80 <sup>23</sup>	0.9648 <sup>25</sup>		



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7361	<i>L</i> -1-Methylhistidine		C <sub>7</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	332-80-9	169.181	pl (DMF aq)	249				
7362	<i>L</i> -3-Methylhistidine		C <sub>7</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	368-16-1	169.181		250				
7363	Methylhydrazine		CH <sub>3</sub> N <sub>2</sub>	60-34-4	46.072	liq	-52.36	87.5		1.4325 <sup>20</sup>	s H <sub>2</sub> O, eth, ctc; msc EtOH; i lig
7364	Methyl hydrazinecarboxylate	Methyl carbazate	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	6294-89-9	90.081		73	108 <sup>12</sup>			s H <sub>2</sub> O, EtOH; sl bz; i peth
7365	Methyl hydrogen succinate	Monomethyl succinate	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	3878-55-5	132.116		58	151 <sup>20</sup> , 122 <sup>4</sup>			s H <sub>2</sub> O
7366	Methyl hydroperoxide	Methyl hydrogen peroxide	CH <sub>3</sub> O <sub>2</sub>	3031-73-0	48.042	liq	-72	86; 39 <sup>65</sup>	1.9967 <sup>15</sup>	1.3641 <sup>15</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
7367	Methyl hydroxyacetate		C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	96-35-5	90.078			149; 52 <sup>17</sup>	1.1677 <sup>18</sup>		s H <sub>2</sub> O; msc EtOH, eth
7368	Methyl 3-hydroxybenzoate		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	19438-10-9	152.148	nd (bz-peth)	73	281; 178 <sup>17</sup>	1.1528 <sup>100</sup>		s EtOH, bz, peth; sl chl
7369	Methyl 4-hydroxybenzoate	Methylparaben	C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	99-76-3	152.148	nd (dil al)	131	dec 275			sl H <sub>2</sub> O; vs EtOH, eth, ace; s tfa
7370	Methyl α-hydroxydiphenylacetate	Methyl diphenylglycolate	C <sub>15</sub> H <sub>14</sub> O <sub>3</sub>	76-89-1	242.270	mcl or tcl cry (al)	75.8	187 <sup>13</sup>			vs eth, EtOH
7371	<i>O</i> -Methylhydroxylamine	Methoxyamine	CH <sub>3</sub> NO	67-62-9	47.057			49			
7372	<i>O</i> -Methylhydroxylamine hydrochloride	Methoxyamine hydrochloride	CH <sub>6</sub> ClNO	593-56-6	83.518	pr	150.0				vs H <sub>2</sub> O, EtOH
7373	Methyl 4-hydroxy-3-methoxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	3943-74-6	182.173	nd (dil al)	64	286			s EtOH, peth; sl chl
7374	Methyl 2-hydroxy-3-methylbenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	23287-26-5	166.173		29	235	1.1683 <sup>25</sup>	1.5354 <sup>16</sup>	
7375	Methyl 2-hydroxy-5-methylbenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	22717-57-3	166.173	liq	-1	244.5	1.1673 <sup>25</sup>	1.5351 <sup>15</sup>	
7376	Methyl 2-hydroxy-2-methylpropanoate	Methyl 2-methylactate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	2110-78-3	118.131			137		1.4056 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
7377	Methyl 3-hydroxy-2-naphthalenecarboxylate	Methyl 3-hydroxy-2-naphthoate	C <sub>12</sub> H <sub>10</sub> O <sub>3</sub>	883-99-8	202.205	pa ye orth nd (dil MeOH)	75.5	206			i H <sub>2</sub> O; s EtOH
7378	Methyl α-hydroxyphenylacetate, (±)	(±)-Methyl mandelate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	4358-87-6	166.173	pl (bz-lig)	58	dec 250; 144 <sup>20</sup>	1.1756 <sup>20</sup>		vs EtOH, chl
7379	1-Methylimidazol		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	616-47-7	82.104	liq	-6	195.5	1.0325 <sup>20</sup>	1.4970 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
7380	2-Methyl-1 <i>H</i> -imidazole		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	693-98-1	82.104		144	267			vs H <sub>2</sub> O, EtOH
7381	4-Methyl-1 <i>H</i> -imidazole		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	822-36-6	82.104		56	263	1.0416 <sup>14</sup>	1.5037 <sup>14</sup>	vs H <sub>2</sub> O, EtOH
7382	<i>N</i> -Methyliminodiacetic acid	<i>N</i> -(Carboxymethyl)- <i>N</i> -methylglycine	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	4408-64-4	147.130	cry (w)	226				s H <sub>2</sub> O; i EtOH, eth
7383	1-Methyl-1 <i>H</i> -indene		C <sub>10</sub> H <sub>10</sub>	767-59-9	130.186			199; 82 <sup>15</sup>	0.970 <sup>25</sup>	1.5616 <sup>20</sup>	
7384	2-Methyl-1 <i>H</i> -indene		C <sub>10</sub> H <sub>10</sub>	2177-47-1	130.186		80	208	0.974 <sup>25</sup>	1.5652 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz
7385	3-Methyl-1 <i>H</i> -indene		C <sub>10</sub> H <sub>10</sub>	767-60-2	130.186			198	0.972 <sup>25</sup>	1.5621 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz
7386	1-Methyl-1 <i>H</i> -indole		C <sub>9</sub> H <sub>9</sub> N	603-76-9	131.174			237	1.0707 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, bz
7387	2-Methyl-1 <i>H</i> -indole		C <sub>9</sub> H <sub>9</sub> N	95-20-5	131.174	pl (dil al) nd or lf (w)	61	272	1.07 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s ace, bz
7388	3-Methyl-1 <i>H</i> -indole	Skatole	C <sub>9</sub> H <sub>9</sub> N	83-34-1	131.174	lf (lig)	97.5	266			s H <sub>2</sub> O, EtOH, eth, ace, bz, chl
7389	5-Methyl-1 <i>H</i> -indole		C <sub>9</sub> H <sub>9</sub> N	614-96-0	131.174		60	267	1.0202 <sup>78</sup>		s H <sub>2</sub> O, EtOH, eth, bz, lig
7390	7-Methyl-1 <i>H</i> -indole		C <sub>9</sub> H <sub>9</sub> N	933-67-5	131.174		85	266	1.0202 <sup>100</sup>		
7391	Methyl 2-iodobenzoate		C <sub>8</sub> H <sub>7</sub> I O <sub>2</sub>	610-97-9	262.045			280; 146 <sup>16</sup>		1.6052 <sup>20</sup>	s EtOH
7392	Methyl 3-iodobenzoate		C <sub>8</sub> H <sub>7</sub> I O <sub>2</sub>	618-91-7	262.045	nd (dil al)	54.5	277; 150 <sup>18</sup>			i H <sub>2</sub> O, lig; s EtOH; vs eth, ace
7393	Methyl 4-iodobenzoate		C <sub>8</sub> H <sub>7</sub> I O <sub>2</sub>	619-44-3	262.045	nd (eth-al)	114.8	sub	2.0200 <sup>10</sup>		s EtOH, eth
7394	5-Methyl-1,3-isobenzofurandione		C <sub>9</sub> H <sub>6</sub> O <sub>3</sub>	19438-61-0	162.142		93.0	295			
7395	Methyl isobutanoate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	547-63-7	102.132	liq	-84.7	92.5	0.8906 <sup>20</sup>	1.3840 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
7396	Methyl isocyanate		C <sub>2</sub> H <sub>3</sub> NO	624-83-9	57.051	liq	-45	38.3	0.9588 <sup>20</sup>	1.3694 <sup>20</sup>	vs H <sub>2</sub> O
7397	2-Methyl-1 <i>H</i> -isoinsole-1,3(2 <i>H</i> )-dione		C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	550-44-7	161.158	nd (al), lf (sub)	134	286			i H <sub>2</sub> O; sl EtOH
7398	Methyl isopentanoate	Methyl isovalerate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	556-24-1	116.158			116.5	0.8808 <sup>20</sup>	1.3927 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace
7399	6-Methyl- <i>N</i> -isopentyl-2-heptanamine	Octamylamine	C <sub>13</sub> H <sub>25</sub> N	502-59-0	199.376			100 <sup>7</sup>			
7400	2-Methyl-5-isopropylaniline		C <sub>10</sub> H <sub>13</sub> N	2051-53-8	149.233	liq	-16	241	0.9942 <sup>20</sup>	1.5387 <sup>20</sup>	s ctc, CS <sub>2</sub>
7401	α-Methyl-4-isopropylbenzenepropanal	3- <i>p</i> -Cumenyl-2-methylpropionaldehyde	C <sub>13</sub> H <sub>18</sub> O	103-95-7	190.281			270; 135 <sup>99</sup>	0.9459 <sup>20</sup>	1.5068 <sup>20</sup>	vs bz, eth, EtOH
7402	2-Methyl-5-isopropylbicyclo[3.1.0]hex-2-ene		C <sub>10</sub> H <sub>16</sub>	2867-05-2	136.234			151	0.8301 <sup>20</sup>	1.4515 <sup>20</sup>	



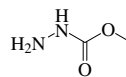
L-1-Methylhistidine



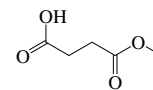
L-3-Methylhistidine



Methylhydrazine



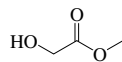
Methyl hydrazinecarboxylate



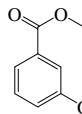
Methyl hydrogen succinate



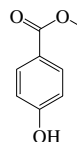
Methyl hydroperoxide



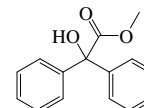
Methyl hydroxyacetate



Methyl 3-hydroxybenzoate



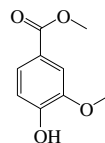
Methyl 4-hydroxybenzoate

Methyl  $\alpha$ -hydroxydiphenylacetate

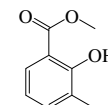
O-Methylhydroxylamine



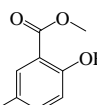
O-Methylhydroxylamine hydrochloride



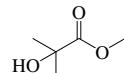
Methyl 4-hydroxy-3-methoxybenzoate



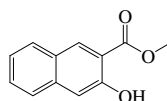
Methyl 2-hydroxy-3-methylbenzoate



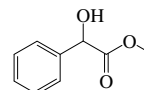
Methyl 2-hydroxy-5-methylbenzoate



Methyl 2-hydroxy-2-methylpropanoate



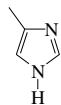
Methyl 3-hydroxy-2-naphthalenecarboxylate

Methyl  $\alpha$ -hydroxyphenylacetate, ( $\pm$ )

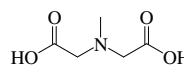
1-Methylimidazole



2-Methyl-1H-imidazole



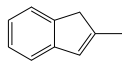
4-Methyl-1H-imidazole



N-Methyliminodiacetic acid



1-Methyl-1H-indene



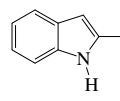
2-Methyl-1H-indene



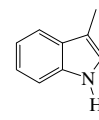
3-Methyl-1H-indene



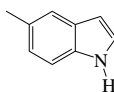
1-Methyl-1H-indole



2-Methyl-1H-indole



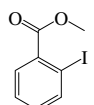
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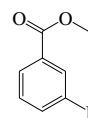
5-Methyl-1H-indole



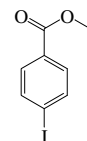
7-Methyl-1H-indole



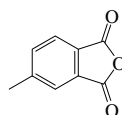
Methyl 2-iodobenzoate



Methyl 3-iodobenzoate



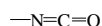
Methyl 4-iodobenzoate



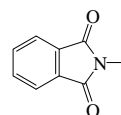
5-Methyl-1,3-isobenzofurandione



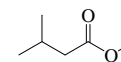
Methyl isobutanoate



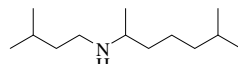
Methyl isocyanate



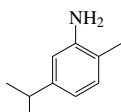
2-Methyl-1H-isindole-1,3(2H)-dione



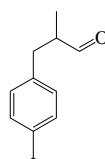
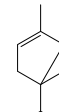
Methyl isopentanoate



6-Methyl-N-isopentyl-2-heptanamine



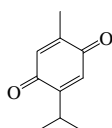
2-Methyl-5-isopropylaniline

 $\alpha$ -Methyl-4-isopropylbenzenepropanal

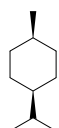
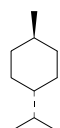
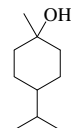
2-Methyl-5-isopropylbicyclo[3.1.0]hex-2-ene

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7403	2-Methyl-5-isopropyl-2,5-cyclohexadiene-1,4-dione		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	490-91-5	164.201		45.5	232			s chl
7404	<i>cis</i> -1-Methyl-4-isopropylcyclohexane		C <sub>10</sub> H <sub>20</sub>	6069-98-3	140.266	liq	-89.9	172	0.8039 <sup>20</sup>	1.4431 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, peth
7405	<i>trans</i> -1-Methyl-4-isopropylcyclohexane	<i>trans</i> - <i>p</i> -Menthane	C <sub>10</sub> H <sub>20</sub>	1678-82-6	140.266	oil	-86.3	170.6	0.7928 <sup>20</sup>	1.4366 <sup>20</sup>	vs bz, eth, EtOH, lig
7406	1-Methyl-4-isopropylcyclohexanol		C <sub>10</sub> H <sub>20</sub> O	21129-27-1	156.265			208.5	0.90 <sup>20</sup>	1.4619 <sup>20</sup>	
7407	5-Methyl-2-isopropylcyclohexanol, [1 <i>S</i> -(1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )]-	(+)-Menthol	C <sub>10</sub> H <sub>20</sub> O	15356-60-2	156.265		39	103 <sup>9</sup>			vs ace, bz, eth, EtOH
7408	5-Methyl-2-isopropylcyclohexanol, [1 <i>R</i> -(1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )]-	(-)-Menthol	C <sub>10</sub> H <sub>20</sub> O	2216-51-5	156.265	nd (MeOH)	43	216	0.903 <sup>15</sup>	1.460 <sup>22</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, bz; s peth
7409	5-Methyl-2-isopropylcyclohexanol, [1 <i>S</i> -(1 $\alpha$ ,2 $\alpha$ ,5 $\beta$ )]-	(+)-Neomenthol	C <sub>10</sub> H <sub>20</sub> O	2216-52-6	156.265	oil	-22	211.7	0.897 <sup>22</sup>	1.4600 <sup>20</sup>	vs ace, EtOH
7410	5-Methyl-2-isopropylcyclohexanol, [1 <i>S</i> -(1 $\alpha$ ,2 $\beta$ ,5 $\beta$ )]-	(+)-Isomenthol	C <sub>10</sub> H <sub>20</sub> O	23283-97-8	156.265	nd(dil al)	82.5	218			vs eth, EtOH
7411	5-Methyl-2-isopropylcyclohexanol acetate, [1 <i>R</i> -(1 $\alpha$ ,2 $\alpha$ ,5 $\beta$ )]		C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	2623-23-6	198.302			222; 109 <sup>10</sup>	0.9244 <sup>20</sup>	1.4469 <sup>20</sup>	
7412	<i>cis</i> -5-Methyl-2-isopropylcyclohexanone	Menthone	C <sub>10</sub> H <sub>18</sub> O	491-07-6	154.249			205; 89 <sup>15</sup>	0.8995 <sup>20</sup>	1.4527 <sup>20</sup>	
7413	<i>trans</i> -5-Methyl-2-isopropylcyclohexanone, (2 <i>S</i> )	<i>l</i> -Menthone	C <sub>10</sub> H <sub>18</sub> O	14073-97-3	154.249	liq	-6	207	0.8954 <sup>20</sup>	1.4505 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz, CS <sub>2</sub> ; s ace
7414	1-Methyl-4-isopropylcyclohexene		C <sub>10</sub> H <sub>18</sub>	5502-88-5	138.250			174.5	0.8457 <sup>15</sup>	1.4735 <sup>20</sup>	
7415	3-Methyl-6-isopropyl-2-cyclohexen-1-ol		C <sub>10</sub> H <sub>18</sub> O	491-04-3	154.249			97 <sup>15.5</sup>	0.9119 <sup>25</sup>	1.4729 <sup>25</sup>	
7416	4-Methyl-1-isopropyl-3-cyclohexen-1-ol		C <sub>10</sub> H <sub>18</sub> O	562-74-3	154.249			209	0.926 <sup>20</sup>	1.4785 <sup>19</sup>	
7417	5-Methyl-2-isopropylcyclohexyl ethoxyacetate, (1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )		C <sub>14</sub> H <sub>26</sub> O <sub>3</sub>	579-94-2	242.354			155 <sup>20</sup> , 144 <sup>14</sup>	0.9545 <sup>20</sup>		vs eth, EtOH, chl
7418	1-Methyl-4-isopropyl-2-nitrobenzene		C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	943-15-7	179.216			126 <sup>10</sup>	1.0744 <sup>20</sup>	1.5301 <sup>20</sup>	vs eth, EtOH
7419	1-Methyl-4-isopropyl-7-oxabicyclo[2.2.1]heptane		C <sub>10</sub> H <sub>18</sub> O	470-67-7	154.249		1	173.5	0.8997 <sup>20</sup>	1.4562 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, lig
7420	1-Methyl-7-isopropylphenanthrene	Retene	C <sub>18</sub> H <sub>18</sub>	483-65-8	234.336		101	390	1.035 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> , HOAc
7421	4-Methyl-2-isopropylphenol		C <sub>10</sub> H <sub>14</sub> O	4427-56-9	150.217	nd (HOAc)	36.5	228.5	0.9910 <sup>20</sup>	1.5275 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, bz, chl
7422	5-Methyl-2-isopropylphenyl acetate	Thymol, acetate	C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	528-79-0	192.254			245	1.009 <sup>9</sup>		vs bz, eth, EtOH, chl
7423	1-Methylisoquinoline	Isoquinaldine	C <sub>10</sub> H <sub>9</sub> N	1721-93-3	143.185		10	248	1.0777 <sup>20</sup>	1.6095 <sup>20</sup>	sl H <sub>2</sub> O; s eth, ace, bz
7424	3-Methylisoquinoline		C <sub>10</sub> H <sub>9</sub> N	1125-80-0	143.185	cry (eth)	68	249			sl H <sub>2</sub> O, chl; s eth, ace
7425	Methyl isothiocyanate		C <sub>2</sub> H <sub>3</sub> NS	556-61-6	73.117		36	119	1.0691 <sup>37</sup>	1.5258	sl H <sub>2</sub> O; msc EtOH; vs eth
7426	5-Methyl-3-isoxazolamine		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O	1072-67-9	98.103		62				
7427	4-Methylisoxazole		C <sub>4</sub> H <sub>6</sub> NO	6454-84-8	83.089	liq		127			
7428	5-Methylisoxazole		C <sub>4</sub> H <sub>6</sub> NO	5765-44-6	83.089			122	1.023 <sup>20</sup>	1.4386 <sup>20</sup>	s DMSO
7429	Methyl lactate, ( $\pm$ )	Methyl 2-hydroxypropanoate, ( $\pm$ )	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	2155-30-8	104.105	oil		144.8	1.0928 <sup>20</sup>	1.4141 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
7430	Methyl linoleate		C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>	112-63-0	294.472		-35	215 <sup>20</sup>	0.8886 <sup>10</sup>	1.4638 <sup>20</sup>	vs eth, EtOH
7431	Methyl linolenate		C <sub>19</sub> H <sub>32</sub> O <sub>2</sub>	301-00-8	292.456		-45.5	207 <sup>14</sup> , 182 <sup>3</sup>	0.895 <sup>25</sup>	1.4709 <sup>20</sup>	
7432	Methyl magnesium bromide	Bromomethylmagnesium	CH <sub>3</sub> BrMg	75-16-1	119.244						s eth, thf; i hx, bz
7433	Methylmagnesium chloride	Chloromethylmagnesium	CH <sub>3</sub> ClMg	676-58-4	74.793	stab in thf soln					i peth, bz
7434	Methylmalonic acid		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	516-05-2	118.089	nd (bz-AcOEt) pr (eth-bz)	135 dec		1.455 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, eth; sl bz, tfa; s AcOEt
7435	Methyl mercaptoacetate		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	2365-48-2	106.144			42 <sup>10</sup>		1.4657 <sup>20</sup>	vs eth, EtOH
7436	Methyl 3-mercaptopropanoate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	2935-90-2	120.171			54 <sup>14</sup>	1.085 <sup>25</sup>	1.4640 <sup>20</sup>	
7437	Methylmercuric dicyanamide	1-Cyano-3-(methylmercurio) guanidine	C <sub>3</sub> H <sub>6</sub> HgN <sub>4</sub>	502-39-6	298.70		157				
7438	Methyl methacrylate		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-62-6	100.117	liq	-47.55	100.5	0.9377 <sup>25</sup>	1.4142 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace; s chl
7439	Methyl methanesulfonate		C <sub>2</sub> H <sub>6</sub> O <sub>3</sub> S	66-27-3	110.132		20	202.5	1.2943 <sup>20</sup>	1.4138 <sup>20</sup>	
7440	Methyl methoxyacetate		C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	6290-49-9	104.105			131	1.0511 <sup>20</sup>	1.3962 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace

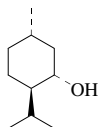
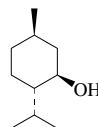
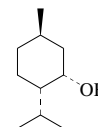
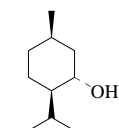
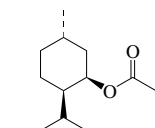
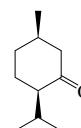
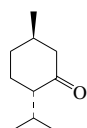
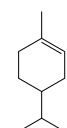




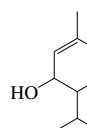
2-Methyl-5-isopropyl-2,5-cyclohexadiene-1,4-dione

*cis*-1-Methyl-4-isopropylcyclohexane*trans*-1-Methyl-4-isopropylcyclohexane

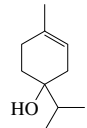
1-Methyl-4-isopropylcyclohexanol

5-Methyl-2-isopropylcyclohexanol, [1*S*-(1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )]-5-Methyl-2-isopropylcyclohexanol, [1*R*-(1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )]-5-Methyl-2-isopropylcyclohexanol, [1*S*-(1 $\alpha$ ,2 $\alpha$ ,5 $\beta$ )]-5-Methyl-2-isopropylcyclohexanol, [1*S*-(1 $\alpha$ ,2 $\beta$ ,5 $\beta$ )]-5-Methyl-2-isopropylcyclohexanol acetate, [1*R*-(1 $\alpha$ ,2 $\alpha$ ,5 $\beta$ )]-*cis*-5-Methyl-2-isopropylcyclohexanone*trans*-5-Methyl-2-isopropylcyclohexanone, (2*S*)

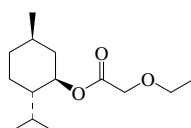
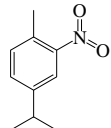
1-Methyl-4-isopropylcyclohexene



3-Methyl-6-isopropyl-2-cyclohexen-1-ol



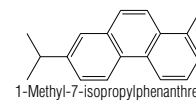
4-Methyl-1-isopropyl-3-cyclohexen-1-ol

5-Methyl-2-isopropylcyclohexyl ethoxyacetate, (1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )

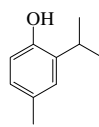
1-Methyl-4-isopropyl-2-nitrobenzene



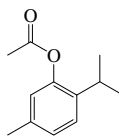
1-Methyl-4-isopropyl-7-oxabicyclo[2.2.1]heptane



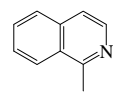
1-Methyl-7-isopropylphenanthrene



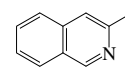
4-Methyl-2-isopropylphenol



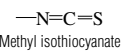
5-Methyl-2-isopropylphenyl acetate



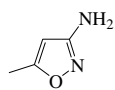
1-Methylisoquinoline



3-Methylisoquinoline



Methyl isothiocyanate



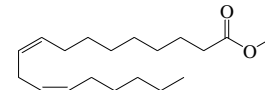
5-Methyl-3-isoxazolamine



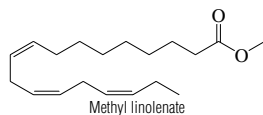
4-Methylisoxazole



5-Methylisoxazole

Methyl lactate, ( $\pm$ )

Methyl linoleate



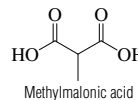
Methyl linolenate



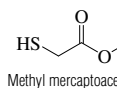
Methyl magnesium bromide



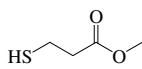
Methylmagnesium chloride



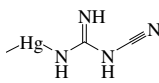
Methylmalonic acid



Methyl mercaptoacetate



Methyl 3-mercaptopropanoate



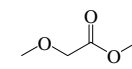
Methylmercuric dicyanamide



Methyl methacrylate

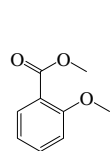


Methyl methanesulfonate

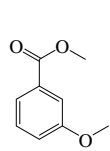


Methyl methoxyacetate

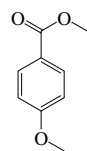
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7441	Methyl 2-methoxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	606-45-1	166.173			246.5	1.1571 <sup>19</sup>	1.534 <sup>19</sup>	i H <sub>2</sub> O; s EtOH
7442	Methyl 3-methoxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	5368-81-0	166.173			248	1.1310 <sup>20</sup>	1.5224 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
7443	Methyl 4-methoxybenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	121-98-2	166.173	lf (al or eth)	49	244			i H <sub>2</sub> O; s EtOH, eth, chl
7444	Methyl 3-methoxy-2-(methylamino)benzoate	Damascenine	C <sub>10</sub> H <sub>13</sub> NO <sub>3</sub>	483-64-7	195.215	pr (al)	28	271; 147 <sup>10</sup>			vs bz, eth, EtOH, lig
7445	Methyl 3-methoxypropanoate		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	3852-09-3	118.131			142.8	1.0139 <sup>15</sup>	1.4030 <sup>20</sup>	
7446	Methyl 2-methylacetacetate		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	17094-21-2	130.141			177.4	1.0217 <sup>25</sup>	1.416 <sup>24</sup>	vs eth, EtOH
7447	Methyl 2-(methylamino)benzoate		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	85-91-6	165.189	cry (peth)	19	255	1.120 <sup>15</sup>	1.5839 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth
7448	Methyl 2-methylbenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	89-71-4	150.174		<-50	215	1.068 <sup>20</sup>		i H <sub>2</sub> O; msc EtOH, eth
7449	Methyl 3-methylbenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	99-36-5	150.174			221	1.061 <sup>20</sup>		i H <sub>2</sub> O; s EtOH; sl ctc
7450	Methyl 4-methylbenzoate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	99-75-2	150.174	cry (aq MeOH, peth)	33.2	220			i H <sub>2</sub> O; vs EtOH, eth
7451	Methyl 2-methyl-2-butenolate, (E)		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	6622-76-0	114.142			139	0.9349 <sup>12</sup>	1.4370 <sup>20</sup>	
7452	Methyl 3-methyl-2-butenolate		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	924-50-5	114.142		114	136.5	0.9337 <sup>20</sup>	1.432 <sup>20</sup>	
7453	3-Methyl-4-methylenehexane		C <sub>9</sub> H <sub>16</sub>	3404-67-9	112.213			112.5	0.725 <sup>25</sup>	1.414 <sup>20</sup>	
7454	2-Methyl-5-(1-methylethenyl)cyclohexanone, (2 <i>R</i> - <i>trans</i> )		C <sub>10</sub> H <sub>16</sub> O	5524-05-0	152.233			221.5	0.928 <sup>19</sup>	1.4724	vs ace, eth
7455	5-Methyl-2-(1-methylethylidene)cyclohexanone		C <sub>10</sub> H <sub>16</sub> O	15932-80-6	152.233			93 <sup>10</sup>	0.9367 <sup>20</sup>	1.4869 <sup>20</sup>	
7456	3-Methyl-6-(1-methylethylidene)-2-cyclohexen-1-one	Piperitenone	C <sub>10</sub> H <sub>14</sub> O	491-09-8	150.217			120 <sup>14</sup>	0.9774 <sup>20</sup>	1.5294 <sup>20</sup>	vs EtOH, eth
7457	1-Methyl-4-(5-methyl-1-methylene-4-hexenyl)cyclohexene, (S)		C <sub>15</sub> H <sub>24</sub>	495-61-4	204.352			129 <sup>10</sup>	0.8673 <sup>20</sup>	1.4880 <sup>20</sup>	
7458	<i>N</i> -Methyl- <i>N</i> -(2-methylphenyl)acetamide		C <sub>10</sub> H <sub>13</sub> NO	573-26-2	163.216		55.5	260			s EtOH, chl
7459	4-Methyl- <i>N</i> -(4-methylphenyl)aniline		C <sub>14</sub> H <sub>15</sub> N	620-93-9	197.276	nd (peth)	79.8	330.5			vs eth, peth
7460	2-Methyl-3-(2-methylphenyl)-4(3 <i>H</i> )-quinazolinone	Methaqualone	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O	72-44-6	250.294			120			vs eth, EtOH, chl
7461	Methyl 3-(methylthio)propanoate	2-Methoxycarbonylthio methyl sulfide	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub> S	13532-18-8	134.197			75 <sup>13</sup> , 69 <sup>11</sup>	1.077 <sup>25</sup>	1.4650 <sup>20</sup>	
7462	1-Methyl-4-(1-methylvinyl)benzene		C <sub>10</sub> H <sub>12</sub>	1195-32-0	132.202	liq	-20	185.3	0.8936 <sup>23</sup>	1.5283 <sup>23</sup>	
7463	1-Methyl-4-(1-methylvinyl)cyclohexanol	β-Terpineol	C <sub>10</sub> H <sub>18</sub> O	138-87-4	154.249	nd	32.5	210; 90 <sup>10</sup>	0.917 <sup>20</sup>	1.4747 <sup>20</sup>	
7464	5-Methyl-2-(1-methylvinyl)cyclohexanol, [1 <i>R</i> -(1α,2β,5α)]		C <sub>10</sub> H <sub>18</sub> O	89-79-2	154.249		78	93 <sup>14</sup>	0.911 <sup>20</sup>	1.4723 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7465	5-Methyl-2-(1-methylvinyl)cyclohexanol acetate, [1 <i>R</i> -(1α,2β,5α)]		C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	57576-09-7	196.286		85	113 <sup>8</sup>	0.925 <sup>25</sup>	1.4566 <sup>20</sup>	
7466	<i>trans</i> -5-Methyl-2-(1-methylvinyl)cyclohexanone		C <sub>10</sub> H <sub>16</sub> O	29606-79-9	152.233			100 <sup>18</sup>	0.9198 <sup>20</sup>	1.4675 <sup>20</sup>	
7467	2-Methyl-5-(1-methylvinyl)-2-cyclohexen-1-ol		C <sub>10</sub> H <sub>16</sub> O	99-48-9	152.233			228	0.9484 <sup>25</sup>	1.4942 <sup>25</sup>	
7468	4-Methylmorpholine		C <sub>7</sub> H <sub>11</sub> NO	109-02-4	101.147	liq	-64.40	116	0.9051 <sup>20</sup>	1.4332 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth
7469	α-Methyl-4-morpholineethanol		C <sub>7</sub> H <sub>15</sub> NO <sub>2</sub>	2109-66-2	145.200			121 <sup>18</sup> , 93 <sup>13</sup>	1.0174 <sup>20</sup>	1.4638 <sup>20</sup>	vs H <sub>2</sub> O, ace, bz, EtOH
7470	1-Methylnaphthalene		C <sub>11</sub> H <sub>10</sub>	90-12-0	142.197	liq	-30.43	244.7	1.0202 <sup>20</sup>	1.6170 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
7471	2-Methylnaphthalene		C <sub>11</sub> H <sub>10</sub>	91-57-6	142.197	mcl (al)	34.6	241.1	1.0058 <sup>20</sup>	1.6015 <sup>40</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, chl
7472	Methyl 1-naphthalenecarboxylate	Methyl 1-naphthoate	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	2459-24-7	186.206		59.5	168 <sup>20</sup> , 101 <sup>0.04</sup>	1.1290 <sup>20</sup>	1.6086 <sup>20</sup>	vs bz, EtOH
7473	Methyl 2-naphthalenecarboxylate	Methyl 2-naphthoate	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	2459-25-8	186.206	lf (MeOH)	77	290			vs bz, eth, EtOH, chl
7474	2-Methyl-1,4-naphthalenediol diacetate	Menadiol diacetate	C <sub>15</sub> H <sub>14</sub> O <sub>4</sub>	573-20-6	258.270	pr (al)	113				vs EtOH
7475	2-Methyl-1,4-naphthalenedione	Menadione	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	58-27-5	172.181	ye nd (al, peth)	107				i H <sub>2</sub> O; sl EtOH, HOAc; s eth, bz, chl
7476	Methyl-1-naphthylamine	<i>N</i> -Methyl-1-naphthalenamine	C <sub>11</sub> H <sub>11</sub> N	2216-68-4	157.212	oil	174	294.5		1.6722 <sup>20</sup>	vs eth, EtOH
7477	Methyl nitrate		CH <sub>3</sub> NO <sub>3</sub>	598-58-3	77.040	exp gas	-83.0	exp 64.6	1.2075 <sup>20</sup>	1.3748 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7478	Methyl nitrite		CH <sub>3</sub> NO <sub>2</sub>	624-91-9	61.041	ye gas	-16	-12	0.991 <sup>15</sup>		s EtOH, eth
7479	Methyl nitroacetate		C <sub>3</sub> H <sub>5</sub> NO <sub>4</sub>	2483-57-0	119.077			107 <sup>28</sup>	1.320 <sup>0</sup>		
7480	2-Methyl-3-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	603-83-8	152.151	ye orth nd (w), ye lf (al)	92	305	1.3780 <sup>15</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz, chl



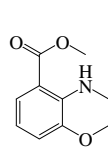
Methyl 2-methoxybenzoate



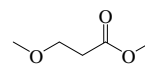
Methyl 3-methoxybenzoate



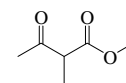
Methyl 4-methoxybenzoate



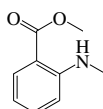
Methyl 3-methoxy-2-(methylamino)benzoate



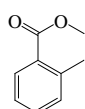
Methyl 3-methoxypropanoate



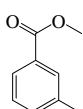
Methyl 2-methylacetoacetate



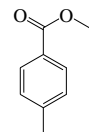
Methyl 2-(methylamino)benzoate



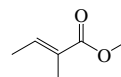
Methyl 2-methylbenzoate



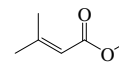
Methyl 3-methylbenzoate



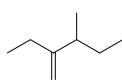
Methyl 4-methylbenzoate



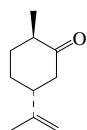
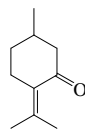
Methyl 2-methyl-2-butenoate, (E)



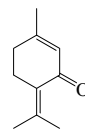
Methyl 3-methyl-2-butenoate



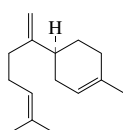
3-Methyl-4-methylenehexane

2-Methyl-5-(1-methylethenyl)cyclohexanone, (2*R*-*trans*)

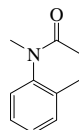
5-Methyl-2-(1-methylethylidene)cyclohexanone



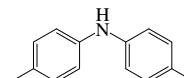
3-Methyl-6-(1-methylethylidene)-2-cyclohexen-1-one



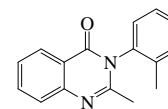
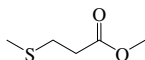
1-Methyl-4-(5-methyl-1-methylene-4-hexenyl)cyclohexene, (S)



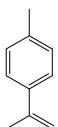
N-Methyl-N-(2-methylphenyl)acetamide



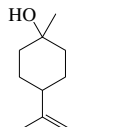
4-Methyl-N-(4-methylphenyl)aniline

2-Methyl-3-(2-methylphenyl)-4(3*H*)-quinazolinone

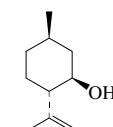
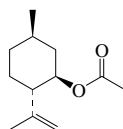
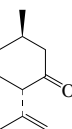
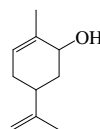
Methyl 3-(methylthio)propanoate



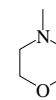
1-Methyl-4-(1-methylvinyl)benzene



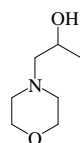
1-Methyl-4-(1-methylvinyl)cyclohexanol

5-Methyl-2-(1-methylvinyl)cyclohexanol, [1*R*-(1α,2β,5α)]5-Methyl-2-(1-methylvinyl)cyclohexanol acetate, [1*R*-(1α,2β,5α)]*trans*-5-Methyl-2-(1-methylvinyl)cyclohexanone

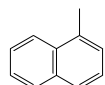
2-Methyl-5-(1-methylvinyl)-2-cyclohexen-1-ol



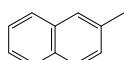
4-Methylmorpholine



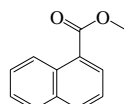
α-Methyl-4-morpholineethanol



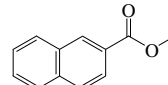
1-Methylnaphthalene



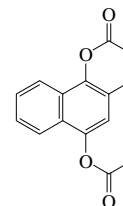
2-Methylnaphthalene



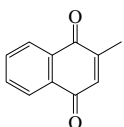
Methyl 1-naphthalenecarboxylate



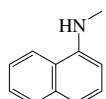
Methyl 2-naphthalenecarboxylate



2-Methyl-1,4-naphthalenediol diacetate



2-Methyl-1,4-naphthalenedione



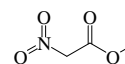
Methyl-1-naphthylamine



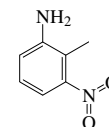
Methyl nitrate



Methyl nitrite

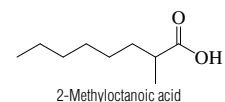
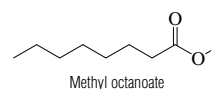
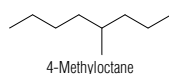
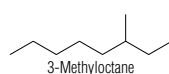
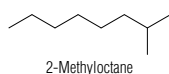
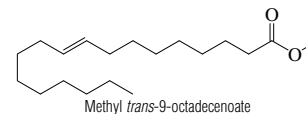
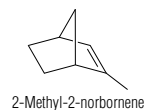
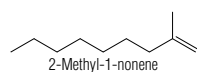
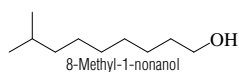
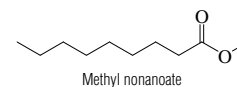
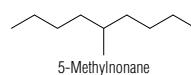
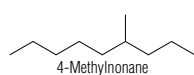
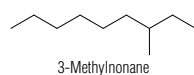
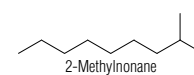
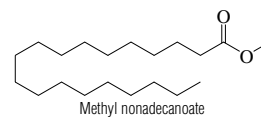
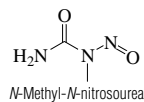
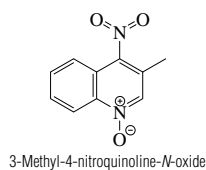
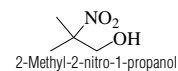
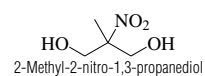
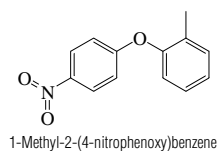
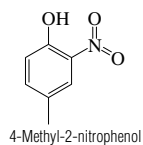
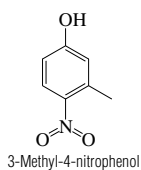
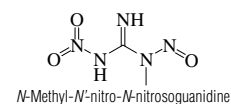
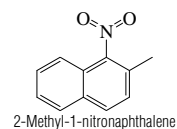
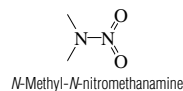
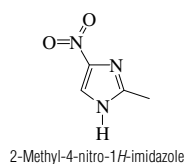
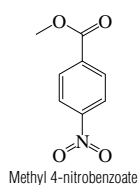
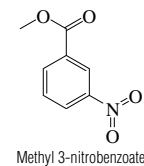
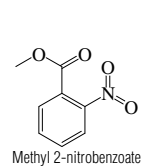
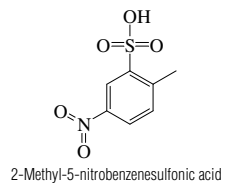
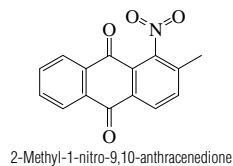
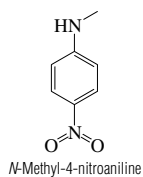
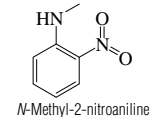
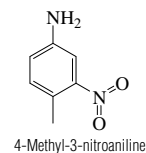
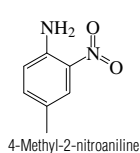
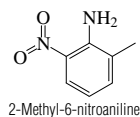
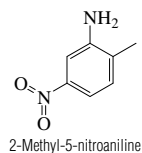
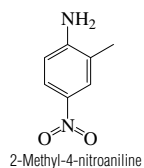


Methyl nitroacetate

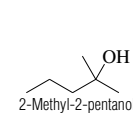
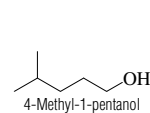
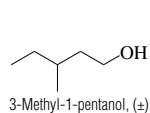
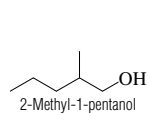
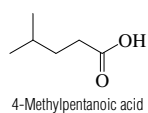
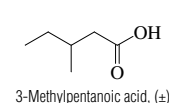
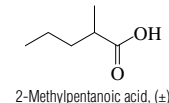
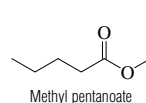
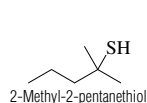
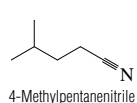
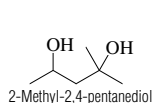
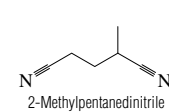
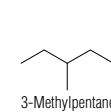
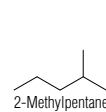
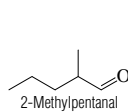
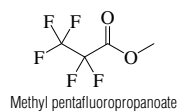
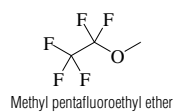
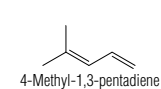
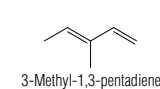
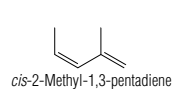
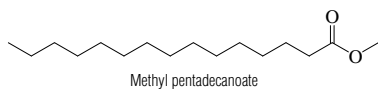
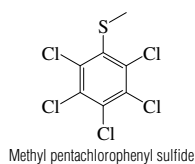
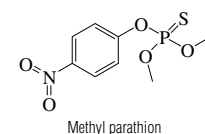
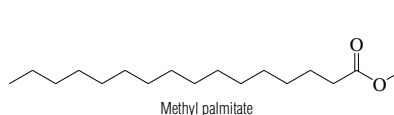
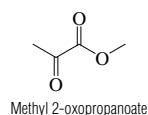
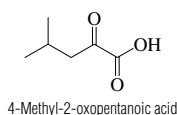
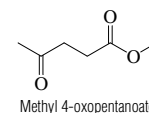
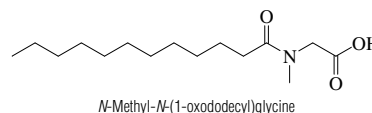
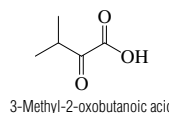
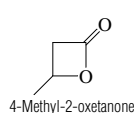
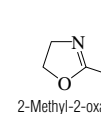
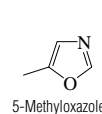
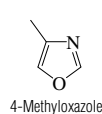
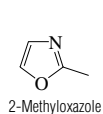
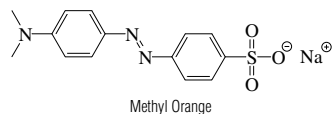
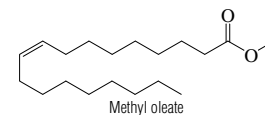
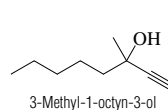
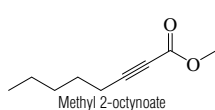
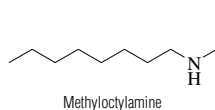
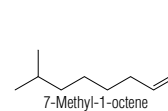
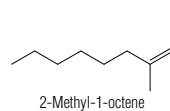
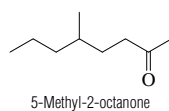
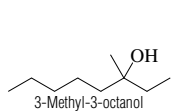
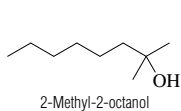


2-Methyl-3-nitroaniline

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7481	2-Methyl-4-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	99-52-5	152.151		133.5		1.1586 <sup>140</sup>		sl H <sub>2</sub> O, DMSO; s EtOH, bz, HOAc
7482	2-Methyl-5-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	99-55-8	152.151		105.5				sl H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
7483	2-Methyl-6-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	570-24-1	152.151		96		1.1900 <sup>100</sup>		sl H <sub>2</sub> O; s EtOH, eth, bz, chl
7484	4-Methyl-2-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	89-62-3	152.151		116.3		1.16 <sup>121</sup>		sl H <sub>2</sub> O; s EtOH, chl
7485	4-Methyl-3-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	119-32-4	152.151		79.8				sl H <sub>2</sub> O, CS <sub>2</sub> ; s EtOH, eth, bz
7486	<i>N</i> -Methyl-2-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	612-28-2	152.151	red or orange (peth)	38	158 <sup>18</sup>			sl H <sub>2</sub> O, lig; s EtOH, eth, ace, bz
7487	<i>N</i> -Methyl-4-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	100-15-2	152.151	br-ye pr (al) cry (eth)	152	dec	1.201 <sup>155</sup>		i H <sub>2</sub> O; s EtOH, bz, chl; sl eth, lig
7488	2-Methyl-1-nitro-9,10-anthracenedione		C <sub>15</sub> H <sub>9</sub> N <sub>2</sub> O <sub>4</sub>	129-15-7	267.237	pa ye nd (HOAc)	273.0				i H <sub>2</sub> O, EtOH; sl eth, bz, chl; s PhNO <sub>2</sub>
7489	2-Methyl-5-nitrobenzenesulfonic acid		C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub> S	121-03-9	217.200		135.8				vs H <sub>2</sub> O, EtOH, eth, chl
7490	Methyl 2-nitrobenzoate		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	606-27-9	181.147	liq	-13	275	1.2855 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, chl; i lig
7491	Methyl 3-nitrobenzoate		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	618-95-1	181.147		78	279 <sup>60</sup>			i H <sub>2</sub> O; sl EtOH, eth, MeOH
7492	Methyl 4-nitrobenzoate		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	619-50-1	181.147		96				i H <sub>2</sub> O; s EtOH, eth, chl
7493	2-Methyl-4-nitro-1 <i>H</i> -imidazole		C <sub>4</sub> H <sub>6</sub> N <sub>3</sub> O <sub>2</sub>	696-23-1	127.102		253				
7494	<i>N</i> -Methyl- <i>N</i> -nitromethanamine		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	4164-28-7	90.081	nd(eth)	58	187	1.1090 <sup>72</sup>	1.4462 <sup>72</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
7495	2-Methyl-1-nitronaphthalene		C <sub>11</sub> H <sub>9</sub> NO <sub>2</sub>	881-03-8	187.195	ye pr or nd (al)	81.5	188 <sup>20</sup>			i H <sub>2</sub> O; s EtOH; vs ace
7496	<i>N</i> -Methyl- <i>N'</i> -nitro- <i>N</i> -nitrosoguanidine		C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>3</sub>	70-25-7	147.093						s DMSO
7497	3-Methyl-4-nitrophenol		C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	2581-34-2	153.136	nd or pr (w)	129				sl H <sub>2</sub> O; s EtOH, eth, bz, chl
7498	4-Methyl-2-nitrophenol		C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	119-33-5	153.136	ye nd (al, w)	36.5	125 <sup>22</sup>	1.2399 <sup>20</sup>	1.5744 <sup>40</sup>	vs ace, bz, eth, EtOH
7499	1-Methyl-2-(4-nitrophenoxy)benzene	2-Methylphenyl ether	C <sub>13</sub> H <sub>11</sub> NO <sub>3</sub>	2444-29-3	229.231	ye cry (peth)		220 <sup>27</sup>			vs bz, eth, EtOH
7500	2-Methyl-2-nitro-1,3-propanediol		C <sub>4</sub> H <sub>9</sub> NO <sub>4</sub>	77-49-6	135.119	mcl	150.1	dec			vs H <sub>2</sub> O, EtOH; sl DMSO
7501	2-Methyl-2-nitro-1-propanol		C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	76-39-1	119.119	nd or pl (MeOH)	89.5	94 <sup>10</sup>			sl H <sub>2</sub> O; vs EtOH, eth; s chl
7502	3-Methyl-4-nitroquinoline- <i>N</i> -oxide		C <sub>10</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	14073-00-8	204.182	cry (MeOH)	179				
7503	<i>N</i> -Methyl- <i>N</i> -nitrosoaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	614-00-6	136.151	ye cry	14.7	dec 225; 121 <sup>13</sup>	1.1240 <sup>20</sup>	1.5769 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7504	<i>N</i> -Methyl- <i>N</i> -nitrosoourea	<i>N</i> -Nitroso- <i>N</i> -methylurea	C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	684-93-5	103.080	col or ye pl (eth)	123	dec			sl H <sub>2</sub> O, EtOH, eth
7505	Methyl nonadecanoate		C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	1731-94-8	312.531		41.3	190 <sup>4</sup>			
7506	2-Methylnonane		C <sub>10</sub> H <sub>22</sub>	871-83-0	142.282	liq	-74.6	167.1	0.7281 <sup>20</sup>	1.4099 <sup>30</sup>	i H <sub>2</sub> O; s eth, bz, chl
7507	3-Methylnonane		C <sub>10</sub> H <sub>22</sub>	5911-04-6	142.282	liq	-84.8	167.9	0.7354 <sup>20</sup>	1.4125 <sup>20</sup>	vs bz, eth, chl
7508	4-Methylnonane		C <sub>10</sub> H <sub>22</sub>	17301-94-9	142.282	liq	-99	165.7	0.7323 <sup>20</sup>	1.4123 <sup>20</sup>	vs bz, eth, chl
7509	5-Methylnonane		C <sub>10</sub> H <sub>22</sub>	15869-85-9	142.282	liq	-87.7	165.1	0.7326 <sup>20</sup>	1.4116 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
7510	Methyl nonanoate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	1731-84-6	172.265			213.5	0.8799 <sup>15</sup>	1.4214 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
7511	8-Methyl-1-nonanol		C <sub>10</sub> H <sub>22</sub> O	55505-26-5	158.281			108 <sup>10</sup>			
7512	2-Methyl-1-nonene		C <sub>10</sub> H <sub>20</sub>	2980-71-4	140.266	liq	-64.2	168.4	0.7412 <sup>25</sup>	1.4241 <sup>20</sup>	
7513	2-Methyl-2-norbornene	2-Methylbicyclo[2.2.1]hept-2-ene	C <sub>8</sub> H <sub>12</sub>	694-92-8	108.181	liq		122			
7514	Methyl <i>trans</i> -9-octadecenoate		C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	1937-62-8	296.488	liq	13.5	218 <sup>24</sup>	0.8730 <sup>20</sup>	1.4513 <sup>20</sup>	vs eth, EtOH
7515	2-Methyloctane		C <sub>9</sub> H <sub>20</sub>	3221-61-2	128.255	liq	-80.3	143.2	0.7095 <sup>25</sup>	1.4031 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc; vs peth
7516	3-Methyloctane		C <sub>9</sub> H <sub>20</sub>	2216-33-3	128.255	liq	-107.6	144.2	0.717 <sup>25</sup>	1.4040 <sup>25</sup>	
7517	4-Methyloctane		C <sub>9</sub> H <sub>20</sub>	2216-34-4	128.255	liq	-113.3	142.4	0.716 <sup>25</sup>	1.4039 <sup>25</sup>	i H <sub>2</sub> O
7518	Methyl octanoate	Methyl caprylate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	111-11-5	158.238	liq	-40	192.9	0.8775 <sup>20</sup>	1.4170 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
7519	2-Methyloctanoic acid		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	3004-93-1	158.238			138 <sup>14</sup> , 88 <sup>4</sup>		1.4281 <sup>25</sup>	

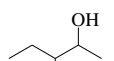


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7520	2-Methyl-2-octanol		C <sub>9</sub> H <sub>20</sub> O	628-44-4	144.254			178	0.8210 <sup>20</sup>	1.4280 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7521	3-Methyl-3-octanol		C <sub>9</sub> H <sub>20</sub> O	5340-36-3	144.254			83 <sup>18</sup> , 36 <sup>3</sup>	0.8108 <sup>25</sup>	1.4257 <sup>25</sup>	
7522	5-Methyl-2-octanone		C <sub>9</sub> H <sub>18</sub> O	58654-67-4	142.238			101 <sup>50</sup>			
7523	2-Methyl-1-octene		C <sub>9</sub> H <sub>18</sub>	4588-18-5	126.239	liq	-77.8	144.8	0.7343 <sup>20</sup>	1.4184 <sup>20</sup>	
7524	7-Methyl-1-octene		C <sub>9</sub> H <sub>18</sub>	13151-06-9	126.239	liq		138.9			
7525	Methyloctylamine	<i>N</i> -Methyl-1-octanamine	C <sub>9</sub> H <sub>21</sub> N	2439-54-5	143.270			68 <sup>8</sup>			
7526	Methyl 2-octynoate		C <sub>9</sub> H <sub>14</sub> O <sub>2</sub>	111-12-6	154.206			217; 107 <sup>20</sup>	0.926 <sup>20</sup>	1.4464 <sup>20</sup>	
7527	3-Methyl-1-octyn-3-ol		C <sub>9</sub> H <sub>16</sub> O	23580-51-0	140.222			174; 75 <sup>10</sup>	0.8547 <sup>20</sup>	1.443 <sup>10</sup>	
7528	Methyl oleate		C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	112-62-9	296.488		-19.9	218.5 <sup>20</sup>	0.8739 <sup>20</sup>	1.4522 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
7529	Methyl Orange	Sodium <i>p</i> -dimethylaminoazobenzenesulfonate	C <sub>14</sub> H <sub>14</sub> N <sub>3</sub> NaO <sub>3</sub> S	547-58-0	327.334	oran, ye pl or sc (w)	dec				sl H <sub>2</sub> O, EtOH, py; i eth
7530	2-Methyloxazole		C <sub>4</sub> H <sub>5</sub> NO	23012-10-4	83.089	liq		87.5			
7531	4-Methyloxazole		C <sub>4</sub> H <sub>5</sub> NO	693-93-6	83.089			88	1.015 <sup>25</sup>	1.4317 <sup>20</sup>	
7532	5-Methyloxazole		C <sub>4</sub> H <sub>5</sub> NO	66333-88-8	83.089	liq		88			
7533	2-Methyl-2-oxazoline		C <sub>4</sub> H <sub>7</sub> NO	1120-64-5	85.105			111	1.005 <sup>25</sup>	1.4340 <sup>20</sup>	
7534	2-Methyloxetane		C <sub>4</sub> H <sub>8</sub> O	2167-39-7	72.106	hyg		59	0.841 <sup>25</sup>	1.3885 <sup>20</sup>	
7535	4-Methyl-2-oxetanone	3-Hydroxybutyric acid lactone	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	3068-88-0	86.090			86 <sup>90</sup> , 57 <sup>9</sup>	1.0555 <sup>20</sup>		
7536	Methyloxirane	1,2-Propylene oxide	C <sub>3</sub> H <sub>6</sub> O	16033-71-9	58.079	liq	-111.9	35	0.859 <sup>0</sup>	1.3660 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
7537	3-Methyl-2-oxobutanoic acid		C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	759-05-7	116.116		31.5	170.5	0.9968 <sup>20</sup>	1.3850 <sup>18</sup>	s H <sub>2</sub> O, EtOH, eth
7538	<i>N</i> -Methyl- <i>N</i> -(1-oxododecyl)glycine	<i>N</i> -Dodecanoylsarcosine	C <sub>15</sub> H <sub>29</sub> NO <sub>3</sub>	97-78-9	271.396		44.5				s chl
7539	Methyl 4-oxopentanoate	Methyl levulinate	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	624-45-3	130.141			196	1.0511 <sup>20</sup>	1.4233 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace, bz, ctc; msc eth
7540	4-Methyl-2-oxopentanoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	816-66-0	130.141	liq	10	84 <sup>15</sup>			
7541	Methyl 2-oxopropanoate	Methyl pyruvate	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	600-22-6	102.089			135.5	1.154 <sup>0</sup>	1.4046 <sup>25</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
7542	Methyl palmitate	Methyl hexadecanoate	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	112-39-0	270.451		30	417; 148 <sup>2</sup>	0.8247 <sup>75</sup>		i H <sub>2</sub> O; vs EtOH, ace, bz; s eth
7543	Methyl parathion		C <sub>7</sub> H <sub>10</sub> NO <sub>3</sub> PS	298-00-0	263.208	cry	38		1.358 <sup>20</sup>	1.5367 <sup>25</sup>	i H <sub>2</sub> O; s os
7544	Methyl pentachlorophenyl sulfide	<i>S</i> -Methyl pentachlorobenzethiol	C <sub>7</sub> H <sub>5</sub> Cl <sub>5</sub> S	1825-19-0	296.429	cry (EtOH)	95.5				
7545	Methyl pentadecanoate		C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	7132-64-1	256.424	nd (dil al)	18.5	153.5	0.8618 <sup>25</sup>	1.4390 <sup>25</sup>	s EtOH, eth
7546	<i>cis</i> -2-Methyl-1,3-pentadiene		C <sub>6</sub> H <sub>10</sub>	1501-60-6	82.143	liq	-117.6	75.8	0.714 <sup>25</sup>	1.446 <sup>20</sup>	
7547	3-Methyl-1,3-pentadiene		C <sub>6</sub> H <sub>10</sub>	4549-74-0	82.143			77	0.730 <sup>25</sup>	1.452 <sup>20</sup>	
7548	4-Methyl-1,3-pentadiene	1,1-Dimethyl-1,3-butadiene	C <sub>6</sub> H <sub>10</sub>	926-56-7	82.143			76.5	0.7181 <sup>20</sup>	1.4532 <sup>20</sup>	
7549	Methyl pentafluoroethyl ether	1-Methoxyperfluoroethane	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> O	22410-44-2	150.047	col gas		5.59			
7550	Methyl pentafluoropropanoate		C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O <sub>2</sub>	378-75-6	178.058			59.5	1.390 <sup>25</sup>	1.2869 <sup>25</sup>	
7551	2-Methylpentanal	2-Methylvaleraldehyde	C <sub>6</sub> H <sub>12</sub> O	123-15-9	100.158			117			s H <sub>2</sub> O; s eth, ace; sl ctc
7552	2-Methylpentane	Isohexane	C <sub>6</sub> H <sub>14</sub>	107-83-5	86.175	liq	-153.6	60.26	0.650 <sup>25</sup>	1.3715 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; msc ace, bz, chl
7553	3-Methylpentane		C <sub>6</sub> H <sub>14</sub>	96-14-0	86.175	liq	-162.90	63.27	0.6598 <sup>25</sup>	1.3765 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ctc; msc eth, ace, bz, hp
7554	2-Methylpentanedinitrile	2-Methylglutaronitrile	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	4553-62-2	108.141	liq	-45	270; 134 <sup>13</sup>	0.950	1.4340 <sup>20</sup>	s H <sub>2</sub> O
7555	2-Methyl-2,4-pentanediol	Hexylene glycol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	107-41-5	118.174	liq	-50	197.1	0.923 <sup>15</sup>	1.4276 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
7556	4-Methylpentanenitrile	Isopentyl cyanide	C <sub>6</sub> H <sub>11</sub> N	542-54-1	97.158	liq	-51	156.5	0.8030 <sup>20</sup>	1.4059 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; msc eth; sl ctc
7557	2-Methyl-2-pentanethiol		C <sub>6</sub> H <sub>14</sub> S	1633-97-2	118.240	liq		125.0; 36 <sup>30</sup>			
7558	Methyl pentanoate	Methyl valerate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	624-24-8	116.158			127.4	0.8947 <sup>20</sup>	1.4003 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
7559	2-Methylpentanoic acid, (±)		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	22160-39-0	116.158			195.6	0.9230 <sup>20</sup>	1.413 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
7560	3-Methylpentanoic acid, (±)		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	22160-40-3	116.158	liq	-41.6	197.5	0.9262 <sup>20</sup>	1.4159 <sup>20</sup>	vs eth, EtOH
7561	4-Methylpentanoic acid		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	646-07-1	116.158	liq	-33	200.5	0.9225 <sup>20</sup>	1.4144 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, chl
7562	2-Methyl-1-pentanol		C <sub>6</sub> H <sub>14</sub> O	105-30-6	102.174			149	0.8263 <sup>20</sup>	1.4182 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, ctc
7563	3-Methyl-1-pentanol, (±)		C <sub>6</sub> H <sub>14</sub> O	20281-83-8	102.174			153	0.8242 <sup>20</sup>	1.4112 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth
7564	4-Methyl-1-pentanol	Isohexyl alcohol	C <sub>6</sub> H <sub>14</sub> O	626-89-1	102.174			151.9	0.8131 <sup>20</sup>	1.4134 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth
7565	2-Methyl-2-pentanol		C <sub>6</sub> H <sub>14</sub> O	590-36-3	102.174	liq	-103	121.1	0.8350 <sup>16</sup>	1.4100 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth

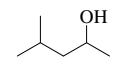


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7566	3-Methyl-2-pentanol		C <sub>6</sub> H <sub>14</sub> O	565-60-6	102.174			134.3	0.8307 <sup>20</sup>	1.4182 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7567	4-Methyl-2-pentanol		C <sub>6</sub> H <sub>14</sub> O	108-11-2	102.174	liq	-90	131.6	0.8075 <sup>20</sup>	1.4100 <sup>20</sup>	sl H <sub>2</sub> O; ctc; s EtOH, eth
7568	2-Methyl-3-pentanol		C <sub>6</sub> H <sub>14</sub> O	565-67-3	102.174			126.5	0.8243 <sup>20</sup>	1.4175 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
7569	3-Methyl-3-pentanol		C <sub>6</sub> H <sub>14</sub> O	77-74-7	102.174	liq	-23.6	122.4	0.8286 <sup>20</sup>	1.4186 <sup>20</sup>	sl H <sub>2</sub> O; ctc; msc EtOH, eth
7570	2-Methyl-1-pentanol acetate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	7789-99-3	144.212			163	0.870 <sup>25</sup>		vs eth, EtOH
7571	3-Methyl-2-pentanone, (±)	(±)- <i>sec</i> -Butyl methyl ketone	C <sub>6</sub> H <sub>12</sub> O	55156-16-6	100.158			117.5	0.8130 <sup>20</sup>	1.4002 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s chl
7572	4-Methyl-2-pentanone	Isobutyl methyl ketone	C <sub>6</sub> H <sub>12</sub> O	108-10-1	100.158	liq	-84	116.5	0.7965 <sup>25</sup>	1.3962 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl
7573	2-Methyl-3-pentanone	Ethyl isopropyl ketone	C <sub>6</sub> H <sub>12</sub> O	565-69-5	100.158			113.5	0.814 <sup>18</sup>	1.3975 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, bz; msc eth, ace; s chl
7574	4-Methylpentanoyl chloride		C <sub>6</sub> H <sub>11</sub> ClO	38136-29-7	134.603			143	0.9725 <sup>20</sup>		
7575	2-Methyl-2-pentenal		C <sub>6</sub> H <sub>10</sub> O	623-36-9	98.142			136.5	0.8581 <sup>20</sup>	1.4488 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, MeOH
7576	2-Methyl-1-pentene		C <sub>6</sub> H <sub>12</sub>	763-29-1	84.159	liq	-135.7	62.1	0.6799 <sup>20</sup>	1.3920 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl; sl ctc
7577	3-Methyl-1-pentene		C <sub>6</sub> H <sub>12</sub>	760-20-3	84.159	liq	-153	54.2	0.6675 <sup>20</sup>	1.3841 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, peth
7578	4-Methyl-1-pentene		C <sub>6</sub> H <sub>12</sub>	691-37-2	84.159	liq	-153.6	53.9	0.6642 <sup>20</sup>	1.3828 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, peth
7579	2-Methyl-2-pentene		C <sub>6</sub> H <sub>12</sub>	625-27-4	84.159	liq	-135	67.3	0.6863 <sup>20</sup>	1.4004 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc, chl
7580	3-Methyl- <i>cis</i> -2-pentene		C <sub>6</sub> H <sub>12</sub>	922-62-3	84.159	liq	-134.8	67.7	0.6886 <sup>25</sup>	1.4016 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, peth
7581	3-Methyl- <i>trans</i> -2-pentene		C <sub>6</sub> H <sub>12</sub>	616-12-6	84.159	liq	-138.5	70.4	0.6930 <sup>25</sup>	1.4045 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc, chl, peth
7582	4-Methyl- <i>cis</i> -2-pentene		C <sub>6</sub> H <sub>12</sub>	691-38-3	84.159	liq	-134.8	56.3	0.6690 <sup>20</sup>	1.3800 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl, peth
7583	4-Methyl- <i>trans</i> -2-pentene		C <sub>6</sub> H <sub>12</sub>	674-76-0	84.159	liq	-140.8	58.6	0.6686 <sup>20</sup>	1.3889 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, chl; sl ctc
7584	<i>trans</i> -2-Methyl-2-pentenoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	16957-70-3	114.142	pr	24.4	214; 112 <sup>12</sup>	0.9751 <sup>20</sup>	1.4513 <sup>20</sup>	sl H <sub>2</sub> O; s eth, chl, CS <sub>2</sub>
7585	4-Methyl-2-pentenoic acid	4,4-Dimethyl-2-butenic acid	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	10321-71-8	114.142		35	217	0.9529 <sup>21</sup>	1.4489 <sup>21</sup>	vs ace, eth, EtOH
7586	2-Methyl-3-pentenoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	37674-63-8	114.142			199	0.966 <sup>15</sup>	1.4402 <sup>25</sup>	
7587	4-Methyl-3-penten-2-ol		C <sub>6</sub> H <sub>12</sub> O	4325-82-0	100.158			134	0.840 <sup>15</sup>	1.9377 <sup>15</sup>	
7588	3-Methyl-2-penten-4-one		C <sub>6</sub> H <sub>10</sub> O	565-62-8	98.142			138		1.4508 <sup>20</sup>	
7589	4-Methyl-4-penten-2-one		C <sub>6</sub> H <sub>10</sub> O	3744-02-3	98.142	liq	-72.6	124.2	0.8411 <sup>20</sup>		
7590	<i>cis</i> -3-Methyl-2-(2-pentenyl)-2-cyclopenten-1-one	Jasmone	C <sub>11</sub> H <sub>16</sub> O	488-10-8	164.244	ye oil		258; 134 <sup>12</sup>	0.9437 <sup>22</sup>	1.4979 <sup>22</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc, lig
7591	3-(4-Methyl-3-pentenyl)furan		C <sub>10</sub> H <sub>14</sub> O	539-52-6	150.217			185.5	0.9017 <sup>20</sup>	1.4705 <sup>21</sup>	
7592	3-Methyl-3-penten-1-yne		C <sub>6</sub> H <sub>8</sub>	1574-33-0	80.128			66.5	0.739 <sup>20</sup>	1.4332 <sup>20</sup>	s eth, bz
7593	3-Methyl-2-pentyl-2-cyclopenten-1-one		C <sub>11</sub> H <sub>16</sub> O	1128-08-1	166.260			143 <sup>22</sup> , 116 <sup>12</sup>	0.9165 <sup>18</sup>	1.4767 <sup>20</sup>	
7594	Methyl pentyl ether		C <sub>6</sub> H <sub>14</sub> O	628-80-8	102.174			99	0.759 <sup>22</sup>	1.3862 <sup>22</sup>	vs ace, eth, EtOH
7595	5-Methyl-2-pentylphenol	6-Pentyl- <i>m</i> -cresol	C <sub>12</sub> H <sub>16</sub> O	1300-94-3	178.270		24	138 <sup>15</sup>			vs ace, eth, EtOH
7596	Methyl pentyl sulfide		C <sub>6</sub> H <sub>14</sub> S	1741-83-9	118.240	liq	-94	145.1	0.8431 <sup>20</sup>	1.4506 <sup>20</sup>	s EtOH, eth, ace, bz, chl
7597	Methyl <i>tert</i> -pentyl sulfide	2-Methyl-2-(methylthio)butane	C <sub>6</sub> H <sub>14</sub> S	13286-92-5	118.240	liq		150	0.84	1.4570 <sup>20</sup>	
7598	4-Methyl-1-pentyne		C <sub>6</sub> H <sub>10</sub>	7154-75-8	82.143	liq	-104.6	61.2	0.7000 <sup>25</sup>	1.3936 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl
7599	4-Methyl-2-pentyne		C <sub>6</sub> H <sub>10</sub>	21020-27-9	82.143	liq	-110.3	73.1	0.7112 <sup>25</sup>	1.4057 <sup>20</sup>	vs bz, chl
7600	3-Methyl-1-pentyn-3-ol	Meparfynol	C <sub>6</sub> H <sub>10</sub> O	77-75-8	98.142		30.5	120.5	0.8688 <sup>20</sup>	1.4310 <sup>20</sup>	
7601	Methyl perfluorooctanoate		C <sub>9</sub> H <sub>3</sub> F <sub>15</sub> O <sub>2</sub>	376-27-2	428.095			158	1.684 <sup>20</sup>	1.304 <sup>27</sup>	
7602	1-Methylphenanthrene		C <sub>15</sub> H <sub>12</sub>	832-69-9	192.256	lf, pl (dil al)	123	354			i H <sub>2</sub> O; s EtOH
7603	3-Methylphenanthrene		C <sub>15</sub> H <sub>12</sub>	832-71-3	192.256	pr or nd (al)	65	350; 145 <sup>6</sup>			i H <sub>2</sub> O; s EtOH, ace; sl chl
7604	4-Methylphenanthrene		C <sub>15</sub> H <sub>12</sub>	832-64-4	192.256	pl (90% al)	53.5	177 <sup>10</sup>			i H <sub>2</sub> O; s EtOH, ctc
7605	Methylphenidate		C <sub>14</sub> H <sub>19</sub> NO <sub>2</sub>	113-45-1	233.307			136 <sup>6</sup>			i H <sub>2</sub> O, peth; s chl, EtOH, eth, AcOEt
7606	10-Methyl-10 <i>H</i> -phenothiazine		C <sub>13</sub> H <sub>11</sub> NS	1207-72-3	213.298		101				
7607	10-Methyl-10 <i>H</i> -phenothiazine-2-acetic acid	Metiazinic acid	C <sub>15</sub> H <sub>13</sub> NO <sub>2</sub> S	13993-65-2	271.335		144				s chl

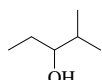




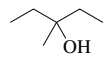
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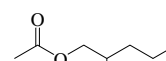
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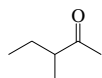
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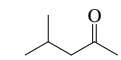
3-Methyl-3-pentanol



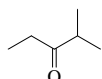
2-Methyl-1-pentanol acetate



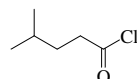
3-Methyl-2-pentanone, (±)



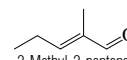
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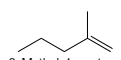
2-Methyl-3-pentanone



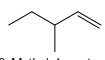
4-Methylpentanoyl chloride



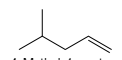
2-Methyl-2-pentenal



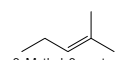
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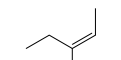
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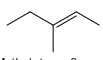
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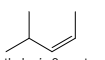
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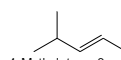
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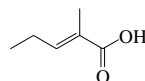
3-Methyl-trans-2-pentene



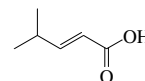
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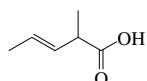
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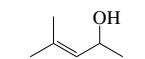
trans-2-Methyl-2-pentenoic acid



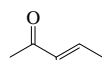
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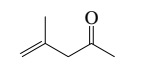
2-Methyl-3-pentenoic acid



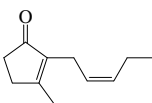
4-Methyl-3-penten-2-ol



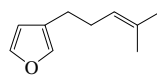
3-Methyl-2-penten-4-one



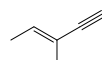
4-Methyl-4-penten-2-one



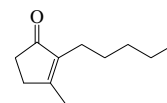
cis-3-Methyl-2-(2-pentenyl)-2-cyclopenten-1-one



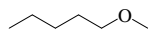
3-(4-Methyl-3-pentenyl)furan



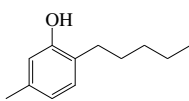
3-Methyl-3-penten-1-yne



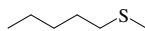
3-Methyl-2-pentyl-2-cyclopenten-1-one



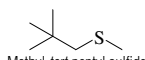
Methyl pentyl ether



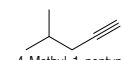
5-Methyl-2-pentylphenol



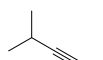
Methyl pentyl sulfide



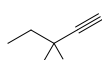
Methyl tert-pentyl sulfide



4-Methyl-1-pentyne



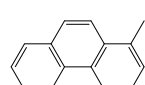
4-Methyl-2-pentyne



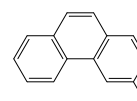
3-Methyl-1-pentyn-3-ol



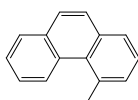
Methyl perfluorooctanoate



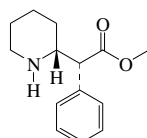
1-Methylphenanthrene



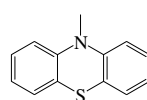
3-Methylphenanthrene



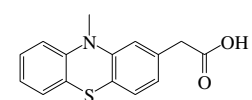
4-Methylphenanthrene



Methylphenidate

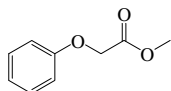


10-Methyl-10H-phenothiazine

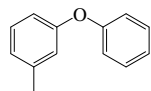


10-Methyl-10H-phenothiazine-2-acetic acid

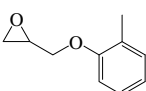
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7608	Methyl phenoxyacetate		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	2065-23-8	166.173			245	1.1493 <sup>20</sup>	1.5155 <sup>20</sup>	vs eth, EtOH
7609	1-Methyl-3-phenoxybenzene		C <sub>13</sub> H <sub>12</sub> O	3586-14-9	184.233			272	1.051 <sup>25</sup>	1.5727 <sup>20</sup>	
7610	[(2-Methylphenoxy)methyl]oxirane		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	2210-79-9	164.201			123 <sup>2</sup>	1.0884 <sup>20</sup>		
7611	3-(2-Methylphenoxy)-1,2-propanediol	Mephnesin	C <sub>10</sub> H <sub>14</sub> O <sub>3</sub>	59-47-2	182.216		70 dec				sl H <sub>2</sub> O, eth; s EtOH
7612	<i>N</i> -(2-Methylphenyl)acetamide		C <sub>9</sub> H <sub>11</sub> NO	120-66-1	149.189	nd (al)	110	296	1.168 <sup>15</sup>		sl H <sub>2</sub> O, bz; s EtOH, eth, ace, HOAc
7613	<i>N</i> -(3-Methylphenyl)acetamide		C <sub>9</sub> H <sub>11</sub> NO	537-92-8	149.189	nd (w)	65.5	303	1.141 <sup>15</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s chl
7614	<i>N</i> -Methyl- <i>N</i> -phenylacetamide	<i>N</i> -Methylacetanilide	C <sub>9</sub> H <sub>11</sub> NO	579-10-2	149.189	nd (eth), pr (al)	103	256	1.0036 <sup>105</sup>	1.576	s H <sub>2</sub> O, EtOH, eth, chl, lig
7615	2-Methylphenyl acetate	<i>o</i> -Cresyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	533-18-6	150.174			208	1.0533 <sup>15</sup>	1.5002 <sup>20</sup>	vs eth, EtOH
7616	3-Methylphenyl acetate	<i>m</i> -Cresyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	122-46-3	150.174		12	212	1.043 <sup>20</sup>	1.4978 <sup>20</sup>	vs bz, eth, EtOH
7617	4-Methylphenyl acetate	<i>p</i> -Cresyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	140-39-6	150.174			212.5	1.0512 <sup>17</sup>	1.5163 <sup>22</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, chl
7618	Methyl 2-phenylacetate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	101-41-7	150.174			216.5	1.0622 <sup>16</sup>	1.5075 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
7619	2-(Methylphenylamino)ethanol		C <sub>9</sub> H <sub>13</sub> NO	93-90-3	151.205			218 <sup>110</sup> , 150 <sup>14</sup>	1.0143 <sup>9</sup>		s H <sub>2</sub> O; vs EtOH, eth, ace, bz
7620	2-[(2-Methylphenyl)amino]ethanol		C <sub>9</sub> H <sub>13</sub> NO	136-80-1	151.205			285.5	1.0794 <sup>20</sup>	1.5675 <sup>20</sup>	vs eth, EtOH
7621	3-Methyl- <i>N</i> -phenylaniline		C <sub>13</sub> H <sub>13</sub> N	1205-64-7	183.249		30	316; 183 <sup>17</sup>		1.6350 <sup>20</sup>	vs bz, eth, EtOH
7622	<i>N</i> -(4-Methylphenyl)benzamide		C <sub>14</sub> H <sub>15</sub> NO	582-78-5	211.259	orth nd (al)	158		1.202 <sup>15</sup>		vs eth, EtOH
7623	<i>N</i> -Methyl- <i>N</i> -phenylbenzenemethanamine		C <sub>14</sub> H <sub>15</sub> N	614-30-2	197.276						s ctc
7624	4-Methyl- $\alpha$ -phenylbenzenemethanol		C <sub>14</sub> H <sub>14</sub> O	1517-63-1	198.260		52				
7625	$\alpha$ -Methyl- $\alpha$ -phenylbenzenemethanol		C <sub>14</sub> H <sub>14</sub> O	599-67-7	198.260			285; 190 <sup>12</sup>	1.1059 <sup>15</sup>		
7626	4-Methyl- <i>N</i> -phenylbenzenesulfonamide		C <sub>13</sub> H <sub>13</sub> NO <sub>2</sub> S	68-34-8	247.313	( $\alpha$ ) tcl, ( $\beta$ ) mcl pr (al, bz)	103.5				i H <sub>2</sub> O; vs EtOH; s bz, HOAc
7627	4-Methylphenyl benzoate		C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	614-34-6	212.244	pl (eth-al)	71.5	316			vs eth, EtOH
7628	1-Methyl- <i>N</i> -phenyl- <i>N</i> -benzyl-4-piperidinamine	Bamipine	C <sub>19</sub> H <sub>24</sub> N <sub>2</sub>	4945-47-5	280.407	cry (MeOH)	115				
7629	Methyl 2-phenylbutanoate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	2294-71-5	178.228	nd (dil al)	77.5	228			vs eth, EtOH
7630	3-Methyl-1-phenyl-1-butanone		C <sub>11</sub> H <sub>14</sub> O	582-62-7	162.228			236.5	0.9701 <sup>16</sup>	1.5139 <sup>15</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace
7631	3-Methyl-4-phenyl-3-butenamide	$\beta$ -Benzalbutyramide	C <sub>11</sub> H <sub>13</sub> NO	7236-47-7	175.227		133				
7632	Methylphenylcarbamic chloride		C <sub>8</sub> H <sub>9</sub> ClNO	4285-42-1	169.609	pl (al)	88.5	280			vs eth, EtOH
7633	1-(2-Methylphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O	577-16-2	134.174			214	1.026 <sup>20</sup>	1.5276 <sup>20</sup>	
7634	1-(3-Methylphenyl)ethanone		C <sub>9</sub> H <sub>10</sub> O	585-74-0	134.174			220	1.0165 <sup>9</sup>	1.533 <sup>15</sup>	s EtOH, eth, ace; sl ctc
7635	4-(1-Methyl-1-phenylethyl)phenol		C <sub>15</sub> H <sub>16</sub> O	599-64-4	212.287	pr (peth)	74.5	335			
7636	<i>N</i> -Methyl- <i>N</i> -phenylformamide		C <sub>8</sub> H <sub>9</sub> NO	93-61-8	135.163		14.5	243	1.0948 <sup>20</sup>	1.5589 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, ace
7637	<i>N</i> -(2-Methylphenyl)formamide		C <sub>8</sub> H <sub>9</sub> NO	94-69-9	135.163	lf (al)	62	288	1.086 <sup>55</sup>		s H <sub>2</sub> O; vs EtOH
7638	5-Methyl-1-phenyl-1-hexen-3-one		C <sub>13</sub> H <sub>16</sub> O	2892-18-4	188.265	cry	43	154 <sup>25</sup>	0.9509 <sup>46</sup>	1.5523 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH, bz, chl
7639	1-Methyl-1-phenylhydrazine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	618-40-6	122.167			228; 131 <sup>35</sup>	1.0404 <sup>20</sup>	1.5691 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz, chl
7640	3-Methyl-5-phenyl-2,4-imidazolidinedione	3-Methyl-5-phenylhydantoin	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	6846-11-3	190.198		164.5				s chl
7641	1-Methyl-6-phenylimidazo[4,5-b]pyridin-2-amine	PhIP	C <sub>13</sub> H <sub>12</sub> N <sub>4</sub>	105650-23-5	224.261	solid	327				
7642	2-[(Methyl(phenylmethyl)amino)ethanol		C <sub>10</sub> H <sub>15</sub> NO	101-98-4	165.232			134 <sup>14</sup>			
7643	4-Methyl- <i>N</i> -(phenylmethylene)aniline		C <sub>14</sub> H <sub>13</sub> N	2272-45-9	195.260	ye cry	35	318; 178 <sup>11</sup>			vs ace
7644	3-Methyl-2-phenylmorpholine	Phenmetrazine	C <sub>11</sub> H <sub>15</sub> NO	134-49-6	177.243			139 <sup>12</sup> , 104 <sup>1</sup>			
7645	2-Methyl-2-phenyloxirane		C <sub>9</sub> H <sub>10</sub> O	2085-88-3	134.174			84 <sup>17</sup>	1.0228 <sup>20</sup>	1.5232 <sup>20</sup>	
7646	<i>N</i> -(2-Methylphenyl)-3-oxobutanamide		C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub>	93-68-5	191.227	pr (AcOEt)	107.5				vs bz, EtOH
7647	<i>N</i> -(4-Methylphenyl)-3-oxobutanamide		C <sub>11</sub> H <sub>13</sub> NO <sub>2</sub>	2415-85-2	191.227	pr (AcOEt)	95				sl H <sub>2</sub> O, lig; s EtOH, bz
7648	(2-Methylphenyl)phenylmethanone		C <sub>14</sub> H <sub>12</sub> O	131-58-8	196.244		<-18	308; 128 <sup>12</sup>	1.1098 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH
7649	(3-Methylphenyl)phenylmethanone		C <sub>14</sub> H <sub>12</sub> O	643-65-2	196.244	oil	2	317; 170 <sup>9</sup>	1.095 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc



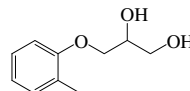
Methyl phenoxacetate



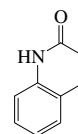
1-Methyl-3-phenoxybenzene



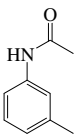
[(2-Methylphenoxy)methyl]loxirane



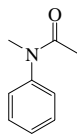
3-(2-Methylphenoxy)-1,2-propanediol



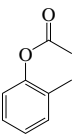
N-(2-Methylphenyl)acetamide



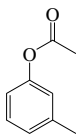
N-(3-Methylphenyl)acetamide



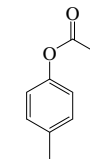
N-Methyl-N-phenylacetamide



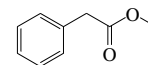
2-Methylphenyl acetate



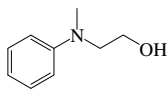
3-Methylphenyl acetate



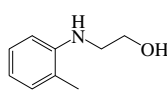
4-Methylphenyl acetate



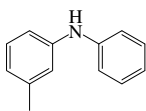
Methyl 2-phenylacetate



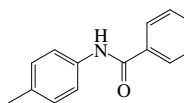
2-(Methylphenylamino)ethanol



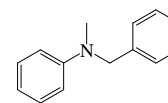
2-[(2-Methylphenyl)amino]ethanol



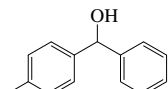
3-Methyl-N-phenylaniline



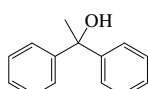
N-(4-Methylphenyl)benzamide



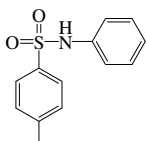
N-Methyl-N-phenylbenzenemethanamine



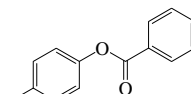
4-Methyl-α-phenylbenzenemethanol



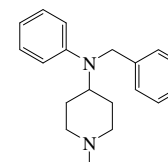
α-Methyl-α-phenylbenzenemethanol



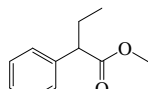
4-Methyl-N-phenylbenzenesulfonamide



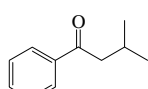
4-Methylphenyl benzoate



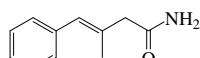
1-Methyl-N-phenyl-N-benzyl-4-piperidinamine



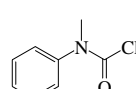
Methyl 2-phenylbutanoate



3-Methyl-1-phenyl-1-butanone



3-Methyl-4-phenyl-3-butenamide



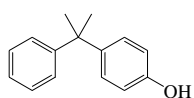
Methylphenylcarbamic chloride



1-(2-Methylphenyl)ethanone



1-(3-Methylphenyl)ethanone



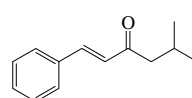
4-(1-Methyl-1-phenylethyl)phenol



N-Methyl-N-phenylformamide



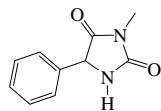
N-(2-Methylphenyl)formamide



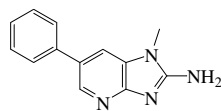
5-Methyl-1-phenyl-1-hexen-3-one



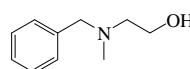
1-Methyl-1-phenylhydrazine



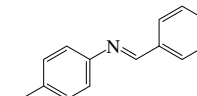
3-Methyl-5-phenyl-2,4-imidazolidinedione



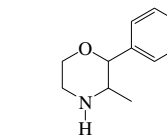
1-Methyl-6-phenylimidazo[4,5-b]pyridin-2-amine



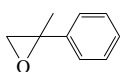
2-[(Methyl(phenyl)methyl)amino]ethanol



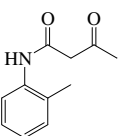
4-Methyl-N-(phenylmethylene)aniline



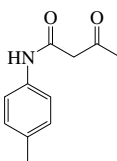
3-Methyl-2-phenylmorpholine



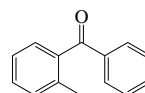
2-Methyl-2-phenyloxirane



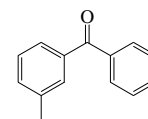
N-(2-Methylphenyl)-3-oxo-butanamide



N-(4-Methylphenyl)-3-oxobutanamide

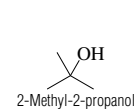
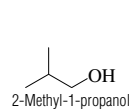
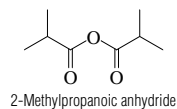
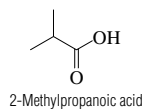
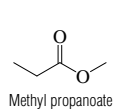
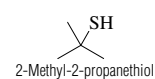
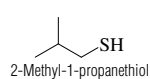
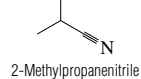
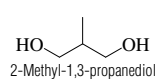
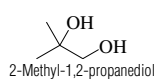
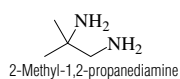
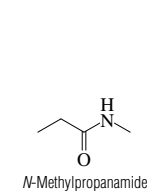
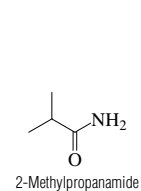
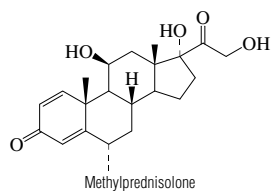
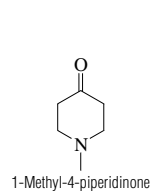
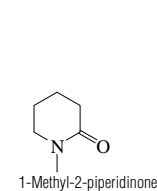
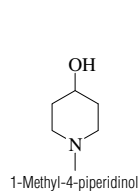
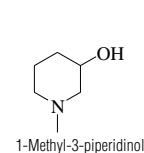
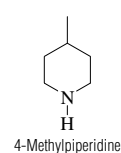
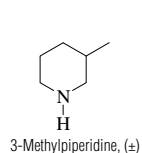
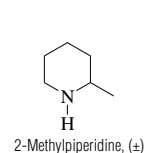
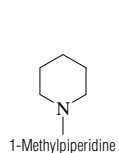
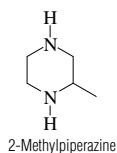
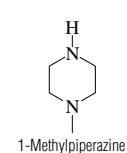
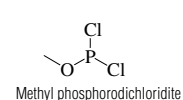
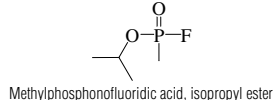
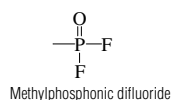
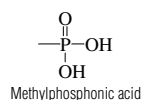
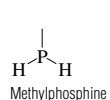
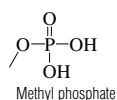
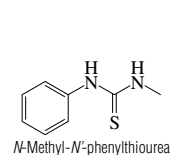
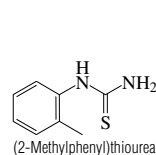
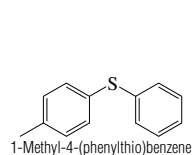
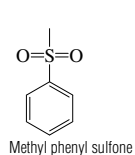
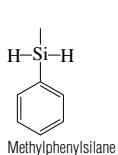
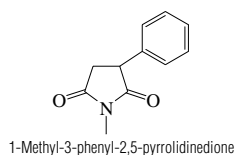
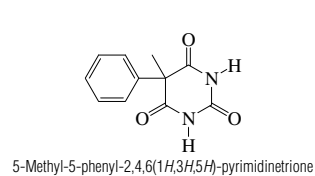
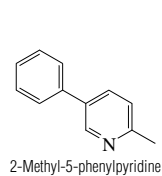
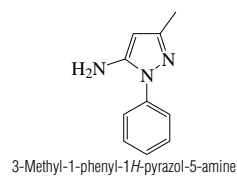
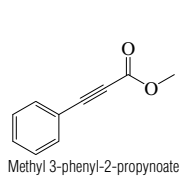
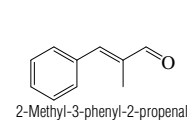
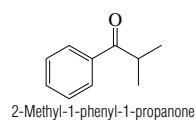
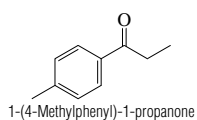
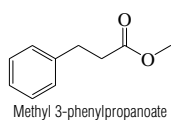
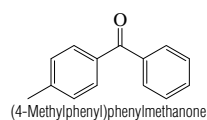


(2-Methylphenyl)phenylmethanone



(3-Methylphenyl)phenylmethanone

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7650	(4-Methylphenyl) phenylmethanone		C <sub>14</sub> H <sub>12</sub> O	134-84-9	196.244	mcl pr	59.5	228 <sup>70</sup>	0.9926 <sup>9</sup>		i H <sub>2</sub> O; sl EtOH, lig; s eth, bz, chl
7651	Methyl 3-phenylpropanoate	Methyl dihydrocinnamate	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	103-25-3	164.201			238.5; 91 <sup>4</sup>	1.0455 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, AcOEt
7652	1-(4-Methylphenyl)-1-propanone		C <sub>10</sub> H <sub>12</sub> O	5337-93-9	148.201		7.2	236	0.9926 <sup>20</sup>	1.5278 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, CS <sub>2</sub>
7653	2-Methyl-1-phenyl-1-propanone		C <sub>10</sub> H <sub>12</sub> O	611-70-1	148.201	liq	-0.7	220	0.9863 <sup>11</sup>	1.5172 <sup>20</sup>	vs eth, EtOH
7654	2-Methyl-3-phenyl-2-propenal		C <sub>10</sub> H <sub>10</sub> O	101-39-3	146.185			248; 150 <sup>100</sup>	1.0407 <sup>17</sup>	1.6057 <sup>17</sup>	
7655	Methyl 3-phenyl-2-propynoate		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	4891-38-7	160.170		26	158 <sup>48</sup> , 132 <sup>16</sup>	1.0830 <sup>25</sup>	1.5618 <sup>25</sup>	
7656	3-Methyl-1-phenyl-1 <i>H</i> -pyrazol-5-amine		C <sub>10</sub> H <sub>11</sub> N <sub>3</sub>	1131-18-6	173.214		116	333			s H <sub>2</sub> O, EtOH, chl; sl bz
7657	2-Methyl-5-phenylpyridine		C <sub>12</sub> H <sub>11</sub> N	3256-88-0	169.222			189 <sup>50</sup>	1.0590 <sup>25</sup>	1.6055 <sup>25</sup>	
7658	5-Methyl-5-phenyl-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	Phenylmethylbarbituric acid	C <sub>11</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	76-94-8	218.208	cry	220				i H <sub>2</sub> O; s EtOH, eth, alk
7659	1-Methyl-3-phenyl-2,5-pyrrolidinedione	Phensuximide	C <sub>11</sub> H <sub>11</sub> NO <sub>2</sub>	86-34-0	189.211	cry (hot al)	72				vs EtOH, MeOH
7660	Methylphenylsilane		C <sub>7</sub> H <sub>10</sub> Si	766-08-5	122.240			140	0.8895 <sup>20</sup>	1.5058 <sup>20</sup>	
7661	Methyl phenyl sulfone		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub> S	3112-85-4	156.203		88				i H <sub>2</sub> O; s EtOH, bz, chl; sl ctc
7662	1-Methyl-4-(phenylthio)benzene		C <sub>13</sub> H <sub>12</sub> S	3699-01-2	200.299		15.7	317	1.0986 <sup>25</sup>	1.6225 <sup>25</sup>	i H <sub>2</sub> O; s ace, bz
7663	(2-Methylphenyl)thiourea	<i>o</i> -Tolylthiourea	C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> S	614-78-8	166.243	nd (dil al, w)	162				vs H <sub>2</sub> O, EtOH; sl eth
7664	<i>N</i> -Methyl- <i>N'</i> -phenylthiourea		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> S	2724-69-8	166.243	ta, pl	112.5				vs EtOH
7665	Methyl phosphate	Methyl dihydrogen phosphate	CH <sub>2</sub> O <sub>4</sub> P	812-00-0	112.022	oil					
7666	Methylphosphine		CH <sub>3</sub> P	593-54-4	48.025	col gas		-16			vs eth
7667	Methylphosphonic acid		CH <sub>2</sub> O <sub>3</sub> P	993-13-5	96.023	hyg pl	108.5	dec			vs H <sub>2</sub> O, EtOH, eth; i bz, peth
7668	Methylphosphonic difluoride		CH <sub>2</sub> F <sub>2</sub> OP	676-99-3	100.005	liq		98; 22 <sup>27</sup>	1.3314 <sup>20</sup>		
7669	Methylphosphonofluoridic acid, isopropyl ester	Sarin	C <sub>6</sub> H <sub>10</sub> FO <sub>2</sub> P	107-44-8	140.093	liq	-57	147	1.10 <sup>20</sup>		dec H <sub>2</sub> O
7670	Methyl phosphorodichloridite	Methyl dichlorophosphite	CH <sub>2</sub> Cl <sub>2</sub> OP	3279-26-3	132.914	hyg liq	-91	93	1.406	1.4740 <sup>20</sup>	
7671	1-Methylpiperazine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	109-01-3	100.162			138		1.4378 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
7672	2-Methylpiperazine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	109-07-9	100.162	hyg lf (al)	62	153			vs H <sub>2</sub> O; s EtOH, eth, bz, chl
7673	1-Methylpiperidine		C <sub>6</sub> H <sub>13</sub> N	626-67-5	99.174	liq	-102.7	107	0.8159 <sup>20</sup>	1.4355 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; s ctc
7674	2-Methylpiperidine, (±)		C <sub>6</sub> H <sub>13</sub> N	3000-79-1	99.174	liq	-2.5	118	0.8436 <sup>24</sup>	1.4459 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth; sl chl; i dil KOH
7675	3-Methylpiperidine, (±)		C <sub>6</sub> H <sub>13</sub> N	53152-98-0	99.174	liq	-24	125.5	0.8446 <sup>25</sup>	1.4470 <sup>20</sup>	vs H <sub>2</sub> O; sl chl
7676	4-Methylpiperidine		C <sub>6</sub> H <sub>13</sub> N	626-58-4	99.174			130	0.8674 <sup>25</sup>	1.4458 <sup>20</sup>	vs H <sub>2</sub> O; sl chl
7677	1-Methyl-3-piperidinol		C <sub>6</sub> H <sub>13</sub> NO	3554-74-3	115.173			93 <sup>26</sup> , 77 <sup>11</sup>	0.9635 <sup>16</sup>	1.4735 <sup>20</sup>	
7678	1-Methyl-4-piperidinol		C <sub>6</sub> H <sub>13</sub> NO	106-52-5	115.173		29	200		1.4775 <sup>20</sup>	
7679	1-Methyl-2-piperidinone		C <sub>6</sub> H <sub>11</sub> NO	931-20-4	113.157			221; 105 <sup>12</sup>	1.0263 <sup>25</sup>	1.4820 <sup>20</sup>	
7680	1-Methyl-4-piperidinone		C <sub>6</sub> H <sub>11</sub> NO	1445-73-4	113.157			85 <sup>45</sup> , 57 <sup>11</sup>	0.971 <sup>25</sup>	1.4580 <sup>25</sup>	
7681	Methylprednisolone		C <sub>22</sub> H <sub>30</sub> O <sub>5</sub>	83-43-2	374.470	cry	232				
7682	2-Methylpropanamide		C <sub>4</sub> H <sub>9</sub> NO	563-83-7	87.120		129.0	217	1.013 <sup>20</sup>		s chl
7683	<i>N</i> -Methylpropanamide		C <sub>4</sub> H <sub>9</sub> NO	1187-58-2	87.120	liq	-30.9	148	0.9305 <sup>25</sup>	1.4345 <sup>25</sup>	
7684	2-Methyl-1,2-propanediamine		C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	811-93-8	88.151			123	0.841 <sup>25</sup>	1.4410 <sup>20</sup>	s ctc
7685	2-Methyl-1,2-propanediol		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	558-43-0	90.121			176	1.0024 <sup>20</sup>	1.4350 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
7686	2-Methyl-1,3-propanediol		C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	2163-42-0	90.121	liq	-91	211.6; 124 <sup>20</sup>	1.015 <sup>20</sup>	1.4450 <sup>20</sup>	
7687	2-Methylpropanenitrile	Isobutyronitrile	C <sub>4</sub> H <sub>7</sub> N	78-82-0	69.106	liq	-71.5	103.9	0.7704 <sup>20</sup>	1.3720 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
7688	2-Methyl-1-propanethiol	Isobutyl mercaptan	C <sub>4</sub> H <sub>10</sub> S	513-44-0	90.187		<-70	88.5	0.8357 <sup>20</sup>	1.4387 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace; s ctc
7689	2-Methyl-2-propanethiol	<i>tert</i> -Butyl mercaptan	C <sub>4</sub> H <sub>10</sub> S	75-66-1	90.187	liq	-0.5	64.2	0.7943 <sup>25</sup>	1.4232 <sup>20</sup>	i H <sub>2</sub> O; s ctc, hp
7690	Methyl propanoate	Methyl propionate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	554-12-1	88.106	liq	-87.5	79.8	0.9150 <sup>20</sup>	1.3775 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, ctc
7691	2-Methylpropanoic acid	Isobutyric acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	79-31-2	88.106	liq	-46	154.45	0.9681 <sup>20</sup>	1.3930 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth; sl ctc
7692	2-Methylpropanoic anhydride	Isobutyric anhydride	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	97-72-3	158.195	liq	-53.5	183; 89 <sup>32</sup>	0.9535 <sup>20</sup>	1.4061 <sup>19</sup>	msc eth; s chl
7693	2-Methyl-1-propanol	Isobutyl alcohol	C <sub>4</sub> H <sub>10</sub> O	78-83-1	74.121	liq	-101.9	107.89	0.8018 <sup>20</sup>	1.3955 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, ctc
7694	2-Methyl-2-propanol	<i>tert</i> -Butyl alcohol	C <sub>4</sub> H <sub>10</sub> O	75-65-0	74.121		25.69	82.4	0.7887 <sup>20</sup>	1.3878 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s chl



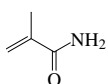
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7695	2-Methylpropanoyl chloride	Isobutyric acid chloride	C <sub>4</sub> H <sub>7</sub> ClO	79-30-1	106.551	liq	-90	92		1.4079 <sup>20</sup>	s eth
7696	2-Methylpropenal	Methacrolein	C <sub>4</sub> H <sub>6</sub> O	78-85-3	70.090			68.4	0.840 <sup>25</sup>	1.4144 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
7697	2-Methyl-2-propenamidine		C <sub>4</sub> H <sub>7</sub> NO	79-39-0	85.105	cry (bz)	110.5				sl eth, chl; s EtOH, CH <sub>2</sub> Cl <sub>2</sub>
7698	<i>N</i> -Methyl-2-propen-1-amine		C <sub>4</sub> H <sub>7</sub> N	627-37-2	71.121			64		1.4065 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
7699	2-Methyl-2-propene-1,1-diol diacetate	Methacrolein diacetate	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	10476-95-6	172.179			191		1.4241 <sup>20</sup>	
7700	2-Methyl-1-propene, tetramer		C <sub>16</sub> H <sub>32</sub>	15220-85-6	224.425	liq	-98	244; 109 <sup>15</sup>	0.7944 <sup>20</sup>	1.4482 <sup>20</sup>	
7701	2-Methyl-2-propenoic anhydride	Methacrylic acid anhydride	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	760-93-0	154.163			89 <sup>5</sup>		1.4540 <sup>20</sup>	msc EtOH, eth
7702	2-Methyl-2-propenol	Methallyl alcohol	C <sub>4</sub> H <sub>8</sub> O	513-42-8	72.106			114.5	0.8515 <sup>20</sup>	1.4255 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth
7703	2-Methyl-2-propenoyl chloride	Methacrylic acid chloride	C <sub>4</sub> H <sub>7</sub> ClO	920-46-7	104.535	liq	-60	96	1.0871 <sup>20</sup>	1.4435 <sup>20</sup>	s eth, ace, chl
7704	<i>cis</i> -(1-Methyl-1-propenyl)benzene		C <sub>10</sub> H <sub>12</sub>	767-99-7	132.202			194.7; 177 <sup>500</sup>	0.9191 <sup>25</sup>	1.5402 <sup>25</sup>	i H <sub>2</sub> O; s bz, chl
7705	<i>trans</i> -(1-Methyl-1-propenyl)benzene		C <sub>10</sub> H <sub>12</sub>	768-00-3	132.202	liq	-23.5	194.7	0.9138 <sup>25</sup>	1.5425 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl
7706	(2-Methyl-1-propenyl)benzene		C <sub>10</sub> H <sub>12</sub>	768-49-0	132.202	liq	-48.0	183; 99 <sup>43</sup>	0.900 <sup>20</sup>	1.5388 <sup>20</sup>	
7707	4-(2-Methylpropenyl)morpholine	1-Morpholinoisobutene	C <sub>8</sub> H <sub>15</sub> NO	2403-55-6	141.211			120	89 <sup>20</sup>		1.4663 <sup>20</sup>
7708	2-(2-Methylpropoxy)ethanol		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	4439-24-1	118.174			160	0.8900 <sup>20</sup>	1.4143 <sup>20</sup>	
7709	Methylpropylamine	<i>N</i> -Methyl-1-propanamine	C <sub>4</sub> H <sub>11</sub> N	627-35-0	73.137			63	0.7204 <sup>17</sup>		
7710	1-Methyl-2-propylbenzene		C <sub>10</sub> H <sub>14</sub>	1074-17-5	134.218	liq	-60.3	185	0.8697 <sup>25</sup>	1.4996 <sup>20</sup>	
7711	1-Methyl-3-propylbenzene		C <sub>10</sub> H <sub>14</sub>	1074-43-7	134.218	liq	-82.5	182	0.8569 <sup>25</sup>	1.4935 <sup>20</sup>	
7712	1-Methyl-4-propylbenzene		C <sub>10</sub> H <sub>14</sub>	1074-55-1	134.218	liq	-63.6	183.4	0.8544 <sup>25</sup>	1.4922 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
7713	<i>cis</i> -1-Methyl-2-propylcyclopentane		C <sub>9</sub> H <sub>18</sub>	932-43-4	126.239	liq	-104	152.6	0.7881 <sup>25</sup>	1.4343 <sup>20</sup>	
7714	<i>trans</i> -1-Methyl-2-propylcyclopentane		C <sub>9</sub> H <sub>18</sub>	932-44-5	126.239	liq	-123	146.4	0.7735 <sup>25</sup>	1.4274 <sup>20</sup>	
7715	Methyl propyl disulfide		C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	2179-60-4	122.252	liq		70 <sup>43</sup>	0.980	1.5080 <sup>20</sup>	
7716	Methyl propyl ether	1-Methoxypropane	C <sub>4</sub> H <sub>10</sub> O	557-17-5	74.121			39.1	0.7356 <sup>13</sup>	1.3579 <sup>25</sup>	s H <sub>2</sub> O, ace; msc EtOH, eth
7717	1-Methyl-2-propylpiperidine, ( <i>S</i> )	Methylconiine	C <sub>9</sub> H <sub>19</sub> N	35305-13-6	141.254			174	0.8326 <sup>22</sup>	1.4538 <sup>12</sup>	vs ace, EtOH
7718	2-Methyl-2-propyl-1,3-propanediol		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	78-26-2	132.201	cry (hx)	62.5	234; 121 <sup>10</sup>			s H <sub>2</sub> O, hx; sl chl
7719	2-Methyl-2-propyl-1,3-propanediol dicarbamate	Meprobamate	C <sub>9</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub>	57-53-4	218.250	cry (w)	105				vs bz, eth, EtOH
7720	Methyl propyl sulfide		C <sub>4</sub> H <sub>10</sub> S	3877-15-4	90.187	liq	-113	95.6	0.8424 <sup>20</sup>	1.4442 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace
7721	<i>N</i> -Methyl-2-propyn-1-amine		C <sub>4</sub> H <sub>7</sub> N	35161-71-8	69.106			83	0.819 <sup>25</sup>	1.4332 <sup>20</sup>	
7722	<i>N</i> -Methyl- <i>N</i> -2-propynylbenzenemethanamine	Pargyline	C <sub>11</sub> H <sub>13</sub> N	555-57-7	159.228			96 <sup>11</sup>	0.944 <sup>25</sup>	1.5213 <sup>20</sup>	
7723	3-Methylpyrazinamine	2-Amino-3-methylpyrazine	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub>	19838-08-5	109.130	nd (hx/ AcOEt)	174				
7724	2-Methylpyrazine		C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	109-08-0	94.115	liq	-29	137	1.03 <sup>20</sup>	1.5042 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace; sl ctc
7725	1-Methyl-1 <i>H</i> -pyrazole		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	930-36-9	82.104			127	0.9929 <sup>13</sup>	1.4787 <sup>13</sup>	
7726	3-Methyl-1 <i>H</i> -pyrazole		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	1453-58-3	82.104		36.5	204; 108 <sup>25</sup>	1.0203 <sup>16</sup>	1.4915 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth
7727	4-Methyl-1 <i>H</i> -pyrazole	Formepizole	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	7554-65-6	82.104			206; 95 <sup>13</sup>	1.015 <sup>20</sup>		
7728	3-Methyl-2-pyrazolin-5-one		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O	108-26-9	98.103		215				vs H <sub>2</sub> O; sl EtOH
7729	1-Methylpyrene		C <sub>17</sub> H <sub>12</sub>	2381-21-7	216.277		71.3	410			
7730	2-Methylpyrene		C <sub>17</sub> H <sub>12</sub>	3442-78-2	216.277	fl (EtOH)	143	409.8			
7731	3-Methylpyridazine	3-Methyl-1,2-diazine	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub>	1632-76-4	94.115		184	214	1.0450 <sup>26</sup>	1.5145 <sup>20</sup>	
7732	3-Methyl-2-pyridinamine	2-Amino-3-picoline	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1603-40-3	108.141	hyg	33.5	222; 95 <sup>9</sup>			vs H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc; sl lig
7733	4-Methyl-2-pyridinamine	2-Amino-4-picoline	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	695-34-1	108.141	lf or pl (lig)	100	116 <sup>11</sup>			vs H <sub>2</sub> O; s EtOH, eth, ace, bz; i lig; sl chl
7734	5-Methyl-2-pyridinamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1603-41-4	108.141		76.5	227			
7735	6-Methyl-2-pyridinamine	2-Amino-6-picoline	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1824-81-3	108.141	hyg (lig)	41	208.5			vs H <sub>2</sub> O; s EtOH, eth, ace, bz, lig
7736	<i>N</i> -Methyl-2-pyridinamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	4597-87-9	108.141		15	200.5	1.048 <sup>29</sup>		s H <sub>2</sub> O, bz; vs EtOH, eth, HOAc
7737	<i>N</i> -Methyl-4-pyridinamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1121-58-0	108.141	pl (eth)	118.8				vs H <sub>2</sub> O, ace, eth, EtOH
7738	2-Methylpyridine	2-Picoline	C <sub>6</sub> H <sub>7</sub> N	109-06-8	93.127	liq	-66.68	129.38	0.9443 <sup>20</sup>	1.4957 <sup>20</sup>	vs H <sub>2</sub> O, ace; msc EtOH, eth; s ctc



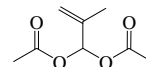
2-Methylpropanoyl chloride



2-Methylpropenal



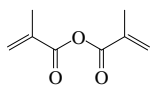
2-Methyl-2-propenamide

*N*-Methyl-2-propen-1-amine

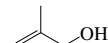
2-Methyl-2-propene-1,1-diol diacetate



2-Methyl-1-propene, tetramer



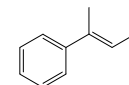
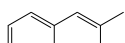
2-Methyl-2-propenoic anhydride



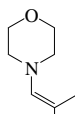
2-Methyl-2-propenol



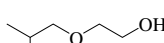
2-Methyl-2-propenoyl chloride

*cis*-(1-Methyl-1-propenyl)benzene*trans*-(1-Methyl-1-propenyl)benzene

(2-Methyl-1-propenyl)benzene



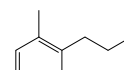
4-(2-Methylpropenyl)morpholine



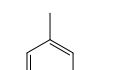
2-(2-Methylpropoxy)ethanol



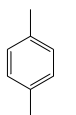
Methylpropylamine



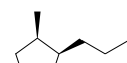
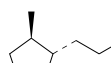
1-Methyl-2-propylbenzene



1-Methyl-3-propylbenzene



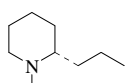
1-Methyl-4-propylbenzene

*cis*-1-Methyl-2-propylcyclopentane*trans*-1-Methyl-2-propylcyclopentane

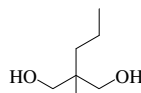
Methyl propyl disulfide



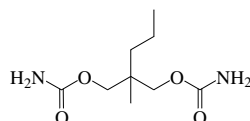
Methyl propyl ether



1-Methyl-2-propylpiperidine, (S)



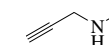
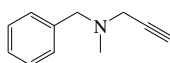
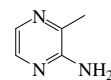
2-Methyl-2-propyl-1,3-propanediol



2-Methyl-2-propyl-1,3-propanediol dicarbamate



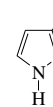
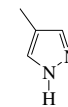
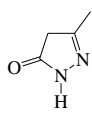
Methyl propyl sulfide

*N*-Methyl-2-propyn-1-amine*N*-Methyl-*N*-2-propynylbenzenemethanamine

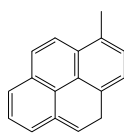
3-Methylpyrazinamine



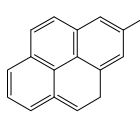
2-Methylpyrazine

1-Methyl-1*H*-pyrazole3-Methyl-1*H*-pyrazole4-Methyl-1*H*-pyrazole

3-Methyl-2-pyrazolin-5-one



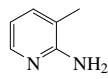
1-Methylpyrene



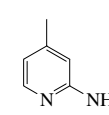
2-Methylpyrene



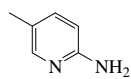
3-Methylpyridazine



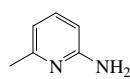
3-Methyl-2-pyridinamine



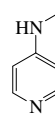
4-Methyl-2-pyridinamine



5-Methyl-2-pyridinamine



6-Methyl-2-pyridinamine

*N*-Methyl-2-pyridinamine*N*-Methyl-4-pyridinamine

2-Methylpyridine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7739	3-Methylpyridine	3-Picoline	C <sub>6</sub> H <sub>7</sub> N	108-99-6	93.127	liq	-18.14	144.14	0.9566 <sup>20</sup>	1.5040 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace; s ctc
7740	4-Methylpyridine	4-Picoline	C <sub>6</sub> H <sub>7</sub> N	108-89-4	93.127		3.67	145.36	0.9548 <sup>20</sup>	1.5037 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, ctc
7741	6-Methyl-2-pyridinecarboxaldehyde		C <sub>7</sub> H <sub>7</sub> NO	1122-72-1	121.137		32	77 <sup>12</sup>			
7742	Methyl 3-pyridinecarboxylate	Methyl nicotinate	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	93-60-7	137.137	cry	42.5	204			s H <sub>2</sub> O, EtOH, bz
7743	Methyl 4-pyridinecarboxylate	Methyl isonicotinate	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	2459-09-8	137.137		16.1	208	1.1599 <sup>20</sup>	1.5135 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, bz
7744	2-Methylpyridine-1-oxide		C <sub>6</sub> H <sub>7</sub> NO	931-19-1	109.126		49	260			
7745	3-Methylpyridine-1-oxide		C <sub>6</sub> H <sub>7</sub> NO	1003-73-2	109.126		39	148 <sup>15</sup>			s chl
7746	4-Methylpyridine-1-oxide		C <sub>6</sub> H <sub>7</sub> NO	1003-67-4	109.126		185.8				
7747	1-Methyl-2(1 <i>H</i> )-pyridinone		C <sub>6</sub> H <sub>7</sub> NO	694-85-9	109.126	nd	31	250	1.1120 <sup>20</sup>		msc H <sub>2</sub> O; sl peth, lig
7748	1-(6-Methyl-3-pyridinyl)ethanone		C <sub>8</sub> H <sub>9</sub> NO	36357-38-7	135.163		17.6	144 <sup>50</sup>	1.0168 <sup>25</sup>	1.5302 <sup>25</sup>	vs H <sub>2</sub> O
7749	4-Methyl-2-pyrimidinamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	108-52-1	109.130	pl (w), nd (sub)	160.3	sub			s H <sub>2</sub> O, EtOH; sl chl
7750	2-Methylpyrimidine	2-Methyl-1,3-diazine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	5053-43-0	94.115	liq	-4	138			msc H <sub>2</sub> O
7751	4-Methylpyrimidine	4-Methyl-1,3-diazine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	3438-46-8	94.115		32	142	1.030 <sup>16</sup>	1.500 <sup>20</sup>	msc H <sub>2</sub> O
7752	5-Methylpyrimidine	5-Methyl-1,3-diazine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	2036-41-1	94.115		30.5	153			vs H <sub>2</sub> O
7753	6-Methyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	6-Methyluracil	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	626-48-2	126.114	oct pr or nd (w, al)	275 dec				s H <sub>2</sub> O, EtOH; sl eth, tfa; vs NH <sub>3</sub>
7754	1-Methylpyrrole		C <sub>5</sub> H <sub>7</sub> N	96-54-8	81.117	liq	-56.32	112.81	0.9145 <sup>15</sup>	1.4875 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
7755	2-Methylpyrrole		C <sub>5</sub> H <sub>7</sub> N	636-41-9	81.117	liq	-35.6	147.6	0.9446 <sup>15</sup>	1.5035 <sup>16</sup>	i H <sub>2</sub> O; msc EtOH, eth
7756	3-Methylpyrrole		C <sub>5</sub> H <sub>7</sub> N	616-43-3	81.117	liq	-48.4	142.9; 45 <sup>11</sup>		1.4970 <sup>20</sup>	msc EtOH, eth
7757	<i>N</i> -Methylpyrrolidine		C <sub>5</sub> H <sub>11</sub> N	120-94-5	85.148			81	0.8188 <sup>20</sup>	1.4247 <sup>20</sup>	vs H <sub>2</sub> O, eth
7758	1-Methyl-2,5-pyrrolidinedione		C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	1121-07-9	113.116	nd (eth-peth, al, ace)	71	234			s H <sub>2</sub> O, EtOH; vs eth
7759	<i>N</i> -Methyl-2-pyrrolidinethione		C <sub>5</sub> H <sub>7</sub> NS	10441-57-3	115.197	oil		100 <sup>0,18</sup>			
7760	5-Methyl-2-pyrrolidinone		C <sub>5</sub> H <sub>9</sub> NO	108-27-0	99.131		43	248	1.0458 <sup>20</sup>		
7761	1-(1-Methyl-2-pyrrolidinyl)-2-propanone, ( <i>R</i> )	Hygrine	C <sub>8</sub> H <sub>15</sub> NO	496-49-1	141.211			76.5 <sup>11</sup>		1.4555 <sup>20</sup>	vs EtOH, chl
7762	3-(1-Methyl-2-pyrrolidinyl)pyridine, (±)		C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	22083-74-5	162.231			244	1.0082 <sup>20</sup>	1.5289 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, eth, chl; s lig
7763	<i>N</i> -Methyl-2-pyrrolidinone		C <sub>5</sub> H <sub>9</sub> NO	872-50-4	99.131	liq	-23.09	202	1.0230 <sup>25</sup>	1.4684 <sup>20</sup>	vs H <sub>2</sub> O; s eth, ace, chl
7764	1-(1-Methyl-1 <i>H</i> -pyrrol-2-yl)ethanone		C <sub>7</sub> H <sub>9</sub> NO	932-16-1	123.152			201 <sup>252</sup> , 93 <sup>22</sup>	1.0445 <sup>15</sup>	1.5403 <sup>15</sup>	s EtOH, bz, chl
7765	6-Methyl-8-quinolinamine	8-Amino-6-methylquinoline	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	68420-93-9	158.199	nd	73	sub			vs ace, bz, eth, EtOH
7766	2-Methylquinoline	Quinaldine	C <sub>10</sub> H <sub>9</sub> N	91-63-4	143.185	col oily liq	-0.8	246.5	1.06 <sup>25</sup>	1.6116 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, ctc, chl
7767	3-Methylquinoline		C <sub>10</sub> H <sub>9</sub> N	612-58-8	143.185	pr	16.5	259.8	1.0673 <sup>20</sup>	1.6171 <sup>20</sup>	vs ace, eth, EtOH
7768	4-Methylquinoline	Lepidine	C <sub>10</sub> H <sub>9</sub> N	491-35-0	143.185	col oily liq	9.5	262	1.083 <sup>20</sup>	1.6200 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace; i alk
7769	5-Methylquinoline		C <sub>10</sub> H <sub>9</sub> N	7661-55-4	143.185	col cry	19	262.7	1.0832 <sup>20</sup>	1.6219 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
7770	6-Methylquinoline		C <sub>10</sub> H <sub>9</sub> N	91-62-3	143.185	col oily liq	-22	258.6	1.0654 <sup>20</sup>	1.6157 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
7771	7-Methylquinoline	<i>m</i> -Toluquinoline	C <sub>10</sub> H <sub>9</sub> N	612-60-2	143.185	ye cry	39	257.6	1.0609 <sup>20</sup>	1.6150 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
7772	8-Methylquinoline		C <sub>10</sub> H <sub>9</sub> N	611-32-5	143.185	col liq	-80	247.5	1.0719 <sup>20</sup>	1.6164 <sup>20</sup>	sl H <sub>2</sub> O; s ace; msc EtOH, eth
7773	2-Methyl-8-quinolinol		C <sub>10</sub> H <sub>9</sub> NO	826-81-3	159.184		73.8	267			i H <sub>2</sub> O; s EtOH, eth, bz, ctc
7774	1-Methyl-2(1 <i>H</i> )-quinolinone		C <sub>10</sub> H <sub>9</sub> NO	606-43-9	159.184	nd (lig)	74	325			sl H <sub>2</sub> O, lig; s EtOH, eth, ace; vs bz
7775	1-Methyl-4(1 <i>H</i> )-quinolinone	Echinopsine	C <sub>10</sub> H <sub>9</sub> NO	83-54-5	159.184	α-nd (bz); β-cry (al)					s H <sub>2</sub> O; vs EtOH, bz, chl; sl eth
7776	2-Methylquinoxaline		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	7251-61-8	144.173	ye cry	180.5	244			msc H <sub>2</sub> O, eth, ace, bz; vs EtOH; s ctc
7777	Methyl Red	Benzoic acid, 2-[[4-(dimethylamino)phenyl]azo]-	C <sub>15</sub> H <sub>15</sub> N <sub>3</sub> O <sub>2</sub>	493-52-7	269.299	viol or red pr (to, bz)	183				sl H <sub>2</sub> O, lig; s EtOH; vs ace, bz, chl
7778	Methyl β- <i>D</i> -ribofuranoside		C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	7473-45-2	164.156		80				

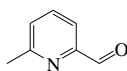




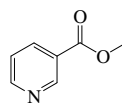
3-Methylpyridine



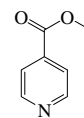
4-Methylpyridine



6-Methyl-2-pyridinecarboxaldehyde



Methyl 3-pyridinecarboxylate



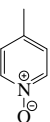
Methyl 4-pyridinecarboxylate



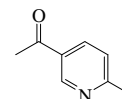
2-Methylpyridine-1-oxide



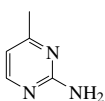
3-Methylpyridine-1-oxide



4-Methylpyridine-1-oxide

1-Methyl-2(1*H*)-pyridinone

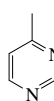
1-(6-Methyl-3-pyridinyl)ethanone



4-Methyl-2-pyrimidinamine



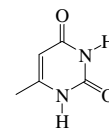
2-Methylpyrimidine



4-Methylpyrimidine



5-Methylpyrimidine

6-Methyl-2,4(1*H*,3*H*)-pyrimidinedione

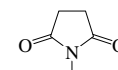
1-Methylpyrrole



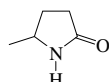
2-Methylpyrrole



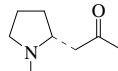
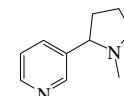
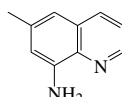
3-Methylpyrrole

*N*-Methylpyrrolidine

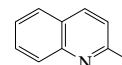
1-Methyl-2,5-pyrrolidinedione

*N*-Methyl-2-pyrrolidinethione

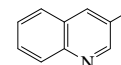
5-Methyl-2-pyrrolidinone

1-(1-Methyl-2-pyrrolidyl)-2-propanone, (*R*)3-(1-Methyl-2-pyrrolidyl)pyridine, ( $\pm$ )*N*-Methyl-2-pyrrolidinone1-(1-Methyl-1*H*-pyrrol-2-yl)ethanone

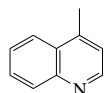
6-Methyl-8-quinolinamine



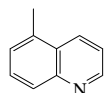
2-Methylquinoline



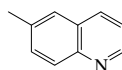
3-Methylquinoline



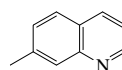
4-Methylquinoline



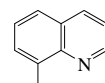
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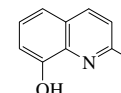
6-Methylquinoline



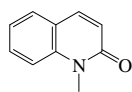
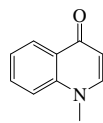
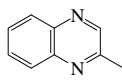
7-Methylquinoline



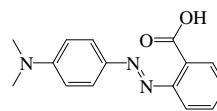
8-Methylquinoline



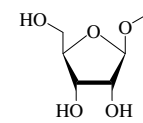
2-Methyl-8-quinolinol

1-Methyl-2(1*H*)-quinolinone1-Methyl-4(1*H*)-quinolinone

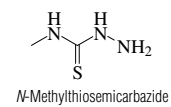
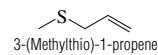
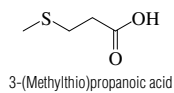
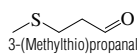
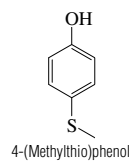
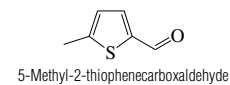
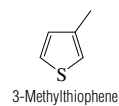
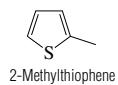
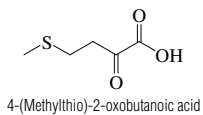
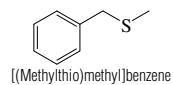
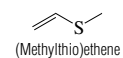
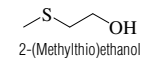
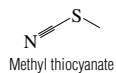
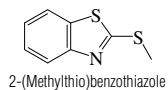
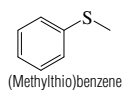
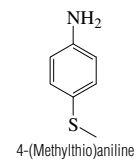
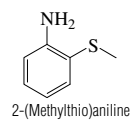
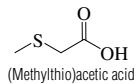
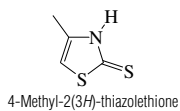
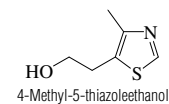
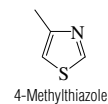
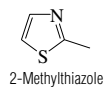
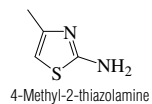
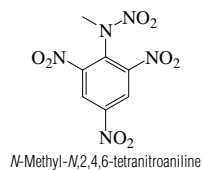
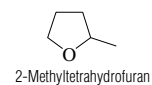
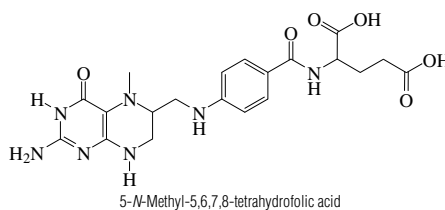
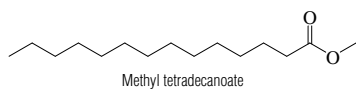
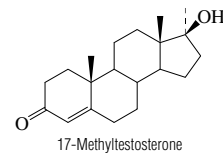
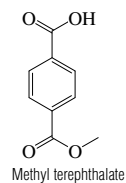
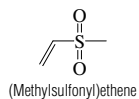
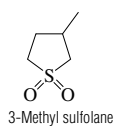
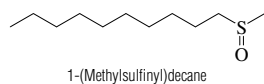
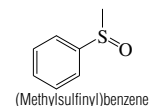
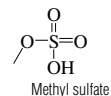
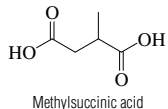
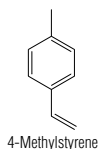
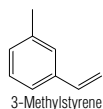
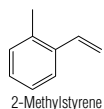
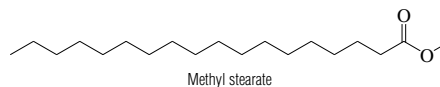
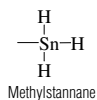
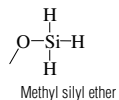
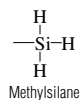
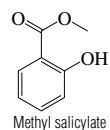
2-Methylquinoxaline



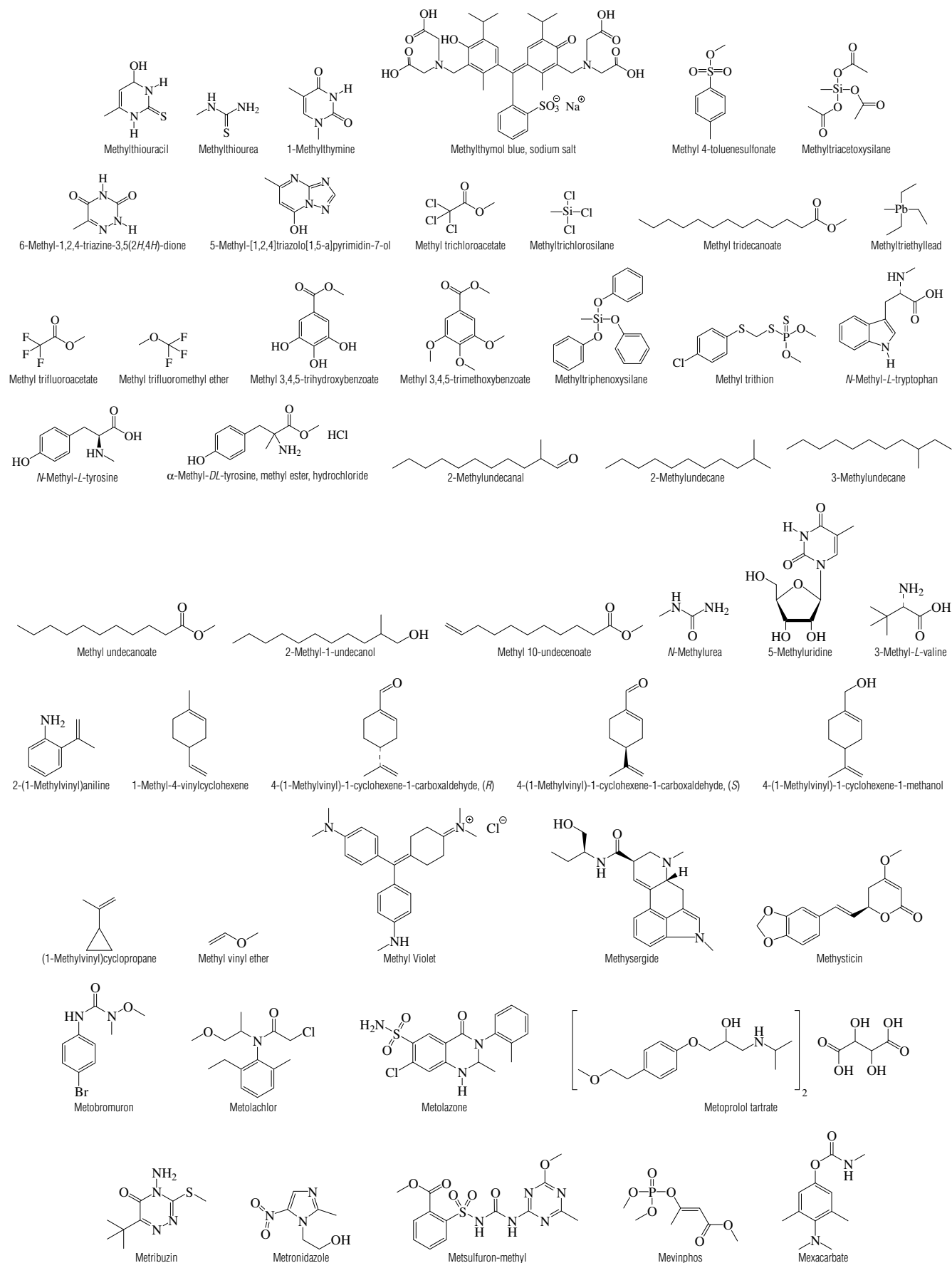
Methyl Red

Methyl  $\beta$ -*D*-ribofuranoside

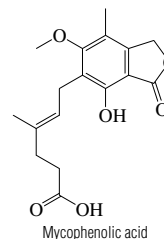
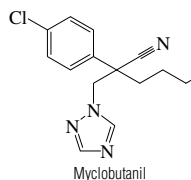
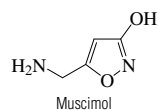
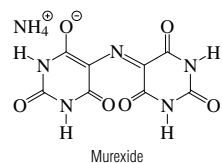
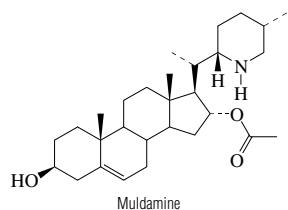
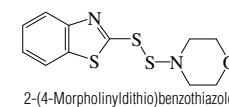
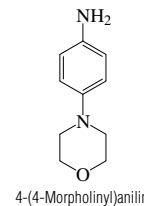
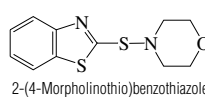
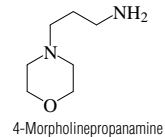
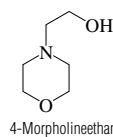
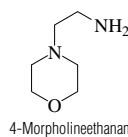
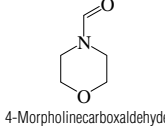
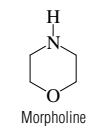
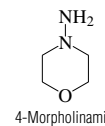
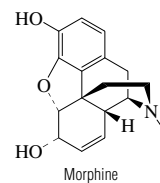
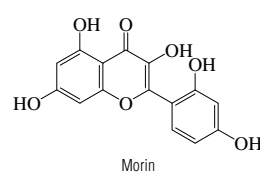
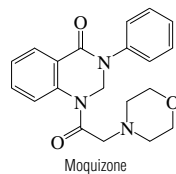
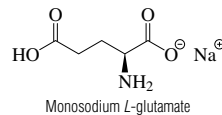
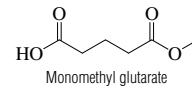
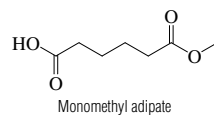
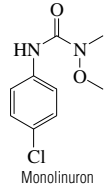
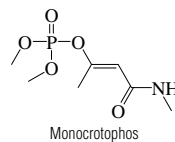
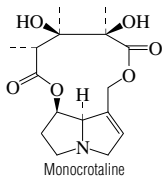
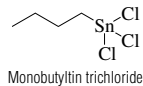
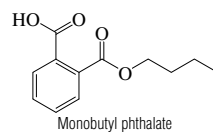
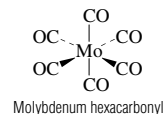
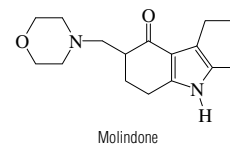
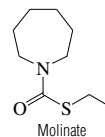
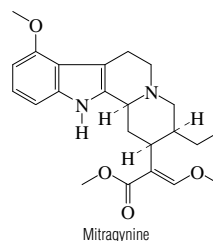
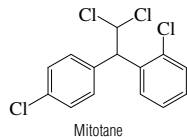
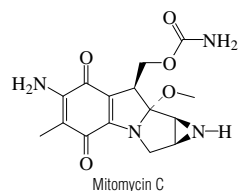
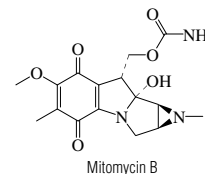
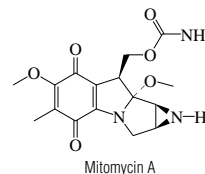
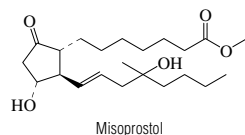
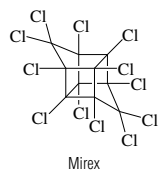
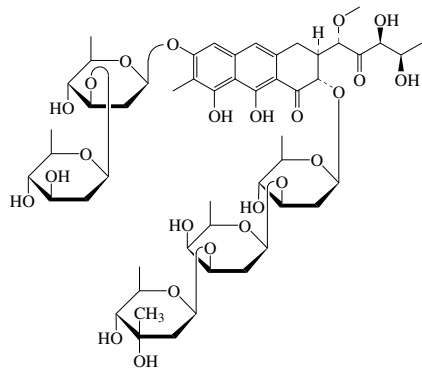
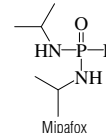
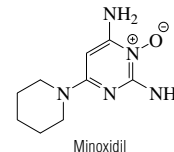
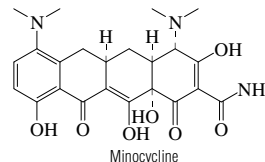
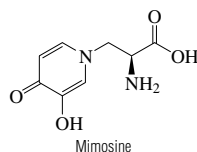
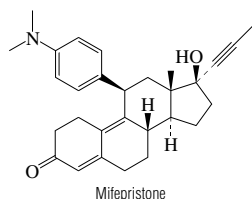
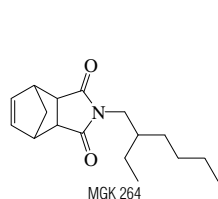
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7779	Methyl salicylate	Methyl 2-hydroxybenzoate	C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	119-36-8	152.148	liq	-8	222.9	1.181 <sup>25</sup>	1.535 <sup>20</sup>	sl H <sub>2</sub> O; vs eth, EtOH, chl
7780	Methylsilane		CH <sub>3</sub> Si	992-94-9	46.145	col gas	-156.5	-57.5			
7781	Methyl silyl ether		CH <sub>3</sub> OSi	2171-96-2	62.144	col gas	-98.5	-21; -87 <sup>10</sup>			
7782	Methylstannane		CH <sub>3</sub> Sn	1631-78-3	136.769	col gas		0			dec H <sub>2</sub> O
7783	Methyl stearate		C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	112-61-8	298.504		39.1	443; 215 <sup>15</sup>	0.8498 <sup>40</sup>	1.4367 <sup>40</sup>	vs eth, chl
7784	2-Methylstyrene		C <sub>9</sub> H <sub>10</sub>	611-15-4	118.175	liq	-68.5	169.8	0.9077 <sup>25</sup>	1.5437 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl
7785	3-Methylstyrene		C <sub>9</sub> H <sub>10</sub>	100-80-1	118.175	liq	-86.3	164	0.9076 <sup>25</sup>	1.5411 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
7786	4-Methylstyrene		C <sub>9</sub> H <sub>10</sub>	622-97-9	118.175	liq	-34.1	172.8	0.9173 <sup>25</sup>	1.5420	i H <sub>2</sub> O; s bz
7787	Methylsuccinic acid		C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	636-60-2	132.116	pr	115	dec	1.4200 <sup>9</sup>	1.4303	vs H <sub>2</sub> O, EtOH, MeOH; s eth; sl chl
7788	Methyl sulfate		CH <sub>3</sub> O <sub>2</sub> S	75-93-4	112.106		<-30	dec 135			vs H <sub>2</sub> O, eth, EtOH
7789	(Methylsulfinyl)benzene		C <sub>7</sub> H <sub>8</sub> OS	1193-82-4	140.203		32.0	263.5; 140 <sup>13</sup>		1.5885 <sup>20</sup>	
7790	1-(Methylsulfinyl)decane	Decyl methyl sulfoxide	C <sub>11</sub> H <sub>24</sub> OS	3079-28-5	204.373	cry	52.5				
7791	3-Methyl sulfolane		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub> S	872-93-5	134.197		1	276	1.188 <sup>25</sup>	1.4772 <sup>20</sup>	
7792	(Methylsulfonyl)ethene		C <sub>3</sub> H <sub>4</sub> O <sub>2</sub> S	3680-02-2	106.144			122 <sup>24</sup>	1.2117 <sup>20</sup>	1.4636 <sup>20</sup>	s eth, ace
7793	Methyl terephthalate	Methyl 1,4-benzenedicarboxylate	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	1679-64-7	180.158	nd (w)	222	subl ≈ 230			
7794	17-Methyltestosterone	17-Hydroxy-17-methylandrosta-4-en-3-one, (17β)	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	58-18-4	302.451		163.5				vs eth, EtOH
7795	Methyl tetradecanoate		C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	124-10-7	242.398		19	295; 155 <sup>7</sup>	0.8671 <sup>20</sup>	1.425 <sup>45</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl, ctc
7796	5-N-Methyl-5,6,7,8-tetrahydrofolic acid		C <sub>20</sub> H <sub>28</sub> N <sub>7</sub> O <sub>6</sub>	134-35-0	459.456	cry (w)					
7797	2-Methyltetrahydrofuran		C <sub>5</sub> H <sub>10</sub> O	96-47-9	86.132			78	0.8552 <sup>20</sup>	1.4059 <sup>21</sup>	s H <sub>2</sub> O; vs EtOH, eth, ace, bz; sl ctc
7798	N-Methyl-N,2,4,6-tetranitroaniline	Tetryl	C <sub>7</sub> H <sub>5</sub> N <sub>5</sub> O <sub>8</sub>	479-45-8	287.144	ye pr (al)	131.5	exp 180	1.57 <sup>10</sup>		i H <sub>2</sub> O; sl EtOH, eth, chl; s ace, bz, py
7799	4-Methyl-2-thiazolamine	2-Amino-4-methylthiazole	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> S	1603-91-4	114.169		45.5	125 <sup>20</sup> , 70 <sup>0.4</sup>			vs H <sub>2</sub> O, EtOH, eth
7800	2-Methylthiazole		C <sub>4</sub> H <sub>5</sub> NS	3581-87-1	99.155			128		1.510	msc H <sub>2</sub> O; s EtOH, ace
7801	4-Methylthiazole		C <sub>4</sub> H <sub>5</sub> NS	693-95-8	99.155			133.3	1.112 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth
7802	4-Methyl-5-thiazoleethanol		C <sub>6</sub> H <sub>9</sub> NOS	137-00-8	143.206	col to pa ye		135 <sup>7</sup>	1.196 <sup>24</sup>		vs H <sub>2</sub> O; s EtOH, eth, bz, chl
7803	4-Methyl-2(3H)-thiazolethione		C <sub>4</sub> H <sub>4</sub> NS <sub>2</sub>	5685-06-3	131.220	ye cry (dil al)	89.3	188 <sup>3</sup>			vs EtOH
7804	Methylthiirane		C <sub>2</sub> H <sub>4</sub> S	1072-43-1	74.145	liq	-91	72.5	0.941 <sup>20</sup>	1.472 <sup>20</sup>	s chl
7805	(Methylthio)acetic acid		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> S	2444-37-3	106.144		13.0	130 <sup>27</sup>	1.221 <sup>20</sup>	1.495 <sup>20</sup>	
7806	2-(Methylthio)aniline		C <sub>7</sub> H <sub>9</sub> NS	2987-53-3	139.218			234	1.111 <sup>25</sup>	1.6239 <sup>20</sup>	
7807	4-(Methylthio)aniline		C <sub>7</sub> H <sub>9</sub> NS	104-96-1	139.218			272.5	1.1379 <sup>20</sup>	1.6395 <sup>20</sup>	s EtOH, eth, ace, bz
7808	(Methylthio)benzene	Methyl phenyl sulfide	C <sub>7</sub> H <sub>8</sub> S	100-68-5	124.204			194.3	1.0579 <sup>20</sup>	1.5868 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs ace
7809	2-(Methylthio)benzothiazole		C <sub>8</sub> H <sub>7</sub> NS <sub>2</sub>	615-22-5	181.279	pr (dil al)	52	174 <sup>22</sup>			s EtOH, chl
7810	Methyl thiocyanate		C <sub>2</sub> H <sub>3</sub> NS	556-64-9	73.117	col liq	-2.5	132.9	1.0678 <sup>25</sup>	1.4669 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
7811	2-(Methylthio)ethanol		C <sub>3</sub> H <sub>8</sub> OS	5271-38-5	92.160			70 <sup>20</sup>	1.063 <sup>20</sup>	1.4861 <sup>30</sup>	vs H <sub>2</sub> O, eth, EtOH
7812	(Methylthio)ethene		C <sub>3</sub> H <sub>6</sub> S	1822-74-8	74.145			69.5	0.9026 <sup>20</sup>	1.4837 <sup>20</sup>	s eth, ace, chl
7813	[(Methylthio)methyl]benzene		C <sub>8</sub> H <sub>10</sub> S	766-92-7	138.230	liq	-30	210; 120 <sup>48</sup>	1.0274 <sup>20</sup>	1.5620 <sup>20</sup>	
7814	4-(Methylthio)-2-oxobutanoic acid		C <sub>6</sub> H <sub>9</sub> O <sub>3</sub> S	583-92-6	148.181	oil					
7815	2-Methylthiophene		C <sub>5</sub> H <sub>6</sub> S	554-14-3	98.167	liq	-63.4	112.6	1.0193 <sup>20</sup>	1.5203 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, hp, ctc
7816	3-Methylthiophene		C <sub>5</sub> H <sub>6</sub> S	616-44-4	98.167	liq	-69	115.5	1.0218 <sup>20</sup>	1.5204 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; vs chl
7817	5-Methyl-2-thiophenecarboxaldehyde		C <sub>6</sub> H <sub>6</sub> OS	13679-70-4	126.176			114 <sup>25</sup>		1.5825 <sup>20</sup>	s chl
7818	4-(Methylthio)phenol		C <sub>7</sub> H <sub>8</sub> OS	1073-72-9	140.203		84	154 <sup>20</sup> , 113 <sup>6</sup>			
7819	3-(Methylthio)propanal		C <sub>6</sub> H <sub>10</sub> OS	3268-49-3	104.171			62 <sup>11</sup>			
7820	3-(Methylthio)propanoic acid	S-Methylpropiothetin	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub> S	646-01-5	120.171	ye oil or fl (hx)	21	132 <sup>13</sup>			
7821	3-(Methylthio)-1-propene		C <sub>4</sub> H <sub>6</sub> S	10152-76-8	88.172			92	0.8767 <sup>20</sup>	1.4714 <sup>20</sup>	
7822	N-Methylthiosemicarbazide	N-Methylhydrazinecarbothioamide	C <sub>2</sub> H <sub>4</sub> N <sub>3</sub> S	6610-29-3	105.162		136.5				s H <sub>2</sub> O, EtOH, DMSO; i eth, bz, lig



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7823	Methylthiouracil		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> OS	56-04-2	142.179		330 dec	sub			i H <sub>2</sub> O; sl EtOH, eth, MeOH, bz
7824	Methylthiourea		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> S	598-52-7	90.147	pr (EtOH)	121				vs H <sub>2</sub> O, EtOH; sl eth; s ace
7825	1-Methylthymine	1,5-Dimethyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	4160-72-9	140.140	nd (w)	295				s H <sub>2</sub> O
7826	Methylthymol blue, sodium salt		C <sub>37</sub> H <sub>40</sub> N <sub>2</sub> O <sub>13</sub> Na <sub>4</sub> S	1945-77-3	844.743	bl-viol cry					s H <sub>2</sub> O
7827	Methyl 4-toluenesulfonate		C <sub>8</sub> H <sub>10</sub> O <sub>3</sub> S	80-48-8	186.228		28.5	292; 186 <sup>22</sup>	1.2087 <sup>40</sup>		i H <sub>2</sub> O; vs EtOH, bz; s eth, ctc; sl lig
7828	Methyltriacetoxysilane	Methylsilanetriol, triacetate	C <sub>7</sub> H <sub>12</sub> O <sub>5</sub> Si	4253-34-3	220.252		40.5	111 <sup>17</sup>	1.1750 <sup>20</sup>	1.4083 <sup>20</sup>	
7829	6-Methyl-1,2,4-triazine-3,5(2 <i>H</i> ,4 <i>H</i> )-dione	6-Azathymine	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	932-53-6	127.102	cry (w)	211				s H <sub>2</sub> O, EtOH, ace
7830	5-Methyl-[1,2,4]triazolo[1,5- <i>a</i> ]pyrimidin-7-ol		C <sub>6</sub> H <sub>8</sub> N <sub>4</sub> O	2503-56-2	150.138		>245				
7831	Methyl trichloroacetate		C <sub>3</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	598-99-2	177.414	liq	-17.5	153.8	1.4874 <sup>20</sup>	1.4572 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
7832	Methyltrichlorosilane		CH <sub>2</sub> Cl <sub>3</sub> Si	75-79-6	149.480	liq	-90	65.6	1.273 <sup>20</sup>	1.4106 <sup>20</sup>	dec H <sub>2</sub> O, EtOH
7833	Methyl tridecanoate		C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	1731-88-0	228.371		6.5	92 <sup>1</sup>		1.4405 <sup>20</sup>	msc EtOH; s ctc
7834	Methyltriethyllead	Triethylmethylplumbane	C <sub>7</sub> H <sub>18</sub> Pb	1762-28-3	309.4	col liq		70 <sup>16</sup>	1.71 <sup>20</sup>		
7835	Methyl trifluoroacetate		C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> O <sub>2</sub>	431-47-0	128.050			43.0	1.28 <sup>20</sup>		
7836	Methyl trifluoromethyl ether		C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	421-14-7	100.039	col gas	-149	-23.66			
7837	Methyl 3,4,5-trihydroxybenzoate		C <sub>8</sub> H <sub>8</sub> O <sub>5</sub>	99-24-1	184.147	mcl pr (MeOH)	202				sl H <sub>2</sub> O; vs EtOH, MeOH
7838	Methyl 3,4,5-trimethoxybenzoate		C <sub>11</sub> H <sub>14</sub> O <sub>5</sub>	1916-07-0	226.226		83	274.5			
7839	Methyltriphenoxysilane		C <sub>19</sub> H <sub>16</sub> O <sub>3</sub> Si	3439-97-2	322.430			269 <sup>100</sup> , 179 <sup>2</sup>	1.135 <sup>20</sup>	1.5599 <sup>20</sup>	
7840	Methyl trithion		C <sub>6</sub> H <sub>12</sub> ClO <sub>2</sub> PS <sub>3</sub>	953-17-3	314.812	ye liq	-18				sl H <sub>2</sub> O; misc os
7841	<i>N</i> -Methyl- <i>L</i> -tryptophan	<i>L</i> -Abrine	C <sub>12</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	526-31-8	218.251	pr (w)	295 dec				sl H <sub>2</sub> O, MeOH; i eth; s alk
7842	<i>N</i> -Methyl- <i>L</i> -tyrosine	Surinamine	C <sub>10</sub> H <sub>13</sub> NO <sub>3</sub>	537-49-5	195.215	nd	293				
7843	$\alpha$ -Methyl- <i>DL</i> -tyrosine, methyl ester, hydrochloride		C <sub>11</sub> H <sub>16</sub> ClNO <sub>3</sub>	7361-31-1	245.703		190 dec				s H <sub>2</sub> O
7844	2-Methylundecanal		C <sub>12</sub> H <sub>24</sub> O	110-41-8	184.318			119 <sup>16</sup> , 114 <sup>10</sup>	0.832 <sup>15</sup>	1.4321 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
7845	2-Methylundecane		C <sub>12</sub> H <sub>26</sub>	7045-71-8	170.334	liq	-45.6	210.2		1.4191 <sup>20</sup>	
7846	3-Methylundecane		C <sub>12</sub> H <sub>26</sub>	1002-43-3	170.334	col liq	-58.0	211.2	0.7485 <sup>25</sup>	1.4208 <sup>25</sup>	
7847	Methyl undecanoate		C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	1731-86-8	200.318			123 <sup>10</sup>			
7848	2-Methyl-1-undecanol		C <sub>12</sub> H <sub>26</sub> O	10522-26-6	186.333			129 <sup>12</sup>	0.8300 <sup>15</sup>	1.4382 <sup>20</sup>	vs eth, EtOH
7849	Methyl 10-undecenoate		C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	111-81-9	198.302	liq	-27.5	248	0.889 <sup>15</sup>	1.4393 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, HOAc; sl ctc
7850	<i>N</i> -Methylurea		C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	598-50-5	74.081	orth pr (w, al)	104.9	dec	1.2040 <sup>9</sup>		vs H <sub>2</sub> O, EtOH; i eth, bz; s CS <sub>2</sub> , lig
7851	5-Methyluridine	Thymine riboside	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	1463-10-1	258.227	cry (EtOH)	184				
7852	3-Methyl- <i>L</i> -valine	<i>L</i> - <i>tert</i> -Leucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	20859-02-3	131.173		248 dec				
7853	2-(1-Methylvinyl)aniline		C <sub>9</sub> H <sub>11</sub> N	52562-19-3	133.190			115 <sup>20</sup> , 95 <sup>13</sup>	0.977 <sup>25</sup>	1.5722 <sup>20</sup>	
7854	1-Methyl-4-vinylcyclohexene		C <sub>9</sub> H <sub>14</sub>	17699-86-4	122.207	liq		152	0.85	1.4701 <sup>20</sup>	
7855	4-(1-Methylvinyl)-1-cyclohexene-1-carboxaldehyde, ( <i>R</i> )	<i>d</i> -Perillaldehyde	C <sub>10</sub> H <sub>14</sub> O	5503-12-8	150.217	oil		238; 99 <sup>7</sup>	0.953 <sup>20</sup>	1.5058 <sup>20</sup>	s ctc
7856	4-(1-Methylvinyl)-1-cyclohexene-1-carboxaldehyde, ( <i>S</i> )	<i>l</i> -Perillaldehyde	C <sub>10</sub> H <sub>14</sub> O	18031-40-8	150.217	oil		104 <sup>10</sup>	0.9645 <sup>20</sup>	1.5072 <sup>20</sup>	
7857	4-(1-Methylvinyl)-1-cyclohexene-1-methanol		C <sub>10</sub> H <sub>16</sub> O	536-59-4	152.233			244; 12.5 <sup>12</sup>	0.9690 <sup>20</sup>	1.5005 <sup>20</sup>	
7858	(1-Methylvinyl)cyclopropane		C <sub>6</sub> H <sub>10</sub>	4663-22-3	82.143	liq	-102.3	70	0.751 <sup>20</sup>	1.4252 <sup>20</sup>	
7859	Methyl vinyl ether		C <sub>3</sub> H <sub>6</sub> O	107-25-5	58.079	col gas	-122	5.5	0.7725 <sup>9</sup>	1.3730 <sup>9</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, bz
7860	Methyl Violet	C.I. Basic Violet 1	C <sub>24</sub> H <sub>28</sub> ClN <sub>3</sub>	8004-87-3	393.952	bl-viol pow	137 dec				s H <sub>2</sub> O, EtOH
7861	Methysergide		C <sub>21</sub> H <sub>27</sub> N <sub>3</sub> O <sub>2</sub>	361-37-5	353.458	cry	195				
7862	Methysticin		C <sub>15</sub> H <sub>14</sub> O <sub>3</sub>	495-85-2	274.269	nd (MeOH), pr (ace)	137				
7863	Metobromuron	3-( <i>p</i> -Bromophenyl)-1-methoxy-1-methylurea	C <sub>9</sub> H <sub>11</sub> BrN <sub>2</sub> O <sub>2</sub>	3060-89-7	259.099		95		1.60 <sup>20</sup>		
7864	Metolachlor		C <sub>15</sub> H <sub>22</sub> ClNO <sub>2</sub>	51218-45-2	283.795			100 <sup>0.001</sup>	1.12 <sup>20</sup>		
7865	Metolazone		C <sub>16</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>3</sub> S	17560-51-9	365.834	cry (EtOH)	254				
7866	Metoprolol tartrate		C <sub>34</sub> H <sub>56</sub> N <sub>2</sub> O <sub>12</sub>	56392-17-7	684.815	cry	121				
7867	Metribuzin		C <sub>8</sub> H <sub>14</sub> N <sub>4</sub> OS	21087-64-9	214.288		126		1.31 <sup>20</sup>		
7868	Metronidazole	2-Methyl-5-nitro-1 <i>H</i> -imidazole-1-ethanol	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>3</sub>	443-48-1	171.153		160.5				
7869	Metsulfuron-methyl		C <sub>14</sub> H <sub>15</sub> N <sub>3</sub> O <sub>5</sub> S	74223-64-6	381.364	wh cry	163				sl H <sub>2</sub> O
7870	Mevinphos		C <sub>7</sub> H <sub>13</sub> O <sub>6</sub> P	7786-34-7	224.148		21 ( <i>E</i> ), 6.9 ( <i>Z</i> )	101 <sup>0.3</sup>			
7871	Mexacarbate	4-(Dimethylamino)-3,5-xylol methylcarbamate	C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	315-18-4	222.283	cry	85				vs EtOH, bz, ace

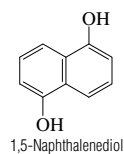
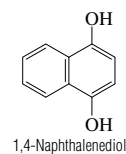
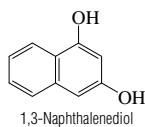
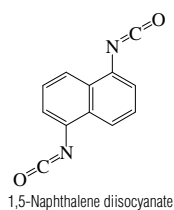
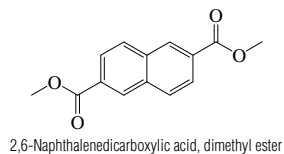
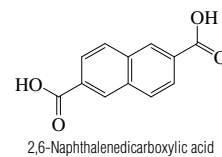
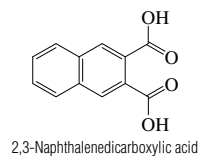
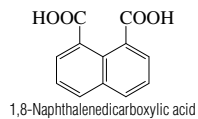
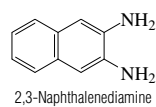
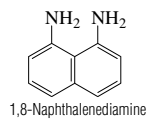
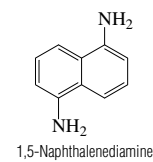
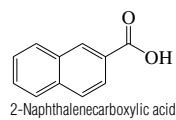
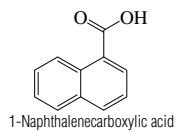
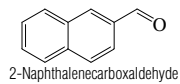
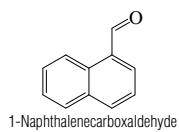
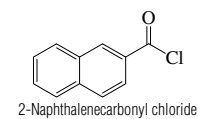
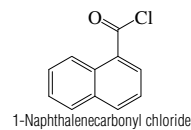
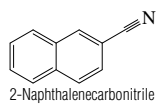
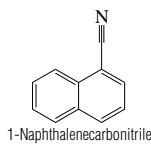
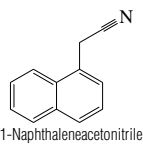
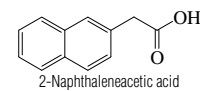
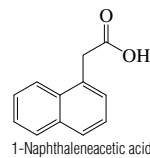
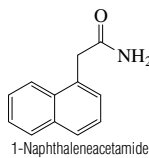
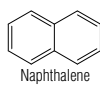
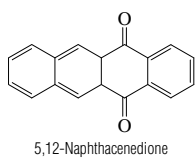
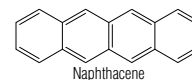
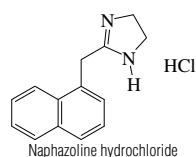
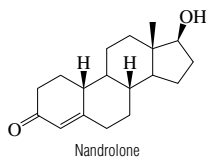
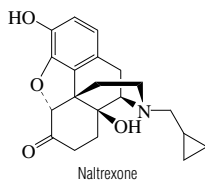
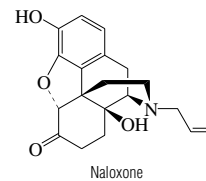
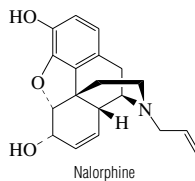
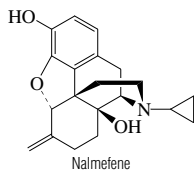
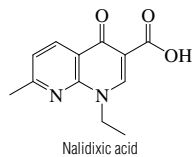
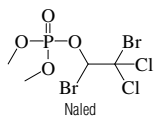
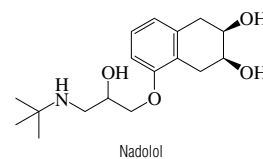
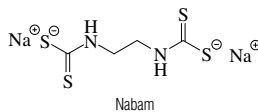
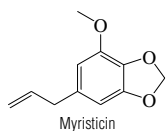
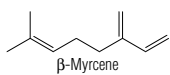


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7872	MGK 264		C <sub>17</sub> H <sub>25</sub> NO <sub>2</sub>	113-48-4	275.387		<-20	157	1.04		
7873	Mifepristone	RU-486	C <sub>29</sub> H <sub>35</sub> NO <sub>2</sub>	84371-65-3	429.594	cry	150				
7874	Mimosine		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	500-44-7	198.176	tab (w)	228 dec				sl H <sub>2</sub> O; i EtOH, eth, ace, bz; s dil alk
7875	Minocycline		C <sub>23</sub> H <sub>27</sub> N <sub>3</sub> O <sub>7</sub>	10118-90-8	457.476	ye-oran amorp solid					
7876	Minoxidil		C <sub>9</sub> H <sub>15</sub> N <sub>5</sub> O	38304-91-5	209.248	cry	248				i ace, bz, chl, sl; EtOH, MeOH
7877	Mipafox	Bis(isopropylamido) fluorophosphate	C <sub>6</sub> H <sub>16</sub> FN <sub>2</sub> OP	371-86-8	182.175	cry (peth)	65	125 <sup>2</sup>			sl H <sub>2</sub> O
7878	Mirex	Hexachloropentadiene dimer	C <sub>10</sub> Cl <sub>12</sub>	2385-85-5	545.543	cry (bz)	485 dec				vs bz, diox
7879	Misoprostol		C <sub>22</sub> H <sub>38</sub> O <sub>5</sub>	59122-46-2	382.534	ye oil					s H <sub>2</sub> O
7880	Mithramycin	Plicamycin	C <sub>52</sub> H <sub>76</sub> O <sub>24</sub>	18378-89-7	1085.145	ye cry (ace)	182				s H <sub>2</sub> O, EtOH, AcOEt; sl bz, eth
7881	Mitomycin A		C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>6</sub>	4055-39-4	349.338	purp nd	160 dec				
7882	Mitomycin B		C <sub>16</sub> H <sub>19</sub> N <sub>3</sub> O <sub>6</sub>	4055-40-7	349.338	purp-bl nd	dec				
7883	Mitomycin C		C <sub>15</sub> H <sub>18</sub> N <sub>4</sub> O <sub>5</sub>	50-07-7	334.328	bl-viol cry	360				s H <sub>2</sub> O, MeOH, ace
7884	Mitotane		C <sub>14</sub> H <sub>10</sub> Cl <sub>4</sub>	53-19-0	320.041		77				
7885	Mitragynine	9-Methoxycorynantheidine	C <sub>23</sub> H <sub>30</sub> N <sub>2</sub> O <sub>4</sub>	4098-40-2	398.495	wh amorp pow	104	235 <sup>5</sup>			s EtOH, chl, HOAc
7886	Molinate	Ethyl 1-hexamethyleneiminecarbothiolate	C <sub>9</sub> H <sub>17</sub> NOS	2212-67-1	187.302			202 <sup>10</sup>	1.063 <sup>20</sup>		
7887	Molindone		C <sub>16</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	7416-34-4	276.374	cry	180				
7888	Molybdenum hexacarbonyl		C <sub>6</sub> MoO <sub>6</sub>	13939-06-5	264.00		dec 150				s os
7889	Monobutyl phthalate	1,2-Benzenedicarboxylic acid, monobutyl ester	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	131-70-4	222.237	pl (ace, al)	73.5				vs EtOH, chl
7890	Monobutyltin trichloride		C <sub>4</sub> H <sub>9</sub> Cl <sub>3</sub> Sn	1118-46-3	282.183	hyg liq	-63	93 <sup>10</sup>	0.85 <sup>20</sup>		s bz, CH <sub>2</sub> Cl <sub>2</sub>
7891	Monocrotaline		C <sub>16</sub> H <sub>23</sub> NO <sub>6</sub>	315-22-0	325.357	wh pr (EtOH)	198 dec				
7892	Monocrotophos		C <sub>7</sub> H <sub>14</sub> NO <sub>3</sub> P	6923-22-4	223.164		55	125 <sup>0.0005</sup>	1.33 <sup>20</sup>		
7893	Monolinuron	<i>N</i> -(4-Chlorophenyl)- <i>N</i> -methoxy- <i>N</i> -methylurea	C <sub>8</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>2</sub>	1746-81-2	214.648	solid	77				
7894	Monomethyl adipate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	627-91-8	160.168	lf (Me <sub>3</sub> N-MeOH)	9	158 <sup>10</sup>	1.0623 <sup>20</sup>	1.4283 <sup>20</sup>	s EtOH
7895	Monomethyl glutarate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	1501-27-5	146.141			158 <sup>27</sup> , 150 <sup>10</sup>	1.169 <sup>25</sup>	1.4381 <sup>20</sup>	
7896	Monosodium <i>L</i> -glutamate		C <sub>5</sub> H <sub>9</sub> NNaO <sub>4</sub>	142-47-2	169.113						s H <sub>2</sub> O
7897	Moquizone		C <sub>20</sub> H <sub>21</sub> N <sub>3</sub> O <sub>3</sub>	19395-58-5	351.399		136				s chl
7898	Morin		C <sub>15</sub> H <sub>10</sub> O <sub>7</sub>	480-16-0	302.236	pa ye nd (+1 w, dil al)	303.5				sl H <sub>2</sub> O, eth; vs EtOH; s bz, alk; i CS <sub>2</sub>
7899	Morphine		C <sub>17</sub> H <sub>19</sub> NO <sub>3</sub>	57-27-2	285.338	pr	255	sub 190			i H <sub>2</sub> O, eth, ace; s MeOH, py; sl EtOH
7900	4-Morpholinamine		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	4319-49-7	102.134			166	1.059 <sup>25</sup>	1.4772 <sup>20</sup>	
7901	Morpholine	Tetrahydro-1,4-oxazine	C <sub>4</sub> H <sub>9</sub> NO	110-91-8	87.120	hyg liq	-4.8	128	1.0005 <sup>20</sup>	1.4548 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, ace, bz; sl chl
7902	4-Morpholinecarboxaldehyde		C <sub>6</sub> H <sub>9</sub> NO <sub>2</sub>	4394-85-8	115.131		21	239	1.1520 <sup>20</sup>	1.4845 <sup>20</sup>	
7903	4-Morpholineethanamine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O	2038-03-1	130.187		25.6	205	0.9897 <sup>20</sup>	1.4715 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, bz, lig; s ace
7904	4-Morpholineethanol		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	622-40-2	131.173	liq	-0.8	227	1.0710 <sup>20</sup>	1.4763 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl ctc
7905	4-Morpholinepropanamine	4-(3-Aminopropyl)morpholine	C <sub>7</sub> H <sub>16</sub> N <sub>2</sub> O	123-00-2	144.214	liq	-15	220; 134 <sup>50</sup>	0.9854 <sup>20</sup>	1.4762 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, bz, lig; s ace; sl ctc
7906	2-(4-Morpholiniothio) benzothiazole	4-(2-Benzothiazolythio) morpholine	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> OS <sub>2</sub>	102-77-2	252.355	cry (EtOH)	85				
7907	4-(4-Morpholinyl)aniline		C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O	2524-67-6	178.230		131.6				
7908	2-(4-Morpholinylidithio) benzothiazole		C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> OS <sub>3</sub>	95-32-9	284.420		135				
7909	Muldamine		C <sub>29</sub> H <sub>47</sub> NO <sub>3</sub>	36069-45-1	457.688		210				
7910	Murexide	5,5'-Nitrilobarbituric acid, ammonium salt	C <sub>8</sub> H <sub>10</sub> N <sub>6</sub> O <sub>7</sub>	3051-09-0	302.201						sl H <sub>2</sub> O; i EtOH, eth; s alk
7911	Muscimol	5-(Aminomethyl)-3(2 <i>H</i> )-isoxazolone	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	2763-96-4	114.103	cry (EtOH)	175 dec				
7912	Myclobutanil		C <sub>15</sub> H <sub>17</sub> ClN <sub>4</sub>	88671-89-0	288.776	ye cry	65	205 <sup>1.0</sup>			i H <sub>2</sub> O, peth; s EtOH
7913	Mycophenolic acid		C <sub>17</sub> H <sub>20</sub> O <sub>6</sub>	24280-93-1	320.337	nd (w)	141				i H <sub>2</sub> O; vs EtOH, eth, chl; sl bz, tol

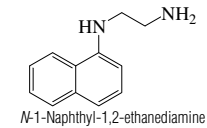
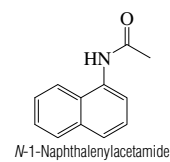
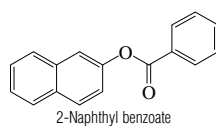
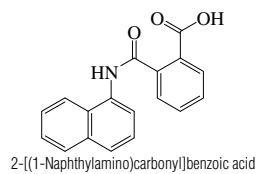
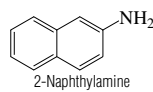
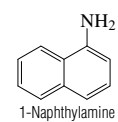
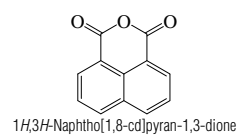
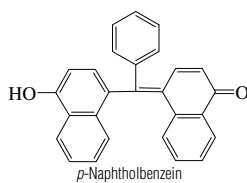
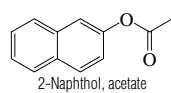
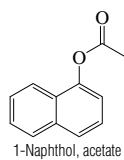
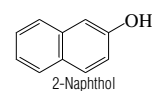
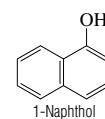
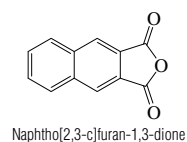
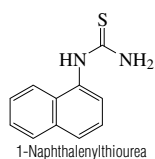
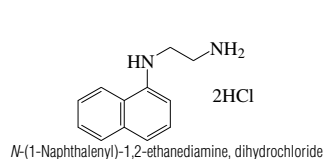
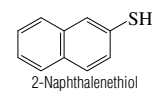
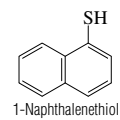
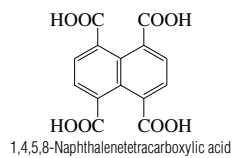
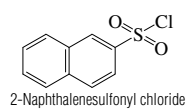
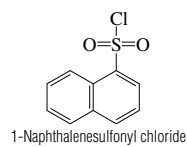
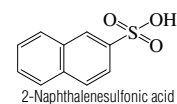
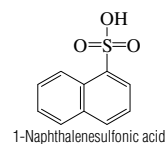
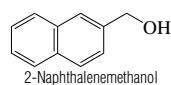
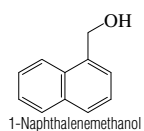
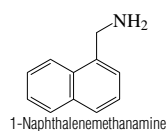
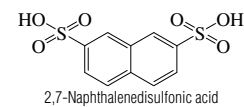
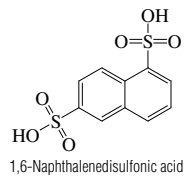
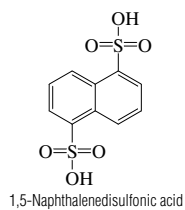
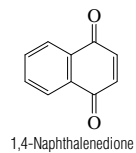
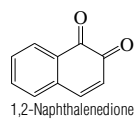
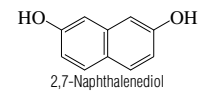
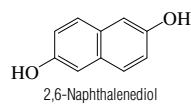
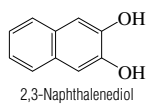
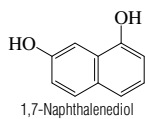
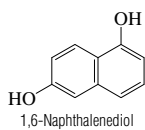


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7914	β-Myrcene	7-Methyl-3-methylene-1,6-octadiene	C <sub>10</sub> H <sub>16</sub>	123-35-3	136.234			167	0.8013 <sup>15</sup>	1.4722 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, HOAc
7915	Myristicin		C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	607-91-0	192.211		<-20	276.5	1.1416 <sup>20</sup>	1.5403 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, bz
7916	Nabam	Sodium ethylenebisdithiocarbamic acid	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> Na <sub>2</sub> S <sub>4</sub>	142-59-6	256.344	cry (w)					s H <sub>2</sub> O
7917	Nadolol		C <sub>17</sub> H <sub>27</sub> NO <sub>4</sub>	42200-33-9	309.401	cry (bz)	≈130				s EtOH; sl chl; i ace, eth, hx
7918	Naled	1,2-Dibromo-2,2-dichloroethylphosphoric acid, dimethyl ester	C <sub>4</sub> H <sub>7</sub> Br <sub>2</sub> Cl <sub>2</sub> O <sub>4</sub> P	300-76-5	380.784		27	110 <sup>0.5</sup>	1.96 <sup>20</sup>		
7919	Nalidixic acid		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	389-08-2	232.234		229.5				sl EtOH, eth; s chl
7920	Nalmefene		C <sub>21</sub> H <sub>25</sub> NO <sub>3</sub>	55096-26-9	339.429	cry (AcOEt)	189				
7921	Nalorphine	Acetorphin	C <sub>19</sub> H <sub>21</sub> NO <sub>3</sub>	62-67-9	311.375	cry (eth)	208				sl H <sub>2</sub> O; s alk, ace, EtOH
7922	Naloxone		C <sub>19</sub> H <sub>21</sub> NO <sub>4</sub>	465-65-6	327.375	cry (AcOEt)	178				i peth; s chl
7923	Naltrexone		C <sub>20</sub> H <sub>23</sub> NO <sub>4</sub>	16590-41-3	341.402	cry (ace)	169				
7924	Nandrolone	17-Hydroxyestr-4-en-3-one	C <sub>18</sub> H <sub>26</sub> O <sub>2</sub>	434-22-0	274.398	cry	112				s EtOH, eth, chl
7925	Naphazoline hydrochloride		C <sub>14</sub> H <sub>14</sub> ClN <sub>2</sub>	550-99-2	245.727						sl H <sub>2</sub> O
7926	Naphthacene	2,3-Benzanthracene	C <sub>18</sub> H <sub>12</sub>	92-24-0	228.288	oran-ye lf (bz, xyl)	357	sub			i H <sub>2</sub> O; sl bz; s con sulf
7927	5,12-Naphthacenedione		C <sub>18</sub> H <sub>10</sub> O <sub>2</sub>	1090-13-7	258.271		285 dec				sl ace, bz, gl HOAc
7928	Naphthalene		C <sub>10</sub> H <sub>8</sub>	91-20-3	128.171	mcl pl (al)	80.26	217.9	1.0253 <sup>20</sup>	1.5898 <sup>25</sup>	i H <sub>2</sub> O; s EtOH; vs eth, ace, bz, CS <sub>2</sub>
7929	1-Naphthaleneacetamide		C <sub>12</sub> H <sub>11</sub> NO	86-86-2	185.221	nd(w, al)		sub 180			i H <sub>2</sub> O; s eth, bz, CS <sub>2</sub> , HOAc
7930	1-Naphthaleneacetic acid	1-Naphthylacetic acid	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	86-87-3	186.206	nd (w)	133	dec			sl H <sub>2</sub> O, EtOH; vs eth, ace, chl; s bz
7931	2-Naphthaleneacetic acid	2-Naphthylacetic acid	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	581-96-4	186.206	lf(w) cry (bz)	143				vs eth, lig, chl
7932	1-Naphthaleneacetonitrile		C <sub>12</sub> H <sub>9</sub> N	132-75-2	167.206		32.5	192 <sup>18</sup> , 163 <sup>12</sup>		1.6192 <sup>20</sup>	s EtOH
7933	1-Naphthalenecarbonitrile		C <sub>11</sub> H <sub>7</sub> N	86-53-3	153.181	nd (lig)	37.5	299	1.1080 <sup>25</sup>	1.6298 <sup>18</sup>	i H <sub>2</sub> O; vs EtOH, eth; s lig
7934	2-Naphthalenecarbonitrile		C <sub>11</sub> H <sub>7</sub> N	613-46-7	153.181	lf (lig)	66	306.5	1.0755 <sup>60</sup>		sl H <sub>2</sub> O, chl; s EtOH, eth, lig
7935	1-Naphthalenecarbonyl chloride		C <sub>11</sub> H <sub>7</sub> ClO	879-18-5	190.626		20	297.5			
7936	2-Naphthalenecarbonyl chloride		C <sub>11</sub> H <sub>7</sub> ClO	2243-83-6	190.626	cry (peth)	51	305			vs bz, eth, chl
7937	1-Naphthalenecarboxaldehyde		C <sub>11</sub> H <sub>8</sub> O	66-77-3	156.181	pa ye	33.5	292	1.1503 <sup>20</sup>	1.6507 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, sulf
7938	2-Naphthalenecarboxaldehyde		C <sub>11</sub> H <sub>8</sub> O	66-99-9	156.181	lf (w)	62	160 <sup>19</sup>	1.0775 <sup>99</sup>	1.6211 <sup>99</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ace
7939	1-Naphthalenecarboxylic acid	1-Naphthoic acid	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	86-55-5	172.181	nd (HOAc-w, w, al)	161	>300	1.398 <sup>25</sup>	1.46	i H <sub>2</sub> O; vs eth, EtOH, chl
7940	2-Naphthalenecarboxylic acid	2-Naphthoic acid	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	93-09-4	172.181	nd (lig, chl, sub) pl (ace)	185.5	>300	1.077 <sup>100</sup>		sl H <sub>2</sub> O, DMSO, lig; s EtOH, eth, chl
7941	1,5-Naphthalenediamine	1,5-Diaminonaphthalene	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	2243-62-1	158.199	pr (eth, al, w)	190	sub	1.4 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth; vs chl
7942	1,8-Naphthalenediamine	1,8-Diaminonaphthalene	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	479-27-6	158.199		66.5	205 <sup>12</sup>	1.1265 <sup>90</sup>	1.6828 <sup>99</sup>	vs eth, EtOH
7943	2,3-Naphthalenediamine	2,3-Diaminonaphthalene	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	771-97-1	158.199	lf (eth, w)	199		1.0968 <sup>25</sup>	1.6392 <sup>25</sup>	sl H <sub>2</sub> O, DMSO; vs EtOH; s eth
7944	1,8-Naphthalenedicarboxylic acid	Naphthalic acid	C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	518-05-8	216.190		260				i H <sub>2</sub> O; sl EtOH, eth
7945	2,3-Naphthalenedicarboxylic acid		C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	2169-87-1	216.190	pr (HOAc, w, sub)	244.5				i H <sub>2</sub> O, bz, chl; sl EtOH, eth, DMSO
7946	2,6-Naphthalenedicarboxylic acid		C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	1141-38-4	216.190	nd (al or sub)	>300 dec				vs EtOH
7947	2,6-Naphthalenedicarboxylic acid, dimethyl ester		C <sub>14</sub> H <sub>12</sub> O <sub>4</sub>	840-65-3	244.243		190.0				
7948	1,5-Naphthalene diisocyanate	1,5-Diisocyanatonaphthalene	C <sub>12</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	3173-72-6	210.188	cry	127	183 <sup>10</sup>			
7949	1,3-Naphthalenediol	Naphthoresorcinol	C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	132-86-5	160.170	lf (w)	123.5				s H <sub>2</sub> O, EtOH, eth; sl ace, bz, lig
7950	1,4-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	571-60-8	160.170	mcl nd (bz, w)	192				s H <sub>2</sub> O, EtOH, eth; sl ace; i bz
7951	1,5-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	83-56-7	160.170	pr (w), nd (sub)	262 dec	sub			sl H <sub>2</sub> O, EtOH; vs eth, ace; i bz; s HOAc

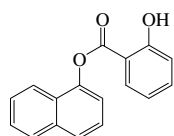




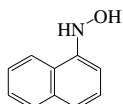
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7952	1,6-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	575-44-0	160.170	pr (bz)	138	sub			sl H <sub>2</sub> O, EtOH; s eth, ace, bz, DMSO
7953	1,7-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	575-38-2	160.170	nd (bz or sub)	180.5	sub			sl H <sub>2</sub> O; vs EtOH, eth; s bz, HOAc
7954	2,3-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	92-44-4	160.170	lf (w)	163.5				s H <sub>2</sub> O, EtOH, eth, ace, bz, lig, HOAc
7955	2,6-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	581-43-1	160.170	orth pl (w)	220	sub			sl H <sub>2</sub> O, bz; s EtOH, eth, ace; i lig
7956	2,7-Naphthalenediol		C <sub>10</sub> H <sub>8</sub> O <sub>2</sub>	582-17-2	160.170	nd, (w, dil al), pl (dil al)	193	sub			s H <sub>2</sub> O, EtOH, eth, bz, chl; sl ace; i lig
7957	1,2-Naphthalenedione	1,2-Naphthoquinone	C <sub>10</sub> H <sub>6</sub> O <sub>2</sub>	524-42-5	158.154	ye-red nd (eth) oran lf (bz)	146		1.450 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth, sulf; sl lig
7958	1,4-Naphthalenedione	1,4-Naphthoquinone	C <sub>10</sub> H <sub>6</sub> O <sub>2</sub>	130-15-4	158.154	bt ye nd (al, peth) ye (sub)	128.5	sub			sl H <sub>2</sub> O; vs EtOH; s eth, bz, chl, CS <sub>2</sub>
7959	1,5-Naphthalenedisulfonic acid	Armstrong's acid	C <sub>10</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	81-04-9	288.297	pl (+4w, dil HOAc)	242 dec		1.493 <sup>25</sup>		vs H <sub>2</sub> O; s EtOH; i eth
7960	1,6-Naphthalenedisulfonic acid	Naphthalene-1,6-disulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	525-37-1	288.297	oran pr (+4w, HOAc or w)	125 dec				vs H <sub>2</sub> O; s EtOH; i eth
7961	2,7-Naphthalenedisulfonic acid	Naphthalene-2,7-disulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>6</sub> S <sub>2</sub>	92-41-1	288.297	hyg nd (conc HCl)	199				s H <sub>2</sub> O; sl con HCl
7962	1-Naphthalenemethanamine		C <sub>11</sub> H <sub>11</sub> N	118-31-0	157.212			292	1.0958 <sup>20</sup>		s EtOH, eth, sulf, CS <sub>2</sub>
7963	1-Naphthalenemethanol		C <sub>11</sub> H <sub>10</sub> O	4780-79-4	158.196	nd (w, al), cry (bz-lig)	64	304; 163 <sup>12</sup>	1.1039 <sup>80</sup>		sl H <sub>2</sub> O; vs EtOH, eth
7964	2-Naphthalenemethanol		C <sub>11</sub> H <sub>10</sub> O	1592-38-7	158.196	lf	81.3	178 <sup>12</sup>			sl H <sub>2</sub> O; s EtOH, eth
7965	1-Naphthalenesulfonic acid	α-Naphthylsulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>3</sub> S	85-47-2	208.234	pr (+2 w, dil HCl)	140				s H <sub>2</sub> O, EtOH; sl eth
7966	2-Naphthalenesulfonic acid	β-Naphthylsulfonic acid	C <sub>10</sub> H <sub>6</sub> O <sub>3</sub> S	120-18-3	208.234	hyg pl (+1w), cry (+3w, HCl)	91	dec	1.441 <sup>25</sup>		vs H <sub>2</sub> O, EtOH; s eth; sl bz
7967	1-Naphthalenesulfonyl chloride		C <sub>10</sub> H <sub>7</sub> ClO <sub>2</sub> S	85-46-1	226.680	lf (eth)	68	209 <sup>20</sup> , 147 <sup>9</sup>			vs bz, eth, EtOH
7968	2-Naphthalenesulfonyl chloride		C <sub>10</sub> H <sub>7</sub> ClO <sub>2</sub> S	93-11-8	226.680	pow or lf (bz-peth)	81	201 <sup>13</sup> , 148 <sup>9.5</sup>			i H <sub>2</sub> O; s EtOH, bz, chl; sl peth; vs eth
7969	1,4,5,8-Naphthalenetetracarboxylic acid		C <sub>14</sub> H <sub>6</sub> O <sub>8</sub>	128-97-2	304.209	lf or nd (w, dil HCl)	320				sl H <sub>2</sub> O, bz, chl, EtOH; vs ace
7970	1-Naphthalenethiol	1-Naphthyl mercaptan	C <sub>10</sub> H <sub>8</sub> S	529-36-2	160.236			dec 285; 161 <sup>20</sup>	1.1607 <sup>20</sup>	1.6802 <sup>20</sup>	sl H <sub>2</sub> O, dil alk; vs EtOH, eth
7971	2-Naphthalenethiol	2-Naphthyl mercaptan	C <sub>10</sub> H <sub>8</sub> S	91-60-1	160.236	pl (al)	81	288	1.550 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth, lig
7972	N-(1-Naphthalenyl)-1,2-ethanediamine, dihydrochloride		C <sub>12</sub> H <sub>16</sub> Cl <sub>2</sub> N <sub>2</sub>	1465-25-4	259.174	hex pr	189				vs H <sub>2</sub> O, EtOH
7973	1-Naphthalenylthiourea	ANTU	C <sub>11</sub> H <sub>10</sub> N <sub>2</sub> S	86-88-4	202.275	pr (al)	198				i H <sub>2</sub> O; sl EtOH, eth, ace
7974	Naphtho[2,3-c]furan-1,3-dione	2,3-Naphthalenedicarboxylic acid anhydride	C <sub>12</sub> H <sub>6</sub> O <sub>3</sub>	716-39-2	198.174		246				sl EtOH, chl; s eth, bz
7975	1-Naphthol	1-Naphthalenol	C <sub>10</sub> H <sub>8</sub> O	90-15-3	144.170	ye nd (w)	95.0	288; 184 <sup>40</sup>	1.0989 <sup>99</sup>	1.6224 <sup>99</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ace, bz; sl ctc
7976	2-Naphthol	2-Naphthalenol	C <sub>10</sub> H <sub>8</sub> O	135-19-3	144.170	mcl lf (w)	121.5	285	1.28 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth; s bz, chl; sl lig
7977	1-Naphthol, acetate	1-Naphthyl acetate	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	830-81-9	186.206	nd or pl (al)	49	114 <sup>1</sup>			i H <sub>2</sub> O; s EtOH, eth
7978	2-Naphthol, acetate	2-Naphthyl acetate	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	1523-11-1	186.206	nd (al)	71.0	132 <sup>2</sup>			i H <sub>2</sub> O; s EtOH, eth, chl
7979	p-Naphtholbenzein		C <sub>27</sub> H <sub>16</sub> O <sub>2</sub>	145-50-6	374.431		123				
7980	1 <i>H</i> ,3 <i>H</i> -Naphtho[1,8-cd]pyran-1,3-dione		C <sub>12</sub> H <sub>6</sub> O <sub>3</sub>	81-84-5	198.174		275.0				i H <sub>2</sub> O, eth, bz; sl EtOH; s HOAc
7981	1-Naphthylamine	α-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	134-32-7	143.185		49.2	300.7	1.0228 <sup>20</sup>	1.6140 <sup>20</sup>	s chl
7982	2-Naphthylamine	β-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	91-59-8	143.185		113	306.2	1.6414 <sup>98</sup>	1.6493 <sup>98</sup>	s H <sub>2</sub> O, EtOH, eth
7983	2-[(1-Naphthylamino)carbonyl] benzoic acid	Naphtalam	C <sub>18</sub> H <sub>13</sub> NO <sub>3</sub>	132-66-1	291.301		185		1.4 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH, ace, bz, tfa
7984	2-Naphthyl benzoate	2-Naphthalenol benzoate	C <sub>17</sub> H <sub>12</sub> O <sub>2</sub>	93-44-7	248.276	nd or pr (al)	107				i H <sub>2</sub> O; s EtOH; sl eth, HOAc
7985	N-1-Naphthalenylacetamide		C <sub>12</sub> H <sub>11</sub> NO	575-36-0	185.221		160				s H <sub>2</sub> O, EtOH; sl eth
7986	N-1-Naphthyl-1,2-ethanediamine	N-(1-Naphthyl)ethylenediamine	C <sub>12</sub> H <sub>14</sub> N <sub>2</sub>	551-09-7	186.252	visc lig		204 <sup>9</sup>	1.114 <sup>25</sup>	1.6648 <sup>25</sup>	



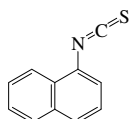
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
7987	1-Naphthyl 2-hydroxybenzoate	1-Naphthyl salicylate	C <sub>17</sub> H <sub>12</sub> O <sub>3</sub>	550-97-0	264.275		83				vs eth
7988	1-Naphthylhydroxylamine	<i>N</i> -Hydroxyl-1-naphthalenamine	C <sub>10</sub> H <sub>9</sub> NO	607-30-7	159.184		79				
7989	1-Naphthyl isothiocyanate	1-Isothiocyanatonaphthalene	C <sub>11</sub> H <sub>7</sub> NS	551-06-4	185.246	wh nd (al)	58				vs bz, eth, EtOH, chl
7990	<i>N</i> -2-Naphthyl-2-naphthalenamine	β,β'-Dinaphthylamine	C <sub>20</sub> H <sub>15</sub> N	532-18-3	269.340	lf(bz)	172.2	471			i H <sub>2</sub> O; sl EtOH, bz, DMSO; s eth, HOAc
7991	(2-Naphthoxy)acetic acid	2-Naphthoxyacetic acid	C <sub>12</sub> H <sub>10</sub> O <sub>3</sub>	120-23-0	202.205	pr(w)	156				s H <sub>2</sub> O, EtOH, eth; sl DMSO
7992	1-Naphthyl phosphate	1-Naphthalenol, dihydrogen phosphate	C <sub>10</sub> H <sub>9</sub> O <sub>4</sub> P	1136-89-6	224.149	cry	160				
7993	2-Naphthyl salicylate	2-Naphthyl 2-hydroxybenzoate	C <sub>17</sub> H <sub>12</sub> O <sub>3</sub>	613-78-5	264.275	cry (al)	95.5		1.111 <sup>16</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz
7994	1,5-Naphthyridine	1,5-Diazanaphthalene	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	254-79-5	130.147	ye nd (peth)	75	112 <sup>12</sup>	1.2100 <sup>20</sup>		
7995	1,6-Naphthyridine		C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	253-72-5	130.147		29.5				
7996	Napropamide	Propanamide, <i>N,N</i> -diethyl-2-(1-naphthalenyl)-	C <sub>17</sub> H <sub>21</sub> NO <sub>2</sub>	15299-99-7	271.355		75				
7997	Naproxen	6-Methoxy- $\alpha$ -methyl-2-naphthaleneacetic acid	C <sub>14</sub> H <sub>14</sub> O <sub>3</sub>	22204-53-1	230.259	cry (ace/hx)	155				i H <sub>2</sub> O; sl eth; s MeOH, chl
7998	Narceine		C <sub>23</sub> H <sub>27</sub> NO <sub>8</sub>	131-28-2	445.462		138				i H <sub>2</sub> O
7999	Narcobarbital		C <sub>11</sub> H <sub>15</sub> BrN <sub>2</sub> O <sub>3</sub>	125-55-3	303.152		115				sl H <sub>2</sub> O; s EtOH, py
8000	Naringenin		C <sub>15</sub> H <sub>12</sub> O <sub>5</sub>	480-41-1	272.253	nd (dil al)	251				vs bz, eth, EtOH
8001	Naringin		C <sub>27</sub> H <sub>32</sub> O <sub>14</sub>	10236-47-2	580.535	nd (w+8)					sl H <sub>2</sub> O, EtOH; i eth, bz, chl; s HOAc
8002	Nealbarbital		C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	561-83-1	238.282		156				vs ace, eth, EtOH
8003	Nellite	Diamidafos	C <sub>9</sub> H <sub>13</sub> N <sub>2</sub> O <sub>2</sub> P	1754-58-1	200.175	cry (ctc)	103.5				sl AcOEt, bz
8004	Neobietic acid	8(14),13(15)-Abietadien-18-oic acid	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	471-77-2	302.451	cry (EtOH aq)	173				
8005	Neobornylamine		C <sub>10</sub> H <sub>19</sub> N	2223-67-8	153.265	pow	184				vs ace, eth
8006	Neopentane	2,2-Dimethylpropane	C <sub>5</sub> H <sub>12</sub>	463-82-1	72.149	col gas	-16.4	9.48	0.5852 <sup>25</sup> ( <i>p</i> >1 atm)	1.3476 <sup>6</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
8007	Neopine		C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	467-14-1	299.365	nd (peth)	127.5				s H <sub>2</sub> O, EtOH, eth, bz; vs chl; sl lig
8008	Neostigmine bromide		C <sub>12</sub> H <sub>19</sub> BrN <sub>2</sub> O <sub>2</sub>	114-80-7	303.195	cry (al-eth)	167 dec				vs H <sub>2</sub> O; s EtOH
8009	Nepetalactone		C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	490-10-8	166.217			71 <sup>0.05</sup>	1.0663 <sup>25</sup>	1.4859 <sup>25</sup>	
8010	<i>cis</i> -Nerolidol		C <sub>15</sub> H <sub>26</sub> O	142-50-7	222.366			276; 70 <sup>0.1</sup>	0.8778 <sup>20</sup>	1.4898 <sup>20</sup>	vs EtOH; s eth, ace, HOAc
8011	Neurine		C <sub>6</sub> H <sub>13</sub> NO	463-88-7	103.163	syr					vs H <sub>2</sub> O, eth, EtOH
8012	Neutral Red		C <sub>15</sub> H <sub>17</sub> ClN <sub>4</sub>	553-24-2	288.776	grn pow					s H <sub>2</sub> O, ethylene glycol, EtOH; i xyl
8013	Nialamide		C <sub>16</sub> H <sub>18</sub> N <sub>4</sub> O <sub>2</sub>	51-12-7	298.340		151.6				
8014	Nickel(II) acetate		C <sub>4</sub> H <sub>8</sub> NiO <sub>4</sub>	373-02-4	176.782						vs H <sub>2</sub> O; s EtOH
8015	Nickel bis(dibutylthiocarbamate)		C <sub>18</sub> H <sub>38</sub> N <sub>2</sub> NiS <sub>4</sub>	13927-77-0	467.445	grn cry (bz/EtOH)	91				s bz, ace
8016	Nickel bis(2,4-pentanedioate)	Nickel acetylacetonate	C <sub>10</sub> H <sub>14</sub> NiO <sub>4</sub>	3264-82-2	256.909	grn orth cry	230	227 <sup>11</sup>			s H <sub>2</sub> O, bz, chl, EtOH; i eth
8017	Nickel carbonyl	Nickel tetracarbonyl	C <sub>4</sub> NiO <sub>4</sub>	13463-39-3	170.734	col liq	-19.3	43 (exp 60)	1.31 <sup>25</sup>		
8018	Nickelocene	Bis(η <sup>5</sup> -2,4-cyclopentadien-1-yl)nickel	C <sub>10</sub> H <sub>10</sub> Ni	1271-28-9	188.879		172				
8019	Nicosamide		C <sub>13</sub> H <sub>8</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	50-65-7	327.120		227				
8020	Nicofibrate		C <sub>16</sub> H <sub>16</sub> ClNO <sub>3</sub>	31980-29-7	305.756		49	180 <sup>0.4</sup>			
8021	Nicosulfuron		C <sub>15</sub> H <sub>18</sub> N <sub>6</sub> O <sub>6</sub> S	111991-09-4	410.405		172				
8022	Nicotelline	3,2':4',3"-Terpyridine	C <sub>15</sub> H <sub>11</sub> N <sub>3</sub>	494-04-2	233.268	prismatic nd	148	>300			sl H <sub>2</sub> O, eth; s bz, chl, EtOH
8023	Nicotinamide hypoxanthine dinucleotide	Nicotinic acid adenine dinucleotide	C <sub>21</sub> H <sub>26</sub> N <sub>6</sub> O <sub>15</sub> P <sub>2</sub>	1851-07-6	664.410	pow					
8024	β-Nicotinamide mononucleotide	NMN	C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>6</sub> P	1094-61-7	334.219	amor pow					vs H <sub>2</sub> O; i ace
8025	<i>L</i> -Nicotine	3-(1-Methyl-2-pyrrolidinyl)pyridine, ( <i>S</i> -)	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	54-11-5	162.231	hyg liq	-79	247; 125 <sup>18</sup>	1.0097 <sup>20</sup>	1.5282 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, eth, chl; s lig
8026	Nifurthiazole		C <sub>8</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub> S	3570-75-0	254.224	cry	215 dec				
8027	Nitralin	4-(Methylsulfonyl)-2,6-dinitro- <i>N,N</i> -dipropylaniline	C <sub>13</sub> H <sub>19</sub> N <sub>3</sub> O <sub>6</sub> S	4726-14-1	345.371		150				
8028	Nitrilic acid	2,5-Dihydroxy-3,6-dinitro-2,5-cyclohexadiene-1,4-dione	C <sub>6</sub> H <sub>2</sub> N <sub>2</sub> O <sub>8</sub>	479-22-1	230.088	gold-ye pl (+w, dil HNO <sub>3</sub> )	170 dec				vs H <sub>2</sub> O, EtOH; i eth
8029	Nitrapyrin	Pyridine, 2-chloro-6-(trichloromethyl)-	C <sub>6</sub> H <sub>3</sub> Cl <sub>4</sub> N	1929-82-4	230.907		63	136 <sup>11</sup>			



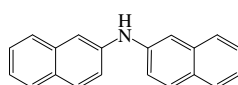
1-Naphthyl 2-hydroxybenzoate



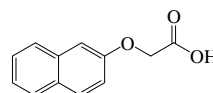
1-Naphthylhydroxylamine



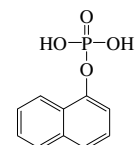
1-Naphthyl isothiocyanate



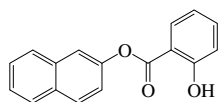
N-2-Naphthyl-2-naphthalenamine



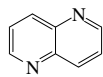
(2-Naphthoxy)acetic acid



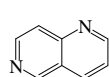
1-Naphthyl phosphate



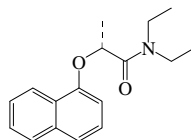
2-Naphthyl salicylate



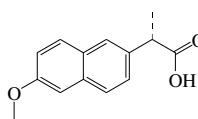
1,5-Naphthyridine



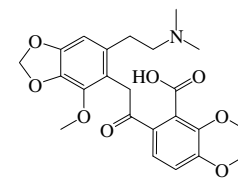
1,6-Naphthyridine



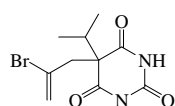
Napropamide



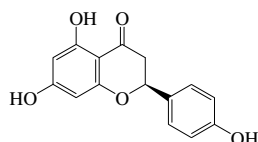
Naproxen



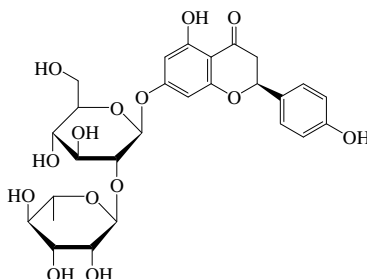
Narceine



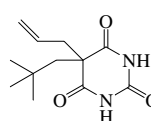
Narcobarbital



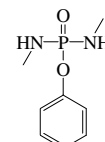
Naringenin



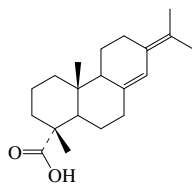
Naringin



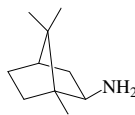
Neobarbital



Nellite



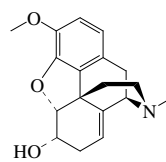
Neobietic acid



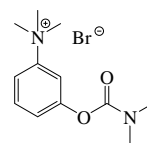
Neobornylamine



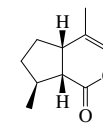
Neopentane



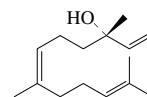
Neopine



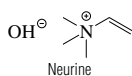
Neostigmine bromide



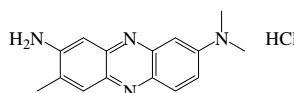
Nepetalactone



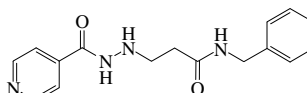
cis-Nerolidol



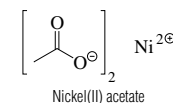
Neurine



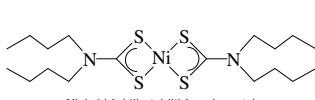
Neutral Red



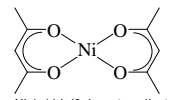
Nialamide



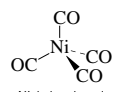
Nickel(II) acetate



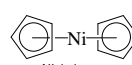
Nickel bis(dibutylthiocarbamate)



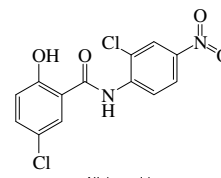
Nickel bis(2,4-pentanedioate)



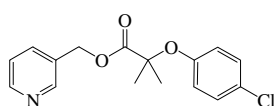
Nickel carbonyl



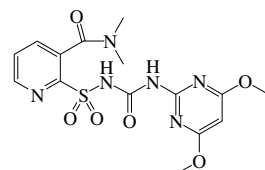
Nickelocene



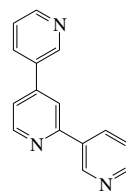
Niclosamide



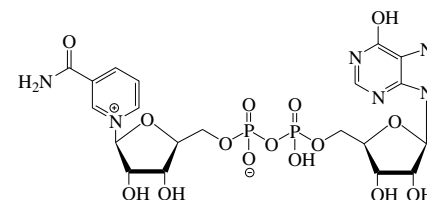
Nicofibrate



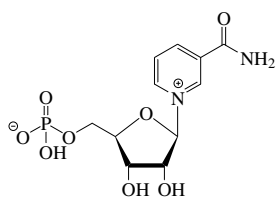
Nicosulfuron



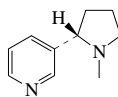
Nicotelline



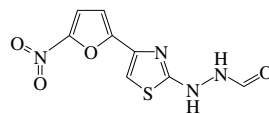
Nicotinamide hypoxanthine dinucleotide



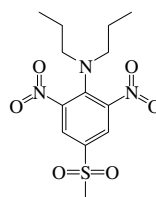
β-Nicotinamide mononucleotide



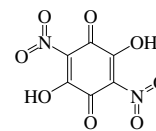
L-Nicotine



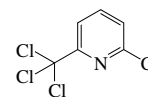
Nifurthiazole



Nitralin

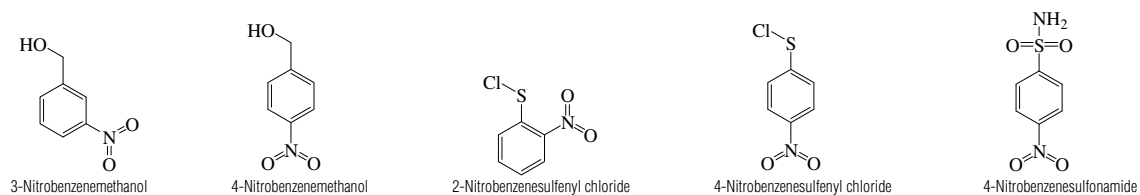
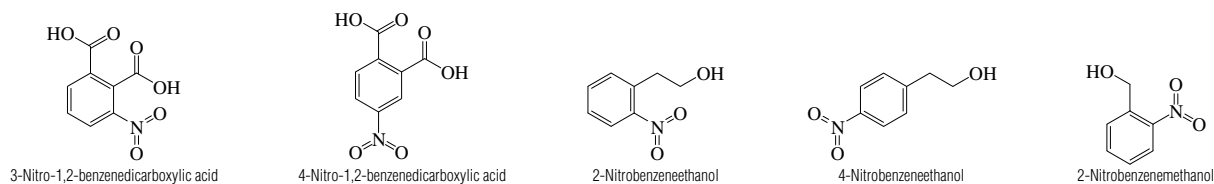
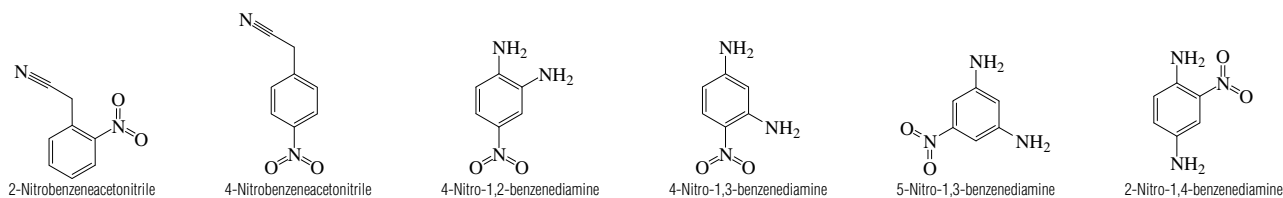
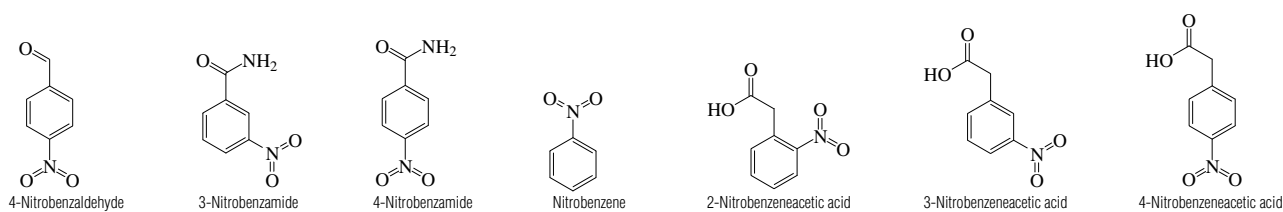
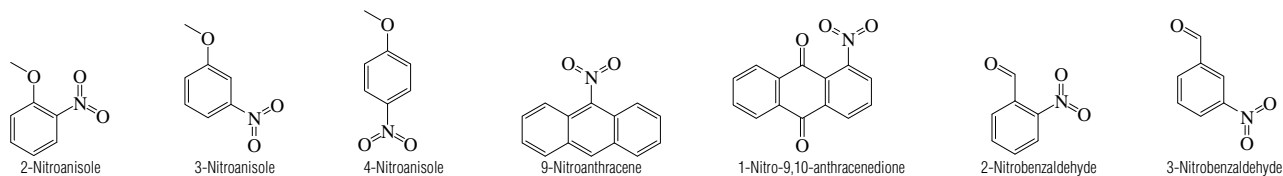
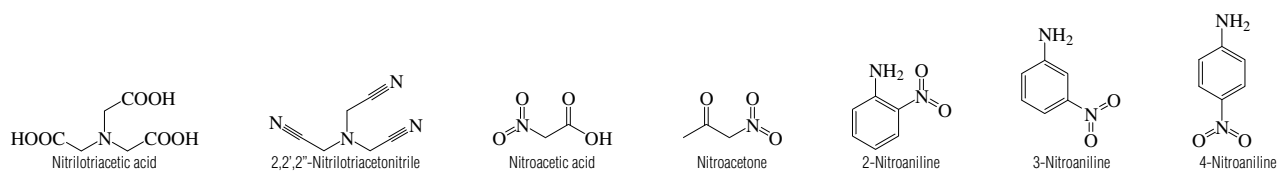


Nitranilic acid



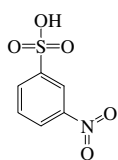
Nitrapyrin

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8030	Nitilotriacetic acid	<i>N,N</i> -Bis(carboxymethyl)glycine	C <sub>6</sub> H <sub>9</sub> NO <sub>6</sub>	139-13-9	191.138	pr cry (w)	242 dec				sl H <sub>2</sub> O, DMSO; s EtOH
8031	2,2,2'-Nitilotriacetoneitrile	Tricyanotrimethylamine	C <sub>6</sub> H <sub>6</sub> N <sub>4</sub>	7327-60-8	134.139	nd (EtOH)	125.5				
8032	Nitroacetic acid		C <sub>2</sub> H <sub>3</sub> NO <sub>4</sub>	625-75-2	105.050	nd (chl)	92 dec				vs bz, eth, EtOH, chl
8033	Nitroacetone		C <sub>3</sub> H <sub>5</sub> NO <sub>3</sub>	10230-68-9	103.077	pl, nd (eth, bz)	50.3	103 <sup>24</sup>			vs bz, eth, EtOH
8034	2-Nitroaniline		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	88-74-4	138.124		71.0	284	0.9015 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH; vs eth, ace, bz, chl
8035	3-Nitroaniline		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	99-09-2	138.124		113.4	dec 306	0.9011 <sup>25</sup>		sl H <sub>2</sub> O, bz; s EtOH, eth, ace; vs MeOH
8036	4-Nitroaniline		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	100-01-6	138.124	pa ye mcl nd (w)	147.5	332	1.424 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, ace; sl bz, DMSO
8037	2-Nitroanisole	1-Methoxy-2-nitrobenzene	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	91-23-6	153.136		10.5	277; 144 <sup>4</sup>	1.2540 <sup>20</sup>	1.5161 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
8038	3-Nitroanisole	1-Methoxy-3-nitrobenzene	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	555-03-3	153.136	nd (al), pl (bz-lig)	38.5	258	1.373 <sup>18</sup>		i H <sub>2</sub> O; s EtOH; vs eth
8039	4-Nitroanisole	1-Methoxy-4-nitrobenzene	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	100-17-4	153.136	pr (al), nd (dil al)	54	274	1.2192 <sup>60</sup>	1.5070 <sup>60</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc; sl peth
8040	9-Nitroanthracene		C <sub>14</sub> H <sub>9</sub> NO <sub>2</sub>	602-60-8	223.227	ye nd (al) pr (HOAc or xyl)	146	275 <sup>17</sup>			i H <sub>2</sub> O; sl EtOH, chl; vs ace, CS <sub>2</sub>
8041	1-Nitro-9,10-anthracenedione		C <sub>14</sub> H <sub>7</sub> NO <sub>4</sub>	82-34-8	253.211	nd (HOAc) ye pr (ace)	231.5	270 <sup>7</sup>			i H <sub>2</sub> O; sl EtOH, eth; s ace, bz
8042	2-Nitrobenzaldehyde		C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	552-89-6	151.120	ye nd (w)	43.5	153 <sup>23</sup>	1.2844 <sup>20</sup>		sl H <sub>2</sub> O, chl; vs EtOH, eth, ace, bz
8043	3-Nitrobenzaldehyde		C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	99-61-6	151.120	lt ye nd (w)	58.5	164 <sup>23</sup>	1.2792 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, chl; vs ace, bz
8044	4-Nitrobenzaldehyde		C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	555-16-8	151.120	lf, pr (w)	107	sub	1.496 <sup>25</sup>		sl H <sub>2</sub> O, lig; vs EtOH; s bz, chl, HOAc
8045	3-Nitrobenzamide		C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	645-09-0	166.134		142.7	312.5			s H <sub>2</sub> O, EtOH, eth
8046	4-Nitrobenzamide		C <sub>7</sub> H <sub>7</sub> N <sub>2</sub> O <sub>3</sub>	619-80-7	166.134	nd (w)	200.7				i H <sub>2</sub> O; s EtOH, eth
8047	Nitrobenzene		C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	98-95-3	123.110		5.7	210.8	1.2037 <sup>20</sup>	1.5562 <sup>20</sup>	sl H <sub>2</sub> O, ctc; vs EtOH, eth, ace, bz
8048	2-Nitrobenzeneacetic acid	<i>o</i> -Nitrophenylacetic acid	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	3740-52-1	181.147	nd (w, pl (dil al)	141.5				s H <sub>2</sub> O, EtOH
8049	3-Nitrobenzeneacetic acid	<i>m</i> -Nitrophenylacetic acid	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	1877-73-2	181.147	nd (w)	122				vs EtOH
8050	4-Nitrobenzeneacetic acid	<i>p</i> -Nitrophenylacetic acid	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	104-03-0	181.147	pa ye nd (w)	154				sl H <sub>2</sub> O; s EtOH, eth, bz
8051	2-Nitrobenzeneacetonitrile	2-Nitrobenzyl cyanide	C <sub>8</sub> H <sub>7</sub> N <sub>2</sub> O <sub>2</sub>	610-66-2	162.146	nd (dil al), pr (HOAc, al)	84	178 <sup>12</sup> , 138 <sup>1</sup>			vs ace, bz, eth, EtOH
8052	4-Nitrobenzeneacetonitrile	4-Nitrobenzyl cyanide	C <sub>8</sub> H <sub>7</sub> N <sub>2</sub> O <sub>2</sub>	555-21-5	162.146	pr (al)	117	196 <sup>12</sup>			sl H <sub>2</sub> O; s EtOH, eth, bz, chl
8053	4-Nitro-1,2-benzenediamine	4-Nitro- <i>o</i> -phenylenediamine	C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	99-56-9	153.139	dk red nd (dil al)	199.5				s acid
8054	4-Nitro-1,3-benzenediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	5131-58-8	153.139	oran pr (w)	161				
8055	5-Nitro-1,3-benzenediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	5042-55-7	153.139	red cry (w)	143				
8056	2-Nitro-1,4-benzenediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	5307-14-2	153.139		140.0				
8057	3-Nitro-1,2-benzenedicarboxylic acid		C <sub>8</sub> H <sub>5</sub> NO <sub>6</sub>	603-11-2	211.129	pa ye pr (w)	218				sl H <sub>2</sub> O, ace; s EtOH; i bz, peth, chl
8058	4-Nitro-1,2-benzenedicarboxylic acid		C <sub>8</sub> H <sub>5</sub> NO <sub>6</sub>	610-27-5	211.129	pa ye nd (w, eth)	164.8				s H <sub>2</sub> O, EtOH; i bz, chl, CS <sub>2</sub> , peth
8059	2-Nitrobenzeneethanol		C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	15121-84-3	167.162		1.0	267	1.19 <sup>25</sup>	1.5637 <sup>20</sup>	
8060	4-Nitrobenzeneethanol		C <sub>8</sub> H <sub>9</sub> NO <sub>3</sub>	100-27-6	167.162		63	148 <sup>2</sup>			
8061	2-Nitrobenzenemethanol	2-Nitrobenzyl alcohol	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	612-25-9	153.136	nd (w)	74	270; 168 <sup>20</sup>			sl H <sub>2</sub> O; s EtOH, eth
8062	3-Nitrobenzenemethanol	3-Nitrobenzyl alcohol	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	619-25-0	153.136	orth nd (w)	30.5	177 <sup>3</sup>	1.296 <sup>19</sup>		s H <sub>2</sub> O, EtOH, eth; sl chl
8063	4-Nitrobenzenemethanol	4-Nitrobenzyl alcohol	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	619-73-8	153.136	nd (w)	96.5	dec 255; 185 <sup>12</sup>			sl H <sub>2</sub> O, ace; s EtOH, eth
8064	2-Nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub> S	7669-54-7	189.620	ye nd (bz)	75				vs eth, bz, chl
8065	4-Nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub> S	937-32-6	189.620	ye lf (peth)	52	125 <sup>01</sup>			vs bz
8066	4-Nitrobenzenesulfonamide		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub> S	6325-93-5	202.188		180 dec				

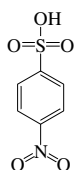


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8067	3-Nitrobenzenesulfonic acid		C <sub>6</sub> H <sub>4</sub> NO <sub>3</sub> S	98-47-5	203.173	pl	48				vs H <sub>2</sub> O; s EtOH; i eth, bz
8068	4-Nitrobenzenesulfonic acid		C <sub>6</sub> H <sub>4</sub> NO <sub>3</sub> S	138-42-1	203.173		95				vs H <sub>2</sub> O
8069	2-Nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub> S	1694-92-4	221.619	pr (lig, eth-peth)	68.5				s eth; sl peth
8070	3-Nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub> S	121-51-7	221.619	mcl pr (eth) nd (lig)	64				i H <sub>2</sub> O; s EtOH
8071	4-Nitrobenzenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub> S	98-74-8	221.619	mcl pr (peth)	79.5	143 <sup>1.5</sup>			s peth
8072	5-Nitro-1 <i>H</i> -benzimidazole		C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	94-52-0	163.134	nd (w)	207.8				i H <sub>2</sub> O, eth, bz, chl; s acid; vs EtOH
8073	2-Nitrobenzoic acid		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	552-16-9	167.120	tcl nd (w)	147.5		1.575 <sup>20</sup>		s H <sub>2</sub> O, eth; vs EtOH, ace; sl bz, lig
8074	3-Nitrobenzoic acid		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	121-92-6	167.120	mcl pr (w)	141.1		1.494 <sup>20</sup>		sl H <sub>2</sub> O, bz; vs EtOH, eth, ace; s chl
8075	4-Nitrobenzoic acid		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	62-23-7	167.120	mcl lf (w)	242	sub	1.610 <sup>20</sup>		vs ace, eth, EtOH, chl, MeOH
8076	3-Nitrobenzoic acid, hydrazide		C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>3</sub>	618-94-0	181.149		153.5				sl H <sub>2</sub> O, EtOH; i eth, bz, chl
8077	4-Nitrobenzoic acid, hydrazide		C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>3</sub>	636-97-5	181.149		215.5				sl H <sub>2</sub> O, EtOH; i eth, bz, chl
8078	3-Nitrobenzotrile		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	619-24-9	148.119		118	165 <sup>16</sup>			s H <sub>2</sub> O, EtOH, bz; vs eth, ace; i peth
8079	4-Nitrobenzotrile		C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	619-72-7	148.119		150.0				sl H <sub>2</sub> O, EtOH, eth; s chl, HOAc
8080	5-Nitro-1 <i>H</i> -benzotriazole		C <sub>6</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	2338-12-7	164.122		217				
8081	2-Nitrobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> ClNO <sub>2</sub>	610-14-0	185.565		20				vs eth; sl ctc
8082	3-Nitrobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> ClNO <sub>2</sub>	121-90-4	185.565		36	276.5			vs eth
8083	4-Nitrobenzoyl chloride		C <sub>7</sub> H <sub>5</sub> ClNO <sub>2</sub>	122-04-3	185.565	ye nd (lig)	75	203 <sup>105</sup> , 151 <sup>15</sup>			s eth
8084	2-Nitrobiphenyl	2-Nitro-1,1'-biphenyl	C <sub>12</sub> H <sub>9</sub> NO <sub>2</sub>	86-00-0	199.205	pl (al, MeOH)	37.2	320	1.44 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, chl
8085	3-Nitrobiphenyl	3-Nitro-1,1'-biphenyl	C <sub>12</sub> H <sub>9</sub> NO <sub>2</sub>	2113-58-8	199.205	ye pl or nd (dil al)	62	227 <sup>35</sup> , 143 <sup>9</sup>			i H <sub>2</sub> O; s EtOH, eth, HOAc, lig
8086	4-Nitrobiphenyl	4-Nitro-1,1'-biphenyl	C <sub>12</sub> H <sub>9</sub> NO <sub>2</sub>	92-93-3	199.205	ye nd (al)	114	340			i H <sub>2</sub> O; sl EtOH; s eth, bz, chl, HOAc
8087	2-Nitro-1,1-bis( <i>p</i> -chlorophenyl)propane		C <sub>15</sub> H <sub>13</sub> Cl <sub>2</sub> NO <sub>2</sub>	117-27-1	310.176	cry	81	180 <sup>16</sup>			
8088	1-Nitrobutane		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	627-05-4	103.120			153	0.970 <sup>25</sup>	1.4303 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s alk
8089	2-Nitro-1-butanol		C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	609-31-4	119.119		-47	105 <sup>10</sup>	1.1332 <sup>25</sup>	1.4390 <sup>20</sup>	s H <sub>2</sub> O, ace; msc EtOH, eth; sl ctc
8090	3-Nitro-2-butanol		C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	6270-16-2	119.119			91 <sup>9</sup> , 55 <sup>0.5</sup>	1.1260 <sup>20</sup>	1.4414 <sup>20</sup>	
8091	6-Nitrochrysene		C <sub>18</sub> H <sub>11</sub> NO <sub>2</sub>	7496-02-8	273.286	ye nd (bz)	≈215 dec				
8092	Nitrocyclohexane		C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	1122-60-7	129.157	liq	-34	205; 95 <sup>22</sup>	1.0610 <sup>20</sup>	1.4612 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, lig
8093	1-Nitrodecane		C <sub>10</sub> H <sub>21</sub> NO <sub>2</sub>	4609-87-4	187.280			86 <sup>1</sup>		1.4337 <sup>20</sup>	
8094	<i>N</i> -Nitrodiethylamine	<i>N</i> -Ethyl- <i>N</i> -nitroethanamine	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	7119-92-8	118.134			206.5	1.057 <sup>15</sup>		vs eth, EtOH
8095	Nitroethane		C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	79-24-3	75.067	liq	-89.5	114.0	1.0448 <sup>25</sup>	1.3917 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, chl
8096	2-Nitroethanol		C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	625-48-9	91.066	liq	-80	194; 102 <sup>10</sup>	1.270 <sup>15</sup>	1.4438 <sup>19</sup>	msc H <sub>2</sub> O, EtOH, eth; i bz
8097	Nitroethene		C <sub>2</sub> H <sub>3</sub> NO <sub>2</sub>	3638-64-0	73.051	liq	-55.5	98.5	1.2212 <sup>14</sup>	1.4282 <sup>20</sup>	vs EtOH, eth, ace, bz, chl
8098	(2-Nitroethyl)benzene		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	6125-24-2	151.163	liq	-23	250; 137 <sup>16</sup>	1.126 <sup>24</sup>	1.5407 <sup>19</sup>	
8099	Nitrofen	2,4-Dichloro-1-(4-nitrophenoxy)benzene	C <sub>12</sub> H <sub>7</sub> Cl <sub>2</sub> NO <sub>3</sub>	1836-75-5	284.095		70				
8100	2-Nitro-9 <i>H</i> -fluorene		C <sub>13</sub> H <sub>9</sub> NO <sub>2</sub>	607-57-8	211.216	nd (50% HOAc ace)	159.3				i H <sub>2</sub> O; s ace, bz
8101	2-Nitro-9 <i>H</i> -fluoren-9-one		C <sub>13</sub> H <sub>7</sub> NO <sub>3</sub>	3096-52-4	225.200	ye nd or lf (HOAc)	224.3	sub			sl EtOH; s ace, sulf, HOAc
8102	5-Nitro-2-furaldehyde diacetate		C <sub>8</sub> H <sub>9</sub> NO <sub>7</sub>	92-55-7	243.170		92.0				s chl
8103	2-Nitrofuran		C <sub>4</sub> H <sub>3</sub> NO <sub>3</sub>	609-39-2	113.072	ye mcl cry (peth)	30	134 <sup>123</sup> , 84 <sup>13</sup>			s H <sub>2</sub> O, EtOH, eth
8104	5-Nitro-2-furancarboxaldehyde		C <sub>5</sub> H <sub>3</sub> NO <sub>4</sub>	698-63-5	141.083	pa ye (peth)	35.5	130 <sup>10</sup>			sl H <sub>2</sub> O; s peth

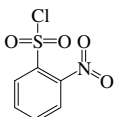




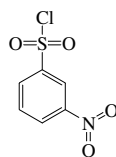
3-Nitrobenzenesulfonic acid



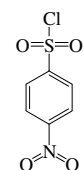
4-Nitrobenzenesulfonic acid



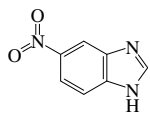
2-Nitrobenzenesulfonyl chloride



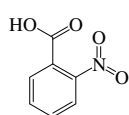
3-Nitrobenzenesulfonyl chloride



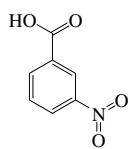
4-Nitrobenzenesulfonyl chloride



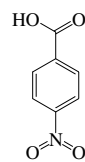
5-Nitro-1H-benzimidazole



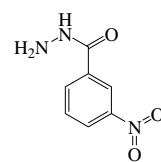
2-Nitrobenzoic acid



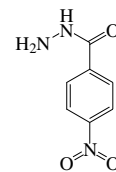
3-Nitrobenzoic acid



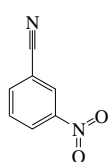
4-Nitrobenzoic acid



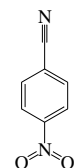
3-Nitrobenzoic acid, hydrazide



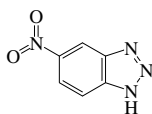
4-Nitrobenzoic acid, hydrazide



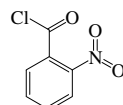
3-Nitrobenzonitrile



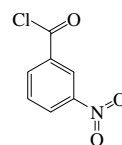
4-Nitrobenzonitrile



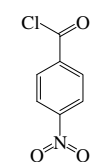
5-Nitro-1H-benzotriazole



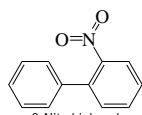
2-Nitrobenzoyl chloride



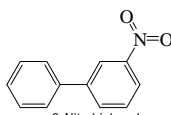
3-Nitrobenzoyl chloride



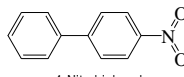
4-Nitrobenzoyl chloride



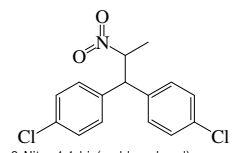
2-Nitrobiphenyl



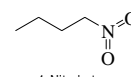
3-Nitrobiphenyl



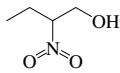
4-Nitrobiphenyl



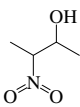
2-Nitro-1,1-bis(p-chlorophenyl)propane



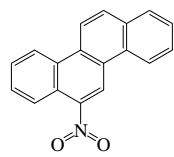
1-Nitrobutane



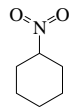
2-Nitro-1-butanol



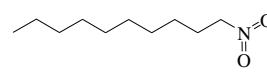
3-Nitro-2-butanol



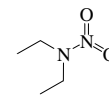
6-Nitrochrysene



Nitrocyclohexane



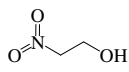
1-Nitrodecane



N-Nitrodiethylamine



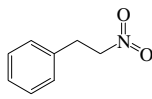
Nitroethane



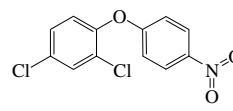
2-Nitroethanol



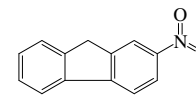
Nitroethene



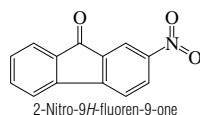
(2-Nitroethyl)benzene



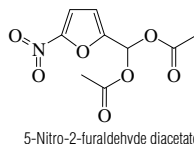
Nitrofen



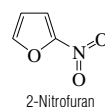
2-Nitro-9H-fluorene



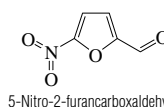
2-Nitro-9H-fluoren-9-one



5-Nitro-2-furaldehyde diacetate

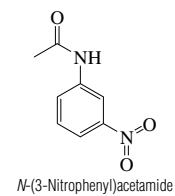
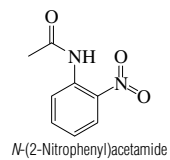
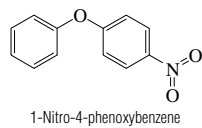
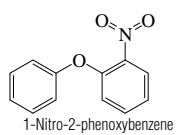
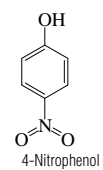
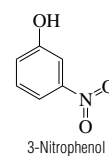
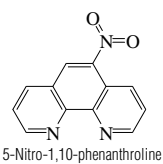
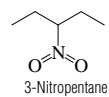
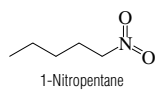
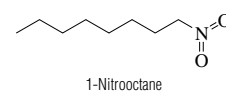
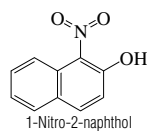
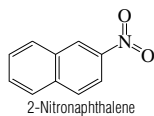
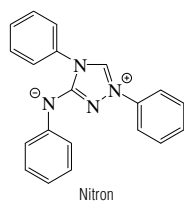
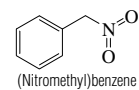
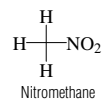
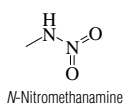
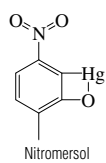
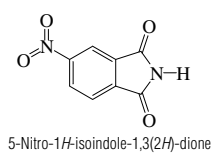
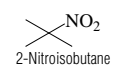
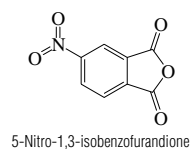
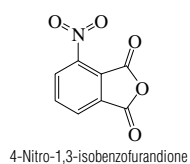
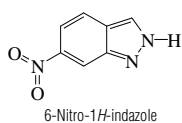
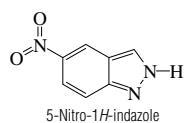
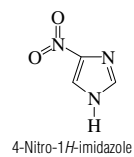
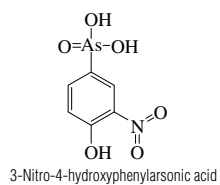
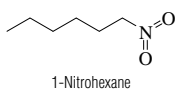
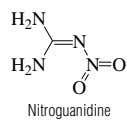
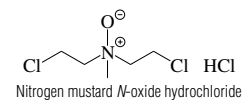
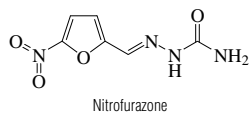
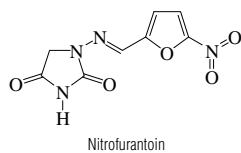
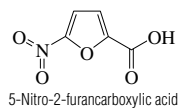


2-Nitrofuran

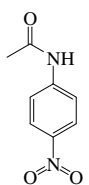


5-Nitro-2-furancarboxaldehyde

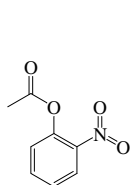
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8105	5-Nitro-2-furancarboxylic acid		C <sub>6</sub> H <sub>3</sub> NO <sub>5</sub>	645-12-5	157.082	pa ye pl (w)	186	sub			s H <sub>2</sub> O, EtOH, eth; sl ace, bz; i chl
8106	Nitrofurantoin		C <sub>8</sub> H <sub>8</sub> N <sub>4</sub> O <sub>5</sub>	67-20-9	238.158		263				
8107	Nitrofurazone	2-[(5-Nitro-2-furanyl)methylene]hydrazinecarboxamide	C <sub>6</sub> H <sub>6</sub> N <sub>4</sub> O <sub>4</sub>	59-87-0	198.137	pa ye nd	238 dec				i H <sub>2</sub> O, eth; sl EtOH, DMSO; s alk
8108	Nitrogen mustard <i>N</i> -oxide hydrochloride	Mechlorethamine oxide hydrochloride	C <sub>3</sub> H <sub>12</sub> Cl <sub>3</sub> NO	302-70-5	208.514	pr (ace)	110				s H <sub>2</sub> O
8109	Nitroguanidine		CH <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	556-88-7	104.069	nd or pr (w)	239 dec				sl H <sub>2</sub> O, EtOH; i eth; vs alk
8110	1-Nitrohexane		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	646-14-0	131.173			193; 84 <sup>21</sup>	0.9396 <sup>20</sup>	1.4270 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, alk
8111	3-Nitro-4-hydroxyphenylarsonic acid	Roxarsone	C <sub>6</sub> H <sub>6</sub> AsNO <sub>6</sub>	121-19-7	263.037	ye nd or pl (w)	300				sl hot H <sub>2</sub> O; i eth, EtOAc; vs MeOH, EtOH
8112	2-Nitro-1 <i>H</i> -imidazole	Azomycin	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>2</sub>	527-73-1	113.075	cry (MeOH)	287 dec				
8113	4-Nitro-1 <i>H</i> -imidazole		C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>2</sub>	3034-38-6	113.075		303 dec				
8114	5-Nitro-1 <i>H</i> -indazole		C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	5401-94-5	163.134	ye nd or col nd (al)	208				s EtOH, eth, bz; vs ace, HOAc; i lig
8115	6-Nitro-1 <i>H</i> -indazole		C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	7597-18-4	163.134	nd (w, al, ace)	181 dec				s H <sub>2</sub> O, EtOH, eth, bz; vs ace; i lig
8116	4-Nitro-1,3-isobenzofurandione		C <sub>8</sub> H <sub>5</sub> NO <sub>3</sub>	641-70-3	193.114	nd (ace, al)	164				i H <sub>2</sub> O; s EtOH, ace, HOAc; sl bz
8117	5-Nitro-1,3-isobenzofurandione		C <sub>8</sub> H <sub>5</sub> NO <sub>3</sub>	5466-84-2	193.114		120.3	196 <sup>8</sup>			i H <sub>2</sub> O, peth; s EtOH, ace; sl eth
8118	2-Nitroisobutane		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	594-70-7	103.120		26.23	127.16	0.9501 <sup>28</sup>	1.4015 <sup>20</sup>	msc EtOH, eth, ace, bz; vs chl; i alk
8119	5-Nitro-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione		C <sub>8</sub> H <sub>7</sub> N <sub>2</sub> O <sub>4</sub>	89-40-7	192.129	col nd (w), ye lf (al-ace)	202				vs ace
8120	Nitromersol		C <sub>7</sub> H <sub>9</sub> HgNO <sub>3</sub>	133-58-4	351.71						i H <sub>2</sub> O; sl ace, EtOH; s alk
8121	<i>N</i> -Nitromethanamine		CH <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	598-57-2	76.055		38	82 <sup>10</sup>	1.2433 <sup>49</sup>	1.4616 <sup>49</sup>	vs H <sub>2</sub> O, EtOH, bz, chl; s eth; sl peth
8122	Nitromethane		CH <sub>3</sub> NO <sub>2</sub>	75-52-5	61.041	liq	-28.38	101.19	1.1371 <sup>20</sup>	1.3817 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, ctc, alk
8123	(Nitromethyl)benzene		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	622-42-4	137.137	ye liq		226; 135 <sup>25</sup>	1.1596 <sup>20</sup>	1.5323 <sup>20</sup>	vs ace, eth
8124	Nitron		C <sub>20</sub> H <sub>16</sub> N <sub>4</sub>	2218-94-2	312.368	ye lf (al), nd (chl)	189 dec				vs ace, bz, EtOH, chl
8125	1-Nitronaphthalene		C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	86-57-7	173.169	ye nd (al)	61	180 <sup>14</sup>	1.332 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz, chl, py
8126	2-Nitronaphthalene		C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	581-89-5	173.169	ye orth nd or pl (al)	79	314; 165 <sup>15</sup>			i H <sub>2</sub> O; vs EtOH, eth
8127	1-Nitro-2-naphthol		C <sub>10</sub> H <sub>7</sub> NO <sub>3</sub>	550-60-7	189.168	ye nd, lf or pr (al)	104	115 <sup>0.05</sup>			s H <sub>2</sub> O, EtOH; vs eth; sl chl
8128	1-Nitrooctane		C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	629-37-8	159.227		15	208.5	0.9346 <sup>20</sup>	1.4322 <sup>20</sup>	
8129	1-Nitropentane		C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	628-05-7	117.147			172.5	0.9525 <sup>20</sup>	1.4175 <sup>20</sup>	s EtOH, eth, bz
8130	3-Nitropentane		C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	551-88-2	117.147			154	0.957 <sup>0</sup>		vs ace, eth, EtOH
8131	5-Nitro-1,10-phenanthroline		C <sub>12</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	4199-88-6	225.203		202.3				
8132	2-Nitrophenol		C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	88-75-5	139.109	ye nd or pr (eth, al)	44.8	216	1.2942 <sup>40</sup>	1.5723 <sup>30</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, bz, py
8133	3-Nitrophenol		C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	554-84-7	139.109	ye mcl (eth, aq Hcl)	96.8	194 <sup>70</sup>	1.2797 <sup>100</sup>		sl H <sub>2</sub> O, DMSO; vs EtOH, eth, ace, bz
8134	4-Nitrophenol		C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	100-02-7	139.109	ye mcl pr (to)	113.6		1.479 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth, ace; s tol, py
8135	1-Nitro-2-phenoxybenzene		C <sub>12</sub> H <sub>9</sub> NO <sub>3</sub>	2216-12-8	215.204	ye liq	<-20	235 <sup>60</sup> , 184 <sup>8</sup>	1.2539 <sup>22</sup>	1.575 <sup>20</sup>	vs bz, eth, EtOH, chl
8136	1-Nitro-4-phenoxybenzene		C <sub>12</sub> H <sub>9</sub> NO <sub>3</sub>	620-88-2	215.204	pl (peth), MeOH)	61	320; 225 <sup>30</sup>			i H <sub>2</sub> O; sl EtOH, ctc; s eth, bz
8137	<i>N</i> -(2-Nitrophenyl)acetamide		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	552-32-9	180.161		94	100 <sup>0.1</sup>	1.419 <sup>15</sup>		s H <sub>2</sub> O, EtOH, bz, chl, lig; vs eth
8138	<i>N</i> -(3-Nitrophenyl)acetamide		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	122-28-1	180.161	wh lf (al)	155	100 <sup>0.0074</sup>			s H <sub>2</sub> O, EtOH, chl; i eth; sl tfa



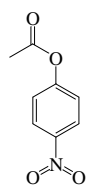
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8139	<i>N</i> -(4-Nitrophenyl)acetamide		C <sub>8</sub> H <sub>9</sub> N <sub>2</sub> O <sub>3</sub>	104-04-1	180.161	ye pr (w)	216	100 <sup>008</sup>			sl H <sub>2</sub> O, eth, chl; s EtOH, tfa, alk
8140	2-Nitrophenyl acetate		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	610-69-5	181.147	nd or pr (lig)	40.5	dec 253; 141 <sup>11</sup>			s H <sub>2</sub> O; vs EtOH, eth, ace, bz; sl lig
8141	4-Nitrophenyl acetate		C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	830-03-5	181.147	lf (dil al)	82.3				vs H <sub>2</sub> O, bz; s EtOH, chl, lig
8142	2-Nitro- <i>N</i> -phenylaniline		C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	119-75-5	214.219		75.5	215 <sup>15</sup>	1.3660 <sup>20</sup>		i H <sub>2</sub> O; s EtOH; sl ctc
8143	4-Nitro- <i>N</i> -phenylaniline		C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	836-30-6	214.219		135.3	211 <sup>30</sup>			i H <sub>2</sub> O; vs EtOH; sl ace; s con sulf
8144	(4-Nitrophenyl)arsonic acid	Nitarsonic	C <sub>6</sub> H <sub>5</sub> AsNO <sub>3</sub>	98-72-6	247.038	lf or nd (w)	>310	dec			sl H <sub>2</sub> O, EtOH, DMSO
8145	4-[(4-Nitrophenyl)azo]-1,3-benzenediol	Magneson	C <sub>12</sub> H <sub>9</sub> N <sub>3</sub> O <sub>4</sub>	74-39-5	259.217	red pow (al or MeOH)	200				i H <sub>2</sub> O; sl EtOH, bz, HOAc, tol
8146	1-[(4-Nitrophenyl)azo]-2-naphthol		C <sub>16</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub>	6410-10-2	293.276	br-oran pl (to or bz)	257				vs bz, EtOH
8147	(3-Nitrophenyl)boronic acid		C <sub>6</sub> H <sub>6</sub> BN <sub>2</sub> O <sub>4</sub>	13331-27-6	166.928		274.5				
8148	1-(2-Nitrophenyl)ethanone	2-Nitroacetophenone	C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	577-59-3	165.147		28.5	178 <sup>32</sup> , 158 <sup>16</sup>	1.2370 <sup>25</sup>	1.5468 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl
8149	1-(3-Nitrophenyl)ethanone	3-Nitroacetophenone	C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	121-89-1	165.147	nd (al)	81	202; 167 <sup>18</sup>			vs H <sub>2</sub> O, eth; sl EtOH, chl
8150	1-(4-Nitrophenyl)ethanone	4-Nitroacetophenone	C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	100-19-6	165.147	ye pr (al)	81.8	165 <sup>5</sup>			vs eth, EtOH
8151	2-Nitro-1-phenylethanone		C <sub>8</sub> H <sub>7</sub> NO <sub>3</sub>	614-21-1	165.147		106	158 <sup>16</sup> , 142 <sup>10</sup>		1.5468 <sup>30</sup>	vs eth, EtOH
8152	(4-Nitrophenyl)hydrazine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	100-16-3	153.139	oran-red lf or nd (al)	158	dec			sl H <sub>2</sub> O; s EtOH, eth, bz, chl, AcOEt
8153	(4-Nitrophenyl)phenylmethanone		C <sub>13</sub> H <sub>9</sub> NO <sub>3</sub>	1144-74-7	227.215	nd or lf (al)	138		1.406 <sup>9</sup>		vs bz
8154	3-(4-Nitrophenyl)-1-phenyl-2-propen-1-one	Nitrochalcone	C <sub>15</sub> H <sub>11</sub> NO <sub>3</sub>	1222-98-6	253.253	pa ye nd (al) pl (bz)	164				s EtOH, chl; i eth, lig
8155	4-Nitrophenyl phosphate	4-Nitrophenyl dihydrogen phosphate	C <sub>6</sub> H <sub>5</sub> NO <sub>6</sub> P	330-13-2	219.089	ye-wh nd	155				i cold H <sub>2</sub> O; s EtOH, chl, bz
8156	3-(2-Nitrophenyl)propanoic acid	2-Nitrobenzenepropanoic acid	C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	2001-32-3	195.172	ye cry	115				
8157	3-(4-Nitrophenyl)propanoic acid	4-Nitrobenzenepropanoic acid	C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	16642-79-8	195.172	nd (w)	163				
8158	3-(4-Nitrophenyl)-2-propenal	4-Nitrocinnamaldehyde	C <sub>9</sub> H <sub>7</sub> NO <sub>3</sub>	1734-79-8	177.157	nd (w, al)	141.5				s H <sub>2</sub> O, eth, ace, bz; vs EtOH
8159	3-(2-Nitrophenyl)-2-propynoic acid	<i>o</i> -Nitrophenylpropionic acid	C <sub>9</sub> H <sub>7</sub> NO <sub>4</sub>	530-85-8	191.141			≈157 dec; may explode			sl H <sub>2</sub> O; vs EtOH, eth; i CS <sub>2</sub> O
8160	1-Nitro-4-(phenylthio)benzene		C <sub>12</sub> H <sub>9</sub> NO <sub>2</sub> S	952-97-6	231.270	pa ye mcl pr (lig)	56	288 <sup>100</sup> , 240 <sup>25</sup>			vs eth, EtOH
8161	(4-Nitrophenyl)urea	<i>p</i> -Nitrophenylurea	C <sub>7</sub> H <sub>7</sub> N <sub>3</sub> O <sub>3</sub>	556-10-5	181.149	pr (al), nd (dil al)	238				vs H <sub>2</sub> O, EtOH
8162	<i>N</i> -Nitropiperidine		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	7119-94-0	130.145	liq	-5.5	245; 121 <sup>20</sup>	1.1519 <sup>26</sup>	1.4954 <sup>26</sup>	
8163	1-Nitropropane		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	108-03-2	89.094	liq	-108	131.1	0.9961 <sup>25</sup>	1.4018 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s chl
8164	2-Nitropropane		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	79-46-9	89.094	liq	-91.3	120.2	0.9821 <sup>25</sup>	1.3944 <sup>20</sup>	sl H <sub>2</sub> O; s chl
8165	3-Nitropropanoic acid		C <sub>3</sub> H <sub>5</sub> NO <sub>4</sub>	504-88-1	119.077		62		1.59 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, eth; s chl; i lig
8166	2-Nitro-1-propanol		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	2902-96-7	105.093			120 <sup>32</sup> , 100 <sup>12</sup>	1.1841 <sup>25</sup>	1.4379 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl chl
8167	1-Nitro-1-propene		C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	3156-70-5	87.078			60 <sup>34</sup> , 37 <sup>10</sup>	1.0661 <sup>20</sup>	1.4527 <sup>20</sup>	s eth, ace, chl
8168	2-Nitro-1-propene		C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	4749-28-4	87.078	ye-grn liq		52 <sup>20</sup> , 32 <sup>30</sup>	1.0559 <sup>25</sup>	1.4358 <sup>20</sup>	s eth, ace, chl
8169	5-Nitro-2-propoxyaniline		C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	553-79-7	196.202	oran (PROH-peth)	49				vs EtOH
8170	<i>N</i> -(5-Nitro-2-propoxyphenyl)acetamide	5'-Nitro-2'-propoxyacetanilide	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub>	553-20-8	238.240	cry (PROH)	102.5				
8171	1-Nitropyrene		C <sub>16</sub> H <sub>9</sub> NO <sub>2</sub>	5522-43-0	247.248	ye nd (MeCN)	152				
8172	5-Nitro-2-pyridinamine		C <sub>6</sub> H <sub>6</sub> N <sub>3</sub> O <sub>2</sub>	4214-76-0	139.113	ye lf (dil al)	188				sl H <sub>2</sub> O, eth, bz, lig; s EtOH
8173	4-Nitropyridine		C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	1122-61-8	124.098	pl (aq al)	50				
8174	4-Nitropyridine 1-oxide		C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	1124-33-0	140.097		160.5				
8175	5-Nitropyrimidinamine		C <sub>4</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	3073-77-6	140.101	nd (al)	236.5				sl H <sub>2</sub> O, DMSO; s EtOH, ace; i eth, bz
8176	5-Nitro-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	5-Nitroouracil	C <sub>4</sub> H <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	611-08-5	157.085	gold nd (al)	>300	exp			sl H <sub>2</sub> O; s EtOH
8177	5-Nitro-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	5-Nitrobarbituric acid	C <sub>4</sub> H <sub>3</sub> N <sub>3</sub> O <sub>5</sub>	480-68-2	173.084	pr, lf (w+3)	180.5				s H <sub>2</sub> O, EtOH; i eth
8178	5-Nitroquinoline		C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	607-34-1	174.156	pl (w, al) nd (+w)	74	sub			sl H <sub>2</sub> O, chl; s EtOH, bz



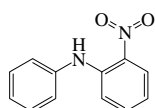
N-(4-Nitrophenyl)acetamide



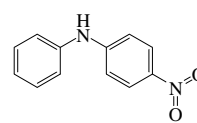
2-Nitrophenyl acetate



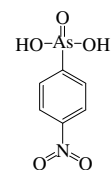
4-Nitrophenyl acetate



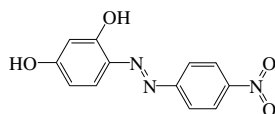
2-Nitro-N-phenylaniline



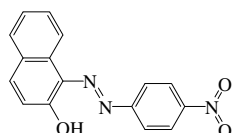
4-Nitro-N-phenylaniline



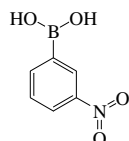
(4-Nitrophenyl)arsonic acid



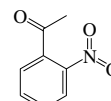
4-[(4-Nitrophenyl)azo]-1,3-benzenediol



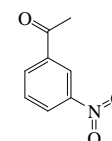
1-[(4-Nitrophenyl)azo]-2-naphthol



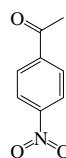
(3-Nitrophenyl)boronic acid



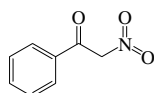
1-(2-Nitrophenyl)ethanone



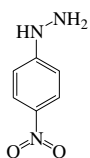
1-(3-Nitrophenyl)ethanone



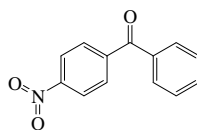
1-(4-Nitrophenyl)ethanone



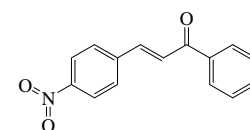
2-Nitro-1-phenylethanone



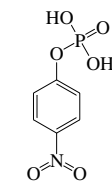
(4-Nitrophenyl)hydrazine



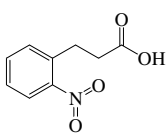
(4-Nitrophenyl)phenylmethanone



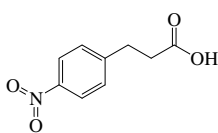
3-(4-Nitrophenyl)-1-phenyl-2-propen-1-one



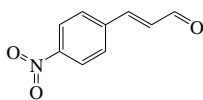
4-Nitrophenyl phosphate



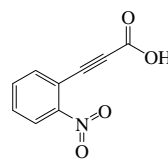
3-(2-Nitrophenyl)propanoic acid



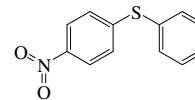
3-(4-Nitrophenyl)propanoic acid



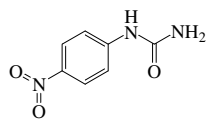
3-(4-Nitrophenyl)-2-propenal



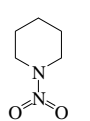
3-(2-Nitrophenyl)-2-propynoic acid



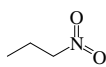
1-Nitro-4-(phenylthio)benzene



(4-Nitrophenyl)urea



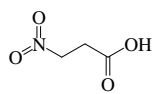
N-Nitropiperidine



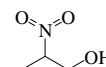
1-Nitropropane



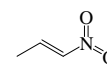
2-Nitropropane



3-Nitropropanoic acid



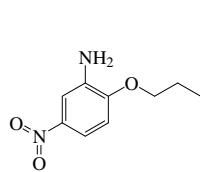
2-Nitro-1-propanol



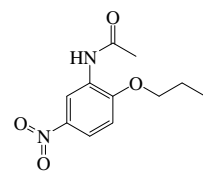
1-Nitro-1-propene



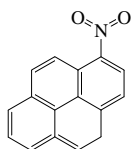
2-Nitro-1-propene



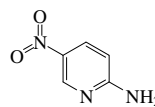
5-Nitro-2-propoxyaniline



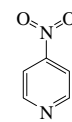
N-(5-Nitro-2-propoxyphenyl)acetamide



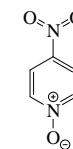
1-Nitropyrene



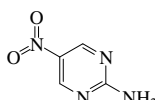
5-Nitro-2-pyridinamine



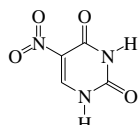
4-Nitropyridine



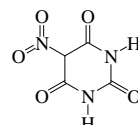
4-Nitropyridine 1-oxide



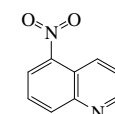
5-Nitropyrimidinamine



5-Nitro-2,4,6(1H,3H)-pyrimidinone

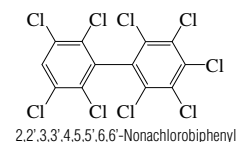
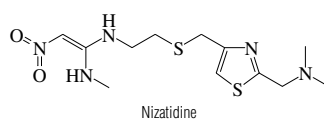
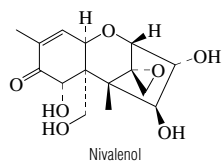
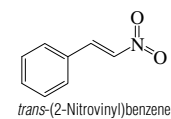
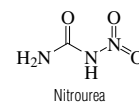
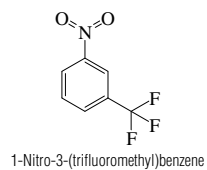
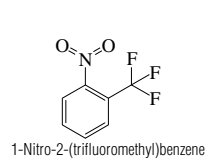
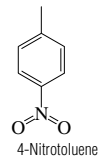
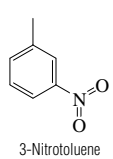
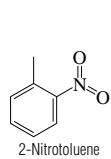
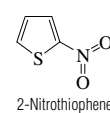
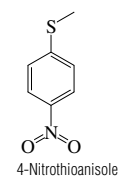
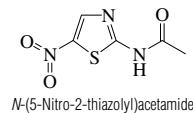
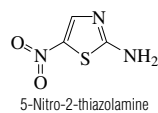
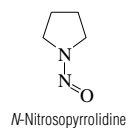
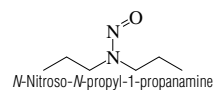
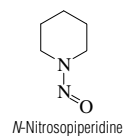
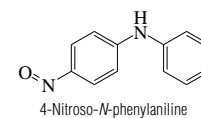
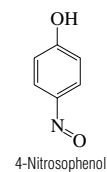
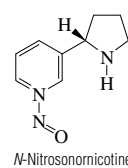
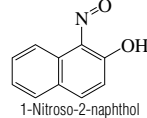
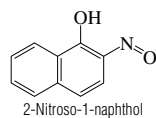
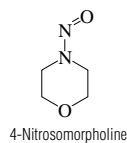
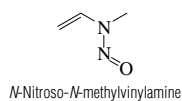
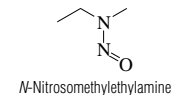
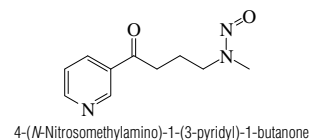
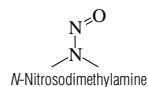
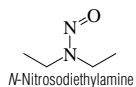
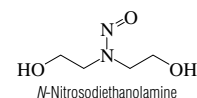
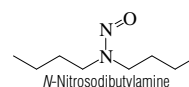
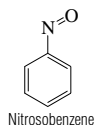
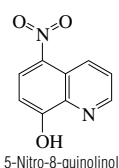
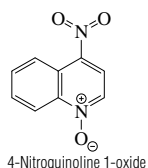
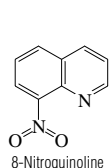
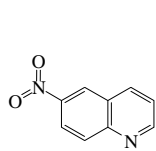


5-Nitro-2,4,6(1H,3H,5H)-pyrimidinetrione



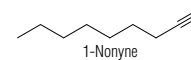
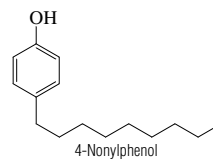
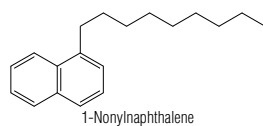
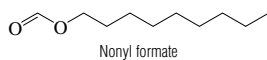
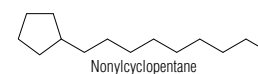
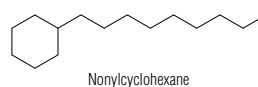
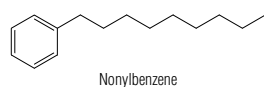
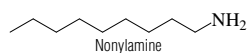
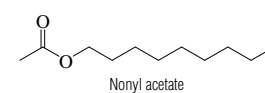
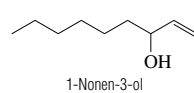
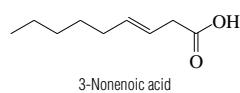
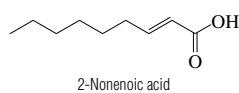
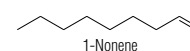
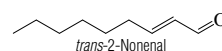
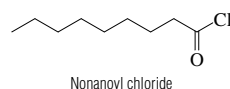
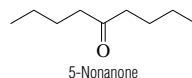
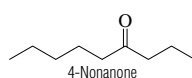
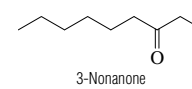
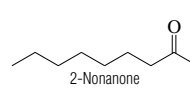
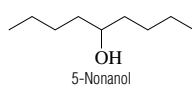
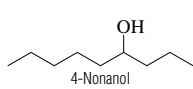
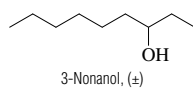
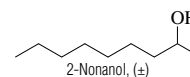
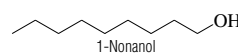
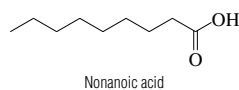
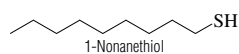
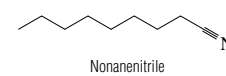
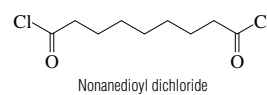
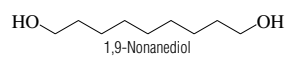
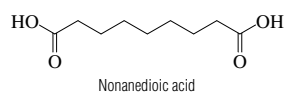
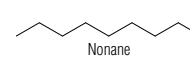
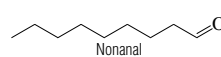
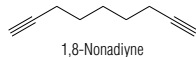
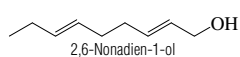
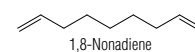
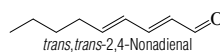
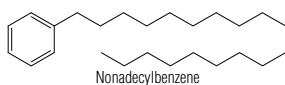
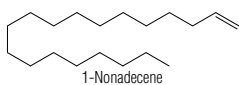
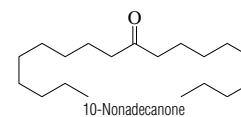
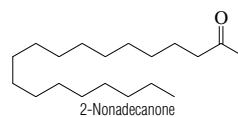
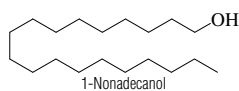
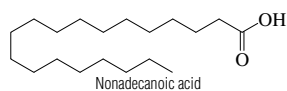
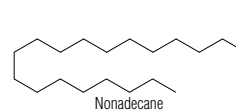
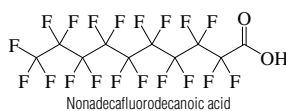
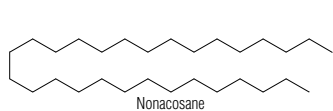
5-Nitroquinoline

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8179	6-Nitroquinoline		C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	613-50-3	174.156	ye pl (HCl-HOAc)	153.5	170 <sup>0.2</sup>			s H <sub>2</sub> O, EtOH; sl eth, chl; vs bz
8180	8-Nitroquinoline		C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	607-35-2	174.156	mcl pr (al)	91.5				sl H <sub>2</sub> O, chl; s EtOH, eth, bz, acid
8181	4-Nitroquinoline 1-oxide		C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	56-57-5	190.155	ye nd, pl (ace)	154				
8182	5-Nitro-8-quinolinol	Nitroxoline	C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	4008-48-4	190.155		180				
8183	Nitrosobenzene		C <sub>6</sub> H <sub>5</sub> NO	586-96-9	107.110	orth or mcl (al-eth)	67	58 <sup>18</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, lig
8184	<i>N</i> -Nitrosodibutylamine	Dibutylnitrosamine	C <sub>8</sub> H <sub>18</sub> N <sub>2</sub> O	924-16-3	158.241			105 <sup>8</sup>			
8185	<i>N</i> -Nitrosodiethanolamine	2,2'-(Nitrosoimino)ethanol	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	1116-54-7	134.133	wh-ye oil		125 <sup>0.01</sup>		1.4849 <sup>20</sup>	
8186	<i>N</i> -Nitrosodiethylamine	Diethylnitrosamine	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	55-18-5	102.134	ye oil		176.9	0.9422 <sup>20</sup>	1.4386 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl chl
8187	<i>N</i> -Nitrosodimethylamine	Dimethylnitrosamine	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	62-75-9	74.081	ye liq		152	1.0048 <sup>20</sup>	1.4368 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
8188	<i>p</i> -Nitroso- <i>N,N</i> -dimethylaniline		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O	138-89-6	150.177	grn pl (eth)	92.5		1.145 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, eth, chl, HCONH <sub>2</sub>
8189	<i>N</i> -Nitrosodiphenylamine	<i>N,N</i> -Diphenylnitrosamine	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	86-30-6	198.219	ye pl(lig)	66.5				i H <sub>2</sub> O; sl EtOH, chl; s bz
8190	4-( <i>N</i> -Nitrosomethylamino)-1-(3-pyridyl)-1-butanone	Ketone, 3-pyridyl-3-( <i>N</i> -methyl- <i>N</i> -nitrosamino)propyl	C <sub>10</sub> H <sub>13</sub> N <sub>3</sub> O <sub>2</sub>	64091-91-4	207.229		63				sl H <sub>2</sub> O
8191	<i>N</i> -Nitrosomethylethylamine		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O	10595-95-6	88.108	ye liq		67 <sup>40</sup>			
8192	<i>N</i> -Nitroso- <i>N</i> -methylvinylamine	<i>N</i> -Methyl- <i>N</i> -nitrosoethenamine	C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O	4549-40-0	86.092	ye liq		47			sl H <sub>2</sub> O
8193	4-Nitrosomorpholine	<i>N</i> -Nitrosomorpholine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	59-89-2	116.119		29	225; 140 <sup>25</sup>			s H <sub>2</sub> O
8194	2-Nitroso-1-naphthol		C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	132-53-6	173.169		157 dec				sl H <sub>2</sub> O, eth, bz, chl; s EtOH, ace, HOAc
8195	1-Nitroso-2-naphthol	1-Nitroso-β-naphthol	C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	131-91-9	173.169	ye-br nd (peth)	109.5				vs bz, eth
8196	<i>N</i> -Nitrosornicotine	<i>N</i> -Nitroso-3-(2-pyrrolidinyl)pyridine	C <sub>9</sub> H <sub>11</sub> N <sub>3</sub> O	16543-55-8	177.202			155 <sup>0.2</sup>			
8197	4-Nitrosophenol		C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	104-91-6	123.110	pa ye orth nd (ace, bz)	144 dec				sl H <sub>2</sub> O; s EtOH, eth, ace, bz, dil alk
8198	4-Nitroso- <i>N</i> -phenylaniline	<i>p</i> -Nitrosodiphenylamine	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	156-10-5	198.219		143				sl H <sub>2</sub> O, lig; vs EtOH, eth, bz
8199	<i>N</i> -Nitrosopiperidine	1-Nitrosopiperidine	C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O	100-75-4	114.145	pa ye		219; 109 <sup>20</sup>	1.0631 <sup>18</sup>	1.4933 <sup>18</sup>	s H <sub>2</sub> O, HCl
8200	<i>N</i> -Nitroso- <i>N</i> -propyl-1-propanamine	<i>N</i> -Nitrosodipropylamine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O	621-64-7	130.187	gold		206; 113 <sup>40</sup>	0.9163 <sup>20</sup>	1.4437 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8201	<i>N</i> -Nitrosopyrrolidine		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O	930-55-2	100.119			214	1.085 <sup>25</sup>	1.4880 <sup>25</sup>	
8202	5-Nitro-2-thiazolamine	2-Amino-5-nitrothiazole	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>2</sub> S	121-66-4	145.140	oran-ye pow	202 dec				
8203	<i>N</i> -(5-Nitro-2-thiazolyl)acetamide	Aminitroazole	C <sub>5</sub> H <sub>5</sub> N <sub>3</sub> O <sub>3</sub> S	140-40-9	187.177	nd (al), pl (HOAc)	264.5				s alk
8204	4-Nitrothioanisole		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub> S	701-57-5	169.202		72	137 <sup>2</sup>	1.2391 <sup>80</sup>	1.6401 <sup>20</sup>	i H <sub>2</sub> O; s ace, bz
8205	2-Nitrothiophene		C <sub>4</sub> H <sub>3</sub> NO <sub>2</sub> S	609-40-5	129.138	lt ye mcl nd (peth)	46.5	224.5	1.3644 <sup>43</sup>		i H <sub>2</sub> O; vs EtOH; s alk; sl peth
8206	2-Nitrotoluene		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	88-72-2	137.137	liq	-10.4	222	1.1611 <sup>19</sup>	1.5450 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
8207	3-Nitrotoluene		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	99-08-1	137.137	pa ye	15.5	232	1.1581 <sup>20</sup>	1.5466 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, ctc; msc eth
8208	4-Nitrotoluene		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	99-99-0	137.137	orth cry (al, eth)	51.63	238.3	1.1038 <sup>75</sup>		i H <sub>2</sub> O; s EtOH; vs eth, ace, bz, chl
8209	1-Nitro-2-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> F <sub>3</sub> NO <sub>2</sub>	384-22-5	191.108	cry (al)	32.5	217; 105 <sup>20</sup>			i H <sub>2</sub> O; vs EtOH, HOAc, bz; sl ctc
8210	1-Nitro-3-(trifluoromethyl)benzene		C <sub>7</sub> H <sub>4</sub> F <sub>3</sub> NO <sub>2</sub>	98-46-4	191.108	liq	-2.4	202.8; 103 <sup>40</sup>	1.4357 <sup>15</sup>	1.4719 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
8211	Nitrourea		CH <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	556-89-8	105.053	pl (al-peth)	158 dec				vs ace, EtOH
8212	<i>trans</i> -(2-Nitrovinyl)benzene		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	5153-67-3	149.148	ye pr (peth, al)	60	255			i H <sub>2</sub> O; s EtOH, ace; vs eth, chl, CS <sub>2</sub>
8213	Nivalenol		C <sub>15</sub> H <sub>26</sub> O <sub>7</sub>	23282-20-4	312.316	cry (MeOH)	224 dec				sl H <sub>2</sub> O; s EtOH, MeOH
8214	Nizatidine		C <sub>12</sub> H <sub>21</sub> N <sub>5</sub> O <sub>2</sub> S <sub>2</sub>	76963-41-2	331.458	cry (EtOH/AcOEt)	131				sl H <sub>2</sub> O; s MeOH; vs chl; i bz, eth
8215	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl		C <sub>12</sub> HCl <sub>9</sub>	52663-77-1	464.213	cry	180.5				i H <sub>2</sub> O
8216	Nonacontane		C <sub>90</sub> H <sub>182</sub>	7667-51-8	1264.408			612 <sup>200</sup>			

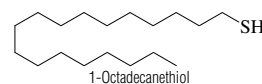
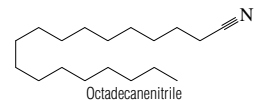
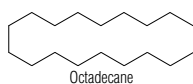
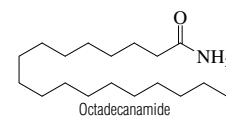
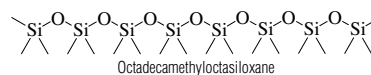
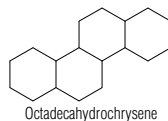
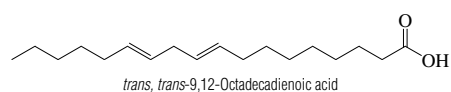
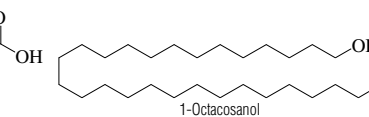
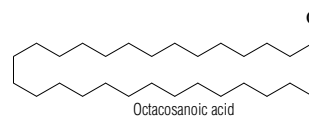
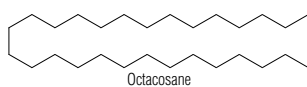
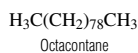
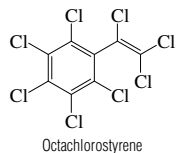
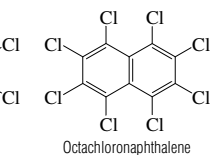
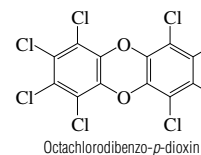
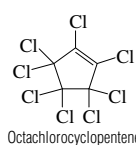
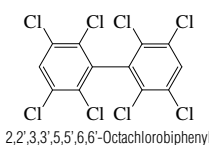
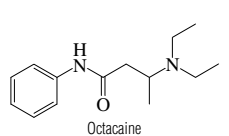
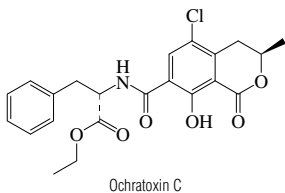
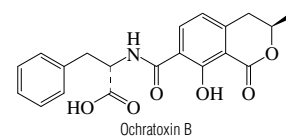
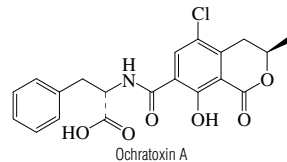
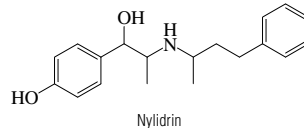
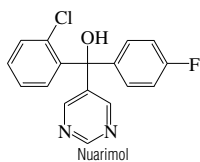
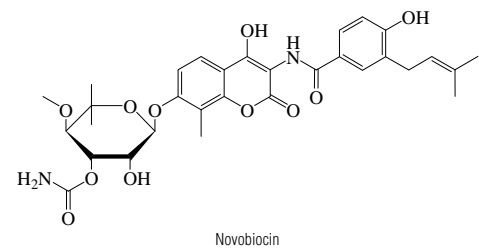
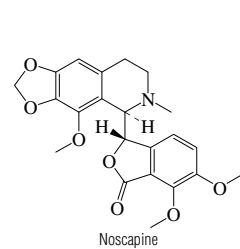
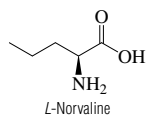
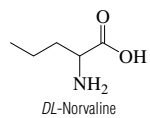
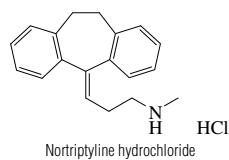
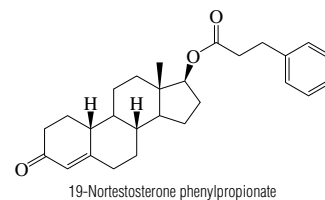
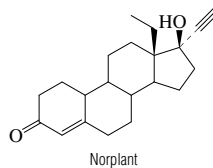
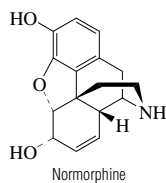
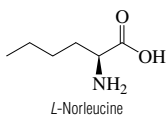
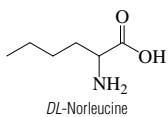
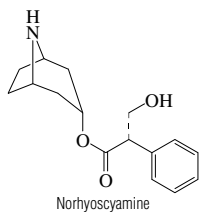
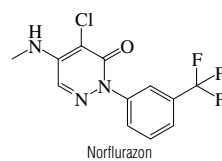
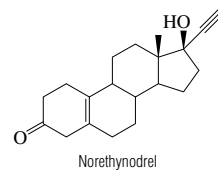
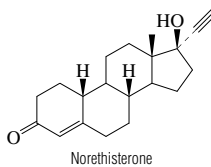
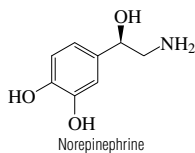
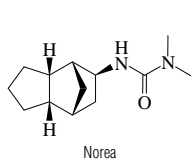
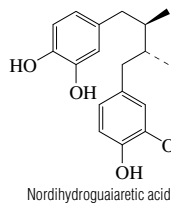
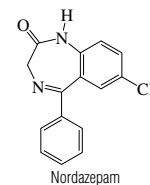
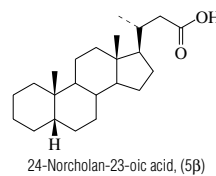
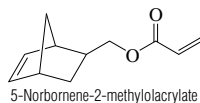
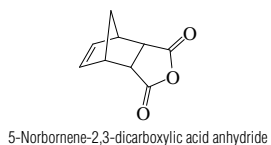
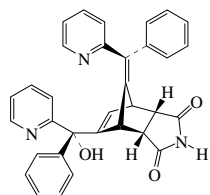


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8217	Nonacosane		C <sub>29</sub> H <sub>60</sub>	630-03-5	408.786	orth cry (peth)	63.7	440.8	0.8083 <sup>20</sup>	1.4529 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace; s bz; sl chl
8218	Nonadecafluorodecanoic acid		C <sub>10</sub> HF <sub>19</sub> O <sub>2</sub>	335-76-2	514.084			219.4			
8219	Nonadecane		C <sub>19</sub> H <sub>40</sub>	629-92-5	268.521	wax	32.0	329.9	0.7855 <sup>20</sup>	1.4409 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace, ctc
8220	Nonadecanoic acid		C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	646-30-0	298.504	lf (al)	69.4	297 <sup>100</sup> , 228 <sup>10</sup>	0.8468 <sup>70</sup>		i H <sub>2</sub> O; vs EtOH, eth, bz, chl, lig
8221	1-Nonadecanol		C <sub>19</sub> H <sub>40</sub> O	1454-84-8	284.520	cry (ace)	61.7	345; 166 <sup>0,3</sup>		1.4328 <sup>75</sup>	s eth, ace
8222	2-Nonadecanone		C <sub>19</sub> H <sub>38</sub> O	629-66-3	282.504	pr (al)	57	266 <sup>110</sup> , 165 <sup>2</sup>	0.8108 <sup>86</sup>		i H <sub>2</sub> O; sl EtOH; s ace, bz; vs eth, ctc
8223	10-Nonadecanone		C <sub>19</sub> H <sub>38</sub> O	504-57-4	282.504	lf(al)	65.5	>350; 156 <sup>1,1</sup>			i H <sub>2</sub> O; sl EtOH; s eth, ace, lig; vs bz
8224	1-Nonadecene		C <sub>19</sub> H <sub>38</sub>	18435-45-5	266.505		23.4	329.0	0.7886 <sup>25</sup>	1.4445 <sup>25</sup>	
8225	Nonadecylbenzene		C <sub>25</sub> H <sub>44</sub>	29136-19-4	344.617		40	419	0.8545 <sup>20</sup>	1.4807 <sup>20</sup>	
8226	<i>trans,trans</i> -2,4-Nonadienal		C <sub>9</sub> H <sub>14</sub> O	5910-87-2	138.206			98 <sup>10</sup>	0.862 <sup>25</sup>	1.5207 <sup>20</sup>	
8227	1,8-Nonadiene		C <sub>9</sub> H <sub>16</sub>	4900-30-5	124.223			142.5	0.7511 <sup>20</sup>	1.4302 <sup>20</sup>	
8228	2,6-Nonadien-1-ol		C <sub>9</sub> H <sub>16</sub> O	7786-44-9	140.222			108 <sup>24</sup> , 98 <sup>11</sup>	0.8604 <sup>25</sup>	1.4598 <sup>25</sup>	
8229	1,8-Nonadiyne		C <sub>9</sub> H <sub>12</sub>	2396-65-8	120.191	liq	-27.3	162	0.8158 <sup>20</sup>	1.4490 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace
8230	Nonanal	Nonaldehyde	C <sub>9</sub> H <sub>18</sub> O	124-19-6	142.238		-19.3	191	0.8264 <sup>22</sup>	1.4273 <sup>20</sup>	s eth, chl
8231	Nonane		C <sub>9</sub> H <sub>20</sub>	111-84-2	128.255	liq	-53.46	150.82	0.7192 <sup>20</sup>	1.4058 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc ace, bz, hp
8232	Nonanedioic acid	Azelaic acid	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	123-99-9	188.221	lf or nd	106.5	357.1; 287 <sup>100</sup>	1.225 <sup>25</sup>	1.4303 <sup>111</sup>	sl H <sub>2</sub> O, eth, bz, DMSO; s EtOH
8233	1,9-Nonanediol		C <sub>9</sub> H <sub>20</sub> O <sub>2</sub>	3937-56-2	160.254	cry (bz)	45.8	173 <sup>20</sup> , 150 <sup>3</sup>			sl H <sub>2</sub> O; vs EtOH, eth; s bz; i lig
8234	Nonanedioyl dichloride		C <sub>9</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>2</sub>	123-98-8	225.112			166 <sup>18</sup>	1.143	1.4680 <sup>20</sup>	s eth; vs bz
8235	Nonanenitrile		C <sub>9</sub> H <sub>17</sub> N	2243-27-8	139.238	liq	-34.2	224.4	0.8178 <sup>20</sup>	1.4255 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
8236	1-Nonanethiol	Nonyl mercaptan	C <sub>9</sub> H <sub>20</sub> S	1455-21-6	160.320	liq	-20.1	220	0.842 <sup>25</sup>	1.4548 <sup>20</sup>	
8237	Nonanoic acid	Pelargonic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	112-05-0	158.238		12.4	254.5	0.9052 <sup>20</sup>	1.4343 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
8238	1-Nonanol	Nonyl alcohol	C <sub>9</sub> H <sub>20</sub> O	143-08-8	144.254	liq	-5	213.37	0.8280 <sup>20</sup>	1.4333 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
8239	2-Nonanol, (±)		C <sub>9</sub> H <sub>20</sub> O	74683-66-2	144.254	liq	-35	193.5	0.8471 <sup>20</sup>	1.4353 <sup>20</sup>	i H <sub>2</sub> O; vs eth, EtOH
8240	3-Nonanol, (±)		C <sub>9</sub> H <sub>20</sub> O	74742-08-8	144.254		22	195; 93 <sup>18</sup>	0.8250 <sup>20</sup>	1.4289 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8241	4-Nonanol		C <sub>9</sub> H <sub>20</sub> O	52708-03-9	144.254			192.5; 94 <sup>18</sup>	0.8282 <sup>20</sup>	1.4197 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8242	5-Nonanol	Dibutylcarbinol	C <sub>9</sub> H <sub>20</sub> O	623-93-8	144.254		5.6	193; 97 <sup>20</sup>	0.8220 <sup>20</sup>	1.4289 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
8243	2-Nonanone	Heptyl methyl ketone	C <sub>9</sub> H <sub>18</sub> O	821-55-6	142.238	liq	-7.5	195.3	0.8208 <sup>20</sup>	1.4210 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; vs ace, chl
8244	3-Nonanone	Ethyl hexyl ketone	C <sub>9</sub> H <sub>18</sub> O	925-78-0	142.238	liq	-8	190; 86 <sup>20</sup>	0.8241 <sup>20</sup>	1.4208 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl; vs ace
8245	4-Nonanone	Pentyl propyl ketone	C <sub>9</sub> H <sub>18</sub> O	4485-09-0	142.238			187.5	0.8190 <sup>25</sup>	1.4189 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; vs ace
8246	5-Nonanone	Dibutyl ketone	C <sub>9</sub> H <sub>18</sub> O	502-56-7	142.238	liq	-3.8	188.45	0.8217 <sup>20</sup>	1.4195 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth, chl
8247	Nonanoyl chloride		C <sub>9</sub> H <sub>17</sub> ClO	764-85-2	176.683	liq	-60.5	215.3	0.9463 <sup>15</sup>		s eth, ace
8248	<i>trans</i> -2-Nonenal		C <sub>9</sub> H <sub>16</sub> O	18829-56-6	140.222	liq		101 <sup>16</sup> , 89 <sup>12</sup>	0.846	1.4531 <sup>20</sup>	
8249	1-Nonene		C <sub>9</sub> H <sub>18</sub>	124-11-8	126.239	liq	-81.3	146.9	0.7253 <sup>25</sup>	1.4257 <sup>20</sup>	
8250	2-Nonenoic acid		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	3760-11-0	156.222			173 <sup>20</sup> , 136 <sup>5</sup>			
8251	3-Nonenoic acid		C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	4124-88-3	156.222		-4.4	156 <sup>16</sup> , 106 <sup>1</sup>	0.9254 <sup>20</sup>	1.4454 <sup>25</sup>	
8252	1-Nonen-3-ol	1-Vinylheptanol	C <sub>9</sub> H <sub>18</sub> O	21964-44-3	142.238			193.5	0.824 <sup>21</sup>	1.4382 <sup>15</sup>	
8253	Nonyl acetate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	143-13-5	186.292	liq	-26	210	0.8785 <sup>15</sup>	1.426 <sup>20</sup>	
8254	Nonylamine	1-Nonanamine	C <sub>9</sub> H <sub>21</sub> N	112-20-9	143.270	liq	-1	202.2	0.7886 <sup>20</sup>	1.4336 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth
8255	Nonylbenzene		C <sub>15</sub> H <sub>24</sub>	1081-77-2	204.352	liq	-24	280.5	0.8584 <sup>20</sup>	1.4816 <sup>20</sup>	
8256	Nonylcyclohexane		C <sub>15</sub> H <sub>30</sub>	2883-02-5	210.399	liq	-10	282	0.8163 <sup>20</sup>	1.4519 <sup>20</sup>	
8257	Nonylcyclopentane		C <sub>14</sub> H <sub>28</sub>	2882-98-6	196.372	liq	-29	262	0.8081 <sup>20</sup>	1.4467 <sup>20</sup>	vs ace, bz, eth, EtOH
8258	Nonyl formate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	5451-92-3	172.265	liq	-33	214	0.86	1.4216 <sup>20</sup>	
8259	1-Nonylnaphthalene		C <sub>19</sub> H <sub>26</sub>	26438-26-6	254.409		8	366	0.9371 <sup>20</sup>	1.5477 <sup>20</sup>	
8260	4-Nonylphenol		C <sub>15</sub> H <sub>24</sub> O	104-40-5	220.351	visc ye liq	42	≈295; 180 <sup>10</sup>	0.950 <sup>20</sup>	1.513 <sup>20</sup>	i H <sub>2</sub> O; s bz, ctc, hp
8261	1-Nonyne	Heptylacetylene	C <sub>9</sub> H <sub>16</sub>	3452-09-3	124.223	liq	-50	150.8	0.7658 <sup>20</sup>	1.4217 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, ctc

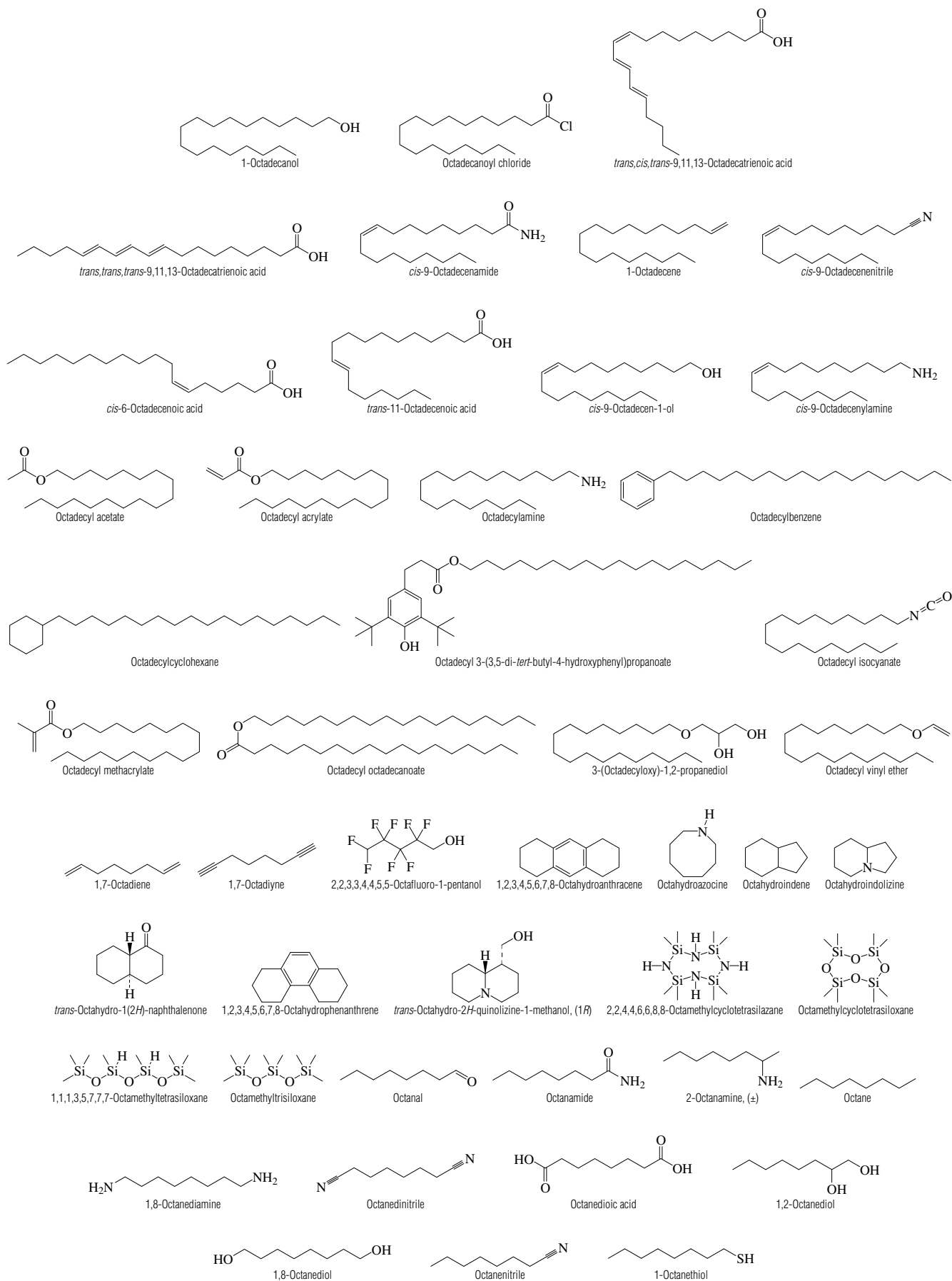




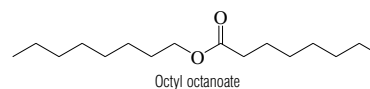
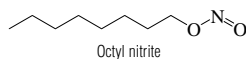
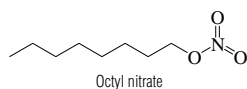
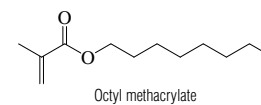
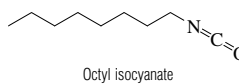
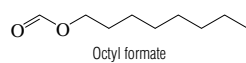
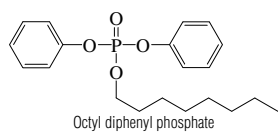
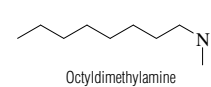
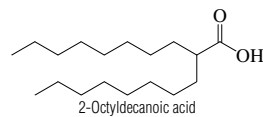
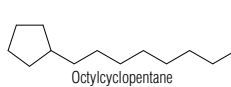
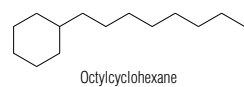
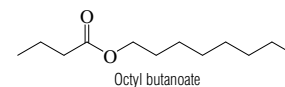
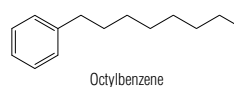
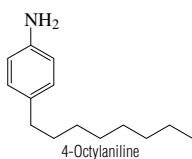
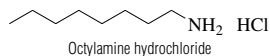
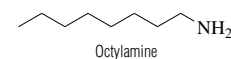
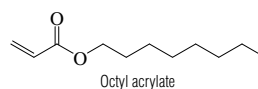
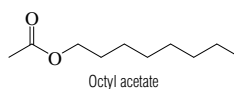
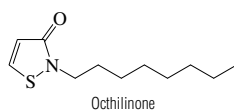
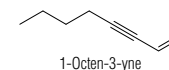
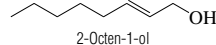
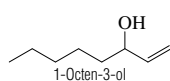
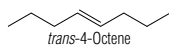
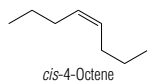
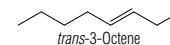
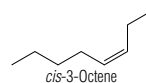
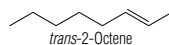
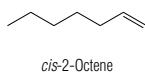
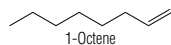
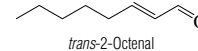
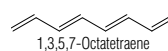
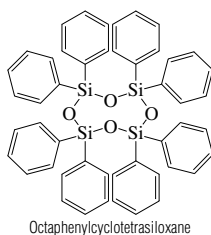
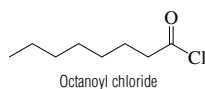
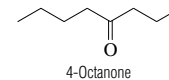
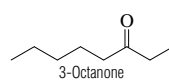
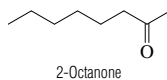
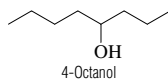
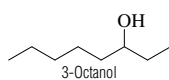
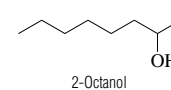
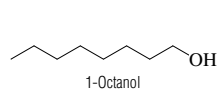
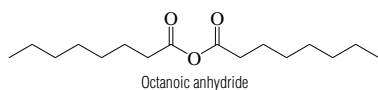
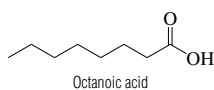
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8262	Norbormide		C <sub>33</sub> H <sub>29</sub> N <sub>3</sub> O <sub>3</sub>	991-42-4	511.570	cry (eth)	194				
8263	2,5-Norbornadiene	Bicyclo[2.2.1]hepta-2,5-diene	C <sub>7</sub> H <sub>8</sub>	121-46-0	92.139	liq	-19.1	89.5	0.9064 <sup>20</sup>	1.4702 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; msc tol
8264	5-Norbornene-2,3-dicarboxylic acid anhydride		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	826-62-0	164.158		166				
8265	5-Norbornene-2-methylolacrylate		C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	95-39-6	178.228	col liq		104	1.029 <sup>25</sup>		s os
8266	24-Norcholan-23-oic acid, (5β)	Norcholan acid	C <sub>23</sub> H <sub>38</sub> O <sub>2</sub>	511-18-2	346.547	nd(HOAc)	177				
8267	Nordazepam	7-Chloro-1,3-dihydro-5-phenyl-2H-1,4-benzodiazepin-2-one	C <sub>15</sub> H <sub>11</sub> ClN <sub>2</sub> O	1088-11-5	270.713		216.5				
8268	Nordihydroguaiaretic acid		C <sub>18</sub> H <sub>22</sub> O <sub>4</sub>	500-38-9	302.366	nd(w, al, HOAc)	185.5				sl H <sub>2</sub> O; s EtOH, eth, ace, alk; i bz
8269	Norea		C <sub>13</sub> H <sub>22</sub> N <sub>2</sub> O	18530-56-8	222.326		177				
8270	Norepinephrine	Noradrenaline	C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	51-41-2	169.178		217 dec				sl H <sub>2</sub> O, EtOH, eth; vs alk, dil HCl
8271	Norethisterone	19-Norpregn-4-en-20-yn-3-one, 17-hydroxy-, (17 α)-	C <sub>20</sub> H <sub>26</sub> O <sub>2</sub>	68-22-4	298.419	cry	204				
8272	Norethynodrel		C <sub>20</sub> H <sub>26</sub> O <sub>2</sub>	68-23-5	298.419	cry (MeOH)	170				
8273	Norflurazon		C <sub>12</sub> H <sub>9</sub> ClF <sub>3</sub> N <sub>3</sub> O	27314-13-2	303.666		184				
8274	Norhysocyamine		C <sub>16</sub> H <sub>21</sub> NO <sub>3</sub>	537-29-1	275.343	nd	140.5				vs EtOH, chl
8275	DL-Norleucine	2-Aminohexanoic acid, (DL)	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	616-06-8	131.173	lf(w)	327 dec		1.172 <sup>25</sup>		s H <sub>2</sub> O; sl EtOH; i eth
8276	L-Norleucine	2-Aminohexanoic acid, (L)	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	327-57-1	131.173		301 dec				sl H <sub>2</sub> O
8277	Normorphine		C <sub>16</sub> H <sub>17</sub> NO <sub>3</sub>	466-97-7	271.311		273				
8278	Norplant	Norgestrel, (-)	C <sub>21</sub> H <sub>28</sub> O <sub>2</sub>	797-63-7	312.446	cry (MeOH)	206				
8279	19-Nortestosterone phenylpropionate	Nandrolone phenpropionate	C <sub>27</sub> H <sub>34</sub> O <sub>3</sub>	62-90-8	406.557	cry	95				
8280	Nortriptyline hydrochloride		C <sub>19</sub> H <sub>22</sub> ClN	894-71-3	299.838	cry (eth)	214				s H <sub>2</sub> O, EtOH; i bz, eth, ace
8281	DL-Norvaline	2-Aminopentanoic acid, (±)	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	760-78-1	117.147	lf(al, w)	303	sub			s H <sub>2</sub> O; i EtOH, eth, chl, AcOEt, lig
8282	L-Norvaline	2-Aminopentanoic acid, (S)	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	6600-40-4	117.147	cry (dil al)	307				s H <sub>2</sub> O
8283	Noscapine		C <sub>22</sub> H <sub>23</sub> NO <sub>7</sub>	128-62-1	413.421	pr or nd (al)	176				i H <sub>2</sub> O; s EtOH, bz, chl; sl eth; vs ace
8284	Novobiocin	Streptonivicin	C <sub>31</sub> H <sub>38</sub> N <sub>2</sub> O <sub>11</sub>	303-81-1	612.624	wh-ye orth cry	154		1.3448		i H <sub>2</sub> O; s EtOH, EtOAc, ace, py
8285	Nuarimol		C <sub>17</sub> H <sub>12</sub> ClFN <sub>2</sub> O	63284-71-9	314.740		126				
8286	Nylidrin	Buphenine	C <sub>19</sub> H <sub>25</sub> NO <sub>2</sub>	447-41-6	299.408	cry (MeOH)	111				
8287	Ochratoxin A		C <sub>20</sub> H <sub>16</sub> ClNO <sub>6</sub>	303-47-9	403.813	cry (xyl)	169				
8288	Ochratoxin B		C <sub>20</sub> H <sub>15</sub> NO <sub>6</sub>	4825-86-9	369.368	cry (MeOH)	221				
8289	Ochratoxin C		C <sub>22</sub> H <sub>22</sub> ClNO <sub>6</sub>	4865-85-4	431.866	amorp solid					
8290	Octacaine	3-(Diethylamino)-N-phenylbutanamide	C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O	13912-77-1	234.337	cry	47	200 <sup>1</sup>			vs EtOH, bz, eth
8291	2,2',3,3',5,5',6,6'-Octachlorobiphenyl		C <sub>12</sub> H <sub>2</sub> Cl <sub>8</sub>	2136-99-4	429.768	cry	161				i H <sub>2</sub> O
8292	Octachlorocyclopentene	Perchlorocyclopentene	C <sub>5</sub> Cl <sub>8</sub>	706-78-5	343.678	nd	40	283	1.8200 <sup>50</sup>	1.5660 <sup>50</sup>	i H <sub>2</sub> O; vs EtOH
8293	Octachlorodibenzo-p-dioxin		C <sub>12</sub> Cl <sub>8</sub> O <sub>2</sub>	3268-87-9	459.751	nd	331				
8294	Octachloronaphthalene	Perchloronaphthalene	C <sub>10</sub> Cl <sub>8</sub>	2234-13-1	403.731	nd (bz-CCl <sub>4</sub> )	197.5	441 <sup>7</sup> , 248 <sup>05</sup>			sl EtOH; vs bz, chl, lig
8295	Octachlorostyrene	Perchlorostyrene	C <sub>8</sub> Cl <sub>8</sub>	29082-74-4	379.710	cry (ace/ EtOH)	99				
8296	Octacotane		C <sub>80</sub> H <sub>162</sub>	7667-88-1	1124.142		112	672			
8297	Octacosane		C <sub>28</sub> H <sub>58</sub>	630-02-4	394.761	mcl or orth (bz-al)	61.1	431.6	0.8067 <sup>20</sup>	1.4330 <sup>70</sup>	i H <sub>2</sub> O; msc ace; s bz, chl
8298	Octacosanoic acid	Montanic acid	C <sub>28</sub> H <sub>56</sub> O <sub>2</sub>	506-48-9	424.744		90.9		0.8191 <sup>100</sup>	1.4313 <sup>100</sup>	vs bz, chl
8299	1-Octacosanol	Montanyl alcohol	C <sub>28</sub> H <sub>58</sub> O	557-61-9	410.760	cry (ace, peth)	83.4	200 <sup>1</sup>			i H <sub>2</sub> O; s CS <sub>2</sub>
8300	trans, trans-9,12-Octadecadienoic acid	Linolelaic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	506-21-8	280.446	cry (MeOH)	28.5	181 <sup>08</sup>			sl H <sub>2</sub> O; s ace, hx
8301	Octadecahydrochrysene		C <sub>18</sub> H <sub>30</sub>	2090-14-4	246.431		115	353			vs EtOH
8302	Octadecamethyloctasiloxane		C <sub>18</sub> H <sub>54</sub> O <sub>8</sub> Si <sub>8</sub>	556-69-4	607.302		-63	186 <sup>20</sup> , 153 <sup>5</sup>	0.913 <sup>25</sup>	1.3970 <sup>20</sup>	vs bz, peth, lig
8303	Octadecanamide		C <sub>18</sub> H <sub>37</sub> NO	124-26-5	283.493	lf (al)	109	250 <sup>12</sup>			vs eth, chl
8304	Octadecane		C <sub>18</sub> H <sub>38</sub>	593-45-3	254.495	nd (al, eth-MeOH)	28.2	316.3	0.7768 <sup>28</sup>	1.4390 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace, chl, lig
8305	Octadecanenitrile		C <sub>18</sub> H <sub>35</sub> N	638-65-3	265.478		41	362	0.8325 <sup>20</sup>	1.4389 <sup>45</sup>	i H <sub>2</sub> O; s EtOH; vs eth, ace, chl
8306	1-Octadecanethiol	Stearyl mercaptan	C <sub>18</sub> H <sub>36</sub> S	2885-00-9	286.560		30	207 <sup>11</sup>	0.8475 <sup>20</sup>	1.4645 <sup>20</sup>	vs eth



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8307	1-Octadecanol	Stearyl alcohol	C <sub>18</sub> H <sub>38</sub> O	112-92-5	270.494	lf (al)	57.9	335; 210.5 <sup>15</sup>	0.8124 <sup>59</sup>		i H <sub>2</sub> O; s EtOH, eth; sl ace, bz
8308	Octadecanoyl chloride		C <sub>18</sub> H <sub>35</sub> ClO	112-76-5	302.923		23	215 <sup>15</sup>	0.8969 <sup>9</sup>	1.4523 <sup>24</sup>	sl EtOH
8309	<i>cis,trans,trans</i> -9,11,13-Octadecatrienoic acid	α-Eleostearic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	506-23-0	278.430	nd (al)	49	235 <sup>12</sup> dec, 170 <sup>1</sup>	0.9028 <sup>50</sup>	1.5112 <sup>50</sup>	vs eth, EtOH
8310	<i>trans,trans,trans</i> -9,11,13-Octadecatrienoic acid	<i>trans</i> -Eleostearic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	544-73-0	278.430	lf (al)	71.5	188 <sup>1</sup>	0.8839 <sup>90</sup>	1.5000 <sup>80</sup>	vs EtOH
8311	<i>cis</i> -9-Octadecenamide		C <sub>18</sub> H <sub>35</sub> NO	301-02-0	281.477		76				vs eth
8312	1-Octadecene		C <sub>18</sub> H <sub>36</sub>	112-88-9	252.479		17.5	179 <sup>15</sup> , 145 <sup>9</sup>	0.7891 <sup>20</sup>	1.4448 <sup>20</sup>	i H <sub>2</sub> O; s ace, ctc
8313	<i>cis</i> -9-Octadecenitrile		C <sub>18</sub> H <sub>33</sub> N	112-91-4	263.462		-1	dec 332	0.847 <sup>17</sup>	1.4566 <sup>20</sup>	vs EtOH
8314	<i>cis</i> -6-Octadecenoic acid	Petroselinic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	593-39-5	282.462	lf	29.8	238 <sup>18</sup>	0.8700 <sup>40</sup>	1.4533 <sup>40</sup>	s eth; sl hp, MeOH
8315	<i>trans</i> -11-Octadecenoic acid	Vaccenic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	693-72-1	282.462		44			1.4499 <sup>90</sup>	s ace
8316	<i>cis</i> -9-Octadecen-1-ol	Oleyl alcohol	C <sub>18</sub> H <sub>36</sub> O	143-28-2	268.478		6.5	207 <sup>15</sup>	0.8489 <sup>20</sup>	1.4606 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
8317	<i>cis</i> -9-Octadecenylamine	Oleylamine	C <sub>18</sub> H <sub>37</sub> N	112-90-3	267.494	oil	25	147 <sup>2</sup>			
8318	Octadecyl acetate		C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	822-23-1	312.531		34.5	208 <sup>9</sup>	0.8510 <sup>90</sup>		vs EtOH
8319	Octadecyl acrylate	Stearyl 2-propenoate	C <sub>21</sub> H <sub>40</sub> O <sub>2</sub>	4813-57-4	324.542						s ctc, CS <sub>2</sub>
8320	Octadecylamine	1-Octadecanamine	C <sub>18</sub> H <sub>39</sub> N	124-30-1	269.510	cry (w)	52.9	346.8	0.8618 <sup>20</sup>	1.4522 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl ace
8321	Octadecylbenzene		C <sub>24</sub> H <sub>42</sub>	4445-07-2	330.590		36	400	0.85 <sup>36</sup>	1.479 <sup>36</sup>	
8322	Octadecylcyclohexane		C <sub>24</sub> H <sub>48</sub>	4445-06-1	336.638		41.6	409; 175 <sup>1</sup>	0.8300 <sup>20</sup>	1.4610 <sup>20</sup>	
8323	Octadecyl 3-(3,5-di- <i>tert</i> -butyl-4-hydroxyphenyl)propanoate	Irganox 1076	C <sub>35</sub> H <sub>62</sub> O <sub>3</sub>	2082-79-3	530.865	cry (MeOH/AcOEt)	50				
8324	Octadecyl isocyanate	1-Isocyanatooctadecane	C <sub>19</sub> H <sub>37</sub> NO	112-96-9	295.503		15.5	172 <sup>5</sup>			
8325	Octadecyl methacrylate	Stearyl methacrylate	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	32360-05-7	338.567			195 <sup>6</sup>	0.880 <sup>25</sup>	1.429 <sup>25</sup>	
8326	Octadecyl octadecanoate	Octadecyl stearate	C <sub>36</sub> H <sub>72</sub> O <sub>2</sub>	2778-96-3	536.956	cry (EtOH)	60				
8327	3-(Octadecyloxy)-1,2-propanediol	Batyl alcohol	C <sub>21</sub> H <sub>44</sub> O <sub>3</sub>	544-62-7	344.572		70.5	217 <sup>2</sup>			vs eth
8328	Octadecyl vinyl ether	1-(Ethenyloxy)octadecane	C <sub>20</sub> H <sub>40</sub> O	930-02-9	296.531		30	182 <sup>3</sup>	0.8138 <sup>40</sup>		sl chl
8329	1,7-Octadiene		C <sub>8</sub> H <sub>14</sub>	3710-30-3	110.197			115.5	0.734 <sup>20</sup>	1.4245 <sup>20</sup>	
8330	1,7-Octadiyne		C <sub>8</sub> H <sub>10</sub>	871-84-1	106.165			135.5; 59 <sup>35</sup>	0.8169 <sup>21</sup>	1.4521 <sup>18</sup>	s eth
8331	2,2,3,3,4,4,5,5-Octafluoro-1-pentanol		C <sub>5</sub> H <sub>4</sub> F <sub>8</sub> O	355-80-6	232.072			140.5	1.6647 <sup>20</sup>	1.3178 <sup>20</sup>	
8332	1,2,3,4,5,6,7,8-Octahydroanthracene		C <sub>14</sub> H <sub>18</sub>	1079-71-6	186.293	pl (al)	78	294	0.9703 <sup>90</sup>	1.5372 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, HOAc; vs bz; sl ctc
8333	Octahydroazocine		C <sub>7</sub> H <sub>15</sub> N	1121-92-2	113.201		29	52 <sup>15</sup>	0.896 <sup>25</sup>	1.4720 <sup>20</sup>	
8334	Octahydroindene		C <sub>9</sub> H <sub>16</sub>	496-10-6	124.223	liq	-53	167	0.876 <sup>25</sup>	1.4702 <sup>20</sup>	
8335	Octahydroindolizine		C <sub>8</sub> H <sub>15</sub> N	13618-93-4	125.212			75 <sup>43</sup>	0.9074 <sup>10</sup>	1.4748	vs eth, EtOH
8336	<i>trans</i> -Octahydro-1(2 <i>H</i> )-naphthalenone		C <sub>10</sub> H <sub>16</sub> O	21370-71-8	152.233		33	122 <sup>20</sup>	0.986 <sup>20</sup>	1.4849 <sup>21</sup>	
8337	1,2,3,4,5,6,7,8-Octahydrophenanthrene		C <sub>14</sub> H <sub>18</sub>	5325-97-3	186.293		16.7	295	1.026 <sup>20</sup>	1.5569 <sup>17</sup>	i H <sub>2</sub> O; s ace, bz, CS <sub>2</sub> , HOAc
8338	<i>trans</i> -Octahydro-2 <i>H</i> -quinolizine-1-methanol, (1 <i>H</i> )	Lupinine	C <sub>10</sub> H <sub>19</sub> NO	486-70-4	169.264	orth (peth)	70	270			s H <sub>2</sub> O, EtOH, eth, bz, chl; sl peth
8339	2,2,4,4,6,6,8,8-Octamethylcyclotetrasilazane		C <sub>8</sub> H <sub>28</sub> N <sub>4</sub> Si <sub>4</sub>	1020-84-4	292.677		97				
8340	Octamethylcyclotetrasiloxane		C <sub>8</sub> H <sub>24</sub> O <sub>4</sub> Si <sub>4</sub>	556-67-2	296.617		17.5	175.8	0.9561 <sup>20</sup>	1.3968 <sup>20</sup>	i H <sub>2</sub> O; s ctc
8341	1,1,1,3,5,7,7,7-Octamethyltetrasiloxane		C <sub>8</sub> H <sub>26</sub> O <sub>5</sub> Si <sub>4</sub>	16066-09-4	282.632			170	0.8559 <sup>20</sup>	1.3854 <sup>20</sup>	
8342	Octamethyltrisiloxane		C <sub>8</sub> H <sub>24</sub> O <sub>2</sub> Si <sub>3</sub>	107-51-7	236.533	liq	-80	153; 51 <sup>17</sup>	0.8200 <sup>20</sup>	1.3840 <sup>20</sup>	sl EtOH; s bz, peth
8343	Octanal	Caprylic aldehyde	C <sub>8</sub> H <sub>16</sub> O	124-13-0	128.212			171	0.8211 <sup>20</sup>	1.4217 <sup>20</sup>	vs ace, bz, eth, EtOH
8344	Octanamide		C <sub>8</sub> H <sub>17</sub> NO	629-01-6	143.227	lf, pl	108	239	0.8450 <sup>110</sup>		sl H <sub>2</sub> O, bz, chl; vs EtOH; s eth, ace
8345	2-Octanamine, (±)		C <sub>8</sub> H <sub>19</sub> N	44855-57-4	129.244		97	164	0.7744 <sup>20</sup>	1.4232 <sup>25</sup>	vs eth, EtOH
8346	Octane		C <sub>8</sub> H <sub>18</sub>	111-65-9	114.229	liq	-56.82	125.67	0.6986 <sup>25</sup>	1.3944 <sup>25</sup>	i H <sub>2</sub> O; s eth; msc EtOH, ace, bz
8347	1,8-Octanediamine		C <sub>8</sub> H <sub>20</sub> N <sub>2</sub>	373-44-4	144.258	pl	51.64	225.6			vs H <sub>2</sub> O, eth, EtOH
8348	Octanedinitrile	Suberonitrile	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	629-40-3	136.194		-1.8	185 <sup>15</sup>	0.954 <sup>25</sup>	1.4436 <sup>20</sup>	
8349	Octanedioic acid	Suberic acid	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	505-48-6	174.195	lo nd or pl (w)	144	345.5; 219 <sup>20</sup>			i H <sub>2</sub> O; msc eth, bz; sl DMSO
8350	1,2-Octanediol		C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	1117-86-8	146.228		30	131 <sup>10</sup> , 104 <sup>9,2</sup>			
8351	1,8-Octanediol		C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	629-41-4	146.228	nd (bz-liq), pr	63	172 <sup>20</sup>			sl H <sub>2</sub> O, eth, chl, lig; vs EtOH; s bz
8352	Octanenitrile	Caprylnitrile	C <sub>8</sub> H <sub>15</sub> N	124-12-9	125.212	liq	-45.6	205.25	0.8136 <sup>20</sup>	1.4203 <sup>20</sup>	vs eth
8353	1-Octanethiol	Octyl mercaptan	C <sub>8</sub> H <sub>18</sub> S	111-88-6	146.294	liq	-49.2	199.1	0.8433 <sup>20</sup>	1.4540 <sup>20</sup>	s EtOH; sl ctc

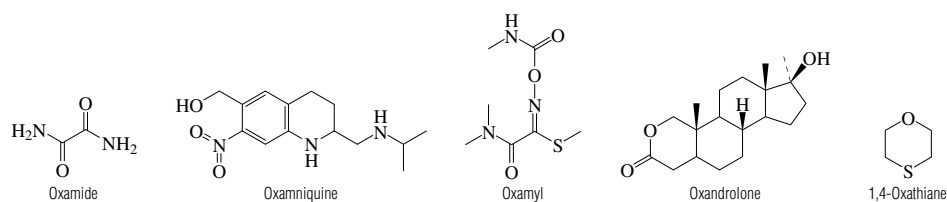
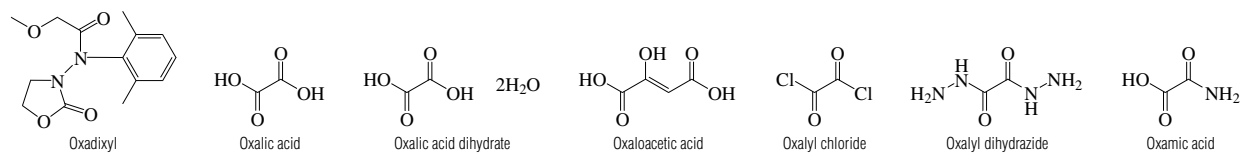
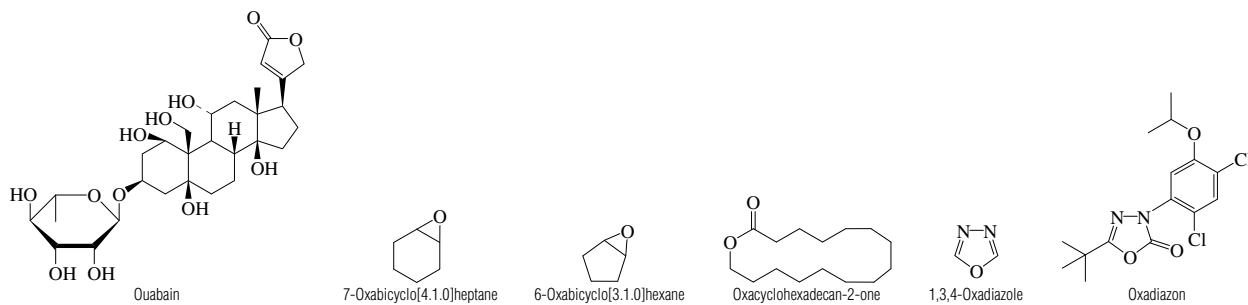
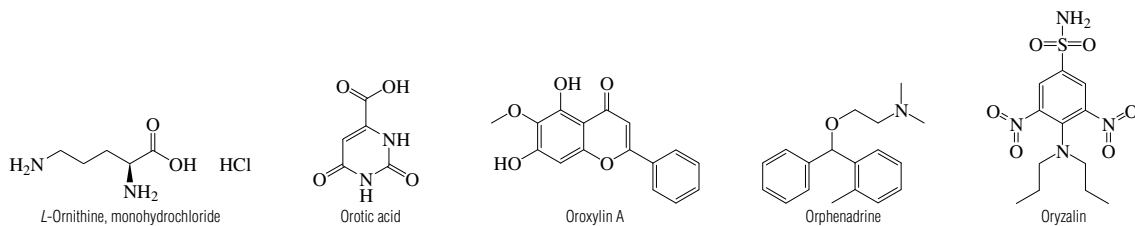
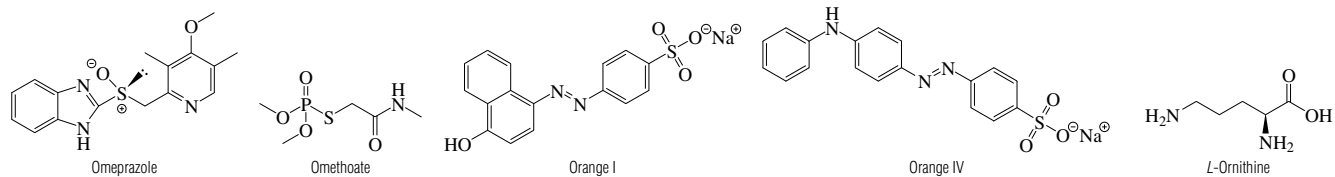
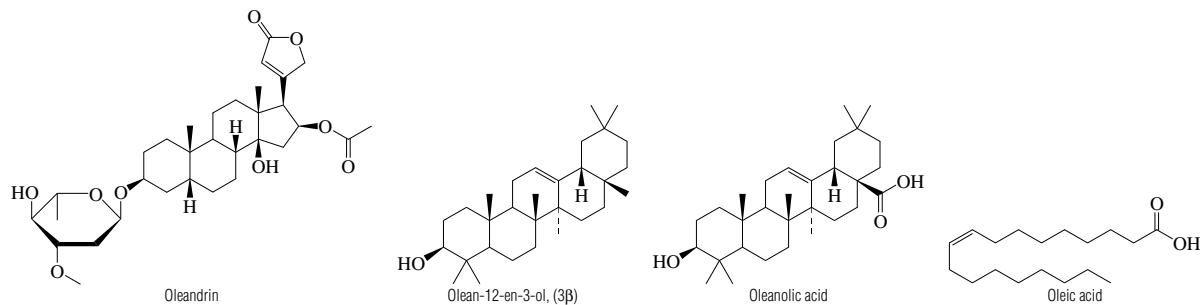
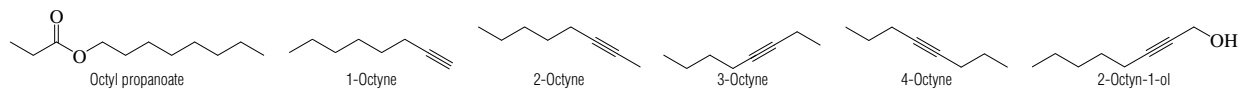
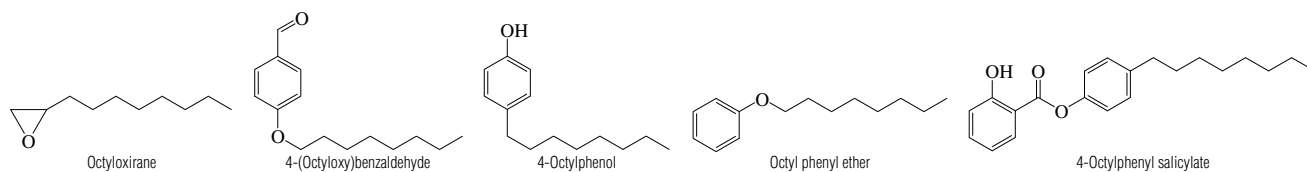


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8354	Octanoic acid	Caprylic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	124-07-2	144.212		16.5	239	0.9073 <sup>25</sup>	1.4285 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, chl, CH <sub>2</sub> CN
8355	Octanoic anhydride		C <sub>16</sub> H <sub>30</sub> O <sub>3</sub>	623-66-5	270.407	liq	-1	282.5	0.9065 <sup>18</sup>	1.4358 <sup>18</sup>	vs ace, eth, EtOH
8356	1-Octanol	Capryl alcohol	C <sub>8</sub> H <sub>18</sub> O	111-87-5	130.228	liq	-14.8	195.16	0.8262 <sup>25</sup>	1.4295 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
8357	2-Octanol	(±)- <i>sec</i> -Caprylic alcohol	C <sub>8</sub> H <sub>18</sub> O	4128-31-8	130.228	liq	-31.6	179.3	0.8193 <sup>20</sup>	1.4203 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
8358	3-Octanol		C <sub>8</sub> H <sub>18</sub> O	589-98-0	130.228	liq	-45	171	0.8258 <sup>20</sup>		
8359	4-Octanol		C <sub>8</sub> H <sub>18</sub> O	74778-22-6	130.228	liq	-40.7	176.3	0.8186 <sup>20</sup>	1.4248 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH
8360	2-Octanone	Hexyl methyl ketone	C <sub>8</sub> H <sub>16</sub> O	111-13-7	128.212	liq	-16	172.5	0.820 <sup>20</sup>	1.4151 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8361	3-Octanone	Ethyl pentyl ketone	C <sub>8</sub> H <sub>16</sub> O	106-68-3	128.212			167.5	0.822 <sup>25</sup>	1.4150 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
8362	4-Octanone	Butyl propyl ketone	C <sub>8</sub> H <sub>16</sub> O	589-63-9	128.212			163	0.8146 <sup>25</sup>	1.4173 <sup>14</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ctc
8363	Octanoyl chloride		C <sub>8</sub> H <sub>15</sub> ClO	111-64-8	162.657	liq	-63	195.6	0.9535 <sup>15</sup>	1.4335 <sup>20</sup>	s eth
8364	Octaphenylcyclotetrasiloxane		C <sub>48</sub> H <sub>40</sub> O <sub>4</sub> Si <sub>4</sub>	546-56-5	793.172	nd (bz-al, HOAc)	200.5	330 <sup>1</sup>			i H <sub>2</sub> O; sl EtOH; s bz, chl, HOAc
8365	1,3,5,7-Octatetraene		C <sub>8</sub> H <sub>10</sub>	1482-91-3	106.165	cry (bz)	50	sub			s peth, HOAc
8366	<i>trans</i> -2-Octenal		C <sub>8</sub> H <sub>14</sub> O	2548-87-0	126.196	liq		85 <sup>19</sup>	0.846	1.4500 <sup>20</sup>	
8367	1-Octene	Caprylene	C <sub>8</sub> H <sub>16</sub>	111-66-0	112.213	liq	-101.7	121.29	0.7149 <sup>20</sup>	1.4087 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; s eth, ace; sl ctc
8368	<i>cis</i> -2-Octene		C <sub>8</sub> H <sub>16</sub>	7642-04-8	112.213	liq	-100.2	125.6	0.7243 <sup>20</sup>	1.4150 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
8369	<i>trans</i> -2-Octene		C <sub>8</sub> H <sub>16</sub>	13389-42-9	112.213	liq	-87.7	125	0.7199 <sup>20</sup>	1.4132 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz; vs chl
8370	<i>cis</i> -3-Octene		C <sub>8</sub> H <sub>16</sub>	14850-22-7	112.213	liq	-126	122.9	0.7159 <sup>20</sup>	1.4135 <sup>20</sup>	vs ace, bz, eth, EtOH
8371	<i>trans</i> -3-Octene		C <sub>8</sub> H <sub>16</sub>	14919-01-8	112.213	liq	-110	123.3	0.7152 <sup>20</sup>	1.4126 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, lig, ctc
8372	<i>cis</i> -4-Octene		C <sub>8</sub> H <sub>16</sub>	7642-15-1	112.213	liq	-118.7	122.5	0.7212 <sup>20</sup>	1.4148 <sup>20</sup>	vs ace, bz, eth, EtOH
8373	<i>trans</i> -4-Octene		C <sub>8</sub> H <sub>16</sub>	14850-23-8	112.213	liq	-93.8	122.3	0.7141 <sup>20</sup>	1.4114 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, lig; sl ctc
8374	1-Octen-3-ol		C <sub>8</sub> H <sub>16</sub> O	3391-86-4	128.212			174; 69 <sup>12</sup>	0.8395 <sup>13</sup>	1.4391 <sup>12</sup>	
8375	2-Octen-1-ol		C <sub>8</sub> H <sub>16</sub> O	22104-78-5	128.212			88 <sup>11</sup>	0.850 <sup>20</sup>	1.4470 <sup>20</sup>	
8376	1-Octen-3-yne		C <sub>8</sub> H <sub>12</sub>	17679-92-4	108.181			134; 62 <sup>20</sup>	0.7749 <sup>20</sup>	1.4592 <sup>20</sup>	vs eth
8377	Octhilinone	2-Octyl-3-(2 <i>H</i> )-isothiazolone	C <sub>11</sub> H <sub>15</sub> NOS	26530-20-1	213.340			120 <sup>0,01</sup>			
8378	Octyl acetate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	112-14-1	172.265	liq	-38.5	210	0.8705 <sup>20</sup>	1.4150 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
8379	Octyl acrylate	Octyl 2-propenoate	C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	2499-59-4	184.276			229; 57 <sup>0,05</sup>	0.8810 <sup>20</sup>		
8380	Octylamine	1-Octanamine	C <sub>8</sub> H <sub>19</sub> N	111-86-4	129.244		0	179.6	0.7826 <sup>20</sup>	1.4292 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s ctc
8381	Octylamine hydrochloride	1-Octanamine hydrochloride	C <sub>8</sub> H <sub>20</sub> ClN	142-95-0	165.705		196.5				s H <sub>2</sub> O
8382	4-Octylaniline		C <sub>14</sub> H <sub>23</sub> N	16245-79-7	205.340		20	310; 138 <sup>5</sup>	0.9128 <sup>20</sup>		vs eth
8383	Octylbenzene		C <sub>14</sub> H <sub>22</sub>	2189-60-8	190.325	liq	-36	264	0.8562 <sup>20</sup>	1.4845 <sup>20</sup>	i H <sub>2</sub> O; msc eth, bz
8384	Octyl butanoate		C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	110-39-4	200.318	liq	-55.6	244.1	0.8629 <sup>20</sup>	1.4267 <sup>15</sup>	vs EtOH
8385	Octylcyclohexane		C <sub>14</sub> H <sub>28</sub>	1795-15-9	196.372	liq	-20	264	0.8138 <sup>20</sup>	1.4503 <sup>20</sup>	
8386	Octylcyclopentane		C <sub>13</sub> H <sub>26</sub>	1795-20-6	182.345	liq	-44	243	0.8048 <sup>20</sup>	1.4446 <sup>20</sup>	
8387	2-Octyldecanoic acid		C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	619-39-6	284.478	nd or lf (al)	38.5	215 <sup>13</sup>	0.8447 <sup>20</sup>		vs eth, EtOH
8388	Octyldimethylamine	<i>N,N</i> -Dimethyl-1-octanamine	C <sub>10</sub> H <sub>23</sub> N	7378-99-6	157.297			194			
8389	Octyl diphenyl phosphate		C <sub>20</sub> H <sub>27</sub> O <sub>4</sub> P	115-88-8	362.399				1.09 <sup>25</sup>		
8390	Octyl formate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	112-32-3	158.238	liq	-39.1	198.8	0.8744 <sup>20</sup>	1.4208 <sup>15</sup>	i H <sub>2</sub> O; s EtOH; msc eth; sl ctc
8391	Octyl isocyanate		C <sub>9</sub> H <sub>17</sub> NO	3158-26-7	155.237			78 <sup>6</sup>			
8392	Octyl methacrylate		C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	2157-01-9	198.302			239.5			
8393	Octyl nitrate		C <sub>8</sub> H <sub>17</sub> NO <sub>3</sub>	629-39-0	175.226			110 <sup>20</sup>	0.975 <sup>0</sup>		sl H <sub>2</sub> O; s EtOH, eth
8394	Octyl nitrite		C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	629-46-9	159.227			174.5	0.862 <sup>17</sup>	1.4127 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
8395	Octyl octanoate		C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	2306-88-9	256.424	liq	-18.1	306.8	0.8554 <sup>20</sup>	1.4352 <sup>20</sup>	vs ace, eth, EtOH

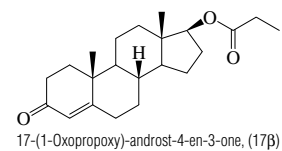
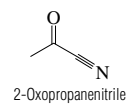
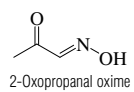
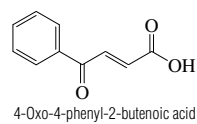
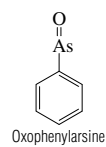
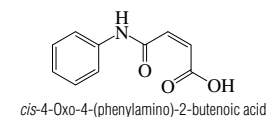
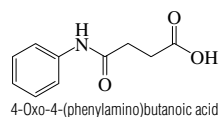
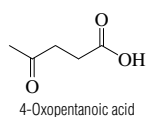
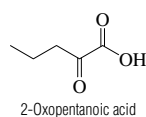
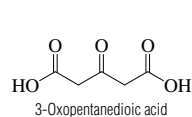
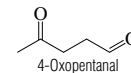
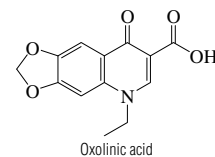
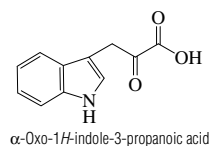
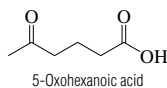
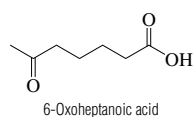
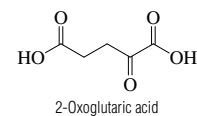
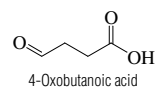
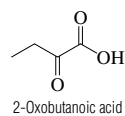
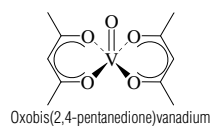
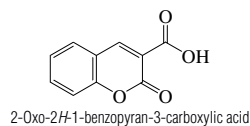
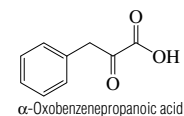
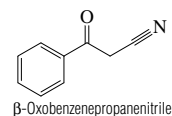
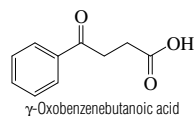
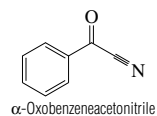
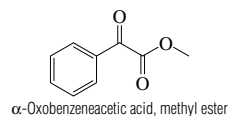
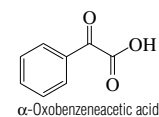
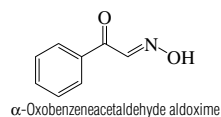
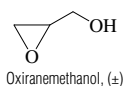
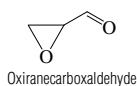
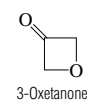
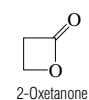
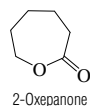
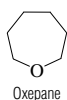
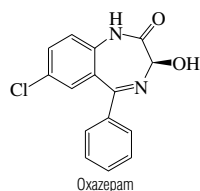


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8396	Octyloxirane		C <sub>10</sub> H <sub>20</sub> O	2404-44-6	156.265	liq		128 <sup>95</sup> , 97 <sup>30</sup>			
8397	4-(Octyloxy)benzaldehyde		C <sub>15</sub> H <sub>22</sub> O <sub>2</sub>	24083-13-4	234.335			131 <sup>0.5</sup>			
8398	4-Octylphenol		C <sub>14</sub> H <sub>22</sub> O	1806-26-4	206.324		43.0	169 <sup>10</sup> , 150 <sup>4</sup>			
8399	Octyl phenyl ether	(Octyloxy)benzene	C <sub>14</sub> H <sub>22</sub> O	1818-07-1	206.324		8	285	0.9131 <sup>15</sup>	1.4875 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8400	4-Octylphenyl salicylate	2-Hydroxybenzoic acid, 4-octylphenyl ester	C <sub>21</sub> H <sub>26</sub> O <sub>3</sub>	2512-56-3	326.429	wh cry	73				
8401	Octyl propanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	142-60-9	186.292	liq	-42.6	228	0.8663 <sup>20</sup>	1.4221 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl ctc
8402	1-Octyne	Hexylacetylene	C <sub>8</sub> H <sub>14</sub>	629-05-0	110.197	liq	-79.3	126.3	0.7461 <sup>20</sup>	1.4159 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8403	2-Octyne	Methylpentylacetylene	C <sub>8</sub> H <sub>14</sub>	2809-67-8	110.197	liq	-61.6	137.6	0.7596 <sup>20</sup>	1.4278 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8404	3-Octyne		C <sub>8</sub> H <sub>14</sub>	15232-76-5	110.197	liq	-103.9	133.1	0.7529 <sup>20</sup>	1.4250 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8405	4-Octyne	Dipropylacetylene	C <sub>8</sub> H <sub>14</sub>	1942-45-6	110.197	liq	-101	131.6	0.7509 <sup>20</sup>	1.4248 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
8406	2-Octyn-1-ol	2-Octynol	C <sub>8</sub> H <sub>14</sub> O	20739-58-6	126.196		-18	98 <sup>15</sup>	0.8805 <sup>20</sup>	1.4556 <sup>20</sup>	vs eth
8407	Oleandrin		C <sub>32</sub> H <sub>48</sub> O <sub>9</sub>	465-16-7	576.718	cry (EtOH)	250 dec				i H <sub>2</sub> O; s EtOH, chl
8408	Olean-12-en-3-ol, (3β)	β-Amyrin	C <sub>30</sub> H <sub>50</sub> O	559-70-6	426.717	nd (lig or al)	197	260 <sup>05</sup>			i H <sub>2</sub> O; sl EtOH, chl, lig; s eth, bz
8409	Oleanolic acid		C <sub>30</sub> H <sub>48</sub> O <sub>3</sub>	508-02-1	456.700	nd or pr (al)	310 dec	sub 280			i H <sub>2</sub> O; sl EtOH, eth, ace; vs py, HOAc
8410	Oleic acid	<i>cis</i> -9-Octadecenoic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	112-80-1	282.462		13.4	360; 286 <sup>100</sup>	0.8935 <sup>20</sup>	1.4582 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl, ctc
8411	Omeprazole		C <sub>17</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub> S	73590-58-6	345.416	cry (MeCN)	156				
8412	Omethoate		C <sub>8</sub> H <sub>12</sub> NO <sub>4</sub> PS	1113-02-6	213.192	oil	≈135 dec		1.32 <sup>20</sup>	1.4987 <sup>20</sup>	msc H <sub>2</sub> O; i hx
8413	Orange I	1-Naphthol Orange	C <sub>16</sub> H <sub>11</sub> N <sub>2</sub> NaO <sub>4</sub> S	523-44-4	350.324	red-br pow					s H <sub>2</sub> O; sl EtOH; i bz
8414	Orange IV	Tropaeolin OO	C <sub>18</sub> H <sub>14</sub> N <sub>2</sub> NaO <sub>3</sub> S	554-73-4	375.377	ye pow					s H <sub>2</sub> O
8415	Orcein			1400-62-0		br-red pow					
8416	L-Ornithine	2,5-Diaminopentanoic acid, (S)	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	70-26-8	132.161	micro cry (al-eth)	140				vs H <sub>2</sub> O, EtOH
8417	L-Ornithine, monohydrochloride		C <sub>6</sub> H <sub>13</sub> ClN <sub>2</sub> O <sub>2</sub>	3184-13-2	168.622	nd	215				vs H <sub>2</sub> O
8418	Orotic acid	1,2,3,6-Tetrahydro-2,6-dioxo-4-pyrimidinecarboxylic acid	C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	65-86-1	156.097	cry (w)	345.5				sl H <sub>2</sub> O; i os
8419	Oroxilin A	5,7-Dihydroxy-6-methoxy-2-phenyl-4 <i>H</i> -1-benzopyran-4-one	C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	480-11-5	284.263	ye nd (al)	231.5				vs ace, eth, EtOH
8420	Orphenadrine		C <sub>18</sub> H <sub>22</sub> NO	83-98-7	269.382			195 <sup>12</sup>			
8421	Oryzalin	Benzenesulfonamide, 4-(dipropylamino)-3,5-dinitro-	C <sub>12</sub> H <sub>18</sub> N <sub>4</sub> O <sub>6</sub> S	19044-88-3	346.359		141				
8422	Ouabain		C <sub>29</sub> H <sub>44</sub> O <sub>12</sub>	630-60-4	584.652	hyg pl (+9w)	200				sl H <sub>2</sub> O; vs EtOH
8423	7-Oxabicyclo[4.1.0]heptane		C <sub>6</sub> H <sub>10</sub> O	286-20-4	98.142		<-10	131.5	0.9663 <sup>20</sup>	1.4519 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz; s chl; sl ctc
8424	6-Oxabicyclo[3.1.0]hexane		C <sub>6</sub> H <sub>10</sub> O	285-67-6	84.117			102	0.964 <sup>25</sup>	1.4336 <sup>20</sup>	
8425	Oxacyclohexadecan-2-one	Exaltolide	C <sub>15</sub> H <sub>26</sub> O <sub>2</sub>	106-02-5	240.382	thick oil		176 <sup>15</sup>	0.9549 <sup>20</sup>	1.4708 <sup>20</sup>	
8426	1,3,4-Oxadiazole	1-Oxa-3,4-diazacyclopentadiene	C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> O	288-99-3	70.049			150		1.4300 <sup>25</sup>	
8427	Oxadiazon		C <sub>15</sub> H <sub>18</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>3</sub>	19666-30-9	345.221		90				
8428	Oxadixyl		C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> O <sub>4</sub>	77732-09-3	278.304		104				
8429	Oxalic acid		C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	144-62-7	90.035	orth pym or oct	189.5 dec	sub 157	1.900 <sup>17</sup>		s H <sub>2</sub> O; vs EtOH; sl eth; i bz, chl, peth
8430	Oxalic acid dihydrate		C <sub>2</sub> H <sub>2</sub> O <sub>6</sub>	6153-56-6	126.065	mcl tab or pr	101.5		1.653 <sup>18</sup>		s H <sub>2</sub> O, EtOH; sl eth
8431	Oxaloacetic acid	Oxalacetic acid	C <sub>4</sub> H <sub>4</sub> O <sub>5</sub>	328-42-7	132.072		161 dec				
8432	Oxalyl chloride	Oxalyl dichloride	C <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	79-37-8	126.926	liq	-16	63.5	1.4785 <sup>20</sup>	1.4316 <sup>20</sup>	s eth
8433	Oxalyl dihydrazide		C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	996-98-5	118.095	nd (w)	244.0		1.458 <sup>22</sup>		s H <sub>2</sub> O; sl EtOH, eth, bz, chl
8434	Oxamic acid		C <sub>2</sub> H <sub>3</sub> NO <sub>3</sub>	471-47-6	89.050	cry (w)	210 dec				sl H <sub>2</sub> O; i EtOH, eth
8435	Oxamide		C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	471-46-5	88.065	nd (w)	350 dec		1.667 <sup>20</sup>		sl H <sub>2</sub> O, EtOH; i eth
8436	Oxamniquine		C <sub>14</sub> H <sub>21</sub> N <sub>3</sub> O <sub>3</sub>	21738-42-1	279.335	ye-oran cry	149				s ace, chl, MeOH
8437	Oxamyl		C <sub>7</sub> H <sub>13</sub> N <sub>3</sub> O <sub>2</sub> S	23135-22-0	219.261		109	dec	0.97 <sup>25</sup>		
8438	Oxandrolone		C <sub>19</sub> H <sub>30</sub> O <sub>3</sub>	53-39-4	306.439		236				
8439	1,4-Oxathiane		C <sub>4</sub> H <sub>8</sub> OS	15980-15-1	104.171	liq	-17	147	1.1174 <sup>20</sup>		sl H <sub>2</sub> O

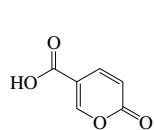




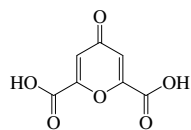
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8440	Oxazepam		C <sub>15</sub> H <sub>11</sub> ClN <sub>2</sub> O <sub>2</sub>	604-75-1	286.713	cry (EtOH)	205.5				i H <sub>2</sub> O; s EtOH, chl, diox
8441	Oxazole		C <sub>3</sub> H <sub>3</sub> NO	288-42-6	69.062			69.5		1.4285 <sup>17</sup>	
8442	Oxepane		C <sub>6</sub> H <sub>12</sub> O	592-90-5	100.158			119	0.89 <sup>25</sup>	1.4400 <sup>20</sup>	
8443	2-Oxepanone	Caprolactone	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	502-44-3	114.142	liq	-1.0	215	1.0761 <sup>20</sup>	1.4611 <sup>20</sup>	s EtOH, eth, ace
8444	Oxetane	Trimethylene oxide	C <sub>3</sub> H <sub>6</sub> O	503-30-0	58.079	liq	-97	47.6	0.8930 <sup>25</sup>	1.3961 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth; vs ace
8445	2-Oxetanone	β-Propiolactone	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	57-57-8	72.063	liq	-33.4	162	1.1460 <sup>20</sup>	1.4105 <sup>20</sup>	msc eth; s chl
8446	3-Oxetanone		C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	6704-31-0	72.063	unstab liq		106	1.137		
8447	Oxirane	Ethylene oxide	C <sub>2</sub> H <sub>4</sub> O	75-21-8	44.052	vol liq or gas	-112.5	10.6	0.8821 <sup>10</sup>	1.3597 <sup>7</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz
8448	Oxiranecarboxaldehyde	Glycidaldehyde	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	765-34-4	72.063	liq	-62	112.5	1.1403 <sup>20</sup>	1.4265 <sup>20</sup>	
8449	Oxiranemethanol, (±)	Glycidol	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	61915-27-3	74.079		-45	dec 167; 66 <sup>25</sup>	1.1143 <sup>25</sup>	1.4287 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH; s bz, chl
8450	α-Oxobenzeneacetaldehyde aldoxime	Isonitrosoacetophenone	C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	532-54-7	149.148		129				sl H <sub>2</sub> O; s chl
8451	α-Oxobenzeneacetic acid		C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	611-73-4	150.132	pr (CCl <sub>4</sub> )	66	163 <sup>15</sup>			vs H <sub>2</sub> O; s EtOH, eth; sl ctc; i CS <sub>2</sub>
8452	α-Oxobenzeneacetic acid, methyl ester		C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	15206-55-0	164.158			247		1.5268 <sup>20</sup>	
8453	α-Oxobenzeneacetoneitrile		C <sub>8</sub> H <sub>5</sub> NO	613-90-1	131.132		32.5	206			i H <sub>2</sub> O; vs EtOH, eth; sl chl
8454	γ-Oxobenzenebutanoic acid		C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	2051-95-8	178.184	lf (dil al)	116.5				s H <sub>2</sub> O, EtOH, eth, bz, chl, CS <sub>2</sub>
8455	β-Oxobenzenepropanenitrile	Benzoylacetoneitrile	C <sub>9</sub> H <sub>7</sub> NO	614-16-4	145.158		80.5	160 <sup>10</sup>			sl H <sub>2</sub> O; s EtOH, eth, bz, chl, alk, aq KCN
8456	α-Oxobenzenepranoic acid	3-Phenylpyruvic acid	C <sub>9</sub> H <sub>8</sub> O <sub>3</sub>	156-06-9	164.158	lf (bz, chl)	157.5				sl H <sub>2</sub> O; vs EtOH, eth; s bz, chl; i lig
8457	2-Oxo-2H-1-benzopyran-3-carboxylic acid	Coumarin-3-carboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>3</sub>	531-81-7	162.142	nd (w, bz)	190 dec				vs EtOH
8458	Oxobis(2,4-pentanedione) vanadium	Vanadyl acetylacetonate	C <sub>10</sub> H <sub>14</sub> O <sub>5</sub> V	3153-26-2	265.157	bl cry	258	174 <sup>02</sup>			i H <sub>2</sub> O; s EtOH, MeOH, bz, chl
8459	2-Oxobutanoic acid		C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	600-18-0	102.089		33	81 <sup>16</sup>	1.200 <sup>17</sup>	1.3972 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; sl eth
8460	4-Oxobutanoic acid		C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	692-29-5	102.089	oil		135 <sup>14</sup>			s H <sub>2</sub> O, EtOH, eth, bz
8461	2-Oxoglutaric acid	α-Ketoglutaric acid	C <sub>5</sub> H <sub>8</sub> O <sub>5</sub>	328-50-7	146.099	cry (ace-bz)	115.5				vs H <sub>2</sub> O, EtOH, eth; s ace
8462	6-Oxoheptanoic acid		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	3128-07-2	144.168		40.2	251 <sup>280</sup> , 135 <sup>1</sup>		1.4306 <sup>25</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
8463	5-Oxohexanoic acid		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	3128-06-1	130.141		13.5	274.5	1.09 <sup>25</sup>	1.4451 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
8464	α-Oxo-1H-indole-3-propanoic acid	Indole-3-pyruvic acid	C <sub>11</sub> H <sub>9</sub> NO <sub>3</sub>	392-12-1	203.194	gray cry	211				
8465	Oxolinic acid		C <sub>13</sub> H <sub>11</sub> NO <sub>5</sub>	14698-29-4	261.230	cry (DMF)	313 dec				
8466	4-Oxopentanal		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	626-96-0	100.117		<-21	dec 187	1.0134 <sup>21</sup>	1.4257 <sup>22</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
8467	3-Oxopentanedioic acid	Acetonedicarboxylic acid	C <sub>5</sub> H <sub>6</sub> O <sub>5</sub>	542-05-2	146.099	nd (AcOEt)	138 dec				s H <sub>2</sub> O, EtOH; sl eth; i bz, chl, lig
8468	2-Oxopentanoic acid		C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	1821-02-9	116.116		6.5	179	1.0970 <sup>14</sup>		sl H <sub>2</sub> O; s eth, bz, chl, lig, CS <sub>2</sub>
8469	4-Oxopentanoic acid	Levulinic acid	C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	123-76-2	116.116	lf or pl	33	dec 245	1.1335 <sup>20</sup>	1.4396 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth; s chl
8470	4-Oxo-4-(phenylamino)butanoic acid	Succinilic acid	C <sub>10</sub> H <sub>11</sub> NO <sub>3</sub>	102-14-7	193.199	nd (w)	148.5				sl H <sub>2</sub> O; s EtOH; vs eth
8471	cis-4-Oxo-4-(phenylamino)-2-butenic acid	Maleanilic acid	C <sub>10</sub> H <sub>9</sub> NO <sub>3</sub>	555-59-9	191.183	mcl ye cry	192 dec			1.418 <sup>30</sup>	
8472	Oxophenylarsine	Phenylarsine oxide	C <sub>6</sub> H <sub>5</sub> AsO	637-03-6	168.025	cry (bz-eth) or (chl-eth)	145				i H <sub>2</sub> O, eth; sl EtOH; vs bz, chl
8473	4-Oxo-4-phenyl-2-butenic acid		C <sub>10</sub> H <sub>8</sub> O <sub>3</sub>	583-06-2	176.169	nd or pr (tol)	99				sl H <sub>2</sub> O, chl, lig; s EtOH, eth, tol
8474	2-Oxopropanal oxime	Isonitrosoacetone	C <sub>3</sub> H <sub>5</sub> NO <sub>2</sub>	306-44-5	87.078	nd(CCl <sub>4</sub> ) lf (eth-peth)	69	sub	1.0744 <sup>67</sup>		s H <sub>2</sub> O, eth; sl bz, ctc, chl
8475	2-Oxopropanenitrile		C <sub>3</sub> H <sub>3</sub> NO	631-57-2	69.062			92.3	0.9745 <sup>20</sup>	1.3764 <sup>20</sup>	s eth, ace, CH <sub>3</sub> CN
8476	17-(1-Oxopropoxy)-androst-4-en-3-one, (17β)	Testosterone-17-propionate	C <sub>22</sub> H <sub>32</sub> O <sub>3</sub>	57-85-2	344.487		120				vs eth, py, EtOH



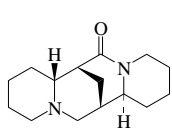
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8477	2-Oxo-2H-pyran-5-carboxylic acid	Coumalic acid	C <sub>6</sub> H <sub>4</sub> O <sub>4</sub>	500-05-0	140.094	pr (MeOH)	207 dec	218 <sup>20</sup>			sl H <sub>2</sub> O, eth, ace; i bz, chl; s EtOH, HOAc
8478	4-Oxo-4H-pyran-2,6-dicarboxylic acid	Chelidonic acid	C <sub>7</sub> H <sub>4</sub> O <sub>6</sub>	99-32-1	184.103	rose mcl nd (al-w,+1w)	262				sl H <sub>2</sub> O, EtOH
8479	17-Oxosparteine		C <sub>15</sub> H <sub>24</sub> N <sub>2</sub> O	489-72-5	248.364	ye to col hyg nd (peth)	84	209 <sup>12</sup>			vs H <sub>2</sub> O, EtOH, eth; s chl
8480	4,4'-Oxybis(benzenesulfonyl chloride)	Diphenyl ether 4,4'-disulfonyl chloride	C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub> S <sub>2</sub>	121-63-1	367.225	cry (peth)	128				
8481	4,4'-Oxybis(benzenesulfonyl hydrazide)		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>5</sub> S <sub>2</sub>	80-51-3	358.393	cry (H <sub>2</sub> O)	164 dec				
8482	Oxybutynin		C <sub>22</sub> H <sub>31</sub> NO <sub>3</sub>	5633-20-5	357.486	cry	114				
8483	Oxycarboxin	Carboxin S,S-dioxide	C <sub>12</sub> H <sub>13</sub> NO <sub>4</sub> S	5259-88-1	267.301	pr (EtOH)	129				sl H <sub>2</sub> O; s bz, EtOH; vs ace
8484	Oxychloridane		C <sub>10</sub> H <sub>4</sub> Cl <sub>6</sub> O	27304-13-8	423.762	cry (pentane)	100				
8485	Oxycodone	Dihydro-14-hydroxycodeinone	C <sub>18</sub> H <sub>21</sub> NO <sub>4</sub>	76-42-6	315.365	rods (EtOH)	219				i H <sub>2</sub> O, eth; s EtOH, chl
8486	Oxydemeton-methyl		C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> PS <sub>2</sub>	301-12-2	246.284		<-20	106 <sup>01</sup>	1.289 <sup>20</sup>		
8487	10,10'-Oxydiphenoxarsine	10,10'-Oxybis[10H-phenoxarsine]	C <sub>24</sub> H <sub>16</sub> As <sub>2</sub> O <sub>3</sub>	58-36-6	502.225	col mcl cry	185		1.41		i H <sub>2</sub> O; s EtOH, chl; i CH <sub>2</sub> Cl <sub>2</sub>
8488	Oxyfluorfen		C <sub>15</sub> H <sub>11</sub> ClF <sub>3</sub> NO <sub>4</sub>	42874-03-3	361.701		84	dec 358	1.35 <sup>73</sup>		
8489	Oxymetazoline		C <sub>16</sub> H <sub>24</sub> N <sub>2</sub> O	1491-59-4	260.374	cry (bz)	182				i eth, chl
8490	Oxymetholone		C <sub>21</sub> H <sub>32</sub> O <sub>3</sub>	434-07-1	332.477	cry	179				
8491	Oxymethurea		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	140-95-4	120.107	pr(al)	126	149 <sup>25</sup>			s H <sub>2</sub> O, EtOH, MeOH; i eth; sl DMSO
8492	Oxyphenbutazone		C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O <sub>3</sub>	129-20-4	324.373	cry (eth/ peth)	124				s EtOH, MeOH, chl, bz, eth
8493	Oxyphenonium bromide		C <sub>21</sub> H <sub>24</sub> BrNO <sub>3</sub>	50-10-2	428.404		191.5				vs H <sub>2</sub> O; sl EtOH
8494	Oxytetracycline		C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>3</sub>	79-57-2	460.434		184.5		1.634 <sup>20</sup>		
8495	Oxytocin		C <sub>43</sub> H <sub>66</sub> N <sub>12</sub> O <sub>12</sub> S <sub>2</sub>	50-56-6	1007.187	wh pow					s H <sub>2</sub> O, BuOH
8496	Paclitaxel		C <sub>45</sub> H <sub>56</sub> ClN <sub>2</sub> O	76738-62-0	293.792	wh cry	166		1.22		i H <sub>2</sub> O; vs ace, MeOH; s xyl, hx
8497	Palustric acid		C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	1945-53-5	302.451	cry (MeOH)	164.5				
8498	Pamoic acid		C <sub>23</sub> H <sub>16</sub> O <sub>6</sub>	130-85-8	388.369		315				
8499	Pancuronium dibromide		C <sub>35</sub> H <sub>60</sub> Br <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	15500-66-0	732.670	cry	215				sl chl
8500	Panose	4-α-Isomaltosylglucose	C <sub>18</sub> H <sub>32</sub> O <sub>16</sub>	33401-87-5	504.437		223 dec				
8501	Panthesin		C <sub>18</sub> H <sub>32</sub> N <sub>2</sub> O <sub>3</sub> S	135-44-4	388.522	pa ye pow (al)	158				vs H <sub>2</sub> O, EtOH
8502	Pantolactone		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	599-04-2	130.141		92				
8503	Pantothenic acid		C <sub>9</sub> H <sub>17</sub> NO <sub>5</sub>	79-83-4	219.235	ye visc oil					vs H <sub>2</sub> O, bz, eth
8504	Papaveraldine		C <sub>20</sub> H <sub>19</sub> NO <sub>5</sub>	522-57-6	353.369	nd (al),cry (bz, peth)	210.5				i H <sub>2</sub> O; sl EtOH, eth; s bz, chl
8505	Papaverine		C <sub>20</sub> H <sub>21</sub> NO <sub>4</sub>	58-74-2	339.386	wh pr (al- eth), nd (chl-peth)	147.5	sub 135	1.337 <sup>20</sup>	1.625	sl H <sub>2</sub> O; vs EtOH, chl; s ace, bz, py
8506	Papaverine hydrochloride	Cerespan	C <sub>20</sub> H <sub>22</sub> ClNO <sub>4</sub>	61-25-6	375.847	wh mcl pr (w)	224.5				vs H <sub>2</sub> O, EtOH
8507	Paraformaldehyde		(CH <sub>2</sub> O) <sub>x</sub>	30525-89-4	30.026		164 dec				
8508	Paraldehyde	2,4,6-Trimethyl-1,3,5-trioxane	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	123-63-7	132.157		12.6	124.3	0.9943 <sup>20</sup>	1.4049 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, chl
8509	Paramethadione		C <sub>7</sub> H <sub>11</sub> NO <sub>3</sub>	115-67-3	157.167	liq			1.121 <sup>25</sup>	1.449 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH, chl, bz, eth
8510	Paraoxon	O,O-Diethyl O-(4-nitrophenyl) phosphate	C <sub>10</sub> H <sub>14</sub> NO <sub>6</sub> P	311-45-5	275.195	oily liq		161 <sup>05</sup>	1.2683 <sup>25</sup>	1.5096	s eth
8511	Paraquat		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub>	4685-14-7	186.252	cation					
8512	Pararosaniline hydrochloride	Basic fuchsin	C <sub>19</sub> H <sub>18</sub> ClN <sub>3</sub>	569-61-9	323.819	pale viol pow	269 dec				
8513	Parasorbic acid		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	10048-32-5	112.127	oily lig		100 <sup>15</sup>	1.079 <sup>18</sup>	1.4736 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
8514	Parathion		C <sub>10</sub> H <sub>14</sub> NO <sub>3</sub> PS	56-38-2	291.261	ye liq	6.1	375	1.2681 <sup>20</sup>	1.5370 <sup>25</sup>	i H <sub>2</sub> O; s eth, ace; sl ctc; vs EtOH, AcOEt
8515	Patchouli alcohol		C <sub>15</sub> H <sub>26</sub> O	5986-55-0	222.366		56		0.9906 <sup>55</sup>	1.5029 <sup>65</sup>	i H <sub>2</sub> O; s EtOH, eth
8516	Pebulate		C <sub>10</sub> H <sub>21</sub> NOS	1114-71-2	203.345			142 <sup>20</sup>	0.9458 <sup>20</sup>	1.4752 <sup>20</sup>	vs ace, bz, MeOH
8517	Pelargonidin chloride		C <sub>15</sub> H <sub>11</sub> ClO <sub>5</sub>	134-04-3	306.698	red br hyg (anh) pr or pl	>350				s H <sub>2</sub> O; vs EtOH; sl chl, MeOH
8518	Pellotine		C <sub>13</sub> H <sub>19</sub> NO <sub>3</sub>	83-14-7	237.295	pl (al, peth)	111.5				vs ace, eth, EtOH, peth
8519	Pemoline	2-Amino-5-phenyl-4(5H)-oxazolone	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	2152-34-3	176.172	cry	256 dec				i H <sub>2</sub> O, eth, ace; sl hot EtOH



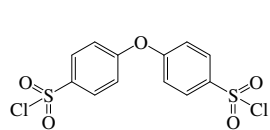
2-Oxo-2H-pyran-5-carboxylic acid



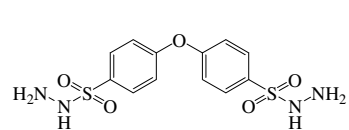
4-Oxo-4H-pyran-2,6-dicarboxylic acid



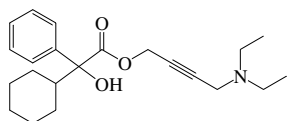
17-Oxosparteine



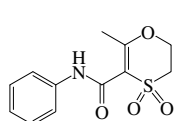
4,4'-Oxybis(benzenesulfonyl chloride)



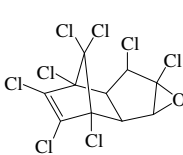
4,4'-Oxybis(benzenesulfonyl hydrazide)



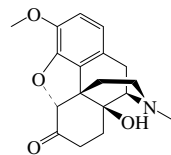
Oxybutynin



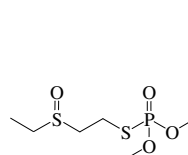
Oxycarboxin



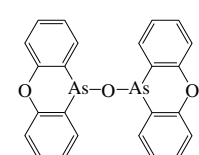
Oxychlordane



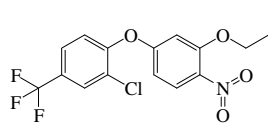
Oxycodone



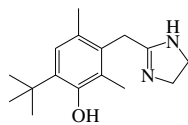
Oxydemeton-methyl



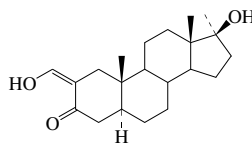
10,10'-Oxydiphenoxarsine



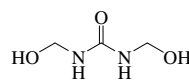
Oxyfluorfen



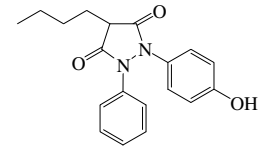
Oxymetazoline



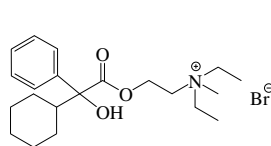
Oxymetholone



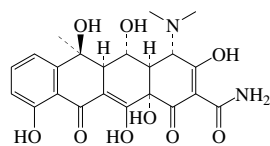
Oxymethurea



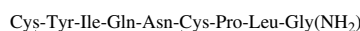
Oxypfenbutazone



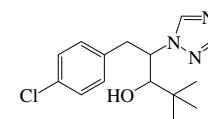
Oxypheonium bromide



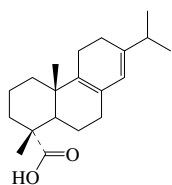
Oxytetracycline



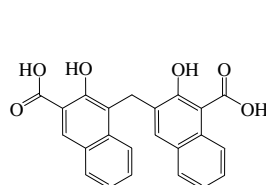
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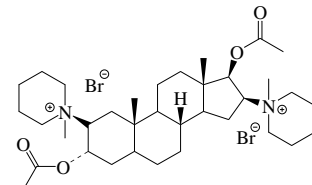
Paclobutrazol



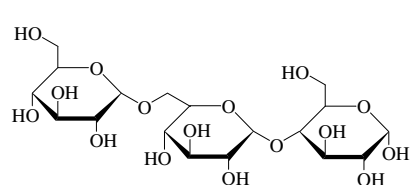
Palustric acid



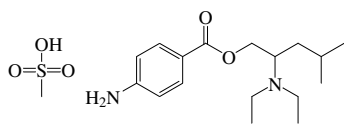
Pamoic acid



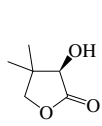
Pancuronium dibromide



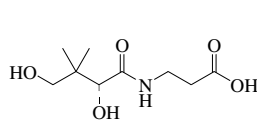
Panose



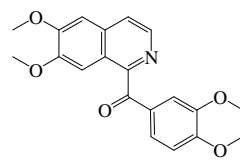
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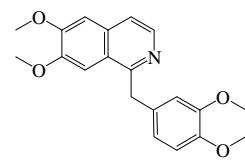
Pantolactone



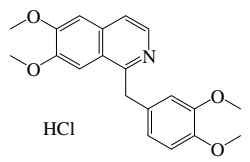
Pantothenic acid



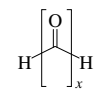
Papaveralidine



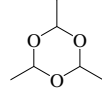
Papaverine



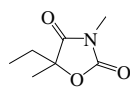
Papaverine hydrochloride



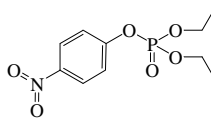
Paraformaldehyde



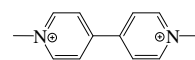
Paraldehyde



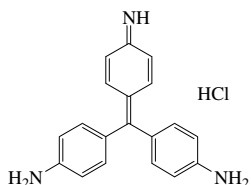
Paramethadione



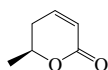
Paraoxon



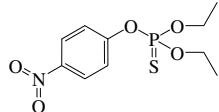
Paraquat



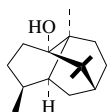
Parosanol hydrochloride



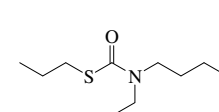
Parasorbic acid



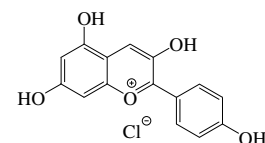
Parathion



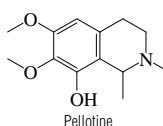
Patchouli alcohol



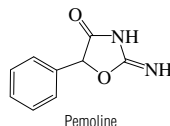
Pebulate



Pelargonidin chloride

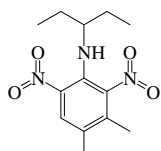


Pellotine

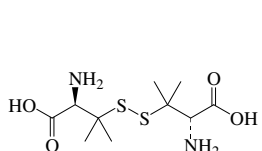


Pemoline

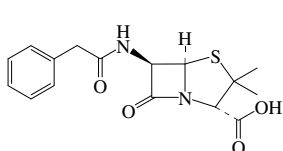
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8520	Pendimethalin	<i>N</i> -(1-Ethylpropyl)-3,4-dimethyl-2,6-dinitroaniline	C <sub>13</sub> H <sub>19</sub> N <sub>3</sub> O <sub>4</sub>	40487-42-1	281.308		56	dec	1.19 <sup>25</sup>		
8521	Penicillamine cysteine disulfide		C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	18840-45-4	268.354		195				
8522	Penicillin G	Benzylpenicillinic acid	C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>4</sub> S	61-33-6	334.390	amor wh pow					s H <sub>2</sub> O; s MeOH, EtOH, eth, chl, bz, ace
8523	Penicillin G procaine		C <sub>29</sub> H <sub>38</sub> N <sub>4</sub> O <sub>6</sub> S	54-35-3	570.700		108	dec	1.2555 <sup>25</sup>		s H <sub>2</sub> O, EtOH, chl
8524	Penicillin V	Phenoxymethylpenicillin	C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>5</sub> S	87-08-1	350.389	cry	124	dec			sl H <sub>2</sub> O; s os
8525	1,2,3,4,5-Pentabromo-6-chlorocyclohexane		C <sub>6</sub> H <sub>6</sub> Br <sub>5</sub> Cl	87-84-3	513.085	cry	204				
8526	Pentabromomethylbenzene		C <sub>7</sub> H <sub>3</sub> Br <sub>5</sub>	87-83-2	486.619		288		2.97 <sup>17</sup>		i H <sub>2</sub> O; sl EtOH, HOAc; s bz
8527	Pentabromophenol		C <sub>6</sub> HBr <sub>5</sub> O	608-71-9	488.591	mcl pr (HOAc) nd (al)	229.5	sub			i H <sub>2</sub> O; s EtOH, bz, HOAc; sl eth
8528	1,1,1,3,3-Pentabromo-2-propanone	Pentabromoacetone	C <sub>3</sub> HBr <sub>5</sub> O	79-49-2	452.559	nd (w, al) pr (eth)	79.5	sub			i H <sub>2</sub> O; vs EtOH, eth, ace, chl
8529	Pentac	Dienochlor	C <sub>10</sub> Cl <sub>10</sub>	2227-17-0	474.637	tan cry (peth)	122				
8530	Pentacene	Benzo[b]naphthacene	C <sub>22</sub> H <sub>14</sub>	135-48-8	278.346	ye grn nd or lf (xyl)	>300	dec			i H <sub>2</sub> O; sl bz; s PhNO <sub>2</sub>
8531	2,3,4,5,6-Pentachloroaniline		C <sub>6</sub> H <sub>2</sub> Cl <sub>5</sub> N	527-20-8	265.352	nd (al)	233.0				vs eth, EtOH, lig
8532	2,3,4,5,6-Pentachloroanisole	Methyl pentachlorophenyl ether	C <sub>7</sub> H <sub>2</sub> Cl <sub>5</sub> O	1825-21-4	280.363	nd MeOH	108.5				
8533	Pentachlorobenzene		C <sub>6</sub> HCl <sub>5</sub>	608-93-5	250.337	nd (al)	86	277	1.8342 <sup>16</sup>		i H <sub>2</sub> O, EtOH; sl eth, bz, chl, CS <sub>2</sub>
8534	Pentachlorobenzenethiol	Pentachlorophenyl mercaptan	C <sub>6</sub> HCl <sub>5</sub> S	133-49-3	282.402		231.5				
8535	2,3,4,5,6-Pentachlorobiphenyl		C <sub>12</sub> H <sub>2</sub> Cl <sub>5</sub>	18259-05-7	326.433	nd (peth)	123.5				i H <sub>2</sub> O
8536	2,2',4,5,5'-Pentachlorobiphenyl		C <sub>12</sub> H <sub>5</sub> Cl <sub>5</sub>	37680-73-2	326.433	cry (EtOH)	78.5				i H <sub>2</sub> O
8537	1,2,3,4,7-Pentachlorodibenzo- <i>p</i> -dioxin		C <sub>12</sub> H <sub>3</sub> Cl <sub>5</sub> O <sub>2</sub>	39227-61-7	356.416	cry (bz/ MeOH)	195				
8538	Pentachloroethane	Refrigerant 120	C <sub>2</sub> HCl <sub>5</sub>	76-01-7	202.294	liq	-28.78	162.0	1.6796 <sup>20</sup>	1.5025 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
8539	Pentachlorofluoroethane		C <sub>2</sub> Cl <sub>5</sub> F	354-56-3	220.284	col liq	101.3	138	1.74 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth
8540	Pentachloronitrobenzene	Quintozene	C <sub>6</sub> Cl <sub>5</sub> NO <sub>2</sub>	82-68-8	295.335	cry (al)	144	dec 328	1.718 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH; s bz, chl
8541	Pentachlorophenol		C <sub>6</sub> HCl <sub>5</sub> O	87-86-5	266.336	mcl pr (al + 1w) nd (bz)	174	dec 310	1.978 <sup>22</sup>		i H <sub>2</sub> O; sl lig; vs EtOH, eth; s bz
8542	1,1,2,2,3-Pentachloropropane		C <sub>3</sub> H <sub>2</sub> Cl <sub>5</sub>	16714-68-4	216.321			181 <sup>500</sup>	1.633 <sup>25</sup>	1.5098 <sup>25</sup>	
8543	1,1,2,3,3-Pentachloro-1-propene		C <sub>3</sub> HCl <sub>5</sub>	1600-37-9	214.305			185	1.6317 <sup>94</sup>	1.5313 <sup>30</sup>	vs eth
8544	Pentachloropyridine		C <sub>5</sub> Cl <sub>5</sub> N	2176-62-7	251.326		125.5	280			vs bz, EtOH, lig
8545	2,3,4,5,6-Pentachlorotoluene		C <sub>7</sub> H <sub>2</sub> Cl <sub>5</sub>	877-11-2	264.364	nd (bz, peth)	224.8	301			sl EtOH, eth, CS <sub>2</sub> ; s bz, tol, peth
8546	Pentacontane		C <sub>50</sub> H <sub>102</sub>	6596-40-3	703.345		92.1	575.0			
8547	Pentacosane		C <sub>25</sub> H <sub>52</sub>	629-99-2	352.681		53.93	401.9; 282 <sup>40</sup>	0.8012 <sup>20</sup>	1.4491 <sup>20</sup>	s bz, chl
8548	1 <i>H</i> -Pentadecafluoroheptane		C <sub>7</sub> HF <sub>15</sub>	375-83-7	370.059			96.0	1.725 <sup>25</sup>	1.2690 <sup>25</sup>	
8549	Pentadecafluorooctanoic acid		C <sub>8</sub> HF <sub>15</sub> O <sub>2</sub>	335-67-1	414.069		54.3	192.4			
8550	2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-Pentadecafluoro-1-octanol	1,1-Dihydroperfluorooctanol	C <sub>8</sub> H <sub>3</sub> F <sub>15</sub> O	307-30-2	400.085	waxy solid	47	164; 68 <sup>8</sup>			
8551	Pentadecanal		C <sub>15</sub> H <sub>30</sub> O	2765-11-9	226.398	nd	24.5	185 <sup>25</sup>			vs ace, eth, EtOH
8552	Pentadecane		C <sub>15</sub> H <sub>32</sub>	629-62-9	212.415		9.95	270.6	0.7685 <sup>20</sup>	1.4315 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
8553	Pentadecanoic acid	Pentadecylic acid	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	1002-84-2	242.398	pl (dil al, HOAc) cry (peth)	52.3	257 <sup>100</sup> , 158 <sup>1</sup>	0.8423 <sup>80</sup>	1.4254 <sup>80</sup>	i H <sub>2</sub> O; vs EtOH, ace; s eth; sl tfa
8554	1-Pentadecanol		C <sub>15</sub> H <sub>32</sub> O	629-76-5	228.414		43.9	300	0.8347 <sup>25</sup>		i H <sub>2</sub> O
8555	2-Pentadecanone		C <sub>15</sub> H <sub>30</sub> O	2345-28-0	226.398		39.5	294	0.8182 <sup>39</sup>		
8556	8-Pentadecanone		C <sub>15</sub> H <sub>30</sub> O	818-23-5	226.398	cry (al)	43	291	0.8180 <sup>39</sup>		s EtOH, eth, bz, ctc, chl
8557	1-Pentadecene		C <sub>15</sub> H <sub>30</sub>	13360-61-7	210.399	liq	-1.4	268.2	0.7764 <sup>20</sup>	1.4389 <sup>30</sup>	i H <sub>2</sub> O; s ace
8558	Pentadecylamine	Pentadecanamine	C <sub>15</sub> H <sub>33</sub> N	2570-26-5	227.430		37.3	307.6	0.8104 <sup>20</sup>	1.4480 <sup>20</sup>	vs eth, EtOH
8559	Pentadecylbenzene		C <sub>21</sub> H <sub>36</sub>	2131-18-2	288.511		22	373	0.8548 <sup>20</sup>	1.4815 <sup>20</sup>	
8560	3-Pentadecyl-1,2-benzenediol	3-Pentadecylcatechol	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub>	492-89-7	320.510	nd (to, peth)	59.5				vs bz, eth, EtOH
8561	Pentadecylcyclohexane		C <sub>21</sub> H <sub>42</sub>	6006-95-7	294.558		29	373	0.8267 <sup>20</sup>	1.4588 <sup>20</sup>	
8562	3-Pentadecylphenol		C <sub>21</sub> H <sub>36</sub> O	501-24-6	304.510	nd (peth)	53.5	230 <sup>8</sup> , 197 <sup>15</sup>			vs ace, bz, EtOH
8563	1-Pentadecyne		C <sub>15</sub> H <sub>28</sub>	765-13-9	208.383		10	268	0.7928 <sup>20</sup>	1.4419 <sup>20</sup>	vs ace
8564	1,2-Pentadiene	Ethylallene	C <sub>5</sub> H <sub>8</sub>	591-95-7	68.118	liq	-137.3	44.9	0.6926 <sup>20</sup>	1.4209 <sup>30</sup>	msc EtOH, eth, ace, bz, ctc, hp
8565	<i>cis</i> -1,3-Pentadiene	<i>cis</i> -Piperylene	C <sub>5</sub> H <sub>8</sub>	1574-41-0	68.118	liq	-140.8	44.1	0.6910 <sup>20</sup>	1.4363 <sup>30</sup>	msc EtOH, eth, ace, bz, ctc, hp
8566	<i>trans</i> -1,3-Pentadiene	<i>trans</i> -Piperylene	C <sub>5</sub> H <sub>8</sub>	2004-70-8	68.118	liq	-87.4	42	0.6710 <sup>25</sup>	1.4301 <sup>20</sup>	



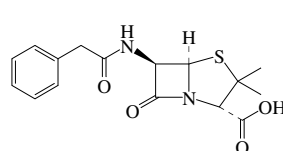
Pendimethalin



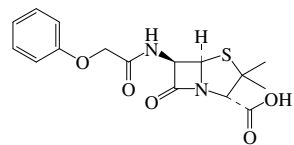
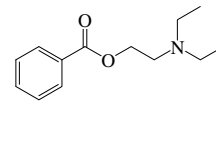
Penicillamine cysteine disulfide



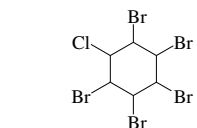
Penicillin G



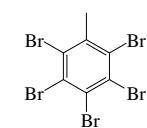
Penicillin G procaine



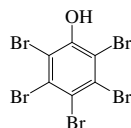
Penicillin V



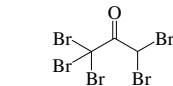
1,2,3,4,5-Pentabromo-6-chlorocyclohexane



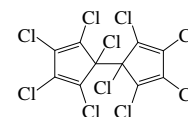
Pentabromomethylbenzene



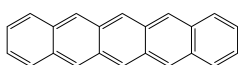
Pentabromophenol



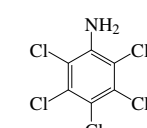
1,1,1,3,3-Pentabromo-2-propanone



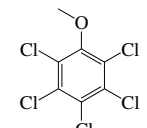
Pentac



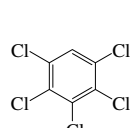
Pentacene



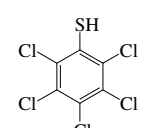
2,3,4,5,6-Pentachloroaniline



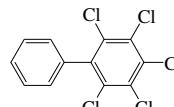
2,3,4,5,6-Pentachloroanisole



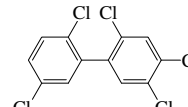
Pentachlorobenzene



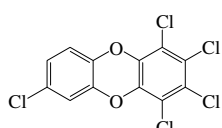
Pentachlorobenzenethiol



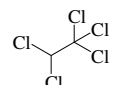
2,3,4,5,6-Pentachlorobiphenyl



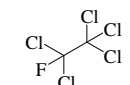
2,2',4,4,5,5'-Pentachlorobiphenyl



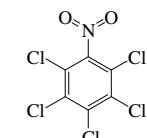
1,2,3,4,7-Pentachlorodibenzo-p-dioxin



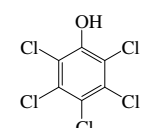
Pentachloroethane



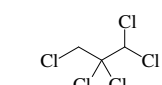
Pentachlorofluoroethane



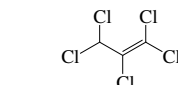
Pentachloronitrobenzene



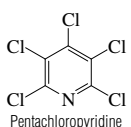
Pentachlorophenol



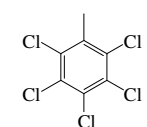
1,1,2,2,3-Pentachloropropane



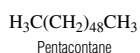
1,1,2,3,3-Pentachloro-1-propene



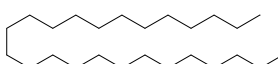
Pentachloropyridine



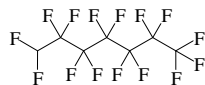
2,3,4,5,6-Pentachlorotoluene



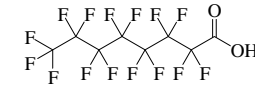
Pentacotane



Pentacosane



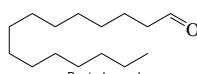
1H-Pentadecafluoroheptane



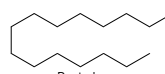
Pentadecafluorooctanoic acid



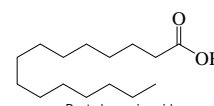
2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-Pentadecafluoro-1-octanol



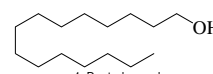
Pentadecanal



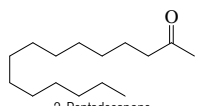
Pentadecane



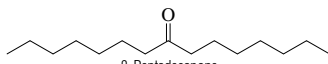
Pentadecanoic acid



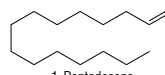
1-Pentadecanol



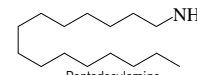
2-Pentadecanone



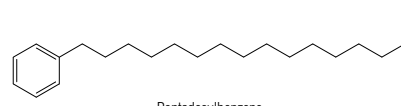
8-Pentadecanone



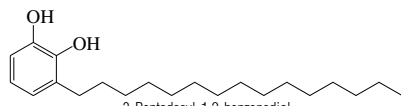
1-Pentadecene



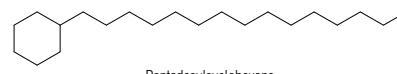
Pentadecylamine



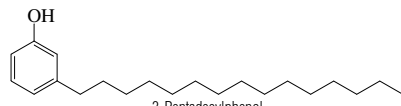
Pentadecylbenzene



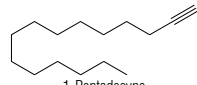
3-Pentadecyl-1,2-benzenediol



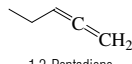
Pentadecylcyclohexane



3-Pentadecylphenol



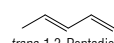
1-Pentadecyne



1,2-Pentadiene



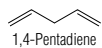
cis-1,3-Pentadiene



trans-1,3-Pentadiene

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8567	1,4-Pentadiene		C <sub>5</sub> H <sub>8</sub>	591-93-5	68.118	vol liq or gas	-148.2	26	0.6608 <sup>20</sup>	1.3888 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz
8568	2,3-Pentadiene	1,3-Dimethylallene	C <sub>5</sub> H <sub>8</sub>	591-96-8	68.118	liq	-125.6	48.2	0.6950 <sup>20</sup>	1.4284 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, hp, ctc
8569	1,4-Pentadien-3-ol		C <sub>5</sub> H <sub>8</sub> O	922-65-6	84.117			115.5	0.860 <sup>23</sup>	1.4400 <sup>17</sup>	
8570	1,3-Pentadiyne	Methyldiacetylene	C <sub>6</sub> H <sub>4</sub>	4911-55-1	64.086	liq	-38.5	55	0.7909 <sup>20</sup>	1.4431 <sup>21</sup>	i H <sub>2</sub> O; s eth, bz, chl
8571	Pentaerythritol		C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	115-77-5	136.147	cry (dil HCl)	258	sub		1.548	s H <sub>2</sub> O; i eth, bz
8572	Pentaerythritol tetraacetate	2,2-Bis((acetyloxy)methyl)-1,3-propanediol diacetate	C <sub>13</sub> H <sub>20</sub> O <sub>8</sub>	597-71-7	304.293	tetr nd (w, bz)	83.5		1.273 <sup>18</sup>		s H <sub>2</sub> O; vs EtOH, eth
8573	Pentaerythritol tetrakis(2-mercaptoacetate)		C <sub>13</sub> H <sub>20</sub> O <sub>8</sub> S <sub>4</sub>	10193-99-4	432.553	liq		250 <sup>1</sup>	1.385 <sup>25</sup>	1.5470 <sup>20</sup>	
8574	Pentaerythritol tetramethacrylate	Tetramethylolmethane tetramethacrylate	C <sub>21</sub> H <sub>28</sub> O <sub>8</sub>	3253-41-6	408.442			53.5			
8575	Pentaerythritol tetranitrate		C <sub>5</sub> H <sub>8</sub> N <sub>4</sub> O <sub>12</sub>	78-11-5	316.138	tetr (ace) pr (ace-al)	140.5		1.773 <sup>20</sup>		sl H <sub>2</sub> O, EtOH, eth; vs ace; s bz, py
8576	Pentaethylbenzene		C <sub>16</sub> H <sub>26</sub>	605-01-6	218.377		<-20	277	0.8971 <sup>19</sup>	1.5127 <sup>20</sup>	
8577	Pentaethyl tantalate	Ethanol, tantalum(5+) salt	C <sub>10</sub> H <sub>25</sub> O <sub>5</sub> Ta	6074-84-6	406.251			151 <sup>1</sup>			
8578	2,3,4,5,6-Pentafluoroaniline		C <sub>6</sub> H <sub>2</sub> F <sub>5</sub> N	771-60-8	183.079		34	153.5			
8579	Pentafluorobenzaldehyde		C <sub>7</sub> HF <sub>5</sub> O	653-37-2	196.074		20	167		1.4506 <sup>20</sup>	
8580	Pentafluorobenzene		C <sub>6</sub> HF <sub>5</sub>	363-72-4	168.064	liq	-47.4	85.74	1.514 <sup>25</sup>	1.3905 <sup>20</sup>	
8581	Pentafluorobenzenethiol		C <sub>6</sub> HF <sub>5</sub> S	771-62-0	200.129	liq	-24	143	1.501 <sup>25</sup>	1.4645 <sup>20</sup>	
8582	Pentafluorobenzoic acid		C <sub>7</sub> HF <sub>5</sub> O <sub>2</sub>	602-94-8	212.074		101	220			
8583	Pentafluorobenzonitrile		C <sub>7</sub> F <sub>5</sub> N	773-82-0	193.074		1.2	162	1.563 <sup>20</sup>	1.4402 <sup>25</sup>	
8584	Pentafluoroethane		C <sub>2</sub> HF <sub>5</sub>	354-33-6	120.021	col gas	-100.6	-48.1			
8585	Pentafluoriodobenzene		C <sub>6</sub> F <sub>5</sub> I	827-15-6	293.960	liq	-29	166	2.212 <sup>20</sup>	1.4950 <sup>25</sup>	
8586	Pentafluoromethoxybenzene	Methyl pentafluorophenyl ether	C <sub>7</sub> H <sub>2</sub> F <sub>6</sub> O	389-40-2	198.090	liq	-37	138.5	1.493 <sup>20</sup>	1.4087 <sup>20</sup>	
8587	Pentafluorophenol		C <sub>6</sub> HF <sub>5</sub> O	771-61-9	184.063		37.5	145.6		1.4263 <sup>20</sup>	
8588	1,1,1,2,2-Pentafluoropropane	Refrigerant 245cb	C <sub>3</sub> H <sub>2</sub> F <sub>5</sub>	1814-88-6	134.048	col gas		-17.4			
8589	2,2,3,3,3-Pentafluoro-1-propanol		C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	422-05-9	150.047			26 <sup>20</sup>			
8590	2,3,4,5,6-Pentafluorotoluene		C <sub>7</sub> H <sub>2</sub> F <sub>5</sub>	771-56-2	182.091	liq	-29.78	117.5	1.440 <sup>20</sup>	1.4016 <sup>25</sup>	
8591	1,1,2,4,4-Pentafluoro-3-(trifluoromethyl)-1,3-butadiene		C <sub>5</sub> F <sub>8</sub>	384-04-3	212.041			39	1.527 <sup>0</sup>	1.3000 <sup>0</sup>	vs ace, bz, eth
8592	Pentagastrin		C <sub>37</sub> H <sub>49</sub> N <sub>7</sub> O <sub>9</sub> S	5534-95-2	767.892	col nd	230 dec				i H <sub>2</sub> O, bz, EtOH, eth
8593	<i>trans</i> -3,3',4',5,7-Pentahydroxyflavanone, (±)	Taxifolin	C <sub>15</sub> H <sub>12</sub> O <sub>7</sub>	480-18-2	304.252		227 dec				s chl
8594	Pentamethonium bromide		C <sub>11</sub> H <sub>28</sub> Br <sub>2</sub> N <sub>2</sub>	541-20-8	348.161		301				sl H <sub>2</sub> O
8595	Pentamethylbenzene		C <sub>11</sub> H <sub>16</sub>	700-12-9	148.245	pr (al)	54.5	232	0.917 <sup>20</sup>	1.527 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, bz; s chl
8596	2,4,6,8,10-Pentamethylcyclopentasiloxane		C <sub>6</sub> H <sub>20</sub> O <sub>5</sub> Si <sub>5</sub>	6166-86-5	300.638	liq	-108	169	0.9985 <sup>20</sup>	1.3912 <sup>20</sup>	
8597	2,2,4,6,6-Pentamethylheptane		C <sub>12</sub> H <sub>26</sub>	13475-82-6	170.334	liq	-67	177.8	0.7463 <sup>20</sup>	1.4440 <sup>20</sup>	
8598	2,2,4,6,6-Pentamethyl-3-heptene		C <sub>12</sub> H <sub>24</sub>	123-48-8	168.319	liq		180.5			
8599	2,2,3,3,4-Pentamethylpentane		C <sub>10</sub> H <sub>22</sub>	16747-44-7	142.282	liq	-36.4	166.1	0.7767 <sup>25</sup>	1.4361 <sup>20</sup>	
8600	2,2,3,4,4-Pentamethylpentane		C <sub>10</sub> H <sub>22</sub>	16747-45-8	142.282	liq	-38.7	159.3	0.7636 <sup>25</sup>	1.4307 <sup>20</sup>	
8601	Pentamethylphenol		C <sub>11</sub> H <sub>16</sub> O	2819-86-5	164.244	nd (al, peth, ace)	128	267			i H <sub>2</sub> O; s EtOH
8602	1,2,2,6,6-Pentamethylpiperidine	Pempidine	C <sub>10</sub> H <sub>21</sub> N	79-55-0	155.281			147	0.8580 <sup>0</sup>	1.4550 <sup>21</sup>	
8603	Pentamethylsilanamine		C <sub>5</sub> H <sub>15</sub> NSi	2083-91-2	117.266			86	0.7400 <sup>20</sup>	1.4379 <sup>24</sup>	
8604	Pentanal	Valeraldehyde	C <sub>5</sub> H <sub>10</sub> O	110-62-3	86.132	liq	-91.5	103	0.8095 <sup>20</sup>	1.3944 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
8605	Pentanamide		C <sub>5</sub> H <sub>11</sub> NO	626-97-1	101.147	mcl pl (peth, al)	106	225	0.8735 <sup>110</sup>	1.4183 <sup>110</sup>	vs H <sub>2</sub> O, EtOH, eth; sl chl
8606	3-Pentanamine		C <sub>5</sub> H <sub>13</sub> N	616-24-0	87.164			89	0.7487 <sup>20</sup>	1.4063 <sup>20</sup>	s EtOH; sl chl
8607	Pentane		C <sub>5</sub> H <sub>12</sub>	109-66-0	72.149	liq	-129.67	36.06	0.6262 <sup>20</sup>	1.3575 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz, chl; s ctc
8608	Pentanedial	Glutaraldehyde	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	111-30-8	100.117			dec 188			msc H <sub>2</sub> O, EtOH; s bz
8609	1,5-Pentanediamine	Cadaverine	C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	462-94-2	102.178		11.83	179	0.873 <sup>25</sup>	1.463 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl eth
8610	Pentanedinitrile	Glutaronitrile	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	544-13-8	94.115	liq	-29	286	0.9911 <sup>15</sup>	1.4295 <sup>20</sup>	vs EtOH, chl
8611	1,2-Pentanediol, (±)		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	91049-43-3	104.148			209	0.9723 <sup>20</sup>	1.4397 <sup>19</sup>	
8612	1,4-Pentanediol		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	626-95-9	104.148			202; 125 <sup>10</sup>	0.9883 <sup>20</sup>	1.4452 <sup>23</sup>	vs H <sub>2</sub> O, EtOH, chl
8613	1,5-Pentanediol	Pentamethylene glycol	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	111-29-5	104.148	liq	-18	239	0.9914 <sup>20</sup>	1.4494 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl eth, bz
8614	2,3-Pentanediol		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	42027-23-6	104.148			187.5; 100 <sup>17</sup>	0.9798 <sup>19</sup>	1.4412 <sup>25</sup>	s H <sub>2</sub> O, EtOH; sl eth
8615	2,4-Pentanediol	2,4-Amylene glycol	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	625-69-4	104.148			199; 97 <sup>13</sup>	0.9635 <sup>20</sup>	1.4349 <sup>20</sup>	vs H <sub>2</sub> O, EtOH

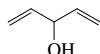




1,4-Pentadiene



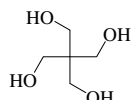
2,3-Pentadiene



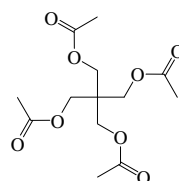
1,4-Pentadien-3-ol



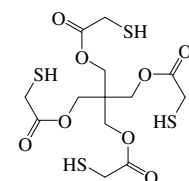
1,3-Pentadiyne



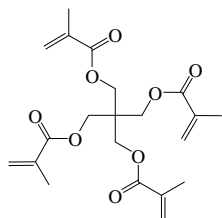
Pentaerythritol



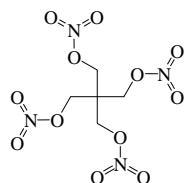
Pentaerythritol tetraacetate



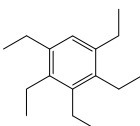
Pentaerythritol tetrakis(2-mercaptoacetate)



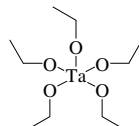
Pentaerythritol tetramethacrylate



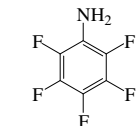
Pentaerythritol tetranitrate



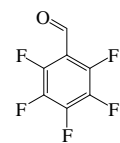
Pentaethylbenzene



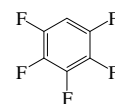
Pentaethyl tantalate



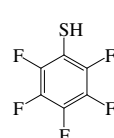
2,3,4,5,6-Pentafluoroaniline



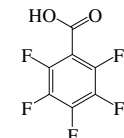
Pentafluorobenzaldehyde



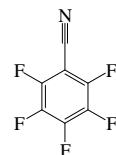
Pentafluorobenzene



Pentafluorobenzenethiol



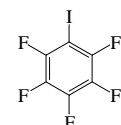
Pentafluorobenzoic acid



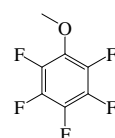
Pentafluorobenzonitrile



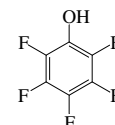
Pentafluoroethane



Pentafluoroiodobenzene



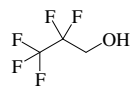
Pentafluoromethoxybenzene



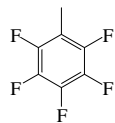
Pentafluorophenol



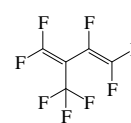
1,1,1,2,2-Pentafluoropropane



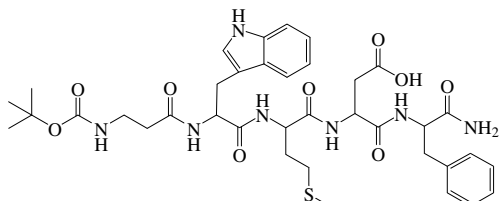
2,2,3,3,3-Pentafluoro-1-propanol



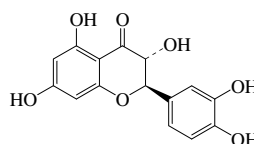
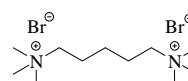
2,3,4,5,6-Pentafluorotoluene



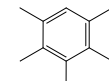
1,1,2,4,4-Pentafluoro-3-(trifluoromethyl)-1,3-butadiene



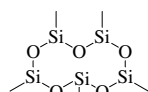
Pentagastrin

*trans*-3,3',4',5,7-Pentahydroxyflavanone, (±)

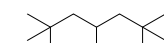
Pentamethonium bromide



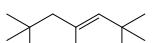
Pentamethylbenzene



2,4,6,8,10-Pentamethylcyclopentasiloxane



2,2,4,6,6-Pentamethylheptane



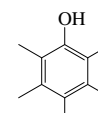
2,2,4,6,6-Pentamethyl-3-heptene



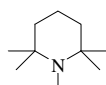
2,2,3,3,4-Pentamethylpentane



2,2,3,4,4-Pentamethylpentane



Pentamethylphenol



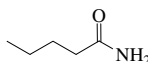
1,2,2,6,6-Pentamethylpiperidine



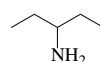
Pentamethylsilanamine



Pentanal



Pentanamide



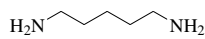
3-Pentanamine



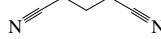
Pentane



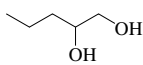
Pentanedial



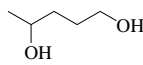
1,5-Pentanediamine



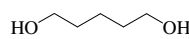
Pentanedinitrile



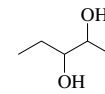
1,2-Pentandiol, (±)



1,4-Pentandiol



1,5-Pentandiol

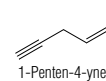
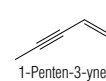
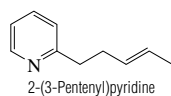
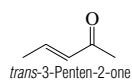
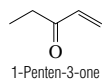
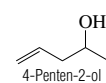
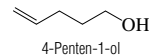
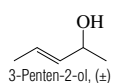
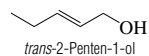
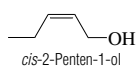
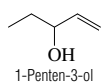
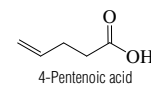
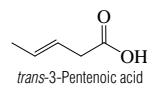
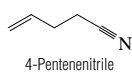
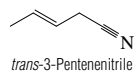
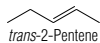
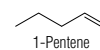
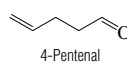
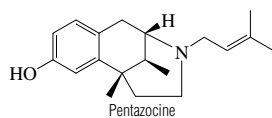
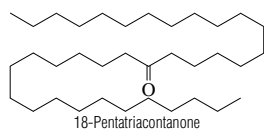
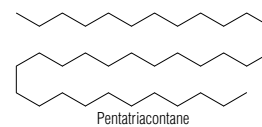
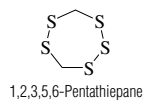
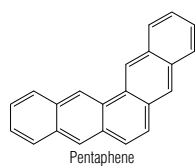
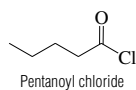
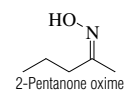
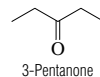
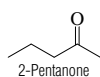
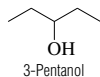
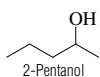
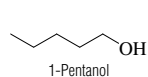
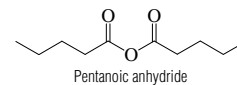
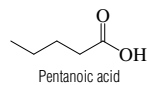
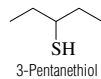
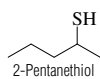
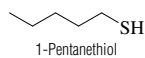
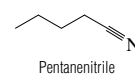
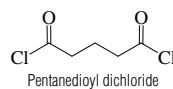
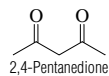
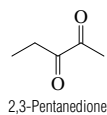
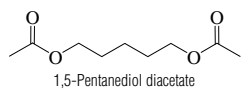


2,3-Pentandiol

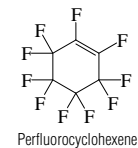
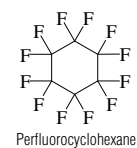
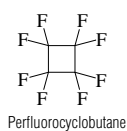
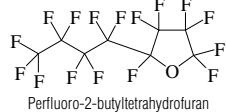
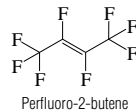
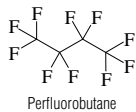
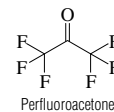
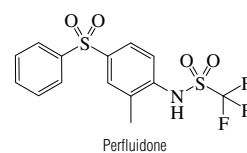
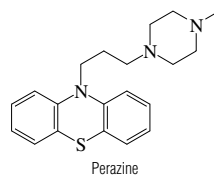
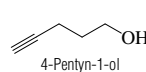
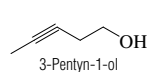
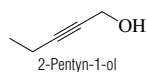
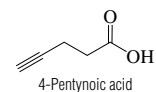
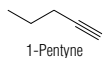
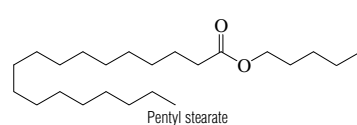
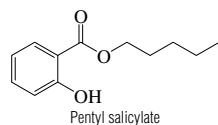
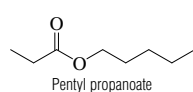
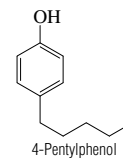
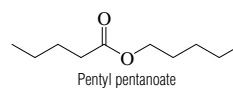
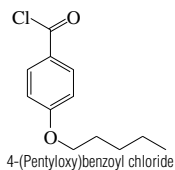
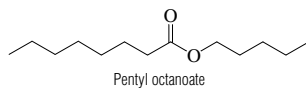
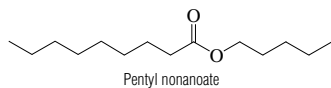
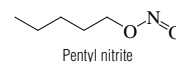
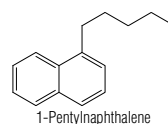
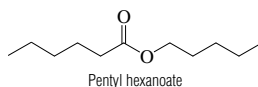
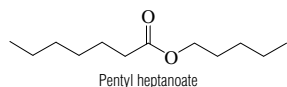
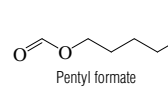
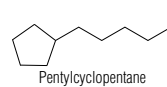
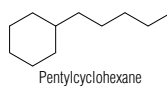
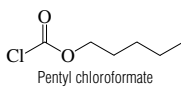
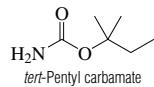
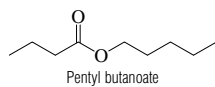
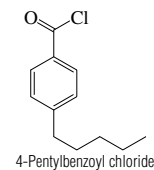
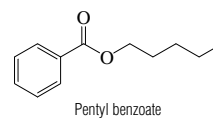
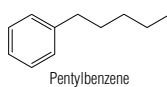
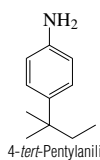
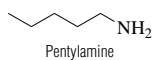
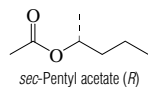
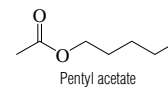
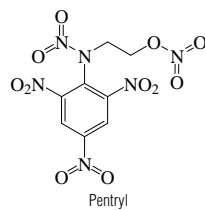
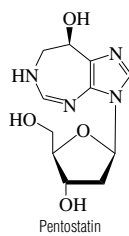
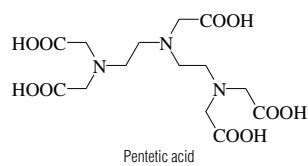
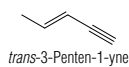
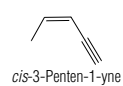


2,4-Pentandiol

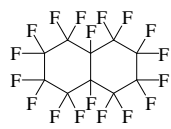
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8616	1,5-Pentanediol diacetate	Pentamethylene acetate	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	6963-44-6	188.221		2	241; 123 <sup>3</sup>	1.0296 <sup>20</sup>	1.4261 <sup>19</sup>	
8617	2,3-Pentanedione	Acetylpropionyl	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	600-14-6	100.117	dk ye liq		108	0.9565 <sup>19</sup>	1.4014 <sup>19</sup>	s H <sub>2</sub> O; msc EtOH, eth, ace
8618	2,4-Pentanedione	Acetylacetone	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	123-54-6	100.117	liq	-23	138	0.9721 <sup>25</sup>	1.4494 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth, ace, chl
8619	Pentanedioyl dichloride		C <sub>5</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	2873-74-7	169.006			217	1.324 <sup>20</sup>	1.4728 <sup>20</sup>	s eth; sl chl
8620	Pentanenitrile	Valeronitrile	C <sub>5</sub> H <sub>9</sub> N	110-59-8	83.132	liq	-96.2	141.3	0.8008 <sup>20</sup>	1.3971 <sup>20</sup>	s eth, ace, bz; sl ctc
8621	1-Pentanethiol	Pentyl mercaptan	C <sub>5</sub> H <sub>12</sub> S	110-66-7	104.214	liq	-75.65	126.6	0.850 <sup>20</sup>	1.4469 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
8622	2-Pentanethiol	sec-Pentyl mercaptan	C <sub>5</sub> H <sub>12</sub> S	2084-19-7	104.214	liq	-169	112.9	0.8327 <sup>20</sup>	1.4412 <sup>20</sup>	s EtOH, liq
8623	3-Pentanethiol	3-Pentyl mercaptan	C <sub>5</sub> H <sub>12</sub> S	616-31-9	104.214	liq	-110.8	105	0.8410 <sup>20</sup>	1.4447 <sup>20</sup>	s EtOH; sl DMSO
8624	Pentanoic acid	Valeric acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	109-52-4	102.132	liq	-33.6	186.1	0.9339 <sup>25</sup>	1.4085 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl ctc
8625	Pentanoic anhydride		C <sub>10</sub> H <sub>16</sub> O <sub>3</sub>	2082-59-9	186.248	liq	-56.1	227	0.924 <sup>20</sup>	1.4171 <sup>26</sup>	vs eth, EtOH
8626	1-Pentanol	Amyl alcohol	C <sub>5</sub> H <sub>12</sub> O	71-41-0	88.148	liq	-77.6	137.98	0.8144 <sup>20</sup>	1.4101 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ace, chl
8627	2-Pentanol	sec-Amyl alcohol	C <sub>5</sub> H <sub>12</sub> O	6032-29-7	88.148	liq	-73	119.3	0.8094 <sup>20</sup>	1.4053 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc, chl
8628	3-Pentanol	Diethyl carbinol	C <sub>5</sub> H <sub>12</sub> O	584-02-1	88.148	liq	-69	116.25	0.8203 <sup>20</sup>	1.4104 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, ctc
8629	2-Pentanone	Methyl propyl ketone	C <sub>5</sub> H <sub>10</sub> O	107-87-9	86.132	liq	-76.8	102.26	0.809 <sup>20</sup>	1.3895 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
8630	3-Pentanone	Diethyl ketone	C <sub>5</sub> H <sub>10</sub> O	96-22-0	86.132	liq	-39	101.7	0.8098 <sup>25</sup>	1.3905 <sup>25</sup>	s H <sub>2</sub> O, ctc; msc EtOH, eth
8631	2-Pentanone oxime	Methyl propyl ketone oxime	C <sub>5</sub> H <sub>11</sub> NO	623-40-5	101.147			168	0.9095 <sup>20</sup>	1.4450 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
8632	Pentanoyl chloride	Valeroyl chloride	C <sub>5</sub> H <sub>9</sub> ClO	638-29-9	120.577	liq	-110	109	1.0155 <sup>15</sup>	1.4200 <sup>20</sup>	
8633	Pentaphene	2,3,6,7-Dibenzphenanthrene	C <sub>22</sub> H <sub>14</sub>	222-93-5	278.346	ye grn lf(xyl)	257				i H <sub>2</sub> O; sl EtOH, xyl, eth; s bz
8634	1,2,3,5,6-Pentathiepane	Lenthionine	C <sub>2</sub> H <sub>2</sub> S <sub>5</sub>	292-46-6	188.378		60.5				
8635	Pentatriacontane		C <sub>35</sub> H <sub>72</sub>	630-07-9	492.947	cry (al)	74.6	490	0.8157 <sup>20</sup>	1.4568 <sup>20</sup>	i H <sub>2</sub> O; sl eth; s ace
8636	18-Pentatriacontanone		C <sub>35</sub> H <sub>70</sub> O	504-53-0	506.930	lf (lig)	89.0	270 <sup>0.1</sup>	0.793 <sup>95</sup>		i H <sub>2</sub> O; sl EtOH, eth, ace, bz, lig, chl
8637	Pentazocine		C <sub>19</sub> H <sub>27</sub> NO	359-83-1	285.423	cry (MeOH aq)	147				
8638	4-Pentalenal		C <sub>9</sub> H <sub>8</sub> O	2100-17-6	84.117			99	0.852 <sup>20</sup>	1.4191 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace
8639	1-Pentene	α-Amylene	C <sub>5</sub> H <sub>10</sub>	109-67-1	70.133	vol liq or gas	-165.12	29.96	0.6405 <sup>20</sup>	1.3715 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz; sl ctc
8640	cis-2-Pentene	cis-β-Amylene	C <sub>5</sub> H <sub>10</sub>	627-20-3	70.133	liq	-151.36	36.93	0.6556 <sup>20</sup>	1.3830 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, dil sulf
8641	trans-2-Pentene	trans-β-Amylene	C <sub>5</sub> H <sub>10</sub>	646-04-8	70.133	liq	-140.21	36.34	0.6431 <sup>25</sup>	1.3793 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz; vs dil sulf
8642	trans-3-Pentenenitrile		C <sub>5</sub> H <sub>9</sub> N	16529-66-1	81.117	liq		144	0.837	1.4220 <sup>20</sup>	
8643	4-Pentenenitrile		C <sub>5</sub> H <sub>9</sub> N	592-51-8	81.117			140	0.8239 <sup>24</sup>	1.4213 <sup>14</sup>	i H <sub>2</sub> O; msc EtOH, eth
8644	trans-3-Pentenoic acid		C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	1617-32-9	100.117			193.2	0.989 <sup>19</sup>		
8645	4-Pentenoic acid	Allylacetic acid	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	591-80-0	100.117	liq	-22.5	188.5	0.9809 <sup>20</sup>	1.4281 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth
8646	1-Penten-3-ol		C <sub>5</sub> H <sub>10</sub> O	616-25-1	86.132			115	0.839 <sup>20</sup>	1.4239 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8647	cis-2-Penten-1-ol		C <sub>5</sub> H <sub>10</sub> O	1576-95-0	86.132			138	0.8529 <sup>20</sup>	1.4354 <sup>20</sup>	s EtOH, eth, ace
8648	trans-2-Penten-1-ol		C <sub>5</sub> H <sub>10</sub> O	1576-96-1	86.132			138	0.8471 <sup>20</sup>	1.4341 <sup>20</sup>	s EtOH, eth, ace
8649	3-Penten-2-ol, (±)		C <sub>5</sub> H <sub>10</sub> O	42569-16-4	86.132			121.6, 65 <sup>70</sup>	0.8328 <sup>25</sup>	1.4280 <sup>20</sup>	vs ace, eth, EtOH
8650	4-Penten-1-ol		C <sub>5</sub> H <sub>10</sub> O	821-09-0	86.132			141	0.8457 <sup>20</sup>	1.4309 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s eth
8651	4-Penten-2-ol		C <sub>5</sub> H <sub>10</sub> O	625-31-0	86.132			116	0.8367 <sup>20</sup>	1.4225 <sup>20</sup>	vs H <sub>2</sub> O; msc EtOH, eth
8652	1-Penten-3-one	Ethyl vinyl ketone	C <sub>5</sub> H <sub>8</sub> O	1629-58-9	84.117			103; 44 <sup>90</sup>	0.8468 <sup>20</sup>	1.4195 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
8653	trans-3-Penten-2-one		C <sub>5</sub> H <sub>8</sub> O	3102-33-8	84.117			122	0.8624 <sup>20</sup>	1.4350 <sup>20</sup>	s H <sub>2</sub> O, eth, ace, ctc
8654	2-(3-Pentenyl)pyridine		C <sub>10</sub> H <sub>13</sub> N	2057-43-4	147.217			216; 93 <sup>12</sup>	0.9234 <sup>25</sup>	1.5076 <sup>25</sup>	
8655	1-Penten-3-yne	Methylvinylacetylene	C <sub>5</sub> H <sub>6</sub>	646-05-9	66.102			59.5	0.7401 <sup>20</sup>	1.4496 <sup>20</sup>	vs bz, eth
8656	1-Penten-4-yne		C <sub>5</sub> H <sub>6</sub>	871-28-3	66.102			42.5	0.738 <sup>16</sup>	1.4125 <sup>16</sup>	i H <sub>2</sub> O; s eth, bz



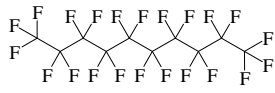
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8657	<i>cis</i> -3-Penten-1-yne		C <sub>5</sub> H <sub>6</sub>	1574-40-9	66.102			44.6			
8658	<i>trans</i> -3-Penten-1-yne		C <sub>5</sub> H <sub>6</sub>	2004-69-5	66.102			52.2			
8659	Pentetic acid	Diethylenetriaminepentaacetic acid	C <sub>14</sub> H <sub>23</sub> N <sub>3</sub> O <sub>10</sub>	67-43-6	393.347	cry (w)	219				s H <sub>2</sub> O, alk
8660	Pentostatin		C <sub>11</sub> H <sub>16</sub> N <sub>4</sub> O <sub>4</sub>	53910-25-1	268.270	wh cry (MeOH aq)	222				
8661	Pentryl	2-( <i>N</i> ,2,4,6-Tetranitroanilino) ethanol	C <sub>8</sub> H <sub>6</sub> N <sub>6</sub> O <sub>11</sub>	4481-55-4	362.167	wh-ye cry	129		1.82		i H <sub>2</sub> O, ctc; s chl; vs eth, bz
8662	Pentyl acetate	Amyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	628-63-7	130.185	liq	-70.8	149.2	0.8756 <sup>20</sup>	1.4023 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
8663	<i>sec</i> -Pentyl acetate ( <i>R</i> )	<i>sec</i> -Amyl acetate ( <i>R</i> )	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	54638-10-7	130.185			142	0.8803 <sup>18</sup>	1.4012 <sup>20</sup>	vs eth, EtOH
8664	Pentylamine	Amylamine	C <sub>6</sub> H <sub>13</sub> N	110-58-7	87.164	liq	-55	104.3	0.7544 <sup>20</sup>	1.448 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; vs ace, bz; sl chl
8665	4- <i>tert</i> -Pentylaniline		C <sub>11</sub> H <sub>17</sub> N	2049-92-5	163.260			260.5			
8666	Pentylbenzene	Amylbenzene	C <sub>11</sub> H <sub>16</sub>	538-68-1	148.245	liq	-75	205.4	0.8585 <sup>20</sup>	1.4878 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
8667	Pentyl benzoate		C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	2049-96-9	192.254			137 <sup>15</sup>			
8668	4-Pentylbenzoyl chloride		C <sub>12</sub> H <sub>15</sub> ClO	49763-65-7	210.699			144 <sup>10</sup> , 121 <sup>8</sup>	1.036 <sup>25</sup>	1.5300 <sup>20</sup>	
8669	Pentyl butanoate	Amyl butyrate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	540-18-1	158.238	liq	-73.2	186.4	0.8713 <sup>15</sup>	1.4123 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
8670	<i>tert</i> -Pentyl carbamate	<i>tert</i> -Amyl carbamate	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	590-60-3	131.173	nd (dil al)	86				vs ace, bz
8671	Pentyl chloroformate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	638-41-5	150.603			61 <sup>15</sup>		1.4181 <sup>18</sup>	s eth
8672	Pentylcyclohexane		C <sub>11</sub> H <sub>22</sub>	4292-92-6	154.293	liq	-57.5	203.7	0.8037 <sup>20</sup>	1.4437 <sup>20</sup>	vs ace, bz, eth, EtOH
8673	Pentylcyclopentane		C <sub>10</sub> H <sub>20</sub>	3741-00-2	140.266	liq	-83	180	0.7912 <sup>20</sup>	1.4356 <sup>20</sup>	i H <sub>2</sub> O; vs ace, bz, eth, EtOH
8674	Pentyl formate	Amyl formate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	638-49-3	116.158	liq	-73.5	130.4	0.8853 <sup>20</sup>	1.3992 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8675	Pentyl heptanoate	Amyl enanthate	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	7493-82-5	200.318	liq	-50	245.4	0.8623 <sup>20</sup>	1.4263 <sup>15</sup>	vs ace, bz, eth, EtOH
8676	Pentyl hexanoate	Amyl caproate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	540-07-8	186.292	liq	-47	226	0.8612 <sup>25</sup>	1.4202 <sup>25</sup>	s EtOH, eth, ace; sl ctc
8677	1-Pentyl-naphthalene		C <sub>15</sub> H <sub>18</sub>	86-89-5	198.304	liq	-22	307	0.9656 <sup>20</sup>	1.5725 <sup>20</sup>	
8678	Pentyl nitrite	Amyl nitrite	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	463-04-7	117.147			104.5	0.8817 <sup>20</sup>	1.3851 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8679	Pentyl nonanoate	Pentyl pelargonate	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	61531-45-1	228.371		-27	131 <sup>20</sup>	0.8506 <sup>25</sup>	1.4318 <sup>20</sup>	
8680	Pentyl octanoate	Amyl octanoate	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	638-25-5	214.344	liq	-34.8	260.2	0.8613 <sup>20</sup>	1.4262 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace
8681	4-(Pentyl-oxo)benzoyl chloride		C <sub>12</sub> H <sub>15</sub> ClO <sub>2</sub>	36823-84-4	226.699			198 <sup>30</sup> , 182 <sup>25</sup>	1.087 <sup>25</sup>	1.5434 <sup>20</sup>	
8682	Pentyl pentanoate		C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2173-56-0	172.265	liq	-78.8	203.7	0.8638 <sup>20</sup>	1.4164 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8683	4-Pentylphenol		C <sub>11</sub> H <sub>16</sub> O	14938-35-3	164.244		23	250.5	0.960 <sup>20</sup>	1.5272 <sup>25</sup>	vs eth, EtOH
8684	Pentyl propanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	624-54-4	144.212	liq	-73.1	168.6	0.8761 <sup>25</sup>	1.4096 <sup>15</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz; sl ctc
8685	Pentyl salicylate		C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	2050-08-0	208.253			270	1.064 <sup>15</sup>	1.506 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8686	Pentyl stearate		C <sub>23</sub> H <sub>46</sub> O <sub>2</sub>	6382-13-4	354.610	pl	30			1.4342 <sup>20</sup>	vs eth, EtOH
8687	1-Pentyne	Propylacetylene	C <sub>6</sub> H <sub>8</sub>	627-19-0	68.118	liq	-90	40.1	0.6901 <sup>20</sup>	1.3852 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth; s bz, chl; sl ctc
8688	2-Pentyne		C <sub>6</sub> H <sub>8</sub>	627-21-4	68.118	liq	-109.3	56.1	0.7058 <sup>25</sup>	1.4039 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth; s bz, chl
8689	4-Pentynoic acid	Propargylacetic acid	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	6089-09-4	98.101		57.7	110 <sup>30</sup> , 102 <sup>17</sup>			vs eth, EtOH
8690	2-Pentyn-1-ol		C <sub>6</sub> H <sub>8</sub> O	6261-22-9	84.117	liq	-49.7	154; 61 <sup>15</sup>	0.909 <sup>20</sup>	1.4518 <sup>17</sup>	
8691	3-Pentyn-1-ol		C <sub>6</sub> H <sub>8</sub> O	10229-10-4	84.117			154	0.9002 <sup>20</sup>	1.4454 <sup>20</sup>	
8692	4-Pentyn-1-ol		C <sub>6</sub> H <sub>8</sub> O	5390-04-5	84.117			154	0.913 <sup>20</sup>	1.4414 <sup>20</sup>	
8693	Perazine	10-[3-(4-Methyl-1-piperazinyl)propyl]-10 <i>H</i> -phenothiazine	C <sub>20</sub> H <sub>28</sub> N <sub>3</sub> S	84-97-9	339.498	cry	52	165 <sup>001</sup>			
8694	Perfluoridone		C <sub>14</sub> H <sub>12</sub> F <sub>3</sub> NO <sub>4</sub> S <sub>2</sub>	37924-13-3	379.375		143				
8695	Perfluoroacetone	Hexafluoroacetone	C <sub>3</sub> F <sub>6</sub> O	684-16-2	166.021	col gas	-125.45	-27.4			
8696	Perfluorobutane	Decafluorobutane	C <sub>4</sub> F <sub>10</sub>	355-25-9	238.027	col gas	-129.1	-1.9	1.6484 <sup>25</sup>		s bz, chl
8697	Perfluoro-2-butene		C <sub>4</sub> F <sub>8</sub>	360-89-4	200.030	col gas	-129	1.5	1.5297 <sup>25</sup>		
8698	Perfluoro-2-butyltetrahydrofuran		C <sub>8</sub> F <sub>16</sub> O	335-36-4	416.059			102.6			
8699	Perfluorocyclobutane	Octafluorocyclobutane	C <sub>4</sub> F <sub>8</sub>	115-25-3	200.030	col gas	-40.19	-5.91	1.500 <sup>25</sup> (p>1 atm)		i H <sub>2</sub> O; s eth
8700	Perfluorocyclohexane		C <sub>6</sub> F <sub>12</sub>	355-68-0	300.045		62.5 (triple point)	52.8 sp			
8701	Perfluorocyclohexene		C <sub>6</sub> F <sub>10</sub>	355-75-9	262.048			52.0	1.6650 <sup>25</sup>	1.293 <sup>20</sup>	



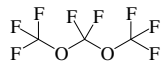
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8702	Perfluorodecalin		C <sub>10</sub> F <sub>18</sub>	306-94-5	462.078	liq	-10	142.02	1.9305 <sup>25</sup>		
8703	Perfluorodecane		C <sub>10</sub> F <sub>22</sub>	307-45-9	538.072			144.2			i H <sub>2</sub> O
8704	Perfluorodimethoxymethane		C <sub>2</sub> F <sub>8</sub> O <sub>2</sub>	53772-78-4	220.018	col gas	-161	-10			
8705	Perfluoro-2,3-dimethylbutane		C <sub>6</sub> F <sub>14</sub>	354-96-1	338.042	liq	-15	59.8			
8706	Perfluoroethyl ethyl ether		C <sub>4</sub> H <sub>2</sub> F <sub>8</sub> O	22052-81-9	164.074	vol liq or gas		28.11			
8707	Perfluoroethyl 2,2,2-trifluoroethyl ether		C <sub>4</sub> H <sub>2</sub> F <sub>8</sub> O	156053-88-2	218.045	vol liq or gas		27.89			
8708	Perfluoroheptane		C <sub>7</sub> F <sub>16</sub>	335-57-9	388.049	liq	-51.2	82.5	1.7333 <sup>20</sup>	1.2618 <sup>20</sup>	i H <sub>2</sub> O; vs ace, eth, EtOH, chl
8709	Perfluoro-1-heptene		C <sub>7</sub> F <sub>14</sub>	355-63-5	350.053			81.0			
8710	Perfluorohexane		C <sub>6</sub> F <sub>14</sub>	355-42-0	338.042	liq	-88.2	57.14	1.6910 <sup>20</sup>	1.2515 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
8711	Perfluoro-1-hexene		C <sub>6</sub> F <sub>12</sub>	755-25-9	300.045			57.0			vs chl
8712	Perfluoroisobutane		C <sub>4</sub> F <sub>10</sub>	354-92-7	238.027	col gas		0			
8713	Perfluoroisobutene	Perfluoroisobutylene	C <sub>4</sub> F <sub>8</sub>	382-21-8	200.030	col gas	-130	7	1.5922 <sup>0</sup>		
8714	Perfluoroisopropyl methyl ether		C <sub>7</sub> H <sub>2</sub> F <sub>7</sub> O	22052-84-2	200.055	vol liq or gas		29.34	1.4205 <sup>20</sup>		
8715	Perfluoromethylcyclohexane		C <sub>7</sub> F <sub>14</sub>	355-02-2	350.053	liq	-44.7	76.3	1.7878 <sup>25</sup>	1.2851 <sup>7</sup>	s ace, bz, ctc, tol, AcOEt
8716	Perfluoro-2-methylpentane		C <sub>6</sub> F <sub>14</sub>	355-04-4	338.042			57.6	1.7326 <sup>20</sup>	1.2564 <sup>22</sup>	i H <sub>2</sub> O; s bz
8717	Perfluoro-3-methylpentane		C <sub>6</sub> F <sub>14</sub>	865-71-4	338.042	liq	-115	58.4			s bz
8718	Perfluoronaphthalene		C <sub>10</sub> F <sub>8</sub>	313-72-4	272.094		87.5	209			
8719	Perfluorononane		C <sub>9</sub> F <sub>20</sub>	375-96-2	488.064			117.61	1.8001 <sup>20</sup>		
8720	Perfluorooctane		C <sub>8</sub> F <sub>18</sub>	307-34-6	438.057			105.9	1.73 <sup>20</sup>	1.282 <sup>20</sup>	i H <sub>2</sub> O
8721	Perfluorooctylsulfonyl fluoride		C <sub>8</sub> F <sub>18</sub> O <sub>2</sub> S	307-35-7	502.121	liq		154			
8722	Perfluorooxetane		C <sub>3</sub> F <sub>6</sub> O	425-82-1	166.021	col gas	-117	-28.4			
8723	Perfluoropentane		C <sub>5</sub> F <sub>12</sub>	678-26-2	288.035	vol liq or gas	-10	29.2			i H <sub>2</sub> O
8724	Perfluoropropane		C <sub>3</sub> F <sub>8</sub>	76-19-7	188.019	col gas	-147.70	-36.6			i H <sub>2</sub> O
8725	Perfluoropropene		C <sub>3</sub> F <sub>6</sub>	116-15-4	150.022	col gas	-156.5	-29.6		1.583 <sup>-40</sup>	i H <sub>2</sub> O
8726	Perfluoropropyl methyl ether		C <sub>4</sub> H <sub>2</sub> F <sub>7</sub> O	375-03-1	200.055			34.23	1.4092 <sup>20</sup>		
8727	Perfluoropyridine	Pentafluoropyridine	C <sub>5</sub> F <sub>5</sub> N	700-16-3	169.053			83.7			
8728	Perfluorotoluene		C <sub>7</sub> F <sub>8</sub>	434-64-0	236.062	liq	-65.49	103.55	1.6616 <sup>25</sup>	1.3670 <sup>20</sup>	
8729	Perfluorotripropylamine		C <sub>9</sub> F <sub>21</sub> N	338-83-0	521.069			130	1.822 <sup>4</sup>	1.279 <sup>25</sup>	
8730	1 <i>H</i> -Perimidine		C <sub>11</sub> H <sub>6</sub> N <sub>2</sub>	204-02-4	168.195	grn cry (dil al)	223.0				i H <sub>2</sub> O; s EtOH, eth, ace, bz; sl DMSO
8731	Permethrin		C <sub>21</sub> H <sub>20</sub> Cl <sub>2</sub> O <sub>3</sub>	52645-53-1	391.288	cry or ye liq	34	200 <sup>0,01</sup>	1.23 <sup>20</sup>		i H <sub>2</sub> O; s os
8732	Peroxyacetic acid	Ethaneperoxoic acid	C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	79-21-0	76.051	liq	-0.2	110	1.226 <sup>15</sup>	1.3974 <sup>20</sup>	vs H <sub>2</sub> O, eth, sulf; s EtOH
8733	Peroxypropanoic acid	Propaneperoxoic acid	C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	4212-43-5	90.078			exp 119.7		1.4148 <sup>15</sup>	
8734	Perphenazine		C <sub>21</sub> H <sub>26</sub> ClN <sub>3</sub> OS	58-39-9	403.968		97				
8735	Perthane	Ethane, 1,1-dichloro-2,2-bis( <i>p</i> -ethylphenyl)-	C <sub>18</sub> H <sub>20</sub> Cl <sub>2</sub>	72-56-0	307.258		56				
8736	Perylene	Dibenz[de,kl]anthracene	C <sub>20</sub> H <sub>12</sub>	198-55-0	252.309	gold-br, ye pl (bz, HOAc)	277.76		1.35 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth; vs ace, chl; s bz
8737	Peucedanin	3-Methoxy-2-isopropyl-7 <i>H</i> -furo[3,2- <i>g</i> ][1]benzopyran-7-one	C <sub>15</sub> H <sub>14</sub> O <sub>4</sub>	133-26-6	258.270	pr or pl (bz-peth)	85	278 <sup>17</sup>			sl H <sub>2</sub> O, bz; s EtOH, eth; vs chl, CS <sub>2</sub>
8738	Phalloidin		C <sub>35</sub> H <sub>48</sub> N <sub>8</sub> O <sub>11</sub> S	17466-45-4	788.868	nd (w)	281 (hyd)				s EtOH, MeOH, py
8739	Phalloin		C <sub>35</sub> H <sub>48</sub> N <sub>8</sub> O <sub>10</sub> S	28227-92-1	772.869	cry (w)	250 dec				
8740	α-Phellandrene	2-Methyl-5-(1-methylethyl)-1,3-cyclohexadiene	C <sub>10</sub> H <sub>16</sub>	99-83-2	136.234		238	174.9	0.8410 <sup>20</sup>	1.471 <sup>25</sup>	i H <sub>2</sub> O; s eth
8741	β-Phellandrene	<i>p</i> -Mentha-1(7),2-diene	C <sub>10</sub> H <sub>16</sub>	555-10-2	136.234			171.5	0.8520 <sup>20</sup>	1.4788 <sup>20</sup>	i H <sub>2</sub> O, EtOH; s eth
8742	9-Phenanthrenamine		C <sub>14</sub> H <sub>11</sub> N	947-73-9	193.244	lt ye cry (al)	138.3	sub			sl eth, bz, chl
8743	Phenanthrene		C <sub>14</sub> H <sub>10</sub>	85-01-8	178.229	mcl pl (al), lf (sub)	99.24	340	0.9800 <sup>4</sup>	1.5943	i H <sub>2</sub> O; s EtOH, eth, ace, bz, CS <sub>2</sub>
8744	9,10-Phenanthrene-dione	Phenanthrenequinone	C <sub>14</sub> H <sub>6</sub> O <sub>2</sub>	84-11-7	208.213	oran nd (to) oran-red pl (sub)	209		1.405 <sup>22</sup>		i H <sub>2</sub> O; sl EtOH, bz; s eth
8745	Phenanthridine		C <sub>13</sub> H <sub>9</sub> N	229-87-8	179.217	nd (dil al)	107.4	348.9			sl H <sub>2</sub> O; vs EtOH, eth, bz, CS <sub>2</sub> ; s ace
8746	1,7-Phenanthroline		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	230-46-6	180.205	pl (anh), nd (w+2)	78	360			s H <sub>2</sub> O; vs EtOH; i eth, bz, lig
8747	1,10-Phenanthroline	<i>o</i> -Phenanthroline	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	66-71-7	180.205	wh nd (bz) cry (w+1)	117	>300			vs H <sub>2</sub> O; s EtOH, ace, bz; i peth
8748	4,7-Phenanthroline		C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	230-07-9	180.205	nd (w)	177	sub 100			s H <sub>2</sub> O, lig; vs EtOH; sl eth, bz, CS <sub>2</sub>



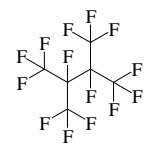
Perfluorodecalin



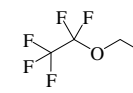
Perfluorodecane



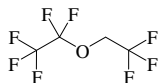
Perfluorodimethoxymethane



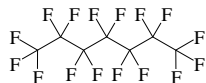
Perfluoro-2,3-dimethylbutane



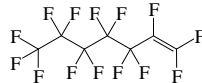
Perfluoroethyl ethyl ether



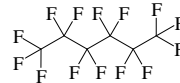
Perfluoroethyl 2,2,2-trifluoroethyl ether



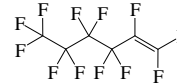
Perfluoroheptane



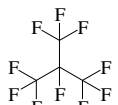
Perfluoro-1-heptene



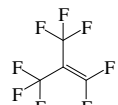
Perfluorohexane



Perfluoro-1-hexene



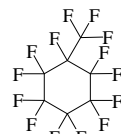
Perfluoroisobutane



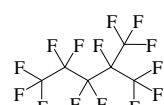
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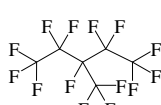
Perfluoroisopropyl methyl ether



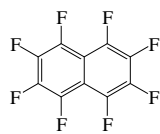
Perfluoromethylcyclohexane



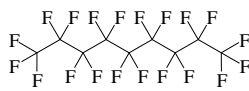
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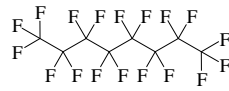
Perfluoro-3-methylpentane



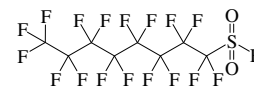
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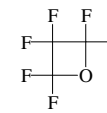
Perfluorononane



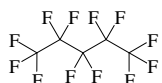
Perfluorooctane



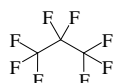
Perfluorooctylsulfonyl fluoride



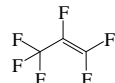
Perfluorooxetane



Perfluoropentane



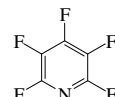
Perfluoropropane



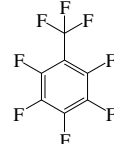
Perfluoropropene



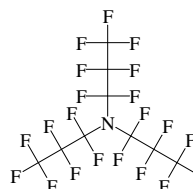
Perfluoropropyl methyl ether



Perfluoropyridine



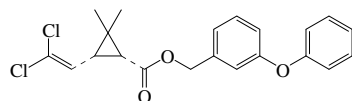
Perfluorotoluene



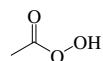
Perfluorotripropylamine



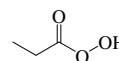
1H-Perimidine



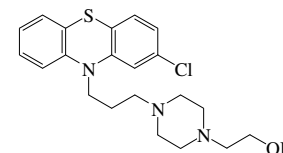
Permethrin



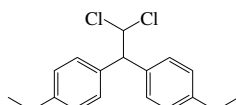
Peroxyacetic acid



Peroxypropanoic acid



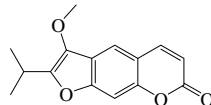
Perphenazine



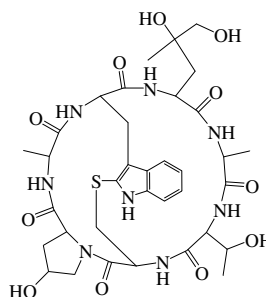
Perthane



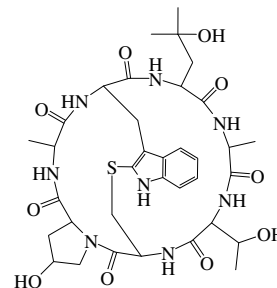
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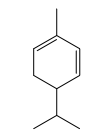
Peucedanin



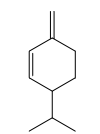
Phalloidin



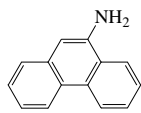
Phalloin



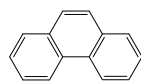
α-Phellandrene



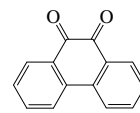
β-Phellandrene



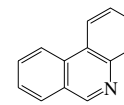
9-Phenanthrenamine



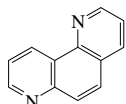
Phenanthrene



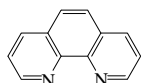
9,10-Phenanthrene-9,10-dione



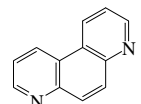
Phenanthridine



1,7-Phenanthroline



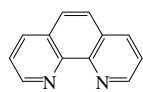
1,10-Phenanthroline



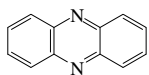
4,7-Phenanthroline

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8749	1,10-Phenanthroline monohydrate	<i>o</i> -Phenanthroline monohydrate	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	5144-89-8	198.219	wh cry pow	93				s EtOH, ace; sl bz
8750	Phenazine	Dibenzopyrazine	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	92-82-0	180.205	ye-red nd (HOAc)	176.5				sl H <sub>2</sub> O, eth; s bz, EtOH
8751	2,3-Phenazinediamine	2,3-Diaminophenazine	C <sub>12</sub> H <sub>10</sub> N <sub>4</sub>	655-86-7	210.234	ye nd	264	sub			vs bz, EtOH
8752	1-Phenazinol	Hemipycocyanine	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub> O	528-71-2	196.204	ye nd (bz, dil MeOH)	158	sub			sl H <sub>2</sub> O, EtOH; s bz, py, dil alk
8753	Phenazopyridine	2,6-Diamino-3-phenylazopyridine	C <sub>11</sub> H <sub>11</sub> N <sub>3</sub>	94-78-0	213.239	red cry	139				
8754	Phenazopyridine hydrochloride	3-(Phenylazo)-2,6-pyridinediamine, monohydrochloride	C <sub>11</sub> H <sub>12</sub> ClN <sub>3</sub>	136-40-3	249.700	ye-red cry					sl H <sub>2</sub> O, EtOH; i bz, ace; s HOAc
8755	Phencarbamide		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> OS	3735-90-8	328.471		48.5	121 <sup>0.01</sup>			vs eth, chl, MeOH, peth
8756	Phendimetrazine	3,4-Dimethyl-2-phenylmorpholine	C <sub>12</sub> H <sub>17</sub> NO	634-03-7	191.269			134 <sup>12</sup> , 78 <sup>0.35</sup>			
8757	Phenethicillin potassium		C <sub>17</sub> H <sub>18</sub> KN <sub>2</sub> O <sub>6</sub> S	132-93-4	402.506	cry (ace)	235				s H <sub>2</sub> O
8758	Phenicin		C <sub>14</sub> H <sub>10</sub> O <sub>6</sub>	128-68-7	274.225	ye-br (al)	230.5				sl H <sub>2</sub> O; vs EtOH, chl, HOAc
8759	Phenindamine		C <sub>19</sub> H <sub>19</sub> N	82-88-2	261.361	cry	91		1.17		
8760	Phenmedipham		C <sub>18</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub>	13684-63-4	300.309		143				
8761	Phenobarbital	5-Ethyl-5-phenyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	50-06-6	232.234	pl (w)	174				i H <sub>2</sub> O, bz; s EtOH, eth; sl DMSO
8762	Phenol	Hydroxybenzene	C <sub>6</sub> H <sub>6</sub> O	108-95-2	94.111		40.89	181.87	1.0545 <sup>45</sup>	1.5408 <sup>41</sup>	s H <sub>2</sub> O, EtOH; vs eth; msc ace, bz
8763	Phenolphthalein	3,3-Bis(4-hydroxyphenyl)-1(3 <i>H</i> )-isobenzofuranone	C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	77-09-8	318.323	wh orth nd	262.5		1.277 <sup>32</sup>		i H <sub>2</sub> O, bz; vs EtOH, ace; s eth, chl
8764	Phenolphthalin	2-[Bis(4-hydroxyphenyl)methyl] benzoic acid	C <sub>20</sub> H <sub>16</sub> O <sub>4</sub>	81-90-3	320.339	nd (w)	230.5				vs eth, EtOH
8765	Phenolphthalol		C <sub>20</sub> H <sub>16</sub> O <sub>3</sub>	81-92-5	306.355	cry (dil al)	201.5				
8766	Phenol Red	Phenolsulfonphthalein	C <sub>19</sub> H <sub>14</sub> O <sub>3</sub> S	143-74-8	354.376	dk red nd or pl	>300				sl H <sub>2</sub> O, EtOH, ace, bz; i eth, chl
8767	10 <i>H</i> -Phenothiazine	Thiodiphenylamine	C <sub>12</sub> H <sub>9</sub> NS	92-84-2	199.271	ye pr (al) ye lf or pl (tol)	187.5	371			vs ace, bz, eth, EtOH
8768	Phenothrin		C <sub>23</sub> H <sub>26</sub> O <sub>3</sub>	26002-80-2	350.450	col liq			1.061 <sup>25</sup>	1.5483 <sup>25</sup>	i H <sub>2</sub> O; s ace, xyl
8769	10 <i>H</i> -Phenoxazine		C <sub>12</sub> H <sub>9</sub> NO	135-67-1	183.205	lf (dil al, bz)	156	dec			vs bz, eth, EtOH
8770	Phenoxyacetic acid		C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	122-59-8	152.148	nd or pl (w)	98.5	dec 285			s H <sub>2</sub> O; vs EtOH, eth, bz, CS <sub>2</sub>
8771	Phenoxyacetyl chloride		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	701-99-5	170.594			225.5			s eth
8772	Phenoxyacetylene		C <sub>8</sub> H <sub>6</sub> O	4279-76-9	118.133		-36	61 <sup>25</sup>	1.0614 <sup>20</sup>	1.5125 <sup>20</sup>	vs eth, EtOH
8773	2-Phenoxyaniline		C <sub>12</sub> H <sub>11</sub> NO	2688-84-8	185.221	cry (lig)	45.8	308; 172 <sup>14</sup>			s EtOH; s eth, ace, bz
8774	3-Phenoxyaniline		C <sub>12</sub> H <sub>11</sub> NO	3586-12-7	185.221	pr (lig)	37	315; 180 <sup>10</sup>	1.1583 <sup>25</sup>		s EtOH, eth, ace, bz; sl lig
8775	4-Phenoxyaniline		C <sub>12</sub> H <sub>11</sub> NO	139-59-3	185.221	nd (w), cry (dil al)	85.5				s H <sub>2</sub> O; vs EtOH, eth; sl lig
8776	3-Phenoxybenzaldehyde		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	39515-51-0	198.217		14.0	169 <sup>11</sup> , 140 <sup>0.1</sup>	1.147 <sup>25</sup>	1.5954 <sup>20</sup>	
8777	Phenoxybenzamine		C <sub>18</sub> H <sub>22</sub> ClNO	59-96-1	303.827		39				s bz
8778	Phenoxybenzamine hydrochloride		C <sub>18</sub> H <sub>23</sub> Cl <sub>2</sub> NO	63-92-3	340.288		139				sl H <sub>2</sub> O; s EtOH
8779	2-Phenoxybenzoic acid		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	2243-42-7	214.216	lf (dil al)	113	355	1.1553 <sup>50</sup>		i H <sub>2</sub> O; vs EtOH, eth; s chl
8780	3-Phenoxybenzoic acid		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	3739-38-6	214.216	nd (aq al)	145.8				i H <sub>2</sub> O; s EtOH, eth
8781	4-Phenoxybenzoic acid		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	2215-77-2	214.216	pr (chl)	161				sl H <sub>2</sub> O; s EtOH, eth, chl
8782	2-Phenoxyethanol		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	122-99-6	138.164	oil	14	245	1.102 <sup>22</sup>	1.534 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl, alk
8783	2-Phenoxyethyl acrylate	Phenyl Cellosolve acrylate	C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	48145-04-6	192.211			110 <sup>2</sup>	1.090 <sup>25</sup>		vs ace, eth, chl
8784	2-Phenoxyethyl butanoate		C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	23511-70-8	208.253			251; 88 <sup>2</sup>	1.0388 <sup>21</sup>		vs ace, eth, EtOH
8785	3-Phenoxyphenol		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	713-68-8	186.206			175 <sup>7</sup>			
8786	4-Phenoxyphenol		C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	831-82-3	186.206		84.0				
8787	2-(3-Phenoxyphenyl)propanoic acid, (±)	Fenoprofen	C <sub>15</sub> H <sub>14</sub> O <sub>3</sub>	31879-05-7	242.270	visc oil		170 <sup>11</sup>		1.5742 <sup>25</sup>	
8788	3-Phenoxy-1,2-propanediol	Phenylglyceryl ether	C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	538-43-2	168.189	nd (eth, peth)	67.5	200 <sup>22</sup>	1.225 <sup>20</sup>		vs H <sub>2</sub> O, bz, eth, EtOH
8789	2-Phenoxypropanoic acid		C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	940-31-8	166.173	nd (w)	115.5	266; 105 <sup>5</sup>	1.1865 <sup>20</sup>	1.5184 <sup>20</sup>	
8790	2-Phenoxy-1-propanol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	4169-04-4	152.190			244	0.9801 <sup>25</sup>	1.4760 <sup>25</sup>	s EtOH, eth
8791	1-Phenoxy-2-propanol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	770-35-4	152.190			233; 134 <sup>20</sup>	1.0622 <sup>20</sup>	1.5232 <sup>20</sup>	
8792	1-Phenoxy-2-propanone	Phenoxyacetone	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	621-87-4	150.174			229.5	1.0903 <sup>20</sup>	1.5228 <sup>20</sup>	s eth, ace

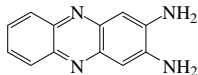




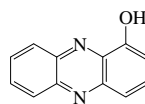
H<sub>2</sub>O  
1,10-Phenanthroline monohydrate



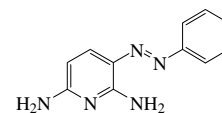
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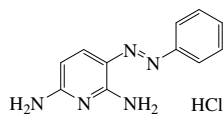
2,3-Phenazinediamine



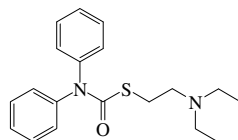
1-Phenazolinol



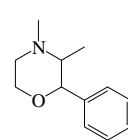
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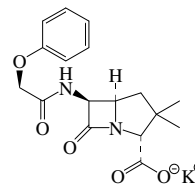
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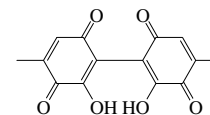
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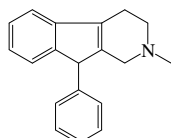
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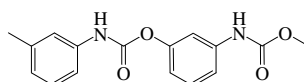
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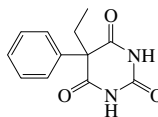
Phenicin



Phenindamine



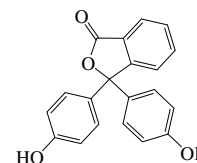
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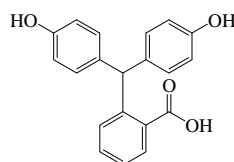
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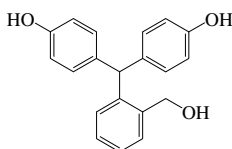
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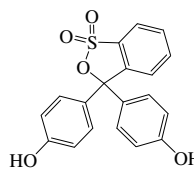
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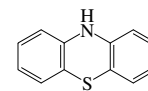
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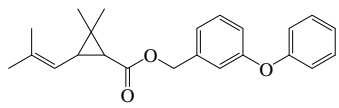
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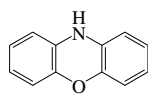
Phenol Red



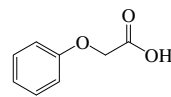
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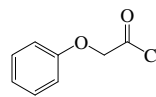
Phenothrin



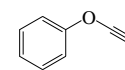
10H-Phenoxazine



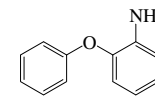
Phenoxyacetic acid



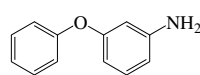
Phenoxyacetyl chloride



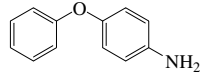
Phenoxyacetylene



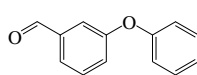
2-Phenoxyaniline



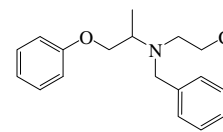
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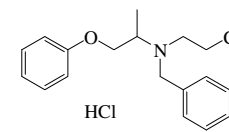
4-Phenoxyaniline



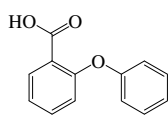
3-Phenoxybenzaldehyde



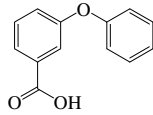
Phenoxybenzamine



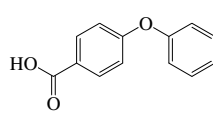
Phenoxybenzamine hydrochloride



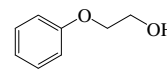
2-Phenoxybenzoic acid



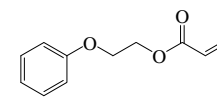
3-Phenoxybenzoic acid



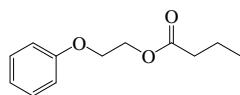
4-Phenoxybenzoic acid



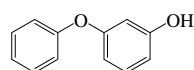
2-Phenoxyethanol



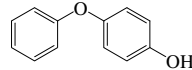
2-Phenoxyethyl acrylate



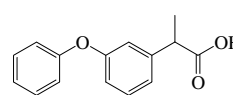
2-Phenoxyethyl butanoate



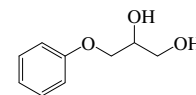
3-Phenoxyphenol



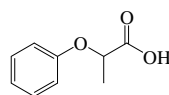
4-Phenoxyphenol



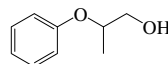
2-(3-Phenoxyphenyl)propanoic acid, (±)



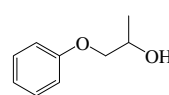
3-Phenoxy-1,2-propanediol



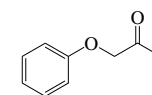
2-Phenoxypropanoic acid



2-Phenoxy-1-propanol

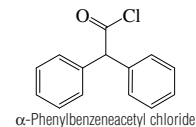
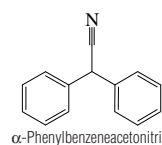
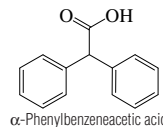
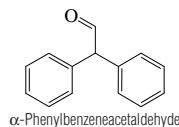
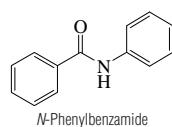
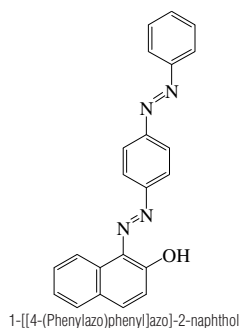
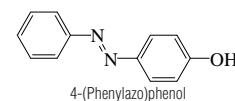
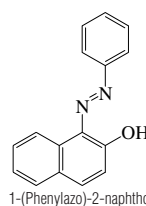
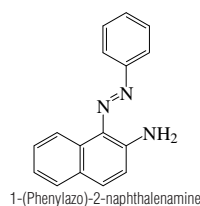
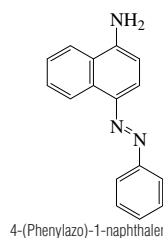
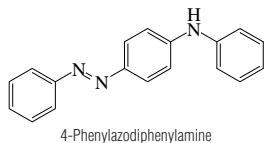
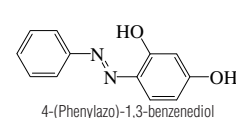
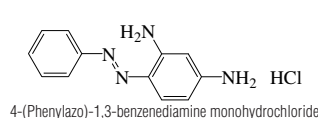
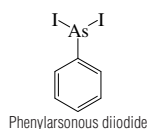
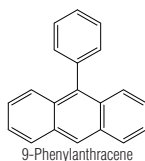
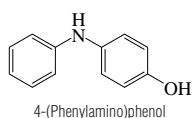
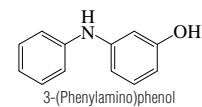
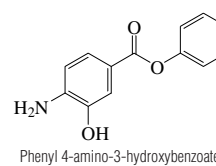
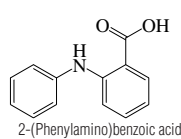
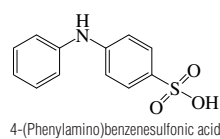
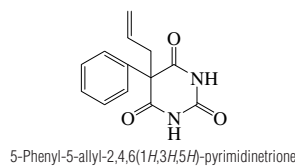
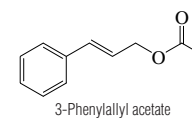
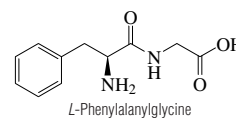
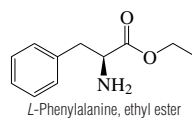
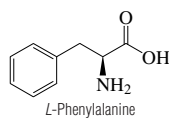
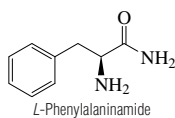
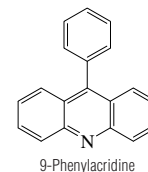
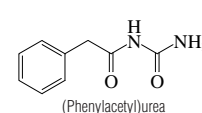
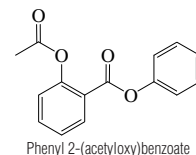
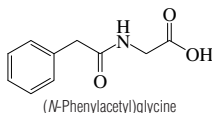
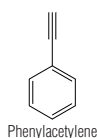
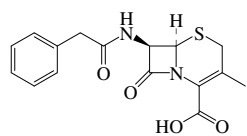
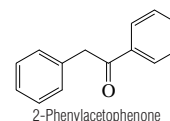
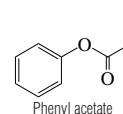
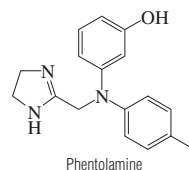
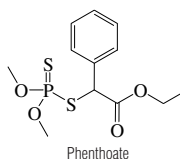
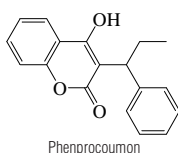
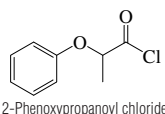


1-Phenoxy-2-propanol

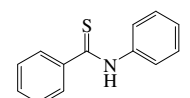


1-Phenoxy-2-propanone

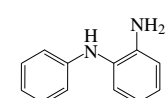
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8793	2-Phenoxypropanoyl chloride		C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	122-35-0	184.619			147; 116 <sup>10</sup>	1.1865 <sup>20</sup>	1.5178 <sup>20</sup>	s eth
8794	Phenprocoumon	3-( $\alpha$ -Ethylbenzyl)-4-hydroxycoumarin	C <sub>18</sub> H <sub>16</sub> O <sub>3</sub>	435-97-2	280.318	pr (MeOH aq)	179				
8795	Phenthoate		C <sub>12</sub> H <sub>17</sub> O <sub>4</sub> PS <sub>2</sub>	2597-03-7	320.364	ye oil		123 <sup>0.01</sup>			sl H <sub>2</sub> O; s hx
8796	Phentolamine		C <sub>17</sub> H <sub>19</sub> N <sub>3</sub> O	50-60-2	281.352		175				
8797	Phenyl acetate		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	122-79-2	136.149			196; 75 <sup>9</sup>	1.0780 <sup>20</sup>	1.5035 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, chl; s ctc
8798	2-Phenylacetophenone		C <sub>14</sub> H <sub>12</sub> O	451-40-1	196.244	pl (al)	60	320	1.201 <sup>0</sup>		sl H <sub>2</sub> O; s EtOH, eth, ctc, chl
8799	<i>N</i> -(Phenylacetyl)-7-aminodeacetoxycephalosporanic acid	7-Phenylacetamidodeacetoxycephalosporanic acid	C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S	27255-72-7	332.374	cry (2-PrOH/peth)	200				
8800	Phenylacetylene	Ethyrylbenzene	C <sub>8</sub> H <sub>6</sub>	536-74-3	102.134	liq	-44.8	143	0.9300 <sup>20</sup>	1.5470 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace; sl chl
8801	( <i>N</i> -Phenylacetyl)glycine	Phenaceturic acid	C <sub>10</sub> H <sub>11</sub> NO <sub>3</sub>	500-98-1	193.199	lf (EtOH)	143				
8802	Phenyl 2-(acetyloxy)benzoate	Phenyl acetylsalicylate	C <sub>15</sub> H <sub>12</sub> O <sub>4</sub>	134-55-4	256.254		96				
8803	(Phenylacetyl)urea	Phenacemide	C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	63-98-9	178.187	cry (al)	215				vs bz, eth, EtOH
8804	9-Phenylacridine		C <sub>19</sub> H <sub>13</sub> N	602-56-2	255.313	ye nd, lf (al)	184	404			i H <sub>2</sub> O; sl EtOH; s eth; vs bz
8805	<i>L</i> -Phenylalaninamide	$\alpha$ -Aminobenzenepropanamide, ( <i>S</i> -)	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O	5241-58-7	164.203		82				
8806	<i>L</i> -Phenylalanine	$\alpha$ -Aminobenzenepropanoic acid, ( <i>S</i> )	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	63-91-2	165.189	pr (w)	283 dec				sl H <sub>2</sub> O; i EtOH, eth, bz, acid
8807	<i>L</i> -Phenylalanine, ethyl ester	Ethyl 2-amino-3-phenylpropionate	C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	3081-24-1	193.243		136	148 <sup>13</sup>	1.065 <sup>15</sup>		sl H <sub>2</sub> O
8808	<i>L</i> -Phenylalanyl glycine		C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	721-90-4	222.240		262 dec				s H <sub>2</sub> O
8809	3-Phenylallyl acetate		C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	103-54-8	176.212			123 <sup>5</sup>			
8810	5-Phenyl-5-allyl-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-pyrimidinetrione	Phenallymal	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	115-43-5	244.245		156.5				sl H <sub>2</sub> O, bz, DMSO; vs EtOH, eth; i lig
8811	4-(Phenylamino)benzenesulfonic acid	<i>N</i> -Phenylsulfanilic acid	C <sub>12</sub> H <sub>11</sub> NO <sub>3</sub> S	101-57-5	249.285	pl (al-eth)	206				vs H <sub>2</sub> O, EtOH
8812	2-(Phenylamino)benzoic acid	<i>N</i> -Phenylanthranilic acid	C <sub>13</sub> H <sub>11</sub> NO <sub>2</sub>	91-40-7	213.232	lf (al)	183.5				i H <sub>2</sub> O; vs EtOH; sl eth, bz
8813	Phenyl 4-amino-3-hydroxybenzoate	Phenyl <i>p</i> -aminosalicylate	C <sub>13</sub> H <sub>11</sub> NO <sub>3</sub>	133-11-9	229.231		153				
8814	3-(Phenylamino)phenol		C <sub>12</sub> H <sub>11</sub> NO	101-18-8	185.221	lf (w)	81.5	340			sl H <sub>2</sub> O; vs EtOH, eth, ace; s bz, acid
8815	4-(Phenylamino)phenol		C <sub>12</sub> H <sub>11</sub> NO	122-37-2	185.221	lf (w)	73	330			sl H <sub>2</sub> O; vs EtOH, eth, bz, chl; s acid
8816	9-Phenylanthracene		C <sub>20</sub> H <sub>14</sub>	602-55-1	254.325	bl lf (al) (HOAc)	156	417			i H <sub>2</sub> O; s EtOH, eth, bz, chl, CS <sub>2</sub>
8817	Phenylarsonous diiodide		C <sub>6</sub> H <sub>5</sub> AsI <sub>2</sub>	6380-34-3	405.835		15	205 <sup>14</sup> , 185 <sup>10</sup>	1.6264 <sup>15</sup>		
8818	4-(Phenylazo)-1,3-benzenediamine monohydrochloride	Chrysoidine hydrochloride	C <sub>12</sub> H <sub>13</sub> ClN <sub>4</sub>	532-82-1	248.711	red-br cry pow	118.5				vs ace
8819	4-(Phenylazo)-1,3-benzenediol		C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	2051-85-6	214.219	dk red nd (dil al)	170				i H <sub>2</sub> O; vs EtOH, eth, bz, HOAc
8820	4-Phenylazodiphenylamine	<i>N</i> -Phenyl-4-(phenylazo)benzenamine	C <sub>18</sub> H <sub>15</sub> N <sub>3</sub>	101-75-7	273.332	ye pl or pr	84.0				i H <sub>2</sub> O; vs EtOH, eth, lig
8821	4-(Phenylazo)-1-naphthalenamine	$\alpha$ -Naphthyl Red	C <sub>16</sub> H <sub>13</sub> N <sub>3</sub>	131-22-6	247.294	red-viol cry (EtOH)	123				s EtOH, dil HCl, bz
8822	1-(Phenylazo)-2-naphthalenamine	Yellow AB	C <sub>16</sub> H <sub>13</sub> N <sub>3</sub>	85-84-7	247.294	red pl (al)	103				vs EtOH, HOAc
8823	1-(Phenylazo)-2-naphthol	Sudan I	C <sub>16</sub> H <sub>12</sub> N <sub>2</sub> O	842-07-9	248.278	ye cry	132				
8824	4-(Phenylazo)phenol		C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	1689-82-3	198.219	ye lf (bz) oran pr (al)	155	225 <sup>20</sup> dec			i H <sub>2</sub> O; vs EtOH, eth; s bz, con sulf
8825	1-[[4-(Phenylazo)phenyl]azo]-2-naphthol	Sudan III	C <sub>22</sub> H <sub>16</sub> N <sub>4</sub> O	85-86-9	352.388	br lf (grn lustre) (HOAc)	195				i H <sub>2</sub> O; s EtOH, eth, ace, bz, xyl, chl
8826	<i>N</i> -Phenylbenzamide	Benzanilide	C <sub>13</sub> H <sub>11</sub> NO	93-98-1	197.232	lf (al)	163	sub 117	1.315 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth, HOAc
8827	$\alpha$ -Phenylbenzeneacetaldehyde		C <sub>14</sub> H <sub>12</sub> O	947-91-1	196.244			dec 315; 157 <sup>7</sup>	1.1061 <sup>21</sup>	1.5920 <sup>21</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz
8828	$\alpha$ -Phenylbenzeneacetic acid	Diphenylacetic acid	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	117-34-0	212.244	nd (w), lf (al)	147.29	194 <sup>25</sup>	1.257 <sup>15</sup>		sl H <sub>2</sub> O; vs EtOH; s eth, chl
8829	$\alpha$ -Phenylbenzeneacetonitrile		C <sub>14</sub> H <sub>11</sub> N	86-29-3	193.244	pr (eth), lf (dil al)	74.3	184 <sup>16</sup>			s EtOH, chl; vs eth; sl lig
8830	$\alpha$ -Phenylbenzeneacetyl chloride		C <sub>14</sub> H <sub>11</sub> ClO	1871-76-7	230.689		56.5	170 <sup>16</sup>			s lig



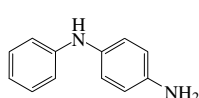
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8831	<i>N</i> -Phenylbenzenecarbothioamide		C <sub>13</sub> H <sub>11</sub> NS	636-04-4	213.298	ye pl or pr (al)	102	dec			i H <sub>2</sub> O; vs EtOH; s eth, bz, chl; sl lig
8832	<i>N</i> -Phenyl-1,2-benzenediamine		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	534-85-0	184.236	nd(w)	79.5	313			sl H <sub>2</sub> O, lig; s ace, bz, chl
8833	<i>N</i> -Phenyl-1,4-benzenediamine	<i>p</i> -Aminodiphenylamine	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	101-54-2	184.236	nd(al)	66	354			sl H <sub>2</sub> O, chl; vs EtOH; s eth, lig
8834	$\alpha$ -Phenylbenzeneethanamine		C <sub>14</sub> H <sub>15</sub> N	25611-78-3	197.276			311; 175 <sup>15</sup>	1.031 <sup>15</sup>		vs eth, EtOH
8835	$\alpha$ -Phenylbenzeneethanol		C <sub>14</sub> H <sub>14</sub> O	614-29-9	198.260	nd (peth-bz)	67	177 <sup>15</sup>	1.0360 <sup>70</sup>		
8836	$\alpha$ -Phenylbenzenemethanamine	Benzhydramine	C <sub>13</sub> H <sub>13</sub> N	91-00-9	183.249	hex pl	34	304; 176 <sup>23</sup>	1.0633 <sup>20</sup>	1.5963	sl H <sub>2</sub> O; s ace
8837	$\alpha$ -Phenylbenzenemethanimine		C <sub>13</sub> H <sub>11</sub> N	1013-88-3	181.233			282	1.0847 <sup>19</sup>	1.6191 <sup>19</sup>	vs eth
8838	$\beta$ -Phenylbenzenepropanoic acid		C <sub>15</sub> H <sub>14</sub> O <sub>2</sub>	606-83-7	226.271	nd (dil al)	156.0				sl H <sub>2</sub> O; vs EtOH; s eth, ace
8839	2-Phenylbenzimidazole	Phenzidole	C <sub>13</sub> H <sub>10</sub> N <sub>2</sub>	716-79-0	194.231	pl (HOAc) (al-w) nd (bz, w)	293				sl H <sub>2</sub> O, bz; s EtOH, chl, HOAc
8840	Phenyl benzoate		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	93-99-2	198.217	mcl pr (eth-al)	71	314	1.235 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, chl
8841	2-Phenylbenzoic acid		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	947-84-2	198.217	lf (dil al)	114.3	343.5			i H <sub>2</sub> O; vs EtOH, bz, HOAc
8842	4-Phenylbenzoic acid		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	92-92-2	198.217	nd (bz, al)	228	sub			i H <sub>2</sub> O; s EtOH, eth, bz
8843	2-Phenyl-4 <i>H</i> -1-benzopyran-4-one	Flavone	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	525-82-6	222.239	nd (lig), cry (30% al)	100				i H <sub>2</sub> O; s EtOH, eth, ace, bz
8844	3-Phenyl-4 <i>H</i> -1-benzopyran-4-one	Isoflavone	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	574-12-9	222.239		148				
8845	2-Phenylbenzothiazole		C <sub>13</sub> H <sub>9</sub> NS	883-93-2	211.282	nd (dil al)	115	371			i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
8846	<i>N</i> -Phenyl- <i>N</i> -benzylbenzenemethanamine		C <sub>20</sub> H <sub>19</sub> N	91-73-6	273.372		69	226 <sup>10</sup>	1.0444 <sup>80</sup>	1.6065 <sup>80</sup>	i H <sub>2</sub> O; sl EtOH, HOAc; s eth, bz
8847	Phenyl biguanide	<i>N</i> -Phenylimidodicarbonimidic diamide	C <sub>8</sub> H <sub>11</sub> N <sub>5</sub>	102-02-3	177.207		143				
8848	2-Phenyl-1,3-butadiene		C <sub>10</sub> H <sub>10</sub>	2288-18-8	130.186			60 <sup>17</sup>	0.925 <sup>20</sup>	1.5489 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl
8849	<i>N</i> -Phenylbutanamide		C <sub>10</sub> H <sub>13</sub> NO	1129-50-6	163.216	mcl pr (al, bz, eth)	97	189 <sup>15</sup>	1.134 <sup>25</sup>		i H <sub>2</sub> O; vs EtOH, eth; sl chl
8850	Phenylbutanedioic acid, (±)		C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	10424-29-0	194.184	lf or nd (w)	168	dec			sl H <sub>2</sub> O, chl; vs EtOH, eth, ace; i bz
8851	1-Phenyl-1,3-butanedione		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	93-91-4	162.185	pr	56	261.5	1.0599 <sup>74</sup>	1.5678 <sup>78</sup>	i H <sub>2</sub> O; s eth; sl chl
8852	Phenyl butanoate	Phenyl butyrate	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	4346-18-3	164.201			225	1.0382 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth
8853	1-Phenyl-1-butanone		C <sub>10</sub> H <sub>12</sub> O	495-40-9	148.201		12	228.5	0.988 <sup>20</sup>	1.5203 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace; s ctc
8854	1-Phenyl-2-butanone		C <sub>10</sub> H <sub>12</sub> O	1007-32-5	148.201			228; 111 <sup>16</sup>	0.9877 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, ctc; msc eth; vs ace
8855	4-Phenyl-2-butanone		C <sub>10</sub> H <sub>12</sub> O	2550-26-7	148.201	liq	-13	233.5	0.9849 <sup>22</sup>	1.511 <sup>22</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc; vs ace
8856	Phenylbutazone		C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	50-33-9	308.374		105				
8857	2-Phenyl-1-butene	$\alpha$ -Ethylstyrene	C <sub>10</sub> H <sub>12</sub>	2039-93-2	132.202			182	0.887 <sup>25</sup>	1.5288 <sup>20</sup>	
8858	1-Phenyl-2-buten-1-one		C <sub>10</sub> H <sub>10</sub> O	495-41-0	146.185		20.5	111 <sup>9</sup>	1.025 <sup>15</sup>	1.5626 <sup>18</sup>	
8859	<i>trans</i> -4-Phenyl-3-buten-2-one	Benzilideneacetone	C <sub>10</sub> H <sub>10</sub> O	1896-62-4	146.185	pl	41.5	261	1.0097 <sup>45</sup>	1.5836 <sup>45</sup>	i H <sub>2</sub> O; vs EtOH; s eth, ace, bz; sl peth
8860	4-Phenyl-3-butyne-2-one		C <sub>10</sub> H <sub>8</sub> O	1817-57-8	144.170		4.5	79 <sup>2</sup>	1.0215 <sup>20</sup>	1.5762 <sup>20</sup>	
8861	Phenyl chloroacetate		C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	620-73-5	170.594	nd or pl (al)	44.5	232.5	1.2202 <sup>44</sup>	1.5146 <sup>44</sup>	i H <sub>2</sub> O; vs EtOH, eth
8862	Phenyl chloroformate		C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	1885-14-9	156.567			71 <sup>9</sup>			
8863	4-Phenyl-2-chlorophenol	3-Chloro-(1,1'-biphenyl)-4-ol	C <sub>12</sub> H <sub>9</sub> ClO	92-04-6	204.651	wh-ye cry	77	161 <sup>7</sup>			
8864	2-Phenyl-2,5-cyclohexadiene-1,4-dione		C <sub>12</sub> H <sub>8</sub> O <sub>2</sub>	363-03-1	184.191	ye lf (peth, al)	114				sl H <sub>2</sub> O; s EtOH, bz, peth; vs chl
8865	4-Phenylcyclohexanone		C <sub>12</sub> H <sub>14</sub> O	4894-75-1	174.238	cry (peth)	79	158 <sup>12</sup>			
8866	1-(1-Phenylcyclohexyl)piperidine	Phencyclidine	C <sub>17</sub> H <sub>25</sub> N	77-10-1	243.388		46.5	136 <sup>10</sup>			
8867	3-Phenyl-2-cyclopenten-1-one		C <sub>11</sub> H <sub>10</sub> O	3810-26-2	158.196	liq	-23	234.2	0.9711 <sup>20</sup>	1.5440 <sup>20</sup>	s EtOH, ace, chl; sl eth
8868	<i>N</i> -Phenyl- <i>N,N</i> -diethanolamine		C <sub>10</sub> H <sub>15</sub> NO <sub>2</sub>	120-07-0	181.232		57	200 <sup>10</sup>	1.201 <sup>60</sup>		vs ace, bz, eth, EtOH
8869	2-Phenyl-1,3-dioxane		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	772-01-0	164.201	nd (peth)	41	253	1.6053 <sup>60</sup>		vs EtOH, eth
8870	4-Phenyl-1,3-dioxane		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	772-00-9	164.201			247	1.1038 <sup>20</sup>	1.5306 <sup>18</sup>	i H <sub>2</sub> O; s os
8871	1-Phenyl-1-dodecanone		C <sub>18</sub> H <sub>36</sub> O	1674-38-0	260.414		47	201 <sup>9</sup> , 181 <sup>5</sup>	0.8794 <sup>18</sup>	1.4700 <sup>18</sup>	i H <sub>2</sub> O; s ace; sl ctc



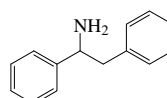
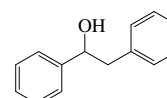
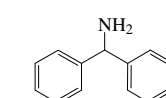
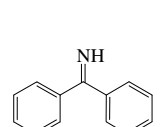
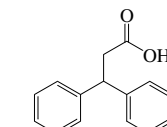
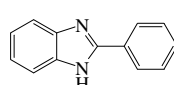
N-Phenylbenzenecarbothioamide



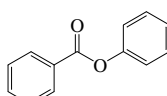
N-Phenyl-1,2-benzenediamine



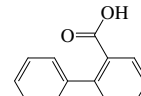
N-Phenyl-1,4-benzenediamine

 $\alpha$ -Phenylbenzeneethanamine $\alpha$ -Phenylbenzeneethanol $\alpha$ -Phenylbenzenemethanamine $\alpha$ -Phenylbenzenemethanimine $\beta$ -Phenylbenzenepranoic acid

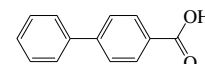
2-Phenylbenzimidazole



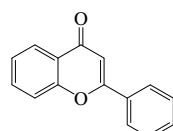
Phenyl benzoate



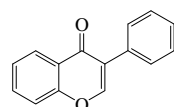
2-Phenylbenzoic acid



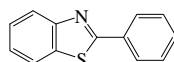
4-Phenylbenzoic acid



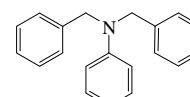
2-Phenyl-4H-1-benzopyran-4-one



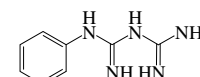
3-Phenyl-4H-1-benzopyran-4-one



2-Phenylbenzothiazole



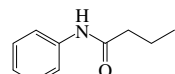
N-Phenyl-N-benzylbenzenemethanamine



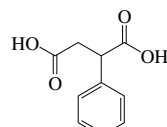
Phenyl biguanide



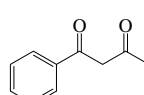
2-Phenyl-1,3-butadiene



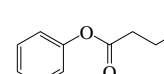
N-Phenylbutanamide



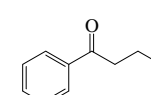
Phenylbutanedioic acid, (+)



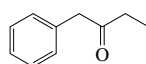
1-Phenyl-1,3-butanedione



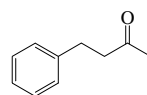
Phenyl butanoate



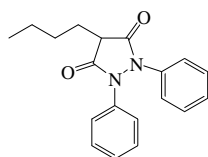
1-Phenyl-1-butanone



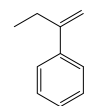
1-Phenyl-2-butanone



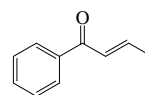
4-Phenyl-2-butanone



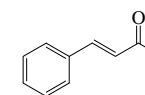
Phenylbutazone



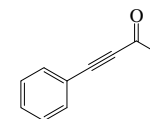
2-Phenyl-1-butene



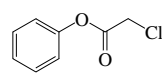
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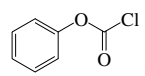
trans-4-Phenyl-3-buten-2-one



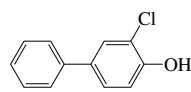
4-Phenyl-3-buten-2-one



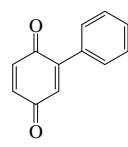
Phenyl chloroacetate



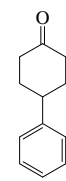
Phenyl chloroformate



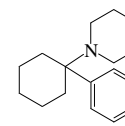
4-Phenyl-2-chlorophenol



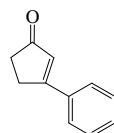
2-Phenyl-2,5-cyclohexadiene-1,4-dione



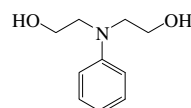
4-Phenylcyclohexanone



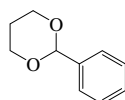
1-(1-Phenylcyclohexyl)piperidine



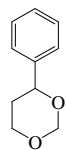
3-Phenyl-2-cyclopenten-1-one



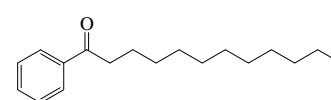
N-Phenyl-N,N-diethanolamine



2-Phenyl-1,3-dioxane

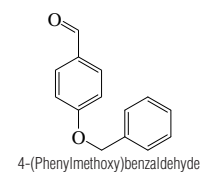
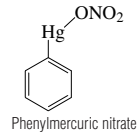
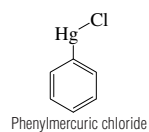
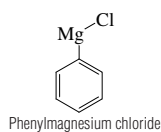
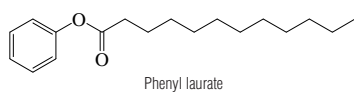
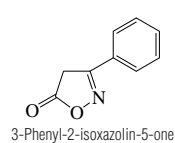
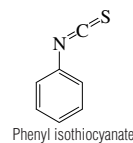
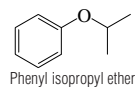
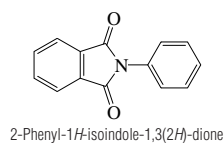
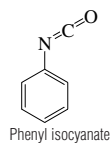
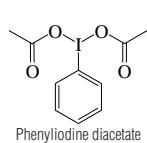
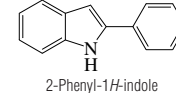
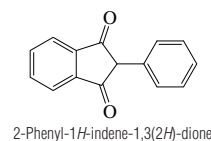
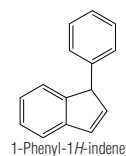
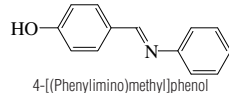
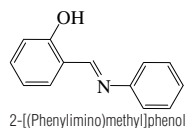
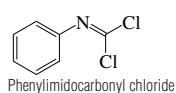
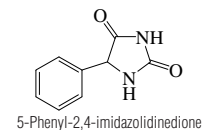
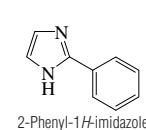
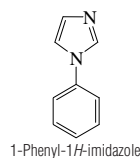
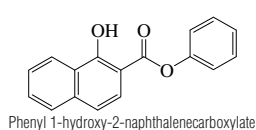
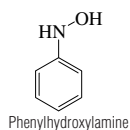
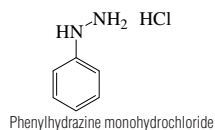
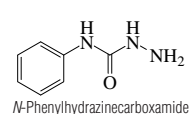
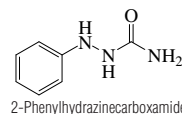
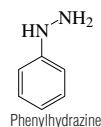
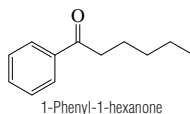
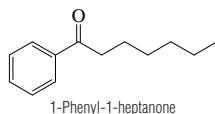
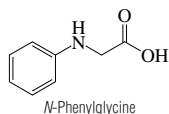
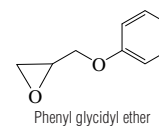
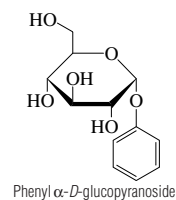
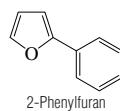
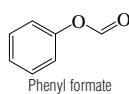
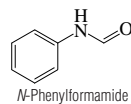
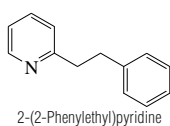
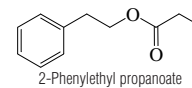
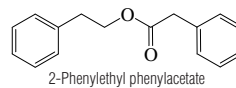
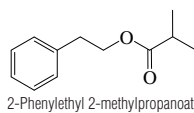
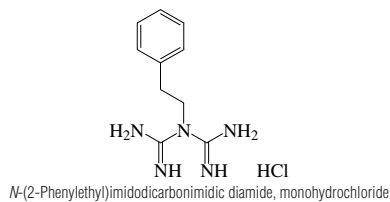
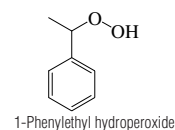
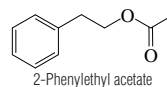
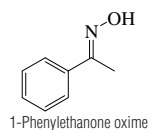
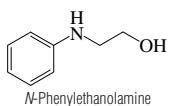
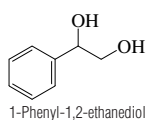


4-Phenyl-1,3-dioxane



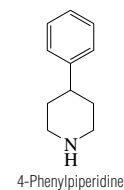
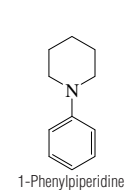
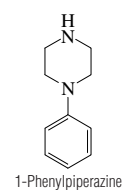
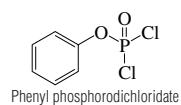
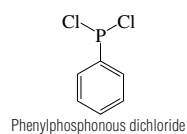
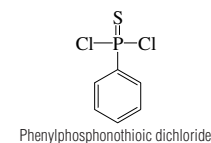
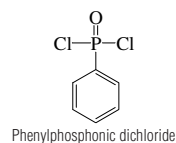
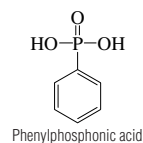
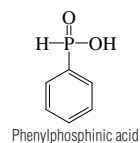
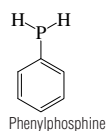
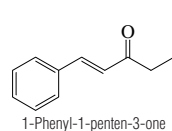
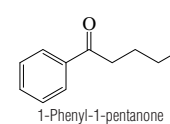
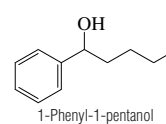
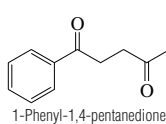
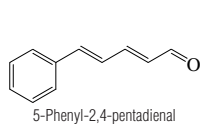
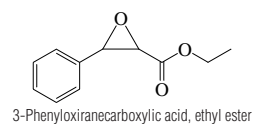
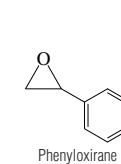
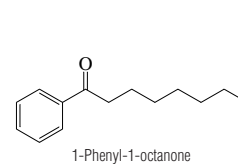
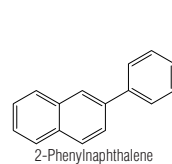
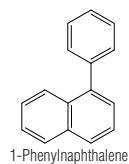
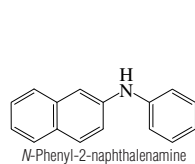
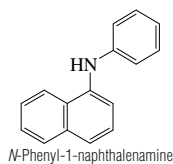
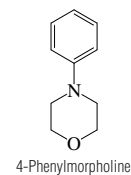
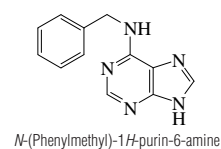
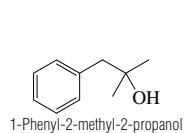
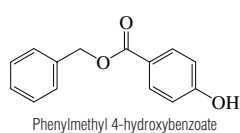
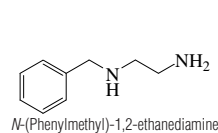
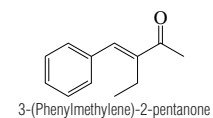
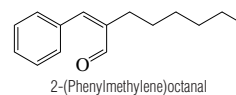
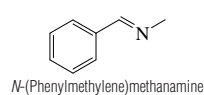
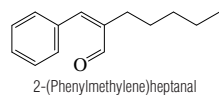
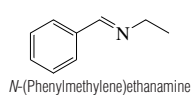
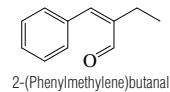
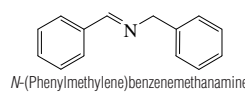
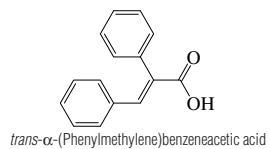
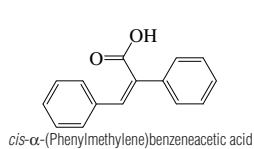
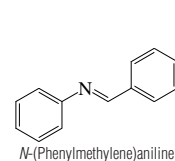
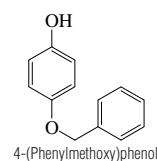
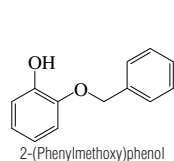
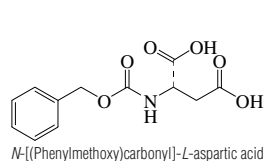
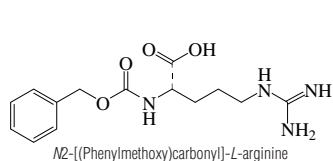
1-Phenyl-1-dodecanone

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8872	1-Phenyl-1,2-ethanediol	Styrene glycol	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	93-56-1	138.164	nd (lig)	67.5	273			vs H <sub>2</sub> O, eth, bz, EtOH; sl lig
8873	<i>N</i> -Phenylethanolamine		C <sub>8</sub> H <sub>11</sub> NO	122-98-5	137.179			279.5; 150 <sup>10</sup>	1.0945 <sup>20</sup>	1.5760 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, chl
8874	1-Phenylethanone oxime		C <sub>8</sub> H <sub>9</sub> NO	613-91-2	135.163	nd (w)	60	245	1.0515 <sup>18</sup>		sl H <sub>2</sub> O; vs EtOH, eth, ace, bz; s ctc
8875	2-Phenylethyl acetate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	103-45-7	164.201	liq	-31.1	232.6	1.0883 <sup>20</sup>	1.5171 <sup>20</sup>	vs eth, EtOH
8876	1-Phenylethyl hydroperoxide		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	3071-32-7	138.164	liq		50 <sup>01</sup>			
8877	<i>N</i> -(2-Phenylethyl)imidodicarbonimidic diamide, monohydrochloride	Phenformin hydrochloride	C <sub>10</sub> H <sub>16</sub> ClN <sub>5</sub>	834-28-6	241.721	cry	177.3				s H <sub>2</sub> O
8878	2-Phenylethyl 2-methylpropanoate	Benzylcarbinol isobutyrate	C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	103-48-0	192.254			250; 123 <sup>15</sup>	0.9950 <sup>15</sup>	1.4871 <sup>20</sup>	
8879	2-Phenylethyl phenylacetate		C <sub>16</sub> H <sub>16</sub> O <sub>2</sub>	102-20-5	240.297		26.5	177 <sup>4.5</sup>	1.077 <sup>25</sup>		vs EtOH
8880	2-Phenylethyl propanoate	Phenethyl propionate	C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	122-70-3	178.228	liq		244	1.02 <sup>25</sup>	1.4950 <sup>20</sup>	
8881	2-(2-Phenylethyl)pyridine		C <sub>13</sub> H <sub>13</sub> N	2116-62-3	183.249	liq	-1.5	289	1.0465 <sup>9</sup>		
8882	<i>N</i> -Phenylformamide	Formanilide	C <sub>7</sub> H <sub>9</sub> NO	103-70-8	121.137	mcl pr (lig-xyl)	46	271	1.1186 <sup>50</sup>		s H <sub>2</sub> O, eth, bz; vs EtOH
8883	Phenyl formate		C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	1864-94-4	122.122	liq		178; 82 <sup>15</sup>			
8884	2-Phenylfuran		C <sub>10</sub> H <sub>8</sub> O	17113-33-6	144.170			108 <sup>18</sup> ; 82 <sup>5</sup>	1.083 <sup>20</sup>	1.5920 <sup>20</sup>	vs ace, bz
8885	Phenyl α- <i>D</i> -glucopyranoside		C <sub>12</sub> H <sub>16</sub> O <sub>6</sub>	4630-62-0	256.251		174				
8886	Phenyl glycidyl ether		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	122-60-1	150.174			243	1.1109 <sup>21</sup>	1.5307 <sup>21</sup>	
8887	<i>N</i> -Phenylglycine	Phenylaminoacetic acid	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	103-01-5	151.163		127.5				vs H <sub>2</sub> O, EtOH
8888	1-Phenyl-1-heptanone		C <sub>13</sub> H <sub>18</sub> O	1671-75-6	190.281	lf	16.4	283.3	0.9516 <sup>20</sup>	1.5060 <sup>20</sup>	vs ace, eth, EtOH
8889	1-Phenyl-1-hexanone		C <sub>12</sub> H <sub>16</sub> O	942-92-7	176.254	fl	27	265	0.9576 <sup>20</sup>	1.5027 <sup>25</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth, ace
8890	Phenylhydrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	100-63-0	108.141	mcl pr or pl	20.6	243.5	1.0986 <sup>20</sup>	1.6084 <sup>10</sup>	s H <sub>2</sub> O; msc EtOH, eth, bz; vs ace
8891	2-Phenylhydrazinecarboxamide	Phenicarbazide	C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> O	103-03-7	151.165		172				sl H <sub>2</sub> O, eth, bz, lig; s EtOH, ace
8892	<i>N</i> -Phenylhydrazinecarboxamide	4-Phenylsemicarbazide	C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> O	537-47-3	151.165	nd (bz), pl (w)	128				sl H <sub>2</sub> O; vs EtOH, chl; i eth
8893	Phenylhydrazine monohydrochloride		C <sub>6</sub> H <sub>8</sub> ClN <sub>2</sub>	59-88-1	144.601	lf (al)	244 dec	sub			vs H <sub>2</sub> O, EtOH
8894	Phenylhydroxylamine	<i>N</i> -Hydroxybenzenamine	C <sub>6</sub> H <sub>9</sub> NO	100-65-2	109.126	nd (w, bz, peth)	83.5				vs bz, eth, EtOH, chl
8895	Phenyl 1-hydroxy-2-naphthalenecarboxylate		C <sub>17</sub> H <sub>12</sub> O <sub>3</sub>	132-54-7	264.275		96				vs bz, EtOH
8896	1-Phenyl-1 <i>H</i> -imidazole		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	7164-98-9	144.173		13	276	1.1397 <sup>15</sup>	1.6025 <sup>25</sup>	i H <sub>2</sub> O; vs eth, ace, chl
8897	2-Phenyl-1 <i>H</i> -imidazole		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	670-96-2	144.173	lf (bz)	149.3	340			vs EtOH
8898	5-Phenyl-2,4-imidazolidinedione	5-Phenylhydantoin	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	89-24-7	176.172		184.5				
8899	Phenylimidocarbonyl chloride		C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> N	622-44-6	174.028	liq		210; 105 <sup>30</sup>	1.28 <sup>15</sup>		
8900	2-[(Phenylimino)methyl]phenol		C <sub>13</sub> H <sub>11</sub> NO	779-84-0	197.232		49.5		1.087 <sup>25</sup>		i H <sub>2</sub> O; s EtOH
8901	4-[(Phenylimino)methyl]phenol	<i>N</i> -(4-Hydroxybenzylidene)aniline	C <sub>13</sub> H <sub>11</sub> NO	1689-73-2	197.232		196.0				i H <sub>2</sub> O; s EtOH, eth; sl bz, chl
8902	1-Phenyl-1 <i>H</i> -indene		C <sub>15</sub> H <sub>12</sub>	1961-96-2	192.256	oil		158 <sup>7</sup>			
8903	2-Phenyl-1 <i>H</i> -indene-1,3(2 <i>H</i> )-dione	Phenindione	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>	83-12-5	222.239	lf (al, bz)	150				i H <sub>2</sub> O; s EtOH, eth, ace, bz, MeOH, chl
8904	2-Phenyl-1 <i>H</i> -indole		C <sub>14</sub> H <sub>11</sub> N	948-65-2	193.244		190.5	250 <sup>10</sup>			sl H <sub>2</sub> O; s eth, bz, chl, HOAc, CS <sub>2</sub>
8905	Phenyl iodine diacetate	Iodobenzene diacetate	C <sub>10</sub> H <sub>11</sub> IO <sub>4</sub>	3240-34-4	322.096	cry	161				
8906	Phenyl isocyanate		C <sub>7</sub> H <sub>5</sub> NO	103-71-9	119.121			163; 55 <sup>13</sup>	1.0956 <sup>20</sup>	1.5368 <sup>20</sup>	vs eth; sl chl
8907	2-Phenyl-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione		C <sub>14</sub> H <sub>9</sub> NO <sub>2</sub>	520-03-6	223.227	wh nd (al)	210	sub			i H <sub>2</sub> O; sl EtOH; msc chl
8908	Phenyl isopropyl ether	Isopropoxybenzene	C <sub>9</sub> H <sub>12</sub> O	2741-16-4	136.190	liq	-33	176.8	0.9408 <sup>25</sup>	1.4975 <sup>20</sup>	s H <sub>2</sub> O, EtOH, ace, bz
8909	Phenyl isothiocyanate		C <sub>7</sub> H <sub>5</sub> NS	103-72-0	135.187	liq	-21	221	1.1303 <sup>20</sup>	1.6492 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
8910	3-Phenyl-2-isoxazolin-5-one		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	1076-59-1	161.158		151				sl chl
8911	Phenyl laurate	Phenyl dodecanoate	C <sub>18</sub> H <sub>28</sub> O <sub>2</sub>	4228-00-6	276.414	lf (al)	24.5	210 <sup>15</sup>	0.9354 <sup>30</sup>		vs ace, eth, EtOH
8912	Phenylmagnesium chloride	Chlorophenylmagnesium	C <sub>6</sub> H <sub>5</sub> ClMg	100-59-4	136.862	cry					reac H <sub>2</sub> O; s thf, eth
8913	Phenylmercuric chloride	Chlorophenylmercury	C <sub>6</sub> H <sub>5</sub> ClHg	100-56-1	313.15	pl (bz)	251				i H <sub>2</sub> O; sl EtOH, bz
8914	Phenylmercuric nitrate		C <sub>6</sub> H <sub>5</sub> HgNO <sub>3</sub>	55-68-5	339.70		≈181				
8915	4-(Phenylmethoxy)benzaldehyde		C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	4397-53-9	212.244		73	217 <sup>13</sup>			

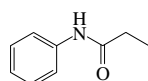


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8916	<i>N</i> 2-[(Phenylmethoxy)carbonyl]- <i>L</i> -arginine		C <sub>14</sub> H <sub>20</sub> N <sub>4</sub> O <sub>4</sub>	1234-35-1	308.334		174				
8917	<i>N</i> -[(Phenylmethoxy)carbonyl]- <i>L</i> -aspartic acid		C <sub>12</sub> H <sub>13</sub> NO <sub>6</sub>	1152-61-0	267.234		117.0				
8918	2-(Phenylmethoxy)phenol		C <sub>13</sub> H <sub>12</sub> O <sub>2</sub>	6272-38-4	200.233			205 <sup>20</sup> , 173 <sup>13</sup>	1.154 <sup>22</sup>	1.5906 <sup>16</sup>	vs eth, EtOH
8919	4-(Phenylmethoxy)phenol	Monobenzene	C <sub>13</sub> H <sub>12</sub> O <sub>2</sub>	103-16-2	200.233	pl (w)	122				sl H <sub>2</sub> O; vs EtOH, bz, eth; s ace
8920	<i>N</i> -(Phenylmethylene)aniline	Benzylideneaniline	C <sub>13</sub> H <sub>11</sub> N	538-51-2	181.233	pa ye nd (CS <sub>2</sub> ) pl (dial)	54	310	1.038 <sup>55</sup>	1.600 <sup>100</sup>	i H <sub>2</sub> O; s EtOH, eth, NH <sub>3</sub> ; sl chl
8921	<i>cis</i> - $\alpha$ -(Phenylmethylene)benzeneacetic acid	<i>cis</i> - $\alpha$ -Phenylcinnamic acid	C <sub>15</sub> H <sub>12</sub> O <sub>2</sub>	91-47-4	224.255	silky needles	174				s H <sub>2</sub> O, EtOH, MeOH, eth, bz
8922	<i>trans</i> - $\alpha$ -(Phenylmethylene)benzeneacetic acid	<i>trans</i> - $\alpha$ -Phenylcinnamic acid	C <sub>15</sub> H <sub>12</sub> O <sub>2</sub>	91-48-5	224.255	prisms	138				vs H <sub>2</sub> O; s EtOH, MeOH, eth, bz
8923	<i>N</i> -(Phenylmethylene)benzenemethanamine		C <sub>14</sub> H <sub>13</sub> N	780-25-6	195.260			205 <sup>20</sup>			
8924	2-(Phenylmethylene)butanal		C <sub>11</sub> H <sub>12</sub> O	28467-92-7	160.212		18	243; 157 <sup>5</sup>	1.0201 <sup>22</sup>	1.578 <sup>20</sup>	
8925	<i>N</i> -(Phenylmethylene)ethanamine		C <sub>9</sub> H <sub>11</sub> N	6852-54-6	133.190			195	0.937 <sup>20</sup>	1.5378 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth
8926	2-(Phenylmethylene)heptanal		C <sub>14</sub> H <sub>18</sub> O	122-40-7	202.292	ye oil	80	174 <sup>20</sup>	0.9711 <sup>20</sup>	1.5381 <sup>20</sup>	i H <sub>2</sub> O; s ace, ctc
8927	<i>N</i> -(Phenylmethylene)methanamine	Benzylidenemethylamine	C <sub>8</sub> H <sub>9</sub> N	622-29-7	119.164			185; 92 <sup>34</sup>	0.9671 <sup>14</sup>	1.5526 <sup>20</sup>	s EtOH, eth, ace, chl
8928	2-(Phenylmethylene)octanal	2-Hexyl-3-phenyl-2-propenal	C <sub>15</sub> H <sub>20</sub> O	101-86-0	216.319	liq	4	252; 169 <sup>20</sup>			
8929	3-(Phenylmethylene)-2-pentanone	Methyl $\alpha$ -ethylstyryl ketone	C <sub>12</sub> H <sub>14</sub> O	3437-89-6	174.238			137 <sup>12</sup>	1.0005 <sup>22</sup>	1.5650 <sup>22</sup>	
8930	<i>N</i> -(Phenylmethyl)-1,2-ethanediamine		C <sub>9</sub> H <sub>14</sub> N <sub>2</sub>	4152-09-4	150.220			130 <sup>11</sup>			
8931	Phenylmethyl 4-hydroxybenzoate		C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	94-18-8	228.243						sl chl
8932	1-Phenyl-2-methyl-2-propanol		C <sub>10</sub> H <sub>14</sub> O	100-86-7	150.217	nd	24	215	0.9787 <sup>16</sup>	1.5173 <sup>16</sup>	
8933	<i>N</i> -(Phenylmethyl)-1 <i>H</i> -purin-6-amine		C <sub>12</sub> H <sub>11</sub> N <sub>5</sub>	1214-39-7	225.249		232.8				
8934	4-Phenylmorpholine		C <sub>10</sub> H <sub>13</sub> NO	92-53-5	163.216	cry (al-eth)	58.3				i H <sub>2</sub> O, EtOH; vs eth
8935	<i>N</i> -Phenyl-1-naphthalenamine	1-Naphthylphenylamine	C <sub>16</sub> H <sub>13</sub> N	90-30-2	219.281		61				sl H <sub>2</sub> O, ctc; s EtOH, eth, bz, HOAc
8936	<i>N</i> -Phenyl-2-naphthalenamine	<i>N</i> -Phenyl- $\beta$ -naphthylamine	C <sub>16</sub> H <sub>13</sub> N	135-88-6	219.281		108	395.5			i H <sub>2</sub> O; s EtOH, eth, bz, HOAc; sl chl
8937	1-Phenyl-naphthalene		C <sub>16</sub> H <sub>12</sub>	605-02-7	204.266	cry	45	334	1.096 <sup>20</sup>	1.6664 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, HOAc; s ctc
8938	2-Phenyl-naphthalene		C <sub>16</sub> H <sub>12</sub>	612-94-2	204.266	lf (al)	103.5	345.5	1.2180 <sup>20</sup>		s EtOH, bz, chl, HOAc; vs eth
8939	1-Phenyl-1-octanone		C <sub>14</sub> H <sub>20</sub> O	1674-37-9	204.308		22.8	285; 164 <sup>15</sup>	0.9360 <sup>30</sup>		s EtOH, eth
8940	Phenyloxirane	Styrene-7,8-oxide	C <sub>8</sub> H <sub>8</sub> O	96-09-3	120.149	colorless liq	-35.6	194.1	1.0490 <sup>25</sup>	1.5342 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
8941	3-Phenyloxiranecarboxylic acid, ethyl ester		C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	121-39-1	192.211			136 <sup>5</sup>			
8942	5-Phenyl-2,4-pentadienal		C <sub>11</sub> H <sub>10</sub> O	13466-40-5	158.196		42.5	160 <sup>3</sup> , 133 <sup>10</sup>			i H <sub>2</sub> O; msc EtOH, bz; vs eth
8943	1-Phenyl-1,4-pentanedione		C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	583-05-1	176.212	ye oil		162 <sup>12</sup>		1.5250 <sup>30</sup>	vs ace
8944	1-Phenyl-1-pentanol		C <sub>11</sub> H <sub>16</sub> O	583-03-9	164.244			141 <sup>25</sup> , 102 <sup>3</sup>	0.9655 <sup>20</sup>	1.4086 <sup>25</sup>	vs ace, eth, EtOH
8945	1-Phenyl-1-pentanone		C <sub>11</sub> H <sub>14</sub> O	1009-14-9	162.228	liq	-9.4	245	0.986 <sup>20</sup>	1.5158 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
8946	1-Phenyl-1-penten-3-one		C <sub>11</sub> H <sub>12</sub> O	3152-68-9	160.212	lf (lig)	38.5	142 <sup>12</sup>	0.8697 <sup>20</sup>	1.5684 <sup>20</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth, bz
8947	Phenylphosphine	Monophenylphosphine	C <sub>6</sub> H <sub>5</sub> P	638-21-1	110.094			160.5	1.001 <sup>15</sup>	1.5796 <sup>20</sup>	
8948	Phenylphosphinic acid	Benzenephosphinic acid	C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> P	1779-48-2	142.093		83.8				s H <sub>2</sub> O; vs EtOH; sl eth, chl
8949	Phenylphosphonic acid	Benzenephosphonic acid	C <sub>6</sub> H <sub>5</sub> O <sub>3</sub> P	1571-33-1	158.092	lf (w)	160				vs H <sub>2</sub> O; s EtOH, eth, ace; i bz
8950	Phenylphosphonic dichloride		C <sub>6</sub> H <sub>5</sub> Cl <sub>2</sub> OP	824-72-6	194.983		1	258	1.197 <sup>25</sup>	1.5581 <sup>25</sup>	sl DMSO
8951	Phenylphosphonothioic dichloride	Dichlorophenylphosphine sulfide	C <sub>6</sub> H <sub>5</sub> Cl <sub>2</sub> PS	3497-00-5	211.049			205 <sup>130</sup>	1.376 <sup>13</sup>		
8952	Phenylphosphonous dichloride	Dichlorophenylphosphine	C <sub>6</sub> H <sub>5</sub> Cl <sub>2</sub> P	644-97-3	178.984	liq	-51	225; 142 <sup>57</sup>	1.356 <sup>20</sup>	1.6030 <sup>20</sup>	vs bz
8953	Phenyl phosphorodichloridate	Phenyl dichlorophosphate	C <sub>6</sub> H <sub>5</sub> Cl <sub>2</sub> O <sub>2</sub> P	770-12-7	210.983	hyg liq		242; 100 <sup>5</sup>	1.412 <sup>20</sup>	1.5230 <sup>20</sup>	
8954	1-Phenylpiperazine		C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	92-54-6	162.231	pa ye oil		286.5; 161 <sup>15</sup>	1.0621 <sup>20</sup>	1.5875 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
8955	1-Phenylpiperidine		C <sub>11</sub> H <sub>15</sub> N	4096-20-2	161.244		4.7	258	0.9944 <sup>25</sup>	1.5598 <sup>25</sup>	vs EtOH, eth, bz, chl
8956	4-Phenylpiperidine		C <sub>11</sub> H <sub>15</sub> N	771-99-3	161.244		60.5	257	0.9996 <sup>16</sup>		s chl

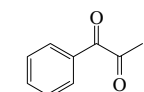




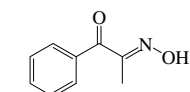
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8957	<i>N</i> -Phenylpropanamide		C <sub>9</sub> H <sub>11</sub> NO	620-71-3	149.189	pl (eth, al, bz)	105.5	222.2	1.175 <sup>25</sup>		sl H <sub>2</sub> O; vs EtOH, eth
8958	1-Phenyl-1,2-propanedione		C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	579-07-7	148.159	ye oil	<20	222; 102 <sup>12</sup>	1.1006 <sup>20</sup>	1.537 <sup>10</sup>	s H <sub>2</sub> O, EtOH, eth
8959	1-Phenyl-1,2-propanedione, 2-oxime		C <sub>9</sub> H <sub>9</sub> NO <sub>2</sub>	119-51-7	163.173	wh nd (w)	115				
8960	Phenyl propanoate		C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	637-27-4	150.174	pr	20	211	1.0436 <sup>25</sup>	1.4980 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
8961	2-Phenyl-1-propanol		C <sub>9</sub> H <sub>12</sub> O	1123-85-9	136.190			121 <sup>26</sup> , 105 <sup>11</sup>	0.975 <sup>25</sup>	1.5582 <sup>2</sup>	i H <sub>2</sub> O; s EtOH
8962	1-Phenyl-2-propanol		C <sub>9</sub> H <sub>12</sub> O	698-87-3	136.190			125 <sup>25</sup> , 120 <sup>20</sup>	0.991 <sup>20</sup>	1.5190 <sup>20</sup>	
8963	Phenylpropanolamine hydrochloride		C <sub>9</sub> H <sub>14</sub> ClNO	154-41-6	187.666		194				vs H <sub>2</sub> O; s EtOH; i eth, bz, chl
8964	1-Phenyl-1-propanone	Propiophenone	C <sub>9</sub> H <sub>10</sub> O	93-55-0	134.174		18.6	217.5	1.0096 <sup>20</sup>	1.5269 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
8965	1-Phenyl-2-propanone	Phenylacetone	C <sub>9</sub> H <sub>10</sub> O	103-79-7	134.174	liq	-15	216.5	1.0157 <sup>20</sup>	1.5168 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; msc bz, xyl; s chl
8966	<i>cis</i> -3-Phenyl-2-propenenitrile		C <sub>9</sub> H <sub>9</sub> N	24840-05-9	129.159	liq	-4.4	249; 139 <sup>30</sup>	1.0289 <sup>20</sup>	1.5843 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs bz
8967	<i>trans</i> -3-Phenyl-2-propenenitrile		C <sub>9</sub> H <sub>9</sub> N	1885-38-7	129.159		22	263.8	1.0304 <sup>20</sup>	1.6013 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, ctc
8968	3-Phenyl-2-propenoic anhydride	Cinnamic anhydride	C <sub>18</sub> H <sub>14</sub> O <sub>3</sub>	538-56-7	278.302	nd (bz or al) pt (al)	136				vs bz
8969	<i>cis</i> -3-Phenyl-2-propen-1-ol		C <sub>9</sub> H <sub>10</sub> O	4510-34-3	134.174	wh nd (eth-peth)	34	257.5	1.0440 <sup>20</sup>	1.5819 <sup>20</sup>	vs eth, EtOH
8970	<i>trans</i> -3-Phenyl-2-propen-1-ol		C <sub>9</sub> H <sub>10</sub> O	4407-36-7	134.174	wh nd (eth-peth)	34	257.5	1.0440 <sup>20</sup>	1.5819 <sup>20</sup>	sl H <sub>2</sub> O, chl; vs EtOH, eth
8971	<i>trans</i> -3-Phenyl-2-propen-1-ol acetate	<i>trans</i> -Cinnamyl acetate	C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	21040-45-9	176.212			265; 145 <sup>15</sup>	1.0567 <sup>20</sup>	1.5425 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
8972	<i>trans</i> -3-Phenyl-2-propenoyl chloride	Cinnamoyl chloride	C <sub>9</sub> H <sub>7</sub> ClO	17082-09-6	166.604	ye cry	37.5	257.5	1.1617 <sup>45</sup>	1.614 <sup>42</sup>	i H <sub>2</sub> O; s EtOH, ctc, lig
8973	3-Phenylpropyl acetate	Benzenepropanol, acetate	C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	122-72-5	178.228	col liq	-40	69 <sup>1</sup>			
8974	1-Phenyl-2-propylamine, (±)	Amphetamine	C <sub>9</sub> H <sub>13</sub> N	300-62-9	135.206	oil		203	0.9306 <sup>25</sup>	1.518 <sup>26</sup>	sl H <sub>2</sub> O, eth; s chl, EtOH
8975	1-Phenyl-2-propylamine, (S)	Dexamphetamine	C <sub>9</sub> H <sub>13</sub> N	51-64-9	135.206	oil	27.5	203.5; 80 <sup>12</sup>	0.949 <sup>15</sup>	1.4704 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
8976	Phenyl propyl ether	Propoxybenzene	C <sub>9</sub> H <sub>12</sub> O	622-85-5	136.190	liq	-27	189.9	0.9474 <sup>20</sup>	1.5014 <sup>20</sup>	s EtOH, eth
8977	4-(3-Phenylpropyl)pyridine		C <sub>14</sub> H <sub>15</sub> N	2057-49-0	197.276			322; 150 <sup>5</sup>	1.024 <sup>25</sup>	1.5616 <sup>25</sup>	vs bz, eth, py, EtOH
8978	3-Phenyl-2-propynal		C <sub>9</sub> H <sub>8</sub> O	2579-22-8	130.143			127 <sup>28</sup> , 104 <sup>11</sup>	1.0622 <sup>20</sup>	1.6079 <sup>12</sup>	
8979	3-Phenyl-2-propynoic acid	Phenylacetylenecarboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	637-44-5	146.143	nd (w)	137.5		1.28 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth
8980	3-Phenyl-2-propyn-1-ol		C <sub>9</sub> H <sub>8</sub> O	1504-58-1	132.159			137 <sup>15</sup>	1.078 <sup>20</sup>	1.5873 <sup>28</sup>	s eth, ace, bz
8981	6-Phenyl-2,4,7-pteridinetriamine	Triamterene	C <sub>12</sub> H <sub>11</sub> N <sub>7</sub>	396-01-0	253.262	ye pl (BuOH)	316				i eth; sl EtOH, chl
8982	1-Phenyl-3-pyrazolidinone		C <sub>9</sub> H <sub>10</sub> N <sub>2</sub> O	92-43-3	162.187		126				i eth, lig
8983	2-Phenylpyridine		C <sub>11</sub> H <sub>9</sub> N	1008-89-5	155.196			271	1.0833 <sup>25</sup>	1.6210 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
8984	3-Phenylpyridine		C <sub>11</sub> H <sub>9</sub> N	1008-88-4	155.196	pa ye oil	164	272		1.6123 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH, eth
8985	4-Phenylpyridine		C <sub>11</sub> H <sub>9</sub> N	939-23-1	155.196	pl (w)	77.5	281			s H <sub>2</sub> O, EtOH, eth
8986	Phenyl-2-pyridinylmethanone		C <sub>12</sub> H <sub>9</sub> NO	91-02-1	183.205		42	317	1.1556 <sup>20</sup>		s chl
8987	Phenyl-4-pyridinylmethanone		C <sub>12</sub> H <sub>9</sub> NO	14548-46-0	183.205	nd (peth), pl (w)	72	315; 170 <sup>10</sup>			sl H <sub>2</sub> O; s EtOH, eth, bz
8988	1-Phenyl-1 <i>H</i> -pyrrole		C <sub>10</sub> H <sub>9</sub> N	635-90-5	143.185	pl (sub), red in air	62	234			i H <sub>2</sub> O; s EtOH, eth, ace, bz; vs peth
8989	2-Phenyl-1 <i>H</i> -pyrrole		C <sub>10</sub> H <sub>9</sub> N	3042-22-6	143.185	pl (al, sub)	129	272			i H <sub>2</sub> O; vs EtOH, eth, bz, chl; sl lig
8990	1-Phenyl-1 <i>H</i> -pyrrole-2,5-dione	<i>N</i> -Phenylmaleimide	C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	941-69-5	173.169	ye nd (bz-lig)	90.5	162 <sup>12</sup>			vs bz, eth, EtOH
8991	1-Phenylpyrrolidine		C <sub>10</sub> H <sub>13</sub> N	4096-21-3	147.217		11	119 <sup>12</sup> , 102 <sup>5</sup>	1.018 <sup>20</sup>	1.5813 <sup>20</sup>	s eth
8992	1-Phenyl-2,5-pyrrolidinedione	Succinanyl	C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	83-25-0	175.184	mcl pr or nd (w, al)	156	400	1.356 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth
8993	2-Phenylquinoline		C <sub>15</sub> H <sub>11</sub> N	612-96-4	205.255	nd (dil al)	86	363; 194 <sup>6</sup>			sl H <sub>2</sub> O, peth; vs EtOH, eth, ace, bz
8994	2-Phenyl-4-quinolinecarboxylic acid	Cinchophen	C <sub>16</sub> H <sub>11</sub> NO <sub>2</sub>	132-60-5	249.264	nd	214.5				i H <sub>2</sub> O; s EtOH, eth, alk; sl ace, bz
8995	Phenyl salicylate		C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	118-55-8	214.216		43	173 <sup>12</sup>	1.2614 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, ace, bz; s eth, HOAc
8996	Phenylsilane		C <sub>6</sub> H <sub>6</sub> Si	694-53-1	108.214			119	0.8681 <sup>20</sup>	1.5125 <sup>20</sup>	i H <sub>2</sub> O



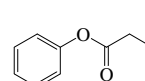
N-Phenylpropanamide



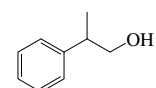
1-Phenyl-1,2-propanedione



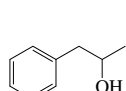
1-Phenyl-1,2-propanedione, 2-oxime



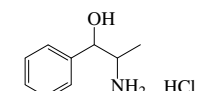
Phenyl propanoate



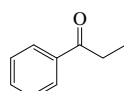
2-Phenyl-1-propanol



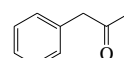
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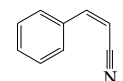
Phenylpropanolamine hydrochloride



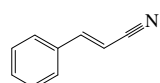
1-Phenyl-1-propanone



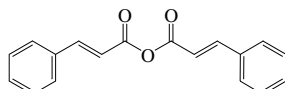
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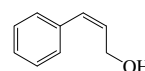
cis-3-Phenyl-2-propenenitrile



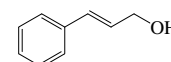
trans-3-Phenyl-2-propenenitrile



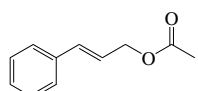
3-Phenyl-2-propenoic anhydride



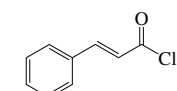
cis-3-Phenyl-2-propen-1-ol



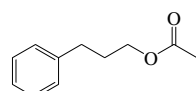
trans-3-Phenyl-2-propen-1-ol



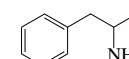
trans-3-Phenyl-2-propen-1-ol acetate



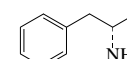
trans-3-Phenyl-2-propenoyl chloride



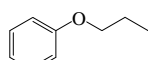
3-Phenylpropyl acetate



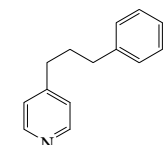
1-Phenyl-2-propylamine, (±)



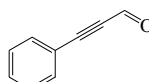
1-Phenyl-2-propylamine, (S)



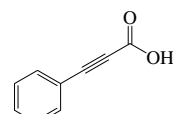
Phenyl propyl ether



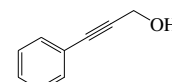
4-(3-Phenylpropyl)pyridine



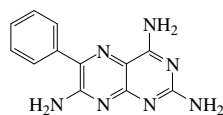
3-Phenyl-2-propynal



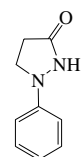
3-Phenyl-2-propynoic acid



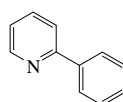
3-Phenyl-2-propyn-1-ol



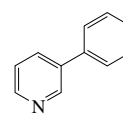
6-Phenyl-2,4,7-pteridinetriamine



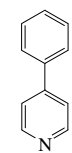
1-Phenyl-3-pyrazolidinone



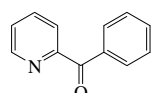
2-Phenylpyridine



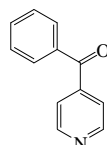
3-Phenylpyridine



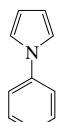
4-Phenylpyridine



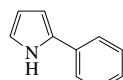
Phenyl-2-pyridinylmethanone



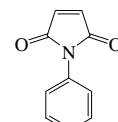
Phenyl-4-pyridinylmethanone



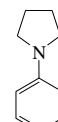
1-Phenyl-1H-pyrrole



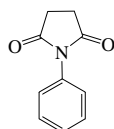
2-Phenyl-1H-pyrrole



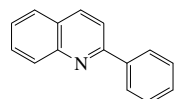
1-Phenyl-1H-pyrrole-2,5-dione



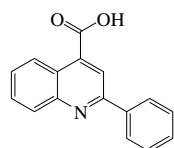
1-Phenylpyrrolidine



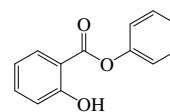
1-Phenyl-2,5-pyrrolidinedione



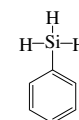
2-Phenylquinoline



2-Phenyl-4-quinolinecarboxylic acid

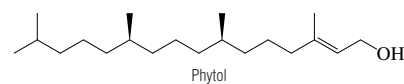
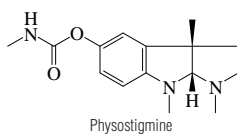
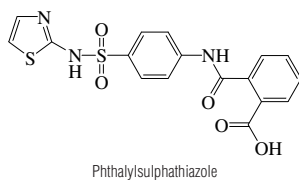
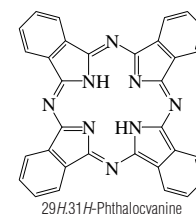
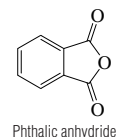
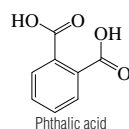
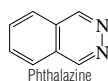
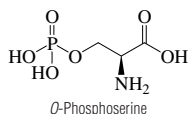
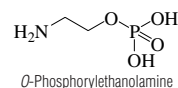
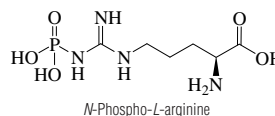
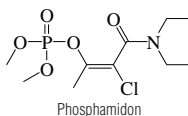
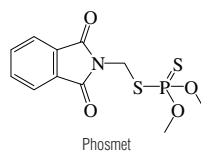
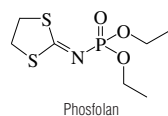
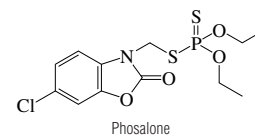
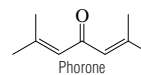
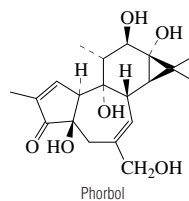
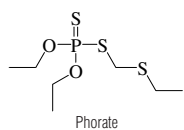
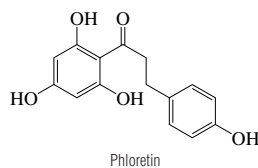
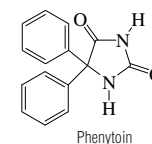
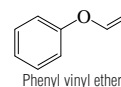
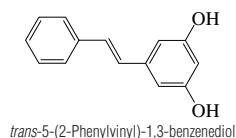
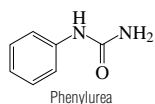
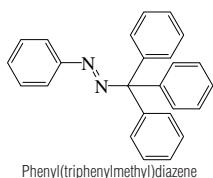
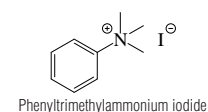
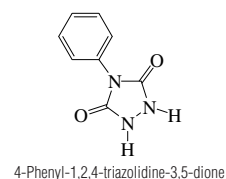
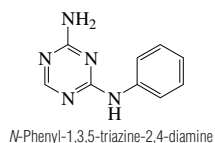
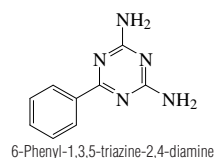
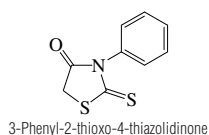
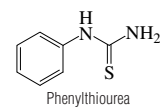
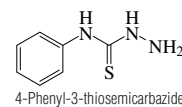
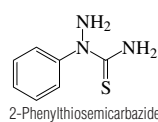
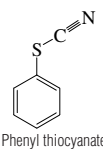
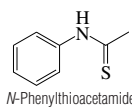
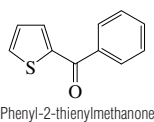
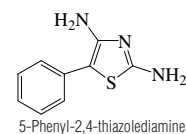
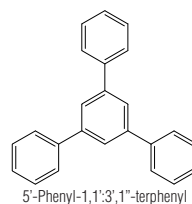
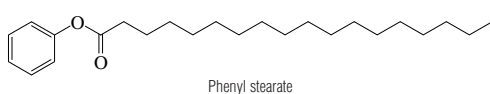
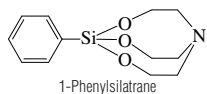


Phenyl salicylate

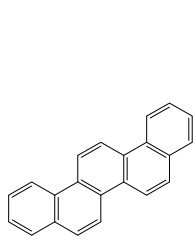


Phenylsilane

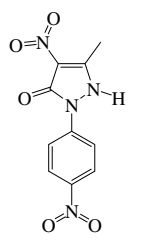
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
8997	1-Phenylsilatrane		C <sub>12</sub> H <sub>17</sub> NO <sub>3</sub> Si	2097-19-0	251.354	pr or nd (ace)	209				
8998	Phenyl stearate		C <sub>24</sub> H <sub>40</sub> O <sub>2</sub>	637-55-8	360.574		52	267 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, eth
8999	5'-Phenyl-1,1':3',1''-terphenyl		C <sub>24</sub> H <sub>18</sub>	612-71-5	306.400	orth nd (al or HOAc)	176	462	1.199 <sup>30</sup>		i H <sub>2</sub> O; s EtOH, eth, HOAc; vs bz; sl chl
9000	5-Phenyl-2,4-thiazolidamine	Amiphenazole	C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> S	490-55-1	191.252	fl (dil al) br in air	163 dec				
9001	Phenyl-2-thienylmethanone		C <sub>11</sub> H <sub>6</sub> OS	135-00-2	188.246	nd (dil al)	56.5	300	1.1890 <sup>54</sup>	1.6181 <sup>54</sup>	i H <sub>2</sub> O; s EtOH, eth
9002	<i>N</i> -Phenylthioacetamide	Thioacetanilide	C <sub>8</sub> H <sub>9</sub> NS	637-53-6	151.229	nd (w)	75.5	dec			
9003	Phenyl thiocyanate		C <sub>7</sub> H <sub>5</sub> NS	5285-87-0	135.187			232.5	1.153 <sup>18</sup>		i H <sub>2</sub> O; s EtOH, eth
9004	2-Phenylthiosemicarbazide	2-Phenylhydrazinecarbothioamide	C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> S	645-48-7	167.231	pr (al)	200 dec				
9005	4-Phenyl-3-thiosemicarbazide	<i>N</i> -Phenylhydrazinecarbothioamide	C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> S	5351-69-9	167.231	pl (al)	140 dec				i EtOH, lig; sl bz
9006	Phenylthiourea		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> S	103-85-5	152.217	nd (w), pr (al)	154				sl H <sub>2</sub> O; s EtOH, NaOH
9007	3-Phenyl-2-thioxo-4-thiazolidinone	3-Phenylrhodanine	C <sub>9</sub> H <sub>9</sub> NOS <sub>2</sub>	1457-46-1	209.288	ye pr (HOAc) nd or pr (al)	194.5				i H <sub>2</sub> O; sl EtOH, eth; s ace, chl, HOAc
9008	6-Phenyl-1,3,5-triazine-2,4-diamine	Benzoguanamine	C <sub>9</sub> H <sub>9</sub> N <sub>5</sub>	91-76-9	187.201	nd, pl (al)	226.5				s EtOH, eth; sl tfa
9009	<i>N</i> -Phenyl-1,3,5-triazine-2,4-diamine	Amanozine	C <sub>9</sub> H <sub>9</sub> N <sub>5</sub>	537-17-7	187.201	cry (diox, 50% al)	235.5				
9010	4-Phenyl-1,2,4-triazolidine-3,5-dione		C <sub>8</sub> H <sub>8</sub> N <sub>3</sub> O <sub>2</sub>	15988-11-1	177.161		205.5				
9011	Phenyltrimethylammonium iodide		C <sub>9</sub> H <sub>14</sub> IN	98-04-4	263.118	lf (al)	224				vs H <sub>2</sub> O; s EtOH, HOAc; sl ace; i chl
9012	Phenyl(triphenylmethyl)diazene		C <sub>25</sub> H <sub>20</sub> N <sub>2</sub>	981-18-0	348.440		111 dec				
9013	Phenylurea		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	64-10-8	136.151	mcl pr (w, al)	147	238	1.302 <sup>25</sup>		sl H <sub>2</sub> O, eth, DMSO; s EtOH, AcOEt
9014	<i>trans</i> -5-(2-Phenylvinyl)-1,3-benzenediol	Pinosylvin	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	22139-77-1	212.244	nd (HOAc)	156				vs ace, bz, chl, HOAc
9015	Phenyl vinyl ether		C <sub>8</sub> H <sub>8</sub> O	766-94-9	120.149			155.5	0.9770 <sup>20</sup>	1.5224 <sup>20</sup>	i H <sub>2</sub> O; vs eth
9016	Phenytol	5,5-Diphenyl-2,4-imidazolidinedione	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	57-41-0	252.268	nd (al)	286				i H <sub>2</sub> O; s EtOH, ace; sl eth, bz
9017	Phloretin		C <sub>15</sub> H <sub>14</sub> O <sub>5</sub>	60-82-2	274.269	nd (dil al), cry (ace)	263 dec				sl H <sub>2</sub> O, chl; msc EtOH, bz; i eth; s ace
9018	Phorate		C <sub>7</sub> H <sub>17</sub> O <sub>2</sub> PS <sub>3</sub>	298-02-2	260.378		<-15	119 <sup>0,8</sup>	1.16 <sup>25</sup>		
9019	Phorbol		C <sub>20</sub> H <sub>28</sub> O <sub>6</sub>	17673-25-5	364.432	cry (EtOH)	250 dec				s H <sub>2</sub> O, ace
9020	Phorone		C <sub>9</sub> H <sub>14</sub> O	504-20-1	138.206	ye-grn pr	28	197.5	0.8850 <sup>20</sup>	1.4998 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, ctc
9021	Phosalone		C <sub>12</sub> H <sub>15</sub> ClNO <sub>4</sub> PS <sub>2</sub>	2310-17-0	367.808		46				
9022	Phosfolan		C <sub>7</sub> H <sub>14</sub> NO <sub>3</sub> PS <sub>2</sub>	947-02-4	255.295		36.5	117 <sup>0,001</sup>			vs H <sub>2</sub> O, bz, ace; sl eth; s hx
9023	Phosmet		C <sub>11</sub> H <sub>12</sub> NO <sub>4</sub> PS <sub>2</sub>	732-11-6	317.321		72	dec			
9024	Phosphamidon		C <sub>10</sub> H <sub>15</sub> ClNO <sub>3</sub> P	13171-21-6	299.689	oil	-45	162 <sup>1,5</sup>	1.2132 <sup>25</sup>	1.4718 <sup>25</sup>	msc H <sub>2</sub> O; s hx
9025	<i>N</i> -Phospho- <i>L</i> -arginine		C <sub>8</sub> H <sub>15</sub> N <sub>4</sub> O <sub>5</sub> P	1189-11-3	254.181	cry (ace aq)	177				
9026	<i>O</i> -Phosphorylethanolamine	Ethanolamine <i>O</i> -phosphate	C <sub>2</sub> H <sub>5</sub> NO <sub>4</sub> P	1071-23-4	141.063	cry (EtOH aq)	242				
9027	<i>O</i> -Phosphoserine		C <sub>3</sub> H <sub>8</sub> NO <sub>5</sub> P	407-41-0	185.073	cry	166 dec				
9028	Phthalazine	2,3-Benzodiazine	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	253-52-1	130.147		90.5	316			s H <sub>2</sub> O, EtOH, bz; sl eth; i lig
9029	Phthalic acid	1,2-Benzenedicarboxylic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	88-99-3	166.132	pl (w)	230 dec	dec	2.18 <sup>191</sup>		sl H <sub>2</sub> O, eth; i chl; s EtOH
9030	Phthalic anhydride		C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	85-44-9	148.116	wh nd (al, bz)	130.8	295	1.527 <sup>4</sup>		sl H <sub>2</sub> O, eth; s EtOH, ace, bz
9031	2 <i>H</i> ,31 <i>H</i> -Phthalocyanine		C <sub>32</sub> H <sub>18</sub> N <sub>6</sub>	574-93-6	514.539	grsh-bl mcl (quinoline)		sub 550			i H <sub>2</sub> O, EtOH, eth; s PhNH <sub>2</sub>
9032	Phthalylsulphathiazole		C <sub>17</sub> H <sub>13</sub> N <sub>3</sub> O <sub>5</sub> S <sub>2</sub>	85-73-4	403.432		273				i H <sub>2</sub> O, eth, chl; sl EtOH; s acid, alk
9033	Physostigmine		C <sub>15</sub> H <sub>21</sub> N <sub>3</sub> O <sub>2</sub>	57-47-6	275.347	orth pr (eth, bz)	105.5				sl H <sub>2</sub> O; s EtOH, eth, bz, chl
9034	Phytol	3,7,11,15-Tetramethyl-2-hexadecen-1-ol, [ <i>R</i> -( <i>R</i> *, <i>R</i> *-( <i>E</i> ))]	C <sub>20</sub> H <sub>40</sub> O	150-86-7	296.531	oily liq		203 <sup>10</sup>	0.8497 <sup>25</sup>	1.4595 <sup>25</sup>	



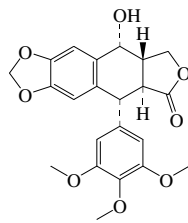
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility	
9035	Picene	Benzo[a]chrysene	C <sub>22</sub> H <sub>14</sub>	213-46-7	278.346	lf, pl (xyl, py, sub)	368	519			i H <sub>2</sub> O; sl EtOH, bz, chl; s con sulf	
9036	Picolonic acid		C <sub>10</sub> H <sub>6</sub> N <sub>4</sub> O <sub>5</sub>	550-74-3	264.195	ye nd (al)	116	dec			sl H <sub>2</sub> O; s EtOH, eth, MeOH	
9037	Picropodophyllin		C <sub>22</sub> H <sub>22</sub> O <sub>8</sub>	477-47-4	414.405	col nd (al, bz)	228				vs ace, bz, eth, EtOH	
9038	Picrotoxin		C <sub>30</sub> H <sub>34</sub> O <sub>13</sub>	124-87-8	602.583	orth lf	203.5				vs py, EtOH	
9039	Pilocarpine		C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	92-13-7	208.257	nd	34	260 <sup>5</sup>			s H <sub>2</sub> O, EtOH; sl eth, bz; vs chl; i peth	
9040	Pilocarpine, monohydrochloride		C <sub>11</sub> H <sub>17</sub> ClN <sub>2</sub> O <sub>2</sub>	54-71-7	244.718	hyg cry	204.5				vs H <sub>2</sub> O, EtOH	
9041	Pilocarpine, mononitrate		C <sub>11</sub> H <sub>17</sub> N <sub>3</sub> O <sub>5</sub>	148-72-1	271.270	wh pow or cry (al)	178				vs H <sub>2</sub> O	
9042	Pilosine		C <sub>16</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	13640-28-3	286.325	nd (al)	179					
9043	Pimaric acid	Dextropimaric acid	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	127-27-5	302.451	orth (ace) pr (al)	218.5	282 <sup>18</sup>			vs eth, py, EtOH	
9044	Pinane	2,6,6-Trimethylbicyclo[3.1.1]heptane	C <sub>10</sub> H <sub>18</sub>	473-55-2	138.250	oil	-53	169	0.8467 <sup>21</sup>	1.4605 <sup>21</sup>		
9045	<i>trans</i> -2-Pinanol	Pinene hydrate	C <sub>10</sub> H <sub>18</sub> O	35408-04-9	154.249		60	81 <sup>10</sup>				
9046	Pindolol		C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	13523-86-9	248.321	cry (EtOH)	172					
9047	α-Pinene	2-Pinene	C <sub>10</sub> H <sub>16</sub>	80-56-8	136.234	liq	-64	156.2	0.8539 <sup>25</sup>	1.4632 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, chl	
9048	β-Pinene	Nopinene	C <sub>10</sub> H <sub>16</sub>	127-91-3	136.234	liq	-61.5	166	0.860 <sup>25</sup>	1.4768 <sup>25</sup>	i H <sub>2</sub> O; s bz, EtOH, eth, chl	
9049	Piperazine	Diethylenediamine	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub>	110-85-0	86.135	hyg pl or lf (al)	106	148.6		1.446 <sup>113</sup>	vs H <sub>2</sub> O; s EtOH, chl; i eth	
9050	1-Piperazinecarboxaldehyde		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O	7755-92-2	114.145			95 <sup>5</sup>		1.5094 <sup>20</sup>		
9051	1,4-Piperazinediethanol		C <sub>8</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	122-96-3	174.241		135	217 <sup>30</sup>				
9052	Piperazine dihydrochloride	Diethylenediamine dihydrochloride	C <sub>4</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub>	142-64-3	159.057						sl H <sub>2</sub> O; i EtOH	
9053	2,5-Piperazinedione		C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	106-57-0	114.103	tab or pl (w)	312 dec	sub 260			sl H <sub>2</sub> O, EtOH; s HCl	
9054	1,4-Piperazinedipropylamine	1,4-Bis(3-aminopropyl)piperazine	C <sub>10</sub> H <sub>24</sub> N <sub>4</sub>	7209-38-3	200.325		15	151 <sup>2</sup>	0.972 <sup>25</sup>	1.5015 <sup>20</sup>		
9055	1-Piperazineethanamine	1-(2-Aminoethyl)piperazine	C <sub>6</sub> H <sub>15</sub> N <sub>3</sub>	140-31-8	129.203			220	0.985 <sup>25</sup>	1.4983 <sup>20</sup>		
9056	1-Piperazineethanol		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O	103-76-4	130.187			246	1.061 <sup>25</sup>	1.5065 <sup>20</sup>		
9057	1-Piperidinamine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	2213-43-6	100.162			147	0.928 <sup>25</sup>	1.4750 <sup>20</sup>		
9058	Piperidine	Azacyclohexane	C <sub>5</sub> H <sub>11</sub> N	110-89-4	85.148	liq	-11.02	106.22	0.8606 <sup>20</sup>	1.4530 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth, ace, bz, chl	
9059	1-Piperidinecarboxaldehyde		C <sub>6</sub> H <sub>11</sub> NO	2591-86-8	113.157	liq	-30.8	222.5	1.0158 <sup>25</sup>	1.4805 <sup>25</sup>	msc H <sub>2</sub> O, EtOH, eth, bz, chl, lig	
9060	4-Piperidinecarboxamide		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O	39546-32-2	128.171			138.5				
9061	2-Piperidinecarboxylic acid, (S)	L-Pipecolic acid	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	3105-95-1	129.157	nd (MeOH/eth)	260					
9062	3-Piperidinecarboxylic acid	Nipecotic acid	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	498-95-3	129.157			261 dec			vs H <sub>2</sub> O	
9063	4-Piperidinecarboxylic acid	Isonipecotic acid	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	498-94-2	129.157	nd		336				
9064	1-Piperidineethanol		C <sub>7</sub> H <sub>15</sub> NO	3040-44-6	129.200			17.9	202; 90 <sup>12</sup>	0.9703 <sup>25</sup>	1.4749 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH
9065	2-Piperidineethanol	2-(2-Hydroxyethyl)piperidine	C <sub>7</sub> H <sub>15</sub> NO	1484-84-0	129.200			69	202; 145 <sup>36</sup>	1.01 <sup>27</sup>	1.4907 <sup>20</sup>	vs H <sub>2</sub> O
9066	4-Piperidineethanol	4-(2-Hydroxyethyl)piperidine	C <sub>7</sub> H <sub>15</sub> NO	622-26-4	129.200	syr	132.5	227.5	1.0059 <sup>15</sup>	1.4907 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH	
9067	Piperidine, hydrochloride	Piperidinium chloride	C <sub>5</sub> H <sub>12</sub> ClN	6091-44-7	121.609			142 dec			vs H <sub>2</sub> O, chl	
9068	4-Piperidinemethanamine	4-(Aminomethyl)piperidine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	7144-05-0	114.188			25	200; 31 <sup>10</sup>		1.4900 <sup>20</sup>	
9069	2-Piperidinemethanol		C <sub>6</sub> H <sub>13</sub> NO	3433-37-2	115.173			69	104 <sup>10</sup> , 80 <sup>1</sup>		sl chl	
9070	3-Piperidinemethanol		C <sub>6</sub> H <sub>13</sub> NO	4606-65-9	115.173			61	106 <sup>3,5</sup>	1.0263 <sup>20</sup>	1.4964 <sup>20</sup>	sl chl
9071	1-Piperidinepropanenitrile		C <sub>8</sub> H <sub>14</sub> N <sub>2</sub>	3088-41-3	138.210			-6.8	145 <sup>50</sup>	0.9403 <sup>25</sup>	1.4676 <sup>25</sup>	
9072	2-Piperidinone		C <sub>5</sub> H <sub>9</sub> NO	675-20-7	99.131	hyg	39.5	256			vs H <sub>2</sub> O, EtOH, eth; s dil acid; i con alk	
9073	2-(1-Piperidinylmethyl)cyclohexanone	Pimeclone	C <sub>12</sub> H <sub>21</sub> NO	534-84-9	195.301					119 <sup>14</sup>		
9074	1-(2-Piperidinyl)-2-propanone, (±)		C <sub>8</sub> H <sub>15</sub> NO	539-00-4	141.211	oil			91 <sup>14</sup>	0.9624 <sup>20</sup>	1.4683 <sup>20</sup>	vs EtOH, chl
9075	3-(2-Piperidinyl)pyridine, (S)	Anabasine	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	494-52-0	162.231	liq	9	276; 146 <sup>14</sup>	1.0455 <sup>20</sup>	1.5430 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, bz	
9076	Piperine		C <sub>17</sub> H <sub>19</sub> NO <sub>3</sub>	94-62-2	285.338	pr (AcOEt) pl or mcl pr (al), cry	131.5				i H <sub>2</sub> O; s EtOH, bz, py; sl eth; vs chl	
9077	Piperonyl butoxide		C <sub>19</sub> H <sub>30</sub> O <sub>5</sub>	51-03-6	338.438			180 <sup>1</sup>	1.05 <sup>25</sup>			
9078	Piperonyl sulfoxide	Isosafrole octyl sulfoxide	C <sub>18</sub> H <sub>26</sub> O <sub>3</sub> S	120-62-7	324.478	ye-br liq		dec		1.530 <sup>25</sup>	sl H <sub>2</sub> O; misc os	
9079	Pipobroman		C <sub>10</sub> H <sub>16</sub> Br <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	54-91-1	356.054		106					
9080	Piprotal	Tropital	C <sub>24</sub> H <sub>40</sub> O <sub>3</sub>	5281-13-0	456.570	liq				215 <sup>04</sup>		



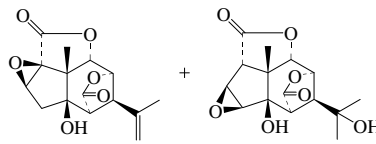
Picene



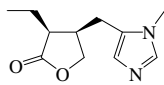
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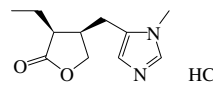
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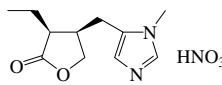
Picrotoxin



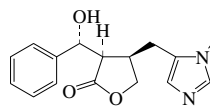
Pilocarpine



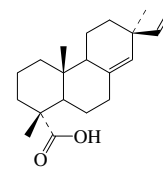
Pilocarpine, monohydrochloride



Pilocarpine, mononitrate



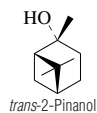
Pilosine



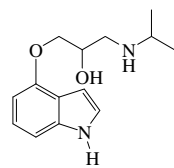
Pimaric acid



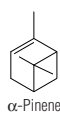
Pinane



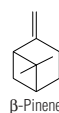
trans-2-Pinanol



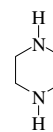
Pindolol



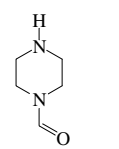
α-Pinene



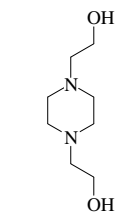
β-Pinene



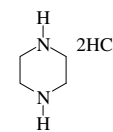
Piperazine



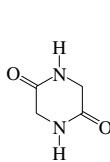
1-Piperazinecarboxaldehyde



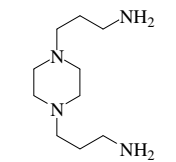
1,4-Piperazinediethanol



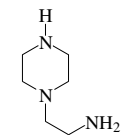
Piperazine dihydrochloride



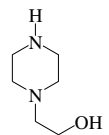
2,5-Piperazinedione



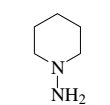
1,4-Piperazinedipropanamine



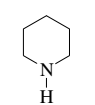
1-Piperazineethanamine



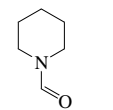
1-Piperazineethanol



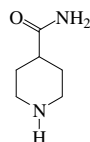
1-Piperidinamine



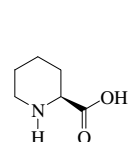
Piperidine



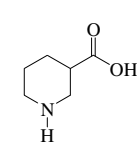
1-Piperidinecarboxaldehyde



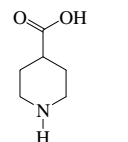
4-Piperidinecarboxamide



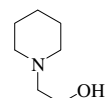
2-Piperidinecarboxylic acid, (S)



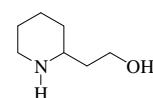
3-Piperidinecarboxylic acid



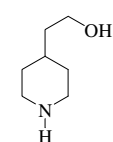
4-Piperidinecarboxylic acid



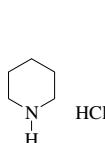
1-Piperidineethanol



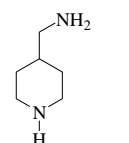
2-Piperidineethanol



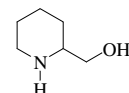
4-Piperidineethanol



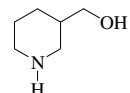
Piperidine, hydrochloride



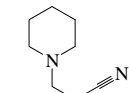
4-Piperidinemethanamine



2-Piperidinemethanol



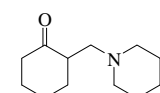
3-Piperidinemethanol



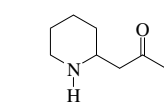
1-Piperidinepropanenitrile



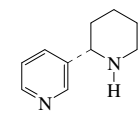
2-Piperidinone



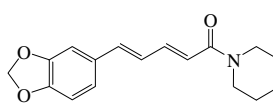
2-(1-Piperidinylmethyl)cyclohexanone



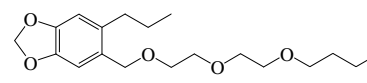
1-(2-Piperidinyl)-2-propanone, (+)



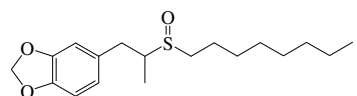
3-(2-Piperidinyl)pyridine, (S)



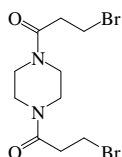
Piperine



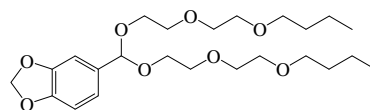
Piperonyl butoxide



Piperonyl sulfoxide



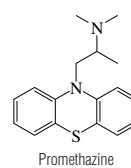
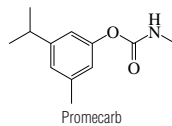
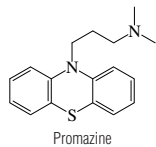
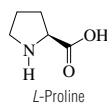
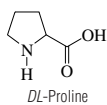
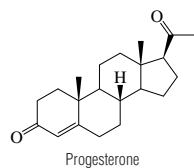
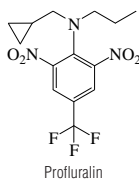
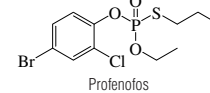
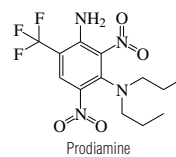
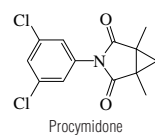
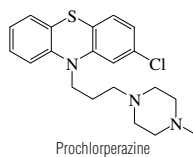
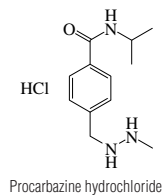
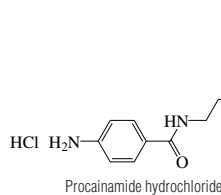
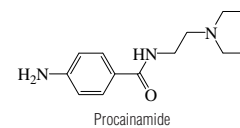
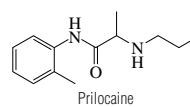
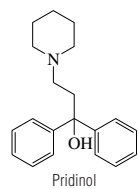
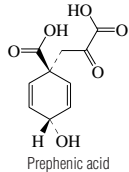
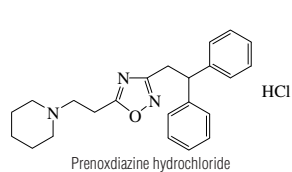
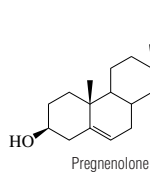
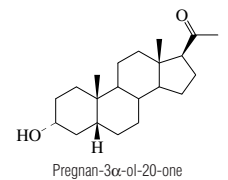
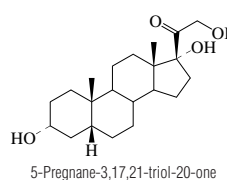
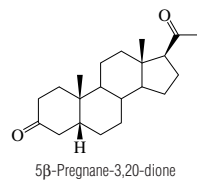
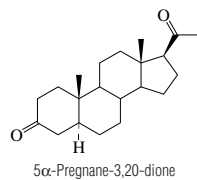
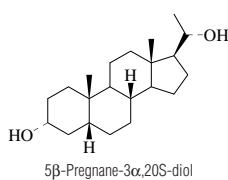
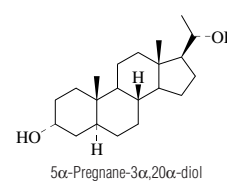
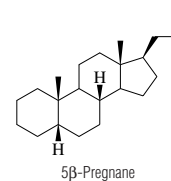
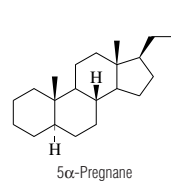
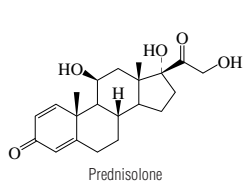
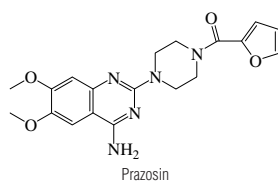
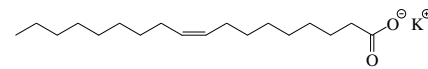
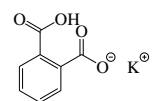
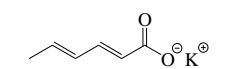
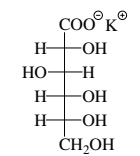
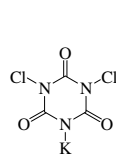
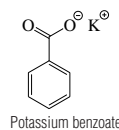
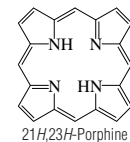
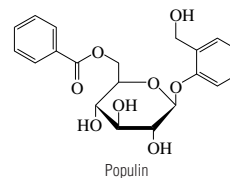
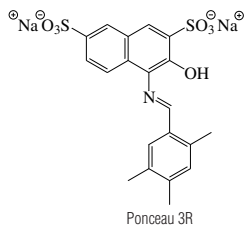
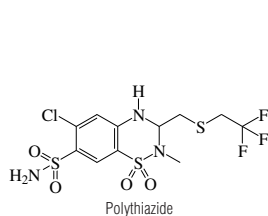
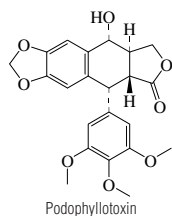
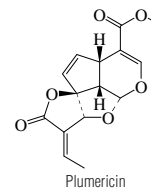
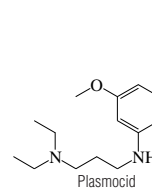
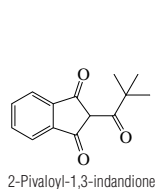
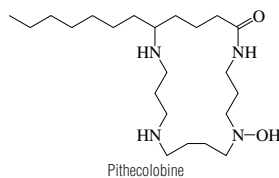
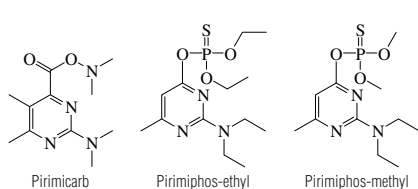
Pipobroman



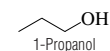
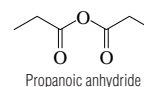
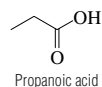
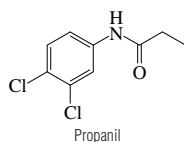
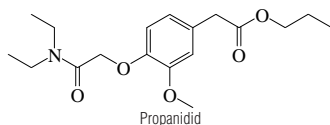
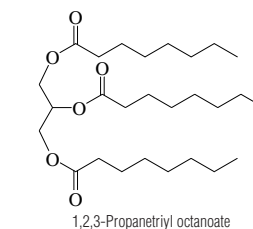
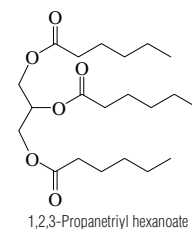
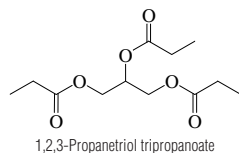
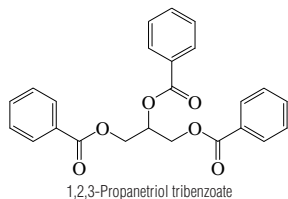
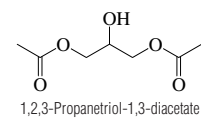
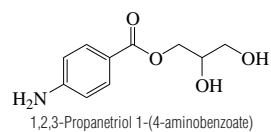
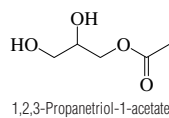
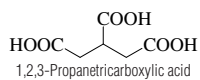
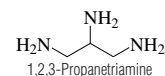
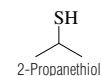
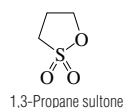
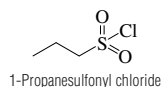
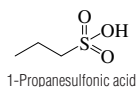
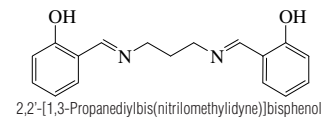
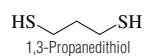
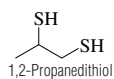
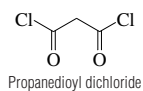
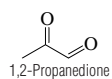
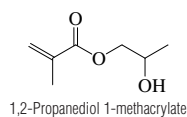
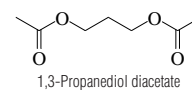
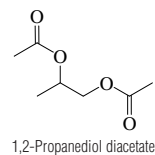
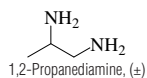
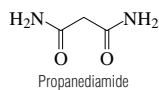
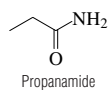
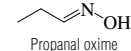
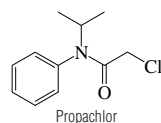
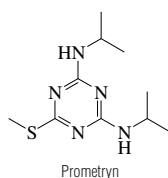
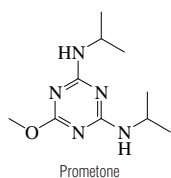
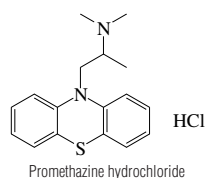
Piprotal

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9081	Pirimicarb		C <sub>11</sub> H <sub>18</sub> N <sub>4</sub> O <sub>2</sub>	23103-98-2	238.287		90.5				
9082	Pirimiphos-ethyl		C <sub>13</sub> H <sub>24</sub> N <sub>3</sub> O <sub>3</sub> PS	23505-41-1	333.387			dec >130	1.14 <sup>20</sup>		
9083	Pirimiphos-methyl		C <sub>11</sub> H <sub>20</sub> N <sub>3</sub> O <sub>3</sub> PS	29232-93-7	305.334		15	dec	1.17 <sup>20</sup>		
9084	Pithecolobine		C <sub>22</sub> H <sub>46</sub> N <sub>4</sub> O <sub>2</sub>	22368-82-7	398.626	cry	68	230 <sup>0.007</sup>			s H <sub>2</sub> O, chl, eth, EtOH, peth
9085	2-Pivaloyl-1,3-indandione	Pindone	C <sub>14</sub> H <sub>14</sub> O <sub>3</sub>	83-26-1	230.259	ye cry	109				
9086	Plasmocid		C <sub>17</sub> H <sub>26</sub> N <sub>2</sub> O	551-01-9	287.400			182 <sup>1.0</sup>	1.0569 <sup>24</sup>	1.5855 <sup>24</sup>	
9087	Plumericin		C <sub>15</sub> H <sub>14</sub> O <sub>6</sub>	77-16-7	290.268						s chl
9088	Podophyllotoxin		C <sub>22</sub> H <sub>22</sub> O <sub>6</sub>	518-28-5	414.405		183				sl H <sub>2</sub> O; vs EtOH; i eth; s ace, bz, HOAc
9089	Polythiazide		C <sub>11</sub> H <sub>13</sub> ClF <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>3</sub>	346-18-9	439.882		214				
9090	Ponceau 3R	C.I. Food Red 6	C <sub>19</sub> H <sub>16</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>7</sub> S <sub>2</sub>	3564-09-8	494.449	dk red pow					s H <sub>2</sub> O; sl EtOH
9091	Populin		C <sub>20</sub> H <sub>22</sub> O <sub>3</sub>	99-17-2	390.384	nd (w+2), pr (al)	180				
9092	21 <i>H</i> ,23 <i>H</i> -Porphine		C <sub>20</sub> H <sub>14</sub> N <sub>4</sub>	101-60-0	310.352	red or oran lf (chl-MeOH)	360	sub 300	1.336 <sup>25</sup>		i H <sub>2</sub> O, eth, ace, bz; sl EtOH; s diox
9093	Potassium benzoate		C <sub>7</sub> H <sub>5</sub> KO <sub>2</sub>	582-25-2	160.212	hyg cry					
9094	Potassium dichloroisocyanurate	Troclosene potassium	C <sub>3</sub> Cl <sub>2</sub> KN <sub>3</sub> O <sub>3</sub>	2244-21-5	236.054	hyg cry	250 dec				
9095	Potassium <i>D</i> -gluconate		C <sub>6</sub> H <sub>11</sub> KO <sub>7</sub>	299-27-4	234.245	ye-wh cry	183 dec				vs H <sub>2</sub> O; i EtOH, eth, bz, chl
9096	Potassium <i>trans,trans</i> -2,4-hexadienoate	Potassium sorbate	C <sub>8</sub> H <sub>7</sub> KO <sub>2</sub>	24634-61-5	150.217		>270 dec		1.361 <sup>25</sup>		vs H <sub>2</sub> O; s EtOH
9097	Potassium hydrogen phthalate	Potassium biphthalate	C <sub>8</sub> H <sub>5</sub> KO <sub>4</sub>	877-24-7	204.222				1.636 <sup>25</sup>		s H <sub>2</sub> O; sl EtOH
9098	Potassium <i>cis</i> -9-octadecenoate	Potassium oleate	C <sub>18</sub> H <sub>33</sub> KO <sub>2</sub>	143-18-0	320.552	ye-br solid					s H <sub>2</sub> O, EtOH
9099	Prazosin		C <sub>19</sub> H <sub>14</sub> N <sub>5</sub> O <sub>4</sub>	19216-56-9	383.402	cry	279				
9100	Prednisolone		C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	50-24-8	360.444		235				
9101	5 $\alpha$ -Pregnane	Allopregnane	C <sub>21</sub> H <sub>36</sub>	641-85-0	288.511		84.5				
9102	5 $\beta$ -Pregnane	17 $\beta$ -Ethyletiocholane	C <sub>21</sub> H <sub>36</sub>	481-26-5	288.511	mcl sc or pl (MeOH)	83.5		1.032 <sup>15</sup>		i H <sub>2</sub> O; s chl, MeOH
9103	5 $\alpha$ -Pregnane-3 $\alpha$ ,20 $\alpha$ -diol	Allopregnane-3 $\alpha$ ,20 $\alpha$ -diol	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub>	566-58-5	320.510	cry (MeOH)	244				
9104	5 $\beta$ -Pregnane-3 $\alpha$ ,20S-diol	Pregnenediol	C <sub>21</sub> H <sub>36</sub> O <sub>2</sub>	80-92-2	320.510	pl (ace)	243.5		1.15 <sup>25</sup>		sl EtOH, eth; s ace
9105	5 $\alpha$ -Pregnane-3,20-dione	3,20-Allopregnenedione	C <sub>21</sub> H <sub>32</sub> O <sub>2</sub>	566-65-4	316.478	cry	200				
9106	5 $\beta$ -Pregnane-3,20-dione		C <sub>21</sub> H <sub>32</sub> O <sub>2</sub>	128-23-4	316.478	nd (dil al) cry (dil ace)	123				i H <sub>2</sub> O; vs EtOH; s eth, ace
9107	5-Pregnane-3,17,21-triol-20-one	3,17,21-Trihydroxypregnan-20-one, (3 $\alpha$ ,5 $\beta$ )	C <sub>21</sub> H <sub>34</sub> O <sub>4</sub>	68-60-0	350.493	cry (EtOAc)	226				
9108	Pregnan-3 $\alpha$ -ol-20-one		C <sub>21</sub> H <sub>34</sub> O <sub>2</sub>	128-20-1	318.494	nd (bz), cry (dil al)	149.5				vs EtOH
9109	Pregnenolone		C <sub>21</sub> H <sub>32</sub> O <sub>2</sub>	145-13-1	316.478	nd (dil al)	192				
9110	Prenoxdiazine hydrochloride		C <sub>23</sub> H <sub>28</sub> ClN <sub>3</sub> O	982-43-4	397.940		186.5				
9111	Prephenic acid		C <sub>10</sub> H <sub>10</sub> O <sub>6</sub>	126-49-8	226.182	free acid unstab					
9112	Pridinol	1,1-Diphenyl-3-(1-piperidinyl)-1-propanol	C <sub>20</sub> H <sub>25</sub> NO	511-45-5	295.419	cry	120				s ace
9113	Prilocaine	<i>N</i> -(2-Methylphenyl)-2-(propylamino)propanamide	C <sub>13</sub> H <sub>20</sub> N <sub>2</sub> O	721-50-6	220.310	nd	38	160 <sup>1</sup>		1.5299 <sup>20</sup>	
9114	Procainamide	4-Amino- <i>N</i> -[2-(diethylamino)ethyl]benzamide	C <sub>13</sub> H <sub>21</sub> N <sub>3</sub> O	51-06-9	235.325		47	212 <sup>2</sup>			
9115	Procainamide hydrochloride		C <sub>13</sub> H <sub>22</sub> ClN <sub>3</sub> O	614-39-1	271.786		166				vs H <sub>2</sub> O; s EtOH; i eth, bz; sl chl
9116	Procarbazine hydrochloride		C <sub>12</sub> H <sub>20</sub> ClN <sub>3</sub> O	366-70-1	257.759	cry (MeOH)	225				
9117	Prochlorperazine		C <sub>20</sub> H <sub>24</sub> ClN <sub>3</sub> S	58-38-8	373.943		228				
9118	Procymidone		C <sub>13</sub> H <sub>11</sub> Cl <sub>2</sub> NO <sub>2</sub>	32809-16-8	284.138		166		1.452 <sup>25</sup>		
9119	Prodiamine		C <sub>13</sub> H <sub>17</sub> F <sub>3</sub> N <sub>4</sub> O <sub>4</sub>	29091-21-2	350.294		124		1.47 <sup>25</sup>		
9120	Profenofos		C <sub>11</sub> H <sub>15</sub> BrClO <sub>3</sub> PS	41198-08-7	373.631			110 <sup>0.001</sup>	1.455 <sup>20</sup>		
9121	Profluralin		C <sub>14</sub> H <sub>16</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	26399-36-0	347.290		34				
9122	Progesterone	Pregn-4-ene-3,20-dione	C <sub>21</sub> H <sub>30</sub> O <sub>2</sub>	57-83-0	314.462	pr	129		1.166 <sup>23</sup>		i H <sub>2</sub> O; s EtOH, diox, ace
9123	<i>DL</i> -Proline		C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	609-36-9	115.131	hyg nd (al-eth) cry (+w)	205 dec				vs H <sub>2</sub> O, EtOH
9124	<i>L</i> -Proline	2-Pyrrolidinecarboxylic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	147-85-3	115.131	nd (al-eth) pr (w)	221 dec				vs H <sub>2</sub> O; sl EtOH, ace, bz; i eth, PrOH
9125	Promazine		C <sub>17</sub> H <sub>20</sub> N <sub>2</sub> S	58-40-2	284.419			206 <sup>0.3</sup>			
9126	Promecarb	Phenol, 3-methyl-5-(1-methylethyl)-, methylcarbamate	C <sub>12</sub> H <sub>17</sub> NO <sub>2</sub>	2631-37-0	207.269		87	117 <sup>0.01</sup>			
9127	Promethazine	<i>N,N</i> $\alpha$ -Trimethyl-10 <i>H</i> -phenothiazine-10-ethanamine	C <sub>17</sub> H <sub>20</sub> N <sub>2</sub> S	60-87-7	284.419		60	191 <sup>0.5</sup>			i H <sub>2</sub> O; vs dil HCl

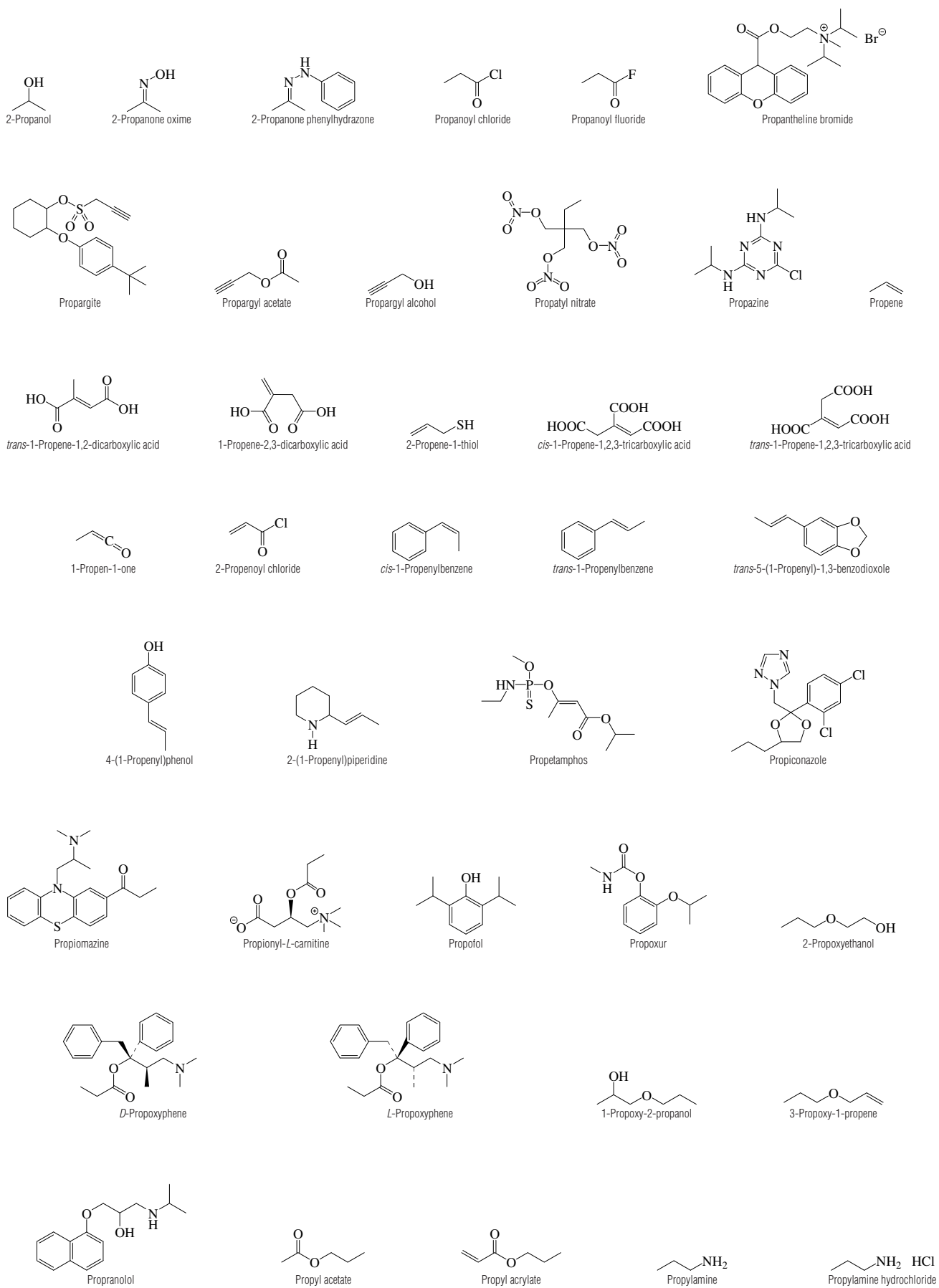




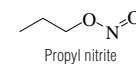
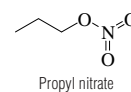
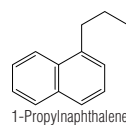
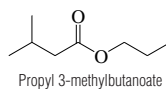
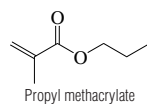
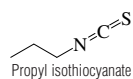
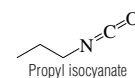
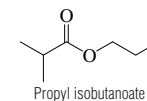
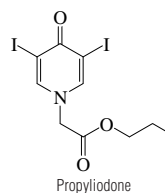
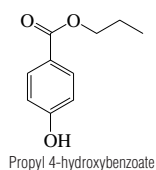
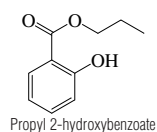
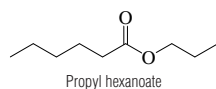
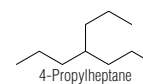
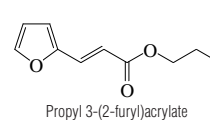
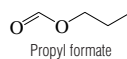
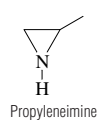
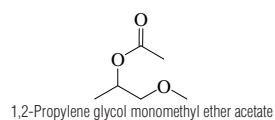
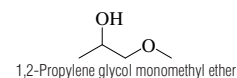
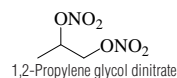
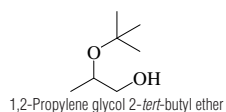
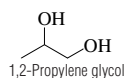
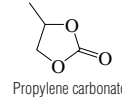
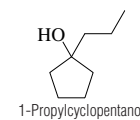
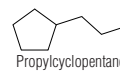
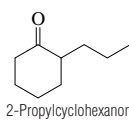
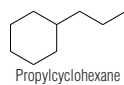
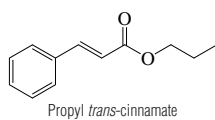
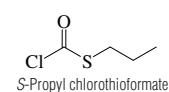
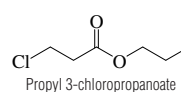
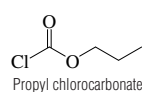
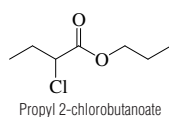
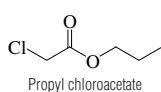
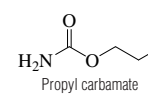
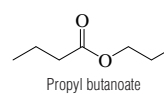
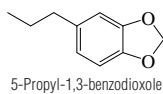
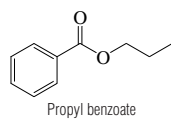
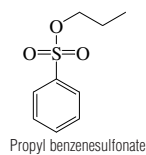
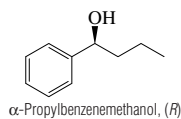
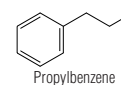
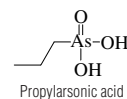
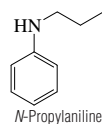
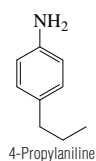
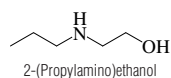
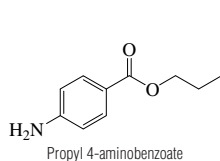
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9128	Promethazine hydrochloride	Diprazin	C <sub>17</sub> H <sub>21</sub> ClN <sub>2</sub> S	58-33-3	320.880		231				vs H <sub>2</sub> O, EtOH, chl
9129	Prometone		C <sub>10</sub> H <sub>19</sub> N <sub>3</sub> O	1610-18-0	225.291	solid	91.5				
9130	Prometryn	<i>N,N'</i> -Diisopropyl-6-(methylthio)-1,3,5-triazine-2,4-diamine	C <sub>10</sub> H <sub>19</sub> N <sub>3</sub> S	7287-19-6	241.357		119		1.157 <sup>20</sup>		
9131	Propachlor	Acetamide, 2-chloro- <i>N</i> -(1-methylethyl)- <i>N</i> -phenyl-	C <sub>11</sub> H <sub>14</sub> ClNO	1918-16-7	211.688		77	110 <sup>0.03</sup>	1.242 <sup>25</sup>		
9132	Propanal	Propionaldehyde	C <sub>3</sub> H <sub>6</sub> O	123-38-6	58.079	liq	-80	48	0.8657 <sup>25</sup>	1.3636 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth
9133	Propanal oxime		C <sub>3</sub> H <sub>7</sub> NO	627-39-4	73.094		40	131.5	0.9258 <sup>20</sup>	1.4287 <sup>20</sup>	
9134	Propanamide	Propionamide	C <sub>3</sub> H <sub>7</sub> NO	79-05-0	73.094	rhom, pl (bz)	81.3	213	0.9262 <sup>10</sup>	1.4180 <sup>110</sup>	vs H <sub>2</sub> O, EtOH, eth, chl
9135	Propane		C <sub>3</sub> H <sub>8</sub>	74-98-6	44.096	col gas	-187.63	-42.1	0.493 <sup>25</sup> (p>1 atm)		s H <sub>2</sub> O, EtOH; vs eth, bz; sl ace
9136	Propanediamide		C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	108-13-4	102.092	mcl pr(w)	170.8				s H <sub>2</sub> O; i EtOH, eth, bz; sl DMSO
9137	1,2-Propanediamine, (±)	Propylenediamine	C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	10424-38-1	74.124	hyg		119.5	0.878 <sup>15</sup>	1.4460 <sup>20</sup>	vs H <sub>2</sub> O; i eth; vs chl
9138	1,3-Propanediamine	1,3-Diaminopropane	C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	109-76-2	74.124	liq	-10.8	139.8	0.884 <sup>25</sup>	1.4600 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth
9139	1,2-Propanediol diacetate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	623-84-7	160.168			190.5	1.059 <sup>20</sup>	1.4173 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth
9140	1,3-Propanediol diacetate		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	628-66-0	160.168			209.5	1.070 <sup>14</sup>	1.4192	vs H <sub>2</sub> O; s EtOH
9141	1,2-Propanediol 1-methacrylate	2-Hydroxypropyl methacrylate	C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	923-26-2	144.168			90 <sup>3</sup> , 57 <sup>0.5</sup>	1.066 <sup>25</sup>	1.4458 <sup>20</sup>	
9142	1,2-Propanedione	Pyruvaldehyde	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	78-98-8	72.063	ye hyg liq		72	1.0455 <sup>20</sup>	1.4002 <sup>18</sup>	s EtOH, eth, bz
9143	Propanediol dichloride		C <sub>3</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	1663-67-8	140.953			57 <sup>28</sup>	1.4509 <sup>20</sup>	1.4639 <sup>20</sup>	s eth, AcOEt
9144	1,2-Propanedithiol		C <sub>3</sub> H <sub>6</sub> S <sub>2</sub>	814-67-5	108.226			152	1.08 <sup>20</sup>	1.532 <sup>20</sup>	s chl
9145	1,3-Propanedithiol	Trimethylene dimercaptan	C <sub>3</sub> H <sub>6</sub> S <sub>2</sub>	109-80-8	108.226	liq	-79	172.9	1.0772 <sup>20</sup>	1.5392 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth, bz
9146	2,2'-[1,3-Propanediylbis(nitrimethylidene)]bisphenol	Disalicylidene-1,3-propanediamine	C <sub>17</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	120-70-7	282.337		54.3				
9147	Propanenitrile	Ethyl cyanide	C <sub>3</sub> H <sub>5</sub> N	107-12-0	55.079	liq	-92.78	97.14	0.7818 <sup>20</sup>	1.3655 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
9148	1-Propanesulfonic acid		C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> S	5284-66-2	124.159		8	136 <sup>1</sup>	1.2516 <sup>25</sup>		
9149	1-Propanesulfonyl chloride		C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub> S	10147-36-1	142.605			dec 180; 77 <sup>12</sup>	1.267 <sup>20</sup>	1.452 <sup>20</sup>	
9150	1,3-Propane sultone	1,2-Oxathiolane, 2,2-dioxide	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> S	1120-71-4	122.143						s chl
9151	1-Propanethiol	Propyl mercaptan	C <sub>3</sub> H <sub>6</sub> S	107-03-9	76.161	liq	-113.13	67.8	0.8411 <sup>20</sup>	1.4380 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz
9152	2-Propanethiol	Isopropyl mercaptan	C <sub>3</sub> H <sub>6</sub> S	75-33-2	76.161	liq	-130.5	52.6	0.8143 <sup>20</sup>	1.4255 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace; s chl
9153	1,2,3-Propanetriamine	1,2,3-Triaminopropane	C <sub>3</sub> H <sub>11</sub> N <sub>3</sub>	21291-99-6	89.139	visc oil		190; 92 <sup>9</sup>			s H <sub>2</sub> O
9154	1,2,3-Propanetricarboxylic acid	Tricarballic acid	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	99-14-9	176.124	orth (eth)	166				vs H <sub>2</sub> O, EtOH; sl eth
9155	1,2,3-Propanetriol-1-acetate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	106-61-6	134.131			158 <sup>165</sup> , 129 <sup>3</sup>	1.2060 <sup>20</sup>	1.4157 <sup>20</sup>	vs H <sub>2</sub> O, EtOH
9156	1,2,3-Propanetriol 1-(4-aminobenzoate)	Glyceryl <i>p</i> -aminobenzoate	C <sub>10</sub> H <sub>13</sub> NO <sub>4</sub>	136-44-7	211.215						i H <sub>2</sub> O; s EtOH
9157	1,2,3-Propanetriol-1,3-diacetate	1,3-Diacetin	C <sub>7</sub> H <sub>12</sub> O <sub>5</sub>	105-70-4	176.167	hyg liq		260; 149 <sup>12</sup>	1.179 <sup>15</sup>	1.4395 <sup>20</sup>	vs H <sub>2</sub> O, EtOH; sl eth; i CS <sub>2</sub>
9158	1,2,3-Propanetriol tribenzoate		C <sub>24</sub> H <sub>26</sub> O <sub>6</sub>	614-33-5	404.412	nd (MeOH)	76		1.228 <sup>12</sup>		i H <sub>2</sub> O; s EtOH; vs eth, ace, bz, chl
9159	1,2,3-Propanetriol tripropanoate		C <sub>12</sub> H <sub>20</sub> O <sub>6</sub>	139-45-7	260.283			175 <sup>20</sup> , 157 <sup>13</sup>	1.108 <sup>15</sup>	1.4318 <sup>19</sup>	i H <sub>2</sub> O; s EtOH, chl; vs eth
9160	1,2,3-Propanetriyl hexanoate		C <sub>21</sub> H <sub>38</sub> O <sub>6</sub>	621-70-5	386.523		-60	>200	0.9867 <sup>20</sup>	1.4427 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, bz; vs ace
9161	1,2,3-Propanetriyl octanoate		C <sub>27</sub> H <sub>50</sub> O <sub>6</sub>	538-23-8	470.682		10	233	0.9540 <sup>20</sup>	1.4482 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH; vs eth, bz, chl, liq
9162	Propanidid		C <sub>18</sub> H <sub>27</sub> NO <sub>5</sub>	1421-14-3	337.411			211 <sup>0.7</sup>			i H <sub>2</sub> O; s EtOH, chl
9163	Propanil	Propanamide, <i>N</i> -(3,4-dichlorophenyl)-	C <sub>9</sub> H <sub>6</sub> Cl <sub>2</sub> NO	709-98-8	218.079		92		1.25 <sup>25</sup>		
9164	Propanoic acid	Propionic acid	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	79-09-4	74.079	liq	-20.5	141.15	0.9882 <sup>25</sup>	1.3809 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth; sl chl
9165	Propanoic anhydride	Propionic anhydride	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	123-62-6	130.141	liq	-45	170; 67.5 <sup>18</sup>	1.0110 <sup>20</sup>	1.4038 <sup>20</sup>	msc eth; sl ctc
9166	1-Propanol	Propyl alcohol	C <sub>3</sub> H <sub>8</sub> O	71-23-8	60.095	liq	-124.39	97.2	0.7997 <sup>25</sup>	1.3850 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, chl; vs bz



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9167	2-Propanol	Isopropyl alcohol	C <sub>3</sub> H <sub>8</sub> O	67-63-0	60.095	liq	-87.9	82.3	0.7809 <sup>25</sup>	1.3776 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace, chl; vs bz
9168	2-Propanone oxime	Acetoxime	C <sub>3</sub> H <sub>7</sub> NO	127-06-0	73.094	pr (al)	61	136; 61 <sup>20</sup>	0.9113 <sup>62</sup>	1.4156 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, chl, lig
9169	2-Propanone phenylhydrazone	Acetone, phenylhydrazone	C <sub>9</sub> H <sub>9</sub> N <sub>2</sub>	103-02-6	148.204	orth	42	163 <sup>50</sup>			s EtOH, eth, dil acid
9170	Propanoyl chloride	Propionyl chloride	C <sub>3</sub> H <sub>5</sub> ClO	79-03-8	92.524	liq	-94	80	1.0646 <sup>20</sup>	1.4032 <sup>20</sup>	s eth
9171	Propanoyl fluoride	Propionyl fluoride	C <sub>3</sub> H <sub>5</sub> FO	430-71-7	76.069			44	0.972 <sup>15</sup>	1.329 <sup>13</sup>	
9172	Propantheline bromide		C <sub>23</sub> H <sub>35</sub> BrNO <sub>3</sub>	50-34-0	448.393	cry	160				vs H <sub>2</sub> O, EtOH, chl; i eth, bz
9173	Propargite		C <sub>19</sub> H <sub>26</sub> O <sub>4</sub> S	2312-35-8	350.472				1.10 <sup>25</sup>		
9174	Propargyl acetate		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	627-09-8	98.101			121.5	0.9982 <sup>20</sup>	1.4187 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
9175	Propargyl alcohol	3-Hydroxy-1-propyne	C <sub>3</sub> H <sub>4</sub> O	107-19-7	56.063	liq	-51.8	113.6	0.9478 <sup>20</sup>	1.4322 <sup>20</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
9176	Propatyl nitrate	2-Ethyl-2-[(nitroxy)methyl]-1,3-propanediol, dinitrate	C <sub>6</sub> H <sub>11</sub> N <sub>2</sub> O <sub>9</sub>	2921-92-8	269.166	wh pow	52		1.49		i H <sub>2</sub> O; s EtOH, ace
9177	Propazine	6-Chloro- <i>N,N'</i> -diisopropyl-1,3,5-triazine-2,4-diamine	C <sub>9</sub> H <sub>16</sub> ClN <sub>5</sub>	139-40-2	229.710		213		1.162 <sup>20</sup>		
9178	Propene	Propylene	C <sub>3</sub> H <sub>6</sub>	115-07-1	42.080	col gas	-185.24	-47.69	0.505 <sup>25</sup> (p>1 atm)	1.3567 <sup>-70</sup>	sl H <sub>2</sub> O; vs EtOH, HOAc
9179	<i>trans</i> -1-Propene-1,2-dicarboxylic acid	Mesaconic acid	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub>	498-24-8	130.100	orth nd or mcl pr (eth)	204.5	sub	1.466 <sup>20</sup>		sl H <sub>2</sub> O, bz, CS <sub>2</sub> ; vs EtOH; s eth, tfa
9180	1-Propene-2,3-dicarboxylic acid	Itaconic acid	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub>	97-65-4	130.100	rhomb (bz)	175	dec	1.632 <sup>25</sup>		s H <sub>2</sub> O, EtOH, ace; sl eth, bz, peth
9181	2-Propene-1-thiol		C <sub>3</sub> H <sub>6</sub> S	870-23-5	74.145			65	0.925 <sup>23</sup>	1.4832 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
9182	<i>cis</i> -1-Propene-1,2,3-tricarboxylic acid	<i>cis</i> -Aconitic acid	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	585-84-2	174.108	nd (w)	125				s H <sub>2</sub> O; sl eth
9183	<i>trans</i> -1-Propene-1,2,3-tricarboxylic acid	<i>trans</i> -Aconitic acid	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	4023-65-8	174.108	lf (w) nd (w, eth)	196 dec				vs H <sub>2</sub> O, EtOH
9184	1-Propen-1-one	Methylketene	C <sub>3</sub> H <sub>2</sub> O	6004-44-0	56.063	col gas	-80	-23			vs eth
9185	2-Propenoyl chloride	Acrylic acid chloride	C <sub>3</sub> H <sub>3</sub> ClO	814-68-6	90.508			75.5	1.1136 <sup>20</sup>	1.4343 <sup>30</sup>	vs chl
9186	<i>cis</i> -1-Propenylbenzene		C <sub>9</sub> H <sub>10</sub>	766-90-5	118.175	liq	-61.6	167.5	0.9088 <sup>20</sup>	1.5420 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
9187	<i>trans</i> -1-Propenylbenzene		C <sub>9</sub> H <sub>10</sub>	873-66-5	118.175	liq	-29.3	178.3	0.9023 <sup>25</sup>	1.5506 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz
9188	<i>trans</i> -5-(1-Propenyl)-1,3-benzodioxole		C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	4043-71-4	162.185		6.8	253	1.1224 <sup>20</sup>	1.5782 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; vs ace; s chl
9189	4-(1-Propenyl)phenol	<i>p</i> -Anol	C <sub>9</sub> H <sub>10</sub> O	539-12-8	134.174	lf	94	dec 250			sl H <sub>2</sub> O; vs DMF
9190	2-(1-Propenyl)piperidine	$\beta$ -Coniceine	C <sub>8</sub> H <sub>13</sub> N	538-90-9	125.212		8	168	0.8716 <sup>15</sup>		
9191	Propetamphos		C <sub>10</sub> H <sub>20</sub> NO <sub>4</sub> PS	31218-83-4	281.309			88 <sup>0.005</sup>	1.1294 <sup>20</sup>		
9192	Propiconazole		C <sub>15</sub> H <sub>17</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>2</sub>	60207-90-1	342.221			180 <sup>0.1</sup>	1.27 <sup>20</sup>		
9193	Propiomazine		C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> OS	362-29-8	340.482			240 <sup>0.5</sup>			
9194	Propionyl- <i>L</i> -carnitine	Carnitine, <i>O</i> -propanoyl	C <sub>10</sub> H <sub>19</sub> NO <sub>4</sub>	20064-19-1	217.263	hyg pr (2- PrOH)	147 dec				
9195	Propofol		C <sub>12</sub> H <sub>18</sub> O	2078-54-8	178.270		19	256; 136 <sup>30</sup>	0.955 <sup>20</sup>	1.5140 <sup>20</sup>	
9196	Propoxur	Phenol, 2-(1-methylethoxy)-, methylcarbamate	C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	114-26-1	209.242		87	dec	1.12 <sup>20</sup>		
9197	2-Propoxyethanol	Ethylene glycol monopropyl ether	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	2807-30-9	104.148			149.8	0.9112 <sup>20</sup>	1.4133 <sup>20</sup>	s H <sub>2</sub> O; vs EtOH, eth
9198	<i>D</i> -Propoxyphene	Dextropropoxyphene	C <sub>22</sub> H <sub>29</sub> NO <sub>2</sub>	469-62-5	339.471	cry (peth)	75.5				
9199	<i>L</i> -Propoxyphene	Levopropoxyphene	C <sub>22</sub> H <sub>29</sub> NO <sub>2</sub>	2338-37-6	339.471	cry (peth)	75.5				
9200	1-Propoxy-2-propanol	1,2-Propylene glycol 1-propyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1569-01-3	118.174			150	0.8886 <sup>20</sup>	1.4130 <sup>20</sup>	
9201	3-Propoxy-1-propene		C <sub>6</sub> H <sub>12</sub> O	1471-03-0	100.158			91	0.7764 <sup>20</sup>	1.3919 <sup>20</sup>	vs ace, eth, EtOH
9202	Propranolol		C <sub>16</sub> H <sub>21</sub> NO <sub>2</sub>	525-66-6	259.344	cry (cyhex)	96				
9203	Propyl acetate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	109-60-4	102.132	liq	-93	101.3	0.8820 <sup>25</sup>	1.3828 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
9204	Propyl acrylate	2-Propenoic acid, propyl ester	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	925-60-0	114.142			122; 63 <sup>100</sup>			
9205	Propylamine	1-Propanamine	C <sub>3</sub> H <sub>7</sub> N	107-10-8	59.110	liq	-84.75	47.22	0.7173 <sup>20</sup>	1.3870 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, ace; s bz, chl; sl ctc
9206	Propylamine hydrochloride	1-Propanamine hydrochloride	C <sub>3</sub> H <sub>10</sub> ClN	556-53-6	95.571		163.5				s DMSO

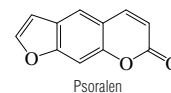
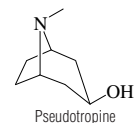
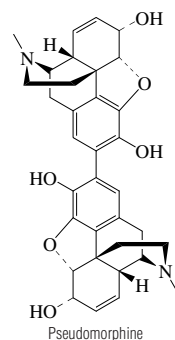
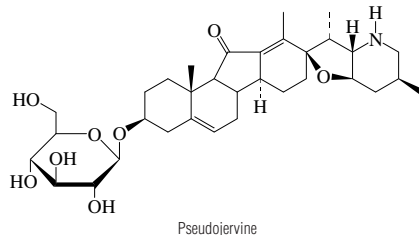
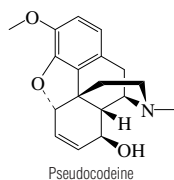
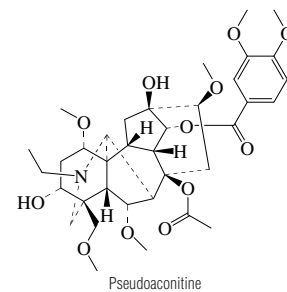
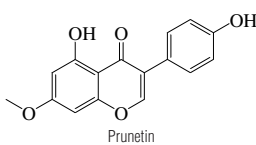
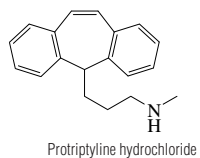
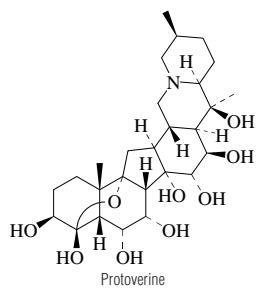
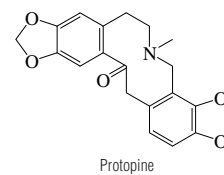
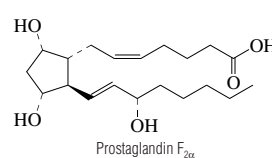
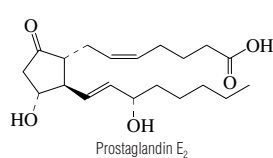
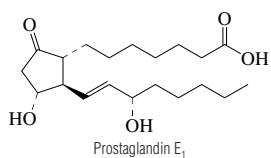
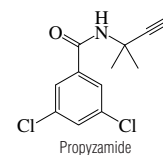
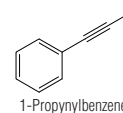
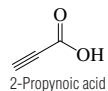
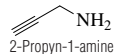
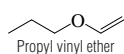
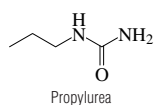
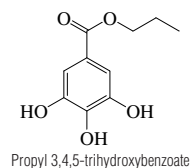
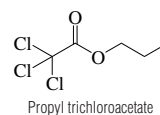
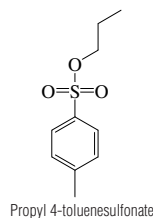
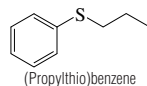
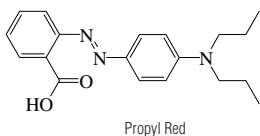
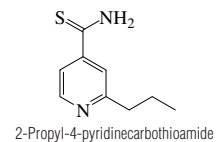
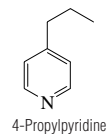
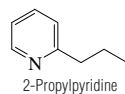
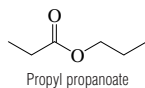
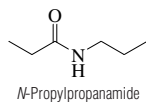
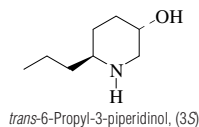
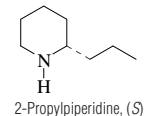
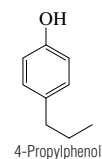
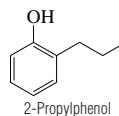
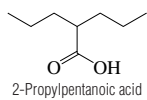
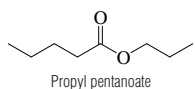
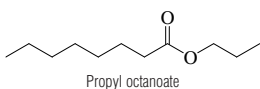


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9207	Propyl 4-aminobenzoate	Risocaine	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	94-12-2	179.216	pr	75				vs bz, eth, EtOH, chl
9208	2-(Propylamino)ethanol		C <sub>8</sub> H <sub>13</sub> NO	16369-21-4	103.163			182	0.9005 <sup>20</sup>	1.4428 <sup>20</sup>	
9209	4-Propylaniline		C <sub>9</sub> H <sub>13</sub> N	2696-84-6	135.206			227			
9210	<i>N</i> -Propylaniline		C <sub>9</sub> H <sub>13</sub> N	622-80-0	135.206			222; 98 <sup>11</sup>	0.9443 <sup>20</sup>	1.5428 <sup>20</sup>	vs eth, EtOH
9211	Propylarsonic acid	1-Propanearsonic acid	C <sub>3</sub> H <sub>9</sub> AsO <sub>3</sub>	107-34-6	168.023	nd (al), pl (w)	134.5				vs H <sub>2</sub> O, EtOH; i eth
9212	Propylbenzene	Isocumene	C <sub>9</sub> H <sub>12</sub>	103-65-1	120.191	liq	-99.6	159.24	0.8593 <sup>25</sup>	1.4895 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
9213	$\alpha$ -Propylbenzenemethanol, ( <i>R</i> )		C <sub>10</sub> H <sub>14</sub> O	22144-60-1	150.217		16	232	0.9740 <sup>20</sup>	1.5139 <sup>20</sup>	vs eth, EtOH
9214	Propyl benzenesulfonate		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub> S	80-42-2	200.254			162 <sup>15</sup>	1.1804 <sup>17</sup>	1.5035 <sup>25</sup>	sl H <sub>2</sub> O; s EtOH; vs eth, chl
9215	Propyl benzoate		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	2315-68-6	164.201	liq	-51.6	211	1.0230 <sup>20</sup>	1.5000 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
9216	5-Propyl-1,3-benzodioxole	Dihydrosafrole	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	94-58-6	164.201			228			s ctc
9217	Propyl butanoate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	105-66-8	130.185	liq	-95.2	143.0	0.8730 <sup>20</sup>	1.4001 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth
9218	Propyl carbamate		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	627-12-3	103.120	pr	60	196			vs ace, eth, EtOH
9219	Propyl chloroacetate		C <sub>6</sub> H <sub>9</sub> ClO <sub>2</sub>	5396-24-7	136.577			161	1.104 <sup>20</sup>	1.4261 <sup>20</sup>	vs eth
9220	Propyl 2-chlorobutanoate		C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	62108-71-8	164.630			183	1.0252 <sup>20</sup>		
9221	Propyl chlorocarbonate		C <sub>6</sub> H <sub>9</sub> ClO <sub>2</sub>	109-61-5	122.551			115.2	1.0901 <sup>20</sup>	1.4035 <sup>20</sup>	msc EtOH, eth
9222	Propyl 3-chloropropanoate		C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	62108-66-1	150.603			180	1.0656 <sup>20</sup>	1.4290 <sup>20</sup>	vs eth, EtOH
9223	<i>S</i> -Propyl chlorothioformate	<i>S</i> -Propyl carbonochloridothioate	C <sub>3</sub> H <sub>7</sub> ClOS	13889-92-4	138.616	liq		59 <sup>26</sup>			
9224	Propyl <i>trans</i> -cinnamate	Propyl <i>trans</i> -3-phenyl-2-propenoate	C <sub>12</sub> H <sub>14</sub> O <sub>2</sub>	74513-58-9	190.238			285	1.0433 <sup>9</sup>		i H <sub>2</sub> O
9225	Propylcyclohexane		C <sub>9</sub> H <sub>18</sub>	1678-92-8	126.239	liq	-94.9	156	0.7936 <sup>20</sup>	1.4370 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, ace, ctc; s eth, bz
9226	2-Propylcyclohexanone		C <sub>9</sub> H <sub>16</sub> O	94-65-5	140.222			197	0.927 <sup>20</sup>	1.4538 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace; vs eth, bz
9227	Propylcyclopentane		C <sub>8</sub> H <sub>16</sub>	2040-96-2	112.213	liq	-117.3	131	0.7763 <sup>20</sup>	1.4266 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace; s bz; vs ctc
9228	1-Propylcyclopentanol		C <sub>8</sub> H <sub>16</sub> O	1604-02-0	128.212	liq	-37.5	173.5	0.9040 <sup>25</sup>	1.4502 <sup>25</sup>	
9229	Propylene carbonate	4-Methyl-1,3-dioxolan-2-one	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	108-32-7	102.089	liq	-48.8	242	1.2047 <sup>20</sup>	1.4189 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, eth, ace, bz
9230	1,2-Propylene glycol	1,2-Propanediol	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	57-55-6	76.095	liq	-60	187.6	1.0361 <sup>20</sup>	1.4324 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; s eth, bz, chl
9231	1,3-Propylene glycol	Trimethylene glycol	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	504-63-2	76.095	liq	-27.7	214.4	1.0538 <sup>20</sup>	1.4398 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; vs eth; sl bz
9232	1,2-Propylene glycol 2- <i>tert</i> -butyl ether	2-(1,1-Dimethylethoxy)-1-propanol	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	94023-15-1	132.201	liq		152	0.87		
9233	1,2-Propylene glycol dinitrate		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	6423-43-4	166.089	liq	exp	92 <sup>10</sup>			
9234	1,2-Propylene glycol monomethyl ether	1-Methoxy-2-propanol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	107-98-2	90.121			119	0.9620 <sup>20</sup>	1.4034 <sup>20</sup>	
9235	1,2-Propylene glycol monomethyl ether acetate	2-Acetoxy-1-methoxypropane	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	108-65-6	132.157	liq		147			
9236	Propyleneimine	2-Methylaziridine	C <sub>3</sub> H <sub>7</sub> N	75-55-8	57.095			67	0.812 <sup>16</sup>		
9237	Propyl formate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	110-74-7	88.106	liq	-92.9	80.9	0.9073 <sup>20</sup>	1.377 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth
9238	Propyl 3-(2-furyl)acrylate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	623-22-3	180.200			113 <sup>16</sup> , 92 <sup>3</sup>	1.0744 <sup>20</sup>	1.5392 <sup>24</sup>	vs bz, eth, EtOH
9239	4-Propylheptane		C <sub>10</sub> H <sub>22</sub>	3178-29-8	142.282			157.5	0.7321 <sup>25</sup>	1.4135 <sup>20</sup>	
9240	Propyl hexanoate		C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	626-77-7	158.238	liq	-68.7	187	0.8672 <sup>20</sup>	1.4170 <sup>20</sup>	vs eth, EtOH
9241	Propyl 2-hydroxybenzoate		C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	607-90-9	180.200		97	239	1.0979 <sup>20</sup>	1.5161 <sup>20</sup>	s ctc, CS <sub>2</sub>
9242	Propyl 4-hydroxybenzoate	Propylparaben	C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	94-13-3	180.200	pr (eth)	97		1.0630 <sup>102</sup>	1.5050 <sup>102</sup>	i H <sub>2</sub> O; s EtOH, eth; sl chl
9243	Propyliodone		C <sub>10</sub> H <sub>11</sub> I <sub>2</sub> NO <sub>3</sub>	587-61-1	447.008		186				
9244	Propyl isobutanoate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	644-49-5	130.185			135.4	0.8843 <sup>9</sup>	1.3955 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, ace; vs eth
9245	Propyl isocyanate	1-Isocyanatopropane	C <sub>4</sub> H <sub>7</sub> NO	110-78-1	85.105			83.5	0.908 <sup>25</sup>	1.3970 <sup>20</sup>	
9246	Propyl isothiocyanate	1-Isothiocyanatopropane	C <sub>4</sub> H <sub>7</sub> NS	628-30-8	101.171			153	0.9781 <sup>16</sup>	1.5085 <sup>16</sup>	sl H <sub>2</sub> O; msc EtOH, eth
9247	Propyl methacrylate		C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	2210-28-8	128.169			141	0.9022 <sup>20</sup>	1.4190 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
9248	Propyl 3-methylbutanoate	Propyl isopentanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	557-00-6	144.212			155.9	0.8617 <sup>20</sup>	1.4031 <sup>20</sup>	vs eth, EtOH
9249	1-Propylnaphthalene		C <sub>13</sub> H <sub>14</sub>	2765-18-6	170.250	liq	-8.6	274.5	0.9897 <sup>20</sup>	1.5923 <sup>20</sup>	
9250	Propyl nitrate		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	627-13-4	105.093			110	1.0538 <sup>20</sup>	1.3973 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ctc
9251	Propyl nitrite		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	543-67-9	89.094	liq		48	0.886 <sup>20</sup>	1.3604 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth

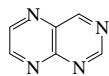


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9252	Propyl octanoate		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	624-13-5	186.292	liq	-46.2	226.4	0.8659 <sup>20</sup>	1.4191 <sup>25</sup>	vs ace, eth, EtOH
9253	Propyl pentanoate		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	141-06-0	144.212	liq	-70.7	167.5	0.8699 <sup>20</sup>	1.4065 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
9254	2-Propylpentanoic acid	Valproic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	99-66-1	144.212	col liq		221; 120 <sup>14</sup>	0.904 <sup>25</sup>	1.425 <sup>25</sup>	sl H <sub>2</sub> O
9255	2-Propylphenol		C <sub>9</sub> H <sub>12</sub> O	644-35-9	136.190		7	220	1.015 <sup>20</sup>		vs eth, EtOH
9256	4-Propylphenol		C <sub>9</sub> H <sub>12</sub> O	645-56-7	136.190		22	232.6	1.009 <sup>20</sup>	1.5379 <sup>25</sup>	sl H <sub>2</sub> O, ctc; s EtOH
9257	2-Propylpiperidine, (S)	Coniine	C <sub>8</sub> H <sub>17</sub> N	458-88-8	127.228	liq	-1.0	166.5	0.8440 <sup>20</sup>	1.4512 <sup>22</sup>	sl H <sub>2</sub> O, chl; msc EtOH; vs eth; s bz
9258	trans-6-Propyl-3-piperidinol, (3S)	Pseudoconhydrine	C <sub>8</sub> H <sub>17</sub> NO	140-55-6	143.227	hyg nd (eth)	106	236			vs H <sub>2</sub> O, eth, EtOH
9259	N-Propylpropanamide		C <sub>8</sub> H <sub>13</sub> NO	3217-86-5	115.173		154	215; 108 <sup>9</sup>	0.8985 <sup>25</sup>		sl H <sub>2</sub> O, eth
9260	Propyl propanoate	Propyl propionate	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	106-36-5	116.158	liq	-75.9	122.5	0.8755 <sup>25</sup>	1.3909 <sup>25</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
9261	2-Propylpyridine		C <sub>8</sub> H <sub>11</sub> N	622-39-9	121.180		1.0	167	0.9119 <sup>20</sup>	1.4925 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; vs ace
9262	4-Propylpyridine		C <sub>8</sub> H <sub>11</sub> N	1122-81-2	121.180			185	0.9381 <sup>15</sup>	1.4966 <sup>20</sup>	vs eth, EtOH
9263	2-Propyl-4-pyridinecarbothioamide	Protionamide	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> S	14222-60-7	180.269		136.7				
9264	Propyl Red	Benzoic acid, 2-[[4-(dipropylamino)phenyl]azo]-	C <sub>19</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub>	2641-01-2	325.405	viol-bl or purp red cry (al)					s EtOH, KOH
9265	(Propylthio)benzene		C <sub>8</sub> H <sub>12</sub> S	874-79-3	152.256	liq	-45	220	0.9995 <sup>20</sup>	1.5571 <sup>20</sup>	
9266	Propyl 4-toluenesulfonate		C <sub>10</sub> H <sub>14</sub> O <sub>3</sub> S	599-91-7	214.281		<-20	189 <sup>9</sup>	1.144 <sup>20</sup>	1.4998 <sup>20</sup>	
9267	Propyl trichloroacetate		C <sub>8</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>2</sub>	13313-91-2	205.468			187	1.3221 <sup>20</sup>	1.4501 <sup>20</sup>	vs eth, EtOH
9268	Propyl 3,4,5-trihydroxybenzoate	Propyl gallate	C <sub>10</sub> H <sub>12</sub> O <sub>5</sub>	121-79-9	212.199	nd (w)	130				sl H <sub>2</sub> O
9269	Propylurea		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O	627-06-5	102.134	pr (al)	108.5				sl H <sub>2</sub> O, DMSO; s EtOH
9270	Propyl vinyl ether	1-(Ethenyloxy)propane	C <sub>6</sub> H <sub>10</sub> O	764-47-6	86.132			65	0.7674 <sup>20</sup>	1.3908 <sup>20</sup>	
9271	2-Propynal	Propargyl aldehyde	C <sub>3</sub> H <sub>2</sub> O	624-67-9	54.047			60	0.9152 <sup>20</sup>	1.4033 <sup>25</sup>	msc H <sub>2</sub> O; s EtOH, eth, ace, bz, tol
9272	2-Propyn-1-amine		C <sub>3</sub> H <sub>3</sub> N	2450-71-7	55.079			83	0.803 <sup>25</sup>	1.4480 <sup>20</sup>	
9273	Propyne	Methylacetylene	C <sub>3</sub> H <sub>4</sub>	74-99-7	40.064	col gas	-102.7	-23.2	0.607 <sup>25</sup> (p>1 atm)	1.3863 <sup>40</sup>	sl H <sub>2</sub> O; vs EtOH; s bz, chl
9274	2-Propynoic acid	Propiolic acid	C <sub>3</sub> H <sub>2</sub> O <sub>2</sub>	471-25-0	70.047	cry (CS <sub>2</sub> )	9	dec 144; 72 <sup>50</sup>	1.1380 <sup>20</sup>	1.4306 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH, chl
9275	1-Propynylbenzene		C <sub>8</sub> H <sub>8</sub>	673-32-5	116.160			183	0.942 <sup>15</sup>	1.563 <sup>15</sup>	
9276	Propyzamide	N-(1,1-Dimethyl-2-propynyl)-3,5-dichlorobenzamide	C <sub>12</sub> H <sub>11</sub> Cl <sub>2</sub> NO	23950-58-5	256.127		155				
9277	Prostaglandin E <sub>1</sub>	11,15-Dihydroxy-9-oxo-13-prostenoic acid	C <sub>20</sub> H <sub>34</sub> O <sub>5</sub>	745-65-3	354.481	cry (EtOAc)	115				s H <sub>2</sub> O
9278	Prostaglandin E <sub>2</sub>	11,15-Dihydroxy-9-oxo-5,13-prostadienoic acid	C <sub>20</sub> H <sub>32</sub> O <sub>5</sub>	363-24-6	352.465	col cry	67				s H <sub>2</sub> O, thf
9279	Prostaglandin F <sub>2α</sub>	9,11,15-Trihydroxyprosta-5,13-dienoic acid	C <sub>20</sub> H <sub>34</sub> O <sub>5</sub>	551-11-1	354.481	oil or solid	≈30				sl H <sub>2</sub> O; s EtOH, MeOH, chl, AcOEt
9280	Protopine	Fumarine	C <sub>20</sub> H <sub>19</sub> NO <sub>5</sub>	130-86-9	353.369	mcl pr (al-chl)	208				i H <sub>2</sub> O; sl EtOH, eth, bz, peth; s chl
9281	Protoverine		C <sub>27</sub> H <sub>43</sub> NO <sub>9</sub>	76-45-9	525.632	nd (MeOH)	221				i H <sub>2</sub> O; s EtOH, bz, aq acid, MeOH
9282	Protriptyline hydrochloride	Triptil	C <sub>19</sub> H <sub>22</sub> ClN	1225-55-4	299.838	cry (2-PrOH/eth)	170				
9283	Prunetin		C <sub>16</sub> H <sub>12</sub> O <sub>5</sub>	552-59-0	284.263		239.5				
9284	Pseudoaconitine		C <sub>36</sub> H <sub>51</sub> NO <sub>12</sub>	127-29-7	689.790	tcl (MeOH)	214				vs eth, EtOH
9285	Pseudocodeine		C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	466-96-6	299.365	wh nd	181.5		1.290 <sup>80</sup>	1.574	
9286	Pseudojervine		C <sub>33</sub> H <sub>49</sub> NO <sub>8</sub>	36069-05-3	587.744	wh nd or hex cry	304 dec				i H <sub>2</sub> O, eth, bz, chl, tol, peth; s EtOH
9287	Pseudomorphine		C <sub>34</sub> H <sub>36</sub> N <sub>2</sub> O <sub>6</sub>	125-24-6	568.659	cry (aq NH <sub>3</sub> + 3 w)	282.5				i H <sub>2</sub> O, EtOH, eth, chl, sulf; s py, NH <sub>3</sub>
9288	Pseudotropine	8-Methyl-8-azabicyclo[3.2.1]octan-3-ol, exo	C <sub>8</sub> H <sub>15</sub> NO	135-97-7	141.211	orth cry (eth), orth bipym (peth-bz)	109	241			vs H <sub>2</sub> O, EtOH; sl eth; s bz, chl
9289	Psoralen		C <sub>11</sub> H <sub>6</sub> O <sub>3</sub>	66-97-7	186.164	nd (w, EtOH)	171				

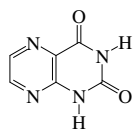




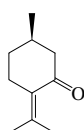
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9290	Pteridine	Pyrazino[2,3-d]pyrimidine	C <sub>6</sub> H <sub>4</sub> N <sub>4</sub>	91-18-9	132.123	ye pl (bz, sub)	139.5	sub 125			vs H <sub>2</sub> O; s EtOH; sl eth, bz
9291	2,4(1 <i>H</i> ,3 <i>H</i> )-Pteridinedione	Lumazine	C <sub>6</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	487-21-8	164.122	ye-oran nd (w)	348.5				vs HOAc
9292	Pulegone		C <sub>10</sub> H <sub>16</sub> O	89-82-7	152.233			224	0.9346 <sup>45</sup>	1.4894 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, chl; s ctc
9293	1 <i>H</i> -Purine	6 <i>H</i> -Imidazo[4,5-d]pyrimidine	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub>	120-73-0	120.113		216.5				vs H <sub>2</sub> O, EtOH; sl eth, chl; s ace
9294	1 <i>H</i> -Purine-2,6-diamine	2,6-Diaminopurine	C <sub>5</sub> H <sub>6</sub> N <sub>6</sub>	1904-98-9	150.142	cry (dil al)	302				
9295	Phycocyanine		C <sub>13</sub> H <sub>10</sub> N <sub>2</sub> O	85-66-5	210.230	dk bl nd (w + 1) (chl-peth)	133 dec				sl H <sub>2</sub> O, bz; s EtOH, ace; i eth; vs chl
9296	4 <i>H</i> -Pyran	1,4-Pyran	C <sub>5</sub> H <sub>6</sub> O	289-65-6	82.101	unstab oil		80		1.4559 <sup>20</sup>	s EtOH, eth, bz
9297	2 <i>H</i> -Pyran-2-one		C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	504-31-4	96.085		8.5	207.5	1.200 <sup>20</sup>	1.5270 <sup>25</sup>	msc H <sub>2</sub> O; vs ace
9298	4 <i>H</i> -Pyran-4-one		C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	108-97-4	96.085		32.5	212.5	1.190 <sup>25</sup>	1.5238	vs H <sub>2</sub> O, chl, eth; s EtOH, bz; sl CS <sub>2</sub>
9299	Pyrantel		C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> S	15686-83-6	206.307	cry (MeOH)	178				
9300	4 <i>H</i> -Pyran-4-thione		C <sub>5</sub> H <sub>4</sub> OS	1120-93-0	112.150		49				s H <sub>2</sub> O
9301	8,16-Pyranthrene-dione		C <sub>30</sub> H <sub>14</sub> O <sub>2</sub>	128-70-1	406.431	red-ye or red-br nd (PhNO <sub>2</sub> )	dec	sub			
9302	Pyrazine	1,4-Diazine	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	290-37-9	80.088	pr (w)	51.0	115	1.0311 <sup>61</sup>	1.4953 <sup>61</sup>	s H <sub>2</sub> O, EtOH, eth, ace; sl ctc
9303	Pyrazinecarboxamide	Pyrazinamide	C <sub>5</sub> H <sub>5</sub> N <sub>3</sub> O	98-96-4	123.113	wh nd (w, al)	192	sub			s H <sub>2</sub> O, EtOH
9304	Pyrazinecarboxylic acid	Pyrazinoic acid	C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	98-97-5	124.098	wh nd (w)	225 dec	sub			
9305	2,3-Pyrazinedicarboxylic acid	2,3-Dicarboxypyrazine	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	89-01-0	168.107	pr (w+2)	193 dec				vs H <sub>2</sub> O; sl EtOH, eth, bz; s ace, MeOH
9306	1 <i>H</i> -Pyrazole	1,2-Diazole	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	288-13-1	68.077	nd or pr (lig)	70.7	187		1.4203	s H <sub>2</sub> O, EtOH, eth, bz; sl chl
9307	1-Pyrenamine		C <sub>16</sub> H <sub>11</sub> N	1606-67-3	217.265	ye nd (hx) lf (dil al)	117.5				s EtOH, ace, hx, acid; sl chl
9308	Pyrene	Benzo[def]phenanthrene	C <sub>16</sub> H <sub>10</sub>	129-00-0	202.250	pa ye pl (to, sub)	150.62	404	1.271 <sup>23</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, tof; sl ctc
9309	Pyrethrin I		C <sub>21</sub> H <sub>28</sub> O <sub>3</sub>	121-21-1	328.445	visc liq		170 <sup>0.1</sup> dec	1.5192 <sup>18</sup>	1.5192 <sup>18</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, peth
9310	Pyrethrin II		C <sub>22</sub> H <sub>28</sub> O <sub>3</sub>	121-29-9	372.454	visc liq		200 <sup>0.1</sup> dec		1.5258 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc, peth
9311	Pyridate		C <sub>19</sub> H <sub>23</sub> ClN <sub>2</sub> O <sub>2</sub> S	55512-33-9	378.916	br oil	27	220 <sup>0.1</sup>	1.555 <sup>20</sup>	1.568 <sup>20</sup>	i H <sub>2</sub> O
9312	Pyridazine	1,2-Diazabenzene	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	289-80-5	80.088	liq	-8	208	1.1035 <sup>23</sup>	1.5218 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; vs eth, ace, bz; i peth
9313	2-Pyridinamine	2-Aminopyridine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	504-29-0	94.115	lf (lig)	57.5	105 <sup>20</sup>			s EtOH, eth, ace, bz; sl chl
9314	3-Pyridinamine	3-Aminopyridine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	462-08-8	94.115	lf (bz-lig)	64.5	252			s H <sub>2</sub> O, EtOH, eth; sl lig
9315	4-Pyridinamine	4-Aminopyridine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	504-24-5	94.115	nd (bz)	158.5	273			s H <sub>2</sub> O, eth, bz; vs EtOH; sl lig
9316	Pyridine	Azine	C <sub>5</sub> H <sub>5</sub> N	110-86-1	79.101	liq	-41.70	115.23	0.9819 <sup>20</sup>	1.5095 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, bz, chl
9317	2-Pyridinecarbonitrile		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	100-70-9	104.109	nd or pr (eth)	29	224.5	1.0810 <sup>25</sup>	1.5242 <sup>25</sup>	s H <sub>2</sub> O, chl; vs EtOH, eth, bz; sl ctc
9318	3-Pyridinecarbonitrile		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	100-54-9	104.109	nd (lig), peth-eth	51	206.9; 170 <sup>300</sup>	1.1590 <sup>25</sup>		vs H <sub>2</sub> O, EtOH, eth, bz; s chl; sl lig
9319	4-Pyridinecarbonitrile		C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	100-48-1	104.109	nd(lig-eth)	83	186			s H <sub>2</sub> O, EtOH, eth, bz, chl; sl lig
9320	3-Pyridinecarbothioamide		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> S	4621-66-3	138.190		192				
9321	4-Pyridinecarbothioamide		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> S	2196-13-6	138.190		198 dec				
9322	2-Pyridinecarboxaldehyde		C <sub>6</sub> H <sub>5</sub> NO	1121-60-4	107.110			180; 62 <sup>13</sup>	1.1181 <sup>25</sup>	1.5389 <sup>18</sup>	s H <sub>2</sub> O, EtOH, eth, AcOEt; sl ctc
9323	3-Pyridinecarboxaldehyde	Nicotinaldehyde	C <sub>6</sub> H <sub>5</sub> NO	500-22-1	107.110			92 <sup>23</sup>	1.1394 <sup>25</sup>		s H <sub>2</sub> O, EtOH, ace, chl; sl eth, peth
9324	4-Pyridinecarboxaldehyde		C <sub>6</sub> H <sub>5</sub> NO	872-85-5	107.110			77 <sup>12</sup>		1.5423 <sup>20</sup>	s H <sub>2</sub> O, eth, ctc
9325	2-Pyridinecarboxaldehyde oxime		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	873-69-8	122.124		112.5				
9326	2-Pyridinecarboxamide		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	1452-77-3	122.124	mcl pr (w)	108.3				sl H <sub>2</sub> O, chl; s EtOH, bz



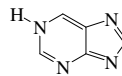
Pteridine



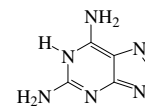
2,4(1H,3H)-Pteridinedione



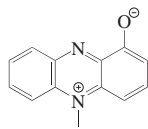
Pulegone



1H-Purine



1H-Purine-2,6-diamine



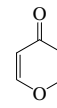
Pyocyanine



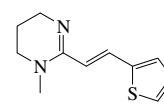
4H-Pyran



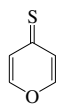
2H-Pyran-2-one



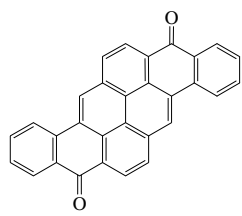
4H-Pyran-4-one



Pyrantel



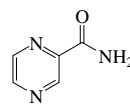
4H-Pyran-4-thione



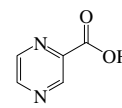
8,16-Pyranthredione



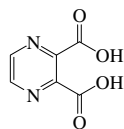
Pyrazine



Pyrazinecarboxamide



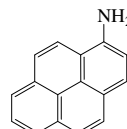
Pyrazinecarboxylic acid



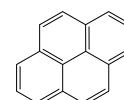
2,3-Pyrazinedicarboxylic acid



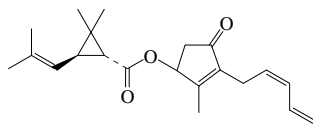
1H-Pyrazole



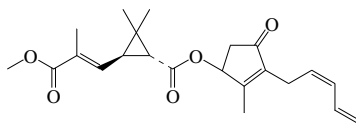
1-Pyrenamine



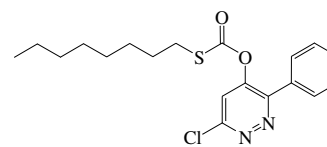
Pyrene



Pyrethrin I



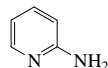
Pyrethrin II



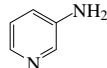
Pyridate



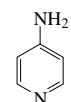
Pyridazine



2-Pyridinamine



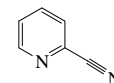
3-Pyridinamine



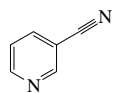
4-Pyridinamine



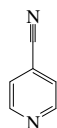
Pyridine



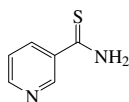
2-Pyridinecarbonitrile



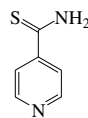
3-Pyridinecarbonitrile



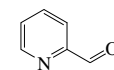
4-Pyridinecarbonitrile



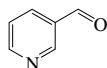
3-Pyridinecarbothioamide



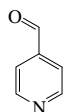
4-Pyridinecarbothioamide



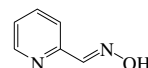
2-Pyridinecarboxaldehyde



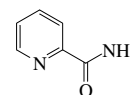
3-Pyridinecarboxaldehyde



4-Pyridinecarboxaldehyde

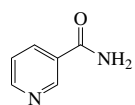


2-Pyridinecarboxaldehyde oxime

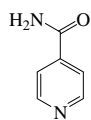


2-Pyridinecarboxamide

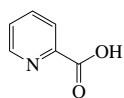
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9327	3-Pyridinecarboxamide	Niacinamide	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	98-92-0	122.124	wh pw, nd (bz)	130	157 <sup>0.005</sup>	1.400 <sup>25</sup>	1.466	vs H <sub>2</sub> O, EtOH, glycerol; sl chl
9328	4-Pyridinecarboxamide		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	1453-82-3	122.124		157.5				
9329	2-Pyridinecarboxylic acid	Picolinic acid	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	98-98-6	123.110	nd (w, al, bz)	136.5	sub			sl H <sub>2</sub> O, bz; s EtOH; i eth, chl, CS <sub>2</sub>
9330	3-Pyridinecarboxylic acid	Nicotinic acid	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	59-67-6	123.110	nd (al, w)	236.6	sub	1.473 <sup>25</sup>		sl H <sub>2</sub> O, EtOH, eth
9331	4-Pyridinecarboxylic acid	Isonicotinic acid	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	55-22-1	123.110	nd(w)	315	sub 260			sl H <sub>2</sub> O, EtOH, eth, bz
9332	3-Pyridinecarboxylic acid 1-oxide	Oxiniac acid	C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	2398-81-4	139.109	nd	254 dec				vs H <sub>2</sub> O, MeOH
9333	4-Pyridinecarboxylic acid 1-oxide		C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	13602-12-5	139.109		273 dec				
9334	2,3-Pyridinediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	452-58-4	109.130	lf or pl (dil al)	120.8	149 <sup>5</sup>			s H <sub>2</sub> O, EtOH, bz
9335	2,5-Pyridinediamine	2,5-Diaminopyridine	C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	4318-76-7	109.130	nd	110.3	182 <sup>12</sup>			vs H <sub>2</sub> O, EtOH
9336	2,6-Pyridinediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	141-86-6	109.130		121.5	285; 148 <sup>5</sup>			sl H <sub>2</sub> O, ace
9337	3,4-Pyridinediamine		C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	54-96-6	109.130	nd or lf	219.3				
9338	2,3-Pyridinedicarboxylic acid	Quinolinic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	89-00-9	167.120	mcl pr (w)	228.5				sl H <sub>2</sub> O, tfa; i EtOH, eth, bz
9339	2,4-Pyridinedicarboxylic acid	Lutidinic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	499-80-9	167.120	lf (w+1)	249		0.942 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH; i eth, bz, CS <sub>2</sub>
9340	2,5-Pyridinedicarboxylic acid	Isocincomeric acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	100-26-5	167.120	lf or pr (dil HCl)	254				s H <sub>2</sub> O, HCl; sl EtOH; i eth, bz
9341	2,6-Pyridinedicarboxylic acid	Dipicolinic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	499-83-2	167.120	nd (w+3/2)	252				sl H <sub>2</sub> O, EtOH, HOAc
9342	3,4-Pyridinedicarboxylic acid	Cincomeric acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	490-11-9	167.120	cry (w)	256	sub			sl H <sub>2</sub> O, EtOH, bz; i eth, i chl
9343	3,5-Pyridinedicarboxylic acid	Dinicotinic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	499-81-0	167.120	cry (w)	324	sub			i H <sub>2</sub> O; sl eth, HOAc; s DMSO, HCl
9344	2,3-Pyridinedicarboxylic acid anhydride	Furo[3,4-b]pyridine-5,7-dione	C <sub>7</sub> H <sub>3</sub> NO <sub>3</sub>	699-98-9	149.104		138				
9345	2-Pyridineethanamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	2706-56-1	122.167			213; 131 <sup>50</sup>	1.0220 <sup>25</sup>	1.5335 <sup>25</sup>	
9346	4-Pyridineethanamine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	13258-63-4	122.167			121 <sup>10</sup>	1.0302 <sup>25</sup>	1.5381 <sup>25</sup>	vs H <sub>2</sub> O
9347	2-Pyridineethanol		C <sub>7</sub> H <sub>9</sub> NO	103-74-2	123.152		-7.8	190 <sup>200</sup> , 170 <sup>100</sup>	1.091 <sup>25</sup>	1.5366 <sup>20</sup>	vs H <sub>2</sub> O, EtOH, chl; sl eth
9348	Pyridine hydrochloride		C <sub>5</sub> H <sub>6</sub> ClN	628-13-7	115.562	hyg pl or sc (al)	146	222			vs H <sub>2</sub> O, EtOH, chl
9349	2-Pyridinemethanamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	3731-51-9	108.141			203; 91 <sup>17</sup>	1.0525 <sup>25</sup>	1.5431 <sup>25</sup>	vs H <sub>2</sub> O
9350	3-Pyridinemethanamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	3731-52-0	108.141	liq	-21.1	226	1.064 <sup>20</sup>	1.552 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
9351	4-Pyridinemethanamine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	3731-53-1	108.141	liq	-7.6	230; 103 <sup>11</sup>	1.072 <sup>20</sup>	1.5495 <sup>25</sup>	vs H <sub>2</sub> O
9352	2-Pyridinemethanol		C <sub>6</sub> H <sub>7</sub> NO	586-98-1	109.126			112 <sup>16</sup> , 102.5 <sup>8</sup>	1.1317 <sup>20</sup>	1.5444 <sup>20</sup>	msc H <sub>2</sub> O; vs EtOH, eth, ace, bz
9353	3-Pyridinemethanol	Nicotinyl alcohol	C <sub>6</sub> H <sub>7</sub> NO	100-55-0	109.126	liq	-6.5	266	1.131 <sup>20</sup>	1.5455 <sup>20</sup>	vs H <sub>2</sub> O, eth
9354	4-Pyridinemethanol	4-Picolyl alcohol	C <sub>6</sub> H <sub>7</sub> NO	586-95-8	109.126		53	141 <sup>12</sup>			s chl
9355	Pyridine-1-oxide	Pyridine N-oxide	C <sub>5</sub> H <sub>5</sub> NO	694-59-7	95.100		65.5	146 <sup>13</sup>			
9356	2-Pyridinepropanol		C <sub>8</sub> H <sub>11</sub> NO	2859-68-9	137.179		34	260.2; 116 <sup>4</sup>	1.060 <sup>25</sup>	1.5298 <sup>20</sup>	vs H <sub>2</sub> O
9357	3-Pyridinepropanol		C <sub>8</sub> H <sub>11</sub> NO	2859-67-8	137.179			284; 130 <sup>3</sup>	1.063 <sup>25</sup>	1.5313 <sup>20</sup>	vs H <sub>2</sub> O
9358	3-Pyridinesulfonic acid	3-Pyridylsulfonic acid	C <sub>6</sub> H <sub>6</sub> NO <sub>3</sub> S	636-73-7	159.164	orth	357 dec		1.713 <sup>25</sup>		vs H <sub>2</sub> O; sl EtOH; i eth
9359	2-Pyridinethiol, 1-oxide		C <sub>6</sub> H <sub>6</sub> NOS	1121-31-9	127.165		70.5				
9360	2(1 <i>H</i> )-Pyridinethione		C <sub>6</sub> H <sub>5</sub> NS	2637-34-5	111.166		130.0				s H <sub>2</sub> O, EtOH, bz, chl
9361	2-Pyridinol		C <sub>6</sub> H <sub>7</sub> NO	72762-00-6	95.100	nd (bz)	107.8		1.3910 <sup>20</sup>		vs H <sub>2</sub> O, bz, EtOH
9362	3-Pyridinol		C <sub>6</sub> H <sub>7</sub> NO	109-00-2	95.100	nd (bz)	129				s H <sub>2</sub> O, EtOH; sl eth, chl
9363	4-Pyridinol		C <sub>6</sub> H <sub>7</sub> NO	626-64-2	95.100	pr or nd (w+1)	149.8	>350; 257 <sup>10</sup>			s H <sub>2</sub> O, EtOH; i eth, bz
9364	2(1 <i>H</i> )-Pyridinone		C <sub>6</sub> H <sub>7</sub> NO	142-08-5	95.100	nd (bz)	107.8	280	1.3910 <sup>20</sup>		s H <sub>2</sub> O, EtOH, bz, chl; sl eth, DMSO
9365	2(1 <i>H</i> )-Pyridinone hydrazone	2-Pyridinylhydrazine	C <sub>6</sub> H <sub>7</sub> N <sub>3</sub>	4930-98-7	109.130		46.6	185 <sup>140</sup> , 90 <sup>1</sup>			s chl
9366	α-[(2-Pyridinylamino)methyl]benzenem ethanol	Phenyramidol	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub> O	553-69-5	214.262	cry (dil MeOH)	83.5				
9367	1-(2-Pyridinyl)ethanone		C <sub>7</sub> H <sub>7</sub> NO	1122-62-9	121.137	ye in air		192	1.077 <sup>25</sup>	1.5203 <sup>20</sup>	s EtOH, eth, HOAc; sl ctc
9368	1-(3-Pyridinyl)ethanone	Methyl pyridyl ketone	C <sub>7</sub> H <sub>7</sub> NO	350-03-8	121.137		13.5	220		1.5341 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, acid
9369	1-(4-Pyridinyl)ethanone		C <sub>7</sub> H <sub>7</sub> NO	1122-54-9	121.137		16	212	1.097 <sup>25</sup>	1.5282 <sup>25</sup>	sl EtOH, eth, acid



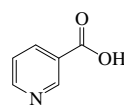
3-Pyridinecarboxamide



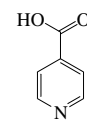
4-Pyridinecarboxamide



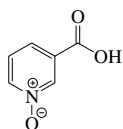
2-Pyridinecarboxylic acid



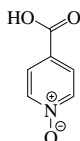
3-Pyridinecarboxylic acid



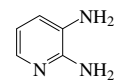
4-Pyridinecarboxylic acid



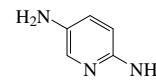
3-Pyridinecarboxylic acid 1-oxide



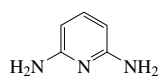
4-Pyridinecarboxylic acid 1-oxide



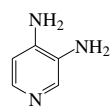
2,3-Pyridinediamine



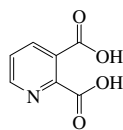
2,5-Pyridinediamine



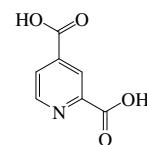
2,6-Pyridinediamine



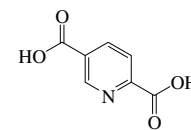
3,4-Pyridinediamine



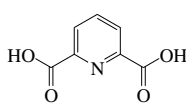
2,3-Pyridinedicarboxylic acid



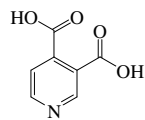
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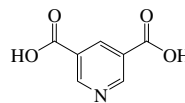
2,5-Pyridinedicarboxylic acid



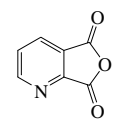
2,6-Pyridinedicarboxylic acid



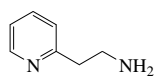
3,4-Pyridinedicarboxylic acid



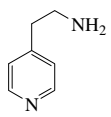
3,5-Pyridinedicarboxylic acid



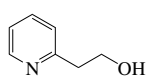
2,3-Pyridinedicarboxylic acid anhydride



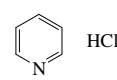
2-Pyridineethanamine



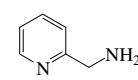
4-Pyridineethanamine



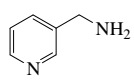
2-Pyridineethanol



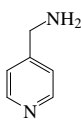
Pyridine hydrochloride



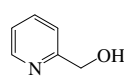
2-Pyridinemethanamine



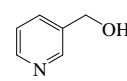
3-Pyridinemethanamine



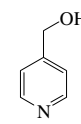
4-Pyridinemethanamine



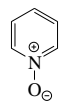
2-Pyridinemethanol



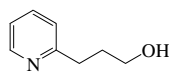
3-Pyridinemethanol



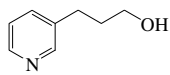
4-Pyridinemethanol



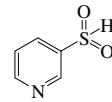
Pyridine-1-oxide



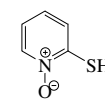
2-Pyridinepropanol



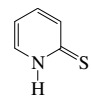
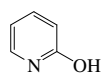
3-Pyridinepropanol



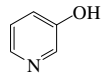
3-Pyridinesulfonic acid



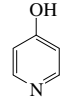
2-Pyridinethiol, 1-oxide

2(1*H*)-Pyridinethione

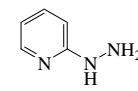
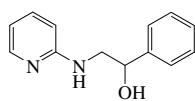
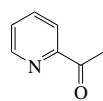
2-Pyridinol



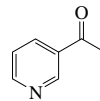
3-Pyridinol



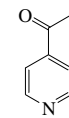
4-Pyridinol

2(1*H*)-Pyridinone2(1*H*)-Pyridinone hydrazone $\alpha$ -[(2-Pyridinylamino)methyl]benzenemethanol

1-(2-Pyridinyl)ethanone

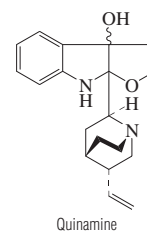
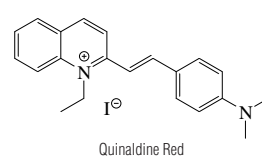
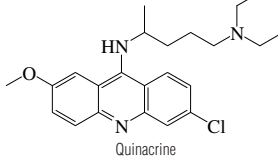
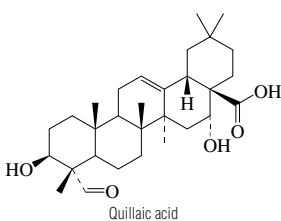
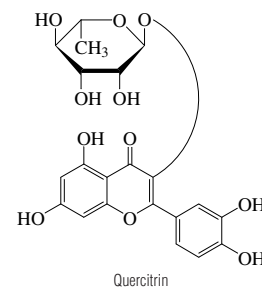
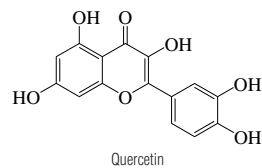
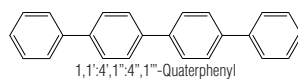
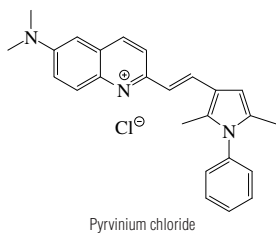
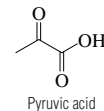
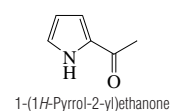
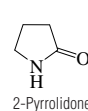
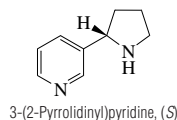
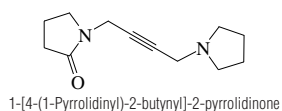
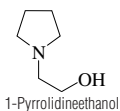
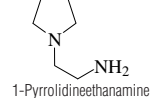
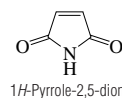
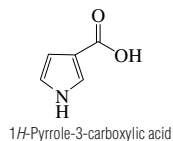
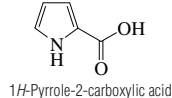
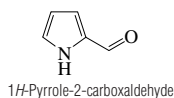
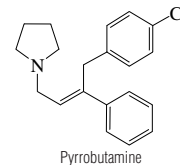
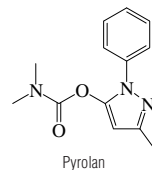
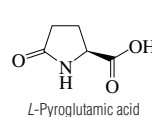
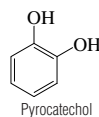
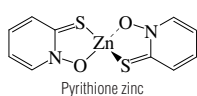
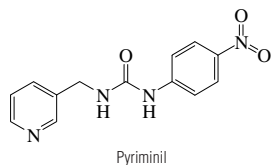
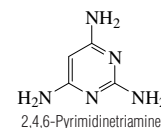
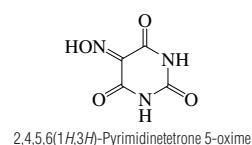
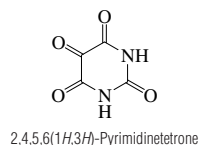
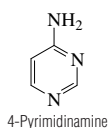
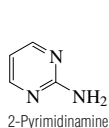
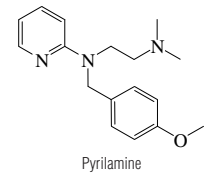
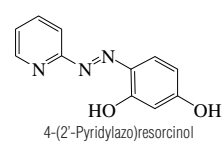
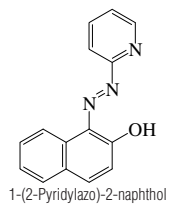
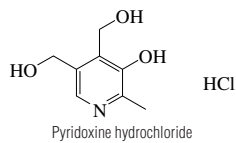
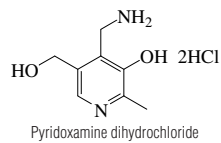
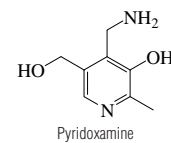
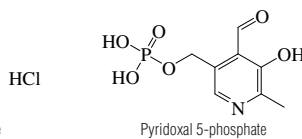
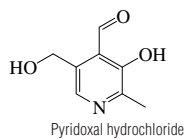
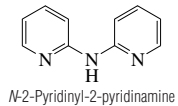
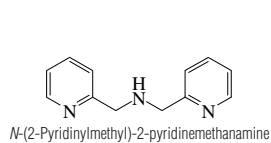


1-(3-Pyridinyl)ethanone



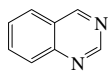
1-(4-Pyridinyl)ethanone

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9370	<i>N</i> -(2-Pyridinylmethyl)-2-pyridinemethanamine		C <sub>12</sub> H <sub>13</sub> N <sub>3</sub>	1539-42-0	199.251			200 <sup>10</sup> , 139 <sup>1</sup>	1.1074 <sup>25</sup>	1.5757 <sup>25</sup>	
9371	<i>N</i> -2-Pyridinyl-2-pyridinamine		C <sub>10</sub> H <sub>9</sub> N <sub>3</sub>	1202-34-2	171.198		90.5	307.5			sl H <sub>2</sub> O, chl; vs EtOH, eth, ace, bz
9372	Pyridoxal hydrochloride	Vitamin B6	C <sub>8</sub> H <sub>10</sub> ClNO <sub>3</sub>	65-22-5	203.623	orth	165 dec				vs H <sub>2</sub> O; sl EtOH
9373	Pyridoxal 5-phosphate	Pyridoxal 5-(dihydrogen phosphate)	C <sub>8</sub> H <sub>10</sub> NO <sub>6</sub> P	54-47-7	247.142	wh-ye pow or cry	141				
9374	Pyridoxamine	4-(Aminomethyl)-5-hydroxy-6-methyl-3-pyridinemethanol	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	85-87-0	168.193	cry	198				s EtOH, acid
9375	Pyridoxamine dihydrochloride		C <sub>8</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	524-36-7	241.115	pl (al)	226 dec				vs H <sub>2</sub> O; sl EtOH
9376	Pyridoxine hydrochloride	5-Hydroxy-6-methyl-3,4-pyridinedimethanol hydrochloride	C <sub>8</sub> H <sub>12</sub> ClNO <sub>3</sub>	58-56-0	205.639	pl (al, ace)	207	sub			vs H <sub>2</sub> O
9377	1-(2-Pyridylazo)-2-naphthol	PAN	C <sub>15</sub> H <sub>11</sub> N <sub>3</sub> O	85-85-8	249.267	red-br cry	130				i H <sub>2</sub> O; s EtOH, eth, chl
9378	4-(2'-Pyridylazo)resorcinol	PAR	C <sub>11</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	1141-59-9	215.208	red-br cry	187 dec				
9379	Pyrilamine		C <sub>17</sub> H <sub>23</sub> N <sub>3</sub> O	91-84-9	285.384			201 <sup>5</sup>			
9380	2-Pyrimidinamine		C <sub>4</sub> H <sub>6</sub> N <sub>3</sub>	109-12-6	95.103	nd (AcOEt)	127.5	sub			s H <sub>2</sub> O; sl chl
9381	4-Pyrimidinamine		C <sub>4</sub> H <sub>6</sub> N <sub>3</sub>	591-54-8	95.103	pl (AcOEt)	151.5				vs H <sub>2</sub> O, EtOH
9382	Pyrimidine	1,3-Diazine	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	289-95-2	80.088		22	123.8		1.4998 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH
9383	2,4,5,6(1 <i>H</i> ,3 <i>H</i> )-Pyrimidinetetrone	Alloxan	C <sub>4</sub> H <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	50-71-5	142.070		256 dec	sub			vs H <sub>2</sub> O; s EtOH, ace, bz, HOAc
9384	2,4,5,6(1 <i>H</i> ,3 <i>H</i> )-Pyrimidinetetrone 5-oxime	Violuric acid	C <sub>4</sub> H <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	87-39-8	157.085	pa ye orth	203 dec				sl H <sub>2</sub> O; s EtOH
9385	2,4,6-Pyrimidinetriamine		C <sub>4</sub> H <sub>7</sub> N <sub>5</sub>	1004-38-2	125.133		248 dec				
9386	Pyriminil		C <sub>13</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub>	53558-25-1	272.259	solid	224 dec				
9387	Pyrithione zinc		C <sub>10</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub> Zn	13463-41-7	317.722	wh solid	262				s chl, DMSO, DMF
9388	Pyrocatechol	1,2-Benzenediol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	120-80-9	110.111	cry	104.6	245	1.344 <sup>20</sup>	1.604 <sup>25</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
9389	<i>L</i> -Pyroglutamic acid	5-Oxo- <i>L</i> -proline	C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	98-79-3	129.115		162				s DMSO
9390	Pyrolan		C <sub>13</sub> H <sub>15</sub> N <sub>3</sub> O <sub>2</sub>	87-47-8	245.277		50	161 <sup>0.2</sup>			s ctc, CS <sub>2</sub>
9391	Pyrrbutamine	1-[4-(4-Chlorophenyl)-3-phenyl-2-butenyl]pyrrolidine	C <sub>20</sub> H <sub>22</sub> ClN	91-82-7	311.849	cry	49	192 <sup>0.3</sup>			
9392	Pyrrrole	Imidole	C <sub>4</sub> H <sub>5</sub> N	109-97-7	67.090	liq	-23.39	129.79	0.9698 <sup>20</sup>	1.5085 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
9393	1 <i>H</i> -Pyrrrole-2-carboxaldehyde		C <sub>5</sub> H <sub>7</sub> NO	1003-29-8	95.100	orth pr (peth)	46.5	218		1.5939 <sup>16</sup>	sl chl, lig
9394	1 <i>H</i> -Pyrrrole-2-carboxylic acid		C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	634-97-9	111.100	lf (w)	208 dec				s H <sub>2</sub> O, EtOH, eth
9395	1 <i>H</i> -Pyrrrole-3-carboxylic acid	3-Pyrrolicarboxylic acid	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	931-03-3	111.100	nd (lig)	161.5				
9396	1 <i>H</i> -Pyrrrole-2,5-dione		C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	541-59-3	97.073	pl (bz)	94	sub	1.2493 <sup>106</sup>		s H <sub>2</sub> O, EtOH, eth
9397	Pyrrrolidine	Azacyclopentane	C <sub>4</sub> H <sub>9</sub> N	123-75-1	71.121	col liq	-57.79	86.56	0.8586 <sup>20</sup>	1.4431 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth; sl bz, chl
9398	1-Pyrrrolidineethanamine		C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	7154-73-6	114.188			166; 68 <sup>23</sup>	0.901 <sup>25</sup>	1.4687 <sup>20</sup>	
9399	1-Pyrrrolidineethanol		C <sub>6</sub> H <sub>13</sub> NO	2955-88-6	115.173			187; 80 <sup>13</sup>	0.9750 <sup>20</sup>	1.4713 <sup>20</sup>	
9400	1-[4-(1-Pyrrrolidinyl)-2-butenyl]-2-pyrrrolidinone	Oxotremorine	C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O	70-22-4	206.283	pa ye liq		124 <sup>0.1</sup>	0.991 <sup>25</sup>	1.5160 <sup>20</sup>	
9401	3-(2-Pyrrrolidinyl)pyridine, ( <i>S</i> )	Normicotine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	494-97-3	148.204	hyg		270	1.0737 <sup>19</sup>	1.5378 <sup>18</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
9402	2-Pyrrrolidone	γ-Butyrolactam	C <sub>4</sub> H <sub>7</sub> NO	616-45-5	85.105	cry (peth)	25	251; 133 <sup>12</sup>	1.120 <sup>20</sup>	1.4806 <sup>30</sup>	vs H <sub>2</sub> O, EtOH, eth, bz, chl, CS <sub>2</sub>
9403	1-(1 <i>H</i> -Pyrrrol-2-yl)ethanone		C <sub>6</sub> H <sub>9</sub> NO	1072-83-9	109.126	mcl nd (w)	90	220			s H <sub>2</sub> O, EtOH, eth
9404	Pyruvic acid		C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	127-17-3	88.062		13.8	dec 165; 54 <sup>10</sup>	1.2272 <sup>20</sup>	1.4280 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; s ace
9405	Pyrvinium chloride		C <sub>25</sub> H <sub>28</sub> ClN <sub>5</sub>	548-84-5	417.973	red pow (w)	250 dec				
9406	1,1':4,1'':4'',1'''-Quaterphenyl		C <sub>24</sub> H <sub>18</sub>	135-70-6	306.400		320	428 <sup>18</sup>			i H <sub>2</sub> O, EtOH, eth, chl; s bz, PhNO <sub>2</sub> , HOAc
9407	Quercetin		C <sub>15</sub> H <sub>10</sub> O <sub>7</sub>	117-39-5	302.236	ye nd (dil al, + 2 w)	316.5	sub			sl H <sub>2</sub> O, eth, MeOH; s EtOH, ace, py
9408	Quercitrin	Quercetin-3- <i>L</i> -rhamnoside	C <sub>21</sub> H <sub>26</sub> O <sub>11</sub>	522-12-3	448.377	pa ye nd or pl (+2w, dil al)	170				i H <sub>2</sub> O, eth; s EtOH, HOAc, MeOH, alk
9409	Quillaic acid		C <sub>30</sub> H <sub>46</sub> O <sub>5</sub>	631-01-6	486.683	nd (dil al)	294				vs ace, eth, py, EtOH
9410	Quinacrine	Mepacrine	C <sub>23</sub> H <sub>30</sub> ClN <sub>3</sub> O	83-89-6	399.956	ye oil	87				
9411	Quinaldine Red		C <sub>21</sub> H <sub>22</sub> N <sub>2</sub>	117-92-0	430.325	dk red pow					s H <sub>2</sub> O; vs EtOH
9412	Quinamine		C <sub>19</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	464-85-7	312.406	pr (bz), nd (80% al)	185.5				i H <sub>2</sub> O; vs EtOH, bz; s eth, ace

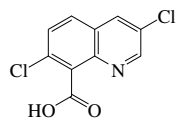


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9413	Quinazoline	1,3-Benzodiazine	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	253-82-7	130.147	ye pl (peth)	48	241			vs H <sub>2</sub> O; s EtOH, eth, ace, bz; sl chl
9414	Quinlorac	3,7-Dichloroquinoline-8-carboxylic acid	C <sub>10</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	84087-01-4	242.059		274		1.75		
9415	Quinethazone		C <sub>10</sub> H <sub>12</sub> ClN <sub>3</sub> O <sub>3</sub> S	73-49-4	289.738						s tfa
9416	Quinic acid		C <sub>7</sub> H <sub>12</sub> O <sub>6</sub>	77-95-2	192.166		162.5		1.64 <sup>25</sup>		vs H <sub>2</sub> O, EtOH, HOAc
9417	Quinidine		C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	56-54-2	324.417	cry (+2.5w, dil al)	174				sl H <sub>2</sub> O, eth; s EtOH, bz; vs chl; i peth
9418	Quinine	6'-Methoxycinchonan-9-ol, (8 $\alpha$ ,9 $\beta$ )	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	130-95-0	324.417		57			1.625 <sup>15</sup>	sl H <sub>2</sub> O, ace; vs EtOH, py; s eth, chl
9419	Quinine hydrochloride	6'-Methoxycinchonan-9-ol monohydrochloride, (8 $\alpha$ ,9 $\beta$ )	C <sub>20</sub> H <sub>25</sub> ClN <sub>2</sub> O <sub>2</sub>	130-89-2	360.878	silky efflor nd (w)	159				vs H <sub>2</sub> O, EtOH, chl
9420	Quinine sulfate		C <sub>40</sub> H <sub>50</sub> N <sub>4</sub> O <sub>8</sub> S	804-63-7	746.912	silky nd (w)	235.2				vs EtOH
9421	Quininone		C <sub>20</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	84-31-1	322.401	nd, lf (eth)	108				vs bz, eth, EtOH
9422	2-Quinolinamine	2-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	580-22-3	144.173	lf (w)	131.5	sub			vs H <sub>2</sub> O; s EtOH, eth, ace, chl; sl bz
9423	3-Quinolinamine	3-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	580-17-6	144.173	orth (w, dil al)	94				vs eth, EtOH, chl
9424	4-Quinolinamine	4-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	578-68-7	144.173	nd (bz, dil al)	154.8	180 <sup>12</sup>			s H <sub>2</sub> O, bz, chl; vs EtOH, eth
9425	5-Quinolinamine	5-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	611-34-7	144.173	ye nd (al) lf (eth)	110	310; 184 <sup>10</sup>			sl H <sub>2</sub> O; vs EtOH, eth; s bz; i lig
9426	6-Quinolinamine	6-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	580-15-4	144.173	cry (w+2), pr (eth)	114	187 <sup>12</sup>			sl H <sub>2</sub> O, eth; s NH <sub>3</sub> , EtOH
9427	8-Quinolinamine	8-Aminoquinoline	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	578-66-5	144.173	pa ye nd (sub) cry (al, lig)	70	157 <sup>19</sup>			vs H <sub>2</sub> O, EtOH
9428	Quinoline	1-Azaphthalene	C <sub>9</sub> H <sub>7</sub> N	91-22-5	129.159	liq	-14.78	237.16	1.0977 <sup>15</sup>	1.6268 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, ace, bz, CS <sub>2</sub> ; s ctc
9429	4-Quinolinecarboxaldehyde	Cinchonaldehyde	C <sub>10</sub> H <sub>7</sub> NO	4363-93-3	157.169	nd (to-peth)	51	122 <sup>4</sup>			vs eth, tol
9430	2-Quinolinecarboxylic acid	Quinaldic acid	C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	93-10-7	173.169		156				s H <sub>2</sub> O; vs bz
9431	8-Quinolinecarboxylic acid	8-Carboxyquinoline	C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	86-59-9	173.169	nd (w)	187	sub			vs EtOH
9432	2(1 <i>H</i> )-Quinolinethione		C <sub>9</sub> H <sub>7</sub> NS	2637-37-8	161.224		187				i H <sub>2</sub> O; vs EtOH, eth, bz; sl DMSO
9433	2-Quinolinol	2-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	59-31-4	145.158	pr (MeOH)	199.5	sub			sl H <sub>2</sub> O, DMSO; vs EtOH, eth; s dil HCl
9434	3-Quinolinol	3-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	580-18-7	145.158	cry (bz, dil al)	201.3				i H <sub>2</sub> O; s EtOH; sl eth, chl; vs bz
9435	4-Quinolinol	4-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	611-36-9	145.158	nd (w+3)	210				vs H <sub>2</sub> O, EtOH; sl eth, bz, peth
9436	5-Quinolinol	5-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	578-67-6	145.158	nd (al), pl	226 dec	sub			s H <sub>2</sub> O, bz, chl; sl EtOH; vs MeOH; i lig
9437	6-Quinolinol	6-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	580-16-5	145.158	pr (al, eth)	195	360			i H <sub>2</sub> O, bz, chl; sl EtOH, eth; s alk
9438	7-Quinolinol	7-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	580-20-1	145.158	pr (al), nd (dil al-eth)	239	sub			vs EtOH
9439	8-Quinolinol	8-Hydroxyquinoline	C <sub>9</sub> H <sub>7</sub> NO	148-24-3	145.158	nd (dil al)	75.5	267	1.034 <sup>20</sup>		i H <sub>2</sub> O, eth; vs EtOH, bz, chl; s ace
9440	8-Quinolinol benzoate	Benzoxiquine	C <sub>16</sub> H <sub>11</sub> NO <sub>2</sub>	86-75-9	249.264						sl chl
9441	8-Quinolinol sulfate (2:1)	8-Hydroxyquinoline sulfate	C <sub>18</sub> H <sub>16</sub> N <sub>2</sub> O <sub>6</sub> S	134-31-6	388.934		177.5				vs H <sub>2</sub> O; s EtOH; i eth
9442	Quinovic acid		C <sub>30</sub> H <sub>46</sub> O <sub>5</sub>	465-74-7	486.683	pl or nd	298 dec				
9443	Quinovose		C <sub>9</sub> H <sub>12</sub> O <sub>5</sub>	7658-08-4	164.156	cry (AcOEt)	139.5				vs H <sub>2</sub> O, EtOH
9444	Quinoxaline	1,4-Benzodiazine	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	91-19-0	130.147	cry (peth)	28	229.5	1.1334 <sup>48</sup>	1.6231 <sup>48</sup>	s H <sub>2</sub> O; msc EtOH, eth, ace, bz; sl chl
9445	2(1 <i>H</i> )-Quinoxalinone		C <sub>8</sub> H <sub>6</sub> N <sub>2</sub> O	1196-57-2	146.146	lf (al)	271	sub 200			
9446	Quizalofop-Ethyl		C <sub>19</sub> H <sub>17</sub> ClN <sub>2</sub> O <sub>4</sub>	76578-14-8	372.802	wh cry	93	220 <sup>0.2</sup>			i H <sub>2</sub> O; s bz, EtOH, ace, xyl
9447	Radicinin		C <sub>12</sub> H <sub>12</sub> O <sub>5</sub>	10088-95-6	236.220		221.5				sl chl
9448	Raffinose		C <sub>18</sub> H <sub>32</sub> O <sub>16</sub>	512-69-6	504.437		80		1.465 <sup>25</sup>		s H <sub>2</sub> O, py; vs MeOH; sl EtOH; i eth
9449	Ranitidine		C <sub>13</sub> H <sub>22</sub> N <sub>4</sub> O <sub>3</sub> S	66357-35-5	314.404	solid	69.5				

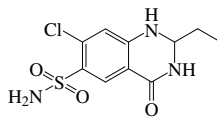




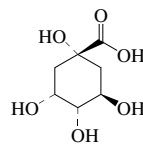
Quinazoline



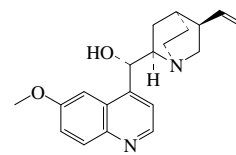
Quinlorac



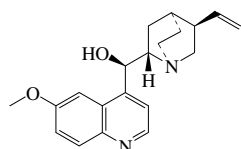
Quinethazone



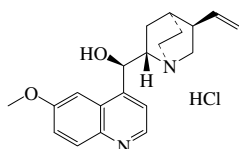
Quinic acid



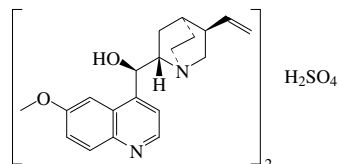
Quinidine



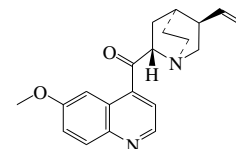
Quinine



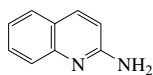
Quinine hydrochloride



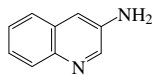
Quinine sulfate



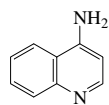
Quinone



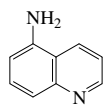
2-Quinolinamine



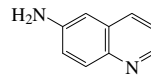
3-Quinolinamine



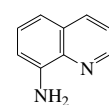
4-Quinolinamine



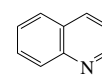
5-Quinolinamine



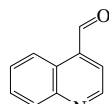
6-Quinolinamine



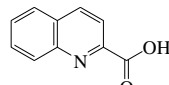
8-Quinolinamine



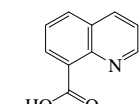
Quinoline



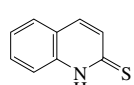
4-Quinolinecarboxaldehyde



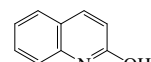
2-Quinolinecarboxylic acid



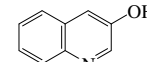
8-Quinolinecarboxylic acid



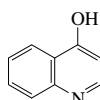
2(1H)-Quinolmethione



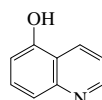
2-Quinolol



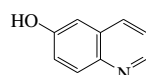
3-Quinolol



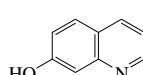
4-Quinolol



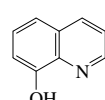
5-Quinolol



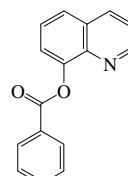
6-Quinolol



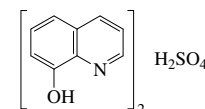
7-Quinolol



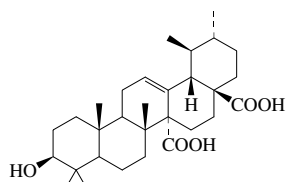
8-Quinolol



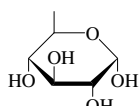
8-Quinolol benzoate



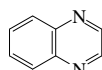
8-Quinolol sulfate (2:1)



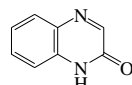
Quinovic acid



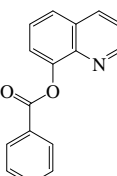
Quinovose



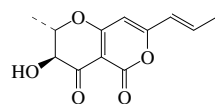
Quinoxaline



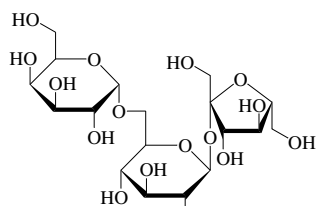
2(1H)-Quinoxalinone



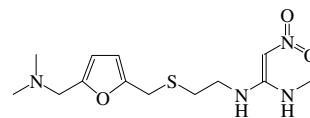
Quizalofop-Ethyl



Radicinin

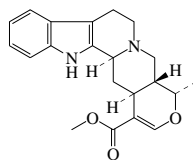


Raffinose

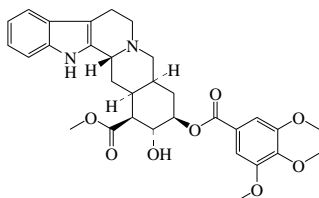


Ranitidine

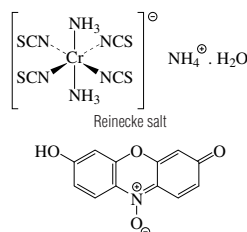
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9450	Raubasine		C <sub>21</sub> H <sub>24</sub> N <sub>2</sub> O <sub>3</sub>	483-04-5	352.427		258 dec				i H <sub>2</sub> O; s MeOH
9451	Raunescine		C <sub>31</sub> H <sub>36</sub> N <sub>2</sub> O <sub>6</sub>	117-73-7	564.626		165				i H <sub>2</sub> O; s EtOH, chl, HOAc
9452	Reinecke salt		C <sub>4</sub> H <sub>12</sub> CrN <sub>7</sub> OS <sub>4</sub>	13573-16-5	354.440	red cry (w)	270 dec				s H <sub>2</sub> O, EtOH, ace; i bz
9453	Resazurin	7-Hydroxy-3 <i>H</i> -phenoxazin-3-one, 10-oxide	C <sub>12</sub> H <sub>7</sub> NO <sub>4</sub>	550-82-3	229.189	dk red to gr pr or pl (HOAc)		sub			i H <sub>2</sub> O, eth; sl EtOH, HOAc; s alk
9454	Rescinnamine		C <sub>35</sub> H <sub>42</sub> N <sub>2</sub> O <sub>3</sub>	24815-24-5	634.716	nd (bz)	238.5				i H <sub>2</sub> O; sl EtOH; s ace, chl, AcOEt
9455	Reserpine acid		C <sub>22</sub> H <sub>26</sub> N <sub>2</sub> O <sub>5</sub>	83-60-3	400.467	cry (MeOH)	242				
9456	Reserpine		C <sub>33</sub> H <sub>40</sub> N <sub>2</sub> O <sub>5</sub>	50-55-5	608.679	lo pr (dil ace)	264.5				sl H <sub>2</sub> O, eth, ace; s EtOH, bz, AcOEt
9457	<i>cis</i> -Resmethrin, (-)		C <sub>22</sub> H <sub>26</sub> O <sub>3</sub>	10453-86-8	338.439		75				
9458	Resorcinol	1,3-Benzenediol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	108-46-3	110.111	nd (bz), pl (w)	109.4	276.5; 178 <sup>16</sup>	1.278 <sup>20</sup>	1.578 <sup>25</sup>	vs H <sub>2</sub> O, ctc; s EtOH, eth; sl bz, chl
9459	11- <i>cis</i> -Retinal	Vitamin A <sub>1</sub> aldehyde	C <sub>20</sub> H <sub>28</sub> O	564-87-4	284.435	cry					
9460	Retinal (all <i>trans</i> )		C <sub>20</sub> H <sub>28</sub> O	116-31-4	284.435	oran cry	64				i H <sub>2</sub> O; s EtOH, chl, cy, peth
9461	13- <i>cis</i> -Retinoic acid	Accutane	C <sub>20</sub> H <sub>28</sub> O <sub>2</sub>	4759-48-2	300.435	cry (EtOH)	189				
9462	13- <i>trans</i> -Retinoic acid		C <sub>20</sub> H <sub>28</sub> O <sub>2</sub>	302-79-4	300.435	cry (MeOH)	181.5				
9463	Retinol	Vitamin A	C <sub>20</sub> H <sub>30</sub> O	68-26-8	286.451	ye pr (peth)	63.5	1370.000001			i H <sub>2</sub> O; s EtOH, eth, ace, bz
9464	Retinyl palmitate	Retinol, hexadecanoate	C <sub>36</sub> H <sub>60</sub> O <sub>2</sub>	79-81-2	524.860		28				
9465	Retronecine, (+)		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	480-85-3	155.195	cry (ace)	121				s H <sub>2</sub> O, EtOH; sl eth
9466	Retrorsine		C <sub>18</sub> H <sub>26</sub> NO <sub>6</sub>	480-54-6	351.395	cry (AcOEt)	212				sl H <sub>2</sub> O, ace; s EtOH, chl; i eth
9467	Rhamnetin		C <sub>16</sub> H <sub>12</sub> O <sub>7</sub>	90-19-7	316.262	ye nd (al)	295				sl H <sub>2</sub> O; s EtOH, ace, PhOH; vs dil alk
9468	<i>DL</i> -α-Rhamnose		C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	116908-82-8	164.156	cry (w)	151				vs H <sub>2</sub> O, EtOH
9469	<i>D</i> -Rhamnose	6-Deoxy- <i>D</i> -mannose	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	634-74-2	164.156						s H <sub>2</sub> O
9470	Rheadine		C <sub>21</sub> H <sub>21</sub> NO <sub>6</sub>	2718-25-4	383.395	nd (chl, eth, al)	257	sub			
9471	Rhein		C <sub>15</sub> H <sub>8</sub> O <sub>6</sub>	478-43-3	284.221	ye or oran nd (MeOH, py)	321	sub			sl H <sub>2</sub> O, EtOH, eth, ace, bz; vs py
9472	Rhenium carbonyl	Dirhenium decacarbonyl	C <sub>10</sub> O <sub>10</sub> Re <sub>2</sub>	14285-68-8	652.515	ye-wh cry	170 dec		2.87		s os
9473	Rhizopterin		C <sub>15</sub> H <sub>12</sub> N <sub>6</sub> O <sub>4</sub>	119-20-0	340.294	lt ye pl (w)	>300				i H <sub>2</sub> O, EtOH, eth; s aq alk, aq NH <sub>3</sub> , py
9474	Rhodamine B		C <sub>28</sub> H <sub>32</sub> ClN <sub>2</sub> O <sub>3</sub>	81-88-9	480.018		165				s H <sub>2</sub> O, EtOH, eth, bz, xyl
9475	Rhodium carbonyl chloride	Dirhodium tetracarbonyl dichloride	C <sub>4</sub> Cl <sub>2</sub> O <sub>4</sub> Rh <sub>2</sub>	14523-22-9	388.758	red-oran cry	124				s os
9476	Ribavirin	Tribavirin	C <sub>8</sub> H <sub>12</sub> N <sub>4</sub> O <sub>5</sub>	36791-04-5	244.205	col cry (EtOH)	175				s H <sub>2</sub> O
9477	Ribitol	Adonitol	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	488-81-3	152.146	pr (w), nd (al)	104				s H <sub>2</sub> O, EtOH; i eth, lig
9478	Riboflavin		C <sub>17</sub> H <sub>20</sub> N <sub>4</sub> O <sub>6</sub>	83-88-5	376.364	ye or oran-ye nd (w)	280 dec				i H <sub>2</sub> O, eth, ace, chl; sl EtOH
9479	Riboflavin-5'-phosphate		C <sub>17</sub> H <sub>20</sub> N <sub>4</sub> O <sub>9</sub> P	146-17-8	455.336	ye cry (w)					
9480	<i>D</i> -Ribose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	50-69-1	150.130	pl (al)	88				s H <sub>2</sub> O; sl EtOH
9481	<i>L</i> -Ribose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	24259-59-4	150.130		81				
9482	<i>D</i> -Ribulose	<i>erythro</i> -2-Pentulose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	488-84-6	150.130	syrup					vs H <sub>2</sub> O
9483	Ricinine	1,2-Dihydro-4-methoxy-1-methyl-2-oxo-3-pyridinecarbonitrile	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	524-40-3	164.162	pr or lf (w, al)	201.5	sub 170			s H <sub>2</sub> O, chl; sl EtOH, bz; vs py; i peth
9484	Rifabutin		C <sub>46</sub> H <sub>62</sub> N <sub>4</sub> O <sub>11</sub>	72559-06-9	847.004	viol-red cry					i H <sub>2</sub> O; vs chl; s MeOH; sl EtOH
9485	Rifampin		C <sub>43</sub> H <sub>58</sub> N <sub>4</sub> O <sub>12</sub>	13292-46-1	822.941	red-oran pl (ace)	185 dec				
9486	Rinderine	Echinatine-3'-epimer	C <sub>15</sub> H <sub>22</sub> NO <sub>5</sub>	6029-84-1	299.364	cry (ace)	100.5				
9487	Ronnel		C <sub>8</sub> H <sub>8</sub> Cl <sub>3</sub> O <sub>3</sub> PS	299-84-3	321.546		41	152 <sup>0.4</sup>	1.44 <sup>32</sup>	1.5335 <sup>35</sup>	
9488	Rotenone		C <sub>23</sub> H <sub>22</sub> O <sub>6</sub>	83-79-4	394.417	nd or lf (al, aq-ace)	176	215 <sup>0.5</sup>			i H <sub>2</sub> O; s EtOH, ace, bz; sl eth; vs chl
9489	Rubijervine		C <sub>27</sub> H <sub>43</sub> NO <sub>2</sub>	79-58-3	413.636	nd (+1w, dil al)	242				vs bz, EtOH, chl
9490	Rubratoxin B		C <sub>26</sub> H <sub>30</sub> O <sub>11</sub>	21794-01-4	518.509	cry (MeCN)	169 dec				



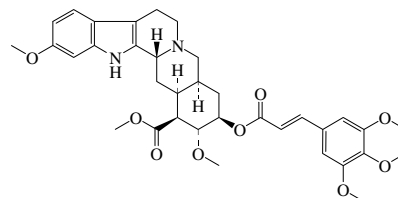
Raubasine



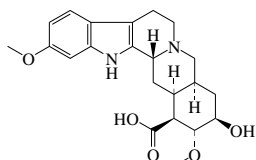
Raunescine



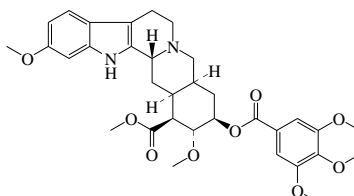
Reinecke salt



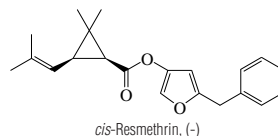
Rescinnamine



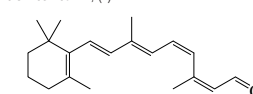
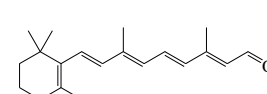
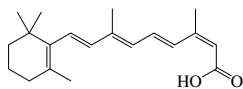
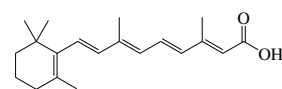
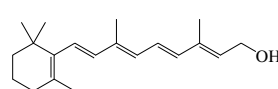
Reserpine acid



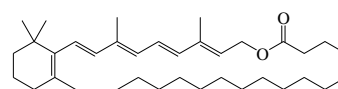
Reserpine

*cis*-Resmethrin, (-)

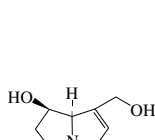
Resorcinol

11-*cis*-RetinalRetinal (all *trans*)13-*cis*-Retinoic acid13-*trans*-Retinoic acid

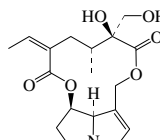
Retinol



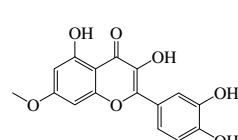
Retinyl palmitate



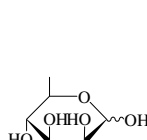
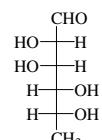
Retronecine, (+)



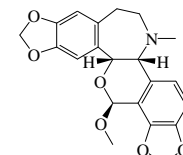
Retrorsine



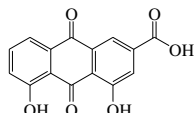
Rhamnetin

DL- $\alpha$ -Rhamnose

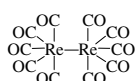
D-Rhamnose



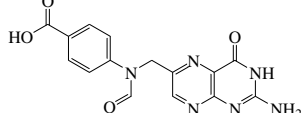
Rheadine



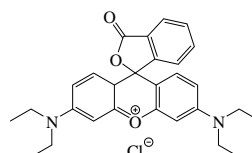
Rhein



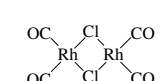
Rhenium carbonyl



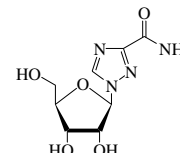
Rhizopterin



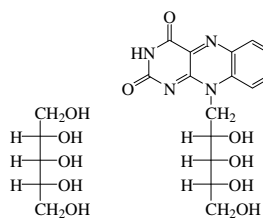
Rhodamine B



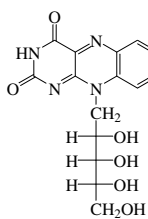
Rhodium carbonyl chloride



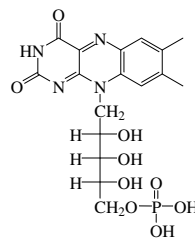
Ribavirin



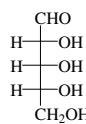
Ribitol



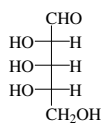
Riboflavin



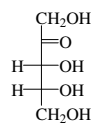
Riboflavin-5'-phosphate



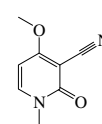
D-Ribose



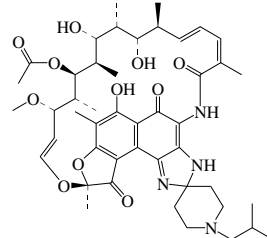
L-Ribose



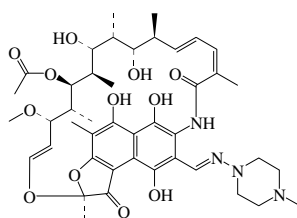
D-Ribulose



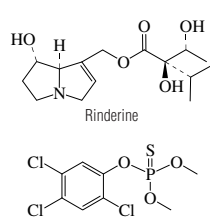
Ricinine



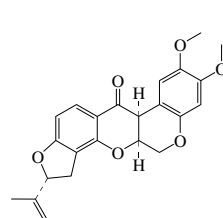
Rifabutin



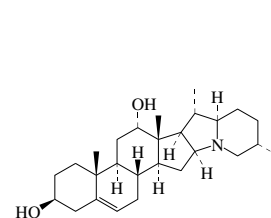
Rifampin



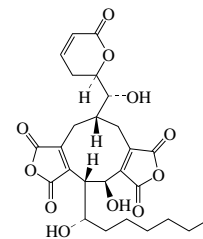
Rinderine



Rotenone

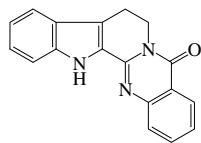


Rubijervine

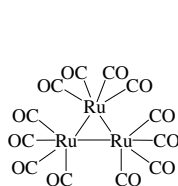


Rubratoxin B

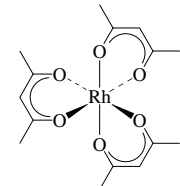
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9491	Rutecarpine		C <sub>18</sub> H <sub>13</sub> N <sub>3</sub> O	84-26-4	287.315	ye nd (al, AcOEt)	259.5				sl EtOH, ace, bz
9492	Ruthenium dodecacarbonyl	Triruthenium dodecacarbonyl	C <sub>12</sub> O <sub>12</sub> Ru <sub>3</sub>	15243-33-1	639.33	oran cry	dec 150				
9493	Ruthenium(III) 2,4-pentanedioate	Ruthenium(III) acetylacetonate	C <sub>15</sub> H <sub>21</sub> O <sub>9</sub> Ru	14284-93-6	398.39		230				
9494	Rutinoside		C <sub>12</sub> H <sub>22</sub> O <sub>10</sub>	90-74-4	326.297	hyg pow (al, eth)	190 dec				vs H <sub>2</sub> O, EtOH
9495	Sabadine		C <sub>29</sub> H <sub>47</sub> NO <sub>8</sub>	124-80-1	537.685	nd (eth)	258				vs ace, EtOH
9496	Saccharin		C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub> S	81-07-2	183.185	nd (ace) pr (al), lf (w)	228 dec	sub	0.828 <sup>25</sup>		sl H <sub>2</sub> O, bz, eth, chl; s ace, EtOH
9497	Saccharin sodium	1,2-Benzisothiazolin-3-one, 1,1-dioxide, sodium salt	C <sub>7</sub> H <sub>4</sub> NNaO <sub>3</sub> S	128-44-9	205.168	wh cry	229				s H <sub>2</sub> O
9498	Safranal	2,6,6-Trimethyl-1,3-cyclohexadiene-1-carboxaldehyde	C <sub>10</sub> H <sub>14</sub> O	116-26-7	150.217			70 <sup>1</sup>	0.9734 <sup>19</sup>	1.5281 <sup>19</sup>	vs EtOH, peth
9499	Safrole	5-(2-Propenyl)-1,3-benzodioxole	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	94-59-7	162.185	mcl	11.2	234.5	1.1000 <sup>20</sup>	1.5381 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, chl
9500	Salcomine	<i>N,N'</i> -Bis(salicylidene)ethylenediamine cobalt(II)	C <sub>16</sub> H <sub>14</sub> CoN <sub>2</sub> O <sub>2</sub>	14167-18-1	325.227	red cry (DMF)					s bz, chl, py
9501	Salicylaldehyde	2-Hydroxybenzaldehyde	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	90-02-8	122.122	liq	-7	197	1.1674 <sup>20</sup>	1.5740 <sup>20</sup>	sl H <sub>2</sub> O, chl; msc EtOH; vs ace, bz
9502	Salicylaldoxime		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	94-67-7	137.137		57				sl H <sub>2</sub> O; vs EtOH, eth, bz; s chl; i lig
9503	Salsoline		C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	89-31-6	193.243	pow or cry (al)	221.5				sl H <sub>2</sub> O, EtOH; i eth, peth; s chl, alk
9504	Salvarsan dihydrochloride	Arsphenamine	C <sub>12</sub> H <sub>14</sub> As <sub>2</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	139-93-5	439.001	ye hyg pow	190 dec				vs H <sub>2</sub> O
9505	Sanguinarine		C <sub>20</sub> H <sub>15</sub> NO <sub>5</sub>	2447-54-3	349.337	cry (eth, al)	266				vs ace, bz, eth, EtOH
9506	α-Santalol		C <sub>15</sub> H <sub>24</sub> O	115-71-9	220.351			301.5	0.9679 <sup>20</sup>	1.5023 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
9507	β-Santalol		C <sub>15</sub> H <sub>24</sub> O	77-42-9	220.351			167 <sup>10</sup>	0.9750 <sup>20</sup>	1.5115 <sup>20</sup>	
9508	Santonin acid		C <sub>15</sub> H <sub>20</sub> O <sub>4</sub>	510-35-0	264.318	cry	171	285 <sup>15</sup>			sl H <sub>2</sub> O; s chl, eth, HOAc, EtOH
9509	α-Santonin		C <sub>15</sub> H <sub>18</sub> O <sub>3</sub>	481-06-1	246.302	orth (w, eth)	175		1.590 <sup>25</sup>		sl H <sub>2</sub> O, EtOH, eth; s bz, chl; i peth
9510	Sarcosine	<i>N</i> -Methylglycine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	107-97-1	89.094	cry (al)	212 dec				s H <sub>2</sub> O
9511	Sarmentogenin		C <sub>23</sub> H <sub>34</sub> O <sub>5</sub>	76-28-8	390.513	pr (95% al, MeOH-eth)	280				i H <sub>2</sub> O, eth, bz; s EtOH; sl ace, chl
9512	Sarpagan-17-al	Vellosimine	C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O	6874-98-2	292.374	cry (MeOH)	305.5	sub 180			
9513	Sarpagan-10,17-diol	Sarpagine	C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	482-68-8	310.390	nd	320				i H <sub>2</sub> O; s EtOH
9514	Saxitoxin dihydrochloride		C <sub>10</sub> H <sub>15</sub> Cl <sub>2</sub> N <sub>7</sub> O <sub>4</sub>	35554-08-6	372.209	hyg wh solid					vs H <sub>2</sub> O, MeOH, EtOH
9515	Scarlet red		C <sub>24</sub> H <sub>20</sub> N <sub>4</sub> O	85-83-6	380.442	dk br pow or nd	185; dec 260				i H <sub>2</sub> O; sl ace, bz; vs chl, peth
9516	Schradan		C <sub>8</sub> H <sub>24</sub> N <sub>4</sub> O <sub>3</sub> P <sub>2</sub>	152-16-9	286.250		17	154 <sup>2,0</sup>	1.09 <sup>25</sup>	1.462 <sup>25</sup>	vs H <sub>2</sub> O, EtOH, chl
9517	Scilliroside		C <sub>32</sub> H <sub>44</sub> O <sub>12</sub>	507-60-8	620.684	lo pr (dil MeOH)	169	dec			sl H <sub>2</sub> O, ace, chl; vs EtOH, diox; i eth
9518	Scopolamine		C <sub>17</sub> H <sub>21</sub> NO <sub>4</sub>	51-34-3	303.354	visc liq					vs hot H <sub>2</sub> O, EtOH, ace; sl bz
9519	Scopoline		C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	487-27-4	155.195	hyg nd (lig, eth, chl, peth)	108.5	248	1.0891 <sup>134</sup>		s H <sub>2</sub> O
9520	Sebacic acid	Decanedioic acid	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	111-20-6	202.248	lf	130.9	353.9; 295 <sup>100</sup>	1.2705 <sup>20</sup>	1.422 <sup>133</sup>	sl H <sub>2</sub> O; s EtOH, eth; i bz
9521	Selenium methionine	Selenomethionine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> Se	1464-42-2	196.11	hex pl (MeOH aq)	265 dec				
9522	Selenoformaldehyde		CH <sub>2</sub> Se	6596-50-5	92.99	unstab gas					
9523	Selenourea	Carbamimidoseleonic acid	CH <sub>3</sub> N <sub>2</sub> Se	630-10-4	123.02	pr or nd (w)		dec 200			vs H <sub>2</sub> O
9524	Semicarbazide hydrochloride		CH <sub>2</sub> ClN <sub>3</sub> O	563-41-7	111.531	pr (dil al)	176 dec				vs H <sub>2</sub> O
9525	Senecionine		C <sub>18</sub> H <sub>25</sub> NO <sub>5</sub>	130-01-8	335.396	pl	232				i H <sub>2</sub> O; sl EtOH, eth; s chl
9526	Seneciophylline		C <sub>18</sub> H <sub>23</sub> NO <sub>5</sub>	480-81-9	333.380	pl (AcOEt)	217 dec				s chl; sl EtOH, ace; i eth
9527	Senkirkin		C <sub>19</sub> H <sub>27</sub> NO <sub>6</sub>	2318-18-5	365.420	pl (ace)	197				
9528	<i>L</i> -Septapterin	6-Lactoyl-7,8-dihydropterin	C <sub>9</sub> H <sub>11</sub> N <sub>5</sub> O <sub>3</sub>	17094-01-8	237.215	ye pow or cry					



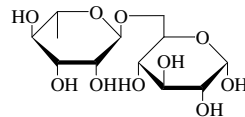
Rutecarpine



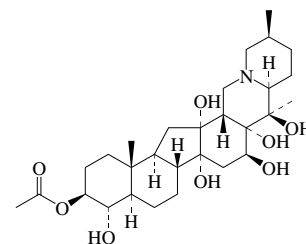
Ruthenium dodecacarbonyl



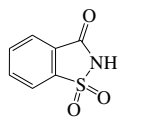
Ruthenium(III) 2,4-pentanedioate



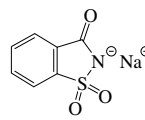
Rutinose



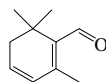
Sabadine



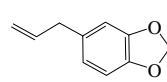
Saccharin



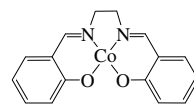
Saccharin sodium



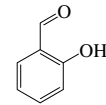
Safranal



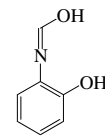
Safrole



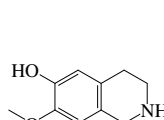
Salcomine



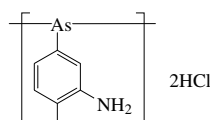
Salicylaldehyde



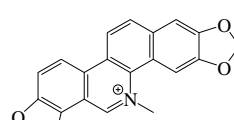
Salicylaldoxime



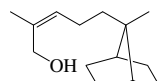
Salsoline



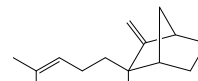
Salvarsan dihydrochloride



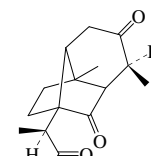
Sanguinarine



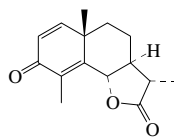
α-Santalol



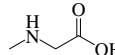
β-Santalol



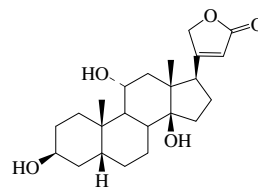
Santonic acid



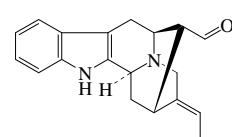
α-Santonin



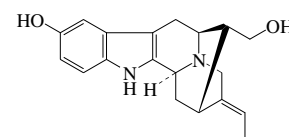
Sarcosine



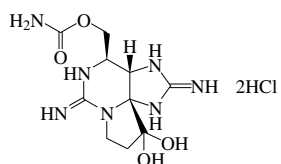
Sarmentogenin



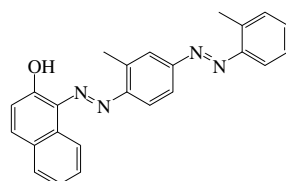
Sarpagan-17-al



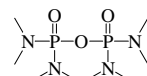
Sarpagan-10,17-diol



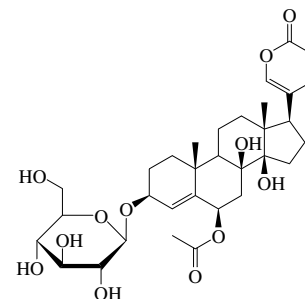
Saxitoxin dihydrochloride



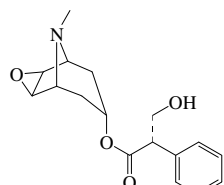
Scarlet red



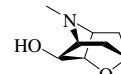
Schradan



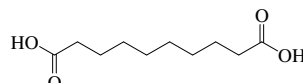
Scilliroside



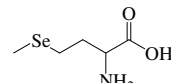
Scopolamine



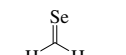
Scopoline



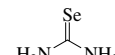
Sebacic acid



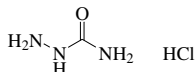
Selenium methionine



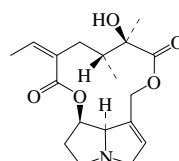
Selenoformaldehyde



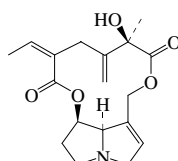
Selenourea



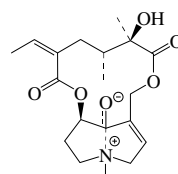
Semicarbazide hydrochloride



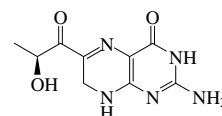
Senecionine



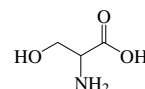
Seneciophylline



Senkirkirin

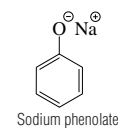
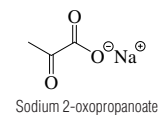
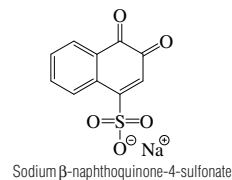
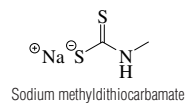
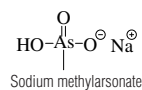
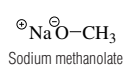
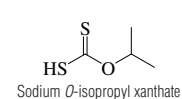
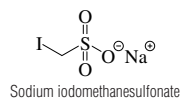
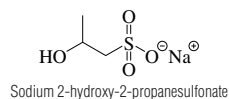
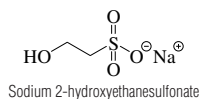
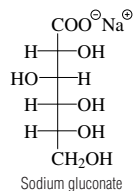
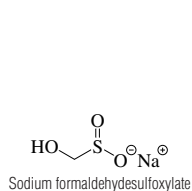
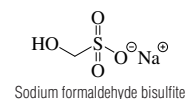
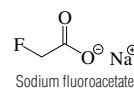
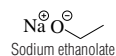
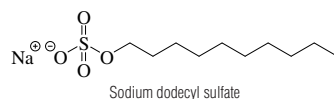
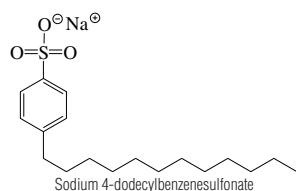
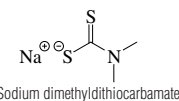
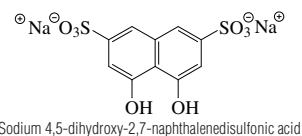
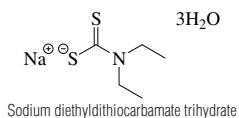
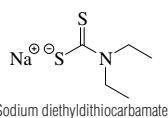
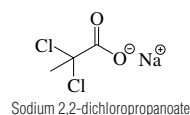
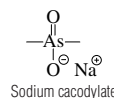
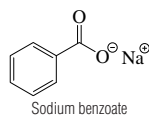
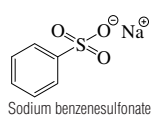
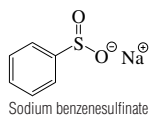
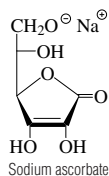
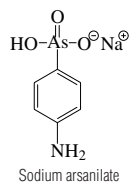
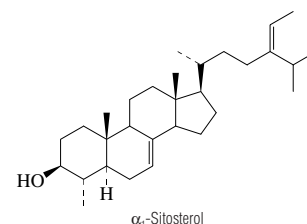
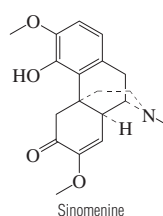
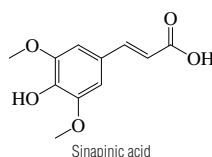
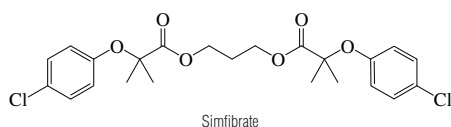
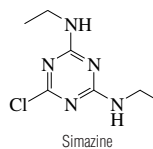
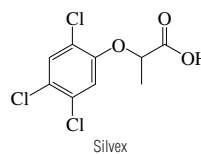
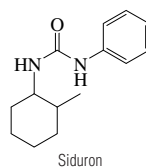
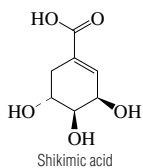
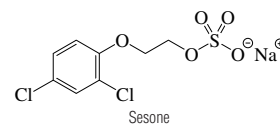
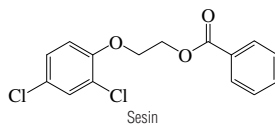
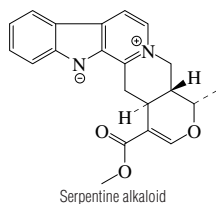
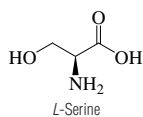
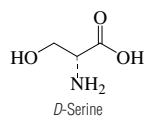


L-Septapterin



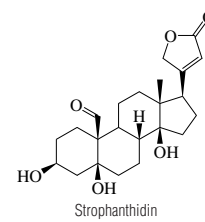
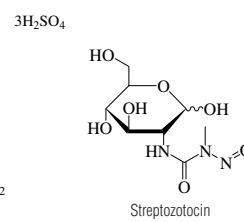
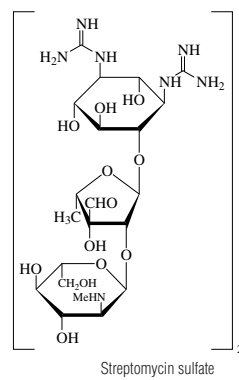
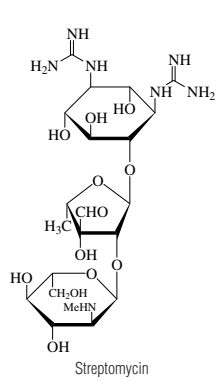
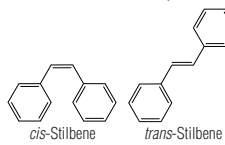
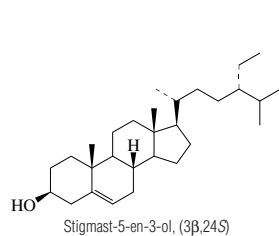
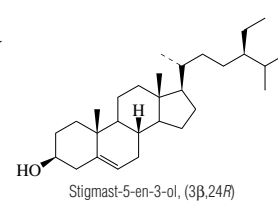
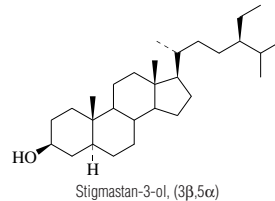
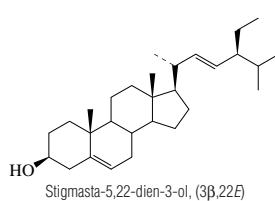
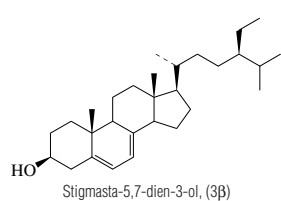
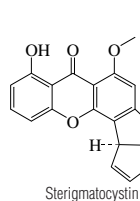
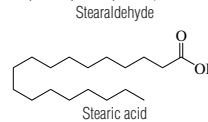
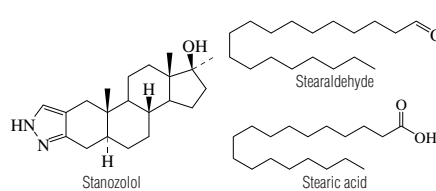
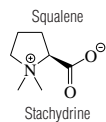
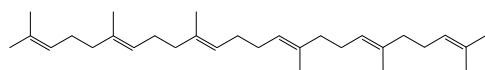
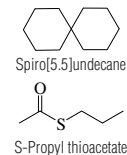
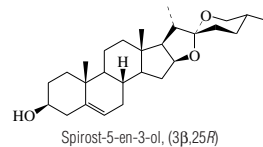
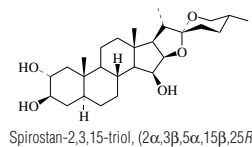
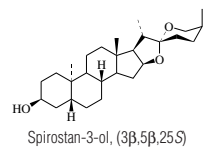
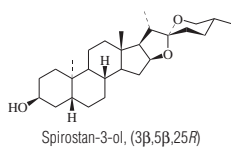
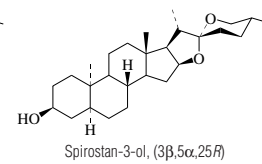
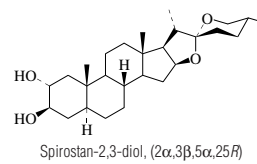
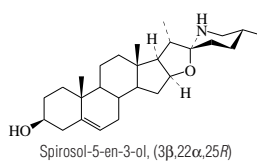
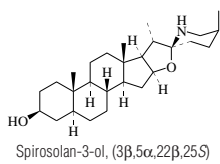
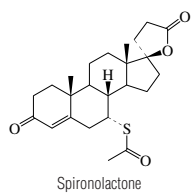
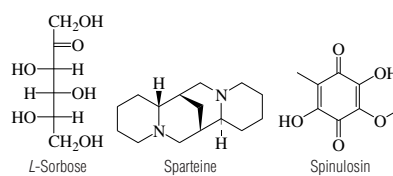
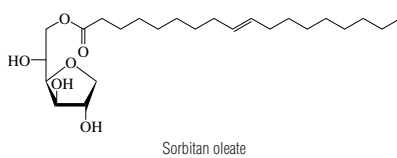
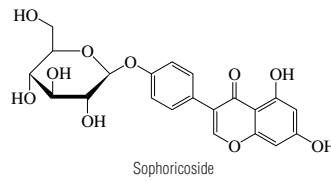
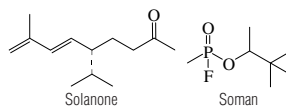
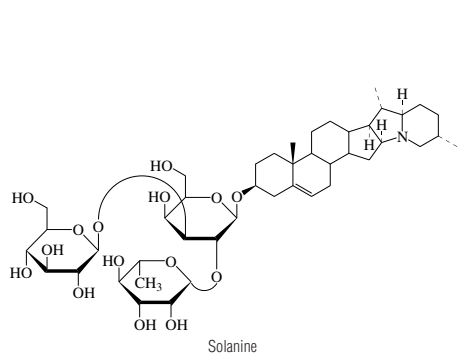
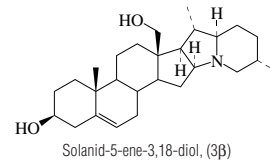
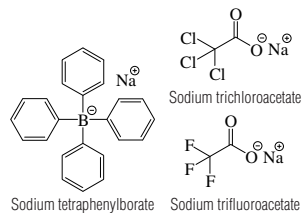
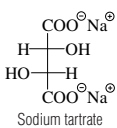
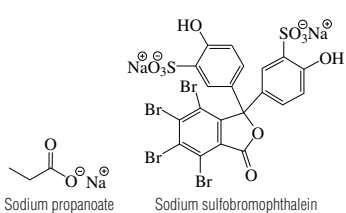
DL-Serine

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9529	<i>DL</i> -Serine		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	302-84-1	105.093	mcl pr or lf (w)	246 dec		1.603 <sup>22</sup>		s H <sub>2</sub> O; i EtOH, eth, bz, HOAc
9530	<i>D</i> -Serine		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	312-84-5	105.093	nd or hex pr (w)	229 dec	dec			vs H <sub>2</sub> O; i EtOH, eth, bz, HOAc
9531	<i>L</i> -Serine	2-Amino-3-hydroxypropanoic acid, (S)	C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	56-45-1	105.093	hex pl or pr (w)	228 dec	sub 150	1.6 <sup>22</sup>		s H <sub>2</sub> O; i EtOH, eth, bz, HOAc
9532	Serpentine alkaloid		C <sub>21</sub> H <sub>20</sub> N <sub>2</sub> O <sub>3</sub>	18786-24-8	348.395		175				i H <sub>2</sub> O; s EtOH, eth, ace
9533	Sesin	2,4-Dichlorophenoxyethyl benzoate	C <sub>15</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>3</sub>	94-83-7	311.160	cry	66	185 <sup>1,5</sup>			
9534	Sesone	Sodium 2-(2,4-dichlorophenoxy)ethyl sulfate	C <sub>8</sub> H <sub>7</sub> Cl <sub>2</sub> NaO <sub>5</sub> S	136-78-7	309.100		245 dec				
9535	Sethoxydim		C <sub>17</sub> H <sub>28</sub> NO <sub>3</sub> S	74051-80-2	327.482			>90 <sup>0.00003</sup>	1.043 <sup>25</sup>		
9536	Shikimic acid		C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	138-59-0	174.151	nd	184	subl			sl EtOH; i eth, bz, chl
9537	Siduron		C <sub>14</sub> H <sub>20</sub> N <sub>2</sub> O	1982-49-6	232.321	cry solid	135				s EtOH, DMF, CH <sub>2</sub> Cl <sub>2</sub>
9538	Silvex	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-	C <sub>9</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>3</sub>	93-72-1	269.509		181.6				
9539	Simazine	1,3,5-Triazine-2,4-diamine, 6-chloro- <i>N,N'</i> -diethyl-	C <sub>7</sub> H <sub>12</sub> ClN <sub>5</sub>	122-34-9	201.657		226		1.302 <sup>20</sup>		
9540	Simfibrate		C <sub>23</sub> H <sub>26</sub> Cl <sub>2</sub> O <sub>6</sub>	14929-11-4	469.354	cry	52	225 <sup>0.15</sup>			
9541	Sinapinic acid	3-(4-Hydroxy-3,5-dimethoxyphenyl)-2-propenoic acid	C <sub>11</sub> H <sub>12</sub> O <sub>5</sub>	530-59-6	224.210	wh pow					i H <sub>2</sub> O; s MeOH, ace
9542	Sinomenine		C <sub>19</sub> H <sub>23</sub> NO <sub>4</sub>	115-53-7	329.391	nd (bz)	162				sl H <sub>2</sub> O, eth, bz; s EtOH, ace, dil alk
9543	α <sub>1</sub> -Sitosterol	4-Methylstigmaster-7,24(28)-dien-3-ol, (3β,4α,5α,24Z)	C <sub>30</sub> H <sub>50</sub> O	474-40-8	426.717	nd (al)	166				vs EtOH, chl
9544	Sodium arsanilate	Sodium (4-aminophenyl)arsonate	C <sub>6</sub> H <sub>7</sub> AsNNaO <sub>3</sub>	127-85-5	239.037	wh cry					s H <sub>2</sub> O
9545	Sodium ascorbate		C <sub>6</sub> H <sub>7</sub> NaO <sub>5</sub>	134-03-2	198.106	cry	218 dec				
9546	Sodium benzenesulfinate		C <sub>6</sub> H <sub>5</sub> NaO <sub>2</sub> S	873-55-2	164.158	cry	300				
9547	Sodium benzenesulfonate	Monosodium benzenesulfonate	C <sub>6</sub> H <sub>5</sub> NaO <sub>3</sub> S	515-42-4	180.157		>300				s H <sub>2</sub> O; sl EtOH
9548	Sodium benzoate		C <sub>7</sub> H <sub>5</sub> NaO <sub>2</sub>	532-32-1	144.104		>300				s H <sub>2</sub> O
9549	Sodium cacodylate	Sodium dimethylarsonate	C <sub>2</sub> H <sub>6</sub> AsNaO <sub>2</sub>	124-65-2	159.980	gran cry	60 (hyd)				vs H <sub>2</sub> O; s EtOH
9550	Sodium 2,2-dichloropropanoate		C <sub>3</sub> H <sub>3</sub> Cl <sub>2</sub> NaO <sub>2</sub>	127-20-8	164.951	hyg pow	166 dec				
9551	Sodium diethyldithiocarbamate	Dithiocarb sodium	C <sub>5</sub> H <sub>10</sub> NNaS <sub>2</sub>	148-18-5	171.260	cry (EtOH)	95				s H <sub>2</sub> O, EtOH, MeOH, ace; i eth, bz
9552	Sodium diethyldithiocarbamate trihydrate	Diethyldithiocarbamate sodium salt trihydrate	C <sub>5</sub> H <sub>16</sub> NNaO <sub>3</sub> S <sub>2</sub>	20624-25-3	225.306	orth cry (ace)	95				vs H <sub>2</sub> O; s EtOH, ace; i bz, eth
9553	Sodium 4,5-dihydroxy-2,7-naphthalenedisulfonic acid	Chromotropic acid disodium salt	C <sub>10</sub> H <sub>6</sub> Na <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	129-96-4	364.260	wh nd or lf (w)					vs H <sub>2</sub> O
9554	Sodium dimethyldithiocarbamate		C <sub>3</sub> H <sub>7</sub> NNaS <sub>2</sub>	128-04-1	144.215	col cry (w)	121 (hyd)				
9555	Sodium 4-dodecylbenzenesulfonate		C <sub>18</sub> H <sub>29</sub> NaO <sub>3</sub> S	2211-98-5	348.476	cry	144				
9556	Sodium dodecyl sulfate	Sodium lauryl sulfate	C <sub>12</sub> H <sub>25</sub> NaO <sub>4</sub> S	151-21-3	288.379	wh pow	205				
9557	Sodium ethanolate	Sodium ethoxide	C <sub>2</sub> H <sub>5</sub> NaO	141-52-6	68.050	hyg wh pow	260 dec				reac H <sub>2</sub> O; s EtOH
9558	Sodium fluoroacetate		C <sub>2</sub> H <sub>2</sub> FNaO <sub>2</sub>	62-74-8	100.024	wh mcl cry	200				i ace, chl; sl EtOH, MeOH
9559	Sodium formaldehyde bisulfite	Sodium hydroxymethanesulfonate	CH <sub>3</sub> NaO <sub>3</sub> S	870-72-4	134.088	cry (EtOH aq)					
9560	Sodium formaldehydesulfoxylate	Sodium hydroxymethanesulfinate	CH <sub>3</sub> NaO <sub>3</sub> S	149-44-0	118.088	cry (w)	63 (hyd)				s H <sub>2</sub> O; i EtOH, bz, eth
9561	Sodium gluconate		C <sub>6</sub> H <sub>11</sub> NaO <sub>7</sub>	527-07-1	218.137						s H <sub>2</sub> O
9562	Sodium 2-hydroxyethanesulfonate	Monosodium 2-hydroxyethanesulfonate	C <sub>2</sub> H <sub>5</sub> NaO <sub>3</sub> S	1562-00-1	148.114						s H <sub>2</sub> O
9563	Sodium 2-hydroxy-2-propanesulfonate	Monosodium 2-hydroxy-2-propanesulfonate	C <sub>3</sub> H <sub>7</sub> NaO <sub>3</sub> S	540-92-1	162.141	cry					s H <sub>2</sub> O; sl EtOH
9564	Sodium iodomethanesulfonate	Methiodal sodium	CH <sub>2</sub> I <sub>2</sub> NaO <sub>3</sub> S	126-31-8	243.984	cry					sl EtOH, ace, bz
9565	Sodium <i>O</i> -isopropyl xanthate		C <sub>4</sub> H <sub>9</sub> NaOS <sub>2</sub>	140-93-2	158.218	hyg wh-ye pow	150 dec				
9566	Sodium methanolate	Sodium methoxide	CH <sub>3</sub> NaO	124-41-4	54.024	wh hyg tetr cry	300				reac H <sub>2</sub> O; s MeOH, EtOH
9567	Sodium methylarsonate		CH <sub>3</sub> AsNaO <sub>3</sub>	2163-80-6	161.953	cry (w)	115				vs H <sub>2</sub> O; s MeOH; i os
9568	Sodium methyldithiocarbamate	Metham sodium	C <sub>2</sub> H <sub>5</sub> NNaS <sub>2</sub>	137-42-8	129.180	cry (w)					vs H <sub>2</sub> O
9569	Sodium β-naphthoquinone-4-sulfonate	Sodium 3,4-dihydro-3,4-dioxo-1-naphthalenesulfonate	C <sub>10</sub> H <sub>5</sub> NaO <sub>5</sub> S	521-24-4	260.199		287 dec				
9570	Sodium 2-oxopropanoate		C <sub>3</sub> H <sub>3</sub> NaO <sub>3</sub>	113-24-6	110.044						s H <sub>2</sub> O; sl abs EtOH

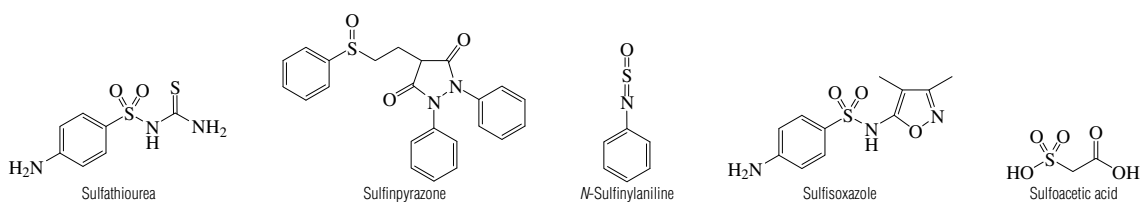
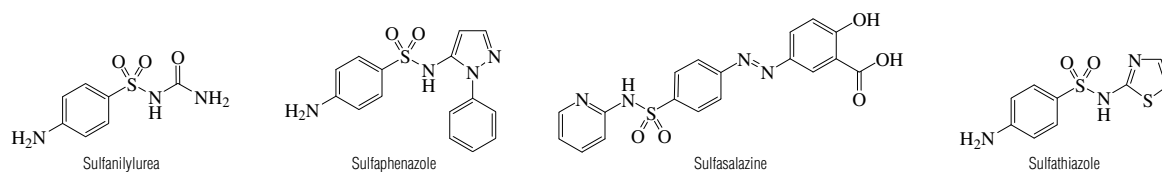
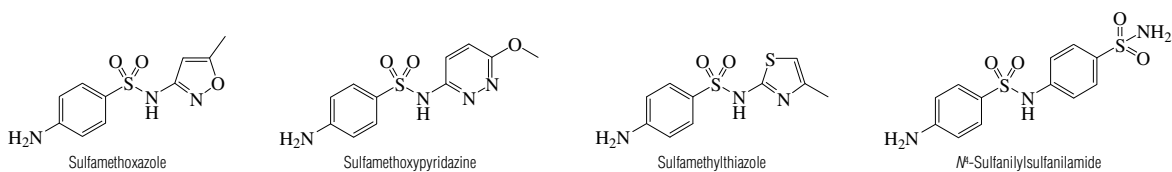
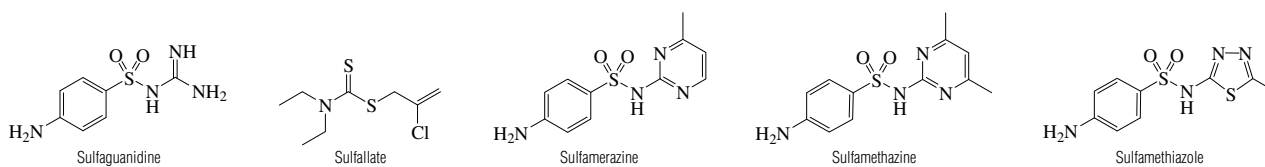
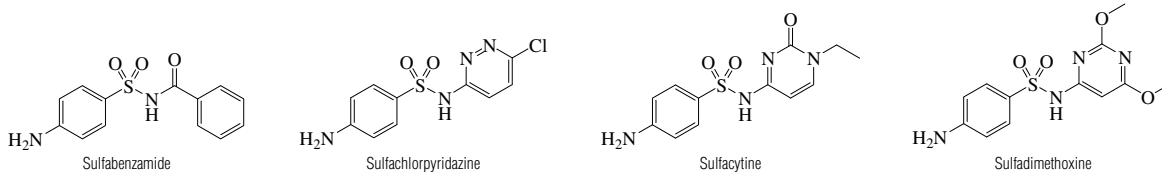
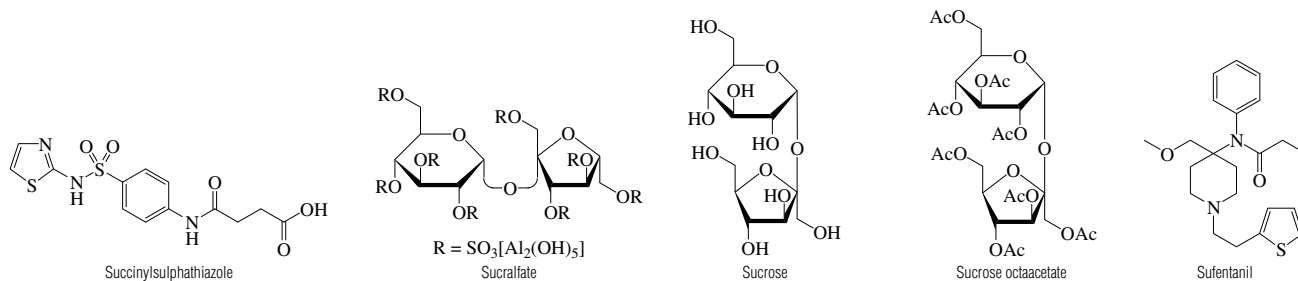
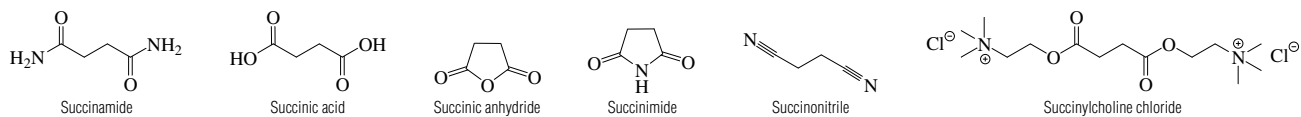
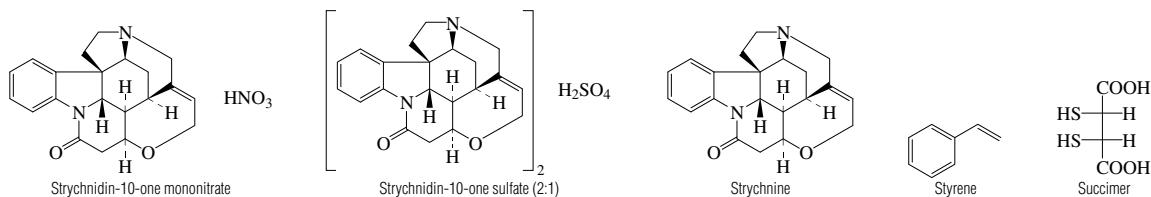


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9571	Sodium phenolate	Sodium phenoxide	C <sub>6</sub> H <sub>5</sub> NaO	139-02-6	116.093	hyg cry	384				vs H <sub>2</sub> O; s EtOH, thf
9572	Sodium propanoate		C <sub>3</sub> H <sub>5</sub> NaO <sub>2</sub>	137-40-6	96.061						sl H <sub>2</sub> O
9573	Sodium sulfobromophthalein	Sulfobromophthalein sodium	C <sub>20</sub> H <sub>6</sub> Br <sub>4</sub> Na <sub>2</sub> O <sub>10</sub> S <sub>2</sub>	71-67-0	837.998	hyg cry					s H <sub>2</sub> O; i EtOH, ace
9574	Sodium tartrate		C <sub>4</sub> H <sub>4</sub> Na <sub>2</sub> O <sub>6</sub>	868-18-8	194.051						s H <sub>2</sub> O
9575	Sodium tartrate dihydrate		C <sub>4</sub> H <sub>6</sub> Na <sub>2</sub> O <sub>8</sub>	6106-24-7	230.082				1.545 <sup>25</sup>		s H <sub>2</sub> O; i EtOH
9576	Sodium tetraphenylborate		C <sub>24</sub> H <sub>20</sub> BNa	143-66-8	342.217	nd	300				s H <sub>2</sub> O, EtOH, ace; sl eth, chl; i peth
9577	Sodium trichloroacetate		C <sub>2</sub> Cl <sub>3</sub> NaO <sub>2</sub>	650-51-1	185.369	ye-wh pow	300				s H <sub>2</sub> O, EtOH
9578	Sodium trifluoroacetate		C <sub>2</sub> F <sub>3</sub> NaO <sub>2</sub>	2923-18-4	136.005	cry	207 dec				
9579	Solanid-5-ene-3,18-diol, (3β)	Isorubijervine	C <sub>27</sub> H <sub>43</sub> NO <sub>2</sub>	468-45-1	413.636	pr(al)	242.5				vs bz, chl
9580	Solanine		C <sub>45</sub> H <sub>73</sub> NO <sub>15</sub>	20562-02-1	868.060	nd (EtOH aq)	286 dec				i H <sub>2</sub> O, eth, chl; s hot EtOH
9581	Solanone		C <sub>13</sub> H <sub>22</sub> O	1937-54-8	194.313			60 <sup>1</sup>	0.870 <sup>20</sup>	1.4755 <sup>20</sup>	
9582	Soman		C <sub>7</sub> H <sub>16</sub> FO <sub>2</sub> P	96-64-0	182.173	liq					
9583	Sophoricoside		C <sub>21</sub> H <sub>20</sub> O <sub>10</sub>	152-95-4	432.378		274				
9584	Sorbitan oleate		C <sub>24</sub> H <sub>44</sub> O <sub>6</sub>	1338-43-8	428.602	ye oil			0.986	1.4800 <sup>20</sup>	i H <sub>2</sub> O; s EtOH
9585	L-Sorbose	L-Sorbitose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	87-79-6	180.155	orth (al)	165		1.612 <sup>17</sup>		s H <sub>2</sub> O; sl EtOH, eth, MeOH
9586	Sparteine		C <sub>15</sub> H <sub>26</sub> N <sub>2</sub>	90-39-1	234.380		30.5	325; 173 <sup>8</sup>	1.0196 <sup>20</sup>	1.5312 <sup>20</sup>	vs eth, EtOH, chl
9587	Spinulosin		C <sub>8</sub> H <sub>8</sub> O <sub>5</sub>	85-23-4	184.147	red-bl	202.5	sub 120			sl H <sub>2</sub> O; s alk
9588	Spironolactone		C <sub>24</sub> H <sub>32</sub> O <sub>4</sub> S	52-01-7	416.574			134			
9589	Spiro[2.2]pentane		C <sub>5</sub> H <sub>8</sub>	157-40-4	68.118	liq	-107.0	39	0.7266 <sup>20</sup>	1.4120 <sup>20</sup>	
9590	Spirosolan-3-ol, (3β,5α,22β,25S)	Tomatidine	C <sub>27</sub> H <sub>45</sub> NO <sub>2</sub>	77-59-8	415.652	pl	210.5				s EtOH, eth
9591	Spirosol-5-en-3-ol, (3β,22α,25R)	Solasodine	C <sub>27</sub> H <sub>45</sub> NO <sub>2</sub>	126-17-0	413.636	hex pl (sub)	202				s EtOH, ace, bz, diox, py; sl eth; vs chl
9592	Spirostan-2,3-diol, (2α,3β,5α,25R)	Gitogenin	C <sub>27</sub> H <sub>44</sub> O <sub>4</sub>	511-96-6	432.636	lf (bz), nd (eth)	271.5				i H <sub>2</sub> O; s EtOH, chl; sl eth
9593	Spirostan-3-ol, (3β,5α,25R)	Tigogenin	C <sub>27</sub> H <sub>44</sub> O <sub>3</sub>	77-60-1	416.636	lf (al +1w) pr (ace)	205.5				s EtOH, eth, ace, ctc, MeOH, peth
9594	Spirostan-3-ol, (3β,5β,25R)	Smilagenin	C <sub>27</sub> H <sub>44</sub> O <sub>3</sub>	126-18-1	416.636	nd (ace)	185				vs ace, bz, EtOH
9595	Spirostan-3-ol, (3β,5β,25S)	Sarsasapogenin	C <sub>27</sub> H <sub>44</sub> O <sub>3</sub>	126-19-2	416.636	lo pr, nd (ace)	200.5				s EtOH, ace, bz, chl
9596	Spirostan-2,3,15-triol, (2α,3β,5α,15β,25R)	Digitogenin	C <sub>27</sub> H <sub>44</sub> O <sub>5</sub>	511-34-2	448.635	nd (al)	281.5				vs chl
9597	Spirost-5-en-3-ol, (3β,25R)	Diosgenin	C <sub>27</sub> H <sub>42</sub> O <sub>3</sub>	512-04-9	414.620	cry (ace)	205.5				vs EtOH
9598	Spiro[5.5]undecane		C <sub>11</sub> H <sub>20</sub>	180-43-8	152.277			208	0.8783 <sup>20</sup>	1.4731	
9599	S-Propyl thioacetate		C <sub>5</sub> H <sub>10</sub> OS	2307-10-0	118.197			137.9	0.9535 <sup>25</sup>		
9600	Squalene		C <sub>30</sub> H <sub>50</sub>	111-02-4	410.718	oil	-4.8	421.3; 280 <sup>17</sup>	0.8584 <sup>20</sup>	1.4990 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace, ctc
9601	Stachydrine		C <sub>7</sub> H <sub>13</sub> NO <sub>2</sub>	471-87-4	143.184	cry (w+1)	235				vs H <sub>2</sub> O, EtOH
9602	Stanozolol		C <sub>21</sub> H <sub>32</sub> N <sub>2</sub> O	10418-03-8	328.491	cry (EtOH)	≈236				
9603	Stearaldehyde		C <sub>18</sub> H <sub>36</sub> O	638-66-4	268.478	nd (peth)		261			
9604	Stearic acid	Octadecanoic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	57-11-4	284.478	mcl lf (al)	69.3	dec 350; 232 <sup>15</sup>	0.9408 <sup>20</sup>	1.4299 <sup>80</sup>	i H <sub>2</sub> O; sl EtOH, bz; s ace, chl, CS <sub>2</sub>
9605	Stearic acid anhydride	Octadecanoic anhydride	C <sub>36</sub> H <sub>70</sub> O <sub>3</sub>	638-08-4	550.939		72		0.8365 <sup>82</sup>	1.4362 <sup>80</sup>	i H <sub>2</sub> O, EtOH; sl eth, bz
9606	Sterigmatocystin		C <sub>18</sub> H <sub>12</sub> O <sub>6</sub>	10048-13-2	324.284	ye nd	246 dec				
9607	Stigmasta-5,7-dien-3-ol, (3β)	7-Dehydrostosterol	C <sub>29</sub> H <sub>48</sub> O	521-04-0	412.690			144.5			vs bz, eth, EtOH
9608	Stigmasta-5,22-dien-3-ol, (3β,22E)	Stigmasterol	C <sub>29</sub> H <sub>48</sub> O	83-48-7	412.690			170			vs bz, eth, EtOH
9609	Stigmastan-3-ol, (3β,5α)		C <sub>29</sub> H <sub>50</sub> O	83-45-4	416.722			144			
9610	Stigmast-5-en-3-ol, (3β,24R)	β-Sitosterol	C <sub>29</sub> H <sub>50</sub> O	83-46-5	414.706	pl (al)	137				s EtOH, eth, HOAc
9611	Stigmast-5-en-3-ol, (3β,24S)	γ-Sitosterol	C <sub>29</sub> H <sub>50</sub> O	83-47-6	414.706	cry (EtOH)	148				s EtOH
9612	cis-Stilbene	cis-1,2-Diphenylethene	C <sub>14</sub> H <sub>12</sub>	645-49-8	180.245		-5	141 <sup>12</sup>	1.0143 <sup>20</sup>	1.6130 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth, chl
9613	trans-Stilbene	trans-1,2-Diphenylethene	C <sub>14</sub> H <sub>12</sub>	103-30-0	180.245	cry (al)	124.2	307; 166 <sup>12</sup>	0.9707 <sup>20</sup>	1.6264 <sup>17</sup>	i H <sub>2</sub> O; sl EtOH, chl; vs eth, bz
9614	Streptomycin	N-Methyl-L-glucosaminidostreptosidostrep tidine	C <sub>21</sub> H <sub>39</sub> N <sub>7</sub> O <sub>12</sub>	57-92-1	581.575	hyg pow					s H <sub>2</sub> O
9615	Streptomycin sulfate		C <sub>42</sub> H <sub>84</sub> N <sub>14</sub> O <sub>36</sub> S <sub>3</sub>	3810-74-0	1457.383	pow	≈230 dec				
9616	Streptozotocin		C <sub>7</sub> H <sub>13</sub> N <sub>3</sub> O <sub>7</sub>	18883-66-4	265.221	pl	115 dec				s H <sub>2</sub> O, EtOH
9617	Strophanthidin		C <sub>23</sub> H <sub>32</sub> O <sub>6</sub>	66-28-4	404.496	orth tab (MeOH-w) lf (w+2)	173 dec				i H <sub>2</sub> O, eth; s EtOH, ace, bz, HOAc, chl

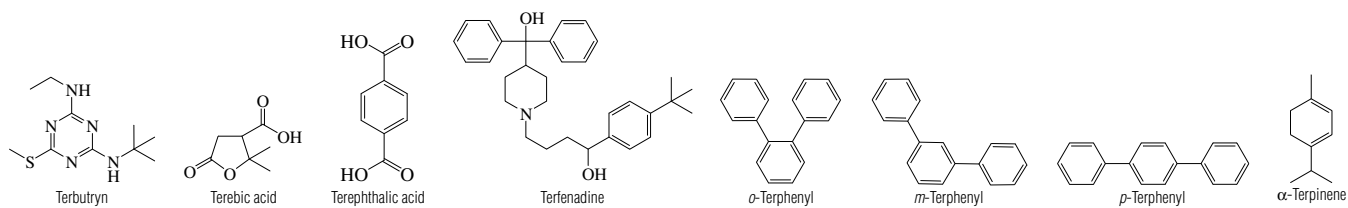
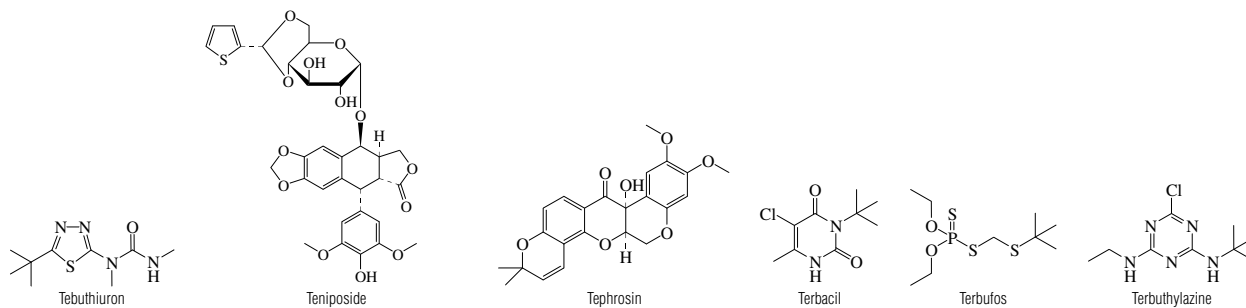
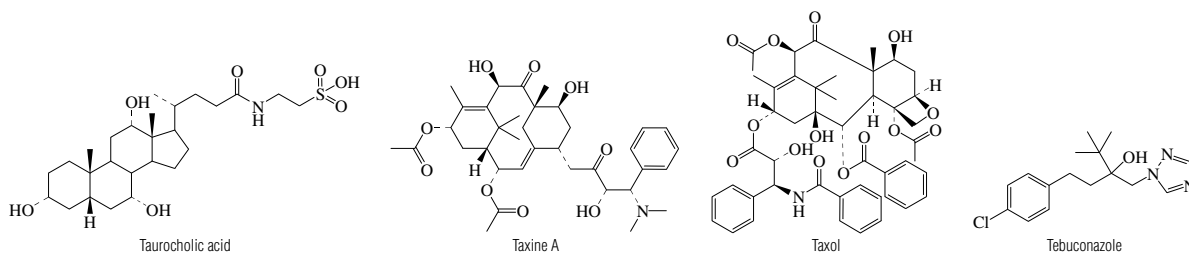
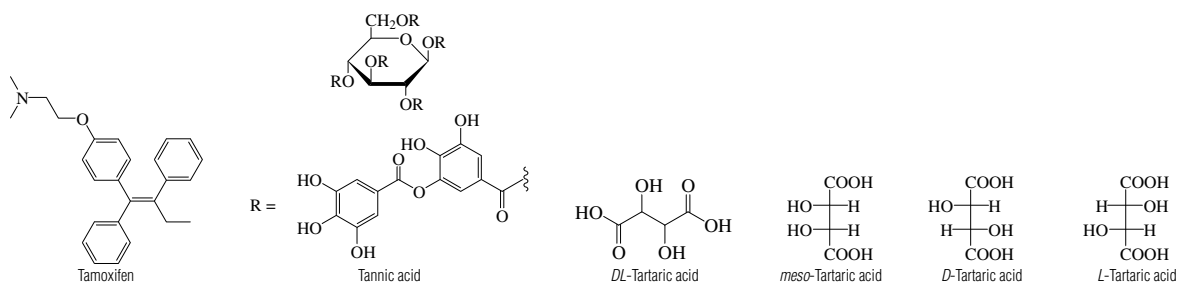
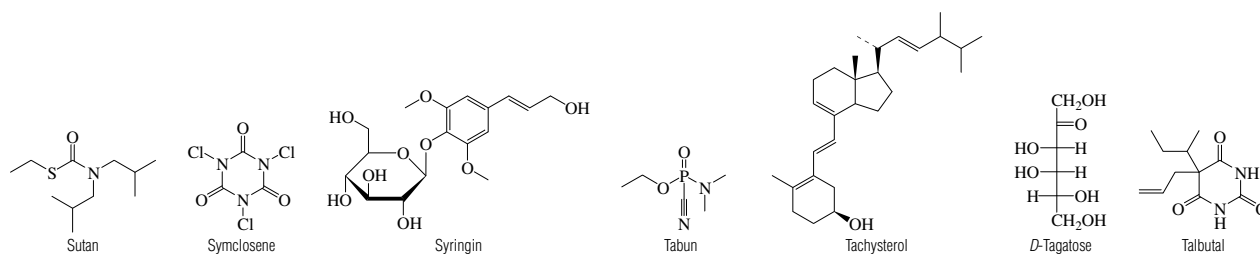
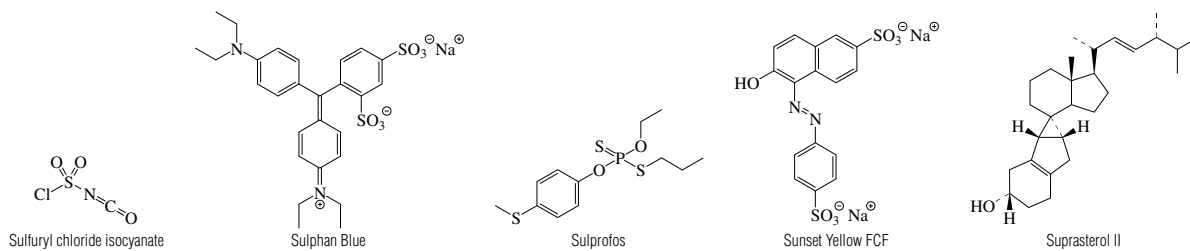
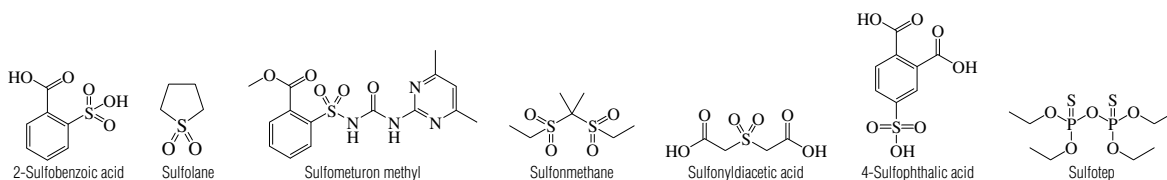




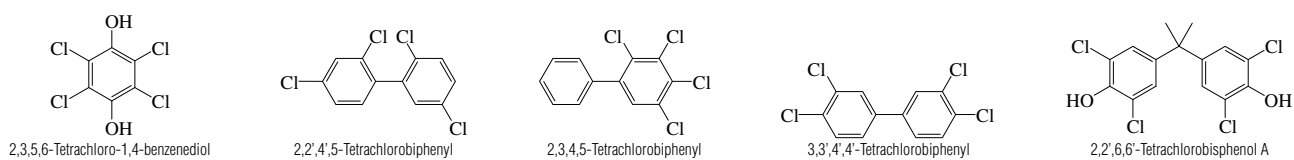
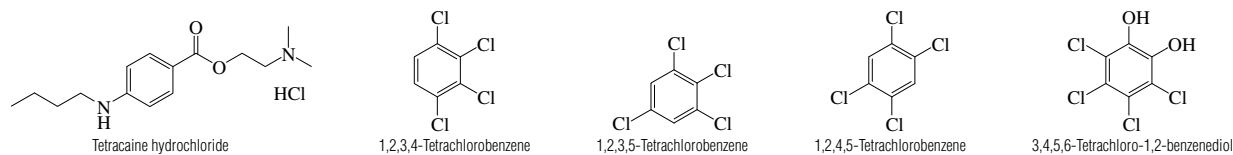
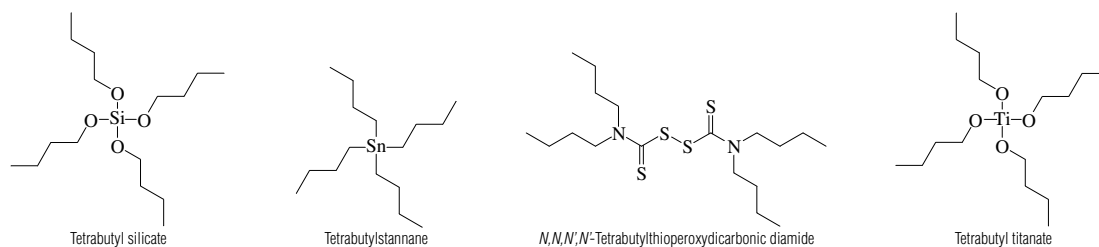
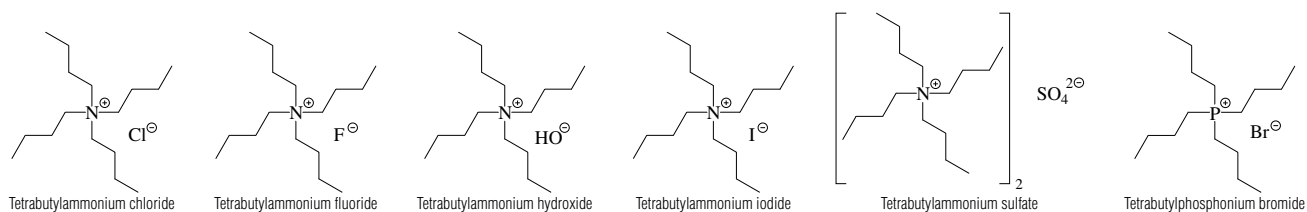
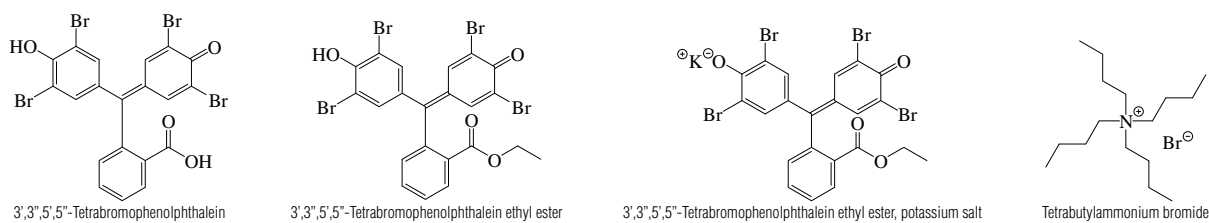
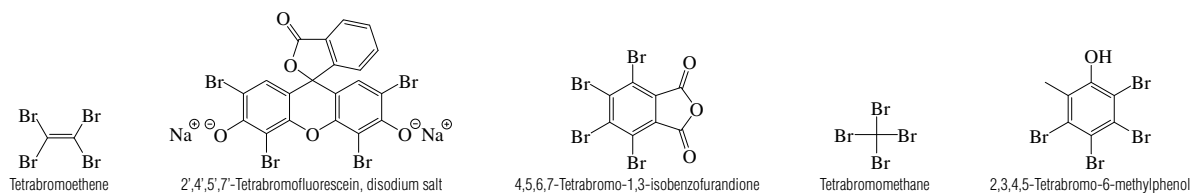
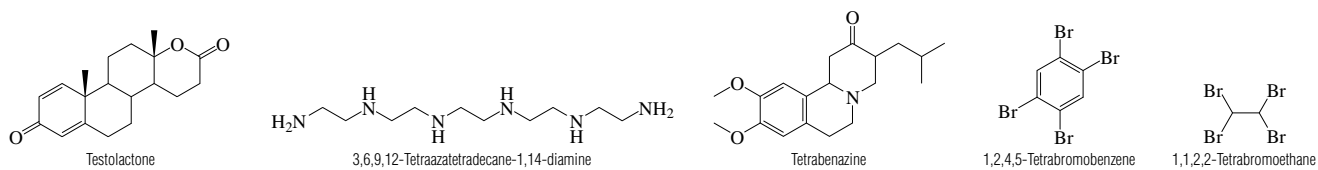
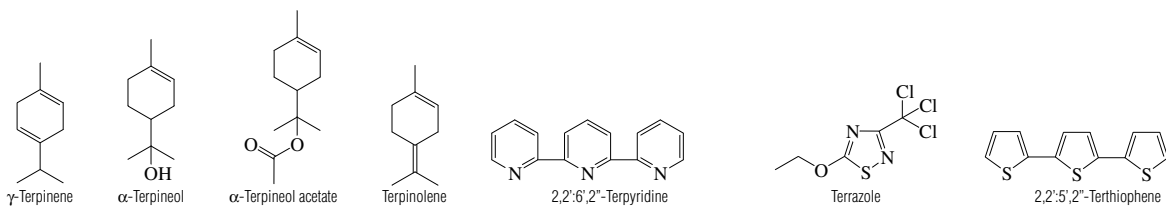
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9618	Strychnidin-10-one mononitrate	Strychnine nitrate	C <sub>21</sub> H <sub>23</sub> N <sub>3</sub> O <sub>5</sub>	66-32-0	397.425	nd (w)	295		1.627 <sup>25</sup>		vs H <sub>2</sub> O, MeOH; sl bz; s chl, EtOH
9619	Strychnidin-10-one sulfate (2:1)	Strychnine sulfate	C <sub>42</sub> H <sub>46</sub> N <sub>4</sub> O <sub>8</sub> S	60-41-3	766.901		200 dec				s H <sub>2</sub> O, EtOH, MeOH; i eth; sl chl
9620	Strychnine		C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	57-24-9	334.412	orth pr (al)	287	270 <sup>5</sup>	1.36 <sup>20</sup>		sl H <sub>2</sub> O, EtOH, ace, bz; i eth; s chl
9621	Styrene	Vinylbenzene	C <sub>8</sub> H <sub>8</sub>	100-42-5	104.150	liq	-30.65	145	0.9016 <sup>25</sup>	1.5440 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace; msc bz; sl ctc
9622	Succimer	2,3-Dimercaptobutanedioic acid, (R*,S*)	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub> S <sub>2</sub>	304-55-2	182.219	wh cry (MeOH)	193				
9623	Succinamide		C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	110-14-5	116.119	orth nd (w)	268 dec	sub 125			s H <sub>2</sub> O
9624	Succinic acid		C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	110-15-6	118.089	tcl or mcl pr	187.9	dec 235	1.572 <sup>25</sup>	1.450	sl H <sub>2</sub> O, DMSO; s EtOH, eth, ace; i bz
9625	Succinic anhydride		C <sub>6</sub> H <sub>4</sub> O <sub>3</sub>	108-30-5	100.073	nd (al), orth pym (chl)	119	261	1.2 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, chl; sl eth
9626	Succinimide		C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	123-56-8	99.089	pl (+1w, al) orth (ace)	126.5	dec 287	1.418 <sup>25</sup>		s H <sub>2</sub> O; sl EtOH, eth, ace
9627	Succinonitrile	Butanedinitrile	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	110-61-2	80.088		57.98	266	0.9867 <sup>60</sup>	1.4173 <sup>60</sup>	vs H <sub>2</sub> O; s EtOH, ace, bz, chl; sl eth
9628	Succinylcholine chloride	Suxamethonium chloride	C <sub>14</sub> H <sub>30</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	71-27-2	361.305	cry (w)	190				sl EtOH, bz, chl; i eth
9629	Succinylsulphathiazole		C <sub>13</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> S <sub>2</sub>	116-43-8	355.389	cry	193.5				i H <sub>2</sub> O, eth, chl; sl EtOH, ace; s alk
9630	Sucralfate		C <sub>12</sub> H <sub>54</sub> Al <sub>16</sub> O <sub>75</sub> S <sub>8</sub>	54182-58-0	2086.737	wh amorp pow					i H <sub>2</sub> O, EtOH, chl; s dil HCl, alk
9631	Sucrose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	57-50-1	342.296	mcl	185.5		1.5805 <sup>17</sup>	1.5376	s H <sub>2</sub> O, py; sl EtOH; i eth
9632	Sucrose monohexadecanoate	Sucrose palmitate	C <sub>28</sub> H <sub>52</sub> O <sub>12</sub>	26446-38-8	580.706	cry	61				s H <sub>2</sub> O
9633	Sucrose octaacetate		C <sub>28</sub> H <sub>38</sub> O <sub>19</sub>	126-14-7	678.591	nd (al)	86.5	250 <sup>1</sup>	1.27 <sup>16</sup>	1.4660	sl H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
9634	Sufentanil		C <sub>22</sub> H <sub>30</sub> N <sub>2</sub> O <sub>2</sub> S	56030-54-7	386.550	cry (peth)	96.6				
9635	Sulfabenzamide	<i>N</i> -[(4-Aminophenyl)sulfonyl] benzamide	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub> S	127-71-9	276.310	hex pr (60% al)	181.5				
9636	Sulfachlorpyridazine		C <sub>10</sub> H <sub>9</sub> ClN <sub>4</sub> O <sub>3</sub> S	80-32-0	284.722		187				
9637	Sulfacytine		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub> S	17784-12-2	294.329	cry (MeOH/ BuOH)	167				i H <sub>2</sub> O; s alk
9638	Sulfadimethoxine		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>4</sub> S	122-11-2	310.329		203.5				
9639	Sulfaguandine		C <sub>7</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S	57-67-0	214.245	nd (w)	191.5				
9640	Sulfallate	Carbamodithioic acid, diethyl-, 2-chloro-2-propenyl ester	C <sub>8</sub> H <sub>14</sub> ClNS <sub>2</sub>	95-06-7	223.787			129 <sup>1</sup>	1.088		
9641	Sulfamerazine		C <sub>11</sub> H <sub>12</sub> N <sub>4</sub> O <sub>2</sub> S	127-79-7	264.304	cry	236				sl H <sub>2</sub> O, EtOH, ace, DMSO; i eth, chl
9642	Sulfamethazine		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub> S	57-68-1	278.330	pa ye (w+/ 2) cry (diox-w)	198.5				s H <sub>2</sub> O, acid, alk; sl DMSO
9643	Sulfamethiazole		C <sub>9</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub> S <sub>2</sub>	144-82-1	270.331	cry (w)	210				sl hot H <sub>2</sub> O
9644	Sulfamethoxazole		C <sub>10</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub> S	723-46-6	253.277	ye-wh pow	171				i eth
9645	Sulfamethoxypyridazine		C <sub>11</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub> S	80-35-3	280.303		182.5				
9646	Sulfamethylthiazole		C <sub>10</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	515-59-3	269.343		237				vs EtOH
9647	<i>N</i> -Sulfanilylsulfanilamide	4-Amino- <i>N</i> -[4-(aminosulfonyl) phenyl]benzenesulfonamide	C <sub>12</sub> H <sub>13</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	547-52-4	327.379		137				sl H <sub>2</sub> O; s EtOH, eth, ace; i chl, peth
9648	Sulfanilylurea		C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> O <sub>3</sub> S	547-44-4	215.229	cry (w)	147 dec				
9649	Sulfaphenazole		C <sub>15</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub> S	526-08-9	314.363	cry (EtOH)	181				sl EtOH, MeOH, gl HOAc
9650	Sulfasalazine		C <sub>18</sub> H <sub>14</sub> N <sub>4</sub> O <sub>5</sub> S	599-79-1	398.393		220 dec				
9651	Sulfathiazole	4-Amino- <i>N</i> -2- thiazolylbenzenesulfonamide	C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	72-14-0	255.316	br pl, rods or pow (45% al)	175(form a); 202(form b)				sl H <sub>2</sub> O, EtOH, DMSO
9652	Sulfathiourea		C <sub>7</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	515-49-1	231.295		182				i H <sub>2</sub> O; sl EtOH
9653	Sulfinyprazole		C <sub>23</sub> H <sub>20</sub> N <sub>2</sub> O <sub>3</sub> S	57-96-5	404.481		137				
9654	<i>N</i> -Sulfinylaniline		C <sub>8</sub> H <sub>9</sub> NOS	1122-83-4	139.175			200	1.236 <sup>25</sup>	1.6270 <sup>20</sup>	
9655	Sulfisoxazole		C <sub>11</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> S	127-69-5	267.304	ye-wh pow	191				sl H <sub>2</sub> O
9656	Sulfoacetic acid		C <sub>2</sub> H <sub>3</sub> O <sub>3</sub> S	123-43-3	140.115	hyg tab (w+1)	85	dec 245			vs H <sub>2</sub> O, ace, EtOH



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9657	2-Sulfobenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub> S	632-25-7	202.185	nd (w+3)	141				vs H <sub>2</sub> O, EtOH
9658	Sulfolane	Tetrahydrothiophene, 1-1-dioxide	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	126-33-0	120.171		27.6	287.3	1.2723 <sup>18</sup>	1.4833 <sup>18</sup>	s chl
9659	Sulfometuron methyl		C <sub>13</sub> H <sub>16</sub> N <sub>4</sub> O <sub>5</sub> S	74222-97-2	364.377	wh solid	202				
9660	Sulfonmethane	2,2-Bis(ethylsulfonyl)propane	C <sub>7</sub> H <sub>16</sub> O <sub>4</sub> S <sub>2</sub>	115-24-2	228.330	mcl (w), pr (al)	125.8	dec 300			vs bz, EtOH, chl
9661	Sulfonyldiacetic acid		C <sub>4</sub> H <sub>6</sub> O <sub>6</sub> S	123-45-5	182.152		187				vs H <sub>2</sub> O, EtOH; s eth, sulf
9662	4-Sulphthalic acid	4-Sulfo-1,2-benzenedicarboxylic acid	C <sub>8</sub> H <sub>6</sub> O <sub>7</sub> S	89-08-7	246.195	cry	139				
9663	Sulfotep		C <sub>8</sub> H <sub>20</sub> O <sub>5</sub> P <sub>2</sub> S <sub>2</sub>	3689-24-5	322.320			137 <sup>2</sup>	1.196 <sup>25</sup>	1.4753 <sup>25</sup>	i H <sub>2</sub> O; s EtOH
9664	Sulfuryl chloride isocyanate		CCINO <sub>2</sub> S	1189-71-5	141.534	liq	-44	107	1.626 <sup>25</sup>	1.4467 <sup>20</sup>	
9665	Sulphan Blue		C <sub>27</sub> H <sub>31</sub> N <sub>2</sub> NaO <sub>6</sub> S <sub>2</sub>	129-17-9	566.664	viol pow					s EtOH
9666	Sulprofos		C <sub>12</sub> H <sub>19</sub> O <sub>2</sub> PS <sub>3</sub>	35400-43-2	322.447			156 <sup>0.1</sup>	1.20 <sup>20</sup>	1.5859	sl H <sub>2</sub> O
9667	Sunset Yellow FCF	C.I. Food Yellow 3	C <sub>18</sub> H <sub>10</sub> N <sub>2</sub> Na <sub>2</sub> O <sub>7</sub> S <sub>2</sub>	2783-94-0	452.369	cry	>300				s H <sub>2</sub> O; sl EtOH
9668	Suprasterol II		C <sub>28</sub> H <sub>44</sub> O	562-71-0	396.648	pr	110	190 <sup>0.005</sup>			s MeOH
9669	Sutan	Carbamothioic acid, bis(2-methylpropyl)-, S-ethyl ester	C <sub>11</sub> H <sub>23</sub> NOS	2008-41-5	217.372			138 <sup>21</sup>	0.9402 <sup>25</sup>		
9670	Symclosene	1,3,5-Trichloro-1,3,5-triazine-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-trione	C <sub>3</sub> Cl <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	87-90-1	232.409		246.7	dec			
9671	Syringin		C <sub>17</sub> H <sub>24</sub> O <sub>3</sub>	118-34-3	372.368	cry (w), nd (al)	192				vs EtOH
9672	Tabun	Dimethylphosphoroamidocyanidic acid, ethyl ester	C <sub>5</sub> H <sub>11</sub> N <sub>2</sub> O <sub>2</sub> P	77-81-6	162.127	liq	-50	240	1.077	1.4250 <sup>20</sup>	msc H <sub>2</sub> O
9673	Tachysterol	9,10-Secoergosta-5(10),6,8,22-tetraen-3-ol, (3β,6 <i>E</i> ,22 <i>E</i> )-	C <sub>28</sub> H <sub>44</sub> O	115-61-7	396.648						i H <sub>2</sub> O, MeOH; s EtOH, eth, ace, bz
9674	D-Tagatose		C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	87-81-0	180.155	cry (dil al)	134.5				vs H <sub>2</sub> O
9675	Talbutal		C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	115-44-6	224.256	cry	109				i H <sub>2</sub> O, peth; s EtOH, ace, eth, chl
9676	Tamoxifen		C <sub>26</sub> H <sub>28</sub> NO	10540-29-1	371.514	cry (peth)	97				
9677	Tannic acid	Tannin	C <sub>76</sub> H <sub>52</sub> O <sub>46</sub>	1401-55-4	1701.198	ye-br amorp pow	≈210	dec			vs EtOH, ace; i bz, chl, eth, ctc
9678	DL-Tartaric acid	2,3-Dihydroxybutanedioic acid, (R*, R*)-(±)-	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	133-37-9	150.087	mcl pr (w, al +1w)	206		1.788 <sup>25</sup>		s H <sub>2</sub> O, EtOH; sl eth; i bz
9679	meso-Tartaric acid		C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	147-73-9	150.087	tcl pl (w)	147		1.666 <sup>20</sup>		vs H <sub>2</sub> O, EtOH
9680	D-Tartaric acid	2,3-Dihydroxybutanedioic acid, [S-(R*, R*)]-	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	147-71-7	150.087	mcl, orth pr (w+1)	172.5		1.7598 <sup>20</sup>	1.4955 <sup>20</sup>	sl DMSO
9681	L-Tartaric acid	2,3-Dihydroxybutanedioic acid, [R-(R*, R*)]-	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	87-69-4	150.087		169				
9682	Taurocholic acid	Cholaic acid	C <sub>26</sub> H <sub>45</sub> NO <sub>7</sub> S	81-24-3	515.703	pr (al-eth)	125	dec			vs H <sub>2</sub> O, EtOH; sl eth, AcOEt
9683	Taxine A		C <sub>35</sub> H <sub>47</sub> NO <sub>10</sub>	1361-49-5	641.749	cry (ace)	205				i H <sub>2</sub> O; s EtOH, eth, chl
9684	Taxol	Pacitaxel	C <sub>47</sub> H <sub>51</sub> NO <sub>14</sub>	33069-62-4	853.907	nd (MeOH aq)	214	dec			
9685	Tebuconazole		C <sub>16</sub> H <sub>23</sub> ClN <sub>3</sub> O	107534-96-3	308.826		102.4				
9686	Tebuthiuron		C <sub>9</sub> H <sub>16</sub> N <sub>4</sub> OS	34014-18-1	228.314		163	dec			
9687	Teniposide		C <sub>32</sub> H <sub>32</sub> O <sub>13</sub> S	29767-20-2	656.653	cry (EtOH)	244				
9688	Tephrosin		C <sub>23</sub> H <sub>22</sub> O <sub>7</sub>	76-80-2	410.417	pr (chl-MeOH)	198				vs ace, eth, chl
9689	Terbacil	5-Chloro-3- <i>tert</i> -butyl-6-methyl-2,4(1 <i>H</i> ,3 <i>H</i> )-pyrimidinedione	C <sub>8</sub> H <sub>13</sub> ClN <sub>2</sub> O <sub>2</sub>	5902-51-2	216.664		176	sub 175	1.34 <sup>25</sup>		
9690	Terbufos		C <sub>9</sub> H <sub>21</sub> O <sub>2</sub> PS <sub>3</sub>	13071-79-9	288.431		-29.2	69 <sup>0.01</sup>	1.105 <sup>24</sup>		
9691	Terbutylazine	6-Chloro- <i>N-tert</i> -butyl- <i>N'</i> -ethyl-1,3,5-triazine-2,4-diamine	C <sub>9</sub> H <sub>16</sub> ClN <sub>6</sub>	5915-41-3	229.710		178		1.188 <sup>20</sup>		
9692	Terbutryn		C <sub>10</sub> H <sub>19</sub> N <sub>3</sub> S	886-50-0	241.357		104	157 <sup>0.06</sup>	1.115 <sup>20</sup>		
9693	Terebic acid	Tetrahydro-2,2-dimethyl-5-oxo-3-furancarboxylic acid	C <sub>7</sub> H <sub>10</sub> O <sub>4</sub>	79-91-4	158.152	cry	175		0.815		sl H <sub>2</sub> O; s EtOH
9694	Terephthalic acid	1,4-Benzenedicarboxylic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	100-21-0	166.132	nd (sub)		sub 300			i H <sub>2</sub> O, EtOH, eth, chl, HOAc; sl ctc
9695	Terfenadine	Seldane	C <sub>32</sub> H <sub>41</sub> NO <sub>2</sub>	50679-08-8	471.674		147				i H <sub>2</sub> O; s EtOH; sl hx
9696	<i>o</i> -Terphenyl		C <sub>18</sub> H <sub>14</sub>	84-15-1	230.304	mcl pr (MeOH)	56.20	332			i H <sub>2</sub> O; s ace, bz, chl, MeOH
9697	<i>m</i> -Terphenyl		C <sub>18</sub> H <sub>14</sub>	92-06-8	230.304	ye nd (al)	87	363	1.199 <sup>20</sup>		i H <sub>2</sub> O; s EtOH, eth, bz, HOAc; sl chl
9698	<i>p</i> -Terphenyl		C <sub>18</sub> H <sub>14</sub>	92-94-4	230.304		213.9	376			i H <sub>2</sub> O; sl EtOH; s eth, bz, CS <sub>2</sub>
9699	$\alpha$ -Terpinene	4-Isopropyl-1-methyl-1,3-cyclohexadiene	C <sub>10</sub> H <sub>16</sub>	99-86-5	136.234			174	0.8375 <sup>19</sup>	1.477 <sup>19</sup>	i H <sub>2</sub> O; msc EtOH, eth

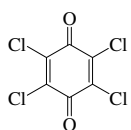


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9700	γ-Terpinene		C <sub>10</sub> H <sub>16</sub>	99-85-4	136.234			183	0.849 <sup>20</sup>	1.4765 <sup>14</sup>	
9701	α-Terpineol		C <sub>10</sub> H <sub>18</sub> O	2438-12-2	154.249	cry (peth)	40.5	220	0.9337 <sup>20</sup>	1.4831 <sup>20</sup>	sl H <sub>2</sub> O; vs ace, bz, eth, EtOH
9702	α-Terpineol acetate		C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	80-26-2	196.286			140 <sup>40</sup> , 105 <sup>11</sup>	0.9659 <sup>21</sup>	1.4689 <sup>21</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
9703	Terpinolene	ρ-Mentha-1,4(8)-diene	C <sub>10</sub> H <sub>16</sub>	586-62-9	136.234			186	0.8632 <sup>15</sup>	1.4883 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s bz, ctc
9704	2,2':6',2"-Terpyridine		C <sub>15</sub> H <sub>11</sub> N <sub>3</sub>	1148-79-4	233.268		88.0	370			
9705	Terrazole	1,2,4-Thiadiazole, 5-ethoxy-3-(trichloromethyl)-	C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> N <sub>2</sub> OS	2593-15-9	247.530		19.9	95 <sup>1</sup>	1.503 <sup>25</sup>		
9706	2,2':5',2"-Terthiophene	α-Terthienyl	C <sub>12</sub> H <sub>6</sub> S <sub>3</sub>	1081-34-1	248.387	ye-oran pl (MeOH)	93				i H <sub>2</sub> O; sl EtOH; s bz, eth, ace, peth
9707	Testolactone		C <sub>19</sub> H <sub>24</sub> O <sub>3</sub>	968-93-4	300.392	cry (ace)	218				
9708	3,6,9,12-Tetraazatetradecane-1,14-diamine	Pentaethylenehexamine	C <sub>10</sub> H <sub>28</sub> N <sub>6</sub>	4067-16-7	232.369	liq			0.950	1.5096 <sup>20</sup>	
9709	Tetrabenazine		C <sub>19</sub> H <sub>27</sub> NO <sub>3</sub>	58-46-8	317.422		128				s chl
9710	1,2,4,5-Tetrabromobenzene		C <sub>6</sub> H <sub>2</sub> Br <sub>4</sub>	636-28-2	393.696	mcl pr (CS <sub>2</sub> )	182	3.1 <sup>20</sup>	3.072 <sup>20</sup>		i H <sub>2</sub> O; vs eth
9711	1,1,2,2-Tetrabromoethane	Acetylene tetrabromide	C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	79-27-6	345.653	ye visc liq	0	243.5; 151 <sup>54</sup>	2.9655 <sup>20</sup>	1.6353 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, bz; sl ctc
9712	Tetrabromoethene	Tetrabromoethylene	C <sub>2</sub> Br <sub>4</sub>	79-28-7	343.637	pl (dil al), nd (al)	56.5	226			i H <sub>2</sub> O; s EtOH, eth, ace; vs chl
9713	2',4',5',7'-Tetrabromofluorescein, disodium salt	Eosine YS	C <sub>20</sub> H <sub>6</sub> Br <sub>4</sub> Na <sub>2</sub> O <sub>5</sub>	17372-87-1	691.855	ye-red cry	295.5				vs EtOH
9714	4,5,6,7-Tetrabromo-1,3-isobenzofurandione		C <sub>8</sub> Br <sub>4</sub> O <sub>3</sub>	632-79-1	463.700	nd (xyl, HOAc)	280				i H <sub>2</sub> O, EtOH; sl bz; s PhNO <sub>2</sub>
9715	Tetrabromomethane	Carbon tetrabromide	CBr <sub>4</sub>	558-13-4	331.627	mcl tab (dil al)	92.3	189.5	2.9608 <sup>100</sup>	1.5942 <sup>100</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; vs CS <sub>2</sub>
9716	2,3,4,5-Tetrabromo-6-methylphenol	3,4,5,6-Tetrabromo- <i>o</i> -cresol	C <sub>7</sub> H <sub>6</sub> Br <sub>4</sub> O	576-55-6	423.722	ye nd (chl, HOAc)	208	dec			i H <sub>2</sub> O; s EtOH, eth, bz, chl; sl lig, HOAc
9717	3',3'',5',5''-Tetrabromophenolphthalein		C <sub>20</sub> H <sub>10</sub> Br <sub>4</sub> O <sub>4</sub>	76-62-0	633.907	nd (al, eth)	296				i H <sub>2</sub> O; sl EtOH; vs eth; s alk, HOAc
9718	3',3'',5',5''-Tetrabromophenolphthalein ethyl ester		C <sub>22</sub> H <sub>14</sub> Br <sub>4</sub> O <sub>4</sub>	1176-74-5	661.960	ye cry (bz)	210				
9719	3',3'',5',5''-Tetrabromophenolphthalein ethyl ester, potassium salt		C <sub>22</sub> H <sub>13</sub> Br <sub>4</sub> KO <sub>4</sub>	62637-91-6	700.050		210				
9720	Tetrabutylammonium bromide	TMAB	C <sub>16</sub> H <sub>36</sub> BrN	1643-19-2	322.368		99				s chl
9721	Tetrabutylammonium chloride		C <sub>16</sub> H <sub>36</sub> ClN	1112-67-0	277.917	cry	74				
9722	Tetrabutylammonium fluoride		C <sub>16</sub> H <sub>36</sub> FN	429-41-4	261.462	cry (w)	37				
9723	Tetrabutylammonium hydroxide		C <sub>16</sub> H <sub>37</sub> NO	2052-49-5	259.471	stab in soln					s H <sub>2</sub> O, MeOH
9724	Tetrabutylammonium iodide		C <sub>16</sub> H <sub>36</sub> IN	311-28-4	369.368	lf (w, bz)	148				sl H <sub>2</sub> O, chl; vs EtOH
9725	Tetrabutylammonium sulfate		C <sub>32</sub> H <sub>72</sub> N <sub>2</sub> O <sub>4</sub> S	32503-27-8	580.990		170				sl chl
9726	Tetrabutylphosphonium bromide		C <sub>16</sub> H <sub>36</sub> BrP	3115-68-2	339.335	cry (ace/eth)	102				
9727	Tetrabutyl silicate	Silicic acid, tetrabutyl ester	C <sub>16</sub> H <sub>36</sub> O <sub>4</sub> Si	4766-57-8	320.541			256; 120 <sup>3</sup>	0.8990 <sup>20</sup>	1.4128 <sup>20</sup>	
9728	Tetrabutylstannane		C <sub>16</sub> H <sub>36</sub> Sn	1461-25-2	347.167	liq	-97	145 <sup>10</sup> , 95 <sup>0,28</sup>	1.06 <sup>20</sup>		
9729	<i>N,N,N,N'</i> -Tetrabutylthioperoxydicarbonic diamide	Bis(dibutylthiocarbonyl) disulfide	C <sub>18</sub> H <sub>36</sub> N <sub>2</sub> S <sub>4</sub>	1634-02-2	408.752		39.5		1.03 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth
9730	Tetrabutyl titanate	Titanium(IV) butoxide	C <sub>16</sub> H <sub>36</sub> O <sub>4</sub> Ti	5593-70-4	340.322			292.4			
9731	Tetracaine hydrochloride		C <sub>15</sub> H <sub>25</sub> ClN <sub>2</sub> O <sub>2</sub>	136-47-0	300.825		147				
9732	1,2,3,4-Tetrachlorobenzene		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	634-66-2	215.892	nd (al)	47.5	254			i H <sub>2</sub> O; sl EtOH; vs eth, CS <sub>2</sub>
9733	1,2,3,5-Tetrachlorobenzene		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	634-90-2	215.892	nd (al)	54.5	246			i H <sub>2</sub> O
9734	1,2,4,5-Tetrachlorobenzene		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	95-94-3	215.892	nd, mcl pr (eth, al or bz)	139.5	244.5	1.858 <sup>22</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz, chl, CS <sub>2</sub>
9735	3,4,5,6-Tetrachloro-1,2-benzenediol		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub> O <sub>2</sub>	1198-55-6	247.891	cry (dil al, bz)	194				sl H <sub>2</sub> O
9736	2,3,5,6-Tetrachloro-1,4-benzenediol		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub> O <sub>2</sub>	87-87-6	247.891	nd (HOAc)		sub			i H <sub>2</sub> O, bz, ctc; vs EtOH, eth; sl HOAc
9737	2,2',4',5'-Tetrachlorobiphenyl		C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub>	41464-40-8	291.988	cry (MeOH)	66.5				i H <sub>2</sub> O
9738	2,3,4,5-Tetrachlorobiphenyl		C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub>	33284-53-6	291.988	cry	92.2				i H <sub>2</sub> O
9739	3,3',4',4'-Tetrachlorobiphenyl		C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub>	32598-13-3	291.988	cry (EtOH)	180				
9740	2,2',6,6'-Tetrachlorobisphenol A		C <sub>15</sub> H <sub>12</sub> Cl <sub>4</sub> O <sub>2</sub>	79-95-8	366.067	cry (HOAc)	136				

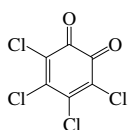


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9741	2,3,5,6-Tetrachloro-2,5-cyclohexadiene-1,4-dione	Chloranil	C <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub>	118-75-2	245.875	ye mcl, pr (bz) ye lf (HOAc)	290	sub			i H <sub>2</sub> O, liq; sl EtOH, chl; s eth
9742	3,4,5,6-Tetrachloro-3,5-cyclohexadiene-1,2-dione		C <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub>	2435-53-2	245.875		130.5				
9743	2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin	Dioxin	C <sub>12</sub> H <sub>4</sub> Cl <sub>4</sub> O <sub>2</sub>	1746-01-6	321.971	nd	295				
9744	2,3,7,8-Tetrachlorodibenzofuran		C <sub>12</sub> H <sub>4</sub> Cl <sub>4</sub> O	51207-31-9	305.971	cry	227				
9745	1,1,1,2-Tetrachloro-2,2-difluoroethane		C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	76-11-9	203.830		41.0	92.8	1.649 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, chl
9746	1,1,2,2-Tetrachloro-1,2-difluoroethane		C <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	76-12-0	203.830		24.8	92.8	1.5951 <sup>50</sup>	1.4130 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
9747	1,2,3,4-Tetrachloro-5,5-dimethoxy-1,3-cyclopentadiene		C <sub>7</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub>	2207-27-4	263.934			109	1.501 <sup>25</sup>	1.5282 <sup>20</sup>	
9748	1,2,3,4-Tetrachloro-5,6-dimethylbenzene		C <sub>8</sub> H <sub>6</sub> Cl <sub>4</sub>	877-08-7	243.946		228				i H <sub>2</sub> O; s EtOH, eth, bz
9749	1,2,3,5-Tetrachloro-4,6-dimethylbenzene		C <sub>8</sub> H <sub>6</sub> Cl <sub>4</sub>	877-09-8	243.946		223		1.703 <sup>25</sup>		i H <sub>2</sub> O, EtOH, eth, bz, chl
9750	1,1,2,2-Tetrachloro-1,2-dimethyldisilane		C <sub>2</sub> H <sub>6</sub> Cl <sub>4</sub> Si <sub>2</sub>	4518-98-3	228.052			154			
9751	1,1,1,2-Tetrachloroethane		C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	630-20-6	167.849	liq	-70.2	130.2	1.5406 <sup>20</sup>	1.4821 <sup>20</sup>	sl H <sub>2</sub> O; s ace, bz, chl; msc EtOH, eth
9752	1,1,2,2-Tetrachloroethane	Acetylene tetrachloride	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	79-34-5	167.849	liq	-42.4	145.2	1.5953 <sup>20</sup>	1.4940 <sup>20</sup>	sl H <sub>2</sub> O; s ace, bz, chl; msc EtOH, eth
9753	Tetrachloroethene	Perchloroethylene	C <sub>2</sub> Cl <sub>4</sub>	127-18-4	165.833	liq	-22.3	121.3	1.6230 <sup>20</sup>	1.5059 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
9754	1,1,1,2-Tetrachloro-2-fluoroethane		C <sub>2</sub> HCl <sub>3</sub> F	354-11-0	185.839	liq	-95.3	117.1			
9755	1,1,2,2-Tetrachloro-1-fluoroethane		C <sub>2</sub> HCl <sub>2</sub> F	354-14-3	185.839	liq	-82.6	116.7	1.5497 <sup>17</sup>	1.4390 <sup>20</sup>	
9756	Tetrachloromethane	Carbon tetrachloride	CCl <sub>4</sub>	56-23-5	153.823	liq	-22.62	76.8	1.5940 <sup>20</sup>	1.4601 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace; msc eth, bz, chl
9757	2,3,5,6-Tetrachloro-4-methoxyphenol	Drosophilin A	C <sub>7</sub> H <sub>4</sub> Cl <sub>4</sub> O <sub>2</sub>	484-67-3	261.918		116				
9758	2,3,4,6-Tetrachloro-5-methylphenol		C <sub>7</sub> H <sub>4</sub> Cl <sub>4</sub> O	10460-33-0	245.918	nd (peth)	189.5				i H <sub>2</sub> O; s EtOH, eth, ace, bz, KOH
9759	1,2,3,4-Tetrachloronaphthalene		C <sub>10</sub> H <sub>4</sub> Cl <sub>4</sub>	20020-02-4	265.951		199				
9760	1,2,3,4-Tetrachloro-5-nitrobenzene		C <sub>6</sub> HCl <sub>4</sub> NO <sub>2</sub>	879-39-0	260.890		66				
9761	1,2,4,5-Tetrachloro-3-nitrobenzene		C <sub>6</sub> HCl <sub>4</sub> NO <sub>2</sub>	117-18-0	260.890		99.5	304	1.744 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, bz, chl
9762	2,3,4,5-Tetrachlorophenol		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub> O	4901-51-3	231.891	nd (peth, sub)	116.5	sub			vs EtOH
9763	2,3,4,6-Tetrachlorophenol		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub> O	58-90-2	231.891	nd (lig)	70	150 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, bz, chl, HOAc; vs NaOH
9764	2,3,5,6-Tetrachlorophenol		C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub> O	935-95-5	231.891	lf (lig)	115				sl H <sub>2</sub> O; vs bz; s lig
9765	Tetrachlorophthalic anhydride		C <sub>6</sub> Cl <sub>4</sub> O <sub>3</sub>	117-08-8	285.896		254.5	sub	1.49 <sup>275</sup>		sl eth
9766	1,1,1,2-Tetrachloropropane		C <sub>3</sub> H <sub>3</sub> Cl <sub>4</sub>	812-03-3	181.876	liq	-64	152.5	1.473 <sup>20</sup>	1.4867 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth, chl
9767	1,1,1,3-Tetrachloropropane		C <sub>3</sub> H <sub>3</sub> Cl <sub>4</sub>	1070-78-6	181.876			157	1.4509 <sup>20</sup>	1.4825 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, chl
9768	1,1,2,3-Tetrachloropropane		C <sub>3</sub> H <sub>3</sub> Cl <sub>4</sub>	18495-30-2	181.876			179.5	1.513 <sup>17</sup>	1.5037 <sup>17</sup>	i H <sub>2</sub> O; s EtOH, chl; vs eth
9769	1,2,2,3-Tetrachloropropane		C <sub>3</sub> H <sub>3</sub> Cl <sub>4</sub>	13116-53-5	181.876			165	1.500 <sup>18</sup>	1.4940 <sup>18</sup>	i H <sub>2</sub> O; vs EtOH, eth; s chl
9770	1,1,2,3-Tetrachloropropene		C <sub>3</sub> H <sub>2</sub> Cl <sub>4</sub>	10436-39-2	179.860	liq		167.2; 59 <sup>17</sup>	1.55 <sup>20</sup>		
9771	2,3,5,6-Tetrachloropyridine		C <sub>5</sub> HCl <sub>4</sub> N	2402-79-1	216.881	cry (aq al)	90.5	250.5			vs eth, EtOH, peth
9772	Tetrachloropyrimidine		C <sub>4</sub> Cl <sub>4</sub> N <sub>2</sub>	1780-40-1	217.868		69.0				
9773	3,3',4',5'-Tetrachlorosalicylanilide	3,5-Dichloro- <i>N</i> -(3,4-dichlorophenyl)-2-hydroxybenzamide	C <sub>13</sub> H <sub>7</sub> Cl <sub>4</sub> NO <sub>2</sub>	1154-59-2	351.013		161				
9774	2,3,5,6-Tetrachloro-terphthaloyl dichloride		C <sub>8</sub> Cl <sub>6</sub> O <sub>2</sub>	719-32-4	340.803	cry (ctc)	146.5				
9775	Tetrachlorothiophene		C <sub>4</sub> Cl <sub>4</sub> S	6012-97-1	221.920	nd (dil al)	30.5	233.4	1.7036 <sup>30</sup>	1.5915 <sup>30</sup>	i H <sub>2</sub> O; vs EtOH; msc eth
9776	Tetrachlorovinphos		C <sub>10</sub> H <sub>9</sub> Cl <sub>4</sub> O <sub>4</sub> P	961-11-5	365.961		97				
9777	Tetracontane		C <sub>40</sub> H <sub>82</sub>	4181-95-7	563.079		81.5	522; 400 <sup>50</sup>	0.8171 <sup>25</sup>	1.4572 <sup>25</sup>	
9778	Tetracosamethylundecasiloxane	Tetracosamethylundecasiloxane	C <sub>24</sub> H <sub>72</sub> O <sub>10</sub> Si <sub>11</sub>	107-53-9	829.764			322.8; 202 <sup>47</sup>	0.9247 <sup>25</sup>	1.3994 <sup>20</sup>	vs bz
9779	Tetracosane		C <sub>24</sub> H <sub>50</sub>	646-31-1	338.654	cry (eth)	50.4	391.3	0.7991 <sup>20</sup>	1.4283 <sup>70</sup>	i H <sub>2</sub> O; sl EtOH; vs eth

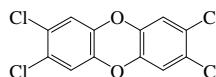
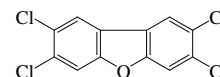




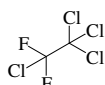
2,3,5,6-Tetrachloro-2,5-cyclohexadiene-1,4-dione



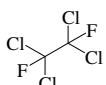
3,4,5,6-Tetrachloro-3,5-cyclohexadiene-1,2-dione

2,3,7,8-Tetrachlorodibenzo-*p*-dioxin

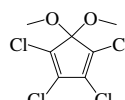
2,3,7,8-Tetrachlorodibenzofuran



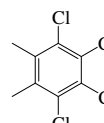
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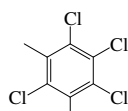
1,1,2,2-Tetrachloro-1,2-difluoroethane



1,2,3,4-Tetrachloro-5,5-dimethoxy-1,3-cyclopentadiene



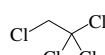
1,2,3,4-Tetrachloro-5,6-dimethylbenzene



1,2,3,5-Tetrachloro-4,6-dimethylbenzene



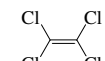
1,1,2,2-Tetrachloro-1,2-dimethyldisilane



1,1,1,2-Tetrachloroethane



1,1,2,2-Tetrachloroethane



Tetrachloroethene



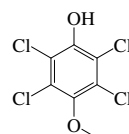
1,1,1,2-Tetrachloro-2-fluoroethane



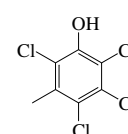
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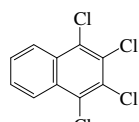
Tetrachloromethane



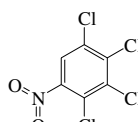
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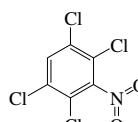
2,3,4,6-Tetrachloro-5-methylphenol



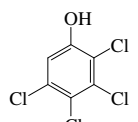
1,2,3,4-Tetrachloronaphthalene



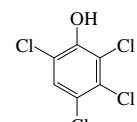
1,2,3,4-Tetrachloro-5-nitrobenzene



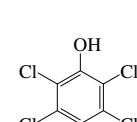
1,2,4,5-Tetrachloro-3-nitrobenzene



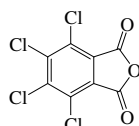
2,3,4,5-Tetrachlorophenol



2,3,4,6-Tetrachlorophenol



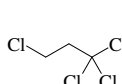
2,3,5,6-Tetrachlorophenol



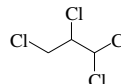
Tetrachlorophthalic anhydride



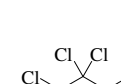
1,1,1,2-Tetrachloropropane



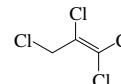
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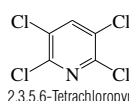
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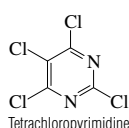
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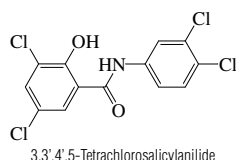
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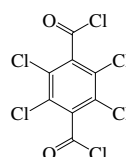
2,3,5,6-Tetrachloropyridine



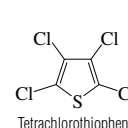
Tetrachloropyrimidine



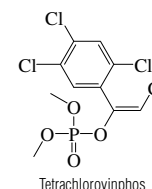
3,3',4',5'-Tetrachlorosalicylanilide



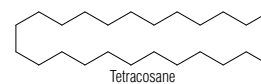
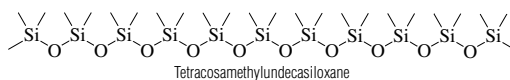
2,3,5,6-Tetrachloroterphthaloyl dichloride



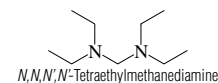
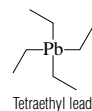
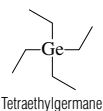
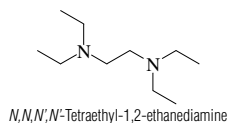
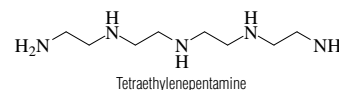
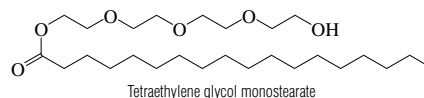
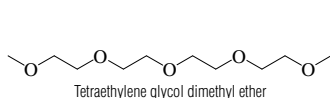
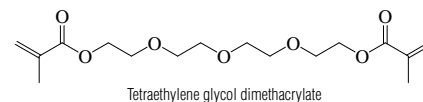
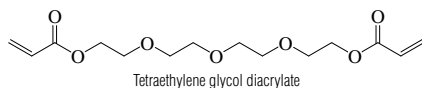
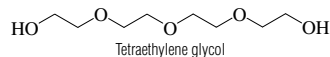
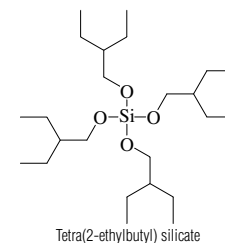
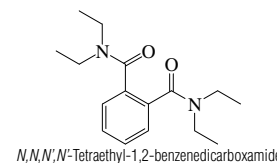
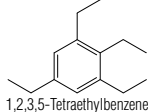
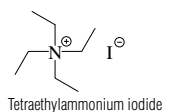
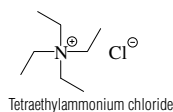
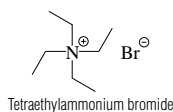
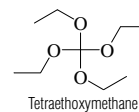
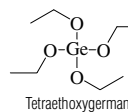
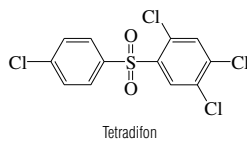
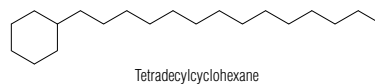
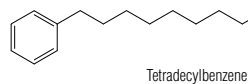
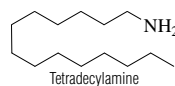
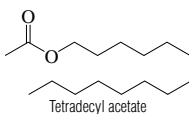
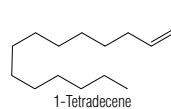
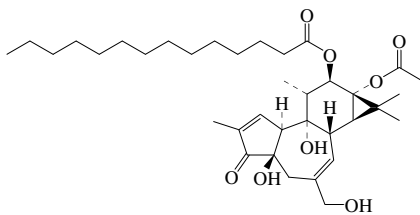
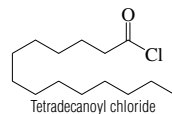
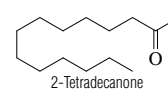
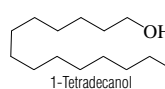
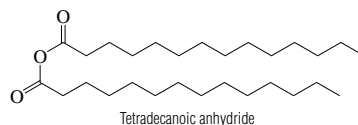
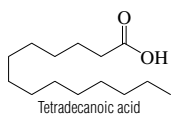
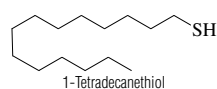
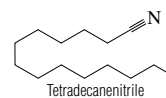
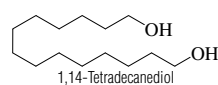
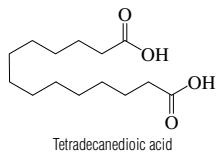
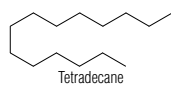
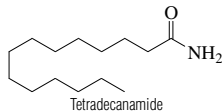
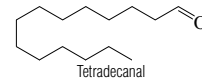
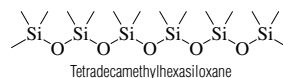
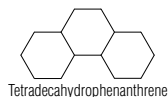
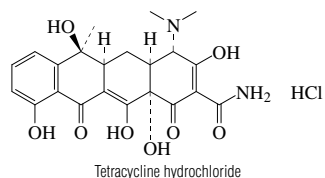
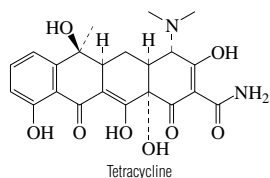
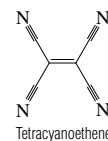
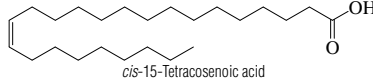
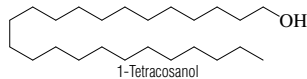
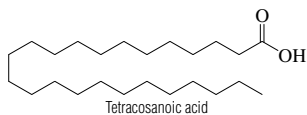
Tetrachlorothiophene



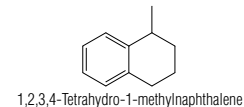
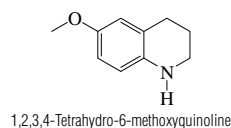
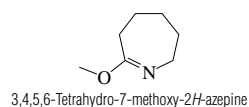
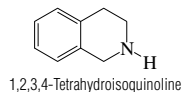
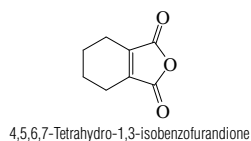
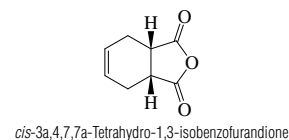
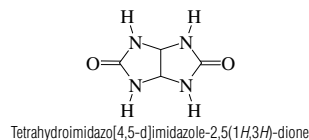
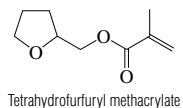
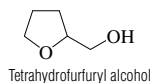
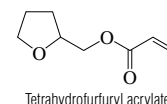
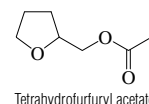
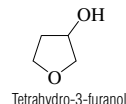
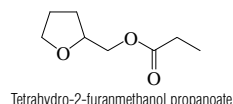
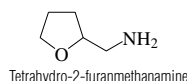
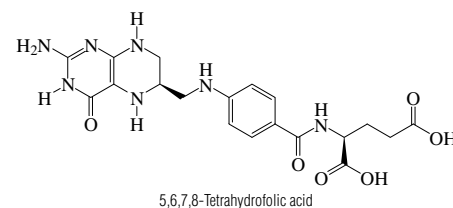
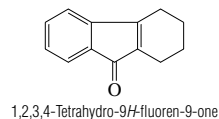
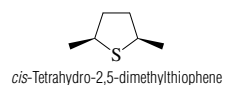
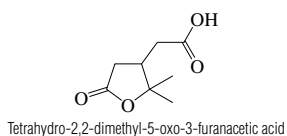
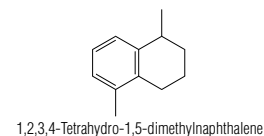
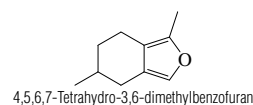
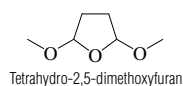
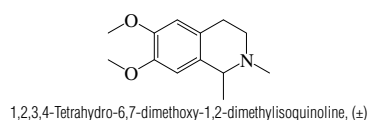
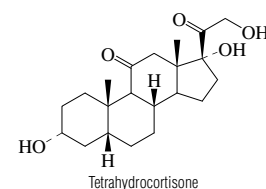
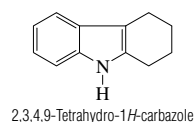
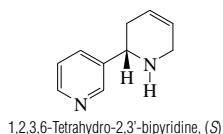
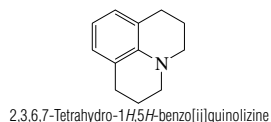
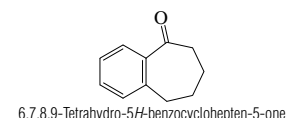
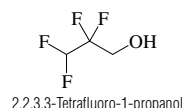
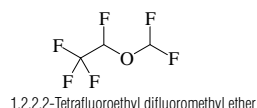
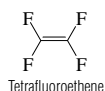
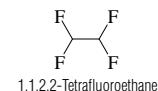
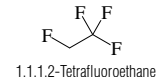
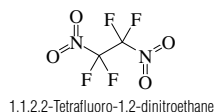
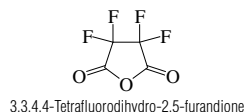
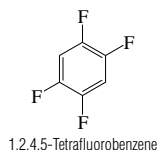
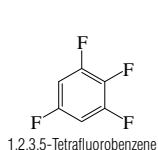
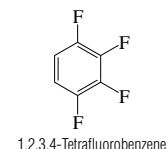
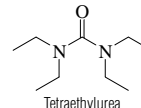
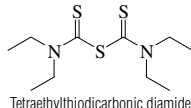
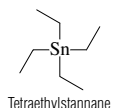
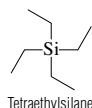
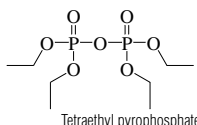
Tetrachlorovinphos



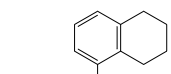
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9780	Tetracosanoic acid	Lignoceric acid	C <sub>24</sub> H <sub>48</sub> O <sub>2</sub>	557-59-5	368.637		87.5	272 <sup>10</sup>	0.8207 <sup>100</sup>	1.4287 <sup>100</sup>	vs bz, eth
9781	1-Tetracosanol		C <sub>24</sub> H <sub>50</sub> O	506-51-4	354.653		77	210 <sup>0,4</sup>			
9782	<i>cis</i> -15-Tetracosenoic acid	Nervonic acid	C <sub>24</sub> H <sub>46</sub> O <sub>2</sub>	506-37-6	366.621		43				
9783	Tetracyanoethene	Tetracyanoethylene	C <sub>6</sub> N <sub>4</sub>	670-54-2	128.091		199	223	1.348 <sup>25</sup>	1.560 <sup>25</sup>	sl eth, bz, ctc, chl; s ace
9784	Tetracycline		C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>6</sub>	60-54-8	444.434	cry (+3w)	172 dec				
9785	Tetracycline hydrochloride		C <sub>22</sub> H <sub>25</sub> ClN <sub>2</sub> O <sub>6</sub>	64-75-5	480.895		214				
9786	Tetradecahydrophenanthrene		C <sub>14</sub> H <sub>24</sub>	5743-97-5	192.341	liq	-3	270; 87 <sup>2</sup>	0.944 <sup>20</sup>	1.5011 <sup>20</sup>	i H <sub>2</sub> O; s eth, ace, bz
9787	Tetradecamethylhexasiloxane		C <sub>14</sub> H <sub>42</sub> O <sub>6</sub> Si <sub>6</sub>	107-52-8	458.993	liq	-59	245.5	0.8910 <sup>20</sup>	1.3948 <sup>20</sup>	vs bz
9788	Tetradecanal		C <sub>14</sub> H <sub>28</sub> O	124-25-4	212.371	lf	30				i H <sub>2</sub> O; s EtOH, eth, ace
9789	Tetradecanamide		C <sub>14</sub> H <sub>29</sub> NO	638-58-4	227.386	lf (ace)	104	217 <sup>12</sup>			vs EtOH
9790	Tetradecane		C <sub>14</sub> H <sub>30</sub>	629-59-4	198.388		5.82	253.58	0.7596 <sup>20</sup>	1.4290 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
9791	Tetradecanedioic acid		C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	821-38-5	258.354		125.5				
9792	1,14-Tetradecanediol		C <sub>14</sub> H <sub>30</sub> O <sub>2</sub>	19812-64-7	230.387	nd (bz)	85.8	200 <sup>9</sup>			vs eth, EtOH
9793	Tetradecanenitrile	Myristonitrile	C <sub>14</sub> H <sub>27</sub> N	629-63-0	209.371		19	226 <sup>100</sup> , 119 <sup>1</sup>	0.8281 <sup>19</sup>	1.4392 <sup>23</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; sl ctc
9794	1-Tetradecanethiol		C <sub>14</sub> H <sub>30</sub> S	2079-95-0	230.453		7	310; 178 <sup>22</sup>	0.8641 <sup>20</sup>	1.4597 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
9795	Tetradecanoic acid	Myristic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	544-63-8	228.371	lf (eth)	54.2	250 <sup>100</sup>	0.8622 <sup>54</sup>	1.4723 <sup>70</sup>	i H <sub>2</sub> O; s EtOH, ace, chl; sl eth; vs bz
9796	Tetradecanoic anhydride		C <sub>28</sub> H <sub>54</sub> O <sub>3</sub>	626-29-9	438.727	lf (peth)	53.4		0.8502 <sup>70</sup>	1.4335 <sup>70</sup>	vs eth, EtOH
9797	1-Tetradecanol	Tetradecyl alcohol	C <sub>14</sub> H <sub>30</sub> O	112-72-1	214.387	lf	38.2	287	0.8236 <sup>38</sup>		i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
9798	2-Tetradecanone	Dodecyl methyl ketone	C <sub>14</sub> H <sub>28</sub> O	2345-27-9	212.371	cry (dil al)	33.5	205 <sup>100</sup> , 134 <sup>13</sup>			i H <sub>2</sub> O; s EtOH, ace
9799	Tetradecanoyl chloride	Myristoyl chloride	C <sub>14</sub> H <sub>27</sub> ClO	112-64-1	246.816		-1	171 <sup>16</sup>	0.9078 <sup>25</sup>		s eth
9800	12- <i>O</i> -Tetradecanoylphorbol-13-acetate	Cocarcinogen A1	C <sub>36</sub> H <sub>56</sub> O <sub>8</sub>	16561-29-8	616.825	oil					
9801	1-Tetradecene		C <sub>14</sub> H <sub>28</sub>	1120-36-1	196.372	liq	-12	233	0.7745 <sup>25</sup>	1.4351 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz; sl ctc
9802	Tetradecyl acetate	1-Tetradecanol, acetate	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	638-59-5	256.424			173 <sup>10</sup>			
9803	Tetradecylamine	1-Tetradecanamine	C <sub>14</sub> H <sub>31</sub> N	2016-42-4	213.403		83.1	291.2	0.8079 <sup>20</sup>	1.4463 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, bz, chl; s ace
9804	Tetradecylbenzene		C <sub>20</sub> H <sub>34</sub>	1459-10-5	274.484		16	359	0.8549 <sup>20</sup>	1.4818 <sup>20</sup>	
9805	Tetradecylcyclohexane		C <sub>20</sub> H <sub>40</sub>	1795-18-2	280.532		24	360	0.8254 <sup>20</sup>	1.4579 <sup>20</sup>	
9806	Tetradifon	1,2,4-Trichloro-5-[(4-chlorophenyl)sulfonyl]benzene	C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub> S	116-29-0	356.052		146		1.151 <sup>20</sup>		
9807	Tetraethoxygermane	Ethanol, germanium(4+) salt	C <sub>8</sub> H <sub>20</sub> GeO <sub>4</sub>	14165-55-0	252.88			139 <sup>200</sup>			
9808	Tetraethoxymethane	Tetraethyl orthocarbonate	C <sub>8</sub> H <sub>20</sub> O <sub>4</sub>	78-09-1	192.253			159.5	0.9186 <sup>20</sup>	1.3905 <sup>25</sup>	msc EtOH, eth; s ctc
9809	Tetraethylammonium bromide		C <sub>8</sub> H <sub>20</sub> BrN	71-91-0	210.156	hyg (al)	286 dec		1.3970 <sup>20</sup>		vs H <sub>2</sub> O, EtOH, chl, MeOH
9810	Tetraethylammonium chloride		C <sub>8</sub> H <sub>20</sub> ClN	56-34-8	165.705	hyg cry					vs H <sub>2</sub> O, EtOH, ace, chl
9811	Tetraethylammonium iodide		C <sub>8</sub> H <sub>20</sub> I	68-05-3	257.156	cry (w)	300 dec				s H <sub>2</sub> O
9812	1,2,3,5-Tetraethylbenzene		C <sub>14</sub> H <sub>22</sub>	38842-05-6	190.325			249.0			
9813	<i>N,N,N',N'</i> -Tetraethyl-1,2-benzenedicarboxamide	<i>N,N,N',N'</i> -Tetraethylphthalamide	C <sub>16</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	83-81-8	276.374		36	204 <sup>16</sup>			
9814	Tetra(2-ethylbutyl) silicate	Silicic acid, tetrakis(2-ethylbutyl) ester	C <sub>24</sub> H <sub>52</sub> O <sub>4</sub> Si	78-13-7	432.754	liq			0.8920 <sup>20</sup>	1.4307 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, ctc; s eth, bz
9815	Tetraethylene glycol	3,6,9-Trioxaundecane-1,11-diol	C <sub>8</sub> H <sub>18</sub> O <sub>5</sub>	112-60-7	194.226	liq	-6.2	328	1.1285 <sup>15</sup>	1.4577 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth, ctc, diox
9816	Tetraethylene glycol diacrylate		C <sub>14</sub> H <sub>22</sub> O <sub>7</sub>	17831-71-9	302.321				1.125 <sup>25</sup>		
9817	Tetraethylene glycol dimethacrylate		C <sub>16</sub> H <sub>26</sub> O <sub>7</sub>	109-17-1	330.373			220 <sup>1</sup>		1.4610 <sup>25</sup>	
9818	Tetraethylene glycol dimethyl ether		C <sub>10</sub> H <sub>22</sub> O <sub>3</sub>	143-24-8	222.279			275.3	1.0114 <sup>20</sup>		msc H <sub>2</sub> O; s EtOH, eth, ctc
9819	Tetraethylene glycol monostearate		C <sub>26</sub> H <sub>52</sub> O <sub>6</sub>	106-07-0	460.687		40	328	1.1285 <sup>15</sup>	1.4593 <sup>20</sup>	
9820	Tetraethylenepentamine		C <sub>8</sub> H <sub>23</sub> N <sub>5</sub>	112-57-2	189.303			341.5		1.5042 <sup>20</sup>	s H <sub>2</sub> O
9821	<i>N,N,N',N'</i> -Tetraethyl-1,2-ethanediamine		C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>	150-77-6	172.311			192	0.808 <sup>25</sup>	1.4343 <sup>20</sup>	
9822	Tetraethylgermane		C <sub>8</sub> H <sub>20</sub> Ge	597-63-7	188.89			164.5	1.199		
9823	Tetraethyl lead		C <sub>8</sub> H <sub>20</sub> Pb	78-00-2	323.4			dec 200	1.653 <sup>20</sup>	1.5198 <sup>20</sup>	i H <sub>2</sub> O; s bz; sl EtOH
9824	<i>N,N,N',N'</i> -Tetraethylmethanediamine		C <sub>8</sub> H <sub>22</sub> N <sub>2</sub>	102-53-4	158.284			165.8	0.8000 <sup>20</sup>	1.4420 <sup>25</sup>	



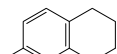
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9825	Tetraethyl pyrophosphate		C <sub>8</sub> H <sub>20</sub> O <sub>7</sub> P <sub>2</sub>	107-49-3	290.188		170 dec	155 <sup>3</sup>	1.1847 <sup>20</sup>	1.4180 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth, ace, xyl, chl; sl ctc
9826	Tetraethylsilane		C <sub>8</sub> H <sub>20</sub> Si	631-36-7	144.331			154.7	0.7658 <sup>20</sup>	1.4268 <sup>20</sup>	i H <sub>2</sub> O
9827	Tetraethylstannane	Tin tetraethyl	C <sub>8</sub> H <sub>20</sub> Sn	597-64-8	234.955	liq	-112	181; 64 <sup>12</sup>	1.187 <sup>25</sup>	1.4730 <sup>20</sup>	
9828	Tetraethylthiocarbonic diamide	Sulfiram	C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> S <sub>2</sub>	95-05-6	264.474			232 <sup>3</sup>	1.12 <sup>20</sup>		s chl
9829	Tetraethylurea		C <sub>8</sub> H <sub>20</sub> N <sub>2</sub> O	1187-03-7	172.267			209	0.919 <sup>20</sup>	1.4474 <sup>20</sup>	i H <sub>2</sub> O, alk, acid
9830	1,2,3,4-Tetrafluorobenzene		C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	551-62-2	150.074			94.3		1.4054 <sup>20</sup>	
9831	1,2,3,5-Tetrafluorobenzene		C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	2367-82-0	150.074	liq	-46.25	84.4	1.319 <sup>25</sup>	1.4035 <sup>20</sup>	
9832	1,2,4,5-Tetrafluorobenzene		C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	327-54-8	150.074		3.88	90.2	1.4255 <sup>20</sup>	1.4075 <sup>20</sup>	
9833	3,3,4,4-Tetrafluorodihydro-2,5-furandione		C <sub>4</sub> F <sub>4</sub> O <sub>3</sub>	699-30-9	172.035			54.5	1.6209 <sup>20</sup>	1.3240 <sup>20</sup>	
9834	1,1,2,2-Tetrafluoro-1,2-dinitroethane		C <sub>2</sub> F <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	356-16-1	192.026	liq	-41.5	58.5	1.6024 <sup>25</sup>	1.3265 <sup>25</sup>	i H <sub>2</sub> O; s ace
9835	1,1,1,2-Tetrafluoroethane		C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	811-97-2	102.031	col gas	-103.3	-26.5	1.2072 <sup>25</sup>		i H <sub>2</sub> O; s eth
9836	1,1,2,2-Tetrafluoroethane		C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	359-35-3	102.031	col gas	-89	-19.9			
9837	Tetrafluoroethene	Tetrafluoroethylene	C <sub>2</sub> F <sub>4</sub>	116-14-3	100.015	col gas	-131.15	-75.9	1.519 <sup>-76</sup>		i H <sub>2</sub> O
9838	1,2,2,2-Tetrafluoroethyl difluoromethyl ether	Refrigerant 236me	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	57041-67-5	168.037	vol liq or gas		23.35	1.4540 <sup>23</sup>		
9839	Tetrafluoromethane	Carbon tetrafluoride	CF <sub>4</sub>	75-73-0	88.005	col gas	-183.60	-128.0	3.034 <sup>25</sup>		i H <sub>2</sub> O; s bz, chl
9840	2,2,3,3-Tetrafluoro-1-propanol		C <sub>3</sub> H <sub>4</sub> F <sub>4</sub> O	76-37-9	132.057	liq	-15	109.5	1.4853 <sup>20</sup>	1.3197 <sup>20</sup>	s EtOH, ace, chl
9841	6,7,8,9-Tetrahydro-5H-benzocyclohepten-5-one		C <sub>11</sub> H <sub>12</sub> O	826-73-3	160.212			175 <sup>40</sup> , 124 <sup>7</sup>	1.080 <sup>20</sup>	1.5698 <sup>20</sup>	s EtOH
9842	2,3,6,7-Tetrahydro-1H,5H-benzo[ij]quinolizine	Julolidine	C <sub>12</sub> H <sub>13</sub> N	479-59-4	173.254		40	dec 280; 155 <sup>17</sup>	1.003 <sup>20</sup>	1.568 <sup>25</sup>	
9843	1,2,3,6-Tetrahydro-2,3'-bipyridine (S)	Anatabine	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub>	581-49-7	160.215			145 <sup>10</sup>	1.091 <sup>19</sup>	1.5676 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, eth, bz
9844	2,3,4,9-Tetrahydro-1H-carbazole		C <sub>12</sub> H <sub>13</sub> N	942-01-8	171.238	lf (dil al)	120	327.5			i H <sub>2</sub> O; s EtOH; vs eth, bz, MeOH
9845	Tetrahydrocortisone		C <sub>21</sub> H <sub>32</sub> O <sub>5</sub>	53-05-4	364.476	cry (EtOAc)	190				
9846	1,2,3,4-Tetrahydro-6,7-dimethoxy-1,2-dimethylisoquinoline, (±)	Carnegine	C <sub>13</sub> H <sub>19</sub> NO <sub>2</sub>	490-53-9	221.296	pa br syr		170 <sup>1</sup>			vs H <sub>2</sub> O, eth, EtOH
9847	Tetrahydro-2,5-dimethoxyfuran		C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	696-59-3	132.157			145.7	1.02 <sup>25</sup>	1.4180 <sup>20</sup>	
9848	4,5,6,7-Tetrahydro-3,6-dimethylbenzofuran		C <sub>10</sub> H <sub>14</sub> O	494-90-6	150.217		86	80 <sup>18</sup>	0.972 <sup>15</sup>		
9849	1,2,3,4-Tetrahydro-1,5-dimethylnaphthalene		C <sub>12</sub> H <sub>16</sub>	21564-91-0	160.255			239	0.941 <sup>20</sup>	1.526 <sup>20</sup>	
9850	Tetrahydro-2,2-dimethyl-5-oxo-3-furanacetic acid	Terpenylic acid	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	26754-48-3	172.179	lf or pr (w+1)	90				vs H <sub>2</sub> O
9851	cis-Tetrahydro-2,5-dimethylthiophene		C <sub>6</sub> H <sub>12</sub> S	5161-13-7	116.224	liq	-89	142.3	0.9222 <sup>20</sup>	1.4799 <sup>20</sup>	vs ace, bz, eth, EtOH
9852	1,2,3,4-Tetrahydro-9H-fluorene-9-one	Phenthyrone	C <sub>13</sub> H <sub>12</sub> O	634-19-5	184.233	lt ye nd or pr (pentane)	81.5	139 <sup>0.05</sup>			
9853	5,6,7,8-Tetrahydrofolic acid		C <sub>19</sub> H <sub>23</sub> N <sub>7</sub> O <sub>5</sub>	135-16-0	445.429	pow					s H <sub>2</sub> O
9854	Tetrahydrofuran	Tetramethylene oxide	C <sub>4</sub> H <sub>8</sub> O	109-99-9	72.106	liq	-108.44	65	0.8833 <sup>25</sup>	1.4050 <sup>25</sup>	s H <sub>2</sub> O, chl; vs EtOH, eth, ace, bz
9855	Tetrahydro-2-furanmethanamine	Tetrahydrofurfurylamine	C <sub>5</sub> H <sub>11</sub> NO	4795-29-3	101.147			153	0.9752 <sup>20</sup>	1.4551 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
9856	Tetrahydro-2-furanmethanol propanoate		C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	637-65-0	158.195			205.5	1.044 <sup>20</sup>		vs eth, EtOH, chl
9857	Tetrahydro-3-furanol		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	453-20-3	88.106			181	1.09 <sup>25</sup>	1.4500 <sup>20</sup>	
9858	Tetrahydrofurfuryl acetate		C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	637-64-9	144.168			193; 89 <sup>18</sup>	1.0624 <sup>20</sup>	1.4350 <sup>25</sup>	vs H <sub>2</sub> O, eth, EtOH, chl
9859	Tetrahydrofurfuryl acrylate		C <sub>8</sub> H <sub>12</sub> O <sub>3</sub>	2399-48-6	156.179		<-60	96 <sup>6</sup>	1.061 <sup>20</sup>		
9860	Tetrahydrofurfuryl alcohol	Tetrahydro-2-furancarbinol	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	97-99-4	102.132		<-80	178	1.0524 <sup>20</sup>	1.4520 <sup>20</sup>	vs ace, eth
9861	Tetrahydrofurfuryl methacrylate		C <sub>9</sub> H <sub>14</sub> O <sub>3</sub>	2455-24-5	170.205			265; 81 <sup>4</sup>	1.040 <sup>25</sup>	1.4554 <sup>25</sup>	
9862	Tetrahydroimidazo[4,5-d]imidazole-2,5(1H,3H)-dione	Acetyleneurea	C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	496-46-8	142.117	nd or pr (w)	300 dec				sl H <sub>2</sub> O; i EtOH, HOAc; s eth, HCl, alk
9863	cis-3a,4,7a-Tetrahydro-1,3-isobenzofurandione	4-Cyclohexene-1,2-dicarboxylic acid, anhydride	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	935-79-5	152.148	cry (peth)	103.5				s EtOH, ace, chl, bz; sl peth
9864	4,5,6,7-Tetrahydro-1,3-isobenzofurandione	1-Cyclohexene-1,2-dicarboxylic acid, anhydride	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	2426-02-0	152.148	pl (EtOH)	74		1.2 <sup>105</sup>		s EtOH, ace, chl; vs eth
9865	1,2,3,4-Tetrahydroisoquinoline		C <sub>9</sub> H <sub>11</sub> N	91-21-4	133.190		<-15	232.5	1.0642 <sup>24</sup>	1.5668 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, bz, acid, xyl
9866	3,4,5,6-Tetrahydro-7-methoxy-2H-azepine		C <sub>7</sub> H <sub>13</sub> NO	2525-16-8	127.184	liq		49 <sup>16</sup> , 66 <sup>24</sup>	0.887	1.4630 <sup>20</sup>	
9867	1,2,3,4-Tetrahydro-6-methoxyquinoline		C <sub>10</sub> H <sub>13</sub> NO	120-15-0	163.216	pr (peth, al) orth pym (w)	42.5	284; 128 <sup>1</sup>		1.5718 <sup>20</sup>	s chl
9868	1,2,3,4-Tetrahydro-1-methylnaphthalene		C <sub>11</sub> H <sub>14</sub>	1559-81-5	146.229			220.6	0.9583 <sup>20</sup>	1.5353 <sup>20</sup>	



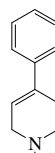
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9869	1,2,3,4-Tetrahydro-5-methylnaphthalene		C <sub>11</sub> H <sub>14</sub>	2809-64-5	146.229	liq	-23	234	0.9720 <sup>20</sup>	1.5439 <sup>20</sup>	
9870	1,2,3,4-Tetrahydro-6-methylnaphthalene		C <sub>11</sub> H <sub>14</sub>	1680-51-9	146.229	liq	-40	229	0.9537 <sup>20</sup>	1.5357 <sup>20</sup>	
9871	1,2,3,6-Tetrahydro-1-methyl-4-phenylpyridine	MPTP	C <sub>12</sub> H <sub>13</sub> N	28289-54-5	173.254	cry	41	870 <sup>8</sup>			
9872	Tetrahydro-3-methyl-2H-thiopyran		C <sub>6</sub> H <sub>12</sub> S	5258-50-4	116.224	liq	-60	158	0.9473 <sup>20</sup>	1.4922 <sup>20</sup>	
9873	5,6,7,8-Tetrahydro-1-naphthalenamine		C <sub>10</sub> H <sub>13</sub> N	2217-41-6	147.217		38	279	1.0625 <sup>16</sup>	1.5900 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, acid
9874	1,2,3,4-Tetrahydronaphthalene	Tetralin	C <sub>10</sub> H <sub>12</sub>	119-64-2	132.202	liq	-35.7	207.6	0.9645 <sup>25</sup>	1.5413 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s chl, PhNH <sub>2</sub>
9875	1,2,3,4-Tetrahydro-1-naphthol	1,2,3,4-Tetrahydro- $\alpha$ -naphthol	C <sub>10</sub> H <sub>12</sub> O	529-33-9	148.201		34.5	255; 103 <sup>2</sup>	1.0996 <sup>20</sup>	1.5638 <sup>20</sup>	
9876	5,6,7,8-Tetrahydro-1-naphthol	5,6,7,8-Tetrahydro- $\alpha$ -naphthol	C <sub>10</sub> H <sub>12</sub> O	529-35-1	148.201		70	266; 143 <sup>11</sup>	1.0556 <sup>15</sup>		
9877	1,2,3,4-Tetrahydro-2-naphthol	Tetralol	C <sub>10</sub> H <sub>12</sub> O	530-91-6	148.201		15.5	140 <sup>12</sup>			
9878	5,6,7,8-Tetrahydro-2-naphthol	5,6,7,8-Tetrahydro- $\beta$ -naphthol	C <sub>10</sub> H <sub>12</sub> O	1125-78-6	148.201		57	275.5	1.0552 <sup>85</sup>		
9879	Tetrahydro-6-pentyl-2H-pyran-2-one	5-Hydroxydecanoic acid lactone	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	705-86-2	170.249	liq	-27	121 <sup>3</sup>			
9880	1,2,3,4-Tetrahydrophenanthrene		C <sub>14</sub> H <sub>14</sub>	1013-08-7	182.261	lf (MeOH)	33.5	173 <sup>11</sup>	1.0601 <sup>40</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz, HOAc, chl, lig
9881	1,2,3,6-Tetrahydrophthalimide		C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	85-40-5	151.163	cry (EtOH)	137				
9882	Tetrahydro-6-propyl-2H-pyran-2-one	5-Hydroxyoctanoic acid lactone	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	698-76-0	142.196	liq	-13	126 <sup>15</sup>			
9883	2,3,4,5-Tetrahydro-6-propylpyridine	$\gamma$ -Coniceine	C <sub>8</sub> H <sub>15</sub> N	1604-01-9	125.212			174	0.8753 <sup>15</sup>	1.4661 <sup>16</sup>	
9884	Tetrahydropyran	Oxane	C <sub>5</sub> H <sub>10</sub> O	142-68-7	86.132	liq	-49.1	88	0.8814 <sup>20</sup>	1.4200 <sup>20</sup>	s EtOH, eth, bz, ctc
9885	Tetrahydro-2H-pyran-2-methanol		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	100-72-1	116.158			185	1.027 <sup>25</sup>	1.458 <sup>20</sup>	
9886	Tetrahydro-2H-pyran-2-one		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	542-28-9	100.117	liq	-12.5	219	1.1082 <sup>20</sup>	1.4503 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, eth; sl ctc
9887	Tetrahydro-4H-pyran-4-one		C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	29943-42-8	100.117			166.5	1.084 <sup>25</sup>	1.4520 <sup>20</sup>	
9888	1,2,5,6-Tetrahydropyridine	$\Delta^3$ -Piperidine	C <sub>5</sub> H <sub>9</sub> N	694-05-3	83.132	liq	-48	108	0.911 <sup>25</sup>	1.4800 <sup>20</sup>	s chl
9889	1,2,5,6-Tetrahydro-3-pyridinecarboxylic acid	Guvacine	C <sub>6</sub> H <sub>9</sub> NO <sub>2</sub>	498-96-4	127.141	pr (w), rods (+1w dil al)	295 dec				vs H <sub>2</sub> O
9890	3,4,5,6-Tetrahydro-2(1H)-pyrimidinethione	Hexahydropyrimidine-2-thione	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> S	2055-46-1	116.185		211		1.33 <sup>20</sup>		
9891	1,2,3,4-Tetrahydroquinoline		C <sub>8</sub> H <sub>11</sub> N	635-46-1	133.190	nd	20	251	1.0588 <sup>20</sup>	1.6062 <sup>19</sup>	s H <sub>2</sub> O, chl; msc EtOH, eth
9892	5,6,7,8-Tetrahydroquinoline	2,3-Cyclohexenopyridine	C <sub>8</sub> H <sub>11</sub> N	10500-57-9	133.190			222	1.0304 <sup>13</sup>	1.5435 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace, bz
9893	1,2,3,4-Tetrahydroquinoxaline		C <sub>8</sub> H <sub>10</sub> N <sub>2</sub>	3476-89-9	134.178	lf (w, eth, peth)	99	289			s H <sub>2</sub> O, chl; vs EtOH, eth, bz; sl peth
9894	6,7,8,9-Tetrahydro-5H-tetrazolo[1,5-a]azepine	Pentylentetrazole	C <sub>6</sub> H <sub>10</sub> N <sub>4</sub>	54-95-5	138.170	cry (bz-lig)	59.5	194 <sup>12</sup>			vs H <sub>2</sub> O, EtOH, ace; s eth, bz; sl chl
9895	Tetrahydrothiophene	Thiacyclopentane	C <sub>4</sub> H <sub>8</sub> S	110-01-0	88.172	liq	-96.2	121.1	0.9987 <sup>20</sup>	1.4871 <sup>18</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl
9896	1,2,3,4-Tetrahydro-1,1,6-trimethylnaphthalene		C <sub>13</sub> H <sub>18</sub>	475-03-6	174.282			240; 90 <sup>4</sup>	0.9303 <sup>20</sup>	1.5257 <sup>20</sup>	s EtOH, eth, bz, chl
9897	1,2,5,8-Tetrahydroxy-9,10-anthracenedione	Quinalizarin	C <sub>14</sub> H <sub>6</sub> O <sub>6</sub>	81-61-8	272.210	oran nd	>275				sl H <sub>2</sub> O, ace, bz, EtOH, eth
9898	2,3,4,6-Tetrahydroxy-5H-benzocyclohepten-5-one	Purpurogallin	C <sub>11</sub> H <sub>8</sub> O <sub>5</sub>	569-77-7	220.179	red nd (gl HOAc)	274 dec				
9899	2,2',4,4'-Tetrahydroxybenzophenone		C <sub>13</sub> H <sub>10</sub> O <sub>5</sub>	131-55-5	246.215	ye nd (w+1)	197				vs H <sub>2</sub> O, ace, eth, EtOH
9900	2,3,5,6-Tetrahydroxy-2,5-cyclohexadiene-1,4-dione	Tetroquinone	C <sub>6</sub> H <sub>4</sub> O <sub>6</sub>	319-89-1	172.092	bl-blk cry					sl H <sub>2</sub> O, eth, ctc; vs EtOH
9901	11,17,20,21-Tetrahydroxypregn-4-en-3-one, (11 $\beta$ ,20 $R$ )	4-Pregnene-11 $\beta$ ,17 $\alpha$ ,20 $\beta$ ,21-tetrol-3-on	C <sub>21</sub> H <sub>32</sub> O <sub>5</sub>	116-58-5	364.476	cry (aq ace)	125 dec				vs ace, EtOH
9902	N,N,N',N'-Tetra(2-hydroxypropyl)ethylenediamine	ENTPROL	C <sub>14</sub> H <sub>32</sub> N <sub>2</sub> O <sub>4</sub>	102-60-3	292.415				1.030 <sup>25</sup>	1.478 <sup>25</sup>	sl chl
9903	Tetraiodoethene	Tetraiodoethylene	C <sub>2</sub> I <sub>4</sub>	513-92-8	531.639	ye lf, pr (eth)	187	sub	2.983 <sup>20</sup>		vs bz, chl
9904	4,5,6,7-Tetraiodo-1,3-isobenzofurandione		C <sub>8</sub> I <sub>4</sub> O <sub>3</sub>	632-80-4	651.702	ye pr, nd (HOAc) nd (sub)	327.5	sub			i H <sub>2</sub> O, EtOH, bz; sl HOAc
9905	Tetraiodomethane	Carbon tetraiodide	Cl <sub>4</sub>	507-25-5	519.629	red lf (bz, chl)	171	135 <sup>1,5</sup>	4.23 <sup>20</sup>		vs py, chl
9906	2,3,4,5-Tetraiodo-1H-pyrrole	Iodopyrrole	C <sub>4</sub> HI <sub>4</sub> N	87-58-1	570.676	ye nd (al)	150 dec				vs ace, eth, chl
9907	Tetraisobutyl titanate	2-Methyl-1-propanol, titanium(4+) salt	C <sub>16</sub> H <sub>36</sub> O <sub>4</sub> Ti	7425-80-1	340.322			256 <sup>500</sup>	0.960 <sup>50</sup>		dec H <sub>2</sub> O



1,2,3,4-Tetrahydro-5-methylnaphthalene



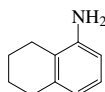
1,2,3,4-Tetrahydro-6-methylnaphthalene



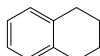
1,2,3,6-Tetrahydro-1-methyl-4-phenylpyridine



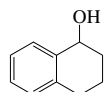
Tetrahydro-3-methyl-2H-thiopyran



5,6,7,8-Tetrahydro-1-naphthalenamine



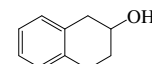
1,2,3,4-Tetrahydronaphthalene



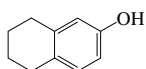
1,2,3,4-Tetrahydro-1-naphthol



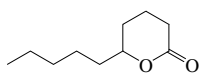
5,6,7,8-Tetrahydro-1-naphthol



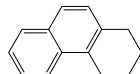
1,2,3,4-Tetrahydro-2-naphthol



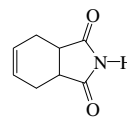
5,6,7,8-Tetrahydro-2-naphthol



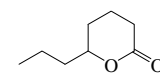
Tetrahydro-6-pentyl-2H-pyran-2-one



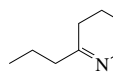
1,2,3,4-Tetrahydrophenanthrene



1,2,3,6-Tetrahydrophthalimide



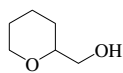
Tetrahydro-6-propyl-2H-pyran-2-one



2,3,4,5-Tetrahydro-6-propylpyridine



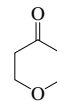
Tetrahydropyran



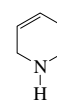
Tetrahydro-2H-pyran-2-methanol



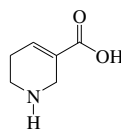
Tetrahydro-2H-pyran-2-one



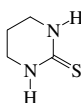
Tetrahydro-4H-pyran-4-one



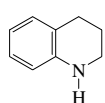
1,2,5,6-Tetrahydropyridine



1,2,5,6-Tetrahydro-3-pyridinecarboxylic acid



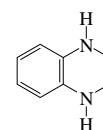
3,4,5,6-Tetrahydro-2(1H)-pyrimidinethione



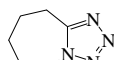
1,2,3,4-Tetrahydroquinoline



5,6,7,8-Tetrahydroquinoline



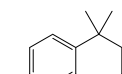
1,2,3,4-Tetrahydroquinoxaline



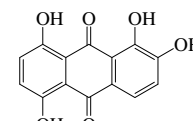
6,7,8,9-Tetrahydro-5H-tetrazolo[1,5-a]azepine



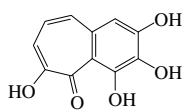
Tetrahydrothiophene



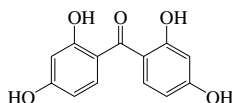
1,2,3,4-Tetrahydro-1,1,6-trimethylnaphthalene



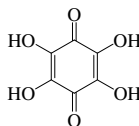
1,2,5,8-Tetrahydroxy-9,10-anthracenedione



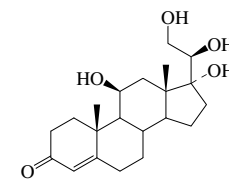
2,3,4,6-Tetrahydroxy-5H-benzocyclohepten-5-one



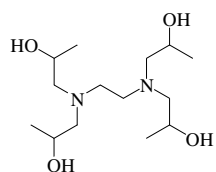
2,2',4,4'-Tetrahydroxybenzophenone



2,3,5,6-Tetrahydroxy-2,5-cyclohexadiene-1,4-dione



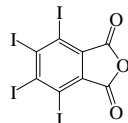
11,17,20,21-Tetrahydroxypregn-4-en-3-one, (11β,20R)



N,N,N',N'-Tetra(2-hydroxypropyl)ethylenediamine



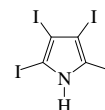
Tetraiodoethene



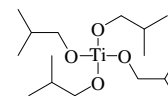
4,5,6,7-Tetraiodo-1,3-isobenzofurandione



Tetraiodomethane



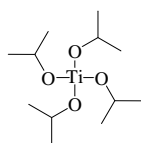
2,3,4,5-Tetraiodo-1H-pyrrole



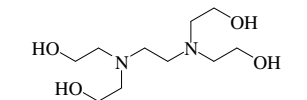
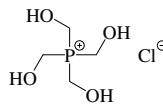
Tetraisobutyl titanate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9908	Tetraisopropyl titanate	2-Propanol, titanium(4+) salt	C <sub>12</sub> H <sub>28</sub> O <sub>4</sub> Ti	546-68-9	284.215			227.5	0.9711 <sup>20</sup>		dec H <sub>2</sub> O; s EtOH, eth, bz, chl
9909	<i>N,N,N',N'</i> -Tetrakis(2-hydroxyethyl)-1,2-ethanediamine		C <sub>10</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	140-07-8	236.309						sl H <sub>2</sub> O, EtOH
9910	Tetrakis(hydroxymethyl)phosphonium chloride		C <sub>4</sub> H <sub>12</sub> ClO <sub>4</sub> P	124-64-1	190.562		152.5				s H <sub>2</sub> O
9911	Tetrakis(methylthio)methane		C <sub>8</sub> H <sub>12</sub> S <sub>4</sub>	6156-25-8	200.409						s chl
9912	1-Tetralone		C <sub>10</sub> H <sub>10</sub> O	529-34-0	146.185		8	115 <sup>6</sup>	1.0988 <sup>16</sup>	1.5672 <sup>20</sup>	
9913	Tetramethoxymethane		C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	1850-14-2	136.147	liq	-2.5	114	1.023 <sup>25</sup>	1.3845 <sup>20</sup>	
9914	1,1,3,3-Tetramethoxypropane		C <sub>7</sub> H <sub>16</sub> O <sub>4</sub>	102-52-3	164.200			183; 66 <sup>12</sup>	0.997 <sup>25</sup>	1.4081 <sup>20</sup>	
9915	Tetramethrin		C <sub>19</sub> H <sub>28</sub> NO <sub>4</sub>	7696-12-0	331.407	wh cry	≈65-80		1.108 <sup>20</sup>	1.5175 <sup>21</sup>	
9916	<i>N,N,N',N'</i> -Tetramethyl-3,6-acridinediamine, monohydrochloride	Acridine Orange	C <sub>17</sub> H <sub>20</sub> ClN <sub>3</sub>	65-61-2	301.814	oran-ye soln					s H <sub>2</sub> O, EtOH
9917	Tetramethylammonium bromide		C <sub>4</sub> H <sub>12</sub> BrN	64-20-0	154.049	hyg bipym	230 dec		1.56 <sup>25</sup>		vs H <sub>2</sub> O; sl EtOH; i eth, bz, chl; s MeOH
9918	Tetramethylammonium chloride		C <sub>4</sub> H <sub>12</sub> ClN	75-57-0	109.598	hyg bipym (dil al)	420 dec		1.169 <sup>20</sup>		s H <sub>2</sub> O; sl EtOH; i eth, bz, chl; vs MeOH
9919	Tetramethylammonium iodide		C <sub>4</sub> H <sub>12</sub> IN	75-58-1	201.049		>230 dec		1.829 <sup>25</sup>		sl H <sub>2</sub> O, alk, EtOH, ace; i eth, chl
9920	<i>N,N</i> ,2,6-Tetramethylaniline		C <sub>10</sub> H <sub>13</sub> N	769-06-2	149.233	liq	-36	196; 88 <sup>20</sup>	0.9147 <sup>20</sup>		
9921	1,2,3,4-Tetramethylbenzene		C <sub>10</sub> H <sub>14</sub>	488-23-3	134.218	liq	-6.2	205	0.9052 <sup>20</sup>	1.5203 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
9922	1,2,3,5-Tetramethylbenzene	Isodurene	C <sub>10</sub> H <sub>14</sub>	527-53-7	134.218	liq	-23.7	198	0.8903 <sup>20</sup>	1.5130 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
9923	1,2,4,5-Tetramethylbenzene	Durene	C <sub>10</sub> H <sub>14</sub>	95-93-2	134.218		79.3	196.8	0.8380 <sup>81</sup>	1.4790 <sup>81</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
9924	<i>N,N,N',N'</i> -Tetramethyl-1,2-benzenediamine		C <sub>10</sub> H <sub>16</sub> N <sub>2</sub>	704-01-8	164.247		8.9	215.5	0.9560 <sup>20</sup>		
9925	<i>N,N,N',N'</i> -Tetramethyl-1,4-benzenediamine	Tetramethyl- <i>p</i> -phenylenediamine	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub>	100-22-1	164.247	lf (dil al or lig)	51	260			sl H <sub>2</sub> O; vs EtOH, eth, bz, chl
9926	2,3,5,6-Tetramethyl-1,4-benzenediol	Durohydroquinone	C <sub>10</sub> H <sub>14</sub> O <sub>2</sub>	527-18-4	166.217	nd (al)	233				s EtOH; sl eth
9927	Tetramethyl 1,2,4,5-benzenetetracarboxylate		C <sub>14</sub> H <sub>14</sub> O <sub>8</sub>	635-10-9	310.256	nd (al)	144	sub			vs EtOH
9928	3,3',5,5'-Tetramethyl-[1,1'-biphenyl]-4,4'-diamine		C <sub>16</sub> H <sub>20</sub> N <sub>2</sub>	54827-17-7	240.343			168.5			
9929	<i>N,N,N',N'</i> -Tetramethyl-[1,1'-biphenyl]-4,4'-diamine		C <sub>16</sub> H <sub>20</sub> N <sub>2</sub>	366-29-0	240.343			196.0			
9930	3,3',5,5'-Tetramethyl-[1,1'-biphenyl]-4,4'-diol		C <sub>16</sub> H <sub>18</sub> O <sub>2</sub>	2417-04-1	242.313	pa ye nd or pr (HOAc)	221.8	sub			sl EtOH, bz, gl HOAc, tol; i liq
9931	2,2,3,3-Tetramethylbutane		C <sub>8</sub> H <sub>18</sub>	594-82-1	114.229	lf (eth)	100.7	106.45	0.8242 <sup>20</sup>	1.4695 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl
9932	<i>N,N,N',N'</i> -Tetramethyl-1,4-butanediamine		C <sub>8</sub> H <sub>20</sub> N <sub>2</sub>	111-51-3	144.258			168	0.7942 <sup>15</sup>	1.4621 <sup>25</sup>	msc H <sub>2</sub> O; s EtOH, eth
9933	4-(1,1,3,3-Tetramethylbutyl)phenol		C <sub>14</sub> H <sub>22</sub> O	140-66-9	206.324		85.8	279			
9934	2,2,4,4-Tetramethyl-1,3-cyclobutanedione		C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	933-52-8	140.180						s chl
9935	2,3,5,6-Tetramethyl-2,5-cyclohexadiene-1,4-dione	Duroquinone	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	527-17-3	164.201	ye nd (al or lig)	111.5				i H <sub>2</sub> O; s EtOH, eth, ace, bz, sulf, chl
9936	1,2,3,4-Tetramethylcyclohexane		C <sub>10</sub> H <sub>20</sub>	3726-45-2	140.266				0.8219 <sup>20</sup>	1.4531 <sup>20</sup>	
9937	1,1,3,3-Tetramethylcyclopentane		C <sub>9</sub> H <sub>18</sub>	50876-33-0	126.239	liq	-88.4	118	0.7469 <sup>25</sup>	1.4125 <sup>20</sup>	
9938	1,1,2,2-Tetramethylcyclopropane		C <sub>7</sub> H <sub>14</sub>	4127-47-3	98.186	liq	-81	76			
9939	2,4,6,8-Tetramethylcyclotetrasiloxane		C <sub>4</sub> H <sub>16</sub> O <sub>4</sub> Si <sub>4</sub>	2370-88-9	240.510	liq	-65	134.5	0.9912 <sup>20</sup>	1.3870 <sup>20</sup>	i H <sub>2</sub> O
9940	2,4,7,9-Tetramethyl-5-decylene-4,7-diol		C <sub>14</sub> H <sub>26</sub> O <sub>2</sub>	126-86-3	226.355		47	165 <sup>40</sup>			
9941	<i>N,N,N',N'</i> -Tetramethyl-4,4'-diaminobenzophenone	Michler's ketone	C <sub>17</sub> H <sub>20</sub> N <sub>2</sub> O	90-94-8	268.353	lf (al), nd (bz)	179	dec 360			i H <sub>2</sub> O, eth; sl EtOH; vs bz; s chl
9942	Tetramethyldiarsine	Cacodyl	C <sub>4</sub> H <sub>12</sub> As <sub>2</sub>	471-35-2	209.981	liq	-6	165	1.447 <sup>15</sup>		vs eth, EtOH
9943	1,1,3,3-Tetramethyl-1,3-diphenyldisiloxane		C <sub>16</sub> H <sub>22</sub> OSi <sub>2</sub>	56-33-7	286.516	liq	-80	292; 156 <sup>13</sup>	0.9763 <sup>20</sup>	1.5176 <sup>20</sup>	s ctc
9944	1,1,3,3-Tetramethyldisiloxane		C <sub>4</sub> H <sub>14</sub> OSi <sub>2</sub>	3277-26-7	134.324			71	0.756 <sup>20</sup>	1.3700 <sup>20</sup>	
9945	1,1,3,3-Tetramethyl-1,3-disiloxanediol		C <sub>4</sub> H <sub>14</sub> O <sub>3</sub> Si <sub>2</sub>	1118-15-6	166.323		66		1.095 <sup>25</sup>		

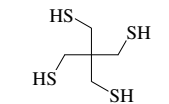




Tetraisopropyl titanate

*N,N,N',N'*-Tetrakis(2-hydroxyethyl)-1,2-ethanediamine

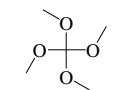
Tetrakis(hydroxymethyl)phosphonium chloride



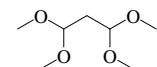
Tetrakis(methylthio)methane



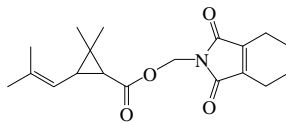
1-Tetralone



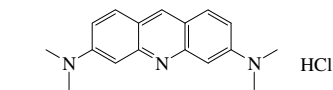
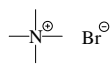
Tetramethoxymethane



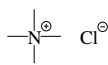
1,1,3,3-Tetramethoxypropane



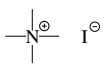
Tetramethrin

*N,N,N',N'*-Tetramethyl-3,6-acridinediamine, monohydrochloride

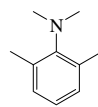
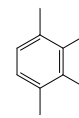
Tetramethylammonium bromide



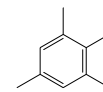
Tetramethylammonium chloride



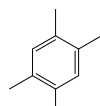
Tetramethylammonium iodide

*N,N,2,6*-Tetramethylaniline

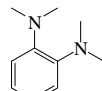
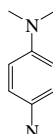
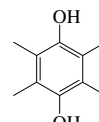
1,2,3,4-Tetramethylbenzene



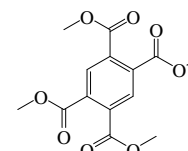
1,2,3,5-Tetramethylbenzene



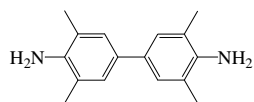
1,2,4,5-Tetramethylbenzene

*N,N,N',N'*-Tetramethyl-1,2-benzenediamine*N,N,N',N'*-Tetramethyl-1,4-benzenediamine

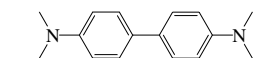
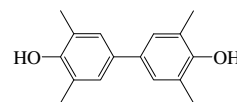
2,3,5,6-Tetramethyl-1,4-benzenediol



Tetramethyl 1,2,4,5-benzenetetra-carboxylate



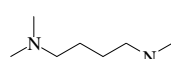
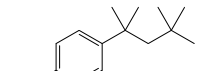
3,3',5,5'-Tetramethyl-[1,1'-biphenyl]-4,4'-diamine

*N,N,N',N'*-Tetramethyl-[1,1'-biphenyl]-4,4'-diamine

3,3',5,5'-Tetramethyl-[1,1'-biphenyl]-4,4'-diol



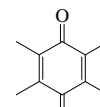
2,2,3,3-Tetramethylbutane

*N,N,N',N'*-Tetramethyl-1,4-butanediamine

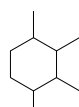
4-(1,1,3,3-Tetramethylbutyl)phenol



2,2,4,4-Tetramethyl-1,3-cyclobutanedione



2,3,5,6-Tetramethyl-2,5-cyclohexadiene-1,4-dione



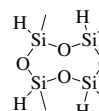
1,2,3,4-Tetramethylcyclohexane



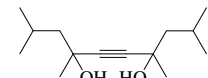
1,1,3,3-Tetramethylcyclopentane



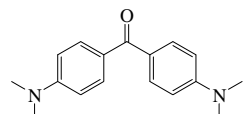
1,1,2,2-Tetramethylcyclopropane



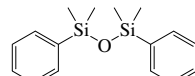
2,4,6,8-Tetramethylcyclotetrasiloxane



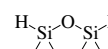
2,4,7,9-Tetramethyl-5-decyne-4,7-diol

*N,N,N',N'*-Tetramethyl-4,4'-diaminobenzophenone

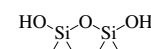
Tetramethyldiarsine



1,1,3,3-Tetramethyl-1,3-diphenyldisiloxane

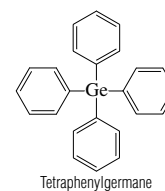
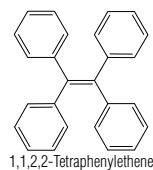
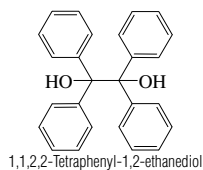
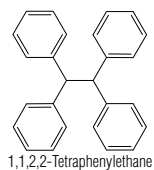
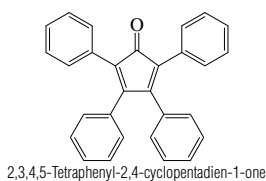
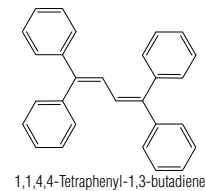
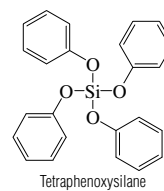
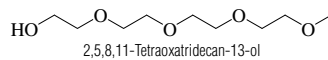
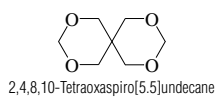
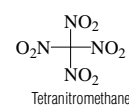
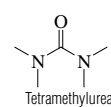
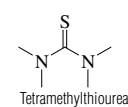
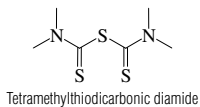
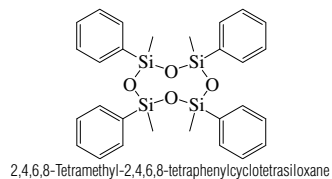
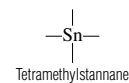
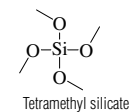
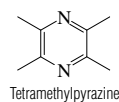
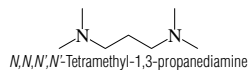
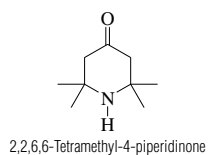
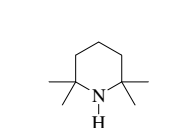
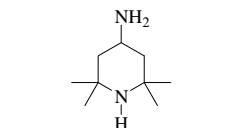
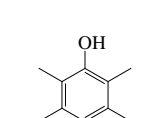
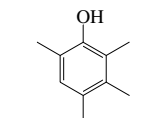
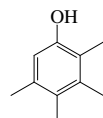
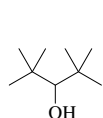
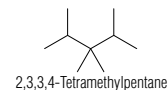
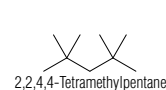
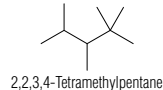
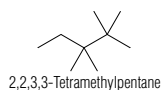
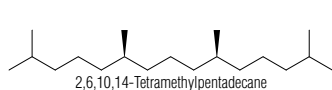
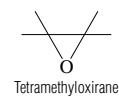
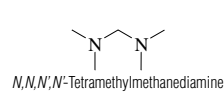
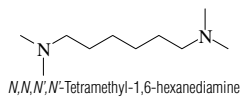
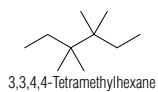
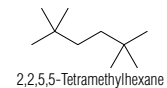
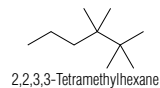
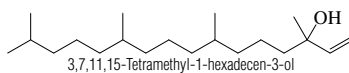
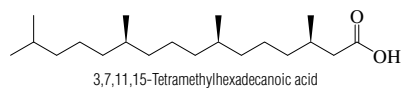
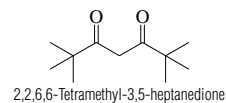
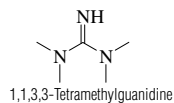
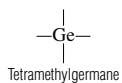
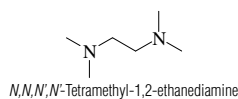


1,1,3,3-Tetramethyldisiloxane

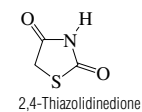
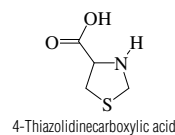
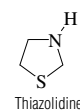
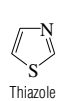
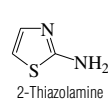
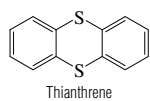
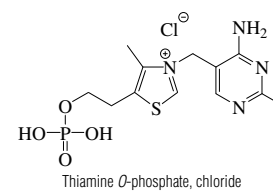
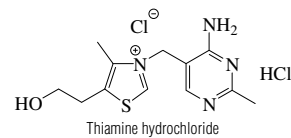
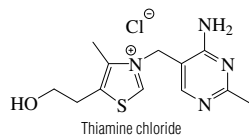
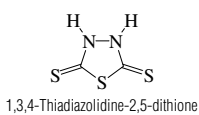
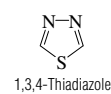
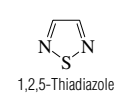
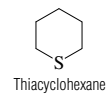
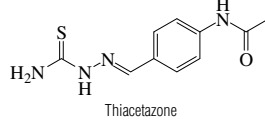
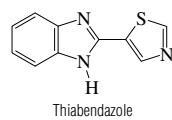
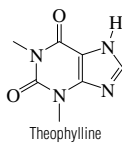
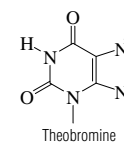
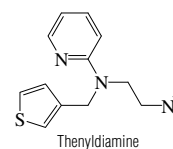
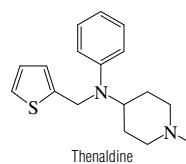
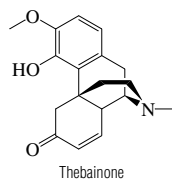
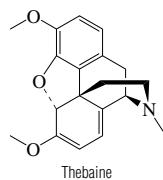
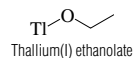
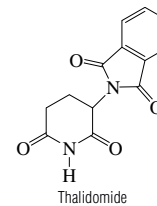
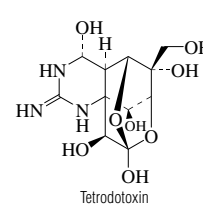
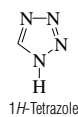
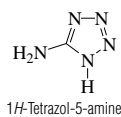
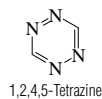
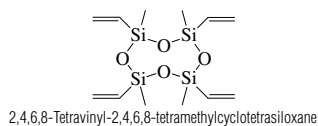
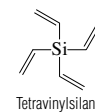
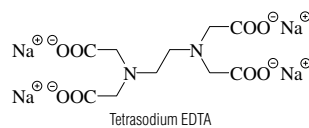
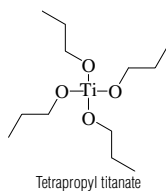
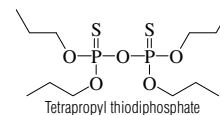
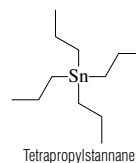
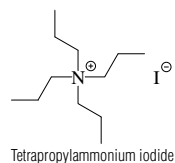
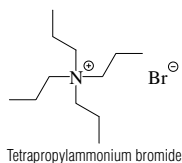
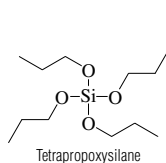
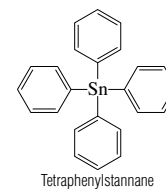
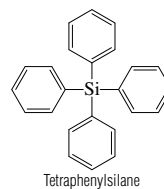
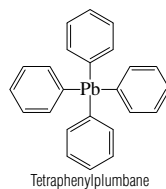
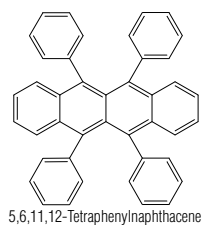
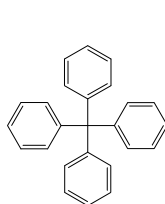


1,1,3,3-Tetramethyl-1,3-disiloxanediol

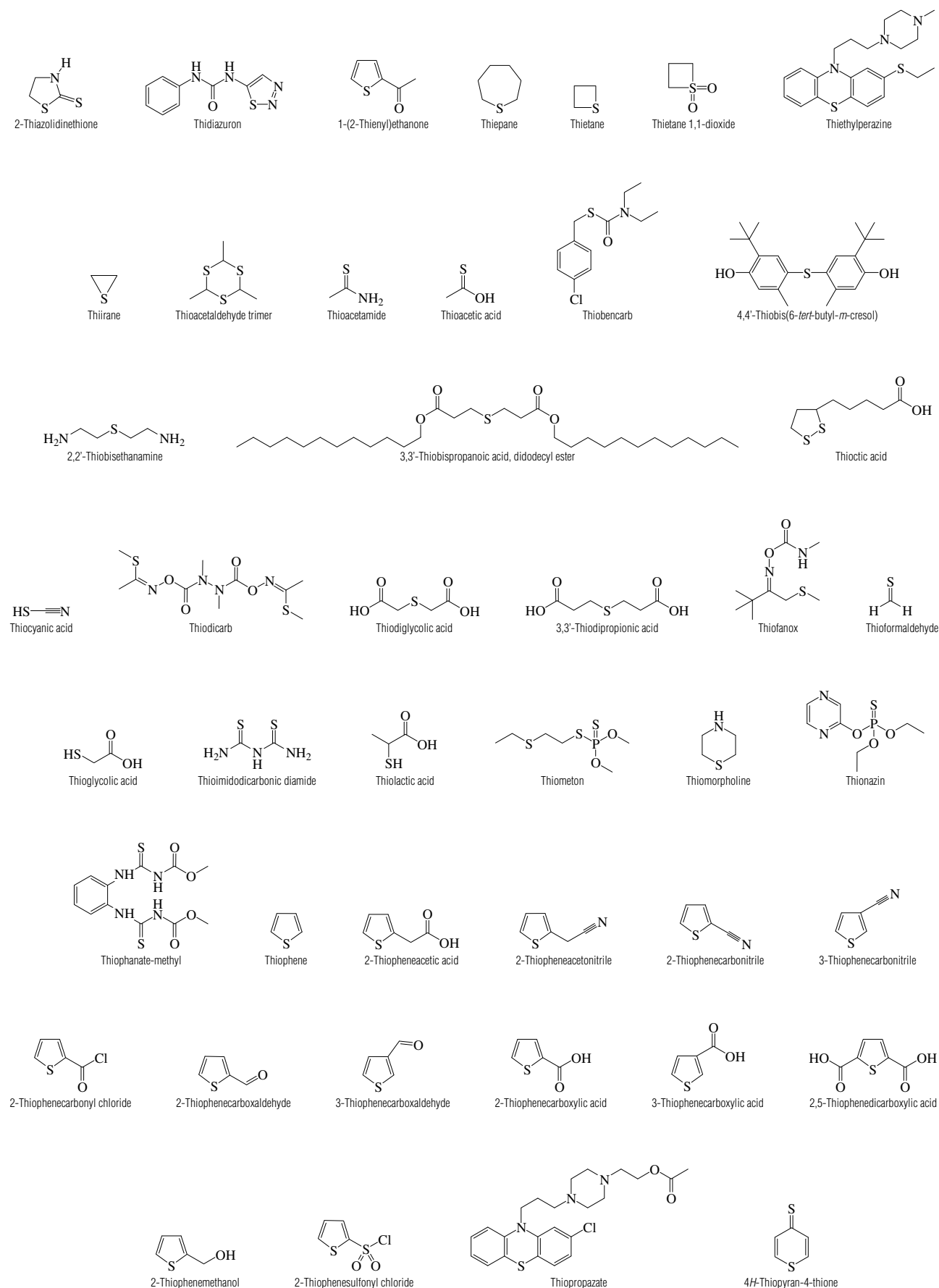
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9946	<i>N,N,N',N'</i> -Tetramethyl-1,2-ethanediamine	1,2-Dimethylaminoethane	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	110-18-9	116.204	liq	-55	121	0.777 <sup>25</sup>	1.4179 <sup>20</sup>	
9947	Tetramethylgermane	Germanium tetramethyl	C <sub>4</sub> H <sub>12</sub> Ge	865-52-1	132.78			32 <sup>500</sup>	1.006		
9948	1,1,3,3-Tetramethylguanidine		C <sub>2</sub> H <sub>13</sub> N <sub>3</sub>	80-70-6	115.177						s ctc
9949	2,2,6,6-Tetramethyl-3,5-heptanedione	Dipivaloylmethane	C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	1118-71-4	184.276			93 <sup>25</sup> , 72 <sup>5</sup>	0.883 <sup>25</sup>	1.4589 <sup>20</sup>	sl ctc
9950	3,7,11,15-Tetramethylhexadecanoic acid	Phytanic acid	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	14721-66-5	312.531		-65				
9951	3,7,11,15-Tetramethyl-1-hexadecen-3-ol	Isophytol	C <sub>20</sub> H <sub>40</sub> O	505-32-8	296.531	oil		108 <sup>001</sup>	0.8519 <sup>20</sup>	1.4571 <sup>20</sup>	vs bz, eth, EtOH
9952	2,2,3,3-Tetramethylhexane		C <sub>10</sub> H <sub>22</sub>	13475-81-5	142.282	liq	-54	160.3	0.7609 <sup>25</sup>	1.4282 <sup>20</sup>	
9953	2,2,5,5-Tetramethylhexane		C <sub>10</sub> H <sub>22</sub>	1071-81-4	142.282	liq	-12.6	137.4	0.7148 <sup>25</sup>	1.4055 <sup>20</sup>	
9954	3,3,4,4-Tetramethylhexane		C <sub>10</sub> H <sub>22</sub>	5171-84-6	142.282			170.0	0.7789 <sup>25</sup>	1.4368 <sup>20</sup>	
9955	<i>N,N,N',N'</i> -Tetramethyl-1,6-hexanediamine		C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>	111-18-2	172.311			209.5	0.806 <sup>25</sup>	1.4359 <sup>20</sup>	
9956	Tetramethyl lead		C <sub>4</sub> H <sub>12</sub> Pb	75-74-1	267.3	liq	-30.2	110	1.995 <sup>20</sup>		
9957	<i>N,N,N',N'</i> -Tetramethylmethanediamine		C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	51-80-9	102.178			83	0.7491 <sup>18</sup>		s H <sub>2</sub> O
9958	Tetramethyloxirane		C <sub>6</sub> H <sub>12</sub> O	5076-20-0	100.158			90.4	0.8156 <sup>16</sup>	1.3984 <sup>16</sup>	s H <sub>2</sub> O
9959	2,6,10,14-Tetramethylpentadecane	Pristane	C <sub>19</sub> H <sub>40</sub>	1921-70-6	268.521			296	0.7791 <sup>25</sup>	1.4370 <sup>25</sup>	vs bz, eth, chl, peth
9960	2,2,3,3-Tetramethylpentane		C <sub>9</sub> H <sub>20</sub>	7154-79-2	128.255	liq	-9.75	140.2	0.7530 <sup>25</sup>	1.4236 <sup>20</sup>	
9961	2,2,3,4-Tetramethylpentane		C <sub>9</sub> H <sub>20</sub>	1186-53-4	128.255	liq	-121.0	133.0	0.7389 <sup>20</sup>	1.4147 <sup>20</sup>	
9962	2,2,4,4-Tetramethylpentane	Di- <i>tert</i> -butylmethane	C <sub>9</sub> H <sub>20</sub>	1070-87-7	128.255	liq	-66.54	122.29	0.7195 <sup>20</sup>	1.4069 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, bz
9963	2,3,3,4-Tetramethylpentane		C <sub>9</sub> H <sub>20</sub>	16747-38-9	128.255	liq	-102.1	141.5	0.7547 <sup>20</sup>	1.4222 <sup>20</sup>	
9964	2,2,4,4-Tetramethyl-3-pentanol		C <sub>9</sub> H <sub>20</sub> O	14609-79-1	144.254		52	165.5			
9965	2,3,4,5-Tetramethylphenol	Prehnitenol	C <sub>10</sub> H <sub>14</sub> O	488-70-0	150.217	nd (lig, aq al)	85.3	266			sl H <sub>2</sub> O, lig; vs EtOH, eth
9966	2,3,4,6-Tetramethylphenol		C <sub>10</sub> H <sub>14</sub> O	3238-38-8	150.217	cry (peth)	80.5	240			s EtOH
9967	2,3,5,6-Tetramethylphenol		C <sub>10</sub> H <sub>14</sub> O	527-35-5	150.217	nd (lig), pr (al)	118.5	247			s chl, peth, HOAc
9968	2,2,6,6-Tetramethyl-4-piperidinamine		C <sub>9</sub> H <sub>20</sub> N <sub>2</sub>	36768-62-4	156.268		17	188.5	0.912 <sup>25</sup>	1.4706 <sup>20</sup>	
9969	2,2,6,6-Tetramethylpiperidine	Norpempidine	C <sub>9</sub> H <sub>19</sub> N	768-66-1	141.254		28	156	0.8367 <sup>16</sup>	1.4455 <sup>20</sup>	vs eth
9970	2,2,6,6-Tetramethyl-4-piperidinone		C <sub>9</sub> H <sub>17</sub> NO	826-36-8	155.237	orth pl (eth-w) nd (eth)	36	205			s H <sub>2</sub> O, EtOH, eth; sl chl
9971	<i>N,N,N',N'</i> -Tetramethyl-1,3-propanediamine		C <sub>7</sub> H <sub>18</sub> N <sub>2</sub>	110-95-2	130.231			144	0.7837 <sup>18</sup>		msc H <sub>2</sub> O, EtOH, eth
9972	Tetramethylpyrazine		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	1124-11-4	136.194	cry (w)	86	190			
9973	Tetramethylsilane	TMS	C <sub>4</sub> H <sub>12</sub> Si	75-76-3	88.224	vol liq or gas	-99.06	26.6	0.648 <sup>19</sup>	1.3587 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; i sulf
9974	Tetramethyl silicate	Methyl silicate	C <sub>4</sub> H <sub>12</sub> O <sub>2</sub> Si	681-84-5	152.222	liq	-1.0	121	1.0232 <sup>20</sup>	1.3683 <sup>20</sup>	vs EtOH
9975	Tetramethylstannane		C <sub>4</sub> H <sub>12</sub> Sn	594-27-4	178.848	liq	-55.1	78	1.314 <sup>25</sup>	1.4386	i H <sub>2</sub> O; s ctc, CS <sub>2</sub>
9976	Tetramethylsuccinonitrile	Tetramethylbutanedinitrile	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	3333-52-6	136.194	mcl pl, lf, pr (dil al)	170.5		1.070 <sup>25</sup>		s EtOH
9977	2,4,6,8-Tetramethyl-2,4,6,8-tetraphenylcyclotetrasiloxane		C <sub>28</sub> H <sub>32</sub> O <sub>4</sub> Si <sub>4</sub>	77-63-4	544.894	cry (HOAc)	99	237 <sup>115</sup>	1.1183 <sup>20</sup>	1.5461 <sup>20</sup>	i H <sub>2</sub> O; msc ace, hp
9978	Tetramethylthiodicarbonic diamide		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>3</sub>	97-74-5	208.367		109.5		1.37 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, ace, bz, chl; sl eth
9979	Tetramethylthiourea		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S	2782-91-4	132.227		79.3	245			s H <sub>2</sub> O, EtOH, chl; sl eth
9980	Tetramethylurea		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O	632-22-4	116.161	liq	-0.6	176.5	0.9687 <sup>20</sup>	1.4496 <sup>23</sup>	sl EtOH, eth, ctc
9981	Tetranitromethane		CN <sub>4</sub> O <sub>8</sub>	509-14-8	196.033		13.8	126.1	1.6380 <sup>20</sup>	1.4384 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
9982	2,4,8,10-Tetraoxaspiro[5.5]undecane		C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	126-54-5	160.168		48.3	147 <sup>23</sup> , 68 <sup>1</sup>			vs H <sub>2</sub> O, ace, eth, EtOH
9983	2,5,8,11-Tetraoxatridecan-13-ol		C <sub>9</sub> H <sub>20</sub> O <sub>5</sub>	23783-42-8	208.252			164 <sup>11</sup>	0.987 <sup>25</sup>	1.4453 <sup>20</sup>	
9984	Tetraphenoxysilane		C <sub>24</sub> H <sub>20</sub> O <sub>4</sub> Si	1174-72-7	400.500		49	417; 236 <sup>1</sup>	1.1412 <sup>60</sup>		
9985	1,1,4,4-Tetraphenyl-1,3-butadiene		C <sub>28</sub> H <sub>22</sub>	1450-63-1	358.475		203.5				s EtOH, bz, chl, HOAc
9986	2,3,4,5-Tetraphenyl-2,4-cyclopentadien-1-one		C <sub>29</sub> H <sub>20</sub> O	479-33-4	384.468	blk-viol lf (HOAc, xyl)	222.3				s EtOH, bz, xyl, HOAc
9987	1,1,2,2-Tetraphenylethane		C <sub>26</sub> H <sub>22</sub>	632-50-8	334.453	cry (bz), orth nd (chl)	214.5	360			sl EtOH; s bz, HOAc
9988	1,1,2,2-Tetraphenyl-1,2-ethanediol	Benzopinacol	C <sub>26</sub> H <sub>22</sub> O <sub>2</sub>	464-72-2	366.452	pr (bz), cry (ace)	182				i H <sub>2</sub> O, peth; sl EtOH; s eth, ace, CS <sub>2</sub>
9989	1,1,2,2-Tetraphenylethane		C <sub>26</sub> H <sub>20</sub>	632-51-9	332.437	mcl or orth (bz-eth or chl-al)	225	420	1.155 <sup>0</sup>		i H <sub>2</sub> O; sl EtOH, chl, eth; vs bz
9990	Tetraphenylgermane	Germanium tetraphenyl	C <sub>24</sub> H <sub>20</sub> Ge	1048-05-1	381.06		229.0				



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
9991	Tetraphenylmethane		C <sub>25</sub> H <sub>20</sub>	630-76-2	320.427	orth nd (bz, sub)	282	431			i H <sub>2</sub> O, EtOH, eth, lig, HOAc; s bz, tol
9992	5,6,11,12-Tetraphenyl-naphthacene	Rubrene	C <sub>42</sub> H <sub>28</sub>	517-51-1	532.671	oran-red (bz-lig)	332.5				i H <sub>2</sub> O; sl EtOH, eth, ace, py; s bz
9993	Tetraphenylplumbane		C <sub>24</sub> H <sub>20</sub> Pb	595-89-1	515.6		228.3	126 <sup>13</sup>	1.5298 <sup>20</sup>		s chl
9994	Tetraphenylsilane		C <sub>24</sub> H <sub>20</sub> Si	1048-08-4	336.502		236.5	228 <sup>3</sup>	1.078 <sup>20</sup>		s ctc, CS <sub>2</sub>
9995	Tetraphenylstannane		C <sub>24</sub> H <sub>20</sub> Sn	595-90-4	427.126		228	420			sl chl
9996	Tetrapropoxysilane		C <sub>12</sub> H <sub>28</sub> O <sub>4</sub> Si	682-01-9	264.434			226	0.9158 <sup>20</sup>	1.4012 <sup>20</sup>	s ctc, CS <sub>2</sub>
9997	Tetrapropylammonium bromide	<i>N,N,N</i> -Tripropyl-1-propanaminium bromide	C <sub>12</sub> H <sub>28</sub> BrN	1941-30-6	266.261		252				vs H <sub>2</sub> O, chl
9998	Tetrapropylammonium iodide		C <sub>12</sub> H <sub>28</sub> IN	631-40-3	313.261	orth bipym	280 dec		1.3138 <sup>25</sup>		vs H <sub>2</sub> O, chl; s EtOH, HOAc; sl eth
9999	Tetrapropylstannane		C <sub>12</sub> H <sub>28</sub> Sn	2176-98-9	291.060	liq	-109.1	228	1.1065 <sup>20</sup>	1.4745 <sup>20</sup>	
10000	Tetrapropyl thiodiphosphate	Aspon	C <sub>12</sub> H <sub>28</sub> O <sub>9</sub> P <sub>2</sub> S <sub>2</sub>	3244-90-4	378.425	amber liq		104 <sup>9,1</sup>	1.12 <sup>25</sup>	1.4710 <sup>21</sup>	sl H <sub>2</sub> O, peth
10001	Tetrapropyl titanate	1-Propanol, titanium(4+) salt	C <sub>12</sub> H <sub>28</sub> O <sub>4</sub> Ti	3087-37-4	284.215			206 <sup>100</sup>			sl EtOH
10002	Tetrasodium EDTA	Edetate sodium	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> Na <sub>4</sub> O <sub>8</sub>	64-02-8	380.169	amorp pow	300 (dihydrate)				sl EtOH
10003	Tetratetracontane		C <sub>44</sub> H <sub>90</sub>	7098-22-8	619.186		85.6				
10004	Tetraacontane		C <sub>34</sub> H <sub>70</sub>	14167-59-0	478.920	pl (eth)	72.5	285.4 <sup>3</sup>	0.7728 <sup>90</sup>	1.4296 <sup>90</sup>	
10005	Tetravinylsilane		C <sub>8</sub> H <sub>12</sub> Si	1112-55-6	136.267			130.2	0.7999 <sup>20</sup>	1.4625 <sup>20</sup>	
10006	2,4,6,8-Tetravinyl-2,4,6,8-tetramethylcyclotetrasiloxane		C <sub>12</sub> H <sub>24</sub> O <sub>4</sub> Si <sub>4</sub>	2554-06-5	344.659	liq	-43.5	224; 111 <sup>12</sup>	0.9875 <sup>20</sup>		s ctc, CS <sub>2</sub>
10007	1,2,4,5-Tetrazine	<i>sym</i> -Tetrazine	C <sub>2</sub> H <sub>2</sub> N <sub>4</sub>	290-96-0	82.064	dk red pr	99	sub			s H <sub>2</sub> O, EtOH, eth, sulf
10008	1 <i>H</i> -Tetrazol-5-amine		CH <sub>3</sub> N <sub>3</sub>	4418-61-5	85.069		204 dec				
10009	1 <i>H</i> -Tetrazole		CH <sub>2</sub> N <sub>4</sub>	288-94-8	70.054	pl (al)	157.3	sub	1.4060 <sup>20</sup>		sl H <sub>2</sub> O
10010	Tetrodotoxin		C <sub>11</sub> H <sub>17</sub> N <sub>3</sub> O <sub>8</sub>	4368-28-9	319.268	cry	225 dec				sl H <sub>2</sub> O, eth, EtOH; s dil HOAc
10011	Thalidomide	2-(2,6-Dioxo-3-piperidinyl)-1 <i>H</i> -isoindole-1,3(2 <i>H</i> )-dione	C <sub>13</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	50-35-1	258.229	nd	270				vs py, diox
10012	Thallium(I) ethanolate	Thalious ethoxide	C <sub>2</sub> H <sub>5</sub> OTl	20398-06-5	249.443	cloudy liq	-3	dec 130	3.49		dec H <sub>2</sub> O
10013	Thebaine		C <sub>19</sub> H <sub>21</sub> NO <sub>3</sub>	115-37-7	311.375	pl (eth), pr (dil al)	193	sub 91	1.305 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, chl; sl eth; s bz
10014	Thebainone		C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	467-98-1	299.365	nd or pr (al)	151.5				sl H <sub>2</sub> O, EtOH, eth; s ace, bz, AcOEt
10015	Thenaldine	1-Methyl- <i>N</i> -phenyl- <i>N</i> -(2-thienylmethyl)-4-piperidinamine	C <sub>17</sub> H <sub>22</sub> N <sub>2</sub> S	86-12-4	286.435		96	159 <sup>0,2</sup>			
10016	Thenyldiamine		C <sub>14</sub> H <sub>18</sub> N <sub>2</sub> S	91-79-2	261.386			170 <sup>1</sup>		1.5915 <sup>20</sup>	
10017	Theobromine		C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	83-67-0	180.165	orth or mcl nd (w)	357	sub 290			sl H <sub>2</sub> O, EtOH; i eth, bz, ctc, lig, chl
10018	Theophylline	3,7-Dihydro-1,3-dimethyl-1 <i>H</i> -purine-2,6-dione	C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	58-55-9	180.165	nd or pl (w+1)	273				s H <sub>2</sub> O; sl EtOH, eth, chl
10019	Thiabenzazole	1 <i>H</i> -Benzimidazole, 2-(4-thiazolyl)-	C <sub>10</sub> H <sub>7</sub> N <sub>3</sub> S	148-79-8	201.248			sub 305			
10020	Thiacetazone		C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> OS	104-06-3	236.293		225 dec				i H <sub>2</sub> O, os, CS <sub>2</sub>
10021	Thiacyclohexane		C <sub>6</sub> H <sub>10</sub> S	1613-51-0	102.198		19	141.8	0.9861 <sup>20</sup>	1.5067 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz
10022	1,2,5-Thiadiazole	Piazthiole	C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> S	288-39-1	86.115	liq	-50.1	94	1.268 <sup>25</sup>	1.5150 <sup>25</sup>	
10023	1,3,4-Thiadiazole		C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> S	289-06-5	86.115	cry (sub)	42.5	204			
10024	1,3,4-Thiadiazolidine-2,5-dithione		C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> S <sub>3</sub>	1072-71-5	150.245	ye cry (MeOH)	168				s H <sub>2</sub> O
10025	Thiamine chloride		C <sub>12</sub> H <sub>17</sub> ClN <sub>4</sub> OS	59-43-8	300.807	cry	164				s H <sub>2</sub> O
10026	Thiamine hydrochloride		C <sub>12</sub> H <sub>18</sub> Cl <sub>2</sub> N <sub>4</sub> OS	67-03-8	337.268	mcl pl	248 dec				vs H <sub>2</sub> O; sl EtOH; i eth, bz, chl
10027	Thiamine <i>O</i> -phosphate, chloride		C <sub>12</sub> H <sub>18</sub> ClN <sub>4</sub> O <sub>4</sub> PS	532-40-1	380.787		200				
10028	Thianthrene		C <sub>12</sub> H <sub>6</sub> S <sub>2</sub>	92-85-3	216.322	mcl pr or pl (al)	159.3	365	1.4420 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz, CS <sub>2</sub>
10029	2-Thiazolamine	2-Aminothiazole	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> S	96-50-4	100.142	ye pl (al)	93	140 <sup>11</sup>			sl H <sub>2</sub> O, EtOH, eth, chl; vs dil HCl
10030	Thiazole		C <sub>3</sub> H <sub>3</sub> NS	288-47-1	85.128		-33.62	118	1.1998 <sup>17</sup>	1.5969 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, ace
10031	Thiazolidine		C <sub>3</sub> H <sub>7</sub> NS	504-78-9	89.160			164.5	1.131 <sup>25</sup>	1.551 <sup>20</sup>	msc H <sub>2</sub> O; s EtOH, ctc; vs eth, ace
10032	4-Thiazolidinecarboxylic acid	Timonacic	C <sub>4</sub> H <sub>7</sub> NO <sub>2</sub> S	444-27-9	133.170	cry (w)	196.5				vs H <sub>2</sub> O
10033	2,4-Thiazolidinedione		C <sub>3</sub> H <sub>3</sub> NO <sub>2</sub> S	2295-31-0	117.127	pl (w), pr (al)	128	179 <sup>19</sup>			vs eth

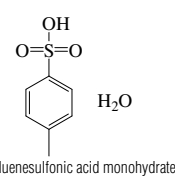
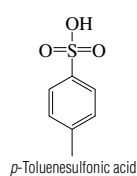
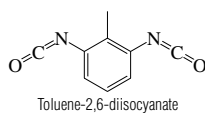
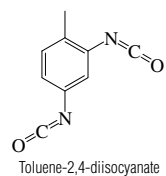
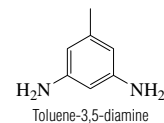
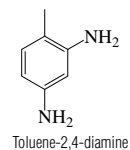
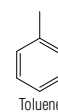
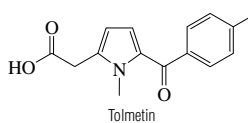
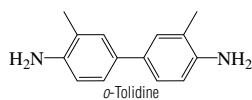
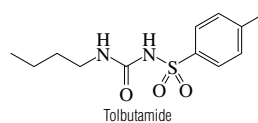
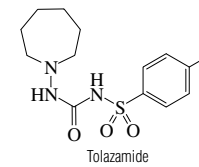
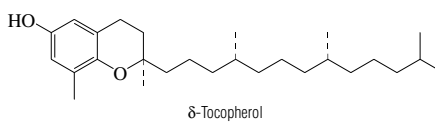
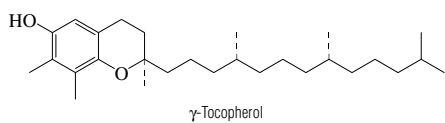
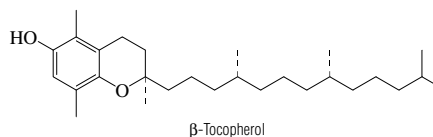
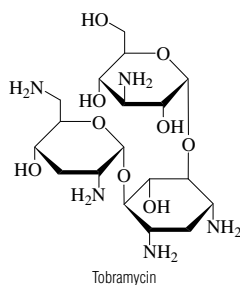
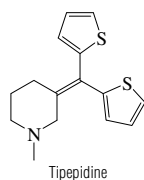
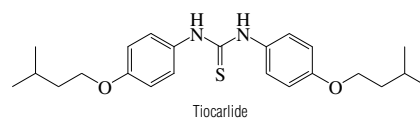
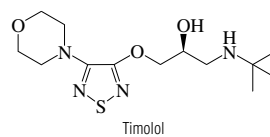
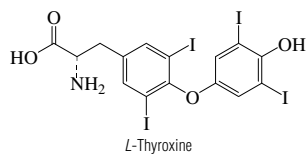
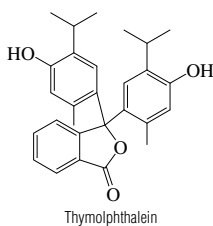
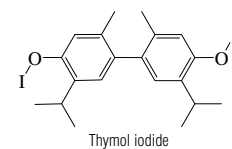
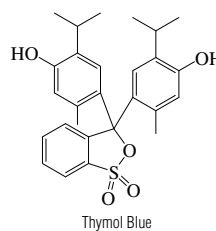
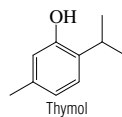
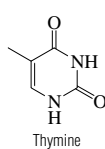
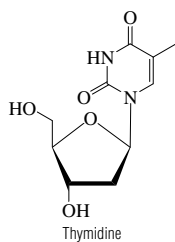
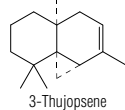
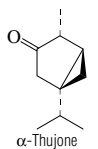
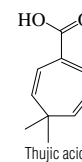
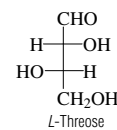
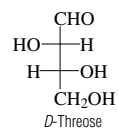
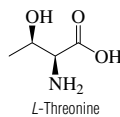
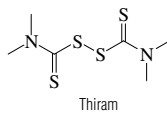
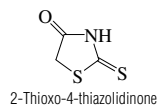
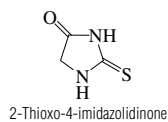
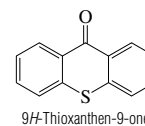
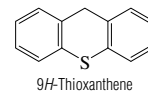
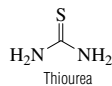
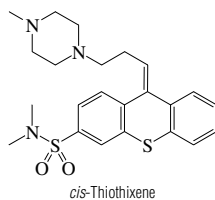
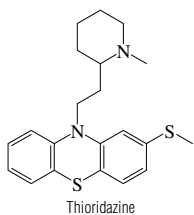
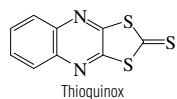


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10034	2-Thiazolidinethione		C <sub>3</sub> H <sub>5</sub> NS <sub>2</sub>	96-53-7	119.209	nd (w, MeOH)	107.3				s H <sub>2</sub> O, bz, chl; sl EtOH; i eth, CS <sub>2</sub>
10035	Thidiazuron	<i>N</i> -Phenyl- <i>N'</i> -1,2,3-thiadiazol-5-yl-urea	C <sub>9</sub> H <sub>8</sub> N <sub>4</sub> OS	51707-55-2	220.251		211 dec				
10036	1-(2-Thienyl)ethanone		C <sub>8</sub> H <sub>6</sub> OS	88-15-3	126.176		10.5	213.5	1.1679 <sup>20</sup>	1.5667 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
10037	Thiepane	Hexamethylene sulfide	C <sub>6</sub> H <sub>12</sub> S	4753-80-4	116.224	liq	0.5	173.5	0.991 <sup>20</sup>	1.5044 <sup>18</sup>	i H <sub>2</sub> O; s eth, ace, chl
10038	Thietane	Trimethylene sulfide	C <sub>3</sub> H <sub>6</sub> S	287-27-4	74.145	liq	-73.24	95.0	1.0200 <sup>20</sup>	1.5102 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, bz; s ace
10039	Thietane 1,1-dioxide	Trimethylene sulfone	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	5687-92-3	106.144		75.5	91.2 <sup>14</sup>		1.5156 <sup>20</sup>	s H <sub>2</sub> O, EtOH; sl eth, peth
10040	Thiethylperazine		C <sub>22</sub> H <sub>29</sub> N <sub>3</sub> S <sub>2</sub>	1420-55-9	399.615	cry	63	227 <sup>0.01</sup>			sl ace
10041	Thiirane	Ethylene sulfide	C <sub>2</sub> H <sub>4</sub> S	420-12-2	60.118		-109	dec 57	1.0130 <sup>20</sup>	1.4935 <sup>20</sup>	sl EtOH, eth; s ace, chl
10042	Thioacetaldehyde trimer	2,4,6-Trimethyl-1,3,5-trithiane	C <sub>6</sub> H <sub>12</sub> S <sub>3</sub>	2765-04-0	180.354	α-mcl pl; β-nd (ace)	101	246.5			i H <sub>2</sub> O; s EtOH, eth, ace; vs bz, chl
10043	Thioacetamide	Ethanethioamide	C <sub>2</sub> H <sub>5</sub> NS	62-55-5	75.133		115.5				vs H <sub>2</sub> O, EtOH; sl eth, bz; s DMSO
10044	Thioacetic acid		C <sub>2</sub> H <sub>4</sub> OS	507-09-5	76.117	ye fuming liq	<-17	93; 26 <sup>35</sup>	1.064 <sup>20</sup>	1.4648 <sup>20</sup>	s H <sub>2</sub> O, chl; vs EtOH, ace; msc eth
10045	Thiobencarb		C <sub>12</sub> H <sub>16</sub> ClNOS	28249-77-6	257.779		1.7	127 <sup>0.008</sup>	1.16 <sup>20</sup>		
10046	4,4'-Thiobis(6- <i>tert</i> -butyl- <i>m</i> -cresol)	Bis(5- <i>tert</i> -butyl-4-hydroxy-2-methylphenyl) sulfide	C <sub>22</sub> H <sub>30</sub> O <sub>2</sub> S	96-69-5	358.537	cry	163				
10047	2,2'-Thiobisethanamine	Bis(2-aminoethyl) sulfide	C <sub>4</sub> H <sub>12</sub> N <sub>2</sub> S	871-76-1	120.216	ye cry		232; 119 <sup>17</sup>			
10048	3,3'-Thiobispropanoic acid, didodecyl ester	Didodecyl thiobispropanoate	C <sub>30</sub> H <sub>58</sub> O <sub>4</sub> S	123-28-4	514.845		39				
10049	Thioctic acid	1,2-Dithiolane-3-pentanoic acid	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub> S <sub>2</sub>	62-46-4	206.326	ye nd	61	162			i H <sub>2</sub> O
10050	Thiocyanic acid		CHNS	463-56-9	59.091		dec 0				vs H <sub>2</sub> O; s os
10051	Thiodicarb		C <sub>10</sub> H <sub>18</sub> N <sub>4</sub> O <sub>4</sub> S <sub>3</sub>	59669-26-0	354.470		173		1.4 <sup>20</sup>		
10052	Thiodiglycolic acid	Thiodiacetic acid	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub> S	123-93-3	150.154	cry (w)	129				sl H <sub>2</sub> O; vs EtOH; s bz
10053	3,3'-Thiodipropionic acid		C <sub>8</sub> H <sub>10</sub> O <sub>4</sub> S	111-17-1	178.206	cry wh pow	129				vs H <sub>2</sub> O, EtOH
10054	Thiofanox		C <sub>9</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub> S	39196-18-4	218.316		57				
10055	Thioformaldehyde	Methanethial	CH <sub>2</sub> S	865-36-1	46.092	unstab gas					
10056	Thioglycolic acid		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> S	68-11-1	92.117		-16.5	120 <sup>20</sup>	1.3253 <sup>20</sup>	1.5080 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, eth; sl chl
10057	Thioimidodicarbonic diamide	2,4-Dithiobiuret	C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> S <sub>2</sub>	541-53-7	135.211	mcl cry	181 dec				vs ace
10058	Thiolactic acid		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	71563-86-5	106.144		12	106 <sup>15</sup>	1.1938 <sup>20</sup>	1.4810 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth; sl chl
10059	Thiometon		C <sub>8</sub> H <sub>15</sub> O <sub>2</sub> PS <sub>3</sub>	640-15-3	246.351	oil		110 <sup>0.1</sup> , 77 <sup>0.01</sup>	1.209 <sup>20</sup>		sl H <sub>2</sub> O; s os
10060	Thiomorpholine	Thiamorpholine	C <sub>4</sub> H <sub>8</sub> NS	123-90-0	103.186			175; 110 <sup>100</sup>	1.0882 <sup>20</sup>	1.5386 <sup>20</sup>	vs H <sub>2</sub> O, ace, eth, EtOH
10061	Thionazin	Phosphorothioic acid, <i>O,O</i> -diethyl <i>O</i> -pyrazinyl ester	C <sub>8</sub> H <sub>13</sub> N <sub>2</sub> O <sub>3</sub> PS	297-97-2	248.239	liq	-0.9	80			
10062	Thiophanate-methyl		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>4</sub> S <sub>2</sub>	23564-05-8	342.394		172 dec				
10063	Thiophene	Thiofuran	C <sub>4</sub> H <sub>4</sub> S	110-02-1	84.140	liq	-38.21	84.0	1.0649 <sup>20</sup>	1.5289 <sup>20</sup>	msc EtOH, eth, ace, bz, ctc, diox, py; sl chl
10064	2-Thiopheneacetic acid		C <sub>6</sub> H <sub>6</sub> O <sub>2</sub> S	1918-77-0	142.176	cry (w)	76				vs H <sub>2</sub> O, eth, EtOH
10065	2-Thiopheneacetonitrile		C <sub>6</sub> H <sub>5</sub> NS	20893-30-5	123.176			120 <sup>23</sup>	1.155 <sup>25</sup>	1.5425 <sup>20</sup>	
10066	2-Thiophenecarbonitrile	2-Cyanothiophene	C <sub>5</sub> H <sub>3</sub> NS	1003-31-2	109.150			192	1.172 <sup>25</sup>	1.5629 <sup>20</sup>	s chl
10067	3-Thiophenecarbonitrile	3-Cyanothiophene	C <sub>5</sub> H <sub>3</sub> NS	1641-09-4	109.150	oil		204; 85 <sup>15</sup>			
10068	2-Thiophenecarbonyl chloride		C <sub>5</sub> H <sub>4</sub> ClOS	5271-67-0	146.595			280			
10069	2-Thiophenecarboxaldehyde		C <sub>5</sub> H <sub>4</sub> OS	98-03-3	112.150	pa ye liq		197; 85 <sup>16</sup>	1.2127 <sup>21</sup>	1.5920 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; s eth; sl chl
10070	3-Thiophenecarboxaldehyde	3-Formylthiophene	C <sub>5</sub> H <sub>4</sub> OS	498-62-4	112.150			86.7 <sup>20</sup>		1.5855 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
10071	2-Thiophenecarboxylic acid	2-Carboxythiophene	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub> S	527-72-0	128.150	nd (w)	129.5	dec 260			vs H <sub>2</sub> O, EtOH, eth; s chl; sl peth
10072	3-Thiophenecarboxylic acid	3-Thenoic acid	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub> S	88-13-1	128.150		138				s H <sub>2</sub> O
10073	2,5-Thiophenedicarboxylic acid	2,5-Dicarboxythiophene	C <sub>6</sub> H <sub>4</sub> O <sub>4</sub> S	4282-31-9	172.159		359	sub 150			sl H <sub>2</sub> O; s EtOH, eth
10074	2-Thiophenemethanol		C <sub>5</sub> H <sub>6</sub> OS	636-72-6	114.166			207; 86 <sup>10</sup>	1.2053 <sup>16</sup>	1.5280 <sup>20</sup>	s EtOH, ace
10075	2-Thiophenesulfonyl chloride		C <sub>6</sub> H <sub>4</sub> ClO <sub>2</sub> S <sub>2</sub>	16629-19-9	182.649		28	100 <sup>6</sup>			s eth
10076	Thiopropazate		C <sub>23</sub> H <sub>28</sub> ClN <sub>3</sub> O <sub>2</sub> S	84-06-0	446.005			216 <sup>0.1</sup>			
10077	4 <i>H</i> -Thiopyran-4-thione		C <sub>5</sub> H <sub>6</sub> S <sub>2</sub>	1120-94-1	128.216		47				

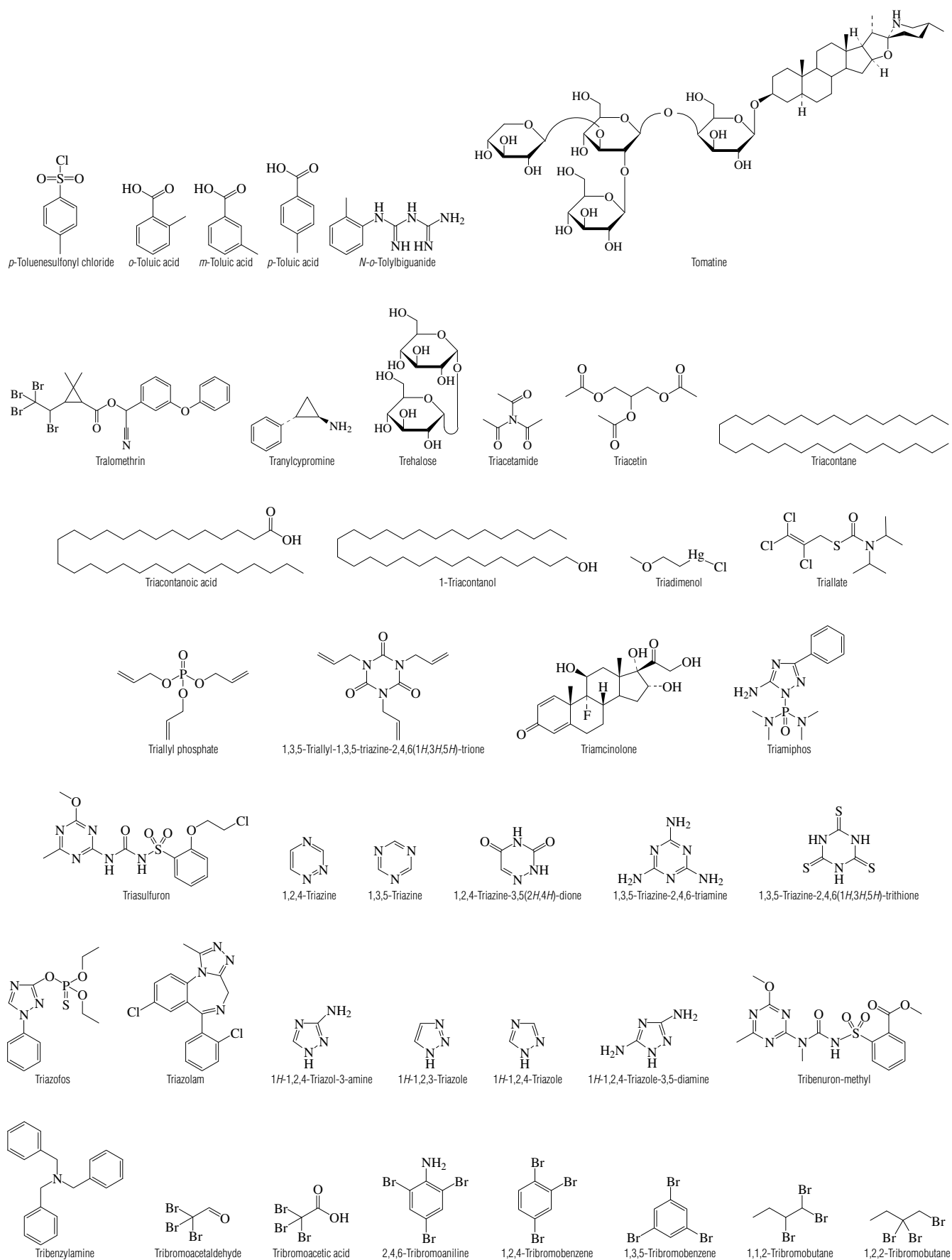


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10078	Thioquinox		C <sub>9</sub> H <sub>4</sub> N <sub>2</sub> S <sub>3</sub>	93-75-4	236.336	br-ye pow	180				i H <sub>2</sub> O; sl ace, EtOH, peth
10079	Thioridazine		C <sub>12</sub> H <sub>26</sub> N <sub>2</sub> S <sub>2</sub>	50-52-2	262.477	cry	73	230 <sup>0.02</sup>			sl ace
10080	<i>cis</i> -Thiothixene		C <sub>23</sub> H <sub>28</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	3313-26-6	443.625	cry	148				
10081	Thiourea	Thiocarbamide	CH <sub>4</sub> N <sub>2</sub> S	62-56-6	76.121	orth (al)	178		1.405 <sup>25</sup>		s H <sub>2</sub> O, EtOH; i eth
10082	9 <i>H</i> -Thioxanthene	Dibenzothiapyran	C <sub>13</sub> H <sub>10</sub> S	261-31-4	198.283	nd (al-chl)	128.5	341			s chl
10083	9 <i>H</i> -Thioxanthen-9-one	Thioxanthone	C <sub>13</sub> H <sub>8</sub> O	492-22-8	212.267	ye nd (chl)	209	373			i H <sub>2</sub> O, peth; sl EtOH; s bz, chl, CS <sub>2</sub>
10084	2-Thioxo-4-imidazolidinone	2-Thiohydantoin	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> OS	503-87-7	116.141	wh nd (w)	230 dec				vs H <sub>2</sub> O, EtOH; s eth, alk
10085	2-Thioxo-4-thiazolidinone	Rhodanine	C <sub>3</sub> H <sub>3</sub> NOS <sub>2</sub>	141-84-4	133.192	lt ye pr (al, w)	170		0.868 <sup>25</sup>		sl H <sub>2</sub> O, DMSO; vs EtOH, eth
10086	Thiram		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub>	137-26-8	240.432	wh or ye mcl (chl-al)	155.6	129 <sup>20</sup>			vs chl
10087	<i>L</i> -Threonine	2-Amino-3-hydroxybutanoic acid, [ <i>R</i> -( <i>R</i> *, <i>S</i> *)]	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	72-19-5	119.119		256 dec				s H <sub>2</sub> O; i EtOH, eth, chl
10088	<i>D</i> -Threose		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	95-43-2	120.105	hyg-syr or nd (w)	129				vs H <sub>2</sub> O
10089	<i>L</i> -Threose		C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	95-44-3	120.105						vs H <sub>2</sub> O
10090	Thujic acid	5,5-Dimethyl-1,3,6-cycloheptatriene-1-carboxylic acid	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	499-89-8	164.201	cry (peth)	88.5				
10091	$\alpha$ -Thujone	4-Methyl-1-(1-methylethyl)-bicyclo[3.1.0]hexan-3-one, (/)	C <sub>10</sub> H <sub>16</sub> O	546-80-5	152.233			201.2	0.9109 <sup>25</sup>	1.4490 <sup>15</sup>	i H <sub>2</sub> O; s EtOH
10092	3-Thujopsene	Widdrene	C <sub>15</sub> H <sub>24</sub>	470-40-6	204.352	liq		122 <sup>12</sup>	0.932 <sup>24</sup>	1.5031 <sup>25</sup>	
10093	Thymidine	Thymine 2-desoxyriboside	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	50-89-5	242.228	nd (AcOEt)	186.5				s H <sub>2</sub> O, EtOH, ace, py, HOAc; sl chl
10094	Thymine		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	65-71-4	126.114		316				sl H <sub>2</sub> O, EtOH, eth, DMSO
10095	Thymol	2-Isopropyl-5-methylphenol	C <sub>10</sub> H <sub>14</sub> O	89-83-8	150.217		49.5	232.5	0.970 <sup>25</sup>	1.5227 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, chl, AcOEt
10096	Thymol Blue		C <sub>27</sub> H <sub>30</sub> O <sub>5</sub> S	76-61-9	466.589	grn-red (al, eth)	222 dec				sl H <sub>2</sub> O, ace, bz; s EtOH, HOAc, PhNH <sub>2</sub>
10097	Thymol iodide		C <sub>20</sub> H <sub>24</sub> I <sub>2</sub> O <sub>2</sub>	552-22-7	550.213	amorp					i H <sub>2</sub> O; s eth; vs EtOH
10098	Thymolphthalein		C <sub>28</sub> H <sub>30</sub> O <sub>4</sub>	125-20-2	430.536	pr or nd (al)	253				i H <sub>2</sub> O; s EtOH, eth, ace; sl DMSO
10099	<i>L</i> -Thyroxine		C <sub>15</sub> H <sub>11</sub> I <sub>4</sub> NO <sub>4</sub>	51-48-9	776.871	nd	235				sl H <sub>2</sub> O; i EtOH, bz
10100	Timolol		C <sub>13</sub> H <sub>24</sub> N <sub>4</sub> O <sub>3</sub> S	26839-75-8	316.420	oil					
10101	Tiocarlide		C <sub>23</sub> H <sub>32</sub> N <sub>2</sub> O <sub>2</sub> S	910-86-1	400.577		146				
10102	Tipepidine	3-(Di-2-thienylmethylene)-1-methylpiperidine	C <sub>15</sub> H <sub>17</sub> NS <sub>2</sub>	5169-78-8	275.433	ye cry	65	181 <sup>4.5</sup>			
10103	Tobramycin		C <sub>18</sub> H <sub>37</sub> N <sub>5</sub> O <sub>3</sub>	32986-56-4	467.516	cry					s H <sub>2</sub> O
10104	$\beta$ -Tocopherol	5,8-Dimethyltolcol	C <sub>28</sub> H <sub>48</sub> O <sub>2</sub>	148-03-8	416.680	pa ye visc oil		205 <sup>0.1</sup>			vs ace, eth, EtOH, chl
10105	$\gamma$ -Tocopherol	7,8-Dimethyltolcol	C <sub>28</sub> H <sub>48</sub> O <sub>2</sub>	7616-22-0	416.680	pa ye visc oil	-1.5	205 <sup>0.1</sup>			i H <sub>2</sub> O; msc EtOH, eth, ace, chl
10106	$\delta$ -Tocopherol	8-Methyltolcol	C <sub>27</sub> H <sub>46</sub> O <sub>2</sub>	119-13-1	402.653	pa ye visc oil		150 <sup>0.001</sup>			i H <sub>2</sub> O; vs EtOH, eth, ace, chl
10107	Tolazamide		C <sub>14</sub> H <sub>21</sub> N <sub>3</sub> O <sub>3</sub> S	1156-19-0	311.400	cry	172				
10108	Tolbutamide	<i>N</i> -(Butylamino)carbonyl-4-methylbenzenesulfonamide	C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub> S	64-77-7	270.347	orth cry	128.5		1.245 <sup>25</sup>		sl H <sub>2</sub> O; s EtOH, eth, chl
10109	<i>o</i> -Tolidine	3,3'-Dimethylbenzidine	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub>	119-93-7	212.290	wh-red lf (EtOH aq)	131				sl H <sub>2</sub> O, chl; vs EtOH, eth
10110	Tolmetin		C <sub>15</sub> H <sub>15</sub> NO <sub>3</sub>	26171-23-3	257.285	cry (MeCN)	156 dec				
10111	Toluene	Methylbenzene	C <sub>7</sub> H <sub>8</sub>	108-88-3	92.139	liq	-94.95	110.63	0.8623 <sup>25</sup>	1.4941 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth; s ace, CS <sub>2</sub>
10112	Toluene-2,4-diamine	4-Methyl-1,3-benzenediamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	95-80-7	122.167	nd (w), cry (al)	99	292			vs H <sub>2</sub> O, EtOH, eth, bz; s chl
10113	Toluene-3,5-diamine	5-Methyl-1,3-benzenediamine	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	108-71-4	122.167	oil		284			
10114	Toluene-2,4-diisocyanate		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	584-84-9	174.156		20.5	251	1.2244 <sup>20</sup>		vs ace, bz, eth
10115	Toluene-2,6-diisocyanate		C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	91-08-7	174.156		18.3				dec H <sub>2</sub> O; s ace, bz
10116	<i>p</i> -Toluenesulfonic acid		C <sub>7</sub> H <sub>6</sub> O <sub>3</sub> S	104-15-4	172.202	hyg pl (w+1) mcl lf or pl	104.5	140 <sup>20</sup>			vs H <sub>2</sub> O; s EtOH, eth
10117	<i>p</i> -Toluenesulfonic acid monohydrate	4-Methylbenzenesulfonic acid, monohydrate	C <sub>7</sub> H <sub>10</sub> O <sub>4</sub> S	6192-52-5	190.217		105.3				s H <sub>2</sub> O

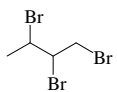




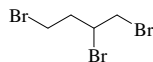
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10118	<i>p</i> -Toluenesulfonyl chloride		C <sub>7</sub> H <sub>7</sub> ClO <sub>2</sub> S	98-59-9	190.648	tcl (eth, peth)	71	145 <sup>15</sup>			i H <sub>2</sub> O; s EtOH, eth, chl; vs bz
10119	<i>o</i> -Toluic acid		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	118-90-1	136.149	pr or nd (w)	103.5	259	1.062 <sup>115</sup>	1.512 <sup>115</sup>	i H <sub>2</sub> O; vs EtOH, eth; s chl
10120	<i>m</i> -Toluic acid		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	99-04-7	136.149		109.9		1.054 <sup>112</sup>	1.509	sl H <sub>2</sub> O, chl; vs EtOH, eth
10121	<i>p</i> -Toluic acid		C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	99-94-5	136.149		179.6				i H <sub>2</sub> O; vs EtOH, eth, MeOH; sl tfa
10122	<i>N</i> - <i>o</i> -Tolylbiguanide	<i>N</i> -(2-Methylphenyl)imidodicarbonimidic diamide	C <sub>9</sub> H <sub>13</sub> N <sub>5</sub>	93-69-6	191.233	nd or pl (w+1)	145.0				sl H <sub>2</sub> O; vs EtOH, ace; i bz, chl, eth
10123	Tomatine		C <sub>50</sub> H <sub>83</sub> NO <sub>21</sub>	17406-45-0	1034.188	nd (MeOH)	270				vs EtOH, diox
10124	Tralomethrin		C <sub>22</sub> H <sub>19</sub> Br <sub>4</sub> NO <sub>3</sub>	66841-25-6	665.007	oran-ye solid					
10125	Tranlylcypromine	2-Phenylcyclopropylamine	C <sub>9</sub> H <sub>11</sub> N	155-09-9	133.190	cry	44	127 <sup>32</sup>			
10126	Trehalose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	99-20-7	342.296	orth cry	203		1.58 <sup>24</sup>		vs H <sub>2</sub> O; s EtOH; i eth, bz
10127	Triacetamide		C <sub>6</sub> H <sub>9</sub> NO <sub>3</sub>	641-06-5	143.140	nd (eth)	79				vs eth
10128	Triacetin	Glycerol triacetate	C <sub>9</sub> H <sub>14</sub> O <sub>6</sub>	102-76-1	218.203	col oily liq	-78	259	1.1583 <sup>20</sup>	1.4301 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz; vs ace
10129	Triacotane		C <sub>30</sub> H <sub>62</sub>	638-68-6	422.813	orth (eth, bz)	65.1	452.0	0.8097 <sup>20</sup>	1.4352 <sup>10</sup>	i H <sub>2</sub> O; sl EtOH; s eth; vs bz
10130	Triacotanoic acid		C <sub>30</sub> H <sub>60</sub> O <sub>2</sub>	506-50-3	452.796	sc, nd (al, ace)	93.6			1.4323 <sup>100</sup>	vs bz, CS <sub>2</sub> , chl
10131	1-Triacotanol	Myricyl alcohol	C <sub>30</sub> H <sub>62</sub> O	593-50-0	438.812	nd (eth), pl (bz)	88		0.777 <sup>95</sup>		vs bz, eth, EtOH
10132	Triadimenol	Mercury, chloro(2-methoxyethyl)-	C <sub>3</sub> H <sub>7</sub> ClHgO	123-88-6	295.13	cry	115				i H <sub>2</sub> O; s EtOH, ace
10133	Triallate		C <sub>10</sub> H <sub>16</sub> Cl <sub>3</sub> NOS	2303-17-5	304.664		29	1170 <sup>0003</sup>	1.273 <sup>25</sup>		
10134	Triallyl phosphate		C <sub>9</sub> H <sub>15</sub> O <sub>4</sub> P	1623-19-4	218.186		-50	108 <sup>7</sup>	1.0815 <sup>20</sup>		sl chl
10135	1,3,5-Triallyl-1,3,5-triazine-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-trione		C <sub>12</sub> H <sub>15</sub> N <sub>3</sub> O <sub>3</sub>	1025-15-6	249.265		20.5	149 <sup>4</sup> , 105 <sup>05</sup>	1.1590 <sup>20</sup>		
10136	Triamcinolone	Fluoxiprednisolone	C <sub>21</sub> H <sub>27</sub> FO <sub>6</sub>	124-94-7	394.433	cry	270				
10137	Triamphos		C <sub>12</sub> H <sub>19</sub> N <sub>6</sub> OP	1031-47-6	294.292	cry (EtOH aq)	167				sl H <sub>2</sub> O; s os
10138	Triasulfuron		C <sub>14</sub> H <sub>16</sub> ClN <sub>5</sub> O <sub>5</sub> S	82097-50-5	401.826		186				
10139	1,2,4-Triazine		C <sub>3</sub> H <sub>3</sub> N <sub>3</sub>	290-38-0	81.076	pa ye oil	16.5	157		1.5149 <sup>25</sup>	
10140	1,3,5-Triazine		C <sub>3</sub> H <sub>3</sub> N <sub>3</sub>	290-87-9	81.076		80.3	114	1.38 <sup>25</sup>		s EtOH, eth
10141	1,2,4-Triazine-3,5-(2 <i>H</i> ,4 <i>H</i> )-dione		C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>2</sub>	461-89-2	113.075		276.8				
10142	1,3,5-Triazine-2,4,6-triamine	Melamine	C <sub>3</sub> H <sub>6</sub> N <sub>6</sub>	108-78-1	126.120	mcl pr (w)	345 dec	sub	1.573 <sup>16</sup>	1.872 <sup>20</sup>	sl H <sub>2</sub> O, EtOH; i eth
10143	1,3,5-Triazine-2,4,6-(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-trithione	Triithiocyanuric acid	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> S <sub>3</sub>	638-16-4	177.271	ye pr	>300	100 <sup>22</sup>			
10144	Triazofos		C <sub>12</sub> H <sub>16</sub> N <sub>3</sub> O <sub>3</sub> PS	24017-47-8	313.312	ye-br oil	5		1.2514 <sup>20</sup>		i H <sub>2</sub> O; s os
10145	Triazolam		C <sub>17</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>4</sub>	28911-01-5	343.210	tan cry (2-PrOH)	234				
10146	1 <i>H</i> -1,2,4-Triazol-3-amine	Amitrole	C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	61-82-5	84.080	cry (w, al)	159				vs H <sub>2</sub> O, EtOH; i eth, ace; s chl; sl AcOEt
10147	1 <i>H</i> -1,2,3-Triazole		C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	288-36-8	69.065	hyg cry	23	204	1.1861 <sup>25</sup>	1.4854 <sup>25</sup>	s H <sub>2</sub> O; s eth, ace; i lig
10148	1 <i>H</i> -1,2,4-Triazole	Pyrrrodiazole	C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	288-88-0	69.065	nd (bz/EtOH)	120.5	260 dec			s H <sub>2</sub> O, EtOH
10149	1 <i>H</i> -1,2,4-Triazole-3,5-diamine		C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	1455-77-2	99.095		211.5				s H <sub>2</sub> O, EtOH; i eth, bz
10150	Tribenuron-methyl		C <sub>15</sub> H <sub>17</sub> N <sub>5</sub> O <sub>6</sub> S	101200-48-0	395.391	solid	141				
10151	Tribenzylamine	<i>N,N</i> -Bis(phenylmethyl)benzenemethanamine	C <sub>21</sub> H <sub>21</sub> N	620-40-6	287.399	pl (eth), mcl (al)	91.5	385	0.9912 <sup>95</sup>		sl H <sub>2</sub> O, EtOH; s eth, ctc
10152	Tribromoacetaldehyde	Bromal	C <sub>2</sub> HBr <sub>3</sub> O	115-17-3	280.740			174	2.6649 <sup>25</sup>	1.5939 <sup>20</sup>	vs ace, eth, EtOH
10153	Tribromoacetic acid		C <sub>2</sub> HBr <sub>3</sub> O <sub>2</sub>	75-96-7	296.740	mcl	132	dec 245			s H <sub>2</sub> O, EtOH, eth
10154	2,4,6-Tribromoaniline		C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub> N	147-82-0	329.815	nd (al, bz)	122	300	2.35 <sup>20</sup>		i H <sub>2</sub> O; sl EtOH; s eth, chl
10155	1,2,4-Tribromobenzene		C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub>	615-54-3	314.800		44.5	275			i H <sub>2</sub> O; s EtOH; vs eth, ace; sl bz
10156	1,3,5-Tribromobenzene		C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub>	626-39-1	314.800	nd or pr (al)	122.8	271			i H <sub>2</sub> O; sl EtOH; s eth, bz, chl
10157	1,1,2-Tribromobutane		C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	3675-68-1	294.811			216.2	2.1835 <sup>20</sup>	1.5626 <sup>17</sup>	vs eth, EtOH, chl
10158	1,2,2-Tribromobutane		C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	3675-69-2	294.811			213.8	2.1692 <sup>20</sup>	1.568 <sup>20</sup>	vs eth, EtOH, chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10159	1,2,3-Tribromobutane		C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	632-05-3	294.811	liq	-19	220	2.1907 <sup>20</sup>	1.5680 <sup>20</sup>	vs eth, EtOH, chl
10160	1,2,4-Tribromobutane		C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	38300-67-3	294.811	liq	-18	215	2.170 <sup>20</sup>	1.5608 <sup>20</sup>	vs eth, EtOH, chl
10161	2,2,3-Tribromobutane		C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	62127-47-3	294.811		0.9	206	2.1723 <sup>20</sup>	1.5602 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl; sl ctc
10162	Tribromochloromethane		CBBr <sub>2</sub> Cl	594-15-0	287.176	lf (eth)	55	158.5	2.71 <sup>15</sup>		vs eth
10163	1,1,2-Tribromoethane		C <sub>2</sub> H <sub>3</sub> Br <sub>3</sub>	78-74-0	266.757	liq	-29.3	188.93	2.6210 <sup>20</sup>	1.5933 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, ctc
10164	2,2,2-Tribromoethanol		C <sub>2</sub> H <sub>3</sub> Br <sub>3</sub> O	75-80-9	282.756	nd or pr (peth)	81	92 <sup>10</sup>			vs bz, eth, EtOH
10165	Tribromoethene		C <sub>2</sub> HBr <sub>3</sub>	598-16-3	264.741			164	2.708 <sup>20</sup>	1.6045 <sup>16</sup>	sl H <sub>2</sub> O; vs EtOH; s eth, ace, chl
10166	Tribromofluoromethane		CBBr <sub>2</sub> F	353-54-8	270.721	liq	-73.6	108			i H <sub>2</sub> O; s EtOH
10167	Tribromomethane	Bromoform	CHBr <sub>3</sub>	75-25-2	252.731		8.69	149.1	2.8788 <sup>25</sup>	1.5948 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s bz, lig, chl
10168	1,3,5-Tribromo-2-methoxybenzene		C <sub>7</sub> H <sub>5</sub> Br <sub>3</sub> O	607-99-8	344.826	nd (al)	88	298	2.491 <sup>25</sup>		sl H <sub>2</sub> O, EtOH; vs ace, bz; s ctc
10169	2,4,6-Tribromo-3-methylphenol	2,4,6-Tribromo- <i>m</i> -cresol	C <sub>7</sub> H <sub>5</sub> Br <sub>3</sub> O	4619-74-3	344.826		84				s EtOH, eth, bz, HOAc; sl chl, peth
10170	1,1,1-Tribromo-2-methyl-2-propanol	1,1,1-Tribromo- <i>tert</i> -butyl alcohol	C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub> O	76-08-4	310.810	nd (lig) cry (dil al)	169	sub			sl H <sub>2</sub> O, chl; s EtOH, eth
10171	Tribromonitromethane		CBBr <sub>2</sub> NO <sub>2</sub>	464-10-8	297.729	pr	10	127 <sup>18</sup>	2.811 <sup>12</sup>	1.5790 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs ace, bz
10172	2,4,6-Tribromophenol		C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub> O	118-79-6	330.799	nd (al), pr (bz)	95.5	286	2.55 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH; s eth, bz, HOAc, chl
10173	1,1,2-Tribromopropane		C <sub>3</sub> H <sub>5</sub> Br <sub>3</sub>	14602-62-1	280.784			200.5	2.3547 <sup>20</sup>	1.5790 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, chl, HOAc; vs eth
10174	1,2,2-Tribromopropane		C <sub>3</sub> H <sub>5</sub> Br <sub>3</sub>	14476-30-3	280.784			190.5	2.2984 <sup>20</sup>	1.5670 <sup>20</sup>	vs eth, EtOH, chl
10175	1,2,3-Tribromopropane		C <sub>3</sub> H <sub>5</sub> Br <sub>3</sub>	96-11-7	280.784		16.9	222.1	2.4208 <sup>20</sup>	1.5862 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; sl ctc
10176	2,3,5-Tribromothiophene		C <sub>4</sub> HBr <sub>3</sub> S	3141-24-0	320.828	nd (al)	29	260			s chl
10177	Tribromotrimethyldialuminum	Methyl aluminum sesquibromide	C <sub>3</sub> H <sub>9</sub> Al <sub>2</sub> Br <sub>3</sub>	12263-85-3	338.778	hyg col liq		110 <sup>50</sup>			
10178	Tributyl 2-(acetyloxy)-1,2,3-propanetricarboxylate		C <sub>20</sub> H <sub>34</sub> O <sub>6</sub>	77-90-7	402.479			173 <sup>1</sup>			sl chl
10179	Tributyl aluminate	1-Butanol, aluminum salt	C <sub>12</sub> H <sub>27</sub> AlO <sub>3</sub>	3085-30-1	246.322			260 <sup>5</sup>			
10180	Tributylaluminum		C <sub>12</sub> H <sub>27</sub> Al	1116-70-7	198.324			102 <sup>2</sup>			
10181	Tributylamine	<i>N,N</i> -Dibutyl-1-butanamine	C <sub>12</sub> H <sub>27</sub> N	102-82-9	185.349	liq	-70	216.5	0.7770 <sup>20</sup>	1.4299 <sup>20</sup>	sl H <sub>2</sub> O, ctc; vs EtOH, eth; s ace, bz
10182	Tributyl borate		C <sub>12</sub> H <sub>27</sub> BO <sub>3</sub>	688-74-4	230.151	oil	<-70	234	0.8567 <sup>20</sup>	1.4106 <sup>18</sup>	s EtOH, bz; vs eth, MeOH
10183	Tributylfluorostannane	Tributyltin fluoride	C <sub>12</sub> H <sub>27</sub> FSn	1983-10-4	309.050	nd	≈260	sub >200			
10184	2,4,6-Tri- <i>tert</i> -butylphenol		C <sub>18</sub> H <sub>30</sub> O	732-26-3	262.430	cry (al, peth)	131	278	0.864 <sup>27</sup>		i H <sub>2</sub> O, alk; s EtOH, ace, ctc
10185	Tributyl phosphate		C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	126-73-8	266.313			289	0.9727 <sup>25</sup>	1.4224 <sup>25</sup>	s H <sub>2</sub> O, eth, bz, CS <sub>2</sub> ; msc EtOH
10186	Tributylphosphine		C <sub>12</sub> H <sub>27</sub> P	998-40-3	202.316			240; 150 <sup>50</sup>	0.812 <sup>25</sup>	1.4619 <sup>20</sup>	
10187	Tributyl phosphite	Tributoxyphosphine	C <sub>12</sub> H <sub>27</sub> O <sub>3</sub> P	102-85-2	250.314			137 <sup>26</sup> , 122 <sup>12</sup>	0.9259 <sup>20</sup>	1.4321 <sup>19</sup>	s EtOH; sl ctc; vs eth
10188	<i>S,S,S</i> -Tributyl phosphorothioate	<i>S,S,S</i> -Tributyl trithiophosphate	C <sub>12</sub> H <sub>27</sub> OPS <sub>3</sub>	78-48-8	314.510		<-25	150 <sup>0,3</sup>	1.057 <sup>20</sup>		
10189	Tributylsilane		C <sub>12</sub> H <sub>26</sub> Si	998-41-4	200.436			221	0.7794 <sup>20</sup>	1.4380 <sup>20</sup>	
10190	Tributylstannane	Tributyltin hydride	C <sub>12</sub> H <sub>26</sub> Sn	688-73-3	291.060	liq		113 <sup>8</sup> , 76 <sup>0,7</sup>	1.103 <sup>20</sup>		
10191	Tributyryl	Butanoic acid, 1,2,3-propanetriyl ester	C <sub>15</sub> H <sub>26</sub> O <sub>6</sub>	60-01-5	302.363	liq	-75	307.5	1.0350 <sup>20</sup>	1.4359 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, ace, bz; sl ctc; vs eth
10192	Tricalcium citrate	Calcium citrate	C <sub>12</sub> H <sub>10</sub> Ca <sub>3</sub> O <sub>14</sub>	813-94-5	498.433	cry (w)	≈100 dec (hyd)				sl H <sub>2</sub> O; i EtOH
10193	Trichloron		C <sub>4</sub> H <sub>8</sub> Cl <sub>3</sub> O <sub>4</sub> P	52-68-6	257.437		77	100 <sup>0,1</sup>	1.73 <sup>20</sup>		
10194	Trichloroacetaldehyde	Chloral	C <sub>2</sub> HCl <sub>3</sub> O	75-87-6	147.387	liq	-57.5	97.8	1.512 <sup>20</sup>	1.4580 <sup>20</sup>	vs H <sub>2</sub> O; s EtOH, eth
10195	2,2,2-Trichloroacetamide		C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> NO	594-65-0	162.402		142	240			sl H <sub>2</sub> O; vs EtOH, eth
10196	Trichloroacetic acid		C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	76-03-9	163.387	hyg cry	59.2	196.5	1.6126 <sup>64</sup>	1.4603 <sup>61</sup>	vs H <sub>2</sub> O; s EtOH, eth; sl ctc
10197	Trichloroacetic anhydride		C <sub>4</sub> Cl <sub>6</sub> O <sub>3</sub>	4124-31-6	308.759			dec 223; 139 <sup>50</sup>	1.6908 <sup>20</sup>		vs eth, HOAc
10198	Trichloroacetoneitrile		C <sub>2</sub> Cl <sub>3</sub> N	545-06-2	144.387	liq	-42	85.7	1.4403 <sup>25</sup>	1.4409 <sup>20</sup>	i H <sub>2</sub> O
10199	Trichloroacetyl chloride		C <sub>2</sub> Cl <sub>3</sub> O	76-02-8	181.832			117.9	1.6202 <sup>20</sup>	1.4695 <sup>20</sup>	msc eth
10200	2,3,4-Trichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N	634-67-3	196.462	nd (lig)	73	292			vs EtOH



1,2,3-Tribromobutane



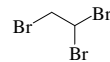
1,2,4-Tribromobutane



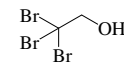
2,2,3-Tribromobutane



Tribromochloromethane



1,1,2-Tribromoethane



2,2,2-Tribromoethanol



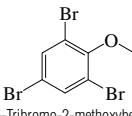
Tribromoethene



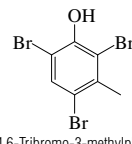
Tribromofluoromethane



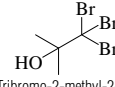
Tribromomethane



1,3,5-Tribromo-2-methoxybenzene



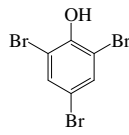
2,4,6-Tribromo-3-methylphenol



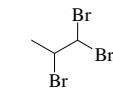
1,1,1-Tribromo-2-methyl-2-propanol



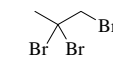
Tribromonitromethane



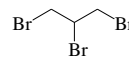
2,4,6-Tribromophenol



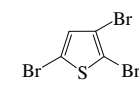
1,1,2-Tribromopropane



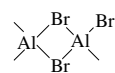
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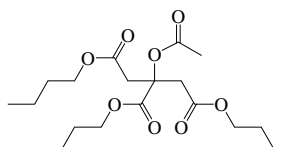
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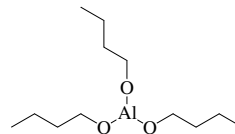
2,3,5-Tribromothiophene



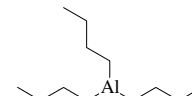
Tribromotrimethyldialuminum



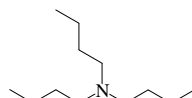
Tributyl 2-(acetyloxy)-1,2,3-propanetricarboxylate



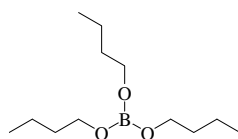
Tributyl aluminate



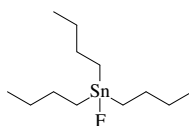
Tributylaluminum



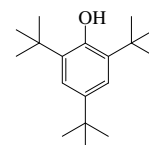
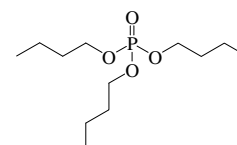
Tributylamine



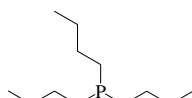
Tributyl borate



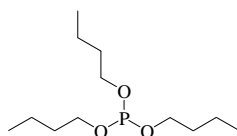
Tributylfluorostannane

2,4,6-Tri-*tert*-butylphenol

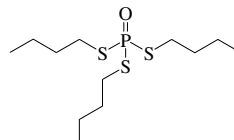
Tributyl phosphate



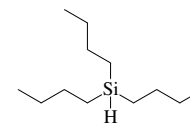
Tributylphosphine



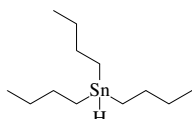
Tributyl phosphite



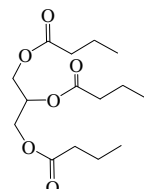
S,S,S-Tributyl phosphorotriothioate



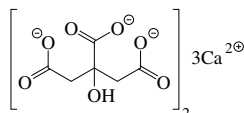
Tributylsilane



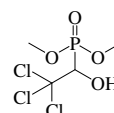
Tributylstannane



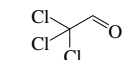
Tributyrin



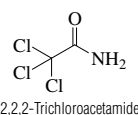
Tricalcium citrate



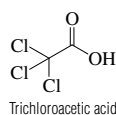
Trichlorfon



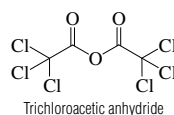
Trichloroacetaldehyde



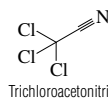
2,2,2-Trichloroacetamide



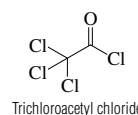
Trichloroacetic acid



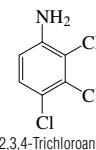
Trichloroacetic anhydride



Trichloroacetonitrile

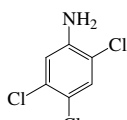


Trichloroacetyl chloride

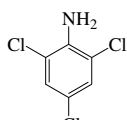


2,3,4-Trichloroaniline

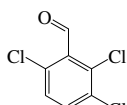
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10201	2,4,5-Trichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N	636-30-6	196.462	nd (lig)	96.5	270			s EtOH, eth; vs CS <sub>2</sub> ; sl lig
10202	2,4,6-Trichloroaniline		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N	634-93-5	196.462	cry (al), nd (lig or peth)	78.5	262			i H <sub>2</sub> O; s EtOH, eth, chl; vs CS <sub>2</sub>
10203	2,3,6-Trichlorobenzaldehyde		C <sub>7</sub> H <sub>3</sub> Cl <sub>3</sub> O	4659-47-6	209.457	nd (lig)	87.3				vs ace, bz, eth
10204	1,2,3-Trichlorobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	87-61-6	181.447	pl (al)	51.3	218.5	1.4533 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, chl; vs eth, bz
10205	1,2,4-Trichlorobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	120-82-1	181.447	orth	16.92	213.5	1.459 <sup>25</sup>	1.5717 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH, chl; vs eth
10206	1,3,5-Trichlorobenzene		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	108-70-3	181.447	nd	62.8	208			i H <sub>2</sub> O; sl EtOH; vs eth, bz; s chl
10207	2,3,6-Trichlorobenzeneacetic acid	Chlorfenac	C <sub>8</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	85-34-7	239.484			161			vs ace, bz; vs EtOH, HOAc
10208	3,4,5-Trichloro-1,2-benzenediol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	56961-20-7	213.446	(i) pr (HOAc) (ii) pr (bz)	115(form a); 134(form b)				sl H <sub>2</sub> O; vs EtOH, HOAc
10209	2,3,6-Trichlorobenzoic acid		C <sub>7</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	50-31-7	225.457			124.5			sl H <sub>2</sub> O; s eth
10210	2,4,5-Trichlorobiphenyl		C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	15862-07-4	257.543	cry	78.5				i H <sub>2</sub> O
10211	2,4,6-Trichlorobiphenyl		C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	35693-92-6	257.543	cry (EtOH aq)	62.5	172 <sup>15</sup>			i H <sub>2</sub> O
10212	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane	Dichlorodiphenyltrichloroethane (DDT)	C <sub>14</sub> H <sub>9</sub> Cl <sub>5</sub>	50-29-3	354.486	nd (al)	108.5	260; 186 <sup>005</sup>			i H <sub>2</sub> O; sl EtOH; vs eth, ace, bz, py
10213	2,2,3-Trichlorobutanal	2,2,3-Trichlorobutyraldehyde	C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O	76-36-8	175.441			164	1.3956 <sup>20</sup>	1.4755 <sup>20</sup>	vs H <sub>2</sub> O, eth, EtOH
10214	2,3,4-Trichloro-1-butene		C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub>	2431-50-7	159.442			60 <sup>20</sup> , 40 <sup>10</sup>	1.3430 <sup>20</sup>	1.4944 <sup>20</sup>	vs ace, chl
10215	3,4,4'-Trichlorocarbaniilide	Triclocarban	C <sub>13</sub> H <sub>9</sub> Cl <sub>3</sub> N <sub>2</sub> O	101-20-2	315.581	fine pl	256				
10216	1,2,4-Trichloro-5-(chloromethyl)benzene		C <sub>7</sub> H <sub>7</sub> Cl <sub>4</sub>	3955-26-8	229.919			273	1.547 <sup>20</sup>		vs ace, eth, EtOH
10217	Trichloro(chloromethyl)silane	(Chloromethyl)trichlorosilane	CH <sub>2</sub> Cl <sub>3</sub> Si	1558-25-4	183.925			118	1.4650 <sup>20</sup>	1.4555 <sup>20</sup>	
10218	Trichloro(4-chlorophenyl)silane		C <sub>6</sub> H <sub>4</sub> Cl <sub>4</sub> Si	825-94-5	245.994			233; 116 <sup>20</sup>	1.4062 <sup>20</sup>	1.5418 <sup>20</sup>	
10219	Trichloro(3-chloropropyl)silane		C <sub>3</sub> H <sub>6</sub> Cl <sub>4</sub> Si	2550-06-3	211.978			181.5	1.3590 <sup>20</sup>	1.4668 <sup>20</sup>	
10220	Trichloro(dichloromethyl)silane	(Dichloromethyl)trichlorosilane	CHCl <sub>2</sub> Si	1558-24-3	218.370			145	1.5518 <sup>20</sup>	1.4714 <sup>20</sup>	
10221	1,1,1-Trichloro-2,2-difluoroethane		C <sub>2</sub> HCl <sub>3</sub> F <sub>2</sub>	354-12-1	169.385			73			
10222	1,2,2-Trichloro-1,1-difluoroethane		C <sub>2</sub> HCl <sub>2</sub> F <sub>2</sub>	354-21-2	169.385		-140	71.9	1.5447 <sup>20</sup>	1.3889 <sup>20</sup>	
10223	1,2,2-Trichloro-1,2-difluoroethane		C <sub>2</sub> HCl <sub>2</sub> F <sub>2</sub>	354-15-4	169.385		-174	72.5			
10224	2,4,6-Trichloro-3,5-dimethylphenol		C <sub>8</sub> H <sub>7</sub> Cl <sub>3</sub> O	6972-47-0	225.500	ye nd (peth)	175				i H <sub>2</sub> O; s chl; vs peth
10225	1,1,1-Trichloro-2,2-diphenylethane		C <sub>14</sub> H <sub>11</sub> Cl <sub>3</sub>	2971-22-4	285.596		65				s EtOH; sl chl
10226	Trichlorododecylsilane	Dodecyltrichlorosilane	C <sub>12</sub> H <sub>25</sub> Cl <sub>3</sub> Si	4484-72-4	303.772			155 <sup>10</sup>		1.4581 <sup>20</sup>	
10227	1,1,1-Trichloro-3,4-epoxybutane	(2,2,2-Trichloroethyl)oxirane	C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O	3083-25-8	175.441	liq		110 <sup>100</sup>			
10228	1,1,1-Trichloroethane	Methyl chloroform	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	71-55-6	133.404	liq	-30.01	74.09	1.3390 <sup>20</sup>	1.4379 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, chl; msc eth
10229	1,1,2-Trichloroethane	Vinyl trichloride	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	79-00-5	133.404	liq	-36.3	113.8	1.4397 <sup>20</sup>	1.4714 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
10230	2,2,2-Trichloroethanol		C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> O	115-20-8	149.403	hyg orth tab or pl	19	152; 52 <sup>11</sup>		1.4861 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s alk
10231	Trichloroethene	Trichloroethylene	C <sub>2</sub> HCl <sub>3</sub>	79-01-6	131.388	liq	-84.7	87.21	1.4642 <sup>20</sup>	1.4773 <sup>20</sup>	sl H <sub>2</sub> O, ctc; msc EtOH, eth; s ace
10232	2,2,2-Trichloro-1-ethoxyethanol	Chloral alcoholate	C <sub>4</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>2</sub>	515-83-3	193.457		56.5	115.5	1.143 <sup>40</sup>		s H <sub>2</sub> O, EtOH, eth
10233	Trichloroethoxysilane		C <sub>2</sub> H <sub>5</sub> Cl <sub>3</sub> OSi	1825-82-7	179.505	liq	-135	101.9	1.2274 <sup>20</sup>	1.4045 <sup>20</sup>	vs EtOH
10234	2,2,2-Trichloroethyl-β-D-glucopyranosiduronic acid	Urochloralic acid	C <sub>8</sub> H <sub>11</sub> Cl <sub>3</sub> O <sub>7</sub>	97-25-6	325.528	nd	142				vs H <sub>2</sub> O, EtOH
10235	Trichloroethylsilane	Ethyltrichlorosilane	C <sub>2</sub> H <sub>5</sub> Cl <sub>3</sub> Si	115-21-9	163.506	liq	-105.6	100.5	1.2373 <sup>20</sup>	1.4256 <sup>20</sup>	s ctc
10236	1,1,1-Trichloro-2-fluoroethane	Refrigerant 131b	C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> F	2366-36-1	151.394	liq		86.5			
10237	1,1,2-Trichloro-1-fluoroethane	Refrigerant 131a	C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> F	811-95-0	151.394		-104.7	88.0	1.492 <sup>20</sup>		
10238	1,1,2-Trichloro-2-fluoroethane		C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> F	359-28-4	151.394			102.4	1.5393 <sup>20</sup>	1.4390 <sup>20</sup>	i H <sub>2</sub> O
10239	Trichlorofluoromethane	Refrigerant 11	CCl <sub>3</sub> F	75-69-4	137.368	vol liq or gas	-110.44	23.7			i H <sub>2</sub> O
10240	2,2,3-Trichloro-1,1,1,3,4,4,4-heptafluorobutane		C <sub>4</sub> Cl <sub>3</sub> F <sub>7</sub>	335-44-4	287.391		2.0	98	1.7484 <sup>20</sup>	1.3530 <sup>20</sup>	
10241	Trichlorohexylsilane	Hexyltrichlorosilane	C <sub>6</sub> H <sub>13</sub> Cl <sub>3</sub> Si	928-65-4	219.612			190	1.1100 <sup>20</sup>		dec H <sub>2</sub> O
10242	N-(2,2,2-Trichloro-1-hydroxyethyl)formamide	Chloral formamide	C <sub>3</sub> H <sub>4</sub> Cl <sub>3</sub> NO <sub>2</sub>	515-82-2	192.429	cry	120				vs ace, eth, EtOH
10243	3,3,3-Trichloro-2-hydroxypropanenitrile	Chlorocyanohydrin	C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> NO	513-96-2	174.413	pl (w)	61	dec 217			vs H <sub>2</sub> O, eth, EtOH
10244	Trichloroisobutylsilane		C <sub>4</sub> H <sub>9</sub> Cl <sub>3</sub> Si	18169-57-8	191.559			143.3	1.154 <sup>20</sup>		dec H <sub>2</sub> O
10245	Trichloromethane	Chloroform	CHCl <sub>3</sub>	67-66-3	119.378	liq	-63.41	61.17	1.4788 <sup>25</sup>	1.4459 <sup>20</sup>	sl H <sub>2</sub> O; msc EtOH, eth, bz; s ace, ctc
10246	Trichloromethanesulfonyl chloride	Perchloromethyl mercaptan	CCl <sub>3</sub> S	594-42-3	185.888	ye oil		149	1.6947 <sup>20</sup>	1.5484 <sup>20</sup>	s eth



2,4,5-Trichloroaniline



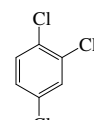
2,4,6-Trichloroaniline



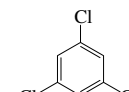
2,3,6-Trichlorobenzaldehyde



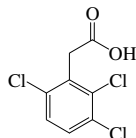
1,2,3-Trichlorobenzene



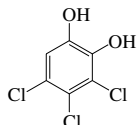
1,2,4-Trichlorobenzene



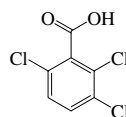
1,3,5-Trichlorobenzene



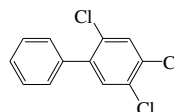
2,3,6-Trichlorobenzeneacetic acid



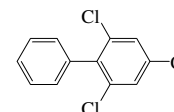
3,4,5-Trichloro-1,2-benzenediol



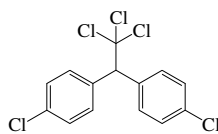
2,3,6-Trichlorobenzoic acid



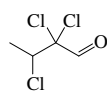
2,4,5-Trichlorobiphenyl



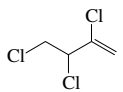
2,4,6-Trichlorobiphenyl



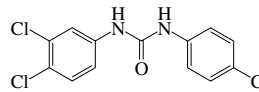
1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane



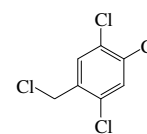
2,2,3-Trichlorobutanal



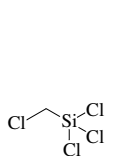
2,3,4-Trichloro-1-butene



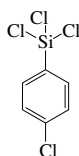
3,4,4'-Trichlorocarbaniide



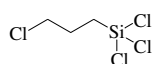
1,2,4-Trichloro-5-(chloromethyl)benzene



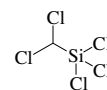
Trichloro(chloromethyl)silane



Trichloro(4-chlorophenyl)silane



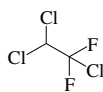
Trichloro(3-chloropropyl)silane



Trichloro(dichloromethyl)silane



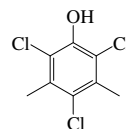
1,1,1-Trichloro-2,2-difluoroethane



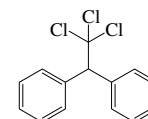
1,2,2-Trichloro-1,1-difluoroethane



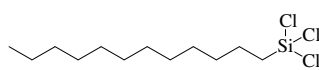
1,2,2-Trichloro-1,2-difluoroethane



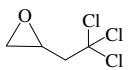
2,4,6-Trichloro-3,5-dimethylphenol



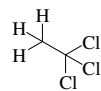
1,1,1-Trichloro-2,2-diphenylethane



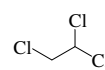
Trichlorododecylsilane



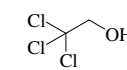
1,1,1-Trichloro-3,4-epoxybutane



1,1,1-Trichloroethane



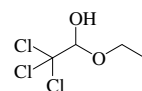
1,1,2-Trichloroethane



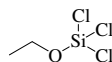
2,2,2-Trichloroethanol



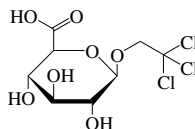
Trichloroethene



2,2,2-Trichloro-1-ethoxyethanol



Trichloroethoxysilane



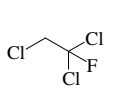
2,2,2-Trichloroethyl-β-D-glucopyranosiduronic acid



Trichloroethylsilane



1,1,1-Trichloro-2-fluoroethane



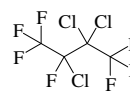
1,1,2-Trichloro-1-fluoroethane



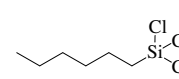
1,1,2-Trichloro-2-fluoroethane



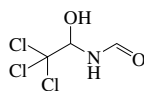
Trichlorofluoromethane



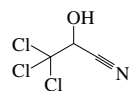
2,2,3-Trichloro-1,1,1,3,4,4,4-heptafluorobutane



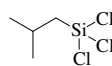
Trichlorohexylsilane



N-(2,2,2-Trichloro-1-hydroxyethyl)formamide



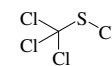
3,3,3-Trichloro-2-hydroxypropanenitrile



Trichloroisobutylsilane



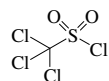
Trichloromethane



Trichloromethanesulfonyl chloride

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10247	Trichloromethanesulfonyl chloride		CCl <sub>3</sub> O <sub>2</sub> S	2547-61-7	217.887	cry (al-w)	140.5	170			i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
10248	Trichloromethanethiol	Trichloromethyl mercaptan	CHCl <sub>3</sub> S	75-70-7	151.443	oran oil		125 <sup>15</sup>			
10249	Trichloromethiazide		C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub> S <sub>2</sub>	133-67-5	380.657		270 dec				sl H <sub>2</sub> O; s EtOH
10250	1,2,4-Trichloro-5-methoxybenzene		C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> O	6130-75-2	211.473	nd (dil al)	77.5	254			vs EtOH, ace
10251	1,3,5-Trichloro-2-methoxybenzene	2,4,6-Trichloroanisole	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> O	87-40-1	211.473	mcl nd (al)	61.5	241	1.640 <sup>25</sup>		s EtOH, bz, chl; vs ace
10252	1,2,4-Trichloro-5-methylbenzene	2,4,5-Trichlorotoluene	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub>	6639-30-1	195.474	nd or lf (al)	82.4	231			i H <sub>2</sub> O; s EtOH, ace
10253	(Trichloromethyl)benzene	Benzotrichloride	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub>	98-07-7	195.474	liq	-4.42	221	1.3723 <sup>20</sup>	1.5580 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
10254	(Trichloromethyl)oxirane		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> O	3083-23-6	161.414			149; 44 <sup>13</sup>	1.495 <sup>20</sup>	1.4737 <sup>25</sup>	vs eth; s chl
10255	2,3,4-Trichloro-6-methylphenol	4,5,6-Trichloro- <i>o</i> -cresol	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> O	551-78-0	211.473	nd (peth)	77				
10256	2,3,6-Trichloro-4-methylphenol	2,3,6-Trichloro- <i>p</i> -cresol	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> O	551-77-9	211.473	nd (HOAc, peth)	66.5				vs EtOH
10257	2,4,6-Trichloro-3-methylphenol	2,4,6-Trichloro- <i>m</i> -cresol	C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> O	551-76-8	211.473	nd or pl (w, peth)	46	265			i H <sub>2</sub> O; vs EtOH, MeOH, chl
10258	1,1,1-Trichloro-2-methyl-2-propanol	1,1,1-Trichloro- <i>tert</i> -butyl alcohol	C <sub>4</sub> H <sub>7</sub> Cl <sub>3</sub> O	57-15-8	177.457	hyg nd (w + 1)	97	167			i H <sub>2</sub> O; s EtOH, eth, ace, bz, lig, chl
10259	Trichloronate		C <sub>10</sub> H <sub>12</sub> Cl <sub>3</sub> O <sub>2</sub> PS	327-98-0	333.599	ye liq		108 <sup>0.01</sup>	1.365 <sup>20</sup>		
10260	1,2,4-Trichloro-5-nitrobenzene		C <sub>6</sub> H <sub>2</sub> Cl <sub>3</sub> NO <sub>2</sub>	89-69-0	226.445	pr (al), nd (al)	57.5	288	1.790 <sup>23</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz, chl, CS <sub>2</sub>
10261	Trichloronitromethane	Chloropicrin	CCl <sub>3</sub> NO <sub>2</sub>	76-06-2	164.376	liq	-64	112	1.6558 <sup>20</sup>	1.4611 <sup>20</sup>	s H <sub>2</sub> O; msc EtOH, ace, bz, MeOH, HOAc
10262	3,4,6-Trichloro-2-nitrophenol		C <sub>6</sub> H <sub>2</sub> Cl <sub>3</sub> NO <sub>3</sub>	82-62-2	242.444	pa ye cry (peth)	92.5				
10263	Trichlorooctadecylsilane	Octadecyltrichlorosilane	C <sub>18</sub> H <sub>37</sub> Cl <sub>3</sub> Si	112-04-9	387.932			223 <sup>10</sup>	0.984 <sup>25</sup>	1.4602 <sup>20</sup>	
10264	Trichlorooctylsilane	Octyltrichlorosilane	C <sub>8</sub> H <sub>17</sub> Cl <sub>3</sub> Si	5283-66-9	247.666			232		1.4480 <sup>20</sup>	dec H <sub>2</sub> O, EtOH; s ctc
10265	1,2,3-Trichloro-1,1,2,3,3-pentafluoropropane		C <sub>3</sub> Cl <sub>3</sub> F <sub>5</sub>	76-17-5	237.383	liq	-72	73.7	1.6631 <sup>20</sup>	1.3512 <sup>20</sup>	
10266	Trichloropentylsilane	Amyltrichlorosilane	C <sub>5</sub> H <sub>11</sub> Cl <sub>3</sub> Si	107-72-2	205.586			172; 60.5 <sup>15</sup>	1.1330 <sup>20</sup>	1.4503 <sup>20</sup>	
10267	2,3,4-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	15950-66-0	197.446	nd (bz, lig, sub)	83.5	sub			s EtOH, eth, bz, alk, HOAc
10268	2,3,5-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	933-78-8	197.446	nd (al)	62	248 <sup>250</sup>			vs eth, EtOH
10269	2,3,6-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	933-75-5	197.446	nd (dil al, lig)	58				sl H <sub>2</sub> O; vs EtOH, eth, bz; s HOAc
10270	2,4,5-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	95-95-4	197.446	nd (al, peth)	69	247			sl H <sub>2</sub> O; vs EtOH, eth, bz; s HOAc
10271	2,4,6-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	88-06-2	197.446	orth nd (HOAc)	69	246	1.4901 <sup>75</sup>		sl H <sub>2</sub> O; s EtOH, eth, HOAc
10272	3,4,5-Trichlorophenol		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	609-19-8	197.446	nd (lig)	101	275			sl H <sub>2</sub> O, lig; s eth
10273	2,4,5-Trichlorophenoxyacetic acid	2,4,5-T	C <sub>8</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>3</sub>	93-76-5	255.483	cry (bz)	153	dec			i H <sub>2</sub> O; s EtOH; vs bz
10274	2-(2,4,5-Trichlorophenoxy)ethyl 2,2-dichloropropanoate	Pentanate	C <sub>11</sub> H <sub>9</sub> Cl <sub>5</sub> O <sub>3</sub>	136-25-4	366.452		49	162 <sup>0.5</sup>	1.55 <sup>50</sup>		i H <sub>2</sub> O; s EtOH, ace, xyl
10275	Trichloro(2-phenylethyl)silane		C <sub>8</sub> H <sub>9</sub> Cl <sub>3</sub> Si	940-41-0	239.602			242; 98 <sup>5</sup>	1.2397 <sup>20</sup>	1.5185 <sup>20</sup>	
10276	(2,4,6-Trichlorophenyl)hydrazine		C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N <sub>2</sub>	5329-12-4	211.476	cry (bz)	143				s H <sub>2</sub> O, bz
10277	Trichlorophenylsilane		C <sub>7</sub> H <sub>2</sub> Cl <sub>3</sub> Si	98-13-5	211.549			201	1.321 <sup>20</sup>	1.5230 <sup>20</sup>	s ctc, chl, CS <sub>2</sub>
10278	1,1,2-Trichloropropane		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	598-77-6	147.431			132.0; 117 <sup>500</sup>	1.372 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, chl; vs eth; sl ctc
10279	1,1,3-Trichloropropane		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	20395-25-9	147.431	liq	-59	145.5	1.3557 <sup>20</sup>	1.4718 <sup>20</sup>	vs eth, EtOH, chl
10280	1,2,2-Trichloropropane		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	3175-23-3	147.431			124	1.318 <sup>25</sup>	1.4609 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs chl
10281	1,2,3-Trichloropropane		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	96-18-4	147.431	liq	-14.7	157	1.3889 <sup>20</sup>	1.4852 <sup>20</sup>	sl H <sub>2</sub> O, ctc; s EtOH, eth; vs chl
10282	1,1,1-Trichloro-2-propanol		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> O	76-00-6	163.430		50.5	163; 54 <sup>12</sup>			vs ace, bz, eth, EtOH
10283	1,1,1-Trichloro-2-propanone	1,1,1-Trichloroacetone	C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> O	918-00-3	161.414			149; 28 <sup>10</sup>	1.435 <sup>20</sup>	1.4635 <sup>17</sup>	i H <sub>2</sub> O; vs EtOH, eth
10284	1,2,3-Trichloro-1-propene		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	96-19-5	145.415			142	1.412 <sup>20</sup>	1.5030 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz, chl
10285	3,3,3-Trichloro-1-propene		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub>	2233-00-3	145.415	liq	-30	114.5	1.367 <sup>20</sup>	1.4827 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl
10286	2,3,3-Trichloro-2-propenoyl chloride		C <sub>3</sub> Cl <sub>4</sub> O	815-58-7	193.843			158		1.5271 <sup>18</sup>	vs bz
10287	Trichloropropylsilane	Propyltrichlorosilane	C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> Si	141-57-1	177.533			123.5	1.195 <sup>20</sup>	1.4310 <sup>20</sup>	

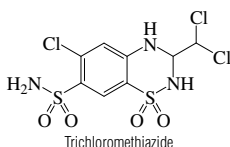




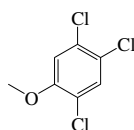
Trichloromethanesulfonyl chloride



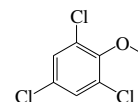
Trichloromethanethiol



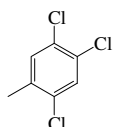
Trichloromethiazide



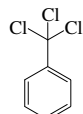
1,2,4-Trichloro-5-methoxybenzene



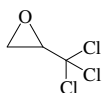
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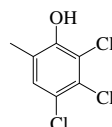
1,2,4-Trichloro-5-methylbenzene



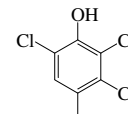
(Trichloromethyl)benzene



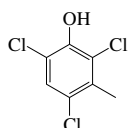
(Trichloromethyl)oxirane



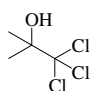
2,3,4-Trichloro-6-methylphenol



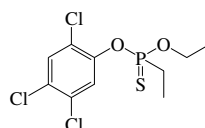
2,3,6-Trichloro-4-methylphenol



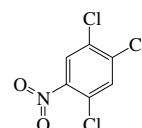
2,4,6-Trichloro-3-methylphenol



1,1,1-Trichloro-2-methyl-2-propanol



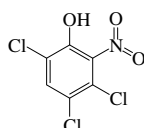
Trichloronate



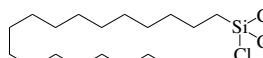
1,2,4-Trichloro-5-nitrobenzene



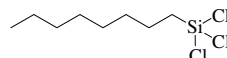
Trichloronitromethane



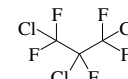
3,4,6-Trichloro-2-nitrophenol



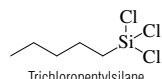
Trichlorooctadecylsilane



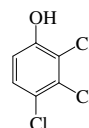
Trichlorooctylsilane



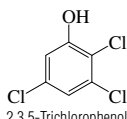
1,2,3-Trichloro-1,1,2,3,3-pentafluoropropane



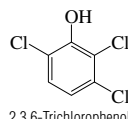
Trichloropentylsilane



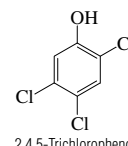
2,3,4-Trichlorophenol



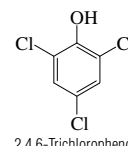
2,3,5-Trichlorophenol



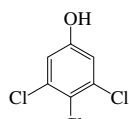
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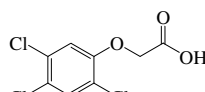
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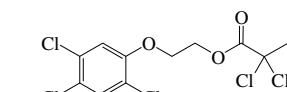
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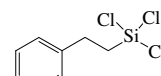
3,4,5-Trichlorophenol



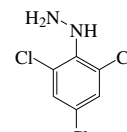
2,4,5-Trichlorophenoxyacetic acid



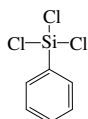
2-(2,4,5-Trichlorophenoxy)ethyl 2,2-dichloropropanoate



Trichloro(2-phenylethyl)silane



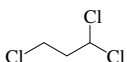
(2,4,6-Trichlorophenyl)hydrazine



Trichlorophenylsilane



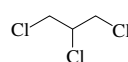
1,1,2-Trichloropropane



1,1,3-Trichloropropane



1,2,2-Trichloropropane



1,2,3-Trichloropropane



1,1,1-Trichloro-2-propanol



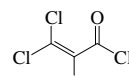
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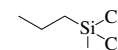
1,2,3-Trichloro-1-propene



3,3,3-Trichloro-1-propene

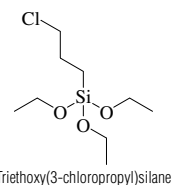
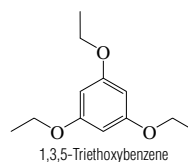
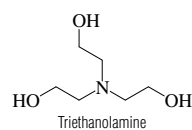
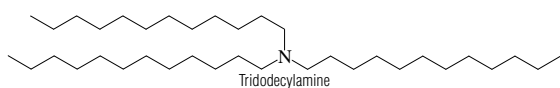
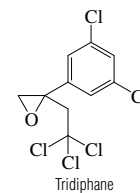
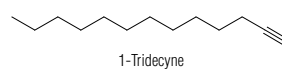
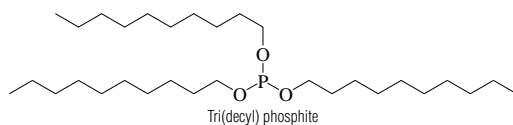
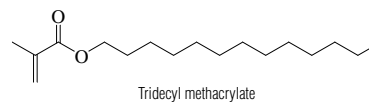
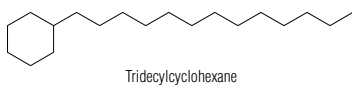
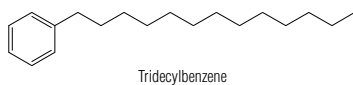
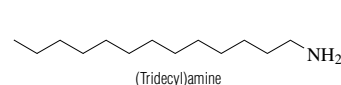
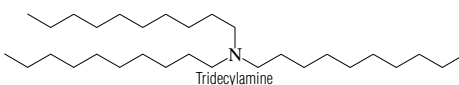
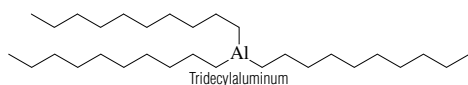
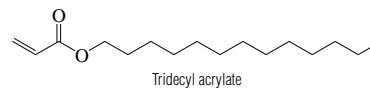
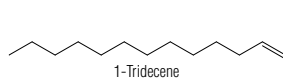
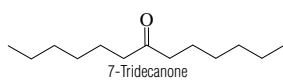
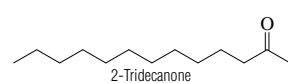
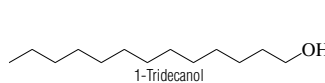
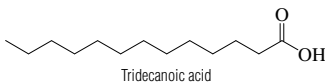
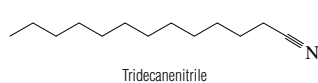
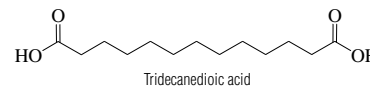
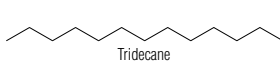
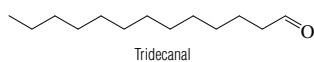
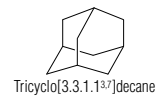
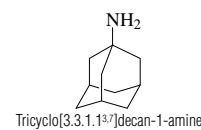
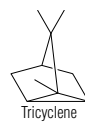
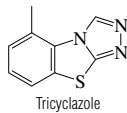
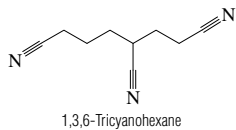
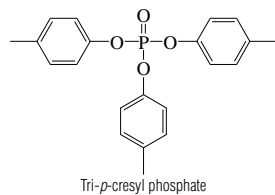
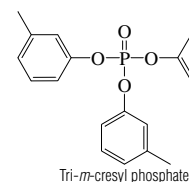
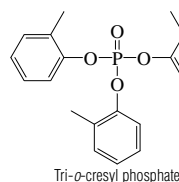
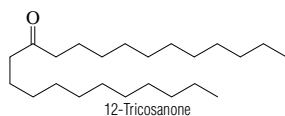
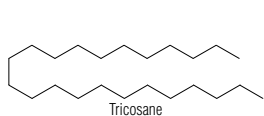
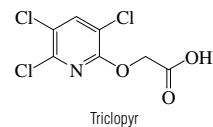
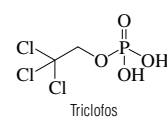
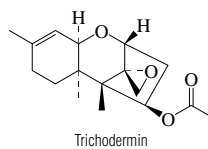
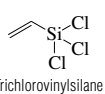
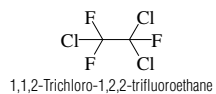
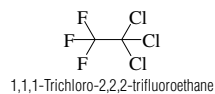
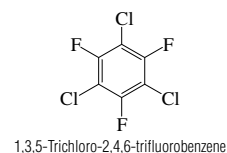
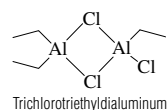
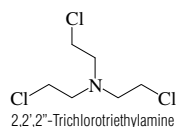
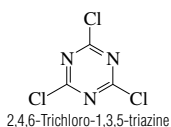
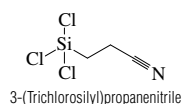
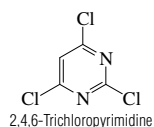


2,3,3-Trichloro-2-propenoyl chloride

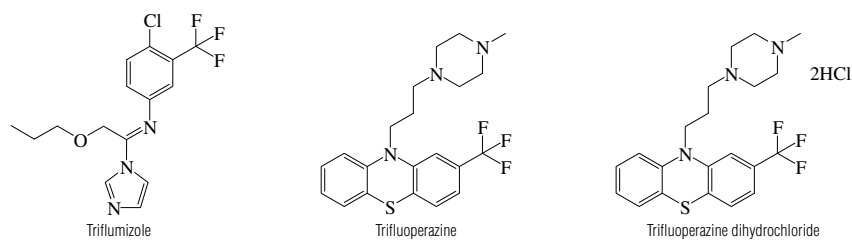
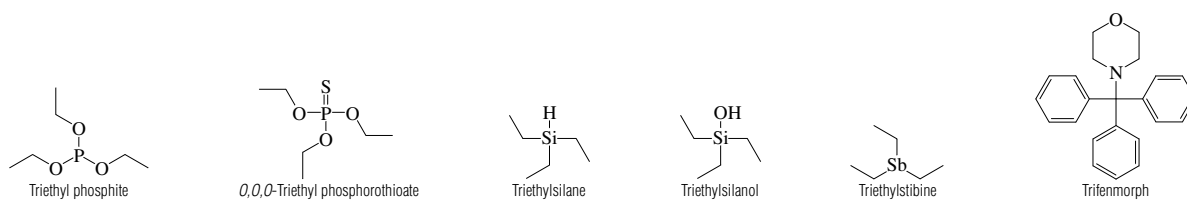
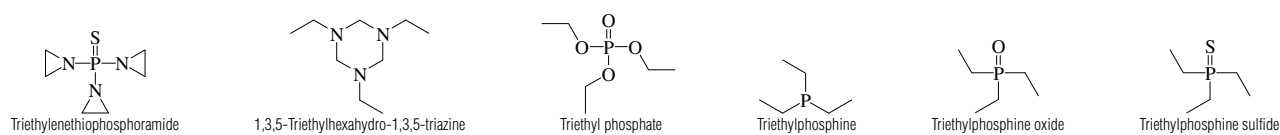
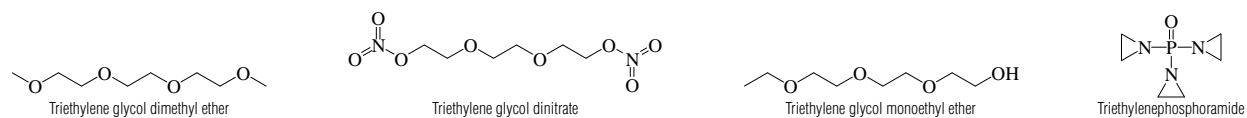
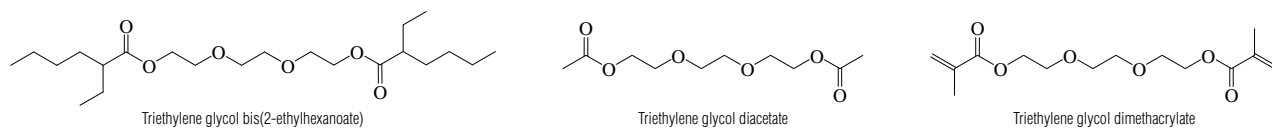
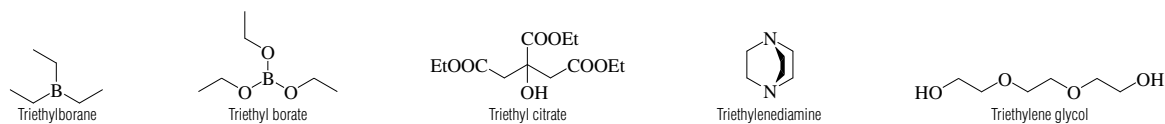
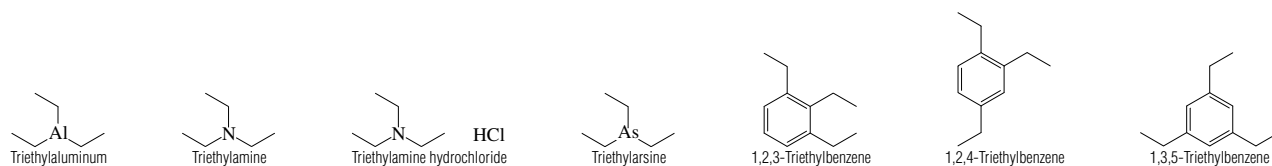
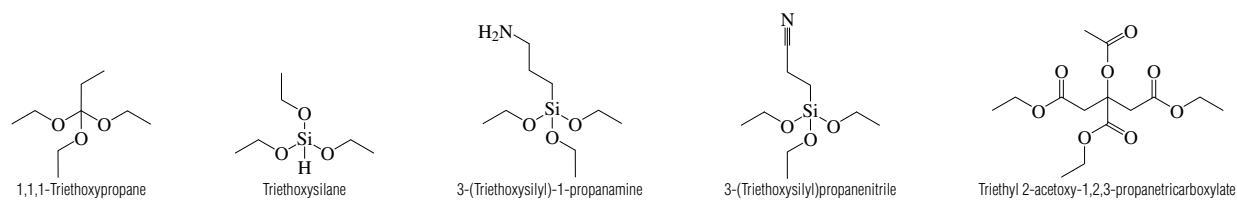
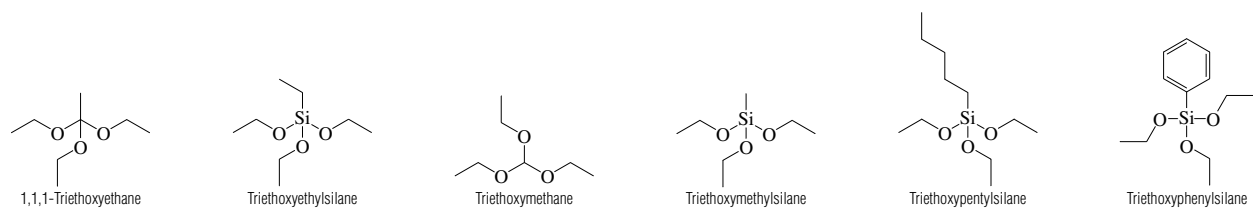


Trichloropropylsilane

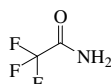
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10288	2,4,6-Trichloropyrimidine		C <sub>4</sub> HCl <sub>3</sub> N <sub>2</sub>	3764-01-0	183.423		22.5	212.5		1.5700 <sup>20</sup>	
10289	3-(Trichlorosilyl)propanenitrile		C <sub>3</sub> H <sub>2</sub> Cl <sub>3</sub> NSi	1071-22-3	188.516			109 <sup>30</sup>			
10290	2,4,6-Trichloro-1,3,5-triazine	Cyanuric acid trichloride	C <sub>3</sub> Cl <sub>3</sub> N <sub>3</sub>	108-77-0	184.411	cry (eth, bz)	154	192			vs EtOH
10291	2,2,2'-Trichlorotriethylamine		C <sub>6</sub> H <sub>12</sub> Cl <sub>3</sub> N	555-77-1	204.525	pa ye	-2.0	143 <sup>15</sup>			vs bz, eth, EtOH
10292	Trichlorotriethylaluminum	Ethylaluminum sesquichloride	C <sub>6</sub> H <sub>9</sub> Al <sub>2</sub> Cl <sub>3</sub>	12075-68-2	247.505	ye liq		115.5 <sup>50</sup> , 36.2 <sup>20</sup>			
10293	1,3,5-Trichloro-2,4,6-trifluorobenzene		C <sub>6</sub> Cl <sub>3</sub> F <sub>3</sub>	319-88-0	235.418			198.4			
10294	1,1,1-Trichloro-2,2,2-trifluoroethane		C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	354-58-5	187.375		14.37	45.5	1.5790 <sup>20</sup>	1.3610 <sup>38</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
10295	1,1,2-Trichloro-1,2,2-trifluoroethane		C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	76-13-1	187.375	liq	-36.22	47.7	1.5635 <sup>25</sup>	1.3557 <sup>25</sup>	i H <sub>2</sub> O; s EtOH; msc eth, bz
10296	Trichlorovinylsilane	Vinyltrichlorosilane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> Si	75-94-5	161.490	liq	-95	91.5	1.2426 <sup>20</sup>	1.4295 <sup>20</sup>	vs chl
10297	Trichodermin	12,13-Epoxytrichothec-9-en-4-ol acetate	C <sub>17</sub> H <sub>24</sub> O <sub>4</sub>	4682-50-2	292.371	cry	59	111 <sup>0.05</sup>			sl H <sub>2</sub> O; s EtOH, chl
10298	Triclofos	2,2,2-Trichloroethanol dihydrogen phosphate	C <sub>2</sub> H <sub>4</sub> Cl <sub>3</sub> O <sub>4</sub> P	306-52-5	229.383	cry (bz)	120.5				
10299	Triclopyr	Acetic acid, [(3,5,6-trichloro-2-pyridinyl)oxy]-	C <sub>7</sub> H <sub>4</sub> Cl <sub>3</sub> NO <sub>3</sub>	55335-06-3	256.471		149	dec 290			
10300	Tricosane		C <sub>23</sub> H <sub>46</sub>	638-67-5	324.627	lf (eth-al)	47.76	380	0.7785 <sup>48</sup>	1.4468 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ctc
10301	12-Tricosanone	Diundecyl ketone	C <sub>23</sub> H <sub>46</sub> O	540-09-0	338.610	lf (al)	70.2		0.8086 <sup>69</sup>	1.4283 <sup>80</sup>	vs bz, eth, chl
10302	Tri- <i>o</i> -cresyl phosphate	Tri- <i>o</i> -tolyl phosphate	C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	78-30-8	368.363	col or pa ye	11	410	1.1955 <sup>20</sup>	1.5575 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ctc, tol; s HOAc
10303	Tri- <i>m</i> -cresyl phosphate	Tri- <i>m</i> -tolyl phosphate	C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	563-04-2	368.363	wax	25.5	260 <sup>15</sup>	1.150 <sup>25</sup>	1.5575 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth; vs ctc, tol
10304	Tri- <i>p</i> -cresyl phosphate	Tri- <i>p</i> -tolyl phosphate	C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	78-32-0	368.363	nd (al), tab (eth)	77.5	224 <sup>35</sup>	1.247 <sup>25</sup>		s EtOH, eth, bz, chl, HOAc
10305	1,3,6-Tricyanohexane		C <sub>6</sub> H <sub>4</sub> N <sub>3</sub>	1772-25-4	161.203	br liq		257 <sup>2</sup>	1.040	1.4660 <sup>20</sup>	
10306	Tricyclazole	1,2,4-Triazolo[3,4-b]benzothiazole, 5-methyl-	C <sub>9</sub> H <sub>7</sub> N <sub>3</sub> S	41814-78-2	189.237		187				
10307	Tricyclene	1,7,7-Trimethyltricyclo[2.2.1.0 <sup>2,6</sup> ]heptane	C <sub>10</sub> H <sub>16</sub>	508-32-7	136.234	cry (al)	67.5	152.5	0.8668 <sup>80</sup>	1.4296 <sup>80</sup>	
10308	Tricyclo[3.3.1.1 <sup>3,7</sup> ]decan-1-amine	Amantadine	C <sub>10</sub> H <sub>17</sub> N	768-94-5	151.249		180				sl H <sub>2</sub> O
10309	Tricyclo[3.3.1.1 <sup>3,7</sup> ]decane	Adamantane	C <sub>10</sub> H <sub>16</sub>	281-23-2	136.234	nd (sub)	268	sub	1.07 <sup>25</sup>	1.568	s bz, ctc
10310	Tridecanal		C <sub>13</sub> H <sub>26</sub> O	10486-19-8	198.344		14	156 <sup>13</sup>	0.8356 <sup>18</sup>	1.4384 <sup>18</sup>	i H <sub>2</sub> O; s EtOH
10311	Tridecane		C <sub>13</sub> H <sub>28</sub>	629-50-5	184.361	liq	-5.4	235.47	0.7564 <sup>20</sup>	1.4256 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s ctc
10312	Tridecanedioic acid		C <sub>13</sub> H <sub>24</sub> O <sub>4</sub>	505-52-2	244.328		114				sl H <sub>2</sub> O, bz, tfa; s EtOH, eth, chl
10313	Tridecanenitrile		C <sub>13</sub> H <sub>25</sub> N	629-60-7	195.345		9.7	293	0.8257 <sup>20</sup>	1.4378 <sup>20</sup>	vs EtOH, eth
10314	Tridecanoic acid	Tridecylic acid	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	638-53-9	214.344	cry (peth ace)	41.5	236 <sup>100</sup> , 140 <sup>1</sup>	0.8458 <sup>80</sup>	1.4286 <sup>60</sup>	i H <sub>2</sub> O; vs EtOH, eth, HOAc; s ace
10315	1-Tridecanol	Tridecyl alcohol	C <sub>13</sub> H <sub>28</sub> O	112-70-9	200.360	cry (al)	31.7	274; 152 <sup>14</sup>	0.8223 <sup>31</sup>		i H <sub>2</sub> O; s EtOH, eth
10316	2-Tridecanone	Methyl undecyl ketone	C <sub>13</sub> H <sub>26</sub> O	593-08-8	198.344		30.5	263	0.8217 <sup>30</sup>	1.4318 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz, chl
10317	7-Tridecanone	Dihexyl ketone	C <sub>13</sub> H <sub>26</sub> O	462-18-0	198.344	lf (al)	33	261	0.825 <sup>30</sup>		s EtOH, chl, liq; vs eth
10318	1-Tridecene		C <sub>13</sub> H <sub>26</sub>	2437-56-1	182.345	liq	-13	232.8	0.7658 <sup>20</sup>	1.4340 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth; s bz
10319	Tridecyl acrylate		C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	3076-04-8	254.408	liq		150 <sup>10</sup>	0.88 <sup>20</sup>		
10320	Tridecylaluminum		C <sub>30</sub> H <sub>63</sub> Al	1726-66-5	450.803	hyg visc liq	-38				
10321	Tridecylamine	<i>N,N</i> -Didecyl-1-decanamine	C <sub>30</sub> H <sub>63</sub> N	1070-01-5	437.828			406			
10322	(Tridecyl)amine	1-Tridecanamine	C <sub>13</sub> H <sub>29</sub> N	2869-34-3	199.376		27.4	275.8	0.8049 <sup>20</sup>	1.4443 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
10323	Tridecylbenzene	1-Phenyltridecane	C <sub>19</sub> H <sub>32</sub>	123-02-4	260.457		10	346	0.8550 <sup>20</sup>	1.4821 <sup>20</sup>	
10324	Tridecylcyclohexane		C <sub>19</sub> H <sub>38</sub>	6006-33-3	266.505		18.5	346	0.8239 <sup>20</sup>	1.4570 <sup>20</sup>	
10325	Tridecyl methacrylate		C <sub>17</sub> H <sub>32</sub> O <sub>2</sub>	2495-25-2	268.435			118 <sup>1</sup>	0.881 <sup>20</sup>	1.448 <sup>25</sup>	
10326	Tri(decyl) phosphite		C <sub>30</sub> H <sub>63</sub> O <sub>3</sub> P	2929-86-4	502.793	liq		255 <sup>3</sup> , 180 <sup>0.1</sup>			
10327	1-Tridecyne		C <sub>13</sub> H <sub>24</sub>	26186-02-7	180.330		2.5	234; 94 <sup>25</sup>	0.7842 <sup>20</sup>	1.4309 <sup>20</sup>	vs bz, eth
10328	Tridiphane	2-(3,5-Dichlorophenyl)-2-(2,2,2-trichloroethyl)oxirane, (±)	C <sub>10</sub> H <sub>7</sub> Cl <sub>5</sub> O	58138-08-2	320.427		42.8				
10329	Tridodecylamine	<i>N,N</i> -Didodecyl-1-dodecanamine	C <sub>36</sub> H <sub>78</sub> N	102-87-4	521.988		16.4	220 <sup>0.03</sup>			
10330	Triethanolamine	Tris(2-hydroxyethyl)amine	C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub>	102-71-6	149.188	hyg cry	20.5	335.4	1.1242 <sup>20</sup>	1.4852 <sup>20</sup>	msc H <sub>2</sub> O, EtOH; sl eth, bz; s chl
10331	1,3,5-Triethoxybenzene		C <sub>12</sub> H <sub>10</sub> O <sub>3</sub>	2437-88-9	210.269	cry (al, dil al)	43.5	170 <sup>24</sup>			vs eth, EtOH
10332	Triethoxy(3-chloropropyl)silane	(3-Chloropropyl)triethoxysilane	C <sub>9</sub> H <sub>21</sub> ClO <sub>3</sub> Si	5089-70-3	240.800	col gas		-149			



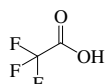
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10333	1,1,1-Triethoxyethane		C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	78-39-7	162.227			145	0.8847 <sup>25</sup>	1.3980 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ctc, chl
10334	Triethoxyethylsilane		C <sub>8</sub> H <sub>20</sub> O <sub>3</sub> Si	78-07-9	192.329			158.5	0.8963 <sup>20</sup>	1.3955 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth; s chl
10335	Triethoxymethane		C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	122-51-0	148.200			143; 60 <sup>20</sup>	0.8909 <sup>20</sup>	1.3922 <sup>20</sup>	s EtOH, eth
10336	Triethoxymethylsilane		C <sub>7</sub> H <sub>18</sub> O <sub>3</sub> Si	2031-67-6	178.302			142	0.8948 <sup>25</sup>	1.3832 <sup>20</sup>	
10337	Triethoxypentylsilane		C <sub>11</sub> H <sub>26</sub> O <sub>3</sub> Si	2761-24-2	234.408			100 <sup>30</sup> , 95 <sup>13</sup>	0.8862 <sup>20</sup>	1.4059 <sup>20</sup>	
10338	Triethoxyphenylsilane		C <sub>12</sub> H <sub>20</sub> O <sub>3</sub> Si	780-69-8	240.371			232; 113 <sup>10</sup>	0.996 <sup>25</sup>	1.4604 <sup>20</sup>	
10339	1,1,1-Triethoxypropane		C <sub>9</sub> H <sub>20</sub> O <sub>3</sub>	115-80-0	176.253			171		1.4000 <sup>25</sup>	vs eth, EtOH
10340	Triethoxysilane		C <sub>8</sub> H <sub>16</sub> O <sub>3</sub> Si	998-30-1	164.275			133.5	0.8745 <sup>20</sup>		
10341	3-(Triethoxysilyl)-1-propanamine		C <sub>9</sub> H <sub>23</sub> NO <sub>3</sub> Si	919-30-2	221.370			119 <sup>20</sup>	0.9506 <sup>20</sup>	1.4225 <sup>20</sup>	
10342	3-(Triethoxysilyl)propanenitrile		C <sub>9</sub> H <sub>19</sub> NO <sub>3</sub> Si	919-31-3	217.338	liq		109 <sup>10</sup>	0.974 <sup>20</sup>		
10343	Triethyl 2-acetoxy-1,2,3-propanetricarboxylate	Triethyl acetyl/citrate	C <sub>14</sub> H <sub>22</sub> O <sub>8</sub>	77-89-4	318.320			214 <sup>40</sup>	1.135 <sup>25</sup>	1.4380	
10344	Triethylaluminum	Hexaethylaluminum	C <sub>6</sub> H <sub>15</sub> Al	97-93-8	114.165	col hyg liq	-46	194; 100 <sup>13</sup>	0.832 <sup>25</sup>		
10345	Triethylamine	<i>N,N</i> -Diethylethanamine	C <sub>6</sub> H <sub>15</sub> N	121-44-8	101.190	liq	-114.7	89	0.7275 <sup>20</sup>	1.4010 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ctc; vs ace, bz, chl
10346	Triethylamine hydrochloride	<i>N,N</i> -Diethylethanamine hydrochloride	C <sub>6</sub> H <sub>16</sub> ClN	554-68-7	137.651	hex (al)	260 dec	sub 245	1.0689 <sup>21</sup>		vs H <sub>2</sub> O, EtOH, chl
10347	Triethylarsine		C <sub>6</sub> H <sub>15</sub> As	617-75-4	162.105			138.5	1.150 <sup>20</sup>	1.467 <sup>20</sup>	vs ace, eth, EtOH
10348	1,2,3-Triethylbenzene		C <sub>12</sub> H <sub>18</sub>	42205-08-3	162.271	col liq	-26	172			
10349	1,2,4-Triethylbenzene		C <sub>12</sub> H <sub>18</sub>	877-44-1	162.271			218; 99 <sup>15</sup>	0.8738 <sup>20</sup>	1.5024 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth
10350	1,3,5-Triethylbenzene		C <sub>12</sub> H <sub>18</sub>	102-25-0	162.271	liq	-66.5	215.9	0.8631 <sup>20</sup>	1.4969 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
10351	Triethylborane		C <sub>6</sub> H <sub>15</sub> B	97-94-9	97.994	liq	-93	95	0.70 <sup>23</sup>	1.3971	s EtOH, eth
10352	Triethyl borate	Boric acid, triethyl ester	C <sub>6</sub> H <sub>15</sub> BO <sub>3</sub>	150-46-9	145.992	liq	-84.8	120	0.8546 <sup>20</sup>	1.3749 <sup>20</sup>	msc EtOH, eth
10353	Triethyl citrate		C <sub>12</sub> H <sub>20</sub> O <sub>7</sub>	77-93-0	276.283			294	1.1369 <sup>20</sup>	1.4455 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
10354	Triethylenediamine		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	280-57-9	112.172		159				s chl
10355	Triethylene glycol	Triglycol	C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	112-27-6	150.173	hyg liq	-7	285	1.1274 <sup>15</sup>	1.4531 <sup>20</sup>	msc H <sub>2</sub> O, EtOH, bz; sl eth, chl; i peth
10356	Triethylene glycol bis(2-ethylhexanoate)		C <sub>22</sub> H <sub>42</sub> O <sub>6</sub>	94-28-0	402.564						s chl
10357	Triethylene glycol diacetate		C <sub>10</sub> H <sub>18</sub> O <sub>6</sub>	111-21-7	234.246	liq	-50	286	1.1153 <sup>20</sup>		vs H <sub>2</sub> O, eth, EtOH
10358	Triethylene glycol dimethacrylate		C <sub>14</sub> H <sub>22</sub> O <sub>6</sub>	109-16-0	286.321			170 <sup>5</sup>	1.092 <sup>20</sup>	1.4595 <sup>25</sup>	vs ace, eth, EtOH, peth
10359	Triethylene glycol dimethyl ether	Triglyme	C <sub>6</sub> H <sub>16</sub> O <sub>4</sub>	112-49-2	178.227	liq	-45	216	0.986 <sup>20</sup>	1.4224 <sup>20</sup>	vs H <sub>2</sub> O, bz
10360	Triethylene glycol dinitrate	Ethanol, 2,2'-[1,2-ethanediy]bis(oxy)]bis-, dinitrate	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>8</sub>	111-22-8	240.167			82 <sup>20,03</sup>			
10361	Triethylene glycol monoethyl ether	2-[2-(2-Ethoxyethoxy)ethoxy] ethanol	C <sub>8</sub> H <sub>18</sub> O <sub>4</sub>	112-50-5	178.227			256	1.0209 <sup>20</sup>		
10362	Triethylenephosphoramidate	Tris(1-aziridinyl)phosphine, oxide	C <sub>6</sub> H <sub>12</sub> N <sub>3</sub> OP	545-55-1	173.152	cry	41	91 <sup>23</sup>			vs H <sub>2</sub> O, EtOH, eth, ace
10363	Triethylenethiophosphoramidate	Thiotepa	C <sub>6</sub> H <sub>12</sub> N <sub>3</sub> PS	52-24-4	189.218	cry	51.5				vs H <sub>2</sub> O; s bz, chl, eth, EtOH
10364	1,3,5-Triethylhexahydro-1,3,5-triazine		C <sub>9</sub> H <sub>21</sub> N <sub>3</sub>	7779-27-3	171.283			78 <sup>6</sup>		1.4580 <sup>25</sup>	
10365	Triethyl phosphate	Ethyl phosphate	C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> P	78-40-0	182.154	liq	-56.4	215.5	1.0695 <sup>20</sup>	1.4053 <sup>20</sup>	s H <sub>2</sub> O, eth, bz; vs EtOH; sl chl
10366	Triethylphosphine		C <sub>6</sub> H <sub>15</sub> P	554-70-1	118.157	liq	-88	129	0.8006 <sup>19</sup>	1.458 <sup>15</sup>	i H <sub>2</sub> O; msc EtOH, eth
10367	Triethylphosphine oxide		C <sub>6</sub> H <sub>15</sub> OP	597-50-2	134.156	wh hyg nd	48	243			vs H <sub>2</sub> O, eth, EtOH
10368	Triethylphosphine sulfide		C <sub>6</sub> H <sub>15</sub> PS	597-51-3	150.222	cry (al)	94				s H <sub>2</sub> O; sl ctc
10369	Triethyl phosphite	Triethoxyphosphine	C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> P	122-52-1	166.155			157.9	0.9629 <sup>20</sup>	1.4127 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
10370	<i>O,O,O</i> -Triethyl phosphorothioate	<i>O,O,O</i> -Triethyl thiophosphate	C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> PS	126-68-1	198.220			217; 100 <sup>16</sup>	1.0768 <sup>20</sup>	1.4480 <sup>20</sup>	
10371	Triethylsilane		C <sub>6</sub> H <sub>16</sub> Si	617-86-7	116.277	liq	-156.9	109	0.7302 <sup>20</sup>	1.447 <sup>20</sup>	i H <sub>2</sub> O, sulf
10372	Triethylsilanol		C <sub>6</sub> H <sub>16</sub> OSi	597-52-4	132.276			154	0.8647 <sup>20</sup>	1.4329 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
10373	Triethylstibine		C <sub>6</sub> H <sub>15</sub> Sb	617-85-6	208.943	liq	-98	161.4	1.3224 <sup>15</sup>		i H <sub>2</sub> O; s EtOH, eth
10374	Trifenmorph	4-(Triphenylmethyl)morpholine	C <sub>23</sub> H <sub>23</sub> NO	1420-06-0	329.435	cry (EtOH)	176				i H <sub>2</sub> O; s chl, ctc
10375	Triflumizole		C <sub>15</sub> H <sub>15</sub> ClF <sub>3</sub> N <sub>3</sub> O	68694-11-1	345.747		63.5				
10376	Trifluoperazine		C <sub>21</sub> H <sub>24</sub> F <sub>3</sub> N <sub>3</sub> S	117-89-5	407.496	cry		206 <sup>0,7</sup>			
10377	Trifluoperazine dihydrochloride	Stelazine	C <sub>21</sub> H <sub>26</sub> Cl <sub>2</sub> F <sub>3</sub> N <sub>3</sub> S	440-17-5	480.417		241.5				



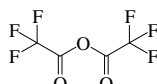
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10378	2,2,2-Trifluoroacetamide		C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> NO	354-38-1	113.038		73.8	162.5			
10379	Trifluoroacetic acid		C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	76-05-1	114.023	liq	-15.2	73	1.5351 <sup>25</sup>		s H <sub>2</sub> O, EtOH, eth, ace
10380	Trifluoroacetic acid anhydride		C <sub>2</sub> F <sub>6</sub> O <sub>3</sub>	407-25-0	210.031	liq	-65	39.5	1.490 <sup>25</sup>	1.269 <sup>25</sup>	
10381	1,1,1-Trifluoroacetone	Methyl trifluoromethyl ketone	C <sub>3</sub> H <sub>2</sub> F <sub>3</sub> O	421-50-1	112.050	vol liq or gas		21.5	1.252 <sup>25</sup>		
10382	Trifluoroacetonitrile		C <sub>2</sub> F <sub>3</sub> N	353-85-5	95.023	col gas		-68.8			
10383	Trifluoroacetyl chloride		C <sub>2</sub> ClF <sub>2</sub> O	354-32-5	132.468	col gas	-146	-18			
10384	1,2,4-Trifluorobenzene		C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	367-23-7	132.083			90	1.264 <sup>25</sup>	1.4171 <sup>20</sup>	
10385	1,3,5-Trifluorobenzene		C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	372-38-3	132.083	liq	-5.5	75.5	1.277 <sup>25</sup>	1.4140 <sup>20</sup>	
10386	1,1,1-Trifluoroethane	Methyl fluoroform	C <sub>2</sub> H <sub>2</sub> F <sub>3</sub>	420-46-2	84.040	col gas	-111.3	-47.25			s eth, chl
10387	1,1,2-Trifluoroethane		C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	430-66-0	84.040	col gas	-84	3.7			
10388	2,2,2-Trifluoroethanol		C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> O	75-89-8	100.039	liq	-43.5	74	1.3842 <sup>20</sup>	1.2907 <sup>22</sup>	vs EtOH; s eth, ace, bz, chl
10389	Trifluoroethene	Trifluoroethylene	C <sub>2</sub> HF <sub>3</sub>	359-11-5	82.024	col gas		-51	1.26 <sup>70</sup>		i H <sub>2</sub> O; sl EtOH; s eth
10390	2,2,2-Trifluoroethylamine	2,2,2-Trifluoroethanamine	C <sub>3</sub> H <sub>4</sub> F <sub>3</sub> N	753-90-2	99.055			36	1.245 <sup>25</sup>		
10391	2,2,2-Trifluoroethyl methyl ether		C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> O	460-43-5	114.066			31.62			
10392	1,1,1-Trifluoro-2-iodoethane		C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> I	353-83-3	209.936			54.5	2.13 <sup>25</sup>	1.4009 <sup>20</sup>	
10393	Trifluoroiodomethane		CF <sub>3</sub> I	2314-97-8	195.910	col gas		-22.5	2.3607 <sup>32</sup>	1.3790 <sup>32</sup>	
10394	Trifluoroisocyanomethane	Trifluoromethyl isocyanide	C <sub>2</sub> F <sub>3</sub> N	19480-01-4	95.023	col gas		-80			
10395	Trifluoromethane	Fluoroform	CHF <sub>3</sub>	75-46-7	70.014	col gas	-155.2	-82.1	0.673 <sup>25</sup> (p>1 atm)		s H <sub>2</sub> O, ace, bz; vs EtOH; sl chl
10396	Trifluoromethanesulfonyl chloride		CClF <sub>3</sub> S	421-17-0	136.524	col gas		-0.7			i H <sub>2</sub> O
10397	Trifluoromethanesulfonic acid		CHF <sub>3</sub> O <sub>3</sub> S	1493-13-6	150.077	hyg liq	45	162			vs eth
10398	Trifluoromethanesulfonyl chloride		CClF <sub>3</sub> O <sub>2</sub> S	421-83-0	168.523			162; 62 <sup>18</sup>		1.3344 <sup>20</sup>	i H <sub>2</sub> O
10399	Trifluoromethanesulfonyl fluoride		CF <sub>3</sub> O <sub>2</sub> S	335-05-7	152.069	col gas		-21.7			
10400	2-(Trifluoromethyl)aniline		C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	88-17-5	161.125		35.5	68 <sup>15</sup>	1.282 <sup>25</sup>	1.4810 <sup>20</sup>	
10401	3-(Trifluoromethyl)aniline		C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	98-16-8	161.125		5.5	187; 74 <sup>10</sup>	1.3047 <sup>12</sup>	1.4787 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
10402	4-(Trifluoromethyl)aniline		C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	455-14-1	161.125		38	117.5 <sup>60</sup>	1.283 <sup>27</sup>	1.4815 <sup>25</sup>	
10403	4-(Trifluoromethyl)benzaldehyde		C <sub>8</sub> H <sub>5</sub> F <sub>3</sub> O	455-19-6	174.120			80 <sup>25</sup>		1.4630 <sup>20</sup>	
10404	(Trifluoromethyl)benzene	Benzotrifluoride	C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	98-08-8	146.110	liq	-28.95	102.1	1.1884 <sup>20</sup>	1.4146 <sup>20</sup>	msc EtOH, eth, ace, bz, ctc
10405	3-(Trifluoromethyl)benzonitrile		C <sub>8</sub> H <sub>5</sub> F <sub>3</sub> N	368-77-4	171.120		14.5	189	1.2813 <sup>20</sup>	1.4508 <sup>20</sup>	
10406	4-(Trifluoromethyl)benzonitrile		C <sub>8</sub> H <sub>5</sub> F <sub>3</sub> N	455-18-5	171.120		37.5				
10407	3-(Trifluoromethyl)benzoyl chloride		C <sub>8</sub> H <sub>4</sub> ClF <sub>3</sub> O	2251-65-2	208.565	oil		186; 80 <sup>16</sup>	1.383	1.4770 <sup>20</sup>	
10408	Trifluoromethyl difluoromethyl ether		C <sub>2</sub> H <sub>2</sub> F <sub>5</sub> O	3822-68-2	136.020	col gas	-157	-38			
10409	2-(Trifluoromethyl)phenol		C <sub>7</sub> H <sub>5</sub> F <sub>3</sub> O	444-30-4	162.109		45.5	147.5			
10410	3-(Trifluoromethyl)phenol		C <sub>7</sub> H <sub>5</sub> F <sub>3</sub> O	98-17-9	162.109	liq	-0.9	178	1.3418 <sup>25</sup>		
10411	2-[[3-(Trifluoromethyl)phenyl]amino]benzoic acid	Flufenamic acid	C <sub>14</sub> H <sub>10</sub> F <sub>3</sub> NO <sub>2</sub>	530-78-9	281.230		133.5				s DMSO
10412	Trifluoromethylsilane		CH <sub>3</sub> F <sub>3</sub> Si	373-74-0	100.116	col gas	-73	-30			
10413	(Trifluoromethyl)silane		CH <sub>3</sub> F <sub>3</sub> Si	10112-11-5	100.116	col gas	-124	-38.3			
10414	Trifluoromethyl 1,1,2,2-tetrafluoroethyl ether		C <sub>3</sub> HF <sub>7</sub> O	2356-61-8	186.028	col gas	-141	-3			
10415	1,1,1-Trifluoro-2,4-pentanedione	1,1,1-Trifluoroacetylacetone	C <sub>5</sub> H <sub>3</sub> F <sub>3</sub> O <sub>2</sub>	367-57-7	154.088	liq		107			s os
10416	4,4,4-Trifluoro-1-phenyl-1,3-butanedione		C <sub>10</sub> H <sub>7</sub> F <sub>3</sub> O <sub>2</sub>	326-06-7	216.157	cry	39	224			i H <sub>2</sub> O; s EtOH, ace
10417	2,2,2-Trifluoro-1-phenylethanone		C <sub>8</sub> H <sub>7</sub> F <sub>3</sub> O	434-45-7	174.120	liq	-40	153	1.279 <sup>20</sup>	1.4583 <sup>20</sup>	
10418	Trifluorophenylsilane		C <sub>6</sub> H <sub>3</sub> F <sub>3</sub> Si	368-47-8	162.185	liq	-18	101.5	1.2169 <sup>20</sup>	1.4110 <sup>20</sup>	vs bz, EtOH
10419	1,1,1-Trifluoropropane		C <sub>3</sub> H <sub>2</sub> F <sub>3</sub>	421-07-8	98.067	col gas		-13			
10420	1,1,1-Trifluoro-2-propanol, (±)		C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> O	17556-48-8	114.066	liq	-52	78	1.2632 <sup>25</sup>	1.3130 <sup>25</sup>	vs EtOH, eth; s ace, bz; sl ctc
10421	3,3,3-Trifluoropropene		C <sub>3</sub> H <sub>2</sub> F <sub>3</sub>	677-21-4	96.051	col gas		-17			
10422	3,3,3-Trifluoro-1-propyne	(Trifluoromethyl)acetylene	C <sub>2</sub> HF <sub>3</sub>	661-54-1	94.035	col gas		-48.3			
10423	4,4,4-Trifluoro-1-(2-thienyl)-1,3-butanedione	Thenyltrifluoroacetone	C <sub>8</sub> H <sub>6</sub> F <sub>3</sub> O <sub>2</sub> S	326-91-0	222.185		42.8	97 <sup>9</sup>			
10424	Trifluoro(trifluoromethyl)oxirane	Perfluoropropylene oxide	C <sub>3</sub> F <sub>6</sub> O	428-59-1	166.021	gas		-27.4			
10425	Trifluoromazine	Fluopromazine	C <sub>18</sub> H <sub>16</sub> F <sub>3</sub> N <sub>2</sub> S	146-54-3	352.417	visc oil		176 <sup>9,7</sup>		1.5780 <sup>23</sup>	
10426	Trifluralin	2,6-Dinitro- <i>N,N</i> -dipropyl-4-(trifluoromethyl)aniline	C <sub>13</sub> H <sub>16</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub>	1582-09-8	335.279		49	140 <sup>4,2</sup>			
10427	Triforine		C <sub>10</sub> H <sub>14</sub> Cl <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	26644-46-2	434.962		155 dec				
10428	Trigonelline		C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	535-83-1	137.137	pr (aq, al, +1w)					vs H <sub>2</sub> O
10429	Trihexylamine	<i>N,N</i> -Dihexyl-1-hexanamine	C <sub>18</sub> H <sub>39</sub> N	102-86-3	269.510			261.7	0.7976 <sup>21</sup>		i H <sub>2</sub> O; vs EtOH, eth; s acid
10430	Trihexyl borate		C <sub>18</sub> H <sub>39</sub> BO <sub>3</sub>	5337-36-0	314.312			143 <sup>2</sup>			sl ctc



2,2,2-Trifluoroacetamide



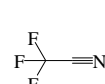
Trifluoroacetic acid



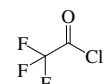
Trifluoroacetic acid anhydride



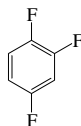
1,1,1-Trifluoroacetone



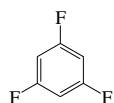
Trifluoroacetonitrile



Trifluoroacetyl chloride



1,2,4-Trifluorobenzene



1,3,5-Trifluorobenzene



1,1,1-Trifluoroethane



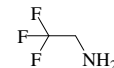
1,1,2-Trifluoroethane



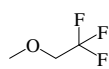
2,2,2-Trifluoroethanol



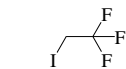
Trifluoroethene



2,2,2-Trifluoroethylamine



2,2,2-Trifluoroethyl methyl ether



1,1,1-Trifluoro-2-iodoethane



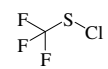
Trifluoroiodomethane



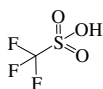
Trifluoroisocyanomethane



Trifluoromethane



Trifluoromethanesulfonyl chloride



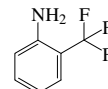
Trifluoromethanesulfonic acid



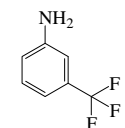
Trifluoromethanesulfonyl chloride



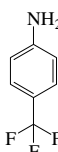
Trifluoromethanesulfonyl fluoride



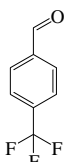
2-(Trifluoromethyl)aniline



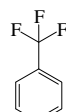
3-(Trifluoromethyl)aniline



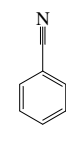
4-(Trifluoromethyl)aniline



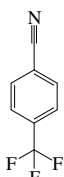
4-(Trifluoromethyl)benzaldehyde



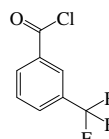
(Trifluoromethyl)benzene



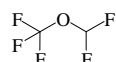
3-(Trifluoromethyl)benzonitrile



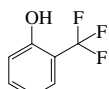
4-(Trifluoromethyl)benzonitrile



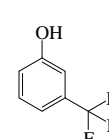
3-(Trifluoromethyl)benzoyl chloride



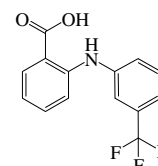
Trifluoromethyl difluoromethyl ether



2-(Trifluoromethyl)phenol



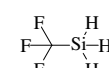
3-(Trifluoromethyl)phenol



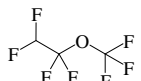
2-[[3-(Trifluoromethyl)phenyl]amino]benzoic acid



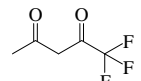
Trifluoromethylsilane



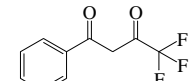
(Trifluoromethyl)silane



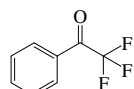
Trifluoromethyl 1,1,2,2-tetrafluoroethyl ether



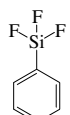
1,1,1-Trifluoro-2,4-pentanedione



4,4,4-Trifluoro-1-phenyl-1,3-butanedione



2,2,2-Trifluoro-1-phenylethanone



Trifluorophenylsilane



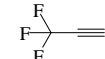
1,1,1-Trifluoropropane



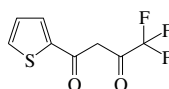
1,1,1-Trifluoro-2-propanol, (±)



3,3,3-Trifluoropropene



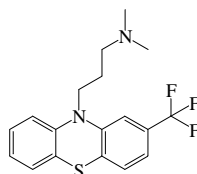
3,3,3-Trifluoro-1-propyne



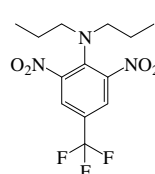
4,4,4-Trifluoro-1-(2-thienyl)-1,3-butanedione



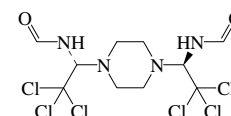
Trifluoro(trifluoromethyl)oxirane



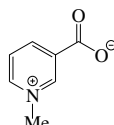
Triflupromazine



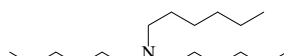
Trifluralin



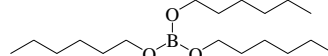
Triflorine



Trigonelline



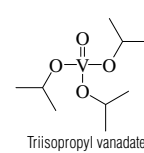
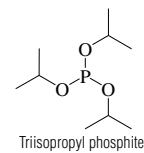
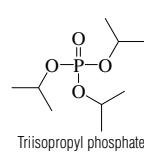
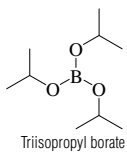
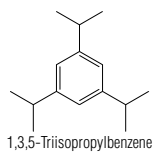
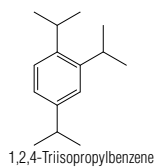
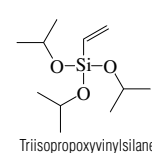
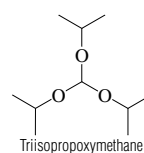
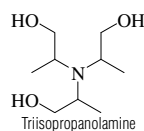
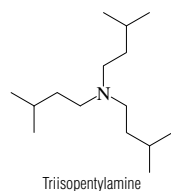
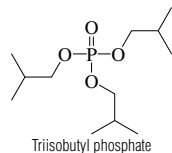
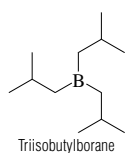
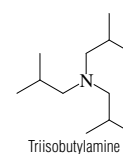
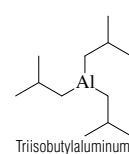
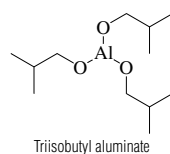
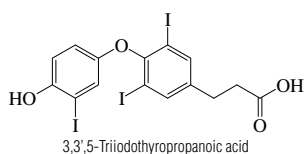
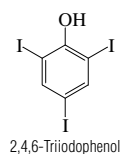
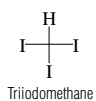
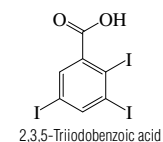
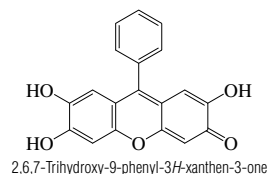
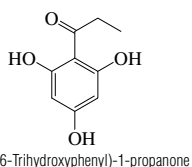
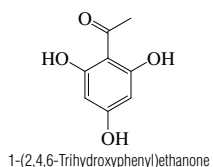
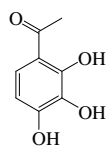
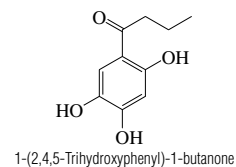
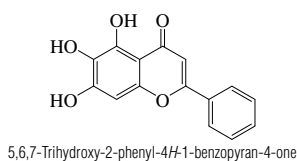
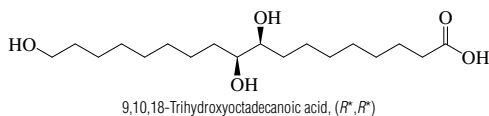
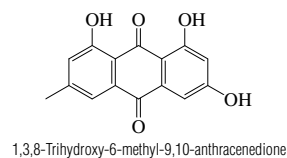
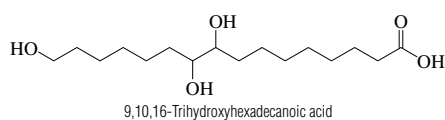
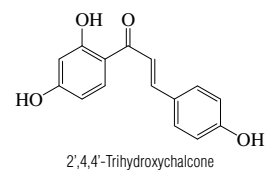
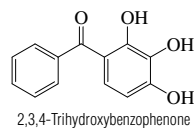
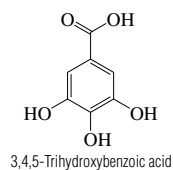
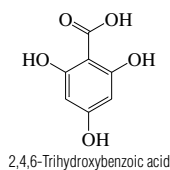
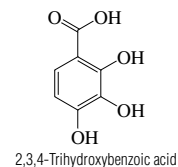
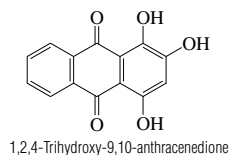
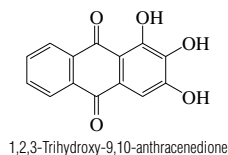
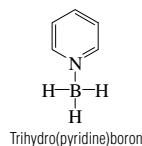
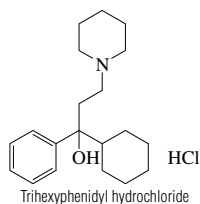
Trihexylamine



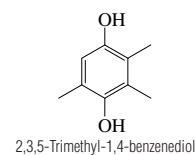
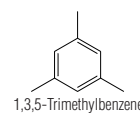
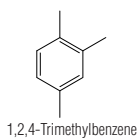
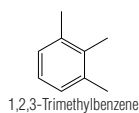
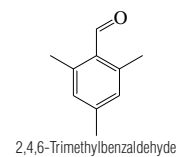
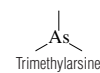
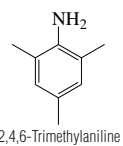
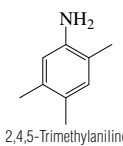
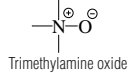
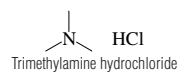
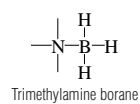
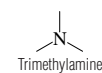
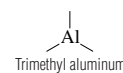
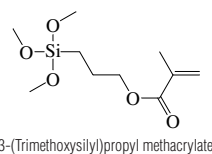
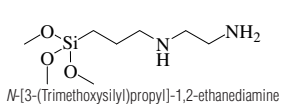
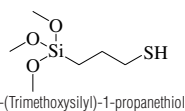
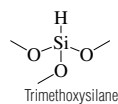
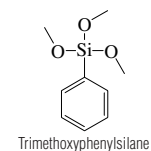
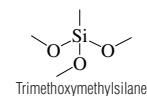
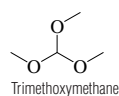
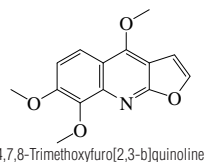
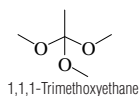
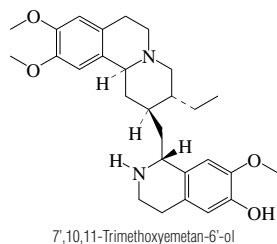
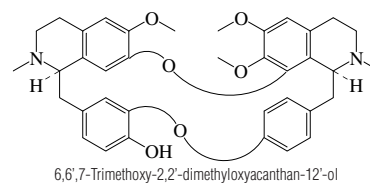
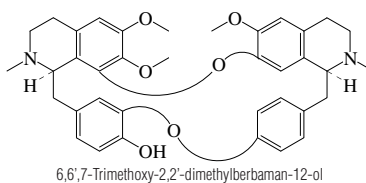
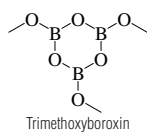
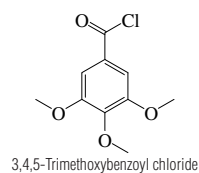
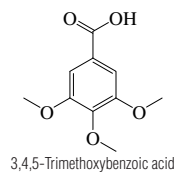
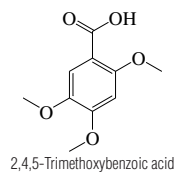
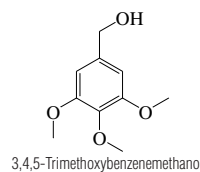
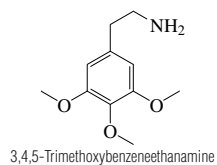
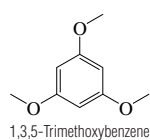
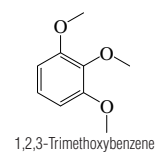
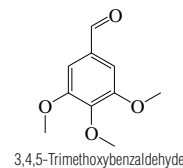
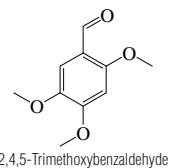
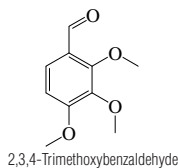
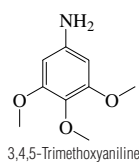
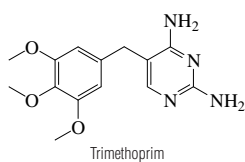
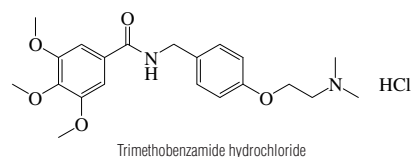
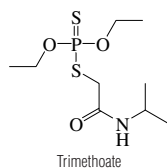
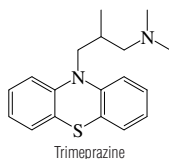
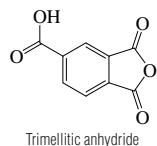
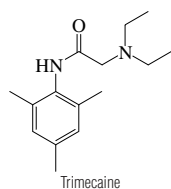
Trihexyl borate

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10431	Trihexyphenidyl hydrochloride	$\alpha$ -Cyclohexyl- $\alpha$ -phenyl-1-piperidinepropanol hydrochloride	C <sub>20</sub> H <sub>32</sub> ClNO	52-49-3	337.927		258.5				
10432	Trihydro(pyridine)boron	Borane pyridine	C <sub>5</sub> H <sub>6</sub> BN	110-51-0	92.936		10.5		0.920 <sup>20</sup>	1.5280 <sup>25</sup>	i H <sub>2</sub> O; dec acid
10433	1,2,3-Trihydroxy-9,10-anthracenedione	Anthragallol	C <sub>14</sub> H <sub>8</sub> O <sub>5</sub>	602-64-2	256.211	ye nd (dil al)	313	sub 290			sl H <sub>2</sub> O; s EtOH, eth, HOAc, CS <sub>2</sub>
10434	1,2,4-Trihydroxy-9,10-anthracenedione	Purpurin	C <sub>14</sub> H <sub>8</sub> O <sub>5</sub>	81-54-9	256.211	oran red or oran-ye nd (al)	259	sub			sl H <sub>2</sub> O; vs EtOH, bz, HOAc; s eth
10435	2,3,4-Trihydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	610-02-6	170.120	nd (+w)	221	sub			sl H <sub>2</sub> O; s EtOH, eth, ace; i bz, CS <sub>2</sub>
10436	2,4,6-Trihydroxybenzoic acid		C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	83-30-7	170.120	cry (w+1)	100 dec				sl H <sub>2</sub> O; s EtOH; vs eth; i bz
10437	3,4,5-Trihydroxybenzoic acid	Gallic acid	C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	149-91-7	170.120	pr (w+1)	253 dec		1.694 <sup>6</sup>		sl H <sub>2</sub> O, eth; vs EtOH; s ace; i bz, chl
10438	2,3,4-Trihydroxybenzophenone	Alizarin Yellow A	C <sub>13</sub> H <sub>10</sub> O <sub>4</sub>	1143-72-2	230.216	ye nd (dil al)	140.5				sl H <sub>2</sub> O, bz; s EtOH, eth, ace, HOAc
10439	2',4',4'-Trihydroxychalcone	Isoliquiritigenin	C <sub>15</sub> H <sub>12</sub> O <sub>4</sub>	961-29-5	256.254	ye nd (EtOH-w)	200				
10440	9,10,16-Trihydroxyhexadecanoic acid	Aleuritic acid	C <sub>16</sub> H <sub>32</sub> O <sub>5</sub>	6949-98-0	304.422	lf (dil al), nd (w)	102				sl H <sub>2</sub> O
10441	1,3,8-Trihydroxy-6-methyl-9,10-anthracenedione	Emodin	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	518-82-1	270.237	oran-red mcl nd (HOAc)	257	sub			vs eth, EtOH
10442	9,10,18-Trihydroxyoctadecanoic acid, ( <i>R</i> *, <i>R</i> ')	Phloionolic acid	C <sub>18</sub> H <sub>36</sub> O <sub>5</sub>	583-86-8	332.476	cry (dil al)	101.5				
10443	5,6,7-Trihydroxy-2-phenyl-4 <i>H</i> -1-benzopyran-4-one	Baicalein	C <sub>15</sub> H <sub>10</sub> O <sub>5</sub>	491-67-8	270.237	ye pr (al)	264 dec				sl H <sub>2</sub> O, bz; s EtOH, eth, ace, HOAc
10444	1-(2,4,5-Trihydroxyphenyl)-1-butanone		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	1421-63-2	196.200			153.8			
10445	1-(2,3,4-Trihydroxyphenyl) ethanone	Gallacetophenone	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	528-21-2	168.148			173			s H <sub>2</sub> O, eth; vs EtOH, ace; sl bz, chl
10446	1-(2,4,6-Trihydroxyphenyl) ethanone	2',4',6'-Trihydroxyacetophenone	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	480-66-0	168.148			221.0			sl H <sub>2</sub> O, chl, bz; vs EtOH, eth, ace
10447	1-(2,4,6-Trihydroxyphenyl)-1-propanone	Flopropione	C <sub>9</sub> H <sub>10</sub> O <sub>4</sub>	2295-58-1	182.173	nd (w, +1w)	175.5				vs eth, EtOH
10448	2,6,7-Trihydroxy-9-phenyl-3 <i>H</i> -xanthen-3-one	Phenylfluorone	C <sub>19</sub> H <sub>12</sub> O <sub>5</sub>	975-17-7	320.295	oran red (al-HCl)	>300				
10449	2,3,5-Triiodobenzoic acid		C <sub>7</sub> H <sub>3</sub> I <sub>3</sub> O <sub>2</sub>	88-82-4	499.811	pr (al)	225				i H <sub>2</sub> O; vs EtOH, eth; sl bz
10450	Triiodomethane	Iodoform	CHI <sub>3</sub>	75-47-8	393.732	ye cry	121.2	218	4.008 <sup>25</sup>		i H <sub>2</sub> O, bz; s EtOH, eth, ace; sl DMSO
10451	2,4,6-Triiodophenol		C <sub>6</sub> H <sub>3</sub> I <sub>3</sub> O	609-23-4	471.800	nd (dil al)	159.8	sub			i H <sub>2</sub> O; sl EtOH; s eth, ace
10452	3,3',5-Triiodothyropropanoic acid		C <sub>15</sub> H <sub>11</sub> I <sub>3</sub> O <sub>4</sub>	51-26-3	635.959	cry (EtOH)	200				sl EtOH
10453	Triisobutyl aluminate	2-Methyl-1-propanol, aluminum salt	C <sub>12</sub> H <sub>27</sub> AlO <sub>3</sub>	3453-79-0	246.322			275 <sup>50</sup>			
10454	Triisobutylaluminum		C <sub>12</sub> H <sub>27</sub> Al	100-99-2	198.324	liq	6	86 <sup>10</sup>			
10455	Triisobutylamine	2-Methyl- <i>N,N</i> -bis(2-methylpropyl)-1-propanamine	C <sub>12</sub> H <sub>27</sub> N	1116-40-1	185.349	liq	-21.8	191.5	0.7684 <sup>20</sup>	1.4252 <sup>17</sup>	vs eth, EtOH
10456	Triisobutylborane		C <sub>12</sub> H <sub>27</sub> B	1116-39-8	182.153			188; 86 <sup>20</sup>	0.7380 <sup>25</sup>	1.4188 <sup>23</sup>	vs bz, eth, EtOH
10457	Triisobutyl phosphate		C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	126-71-6	266.313			264	0.9681 <sup>20</sup>	1.4193 <sup>20</sup>	vs H <sub>2</sub> O, bz, eth, EtOH
10458	Triisopentylamine	3-Methyl- <i>N,N</i> -bis(3-methylbutyl)-1-butanamine	C <sub>15</sub> H <sub>33</sub> N	645-41-0	227.430			235	0.7848 <sup>20</sup>	1.4331 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, bz, ctc
10459	Triisopropanolamine		C <sub>9</sub> H <sub>21</sub> NO <sub>3</sub>	122-20-3	191.268		45	175 <sup>10</sup>	1.0 <sup>20</sup>		s H <sub>2</sub> O, EtOH; sl chl
10460	Triisopropoxymethane	Isopropyl orthoformate	C <sub>10</sub> H <sub>22</sub> O <sub>3</sub>	4447-60-3	190.280			167	0.8621 <sup>20</sup>	1.4000 <sup>20</sup>	vs eth, EtOH
10461	Triisopropoxyvinylsilane		C <sub>11</sub> H <sub>24</sub> O <sub>3</sub> Si	18023-33-1	232.393			179.5; 77 <sup>20</sup>	0.8627 <sup>25</sup>	1.3981 <sup>20</sup>	s ctc
10462	1,2,4-Triisopropylbenzene		C <sub>15</sub> H <sub>24</sub>	948-32-3	204.352			244	0.8574 <sup>25</sup>	1.4896 <sup>25</sup>	
10463	1,3,5-Triisopropylbenzene		C <sub>15</sub> H <sub>24</sub>	717-74-8	204.352	liq	-7.4	238	0.8545 <sup>20</sup>	1.4882 <sup>20</sup>	s ace, bz, chl
10464	Triisopropyl borate		C <sub>9</sub> H <sub>21</sub> BO <sub>3</sub>	5419-55-6	188.072			140; 75 <sup>16</sup>	0.8251 <sup>20</sup>	1.3777 <sup>20</sup>	vs EtOH, eth, bz, PrOH
10465	Triisopropyl phosphate		C <sub>9</sub> H <sub>21</sub> O <sub>4</sub> P	513-02-0	224.234			219	0.9867 <sup>20</sup>	1.4057 <sup>20</sup>	vs EtOH
10466	Triisopropyl phosphite		C <sub>9</sub> H <sub>21</sub> O <sub>3</sub> P	116-17-6	208.235			74 <sup>20</sup> , 60 <sup>10</sup>	0.9063 <sup>20</sup>	1.4085 <sup>25</sup>	s EtOH, eth, chl
10467	Triisopropyl vanadate	Vanadium, oxotris(2-propanolato)-, (T-4)-	C <sub>9</sub> H <sub>21</sub> O <sub>4</sub> V	5588-84-1	244.203			104 <sup>10</sup>			

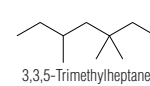
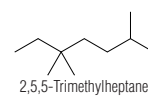
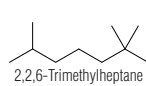
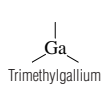
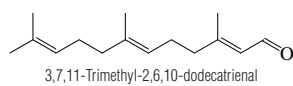
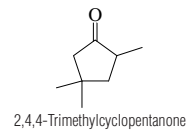
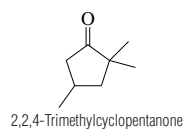
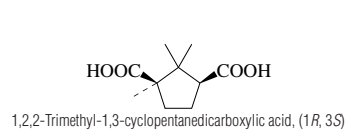
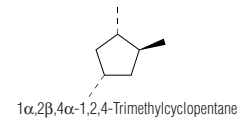
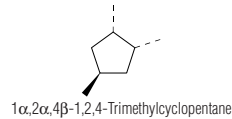
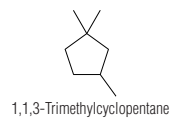
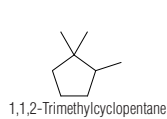
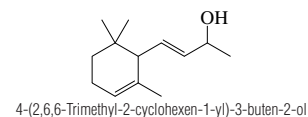
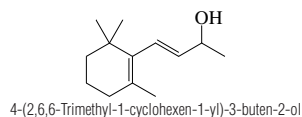
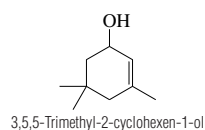
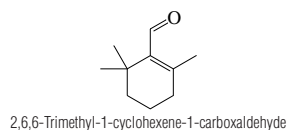
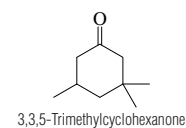
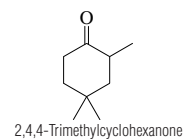
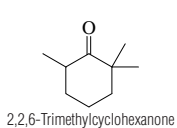
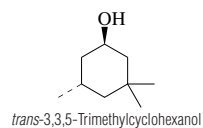
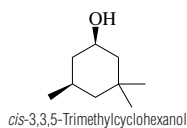
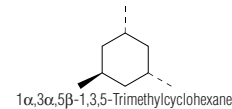
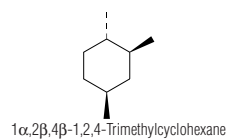
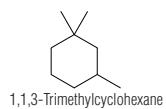
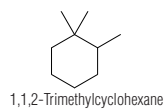
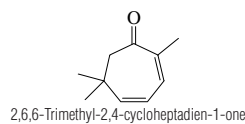
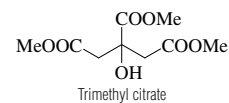
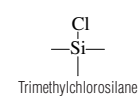
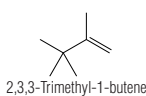
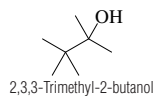
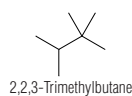
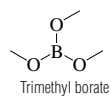
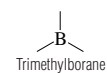
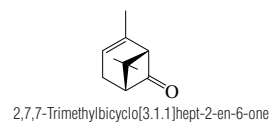
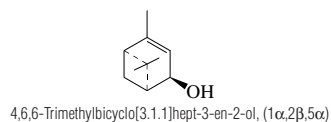
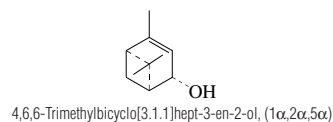
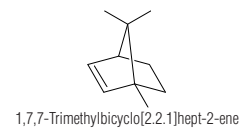
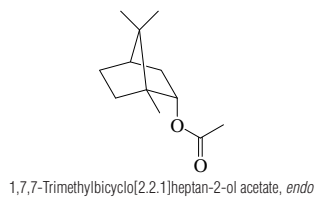
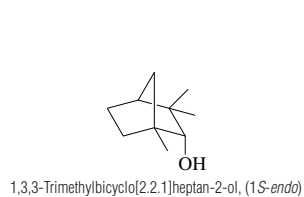
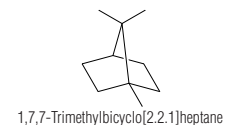
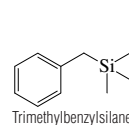
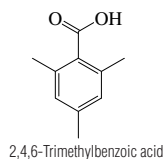
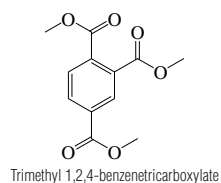
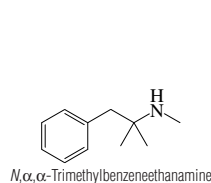




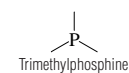
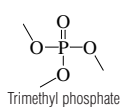
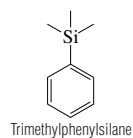
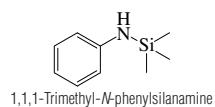
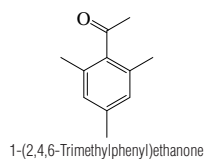
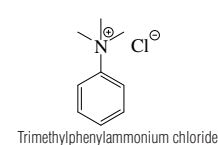
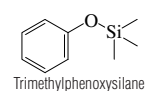
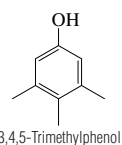
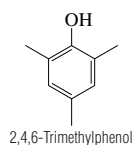
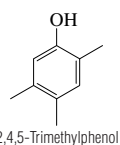
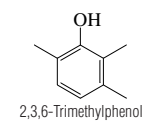
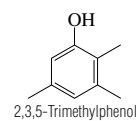
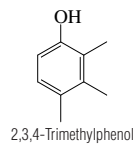
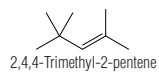
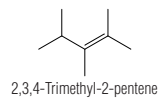
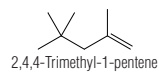
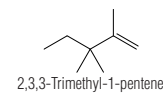
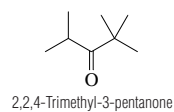
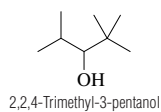
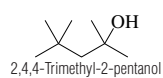
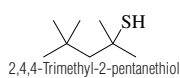
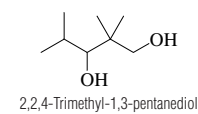
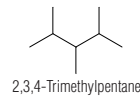
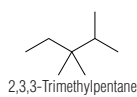
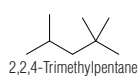
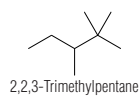
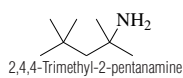
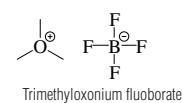
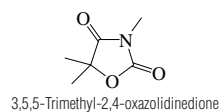
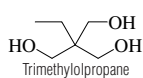
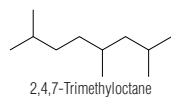
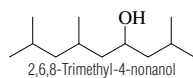
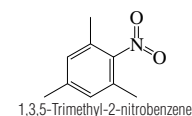
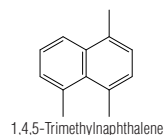
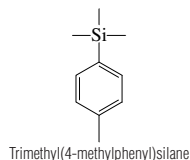
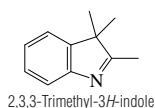
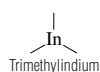
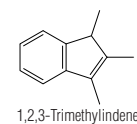
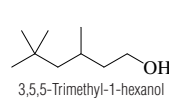
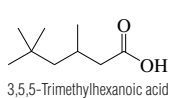
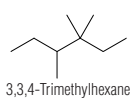
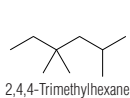
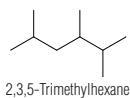
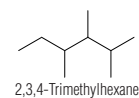
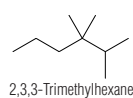
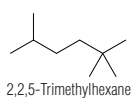
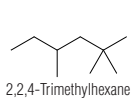
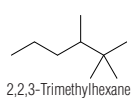
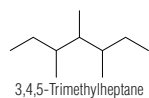
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10468	Trimecaine	2-Diethylamino-2',4',6'-trimethylacetanilide	C <sub>15</sub> H <sub>24</sub> N <sub>2</sub> O	616-68-2	248.364	cry	44	187 <sup>6</sup>			
10469	Trimellitic anhydride		C <sub>9</sub> H <sub>4</sub> O <sub>5</sub>	552-30-7	192.125		162	241 <sup>14</sup>			
10470	Trimeprazine	<i>N,N</i> ,β-Trimethyl-10 <i>H</i> -phenothiazine-10-propanamine	C <sub>18</sub> H <sub>22</sub> N <sub>2</sub> S	84-96-8	298.446	cry	68	162 <sup>20,3</sup>			
10471	Trimethoate		C <sub>9</sub> H <sub>20</sub> NO <sub>3</sub> PS <sub>2</sub>	2275-18-5	285.364	solid	28.5	135 <sup>0,1</sup>			sl H <sub>2</sub> O
10472	Trimethobenzamide hydrochloride		C <sub>21</sub> H <sub>25</sub> ClN <sub>2</sub> O <sub>3</sub>	554-92-7	424.918	cry	188				vs H <sub>2</sub> O
10473	Trimethoprim		C <sub>14</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub>	738-70-5	290.318	ye cry	201				sl chl, MeOH; i eth, bz
10474	3,4,5-Trimethoxyaniline		C <sub>9</sub> H <sub>13</sub> NO <sub>3</sub>	24313-88-0	183.204		112.8				
10475	2,3,4-Trimethoxybenzaldehyde		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	2103-57-3	196.200			122 <sup>0,5</sup>		1.5547 <sup>20</sup>	
10476	2,4,5-Trimethoxybenzaldehyde		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	4460-86-0	196.200		114				s H <sub>2</sub> O, eth, chl, lig
10477	3,4,5-Trimethoxybenzaldehyde		C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	86-81-7	196.200		72.5	148 <sup>5</sup>			s chl
10478	1,2,3-Trimethoxybenzene		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	634-36-6	168.189	orth nd (al)	48.5	235	1.1009 <sup>45</sup>		i H <sub>2</sub> O; s EtOH, eth, bz
10479	1,3,5-Trimethoxybenzene		C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	621-23-8	168.189	pr (al), lf (peth)	54.5	255.5			i H <sub>2</sub> O; s EtOH, eth, bz
10480	3,4,5-Trimethoxybenzeneethanamine	Mescaline	C <sub>11</sub> H <sub>17</sub> NO <sub>3</sub>	54-04-6	211.258	cry	35.5	180 <sup>12</sup>			s H <sub>2</sub> O, EtOH, bz, chl; i eth, peth
10481	3,4,5-Trimethoxybenzenemethanol	3,4,5-Trimethoxybenzyl alcohol	C <sub>10</sub> H <sub>14</sub> O <sub>4</sub>	3840-31-1	198.216		3	228 <sup>25</sup>	1.1427 <sup>20</sup>	1.5439 <sup>20</sup>	
10482	2,4,5-Trimethoxybenzoic acid		C <sub>10</sub> H <sub>12</sub> O <sub>5</sub>	490-64-2	212.199	nd (al or bz-peth)	145	300			vs H <sub>2</sub> O, bz, EtOH, peth
10483	3,4,5-Trimethoxybenzoic acid		C <sub>10</sub> H <sub>12</sub> O <sub>5</sub>	118-41-2	212.199	mcl nd (w)	172.3	226 <sup>10</sup>			sl H <sub>2</sub> O; vs EtOH, eth, chl
10484	3,4,5-Trimethoxybenzoyl chloride		C <sub>10</sub> H <sub>11</sub> ClO <sub>4</sub>	4521-61-3	230.645		82	185 <sup>18</sup>			
10485	Trimethoxyboroxin		C <sub>3</sub> H <sub>3</sub> B <sub>3</sub> O <sub>6</sub>	102-24-9	173.532					1.40 <sup>25</sup>	
10486	6,6',7'-Trimethoxy-2,2'-dimethylberbaman-12-ol	Berbamine	C <sub>37</sub> H <sub>40</sub> N <sub>2</sub> O <sub>6</sub>	478-61-5	608.723	lf (+2w, al) cry (peth)	198.5				sl H <sub>2</sub> O; s EtOH, eth, chl, peth
10487	6,6',7'-Trimethoxy-2,2'-dimethoxyacanthan-12'-ol	Oxyacanthine	C <sub>37</sub> H <sub>40</sub> N <sub>2</sub> O <sub>6</sub>	548-40-3	608.723	nd (al, eth)	216.5				i H <sub>2</sub> O; s EtOH, eth, bz, chl; i lig
10488	7',10,11-Trimethoxyemetan-6'-ol	Cephaeline	C <sub>28</sub> H <sub>38</sub> N <sub>2</sub> O <sub>4</sub>	483-17-0	466.613	nd (eth)	115.5				vs ace, EtOH, MeOH, chl
10489	1,1,1-Trimethoxyethane		C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	1445-45-0	120.147			108	0.9438 <sup>25</sup>	1.3859 <sup>25</sup>	vs eth, EtOH
10490	4,7,8-Trimethoxyfuro[2,3-b]quinoline	Skimmianine	C <sub>14</sub> H <sub>13</sub> NO <sub>4</sub>	83-95-4	259.258	pym (al)	177				i H <sub>2</sub> O, peth; s EtOH, chl; sl eth, CS <sub>2</sub>
10491	Trimethoxymethane		C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	149-73-5	106.120		15	104	0.9676 <sup>20</sup>	1.3793 <sup>20</sup>	s EtOH, eth
10492	Trimethoxymethylsilane		C <sub>3</sub> H <sub>12</sub> O <sub>2</sub> Si	1185-55-3	136.222			102.5	0.9548 <sup>20</sup>	1.3696 <sup>20</sup>	s chl
10493	Trimethoxyphenylsilane		C <sub>9</sub> H <sub>14</sub> O <sub>3</sub> Si	2996-92-1	198.291			130 <sup>45</sup> , 110 <sup>20</sup>	1.064 <sup>20</sup>	1.4734 <sup>20</sup>	s ctc, CS <sub>2</sub>
10494	Trimethoxysilane		C <sub>3</sub> H <sub>10</sub> O <sub>3</sub> Si	2487-90-3	122.195			32 <sup>100</sup>			
10495	3-(Trimethoxysilyl)-1-propanethiol (3-Mercaptopropyl) trimethoxysilane		C <sub>6</sub> H <sub>16</sub> O <sub>3</sub> SSi	4420-74-0	196.340			128 <sup>50</sup> , 93 <sup>10</sup>	1.015 <sup>25</sup>	1.4420 <sup>25</sup>	
10496	<i>N</i> -[3-(Trimethoxysilyl)propyl]-1,2-ethanediamine		C <sub>8</sub> H <sub>22</sub> N <sub>2</sub> O <sub>3</sub> Si	1760-24-3	222.358			140.5 <sup>15</sup>	1.01 <sup>25</sup>	1.4416 <sup>25</sup>	
10497	3-(Trimethoxysilyl)propyl methacrylate		C <sub>10</sub> H <sub>20</sub> O <sub>5</sub> Si	2530-85-0	248.349	liq		107 <sup>5</sup> , 95 <sup>1</sup>			
10498	Trimethyl aluminum		C <sub>3</sub> H <sub>9</sub> Al	75-24-1	72.085		15.4	130; 20 <sup>9</sup>	0.752 <sup>20</sup>		
10499	Trimethylamine	<i>N,N</i> -Dimethylmethanamine	C <sub>3</sub> H <sub>9</sub> N	75-50-3	59.110	col gas	-117.1	2.87	0.627 <sup>25</sup> (p>1 atm)	1.3631 <sup>0</sup>	vs H <sub>2</sub> O, chl, tol; s EtOH, eth, bz
10500	Trimethylamine borane	<i>N,N</i> -Dimethylmethanamine borane	C <sub>3</sub> H <sub>12</sub> BN	75-22-9	72.945		94	172	0.792 <sup>25</sup>		vs eth, EtOH
10501	Trimethylamine hydrochloride	<i>N,N</i> -Dimethylmethanamine hydrochloride	C <sub>3</sub> H <sub>10</sub> ClN	593-81-7	95.571	mcl hyg nd (al)	277.5	sub 200			vs H <sub>2</sub> O, EtOH, chl
10502	Trimethylamine oxide	<i>N,N</i> -Dimethylmethanamine oxide	C <sub>3</sub> H <sub>9</sub> NO	1184-78-7	75.109	hyg nd (w+2)	256				vs H <sub>2</sub> O, EtOH
10503	2,4,5-Trimethylaniline		C <sub>9</sub> H <sub>13</sub> N	137-17-7	135.206	nd (w)	68	234.5	0.957 <sup>25</sup>		vs EtOH
10504	2,4,6-Trimethylaniline	Mesitylamine	C <sub>9</sub> H <sub>13</sub> N	88-05-1	135.206	liq	-2.5	232.5	0.9633 <sup>25</sup>	1.5495 <sup>20</sup>	sl ctc
10505	Trimethylarsine		C <sub>3</sub> H <sub>9</sub> As	593-88-4	120.025	liq	-87.3	52	1.144 <sup>15</sup>		vs bz, eth, EtOH
10506	2,4,6-Trimethylbenzaldehyde		C <sub>10</sub> H <sub>12</sub> O	487-68-3	148.201		14	238.5	1.0154 <sup>25</sup>		i H <sub>2</sub> O; s EtOH, eth, ace, bz
10507	1,2,3-Trimethylbenzene	Hemimellitene	C <sub>9</sub> H <sub>12</sub>	526-73-8	120.191	liq	-25.4	176.12	0.8944 <sup>20</sup>	1.5139 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
10508	1,2,4-Trimethylbenzene	Pseudocumene	C <sub>9</sub> H <sub>12</sub>	95-63-6	120.191	liq	-43.77	169.38	0.8758 <sup>20</sup>	1.5048 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
10509	1,3,5-Trimethylbenzene	Mesitylene	C <sub>9</sub> H <sub>12</sub>	108-67-8	120.191	liq	-44.72	164.74	0.8615 <sup>25</sup>	1.4994 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
10510	2,3,5-Trimethyl-1,4-benzenediol		C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	700-13-0	152.190	nd (w)	169 dec				sl H <sub>2</sub> O; vs EtOH, eth, bz



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10511	<i>N</i> , $\alpha$ , $\alpha$ -Trimethylbenzeneethanamine	Mephentermine	C <sub>11</sub> H <sub>17</sub> N	100-92-5	163.260	liq		95 <sup>5</sup>			i H <sub>2</sub> O; s eth; vs EtOH
10512	Trimethyl 1,2,4-benzenetricarboxylate	Trimethyl trimellitate	C <sub>12</sub> H <sub>12</sub> O <sub>6</sub>	2459-10-1	252.219	visc oil	-13	194 <sup>12</sup>	1.261	1.5230 <sup>20</sup>	
10513	2,4,6-Trimethylbenzoic acid		C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	480-63-7	164.201	pr (liq)	156.5				sl H <sub>2</sub> O; s EtOH, eth, ace, chl
10514	Trimethylbenzylsilane		C <sub>10</sub> H <sub>16</sub> Si	770-09-2	164.320			190.5	0.8933 <sup>20</sup>	1.4941 <sup>20</sup>	
10515	1,7,7-Trimethylbicyclo[2.2.1]heptane		C <sub>10</sub> H <sub>18</sub>	464-15-3	138.250	hex pl(al), pr(MeOH)		161			i H <sub>2</sub> O; s EtOH, eth, AcOEt, MeOH
10516	1,3,3-Trimethylbicyclo[2.2.1]heptan-2-ol, (1 <i>S</i> -endo)	$\alpha$ -Fenchyl alcohol, ( <i>l</i> )	C <sub>10</sub> H <sub>18</sub> O	512-13-0	154.249	pr	48	94 <sup>20</sup>	0.9034 <sup>84</sup>		
10517	1,7,7-Trimethylbicyclo[2.2.1]heptan-2-ol acetate, endo	Bornyl acetate	C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	76-49-3	196.286		29	221			
10518	1,7,7-Trimethylbicyclo[2.2.1]hept-2-ene		C <sub>10</sub> H <sub>16</sub>	464-17-5	136.234	cry (al)	113	146			vs bz, eth, EtOH
10519	4,6,6-Trimethylbicyclo[3.1.1]hept-3-en-2-ol, (1 $\alpha$ ,2 $\alpha$ ,5 $\alpha$ )		C <sub>10</sub> H <sub>16</sub> O	1820-09-3	152.233		24	92 <sup>10</sup>	0.9657 <sup>25</sup>	1.4908 <sup>25</sup>	
10520	4,6,6-Trimethylbicyclo[3.1.1]hept-3-en-2-ol, (1 $\alpha$ ,2 $\beta$ ,5 $\alpha$ )		C <sub>10</sub> H <sub>16</sub> O	1845-30-3	152.233		15.5	90 <sup>10</sup>	0.9684 <sup>25</sup>	1.4912 <sup>25</sup>	
10521	2,7,7-Trimethylbicyclo[3.1.1]hept-2-en-6-one	Chrysanthenone	C <sub>10</sub> H <sub>14</sub> O	473-06-3	150.217			88 <sup>12</sup>		1.4720 <sup>22</sup>	vs EtOH
10522	Trimethylborane		C <sub>3</sub> H <sub>9</sub> B	593-90-8	55.914	col gas	-161.5	-20.2			
10523	Trimethyl borate		C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	121-43-7	103.912	liq	-29.3	67.5	0.915 <sup>25</sup>	1.3568 <sup>20</sup>	vs eth, MeOH
10524	2,2,3-Trimethylbutane	Triptane	C <sub>7</sub> H <sub>16</sub>	464-06-2	100.202	liq	-24.6	80.86	0.6901 <sup>20</sup>	1.3864 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; vs ace, bz, peth, ctc
10525	2,3,3-Trimethyl-2-butanol		C <sub>7</sub> H <sub>16</sub> O	594-83-2	116.201	cry (dil al +1/2w)	17	131	0.8380 <sup>25</sup>	1.4233 <sup>22</sup>	sl H <sub>2</sub> O; vs ace, eth, EtOH
10526	2,3,3-Trimethyl-1-butene		C <sub>7</sub> H <sub>14</sub>	594-56-9	98.186	liq	-109.9	77.9	0.7050 <sup>20</sup>	1.4025 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, chl, MeOH
10527	Trimethylchlorosilane		C <sub>3</sub> H <sub>9</sub> ClSi	75-77-4	108.642	liq	-40	60	0.856 <sup>25</sup>	1.3870 <sup>20</sup>	
10528	Trimethyl citrate		C <sub>9</sub> H <sub>14</sub> O <sub>7</sub>	1587-20-8	234.203	tcl	79.3	285; 176 <sup>16</sup>			vs eth, EtOH
10529	2,6,6-Trimethyl-2,4-cycloheptadien-1-one	Eucarvone	C <sub>10</sub> H <sub>14</sub> O	503-93-5	150.217			210; 105 <sup>22</sup>	0.9490 <sup>20</sup>	1.5087 <sup>20</sup>	s eth, ace
10530	1,1,2-Trimethylcyclohexane		C <sub>9</sub> H <sub>18</sub>	7094-26-0	126.239	liq	-29	145.2	0.7963 <sup>25</sup>	1.4382 <sup>20</sup>	
10531	1,1,3-Trimethylcyclohexane		C <sub>9</sub> H <sub>18</sub>	3073-66-3	126.239	liq	-65.7	136.6	0.7749 <sup>25</sup>	1.4295 <sup>20</sup>	i H <sub>2</sub> O
10532	1 $\alpha$ ,2 $\beta$ ,4 $\beta$ -1,2,4-Trimethylcyclohexane		C <sub>9</sub> H <sub>18</sub>	7667-60-9	126.239	liq	-83.5	142.9	0.7870 <sup>25</sup>	1.4341 <sup>20</sup>	
10533	1 $\alpha$ ,3 $\alpha$ ,5 $\beta$ -1,3,5-Trimethylcyclohexane	<i>trans</i> -1,3,5-Trimethylcyclohexane	C <sub>9</sub> H <sub>18</sub>	1795-26-2	126.239	liq	-107.4	140.5	0.7794 <sup>20</sup>	1.4307 <sup>20</sup>	vs bz, eth, liq
10534	<i>cis</i> -3,3,5-Trimethylcyclohexanol		C <sub>9</sub> H <sub>18</sub> O	933-48-2	142.238		37.3	202; 92 <sup>12</sup>	0.9006 <sup>16</sup>	1.4550 <sup>16</sup>	i H <sub>2</sub> O; s EtOH, eth, chl
10535	<i>trans</i> -3,3,5-Trimethylcyclohexanol		C <sub>9</sub> H <sub>18</sub> O	767-54-4	142.238	cry (eth)	55.8	189.2	0.8631 <sup>60</sup>		i H <sub>2</sub> O; s EtOH, eth, chl
10536	2,2,6-Trimethylcyclohexanone		C <sub>9</sub> H <sub>16</sub> O	2408-37-9	140.222	liq	-31.8	178.5	0.9043 <sup>18</sup>	1.4470 <sup>20</sup>	
10537	2,4,4-Trimethylcyclohexanone		C <sub>9</sub> H <sub>16</sub> O	2230-70-8	140.222			191	0.902 <sup>20</sup>	1.4493 <sup>20</sup>	
10538	3,3,5-Trimethylcyclohexanone	Dihydroisophorone	C <sub>9</sub> H <sub>16</sub> O	873-94-9	140.222	ye oil		189	0.8919 <sup>19</sup>	1.4454 <sup>15</sup>	
10539	2,6,6-Trimethyl-1-cyclohexene-1-carboxaldehyde	$\beta$ -Cyclocitral	C <sub>10</sub> H <sub>16</sub> O	432-25-7	152.233			112 <sup>29</sup> , 97 <sup>15</sup>	0.959 <sup>15</sup>	1.4971 <sup>15</sup>	
10540	3,5,5-Trimethyl-2-cyclohexen-1-ol	Isophorol	C <sub>9</sub> H <sub>16</sub> O	470-99-5	140.222			69 <sup>5</sup>	0.914 <sup>20</sup>	1.4717 <sup>20</sup>	
10541	4-(2,6,6-Trimethyl-1-cyclohexen-1-yl)-3-buten-2-ol	$\beta$ -lonol	C <sub>13</sub> H <sub>22</sub> O	22029-76-1	194.313			130 <sup>14</sup>	0.9243 <sup>20</sup>	1.4969 <sup>20</sup>	s EtOH, eth, ace
10542	4-(2,6,6-Trimethyl-2-cyclohexen-1-yl)-3-buten-2-ol	$\alpha$ -lonol	C <sub>13</sub> H <sub>22</sub> O	25312-34-9	194.313	oil		127 <sup>14</sup>	0.9189 <sup>20</sup>	1.4735 <sup>20</sup>	
10543	1,1,2-Trimethylcyclopentane		C <sub>8</sub> H <sub>16</sub>	4259-00-1	112.213	liq	-21.6	114; 53 <sup>100</sup>	0.7660 <sup>20</sup>	1.4199 <sup>20</sup>	
10544	1,1,3-Trimethylcyclopentane		C <sub>8</sub> H <sub>16</sub>	4516-69-2	112.213	liq	-142.4	104.9	0.7439 <sup>25</sup>	1.4112 <sup>20</sup>	i H <sub>2</sub> O
10545	1 $\alpha$ ,2 $\alpha$ ,4 $\beta$ -1,2,4-Trimethylcyclopentane		C <sub>8</sub> H <sub>16</sub>	4850-28-6	112.213	liq	-132.6	116.7	0.7592 <sup>25</sup>	1.4186 <sup>20</sup>	
10546	1 $\alpha$ ,2 $\beta$ ,4 $\alpha$ -1,2,4-Trimethylcyclopentane		C <sub>8</sub> H <sub>16</sub>	16883-48-0	112.213	liq	-130.8	109.3	0.7430 <sup>25</sup>	1.4106 <sup>20</sup>	
10547	1,2,2-Trimethyl-1,3-cyclopentanedicarboxylic acid, (1 <i>R</i> , 3 <i>S</i> )	(+)-Camphoric acid	C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	124-83-4	200.232	pr, lf (w)	187		1.186 <sup>20</sup>		sl H <sub>2</sub> O; vs EtOH, eth; s ace; i bz, chl
10548	2,2,4-Trimethylcyclopentanone		C <sub>8</sub> H <sub>14</sub> O	28056-54-4	126.196	liq	-40.6	158	0.877 <sup>25</sup>	1.4300 <sup>20</sup>	
10549	2,4,4-Trimethylcyclopentanone		C <sub>8</sub> H <sub>14</sub> O	4694-12-6	126.196	liq	-25.6	160.5	0.8785 <sup>18</sup>	1.433 <sup>18</sup>	
10550	1,1,2-Trimethylcyclopropane		C <sub>6</sub> H <sub>12</sub>	4127-45-1	84.159	liq	-138.2	54	0.6897 <sup>25</sup>	1.3864 <sup>20</sup>	
10551	3,7,11-Trimethyl-2,6,10-dodecatrienal		C <sub>15</sub> H <sub>24</sub> O	19317-11-4	220.351			172 <sup>14</sup>	0.893 <sup>18</sup>	1.4995	
10552	Trimethylgallium		C <sub>3</sub> H <sub>9</sub> Ga	1445-79-0	114.826			55.7			dec H <sub>2</sub> O (exp)
10553	2,2,6-Trimethylheptane		C <sub>10</sub> H <sub>22</sub>	1190-83-6	142.282	liq	-105	148.9	0.7200 <sup>25</sup>	1.4078 <sup>20</sup>	
10554	2,5,5-Trimethylheptane		C <sub>10</sub> H <sub>22</sub>	1189-99-7	142.282			152.8	0.7362 <sup>25</sup>	1.4149 <sup>20</sup>	
10555	3,3,5-Trimethylheptane		C <sub>10</sub> H <sub>22</sub>	7154-80-5	142.282			155.7	0.7248 <sup>20</sup>	1.4170 <sup>20</sup>	i H <sub>2</sub> O; s bz, ctc, chl

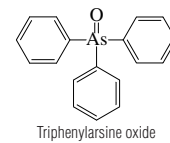
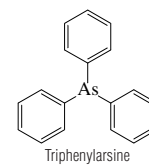
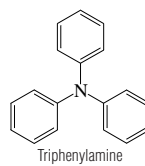
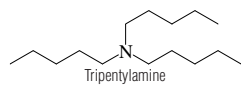
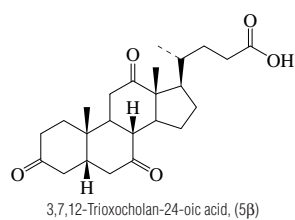
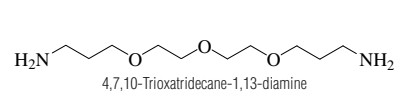
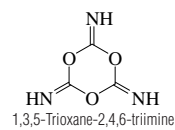
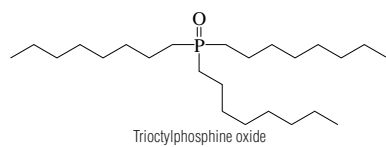
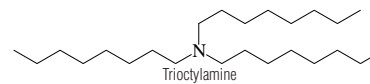
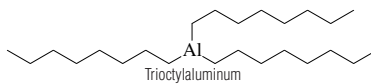
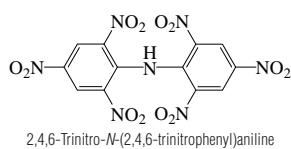
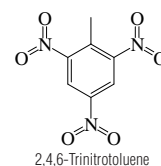
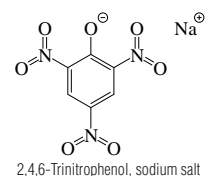
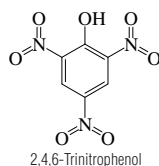
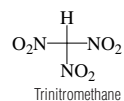
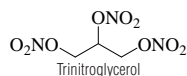
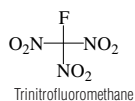
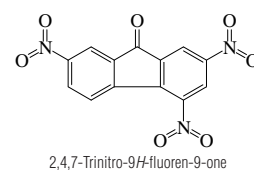
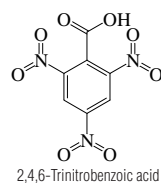
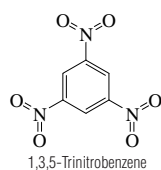
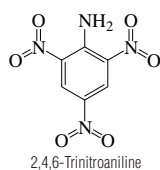
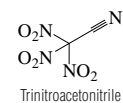
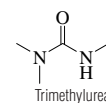
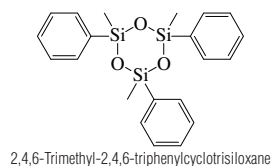
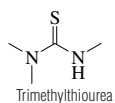
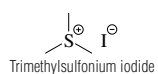
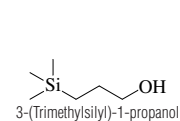
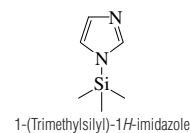
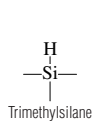
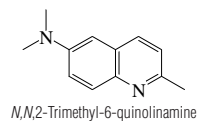
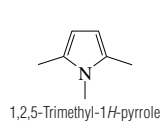
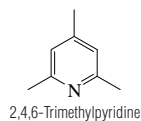
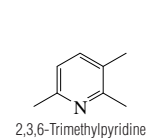
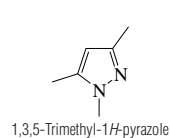
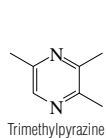
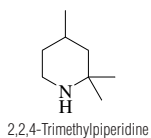
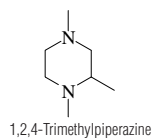
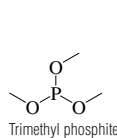


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10556	3,4,5-Trimethylheptane		C <sub>10</sub> H <sub>22</sub>	20278-89-1	142.282			162.5	0.7519 <sup>25</sup>	1.4229 <sup>20</sup>	
10557	2,2,3-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	16747-25-4	128.255			133.6	0.7257 <sup>25</sup>	1.4106 <sup>20</sup>	
10558	2,2,4-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	16747-26-5	128.255	liq	-120	126.5	0.711 <sup>20</sup>	1.4033 <sup>20</sup>	
10559	2,2,5-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	3522-94-9	128.255	liq	-105.7	124.09	0.7072 <sup>20</sup>	1.3997 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth, ace, bz; s ctc
10560	2,3,3-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	16747-28-7	128.255	liq	-116.8	137.7	0.7345 <sup>25</sup>	1.4141 <sup>20</sup>	
10561	2,3,4-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	921-47-1	128.255			139.1	0.7354 <sup>25</sup>	1.4144 <sup>20</sup>	
10562	2,3,5-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	1069-53-0	128.255	liq	-127.9	131.4	0.7218 <sup>20</sup>	1.4051 <sup>20</sup>	
10563	2,4,4-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	16747-30-1	128.255	liq	-113.4	130.7	0.7201 <sup>25</sup>	1.4074 <sup>20</sup>	
10564	3,3,4-Trimethylhexane		C <sub>9</sub> H <sub>20</sub>	16747-31-2	128.255	liq	-101.2	140.5	0.7414 <sup>25</sup>	1.4178 <sup>20</sup>	
10565	3,5,5-Trimethylhexanoic acid	Isononanoic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	3302-10-1	158.238	liq		121 <sup>10</sup> , 85 <sup>4</sup>			
10566	3,5,5-Trimethyl-1-hexanol		C <sub>9</sub> H <sub>20</sub> O	3452-97-9	144.254			194	0.8236 <sup>25</sup>	1.4300 <sup>25</sup>	
10567	1,2,3-Trimethylindene		C <sub>12</sub> H <sub>14</sub>	4773-83-5	158.239	liq		100.5 <sup>10</sup>	0.9714 <sup>20</sup>	1.5521 <sup>20</sup>	
10568	Trimethylindium	Indium trimethyl	C <sub>3</sub> H <sub>3</sub> In	3385-78-2	159.921			135.7		1.568 <sup>19</sup>	
10569	2,3,3-Trimethyl-3H-indole		C <sub>11</sub> H <sub>13</sub> N	1640-39-7	159.228			107 <sup>11</sup>			
10570	Trimethyl(4-methylphenyl)silane		C <sub>10</sub> H <sub>16</sub> Si	3728-43-6	164.320		38	192; 73 <sup>10</sup>	0.8666 <sup>20</sup>	1.4900 <sup>20</sup>	
10571	1,4,5-Trimethylnaphthalene		C <sub>13</sub> H <sub>14</sub>	2131-41-1	170.250	lf (MeOH)	63	145 <sup>12</sup>			i H <sub>2</sub> O
10572	1,3,5-Trimethyl-2-nitrobenzene		C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	603-71-4	165.189	orth pr (al)	44	255	1.51 <sup>25</sup>		vs EtOH
10573	2,6,8-Trimethyl-4-nonanol		C <sub>12</sub> H <sub>26</sub> O	123-17-1	186.333			225.4	0.8178 <sup>20</sup>		sl ctc
10574	2,4,7-Trimethyloctane		C <sub>11</sub> H <sub>24</sub>	62016-38-0	156.309			168.1			
10575	Trimethylolpropane		C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	77-99-6	134.173	wh pow or pl	58	160 <sup>5</sup>			vs H <sub>2</sub> O, EtOH
10576	3,5,5-Trimethyl-2,4-oxazolidinedione	Trimethadione	C <sub>6</sub> H <sub>8</sub> NO <sub>3</sub>	127-48-0	143.140		46	79 <sup>5</sup>			s H <sub>2</sub> O; vs EtOH, eth, ace, bz; i peth
10577	Trimethyloxonium fluoborate		C <sub>3</sub> H <sub>9</sub> BF <sub>4</sub> O	420-37-1	147.907	hyg nd	148 dec				vs ace, chl
10578	2,4,4-Trimethyl-2-pentanamine		C <sub>8</sub> H <sub>19</sub> N	107-45-9	129.244						s chl
10579	2,2,3-Trimethylpentane		C <sub>8</sub> H <sub>18</sub>	564-02-3	114.229	liq	-112.2	110	0.7161 <sup>20</sup>	1.4030 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, hp; s bz
10580	2,2,4-Trimethylpentane	Isooctane	C <sub>8</sub> H <sub>18</sub>	540-84-1	114.229	liq	-107.3	99.22	0.6878 <sup>25</sup>	1.3884 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, ace, hp; s eth, ctc
10581	2,3,3-Trimethylpentane		C <sub>8</sub> H <sub>18</sub>	560-21-4	114.229	liq	-100.9	114.8	0.7262 <sup>20</sup>	1.4075 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, ace, bz, hp
10582	2,3,4-Trimethylpentane		C <sub>8</sub> H <sub>18</sub>	565-75-3	114.229	liq	-109.2	113.5	0.7191 <sup>20</sup>	1.4042 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH; msc eth, ace, bz; sl ctc
10583	2,2,4-Trimethyl-1,3-pentanediol		C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	144-19-4	146.228	pl (bz)	51.5	235; 81 <sup>1</sup>	0.936 <sup>15</sup>	1.4513 <sup>15</sup>	sl H <sub>2</sub> O; vs EtOH, eth; s bz, chl
10584	2,4,4-Trimethyl-2-pentanethiol		C <sub>8</sub> H <sub>18</sub> S	141-59-3	146.294	liq		76 <sup>20</sup>			
10585	2,4,4-Trimethyl-2-pentanol		C <sub>8</sub> H <sub>18</sub> O	690-37-9	130.228	liq	-20	147.5	0.8225 <sup>20</sup>	1.4284 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth
10586	2,2,4-Trimethyl-3-pentanol		C <sub>8</sub> H <sub>18</sub> O	5162-48-1	130.228	liq	-13	150.5	0.8297 <sup>20</sup>	1.4288 <sup>20</sup>	
10587	2,2,4-Trimethyl-3-pentanone	<i>tert</i> -Butyl isopropyl ketone	C <sub>8</sub> H <sub>16</sub> O	5857-36-3	128.212			135.1	0.8065 <sup>20</sup>	1.4060	i H <sub>2</sub> O; s eth, ace
10588	2,3,3-Trimethyl-1-pentene		C <sub>8</sub> H <sub>16</sub>	560-23-6	112.213	liq	-69	108.3	0.7308 <sup>25</sup>	1.4174 <sup>20</sup>	
10589	2,4,4-Trimethyl-1-pentene		C <sub>8</sub> H <sub>16</sub>	107-39-1	112.213	liq	-93.5	101.4	0.7150 <sup>20</sup>	1.4086 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, ctc, chl, lig
10590	2,3,4-Trimethyl-2-pentene		C <sub>8</sub> H <sub>16</sub>	565-77-5	112.213	liq	-113.4	116.5	0.7434 <sup>20</sup>	1.4274 <sup>20</sup>	
10591	2,4,4-Trimethyl-2-pentene		C <sub>8</sub> H <sub>16</sub>	107-40-4	112.213	liq	-106.3	104.9	0.7218 <sup>20</sup>	1.4160 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, ctc, chl; vs lig
10592	2,3,4-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	526-85-2	136.190	nd (peth)	81	236			vs bz, eth, EtOH
10593	2,3,5-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	697-82-5	136.190		94.5	233			
10594	2,3,6-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	2416-94-6	136.190		63				
10595	2,4,5-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	496-78-6	136.190	nd (lig)	72	232			i H <sub>2</sub> O; vs EtOH, eth
10596	2,4,6-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	527-60-6	136.190	nd (peth, MeOH)	73	220			vs eth, EtOH
10597	3,4,5-Trimethylphenol		C <sub>9</sub> H <sub>12</sub> O	527-54-8	136.190	nd (peth)	108	248.5			
10598	Trimethylphenoxysilane		C <sub>9</sub> H <sub>14</sub> OSi	1529-17-5	166.292	liq	-55	119	0.8681 <sup>20</sup>	1.5125 <sup>20</sup>	
10599	Trimethylphenylammonium chloride	Phenyltrimethylammonium chloride	C <sub>9</sub> H <sub>14</sub> CIN	138-24-9	171.667						vs H <sub>2</sub> O, EtOH
10600	1-(2,4,6-Trimethylphenyl)ethane		C <sub>11</sub> H <sub>14</sub> O	1667-01-2	162.228			241; 120 <sup>12</sup>	0.9754 <sup>20</sup>	1.5175 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, ctc
10601	1,1,1-Trimethyl- <i>N</i> -phenylsilanamine	Phenyl(trimethylsilyl)amine	C <sub>9</sub> H <sub>15</sub> NSi	3768-55-6	165.308			206	0.940 <sup>20</sup>		
10602	Trimethylphenylsilane		C <sub>9</sub> H <sub>14</sub> Si	768-32-1	150.293			169.5	0.8722 <sup>20</sup>	1.4907 <sup>20</sup>	s ctc, CS <sub>2</sub>
10603	Trimethyl phosphate	Methyl phosphate	C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P	512-56-1	140.074	liq	-46	197.2	1.2144 <sup>20</sup>	1.3967 <sup>20</sup>	vs H <sub>2</sub> O; sl EtOH; s eth
10604	Trimethylphosphine		C <sub>3</sub> H <sub>9</sub> P	594-09-2	76.077	liq	-85	37.5			i H <sub>2</sub> O; s eth

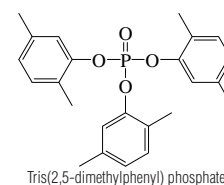
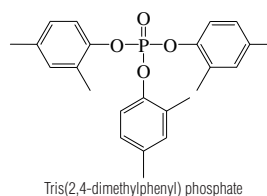
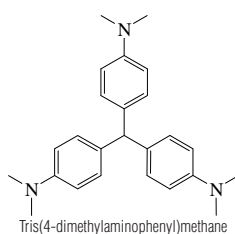
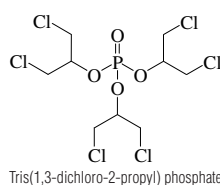
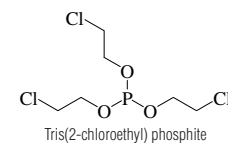
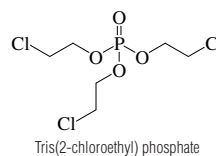
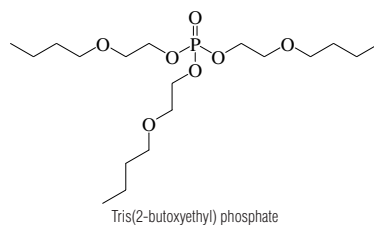
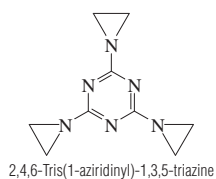
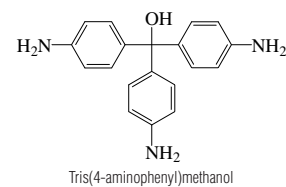
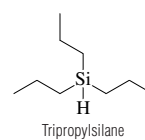
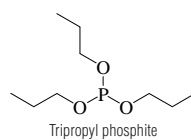
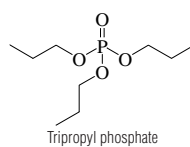
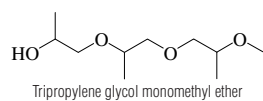
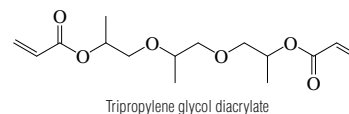
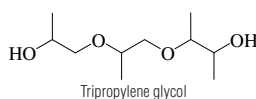
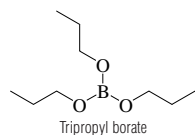
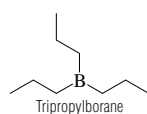
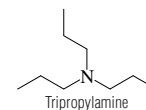
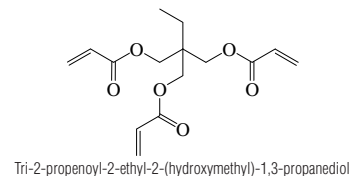
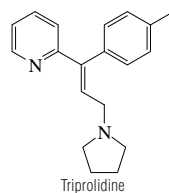
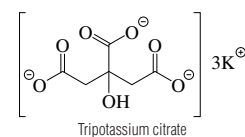
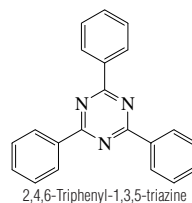
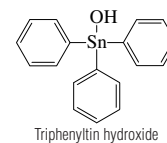
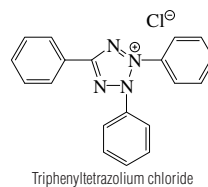
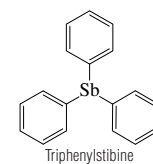
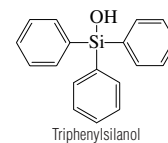
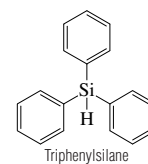
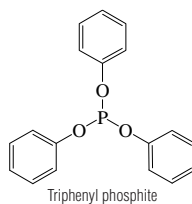
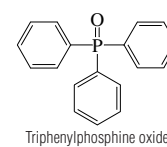
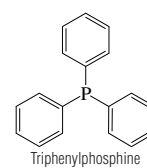
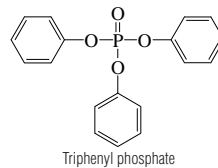
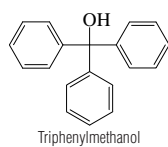
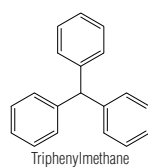
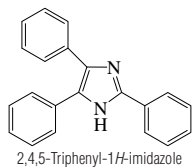
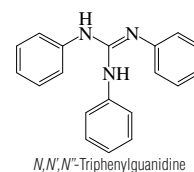
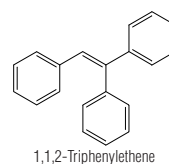
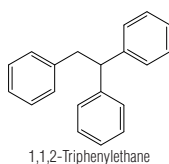
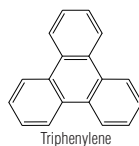
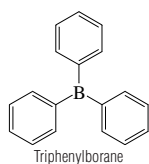
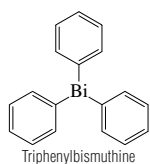


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10605	Trimethyl phosphite		C <sub>3</sub> H <sub>9</sub> O <sub>3</sub> P	121-45-9	124.075			111.5	1.0518 <sup>20</sup>	1.4095 <sup>20</sup>	vs EtOH, eth; sl ctc
10606	1,2,4-Trimethylpiperazine		C <sub>7</sub> H <sub>16</sub> N <sub>2</sub>	120-85-4	128.215			149.5		1.4433 <sup>20</sup>	s ctc
10607	2,2,4-Trimethylpiperidine		C <sub>9</sub> H <sub>17</sub> N	101257-71-0	127.228			148	0.832 <sup>15</sup>	1.4458 <sup>20</sup>	vs eth, EtOH
10608	Trimethylpyrazine		C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	14667-55-1	122.167			87 <sup>25</sup>			
10609	1,3,5-Trimethyl-1 <i>H</i> -pyrazole		C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	1072-91-9	110.156		37	170	0.9269 <sup>40</sup>	1.4589 <sup>57</sup>	
10610	2,3,6-Trimethylpyridine	2,3,6-Collidine	C <sub>8</sub> H <sub>11</sub> N	1462-84-6	121.180			171.6	0.9220 <sup>25</sup>	1.5053 <sup>20</sup>	s H <sub>2</sub> O, EtOH, eth, ace, bz
10611	2,4,6-Trimethylpyridine	2,4,6-Collidine	C <sub>8</sub> H <sub>11</sub> N	108-75-8	121.180	liq	-46	170.6	0.9166 <sup>22</sup>	1.4959 <sup>25</sup>	s H <sub>2</sub> O, EtOH, eth, ace, ctc
10612	1,2,5-Trimethyl-1 <i>H</i> -pyrrole		C <sub>7</sub> H <sub>11</sub> N	930-87-0	109.169			171	0.807 <sup>25</sup>	1.4969 <sup>20</sup>	
10613	<i>N,N</i> ,2-Trimethyl-6-quinolinamine		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub>	92-99-9	186.252	ye pr (HOAc, AcOEt)	101	319			s ctc, CS <sub>2</sub>
10614	Trimethylsilane		C <sub>3</sub> H <sub>10</sub> Si	993-07-7	74.197	col gas	-135.9	6.7			
10615	1-(Trimethylsilyl)-1 <i>H</i> -imidazole		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> Si	18156-74-6	140.258						s chl
10616	3-(Trimethylsilyl)-1-propanol		C <sub>6</sub> H <sub>16</sub> OSi	2917-47-7	132.276			141; 82 <sup>24</sup>	0.822 <sup>25</sup>	1.4298 <sup>20</sup>	
10617	Trimethylstibine		C <sub>3</sub> H <sub>9</sub> Sb	594-10-5	166.863	liq	-62	80.6	1.523 <sup>15</sup>	1.42 <sup>15</sup>	i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
10618	Trimethylsulfonium iodide		C <sub>3</sub> H <sub>9</sub> I <sup>+</sup> S <sup>-</sup>	2181-42-2	204.072	cry (eth)	211 dec				
10619	Trimethylthiourea		C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> S	2489-77-2	118.200	pr (bz-liq)	87.5				vs bz, EtOH, chl
10620	2,4,6-Trimethyl-2,4,6-triphenylcyclotrisiloxane		C <sub>21</sub> H <sub>24</sub> O <sub>3</sub> Si <sub>3</sub>	546-45-2	408.671		100	190 <sup>1.5</sup>	1.1062 <sup>20</sup>	1.5397 <sup>20</sup>	
10621	Trimethylurea		C <sub>3</sub> H <sub>10</sub> N <sub>2</sub> O	632-14-4	102.134	pr (eth)	75.5	232.5	1.1900 <sup>20</sup>		s H <sub>2</sub> O, EtOH; sl eth, bz
10622	Trinitroacetone		C <sub>2</sub> N <sub>6</sub> O <sub>6</sub>	630-72-8	176.044	wax	41.5	exp 220			vs eth
10623	2,4,6-Trinitroaniline		C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>6</sub>	489-98-5	228.119	dk ye pr (HOAc)	193.5	exp	1.762 <sup>10</sup>		i H <sub>2</sub> O; sl EtOH, eth; s ace, bz, AcOEt
10624	1,3,5-Trinitrobenzene	<i>sym</i> -Trinitrobenzene	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>6</sub>	99-35-4	213.104	orth pl (bz) lf (w)	122.9	315	1.4775 <sup>152</sup>		sl H <sub>2</sub> O, EtOH, eth; vs ace; s bz, py
10625	2,4,6-Trinitro-1,3-benzenediol	Styphnic acid	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>8</sub>	82-71-3	245.103	hex ye cry (dil al)	175.5	sub			vs eth, EtOH
10626	2,4,6-Trinitrobenzoic acid		C <sub>7</sub> H <sub>3</sub> N <sub>3</sub> O <sub>8</sub>	129-66-8	257.114	orth (w)	228 dec				sl H <sub>2</sub> O, bz; vs EtOH; s eth, ace
10627	2,4,7-Trinitro-9 <i>H</i> -fluoren-9-one		C <sub>13</sub> H <sub>5</sub> N <sub>3</sub> O <sub>7</sub>	129-79-3	315.195	pa ye nd (bz, HOAc)	175.8				sl H <sub>2</sub> O; vs ace, bz, chl
10628	Trinitrofluoromethane	Fluorotrinitromethane	CFN <sub>3</sub> O <sub>6</sub>	1840-42-2	169.025			86.3	1.59 <sup>20</sup>		
10629	Trinitroglycerol	Nitroglycerin	C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>9</sub>	55-63-0	227.087	pa ye tcl or orth	13.5	exp 218; 93 <sup>0.31</sup>	1.5931 <sup>20</sup>	1.4786 <sup>12</sup>	sl H <sub>2</sub> O; s EtOH, bz; msc eth; vs ace, chl
10630	Trinitromethane		CHN <sub>3</sub> O <sub>6</sub>	517-25-9	151.035		15	exp	1.479 <sup>20</sup>	1.4451 <sup>24</sup>	vs ace, EtOH
10631	2,4,6-Trinitrophenol	Picric acid	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	88-89-1	229.104	ye lf (w), pr (eth) pl (al)	122.5	exp 300		1.763	sl H <sub>2</sub> O; s EtOH, eth, bz, chl; vs ace
10632	2,4,6-Trinitrophenol, sodium salt	Sodium picrate	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> NaO <sub>7</sub>	3324-58-1	251.086	nd (w)	270.4				
10633	2,4,6-Trinitrotoluene	2-Methyl-1,3,5-trinitrobenzene	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>6</sub>	118-96-7	227.131	orth (al)	80.5	exp 240	1.654 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH; s eth; vs ace, bz
10634	2,4,6-Trinitro- <i>N</i> -(2,4,6-trinitrophenyl)aniline	Dipicrylamine	C <sub>12</sub> H <sub>5</sub> N <sub>7</sub> O <sub>12</sub>	131-73-7	439.208	pa ye pr(HOAc)	244 dec				i H <sub>2</sub> O, EtOH, bz, ctc; sl eth, ace; vs py
10635	Trioctylaluminum		C <sub>24</sub> H <sub>51</sub> Al	1070-00-4	366.644	hyg visc liq	-62		0.701		
10636	Trioctylamine	<i>N,N</i> -Dioctyl-1-octanamine	C <sub>24</sub> H <sub>51</sub> N	1116-76-3	353.669	liq	-34.6	366	0.8110 <sup>20</sup>	1.4510 <sup>19</sup>	
10637	Trioctylphosphine oxide	TOPO	C <sub>24</sub> H <sub>51</sub> OP	78-50-2	386.635		52	201 <sup>2</sup>			
10638	1,3,5-Trioxane	Formaldehyde, trimer	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	110-88-3	90.078	orth nd (eth)	60.29	114.5	1.17 <sup>85</sup>		vs H <sub>2</sub> O; s EtOH, eth, bz, CS <sub>2</sub> ; i peth
10639	1,3,5-Trioxane-2,4,6-trimine	Cyamelide	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	462-02-2	129.074	amor pow	dec	dec	1.127 <sup>15</sup>		vs eth, EtOH
10640	4,7,10-Trioxatridecane-1,13-diamine	Diethyleneglycol diaminopropyl ether	C <sub>10</sub> H <sub>24</sub> N <sub>2</sub> O <sub>3</sub>	4246-51-9	220.309	liq		147 <sup>4</sup>	1.005	1.4640 <sup>20</sup>	
10641	3,7,12-Trioxocholan-24-oic acid, (5β)	Dehydrocholic acid	C <sub>24</sub> H <sub>34</sub> O <sub>5</sub>	81-23-2	402.524		237				i H <sub>2</sub> O, eth; sl EtOH, bz; s ace, AcOEt
10642	Tripenylamine	<i>N,N</i> -Dipentyl-1-pentanamine	C <sub>15</sub> H <sub>33</sub> N	621-77-2	227.430			242.5	0.7907 <sup>20</sup>	1.4366 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, acid
10643	Triphenylamine	<i>N,N</i> -Diphenylbenzenamine	C <sub>18</sub> H <sub>15</sub> N	603-34-9	245.319	mcl (MeOH, bz)	126.5	365	1.18 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH; s eth, bz, MeOH
10644	Triphenylarsine		C <sub>18</sub> H <sub>15</sub> As	603-32-7	306.234		61	360	1.2634 <sup>18</sup>	1.6888 <sup>21</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, bz; s chl
10645	Triphenylarsine oxide		C <sub>18</sub> H <sub>15</sub> AsO	1153-05-5	322.233		192	324.0			

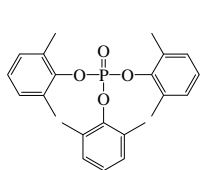




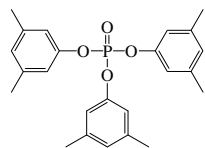
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10646	Triphenylbismuthine		C <sub>18</sub> H <sub>15</sub> Bi	603-33-8	440.292		77.6	242 <sup>14</sup>	1.715 <sup>75</sup>	1.7040 <sup>75</sup>	sl EtOH, chl; s eth, ace, bz, CS <sub>2</sub>
10647	Triphenylborane		C <sub>18</sub> H <sub>15</sub> B	960-71-4	242.123	wh cry	142				i H <sub>2</sub> O; sl eth; s bz, lig
10648	Triphenylene	Benzo[1]phenanthrene	C <sub>18</sub> H <sub>12</sub>	217-59-4	228.288	nd (al, chl, bz)	197.8	425			i H <sub>2</sub> O; s EtOH, HOAc; vs bz, chl
10649	1,1,2-Triphenylethane		C <sub>20</sub> H <sub>18</sub>	1520-42-9	258.357	mcl lf (dil al), nd (al)	57				i H <sub>2</sub> O; vs EtOH, eth, bz; sl MeOH
10650	1,1,2-Triphenylethene		C <sub>20</sub> H <sub>16</sub>	58-72-0	256.341	lf (al)	72.5	220 <sup>14</sup>	1.0373 <sup>78</sup>	1.6292 <sup>78</sup>	i H <sub>2</sub> O; s EtOH, chl, MeOH; vs eth
10651	<i>N,N,N'</i> -Triphenylguanidine		C <sub>19</sub> H <sub>17</sub> N <sub>3</sub>	101-01-9	287.358	nd or pr (al)	146.5	dec	1.163 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH
10652	2,4,5-Triphenyl-1 <i>H</i> -imidazole		C <sub>21</sub> H <sub>16</sub> N <sub>2</sub>	484-47-9	296.365	nd (al)	275	sub			i H <sub>2</sub> O; s EtOH, eth
10653	Triphenylmethane		C <sub>19</sub> H <sub>16</sub>	519-73-3	244.330	orth (al)	93.4	359; 200 <sup>10</sup>	1.014 <sup>99</sup>	1.5839 <sup>99</sup>	i H <sub>2</sub> O; sl EtOH; vs eth, py, chl; s bz
10654	Triphenylmethanol		C <sub>19</sub> H <sub>16</sub> O	76-84-6	260.329	pl (al), trg (bz)	164.2	380	1.199 <sup>0</sup>		i H <sub>2</sub> O, peth; vs EtOH, eth; s ace, bz
10655	Triphenyl phosphate		C <sub>18</sub> H <sub>15</sub> O <sub>4</sub> P	115-86-6	326.283	cry (lig), pr (al) nd (eth)	50.5	245 <sup>11</sup>	1.2055 <sup>50</sup>		i H <sub>2</sub> O; s EtOH; vs eth, bz, ctc, chl
10656	Triphenylphosphine		C <sub>18</sub> H <sub>15</sub> P	603-35-0	262.286		80	188 <sup>1</sup>	1.0749 <sup>60</sup>	1.6358 <sup>60</sup>	i H <sub>2</sub> O; s EtOH, bz, chl; vs eth
10657	Triphenylphosphine oxide		C <sub>18</sub> H <sub>15</sub> OP	791-28-6	278.285	pr	156.5	>360	1.2124 <sup>23</sup>		sl H <sub>2</sub> O, eth, chl; vs EtOH, bz
10658	Triphenyl phosphite		C <sub>18</sub> H <sub>15</sub> O <sub>3</sub> P	101-02-0	310.284		25	360	1.1842 <sup>20</sup>	1.5900 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH
10659	Triphenylsilane		C <sub>18</sub> H <sub>16</sub> Si	789-25-3	260.406						s ctc, CS <sub>2</sub>
10660	Triphenylsilanol		C <sub>18</sub> H <sub>16</sub> OSi	791-31-1	276.405		154.8		1.1777 <sup>20</sup>		s ctc, CS <sub>2</sub>
10661	Triphenylstibine		C <sub>18</sub> H <sub>15</sub> Sb	603-36-1	353.072	pr (peth)	53.5	>360	1.4343 <sup>25</sup>	1.6948 <sup>42</sup>	i H <sub>2</sub> O; s EtOH; vs eth, ace, bz, chl
10662	Triphenyltetrazolium chloride		C <sub>19</sub> H <sub>15</sub> ClN <sub>4</sub>	298-96-4	334.802	nd (al, chl)	243	dec			s H <sub>2</sub> O, EtOH, ace, chl; i eth
10663	Triphenyltin hydroxide	Stannane, hydroxytriphenyl-	C <sub>18</sub> H <sub>16</sub> OSn	76-87-9	367.029		119		1.54 <sup>20</sup>		
10664	2,4,6-Triphenyl-1,3,5-triazine		C <sub>21</sub> H <sub>16</sub> N <sub>3</sub>	493-77-6	309.364		257				
10665	Tripotassium citrate	Potassium citrate	C <sub>6</sub> H <sub>5</sub> K <sub>3</sub> O <sub>7</sub>	866-84-2	306.395	wh cry (w)	275	dec			vs H <sub>2</sub> O; i EtOH
10666	Tripolidine		C <sub>19</sub> H <sub>22</sub> N <sub>2</sub>	486-12-4	278.391	cry (peth)	60				
10667	Tri-2-propenoyl-2-ethyl-2-(hydroxymethyl)-1,3-propanediol	Trimethylolpropane triacrylate	C <sub>15</sub> H <sub>20</sub> O <sub>6</sub>	15625-89-5	296.316			>200 <sup>1</sup>		1.4735 <sup>20</sup>	
10668	Tripropylamine	<i>N,N</i> -Dipropyl-1-propanamine	C <sub>9</sub> H <sub>21</sub> N	102-69-2	143.270	liq	-93.5	156	0.7558 <sup>20</sup>	1.4181 <sup>20</sup>	vs eth, EtOH
10669	Tripropylborane		C <sub>9</sub> H <sub>21</sub> B	1116-61-6	140.074	liq	-56	159	0.7204 <sup>25</sup>	1.4135 <sup>22</sup>	
10670	Tripropyl borate	Boric acid, tripropyl ester	C <sub>9</sub> H <sub>21</sub> BO <sub>3</sub>	688-71-1	188.072			179.5	0.8576 <sup>20</sup>	1.3948 <sup>20</sup>	vs EtOH; msc eth; s PrOH
10671	Tripropylene glycol	[(1-Methyl-1,2-ethanediyl) bis(oxy)]bispropanol	C <sub>9</sub> H <sub>20</sub> O <sub>4</sub>	24800-44-0	192.253	liq		268; 115 <sup>2</sup>	1.02 <sup>20</sup>	1.4440 <sup>20</sup>	
10672	Tripropylene glycol diacrylate		C <sub>15</sub> H <sub>24</sub> O <sub>6</sub>	42978-66-5	300.348			>120 <sup>1</sup>			
10673	Tripropylene glycol monomethyl ether	1-[2-(2-Methoxy-1-methylethoxy)-1-methylethoxy]-2-propanol	C <sub>10</sub> H <sub>22</sub> O <sub>4</sub>	20324-33-8	206.280			241.3			
10674	Tripropyl phosphate		C <sub>9</sub> H <sub>21</sub> O <sub>4</sub> P	513-08-6	224.234			252	1.0121 <sup>20</sup>	1.4165 <sup>20</sup>	sl H <sub>2</sub> O, chl; s EtOH, eth, tol, CS <sub>2</sub>
10675	Tripropyl phosphite	Tripropoxyphosphine	C <sub>9</sub> H <sub>21</sub> O <sub>3</sub> P	923-99-9	208.235			206.5	0.9417 <sup>20</sup>	1.4282 <sup>20</sup>	vs eth, EtOH
10676	Tripropylsilane		C <sub>9</sub> H <sub>22</sub> Si	998-29-8	158.357			172	0.7723 <sup>9</sup>	1.4280 <sup>20</sup>	i H <sub>2</sub> O
10677	Tris(4-aminophenyl)methanol	C.I. Basic Red 9	C <sub>19</sub> H <sub>19</sub> N <sub>3</sub> O	467-62-9	305.373	purp cry	205				
10678	2,4,6-Tris(1-aziridinyl)-1,3,5-triazine	Triethylenemelamine	C <sub>9</sub> H <sub>12</sub> N <sub>6</sub>	51-18-3	204.231	cry pow	139	dec			s H <sub>2</sub> O
10679	Tris(2-butoxyethyl) phosphate		C <sub>18</sub> H <sub>39</sub> O <sub>7</sub> P	78-51-3	398.473	liq		255 <sup>10</sup>	1.02 <sup>25</sup>		i H <sub>2</sub> O
10680	Tris(2-chloroethyl) phosphate		C <sub>6</sub> H <sub>12</sub> Cl <sub>3</sub> O <sub>4</sub> P	115-96-8	285.489			330; 194 <sup>10</sup>	1.39 <sup>25</sup>	1.4721 <sup>20</sup>	s ctc
10681	Tris(2-chloroethyl) phosphite		C <sub>6</sub> H <sub>12</sub> Cl <sub>3</sub> O <sub>3</sub> P	140-08-9	269.490			120 <sup>3</sup>	1.3443 <sup>25</sup>	1.4868 <sup>20</sup>	
10682	Tris(1,3-dichloro-2-propyl) phosphate	Fyrol FR-2	C <sub>9</sub> H <sub>15</sub> Cl <sub>6</sub> O <sub>4</sub> P	13674-87-8	430.904	visc liq		236 <sup>5</sup>		1.5022 <sup>20</sup>	i H <sub>2</sub> O
10683	Tris(4-dimethylaminophenyl) methane	Paraleucaniline	C <sub>25</sub> H <sub>31</sub> N <sub>3</sub>	603-48-5	373.534	lf (al), nd (bz)	176.5				vs bz, eth, chl
10684	Tris(2,4-dimethylphenyl) phosphate	2,4-Xylenol, phosphate (3:1)	C <sub>24</sub> H <sub>27</sub> O <sub>4</sub> P	3862-12-2	410.442			233.5	1.142 <sup>38</sup>	1.5550 <sup>20</sup>	i H <sub>2</sub> O; s bz, chl, hx
10685	Tris(2,5-dimethylphenyl) phosphate	2,5-Xylenol, phosphate (3:1)	C <sub>24</sub> H <sub>27</sub> O <sub>4</sub> P	19074-59-0	410.442		79.8	262 <sup>8</sup>	1.197 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, hx; s eth, bz, ctc



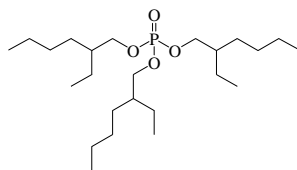
No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10686	Tris(2,6-dimethylphenyl)phosphate	2,6-Xylenol, phosphate (3:1)	C <sub>24</sub> H <sub>27</sub> O <sub>4</sub> P	121-06-2	410.442	wax	137.8	263 <sup>6</sup>			i H <sub>2</sub> O; sl EtOH, hx; s bz
10687	Tris(3,5-dimethylphenyl)phosphate		C <sub>24</sub> H <sub>27</sub> O <sub>4</sub> P	25653-16-1	410.442		46.2	290 <sup>10</sup>			i H <sub>2</sub> O; sl EtOH, chl, hx; s HOAc
10688	Tris(2-ethylhexyl) phosphate		C <sub>24</sub> H <sub>51</sub> O <sub>4</sub> P	78-42-2	434.633	liq		215 <sup>5</sup>	0.99 <sup>20</sup>		
10689	Tris(ethylthio)methane	Triethyl orthothioformate	C <sub>7</sub> H <sub>16</sub> S <sub>3</sub>	6267-24-9	196.397			dec 235; 127 <sup>12</sup>	1.053 <sup>20</sup>	1.5410 <sup>15</sup>	vs eth, EtOH
10690	1,3,5-Tris(2-hydroxyethyl)isocyanuric acid		C <sub>9</sub> H <sub>15</sub> N <sub>3</sub> O <sub>6</sub>	839-90-7	261.231	cry	136				
10691	1,1,1-Tris(hydroxymethyl)ethane trinitrate	2-Methyl-2-[(nitrooxy)methyl]-1,3-propanediol, dinitrate	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>9</sub>	3032-55-1	255.140			83 <sup>0.05</sup>			
10692	<i>N,N,N'</i> -Tris(hydroxymethyl)melamine	Trimethylolmelamine	C <sub>6</sub> H <sub>12</sub> N <sub>6</sub> O <sub>3</sub>	1017-56-7	216.197	cry	148				
10693	Tris(hydroxymethyl)methylamine	2-Amino-2-(hydroxymethyl)-1,3-propanediol	C <sub>4</sub> H <sub>11</sub> NO <sub>3</sub>	77-86-1	121.135		171.5	219 <sup>10</sup>			vs H <sub>2</sub> O; s MeOH
10694	Tris(methoxyethoxy)vinylsilane		C <sub>11</sub> H <sub>24</sub> O <sub>6</sub> Si	1067-53-4	280.391						s ctc
10695	Tris(4-methoxyphenyl)chloroethene	Chlorotrianisene	C <sub>23</sub> H <sub>21</sub> ClO <sub>3</sub>	569-57-3	380.864		115				
10696	Tris(2-methylphenyl)phosphine		C <sub>21</sub> H <sub>21</sub> P	6163-58-2	304.366		127.0				
10697	Tris(3-methylphenyl)phosphine		C <sub>21</sub> H <sub>21</sub> P	6224-63-1	304.366		101.0				
10698	Tris(4-methylphenyl)phosphine		C <sub>21</sub> H <sub>21</sub> P	1038-95-5	304.366		147.0				
10699	Tris(2-methyl-2-propenyl)-2-ethyl-2-hydroxymethyl-1,3-propanediol	1,1,1-Trimethylolpropane trimethacrylate	C <sub>18</sub> H <sub>26</sub> O <sub>6</sub>	3290-92-4	338.395			>200 <sup>1</sup>		1.470 <sup>25</sup>	
10700	Trisodium citrate	Sodium citrate	C <sub>6</sub> H <sub>7</sub> Na <sub>3</sub> O <sub>7</sub>	68-04-2	258.069	wh cry (w)	300				vs H <sub>2</sub> O; i EtOH
10701	Trisodium <i>N</i> -hydroxyethylthylenediaminetriacetate	Versen-OI	C <sub>10</sub> H <sub>15</sub> N <sub>2</sub> Na <sub>3</sub> O <sub>7</sub>	139-89-9	344.204		288 (hyd)				
10702	Tris(perfluorobutyl)amine	Trinonafluorobutylamine	C <sub>12</sub> F <sub>27</sub> N	311-89-7	671.092			178	1.884 <sup>25</sup>	1.291 <sup>25</sup>	s ace
10703	2,4,6-Tris(2-pyridinyl)-1,3,5-triazine	2,4,6-Tripyridyl-s-triazine	C <sub>18</sub> H <sub>12</sub> N <sub>6</sub>	3682-35-7	312.328		210				
10704	Tris( <i>o</i> -tolyl) phosphite		C <sub>21</sub> H <sub>21</sub> O <sub>3</sub> P	2622-08-4	352.364		11	238 <sup>11</sup> , 197 <sup>2</sup>	1.1423 <sup>20</sup>	1.5740 <sup>28</sup>	s eth; sl chl
10705	Tris( <i>p</i> -tolyl) phosphite		C <sub>21</sub> H <sub>21</sub> O <sub>3</sub> P	620-42-8	352.364	pa ye	52	252 <sup>10</sup>	1.1280 <sup>25</sup>	1.5703 <sup>28</sup>	vs eth
10706	Tris(triphenylphosphine) rhodium carbonyl hydride	Carbonylhydrotris(triphenylphosphine)rhodium	C <sub>55</sub> H <sub>46</sub> OP <sub>3</sub> Rh	17185-29-4	918.781	ye cry	121		1.33		sl bz, chl
10707	1,3,5-Trithiane		C <sub>3</sub> H <sub>6</sub> S <sub>3</sub>	291-21-4	138.275	hex (bz), pr (w) nd (al)	220	sub	1.6374 <sup>24</sup>		sl H <sub>2</sub> O, EtOH, eth; s bz
10708	Trithiocarbonic acid		CH <sub>2</sub> S <sub>3</sub>	594-08-1	110.222	red oil	-26.9	57.8	1.476 <sup>25</sup>	1.8225 <sup>20</sup>	dec H <sub>2</sub> O, EtOH; vs tol, chl
10709	Tritriacontane		C <sub>33</sub> H <sub>68</sub>	630-05-7	464.893		71.2				
10710	Tropacocaine		C <sub>15</sub> H <sub>19</sub> NO <sub>2</sub>	537-26-8	245.318	pl or tab	49	dec	1.0426 <sup>100</sup>	1.5080 <sup>100</sup>	vs bz, eth, EtOH, peth
10711	Tropine	8-Methyl-8-azabicyclo[3.2.1]octan-3-ol, <i>endo</i>	C <sub>8</sub> H <sub>15</sub> NO	120-29-6	141.211	hyg pl (eth)	64	233	1.016 <sup>100</sup>	1.4811 <sup>100</sup>	vs H <sub>2</sub> O, eth, EtOH
10712	Trypan blue		C <sub>34</sub> H <sub>24</sub> N <sub>6</sub> Na <sub>4</sub> O <sub>14</sub> S <sub>4</sub>	72-57-1	960.805	dk bl cry	300				s H <sub>2</sub> O, acid; i EtOH
10713	Tryptamine		C <sub>10</sub> H <sub>12</sub> N <sub>2</sub>	61-54-1	160.215	nd (al-bz, lig)	118	137 <sup>0.15</sup>			i H <sub>2</sub> O, eth, bz, chl; s EtOH, ace
10714	<i>L</i> -Tryptophan	$\alpha$ -Aminoindole-3-propionic acid, ( <i>l</i> )	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	73-22-3	204.225	lf or pl (dil al)	289 dec				sl H <sub>2</sub> O, HOAc; s EtOH; i eth, chl
10715	Tsuduranine		C <sub>18</sub> H <sub>19</sub> NO <sub>3</sub>	517-97-5	297.349	nd (eth)	204				vs ace, eth, EtOH
10716	T-2 Toxin	Mycotoxin T2	C <sub>24</sub> H <sub>34</sub> O <sub>3</sub>	21259-20-1	466.522	nd	151				sl H <sub>2</sub> O, peth; s EtOH, chl, DMSO
10717	Tubocurarine dichloride		C <sub>37</sub> H <sub>42</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>6</sub>	57-94-3	681.644	hyg cry	275 dec				s MeOH; i py, bz, ace, eth
10718	Tungsten carbonyl	Tungsten hexacarbonyl	C <sub>6</sub> O <sub>6</sub> W	14040-11-0	351.90	wh cry	dec 170	sub	2.65		i H <sub>2</sub> O; s os
10719	Turanose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	547-25-1	342.296	pr (w-al, MeOH)	168				vs H <sub>2</sub> O; s EtOH, MeOH
10720	Tybamate		C <sub>13</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub>	4268-36-4	274.356	cry	50	151 <sup>0.06</sup>			
10721	<i>L</i> -Tyrosine	4-Hydroxy- <i>L</i> -phenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	60-18-4	181.188	nd (w)	343 dec	sub			sl H <sub>2</sub> O, HOAc; i EtOH, eth
10722	Tyrosineamide		C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	4985-46-0	180.203	pl or pl (al)	153.5				vs H <sub>2</sub> O, EtOH
10723	<i>L</i> -Tyrosine, ethyl ester		C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	949-67-7	209.242	pr (AcOEt)	108.5				vs bz, EtOH, AcOEt
10724	<i>L</i> -Tyrosine, methyl ester, hydrochloride		C <sub>10</sub> H <sub>14</sub> ClNO <sub>3</sub>	3417-91-2	231.676		191.0				s H <sub>2</sub> O
10725	1,10-Undecadiyne		C <sub>11</sub> H <sub>16</sub>	4117-15-1	148.245		-17	83 <sup>12</sup>	0.8182 <sup>21</sup>	1.453 <sup>21</sup>	vs ace, bz
10726	Undecafluorocyclohexane		C <sub>6</sub> HF <sub>11</sub>	308-24-7	282.054			62.0			
10727	Undecanal		C <sub>11</sub> H <sub>22</sub> O	112-44-7	170.292		-2.0	117 <sup>18</sup>	0.8251 <sup>23</sup>	1.4520 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth



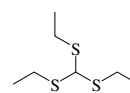
Tris(2,6-dimethylphenyl) phosphate



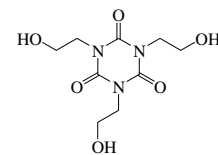
Tris(3,5-dimethylphenyl) phosphate



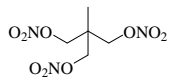
Tris(2-ethylhexyl) phosphate



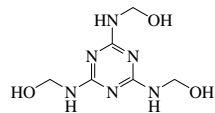
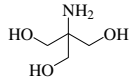
Tris(ethylthio)methane



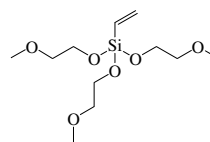
1,3,5-Tris(2-hydroxyethyl) isocyanuric acid



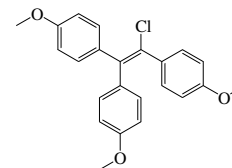
1,1,1-Tris(hydroxymethyl)ethane trinitrate

*N,N,N'*-Tris(hydroxymethyl)melamine

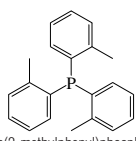
Tris(hydroxymethyl)methylamine



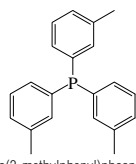
Tris(methoxyethoxy)vinylsilane



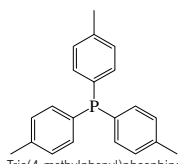
Tris(4-methoxyphenyl)chloroethene



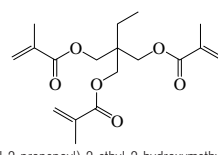
Tris(2-methylphenyl)phosphine



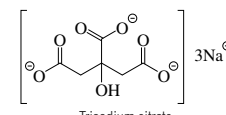
Tris(3-methylphenyl)phosphine



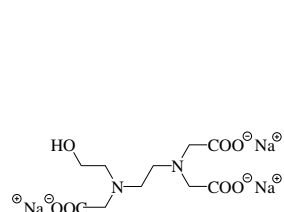
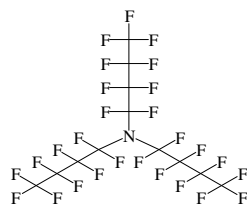
Tris(4-methylphenyl)phosphine



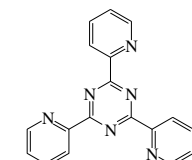
Tris(2-methyl-2-propenyl)-2-ethyl-2-hydroxymethyl-1,3-propanediol



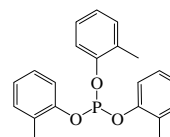
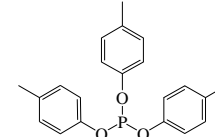
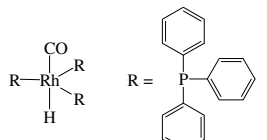
Trisodium citrate

Trisodium *N*-hydroxyethylethylenediaminetriacetate

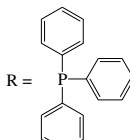
Tris(perfluorobutyl)amine



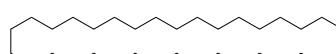
2,4,6-Tris(2-pyridinyl)-1,3,5-triazine

Tris(*o*-tolyl) phosphiteTris(*p*-tolyl) phosphite

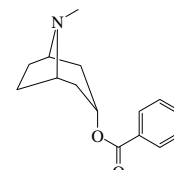
Tris(triphenylphosphine) rhodium carbonyl hydride



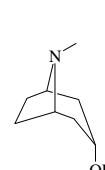
Trithiocarbonic acid



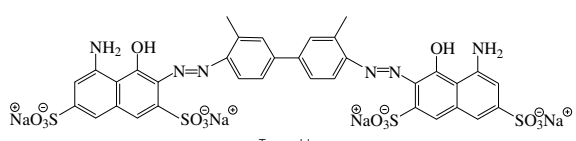
Tritriacontane



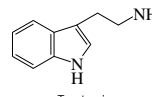
Tropacocaine



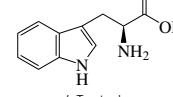
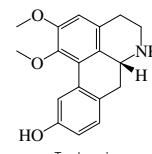
Tropine



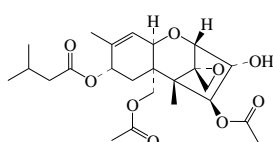
Trypan blue



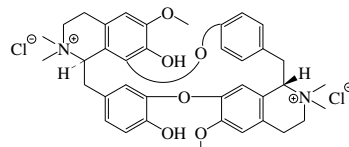
Tryptamine

*L*-Tryptophan

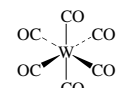
Tsuduranine



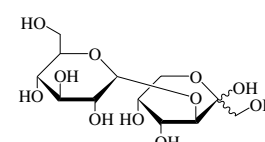
T-2 Toxin



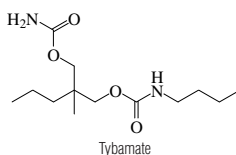
Tubocurarine dichloride



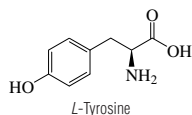
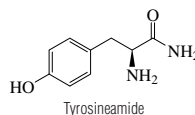
Tungsten carbonyl



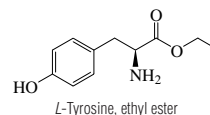
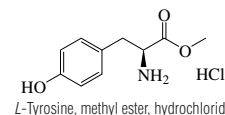
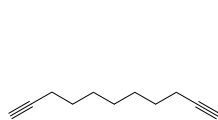
Turanose



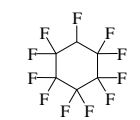
Tybamate

*L*-Tyrosine

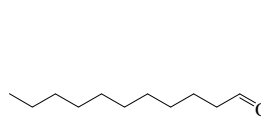
Tyrosineamide

*L*-Tyrosine, ethyl ester*L*-Tyrosine, methyl ester, hydrochloride

1,10-Undecadiyne

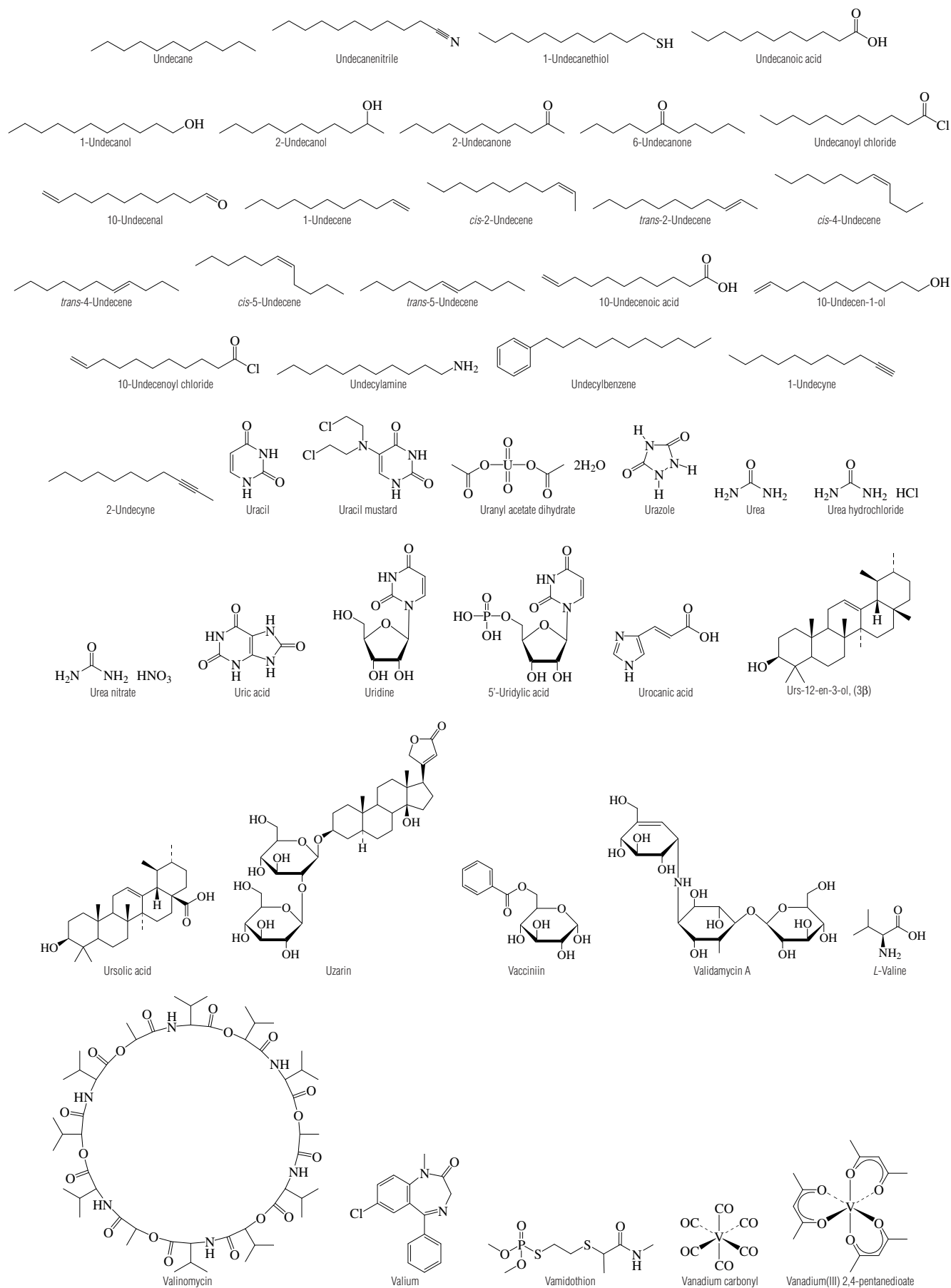


Undecafluorocyclohexane



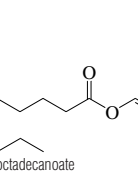
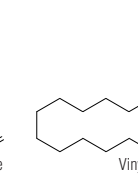
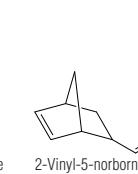
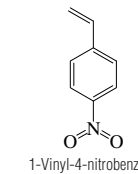
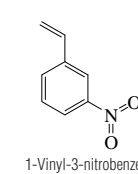
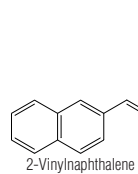
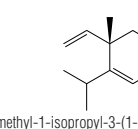
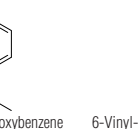
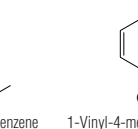
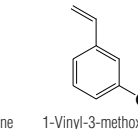
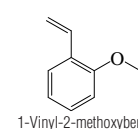
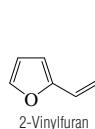
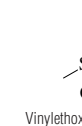
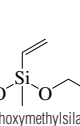
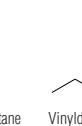
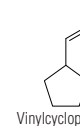
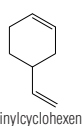
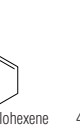
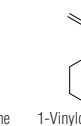
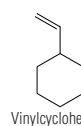
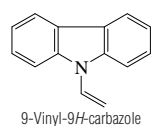
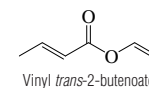
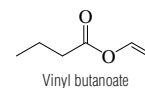
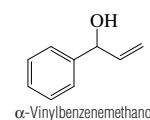
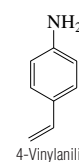
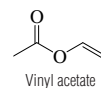
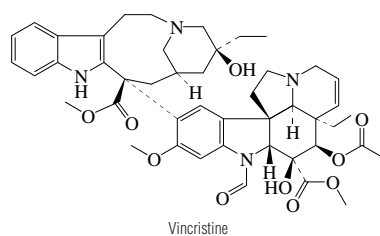
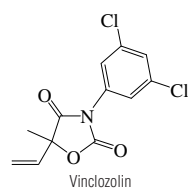
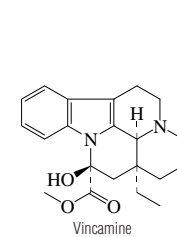
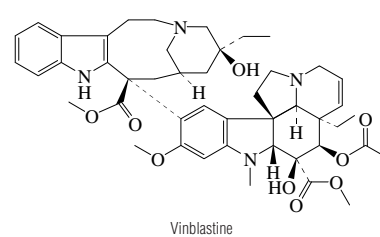
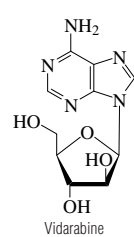
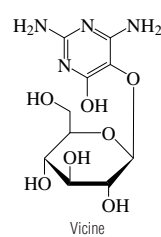
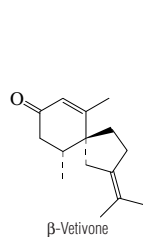
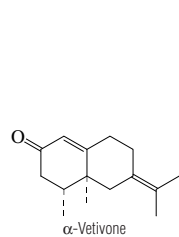
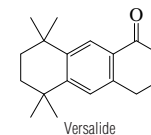
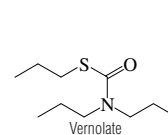
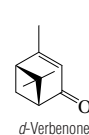
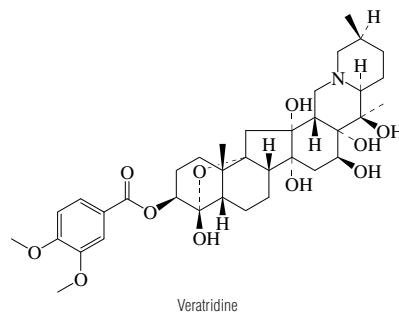
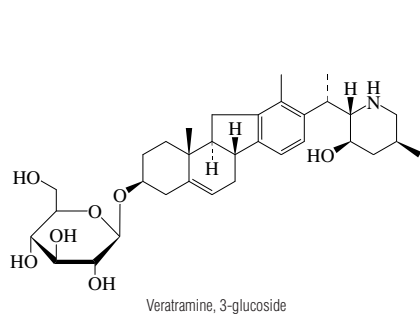
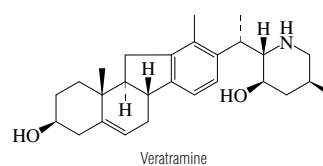
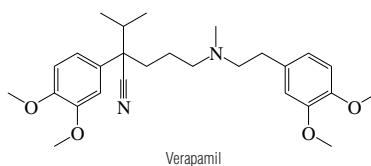
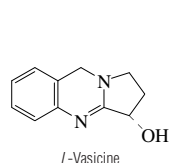
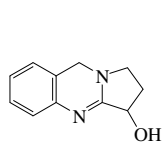
Undecanal

No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10728	Undecane	Henecane	C <sub>11</sub> H <sub>24</sub>	1120-21-4	156.309	liq	-25.5	195.9	0.7402 <sup>20</sup>	1.4164 <sup>20</sup>	i H <sub>2</sub> O; msc EtOH, eth
10729	Undecanenitrile	Decyl cyanide	C <sub>11</sub> H <sub>21</sub> N	2244-07-7	167.292			253	0.8254 <sup>20</sup>	1.4293 <sup>30</sup>	i H <sub>2</sub> O; s EtOH, eth, ctc
10730	1-Undecanethiol	Undecyl mercaptan	C <sub>11</sub> H <sub>24</sub> S	5332-52-5	188.374	liq	-1.5	257.4	0.8448 <sup>20</sup>	1.4585 <sup>20</sup>	
10731	Undecanoic acid		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	112-37-8	186.292	cry (ace)	28.6	280	0.8907 <sup>20</sup>	1.4294 <sup>45</sup>	i H <sub>2</sub> O; vs EtOH, ace; s eth; msc bz
10732	1-Undecanol	Undecyl alcohol	C <sub>11</sub> H <sub>24</sub> O	112-42-5	172.308		15.9	245	0.8298 <sup>20</sup>	1.4392 <sup>20</sup>	i H <sub>2</sub> O; s EtOH; vs eth
10733	2-Undecanol	sec-Undecyl alcohol	C <sub>11</sub> H <sub>24</sub> O	1653-30-1	172.308	col liq	0	229.7	0.8234 <sup>25</sup>	1.4352 <sup>25</sup>	
10734	2-Undecanone	Methyl nonyl ketone	C <sub>11</sub> H <sub>22</sub> O	112-12-9	170.292		15	231.5	0.8250 <sup>20</sup>	1.4291 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, chl
10735	6-Undecanone	Butyl hexyl ketone	C <sub>11</sub> H <sub>22</sub> O	927-49-1	170.292		14.5	228	0.8308 <sup>20</sup>	1.4270 <sup>20</sup>	i H <sub>2</sub> O; vs EtOH, eth
10736	Undecanoyl chloride		C <sub>11</sub> H <sub>21</sub> ClO	17746-05-3	204.737						sl ctc
10737	10-Undecenal		C <sub>11</sub> H <sub>20</sub> O	112-45-8	168.276						sl ctc
10738	1-Undecene		C <sub>11</sub> H <sub>22</sub>	821-95-4	154.293	liq	-49.2	192.7	0.7503 <sup>20</sup>	1.4261 <sup>20</sup>	i H <sub>2</sub> O; s eth, chl, lig
10739	cis-2-Undecene		C <sub>11</sub> H <sub>22</sub>	821-96-5	154.293	liq	-66.5	196.1	0.7576 <sup>20</sup>		
10740	trans-2-Undecene		C <sub>11</sub> H <sub>22</sub>	693-61-8	154.293	liq	-48.3	192.5	0.7528 <sup>20</sup>	1.4292 <sup>20</sup>	
10741	cis-4-Undecene		C <sub>11</sub> H <sub>22</sub>	821-98-7	154.293	liq	-97	192.6	0.7541 <sup>20</sup>	1.4302 <sup>20</sup>	
10742	trans-4-Undecene		C <sub>11</sub> H <sub>22</sub>	693-62-9	154.293	liq	-63.7	193	0.7508 <sup>20</sup>	1.4285 <sup>20</sup>	
10743	cis-5-Undecene		C <sub>11</sub> H <sub>22</sub>	764-96-5	154.293	liq	-106.5	192.3	0.7537 <sup>20</sup>	1.4302 <sup>20</sup>	
10744	trans-5-Undecene		C <sub>11</sub> H <sub>22</sub>	764-97-6	154.293	liq	-61.1	192	0.7497 <sup>20</sup>	1.4285 <sup>20</sup>	vs eth, chl, lig
10745	10-Undecenoic acid	Undecylenic acid	C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	112-38-9	184.276	cry	24.5	275	0.9072 <sup>24</sup>	1.4486 <sup>24</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
10746	10-Undecen-1-ol		C <sub>11</sub> H <sub>22</sub> O	112-43-6	170.292	liq	-1.0	250	0.8495 <sup>15</sup>	1.4500 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth; sl ctc
10747	10-Undecenoyl chloride		C <sub>11</sub> H <sub>19</sub> ClO	38460-95-6	202.721			127 <sup>13</sup>	0.944 <sup>20</sup>	1.454 <sup>20</sup>	
10748	Undecylamine	1-Undecanamine	C <sub>11</sub> H <sub>25</sub> N	7307-55-3	171.324	cry (eth, al)	17	242	0.7979 <sup>20</sup>	1.4398 <sup>20</sup>	s H <sub>2</sub> O, EtOH; i eth; sl ctc
10749	Undecylbenzene		C <sub>17</sub> H <sub>28</sub>	6742-54-7	232.404	liq	-5	316	0.8553 <sup>20</sup>	1.4828 <sup>20</sup>	
10750	1-Undecyne		C <sub>11</sub> H <sub>20</sub>	2243-98-3	152.277	liq	-25	196	0.7728 <sup>20</sup>	1.4306 <sup>20</sup>	vs ace, bz, eth, EtOH
10751	2-Undecyne		C <sub>11</sub> H <sub>20</sub>	60212-29-5	152.277	liq	-30.1	204.2	0.7827 <sup>20</sup>	1.4391 <sup>20</sup>	
10752	Uracil		C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	66-22-8	112.087	nd (w)	338				sl H <sub>2</sub> O; vs EtOH, eth; s dil NH <sub>3</sub>
10753	Uracil mustard		C <sub>8</sub> H <sub>11</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>2</sub>	66-75-1	252.098		206 dec				sl H <sub>2</sub> O
10754	Uranyl acetate dihydrate		C <sub>4</sub> H <sub>10</sub> O <sub>8</sub> U	6159-44-0	424.146	ye cry (HOAc)	80 dec		2.89		sl EtOH
10755	Urazole		C <sub>2</sub> H <sub>3</sub> N <sub>3</sub> O <sub>2</sub>	3232-84-6	101.064	lf (w)	249 dec				
10756	Urea	Carbamide	CH <sub>4</sub> N <sub>2</sub> O	57-13-6	60.055	tetr pr (al)	133.3	dec	1.3230 <sup>20</sup>	1.484	vs H <sub>2</sub> O, EtOH; i eth, bz; s HOAc, py
10757	Urea hydrochloride		CH <sub>5</sub> ClN <sub>2</sub> O	506-89-8	96.516		145 dec				s H <sub>2</sub> O
10758	Urea nitrate		CH <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	124-47-0	123.069	mcl lf (w)	152 dec		1.690 <sup>20</sup>		vs EtOH
10759	Uric acid		C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub>	69-93-2	168.111	orth pr or pl	dec	dec	1.89 <sup>25</sup>		i H <sub>2</sub> O, EtOH, eth; s alk, glycerol; sl acid
10760	Uridine	1-β-D-Ribofuranosyluracil	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>6</sub>	58-96-8	244.200	nd (aq al)	165				s H <sub>2</sub> O, EtOH, py
10761	5'-Uridylic acid	Uridine 5'-phosphoric acid	C <sub>9</sub> H <sub>13</sub> N <sub>2</sub> O <sub>8</sub> P	58-97-9	324.180	pr (MeOH)	202 dec				vs H <sub>2</sub> O; s MeOH
10762	Urocanic acid	Imidazole-4-acrylic acid	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	104-98-3	138.124		227				s H <sub>2</sub> O, ace; i EtOH, eth
10763	Urs-12-en-3-ol, (3β)	α-Amyrin	C <sub>30</sub> H <sub>50</sub> O	638-95-9	426.717	nd (al)	186	243 <sup>0.5</sup>			s EtOH, eth, bz, chl, HOAc; sl peth
10764	Ursolic acid		C <sub>30</sub> H <sub>48</sub> O <sub>3</sub>	77-52-1	456.700	pl (al)	284				vs ace, eth, chl
10765	Uzarin		C <sub>35</sub> H <sub>54</sub> O <sub>14</sub>	20231-81-6	698.796	pr	269				
10766	Vacciniin	D-Glucose, 6-benzoate	C <sub>13</sub> H <sub>16</sub> O <sub>7</sub>	14200-76-1	284.262	amor (aq ace, +1w)	122				vs H <sub>2</sub> O, ace, EtOH, eth
10767	Validamycin A		C <sub>20</sub> H <sub>35</sub> NO <sub>13</sub>	37248-47-8	497.491	amorp pow	95 dec				
10768	L-Valine	2-Aminoisovaleric acid	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	72-18-4	117.147	lf (w-al)	315	sub	1.23 <sup>25</sup>		s H <sub>2</sub> O
10769	Valinomycin		C <sub>54</sub> H <sub>90</sub> N <sub>6</sub> O <sub>18</sub>	2001-95-8	1111.322	cry	187				
10770	Valium		C <sub>16</sub> H <sub>13</sub> ClN <sub>2</sub> O	439-14-5	284.739		132				
10771	Vamidothion		C <sub>8</sub> H <sub>18</sub> NO <sub>4</sub> PS <sub>2</sub>	2275-23-2	287.337	oil					i peth; s os
10772	Vanadium carbonyl	Vanadium hexacarbonyl	C <sub>6</sub> O <sub>6</sub> V	14024-00-1	219.002	bl-grn cry	dec 60	sub			
10773	Vanadium(III) 2,4-pentanedioate	Vanadium(III) acetylacetonate	C <sub>15</sub> H <sub>21</sub> O <sub>6</sub> V	13476-99-8	348.266	brn cry	≈185	sub	≈1.0		s MeOH, ace, bz, chl

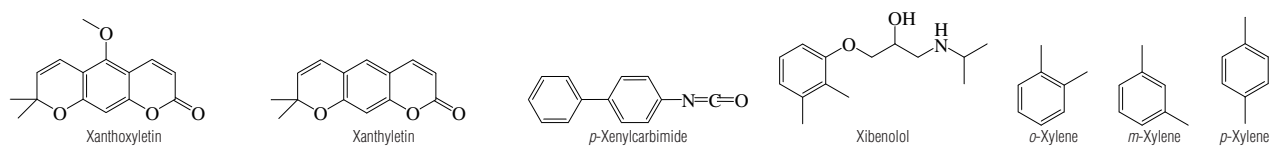
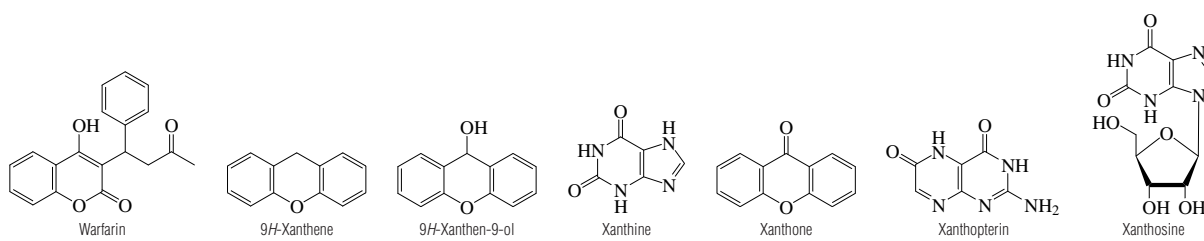
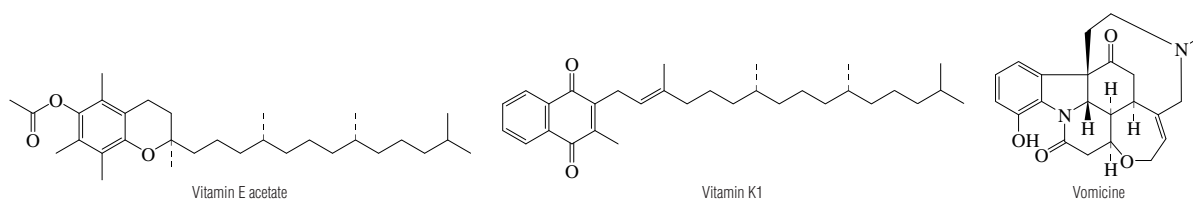
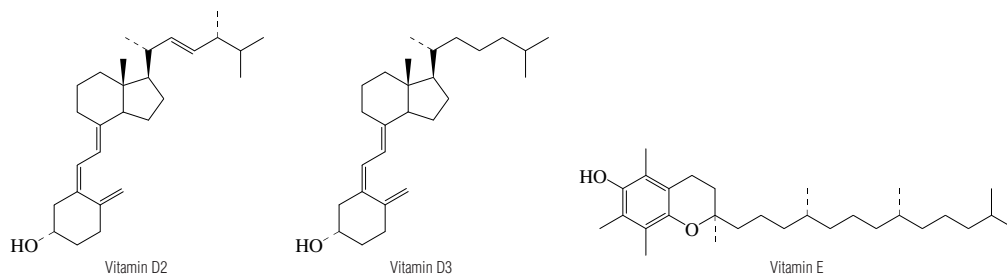
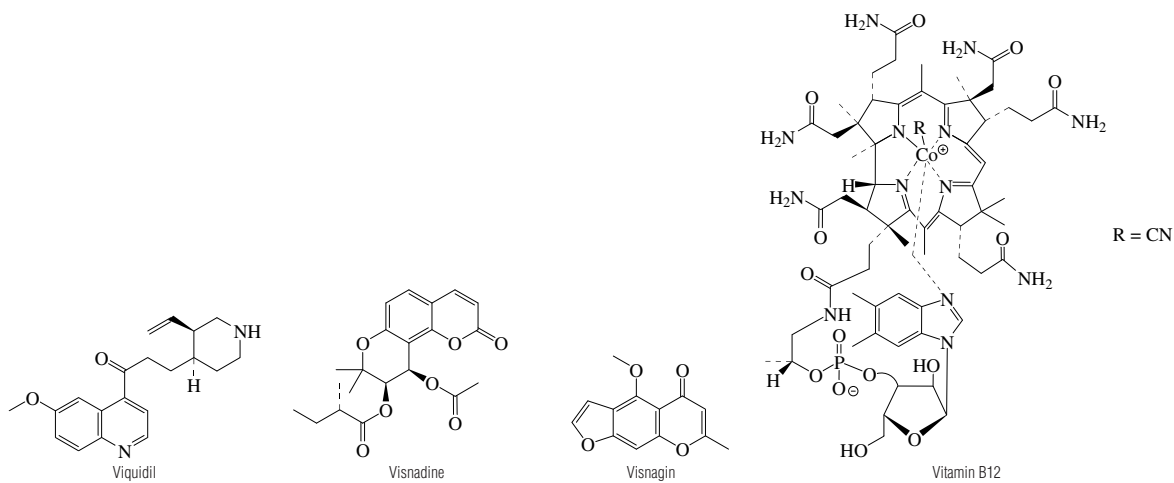
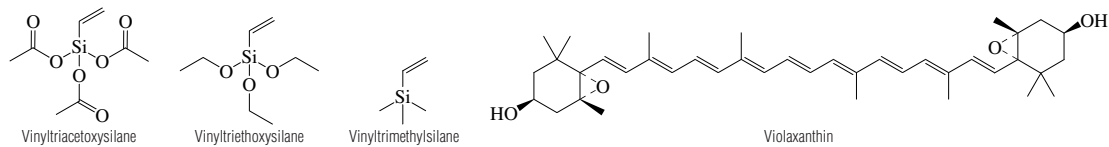
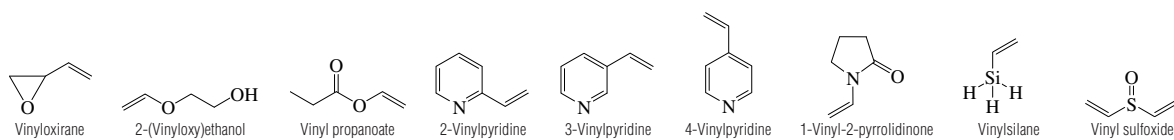


No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10774	DL-Vasicine	DL-Peganine	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O	6159-56-4	188.225	nd (al)	210.8				sl H <sub>2</sub> O, eth, bz; s EtOH, ace, chl
10775	L-Vasicine	L-Peganine	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O	6159-55-3	188.225	nd (al)	211.5				sl H <sub>2</sub> O, eth, bz; s EtOH, ace, chl
10776	Verapamil		C <sub>27</sub> H <sub>38</sub> N <sub>2</sub> O <sub>4</sub>	52-53-9	454.602	ye oil		245 <sup>0.01</sup>		1.5448 <sup>25</sup>	i H <sub>2</sub> O; vs EtOH, ace; sl bz, hx
10777	Veratramine		C <sub>27</sub> H <sub>39</sub> NO <sub>2</sub>	60-70-8	409.605	nd	206				s EtOH, bz, chl, dil acid; i dil alk
10778	Veratramine, 3-glucoside		C <sub>33</sub> H <sub>49</sub> NO <sub>7</sub>	475-00-3	571.745	nd (aq. MeOH)	242 dec				
10779	Veratridine		C <sub>36</sub> H <sub>51</sub> NO <sub>11</sub>	71-62-5	673.790	ye amorp pow	180				i H <sub>2</sub> O; sl eth
10780	d-Verbenone		C <sub>10</sub> H <sub>14</sub> O	18309-32-5	150.217		9.8	227.5	0.9978 <sup>20</sup>	1.4993 <sup>18</sup>	s H <sub>2</sub> O, EtOH, ace, bz
10781	Vernolate	Carbamothioic acid, dipropyl-, S-propyl ester	C <sub>10</sub> H <sub>21</sub> NOS	1929-77-7	203.345			150 <sup>30</sup>		0.952 <sup>20</sup>	
10782	Versalide		C <sub>18</sub> H <sub>26</sub> O	88-29-9	258.398	cry	46.5	130 <sup>2</sup>			s EtOH
10783	α-Vetivone	Isonootkatone	C <sub>15</sub> H <sub>22</sub> O	15764-04-2	218.335	cry (peth)	51.5	144 <sup>2</sup>	1.0035 <sup>20</sup>	1.5370 <sup>20</sup>	vs ace
10784	β-Vetivone		C <sub>15</sub> H <sub>22</sub> O	18444-79-6	218.335	cry (peth)	44.5	141 <sup>2</sup>	1.0001 <sup>20</sup>	1.5309 <sup>20</sup>	s ace
10785	Vicine	2,6-Diamino-5-(β-D- glucopyranosyloxy)-4(1H)- pyrimidinone	C <sub>10</sub> H <sub>16</sub> N <sub>4</sub> O <sub>7</sub>	152-93-2	304.257	nd (w, dil al, +1 w)	240 dec				sl H <sub>2</sub> O, EtOH; vs acid, alk
10786	Vidarabine	β-D-9-Arabinofuranosyladenine	C <sub>10</sub> H <sub>15</sub> N <sub>5</sub> O <sub>5</sub>	5536-17-4	285.257	nd (w)	257				
10787	Vinblastine		C <sub>46</sub> H <sub>58</sub> N <sub>4</sub> O <sub>9</sub>	865-21-4	810.975	nd (MeOH)	216				i H <sub>2</sub> O; s EtOH, ace, chl, AcOEt
10788	Vincamine		C <sub>21</sub> H <sub>26</sub> N <sub>2</sub> O <sub>3</sub>	1617-90-9	354.442		231.5				
10789	Vinclozolin		C <sub>12</sub> H <sub>9</sub> Cl <sub>2</sub> NO <sub>3</sub>	50471-44-8	286.110		108	131 <sup>0.05</sup>	1.51		
10790	Vincristine		C <sub>46</sub> H <sub>56</sub> N <sub>4</sub> O <sub>10</sub>	57-22-7	824.958		219				
10791	Vinyl acetate		C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	108-05-4	86.090	liq	-93.2	72.8	0.9256 <sup>25</sup>	1.3926 <sup>25</sup>	sl H <sub>2</sub> O; msc EtOH; s eth, ace, bz, chl
10792	4-Vinylaniline		C <sub>8</sub> H <sub>9</sub> N	1520-21-4	119.164		23.5	116 <sup>9</sup>	1.010 <sup>20</sup>	1.6250 <sup>22</sup>	s ace, bz
10793	α-Vinylbenzenemethanol	1-Phenylallyl alcohol	C <sub>9</sub> H <sub>10</sub> O	4393-06-0	134.174				1.0249 <sup>21</sup>	1.5406 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth, bz, chl
10794	Vinyl butanoate		C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	123-20-6	114.142			116.7; 64 <sup>130</sup>	0.9006 <sup>20</sup>		s ctc
10795	Vinyl trans-2-butenoate	Vinyl crotonate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	3234-54-6	112.127						
10796	9-Vinyl-9H-carbazole		C <sub>14</sub> H <sub>11</sub> N	1484-13-5	193.244	cry (al)	66				i H <sub>2</sub> O; sl EtOH; vs eth
10797	Vinylcyclohexane		C <sub>8</sub> H <sub>14</sub>	695-12-5	110.197			128	0.8166 <sup>19</sup>	1.455 <sup>19</sup>	
10798	1-Vinylcyclohexene		C <sub>8</sub> H <sub>12</sub>	2622-21-1	108.181			145	0.8623 <sup>15</sup>	1.4915 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz; vs MeOH
10799	4-Vinylcyclohexene		C <sub>8</sub> H <sub>12</sub>	100-40-3	108.181	liq	-108.9	128	0.8299 <sup>20</sup>	1.4639 <sup>20</sup>	i H <sub>2</sub> O; s eth, bz, peth
10800	Vinylcyclopentane		C <sub>7</sub> H <sub>12</sub>	3742-34-5	96.170	liq	-126.5	97	0.7834 <sup>20</sup>	1.4360 <sup>20</sup>	
10801	Vinyldiethoxymethylsilane		C <sub>7</sub> H <sub>16</sub> O <sub>2</sub> Si	5507-44-8	160.287			133	0.8620 <sup>20</sup>	1.4001 <sup>20</sup>	
10802	Vinylethoxydimethylsilane		C <sub>8</sub> H <sub>14</sub> O <sub>2</sub> Si	5356-83-2	130.260			99	0.790 <sup>20</sup>	1.3983 <sup>20</sup>	
10803	1-Vinyl-4-fluorobenzene		C <sub>8</sub> H <sub>7</sub> F	405-99-2	122.140		-34.5	67.4 <sup>50</sup> , 30 <sup>4</sup>	1.0220 <sup>20</sup>	1.5150 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
10804	Vinyl formate		C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	692-45-5	72.063	visc liq	-78	46	0.965 <sup>20</sup>	1.3842 <sup>20</sup>	
10805	2-Vinylfuran		C <sub>7</sub> H <sub>8</sub> O	1487-18-9	94.111	liq	-94	99.5	0.9445 <sup>19</sup>	1.4992 <sup>19</sup>	
10806	1-Vinyl-2-methoxybenzene		C <sub>9</sub> H <sub>10</sub> O	612-15-7	134.174	nd	29	197; 83 <sup>12</sup>	1.0049 <sup>17</sup>	1.5388 <sup>20</sup>	vs ace, bz, eth, EtOH
10807	1-Vinyl-3-methoxybenzene		C <sub>9</sub> H <sub>10</sub> O	626-20-0	134.174			91 <sup>15</sup> , 70 <sup>5</sup>	0.9919 <sup>20</sup>	1.5586 <sup>23</sup>	i H <sub>2</sub> O; s EtOH, eth, bz
10808	1-Vinyl-4-methoxybenzene		C <sub>9</sub> H <sub>10</sub> O	637-69-4	134.174		2.0	205; 91 <sup>13</sup>	1.0001 <sup>13</sup>	1.5642 <sup>13</sup>	i H <sub>2</sub> O; s EtOH, eth, bz; sl ctc
10809	6-Vinyl-6-methyl-1-isopropyl-3-(1-methylethylidene)cyclohexene, (S)		C <sub>15</sub> H <sub>24</sub>	5951-67-7	204.352			125 <sup>8</sup>	0.8782 <sup>20</sup>	1.5130 <sup>26</sup>	vs ace, bz
10810	1-Vinylnaphthalene		C <sub>12</sub> H <sub>10</sub>	826-74-4	154.207			124 <sup>15</sup>	1.0656 <sup>20</sup>	1.644 <sup>20</sup>	
10811	2-Vinylnaphthalene		C <sub>12</sub> H <sub>10</sub>	827-54-3	154.207		66	135 <sup>16</sup> , 95 <sup>2</sup>			i H <sub>2</sub> O; s EtOH, ace, bz
10812	1-Vinyl-3-nitrobenzene		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	586-39-0	149.148		-10	120 <sup>11</sup>	1.1552 <sup>32</sup>	1.5836 <sup>20</sup>	i H <sub>2</sub> O; s EtOH, eth, bz, chl, lig, HOAc
10813	1-Vinyl-4-nitrobenzene		C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	100-13-0	149.148	pr (liq)	29	dec			vs EtOH, eth; s chl, HOAc, lig
10814	2-Vinyl-5-norbornene	5-Vinylbicyclo[2.2.1]hept-2-ene	C <sub>9</sub> H <sub>12</sub>	3048-64-4	120.191	liq	-80	139	0.841	1.4810 <sup>20</sup>	
10815	Vinyl octadecanoate	Vinyl stearate	C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	111-63-7	310.515		29	167 <sup>2</sup>	0.8517 <sup>20</sup>		sl chl
10816	3-Vinyl-7-oxabicyclo[4.1.0]heptane		C <sub>8</sub> H <sub>12</sub> O	106-86-5	124.180		<-100	169; 70 <sup>20</sup>	0.9581 <sup>20</sup>	1.4700 <sup>20</sup>	

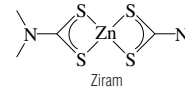
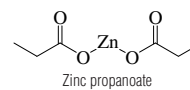
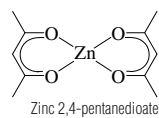
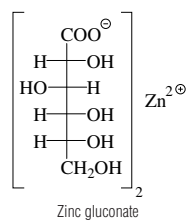
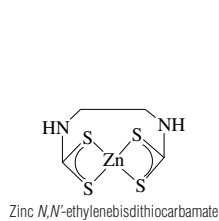
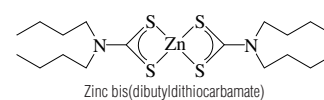
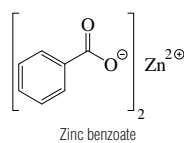
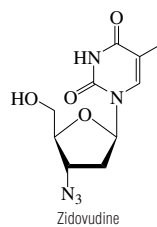
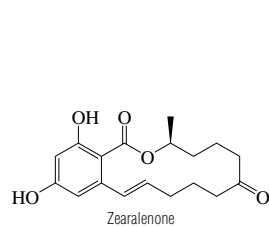
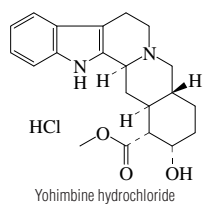
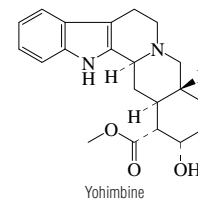
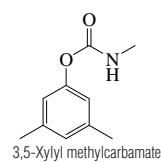
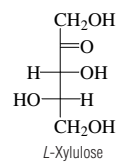
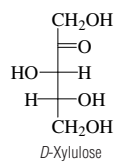
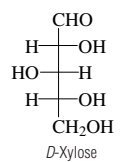
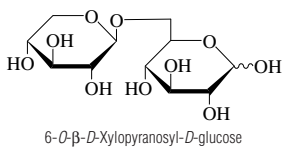
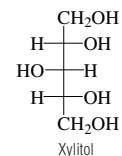
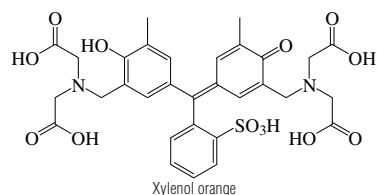
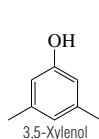
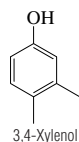
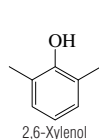
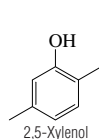
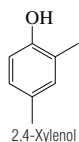
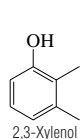




No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10817	Vinyloxirane		C <sub>2</sub> H <sub>4</sub> O	930-22-3	70.090			68	0.9006 <sup>25</sup>	1.4168 <sup>20</sup>	s EtOH, eth, bz
10818	2-(Vinylloxy)ethanol	Ethylene glycol monovinyl ether	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	764-48-7	88.106			141.6	0.9821 <sup>20</sup>	1.4564 <sup>17</sup>	s H <sub>2</sub> O, EtOH, eth, bz; i lig
10819	Vinyl propanoate	Vinyl propionate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	105-38-4	100.117			91.2			
10820	2-Vinylpyridine		C <sub>7</sub> H <sub>7</sub> N	100-69-6	105.138			159.5	0.9983 <sup>20</sup>	1.5495 <sup>20</sup>	sl H <sub>2</sub> O; vs EtOH, eth, ace, chl
10821	3-Vinylpyridine		C <sub>7</sub> H <sub>7</sub> N	1121-55-7	105.138			162	0.9879 <sup>20</sup>	1.5530 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
10822	4-Vinylpyridine		C <sub>7</sub> H <sub>7</sub> N	100-43-6	105.138	red to dk-br		121 <sup>150</sup> , 79 <sup>33</sup>	0.9879 <sup>20</sup>	1.5449 <sup>20</sup>	s H <sub>2</sub> O, EtOH, chl; sl eth
10823	1-Vinyl-2-pyrrolidinone		C <sub>6</sub> H <sub>9</sub> NO	88-12-0	111.141		13.5	193 <sup>400</sup> , 93 <sup>11</sup>	1.04 <sup>20</sup>		
10824	Vinylsilane		C <sub>2</sub> H <sub>4</sub> Si	7291-09-0	58.155	col gas	-171.6	-22.8			
10825	Vinyl sulfoxide		C <sub>4</sub> H <sub>6</sub> OS	1115-15-7	102.155	liq		86 <sup>18</sup>			
10826	Vinyltriacetoxysilane	Vinylsilanetriol, triacetate	C <sub>8</sub> H <sub>12</sub> O <sub>6</sub> Si	4130-08-9	232.263			115 <sup>10</sup>	1.169 <sup>20</sup>	1.4226 <sup>20</sup>	
10827	Vinyltriethoxysilane		C <sub>8</sub> H <sub>18</sub> O <sub>3</sub> Si	78-08-0	190.313			160; 62 <sup>20</sup>	0.901 <sup>20</sup>	1.3960 <sup>25</sup>	s chl
10828	Vinyltrimethylsilane		C <sub>6</sub> H <sub>12</sub> Si	754-05-2	100.235			55	0.65 <sup>20</sup>	1.3914 <sup>20</sup>	i H <sub>2</sub> O
10829	Violaxanthin		C <sub>40</sub> H <sub>56</sub> O <sub>4</sub>	126-29-4	600.871	red pr (MeOH, al-eth)	208				s EtOH, eth, CS <sub>2</sub> ; i peth
10830	Viquidil		C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	84-55-9	324.417	red ye amor	60				vs eth, EtOH, chl
10831	Visnadine		C <sub>21</sub> H <sub>24</sub> O <sub>7</sub>	477-32-7	388.412	nd	85.5				i H <sub>2</sub> O; s EtOH, eth
10832	Visnagin	4-Methoxy-7-methyl-5 <i>H</i> -furo[3,2- <i>g</i> ][1]benzopyran-5-one	C <sub>13</sub> H <sub>10</sub> O <sub>4</sub>	82-57-5	230.216	nd (w, MeOH)	144.5				sl H <sub>2</sub> O, EtOH; vs chl
10833	Vitamin B12	Cyanocobalamin	C <sub>63</sub> H <sub>88</sub> CoN <sub>14</sub> O <sub>14</sub> P	68-19-9	1355.365		>300				
10834	Vitamin D2		C <sub>28</sub> H <sub>44</sub> O	50-14-6	396.648	pr (ace)	116.5	sub			i H <sub>2</sub> O; s EtOH, eth, ace, chl
10835	Vitamin D3	9,10-Secocholesta-5,7,10(19)-trien-3-ol, (3 <i>β</i> ,5,7 <i>E</i> )-	C <sub>27</sub> H <sub>44</sub> O	67-97-0	384.637		84.5				i H <sub>2</sub> O; s os
10836	Vitamin E	$\alpha$ -Tocopherol	C <sub>29</sub> H <sub>50</sub> O <sub>2</sub>	59-02-9	430.706	pale ye oil	3.0	210 <sup>0.1</sup>	0.950 <sup>25</sup>	1.5045 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, chl
10837	Vitamin E acetate		C <sub>31</sub> H <sub>52</sub> O <sub>3</sub>	58-95-7	472.743		-27.5	184 <sup>0.01</sup>	0.9533 <sup>21</sup>	1.497 <sup>20</sup>	i H <sub>2</sub> O; sl EtOH; s eth, ace, chl
10838	Vitamin K1		C <sub>31</sub> H <sub>46</sub> O <sub>2</sub>	84-80-0	450.696		-20	142 <sup>0.001</sup>	0.964 <sup>25</sup>	1.5250 <sup>25</sup>	i H <sub>2</sub> O; s EtOH, eth, ace, bz, peth, chl
10839	Vomicine	4-Hydroxy-19-methyl-16,19-secostrychnidine-10,16-dione	C <sub>22</sub> H <sub>24</sub> N <sub>2</sub> O <sub>4</sub>	125-15-5	380.437	nd (80% al) pr (ace)	282				sl EtOH, eth, ace; vs chl; s AcOEt
10840	Warfarin	Coumadin	C <sub>19</sub> H <sub>16</sub> O <sub>4</sub>	81-81-2	308.328	cry (al)	161				i H <sub>2</sub> O; s EtOH, ace, diox
10841	9 <i>H</i> -Xanthene	10 <i>H</i> -9-Oxaanthracene	C <sub>13</sub> H <sub>10</sub> O	92-83-1	182.217	ye lf (al)	100.5	311			i H <sub>2</sub> O; sl EtOH, ctc; s eth, bz, chl
10842	9 <i>H</i> -Xanthen-9-ol		C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	90-46-0	198.217	nd (aq al)	125				sl H <sub>2</sub> O; s EtOH, eth, chl
10843	Xanthine		C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	69-89-6	152.112	ye pl (w)	dec	sub			i H <sub>2</sub> O
10844	Xanthone		C <sub>13</sub> H <sub>6</sub> O <sub>2</sub>	90-47-1	196.202	nd (al)	174	351; 146 <sup>3</sup>			i H <sub>2</sub> O; s EtOH, eth, bz, chl; sl peth
10845	Xanthopterin		C <sub>6</sub> H <sub>8</sub> N <sub>6</sub> O <sub>2</sub>	119-44-8	179.137	hyg ye amor or oran pow (HOAc)	>410 dec	99 <sup>18</sup>	1.559 <sup>25</sup>		i H <sub>2</sub> O; sl EtOH, eth; vs acid, alk
10846	Xanthosine		C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> O <sub>6</sub>	146-80-5	284.225	pr cry (w)					sl cold H <sub>2</sub> O; vs hot H <sub>2</sub> O; dec acid
10847	Xanthoxyletin		C <sub>15</sub> H <sub>14</sub> O <sub>4</sub>	84-99-1	258.270	pr (MeOH, peth)	133				i H <sub>2</sub> O; s EtOH, ace; sl eth; vs bz, alk
10848	Xanthyletin	8,8-Dimethyl-2 <i>H</i> ,8 <i>H</i> -benzo[1,2- <i>b</i> :5,4- <i>b'</i> ]dipyran-2-one	C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	553-19-5	228.243	pr (MeOH)	131.5	142 <sup>0.1</sup>			s EtOH, peth
10849	<i>p</i> -Xenylcarbimide	4-Isocyanato-1,1'-biphenyl	C <sub>13</sub> H <sub>9</sub> NO	92-95-5	195.216	nd	56	dec 283			vs eth
10850	Xibenolol		C <sub>15</sub> H <sub>25</sub> NO <sub>2</sub>	81584-06-7	251.366	cry	57	135 <sup>0.7</sup>			s EtOH
10851	<i>o</i> -Xylene	1,2-Dimethylbenzene	C <sub>8</sub> H <sub>10</sub>	95-47-6	106.165	liq	-25.2	144.5	0.8755 <sup>25</sup>	1.5018 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz, peth, ctc
10852	<i>m</i> -Xylene	1,3-Dimethylbenzene	C <sub>8</sub> H <sub>10</sub>	108-38-3	106.165	liq	-47.8	139.07	0.8598 <sup>25</sup>	1.4944 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl
10853	<i>p</i> -Xylene	1,4-Dimethylbenzene	C <sub>8</sub> H <sub>10</sub>	106-42-3	106.165	mcl pr (al)	13.25	138.23	0.8565 <sup>25</sup>	1.4929 <sup>25</sup>	i H <sub>2</sub> O; msc EtOH, eth, ace, bz; s chl



No.	Name	Synonym	Mol. Form.	CAS RN	Mol. Wt.	Physical Form	mp/°C	bp/°C	den/ g cm <sup>-3</sup>	n <sub>D</sub>	Solubility
10854	2,3-Xylenol	2,3-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	526-75-0	122.164	nd (w, dil al)	72.5	216.9		1.5420 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH, eth
10855	2,4-Xylenol	2,4-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	105-67-9	122.164	nd (w)	24.5	210.98	0.9650 <sup>20</sup>	1.5420 <sup>14</sup>	sl H <sub>2</sub> O; msc EtOH, eth; s ctc
10856	2,5-Xylenol	2,5-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	95-87-4	122.164	nd (w), pr (al-eth)	74.8	211.1			s H <sub>2</sub> O, EtOH; vs eth; sl chl
10857	2,6-Xylenol	2,6-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	576-26-1	122.164	lf or nd (al)	45.8	201.07			s H <sub>2</sub> O, EtOH, eth, ctc
10858	3,4-Xylenol	3,4-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	95-65-8	122.164		65.1	227	0.9830 <sup>20</sup>		sl H <sub>2</sub> O; s EtOH, ctc; msc eth
10859	3,5-Xylenol	3,5-Dimethylphenol	C <sub>8</sub> H <sub>10</sub> O	108-68-9	122.164	nd (w, peth)	63.4	221.74	0.9680 <sup>20</sup>		s H <sub>2</sub> O, EtOH, ctc
10860	Xylenol orange		C <sub>31</sub> H <sub>32</sub> N <sub>2</sub> O <sub>13</sub> S	1611-35-4	672.656	dk red cry	286 dec				s H <sub>2</sub> O
10861	Xylitol	Xylite	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	87-99-0	152.146	mcl (al)	93.5	216			vs H <sub>2</sub> O, py, EtOH
10862	6-O-β-D-Xylopyranosyl-D-glucose	Primeverose	C <sub>11</sub> H <sub>20</sub> O <sub>10</sub>	26531-85-1	312.271	cry (MeOH)	210				vs H <sub>2</sub> O, MeOH
10863	D-Xylose		C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	58-86-6	150.130	mcl nd	90.5		1.525 <sup>20</sup>		vs H <sub>2</sub> O; s EtOH; sl eth
10864	D-Xylulose	D-threo-2-Pentulose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	551-84-8	150.130	visc liq					s H <sub>2</sub> O
10865	L-Xylulose	L-threo-2-Pentulose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	527-50-4	150.130	syrup					vs H <sub>2</sub> O
10866	3,5-Xylyl methylcarbamate	3,5-Dimethylphenyl methylcarbamate	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	2655-14-3	179.216	cry	99				sl H <sub>2</sub> O; s os
10867	Yohimbine		C <sub>21</sub> H <sub>26</sub> N <sub>2</sub> O <sub>3</sub>	146-48-5	354.442	nd (dil al)	241	sub 160			sl H <sub>2</sub> O, bz; s EtOH, eth, chl
10868	Yohimbine hydrochloride	Tosanpin	C <sub>21</sub> H <sub>27</sub> ClN <sub>2</sub> O <sub>3</sub>	65-19-0	390.903	orth nd or pl (w, dil HCl)	302				vs H <sub>2</sub> O
10869	Zearalenone		C <sub>18</sub> H <sub>22</sub> O <sub>5</sub>	17924-92-4	318.365	cry	164				i H <sub>2</sub> O; s alk, bz, EtOH, eth
10870	Zidovudine	3'-Azido-3'-deoxythymidine	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	30516-87-1	267.242	cry (w)	121				
10871	Zinc benzoate		C <sub>14</sub> H <sub>10</sub> O <sub>4</sub> Zn	553-72-0	307.636						sl H <sub>2</sub> O
10872	Zinc bis(dibutylthiocarbamate)		C <sub>18</sub> H <sub>36</sub> N <sub>2</sub> S <sub>4</sub> Zn	136-23-2	474.161	cry	138				
10873	Zinc N,N'-ethylenebisdithiocarbamate	Zineb	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> S <sub>4</sub> Zn	12122-67-7	275.773		157 dec				
10874	Zinc gluconate		C <sub>12</sub> H <sub>22</sub> O <sub>12</sub> Zn	4468-02-4	455.704	pow					s DMSO
10875	Zinc 2,4-pentanedioate	Zinc acetylacetonate	C <sub>10</sub> H <sub>14</sub> O <sub>4</sub> Zn	14024-63-6	263.625						sl EtOH
10876	Zinc propanoate		C <sub>6</sub> H <sub>10</sub> O <sub>4</sub> Zn	557-28-8	211.550	hyg pl or nd					
10877	Ziram	Zinc, bis(dimethylcarbamo-dithioato-S,S)-, (T-4)-	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub> Zn	137-30-4	305.841	cry	250		1.66 <sup>25</sup>		i H <sub>2</sub> O; sl bz; s chl



## DIAMAGNETIC SUSCEPTIBILITY OF SELECTED ORGANIC COMPOUNDS

When a material is placed in a magnetic field  $H$ , a magnetization  $M$  is induced in the material which is related to  $H$  by  $M = \kappa H$ , where  $\kappa$  is called the volume susceptibility. Since  $H$  and  $M$  have the same dimensions,  $\kappa$  is dimensionless. A more useful parameter is the molar susceptibility  $\chi_m$ , defined by

$$\chi_m = \kappa V_m = \kappa M/\rho$$

where  $V_m$  is the molar volume of the substance,  $M$  the molar mass, and  $\rho$  the mass density. When the cgs system is used, the customary unit for  $\chi_m$  is  $\text{cm}^3 \text{mol}^{-1}$ ; the corresponding SI unit is  $\text{m}^3 \text{mol}^{-1}$ . Substances with no unpaired electrons are called diamagnetic; they have negative values of  $\chi_m$ .

This table gives values of the diamagnetic susceptibility for about 400 common organic compounds. All values refer to room temperature and atmospheric pressure and to the physical form

that is stable under these conditions. Substances are arranged by molecular formula in Hill order. A more extensive table may be found in Reference 1.

In keeping with customary practice, the molar susceptibility is given here in units appropriate to the cgs system. These values should be multiplied by  $4\pi$  to obtain values for use in SI equations (where the magnetic field strength  $H$  has units of  $\text{A m}^{-1}$ ).

### References

1. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, New Series, II/16, Diamagnetic Susceptibility*, Gupta, R. R., Ed., Springer-Verlag, Heidelberg, 1986.
2. Barter, C., Meisenheimer, R. G., and Stevenson, D. P., *J. Phys. Chem.* 64, 1312, 1960.
3. Broersma, S., *J. Chem. Phys.* 17, 873, 1949.

Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
CBrCl <sub>3</sub>	Bromotrichloromethane	73.2	CN <sub>4</sub> O <sub>8</sub>	Tetranitromethane	43.0
CBr <sub>4</sub>	Tetrabromomethane	93.7	C <sub>2</sub> ClF <sub>3</sub>	Chlorotrifluoroethylene	49.1
CClF <sub>3</sub>	Chlorotrifluoromethane	45.3	C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene	81.6
CClN	Cyanogen chloride	32.4	C <sub>2</sub> Cl <sub>6</sub>	Hexachloroethane	112.8
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	52.2	C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	65.8
CCl <sub>2</sub> O	Carbonyl chloride	47.9	C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde	73.0
CCl <sub>3</sub> F	Trichlorofluoromethane	58.7	C <sub>2</sub> HCl <sub>3</sub> O	Dichloroacetyl chloride	69.0
CCl <sub>3</sub> NO <sub>2</sub>	Trichloronitromethane	75.3	C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid	73.0
CCl <sub>4</sub>	Tetrachloromethane	66.8	C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane	99.1
CHBrCl <sub>2</sub>	Bromodichloromethane	66.3	C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid	43.3
CHBr <sub>3</sub>	Tribromomethane	82.6	C <sub>2</sub> H <sub>2</sub>	Acetylene	20.8
CHCl <sub>3</sub>	Trichloromethane	58.9	C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	1,1,2,2-Tetrabromoethane	123.4
CHI <sub>3</sub>	Triiodomethane	117.1	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethylene	49.2
CH <sub>2</sub> BrCl	Bromochloromethane	55.1	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene	51.0
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	65.1	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	48.9
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	46.6	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane	89.8
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane	93.1	C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	35.9
CH <sub>2</sub> N <sub>2</sub>	Cyanamide	24.8	C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride	39.3
CH <sub>2</sub> O	Formaldehyde	18.6	C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	27.8
CH <sub>2</sub> O <sub>2</sub>	Formic acid	19.9	C <sub>2</sub> H <sub>4</sub>	Ethylene	18.8
CH <sub>3</sub> Br	Bromomethane	42.8	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane	78.9
CH <sub>3</sub> Cl	Chloromethane	32.0	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	57.4
CH <sub>3</sub> F	Fluoromethane	17.8	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	59.6
CH <sub>3</sub> I	Iodomethane	57.2	C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	22.2
CH <sub>3</sub> NO	Formamide	23.0	C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	30.5
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	21.0	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	31.8
CH <sub>4</sub>	Methane	17.4	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	31.1
CH <sub>4</sub> N <sub>2</sub> O	Urea	33.5	C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	78.8
CH <sub>4</sub> O	Methanol	21.4	C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	69.9
CH <sub>5</sub> N	Methylamine	27.0	C <sub>2</sub> H <sub>5</sub> I	Iodoethane	69.1
Cl <sub>4</sub>	Tetraiodomethane	136	C <sub>2</sub> H <sub>5</sub> NO	Acetamide	33.9

Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	35.4	C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene	35.6
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Glycine	39.6	C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	32.1
C <sub>2</sub> H <sub>6</sub>	Ethane	26.8	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	46.4
C <sub>2</sub> H <sub>6</sub> O	Ethanol	33.7	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	52.8
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	26.3	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Succinic acid	58.0
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	38.9	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Dimethyl oxalate	55.7
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol	47.0	C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	50.4
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	44.9	C <sub>4</sub> H <sub>8</sub>	1-Butene	41.0
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	46.5	C <sub>4</sub> H <sub>8</sub>	<i>cis</i> -2-Butene	42.6
C <sub>2</sub> N <sub>2</sub>	Cyanogen	21.6	C <sub>4</sub> H <sub>8</sub>	<i>trans</i> -2-Butene	43.3
C <sub>3</sub> H <sub>4</sub>	Allene	25.3	C <sub>4</sub> H <sub>8</sub>	Isobutene	40.8
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Vinyl formate	34.7	C <sub>4</sub> H <sub>8</sub>	Cyclobutane	40.0
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	58.6	C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether	47.9
C <sub>3</sub> H <sub>5</sub> Cl	2-Chloropropene	47.8	C <sub>4</sub> H <sub>8</sub> O	1,2-Epoxybutane	54.8
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene	47.8	C <sub>4</sub> H <sub>8</sub> O	Butanal	45.9
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	38.6	C <sub>4</sub> H <sub>8</sub> O	2-Butanone	45.6
C <sub>3</sub> H <sub>6</sub>	Propene	30.7	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid	55.2
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	39.2	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid	56.1
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	36.7	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	55.0
C <sub>3</sub> H <sub>6</sub> O	Propanal	34.2	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	54.1
C <sub>3</sub> H <sub>6</sub> O	Acetone	33.8	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	54.5
C <sub>3</sub> H <sub>6</sub> O	Methyloxirane	42.5	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	52.2
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	43.2	C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	77.1
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	42.4	C <sub>4</sub> H <sub>9</sub> Br	1-Bromo-2-methylpropane	79.9
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	65.6	C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	67.1
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	65.1	C <sub>4</sub> H <sub>9</sub> Cl	2-Chlorobutane	67.4
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	56.0	C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	93.6
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	84.3	C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine	54.8
C <sub>3</sub> H <sub>7</sub> N	Allylamine	40.1	C <sub>4</sub> H <sub>9</sub> NO	Morpholine	55.0
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	45.0	C <sub>4</sub> H <sub>10</sub>	Butane	50.3
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane	45.4	C <sub>4</sub> H <sub>10</sub>	Isobutane	50.5
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl carbamate	57.0	C <sub>4</sub> H <sub>10</sub> O	1-Butanol	56.4
C <sub>3</sub> H <sub>8</sub>	Propane	38.6	C <sub>4</sub> H <sub>10</sub> O	2-Butanol	57.6
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	44.8	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	57.6
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	45.7	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	56.6
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propylene glycol	50.2	C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	55.5
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Dimethoxymethane	47.3	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Butanediol	61.8
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol	57.1	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Butanediol	61.8
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride	35.8	C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	70.2
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrazine	37.8	C <sub>4</sub> H <sub>11</sub> N	Butylamine	58.9
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine	43.1	C <sub>4</sub> H <sub>11</sub> N	Isobutylamine	59.8
C <sub>4</sub> H <sub>4</sub> O	Furan	43.1	C <sub>4</sub> H <sub>11</sub> N	Diethylamine	56.8
C <sub>4</sub> H <sub>4</sub> O <sub>3</sub>	Succinic anhydride	47.5	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural	47.2
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Maleic acid	49.6	C <sub>5</sub> H <sub>5</sub> N	Pyridine	48.7
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Fumaric acid	49.1	C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	Furfuryl alcohol	61.0
C <sub>4</sub> H <sub>4</sub> S	Thiophene	57.3	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl cyanoacetate	67.3
C <sub>4</sub> H <sub>5</sub> N	Pyrrole	48.6	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	46.0

Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone	51.6	C <sub>6</sub> H <sub>6</sub> ClN	<i>o</i> -Chloroaniline	79.5
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	57.3	C <sub>6</sub> H <sub>6</sub> ClN	<i>m</i> -Chloroaniline	76.6
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione	54.9	C <sub>6</sub> H <sub>6</sub> ClN	<i>p</i> -Chloroaniline	76.7
C <sub>5</sub> H <sub>10</sub>	1-Pentene	54.6	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>o</i> -Nitroaniline	67.4
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	54.7	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>m</i> -Nitroaniline	69.7
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	56.2	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>p</i> -Nitroaniline	68.0
C <sub>5</sub> H <sub>10</sub> O	Cyclopentanol	64.0	C <sub>6</sub> H <sub>6</sub> O	Phenol	60.6
C <sub>5</sub> H <sub>10</sub> O	Pentanal	57.5	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	<i>p</i> -Hydroquinone	64.7
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	57.5	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Pyrocatechol	68.2
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	57.7	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Resorcinol	67.2
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid	66.5	C <sub>6</sub> H <sub>7</sub> N	Aniline	62.4
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	3-Methylbutanoic acid	67.7	C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	59.8
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	65.8	C <sub>6</sub> H <sub>8</sub>	1,4-Cyclohexadiene	48.7
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isobutyl formate	66.8	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>o</i> -Phenylenediamine	72.5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	65.9	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>m</i> -Phenylenediamine	70.4
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate	67.0	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>p</i> -Phenylenediamine	70.7
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	66.3	C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene	55.1
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Tetrahydrofurfuryl alcohol	69.4	C <sub>6</sub> H <sub>10</sub>	1-Hexyne	64.5
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Diethyl carbonate	75.4	C <sub>6</sub> H <sub>10</sub>	Cyclohexene	58.0
C <sub>5</sub> H <sub>11</sub> N	Piperidine	64.2	C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	62.0
C <sub>5</sub> H <sub>12</sub>	Pentane	61.5	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate	71.7
C <sub>5</sub> H <sub>12</sub>	Isopentane	63.0	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate	81.7
C <sub>5</sub> H <sub>12</sub>	Neopentane	63.0	C <sub>6</sub> H <sub>12</sub>	1-Hexene	66.4
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	67.0	C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-2-butene	65.9
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	69.1	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	68
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,5-Pentanediol	73.5	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	70.2
C <sub>5</sub> H <sub>13</sub> N	Pentylamine	69.3	C <sub>6</sub> H <sub>12</sub> O	Hexanal	69.4
C <sub>6</sub> Cl <sub>6</sub>	Hexachlorobenzene	147.0	C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	69.2
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-2-nitrobenzene	75.5	C <sub>6</sub> H <sub>12</sub> O	3-Hexanone	69.0
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-3-nitrobenzene	77.2	C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone	69.7
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-4-nitrobenzene	74.7	C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol	73.4
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene	84.4	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid	78.1
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene	84.1	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isopentyl formate	78.4
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene	81.7	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate	78.7
C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	<i>p</i> -Benzoquinone	36	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Propyl propanoate	77.7
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	78.4	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde	86.1
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	69.5	C <sub>6</sub> H <sub>14</sub>	Hexane	74.1
C <sub>6</sub> H <sub>5</sub> ClO	<i>o</i> -Chlorophenol	77.3	C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	75.3
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol	77.6	C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	75.5
C <sub>6</sub> H <sub>5</sub> ClO	<i>p</i> -Chlorophenol	77.7	C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane	76.2
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	58.4	C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	76.2
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	92.0	C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	79.5
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene	61.9	C <sub>6</sub> H <sub>14</sub> O	4-Methyl-2-pentanol	80.4
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>o</i> -Nitrophenol	68.9	C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	79.4
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>m</i> -Nitrophenol	65.9	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,6-Hexanediol	84.3
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>p</i> -Nitrophenol	66.9	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-Diethoxyethane	81.4
C <sub>6</sub> H <sub>6</sub>	Benzene	54.8	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	<i>D</i> -Glucitol	107.8



Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	83.3	C <sub>7</sub> H <sub>16</sub>	3,3-Dimethylpentane	89.5
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile	65.2	C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	91.7
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	60.7	C <sub>7</sub> H <sub>16</sub> O	4-Heptanol	92.1
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Salicylaldehyde	66.8	C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	Phthalic anhydride	66.7
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	Salicylic acid	75	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Phthalic acid	83.6
C <sub>7</sub> H <sub>7</sub> Br	<i>p</i> -Bromotoluene	88.7	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Isophthalic acid	84.6
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene	82.4	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Terephthalic acid	83.5
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene	79.7	C <sub>8</sub> H <sub>7</sub> N	Benzeneacetonitrile	76.9
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene	80.3	C <sub>8</sub> H <sub>7</sub> N	Indole	85.0
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene	81.6	C <sub>8</sub> H <sub>8</sub>	Styrene	68.2
C <sub>7</sub> H <sub>7</sub> NO	Benzamide	72.0	C <sub>8</sub> H <sub>8</sub> O	Acetophenone	72.5
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>o</i> -Nitrotoluene	72.2	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>o</i> -Toluic acid	84.3
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>m</i> -Nitrotoluene	72.7	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>m</i> -Toluic acid	83.0
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>p</i> -Nitrotoluene	73.3	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>p</i> -Toluic acid	82.4
C <sub>7</sub> H <sub>8</sub>	Toluene	65.6	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzeneacetic acid	82.4
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	73.3	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate	81.6
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	72.2	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Methyl salicylate	86.6
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	72.4	C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	77.3
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	71.8	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	77.7
C <sub>7</sub> H <sub>8</sub> O	Anisole	72.2	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	76.4
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methylaniline	74.9	C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	77.0
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methylaniline	74.6	C <sub>8</sub> H <sub>10</sub> O	Phenetole	84.5
C <sub>7</sub> H <sub>9</sub> N	<i>p</i> -Methylaniline	72.5	C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline	85.6
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline	74.1	C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline	85.1
C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine	71.3	C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine	83.1
C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	72.5	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Ethyl succinate	105.0
C <sub>7</sub> H <sub>9</sub> NO	<i>o</i> -Methoxyaniline [ <i>o</i> -Anisidine]	79.1	C <sub>8</sub> H <sub>16</sub>	1-Octene	88.8
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl malonate	92.6	C <sub>8</sub> H <sub>16</sub>	Cyclooctane	85.3
C <sub>7</sub> H <sub>14</sub>	1-Heptene	77.8	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid	99.5
C <sub>7</sub> H <sub>14</sub>	Cycloheptane	73.9	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Hexyl acetate	100.9
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	78.9	C <sub>8</sub> H <sub>17</sub> Cl	1-Chlorooctane	114.9
C <sub>7</sub> H <sub>14</sub> O	1-Heptanal	81.0	C <sub>8</sub> H <sub>18</sub>	Octane	96.6
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone	80.5	C <sub>8</sub> H <sub>18</sub>	4-Methylheptane	97.3
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone	80.7	C <sub>8</sub> H <sub>18</sub>	3-Ethylhexane	97.8
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone	80.5	C <sub>8</sub> H <sub>18</sub>	3,4-Dimethylhexane	99.1
C <sub>7</sub> H <sub>14</sub> O	2,4-Dimethyl-3-pentanone	81.1	C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	99.1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid	89.0	C <sub>8</sub> H <sub>18</sub>	2,3,4-Trimethylpentane	99.8
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Pentyl acetate	88.9	C <sub>8</sub> H <sub>18</sub> O	1-Octanol	101.6
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopentyl acetate	89.4	C <sub>8</sub> H <sub>19</sub> N	Dibutylamine	103.7
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Butyl propanoate	89.1	C <sub>9</sub> H <sub>7</sub> N	Quinoline	86.1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl 3-methylbutanoate	91.1	C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	83.9
C <sub>7</sub> H <sub>16</sub>	Heptane	85.2	C <sub>9</sub> H <sub>8</sub>	Indene	83
C <sub>7</sub> H <sub>16</sub>	3-Ethylpentane	86.2	C <sub>9</sub> H <sub>10</sub>	Isopropenylbenzene	80.0
C <sub>7</sub> H <sub>16</sub>	2,2-Dimethylpentane	87.0	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate	93.8
C <sub>7</sub> H <sub>16</sub>	2,3-Dimethylpentane	87.5	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzyl acetate	93.2
C <sub>7</sub> H <sub>16</sub>	2,4-Dimethylpentane	87.5	C <sub>9</sub> H <sub>12</sub>	Propylbenzene	89.1

Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Molecular formula	Compound	$-\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene [Cumene]	89.5	C <sub>12</sub> H <sub>9</sub> N	Carbazole	119.9
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene [Mesitylene]	92.3	C <sub>12</sub> H <sub>10</sub>	Acenaphthene	109.9
C <sub>9</sub> H <sub>18</sub>	1-Nonene	100.1	C <sub>12</sub> H <sub>10</sub>	Biphenyl	103.3
C <sub>9</sub> H <sub>18</sub> O	2,6-Dimethyl-4-heptanone	104.3	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	Azobenzene	106.8
C <sub>9</sub> H <sub>20</sub>	Nonane	108.1	C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	108.4
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene	123.6	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate	127.5
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene	107.6	C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	122.5
C <sub>10</sub> H <sub>8</sub>	Naphthalene	91.6	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Dodecanoic acid	113.0
C <sub>10</sub> H <sub>8</sub>	Azulene	123.7	C <sub>13</sub> H <sub>9</sub> N	Acridine	118.8
C <sub>10</sub> H <sub>8</sub> O	1-Naphthol	96.2	C <sub>13</sub> H <sub>10</sub> O	Benzophenone	109.6
C <sub>10</sub> H <sub>8</sub> O	2-Naphthol	96.8	C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	116.0
C <sub>10</sub> H <sub>9</sub> N	1-Naphthalenamine	92.5	C <sub>13</sub> H <sub>28</sub>	Tridecane	153.7
C <sub>10</sub> H <sub>9</sub> N	2-Naphthalenamine	98.0	C <sub>14</sub> H <sub>8</sub> O <sub>2</sub>	9,10-Anthracenedione	113.0
C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	Safrole	97.5	C <sub>14</sub> H <sub>10</sub>	Anthracene	129.8
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl terephthalate	101.6	C <sub>14</sub> H <sub>10</sub>	Phenanthrene	127.6
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	100.7	C <sub>14</sub> H <sub>10</sub>	Diphenylacetylene	116
C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	101.8	C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	Benzil	106.8
C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	101.7	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	Benzyl benzoate	132.2
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Cymene	102.8	C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	127.8
C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	101.2	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Tetradecanoic acid [Myristic acid]	176.0
C <sub>10</sub> H <sub>14</sub> O	<i>p-tert</i> -Butylphenol	108.0	C <sub>14</sub> H <sub>30</sub>	Tetradecane	166.2
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> -Diethylaniline	107.9	C <sub>16</sub> H <sub>10</sub>	Pyrene	147
C <sub>10</sub> H <sub>16</sub>	<i>d</i> -Limonene	98.0	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Hexadecanoic acid [Palmitic acid]	198.6
C <sub>10</sub> H <sub>16</sub>	$\alpha$ -Pinene	100.7	C <sub>16</sub> H <sub>34</sub>	Hexadecane	187.6
C <sub>10</sub> H <sub>16</sub>	$\beta$ -Pinene	101.9	C <sub>16</sub> H <sub>34</sub> O	1-Hexadecanol	183.5
C <sub>10</sub> H <sub>16</sub> O	Camphor, (+)	103.0	C <sub>18</sub> H <sub>12</sub>	Chrysene	148.0
C <sub>10</sub> H <sub>18</sub>	<i>cis</i> -Decahydronaphthalene	107.0	C <sub>18</sub> H <sub>14</sub>	<i>o</i> -Terphenyl	150.4
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene	107.6	C <sub>18</sub> H <sub>14</sub>	<i>m</i> -Terphenyl	155.5
C <sub>10</sub> H <sub>22</sub>	Decane	119.5	C <sub>18</sub> H <sub>14</sub>	<i>p</i> -Terphenyl	156.0
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	102.9	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	<i>cis</i> -9-Octadecenoic acid [Oleic acid]	208.5
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	102.7	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Octadecanoic acid [Stearic acid]	220.8
C <sub>11</sub> H <sub>24</sub>	Undecane	131.8	C <sub>20</sub> H <sub>12</sub>	Perylene	167.5
C <sub>12</sub> H <sub>8</sub>	Acenaphthylene	111.6			

# THE ELEMENTS

C. R. Hammond

One of the most striking facts about the elements is their unequal distribution and occurrence in nature. Present knowledge of the chemical composition of the universe, obtained from the study of the spectra of stars and nebulae, indicates that hydrogen is by far the most abundant element and may account for more than 90% of the atoms or about 75% of the mass of the universe. Helium atoms make up most of the remainder. All of the other elements together contribute only slightly to the total mass.

The chemical composition of the universe is undergoing continuous change. Hydrogen is being converted into helium, and helium is being changed into heavier elements. As time goes on, the ratio of heavier elements increases relative to hydrogen. Presumably, the process is not reversible.

Burbidge, Burbidge, Fowler, and Hoyle, and more recently, Peebles, Penzias, and others have studied the synthesis of elements in stars. To explain all of the features of the nuclear abundance curve — obtained by studies of the composition of the earth, meteorites, stars, etc. — it is necessary to postulate that the elements were originally formed by at least eight different processes: (1) hydrogen burning, (2) helium burning, (3)  $\chi$  process, (4)  $e$  process, (5)  $s$  process, (6)  $r$  process, (7)  $p$  process, and (8) the X process. The X process is thought to account for the existence of light nuclei such as D, Li, Be, and B. Common metals such as Fe, Cr, Ni, Cu, Ti, Zn, etc. were likely produced early in the history of our galaxy. It is also probable that most of the heavy elements on Earth and elsewhere in the universe were originally formed in supernovae, or in the hot interior of stars.

Studies of the solar spectrum have led to the identification of 67 elements in the sun's atmosphere; however, all elements cannot be identified with the same degree of certainty. Other elements may be present in the sun, although they have not yet been detected spectroscopically. The element helium was discovered on the sun before it was found on Earth. Some elements such as scandium are relatively more plentiful in the sun and stars than here on Earth.

Minerals in lunar rocks brought back from the moon on the Apollo missions consist predominantly of *plagioclase*  $\{(Ca,Na)(Al,Si)O_4O_8\}$  and *pyroxene*  $\{(Ca,Mg,Fe)_2Si_2O_6\}$  — two minerals common in terrestrial volcanic rock. No new elements have been found on the moon that cannot be accounted for on Earth; however, three minerals, *armalcolite*  $\{(Fe,Mg)Ti_2O_5\}$ , *pyroxferroite*  $\{CaFe_6(SiO_3)_7\}$ , and *tranquillityite*  $\{Fe_8(Zr,Y)Ti_3Si_3O_{21}\}$ , are new. The oldest known terrestrial rocks are about 4 billion years old. One rock, known as the "Genesis Rock," brought back from the Apollo 15 Mission, is about 4.15 billion years old. This is only about one-half billion years younger than the supposed age of the moon and solar system. Lunar rocks appear to be relatively enriched in refractory elements such as chromium, titanium, zirconium, and the rare earths, and impoverished in volatile elements such as the alkali metals, in chlorine, and in noble metals such as nickel, platinum, and gold.

Even older than the "Genesis Rock" are *carbonaceous chondrites*, a type of meteorite that has fallen to Earth and has been studied. These are some of the most primitive objects of the solar system yet found. The grains making up these objects probably condensed directly out the gaseous nebula from which the sun and planets were born. Most of the condensation of the grains probably was completed within 50,000 years of the time the disk of the nebula was first formed — about 4.6 billion years ago. It is now thought that this type of meteorite may contain a small percentage

of presolar dust grains. The relative abundances of the elements of these meteorites are about the same as the abundances found in the solar chromosphere.

The X-ray fluorescent spectrometer sent with the Viking I spacecraft to Mars shows that the Martian soil contains about 12 to 16% iron, 14 to 15% silicon, 3 to 8% calcium, 2 to 7% aluminum, and one-half to 2% titanium. The gas chromatograph — mass spectrometer on Viking II found no trace of organic compounds.

F. W. Clarke and others have carefully studied the composition of rocks making up the crust of the earth. Oxygen accounts for about 47% of the crust, by weight, while silicon comprises about 28% and aluminum about 8%. These elements, plus iron, calcium, sodium, potassium, and magnesium, account for about 99% of the composition of the crust.

Many elements such as tin, copper, zinc, lead, mercury, silver, platinum, antimony, arsenic, and gold, which are so essential to our needs and civilization, are among some of the rarest elements in the earth's crust. These are made available to us only by the processes of concentration in ore bodies. Some of the so-called *rare-earth* elements have been found to be much more plentiful than originally thought and are about as abundant as uranium, mercury, lead, or bismuth. The least abundant rare-earth or *lanthanide* element, thulium, is now believed to be more plentiful on earth than silver, cadmium, gold, or iodine, for example. Rubidium, the 16th most abundant element, is more plentiful than chlorine while its compounds are little known in chemistry and commerce.

It is now thought that at least 24 elements are essential to living matter. The four most abundant in the human body are hydrogen, oxygen, carbon, and nitrogen. The seven next most common, in order of abundance, are calcium, phosphorus, chlorine, potassium, sulfur, sodium, and magnesium. Iron, copper, zinc, silicon, iodine, cobalt, manganese, molybdenum, fluorine, tin, chromium, selenium, and vanadium are needed and play a role in living matter. Boron is also thought essential for some plants, and it is possible that aluminum, nickel, and germanium may turn out to be necessary.

Ninety-one elements occur naturally on earth. Minute traces of plutonium-244 have been discovered in rocks mined in Southern California. This discovery supports the theory that heavy elements were produced during creation of the solar system. While technetium and promethium have not yet been found naturally on earth, they have been found to be present in stars. Technetium has been identified in the spectra of certain "late" type stars, and promethium lines have been identified in the spectra of a faintly visible star HR465 in Andromeda. Promethium must have been made near the star's surface for no known isotope of this element has a half-life longer than 17.7 years.

It has been suggested that californium is present in certain stellar explosions known as supernovae; however, this has not been proved. At present no elements are found elsewhere in the universe that cannot be accounted for here on earth.

All atomic mass numbers from 1 to 238 are found naturally on earth except for masses 5 and 8. About 285 relatively stable and 67 naturally radioactive isotopes occur on earth totaling 352. In addition, the neutron, technetium, promethium, and the transuranic elements (lying beyond uranium) have now been produced artificially. In June 1999, scientists at the Lawrence Berkeley National Laboratory reported that they had found evidence of an isotope of Element 118 and its immediate decay

products of Elements 116, 114, and 112. This sequence of events tended to reinforce the theory that was predicted since the 1970s that an “island of stability” existed for nuclei with approximately 114 protons and 184 neutrons. This “island” refers to nuclei in which the decay lasts for a period of time instead of a decay that occurs instantaneously. However, on July 27, 2001, researchers at LBNL reported that their laboratory and the facilities at the GSI Laboratory in Germany and at Japanese laboratories failed to confirm the results of their earlier experiments where the fusion of a krypton atom with a lead target resulted in Element 118, with chains of decay leading to Elements 116, 114, and 112, and on down to Element 106. Therefore, the discovery was reported to be spurious. However, with the announcement it was said that different experiments at the Livermore Laboratory and Joint Institute for Nuclear Research in Dubna, Russia indicated that Element 116 had since been created directly. (See also under Elements 116 and 118.)

Laboratory processes have now extended the radioactive element mass numbers beyond 238 to about 280. Each element from atomic numbers 1 to 110 is known to have at least one radioactive isotope. As of December 2001, about 3286 isotopes and isomers were thought to be known and recognized. Many stable and radioactive isotopes are now produced and distributed by the Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A., to customers licensed by the U.S. Department of Energy.

The nucleus of an atom is characterized by the number of protons it contains, denoted by  $Z$ , and by the number of neutrons,  $N$ . Isotopes of an element have the same value of  $Z$ , but different values of  $N$ . The *mass number*  $A$ , is the sum of  $Z$  and  $N$ . For example, Uranium-238 has a mass number of 238, and contains 92 protons and 146 neutrons.

There is evidence that the definition of chemical elements must be broadened to include the electron. Several compounds known as *electrides* have recently been made of alkaline metal elements and electrons. A relatively stable combination of a positron and electron, known as *positronium*, has also been studied.

The well-known proton, neutron, and electron are now thought to be members of a group that includes other fundamental particles that have been discovered or hypothesized by physicists. These very elemental particles, of which all matter is made, are now thought to belong to one of two families: namely, **quarks** or **leptons**. Each of these two families consists of six particles. Also, there are four different force carriers that lead to interactions between particles. The six members or “flavors” of the quark family are called **up**, **charm**, **top**, **down**, **strange**, and **bottom**. The force carriers for the quarks are the **gluon** and the **photon**. The six members of the lepton family are the **e neutrino**, the **mu neutrino**, the **tau neutrino**, the **electron**, the **muon particle**, and the **tau particle**. The force carriers for these are the **w boson** and the **z boson**. Furthermore, it appears that each of these particles has an anti-particle that has an opposite electrical charge from the above particles.

Quarks are not found individually, but are found with other quarks arranged to form composites known as **hadrons**. There are two basic types of hadrons: **baryons**, composed of three quarks, and **mesons**, composed of a quark and an anti-quark. Examples of baryons are the neutron and the proton. Neutrons are made of two down quarks and one up quark. Protons are made of two up quarks and one down quark. An example of the meson is the **pion**. This particle is made of an up quark and a down anti-quark. Such particles are unstable and tend to decay rapidly. The anti-particle of the proton is the anti-proton. The exception to the rule is the electron, whose anti-particle is the **positron**.

In recent years a search has been made for a hypothetical particle known as the **Higgs particle** or **Higgs boson**, suggested in 1966 by Peter Higgs of the University of Edinburgh, which could possibly explain why the carriers of the “electro-weak” field ( $w$  and  $z$  bosons) have mass. The Higgs particle is thought to be responsible possibly for the mass of objects throughout the universe.

Many physicists now hold that all matter and energy in the universe are controlled by four fundamental forces: the **electromagnetic force**, **gravity**, a **weak nuclear force**, and a **strong nuclear force**. The **gluon** binds quarks together by carrying the strong nuclear force. Each of these natural forces is passed back and forth among the basic particles of matter by the force carriers mentioned above. The electromagnetic force is carried by the photon, the weak nuclear force by the **intermediate vector boson**, and the gravity by the **graviton**.

For more complete information on these fundamental particles, please consult recent articles and books on nuclear or particle physics.

The available evidence leads to the conclusion that elements 89 (actinium) through 103 (lawrencium) are chemically similar to the rare-earth or lanthanide elements (elements 57 to 71, inclusive). These elements therefore have been named *actinides* after the first member of this series. Those elements beyond uranium that have been produced artificially have the following names and symbols: neptunium, 93 (Np); plutonium, 94 (Pu); americium, 95 (Am); curium, 96 (Cm); berkelium, 97 (Bk); californium, 98 (Cf); einsteinium, 99 (Es); fermium, 100 (Fm); mendelevium, 101 (Md); nobelium, 102 (No); lawrencium, 103 (Lr); rutherfordium, 104 (Rf); dubnium, 105 (Db); seaborgium, 106 (Sg); bohrium, 107 (Bh); hassium, 108 (Hs); meitnerium, 109 (Mt); darmstadtium, 110 (Ds); and roentgenium, 111 (Rg). As of 2005, evidence has been reported for elements 112, 113, 114, 115, 116, and 118, but these elements have not been officially recognized or named. IUPAC recommends that until the existence of a new element is proven to their satisfaction, the elements are to have names and symbols derived according to these precise and simple rules: The name is based on the digits in the element’s atomic number. Each digit is replaced with these expressions, with the end using the usual -ium suffix as follows: **0 nil**, **1 un**, **2 bi**, **3 tri**, **4 quad**, **5 pent**, **6 hex**, **7 sept**, **8 oct**, **9 enn**. Double letter i’s are not used, as for example Ununbium, but would be Ununbium. The symbol used would be the first letter of the three main syllables. For example, Element 126 would be Unbihexium, with the symbol Ubh. (See J. Chatt, *Pure Appl. Chem.* 51, 381, 1979; W. H. Koppenol, *Pure Appl. Chem.* 74, 787, 2002.)

There are many claims in the literature of the existence of various allotropic modifications of the elements, some of which are based on doubtful or incomplete evidence. Also, the physical properties of an element may change drastically by the presence of small amounts of impurities. With new methods of purification, which are now able to produce elements with 99.9999% purity, it has been necessary to restudy the properties of the elements. For example, the melting point of thorium changes by several hundred degrees by the presence of a small percentage of ThO<sub>2</sub> as an impurity. Ordinary commercial tungsten is brittle and can be worked only with difficulty. Pure tungsten, however, can be cut with a hacksaw, forged, spun, drawn, or extruded. In general, the value of a physical property given here applies to the pure element, when it is known.

Many of the chemical elements and their compounds are toxic and should be handled with due respect and care. In recent years there has been greatly increased knowledge and awareness of the health hazards associated with chemicals, radioactive materials,



and other agents. Anyone working with the elements and certain of their compounds should become thoroughly familiar with the proper safeguards to be taken. Information on specific hazards and recommended exposure limits may also be found in Section 16. Reference should also be made to publications such as the following:

1. *Code of Federal Regulations, Title 29, Labor*. With additions found in issues of the *Federal Register*.
2. *Code of Federal Regulations, Title 10, Energy*. With additions found in issues of the *Federal Register*. (Published by the U.S. Government Printing Office. Supt. of Documents.)
3. *Occupational Safety and Health Reporter* (latest edition with amendments and corrections), Bureau of National Affairs, Washington, D.C.
4. *Atomic Energy Law Reporter*, Commerce Clearing House, Chicago, IL.
5. *Nuclear Regulation Reporter*, Commerce Clearing House, Chicago, IL.
6. *TLVs® Threshold Limit Values for Chemical Substances and Physical Agents* is issued annually by the American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
7. *The Sigma Aldrich Library of Regulatory and Safety Data*. Vol. 3, Robert E. Lenga and Kristine L. Volonpal, Sigma Chemical Co. and Aldrich Chemical Co., Inc. 1993.
8. *Hazardous Chemicals Desk Reference*, Richard J. Lewis, Sr., 4th ed., John Wiley & Sons, New York, 1997.
9. *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens*, 3rd ed., Noyes Publications, 2001/2.
10. *Sax's Dangerous Properties of Industrial Materials*, Richard J. Lewis and N. Irving Sax, John Wiley & Sons, New York, 1999.
11. *World Wide Limits for Toxic and Hazardous Chemicals in Air, Water, and Soil*, Marshall Sittig, Noyes Publishers.

The prices of elements as indicated in this article are intended to be only a rough guide. Prices may vary, over time, widely with supplier, quantity, and purity.

The density of gases is given in grams per liter at 0°C and a pressure of 1 atm.

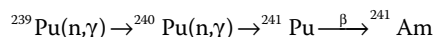
**Actinium** — (Gr. *aktis*, *aktinos*, beam or ray), Ac; at. wt. (227); at. no. 89; m.p. 1050°C, b.p. 3198°C; sp. gr. 10.07 (calc.). Discovered by Andre Debierne in 1899 and independently by F. Giesel in 1902. Occurs naturally in association with uranium minerals. Thirty-four isotopes and isomers are now recognized. All are radioactive. Actinium-227, a decay product of uranium-235, is an alpha and beta emitter with a 21.77-year half-life. Its principal decay products are thorium-227 (18.72-day half-life), radium-223 (11.4-day half-life), and a number of short-lived products including radon, bismuth, polonium, and lead isotopes. In equilibrium with its decay products, it is a powerful source of alpha rays. Actinium metal has been prepared by the reduction of actinium fluoride with lithium vapor at about 1100 to 1300°C. The chemical behavior of actinium is similar to that of the rare earths, particularly lanthanum. Purified actinium comes into equilibrium with its decay products at the end of 185 days, and then decays according to its 21.77-year half-life. It is about 150 times as active as radium, making it of value in the production of neutrons. Actinium-225, with a purity of 99%, is available from the Oak Ridge National

Laboratory to holders of a permit for about \$500/millicurie, plus packing charges.

**Aluminum** — (L. *alumen*, *alum*), Al; at. wt. 26.9815386(8); at. no. 13; m.p. 660.32°C; b.p. 2519°C; sp. gr. 2.6989 (20°C); valence 3. The ancient Greeks and Romans used *alum* in medicine as an astringent, and as a mordant in dyeing. In 1761 de Morveau proposed the name *alumine* for the base in alum, and Lavoisier, in 1787, thought this to be the oxide of a still undiscovered metal. Wohler is generally credited with having isolated the metal in 1827, although an impure form was prepared by Oersted two years earlier. In 1807, Davy proposed the name *aluminium* for the metal, undiscovered at that time, and later agreed to change it to *aluminum*. Shortly thereafter, the name *aluminium* was adopted to conform with the "ium" ending of most elements, and this spelling is now in use elsewhere in the world. *Aluminium* was also the accepted spelling in the U.S. until 1925, at which time the American Chemical Society officially decided to use the name *aluminum* thereafter in their publications. The method of obtaining aluminum metal by the electrolysis of alumina dissolved in *cryolite* was discovered in 1886 by Hall in the U.S. and at about the same time by Heroult in France. *Cryolite*, a natural ore found in Greenland, is no longer widely used in commercial production, but has been replaced by an artificial mixture of sodium, aluminum, and calcium fluorides. *Bauxite*, an impure hydrated oxide ore, is found in large deposits in Jamaica, Australia, Suriname, Guyana, Russia, Arkansas, and elsewhere. The Bayer process is most commonly used today to refine bauxite so it can be accommodated in the Hall-Heroult refining process used to make most aluminum. Aluminum can now be produced from clay, but the process is not economically feasible at present. Aluminum is the most abundant metal to be found in the Earth's crust (8.1%), but is never found free in nature. In addition to the minerals mentioned above, it is found in feldspars, granite, and in many other common minerals. Twenty-two isotopes and isomers are known. Natural aluminum is made of one isotope, <sup>27</sup>Al. Pure aluminum, a silvery-white metal, possesses many desirable characteristics. It is light, nontoxic, has a pleasing appearance, can easily be formed, machined, or cast, has a high thermal conductivity, and has excellent corrosion resistance. It is nonmagnetic and nonsparking, stands second among metals in the scale of malleability, and sixth in ductility. It is extensively used for kitchen utensils, outside building decoration, and in thousands of industrial applications where a strong, light, easily constructed material is needed. Although its electrical conductivity is only about 60% that of copper, it is used in electrical transmission lines because of its light weight. Pure aluminum is soft and lacks strength, but it can be alloyed with small amounts of copper, magnesium, silicon, manganese, and other elements to impart a variety of useful properties. These alloys are of vital importance in the construction of modern aircraft and rockets. Aluminum, evaporated in a vacuum, forms a highly reflective coating for both visible light and radiant heat. These coatings soon form a thin layer of the protective oxide and do not deteriorate as do silver coatings. They have found application in coatings for telescope mirrors, in making decorative paper, packages, toys, and in many other uses. The compounds of greatest importance are aluminum oxide, the sulfate, and the soluble sulfate with potassium (alum). The oxide, alumina, occurs naturally as ruby, sapphire, corundum, and emery, and is used in glassmaking and refractories. Synthetic ruby and sapphire have found application in the construction of lasers

for producing coherent light. In 1852, the price of aluminum was about \$1200/kg, and just before Hall's discovery in 1886, about \$25/kg. The price rapidly dropped to 60¢ and has been as low as 33¢/kg. The price in December 2001 was about 64¢/lb or \$1.40/kg.

**Americium** — (the Americas), Am; at. wt. 243; at. no. 95; m.p. 1176°C; b.p. 2011°C; sp. gr. 12; valence 2, 3, 4, 5, or 6. Americium was the fourth transuranium element to be discovered; the isotope  $^{241}\text{Am}$  was identified by Seaborg, James, Morgan, and Ghiorso late in 1944 at the wartime Metallurgical Laboratory of the University of Chicago as the result of successive neutron capture reactions by plutonium isotopes in a nuclear reactor:



Since the isotope  $^{241}\text{Am}$  can be prepared in relatively pure form by extraction as a decay product over a period of years from strongly neutron-bombarded plutonium,  $^{241}\text{Pu}$ , this isotope is used for much of the chemical investigation of this element. Better suited is the isotope  $^{243}\text{Am}$  due to its longer half-life ( $7.37 \times 10^3$  years as compared to 432.2 years for  $^{241}\text{Am}$ ). A mixture of the isotopes  $^{241}\text{Am}$ ,  $^{242}\text{Am}$ , and  $^{243}\text{Am}$  can be prepared by intense neutron irradiation of  $^{241}\text{Am}$  according to the reactions  $^{241}\text{Am}(n,\gamma) \rightarrow ^{242}\text{Am}(n,\gamma) \rightarrow ^{243}\text{Am}$ . Nearly isotopically pure,  $^{243}\text{Am}$  can be prepared by a sequence of neutron bombardments and chemical separations as follows: neutron bombardment of  $^{241}\text{Am}$  yields  $^{242}\text{Pu}$  by the reactions  $^{241}\text{Am}(n,\gamma) \rightarrow ^{242}\text{Am} \rightarrow ^{242}\text{Pu}$ , after chemical separation the  $^{242}\text{Pu}$  can be transformed to  $^{243}\text{Am}$  via the reactions  $^{242}\text{Pu}(n,\gamma) \rightarrow ^{243}\text{Pu} \rightarrow ^{243}\text{Am}$ , and the  $^{243}\text{Am}$  can be chemically separated. Fairly pure  $^{242}\text{Pu}$  can be prepared more simply by very intense neutron irradiation of  $^{239}\text{Pu}$  as the result of successive neutron-capture reactions. Seventeen radioactive isotopes and isomers are now recognized. Americium metal has been prepared by reducing the trifluoride with barium vapor at 1000 to 1200°C or the dioxide by lanthanum metal. The luster of freshly prepared americium metal is white and more silvery than plutonium or neptunium prepared in the same manner. It appears to be more malleable than uranium or neptunium and tarnishes slowly in dry air at room temperature. Americium is thought to exist in two forms: an alpha form which has a double hexagonal close-packed structure and a loose-packed cubic beta form. Americium must be handled with great care to avoid personal contamination. As little as 0.03  $\mu\text{Ci}$  of  $^{241}\text{Am}$  is the maximum permissible total body burden. The alpha activity from  $^{241}\text{Am}$  is about three times that of radium. When gram quantities of  $^{241}\text{Am}$  are handled, the intense gamma activity makes exposure a serious problem. Americium dioxide,  $\text{AmO}_2$ , is the most important oxide.  $\text{AmF}_3$ ,  $\text{AmF}_4$ ,  $\text{AmCl}_3$ ,  $\text{AmBr}_3$ ,  $\text{AmI}_3$ , and other compounds have been prepared. The isotope  $^{241}\text{Am}$  has been used as a portable source for gamma radiography. It has also been used as a radioactive glass thickness gage for the flat glass industry, and as a source of ionization for smoke detectors. Americium-243 (99%) is available from the Oak Ridge National Laboratory at a cost of about \$750/g plus packing charges.

**Antimony** — (Gr. *anti* plus *monos* - a metal not found alone), Sb; at. wt. 121.760(1); at. no. 51; m.p. 630.63°C; b.p. 1587°C; sp. gr. 6.68 (20°C); valence 0, -3, +3, or +5. Antimony was recognized in compounds by the ancients and was known as a metal at the beginning of the 17th century and possibly much earlier.

It is not abundant, but is found in over 100 mineral species. It is sometimes found native, but more frequently as the sulfide, *stibnite* ( $\text{Sb}_2\text{S}_3$ ); it is also found as antimonides of the heavy metals, and as oxides. It is extracted from the sulfide by roasting to the oxide, which is reduced by salt and scrap iron; from its oxides it is also prepared by reduction with carbon. Two allotropic forms of antimony exist: the normal stable, metallic form, and the amorphous gray form. The so-called explosive antimony is an ill-defined material always containing an appreciable amount of halogen; therefore, it no longer warrants consideration as a separate allotrope. The yellow form, obtained by oxidation of *stibine*,  $\text{SbH}_3$ , is probably impure, and is not a distinct form. Natural antimony is made of two stable isotopes,  $^{121}\text{Sb}$  and  $^{123}\text{Sb}$ . Forty-five other radioactive isotopes and isomers are now recognized. Metallic antimony is an extremely brittle metal of a flaky, crystalline texture. It is bluish white and has a metallic luster. It is not acted on by air at room temperature, but burns brilliantly when heated with the formation of white fumes of  $\text{Sb}_2\text{O}_3$ . It is a poor conductor of heat and electricity, and has a hardness of 3 to 3.5. Antimony, available commercially with a purity of 99.999 + %, is finding use in semiconductor technology for making infrared detectors, diodes, and Hall-effect devices. Commercial-grade antimony is widely used in alloys with percentages ranging from 1 to 20. It greatly increases the hardness and mechanical strength of lead. Batteries, antifriction alloys, type metal, small arms and tracer bullets, cable sheathing, and minor products use about half the metal produced. Compounds taking up the other half are oxides, sulfides, sodium antimonate, and antimony trichloride. These are used in manufacturing flame-proofing compounds, paints, ceramic enamels, glass, and pottery. Tartar emetic (hydrated potassium antimonyl tartrate) has been used in medicine. Antimony and many of its compounds are toxic. Antimony costs about \$1.30/kg for the commercial metal or about \$12/g (99.999%).

**Argon** — (Gr. *argos*, inactive), Ar; at. wt. 39.948(1); at. no. 18; m.p. -189.36°C; b.p. -185.85°C;  $t_c$  -122.28°C; density 1.7837 g/L. Its presence in air was suspected by Cavendish in 1785, discovered by Lord Rayleigh and Sir William Ramsay in 1894. The gas is prepared by fractionation of liquid air, the atmosphere containing 0.94% argon. The atmosphere of Mars contains 1.6% of  $^{40}\text{Ar}$  and 5 p.p.m. of  $^{36}\text{Ar}$ . Argon is two and one half times as soluble in water as nitrogen, having about the same solubility as oxygen. It is recognized by the characteristic lines in the red end of the spectrum. It is used in electric light bulbs and in fluorescent tubes at a pressure of about 400 Pa, and in filling photo tubes, glow tubes, etc. Argon is also used as an inert gas shield for arc welding and cutting, as a blanket for the production of titanium and other reactive elements, and as a protective atmosphere for growing silicon and germanium crystals. Argon is colorless and odorless, both as a gas and liquid. It is available in high-purity form. Commercial argon is available at a cost of about 3¢ per cubic foot. Argon is considered to be a very inert gas and is not known to form true chemical compounds, as do krypton, xenon, and radon. However, it does form a hydrate having a dissociation pressure of 105 atm at 0°C. Ion molecules such as  $(\text{ArKr})^+$ ,  $(\text{ArXe})^+$ ,  $(\text{NeAr})^+$  have been observed spectroscopically. Argon also forms a clathrate with  $\beta$ -hydroquinone. This clathrate is stable and can be stored for a considerable time, but a true chemical bond does not exist. Van der Waals' forces act to hold the argon. In August 2000, researchers at the University of Helsinki, Finland reported they made a new argon compound HArF

by shining UV light on frozen argon that contained a small amount of HE. Naturally occurring argon is a mixture of three isotopes. Seventeen other radioactive isotopes are now known to exist. Commercial argon is priced at about \$70/300 cu. ft. or 8.5 cu. meters.

**Arsenic** — (L. *arsenicum*, Gr. *arsenikon*, yellow orpiment, identified with *arsenikos*, male, from the belief that metals were different sexes; Arabic, *Az-zernikh*, the orpiment from Persian *zerni-zar*, gold), As; at. wt. 74.92160(2); at. no. 33; valence -3, 0, +3 or +5. Elemental arsenic occurs in two solid modifications: yellow, and gray or metallic, with specific gravities of 1.97, and 5.75, respectively. Gray arsenic, the ordinary stable form, has a triple point of 817°C and sublimates at 616°C and has a critical temperature of 1400°C. Several other allotropic forms of arsenic are reported in the literature. It is believed that Albertus Magnus obtained the element in 1250 A.D. In 1649 Schroeder published two methods of preparing the element. It is found native, in the sulfides *realgar* and *orpiment*, as arsenides and sulfarsenides of heavy metals, as the oxide, and as arsenates. *Mispickel*, arsenopyrite, (FeSAs) is the most common mineral, from which on heating the arsenic sublimates leaving ferrous sulfide. The element is a steel gray, very brittle, crystalline, semimetallic solid; it tarnishes in air, and when heated is rapidly oxidized to arsenous oxide (As<sub>2</sub>O<sub>3</sub>) with the odor of garlic. Arsenic and its compounds are poisonous. Exposure to arsenic and its compounds should not exceed 0.01 mg/m<sup>3</sup> as elemental As during an 8-h work day. Arsenic is also used in bronzing, pyrotechny, and for hardening and improving the sphericity of shot. The most important compounds are white arsenic (As<sub>2</sub>O<sub>3</sub>), the sulfide, Paris green 3Cu(AsO<sub>2</sub>)<sub>2</sub>·Cu(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>, calcium arsenate, and lead arsenate; the last three have been used as agricultural insecticides and poisons. Marsh's test makes use of the formation and ready decomposition of arsine (AsH<sub>3</sub>). Arsenic is available in high-purity form. It is finding increasing uses as a doping agent in solid-state devices such as transistors. Gallium arsenide is used as a laser material to convert electricity directly into coherent light. Natural arsenic is made of one isotope <sup>75</sup>As. Thirty other radioactive isotopes and isomers are known. Arsenic (99%) costs about \$75/50g. Purified arsenic (99.9995%) costs about \$50/g.

**Astatine** — (Gr. *astatos*, unstable), At; at. wt. (210); at. no. 85; m.p. 302°C; valence probably 1, 3, 5, or 7. Synthesized in 1940 by D. R. Corson, K. R. MacKenzie, and E. Segre at the University of California by bombarding bismuth with alpha particles. The longest-lived isotope, <sup>210</sup>At, has a half-life of only 8.1 hours. Thirty-six other isotopes and isomers are now known. Minute quantities of <sup>215</sup>At, <sup>218</sup>At, and <sup>219</sup>At exist in equilibrium in nature with naturally occurring uranium and thorium isotopes, and traces of <sup>217</sup>At are in equilibrium with <sup>233</sup>U and <sup>239</sup>Np resulting from interaction of thorium and uranium with naturally produced neutrons. The total amount of astatine present in the Earth's crust, however, is probably less than 1 oz. Astatine can be produced by bombarding bismuth with energetic alpha particles to obtain the relatively long-lived <sup>209-211</sup>At, which can be distilled from the target by heating it in air. Only about 0.05 µg of astatine has been prepared to date. The "time of flight" mass spectrometer has been used to confirm that this highly radioactive halogen behaves chemically very much like other halogens, particularly iodine. The interhalogen compounds AtI, AtBr, and AtCl are known to form, but it is not yet known if astatine forms diatomic astatine mol-

ecules. HAt and CH<sub>3</sub>At (methyl astatide) have been detected. Astatine is said to be more metallic than iodine, and, like iodine, it probably accumulates in the thyroid gland.

**Barium** — (Gr. *barys*, heavy), Ba; at. wt. 137.327(7), at. no. 56; m.p. 727°C; b.p. 1897°C; sp. gr. 3.62 (20°C); valence 2. Baryta was distinguished from lime by Scheele in 1774; the element was discovered by Sir Humphrey Davy in 1808. It is found only in combination with other elements, chiefly in *barite* or *heavy spar* (sulfate) and *witherite* (carbonate) and is prepared by electrolysis of the chloride. Large deposits of barite are found in China, Germany, India, Morocco, and in the U.S. Barium is a metallic element, soft, and when pure is silvery white like lead; it belongs to the alkaline earth group, resembling calcium chemically. The metal oxidizes very easily and should be kept under petroleum or other suitable oxygen-free liquids to exclude air. It is decomposed by water or alcohol. The metal is used as a "getter" in vacuum tubes. The most important compounds are the peroxide (BaO<sub>2</sub>), chloride, sulfate, carbonate, nitrate, and chlorate. Lithopone, a pigment containing barium sulfate and zinc sulfide, has good covering power, and does not darken in the presence of sulfides. The sulfate, as permanent white or *blanc fixe*, is also used in paint, in X-ray diagnostic work, and in glassmaking. *Barite* is extensively used as a weighting agent in oilwell drilling fluids, and also in making rubber. The carbonate has been used as a rat poison, while the nitrate and chlorate give green colors in pyrotechny. The impure sulfide phosphoresces after exposure to the light. The compounds and the metal are not expensive. Barium metal (99.2 + % pure) costs about \$3/g. All barium compounds that are water or acid soluble are poisonous. Naturally occurring barium is a mixture of seven stable isotopes. Thirty-six other radioactive isotopes and isomers are known to exist.

**Berkelium** — (*Berkeley*, home of the University of California), Bk; at. wt. (247); at. no. 97; m.p. 996°C; valence 3 or 4; sp. gr. 14 (est.). Berkelium, the eighth member of the actinide transition series, was discovered in December 1949 by Thompson, Ghiorso, and Seaborg, and was the fifth transuranium element synthesized. It was produced by cyclotron bombardment of milligram amounts of <sup>241</sup>Am with helium ions at Berkeley, California. The first isotope produced had a mass number of 243 and decayed with a half-life of 4.5 hours. Thirteen isotopes are now known and have been synthesized. The existence of <sup>249</sup>Bk, with a half-life of 320 days, makes it feasible to isolate berkelium in weighable amounts so that its properties can be investigated with macroscopic quantities. One of the first visible amounts of a pure berkelium compound, berkelium chloride, was produced in 1962. It weighed 3 billionth of a gram. Berkelium probably has not yet been prepared in elemental form, but it is expected to be a silvery metal, easily soluble in dilute mineral acids, and readily oxidized by air or oxygen at elevated temperatures to form the oxide. X-ray diffraction methods have been used to identify the following compounds: BkO<sub>2</sub>, BkO<sub>3</sub>, BkF<sub>3</sub>, BkCl, and BkOCl. As with other actinide elements, berkelium tends to accumulate in the skeletal system. The maximum permissible body burden of <sup>249</sup>Bk in the human skeleton is about 0.0004 µg. Because of its rarity, berkelium presently has no commercial or technological use. Berkelium most likely resembles terbium with respect to chemical properties. Berkelium-249 is available from O.R.N.L. at a cost of \$185/µg plus packing charges.



**Beryllium** — (Gr. *beryllos*, *beryl*; also called Glucinium or Glucinum, Gr. *glykys*, sweet), Be; at. wt. 9.012182(3); at. no. 4; m.p. 1287°C; b.p. 2471°C; sp. gr. 1.848 (20°C); valence 2. Discovered as the oxide by Vauquelin in beryl and in emeralds in 1798. The metal was isolated in 1828 by Wohler and by Bussy independently by the action of potassium on beryllium chloride. Beryllium is found in some 30 mineral species, the most important of which are *bertrandite*, *beryl*, *chrysoberyl*, and *phenacite*. *Aquamarine* and *emerald* are precious forms of *beryl*. Beryllium minerals are found in the U.S., Brazil, Russia, Kazakhstan, and elsewhere. Colombia is known for its emeralds. *Beryl* ( $3\text{BeO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$ ) and *bertrandite* ( $4\text{BeO} \cdot 2\text{SiO}_2 \cdot \text{H}_2\text{O}$ ) are the most important commercial sources of the element and its compounds. Most of the metal is now prepared by reducing beryllium fluoride with magnesium metal. Beryllium metal did not become readily available to industry until 1957. The metal, steel gray in color, has many desirable properties. It is one of the lightest of all metals, and has one of the highest melting points of the light metals. Its modulus of elasticity is about one third greater than that of steel. It resists attack by concentrated nitric acid, has excellent thermal conductivity, and is nonmagnetic. It has a high permeability to X-rays, and when bombarded by alpha particles, as from radium or polonium, neutrons are produced in the ratio of about 30 neutrons/million alpha particles. At ordinary temperatures beryllium resists oxidation in air, although its ability to scratch glass is probably due to the formation of a thin layer of the oxide. Beryllium is used as an alloying agent in producing beryllium copper, which is extensively used for springs, electrical contacts, spot-welding electrodes, and nonsparking tools. It has found application as a structural material for high-speed aircraft, missiles, spacecraft, and communication satellites. It is being used in the windshield frame, brake discs, support beams, and other structural components of the space shuttle. Because beryllium is relatively transparent to X-rays, ultra-thin Be-foil is finding use in X-ray lithography for reproduction of microminiature integrated circuits. Natural beryllium is made of  $^9\text{Be}$  and is stable. Eight other radioactive isotopes are known.

Beryllium is used in nuclear reactors as a reflector or moderator for it has a low thermal neutron absorption cross section. It is used in gyroscopes, computer parts, and instruments where lightness, stiffness, and dimensional stability are required. The oxide has a very high melting point and is also used in nuclear work and ceramic applications. Beryllium and its salts are toxic and should be handled with the greatest of care. Beryllium and its compounds should not be tasted to verify the sweetish nature of beryllium (as did early experimenters). The metal, its alloys, and its salts can be handled safely if certain work codes are observed, but no attempt should be made to work with beryllium before becoming familiar with proper safeguards. Beryllium metal is available at a cost of about \$5/g (99.5% pure).

**Bismuth** — (Ger. *Weisse Masse*, white mass; later *Wisuth* and *Bisemutum*), Bi; at. wt. 208.98040(1); at. no. 83; m.p. 271.4°C; b.p. 1564°C; sp. gr. 9.79 (20°C); valence 3 or 5. In early times bismuth was confused with tin and lead. Claude Geoffroy the Younger showed it to be distinct from lead in 1753. It is a white crystalline, brittle metal with a pinkish tinge. It occurs native. The most important ores are *bismuthinite* or bismuth glance ( $\text{Bi}_2\text{S}_3$ ) and *bismite* ( $\text{Bi}_2\text{O}_3$ ). Peru, Japan, Mexico, Bolivia, and Canada are major bismuth producers. Much of the bismuth produced in the U.S. is obtained as a by-product in refining

lead, copper, tin, silver, and gold ores. Bismuth is the most diamagnetic of all metals, and the thermal conductivity is lower than any metal, except mercury. It has a high electrical resistance, and has the highest Hall effect of any metal (i.e., greatest increase in electrical resistance when placed in a magnetic field). "Bismanol" is a permanent magnet of high coercive force, made of MnBi, by the U.S. Naval Surface Weapons Center. Bismuth expands 3.32% on solidification. This property makes bismuth alloys particularly suited to the making of sharp castings of objects subject to damage by high temperatures. With other metals such as tin, cadmium, etc., bismuth forms low-melting alloys that are extensively used for safety devices in fire detection and extinguishing systems. Bismuth is used in producing malleable irons and is finding use as a catalyst for making acrylic fibers. When bismuth is heated in air it burns with a blue flame, forming yellow fumes of the oxide. The metal is also used as a thermocouple material, and has found application as a carrier for  $\text{U}^{235}$  or  $\text{U}^{233}$  fuel in atomic reactors. Its soluble salts are characterized by forming insoluble basic salts on the addition of water, a property sometimes used in detection work. Bismuth oxychloride is used extensively in cosmetics. Bismuth subnitrate and subcarbonate are used in medicine. Natural bismuth contains only one isotope  $^{209}\text{Bi}$ . Forty-four isotopes and isomers of bismuth are known. Bismuth metal (99.5%) costs about \$250/kg.

**Bohrium** — (Named after Niels Bohr [1885–1962], Danish atomic and nuclear physicist.) Bh; at. wt. [264]. at. no. 107. Bohrium is expected to have chemical properties similar to rhenium. This element was synthesized and unambiguously identified in 1981 using the Universal Linear Accelerator (UNILAC) at the Gesellschaft für Schwerionenforschung (G.S.I.) in Darmstadt, Germany. The discovery team was led by Armbruster and Münzenberg. The reaction producing the element was proposed and applied earlier by a Dubna Group led by Oganessian in 1976. A target of  $^{209}\text{Bi}$  was bombarded by a beam of  $^{54}\text{Cr}$  ions. In 1983 experiments at Dubna using the 157-inch cyclotron, produced  $^{262}107$  by the reaction  $^{209}\text{Bi} + ^{54}\text{Cr}$ . The alpha decay of  $^{246}\text{Cf}$ , the sixth member in the decay chain of  $^{262}107$ , served to establish a 1-neutron reaction channel. The IUPAC adopted the name *Bohrium* with the symbol Bh for Element 107 in August 1997. Five isotopes of bohrium are now recognized. One isotope of bohrium appears to have a relatively long life of 15 seconds. Work on this relatively long-lived isotope has been performed with the 88-inch cyclotron at the Lawrence-Berkeley National Laboratory.

**Boron** — (Ar. *Buraq*, Pers. *Burah*), B; at. wt. 10.811(7); at. no. 5; m.p. 2075°C; b.p. 4000°C; sp. gr. of crystals 2.34, of amorphous variety 2.37; valence 3. Boron compounds have been known for thousands of years, but the element was not discovered until 1808 by Sir Humphry Davy and by Gay-Lussac and Thenard. The element is not found free in nature, but occurs as orthoboric acid usually in certain volcanic spring waters and as borates in *borax* and *colemanite*. *Ulexite*, another boron mineral, is interesting as it is nature's own version of "fiber optics." Important sources of boron are the ores *rasorite* (*kernite*) and *tincal* (*borax ore*). Both of these ores are found in the Mojave Desert. *Tincal* is the most important source of boron from the Mojave. Extensive *borax* deposits are also found in Turkey. Boron exists naturally as 19.9%  $^{10}\text{B}$  isotope and 80.1%  $^{11}\text{B}$  isotope. Ten other isotopes of boron are known. High-purity crystalline boron may be prepared by the vapor phase reduction of boron trichloride or tribromide with hydrogen on



electrically heated filaments. The impure, or amorphous, boron, a brownish-black powder, can be obtained by heating the trioxide with magnesium powder. Boron of 99.9999% purity has been produced and is available commercially. Elemental boron has an energy band gap of 1.50 to 1.56 eV, which is higher than that of either silicon or germanium. It has interesting optical characteristics, transmitting portions of the infrared, and is a poor conductor of electricity at room temperature, but a good conductor at high temperature. Amorphous boron is used in pyrotechnic flares to provide a distinctive green color, and in rockets as an igniter. By far the most commercially important boron compound in terms of dollar sales is  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$ . This pentahydrate is used in very large quantities in the manufacture of insulation fiberglass and sodium perborate bleach. Boric acid is also an important boron compound with major markets in textile fiberglass and in cellulose insulation as a flame retardant. Next in order of importance is borax ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ) which is used principally in laundry products. Use of borax as a mild antiseptic is minor in terms of dollars and tons. Boron compounds are also extensively used in the manufacture of borosilicate glasses. The isotope boron-10 is used as a control for nuclear reactors, as a shield for nuclear radiation, and in instruments used for detecting neutrons. Boron nitride has remarkable properties and can be used to make a material as hard as diamond. The nitride also behaves like an electrical insulator but conducts heat like a metal. It also has lubricating properties similar to graphite. The hydrides are easily oxidized with considerable energy liberation, and have been studied for use as rocket fuels. Demand is increasing for boron filaments, a high-strength, lightweight material chiefly employed for advanced aerospace structures. Boron is similar to carbon in that it has a capacity to form stable covalently bonded molecular networks. Carboranes, metalloboranes, phosphacboranes, and other families comprise thousands of compounds. Crystalline boron (99.5%) costs about \$6/g. Amorphous boron (94–96%) costs about \$1.50/g. Elemental boron and the borates are not considered to be toxic, and they do not require special care in handling. However, some of the more exotic boron hydrogen compounds are definitely toxic and do require care.

**Bromine** — (Gr. *bromos*, stench), Br; at. wt. 79.904(1); at. no. 35; m.p.  $-7.2^\circ\text{C}$ ; b.p.  $58.8^\circ\text{C}$ ;  $t_c$   $315^\circ\text{C}$ ; density of gas 7.59 g/l, liquid 3.12 ( $20^\circ\text{C}$ ); valence 1, 3, 5, or 7. Discovered by Balard in 1826, but not prepared in quantity until 1860. A member of the halogen group of elements, it is obtained from natural brines from wells in Michigan and Arkansas. Little bromine is extracted today from seawater, which contains only about 85 ppm. Bromine is the only liquid nonmetallic element. It is a heavy, mobile, reddish-brown liquid, volatilizing readily at room temperature to a red vapor with a strong disagreeable odor, resembling chlorine, and having a very irritating effect on the eyes and throat; it is readily soluble in water or carbon disulfide, forming a red solution, is less active than chlorine but more so than iodine; it unites readily with many elements and has a bleaching action; when spilled on the skin it produces painful sores. It presents a serious health hazard, and maximum safety precautions should be taken when handling it. Much of the bromine output in the U.S. was used in the production of ethylene dibromide, a lead scavenger used in making gasoline antiknock compounds. Lead in gasoline, however, has been drastically reduced, due to environmental considerations. This will greatly affect future production of bromine. Bromine is also used in making fumigants,

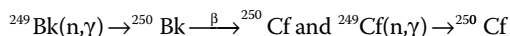
flameproofing agents, water purification compounds, dyes, medicinals, sanitizers, inorganic bromides for photography, etc. Organic bromides are also important. Natural bromine is made of two isotopes,  $^{79}\text{Br}$  and  $^{81}\text{Br}$ . Thirty-four isotopes and isomers are known. Bromine (99.8%) costs about \$70/kg.

**Cadmium** — (L. *cadmia*; Gr. *kadmeia* - ancient name for calamine, zinc carbonate), Cd; at. wt. 112.411(8); at. no. 48; m.p.  $321.07^\circ\text{C}$ ; b.p.  $767^\circ\text{C}$ ; sp. gr. 8.69 ( $20^\circ\text{C}$ ); valence 2. Discovered by Stromeyer in 1817 from an impurity in zinc carbonate. Cadmium most often occurs in small quantities associated with zinc ores, such as *sphalerite* ( $\text{ZnS}$ ). *Greenockite* ( $\text{CdS}$ ) is the only mineral of any consequence bearing cadmium. Almost all cadmium is obtained as a by-product in the treatment of zinc, copper, and lead ores. It is a soft, bluish-white metal which is easily cut with a knife. It is similar in many respects to zinc. It is a component of some of the lowest melting alloys; it is used in bearing alloys with low coefficients of friction and great resistance to fatigue; it is used extensively in electroplating, which accounts for about 60% of its use. It is also used in many types of solder, for standard E.M.F. cells, for Ni-Cd batteries, and as a barrier to control atomic fission. The market for Ni-Cd batteries is expected to grow significantly. Cadmium compounds are used in black and white television phosphors and in blue and green phosphors for color TV tubes. It forms a number of salts, of which the sulfate is most common; the sulfide is used as a yellow pigment. Cadmium and solutions of its compounds are toxic. Failure to appreciate the toxic properties of cadmium may cause workers to be unwittingly exposed to dangerous fumes. Some silver solders, for example, contain cadmium and should be handled with care. Serious toxicity problems have been found from long-term exposure and work with cadmium plating baths. Cadmium is present in certain phosphate rocks. This has raised concerns that the long-term use of certain phosphate fertilizers might pose a health hazard from levels of cadmium that might enter the food chain. In 1927 the International Conference on Weights and Measures redefined the meter in terms of the wavelength of the red cadmium spectral line (i.e.,  $1\text{ m} = 1,553,164.13$  wavelengths). This definition has been changed (see under Krypton). The current price of cadmium is about 50¢/g (99.5%). It is available in high purity form for about \$550/kg. Natural cadmium is made of eight isotopes. Thirty-four other isotopes and isomers are now known and recognized.

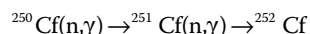
**Calcium** — (L. *calx*, lime), Ca; at. wt. 40.078(4); at. no. 20; m.p.  $842^\circ\text{C}$ ; b.p.  $1484^\circ\text{C}$ ; sp. gr. 1.54 ( $20^\circ\text{C}$ ); valence 2. Though lime was prepared by the Romans in the first century under the name *calx*, the metal was not discovered until 1808. After learning that Berzelius and Pontin prepared calcium amalgam by electrolyzing lime in mercury, Davy was able to isolate the impure metal. Calcium is a metallic element, fifth in abundance in the Earth's crust, of which it forms more than 3%. It is an essential constituent of leaves, bones, teeth, and shells. Never found in nature uncombined, it occurs abundantly as *limestone* ( $\text{CaCO}_3$ ), *gypsum* ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ), and *fluorite* ( $\text{CaF}_2$ ); *apatite* is the fluorophosphate or chlorophosphate of calcium. The metal has a silvery color, is rather hard, and is prepared by electrolysis of the fused chloride to which calcium fluoride is added to lower the melting point. Chemically it is one of the alkaline earth elements; it readily forms a white coating of oxide in air, reacts with water, burns with a yellow-red flame, largely forming the oxide. The metal is used as a reducing agent in preparing other metals such as thorium,

uranium, zirconium, etc., and is used as a deoxidizer, desulfurizer, and inclusion modifier for various ferrous and nonferrous alloys. It is also used as an alloying agent for aluminum, beryllium, copper, lead, and magnesium alloys, and serves as a "getter" for residual gases in vacuum tubes. Its natural and prepared compounds are widely used. Quicklime (CaO), made by heating limestone and changed into slaked lime by the careful addition of water, is the great cheap base of the chemical industry with countless uses. Mixed with sand it hardens as mortar and plaster by taking up carbon dioxide from the air. Calcium from limestone is an important element in Portland cement. The solubility of the carbonate in water containing carbon dioxide causes the formation of caves with stalactites and stalagmites and is responsible for hardness in water. Other important compounds are the carbide (CaC<sub>2</sub>), chloride (CaCl<sub>2</sub>), cyanamide (CaCN<sub>2</sub>), hypochlorite (Ca(OCl)<sub>2</sub>), nitrate (Ca(NO<sub>3</sub>)<sub>2</sub>), and sulfide (CaS). Calcium sulfide is phosphorescent after being exposed to light. Natural calcium contains six isotopes. Sixteen other radioactive isotopes are known. Metallic calcium (99.5%) costs about \$200/kg.

**Californium** — (State and University of California), Cf; at. wt. (251); m.p. 900°C; sp. gr. 15.1; at. no. 98. Californium, the sixth transuranium element to be discovered, was produced by Thompson, Street, Ghioirso, and Seaborg in 1950 by bombarding microgram quantities of <sup>242</sup>Cm with 35 MeV helium ions in the Berkeley 60-inch cyclotron. Californium (III) is the only ion stable in aqueous solutions, all attempts to reduce or oxidize californium (III) having failed. The isotope <sup>249</sup>Cf results from the beta decay of <sup>249</sup>Bk while the heavier isotopes are produced by intense neutron irradiation by the reactions:



followed by



The existence of the isotopes <sup>249</sup>Cf, <sup>250</sup>Cf, <sup>251</sup>Cf, and <sup>252</sup>Cf makes it feasible to isolate californium in weighable amounts so that its properties can be investigated with macroscopic quantities. Californium-252 is a very strong neutron emitter. One microgram releases 170 million neutrons per minute, which presents biological hazards. Proper safeguards should be used in handling californium. Twenty isotopes of californium are now recognized. <sup>249</sup>Cf and <sup>252</sup>Cf have half-lives of 351 years and 900 years, respectively. In 1960 a few tenths of a microgram of californium trichloride, CfCl<sub>3</sub>, californium oxychloride, CfOCl, and californium oxide, Cf<sub>2</sub>O<sub>3</sub>, were first prepared. Reduction of californium to its metallic state has not yet been accomplished. Because californium is a very efficient source of neutrons, many new uses are expected for it. It has already found use in neutron moisture gages and in well-logging (the determination of water and oil-bearing layers). It is also being used as a portable neutron source for discovery of metals such as gold or silver by on-the-spot activation analysis. <sup>252</sup>Cf is now being offered for sale by the Oak Ridge National Laboratory (O.R.N.L.) at a cost of \$60/μg and <sup>249</sup>Cf at a cost of \$185/μg plus packing charges. It has been suggested that californium may be produced in certain stellar explosions, called *supernovae*, for the radioactive decay of <sup>254</sup>Cf (55-day half-life) agrees with the characteristics of the light curves of such explosions observed through telescopes. This suggestion, however, is

questioned. Californium is expected to have chemical properties similar to dysprosium.

**Carbon** — (L. *carbo*, charcoal), C; at. wt. 12.0107(8); at. no. 6; sublimes at 3825°C; triple point (graphite-liquid-gas), 4489°C; sp. gr. amorphous 1.8 to 2.1, graphite 1.9 to 2.3, diamond 3.15 to 3.53 (depending on variety); gem diamond 3.513 (25°C); valence 2, 3, or 4. Carbon, an element of prehistoric discovery, is very widely distributed in nature. It is found in abundance in the sun, stars, comets, and atmospheres of most planets. Carbon in the form of microscopic diamonds is found in some meteorites. Natural diamonds are found in *kimberlite* or *lamproite* of ancient formations called "pipes," such as found in South Africa, Arkansas, and elsewhere. Diamonds are now also being recovered from the ocean floor off the Cape of Good Hope. About 30% of all industrial diamonds used in the U.S. are now made synthetically. The energy of the sun and stars can be attributed at least in part to the well-known carbon-nitrogen cycle. Carbon is found free in nature in three allotropic forms: amorphous, graphite, and diamond. Graphite is one of the softest known materials while diamond is one of the hardest. Graphite exists in two forms: alpha and beta. These have identical physical properties, except for their crystal structure. Naturally occurring graphites are reported to contain as much as 30% of the rhombohedral (beta) form, whereas synthetic materials contain only the alpha form. The hexagonal alpha type can be converted to the beta by mechanical treatment, and the beta form reverts to the alpha on heating it above 1000°C. Of recent interest is the discovery of all-carbon molecules, known as "buckyballs" or fullerenes, which have a number of unusual properties. These interesting molecules, consisting of 60 or 70 carbon atoms linked together, seem capable of withstanding great pressure and trapping foreign atoms inside their network of carbon. They are said to be capable of magnetism and superconductivity and have potential as a nonlinear optical material. Buckyball films are reported to remain superconductive at temperatures as high as 45 K. In combination, carbon is found as carbon dioxide in the atmosphere of the Earth and dissolved in all natural waters. It is a component of great rock masses in the form of carbonates of calcium (limestone), magnesium, and iron. Coal, petroleum, and natural gas are chiefly hydrocarbons. Carbon is unique among the elements in the vast number and variety of compounds it can form. With hydrogen, oxygen, nitrogen, and other elements, it forms a very large number of compounds, carbon atom often being linked to carbon atom. There are close to ten million known carbon compounds, many thousands of which are vital to organic and life processes. Without carbon, the basis for life would be impossible. While it has been thought that silicon might take the place of carbon in forming a host of similar compounds, it is now not possible to form stable compounds with very long chains of silicon atoms. The atmosphere of Mars contains 96.2% CO<sub>2</sub>. Some of the most important compounds of carbon are carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), carbon disulfide (CS<sub>2</sub>), chloroform (CHCl<sub>3</sub>), carbon tetrachloride (CCl<sub>4</sub>), methane (CH<sub>4</sub>), ethylene (C<sub>2</sub>H<sub>4</sub>), acetylene (C<sub>2</sub>H<sub>2</sub>), benzene (C<sub>6</sub>H<sub>6</sub>), ethyl alcohol (C<sub>2</sub>H<sub>5</sub>OH), acetic acid (CH<sub>3</sub>COOH), and their derivatives. Carbon has fifteen isotopes. Natural carbon consists of 98.89% <sup>12</sup>C and 1.11% <sup>13</sup>C. In 1961 the International Union of Pure and Applied Chemistry adopted the isotope carbon-12 as the basis for atomic weights. Carbon-14, an isotope with a half-life of 5715 years, has been widely used to date such materials as wood, archeological specimens, etc. A new brittle form of car-

bon, known as "glassy carbon," has been developed. It can be obtained with high purity. It has a high resistance to corrosion, has good thermal stability, and is structurally impermeable to both gases and liquids. It has a randomized structure, making it useful in ultra-high technology applications, such as crystal growing, crucibles for high-temperature use, etc. Glassy carbon is available at a cost of about \$35/10g. Fullerene powder is available at a cost of about \$55/10mg (99% $C_{10}$ ). Diamond powder (99.9%) costs about \$40/g.

**Cerium** — (named for the asteroid *Ceres*, which was discovered in 1801 only 2 years before the element), Ce; at. wt. 140.116(1); at. no. 58; m.p. 799°C; b.p. 3443°C; sp. gr. 6.770 (25°C); valence 3 or 4. Discovered in 1803 by Klaproth and by Berzelius and Hisinger; metal prepared by Hillebrand and Norton in 1875. Cerium is the most abundant of the metals of the so-called rare earths. It is found in a number of minerals including *allanite* (also known as *orthite*), *monazite*, *bastnasite*, *cerite*, and *samaraskite*. Monazite and bastnasite are presently the two most important sources of cerium. Large deposits of monazite found on the beaches of Travancore, India, in river sands in Brazil, and deposits of *allanite* in the western United States, and *bastnasite* in Southern California will supply cerium, thorium, and the other rare-earth metals for many years to come. Metallic cerium is prepared by metallothermic reduction techniques, such as by reducing cerous fluoride with calcium, or by electrolysis of molten cerous chloride or other cerous halides. The metallothermic technique is used to produce high-purity cerium. Cerium is especially interesting because of its variable electronic structure. The energy of the inner 4f level is nearly the same as that of the outer or valence electrons, and only small amounts of energy are required to change the relative occupancy of these electronic levels. This gives rise to dual valency states. For example, a volume change of about 10% occurs when cerium is subjected to high pressures or low temperatures. It appears that the valence changes from about 3 to 4 when it is cooled or compressed. The low temperature behavior of cerium is complex. Four allotropic modifications are thought to exist: cerium at room temperature and at atmospheric pressure is known as  $\gamma$  cerium. Upon cooling to  $-16^\circ\text{C}$ ,  $\gamma$  cerium changes to  $\beta$  cerium. The remaining  $\gamma$  cerium starts to change to  $\alpha$  cerium when cooled to  $-172^\circ\text{C}$ , and the transformation is complete at  $-269^\circ\text{C}$ .  $\alpha$  Cerium has a density of 8.16;  $\delta$  cerium exists above  $726^\circ\text{C}$ . At atmospheric pressure, liquid cerium is more dense than its solid form at the melting point. Cerium is an iron-gray lustrous metal. It is malleable, and oxidizes very readily at room temperature, especially in moist air. Except for europium, cerium is the most reactive of the "rare-earth" metals. It slowly decomposes in cold water, and rapidly in hot water. Alkali solutions and dilute and concentrated acids attack the metal rapidly. The pure metal is likely to ignite if scratched with a knife. Ceric salts are orange red or yellowish; cerous salts are usually white. Cerium is a component of misch metal, which is extensively used in the manufacture of pyrophoric alloys for cigarette lighters, etc. Natural cerium is stable and contains four isotopes. Thirty-two other radioactive isotopes and isomers are known. While cerium is not radioactive, the impure commercial grade may contain traces of thorium, which is radioactive. The oxide is an important constituent of incandescent gas mantles and it is emerging as a hydrocarbon catalyst in "self-cleaning" ovens. In this application it can be incorporated into oven walls to prevent the collection of cooking residues. As ceric sulfate it finds extensive use as a volumetric oxidizing agent in quan-

titative analysis. Cerium compounds are used in the manufacture of glass, both as a component and as a decolorizer. The oxide is finding increased use as a glass polishing agent instead of rouge, for it is much faster than rouge in polishing glass surfaces. Cerium compounds are finding use in automobile exhaust catalysts. Cerium is also finding use in making permanent magnets. Cerium, with other rare earths, is used in carbon-arc lighting, especially in the motion picture industry. It is also finding use as an important catalyst in petroleum refining and in metallurgical and nuclear applications. In small lots, cerium costs about \$5/g (99.9%).

**Cesium** — (*L. caesius*, sky blue), Cs; at. wt. 132.9054519(2); at. no. 55; m.p.  $28.44^\circ\text{C}$ ; b.p.  $671^\circ\text{C}$ ; sp. gr. 1.873 ( $20^\circ\text{C}$ ); valence 1. Cesium was discovered spectroscopically by Bunsen and Kirchhoff in 1860 in mineral water from Durkheim. Cesium, an alkali metal, occurs in *lepidolite*, *pollucite* (a hydrated silicate of aluminum and cesium), and in other sources. One of the world's richest sources of cesium is located at Bernic Lake, Manitoba. The deposits are estimated to contain 300,000 tons of pollucite, averaging 20% cesium. It can be isolated by electrolysis of the fused cyanide and by a number of other methods. Very pure, gas-free cesium can be prepared by thermal decomposition of cesium azide. The metal is characterized by a spectrum containing two bright lines in the blue along with several others in the red, yellow, and green. It is silvery white, soft, and ductile. It is the most electropositive and most alkaline element. Cesium, gallium, and mercury are the only three metals that are liquid at room temperature. Cesium reacts explosively with cold water, and reacts with ice at temperatures above  $-116^\circ\text{C}$ . Cesium hydroxide, the strongest base known, attacks glass. Because of its great affinity for oxygen the metal is used as a "getter" in electron tubes. It is also used in photoelectric cells, as well as a catalyst in the hydrogenation of certain organic compounds. The metal has recently found application in ion propulsion systems. Cesium is used in atomic clocks, which are accurate to 5 s in 300 years. A second of time is now defined as being the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyper-fine levels of the ground state of the cesium-133 atom. Its chief compounds are the chloride and the nitrate. Cesium has 52 isotopes and isomers with masses ranging from 112 to 148. The present price of cesium is about \$50/g (99.98%) sealed in a glass ampoule.

**Chlorine** — (*Gr. chloros*, greenish yellow), Cl; at. wt. 35.453(2); at. no. 17; m.p.  $-101.5^\circ\text{C}$ ; b.p.  $-34.04^\circ\text{C}$ ;  $t_c$   $143.8^\circ\text{C}$ ; density 3.214 g/L; sp. gr. 1.56 ( $-33.6^\circ\text{C}$ ); valence 1, 3, 5, or 7. Discovered in 1774 by Scheele, who thought it contained oxygen; named in 1810 by Davy, who insisted it was an element. In nature it is found in the combined state only, chiefly with sodium as common salt (NaCl), *carnallite* ( $\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$ ), and *sylvite* (KCl). It is a member of the halogen (salt-forming) group of elements and is obtained from chlorides by the action of oxidizing agents and more often by electrolysis; it is a greenish-yellow gas, combining directly with nearly all elements. At  $10^\circ\text{C}$  one volume of water dissolves 3.10 volumes of chlorine, at  $30^\circ\text{C}$  only 1.77 volumes. Chlorine is widely used in making many everyday products. It is used for producing safe drinking water the world over. Even the smallest water supplies are now usually chlorinated. It is also extensively used in the production of paper products, dyestuffs, textiles, petroleum products, medicines, antiseptics, insecticides, foodstuffs, solvents, paints, plastics, and many other consumer products. Most of the chlorine produced is used in the manufacture of chlorinat-



ed compounds for sanitation, pulp bleaching, disinfectants, and textile processing. Further use is in the manufacture of chlorates, chloroform, carbon tetrachloride, and in the extraction of bromine. Organic chemistry demands much from chlorine, both as an oxidizing agent and in substitution, since it often brings desired properties in an organic compound when substituted for hydrogen, as in one form of synthetic rubber. Chlorine is a respiratory irritant. The gas irritates the mucous membranes and the liquid burns the skin. As little as 3.5 ppm can be detected as an odor, and 1000 ppm is likely to be fatal after a few deep breaths. It was used as a war gas in 1915. Natural chlorine contains two isotopes. Twenty other isotopes and isomers are known.

**Chromium** — (Gr. *chroma*, color), Cr; at. wt. 51.9961(6); at. no. 24; m.p. 1907°C; b.p. 2671°C; sp. gr. 7.15 (20°C); valence chiefly 2, 3, or 6. Discovered in 1797 by Vauquelin, who prepared the metal the next year, chromium is a steel-gray, lustrous, hard metal that takes a high polish. The principal ore is *chromite* ( $\text{FeCr}_2\text{O}_4$ ), which is found in Zimbabwe, Russia, South Africa, Turkey, Iran, Albania, Finland, Democratic Republic of Madagascar, the Philippines, and elsewhere. The U.S. has no appreciable chromite ore reserves. The metal is usually produced by reducing the oxide with aluminum. Chromium is used to harden steel, to manufacture stainless steel, and to form many useful alloys. Much is used in plating to produce a hard, beautiful surface and to prevent corrosion. Chromium is used to give glass an emerald green color. It finds wide use as a catalyst. All compounds of chromium are colored; the most important are the chromates of sodium and potassium ( $\text{K}_2\text{CrO}_4$ ) and the dichromates ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) and the potassium and ammonium chrome alums, as  $\text{KCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ . The dichromates are used as oxidizing agents in quantitative analysis, also in tanning leather. Other compounds are of industrial value; lead chromate is chrome yellow, a valued pigment. Chromium compounds are used in the textile industry as mordants, and by the aircraft and other industries for anodizing aluminum. The refractory industry has found chromite useful for forming bricks and shapes, as it has a high melting point, moderate thermal expansion, and stability of crystalline structure. Chromium is an essential trace element for human health. Many chromium compounds, however, are acutely or chronically toxic, and some are carcinogenic. They should be handled with proper safeguards. Natural chromium contains four isotopes. Twenty other isotopes are known. Chromium metal (99.95%) costs about \$1000/kg. Commercial grade chromium (99%) costs about \$75/kg.

**Cobalt** — (*Kobald*, from the German, goblin or evil spirit, *cobalos*, Greek, mine), Co; at. wt. 58.933195(5); at. no. 27; m.p. 1495°C; b.p. 2927°C; sp. gr. 8.9 (20°C); valence 2 or 3. Discovered by Brandt about 1735. Cobalt occurs in the mineral *cobaltite*, *smaltite*, and *erythrite*, and is often associated with nickel, silver, lead, copper, and iron ores, from which it is most frequently obtained as a by-product. It is also present in meteorites. Important ore deposits are found in Congo-Kinshasa, Australia, Zambia, Russia, Canada, and elsewhere. The U.S. Geological Survey has announced that the bottom of the north central Pacific Ocean may have cobalt-rich deposits at relatively shallow depths in waters close to the Hawaiian Islands and other U.S. Pacific territories. Cobalt is a brittle, hard metal, closely resembling iron and nickel in appearance. It has a magnetic permeability of about two thirds that of iron. Cobalt tends to exist as a mixture of two allotropes over a wide temperature

range; the  $\beta$ -form predominates below 400°C, and the  $\alpha$  above that temperature. The transformation is sluggish and accounts in part for the wide variation in reported data on physical properties of cobalt. It is alloyed with iron, nickel and other metals to make Alnico, an alloy of unusual magnetic strength with many important uses. Stellite alloys, containing cobalt, chromium, and tungsten, are used for high-speed, heavy-duty, high-temperature cutting tools, and for dies. Cobalt is also used in other magnet steels and stainless steels, and in alloys used in jet turbines and gas turbine generators. The metal is used in electroplating because of its appearance, hardness, and resistance to oxidation. The salts have been used for centuries for the production of brilliant and permanent blue colors in porcelain, glass, pottery, tiles, and enamels. It is the principal ingredient in Sevre's and Thenard's blue. A solution of the chloride ( $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ ) is used as sympathetic ink. The cobalt amines are of interest; the oxide and the nitrate are important. Cobalt carefully used in the form of the chloride, sulfate, acetate, or nitrate has been found effective in correcting a certain mineral deficiency disease in animals. Soils should contain 0.13 to 0.30 ppm of cobalt for proper animal nutrition. Cobalt is found in Vitamin B-12, which is essential for human nutrition. Cobalt of 99.9+% purity is priced at about \$250/kg. Cobalt-60, an artificial isotope, is an important gamma ray source, and is extensively used as a tracer and a radiotherapeutic agent. Single compact sources of Cobalt-60 vary from about \$1 to \$10/curie, depending on quantity and specific activity. Thirty isotopes and isomers of cobalt are known.

**Columbium** — See Niobium.

**Copper** — (L. *cuprum*, from the island of Cyprus), Cu; at. wt. 63.546(3); at. no. 29; f.p. 1084.62 °C; b.p. 2562°C; sp. gr. 8.96 (20°C); valence 1 or 2. The discovery of copper dates from prehistoric times. It is said to have been mined for more than 5000 years. It is one of man's most important metals. Copper is reddish colored, takes on a bright metallic luster, and is malleable, ductile, and a good conductor of heat and electricity (second only to silver in electrical conductivity). The electrical industry is one of the greatest users of copper. Copper occasionally occurs native, and is found in many minerals such as *cuprite*, *malachite*, *azurite*, *chalcopyrite*, and *bornite*. Large copper ore deposits are found in the U.S., Chile, Zambia, Zaire, Peru, and Canada. The most important copper ores are the sulfides, oxides, and carbonates. From these, copper is obtained by smelting, leaching, and by electrolysis. Its alloys, brass and bronze, long used, are still very important; all American coins are now copper alloys; monel and gun metals also contain copper. The most important compounds are the oxide and the sulfate, blue vitriol; the latter has wide use as an agricultural poison and as an algicide in water purification. Copper compounds such as Fehling's solution are widely used in analytical chemistry in tests for sugar. High-purity copper (99.999 + %) is readily available commercially. The price of commercial copper has fluctuated widely. The price of copper in December 2001 was about \$1.50/kg. Natural copper contains two isotopes. Twenty-six other radioactive isotopes and isomers are known.

**Curium** — (Pierre and Marie Curie), Cm; at. wt. (247); at. no. 96; m.p. 1345°C; sp. gr. 13.51 (calc.); valence 3 and 4. Although curium follows americium in the periodic system, it was actually known before americium and was the third transuranium element to be discovered. It was identified by Seaborg, James,

and Ghiorso in 1944 at the wartime Metallurgical Laboratory in Chicago as a result of helium-ion bombardment of  $^{239}\text{Pu}$  in the Berkeley, California, 60-inch cyclotron. Visible amounts (30  $\mu\text{g}$ ) of  $^{242}\text{Cm}$ , in the form of the hydroxide, were first isolated by Werner and Perlman of the University of California in 1947. In 1950, Crane, Wallmann, and Cunningham found that the magnetic susceptibility of microgram samples of  $\text{CmF}_3$  was of the same magnitude as that of  $\text{GdF}_3$ . This provided direct experimental evidence for assigning an electronic configuration to  $\text{Cm}^{+3}$ . In 1951, the same workers prepared curium in its elemental form for the first time. Sixteen isotopes of curium are now known. The most stable,  $^{247}\text{Cm}$ , with a half-life of 16 million years, is so short compared to the Earth's age that any primordial curium must have disappeared long ago from the natural scene. Minute amounts of curium probably exist in natural deposits of uranium, as a result of a sequence of neutron captures and  $\beta$  decays sustained by the very low flux of neutrons naturally present in uranium ores. The presence of natural curium, however, has never been detected.  $^{242}\text{Cm}$  and  $^{244}\text{Cm}$  are available in multigram quantities.  $^{248}\text{Cm}$  has been produced only in milligram amounts. Curium is similar in some regards to gadolinium, its rare-earth homolog, but it has a more complex crystal structure. Curium is silver in color, is chemically reactive, and is more electropositive than aluminum.  $\text{CmO}_2$ ,  $\text{Cm}_2\text{O}_3$ ,  $\text{CmF}_3$ ,  $\text{CmF}_4$ ,  $\text{CmCl}_3$ ,  $\text{CmBr}_3$ , and  $\text{CmI}_3$  have been prepared. Most compounds of trivalent curium are faintly yellow in color.  $^{242}\text{Cm}$  generates about three watts of thermal energy per gram. This compares to one-half watt per gram of  $^{238}\text{Pu}$ . This suggests use for curium as a power source.  $^{244}\text{Cm}$  is now offered for sale by the O.R.N.L. at \$185/mg plus packing charges.  $^{248}\text{Cm}$  is available at a cost of \$160/ $\mu\text{g}$ , plus packing charges, from the O.R.N.L. Curium absorbed into the body accumulates in the bones, and is therefore very toxic as its radiation destroys the red-cell forming mechanism. The maximum permissible total body burden of  $^{244}\text{Cm}$  (soluble) in a human being is 0.3  $\mu\text{Ci}$  (microcurie).

**Darmstadtium** — (Darmstadt, city in Germany), Ds. In 1987 Oganessian et al., at Dubna, claimed discovery of this element. Their experiments indicated the spontaneous fissioning nuclide  $^{272}110$  with a half-life of 10 ms. More recently a group led by Armbruster at G.S.I. in Darmstadt, Germany, reported evidence of  $^{269}110$ , which was produced by bombarding lead for many days with more than  $10^{18}$  nickel atoms. A detector searched each collision for Element 110's distinct decay sequence. On November 9, 1994, evidence of 110 was detected. In 2003 IUPAC approved the name darmstadtium, symbol Ds, for Element 110. Seven isotopes of Element 110 are now recognized.

**Deuterium** — an isotope of hydrogen — see Hydrogen.

**Dubnium** — (named after the Joint Institute of Nuclear Research in Dubna, Russia). Db; at. wt. [262]; at. no. 105. In 1967 G. N. Flerov reported that a Soviet team working at the Joint Institute for Nuclear Research at Dubna may have produced a few atoms of  $^{260}105$  and  $^{261}105$  by bombarding  $^{243}\text{Am}$  with  $^{22}\text{Ne}$ . Their evidence was based on time-coincidence measurements of alpha energies. More recently, it was reported that early in 1970 Dubna scientists synthesized Element 105 and that by the end of April 1970 "had investigated all the types of decay of the new element and had determined its chemical properties." In late April 1970, it was announced that Ghiorso, Nurmia, Harris, K. A. Y. Eskola, and P. L. Eskola, working at the University of California at Berkeley, had positively identi-

fied Element 105. The discovery was made by bombarding a target of  $^{249}\text{Cf}$  with a beam of 84 MeV nitrogen nuclei in the Heavy Ion Linear Accelerator (HILAC). When a  $^{15}\text{N}$  nucleus is absorbed by a  $^{249}\text{Cf}$  nucleus, four neutrons are emitted and a new atom of  $^{260}105$  with a half-life of 1.6 s is formed. While the first atoms of Element 105 are said to have been detected conclusively on March 5, 1970, there is evidence that Element 105 had been formed in Berkeley experiments a year earlier by the method described. Ghiorso and his associates have attempted to confirm Soviet findings by more sophisticated methods without success.

In October 1971, it was announced that two new isotopes of Element 105 were synthesized with the heavy ion linear accelerator by A. Ghiorso and co-workers at Berkeley. Element  $^{261}105$  was produced both by bombarding  $^{250}\text{Cf}$  with  $^{15}\text{N}$  and by bombarding  $^{249}\text{Bk}$  with  $^{16}\text{O}$ . The isotope emits 8.93-MeV  $\alpha$  particles and decays to  $^{257}\text{Lr}$  with a half-life of about 1.8 s. Element  $^{262}105$  was produced by bombarding  $^{249}\text{Bk}$  with  $^{18}\text{O}$ . It emits 8.45 MeV  $\alpha$  particles and decays to  $^{258}\text{Lr}$  with a half-life of about 40 s. Nine isotopes of Dubnium are now recognized. Soon after the discovery the names *Hahnium* and *Joliotium*, named after Otto Hahn and Jean-Frederic Joliot and Mme. Joliot-Curie, were suggested as names for Element 105. The IUPAC in August 1997 finally resolved the issue, naming Element 105 Dubnium with the symbol Db. Dubnium is thought to have properties similar to tantalum.

**Dysprosium** — (Gr. *dysprositos*, hard to get at), Dy; at. wt. 160.500(1); at. no. 66; m.p. 1412°C; b.p. 2567°C; sp. gr. 8.551 (25°C); valence 3. Dysprosium was discovered in 1886 by Lecoq de Boisbaudran, but not isolated. Neither the oxide nor the metal was available in relatively pure form until the development of ion-exchange separation and metallographic reduction techniques by Spedding and associates about 1950. Dysprosium occurs along with other so-called rare-earth or lanthanide elements in a variety of minerals such as *xenotime*, *fergusonite*, *gadolinite*, *euxenite*, *polycrase*, and *blomstrandine*. The most important sources, however, are from *monazite* and *bastnasite*. Dysprosium can be prepared by reduction of the trifluoride with calcium. The element has a metallic, bright silver luster. It is relatively stable in air at room temperature, and is readily attacked and dissolved, with the evolution of hydrogen, by dilute and concentrated mineral acids. The metal is soft enough to be cut with a knife and can be machined without sparking if overheating is avoided. Small amounts of impurities can greatly affect its physical properties. While dysprosium has not yet found many applications, its thermal neutron absorption cross-section and high melting point suggest metallurgical uses in nuclear control applications and for alloying with special stainless steels. A dysprosium oxide-nickel cermet has found use in cooling nuclear reactor rods. This cermet absorbs neutrons readily without swelling or contracting under prolonged neutron bombardment. In combination with vanadium and other rare earths, dysprosium has been used in making laser materials. Dysprosium-cadmium chalcogenides, as sources of infrared radiation, have been used for studying chemical reactions. The cost of dysprosium metal has dropped in recent years since the development of ion-exchange and solvent extraction techniques, and the discovery of large ore bodies. Thirty-two isotopes and isomers are now known. The metal costs about \$6/g (99.9% purity).

**Einsteinium** — (Albert Einstein [1879–1955]), Es; at. wt. (252); m.p. 860°C (est.); at. no. 99. Einsteinium, the seventh transura-

nic element of the actinide series to be discovered, was identified by Ghiorso and co-workers at Berkeley in December 1952 in debris from the first large thermonuclear explosion, which took place in the Pacific in November 1952. The isotope produced was the 20-day  $^{253}\text{Es}$  isotope. In 1961, a sufficient amount of einsteinium was produced to permit separation of a macroscopic amount of  $^{253}\text{Es}$ . This sample weighed about 0.01  $\mu\text{g}$ . A special magnetic-type balance was used in making this determination.  $^{253}\text{Es}$  so produced was used to produce mendelevium. About 3  $\mu\text{g}$  of einsteinium has been produced at Oak Ridge National Laboratories by irradiating for several years kilogram quantities of  $^{239}\text{Pu}$  in a reactor to produce  $^{242}\text{Pu}$ . This was then fabricated into pellets of plutonium oxide and aluminum powder, and loaded into target rods for an initial 1-year irradiation at the Savannah River Plant, followed by irradiation in a HFIR (High Flux Isotopic Reactor). After 4 months in the HFIR the targets were removed for chemical separation of the einsteinium from californium. Nineteen isotopes and isomers of einsteinium are now recognized.  $^{254}\text{Es}$  has the longest half-life (276 days). Tracer studies using  $^{253}\text{Es}$  show that einsteinium has chemical properties typical of a heavy trivalent, actinide element. Einsteinium is extremely radioactive. Great care must be taken when handling it.

**Element 112** — In late February 1996, Sigurd Hofmann and his collaborators at GSI Darmstadt announced their discovery of Element 112, having 112 protons and 165 neutrons, with an atomic mass of 277. This element was made by bombarding a lead target with high-energy zinc ions. A single nucleus of Element 112 was detected, which decayed after less than 0.001 sec by emitting an  $\alpha$  particle, consisting of two protons and two neutrons. This created Element  $110_{273}$ , which in turn decayed by emitting an  $\alpha$  particle to form a new isotope of Element 108 and so on. Evidence indicates that nuclei with 162 neutrons are held together more strongly than nuclei with a smaller or larger number of neutrons. This suggests a narrow “peninsula” of relatively stable isotopes around Element 114. GSI scientists are experimenting to bombard targets with ions heavier than zinc to produce Elements 113 and 114. A name has not yet been suggested for Element 112, although the IUPAC suggested the temporary name of ununbium, with the symbol of Uub, when the element was discovered. Element 112 is expected to have properties similar to mercury.

**Element 113** — (Ununtrium) See Element 115.

**Element 114** — (Ununquadium) Symbol Uuq. Element 114 is the first new element to be discovered since 1996. This element was found by a Russian–American team, including Livermore researchers, by bombarding a sheet of plutonium with a rare form of calcium hoping to make the atoms stick together in a new element. Radiation showed that the new element broke into smaller pieces. Data of radiation collected at the Russian Joint Institute for Nuclear Research in November and December 1998 were analyzed in January 1999. It was found that some of the heavy atoms created when 114 decayed lived up to 30 seconds, which was longer than ever seen before for such a heavy element. This isotope decayed into a previously unknown isotope of Element 112, which itself lasted 15 minutes. That isotope, in turn, decayed to a previously undiscovered isotope of Element 108, which survived 17 minutes. Isotopes of these and those with longer life-times have been predicted for some time by theorists. It appears that these isotopes are on the edge of the “island of stability,” and that some

of the isotopes in this region might last long enough for studies of their nuclear behavior and for a chemical evaluation to be made. No name has yet been suggested for Element 114; however, the temporary name of ununquadium with symbol Uuq may be used.

**Element 115**— (Ununpentium) On February 2, 2004, it was reported that Element 115 had been discovered at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. Four atoms of this element were produced by JINR physicists and collaborators from the Lawrence Livermore (California) Laboratory using a 248-MeV beam of calcium-48 ions striking a target of americium-243 atoms. The nuclei of these atoms are said to have a life of 90 milliseconds. The relatively long lifetime of Element 115 suggests that these experiments might be getting closer to the “island of stability” long sought to exist by some nuclear physicists. These atoms were thought to decay first to Element 113 by the emission of an alpha particle, then decay further to Element 111 by alpha emission again, and then by three more alpha decay processes to Element 105 (dubnium), which after a long delay from the time of the initial interaction, fissioned. This experiment entailed separating four atoms from trillions of other atoms. A gas-filled separator, employing chemistry, was important in this experiment. Names for Elements 115, Element 113, and Element 111 have not yet been chosen.

**Element 116** — (Ununhexium) Symbol Uuh. As of January 2004 it is questionable if this element has been discovered.

**Element 117** — (Ununseptium) Symbol Uus. As of January 2004, this element remains undiscovered.

**Element 118** — (Ununoctium) Symbol Uuo. In June 1999 it was announced that Elements 118 and 116 had been discovered at the Lawrence Berkeley National Laboratory. A lead target was bombarded for more than 10 days with roughly 1 quintillion krypton ions. The team reported that three atoms of Element 118 were made, which quickly decayed into Elements 116, 114, and elements of lower atomic mass. It was said that the isotopes of Element 118 lasted only about 200 milliseconds, while the isotope of Element 116 lasted only 1.2 milliseconds. It was hoped that these elements might be members of “an island of stability,” which had long been sought. At that time it was hoped that a target of bismuth might be bombarded with krypton ions to make Element 119, which, in turn, would decay into Elements 117, 115, and 113.

On July 27, 2001 researchers at the Lawrence Berkeley Laboratory announced that their discovery of Element 118 was being retracted because workers at the GSI Laboratory in Germany and at Japanese laboratories failed to confirm their results. However, it was reported that different experiments at the Livermore Laboratory and Joint Institute from Nuclear Research in Dubna, Russia indicated that Element 116 had since been created.

Researchers at the Australian National Laboratory suggest that super-heavy elements may be more difficult to make than previously thought. Their data suggest the best way to encourage fusion in making super-heavy elements is to combine the lightest projectiles possible with the heaviest possible targets. This would minimize a so-called “quasi-fission process” in which a projectile nucleus steals protons and neutrons from a target nucleus. In this process the two nuclei are said to fly apart without ever having actually combined.



**Erbium** — (*Ytterby*, a town in Sweden), Er; at. wt. 167.259(3); at. no. 68; m.p. 1529°C; b.p. 2868°C; sp. gr. 9.066 (25°C); valence 3, Erbium, one of the so-called rare-earth elements of the lanthanide series, is found in the minerals mentioned under dysprosium above. In 1842 Mosander separated “yttria,” found in the mineral *gadolinite*, into three fractions which he called *yttria*, *erbia*, and *terbia*. The names *erbia* and *terbia* became confused in this early period. After 1860, Mosander’s *terbia* was known as *erbia*, and after 1877, the earlier known *erbia* became *terbia*. The *erbia* of this period was later shown to consist of five oxides, now known as *erbia*, *scandia*, *holmia*, *thulia* and *ytterbia*. By 1905 Urbain and James independently succeeded in isolating fairly pure  $\text{Er}_2\text{O}_3$ . Klemm and Bommer first produced reasonably pure erbium metal in 1934 by reducing the anhydrous chloride with potassium vapor. The pure metal is soft and malleable and has a bright, silvery, metallic luster. As with other rare-earth metals, its properties depend to a certain extent on the impurities present. The metal is fairly stable in air and does not oxidize as rapidly as some of the other rare-earth metals. Naturally occurring erbium is a mixture of six isotopes, all of which are stable. Twenty-seven radioactive isotopes of erbium are also recognized. Recent production techniques, using ion-exchange reactions, have resulted in much lower prices of the rare-earth metals and their compounds in recent years. The cost of 99.9% erbium metal is about \$21/g. Erbium is finding nuclear and metallurgical uses. Added to vanadium, for example, erbium lowers the hardness and improves workability. Most of the rare-earth oxides have sharp absorption bands in the visible, ultraviolet, and near infrared. This property, associated with the electronic structure, gives beautiful pastel colors to many of the rare-earth salts. Erbium oxide gives a pink color and has been used as a colorant in glasses and porcelain enamel glazes.

**Europium** — (Europe), Eu; at. wt. 151.964(1); at. no. 63; m.p. 822°C; b.p. 1596°C; sp. gr. 5.244 (25°C); valence 2 or 3. In 1890 Boisbaudran obtained basic fractions from samarium-gadolinium concentrates that had spark spectral lines not accounted for by samarium or gadolinium. These lines subsequently have been shown to belong to europium. The discovery of europium is generally credited to Demarcay, who separated the rare earth in reasonably pure form in 1901. The pure metal was not isolated until recent years. Europium is now prepared by mixing  $\text{Eu}_2\text{O}_3$  with a 10% excess of lanthanum metal and heating the mixture in a tantalum crucible under high vacuum. The element is collected as a silvery-white metallic deposit on the walls of the crucible. As with other rare-earth metals, except for lanthanum, europium ignites in air at about 150 to 180°C. Europium is about as hard as lead and is quite ductile. It is the most reactive of the rare-earth metals, quickly oxidizing in air. It resembles calcium in its reaction with water. *Bastnasite* and *monazite* are the principal ores containing europium. Europium has been identified spectroscopically in the sun and certain stars. Europium isotopes are good neutron absorbers and are being studied for use in nuclear control applications. Europium oxide is now widely used as a phosphor activator and europium-activated yttrium vanadate is in commercial use as the red phosphor in color TV tubes. Europium-doped plastic has been used as a laser material. With the development of ion-exchange techniques and special processes, the cost of the metal has been greatly reduced in recent years. Natural europium contains two stable isotopes. Thirty-five other radioactive isotopes and isomers are known. Europium

is one of the rarest and most costly of the rare-earth metals. It is priced at about \$60/g (99.9% pure).

**Fermium** — (Enrico Fermi [1901–1954], nuclear physicist), Fm; at. wt. [257]; at. no. 100; m.p. 1527°C. Fermium, the eighth transuranium element of the actinide series to be discovered, was identified by Ghiorso and co-workers in 1952 in the debris from a thermonuclear explosion in the Pacific in work involving the University of California Radiation Laboratory, the Argonne National Laboratory, and the Los Alamos Scientific Laboratory. The isotope produced was the 20-hour  $^{255}\text{Fm}$ . During 1953 and early 1954, while discovery of elements 99 and 100 was withheld from publication for security reasons, a group from the Nobel Institute of Physics in Stockholm bombarded  $^{238}\text{U}$  with  $^{16}\text{O}$  ions, and isolated a 30-min  $\alpha$ -emitter, which they ascribed to  $^{250}\text{100}$ , without claiming discovery of the element. This isotope has since been identified positively, and the 30-min half-life confirmed. The chemical properties of fermium have been studied solely with tracer amounts, and in normal aqueous media only the (III) oxidation state appears to exist. The isotope  $^{254}\text{Fm}$  and heavier isotopes can be produced by intense neutron irradiation of lower elements such as plutonium by a process of successive neutron capture interspersed with beta decays until these mass numbers and atomic numbers are reached. Twenty isotopes and isomers of fermium are known to exist.  $^{257}\text{Fm}$ , with a half-life of about 100.5 days, is the longest lived.  $^{250}\text{Fm}$ , with a half-life of 30 min, has been shown to be a product of decay of Element  $^{254}\text{102}$ . It was by chemical identification of  $^{250}\text{Fm}$  that production of Element 102 (nobelium) was confirmed. Fermium would probably have chemical properties resembling erbium.

**Fluorine** — (L. and F. *fluere*, flow, or flux), F; at. wt. 18.9984032(5); at. no. 9; m.p.  $-219.67^\circ\text{C}$  (1 atm); b.p.  $-188.12^\circ\text{C}$  (1 atm);  $t_c$   $-129.02^\circ\text{C}$ ; density 1.696 g/L (0°C, 1 atm); liq. den. at b.p. 1.50 g/cm<sup>3</sup>; valence 1. In 1529, Georgius Agricola described the use of fluorspar as a flux, and as early as 1670 Schwandhard found that glass was etched when exposed to fluorspar treated with acid. Scheele and many later investigators, including Davy, Gay-Lussac, Lavoisier, and Thenard, experimented with hydrofluoric acid, some experiments ending in tragedy. The element was finally isolated in 1886 by Moisson after nearly 74 years of continuous effort. Fluorine occurs chiefly in *fluorspar* ( $\text{CaF}_2$ ) and *cryolite* ( $\text{Na}_3\text{AlF}_6$ ), and is in *topaz* and other minerals. It is a member of the halogen family of elements, and is obtained by electrolyzing a solution of potassium hydrogen fluoride in anhydrous hydrogen fluoride in a vessel of metal or transparent fluorspar. Modern commercial production methods are essentially variations on the procedures first used by Moisson. Fluorine is the most electronegative and reactive of all elements. It is a pale yellow, corrosive gas, which reacts with practically all organic and inorganic substances. Finely divided metals, glass, ceramics, carbon, and even water burn in fluorine with a bright flame. Until World War II, there was no commercial production of elemental fluorine. The atom bomb project and nuclear energy applications, however, made it necessary to produce large quantities. Safe handling techniques have now been developed and it is possible at present to transport liquid fluorine by the ton. Fluorine and its compounds are used in producing uranium (from the hexafluoride) and more than 100 commercial fluorochemicals, including many well-known high-temperature plastics. Hydrofluoric acid is extensively used for etching the glass of light bulbs, etc. Fluorochlorohydrocarbons have been extensively used in air

conditioning and refrigeration. However, in recent years the U.S. and other countries have been phasing out ozone-depleting substances, such as the fluorochlorohydrocarbons that have been used in these applications. It has been suggested that fluorine might be substituted for hydrogen wherever it occurs in organic compounds, which could lead to an astronomical number of new fluorine compounds. The presence of fluorine as a soluble fluoride in drinking water to the extent of 2 ppm may cause mottled enamel in teeth, when used by children acquiring permanent teeth; in smaller amounts, however, fluorides are said to be beneficial and used in water supplies to prevent dental cavities. Elemental fluorine has been studied as a rocket propellant as it has an exceptionally high specific impulse value. Compounds of fluorine with rare gases have now been confirmed. Fluorides of xenon, radon, and krypton are among those known. Elemental fluorine and the fluoride ion are highly toxic. The free element has a characteristic pungent odor, detectable in concentrations as low as 20 ppb, which is below the safe working level. The recommended maximum allowable concentration for a daily 8-hour time-weighted exposure is 1 ppm. Fluorine is known to have fourteen isotopes.

**Francium** — (France), Fr; at. no. 87; at. wt. [223]; m.p. 27°C; valence 1. Discovered in 1939 by Mlle. Marguerite Perey of the Curie Institute, Paris. Francium, the heaviest known member of the alkali metal series, occurs as a result of an alpha disintegration of actinium. It can also be made artificially by bombarding thorium with protons. While it occurs naturally in uranium minerals, there is probably less than an ounce of francium at any time in the total crust of the earth. It has the highest equivalent weight of any element, and is the most unstable of the first 101 elements of the periodic system. Thirty-six isotopes and isomers of francium are recognized. The longest lived  $^{223}\text{Fr}$  (Ac, K), a daughter of  $^{227}\text{Ac}$ , has a half-life of 21.8 min. This is the only isotope of francium occurring in nature. Because all known isotopes of francium are highly unstable, knowledge of the chemical properties of this element comes from radiochemical techniques. No weighable quantity of the element has been prepared or isolated. The chemical properties of francium most closely resemble cesium. In 1996, researchers Orozco, Sprouse, and co-workers at the State University of New York, Stony Brook, reported that they had produced francium atoms by bombarding  $^{18}\text{O}$  atoms at a gold target heated almost to its melting point. Collisions between gold and oxygen nuclei created atoms of francium-210 which had 87 protons and 123 neutrons. This team reported they had generated about 1 million francium-210 ions per second and held 1000 or more atoms at a time for about 20 secs in a magnetic trap they had devised before the atoms decayed or escaped. Enough francium was trapped so that a videocamera could capture the light given off by the atoms as they fluoresced. A cluster of about 10,000 francium atoms appeared as a glowing sphere about 1 mm in diameter. It is thought that the francium atoms could serve as miniature laboratories for probing interactions between electrons and quarks.

**Gadolinium** — (*gadolinite*, a mineral named for Gadolin, a Finnish chemist), Gd; at. wt. 157.25(3); at. no. 64; m.p. 1313°C; b.p. 3273°C; sp. gr. 7.901 (25°C); valence 3. Gadolinia, the oxide of gadolinium, was separated by Marignac in 1880 and Lecoq de Boisbaudran independently isolated the element from Mosander's "yttria" in 1886. The element was named for the mineral *gadolinite* from which this rare earth was originally

obtained. Gadolinium is found in several other minerals, including *monazite* and *bastnasite*, which are of commercial importance. The element has been isolated only in recent years. With the development of ion-exchange and solvent extraction techniques, the availability and price of gadolinium and the other rare-earth metals have greatly improved. Thirty-one isotopes and isomers of gadolinium are now recognized; seven are stable and occur naturally. The metal can be prepared by the reduction of the anhydrous fluoride with metallic calcium. As with other related rare-earth metals, it is silvery white, has a metallic luster, and is malleable and ductile. At room temperature, gadolinium crystallizes in the hexagonal, close-packed  $\alpha$  form. Upon heating to 1235°C,  $\alpha$  gadolinium transforms into the  $\beta$  form, which has a body-centered cubic structure. The metal is relatively stable in dry air, but in moist air it tarnishes with the formation of a loosely adhering oxide film which splits off and exposes more surface to oxidation. The metal reacts slowly with water and is soluble in dilute acid. Gadolinium has the highest thermal neutron capture cross-section of any known element (49,000 barns). Natural gadolinium is a mixture of seven isotopes. Two of these,  $^{155}\text{Gd}$  and  $^{157}\text{Gd}$ , have excellent capture characteristics, but they are present naturally in low concentrations. As a result, gadolinium has a very fast burnout rate and has limited use as a nuclear control rod material. It has been used in making gadolinium yttrium garnets, which have microwave applications. Compounds of gadolinium are used in making phosphors for color TV tubes. The metal has unusual superconductive properties. As little as 1% gadolinium has been found to improve the workability and resistance of iron, chromium, and related alloys to high temperatures and oxidation. Gadolinium ethyl sulfate has extremely low noise characteristics and may find use in duplicating the performance of amplifiers, such as the maser. The metal is ferromagnetic. Gadolinium is unique for its high magnetic moment and for its special Curie temperature (above which ferromagnetism vanishes) lying just at room temperature. This suggests uses as a magnetic component that senses hot and cold. The price of the metal is about \$5/g (99.9% purity).

**Gallium** — (L. *Gallia*, France), Ga; at. wt. 69.723(1); at. no. 31; m.p. 29.76°C; b.p. 2204°C; sp. gr. 5.904 (29.6°C) solid; sp. gr. 6.095 (29.6°C) liquid; valence 2 or 3. Predicted and described by Mendeleev as ekaaluminum, and discovered spectroscopically by Lecoq de Boisbaudran in 1875, who in the same year obtained the free metal by electrolysis of a solution of the hydroxide in KOH, Gallium is often found as a trace element in *diaspore*, *sphalerite*, *germanite*, *bauxite*, and *coal*. Some flue dusts from burning coal have been shown to contain as much as 1.5% gallium. It is the only metal, except for mercury, cesium, and rubidium, which can be liquid near room temperatures; this makes possible its use in high-temperature thermometers. It has one of the longest liquid ranges of any metal and has a low vapor pressure even at high temperatures. There is a strong tendency for gallium to supercool below its freezing point. Therefore, seeding may be necessary to initiate solidification. Ultra-pure gallium has a beautiful, silvery appearance, and the solid metal exhibits a conchoidal fracture similar to glass. The metal expands 3.1% on solidifying; therefore, it should not be stored in glass or metal containers, as they may break as the metal solidifies. Gallium wets glass or porcelain, and forms a brilliant mirror when it is painted on glass. It is widely used in doping semiconductors and producing solid-state devices such as transistors. High-purity gallium is attacked slowly only by



mineral acids. Magnesium gallate containing divalent impurities such as  $Mn^{2+}$  is finding use in commercial ultraviolet activated powder phosphors. Gallium nitride has been used to produce blue light-emitting diodes such as those used in CD and DVD readers. Gallium has found application in the Gallex Detector Experiment located in the Gran Sasso Underground Laboratory in Italy. This underground facility has been built by the Italian Istituto Nazionale di Fisica Nucleare in the middle of a highway tunnel through the Abruzzese mountains, about 150 km east of Rome. In this experiment, 30.3 tons of gallium in the form of 110 tons of  $GaCl_3$ -HCl solution are being used to detect solar neutrinos. The production of  $^{71}Ge$  from gallium is being measured. Gallium arsenide is capable of converting electricity directly into coherent light. Gallium readily alloys with most metals, and has been used as a component in low melting alloys. Its toxicity appears to be of a low order, but it should be handled with care until more data are forthcoming. Natural gallium contains two stable isotopes. Twenty-six other isotopes, one of which is an isomer, are known. The metal can be supplied in ultrapure form (99.9999+%). The cost is about \$5/g (99.999%).

**Germanium** — (L. *Germania*, Germany), Ge; at. wt. 72.64(2); at. no. 32; m.p. 938.25°C; b.p. 2833°C; sp. gr. 5.323 (25°C); valence 2 and 4. Predicted by Mendeleev in 1871 as ekasilicon, and discovered by Winkler in 1886. The metal is found in *argyrodite*, a sulfide of germanium and silver; in *germanite*, which contains 8% of the element; in zinc ores; in coal; and in other minerals. The element is frequently obtained commercially from flue dusts of smelters processing zinc ores, and has been recovered from the by-products of combustion of certain coals. Its presence in coal insures a large reserve of the element in the years to come. Germanium can be separated from other metals by fractional distillation of its volatile tetrachloride. The tetrachloride may then be hydrolyzed to give  $GeO_2$ ; the dioxide can be reduced with hydrogen to give the metal. Recently developed zone-refining techniques permit the production of germanium of ultra-high purity. The element is a gray-white metalloid, and in its pure state is crystalline and brittle, retaining its luster in air at room temperature. It is a very important semiconductor material. Zone-refining techniques have led to production of crystalline germanium for semiconductor use with an impurity of only one part in  $10^{10}$ . Doped with arsenic, gallium, or other elements, it is used as a transistor element in thousands of electronic applications. Its application in fiber optics and infrared optical systems now provides the largest use for germanium. Germanium is also finding many other applications including use as an alloying agent, as a phosphor in fluorescent lamps, and as a catalyst. Germanium and germanium oxide are transparent to the infrared and are used in infrared spectrometers and other optical equipment, including extremely sensitive infrared detectors. Germanium oxide's high index of refraction and dispersion make it useful as a component of glasses used in wide-angle camera lenses and microscope objectives. The field of organogermanium chemistry is becoming increasingly important. Certain germanium compounds have a low mammalian toxicity, but a marked activity against certain bacteria, which makes them of interest as chemotherapeutic agents. The cost of germanium is about \$10/g (99.999% purity). Thirty isotopes and isomers are known, five of which occur naturally.

**Gold** — (Sanskrit *Ival*; Anglo-Saxon *gold*), Au (L. *aurum*, gold); at. wt. 196.966569(4); at. no. 79; m.p. 1064.18°C; b.p. 2856°C;

sp. gr. ~19.3 (20°C); valence 1 or 3. Known and highly valued from earliest times, gold is found in nature as the free metal and in tellurides; it is very widely distributed and is almost always associated with quartz or pyrite. It occurs in veins and alluvial deposits, and is often separated from rocks and other minerals by sluicing and panning operations. About 25% of the world's gold output comes from South Africa, and about two thirds of the total U.S. production now comes from South Dakota and Nevada. The metal is recovered from its ores by cyaniding, amalgamating, and smelting processes. Refining is also frequently done by electrolysis. Gold occurs in sea water to the extent of 0.1 to 2 mg/ton, depending on the location where the sample is taken. As yet, no method has been found for recovering gold from sea water profitably. It is estimated that all the gold in the world, so far refined, could be placed in a single cube 60 ft on a side. Of all the elements, gold in its pure state is undoubtedly the most beautiful. It is metallic, having a yellow color when in a mass, but when finely divided it may be black, ruby, or purple. The Purple of Cassius is a delicate test for auric gold. It is the most malleable and ductile metal; 1 oz. of gold can be beaten out to 300 ft<sup>2</sup>. It is a soft metal and is usually alloyed to give it more strength. It is a good conductor of heat and electricity, and is unaffected by air and most reagents. It is used in coinage and is a standard for monetary systems in many countries. It is also extensively used for jewelry, decoration, dental work, and for plating. It is used for coating certain space satellites, as it is a good reflector of infrared and is inert. Gold, like other precious metals, is measured in troy weight; when alloyed with other metals, the term *carat* is used to express the amount of gold present, 24 carats being pure gold. For many years the value of gold was set by the U.S. at \$20.67/troy ounce; in 1934 this value was fixed by law at \$35.00/troy ounce, 9/10th fine. On March 17, 1968, because of a gold crisis, a two-tiered pricing system was established whereby gold was still used to settle international accounts at the old \$35.00/troy ounce price while the price of gold on the private market would be allowed to fluctuate. Since this time, the price of gold on the free market has fluctuated widely. The price of gold on the free market reached a price of \$620/troy oz. in January 1980. More recently, the U.K. and other nations, including the I.M.F. have sold or threatened to sell a sizeable portion of their gold reserves. This has caused wide fluctuations in the price of gold. Because this has damaged the economy of some countries, a moratorium for a few years has been declared. This has tended to stabilize temporarily the price of gold. The most common gold compounds are auric chloride ( $AuCl_3$ ) and chlorauric acid ( $HAuCl_4$ ), the latter being used in photography for toning the silver image. Gold has forty-eight recognized isotopes and isomers;  $^{198}Au$ , with a half-life of 2.7 days, is used for treating cancer and other diseases. Disodium aurothiomalate is administered intramuscularly as a treatment for arthritis. A mixture of one part nitric acid with three of hydrochloric acid is called *aqua regia* (because it dissolved gold, the King of Metals). Gold is available commercially with a purity of 99.999+%. For many years the temperature assigned to the freezing point of gold has been 1063.0°C; this has served as a calibration point for the International Temperature Scales (ITS-27 and ITS-48) and the International Practical Temperature Scale (IPTS-48). In 1968, a new International Practical Temperature Scale (IPTS-68) was adopted, which demanded that the freezing point of gold be changed to 1064.43°C. In 1990 a new International Temperature Scale (ITS-90) was adopted bringing the t.p.

(triple point) of  $\text{H}_2\text{O}$  ( $t_{90}$  (°C)) to 0.01°C and the freezing point of gold to 1064.18°C. The specific gravity of gold has been found to vary considerably depending on temperature, how the metal is precipitated, and cold-worked. As of December 2001, gold was priced at about \$275/troy oz. (\$8.50/g).

**Hafnium** — (*Hafnia*, Latin name for Copenhagen), Hf; at. wt. 178.49(2); at. no. 72; m.p. 2233°C; b.p. 4603°C; sp. gr. 13.31 (20°C); valence 4. Hafnium was thought to be present in various minerals and concentrations many years prior to its discovery, in 1923, credited to D. Coster and G. von Hevesey. On the basis of the Bohr theory, the new element was expected to be associated with zirconium. It was finally identified in *zircon* from Norway, by means of X-ray spectroscopic analysis. It was named in honor of the city in which the discovery was made. Most zirconium minerals contain 1 to 5% hafnium. It was originally separated from zirconium by repeated recrystallization of the double ammonium or potassium fluorides by von Hevesey and Jantzen. Metallic hafnium was first prepared by van Arkel and deBoer by passing the vapor of the tetraiodide over a heated tungsten filament. Almost all hafnium metal now produced is made by reducing the tetrachloride with magnesium or with sodium (Kroll Process). Hafnium is a ductile metal with a brilliant silver luster. Its properties are considerably influenced by the impurities of zirconium present. Of all the elements, zirconium and hafnium are two of the most difficult to separate. Their chemistry is almost identical; however, the density of zirconium is about half that of hafnium. Very pure hafnium has been produced, with zirconium being the major impurity. Natural hafnium contains six isotopes, one of which is slightly radioactive. Hafnium has a total of 41 recognized isotopes and isomers. Because hafnium has a good absorption cross section for thermal neutrons (almost 600 times that of zirconium), has excellent mechanical properties, and is extremely corrosion resistant, it is used for reactor control rods. Such rods are used in nuclear submarines. Hafnium has been successfully alloyed with iron, titanium, niobium, tantalum, and other metals. Hafnium carbide is the most refractory binary composition known, and the nitride is the most refractory of all known metal nitrides (m.p. 3310°C). Hafnium is used in gas-filled and incandescent lamps, and is an efficient "getter" for scavenging oxygen and nitrogen. Finely divided hafnium is pyrophoric and can ignite spontaneously in air. Care should be taken when machining the metal or when handling hot sponge hafnium. At 700°C hafnium rapidly absorbs hydrogen to form the composition  $\text{HfH}_{1.86}$ . Hafnium is resistant to concentrated alkalis, but at elevated temperatures reacts with oxygen, nitrogen, carbon, boron, sulfur, and silicon. Halogens react directly to form tetrahalides. The price of the metal is about \$2/g. The yearly demand for hafnium in the U.S. is now in excess of 50,000 kg.

**Hahnium** — A name previously used for Element 105, now named *dubnium*.

**Hassium** — (named for the German state, Hesse) Hs; at. wt. [277]; at. no. 108. This element was first synthesized and identified in 1964 by the same G.S.I. Darmstadt Group who first identified *Bohrium* and *Meitnerium*. Presumably this element has chemical properties similar to osmium. Isotope  $^{265}\text{108}$  was produced using a beam of  $^{58}\text{Fe}$  projectiles, produced by the Universal Linear Accelerator (UNILAC) to bombard a  $^{208}\text{Pb}$  target. Discovery of *Bohrium* and *Meitnerium* was made using detection of isotopes with odd proton and neutron numbers.

Elements having even atomic numbers have been thought to be less stable against spontaneous fission than odd elements. The production of  $^{265}\text{108}$  in the same reaction as was used at G.S.I. was confirmed at Dubna with detection of the seventh member of the decay chain  $^{253}\text{Es}$ . Isotopes of *Hassium* are believed to decay by spontaneous fission, explaining why 109 was produced before 108. Isotope  $^{265}\text{108}$  and  $^{266}\text{108}$  are thought to decay to  $^{261}\text{106}$ , which in turn decay to  $^{257}\text{104}$  and  $^{253}\text{102}$ . The IUPAC adopted the name *Hassium* after the German state of Hesse in September 1997. In June 2001 it was announced that hassium is now the heaviest element to have its chemical properties analyzed. A research team at the UNILAC heavy-ion accelerator in Darmstadt, Germany built an instrument to detect and analyze hassium. Atoms of curium-248 were collided with atoms of magnesium-26, producing about 6 atoms of hassium with a half-life of 9 sec. This was sufficiently long to obtain data showing that hassium atoms react with oxygen to form hassium oxide molecules. These condensed at a temperature consistent with the behavior of Group 8 elements. This experiment appears to confirm hassium's location under osmium in the periodic table.

**Helium** — (Gr. *helios*, the sun), He; at. wt. 4.002602(2); at. no. 2; b.p. — 268.93°C;  $t_c$  —267.96°C; density 0.1785 g/L (0°C, 1 atm); liquid density 0.125 g/mL at. b.p.; valence usually 0. Evidence of the existence of helium was first obtained by Janssen during the solar eclipse of 1868 when he detected a new line in the solar spectrum; Lockyer and Frankland suggested the name *helium* for the new element; in 1895, Ramsay discovered helium in the uranium mineral *cleveite*, and it was independently discovered in *cleveite* by the Swedish chemists Cleve and Langlet about the same time. Rutherford and Roysds in 1907 demonstrated that  $\alpha$  particles are helium nuclei. Except for hydrogen, helium is the most abundant element found throughout the universe. Helium is extracted from natural gas; all natural gas contains at least trace quantities of helium. It has been detected spectroscopically in great abundance, especially in the hotter stars, and it is an important component in both the proton-proton reaction and the carbon cycle, which account for the energy of the sun and stars. The fusion of hydrogen into helium provides the energy of the hydrogen bomb. The helium content of the atmosphere is about 1 part in 200,000. It is present in various radioactive minerals as a decay product. Much of the world's supply of helium is obtained from wells in Texas, Colorado, and Kansas. The only other known helium extraction plants, outside the United States, in 1999 were in Poland, Russia, China, Algeria, and India. The cost of helium has fallen from \$2500/ft<sup>3</sup> in 1915 to about 2.5¢/cu.ft. (.028 cu meters) in 1999. Helium has the lowest melting point of any element and has found wide use in cryogenic research, as its boiling point is close to absolute zero. Its use in the study of superconductivity is vital. Using liquid helium, Kurti and co-workers, and others, have succeeded in obtaining temperatures of a few microkelvins by the adiabatic demagnetization of copper nuclei, starting from about 0.01 K. Liquid helium ( $\text{He}^4$ ) exists in two forms:  $\text{He}^4\text{I}$  and  $\text{He}^4\text{II}$ , with a sharp transition point at 2.174 K (3.83 cm Hg).  $\text{He}^4\text{I}$  (above this temperature) is a normal liquid, but  $\text{He}^4\text{II}$  (below it) is unlike any other known substance. It expands on cooling; its conductivity for heat is enormous; and neither its heat conduction nor viscosity obeys normal rules. It has other peculiar properties. Helium is the only liquid that cannot be solidified by lowering the temperature. It remains liquid down to absolute zero at ordinary pressures, but it can readily be solidified by increasing

the pressure. Solid  $^3\text{He}$  and  $^4\text{He}$  are unusual in that both can readily be changed in volume by more than 30% by application of pressure. The specific heat of helium gas is unusually high. The density of helium vapor at the normal boiling point is also very high, with the vapor expanding greatly when heated to room temperature. Containers filled with helium gas at 5 to 10 K should be treated as though they contained liquid helium due to the large increase in pressure resulting from warming the gas to room temperature. While helium normally has a 0 valence, it seems to have a weak tendency to combine with certain other elements. Means of preparing helium difluoride have been studied, and species such as  $\text{HeNe}$  and the molecular ions  $\text{He}^+$  and  $\text{He}^{++}$  have been investigated. Helium is widely used as an inert gas shield for arc welding; as a protective gas in growing silicon and germanium crystals, and in titanium and zirconium production; as a cooling medium for nuclear reactors, and as a gas for supersonic wind tunnels. A mixture of helium and oxygen is used as an artificial atmosphere for divers and others working under pressure. Different ratios of  $\text{He}/\text{O}_2$  are used for different depths at which the diver is operating. Helium is extensively used for filling balloons as it is a much safer gas than hydrogen. One of the recent largest uses for helium has been for pressurizing liquid fuel rockets. A Saturn booster such as used on the Apollo lunar missions required about 13 million  $\text{ft}^3$  of helium for a firing, plus more for checkouts. Liquid helium's use in magnetic resonance imaging (MRI) continues to increase as the medical profession accepts and develops new uses for the equipment. This equipment is providing accurate diagnoses of problems where exploratory surgery has previously been required to determine problems. Another medical application that is being developed uses MRI to determine by blood analysis whether a patient has any form of cancer. Lifting gas applications are increasing. Various companies in addition to Goodyear, are now using "blimps" for advertising. The Navy and the Air Force are investigating the use of airships to provide early warning systems to detect low-flying cruise missiles. The Drug Enforcement Agency has used radar-equipped blimps to detect drug smugglers along the southern border of the U.S. In addition, NASA is currently using helium-filled balloons to sample the atmosphere in Antarctica to determine what is depleting the ozone layer that protects Earth from harmful U.V. radiation. Research on and development of materials which become superconductive at temperatures well above the boiling point of helium could have a major impact on the demand for helium. Less costly refrigerants having boiling points considerably higher could replace the present need to cool such superconductive materials to the boiling point of helium. Natural helium contains two stable isotopes  $^3\text{He}$  and  $^4\text{He}$ .  $^3\text{He}$  is present in very small quantities. Six other isotopes of helium are now recognized.

**Holmium** — (*L. Holmia*, for Stockholm), Ho; at. wt. 164.93032(2); at. no. 67; m.p.  $1472^\circ\text{C}$ ; b.p.  $2700^\circ\text{C}$ ; sp. gr. 8.795 ( $25^\circ\text{C}$ ); valence + 3. The spectral absorption bands of holmium were noticed in 1878 by the Swiss chemists Delafontaine and Soret, who announced the existence of an "Element X." Cleve, of Sweden, later independently discovered the element while working on erbia earth. The element is named after Cleve's native city. Pure holmia, the yellow oxide, was prepared by Homberg in 1911. Holmium occurs in *gadolinite*, *monazite*, and in other rare-earth minerals. It is commercially obtained from monazite, occurring in that mineral to the extent of about 0.05%. It has been isolated by the reduction of its anhydrous chloride or fluoride with calcium metal. Pure holmium has a metallic

to bright silver luster. It is relatively soft and malleable, and is stable in dry air at room temperature, but rapidly oxidizes in moist air and at elevated temperatures. The metal has unusual magnetic properties. Few uses have yet been found for the element. The element, as with other rare earths, seems to have a low acute toxic rating. Natural holmium consists of one isotope  $^{165}\text{Ho}$ , which is not radioactive. Holmium has 49 other isotopes known, all of which are radioactive. The price of 99.9% holmium metal is about \$20/g.

**Hydrogen** — (*Gr. hydro*, water, and *genes*, forming), H; at. wt. 1.00794(7); at. no. 1; m.p.  $-259.1^\circ\text{C}$ ; b.p.  $-252.76^\circ\text{C}$ ;  $t_c$   $-240.18$ ; density 0.08988 g/L; density (liquid) 0.0708 g/mL ( $-253^\circ\text{C}$ ); density (solid) 0.0706 g/mL ( $-262^\circ\text{C}$ ); valence 1. Hydrogen was prepared many years before it was recognized as a distinct substance by Cavendish in 1766. It was named by Lavoisier. Hydrogen is the most abundant of all elements in the universe, and it is thought that the heavier elements were, and still are, being built from hydrogen and helium. It has been estimated that hydrogen makes up more than 90% of all the atoms or three quarters of the mass of the universe. It is found in the sun and most stars, and plays an important part in the proton-proton reaction and carbon-nitrogen cycle, which accounts for the energy of the sun and stars. It is thought that hydrogen is a major component of the planet Jupiter and that at some depth in the planet's interior the pressure is so great that solid molecular hydrogen is converted into solid metallic hydrogen. In 1973, it was reported that a group of Russian experimenters may have produced metallic hydrogen at a pressure of 2.8 Mbar. At the transition the density changed from 1.08 to 1.3  $\text{g}/\text{cm}^3$ . Earlier, in 1972, a Livermore (California) group also reported on a similar experiment in which they observed a pressure-volume point centered at 2 Mbar. It has been predicted that metallic hydrogen may be metastable; others have predicted it would be a superconductor at room temperature. On Earth, hydrogen occurs chiefly in combination with oxygen in water, but it is also present in organic matter such as living plants, petroleum, coal, etc. It is present as the free element in the atmosphere, but only to the extent of less than 1 ppm by volume. It is the lightest of all gases, and combines with other elements, sometimes explosively, to form compounds. Great quantities of hydrogen are required commercially for the fixation of nitrogen from the air in the Haber ammonia process and for the hydrogenation of fats and oils. It is also used in large quantities in methanol production, in hydrodealkylation, hydrocracking, and hydrodesulfurization. It is also used as a rocket fuel, for welding, for production of hydrochloric acid, for the reduction of metallic ores, and for filling balloons. The lifting power of 1  $\text{ft}^3$  of hydrogen gas is about 0.076 lb at  $0^\circ\text{C}$ , 760 mm pressure. Production of hydrogen in the U.S. alone now amounts to about 3 billion cubic feet per year. It is prepared by the action of steam on heated carbon, by decomposition of certain hydrocarbons with heat, by the electrolysis of water, or by the displacement from acids by certain metals. It is also produced by the action of sodium or potassium hydroxide on aluminum. Liquid hydrogen is important in cryogenics and in the study of superconductivity, as its melting point is only a  $20^\circ\text{C}$  above absolute zero. Hydrogen consists of three isotopes, most of which is  $^1\text{H}$ . The ordinary isotope of hydrogen, H, is known as *protium*. In 1932, Urey announced the discovery of a stable isotope, deuterium ( $^2\text{H}$  or D) with an atomic weight of 2. Deuterium is present in natural hydrogen to the extent of 0.015%. Two years later an unstable isotope, tritium ( $^3\text{H}$ ), with an atomic weight of 3 was discovered. Tritium has a half-life



of about 12.32 years. Tritium atoms are also present in natural hydrogen but in a much smaller proportion. Tritium is readily produced in nuclear reactors and is used in the production of the hydrogen bomb. It is also used as a radioactive agent in making luminous paints, and as a tracer. On August 27, 2001 Russian, French, and Japanese physicists working at the Joint Institute for Nuclear Research near Moscow reported they had made "super-heavy hydrogen," which had a nucleus with one proton and four neutrons. Using an accelerator, they used a beam of helium-6 nuclei to strike a hydrogen target, which resulted in the occasional production of a hydrogen-5 nucleus plus a helium-2 nucleus. These unstable particles quickly disintegrated. This resulted in two protons from the He-2, a triton, and two neutrons from the H-5 breakup. Deuterium gas is readily available, without permit, at about \$1/l. Heavy water, deuterium oxide (D<sub>2</sub>O), which is used as a moderator to slow down neutrons, is available without permit at a cost of 6¢ to \$1/g, depending on quantity and purity. About 1000 tons (4,400,000 kg) of deuterium oxide (heavy water) are now in use at the Sudbury (Ontario) Neutrino Observatory. This observatory is taking data to provide new revolutionary insight into the properties of neutrinos and into the core of the sun. The heavy water is on loan from Atomic Energy of Canada, Ltd. (AECL). The observatory and detectors are located 6800 ft (2072 m) deep in the Creighton mine of the International Nickel Co., near Sudbury. The heavy water is contained in an acrylic vessel, 12 m in diameter. Neutrinos react with the heavy water to produce Cherenkov radiation. This light is then detected with 9600 photomultiplier tubes surrounding the vessel. The detector laboratory is immensely clean to reduce background radiation, which otherwise hides the very weak signals from neutrinos. Quite apart from isotopes, it has been shown that hydrogen gas under ordinary conditions is a mixture of two kinds of molecules, known as *ortho*- and *para*-hydrogen, which differ from one another by the spins of their electrons and nuclei. Normal hydrogen at room temperature contains 25% of the *para* form and 75% of the *ortho* form. The *ortho* form cannot be prepared in the pure state. Since the two forms differ in energy, the physical properties also differ. The melting and boiling points of *parahydrogen* are about 0.1°C lower than those of normal hydrogen. Consideration is being given to an entire economy based on solar- and nuclear-generated hydrogen. Located in remote regions, power plants would electrolyze sea water; the hydrogen produced would travel to distant cities by pipelines. Pollution-free hydrogen could replace natural gas, gasoline, etc., and could serve as a reducing agent in metallurgy, chemical processing, refining, etc. It could also be used to convert trash into methane and ethylene. Public acceptance, high capital investment, and the high present cost of hydrogen with respect to current fuels are but a few of the problems facing establishment of such an economy. Hydrogen is being investigated as a substitute for deep-sea diving applications below 300 m. Hydrogen is readily available from air product suppliers.

**Indium** — (from the brilliant indigo line in its spectrum), In; at. wt. 114.818(3); at. no. 49; m.p. 156.60°C; b.p. 2072°C; sp. gr. 7.31 (20°C); valence 1, 2, or 3. Discovered by Reich and Richter, who later isolated the metal. Indium is most frequently associated with zinc materials, and it is from these that most commercial indium is now obtained; however, it is also found in iron, lead, and copper ores. Until 1924, a gram or so constituted the world's supply of this element in isolated form. It is probably about as abundant as silver. About 4 million troy ounces of

indium are now produced annually in the Free World. Canada is presently producing more than 1,000,000 troy ounces annually. The present cost of indium is about \$2 to \$10/g, depending on quantity and purity. It is available in ultrapure form. Indium is a very soft, silvery-white metal with a brilliant luster. The pure metal gives a high-pitched "cry" when bent. It wets glass, as does gallium. It has found application in making low-melting alloys; an alloy of 24% indium–76% gallium is liquid at room temperature. Indium is used in making bearing alloys, germanium transistors, rectifiers, thermistors, liquid crystal displays, high definition television, batteries, and photoconductors. It can be plated onto metal and evaporated onto glass, forming a mirror as good as that made with silver but with more resistance to atmospheric corrosion. There is evidence that indium has a low order of toxicity; however, care should be taken until further information is available. Seventy isotopes and isomers are now recognized (more than any other element). Natural indium contains two isotopes. One is stable. The other, <sup>115</sup>In, comprising 95.71% of natural indium is slightly radioactive with a very long half-life.

**Iodine** — (Gr. *iodēs*, violet), I; at. wt. 126.90447(3); at. no. 53; m.p. 113.7°C; b.p. 184.4°C; *t<sub>c</sub>* 546°C; density of the gas 11.27 g/L; sp. gr. solid 4.93 (20°C); valence 1, 3, 5, or 7. Discovered by Courtois in 1811. Iodine, a halogen, occurs sparingly in the form of iodides in sea water from which it is assimilated by seaweeds, in Chilean saltpeter and nitrate-bearing earth, known as *caliche* in brines from old sea deposits, and in brackish waters from oil and salt wells. Ultrapure iodine can be obtained from the reaction of potassium iodide with copper sulfate. Several other methods of isolating the element are known. Iodine is a bluish-black, lustrous solid, volatilizing at ordinary temperatures into a blue-violet gas with an irritating odor; it forms compounds with many elements, but is less active than the other halogens, which displace it from iodides. Iodine exhibits some metallic-like properties. It dissolves readily in chloroform, carbon tetrachloride, or carbon disulfide to form beautiful purple solutions. It is only slightly soluble in water. Iodine compounds are important in organic chemistry and very useful in medicine. Forty-two isotopes and isomers are recognized. Only one stable isotope, <sup>127</sup>I, is found in nature. The artificial radioisotope <sup>131</sup>I, with a half-life of 8 days, has been used in treating the thyroid gland. The most common compounds are the iodides of sodium and potassium (KI) and the iodates (KIO<sub>3</sub>). Lack of iodine is the cause of goiter. Iodides and thyroxin, which contains iodine, are used internally in medicine, and a solution of KI and iodine in alcohol is used for external wounds. Potassium iodide finds use in photography. The deep blue color with starch solution is characteristic of the free element. Care should be taken in handling and using iodine, as contact with the skin can cause lesions; iodine vapor is intensely irritating to the eyes and mucous membranes. Elemental iodine costs about 25 to 75¢/g depending on purity and quantity.

**Iridium** — (L. *iris*, rainbow), Ir; at. wt. 192.217(3); at. no. 77; m.p. 2446°C; b.p. 4428°C; sp. gr. 22.562 (20°C); valence 3 or 4. Discovered in 1803 by Tennant in the residue left when crude platinum is dissolved by aqua regia. The name iridium is appropriate, for its salts are highly colored. Iridium, a metal of the platinum family, is white, similar to platinum, but with a slight yellowish cast. It is very hard and brittle, making it very hard to machine, form, or work. It is the most corrosion-resistant metal known, and was used in making the standard meter

bar of Paris, which is a 90% platinum–10% iridium alloy. This meter bar was replaced in 1960 as a fundamental unit of length (see under Krypton). Iridium is not attacked by any of the acids nor by aqua regia, but is attacked by molten salts, such as NaCl and NaCN. Iridium occurs uncombined in nature with platinum and other metals of this family in alluvial deposits. It is recovered as a by-product from the nickel mining industry. The largest reserves and production of the platinum group of metals, which includes iridium, is in South Africa, followed by Russia and Canada. The U.S. has only one active mine, located at Nye, MT. The presence of iridium has recently been used in examining the Cretaceous-Tertiary (K-T) boundary. Meteorites contain small amounts of iridium. Because iridium is found widely distributed at the K-T boundary, it has been suggested that a large meteorite or asteroid collided with the Earth, killing the dinosaurs, and creating a large dust cloud and crater. Searches for such a crater point to one in the Yucatan, known as Chicxulub. Iridium has found use in making crucibles and apparatus for use at high temperatures. It is also used for electrical contacts. Its principal use is as a hardening agent for platinum. With osmium, it forms an alloy that is used for tipping pens and compass bearings. The specific gravity of iridium is only very slightly lower than that of osmium, which has been generally credited as being the heaviest known element. Calculations of the densities of iridium and osmium from the space lattices give values of 22.65 and 22.61 g/cm<sup>3</sup>, respectively. These values may be more reliable than actual physical measurements. At present, therefore, we know that either iridium or osmium is the densest known element, but the data do not yet allow selection between the two. Natural iridium contains two stable isotopes. Forty-five other isotopes, all radioactive, are now recognized. Iridium (99.9%) costs about \$100/g.

**Iron** — (Anglo-Saxon, *iron*), Fe (L. *ferrum*); at. wt. 55.845(2); at. no. 26; m.p. 1538°C; b.p. 2861°C; sp. gr. 7.874 (20°C); valence 2, 3, 4, or 6. The use of iron is prehistoric. Genesis mentions that Tubal-Cain, seven generations from Adam, was “an instructor of every artificer in brass and iron.” A remarkable iron pillar, dating to about A.D. 400, remains standing today in Delhi, India. This solid shaft of wrought iron is about 7¼ m high by 40 cm in diameter. Corrosion to the pillar has been minimal although it has been exposed to the weather since its erection. Iron is a relatively abundant element in the universe. It is found in the sun and many types of stars in considerable quantity. It has been suggested that the iron we have here on Earth may have originated in a supernova. Iron is a very difficult element to produce in ordinary nuclear reactions, such as would take place in the sun. Iron is found native as a principal component of a class of iron–nickel meteorites known as *siderites*, and is a minor constituent of the other two classes of meteorites. The core of the Earth, 2150 miles in radius, is thought to be largely composed of iron with about 10% occluded hydrogen. The metal is the fourth most abundant element, by weight, making up the crust of the Earth. The most common ore is *hematite* (Fe<sub>2</sub>O<sub>3</sub>). Magnetite (Fe<sub>3</sub>O<sub>4</sub>) is frequently seen as *black sands* along beaches and banks of streams. *Lodestone* is another form of magnetite. *Taconite* is becoming increasingly important as a commercial ore. Iron is a vital constituent of plant and animal life, and appears in hemoglobin. The pure metal is not often encountered in commerce, but is usually alloyed with carbon or other metals. The pure metal is very reactive chemically, and rapidly corrodes, especially in moist air or at elevated temperatures. It has four allotropic forms,

or ferrites, known as  $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$ , with transition points at 700, 928, and 1530°C. The  $\alpha$  form is magnetic, but when transformed into the  $\beta$  form, the magnetism disappears although the lattice remains unchanged. The relations of these forms are peculiar. Pig iron is an alloy containing about 3% carbon with varying amounts of S, Si, Mn, and P. It is hard, brittle, fairly fusible, and is used to produce other alloys, including steel. Wrought iron contains only a few tenths of a percent of carbon, is tough, malleable, less fusible, and usually has a “fibrous” structure. Carbon steel is an alloy of iron with carbon, with small amounts of Mn, S, P, and Si. Alloy steels are carbon steels with other additives such as nickel, chromium, vanadium, etc. Iron is the cheapest and most abundant, useful, and important of all metals. Natural iron contains four isotopes. Twenty-six other isotopes and isomers, all radioactive, are now recognized.

**Krypton** — (Gr. *kryptos*, hidden), Kr; at. wt. 83.798(2); at. no. 36; m.p. –157.36°C; b.p. –153.34 ± 0.10°C;  $t_c$  –63.67°C; density 3.733 g/L (0°C); valence usually 0. Discovered in 1898 by Ramsay and Travers in the residue left after liquid air had nearly boiled away, krypton is present in the air to the extent of about 1 ppm. The atmosphere of Mars has been found to contain 0.3 ppm of krypton. It is one of the “noble” gases. It is characterized by its brilliant green and orange spectral lines. Naturally occurring krypton contains six stable isotopes. Thirty other unstable isotopes and isomers are now recognized. The spectral lines of krypton are easily produced and some are very sharp. In 1960 it was internationally agreed that the fundamental unit of length, the meter, should be defined in terms of the orange-red spectral line of <sup>86</sup>Kr. This replaced the standard meter of Paris, which was defined in terms of a bar made of a platinum-iridium alloy. In October 1983 the meter was again redefined by the International Bureau of Weights and Measures as being the length of path traveled by light in a vacuum during a time interval of 1/299,792,458 of a second. Solid krypton is a white crystalline substance with a face-centered cubic structure that is common to all the rare gases. While krypton is generally thought of as a noble gas that normally does not combine with other elements, the existence of some krypton compounds has been established. Krypton difluoride has been prepared in gram quantities and can be made by several methods. A higher fluoride of krypton and a salt of an oxyacid of krypton also have been prepared. Molecule-ions of ArKr<sup>+</sup> and KrH<sup>+</sup> have been identified and investigated, and evidence is provided for the formation of KrXe or KrXe<sup>+</sup>. Krypton clathrates have been prepared with hydroquinone and phenol. <sup>85</sup>Kr has found recent application in chemical analysis. By imbedding the isotope in various solids, *kryptonates* are formed. The activity of these kryptonates is sensitive to chemical reactions at the surface. Estimates of the concentration of reactants are therefore made possible. Krypton is used in certain photographic flash lamps for high-speed photography. Uses thus far have been limited because of its high cost. Krypton gas presently costs about \$690/100 L.

**Kurchatovium** — See Rutherfordium.

**Lanthanum** — (Gr. *lanthanein*, to lie hidden), La; at. wt. 138.90547(7); at. no. 57; m.p. 920°C; b.p. 3464°C; sp. gr. 6.145 (25°C); valence 3. Mosander in 1839 extracted a new earth *lanthana*, from impure cerium nitrate, and recognized the new element. Lanthanum is found in rare-earth minerals such as *cerite*, *monazite*, *allanite*, and *bastnasite*. Monazite and bastnasite are principal ores in which lanthanum occurs

in percentages up to 25 and 38%, respectively. Misch metal, used in making lighter flints, contains about 25% lanthanum. Lanthanum was isolated in relatively pure form in 1923. Ion-exchange and solvent extraction techniques have led to much easier isolation of the so-called "rare-earth" elements. The availability of lanthanum and other rare earths has improved greatly in recent years. The metal can be produced by reducing the anhydrous fluoride with calcium. Lanthanum is silvery white, malleable, ductile, and soft enough to be cut with a knife. It is one of the most reactive of the rare-earth metals. It oxidizes rapidly when exposed to air. Cold water attacks lanthanum slowly, and hot water attacks it much more rapidly. The metal reacts directly with elemental carbon, nitrogen, boron, selenium, silicon, phosphorus, sulfur, and with halogens. At 310°C, lanthanum changes from a hexagonal to a face-centered cubic structure, and at 865°C it again transforms into a body-centered cubic structure. Natural lanthanum is a mixture of two isotopes, one of which is stable and one of which is radioactive with a very long half-life. Thirty other radioactive isotopes are recognized. Rare-earth compounds containing lanthanum are extensively used in carbon lighting applications, especially by the motion picture industry for studio lighting and projection. This application consumes about 25% of the rare-earth compounds produced.  $\text{La}_2\text{O}_3$  improves the alkali resistance of glass, and is used in making special optical glasses. Small amounts of lanthanum, as an additive, can be used to produce nodular cast iron. There is current interest in hydrogen sponge alloys containing lanthanum. These alloys take up to 400 times their own volume of hydrogen gas, and the process is reversible. Heat energy is released every time they do so; therefore these alloys have possibilities in energy conservation systems. Lanthanum and its compounds have a low to moderate acute toxicity rating; therefore, care should be taken in handling them. The metal costs about \$2/g (99.9%).

**Lawrencium** — (Ernest O. Lawrence [1901–1958], inventor of the cyclotron), Lr; at. no. 103; at. mass no. [262]; valence + 3(?). This member of the 5f transition elements (actinide series) was discovered in March 1961 by A. Ghiorso, T. Sikkeland, A. E. Larsh, and R. M. Latimer. A 3- $\mu\text{g}$  californium target, consisting of a mixture of isotopes of mass number 249, 250, 251, and 252, was bombarded with either  $^{10}\text{B}$  or  $^{11}\text{B}$ . The electrically charged transmutation nuclei recoiled with an atmosphere of helium and were collected on a thin copper conveyor tape which was then moved to place collected atoms in front of a series of solid-state detectors. The isotope of element 103 produced in this way decayed by emitting an 8.6-MeV alpha particle with a half-life of 8 s. In 1967, Flerov and associates of the Dubna Laboratory reported their inability to detect an alpha emitter with a half-life of 8 s which was assigned by the Berkeley group to  $^{257}\text{103}$ . This assignment has been changed to  $^{258}\text{Lr}$  or  $^{259}\text{Lr}$ . In 1965, the Dubna workers found a longer-lived lawrencium isotope,  $^{256}\text{Lr}$ , with a half-life of 35 s. In 1968, Ghiorso and associates at Berkeley were able to use a few atoms of this isotope to study the oxidation behavior of lawrencium. Using solvent extraction techniques and working very rapidly, they extracted lawrencium ions from a buffered aqueous solution into an organic solvent, completing each extraction in about 30 s. It was found that lawrencium behaves differently from dipositive nobelium and more like the tripositive elements earlier in the actinide series. Ten isotopes of lawrencium are now recognized.

**Lead** — (Anglo-Saxon *lead*), Pb (L. *plumbum*); at. wt. 207.2(1); at. no. 82; m.p. 327.46°C; b.p. 1749°C; sp. gr. 11.35 (20°C); valence 2 or 4. Long known, mentioned in Exodus. The alchemists believed lead to be the oldest metal and associated it with the planet Saturn. Native lead occurs in nature, but it is rare. Lead is obtained chiefly from *galena* ( $\text{PbS}$ ) by a roasting process. *Anglesite* ( $\text{PbSO}_4$ ), *cerussite* ( $\text{PbCO}_3$ ), and *minim* ( $\text{Pb}_3\text{O}_4$ ) are other common lead minerals. Lead is a bluish-white metal of bright luster, is very soft, highly malleable, ductile, and a poor conductor of electricity. It is very resistant to corrosion; lead pipes bearing the insignia of Roman emperors, used as drains from the baths, are still in service. It is used in containers for corrosive liquids (such as sulfuric acid) and may be toughened by the addition of a small percentage of antimony or other metals. Natural lead is a mixture of four stable isotopes:  $^{204}\text{Pb}$  (1.4%),  $^{206}\text{Pb}$  (24.1%),  $^{207}\text{Pb}$  (22.1%), and  $^{208}\text{Pb}$  (52.4%). Lead isotopes are the end products of each of the three series of naturally occurring radioactive elements:  $^{206}\text{Pb}$  for the uranium series,  $^{207}\text{Pb}$  for the actinium series, and  $^{208}\text{Pb}$  for the thorium series. Forty-three other isotopes of lead, all of which are radioactive, are recognized. Its alloys include solder, type metal, and various antifriction metals. Great quantities of lead, both as the metal and as the dioxide, are used in storage batteries. Lead is also used for cable covering, plumbing, and ammunition. The metal is very effective as a sound absorber, is used as a radiation shield around X-ray equipment and nuclear reactors, and is used to absorb vibration. Lead, alloyed with tin, is used in making organ pipes. White lead, the basic carbonate, sublimed white lead ( $\text{PbSO}_4$ ), chrome yellow ( $\text{PbCrO}_4$ ), red lead ( $\text{Pb}_3\text{O}_4$ ), and other lead compounds are used extensively in paints, although in recent years the use of lead in paints has been drastically curtailed to eliminate or reduce health hazards. Lead oxide is used in producing fine "crystal glass" and "flint glass" of a high index of refraction for achromatic lenses. The nitrate and the acetate are soluble salts. Lead salts such as lead arsenate have been used as insecticides, but their use in recent years has been practically eliminated in favor of less harmful organic compounds. Care must be used in handling lead as it is a cumulative poison. Environmental concern with lead poisoning led to elimination of lead tetraethyl in gasoline. The U.S. Occupational Safety and Health Administration (OSHA) has recommended that industries limit airborne lead to 50  $\mu\text{g}/\text{cu. meter}$ . Lead is priced at about 90¢/kg (99.9%).

**Lithium** — (Gr. *lithos*, stone), Li; at. wt. 6.941(2); at. no. 3; m.p. 180.5°C; b.p. 1342°C; sp. gr. 0.534 (20°C); valence 1. Discovered by Arfvedson in 1817. Lithium is the lightest of all metals, with a density only about half that of water. It does not occur free in nature; combined it is found in small amounts in nearly all igneous rocks and in the waters of many mineral springs. *Lepidolite*, *spodumene*, *petalite*, and *amblygonite* are the more important minerals containing it. Lithium is presently being recovered from brines of Searles Lake, in California, and from Nevada, Chile, and Argentina. Large deposits of spodumene are found in North Carolina. The metal is produced electrolytically from the fused chloride. Lithium is silvery in appearance, much like Na and K, other members of the alkali metal series. It reacts with water, but not as vigorously as sodium. Lithium imparts a beautiful crimson color to a flame, but when the metal burns strongly the flame is a dazzling white. Since World War II, the production of lithium metal and its compounds has increased greatly. Because the metal has the highest specific heat of any solid element, it has found use in heat transfer applications; however, it is corrosive and re-



quires special handling. The metal has been used as an alloying agent, is of interest in synthesis of organic compounds, and has nuclear applications. It ranks as a leading contender as a battery anode material because it has a high electrochemical potential. Lithium is used in special glasses and ceramics. The glass for the 200-inch telescope at Mt. Palomar contains lithium as a minor ingredient. Lithium chloride is one of the most hygroscopic materials known, and it, as well as lithium bromide, is used in air conditioning and industrial drying systems. Lithium stearate is used as an all-purpose and high-temperature lubricant. Other lithium compounds are used in dry cells and storage batteries. Seven isotopes of lithium are recognized. Natural lithium contains two isotopes. The metal is priced at about \$1.50/g (99.9%).

**Lutetium** — (Lutetia, ancient name for Paris, sometimes called *cassiopeium* by the Germans), Lu; at. wt. 174.967(1); at. no. 71; m.p. 1663°C; b.p. 3402°C; sp. gr. 9.841 (25°C); valence 3. In 1907, Urbain described a process by which Marignac's ytterbium (1879) could be separated into the two elements, ytterbium (neoytterbium) and lutetium. These elements were identical with "aldebaranum" and "cassiopeium," independently discovered by von Welsbach about the same time. Charles James of the University of New Hampshire also independently prepared the very pure oxide, *lutecia*, at this time. The spelling of the element was changed from *lutecium* to *lutetium* in 1949. Lutetium occurs in very small amounts in nearly all minerals containing yttrium, and is present in *monazite* to the extent of about 0.003%, which is a commercial source. The pure metal has been isolated only in recent years and is one of the most difficult to prepare. It can be prepared by the reduction of anhydrous  $\text{LuCl}_3$  or  $\text{LuF}_3$  by an alkali or alkaline earth metal. The metal is silvery white and relatively stable in air. While new techniques, including ion-exchange reactions, have been developed to separate the various rare-earth elements, lutetium is still the most costly of all rare earths. It is priced at about \$100/g (99.9%).  $^{176}\text{Lu}$  occurs naturally (97.41%) with  $^{175}\text{Lu}$  (2.59%), which is radioactive with a very long half-life of about  $4 \times 10^{10}$  years. Lutetium has 50 isotopes and isomers that are now recognized. Stable lutetium nuclides, which emit pure beta radiation after thermal neutron activation, can be used as catalysts in cracking, alkylation, hydrogenation, and polymerization. Virtually no other commercial uses have been found yet for lutetium. While lutetium, like other rare-earth metals, is thought to have a low toxicity rating, it should be handled with care until more information is available.

**Magnesium** — (*Magnesia*, district in Thessaly) Mg; at. wt. 24.3050(6); at. no. 12; m.p. 650°C; b.p. 1090°C; sp. gr. 1.738 (20°C); valence 2. Compounds of magnesium have long been known. Black recognized magnesium as an element in 1755. It was isolated by Davy in 1808, and prepared in coherent form by Bussy in 1831. Magnesium is the eighth most abundant element in the Earth's crust. It does not occur uncombined, but is found in large deposits in the form of *magnesite*, *dolomite*, and other minerals. The metal is now principally obtained in the U.S. by electrolysis of fused magnesium chloride derived from brines, wells, and sea water. Magnesium is a light, silvery-white, and fairly tough metal. It tarnishes slightly in air, and finely divided magnesium readily ignites upon heating in air and burns with a dazzling white flame. It is used in flashlight photography, flares, and pyrotechnics, including incendiary bombs. It is one third lighter than aluminum, and in alloys is essential for airplane and missile

construction. The metal improves the mechanical, fabrication, and welding characteristics of aluminum when used as an alloying agent. Magnesium is used in producing nodular graphite in cast iron, and is used as an additive to conventional propellants. It is also used as a reducing agent in the production of pure uranium and other metals from their salts. The hydroxide (*milk of magnesia*), chloride, sulfate (*Epsom salts*), and citrate are used in medicine. Dead-burned magnesite is employed for refractory purposes such as brick and liners in furnaces and converters. Calcined magnesia is also used for water treatment and in the manufacture of rubber, paper, etc. Organic magnesium compounds (Grignard's reagents) are important. Magnesium is an important element in both plant and animal life. Chlorophylls are magnesium-centered porphyrins. The adult daily requirement of magnesium is about 300 mg/day, but this is affected by various factors. Great care should be taken in handling magnesium metal, especially in the finely divided state, as serious fires can occur. Water should not be used on burning magnesium or on magnesium fires. Natural magnesium contains three isotopes. Twelve other isotopes are recognized. Magnesium metal costs about \$100/kg (99.8%).

**Manganese** — (*L. magnes*, magnet, from magnetic properties of pyrolusite; It. *manganese*, corrupt form of *magnesia*), Mn; at. wt. 54.938045(5); at. no. 25; m.p. 1246°C; b.p. 2061°C; sp. gr. 7.21 to 7.44, depending on allotropic form; valence 1, 2, 3, 4, 6, or 7. Recognized by Scheele, Bergman, and others as an element and isolated by Gahn in 1774 by reduction of the dioxide with carbon. Manganese minerals are widely distributed; oxides, silicates, and carbonates are the most common. The discovery of large quantities of manganese nodules on the floor of the oceans holds promise as a source of manganese. These nodules contain about 24% manganese together with many other elements in lesser abundance. Most manganese today is obtained from ores found in Ukraine, Brazil, Australia, Republic of So. Africa, Gabon, China, and India. *Pyrolusite* ( $\text{MnO}_2$ ) and *rhodochrosite* ( $\text{MnCO}_3$ ) are among the most common manganese minerals. The metal is obtained by reduction of the oxide with sodium, magnesium, aluminum, or by electrolysis. It is gray-white, resembling iron, but is harder and very brittle. The metal is reactive chemically, and decomposes in cold water slowly. Manganese is used to form many important alloys. In steel, manganese improves the rolling and forging qualities, strength, toughness, stiffness, wear resistance, hardness, and hardenability. With aluminum and antimony, especially with small amounts of copper, it forms highly ferromagnetic alloys. Manganese metal is ferromagnetic only after special treatment. The pure metal exists in four allotropic forms. The alpha form is stable at ordinary temperature; gamma manganese, which changes to alpha at ordinary temperatures, is soft, easily cut, and capable of being bent. The dioxide (pyrolusite) is used as a depolarizer in dry cells, and is used to "decolorize" glass that is colored green by impurities of iron. Manganese by itself colors glass an amethyst color, and is responsible for the color of true amethyst. The dioxide is also used in the preparation of oxygen and chlorine, and in drying black paints. The permanganate is a powerful oxidizing agent and is used in quantitative analysis and in medicine. Manganese is widely distributed throughout the animal kingdom. It is an important trace element and may be essential for utilization of vitamin  $\text{B}_1$ . Twenty-seven isotopes and isomers are known. Manganese metal (99.95%) is priced at about \$800/kg. Metal of 99.6% purity is priced at about \$80/kg.

**Meitnerium** — (Lise Meitner [1878–1968], Austrian–Swedish physicist and mathematician), Mt; at. wt [268]; at. no. 109. On August 29, 1992, Element 109 was made and identified by physicists at the Heavy Ion Research Laboratory (G.S.I.), Darmstadt, Germany, by bombarding a target of  $^{209}\text{Bi}$  with accelerated nuclei of  $^{58}\text{Fe}$ . The production of Element 109 has been extremely small. It took a week of target bombardment ( $10^{11}$  nuclear encounters) to produce a single atom of 109. Oganessian and his team at Dubna in 1994 repeated the Darmstadt experiment using a tenfold irradiation dose. One fission event from seven alpha decays of 109 was observed, thus indirectly confirming the existence of isotope  $^{266}\text{109}$ . In August 1997, the IUPAC adopted the name *meitnerium* for this element, honoring L. Meitner. Four isotopes of *meitnerium* are now recognized.

**Mendelevium** — (Dmitri Mendeleev [1834–1907]), Md; at. wt. (258); at. no. 101; m.p.  $827^\circ\text{C}$ ; valence +2, +3. Mendelevium, the ninth transuranium element of the actinide series to be discovered, was first identified by Ghiorso, Harvey, Choppin, Thompson, and Seaborg early in 1955 as a result of the bombardment of the isotope  $^{253}\text{Es}$  with helium ions in the Berkeley 60-inch cyclotron. The isotope produced was  $^{256}\text{Md}$ , which has a half-life of 78 min. This first identification was notable in that  $^{256}\text{Md}$  was synthesized on a one-atom-at-a-time basis. Nineteen isotopes and isomers are now recognized.  $^{258}\text{Md}$  has a half-life of 51.5 days. This isotope has been produced by the bombardment of an isotope of einsteinium with ions of helium. It now appears possible that eventually enough  $^{258}\text{Md}$  can be made so that some of its physical properties can be determined.  $^{256}\text{Md}$  has been used to elucidate some of the chemical properties of mendelevium in aqueous solution. Experiments seem to show that the element possesses a moderately stable dipositive (II) oxidation state in addition to the tripositive (III) oxidation state, which is characteristic of actinide elements.

**Mercury** — (Planet *Mercury*), Hg (*hydrargyrum*, liquid silver); at. wt. 200.59(2); at. no. 80; t.p.  $-38.83^\circ\text{C}$ ; b.p.  $356.62^\circ\text{C}$ ;  $t_c$   $1477^\circ\text{C}$ ; sp. gr. 13.546 ( $20^\circ\text{C}$ ); valence 1 or 2. Known to ancient Chinese and Hindus; found in Egyptian tombs of 1500 B.C. Mercury is the only common metal liquid at ordinary temperatures. It only rarely occurs free in nature. The chief ore is *cinnabar* ( $\text{HgS}$ ). Spain and China produce about 75% of the world's supply of the metal. The commercial unit for handling mercury is the "flask," which weighs 76 lb (34.46 kg). The metal is obtained by heating cinnabar in a current of air and by condensing the vapor. It is a heavy, silvery-white metal; a rather poor conductor of heat, as compared with other metals, and a fair conductor of electricity. It easily forms alloys with many metals, such as gold, silver, and tin, which are called *amalgams*. Its ease in amalgamating with gold is made use of in the recovery of gold from its ores. The metal is widely used in laboratory work for making thermometers, barometers, diffusion pumps, and many other instruments. It is used in making mercury-vapor lamps and advertising signs, etc. and is used in mercury switches and other electrical apparatus. Other uses are in making pesticides, mercury cells for caustic soda and chlorine production, dental preparations, antifouling paint, batteries, and catalysts. The most important salts are mercuric chloride  $\text{HgCl}_2$  (corrosive sublimate — a violent poison), mercurous chloride  $\text{Hg}_2\text{Cl}_2$  (calomel, occasionally still used in medicine), mercury fulminate ( $\text{Hg}(\text{ONC})_2$ ), a detonator widely used in explosives, and mercuric sulfide ( $\text{HgS}$ , vermilion, a high-grade paint pigment). Organic mercury compounds are im-

portant. It has been found that an electrical discharge causes mercury vapor to combine with neon, argon, krypton, and xenon. These products, held together with van der Waals' forces, correspond to  $\text{HgNe}$ ,  $\text{HgAr}$ ,  $\text{HgKr}$ , and  $\text{HgXe}$ . Mercury is a virulent poison and is readily absorbed through the respiratory tract, the gastrointestinal tract, or through unbroken skin. It acts as a cumulative poison and dangerous levels are readily attained in air. Air saturated with mercury vapor at  $20^\circ\text{C}$  contains a concentration that exceeds the toxic limit many times. The danger increases at higher temperatures. *It is therefore important that mercury be handled with care.* Containers of mercury should be securely covered and spillage should be avoided. If it is necessary to heat mercury or mercury compounds, it should be done in a well-ventilated hood. Methyl mercury is a dangerous pollutant and is now widely found in water and streams. The triple point of mercury,  $-38.8344^\circ\text{C}$ , is a fixed point on the International Temperature Scale (ITS-90). Mercury (99.98%) is priced at about \$110/kg. Native mercury contains seven isotopes. Thirty-six other isotopes and isomers are known.

**Molybdenum** — (Gr. *molybdos*, lead), Mo; at. wt. 95.94(2); at. no. 42; m.p.  $2623^\circ\text{C}$ ; b.p.  $4639^\circ\text{C}$ ; sp. gr. 10.22 ( $20^\circ\text{C}$ ); valence 2, 3, 4?, 5?, or 6. Before Scheele recognized molybdenite as a distinct ore of a new element in 1778, it was confused with graphite and lead ore. The metal was prepared in an impure form in 1782 by Hjelm. Molybdenum does not occur native, but is obtained principally from *molybdenite* ( $\text{MoS}_2$ ). *Wulfenite* ( $\text{PbMoO}_4$ ) and *powellite* ( $\text{Ca}(\text{MoW})\text{O}_4$ ) are also minor commercial ores. Molybdenum is also recovered as a by-product of copper and tungsten mining operations. The U.S., Canada, Chile, and China produce most of the world's molybdenum ores. The metal is prepared from the powder made by the hydrogen reduction of purified molybdc trioxide or ammonium molybdate. The metal is silvery white, very hard, but is softer and more ductile than tungsten. It has a high elastic modulus, and only tungsten and tantalum, of the more readily available metals, have higher melting points. It is a valuable alloying agent, as it contributes to the hardenability and toughness of quenched and tempered steels. It also improves the strength of steel at high temperatures. It is used in certain nickel-based alloys, such as the Hastelloys® which are heat-resistant and corrosion-resistant to chemical solutions. Molybdenum oxidizes at elevated temperatures. The metal has found recent application as electrodes for electrically heated glass furnaces and forehearths. It is also used in nuclear energy applications and for missile and aircraft parts. Molybdenum is valuable as a catalyst in the refining of petroleum. It has found application as a filament material in electronic and electrical applications. Molybdenum is an essential trace element in plant nutrition. Some lands are barren for lack of this element in the soil. Molybdenum sulfide is useful as a lubricant, especially at high temperatures where oils would decompose. Almost all ultra-high strength steels with minimum yield points up to 300,000 lb/in.<sup>2</sup> contain molybdenum in amounts from 0.25 to 8%. Natural molybdenum contains seven isotopes. Thirty other isotopes and isomers are known, all of which are radioactive. Molybdenum metal costs about \$1/g (99.999% purity). Molybdenum metal (99.9%) costs about \$160/kg.

**Neodymium** — (Gr. *neos*, new, and *didymos*, twin), Nd; at. wt. 144.242(3); at. no. 60; m.p.  $1016^\circ\text{C}$ ; b.p.  $3074^\circ\text{C}$ ; sp. gr. 7.008 ( $25^\circ\text{C}$ ); valence 3. In 1841 Mosander extracted from *cerite* a new rose-colored oxide, which he believed contained a new



element. He named the element *didymium*, as it was *an inseparable twin brother of lanthanum*. In 1885 von Welsbach separated didymium into two new elemental components, *neodymia* and *praseodymia*, by repeated fractionation of ammonium didymium nitrate. While the free metal is in *misch metal*, long known and used as a pyrophoric alloy for light flints, the element was not isolated in relatively pure form until 1925. Neodymium is present in misch metal to the extent of about 18%. It is present in the minerals *monazite* and *bastnasite*, which are principal sources of rare-earth metals. The element may be obtained by separating neodymium salts from other rare earths by ion-exchange or solvent extraction techniques, and by reducing anhydrous halides such as  $\text{NdF}_3$  with calcium metal. Other separation techniques are possible. The metal has a bright silvery metallic luster. Neodymium is one of the more reactive rare-earth metals and quickly tarnishes in air, forming an oxide that splits off and exposes metal to oxidation. The metal, therefore, should be kept under light mineral oil or sealed in a plastic material. Neodymium exists in two allotropic forms, with a transformation from a double hexagonal to a body-centered cubic structure taking place at 863°C. Natural neodymium is a mixture of seven isotopes, one of which has a very long half-life. Twenty-seven other radioactive isotopes and isomers are recognized. Didymium, of which neodymium is a component, is used for coloring glass to make welder's goggles. By itself, neodymium colors glass delicate shades ranging from pure violet through wine-red and warm gray. Light transmitted through such glass shows unusually sharp absorption bands. The glass has been used in astronomical work to produce sharp bands by which spectral lines may be calibrated. Glass containing neodymium can be used as a laser material to produce coherent light. Neodymium salts are also used as a colorant for enamels. The element is also being used with iron and boron to produce extremely strong magnets. These are the most compact magnets commercially available. The price of the metal is about \$4/g. Neodymium has a low-to-moderate acute toxic rating. As with other rare earths, neodymium should be handled with care.

**Neon** — (Gr. *neos*, new), Ne; at. wt. 20.1797(6); at. no. 10; t.p.  $-248.609^\circ\text{C}$ ; b.p.  $-246.053^\circ\text{C}$ ;  $t_c$   $-228.7^\circ\text{C}$ ; density of gas 0.89990 g/L (1 atm,  $0^\circ\text{C}$ ); density of liquid at b.p. 1.204 g/cm<sup>3</sup>; valence 0. Discovered by Ramsay and Travers in 1898. Neon is a rare gaseous element present in the atmosphere to the extent of 1 part in 65,000 of air. It is obtained by liquefaction of air and separated from the other gases by fractional distillation. Natural neon is a mixture of three isotopes. Fourteen other unstable isotopes are known. It is very inert element; however, it is said to form a compound with fluorine. It is still questionable if true compounds of neon exist, but evidence is mounting in favor of their existence. The following ions are known from optical and mass spectrometric studies:  $\text{Ne}^+$ ,  $(\text{NeAr})^+$ ,  $(\text{NeH})^+$ , and  $(\text{HeNe}^+)$ . Neon also forms an unstable hydrate. In a vacuum discharge tube, neon glows reddish orange. Of all the rare gases, the discharge of neon is the most intense at ordinary voltages and currents. Neon is used in making the common neon advertising signs, which accounts for its largest use. It is also used to make high-voltage indicators, lightning arrestors, wave meter tubes, and TV tubes. Neon and helium are used in making gas lasers. Liquid neon is now commercially available and is finding important application as an economical cryogenic refrigerant. It has over 40 times more refrigerating capacity per unit volume than liquid helium and more than three times that of liquid hydrogen. It

is compact, inert, and is less expensive than helium when it meets refrigeration requirements. Neon costs about \$800/80 cu. ft. (2265 l).

**Neptunium** — (Planet *Neptune*), Np; at. wt. (237); at. no. 93; m.p.  $644^\circ\text{C}$ ; sp. gr. 20.25 ( $20^\circ\text{C}$ ); valence 3, 4, 5, and 6. Neptunium was the first synthetic transuranium element of the actinide series discovered; the isotope  $^{239}\text{Np}$  was produced by McMillan and Abelson in 1940 at Berkeley, California, as the result of bombarding uranium with cyclotron-produced neutrons. The isotope  $^{237}\text{Np}$  (half-life of  $2.14 \times 10^6$  years) is currently obtained in gram quantities as a by-product from nuclear reactors in the production of plutonium. Twenty-three isotopes and isomers of neptunium are now recognized. Trace quantities of the element are actually found in nature due to transmutation reactions in uranium ores produced by the neutrons which are present. Neptunium is prepared by the reduction of  $\text{NpF}_3$  with barium or lithium vapor at about  $1200^\circ\text{C}$ . Neptunium metal has a silvery appearance, is chemically reactive, and exists in at least three structural modifications:  $\alpha$ -neptunium, orthorhombic, density 20.25 g/cm<sup>3</sup>,  $\beta$ -neptunium (above  $280^\circ\text{C}$ ), tetragonal, density ( $313^\circ\text{C}$ ) 19.36 g/cm<sup>3</sup>,  $\gamma$ -neptunium (above  $577^\circ\text{C}$ ), cubic, density ( $600^\circ\text{C}$ ) 18.0 g/cm<sup>3</sup>. Neptunium has four ionic oxidation states in solution:  $\text{Np}^{+3}$  (pale purple), analogous to the rare earth ion  $\text{Pm}^{+3}$ ,  $\text{Np}^{+4}$  (yellow green);  $\text{NpO}^+$  (green blue); and  $\text{NpO}^{++}$  (pale pink). These latter oxygenated species are in contrast to the rare earths that exhibit only simple ions of the (II), (III), and (IV) oxidation states in aqueous solution. The element forms tri- and tetrahalides such as  $\text{NpF}_3$ ,  $\text{NpF}_4$ ,  $\text{NpCl}_4$ ,  $\text{NpBr}_3$ ,  $\text{NpI}_3$ , and oxides of various compositions such as are found in the uranium-oxygen system, including  $\text{Np}_3\text{O}_8$  and  $\text{NpO}_2$ .

**Nickel** — (Ger. *Nickel*, Satan or Old Nick's and from *kupfernickel*, Old Nick's copper), Ni; at. wt. 58.6934(2); at. no. 28; m.p.  $1455^\circ\text{C}$ ; b.p.  $2913^\circ\text{C}$ ; sp. gr. 8.902 ( $25^\circ\text{C}$ ); valence 0, 1, 2, 3. Discovered by Cronstedt in 1751 in *kupfernickel* (*niccolite*). Nickel is found as a constituent in most meteorites and often serves as one of the criteria for distinguishing a meteorite from other minerals. Iron meteorites, or *siderites*, may contain iron alloyed with from 5 to nearly 20% nickel. Nickel is obtained commercially from *pentlandite* and *pyrrhotite* of the Sudbury region of Ontario, a district that produces much of the world's nickel. It is now thought that the Sudbury deposit is the result of an ancient meteorite impact. Large deposits of nickel, cobalt, and copper have recently been developed at Voisey's Bay, Labrador. Other deposits of nickel are found in Russia, New Caledonia, Australia, Cuba, Indonesia, and elsewhere. Nickel is silvery white and takes on a high polish. It is hard, malleable, ductile, somewhat ferromagnetic, and a fair conductor of heat and electricity. It belongs to the iron-cobalt group of metals and is chiefly valuable for the alloys it forms. It is extensively used for making stainless steel and other corrosion-resistant alloys such as Invar®, Monel®, Inconel®, and the Hastelloys®. Tubing made of a copper-nickel alloy is extensively used in making desalination plants for converting sea water into fresh water. Nickel is also now used extensively in coinage and in making nickel steel for armor plate and burglar-proof vaults, and is a component in Nichrome®, Permalloy®, and constantan. Nickel added to glass gives a green color. Nickel plating is often used to provide a protective coating for other metals, and finely divided nickel is a catalyst for hydrogenating vegetable oils. It is also used in ceramics, in the manufacture of Alnico magnets, and in batteries. The sulfate and the

oxides are important compounds. Natural nickel is a mixture of five stable isotopes; twenty-five other unstable isotopes are known. Nickel sulfide fume and dust, as well as other nickel compounds, are carcinogens. Nickel metal (99.9%) is priced at about \$2/g or less in larger quantities.

**Niobium** — (*Niobe*, daughter of Tantalus), Nb; or Columbium (*Columbia*, name for America); at. wt. 92.90638(2); at. no. 41; m.p. 2477°C; b.p. 4744°C, sp. gr. 8.57 (20°C); valence 2, 3, 4?, 5. Discovered in 1801 by Hatchett in an ore sent to England more than a century before by John Winthrop the Younger, first governor of Connecticut. The metal was first prepared in 1864 by Blomstrand, who reduced the chloride by heating it in a hydrogen atmosphere. The name *niobium* was adopted by the International Union of Pure and Applied Chemistry in 1950 after 100 years of controversy. Most leading chemical societies and government organizations refer to it by this name. Some metallurgists and commercial producers, however, still refer to the metal as “columbium.” The element is found in *niobite* (or *columbite*), *niobite-tantalite*, *pyrochlore*, and *euxenite*. Large deposits of niobium have been found associated with *carbonatites* (carbon-silicate rocks), as a constituent of *pyrochlore*. Extensive ore reserves are found in Canada, Brazil, Congo-Kinshasa, Rwanda, and Australia. The metal can be isolated from tantalum, and prepared in several ways. It is a shiny, white, soft, and ductile metal, and takes on a bluish cast when exposed to air at room temperatures for a long time. The metal starts to oxidize in air at 200°C, and when processed at even moderate temperatures must be placed in a protective atmosphere. It is used in arc-welding rods for stabilized grades of stainless steel. Thousands of pounds of niobium have been used in advanced air frame systems such as were used in the Gemini space program. It has also found use in super-alloys for applications such as jet engine components, rocket sub-assemblies, and heat-resisting equipment. The element has superconductive properties; superconductive magnets have been made with Nb-Zr wire, which retains its superconductivity in strong magnetic fields. Natural niobium is composed of only one isotope, <sup>93</sup>Nb. Forty-seven other isotopes and isomers of niobium are now recognized. Niobium metal (99.9% pure) is priced at about 50¢/g.

**Nitrogen** — (*L. nitrum*, Gr. *nitron*, native soda; genes, *forming*, N; at. wt. 14.0067(2); at. no. 7; m.p. -210.00°C; b.p. -195.798°C;  $t_c$  -146.94°C; density 1.2506 g/L; sp. gr. liquid 0.808 (-195.8°C), solid 1.026 (-252°C); valence 3 or 5. Discovered by Daniel Rutherford in 1772, but Scheele, Cavendish, Priestley, and others about the same time studied “burnt or dephlogisticated air,” as air without oxygen was then called. Nitrogen makes up 78% of the air, by volume. The atmosphere of Mars, by comparison, is 2.6% nitrogen. The estimated amount of this element in our atmosphere is more than 4000 trillion tons. From this inexhaustible source it can be obtained by liquefaction and fractional distillation. Nitrogen molecules give the orange-red, blue-green, blue-violet, and deep violet shades to the aurora. The element is so inert that Lavoisier named it *azote*, meaning without life, yet its compounds are so active as to be most important in foods, poisons, fertilizers, and explosives. Nitrogen can be also easily prepared by heating a water solution of ammonium nitrite. Nitrogen, as a gas, is colorless, odorless, and a generally inert element. As a liquid it is also colorless and odorless, and is similar in appearance to water. Two allotropic forms of solid nitrogen exist, with the transition from the  $\alpha$  to the  $\beta$  form taking place at -237°C. When nitrogen is heated, it

combines directly with magnesium, lithium, or calcium; when mixed with oxygen and subjected to electric sparks, it forms first nitric oxide (NO) and then the dioxide (NO<sub>2</sub>); when heated under pressure with a catalyst with hydrogen, ammonia is formed (Haber process). The ammonia thus formed is of the utmost importance as it is used in fertilizers, and it can be oxidized to nitric acid (Ostwald process). The ammonia industry is the largest consumer of nitrogen. Large amounts of gas are also used by the electronics industry, which uses the gas as a blanketing medium during production of such components as transistors, diodes, etc. Large quantities of nitrogen are used in annealing stainless steel and other steel mill products. The drug industry also uses large quantities. Nitrogen is used as a refrigerant both for the immersion freezing of food products and for transportation of foods. Liquid nitrogen is also used in missile work as a purge for components, insulators for space chambers, etc., and by the oil industry to build up great pressures in wells to force crude oil upward. Sodium and potassium nitrates are formed by the decomposition of organic matter with compounds of the metals present. In certain dry areas of the world these saltpeters are found in quantity. Ammonia, nitric acid, the nitrates, the five oxides (N<sub>2</sub>O, NO, N<sub>2</sub>O<sub>3</sub>, NO<sub>2</sub>, and N<sub>2</sub>O<sub>5</sub>), TNT, the cyanides, etc. are but a few of the important compounds. Nitrogen gas prices vary from 2¢ to \$2.75 per 100 ft<sup>3</sup> (2.83 cu. meters), depending on purity, etc. Production of elemental nitrogen in the U.S. is more than 9 million short tons per year. Natural nitrogen contains two isotopes, <sup>14</sup>N and <sup>15</sup>N. Ten other isotopes are known.

**Nobelium** — (Alfred Nobel [1833–1896], inventor of dynamite), No; at. wt. [259]; at. no. 102; valence +2, +3. Nobelium was unambiguously discovered and identified in April 1958 at Berkeley by A. Ghiorso, T. Sikkeland, J. R. Walton, and G. T. Seaborg, who used a new double-recoil technique. A heavy-ion linear accelerator (HILAC) was used to bombard a thin target of curium (95% <sup>244</sup>Cm and 4.5% <sup>246</sup>Cm) with <sup>12</sup>C ions to produce <sup>102</sup>254 according to the <sup>246</sup>Cm (<sup>12</sup>C, 4n) reaction. Earlier in 1957 workers of the U.S., Britain, and Sweden announced the discovery of an isotope of Element 102 with a 10-min half-life at 8.5 MeV, as a result of bombarding <sup>244</sup>Cm with <sup>13</sup>C nuclei. On the basis of this experiment the name *nobelium* was assigned and accepted by the Commission on Atomic Weights of the International Union of Pure and Applied Chemistry. The acceptance of the name was premature, for both Russian and American efforts now completely rule out the possibility of any isotope of Element 102 having a half-life of 10 min in the vicinity of 8.5 MeV. Early work in 1957 on the search for this element, in Russia at the Kurchatov Institute, was marred by the assignment of 8.9 ± 0.4 MeV alpha radiation with a half-life of 2 to 40 sec, which was too indefinite to support claim to discovery. Confirmatory experiments at Berkeley in 1966 have shown the existence of <sup>254</sup>102 with a 55-s half-life, <sup>252</sup>102 with a 2.3-s half-life, and <sup>257</sup>102 with a 25-s half-life. Twelve isotopes are now recognized, one of which — <sup>255</sup>102 — has a half-life of 3.1 min. In view of the discoverer’s traditional right to name an element, the Berkeley group, in 1967, suggested that the hastily given name *nobelium*, along with the symbol No, be retained.

**Osmium** — (Gr. *osme*, a smell), Os; at. wt. 190.23(3); at. no. 76; m.p. 3033°C; b.p. 5012°C; sp. gr. 22.587; valence 0 to +8, more usually +3, +4, +6, and +8. Discovered in 1803 by Tennant in the residue left when crude platinum is dissolved by *aqua regia*. Osmium occurs in *iridosmine* and in platinum-bearing

river sands of the Urals, North America, and South America. It is also found in the nickel-bearing ores of the Sudbury, Ontario, region along with other platinum metals. While the quantity of platinum metals in these ores is very small, the large tonnages of nickel ores processed make commercial recovery possible. The metal is lustrous, bluish white, extremely hard, and brittle even at high temperatures. It has the highest melting point and the lowest vapor pressure of the platinum group. The metal is very difficult to fabricate, but the powder can be sintered in a hydrogen atmosphere at a temperature of 2000°C. The solid metal is not affected by air at room temperature, but the powdered or spongy metal slowly gives off osmium tetroxide, which is a powerful oxidizing agent and has a strong smell. The tetroxide is highly toxic, and boils at 130°C (760 mm). Concentrations in air as low as  $10^{-7}$  g/m<sup>3</sup> can cause lung congestion, skin damage, or eye damage. The tetroxide has been used to detect fingerprints and to stain fatty tissue for microscope slides. The metal is almost entirely used to produce very hard alloys, with other metals of the platinum group, for fountain pen tips, instrument pivots, phonograph needles, and electrical contacts. The price of 99.9% pure osmium powder — the form usually supplied commercially — is about \$100/g, depending on quantity and supplier. Natural osmium contains seven isotopes, one of which, <sup>186</sup>Os, is radioactive with a very long half-life. Thirty-four other isotopes and isomers are known, all of which are radioactive. The measured densities of iridium and osmium seem to indicate that osmium is slightly more dense than iridium, so osmium has generally been credited with being the heaviest known element. Calculations of the density from the space lattice, which may be more reliable for these elements than actual measurements, however, give a density of 22.65 for iridium compared to 22.61 for osmium. At present, therefore, we know either iridium or osmium is the heaviest element, but the data do not allow selection between the two.

**Oxygen** — (Gr. *oxys*, sharp, acid, and *genes*, forming; acid former), O; at. wt. 15.9994(3); at. no. 8; t.p. -218.79°C; *t*<sub>c</sub> -118.56°C; valence 2. For many centuries, workers occasionally realized air was composed of more than one component. The behavior of oxygen and nitrogen as components of air led to the advancement of the phlogiston theory of combustion, which captured the minds of chemists for a century. Oxygen was prepared by several workers, including Bayen and Borch, but they did not know how to collect it, did not study its properties, and did not recognize it as an elementary substance. Priestley is generally credited with its discovery, although Scheele also discovered it independently. Oxygen is the third most abundant element found in the sun, and it plays a part in the carbon–nitrogen cycle, one process thought to give the sun and stars their energy. Oxygen under excited conditions is responsible for the bright red and yellow-green colors of the aurora. Oxygen, as a gaseous element, forms 21% of the atmosphere by volume from which it can be obtained by liquefaction and fractional distillation. The atmosphere of Mars contains about 0.15% oxygen. The element and its compounds make up 49.2%, by weight, of the Earth's crust. About two thirds of the human body and nine tenths of water is oxygen. In the laboratory it can be prepared by the electrolysis of water or by heating potassium chlorate with manganese dioxide as a catalyst. The gas is colorless, odorless, and tasteless. The liquid and solid forms are a pale blue color and are strongly paramagnetic. Ozone (O<sub>3</sub>), a highly active compound, is formed by the action of an

electrical discharge or ultraviolet light on oxygen. Ozone's presence in the atmosphere (amounting to the equivalent of a layer 3 mm thick at ordinary pressures and temperatures) is of vital importance in preventing harmful ultraviolet rays of the sun from reaching the Earth's surface. There has been recent concern that pollutants in the atmosphere may have a detrimental effect on this ozone layer. Ozone is toxic and exposure should not exceed 0.2 mg/m<sup>3</sup> (8-hour time-weighted average — 40-hour work week). Undiluted ozone has a bluish color. Liquid ozone is bluish black, and solid ozone is violet-black. Oxygen is very reactive and capable of combining with most elements. It is a component of hundreds of thousands of organic compounds. It is essential for respiration of all plants and animals and for practically all combustion. In hospitals it is frequently used to aid respiration of patients. Its atomic weight was used as a standard of comparison for each of the other elements until 1961 when the International Union of Pure and Applied Chemistry adopted carbon 12 as the new basis. Oxygen has thirteen recognized isotopes. Natural oxygen is a mixture of three isotopes. Oxygen 18 occurs naturally, is stable, and is available commercially. Water (H<sub>2</sub>O with 1.5% <sup>18</sup>O) is also available. Commercial oxygen consumption in the U.S. is estimated to be 20 million short tons per year and the demand is expected to increase substantially in the next few years. Oxygen enrichment of steel blast furnaces accounts for the greatest use of the gas. Large quantities are also used in making synthesis gas for ammonia and methanol, ethylene oxide, and for oxy-acetylene welding. Air separation plants produce about 99% of the gas, electrolysis plants about 1%. The gas costs 5¢/ft<sup>3</sup> (\$1.75/cu. meter) in small quantities.

**Palladium** — (named after the asteroid *Pallas*, discovered about the same time; Gr. *Pallas*, goddess of wisdom), Pd; at. wt. 106.42(1) at. no. 46; m.p. 1554.8°C; b.p. 2963°C; sp. gr. 12.02 (20°C); valence 2, 3, or 4. Discovered in 1803 by Wollaston. Palladium is found along with platinum and other metals of the platinum group in deposits of Russia, South Africa, Canada (Ontario), and elsewhere. Natural palladium contains six stable isotopes. Twenty-nine other isotopes are recognized, all of which are radioactive. It is frequently found associated with the nickel-copper deposits such as those found in Ontario. Its separation from the platinum metals depends upon the type of ore in which it is found. It is a steel-white metal, does not tarnish in air, and is the least dense and lowest melting of the platinum group of metals. When annealed, it is soft and ductile; cold working greatly increases its strength and hardness. Palladium is attacked by nitric and sulfuric acid. At room temperatures the metal has the unusual property of absorbing up to 900 times its own volume of hydrogen, possibly forming Pd<sub>2</sub>H. It is not yet clear if this a true compound. Hydrogen readily diffuses through heated palladium and this provides a means of purifying the gas. Finely divided palladium is a good catalyst and is used for hydrogenation and dehydrogenation reactions. It is alloyed and used in jewelry trades. White gold is an alloy of gold decolorized by the addition of palladium. Like gold, palladium can be beaten into leaf as thin as 1/250,000 in. The metal is used in dentistry, watchmaking, and in making surgical instruments and electrical contacts. Palladium recently has been substituted for higher priced platinum in catalytic converters by some automobile companies. This has caused a large increase in the cost of palladium. The prices of the two metals are now, in 2002, about the same. Palladium, however, is less resistant to poisoning



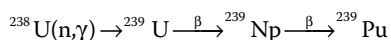
by sulfur and lead than platinum, but it may prove useful in controlling emissions from diesel vehicles. The metal sells for about \$350/tr. oz. (\$11/g).

**Phosphorus** — (Gr. *phosphoros*, light bearing; ancient name for the planet Venus when appearing before sunrise), P; at. wt. 30.973762(2); at. no. 15; m.p. (white) 44.15°C; b.p. 280.5°C; sp. gr. (white) 1.82, (red) 2.16, (black) 2.25 to 2.69; valence 3 or 5. Discovered in 1669 by Brand, who prepared it from urine. Phosphorus exists in four or more allotropic forms: white (or yellow), red, and black (or violet). White phosphorus has two modifications:  $\alpha$  and  $\beta$  with a transition temperature at  $-3.8^\circ\text{C}$ . Never found free in nature, it is widely distributed in combination with minerals. Twenty-one isotopes of phosphorus are recognized. *Phosphate* rock, which contains the mineral *apatite*, an impure tricalcium phosphate, is an important source of the element. Large deposits are found in the Russia, China, Morocco, and in Florida, Tennessee, Utah, Idaho, and elsewhere. Phosphorus is an essential ingredient of all cell protoplasm, nervous tissue, and bones. Ordinary phosphorus is a waxy white solid; when pure it is colorless and transparent. It is insoluble in water, but soluble in carbon disulfide. It takes fire spontaneously in air, burning to the pentoxide. It is very poisonous, 50 mg constituting an approximate fatal dose. Exposure to white phosphorus should not exceed 0.1 mg/m<sup>3</sup> (8-hour time-weighted average — 40-hour work week). White phosphorus should be kept under water, as it is dangerously reactive in air, and it should be handled with forceps, as contact with the skin may cause severe burns. When exposed to sunlight or when heated in its own vapor to 250°C, it is converted to the red variety, which does not phosphoresce in air as does the white variety. This form does not ignite spontaneously and it is not as dangerous as white phosphorus. It should, however, be handled with care as it does convert to the white form at some temperatures and it emits highly toxic fumes of the oxides of phosphorus when heated. The red modification is fairly stable, sublimates with a vapor pressure of 1 atm at 417°C, and is used in the manufacture of safety matches, pyrotechnics, pesticides, incendiary shells, smoke bombs, tracer bullets, etc. White phosphorus may be made by several methods. By one process, tricalcium phosphate, the essential ingredient of phosphate rock, is heated in the presence of carbon and silica in an electric furnace or fuel-fired furnace. Elementary phosphorus is liberated as vapor and may be collected under water. If desired, the phosphorus vapor and carbon monoxide produced by the reaction can be oxidized at once in the presence of moisture to produce phosphoric acid, an important compound in making super-phosphate fertilizers. In recent years, concentrated phosphoric acids, which may contain as much as 70 to 75% P<sub>2</sub>O<sub>5</sub> content, have become of great importance to agriculture and farm production. World-wide demand for fertilizers has caused record phosphate production. Phosphates are used in the production of special glasses, such as those used for sodium lamps. Bone-ash, calcium phosphate, is also used to produce fine chinaware and to produce monocalcium phosphate used in baking powder. Phosphorus is also important in the production of steels, phosphor bronze, and many other products. Trisodium phosphate is important as a cleaning agent, as a water softener, and for preventing boiler scale and corrosion of pipes and boiler tubes. Organic compounds of phosphorus are important. Amorphous (red) phosphorus costs about \$70/kg (99%).

**Platinum** — (It. *platina*, silver), Pt; at. wt. 195.084(9); at. no. 78; m.p. 1768.2°C; b.p. 3825°C; sp. gr. 21.45 (20°C); valence 1, 2, 3, or 4. Discovered in South America by Ulloa in 1735 and by Wood in 1741. The metal was used by pre-Columbian Indians. Platinum occurs native, accompanied by small quantities of iridium, osmium, palladium, ruthenium, and rhodium, all belonging to the same group of metals. These are found in the alluvial deposits of the Ural mountains and in Columbia. *Sperrylite* (PtAs<sub>2</sub>), occurring with the nickel-bearing deposits of Sudbury, Ontario, is a source of a considerable amount of metal. The large production of nickel offsets there being only one part of the platinum metals in two million parts of ore. The largest supplier of the platinum group of metals is now South Africa, followed by Russia and Canada. Platinum is a beautiful silvery-white metal, when pure, and is malleable and ductile. It has a coefficient of expansion almost equal to that of soda-lime-silica glass, and is therefore used to make sealed electrodes in glass systems. The metal does not oxidize in air at any temperature, but is corroded by halogens, cyanides, sulfur, and caustic alkalis. It is insoluble in hydrochloric and nitric acid, but dissolves when they are mixed as *aqua regia*, forming chloroplatinic acid (H<sub>2</sub>PtCl<sub>6</sub>), an important compound. Natural platinum contains six isotopes, one of which, <sup>190</sup>Pt, is radioactive with a long half-life. Thirty-seven other radioactive isotopes and isomers are recognized. The metal is used extensively in jewelry, wire, and vessels for laboratory use, and in many valuable instruments including thermocouple elements. It is also used for electrical contacts, corrosion-resistant apparatus, and in dentistry. Platinum-cobalt alloys have magnetic properties. One such alloy made of 76.7% Pt and 23.3% Co, by weight, is an extremely powerful magnet that offers a B-H (max) almost twice that of Alnico V. Platinum resistance wires are used for constructing high-temperature electric furnaces. The metal is used for coating missile nose cones, jet engine fuel nozzles, etc., which must perform reliably for long periods of time at high temperatures. The metal, like palladium, absorbs large volumes of hydrogen, retaining it at ordinary temperatures but giving it up at red heat. In the finely divided state platinum is an excellent catalyst, having long been used in the contact process for producing sulfuric acid. It is also used as a catalyst in cracking petroleum products. There is also much current interest in the use of platinum as a catalyst in fuel cells and in its use as antipollution devices for automobiles. Platinum anodes are extensively used in cathodic protection systems for large ships and ocean-going vessels, pipelines, steel piers, etc. Pure platinum wire will glow red hot when placed in the vapor of methyl alcohol. It acts here as a catalyst, converting the alcohol to formaldehyde. This phenomenon has been used commercially to produce cigarette lighters and hand warmers. Hydrogen and oxygen explode in the presence of platinum. The price of platinum has varied widely; more than a century ago it was used to adulterate gold. It was nearly eight times as valuable as gold in 1920. The price in January 2002 was about \$430/troy oz. (\$15/g), higher than the price of gold.

**Plutonium** — (planet *Pluto*), Pu; at. wt. (244); at. no. 94; sp. gr. ( $\alpha$  modification) 19.84 (25°C); m.p. 640°C; b.p. 3228°C; valence 3, 4, 5, or 6. Plutonium was the second transuranium element of the actinide series to be discovered. The isotope <sup>238</sup>Pu was produced in 1940 by Seaborg, McMillan, Kennedy, and Wahl by deuteron bombardment of uranium in the 60-inch cyclotron at Berkeley, California. Plutonium also exists

in trace quantities in naturally occurring uranium ores. It is formed in much the same manner as neptunium, by irradiation of natural uranium with the neutrons that are present. By far of greatest importance is the isotope  $\text{Pu}^{239}$ , with a half-life of 24,100 years, produced in extensive quantities in nuclear reactors from natural uranium:



Nineteen isotopes of plutonium are now known. Plutonium has assumed the position of dominant importance among the transuranium elements because of its successful use as an explosive ingredient in nuclear weapons and the place it holds as a key material in the development of industrial use of nuclear power. One kilogram is equivalent to about 22 million kilowatt hours of heat energy. The complete detonation of a kilogram of plutonium produces an explosion equal to about 20,000 tons of chemical explosive. Its importance depends on the nuclear property of being readily fissionable with neutrons and its availability in quantity. The world's nuclear-power reactors are now producing about 20,000 kg of plutonium/yr. By 1982 it was estimated that about 300,000 kg had accumulated. The various nuclear applications of plutonium are well known.  $^{238}\text{Pu}$  has been used in the Apollo lunar missions to power seismic and other equipment on the lunar surface. As with neptunium and uranium, plutonium metal can be prepared by reduction of the trifluoride with alkaline-earth metals. The metal has a silvery appearance and takes on a yellow tarnish when slightly oxidized. It is chemically reactive. A relatively large piece of plutonium is warm to the touch because of the energy given off in alpha decay. Larger pieces will produce enough heat to boil water. The metal readily dissolves in concentrated hydrochloric acid, hydroiodic acid, or perchloric acid with formation of the  $\text{Pu}^{+3}$  ion. The metal exhibits six allotropic modifications having various crystalline structures. The densities of these vary from 16.00 to 19.86 g/cm<sup>3</sup>. Plutonium also exhibits four ionic valence states in aqueous solutions:  $\text{Pu}^{+3}$  (blue lavender),  $\text{Pu}^{+4}$  (yellow brown),  $\text{PuO}^+$  (pink?), and  $\text{PuO}^{+2}$  (pink orange). The ion  $\text{PuO}^+$  is unstable in aqueous solutions, disproportionating into  $\text{Pu}^{+4}$  and  $\text{PuO}^{+2}$ . The  $\text{Pu}^{+4}$  thus formed, however, oxidizes the  $\text{PuO}^+$  into  $\text{PuO}^{+2}$ , itself being reduced to  $\text{Pu}^{+3}$ , giving finally  $\text{Pu}^{+3}$  and  $\text{PuO}^{+2}$ . Plutonium forms binary compounds with oxygen:  $\text{PuO}$ ,  $\text{PuO}_2$ , and intermediate oxides of variable composition; with the halides:  $\text{PuF}_3$ ,  $\text{PuF}_4$ ,  $\text{PuCl}_3$ ,  $\text{PuBr}_3$ ,  $\text{PuI}_3$ ; with carbon, nitrogen, and silicon:  $\text{PuC}$ ,  $\text{PuN}$ ,  $\text{PuSi}_2$ . Oxyhalides are also well known:  $\text{PuOCl}$ ,  $\text{PuOBr}$ ,  $\text{PuOI}$ . Because of the high rate of emission of alpha particles and the element being specifically absorbed by bone marrow, plutonium, as well as all of the other transuranium elements except neptunium, are radiological poisons and must be handled with very special equipment and precautions. Plutonium is a very dangerous radiological hazard. Precautions must also be taken to prevent the unintentional formation of a critical mass. Plutonium in liquid solution is more likely to become critical than solid plutonium. The shape of the mass must also be considered where criticality is concerned. Plutonium-239 is available to authorized users from the O.R.N.L. at a cost of about \$4.80/mg (99.9%) plus packing costs.

**Polonium** — (Poland, native country of Mme. Curie [1867–1934]), Po; at. wt. (209); at. no. 84; m.p. 254°C; b.p. 962°C; sp. gr. 9.20; valence -2, 0, +2, +3(?), +4, and +6. Polonium was the first element discovered by Mme. Curie in 1898, while seeking

the cause of radioactivity of pitchblende from Joachimsthal, Bohemia. The electroscope showed it separating with bismuth. Polonium is also called Radium F. Polonium is a very rare natural element. Uranium ores contain only about 100 µg of the element per ton. Its abundance is only about 0.2% of that of radium. In 1934, it was found that when natural bismuth ( $^{209}\text{Bi}$ ) was bombarded by neutrons,  $^{210}\text{Bi}$ , the parent of polonium, was obtained. Milligram amounts of polonium may now be prepared this way, by using the high neutron fluxes of nuclear reactors. Polonium-210 is a low-melting, fairly volatile metal, 50% of which is vaporized in air in 45 hours at 55°C. It is an alpha emitter with a half-life of 138.39 days. A milligram emits as many alpha particles as 5 g of radium. The energy released by its decay is so large (140 W/g) that a capsule containing about half a gram reaches a temperature above 500°C. The capsule also presents a contact gamma-ray dose rate of 0.012 Gy/h. A few curies (1 curie =  $3.7 \times 10^{10}$  Bq) of polonium exhibit a blue glow, caused by excitation of the surrounding gas. Because almost all alpha radiation is stopped within the solid source and its container, giving up its energy, polonium has attracted attention for uses as a lightweight heat source for thermoelectric power in space satellites. Thirty-eight isotopes and isomers of polonium are known, with atomic masses ranging from 192 to 218. All are radioactive. Polonium-210 is the most readily available. Isotopes of mass 209 (half-life 102 years) and mass 208 (half-life 2.9 years) can be prepared by alpha, proton, or deuteron bombardment of lead or bismuth in a cyclotron, but these are expensive to produce. Metallic polonium has been prepared from polonium hydroxide and some other polonium compounds in the presence of concentrated aqueous or anhydrous liquid ammonia. Two allotropic modifications are known to exist. Polonium is readily dissolved in dilute acids, but is only slightly soluble in alkalis. Polonium salts of organic acids char rapidly; halide amines are reduced to the metal. Polonium can be mixed or alloyed with beryllium to provide a source of neutrons. It has been used in devices for eliminating static charges in textile mills, etc.; however, beta sources are more commonly used and are less dangerous. It is also used on brushes for removing dust from photographic films. The polonium for these is carefully sealed and controlled, minimizing hazards to the user. Polonium-210 is very dangerous to handle in even milligram or microgram amounts, and special equipment and strict control are necessary. Damage arises from the complete absorption of the energy of the alpha particle into tissue. The maximum permissible body burden for ingested polonium is only 0.03 µCi, which represents a particle weighing only  $6.8 \times 10^{-12}$  g. Weight for weight it is about  $2.5 \times 10^{11}$  times as toxic as hydrocyanic acid. The maximum allowable concentration for soluble polonium compounds in air is about  $2 \times 10^{11}$  µCi/cm<sup>3</sup>. Polonium-209 is available on special order from the Oak Ridge National Laboratory at a cost of \$3600/µCi plus packing costs.

**Potassium** — (English, *potash* — pot ashes; L. *kalium*, Arab. *qali*, alkali), K; at. wt. 39.0983(1); at. no. 19; m.p. 63.5°C; b.p. 759°C; sp. gr. 0.89; valence 1. Discovered in 1807 by Davy, who obtained it from caustic potash (KOH); this was the first metal isolated by electrolysis. The metal is the seventh most abundant and makes up about 2.4% by weight of the Earth's crust. Most potassium minerals are insoluble and the metal is obtained from them only with great difficulty. Certain minerals, however, such as *sylvite*, *carnallite*, *langbeinite*, and *polyhalite* are found in ancient lake and sea beds and form rather extensive deposits from which potassium and its salts can readily be obtained.

Potash is mined in Germany, New Mexico, California, Utah, and elsewhere. Large deposits of potash, found at a depth of some 1000 m in Saskatchewan, promise to be important in coming years. Potassium is also found in the ocean, but is present only in relatively small amounts compared to sodium. The greatest demand for potash has been in its use for fertilizers. Potassium is an essential constituent for plant growth and it is found in most soils. Potassium is never found free in nature, but is obtained by electrolysis of the hydroxide, much in the same manner as prepared by Davy. Thermal methods also are commonly used to produce potassium (such as by reduction of potassium compounds with  $\text{CaC}_2$ , C, Si, or Na). It is one of the most reactive and electropositive of metals. Except for lithium, it is the lightest known metal. It is soft, easily cut with a knife, and is silvery in appearance immediately after a fresh surface is exposed. It rapidly oxidizes in air and should be preserved in a mineral oil. As with other metals of the alkali group, it decomposes in water with the evolution of hydrogen. It catches fire spontaneously on water. Potassium and its salts impart a violet color to flames. Twenty-one isotopes, one of which is an isomer, of potassium are known. Ordinary potassium is composed of three isotopes, one of which is  $^{40}\text{K}$  (0.0117%), a radioactive isotope with a half-life of  $1.26 \times 10^9$  years. The radioactivity presents no appreciable hazard. An alloy of sodium and potassium (NaK) is used as a heat-transfer medium. Many potassium salts are of utmost importance, including the hydroxide, nitrate, carbonate, chloride, chlorate, bromide, iodide, cyanide, sulfate, chromate, and dichromate. Metallic potassium is available commercially for about \$1200/kg (98% purity) or \$75/g (99.95% purity).

**Praseodymium** — (Gr. *praios*, green, and *didymos*, twin), Pr; at. wt. 140.90765(2); at. no. 59; m.p. 931°C; b.p. 3520°C; sp. gr. 6.773; valence 3. In 1841 Mosander extracted the rare earth *didymia* from *lanthana*; in 1879, Lecoq de Boisbaudran isolated a new earth, *samarium*, from didymia obtained from the mineral *samaraskite*. Six years later, in 1885, von Welsbach separated didymia into two others, *praseodymia* and *neodymia*, which gave salts of different colors. As with other rare earths, compounds of these elements in solution have distinctive sharp spectral absorption bands or lines, some of which are only a few Angstroms wide. The element occurs along with other rare-earth elements in a variety of minerals. *Monazite* and *bastnasite* are the two principal commercial sources of the rare-earth metals. Ion-exchange and solvent extraction techniques have led to much easier isolation of the rare earths and the cost has dropped greatly. Thirty-seven isotopes and isomers are now recognized. Praseodymium can be prepared by several methods, such as by calcium reduction of the anhydrous chloride or fluoride. Misch metal, used in making cigarette lighters, contains about 5% praseodymium metal. Praseodymium is soft, silvery, malleable, and ductile. It was prepared in relatively pure form in 1931. It is somewhat more resistant to corrosion in air than europium, lanthanum, cerium, or neodymium, but it does develop a green oxide coating that splits off when exposed to air. As with other rare-earth metals it should be kept under a light mineral oil or sealed in plastic. The rare-earth oxides, including  $\text{Pr}_2\text{O}_3$ , are among the most refractory substances known. Along with other rare earths, it is widely used as a core material for carbon arcs used by the motion picture industry for studio lighting and projection. Salts of praseodymium are used to color glasses and enamels; when mixed with certain other materials, praseodymium produces an intense and unusually clean yellow color

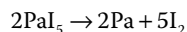
in glass. Didymium glass, of which praseodymium is a component, is a colorant for welder's goggles. The metal (99.9% pure) is priced at about \$4/g.

**Promethium** — (*Prometheus*, who, according to mythology, stole fire from heaven), Pm; at. no. 61; at. wt. (145); m.p. 1042°C; b.p. 3000°C (est.); sp. gr. 7.264 (25°C); valence 3. In 1902 Branner predicted the existence of an element between neodymium and samarium, and this was confirmed by Moseley in 1914. Unsuccessful searches were made for this predicted element over two decades, and various investigators proposed the names "illinium," "florentium," and "cyclonium" for this element. In 1941, workers at Ohio State University irradiated neodymium and praseodymium with neutrons, deuterons, and alpha particles, resp., and produced several new radioactivities, which most likely were those of Element 61. Wu and Segre, and Bethe, in 1942, confirmed the formation; however, chemical proof of the production of Element 61 was lacking because of the difficulty in separating the rare earths from each other at that time. In 1945, Marinisky, Glendenin, and Coryell made the first chemical identification by using ion-exchange chromatography. Their work was done by fission of uranium and by neutron bombardment of neodymium. These investigators named the newly discovered element. Searches for the element on Earth have been fruitless, and it now appears that promethium is completely missing from the Earth's crust. Promethium, however, has been reported to be in the spectrum of the star HR<sup>465</sup> in Andromeda. It must be formed near the star's surface, for no known isotope of promethium has a half-life longer than 17.7 years. Thirty-five isotopes and isomers of promethium, with atomic masses from 130 to 158 are now known. Promethium-145, with a half-life of 17.7 years, is the most useful. Promethium-145 has a specific activity of 940 Ci/g. It is a soft beta emitter; although no gamma rays are emitted, X-radiation can be generated when beta particles impinge on elements of a high atomic number, and great care must be taken in handling it. Promethium salts luminesce in the dark with a pale blue or greenish glow, due to their high radioactivity. Ion-exchange methods led to the preparation of about 10 g of promethium from atomic reactor fuel processing wastes in early 1963. Little is yet generally known about the properties of metallic promethium. Two allotropic modifications exist. The element has applications as a beta source for thickness gages, and it can be absorbed by a phosphor to produce light. Light produced in this manner can be used for signs or signals that require dependable operation; it can be used as a nuclear-powered battery by capturing light in photocells that convert it into electric current. Such a battery, using  $^{147}\text{Pm}$ , would have a useful life of about 5 years. It is being used for fluorescent lighting starters and coatings for self-luminous watch dials. Promethium shows promise as a portable X-ray source, and it may become useful as a heat source to provide auxiliary power for space probes and satellites. More than 30 promethium compounds have been prepared. Most are colored.

**Protactinium** — (Gr. *protos*, first), Pa; at. wt. 231.03588(2); at. no. 91; m.p. 1572°C; sp. gr. 15.37 (calc.); valence 4 or 5. The first isotope of Element 91 to be discovered was  $^{234}\text{Pa}$ , also known as  $\text{UX}_2$ , a short-lived member of the naturally occurring  $^{238}\text{U}$  decay series. It was identified by K. Fajans and O. H. Gohring in 1913 and they named the new element *brevium*. When the longer-lived isotope  $^{231}\text{Pa}$  was identified by Hahn and Meitner



in 1918, the name protoactinium was adopted as being more consistent with the characteristics of the most abundant isotope. Soddy, Cranson, and Fleck were also active in this work. The name *protoactinium* was shortened to *protactinium* in 1949. In 1927, Grosse prepared 2 mg of a white powder, which was shown to be Pa<sub>2</sub>O<sub>5</sub>. Later, in 1934, from 0.1 g of pure Pa<sub>2</sub>O<sub>5</sub>, he isolated the element by two methods, one of which was by converting the oxide to an iodide and "cracking" it in a high vacuum by an electrically heated filament by the reaction



Protactinium has a bright metallic luster that it retains for some time in air. The element occurs in *pitchblende* to the extent of about 1 part <sup>231</sup>Pa to 10 million of ore. Ores from Congo-Kinshasa have about 3 ppm. Protactinium has twenty-eight isotopes and isomers, the most common of which is <sup>231</sup>Pa with a half-life of 32,500 years. A number of protactinium compounds are known, some of which are colored. The element is superconductive below 1.4 K. The element is a dangerous toxic material and requires precautions similar to those used when handling plutonium. In 1959 and 1961, it was announced that the Great Britain Atomic Energy Authority extracted by a 12-stage process 125 g of 99.9% protactinium, the world's only stock of the metal for many years to come. The extraction was made from 60 tons of waste material at a cost of about \$500,000. Protactinium is one of the rarest and most expensive naturally occurring elements.

**Radium** — (L. *radius*, ray), Ra; at. wt. (226); at. no. 88; m.p. 696°C; sp. gr. 5; valence 2. Radium was discovered in 1898 by M. and Mme. Curie in the *pitchblende* or *uraninite* of North Bohemia (Czech Republic), where it occurs. There is about 1 g of radium in 7 tons of pitchblende. The element was isolated in 1911 by Mme. Curie and Debierne by the electrolysis of a solution of pure radium chloride, employing a mercury cathode; on distillation in an atmosphere of hydrogen this amalgam yielded the pure metal. Originally, radium was obtained from the rich pitchblende ore found at Joachimsthal, Bohemia. The *carnotite* sands of Colorado furnish some radium, but richer ores are found in the Republic of Congo-Kinshasa and the Great Bear Lake region of Canada. Radium is present in all uranium minerals, and could be extracted, if desired, from the extensive wastes of uranium processing. Large uranium deposits are located in Ontario, New Mexico, Utah, Australia, and elsewhere. Radium is obtained commercially as the bromide or chloride; it is doubtful if any appreciable stock of the isolated element now exists. The pure metal is brilliant white when freshly prepared, but blackens on exposure to air, probably due to formation of the nitride. It exhibits luminescence, as do its salts; it decomposes in water and is somewhat more volatile than barium. It is a member of the alkaline-earth group of metals. Radium imparts a carmine red color to a flame. Radium emits alpha, beta, and gamma rays and when mixed with beryllium produce neutrons. One gram of <sup>226</sup>Ra undergoes  $3.7 \times 10^{10}$  disintegrations per s. The *curie* (Ci) is defined as that amount of radioactivity which has the same disintegration rate as 1 g of <sup>226</sup>Ra. Thirty-six isotopes are now known; radium 226, the common isotope, has a half-life of 1599 years. One gram of radium produces about 0.0001 mL (stp) of emanation, or radon gas, per day. This is pumped from the radium and sealed in minute tubes, which are used in the treatment of cancer and other diseases. One gram of radium yields about 4186 kJ per year. Radium is used in producing self-luminous

paints, neutron sources, and in medicine for the treatment of cancer. Some of the more recently discovered radioisotopes, such as <sup>60</sup>Co, are now being used in place of radium. Some of these sources are much more powerful, and others are safer to use. Radium loses about 1% of its activity in 25 years, being transformed into elements of lower atomic weight. Lead is a final product of disintegration. Stored radium should be ventilated to prevent build-up of radon. Inhalation, injection, or body exposure to radium can cause cancer and other body disorders. The maximum permissible burden in the total body for <sup>226</sup>Ra is 7400 becquerel.

**Radon** — (from *radium*; called *niton* at first, L. *nitens*, shining), Rn; at. wt. (222); at. no. 86; m.p. -71°C; b.p. -61.7°C; *t*<sub>c</sub> 104°C; density of gas 9.73 g/L; sp. gr. liquid 4.4 at -62°C, solid 4; valence usually 0. The element was discovered in 1900 by Dorn, who called it *radium emanation*. In 1908 Ramsay and Gray, who named it *niton*, isolated the element and determined its density, finding it to be the heaviest known gas. It is essentially inert and occupies the last place in the zero group of gases in the Periodic Table. Since 1923, it has been called radon. Thirty-seven isotopes and isomers are known. Radon-222, coming from radium, has a half-life of 3.823 days and is an alpha emitter; Radon-220, emanating naturally from thorium and called *thoron*, has a half-life of 55.6 s and is also an alpha emitter. Radon-219 emanates from actinium and is called *actinon*. It has a half-life of 3.9 s and is also an alpha emitter. It is estimated that every square mile of soil to a depth of 6 inches contains about 1 g of radium, which releases radon in tiny amounts to the atmosphere. Radon is present in some spring waters, such as those at Hot Springs, Arkansas. On the average, one part of radon is present to  $1 \times 10^{21}$  part of air. At ordinary temperatures radon is a colorless gas; when cooled below the freezing point, radon exhibits a brilliant phosphorescence which becomes yellow as the temperature is lowered and orange-red at the temperature of liquid air. It has been reported that fluorine reacts with radon, forming radon fluoride. Radon clathrates have also been reported. Radon is still produced for therapeutic use by a few hospitals by pumping it from a radium source and sealing it in minute tubes, called seeds or needles, for application to patients. This practice has now been largely discontinued as hospitals can order the seeds directly from suppliers, who make up the seeds with the desired activity for the day of use. Care must be taken in handling radon, as with other radioactive materials. The main hazard is from inhalation of the element and its solid daughters, which are collected on dust in the air. Good ventilation should be provided where radium, thorium, or actinium is stored to prevent build-up of this element. Radon build-up is a health consideration in uranium mines. Recently radon build-up in homes has been a concern. Many deaths from lung cancer are caused by radon exposure. In the U.S. it is recommended that remedial action be taken if the air from radon in homes exceeds 4 pCi/L.

**Rhenium** — (L. *Rhenus*, Rhine), Re; at. wt. 186.207(1); at. no. 75; m.p. 3185°C; b.p. 5596°C; sp. gr. 20.8 (20°C); valence -1, +1, 2, 3, 4, 5, 6, 7. Discovery of rhenium is generally attributed to Noddack, Tacke, and Berg, who announced in 1925 they had detected the element in platinum ores and *columbite*. They also found the element in *gadolinite* and *molybdenite*. By working up 660 kg of molybdenite they were able in 1928 to extract 1 g of rhenium. The price in 1928 was \$10,000/g. Rhenium does not occur free in nature or as a compound in a distinct mineral

species. It is, however, widely spread throughout the Earth's crust to the extent of about 0.001 ppm. Commercial rhenium in the U.S. today is obtained from molybdenite roaster-flue dusts obtained from copper-sulfide ores mined in the vicinity of Miami, Arizona, and elsewhere in Arizona and Utah. Some molybdenites contain from 0.002 to 0.2% rhenium. It is estimated that in 1999 about 16,000 kg of rhenium was being produced. The total estimated world reserves of rhenium is 11,000,000 kg. Natural rhenium is a mixture of two isotopes, one of which has a very long half-life. Thirty-nine other unstable isotopes are recognized. Rhenium metal is prepared by reducing ammonium perrhenate with hydrogen at elevated temperatures. The element is silvery white with a metallic luster; its density is exceeded by that of only platinum, iridium, and osmium, and its melting point is exceeded by that of only tungsten and carbon. It has other useful properties. The usual commercial form of the element is a powder, but it can be consolidated by pressing and resistance-sintering in a vacuum or hydrogen atmosphere. This produces a compact shape in excess of 90% of the density of the metal. Annealed rhenium is very ductile, and can be bent, coiled, or rolled. Rhenium is used as an additive to tungsten and molybdenum-based alloys to impart useful properties. It is widely used for filaments for mass spectrographs and ion gages. Rhenium-molybdenum alloys are superconductive at 10 K. Rhenium is also used as an electrical contact material as it has good wear resistance and withstands arc corrosion. Thermocouples made of Re-W are used for measuring temperatures up to 2200°C, and rhenium wire has been used in photoflash lamps for photography. Rhenium catalysts are exceptionally resistant to poisoning from nitrogen, sulfur, and phosphorus, and are used for hydrogenation of fine chemicals, hydrocracking, reforming, and disproportionation of olefins. Rhenium has recently become especially important as a catalyst for petroleum refining and in making super-alloys for jet engines. Rhenium costs about \$16/g (99.99% pure). Little is known of its toxicity; therefore, it should be handled with care until more data are available.

**Rhodium** — (Gr. *rhodon*, rose), Rh; at. wt. 102.90550(2); at. no. 45; m.p. 1964°C; b.p. 3695°C; sp. gr. 12.41 (20°C); valence 2, 3, 4, 5, and 6. Wollaston discovered rhodium in 1803-4 in crude platinum ore he presumably obtained from South America. Rhodium occurs native with other platinum metals in river sands of the Urals and in North and South America. It is also found with other platinum metals in the copper-nickel sulfide ores of the Sudbury, Ontario region. Although the quantity occurring here is very small, the large tonnages of nickel processed make the recovery commercially feasible. The annual world production of rhodium in 1999 was only about 9000 kg. The metal is silvery white and at red heat slowly changes in air to the sesquioxide. At higher temperatures it converts back to the element. Rhodium has a higher melting point and lower density than platinum. Its major use is as an alloying agent to harden platinum and palladium. Such alloys are used for furnace windings, thermocouple elements, bushings for glass fiber production, electrodes for aircraft spark plugs, and laboratory crucibles. It is useful as an electrical contact material as it has a low electrical resistance, a low and stable contact resistance, and is highly resistant to corrosion. Plated rhodium, produced by electroplating or evaporation, is exceptionally hard and is used for optical instruments. It has a high reflectance and is hard and durable. Rhodium is also used for jewelry, for decoration, and as a catalyst. Fifty-two isotopes

and isomers are now known. Rhodium metal (powder) costs about \$180/g (99.9%).

**Roentgenium** — (Wilhelm Roentgen, discoverer of X-rays), Rg. On December 20, 1994, scientists at GSI Darmstadt, Germany announced they had detected three atoms of a new element with 111 protons and 161 neutrons. This element was made by bombarding  $^{83}\text{Bi}$  with  $^{28}\text{Ni}$ . Signals of Element 111 appeared for less than 0.002 s, then decayed into lighter elements including Element  $^{268}109$  and Element  $^{264}107$ . These isotopes had not previously been observed. In 2004 IUPAC approved the name roentgenium for Element 111. Roentgenium is expected to have properties similar to gold.

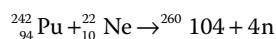
**Rubidium** — (L. *rubidus*, deepest red), Rb; at. wt. 85.4678(3); at. no. 37; m.p. 39.30°C; b.p. 688°C; sp. gr. (solid) 1.532 (20°C), (liquid) 1.475 (39°C); valence 1, 2, 3, 4. Discovered in 1861 by Bunsen and Kirchhoff in the mineral *lepidolite* by use of the spectroscope. The element is much more abundant than was thought several years ago. It is now considered to be the 16th most abundant element in the Earth's crust. Rubidium occurs in *pollucite*, *carnallite*, *leucite*, and *zinnwaldite*, which contains traces up to 1%, in the form of the oxide. It is found in lepidolite to the extent of about 1.5%, and is recovered commercially from this source. Potassium minerals, such as those found at Searles Lake, California, and potassium chloride recovered from brines in Michigan also contain the element and are commercial sources. It is also found along with cesium in the extensive deposits of *pollucite* at Bernic Lake, Manitoba. Rubidium can be liquid at room temperature. It is a soft, silvery-white metallic element of the alkali group and is the second most electropositive and alkaline element. It ignites spontaneously in air and reacts violently in water, setting fire to the liberated hydrogen. As with other alkali metals, it forms amalgams with mercury and it alloys with gold, cesium, sodium, and potassium. It colors a flame yellowish violet. Rubidium metal can be prepared by reducing rubidium chloride with calcium, and by a number of other methods. It must be kept under a dry mineral oil or in a vacuum or inert atmosphere. Thirty-five isotopes and isomers of rubidium are known. Naturally occurring rubidium is made of two isotopes,  $^{85}\text{Rb}$  and  $^{87}\text{Rb}$ . Rubidium-87 is present to the extent of 27.83% in natural rubidium and is a beta emitter with a half-life of  $4.9 \times 10^{10}$  years. Ordinary rubidium is sufficiently radioactive to expose a photographic film in about 30 to 60 days. Rubidium forms four oxides:  $\text{Rb}_2\text{O}$ ,  $\text{Rb}_2\text{O}_2$ ,  $\text{Rb}_2\text{O}_3$ ,  $\text{Rb}_2\text{O}_4$ . Because rubidium can be easily ionized, it has been considered for use in "ion engines" for space vehicles; however, cesium is somewhat more efficient for this purpose. It is also proposed for use as a working fluid for vapor turbines and for use in a thermoelectric generator using the magnetohydrodynamic principle where rubidium ions are formed by heat at high temperature and passed through a magnetic field. These conduct electricity and act like an armature of a generator thereby generating an electric current. Rubidium is used as a getter in vacuum tubes and as a photocell component. It has been used in making special glasses.  $\text{RbAg}_4\text{I}_5$  is important, as it has the highest room-temperature conductivity of any known ionic crystal. At 20°C its conductivity is about the same as dilute sulfuric acid. This suggests use in thin film batteries and other applications. The present cost in small quantities is about \$50/g (99.8% pure).

**Ruthenium** — (L. *Ruthenia*, Russia), Ru; at. wt. 101.07(2); at. no. 44, m.p. 2334°C; b.p. 4150°C; sp. gr. 12.1 (20°C); valence 0, 1, 2, 3, 4, 5, 6, 7, 8. Berzelius and Osann in 1827 examined the



residues left after dissolving crude platinum from the Ural mountains in *aqua regia*. While Berzelius found no unusual metals, Osann thought he found three new metals, one of which he named ruthenium. In 1844 Klaus, generally recognized as the discoverer, showed that Osann's ruthenium oxide was very impure and that it contained a new metal. Klaus obtained 6 g of ruthenium from the portion of crude platinum that is insoluble in *aqua regia*. A member of the platinum group, ruthenium occurs native with other members of the group of ores found in the Ural mountains and in North and South America. It is also found along with other platinum metals in small but commercial quantities in *pentlandite* of the Sudbury, Ontario, nickel-mining region, and in *pyroxinite* deposits of South Africa. Natural ruthenium contains seven isotopes. Twenty-eight other isotopes and isomers are known, all of which are radioactive. The metal is isolated commercially by a complex chemical process, the final stage of which is the hydrogen reduction of ammonium ruthenium chloride, which yields a powder. The powder is consolidated by powder metallurgy techniques or by argon-arc welding. Ruthenium is a hard, white metal and has four crystal modifications. It does not tarnish at room temperatures, but oxidizes in air at about 800°C. The metal is not attacked by hot or cold acids or *aqua regia*, but when potassium chlorate is added to the solution, it oxidizes explosively. It is attacked by halogens, hydroxides, etc. Ruthenium can be plated by electrodeposition or by thermal decomposition methods. The metal is one of the most effective hardeners for platinum and palladium, and is alloyed with these metals to make electrical contacts for severe wear resistance. A ruthenium–molybdenum alloy is said to be superconductive at 10.6 K. The corrosion resistance of titanium is improved a hundredfold by addition of 0.1% ruthenium. It is a versatile catalyst. Hydrogen sulfide can be split catalytically by light using an aqueous suspension of CdS particles loaded with ruthenium dioxide. It is thought this may have application to removal of H<sub>2</sub>S in oil refining and other industrial processes. Compounds in at least eight oxidation states have been found, but of these, the +2, +3, and +4 states are the most common. Ruthenium tetroxide, like osmium tetroxide, is highly toxic. In addition, it may explode. Ruthenium compounds show a marked resemblance to those of osmium. The metal is priced at about \$25/g (99.95% pure).

**Rutherfordium** — (Ernest Rutherford [1871–1937], New Zealand, Canadian, and British physicist); Rf; at. wt. [261]; at. no. 104. In 1964, workers of the Joint Nuclear Research Institute at Dubna (Russia) bombarded plutonium with accelerated 113 to 115 MeV neon ions. By measuring fission tracks in a special glass with a microscope, they detected an isotope that decays by spontaneous fission. They suggested that this isotope, which has a half-life of 0.3 ± 0.1 s, might be <sup>260</sup>104, produced by the following reaction:



Element 104, the first *transactinide* element, is expected to have chemical properties similar to those of hafnium. It would, for example, form a relatively volatile compound with chlorine (a tetrachloride). The Soviet scientists have performed experiments aimed at chemical identification, and have attempted to show that the 0.3-s activity is more volatile than that of the relatively nonvolatile actinide trichlorides. This experiment does not fulfill the test of chemically separating the new element from all others, but it provides important evidence for

evaluation. New data, reportedly issued by Soviet scientists, have reduced the half-life of the isotope they worked with from 0.3 to 0.15 s. The Dubna scientists suggest the name *kurchatovium* and symbol *Ku* for Element 104, in honor of Igor Vasilevich Kurchatov (1903–1960), late Head of Soviet Nuclear Research. The Dubna Group also has proposed the name *dubnium* for Element 104. In 1969, Ghiorso, Nurmia, Harris, K. A. Y. Eskola, and P. I. Eskola of the University of California at Berkeley reported they had positively identified two, and possibly three, isotopes of Element 104. The group also indicated that after repeated attempts so far they have been unable to produce isotope <sup>260</sup>104 reported by the Dubna groups in 1964. The discoveries at Berkeley were made by bombarding a target of <sup>249</sup>Cf with <sup>12</sup>C nuclei of 71 MeV, and <sup>13</sup>C nuclei of 69 MeV. The combination of <sup>12</sup>C with <sup>249</sup>Cf followed by instant emission of four neutrons produced Element <sup>257</sup>104. This isotope has a half-life of 4 to 5 s, decaying by emitting an alpha particle into <sup>253</sup>No, with a half-life of 105 s. The same reaction, except with the emission of three neutrons, was thought to have produced <sup>258</sup>104 with a half-life of about 1/100 s. Element <sup>259</sup>104 is formed by the merging of a <sup>13</sup>C nuclei with <sup>249</sup>Cf, followed by emission of three neutrons. This isotope has a half-life of 3 to 4 s, and decays by emitting an alpha particle into <sup>255</sup>No, which has a half-life of 185 s. Thousands of atoms of <sup>257</sup>104 and <sup>259</sup>104 have been detected. The Berkeley group believes its identification of <sup>258</sup>104 was correct. Eleven isotopes of Element 104 have now been identified. The Berkeley group proposed the name *rutherfordium* (symbol Rf) for the new element, in honor of Ernest Rutherford. This name was formally adapted by IUPAC in August 1997.

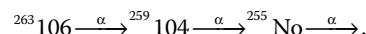
**Samarium** — (*Samarskite*, a mineral), Sm; at. wt. 150.36(3); at. no. 62; m.p. 1072°C; b.p. 1794°C; sp. gr (α) 7.520 (25°C); valence 2 or 3. Discovered spectroscopically by its sharp absorption lines in 1879 by Lecoq de Boisbaudran in the mineral *samarskite*, named in honor of a Russian mine official, Col. Samarski. Samarium is found along with other members of the rare-earth-elements in many minerals, including *monazite* and *bastnasite*, which are commercial sources. The largest producer of rare-earth minerals is now China, followed by the U.S., India, and Russia. It occurs in monazite to the extent of 2.8%. While *misch metal* containing about 1% of samarium metal has long been used, samarium has not been isolated in relatively pure form until recently. Ion-exchange and solvent extraction techniques have recently simplified separation of the rare earths from one another; more recently, electrochemical deposition, using an electrolytic solution of lithium citrate and a mercury electrode, is said to be a simple, fast, and highly specific way to separate the rare earths. Samarium metal can be produced by reducing the oxide with barium or lanthanum. Samarium has a bright silver luster and is reasonably stable in air. Three crystal modifications of the metal exist, with transformations at 734 and 922°C. The metal ignites in air at about 150°C. Thirty-three isotopes and isomers of samarium are now recognized. Natural samarium is a mixture of seven isotopes, three of which are unstable but have long half-lives. Samarium, along with other rare earths, is used for carbon-arc lighting for the motion picture industry. The sulfide has excellent high-temperature stability and good thermoelectric efficiencies up to 1100°C. SmCo<sub>5</sub> has been used in making a new permanent magnet material with the highest resistance to demagnetization of any known material. It is said to have an intrinsic coercive force as high as 2200 kA/m. Samarium oxide has been used in optical glass to absorb the infrared.

Samarium is used to dope calcium fluoride crystals for use in optical masers or lasers. Compounds of the metal act as sensitizers for phosphors excited in the infrared; the oxide exhibits catalytic properties in the dehydration and dehydrogenation of ethyl alcohol. It is used in infrared absorbing glass and as a neutron absorber in nuclear reactors. The metal is priced at about \$3.50/g (99.9%). Little is known of the toxicity of samarium; therefore, it should be handled carefully.

**Scandium** — (L. *Scandia*, Scandinavia), Sc; at. wt. 44.955912(6); at. no. 21; m.p. 1541°C; b.p. 2836°C; sp. gr. 2.989 (25°C); valence 3. On the basis of the Periodic System, Mendeleev predicted the existence of *ekaboron*, which would have an atomic weight between 40 of calcium and 48 of titanium. The element was discovered by Nilson in 1878 in the minerals *euxenite* and *gadolinite*, which had not yet been found anywhere except in Scandinavia. By processing 10 kg of euxenite and other residues of rare-earth minerals, Nilson was able to prepare about 2 g of scandium oxide of high purity. Cleve later pointed out that Nilson's scandium was identical with Mendeleev's *ekaboron*. Scandium is apparently a much more abundant element in the sun and certain stars than here on Earth. It is about the 23rd most abundant element in the sun, compared to the 50th most abundant on Earth. It is widely distributed on Earth, occurring in very minute quantities in over 800 mineral species. The blue color of beryl (aquamarine variety) is said to be due to scandium. It occurs as a principal component in the rare mineral *thortveitite*, found in Scandinavia and Malagasy. It is also found in the residues remaining after the extraction of tungsten from Zinnwald *wolframite*, and in *wiikite* and *bazzite*. Most scandium is presently being recovered from *thortveitite* or is extracted as a by-product from uranium mill tailings. Metallic scandium was first prepared in 1937 by Fischer, Brunger, and Grieneisen, who electrolyzed a eutectic melt of potassium, lithium, and scandium chlorides at 700 to 800°C. Tungsten wire and a pool of molten zinc served as the electrodes in a graphite crucible. Pure scandium is now produced by reducing scandium fluoride with calcium metal. The production of the first pound of 99% pure scandium metal was announced in 1960. Scandium is a silver-white metal that develops a slightly yellowish or pinkish cast upon exposure to air. It is relatively soft, and resembles yttrium and the rare-earth metals more than it resembles aluminum or titanium. It is a very light metal and has a much higher melting point than aluminum, making it of interest to designers of spacecraft. Scandium is not attacked by a 1:1 mixture of conc. HNO<sub>3</sub> and 48% HF. Scandium reacts rapidly with many acids. Twenty-three isotopes and isomers of scandium are recognized. The metal is expensive, costing about \$200/g with a purity of about 99.9%. About 20 kg of scandium (as Sc<sub>2</sub>O<sub>3</sub>) are now being used yearly in the U.S. to produce high-intensity lights, and the radioactive isotope <sup>46</sup>Sc is used as a tracing agent in refinery crackers for crude oil, etc. Scandium iodide added to mercury vapor lamps produces a highly efficient light source resembling sunlight, which is important for indoor or night-time color TV. Little is yet known about the toxicity of scandium; therefore, it should be handled with care.

**Seaborgium** — (Glenn T. Seaborg [1912–1999], American chemist and nuclear physicist). Sg; at. wt. [266]; at no. 106. The discovery of *Seaborgium*, Element 106, took place in 1974 almost simultaneously at the Lawrence-Berkeley Laboratory and at the Joint Institute for Nuclear Research at Dubna, Russia. The Berkeley Group, under direction of Ghiorso, used the Super-

Heavy Ion Linear Accelerator (Super HILAC) as a source of heavy <sup>18</sup>O ions to bombard a 259-μg target of <sup>249</sup>Cf. This resulted in the production and positive identification of <sup>263</sup>106, which decayed with a half-life of 0.9 ± 0.2 s by the emission of alpha particles as follows:



The Dubna Team, directed by Flerov and Organessian, produced heavy ions of <sup>54</sup>Cr with their 310-cm heavy-ion cyclotron to bombard <sup>207</sup>Pb and <sup>208</sup>Pb and found a product that decayed with a half-life of 7 ms. They assigned <sup>259</sup>106 to this isotope. It is now thought seven isotopes of *Seaborgium* have been identified. Two of the isotopes are believed to have half-lives of about 30 s. *Seaborgium* most likely would have properties resembling tungsten. The IUPAC adopted the name *Seaborgium* in August 1997. Normally the naming of an element is not given until after the death of the person for which the element is named; however, in this case, it was named while Dr. Seaborg was still alive.

**Selenium** — (Gr. *Selene*, moon), Se; at. wt. 78.96(3); at. no. 34; m.p. (gray) 221°C; b.p. (gray) 685°C; sp. gr. (gray) 4.79, (vitreous) 4.28; valence -2, +4, or +6. Discovered by Berzelius in 1817, who found it associated with tellurium, named for the Earth. Selenium is found in a few rare minerals, such as *crooksite* and *clausthalite*. In years past it has been obtained from flue dusts remaining from processing copper sulfide ores, but the anode muds from electrolytic copper refineries now provide the source of most of the world's selenium. Selenium is recovered by roasting the muds with soda or sulfuric acid, or by smelting them with soda and niter. Selenium exists in several allotropic forms. Three are generally recognized, but as many as six have been claimed. Selenium can be prepared with either an amorphous or crystalline structure. The color of amorphous selenium is either red, in powder form, or black, in vitreous form. Crystalline monoclinic selenium is a deep red; crystalline hexagonal selenium, the most stable variety, is a metallic gray. Natural selenium contains six stable isotopes. Twenty-nine other isotopes and isomers have been characterized. The element is a member of the sulfur family and resembles sulfur both in its various forms and in its compounds. Selenium exhibits both photovoltaic action, where light is converted directly into electricity, and photoconductive action, where the electrical resistance decreases with increased illumination. These properties make selenium useful in the production of photocells and exposure meters for photographic use, as well as solar cells. Selenium is also able to convert a.c. electricity to d.c., and is extensively used in rectifiers. Below its melting point, selenium is a p-type semiconductor and is finding many uses in electronic and solid-state applications. It is used in xerography for reproducing and copying documents, letters, etc., but recently its use in this application has been decreasing in favor of certain organic compounds. It is used by the glass industry to decolorize glass and to make ruby-colored glasses and enamels. It is also used as a photographic toner, and as an additive to stainless steel. Elemental selenium has been said to be practically nontoxic and is considered to be an essential trace element; however, hydrogen selenide and other selenium compounds are extremely toxic, and resemble arsenic in their physiological reactions. Hydrogen selenide in a concentration of 1.5 ppm is intolerable to man. Selenium occurs in some soils in amounts sufficient to produce serious effects on animals feeding on plants, such as locoweed, grown

in such soils. Selenium (99.5%) is priced at about \$250/kg. It is also available in high-purity form at a cost of about \$350/kg (99.999%).

**Silicon** — (L. *silex*, *silicis*, flint), Si; at. wt. 28.0855(3); at. no. 14; m.p. 1414°C; b.p. 3265°C; sp. gr. 2.33 (25°C); valence 4. Davy in 1800 thought silica to be a compound and not an element; later in 1811, Gay Lussac and Thenard probably prepared impure amorphous silicon by heating potassium with silicon tetrafluoride. Berzelius, generally credited with the discovery, in 1824 succeeded in preparing amorphous silicon by the same general method as used earlier, but he purified the product by removing the fluosilicates by repeated washings. Deville in 1854 first prepared crystalline silicon, the second allotropic form of the element. Silicon is present in the sun and stars and is a principal component of a class of meteorites known as “aerolites.” It is also a component of *tektites*, a natural glass of uncertain origin. Natural silicon contains three isotopes. Twenty-four other radioactive isotopes are recognized. Silicon makes up 25.7% of the Earth’s crust, by weight, and is the second most abundant element, being exceeded only by oxygen. Silicon is not found free in nature, but occurs chiefly as the oxide and as silicates. *Sand, quartz, rock crystal, amethyst, agate, flint, jasper, and opal* are some of the forms in which the oxide appears. *Granite, hornblende, asbestos, feldspar, clay mica*, etc. are but a few of the numerous silicate minerals. Silicon is prepared commercially by heating silica and carbon in an electric furnace, using carbon electrodes. Several other methods can be used for preparing the element. Amorphous silicon can be prepared as a brown powder, which can be easily melted or vaporized. Crystalline silicon has a metallic luster and grayish color. The Czochralski process is commonly used to produce single crystals of silicon used for solid-state or semiconductor devices. Hyperpure silicon can be prepared by the thermal decomposition of ultra-pure trichlorosilane in a hydrogen atmosphere, and by a vacuum float zone process. This product can be doped with boron, gallium, phosphorus, or arsenic to produce silicon for use in transistors, solar cells, rectifiers, and other solid-state devices that are used extensively in the electronics and space-age industries. Hydrogenated amorphous silicon has shown promise in producing economical cells for converting solar energy into electricity. Silicon is a relatively inert element, but it is attacked by halogens and dilute alkali. Most acids, except hydrofluoric, do not affect it. Silicones are important products of silicon. They may be prepared by hydrolyzing a silicon organic chloride, such as dimethyl silicon chloride. Hydrolysis and condensation of various substituted chlorosilanes can be used to produce a very great number of polymeric products, or silicones, ranging from liquids to hard, glasslike solids with many useful properties. Elemental silicon transmits more than 95% of all wavelengths of infrared, from 1.3 to 6.7  $\mu\text{m}$ . Silicon is one of man’s most useful elements. In the form of sand and clay it is used to make concrete and brick; it is a useful refractory material for high-temperature work, and in the form of silicates it is used in making enamels, pottery, etc. Silica, as sand, is a principal ingredient of glass, one of the most inexpensive of materials with excellent mechanical, optical, thermal, and electrical properties. Glass can be made in a very great variety of shapes, and is used as containers, window glass, insulators, and thousands of other uses. Silicon tetrachloride can be used to iridize glass. Silicon is important in plant and animal life. Diatoms in both fresh and salt water extract silica from the water to build up their cell walls. Silica is present in ashes of plants and in the human

skeleton. Silicon is an important ingredient in steel; silicon carbide is one of the most important abrasives and has been used in lasers to produce coherent light of 4560 Å. A remarkable material, first discovered in 1930, is *Aerogel*, which is now used by NASA in their space missions to collect cometary and interplanet dust. *Aerogel* is a highly insulative material that has the lowest density of any known solid. One form of *Aerogel* is 99.9% air and 0.1%  $\text{SiO}_2$  by volume. It is 1000 times less dense than glass. It has been called “blue smoke” or “solid smoke.” A block of *Aerogel* as large as a person may weigh less than a pound and yet support the weight of 1000 lbs (455 kg). This material is expected to trap cometary particles traveling at speeds of 32 km/sec. *Aerogel* is said to be non-toxic and non-inflammable. It has high thermal insulating qualities that could be used in home insulation. Its light weight may have aircraft applications. Regular grade silicon (99.5%) costs about \$160/kg. Silicon (99.9999%) pure costs about \$200/kg; hyper-pure silicon is available at a higher cost. Miners, stonemasons, and other engaged in work where siliceous dust is breathed in large quantities often develop a serious lung disease known as *silicosis*.

**Silver** — (Anglo-Saxon, *Seolfor siolfur*), Ag (L. *argentum*), at. wt. 107.8682(2); at. no. 47; m.p. 961.78°C; b.p. 2162°C; sp. gr. 10.50 (20°C); valence 1, 2. Silver has been known since ancient times. It is mentioned in Genesis. Slag dumps in Asia Minor and on islands in the Aegean Sea indicate that man learned to separate silver from lead as early as 3000 B.C. Silver occurs native and in ores such as *argentite* ( $\text{Ag}_2\text{S}$ ) and *horn silver* ( $\text{AgCl}$ ); lead, lead-zinc, copper, gold, and copper-nickel ores are principal sources. Mexico, Canada, Peru, and the U.S. are the principal silver producers in the western hemisphere. Silver is also recovered during electrolytic refining of copper. Commercial fine silver contains at least 99.9% silver. Purities of 99.999+% are available commercially. Pure silver has a brilliant white metallic luster. It is a little harder than gold and is very ductile and malleable, being exceeded only by gold and perhaps palladium. Pure silver has the highest electrical and thermal conductivity of all metals, and possesses the lowest contact resistance. It is stable in pure air and water, but tarnishes when exposed to ozone, hydrogen sulfide, or air containing sulfur. The alloys of silver are important. Sterling silver is used for jewelry, silverware, etc. where appearance is paramount. This alloy contains 92.5% silver, the remainder being copper or some other metal. Silver is of utmost importance in photography, about 30% of the U.S. industrial consumption going into this application. It is used for dental alloys. Silver is used in making solder and brazing alloys, electrical contacts, and high capacity silver-zinc and silver-cadmium batteries. Silver paints are used for making printed circuits. It is used in mirror production and may be deposited on glass or metals by chemical deposition, electrodeposition, or by evaporation. When freshly deposited, it is the best reflector of visible light known, but is rapidly tarnishes and loses much of its reflectance. It is a poor reflector of ultraviolet. Silver fulminate ( $\text{Ag}_2\text{C}_2\text{N}_2\text{O}_2$ ), a powerful explosive, is sometimes formed during the silvering process. Silver iodide is used in seeding clouds to produce rain. Silver chloride has interesting optical properties as it can be made transparent; it also is a cement for glass. Silver nitrate, or *lunar caustic*, the most important silver compound, is used extensively in photography. While silver itself is not considered to be toxic, most of its salts are poisonous. Natural silver contains two stable isotopes. Fifty-six other radioactive isotopes and isomers are



known. Silver compounds can be absorbed in the circulatory system and reduced silver deposited in the various tissues of the body. A condition, known as *argyria*, results with a greyish pigmentation of the skin and mucous membranes. Silver has germicidal effects and kills many lower organisms effectively without harm to higher animals. Silver for centuries has been used traditionally for coinage by many countries of the world. In recent times, however, consumption of silver has at times greatly exceeded the output. In 1939, the price of silver was fixed by the U.S. Treasury at 71¢/troy oz., and at 90.5¢/troy oz. in 1946. In November 1961 the U.S. Treasury suspended sales of nonmonetized silver, and the price stabilized for a time at about \$1.29, the melt-down value of silver U.S. coins. The Coinage Act of 1965 authorized a change in the metallic composition of the three U.S. subsidiary denominations to clad or composite type coins. This was the first change in U.S. coinage since the monetary system was established in 1792. Clad dimes and quarters are made of an outer layer of 75% Cu and 25% Ni bonded to a central core of pure Cu. The composition of the one- and five-cent pieces remains unchanged. One-cent coins are 95% Cu and 5% Zn. Five-cent coins are 75% Cu and 25% Ni. Old silver dollars are 90% Ag and 10% Cu. Earlier subsidiary coins of 90% Ag and 10% Cu officially were to circulate alongside the clad coins; however, in practice they have largely disappeared (Gresham's Law), as the value of the silver is now greater than their exchange value. Silver coins of other countries have largely been replaced with coins made of other metals. On June 24, 1968, the U.S. Government ceased to redeem U.S. Silver Certificates with silver. Since that time, the price of silver has fluctuated widely. As of January 2002, the price of silver was about \$4.10/troy oz. (13¢/g); however the price has fluctuated considerably due to market instability. The price of silver in 2001 was only about four times the cost of the metal about 150 years ago. This has largely been caused by Central Banks disposing of some of their silver reserves and the development of more productive mines with better refining methods. Also, silver has been displaced by other metals or processes, such as digital photography.

**Sodium** — (English, *soda*; Medieval Latin, *sodanum*, headache remedy), Na (L. *natrium*); at. wt. 22.98976928(2); at. no. 11; m.p. 97.80°C; b.p. 883°C; sp. gr. 0.971 (20°C); valence 1. Long recognized in compounds, sodium was first isolated by Davy in 1807 by electrolysis of caustic soda. Sodium is present in fair abundance in the sun and stars. The D lines of sodium are among the most prominent in the solar spectrum. Sodium is the sixth most abundant element on earth, comprising about 2.6% of the Earth's crust; it is the most abundant of the alkali group of metals of which it is a member. The most common compound is sodium chloride, but it occurs in many other minerals, such as *soda niter*, *cryolite*, *amphibole*, *zeolite*, *sodalite*, etc. It is a very reactive element and is never found free in nature. It is now obtained commercially by the electrolysis of absolutely dry fused sodium chloride. This method is much cheaper than that of electrolyzing sodium hydroxide, as was used several years ago. Sodium is a soft, bright, silvery metal that floats on water, decomposing it with the evolution of hydrogen and the formation of the hydroxide. It may or may not ignite spontaneously on water, depending on the amount of oxide and metal exposed to the water. It normally does not ignite in air at temperatures below 115°C. Sodium should be handled with respect, as it can be dangerous when improperly handled. Metallic sodium is vital in the manufacture of sodamide and esters, and in the preparation of organic

compounds. The metal may be used to improve the structure of certain alloys, to descale metal, to purify molten metals, and as a heat transfer agent. An alloy of sodium with potassium, NaK, is also an important heat transfer agent. Sodium compounds are important to the paper, glass, soap, textile, petroleum, chemical, and metal industries. Soap is generally a sodium salt of certain fatty acids. The importance of common salt to animal nutrition has been recognized since prehistoric times. Among the many compounds that are of the greatest industrial importance are common salt (NaCl), soda ash (Na<sub>2</sub>CO<sub>3</sub>), baking soda (NaHCO<sub>3</sub>), caustic soda (NaOH), Chile saltpeter (NaNO<sub>3</sub>), di- and tri-sodium phosphates, sodium thiosulfate (hypo, Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> · 5H<sub>2</sub>O), and borax (Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub> · 10H<sub>2</sub>O). Seventeen isotopes of sodium are recognized. Metallic sodium is priced at about \$575/kg (99.95%). On a volume basis, it is the cheapest of all metals. Sodium metal should be handled with great care. It should be kept in an inert atmosphere and contact with water and other substances with which sodium reacts should be avoided.

**Strontium** — (*Strontian*, town in Scotland), Sr; at. wt. 87.62(1); at. no. 38; m.p. 777°C; b.p. 1382°C; sp. gr. 2.64; valence 2. Isolated by Davy by electrolysis in 1808; however, Adair Crawford in 1790 recognized a new mineral (strontianite) as differing from other barium minerals (baryta). Strontium is found chiefly as *celestite* (SrSO<sub>4</sub>) and *strontianite* (SrCO<sub>3</sub>). *Celestite* is found in Mexico, Turkey, Iran, Spain, Algeria, and in the U.K. The U.S. has no active *celestite* mines. The metal can be prepared by electrolysis of the fused chloride mixed with potassium chloride, or is made by reducing strontium oxide with aluminum in a vacuum at a temperature at which strontium distills off. Three allotropic forms of the metal exist, with transition points at 235 and 540°C. Strontium is softer than calcium and decomposes water more vigorously. It does not absorb nitrogen below 380°C. It should be kept under mineral oil to prevent oxidation. Freshly cut strontium has a silvery appearance, but rapidly turns a yellowish color with the formation of the oxide. The finely divided metal ignites spontaneously in air. Volatile strontium salts impart a beautiful crimson color to flames, and these salts are used in pyrotechnics and in the production of flares. Natural strontium is a mixture of four stable isotopes. Thirty-two other unstable isotopes and isomers are known to exist. Of greatest importance is <sup>90</sup>Sr with a half-life of 29 years. It is a product of nuclear fallout and presents a health problem. This isotope is one of the best long-lived high-energy beta emitters known, and is used in SNAP (Systems for Nuclear Auxiliary Power) devices. These devices hold promise for use in space vehicles, remote weather stations, navigational buoys, etc., where a lightweight, long-lived, nuclear-electric power source is needed. The major use for strontium at present is in producing glass for color television picture tubes. All color TV and cathode ray tubes sold in the U.S. are required by law to contain strontium in the face plate glass to block X-ray emission. Strontium also improves the brilliance of the glass and the quality of the picture. It has also found use in producing ferrite magnets and in refining zinc. Strontium titanate is an interesting optical material as it has an extremely high refractive index and an optical dispersion greater than that of diamond. It has been used as a gemstone, but it is very soft. It does not occur naturally. Strontium metal (99% pure) costs about \$220/kg.

**Sulfur** — (Sanskrit, *sulvere*; L. *sulphurium*), S; at. wt. 32.065(5); at. no. 16; m.p. 115.21°C; b.p. 444.61°C; *t*<sub>c</sub> 1041°C; sp. gr. (rhombohedral) 2.07, (monoclinic) 2.00 (20°C); valence 2, 4, or 6. Known to the

ancients; referred to in Genesis as *brimstone*. Sulfur is found in meteorites. A dark area near the crater Aristarchus on the moon has been studied by R. W. Wood with ultraviolet light. This study suggests strongly that it is a sulfur deposit. Sulfur occurs native in the vicinity of volcanoes and hot springs. It is widely distributed in nature as *iron pyrites*, *galena*, *sphalerite*, *cinnabar*, *stibnite*, *gypsum*, *Epsom salts*, *celestite*, *barite*, etc. Sulfur is commercially recovered from wells sunk into the salt domes along the Gulf Coast of the U.S. It is obtained from these wells by the Frasch process, which forces heated water into the wells to melt the sulfur, which is then brought to the surface. Sulfur also occurs in natural gas and petroleum crudes and must be removed from these products. Formerly this was done chemically, which wasted the sulfur. New processes now permit recovery, and these sources promise to be very important. Large amounts of sulfur are being recovered from Alberta gas fields. Sulfur is a pale yellow, odorless, brittle solid that is insoluble in water but soluble in carbon disulfide. In every state, whether gas, liquid or solid, elemental sulfur occurs in more than one allotropic form or modification; these present a confusing multitude of forms whose relations are not yet fully understood. Amorphous or "plastic" sulfur is obtained by fast cooling of the crystalline form. X-ray studies indicate that amorphous sulfur may have a helical structure with eight atoms per spiral. Crystalline sulfur seems to be made of rings, each containing eight sulfur atoms that fit together to give a normal X-ray pattern. Twenty-one isotopes of sulfur are now recognized. Four occur in natural sulfur, none of which is radioactive. A finely divided form of sulfur, known as *flowers of sulfur*, is obtained by sublimation. Sulfur readily forms sulfides with many elements. Sulfur is a component of black gunpowder, and is used in the vulcanization of natural rubber and a fungicide. It is also used extensively in making phosphatic fertilizers. A tremendous tonnage is used to produce sulfuric acid, the most important manufactured chemical. It is used in making sulfite paper and other papers, as a fumigant, and in the bleaching of dried fruits. The element is a good electrical insulator. Organic compounds containing sulfur are very important. Calcium sulfate, ammonium sulfate, carbon disulfide, sulfur dioxide, and hydrogen sulfide are but a few of the many other important compounds of sulfur. Sulfur is essential to life. It is a minor constituent of fats, body fluids, and skeletal minerals. Carbon disulfide, hydrogen sulfide, and sulfur dioxide should be handled carefully. Hydrogen sulfide in small concentrations can be metabolized, but in higher concentrations it can quickly cause death by respiratory paralysis. It is insidious in that it quickly deadens the sense of smell. Sulfur dioxide is a dangerous component in atmospheric pollution. Sulfur (99.999%) costs about \$575/kg.

**Tantalum** — (Gr. *Tantalos*, mythological character, father of *Niobe*), Ta; at. wt. 180.94788(2); at. no. 73; m.p. 3017°C; b.p. 5458°C; sp. gr. 16.4; valence 2?, 3, 4?, or 5. Discovered in 1802 by Ekeberg, but many chemists thought niobium and tantalum were identical elements until Rose, in 1844, and Marignac, in 1866, showed that niobic and tantalic acids were two different acids. The early investigators only isolated the impure metal. The first relatively pure ductile tantalum was produced by von Bolton in 1903. Tantalum occurs principally in the mineral *columbite-tantalite* (Fe, Mn)(Nb, Ta)<sub>2</sub>O<sub>6</sub>. Tantalum ores are found in Australia, Brazil, Rwanda, Zimbabwe, Congo-Kinshasa, Nigeria, and Canada. Separation of tantalum from niobium requires several complicated steps. Several methods are used to commercially produce the element, including

electrolysis of molten potassium fluorotantalate, reduction of potassium fluorotantalate with sodium, or reacting tantalum carbide with tantalum oxide. Thirty-four isotopes and isomers of tantalum are known to exist. Natural tantalum contains two isotopes, one of which is radioactive with a very long half-life. Tantalum is a gray, heavy, and very hard metal. When pure, it is ductile and can be drawn into fine wire, which is used as a filament for evaporating metals such as aluminum. Tantalum is almost completely immune to chemical attack at temperatures below 150°C, and is attacked only by hydrofluoric acid, acidic solutions containing the fluoride ion, and free sulfur trioxide. Alkalis attack it only slowly. At high temperatures, tantalum becomes much more reactive. The element has a melting point exceeded only by tungsten and rhenium. Tantalum is used to make a variety of alloys with desirable properties such as high melting point, high strength, good ductility, etc. Scientists at Los Alamos have produced a tantalum carbide graphite composite material that is said to be one of the hardest materials ever made. The compound has a melting point of 3738°C. Tantalum has good "gettering" ability at high temperatures, and tantalum oxide films are stable and have good rectifying and dielectric properties. Tantalum is used to make electrolytic capacitors and vacuum furnace parts, which account for about 60% of its use. The metal is also widely used to fabricate chemical process equipment, nuclear reactors, and aircraft and missile parts. Tantalum is completely immune to body liquids and is a nonirritating metal. It has, therefore, found wide use in making surgical appliances. Tantalum oxide is used to make special glass with a high index of refraction for camera lenses. The metal has many other uses. The price of (99.9%) tantalum is about \$2/g.

**Technetium** — (Gr. *technetos*, artificial), Tc; at. wt. (98); at. no. 43; m.p. 2157°C; b.p. 4265°C; sp. gr. 11.50 (calc.); valence 0, +2, +4, +5, +6, and +7. Element 43 was predicted on the basis of the periodic table, and was erroneously reported as having been discovered in 1925, at which time it was named *masurium*. The element was actually discovered by Perrier and Segre in Italy in 1937. It was found in a sample of molybdenum that was bombarded by deuterons in the Berkeley cyclotron, and which E. Lawrence sent to these investigators. Technetium was the first element to be produced artificially. Since its discovery, searches for the element in terrestrial materials have been made without success. If it does exist, the concentration must be very small. Technetium has been found in the spectrum of S-, M-, and N-type stars, and its presence in stellar matter is leading to new theories of the production of heavy elements in the stars. Forty-three isotopes and isomers of technetium, with mass numbers ranging from 86 to 113, are known. <sup>97</sup>Tc has a half-life of 2.6 × 10<sup>6</sup> years. <sup>98</sup>Tc has a half-life of 4.2 × 10<sup>6</sup> years. The isomeric isotope <sup>95m</sup>Tc, with a half-life of 61 days, is useful for tracer work, as it produces energetic gamma rays. Technetium metal has been produced in kilogram quantities. The metal was first prepared by passing hydrogen gas at 1100°C over Tc<sub>2</sub>S<sub>7</sub>. It is now conveniently prepared by the reduction of ammonium pertechnetate with hydrogen. Technetium is a silvery-gray metal that tarnishes slowly in moist air. Until 1960, technetium was available only in small amounts and the price was as high as \$2800/g, but the price is now of the order of \$100/g. The chemistry of technetium is similar to that of rhenium. Technetium dissolves in nitric acid, aqua regia, and concentrated sulfuric acid, but is not soluble in hydrochloric acid of any strength. The element is a remarkable corrosion inhibitor for steel. It is reported that

mild carbon steels may be effectively protected by as little as 55 ppm of  $\text{KTcO}_4$  in aerated distilled water at temperatures up to 250°C. This corrosion protection is limited to closed systems, since technetium is radioactive and must be confined.  $^{99}\text{Tc}$  has a specific activity of  $6.2 \times 10^8$  Bq/g. Activity of this level must not be allowed to spread.  $^{99}\text{Tc}$  is a contamination hazard and should be handled in a glove box. The metal is an excellent superconductor at 11K and below.

**Tellurium** — (*L. tellus*, earth), Te; at. wt. 127.60(3); at. no. 52; m.p. 449.51°C; b.p. 988°C; sp. gr. 6.23 (20°C); valence -2, 4, or 6. Discovered by Muller von Reichenstein in 1782; named by Klaproth, who isolated it in 1798. Tellurium is occasionally found native, but is more often found as the telluride of gold (*calaverite*), and combined with other metals. It is recovered commercially from the anode muds produced during the electrolytic refining of blister copper. The U.S., Canada, Peru, and Japan are the largest producers of the element. Crystalline tellurium has a silvery-white appearance, and when pure exhibits a metallic luster. It is brittle and easily pulverized. Amorphous tellurium is formed by precipitating tellurium from a solution of telluric or tellurous acid. Whether this form is truly amorphous, or made of minute crystals, is open to question. Tellurium is a p-type semiconductor, and shows greater conductivity in certain directions, depending on alignment of the atoms. Its conductivity increases slightly with exposure to light. It can be doped with silver, copper, gold, tin, or other elements. In air, tellurium burns with a greenish-blue flame, forming the dioxide. Molten tellurium corrodes iron, copper, and stainless steel. Tellurium and its compounds are probably toxic and should be handled with care. Workmen exposed to as little as 0.01 mg/m<sup>3</sup> of air, or less, develop "tellurium breath," which has a garlic-like odor. Forty-two isotopes and isomers of tellurium are known, with atomic masses ranging from 106 to 138. Natural tellurium consists of eight isotopes, two of which are radioactive with very long half-lives. Tellurium improves the machinability of copper and stainless steel, and its addition to lead decreases the corrosive action of sulfuric acid on lead and improves its strength and hardness. Tellurium catalysts are used in the oxidation of organic compounds and are used in hydrogenation and halogenation reactions. Tellurium is also used in electronic and semiconductor devices. It is also used as a basic ingredient in blasting caps, and is added to cast iron for chill control. Tellurium is used in ceramics. Bismuth telluride has been used in thermoelectric devices. Tellurium costs about 50¢/g, with a purity of about 99.5%. The metal with a purity of 99.9999% costs about \$5/g.

**Terbium** — (*Ytterby*, village in Sweden), Tb; at. wt. 158.92534(2); at. no. 65; m.p. 1356°C; b.p. 3230°C; sp. gr. 8.230; valence 3, 4. Discovered by Mosander in 1843. Terbium is a member of the lanthanide or "rare earth" group of elements. It is found in *cerite*, *gadolinite*, and other minerals along with other rare earths. It is recovered commercially from *monazite* in which it is present to the extent of 0.03%, from *xenotime*, and from *euxenite*, a complex oxide containing 1% or more of terbium. Terbium has been isolated only in recent years with the development of ion-exchange techniques for separating the rare-earth elements. As with other rare earths, it can be produced by reducing the anhydrous chloride or fluoride with calcium metal in a tantalum crucible. Calcium and tantalum impurities can be removed by vacuum remelting. Other methods of isolation are possible. Terbium is reasonably stable in air. It is

a silver-gray metal, and is malleable, ductile, and soft enough to be cut with a knife. Two crystal modifications exist, with a transformation temperature of 1289°C. Forty-two isotopes and isomers are recognized. The oxide is a chocolate or dark maroon color. Sodium terbium borate is used as a laser material and emits coherent light at 0.546  $\mu\text{m}$ . Terbium is used to dope calcium fluoride, calcium tungstate, and strontium molybdate, used in solid-state devices. The oxide has potential application as an activator for green phosphors used in color TV tubes. It can be used with  $\text{ZrO}_2$  as a crystal stabilizer of fuel cells that operate at elevated temperature. Few other uses have been found. The element is priced at about \$40/g (99.9%). Little is known of the toxicity of terbium. It should be handled with care as with other lanthanide elements.

**Thallium** — (*Gr. thallos*, a green shoot or twig), Tl; at. wt. 204.3833(2); at. no. 81; m.p. 304°C; b.p. 1473°C; sp. gr. 11.85 (20°C); valence 1, or 3. Thallium was discovered spectroscopically in 1861 by Crookes. The element was named after the beautiful green spectral line, which identified the element. The metal was isolated both by Crookes and Lamy in 1862 about the same time. Thallium occurs in *crooksite*, *lorandite*, and *hutchinsonite*. It is also present in *pyrites* and is recovered from the roasting of this ore in connection with the production of sulfuric acid. It is also obtained from the smelting of lead and zinc ores. Extraction is somewhat complex and depends on the source of the thallium. Manganese nodules, found on the ocean floor, contain thallium. When freshly exposed to air, thallium exhibits a metallic luster, but soon develops a bluish-gray tinge, resembling lead in appearance. A heavy oxide builds up on thallium if left in air, and in the presence of water the hydroxide is formed. The metal is very soft and malleable. It can be cut with a knife. Forty-seven isotopes of thallium, with atomic masses ranging from 179 to 210 are recognized. Natural thallium is a mixture of two isotopes. The element and its compounds are toxic and should be handled carefully. Contact of the metal with skin is dangerous, and when melting the metal adequate ventilation should be provided. Thallium is suspected of carcinogenic potential for man. Thallium sulfate has been widely employed as a rodenticide and ant killer. It is odorless and tasteless, giving no warning of its presence. Its use, however, has been prohibited in the U.S. since 1975 as a household insecticide and rodenticide. The electrical conductivity of thallium sulfide changes with exposure to infrared light, and this compound is used in photocells. Thallium bromide-iodide crystals have been used as infrared optical materials. Thallium has been used, with sulfur or selenium and arsenic, to produce low melting glasses which become fluid between 125 and 150°C. These glasses have properties at room temperatures similar to ordinary glasses and are said to be durable and insoluble in water. Thallium oxide has been used to produce glasses with a high index of refraction. Thallium has been used in treating ringworm and other skin infections; however, its use has been limited because of the narrow margin between toxicity and therapeutic benefits. A mercury-thallium alloy, which forms a eutectic at 8.5% thallium, is reported to freeze at -60°C, some 20° below the freezing point of mercury. Thallium metal (99.999%) costs about \$2/g.

**Thorium** — (*Thor*, Scandinavian god of war), Th; at. wt. 232.03806(2); at. no. 90; m.p. 1750°C; b.p. 4788°C; sp. gr. 11.72; valence +2(?), +3(?), +4. Discovered by Berzelius in 1828. Thorium occurs in *thorite* ( $\text{ThSiO}_4$ ) and in *thorianite*



( $\text{ThO}_2 + \text{UO}_2$ ). Large deposits of thorium minerals have been reported in New England and elsewhere, but these have not yet been exploited. Thorium is now thought to be about three times as abundant as uranium and about as abundant as lead or molybdenum. The metal is a source of nuclear power. There is probably more energy available for use from thorium in the minerals of the Earth's crust than from both uranium and fossil fuels. Any sizable demand for thorium as a nuclear fuel is still several years in the future. Work has been done in developing thorium cycle converter-reactor systems. Several prototypes, including the HTGR (high-temperature gas-cooled reactor) and MSRE (molten salt converter reactor experiment), have operated. While the HTGR reactors are efficient, they are not expected to become important commercially for many years because of certain operating difficulties. Thorium is recovered commercially from the mineral *monazite*, which contains from 3 to 9%  $\text{ThO}_2$  along with rare-earth minerals. Much of the internal heat the Earth produces has been attributed to thorium and uranium. Several methods are available for producing thorium metal: it can be obtained by reducing thorium oxide with calcium, by electrolysis of anhydrous thorium chloride in a fused mixture of sodium and potassium chlorides, by calcium reduction of thorium tetrachloride mixed with anhydrous zinc chloride, and by reduction of thorium tetrachloride with an alkali metal. Thorium was originally assigned a position in Group IV of the periodic table. Because of its atomic weight, valence, etc., it is now considered to be the second member of the *actinide* series of elements. When pure, thorium is a silvery-white metal which is air stable and retains its luster for several months. When contaminated with the oxide, thorium slowly tarnishes in air, becoming gray and finally black. The physical properties of thorium are greatly influenced by the degree of contamination with the oxide. The purest specimens often contain several tenths of a percent of the oxide. High-purity thorium has been made. Pure thorium is soft, very ductile, and can be cold-rolled, swaged, and drawn. Thorium is dimorphic, changing at  $1400^\circ\text{C}$  from a cubic to a body-centered cubic structure. Thorium oxide has a melting point of  $3300^\circ\text{C}$ , which is the highest of all oxides. Only a few elements, such as tungsten, and a few compounds, such as tantalum carbide, have higher melting points. Thorium is slowly attacked by water, but does not dissolve readily in most common acids, except hydrochloric. Powdered thorium metal is often pyrophoric and should be carefully handled. When heated in air, thorium turnings ignite and burn brilliantly with a white light. The principal use of thorium has been in the preparation of the Welsbach mantle, used for portable gas lights. These mantles, consisting of thorium oxide with about 1% cerium oxide and other ingredients, glow with a dazzling light when heated in a gas flame. Thorium is an important alloying element in magnesium, imparting high strength and creep resistance at elevated temperatures. Because thorium has a low work-function and high electron emission, it is used to coat tungsten wire used in electronic equipment. The oxide is also used to control the grain size of tungsten used for electric lamps; it is also used for high-temperature laboratory crucibles. Glasses containing thorium oxide have a high refractive index and low dispersion. Consequently, they find application in high quality lenses for cameras and scientific instruments. Thorium oxide has also found use as a catalyst in the conversion of ammonia to nitric acid, in petroleum cracking, and in producing sulfuric acid. Thorium has not found many uses due to its radioactive nature

and its handling and disposal problems. Thirty isotopes of thorium are known with atomic masses ranging from 210 to 237. All are unstable.  $^{232}\text{Th}$  occurs naturally and has a half-life of  $1.4 \times 10^{10}$  years. It is an alpha emitter.  $^{232}\text{Th}$  goes through six alpha and four beta decay steps before becoming the stable isotope  $^{208}\text{Pb}$ .  $^{232}\text{Th}$  is sufficiently radioactive to expose a photographic plate in a few hours. Thorium disintegrates with the production of "thoron" ( $^{220}\text{Rn}$ ), which is an alpha emitter and presents a radiation hazard. Good ventilation of areas where thorium is stored or handled is therefore essential. Thorium metal (99.8%) costs about \$25/g.

**Thulium** — (*Thule*, the earliest name for Scandinavia), Tm; at. wt. 168.93421(2); at. no. 69; m.p.  $1545^\circ\text{C}$ ; b.p.  $1950^\circ\text{C}$ ; sp. gr. 9.321 ( $25^\circ\text{C}$ ); valence 3. Discovered in 1879 by Cleve. Thulium occurs in small quantities along with other rare earths in a number of minerals. It is obtained commercially from *monazite*, which contains about 0.007% of the element. Thulium is the least abundant of the rare-earth elements, but with new sources recently discovered, it is now considered to be about as rare as silver, gold, or cadmium. Ion-exchange and solvent extraction techniques have recently permitted much easier separation of the rare earths, with much lower costs. Only a few years ago, thulium metal was not obtainable at any cost; in 1996 the oxide cost \$20/g. Thulium metal powder now costs \$70/g (99.9%). Thulium can be isolated by reduction of the oxide with lanthanum metal or by calcium reduction of the anhydrous fluoride. The pure metal has a bright, silvery luster. It is reasonably stable in air, but the metal should be protected from moisture in a closed container. The element is silver-gray, soft, malleable, and ductile, and can be cut with a knife. Forty-one isotopes and isomers are known, with atomic masses ranging from 146 to 176. Natural thulium, which is 100%  $^{169}\text{Tm}$ , is stable. Because of the relatively high price of the metal, thulium has not yet found many practical applications.  $^{169}\text{Tm}$  bombarded in a nuclear reactor can be used as a radiation source in portable X-ray equipment.  $^{171}\text{Tm}$  is potentially useful as an energy source. Natural thulium also has possible use in *ferrites* (ceramic magnetic materials) used in microwave equipment. As with other lanthanides, thulium has a low-to-moderate acute toxicity rating. It should be handled with care.

**Tin** — (Anglo-Saxon, *tin*), Sn (L. *stannum*); at. wt. 118.710(7); at. no. 50; m.p.  $231.93^\circ\text{C}$ ; b.p.  $2602^\circ\text{C}$ ; sp. gr. (gray) 5.77, (white) 7.29; valence 2, 4. Known to the ancients. Tin is found chiefly in *cassiterite* ( $\text{SnO}_2$ ). Most of the world's supply comes from China, Indonesia, Peru, Brazil, and Bolivia. The U.S. produces almost none, although occurrences have been found in Alaska and Colorado. Tin is obtained by reducing the ore with coal in a reverberatory furnace. Ordinary tin is composed of ten stable isotopes; thirty-six unstable isotopes and isomers are also known. Ordinary tin is a silver-white metal, is malleable, somewhat ductile, and has a highly crystalline structure. Due to the breaking of these crystals, a "tin cry" is heard when a bar is bent. The element has two allotropic forms at normal pressure. On warming, gray, or  $\alpha$  tin, with a cubic structure, changes at  $13.2^\circ\text{C}$  into white, or  $\beta$  tin, the ordinary form of the metal. White tin has a tetragonal structure. When tin is cooled below  $13.2^\circ\text{C}$ , it changes slowly from white to gray. This change is affected by impurities such as aluminum and zinc, and can be prevented by small additions of antimony or bismuth. This change from the  $\alpha$  to  $\beta$  form is called the tin pest. Tin-lead alloys are used to make organ pipes. There are few if any uses

for gray tin. Tin takes a high polish and is used to coat other metals to prevent corrosion or other chemical action. Such tin plate over steel is used in the so-called tin can for preserving food. Alloys of tin are very important. Soft solder, type metal, fusible metal, pewter, bronze, bell metal, Babbitt metal, white metal, die casting alloy, and phosphor bronze are some of the important alloys using tin. Tin resists distilled sea and soft tap water, but is attacked by strong acids, alkalis, and acid salts. Oxygen in solution accelerates the attack. When heated in air, tin forms  $\text{SnO}_2$ , which is feebly acid, forming stannate salts with basic oxides. The most important salt is the chloride ( $\text{SnCl}_2 \cdot \text{H}_2\text{O}$ ), which is used as a reducing agent and as a mordant in calico printing. Tin salts sprayed onto glass are used to produce electrically conductive coatings. These have been used for panel lighting and for frost-free windshields. Most window glass is now made by floating molten glass on molten tin (float glass) to produce a flat surface (Pilkington process). Of recent interest is a crystalline tin–niobium alloy that is superconductive at very low temperatures. This promises to be important in the construction of superconductive magnets that generate enormous field strengths but use practically no power. Such magnets, made of tin–niobium wire, weigh but a few pounds and produce magnetic fields that, when started with a small battery, are comparable to that of a 100 ton electromagnet operated continuously with a large power supply. The small amount of tin found in canned foods is quite harmless. The agreed limit of tin content in U.S. foods is 300 mg/kg. The trialkyl and triaryl tin compounds are used as biocides and must be handled carefully. Over the past 25 years the price of commercial tin has varied from 50¢/lb (\$1.10/kg) to about \$6/kg. Tin (99.99% pure) costs about \$260/kg.

**Titanium** — (L. *Titans*, the first sons of the Earth, myth.), Ti; at. wt. 47.867(1); at. no. 22; m.p. 1668°C; b.p. 3287°C; sp. gr. 4.51; valence 2, 3, or 4. Discovered by Gregor in 1791; named by Klaproth in 1795. Impure titanium was prepared by Nilson and Pettersson in 1887; however, the pure metal (99.9%) was not made until 1910 by Hunter by heating  $\text{TiCl}_4$  with sodium in a steel bomb. Titanium is present in meteorites and in the sun. Rocks obtained during the Apollo 17 lunar mission showed presence of 12.1%  $\text{TiO}_2$ . Analyses of rocks obtained during earlier Apollo missions show lower percentages. Titanium oxide bands are prominent in the spectra of M-type stars. The element is the ninth most abundant in the crust of the Earth. Titanium is almost always present in igneous rocks and in the sediments derived from them. It occurs in the minerals *rutile*, *ilmenite*, and *sphene*, and is present in titanates and in many iron ores. Deposits of ilmenite and rutile are found in Florida, California, Tennessee, and New York. Australia, Norway, Malaysia, India, and China are also large suppliers of titanium minerals. Titanium is present in the ash of coal, in plants, and in the human body. The metal was a laboratory curiosity until Kroll, in 1946, showed that titanium could be produced commercially by reducing titanium tetrachloride with magnesium. This method is largely used for producing the metal today. The metal can be purified by decomposing the iodide. Titanium, when pure, is a lustrous, white metal. It has a low density, good strength, is easily fabricated, and has excellent corrosion resistance. It is ductile only when it is free of oxygen. The metal burns in air and is the only element that burns in nitrogen. Titanium is resistant to dilute sulfuric and hydrochloric acid, most organic acids, moist chlorine gas, and chloride solutions. Natural titanium consists of five isotopes with atomic masses from 46 to 50. All are stable. Eighteen

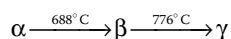
other unstable isotopes are known. The metal is dimorphic. The hexagonal  $\alpha$  form changes to the cubic  $\beta$  form very slowly at about 880°C. The metal combines with oxygen at red heat, and with chlorine at 550°C. Titanium is important as an alloying agent with aluminum, molybdenum, manganese, iron, and other metals. Alloys of titanium are principally used for aircraft and missiles where lightweight strength and ability to withstand extremes of temperature are important. Titanium is as strong as steel, but 45% lighter. It is 60% heavier than aluminum, but twice as strong. Titanium has potential use in desalination plants for converting sea water into fresh water. The metal has excellent resistance to sea water and is used for propeller shafts, rigging, and other parts of ships exposed to salt water. A titanium anode coated with platinum has been used to provide cathodic protection from corrosion by salt water. Titanium metal is considered to be physiologically inert; however, titanium powder may be a carcinogenic hazard. When pure, titanium dioxide is relatively clear and has an extremely high index of refraction with an optical dispersion higher than diamond. It is produced artificially for use as a gemstone, but it is relatively soft. Star sapphires and rubies exhibit their asterism as a result of the presence of  $\text{TiO}_2$ . Titanium dioxide is extensively used for both house paint and artist's paint, as it is permanent and has good covering power. Titanium oxide pigment accounts for the largest use of the element. Titanium paint is an excellent reflector of infrared, and is extensively used in solar observatories where heat causes poor seeing conditions. Titanium tetrachloride is used to iridize glass. This compound fumes strongly in air and has been used to produce smoke screens. The price of titanium metal (99.9%) is about \$1100/kg.

**Tungsten** — (Swedish, *tung sten*, heavy stone); also known as *wolfram* (from *wolframite*, said to be named from *wolf rahm* or *spumi lupi*, because the ore interfered with the smelting of tin and was supposed to devour the tin), W; at. wt. 183.84(1); at. no. 74; m.p. 3422°C; b.p. 5555°C; sp. gr. 19.3 (20°C); valence 2, 3, 4, 5, or 6. In 1779 Peter Woulfe examined the mineral now known as *wolframite* and concluded it must contain a new substance. Scheele, in 1781, found that a new acid could be made from *tung sten* (a name first applied about 1758 to a mineral now known as *scheelite*). Scheele and Berman suggested the possibility of obtaining a new metal by reducing this acid. The de Elhuyar brothers found an acid in *wolframite* in 1783 that was identical to the acid of *tungsten* (tungstic acid) of Scheele, and in that year they succeeded in obtaining the element by reduction of this acid with charcoal. Tungsten occurs in *wolframite*,  $(\text{Fe}, \text{Mn})\text{WO}_4$ ; *scheelite*,  $\text{CaWO}_4$ ; *huebnerite*,  $\text{MnWO}_4$ ; and *ferberite*,  $\text{FeWO}_4$ . Important deposits of tungsten occur in California, Colorado, Bolivia, Russia, and Portugal. China is reported to have about 75% of the world's tungsten resources. Natural tungsten contains five stable isotopes. Thirty-two other unstable isotopes and isomers are recognized. The metal is obtained commercially by reducing tungsten oxide with hydrogen or carbon. Pure tungsten is a steel-gray to tin-white metal. Very pure tungsten can be cut with a hacksaw, and can be forged, spun, drawn, and extruded. The impure metal is brittle and can be worked only with difficulty. Tungsten has the highest melting point of all metals, and at temperatures over 1650°C has the highest tensile strength. The metal oxidizes in air and must be protected at elevated temperatures. It has excellent corrosion resistance and is attacked only slightly by most mineral acids. The thermal expansion is about the same as borosilicate glass, which makes the metal useful for glass-



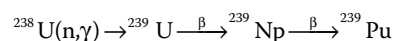
to-metal seals. Tungsten and its alloys are used extensively for filaments for electric lamps, electron and television tubes, and for metal evaporation work; for electrical contact points for automobile distributors; X-ray targets; windings and heating elements for electrical furnaces; and for numerous spacecraft and high-temperature applications. High-speed tool steels, Hastelloy®, Stellite®, and many other alloys contain tungsten. Tungsten carbide is of great importance to the metal-working, mining, and petroleum industries. Calcium and magnesium tungstates are widely used in fluorescent lighting; other salts of tungsten are used in the chemical and tanning industries. Tungsten disulfide is a dry, high-temperature lubricant, stable to 500°C. Tungsten bronzes and other tungsten compounds are used in paints. Zirconium tungstate has found recent applications (see under Zirconium). Tungsten powder (99.999%) costs about \$2900/kg.

**Uranium** — (Planet *Uranus*), U; at. wt. 238.02891(3); at. no. 92; m.p. 1135°C; b.p. 4131°C; sp. gr. 19.1; valence 2, 3, 4, 5, or 6. Yellow-colored glass, containing more than 1% uranium oxide and dating back to 79 A.D., has been found near Naples, Italy. Klaproth recognized an unknown element in *pitchblende* and attempted to isolate the metal in 1789. The metal apparently was first isolated in 1841 by Peligot, who reduced the anhydrous chloride with potassium. Uranium is not as rare as it was once thought. It is now considered to be more plentiful than mercury, antimony, silver, or cadmium, and is about as abundant as molybdenum or arsenic. It occurs in numerous minerals such as *pitchblende*, *uraninite*, *carnotite*, *autunite*, *uranophane*, *davidite*, and *tobernite*. It is also found in *phosphate rock*, *lignite*, *monazite sands*, and can be recovered commercially from these sources. Large deposits of uranium ore occur in Utah, Colorado, New Mexico, Canada, and elsewhere. Uranium can be made by reducing uranium halides with alkali or alkaline earth metals or by reducing uranium oxides by calcium, aluminum, or carbon at high temperatures. The metal can also be produced by electrolysis of  $KUF_5$  or  $UF_4$ , dissolved in a molten mixture of  $CaCl_2$  and  $NaCl$ . High-purity uranium can be prepared by the thermal decomposition of uranium halides on a hot filament. Uranium exhibits three crystallographic modifications as follows:

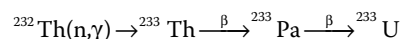


Uranium is a heavy, silvery-white metal that is pyrophoric when finely divided. It is a little softer than steel, and is attacked by cold water in a finely divided state. It is malleable, ductile, and slightly paramagnetic. In air, the metal becomes coated with a layer of oxide. Acids dissolve the metal, but it is unaffected by alkalis. Uranium has twenty-three isotopes, one of which is an isomer and all of which are radioactive. Naturally occurring uranium contains 99.2745% by weight  $^{238}U$ , 0.720%  $^{235}U$ , and 0.0055%  $^{234}U$ . Studies show that the percentage weight of  $^{235}U$  in natural uranium varies by as much as 0.1%, depending on the source. The U.S.D.O.E. has adopted the value of 0.711 as being their “official” percentage of  $^{235}U$  in natural uranium. Natural uranium is sufficiently radioactive to expose a photographic plate in an hour or so. Much of the internal heat of the Earth is thought to be attributable to the presence of uranium and thorium.  $^{238}U$ , with a half-life of  $4.46 \times 10^9$  years, has been used to estimate the age of igneous rocks. The origin of uranium, the highest member of the naturally occurring elements — except perhaps for traces of nep-

tunium or plutonium — is not clearly understood, although it has been thought that uranium might be a decay product of elements of higher atomic weight, which may have once been present on Earth or elsewhere in the universe. These original elements may have been formed as a result of a primordial “creation,” known as “the big bang,” in a supernova, or in some other stellar processes. The fact that recent studies show that most trans-uranic elements are extremely rare with very short half-lives indicates that it may be necessary to find some alternative explanation for the very large quantities of radioactive uranium we find on Earth. Studies of meteorites from other parts of the solar system show a relatively low radioactive content, compared to terrestrial rocks. Uranium is of great importance as a nuclear fuel.  $^{238}U$  can be converted into fissionable plutonium by the following reactions:



This nuclear conversion can be brought about in “breeder” reactors where it is possible to produce more new fissionable material than the fissionable material used in maintaining the chain reaction.  $^{235}U$  is of even greater importance, for it is the key to the utilization of uranium.  $^{235}U$ , while occurring in natural uranium to the extent of only 0.72%, is so fissionable with slow neutrons that a self-sustaining fission chain reaction can be made to occur in a reactor constructed from natural uranium and a suitable moderator, such as heavy water or graphite, alone.  $^{235}U$  can be concentrated by gaseous diffusion and other physical processes, if desired, and used directly as a nuclear fuel, instead of natural uranium, or used as an explosive. Natural uranium, slightly enriched with  $^{235}U$  by a small percentage, is used to fuel nuclear power reactors for the generation of electricity. Natural thorium can be irradiated with neutrons as follows to produce the important isotope  $^{233}U$ .



While thorium itself is not fissionable,  $^{233}U$  is, and in this way may be used as a nuclear fuel. One pound of completely fissioned uranium has the fuel value of over 1500 tons of coal. The uses of nuclear fuels to generate electrical power, to make isotopes for peaceful purposes, and to make explosives are well known. The estimated world-wide production of the 437 nuclear power reactors in operation in 1998 amounted to about 352,000 megawatt hours. In 1998 the U.S. had about 107 commercial reactors with an output of about 100,000 megawatt-hours. Some nuclear-powered electric generating plants have recently been closed because of safety concerns. There are also serious problems with nuclear waste disposal that have not been completely resolved. Uranium in the U.S. is controlled by the U.S. Nuclear Regulatory Commission, under the Department of Energy. Uses are being found for the large quantities of “depleted” uranium now available, where uranium-235 has been lowered to about 0.2%. Depleted uranium has been used for inertial guidance devices, gyrocompasses, counterweights for aircraft control surfaces, ballast for missile reentry vehicles, and as a shielding material for tanks, etc. Concerns, however, have been raised over its low radioactive properties. Uranium metal is used for X-ray targets for production of high-energy X-rays. The nitrate has been used as photographic toner, and the acetate is used in analytical chemistry. Crystals of uranium nitrate are triboluminescent. Uranium salts have also been used for producing yellow “vase-

line" glass and glazes. Uranium and its compounds are highly toxic, both from a chemical and radiological standpoint. Finely divided uranium metal, being pyrophoric, presents a fire hazard. The maximum permissible total body burden of natural uranium (based on radiotoxicity) is 0.2  $\mu\text{Ci}$  for soluble compounds. Recently, the natural presence of uranium and thorium in many soils has become of concern to homeowners because of the generation of radon and its daughters (see under Radon). Uranium metal is available commercially at a cost of about \$6/g (99.7%) in air-tight glass under argon.

**Vanadium** — (Scandinavian goddess, *Vanadis*), V; at. wt. 50.9415(1); at. no. 23; m.p. 1910°C; b.p. 3407°C; sp. gr. 6.0 (18.7°C); valence 2, 3, 4, or 5. Vanadium was first discovered by del Rio in 1801. Unfortunately, a French chemist incorrectly declared that del Rio's new element was only impure chromium; del Rio thought himself to be mistaken and accepted the French chemist's statement. The element was re-discovered in 1830 by Sefstrom, who named the element in honor of the Scandinavian goddess *Vanadis* because of its beautiful multicolored compounds. It was isolated in nearly pure form by Roscoe, in 1867, who reduced the chloride with hydrogen. Vanadium of 99.3 to 99.8% purity was not produced until 1927. Vanadium is found in about 65 different minerals among which *carnotite*, *roscoelite*, *vanadinite*, and *patronite* are important sources of the metal. Vanadium is also found in phosphate rock and certain iron ores, and is present in some crude oils in the form of organic complexes. It is also found in small percentages in meteorites. Commercial production from petroleum ash holds promise as an important source of the element. China, South Africa, and Russia supply much of the world's vanadium ores. High-purity ductile vanadium can be obtained by reduction of vanadium trichloride with magnesium or with magnesium-sodium mixtures. Much of the vanadium metal being produced is now made by calcium reduction of  $\text{V}_2\text{O}_5$  in a pressure vessel, an adaptation of a process developed by McKechnie and Seybolt. Natural vanadium is a mixture of two isotopes,  $^{50}\text{V}$  (0.25%) and  $^{51}\text{V}$  (99.75%).  $^{50}\text{V}$  is slightly radioactive, having a long half-life. Twenty other unstable isotopes are recognized. Pure vanadium is a bright white metal, and is soft and ductile. It has good corrosion resistance to alkalis, sulfuric and hydrochloric acid, and salt water, but the metal oxidizes readily above 660°C. The metal has good structural strength and a low-fission neutron cross section, making it useful in nuclear applications. Vanadium is used in producing rust-resistant, spring, and high-speed tool steels. It is an important carbide stabilizer in making steels. About 80% of the vanadium now produced is used as ferrovanadium or as a steel additive. Vanadium foil is used as a bonding agent in cladding titanium to steel. Vanadium pentoxide is used in ceramics and as a catalyst. It is also used in producing a superconductive magnet with a field of 175,000 gauss. Vanadium and its compounds are toxic and should be handled with care. Ductile vanadium is commercially available. Vanadium metal (99.7%) costs about \$3/g.

**Wolfram** — see Tungsten.

**Xenon** — (Gr. *xenon*, stranger), Xe; at. wt. 131.293(6); at. no. 54; m.p. -111.74°C; b.p. -108.09°C;  $t_c$  16.58°C; density (gas)  $5.887 \pm 0.009$  g/L, sp. gr (liquid) 2.95 (-109°C); valence usually 0. Discovered by Ramsay and Travers in 1898 in the residue left after evaporating liquid air components. Xenon is a member of the so-called noble or "inert" gases. It is present

in the atmosphere to the extent of about one part in twenty million. Xenon is present in the Martian atmosphere to the extent of 0.08 ppm. The element is found in the gases evolved from certain mineral springs, and is commercially obtained by extraction from liquid air. Natural xenon is composed of nine stable isotopes. In addition to these, thirty-five unstable isotopes and isomers have been characterized. Before 1962, it had generally been assumed that xenon and other noble gases were unable to form compounds. However, it is now known that xenon, as well as other members of the zero valence elements, do form compounds. Among the compounds of xenon now reported are xenon hydrate, sodium perxenate, xenon deuterate, difluoride, tetrafluoride, hexafluoride, and  $\text{XePtF}_6$  and  $\text{XeRhF}_6$ . Xenon trioxide, which is highly explosive, has been prepared. More than 80 xenon compounds have been made with xenon chemically bonded to fluorine and oxygen. Some xenon compounds are colored. Metallic xenon has been produced, using several hundred kilobars of pressure. Xenon in a vacuum tube produces a beautiful blue glow when excited by an electrical discharge. The gas is used in making electron tubes, stroboscopic lamps, bactericidal lamps, and lamps used to excite ruby lasers for generating coherent light. Xenon is used in the atomic energy field in bubble chambers, probes, and other applications where its high molecular weight is of value. The perxenates are used in analytical chemistry as oxidizing agents.  $^{133}\text{Xe}$  and  $^{135}\text{Xe}$  are produced by neutron irradiation in air-cooled nuclear reactors.  $^{133}\text{Xe}$  has useful applications as a radioisotope. The element is available in sealed glass containers for about \$20/L of gas at standard pressure. Xenon is not toxic, but its compounds are highly toxic because of their strong oxidizing characteristics.

**Ytterbium** — (*Ytterby*, village in Sweden), Yb; at. wt. 173.04(3); at. no. 70; m.p. 824°C; b.p. 1196°C; sp. gr ( $\alpha$ ) 6.903 ( $\beta$ ) 6.966; valence 2, 3. Marignac in 1878 discovered a new component, which he called *ytterbia*, in the Earth then known as *erbia*. In 1907, Urbain separated ytterbia into two components, which he called *neoytterbia* and *lutecia*. The elements in these earths are now known as *ytterbium* and *lutetium*, respectively. These elements are identical with *aldebaranium* and *cassiopeium*, discovered independently and at about the same time by von Welsbach. Ytterbium occurs along with other rare earths in a number of rare minerals. It is commercially recovered principally from *monazite sand*, which contains about 0.03%. Ion-exchange and solvent extraction techniques developed in recent years have greatly simplified the separation of the rare earths from one another. The element was first prepared by Klemm and Bonner in 1937 by reducing ytterbium trichloride with potassium. Their metal was mixed, however, with KCl. Daane, Dennison, and Spedding prepared a much purer form in 1953 from which the chemical and physical properties of the element could be determined. Ytterbium has a bright silvery luster, is soft, malleable, and quite ductile. While the element is fairly stable, it should be kept in closed containers to protect it from air and moisture. Ytterbium is readily attacked and dissolved by dilute and concentrated mineral acids and reacts slowly with water. Ytterbium has three allotropic forms with transformation points at -13° and 795°C. The beta form is a room-temperature, face-centered, cubic modification, while the high-temperature gamma form is a body-centered cubic form. Another body-centered cubic phase has recently been found to be stable at high pressures at room temperatures. The beta form ordinarily has metallic-type conductivity, but becomes a semiconductor when the pressure is increased above 16,000 atm. The electri-

cal resistance increases tenfold as the pressure is increased to 39,000 atm and drops to about 80% of its standard temperature-pressure resistivity at a pressure of 40,000 atm. Natural ytterbium is a mixture of seven stable isotopes. Twenty-six other unstable isotopes and isomers are known. Ytterbium metal has possible use in improving the grain refinement, strength, and other mechanical properties of stainless steel. One isotope is reported to have been used as a radiation source as a substitute for a portable X-ray machine where electricity is unavailable. Few other uses have been found. Ytterbium metal is available with a purity of about 99.9% for about \$10/g. Ytterbium has a low acute toxicity rating.

**Yttrium** — (*Ytterby*, village in Sweden near Vauxholm), Y; at. wt. 88.90585(2); at. no. 39; m.p. 1522°C; b.p. 3345°C; sp. gr. 4.469 (25°C); valence 3. *Yttria*, which is an earth containing yttrium, was discovered by Gadolin in 1794. *Ytterby* is the site of a quarry which yielded many unusually minerals containing rare earths and other elements. This small town, near Stockholm, bears the honor of giving names to *erbium*, *terbium*, and *ytterbium* as well as *yttrium*. In 1843 Mosander showed that yttria could be resolved into the oxides (or earths) of three elements. The name yttria was reserved for the most basic one; the others were named *erbia* and *terbia*. Yttrium occurs in nearly all of the rare-earth minerals. Analysis of lunar rock samples obtained during the Apollo missions show a relatively high yttrium content. It is recovered commercially from *monazite sand*, which contains about 3%, and from *bastnasite*, which contains about 0.2%. Wohler obtained the impure element in 1828 by reduction of the anhydrous chloride with potassium. The metal is now produced commercially by reduction of the fluoride with calcium metal. It can also be prepared by other techniques. Yttrium has a silver-metallic luster and is relatively stable in air. Turnings of the metal, however, ignite in air if their temperature exceeds 400°C, and finely divided yttrium is very unstable in air. Yttrium oxide is one of the most important compounds of yttrium and accounts for the largest use. It is widely used in making YVO<sub>4</sub> europium, and Y<sub>2</sub>O<sub>3</sub> europium phosphors to give the red color in color television tubes. Many hundreds of thousands of pounds are now used in this application. Yttrium oxide also is used to produce yttrium iron garnets, which are very effective microwave filters. Yttrium iron, aluminum, and gadolinium garnets, with formulas such as Y<sub>3</sub>Fe<sub>5</sub>O<sub>12</sub> and Y<sub>3</sub>Al<sub>5</sub>O<sub>12</sub>, have interesting magnetic properties. Yttrium iron garnet is also exceptionally efficient as both a transmitter and transducer of acoustic energy. Yttrium aluminum garnet, with a hardness of 8.5, is also finding use as a gemstone (simulated diamond). Small amounts of yttrium (0.1 to 0.2%) can be used to reduce the grain size in chromium, molybdenum, zirconium, and titanium, and to increase strength of aluminum and magnesium alloys. Alloys with other useful properties can be obtained by using yttrium as an additive. The metal can be used as a deoxidizer for vanadium and other nonferrous metals. The metal has a low cross section for nuclear capture. <sup>90</sup>Y, one of the isotopes of yttrium, exists in equilibrium with its parent <sup>90</sup>Sr, a product of atomic explosions. Yttrium has been considered for use as a nodulizer for producing nodular cast iron, in which the graphite forms compact nodules instead of the usual flakes. Such iron has increased ductility. Yttrium is also finding application in laser systems and as a catalyst for ethylene polymerization. It also has potential use in ceramic and glass formulas, as the oxide has a high melting point and imparts shock resistance and low expansion characteristics to glass. Natural yttrium contains

but one isotope, <sup>89</sup>Y. Forty-three other unstable isotopes and isomers have been characterized. Yttrium metal of 99.9% purity is commercially available at a cost of about \$5/g.

**Zinc** — (Ger. *Zink*, of obscure origin), Zn; at. wt. 65.409(4); at. no. 30; m.p. 419.53°C; b.p. 907°C; sp. gr. 7.134 (25°C); valence 2. Centuries before zinc was recognized as a distinct element, zinc ores were used for making brass. Tubal-Cain, seven generations from Adam, is mentioned as being an "instructor in every artificer in brass and iron." An alloy containing 87% zinc has been found in prehistoric ruins in Transylvania. Metallic zinc was produced in the 13th century A.D. in India by reducing calamine with organic substances such as wool. The metal was rediscovered in Europe by Marggraf in 1746, who showed that it could be obtained by reducing *calamine* with charcoal. The principal ores of zinc are *sphalerite* or *blende* (sulfide), *smithsonite* (carbonate), *calamine* (silicate), and *franklinite* (zinc, manganese, iron oxide). Canada, Japan, Belgium, Germany, and the Netherlands are suppliers of zinc ores. Zinc is also mined in Alaska, Tennessee, Missouri, and elsewhere in the U.S. Zinc can be obtained by roasting its ores to form the oxide and by reduction of the oxide with coal or carbon, with subsequent distillation of the metal. Other methods of extraction are possible. Naturally occurring zinc contains five stable isotopes. Twenty-five other unstable isotopes and isomers are recognized. Zinc is a bluish-white, lustrous metal. It is brittle at ordinary temperatures but malleable at 100 to 150°C. It is a fair conductor of electricity, and burns in air at high red heat with evolution of white clouds of the oxide. The metal is employed to form numerous alloys with other metals. Brass, nickel silver, typewriter metal, commercial bronze, spring brass, German silver, soft solder, and aluminum solder are some of the more important alloys. Large quantities of zinc are used to produce die castings, used extensively by the automotive, electrical, and hardware industries. An alloy called *Prestal*®, consisting of 78% zinc and 22% aluminum, is reported to be almost as strong as steel but as easy to mold as plastic. It is said to be so plastic that it can be molded into form by relatively inexpensive die casts made of ceramics and cement. It exhibits superplasticity. Zinc is also extensively used to galvanize other metals such as iron to prevent corrosion. Neither zinc nor zirconium is ferromagnetic; but ZrZn<sub>2</sub> exhibits ferromagnetism at temperatures below 35 K. Zinc oxide is a unique and very useful material to modern civilization. It is widely used in the manufacture of paints, rubber products, cosmetics, pharmaceuticals, floor coverings, plastics, printing inks, soap, storage batteries, textiles, electrical equipment, and other products. It has unusual electrical, thermal, optical, and solid-state properties that have not yet been fully investigated. Lithopone, a mixture of zinc sulfide and barium sulfate, is an important pigment. Zinc sulfide is used in making luminous dials, X-ray and TV screens, and fluorescent lights. The chloride and chromate are also important compounds. Zinc is an essential element in the growth of human beings and animals. Tests show that zinc-deficient animals require 50% more food to gain the same weight as an animal supplied with sufficient zinc. Zinc is not considered to be toxic, but when freshly formed ZnO is inhaled a disorder known as the *oxide shakes* or *zinc chills* sometimes occurs. It is recommended that where zinc oxide is encountered good ventilation be provided. The commercial price of zinc in January 2002 was roughly 40¢/lb (\$90 kg). Zinc metal with a purity of 99.9999% is priced at about \$5/g.



**Zirconium** — (Syriac, *zargun*, color of gold), Zr; at. wt. 91.224(2); at. no. 40; m.p. 1855°C; b.p. 4409°C; sp. gr. 6.52 (20°C); valence +2, +3, and +4. The name *zircon* may have originated from the Syriac word *zargono*, which describes the color of certain gemstones now known as *zircon*, *jargon*, *hyacinth*, *jacinth*, or *ligure*. This mineral, or its variations, is mentioned in biblical writings. These minerals were not known to contain this element until Klaproth, in 1789, analyzed a *jargon* from Sri Lanka and found a new earth, which Werner named zircon (*silex circonius*), and Klaproth called *Zirkonerde* (*zirconia*). The impure metal was first isolated by Berzelius in 1824 by heating a mixture of potassium and potassium zirconium fluoride in a small iron tube. Pure zirconium was first prepared in 1914. Very pure zirconium was first produced in 1925 by van Arkel and de Boer by an iodide decomposition process they developed. Zirconium is found in abundance in S-type stars, and has been identified in the sun and meteorites. Analyses of lunar rock samples obtained during the various Apollo missions to the moon show a surprisingly high zirconium oxide content, compared with terrestrial rocks. Naturally occurring zirconium contains five isotopes. Thirty-one other radioactive isotopes and isomers are known to exist. *Zircon*,  $ZrSiO_4$ , the principal ore, is found in deposits in Florida, South Carolina, Australia, South Africa, and elsewhere. *Baddeleyite*, found in Brazil, is an important zirconium mineral. It is principally pure  $ZrO_2$  in crystalline form having a hafnium content of about 1%. Zirconium also occurs in some 30 other recognized mineral species. Zirconium is produced commercially by reduction of the chloride with magnesium (the Kroll Process), and by other methods. It is a grayish-white lustrous metal. When finely divided, the metal may ignite spontaneously in air, especially at elevated temperatures. The solid metal is much more difficult to ignite. The inherent toxicity of zirconium compounds is low. Hafnium is invariably found in zirconium ores, and the separation is difficult. Commercial-grade zirconium contains

from 1 to 3% hafnium. Zirconium has a low absorption cross section for neutrons, and is therefore used for nuclear energy applications, such as for cladding fuel elements. Commercial nuclear power generation now takes more than 90% of zirconium metal production. Reactors of the size now being made may use as much as a half-million lineal feet of zirconium alloy tubing. Reactor-grade zirconium is essentially free of hafnium. *Zircaloy*<sup>®</sup> is an important alloy developed specifically for nuclear applications. Zirconium is exceptionally resistant to corrosion by many common acids and alkalis, by sea water, and by other agents. It is used extensively by the chemical industry where corrosive agents are employed. Zirconium is used as a getter in vacuum tubes, as an alloying agent in steel, in surgical appliances, photoflash bulbs, explosive primers, rayon spinnerets, lamp filaments, etc. It is used in poison ivy lotions in the form of the carbonate as it combines with *urushiol*. With niobium, zirconium is superconductive at low temperatures and is used to make superconductive magnets. Alloyed with zinc, zirconium becomes magnetic at temperatures below 35 K. Zirconium oxide (zircon) has a high index of refraction and is used as a gem material. The impure oxide, zirconia, is used for laboratory crucibles that will withstand heat shock, for linings of metallurgical furnaces, and by the glass and ceramic industries as a refractory material. Its use as a refractory material accounts for a large share of all zirconium consumed. Zirconium tungstate is an unusual material that shrinks, rather than expands, when heated. A few other compounds are known to possess this property, but they tend to shrink in one direction, while they stretch out in others in order to maintain an overall volume. Zirconium tungstate shrinks in all directions over a wide temperature range of from near absolute zero to +777°C. It is being considered for use in composite materials where thermal expansion may be a problem. Zirconium of about 99.5% purity is available at a cost of about \$2000/kg or about \$4/g.

## PHYSICAL CONSTANTS OF INORGANIC COMPOUNDS

The compounds in this table were selected on the basis of their laboratory and industrial importance, as well as their value in illustrating trends in the variation of physical properties with position in the periodic table. An effort has been made to include the most frequently encountered inorganic substances; a limited number of organometallics are also covered. Many, if not most, of the compounds that are solids at ambient temperature can exist in more than one crystalline modification. In the absence of other information, the data given here can be assumed to apply to the most stable or common crystalline form. In many cases, however, two or more forms are of practical importance, and separate entries will be found in the table.

Compounds are arranged primarily in alphabetical order by the most commonly used name. However, adjustments are made in many instances so as to bring closely related compounds together. For example, hydrides of elements such as boron, silicon, and germanium are grouped together immediately following the entry for the parent element, since they would otherwise be scattered throughout the table. Likewise, the oxoacids of an element are given in one group whenever a strict alphabetical order would separate them (e.g., sulfuric acid and fluorosulfuric acid). The Formula Index following the table provides another means of locating a compound. There is also an index to CAS Registry Numbers.

The following data fields appear in the table:

- **Name:** Systematic name for the substance. The valence state of a metallic element is indicated by a Roman numeral, e.g., copper in the +1 state is written as copper(I) rather than cuprous, iron in the +3 state is iron(III) rather than ferric.
- **Formula:** The simplest descriptive formula is given, but this does not necessarily specify the actual structure of the compound. For example, aluminum chloride is designated as  $\text{AlCl}_3$ , even though a more accurate representation of the structure in the solid phase (and, under some conditions, in the gas phase) is  $\text{Al}_2\text{Cl}_6$ . A few exceptions are made, such as the use of  $\text{Hg}_2^{+2}$  for the mercury(I) ion.
- **CAS Registry Number:** Chemical Abstracts Service Registry Number. An asterisk\* following the CAS RN for a hydrate indicates that the number refers to the anhydrous compound. In most cases the generic CAS RN for the compound is given rather than the number for a specific crystalline form or mineral.
- **Mol. Weight:** Molecular weight (relative molar mass) as calculated with the 2005 IUPAC Recommended Atomic Weights. The number of decimal places corresponds to the number of places in the atomic weight of the least accurately known element (e.g., one place for lead compounds, two places for compounds of selenium, germanium, etc.); a maximum of three places is given. For compounds of

radioactive elements for which IUPAC makes no recommendation, the mass number of the isotope with longest half-life is used.

- **Physical Form:** The crystal system is given, when available, for compounds that are solid at room temperature, together with color and other descriptive features. Abbreviations are listed below.
- **mp:** Normal melting point in °C. The notation tp indicates the temperature where solid, liquid, and gas are in equilibrium at a pressure greater than one atmosphere (i.e., the normal melting point does not exist). When available, the triple point pressure is listed.
- **bp:** Normal boiling point in °C (referred to 101.325 kPa or 760 mmHg pressure). The notation sp following the number indicates the temperature where the pressure of the vapor in equilibrium with the solid reaches 101.325 kPa. See Reference 8, p. 23, for further discussion of sublimation points and triple points. A notation “sublimes” without a temperature being given indicates that there is a perceptible sublimation pressure above the solid at ambient temperatures.
- **Density:** Density values for solids and liquids are always in units of grams per cubic centimeter and can be assumed to refer to temperatures near room temperature unless otherwise stated. Values for gases are the calculated ideal gas densities in grams per liter at 25 °C and 101.325 kPa; the unit is always specified for a gas value.
- **Aqueous Solubility:** Solubility is expressed as the number of grams of the compound (excluding any water of hydration) that will dissolve in 100 grams of water. The temperature in °C is given as a superscript. Solubility at other temperatures can be found for many compounds in the table “Aqueous Solubility of Inorganic Compounds at Various Temperatures” in Section 8.
- **Qualitative Solubility:** Qualitative information on the solubility in other solvents (and in water, if quantitative data are unavailable) is given here. The abbreviations are:

i insoluble  
sl slightly soluble  
s soluble  
vs very soluble  
reac reacts with the solvent

Data were taken from a wide variety of reliable sources, including monographs, treatises, review articles, evaluated compilations and databases, and in many cases the primary literature. Some of the most useful references for the properties covered here are listed below.

### List of Abbreviations

<b>Ac</b> - acetyl	<b>blk</b> - black	<b>cub</b> - cubic	<b>exp</b> - explodes, explosive
<b>ace</b> - acetone	<b>brn</b> - brown	<b>cyhex</b> - cyclohexane	<b>extrap</b> - extrapolated
<b>acid</b> - acid solutions	<b>bz</b> - benzene	<b>dec</b> - decomposes	<b>flam</b> - flammable
<b>alk</b> - alkaline solutions	<b>chl</b> - chloroform	<b>dil</b> - dilute	<b>gl</b> - glass, glassy
<b>amorp</b> - amorphous	<b>col</b> - colorless	<b>diox</b> - dioxane	<b>grn</b> - green
<b>anh</b> - anhydrous	<b>conc</b> - concentrated	<b>eth</b> - ethyl ether	<b>hc</b> - hydrocarbon solvents
<b>aq</b> - aqueous	<b>cry</b> - crystals, crystalline	<b>EtOH</b> - ethanol	<b>hex</b> - hexagonal, hexane

<b>hp</b> - heptane	<b>orth</b> - orthorhombic
<b>HT</b> - high temperature	<b>os</b> - organic solvents
<b>hyd</b> - hydrate	<b>peth</b> - petroleum ether
<b>hyg</b> - hygroscopic	<b>pow</b> - powder
<b>i</b> - insoluble in	<b>prec</b> - precipitate
<b>liq</b> - liquid	<b>pur</b> - purple
<b>LT</b> - low temperature	<b>py</b> - pyridine
<b>MeOH</b> - methanol	<b>reac</b> - reacts with
<b>monocl</b> - monoclinic	<b>refrac</b> - refractory
<b>octahed</b> - octahedral	<b>rhom</b> - rhombohedral
<b>oran</b> - orange	<b>r.t.</b> - room temperature

<b>s</b> - soluble in	<b>tp</b> - triple point
<b>silv</b> - silvery	<b>trans</b> - transition, transformation
<b>sl</b> - slightly soluble in	<b>tricl</b> - triclinic
<b>soln</b> - solution	<b>trig</b> - trigonal
<b>sp</b> - sublimation point	<b>unstab</b> - unstable
<b>stab</b> - stable	<b>viol</b> - violet
<b>subl</b> - sublimes	<b>visc</b> - viscous
<b>temp</b> - temperature	<b>vs</b> - very soluble in
<b>tetr</b> - tetragonal	<b>wh</b> - white
<b>thf</b> - tetrahydrofuran	<b>xyl</b> - xylene
<b>tol</b> - toluene	<b>yel</b> - yellow

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No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1	Actinium	Ac	7440-34-8	227	silv metal; cub	1050	3198	10		
2	Actinium bromide	AcBr <sub>3</sub>	33689-81-5	467	wh hex cry		800 subl	5.85		s H <sub>2</sub> O
3	Actinium chloride	AcCl <sub>3</sub>	22986-54-5	333	wh hex cry		960 subl	4.81		
4	Actinium fluoride	AcF <sub>3</sub>	33689-80-4	284	wh hex cry			7.88		i H <sub>2</sub> O
5	Actinium iodide	AcI <sub>3</sub>	33689-82-6	608	wh cry					s H <sub>2</sub> O
6	Actinium oxide	Ac <sub>2</sub> O <sub>3</sub>	12002-61-8	502	wh hex cry	1977		9.19		i H <sub>2</sub> O
7	Aluminum	Al	7429-90-5	26.982	silv-wh metal; cub cry	660.32	2519	2.70		i H <sub>2</sub> O; s acid, alk
8	Aluminum acetate	Al(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	139-12-8	204.113	wh hyg solid	dec				s H <sub>2</sub> O; sl ace
9	Aluminum diacetate	Al(OH)(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	142-03-0	162.078	wh amorp powder					i H <sub>2</sub> O
10	Aluminum ammonium sulfate	AlNH <sub>4</sub> (SO <sub>4</sub> ) <sub>2</sub>	7784-25-0	237.146	wh powder					sl H <sub>2</sub> O; i EtOH
11	Aluminum ammonium sulfate dodecahydrate	AlNH <sub>4</sub> (SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7784-26-1	453.329	col cry or powder	94.5	>280 dec	1.65		s H <sub>2</sub> O; i EtOH
12	Aluminum antimonide	AlSb	25152-52-7	148.742	brn cub cry	1065		4.26		
13	Aluminum arsenide	AlAs	22831-42-1	101.903	oran cub cry; hyg	1740		3.76		
14	Aluminum borate	2Al <sub>2</sub> O <sub>3</sub> · B <sub>2</sub> O <sub>3</sub>	11121-16-7	273.543	needles	≈1050				i H <sub>2</sub> O
15	Aluminum borohydride	Al(BH <sub>4</sub> ) <sub>3</sub>	16962-07-5	71.510	flam liq	-64.5	44.5			reac H <sub>2</sub> O
16	Aluminum bromate nonahydrate	Al(BrO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	11126-81-1*	572.826	wh hyg cry	62	>100 dec			s H <sub>2</sub> O
17	Aluminum bromide	AlBr <sub>3</sub>	7727-15-3	266.694	wh-yel monocl cry; hyg	97.5	255	3.2		reac H <sub>2</sub> O; s bz, tol

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
18	Aluminum bromide hexahydrate	AlBr <sub>3</sub> · 6H <sub>2</sub> O	7784-11-4	374.785	col-yel hyg cry	93		2.54		s H <sub>2</sub> O, EtOH, CS <sub>2</sub>
19	Aluminum carbide	Al <sub>4</sub> C <sub>3</sub>	1299-86-1	143.958	yel hex cry	2100	>2200 dec	2.36		react H <sub>2</sub> O
20	Aluminum chlorate nonahydrate	Al(ClO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	15477-33-5	439.473	hyg cry					vs H <sub>2</sub> O; s EtOH
21	Aluminum chloride	AlCl <sub>3</sub>	7446-70-0	133.341	wh hex cry or powder; hyg	192.6	180 sp	2.48	45.1 <sup>25</sup>	s bz, ctc, chl
22	Aluminum chloride hexahydrate	AlCl <sub>3</sub> · 6H <sub>2</sub> O	7784-13-6	241.432	col hyg cry	100 dec		2.398	45.1 <sup>25</sup>	s EtOH, eth
23	Dichloromethylaluminum	AlCl <sub>2</sub> CH <sub>3</sub>	917-65-7	112.923	cry	72.7	95 <sup>10</sup>			s bz, eth, hc
24	Chlorodiethylaluminum	AlCl(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	96-10-6	120.557	col liq	-74		0.96		react H <sub>2</sub> O
25	Chlorodiisobutylaluminum	AlCl(C <sub>4</sub> H <sub>9</sub> ) <sub>2</sub>	1779-25-5	176.664	hyg col liq	-40		0.95		s eth, hx
26	Aluminum diboride	AlB <sub>2</sub>	12041-50-8	48.604	powder	>920 dec		3.19		s dil HCl
27	Aluminum dodecaboride	AlB <sub>12</sub>	12041-54-2	156.714	yel-brn prisms	2070		2.55		s hot HNO <sub>3</sub> ; i acid, alk
28	Aluminum ethanolate	Al(C <sub>2</sub> H <sub>5</sub> O) <sub>3</sub>	555-75-9	162.163	liq, condenses to wh solid	140				react H <sub>2</sub> O; sl xyl
29	Aluminum fluoride	AlF <sub>3</sub>	7784-18-1	83.977	wh hex cry	2250 tp (220 MPa)	1276 sp	3.10	0.50 <sup>25</sup>	
30	Aluminum fluoride monohydrate	AlF <sub>3</sub> · H <sub>2</sub> O	32287-65-3	101.992	orth cry			2.17	0.50 <sup>25</sup>	
31	Aluminum fluoride trihydrate	AlF <sub>3</sub> · 3H <sub>2</sub> O	15098-87-0	138.023	wh hyg cry			1.914	0.50 <sup>25</sup>	
32	Aluminum hexafluorosilicate nonahydrate	Al <sub>2</sub> (SiF <sub>6</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	17099-70-6	642.329	hex prisms	>500 dec				s H <sub>2</sub> O
33	Aluminum hydride	AlH <sub>3</sub>	7784-21-6	30.006	col hex cry	>150 dec				react H <sub>2</sub> O
34	Aluminum hydroxide	Al(OH) <sub>3</sub>	21645-51-2	78.004	wh amorp powder			2.42		i H <sub>2</sub> O; s alk, acid
35	Aluminum hydroxychloride	Al <sub>2</sub> (OH) <sub>2</sub> Cl · 2H <sub>2</sub> O	1327-41-9	210.483	gl solid					s H <sub>2</sub> O
36	Aluminum iodide	AlI <sub>3</sub>	7784-23-8	407.695	wh leaflets	188.28	382	3.98		react H <sub>2</sub> O
37	Aluminum iodide hexahydrate	AlI <sub>3</sub> · 6H <sub>2</sub> O	10090-53-6	515.786	yel hyg cry powder					vs H <sub>2</sub> O; s EtOH, eth
38	Aluminum lactate	Al(C <sub>3</sub> H <sub>5</sub> O <sub>3</sub> ) <sub>3</sub>	18917-91-4	294.192	powder					vs H <sub>2</sub> O
39	Aluminum molybdate	Al <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	15123-80-5	533.78	wh pow	≈950				
40	Aluminum nitrate	Al(NO <sub>3</sub> ) <sub>3</sub>	13473-90-0	212.997	wh hyg solid	dec			68.9 <sup>25</sup>	vs EtOH; sl ace
41	Aluminum nitrate nonahydrate	Al(NO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	7784-27-2	375.134	wh hyg monocl cry	73	135 dec	1.72	68.9 <sup>25</sup>	vs EtOH; i pyr
42	Aluminum nitride	AlN	24304-00-5	40.989	blue-wh hex cry	3000		3.255		react H <sub>2</sub> O
43	Aluminum oleate	Al(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>3</sub>	688-37-9	871.342	yel solid					i H <sub>2</sub> O; s EtOH, bz
44	Aluminum oxalate monohydrate	Al <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · H <sub>2</sub> O	814-87-9	336.035	wh pow					i H <sub>2</sub> O, EtOH; s acid
45	Aluminum oxide (α)	Al <sub>2</sub> O <sub>3</sub>	1344-28-1	101.961	wh powder; hex	2054	2977	3.99		i H <sub>2</sub> O, os; sl alk
46	Aluminum oxide (γ)	Al <sub>2</sub> O <sub>3</sub>	1344-28-1	101.961	soft wh pow	trans to corundum 1200		3.97		i H <sub>2</sub> O; s acid; sl alk
47	Aluminum oxyhydroxide (boehmite)	AlO(OH)	1318-23-6	59.989	wh orth cry	trans to diasphore 227		3.07		i H <sub>2</sub> O; s hot acid, alk
48	Aluminum oxyhydroxide (diaspore)	AlO(OH)	14457-84-2	59.989	orth cry	dec 450		3.38		i H <sub>2</sub> O; s acid, alk
49	Aluminum palmitate	Al(C <sub>15</sub> H <sub>31</sub> COO) <sub>3</sub>	555-35-1	793.230	wh-yel powder					i H <sub>2</sub> O, EtOH; s peth
50	Aluminum 2,4-pentanedioate	Al(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	13963-57-0	324.306	pale yel prisms	194.6	315	1.27		i H <sub>2</sub> O; s bz, EtOH; sl hex
51	Aluminum perchlorate	Al(ClO <sub>4</sub> ) <sub>3</sub>	14452-39-2	325.334	wh hyg cry				55 <sup>0</sup>	s H <sub>2</sub> O, eth; i ctc
52	Aluminum perchlorate nonahydrate	Al(ClO <sub>4</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	14452-39-2	487.471	wh hyg cry	82 dec		2.0	182.4 <sup>0</sup>	
53	Aluminum phosphate	AlPO <sub>4</sub>	7784-30-7	121.953	wh rhomb plates	>1460		2.56		i H <sub>2</sub> O; sl acid
54	Aluminum phosphate dihydrate	AlPO <sub>4</sub> · 2H <sub>2</sub> O	13477-75-3	157.984	wh rhom cry	dec 1500		2.54		i H <sub>2</sub> O
55	Aluminum phosphate trihydroxide	Al <sub>2</sub> (OH) <sub>3</sub> PO <sub>4</sub>	12004-29-4	199.957	wh or yel monocl cry			2.7		
56	Aluminum metaphosphate	Al(PO <sub>3</sub> ) <sub>3</sub>	32823-06-6	263.898	col powder; tetr	≈1525		2.78		i H <sub>2</sub> O
57	Aluminum hypophosphite	Al(H <sub>2</sub> PO <sub>2</sub> ) <sub>3</sub>	7784-22-7	221.948	cry powder	220 dec				i H <sub>2</sub> O; s alk, acid
58	Aluminum phosphide	AlP	20859-73-8	57.956	grn or yel cub cry	2550		2.40		react H <sub>2</sub> O
59	Aluminum selenide	Al <sub>2</sub> Se <sub>3</sub>	1302-82-5	290.84	yel-brown powder	960		3.437		react H <sub>2</sub> O
60	Aluminum silicate (andalusite)	Al <sub>2</sub> SiO <sub>5</sub>	12183-80-1	162.046	gray-grn cry			3.145		
61	Aluminum silicate (kyanite)	Al <sub>2</sub> SiO <sub>5</sub>	1302-76-7	162.046	blue or gray tricrl cry	dec 1000		3.68		
62	Aluminum silicate (mullite)	3Al <sub>2</sub> O <sub>3</sub> · 2SiO <sub>2</sub>	1302-93-8	426.052	col orth cry	1750		3.17		i H <sub>2</sub> O, acid, HF
63	Aluminum silicate (sillimanite)	Al <sub>2</sub> SiO <sub>5</sub>	12141-45-6	162.046	wh orth cry	1816		3.25		
64	Aluminum silicate dihydrate	Al <sub>2</sub> O <sub>3</sub> · 2SiO <sub>2</sub> · 2H <sub>2</sub> O	1332-58-7	258.161	wh-yel powder; tricrl			2.59		i H <sub>2</sub> O, acid, alk
65	Aluminum stearate	Al(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>3</sub>	637-12-7	877.390	wh powder	115		1.070		i H <sub>2</sub> O, EtOH, eth; s alk
66	Aluminum monostearate	Al(OH)(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> )	7047-84-9	344.467	yel-wh pow	155		1.02		i H <sub>2</sub> O
67	Aluminum distearate	Al(OH)(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	300-92-5	610.928	wh pow	145				i H <sub>2</sub> O
68	Aluminum sulfate	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10043-01-3	342.151	wh cry	1040 dec			38.5 <sup>25</sup>	i EtOH
69	Aluminum sulfate octadecahydrate	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 18H <sub>2</sub> O	7784-31-8	666.426	col monocl cry	86 dec		1.69	38.5 <sup>25</sup>	
70	Aluminum sulfide	Al <sub>2</sub> S <sub>3</sub>	1302-81-4	150.158	yel-gray powder	1100		2.02		
71	Aluminum telluride	Al <sub>2</sub> Te <sub>3</sub>	12043-29-7	436.76	gray-blk hex cry	≈895		4.5		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
72	Aluminum thiocyanate	Al(SCN) <sub>3</sub>	538-17-0	201.229	yel powder					s H <sub>2</sub> O; i EtOH, eth
73	Aluminum titanate	Al <sub>2</sub> TiO <sub>5</sub>	12004-39-6	181.827	refrac solid	1860				
74	Aluminum zirconium	Al <sub>2</sub> Zr	12004-50-1	145.187	metallic solid	1645				
75	Americium	Am	7440-35-9	243	silv metal; hex or cub	1176	2011	12		s acid
76	Americium(III) oxide	Am <sub>2</sub> O <sub>3</sub>	12254-64-7	534	tan hex cry			11.77		s acid
77	Americium(III) bromide	AmBr <sub>3</sub>	14933-38-1	483	wh orth cry			6.85		s H <sub>2</sub> O
78	Americium(III) chloride	AmCl <sub>3</sub>	13464-46-5	349	pink hex cry	500		5.87		
79	Americium(III) fluoride	AmF <sub>3</sub>	13708-80-0	300	pink hex cry	1393		9.53		
80	Americium(III) iodide	AmI <sub>3</sub>	13813-47-3	624	yel ortho cry	≈950		6.9		
81	Americium(IV) fluoride	AmF <sub>4</sub>	15947-41-8	319	tan monocl cry			7.23		
82	Americium(IV) oxide	AmO <sub>2</sub>	12005-67-3	275	blk cub cry	>1000 dec		11.68		s acid
83	Ammonia	NH <sub>3</sub>	7664-41-7	17.031	col gas	-77.73	-33.33	0.696 g/L		vs H <sub>2</sub> O; s EtOH, eth
84	Ammonium acetate	NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	631-61-8	77.083	wh hyg cry	114		1.073	148 <sup>4</sup>	s EtOH; sl ace
85	Ammonium azide	NH <sub>4</sub> N <sub>3</sub>	12164-94-2	60.059	orth cry; flam	160	exp	1.346	20.2 <sup>30</sup>	
86	Ammonium benzoate	NH <sub>4</sub> C <sub>6</sub> H <sub>5</sub> O <sub>2</sub>	1863-63-4	139.152	wh cry or powder	198		1.26		s H <sub>2</sub> O; sl EtOH
87	Ammonium bromate	NH <sub>4</sub> BrO <sub>3</sub>	13843-59-9	145.941	col hex cry	exp				vs H <sub>2</sub> O
88	Ammonium bromide	NH <sub>4</sub> Br	12124-97-9	97.943	wh hyg tetr cry	542 dec	396 sp	2.429	78.3 <sup>25</sup>	s EtOH, ace; sl eth
89	Ammonium caprylate	NH <sub>4</sub> C <sub>8</sub> H <sub>15</sub> O <sub>2</sub>	5972-76-9	161.243	hyg monocl cry	≈75				reac H <sub>2</sub> O; s EtOH; i chl, bz
90	Ammonium carbamate	NH <sub>4</sub> COONH <sub>2</sub>	1111-78-0	78.071	cry powder					vs H <sub>2</sub> O; s EtOH
91	Ammonium carbonate	(NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>	506-87-6	96.086	col cry powder	58 dec			100 <sup>15</sup>	
92	Ammonium chlorate	NH <sub>4</sub> ClO <sub>3</sub>	10192-29-7	101.490	wh cry	102 exp		1.80	28.7 <sup>9</sup>	
93	Ammonium chloride	NH <sub>4</sub> Cl	12125-02-9	53.492	col cub cry	520.1 tp (dec)	338 sp	1.519	39.5 <sup>25</sup>	
94	Ammonium chromate	(NH <sub>4</sub> ) <sub>2</sub> CrO <sub>4</sub>	7788-98-9	152.071	yel cry	185 dec		1.90	37 <sup>25</sup>	sl ace, MeOH; i EtOH
95	Ammonium chromic sulfate dodecahydrate	NH <sub>4</sub> Cr(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10022-47-6	478.343	blue-viol cry	94 dec		1.72		s H <sub>2</sub> O; sl EtOH
96	Ammonium cobalt(II) phosphate	CoNH <sub>4</sub> PO <sub>4</sub>	14590-13-7	171.943	red-viol powder (hyd)					i H <sub>2</sub> O; s acid
97	Ammonium cobalt(II) phosphate monohydrate	CoNH <sub>4</sub> PO <sub>4</sub> · H <sub>2</sub> O	16827-96-6	189.959	red-purp orth plates	dec 450				s acid
98	Ammonium cobalt(II) sulfate hexahydrate	(NH <sub>4</sub> ) <sub>2</sub> Co(SO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13586-38-4	395.227	red monocl prisms			1.90		s H <sub>2</sub> O; i EtOH
99	Ammonium copper(II) chloride	CuCl <sub>2</sub> · 2NH <sub>4</sub> Cl	10060-13-6*	241.435	yel hyg orth cry					s H <sub>2</sub> O
100	Ammonium copper(II) chloride dihydrate	CuCl <sub>2</sub> · 2NH <sub>4</sub> Cl · 2H <sub>2</sub> O	10060-13-6	277.465	blue-grn tetr cry	110 dec		1.993		s H <sub>2</sub> O, EtOH
101	Ammonium cyanide	NH <sub>4</sub> CN	12211-52-8	44.056	col tetr cry	dec		1.10		vs H <sub>2</sub> O
102	Ammonium dichromate	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	7789-09-5	252.065	oran-red monocl cry; hyg	180 dec		2.155	35.6 <sup>20</sup>	
103	Ammonium dihydrogen arsenate	NH <sub>4</sub> H <sub>2</sub> AsO <sub>4</sub>	13462-93-6	158.975	tetr cry	300 dec		2.311	52.7 <sup>25</sup>	
104	Ammonium dihydrogen phosphate	NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>	7722-76-1	115.026	wh tetr cry	190		1.80	40.4 <sup>25</sup>	sl EtOH; i ace
105	Ammonium <i>O,O</i> -diethylthiophosphate	(C <sub>2</sub> H <sub>5</sub> O) <sub>2</sub> P(S)SNH <sub>4</sub>	1068-22-0	203.264	cry	165				
106	Ammonium dithiocarbamate	NH <sub>4</sub> NH <sub>2</sub> CSS	513-74-6	110.202	yel ortho cry	99 dec		1.45		s H <sub>2</sub> O
107	Ammonium ferricyanide trihydrate	(NH <sub>4</sub> ) <sub>3</sub> Fe(CN) <sub>6</sub> · 3H <sub>2</sub> O	14221-48-8*	320.110	red cry					s H <sub>2</sub> O; i EtOH
108	Ammonium ferrocyanide trihydrate	(NH <sub>4</sub> ) <sub>4</sub> Fe(CN) <sub>6</sub> · 3H <sub>2</sub> O	14481-29-9*	338.149	yel cry	dec				s H <sub>2</sub> O; i EtOH
109	Ammonium fluoride	NH <sub>4</sub> F	12125-01-8	37.037	wh hex cry; hyg	238		1.015	83.5 <sup>25</sup>	sl EtOH
110	Ammonium fluorosulfonate	NH <sub>4</sub> SO <sub>3</sub> F	13446-08-7	117.100	col needles	245				s H <sub>2</sub> O, EtOH, MeOH
111	Ammonium formate	NH <sub>4</sub> CHO <sub>2</sub>	540-69-2	63.057	hyg cry	116		1.27	143 <sup>30</sup>	s EtOH
112	Ammonium heptafluorotantalate	(NH <sub>4</sub> ) <sub>7</sub> TaF <sub>7</sub>	12022-02-5	350.014	hyg cry					
113	Ammonium hexabromoosmate(IV)	(NH <sub>4</sub> ) <sub>2</sub> OsBr <sub>6</sub>	24598-62-7	705.73	small blk cubes					sl H <sub>2</sub> O; s glycerol; i EtOH
114	Ammonium hexabromoplatinate(IV)	(NH <sub>4</sub> ) <sub>2</sub> PtBr <sub>6</sub>	17363-02-9	710.585	powder	145 dec			0.59 <sup>20</sup>	
115	Ammonium hexachloroiridate(III)	(NH <sub>4</sub> ) <sub>3</sub> IrCl <sub>6</sub>	15752-05-3	459.050	grn pow					
116	Ammonium hexachloroiridate(IV)	(NH <sub>4</sub> ) <sub>3</sub> IrCl <sub>6</sub>	16940-92-4	441.012	blk cry powder	dec		2.856	1.09 <sup>25</sup>	
117	Ammonium hexachloroosmate(IV)	(NH <sub>4</sub> ) <sub>2</sub> OsCl <sub>6</sub>	12125-08-5	439.03	red cry or powder		subl	2.93		s H <sub>2</sub> O, EtOH
118	Ammonium hexachloropalladate(IV)	(NH <sub>4</sub> ) <sub>2</sub> PdCl <sub>6</sub>	19168-23-1	355.22	red-brn hyg cry	dec		2.418		
119	Ammonium hexachloroplatinatate(IV)	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>6</sub>	16919-58-7	443.879	red-oran cub cry	380 dec		3.065	0.5 <sup>20</sup>	i EtOH
120	Ammonium hexachlororuthenate(IV)	(NH <sub>4</sub> ) <sub>2</sub> RuCl <sub>6</sub>	18746-63-9	349.87	red cry					
121	Ammonium hexafluoroaluminate	(NH <sub>4</sub> ) <sub>6</sub> AlF <sub>6</sub>	7784-19-2	195.087	cub cry			1.78		s H <sub>2</sub> O
122	Ammonium hexafluorogallate	(NH <sub>4</sub> ) <sub>6</sub> GaF <sub>6</sub>	14639-94-2	237.828	col cub cry	>200 dec		2.10		
123	Ammonium hexafluorogermanate	(NH <sub>4</sub> ) <sub>6</sub> GeF <sub>6</sub>	16962-47-3	222.71	wh cry	380	subl	2.564		s H <sub>2</sub> O; i EtOH
124	Ammonium hexafluorophosphate	NH <sub>4</sub> PF <sub>6</sub>	16941-11-0	163.003	wh cub cry	58 dec		2.180		vs H <sub>2</sub> O; s ace, EtOH, MeOH
125	Ammonium hexafluorosilicate	(NH <sub>4</sub> ) <sub>6</sub> SiF <sub>6</sub>	16919-19-0	178.153	wh cub or trig cry	dec		2.011	22.7 <sup>25</sup>	i EtOH, ace
126	Ammonium hexafluorotitanate	(NH <sub>4</sub> ) <sub>6</sub> TiF <sub>6</sub>	16962-40-6	197.934	wh solid					s H <sub>2</sub> O



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
127	Ammonium hexafluorozirconate(IV)	(NH <sub>4</sub> ) <sub>2</sub> ZrF <sub>6</sub>	16919-31-6	241.291	wh hex cry			1.154		s H <sub>2</sub> O
128	Ammonium hydrogen arsenate	(NH <sub>4</sub> ) <sub>2</sub> HAsO <sub>4</sub>	7784-44-3	176.004	wh powder			1.99		s H <sub>2</sub> O
129	Ammonium hydrogen carbonate	NH <sub>4</sub> HCO <sub>3</sub>	1066-33-7	79.056	col or wh prisms	107 dec		1.586	24.8 <sup>25</sup>	i EtOH, bz
130	Ammonium hydrogen citrate	(NH <sub>4</sub> ) <sub>3</sub> HC <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	3012-65-5	226.184	col cry			1.48		vs H <sub>2</sub> O; sl EtOH
131	Ammonium hydrogen fluoride	NH <sub>4</sub> HF <sub>2</sub>	1341-49-7	57.044	wh orth cry	125	240 dec	1.50	60.2 <sup>20</sup>	
132	Ammonium hydrogen malate	NH <sub>4</sub> C <sub>4</sub> H <sub>3</sub> O <sub>5</sub>	5972-71-4	151.118	orth cry	160		1.15		s H <sub>2</sub> O; sl EtOH
133	Ammonium hydrogen oxalate monohydrate	NH <sub>4</sub> HC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	5972-72-5*	125.081	col rhomb cry	dec		1.56		sl H <sub>2</sub> O, EtOH
134	Ammonium hydrogen phosphate	(NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub>	7783-28-0	132.055	wh cry	155 dec		1.619	69.5 <sup>25</sup>	i EtOH, ace
135	Ammonium hydrogen phosphite monohydrate	(NH <sub>4</sub> ) <sub>2</sub> HPO <sub>3</sub> · H <sub>2</sub> O	51503-61-8	134.071	hyg cry					s H <sub>2</sub> O
136	Ammonium hydrogen selenate	NH <sub>4</sub> HSeO <sub>4</sub>	10294-60-7	162.01	rhomb cry	dec		2.162		
137	Ammonium hydrogen sulfate	NH <sub>4</sub> HSO <sub>4</sub>	7803-63-6	115.110	wh hyg cry	147		1.78	100 <sup>20</sup>	i EtOH, ace, py
138	Ammonium hydrogen sulfide	NH <sub>4</sub> HS	12124-99-1	51.112	wh tetr or orth cry	dec		1.17	128 <sup>0</sup>	sl ace; i bz, eth
139	Ammonium hydrogen sulfite	NH <sub>4</sub> HSO <sub>3</sub>	10192-30-0	99.110	col cry	dec		2.03	71.8 <sup>0</sup>	
140	Ammonium hydrogen tartrate	NH <sub>4</sub> HC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	3095-65-6	167.117	wh cry			1.68		sl H <sub>2</sub> O; s alk; i EtOH
141	Ammonium hydroxide	NH <sub>4</sub> OH	1336-21-6	35.046	exists only in soln					
142	Ammonium hypophosphite	NH <sub>4</sub> H <sub>2</sub> PO <sub>2</sub>	7803-65-8	83.028	wh hyg cry	dec				vs H <sub>2</sub> O; sl EtOH; i ace
143	Ammonium iodate	NH <sub>4</sub> IO <sub>3</sub>	13446-09-8	192.941	wh powder	150		3.3	3.84 <sup>25</sup>	
144	Ammonium iodide	NH <sub>4</sub> I	12027-06-4	144.943	wh tetr cry; hyg	551 dec	405 sp	2.514	178 <sup>25</sup>	sl EtOH, MeOH
145	Ammonium iron(II) sulfate hexahydrate	(NH <sub>4</sub> ) <sub>2</sub> Fe(SO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	7783-85-9	392.139	blue-grn monocl cry	≈100 dec		1.86		s H <sub>2</sub> O; i EtOH
146	Ammonium iron(III) chromate	NH <sub>4</sub> Fe(CrO <sub>4</sub> ) <sub>2</sub>	7789-08-4	305.871	red powder					i H <sub>2</sub> O
147	Ammonium iron(III) oxalate trihydrate	(NH <sub>4</sub> ) <sub>3</sub> Fe(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	13268-42-3	428.063	grn monocl cry; hyg	≈160 dec		1.780		vs H <sub>2</sub> O; i EtOH
148	Ammonium iron(III) sulfate dodecahydrate	NH <sub>4</sub> Fe(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7783-83-7	482.192	col to viol cry	≈37		1.71		vs H <sub>2</sub> O; i EtOH
149	Ammonium lactate	NH <sub>4</sub> C <sub>3</sub> H <sub>5</sub> O <sub>3</sub>	52003-58-4	107.108	col cry	92				s H <sub>2</sub> O, EtOH; sl MeOH; i ace, eth
150	Ammonium magnesium chloride hexahydrate	NH <sub>4</sub> MgCl <sub>3</sub> · 6H <sub>2</sub> O	39733-35-2	256.794	hyg cry	dec 100		1.46	17 <sup>20</sup>	s H <sub>2</sub> O
151	Ammonium mercuric chloride dihydrate	(NH <sub>4</sub> ) <sub>2</sub> HgCl <sub>4</sub> · 2H <sub>2</sub> O	33445-15-7*	414.51	powder					s H <sub>2</sub> O; sl EtOH
152	Ammonium metatungstate hexahydrate	(NH <sub>4</sub> ) <sub>6</sub> W <sub>12</sub> O <sub>24</sub> · 6H <sub>2</sub> O	12028-48-7	1887.19	wh cry					s H <sub>2</sub> O; i EtOH
153	Ammonium metavanadate	NH <sub>4</sub> VO <sub>3</sub>	7803-55-6	116.979	wh-yel cry	200 dec		2.326	4.8 <sup>20</sup>	
154	Ammonium molybdate(VI) tetrahydrate	(NH <sub>4</sub> ) <sub>3</sub> Mo <sub>7</sub> O <sub>24</sub> · 4H <sub>2</sub> O	12054-85-2	1235.86	col or grn-yel cry	90 dec		2.498	43	i EtOH
155	Ammonium dimolybdate	(NH <sub>4</sub> ) <sub>2</sub> Mo <sub>2</sub> O <sub>7</sub>	27546-07-2	339.95	cry					s H <sub>2</sub> O
156	Ammonium molybdophosphate	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> · 12MoO <sub>3</sub>	12026-66-3	1876.35	grn or yel cry	dec			0.02 <sup>20</sup>	sl H <sub>2</sub> O; s alk
157	Ammonium nitrate	NH <sub>4</sub> NO <sub>3</sub>	6484-52-2	80.043	wh hyg cry; orth	169.7	dec 200-260	1.72	213 <sup>25</sup>	sl MeOH
158	Ammonium nitrite	NH <sub>4</sub> NO <sub>2</sub>	13446-48-5	64.044	wh-yel cry	60 exp		1.69	221 <sup>25</sup>	i eth
159	Ammonium nitroferricyanide	(NH <sub>4</sub> ) <sub>5</sub> Fe(CN) <sub>5</sub> NO	14402-70-1	252.016	red-brn cry					s H <sub>2</sub> O, EtOH
160	Ammonium oleate	NH <sub>4</sub> C <sub>18</sub> H <sub>33</sub> O <sub>2</sub>	544-60-5	299.493	yel-brn paste	21				s H <sub>2</sub> O; sl ace
161	Ammonium oxalate	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	1113-38-8	124.096	col sol			1.5	5.20 <sup>25</sup>	
162	Ammonium oxalate monohydrate	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	6009-70-7	142.110	wh orth cry	dec		1.50	5.20 <sup>25</sup>	sl EtOH
163	Ammonium palmitate	NH <sub>4</sub> C <sub>15</sub> H <sub>31</sub> CO <sub>2</sub>	593-26-0	273.455	yel-wh powder	22				s H <sub>2</sub> O; sl bz, xyl; i ace, EtOH, etc
164	Ammonium pentaborate tetrahydrate	NH <sub>4</sub> B <sub>5</sub> O <sub>8</sub> · 4H <sub>2</sub> O	12007-89-5	272.150	wh cry				7.03 <sup>18</sup>	
165	Ammonium pentachlororhodate(III) monohydrate	(NH <sub>4</sub> ) <sub>2</sub> RhCl <sub>5</sub> · H <sub>2</sub> O	63771-33-5	334.262	red cry	dec 210				
166	Ammonium pentachlorozincate	(NH <sub>4</sub> ) <sub>2</sub> ZnCl <sub>5</sub>	14639-98-6	296.789	hyg orth cry			1.81		vs H <sub>2</sub> O
167	Ammonium perchlorate	NH <sub>4</sub> ClO <sub>4</sub>	7790-98-9	117.490	wh orth cry	dec, exp		1.95	24.5 <sup>25</sup>	s MeOH; sl EtOH, ace; i eth
168	Ammonium permanganate	NH <sub>4</sub> MnO <sub>4</sub>	13446-10-1	136.975	purp rhomb cry	70 dec		2.22	7.9 <sup>15</sup>	
169	Ammonium peroxydisulfate	(NH <sub>4</sub> ) <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	7727-54-0	228.202	monocl cry or wh powder	dec		1.982	83.5 <sup>25</sup>	
170	Ammonium perrhenate	NH <sub>4</sub> ReO <sub>4</sub>	13598-65-7	268.244	col powder			3.97	6.23 <sup>20</sup>	
171	Ammonium phosphate trihydrate	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> · 3H <sub>2</sub> O	10361-65-6*	203.133	wh prisms				25.0 <sup>25</sup>	i ace
172	Ammonium phosphomolybdate monohydrate	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> · 12MoO <sub>3</sub> · H <sub>2</sub> O	54723-94-3	1894.36	yel cry or powder	dec			0.02	
173	Ammonium phosphotungstate dihydrate	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> · 12WO <sub>3</sub> · 2H <sub>2</sub> O	1311-90-6	2967.18	cry powder					sl H <sub>2</sub> O
174	Ammonium picrate	NH <sub>4</sub> C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	131-74-8	246.135	yel orth cry	exp		1.72		sl H <sub>2</sub> O
175	Ammonium polysulfide	(NH <sub>4</sub> ) <sub>2</sub> S <sub>x</sub>	9080-17-5		yel unstab soln					reac acids
176	Ammonium salicylate	NH <sub>4</sub> C <sub>7</sub> H <sub>5</sub> O <sub>3</sub>	528-94-9	155.151	wh cry powder					vs H <sub>2</sub> O; s EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
177	Ammonium selenate	(NH <sub>4</sub> ) <sub>2</sub> SeO <sub>4</sub>	7783-21-3	179.04	wh monocl cry	dec		2.194	117 <sup>25</sup>	i EtOH, ace
178	Ammonium selenite	(NH <sub>4</sub> ) <sub>2</sub> SeO <sub>3</sub>	7783-19-9	163.04	wh or red hyg cry	dec			121 <sup>25</sup>	
179	Ammonium stearate	NH <sub>4</sub> C <sub>18</sub> H <sub>35</sub> O <sub>2</sub>	1002-89-7	301.509	yel-wh powder	22		0.89		sl H <sub>2</sub> O, bz; s EtOH, MeOH; i ace
180	Ammonium sulfamate	NH <sub>4</sub> NH <sub>2</sub> SO <sub>3</sub>	7773-06-0	114.124	wh hyg cry	131	160 dec			vs H <sub>2</sub> O; sl EtOH
181	Ammonium sulfate	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	7783-20-2	132.140	wh or brn orth cry	280 dec		1.77	76.4 <sup>25</sup>	i EtOH, ace
182	Ammonium sulfide	(NH <sub>4</sub> ) <sub>2</sub> S	12135-76-1	68.142	yel-oran cry	≈0 dec				s H <sub>2</sub> O, EtOH, alk
183	Ammonium sulfite	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>3</sub>	17026-44-7	116.140	wh hyg cry				64.2 <sup>25</sup>	
184	Ammonium sulfite monohydrate	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>3</sub> · H <sub>2</sub> O	7783-11-1	134.155	col cry	dec		1.41	64.2 <sup>25</sup>	i EtOH, ace
185	Ammonium tartrate	(NH <sub>4</sub> ) <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	3164-29-2	184.147	wh cry	dec		1.601		s H <sub>2</sub> O
186	Ammonium tellurate	(NH <sub>4</sub> ) <sub>2</sub> TeO <sub>4</sub>	13453-06-0	227.68	wh powder	dec		3.024		
187	Ammonium tetraborate tetrahydrate	(NH <sub>4</sub> ) <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 4H <sub>2</sub> O	12228-87-4	263.377	wh tetr cry	dec 87				vs H <sub>2</sub> O; s HNO <sub>3</sub>
188	Ammonium tetrachloroaluminate	NH <sub>4</sub> AlCl <sub>4</sub>	7784-14-7	186.833	wh hyg solid	304				s H <sub>2</sub> O, eth
189	Ammonium tetrachloropalladate(II)	(NH <sub>4</sub> ) <sub>2</sub> PdCl <sub>4</sub>	13820-40-1	284.31	grn cry or red-brn pow					s H <sub>2</sub> O
190	Ammonium tetrachloroplatinate(II)	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>4</sub>	13820-41-2	372.973	red cry	dec		2.936		s H <sub>2</sub> O; i EtOH
191	Ammonium tetrachlorozincate	(NH <sub>4</sub> ) <sub>2</sub> ZnCl <sub>4</sub>	14639-97-5	243.298	wh orth plates; hyg	150 dec		1.879		vs H <sub>2</sub> O
192	Ammonium tetrafluoroantimonate	NH <sub>4</sub> SbF <sub>4</sub>	14972-90-8	215.793	col cry					s H <sub>2</sub> O
193	Ammonium tetrafluoroborate	NH <sub>4</sub> BF <sub>4</sub>	13826-83-0	104.844	wh powder; orth	487 dec		1.871	25 <sup>20</sup>	
194	Ammonium tetrathiocyanodiammonochromate(III) monohydrate	NH <sub>4</sub> [Cr(NH <sub>4</sub> ) <sub>2</sub> (SCN) <sub>4</sub> ] · H <sub>2</sub> O	13573-16-5	354.440	red cry	270 dec				s H <sub>2</sub> O, EtOH, ace; i bz
195	Ammonium tetrathiomolybdate	(NH <sub>4</sub> ) <sub>2</sub> MoS <sub>4</sub>	15060-55-6	260.28	red cry	100 dec				vs H <sub>2</sub> O
196	Ammonium tetrathiotungstate	(NH <sub>4</sub> ) <sub>2</sub> WS <sub>4</sub>	13862-78-7	348.18	oran cry	dec		2.71		s H <sub>2</sub> O
197	Ammonium tetrathiovanadate	(NH <sub>4</sub> ) <sub>2</sub> VS <sub>4</sub>	14693-56-2	233.317	dark viol cry					
198	Ammonium thiocyanate	NH <sub>4</sub> SCN	1762-95-4	76.121	col hyg cry	≈149	dec	1.30	181 <sup>25</sup>	vs EtOH; s ace; i chl
199	Ammonium thiosulfate	(NH <sub>4</sub> ) <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7783-18-8	148.205	wh cry	150 dec		1.678		vs H <sub>2</sub> O; i EtOH, eth
200	Ammonium titanium oxalate monohydrate	(NH <sub>4</sub> ) <sub>2</sub> TiO(C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> · H <sub>2</sub> O	10580-03-7	293.996	hyg cry					vs H <sub>2</sub> O
201	Ammonium tungstate(VI)	(NH <sub>4</sub> ) <sub>10</sub> W <sub>12</sub> O <sub>41</sub>	11120-25-5	3042.44	cry powder			2.3		s H <sub>2</sub> O; i EtOH
202	Ammonium tungstate(VI) pentahydrate	(NH <sub>4</sub> ) <sub>10</sub> W <sub>12</sub> O <sub>41</sub> · 5H <sub>2</sub> O	1311-93-9	3132.52	cry pow or plates			2.3		vs H <sub>2</sub> O; i EtOH
203	Ammonium uranate(VI)	(NH <sub>4</sub> ) <sub>2</sub> U <sub>2</sub> O <sub>7</sub>	7783-22-4	624.131	red-yel amorp powder					i H <sub>2</sub> O, alk; s acid
204	Ammonium uranium fluoride	UO <sub>2</sub> (NH <sub>4</sub> ) <sub>3</sub> F <sub>5</sub>	18433-40-4	419.135	grn-yel monocl cry					s H <sub>2</sub> O; i EtOH
205	Ammonium valerate	NH <sub>4</sub> C <sub>4</sub> H <sub>9</sub> CO <sub>2</sub>	42739-38-8	119.163	hyg cry	108				vs H <sub>2</sub> O, EtOH; s eth
206	Antimony (gray)	Sb	7440-36-0	121.760	silv metal; hex	630.628	1587	6.68		i dil acid
207	Antimony (black)	Sb	7440-36-0	121.760	blk amorp solid	trans gray 0				
208	Stibine	SbH <sub>3</sub>	7803-52-3	124.784	col gas; flam	-88	-17	5.100 g/L		sl H <sub>2</sub> O; s EtOH
209	Trimethylstibine	Sb(CH <sub>3</sub> ) <sub>3</sub>	594-10-5	166.863	col flam liq	-62	81	1.52		
210	Pentamethylstibine	Sb(CH <sub>3</sub> ) <sub>5</sub>	15120-50-0	196.933	col hyg liq	-19	127			reac H <sub>2</sub> O
211	Tetramethyldistibine	[Sb(CH <sub>3</sub> ) <sub>2</sub> ] <sub>2</sub>	41422-43-9	303.658	yel flam liq or red solid	17				
212	Antimony arsenide	SbAs	12322-34-8	196.682	hex cry	≈680		6.0		
213	Antimony potassium tartrate trihydrate	K <sub>2</sub> (SbC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	28300-74-5	667.873	col cry			2.6		sl H <sub>2</sub> O
214	Antimony(III) acetate	Sb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	3643-76-3	298.891	wh pow					
215	Antimony(III) bromide	SbBr <sub>3</sub>	7789-61-9	361.472	yel orth cry; hyg	97	288	4.35		reac H <sub>2</sub> O; s ace, bz, chl
216	Antimony(III) chloride	SbCl <sub>3</sub>	10025-91-9	228.119	col orth cry; hyg	73.4	220.3	3.14	987 <sup>25</sup>	s acid, EtOH, bz, ace
217	Antimony(III) fluoride	SbF <sub>3</sub>	7783-56-4	178.755	wh orth cry; hyg	287	376	4.38	492 <sup>25</sup>	
218	Antimony(III) iodide	SbI <sub>3</sub>	7790-44-5	502.473	red rhomb cry	171	400	4.92		reac H <sub>2</sub> O; s EtOH, ace; i ctc
219	Antimony(III) iodide sulfide	SbI <sub>2</sub> S	13816-38-1	280.729	dark red prisms or needles	400				
220	Antimony(III) oxide (senarmontite)	Sb <sub>2</sub> O <sub>3</sub>	1309-64-4	291.518	col cub cry	570 trans	1425	5.58		sl H <sub>2</sub> O; i os
221	Antimony(III) oxide (valentinite)	Sb <sub>2</sub> O <sub>3</sub>	1309-64-4	291.518	wh orth cry	655	1425	5.7		sl H <sub>2</sub> O; i os
222	Antimony(III) oxychloride	SbOCl	7791-08-4	173.212	wh momo cry	170 dec				reac H <sub>2</sub> O; i EtOH, eth
223	Antimony(III) phosphate	SbPO <sub>4</sub>	12036-46-3	216.731	cry pow					reac H <sub>2</sub> O
224	Antimony(III) potassium oxalate trihydrate	K <sub>3</sub> Sb(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	5965-33-3*	557.158	cry pow					s H <sub>2</sub> O
225	Antimony(III) selenide	Sb <sub>2</sub> Se <sub>3</sub>	1315-05-5	480.40	grn orth cry	611		5.81		sl H <sub>2</sub> O
226	Antimony(III) sulfate	Sb <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	7446-32-4	531.708	wh cry powder; hyg	dec		3.62		sl H <sub>2</sub> O
227	Antimony(III) sulfide	Sb <sub>2</sub> S <sub>3</sub>	1345-04-6	339.715	gray-blk orth cry	550		4.562		i H <sub>2</sub> O; s conc HCl
228	Antimony(III) telluride	Sb <sub>2</sub> Te <sub>3</sub>	1327-50-0	626.32	gray cry	620		6.5		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
229	Antimony(III,V) oxide	Sb <sub>2</sub> O <sub>4</sub>	1332-81-6	307.518	yel orth cry			6.64		
230	Antimony(V) chloride	SbCl <sub>5</sub>	7647-18-9	299.025	col or yel liq	4	140 dec	2.34		reac H <sub>2</sub> O; s chl, ctc
231	Antimony(V) fluoride	SbF <sub>5</sub>	7783-70-2	216.752	hyg visc liq	8.3	141	3.10		reac H <sub>2</sub> O
232	Antimony(V) dichlorotrifluoride	SbCl <sub>2</sub> F <sub>3</sub>	7791-16-4	249.661	visc liq					reac H <sub>2</sub> O
233	Antimony(V) oxide	Sb <sub>2</sub> O <sub>5</sub>	1314-60-9	323.517	yel powder; cub	dec		3.78	0.3 <sup>20</sup>	
234	Antimony(V) sulfide	Sb <sub>2</sub> S <sub>5</sub>	1315-04-4	403.845	oran-yel powder	75 dec		4.120		i H <sub>2</sub> O; s acid, alk
235	Argon	Ar	7440-37-1	39.948	col gas	-189.36 tp (69 kPa)	-185.847	1.633 g/L		sl H <sub>2</sub> O
236	Arsenic (gray)	As	7440-38-2	74.922	gray metal; rhomb	817 tp (3.70 MPa)	616 sp	5.75		i H <sub>2</sub> O
237	Arsenic (black)	As	7440-38-2	74.922	blk amorp solid	trans gray As 270		4.9		
238	Arsenic (yellow)	As	7440-38-2	74.922	soft yel cub cry	trans gray As 358		1.97		s CS <sub>2</sub>
239	Arsine	AsH <sub>3</sub>	7784-42-1	77.946	col gas	-116	-62.5	3.186 g/L		sl H <sub>2</sub> O
240	Diarsine	As <sub>2</sub> H <sub>4</sub>	15942-63-9	153.875	unstab liq		≈100			
241	Arsenic acid	H <sub>3</sub> AsO <sub>4</sub>	7778-39-4	141.944	exists only in soln					
242	Arsenic acid hemihydrate	H <sub>3</sub> AsO <sub>4</sub> · 0.5H <sub>2</sub> O	7778-39-4*	150.951	wh hyg cry	36.1		2.5		vs H <sub>2</sub> O, EtOH
243	Arsenious acid	H <sub>3</sub> AsO <sub>3</sub>	13464-58-9	125.944	exists only in soln					
244	Arsenic diiodide	As <sub>2</sub> I <sub>4</sub>	13770-56-4	657.461	red cry	137				reac H <sub>2</sub> O; s os
245	Arsenic hemiselenide	As <sub>2</sub> Se	1303-35-1	228.80	blk cry					i H <sub>2</sub> O, os; dec acid, alk
246	Arsenic sulfide	As <sub>2</sub> S <sub>4</sub>	12279-90-2	427.946	red monocl cry	320	565	3.5		i H <sub>2</sub> O; sl bz; s alk
247	Arsenic(III) bromide	AsBr <sub>3</sub>	7784-33-0	314.634	col or yel orth cry; hyg	31.1	221	3.40		reac H <sub>2</sub> O; s hc, ctc; vs eth, bz
248	Arsenic(III) chloride	AsCl <sub>3</sub>	7784-34-1	181.281	col liq	-16	130	2.150		reac H <sub>2</sub> O; vs chl, ctc, eth
249	Arsenic(III) ethoxide	As(C <sub>2</sub> H <sub>5</sub> O) <sub>3</sub>	3141-12-6	210.103	liq		166	1.21		
250	Arsenic(III) fluoride	AsF <sub>3</sub>	7784-35-2	131.917	col liq	-5.9	57.13	2.7		reac H <sub>2</sub> O; s EtOH, eth, bz
251	Arsenic(III) iodide	AsI <sub>3</sub>	7784-45-4	455.635	red hex cry	141	424	4.73		sl H <sub>2</sub> O, EtOH, eth; s bz, tol
252	Arsenic(III) oxide (arsenolite)	As <sub>2</sub> O <sub>3</sub>	1327-53-3	197.841	wh cub cry	274	460	3.86	2.05 <sup>25</sup>	
253	Arsenic(III) oxide (claudetite)	As <sub>2</sub> O <sub>3</sub>	1327-53-3	197.841	wh monocl cry	314	460	3.74	2.05 <sup>25</sup>	s dil acid, alk; i EtOH
254	Arsenic(III) selenide	As <sub>2</sub> Se <sub>3</sub>	1303-36-2	386.72	brn-blk solid	260		4.75		i H <sub>2</sub> O; s alk
255	Arsenic(III) sulfide	As <sub>2</sub> S <sub>3</sub>	1303-33-9	246.038	yel-oran monocl cry	312	707	3.46		i H <sub>2</sub> O; s alk
256	Arsenic(III) telluride	As <sub>2</sub> Te <sub>3</sub>	12044-54-1	532.64	blk monocl cry	621		6.50		
257	Arsenic(V) chloride	AsCl <sub>5</sub>	22441-45-8	252.187	stab at low temp	≈-50 dec				
258	Arsenic(V) fluoride	AsF <sub>5</sub>	7784-36-3	169.914	col gas	-79.8	-52.8	6.945 g/L		reac H <sub>2</sub> O; s EtOH, bz, eth
259	Arsenic(V) oxide	As <sub>2</sub> O <sub>5</sub>	1303-28-2	229.840	wh amorp powder	315		4.32	65.8 <sup>20</sup>	vs EtOH
260	Arsenic(V) selenide	As <sub>2</sub> Se <sub>5</sub>	1303-37-3	544.64	blk solid	dec				i H <sub>2</sub> O, EtOH, eth; s alk
261	Arsenic(V) sulfide	As <sub>2</sub> S <sub>5</sub>	1303-34-0	310.168	brn-yel amorp solid	dec				i H <sub>2</sub> O; s alk
262	Astatine	At	7440-68-8	210	cry	302				s HNO <sub>3</sub> , os
263	Barium	Ba	7440-39-3	137.327	silv-yel metal; cub	727	1897	3.62		reac H <sub>2</sub> O; sl EtOH
264	Barium acetate	Ba(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	543-80-6	255.416	wh powder			2.47	79.2 <sup>25</sup>	
265	Barium acetate monohydrate	Ba(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	5908-64-5	273.431	wh cry	110 dec		2.19	79.2 <sup>25</sup>	sl EtOH
266	Barium aluminate	BaAl <sub>2</sub> O <sub>4</sub>	12004-04-5	255.288	hex cry	1827				
267	Barium aluminide	BaAl <sub>2</sub>	12672-79-6	245.253	metallic solid	1097				
268	Barium azide	Ba(N <sub>3</sub> ) <sub>2</sub>	18810-58-7	221.367	monocl cry; exp	≈-120 dec		2.936	17.3 <sup>20</sup>	sl EtOH; i eth
269	Barium bismuthate	BaBiO <sub>3</sub>	12785-50-1	394.305	bronze cry	1040 dec				
270	Barium bromate	Ba(BrO <sub>3</sub> ) <sub>2</sub>	13967-90-3	393.131	col monocl cry				0.79 <sup>25</sup>	s ace
271	Barium bromate monohydrate	Ba(BrO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	10326-26-8	411.147	wh monocl cry	260 dec		3.99	0.831 <sup>25</sup>	i EtOH
272	Barium bromide	BaBr <sub>2</sub>	10553-31-8	297.135	wh orth cry	857	1835	4.781	100 <sup>25</sup>	
273	Barium bromide dihydrate	BaBr <sub>2</sub> · 2H <sub>2</sub> O	7791-28-8	333.166	wh cry	75 dec		3.7	100 <sup>25</sup>	s MeOH; i EtOH, ace, diox
274	Barium calcium tungstate	Ba <sub>2</sub> CaWO <sub>6</sub>	15552-14-4	594.57	cub cry	1420				
275	Barium carbide	BaC <sub>2</sub>	50813-65-5	161.348	gray tetr cry	dec		3.74		reac H <sub>2</sub> O
276	Barium carbonate	BaCO <sub>3</sub>	513-77-9	197.336	wh orth cry	1380 dec; 1555 (high pres.)		4.308	0.0014 <sup>20</sup>	s acid
277	Barium chlorate	Ba(ClO <sub>3</sub> ) <sub>2</sub>	13477-00-4	304.229	wh cry	414			37.9 <sup>25</sup>	sl EtOH, ace
278	Barium chlorate monohydrate	Ba(ClO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	10294-38-9	322.245	wh monocl cry	120 dec		3.179	37.9 <sup>25</sup>	s acid; sl EtOH, ace
279	Barium chloride	BaCl <sub>2</sub>	10361-37-2	208.233	wh orth cry; hyg	961	1560	3.9	37.0 <sup>25</sup>	
280	Barium chloride dihydrate	BaCl <sub>2</sub> · 2H <sub>2</sub> O	10326-27-9	244.264	wh monocl cry	≈-120 dec		3.097	37.0 <sup>25</sup>	i EtOH
281	Barium chloride fluoride	BaClF	13718-55-3	191.778	wh cry					
282	Barium chromate(V)	Ba <sub>3</sub> (CrO <sub>4</sub> ) <sub>2</sub>	12345-14-1	643.968	grn-blk hex cry			5.25		s H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
283	Barium chromate(VI)	BaCrO <sub>4</sub>	10294-40-3	253.321	yel orth cry	1380		4.50	0.00026 <sup>20</sup>	reac acid
284	Barium citrate monohydrate	Ba <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · H <sub>2</sub> O	512-25-4*	808.195	gray-wh cry					s H <sub>2</sub> O, acid
285	Barium copper yttrium oxide	BaCuY <sub>2</sub> O <sub>5</sub>	82642-06-6	458.682	grn cry; not superconductor					
286	Barium copper yttrium oxide	Ba <sub>2</sub> Cu <sub>3</sub> YO <sub>7</sub>	109064-29-1	666.194	blk solid; HT superconductor					
287	Barium copper yttrium oxide	Ba <sub>2</sub> Cu <sub>4</sub> YO <sub>8</sub>	114104-80-2	745.739	HT superconductor					
288	Barium copper yttrium oxide	Ba <sub>4</sub> Cu <sub>7</sub> Y <sub>2</sub> O <sub>15</sub>	124365-83-9	1411.933	HT superconductor					
289	Barium cyanide	Ba(CN) <sub>2</sub>	542-62-1	189.361	wh cry powder					vs H <sub>2</sub> O; s EtOH
290	Barium dichromate dihydrate	BaCr <sub>2</sub> O <sub>7</sub> · 2H <sub>2</sub> O	10031-16-0	389.346	brn-red needles	dec				reac H <sub>2</sub> O
291	Barium disilicate	BaSi <sub>2</sub> O <sub>5</sub>	12650-28-1	273.495	wh orth cry	1420		3.70		
292	Barium dithionate dihydrate	BaS <sub>2</sub> O <sub>6</sub> · 2H <sub>2</sub> O	13845-17-5	333.484	wh cry	140 dec		4.54	22.1 <sup>20</sup>	sl EtOH
293	Barium ferrite	BaFe <sub>12</sub> O <sub>19</sub>	11138-11-7	1111.456	magnetic solid					
294	Barium ferrocyanide hexahydrate	Ba <sub>2</sub> Fe(CN) <sub>6</sub> · 6H <sub>2</sub> O	13821-06-2*	594.694	yel monocl cry	80 dec				i H <sub>2</sub> O, EtOH
295	Barium fluoride	BaF <sub>2</sub>	7787-32-8	175.324	wh cub cry	1368	2260	4.893	0.161 <sup>25</sup>	
296	Barium formate	Ba(CHO <sub>2</sub> ) <sub>2</sub>	541-43-5	227.362	cry			3.21		s H <sub>2</sub> O; i EtOH
297	Barium hexaboride	BaB <sub>6</sub>	12046-08-1	202.193	blk cub cry	2070		4.36		i H <sub>2</sub> O; s acid; i EtOH
298	Barium hexafluorogermanate	BaGeF <sub>6</sub>		323.96	wh cry	≈665		4.56		
299	Barium hexafluorosilicate	BaSiF <sub>6</sub>	17125-80-3	279.403	wh orth needles	300 dec		4.29		i H <sub>2</sub> O, EtOH; sl acid
300	Barium hydride	BaH <sub>2</sub>	13477-09-3	139.343	gray orth cry	1200		4.16		reac H <sub>2</sub> O
301	Barium hydrogen phosphate	BaHPO <sub>4</sub>	10048-98-3	233.306	wh cry powder	400 dec		4.16	0.015 <sup>20</sup>	s dil acid
302	Barium hydrosulfide	Ba(HS) <sub>2</sub>	25417-81-6	203.473	yel hyg cry					s H <sub>2</sub> O
303	Barium hydrosulfide tetrahydrate	Ba(HS) <sub>2</sub> · 4H <sub>2</sub> O	12230-74-9	275.534	yel rhomb cry	50 dec				s H <sub>2</sub> O
304	Barium hydroxide	Ba(OH) <sub>2</sub>	17194-00-2	171.342	wh powder	408			4.91 <sup>25</sup>	
305	Barium hydroxide monohydrate	Ba(OH) <sub>2</sub> · H <sub>2</sub> O	22326-55-2	189.357	wh powder			3.743	4.91 <sup>25</sup>	s acid
306	Barium hydroxide octahydrate	Ba(OH) <sub>2</sub> · 8H <sub>2</sub> O	12230-71-6	315.464	wh monocl cry	78 dec		2.18	4.91 <sup>25</sup>	
307	Barium hypophosphite monohydrate	Ba(H <sub>2</sub> PO <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	14871-79-5*	285.320	monoc plates			2.90		s H <sub>2</sub> O; i EtOH
308	Barium iodate	Ba(IO <sub>3</sub> ) <sub>2</sub>	10567-69-8	487.132	wh cry powder	476 dec		5.23	0.0396 <sup>25</sup>	
309	Barium iodate monohydrate	Ba(IO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	7787-34-0	505.148	cry	130 dec		5.00	0.0396 <sup>25</sup>	s acid; i EtOH
310	Barium iodide	BaI <sub>2</sub>	13718-50-8	391.136	wh orth cry	711		5.15	221 <sup>25</sup>	
311	Barium iodide dihydrate	BaI <sub>2</sub> · 2H <sub>2</sub> O	7787-33-9	427.167	col cry	740 dec		5.0	221 <sup>25</sup>	s EtOH, ace
312	Barium manganate(VI)	BaMnO <sub>4</sub>	7787-35-1	256.263	grn-gray hyg cry			4.85	0.00041 <sup>20</sup>	
313	Barium metaborate monohydrate	Ba(BO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	26124-86-7	240.962	wh powder	>900		3.3		sl H <sub>2</sub> O
314	Barium metaborate dihydrate	Ba(BO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	23436-05-7	258.977	wh prec	dec			1.3 <sup>25</sup>	sl H <sub>2</sub> O
315	Barium metaphosphate	Ba(PO <sub>3</sub> ) <sub>2</sub>	13466-20-1	295.271	wh powder	1560				i H <sub>2</sub> O; sl acid
316	Barium metasilicate	BaSiO <sub>3</sub>	13255-26-0	213.411	col rhomb powder	1605		4.40		i H <sub>2</sub> O; s acid
317	Barium molybdate	BaMoO <sub>4</sub>	7787-37-3	297.27	wh powder	1450		4.975	0.0021 <sup>20</sup>	
318	Barium niobate	Ba(NbO <sub>3</sub> ) <sub>2</sub>	12009-14-2	419.136	yel orth cry	1455		5.44		i H <sub>2</sub> O
319	Barium nitrate	Ba(NO <sub>3</sub> ) <sub>2</sub>	10022-31-8	261.336	wh cub cry	590		3.24	10.3 <sup>25</sup>	sl EtOH, ace
320	Barium nitride	Ba <sub>3</sub> N <sub>2</sub>	12047-79-9	439.994	yel-brn cry	>500 dec		4.78		reac H <sub>2</sub> O
321	Barium nitrite	Ba(NO <sub>2</sub> ) <sub>2</sub>	13465-94-6	229.338	col hex cry	267		3.234	79.5 <sup>25</sup>	
322	Barium nitrite monohydrate	Ba(NO <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	7787-38-4	247.353	yel-wh hex cry	217 dec		3.18	79.5 <sup>25</sup>	i EtOH
323	Barium orthovanadate	Ba <sub>2</sub> (VO <sub>4</sub> ) <sub>3</sub>	39416-30-3	641.859	hex cry	707		5.14		
324	Barium oxalate	BaC <sub>2</sub> O <sub>4</sub>	516-02-9	225.346	wh powder	400 dec		2.658	0.0075	
325	Barium oxalate monohydrate	BaC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	13463-22-4	243.361	wh cry powder			2.66	0.0075 <sup>20</sup>	s acid
326	Barium oxide	BaO	1304-28-5	153.326	wh-yel powder; cub and hex	1973		5.72(cub)	1.5 <sup>20</sup>	s dil acid, EtOH; i ace
327	Barium 2,4-pentanedioate octahydrate	Ba(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	12084-29-6*	479.665	col hyg cry	320 (anh)				
328	Barium perchlorate	Ba(ClO <sub>4</sub> ) <sub>2</sub>	13465-95-7	336.228	col hex cry	505		3.20	312 <sup>25</sup>	vs EtOH
329	Barium perchlorate trihydrate	Ba(ClO <sub>4</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	10294-39-0	390.274	col cry			2.74	312 <sup>25</sup>	s MeOH; sl EtOH, ace; i eth
330	Barium permanganate	Ba(MnO <sub>4</sub> ) <sub>2</sub>	7787-36-2	375.198	brn-viol cry	200 dec		3.77	62.5 <sup>20</sup>	reac EtOH
331	Barium peroxide	BaO <sub>2</sub>	1304-29-6	169.326	gray-wh tet cry	450 dec		4.96	0.091 <sup>20</sup>	reac dil acid
332	Barium plumbate	BaPbO <sub>3</sub>	12047-25-5	392.5	orth cry					
333	Barium potassium chromate	BaK <sub>2</sub> (CrO <sub>4</sub> ) <sub>2</sub>	27133-66-0	447.511	yel hex cry			3.63		vs H <sub>2</sub> O
334	Barium pyrophosphate	Ba <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	13466-21-2	448.597	wh powder	1430		3.9	0.0088 <sup>20</sup>	s acid
335	Barium selenate	BaSeO <sub>4</sub>	7787-41-9	280.29	wh rhomb cry	dec		4.75	0.015 <sup>20</sup>	
336	Barium selenide	BaSe	1304-39-8	216.29	cub cry powder	1780		5.02		reac H <sub>2</sub> O
337	Barium selenite	BaSeO <sub>3</sub>	13718-59-7	264.29	solid					i H <sub>2</sub> O
338	Barium silicide	BaSi <sub>2</sub>	1304-40-1	193.498	gray lumps	1180				reac H <sub>2</sub> O
339	Barium sodium niobate	Ba <sub>2</sub> Na(NbO <sub>3</sub> ) <sub>3</sub>	12323-03-4	1002.167	wh orth cry	1437		5.40		i H <sub>2</sub> O
340	Barium stannate	BaSnO <sub>3</sub>	12009-18-6	304.035	cub cry			7.24		sl H <sub>2</sub> O
341	Barium stannate trihydrate	BaSnO <sub>3</sub> · 3H <sub>2</sub> O	12009-18-6*	358.081	wh cry powder					sl H <sub>2</sub> O; s acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
342	Barium stearate	Ba(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	6865-35-6	704.266	wh powder	160		1.145		i H <sub>2</sub> O, EtOH
343	Barium strontium niobate	BaSr(NbO <sub>3</sub> ) <sub>4</sub>	37185-09-4	788.57	pale yel solid					
344	Barium strontium tungstate	Ba <sub>2</sub> SrWO <sub>6</sub>	14871-56-8	642.11	hyg pow	1400				
345	Barium sulfate	BaSO <sub>4</sub>	7727-43-7	233.390	wh orth cry	1580		4.49	0.00031 <sup>20</sup>	i EtOH
346	Barium sulfide	BaS	21109-95-5	169.392	col cub cry or gray powder	2227		4.3	8.94 <sup>25</sup>	
347	Barium sulfite	BaSO <sub>3</sub>	7787-39-5	217.390	wh monocry	dec		4.44	0.0011 <sup>25</sup>	i EtOH
348	Barium tartrate	BaC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	5908-81-6	285.398	wh cry			2.98		s H <sub>2</sub> O; i EtOH
349	Barium tetracyanoplatinate(II) tetrahydrate	BaPt(CN) <sub>4</sub> · 4H <sub>2</sub> O	13755-32-3	508.543	yel powder or cry			2.076		sl H <sub>2</sub> O; i EtOH
350	Barium tetraiodomercurate(II)	BaHgI <sub>4</sub>	10048-99-4	845.54	yel-red hyg cry					vs H <sub>2</sub> O, EtOH
351	Barium thiocyanate	Ba(SCN) <sub>2</sub>	2092-17-3	253.491	hyg cry				167 <sup>25</sup>	s ace, MeOH, EtOH
352	Barium thiocyanate dihydrate	Ba(SCN) <sub>2</sub> · 2H <sub>2</sub> O	2092-17-3*	289.522	hyg wh cry				167 <sup>25</sup>	s EtOH
353	Barium thiocyanate trihydrate	Ba(SCN) <sub>2</sub> · 3H <sub>2</sub> O	68016-36-4	307.537	wh needles; hyg			2.286	167 <sup>25</sup>	s EtOH
354	Barium thiosulfate	BaS <sub>2</sub> O <sub>3</sub>	35112-53-9	249.455	wh cry powder	220 dec			0.2 <sup>20</sup>	i EtOH
355	Barium thiosulfate monohydrate	BaS <sub>2</sub> O <sub>3</sub> · H <sub>2</sub> O	7787-40-8	267.471	wh cry powder	dec		3.5	0.2	i EtOH
356	Barium titanate (BaTiO <sub>3</sub> )	BaTiO <sub>3</sub>	12047-27-7	233.192	wh tetr cry	1625		6.02		i H <sub>2</sub> O
357	Barium titanate (BaTi <sub>2</sub> O <sub>7</sub> )	BaTi <sub>2</sub> O <sub>7</sub>	12009-27-7	313.058	wh solid					
358	Barium titanate (BaTi <sub>4</sub> O <sub>9</sub> )	BaTi <sub>4</sub> O <sub>9</sub>	12009-31-3	472.790	wh solid					
359	Barium titanium silicate	BaTi(SiO <sub>3</sub> ) <sub>3</sub>	15491-35-7	413.446	rhomb blue-pur cry					
360	Barium tungstate	BaWO <sub>4</sub>	7787-42-0	385.17	wh tetr cry	1475	1730	5.04	0.0016 <sup>20</sup>	
361	Barium uranium oxide	BaU <sub>2</sub> O <sub>7</sub>	10380-31-1	725.381	oran-yel powder					i H <sub>2</sub> O; s acid
362	Barium yttrium tungsten oxide	Ba <sub>2</sub> Y <sub>3</sub> WO <sub>9</sub>	37265-86-4	1006.53	cub cry	1470				
363	Barium zirconate	BaZrO <sub>3</sub>	12009-21-1	276.549	gray-wh cub cry	2500		5.52		i H <sub>2</sub> O, alk; sl acid
364	Barium zirconium silicate	BaO · ZrO <sub>2</sub> · SiO <sub>2</sub>		336.634	wh pow					
365	Berkelium (α form)	Bk	7440-40-6	247	hex cry	trans to	930	14.78		
366	Berkelium (β form)	Bk	7440-40-6	247	cub cry	986		13.25		
367	Beryllium	Be	7440-41-7	9.012	hex cry	1287	2471	1.85		s acid, alk
368	Beryllium acetate	Be(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	543-81-7	127.101	wh cry	60 dec				i H <sub>2</sub> O, EtOH
369	Beryllium basic acetate	Be <sub>2</sub> O(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>6</sub>	1332-52-1	406.312	wh cry	285	330	1.25		i H <sub>2</sub> O; s eth, os
370	Beryllium aluminate	BeAl <sub>2</sub> O <sub>4</sub>	12004-06-7	126.973	orth cry			3.65		
371	Beryllium aluminum metasilicate	Be <sub>3</sub> Al <sub>2</sub> (SiO <sub>3</sub> ) <sub>6</sub>	1302-52-9	537.502	col or grn-yel cry; hex			2.64		
372	Beryllium boride (BeB <sub>2</sub> )	BeB <sub>2</sub>	12228-40-9	30.634	refrac solid	>1970				
373	Beryllium boride (BeB <sub>3</sub> )	BeB <sub>3</sub>	12429-94-6	73.878	red solid	2070				
374	Beryllium boride (Be <sub>2</sub> B)	Be <sub>2</sub> B	12536-51-5	28.835	pink cry	1520				
375	Beryllium boride (Be <sub>3</sub> B)	Be <sub>3</sub> B	12536-52-6	46.860	refrac solid	1160				
376	Beryllium borohydride	Be(BH <sub>4</sub> ) <sub>2</sub>	17440-85-6	36.682	solid	125 dec	subl			reac H <sub>2</sub> O
377	Beryllium bromide	BeBr <sub>2</sub>	7787-46-4	168.820	orth cry; hyg	508	473 sp	3.465		vs H <sub>2</sub> O; s EtOH, pyr
378	Beryllium carbide	Be <sub>3</sub> C	506-66-1	30.035	red cub cry	2127		1.90		reac H <sub>2</sub> O
379	Beryllium carbonate tetrahydrate	BeCO <sub>3</sub> · 4H <sub>2</sub> O	60883-64-9	93.085	wh solid	100 dec			0.36 <sup>9</sup>	
380	Beryllium basic carbonate	Be <sub>2</sub> (OH) <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub>	66104-24-3	181.069	wh powder					i H <sub>2</sub> O; s acid, alk
381	Beryllium chloride	BeCl <sub>2</sub>	7787-47-5	79.918	wh-yel orth cry; hyg	415	482	1.90	71.5 <sup>25</sup>	s EtOH, eth, py; i bz, tol
382	Beryllium fluoride	BeF <sub>2</sub>	7787-49-7	47.009	tetr cry or gl; hyg	552	1283	2.1		vs H <sub>2</sub> O; sl EtOH
383	Beryllium formate	Be(CHO <sub>2</sub> ) <sub>2</sub>	1111-71-3	99.047	powder	>250 dec				reac H <sub>2</sub> O; i os
384	Beryllium hydride	BeH <sub>2</sub>	7787-52-2	11.028	wh amorp solid	250 dec		0.65		reac H <sub>2</sub> O; i eth, tol
385	Beryllium hydrogen phosphate	BeHPO <sub>4</sub>	13598-15-7	104.991	cry					i H <sub>2</sub> O
386	Beryllium hydroxide (α)	Be(OH) <sub>2</sub>	13327-32-7	43.027	wh powder or cry	≈200 dec		1.92		sl H <sub>2</sub> O, alk; s acid
387	Beryllium hydroxide (β)	Be(OH) <sub>2</sub>	13327-32-7	43.027	col tetr cry	dec 138				i H <sub>2</sub> O; s, acid, alk
388	Beryllium iodide	BeI <sub>2</sub>	7787-53-3	262.821	hyg needles	480	590	4.32		reac H <sub>2</sub> O; s EtOH
389	Beryllium nitrate trihydrate	Be(NO <sub>3</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	13597-99-4	187.068	yel-wh hyg cry	≈30	dec		107 <sup>20</sup>	s EtOH
390	Beryllium nitride	Be <sub>3</sub> N <sub>2</sub>	1304-54-7	55.050	gray refrac cry; cub	2200		2.71		reac acid, alk
391	Beryllium oxalate trihydrate	BeC <sub>2</sub> O <sub>4</sub> · 3H <sub>2</sub> O	15771-43-4	151.077	rhomb cry	dec 320				vs H <sub>2</sub> O
392	Beryllium oxide	BeO	1304-56-9	25.011	wh hex cry	2578		3.01		i H <sub>2</sub> O; sl acid, alk
393	Beryllium 2,4-pentanedioate	Be(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	10210-64-7	207.228	monocry powder	108	270	1.168		i H <sub>2</sub> O; vs EtOH, eth
394	Beryllium perchlorate tetrahydrate	Be(ClO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	7787-48-6	279.975	hyg cry	250 dec			198 <sup>25</sup>	
395	Beryllium selenate tetrahydrate	BeSeO <sub>4</sub> · 4H <sub>2</sub> O	10039-31-3	224.03	orth cry	100 dec		2.03		vs H <sub>2</sub> O
396	Beryllium sulfate	BeSO <sub>4</sub>	13510-49-1	105.075	col tetr cry; hyg	1127		2.5	41.3 <sup>25</sup>	
397	Beryllium sulfate dihydrate	BeSO <sub>4</sub> · 2H <sub>2</sub> O	14215-00-0	141.105	col cry	dec 92				
398	Beryllium sulfate tetrahydrate	BeSO <sub>4</sub> · 4H <sub>2</sub> O	7787-56-6	177.136	col tetr cry	≈100 dec		1.71	41.3 <sup>25</sup>	i EtOH
399	Beryllium sulfide	BeS	13598-22-6	41.077	col cub cry	dec		2.36		reac hot H <sub>2</sub> O
400	Bismuth	Bi	7440-69-9	208.980	gray-wh soft metal	271.406	1564	9.79		s acid
401	Bismuth acetate	Bi(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	22306-37-2	386.111	col tablets	250				i H <sub>2</sub> O
402	Bismuth subacetate	BiOC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	5142-76-7	284.023	thin cry plates					i H <sub>2</sub> O; s dil acid
403	Bismuth antimonide	BiSb	12323-19-2	330.740	cry	475				

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
404	Bismuth arsenate	BiAsO <sub>4</sub>	13702-38-0	347.900	wh monocry			7.14		i H <sub>2</sub> O; sl conc HNO <sub>3</sub>
405	Bismuth basic carbonate	(BiO) <sub>2</sub> CO <sub>3</sub>	5892-10-4	509.969	wh powder			6.86		i H <sub>2</sub> O; s acid
406	Bismuth basic dichromate	Bi <sub>2</sub> O <sub>3</sub> · 2CrO <sub>3</sub>		665.948	red-oran amorp pow					i H <sub>2</sub> O; s acid, alk
407	Bismuth citrate	BiC <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	813-93-4	398.080	wh powder			3.458		i H <sub>2</sub> O; sl EtOH
408	Bismuth hydride	BiH <sub>3</sub>	18288-22-7	212.004	col gas; unstab	-67	≈17	8.665 g/L		
409	Bismuth hydroxide	Bi(OH) <sub>3</sub>	10361-43-0	260.002	wh-yel amorp powder			4.962		i H <sub>2</sub> O; s acid
410	Bismuth germanium oxide	2Bi <sub>2</sub> O <sub>3</sub> · 3GeO <sub>2</sub>	12233-56-6	1245.84	wh pow	1044				
411	Bismuth hexafluoro-2,4-pentanedioate	Bi(CF <sub>3</sub> COCHCOCF <sub>3</sub> ) <sub>2</sub>	142617-56-9	830.132	powder	96				
412	Bismuth molybdate	Bi <sub>2</sub> MoO <sub>6</sub>	13565-96-3	609.90	yel solid			9.32		
413	Bismuth molybdate	Bi <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	51898-99-8	897.77	monocry			5.95		
414	Bismuth nitrate pentahydrate	Bi(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	10035-06-0	485.071	col tricry; hyg	≈75 dec		2.83		reac H <sub>2</sub> O; s ace; i EtOH
415	Bismuth subnitrate	Bi <sub>5</sub> O(OH) <sub>9</sub> (NO <sub>3</sub> ) <sub>4</sub>	1304-85-4	1461.987	hyg cry powder	260 dec		4.928		i H <sub>2</sub> O, EtOH; s dil acid
416	Bismuth oleate	Bi(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	52951-38-9	1053.340	soft yel-brn solid					i H <sub>2</sub> O; s eth; sl bz
417	Bismuth oxalate	Bi <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub>	6591-55-5	682.018	wh powder					i H <sub>2</sub> O, EtOH; s dil acid
418	Bismuth oxide	Bi <sub>2</sub> O <sub>3</sub>	1304-76-3	465.959	yel monocry or powder	825	1890	8.9		i H <sub>2</sub> O; s acid
419	Bismuth tetroxide	Bi <sub>2</sub> O <sub>7</sub>	12048-50-9	481.959	red-oran powder	305		5.6		reac H <sub>2</sub> O
420	Bismuth oxybromide	BiOBr	7787-57-7	304.883	col tetr cry	560 dec		8.08		i H <sub>2</sub> O, EtOH; s acid
421	Bismuth oxychloride	BiOCl	7787-59-9	260.432	wh tetr cry	575 dec		7.72		i H <sub>2</sub> O
422	Bismuth oxyiodide	BiOI	7787-63-5	351.883	red tetr cry	300 dec		7.92		i H <sub>2</sub> O, EtOH, chl; s HCl
423	Bismuth oxynitrate	BiONO <sub>3</sub>	10361-46-3	286.985	wh powder	260 dec		4.93		i H <sub>2</sub> O, EtOH; s acid
424	Bismuth phosphate	BiPO <sub>4</sub>	10049-01-1	303.951	monocry			6.32		sl H <sub>2</sub> O, dil acid; i EtOH
425	Bismuth potassium iodide	BiK <sub>2</sub> I <sub>7</sub>	41944-01-8	1253.704	red cry					reac H <sub>2</sub> O; s alk iodide soln
426	Bismuth selenide	Bi <sub>2</sub> Se <sub>3</sub>	12068-69-8	654.84	blk hex cry	710 dec		7.5		i H <sub>2</sub> O
427	Bismuth stannate pentahydrate	Bi <sub>2</sub> (SnO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	12777-45-6	1008.162	wh cry					i H <sub>2</sub> O
428	Bismuth sulfate	Bi <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	7787-68-0	706.149	wh needles or powder	405 dec		5.08		reac H <sub>2</sub> O, EtOH
429	Bismuth sulfide	Bi <sub>2</sub> S <sub>3</sub>	1345-07-9	514.156	blk-brn orth cry	850		6.78		i H <sub>2</sub> O; s acid
430	Bismuth telluride	Bi <sub>2</sub> Te <sub>3</sub>	1304-82-1	800.76	gray hex plates	580		7.74		i H <sub>2</sub> O; s EtOH
431	Bismuth tribromide	BiBr <sub>3</sub>	7787-58-8	448.692	yel cub cry	219	462	5.72		reac H <sub>2</sub> O; s dil acid, ace; i EtOH
432	Bismuth trichloride	BiCl <sub>3</sub>	7787-60-2	315.339	col or yel cub cry; hyg	234	441	4.75		reac H <sub>2</sub> O; s acid, EtOH, ace
433	Bismuth trifluoride	BiF <sub>3</sub>	7787-61-3	265.975	wh-gray cub cry	727	900	8.3		i H <sub>2</sub> O
434	Bismuth pentafluoride	BiF <sub>5</sub>	7787-62-4	303.972	wh tetr needles; hyg	151.4	230	5.55		reac H <sub>2</sub> O
435	Bismuth triiodide	BiI <sub>3</sub>	7787-64-6	589.693	blk-brn hex cry	408.6	542	5.778	0.00078 <sup>20</sup>	s EtOH
436	Bismuth trimethyl	Bi(CH <sub>3</sub> ) <sub>3</sub>	593-91-9	254.083	col flam liq	-86	110	2.3		
437	Bismuth titanate	Bi <sub>2</sub> (TiO <sub>3</sub> ) <sub>3</sub>	12048-51-0	1171.516	wh orth cry			7.85		
438	Bismuth tungstate	Bi <sub>2</sub> (WO <sub>4</sub> ) <sub>3</sub>	13595-87-4	1161.47	wh powder					
439	Bismuth vanadate	BiVO <sub>4</sub>	14059-33-7	323.920	orth cry	trans 500		6.25		i H <sub>2</sub> O; s acid
440	Bismuth zirconate	2Bi <sub>2</sub> O <sub>3</sub> · 3ZrO <sub>2</sub>	37306-42-6	1301.587	wh pow					
441	Boron	B	7440-42-8	10.811	blk rhomb cry	2075	4000	2.34		i H <sub>2</sub> O
442	Diborane	B <sub>2</sub> H <sub>6</sub>	19287-45-7	27.670	col gas; flam	-164.85	-92.49	1.131 g/L		reac H <sub>2</sub> O
443	Tetraborane(10)	B <sub>4</sub> H <sub>10</sub>	18283-93-7	53.323	unstab col gas	-120	18	2.180 g/L		reac H <sub>2</sub> O
444	Pentaborane(9)	B <sub>5</sub> H <sub>9</sub>	19624-22-7	63.126	flam col liq	-46.74	60.10	0.60		reac hot H <sub>2</sub> O
445	Pentaborane(11)	B <sub>5</sub> H <sub>11</sub>	18433-84-6	65.142	col liq; unstab	-122	65			reac H <sub>2</sub> O
446	Hexaborane(10)	B <sub>6</sub> H <sub>10</sub>	23777-80-2	74.945	col liq	-62.3	108 dec	0.67		reac hot H <sub>2</sub> O
447	Hexaborane(12)	B <sub>6</sub> H <sub>12</sub>	12008-19-4	76.961	col liq	-82.3	≈85			reac H <sub>2</sub> O
448	Nonaborane(15)	B <sub>9</sub> H <sub>15</sub>	19465-30-6	112.418	col liq	2.7				
449	Decaborane(14)	B <sub>10</sub> H <sub>14</sub>	17702-41-9	122.221	wh orth cry	98.78	213	0.94		sl H <sub>2</sub> O; s EtOH, bz, CS <sub>2</sub> , ctc
450	Decaborane(16)	B <sub>10</sub> H <sub>16</sub>	71595-75-0	124.237	col cry	≈81	dec 170	subl		
451	Dodecaborane(16)	B <sub>12</sub> H <sub>16</sub>	89711-39-7	145.859	col cry	65				s bz, hx
452	Tridecaborane(19)	B <sub>13</sub> H <sub>19</sub>	43093-20-5	159.694	yel cry	44				s hx, CH <sub>2</sub> Cl <sub>2</sub>
453	Tetradecaborane(18)	B <sub>14</sub> H <sub>18</sub>	55606-55-8	169.497	visc yel oil		dec 100			s cyhex, CS <sub>2</sub>
454	Hexadecaborane(20)	B <sub>16</sub> H <sub>20</sub>	28265-11-4	193.135	col cry	≈110				s ctc, cyhex, thf
455	Octadecaborane(22)	B <sub>18</sub> H <sub>22</sub>	11071-61-7	216.773	yel cry	180				s os
456	Tetrabromodiborane	B <sub>2</sub> Br <sub>4</sub>	14355-29-4	341.238	col liq	≈1	dec 20			
457	Tetrachlorodiborane	B <sub>2</sub> Cl <sub>4</sub>	13701-67-2	163.434	col liq; flam	-92.6	66.5			reac H <sub>2</sub> O



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
458	Tetrafluorodiborane	B <sub>2</sub> F <sub>4</sub>	13965-73-6	97.616	col gas; flam	-56	-34.0	3.990 g/L		react H <sub>2</sub> O
459	Borane carbonyl	BH <sub>3</sub> CO	13205-44-2	41.845	col gas	-137	-64	1.710 g/L		react H <sub>2</sub> O
460	Borazine	B <sub>3</sub> N <sub>3</sub> H <sub>6</sub>	6569-51-3	80.501	col liq	-58	53	0.824		react H <sub>2</sub> O
461	Boric acid	H <sub>3</sub> BO <sub>3</sub>	10043-35-3	61.833	col tricr cry	170.9		1.5	5.80 <sup>25</sup>	sl EtOH
462	Metaboric acid (α form)	HBO <sub>2</sub>	13460-50-9	43.818	col orth cry; hyg	176		1.784		s H <sub>2</sub> O
463	Metaboric acid (β form)	HBO <sub>2</sub>	13460-50-9	43.818	col monocr cry; hyg	201		2.045		s H <sub>2</sub> O
464	Metaboric acid (γ form)	HBO <sub>2</sub>	13460-50-9	43.818	col cub cry	236		2.487		s H <sub>2</sub> O
465	Tetrafluoroboric acid	HF <sub>4</sub> B	16872-11-0	87.813	col liq		130 dec	≈1.8		vs H <sub>2</sub> O, EtOH
466	Boron arsenide	BA <sub>s</sub>	12005-69-5	85.733	brn cub cry	1100 dec		5.22		
467	Boron carbide	B <sub>4</sub> C	12069-32-8	55.255	hard blk cry	2350	>3500	2.50		i H <sub>2</sub> O, acid
468	Boron nitride	BN	10043-11-5	24.818	wh powder; hex or cub cry	2967		2.18		i H <sub>2</sub> O, acid
469	Boron oxide	B <sub>2</sub> O <sub>3</sub>	1303-86-2	69.620	col gl or hex cry; hyg	450		2.55	2.2 <sup>20</sup>	s EtOH
470	Boron phosphide	BP	20205-91-8	41.785	red cub cry or powder	1125 dec				react H <sub>2</sub> O, acid
471	Boron silicide	B <sub>6</sub> Si	12008-29-6	92.952	blk cry	1980				
472	Boron sulfide	B <sub>2</sub> S <sub>3</sub>	12007-33-9	117.817	yel amorp solid	563		≈1.7		
473	Boron tribromide	BB <sub>3</sub>	10294-33-4	250.523	col liq; hyg	-46	91.3	2.6		react H <sub>2</sub> O, EtOH
474	Boron trichloride	BCl <sub>3</sub>	10294-34-5	117.170	col liq or gas	-107.3	12.5	4.789 g/L		react H <sub>2</sub> O, EtOH
475	Boron trifluoride	BF <sub>3</sub>	7637-07-2	67.806	col gas	-126.8	-99.9	2.772 g/L		s H <sub>2</sub> O
476	Boron trifluoride etherate	BF <sub>3</sub> (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O	109-63-7	141.927	liq	-60.4	125.5	1.125 <sup>25</sup>		react H <sub>2</sub> O; vs eth, EtOH
477	Boron triiodide	BI <sub>3</sub>	13517-10-7	391.524	wh needles	49.7	209.5	3.35		i H <sub>2</sub> O
478	Bromine	Br <sub>2</sub>	7726-95-6	159.808	red liq	-7.2	58.8	3.1028		sl H <sub>2</sub> O
479	Bromic acid	HBrO <sub>3</sub>	7789-31-3	128.910	stab only in aq soln					s H <sub>2</sub> O
480	Hypobromous acid	HOBr	13517-11-8	96.911	exists aq soln					s H <sub>2</sub> O
481	Bromine dioxide	BrO <sub>2</sub>	21255-83-4	111.903	unstab yel cry	≈0 dec				
482	Bromine monoxide	Br <sub>2</sub> O	21308-80-5	175.807	unstab brn solid	-17.5 dec				
483	Dibromine trioxide	Br <sub>2</sub> O <sub>3</sub>	53809-75-9	207.806	oran needles (LT)	dec -40				
484	Dibromine pentoxide	Br <sub>2</sub> O <sub>5</sub>	58572-43-3	239.805	col cry (low temp)	-20 dec				
485	Bromine azide	BrN <sub>3</sub>	13973-87-0	121.924	red cry; exp	≈45	exp			
486	Bromine chloride	BrCl	13863-41-7	115.357	dark red liq (<5°C)	-66	5 dec			react H <sub>2</sub> O; s eth, CS <sub>2</sub>
487	Bromine fluoride	BrF	13863-59-7	98.902	unstab red-brn gas	≈-33	≈20 dec	4.043 g/L		
488	Bromine trifluoride	BrF <sub>3</sub>	7787-71-5	136.899	col hyg liq	8.77	125.8	2.803		react H <sub>2</sub> O
489	Bromine pentafluoride	BrF <sub>5</sub>	7789-30-2	174.896	col liq	-60.5	41.3	2.460		react H <sub>2</sub> O (exp)
490	Bromosyl trifluoride	BrOF <sub>3</sub>	61519-37-7	152.898	col liq	-5	dec >20			react H <sub>2</sub> O
491	Bromyl fluoride	BrO <sub>2</sub> F	22585-64-4	130.901	col liq	-9	dec 55			react H <sub>2</sub> O
492	Perbromyl fluoride	BrO <sub>3</sub> F	37265-91-1	146.900	col gas	-110	dec 20			react H <sub>2</sub> O
493	Cadmium	Cd	7440-43-9	112.411	silv-wh metal	321.069	767	8.69		i H <sub>2</sub> O; react acid
494	Cadmium acetate	Cd(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	543-90-8	230.500	col cry	255		2.34		s H <sub>2</sub> O, EtOH
495	Cadmium acetate dihydrate	Cd(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	5743-04-4	266.529	wh cry	130 dec		2.01		vs H <sub>2</sub> O; s EtOH
496	Cadmium antimonide	CdSb	12014-29-8	234.171	orth cry	456		6.92		
497	Cadmium arsenide	Cd <sub>3</sub> As <sub>2</sub>	12006-15-4	487.076	gray tetr cry	721		6.25		
498	Cadmium azide	Cd(N <sub>3</sub> ) <sub>2</sub>	14215-29-3	196.451	yel-wh orth cry; exp	exp		3.24		
499	Cadmium borotungstate octadecahydrate	Cd <sub>3</sub> (BW <sub>12</sub> O <sub>40</sub> ) · 18H <sub>2</sub> O	1306-26-9	3743.20	yel cry					vs H <sub>2</sub> O
500	Cadmium bromide	CdBr <sub>2</sub>	7789-42-6	272.219	wh-yel hex cry; hyg	568	863	5.19	115 <sup>25</sup>	sl ace, eth
501	Cadmium bromide tetrahydrate	CdBr <sub>2</sub> · 4H <sub>2</sub> O	13464-92-1	344.281	wh-yel cry				115 <sup>25</sup>	s ace, EtOH
502	Cadmium carbonate	CdCO <sub>3</sub>	513-78-0	172.420	wh hex cry	500 dec		5.026		i H <sub>2</sub> O; s acid
503	Cadmium chlorate dihydrate	Cd(ClO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	22750-54-5*	315.344	col hyg cry	80 dec		2.28	2.64 <sup>9</sup>	
504	Cadmium chloride	CdCl <sub>2</sub>	10108-64-2	183.317	rhomb cry; hyg	568	964	4.08	120 <sup>25</sup>	s ace; sl EtOH; i eth
505	Cadmium chloride monohydrate	CdCl <sub>2</sub> · H <sub>2</sub> O	34330-64-8	201.332	wh cry				120 <sup>25</sup>	
506	Cadmium chloride hemipentahydrate	CdCl <sub>2</sub> · 2.5H <sub>2</sub> O	7790-78-5	228.354	wh rhomb leaflets			3.327	120 <sup>25</sup>	s ace
507	Cadmium chromate	CdCrO <sub>4</sub>	14312-00-6	228.405	yel orth cry			4.5		i H <sub>2</sub> O
508	Cadmium cyanide	Cd(CN) <sub>2</sub>	542-83-6	164.445	wh cub cry			2.23	1.7 <sup>15</sup>	
509	Cadmium dichromate monohydrate	CdCr <sub>2</sub> O <sub>7</sub> · H <sub>2</sub> O	69239-51-6	346.414	oran solid					s H <sub>2</sub> O
510	Cadmium 2-ethylhexanoate	Cd(C <sub>8</sub> H <sub>15</sub> O <sub>2</sub> ) <sub>2</sub>	2420-98-6	398.818	powder					
511	Cadmium fluoride	CdF <sub>2</sub>	7790-79-6	150.408	cub cry	1075	1750	6.33	4.36 <sup>25</sup>	s acid; i EtOH
512	Cadmium hydroxide	Cd(OH) <sub>2</sub>	21041-95-2	146.426	wh trig or hex cry	130 dec		4.79	0.00015 <sup>20</sup>	s dil acid
513	Cadmium iodate	Cd(IO <sub>3</sub> ) <sub>2</sub>	7790-81-0	462.216	wh powder			6.48	0.091 <sup>25</sup>	s HNO <sub>3</sub>

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
514	Cadmium iodide	CdI <sub>2</sub>	7790-80-9	366.220	col hex flakes	388	744	5.64	86.2 <sup>25</sup>	vs H <sub>2</sub> O; s EtOH, eth, ace
515	Cadmium metasilicate	CdSiO <sub>3</sub>	13477-19-5	188.495	grn monoc cry	1252		5.10		
516	Cadmium molybdate	CdMoO <sub>4</sub>	13972-68-4	272.35	col tetr cry	≈900 dec		5.4		i H <sub>2</sub> O; s acid
517	Cadmium niobate	Cd <sub>2</sub> Nb <sub>2</sub> O <sub>7</sub>	12187-14-3	522.631	cub cry	≈1410		6.28		i H <sub>2</sub> O
518	Cadmium nitrate	Cd(NO <sub>3</sub> ) <sub>2</sub>	10325-94-7	236.420	wh cub cry; hyg	360		3.6	156 <sup>25</sup>	s EtOH
519	Cadmium nitrate tetrahydrate	Cd(NO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	10022-68-1	308.482	col orth cry; hyg	59.5		2.45	156 <sup>25</sup>	s EtOH, ace
520	Cadmium oxalate	CdC <sub>2</sub> O <sub>4</sub>	814-88-0	200.430	wh solid			3.32	0.0060 <sup>25</sup>	
521	Cadmium oxalate trihydrate	CdC <sub>2</sub> O <sub>4</sub> · 3H <sub>2</sub> O	20712-42-9	254.476	wh amorp powder	340 dec			0.0060 <sup>25</sup>	i EtOH; s dil acid
522	Cadmium oxide	CdO	1306-19-0	128.410	brn cub cry		1559 sp	8.15		i H <sub>2</sub> O; s dil acid
523	Cadmium 2,4-pentanedioate	Cd(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14689-45-3	310.627	wh solid or red cry	235				
524	Cadmium perchlorate hexahydrate	Cd(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10326-28-0	419.404	wh hex cry			2.37	191.5 <sup>25</sup>	
525	Cadmium phosphate	Cd <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	13477-17-3	527.176	powder	≈1500				i H <sub>2</sub> O
526	Cadmium phosphide	Cd <sub>3</sub> P <sub>2</sub>	12014-28-7	399.181	grn tetr needles	700		5.96		s dil HCl
527	Cadmium selenate dihydrate	CdSeO <sub>4</sub> · 2H <sub>2</sub> O	10060-09-0	291.40	orth cry	100 dec		3.62	70.5 <sup>25</sup>	
528	Cadmium selenide	CdSe	1306-24-7	191.37	wh cub cry	1240		5.81		i H <sub>2</sub> O
529	Cadmium selenite	CdSeO <sub>3</sub>	13814-59-0	239.37	col prisms					
530	Cadmium stearate	Cd(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	2223-93-0	679.350	wh cry pow	134		1.21		
531	Cadmium succinate	CdC <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	141-00-4	228.484	wh pow or needles				0.37 <sup>40</sup>	sl H <sub>2</sub> O; i EtOH
532	Cadmium sulfate	CdSO <sub>4</sub>	10124-36-4	208.474	col orth cry	1000		4.69	76.7 <sup>25</sup>	i EtOH
533	Cadmium sulfate monohydrate	CdSO <sub>4</sub> · H <sub>2</sub> O	7790-84-3	226.489	monoc cry	105		3.79	76.7 <sup>25</sup>	
534	Cadmium sulfate octahydrate	CdSO <sub>4</sub> · 8H <sub>2</sub> O	15244-35-6	352.596	col monoc cry	40 dec		3.08	76.7 <sup>25</sup>	
535	Cadmium sulfide	CdS	1306-23-6	144.476	yel-oran hex cry	≈1480		4.826		i H <sub>2</sub> O; s acid
536	Cadmium sulfite	CdSO <sub>3</sub>	13477-23-1	192.474	col prisms	dec ≈400			0.05 <sup>20</sup>	sl H <sub>2</sub> O
537	Cadmium telluride	CdTe	1306-25-8	240.01	brn-blk cub cry	1042		6.2		i H <sub>2</sub> O, dil acid
538	Cadmium tellurite	CdTeO <sub>3</sub>	15851-44-2	288.01	col monoc cry	695	dec 1050			
539	Cadmium tetrafluoroborate	Cd(BF <sub>4</sub> ) <sub>2</sub>	14486-19-2	286.020	col hyg liq			1.6		vs H <sub>2</sub> O, EtOH
540	Cadmium titanate	CdTiO <sub>3</sub>	12014-14-1	208.276	orth cry			6.5		
541	Cadmium tungstate	CdWO <sub>4</sub>	7790-85-4	360.25	wh monoc cry			8.0		i H <sub>2</sub> O, acid; s NH <sub>4</sub> OH
542	Calcium	Ca	7440-70-2	40.078	silv-wh metal	842	1484	1.54		reac H <sub>2</sub> O; i bz
543	Calcium acetate	Ca(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	62-54-4	158.167	wh hyg cry	160 dec		1.50		s H <sub>2</sub> O; sl EtOH
544	Calcium acetate monohydrate	Ca(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	5743-26-0	176.182	wh needles or powder	≈150 dec				s H <sub>2</sub> O; sl EtOH
545	Calcium acetate dihydrate	Ca(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	14977-17-4	194.196	long col needles					s H <sub>2</sub> O
546	Calcium aluminate	CaAl <sub>2</sub> O <sub>4</sub>	12042-68-1	158.039	wh monoc cry	1605		2.98		reac H <sub>2</sub> O
547	Calcium aluminate (β form)	Ca <sub>2</sub> Al <sub>2</sub> O <sub>5</sub>	12042-78-3	270.193	wh cub cry; refr	1535		3.04		i H <sub>2</sub> O
548	Calcium arsenate	Ca <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	7778-44-1	398.072	wh powder	dec		3.6	0.0036 <sup>20</sup>	s dil acid
549	Calcium arsenite (1:1)	CaAsO <sub>3</sub>	52740-16-6	162.998	wh powder					sl H <sub>2</sub> O; s acid
550	Calcium borate hexahydrate	CaB <sub>2</sub> O <sub>7</sub> · 6H <sub>2</sub> O	13701-64-9*	303.409	wh cry pow	1162 (anh)				
551	Calcium boride	CaB <sub>6</sub>	12007-99-7	104.944	refrac solid	2235		2.49		
552	Calcium bromate	Ca(BrO <sub>3</sub> ) <sub>2</sub>	10102-75-7	295.882	wh pow	180				
553	Calcium bromate monohydrate	Ca(BrO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	10102-75-7*	313.898	wh monoc cry	dec 180		3.33		vs H <sub>2</sub> O
554	Calcium bromide	CaBr <sub>2</sub>	7789-41-5	199.886	rhom cry; hyg	742	1815	3.38	156 <sup>25</sup>	s EtOH, ace
555	Calcium bromide dihydrate	CaBr <sub>2</sub> · 2H <sub>2</sub> O	22208-73-7	235.917	wh cry pow					vs H <sub>2</sub> O
556	Calcium bromide hexahydrate	CaBr <sub>2</sub> · 6H <sub>2</sub> O	13477-28-6	307.977	wh hyg powder	38 dec		2.29	156 <sup>25</sup>	
557	Calcium carbide	CaC <sub>2</sub>	75-20-7	64.099	gray-blk orth cry	2300		2.22		reac H <sub>2</sub> O
558	Calcium carbonate (aragonite)	CaCO <sub>3</sub>	471-34-1	100.087	wh orth cry or powder	trans calcite 450		2.930	0.00066 <sup>20</sup>	s dil acid
559	Calcium carbonate (calcite)	CaCO <sub>3</sub>	471-34-1	100.087	wh hex cry or powder	dec 700-900		2.710	0.00066 <sup>20</sup>	s dil acid
560	Calcium carbonate (vaterite)	CaCO <sub>3</sub>	471-34-1	100.087	col hex cry			2.653	0.0011 <sup>25</sup>	s dil acid
561	Calcium chlorate	Ca(ClO <sub>3</sub> ) <sub>2</sub>	10137-74-3	206.980	wh cry	340			197 <sup>25</sup>	
562	Calcium chlorate dihydrate	Ca(ClO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	10035-05-9	243.011	wh monoc cry; hyg	100 dec		2.711	197 <sup>25</sup>	s EtOH
563	Calcium chloride	CaCl <sub>2</sub>	10043-52-4	110.984	wh cub cry or powder; hyg	775	1935	2.15	81.3 <sup>25</sup>	vs EtOH
564	Calcium chloride monohydrate	CaCl <sub>2</sub> · H <sub>2</sub> O	13477-29-7	128.999	wh hyg cry	260 dec		2.24	81.3 <sup>25</sup>	s EtOH
565	Calcium chloride dihydrate	CaCl <sub>2</sub> · 2H <sub>2</sub> O	10035-04-8	147.015	hyg flakes or powder	175 dec		1.85	81.3 <sup>25</sup>	vs EtOH
566	Calcium chloride tetrahydrate	CaCl <sub>2</sub> · 4H <sub>2</sub> O	25094-02-4	183.046	col tricr cry			1.83		
567	Calcium chloride hexahydrate	CaCl <sub>2</sub> · 6H <sub>2</sub> O	7774-34-7	219.075	wh hex cry; hyg	30 dec		1.71	81.3 <sup>25</sup>	
568	Calcium chlorite	Ca(ClO <sub>2</sub> ) <sub>2</sub>	14674-72-7	174.982	wh cub cry			2.71		reac H <sub>2</sub> O
569	Calcium chromate	CaCrO <sub>4</sub>	13765-19-0	156.072	yel cry	1000 dec				sl H <sub>2</sub> O; i EtOH, ace
570	Calcium chromate dihydrate	CaCrO <sub>4</sub> · 2H <sub>2</sub> O	10060-08-9	192.102	yel orth cry	dec 200		2.50	13.2 <sup>20</sup>	s dil acids
571	Calcium citrate tetrahydrate	Ca <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	5785-44-4	570.494	wh needles or pow	dec 100			0.096 <sup>23</sup>	i eth
572	Calcium cyanamide	CaCN <sub>2</sub>	156-62-7	80.102	col hex cry	≈1340	subl	2.29		reac H <sub>2</sub> O
573	Calcium cyanide	Ca(CN) <sub>2</sub>	592-01-8	92.112	wh rhomb cry; hyg					s H <sub>2</sub> O, EtOH



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
574	Calcium dichromate trihydrate	CaCr <sub>2</sub> O <sub>7</sub> · 3H <sub>2</sub> O	14307-33-6*	310.112	red-oran cry	100 dec		2.37		vs H <sub>2</sub> O; reac EtOH; i eth, ctc
575	Calcium dihydrogen phosphate monohydrate	Ca(H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub> · H <sub>2</sub> O	10031-30-8	252.068	col tricr plates	100 dec		2.220		sl H <sub>2</sub> O; s dil acid
576	Calcium 2-ethylhexanoate	Ca(C <sub>8</sub> H <sub>16</sub> O <sub>2</sub> ) <sub>2</sub>	136-51-6	326.485	powder					
577	Calcium ferrocyanide dodecahydrate	Ca <sub>2</sub> Fe(CN) <sub>6</sub> · 12H <sub>2</sub> O		508.289	yel tricr cry	dec		1.68	87 <sup>25</sup>	vs H <sub>2</sub> O; i EtOH
578	Calcium fluoride	CaF <sub>2</sub>	7789-75-5	78.075	wh cub cry or powder	1418	2500	3.18	0.0016 <sup>25</sup>	sl acid
579	Calcium fluorophosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> F	12015-73-5	504.302	col hex cry	1650		3.201		i H <sub>2</sub> O
580	Calcium fluorophosphate dihydrate	CaPO <sub>3</sub> F · 2H <sub>2</sub> O	37809-19-1	174.079	col monocry				0.42 <sup>27</sup>	i os
581	Calcium formate	Ca(CHO <sub>2</sub> ) <sub>2</sub>	544-17-2	130.113	orth cry	300 dec		2.02	16.6 <sup>20</sup>	i EtOH
582	Calcium hexaborate pentahydrate	2CaO · 3B <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	12291-65-5	411.091	col monocry	dec 375 (exp)		2.42	1 <sup>25</sup>	sl acid
583	Calcium hexafluoro-2,4-pentanedioate	Ca(CF <sub>3</sub> COCHCOCF <sub>3</sub> ) <sub>2</sub>	121012-90-6	454.180	powder	135				
584	Calcium hexafluorosilicate dihydrate	CaSiF <sub>6</sub> · 2H <sub>2</sub> O	16925-39-6	218.185	col tetr cry			2.25	0.52 <sup>20</sup>	i ace; reac hot H <sub>2</sub> O
585	Calcium hydride	CaH <sub>2</sub>	7789-78-8	42.094	gray orth cry or powder	1000		1.7		reac H <sub>2</sub> O, EtOH
586	Calcium hydrogen phosphate	CaHPO <sub>4</sub>	7757-93-9	136.057	wh tricr cry	dec		2.92	0.02 <sup>25</sup>	i EtOH
587	Calcium hydrogen phosphate dihydrate	CaHPO <sub>4</sub> · 2H <sub>2</sub> O	7789-77-7	172.088	monocry	≈100 dec		2.31	0.02 <sup>25</sup>	i EtOH; s dil acid
588	Calcium hydrogen sulfite	CaH <sub>2</sub> (SO <sub>3</sub> ) <sub>2</sub>	13780-03-5	202.220				1.06		s H <sub>2</sub> O
589	Calcium hydrosulfide hexahydrate	Ca(HS) <sub>2</sub> · 6H <sub>2</sub> O		214.315	col cry	dec				s H <sub>2</sub> O, EtOH
590	Calcium hydroxide	Ca(OH) <sub>2</sub>	1305-62-0	74.093	soft hex cry			≈2.2	0.160 <sup>20</sup>	s acid
591	Calcium hydroxide phosphate	Ca <sub>3</sub> (OH)(PO <sub>4</sub> ) <sub>3</sub>	12167-74-7	502.311	col hex cry	dec >900		3.155		i H <sub>2</sub> O
592	Calcium hypochlorite	Ca(OCl) <sub>2</sub>	7778-54-3	142.983	powder	100		2.350		
593	Calcium hypophosphite	Ca(H <sub>2</sub> PO <sub>2</sub> ) <sub>2</sub>	7789-79-9	170.055	wh monocry	300 dec				s H <sub>2</sub> O; i EtOH
594	Calcium iodate	Ca(IO <sub>3</sub> ) <sub>2</sub>	7789-80-2	389.883	wh monocry			4.52	0.306 <sup>25</sup>	s HNO <sub>3</sub> ; i EtOH
595	Calcium iodide	CaI <sub>2</sub>	10102-68-8	293.887	hyg hex cry	783	1100	3.96	215 <sup>25</sup>	s MeOH, EtOH, ace; i eth
596	Calcium iodide hexahydrate	CaI <sub>2</sub> · 6H <sub>2</sub> O	71626-98-7	401.978	wh hex needles or powder	42 dec		2.55	215 <sup>25</sup>	vs EtOH
597	Calcium metaborate	Ca(BO <sub>2</sub> ) <sub>2</sub>	13701-64-9	125.698	powder				0.13 <sup>20</sup>	
598	Calcium metasilicate	CaSiO <sub>3</sub>	1344-95-2	116.162	wh monocry	1540		2.92		i H <sub>2</sub> O
599	Calcium molybdate	CaMoO <sub>4</sub>	7789-82-4	200.02	wh tetr cry	1520		4.35	0.0011 <sup>20</sup>	i EtOH; s conc acid
600	Calcium nitrate	Ca(NO <sub>3</sub> ) <sub>2</sub>	10124-37-5	164.087	wh cub cry; hyg	561		2.5	144 <sup>25</sup>	s EtOH, MeOH, ace
601	Calcium nitrate tetrahydrate	Ca(NO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	13477-34-4	236.149	wh cry	≈40 dec		1.82	144 <sup>25</sup>	s EtOH, ace
602	Calcium nitride	Ca <sub>3</sub> N <sub>2</sub>	12013-82-0	148.247	red-brn cub cry	1195		2.67		s H <sub>2</sub> O, acid; i EtOH
603	Calcium nitrite	Ca(NO <sub>2</sub> ) <sub>2</sub>	13780-06-8	132.089	wh-yel hex cry; hyg	392		2.23	94.6 <sup>25</sup>	sl EtOH
604	Calcium nitrite monohydrate	Ca(NO <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	10031-34-2	150.104	col or yel cry	dec 100				vs H <sub>2</sub> O; sl EtOH
605	Calcium oleate	Ca(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	142-17-6	602.985	pale yel solid	dec 140			0.04 <sup>25</sup>	sl H <sub>2</sub> O; s bz; i EtOH, ace, eth
606	Calcium oxalate	CaC <sub>2</sub> O <sub>4</sub>	563-72-4	128.097	wh cry powder			2.2	0.00061 <sup>20</sup>	
607	Calcium oxalate monohydrate	CaC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	5794-28-5	146.112	cub cry	200 dec		2.2	0.00061 <sup>20</sup>	s dil acid
608	Calcium oxide	CaO	1305-78-8	56.077	gray-wh cub cry	2613		3.34		reac H <sub>2</sub> O; s acid
609	Calcium oxide silicate	Ca <sub>3</sub> OSiO <sub>4</sub>	12168-85-3	228.317	refrac solid	2150				
610	Calcium palmitate	Ca(C <sub>16</sub> H <sub>31</sub> O <sub>2</sub> ) <sub>2</sub>	542-42-7	550.910	wh-yel pow	dec 155				i H <sub>2</sub> O, EtOH, eth, ace; sl bz
611	Calcium perborate heptahydrate	Ca(BO <sub>2</sub> ) <sub>3</sub> · 7H <sub>2</sub> O		283.803	gray-wh pow					s H <sub>2</sub> O, acid
612	Calcium 2,4-pentanedioate	Ca(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	19372-44-2	238.294	cry	dec 175				
613	Calcium perchlorate	Ca(ClO <sub>4</sub> ) <sub>2</sub>	13477-36-6	238.979	wh cry	270 dec		2.65	188 <sup>25</sup>	s EtOH, MeOH
614	Calcium perchlorate tetrahydrate	Ca(ClO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	15627-86-8	311.041	wh cry					vs H <sub>2</sub> O
615	Calcium permanganate	Ca(MnO <sub>4</sub> ) <sub>2</sub>	10118-76-0	277.949	purp hyg cry			2.4	331 <sup>20</sup>	reac EtOH
616	Calcium peroxide	CaO <sub>2</sub>	1305-79-9	72.077	wh-yel tetr cry; hyg	≈200 dec		2.9		sl H <sub>2</sub> O; s acid
617	Calcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7758-87-4	310.177	wh amorp powder	1670		3.14	0.00012 <sup>20</sup>	i EtOH; s dil acid
618	Calcium phosphide	Ca <sub>3</sub> P <sub>2</sub>	1305-99-3	182.182	red-brn hyg cry	≈1600		2.51		reac H <sub>2</sub> O; i EtOH, eth
619	Calcium phosphonate monohydrate	CaHPO <sub>3</sub> · H <sub>2</sub> O	25232-60-4	138.073	col monocry	dec 150				sl H <sub>2</sub> O; i EtOH
620	Calcium plumbate	Ca <sub>3</sub> PbO <sub>4</sub>	12013-69-3	351.4	oran-brn orth cry	dec		5.71		i H <sub>2</sub> O; s acid
621	Calcium propanoate	Ca(C <sub>3</sub> H <sub>7</sub> O <sub>2</sub> ) <sub>2</sub>	4075-81-4	186.219	monocry, powder					s H <sub>2</sub> O; sl MeOH, EtOH; i ace, bz
622	Calcium pyrophosphate	Ca <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	7790-76-3	254.099	wh powder	1353		3.09		i H <sub>2</sub> O; s dil acid
623	Calcium selenate dihydrate	CaSeO <sub>4</sub> · 2H <sub>2</sub> O	7790-74-1	219.07	wh monocry			2.75	8.3 <sup>18</sup>	
624	Calcium selenide	CaSe	1305-84-6	119.04	wh-brn cub cry	1400 dec		3.8		reac H <sub>2</sub> O
625	Calcium silicide (CaSi)	CaSi	12013-55-7	68.164	orth cry	1324		2.39		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
626	Calcium silicide (CaSi <sub>2</sub> )	CaSi <sub>2</sub>	12013-56-8	96.249	gray hex cry	1040		2.50		i cold H <sub>2</sub> O; reac hot H <sub>2</sub> O; s acid
627	Calcium stannate trihydrate	CaSnO <sub>3</sub> · 3H <sub>2</sub> O	12013-46-6*	260.832	wh cry pow	dec ~350				i H <sub>2</sub> O
628	Calcium stearate	Ca(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	1592-23-0	607.017	granular powder	180				i H <sub>2</sub> O, EtOH
629	Calcium succinate trihydrate	CaC <sub>4</sub> H <sub>4</sub> O <sub>4</sub> · 3H <sub>2</sub> O	140-99-8	210.196	needles					sl H <sub>2</sub> O; s dil acid; i EtOH
630	Calcium sulfate	CaSO <sub>4</sub>	7778-18-9	136.141	orth cry	1460		2.96	0.205 <sup>25</sup>	
631	Calcium sulfate hemihydrate	CaSO <sub>4</sub> · 0.5H <sub>2</sub> O	10034-76-1	145.149	wh powder				0.205 <sup>25</sup>	
632	Calcium sulfate dihydrate	CaSO <sub>4</sub> · 2H <sub>2</sub> O	10101-41-4	172.171	monocl cry or powder	150 dec		2.32	0.205 <sup>20</sup>	i os
633	Calcium sulfide	CaS	20548-54-3	72.143	wh-yel cub cry; hyg	2524		2.59		sl H <sub>2</sub> O; i EtOH
634	Calcium sulfite dihydrate	CaSO <sub>3</sub> · 2H <sub>2</sub> O	10257-55-3	156.172	wh powder				0.0070 <sup>25</sup>	sl EtOH; s acid
635	Calcium tartrate tetrahydrate	CaC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 4H <sub>2</sub> O	3164-34-9*	260.210	wh pow				0.04 <sup>10</sup>	s dil acid; sl EtOH
636	Calcium telluride	CaTe	12013-57-9	167.68	wh cub cry	1600 dec		4.87		
637	Calcium tetrahydroaluminate	Ca(AlH <sub>4</sub> ) <sub>2</sub>	16941-10-9	102.105	gray powder; flam					reac H <sub>2</sub> O; s thf; i eth, bz
638	Calcium thiocyanate tetrahydrate	Ca(SCN) <sub>2</sub> · 4H <sub>2</sub> O	2092-16-2	228.304	hyg cry	160 dec				vs H <sub>2</sub> O; s EtOH, ace
639	Calcium thiosulfate hexahydrate	CaS <sub>2</sub> O <sub>3</sub> · 6H <sub>2</sub> O	10124-41-1	260.298	tricl cry	45 dec		1.87		s H <sub>2</sub> O; i EtOH
640	Calcium titanate	CaTiO <sub>3</sub>	12049-50-2	135.943	cub cry	1980		3.98		
641	Calcium tungstate	CaWO <sub>4</sub>	7790-75-2	287.92	wh tetr cry	1620		6.06	0.2 <sup>18</sup>	s hot acid
642	Calcium zirconate	CaZrO <sub>3</sub>	12013-47-7	179.300	powder	2550				
643	Californium	Cf	7440-71-3	251	hex or cub metal	900		15.1		
644	Carbon (diamond)	C	7782-40-3	12.011	col cub cry	4440 (12.4 GPa)		3.513		i H <sub>2</sub> O
645	Carbon (graphite)	C	7782-42-5	12.011	soft blk hex cry	4489 tp (10.3 MPa)	3825 sp	2.2		i H <sub>2</sub> O
646	Carbon black	C	1333-86-4	12.011	fine blk pow					i H <sub>2</sub> O
647	Carbon (fullerene-C <sub>60</sub> )	C <sub>60</sub>	99685-96-8	720.642	yel needles or plates	>280				s os
648	Carbon (fullerene-C <sub>70</sub> )	C <sub>70</sub>	115383-22-7	840.749	red-brn solid	>280				s bz, tol
649	Fullerene fluoride	C <sub>60</sub> F <sub>60</sub>	134929-59-2	1860.546	col plates	287				vs ace; s thf; i chl
650	Carbon monoxide	CO	630-08-0	28.010	col gas	-205.02	-191.5	1.145 g/L		sl H <sub>2</sub> O; s chl, EtOH
651	Carbon dioxide	CO <sub>2</sub>	124-38-9	44.010	col gas	-56.558 tp	-78.464 sp	1.799 g/L		s H <sub>2</sub> O
652	Carbon suboxide	C <sub>3</sub> O <sub>2</sub>	504-64-3	68.031	col gas	-112.5	6.8	2.781 g/L		reac H <sub>2</sub> O
653	Carbon disulfide	CS <sub>2</sub>	75-15-0	76.141	col or yel liq	-112.1	46	1.2632 <sup>20</sup>		i H <sub>2</sub> O; vs EtOH, bz, os
654	Carbon subsulfide	C <sub>2</sub> S <sub>2</sub>	627-34-9	100.162	red liq	-1	90 dec	1.27		reac H <sub>2</sub> O
655	Carbon diselenide	CSe <sub>2</sub>	506-80-9	169.93	yel liq	-43.7	125.5	2.6823 <sup>20</sup>		i H <sub>2</sub> O; vs ctc, tol
656	Carbon oxysulfide	COS	463-58-1	60.075	col gas	-138.8	-50	2.456 g/L		s H <sub>2</sub> O, EtOH
657	Carbon oxyselenide	COSe	1603-84-5	106.97	col gas; unstab	-124.4	-21.7	4.372 g/L		reac H <sub>2</sub> O
658	Carbon sulfide selenide	CSSe	5951-19-9	123.04	yel liq	-85	84.5	1.99		i H <sub>2</sub> O
659	Carbon sulfide telluride	CS <sub>2</sub> Te	10340-06-4	171.68	red-yel liq; unstab	-54	20 dec			reac H <sub>2</sub> O
660	Carbonyl bromide	COBr <sub>2</sub>	593-95-3	187.818	col liq			64.5	2.5	reac H <sub>2</sub> O
661	Carbonyl chloride	COCl <sub>2</sub>	75-44-5	98.916	col gas	-127.78	8	4.043 g/L		sl H <sub>2</sub> O; s bz, tol
662	Carbonyl fluoride	COF <sub>2</sub>	353-50-4	66.007	col gas	-111.26	-84.57	2.698 g/L		reac H <sub>2</sub> O
663	Cyanogen	C <sub>2</sub> N <sub>2</sub>	460-19-5	52.034	col gas	-27.83	-21.1	2.127 g/L		sl H <sub>2</sub> O, eth; s EtOH
664	Cyanogen azide	N <sub>3</sub> CN	764-05-6	68.038	col oily liq	exp				
665	Cyanogen bromide	BrCN	506-68-3	105.922	wh hyg needles	52	61.5	2.015		s H <sub>2</sub> O, EtOH, eth
666	Cyanogen chloride	CICN	506-77-4	61.471	col vol liq or gas	-6.55	13	2.513 g/L		s H <sub>2</sub> O, EtOH, eth
667	Cyanogen fluoride	FCN	1495-50-7	45.016	col gas	-82	-46	1.840 g/L		
668	Cyanogen iodide	ICN	506-78-5	152.922	col needles	146.7		2.84		s H <sub>2</sub> O, EtOH, eth
669	Cerium	Ce	7440-45-1	140.116	silv metal; cub or hex	799	3443	6.770		s dil acid
670	Cerium boride	CeB <sub>6</sub>	12008-02-5	204.982	blue refrac solid; hex	2550		4.87		i H <sub>2</sub> O, HCl
671	Cerium carbide	CeC <sub>2</sub>	12012-32-7	164.137	red hex cry	2250		5.47		reac H <sub>2</sub> O
672	Cerium carbide	Ce <sub>2</sub> C <sub>3</sub>	12115-63-8	316.264	yel-brn cub cry	1505		6.9		
673	Cerium nitride	CeN	25764-08-3	154.123	refrac cub cry	2557		7.89		
674	Cerium silicide	CeSi <sub>2</sub>	12014-85-6	196.287	tetr cry	1420		5.31		i H <sub>2</sub> O
675	Cerium(II) hydride	CeH <sub>2</sub>	13569-50-1	142.132	cub cry			5.45		reac H <sub>2</sub> O
676	Cerium(II) iodide	CeI <sub>2</sub>	19139-47-0	393.925	bronze cry	808				
677	Cerium(II) sulfide	CeS	12014-82-3	172.181	yel cub cry	2445		5.9		
678	Cerium(III) acetate sesquihydrate	Ce(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 1.5H <sub>2</sub> O	17829-82-2		col cry	dec 115			26 <sup>15</sup>	s H <sub>2</sub> O
679	Cerium(III) ammonium nitrate tetrahydrate	(NH <sub>4</sub> ) <sub>2</sub> Ce(NO <sub>3</sub> ) <sub>6</sub> · 4H <sub>2</sub> O	13083-04-0	558.279	col monocl cry	74				vs H <sub>2</sub> O
680	Cerium(III) ammonium sulfate tetrahydrate	NH <sub>4</sub> Ce(SO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	21995-38-0*	422.341	monocl cry					s H <sub>2</sub> O
681	Cerium(III) bromide	CeBr <sub>3</sub>	14457-87-5	379.828	wh hex cry; hyg	732	1457			s H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
682	Cerium(III) bromide heptahydrate	CeBr <sub>3</sub> · 7H <sub>2</sub> O	7789-56-2	505.935	col hyg needles	732				s H <sub>2</sub> O, EtOH
683	Cerium(III) carbonate	Ce <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub>	537-01-9	460.259	wh pow	dec 500				i H <sub>2</sub> O; s acid
684	Cerium(III) carbonate pentahydrate	Ce <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	72520-94-6	550.335	wh powder					i H <sub>2</sub> O; s dil acid
685	Cerium(III) chloride	CeCl <sub>3</sub>	7790-86-5	246.475	wh hex cry	807		3.97		s H <sub>2</sub> O, EtOH
686	Cerium(III) chloride heptahydrate	CeCl <sub>3</sub> · 7H <sub>2</sub> O	18618-55-8	372.582	yel orth cry; hyg	90 dec				vs H <sub>2</sub> O, EtOH
687	Cerium(III) fluoride	CeF <sub>3</sub>	7758-88-5	197.111	wh hex cry; hyg	1430	2180	6.157		i H <sub>2</sub> O
688	Cerium(III) hydride	CeH <sub>3</sub>	13864-02-3	143.140	blk pow or blue-blk cry	dec (flam)				reac H <sub>2</sub> O
689	Cerium(III) hydroxide	Ce(OH) <sub>3</sub>	15785-09-8	191.138	wh solid					i H <sub>2</sub> O; s acid
690	Cerium(III) iodide	CeI <sub>3</sub>	7790-87-6	520.829	yel orth cry; hyg	760				s H <sub>2</sub> O
691	Cerium(III) iodide nonahydrate	CeI <sub>3</sub> · 9H <sub>2</sub> O	7790-87-6*	682.967	wh-red cry					vs H <sub>2</sub> O; s EtOH
692	Cerium(III) nitrate hexahydrate	Ce(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	10108-73-3*	434.222	col-red cry	150 dec			176 <sup>25</sup>	s ace
693	Cerium(III) oxalate nonahydrate	Ce(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	13266-83-6	706.426	wh pow	dec				i H <sub>2</sub> O, EtOH; s acid
694	Cerium(III) oxide	Ce <sub>2</sub> O <sub>3</sub>	1345-13-7	328.230	yel-grn cub cry	2210	3730	6.2		i H <sub>2</sub> O; s acid
695	Cerium(III) 2,4-pentanedioate trihydrate	Ce(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	15653-01-7	491.486	yel hyg cry	≈150				vs EtOH
696	Cerium(III) perchlorate hexahydrate	Ce(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	36907-38-7	546.559	hyg col cry	dec 200				s H <sub>2</sub> O, EtOH
697	Cerium(III) selenate	Ce <sub>2</sub> (SeO <sub>4</sub> ) <sub>3</sub>		709.11	rhomb cry			4.46		s H <sub>2</sub> O
698	Cerium(III) sulfate	Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13454-94-9	568.420	col hyg cry	920 dec				s H <sub>2</sub> O
699	Cerium(III) sulfate octahydrate	Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13454-94-9	712.542	wh orth cry	≈250 dec		2.87		s H <sub>2</sub> O
700	Cerium(III) sulfide	Ce <sub>2</sub> S <sub>3</sub>	12014-93-6	376.427	red cub cry	2450		5.02		i H <sub>2</sub> O
701	Cerium(III) tungstate	Ce <sub>2</sub> (WO <sub>4</sub> ) <sub>3</sub>	13454-74-5	1023.75	yel tetr cry	1089		6.77		i H <sub>2</sub> O
702	Cerium(IV) ammonium nitrate	(NH <sub>4</sub> ) <sub>2</sub> Ce(NO <sub>3</sub> ) <sub>6</sub>	16774-21-3	548.223	red-oran cry					vs H <sub>2</sub> O
703	Cerium(IV) ammonium sulfate dihydrate	(NH <sub>4</sub> ) <sub>4</sub> Ce(SO <sub>4</sub> ) <sub>4</sub> · 2H <sub>2</sub> O	10378-47-9	632.551	cry pow	dec 450				
704	Cerium(IV) fluoride	CeF <sub>4</sub>	10060-10-3	216.110	wh hyg powder	≈600 dec		4.77		i H <sub>2</sub> O
705	Cerium(IV) hydroxide	Ce(OH) <sub>4</sub>	12014-56-1	208.146	yel-wh pow					i H <sub>2</sub> O; s conc acid
706	Cerium(IV) oxide	CeO <sub>2</sub>	1306-38-3	172.115	wh-yel powder; cub	2480		7.216		i H <sub>2</sub> O, dil acid
707	Cerium(IV) sulfate tetrahydrate	Ce(SO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	10294-42-5	404.303	yel-oran orth cry	180 dec		3.91	9.66 <sup>20</sup>	
708	Cesium	Cs	7440-46-2	132.905	silv-wh metal	28.5	671	1.873		reac H <sub>2</sub> O
709	Cesium acetate	CsC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	3396-11-0	191.949	hyg lumps	194			10 <sup>11</sup>	
710	Cesium aluminum sulfate dodecahydrate	CsAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7784-17-0	568.196	col cub cry	117 dec		1.97		s H <sub>2</sub> O; i EtOH
711	Cesium amide	CsNH <sub>2</sub>	22205-57-8	148.928	wh tetr cry			3.70		
712	Cesium azide	CsN <sub>3</sub>	22750-57-8	174.925	hyg tetr cry; exp	326		≈3.5	22 <sup>40</sup>	
713	Cesium bromate	CsBrO <sub>3</sub>	13454-75-6	260.807	col hex cry			4.11	3.83 <sup>25</sup>	
714	Cesium bromide	CsBr	7787-69-1	212.809	wh cub cry; hyg	636	≈1300	4.43	123 <sup>25</sup>	s EtOH; i ace
715	Cesium carbonate	Cs <sub>2</sub> CO <sub>3</sub>	534-17-8	325.820	wh monocl cry; hyg	793		4.24	261 <sup>15</sup>	s EtOH, eth
716	Cesium chlorate	CsClO <sub>3</sub>	13763-67-2	216.356	col hex cry	342		3.57	7.78 <sup>25</sup>	sl H <sub>2</sub> O
717	Cesium chloride	CsCl	7647-17-8	168.358	wh cub cry; hyg	646	1297	3.988	191 <sup>25</sup>	s EtOH
718	Cesium chromate(IV)	Cs <sub>2</sub> CrO <sub>4</sub>	56320-90-2	647.616	yel hex cry	982		4.24		vs H <sub>2</sub> O
719	Cesium cyanide	CsCN	21159-32-0	158.923	wh cub cry; hyg	350		3.34		vs H <sub>2</sub> O
720	Cesium dibromiodate	CsIBr <sub>2</sub>	18278-82-5	419.617	dark oran cry	dec				s H <sub>2</sub> O
721	Cesium fluoride	CsF	13400-13-0	151.903	wh cub cry; hyg	703		4.64	573 <sup>25</sup>	s MeOH; i diox, py
722	Cesium fluoroborate	CsBF <sub>4</sub>	18909-69-8	219.710	wh orth cry	555 dec		3.2	1.6 <sup>17</sup>	sl H <sub>2</sub> O
723	Cesium formate	CsCHO <sub>2</sub>	3495-36-1	177.923	wh cry			1.017		vs H <sub>2</sub> O
724	Cesium hexafluorogermanate	Cs <sub>2</sub> GeF <sub>6</sub>		452.44	wh cry	≈675		4.10		sl cold H <sub>2</sub> O; s hot H <sub>2</sub> O
725	Cesium hydride	CsH	58724-12-2	133.913	wh cub cry; flam	528		3.42		reac H <sub>2</sub> O
726	Cesium hydrogen carbonate	CsHCO <sub>3</sub>	15519-28-5	193.922	rhomb cry	175 dec			209 <sup>15</sup>	s EtOH
727	Cesium hydrogen fluoride	CsHF <sub>2</sub>	12280-52-3	171.910	tetr cry	170		3.86		
728	Cesium hydrogen sulfate	CsHSO <sub>4</sub>	7789-16-4	229.976	col rhomb prisms	dec		3.352		s H <sub>2</sub> O
729	Cesium hydroxide	CsOH	21351-79-1	149.912	wh-yel hyg cry	342.3		3.68	300 <sup>30</sup>	s EtOH
730	Cesium iodate	CsIO <sub>3</sub>	13454-81-4	307.807	wh monocl cry			4.85	2.6 <sup>25</sup>	
731	Cesium iodide	CsI	7789-17-5	259.809	col cub cry; hyg	632	≈1280	4.51	84.8 <sup>25</sup>	s EtOH, MeOH, ace
732	Cesium metaborate	CsBO <sub>2</sub>	92141-86-1	175.715	cub cry	732		≈3.7		
733	Cesium molybdate	Cs <sub>2</sub> MoO <sub>4</sub>	13597-64-3	425.75	wh cry	956.3			67 <sup>18</sup>	s H <sub>2</sub> O
734	Cesium nitrate	CsNO <sub>3</sub>	7789-18-6	194.910	wh hex or cub cry	409		3.66	27.9 <sup>25</sup>	s ace; sl EtOH
735	Cesium nitrite	CsNO <sub>2</sub>	13454-83-6	178.911	yel cry	406				s H <sub>2</sub> O
736	Cesium oxide	Cs <sub>2</sub> O	20281-00-9	281.810	yel-oran hex cry	495		4.65		vs H <sub>2</sub> O
737	Cesium superoxide	CsO <sub>2</sub>	12018-61-0	164.904	yel tetr cry	432		3.77		reac H <sub>2</sub> O
738	Cesium trioxide	Cs <sub>2</sub> O <sub>3</sub>	12134-22-4	313.809	brn cry	≈400		4.25		reac H <sub>2</sub> O
739	Cesium perchlorate	CsClO <sub>4</sub>	13454-84-7	232.356	wh orth cry; hyg	≈600 dec		3.327	2.00 <sup>25</sup>	
740	Cesium periodate	CsIO <sub>4</sub>	13478-04-1	323.807	wh rhomb prisms			4.26	2.2 <sup>15</sup>	
741	Cesium sulfate	Cs <sub>2</sub> SO <sub>4</sub>	10294-54-9	361.874	wh orth cry or hex prisms; hyg	1005		4.24	182 <sup>25</sup>	i EtOH, ace, py

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
742	Cesium sulfide	Cs <sub>2</sub> S	12214-16-3	297.876	yel orth hyg cry	520				vs H <sub>2</sub> O
743	Cesium trifluoroacetate	Cs(C <sub>2</sub> F <sub>3</sub> O <sub>2</sub> )	21907-50-6	245.920	hyg solid	115				vs H <sub>2</sub> O
744	Chlorine	Cl <sub>2</sub>	7782-50-5	70.906	grn-yel gas	-101.5	-34.04	2.898 g/L		sl H <sub>2</sub> O
745	Hypochlorous acid	HOCl	7790-92-3	52.460	grn-yel; stable only in aq soln					s H <sub>2</sub> O
746	Chloric acid	HClO <sub>3</sub>	7790-93-4	84.459	exists only in aq soln					vs H <sub>2</sub> O
747	Perchloric acid	HClO <sub>4</sub>	7601-90-3	100.459	col hyg liq	-112	≈90 dec	1.77		s H <sub>2</sub> O
748	Chlorine monoxide	Cl <sub>2</sub> O	7791-21-1	86.905	yel-brn gas	-120.6	2.2	3.552 g/L		vs H <sub>2</sub> O
749	Chlorine dioxide	ClO <sub>2</sub>	10049-04-4	67.452	oran-grn gas	-59	11	2.757 g/L		sl H <sub>2</sub> O
750	Dichlorine trioxide	Cl <sub>2</sub> O <sub>3</sub>	17496-59-2	118.904	dark brn solid	exp <25				
751	Dichlorine hexoxide	Cl <sub>2</sub> O <sub>6</sub>	12442-63-6	166.902	red liq	3.5	≈200			react H <sub>2</sub> O
752	Dichlorine heptoxide	Cl <sub>2</sub> O <sub>7</sub>	10294-48-1	182.902	col oily liq; exp	-91.5	82	1.9		react H <sub>2</sub> O
753	Chlorine fluoride	ClF	7790-89-8	54.451	col gas	-155.6	-101.1	2.226 g/L		react H <sub>2</sub> O
754	Chlorine trifluoride	ClF <sub>3</sub>	7790-91-2	92.448	gas	-76.34	11.75	3.779 g/L		react H <sub>2</sub> O
755	Chlorine pentafluoride	ClF <sub>5</sub>	13637-63-3	130.445	col gas	-103	-13.1	5.332 g/L		
756	Chlorosyl trifluoride	ClOF <sub>3</sub>	30708-80-6	108.447	col liq	-42	27			react H <sub>2</sub> O
757	Chloryl fluoride	ClO <sub>2</sub> F	13637-83-7	86.450	col gas	-115	-6	3.534 g/L		react H <sub>2</sub> O
758	Chloryl trifluoride	ClO <sub>2</sub> F <sub>3</sub>	38680-84-1	124.447	col gas	-81.2	-21.6	5.087 g/L		react H <sub>2</sub> O
759	Perchloryl fluoride	ClO <sub>3</sub> F	7616-94-6	102.449	col gas	-147	-46.75	4.187 g/L		
760	Chlorine perchlorate	ClOClO <sub>3</sub>	27218-16-2	134.904	unstab yel liq	-117	≈45 dec	1.81°		
761	Chromium	Cr	7440-47-3	51.996	blue-wh metal; cub	1907	2671	7.15		react dil acid
762	Chromic acid	H <sub>2</sub> CrO <sub>4</sub>	7738-94-5	118.010	aq soln only					s H <sub>2</sub> O
763	Chromium antimonide	CrSb	12053-12-2	173.756	hex cry	1110		7.11		
764	Chromium arsenide	Cr <sub>3</sub> As	12254-85-2	178.914	tetr cry			7.04		
765	Chromium boride (CrB)	CrB	12006-79-0	62.807	refrac orth cry	2100		6.1		
766	Chromium boride (Cr <sub>2</sub> B <sub>3</sub> )	Cr <sub>2</sub> B <sub>3</sub>	12007-16-8	73.618	refrac solid; hex	2200		5.22		
767	Chromium boride (Cr <sub>3</sub> B)	Cr <sub>3</sub> B	12006-80-3	114.803	refrac solid	1875				
768	Chromium boride (Cr <sub>5</sub> B <sub>3</sub> )	Cr <sub>5</sub> B <sub>3</sub>	12007-38-4	292.414	tetr cry	1900		6.10		
769	Chromium carbide	Cr <sub>3</sub> C <sub>2</sub>	12012-35-0	180.009	gray orth cry	1895		6.68		
770	Chromium carbonyl	Cr(CO) <sub>5</sub>	13007-92-6	220.056	col orth cry	130 dec	subl	1.77		i H <sub>2</sub> O, EtOH; s eth, chl
771	Chromium nitride (CrN)	CrN	24094-93-7	66.003	gray cub cry	1080 dec		5.9		
772	Chromium nitride (Cr <sub>2</sub> N)	Cr <sub>2</sub> N	12053-27-9	117.999	hex cry	1650		6.8		
773	Chromium phosphide	CrP	26342-61-0	82.970	orth cry			5.25		
774	Chromium selenide	CrSe	12053-13-3	130.96	hex cry	≈1500		6.1		
775	Chromium silicide (CrSi <sub>2</sub> )	CrSi <sub>2</sub>	12018-09-6	108.167	gray hex cry	1490		4.91		
776	Chromium silicide (Cr <sub>3</sub> Si)	Cr <sub>3</sub> Si	12018-36-9	184.074	cub cry	1770		6.4		
777	Chromium(II) acetate monohydrate	Cr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	628-52-4*	188.100	red monocl cry			1.79		sl H <sub>2</sub> O
778	Chromium(II) bromide	CrBr <sub>2</sub>	10049-25-9	211.804	wh monocl cry; aq soln blue	842		4.236		s H <sub>2</sub> O, EtOH
779	Chromium(II) chloride	CrCl <sub>2</sub>	10049-05-5	122.902	wh hyg needles; aq soln blue	824	1120	2.88		s H <sub>2</sub> O
780	Chromium(II) chloride tetrahydrate	Cr(H <sub>2</sub> O) <sub>4</sub> Cl <sub>2</sub> · 4H <sub>2</sub> O	13931-94-7	267.024	blue hyg cry	51 dec				s H <sub>2</sub> O
781	Chromium(II) fluoride	CrF <sub>2</sub>	10049-10-2	89.993	blue-grn monocl cry	894		3.79		sl H <sub>2</sub> O; i EtOH
782	Chromium(II) formate monohydrate	Cr(CHOO) <sub>2</sub> · H <sub>2</sub> O	4493-37-2	160.046	red needles					s H <sub>2</sub> O
783	Chromium(II) iodide	CrI <sub>2</sub>	13478-28-9	305.805	red-brn cry; hyg	867		5.1		s H <sub>2</sub> O
784	Chromium(II) oxalate monohydrate	CrC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	814-90-4*	158.030	yel-grn powder			2.468		sl H <sub>2</sub> O
785	Chromium(II) sulfate pentahydrate	CrSO <sub>4</sub> · 5H <sub>2</sub> O	13825-86-0	238.135	blue cry				21°	s dil acid; sl EtOH; i ace
786	Chromium(II,III) oxide	Cr <sub>3</sub> O <sub>4</sub>	12018-34-7	219.986	cub cry			6.1		
787	Chromium(III) acetate	Cr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	1066-30-4	229.127	blue-grn pwd					sl H <sub>2</sub> O
788	Chromium(III) acetate monohydrate	Cr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · H <sub>2</sub> O	25013-82-5	247.143	gray-grn pow					sl H <sub>2</sub> O; i EtOH
789	Chromium(III) acetate hexahydrate	Cr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	1066-30-4*	337.220	blue needles					s H <sub>2</sub> O
790	Chromium(III) acetate hydroxide	Cr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> (OH)	39430-51-8	187.092	viol cry pow					vs H <sub>2</sub> O
791	Chromium(III) bromide	CrBr <sub>3</sub>	10031-25-1	291.708	dark grn hex cry	812		4.68		s hot H <sub>2</sub> O, bz
792	Chromium(III) bromide hexahydrate (α)	CrBr <sub>3</sub> (H <sub>2</sub> O) <sub>4</sub> · 2H <sub>2</sub> O	18721-05-6	399.799	grn hyg cry					s H <sub>2</sub> O, EtOH
793	Chromium(III) bromide hexahydrate (β)	Cr(H <sub>2</sub> O) <sub>6</sub> Br <sub>3</sub>	10031-25-1*	399.799	viol hyg cry					s H <sub>2</sub> O; i EtOH, eth
794	Chromium(III) chloride	CrCl <sub>3</sub>	10025-73-7	158.355	red-viol cry	1152	1300 dec	2.76		sl H <sub>2</sub> O
795	Chromium(III) chloride hexahydrate	[CrCl <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub> ]Cl · 2H <sub>2</sub> O	10060-12-5	266.446	grn monocl cry; hyg					s H <sub>2</sub> O, EtOH; sl ace; i eth
796	Chromium(III) fluoride	CrF <sub>3</sub>	7788-97-8	108.991	grn needles	1425		3.8		i H <sub>2</sub> O, EtOH
797	Chromium(III) fluoride trihydrate	CrF <sub>3</sub> · 3H <sub>2</sub> O	16671-27-5	163.037	grn hex cry			2.2		sl H <sub>2</sub> O
798	Chromium(III) hydroxide sulfate	Cr(OH)SO <sub>4</sub>	12336-95-7	165.066	grn cry					
799	Chromium(III) fluoride nonahydrate	Cr(H <sub>2</sub> O) <sub>9</sub> F <sub>3</sub> · 3H <sub>2</sub> O	102430-09-1	271.129	rhomb viol cry					sl H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
800	Chromium(III) hydroxide trihydrate	Cr(OH) <sub>3</sub> · 3H <sub>2</sub> O	1308-14-1	157.063	blue-grn powder					i H <sub>2</sub> O; s acid
801	Chromium(III) iodide	CrI <sub>3</sub>	13569-75-0	432.709	dark grn hex cry	500 dec		5.32		sl H <sub>2</sub> O
802	Chromium(III) nitrate	Cr(NO <sub>3</sub> ) <sub>3</sub>	13548-38-4	238.011	grn hyg powder	>60 dec				vs H <sub>2</sub> O
803	Chromium(III) nitrate nonahydrate	Cr(NO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	7789-02-8	400.148	grn-blk monocl cry	66.3	>100 dec	1.80		vs H <sub>2</sub> O
804	Chromium(III) oxide	Cr <sub>2</sub> O <sub>3</sub>	1308-38-9	151.990	grn hex cry	2320	≈3000	5.22		i H <sub>2</sub> O, EtOH; sl acid, alk
805	Chromium(III) 2,4-pentanedioate	Cr(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	21679-31-2	349.320	red monocl cry	208	345	1.34		i H <sub>2</sub> O; s bz
806	Chromium(III) perchlorate	Cr(ClO <sub>4</sub> ) <sub>3</sub>	27535-70-2	350.348	grn-blue cry				58 <sup>25</sup>	vs H <sub>2</sub> O
807	Chromium(III) phosphate	CrPO <sub>4</sub>	7789-04-0	146.967	blue orth cry	>1800		4.6		i H <sub>2</sub> O, acid, aqua regia
808	Chromium(III) phosphate hemiheptahydrate	CrPO <sub>4</sub> · 3.5H <sub>2</sub> O	84359-31-9	210.021	blue-grn powder			2.15		i H <sub>2</sub> O; s acid
809	Chromium(III) phosphate hexahydrate	CrPO <sub>4</sub> · 6H <sub>2</sub> O	84359-31-9	255.059	viol cry	>500 dec		2.121		i H <sub>2</sub> O; s acid, alk
810	Chromium(III) potassium oxalate trihydrate	K <sub>3</sub> Cr(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	15275-09-9	487.394	blue-grn monocl cry					s H <sub>2</sub> O
811	Chromium(III) potassium sulfate dodecahydrate	CrK(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7788-99-0	499.403	viol-blk cub cry	89 dec		1.83		s H <sub>2</sub> O; i EtOH
812	Chromium(III) sulfate	Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10101-53-8	392.180	red pow	dec >700		3.1	64 <sup>25</sup>	s H <sub>2</sub> O; vs acid
813	Chromium(III) sulfate octadecahydrate	Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 18H <sub>2</sub> O	10101-53-8*	716.455	viol cry	dec 115		1.7		reac H <sub>2</sub> O
814	Chromium(III) sulfide	Cr <sub>2</sub> S <sub>3</sub>	12018-22-3	200.187	brn-blk hex cry			3.8		
815	Chromium(III) telluride	Cr <sub>2</sub> Te <sub>3</sub>	12053-39-3	486.79	hex cry	≈1300		7.0		
816	Chromium(IV) chloride	CrCl <sub>4</sub>	15597-88-3	193.808	gas, stable at HT		>600 dec	7.922 g/L		
817	Chromium(IV) fluoride	CrF <sub>4</sub>	10049-11-3	127.990	grn cry	277		2.89		reac H <sub>2</sub> O
818	Chromium(IV) oxide	CrO <sub>2</sub>	12018-01-8	83.995	brn-blk tetr powder	≈400 dec		4.89		i H <sub>2</sub> O; s acid
819	Chromium(V) fluoride	CrF <sub>5</sub>	14884-42-5	146.988	red orth cry	34	117			reac H <sub>2</sub> O
820	Chromium(V) oxide	Cr <sub>2</sub> O <sub>5</sub>	12218-36-9	183.989	blk needles	dec 200				
821	Chromium(VI) fluoride	CrF <sub>6</sub>	13843-28-2	165.986	yel solid; stable at low temp	-100 dec				
822	Chromium(VI) oxide	CrO <sub>3</sub>	1333-82-0	99.994	red orth cry	197	≈250 dec	2.7	169 <sup>25</sup>	
823	Chromium(VI) tetrafluoride oxide	CrOF <sub>4</sub>	23276-90-6	143.989	dark red solid	55				reac H <sub>2</sub> O, ace, dmsO
824	Chromium(VI) dichloride dioxide	CrO <sub>2</sub> Cl <sub>2</sub>	14977-61-8	154.901	red liq	-96.5	117	1.91		reac H <sub>2</sub> O; s ctc, chl, bz
825	Chromium(VI) difluoride dioxide	CrO <sub>2</sub> F <sub>2</sub>	7788-96-7	121.992	red-viol cry	30	subl			reac H <sub>2</sub> O
826	Cobalt	Co	7440-48-4	58.933	gray metal; hex or cub	1495	2927	8.86		s dil acid
827	Cobaltocene	Co(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	1277-43-6	189.119	blk-purp cry	173				
828	Cobalt antimonide	CoSb	12052-42-5	180.693	hex cry	1202		8.8		
829	Cobalt arsenic sulfide	CoAsS	12254-82-9	165.920	silv-wh solid			≈6.1		
830	Cobalt arsenide (CoAs)	CoAs	27016-73-5	133.855	orth cry	1180		8.22		
831	Cobalt arsenide (CoAs <sub>2</sub> )	CoAs <sub>2</sub>	12044-42-7	208.776	monocl cry			7.2		
832	Cobalt arsenide (CoAs <sub>3</sub> )	CoAs <sub>3</sub>	12256-04-1	283.698	cub cry	942		6.84		
833	Cobalt boride (CoB)	CoB	12006-77-8	69.744	refrac solid	1460		7.25		reac H <sub>2</sub> O, HNO <sub>3</sub>
834	Cobalt boride (Co <sub>2</sub> B)	Co <sub>2</sub> B	12045-01-1	128.677	refrac solid	1280		8.1		
835	Cobalt carbonyl	Co <sub>2</sub> (CO) <sub>8</sub>	10210-68-1	341.947	oran cry	51 dec		1.78		i H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
836	Cobalt disulfide	CoS <sub>2</sub>	12013-10-4	123.063	cub cry			4.3		
837	Cobalt dodecacarbonyl	Co <sub>4</sub> (CO) <sub>12</sub>	17786-31-1	571.854	blk cry	60 dec		2.09		
838	Cobalt phosphide	Co <sub>3</sub> P	12134-02-0	148.840	gray needles	1386		6.4		i H <sub>2</sub> O; s HNO <sub>3</sub>
839	Cobalt silicide	CoSi <sub>2</sub>	12017-12-8	115.104	gray cub cry	1326		4.9		s hot HCl
840	Cobalt(II) acetate	Co(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	71-48-7	177.022	pink cry					vs H <sub>2</sub> O; s EtOH
841	Cobalt(II) acetate tetrahydrate	Co(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	6147-53-1	249.082	red monocl cry			1.705		s H <sub>2</sub> O, EtOH, dil acid
842	Cobalt(II) aluminate	CoAl <sub>2</sub> O <sub>4</sub>	13820-62-7	176.894	blue cub cry			4.37		i H <sub>2</sub> O
843	Cobalt(II) arsenate octahydrate	Co <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	24719-19-5	598.760	red monocl needles	400 dec	1000 dec	3.0		i H <sub>2</sub> O; s dil acid
844	Cobalt(II) bromate hexahydrate	Co(BrO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13476-01-2	422.829	viol cry			≈2.5		vs H <sub>2</sub> O
845	Cobalt(II) bromide	CoBr <sub>2</sub>	7789-43-7	218.741	grn hex cry; hyg	678		4.91	113.2 <sup>20</sup>	s MeOH, EtOH, ace
846	Cobalt(II) bromide hexahydrate	CoBr <sub>2</sub> · 6H <sub>2</sub> O	13762-12-4	326.832	red hyg cry	47 dec	100 dec	2.46	113.2	
847	Cobalt(II) carbonate	CoCO <sub>3</sub>	513-79-1	118.942	pink rhomb cry	dec 280		4.2	0.00014 <sup>20</sup>	i EtOH
848	Cobalt(II) basic carbonate	2CoCO <sub>3</sub> · 3Co(OH) <sub>2</sub> · H <sub>2</sub> O	7542-09-8	534.743	red-viol cry	dec				i H <sub>2</sub> O; s acid
849	Cobalt(II) chlorate hexahydrate	Co(ClO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O		333.927	dark red hyg cry	dec 61				s H <sub>2</sub> O
850	Cobalt(II) chloride	CoCl <sub>2</sub>	7646-79-9	129.839	blue hyg leaflets	737	1049	3.36	56.2 <sup>25</sup>	s EtOH, eth, ace, py
851	Cobalt(II) chloride dihydrate	CoCl <sub>2</sub> · 2H <sub>2</sub> O	16544-92-6	165.870	viol-blue cry			2.477	56.2 <sup>25</sup>	

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
852	Cobalt(II) chloride hexahydrate	CoCl <sub>2</sub> · 6H <sub>2</sub> O	7791-13-1	237.930	pink-red monocl cry	87 dec		1.924	56.2 <sup>25</sup>	s EtOH, ace, eth
853	Cobalt(II) chromate	CoCrO <sub>4</sub>	24613-38-5	174.927	yel-brn orth cry			≈4.0		i H <sub>2</sub> O; s acid
854	Cobalt(II) chromite	CoCr <sub>2</sub> O <sub>4</sub>	13455-25-9	226.923	blue-grn cub cry			5.14		i H <sub>2</sub> O, conc acid
855	Cobalt(II) citrate dihydrate	Co <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	18727-04-3	265.170	rose red cry	dec 150			0.8 <sup>15</sup>	
856	Cobalt(II) cyanide	Co(CN) <sub>2</sub>	542-84-7	110.967	blue hyg cry			1.872		i H <sub>2</sub> O
857	Cobalt(II) cyanide dihydrate	Co(CN) <sub>2</sub> · 2H <sub>2</sub> O	20427-11-6	146.998	pink-brn needles					i H <sub>2</sub> O, acid
858	Cobalt(II) diiron tetroxide	CoFe <sub>2</sub> O <sub>4</sub>	12052-28-7	234.621	blk solid					s hot HCl
859	Cobalt(II) ferricyanide	Co <sub>3</sub> [Fe(CN) <sub>6</sub> ] <sub>2</sub>	14049-81-1	600.698	red needles					i H <sub>2</sub> O, HCl; s NH <sub>4</sub> OH
860	Cobalt(II) fluoride	CoF <sub>2</sub>	10026-17-2	96.930	red tetr cry	1127	≈1400	4.46	1.4 <sup>25</sup>	s acid
861	Cobalt(II) fluoride tetrahydrate	CoF <sub>2</sub> · 4H <sub>2</sub> O	13817-37-3	168.992	red orth cry	dec		2.22	1.4 <sup>25</sup>	
862	Cobalt(II) formate dihydrate	Co(CHO <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	6424-20-0	184.998	red cry powder	140 dec		2.13	5.03 <sup>20</sup>	i EtOH
863	Cobalt(II) hexafluoro-2,4-pentanedioate	Co(CF <sub>3</sub> COCHCOCF <sub>3</sub> ) <sub>2</sub>	19648-83-0	473.035	powder	197				
864	Cobalt(II) hexafluorosilicate hexahydrate	CoSiF <sub>6</sub> · 6H <sub>2</sub> O	12021-68-0	309.100	pale red cry			2.087	76.8 <sup>22</sup>	
865	Cobalt(II) hydroxide	Co(OH) <sub>2</sub>	21041-93-0	92.948	blue-grn cry	≈160 dec		3.60		sl H <sub>2</sub> O; s acid
866	Cobalt(II) hydroxide monohydrate	Co(OH) <sub>2</sub> · H <sub>2</sub> O	35340-84-2	110.963	blue solid	136 dec				
867	Cobalt(II) iodate	Co(IO <sub>3</sub> ) <sub>2</sub>	13455-28-2	408.738	blk-viol needles	200 dec		5.09	0.46 <sup>20</sup>	
868	Cobalt(II) iodide	CoI <sub>2</sub>	15238-00-3	312.742	blk hex cry; hyg	520		5.60	203 <sup>25</sup>	
869	Cobalt(II) iodide dihydrate	CoI <sub>2</sub> · 2H <sub>2</sub> O	13455-29-3	348.773	hyg grn cry	dec 100				
870	Cobalt(II) iodide hexahydrate	CoI <sub>2</sub> · 6H <sub>2</sub> O	15238-00-3*	420.833	red hex prisms	130 dec		2.90	203 <sup>25</sup>	s EtOH, eth, ace
871	Cobalt(II) molybdate	CoMoO <sub>4</sub>	13762-14-6	218.87	blk monocl cry	1040		4.7		
872	Cobalt(II) molybdate monohydrate	CoMoO <sub>4</sub> · H <sub>2</sub> O	18601-87-1	236.89	blk pow					
873	Cobalt(II) nitrate	Co(NO <sub>3</sub> ) <sub>2</sub>	10141-05-6	182.942	pale red powder	100 dec		2.49	103 <sup>25</sup>	
874	Cobalt(II) nitrate hexahydrate	Co(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10026-22-9	291.034	red monocl cry; hyg	≈55		1.88	103 <sup>25</sup>	s EtOH
875	Cobalt(II) nitrite	Co(NO <sub>2</sub> ) <sub>2</sub>	18488-96-5	150.944					0.49 <sup>25</sup>	
876	Cobalt(II) oleate	Co(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	14666-94-5	621.840	brn amorp pow					i H <sub>2</sub> O; s EtOH, eth
877	Cobalt(II) orthosilicate	Co <sub>2</sub> SiO <sub>4</sub>	12017-08-2	209.950	red-viol orth cry	1345		4.63		i H <sub>2</sub> O; s dil HCl
878	Cobalt(II) oxalate	CoC <sub>2</sub> O <sub>4</sub>	814-89-1	146.952	pink powder	250 dec		3.02	0.0037 <sup>20</sup>	s acid, NH <sub>4</sub> OH
879	Cobalt(II) oxalate dihydrate	CoC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	5965-38-8	182.982	pink needles	dec			0.0037	sl acid; s NH <sub>4</sub> OH
880	Cobalt(II) oxide	CoO	1307-96-6	74.932	gray cub cry	1830		6.44		i H <sub>2</sub> O; s acid
881	Cobalt(II) 2,4-pentanedioate	Co(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14024-48-7	257.149	bl-viol cry	167				
882	Cobalt(II) perchlorate	Co(ClO <sub>4</sub> ) <sub>2</sub>	13455-31-7	257.834	red needles			3.33	113 <sup>25</sup>	i EtOH, ace
883	Cobalt(II) perchlorate hexahydrate	Co(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13478-33-6	365.926	dark red cry	dec 170		3.33		vs H <sub>2</sub> O
884	Cobalt(II) phosphate octahydrate	Co <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	10294-50-5	510.865	pink amorp powder			2.77		i H <sub>2</sub> O; s acid
885	Cobalt(II) potassium sulfate hexahydrate	CoK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10026-20-7	437.347	red monocl cry	75 dec		2.22		vs H <sub>2</sub> O
886	Cobalt(II) selenate pentahydrate	CoSeO <sub>4</sub> · 5H <sub>2</sub> O	14590-19-3	291.97	red tricr cry	dec		2.51	55 <sup>15</sup>	
887	Cobalt(II) selenide	CoSe	1307-99-9	137.89	yel hex cry	1055		7.65		i H <sub>2</sub> O, alk; s aqua regia
888	Cobalt(II) selenite dihydrate	CoSeO <sub>3</sub> · 2H <sub>2</sub> O	19034-13-0	221.92	blue-red powder					i H <sub>2</sub> O
889	Cobalt(II) stannate	Co <sub>2</sub> SnO <sub>4</sub>	12139-93-4	300.574	grn-blue cub cry			6.30		i H <sub>2</sub> O; s alk
890	Cobalt(II) stearate	Co(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	1002-88-6	625.872	purp solid	74		1.13		
891	Cobalt(II) sulfate	CoSO <sub>4</sub>	10124-43-3	154.996	red orth cry	>700		3.71	38.3 <sup>25</sup>	
892	Cobalt(II) sulfate monohydrate	CoSO <sub>4</sub> · H <sub>2</sub> O	13455-34-0	173.011	red monocl cry			3.08	38.3 <sup>25</sup>	
893	Cobalt(II) sulfate heptahydrate	CoSO <sub>4</sub> · 7H <sub>2</sub> O	10026-24-1	281.102	pink monocl cry	41 dec		2.03	38.3 <sup>25</sup>	sl EtOH, MeOH
894	Cobalt(II) sulfide	CoS	1317-42-6	90.998	blk amorp powder	1117		5.45		i H <sub>2</sub> O; s acid
895	Cobalt(II) telluride	CoTe	12017-13-9	186.53	hex cry			≈8.8		
896	Cobalt(II) thiocyanate	Co(SCN) <sub>2</sub>	3017-60-5	175.097	yel-brn powder				103 <sup>25</sup>	s EtOH, MeOH, ace, eth
897	Cobalt(II) thiocyanate trihydrate	Co(SCN) <sub>2</sub> · 3H <sub>2</sub> O	97126-35-7	229.143	viol rhomb cry				103 <sup>25</sup>	s EtOH, eth, ace
898	Cobalt(II) titanate	CoTiO <sub>3</sub>	12017-01-5	154.798	grn rhomb cry			5.0		
899	Cobalt(II) tungstate	CoWO <sub>4</sub>	12640-47-0	306.77	blue monocl cry			≈7.8		i H <sub>2</sub> O; s hot conc acid
900	Cobalt(II,III) oxide	Co <sub>2</sub> O <sub>4</sub>	1308-06-1	240.798	blk cub cry	900 dec		6.11		i H <sub>2</sub> O; s acid, alk
901	Cobalt(III) acetate	Co(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	917-69-1	236.064	grn hyg cry	100 dec				s H <sub>2</sub> O, EtOH
902	Cobalt(III) ammonium tetranitrodiammine	NH <sub>4</sub> [Co(NH <sub>3</sub> ) <sub>2</sub> (NO <sub>2</sub> ) <sub>4</sub> ]	13600-89-0	295.054	red-brn orth cry			1.97		s H <sub>2</sub> O
903	Cobalt(III) fluoride	CoF <sub>3</sub>	10026-18-3	115.928	brn hex cry	927		3.88		reac H <sub>2</sub> O; s EtOH, eth, bz
904	Cobalt(III) fluoride dihydrate	CoF <sub>3</sub> · 2H <sub>2</sub> O	54496-71-8	267.887	red rhomb cry			2.19		s H <sub>2</sub> O; i EtOH
905	Cobalt(III) hexammine chloride	Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	10534-89-1	267.475	red monocl cry			1.71		s H <sub>2</sub> O; i EtOH
906	Cobalt(III) hydroxide	Co(OH) <sub>3</sub>	1307-86-4	109.955	brn powder	dec		≈4		i H <sub>2</sub> O; s acid
907	Cobalt(III) nitrate	Co(NO <sub>3</sub> ) <sub>3</sub>	15520-84-0	244.948	grn cub cry; hyg			≈3.0		s H <sub>2</sub> O; reac os
908	Cobalt(III) oxide	Co <sub>2</sub> O <sub>3</sub>	1308-04-9	165.864	gray-blk powder	895 dec		5.18		i H <sub>2</sub> O; s conc acid



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
909	Cobalt(III) oxide monohydrate	Co <sub>2</sub> O <sub>3</sub> · H <sub>2</sub> O	12016-80-7	183.880	brn-blk hex cry	150 dec				i H <sub>2</sub> O; s acid
910	Cobalt(III) 2,4-pentanedioate	Co(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	21679-46-9	356.257	dark grn cry	213				s bz, ace
911	Cobalt(III) potassium nitrite sesquihydrate	CoK <sub>3</sub> (NO <sub>2</sub> ) <sub>6</sub> · 1.5H <sub>2</sub> O	13782-01-9*	479.284	yel cub cry			2.6		sl H <sub>2</sub> O; reac acid; i EtOH
912	Cobalt(III) sulfide	Co <sub>2</sub> S <sub>3</sub>	1332-71-4	214.061	blk cub cry			4.8		reac acid
913	Cobalt(III) titanate	Co <sub>2</sub> TiO <sub>4</sub>	12017-38-8	229.731	grn-blk cub cry			5.1		s conc HCl
914	Copper	Cu	7440-50-8	63.546	red metal; cub	1084.62	2562	8.96		sl dil acid
915	Copper arsenide	Cu <sub>3</sub> As	12005-75-3	265.560	dark gray solid	827				
916	Copper nitride	Cu <sub>3</sub> N	1308-80-1	204.645	cub cry	300 dec		5.84		
917	Copper phosphide	Cu <sub>3</sub> P <sub>2</sub>	12019-11-3	125.494	monocl cry	≈900		4.20		
918	Copper silicide	Cu <sub>3</sub> Si	12159-07-8	345.816	solid	825				
919	Copper(I) acetate	Cu <sub>2</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	598-54-9	122.590	col cry	dec	subl			reac H <sub>2</sub> O
920	Copper(I) acetylacetyl	Cu <sub>2</sub> C <sub>2</sub>	1117-94-8	151.113	red amorp powder; exp					
921	Copper(I) azide	CuN <sub>3</sub>	14336-80-2	105.566	tetr cry; exp					
922	Copper(I) bromide	CuBr	7787-70-4	143.450	wh cub cry; hyg	483	1345	4.98	0.0012 <sup>20</sup>	i ace
923	Copper(I) chloride	CuCl	7758-89-6	98.999	wh cub cry	423	1490	4.14	0.0047 <sup>20</sup>	i EtOH, ace
924	Copper(I) cyanide	CuCN	544-92-3	89.564	wh powder or grn orth cry	474	dec	2.9		i H <sub>2</sub> O, EtOH; s KCN soln
925	Copper(I) fluoride	CuF	13478-41-6	82.544	cub cry			7.1		
926	Copper(I) hydride	CuH	13517-00-5	64.554	red-brn solid	60 dec				
927	Copper(I) iodide	CuI	7681-65-4	190.450	wh cub cry	591	≈1290	5.67	0.000020 <sup>20</sup>	i dil acid
928	Copper(I) mercury iodide	Cu <sub>2</sub> HgI <sub>4</sub>	13876-85-2	835.30	red cry powder	trans =60 (brn)				i H <sub>2</sub> O, EtOH
929	Copper(I) oxide	Cu <sub>2</sub> O	1317-39-1	143.091	red-brn cub cry	1244	1800 dec	6.0		i H <sub>2</sub> O
930	Copper(I) selenide	Cu <sub>2</sub> Se	20405-64-5	206.05	blue-blk tetr cry	1113		6.84		i H <sub>2</sub> O; s acid
931	Copper(I) sulfide	Cu <sub>2</sub> S	22205-45-4	159.157	blue-blk orth cry	1129		5.6		i H <sub>2</sub> O; sl acid
932	Copper(I) sulfite hemihydrate	Cu <sub>2</sub> SO <sub>3</sub> · 0.5H <sub>2</sub> O	13982-53-1*	216.164	wh-yel hex cry					sl H <sub>2</sub> O; s acid, alk; i EtOH, eth
933	Copper(I) sulfite monohydrate	Cu <sub>2</sub> SO <sub>3</sub> · H <sub>2</sub> O	35788-00-2	225.171	cry			3.83		sl H <sub>2</sub> O; s HCl
934	Copper(I) telluride	Cu <sub>2</sub> Te	12019-52-2	254.69	blue hex cry	1127		4.6		
935	Copper(I) thiocyanate	CuSCN	1111-67-7	121.629	wh-yel amorp powder	1084		2.85		i H <sub>2</sub> O, dil acid, EtOH, ace; s eth
936	Copper(II) sulfite dihydrate	Cu <sub>2</sub> SO <sub>3</sub> · CuSO <sub>3</sub> · 2H <sub>2</sub> O	13814-81-8	386.795	red prisms or powder					i H <sub>2</sub> O, EtOH; s HCl
937	Copper(II) acetate	Cu(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	142-71-2	181.635	blue-grn hyg powder					
938	Copper(II) acetate monohydrate	Cu(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	6046-93-1	199.650	grn monocl cry	115	240 dec	1.88		s H <sub>2</sub> O, EtOH; sl eth
939	Copper(II) acetate metaarsenite	Cu(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 3Cu(AsO <sub>2</sub> ) <sub>2</sub>	12002-03-8	1013.795	grn cry powder					i H <sub>2</sub> O; reac acid
940	Copper(II) basic acetate	Cu(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · CuO · 6H <sub>2</sub> O	52503-64-7	369.271	blue-grn cry or powder					sl H <sub>2</sub> O, EtOH; s dil acid, NH <sub>4</sub> OH
941	Copper(II) acetylacetyl	CuC <sub>2</sub>	12540-13-5	87.567	brn-blk solid; exp	exp 100				
942	Copper(II) arsenate	Cu <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	7778-41-8	468.476	blue-grn cry					i H <sub>2</sub> O, EtOH; s dil acid
943	Copper(II) arsenite	CuHAsO <sub>3</sub>	10290-12-7	187.474	yel-grn powder					i H <sub>2</sub> O, EtOH; s acid
944	Copper(II) azide	Cu(N <sub>3</sub> ) <sub>2</sub>	14215-30-6	147.586	brn orth cry; exp			≈2.6		
945	Copper(II) borate	Cu(BO <sub>2</sub> ) <sub>2</sub>	39290-85-2	149.166	blue-grn powder			3.859		i H <sub>2</sub> O; s acid
946	Copper(II) bromide	CuBr <sub>2</sub>	7789-45-9	223.354	blk monocl cry; hyg	498	900	4.710	126 <sup>25</sup>	vs H <sub>2</sub> O; s EtOH, ace; i bz, eth
947	Copper(II) butanoate monohydrate	Cu(C <sub>4</sub> H <sub>7</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	540-16-9	255.756	grn monocl plates					s H <sub>2</sub> O, diox, bz; sl EtOH
948	Copper(II) carbonate	CuCO <sub>3</sub>	1184-64-1	123.555	cry					i H <sub>2</sub> O
949	Copper(II) carbonate hydroxide	CuCO <sub>3</sub> · Cu(OH) <sub>2</sub>	12069-69-1	221.116	grn monocl cry	200 dec		4.0		i H <sub>2</sub> O, EtOH; s dil acid
950	Copper(II) chlorate hexahydrate	Cu(ClO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	14721-21-2	338.540	blue-grn hyg cry	65	100 dec		164 <sup>18</sup>	vs EtOH
951	Copper(II) chloride	CuCl <sub>2</sub>	7447-39-4	134.452	yel-brn monocl cry; hyg	598	993	3.4	75.7 <sup>25</sup>	s EtOH, ace
952	Copper(II) chloride dihydrate	CuCl <sub>2</sub> · 2H <sub>2</sub> O	10125-13-0	170.483	grn-blue orth cry; hyg	100 dec		2.51	75.7 <sup>20</sup>	vs EtOH, MeOH; s ace; i eth
953	Copper(II) chloride hydroxide	Cu <sub>2</sub> (OH) <sub>2</sub> Cl	1332-65-6	213.567	pale grn cry					i H <sub>2</sub> O; s acid
954	Copper(II) chromate	CuCrO <sub>4</sub>	13548-42-0	179.540	red-brn cry					i H <sub>2</sub> O; s EtOH
955	Copper(II) basic chromate	CuCrO <sub>4</sub> · 2Cu(OH) <sub>2</sub>	12433-14-6	374.661	brn pow	dec 260				i H <sub>2</sub> O; s HNO <sub>3</sub>
956	Copper(II) chromite	CuCr <sub>2</sub> O <sub>4</sub>	12018-10-9	231.536	gray-blk tetr cry			5.4		i H <sub>2</sub> O, dil acid
957	Copper(II) citrate hemipentahydrate	Cu <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · 2.5H <sub>2</sub> O	10402-15-0	360.221	blue-grn cry	100 dec				sl H <sub>2</sub> O; s dil acid
958	Copper(II) cyanide	Cu(CN) <sub>2</sub>	14763-77-0	115.580	grn powder					i H <sub>2</sub> O; s acid, alk
959	Copper(II) cyclohexanecarboxylate	Cu(C <sub>10</sub> H <sub>17</sub> O <sub>2</sub> ) <sub>2</sub>	2218-80-6	402.028	powder	126 dec				
960	Copper(II) dichromate dihydrate	CuCr <sub>2</sub> O <sub>7</sub> · 2H <sub>2</sub> O	13675-47-3	315.565	red-brn tricl cry			2.286		vs H <sub>2</sub> O
961	Copper(II) ethanolate	Cu(C <sub>2</sub> H <sub>5</sub> O) <sub>2</sub>	2850-65-9	153.667	blue hyg solid	120 dec				i os
962	Copper(II) ethylacetoacetate	Cu(C <sub>2</sub> H <sub>3</sub> CO <sub>2</sub> CHCOCH <sub>3</sub> ) <sub>2</sub>	14284-06-1	321.813	grn cry	192				s EtOH, chl

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
963	Copper(II) 2-ethylhexanoate	Cu(C <sub>8</sub> H <sub>15</sub> O <sub>2</sub> ) <sub>2</sub>	149-11-1	349.953	powder	252 dec				
964	Copper(II) ferrate	CuFe <sub>2</sub> O <sub>4</sub>	12018-79-0	239.234	blk cry					
965	Copper(II) ferrocyanide	Cu <sub>2</sub> Fe(CN) <sub>6</sub>	13601-13-3	339.041	red-br cub cry or powder			2.2		i H <sub>2</sub> O, acid, os
966	Copper(II) ferrous sulfide	CuFeS <sub>2</sub>	1308-56-1	183.521	yel tetr cry	950		4.2		i H <sub>2</sub> O, HCl; s HNO <sub>3</sub>
967	Copper(II) fluoride	CuF <sub>2</sub>	7789-19-7	101.543	wh monocl cry	836	1676	4.23	0.075 <sup>25</sup>	
968	Copper(II) fluoride dihydrate	CuF <sub>2</sub> · 2H <sub>2</sub> O	13454-88-1	137.574	blue monocl cry	130 dec		2.934	0.075 <sup>25</sup>	
969	Copper(II) formate	Cu(CHO <sub>2</sub> ) <sub>2</sub>	544-19-4	153.581	blue cry				12.5 <sup>20</sup>	i os
970	Copper(II) formate tetrahydrate	Cu(CHO <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	5893-61-8	225.641	blue monocl cry				12.5	sl EtOH; i os
971	Copper(II) gluconate	CuC <sub>12</sub> H <sub>22</sub> O <sub>14</sub>	527-09-3	453.841	bl-grn cry	156				sl EtOH; i os
972	Copper(II) hexafluoro-2,4-pentanedioate	Cu(CF <sub>3</sub> COCHCOCF <sub>3</sub> ) <sub>2</sub>	14781-45-4	477.648	cry	98	220 dec			s MeOH, ace, tol
973	Copper(II) hexafluorosilicate tetrahydrate	CuSiF <sub>6</sub> · 4H <sub>2</sub> O	12062-24-7	277.684	blue monocl cry	dec		2.56	99.7 <sup>17</sup>	sl EtOH
974	Copper(II) hydroxide	Cu(OH) <sub>2</sub>	20427-59-2	97.561	blue-grn powder			3.37		i H <sub>2</sub> O; s acid, conc alk
975	Copper(II) iodate	Cu(IO <sub>3</sub> ) <sub>2</sub>	13454-89-2	413.351	grn monocl cry	dec		5.241	0.15 <sup>20</sup>	s dil acid
976	Copper(II) iodate monohydrate	Cu(IO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	13454-90-5	431.367	blue tricl cry	248 dec		4.872	0.15 <sup>20</sup>	s dil H <sub>2</sub> SO <sub>4</sub>
977	Copper(II) molybdate	CuMoO <sub>4</sub>	13767-34-5	223.48	grn cry	≈500		3.4	0.038	
978	Copper(II) nitrate	Cu(NO <sub>3</sub> ) <sub>2</sub>	3251-23-8	187.555	blue-grn orth cry; hyg	255	subl		145 <sup>25</sup>	s diox; reac eth
979	Copper(II) nitrate trihydrate	Cu(NO <sub>3</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	10031-43-3	241.602	blue rhomb cry	114	170 dec	2.32	145 <sup>25</sup>	vs EtOH
980	Copper(II) nitrate hexahydrate	Cu(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13478-38-1	295.647	blue rhomb cry; hyg			2.07	145 <sup>25</sup>	s EtOH
981	Copper(II) oleate	Cu(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	1120-44-1	626.453	blue-grn solid					i H <sub>2</sub> O; sl EtOH; s eth
982	Copper(II) oxalate	CuC <sub>2</sub> O <sub>4</sub>	814-91-5	151.565	blue-wh powder	310 dec			0.0026 <sup>20</sup>	i EtOH, eth; s NH <sub>4</sub> OH
983	Copper(II) oxalate hemihydrate	CuC <sub>2</sub> O <sub>4</sub> · 0.5H <sub>2</sub> O	814-91-5*	144.573	blue-wh cry	200 dec			0.0026 <sup>20</sup>	s NH <sub>4</sub> OH
984	Copper(II) oxide	CuO	1317-38-0	79.545	blk powder or monocl cry	1227		6.31		i H <sub>2</sub> O, EtOH; s dil acid
985	Copper(II) 2,4-pentanedioate	Cu(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	13395-16-9	261.762	blue powder	284 dec	subl			sl H <sub>2</sub> O; s chl
986	Copper(II) oxychloride hemiheptahydrate	CuCl <sub>2</sub> · 3CuO · 3.5H <sub>2</sub> O	1332-40-7		blue-grn pow	dec 140				i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
987	Copper(II) perchlorate	Cu(ClO <sub>4</sub> ) <sub>2</sub>	13770-18-8	262.447	grn hyg cry	130 dec			146 <sup>30</sup>	s eth, diox; i bz, ctc
988	Copper(II) perchlorate hexahydrate	Cu(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10294-46-9	370.539	blue monocl cry; hyg	82	120 dec	2.22	146 <sup>30</sup>	vs EtOH, HOAc, ace; sl eth
989	Copper(II) phosphate	Cu <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7798-23-4	380.581	blue-grn tricl cry					i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
990	Copper(II) phosphate trihydrate	Cu <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	10031-48-8	434.627	blue-grn orth cry					i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
991	Copper(II) phthalocyanine	CuC <sub>32</sub> H <sub>16</sub> N <sub>8</sub>	147-14-8	576.069	bl-purp cry					i H <sub>2</sub> O, EtOH; s conc H <sub>2</sub> SO <sub>4</sub>
992	Copper(II) selenate pentahydrate	CuSeO <sub>4</sub> · 5H <sub>2</sub> O	10031-45-5	296.58	blue tricl cry	80 dec		2.56	27.4 <sup>25</sup>	s acid, NH <sub>4</sub> OH; sl ace; i EtOH
993	Copper(II) selenide	CuSe	1317-41-5	142.51	blue-blk needles or plates	550 dec		5.99		reac acid
994	Copper(II) selenite dihydrate	CuSeO <sub>3</sub> · 2H <sub>2</sub> O	15168-20-4	226.54	blue orth cry			3.31		i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
995	Copper(II) silicate dihydrate	CuSiO <sub>3</sub> · 2H <sub>2</sub> O	26318-99-0	175.661	grn-blue orth cry					
996	Copper(II) stannate	CuSnO <sub>3</sub>	12019-07-7	230.254	blue pow					
997	Copper(II) stearate	Cu(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	660-60-6	630.485	blue-grn amorp powder	≈250				i H <sub>2</sub> O, EtOH, eth; s py
998	Copper(II) sulfate	CuSO <sub>4</sub>	7758-98-7	159.609	wh-grn amorp powder or rhomb cry	560 dec		3.60	22.0 <sup>25</sup>	i EtOH
999	Copper(II) sulfate pentahydrate	CuSO <sub>4</sub> · 5H <sub>2</sub> O	7758-99-8	249.685	blue tricl cry	110 dec		2.286	22.0 <sup>25</sup>	s MeOH; sl EtOH
1000	Copper(II) sulfate, basic	Cu <sub>3</sub> (OH) <sub>4</sub> SO <sub>4</sub>	1332-14-5	354.730	grn rhomb cry			3.88		i H <sub>2</sub> O
1001	Copper(II) sulfide	CuS	1317-40-4	95.611	blk hex cry	trans 507		4.76		i H <sub>2</sub> O, EtOH, dil acid, alk
1002	Copper(II) tartrate trihydrate	CuC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 3H <sub>2</sub> O	815-82-7	265.663	blue-grn powder					sl H <sub>2</sub> O; s acid, alk
1003	Copper(II) telluride	CuTe	12019-23-7	191.15	yel orth cry	trans ≈400		7.09		
1004	Copper(II) tellurite	CuTeO <sub>3</sub>	13812-58-3	239.14	blk glassy solid					i H <sub>2</sub> O
1005	Copper(II) tetrafluoroborate	Cu(BF <sub>4</sub> ) <sub>2</sub>	14735-84-3	237.155	solid					s H <sub>2</sub> O
1006	Copper(II) titanate	CuTiO <sub>3</sub>	12019-08-8	159.411	gray pow					
1007	Copper(II) 1,1,1-trifluoro-2,4-pentanedioate	Cu(CF <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14324-82-4	369.705	blue-purp cry	197	dec 260			s EtOH, tol
1008	Copper(II) tungstate	CuWO <sub>4</sub>	13587-35-4	311.38	yel-brn powder			7.5		
1009	Copper(II) tungstate dihydrate	CuWO <sub>4</sub> · 2H <sub>2</sub> O	13587-35-4*	347.41	grn powder					i H <sub>2</sub> O; sl HOAc; reac conc acid
1010	Copper(II) vanadate	Cu(VO <sub>3</sub> ) <sub>2</sub>	12789-09-2	261.425	powder					



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1011	Curium	Cm	7440-51-9	247	silv metal; hex or cub	1345	≈3100	13.51		
1012	Dysprosium	Dy	7429-91-6	162.500	silv metal; hex	1412	2567	8.55		s dil acid
1013	Dysprosium boride	DyB <sub>4</sub>	12310-43-9	205.744	tetr cry	2500		6.98		
1014	Dysprosium nitride	DyN	12019-88-4	176.507	cub cry			9.93		
1015	Dysprosium silicide	DySi <sub>2</sub>	12133-07-2	218.671	orth cry	1550		5.2		
1016	Dysprosium(II) bromide	DyBr <sub>2</sub>	83229-05-4	322.308	blk solid					
1017	Dysprosium(II) chloride	DyCl <sub>2</sub>	13767-31-2	233.406	blk cry	721 dec				reac H <sub>2</sub> O
1018	Dysprosium(II) iodide	DyI <sub>2</sub>	36377-94-3	416.309	purp cry	659				reac H <sub>2</sub> O
1019	Dysprosium(III) acetate tetrahydrate	Dy(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 4H <sub>2</sub> O	15280-55-4	411.693	yel needles	dec 120				s H <sub>2</sub> O; sl EtOH
1020	Dysprosium(III) bromide	DyBr <sub>3</sub>	14456-48-5	402.212	wh hyg cry	879				s H <sub>2</sub> O
1021	Dysprosium(III) carbonate tetrahydrate	Dy <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> · 4H <sub>2</sub> O	38245-35-1	577.088	wh cry pow					i H <sub>2</sub> O
1022	Dysprosium(III) chloride	DyCl <sub>3</sub>	10025-74-8	268.859	wh or yel cry	718	1530	3.67		s H <sub>2</sub> O, MeOH
1023	Dysprosium(III) chloride hexahydrate	DyCl <sub>3</sub> · 6H <sub>2</sub> O	15059-52-6	376.950	bright yel cry	dec 162				
1024	Dysprosium(III) fluoride	DyF <sub>3</sub>	13569-80-7	219.495	grn cry	1157				
1025	Dysprosium(III) hydride	DyH <sub>3</sub>	13537-09-2	165.524	hex cry			7.1		
1026	Dysprosium(III) hydroxide	Dy(OH) <sub>3</sub>	1308-85-6	213.522	yel or wh needles	205 dec				i H <sub>2</sub> O
1027	Dysprosium(III) iodide	DyI <sub>3</sub>	15474-63-2	543.213	grn cry	978				
1028	Dysprosium(III) nitrate pentahydrate	Dy(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	10143-38-1*	438.591	yel cry	88.6			208.4 <sup>25</sup>	
1029	Dysprosium(III) oxide	Dy <sub>2</sub> O <sub>3</sub>	1308-87-8	372.998	wh cub cry	2228	3900	7.81		s acid
1030	Dysprosium(III) sulfate octahydrate	Dy <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	10031-50-2	757.310	pale yel cry	110				sl H <sub>2</sub> O
1031	Dysprosium(III) sulfide	Dy <sub>2</sub> S <sub>3</sub>	12133-10-7	421.195	red-brn monocl cry			6.08		
1032	Dysprosium(III) telluride	Dy <sub>2</sub> Te <sub>3</sub>	12159-43-2	707.80	solid	≈1550				
1033	Einsteinium	Es	7429-92-7	252	metal; cub	860				
1034	Erbium	Er	7440-52-0	167.259	silv metal; hex	1529	2868	9.07		i H <sub>2</sub> O; s acid
1035	Erbium boride	ErB <sub>4</sub>	12310-44-0	210.503	tetr cry	2450		7.0		
1036	Erbium acetate tetrahydrate	Er(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 4H <sub>2</sub> O	15280-57-6	416.452	pink or wh cry			2.11		s H <sub>2</sub> O
1037	Erbium bromide	ErBr <sub>3</sub>	13536-73-7	406.971	viol hyg cry	950	≈1460			s H <sub>2</sub> O, thf
1038	Erbium bromide hexahydrate	ErBr <sub>3</sub> · 6H <sub>2</sub> O	14890-44-9	515.062	pink cry					s H <sub>2</sub> O
1039	Erbium chloride	ErCl <sub>3</sub>	10138-41-7	273.618	viol monocl cry; hyg	776		4.1		s H <sub>2</sub> O
1040	Erbium chloride hexahydrate	ErCl <sub>3</sub> · 6H <sub>2</sub> O	10025-75-9	381.709	pink hyg cry	dec				s H <sub>2</sub> O; sl EtOH
1041	Erbium fluoride	ErF <sub>3</sub>	13760-83-3	224.254	pink orth cry	1146		7.8		i H <sub>2</sub> O
1042	Erbium hydride	ErH <sub>3</sub>	13550-53-3	170.283	hex cry			≈7.6		
1043	Erbium hydroxide	Er(OH) <sub>3</sub>	14646-16-3	218.281	pink solid					i H <sub>2</sub> O
1044	Erbium iodide	ErI <sub>3</sub>	13813-42-8	547.972	viol hex cry; hyg	1014		≈5.5		s H <sub>2</sub> O
1045	Erbium nitrate pentahydrate	Er(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	10168-80-6*	443.350	red cry	130 dec			240.8 <sup>25</sup>	s EtOH, ace
1046	Erbium nitride	ErN	12020-21-2	181.266	cub cry			10.6		
1047	Erbium oxide	Er <sub>2</sub> O <sub>3</sub>	12061-16-4	382.516	pink powder	2344	3920	8.64		i H <sub>2</sub> O; s acid
1048	Erbium silicide	ErSi <sub>2</sub>	12020-28-9	223.430	orth cry			7.26		
1049	Erbium sulfate	Er <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13478-49-4	622.706	hyg powder	dec		3.68	13 <sup>20</sup>	
1050	Erbium sulfate octahydrate	Er <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	10031-52-4	766.828	pink monocl cry	dec		3.20	13 <sup>20</sup>	
1051	Erbium sulfide	Er <sub>2</sub> S <sub>3</sub>	12159-66-9	430.713	red-brn monocl cry	1730		6.07		
1052	Erbium telluride	Er <sub>2</sub> Te <sub>3</sub>	12020-39-2	717.32	orth cry	1213		7.11		
1053	Europium	Eu	7440-53-1	151.964	soft silv metal; cub	822	1529	5.24		reac H <sub>2</sub> O
1054	Europium boride	EuB <sub>6</sub>	12008-05-8	216.830	cub cry	≈2600		4.91		
1055	Europium nitride	EuN	12020-58-5	165.971	cub cry			8.7		
1056	Europium silicide	EuSi <sub>2</sub>	12434-24-1	208.135	tetr cry	1500		5.46		
1057	Europium(II) bromide	EuBr <sub>2</sub>	13780-48-8	311.772	wh cry	683				s H <sub>2</sub> O
1058	Europium(II) chloride	EuCl <sub>2</sub>	13769-20-5	222.870	wh orth cry	731		4.9		s H <sub>2</sub> O
1059	Europium(II) fluoride	EuF <sub>2</sub>	14077-39-5	189.961	grn-yel cub cry	≈1380		6.5		
1060	Europium(II) iodide	EuI <sub>2</sub>	22015-35-6	405.773	grn cry	580				s H <sub>2</sub> O
1061	Europium(II) selenide	EuSe	12020-66-5	230.92	brn cub cry			6.45		
1062	Europium(II) sulfate	EuSO <sub>4</sub>	10031-54-6	248.027	col orth cry			4.99		i H <sub>2</sub> O
1063	Europium(II) sulfide	EuS	12020-65-4	184.029	cub cry			5.7		
1064	Europium(II) telluride	EuTe	12020-69-8	279.56	blk cub cry	1526		6.48		
1065	Europium(III) bromide	EuBr <sub>3</sub>	13759-88-1	391.676	gray cry	dec				s H <sub>2</sub> O
1066	Europium(III) chloride	EuCl <sub>3</sub>	10025-76-0	258.323	grn-yel needles	623		4.89		
1067	Europium(III) chloride hexahydrate	EuCl <sub>3</sub> · 6H <sub>2</sub> O	13759-92-7	366.414	wh-yel hyg cry	850		4.89		s H <sub>2</sub> O
1068	Europium(III) fluoride	EuF <sub>3</sub>	13765-25-8	208.959	wh hyg cry	1276				i H <sub>2</sub> O
1069	Europium(III) iodide	EuI <sub>3</sub>	13759-90-5	532.677	col cry; unstab	≈875				
1070	Europium(III) nitrate hexahydrate	Eu(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	10031-53-5	446.070	wh-pink hyg cry	85 dec			193 <sup>25</sup>	
1071	Europium(III) oxalate	Eu <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub>	3269-12-3	567.985	wh solid					i H <sub>2</sub> O; s acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1072	Europium(III) oxide	Eu <sub>2</sub> O <sub>3</sub>	1308-96-9	351.926	pink powder	2291	3790	7.42		i H <sub>2</sub> O; s acid
1073	Europium(III) perchlorate hexahydrate	Eu(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	36907-40-1	558.407	wh or pink cry					s H <sub>2</sub> O, EtOH
1074	Europium(III) sulfate	Eu <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13537-15-0	592.116	pale pink cry			4.99	2.1 <sup>20</sup>	
1075	Europium(III) sulfate octahydrate	Eu <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	10031-52-4	736.238	pink cry	375 dec			2.1 <sup>20</sup>	
1076	Fermium	Fm	7440-72-4	257	metal	1527				
1077	Fluorine	F <sub>2</sub>	7782-41-4	37.997	pale yel gas	-219.67 tp	-188.12	1.553 g/L		reac H <sub>2</sub> O
1078	Fluorine monoxide	F <sub>2</sub> O	7783-41-7	53.996	col gas	-223.8	-144.3	2.207 g/L		sl H <sub>2</sub> O
1079	Difluorine dioxide	F <sub>2</sub> O <sub>2</sub>	7783-44-0	69.996	red-oran solid, unstab gas	-163.5	-57 (extrap)	2.861 g/L		
1080	Fluorine tetroxide	F <sub>2</sub> O <sub>4</sub>	107782-11-6	101.995	red-brn solid	-191	dec -185			
1081	Fluorine nitrate	FNO <sub>3</sub>	7789-26-6	81.003	col gas	-175	-46	3.311 g/L		reac H <sub>2</sub> O, EtOH, eth; s ace
1082	Fluorine perchlorate	FOClO <sub>3</sub>	10049-03-3	118.449	col gas; exp	-167.3	-16	4.841 g/L		reac H <sub>2</sub> O
1083	Francium	Fr	7440-73-5	223.000	short-lived alkali metal	27				
1084	Gadolinium	Gd	7440-54-2	157.25	silv metal; hex	1313	3273	7.90		s dil acid
1085	Gadolinium boride	GdB <sub>6</sub>	12008-06-9	222.12	blk-brn cub cry	2510		5.31		
1086	Gadolinium nitride	GdN	25764-15-2	171.26	cub cry			9.10		
1087	Gadolinium silicide	GdSi <sub>2</sub>	12134-75-7	213.42	orth cry	1540		5.9		
1088	Gadolinium(II) iodide	GdI <sub>2</sub>	13814-72-7	411.06	bronze cry	831				
1089	Gadolinium(II) selenide	GdSe	12024-81-6	236.21	cub cry	2170		8.1		
1090	Gadolinium(III) acetate tetrahydrate	Gd(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	15280-53-2	406.44	wh tricr cry	dec		1.61		s H <sub>2</sub> O
1091	Gadolinium(III) bromide	GdBr <sub>3</sub>	13818-75-2	396.96	wh monocry; hyg	770		4.56		
1092	Gadolinium(III) chloride	GdCl <sub>3</sub>	10138-52-0	263.61	wh monocry; hyg	602		4.52		s H <sub>2</sub> O
1093	Gadolinium(III) chloride hexahydrate	GdCl <sub>3</sub> · 6H <sub>2</sub> O	19423-81-5	371.70	col hyg cry			2.424		s H <sub>2</sub> O
1094	Gadolinium(III) fluoride	GdF <sub>3</sub>	13765-26-9	214.25	wh cry	1232				
1095	Gadolinium(III) iodide	GdI <sub>3</sub>	13572-98-0	537.96	yel cry	930				
1096	Gadolinium(III) nitrate pentahydrate	Gd(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	52788-53-1	433.34	wh cry	92 dec		2.41	190 <sup>25</sup>	
1097	Gadolinium(III) nitrate hexahydrate	Gd(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	19598-90-4	451.36	hyg tricr cry	91 dec		2.33	190 <sup>25</sup>	s EtOH
1098	Gadolinium(III) oxalate decahydrate	Gd <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 10H <sub>2</sub> O	22992-15-0	758.71	wh monocry pow	dec 110				i H <sub>2</sub> O; sl acid
1099	Gadolinium(III) oxide	Gd <sub>2</sub> O <sub>3</sub>	12064-62-9	362.50	wh hyg powder	2339	3900	7.41		i H <sub>2</sub> O; s acid
1100	Gadolinium(III) sulfate	Gd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13628-54-1	602.69	col cry	500 dec		4.1	2.60 <sup>20</sup>	sl H <sub>2</sub> O
1101	Gadolinium(III) sulfate octahydrate	Gd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13450-87-8	746.81	col monocry cry	400 dec		4.14	2.3 <sup>20</sup>	sl H <sub>2</sub> O
1102	Gadolinium(III) sulfide	Gd <sub>2</sub> S <sub>3</sub>	12134-77-9	410.70	yel cub cry			6.1		
1103	Gadolinium(III) telluride	Gd <sub>2</sub> Te <sub>3</sub>	12160-99-5	697.30	orth cry	1255		7.7		
1104	Gallium	Ga	7440-55-3	69.723	silv liq or gray orth cry	29.7666 tp	2204	5.91		reac alk
1105	Gallium antimonide	GaSb	12064-03-8	191.483	brn cub cry	712		5.6137		
1106	Gallium arsenide	GaAs	1303-00-0	144.645	gray cub cry	1238		5.3176		
1107	Gallium nitride	GaN	25617-97-4	83.730	gray hex cry	>2500		6.1		
1108	Gallium phosphide	GaP	12063-98-8	100.697	yel cub cry	1457		4.138		
1109	Gallium suboxide	Ga <sub>2</sub> O	12024-20-3	155.445	brn powder	>660	>800 dec	4.77		
1110	Gallium(II) chloride	GaCl <sub>2</sub>	24597-12-4	140.629	wh orth cry	172.4	535	2.74		
1111	Gallium(II) selenide	GaSe	12024-11-2	148.68	hex cry	960		5.03		
1112	Gallium(II) sulfide	GaS	12024-10-1	101.788	hex cry	965		3.86		
1113	Gallium(II) telluride	GaTe	12024-14-5	197.32	monocry cry	824		5.44		
1114	Gallium(III) bromide	GaBr <sub>3</sub>	13450-88-9	309.435	wh orth cry	123	279	3.69		
1115	Gallium(III) chloride	GaCl <sub>3</sub>	13450-90-3	176.082	col needles or gl solid	77.9	201	2.47		
1116	Gallium(III) fluoride	GaF <sub>3</sub>	7783-51-9	126.718	wh powder or col needles	>1000		4.47		i H <sub>2</sub> O
1117	Gallium(III) fluoride trihydrate	GaF <sub>3</sub> · 3H <sub>2</sub> O	22886-66-4	180.764	wh cry	>140 dec				sl H <sub>2</sub> O
1118	Gallium(III) hydride	GaH <sub>3</sub>	13572-93-5	72.747	visc liq	-15	≈0 dec			
1119	Gallium(III) hydroxide	Ga(OH) <sub>3</sub>	12023-99-3	120.745	unstab prec					
1120	Gallium(III) iodide	GaI <sub>3</sub>	13450-91-4	450.436	monocry cry	212	340	4.5		
1121	Gallium(III) nitrate	Ga(NO <sub>3</sub> ) <sub>3</sub>	13494-90-1	255.738	wh cry powder					s H <sub>2</sub> O, EtOH, eth
1122	Gallium(III) oxide	Ga <sub>2</sub> O <sub>3</sub>	12024-21-4	187.444	wh cry	1807		≈6.0		s hot acid
1123	Gallium(III) oxide hydroxide	GaOOH	20665-52-5	102.730	orth cry			5.23		
1124	Gallium(III) 2,4-pentanedioate	Ga(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	14405-43-7	367.047	wh powder	193	subl	1.42		
1125	Gallium(III) perchlorate hexahydrate	Ga(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	17835-81-3	476.166	cry	dec 175				
1126	Gallium(III) selenide	Ga <sub>2</sub> Se <sub>3</sub>	12024-24-7	376.33	cub cry	937		4.92		
1127	Gallium(III) sulfate	Ga <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13494-91-2	427.634	hex cry					
1128	Gallium(III) sulfate octadecahydrate	Ga <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 18H <sub>2</sub> O	13780-42-2	751.909	octahed cry					s H <sub>2</sub> O, EtOH
1129	Gallium(III) sulfide	Ga <sub>2</sub> S <sub>3</sub>	12024-22-5	235.641	monocry cry	1090		3.7		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1130	Gallium(III) telluride	Ga <sub>2</sub> Te <sub>3</sub>	12024-27-0	522.25	cub cry	790		5.57		
1131	Germanium	Ge	7440-56-4	72.64	gray-wh cub cry	938.25	2833	5.3234		i H <sub>2</sub> O, dil acid, alk
1132	Germane	GeH <sub>4</sub>	7782-65-2	76.67	col gas; flam	-165	-88.1	3.133 g/L		i H <sub>2</sub> O
1133	Digermane	Ge <sub>2</sub> H <sub>6</sub>	13818-89-8	151.33	col liq; flam	-109	29	1.98 <sup>-109</sup>		
1134	Trigermane	Ge <sub>3</sub> H <sub>8</sub>	14691-44-2	225.98	col liq	-105.6	110.5	2.20 <sup>-105</sup>		i H <sub>2</sub> O
1135	Tetragermane	Ge <sub>4</sub> H <sub>10</sub>	14691-47-5	300.64	col liq		176.9			i H <sub>2</sub> O
1136	Pentagermane	Ge <sub>5</sub> H <sub>12</sub>	15587-39-0	375.30	col liq		234			i H <sub>2</sub> O
1137	Bromogermane	GeH <sub>3</sub> Br	13569-43-2	155.57	col liq	-32	52	2.34		react H <sub>2</sub> O
1138	Chlorogermane	GeH <sub>3</sub> Cl	13637-65-5	111.12	col liq	-52	28	1.75		react H <sub>2</sub> O
1139	Chlorotrifluorogermane	GeF <sub>3</sub> Cl	14188-40-0	165.09	gas	-66.2	-20.3	6.747 g/L		
1140	Dibromogermane	GeH <sub>2</sub> Br <sub>2</sub>	13769-36-3	234.46	col liq	-15	89	2.80		react H <sub>2</sub> O
1141	Dichlorogermane	GeH <sub>2</sub> Cl <sub>2</sub>	15230-48-5	145.56	col liq	-68	69.5	1.90		react H <sub>2</sub> O
1142	Dichlorodifluorogermane	GeF <sub>2</sub> Cl <sub>2</sub>	24422-21-7	181.54	col gas	-51.8	-2.8	7.419 g/L		
1143	Dichlorodimethylgermane	Ge(CH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	1529-48-2	173.62	liq	-22	124	1.49		
1144	Fluorogermane	GeH <sub>3</sub> F	13537-30-9	94.66	col gas			3.868 g/L		react H <sub>2</sub> O
1145	Iodogermane	GeH <sub>3</sub> I	13573-02-9	202.57	liq	-15	≈90			react H <sub>2</sub> O
1146	Methylgermane	GeH <sub>3</sub> CH <sub>3</sub>	1449-65-6	90.70	col gas	-158	-23	3.706 g/L		
1147	Tribromogermane	GeHBr <sub>3</sub>	14779-70-5	313.36	col liq	-25	dec			react H <sub>2</sub> O
1148	Trichlorogermane	GeHCl <sub>3</sub>	1184-65-2	180.01	liq	-71	75.3	1.93		react H <sub>2</sub> O
1149	Trichlorofluorogermane	GeCl <sub>3</sub> F	24422-20-6	198.00	liq	-49.8	37.5			
1150	Germanium(II) bromide	GeBr <sub>2</sub>	24415-00-7	232.45	yel mono cry	122	150 dec			react H <sub>2</sub> O
1151	Germanium(II) chloride	GeCl <sub>2</sub>	10060-11-4	143.55	wh-yel hyg powder	dec				react H <sub>2</sub> O; s eth, bz
1152	Germanium(II) fluoride	GeF <sub>2</sub>	13940-63-1	110.64	wh orth cry; hyg	110	130 dec	3.64		react H <sub>2</sub> O
1153	Germanium(II) iodide	GeI <sub>2</sub>	13573-08-5	326.45	oran-yel hex cry	428	550 dec	5.4		react H <sub>2</sub> O
1154	Germanium(II) oxide	GeO	20619-16-3	88.64	blk solid	700 dec				
1155	Germanium(II) selenide	GeSe	12065-10-0	151.60	gray orth cry or brn powder	675		5.6		
1156	Germanium(II) sulfide	GeS	12025-32-0	104.71	gray orth cry	658		4.1		
1157	Germanium(II) telluride	GeTe	12025-39-7	200.24	cub cry	724		6.16		i H <sub>2</sub> O; s conc HNO <sub>3</sub>
1158	Germanium(IV) bromide	GeBr <sub>4</sub>	13450-92-5	392.26	wh cry	26.1	186.35	3.132		react H <sub>2</sub> O
1159	Germanium(IV) chloride	GeCl <sub>4</sub>	10038-98-9	214.45	col liq	-51.50	86.55	1.88		react H <sub>2</sub> O; s bz, eth, EtOH, ctc
1160	Germanium(IV) fluoride	GeF <sub>4</sub>	7783-58-6	148.63	col gas	-15 tp	-36.5 sp	6.074 g/L		react H <sub>2</sub> O
1161	Germanium(IV) iodide	GeI <sub>4</sub>	13450-95-8	580.26	red-oran cub cry	146	348	4.322		react H <sub>2</sub> O
1162	Germanium(IV) nitride	Ge <sub>3</sub> N <sub>4</sub>	12065-36-0	273.95	orth cry	900 dec				i H <sub>2</sub> O, acid, aqua regia
1163	Germanium(IV) oxide	GeO <sub>2</sub>	1310-53-8	104.64	wh hex cry	1116		4.25		i H <sub>2</sub> O
1164	Germanium(IV) selenide	GeSe <sub>2</sub>	12065-11-1	230.56	yel-oran orth cry	707 dec		4.56		
1165	Germanium(IV) sulfide	GeS <sub>2</sub>	12025-34-2	136.77	blk orth cry	530		3.01		
1166	Gold	Au	7440-57-5	196.967	soft yel metal	1064.18	2856	19.3		s aqua regia
1167	Bromoaauric(III) acid pentahydrate	HAuBr <sub>4</sub> · 5H <sub>2</sub> O	17083-68-0	607.667	red-brn hyg cry	27				s H <sub>2</sub> O, EtOH
1168	Chloroaauric(III) acid tetrahydrate	HAuCl <sub>4</sub> · 4H <sub>2</sub> O	16903-35-8	411.848	yel mono cry; hyg			≈3.9		vs H <sub>2</sub> O, EtOH; s eth
1169	Gold(I) bromide	AuBr	10294-27-6	276.871	yel-gray tetr cry	165 dec		8.20		i H <sub>2</sub> O
1170	Gold(I) chloride	AuCl	10294-29-8	232.420	yel orth cry	289 dec		7.6	0.000031 <sup>20</sup>	
1171	Gold(I) cyanide	AuCN	506-65-0	222.985	yel hex cry	dec		7.2		i H <sub>2</sub> O, EtOH, eth, dil acid
1172	Gold(I) iodide	AuI	10294-31-2	323.871	yel-grn powder; tetr	120 dec		8.25		i H <sub>2</sub> O; s CN soln
1173	Gold(I) sulfide	Au <sub>2</sub> S	1303-60-2	425.998	brn-blk cub cry; unstab	240 dec		≈11		i H <sub>2</sub> O, acid; s aqua regia
1174	Gold(III) bromide	AuBr <sub>3</sub>	10294-28-7	436.679	red-br mono cry	≈160 dec				s H <sub>2</sub> O, EtOH
1175	Gold(III) chloride	AuCl <sub>3</sub>	13453-07-1	303.326	red mono cry	>160 dec		4.7	68 <sup>20</sup>	
1176	Gold(III) cyanide trihydrate	Au(CN) <sub>3</sub> · 3H <sub>2</sub> O	535-37-5*	329.065	wh hyg cry	50 dec				vs H <sub>2</sub> O; sl EtOH
1177	Gold(III) fluoride	AuF <sub>3</sub>	14720-21-9	253.962	oran-yel hex cry	>300	subl	6.75		
1178	Gold(III) hydroxide	Au(OH) <sub>3</sub>	1303-52-2	247.989	brn powder	≈100 dec				i H <sub>2</sub> O; s acid
1179	Gold(III) iodide	AuI <sub>3</sub>	31032-13-0	577.680	unstab grn powder	20 dec				
1180	Gold(III) oxide	Au <sub>2</sub> O <sub>3</sub>	1303-58-8	441.931	brn powder	≈150 dec				i H <sub>2</sub> O; s acid
1181	Gold(III) selenate	Au <sub>2</sub> (SeO <sub>4</sub> ) <sub>3</sub>	10294-32-3	822.81	yel cry					i H <sub>2</sub> O; s acid
1182	Gold(III) selenide	Au <sub>2</sub> Se <sub>3</sub>	1303-62-4	630.81	blk amorp solid	dec		4.65		s aqua regia
1183	Gold(III) sulfide	Au <sub>2</sub> S <sub>3</sub>	1303-61-3	490.128	unstab blk powder	200 dec				
1184	Hafnium	Hf	7440-58-6	178.49	gray metal; hex	2233	4603	13.3		s HF
1185	Hafnium boride	HfB <sub>2</sub>	12007-23-7	200.11	gray hex cry	3100		10.5		
1186	Hafnium carbide	HfC	12069-85-1	190.50	refrac cub cry	≈3000		12.2		
1187	Hafnium hydride	HfH <sub>2</sub>	12770-26-2	180.51	refrac tetr cry			11.4		
1188	Hafnium nitride	HfN	25817-87-2	192.50	yel-brn cub cry	3310		13.8		
1189	Hafnium phosphide	HfP	12325-59-6	209.46	hex cry			9.78		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1190	Hafnium silicide	HfSi <sub>2</sub>	12401-56-8	234.66	gray orth cry	≈1700		7.6		
1191	Hafnocene dichloride	Hf(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Cl <sub>2</sub>	12116-66-4	379.58	col hyg cry	235				s bz, chl; sl thf, eth; i hex
1192	Hafnium(II) bromide	HfBr <sub>2</sub>	13782-95-1	338.30	blue-blk cry	dec 400				
1193	Hafnium(II) chloride	HfCl <sub>2</sub>	13782-92-8	249.40	blk solid	dec 400				
1194	Hafnium(III) bromide	HfBr <sub>3</sub>	13782-96-2	418.20	blue-blk cry	dec 350				
1195	Hafnium(III) chloride	HfCl <sub>3</sub>	13782-93-9	284.85	blk solid	dec				
1196	Hafnium(III) iodide	HfI <sub>3</sub>	13779-73-2	559.20	blk cry	dec				
1197	Hafnium(IV) bromide	HfBr <sub>4</sub>	13777-22-5	498.11	wh cub cry	424 tp	323 sp	4.90		reac H <sub>2</sub> O
1198	Hafnium(IV) chloride	HfCl <sub>4</sub>	13499-05-3	320.30	wh monocl cry	432 tp	317 sp			reac H <sub>2</sub> O
1199	Hafnium(IV) fluoride	HfF <sub>4</sub>	13709-52-9	254.48	wh monocl cry	1025	970 sp	7.1		reac H <sub>2</sub> O
1200	Hafnium(IV) iodide	HfI <sub>4</sub>	13777-23-6	686.11	yel-oran cub cry	449 tp	394 sp	5.6		reac H <sub>2</sub> O
1201	Hafnium(IV) oxide	HfO <sub>2</sub>	12055-23-1	210.49	wh cub cry	2800	≈5400	9.68		i H <sub>2</sub> O
1202	Hafnium(IV) oxychloride octahydrate	HfOCl <sub>2</sub> · 8H <sub>2</sub> O	14456-34-9	409.52	wh tetr cry	dec				s H <sub>2</sub> O
1203	Hafnium(IV) selenide	HfSe <sub>2</sub>	12162-21-9	336.41	brn hex cry			7.46		
1204	Hafnium(IV) silicate	HfSiO <sub>4</sub>	13870-13-8	270.57	tetr cry	2758		7.0		
1205	Hafnium(IV) sulfate	Hf(SO <sub>4</sub> ) <sub>2</sub>	15823-43-5	370.62	wh cry	>500 dec				
1206	Hafnium(IV) sulfide	HfS <sub>2</sub>	18855-94-2	242.62	purp-brn hex cry			6.03		
1207	Hafnium(IV) titanate	HfTiO <sub>4</sub>	12055-24-2	290.36	wh pow	1980 dec				
1208	Helium	He	7440-59-7	4.003	col gas		-268.93	0.164 g/L		sl H <sub>2</sub> O; i EtOH
1209	Holmium	Ho	7440-60-0	164.930	silv metal; hex	1472	2700	8.80		s dil acid
1210	Holmium acetate	Ho(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	25519-09-9	342.062	yel cry	dec 327				s H <sub>2</sub> O
1211	Holmium bromide	HoBr <sub>3</sub>	13825-76-8	404.642	yel hyg cry	919	1470			
1212	Holmium chloride	HoCl <sub>3</sub>	10138-62-2	271.289	yel monocl cry; hyg	720	1500	3.7		s H <sub>2</sub> O
1213	Holmium chloride hexahydrate	HoCl <sub>3</sub> · 6H <sub>2</sub> O	14914-84-2	379.381	hyg yel cry	160 dec				s H <sub>2</sub> O
1214	Holmium fluoride	HoF <sub>3</sub>	13760-78-6	221.925	pink-yel orth cry; hyg	1143	>2200	7.664		s H <sub>2</sub> O
1215	Holmium iodide	HoI <sub>3</sub>	13813-41-7	545.643	yel hex cry	994		5.4		
1216	Holmium nitrate pentahydrate	Ho(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	14483-18-2	441.022	hyg oran cry					s H <sub>2</sub> O, EtOH, ace
1217	Holmium nitride	HoN	12029-81-1	178.937	cub cry			10.6		
1218	Holmium oxalate decahydrate	Ho <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> · 10H <sub>2</sub> O	28965-57-3	774.070	yel solid	dec 40				
1219	Holmium oxide	Ho <sub>2</sub> O <sub>3</sub>	12055-62-8	377.859	yel cub cry	2330	3900	8.41		s acid
1220	Holmium silicide	HoSi <sub>2</sub>	12136-24-2	221.101	hex cry			7.1		
1221	Holmium sulfide	Ho <sub>2</sub> S <sub>3</sub>	12162-59-3	426.056	yel-oran monocl cry			5.92		
1222	Hydrazine	N <sub>2</sub> H <sub>4</sub>	302-01-2	32.045	col oily liq	1.54	113.55	1.0036		vs H <sub>2</sub> O, EtOH, MeOH
1223	Hydrazine acetate	N <sub>2</sub> H <sub>4</sub> · CH <sub>3</sub> COOH	13255-48-6	92.097	cry	100				
1224	Hydrazine azide	N <sub>2</sub> H <sub>4</sub> · HN <sub>3</sub>	14662-04-5	75.074	hyg wh prism	75 exp				vs H <sub>2</sub> O
1225	Hydrazine monohydrate	N <sub>2</sub> H <sub>4</sub> · H <sub>2</sub> O	7803-57-8	50.060	fuming liq	-51.7	119	1.030		vs H <sub>2</sub> O, EtOH; i chl, eth
1226	Hydrazine hydrobromide	N <sub>2</sub> H <sub>4</sub> · HBr	13775-80-9	112.957	wh monocl cry flakes	84	≈190 dec	2.3		s H <sub>2</sub> O, EtOH
1227	Hydrazine hydrochloride	N <sub>2</sub> H <sub>4</sub> · HCl	2644-70-4	68.506	wh orth cry	89	240 dec	1.5		s H <sub>2</sub> O; i os
1228	Hydrazine dihydrochloride	N <sub>2</sub> H <sub>4</sub> · 2HCl	5341-61-7	104.967	wh orth cry	198 dec		1.42		s H <sub>2</sub> O; sl EtOH
1229	Hydrazine hydroiodide	N <sub>2</sub> H <sub>4</sub> · HI	10039-55-1	159.957	hyg cry	125				s H <sub>2</sub> O
1230	Hydrazine nitrate	N <sub>2</sub> H <sub>4</sub> · HNO <sub>3</sub>	13464-97-6	95.058	monocl cry; exp	70				vs H <sub>2</sub> O
1231	Hydrazine dinitrate	N <sub>2</sub> H <sub>4</sub> · 2HNO <sub>3</sub>	13464-98-7	158.071	needles	104 dec			20 <sup>35</sup>	s H <sub>2</sub> O
1232	Hydrazine perchlorate hemihydrate	N <sub>2</sub> H <sub>4</sub> · HClO <sub>4</sub> · 0.5H <sub>2</sub> O	13762-65-7		solid	137	exp	1.94		reac H <sub>2</sub> O, s EtOH; i eth, bz
1233	Hydrazine sulfate	N <sub>2</sub> H <sub>4</sub> · H <sub>2</sub> SO <sub>4</sub>	10034-93-2	130.124	col orth cry	254		1.378		sl H <sub>2</sub> O; i EtOH
1234	Dihydrazine sulfate	(N <sub>2</sub> H <sub>4</sub> ) <sub>2</sub> · H <sub>2</sub> SO <sub>4</sub>	13464-80-7	162.169	hyg wh cry flakes	104	dec >180		200 <sup>25</sup>	vs H <sub>2</sub> O; i os
1235	Hydrazoic acid	HN <sub>3</sub>	7782-79-8	43.028	col liq; exp	-80	35.7			s H <sub>2</sub> O
1236	Hydroxylamine	H <sub>2</sub> NOH	7803-49-8	33.030	wh orth flakes or needles	33.1	58	1.21		vs H <sub>2</sub> O, MeOH
1237	Hydroxylamine hydrobromide	H <sub>2</sub> NOH · HBr	41591-55-3	113.942	monocl cry			2.35		s H <sub>2</sub> O
1238	Hydroxylamine hydrochloride	H <sub>2</sub> NOH · HCl	5470-11-1	69.491	col monocl cry	159 dec	exp	1.68	94 <sup>25</sup>	vs H <sub>2</sub> O
1239	Hydroxylamine perchlorate	H <sub>2</sub> NOH · HClO <sub>4</sub>		133.489	orth cry	88	dec 120			
1240	Hydroxylamine sulfate	2(H <sub>2</sub> NOH) · H <sub>2</sub> SO <sub>4</sub>	10039-54-0	164.138	cry	170				vs H <sub>2</sub> O
1241	Hydrogen	H <sub>2</sub>	1333-74-0	2.016	col gas; flam	-259.198 tp	-252.762	0.082 g/L		sl H <sub>2</sub> O
1242	Hydrogen-d <sub>2</sub>	D <sub>2</sub>	7782-39-0	4.028	col gas	-254.42	-249.48	0.164 g/L		
1243	Hydrogen-t <sub>2</sub>	T <sub>2</sub>	10028-17-8	6.032	col gas	-252.53	-248.11	0.246 g/L		
1244	Hydrogen-d <sub>1</sub>	HD	13983-20-5	3.022	col gas	-256.55	-251.02	0.123 g/L		
1245	Hydrogen-t <sub>1</sub>	HT	14885-60-0	4.024	col gas	-254.7	-249.6			
1246	Hydrogen-d <sub>1</sub> t <sub>1</sub>	DT	14885-61-1	5.030	col gas	-253.5	-238.9			
1247	Hydrogen bromide	HBr	10035-10-6	80.912	col gas	-86.80	-66.38	3.307 g/L		vs H <sub>2</sub> O; s EtOH
1248	Hydrogen bromide-d	DBr	13536-59-9	81.918	col gas	-87.54	-66.9			s H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1249	Hydrogen chloride	HCl	7647-01-0	36.461	col gas	-114.17	-85	1.490 g/L		vs H <sub>2</sub> O
1250	Hydrogen chloride dihydrate	HCl · 2H <sub>2</sub> O	13465-05-9	72.492	col liq	-17.7		1.46		
1251	Hydrogen chloride- <i>d</i>	DCl	7698-05-7	37.467	col gas	-114.72	-84.4			s H <sub>2</sub> O
1252	Hydrogen cyanide	HCN	74-90-8	27.026	col liq or gas	-13.29	26	0.6876 <sup>20</sup>		vs H <sub>2</sub> O, EtOH; sl eth
1253	Hydrogen fluoride	HF	7664-39-3	20.006	col gas	-83.36	20	0.818 g/L		vs H <sub>2</sub> O, EtOH; sl eth
1254	Hydrogen iodide	HI	10034-85-2	127.912	col or yel gas	-50.76	-35.55	5.228 g/L		vs H <sub>2</sub> O; s os
1255	Hydrogen iodide- <i>d</i>	DI	14104-45-1	128.918	col gas	-51.93	-36.2			s H <sub>2</sub> O
1256	Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	7722-84-1	34.015	col liq	-0.43	150.2	1.44		vs H <sub>2</sub> O
1257	Hydrogen selenide	H <sub>2</sub> Se	7783-07-5	80.98	col gas; flam	-65.73	-41.25	3.310 g/L		s H <sub>2</sub> O
1258	Hydrogen sulfide	H <sub>2</sub> S	7783-06-4	34.081	col gas; flam	-85.5	-59.55	1.393 g/L		s H <sub>2</sub> O
1259	Hydrogen disulfide	H <sub>2</sub> S <sub>2</sub>	13465-07-1	66.146	col liq		70.7	1.334		
1260	Hydrogen telluride	H <sub>2</sub> Te	7783-09-7	129.62	col gas	-49	-2	5.298 g/L		s H <sub>2</sub> O, EtOH, alk
1261	Indium	In	7440-74-6	114.818	soft wh metal	156.60	2072	7.31		s acid
1262	Indium antimonide	InSb	1312-41-0	236.578	blk cub cry	524		5.7747		
1263	Indium arsenide	InAs	1303-11-3	189.740	gray cub cry	942		5.67		i acid
1264	Indium nitride	InN	25617-98-5	128.825	brn hex cry	1100		6.88		
1265	Indium phosphide	InP	22398-80-7	145.792	blk cub cry	1062		4.81		sl acid
1266	Indium(I) bromide	InBr	14280-53-6	194.722	oran-red orth cry	285	656	4.96		reac H <sub>2</sub> O
1267	Indium(I) chloride	InCl	13465-10-6	150.271	yel cub cry	225	608	4.19		reac H <sub>2</sub> O
1268	Indium(I) iodide	InI	13966-94-4	241.722	orth cry	364.4	712	5.32		
1269	Indium(II) bromide	InBr <sub>2</sub>	21264-43-7	274.626	orth cry			4.22		reac H <sub>2</sub> O
1270	Indium(II) chloride	InCl <sub>2</sub>	13465-11-7	185.724	col orth cry	235		3.64		reac H <sub>2</sub> O
1271	Indium(II) sulfide	InS	12030-14-7	146.883	red-brn orth cry	692		5.2		
1272	Indium(III) bromide	InBr <sub>3</sub>	13465-09-3	354.530	hyg yel-wh monocl cry	420		4.74	414 <sup>20</sup>	
1273	Indium(III) chloride	InCl <sub>3</sub>	10025-82-8	221.177	yel monocl cry; hyg	583		4.0	195.1 <sup>22</sup>	s EtOH
1274	Indium(III) chloride tetrahydrate	InCl <sub>3</sub> · 4H <sub>2</sub> O	22519-64-8	293.239	wh cry					s H <sub>2</sub> O
1275	Indium(III) fluoride	InF <sub>3</sub>	7783-52-0	171.813	wh hex cry; hyg	1172	>1200	4.39		sl H <sub>2</sub> O; s dil acid
1276	Indium(III) fluoride trihydrate	InF <sub>3</sub> · 3H <sub>2</sub> O	14166-78-0	225.859	wh cry	100 dec				s H <sub>2</sub> O
1277	Indium(III) hydroxide	In(OH) <sub>3</sub>	20861-21-6	165.840	cub cry			4.4		
1278	Indium(III) iodide	InI <sub>3</sub>	13510-35-5	495.531	yel-red monocl cry; hyg	207		4.69	1308 <sup>22</sup>	
1279	Indium(III) nitrate trihydrate	In(NO <sub>3</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	13770-61-1	354.879	col cry	dec 100				
1280	Indium(III) oxide	In <sub>2</sub> O <sub>3</sub>	1312-43-2	277.634	yel cub cry	1912		7.18		i H <sub>2</sub> O; s hot acid
1281	Indium(III) perchlorate octahydrate	In(ClO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13465-15-1	557.292	wh cry	≈80	200 dec			
1282	Indium(III) phosphate	InPO <sub>4</sub>	14693-82-4	209.789	wh orth cry			4.9		i H <sub>2</sub> O
1283	Indium(III) selenide	In <sub>2</sub> Se <sub>3</sub>	1312-42-1	466.52	blk hex cry	660		5.8		
1284	Indium(III) sulfate	In <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13464-82-9	517.824	hyg wh powder			3.44	117 <sup>20</sup>	
1285	Indium(III) sulfide	In <sub>2</sub> S <sub>3</sub>	12030-24-9	325.831	oran cub cry	1050		4.45		
1286	Indium(III) telluride	In <sub>2</sub> Te <sub>3</sub>	1312-45-4	612.44	blk cub cry	667		5.75		
1287	Iodine	I <sub>2</sub>	7553-56-2	253.809	blue-blk plates	113.7	184.4	4.933	0.03 <sup>20</sup>	s bz, EtOH, eth, ctc, chl
1288	Iodic acid	HI <sub>3</sub>	7782-68-5	175.910	col orth cry	110 dec		4.63	308 <sup>25</sup>	i EtOH, eth
1289	Periodic acid dihydrate	HI <sub>4</sub> · 2H <sub>2</sub> O	10450-60-9	227.940	monocl hyg cry	122 dec				s H <sub>2</sub> O, EtOH; sl eth
1290	Iodine tetroxide	I <sub>2</sub> O <sub>4</sub>	12399-08-5	317.807	yel cry	130	dec >85	4.2		sl H <sub>2</sub> O
1291	Iodine pentoxide	I <sub>2</sub> O <sub>5</sub>	12029-98-0	333.806	hyg wh cry	≈300 dec		4.98	253.4 <sup>20</sup>	i EtOH, eth, CS <sub>2</sub>
1292	Iodine hexoxide	I <sub>2</sub> O <sub>6</sub>	65355-99-9	349.805	yel solid	dec 150				reac H <sub>2</sub> O
1293	Iodine nonaoxide	I <sub>2</sub> O <sub>9</sub>	73560-00-6	651.613	hyg yel powder	75 dec				
1294	Iodine bromide	IBr	7789-33-5	206.808	blk orth cry	40	116 dec	4.3		s H <sub>2</sub> O, EtOH, eth
1295	Iodine chloride	ICl	7790-99-0	162.357	red cry or oily liq	27.38	94.4 dec	3.24		reac H <sub>2</sub> O; s EtOH
1296	Iodine trichloride	ICl <sub>3</sub>	865-44-1	233.263	yel tricl cry; hyg	101 tp (16 atm)	64 sp dec	3.2		reac H <sub>2</sub> O; s EtOH, bz
1297	Iodine fluoride	IF	13873-84-2	145.902	wh pow (-78°C)	-14 dec				
1298	Iodine trifluoride	IF <sub>3</sub>	22520-96-3	183.899	yel solid, stable at low temp	-28 dec				
1299	Iodine pentafluoride	IF <sub>5</sub>	7783-66-6	221.896	yel liq	9.43	100.5	3.19		reac H <sub>2</sub> O
1300	Iodine heptafluoride	IF <sub>7</sub>	16921-96-3	259.893	col gas	6.5 tp	4.8 sp	10.62 g/L		s H <sub>2</sub> O
1301	Iodosyl trifluoride	IOF <sub>3</sub>	19058-78-7	199.898	hyg col needles	dec >110				reac H <sub>2</sub> O
1302	Iodosyl pentafluoride	IOF <sub>5</sub>	16056-61-4	237.895	col liq	4.5				
1303	Iodyl trifluoride	IO <sub>2</sub> F <sub>3</sub>	25402-50-0	215.898	yel solid	41	subl			
1304	Periodyl fluoride	IO <sub>3</sub> F	30708-86-2	193.900	col cry	dec >100				
1305	Iridium	Ir	7439-88-5	192.217	silv-wh metal; cub	2446	4428	22.562 <sup>20</sup>		s aqua regia
1306	Iridium carbonyl	Ir <sub>4</sub> (CO) <sub>12</sub>	11065-24-0	1104.989	yel cry	210 dec				
1307	Iridium(III) bromide	IrBr <sub>3</sub>	10049-24-8	431.929	red-brn monocl cry			6.82		i H <sub>2</sub> O, acid, alk

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1308	Iridium(III) bromide tetrahydrate	IrBr <sub>3</sub> · 4H <sub>2</sub> O	10049-24-8*	503.991	grn-brn cry					s H <sub>2</sub> O; i EtOH
1309	Iridium(III) chloride	IrCl <sub>3</sub>	10025-83-9	298.576	brn monocl cry	763 dec		5.30		i H <sub>2</sub> O, acid, alk
1310	Iridium(III) fluoride	IrF <sub>3</sub>	23370-59-4	249.212	blk hex cry	250 dec		≈8.0		i H <sub>2</sub> O, dil acid
1311	Iridium(III) iodide	IrI <sub>3</sub>	7790-41-2	572.930	dark brn monocl cry			≈7.4		i H <sub>2</sub> O, acid, bz, chl; s alk
1312	Iridium(III) oxide	Ir <sub>2</sub> O <sub>3</sub>	1312-46-5	432.432	blue-blk cry	1000 dec				i H <sub>2</sub> O; sl hot HCl
1313	Iridium(III) 2,4-pentanedioate	Ir(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	15635-87-7	489.541	oran-yel cry	270	subl			sl H <sub>2</sub> O; s tol, chl, ace, MeOH
1314	Iridium(III) sulfide	Ir <sub>2</sub> S <sub>3</sub>	12136-42-4	480.629	orth cry			10.2		
1315	Iridium(IV) chloride	IrCl <sub>4</sub>	10025-97-5	334.029	brn hyg solid	≈700 dec				s H <sub>2</sub> O, EtOH
1316	Iridium(IV) oxide	IrO <sub>2</sub>	12030-49-8	224.216	brn tetr cry	1100 dec		11.7		
1317	Iridium(IV) sulfide	IrS <sub>2</sub>	12030-51-2	256.347	orth cry			9.3		
1318	Iridium(VI) fluoride	IrF <sub>6</sub>	7783-75-7	306.207	yel cub cry; hyg	44	53.6	4.8		reac H <sub>2</sub> O
1319	Iron	Fe	7439-89-6	55.845	silv-wh or gray met	1538	2861	7.87		s dil acid
1320	Ferrocene	Fe(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	102-54-5	186.031	oran needles	172.5	249			i H <sub>2</sub> O; s EtOH, eth, bz, dil HNO <sub>3</sub>
1321	Tetracarbonyldihydroiron	Fe(CO) <sub>4</sub> H <sub>2</sub>	12002-28-7	169.902	col liq, stab low temp	-70	dec -20			s alk
1322	Iron pentacarbonyl	Fe(CO) <sub>5</sub>	13463-40-6	195.896	yel oily liq; flam	-20.5	103	1.46		i H <sub>2</sub> O; s eth, bz, ace
1323	Iron nonacarbonyl	Fe <sub>9</sub> (CO) <sub>9</sub>	15321-51-4	363.781	oran-yel cry	100 dec		2.85		
1324	Iron dodecacarbonyl	Fe <sub>12</sub> (CO) <sub>12</sub>	12088-65-2	503.656	dark grn cry	140		2.00		
1325	Iron arsenide	FeAs	12044-16-5	130.767	gray orth cry	1030		7.85		
1326	Iron boride (FeB)	FeB	12006-84-7	66.656	refrac solid; orth	1658		≈7		
1327	Iron boride (Fe <sub>2</sub> B)	Fe <sub>2</sub> B	12006-86-9	122.501	refrac solid; tetr	1389		7.3		
1328	Iron carbide	Fe <sub>3</sub> C	12011-67-5	179.546	gray cub cry	1227		7.694		
1329	Iron phosphide (FeP)	FeP	26508-33-8	86.819	rhomb cry			6.07		
1330	Iron phosphide (Fe <sub>3</sub> P)	Fe <sub>3</sub> P	1310-43-6	142.664	gray hex needles	1370		6.8		i H <sub>2</sub> O, dil acid, alk
1331	Iron phosphide (Fe <sub>5</sub> P)	Fe <sub>5</sub> P	12023-53-9	198.509	gray solid	1100		6.74		i H <sub>2</sub> O
1332	Iron disulfide	FeS <sub>2</sub>	1317-66-4	119.975	blk cub cry	>600 dec		5.02		i H <sub>2</sub> O
1333	Iron silicide	FeSi	12022-95-6	83.931	gray cub cry	1410		6.1		
1334	Iron disilicide	FeSi <sub>2</sub>	12022-99-0	112.016	gray tetr cry	1220		4.74		
1335	Iron(II) acetate	Fe(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	3094-87-9	173.934	wh cry	190 dec				s H <sub>2</sub> O
1336	Iron(II) acetate tetrahydrate	Fe(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	3094-87-9*	245.994	grn cry	dec				s H <sub>2</sub> O, EtOH
1337	Iron(II) aluminate	Fe(AlO <sub>2</sub> ) <sub>2</sub>	12068-49-4	173.806	blk cub cry			4.3		
1338	Iron(II) arsenate	Fe <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	10102-50-8	445.373	grn powder					i H <sub>2</sub> O
1339	Iron(II) arsenate hexahydrate	Fe <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10102-50-8*	553.465	grn amorp powder	dec				i H <sub>2</sub> O; s acid
1340	Iron(II) bromide	FeBr <sub>2</sub>	7789-46-0	215.653	yel-brn hex cry; hyg	691	dec	4.636	120 <sup>25</sup>	vs EtOH
1341	Iron(II) bromide hexahydrate	FeBr <sub>2</sub> · 6H <sub>2</sub> O	13463-12-2	323.744	grn hyg cry	27 dec		4.64	120 <sup>25</sup>	s EtOH
1342	Iron(II) carbonate	FeCO <sub>3</sub>	563-71-3	115.854	gray-brn hex cry			3.944	0.000062 <sup>20</sup>	
1343	Iron(II) chloride	FeCl <sub>2</sub>	7758-94-3	126.751	wh hex cry; hyg	677	1023	3.16	65.0 <sup>25</sup>	vs EtOH, ace; sl bz
1344	Iron(II) chloride dihydrate	FeCl <sub>2</sub> · 2H <sub>2</sub> O	16399-77-2	162.782	wh-grn monocl cry	120 dec		2.39	65.0 <sup>25</sup>	
1345	Iron(II) chloride tetrahydrate	FeCl <sub>2</sub> · 4H <sub>2</sub> O	13478-10-9	198.813	grn monocl cry	105 dec		1.93	65.0 <sup>25</sup>	s EtOH
1346	Iron(II) chromite	FeCr <sub>2</sub> O <sub>4</sub>	1308-31-2	223.835	blk cub cry			5.0		
1347	Iron(II) fluoride	FeF <sub>2</sub>	7789-28-8	93.842	wh tetr cry	1100		4.09		sl H <sub>2</sub> O; s dil HF; i EtOH, eth
1348	Iron(II) fluoride tetrahydrate	FeF <sub>2</sub> · 4H <sub>2</sub> O	13940-89-1	165.904	col hex cry			2.20		
1349	Iron(II) hydroxide	Fe(OH) <sub>2</sub>	18624-44-7	89.860	wh-grn hex cry			3.4	0.000052 <sup>20</sup>	
1350	Iron(II) iodide	FeI <sub>2</sub>	7783-86-0	309.654	red-viol hex cry; hyg	594		5.3		s H <sub>2</sub> O, EtOH, eth
1351	Iron(II) iodide tetrahydrate	FeI <sub>2</sub> · 4H <sub>2</sub> O	7783-86-0*	381.716	blk hyg leaflets	90 dec		2.87		s H <sub>2</sub> O, EtOH
1352	Iron(II) molybdate	FeMoO <sub>4</sub>	13718-70-2	215.78	brn-yel monocl cry	1115		5.6		i H <sub>2</sub> O
1353	Iron(II) nitrate	Fe(NO <sub>3</sub> ) <sub>2</sub>	14013-86-6	179.854	grn solid				87.5 <sup>25</sup>	
1354	Iron(II) nitrate hexahydrate	Fe(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	14013-86-6*	287.946	grn solid	60 dec			87.5 <sup>25</sup>	
1355	Iron(II) orthosilicate	Fe <sub>2</sub> SiO <sub>4</sub>	10179-73-4	203.774	brn orth cry			4.30		
1356	Iron(II) oxalate dihydrate	FeC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	6047-25-2	179.894	yel cry	150 dec		2.28	0.078 <sup>25</sup>	s acid
1357	Iron(II) oxide	FeO	1345-25-1	71.844	blk cub cry	1377		6.02		i H <sub>2</sub> O, alk; s acid
1358	Iron(II) 2,4-pentanedioate	Fe(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14024-17-0	254.061	oran-brn cry	170	subl			sl bz, tol
1359	Iron(II) perchlorate	Fe(ClO <sub>4</sub> ) <sub>2</sub>	13933-23-8	254.746	grn-wh hyg needles	>100 dec			210 <sup>25</sup>	
1360	Iron(II) phosphate octahydrate	Fe <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	14940-41-1	501.600	gray-blue monocl cry; hyg			2.58		i H <sub>2</sub> O; s acid
1361	Iron(II) selenide	FeSe	1310-32-3	134.81	blk hex cry			6.7		i H <sub>2</sub> O
1362	Iron(II) sulfate	FeSO <sub>4</sub>	7720-78-7	151.908	wh orth cry; hyg			3.65	29.5 <sup>25</sup>	
1363	Iron(II) sulfate monohydrate	FeSO <sub>4</sub> · H <sub>2</sub> O	17375-41-6	169.923	wh-yel monocl cry	300 dec		3.0	29.5 <sup>25</sup>	



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1364	Iron(II) sulfate heptahydrate	FeSO <sub>4</sub> · 7H <sub>2</sub> O	7782-63-0	278.014	blue-grn monocl cry	≈60 dec		1.895	29.5 <sup>25</sup>	i EtOH
1365	Iron(II) sulfide	FeS	1317-37-9	87.910	col hex or tetr cry; hyg	1188	dec	4.7		i H <sub>2</sub> O; reac acid
1366	Iron(II) tantalate	Fe(TaO <sub>3</sub> ) <sub>2</sub>	12140-41-9	513.737	brn tetr cry			7.33		
1367	Iron(II) tartrate	FeC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>		203.916	wh cry				0.88	vs acid; s NH <sub>4</sub> OH
1368	Iron(II) telluride	FeTe	12125-63-2	183.45	tetr cry	914		6.8		
1369	Iron(II) thiocyanate trihydrate	Fe(SCN) <sub>2</sub> · 3H <sub>2</sub> O	6010-09-9	226.055	grn monocl cry					s H <sub>2</sub> O, EtOH, eth
1370	Iron(II) titanate	FeTiO <sub>3</sub>	12168-52-4	151.710	blk rhomb cry	≈1470		4.72		
1371	Iron(II) tungstate	FeWO <sub>4</sub>	13870-24-1	303.68	monocl cry			7.51		
1372	Iron(II,III) oxide	Fe <sub>3</sub> O <sub>4</sub>	1317-61-9	231.533	blk cub cry or amorp powder	1597		5.17		i H <sub>2</sub> O; s acid
1373	Iron(III) acetate, basic	FeOH(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	10450-55-2	190.941	brn-red amorp powder					i H <sub>2</sub> O; s EtOH, acid
1374	Iron(III) ammonium citrate	Fe(NH <sub>4</sub> ) <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub>	1185-57-5	488.160	red or brn pow; hyg					s H <sub>2</sub> O; i EtOH
1375	Iron(III) arsenate dihydrate	FeAsO <sub>4</sub> · 2H <sub>2</sub> O	10102-49-5	230.795	grn-brn powder	dec		3.18		i H <sub>2</sub> O; s dil acid
1376	Iron(III) bromide	FeBr <sub>3</sub>	10031-26-2	295.557	dark red hex cry; hyg	dec		4.5	455 <sup>25</sup>	s EtOH, eth
1377	Iron(III) chloride	FeCl <sub>3</sub>	7705-08-0	162.204	grn hex cry; hyg	307.6	≈316	2.90	91.2 <sup>25</sup>	s EtOH, eth, ace
1378	Iron(III) chloride hexahydrate	FeCl <sub>3</sub> · 6H <sub>2</sub> O	10025-77-1	270.295	yel-oran monocl cry; hyg	37 dec		1.82	91.2 <sup>25</sup>	s EtOH, eth, ace
1379	Iron(III) chromate	Fe <sub>2</sub> (CrO <sub>4</sub> ) <sub>3</sub>	10294-52-7	459.671	yel powder					i H <sub>2</sub> O, EtOH; s acid
1380	Iron(III) citrate pentahydrate	FeC <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · 5H <sub>2</sub> O	3522-50-7	335.021	red-brn cry					s H <sub>2</sub> O; i EtOH
1381	Iron(III) dichromate	Fe <sub>2</sub> (Cr <sub>2</sub> O <sub>7</sub> ) <sub>3</sub>	10294-53-8	759.654	red-brn solid					s H <sub>2</sub> O, acid
1382	Iron(III) ferrocyanide	Fe <sub>3</sub> [Fe(CN) <sub>6</sub> ] <sub>3</sub>	14038-43-8	859.229	dark blue powder			1.80		i H <sub>2</sub> O, dil acid, os
1383	Iron(III) fluoride	FeF <sub>3</sub>	7783-50-8	112.840	grn hex cry	>1000		3.87	5.92 <sup>25</sup>	i EtOH, eth, bz
1384	Iron(III) fluoride trihydrate	FeF <sub>3</sub> · 3H <sub>2</sub> O	15469-38-2	166.886	yel-brn tetr cry			2.3	5.92 <sup>25</sup>	
1385	Iron(III) formate	Fe(CHO <sub>2</sub> ) <sub>3</sub>	555-76-0	190.897	red-yel cry powder					s H <sub>2</sub> O; sl EtOH
1386	Iron(III) hydroxide	Fe(OH) <sub>3</sub>	1309-33-7	106.867	yel monocl cry			3.12		
1387	Iron(III) hydroxide oxide	FeO(OH)	20344-49-4	88.852	red-brn orth cry			4.26		i H <sub>2</sub> O; s acid
1388	Iron(III) metavanadate	Fe(VO <sub>3</sub> ) <sub>3</sub>	65842-03-7	352.665	gray-brn powder					i H <sub>2</sub> O, EtOH; s acid
1389	Iron(III) nitrate	Fe(NO <sub>3</sub> ) <sub>3</sub>	10421-48-4	241.860	cry				82.5 <sup>20</sup>	
1390	Iron(III) nitrate hexahydrate	Fe(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	13476-08-9	349.951	viol cub cry	35 dec			82.5 <sup>20</sup>	
1391	Iron(III) nitrate nonahydrate	Fe(NO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	7782-61-8	403.997	viol-gray hyg cry	47 dec		1.68	82.5 <sup>20</sup>	vs EtOH, ace
1392	Iron(III) oxalate	Fe <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub>	19469-07-9	375.747	yel amorp powder	100 dec				s H <sub>2</sub> O, acid; i alk
1393	Iron(III) oxide	Fe <sub>2</sub> O <sub>3</sub>	1309-37-1	159.688	red-brn hex cry	1539		5.25		i H <sub>2</sub> O; s acid
1394	Iron(III) 2,4-pentanedioate	Fe(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	14024-18-1	353.169	red-oran cry	179		5.24		sl H <sub>2</sub> O; s os
1395	Iron(III) perchlorate hexahydrate	Fe(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	32963-81-8	462.288	viol cry					
1396	Iron(III) phosphate dihydrate	FePO <sub>4</sub> · 2H <sub>2</sub> O	10045-86-0	186.847	gray-wh orth cry			2.87		i H <sub>2</sub> O; s HCl
1397	Iron(III) pyrophosphate nonahydrate	Fe <sub>4</sub> (P <sub>2</sub> O <sub>7</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	10058-44-3	907.348	yel powder					i H <sub>2</sub> O; s acid
1398	Iron(III) hypophosphite	Fe(H <sub>2</sub> PO <sub>2</sub> ) <sub>3</sub>	7783-84-8	250.811	wh-gray powder					i H <sub>2</sub> O
1399	Iron(III) sodium pyrophosphate	FeNaP <sub>2</sub> O <sub>7</sub>	10045-87-1	252.778	wh powder			1.5		i H <sub>2</sub> O; s HCl
1400	Iron(III) sulfate	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10028-22-5	399.878	gray-wh rhomb cry; hyg			3.10	440 <sup>20</sup>	sl EtOH; i ace
1401	Iron(III) sulfate nonahydrate	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	13520-56-4	562.015	yel hex cry	400 dec		2.1	440 <sup>20</sup>	
1402	Iron(III) thiocyanate	Fe(SCN) <sub>3</sub>	4119-52-2	230.092	red-viol hyg cry	dec				s H <sub>2</sub> O, EtOH, ace; i tol, chl
1403	Krypton	Kr	7439-90-9	83.798	col gas	-157.38 tp (73.2 kPa)	-153.34	3.425 g/L		sl H <sub>2</sub> O
1404	Krypton difluoride	KrF <sub>2</sub>	13773-81-4	121.795	col tetr cry	≈25 dec		3.24		reac H <sub>2</sub> O
1405	Krypton fluoride hexafluoroantimonate	KrFSb <sub>2</sub> F <sub>11</sub>	39578-36-4	555.299	wh solid	dec 45				
1406	Lanthanum	La	7439-91-0	138.905	silv metal; hex	920	3464	6.15		s dil acid
1407	Lanthanum aluminum oxide	LaAlO <sub>3</sub>	12003-65-5	213.885	wh rhom cry	trans cub 500				
1408	Lanthanum boride	LaB <sub>6</sub>	12008-21-8	203.771	blk cub cry; refrac	2715		4.76		
1409	Lanthanum bromate nonahydrate	LaBrO <sub>3</sub> · 9H <sub>2</sub> O		684.749	hex cry	dec 100		5.06		vs H <sub>2</sub> O
1410	Lanthanum bromide	LaBr <sub>3</sub>	13536-79-3	378.617	wh hex cry; hyg	788		5.1		s H <sub>2</sub> O
1411	Lanthanum carbide	LaC <sub>2</sub>	12071-15-7	162.926	tetr cry	2360		5.29		
1412	Lanthanum carbonate octahydrate	La <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	6487-39-4	601.960	wh cry powder			2.6		i H <sub>2</sub> O; s dil acid
1413	Lanthanum chloride	LaCl <sub>3</sub>	10099-58-8	245.264	wh hex cry; hyg	858		3.84	95.7 <sup>25</sup>	
1414	Lanthanum chloride heptahydrate	LaCl <sub>3</sub> · 7H <sub>2</sub> O	20211-76-1	371.371	wh tricl cry; hyg	91 dec			95.7 <sup>25</sup>	s EtOH
1415	Lanthanum fluoride	LaF <sub>3</sub>	13709-38-1	195.900	wh hex cry; hyg	1493		5.9		i H <sub>2</sub> O, acid
1416	Lanthanum hydride	LaH <sub>3</sub>	13864-01-2	141.929	blk cub cry			5.36		
1417	Lanthanum hydroxide	La(OH) <sub>3</sub>	14507-19-8	189.927	wh amorp solid	dec			0.000020 <sup>20</sup>	
1418	Lanthanum iodate	La(IO <sub>3</sub> ) <sub>3</sub>	13870-19-4	663.614	col cry				1.7	
1419	Lanthanum iodide	LaI <sub>3</sub>	13813-22-4	519.619	wh orth cry; hyg	778		5.6		s H <sub>2</sub> O
1420	Lanthanum nitrate hexahydrate	La(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	10277-43-7	433.011	wh hyg tricl cry	≈40 dec			200 <sup>25</sup>	vs EtOH; s ace

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1421	Lanthanum nitride	LaN	25764-10-7	152.912	cub cry			6.73		
1422	Lanthanum oxide	La <sub>2</sub> O <sub>3</sub>	1312-81-8	325.809	wh amorp powder	2304	3620	6.51		i H <sub>2</sub> O; s dil acid
1423	Lanthanum perchlorate hexahydrate	La(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	36907-37-6	475.021	hyg col cry	dec 100				vs H <sub>2</sub> O; s EtOH
1424	Lanthanum silicide	LaSi <sub>2</sub>	12056-90-5	195.076	gray tetr cry	1520		5.0		
1425	Lanthanum sulfate	La <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10099-60-2	565.999	hyg wh pow	1150				sl H <sub>2</sub> O
1426	Lanthanum sulfate octahydrate	La <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	57804-25-8	702.058	col cry	dec		2.82		sl H <sub>2</sub> O
1427	Lanthanum sulfate nonahydrate	La <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	10294-62-9	728.136	hex cry			2.82	2.7 <sup>20</sup>	i EtOH
1428	Lanthanum monosulfide	LaS	12031-30-0	170.970	yel cub cry	2300		5.61		
1429	Lanthanum sulfide	La <sub>2</sub> S <sub>3</sub>	12031-49-1	374.006	red cub cry	2110		4.9		
1430	Lawrencium	Lr	22537-19-5	262	metal	1627				
1431	Lead	Pb	7439-92-1	207.2	soft silv-gray metal; cub	327.462	1749	11.3		s conc acid
1432	Plumbane	PbH <sub>4</sub>	15875-18-0	211.2	unstab col gas		-13			
1433	Lead(II) acetate	Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	301-04-2	325.3	wh cry	280	dec	3.25	44.3 <sup>20</sup>	
1434	Lead(II) acetate trihydrate	Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	6080-56-4	427.3	col cry	75 dec		2.55		vs H <sub>2</sub> O; sl EtOH
1435	Lead(II) acetate, basic	Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2Pb(OH) <sub>2</sub>	1335-32-6	807.7	wh powder	dec			6.3 <sup>0</sup>	
1436	Lead(II) antimonate	Pb <sub>3</sub> (SbO <sub>4</sub> ) <sub>2</sub>	13510-89-9	993.1	oran-yel powder			6.58		i H <sub>2</sub> O, dil acid
1437	Lead(II) arsenate	Pb <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	3687-31-8	899.4	wh cry	1042 dec		5.8		i H <sub>2</sub> O; s HNO <sub>3</sub>
1438	Lead(II) arsenite	Pb(AsO <sub>2</sub> ) <sub>2</sub>	10031-13-7	421.0	wh powder			5.85		i H <sub>2</sub> O; s dil HNO <sub>3</sub>
1439	Lead(II) azide	Pb(N <sub>3</sub> ) <sub>2</sub>	13424-46-9	291.2	col orth needles; exp	exp ≈350		4.7	0.023 <sup>18</sup>	vs HOAc
1440	Lead(II) borate monohydrate	Pb(BO <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	10214-39-8	310.8	wh powder	500 dec		5.6		i H <sub>2</sub> O; s dil HNO <sub>3</sub>
1441	Lead(II) bromate monohydrate	Pb(BrO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	10031-21-7	481.0	col cry	≈180 dec		5.53	1.33 <sup>20</sup>	
1442	Lead(II) bromide	PbBr <sub>2</sub>	10031-22-8	367.0	wh orth cry	371	892	6.69	0.975 <sup>25</sup>	i EtOH
1443	Lead(II) butanoate	Pb(C <sub>4</sub> H <sub>7</sub> O <sub>2</sub> ) <sub>2</sub>	819-73-8	381.4	col solid	≈90				i H <sub>2</sub> O; s dil HNO <sub>3</sub>
1444	Lead(II) carbonate	PbCO <sub>3</sub>	598-63-0	267.2	col orth cry	≈315 dec		6.582		i H <sub>2</sub> O
1445	Lead(II) carbonate, basic	Pb(OH) <sub>2</sub> · 2PbCO <sub>3</sub>	1319-46-6	775.6	wh hex cry	400 dec		≈6.5		i H <sub>2</sub> O, EtOH; s acid
1446	Lead(II) chlorate	Pb(ClO <sub>3</sub> ) <sub>2</sub>	10294-47-0	374.1	col hyg cry	230 dec		3.9	144 <sup>18</sup>	vs EtOH
1447	Lead(II) chloride	PbCl <sub>2</sub>	7758-95-4	278.1	wh orth needles or powder	501	951	5.98	1.08 <sup>25</sup>	s alk
1448	Lead(II) chloride fluoride	PbClF	13847-57-9	261.7	tetr cry			7.05	0.035 <sup>20</sup>	
1449	Lead(II) chlorite	Pb(ClO <sub>2</sub> ) <sub>2</sub>	13453-57-1	342.1	yel monocl cry	dec 126			0.2 <sup>25</sup>	sl H <sub>2</sub> O; s alk
1450	Lead(II) chromate	PbCrO <sub>4</sub>	7758-97-6	323.2	yel-oran monocl cry	844		6.12	0.000017 <sup>20</sup>	s alk, dil acid
1451	Lead(II) chromate(VI) oxide	PbCrO <sub>4</sub> · PbO	18454-12-1	546.4	red powder					i H <sub>2</sub> O
1452	Lead(II) citrate trihydrate	Pb <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	512-26-5	1053.8	wh cry powder					s H <sub>2</sub> O; sl EtOH
1453	Lead(II) cyanide	Pb(CN) <sub>2</sub>	592-05-2	259.2	wh-yel powder					sl H <sub>2</sub> O; reac acid
1454	Lead(II) 2-ethylhexanoate	Pb(C <sub>8</sub> H <sub>15</sub> CO <sub>2</sub> ) <sub>2</sub>	301-08-6	493.6	visc liq			1.56		
1455	Lead(II) fluoride	PbF <sub>2</sub>	7783-46-2	245.2	wh orth cry	830	1293	8.44	0.0670 <sup>25</sup>	
1456	Lead(II) fluoroborate	Pb(BF <sub>4</sub> ) <sub>2</sub>	13814-96-5	380.8	stab only in aq soln					s H <sub>2</sub> O
1457	Lead(II) formate	Pb(CHO <sub>2</sub> ) <sub>2</sub>	811-54-1	297.2	wh prisms or needles	190 dec		4.63	1.6 <sup>16</sup>	i EtOH
1458	Lead(II) hexafluoro-2,4-pentanedioate	Pb(CF <sub>3</sub> COCHCOCF <sub>3</sub> ) <sub>2</sub>	19648-88-5	621.3	cry	155	210			
1459	Lead(II) hydrogen arsenate	PbHAsO <sub>4</sub>	7784-40-9	347.1	wh monocl cry	280 dec		5.943		i H <sub>2</sub> O; s HNO <sub>3</sub> , alk
1460	Lead(II) hydrogen phosphate	PbHPO <sub>4</sub>	15845-52-0	303.2	wh monocl cry	dec		5.66		
1461	Lead(II) hydroxide	Pb(OH) <sub>2</sub>	19783-14-3	241.2	wh powder	145 dec		5.69	0.00012 <sup>20</sup>	s acid
1462	Lead(II) iodate	Pb(IO <sub>3</sub> ) <sub>2</sub>	25659-31-8	557.0	wh orth cry			6.50	0.0025 <sup>25</sup>	
1463	Lead(II) iodide	PbI <sub>2</sub>	10101-63-0	461.0	yel hex cry or powder	410	872 dec	6.16	0.076 <sup>25</sup>	i EtOH
1464	Lead(II) lactate	Pb(C <sub>3</sub> H <sub>5</sub> O <sub>3</sub> ) <sub>2</sub>	18917-82-3	385.3	wh cry powder					s H <sub>2</sub> O, hot EtOH
1465	Lead(II) molybdate	PbMoO <sub>4</sub>	10190-55-3	367.1	yel tetr cry	≈1060		6.7		i H <sub>2</sub> O; s HNO <sub>3</sub> , NaOH
1466	Lead(II) niobate	Pb(NbO <sub>3</sub> ) <sub>2</sub>	12034-88-7	489.0	rhomb or tetr cry	1343		6.6		i H <sub>2</sub> O
1467	Lead(II) nitrate	Pb(NO <sub>3</sub> ) <sub>2</sub>	10099-74-8	331.2	col cub cry	470		4.53	59.7 <sup>25</sup>	sl EtOH
1468	Lead(II) oleate	Pb(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	1120-46-3	770.1	wax-like solid					i H <sub>2</sub> O; s EtOH, bz, eth
1469	Lead(II) oxalate	PbC <sub>2</sub> O <sub>4</sub>	814-93-7	295.2	wh powder	300 dec		5.28	0.00025 <sup>20</sup>	s dil HNO <sub>3</sub>
1470	Lead(II) oxide (litharge)	PbO	1317-36-8	223.2	red tetr cry	trans to massicot 489		9.35		i H <sub>2</sub> O, EtOH; s dil HNO <sub>3</sub>
1471	Lead(II) oxide (massicot)	PbO	1317-36-8	223.2	yel orth cry	887		9.64		i H <sub>2</sub> O, EtOH; s dil HNO <sub>3</sub>
1472	Lead(II) oxide hydrate	3PbO · H <sub>2</sub> O	1311-11-1	687.6	wh powder			7.41		i H <sub>2</sub> O; s dil acid
1473	Lead(II) 2,4-pentanedioate	Pb(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	15282-88-9	405.4	cry	143				
1474	Lead(II) perchlorate	Pb(ClO <sub>4</sub> ) <sub>2</sub>	13453-62-8	406.1	wh cry				441 <sup>25</sup>	
1475	Lead(II) perchlorate trihydrate	Pb(ClO <sub>4</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	13637-76-8	460.1	wh cry	100 dec		2.6	441 <sup>25</sup>	s EtOH



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1476	Lead(II) phosphate	Pb <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7446-27-7	811.5	wh hex cry	1014		7.01		i H <sub>2</sub> O, EtOH
1477	Lead(II) hypophosphite	Pb(H <sub>2</sub> PO <sub>2</sub> ) <sub>2</sub>	10294-58-3	337.2	hyg cry powder	dec				sl H <sub>2</sub> O; i EtOH
1478	Lead(II) metasilicate	PbSiO <sub>3</sub>	10099-76-0	283.3	wh monocry powder	764		6.49		i H <sub>2</sub> O, os
1479	Lead(II) orthosilicate	Pb <sub>2</sub> SiO <sub>4</sub>	13566-17-1	506.5	monocry	743		7.60		
1480	Lead(II) hexafluorosilicate dihydrate	PbSiF <sub>6</sub> · 2H <sub>2</sub> O	1310-03-8	385.3	col cry	dec				vs H <sub>2</sub> O
1481	Lead(II) selenate	PbSeO <sub>4</sub>	7446-15-3	350.2	orth cry			6.37	0.013 <sup>25</sup>	s conc acid
1482	Lead(II) selenide	PbSe	12069-00-0	286.2	gray cub cry	1078		8.1		i H <sub>2</sub> O; s HNO <sub>3</sub>
1483	Lead(II) selenite	PbSeO <sub>3</sub>	7488-51-9	334.2	wh monocry	≈500		7.0		i H <sub>2</sub> O
1484	Lead(II) sodium thiosulfate	Na <sub>2</sub> Pb(S <sub>2</sub> O <sub>3</sub> ) <sub>2</sub>	10101-94-7	635.5	wh cry					sl H <sub>2</sub> O
1485	Lead(II) stearate	Pb(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	1072-35-1	774.1	wh powder	≈100		1.4		i H <sub>2</sub> O; s hot EtOH
1486	Lead(II) sulfate	PbSO <sub>4</sub>	7446-14-2	303.3	orth cry	1087		6.29	0.0044 <sup>25</sup>	i acid; sl alk
1487	Lead(II) sulfide	PbS	1314-87-0	239.3	blk powder or silv cub cry	1113		7.60		i H <sub>2</sub> O; s acid
1488	Lead(II) sulfite	PbSO <sub>3</sub>	7446-10-8	287.3	wh powder	dec				i H <sub>2</sub> O; s HNO <sub>3</sub>
1489	Lead(II) tantalate	Pb(TaO <sub>3</sub> ) <sub>2</sub>	12065-68-8	665.1	orth cry			7.9		i H <sub>2</sub> O
1490	Lead(II) telluride	PbTe	1314-91-6	334.8	gray cub cry	924		8.164		i H <sub>2</sub> O, acid
1491	Lead(II) thiocyanate	Pb(SCN) <sub>2</sub>	592-87-0	323.4	wh-yel powder			3.82	0.05 <sup>20</sup>	
1492	Lead(II) thiosulfate	PbS <sub>2</sub> O <sub>3</sub>	13478-50-7	319.3	wh cry	dec		5.18		i H <sub>2</sub> O; s acid
1493	Lead(II) titanate	PbTiO <sub>3</sub>	12060-00-3	303.1	yel tetr cry			7.9		i H <sub>2</sub> O; reac HCl
1494	Lead(II) tungstate (stolzite)	PbWO <sub>4</sub>	7759-01-5	455.0	yel tetr cry	1130		8.24	0.03 <sup>20</sup>	s alk
1495	Lead(II) tungstate (raspite)	PbWO <sub>4</sub>	7759-01-5	455.0	monocry	trans 400		8.46	0.03 <sup>20</sup>	s alk
1496	Lead(II) metavanadate	Pb(VO <sub>3</sub> ) <sub>2</sub>	10099-79-3	405.1	yel powder					i H <sub>2</sub> O; reac HNO <sub>3</sub>
1497	Lead(II) zirconate	PbZrO <sub>3</sub>	12060-01-4	346.4	col orth cry			≈8		i H <sub>2</sub> O, alk; s acid
1498	Lead(II,IV) oxide	Pb <sub>2</sub> O <sub>3</sub>	1314-27-8	462.4	blk monocry or red amorp powder	530 dec		10.05		i H <sub>2</sub> O; s alk; reac conc HCl
1499	Lead(II,IV) oxide	Pb <sub>3</sub> O <sub>4</sub>	1314-41-6	685.6	red tetr cry	830		8.92		i H <sub>2</sub> O, EtOH; s hot HCl
1500	Lead(IV) acetate	Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>4</sub>	546-67-8	443.4	col monocry	≈175		2.23		reac H <sub>2</sub> O, EtOH; s bz, chl
1501	Lead(IV) bromide	PbBr <sub>4</sub>	13701-91-2	526.8	unstab liq					
1502	Lead(IV) chloride	PbCl <sub>4</sub>	13463-30-4	349.0	yel oily liq	-15	≈50 dec			
1503	Lead(IV) fluoride	PbF <sub>4</sub>	7783-59-7	283.2	wh tetr cry; hyg	≈600		6.7		
1504	Lead(IV) oxide	PbO <sub>2</sub>	1309-60-0	239.2	red tetr cry or brn powder	290 dec		9.64		
1505	Lithium	Li	7439-93-2	6.941	soft silv-wh metal	180.50	1342	0.534		reac H <sub>2</sub> O
1506	Lithium acetate	LiC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	546-89-4	65.985	cry	286			45.0 <sup>25</sup>	vs EtOH
1507	Lithium acetate dihydrate	LiC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> · 2H <sub>2</sub> O	6108-17-4	102.016	wh rhomb cry	58 dec		1.3	45.0 <sup>25</sup>	s EtOH
1508	Lithium aluminum hydride	LiAlH <sub>4</sub>	16853-85-3	37.955	gray-wh monocry	>125 dec		0.917		reac H <sub>2</sub> O, EtOH; s eth, thf
1509	Lithium aluminum silicate	LiAlSi <sub>2</sub> O <sub>6</sub>	12068-40-5	186.090	wh monocry	1430		3.188		
1510	Lithium amide	LiNH <sub>2</sub>	7782-89-0	22.964	tetr cry	380		1.18		reac H <sub>2</sub> O
1511	Lithium arsenate	Li <sub>3</sub> AsO <sub>4</sub>	13478-14-3	159.743	col orth cry			3.07		sl H <sub>2</sub> O; s HOAc
1512	Lithium azide	LiN <sub>3</sub>	19597-69-4	48.961	hyg monocry; exp			1.83		vs H <sub>2</sub> O
1513	Lithium borohydride	LiBH <sub>4</sub>	16949-15-8	21.784	wh-gray orth cry or powder	268	380 dec	0.66		s alk, eth, thf
1514	Lithium bromate	LiBrO <sub>3</sub>	13550-28-2	134.843	hyg col orth cry	260			65.4 <sup>25</sup>	vs H <sub>2</sub> O
1515	Lithium bromide	LiBr	7550-35-8	86.845	wh cub cry; hyg	550	≈1300	3.464	181 <sup>25</sup>	s EtOH, eth
1516	Lithium bromide monohydrate	LiBr · H <sub>2</sub> O	23303-71-1	104.860	wh orth cry	trans cub 33		3.46	145 <sup>4</sup>	vs H <sub>2</sub> O
1517	Lithium carbide	Li <sub>2</sub> C <sub>2</sub>	1070-75-3	37.903	wh hyg cry			1.65		reac H <sub>2</sub> O; i os
1518	Lithium carbonate	Li <sub>2</sub> CO <sub>3</sub>	554-13-2	73.891	wh monocry	732	1300 dec	2.11	1.30 <sup>25</sup>	s acid; i EtOH
1519	Lithium chlorate	LiClO <sub>3</sub>	13453-71-9	90.392	col hyg rhom needles	127.6	300 dec	1.119	459 <sup>25</sup>	vs EtOH; sl ace
1520	Lithium chloride	LiCl	7447-41-8	42.394	wh cub cry or powder; hyg	610	1383	2.07	84.5 <sup>25</sup>	s EtOH, ace, py
1521	Lithium chloride monohydrate	LiCl · H <sub>2</sub> O	16712-20-2	60.409	hyg wh tetr cry	dec 98		1.78	45.9 <sup>25</sup>	vs H <sub>2</sub> O
1522	Lithium chromate dihydrate	Li <sub>2</sub> CrO <sub>4</sub> · 2H <sub>2</sub> O	7789-01-7	165.906	yel orth cry; hyg	75 dec		2.15		vs H <sub>2</sub> O; s EtOH
1523	Lithium citrate tetrahydrate	Li <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · 4H <sub>2</sub> O	6680-58-6	281.983	wh cry	210 (anh)			75 <sup>25</sup>	vs H <sub>2</sub> O; sl EtOH
1524	Lithium cobaltite	LiCoO <sub>2</sub>	12190-79-3	97.873	dark gray pow					i H <sub>2</sub> O
1525	Lithium cyanide	LiCN	2408-36-8	32.959	wh orth cry	160				
1526	Lithium hydride-d	LiD	13587-16-1	8.955	hyg wh cry	680		0.82		reac H <sub>2</sub> O
1527	Lithium dichromate dihydrate	Li <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> · 2H <sub>2</sub> O	10022-48-7	265.901	yel-red hyg cry	130 dec		2.34		vs H <sub>2</sub> O
1528	Lithium dihydrogen phosphate	LiH <sub>2</sub> PO <sub>4</sub>	13453-80-0	103.928	col hyg cry	>100		2.461	126 <sup>9</sup>	
1529	Lithium diisopropylamide	LiN(C <sub>3</sub> H <sub>7</sub> ) <sub>2</sub>	4111-54-0	107.123	hyg col cry	dec				s eth; i hc
1530	Lithium ferrosilicon	LiFeSi	64082-35-5	90.872	dark brittle cry					reac H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1531	Lithium fluoride	LiF	7789-24-4	25.939	wh cub cry or powder	848.2	1673	2.640	0.134 <sup>25</sup>	s acid
1532	Lithium formate monohydrate	Li(CHO <sub>2</sub> ) · H <sub>2</sub> O	6108-23-2	69.974	col-wh cry			1.46		s H <sub>2</sub> O
1533	Lithium hexafluoroantimonate	LiSbF <sub>6</sub>	18424-17-4	242.691	hyg pow	dec				
1534	Lithium hexafluoroarsenate	LiAsF <sub>6</sub>	29935-35-1	310.672	rhomb wh cry; hyg					
1535	Lithium hexafluorophosphate	LiPF <sub>6</sub>	21324-40-3	151.905	wh pow					
1536	Lithium hexafluorosilicate	Li <sub>2</sub> SiF <sub>6</sub>	17347-95-4	155.958	col hex cry	dec 350				sl ace
1537	Lithium hexafluorostannate	Li <sub>2</sub> SnF <sub>6</sub>	17029-16-2	246.582	wh pow					
1538	Lithium hydride	LiH	7580-67-8	7.949	gray cub cry or powder; hyg	692		0.78		reac H <sub>2</sub> O, EtOH
1539	Lithium hydrogen carbonate	LiHCO <sub>3</sub>	5006-97-3	67.958	wh pow					sl H <sub>2</sub> O
1540	Lithium hydroxide	LiOH	1310-65-2	23.948	col tetra cry	473	1626	1.45	12.5 <sup>25</sup>	sl EtOH
1541	Lithium hydroxide monohydrate	LiOH · H <sub>2</sub> O	1310-66-3	41.964	wh monocry or powder			1.51	12.5 <sup>25</sup>	sl EtOH
1542	Lithium hypochlorite	LiOCl	13840-33-0	58.393	wh pow					vs H <sub>2</sub> O
1543	Lithium iodate	LiIO <sub>3</sub>	13765-03-2	181.843	wh hyg hex cry	450		4.502	77.9 <sup>25</sup>	i EtOH
1544	Lithium iodide	LiI	10377-51-2	133.845	wh cub cry; hyg	469	1171	4.06	165 <sup>25</sup>	
1545	Lithium iodide trihydrate	LiI · 3H <sub>2</sub> O	7790-22-9	187.891	wh hyg cry	73		2.38	165 <sup>25</sup>	vs EtOH, ace
1546	Lithium manganate	Li <sub>2</sub> MnO <sub>3</sub>	12163-00-7	116.818	red-brn monocry			3.90		i H <sub>2</sub> O
1547	Lithium metaborate	LiBO <sub>2</sub>	13453-69-5	49.751	wh monocry; hyg	844		2.18	2.6 <sup>20</sup>	sl H <sub>2</sub> O; s EtOH
1548	Lithium metaborate dihydrate	LiBO <sub>2</sub> · 2H <sub>2</sub> O	15293-74-0	85.782	wh cry pow			1.8		s H <sub>2</sub> O
1549	Lithium metaphosphate	LiPO <sub>3</sub>	13762-75-9	85.913	wh cry or gl solid			1.8		i H <sub>2</sub> O
1550	Lithium metasilicate	Li <sub>2</sub> SiO <sub>3</sub>	10102-24-6	89.966	wh orth needles	1201		2.52		i cold H <sub>2</sub> O; reac dil acid
1551	Lithium molybdate	Li <sub>2</sub> MoO <sub>4</sub>	13568-40-6	173.82	hyg wh cry	702		2.66	44.8 <sup>25</sup>	s H <sub>2</sub> O
1552	Lithium niobate	LiNbO <sub>3</sub>	12031-63-9	147.845	wh hex cry	1240		4.30		
1553	Lithium nitrate	LiNO <sub>3</sub>	7790-69-4	68.946	col hex cry; hyg	253		2.38	102 <sup>25</sup>	s EtOH
1554	Lithium nitride	Li <sub>3</sub> N	26134-62-3	34.830	red hex cry	813		1.27		reac H <sub>2</sub> O
1555	Lithium nitrite	LiNO <sub>2</sub>	13568-33-7	52.947	wh hyg cry	222				vs H <sub>2</sub> O
1556	Lithium nitrite monohydrate	LiNO <sub>2</sub> · H <sub>2</sub> O	13568-33-7*	70.962	col needles	>100		1.615	139.5 <sup>25</sup>	vs H <sub>2</sub> O, EtOH
1557	Lithium orthosilicate	LiSiO <sub>4</sub>	13453-84-4	99.025	wh rhomb cry	1256		2.39		
1558	Lithium oxalate	Li <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	30903-87-8	101.901	col cry	dec		2.121 <sup>17</sup>		s H <sub>2</sub> O; i EtOH, eth
1559	Lithium phosphate	Li <sub>3</sub> PO <sub>4</sub>	10377-52-3	115.794	wh orth cry	1205		2.46	0.027 <sup>25</sup>	
1560	Lithium oxide	Li <sub>2</sub> O	12057-24-8	29.881	wh cub cry	1438		2.013		
1561	Lithium perchlorate	LiClO <sub>4</sub>	7791-03-9	106.392	wh orth cry or powder	236	430 dec	2.428	58.7 <sup>25</sup>	s EtOH, ace, eth
1562	Lithium perchlorate trihydrate	LiClO <sub>4</sub> · 3H <sub>2</sub> O	13453-78-6	160.438	wh hex cry	95 dec		1.84		vs H <sub>2</sub> O, EtOH, ace; i eth
1563	Lithium peroxide	Li <sub>2</sub> O <sub>2</sub>	12031-80-0	45.881	wh hex cry			2.31		s H <sub>2</sub> O; i EtOH
1564	Lithium selenate monohydrate	Li <sub>2</sub> SeO <sub>4</sub> · H <sub>2</sub> O	7790-71-8	174.86	monocry			2.56		vs H <sub>2</sub> O
1565	Lithium selenite monohydrate	Li <sub>2</sub> SeO <sub>3</sub> · H <sub>2</sub> O	15593-51-8	158.86	hyg cry					
1566	Lithium stearate	LiC <sub>18</sub> H <sub>35</sub> O <sub>2</sub>	4485-12-5	290.411	cry	≈220				
1567	Lithium sulfate	Li <sub>2</sub> SO <sub>4</sub>	10377-48-7	109.945	wh monocry; hyg	860		2.21	34.2 <sup>25</sup>	
1568	Lithium sulfate monohydrate	Li <sub>2</sub> SO <sub>4</sub> · H <sub>2</sub> O	10102-25-7	127.960	col cry	130 dec		2.06	34.2 <sup>25</sup>	sl EtOH
1569	Lithium sulfide	Li <sub>2</sub> S	12136-58-2	45.947	wh cub cry; hyg	1372		1.64		
1570	Lithium tantalate	LiTaO <sub>3</sub>	12031-66-2	235.887	wh pow	1650				
1571	Lithium tetraborate	Li <sub>2</sub> B <sub>4</sub> O <sub>7</sub>	12007-60-2	169.122	wh tetra cry	917		2.9 <sup>20</sup>		sl H <sub>2</sub> O
1572	Lithium tetraborate pentahydrate	Li <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 5H <sub>2</sub> O	1303-94-2	259.198	wh cry pow	dec 200				vs H <sub>2</sub> O; i EtOH
1573	Lithium tetracyanoplatinate pentahydrate	Li <sub>2</sub> Pt(CN) <sub>4</sub> · 5H <sub>2</sub> O	14402-73-4	403.112	grn-yel cry					sl H <sub>2</sub> O
1574	Lithium tetrafluoroborate	LiBF <sub>4</sub>	14283-07-9	93.746	hyg wh pow	dec				vs H <sub>2</sub> O
1575	Lithium thiocyanate	LiSCN	556-65-0	65.024	wh hyg cry				120 <sup>25</sup>	
1576	Lithium titanate	Li <sub>2</sub> TiO <sub>3</sub>	12031-82-2	109.747	wh pow	1325				i H <sub>2</sub> O
1577	Lithium tungstate	Li <sub>2</sub> WO <sub>4</sub>	13568-45-1	261.72	wh trig pow	740		3.71		s H <sub>2</sub> O
1578	Lithium vanadate	LiVO <sub>3</sub>	15060-59-0	105.881	yel pow		subl 1400			
1579	Lithium zirconate	Li <sub>2</sub> ZrO <sub>3</sub>	12031-83-3	153.104	wh solid					
1580	Lutetium	Lu	7439-94-3	174.967	silv metal; hex	1663	3402	9.84		s dil acid
1581	Lutetium boride	LuB <sub>4</sub>	12688-52-7	218.211	tetra cry	2600		≈7.0		
1582	Lutetium bromide	LuBr <sub>3</sub>	14456-53-2	414.679	wh hyg cry	1025				vs H <sub>2</sub> O
1583	Lutetium chloride	LuCl <sub>3</sub>	10099-66-8	281.326	wh monocry; hyg	925		3.98		s H <sub>2</sub> O
1584	Lutetium chloride hexahydrate	LuCl <sub>3</sub> · 6H <sub>2</sub> O	15230-79-2	389.417	col cry	dec 150				s H <sub>2</sub> O, EtOH
1585	Lutetium fluoride	LuF <sub>3</sub>	13760-81-1	231.962	orth cry	1182	2200	8.3		i H <sub>2</sub> O
1586	Lutetium iodide	LuI <sub>3</sub>	13813-45-1	555.680	brn hex cry; hyg	1050		≈5.6		vs H <sub>2</sub> O
1587	Lutetium iron oxide	Lu <sub>2</sub> Fe <sub>6</sub> O <sub>12</sub>	12023-71-1	996.119	cry					
1588	Lutetium nitrate	Lu(NO <sub>3</sub> ) <sub>3</sub>	10099-67-9	360.982	hyg col solid					s H <sub>2</sub> O, EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1589	Lutetium nitride	LuN	12125-25-6	188.974	cub cry			11.6		
1590	Lutetium oxide	Lu <sub>2</sub> O <sub>3</sub>	12032-20-1	397.932	wh cub cry or powder	2427	3980	9.41		
1591	Lutetium perchlorate hexahydrate	Lu(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	14646-29-8	581.410	col cry	dec 350 (anh)				s H <sub>2</sub> O, MeOH
1592	Lutetium sulfate	Lu <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	14986-89-1	638.122	wh pow	dec >850				vs H <sub>2</sub> O
1593	Lutetium sulfate octahydrate	Lu <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13473-77-3	782.244	col cry				42.3 <sup>20</sup>	s H <sub>2</sub> O
1594	Lutetium sulfide	Lu <sub>2</sub> S <sub>3</sub>	12163-20-1	446.129	gray rhomb cry	1750 dec		6.26		
1595	Lutetium telluride	Lu <sub>2</sub> Te <sub>3</sub>	12163-22-3	732.73	orth cry			7.8		
1596	Magnesium	Mg	7439-95-4	24.305	silv-wh metal	650	1090	1.74		s dil acid
1597	Magnesium acetate	Mg(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	142-72-3	142.394	wh orth/monocl cry	323 dec		1.50	65.6 <sup>25</sup>	
1598	Magnesium acetate monohydrate	Mg(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	60582-92-5	160.409	orth cry			1.55		
1599	Magnesium acetate tetrahydrate	Mg(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	16674-78-5	214.454	col monocl cry; hyg	80 dec		1.45	65.6 <sup>25</sup>	vs EtOH
1600	Magnesium aluminate	Mg(AlO <sub>2</sub> ) <sub>2</sub>	12068-51-8	142.266	col cub cry	2105		3.55		i H <sub>2</sub> O
1601	Magnesium aluminum silicate	Mg <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	1302-88-1	584.953	blue cry			2.6		
1602	Magnesium amide	Mg(NH <sub>2</sub> ) <sub>2</sub>	7803-54-5	56.350	wh powder; flam	dec		1.39		reac H <sub>2</sub> O
1603	Magnesium ammonium phosphate hexahydrate	MgNH <sub>4</sub> PO <sub>4</sub> · 6H <sub>2</sub> O	13478-16-5	245.407	wh pow	dec		1.71		i H <sub>2</sub> O, EtOH; s acid
1604	Magnesium antimonide	Mg <sub>3</sub> Sb <sub>2</sub>	12057-75-9	316.435	hex cry	1245		3.99		
1605	Magnesium arsenide	Mg <sub>3</sub> As <sub>2</sub>	12044-49-4	222.758	solid	≈1200		3.15		i H <sub>2</sub> O
1606	Magnesium diboride	MgB <sub>2</sub>	12007-25-9	45.927	hex cry	800 dec		2.57		
1607	Magnesium hexaboride	MgB <sub>6</sub>	12008-22-9	89.171	refrac solid	1100 dec				i H <sub>2</sub> O
1608	Magnesium dodecaboride	MgB <sub>12</sub>	12230-32-9	154.037	refrac solid	1300 dec				
1609	Magnesium bromate hexahydrate	Mg(BrO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	7789-36-8	388.201	col cub cry	200 dec		2.29	98 <sup>25</sup>	
1610	Magnesium bromide	MgBr <sub>2</sub>	7789-48-2	184.113	wh hex cry; hyg	711		3.72	102 <sup>25</sup>	
1611	Magnesium bromide hexahydrate	MgBr <sub>2</sub> · 6H <sub>2</sub> O	13446-53-2	292.204	col monocl cry	165 dec		2.0	102 <sup>25</sup>	s EtOH
1612	Magnesium carbonate	MgCO <sub>3</sub>	546-93-0	84.314	wh hex cry	990		3.010	0.18 <sup>20</sup>	i EtOH; s acid
1613	Magnesium carbonate dihydrate	MgCO <sub>3</sub> · 2H <sub>2</sub> O	5145-48-2	120.345	col tricr cry			2.8		i H <sub>2</sub> O, ace, NH <sub>4</sub> OH
1614	Magnesium carbonate trihydrate	MgCO <sub>3</sub> · 3H <sub>2</sub> O	14457-83-1	138.360	col monocl cry	165		1.8	0.18 <sup>16</sup>	
1615	Magnesium carbonate pentahydrate	MgCO <sub>3</sub> · 5H <sub>2</sub> O	61042-72-6	174.390	wh monocl cry	dec >400		3.04	0.38 <sup>16</sup>	
1616	Magnesium carbonate hydroxide tetrahydrate	4MgCO <sub>3</sub> · Mg(OH) <sub>2</sub> · 4H <sub>2</sub> O	39409-82-0	467.636	wh monocl cry			2.3		
1617	Magnesium carbonate hydroxide pentahydrate	4MgCO <sub>3</sub> · Mg(OH) <sub>2</sub> · 5H <sub>2</sub> O	56378-72-4	485.652	wh pow	dec 700				i H <sub>2</sub> O; s dil acid; i EtOH
1618	Magnesium carbonate dihydroxide trihydrate	MgCO <sub>3</sub> · Mg(OH) <sub>2</sub> · 3H <sub>2</sub> O	12143-96-3	196.680	wh monocl cry	dec		2.04		
1619	Magnesium chlorate hexahydrate	Mg(ClO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13446-19-0	299.299	wh hyg cry	≈35 dec		1.80	142 <sup>25</sup>	sl EtOH
1620	Magnesium chloride	MgCl <sub>2</sub>	7786-30-3	95.211	wh hex leaflets; hyg	714	1412	2.325	56.0 <sup>25</sup>	
1621	Magnesium chloride hexahydrate	MgCl <sub>2</sub> · 6H <sub>2</sub> O	7791-18-6	203.302	wh hyg cry	≈100 dec		1.56	56.0 <sup>25</sup>	s EtOH
1622	Magnesium chromate heptahydrate	MgCrO <sub>4</sub> · 7H <sub>2</sub> O	13423-61-5*	266.405	yel rhom cry			1.695	54.8 <sup>25</sup>	
1623	Magnesium chromite	MgCr <sub>2</sub> O <sub>4</sub>	12053-26-8	192.295	deep grn cry	2390		4.4		
1624	Magnesium citrate	Mg <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub>	3344-18-1	451.114	wh cry					sl H <sub>2</sub> O
1625	Magnesium citrate tetradecahydrate	Mg <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · 14H <sub>2</sub> O	3344-18-1*	703.328	wh cry pow					sl H <sub>2</sub> O; s acid
1626	Magnesium fluoride	MgF <sub>2</sub>	7783-40-6	62.302	wh tetr cry	1263	2227	3.148	0.013 <sup>25</sup>	
1627	Magnesium formate dihydrate	Mg(CHO <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	6150-82-9	150.370	wh cry	dec				s H <sub>2</sub> O; i EtOH
1628	Magnesium germanate	Mg <sub>2</sub> GeO <sub>4</sub>	12025-13-7	185.25	wh prec			3.09		i H <sub>2</sub> O
1629	Magnesium germanide	Mg <sub>2</sub> Ge	1310-52-7	121.25	cub cry	1117				
1630	Magnesium hydride	MgH <sub>2</sub>	7693-27-8	26.321	wh tetr cry	327		1.45		reac H <sub>2</sub> O
1631	Magnesium hydrogen phosphate trihydrate	MgHPO <sub>4</sub> · 3H <sub>2</sub> O	7757-86-0	174.331	wh powder	550 dec		2.13		sl H <sub>2</sub> O; s dil acid
1632	Magnesium hydroxide	Mg(OH) <sub>2</sub>	1309-42-8	58.320	wh hex cry	350		2.37	0.00069 <sup>20</sup>	s dil acid
1633	Magnesium iodate tetrahydrate	Mg(IO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	7790-32-1*	446.172	col monocl cry	210 dec		3.3	11.1 <sup>25</sup>	
1634	Magnesium iodide	MgI <sub>2</sub>	10377-58-9	278.114	wh hex cry; hyg	634		4.43	146 <sup>25</sup>	
1635	Magnesium iodide hexahydrate	MgI <sub>2</sub> · 6H <sub>2</sub> O	66778-21-0	386.205	wh monocl cry			2.35		
1636	Magnesium iodide octahydrate	MgI <sub>2</sub> · 8H <sub>2</sub> O	7790-31-0	422.236	wh orth cry; hyg	41 dec		2.10	146 <sup>25</sup>	s EtOH
1637	Magnesium metaborate octahydrate	Mg(BO <sub>2</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	13703-82-7*	254.047	wh pow	988 (anh)				sl H <sub>2</sub> O
1638	Magnesium metasilicate	MgSiO <sub>3</sub>	13776-74-4	100.389	wh monocl cry	≈1550 dec		3.19		i H <sub>2</sub> O; sl HF
1639	Magnesium metatitanate	MgTiO <sub>3</sub>	12032-30-3	120.170	col hex cry	1565		3.85		
1640	Magnesium molybdate	MgMoO <sub>4</sub>	12013-21-7	184.24	wh pow	≈1060		2.2	15.9 <sup>25</sup>	s H <sub>2</sub> O
1641	Magnesium nitrate	Mg(NO <sub>3</sub> ) <sub>2</sub>	10377-60-3	148.314	wh cub cry			≈2.3	71.2 <sup>25</sup>	
1642	Magnesium nitrate dihydrate	Mg(NO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	15750-45-5	184.345	wh cry	≈100 dec		1.45	71.2 <sup>25</sup>	s EtOH
1643	Magnesium nitrate hexahydrate	Mg(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13446-18-9	256.406	col monocl cry; hyg	≈95 dec		1.46	71.2 <sup>25</sup>	s EtOH
1644	Magnesium nitride	Mg <sub>3</sub> N <sub>2</sub>	12057-71-5	100.928	yel cub cry	≈1500 dec		2.71		
1645	Magnesium nitrite trihydrate	Mg(NO <sub>2</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	15070-34-5	170.362	wh hyg prisms	100 dec			129.9 <sup>25</sup>	s EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1646	Magnesium orthosilicate	Mg <sub>2</sub> SiO <sub>4</sub>	26686-77-1	140.694	wh orth cry	1897		3.21		i H <sub>2</sub> O
1647	Magnesium orthotitanate	Mg <sub>2</sub> TiO <sub>4</sub>	12032-52-9	160.475	wh cub cry	1840		3.53		
1648	Magnesium oxalate	MgC <sub>2</sub> O <sub>4</sub>	547-66-0	112.324	wh powder				0.038 <sup>25</sup>	
1649	Magnesium oxalate dihydrate	MgC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	6150-88-5	148.354	wh powder				0.038 <sup>25</sup>	i EtOH; s dil acid
1650	Magnesium oxide	MgO	1309-48-4	40.304	wh cub cry	2825	3600	3.6		sl H <sub>2</sub> O; i EtOH
1651	Magnesium perborate heptahydrate	Mg(BO <sub>3</sub> ) <sub>2</sub> · 7H <sub>2</sub> O	14635-87-1	268.030	wh pow					sl H <sub>2</sub> O
1652	Magnesium perchlorate	Mg(ClO <sub>4</sub> ) <sub>2</sub>	10034-81-8	223.206	wh hyg powder	250 dec		2.2	100 <sup>25</sup>	
1653	Magnesium perchlorate hexahydrate	Mg(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13446-19-0	331.298	wh hyg cry	190 dec		1.98	100 <sup>25</sup>	s EtOH
1654	Magnesium permanganate hexahydrate	Mg(MnO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10377-62-5	370.268	blue-blk cry	dec		2.18		s H <sub>2</sub> O
1655	Magnesium peroxide	MgO <sub>2</sub>	1335-26-8	56.304	wh cub cry	100 dec		≈3.0		i H <sub>2</sub> O; s dil acid
1656	Magnesium phosphate pentahydrate	Mg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 5H <sub>2</sub> O	7757-87-1*	352.934	wh cry	400 dec			0.00009 <sup>20</sup>	s dil acid
1657	Magnesium phosphate octahydrate	Mg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	13446-23-6	406.980	wh monocl cry			2.17	0.00009 <sup>20</sup>	s acid
1658	Magnesium pyrophosphate	Mg <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	13446-24-7	222.553	col monocl plates	1395		2.56		
1659	Magnesium pyrophosphate trihydrate	Mg <sub>2</sub> P <sub>2</sub> O <sub>7</sub> · 3H <sub>2</sub> O	10102-34-8	276.600	wh powder	100 dec		2.56		i H <sub>2</sub> O; s acid
1660	Magnesium phosphide	Mg <sub>3</sub> P <sub>2</sub>	12057-74-8	134.863	yel cub cry			2.06		react H <sub>2</sub> O
1661	Magnesium selenate hexahydrate	MgSeO <sub>4</sub> · 6H <sub>2</sub> O	13446-28-1	275.35	wh monocl cry			1.928	55.5 <sup>25</sup>	
1662	Magnesium selenide	MgSe	1313-04-8	103.27	brn cub cry			4.2		react H <sub>2</sub> O
1663	Magnesium selenite hexahydrate	MgSeO <sub>3</sub> · 6H <sub>2</sub> O	15593-61-0	259.36	col hex cry			2.09		i H <sub>2</sub> O; s dil acid
1664	Magnesium hexafluorosilicate hexahydrate	MgSiF <sub>6</sub> · 6H <sub>2</sub> O	60950-56-3	274.472	wh cry	120 dec		1.79	39.3 <sup>18</sup>	i EtOH
1665	Magnesium silicide	Mg <sub>2</sub> Si	22831-39-6	76.696	gray cub cry	1102		1.99		react H <sub>2</sub> O
1666	Magnesium stannide	Mg <sub>2</sub> Sn	1313-08-2	167.320	blue cub cry	771		3.60		s H <sub>2</sub> O, dil HCl
1667	Magnesium sulfate	MgSO <sub>4</sub>	7487-88-9	120.368	col orth cry	1137		2.66	35.7 <sup>25</sup>	
1668	Magnesium sulfate monohydrate	MgSO <sub>4</sub> · H <sub>2</sub> O	14168-73-1	138.383	col monocl cry	150 dec		2.57	35.7 <sup>25</sup>	
1669	Magnesium sulfate heptahydrate	MgSO <sub>4</sub> · 7H <sub>2</sub> O	10034-99-8	246.474	col orth cry	150 dec		1.67	35.7 <sup>25</sup>	sl EtOH
1670	Magnesium sulfide	MgS	12032-36-9	56.370	red-brn cub cry	2226		2.68		react H <sub>2</sub> O
1671	Magnesium sulfite trihydrate	MgSO <sub>3</sub> · 3H <sub>2</sub> O	19086-20-5	158.414	col orth cry			2.12	0.79 <sup>25</sup>	
1672	Magnesium sulfite hexahydrate	MgSO <sub>3</sub> · 6H <sub>2</sub> O	13446-29-2	212.460	wh hex cry	200 dec		1.72	0.79 <sup>25</sup>	i EtOH
1673	Magnesium tetrahydrogen phosphate dihydrate	Mg(H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	15609-80-0	254.311	wh hyg cry	dec 90				s H <sub>2</sub> O; i EtOH
1674	Magnesium thiocyanate tetrahydrate	Mg(SCN) <sub>2</sub> · 4H <sub>2</sub> O	306-61-6	212.531	wh hyg cry					vs H <sub>2</sub> O, EtOH
1675	Magnesium thiosulfate hexahydrate	MgS <sub>2</sub> O <sub>3</sub> · 6H <sub>2</sub> O	13446-30-5	244.525	col cry	170 dec		1.82	93 <sup>25</sup>	i EtOH
1676	Magnesium trisilicate	Mg <sub>3</sub> Si <sub>3</sub> O <sub>8</sub>	14987-04-3	260.862	wh powder					i H <sub>2</sub> O, EtOH
1677	Magnesium tungstate	MgWO <sub>4</sub>	13573-11-0	272.14	wh monocl cry			6.89	0.016 <sup>20</sup>	i EtOH
1678	Magnesium vanadate	Mg <sub>2</sub> V <sub>2</sub> O <sub>7</sub>	13568-63-3	262.489	tricl cry			3.1		
1679	Magnesium zirconate	MgZrO <sub>3</sub>	12032-31-4	163.527	col cry	2060		4.23		
1680	Magnesium zirconium silicate	MgO · ZrO <sub>2</sub> · SiO <sub>2</sub>	52110-05-1	223.612	wh solid					i H <sub>2</sub> O, alk; sl acid
1681	Manganese	Mn	7439-96-5	54.938	hard gray metal	1246	2061	7.3		s dil acids
1682	Manganocene	Mn(C <sub>8</sub> H <sub>8</sub> ) <sub>2</sub>	1271-27-8	185.124	yel-brn cry	173				s py, thf; sl bz
1683	Manganese antimonide (MnSb)	MnSb	12032-82-5	176.698	hex cry	840		6.9		
1684	Manganese antimonide (Mn <sub>2</sub> Sb)	Mn <sub>2</sub> Sb	12032-97-2	231.636	tetr cry	948		7.0		
1685	Manganese boride (MnB)	MnB	12045-15-7	65.749	orth cry	1890		6.45		
1686	Manganese boride (Mn <sub>2</sub> B)	Mn <sub>2</sub> B	12228-50-1	76.560	hex cry	1827		5.3		
1687	Manganese boride (Mn <sub>3</sub> B)	Mn <sub>3</sub> B	12045-16-8	120.687	red-brn tetr cry	1580		7.20		
1688	Manganese carbide	Mn <sub>3</sub> C	12266-65-8	176.825	refrac solid	1520		6.89		
1689	Manganese carbonyl	Mn <sub>5</sub> (CO) <sub>10</sub>	10170-69-1	389.977	yel monocl cry	154		1.75		i H <sub>2</sub> O; s os
1690	Manganese pentacarbonyl bromide	Mn(CO) <sub>5</sub> Br	14516-54-2	274.893	oran-yel cry					s os
1691	Manganese phosphide (MnP)	MnP	12032-78-9	85.912	orth cry	1147		5.49		
1692	Manganese phosphide (Mn <sub>2</sub> P)	Mn <sub>2</sub> P	12333-54-9	140.850	hex cry	1327		6.0		
1693	Manganese silicide	MnSi <sub>2</sub>	12032-86-9	111.109	gray solid	1152 dec				
1694	Manganese(II) acetate tetrahydrate	Mn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	6156-78-1	245.087	red monocl cry	80		1.59		s H <sub>2</sub> O, EtOH
1695	Manganese(II) bromide	MnBr <sub>2</sub>	13446-03-2	214.746	pink hex cry	698		4.385	151 <sup>25</sup>	
1696	Manganese(II) bromide tetrahydrate	MnBr <sub>2</sub> · 4H <sub>2</sub> O	10031-20-6	286.808	red hyg cry	64 dec			151 <sup>25</sup>	
1697	Manganese(II) carbonate	MnCO <sub>3</sub>	598-62-9	114.947	pink hex cry	>200 dec		3.70	0.00008 <sup>20</sup>	s dil acid
1698	Manganese(II) chloride	MnCl <sub>2</sub>	7773-01-5	125.844	pink trig cry; hyg	650	1190	2.977	77.3 <sup>25</sup>	s py, EtOH; i eth
1699	Manganese(II) chloride tetrahydrate	MnCl <sub>2</sub> · 4H <sub>2</sub> O	13446-34-9	197.906	red monocl cry; hyg	87.5		1.913	77.3 <sup>25</sup>	s EtOH; i eth
1700	Manganese(II) dihydrogen phosphate dihydrate	Mn(H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	18718-07-5	284.944	col hyg cry					s H <sub>2</sub> O; i EtOH
1701	Manganese(II) fluoride	MnF <sub>2</sub>	7782-64-1	92.935	red tetr cry	900		3.98	1.02 <sup>25</sup>	i EtOH
1702	Manganese(II) hydroxide	Mn(OH) <sub>2</sub>	18933-05-6	88.953	pink hex cry	dec		3.26	0.00034 <sup>20</sup>	
1703	Manganese(II) hypophosphite monohydrate	Mn(H <sub>2</sub> PO <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	10043-84-2	202.931	pink cry	>250			15 <sup>20</sup>	s H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1704	Manganese(II) iodide	MnI <sub>2</sub>	7790-33-2	308.747	wh hex cry; hyg	638		5.04		s H <sub>2</sub> O, EtOH
1705	Manganese(II) iodide tetrahydrate	MnI <sub>2</sub> · 4H <sub>2</sub> O	7790-33-2*	380.809	red cry					vs H <sub>2</sub> O; s EtOH
1706	Manganese(II) metasilicate	MnSiO <sub>3</sub>	7759-00-4	131.022	red orth cry	1291		3.48		i H <sub>2</sub> O
1707	Manganese(II) molybdate	MnMoO <sub>4</sub>	14013-15-1	214.88	yel mono cry			4.05		
1708	Manganese(II) nitrate	Mn(NO <sub>3</sub> ) <sub>2</sub>	10377-93-2	178.947	col orth cry; hyg			2.2	161 <sup>25</sup>	s diox, thf
1709	Manganese(II) nitrate tetrahydrate	Mn(NO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	20694-39-7	251.009	pink hyg cry	37.1 dec		2.13	161 <sup>25</sup>	s EtOH
1710	Manganese(II) nitrate hexahydrate	Mn(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10377-66-9	287.039	rose mono cry	28 dec		1.8	161 <sup>25</sup>	vs EtOH
1711	Manganese(II) orthosilicate	Mn <sub>2</sub> SiO <sub>4</sub>	13568-32-6	201.960	orth cry			4.11		i H <sub>2</sub> O
1712	Manganese(II) oxalate dihydrate	MnC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	6556-16-7	178.987	wh cry powder	150 dec		2.45	0.032 <sup>20</sup>	s acid
1713	Manganese(II) oxide	MnO	1344-43-0	70.937	grn cub cry or powder	1842		5.37		i H <sub>2</sub> O; s acid
1714	Manganese(II) perchlorate hexahydrate	Mn(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	15364-94-0	361.931	pink hex cry			2.10		
1715	Manganese(II) pyrophosphate	Mn <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	53731-35-4	283.819	wh mono cry	1196		3.71		i H <sub>2</sub> O
1716	Manganese(II) selenide	MnSe	1313-22-0	133.90	gray cub cry	1460		5.45		i H <sub>2</sub> O
1717	Manganese(II) sulfate	MnSO <sub>4</sub>	7785-87-7	151.001	wh orth cry	700	850 dec	3.25	63.7 <sup>25</sup>	
1718	Manganese(II) sulfate monohydrate	MnSO <sub>4</sub> · H <sub>2</sub> O	10034-96-5	169.016	red mono cry			2.95	63.7 <sup>25</sup>	i EtOH
1719	Manganese(II) sulfate tetrahydrate	MnSO <sub>4</sub> · 4H <sub>2</sub> O	10101-68-5	223.062	red mono cry	38 dec		2.26	63.7 <sup>25</sup>	i EtOH
1720	Manganese(II) sulfide (α form)	MnS	18820-29-6	87.003	grn cub cry	1610		4.0		i H <sub>2</sub> O; s dil acid
1721	Manganese(II) sulfide (β form)	MnS	18820-29-6	87.003	red cub cry			3.3		i H <sub>2</sub> O; s dil acid
1722	Manganese(II) sulfide (γ form)	MnS	18820-29-6	87.003	red hex cry			≈3.3		i H <sub>2</sub> O; s dil acid
1723	Manganese(II) telluride	MnTe	12032-88-1	182.54	hex cry	≈1150		6.0		
1724	Manganese(II) tetraborate octahydrate	MnB <sub>4</sub> O <sub>7</sub> · 8H <sub>2</sub> O	12228-91-0	354.300	red solid					i H <sub>2</sub> O, EtOH; s dil acid
1725	Manganese(II) titanate	MnTiO <sub>3</sub>	12032-74-5	150.803	red hex cry	1360		4.55		
1726	Manganese(II) tungstate	MnWO <sub>4</sub>	13918-22-4	302.78	wh mono cry			7.2	0.0054 <sup>20</sup>	
1727	Manganese(II,III) oxide	Mn <sub>3</sub> O <sub>4</sub>	1317-35-7	228.812	brn tetr cry	1567		4.84		i H <sub>2</sub> O; s HCl
1728	Manganese(III) acetate dihydrate	Mn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 2H <sub>2</sub> O	19513-05-4	268.100	brn cry					s eth, HOAc
1729	Manganese(III) fluoride	MnF <sub>3</sub>	7783-53-1	111.933	red mono cry; hyg	>600 dec		3.54		reac H <sub>2</sub> O
1730	Manganese(III) hydroxide	MnO(OH)	1332-63-4	87.945	blk mono cry	250 dec		≈4.3		i H <sub>2</sub> O
1731	Manganese(III) oxide	Mn <sub>2</sub> O <sub>3</sub>	1317-34-6	157.874	blk cub cry	1080 dec		≈5.0		i H <sub>2</sub> O
1732	Manganese(IV) oxide	MnO <sub>2</sub>	1313-13-9	86.937	blk tetr cry	535 dec		5.08		i H <sub>2</sub> O, HNO <sub>3</sub>
1733	Manganese(VII) oxide	Mn <sub>2</sub> O <sub>7</sub>	12057-92-0	221.872	grn oil; exp	5.9	95 exp	2.40		vs H <sub>2</sub> O
1734	Mendelevium	Md	7440-11-1	258	metal	827				
1735	Mercury	Hg	7439-97-6	200.59	heavy silv liq	-38.8290	356.62	13.5336		i H <sub>2</sub> O
1736	Dimethyl mercury	Hg(CH <sub>3</sub> ) <sub>2</sub>	593-74-8	230.66	liq		93	3.17		i H <sub>2</sub> O; vs EtOH, eth
1737	Mercury(I) acetate	Hg <sub>2</sub> (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	631-60-7	519.27	col scales	dec				sl H <sub>2</sub> O; i EtOH, eth
1738	Mercury(I) bromate	Hg <sub>2</sub> (BrO <sub>3</sub> ) <sub>2</sub>	13465-33-3	656.98	col cry	dec				i H <sub>2</sub> O; sl acid
1739	Mercury(I) bromide	Hg <sub>2</sub> Br <sub>2</sub>	15385-58-7	560.99	wh tetr cry or powder	345 dec		7.307		i H <sub>2</sub> O, EtOH, eth
1740	Mercury(I) carbonate	Hg <sub>2</sub> CO <sub>3</sub>	6824-78-8	461.19	yel-brn cry	130 dec			0.0000045	i EtOH
1741	Mercury(I) chlorate	Hg <sub>2</sub> (ClO <sub>3</sub> ) <sub>2</sub>	10294-44-7	568.08	wh rhom cry	≈250 dec		6.409		sl H <sub>2</sub> O; s EtOH
1742	Mercury(I) chloride	Hg <sub>2</sub> Cl <sub>2</sub>	10112-91-1	472.09	wh tetr cry	525 tp	383 sp	7.16	0.0004 <sup>25</sup>	i EtOH, eth
1743	Mercury(I) chromate	Hg <sub>2</sub> CrO <sub>4</sub>	13465-34-4	517.17	brn-red solid					i H <sub>2</sub> O EtOH; s conc HNO <sub>3</sub>
1744	Mercury(I) fluoride	Hg <sub>2</sub> F <sub>2</sub>	13967-25-4	439.18	yel cub cry	570 dec	subl	8.73		reac H <sub>2</sub> O
1745	Mercury(I) iodate	Hg <sub>2</sub> (IO <sub>3</sub> ) <sub>2</sub>	13465-35-5	750.99	yel-wh pow	dec 175			0.0032 <sup>20</sup>	
1746	Mercury(I) iodide	Hg <sub>2</sub> I <sub>2</sub>	15385-57-6	654.99	yel amorp powder	290		7.70		i H <sub>2</sub> O, EtOH, eth
1747	Mercury(I) nitrate	Hg <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	10415-75-5	525.19	cry					sl H <sub>2</sub> O
1748	Mercury(I) nitrate dihydrate	Hg <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	14836-60-3	561.22	col cry	70 dec		4.8		sl H <sub>2</sub> O
1749	Mercury(I) nitrite	Hg <sub>2</sub> (NO <sub>2</sub> ) <sub>2</sub>	13492-25-6	493.19	yel cry	100 dec		7.3		reac H <sub>2</sub> O
1750	Mercury(I) oxalate	Hg <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	2949-11-3	489.20	cry					i H <sub>2</sub> O; sl HNO <sub>3</sub>
1751	Mercury(I) oxide	Hg <sub>2</sub> O	15829-53-5	417.18	prob mixture of HgO+Hg	100 dec		9.8		i H <sub>2</sub> O; s HNO <sub>3</sub>
1752	Mercury(I) perchlorate tetrahydrate	Hg <sub>2</sub> (ClO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	65202-12-2	672.14	cry	64			442 <sup>25</sup>	
1753	Mercury(I) sulfate	Hg <sub>2</sub> SO <sub>4</sub>	7783-36-0	497.24	wh-yel cry powder			7.56		s dil HNO <sub>3</sub>
1754	Mercury(I) sulfide	Hg <sub>2</sub> S	51595-71-2	433.25	unstab blk pow	dec				i H <sub>2</sub> O
1755	Mercury(I) thiocyanate	Hg <sub>2</sub> (SCN) <sub>2</sub>	13465-37-7	517.34	col powder	dec			0.03 <sup>25</sup>	s HCl, KCNS
1756	Mercury(I) tungstate	Hg <sub>2</sub> WO <sub>4</sub>	38705-19-0	649.02	yel amorp solid	dec				i H <sub>2</sub> O, EtOH
1757	Mercury(II) acetate	Hg(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	1600-27-7	318.68	wh-yel cry or powder	179 dec		3.28	25 <sup>10</sup>	s EtOH
1758	Mercury(II) amide chloride	Hg(NH <sub>2</sub> )Cl	10124-48-8	252.07	wh solid		subl	5.38		i H <sub>2</sub> O, EtOH; s warm acid
1759	Mercury(II) benzoate monohydrate	Hg(C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> ) <sub>2</sub> · H <sub>2</sub> O	32839-04-6	460.83	wh cry	165			1.2 <sup>15</sup>	sl EtOH
1760	Mercury(II) bromate	Hg(BrO <sub>3</sub> ) <sub>2</sub>	26522-91-8	456.39	cry	130 dec			0.15	s acid
1761	Mercury(II) bromide	HgBr <sub>2</sub>	7789-47-1	360.40	wh rhomb cry or powder	241	318	6.05	0.61 <sup>25</sup>	sl chl; s EtOH, MeOH
1762	Mercury(II) chlorate	Hg(ClO <sub>3</sub> ) <sub>2</sub>	13465-30-0	367.49	wh needles	dec		4.998	25	

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1763	Mercury(II) chloride	HgCl <sub>2</sub>	7487-94-7	271.50	wh orth cry	277	304	5.6	7.31 <sup>25</sup>	sl bz; s EtOH, MeOH, ace, eth
1764	Mercury(II) chromate	HgCrO <sub>4</sub>	13444-75-2	316.58	red monocl cry			6.06		sl H <sub>2</sub> O
1765	Mercury(II) cyanide	Hg(CN) <sub>2</sub>	592-04-1	252.62	col tetr cry	320 dec		4.00	11.4 <sup>25</sup>	s EtOH; sl eth
1766	Mercury(II) dichromate	HgCr <sub>2</sub> O <sub>7</sub>	7789-10-8	416.58	red cry powder					i H <sub>2</sub> O; s acid
1767	Mercury(II) fluoride	HgF <sub>2</sub>	7783-39-3	238.59	wh cub cry; hyg	645 dec		8.95		reac H <sub>2</sub> O
1768	Mercury(II) fulminate	Hg(CNO) <sub>2</sub>	628-86-4	284.62	gray cry	exp		4.42		sl H <sub>2</sub> O; s EtOH, NH <sub>4</sub> OH
1769	Mercury(II) hydrogen arsenate	HgHAsO <sub>4</sub>	7784-37-4	340.52	yel powder					i H <sub>2</sub> O; s acid
1770	Mercury(II) iodate	Hg(IO <sub>3</sub> ) <sub>2</sub>	7783-32-6	550.40	wh powder	175 dec				i H <sub>2</sub> O
1771	Mercury(II) iodide (yellow)	HgI <sub>2</sub>	7774-29-0	454.40	yel tetr cry or powder	256	351	6.28	0.0055 <sup>25</sup>	sl EtOH, ace, eth
1772	Mercury(II) iodide (red)	HgI <sub>2</sub>	7774-29-0	454.40	red pow	trans to yel 127			0.006 <sup>25</sup>	sl EtOH, ace, eth, chl
1773	Mercury(II) nitrate	Hg(NO <sub>3</sub> ) <sub>2</sub>	10045-94-0	324.60	col hyg cry	79		4.3		s H <sub>2</sub> O; i EtOH
1774	Mercury(II) nitrate monohydrate	Hg(NO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	7783-34-8	342.62	wh-yel hyg cry			4.3		s H <sub>2</sub> O, dil acid
1775	Mercury(II) nitrate dihydrate	Hg(NO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	22852-67-1	360.63	monocl cry			4.78		s H <sub>2</sub> O
1776	Mercury(II) oxalate	HgC <sub>2</sub> O <sub>4</sub>	3444-13-1	288.61	powder	165 dec				i H <sub>2</sub> O
1777	Mercury(II) oxide	HgO	21908-53-2	216.59	red or yel orth cry	500 dec		11.14		i H <sub>2</sub> O, EtOH; s dil acid
1778	Mercury(II) oxide sulfate	(Hg <sub>2</sub> O) <sub>2</sub> SO <sub>4</sub>	1312-03-4	729.83	yel powder					i H <sub>2</sub> O; s acid
1779	Mercury(II) oxycyanide	Hg(CN) <sub>2</sub> · HgO	1335-31-5	469.21	wh orth cry	exp		4.44	11.4 <sup>25</sup>	
1780	Mercury(II) perchlorate trihydrate	Hg(ClO <sub>4</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	7616-83-3	453.54	cry					
1781	Mercury(II) phosphate	Hg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7782-66-3	791.71	wh-yel powder					i H <sub>2</sub> O, EtOH; s acid
1782	Mercury(II) selenide	HgSe	20601-83-6	279.55	gray cub cry		subl	8.21		i H <sub>2</sub> O
1783	Mercury(II) sulfate	HgSO <sub>4</sub>	7783-35-9	296.65	wh monocl cry			6.47		reac H <sub>2</sub> O
1784	Mercury(II) sulfide (black)	HgS	1344-48-5	232.66	blk cub cry or powder	850		7.70		i H <sub>2</sub> O; s acid, EtOH
1785	Mercury(II) sulfide (red)	HgS	1344-48-5	232.66	red hex cry	trans to blk HgS 344		8.17		i H <sub>2</sub> O, acid; s aqua regia
1786	Mercury(II) telluride	HgTe	12068-90-5	328.19	gray cub cry	673		8.63		
1787	Mercury(II) thiocyanate	Hg(SCN) <sub>2</sub>	592-85-8	316.75	monocl cry	~165 dec		3.71	0.070 <sup>25</sup>	s dil HCl
1788	Mercury(II) tungstate	HgWO <sub>4</sub>	37913-38-5	448.43	yel cry	dec				i H <sub>2</sub> O, EtOH
1789	Molybdenum	Mo	7439-98-7	95.94	gray-blk metal; cub	2623	4639	10.2		i H <sub>2</sub> O, dil acid, alk
1790	Molybdophosphoric acid	H <sub>3</sub> P(Mo <sub>2</sub> O <sub>7</sub> ) <sub>4</sub>	51429-74-4	1825.25	bright yel cry					
1791	Molybdenum boride (Mo <sub>2</sub> B)	Mo <sub>2</sub> B	12006-99-4	202.69	refrac tetr cry	2000		9.2		
1792	Molybdenum boride (Mo <sub>2</sub> B <sub>3</sub> )	Mo <sub>2</sub> B <sub>3</sub>	12007-97-5	245.94	refrac hex cry	1600		~7.2		
1793	Molybdenum carbide (MoC)	MoC	12011-97-1	107.95	refrac solid; cub	2577				
1794	Molybdenum carbide (Mo <sub>2</sub> C)	Mo <sub>2</sub> C	12069-89-5	203.89	gray orth cry	2687		9.18		
1795	Molybdenum carbonyl	Mo(CO) <sub>6</sub>	13939-06-5	264.00	wh orth cry	148	155 dec	1.96		i H <sub>2</sub> O; s bz; sl eth
1796	Molybdenum nitride (MoN)	MoN	12033-19-1	109.95	hex cry	1750		9.20		
1797	Molybdenum nitride (Mo <sub>2</sub> N)	Mo <sub>2</sub> N	12033-31-7	205.89	gray cub cry	790 dec		9.46		
1798	Molybdenum phosphide	MoP	12163-69-8	126.91	blk hex cry			7.34		
1799	Molybdenum silicide (MoSi <sub>2</sub> )	MoSi <sub>2</sub>	12136-78-6	152.11	gray tetr cry	~1900		6.2		i H <sub>2</sub> O; s HF
1800	Molybdenum(II) bromide	MoBr <sub>2</sub>	13446-56-5	255.75	yel-red cry	dec 700		4.88		i H <sub>2</sub> O, EtOH
1801	Molybdenum(II) chloride	MoCl <sub>2</sub>	13478-17-6	166.85	yel cry	dec 500		3.71		i H <sub>2</sub> O
1802	Molybdenum(II) iodide	MoI <sub>2</sub>	14055-74-4	349.75	blk hyg cry	700		5.28		i H <sub>2</sub> O
1803	Molybdenum(III) bromide	MoBr <sub>3</sub>	13446-57-6	335.65	grn hex cry	dec 500		4.89		i H <sub>2</sub> O, EtOH
1804	Molybdenum(III) chloride	MoCl <sub>3</sub>	13478-18-7	202.30	dark red monocl cry	dec 400		3.74		i H <sub>2</sub> O, os
1805	Molybdenum(III) fluoride	MoF <sub>3</sub>	20193-58-2	152.94	yel-brn hex cry	>600		4.64		i H <sub>2</sub> O
1806	Molybdenum(III) iodide	MoI <sub>3</sub>	14055-75-5	476.65	blk solid	927				i H <sub>2</sub> O
1807	Molybdenum(III) oxide	Mo <sub>2</sub> O <sub>3</sub>	1313-29-7	239.88	gray-blk powder					i H <sub>2</sub> O; sl acid
1808	Molybdenum(IV) bromide	MoBr <sub>4</sub>	13520-59-7	415.56	blk cry	dec 110				reac H <sub>2</sub> O
1809	Molybdenum(IV) chloride	MoCl <sub>4</sub>	13320-71-3	237.75	blk cry	317				reac H <sub>2</sub> O, sl chl; i eth, bz
1810	Molybdenum(IV) fluoride	MoF <sub>4</sub>	23412-45-5	171.93	grn cry	dec				reac H <sub>2</sub> O
1811	Molybdenum(IV) iodide	MoI <sub>4</sub>	14055-76-6	603.56	blk cry	dec 100				i H <sub>2</sub> O
1812	Molybdenum(IV) oxide	MoO <sub>3</sub>	18868-43-4	127.94	brn-viol tetr cry	~1800 dec		6.47		i H <sub>2</sub> O, acid, alk
1813	Molybdenum(IV) selenide	MoSe <sub>2</sub>	12058-18-3	253.86	gray hex cry	>1200		6.90		
1814	Molybdenum(IV) sulfide	MoS <sub>2</sub>	1317-33-5	160.07	blk powder or hex cry	1750		5.06		i H <sub>2</sub> O; s conc acid
1815	Molybdenum(IV) telluride	MoTe <sub>2</sub>	12058-20-7	351.14	gray hex cry			7.7		
1816	Molybdenum(V) chloride	MoCl <sub>5</sub>	10241-05-1	273.21	grn-blk monocl cry; hyg	194	268	2.93		reac H <sub>2</sub> O; s EtOH, eth
1817	Molybdenum(V) fluoride	MoF <sub>5</sub>	13819-84-6	190.93	yel monocl cry	67	213.6	3.5		reac H <sub>2</sub> O
1818	Molybdenum(V) oxytrichloride	MoOCl <sub>3</sub>	13814-74-9	218.30	blk monocl cry	310	subl			reac H <sub>2</sub> O
1819	Molybdenum(VI) acid monohydrate	H <sub>2</sub> MoO <sub>4</sub> · H <sub>2</sub> O	7782-91-4	179.97	wh powder			3.1		sl H <sub>2</sub> O; s alk



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1820	Molybdenum(VI) dioxydichloride	MoO <sub>2</sub> Cl <sub>2</sub>	13637-68-8	198.85	yel-oran solid	176	250	3.31		reac H <sub>2</sub> O
1821	Molybdenum(VI) dioxydifluoride	MoO <sub>2</sub> F <sub>2</sub>	13824-57-2	165.94	pale lilac cry	subl 270		3.5		i MeCN, chl; sl HF
1822	Molybdenum(VI) fluoride	MoF <sub>6</sub>	7783-77-9	209.93	wh cub cry or col liq; hyg	17.5	34.0	2.54		reac H <sub>2</sub> O; vs hex, ctc
1823	Molybdenum(VI) metaphosphate	Mo(PO <sub>3</sub> ) <sub>6</sub>	133863-98-6	569.77	yel powder			3.28		i H <sub>2</sub> O, acid
1824	Molybdenum(VI) oxide	MoO <sub>3</sub>	1313-27-5	143.94	wh-yel rhomb cry	802	1155	4.70	0.14 <sup>20</sup>	sl H <sub>2</sub> O; s alk, acid
1825	Molybdenum(VI) oxytetrachloride	MoOCl <sub>4</sub>	13814-75-0	253.75	grn hyg powder	105	159			
1826	Molybdenum(VI) oxytetrafluoride	MoOF <sub>4</sub>	14459-59-7	187.93	volatile solid	97.2	186.0			
1827	Molybdenum(VI) sulfide	MoS <sub>3</sub>	12033-29-3	192.14	blk solid	350 dec				i H <sub>2</sub> O, os
1828	Neodymium	Nd	7440-00-8	144.242	silv metal; hex	1016	3074	7.01		
1829	Neodymium boride	NdB <sub>6</sub>	12008-23-0	209.108	blk cub cry	2610		4.93		
1830	Neodymium nitride	NdN	25764-11-8	158.249	blk cub cry			7.69		
1831	Neodymium(II) acetate	Nd(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	6192-13-8	321.373	red-purp cry					s H <sub>2</sub> O
1832	Neodymium(II) chloride	NdCl <sub>2</sub>	25469-93-6	215.148	grn hyg solid	841				
1833	Neodymium(III) bromate nonahydrate	Nd(BrO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	15162-92-2	690.086	red hex cry	66 dec				
1834	Neodymium(III) bromide	NdBr <sub>3</sub>	13536-80-6	383.954	viol orth cry; hyg	682	1540	5.3		s H <sub>2</sub> O
1835	Neodymium(III) chloride	NdCl <sub>3</sub>	10024-93-8	250.601	viol hex cry	759	1600	4.13	100 <sup>25</sup>	vs EtOH; i eth, chl
1836	Neodymium(III) chloride hexahydrate	NdCl <sub>3</sub> · 6H <sub>2</sub> O	13477-89-9	358.692	purp cry	124 dec		2.3	100 <sup>25</sup>	s EtOH
1837	Neodymium(III) fluoride	NdF <sub>3</sub>	13709-42-7	201.237	viol hex cry; hyg	1377	2300	6.51		i H <sub>2</sub> O
1838	Neodymium(III) hydroxide	Nd(OH) <sub>3</sub>	16469-17-3	195.264	blue solid	dec 210				i H <sub>2</sub> O
1839	Neodymium(III) iodide	NdI <sub>3</sub>	13813-24-6	524.955	grn orth cry; hyg	787		5.85		s H <sub>2</sub> O
1840	Neodymium(III) nitrate	Nd(NO <sub>3</sub> ) <sub>3</sub>	10045-95-1	330.257	viol hyg. cry				152 <sup>25</sup>	s EtOH
1841	Neodymium(III) nitrate hexahydrate	Nd(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	14517-29-4	438.348	purp hyg cry				152 <sup>25</sup>	s EtOH, ace
1842	Neodymium(III) oxide	Nd <sub>2</sub> O <sub>3</sub>	1313-97-9	336.482	blue hex cry; hyg	2233	3760	7.24		i H <sub>2</sub> O; s dil acid
1843	Neodymium(III) sulfate	Nd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13477-91-3	576.672	pink needles	≈700 dec			7.1 <sup>20</sup>	
1844	Neodymium(III) sulfate octahydrate	Nd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13477-91-3	720.794	red cry	350 dec		2.85		sl H <sub>2</sub> O
1845	Neodymium(III) sulfide	Nd <sub>2</sub> S <sub>3</sub>	12035-32-4	384.679	orth cry	2207		5.46		
1846	Neodymium(III) telluride	Nd <sub>2</sub> Te <sub>3</sub>	12035-35-7	671.28	gray orth cry	1377		7.0		
1847	Neodymium(III) tris(cyclopentadienyl)	Nd(C <sub>5</sub> H <sub>5</sub> ) <sub>3</sub>	1273-98-9	339.522	red-blue cry	380				s thf
1848	Neon	Ne	7440-01-9	20.180	col gas	-248.609 tp (43 kPa)	-246.053	0.825 g/L		sl H <sub>2</sub> O
1849	Neptunium	Np	7439-99-8	237	silv metal	644		20.2		s HCl
1850	Neptunium(IV) oxide	NpO <sub>2</sub>	12035-79-9	269	grn cub cry	2547		11.1		
1851	Nickel	Ni	7440-02-0	58.693	wh metal; cub	1455	2913	8.90		i H <sub>2</sub> O; sl dil acid
1852	Nickelocene	Ni(C <sub>2</sub> H <sub>2</sub> ) <sub>2</sub>	1271-28-9	188.879	grn cry	173				
1853	Nickel aluminide (NiAl)	NiAl	12003-78-0	85.675	metallic solid	1638				
1854	Nickel antimonide	NiSb	12035-52-8	180.453	hex cry	1147		8.74		
1855	Nickel arsenide	NiAs	27016-75-7	133.615	hex cry	967		7.77		
1856	Nickel boride (NiB)	NiB	12007-00-0	69.504	grn refrac solid	1035		7.13		
1857	Nickel boride (Ni <sub>2</sub> B)	Ni <sub>2</sub> B	12007-01-1	128.198	refrac solid	1125		7.90		
1858	Nickel boride (Ni <sub>3</sub> B)	Ni <sub>3</sub> B	12007-02-2	186.891	refrac solid	1166		8.17		
1859	Nickel carbonyl	Ni(CO) <sub>4</sub>	13463-39-3	170.734	col liq	-19.3	42.1 (exp ≈60)	1.31		i H <sub>2</sub> O; s EtOH, bz, ace, ctc
1860	Nickel phosphide	Ni <sub>3</sub> P	12035-64-2	148.361	hex cry	1100		7.33		
1861	Nickel silicide (NiSi <sub>2</sub> )	NiSi <sub>2</sub>	12201-89-7	114.864	cub cry	993		4.83		
1862	Nickel silicide (Ni <sub>2</sub> Si)	Ni <sub>2</sub> Si	12059-14-2	145.473	orth cry	1255		7.40		
1863	Nickel subsulfide	Ni <sub>3</sub> S <sub>2</sub>	12035-72-2	240.210	yel hex cry	789		5.87		
1864	Nickel(II) acetate tetrahydrate	Ni(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	6018-89-9	248.842	grn monoc cry	250 dec		1.74	16 <sup>20</sup>	s H <sub>2</sub> O, EtOH
1865	Nickel(II) ammonium chloride hexahydrate	NH <sub>4</sub> NiCl <sub>3</sub> · 6H <sub>2</sub> O	16122-03-5*	291.182	grn hyg cry			1.65		s H <sub>2</sub> O
1866	Nickel(II) ammonium sulfate	Ni(NH <sub>4</sub> ) <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub>	15699-18-0	286.895	blue-grn cry	dec 250				sl H <sub>2</sub> O
1867	Nickel(II) ammonium sulfate hexahydrate	Ni(NH <sub>4</sub> ) <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	7785-20-8	394.987	blue-grn cry	dec 130		1.92	6.5 <sup>20</sup>	s H <sub>2</sub> O; i EtOH
1868	Nickel(II) arsenate octahydrate	Ni <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	7784-48-7	598.040	yel-grn powder	dec		4.98		i H <sub>2</sub> O; s acid
1869	Nickel(II) bromide	NiBr <sub>2</sub>	13462-88-9	218.501	yel hex cry; hyg	963	subl	5.10	131 <sup>20</sup>	
1870	Nickel(II) bromide trihydrate	NiBr <sub>2</sub> · 3H <sub>2</sub> O	13462-88-9*	272.547	yel-grn hyg cry	200 dec				vs H <sub>2</sub> O; s EtOH, eth
1871	Nickel(II) carbonate	NiCO <sub>3</sub>	3333-67-3	118.702	grn rhomb cry			4.389	0.0043 <sup>20</sup>	s dil acid
1872	Nickel(II) chlorate hexahydrate	Ni(ClO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13477-94-6	333.687	grn cub cry	dec 80		2.07		vs H <sub>2</sub> O
1873	Nickel(II) chloride	NiCl <sub>2</sub>	7718-54-9	129.599	yel hex cry; hyg	1031	985 sp	3.51	67.5 <sup>25</sup>	s EtOH
1874	Nickel(II) chloride hexahydrate	NiCl <sub>2</sub> · 6H <sub>2</sub> O	7791-20-0	237.690	grn monoc cry				67.5 <sup>25</sup>	s EtOH
1875	Nickel(II) chromate	NiCrO <sub>4</sub>	14721-18-7	174.687	red solid					sl H <sub>2</sub> O
1876	Nickel(II) cyanide tetrahydrate	Ni(CN) <sub>2</sub> · 4H <sub>2</sub> O	13477-95-7	182.789	grn plates	200 dec				i H <sub>2</sub> O; sl dil acid; s NH <sub>4</sub> OH
1877	Nickel(II) fluoride	NiF <sub>2</sub>	10028-18-9	96.690	yel tet cry	1380		4.7	2.56 <sup>25</sup>	i EtOH, eth
1878	Nickel(II) fluoride tetrahydrate	NiF <sub>2</sub> · 4H <sub>2</sub> O	13940-83-5	168.752	grn pow					sl H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1879	Nickel(II) hydroxide	Ni(OH) <sub>2</sub>	12054-48-7	92.708	grn hex cry	230 dec		4.1	0.00015 <sup>20</sup>	
1880	Nickel(II) hydroxide monohydrate	Ni(OH) <sub>2</sub> · H <sub>2</sub> O	36897-37-7	110.723	grn powder				0.00015 <sup>20</sup>	s dil acid
1881	Nickel(II) iodate	Ni(IO <sub>3</sub> ) <sub>2</sub>	13477-98-0	408.498	yel needles			5.07	1.1 <sup>30</sup>	sl H <sub>2</sub> O
1882	Nickel(II) iodate tetrahydrate	Ni(IO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	13477-99-1	480.560	yel hex cry	dec 100		5.07		sl H <sub>2</sub> O
1883	Nickel(II) iodide	NiI <sub>2</sub>	13462-90-3	312.502	blk hex cry; hyg	800	subl	5.22	154 <sup>25</sup>	
1884	Nickel(II) iodide hexahydrate	NiI <sub>2</sub> · 6H <sub>2</sub> O	7790-34-3	420.593	grn monocl cry; hyg				154 <sup>25</sup>	vs EtOH
1885	Nickel(II) nitrate	Ni(NO <sub>3</sub> ) <sub>2</sub>	13138-45-9	182.702	grn cry				99.2 <sup>25</sup>	s EtOH
1886	Nickel(II) nitrate hexahydrate	Ni(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13478-00-7	290.794	grn monocl cry; hyg	56 dec		2.05	99.2 <sup>25</sup>	s EtOH
1887	Nickel(II) oxalate dihydrate	NiC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	6018-94-6	182.742	grn-wh solid	dec 150			0.0012 <sup>25</sup>	i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
1888	Nickel(II) oxide	NiO	1313-99-1	74.692	grn cub cry	1957		6.72		i H <sub>2</sub> O; s acid
1889	Nickel(II) perchlorate hexahydrate	Ni(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13637-71-3*	365.686	grn hex needles	140			158.8 <sup>25</sup>	s EtOH, ace
1890	Nickel(II) phosphate octahydrate	Ni <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	10381-36-9*	510.145	grn plates					s acid
1891	Nickel(II) selenate hexahydrate	NiSeO <sub>4</sub> · 6H <sub>2</sub> O	15060-62-5*	309.74	grn tetr cry			2.314	35.5 <sup>20</sup>	
1892	Nickel(II) selenide	NiSe	1314-05-2	137.65	yel-grn hex cry	980		7.2		
1893	Nickel(II) stannate dihydrate	NiSnO <sub>3</sub> · 2H <sub>2</sub> O	12035-38-0	261.432	grn pow	dec 120				
1894	Nickel(II) sulfate	NiSO <sub>4</sub>	7786-81-4	154.756	grn-yel orth cry	840 dec		4.01	40.4 <sup>25</sup>	
1895	Nickel(II) sulfate hexahydrate	NiSO <sub>4</sub> · 6H <sub>2</sub> O	10101-97-0	262.847	blue-grn tetr cry	≈100 dec		2.07	40.4 <sup>25</sup>	sl EtOH
1896	Nickel(II) sulfate heptahydrate	NiSO <sub>4</sub> · 7H <sub>2</sub> O	10101-98-1	280.862	grn orth cry			1.98	40.4 <sup>25</sup>	s EtOH
1897	Nickel(II) sulfide	NiS	16812-54-7	90.758	yel hex cry	976		5.5		i H <sub>2</sub> O
1898	Nickel(II) thiocyanate	Ni(SCN) <sub>2</sub>	13689-92-4	174.857	grn pwd				55.0 <sup>25</sup>	
1899	Nickel(II) titanate	NiTiO <sub>3</sub>	12035-39-1	154.558	brn hex cry			5.0		
1900	Nickel(II,III) sulfide	Ni <sub>3</sub> S <sub>4</sub>	12137-12-1	304.340	cub cry	995		4.77		
1901	Nickel(III) oxide	Ni <sub>2</sub> O <sub>3</sub>	1314-06-3	165.385	gray-blk cub cry	≈600 dec				i H <sub>2</sub> O; s hot acid
1902	Niobium	Nb	7440-03-1	92.906	gray metal; cub	2477	4744	8.57		i acid
1903	Niobocene dichloride	Nb(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> Cl <sub>2</sub>	12793-14-5	293.998	hyg blk cry					sl tol
1904	Niobium boride (NbB)	NbB	12045-19-1	103.717	gray orth cry	2270		7.5		
1905	Niobium boride (NbB <sub>2</sub> )	NbB <sub>2</sub>	12007-29-3	114.528	gray hex cry	3050		6.97		
1906	Niobium carbide (NbC)	NbC	12069-94-2	104.917	gray cub cry	3608	4300	7.82		i H <sub>2</sub> O, acid
1907	Niobium carbide (Nb <sub>2</sub> C)	Nb <sub>2</sub> C	12011-99-3	197.824	refrac hex cry	3080		7.8		i H <sub>2</sub> O
1908	Niobium nitride	NbN	24621-21-4	106.913	gray cry; cub	2300		8.47		i HCl, acid
1909	Niobium phosphide	NbP	12034-66-1	123.880	tetr cry			6.5		
1910	Niobium silicide	NbSi <sub>2</sub>	12034-80-9	149.077	gray hex cry	1950		5.7		
1911	Niobium(II) oxide	NbO	12034-57-0	108.905	gray cub cry	1937		7.30		
1912	Niobium(III) bromide	NbBr <sub>3</sub>	15752-41-7	332.618	dark brn solid		subl 400			
1913	Niobium(III) chloride	NbCl <sub>3</sub>	13569-59-0	199.265	blk solid					
1914	Niobium(III) fluoride	NbF <sub>3</sub>	15195-53-6	149.901	blue cub cry			4.2		
1915	Niobium(III) iodide	NbI <sub>3</sub>	13870-20-7	473.619	blk solid	dec 510				
1916	Niobium(IV) bromide	NbBr <sub>4</sub>	13842-75-6	412.522	dark brn cry		subl 300	4.72		react H <sub>2</sub> O
1917	Niobium(IV) chloride	NbCl <sub>4</sub>	13569-70-5	234.718	viol-blk monocl cry	dec 800	275 subl	3.2		react H <sub>2</sub> O
1918	Niobium(IV) fluoride	NbF <sub>4</sub>	13842-88-1	168.900	blk tetr cry; hyg	>350 dec		4.01		
1919	Niobium(IV) iodide	NbI <sub>4</sub>	13870-21-8	600.524	gray orth cry	503		5.6		react H <sub>2</sub> O
1920	Niobium(IV) oxide	NbO <sub>2</sub>	12034-59-2	124.905	wh tetr cry or powder	1901		5.9		
1921	Niobium(IV) selenide	NbSe <sub>2</sub>	12034-77-4	250.83	gray hex cry	>1300		6.3		
1922	Niobium(IV) sulfide	NbS <sub>2</sub>	12136-97-9	157.036	blk rhomb cry			4.4		
1923	Niobium(IV) telluride	NbTe <sub>2</sub>	12034-83-2	348.11	hex cry			7.6		
1924	Niobium(V) bromide	NbBr <sub>5</sub>	13478-45-0	492.426	oran orth cry	265.2	361.6	4.36		s H <sub>2</sub> O, EtOH
1925	Niobium(V) chloride	NbCl <sub>5</sub>	10026-12-7	270.171	yel monocl cry; hyg	205.8	247.4	2.78		react H <sub>2</sub> O; s HCl, etc
1926	Niobium(V) dioxyfluoride	NbO <sub>2</sub> F	15195-33-2	143.903	wh cub cry			4.0		
1927	Niobium(V) ethoxide	Nb(OC <sub>2</sub> H <sub>5</sub> ) <sub>5</sub>	3236-82-6	318.209	col hyg liq	5	203	1.258		react H <sub>2</sub> O; s peth
1928	Niobium(V) fluoride	NbF <sub>5</sub>	7783-68-8	187.898	col monocl cry; hyg	80	234	2.70		react H <sub>2</sub> O; sl CS <sub>2</sub> , chl
1929	Niobium(V) iodide	NbI <sub>5</sub>	13779-92-5	727.428	yel-blk monocl cry	327		5.32		react H <sub>2</sub> O
1930	Niobium(V) oxide	Nb <sub>2</sub> O <sub>5</sub>	1313-96-8	265.810	wh orth cry	1500		4.47		i H <sub>2</sub> O; s HF
1931	Niobium(V) oxybromide	NbOBr <sub>3</sub>	14459-75-7	348.617	yel-brn cry	≈320 dec	subl			
1932	Niobium(V) oxychloride	NbOCl <sub>3</sub>	13597-20-1	215.264	wh tetr cry		subl	3.72		
1933	Nitrogen	N <sub>2</sub>	7727-37-9	28.013	col gas	-210.0	-195.798	1.145 g/L		sl H <sub>2</sub> O; i EtOH
1934	Nitramide	NO <sub>2</sub> NH <sub>2</sub>	7782-94-7	62.028	unstab wh cry	72 dec				s H <sub>2</sub> O, EtOH, ace, eth; i chl
1935	Nitric acid	HNO <sub>3</sub>	7697-37-2	63.013	col liq; hyg	-41.6	83	1.5129 <sup>20</sup>		vs H <sub>2</sub> O
1936	Nitrous acid	HNO <sub>2</sub>	7782-77-6	47.014	stab only in soln					
1937	Nitrous oxide	N <sub>2</sub> O	10024-97-2	44.012	col gas	-90.8	-88.48	1.799 g/L		sl H <sub>2</sub> O; s EtOH, eth
1938	Nitric oxide	NO	10102-43-9	30.006	col gas	-163.6	-151.74	1.226 g/L		sl H <sub>2</sub> O



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1939	Nitrogen dioxide	NO <sub>2</sub>	10102-44-0	46.006	brn gas; equil with N <sub>2</sub> O <sub>4</sub>		see N <sub>2</sub> O <sub>4</sub>	1.880 g/L		reac H <sub>2</sub> O
1940	Nitrogen trioxide	N <sub>2</sub> O <sub>3</sub>	10544-73-7	76.011	blue solid or liq (low temp)	-101.1	≈3 dec	1.4 <sup>2</sup>		reac H <sub>2</sub> O
1941	Nitrogen tetroxide	N <sub>2</sub> O <sub>4</sub>	10544-72-6	92.011	col liq; equil with NO <sub>2</sub>	-9.3	21.15	1.45 <sup>20</sup>		reac H <sub>2</sub> O
1942	Nitrogen pentoxide	N <sub>2</sub> O <sub>5</sub>	10102-03-1	108.010	col hex cry		33 sp	2.0		s chl; sl ctc
1943	Nitrogen tribromide	NBr <sub>3</sub>	15162-90-0	253.719	unstab solid	exp -100				
1944	Nitrogen trichloride	NCl <sub>3</sub>	10025-85-1	120.366	yel oily liq; exp	-40	71	1.653		i H <sub>2</sub> O; s CS <sub>2</sub> , bz, ctc
1945	Nitrogen trifluoride	NF <sub>3</sub>	7783-54-2	71.002	col gas	-206.79	-128.75	2.902 g/L		i H <sub>2</sub> O
1946	Nitrogen triiodide	NI <sub>3</sub>	13444-85-4	394.720	unstab blk cry; exp					
1947	Nitrogen chloride difluoride	NCIF <sub>2</sub>	13637-87-1	87.457	col gas	-195	-67	3.575 g/L		
1948	Chloramine	NH <sub>2</sub> Cl	10599-90-3	51.476	yel liq	-66				s H <sub>2</sub> O, EtOH, eth; sl bz, ctc
1949	Fluoramine	NHF	15861-05-9	35.021	unstab gas	≈-110		1.431 g/L		
1950	Difluoramine	NHF <sub>2</sub>	10405-27-3	53.012	col gas	-116	-23	2.167 g/L		
1951	<i>cis</i> -Difluorodiazine	N <sub>2</sub> F <sub>2</sub>	13812-43-6	66.010	col gas	<-195	-105.75	2.698 g/L		
1952	<i>trans</i> -Difluorodiazine	N <sub>2</sub> F <sub>2</sub>	13776-62-0	66.010	col gas	-172	-111.45	2.698 g/L		
1953	Tetrafluorohydrazine	N <sub>2</sub> F <sub>4</sub>	10036-47-2	104.007	col gas	-164.5	-74	4.251 g/L		
1954	Nitrosyl bromide	NOBr	13444-87-6	109.910	red gas	-56	≈0	4.492 g/L		reac H <sub>2</sub> O
1955	Nitrosyl chloride	NOCl	2696-92-6	65.459	yel gas	-59.6	-5.5	2.676 g/L		reac H <sub>2</sub> O
1956	Nitrosyl fluoride	NOF	7789-25-5	49.004	col gas	-132.5	-59.9	2.003 g/L		
1957	Trifluoramine oxide	NOF <sub>3</sub>	13847-65-9	87.001	col gas	-161	-87.5	3.556 g/L		
1958	Nitryl chloride	NO <sub>2</sub> Cl	13444-90-1	81.459	col gas	-145	-15	3.330 g/L		
1959	Nitryl fluoride	NO <sub>2</sub> F	10022-50-1	65.004	col gas	-166	-72.4	2.657 g/L		reac H <sub>2</sub> O
1960	Nitrogen selenide	N <sub>2</sub> Se <sub>4</sub>	12033-88-4	371.87	red monocl cry; hyg	exp		4.2		i H <sub>2</sub> O, eth, EtOH; sl bz, CS <sub>2</sub>
1961	Nobelium	No	10028-14-5	259.000	metal	827				
1962	Osmium	Os	7440-04-2	190.23	blue-wh metal; hex	3033	5012	22.587 <sup>20</sup>		s aqua regia
1963	Osmocene	Os(C <sub>2</sub> H <sub>2</sub> ) <sub>2</sub>	1273-81-0	320.42	col cry	229				
1964	Osmium carbonyl	Os <sub>5</sub> (CO) <sub>12</sub>	15696-40-9	906.81	yel cry	224		3.48		
1965	Osmium pentacarbonyl	Os(CO) <sub>5</sub>	16406-49-8	330.28	col liq	-15	dec 100			s os
1966	Osmium nonacarbonyl	Os <sub>3</sub> (CO) <sub>9</sub>	28411-13-4	632.55	oran-yel cry	65 dec				s hc
1967	Osmium(II) chloride	OsCl <sub>2</sub>	13444-92-3	261.14	hyg brn solid	dec >450				s EtOH, eth
1968	Osmium(III) bromide	OsBr <sub>3</sub>	59201-51-3	429.94	dark gray cry	340 dec				i H <sub>2</sub> O, os, acid
1969	Osmium(III) chloride	OsCl <sub>3</sub>	13444-93-4	296.59	gray cub cry	450 dec				i H <sub>2</sub> O, os; s conc acid
1970	Osmium(IV) chloride	OsCl <sub>4</sub>	10026-01-4	332.04	red-blk orth cry	323 dec		4.38		reac H <sub>2</sub> O; i os
1971	Osmium(IV) fluoride	OsF <sub>4</sub>	54120-05-7	266.22	yel cry	230				reac H <sub>2</sub> O
1972	Osmium(IV) oxide	OsO <sub>2</sub>	12036-02-1	222.23	yel-brn tetr cry	dec 500		11.4		i H <sub>2</sub> O, acid
1973	Osmium(V) fluoride	OsF <sub>5</sub>	31576-40-6	285.22	hyg blue-grn cry	70	233			reac H <sub>2</sub> O
1974	Osmium(VI) fluoride	OsF <sub>6</sub>	13768-38-2	304.22	yel cub cry	33.4	47.5	4.1		reac H <sub>2</sub> O
1975	Osmium(VI) tetrachloride oxide	OsOCl <sub>4</sub>	36509-15-6	348.04	dark brn hyg cry	32	200			reac H <sub>2</sub> O; s hc
1976	Osmium(VIII) oxide	OsO <sub>4</sub>	20816-12-0	254.23	yel monocl cry	40.6	131.2	5.1	6.44 <sup>20</sup>	sl H <sub>2</sub> O; s ctc, bz, EtOH, eth
1977	Oxygen	O <sub>2</sub>	7782-44-7	31.999	col gas	-218.79	-182.953	1.308 g/L		sl H <sub>2</sub> O, EtOH, os
1978	Ozone	O <sub>3</sub>	10028-15-6	47.998	blue gas	-193	-111.35	1.962 g/L		sl H <sub>2</sub> O
1979	Palladium	Pd	7440-05-3	106.42	silv-wh metal; cub	1554.8	2963	12.0		s aqua regia
1980	Palladium(II) acetate	Pd(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	3375-31-3	224.51	oran-brn cry	205 dec				i H <sub>2</sub> O; s MeCN, eth, ace
1981	Palladium(II) bromide	PdBr <sub>2</sub>	13444-94-5	266.23	red-blk monocl cry; hyg	250 dec		≈5.2		i H <sub>2</sub> O
1982	Palladium(II) chloride	PdCl <sub>2</sub>	7647-10-1	177.33	red rhomb cry; hyg	679		4.0		s H <sub>2</sub> O, EtOH, ace
1983	Palladium(II) chloride dihydrate	PdCl <sub>2</sub> · 2H <sub>2</sub> O	7647-10-1*	213.36	brn cry					s H <sub>2</sub> O, EtOH, ace
1984	Palladium(II) cyanide	Pd(CN) <sub>2</sub>	2035-66-7	158.45	yel solid	dec				
1985	Palladium(II) fluoride	PdF <sub>2</sub>	13444-96-7	144.42	viol tetr cry; hyg	952		5.76		reac H <sub>2</sub> O
1986	Palladium(II) iodide	PdI <sub>2</sub>	7790-38-7	360.23	blk cry	360 dec		6.0		i H <sub>2</sub> O, EtOH, eth
1987	Palladium(II) nitrate	Pd(NO <sub>3</sub> ) <sub>2</sub>	10102-05-3	230.43	brn hyg cry	dec				sl H <sub>2</sub> O; s dil HNO <sub>3</sub>
1988	Palladium(II) oxide	PdO	1314-08-5	122.42	grn-blk tetr cry	750 dec		8.3		i H <sub>2</sub> O, acid; sl aqua regia
1989	Palladium(II) 2,4-pentanedioate	Pd(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14024-61-4	304.64	oran-yel cry	205 dec				s bz, chl
1990	Palladium(II) sulfate dihydrate	PdSO <sub>4</sub> · 2H <sub>2</sub> O	13566-03-5	238.51	grn-brn cry	dec				
1991	Palladium(II) sulfide	PdS	12125-22-3	138.49	gray tetr cry			6.7		
1992	<i>cis</i> -Dichlorodiamminepalladium(II)	Pd(NH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	15684-18-1	211.39	yel pow				0.025 <sup>25</sup>	
1993	<i>trans</i> -Dichlorodiamminepalladium(II)	Pd(NH <sub>3</sub> ) <sub>2</sub> Cl <sub>2</sub>	13782-33-7	211.39	yel solid			2.50		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
1994	Phosphorus (white)	P	7723-14-0	30.974	col waxlike cub cry	44.15	280.5	1.823		i H <sub>2</sub> O; sl bz, EtOH, chl; s CS <sub>2</sub>
1995	Phosphorus (red)	P	7723-14-0	30.974	red-viol amorp powder	579.2	431 sp	2.16		i H <sub>2</sub> O, os
1996	Phosphorus (black)	P	7723-14-0	30.974	blk orth cry or amorp solid	610		2.69		i os
1997	Phosphine	PH <sub>3</sub>	7803-51-2	33.998	col gas; flam	-133.8	-87.75	1.390 g/L		i H <sub>2</sub> O; sl EtOH, eth
1998	Diphosphine	P <sub>2</sub> H <sub>4</sub>	13445-50-6	65.980	col liq	-99	63.5 dec			reac H <sub>2</sub> O
1999	Diphosphorus tetrachloride	P <sub>2</sub> Cl <sub>4</sub>	13497-91-1	203.760	col oily liq	-28	≈180 dec			
2000	Diphosphorus tetrafluoride	P <sub>2</sub> F <sub>4</sub>	13824-74-3	137.942	col gas	-86.5	-6.2	5.638 g/L		
2001	Diphosphorus tetraiodide	P <sub>2</sub> I <sub>4</sub>	13455-00-0	569.566	red tricr needles	125.5	dec	3.89		
2002	Phosphonium chloride	PH <sub>4</sub> Cl	24567-53-1	70.459	gas		-27 sp	2.880 g/L		reac H <sub>2</sub> O
2003	Phosphonium iodide	PH <sub>4</sub> I	12125-09-6	161.910	col tetr cry	18.5	62.5	2.86		reac H <sub>2</sub> O, EtOH
2004	Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	7664-38-2	97.995	col visc liq	42.4	407		548 <sup>20</sup>	s EtOH
2005	Phosphotungstic acid	H <sub>3</sub> PW <sub>12</sub> O <sub>40</sub>	12067-99-1	2880.05	wh-yel cry	89				vs H <sub>2</sub> O; s EtOH, eth
2006	Phosphonic acid	H <sub>3</sub> PO <sub>3</sub>	13598-36-2	81.996	wh hyg cry	74.4	200	1.65	309 <sup>9</sup>	vs EtOH
2007	Phosphinic acid	HPH <sub>2</sub> O <sub>2</sub>	6303-21-5	65.997	hyg cry or col oily liq	26.5	130	1.49		vs H <sub>2</sub> O, EtOH, eth
2008	Metaphosphoric acid	HPO <sub>3</sub>	37267-86-0	79.980	gl solid; hyg					sl H <sub>2</sub> O; s EtOH
2009	Hypophosphoric acid	H <sub>4</sub> P <sub>2</sub> O <sub>6</sub>	7803-60-3	161.976	col orth cry	73 dec				vs H <sub>2</sub> O
2010	Diphosphoric acid	H <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	2466-09-3	177.975	wh cry	71.5			709 <sup>23</sup>	
2011	Difluorophosphoric acid	HPFO <sub>2</sub>	13779-41-4	101.978	col liq	≈-94	110 dec	1.583		reac H <sub>2</sub> O
2012	Hexafluorophosphoric acid	HPF <sub>6</sub>	16940-81-1	145.972	col oily liq	25 dec				reac H <sub>2</sub> O
2013	Fluorophosphonic acid	H <sub>2</sub> PFO <sub>3</sub>	13537-32-1	99.986	col visc liq	<-70		1.82		vs H <sub>2</sub> O
2014	Phosphorus nitride (P <sub>3</sub> N <sub>3</sub> )	P <sub>3</sub> N <sub>3</sub>	12136-91-3	162.955	yel-brn solid	800 dec				i H <sub>2</sub> O; s os
2015	Phosphorus sesquisulfide	P <sub>4</sub> S <sub>3</sub>	1314-85-8	220.090	yel-grn orth cry	173	407	2.03		i H <sub>2</sub> O; s bz; vs CS <sub>2</sub>
2016	Phosphorus heptasulfide	P <sub>4</sub> S <sub>7</sub>	12037-82-0	348.350	pale yel monocl cry	308	523	2.19		sl CS <sub>2</sub>
2017	Phosphonitric chloride trimer	(PNCl <sub>2</sub> ) <sub>3</sub>	940-71-6	347.659	wh hyg cry	128.8		1.98		reac H <sub>2</sub> O
2018	Phosphorus(III) bromide	PBr <sub>3</sub>	7789-60-8	270.686	col liq	-41.5	173.2	2.8		reac H <sub>2</sub> O, EtOH; s ace, CS <sub>2</sub>
2019	Phosphorus(III) dibromide fluoride	PBr <sub>2</sub> F	15597-39-4	209.780	col liq	-115	78.5			
2020	Phosphorus(III) bromide difluoride	PBrF <sub>2</sub>	15597-40-7	148.875	col gas	-133.8	-16.1	6.085 g/L		
2021	Phosphorus(III) chloride	PCl <sub>3</sub>	7719-12-2	137.333	col liq	-93	76	1.574		reac H <sub>2</sub> O, EtOH; s bz, chl, eth
2022	Phosphorus(III) dichloride fluoride	PCl <sub>2</sub> F	15597-63-4	120.878	col gas	-144	13.85	4.941 g/L		
2023	Phosphorus(III) chloride difluoride	PClF <sub>2</sub>	14335-40-1	104.424	col gas	-164.8	-47.3	4.268 g/L		
2024	Phosphorus(III) fluoride	PF <sub>3</sub>	7783-55-3	87.969	col gas	-151.5	-101.8	3.596 g/L		reac H <sub>2</sub> O
2025	Phosphorus(III) iodide	PI <sub>3</sub>	13455-01-1	411.687	red-oran hex cry; hyg	61.2	227 dec	4.18		reac H <sub>2</sub> O; s EtOH
2026	Phosphorus(III) oxide	P <sub>2</sub> O <sub>3</sub>	1314-24-5	109.946	col monocl cry or liq	23.8	173	2.13		reac H <sub>2</sub> O
2027	Tetraphosphorus(III) hexoxide	P <sub>4</sub> O <sub>6</sub>	12440-00-5	219.891	soft wh cry	23.8	175.4			
2028	Phosphorus(III) selenide	P <sub>2</sub> Se <sub>3</sub>	1314-86-9	298.83	oran-red cry	245	≈380	1.31		reac H <sub>2</sub> O; s bz, ctc, CS <sub>2</sub> , ace
2029	Phosphorus(III) sulfide	P <sub>2</sub> S <sub>3</sub>	12165-69-4	158.143	yel solid	290	490			reac H <sub>2</sub> O; s EtOH, eth, CS <sub>2</sub>
2030	Phosphorus(V) bromide	PBr <sub>5</sub>	7789-69-7	430.494	yel orth cry; hyg	≈100 dec		3.61		reac H <sub>2</sub> O, EtOH; s CS <sub>2</sub> , ctc
2031	Phosphorus(V) tetrabromide fluoride	PBr <sub>4</sub> F		369.588	pale yel cry	87 dec				
2032	Phosphorus(V) dibromide trifluoride	PBr <sub>2</sub> F <sub>3</sub>	13445-58-4	247.777	yel-red liq	-20	15 dec			
2033	Phosphorus(V) chloride	PCl <sub>5</sub>	10026-13-8	208.239	wh-yel tetr cry; hyg	167 tp	160 sp	2.1		reac H <sub>2</sub> O; s CS <sub>2</sub> , ctc
2034	Phosphorus(V) tetrachloride fluoride	PCl <sub>4</sub> F	13498-11-8	191.784	col liq	-59	30 dec			
2035	Phosphorus(V) trichloride difluoride	PCl <sub>3</sub> F <sub>2</sub>	13537-23-0	175.330	col liq	-63				
2036	Phosphorus(V) dichloride trifluoride	PCl <sub>2</sub> F <sub>3</sub>	13454-99-4	158.875	col gas	-125	7.1	6.494 g/L		
2037	Phosphorus(V) chloride tetrafluoride	PClF <sub>4</sub>	13498-11-8	142.421	col gas	-132	-43.4	5.821 g/L		
2038	Phosphorus(V) fluoride	PF <sub>5</sub>	7647-19-0	125.966	col gas	-93.8	-84.6	5.149 g/L		reac H <sub>2</sub> O
2039	Phosphorus(V) oxide	P <sub>2</sub> O <sub>5</sub>	1314-56-3	141.945	wh orth cry; hyg	562	605	2.30		reac H <sub>2</sub> O, EtOH
2040	Phosphorus(V) selenide	P <sub>2</sub> Se <sub>5</sub>	1314-82-5	456.75	blk-purp amorp solid					reac hot H <sub>2</sub> O, ctc; i CS <sub>2</sub>
2041	Phosphorus(V) sulfide	P <sub>2</sub> S <sub>5</sub>	1314-80-3	222.273	grn-yel hyg cry	285	515	2.03		reac H <sub>2</sub> O; s CS <sub>2</sub>
2042	Phosphonic difluoride	POF <sub>2</sub> H	14939-34-5	85.978	volatile liq	>-120	≈60 (gas unstab)			

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2043	Phosphoryl bromide	POBr <sub>3</sub>	7789-59-5	286.685	faint oran plates	55	191.7	2.822		reac H <sub>2</sub> O; s bz, eth, chl
2044	Phosphoryl dibromide chloride	POBr <sub>2</sub> Cl	13550-31-7	242.234	yel solid	31	165			
2045	Phosphoryl dibromide fluoride	POBr <sub>2</sub> F	14014-19-8	225.779	col liq	-117.2	110.1			
2046	Phosphoryl bromide dichloride	POBrCl <sub>2</sub>	13455-03-3	197.783	col liq	11	136.5	2.104 <sup>14</sup>		
2047	Phosphoryl bromide difluoride	POBrF <sub>2</sub>	14014-18-7	164.874	col liq	-84.8	31.6			
2048	Phosphoryl bromide chloride fluoride	POBrClF	14518-81-1	181.328	col liq		79			
2049	Phosphoryl chloride	POCl <sub>3</sub>	10025-87-3	153.332	col liq	1.18	105.5	1.645		reac H <sub>2</sub> O, EtOH
2050	Phosphoryl dichloride fluoride	POCl <sub>2</sub> F	13769-76-1	136.877	col liq	-80.1	52.9			
2051	Phosphoryl chloride difluoride	POClF <sub>2</sub>	13769-75-0	120.423	col gas	-96.4	3.1	4.922 g/L		
2052	Phosphoryl fluoride	POF <sub>3</sub>	13478-20-1	103.968	col gas	-39.1 tp	-39.7 sp	4.250 g/L		reac H <sub>2</sub> O
2053	Phosphoryl iodide	POI <sub>3</sub>	13455-04-4	427.686	viol cry	53				
2054	Phosphorothioic tribromide	PSBr <sub>3</sub>	3931-89-3	302.751	yel cry	37.8	212 dec	2.85		
2055	Phosphorothioic dibromide fluoride	PSBr <sub>2</sub> F	13706-10-0	241.845	yel liq	-75.2	125.3			
2056	Phosphorothioic bromide difluoride	PSBrF <sub>2</sub>	13706-09-7	180.940	yel liq	-136.9	35.5			
2057	Phosphorothioic trichloride	PSCl <sub>3</sub>	3982-91-0	169.398	fuming liq	-36.2	125	1.635		reac H <sub>2</sub> O; s bz, ctc, chl, CS <sub>2</sub>
2058	Phosphorothioic dichloride fluoride	PSCl <sub>2</sub> F	155698-29-6	152.943	col liq	-96.0	64.7			
2059	Phosphorothioic chloride difluoride	PSClF <sub>2</sub>	2524-02-9	136.489	col gas	-155.2	6.3	5.579 g/L		
2060	Phosphorothioic trifluoride	PSF <sub>3</sub>	2404-52-6	120.034	col gas	-148.8	-52.25	4.906 g/L		
2061	Phosphorothioic triiodide	PSI <sub>3</sub>	63972-04-3	443.752	yel cry	48	dec			
2062	Platinum	Pt	7440-06-4	195.084	silv-gray metal; cub	1768.2	3825	21.5		i acid; s aqua regia
2063	Hexachloroplatinic acid	H <sub>2</sub> PtCl <sub>6</sub>	16941-12-1	409.818	hyg yel-brn cry	60				s H <sub>2</sub> O, EtOH
2064	Hydrogen hexahydroxyplatinate(IV)	H <sub>2</sub> Pt(OH) <sub>6</sub>	51850-20-5	299.144	yel needles	dec 100				s H <sub>2</sub> O, acid, dil alk
2065	Platinum(II) bromide	PtBr <sub>2</sub>	13455-12-4	354.892	red-brn powder	250 dec		6.65		i H <sub>2</sub> O
2066	Platinum(II) chloride	PtCl <sub>2</sub>	10025-65-7	265.990	grn hex cry	581 dec		6.0		i H <sub>2</sub> O, EtOH, eth; s HCl
2067	Platinum(II) cyanide	Pt(CN) <sub>2</sub>	592-06-3	247.118	pale yel cry					i H <sub>2</sub> O, acid, alk
2068	Platinum(II) iodide	PtI <sub>2</sub>	7790-39-8	448.893	blk powder	325 dec		6.4		i H <sub>2</sub> O
2069	Platinum(II) oxide	PtO	12035-82-4	211.083	blk tetr cry	325 dec		14.1		i H <sub>2</sub> O, EtOH; s aqua regia
2070	Platinum(II) sulfide	PtS	12038-20-9	227.149	tetr cry			10.25		
2071	Platinum(III) bromide	PtBr <sub>3</sub>	25985-07-3	434.796	grn-blk cry	200 dec				
2072	Platinum(III) chloride	PtCl <sub>3</sub>	25909-39-1	301.443	grn-blk cry	435 dec		5.26		
2073	Platinum(IV) bromide	PtBr <sub>4</sub>	68938-92-1	514.700	brn-blk cry	180 dec			0.41 <sup>20</sup>	sl EtOH, eth
2074	Platinum(IV) chloride	PtCl <sub>4</sub>	37773-49-2	336.896	red-brn cub cry	327 dec		4.30	142 <sup>25</sup>	
2075	Platinum(IV) chloride pentahydrate	PtCl <sub>4</sub> · 5H <sub>2</sub> O	13454-96-1	426.972	red cry			2.43		s H <sub>2</sub> O, EtOH
2076	Platinum(IV) fluoride	PtF <sub>4</sub>	13455-15-7	271.078	red cry	600				
2077	Platinum(IV) iodide	PtI <sub>4</sub>	7790-46-7	702.702	brn-blk powder	130 dec				s H <sub>2</sub> O
2078	Platinum(IV) oxide	PtO <sub>2</sub>	1314-15-4	227.083	blk hex cry	450		11.8		i H <sub>2</sub> O; s conc acid, dil alk
2079	Platinum(IV) sulfide	PtS <sub>2</sub>	12038-21-0	259.214	hex cry			7.85		
2080	Platinum(VI) fluoride	PtF <sub>6</sub>	13693-05-5	309.074	red cub cry	61.3	69.1	≈4.0		
2081	cis-Diamminedichloroplatinum	Pt(NH <sub>2</sub> ) <sub>2</sub> Cl <sub>2</sub>	15663-27-1	300.051	yel solid	270 dec			0.253 <sup>25</sup>	
2082	trans-Diamminedichloroplatinum	Pt(NH <sub>2</sub> ) <sub>2</sub> Cl <sub>2</sub>	14913-33-8	300.051	pale yel solid	270 dec			0.036 <sup>25</sup>	s DMF, DMSO
2083	Hexachloroplatinic acid hexahydrate	H <sub>2</sub> PtCl <sub>6</sub> · 6H <sub>2</sub> O	16941-12-1	517.909	brn-yel hyg cry	60		2.43	140 <sup>18</sup>	vs EtOH
2084	Platinum silicide	PtSi	12137-83-6	223.170	orth cry	1229		12.4		
2085	Plutonium	Pu	7440-07-5	244	silv-wh metal; monocl	640	3228	19.7		
2086	Plutonium nitride	PuN	12033-54-4	258	gray cub cry	2550		14.4		
2087	Plutonium(II) oxide	PuO	12035-83-5	260	cub cry			14.0		
2088	Plutonium(III) bromide	PuBr <sub>3</sub>	15752-46-2	484	grn orth cry	681		6.75		s H <sub>2</sub> O
2089	Plutonium(III) chloride	PuCl <sub>3</sub>	13569-62-5	350	grn hex cry	760		5.71		s H <sub>2</sub> O
2090	Plutonium(III) fluoride	PuF <sub>3</sub>	13842-83-6	301	purp hex cry	1396		9.33		i H <sub>2</sub> O; sl acid
2091	Plutonium(III) iodide	PuI <sub>3</sub>	13813-46-2	625	grn orth cry; hyg	777		6.92		s H <sub>2</sub> O
2092	Plutonium(III) oxide	Pu <sub>2</sub> O <sub>3</sub>	12036-34-9	536	blk cub cry	2085		10.5		
2093	Plutonium(IV) fluoride	PuF <sub>4</sub>	13709-56-3	320	red-brn monocl cry	1037		7.1		
2094	Plutonium(IV) oxide	PuO <sub>2</sub>	12059-95-9	276	yel-brn cub cry	2390		11.5		
2095	Plutonium(VI) fluoride	PuF <sub>6</sub>	13693-06-6	358	red-brn orth cry	51.6		5.08		
2096	Polonium	Po	7440-08-6	209	silv metal; cub	254	962	9.20		
2097	Polonium(IV) chloride	PoCl <sub>4</sub>	10026-02-5	351	yel hyg cry	≈300	390			s H <sub>2</sub> O, EtOH, ace
2098	Polonium(IV) oxide	PoO <sub>2</sub>	7446-06-2	241	yel cub cry	500 dec		8.9		
2099	Potassium	K	7440-09-7	39.098	soft silv-wh metal; cub	63.5	759	0.89		reac H <sub>2</sub> O
2100	Potassium acetate	KC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	127-08-2	98.142	wh hyg cry	309		1.57	269 <sup>25</sup>	s EtOH; i eth

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2101	Potassium aluminate trihydrate	K <sub>2</sub> Al <sub>2</sub> O <sub>4</sub> · 3H <sub>2</sub> O	12003-63-3*	250.204	wh orth cry			2.13		vs H <sub>2</sub> O; i EtOH
2102	Potassium aluminum silicate	KAlSi <sub>3</sub> O <sub>8</sub>	1327-44-2	278.332	col monoc cry			2.56		i H <sub>2</sub> O
2103	Potassium aluminum sulfate	KAl(SO <sub>4</sub> ) <sub>2</sub>	10043-67-1	258.205	wh hyg powder				5.9 <sup>20</sup>	
2104	Potassium aluminum sulfate dodecahydrate	KAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7784-24-9	474.389	col cry	≈100 dec		1.72	5.9 <sup>20</sup>	
2105	Potassium amide	KNH <sub>2</sub>	17242-52-3	55.121	wh/yel-grn hyg cry	335				reac H <sub>2</sub> O, EtOH
2106	Potassium arsenate	K <sub>3</sub> AsO <sub>4</sub>	13464-36-3	256.215	col cry			2.8	125 <sup>25</sup>	
2107	Potassium arsenite	KAsO <sub>2</sub>	13464-35-2	146.019	wh hyg powder					s H <sub>2</sub> O; sl EtOH
2108	Potassium azide	KN <sub>3</sub>	20762-60-1	81.118	tetr cry; exp			2.04	49.7 <sup>17</sup>	
2109	Potassium borohydride	KBH <sub>4</sub>	13762-51-1	53.941	wh cub cry	≈500 dec		1.11		s H <sub>2</sub> O
2110	Potassium bromate	KBrO <sub>3</sub>	7758-01-2	167.000	wh hex cry	434 dec		3.27	8.17 <sup>25</sup>	i EtOH
2111	Potassium bromide	KBr	7758-02-3	119.002	col cub cry; hyg	734	1435	2.74	67.8 <sup>25</sup>	sl EtOH
2112	Potassium carbonate	K <sub>2</sub> CO <sub>3</sub>	584-08-7	138.206	wh monoc cry; hyg	899	dec	2.29	111 <sup>25</sup>	i EtOH
2113	Potassium carbonate sesquihydrate	K <sub>2</sub> CO <sub>3</sub> · 1.5H <sub>2</sub> O	6381-79-9	165.229	granular cry				111 <sup>20</sup>	
2114	Potassium chlorate	KClO <sub>3</sub>	3811-04-9	122.549	wh monoc cry	357	dec	2.34	8.61 <sup>25</sup>	
2115	Potassium chloride	KCl	7447-40-7	74.551	wh cub cry	771		1.988	35.5 <sup>25</sup>	i eth, ace
2116	Potassium chlorochromate	KCrO <sub>3</sub> Cl	16037-50-6	174.545	oran cry			2.5		reac H <sub>2</sub> O; s ace, acid
2117	Potassium chromate	K <sub>2</sub> CrO <sub>4</sub>	7789-00-6	194.191	yel orth cry	974		2.73	65.0 <sup>25</sup>	
2118	Potassium citrate monohydrate	K <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · H <sub>2</sub> O	6100-05-6	324.410	col hyg cry	180 dec		1.98	172 <sup>20</sup>	vs H <sub>2</sub> O; sl EtOH
2119	Potassium cobalt(II) selenate hexahydrate	K <sub>2</sub> Co(SeO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	28041-86-3	531.14	red monoc cry			2.51		
2120	Potassium cyanate	KCNO	590-28-3	81.115	wh tetr cry	≈700 dec		2.05	75 <sup>25</sup>	sl EtOH
2121	Potassium cyanide	KCN	151-50-8	65.116	wh cub cry; hyg	622		1.55	69.9 <sup>20</sup>	sl EtOH
2122	Potassium cyanoaurite	KAu(CN) <sub>2</sub>	13967-50-5	288.099	col cry			3.45	14 <sup>20</sup>	s H <sub>2</sub> O; sl EtOH; i eth, ace
2123	Potassium dichromate	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	7778-50-9	294.185	oran-red tricl cry	398	≈500 dec	2.68	15.1 <sup>25</sup>	
2124	Potassium dihydrogen arsenate	KH <sub>2</sub> AsO <sub>4</sub>	7784-41-0	180.034	col cry	288		2.87	19 <sup>6</sup>	i EtOH
2125	Potassium dihydrogen phosphate	KH <sub>2</sub> PO <sub>4</sub>	7778-77-0	136.085	wh tetr cry	253 dec		2.34	25.0 <sup>25</sup>	sl EtOH
2126	Potassium dihydrogen phosphonate	KH <sub>2</sub> PO <sub>3</sub>	13977-65-6	120.086	col monoc hyg cry					
2127	Potassium dithionate	K <sub>2</sub> S <sub>2</sub> O <sub>6</sub>	13455-20-4	238.323	col hex cry	dec		2.27		sl H <sub>2</sub> O; i EtOH
2128	Potassium ferricyanide	K <sub>3</sub> Fe(CN) <sub>6</sub>	13746-66-2	329.244	red cry	dec		1.89	48.8 <sup>25</sup>	
2129	Potassium ferrocyanide trihydrate	K <sub>4</sub> Fe(CN) <sub>6</sub> · 3H <sub>2</sub> O	14459-95-1	422.388	yel monoc cry	60 dec		1.85	36.0 <sup>25</sup>	i EtOH, eth
2130	Potassium fluoride	KF	7789-23-3	58.096	wh cub cry	858	1502	2.48	102 <sup>25</sup>	
2131	Potassium fluoride dihydrate	KF · 2H <sub>2</sub> O	13455-21-5	94.127	monoc cry	41 dec		2.5	102 <sup>25</sup>	
2132	Potassium fluoroborate	KBF <sub>4</sub>	14075-53-7	125.903	col orth cry	530		2.505	0.55 <sup>25</sup>	sl EtOH
2133	Potassium fluorotantalate	K <sub>2</sub> TaF <sub>7</sub>	16924-00-8	392.134	col cry	730		5.24	0.5 <sup>0</sup>	
2134	Potassium formate	KCHO <sub>2</sub>	590-29-4	84.116	col hyg cry	167		1.91	331 <sup>18</sup>	
2135	Potassium hexachloroosmate(IV)	K <sub>2</sub> OsCl <sub>6</sub>	16871-60-6	481.15	red cub cry					vs H <sub>2</sub> O; sl EtOH
2136	Potassium hexachloroplatinate	K <sub>2</sub> PtCl <sub>6</sub>	16921-30-5	485.999	yel-oran cub cry	250 dec		3.50	0.77 <sup>20</sup>	i EtOH
2137	Potassium hexacyanocobaltate	K <sub>3</sub> Co(CN) <sub>6</sub>	13963-58-1	332.332	yel monoc cry	dec		1.91		vs H <sub>2</sub> O; i EtOH
2138	Potassium hexafluoromanganate(IV)	K <sub>2</sub> MnF <sub>6</sub>	16962-31-5	247.125	yel hex cry					reac H <sub>2</sub> O
2139	Potassium hexafluorosilicate	K <sub>2</sub> SiF <sub>6</sub>	16871-90-2	220.273	wh cry	dec		2.27	0.084 <sup>20</sup>	i EtOH
2140	Potassium hexafluorozirconate(IV)	K <sub>2</sub> ZrF <sub>6</sub>	16923-95-8	283.411	col monoc cry			3.48	0.78 <sup>2</sup>	
2141	Potassium hydride	KH	7693-26-7	40.106	cub cry	619		1.43		reac H <sub>2</sub> O
2142	Potassium hydrogen arsenate	K <sub>2</sub> HAsO <sub>4</sub>	21093-83-4	218.125	col monoc prisms	300 dec			18.7 <sup>8</sup>	i EtOH
2143	Potassium hydrogen carbonate	KHCO <sub>3</sub>	298-14-6	100.115	col monoc cry	≈100 dec		2.17	36.2 <sup>25</sup>	i EtOH
2144	Potassium hydrogen fluoride	KHF <sub>2</sub>	7789-29-9	78.103	col tetr cry	238.8		2.37	39.2 <sup>20</sup>	i EtOH
2145	Potassium hydrogen iodate	KH(IO <sub>3</sub> ) <sub>2</sub>	13455-24-8	389.911	col cry	dec			1.3 <sup>15</sup>	sl H <sub>2</sub> O; i EtOH
2146	Potassium hydrogen oxalate hemihydrate	KHC <sub>2</sub> O <sub>4</sub> · 0.5H <sub>2</sub> O	127-95-7		wh cry	dec		2.09	2.5 <sup>20</sup>	sl EtOH
2147	Potassium hydrogen phosphate	K <sub>2</sub> HPO <sub>4</sub>	7758-11-4	174.176	wh hyg cry	dec			168 <sup>25</sup>	s EtOH
2148	Potassium hydrogen phosphite	K <sub>2</sub> HPO <sub>3</sub>	13492-26-7	158.177	wh hyg powder	dec			170 <sup>20</sup>	i EtOH
2149	Potassium hydrogen selenite	KHSeO <sub>3</sub>	7782-70-9	167.06	hyg orth cry	>100 dec				s H <sub>2</sub> O; sl EtOH
2150	Potassium hydrogen sulfate	KHSO <sub>4</sub>	7646-93-7	136.169	wh monoc cry; hyg	≈200		2.32	50.6 <sup>25</sup>	
2151	Potassium hydrogen sulfide	KHS	1310-61-8	72.171	wh hex cry; hyg	≈450		1.69		s H <sub>2</sub> O, EtOH
2152	Potassium hydrogen sulfide hemihydrate	KHS · 0.5H <sub>2</sub> O	1310-61-8*	81.179	wh-yel hyg cry	≈175		1.7		vs H <sub>2</sub> O, EtOH
2153	Potassium hydrogen sulfite	KHSO <sub>3</sub>	7773-03-7	120.169	wh cry powder	190 dec			49 <sup>20</sup>	i EtOH
2154	Potassium hydrogen tartrate	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	868-14-4	188.177	wh cry			1.98	0.57 <sup>20</sup>	s acid, alk; i EtOH
2155	Potassium hydroxide	KOH	1310-58-3	56.105	wh rhomb cry; hyg	406	1327	2.044	121 <sup>25</sup>	s EtOH; s MeOH
2156	Potassium hypochlorite	KOCl	7778-66-7	90.550	exists only in aq soln					
2157	Potassium phosphinate	KH <sub>2</sub> PO <sub>2</sub>	7782-87-8	104.087	wh hyg cry	dec				vs H <sub>2</sub> O; s EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2158	Potassium iodate	KIO <sub>3</sub>	7758-05-6	214.001	wh monocl cry	560 dec		3.89	9.22 <sup>25</sup>	
2159	Potassium iodide	KI	7681-11-0	166.003	col cub cry	681	1323	3.12	148 <sup>25</sup>	sl EtOH
2160	Potassium iron(III) oxalate trihydrate	K <sub>3</sub> Fe(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 3H <sub>2</sub> O		491.243	grn monocl cry	100	230 dec	2.133	4.7 <sup>0</sup>	i EtOH
2161	Potassium manganate	K <sub>2</sub> MnO <sub>4</sub>	10294-64-1	197.133	grn cry	190 dec				s H <sub>2</sub> O; reac HCl
2162	Potassium metaarsenate	KAsO <sub>3</sub>	19197-73-0	162.018	wh solid	660				
2163	Potassium metabisulfite	K <sub>2</sub> S <sub>2</sub> O <sub>5</sub>	16731-55-8	222.324	wh powder	≈150 dec		2.3	49.5 <sup>25</sup>	reac acid; i EtOH
2164	Potassium metaborate	KBO <sub>2</sub>	13709-94-9	81.908	wh hex cry	947		≈2.3		
2165	Potassium molybdate	K <sub>2</sub> MoO <sub>4</sub>	13446-49-6	238.14	wh hyg cry	919		2.3	183 <sup>25</sup>	i EtOH
2166	Potassium niobate	KNbO <sub>3</sub>	12030-85-2	180.002	wh rhomb cry	≈1100		4.64		i H <sub>2</sub> O
2167	Potassium nitrate	KNO <sub>3</sub>	7757-79-1	101.103	col orth cry or powder	334	400 dec	2.105	38.3 <sup>25</sup>	i EtOH
2168	Potassium nitrite	KNO <sub>2</sub>	7758-09-0	85.104	wh hyg cry	438	537 exp	1.915	312 <sup>25</sup>	sl EtOH
2169	Potassium oxalate	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	583-52-8	166.216	wh pwd					sl H <sub>2</sub> O
2170	Potassium oxalate monohydrate	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	6487-48-5	184.231	col cry	160 dec		2.13	36.4 <sup>20</sup>	
2171	Potassium oxide	K <sub>2</sub> O	12136-45-7	94.196	gray cub cry	740				s H <sub>2</sub> O, EtOH, eth
2172	Potassium perbromate	KBrO <sub>4</sub>	22207-96-1	183.000	wh cry	275 dec			4.21 <sup>25</sup>	
2173	Potassium percarbonate monohydrate	K <sub>2</sub> C <sub>2</sub> O <sub>6</sub> · H <sub>2</sub> O	589-97-9	216.230	oran or blue pow				6.5 <sup>20</sup>	
2174	Potassium perchlorate	KClO <sub>4</sub>	7778-74-7	138.549	col orth cry; hyg	525		2.52	2.08 <sup>25</sup>	
2175	Potassium periodate	KIO <sub>4</sub>	7790-21-8	230.001	col tetr cry	582	exp	3.618	0.51 <sup>25</sup>	
2176	Potassium permanganate	KMnO <sub>4</sub>	7722-64-7	158.034	purp orth cry	dec		2.7	7.60 <sup>25</sup>	reac EtOH
2177	Potassium peroxide	K <sub>2</sub> O <sub>2</sub>	17014-71-0	110.196	yel amorp solid	490				reac H <sub>2</sub> O
2178	Potassium persulfate	K <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	7727-21-1	270.322	col cry	≈100 dec		2.48	4.7 <sup>20</sup>	
2179	Potassium phosphate	K <sub>3</sub> PO <sub>4</sub>	7778-53-2	212.266	wh orth cry; hyg	1340		2.564	106 <sup>25</sup>	i EtOH
2180	Potassium pyrophosphate	K <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	7320-34-5		wh cry	dec 1300				s H <sub>2</sub>
2181	Potassium pyrophosphate trihydrate	K <sub>4</sub> P <sub>2</sub> O <sub>7</sub> · 3H <sub>2</sub> O	7790-67-2	384.383	col hyg cry	dec 300		2.33		vs H <sub>2</sub> O; i EtOH
2182	Potassium pyrosulfate	K <sub>2</sub> S <sub>2</sub> O <sub>7</sub>	7790-62-7	254.323	col needles	≈325		2.28		s H <sub>2</sub> O
2183	Potassium selenate	K <sub>2</sub> SeO <sub>4</sub>	7790-59-2	221.16	wh powder			3.07	114 <sup>25</sup>	
2184	Potassium selenide	K <sub>2</sub> Se	1312-74-9	157.16	red cub cry; hyg	800		2.29		s H <sub>2</sub> O
2185	Potassium selenite	K <sub>2</sub> SeO <sub>3</sub>	10431-47-7	205.16	wh hyg cry	875 dec			217 <sup>25</sup>	sl EtOH
2186	Potassium silver cyanide	KAg(CN) <sub>2</sub>	506-61-6	199.000	wh cry					s H <sub>2</sub> O
2187	Potassium sodium tartrate tetrahydrate	KNaC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 4H <sub>2</sub> O	6381-59-5	282.220	wh cry	≈70 dec	anh at 130	1.79		vs H <sub>2</sub> O; i EtOH
2188	Potassium stannate trihydrate	K <sub>2</sub> SnO <sub>3</sub> · 3H <sub>2</sub> O	12142-33-5*	298.951	col cry			3.20		vs H <sub>2</sub> O; i EtOH
2189	Potassium stearate	KC <sub>18</sub> H <sub>35</sub> O <sub>2</sub>	593-29-3	322.568	wh pow					sl cold H <sub>2</sub> O; s hot H <sub>2</sub> O, EtOH
2190	Potassium sulfate	K <sub>2</sub> SO <sub>4</sub>	7778-80-5	174.260	wh orth cry	1069		2.66	12.0 <sup>25</sup>	i EtOH
2191	Potassium sulfide	K <sub>2</sub> S	1312-73-8	110.262	red-yel cub cry; hyg	948		1.74		s H <sub>2</sub> O, EtOH; i eth
2192	Potassium sulfide pentahydrate	K <sub>2</sub> S · 5H <sub>2</sub> O	37248-34-3	200.338	col rhomb cry	60				vs H <sub>2</sub> O, EtOH; i eth
2193	Potassium sulfite	K <sub>2</sub> SO <sub>3</sub>	10117-38-1	158.260	col hex cry				106 <sup>25</sup>	sl EtOH
2194	Potassium sulfite dihydrate	K <sub>2</sub> SO <sub>3</sub> · 2H <sub>2</sub> O	7790-56-9	194.291	wh monocl cry	dec			107 <sup>20</sup>	sl EtOH; dec dil acid
2195	Potassium superoxide	KO <sub>2</sub>	12030-88-5	71.097	yel tetr cry; hyg	380		2.16		reac H <sub>2</sub> O
2196	Potassium tellurate(VI) trihydrate	K <sub>2</sub> TeO <sub>6</sub> · 3H <sub>2</sub> O	15571-91-2*	323.84	wh cry powder					s H <sub>2</sub> O
2197	Potassium tellurite	K <sub>2</sub> TeO <sub>3</sub>	7790-58-1	253.80	wh hyg cry	≈460 dec				vs H <sub>2</sub> O
2198	Potassium tetraborate pentahydrate	K <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 5H <sub>2</sub> O	1332-77-0	323.513	wh cry powder				16.5 <sup>30</sup>	sl EtOH
2199	Potassium tetrachloroaurate dihydrate	KAuCl <sub>4</sub> · 2H <sub>2</sub> O	13682-61-6	413.908	yel monocl cry					s H <sub>2</sub> O, EtOH, eth
2200	Potassium tetrachloroplatinate	K <sub>2</sub> PtCl <sub>6</sub>	10025-99-7	415.093	pink-red tetr cry	500 dec		3.38		s H <sub>2</sub> O; i EtOH
2201	Potassium tetracyanocadmuate	K <sub>2</sub> Cd(CN) <sub>4</sub>	14402-75-6	294.678	cub cry	≈450		1.85	25 <sup>20</sup>	sl EtOH
2202	Potassium tetracyanonickelate monohydrate	K <sub>2</sub> [Ni(CN) <sub>4</sub> ] · H <sub>2</sub> O	14220-17-8*	258.975	red-oran cry	dec 100				
2203	Potassium tetracyanoplatinate(II) trihydrate	K <sub>2</sub> Pt(CN) <sub>4</sub> · 3H <sub>2</sub> O	562-76-5*	431.397	col rhomb prisms					s H <sub>2</sub> O
2204	Potassium tetracyanozincate	K <sub>2</sub> Zn(CN) <sub>4</sub>	14244-62-3	247.676	cry pow					vs H <sub>2</sub> O
2205	Potassium tetraiodomercurate(II)	K <sub>2</sub> HgI <sub>4</sub>	7783-33-7	786.40	yel hyg cry			4.29		vs H <sub>2</sub> O; s EtOH, eth, ace
2206	Potassium thiocyanate	KSCN	333-20-0	97.181	col tetr cry; hyg	173	500 dec	1.88	238 <sup>25</sup>	s EtOH
2207	Potassium thiosulfate	K <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	10294-66-3	190.325	col hyg cry				165 <sup>25</sup>	i EtOH
2208	Potassium titanate	K <sub>2</sub> TiO <sub>3</sub>	12030-97-6	174.062	wh orth cry	1515		3.1		reac H <sub>2</sub> O
2209	Potassium triiodide monohydrate	KI <sub>3</sub> · H <sub>2</sub> O	7790-42-3	437.827	brn monocl cry; hyg	225 dec		3.5		s H <sub>2</sub> O; reac EtOH, eth
2210	Potassium triiodozincate	KZnI <sub>3</sub>	7790-43-4	485.221	hyg cry					vs H <sub>2</sub> O
2211	Potassium thiocarbonate	K <sub>2</sub> CS <sub>3</sub>	26750-66-3	186.403	yel-red hyg cry					vs H <sub>2</sub> O
2212	Potassium tungstate	K <sub>2</sub> WO <sub>4</sub>	7790-60-5	326.04	hyg cry	921		3.12		vs H <sub>2</sub> O; i EtOH
2213	Potassium uranate	K <sub>2</sub> U <sub>2</sub> O <sub>7</sub>	7790-63-8	666.251	oran cub cry			6.12		i H <sub>2</sub> O; s acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2214	Potassium uranyl nitrate	K(UO <sub>2</sub> )(NO <sub>3</sub> ) <sub>3</sub>	18078-40-5	495.140	grn-yel cry pow					vs H <sub>2</sub> O
2215	Potassium uranyl sulfate dihydrate	K <sub>2</sub> (UO <sub>2</sub> )(SO <sub>4</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	27709-53-1	576.381	grn-yel cry pow	dec 120		3.36		vs H <sub>2</sub> O
2216	Potassium zinc sulfate hexahydrate	K <sub>2</sub> Zn(SO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13932-17-7	443.823	cry					s H <sub>2</sub> O
2217	Potassium zirconium sulfate trihydrate	K <sub>2</sub> Zr(SO <sub>4</sub> ) <sub>4</sub> · 3H <sub>2</sub> O	53608-79-0	685.914	wh cry pow					sl H <sub>2</sub> O
2218	Praseodymium	Pr	7440-10-0	140.908	silv metal; hex	931	3520	6.77		
2219	Praseodymium boride	PrB <sub>6</sub>	12008-27-4	205.774	blk cub cry	2610		4.84		
2220	Praseodymium nitride	PrN	25764-09-4	154.915	cub cry			7.46		
2221	Praseodymium silicide	PrSi <sub>2</sub>	12066-83-0	197.079	tetr cry	1712		5.46		
2222	Praseodymium(II) iodide	PrI <sub>2</sub>	65530-47-4	394.717	bronze solid	758				
2223	Praseodymium(III) bromate	Pr(BrO <sub>3</sub> ) <sub>3</sub>	15162-93-3	524.615	grn cry					vs H <sub>2</sub> O
2224	Praseodymium(III) bromide	PrBr <sub>3</sub>	13536-53-3	380.620	grn hex cry; hyg	693		5.28		s H <sub>2</sub> O
2225	Praseodymium(III) carbonate octahydrate	Pr <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	14948-62-0	605.964	grn silky plates	dec 420 (anh)				i H <sub>2</sub> O; s acid
2226	Praseodymium(III) chloride	PrCl <sub>3</sub>	10361-79-2	247.267	grn hex needles; hyg	786		4.0	96.1 <sup>25</sup>	s EtOH
2227	Praseodymium(III) chloride heptahydrate	PrCl <sub>3</sub> · 7H <sub>2</sub> O	10025-90-8	373.374	grn cry	110 dec			96.1 <sup>25</sup>	s EtOH
2228	Praseodymium(III) fluoride	PrF <sub>3</sub>	13709-46-1	197.903	grn hex cry	1399		6.3		
2229	Praseodymium(III) hydroxide	Pr(OH) <sub>3</sub>	16469-16-2	191.930	grn solid	dec 220		3.7		i H <sub>2</sub> O
2230	Praseodymium(III) iodide	PrI <sub>3</sub>	13813-23-5	521.621	orth hyg cry	738		≈5.8		s H <sub>2</sub> O
2231	Praseodymium(III) nitrate	Pr(NO <sub>3</sub> ) <sub>3</sub>	10361-80-5	326.923	pale grn hyg cry				165 <sup>26</sup>	s EtOH
2232	Praseodymium(III) nitrate hexahydrate	Pr(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	15878-77-0	435.014	grn needles				165 <sup>26</sup>	s EtOH, ace
2233	Praseodymium(III) oxide	Pr <sub>2</sub> O <sub>3</sub>	12036-32-7	329.813	wh hex cry	2183	3760	6.9		
2234	Praseodymium(III) perchlorate hexahydrate	Pr(ClO <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	13498-07-2*	547.351	hyg grn cry	dec 200				s H <sub>2</sub> O, EtOH
2235	Praseodymium(III) sulfate octahydrate	Pr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13510-41-3	714.125	grn monocry			2.83	17 <sup>20</sup>	s H <sub>2</sub> O
2236	Praseodymium(III) sulfide	Pr <sub>2</sub> S <sub>3</sub>	12038-13-0	378.010	cub cry	1765		5.1		
2237	Praseodymium(III) telluride	Pr <sub>2</sub> Te <sub>3</sub>	12038-12-9	664.62	cub cry	1500		≈7.0		
2238	Praseodymium(IV) fluoride	PrF <sub>4</sub>	15192-24-2	216.902	yel-wh solid	dec 90				
2239	Promethium	Pm	7440-12-2	145	silv metal; hex	1042	3000	7.26		
2240	Promethium(III) bromide	PmBr <sub>3</sub>	14325-78-1	385	red cry	625				s H <sub>2</sub> O
2241	Promethium(III) chloride	PmCl <sub>3</sub>	13779-10-7	251	pale blue hyg cry	655				s H <sub>2</sub> O
2242	Promethium(III) fluoride	PmF <sub>3</sub>	13709-45-0	202	pink solid	1338				s H <sub>2</sub> O
2243	Promethium(III) iodide	PmI <sub>3</sub>	13818-73-0	526	red solid	695				
2244	Protactinium	Pa	7440-13-3	231.036	shiny metal; tetr or cub	1572		15.4		
2245	Protactinium(V) chloride	PaCl <sub>5</sub>	13760-41-3	408.301	yel monocry	306		3.74		
2246	Radium	Ra	7440-14-4	226	wh metal; cub	696		5		
2247	Radium bromide	RaBr <sub>2</sub>	10031-23-9	386	wh orth cry	728		5.79	70.6 <sup>20</sup>	s EtOH
2248	Radium carbonate	RaCO <sub>3</sub>	7116-98-5	286	wh orth cry					i H <sub>2</sub> O
2249	Radium chloride	RaCl <sub>2</sub>	10025-66-8	297	wh orth cry	1000		4.9	24.5 <sup>20</sup>	s EtOH
2250	Radium fluoride	RaF <sub>2</sub>	20610-49-5	264	wh cub cry			6.7		
2251	Radium nitrate	Ra(NO <sub>3</sub> ) <sub>2</sub>	10213-12-4	350	cry				13.9	
2252	Radium sulfate	RaSO <sub>4</sub>	7446-16-4	322	wh cry					i H <sub>2</sub> O, acid
2253	Radon	Rn	10043-92-2	222	col gas	-71	-61.7	9.074 g/L		sl H <sub>2</sub> O
2254	Rhenium	Re	7440-15-5	186.207	silv-gray metal	3185	5596	20.8		i HCl
2255	Perrhenic acid	HReO <sub>4</sub>	13768-11-1	251.213	exists only in soln					vs H <sub>2</sub> O, os
2256	Rhenium carbonyl	Re <sub>2</sub> (CO) <sub>10</sub>	14285-68-8	652.515	yel-wh cry	170 dec		2.87		s os
2257	Rhenium pentacarbonyl bromide	Re(CO) <sub>5</sub> Br	14220-21-4	406.162	wh cry	90				
2258	Rhenium pentacarbonyl chloride	Re(CO) <sub>5</sub> Cl	14099-01-5	361.711	wh cry		subl 140			
2259	Rhenium(III) bromide	ReBr <sub>3</sub>	13569-49-8	425.919	red-brn monocry		500 subl	6.10		s ace, MeOH, EtOH
2260	Rhenium(III) chloride	ReCl <sub>3</sub>	13569-63-6	292.566	red-blk hyg cry	500 dec		4.81		s H <sub>2</sub> O
2261	Rhenium(III) iodide	ReI <sub>3</sub>	15622-42-1	566.920	blk solid	dec				
2262	Rhenium(IV) chloride	ReCl <sub>4</sub>	13569-71-6	328.019	purp-blk cry; hyg	300 dec		4.9		
2263	Rhenium(IV) fluoride	ReF <sub>4</sub>	15192-42-4	262.201	blue tetr cry		>300 subl	7.49		
2264	Rhenium(IV) oxide	ReO <sub>2</sub>	12036-09-8	218.206	gray orth cry	900 dec		11.4		
2265	Rhenium(IV) selenide	ReSe <sub>2</sub>	12038-64-1	344.13	tricl cry					
2266	Rhenium(IV) silicide	ReSi <sub>2</sub>	12038-66-3	242.378	refrac solid	2000				
2267	Rhenium(IV) sulfide	ReS <sub>2</sub>	12038-63-0	250.337	tricl cry			7.6		
2268	Rhenium(IV) telluride	ReTe <sub>2</sub>	12067-00-4	441.41	orth cry			8.50		
2269	Rhenium(V) bromide	ReBr <sub>5</sub>	30937-53-2	585.727	brn solid	110 dec				
2270	Rhenium(V) chloride	ReCl <sub>5</sub>	39368-69-9	363.472	brn-blk solid	220		4.9		reac H <sub>2</sub> O
2271	Rhenium(V) fluoride	ReF <sub>5</sub>	30937-52-1	281.199	yel-grn solid	48	221.3			
2272	Rhenium(V) oxide	Re <sub>2</sub> O <sub>5</sub>	12165-05-8	452.411	blue-blk tetr cry			≈7		



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2273	Rhenium(VI) chloride	ReCl <sub>5</sub>	31234-26-1	398.925	red-grn solid	29				
2274	Rhenium(VI) dioxydifluoride	ReO <sub>2</sub> F <sub>2</sub>	81155-18-2	256.203	col cry	156				
2275	Rhenium(VI) fluoride	ReF <sub>6</sub>	10049-17-9	300.197	yel liq or cub cry	18.5	33.8	4.06(cry)		s HNO <sub>3</sub>
2276	Rhenium(VI) oxide	ReO <sub>3</sub>	1314-28-9	234.205	red cub cry	400 dec		6.9		i H <sub>2</sub> O, acid, alk
2277	Rhenium(VI) oxytetrachloride	ReOCl <sub>4</sub>	13814-76-1	344.018	brn cry	29.3	223			reac H <sub>2</sub> O
2278	Rhenium(VI) oxytetrafluoride	ReOF <sub>4</sub>	17026-29-8	278.200	blue solid	108	171.7			
2279	Rhenium(VII) fluoride	ReF <sub>7</sub>	17029-21-9	319.196	yel cub cry	48.3	73.7	4.32		
2280	Rhenium(VII) oxide	Re <sub>2</sub> O <sub>7</sub>	1314-68-7	484.410	yel hyg cry	327	360	6.10		s H <sub>2</sub> O, EtOH, eth, diox, py
2281	Rhenium(VII) trioxchloride	ReO <sub>3</sub> Cl	7791-09-5	269.658	col liq	4.5	128	3.87		reac H <sub>2</sub> O
2282	Rhenium(VII) trioxyfluoride	ReO <sub>3</sub> F	42246-24-2	253.203	yel solid	147	164			
2283	Rhenium(VII) dioxytrifluoride	ReO <sub>2</sub> F <sub>3</sub>	57246-89-6	275.201	yel solid	90	185.4			reac H <sub>2</sub> O
2284	Rhenium(VII) oxypentafluoride	ReOF <sub>5</sub>	23377-53-9	297.198	cream solid	43.8	73.0			
2285	Rhenium(VII) sulfide	Re <sub>2</sub> S <sub>7</sub>	12038-67-4	596.869	brn-blk tetr cry			4.87		i H <sub>2</sub> O
2286	Rhodium	Rh	7440-16-6	102.906	silv-wh metal; cub	1964	3695	12.4		i acid, sl aqua regia
2287	Rhodium carbonyl	Rh <sub>2</sub> (CO) <sub>16</sub>	28407-51-4	1065.594	red-brn cry	220 dec				
2288	Rhodium carbonyl chloride	[Rh(CO) <sub>2</sub> Cl] <sub>2</sub>	14523-22-9	388.758	red-oran cry	124				s os
2289	Rhodium dodecacarbonyl	Rh <sub>12</sub> (CO) <sub>12</sub>	19584-30-6	747.743	red hyg cry	150 dec		2.52		reac H <sub>2</sub> O
2290	Rhodium(III) bromide	RhBr <sub>3</sub>	15608-29-4	342.618	dark brn plates	800 dec		5.56		s H <sub>2</sub> O; i acid, os
2291	Rhodium(III) chloride	RhCl <sub>3</sub>	10049-07-7	209.265	red monocl cry		717	5.38		i H <sub>2</sub> O; s alk
2292	Rhodium(III) fluoride	RhF <sub>3</sub>	60804-25-3	159.901	red hex cry			5.4		
2293	Rhodium(III) iodide	RhI <sub>3</sub>	15492-38-3	483.619	blk monocl cry; hyg			6.4		
2294	Rhodium(III) nitrate	Rh(NO <sub>3</sub> ) <sub>3</sub>	10139-58-9	288.921	hyg brn solid	600 dec				i H <sub>2</sub> O
2295	Rhodium(III) nitrate dihydrate	Rh(NO <sub>3</sub> ) <sub>3</sub> · 2H <sub>2</sub> O	13465-43-5	324.951	blk solid	dec				i H <sub>2</sub> O; s aqua regia
2296	Rhodium(III) oxide	Rh <sub>2</sub> O <sub>3</sub>	12036-35-0	253.809	gray hex cry	1100 dec		8.2		
2297	Rhodium(III) oxide pentahydrate	Rh <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	39373-27-8	309.010	yel pow	dec				sl H <sub>2</sub> O; s acid
2298	Rhodium(III) sulfate	Rh <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10489-46-0	493.999	red-yel solid	>500 dec				
2299	Rhodium(IV) oxide	RhO <sub>2</sub>	12137-27-8	134.905	blk tetr cry			7.2		
2300	Rhodium(IV) oxide dihydrate	RhO <sub>2</sub> · 2H <sub>2</sub> O	12137-27-8	170.936	grn solid	dec		8.20		i H <sub>2</sub> O, sol HCl, alk
2301	Rhodium(VI) fluoride	RhF <sub>6</sub>	13693-07-7	216.896	blk cub cry	≈70		3.1		
2302	Rubidium	Rb	7440-17-7	85.468	soft silv metal; cub	39.30	688	1.53		reac H <sub>2</sub> O
2303	Rubidium acetate	RbC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	563-67-7	144.512	wh hyg cry	246				vs H <sub>2</sub> O
2304	Rubidium aluminum sulfate	RbAl(SO <sub>4</sub> ) <sub>2</sub>	13530-57-9	304.575	hex cry			≈3.1	1.60 <sup>20</sup>	i EtOH
2305	Rubidium aluminum sulfate dodecahydrate	RbAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	7784-29-4	520.759	col cub cry	≈100 dec		≈1.9		s H <sub>2</sub> O; i EtOH
2306	Rubidium azide	RbN <sub>3</sub>	22756-36-1	127.488	tetr cry; exp	317		2.79	107 <sup>16</sup>	
2307	Rubidium bromate	RbBrO <sub>3</sub>	13446-70-3	213.370	cub cry	430		3.68	2.95 <sup>25</sup>	
2308	Rubidium bromide	RbBr	7789-39-1	165.372	wh cub cry; hyg	692	1340	3.35	116 <sup>25</sup>	
2309	Rubidium carbonate	Rb <sub>2</sub> CO <sub>3</sub>	584-09-8	230.945	col monocl cry; hyg	837			223 <sup>30</sup>	
2310	Rubidium chlorate	RbClO <sub>3</sub>	13446-71-4	168.919	col cry	324	dec 480	3.19	6.63 <sup>25</sup>	sl H <sub>2</sub> O
2311	Rubidium chloride	RbCl	7791-11-9	120.921	wh cub cry; hyg	724	1390	2.76	93.9 <sup>25</sup>	sl EtOH
2312	Rubidium chromate	Rb <sub>2</sub> CrO <sub>4</sub>	13446-72-5	286.930	yel rhom cry			3.518	76.2 <sup>25</sup>	
2313	Rubidium dichromate	Rb <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	13446-73-6	386.924	red tricr or yel monocl cry			3.1		s H <sub>2</sub> O
2314	Rubidium cyanide	RbCN	19073-56-4	111.486	wh cub cry			2.3		s H <sub>2</sub> O; i EtOH, eth
2315	Rubidium fluoride	RbF	13446-74-7	104.466	wh cub cry; hyg	795	1410	3.2	300 <sup>30</sup>	i EtOH
2316	Rubidium fluoroborate	RbBF <sub>4</sub>	18909-68-7	172.273	orth cry	612 dec		2.82		sl H <sub>2</sub> O
2317	Rubidium formate	RbCHO <sub>2</sub>	3495-35-0	130.486	wh hyg cry	dec				
2318	Rubidium hexafluorogermanate	Rb <sub>2</sub> GeF <sub>6</sub>	16962-48-4	357.57	wh cry	696				s H <sub>2</sub> O
2319	Rubidium hydride	RbH	13446-75-8	86.476	wh cub cry; flam	≈170 dec		2.60		reac H <sub>2</sub> O
2320	Rubidium hydrogen carbonate	RbHCO <sub>3</sub>	19088-74-5	146.485	wh rhomb cry	175 dec			116 <sup>20</sup>	
2321	Rubidium hydrogen fluoride	RbHF <sub>2</sub>	12280-64-7	124.473	tetr cry	188		3.3		
2322	Rubidium hydrogen sulfate	RbHSO <sub>4</sub>	15587-72-1	182.539	col monocl cry	208		2.9		s H <sub>2</sub> O
2323	Rubidium hydroxide	RbOH	1310-82-3	102.475	gray-wh orth cry; hyg	385		3.2	173 <sup>30</sup>	s EtOH
2324	Rubidium iodate	RbIO <sub>3</sub>	13446-76-9	260.370	monocl or cub cry	dec		4.33	2.44 <sup>25</sup>	vs HCl
2325	Rubidium iodide	RbI	7790-29-6	212.372	wh cub cry	656	1300	3.55	165 <sup>25</sup>	s EtOH
2326	Rubidium molybdate	Rb <sub>2</sub> MoO <sub>4</sub>	13718-22-4	330.87	wh cry	958				s H <sub>2</sub> O
2327	Rubidium nitrate	RbNO <sub>3</sub>	13126-12-0	147.473	wh hex cry; hyg	310		3.11	65.0 <sup>25</sup>	vs H <sub>2</sub> O
2328	Rubidium nitrite	RbNO <sub>2</sub>	13825-25-7	131.474	wh cry	422				vs H <sub>2</sub> O
2329	Rubidium oxide	Rb <sub>2</sub> O	18088-11-4	186.935	yel-brn cub cry; hyg	400 dec		4.0		reac H <sub>2</sub> O
2330	Rubidium perchlorate	RbClO <sub>4</sub>	13510-42-4	184.919	wh hyg cry	550	dec >550	2.9	1.5 <sup>25</sup>	
2331	Rubidium permanganate	RbMnO <sub>3</sub>	13465-49-1	204.404	dark purp cry	300 dec		3.24		sl H <sub>2</sub> O
2332	Rubidium peroxide	Rb <sub>2</sub> O <sub>2</sub>	23611-30-5	202.935	wh orth cry	570		3.8		reac H <sub>2</sub> O
2333	Rubidium selenide	Rb <sub>2</sub> Se	31052-43-4	249.90	wh cub cry	733		3.22		reac H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2334	Rubidium sulfate	Rb <sub>2</sub> SO <sub>4</sub>	7488-54-2	266.999	wh orth cry	1066		3.61	50.8 <sup>25</sup>	
2335	Rubidium sulfide	Rb <sub>2</sub> S	31083-74-6	203.001	wh cub cry	425		2.91		s H <sub>2</sub> O
2336	Rubidium superoxide	RbO <sub>2</sub>	12137-25-6	117.467	tetr cry	412		≈3.0		
2337	Ruthenium	Ru	7440-18-8	101.07	silv-wh metal; hex	2333	4150	12.1		i acid, aqua regia
2338	Ruthenium dodecacarbonyl	Ru <sub>3</sub> (CO) <sub>12</sub>	15243-33-1	639.33	oran cry	150 dec				
2339	Ruthenium pentacarbonyl	Ru(CO) <sub>5</sub>	16406-48-7	241.12	col liq	-22	dec 50			i H <sub>2</sub> O; s EtOH, bz, chl, hc
2340	Ruthenium nonacarbonyl	Ru <sub>3</sub> (CO) <sub>9</sub>	63128-11-0	454.23	stab below -40					s hex
2341	Ruthenium nitrosyl chloride monohydrate	Ru(NO)Cl <sub>3</sub> · H <sub>2</sub> O	18902-42-6	255.45	hyg red cry					
2342	Hexaammineruthenium(III) chloride	Ru(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	14282-91-8	309.61	col monocl cry					s H <sub>2</sub> O
2343	Ruthenium(III) bromide	RuBr <sub>3</sub>	14014-88-1	340.78	brn hex cry	dec 500		5.3		i H <sub>2</sub> O, acid, EtOH
2344	Ruthenium(III) chloride	RuCl <sub>3</sub>	10049-08-8	207.43	blk-brn hex cry	≈500 dec		3.1		i H <sub>2</sub> O; sl EtOH
2345	Ruthenium(III) fluoride	RuF <sub>3</sub>	51621-05-7	158.07	brn rhomb cry	≈600 dec		5.36		i H <sub>2</sub> O, dil acid
2346	Ruthenium(III) iodide	RuI <sub>3</sub>	13896-65-6	481.78	blk hex cry	dec 300		6.0		sl H <sub>2</sub> O
2347	Ruthenium(III) 2,4-pentanedioate	Ru(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	14284-93-6	398.39	red-brn cry	230				
2348	Ruthenium(IV) fluoride	RuF <sub>4</sub>	71500-16-8	177.06	yel-red cry					react H <sub>2</sub> O
2349	Ruthenium(IV) oxide	RuO <sub>2</sub>	12036-10-1	133.07	gray-blk tetr cry	dec 1300		7.05		i H <sub>2</sub> O, acid
2350	Ruthenium(V) fluoride	RuF <sub>5</sub>	14521-18-7	196.06	grn monocl cry	86.5	227	3.90		
2351	Ruthenium(VI) fluoride	RuF <sub>6</sub>	13693-08-8	215.06	dark brn orth cry	54	200 dec	3.54		react H <sub>2</sub> O
2352	Ruthenium(VIII) oxide	RuO <sub>4</sub>	20427-56-9	165.07	yel monocl prisms	25.4	40	3.29	2.03 <sup>20</sup>	sl H <sub>2</sub> O; vs ctc; react EtOH
2353	Samarium	Sm	7440-19-9	150.36	silv metal; rhomb	1072	1794	7.52		
2354	Samarium boride	SmB <sub>6</sub>	12008-30-9	215.23	refrac solid	2580		5.07		
2355	Samarium silicide	SmSi <sub>2</sub>	12300-22-0	206.53	orth cry			5.14		
2356	Samarium(II) bromide	SmBr <sub>2</sub>	50801-97-3	310.17	brn cry	669				react H <sub>2</sub> O
2357	Samarium(II) chloride	SmCl <sub>2</sub>	13874-75-4	221.27	brn cry	855		3.69		react H <sub>2</sub> O
2358	Samarium(II) fluoride	SmF <sub>2</sub>	15192-17-3	188.36	purp cry					react H <sub>2</sub> O
2359	Samarium(II) iodide	SmI <sub>2</sub>	32248-43-4	404.17	grn cry	520				react H <sub>2</sub> O
2360	Samarium(III) acetate trihydrate	Sm(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	17829-86-6	381.54	hyg yel-wh solid			1.94		s H <sub>2</sub> O
2361	Samarium(III) bromate nonahydrate	Sm(BrO <sub>3</sub> ) <sub>3</sub> · 9H <sub>2</sub> O	63427-22-5	696.20	pink hex cry	75 dec				vs H <sub>2</sub> O; sl EtOH
2362	Samarium(III) bromide	SmBr <sub>3</sub>	13759-87-0	390.07	yel cry	640				react H <sub>2</sub> O
2363	Samarium(III) carbonate	Sm <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub>	5895-47-6	480.75	wh-yel pow	dec >500				
2364	Samarium(III) chloride	SmCl <sub>3</sub>	10361-82-7	256.72	yel cry	682		4.46	93.8 <sup>25</sup>	
2365	Samarium(III) chloride hexahydrate	SmCl <sub>3</sub> · 6H <sub>2</sub> O	13465-55-9	364.81	yel cry	dec		2.38	93.8 <sup>25</sup>	
2366	Samarium(III) fluoride	SmF <sub>3</sub>	13765-24-7	207.36	wh cry	1306				react H <sub>2</sub> O
2367	Samarium(III) iodide	SmI <sub>3</sub>	13813-25-7	531.07	oran cry	850				react H <sub>2</sub> O
2368	Samarium(III) nitrate	Sm(NO <sub>3</sub> ) <sub>3</sub>	10361-83-8	336.38	yel-wh hyg solid				144 <sup>25</sup>	s EtOH
2369	Samarium(III) nitrate hexahydrate	Sm(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	13759-83-6	444.47	pale yel cry	78				s H <sub>2</sub> O, MeOH, ace
2370	Samarium(III) oxide	Sm <sub>2</sub> O <sub>3</sub>	12060-58-1	348.72	yel-wh cub cry	2269	3780	7.6		
2371	Samarium(III) sulfate octahydrate	Sm <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13465-58-2	733.03	yel cry			2.93	2.67 <sup>20</sup>	
2372	Samarium(III) sulfide	Sm <sub>2</sub> S <sub>3</sub>	12067-22-0	396.92	gray-brn cub cry	1720		5.87		
2373	Samarium(III) telluride	Sm <sub>2</sub> Te <sub>3</sub>	12040-00-5	683.52	orth cry			7.31		
2374	Scandium	Sc	7440-20-2	44.956	silv metal; hex	1541	2836	2.99		
2375	Scandium boride	ScB <sub>2</sub>	12007-34-0	66.578	refrac solid	2250		3.17		
2376	Scandium bromide	ScBr <sub>3</sub>	13465-59-3	284.668	wh hyg cry	969		9.33		s H <sub>2</sub> O
2377	Scandium chloride	ScCl <sub>3</sub>	10361-84-9	151.315	wh hyg cry	967		2.4		s H <sub>2</sub> O; i EtOH
2378	Scandium fluoride	ScF <sub>3</sub>	13709-47-2	101.951	wh powder	1552				sl H <sub>2</sub> O
2379	Scandium hydroxide	Sc(OH) <sub>3</sub>	17674-34-9	95.978	col amorp solid					i H <sub>2</sub> O; s dil acid
2380	Scandium iodide	ScI <sub>3</sub>	14474-33-0	425.669	hyg yel cry	953	subl			s H <sub>2</sub> O, EtOH, CCD
2381	Scandium nitrate	Sc(NO <sub>3</sub> ) <sub>3</sub>	13465-60-6	230.971	wh cry				169 <sup>25</sup>	s EtOH
2382	Scandium oxide	Sc <sub>2</sub> O <sub>3</sub>	12060-08-1	137.910	wh cub cry	2489		3.864		s conc acid
2383	Scandium sulfate pentahydrate	Sc <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	15292-44-1	468.176	col cry	dec 110				vs H <sub>2</sub> O
2384	Scandium sulfide	Sc <sub>2</sub> S <sub>3</sub>	12166-29-9	186.107	yel orth cry	1775		2.91		
2385	Scandium telluride	Sc <sub>2</sub> Te <sub>3</sub>	12166-44-8	472.71	blk hex cry			5.29		
2386	Selenium (gray)	Se	7782-49-2	78.96	gray metallic cry; hex	220.8	685	4.809		i H <sub>2</sub> O, CS <sub>2</sub>
2387	Selenium (α form)	Se	7782-49-2	78.96	red monocl cry	trans gray Se >120	685	4.39		i H <sub>2</sub> O, EtOH; sl eth
2388	Selenium (vitreous)	Se	7782-49-2	78.96	blk amorp solid	trans gray Se 180	685	4.28		i H <sub>2</sub> O; sl CS <sub>2</sub>
2389	Selenic acid	H <sub>2</sub> SeO <sub>4</sub>	7783-08-6	144.97	wh hyg solid	58	260 dec	2.95		vs H <sub>2</sub> O; react EtOH
2390	Pentafluoroorthoselenic acid	HOSeF <sub>5</sub>	38989-47-8	190.96	col solid	38	47			
2391	Selenous acid	H <sub>2</sub> SeO <sub>3</sub>	7783-00-8	128.97	wh hyg cry	70 dec		3.0		vs H <sub>2</sub> O; s EtOH
2392	Selenium dioxide	SeO <sub>2</sub>	7446-08-4	110.96	wh tetr needles or powder	340 tp	315 sp	3.95	264 <sup>22</sup>	s EtOH, MeOH; sl ace
2393	Selenium trioxide	SeO <sub>3</sub>	13768-86-0	126.96	wh tetr cry; hyg	118	subl	3.44		s H <sub>2</sub> O, os



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2394	Selenium bromide	Se <sub>2</sub> Br <sub>2</sub>	7789-52-8	317.73	red liq	5	225 dec	3.60		reac H <sub>2</sub> O; s CS <sub>2</sub> , chl
2395	Selenium chloride	Se <sub>2</sub> Cl <sub>2</sub>	10025-68-0	228.83	yel-brn oily liq	-85	127 dec	2.774		reac H <sub>2</sub> O; s CS <sub>2</sub> , bz, ctc, chl
2396	Selenium tetrabromide	SeBr <sub>4</sub>	7789-65-3	398.58	oran-red cry	123				reac H <sub>2</sub> O; s CS <sub>2</sub> , chl
2397	Selenium tetrachloride	SeCl <sub>4</sub>	10026-03-6	220.77	wh-yel cry	305 tp	191.4 sp	2.6		reac H <sub>2</sub> O
2398	Selenium tetrafluoride	SeF <sub>4</sub>	13465-66-2	154.95	col liq	-9.5	101.6	2.75		reac H <sub>2</sub> O; vs EtOH, eth
2399	Selenium hexafluoride	SeF <sub>6</sub>	7783-79-1	192.95	col gas	-34.6 tp	-46.6 sp	7.887 g/L		i H <sub>2</sub> O
2400	Selenium chloride pentafluoride	SeF <sub>5</sub> Cl	34979-62-9	209.41	col gas	-19	4.5			
2401	Selenium oxybromide	SeOBr <sub>2</sub>	7789-51-7	254.77	red-yel solid	41.6	220 dec	3.38		reac H <sub>2</sub> O; s CS <sub>2</sub> , bz, ctc
2402	Selenium oxychloride	SeOCl <sub>2</sub>	7791-23-3	165.87	col or yel liq	8.5	177	2.44		reac H <sub>2</sub> O; s ctc, chl, bz, tol
2403	Selenium oxyfluoride	SeOF <sub>2</sub>	7783-43-9	132.96	col liq	15	125	2.8		reac H <sub>2</sub> O
2404	Selenium oxytetrafluoride	SeOF <sub>4</sub>	53319-44-1	170.95	unstab col liq	12	65			
2405	Selenium dioxide difluoride	SeO <sub>2</sub> F <sub>2</sub>	14984-81-7	148.96	col gas	-99.5	-8.4	6.089 g/L		reac H <sub>2</sub> O
2406	Selenium monosulfide	SeS	7446-34-6	111.03						
2407	Selenium disulfide	SeS <sub>2</sub>	7488-56-4	143.09	red-yel cry	100				i H <sub>2</sub> O; s acid
2408	Selenium sulfide (Se <sub>2</sub> S <sub>3</sub> )	Se <sub>2</sub> S <sub>3</sub>	75926-26-0	350.31	oran needles	121.5		2.44		s CS <sub>2</sub> ; sl bz
2409	Selenium sulfide (Se <sub>2</sub> S <sub>4</sub> )	Se <sub>2</sub> S <sub>4</sub>	75926-28-2	444.10	red cry	113 dec		3.29		s bz; sl CS <sub>2</sub>
2410	Selenium sulfide (Se <sub>6</sub> S <sub>8</sub> )	Se <sub>6</sub> S <sub>8</sub>	75926-30-6	537.89	oran cry	121.5				s CS <sub>2</sub>
2411	Silicon	Si	7440-21-3	28.086	gray cry or brn amorp solid	1414	3265	2.3296		i H <sub>2</sub> O, acid; s alk
2412	Silane	SiH <sub>4</sub>	7803-62-5	32.118	col gas; flam	-185	-111.9	1.313 g/L		reac H <sub>2</sub> O; i EtOH, bz
2413	Disilane	Si <sub>2</sub> H <sub>6</sub>	1590-87-0	62.219	col gas; flam	-129.4	-14.8	2.543 g/L		reac H <sub>2</sub> O, ctc, chl; s EtOH, bz
2414	Trisilane	Si <sub>3</sub> H <sub>8</sub>	7783-26-8	92.321	flam col liq	-117.4	52.9	0.739		reac H <sub>2</sub> O
2415	Tetrasilane	Si <sub>4</sub> H <sub>10</sub>	7783-29-1	122.421	col liq; flam	-89.9	108.1	0.792		reac H <sub>2</sub> O
2416	2-Silyltrisilane	Si <sub>4</sub> H <sub>10</sub>	13597-87-0	122.421	col liq	-99.4	101.7	0.792		reac H <sub>2</sub> O
2417	Cyclopentasilane	Si <sub>5</sub> H <sub>12</sub>	289-22-5	150.507	col liq	-10.5	194.3	0.963		reac H <sub>2</sub> O
2418	Pentasilane	Si <sub>5</sub> H <sub>12</sub>	14868-53-2	152.523	col liq	-72.8	153.2	0.827		reac H <sub>2</sub> O
2419	2-Silylpentasilane	Si <sub>5</sub> H <sub>12</sub>	14868-54-3	152.523	col liq	-109.9	146.2	0.820		reac H <sub>2</sub> O
2420	2,2-Disilyltrisilane	Si <sub>5</sub> H <sub>12</sub>	15947-57-6	152.523	col liq	-57.8	134.3	0.815		reac H <sub>2</sub> O
2421	Cyclohexasilane	Si <sub>6</sub> H <sub>14</sub>	291-59-8	180.608	col liq	16.5	226			reac H <sub>2</sub> O
2422	Hexasilane	Si <sub>6</sub> H <sub>14</sub>	14693-61-9	182.624	col liq	-44.7	193.6	0.847		reac H <sub>2</sub> O
2423	2-Silylpentasilane	Si <sub>6</sub> H <sub>14</sub>	14868-55-4	182.624	col liq	-78.4	185.2	0.840		
2424	3-Silylpentasilane	Si <sub>6</sub> H <sub>14</sub>	52988-75-7	182.624	col liq	-69	179.5	0.843		reac H <sub>2</sub> O
2425	Heptasilane	Si <sub>7</sub> H <sub>16</sub>	14693-65-3	212.726	col liq	-30.1	226.8	0.859		reac H <sub>2</sub> O
2426	Bromosilane	SiH <sub>3</sub> Br	13465-73-1	111.014	col gas	-94	1.9	4.538 g/L		
2427	Dibromosilane	SiH <sub>2</sub> Br <sub>2</sub>	13768-94-0	189.910	liq	-70.1	66			
2428	Tribromosilane	SiHBr <sub>3</sub>	7789-57-3	268.806	flam liq	-73	109	2.7		reac H <sub>2</sub> O
2429	Tetrabromosilane	SiBr <sub>4</sub>	7789-66-4	347.702	col fuming liq	5.39	154	2.8		reac H <sub>2</sub> O
2430	Bromotrichlorosilane	SiBrCl <sub>3</sub>	13465-74-2	214.349	col liq	-62	80.3	1.826		reac H <sub>2</sub> O
2431	Dibromodichlorosilane	SiBr <sub>2</sub> Cl <sub>2</sub>	13465-75-3	258.800	col liq	-45.5	104	2.172		reac H <sub>2</sub> O
2432	Tribromochlorosilane	SiBr <sub>3</sub> Cl	13465-76-4	303.251	col liq	-20.8	127	2.497		reac H <sub>2</sub> O
2433	Hexabromosilane	Si <sub>6</sub> Br <sub>6</sub>	13517-13-0	535.595	col cry	95	265			
2434	Octabromotrisilane	Si <sub>3</sub> Br <sub>8</sub>	54804-32-9	723.489	col liq	46				
2435	Chlorosilane	SiH <sub>3</sub> Cl	13465-78-6	66.563	col gas	-118	-30.4	2.721 g/L		
2436	Dichlorosilane	SiH <sub>2</sub> Cl <sub>2</sub>	4109-96-0	101.008	col gas; flam	-122	8.3	4.129 g/L		reac H <sub>2</sub> O
2437	Trichlorosilane	SiHCl <sub>3</sub>	10025-78-2	135.453	fuming liq	-128.2	33	1.331		reac H <sub>2</sub> O
2438	Tetrachlorosilane	SiCl <sub>4</sub>	10026-04-7	169.898	col fuming liq	-68.74	57.65	1.5		reac H <sub>2</sub> O
2439	Chlorotrifluorosilane	SiClF <sub>3</sub>	14049-36-6	120.534	col gas	-138	-70.0	4.927 g/L		reac H <sub>2</sub> O
2440	Dichlorodifluorosilane	SiCl <sub>2</sub> F <sub>2</sub>	18356-71-3	136.989	col gas	-44	-32	5.599 g/L		reac H <sub>2</sub> O
2441	Trichlorofluorosilane	SiCl <sub>3</sub> F	14965-52-7	153.443	col gas		12.25	6.272 g/L		
2442	Trichloroiodosilane	SiCl <sub>3</sub> I	13465-85-5	261.349	col liq	-60	113.5			reac H <sub>2</sub> O
2443	Hexachlorodisilane	Si <sub>2</sub> Cl <sub>6</sub>	13465-77-5	268.889	col liq	2.5	146			reac H <sub>2</sub> O
2444	Octachlorotrisilane	Si <sub>3</sub> Cl <sub>8</sub>	13596-23-1	367.881	col liq	-67	216			
2445	Fluorosilane	SiH <sub>3</sub> F	13537-33-2	50.108	col gas		-98.6	2.048 g/L		
2446	Difluorosilane	SiH <sub>2</sub> F <sub>2</sub>	13824-36-7	68.099	col gas	-122	-77.8	2.783 g/L		
2447	Trifluorosilane	SiHF <sub>3</sub>	13465-71-9	86.089	col gas	-131	-95	3.519 g/L		
2448	Tetrafluorosilane	SiF <sub>4</sub>	7783-61-1	104.080	col gas	-90.2	-86	4.254 g/L		reac H <sub>2</sub> O
2449	Hexafluorodisilane	Si <sub>2</sub> F <sub>6</sub>	13830-68-7	170.161	col gas	-18.7 tp @ 780 mmHg	-19.1 sp			reac H <sub>2</sub> O
2450	Octafluorotrisilane	Si <sub>3</sub> F <sub>8</sub>	14521-14-3	236.244	col liq	-1.2	42			
2451	Decafluorotetrasilane	Si <sub>4</sub> F <sub>10</sub>	14521-15-4	302.326	col cry	68	85.1			
2452	Iodosilane	SiH <sub>3</sub> I	13598-42-0	158.014	col liq	-57	45.6			

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2453	Diiodosilane	SiH <sub>2</sub> I <sub>2</sub>	13760-02-6	283.911	col liq	-1	150			
2454	Triiodosilane	SiH <sub>3</sub> I <sub>3</sub>	13465-72-0	409.807	liq	8	220 dec			
2455	Tetraiodosilane	SiI <sub>4</sub>	13465-84-4	535.704	wh powder	120.5	287.35	4.1		
2456	Hexaiododisilane	Si <sub>2</sub> I <sub>6</sub>	13510-43-5	817.598	pale yel cry	250				
2457	Disiloxane	(SiH <sub>3</sub> ) <sub>2</sub> O	13597-73-4	78.218	gas	-144	-15.2	3.197 g/L		
2458	Hexachlorodisiloxane	(SiCl <sub>3</sub> ) <sub>2</sub> O	14986-21-1	284.888	liq	-28	137			
2459	Methylsilane	SiH <sub>3</sub> CH <sub>3</sub>	992-94-9	46.145	col gas	-156.5	-57.5			
2460	Metasilicic acid	H <sub>2</sub> SiO <sub>3</sub>	7699-41-4	78.100	wh amorp powder					i H <sub>2</sub> O; s HF
2461	Orthosilicic acid	H <sub>4</sub> SiO <sub>4</sub>	10193-36-9	96.116	exists only in soln					
2462	Fluorosilicic acid	H <sub>2</sub> SiF <sub>6</sub>	16961-83-4	144.092	stab only in aq soln					s H <sub>2</sub> O
2463	Silicon carbide (hexagonal)	SiC	409-21-2	40.097	hard grn-black hex cry	2830		3.16		i H <sub>2</sub> O, EtOH
2464	Silicon nitride (Si <sub>3</sub> N <sub>4</sub> )	Si <sub>3</sub> N <sub>4</sub>	12033-89-5	140.284	gray refrac solid; hex	1900		3.17		
2465	Silicon monoxide	SiO	10097-28-6	44.085	blk cub cry, stable >1200			2.18		
2466	Silicon dioxide (α-quartz)	SiO <sub>2</sub>	14808-60-7	60.085	col hex cry	trans to beta quartz 573	2950	2.648		i H <sub>2</sub> O, acid; s HF
2467	Silicon dioxide (β-quartz)	SiO <sub>2</sub>	14808-60-7	60.085	col hex cry	trans to tridymite 867	2950	2.533 <sup>600</sup>		i H <sub>2</sub> O, acid; s HF
2468	Silicon dioxide (tridymite)	SiO <sub>2</sub>	15468-32-3	60.085	col hex cry	trans cristobalite 1470	2950	2.265		i H <sub>2</sub> O, acid; s HF
2469	Silicon dioxide (cristobalite)	SiO <sub>2</sub>	14464-46-1	60.085	col hex cry	1722	2950	2.334		i H <sub>2</sub> O, acid; s HF
2470	Silicon dioxide (vitreous)	SiO <sub>2</sub>	60676-86-0	60.085	col amorp solid	1713	2950	2.196		i H <sub>2</sub> O, acid; s HF
2471	Silicon monosulfide	SiS	12504-41-5	60.151	yel-red hyg powder	1090	940	1.85		reac H <sub>2</sub> O
2472	Silicon disulfide	SiS <sub>2</sub>	13759-10-9	92.216	wh rhomb cry	1090	subl	2.04		reac H <sub>2</sub> O, EtOH; i bz
2473	Silicon tetraacetate	Si(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>4</sub>	562-90-3	264.262	wh hyg cry	110				reac H <sub>2</sub> O; s ace, bz
2474	Silicon tetraboride	SiB <sub>4</sub>	12007-81-7	71.330	gray refrac solid	1870 dec		2.4		
2475	Silicotungstic acid	H <sub>2</sub> SiO <sub>4</sub> · (W <sub>3</sub> O <sub>9</sub> ) <sub>4</sub>	12520-88-6	2878.17	hyg yel cry					vs H <sub>2</sub> O, EtOH
2476	Silver	Ag	7440-22-4	107.868	silv metal; cub	961.78	2162	10.5		
2477	Silver azide	AgN <sub>3</sub>	13863-88-2	149.888	orth cry; exp	exp ≈250		4.9	0.00081 <sup>20</sup>	
2478	Silver subfluoride	Ag <sub>2</sub> F	1302-01-8	234.734	yel hex cry	100 dec		8.6		reac H <sub>2</sub> O
2479	Silver(I) acetate	AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	563-63-3	166.912	wh needles or powder	dec		3.26	1.04 <sup>20</sup>	
2480	Silver(I) acetylide	Ag <sub>2</sub> C <sub>2</sub>	7659-31-6	239.757	wh powder; exp					
2481	Silver(I) acetylide (Ag <sub>2</sub> C <sub>2</sub> H)	Ag <sub>2</sub> C <sub>2</sub> H	13092-75-6	132.897	wh powder; exp					
2482	Silver(I) arsenate	Ag <sub>3</sub> AsO <sub>4</sub>	13510-44-6	462.524	red cub cry	dec		6.657	0.00085	s NH <sub>4</sub> OH
2483	Silver(I) benzoate	Ag(C <sub>6</sub> H <sub>5</sub> CO <sub>2</sub> )	532-31-0	228.982	powder				30 <sup>20</sup>	
2484	Silver(I) bromate	AgBrO <sub>3</sub>	7783-89-3	235.770	wh tetr cry	360 dec		5.21	0.193 <sup>25</sup>	
2485	Silver(I) bromide	AgBr	7785-23-1	187.772	yel cub cry	430	1502	6.47	0.000014 <sup>25</sup>	i H <sub>2</sub> O, acid, EtOH
2486	Silver(I) carbonate	Ag <sub>2</sub> CO <sub>3</sub>	534-16-7	275.745	yel monocl cry	218		6.077	0.0036 <sup>20</sup>	s acid
2487	Silver(I) chlorate	AgClO <sub>3</sub>	7783-92-8	191.319	wh tetr cry	230	270 dec	4.430	17.6 <sup>25</sup>	sl EtOH
2488	Silver(I) chloride	AgCl	7783-90-6	143.321	wh cub cry	455	1547	5.56	0.00019 <sup>25</sup>	
2489	Silver(I) chlorite	AgClO <sub>2</sub>	7783-91-7	175.320	yel cry	105 exp			0.55 <sup>25</sup>	
2490	Silver(I) chromate	Ag <sub>2</sub> CrO <sub>4</sub>	7784-01-2	331.730	brn-red monocl cry			5.625	0.000014 <sup>9</sup>	
2491	Silver(I) citrate	Ag <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	126-45-4	512.705	wh cry powder					i H <sub>2</sub> O; s HNO <sub>3</sub>
2492	Silver(I) cyanide	AgCN	506-64-9	133.886	wh-gray hex cry	320 dec		3.95	0.0000011	i EtOH, dil acid
2493	Silver(I) dichromate	Ag <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	7784-02-3	431.724	red cry			4.770		sl H <sub>2</sub> O
2494	Silver(I) diethyldithiocarbamate	Ag(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NCS <sub>2</sub>	1470-61-7	256.138	powder	173				s py
2495	Silver(I) fluoride	AgF	7775-41-9	126.866	yel-brn cub cry; hyg	435	1159	5.852	172 <sup>20</sup>	
2496	Silver(I) hexafluoroantimonate	AgSbF <sub>6</sub>	26042-64-8	343.618	powder					
2497	Silver(I) hexafluoroarsenate	AgAsF <sub>6</sub>	12005-82-2	296.780	powder					
2498	Silver(I) hexafluorophosphate	AgPF <sub>6</sub>	26042-63-7	252.832	powder	102 dec				
2499	Silver(I) hydrogen fluoride	AgHF <sub>2</sub>	12249-52-4	146.873	hyg cry	dec				
2500	Silver(I) iodate	AgIO <sub>3</sub>	7783-97-3	282.770	wh orth cry	>200		5.53	0.053 <sup>25</sup>	
2501	Silver(I) iodide	AgI	7783-96-2	234.772	yel powder; hex	558	1506	5.68	0.000003	i acid
2502	Silver(I) lactate monohydrate	AgC <sub>3</sub> H <sub>5</sub> O <sub>3</sub> · H <sub>2</sub> O	128-00-7	214.954	gray cry powder					sl H <sub>2</sub> O, EtOH
2503	Silver(I) metaphosphate	AgPO <sub>3</sub>	13465-96-8	186.840	grn glass	490		6.37		i H <sub>2</sub> O; s HNO <sub>3</sub> , NH <sub>4</sub> OH
2504	Silver(I) molybdate	Ag <sub>2</sub> MoO <sub>4</sub>	13765-74-7	375.67	yel cub cry	483		6.18		sl H <sub>2</sub> O
2505	Silver(I) nitrate	AgNO <sub>3</sub>	7761-88-8	169.873	col rhomb cry	210	440 dec	4.35	234 <sup>25</sup>	sl EtOH, ace
2506	Silver(I) nitrite	AgNO <sub>2</sub>	7783-99-5	153.874	yel needles	140 dec		4.453	0.415 <sup>25</sup>	i EtOH; reac acid
2507	Silver(I) oxalate	Ag <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	533-51-7	303.755	wh cry powder	exp 140		5.03	0.0043 <sup>20</sup>	

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2508	Silver(I) oxide	Ag <sub>2</sub> O	20667-12-3	231.735	brn-blk cub cry	≈200 dec		7.2	0.0025	i EtOH; s acid, alk
2509	Silver(I) perchlorate	AgClO <sub>4</sub>	7783-93-9	207.319	col cub cry; hyg	486 dec		2.806	558 <sup>25</sup>	s bz, py, os
2510	Silver(I) perchlorate monohydrate	AgClO <sub>4</sub> · H <sub>2</sub> O	14242-05-8	225.334	hyg wh cry	43 dec			558 <sup>25</sup>	
2511	Silver(I) permanganate	AgMnO <sub>4</sub>	7783-98-4	226.804	viol monoc cry	dec		4.49	0.91 <sup>18</sup>	reac EtOH
2512	Silver(I) phosphate	Ag <sub>3</sub> PO <sub>4</sub>	7784-09-0	418.576	yel powder	849		6.37	0.0064	sl dil acid
2513	Silver(I) picrate monohydrate	AgC <sub>6</sub> H <sub>2</sub> N <sub>3</sub> O <sub>7</sub> · H <sub>2</sub> O	146-84-9	353.979	yel cry					sl H <sub>2</sub> O, EtOH; i chl, eth
2514	Silver(I) selenate	Ag <sub>2</sub> SeO <sub>4</sub>	7784-07-8	358.69	orth cry			5.72	0.118 <sup>20</sup>	
2515	Silver(I) selenide	Ag <sub>2</sub> Se	1302-09-6	294.70	gray hex needles	880		8.216		i H <sub>2</sub> O
2516	Silver(I) selenite	Ag <sub>2</sub> SeO <sub>3</sub>	7784-05-6	342.69	needles	530	>550 dec	5.930		sl H <sub>2</sub> O; s acid
2517	Silver(I) sulfate	Ag <sub>2</sub> SO <sub>4</sub>	10294-26-5	311.799	col cry or powder	660		5.45	0.84 <sup>25</sup>	
2518	Silver(I) sulfide	Ag <sub>2</sub> S	21548-73-2	247.801	gray-blk orth powder	825 (high press.)		7.23		i H <sub>2</sub> O; s acid
2519	Silver(I) sulfite	Ag <sub>2</sub> SO <sub>3</sub>	13465-98-0	295.799	wh cry	100 dec			0.00046 <sup>20</sup>	s acid, NH <sub>4</sub> OH
2520	Silver(I) telluride	Ag <sub>2</sub> Te	12002-99-2	343.34	blk orth cry	955		8.4		
2521	Silver(I) tetraiodomercurate(II)	Ag <sub>2</sub> HgI <sub>4</sub>	7784-03-4	923.94	yel tetr cry	trans to red cub ≈40		6.1		i H <sub>2</sub> O, dil acid
2522	Silver(I) thiocyanate	AgSCN	1701-93-5	165.951	wh powder	dec				i H <sub>2</sub> O
2523	Silver(I) thiosulfate	Ag <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	23149-52-2	327.864	wh cry	dec				sl H <sub>2</sub> O; s NH <sub>4</sub> OH
2524	Silver(II) oxide	AgO	1301-96-8	123.867	gray powder; monoc or cub	>100 dec		7.5	0.0027 <sup>25</sup>	s alk; reac acid
2525	Silver(I) tungstate	Ag <sub>2</sub> WO <sub>4</sub>	13465-93-5	463.57	yel cry	620			0.015	s HNO <sub>3</sub> , NH <sub>4</sub> OH
2526	Silver(II) fluoride	AgF <sub>2</sub>	7783-95-1	145.865	wh or gray hyg cry	690		4.58		reac H <sub>2</sub> O
2527	Silver(II) oxide (Ag <sub>2</sub> O <sub>2</sub> )	Ag <sub>2</sub> O <sub>2</sub>	25455-73-6	247.735	gray-blk cub cry	>100		7.44		i H <sub>2</sub> O; s acid, NH <sub>4</sub> OH
2528	Sodium	Na	7440-23-5	22.990	soft silv met; cub	97.794	882.940	0.97		reac H <sub>2</sub> O
2529	Sodium acetate	NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	127-09-3	82.034	col cry	328.2		1.528	50.4 <sup>25</sup>	
2530	Sodium acetate trihydrate	NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> · 3H <sub>2</sub> O	6131-90-4	136.079	col cry	58 dec		1.45	50.4 <sup>25</sup>	sl EtOH
2531	Sodium aluminate	NaAlO <sub>2</sub>	1302-42-7	81.971	wh orth cry; hyg	1650		4.63		vs H <sub>2</sub> O; i EtOH
2532	Sodium aluminum hydride	NaAlH <sub>4</sub>	13770-96-2	54.004	wh hyg solid	174 dec		1.24		i eth; s thf
2533	Sodium aluminum sulfate dodecahydrate	NaAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10102-71-3	458.281	col cry	≈60		1.61	39.7 <sup>20</sup>	i EtOH
2534	Sodium amide	NaNH <sub>2</sub>	7782-92-5	39.013	wh-grn orth cry	210	500 dec	1.39		reac H <sub>2</sub> O
2535	Sodium ammonium phosphate tetrahydrate	NaNH <sub>4</sub> HPO <sub>4</sub> · 4H <sub>2</sub> O	13011-54-6	209.069	monoc cry	≈80 dec		1.54		s H <sub>2</sub> O; i EtOH
2536	Sodium arsenate dodecahydrate	Na <sub>3</sub> AsO <sub>4</sub> · 12H <sub>2</sub> O	7778-43-0	424.072	col monoc prism	86 dec				s H <sub>2</sub> O; sl EtOH; i eth
2537	Sodium arsenite	NaAsO <sub>2</sub>	7784-46-5	129.911	wh-gray hyg powder			1.87		vs H <sub>2</sub> O; i EtOH
2538	Sodium azide	NaN <sub>3</sub>	26628-22-8	65.010	col hex cry	300 dec		1.846	40.8 <sup>20</sup>	sl EtOH; i eth
2539	Sodium borohydride	NaBH <sub>4</sub>	16940-66-2	37.833	wh cub cry; hyg	≈400 dec		1.07	55 <sup>20</sup>	reac EtOH
2540	Sodium bromate	NaBrO <sub>3</sub>	7789-38-0	150.892	col cub cry	381		3.34	39.4 <sup>25</sup>	i EtOH
2541	Sodium bromide	NaBr	7647-15-6	102.894	wh cub cry	747	1390	3.200	94.6 <sup>25</sup>	s EtOH
2542	Sodium bromide dihydrate	NaBr · 2H <sub>2</sub> O	13466-08-5	138.925	wh cry	36 dec		2.18	94.6 <sup>25</sup>	sl EtOH
2543	Sodium carbonate	Na <sub>2</sub> CO <sub>3</sub>	497-19-8	105.989	wh hyg powder	856		2.54	30.7 <sup>25</sup>	i EtOH
2544	Sodium carbonate monohydrate	Na <sub>2</sub> CO <sub>3</sub> · H <sub>2</sub> O	5968-11-6	124.005	col orth cry	100 dec		2.25	30.7 <sup>25</sup>	i EtOH
2545	Sodium carbonate decahydrate	Na <sub>2</sub> CO <sub>3</sub> · 10H <sub>2</sub> O	6132-02-1	286.142	col cry	34 dec		1.46	30.7 <sup>25</sup>	i EtOH
2546	Sodium chlorate	NaClO <sub>3</sub>	7775-09-9	106.441	col cub cry	248	dec 630	2.5	100 <sup>25</sup>	sl EtOH
2547	Sodium chloride	NaCl	7647-14-5	58.443	col cub cry	800.7	1465	2.17	36.0 <sup>25</sup>	sl EtOH
2548	Sodium chlorite	NaClO <sub>2</sub>	7758-19-2	90.442	wh hyg cry	≈180 dec			64 <sup>17</sup>	
2549	Sodium chromate	Na <sub>2</sub> CrO <sub>4</sub>	7775-11-3	161.974	yel orth cry	794		2.72	87.6 <sup>25</sup>	sl EtOH
2550	Sodium chromate tetrahydrate	Na <sub>2</sub> CrO <sub>4</sub> · 4H <sub>2</sub> O	10034-82-9	234.035	yel hyg cry	dec			87.6 <sup>25</sup>	sl EtOH
2551	Sodium citrate dihydrate	Na <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · 2H <sub>2</sub> O	6132-04-3	294.099	wh cry	150 dec				vs H <sub>2</sub> O; i EtOH, eth
2552	Sodium citrate pentahydrate	Na <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> · 5H <sub>2</sub> O	6858-44-2	348.145	hyg col cry	dec 150		1.86	92 <sup>25</sup>	vs H <sub>2</sub> O; sl EtOH; i eth
2553	Sodium cyanate	NaCNO	917-61-3	65.007	col needles	550		1.89		s H <sub>2</sub> O; sl EtOH; i eth
2554	Sodium cyanide	NaCN	143-33-9	49.008	wh cub cry; hyg	562		1.6	58.2 <sup>20</sup>	sl EtOH
2555	Sodium cyanoborohydride	NaBH <sub>3</sub> (CN)	25895-60-7	62.843	wh hyg powder	240 dec		1.12		vs H <sub>2</sub> O; s thf; sl EtOH; i bz, eth
2556	Sodium dichromate	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	10588-01-9	261.968	red hyg cry	357	400 dec		187 <sup>25</sup>	
2557	Sodium dichromate dihydrate	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> · 2H <sub>2</sub> O	7789-12-0	297.999	oran-red monoc cry	85 dec		2.35		vs H <sub>2</sub> O; S HOAc
2558	Sodium dihydrogen phosphate	NaH <sub>2</sub> PO <sub>4</sub>	7558-80-7	119.977	col monoc cry	200 dec			94.9 <sup>25</sup>	
2559	Sodium dihydrogen phosphate monohydrate	NaH <sub>2</sub> PO <sub>4</sub> · H <sub>2</sub> O	10049-21-5	137.993	wh hyg cry	100 dec			94.9 <sup>25</sup>	i EtOH
2560	Sodium dihydrogen phosphate dihydrate	NaH <sub>2</sub> PO <sub>4</sub> · 2H <sub>2</sub> O	13472-35-0	156.008	col orth cry	60 dec		1.91	94.9 <sup>25</sup>	i EtOH
2561	Sodium dihydrogen hypophosphate hexahydrate	Na <sub>2</sub> H <sub>2</sub> P <sub>2</sub> O <sub>6</sub> · 6H <sub>2</sub> O	7782-95-8	314.031	monoc plates	110 dec		1.849	2.0 <sup>25</sup>	i EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2562	Sodium dihydrogen pyrophosphate	Na <sub>2</sub> H <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	7758-16-9	221.939	wh powder	220 dec		≈1.9		s H <sub>2</sub> O
2563	Sodium dithionate	Na <sub>2</sub> S <sub>2</sub> O <sub>4</sub>	7775-14-6	174.108	gray-wh powder	52 dec			24.1 <sup>20</sup>	sl EtOH
2564	Sodium dithionate dihydrate	Na <sub>2</sub> S <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	7631-94-9*	242.137	col orth cry	110 dec		2.19	15.1 <sup>20</sup>	i EtOH
2565	Sodium ethanolate	NaC <sub>2</sub> H <sub>5</sub> O	141-52-6	68.050	wh-yel hyg powder	260 dec				reac H <sub>2</sub> O; s EtOH
2566	Sodium ferricyanide monohydrate	Na <sub>3</sub> Fe(CN) <sub>6</sub> · H <sub>2</sub> O	14217-21-1*	298.933	red hyg cry					s H <sub>2</sub> O; i EtOH
2567	Sodium ferrocyanide decahydrate	Na <sub>4</sub> Fe(CN) <sub>6</sub> · 10H <sub>2</sub> O	13601-19-9	484.061	yel monocl cry	≈50 dec		1.46	20 <sup>20</sup>	i os
2568	Sodium fluoride	NaF	7681-49-4	41.988	col cub or tetra cry	996	1704	2.78	4.13 <sup>25</sup>	i EtOH
2569	Sodium fluorophosphate	Na <sub>2</sub> PO <sub>3</sub> F	10163-15-2	143.950	powder					
2570	Sodium formate	NaCHO <sub>2</sub>	141-53-7	68.008	wh hyg cry	257.3	dec	1.92	94.9 <sup>25</sup>	sl EtOH
2571	Sodium germanate	Na <sub>2</sub> GeO <sub>3</sub>	12025-19-3	166.62	wh monocl hyg cry	1083		3.31		
2572	Sodium gold cyanide	NaAu(CN) <sub>2</sub>	15280-09-8	271.991	wh-yel cry pow					s H <sub>2</sub> O, NH <sub>4</sub> OH
2573	Sodium gold thiosulfate dihydrate	Na <sub>2</sub> Au(S <sub>2</sub> O <sub>3</sub> ) <sub>2</sub> · 5H <sub>2</sub> O	10233-88-2	526.223	wh needles or prisms	dec 150		3.09		vs H <sub>2</sub> O; i EtOH
2574	Sodium hexabromoplatinate(IV) hexahydrate	Na <sub>2</sub> PtBr <sub>6</sub> · 6H <sub>2</sub> O	39277-13-9	828.579	cry					
2575	Sodium hexachloroiridate(IV) hexahydrate	Na <sub>2</sub> IrCl <sub>6</sub> · 6H <sub>2</sub> O	19567-78-3	559.006	cry	600 dec				
2576	Sodium hexachloroplatinate(IV)	Na <sub>2</sub> PtCl <sub>6</sub>	16923-58-3	453.782	yel hyg cry				53 <sup>16</sup>	s EtOH
2577	Sodium hexachloroplatinate(IV) hexahydrate	Na <sub>2</sub> PtCl <sub>6</sub> · 6H <sub>2</sub> O	16923-58-3	561.873	yel cry	110 dec		2.50	53 <sup>16</sup>	s EtOH; i eth
2578	Sodium hexafluoroaluminate	Na <sub>3</sub> AlF <sub>6</sub>	13775-53-6	209.941	col monocl cry; trans cub 560	1013		2.97		i H <sub>2</sub> O
2579	Sodium hexafluoroantimonate	NaSbF <sub>6</sub>	16925-25-0	258.740	wh cub cry			3.375	129 <sup>20</sup>	s EtOH, ace
2580	Sodium hexafluorophosphate monohydrate	NaPF <sub>6</sub> · H <sub>2</sub> O	20644-15-9	185.969	col orth cry			2.369	103 <sup>3</sup>	s EtOH, MeOH, ace
2581	Sodium hexafluorosilicate	Na <sub>2</sub> SiF <sub>6</sub>	16893-85-9	188.056	wh hex cry	847		2.7	0.67 <sup>20</sup>	i EtOH
2582	Sodium hexanitrocobaltate(III)	Na <sub>3</sub> Co(NO <sub>2</sub> ) <sub>6</sub>	14649-73-1	403.935	yel-brn cry powder					vs H <sub>2</sub> O; sl EtOH
2583	Sodium hydride	NaH	7646-69-7	23.998	silv cub cry; flam	425 dec		1.39		reac H <sub>2</sub> O, EtOH
2584	Sodium hydrogen arsenate	Na <sub>2</sub> HAsO <sub>4</sub>	7778-43-0	185.908	wh powder	≈195 dec			51 <sup>20</sup>	sl EtOH
2585	Sodium hydrogen arsenate heptahydrate	Na <sub>2</sub> HAsO <sub>4</sub> · 7H <sub>2</sub> O	10048-95-0	312.014	wh monocl cry	≈50 dec		1.87	51 <sup>20</sup>	sl EtOH
2586	Sodium hydrogen carbonate	NaHCO <sub>3</sub>	144-55-8	84.007	wh monocl cry	≈50 dec		2.20	10.3 <sup>25</sup>	i EtOH
2587	Sodium hydrogen fluoride	NaHF <sub>2</sub>	1333-83-1	61.995	wh hex cry	>160 dec		2.08	3.25 <sup>20</sup>	
2588	Sodium hydrogen phosphate	Na <sub>2</sub> HPO <sub>4</sub>	7558-79-4	141.959	wh hyg powder			1.7	11.8 <sup>25</sup>	
2589	Sodium hydrogen phosphate heptahydrate	Na <sub>2</sub> HPO <sub>4</sub> · 7H <sub>2</sub> O	7782-85-6	268.066	col cry			≈1.7	11.8 <sup>25</sup>	i EtOH
2590	Sodium hydrogen phosphate dodecahydrate	Na <sub>2</sub> HPO <sub>4</sub> · 12H <sub>2</sub> O	10039-32-4	358.143	col cry	≈35 dec		≈1.5	11.8 <sup>25</sup>	i EtOH
2591	Sodium hydrogen sulfate	NaHSO <sub>4</sub>	7681-38-1	120.061	wh hyg cry	≈315		2.43	28.5 <sup>25</sup>	
2592	Sodium hydrogen sulfate monohydrate	NaHSO <sub>4</sub> · H <sub>2</sub> O	10034-88-5	138.076	wh monocl cry			2.10	28.5 <sup>25</sup>	reac EtOH
2593	Sodium hydrogen sulfide	NaHS	16721-80-5	56.063	col rhomb cry	350		1.79		s H <sub>2</sub> O, EtOH, eth
2594	Sodium hydrogen sulfide dihydrate	NaHS · 2H <sub>2</sub> O	16721-80-5	92.094	yel hyg needles	55 dec				vs H <sub>2</sub> O, EtOH, eth
2595	Sodium hydrogen sulfite	NaHSO <sub>3</sub>	7631-90-5	104.061	wh cry			1.48		s H <sub>2</sub> O; sl EtOH
2596	Sodium hydroxide	NaOH	1310-73-2	39.997	wh orth cry; hyg	323	1388	2.13	100 <sup>25</sup>	s EtOH, MeOH
2597	Sodium hypochlorite	NaClO	7681-52-9	74.442	stab in aq soln	anh form exp			79.9 <sup>25</sup>	
2598	Sodium hypochlorite pentahydrate	NaOCl · 5H <sub>2</sub> O	10022-70-5	164.518	pale grn orth cry	18		1.6		s H <sub>2</sub> O
2599	Sodium iodate	NaIO <sub>3</sub>	7681-55-2	197.892	wh orth cry	422		4.28	9.47 <sup>25</sup>	i EtOH
2600	Sodium iodide	NaI	7681-82-5	149.894	wh cub cry; hyg	661	1304	3.67	184 <sup>25</sup>	s EtOH, ace
2601	Sodium iodide dihydrate	NaI · 2H <sub>2</sub> O	13517-06-1	185.925	hyg col monocl cry	69 dec		2.45	318 <sup>9</sup>	vs H <sub>2</sub> O
2602	Sodium bismuthate	NaBiO <sub>3</sub>	12232-99-4	279.968	yel-brn hyg cry					i cold H <sub>2</sub> O, reac acid
2603	Sodium metabisulfite	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7681-57-4	190.107	wh cry				66.7 <sup>25</sup>	sl EtOH
2604	Sodium metaborate	NaBO <sub>2</sub>	7775-19-1	65.800	wh hex cry	966	1434	2.46		s H <sub>2</sub> O
2605	Sodium metasilicate	Na <sub>2</sub> SiO <sub>3</sub>	6834-92-0	122.064	wh amorp solid; hyg	1089		2.61		s cold H <sub>2</sub> O; reac hot H <sub>2</sub> O; i EtOH
2606	Sodium metasilicate pentahydrate	Na <sub>2</sub> SiO <sub>3</sub> · 5H <sub>2</sub> O	13517-24-3	212.140	wh pow	72 dec				s H <sub>2</sub> O
2607	Sodium molybdate	Na <sub>2</sub> MoO <sub>4</sub>	7631-95-0	205.92	col cub cry	687		≈3.5	65.0 <sup>25</sup>	
2608	Sodium molybdate dihydrate	Na <sub>2</sub> MoO <sub>4</sub> · 2H <sub>2</sub> O	10102-40-6	241.95	cry powder	100 dec		≈3.5	65.0 <sup>25</sup>	
2609	Sodium molybdophosphate	Na <sub>3</sub> PO <sub>4</sub> · 12MoO <sub>3</sub>	1313-30-0	1891.20	hyg solid			2.83		vs H <sub>2</sub> O, EtOH
2610	Sodium niobate	NaNbO <sub>3</sub>	12034-09-2	163.894	rhomb cry	1422		4.55		i H <sub>2</sub> O
2611	Sodium nitrate	NaNO <sub>3</sub>	7631-99-4	84.995	col hex cry; hyg	306.5		2.261	91.2 <sup>25</sup>	sl EtOH, MeOH
2612	Sodium nitrite	NaNO <sub>2</sub>	7632-00-0	68.996	wh orth cry; hyg	284	>320 dec	2.17	84.8 <sup>25</sup>	sl EtOH; reac acid
2613	Sodium nitroferrocyanide dihydrate	Na <sub>2</sub> [Fe(CN) <sub>5</sub> NO] · 2H <sub>2</sub> O	13755-38-9	297.949	red cry			1.72	40 <sup>16</sup>	sl EtOH
2614	Sodium orthovanadate	Na <sub>3</sub> VO <sub>4</sub>	13721-39-6	183.909	col hex prisms	860				s H <sub>2</sub> O; i EtOH
2615	Sodium oxalate	Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	62-76-0	133.999	wh powder	≈250 dec		2.34	3.61 <sup>25</sup>	i EtOH

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2616	Sodium oxide	Na <sub>2</sub> O	1313-59-3	61.979	wh amorp powder	1134		2.27		reac H <sub>2</sub> O
2617	Sodium perborate tetrahydrate	NaBO <sub>3</sub> · 4H <sub>2</sub> O	7632-04-4	153.861	wh cry	60 dec				reac H <sub>2</sub> O
2618	Sodium perchlorate	NaClO <sub>4</sub>	7601-89-0	122.441	wh orth cry; hyg	482 dec		2.52	205 <sup>25</sup>	
2619	Sodium perchlorate monohydrate	NaClO <sub>4</sub> · H <sub>2</sub> O	7791-07-3	140.456	wh hyg cry	≈130 dec		2.02	205 <sup>25</sup>	
2620	Sodium periodate	NaIO <sub>4</sub>	7790-28-5	213.892	wh tetr cry	≈300 dec		3.86	14.4 <sup>25</sup>	s acid
2621	Sodium periodate trihydrate	NaIO <sub>4</sub> · 3H <sub>2</sub> O	13472-31-6	267.938	wh hex cry	175 dec		3.22	14.4 <sup>25</sup>	
2622	Sodium permanganate trihydrate	NaMnO <sub>4</sub> · 3H <sub>2</sub> O	10101-50-5*	195.972	red-blk hyg cry	170 dec		2.47	144 <sup>20</sup>	reac EtOH
2623	Sodium peroxide	Na <sub>2</sub> O <sub>2</sub>	1313-60-6	77.979	yel hyg powder	675		2.805		reac H <sub>2</sub> O
2624	Sodium perrenate	NaReO <sub>4</sub>	13472-33-8	273.195	cry	300		5.39		
2625	Sodium persulfate	Na <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	7775-27-1	238.105	wh hyg cry					vs H <sub>2</sub> O; reac EtOH
2626	Sodium phosphate	Na <sub>3</sub> PO <sub>4</sub>	7601-54-9	163.940	col cry	1583		2.54	14.5 <sup>25</sup>	s H <sub>2</sub> O
2627	Sodium phosphate dodecahydrate	Na <sub>3</sub> PO <sub>4</sub> · 12H <sub>2</sub> O	10101-89-0	380.124	col hex cry	≈75		1.62	14.4 <sup>25</sup>	i EtOH
2628	Sodium phosphate, chlorinated	Na <sub>3</sub> PO <sub>4</sub> · NaOCl	56802-99-4	238.383	wh cry				25 <sup>25</sup>	
2629	Sodium phosphide	Na <sub>3</sub> P	12058-85-4	99.943	red solid	>650				reac H <sub>2</sub> O
2630	Sodium phosphinate	NaH <sub>2</sub> PO <sub>2</sub>	7681-53-0	87.979	wh cry				100 <sup>25</sup>	
2631	Sodium phosphinate monohydrate	NaH <sub>2</sub> PO <sub>2</sub> · H <sub>2</sub> O	10039-56-2	105.994	col hyg cry	310 dec			100 <sup>25</sup>	s EtOH
2632	Sodium phosphonate pentahydrate	Na <sub>2</sub> HPO <sub>3</sub> · 5H <sub>2</sub> O	13517-23-2	216.036	wh hex plates	dec 200			429 <sup>20</sup>	vs H <sub>2</sub> O; i EtOH
2633	Sodium pyrophosphate	Na <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	7722-88-5	265.902	col cry	988		2.53	7.09 <sup>25</sup>	
2634	Sodium selenate	Na <sub>2</sub> SeO <sub>4</sub>	13410-01-0	188.94	col orth cry				58.5 <sup>25</sup>	
2635	Sodium selenate decahydrate	Na <sub>2</sub> SeO <sub>4</sub> · 10H <sub>2</sub> O	10102-23-5	369.09	wh cry			1.61	58.5 <sup>25</sup>	
2636	Sodium selenide	Na <sub>2</sub> Se	1313-85-5	124.94	amorp solid	>875		2.62		reac H <sub>2</sub> O
2637	Sodium selenite	Na <sub>2</sub> SeO <sub>3</sub>	10102-18-8	172.94	wh tetr cry				89.8 <sup>25</sup>	i EtOH
2638	Sodium selenite pentahydrate	Na <sub>2</sub> SeO <sub>3</sub> · 5H <sub>2</sub> O	26970-82-1	184.054	wh tetr cry	dec				s H <sub>2</sub> O; i EtOH
2639	Sodium stannate trihydrate	Na <sub>2</sub> SnO <sub>3</sub> · 3H <sub>2</sub> O	12209-98-2	266.734	col hex cry	dec 140			61 <sup>15</sup>	vs H <sub>2</sub> O; i EtOH, ace
2640	Sodium stearate	NaC <sub>18</sub> H <sub>35</sub> O <sub>2</sub>	822-16-2	306.460	wh powder					sl H <sub>2</sub> O, EtOH; vs hot H <sub>2</sub> O
2641	Sodium succinate hexahydrate	Na <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>4</sub> · 6H <sub>2</sub> O	150-90-3	270.144	cry powder	120 dec			20	i EtOH
2642	Sodium sulfate	Na <sub>2</sub> SO <sub>4</sub>	7757-82-6	142.043	wh orth cry or powder	884		2.7	28.1 <sup>25</sup>	i EtOH
2643	Sodium sulfate heptahydrate	Na <sub>2</sub> SO <sub>4</sub> · 7H <sub>2</sub> O	13472-39-4	204.152	wh cry	dec				vs H <sub>2</sub> O
2644	Sodium sulfate decahydrate	Na <sub>2</sub> SO <sub>4</sub> · 10H <sub>2</sub> O	7727-73-3	322.196	col monocl cry	32 dec		1.46	28.1 <sup>25</sup>	i EtOH
2645	Sodium sulfide	Na <sub>2</sub> S	1313-82-2	78.045	wh cub cry; hyg	1172		1.856	20.6 <sup>25</sup>	sl EtOH; i eth
2646	Sodium sulfide pentahydrate	Na <sub>2</sub> S · 5H <sub>2</sub> O	1313-83-3	168.121	col orth cry	120 dec		1.58	20.6 <sup>25</sup>	s EtOH; i eth
2647	Sodium sulfide nonahydrate	Na <sub>2</sub> S · 9H <sub>2</sub> O	1313-84-4	240.183	wh-yel hyg cry	≈50 dec		1.43	20.6 <sup>25</sup>	sl EtOH; i eth
2648	Sodium sulfite	Na <sub>2</sub> SO <sub>3</sub>	7757-83-7	126.043	wh hex cry	911		2.63	30.7 <sup>25</sup>	i EtOH
2649	Sodium sulfite heptahydrate	Na <sub>2</sub> SO <sub>3</sub> · 7H <sub>2</sub> O	10102-15-5	252.150	wh monocl cry; unstab			1.56	30.7 <sup>25</sup>	sl EtOH
2650	Sodium superoxide	NaO <sub>2</sub>	12034-12-7	54.989	yel cub cry	552		2.2		reac H <sub>2</sub> O
2651	Sodium tartrate dihydrate	Na <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 2H <sub>2</sub> O	6106-24-7	230.082				1.545		s H <sub>2</sub> O; i EtOH
2652	Sodium tellurate	Na <sub>2</sub> TeO <sub>4</sub>	10101-83-4	237.58	wh powder				0.8	
2653	Sodium tellurite	Na <sub>2</sub> TeO <sub>3</sub>	10102-20-2	221.58	wh rhomb prisms					sl H <sub>2</sub> O
2654	Sodium tetraborate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub>	1330-43-4	201.220	col gl solid; hyg	743	1575	2.4	3.17 <sup>25</sup>	sl MeOH
2655	Sodium tetraborate tetrahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 4H <sub>2</sub> O	12045-87-3	273.281	wh monocl cry			1.95	3.17 <sup>25</sup>	
2656	Sodium tetraborate pentahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 5H <sub>2</sub> O	12045-88-4	291.296	hex cry	dec		1.88	3.17 <sup>25</sup>	
2657	Sodium tetraborate decahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> · 10H <sub>2</sub> O	1303-96-4	381.373	wh monocl cry	75 dec		1.73	3.17 <sup>25</sup>	i EtOH
2658	Sodium tetrachloroaluminate	NaAlCl <sub>4</sub>	7784-16-9	191.784	orth cry			2.01		s H <sub>2</sub> O
2659	Sodium tetrachloroaurate(III) dihydrate	NaAuCl <sub>4</sub> · 2H <sub>2</sub> O	13874-02-7	397.800	oran-yel rhom cry	100 dec			150 <sup>10</sup>	s EtOH, eth
2660	Sodium tetrachloropalladate(II) trihydrate	Na <sub>2</sub> PdCl <sub>4</sub> · 3H <sub>2</sub> O	13820-53-6	348.26	brn-red hyg cry					vs H <sub>2</sub> O; s EtOH
2661	Sodium tetrachloroplatinate(II) tetrahydrate	Na <sub>2</sub> PtCl <sub>4</sub> · 4H <sub>2</sub> O	10026-00-3	454.938	red prisms	100				s H <sub>2</sub> O, EtOH
2662	Sodium tetrafluoroberyllate	Na <sub>2</sub> BeF <sub>4</sub>	13871-27-7	130.986	orth cry	575		2.47		sl H <sub>2</sub> O
2663	Sodium tetrafluoroborate	NaBF <sub>4</sub>	13755-29-8	109.795	wh orth prisms	384		2.47	108 <sup>20</sup>	sl EtOH
2664	Sodium thioantimonate nonahydrate	Na <sub>3</sub> SbS <sub>4</sub> · 9H <sub>2</sub> O	10101-91-4	481.127	yel cry	dec 108		1.8	28 <sup>20</sup>	i EtOH
2665	Sodium thiocyanate	NaSCN	540-72-7	81.073	col hyg cry	287			151 <sup>25</sup>	
2666	Sodium thiophosphate dodecahydrate	Na <sub>2</sub> PO <sub>3</sub> S · 12H <sub>2</sub> O	10101-88-9	396.190	hex hyg leaflets	60				vs hot H <sub>2</sub> O
2667	Sodium thiosulfate	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7772-98-7	158.108	col monocl cry	100 dec		1.69	76.4 <sup>25</sup>	i EtOH
2668	Sodium thiosulfate pentahydrate	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	10102-17-7	248.184	col cry	≈50 dec		1.69	76.4 <sup>25</sup>	i EtOH
2669	Sodium trimetaphosphate	Na <sub>3</sub> (PO <sub>3</sub> ) <sub>3</sub>	7785-84-4	305.885	wh cry			2.49	22	
2670	Sodium trimetaphosphate hexahydrate	Na <sub>3</sub> (PO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	7785-84-4	413.976	tricl-rhom hyg prisms	53		1.786	22	i EtOH
2671	Sodium tripolyphosphate	Na <sub>3</sub> P <sub>3</sub> O <sub>10</sub>	7758-29-4	367.864	wh hyg powder	622			20 <sup>25</sup>	
2672	Sodium tungstate	Na <sub>2</sub> WO <sub>4</sub>	13472-45-2	293.82	wh rhom cry	695		4.18	74.2 <sup>25</sup>	
2673	Sodium tungstate dihydrate	Na <sub>2</sub> WO <sub>4</sub> · 2H <sub>2</sub> O	10213-10-2	329.85	wh orth cry	100 dec		3.25	74.2 <sup>25</sup>	i EtOH
2674	Sodium uranate(VI) monohydrate	Na <sub>2</sub> U <sub>2</sub> O <sub>7</sub> · H <sub>2</sub> O	13721-34-1	652.049	yel powder					i H <sub>2</sub> O; s acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2675	Sodium vanadate(V)	NaVO <sub>3</sub>	13718-26-8	121.930	col monoc prisms	630			21 <sup>25</sup>	
2676	Sodium vanadate(V) tetrahydrate	NaVO <sub>3</sub> · 4H <sub>2</sub> O	13718-26-8	193.992	yel-wh cry powder				21 <sup>25</sup>	
2677	Strontium	Sr	7440-24-6	87.62	silv-wh metal; cub	777	1382	2.64		reac H <sub>2</sub> O; s EtOH
2678	Strontium acetate	Sr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	543-94-2	205.71	col hyg cry	dec		2.1	40 <sup>25</sup>	vs H <sub>2</sub> O
2679	Strontium arsenite tetrahydrate	Sr(AsO <sub>2</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	10378-48-0	373.52	wh powder					sl H <sub>2</sub> O, EtOH; sol dil acid
2680	Strontium bromate monohydrate	Sr(BrO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	14519-18-7	361.44	yel hyg monoc cry	120 dec		3.773	39.0 <sup>25</sup>	
2681	Strontium bromide	SrBr <sub>2</sub>	10476-81-0	247.43	wh tetra cry	657		4.216	107 <sup>25</sup>	
2682	Strontium bromide hexahydrate	SrBr <sub>2</sub> · 6H <sub>2</sub> O	7789-53-9	355.52	col hyg cry	88 dec			107 <sup>25</sup>	s EtOH; i eth
2683	Strontium carbide	SrC <sub>2</sub>	12071-29-3	111.64	blk tetra cry	>1700		3.19		i H <sub>2</sub> O
2684	Strontium carbonate	SrCO <sub>3</sub>	1633-05-2	147.63	wh orth cry; hyg	1494		3.785	0.00034 <sup>20</sup>	s dil acid
2685	Strontium chlorate	Sr(ClO <sub>3</sub> ) <sub>2</sub>	7791-10-8	254.52	col cry	120 dec		3.15	176 <sup>25</sup>	sl EtOH
2686	Strontium chloride	SrCl <sub>2</sub>	10476-85-4	158.53	wh cub cry; hyg	874	1250	3.052	54.7 <sup>25</sup>	
2687	Strontium chloride hexahydrate	SrCl <sub>2</sub> · 6H <sub>2</sub> O	10025-70-4	266.62	col hyg cry	100 dec		1.96	54.7 <sup>25</sup>	s EtOH
2688	Strontium chromate	SrCrO <sub>4</sub>	7789-06-2	203.61	yel monoc cry	dec		3.9	0.106 <sup>20</sup>	s dil acid
2689	Strontium cyanide dihydrate	Sr(CN) <sub>2</sub> · 4H <sub>2</sub> O	52870-08-3	211.72	wh hyg cry	dec				vs H <sub>2</sub> O
2690	Strontium ferrocyanide pentadecahydrate	SrFe(CN) <sub>6</sub> · 15H <sub>2</sub> O	14654-44-5	569.80	yel monoc cry				50	
2691	Strontium fluoride	SrF <sub>2</sub>	7783-48-4	125.62	wh cub cry or powder	1477	2460	4.24	0.021 <sup>25</sup>	s dil acid
2692	Strontium formate	Sr(CHO <sub>2</sub> ) <sub>2</sub>	592-89-2	177.66	wh cry	71.9		2.693	9.1 <sup>0</sup>	
2693	Strontium formate dihydrate	Sr(CHO <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	6160-34-5	213.69	col rhom cry	100 dec		2.25	9.1 <sup>37</sup>	i EtOH, eth
2694	Strontium hexaboride	SrB <sub>6</sub>	12046-54-7	152.49	blk cub cry	2235		3.39		i H <sub>2</sub> O; s HNO <sub>3</sub>
2695	Strontium hydride	SrH <sub>2</sub>	13598-33-9	89.64	orth cry	1050		3.26		reac H <sub>2</sub> O
2696	Strontium hydroxide	Sr(OH) <sub>2</sub>	18480-07-4	121.64	col orth cry; hyg	535	710 dec	3.625	2.25 <sup>25</sup>	
2697	Strontium iodate	Sr(IO <sub>3</sub> ) <sub>2</sub>	13470-01-4	437.43	tricl cry			5.045	0.165 <sup>25</sup>	
2698	Strontium iodide	SrI <sub>2</sub>	10476-86-5	341.43	wh hyg cry	538	1773 dec	4.55	177 <sup>25</sup>	
2699	Strontium iodide hexahydrate	SrI <sub>2</sub> · 6H <sub>2</sub> O	73796-25-5	449.52	wh-yel hex cry; hyg	120 dec		4.4	177 <sup>25</sup>	s EtOH
2700	Strontium molybdate	SrMoO <sub>4</sub>	13470-04-7	247.56	wh cry pow	1040		4.54		i H <sub>2</sub> O
2701	Strontium niobate	SrNb <sub>2</sub> O <sub>6</sub>	12034-89-8	369.43	monoc cry	1225		5.11		i H <sub>2</sub> O
2702	Strontium nitrate	Sr(NO <sub>3</sub> ) <sub>2</sub>	10042-76-9	211.63	wh cub cry	570		2.99	80.2 <sup>25</sup>	sl EtOH, ace
2703	Strontium nitride	Sr <sub>3</sub> N <sub>2</sub>	12033-82-8	290.87	refrac solid	1200				reac H <sub>2</sub> O; s HCl
2704	Strontium nitrite	Sr(NO <sub>2</sub> ) <sub>2</sub>	13470-06-9	179.63	wh-yel hyg needles	240 dec		2.8	72.1 <sup>30</sup>	s H <sub>2</sub> O
2705	Strontium orthosilicate	Sr <sub>2</sub> SiO <sub>4</sub>	13597-55-2	267.32	orth cry			4.5		
2706	Strontium oxalate monohydrate	SrC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	814-95-9	193.65	cry pow	dec 150			0.00005 <sup>20</sup>	sl dil acid
2707	Strontium oxide	SrO	1314-11-0	103.62	col cub cry	2531		5.1		reac H <sub>2</sub> O
2708	Strontium perchlorate	Sr(ClO <sub>4</sub> ) <sub>2</sub>	13450-97-0	286.52	col hyg cry				306 <sup>25</sup>	s EtOH, MeOH
2709	Strontium permanganate trihydrate	Sr(MnO <sub>4</sub> ) <sub>2</sub> · 3H <sub>2</sub> O	14446-13-0	379.54	purp cub cry	175 dec		2.75	250 <sup>18</sup>	
2710	Strontium peroxide	SrO <sub>2</sub>	1314-18-7	119.62	wh tetra cry; unstab	215 dec		4.78		reac H <sub>2</sub> O
2711	Strontium phosphate	Sr <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7446-28-8	452.80	wh powder				0.000011 <sup>20</sup>	s acid
2712	Strontium selenate	SrSeO <sub>4</sub>	7446-21-1	230.58	orth cry			4.25	0.115 <sup>20</sup>	s hot HCl
2713	Strontium selenide	SrSe	1315-07-7	166.58	wh cub cry	1600		4.54		
2714	Strontium silicide	SrSi <sub>2</sub>	12138-28-2	143.79	silv-gray cub cry	1100		3.35		
2715	Strontium sulfate	SrSO <sub>4</sub>	7759-02-6	183.68	wh orth cry	1606		3.96	0.0135 <sup>25</sup>	i EtOH; sl acid
2716	Strontium sulfide	SrS	1314-96-1	119.69	gray cub cry	2226		3.70		sl H <sub>2</sub> O; s acid
2717	Strontium sulfite	SrSO <sub>3</sub>	13451-02-0	167.68	col cry	dec			0.0015 <sup>25</sup>	s H <sub>2</sub> SO <sub>4</sub> ; HCl
2718	Strontium telluride	SrTe	12040-08-3	215.22	wh cub cry			4.83		
2719	Strontium thiosulfate pentahydrate	SrS <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	15123-90-7	289.82	monoc needles	100 dec		2.17	36.3 <sup>25</sup>	i EtOH
2720	Strontium titanate	SrTiO <sub>3</sub>	12060-59-2	183.49	wh cub cry	2080		5.1		i H <sub>2</sub> O
2721	Strontium tungstate	SrWO <sub>4</sub>	13451-05-3	335.46	col tetra cry	dec		6.187	0.14 <sup>15</sup>	i EtOH
2722	Strontium zirconate	SrZrO <sub>3</sub>	12036-39-4	226.84	col cry	2600				
2723	Sulfur (rhombic)	S	7704-34-9	32.065	yel orth cry	95.3 (trans to monoc)	444.61	2.07		i H <sub>2</sub> O; sl EtOH, bz, eth; s CS <sub>2</sub>
2724	Sulfur (monoclinic)	S	7704-34-9	32.065	yel monoc needles, stable 95.3-120	115.21	444.61	2.00		i H <sub>2</sub> O; sl EtOH, bz, eth; s CS <sub>2</sub>
2725	Sulfuric acid	H <sub>2</sub> SO <sub>4</sub>	7664-93-9	98.079	col oily liq	10.31	337	1.8302		vs H <sub>2</sub> O
2726	Peroxydisulfuric acid	H <sub>2</sub> S <sub>2</sub> O <sub>8</sub>	7722-86-3	114.078	wh cry; unstab	45 dec				vs H <sub>2</sub> O
2727	Nitrosylsulfuric acid	HNOSO <sub>4</sub>	7782-78-7	127.077	prisms	73 dec				reac H <sub>2</sub> O; s H <sub>2</sub> SO <sub>4</sub>
2728	Chlorosulfonic acid	SO <sub>2</sub> (OH)Cl	7790-94-5	116.524	col-yel liq	-80	152	1.75		reac H <sub>2</sub> O; s py
2729	Fluorosulfonic acid	SO <sub>2</sub> (OH)F	7789-21-1	100.069	col liq	-89	163	1.726		reac H <sub>2</sub> O
2730	Sulfurous acid	H <sub>2</sub> SO <sub>3</sub>	7782-99-2	82.079	exists only in aq soln					
2731	Sulfamic acid	H <sub>2</sub> NSO <sub>3</sub> H	5329-14-6	97.094	orth cry	≈205 dec		2.15	14.7 <sup>0</sup>	sl ace; i eth
2732	Sulfur dioxide	SO <sub>2</sub>	7446-09-5	64.064	col gas	-75.5	-10.05	2.619 g/L		s H <sub>2</sub> O, EtOH, eth, chl



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2733	Sulfur trioxide	SO <sub>3</sub>	7446-11-9	80.063	wh needles	62.2	subl			react H <sub>2</sub> O
2734	Sulfur trioxide (γ-form)	SO <sub>3</sub>	7446-11-9	80.063	col solid or liq	16.8	44.5	1.90		react H <sub>2</sub> O
2735	Sulfur trioxide (β-form)	SO <sub>3</sub>	7446-11-9	80.063	wh needles	30.5	44.5			react H <sub>2</sub> O
2736	Sulfur bromide (SSBr <sub>2</sub> )	SSBr <sub>2</sub>	13172-31-1	223.938	red oily liq	-46	>25 dec	2.63		react H <sub>2</sub> O
2737	Sulfur chloride (SSCl <sub>2</sub> )	SSCl <sub>2</sub>	10025-67-9	135.036	yel-red oily liq	-77	137	1.69		react H <sub>2</sub> O; s EtOH, bz, eth, ctc
2738	Sulfur fluoride (SSF <sub>2</sub> )	SSF <sub>2</sub>	16860-99-4	102.127	col gas	-164.6	-10.6	4.174 g/L		react H <sub>2</sub> O
2739	Sulfur fluoride (FSSF)	FSSF	13709-35-8	102.127	col gas	-133	15	4.174 g/L		react H <sub>2</sub> O
2740	Sulfur dichloride	SCl <sub>2</sub>	10545-99-0	102.971	red visc liq	-122	59.6	1.62		react H <sub>2</sub> O
2741	Sulfur tetrafluoride	SF <sub>4</sub>	7783-60-0	108.059	col gas	-125	-40.45	4.417 g/L		react H <sub>2</sub> O
2742	Sulfur hexafluoride	SF <sub>6</sub>	2551-62-4	146.055	col gas	-49.596 tp	-63.8 sp	5.970 g/L		sl H <sub>2</sub> O; s EtOH
2743	Sulfur bromide pentafluoride	SF <sub>5</sub> Br	15607-89-3	206.961	col gas	-79	3.1	8.459 g/L		
2744	Sulfur chloride pentafluoride	SF <sub>5</sub> Cl	13780-57-9	162.510	col gas	-64	-19.05	6.642 g/L		
2745	Sulfur decafluoride	S <sub>2</sub> F <sub>10</sub>	5714-22-7	254.114	liq	-52.7	30; dec 150	2.08		i H <sub>2</sub> O
2746	Sulfuryl amide	(NH <sub>2</sub> ) <sub>2</sub> SO <sub>2</sub>	7803-58-9	96.109	orth plates	93	250 dec			vs H <sub>2</sub> O; sl EtOH
2747	Sulfuryl chloride	SO <sub>2</sub> Cl <sub>2</sub>	7791-25-5	134.970	col liq	-51	69.4	1.680		react H <sub>2</sub> O; s bz, tol, eth
2748	Sulfuryl fluoride	SO <sub>2</sub> F <sub>2</sub>	2699-79-8	102.061	col gas	-135.8	-55.4	4.172 g/L		sl H <sub>2</sub> O, EtOH; s tol, ctc
2749	Sulfuryl bromide fluoride	SO <sub>2</sub> BrF	13536-61-3	162.966	col liq	-86	41			react H <sub>2</sub> O
2750	Sulfuryl chloride fluoride	SO <sub>2</sub> ClF	13637-84-8	118.515	col gas	-124.7	7.1	1.62 <sup>o</sup>		react H <sub>2</sub> O
2751	Pyrosulfuryl chloride	S <sub>2</sub> O <sub>3</sub> Cl <sub>2</sub>	7791-27-7	215.033	col fuming liq	-37	151	1.837		react H <sub>2</sub> O
2752	Thionyl bromide	SOBr <sub>2</sub>	507-16-4	207.872	yel liq	-50	140			react H <sub>2</sub> O
2753	Thionyl chloride	SOCl <sub>2</sub>	7719-09-7	118.970	yel fuming liq	-101	75.6	1.631		react H <sub>2</sub> O; s bz, ctc, chl
2754	Thionyl fluoride	SOF <sub>2</sub>	7783-42-8	86.061	col gas	-129.5	-43.8	3.518 g/L		react H <sub>2</sub> O; s bz, eth
2755	Sulfur fluoride oxide (SOF <sub>4</sub> )	SOF <sub>4</sub>	13709-54-1	124.058	col gas	-99.6	-48.5	1.95 <sup>82</sup>		react H <sub>2</sub> O
2756	Sulfur fluoride hypofluorite	F <sub>2</sub> SOF	15179-32-5	162.054	col gas	-86	-35.1	6.624 g/L		
2757	Tetrasulfur tetranitride	S <sub>4</sub> N <sub>4</sub>	28950-34-7	184.287	yel-oran cry	178.2	subl			i H <sub>2</sub> O; react alk, acid
2758	Tantalum	Ta	7440-25-7	180.948	gray metal; cub	3017	5458	16.4		react HF
2759	Tantalum aluminate	TaAl <sub>3</sub>	12004-76-1	261.893	gray refrac powder	≈1400		7.02		i H <sub>2</sub> O, acid, alk
2760	Tantalum boride (TaB)	TaB	12007-07-7	191.759	refrac orth cry	2040		14.2		
2761	Tantalum boride (TaB <sub>2</sub> )	TaB <sub>2</sub>	12007-35-1	202.570	blk hex cry	3100		11.2		i H <sub>2</sub> O, acid, alk
2762	Tantalum carbide (TaC)	TaC	12070-06-3	192.959	gold-brown powder; cub	3880	4780	14.3		s HF-HNO <sub>3</sub> mixture
2763	Tantalum carbide (Ta <sub>2</sub> C)	Ta <sub>2</sub> C	12070-07-4	373.907	refrac hex cry	3327		15.1		
2764	Tantalum hydride	TaH	13981-95-8	181.956	gray metallic solid			15.1		i acid
2765	Tantalum nitride	TaN	12033-62-4	194.955	blk hex cry	3090		13.7		i H <sub>2</sub> O; sl aqua regia; react alk
2766	Tantalum silicide	TaSi <sub>2</sub>	12039-79-1	237.119	gray powder	2200		9.14		
2767	Tantalum(III) bromide	TaBr <sub>3</sub>	13842-73-4	420.660	gray-grn solid	dec 220				
2768	Tantalum(III) chloride	TaCl <sub>3</sub>	13569-67-0	287.307	blk-grn solid	dec 440				s H <sub>2</sub> O
2769	Tantalum(IV) bromide	TaBr <sub>4</sub>	13842-76-7	500.564	dark blue solid	392		5.77		react H <sub>2</sub> O
2770	Tantalum(IV) chloride	TaCl <sub>4</sub>	13569-72-7	322.760	dark grn solid	dec 300	subl	4.35		react H <sub>2</sub> O
2771	Tantalum(IV) iodide	TaI <sub>4</sub>	14693-80-2	688.566	gray-blk solid	400 dec				react H <sub>2</sub> O
2772	Tantalum(IV) oxide	Ta <sub>2</sub> O <sub>5</sub>	12036-14-5	212.947	tetr cry			10.0		
2773	Tantalum(IV) selenide	TaSe <sub>2</sub>	12039-55-3	338.87	hex cry			6.7		
2774	Tantalum(IV) sulfide	TaS <sub>2</sub>	12143-72-5	245.078	blk hex cry	>3000		6.86		i H <sub>2</sub> O
2775	Tantalum(IV) telluride	TaTe <sub>2</sub>	12067-66-2	436.15	monocl cry			9.4		
2776	Tantalum(V) bromide	TaBr <sub>5</sub>	13451-11-1	580.468	yel cry powder	265.8	348.8	4.67		
2777	Tantalum(V) chloride	TaCl <sub>5</sub>	7721-01-9	358.213	yel-wh monocl cry; hyg	216.6	239	3.68		react H <sub>2</sub> O; s EtOH
2778	Tantalum(V) fluoride	TaF <sub>5</sub>	7783-71-3	275.940	wh monocl cry; hyg	96.9	229.5	4.74		s H <sub>2</sub> O, eth; sl CS <sub>2</sub> , ctc
2779	Tantalum(V) iodide	TaI <sub>5</sub>	14693-81-3	815.470	blk hex cry; hyg	496	543	5.80		react H <sub>2</sub> O
2780	Tantalum(V) oxide	Ta <sub>2</sub> O <sub>5</sub>	1314-61-0	441.893	wh rhomb cry or powder	1875		8.24		i H <sub>2</sub> O, EtOH, acid; s HF
2781	Technetium	Tc	7440-26-8	98	hex cry	2157	4265	11		
2782	Technetium(V) fluoride	TcF <sub>5</sub>	31052-14-9	193	yel solid	50	dec			
2783	Technetium(VI) fluoride	TcF <sub>6</sub>	13842-93-8	212	yel cub cry	37.4	55.3	3.0		
2784	Tellurium	Te	13494-80-9	127.60	gray-wh rhomb cry	449.51	988	6.232		i H <sub>2</sub> O, bz, CS <sub>2</sub>
2785	Telluric(VI) acid	H <sub>6</sub> TeO <sub>6</sub>	7803-68-1	229.64	wh monocl cry	136		3.07	50.1 <sup>30</sup>	
2786	Tellurous acid	H <sub>2</sub> TeO <sub>3</sub>	10049-23-7	177.61	wh cry	40 dec		3.0		sl H <sub>2</sub> O; s dil acid, alk
2787	Tellurium dioxide	TeO <sub>2</sub>	7446-07-3	159.60	wh orth cry	733	1245	5.9		i H <sub>2</sub> O; s alk, acid
2788	Tellurium trioxide	TeO <sub>3</sub>	13451-18-8	175.60	yel-oran cry	430		5.07		i H <sub>2</sub> O

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2789	Tellurium dibromide	TeBr <sub>2</sub>	7789-54-0	287.41	grn-brn hyg cry	210	339			reac H <sub>2</sub> O; s eth; sl chl
2790	Tellurium dichloride	TeCl <sub>2</sub>	10025-71-5	198.51	blk amorp solid; hyg	208	328	6.9		reac H <sub>2</sub> O; i ctc
2791	Tellurium tetrabromide	TeBr <sub>4</sub>	10031-27-3	447.22	yel-oran monocl cry	380	≈420 dec	4.3		reac H <sub>2</sub> O; s eth
2792	Tellurium tetrachloride	TeCl <sub>4</sub>	10026-07-0	269.41	wh monocl cry; hyg	224	387	3.0		reac H <sub>2</sub> O; s EtOH, tol
2793	Tellurium tetrafluoride	TeF <sub>4</sub>	15192-26-4	203.59	col cry	129	195 dec			reac H <sub>2</sub> O
2794	Tellurium decafluoride	Te <sub>2</sub> F <sub>10</sub>	53214-07-6	445.18	col liq	-33.7	59			
2795	Tellurium tetraiodide	TeI <sub>4</sub>	7790-48-9	635.22	blk orth cry	280		5.05		reac H <sub>2</sub> O; sl ace
2796	Tellurium hexafluoride	TeF <sub>6</sub>	7783-80-4	241.59	col gas	-37.6 tp	-38.9 sp	9.875 g/L		reac H <sub>2</sub> O
2797	Terbium	Tb	7440-27-9	158.925	silv metal; hex	1359	3230	8.23		
2798	Terbium nitride	TbN	12033-64-6	172.932	cub cry			9.55		
2799	Terbium silicide	TbSi <sub>2</sub>	12039-80-4	215.096	orth cry			6.66		
2800	Terbium(III) bromide	TbBr <sub>3</sub>	14456-47-4	398.637	wh hex cry	830	1490			s H <sub>2</sub> O
2801	Terbium(III) chloride	TbCl <sub>3</sub>	10042-88-3	265.284	wh orth cry; hyg	582		4.35		s H <sub>2</sub> O
2802	Terbium(III) chloride hexahydrate	TbCl <sub>3</sub> · 6H <sub>2</sub> O	13798-24-8	373.375	hyg cry			4.35		vs H <sub>2</sub> O
2803	Terbium(III) iodide	TbI <sub>3</sub>	13813-40-6	539.638	hex cry; hyg	955		≈5.2		s H <sub>2</sub> O
2804	Terbium(III) nitrate	Tb(NO <sub>3</sub> ) <sub>3</sub>	10043-27-3	344.940	pink hyg solid				157 <sup>25</sup>	s EtOH
2805	Terbium(III) nitrate hexahydrate	Tb(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	13451-19-9	453.031	col needles	89				s H <sub>2</sub> O, EtOH, ace
2806	Terbium(III) oxide	Tb <sub>2</sub> O <sub>3</sub>	12036-41-8	365.849	wh cub cry	2303		7.91		
2807	Terbium(III) sulfate octahydrate	Tb <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	13842-67-6	750.161	wh cry	dec 360				sl H <sub>2</sub> O
2808	Terbium(III) sulfide	Tb <sub>2</sub> S <sub>3</sub>	12138-11-3	414.046	cub cry			6.35		
2809	Terbium(III) fluoride	TbF <sub>3</sub>	13708-63-9	215.920	wh solid	1175	2280			i H <sub>2</sub> O
2810	Terbium(IV) fluoride	TbF <sub>4</sub>	36781-15-4	234.919	wh monocl cry	dec 300				i H <sub>2</sub> O
2811	Thallium	Tl	7440-28-0	204.383	soft blue-wh metal	304	1473	11.8		i H <sub>2</sub> O; reac acid
2812	Thallium(I) acetate	TlC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	563-68-8	263.427	hyg wh cry	131		3.68		s H <sub>2</sub> O, EtOH
2813	Thallium(I) azide	TlN <sub>3</sub>	13847-66-0	246.403	yel cry	334	exp			s H <sub>2</sub> O
2814	Thallium(I) bromate	TlBrO <sub>3</sub>	14550-84-6	332.285	col needles	120 dec			0.49 <sup>20</sup>	s EtOH
2815	Thallium(I) bromide	TlBr	7789-40-4	284.287	yel cub cry	460	819	7.5	0.059 <sup>20</sup>	
2816	Thallium(I) carbonate	Tl <sub>2</sub> CO <sub>3</sub>	6533-73-9	468.776	wh monocl cry	273		7.11	4.69 <sup>20</sup>	i EtOH
2817	Thallium(I) chlorate	TlClO <sub>3</sub>	13453-30-0	287.834	col hex cry	dec 500		5.5	3.92 <sup>20</sup>	
2818	Thallium(I) chloride	TlCl	7791-12-0	239.836	wh cub cry	431	720	7.0	0.33 <sup>20</sup>	i EtOH
2819	Thallium(I) chromate	Tl <sub>2</sub> CrO <sub>4</sub>	13473-75-1	524.761	yel cry				0.003 <sup>20</sup>	sl acid, alk
2820	Thallium(I) cyanide	TlCN	13453-34-4	230.401	wh hex plates			6.523		s H <sub>2</sub> O, acid, EtOH
2821	Thallium(I) ethanolate	TlC <sub>2</sub> H <sub>3</sub> O	20398-06-5	249.443	cloudy liq	-3	130 dec	3.49		reac H <sub>2</sub> O
2822	Thallium(I) fluoride	TlF	7789-27-7	223.381	wh orth cry	326	826	8.36	245 <sup>25</sup>	
2823	Thallium(I) formate	TlCHO <sub>2</sub>	992-98-3	249.401	hyg col needles	101		4.97		vs H <sub>2</sub> O; s MeOH
2824	Thallium(I) hexafluorophosphate	TlPF <sub>6</sub>	60969-19-9	349.347	wh cub cry			4.6		
2825	Thallium(I) hydroxide	TlOH	12026-06-1	221.390	yel needles	139 dec		7.44	34.3 <sup>18</sup>	
2826	Thallium(I) iodate	TlIO <sub>3</sub>	14767-09-0	379.285	wh needles				0.058	sl HNO <sub>3</sub>
2827	Thallium(I) iodide	TlI	7790-30-9	331.287	yel cry powder	441.7	824	7.1	0.0085 <sup>20</sup>	i EtOH
2828	Thallium(I) molybdate	Tl <sub>2</sub> MoO <sub>4</sub>	34128-09-1	568.71	yel-wh cub cry					i H <sub>2</sub> O
2829	Thallium(I) nitrate	TlNO <sub>3</sub>	10102-45-1	266.388	wh cry	206	450 dec	5.55	9.55 <sup>20</sup>	s H <sub>2</sub> O; i EtOH
2830	Thallium(I) nitrite	TlNO <sub>2</sub>	13826-63-6	250.389	yel cub cry	186		5.7	32.1 <sup>25</sup>	s H <sub>2</sub> O
2831	Thallium(I) oxalate	Tl <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	30737-24-7	496.786	wh powder			6.31	1.83 <sup>20</sup>	
2832	Thallium(I) oxide	Tl <sub>2</sub> O	1314-12-1	424.766	blk rhomb cry; hyg	579	≈1080	9.52		s H <sub>2</sub> O, EtOH
2833	Thallium(I) perchlorate	TlClO <sub>4</sub>	13453-40-2	303.834	col orth cry	501		4.89	19.7 <sup>20</sup>	
2834	Thallium(I) selenate	Tl <sub>2</sub> SeO <sub>4</sub>	7446-22-2	551.73	orth cry	>400		6.875	2.8 <sup>20</sup>	i EtOH, eth
2835	Thallium(I) selenide	Tl <sub>2</sub> Se	15572-25-5	487.73	gray plates	340				i H <sub>2</sub> O, acid
2836	Thallium(I) sulfate	Tl <sub>2</sub> SO <sub>4</sub>	7446-18-6	504.830	wh rhomb prisms	632		6.77	5.47 <sup>25</sup>	
2837	Thallium(I) sulfide	Tl <sub>2</sub> S	1314-97-2	440.832	blue-blk cry	457	1367	8.39	0.02 <sup>20</sup>	sl alk; s acid
2838	Thallium(III) acetate	Tl(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub>	2570-63-0	381.514	hyg wh platelets	182 dec				
2839	Thallium(III) bromide tetrahydrate	TlBr <sub>3</sub> · 4H <sub>2</sub> O	13701-90-1	516.157	yel orth cry			3.65		s H <sub>2</sub> O, EtOH
2840	Thallium(III) chloride	TlCl <sub>3</sub>	13453-32-2	310.742	monocl cry	155		4.7		vs H <sub>2</sub> O, EtOH, eth
2841	Thallium(III) chloride tetrahydrate	TlCl <sub>3</sub> · 4H <sub>2</sub> O	13453-32-2*	382.804	orth cry			3.00		s H <sub>2</sub> O
2842	Thallium(III) fluoride	TlF <sub>3</sub>	7783-57-5	261.378	wh orth cry; hyg	550 dec		8.65		reac H <sub>2</sub> O
2843	Thallium(III) nitrate	Tl(NO <sub>3</sub> ) <sub>3</sub>	13746-98-0	390.398	col cry					reac H <sub>2</sub> O
2844	Thallium(III) oxide	Tl <sub>2</sub> O <sub>3</sub>	1314-32-5	456.765	brn cub cry	834		10.2		i H <sub>2</sub> O; reac acid
2845	Thallium(III) sulfate	Tl <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	16222-66-5	696.955	col leaflets					reac H <sub>2</sub> O
2846	Thallium selenide	TlSe	12039-52-0	283.34	blk solid	330				i H <sub>2</sub> O, acid
2847	Thorium	Th	7440-29-1	232.038	soft gray-wh metal; cub	1750	4788	11.7		s acid
2848	Thorium hydride	ThH <sub>2</sub>	16689-88-6	234.054	tetr cry			9.5		
2849	Thorium boride	ThB <sub>6</sub>	12229-63-9	296.904	refrac solid	2450		6.99		
2850	Thorium(IV) bromide	ThBr <sub>4</sub>	13453-49-1	551.654	wh hyg cry	679			65 <sup>20</sup>	



No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2851	Thorium carbide	ThC	12012-16-7	244.049	cub cry	2500		10.6		react H <sub>2</sub> O
2852	Thorium dicarbide	ThC <sub>2</sub>	12071-31-7	256.059	yel monocl cry	≈2650		9.0		react H <sub>2</sub> O
2853	Thorium(IV) chloride	ThCl <sub>4</sub>	10026-08-1	373.850	gray-wh tetr needles; hyg	770	921	4.59		s H <sub>2</sub> O, EtOH
2854	Thorium(IV) fluoride	ThF <sub>4</sub>	13709-59-6	308.032	wh monocl cry; hyg	1110	1680	6.1		
2855	Thorium(IV) iodide	ThI <sub>4</sub>	7790-49-0	739.656	wh-yel monocl cry	566	837			
2856	Thorium(IV) nitrate	Th(NO <sub>3</sub> ) <sub>4</sub>	13823-29-5	480.058	hyg wh plates	55 dec				vs H <sub>2</sub> O, EtOH
2857	Thorium(IV) nitrate tetrahydrate	Th(NO <sub>3</sub> ) <sub>4</sub> · 4H <sub>2</sub> O	13470-07-0	552.119	wh hyg cry	500 dec			191 <sup>20</sup>	s EtOH
2858	Thorium nitride	ThN	12033-65-7	246.045	refrac cub cry	2820		11.6		react H <sub>2</sub> O
2859	Thorium(IV) oxide	ThO <sub>2</sub>	1314-20-1	264.037	wh cub cry	3350	4400	10.0		i H <sub>2</sub> O, alk; sl acid
2860	Thorium(IV) selenide	ThSe <sub>2</sub>	60763-24-8	389.96	orth cry			8.5		
2861	Thorium orthosilicate	ThSiO <sub>4</sub>	14553-44-7	324.122	brn tetr cry			6.7		
2862	Thorium silicide	ThSi <sub>2</sub>	12067-54-8	288.209	tetr cry	1850		7.9		
2863	Thorium(IV) sulfate nonahydrate	Th(SO <sub>4</sub> ) <sub>2</sub> · 9H <sub>2</sub> O	10381-37-0	586.301	wh monocl cry	dec		2.8	4.2 <sup>20</sup>	
2864	Thorium(IV) sulfide	ThS <sub>2</sub>	12138-07-7	296.168	dark brn cry	1905		7.30		i H <sub>2</sub> O; s acid
2865	Thulium	Tm	7440-30-4	168.934	silv metal; hex	1545	1950	9.32		s dil acid
2866	Thulium(II) bromide	TmBr <sub>2</sub>	64171-97-7	328.742	dark grn solid	619				
2867	Thulium(II) chloride	TmCl <sub>2</sub>	22852-11-5	239.840	red or grn cry	718				react H <sub>2</sub> O
2868	Thulium(II) iodide	TmI <sub>2</sub>	60864-26-8	422.743	blk hyg solid	756				react H <sub>2</sub> O
2869	Thulium(III) bromide	TmBr <sub>3</sub>	14456-51-0	408.646	wh hyg cry	954				s H <sub>2</sub> O
2870	Thulium(III) chloride	TmCl <sub>3</sub>	13537-18-3	275.293	yel hyg cry	845				s H <sub>2</sub> O
2871	Thulium(III) chloride heptahydrate	TmCl <sub>3</sub> · 7H <sub>2</sub> O	13778-39-7	401.400	hyg cry					s H <sub>2</sub> O, EtOH
2872	Thulium(III) fluoride	TmF <sub>3</sub>	13760-79-7	225.929	wh cry	1158				s H <sub>2</sub> O
2873	Thulium(III) hydroxide	Tm(OH) <sub>3</sub>	1311-33-7	219.956	wh or grn prec					i H <sub>2</sub> O
2874	Thulium(III) iodide	TmI <sub>3</sub>	13813-43-9	549.647	yel hyg cry	1021				
2875	Thulium(III) nitrate	Tm(NO <sub>3</sub> ) <sub>3</sub>	14985-19-4	354.949	grn hyg solid				212 <sup>25</sup>	s EtOH
2876	Thulium(III) nitrate pentahydrate	Tm(NO <sub>3</sub> ) <sub>3</sub> · 5H <sub>2</sub> O	36548-87-5	445.025	grn hyg cry					s H <sub>2</sub> O, EtOH, ace
2877	Thulium(III) oxalate hexahydrate	Tm <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	26677-68-9	710.016	grn solid	dec 50				s alk oxalates
2878	Thulium(III) oxide	Tm <sub>2</sub> O <sub>3</sub>	12036-44-1	385.866	grn-wh cub cry	2341	3945	8.6		sl acid
2879	Tin (gray)	Sn	7440-31-5	118.710	cub cry	trans to wh Sn 13.2	2602	5.769		
2880	Tin (white)	Sn	7440-31-5	118.710	silv tetr cry	231.93	2602	7.287		
2881	Stannane	SnH <sub>4</sub>	2406-52-2	122.742	unstab col gas	-146	-51.8	5.017 g/L		
2882	Methylstannane	SnH <sub>3</sub> CH <sub>3</sub>	1631-78-3	136.769	col gas		1.4	5.590 g/L		react H <sub>2</sub> O
2883	(Dimethylamino)trimethylstannane	Sn(CH <sub>3</sub> ) <sub>3</sub> N(CH <sub>3</sub> ) <sub>2</sub>	993-50-0	207.890	liq	1	126	1.22		react H <sub>2</sub> O
2884	Tin monophosphide	SnP	25324-56-5	149.684	dull metallic solid	540				
2885	Tin triphosphide	Sn <sub>3</sub> P <sub>3</sub>	12286-33-8	567.761	wh cry	≈550		5.2		
2886	Tin(II) acetate	Sn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	638-39-1	236.799	wh orth cry	183	subl	2.31		s dil HCl
2887	Tin(II) bromide	SnBr <sub>2</sub>	10031-24-0	278.518	yel powder	215	639	5.12	85 <sup>0</sup>	s EtOH, eth, ace
2888	Tin(II) chloride	SnCl <sub>2</sub>	7772-99-8	189.616	wh orth cry	247.0	623	3.90	178 <sup>10</sup>	s EtOH, ace, eth; i xyl
2889	Tin(II) chloride dihydrate	SnCl <sub>2</sub> · 2H <sub>2</sub> O	10025-69-1	225.647	wh monocl cry	37 dec		2.71	178 <sup>10</sup>	s EtOH, NaOH; vs HCl
2890	Tin(II) fluoride	SnF <sub>2</sub>	7783-47-3	156.707	wh monocl cry; hyg	215	850	4.57		s H <sub>2</sub> O; i EtOH, eth, chl
2891	Tin(II) hexafluorozirconate	SnZrF <sub>6</sub>	12419-43-1	323.924	cry			4.21		s H <sub>2</sub> O
2892	Tin(II) hydroxide	Sn(OH) <sub>2</sub>	12026-24-3	152.725	wh amorp solid					
2893	Tin(II) iodide	SnI <sub>2</sub>	10294-70-9	372.519	red-oran powder	320	714	5.28	0.98 <sup>20</sup>	s bz, chl, CS <sub>2</sub>
2894	Tin(II) oxalate	SnC <sub>2</sub> O <sub>4</sub>	814-94-8	206.729	wh powder	280 dec		3.56		i H <sub>2</sub> O; s dil HCl
2895	Tin(II) oxide	SnO	21651-19-4	134.709	blue-blk tetr cry	1080 dec		6.45		i H <sub>2</sub> O, EtOH; s acid
2896	Tin(II) pyrophosphate	Sn <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	15578-26-4	411.363	wh amorp powder	400 dec		4.009		i H <sub>2</sub> O; s conc acid
2897	Tin(II) selenide	SnSe	1315-06-6	197.67	gray orth cry	861		6.18		i H <sub>2</sub> O; s aqua regia
2898	Tin(II) sulfate	SnSO <sub>4</sub>	7488-55-3	214.773	wh orth cry	378 dec		4.15	18.8 <sup>19</sup>	
2899	Tin(II) sulfide	SnS	1314-95-0	150.775	gray orth cry	881	1210	5.08		i H <sub>2</sub> O; s conc acid
2900	Tin(II) tartrate	SnC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	815-85-0	266.781	wh cry powder					s H <sub>2</sub> O, dil HCl
2901	Tin(II) telluride	SnTe	12040-02-7	246.31	gray cub cry	806		6.5		
2902	Tin(IV) bromide	SnBr <sub>4</sub>	7789-67-5	438.326	wh cry	29.1	205	3.34		vs H <sub>2</sub> O; s EtOH
2903	Tin(IV) chloride	SnCl <sub>4</sub>	7646-78-8	260.522	col fuming liq	-34.07	114.15	2.234		react H <sub>2</sub> O; s EtOH, ctc, bz, ace
2904	Tin(IV) chloride pentahydrate	SnCl <sub>4</sub> · 5H <sub>2</sub> O	10026-06-9	350.598	wh-yel cry	56 dec		2.04		vs H <sub>2</sub> O; s EtOH
2905	Tin(IV) chromate	Sn(CrO <sub>4</sub> ) <sub>2</sub>	38455-77-5	350.697	brn-yel cry powder	dec				s H <sub>2</sub> O
2906	Tin(IV) fluoride	SnF <sub>4</sub>	7783-62-2	194.704	wh tetr cry	442	705 subl	4.78		react H <sub>2</sub> O
2907	Tin(IV) iodide	SnI <sub>4</sub>	7790-47-8	626.328	yel-brn cub cry	143	364.35	4.46		react H <sub>2</sub> O; s EtOH, bz, chl, eth
2908	Tin(IV) oxide	SnO <sub>2</sub>	18282-10-5	150.709	gray tetr cry	1630		6.85		i H <sub>2</sub> O, EtOH; s hot conc alk
2909	Tin(IV) selenide	SnSe <sub>2</sub>	20770-09-6	276.63	red-brn cry	650		≈5.0		i H <sub>2</sub> O; s alk, conc acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2910	Tin(IV) selenite	Sn(SeO <sub>3</sub> ) <sub>2</sub>	7446-25-5	372.63	cry powder					i H <sub>2</sub> O; s hot HCl
2911	Tin(IV) sulfide	SnS <sub>2</sub>	1315-01-1	182.840	gold-yel hex cry	600 dec		4.5		i H <sub>2</sub> O; s alk, aqua regia
2912	Titanium	Ti	7440-32-6	47.867	gray metal; hex	1668	3287	4.506		
2913	Titanocene dichloride	Ti(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Cl <sub>2</sub>	1271-19-8	248.959	red cry	289		1.60		sl H <sub>2</sub> O, bz; s chl, EtOH, tol
2914	Titanium hydride	TiH <sub>2</sub>	7704-98-5	49.883	gray-blk powder	≈450 dec		3.75		i H <sub>2</sub> O
2915	Titanium boride	TiB <sub>2</sub>	12045-63-5	69.489	gray refrac solid; hex	3225		4.38		
2916	Titanium carbide	TiC	12070-08-5	59.878	cub cry	3067		4.93		i H <sub>2</sub> O; s HNO <sub>3</sub>
2917	Titanium nitride	TiN	25583-20-4	61.874	yel-brn cub cry	2947		5.21		i H <sub>2</sub> O; s aqua regia
2918	Titanium phosphide	TiP	12037-65-9	78.841	gray hex cry	1990		4.08		
2919	Titanium silicide	TiSi <sub>2</sub>	12039-83-7	104.038	blk orth cry	1500		4.0		i H <sub>2</sub> O, acid, alk; s HF
2920	Titanium(II) bromide	TiBr <sub>2</sub>	13783-04-5	207.675	blk powder	dec 400		4.0		reac H <sub>2</sub> O
2921	Titanium(II) chloride	TiCl <sub>2</sub>	10049-06-6	118.773	blk hex cryc	1035	1500	3.13		reac H <sub>2</sub> O; s EtOH; i chl, eth
2922	Titanium(II) iodide	TiI <sub>2</sub>	13783-07-8	301.676	blk hex cry	dec 400		5.02		reac H <sub>2</sub> O
2923	Titanium(II) oxide	TiO	12137-20-1	63.866	yel cub cry	1770	3227	4.95		
2924	Titanium(II) sulfide	TiS	12039-07-5	79.932	brn hex cry	1927		3.85		i H <sub>2</sub> O; s conc acid
2925	Titanium(III) bromide	TiBr <sub>3</sub>	13135-31-4	287.579	viol hex cry	dec 400				s H <sub>2</sub> O
2926	Titanium(III) chloride	TiCl <sub>3</sub>	7705-07-9	154.226	red-viol hex cry; hyg	425 dec	960	2.64		reac H <sub>2</sub> O
2927	Titanium(III) fluoride	TiF <sub>3</sub>	13470-08-1	104.862	viol hex cry	950 dec		2.98		i H <sub>2</sub> O, dil acid, alk
2928	Titanium(III) iodide	TiI <sub>3</sub>	13783-08-9	428.580	viol cry	dec 350				
2929	Titanium(III) oxide	Ti <sub>2</sub> O <sub>3</sub>	1344-54-3	143.732	blk hex cry	1842		4.486		s hot HF
2930	Titanium(III) sulfate	Ti <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10343-61-0	383.922	grn cry					i H <sub>2</sub> O, EtOH; s dil HCl
2931	Titanium(III) sulfide	Ti <sub>2</sub> S <sub>3</sub>	12039-16-6	191.929	blk hex cry			3.56		
2932	Titanium(III,IV) oxide	Ti <sub>3</sub> O <sub>5</sub>	12065-65-5	223.598	blk monocl cry	1777		4.24		
2933	Titanium(IV) bromide	TiBr <sub>4</sub>	7789-68-6	367.483	yel-oran cub cry; hyg	38.3	233.5	3.37		reac H <sub>2</sub> O
2934	Titanium(IV) chloride	TiCl <sub>4</sub>	7550-45-0	189.679	col or yel liq	-24.12	136.45	1.73		reac H <sub>2</sub> O; s EtOH
2935	Titanium(IV) fluoride	TiF <sub>4</sub>	7783-63-3	123.861	wh hyg powder	377	subl 284	2.798		reac H <sub>2</sub> O; s EtOH, py
2936	Titanium(IV) iodide	TiI <sub>4</sub>	7720-83-4	555.485	red hyg powder	155	377	4.3		reac H <sub>2</sub> O
2937	Titanium(IV) oxide (anatase)	TiO <sub>2</sub>	1317-70-0	79.866	brn tetr cry	1560		3.9		
2938	Titanium(IV) oxide (brookite)	TiO <sub>2</sub>	12188-41-9	79.866	wh orth cry			4.17		
2939	Titanium(IV) oxide (rutile)	TiO <sub>2</sub>	1317-80-2	79.866	wh tetr cry	1843	≈3000	4.17		i H <sub>2</sub> O, dil acid; s conc acid
2940	Titanium(IV) oxysulfate monohydrate	TiOSO <sub>4</sub> · H <sub>2</sub> O	13825-74-6*	177.944	col orth cry			2.71		reac H <sub>2</sub> O
2941	Titanium(IV) sulfate	Ti(SO <sub>4</sub> ) <sub>2</sub>	13693-11-3	239.992	wh-yel hyg cry	150 dec				s H <sub>2</sub> O
2942	Titanium(IV) sulfide	TiS <sub>2</sub>	12039-13-3	111.997	yel-brn hex cry; hyg			3.37		s H <sub>2</sub> SO <sub>4</sub>
2943	Tungsten	W	7440-33-7	183.84	gray-wh metal; cub	3422	5555	19.3		
2944	Tungstic acid	H <sub>2</sub> WO <sub>4</sub>	7783-03-1	249.85	yel amorp powder	100 dec		5.5		i H <sub>2</sub> O, acid; s alk
2945	Tungsten boride (W <sub>2</sub> B)	W <sub>2</sub> B	12007-10-2	378.49	refrac blk powder	2670		16.0		i H <sub>2</sub> O
2946	Tungsten boride (WB)	WB	12007-09-9	194.65	blk refrac powder	2665		15.2		i H <sub>2</sub> O
2947	Tungsten boride (W <sub>2</sub> B <sub>3</sub> )	W <sub>2</sub> B <sub>3</sub>	12007-98-6	421.74	refrac solid	2370		11.0		i H <sub>2</sub> O
2948	Tungsten carbide (W <sub>2</sub> C)	W <sub>2</sub> C	12070-13-2	379.69	refrac hex cry	≈2800		14.8		i H <sub>2</sub> O
2949	Tungsten carbide (WC)	WC	12070-12-1	195.85	gray hex cry	2785		15.6		i H <sub>2</sub> O; s HNO <sub>3</sub> /HF
2950	Tungsten carbonyl	W(CO) <sub>6</sub>	14040-11-0	351.90	wh cry	170 dec	subl	2.65		i H <sub>2</sub> O; s os
2951	Tungsten nitride (WN <sub>2</sub> )	WN <sub>2</sub>	60922-26-1	211.85	hex cry	600 dec		7.7		
2952	Tungsten nitride (W <sub>2</sub> N)	W <sub>2</sub> N	12033-72-6	381.69	gray cub cry	dec		17.8		
2953	Tungsten silicide (WSi <sub>2</sub> )	WSi <sub>2</sub>	12039-88-2	240.01	blue-gray tetr cry	2160		9.3		i H <sub>2</sub> O
2954	Tungsten silicide (W <sub>5</sub> Si <sub>3</sub> )	W <sub>5</sub> Si <sub>3</sub>	12039-95-1	1003.46	blue-gray refrac solid	2320		14.4		
2955	Tungsten(II) bromide	WBr <sub>2</sub>	13470-10-5	343.65	yel powder	dec 400				i H <sub>2</sub> O
2956	Tungsten(II) chloride	WCl <sub>2</sub>	13470-12-7	254.75	gray solid	dec 500		5.44		sl H <sub>2</sub> O
2957	Tungsten(II) iodide	WI <sub>2</sub>	13470-17-2	437.65	oran-brn cry	dec 800		6.79		i H <sub>2</sub> O
2958	Tungsten(III) bromide	WBr <sub>3</sub>	15163-24-3	423.55	blk hex cry	dec 180				i H <sub>2</sub> O
2959	Tungsten(III) chloride	WCl <sub>3</sub>	20193-56-0	290.20	red solid	550 dec	subl			reac H <sub>2</sub> O
2960	Tungsten(III) iodide	WI <sub>3</sub>	15513-69-6	564.55	blk solid	dec r.t.				i H <sub>2</sub> O; s ace; sl EtOH, chl
2961	Tungsten(IV) bromide	WBr <sub>4</sub>	14055-81-3	503.46	blk orth cry		240 subl			reac H <sub>2</sub> O
2962	Tungsten(IV) chloride	WCl <sub>4</sub>	13470-13-8	325.65	blk hyg powder	450 dec		4.62		reac H <sub>2</sub> O
2963	Tungsten(IV) fluoride	WF <sub>4</sub>	13766-47-7	259.83	red-brn cry	dec 800				reac H <sub>2</sub> O; s MeCN; i bz, tol, ctc

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
2964	Tungsten(IV) iodide	WI <sub>4</sub>	14055-84-6	691.46	blk cry	dec				react H <sub>2</sub> O; s EtOH; i eth chl
2965	Tungsten(IV) oxide	WO <sub>2</sub>	12036-22-5	215.84	brn monocl cry	≈1500 dec	1730	10.8		i H <sub>2</sub> O, os
2966	Tungsten(IV) selenide	WSe <sub>2</sub>	12067-46-8	341.76	gray hex cry			9.2		
2967	Tungsten(IV) sulfide	WS <sub>2</sub>	12138-09-9	247.97	gray hex cry	1250 dec		7.6		i H <sub>2</sub> O, HCl, alk
2968	Tungsten(IV) telluride	WTe <sub>2</sub>	12067-76-4	439.04	gray orth cry	1020		9.43		
2969	Tungsten(V) bromide	WBr <sub>5</sub>	13470-11-6	583.36	brn-blk hyg solid	286	333			react H <sub>2</sub> O
2970	Tungsten(V) chloride	WCl <sub>5</sub>	13470-14-9	361.11	blk-grn hyg cry	253	286	3.88		react H <sub>2</sub> O
2971	Tungsten(V) ethanolate	W(C <sub>2</sub> H <sub>5</sub> O) <sub>3</sub>	62571-53-3	409.14	powder		105(0.05 mmHg)			s EtAc
2972	Tungsten(V) fluoride	WF <sub>5</sub>	19357-83-6	278.83	yel solid	dec 20				react H <sub>2</sub> O
2973	Tungsten(V) oxytribromide	WOBr <sub>3</sub>	20213-56-3	439.55	dark brn tetr cry			≈5.9		
2974	Tungsten(V) oxytrichloride	WOCl <sub>3</sub>	14249-98-0	306.20	grn tetr cry			≈4.6		
2975	Tungsten(VI) bromide	WBr <sub>6</sub>	13701-86-5	663.26	blue-blk cry	309		6.9		react H <sub>2</sub> O
2976	Tungsten(VI) chloride	WCl <sub>6</sub>	13283-01-7	396.56	purp hex cry; hyg	282	337	3.52		react H <sub>2</sub> O; s EtOH, os
2977	Tungsten(VI) dioxidybromide	WO <sub>2</sub> Br <sub>2</sub>	13520-75-7	375.65	red cry		440 subl			
2978	Tungsten(VI) dioxidydichloride	WO <sub>2</sub> Cl <sub>2</sub>	13520-76-8	286.75	yel orth cry	265		4.67		i H <sub>2</sub> O
2979	Tungsten(VI) dioxidydiiodide	WO <sub>2</sub> I <sub>2</sub>	14447-89-3	469.65	grn monocl cry	400 dec		6.39		
2980	Tungsten(VI) fluoride	WF <sub>6</sub>	7783-82-6	297.83	yel liq or col gas	1.9	17.1	3.44		react H <sub>2</sub> O; vs ctc, cyhex
2981	Tungsten(VI) oxide	WO <sub>3</sub>	1314-35-8	231.84	yel powder	1473	≈1700	7.2		i H <sub>2</sub> O, os; sl acid; s alk
2982	Tungsten(VI) oxytetrabromide	WOBr <sub>4</sub>	13520-77-9	519.46	red tetr cry	277	327	≈5.5		react H <sub>2</sub> O
2983	Tungsten(VI) oxytetrachloride	WOCl <sub>4</sub>	13520-78-0	341.65	red hyg cry	210	230	11.92		react H <sub>2</sub> O; s bz, CS <sub>2</sub>
2984	Tungsten(VI) oxytetrafluoride	WOF <sub>4</sub>	13520-79-1	275.83	wh monocl cry	105	185.9	5.07		react H <sub>2</sub> O
2985	Tungsten(VI) sulfide	WS <sub>3</sub>	12125-19-8	280.04	brn powder					sl H <sub>2</sub> O; s alk
2986	Uranium	U	7440-61-1	238.029	silv-wh orth cry	1135	4131	19.1		
2987	Uranium boride (UB <sub>2</sub> )	UB <sub>2</sub>	12007-36-2	259.651	refrac solid	2430		12.7		
2988	Uranium boride (UB <sub>3</sub> )	UB <sub>3</sub>	12007-84-0	281.273	refrac solid	2530		9.32		i H <sub>2</sub> O
2989	Uranium carbide (UC)	UC	12070-09-6	250.040	gray cub cry	2790				
2990	Uranium carbide (UC <sub>2</sub> )	UC <sub>2</sub>	12071-33-9	262.050	gray tetr cry	2350	4370	11.3		react H <sub>2</sub> O; sl EtOH
2991	Uranium carbide (U <sub>2</sub> C <sub>3</sub> )	U <sub>2</sub> C <sub>3</sub>	12076-62-9	512.090	gray cub cry	≈1700 dec		12.7		
2992	Uranium nitride (UN)	UN	25658-43-9	252.036	gray cub cry	2805		14.3		i H <sub>2</sub> O
2993	Uranium nitride (U <sub>3</sub> N <sub>4</sub> )	U <sub>3</sub> N <sub>4</sub>	12033-83-9	518.078	cub cry	dec		11.3		
2994	Uranium(III) bromide	UBr <sub>3</sub>	13470-19-4	477.741	red hyg cry	727				s H <sub>2</sub> O
2995	Uranium(III) chloride	UCl <sub>3</sub>	10025-93-1	344.388	grn hyg cry	837		5.51		vs H <sub>2</sub> O; i bz, ctc
2996	Uranium(III) fluoride	UF <sub>3</sub>	13775-06-9	295.024	blk hex cry	1495		8.9		i H <sub>2</sub> O; s acid
2997	Uranium(III) hydride	UH <sub>3</sub>	13598-56-6	241.053	gray-blk cub cry			11.1		
2998	Uranium(III) iodide	UI <sub>3</sub>	13775-18-3	618.742	blk hyg cry	766				s H <sub>2</sub> O
2999	Uranium(IV) bromide	UBr <sub>4</sub>	13470-20-7	557.645	brn hyg cry	519				s H <sub>2</sub> O, EtOH
3000	Uranium(IV) chloride	UCl <sub>4</sub>	10026-10-5	379.841	grn octahed cry	590	791	4.72		react H <sub>2</sub> O; s EtOH
3001	Uranium(IV) fluoride	UF <sub>4</sub>	10049-14-6	314.023	grn monocl cry	1036	1417	6.7	0.01 <sup>25</sup>	s conc acid, alk
3002	Uranium(IV) iodide	UI <sub>4</sub>	13470-22-9	745.647	blk hyg cry	506				s H <sub>2</sub> O, EtOH
3003	Uranium(IV) oxide	UO <sub>2</sub>	1344-57-6	270.028	brn cub cry	2847		10.97		i H <sub>2</sub> O, dil acid; s conc acid
3004	Uranium(IV,V) oxide	U <sub>4</sub> O <sub>9</sub>	12037-15-9	1096.111	cub cry			11.2		
3005	Uranium(V) bromide	UBr <sub>5</sub>	13775-16-1	637.549	brn hyg cry					react H <sub>2</sub> O
3006	Uranium(V) chloride	UCl <sub>5</sub>	13470-21-8	415.294	brn hyg cry	287				react H <sub>2</sub> O
3007	Uranium(V) fluoride	UF <sub>5</sub>	13775-07-0	333.021	pale blue tetr cry; hyg	348		5.81		s H <sub>2</sub> O
3008	Uranium(V,Vl) oxide	U <sub>3</sub> O <sub>8</sub>	1344-59-8	842.082	grn-blk orth cry	1300 dec		8.38		
3009	Uranium(VI) chloride	UCl <sub>6</sub>	13763-23-0	450.747	grn hex cry	177		3.6		
3010	Uranium(VI) fluoride	UF <sub>6</sub>	7783-81-5	352.019	wh monocl solid	64.06 tp	56.5 sp	5.09		react H <sub>2</sub> O; s ctc, chl
3011	Uranium(VI) oxide	UO <sub>3</sub>	1344-58-7	286.027	oran-yel cry			≈7.3		i H <sub>2</sub> O; s acid
3012	Uranium(VI) oxide monohydrate	UO <sub>3</sub> · H <sub>2</sub> O	12326-21-5	304.043	yel orth cry	570 dec		7.05		
3013	Uranium peroxide dihydrate	UO <sub>2</sub> · 2H <sub>2</sub> O	19525-15-6	338.057	yel hyg cry	115 dec				i H <sub>2</sub> O
3014	Uranyl acetate dihydrate	UO <sub>2</sub> (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	6159-44-0	424.146	ye cry (HOAc)	80 dec		2.89		sl EtOH
3015	Uranyl chloride	UO <sub>2</sub> Cl <sub>2</sub>	7791-26-6	340.934	yel orth cry; hyg	577				vs H <sub>2</sub> O; s EtOH, ace; i bz
3016	Uranyl fluoride	UO <sub>2</sub> F <sub>2</sub>	13536-84-0	308.025	yel hyg solid				64.4 <sup>20</sup>	i bz
3017	Uranyl hydrogen phosphate tetrahydrate	UO <sub>2</sub> HPO <sub>4</sub> · 4H <sub>2</sub> O	18433-48-2	438.068	yel cry pow					i H <sub>2</sub> O; s acid
3018	Uranyl nitrate	UO <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	10102-06-4	394.037	yel cry				127 <sup>25</sup>	s eth
3019	Uranyl nitrate hexahydrate	UO <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13520-83-7	502.129	yel orth cry; hyg	60	118 dec	2.81	127 <sup>25</sup>	s EtOH, eth
3020	Uranyl sulfate	UO <sub>2</sub> SO <sub>4</sub>	1314-64-3	366.090	yel cry					
3021	Uranyl sulfate trihydrate	UO <sub>2</sub> SO <sub>4</sub> · 3H <sub>2</sub> O	20910-28-5	420.137	yel cry			3.28	152 <sup>16</sup>	sl EtOH
3022	Vanadium	V	7440-62-2	50.942	gray-wh metal; cub	1910	3407	6.0		i H <sub>2</sub> O; s acid

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
3023	Vanadocene	V(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub>	1277-47-0	181.128	viol cry; hyg	167				s bz, thf
3024	Vanadocene dichloride	V(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Cl <sub>2</sub>	12083-48-6	252.034	dark grn cry	205 dec				s H <sub>2</sub> O, chl, EtOH
3025	Vanadium boride (VB)	VB	12045-27-1	61.753	refrac solid	2250				i H <sub>2</sub> O
3026	Vanadium boride (VB <sub>2</sub> )	VB <sub>2</sub>	12007-37-3	72.564	refrac solid	2450				
3027	Vanadium carbide (VC)	VC	12070-10-9	62.953	refrac blk cry; cub	2810		5.77		i H <sub>2</sub> O
3028	Vanadium carbide (V <sub>2</sub> C)	V <sub>2</sub> C	12012-17-8	113.894	hex cry	2167				
3029	Vanadium carbonyl	V(CO) <sub>6</sub>	14024-00-1	219.002	blue-grn cry; flam	60 dec	subl			
3030	Vanadium nitride	VN	24646-85-3	64.949	blk powder; cub	2050		6.13		i H <sub>2</sub> O; s aqua regia
3031	Vanadium silicide (VSi <sub>2</sub> )	VSi <sub>2</sub>	12039-87-1	107.113	metallic prisms			4.42		s HF
3032	Vanadium silicide (V <sub>3</sub> Si)	V <sub>3</sub> Si	12039-76-8	180.911	cub cry	1935		5.70		
3033	Vanadium(II) bromide	VBr <sub>2</sub>	14890-41-6	210.750	oran-brn hex cry		800 subl	4.58		reac H <sub>2</sub> O
3034	Vanadium(II) chloride	VCl <sub>2</sub>	10580-52-6	121.848	grn hex plates	1350	910 subl	3.23		reac H <sub>2</sub> O; s EtOH, eth
3035	Vanadium(II) fluoride	VF <sub>2</sub>	13842-80-3	88.939	blue hyg cry	1490				reac H <sub>2</sub> O
3036	Vanadium(II) iodide	VI <sub>2</sub>	15513-84-5	304.751	red-viol hex cry		subl 800	5.44		reac H <sub>2</sub> O
3037	Vanadium(II) oxide	VO	12035-98-2	66.941	gray-blk cry	1790		5.758		s acid
3038	Vanadium(II) sulfate heptahydrate	VSO <sub>4</sub> · 7H <sub>2</sub> O	36907-42-3	273.111	viol cry					
3039	Vanadium(III) bromide	VBr <sub>3</sub>	13470-26-3	290.654	blk-grn hyg cry	dec 500	subl	4.00		reac H <sub>2</sub> O
3040	Vanadium(III) chloride	VCl <sub>3</sub>	7718-98-1	157.301	red-viol hex cry; hyg	500 dec		3.00		reac H <sub>2</sub> O; s EtOH, eth
3041	Vanadium(III) fluoride	VF <sub>3</sub>	10049-12-4	107.937	yel-grn hex cry	1395	subl	3.363		i H <sub>2</sub> O, EtOH
3042	Vanadium(III) fluoride trihydrate	VF <sub>3</sub> · 3H <sub>2</sub> O	10049-12-4*	161.983	grn rhomb cry	≈100 dec				sl H <sub>2</sub> O
3043	Vanadium(III) iodide	VI <sub>3</sub>	15513-94-7	431.655	brn-blk rhomb cry; hyg	dec 300		5.21		reac H <sub>2</sub> O
3044	Vanadium(III) oxide	V <sub>2</sub> O <sub>3</sub>	1314-34-7	149.881	blk powder	1957	≈3000	4.87		i H <sub>2</sub> O
3045	Vanadium(III) 2,4-pentanedioate	V(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>3</sub>	13476-99-8	348.266	brn cry	≈185	subl	≈1.0		s MeOH, ace, bz chl
3046	Vanadium(III) sulfate	V <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13701-70-7	390.071	yel powder	≈400 dec				sl H <sub>2</sub> O
3047	Vanadium(III) sulfide	V <sub>2</sub> S <sub>3</sub>	1315-03-3	198.078	grn-blk powder	dec		4.7		i H <sub>2</sub> O; s hot HCl
3048	Vanadium(IV) bromide	VBr <sub>4</sub>	13595-30-7	370.558	unstab purp cry	-23 dec				
3049	Vanadium(IV) chloride	VCl <sub>4</sub>	7632-51-1	192.754	red-brn liq	-28	151	1.816		reac H <sub>2</sub> O; s EtOH, eth
3050	Vanadium(IV) fluoride	VF <sub>4</sub>	10049-16-8	126.936	grn hyg powder	325 dec	subl	3.15		vs H <sub>2</sub> O
3051	Vanadium(IV) oxide	VO <sub>2</sub>	12036-21-4	82.941	blue-blk powder	1967		4.339		i H <sub>2</sub> O; s acid, alk
3052	Vanadium(V) fluoride	VF <sub>5</sub>	7783-72-4	145.934	col liq	19.5	48.3	2.50		reac H <sub>2</sub> O
3053	Vanadium(V) dioxide fluoride	VO <sub>2</sub> F	14259-82-6	101.939	brn hyg cry	350 dec				reac H <sub>2</sub> O
3054	Vanadium(V) dioxide chloride	VO <sub>2</sub> Cl	13759-30-3	118.394	oran hyg cry	dec 180				s thf
3055	Vanadium(V) oxide	V <sub>2</sub> O <sub>5</sub>	1314-62-1	181.880	yel-brn orth cry	681	1750	3.35	0.07 <sup>25</sup>	s conc acid, alk; i EtOH
3056	Vanadium(V) sulfide	V <sub>2</sub> S <sub>5</sub>	12138-17-9	262.208	grn-blk pow	dec		3.0		i H <sub>2</sub> O; s acid, alk
3057	Vanadyl bromide	VOBr	13520-88-2	146.845	viol cry	480 dec				
3058	Vanadyl chloride	VOCl	13520-87-1	102.394	brn orth cry		127	1.72		
3059	Vanadyl dibromide	VOBr <sub>2</sub>	13520-89-3	226.749	yel-brn cry	180 dec				
3060	Vanadyl dichloride	VOCl <sub>2</sub>	10213-09-9	137.847	grn hyg cry	380 dec		2.88		reac H <sub>2</sub> O; s EtOH
3061	Vanadyl difluoride	VOF <sub>2</sub>	13814-83-0	104.938	yel cry					
3062	Vanadyl selenite hydrate	VSeO <sub>3</sub> · H <sub>2</sub> O	133578-89-9	211.92	grn tricli plates			3.506		
3063	Vanadyl sulfate dihydrate	VOSO <sub>4</sub> · 2H <sub>2</sub> O	27774-13-6	199.035	blue cry powder					s H <sub>2</sub> O
3064	Vanadyl tribromide	VOBr <sub>3</sub>	13520-90-6	306.653	deep red liq	-59	170			reac H <sub>2</sub> O
3065	Vanadyl trichloride	VOCl <sub>3</sub>	7727-18-6	173.300	fuming red-yel liq	-79	127	1.829		reac H <sub>2</sub> O; s MeOH, eth, ace
3066	Vanadyl trifluoride	VOF <sub>3</sub>	13709-31-4	123.936	yel hyg powder	300	480	2.459		reac H <sub>2</sub> O
3067	Water	H <sub>2</sub> O	7732-18-5	18.015	col liq	0.00	99.974	0.9970 <sup>25</sup>		vs EtOH, MeOH, ace
3068	Water-d <sub>2</sub>	D <sub>2</sub> O	7789-20-0	20.027	col liq	3.82	101.42	1.1044 <sup>25</sup>		
3069	Water-t <sub>2</sub>	T <sub>2</sub> O	14940-65-9	22.032	col liq	4.48	101.51	1.2138 <sup>25</sup>		
3070	Xenon	Xe	7440-63-3	131.293	col gas	-111.745 tp (81.6 kPa)	-108.09	5.366 g/L		sl H <sub>2</sub> O
3071	Xenon trioxide	XeO <sub>3</sub>	13776-58-4	179.291	col orth cry	exp ≈25		4.55		s H <sub>2</sub> O
3072	Xenon tetroxide	XeO <sub>4</sub>	12340-14-6	195.291	yel solid or col gas; exp	-35.9	≈0 dec			
3073	Xenon difluoride	XeF <sub>2</sub>	13709-36-9	169.290	col tetr cry	129.03 tp	114.35 sp	4.32		sl H <sub>2</sub> O
3074	Xenon tetrafluoride	XeF <sub>4</sub>	13709-61-0	207.287	col monocl cry	117.10 tp	115.75 sp	4.04		reac H <sub>2</sub> O
3075	Xenon hexafluoride	XeF <sub>6</sub>	13693-09-9	245.283	col monocl cry	49.48	75.6	3.56		reac H <sub>2</sub> O
3076	Xenon fluoride oxide	XeOF <sub>2</sub>	13780-64-8	185.289	yel solid, stab <-25	exp ≈0				reac H <sub>2</sub> O
3077	Xenon oxytetrafluoride	XeOF <sub>4</sub>	13774-85-1	223.286	col liq	-46.2		3.17 <sup>9</sup>		reac H <sub>2</sub> O
3078	Xenon dioxydifluoride	XeO <sub>2</sub> F <sub>2</sub>	13875-06-4	201.289	col orth cry	30.8 exp		4.10		
3079	Xenon difluoride trioxide	XeO <sub>3</sub> F <sub>2</sub>	15192-14-0	217.288	unstab at r.t.	-54.1	exp			
3080	Xenon pentafluoride hexafluoroarsenate	XeF <sub>5</sub> AsF <sub>6</sub>	20328-94-3	415.197	wh monocl cry	130.5		3.51		

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
3081	Xenon pentafluoride hexafluororuthenate	XeF <sub>5</sub> RuF <sub>6</sub>	39796-98-0	441.35	grn orth cry	152		3.79		
3082	Xenon fluoride hexafluoroantimonate	XeF <sub>5</sub> SbF <sub>6</sub>	39797-63-2	424.039	yel-grn monocl cry	≈110		3.92		
3083	Xenon fluoride hexafluoroarsenate	XeF <sub>5</sub> AsF <sub>6</sub>	50432-32-1	508.494	yel-grn monocl cry	99		3.62		reac H <sub>2</sub> O
3084	Xenon fluoride hexafluororuthenate	XeFRuF <sub>6</sub>	22527-13-5	365.35	yel-grn monocl cry	110		3.78		
3085	Xenon fluoride undecafluoroantimonate	XeFSb <sub>2</sub> F <sub>11</sub>	15364-10-0	602.794	yel monocl cry	63		3.69		
3086	Xenon trifluoride undecafluoroantimonate	XeF <sub>3</sub> Sb <sub>2</sub> F <sub>11</sub>	35718-37-7	640.791	yel-grn tricl cry	82		3.98		
3087	Ytterbium	Yb	7440-64-4	173.04	silv metal; cub	824	1196	6.90		s dil acid
3088	Ytterbium silicide	YbSi <sub>2</sub>	12039-89-3	229.21	hex cry			7.54		
3089	Ytterbium(II) bromide	YbBr <sub>2</sub>	25502-05-0	332.85	yel cry	673				reac H <sub>2</sub> O
3090	Ytterbium(II) chloride	YbCl <sub>2</sub>	13874-77-6	243.95	grn cry	721		5.27		reac H <sub>2</sub> O
3091	Ytterbium(II) fluoride	YbF <sub>2</sub>	15192-18-4	211.04	gray solid	1407				i H <sub>2</sub> O
3092	Ytterbium(II) iodide	YbI <sub>2</sub>	19357-86-9	426.85	blk cry	772				reac H <sub>2</sub> O
3093	Ytterbium(III) acetate tetrahydrate	Yb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>3</sub> · 4H <sub>2</sub> O	15280-58-7	422.23	hyg col cry	dec 70		2.09		vs H <sub>2</sub> O
3094	Ytterbium(III) bromide	YbBr <sub>3</sub>	13759-89-2	412.75	col cry	956 dec				s H <sub>2</sub> O
3095	Ytterbium(III) chloride	YbCl <sub>3</sub>	10361-91-8	279.40	wh hyg powder	854				s H <sub>2</sub> O
3096	Ytterbium(III) chloride hexahydrate	YbCl <sub>3</sub> · 6H <sub>2</sub> O	19423-87-1	387.49	grn hyg cry	150 dec		2.57		vs H <sub>2</sub> O
3097	Ytterbium(III) fluoride	YbF <sub>3</sub>	13760-80-0	230.04	wh cry	1157		8.2		i H <sub>2</sub> O
3098	Ytterbium(III) iodide	YbI <sub>3</sub>	13813-44-0	553.75	yel cry	dec 700				s H <sub>2</sub> O
3099	Ytterbium(III) nitrate	Yb(NO <sub>3</sub> ) <sub>3</sub>	13768-67-7	359.06	col hyg solid				239 <sup>25</sup>	s EtOH
3100	Ytterbium(III) oxide	Yb <sub>2</sub> O <sub>3</sub>	1314-37-0	394.08	col cub cry	2355	4070	9.2		s dil acid
3101	Ytterbium(III) sulfate octahydrate	Yb <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	10034-98-7	778.39	col cry			3.3	38.4 <sup>20</sup>	
3102	Yttrium	Y	7440-65-5	88.906	silv metal; hex	1522	3345	4.47		reac H <sub>2</sub> O; s dil acid
3103	Yttrium aluminum oxide	Y <sub>2</sub> Al <sub>5</sub> O <sub>12</sub>	12005-21-9	593.619	grn cub cry			≈4.5		
3104	Yttrium antimonide	YSb	12186-97-9	210.666	cub cry	2310		5.97		
3105	Yttrium arsenide	YAs	12255-48-0	163.828	cub cry			5.59		
3106	Yttrium boride	YB <sub>3</sub>	12008-32-1	153.772	refrac solid	2600		3.72		
3107	Yttrium bromide	YBr <sub>3</sub>	13469-98-2	328.618	col hyg cry	904			83.3 <sup>20</sup>	
3108	Yttrium carbide	YC <sub>2</sub>	12071-35-1	112.927	refrac solid	≈2400		4.13		
3109	Yttrium carbonate trihydrate	Y <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> · 3H <sub>2</sub> O	5970-44-5	411.885	red-brn powder					i H <sub>2</sub> O; s dil acid
3110	Yttrium chloride	YCl <sub>3</sub>	10361-92-9	195.265	wh monocl cry; hyg	721	1482	2.61	75.1 <sup>20</sup>	vs H <sub>2</sub> O
3111	Yttrium chloride hexahydrate	YCl <sub>3</sub> · 6H <sub>2</sub> O	10025-94-2	303.356	hyg col cry	dec 100				vs H <sub>2</sub> O; s EtOH
3112	Yttrium fluoride	YF <sub>3</sub>	13709-49-4	145.901	wh hyg powder	1155		4.0		i H <sub>2</sub> O
3113	Yttrium hydroxide	Y(OH) <sub>3</sub>	16469-22-0	139.928	wh prec or pow	dec 190				i H <sub>2</sub> O
3114	Yttrium iodide	YI <sub>3</sub>	13470-38-7	469.619	hyg wh-yel cry	997				s H <sub>2</sub> O, ace, EtOH
3115	Yttrium iron oxide	Y <sub>2</sub> Fe <sub>2</sub> O <sub>7</sub>	12063-56-8	737.936	cub cry	1555				
3116	Yttrium nitrate	Y(NO <sub>3</sub> ) <sub>3</sub>	10361-93-0	274.921	wh hyg solid				149 <sup>25</sup>	s EtOH
3117	Yttrium nitrate tetrahydrate	Y(NO <sub>3</sub> ) <sub>3</sub> · 4H <sub>2</sub> O	13773-69-8	346.982	red-wh prisms			2.68	149 <sup>25</sup>	
3118	Yttrium nitrate hexahydrate	Y(NO <sub>3</sub> ) <sub>3</sub> · 6H <sub>2</sub> O	13494-98-9	383.012	hyg cry				149 <sup>25</sup>	
3119	Yttrium oxide	Y <sub>2</sub> O <sub>3</sub>	1314-36-9	225.810	wh cry; cub	2439		5.03		s dil acid
3120	Yttrium phosphide	YP	12294-01-8	119.880	cub cry			≈4.4		
3121	Yttrium sulfate octahydrate	Y <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> · 8H <sub>2</sub> O	7446-33-5	610.122	red monocl cry			2.6	7.47 <sup>16</sup>	
3122	Yttrium sulfide	Y <sub>2</sub> S <sub>3</sub>	12039-19-9	274.007	yel cub cry	1925		3.87		
3123	Zinc	Zn	7440-66-6	65.409	blue-wh metal; hex	419.53	907	7.134		s acid, alk
3124	Zinc acetate dihydrate	Zn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	5970-45-6	219.527	wh powder	237 dec		1.735	30.0 <sup>20</sup>	s EtOH
3125	Zinc ammonium sulfate	Zn(NH <sub>4</sub> ) <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub>	7783-24-6	293.611	wh cry				9.2 <sup>20</sup>	
3126	Zinc antimonide	ZnSb	12039-35-9	187.169	silv-wh orth cry	565		6.33		reac H <sub>2</sub> O
3127	Zinc arsenate	Zn <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	13464-44-3	474.065	wh powder				0.000078 <sup>20</sup>	s acid, alk
3128	Zinc arsenate octahydrate	Zn <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> · 8H <sub>2</sub> O	13464-45-4	618.187	wh monocl cry			3.33	0.000078 <sup>20</sup>	s acid, alk
3129	Zinc arsenide	Zn <sub>3</sub> As <sub>2</sub>	12006-40-5	346.070	powder	1015		5.528		
3130	Zinc arsenite	Zn(AsO <sub>2</sub> ) <sub>2</sub>	10326-24-6	279.250	col powder					i H <sub>2</sub> O; s acid
3131	Zinc borate	3ZnO · 2B <sub>2</sub> O <sub>3</sub>	27043-84-1	383.466	wh amorp powder			3.64		sl H <sub>2</sub> O; s dil acid
3132	Zinc borate hemiheptahydrate	2ZnO · 3B <sub>2</sub> O <sub>3</sub> · 3.5H <sub>2</sub> O	12513-27-8	434.69	wh cry	980		4.22		i H <sub>2</sub> O
3133	Zinc borate pentahydrate	2ZnO · 3B <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	12536-65-1	461.753	wh powder			3.64	0.007 <sup>25</sup>	sl HCl
3134	Zinc bromate hexahydrate	Zn(BrO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	13517-27-6	429.305	wh hyg solid	100		2.57		vs H <sub>2</sub> O
3135	Zinc bromide	ZnBr <sub>2</sub>	7699-45-8	225.217	wh hex cry; hyg	402	≈670	4.5	488 <sup>25</sup>	vs EtOH; s eth
3136	Zinc caprylate	Zn(C <sub>8</sub> H <sub>15</sub> O <sub>2</sub> ) <sub>2</sub>	557-09-5	351.816	wh hyg cry	136				sl H <sub>2</sub> O
3137	Zinc carbonate	ZnCO <sub>3</sub>	3486-35-9	125.418	wh hex cry	140 dec		4.434	0.000091 <sup>20</sup>	s dil acid, alk
3138	Zinc carbonate hydroxide	3Zn(OH) <sub>2</sub> · 2ZnCO <sub>3</sub>	12070-69-8	549.107	wh powder					
3139	Zinc chlorate	Zn(ClO <sub>3</sub> ) <sub>2</sub>	10361-95-2	232.311	yel hyg cry	60 dec		2.15	200 <sup>20</sup>	
3140	Zinc chloride	ZnCl <sub>2</sub>	7646-85-7	136.315	wh hyg cry	290	732	2.907	408 <sup>25</sup>	vs H <sub>2</sub> O; s EtOH, ace

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
3141	Zinc chromate	ZnCrO <sub>4</sub>	13530-65-9	181.403	yel prisms	316		3.40	3.08	s acid; i ace
3142	Zinc chromite	ZnCr <sub>2</sub> O <sub>4</sub>	12018-19-8	233.399	grn cub cry				5.29	
3143	Zinc citrate dihydrate	Zn <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	546-46-3	610.456	col powder					sl H <sub>2</sub> O; s dil acid, alk
3144	Zinc cyanide	Zn(CN) <sub>2</sub>	557-21-1	117.443	wh powder			1.852	0.00047 <sup>20</sup>	reac acid
3145	Zinc diethyl	Zn(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	557-20-0	123.531	col liq	-28	118	1.2065		reac H <sub>2</sub> O; msc eth, peth, bz
3146	Zinc dithionate	ZnS <sub>2</sub> O <sub>4</sub>	7779-86-4	193.537	wh amorp solid	200 dec			40 <sup>20</sup>	
3147	Zinc fluoride	ZnF <sub>2</sub>	7783-49-5	103.406	wh tetr needles; hyg	872	1500	4.9	1.55 <sup>25</sup>	sl H <sub>2</sub> O
3148	Zinc fluoride tetrahydrate	ZnF <sub>2</sub> · 4H <sub>2</sub> O	13986-18-0	175.468	wh orth cry			2.30	1.55 <sup>25</sup>	
3149	Zinc fluoroborate hexahydrate	Zn(BF <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	27860-83-9	347.109	hex cry			2.12		vs H <sub>2</sub> O; s EtOH
3150	Zinc formate dihydrate	Zn(CHO <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	5970-62-7	191.474	wh cry			2.207	5.2 <sup>20</sup>	i EtOH
3151	Zinc hexafluorosilicate hexahydrate	ZnSiF <sub>6</sub> · 6H <sub>2</sub> O	16871-71-9	315.576	wh cry					s H <sub>2</sub> O
3152	Zinc hydroxide	Zn(OH) <sub>2</sub>	20427-58-1	99.424	col orth cry	125 dec		3.05	0.000042 <sup>20</sup>	
3153	Zinc iodate	Zn(IO <sub>3</sub> ) <sub>2</sub>	7790-37-6	415.214	wh cry powder				0.64 <sup>25</sup>	
3154	Zinc iodide	ZnI <sub>2</sub>	10139-47-6	319.218	wh-yel hyg cry	450	625	4.74	438 <sup>25</sup>	vs H <sub>2</sub> O; s EtOH, eth
3155	Zinc laurate	Zn(C <sub>12</sub> H <sub>23</sub> O <sub>2</sub> ) <sub>2</sub>	2452-01-9	464.029	wh powder	128				sl H <sub>2</sub> O
3156	Zinc molybdate	ZnMoO <sub>4</sub>	13767-32-3	225.35	wh tetr cry	>700		4.3		i H <sub>2</sub> O
3157	Zinc nitrate	Zn(NO <sub>3</sub> ) <sub>2</sub>	7779-88-6	189.418	wh powder				120 <sup>25</sup>	
3158	Zinc nitrate hexahydrate	Zn(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10196-18-6	297.510	col orth cry	36 dec		2.067	120 <sup>25</sup>	vs EtOH
3159	Zinc nitride	Zn <sub>3</sub> N <sub>2</sub>	1313-49-1	224.240	blue-gray cub cry	700 dec		6.22		i H <sub>2</sub> O
3160	Zinc nitrite	Zn(NO <sub>2</sub> ) <sub>2</sub>	10102-02-0	157.420	hyg solid					reac H <sub>2</sub> O
3161	Zinc oleate	Zn(C <sub>18</sub> H <sub>33</sub> O <sub>2</sub> ) <sub>2</sub>	557-07-3	628.316	wh powder	70 dec				i H <sub>2</sub> O; s EtOH, eth, bz
3162	Zinc oxalate	ZnC <sub>2</sub> O <sub>4</sub>	547-68-2	153.428	wh pwd				0.0026 <sup>25</sup>	
3163	Zinc oxalate dihydrate	ZnC <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	4255-07-6	189.458	wh powder	100 dec		2.56	0.0026 <sup>25</sup>	s dil acid
3164	Zinc tartrate dihydrate	ZnC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 2H <sub>2</sub> O	22570-08-7	249.511	wh cry pow	dec 150			0.022 <sup>20</sup>	
3165	Zinc oxide	ZnO	1314-13-2	81.408	wh powder; hex	1974		5.6		i H <sub>2</sub> O; s dil acid
3166	Zinc 2,4-pentanedioate	Zn(CH <sub>3</sub> COCHCOCH <sub>3</sub> ) <sub>2</sub>	14024-63-6	263.625	cry	137 dec				sl H <sub>2</sub> O; s EtOH, DMSO
3167	Zinc pentanoate dihydrate	Zn(C <sub>5</sub> H <sub>9</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	556-38-7	303.687	scales or powder					sl H <sub>2</sub> O; reac acid; s EtOH
3168	Zinc perchlorate hexahydrate	Zn(ClO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	10025-64-6	372.402	wh cub cry; hyg	106 dec		2.2	121.3 <sup>25</sup>	s EtOH
3169	Zinc permanganate hexahydrate	Zn(MnO <sub>4</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	23414-72-4	411.372	blk orth cry; hyg			2.45		s H <sub>2</sub> O; reac EtOH
3170	Zinc peroxide	ZnO <sub>2</sub>	1314-22-3	97.408	yel-wh powder	>150 dec	212 exp	1.57		i H <sub>2</sub> O; reac acid, EtOH, ace
3171	Zinc phosphate	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	7779-90-0	386.170	wh monocl cry	900		4.0		i H <sub>2</sub> O
3172	Zinc phosphate tetrahydrate	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	7543-51-3	458.231	col orth cry			3.04		i H <sub>2</sub> O, EtOH; s dil acid, alk
3173	Zinc phosphide	Zn <sub>3</sub> P <sub>2</sub>	1314-84-7	258.175	gray tetr cry	1160		4.55		i H <sub>2</sub> O, EtOH; reac acid; s bz
3174	Zinc pyrophosphate	Zn <sub>2</sub> P <sub>2</sub> O <sub>7</sub>	7446-26-6	304.761	wh cry powder			3.75		i H <sub>2</sub> O; s dil acid
3175	Zinc selenate pentahydrate	ZnSeO <sub>4</sub> · 5H <sub>2</sub> O	13597-54-1	298.44	tricl cry	50 dec		2.59	63.4 <sup>25</sup>	
3176	Zinc selenide	ZnSe	1315-09-9	144.37	yel-red cub cry	>1100	subl	5.65		i H <sub>2</sub> O; s dil acid
3177	Zinc orthosilicate	Zn <sub>2</sub> SiO <sub>4</sub>	13597-65-4	222.902	wh hex cry	1509		4.1		i H <sub>2</sub> O, dil acid
3178	Zinc selenite	ZnSeO <sub>3</sub>	13597-46-1	192.37	wh powder	621				
3179	Zinc stearate	Zn(C <sub>18</sub> H <sub>35</sub> O <sub>2</sub> ) <sub>2</sub>	557-05-1	632.348	wh powder	130		1.095		i H <sub>2</sub> O, EtOH, eth; s bz
3180	Zinc sulfate	ZnSO <sub>4</sub>	7733-02-0	161.472	col orth cry	680 dec		3.8	57.7 <sup>25</sup>	
3181	Zinc sulfate monohydrate	ZnSO <sub>4</sub> · H <sub>2</sub> O	7446-19-7	179.487	wh monocl cry	238 dec		3.20	57.7 <sup>25</sup>	i EtOH
3182	Zinc sulfate heptahydrate	ZnSO <sub>4</sub> · 7H <sub>2</sub> O	7446-20-0	287.578	col orth cry	100 dec		1.97	57.7 <sup>25</sup>	i EtOH
3183	Zinc sulfide (sphalerite)	ZnS	1314-98-3	97.474	gray-wh cub cry	trans wurtzite 1020		4.04		i H <sub>2</sub> O, EtOH; s dil acid
3184	Zinc sulfide (wurtzite)	ZnS	1314-98-3	97.474	wh hex cry	1700	subl	4.09		i H <sub>2</sub> O; s dil acid
3185	Zinc sulfite dihydrate	ZnSO <sub>3</sub> · 2H <sub>2</sub> O	7488-52-0	181.503	wh powder	200 dec			0.224 <sup>25</sup>	i EtOH
3186	Zinc telluride	ZnTe	1315-11-3	193.01	red cub cry	1239		5.9		i H <sub>2</sub> O
3187	Zinc thiocyanate	Zn(SCN) <sub>2</sub>	557-42-6	181.573	wh hyg cry					sl H <sub>2</sub> O; s EtOH
3188	Zirconium	Zr	7440-67-7	91.224	gray-wh metal; hex	1854.7	4409	6.52		s hot conc acid
3189	Zirconocene dichloride	Zr(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> Cl <sub>2</sub>	1291-32-3	292.316	col cry	248	subl 150			
3190	Zirconium boride	ZrB <sub>2</sub>	12045-64-6	112.846	gray refrac solid; hex	3050		6.17		
3191	Zirconium carbide	ZrC	12020-14-3	103.235	gray refrac solid; cub	3532		6.73		s HF
3192	Zirconium nitride	ZrN	25658-42-8	105.231	yel cub cry	2952		7.09		s conc HF; sl dil acid
3193	Zirconium phosphide	ZrP <sub>2</sub>	12037-80-8	153.172	orth cry			≈5.1		
3194	Zirconium silicide	ZrSi <sub>2</sub>	12039-90-6	147.395	gray powder	1620		4.88		i H <sub>2</sub> O, aqua regia; s HF

No.	Name	Formula	CAS Reg No.	Mol. weight	Physical form	mp/°C	bp/°C	Density g cm <sup>-3</sup>	Solubility g/100 g H <sub>2</sub> O	Qualitative solubility
3195	Zirconium(II) bromide	ZrBr <sub>2</sub>	24621-17-8	251.032	blue-blk cry	dec 400				
3196	Zirconium(II) chloride	ZrCl <sub>2</sub>	13762-26-0	162.130	blk cry	772		3.16		react H <sub>2</sub> O
3197	Zirconium(II) fluoride	ZrF <sub>2</sub>	13842-94-9	129.221	blk cry	902				
3198	Zirconium(II) hydride	ZrH <sub>2</sub>	7704-99-6	93.240	gray tetr cry	800 dec		5.6		i H <sub>2</sub> O
3199	Zirconium(II) iodide	ZrI <sub>2</sub>	15513-85-6	345.033	blk cry	827				
3200	Zirconium(III) bromide	ZrBr <sub>3</sub>	24621-18-9	330.936	dark blue cry	dec 300				
3201	Zirconium(III) chloride	ZrCl <sub>3</sub>	10241-03-9	197.583	dark blue cry	627		3.05		react H <sub>2</sub> O
3202	Zirconium(III) fluoride	ZrF <sub>3</sub>	13814-22-7	148.219	blue-grn cry	927		4.26		i H <sub>2</sub> O; s acid
3203	Zirconium(III) iodide	ZrI <sub>3</sub>	13779-87-8	471.937	dark blue cry	727				
3204	Zirconium(IV) acetate hydroxide	Zr(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> (OH) <sub>2</sub>	14311-93-4	243.327	wh amorp solid					s H <sub>2</sub> O
3205	Zirconium(IV) ammonium carbonate dihydrate	Zr(NH <sub>4</sub> ) <sub>3</sub> OH(CO <sub>3</sub> ) <sub>3</sub> · 2H <sub>2</sub> O	12616-24-9*	362.404	prisms; unstab					s H <sub>2</sub> O
3206	Zirconium(IV) bromide	ZrBr <sub>4</sub>	13777-25-8	410.840	wh cub cry	450 tp	360 sp	3.98		react H <sub>2</sub> O
3207	Zirconium(IV) chloride	ZrCl <sub>4</sub>	10026-11-6	233.036	wh monocl cry; hyg	437 tp	331 sp	2.80		react H <sub>2</sub> O; s EtOH, eth
3208	Zirconium(IV) fluoride	ZrF <sub>4</sub>	7783-64-4	167.218	wh monocl cry	910	912 sp	4.43	1.5 <sup>25</sup>	
3209	Zirconium(IV) hydroxide	Zr(OH) <sub>4</sub>	14475-63-9	159.254	wh amorp powder	dec		3.25		i H <sub>2</sub> O; s acid
3210	Zirconium(IV) iodide	ZrI <sub>4</sub>	13986-26-0	598.842	yel-oran cub cry	500	431 sp	4.85		vs H <sub>2</sub> O
3211	Zirconium(IV) nitrate pentahydrate	Zr(NO <sub>3</sub> ) <sub>4</sub> · 5H <sub>2</sub> O	13746-89-9	429.320	wh hyg cry	100 dec				vs H <sub>2</sub> O; s EtOH
3212	Zirconium(IV) orthosilicate	ZrSiO <sub>4</sub>	10101-52-7	183.308	wh tetr cry	1540 dec		4.6		i H <sub>2</sub> O, acid
3213	Zirconium(IV) oxide	ZrO <sub>2</sub>	1314-23-4	123.223	wh amorp powder	2710	4300	5.68		i H <sub>2</sub> O; sl acid
3214	Zirconium(IV) pyrophosphate	ZrP <sub>2</sub> O <sub>7</sub>	13565-97-4	265.167	wh refrac solid	dec 1550				i H <sub>2</sub> O, dil acid; s HF
3215	Zirconium(IV) sulfate	Zr(SO <sub>4</sub> ) <sub>2</sub>	14644-61-2	283.349	wh hyg cry	410 dec		3.22		s H <sub>2</sub> O; sl EtOH
3216	Zirconium(IV) sulfate tetrahydrate	Zr(SO <sub>4</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	7446-31-3	355.411	wh tetr cry	100 dec		2.80		vs H <sub>2</sub> O
3217	Zirconium(IV) sulfide	ZrS <sub>2</sub>	12039-15-5	155.354	red-brn hex cry	1550		3.87		i H <sub>2</sub> O
3218	Zirconium(IV) tungstate	Zr(WO <sub>4</sub> ) <sub>2</sub>	16853-74-0	586.90	grn pow					
3219	Zirconyl chloride	ZrOCl <sub>2</sub>	7699-43-6	178.129	wh solid	250 dec				s H <sub>2</sub> O, EtOH
3220	Zirconyl chloride octahydrate	ZrOCl <sub>2</sub> · 8H <sub>2</sub> O	13520-92-8	322.252	tetr cry	400 dec		1.91		vs H <sub>2</sub> O, EtOH



# PHYSICAL PROPERTIES OF THE RARE EARTH METALS

K.A. Gschneidner, Jr.

**TABLE 1. Data for the Trivalent Ions of the Rare Earth Elements**

Rare earth	Symbol	Atomic no.	Atomic wt. <sup>a</sup>	Electronic configuration for R <sup>3+</sup>				Spectroscopic ground state symbol
				No. 4f electrons	S	L	J	
Scandium	Sc	21	44.955910	0	—	—	—	—
Yttrium	Y	39	88.90585	0	—	—	—	—
Lanthanum	La	57	138.9055	0	—	—	—	—
Cerium	Ce	58	140.115	1	1/2	3	5/2	<sup>2</sup> F <sub>5/2</sub>
Praseodymium	Pr	59	140.90765	2	1	5	4	<sup>3</sup> H <sub>4</sub>
Neodymium	Nd	60	144.24	3	3/2	6	9/2	<sup>4</sup> I <sub>9/2</sub>
Promethium	Pm	61	(145)	4	2	6	4	<sup>5</sup> I <sub>4</sub>
Samarium	Sm	62	150.36	5	5/2	5	5/2	<sup>6</sup> H <sub>5/2</sub>
Europium	Eu	63	151.965	6	3	3	0	<sup>7</sup> F <sub>0</sub>
Gadolinium	Gd	64	157.25	7	7/2	0	7/2	<sup>8</sup> S <sub>7/2</sub>
Terbium	Tb	65	158.92534	8	3	3	6	<sup>7</sup> F <sub>6</sub>
Dysprosium	Dy	66	162.50	9	5/2	5	15/2	<sup>6</sup> H <sub>15/2</sub>
Holmium	Ho	67	164.93032	10	2	6	8	<sup>5</sup> I <sub>8</sub>
Erbium	Er	68	167.26	11	3/2	6	15/2	<sup>4</sup> I <sub>15/2</sub>
Thulium	Tm	69	168.93421	12	1	5	6	<sup>3</sup> H <sub>6</sub>
Ytterbium	Yb	70	173.04	13	1/2	3	7/2	<sup>2</sup> F <sub>7/2</sub>
Lutetium	Lu	71	174.967	14	—	—	—	—

Note: For additional information, see Goldschmidt, Z.B., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978; DeLaeter, J.R., and Heumann, K.G., *J. Phys. Chem. Ref. Data*, 20, 1313, 1991; *Pure Appl. Chem.*, 66, 2423, 1994.

<sup>a</sup> 1993 standard atomic weights.

**TABLE 2. Crystallographic Data for the Rare Earth Metals at 24 °C (297 K) or Below**

Rare earth metal	Crystal structure <sup>a</sup>	Lattice constants (Å)			Metallic radius CN = 12 (Å)	Atomic volume (cm <sup>3</sup> /mol)	Density (g/cm <sup>3</sup> )
		a <sub>0</sub>	b <sub>0</sub>	c <sub>0</sub>			
αSc	hcp	3.3088	—	5.2680	1.6406	15.039	2.989
αY	hcp	3.6482	—	5.7318	1.8012	19.893	4.469
αLa	dhcp	3.7740	—	12.171	1.8791	22.602	6.146
αCe <sup>b</sup>	fcc	4.85 <sup>b</sup>	—	—	1.72 <sup>b</sup>	17.2 <sup>b</sup>	8.16 <sup>b</sup>
βCe	dhcp	3.6810	—	11.857	1.8321	20.947	6.689
γCe <sup>c</sup>	fcc	5.1610	—	—	1.8247	20.696	6.770
αPr	dhcp	3.6721	—	11.8326	1.8279	20.803	6.773
αNd	dhcp	3.6582	—	11.7966	1.8214	20.583	7.008
αPm	dhcp	3.65	—	11.65	1.811	20.24	7.264
αSm	rhomb <sup>d</sup>	3.6290 <sup>d</sup>	—	26.207	1.8041	20.000	7.520
Eu	bcc	4.5827	—	—	2.0418	28.979	5.244
αGd	hcp	3.6336	—	5.7810	1.8013	19.903	7.901
α'Tb <sup>e</sup>	ortho	3.605 <sup>e</sup>	6.244 <sup>e</sup>	5.706 <sup>e</sup>	1.784 <sup>e</sup>	19.34 <sup>e</sup>	8.219 <sup>e</sup>
αTb	hcp	3.6055	—	5.6966	1.7833	19.310	8.230
α'Dy <sup>f</sup>	ortho	3.595 <sup>f</sup>	6.184 <sup>f</sup>	5.678 <sup>f</sup>	1.774 <sup>f</sup>	19.00 <sup>f</sup>	8.551 <sup>f</sup>
αDy	hcp	3.5915	—	5.6501	1.7740	19.004	8.551
Ho	hcp	3.5778	—	5.6178	1.7661	18.752	8.795
Er	hcp	3.5592	—	5.5850	1.7566	18.449	9.066
Tm	hcp	3.5375	—	5.5540	1.7462	18.124	9.321
αYb <sup>g</sup>	hcp	3.8799 <sup>g</sup>	—	6.3859 <sup>g</sup>	1.9451 <sup>g</sup>	25.067 <sup>g</sup>	6.903 <sup>g</sup>
βYb	fcc	5.4848	—	—	1.9392	24.841	6.966
Lu	hcp	3.5052	—	5.5494	1.7349	17.779	9.841

Note: For additional information, see Gschneidner, K.A., Jr. and Calderwood, F.W., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 8, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1986; Gschneidner, K.A., Jr., Pecharsky, V.K., Cho, Jaephil and Martin, S.W., *Scripta Mater.*, 34, 1717, 1996.

<sup>a</sup> hcp = hexagonal close-packed; P6<sub>3</sub>/mmc, hP2, A3, Mg-type; dhcp = double-c hexagonal close-packed; P6<sub>3</sub>/mmc, hP4, A3', αLa-type; fcc = face-centered cubic; Fm $\bar{3}$ m, cF4, A1, Cu-type; rhomb = rhombohedral; R $\bar{3}$ m, hR3, αSm-type; bcc = body-centered cubic; Im $\bar{3}$ m, cI2, A2, W-type; ortho = orthorhombic; Cmc, oC4, α' Dy-type.

<sup>b</sup> At 77 K (−196 °C).

<sup>c</sup> Equilibrium room temperature (standard state) phase.

<sup>d</sup> Rhombohedral is the primitive cell. Lattice parameters given are for the nonprimitive hexagonal cell.

<sup>e</sup> At 220 K (−53 °C).

<sup>f</sup> At 86 K (−187 °C).

<sup>g</sup> At 23 °C.



TABLE 3. Crystallographic Data for Rare Earth Metals at High Temperature

Rare earth metal	Structure	Lattice parameter (Å)	Temp. (°C)	Metallic radius		Atomic volume (cm <sup>3</sup> /mol)	Density (g/cm <sup>3</sup> )
				CN = 8 (Å)	CN = 12 (Å)		
βSc	bcc	3.73 (est.)	1337	1.62	1.66	15.6	2.88
βY	bcc	4.10 <sup>a</sup>	1478	1.78	1.83	20.8	4.28
βLa	fcc	5.303	325	—	1.875	22.45	6.187
γLa	bcc	4.26	887	1.84	1.90	23.3	5.97
δCe	bcc	4.12	757	1.78	1.84	21.1	6.65
βPr	bcc	4.13	821	1.79	1.84	21.2	6.64
βNd	bcc	4.13	883	1.79	1.84	21.2	6.80
βPm	bcc	4.10 (est.)	890	1.78	1.83	20.8	6.99
βSm	hcp	$a = 3.6630$ $c = 5.8448$	450 <sup>b</sup>	—	1.8176	20.450	7.353
γSm	bcc	4.10 (est.)	922	1.77	1.82	20.8	7.25
βGd	bcc	4.06	1265	1.76	1.81	20.2	7.80
βTb	bcc	4.07 <sup>a</sup>	1289	1.76	1.81	20.3	7.82
βDy	bcc	4.03 <sup>a</sup>	1381	1.75	1.80	19.7	8.23
γYb	bcc	4.44	763 <sup>c</sup>	1.92	1.98	26.4	6.57

Note: The rare earths Eu, Ho, Er, Tm, and Lu are monomorphic. For additional information, see Gschneidner, K.A., Jr. and Calderwood, F.W., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 8, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1986, 1.

<sup>a</sup> Determined by extrapolation to 0% solute of a vs. composition data for R-Mg alloys at 24 °C and corrected for thermal expansion to temperature given.

<sup>b</sup> The hcp phase was stabilized by impurities and the temperature of measurement was below the equilibrium transition temperature (see Table 4).

<sup>c</sup> The bcc phase was stabilized by impurities and the temperature of measurement was below the equilibrium transition temperature (see Table 4).

TABLE 4. High Temperature Transition Temperatures and Melting Point of Rare Earth Metals

Rare earth metal	Transition I ( $\alpha - \beta$ ) <sup>a</sup>		Transition II ( $\beta - \gamma$ ) <sup>a</sup>		Melting point (°C)
	Temp. (°C)	Phases	Temp. (°C)	Phases	
Sc	1337	hcp $\rightleftharpoons$ bcc	—	—	1541
Y	1478	hcp $\rightleftharpoons$ bcc	—	—	1522
La <sup>b</sup>	310	dhcp $\rightleftharpoons$ fcc	865	fcc $\rightleftharpoons$ bcc	918
Ce <sup>c,d</sup>	139	dhcp $\rightleftharpoons$ fcc ( $\beta - \gamma$ )	726	fcc $\rightleftharpoons$ bcc ( $\gamma - \delta$ )	798
Pr	795	dhcp $\rightleftharpoons$ bcc	—	—	931
Nd	863	dhcp $\rightleftharpoons$ bcc	—	—	1021
Pm	890	dhcp $\rightleftharpoons$ bcc	—	—	1042
Sm <sup>e</sup>	734	rhomb $\rightleftharpoons$ hcp	922	hcp $\rightleftharpoons$ bcc	1074
Eu	—	—	—	—	822
Gd	1235	hcp $\rightleftharpoons$ bcc	—	—	1313
Tb	1289	hcp $\rightleftharpoons$ bcc	—	—	1356
Dy	1381	hcp $\rightleftharpoons$ bcc	—	—	1412
Ho	—	—	—	—	1474
Er	—	—	—	—	1529
Tm	—	—	—	—	1545
Yb	795	fcc $\rightleftharpoons$ bcc ( $\beta - \gamma$ )	—	—	819
Lu	—	—	—	—	1663

Note: For additional information, see Gschneidner, K.A., Jr. and Calderwood, F.W., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 8, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1986; Gschneidner, K.A., Jr., Pecharsky, V.K., Cho, Jaephil and Martin, S.W., *Scripta Mater.*, 34, 1717, 1996.

<sup>a</sup> For all the transformations listed, unless otherwise noted.

<sup>b</sup> On cooling, fcc  $\rightarrow$  dhcp ( $\beta \rightarrow \alpha$ ), 260 °C.

<sup>c</sup> The  $\beta \rightleftharpoons \gamma$  equilibrium transition temperature is  $10 \pm 5$  °C.

<sup>d</sup> On cooling, fcc  $\rightarrow$  dhcp ( $\gamma \rightarrow \beta$ ), -16 °C.

<sup>e</sup> On cooling, hcp  $\rightarrow$  rhomb ( $\beta \rightarrow \alpha$ ), 727 °C.

TABLE 5. Low Temperature Transition Temperatures of the Rare Earth Metals

Rare earth metal	Cooling			Rare earth metal	Heating		
	Transformation	°C	K		Transformation	°C	K
Ce	$\gamma \rightarrow \beta$ <sup>a</sup>	-16	257	Ce	$\alpha \rightarrow \beta$	-148	125
	$\gamma \rightarrow \alpha$	-172	101		$\alpha \rightarrow \beta + \gamma$	-104	169
	$\beta \rightarrow \alpha$	-228	45		$\beta \rightarrow \gamma$ <sup>a</sup>	139	412
Tb	$\alpha \rightarrow \alpha'$	-53	220	Yb	$\alpha \rightarrow \beta$	7	280
Dy	$\alpha \rightarrow \alpha'$	-187	86				
Yb	$\beta \rightarrow \alpha$	-13	260				

Note: For additional information, see Beaudry, B.J. and Gschneidner, K.A., Jr., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 173; Koskenmaki, D.C. and Gschneidner, K.A., Jr., 1978, in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 337; Gschneidner, K.A., Jr., Pecharsky, V.K., Cho, Jaephil and Martin, S.W., *Scripta Mater.*, 34, 1717, 1996.

<sup>a</sup> The  $\beta \rightleftharpoons \gamma$  equilibrium transition temperature is  $10 \pm 5$  °C ( $283 \pm 5$  K).

TABLE 6. Heat Capacity, Standard Entropy, Heats of Transformation, and Fusion of the Rare Earth Metals

Rare earth metal	Heat capacity at 298 K (J/mol K)	Standard entropy $S_{298}^{\circ}$ (J/mol K)	Heat of transformation (kJ/mol)				Heat of fusion (kJ/mol)
			trans. 1	$\Delta H_{tr}^1$	trans. 2	$\Delta H_{tr}^2$	
Sc	25.5	34.6	$\alpha \rightleftharpoons \beta$	4.00	—	—	14.1
Y	26.5	44.4	$\alpha \rightleftharpoons \beta$	4.99	—	—	11.4
La	27.1	56.9	$\alpha \rightleftharpoons \beta$	0.36	$\beta \rightleftharpoons \gamma$	3.12	6.20
Ce	26.9	72.0	$\beta \rightleftharpoons \gamma$	0.05	$\gamma \rightleftharpoons \delta$	2.99	5.46
Pr	27.2	73.2	$\alpha \rightleftharpoons \beta$	3.17	—	—	6.89
Nd	27.5	71.5	$\alpha \rightleftharpoons \beta$	3.03	—	—	7.14
Pm	27.3 <sup>a</sup>	71.6 <sup>a</sup>	$\alpha \rightleftharpoons \beta$	3.0 <sup>a</sup>	—	—	7.7 <sup>a</sup>
Sm	29.5	69.6	$\alpha \rightleftharpoons \beta$	0.2 <sup>a</sup>	$\beta \rightleftharpoons \gamma$	3.11	8.62
Eu	27.7	77.8	—	—	—	—	9.21
Gd	37.0	68.1	$\alpha \rightleftharpoons \beta$	3.91	—	—	10.0
Tb	28.9	73.2	$\alpha \rightleftharpoons \beta$	5.02	—	—	10.79
Dy	27.7	75.6	$\alpha \rightleftharpoons \beta$	4.16	—	—	11.06
Ho	27.2	75.3	—	—	—	—	17.0 <sup>a</sup>
Er	28.1	73.2	—	—	—	—	19.9
Tm	27.0	74.0	—	—	—	—	16.8
Yb	26.7	59.9	$\beta \rightleftharpoons \gamma$	1.75	—	—	7.66
Lu	26.9	51.0	—	—	—	—	22 <sup>a</sup>

Note: For additional information, see Hultgren, R., Desai, P.D., Hawkins, D.T., Gleiser, M., Kelley, K.K., and Wagman, D.D., *Selected Values of the Thermodynamic Properties of the Elements*, ASM International, Metals Park, Ohio, 1973; Wagman, D.D., Evans, W.H., Parker, V.B., Schumm, R.H., Halow, L., Bailey, S.M., Churney, K.L., and Nuttall, R.L., *The NBS Tables of Chemical Thermodynamic Properties*, *J. Phys. Chem. Ref. Data*, Vol. 11, Suppl. 2, 1982; Amitin, E.B., Bessergenev, W.G., Kovalevskaya, Yu. A., and Paukov, I.E., *J. Chem. Thermodyn.*, 15, 181, 1983; Amitin, E.B., Bessergenev, W.G., Kovalevskaya, Yu. A., and Paukov, I.E., *J. Chem. Thermodyn.*, 15, 181, 1983.

<sup>a</sup> Estimated.

TABLE 7. Vapor Pressures, Boiling Points, and Heats of Sublimation of Rare Earth Metals

Rare earth metal	Temperature in °C <sup>a</sup> for a vapor pressure of				Boiling point <sup>a</sup> (°C)	Heat of sublimation at 25 °C (kJ/mol)
	10 <sup>-8</sup> atm (0.001 Pa)	10 <sup>-6</sup> atm (0.101 Pa)	10 <sup>-4</sup> atm (10.1 Pa)	10 <sup>-2</sup> atm (1013 Pa)		
Sc	1036	1243	1533	1999	2836	377.8
Y	1222	1460	1812	2360	3345	424.7
La	1301	1566	1938	2506	3464	431.0
Ce	1290	1554	1926	2487	3443	422.6
Pr	1083	1333	1701	2305	3520	355.6
Nd	955	1175	1500	2029	3074	327.6
Pm	—	—	—	—	3000 <sup>b</sup>	348 <sup>b</sup>
Sm	508	642	835	1150	1794	206.7
Eu	399	515	685	964	1529	175.3
Gd	1167	1408	1760	2306	3273	397.5
Tb	1124	1354	1698	2237	3230	388.7
Dy	804	988	1252	1685	2567	290.4
Ho	845	1036	1313	1771	2700	300.8
Er	908	1113	1405	1896	2868	317.1
Tm	599	748	964	1300	1950	232.2
Yb	301	400	541	776	1196	152.1
Lu	1241	1483	1832	2387	3402	427.6

Note: For additional information, see Hultgren, R., Desai, P.D., Hawkins, D.T., Gleiser, M., Kelley, K.K., and Wagman, D.D., *Selected Values of the Thermodynamic Properties of the Elements*, ASM International, Metals Park, Ohio, 1973; Beaudry, B.J. and Gschneidner, K.A., Jr., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 173.

<sup>a</sup> International Temperature Scale of 1990 (ITS-90) values.

<sup>b</sup> Estimated.

TABLE 8. Magnetic Properties of the Rare Earth Metals

Rare earth metal	$\chi_A \times 10^6$ at 298 K (emu/mol)	Effective magnetic moment				Easy axis	Néel temp. $T_N$ (K)		Curie temp. $T_C$ (K)	$\theta_p$ (K)		
		Paramagnetic at $\sim 298$ K		Ferromagnetic at $\sim 0$ K			Hex sites	Cubic sites		$\parallel c$	$\perp c$	Polycryst. or avg.
		Theory <sup>a</sup>	Obs.	Theory <sup>b</sup>	Obs.							
$\alpha$ Sc	295.2	—	—	—	—	—	—	—	—	—	—	—
$\alpha$ Y	187.7	—	—	—	—	—	—	—	—	—	—	—
$\alpha$ La	95.9	—	—	—	—	—	—	—	—	—	—	—
$\beta$ La	105	—	—	—	—	—	—	—	—	—	—	—
$\gamma$ Ce	2,270	2.54	2.52	2.14	—	—	—	14.4	—	—	—	-50
$\beta$ Ce	2,500	2.54	2.61	2.14	—	13.7	—	12.5	—	—	—	-41
$\alpha$ Pr	5,530	3.58	3.56	3.20	2.7 <sup>c</sup>	<b>a</b>	0.03	—	—	—	—	0
$\alpha$ Nd	5,930	3.62	3.45	3.27	2.2 <sup>c</sup>	<b>b</b>	19.9	7.5	—	0	5	3.3
$\alpha$ Pm	—	2.68	—	2.40	—	—	—	—	—	—	—	—
$\alpha$ Sm	1,278 <sup>d</sup>	0.85	1.74	0.71	0.5 <sup>c</sup>	<b>a</b>	109	14.0	—	—	—	—
Eu	30,900	7.94	8.48	7.0	5.9	$\langle 110 \rangle$	—	90.4	—	—	—	100
$\alpha$ Gd	185,000 <sup>e</sup>	7.94	7.98	7.0	7.63	$30^\circ$ to <b>c</b>	—	—	293.4	317	317	317
$\alpha$ Tb	170,000	9.72	9.77	—	—	—	230.0	—	—	195	239	224
$\alpha'$ Tb	—	—	—	9.0	9.34	<b>b</b>	—	—	219.5	—	—	—
$\alpha$ Dy	98,000	10.64	10.83	—	—	—	180.2	—	—	121	169	153
$\alpha'$ Dy	—	—	—	10.0	10.33	<b>a</b>	—	—	90.5 <sup>e</sup>	—	—	—
Ho	72,900	10.60	11.2	10.0	10.34	<b>b</b>	132	—	19.5	73.0	88.0	83.0
Er	48,000	9.58	9.9	9.0	9.1	$30^\circ$ to <b>c</b>	85	—	18.7	61.7	32.5	42.2
Tm	24,700	7.56	7.61	7.0	7.14	<b>c</b>	58	—	32.0	41.0	-17.0	2.3
$\beta$ Yb	67 <sup>d</sup>	—	—	—	—	—	—	—	—	—	—	—
Lu	182.9	—	—	—	—	—	—	—	—	—	—	—

Note: For additional information, see McEwen, K.A., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 411; Legvold, S., in *Ferromagnetic Materials*, Vol. 1, Wohlfarth, E.P., Ed., North-Holland Physics, Amsterdam, 1980, 183; Pecharsky, V.K., Gschneidner, K.A., Jr. and Fort, D., *Phys. Rev. B*, 47, 5063, 1993; Pecharsky, V.K., Gschneidner, K.A., Jr. and Fort, D., 1996, to be published; Steward, A.M. and Collocott, S.J., *J. Phys.: Condens. Matter*, 1, 677, 1988.

<sup>a</sup>  $g[J(J+1)]^{1/2}$ .

<sup>b</sup>  $gJ$ .

<sup>c</sup> At 38 T and 4.2 K.

<sup>d</sup> At 290 K.

<sup>e</sup> At 350 K.

<sup>f</sup> On cooling  $T_C = 89.6$  K and on warming  $T_C = 91.5$  K.

TABLE 9. Room Temperature Coefficient of Thermal Expansion, Thermal Conductivity, Electrical Resistance, and Hall Coefficient

Rare earth metal	Expansion ( $\alpha_i \times 10^6$ ) ( $^\circ\text{C}^{-1}$ )			Thermal conductivity (W/cm K)	Electrical resistance ( $\mu\Omega\cdot\text{cm}$ )			Hall coefficient ( $R_i \times 10^{12}$ ) (V·cm/A·Oe)		
	$\alpha_a$	$\alpha_c$	$\alpha_{\text{poly}}$		$\rho_a$	$\rho_c$	$\rho_{\text{poly}}$	$R_a$	$R_c$	$R_{\text{poly}}$
$\alpha$ Sc	7.6	15.3	10.2	0.158	70.9	26.9	56.2 <sup>a</sup>	—	—	-0.13
$\alpha$ Y	6.0	19.7	10.6	0.172	72.5	35.5	59.6	-0.27	-1.6	—
$\alpha$ La	4.5	27.2	12.1	0.134	—	—	61.5	—	—	-0.35
$\beta$ Ce	—	—	—	—	—	—	82.8	—	—	—
$\gamma$ Ce	6.3	—	6.3	0.113	—	—	74.4	—	—	+1.81
$\alpha$ Pr	4.5	11.2	6.7	0.125	—	—	70.0	—	—	+0.709
$\alpha$ Nd	7.6	13.5	9.6	0.165	—	—	64.3	—	—	+0.971
$\alpha$ Pm	9 <sup>b</sup>	16 <sup>b</sup>	11 <sup>b</sup>	0.15 <sup>b</sup>	—	—	75 <sup>b</sup>	—	—	—
$\alpha$ Sm	9.6	19.0	12.7	0.133	—	—	94.0	—	—	-0.21
Eu	35.0	—	35.0	0.139 <sup>b</sup>	—	—	90.0	—	—	+24.4
$\alpha$ Gd	9.1 <sup>c</sup>	10.0 <sup>c</sup>	9.4 <sup>c</sup>	0.105	135.1	121.7	131.0	-10	-54	-4.48 <sup>d</sup>
$\alpha$ Tb	9.3	12.4	10.3	0.111	123.5	101.5	115.0	-1.0	-3.7	—
$\alpha$ Dy	7.1	15.6	9.9	0.107	111.0	76.6	92.6	-0.3	-3.7	—
Ho	7.0	19.5	11.2	0.162	101.5	60.5	81.4	+0.2	-3.2	—
Er	7.9	20.9	12.2	0.145	94.5	60.3	86.0	+0.3	-3.6	—
Tm	8.8	22.2	13.3	0.169	88.0	47.2	67.6	—	—	-1.8
$\beta$ Yb	26.3	—	26.3	0.385	—	—	25.0	—	—	+3.77
Lu	4.8	20.0	9.9	0.164	76.6	34.7	58.2	+0.45	-2.6	-0.535

Note: For additional information, see Beaudry, B. J. and Gschneidner, K.A., Jr., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 173; McEwen, K.A., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 411.

<sup>a</sup> Calculated from single crystal values.

<sup>b</sup> Estimated.

<sup>c</sup> At 100  $^\circ\text{C}$ .

<sup>d</sup> At 77  $^\circ\text{C}$ .

TABLE 10. Electronic Specific Heat Constant ( $\gamma$ ), Electron–Electron (Coulomb) Coupling Constant ( $\mu^*$ ), Electron–Phonon Coupling Constant ( $\lambda$ ), Debye Temperature at 0 K ( $\theta_D$ ), and Superconducting Transition Temperature

Rare earth metal	$\gamma$ (mJ/mol·K <sup>2</sup> )	$\mu^*$	$\lambda$	$\theta_D$ (K) from		Superconducting temperature (K)
				Heat capacity	Elastic constants	
$\alpha$ Sc	10.334	0.16	0.30	345.3	—	0.050 <sup>a</sup>
$\alpha$ Y	7.878	0.15	0.30	244.4	258	1.3 <sup>b</sup>
$\alpha$ La	9.45	0.08	0.76	150	154	5.10
$\beta$ La	11.5	—	—	140	—	6.00
$\alpha$ Ce	12.8	—	—	179	—	0.022 <sup>c</sup>
$\alpha$ Pr	20	—	1.07 <sup>d</sup>	155 <sup>e</sup>	153	—
$\alpha$ Nd	f	—	0.86 <sup>d</sup>	157 <sup>e</sup>	163	—
$\alpha$ Pm	—	—	—	159 <sup>e</sup>	—	—
$\alpha$ Sm	8.1 $\pm$ 1.5 <sup>g</sup>	—	0.81 <sup>d</sup>	162 <sup>e,f</sup>	169	—
Eu	f	—	—	f	118	—
$\alpha$ Gd	4.48	—	0.30	169	182	—
$\alpha'$ Tb	3.71	—	0.34 <sup>d</sup>	169.6	177	—
$\alpha'$ Dy	4.9	—	0.32 <sup>d</sup>	192	183	—
Ho	2.1	—	0.30 <sup>d</sup>	175 <sup>e</sup>	190	—
Er	8.7	—	0.33 <sup>d</sup>	176.9	188	—
Tm	f	—	0.36 <sup>d</sup>	179 <sup>e</sup>	200	—
$\alpha$ Yb	3.30	—	—	117.6	118	—
$\beta$ Yb	8.36	—	—	109	—	—
Lu	8.194	0.14	0.31	183.2	185	0.022 <sup>h</sup>

Note: For additional information, see Sundström, L.J., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr., and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 379; Scott, T., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 591; Probst, C. and Wittig, J., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 749; Tsang, T.-W.E., Gschneidner, K.A., Jr., Schmidt, F.A., and Thome, D.K., *Phys. Rev.*, B, 31, 235, 1985; Collocott, S.J., Hill, R.W. and Stewart, A.M., *J. Phys. F* 18, L223, 1988; Hill, R.W. and Gschneidner, K.A., Jr., *J. Phys. F*, 18, 2545, 1988; Skriver, H.L. and Mertig, I., *Phys. Rev. B*, 41, 6553, 1990; Collocott, S.J. and Stewart, A.M., *J. Phys.: Condens. Matter*, 4, 6743, 1992; Pecharsky, V.K., Gschneidner, K.A., Jr. and Fort, D., *Phys. Rev. B*, 47, 5063, 1993.

<sup>a</sup> At 18.6 GPa.

<sup>b</sup> At 11 GPa.

<sup>c</sup> At 2.2 GPa.

<sup>d</sup> Calculated value.

<sup>e</sup> Estimated.

<sup>f</sup> Heat capacity results have been reported, but the resultant  $\gamma$  and  $\theta_D$  values are unreliable because of the presence of impurities and/or there was no reliable procedure or model to correct for the magnetic contribution to the heat capacity.

<sup>g</sup> Based on the values reported for the purer Sm sample (IV).

<sup>h</sup> At 4.5 GPa.

TABLE 11. Room Temperature Elastic Moduli and Mechanical Properties

Rare earth metal	Elastic moduli (GPa)				Mechanical properties (MPa)				Recryst. temp. (°C)
	Young's (elastic) modulus	Shear modulus	Bulk modulus	Poisson's ratio	Yield strength 0.2% offset	Ultimate tensile strength	Uniform elongation (%)	Reduction in area (%)	
Sc	74.4	29.1	56.6	0.279	173 <sup>a</sup>	255 <sup>a</sup>	5.0 <sup>a</sup>	8.0 <sup>a</sup>	550
Y	63.5	25.6	41.2	0.243	42	129	34.0	—	550
$\alpha$ La	36.6	14.3	27.9	0.280	126 <sup>a</sup>	130	7.9 <sup>a</sup>	—	300
$\beta$ Ce	—	—	—	—	86	138	—	24.0	—
$\gamma$ Ce	33.6	13.5	21.5	0.24	28	117	22.0	30.0	325
$\alpha$ Pr	37.3	14.8	28.8	0.281	73	147	15.4	67.0	400
$\alpha$ Nd	41.4	16.3	31.8	0.281	71	164	25.0	72.0	400
$\alpha$ Pm	46 <sup>b</sup>	18 <sup>b</sup>	33 <sup>b</sup>	0.28 <sup>b</sup>	—	—	—	—	400 <sup>b</sup>
$\alpha$ Sm	49.7	19.5	37.8	0.274	68	156	17.0	29.5	440
Eu	18.2	7.9	8.3	0.152	—	—	—	—	300
$\alpha$ Gd	54.8	21.8	37.9	0.259	15	118	37.0	56.0	500
$\alpha$ Tb	55.7	22.1	38.7	0.261	—	—	—	—	500
$\alpha$ Dy	61.4	24.7	40.5	0.247	43	139	30.0	30.0	550
Ho	64.8	26.3	40.2	0.231	—	—	—	—	520
Er	69.9	28.3	44.4	0.237	60	136	11.5	11.9	520
Tm	74.0	30.5	44.5	0.213	—	—	—	—	600
$\beta$ Yb	23.9	9.9	30.5	0.207	7	58	43.0	92.0	300
Lu	68.6	27.2	47.6	0.261	—	—	—	—	600

Note: For additional information, see Scott, T., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 1, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1978, 591.

<sup>a</sup> Value is questionable.

<sup>b</sup> Estimated.

TABLE 12. Liquid Metal Properties near the Melting Point

Rare earth metal	Density (g/cm <sup>3</sup> )	Surface tension (N/m)	Viscosity (centipoise)	Heat capacity (J/mol K)	Thermal conductivity (W/cm K)	Magnetic susceptibility $\chi \times 10^4$ (emu/mol)	Electrical resistivity ( $\mu\Omega\cdot\text{cm}$ )	$\Delta V$ (I→s) <sup>a</sup> (%)	Spectral emittance at $\lambda = 645 \text{ nm}$	
									$\epsilon$ (%)	Temp. range (°C)
Sc	2.80	0.954	—	44.2 <sup>b</sup>	—	—	—	—	—	—
Y	4.24	0.871	—	43.1	—	—	—	—	36.8	1522–1647
La	5.96	0.718	2.65	34.3	0.238	1.20	133	-0.6	25.4	920–1287
Ce	6.68	0.706	3.20	37.7	0.210	9.37	130	+1.1	32.2	877–1547
Pr	6.59	0.707	2.85	43.0	0.251	17.3	139	-0.02	28.4	931–1537
Nd	6.72	0.687	—	48.8	0.195	18.7	151	-0.9	39.4	1021–1567
Pm	6.9 <sup>b</sup>	0.680 <sup>b</sup>	—	50 <sup>b</sup>	—	—	160 <sup>b</sup>	—	—	—
Sm	7.16	0.431	—	50.2 <sup>b</sup>	—	18.3	182	-3.6	43.7	1075
Eu	4.87	0.264	—	38.1	—	97	242	-4.8	—	—
Gd	7.4	0.664	—	37.2	0.149	67	195	-2.0	34.2	1313–1600
Tb	7.65	0.669	—	46.5	—	82	193	-3.1	—	—
Dy	8.2	0.648	—	49.9	0.187	95	210	-4.5	29.7	1412–1437
Ho	8.34	0.650	—	43.9	—	88	221	-7.4	—	—
Er	8.6	0.637	—	38.7	—	69	226	-9.0	37.2	1529–1587
Tm	9.0 <sup>b</sup>	—	—	41.4	—	41	235 <sup>b</sup>	-6.9	—	—
Yb	6.21	0.320	2.67	36.8	—	—	113	-5.1	—	—
Lu	9.3	0.940	—	47.9 <sup>b</sup>	—	—	224	-3.6	—	—

Note: For additional information, see Van Zytveld, J., in *Handbook on the Physics and Chemistry of Rare Earths*, Vol. 12, Gschneidner, K.A., Jr. and Eyring, L., Eds., North-Holland Physics, Amsterdam, 1989, 357; Stretz, L.A. and Bautista, R.G., in *Temperature, Its Measurement and Control in Science and Industry*, Vol. 4, part I, H.H. Plumb, Ed., Instrument Society of America, Pittsburgh, 1972, 489; King, T.S., Baria, D.N., and Bautista, R.G., *Met. Trans. B*, 7, 411, 1976; Baria, D.N., King, T.S., and Bautista, R.G., *Met. Trans. B*, 7, 577, 1976.

<sup>a</sup> Volume change on freezing.

<sup>b</sup> Estimated.

TABLE 13. Ionization Potentials (Electronvolts)

Rare earth	I Neutral atom	II Singly ionized	III Doubly ionized	IV Triply ionized	V Quadruply ionized
Sc	6.56144	12.79967	24.75666	73.4894	91.65
Y	6.217	12.24	20.52	60.597	77.0
La	5.5770	11.060	19.1773	49.95	61.6
Ce	5.5387	10.85	20.198	36.758	65.55
Pr	5.464	10.55	21.624	38.98	57.53
Nd	5.5250	10.73	22.1	40.41	—
Pm	5.554	10.90	22.3	41.1	—
Sm	5.6437	11.07	23.4	41.4	—
Eu	5.6704	11.241	24.92	42.7	—
Gd	6.1500	12.09	20.63	44.0	—
Tb	5.8639	11.52	21.91	39.79	—
Dy	5.9389	11.67	22.8	41.47	—
Ho	6.0216	11.80	22.84	42.5	—
Er	6.1078	11.93	22.74	42.7	—
Tm	6.18431	12.05	23.68	42.7	—
Yb	6.25416	12.1761	25.05	43.56	—
Lu	5.42585	13.9	20.9594	45.25	66.8

Note: For references, see the table "Ionization Potentials of Atoms and Atomic Ions" in Section 10.

TABLE 14. Effective Ionic Radii (Å)<sup>a</sup>

Rare earth ion	$R^{2+}$		$R^{3+}$			$R^{4+}$	
	CN = 6	CN = 8	CN = 6	CN = 8	CN = 12	CN = 6	CN = 8
Sc	—	—	0.745	0.87	1.116	—	—
Y	—	—	0.900	1.015	1.220	—	—
La	—	—	1.045	1.18	1.320	—	—
Ce	—	—	1.010	1.14	1.290	0.80	0.97
Pr	—	—	0.997	1.14	1.286	0.78	0.96
Nd	—	—	0.983	1.12	1.276	—	—
Pm	—	—	0.97	1.10	1.267	—	—
Sm	1.19	1.27	0.958	1.09	1.260	—	—
Eu	1.17	1.25	0.947	1.07	1.252	—	—
Gd	—	—	0.938	1.06	1.246	—	—
Tb	—	—	0.923	1.04	1.236	0.76	0.88
Dy	—	—	0.912	1.03	1.228	—	—
Ho	—	—	0.901	1.02	1.221	—	—
Er	—	—	0.890	1.00	1.214	—	—
Tm	—	—	0.880	0.99	1.207	—	—
Yb	1.00	1.07	0.868	0.98	1.199	—	—
Lu	—	—	0.861	0.97	1.194	—	—

Note: For additional information, see Shannon, R.D. and Prewitt, C.T., *Acta Cryst.*, 25, 925, 1969 and Shannon, R.D. and Prewitt, C.T., *Acta Cryst.*, 26, 1046, 1970.

<sup>a</sup> Radius of O<sup>2-</sup> is 1.40 Å for a coordination number (CN) of 6.

# MELTING, BOILING, TRIPLE, AND CRITICAL POINT TEMPERATURES OF THE ELEMENTS

This table summarizes the significant points on the phase diagrams for the elements for which data are available. Values are given for the solid–liquid–gas triple point  $t_{tp}$ , normal melting point  $t_m$ , normal boiling point  $t_b$ , and critical temperature  $t_c$ ; all are on the ITS-90 scale. An “sp” notation indicates a sublimation point, where the vapor pressure of the solid phase reaches 101.325 kPa (1 atm). Transition temperatures between allotropic forms are included for several elements. The major data sources are listed below; values from Reference 1, which deals with reference points on the ITS-90 scale, were adopted when applicable.

## References

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Element	$t_{tp}/^{\circ}\text{C}$	$t_m/^{\circ}\text{C}$	$t_b/^{\circ}\text{C}$	$t_c/^{\circ}\text{C}$
Actinium		1050	3198	
Aluminum		660.32	2519	
Americium		1176	2011	
Antimony		630.628	1587	
Argon	-189.36 (69 kPa)		-185.847	-122.28
Arsenic (gray)	817 (3.70 MPa)		616 sp	1400
Astatine		302		
Barium		727	1897	
Berkelium ( $\beta$ form)		986		
Beryllium		1287	2471	
Bismuth		271.406	1564	
Boron		2075	4000	
Bromine		-7.2	58.8	315
Cadmium		321.069	767	
Calcium		842	1484	
Californium		900		
Carbon (graphite)	4489 (10.3 MPa)		3825 sp	
Carbon (diamond)		4440 (12.4 GPa)		
Cerium		799	3443	
Cesium		28.5	671	1665
Chlorine		-101.5	-34.04	143.8
Chromium		1907	2671	
Cobalt		1495	2927	
Copper		1084.62	2562	
Curium		1345	~3100	
Dysprosium		1412	2567	
Einsteinium		860		
Erbium		1529	2868	
Europium		822	1529	
Fermium		1527		
Fluorine	-219.67		-188.12	-129.02
Francium		27		
Gadolinium		1313	3273	
Gallium	29.7666		2204	
Germanium		938.25	2833	
Gold		1064.18	2856	
Hafnium		2233	4603	
Helium			-268.93	-267.96
Holmium		1472	2700	
Hydrogen	-259.198 (7.2 kPa)	-259.1	-252.762	-240.18
Indium	156.5936	156.60	2072	
Iodine		113.7	184.4	546
Iridium		2446	4428	
Iron		1538	2861	
Krypton	-157.38 (73.2 kPa)		-153.34	-63.67
Lanthanum		920	3464	
Lawrencium		1627		
Lead		327.462	1749	

## Melting, Boiling, Triple, and Critical Point Temperatures of the Elements

Element	$t_{tp}/^{\circ}\text{C}$	$t_m/^{\circ}\text{C}$	$t_b/^{\circ}\text{C}$	$t_c/^{\circ}\text{C}$
Lithium		180.50	1342	2950
Lutetium		1663	3402	
Magnesium		650	1090	
Manganese		1246	2061	
Mendelevium		827		
Mercury	-38.837	-38.8290	356.62	1491
Molybdenum		2623	4639	
Neodymium		1016	3074	
Neon	-248.609 (43 kPa)		-246.053	-228.7
Neptunium		644		
Nickel		1455	2913	
Niobium		2477	4744	
Nitrogen	-209.999	-210.0	-195.798	-146.94
Nobelium		827		
Osmium		3033	5012	
Oxygen		-218.79	-182.953	-118.56
Palladium		1554.8	2963	
Phosphorus (white)		44.15	280.5	721
Phosphorus (red)	590		431 sp	721
Phosphorus (black)		610		
Platinum		1768.2	3825	
Plutonium		640	3228	
Polonium		254	962	
Potassium		63.5	759	1950
Praseodymium		931	3520	
Promethium		1042	3000	
Protactinium		1572		
Radium		696		
Radon		-71	-61.7	104
Rhenium		3185	5596	
Rhodium		1964	3695	
Rubidium	39.26	39.30	688	1820
Ruthenium		2333	4150	
Samarium		1072	1794	
Scandium		1541	2836	
Selenium (vitreous)		180 (trans to gray)	685	1493
Selenium (gray)		220.8	685	1493
Silicon		1414	3265	
Silver		961.78	2162	
Sodium		97.794	882.940	2300
Strontium		777	1382	
Sulfur (rhombic)		95.3 (trans to monocl)	444.61	1041
Sulfur (monoclinic)		115.21	444.61	1041
Tantalum		3017	5458	
Technetium		2157	4265	
Tellurium		449.51	988	
Terbium		1359	3230	
Thallium		304	1473	
Thorium		1750	4788	
Thulium		1545	1950	
Tin (gray)		13.2 (trans to white)	2602	
Tin (white)		231.93	2602	
Titanium		1668	3287	
Tungsten		3422	5555	
Uranium		1135	4131	
Vanadium		1910	3407	
Xenon	-111.745 (81.6 kPa)		-108.09	16.58
Ytterbium		824	1196	
Yttrium		1522	3345	
Zinc		419.53	907	
Zirconium		1854.7	4409	

## HEAT CAPACITY OF THE ELEMENTS AT 25 °C

This table gives the specific heat capacity ( $c_p$ ) in J/g K and the molar heat capacity ( $C_p$ ) in J/mol K at a temperature of 25 °C and a pressure of 100 kPa (1 bar or 0.987 standard atmospheres) for all the elements for which reliable data are available.

Name	$c_p$ J/g K	$C_p$ J/mol K	Name	$c_p$ J/g K	$C_p$ J/mol K
Actinium	0.120	27.2	Molybdenum	0.251	24.06
Aluminum	0.897	24.20	Neodymium	0.190	27.45
Antimony	0.207	25.23	Neon	1.030	20.786
Argon	0.520	20.786	Nickel	0.444	26.07
Arsenic	0.329	24.64	Niobium	0.265	24.60
Barium	0.204	28.07	Nitrogen (N <sub>2</sub> )	1.040	29.124
Beryllium	1.825	16.443	Osmium	0.130	24.7
Bismuth	0.122	25.52	Oxygen (O <sub>2</sub> )	0.918	29.378
Boron	1.026	11.087	Palladium	0.246	25.98
Bromine (Br <sub>2</sub> )	0.474	75.69	Phosphorus (white)	0.769	23.824
Cadmium	0.232	26.020	Platinum	0.133	25.86
Calcium	0.647	25.929	Potassium	0.757	29.600
Carbon (graphite)	0.709	8.517	Praseodymium	0.193	27.20
Cerium	0.192	26.94	Radon	0.094	20.786
Cesium	0.242	32.210	Rhenium	0.137	25.48
Chlorine (Cl <sub>2</sub> )	0.479	33.949	Rhodium	0.243	24.98
Chromium	0.449	23.35	Rubidium	0.363	31.060
Cobalt	0.421	24.81	Ruthenium	0.238	24.06
Copper	0.385	24.440	Samarium	0.197	29.54
Dysprosium	0.173	28.16	Scandium	0.568	25.52
Erbium	0.168	28.12	Selenium	0.321	25.363
Europium	0.182	27.66	Silicon	0.712	19.99
Fluorine (F <sub>2</sub> )	0.824	31.304	Silver	0.235	25.350
Gadolinium	0.236	37.03	Sodium	1.228	28.230
Gallium	0.373	26.03	Strontium	0.306	26.79
Germanium	0.320	23.222	Sulfur (rhombic)	0.708	22.70
Gold	0.129	25.418	Tantalum	0.140	25.36
Hafnium	0.144	25.73	Tellurium	0.202	25.73
Helium	5.193	20.786	Terbium	0.182	28.91
Holmium	0.165	27.15	Thallium	0.129	26.32
Hydrogen (H <sub>2</sub> )	14.304	28.836	Thorium	0.118	27.32
Indium	0.233	26.74	Thulium	0.160	27.03
Iodine (I <sub>2</sub> )	0.214	54.43	Tin (white)	0.227	26.99
Iridium	0.131	25.10	Titanium	0.523	25.060
Iron	0.449	25.10	Tungsten	0.132	24.27
Krypton	0.248	20.786	Uranium	0.116	27.665
Lanthanum	0.195	27.11	Vanadium	0.489	24.89
Lead	0.130	26.84	Xenon	0.158	20.786
Lithium	3.582	24.860	Ytterbium	0.155	26.74
Lutetium	0.154	26.86	Yttrium	0.298	26.53
Magnesium	1.023	24.869	Zinc	0.388	25.390
Manganese	0.479	26.32	Zirconium	0.278	25.36
Mercury	0.140	27.983			



# VAPOR PRESSURE OF THE METALLIC ELEMENTS — EQUATIONS

C. B. Alcock

This table gives coefficients in an equation for the vapor pressure of 65 metallic elements in both the solid and liquid states. Vapor pressures in the range  $10^{-10}$  to  $10^2$  Pa ( $10^{-15}$  to  $10^{-3}$  atm) are covered. The equation is:

$$\text{for } p \text{ in atmospheres: } \log(p/\text{atm}) = A + BT^{-1} + C\log T + DT^3$$

$$\text{for } p \text{ in pascals: } \log(p/\text{Pa}) = 5.006 + A + BT^{-1} + C\log T + DT^3$$

$$\text{for } p \text{ in torr (mmHg): } \log(p/\text{torr}) = 2.881 + A + BT^{-1} + C\log T + DT^3$$

where  $T$  is the temperature in K.

This equation reproduces the observed vapor pressures to an accuracy of 5% or better. The metals are listed alphabetically by name, and the melting point is included.

The table following this one gives values of the vapor pressure at several temperatures in the 400 K to 2400 K range, as calculated from these equations.

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Alcock, C. B., Itkin, V. P., and Horrigan, M. K., *Canadian Metallurgical Quarterly*, 23, 309, 1984.

Element	Phase	A	B	C	D	Range/K	mp/K
Aluminum	Solid	9.459	-17342	-0.7927		298-mp	933
Aluminum	Liquid	5.911	-16211			mp-1800	
Americium	Solid	11.311	-15059	-1.3449		298-mp	1449
Barium	Solid	12.405	-9690	-2.2890		298-mp	1000
Barium	Liquid	4.007	-8163			mp-1200	
Beryllium	Solid	8.042	-17020	-0.4440		298-mp	1560
Beryllium	Liquid	5.786	-15731			mp-1800	
Cadmium	Solid	5.939	-5799			298-mp	594
Cadmium	Liquid	5.242	-5392			mp-650	
Calcium	Solid	10.127	-9517	-1.4030		298-mp	1115
Cerium	Solid	6.139	-21752			298-mp	1071
Cerium	Liquid	5.611	-21200			mp-2450	
Cesium	Solid	4.711	-3999			298-mp	302
Cesium	Liquid	4.165	-3830			mp-550	
Chromium	Solid	6.800	-20733	0.4391	-0.4094	298-2000	2180
Cobalt	Solid	10.976	-22576	-1.0280		298-mp	1768
Cobalt	Liquid	6.488	-20578			mp-2150	
Copper	Solid	9.123	-17748	-0.7317		298-mp	1358
Copper	Liquid	5.849	-16415			mp-1850	
Curium	Solid	8.369	-20364	-0.5770		298-mp	1618
Curium	Liquid	5.223	-18292			mp-2200	
Dysprosium	Solid	9.579	-15336	-1.1114		298-mp	1685
Erbium	Solid	9.916	-16642	-1.2154		298-mp	1802
Erbium	Liquid	4.668	-14380			mp-1900	
Europium	Solid	9.240	-9459	-1.1661		298-mp	1095
Gadolinium	Solid	8.344	-20861	-0.5775		298-mp	1586
Gadolinium	Liquid	5.557	-19389			mp-2250	
Gallium	Solid	6.657	-14208			298-mp	303
Gallium	Liquid	6.754	-13984	-0.3413		mp-1600	
Gold	Solid	9.152	-19343	-0.7479		298-mp	1337
Gold	Liquid	5.832	-18024			mp-2050	
Hafnium	Solid	9.445	-32482	-0.6735		298-mp	2506
Holmium	Solid	9.785	-15899	-1.1753		298-mp	1747
Indium	Solid	5.991	-12548			298-mp	430
Indium	Liquid	5.374	-12276			mp-1500	
Iridium	Solid	10.506	-35099	-0.7500		298-2500	2719
Iron	Solid	7.100	-21723	0.4536	-0.5846	298-mp	1811
Iron	Liquid	6.347	-19574			mp-2100	
Lanthanum	Solid	7.463	-22551	-0.3142		298-mp	1191
Lanthanum	Liquid	5.911	-21855			mp-2450	
Lead	Solid	5.643	-10143			298-mp	600
Lead	Liquid	4.911	-9701			mp-1200	
Lithium	Solid	5.667	-8310			298-mp	454
Lithium	Liquid	5.055	-8023			mp-1000	
Lutetium	Solid	8.793	-22423	-0.6200		298-mp	1936
Lutetium	Liquid	5.648	-20302			mp-2350	

Element	Phase	A	B	C	D	Range/K	mp/K
Magnesium	Solid	8.489	-7813	-0.8253		298-mp	923
Manganese	Solid	12.805	-15097	-1.7896		298-mp	1519
Mercury	Liquid	5.116	-3190			298-400	234
Molybdenum	Solid	11.529	-34626	-1.1331		298-2500	2895
Neodymium	Solid	8.996	-17264	-0.9519		298-mp	1294
Neodymium	Liquid	4.912	-15824			mp-2000	
Neptunium	Solid	19.643	-24886	-3.9991		298-mp	917
Neptunium	Liquid	10.076	-23378	-1.3250		mp-2500	
Nickel	Solid	10.557	-22606	-0.8717		298-mp	1728
Nickel	Liquid	6.666	-20765			mp-2150	
Niobium	Solid	8.882	-37818	-0.2575		298-2500	2750
Osmium	Solid	9.419	-41198	-0.3896		298-2500	3306
Palladium	Solid	9.502	-19813	-0.9258		298-mp	1828
Palladium	Liquid	5.426	-17899			mp-2100	
Platinum	Solid	4.882	-29387	1.1039	-0.4527	298-mp	2041
Platinum	Liquid	6.386	-26856			mp-2500	
Plutonium	Solid	26.160	-19162	-6.6675		298-600	913
Plutonium	Solid	18.858	-18460	-4.4720		500-mp	
Plutonium	Liquid	3.666	-16658			mp-2450	
Potassium	Solid	4.961	-4646			298-mp	337
Potassium	Liquid	4.402	-4453			mp-600	
Praseodymium	Solid	8.859	-18720	-0.9512		298-mp	1204
Praseodymium	Liquid	4.772	-17315			mp-2200	
Protactinium	Solid	10.552	-34869	-1.0075		298-mp	1845
Protactinium	Liquid	6.177	-32874			mp-2500	
Rhenium	Solid	11.543	-40726	-1.1629		298-2500	3459
Rhodium	Solid	10.168	-29010	-0.7068		298-mp	2236
Rhodium	Liquid	6.802	-26792			mp-2500	
Rubidium	Solid	4.857	-4215			298-mp	312
Rubidium	Liquid	4.312	-4040			mp-550	
Ruthenium	Solid	9.755	-34154	-0.4723		298-mp	2606
Samarium	Solid	9.988	-11034	-1.3287		298-mp	1347
Scandium	Solid	6.650	-19721	0.2885	-0.3663	298-mp	1814
Scandium	Liquid	5.795	-17681			mp-2000	
Silver	Solid	9.127	-14999	-0.7845		298-mp	1235
Silver	Liquid	5.752	-13827			mp-1600	
Sodium	Solid	5.298	-5603			298-mp	371
Sodium	Liquid	4.704	-5377			mp-700	
Strontium	Solid	9.226	-8572	-1.1926		298-mp	1050
Tantalum	Solid	16.807	-41346	-3.2152	0.7437	298-2500	3280
Terbium	Solid	9.510	-20457	-0.9247		298-mp	1629
Terbium	Liquid	5.411	-18639			mp-2200	
Thallium	Solid	5.971	-9447			298-mp	577
Thallium	Liquid	5.259	-9037			mp-1100	
Thorium	Solid	8.668	-31483	-0.5288		298-mp	2023
Thorium	Liquid	-18.453	-24569	6.6473		mp-2500	
Thulium	Solid	8.882	-12270	-0.9564		298-1400	1818
Tin	Solid	6.036	-15710			298-mp	505
Tin	Liquid	5.262	-15332			mp-1850	
Titanium	Solid	11.925	-24991	-1.3376		298-mp	1943
Titanium	Liquid	6.358	-22747			mp-2400	
Tungsten	Solid	2.945	-44094	1.3677		298-2350	3687
Tungsten	Solid	54.527	-57687	-12.2231		2200-2500	
Uranium	Solid	0.770	-27729	2.6982	-1.5471	298-mp	1408
Uranium	Liquid	20.735	-28776	-4.0962		mp-2500	
Vanadium	Solid	9.744	-27132	-0.5501		298-mp	2183
Vanadium	Liquid	6.929	-25011			mp-2500	
Ytterbium	Solid	9.111	-8111	-1.0849		298-900	1092
Yttrium	Solid	9.735	-22306	-0.8705		298-mp	1795
Yttrium	Liquid	5.795	-20341			mp-2300	
Zinc	Solid	6.102	-6776			298-mp	693
Zinc	Liquid	5.378	-6286			mp-750	
Zirconium	Solid	10.008	-31512	-0.7890		298-m.p	2127
Zirconium	Liquid	6.806	-30295			mp-2500	

## DENSITY OF MOLTEN ELEMENTS AND REPRESENTATIVE SALTS

This table lists the liquid density at the melting point,  $\rho_m$ , for elements that are solid at room temperature, as well as for some representative salts of these elements. Densities at higher temperatures (up to the  $t_{\max}$  given in the last column) may be estimated from the equation

$$\rho(t) = \rho_m - k(t - t_m)$$

where  $t_m$  is the melting point and  $k$  is given in the fifth column of the table. If a value of  $t_{\max}$  is not given, the equation should not be used to extrapolate more than about 20°C beyond the melting point.

Data for the elements were selected from the primary literature; the assistance of Gernot Lang in compiling these data is gratefully acknowledged. The molten salt data were derived from Reference 1.

### References

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Formula	Name	$t_m/^\circ\text{C}$	$\rho_m/\text{g cm}^{-3}$	$k/\text{g cm}^{-3} \text{ }^\circ\text{C}^{-1}$	$t_{\max}$
Ag	Silver	961.78	9.320	0.0009	1500
AgBr	Silver(I) bromide	430	5.577	0.001035	667
AgCl	Silver(I) chloride	455	4.83	0.00094	627
AgI	Silver(I) iodide	558	5.58	0.00101	802
AgNO <sub>3</sub>	Silver(I) nitrate	210	3.970	0.001098	360
Ag <sub>2</sub> SO <sub>4</sub>	Silver(I) sulfate	660	4.84	0.001089	770
Al	Aluminum	660.32	2.375	0.000233	1340
AlBr <sub>3</sub>	Aluminum bromide	97.5	2.647	0.002435	267
AlCl <sub>3</sub>	Aluminum chloride	192.6	1.302	0.002711	296
AlI <sub>3</sub>	Aluminum iodide	188.32	3.223	0.0025	240
As	Arsenic	817	5.22	0.000544	
Au	Gold	1064.18	17.31	0.001343	1200
B	Boron	2075	2.08		
Ba	Barium	727	3.338	0.000299	1550
BaBr <sub>2</sub>	Barium bromide	857	3.991	0.000924	900
BaCl <sub>2</sub>	Barium chloride	961	3.174	0.000681	1081
BaF <sub>2</sub>	Barium fluoride	1368	4.14	0.000999	1727
BaI <sub>2</sub>	Barium iodide	711	4.26	0.000977	975
Be	Beryllium	1287	1.690	0.00011	
BeCl <sub>2</sub>	Beryllium chloride	415	1.54	0.0011	473
BeF <sub>2</sub>	Beryllium fluoride	552	1.96	0.000015	850
Bi	Bismuth	271.406	10.05	0.00135	800
BiBr <sub>3</sub>	Bismuth bromide	219	4.76	0.002637	927
BiCl <sub>3</sub>	Bismuth chloride	234	3.916	0.0023	350
Ca	Calcium	842	1.378	0.000230	1484
CaBr <sub>2</sub>	Calcium bromide	742	3.111	0.0005	791
CaCl <sub>2</sub>	Calcium chloride	775	2.085	0.000422	950
CaF <sub>2</sub>	Calcium fluoride	1418	2.52	0.000391	2027
CaI <sub>2</sub>	Calcium iodide	783	3.443	0.000751	1028
Cd	Cadmium	321.069	7.996	0.001218	500
CdBr <sub>2</sub>	Cadmium bromide	568	4.075	0.00108	720
CdCl <sub>2</sub>	Cadmium chloride	568	3.392	0.00082	807
CdI <sub>2</sub>	Cadmium iodide	388	4.396	0.001117	700
Ce	Cerium	799	6.55	0.000710	1460
CeCl <sub>3</sub>	Cerium(III) chloride	807	3.25	0.00092	950
CeF <sub>3</sub>	Cerium(III) fluoride	1430	4.659	0.000936	1927
Co	Cobalt	1495	7.75	0.00165	1580
Cr	Chromium	1907	6.3	0.0011	2100
Cs	Cesium	28.44	1.843	0.000556	510
CsBr	Cesium bromide	636	3.133	0.001223	860
CsCl	Cesium chloride	646	2.79	0.001065	906
CsF	Cesium fluoride	703	3.649	0.001282	912
CsI	Cesium iodide	632	3.197	0.001183	907
CsNO <sub>3</sub>	Cesium nitrate	409	2.820	0.001166	491
Cs <sub>2</sub> SO <sub>4</sub>	Cesium sulfate	1005	3.1	0.00095	1530
Cu	Copper	1084.62	8.02	0.000609	1630
CuCl	Copper(I) chloride	423	3.692	0.00076	585

Formula	Name	$t_m/^\circ\text{C}$	$\rho_m/\text{g cm}^{-3}$	$k/\text{g cm}^{-3} \text{ }^\circ\text{C}^{-1}$	$t_{\text{max}}$
Dy	Dysprosium	1411	8.37	0.00143	1540
DyCl <sub>3</sub>	Dysprosium(III) chloride	718	3.62	0.00068	987
Er	Erbium	1529	8.86	0.00157	1700
Eu	Europium	822	5.13	0.0028	980
Fe	Iron	1538	6.98	0.000572	1680
FeCl <sub>2</sub>	Iron(II) chloride	677	2.348	0.000555	877
Ga	Gallium	29.7666	6.08	0.00062	400
GaBr <sub>3</sub>	Gallium(III) bromide	123	3.116	0.00246	135
GaCl <sub>3</sub>	Gallium(III) chloride	77.9	2.053	0.002083	141
GaI <sub>3</sub>	Gallium(III) iodide	212	3.630	0.002377	252
Gd	Gadolinium	1314	7.4		
GdCl <sub>3</sub>	Gadolinium(III) chloride	602	3.56	0.000671	1007
GdI <sub>3</sub>	Gadolinium(III) iodide	930	4.12	0.000908	1032
Ge	Germanium	938.25	5.60	0.00055	1600
Hf	Hafnium	2233	12		
HgBr <sub>2</sub>	Mercury(II) bromide	241	5.126	0.003233	319
HgCl <sub>2</sub>	Mercury(II) chloride	277	4.368	0.002862	304
HgI <sub>2</sub>	Mercury(II) iodide	256	5.222	0.003235	354
Ho	Holmium	1472	8.34		
In	Indium	156.60	7.02	0.000836	500
InBr <sub>3</sub>	Indium(III) bromide	420	3.121	0.0015	528
InCl <sub>3</sub>	Indium(III) chloride	583	2.140	0.0021	666
InI <sub>3</sub>	Indium(III) iodide	207	3.820	0.0015	360
Ir	Iridium	2446	19		
K	Potassium	63.38	0.828	0.000232	500
KBr	Potassium bromide	734	2.127	0.000825	930
KCl	Potassium chloride	771	1.527	0.000583	939
KF	Potassium fluoride	858	1.910	0.000651	1037
KI	Potassium iodide	681	2.448	0.000956	904
KNO <sub>3</sub>	Potassium nitrate	334	1.865	0.000723	457
La	Lanthanum	920	5.94	0.00061	1600
LaBr <sub>3</sub>	Lanthanum bromide	788	4.933	0.000096	912
LaCl <sub>3</sub>	Lanthanum chloride	858	3.209	0.000777	973
LaF <sub>3</sub>	Lanthanum fluoride	1493	4.589	0.000682	2177
LaI <sub>3</sub>	Lanthanum iodide	778	4.29	0.001110	907
Li	Lithium	180.5	0.512	0.00052	285
LiBr	Lithium bromide	550	2.528	0.000652	739
LiCl	Lithium chloride	610	1.502	0.000432	781
LiF	Lithium fluoride	848.2	1.81	0.000490	1047
LiI	Lithium iodide	469	3.109	0.000917	667
LiNO <sub>3</sub>	Lithium nitrate	253	1.781	0.000546	441
Li <sub>2</sub> SO <sub>4</sub>	Lithium sulfate	860	2.003	0.000407	1214
Lu	Lutetium	1663	9.3		
Mg	Magnesium	650	1.584	0.000234	900
MgBr <sub>2</sub>	Magnesium bromide	711	2.62	0.000478	935
MgCl <sub>2</sub>	Magnesium chloride	714	1.68	0.000271	826
MgI <sub>2</sub>	Magnesium iodide	634	3.05	0.000651	888
Mn	Manganese	1246	5.95	0.00105	1590
MnCl <sub>2</sub>	Manganese(II) chloride	650	2.353	0.000437	850
Mo	Molybdenum	2623	9.33		
Na	Sodium	97.794	0.927	0.00023	600
NaBr	Sodium bromide	747	2.342	0.000816	945
Na <sub>2</sub> CO <sub>3</sub>	Sodium carbonate	856	1.972	0.000448	1004
NaCl	Sodium chloride	800.7	1.556	0.000543	1027
NaF	Sodium fluoride	996	1.948	0.000636	1097
NaI	Sodium iodide	661	2.742	0.000949	912
NaNO <sub>3</sub>	Sodium nitrate	306.5	1.90	0.000715	370
Na <sub>2</sub> SO <sub>4</sub>	Sodium sulfate	884	2.069	0.000483	1077
Nd	Neodymium	1016	6.89	0.00076	1350
Ni	Nickel	1455	7.81	0.000726	1700
NiCl <sub>2</sub>	Nickel(II) chloride	1031	2.653	0.00066	1057
Os	Osmium	3033	20		
Pb	Lead	327.462	10.66	0.00122	700
PbBr <sub>2</sub>	Lead(II) bromide	371	5.73	0.00165	600
PbCl <sub>2</sub>	Lead(II) chloride	501	4.951	0.0015	710

Formula	Name	$t_m/^\circ\text{C}$	$\rho_m/\text{g cm}^{-3}$	$k/\text{g cm}^{-3} \text{ }^\circ\text{C}^{-1}$	$t_{\text{max}}$
PbI <sub>2</sub>	Lead(II) iodide	410	5.691	0.001594	697
Pd	Palladium	1554.8	10.38	0.001169	1700
Pr	Praseodymium	931	6.50	0.00093	1460
PrCl <sub>3</sub>	Praseodymium chloride	786	3.23	0.00074	977
Pt	Platinum	1768.2	19.77	0.0024	2200
Pu	Plutonium	640	16.63	0.001419	950
Rb	Rubidium	39.31	1.46	0.000451	800
RbBr	Rubidium bromide	692	2.715	0.001072	907
Rb <sub>2</sub> CO <sub>3</sub>	Rubidium carbonate	837	2.84	0.000640	1007
RbCl	Rubidium chloride	724	2.248	0.000883	923
RbF	Rubidium fluoride	795	2.87	0.00102	1067
RbI	Rubidium iodide	656	2.904	0.001143	902
RbNO <sub>3</sub>	Rubidium nitrate	310	2.519	0.001068	417
Rb <sub>2</sub> SO <sub>4</sub>	Rubidium sulfate	1066	2.56	0.000665	1545
Re	Rhenium	3185	18.9		
Rh	Rhodium	1964	10.7	0.000895	2200
Ru	Ruthenium	2334	10.65		
S	Sulfur	115.21	1.819	0.00080	160
Sb	Antimony	630.628	6.53	0.00067	745
SbCl <sub>3</sub>	Antimony(III) chloride	73.4	2.681	0.002293	77
SbCl <sub>5</sub>	Antimony(V) chloride	4	2.37	0.001869	77
SbI <sub>3</sub>	Antimony(III) iodide	171	4.171	0.002483	322
Sc	Scandium	1541	2.80		
Se	Selenium	220.8	3.99		
Si	Silicon	1414	2.57	0.00036	1500
Sm	Samarium	1072	7.16		
Sn	Tin	231.93	6.99	0.000601	1200
SnCl <sub>2</sub>	Tin(II) chloride	247	3.36	0.001253	480
SnCl <sub>4</sub>	Tin(IV) chloride	-33	2.37	0.002687	138
Sr	Strontium	777	6.980		
SrBr <sub>2</sub>	Strontium bromide	657	3.70	0.000745	1004
SrCl <sub>2</sub>	Strontium chloride	874	2.727	0.000578	1037
SrF <sub>2</sub>	Strontium fluoride	1477	3.470	0.000751	1927
SrI <sub>2</sub>	Strontium iodide	538	4.085	0.000885	1026
Ta	Tantalum	3017	15		
TaCl <sub>5</sub>	Tantalum(V) chloride	216.6	2.700	0.004316	457
Tb	Terbium	1359	7.65		
Te	Tellurium	449.51	5.70	0.00035	600
ThCl <sub>4</sub>	Thorium chloride	770	3.363	0.0014	847
ThF <sub>4</sub>	Thorium fluoride	1110	6.058	0.000759	1378
Ti	Titanium	1668	4.11		
TiCl <sub>4</sub>	Titanium(IV) chloride	-25	1.807	0.001735	137
Tl	Thallium	304	11.22	0.00144	600
TlBr	Thallium(I) bromide	460	5.98	0.001755	647
TlCl	Thallium(I) chloride	431	5.628	0.0018	642
TlI	Thallium(I) iodide	441.8	6.15	0.001761	737
TlNO <sub>3</sub>	Thallium(I) nitrate	206	4.91	0.001873	279
Tl <sub>2</sub> SO <sub>4</sub>	Thallium(I) sulfate	632	5.62	0.00130	927
Tm	Thulium	1545	8.56	0.00050	1675
U	Uranium	1135	17.3		
UCl <sub>3</sub>	Uranium(III) chloride	837	4.84	0.007943	1057
UCl <sub>4</sub>	Uranium(IV) chloride	590	3.572	0.001945	667
UF <sub>4</sub>	Uranium(IV) fluoride	1036	6.485	0.000992	1341
V	Vanadium	1910	5.5		
W	Tungsten	3422	17.6		
Y	Yttrium	1526	4.24		
YCl <sub>3</sub>	Yttrium chloride	721	2.510	0.0005	845
Yb	Ytterbium	824	6.21		
Zn	Zinc	419.53	6.57	0.0011	700
ZnBr <sub>2</sub>	Zinc bromide	402	3.47	0.000959	602
ZnCl <sub>2</sub>	Zinc chloride	290	2.54	0.00053	557
ZnI <sub>2</sub>	Zinc iodide	450	3.878	0.00136	588
ZnSO <sub>4</sub>	Zinc sulfate	680	3.14	0.00047	987
Zr	Zirconium	1854.7	5.8		
ZrCl <sub>4</sub>	Zirconium chloride	437	1.643	0.007464	492

# MAGNETIC SUSCEPTIBILITY OF THE ELEMENTS AND INORGANIC COMPOUNDS

When a material is placed in a magnetic field  $H$ , a magnetization (magnetic moment per unit volume)  $M$  is induced in the material which is related to  $H$  by  $M = \kappa H$ , where  $\kappa$  is called the volume susceptibility. Since  $H$  and  $M$  have the same dimensions,  $\kappa$  is dimensionless. A more useful parameter is the molar susceptibility  $\chi_m$ , defined by

$$\chi_m = \kappa V_m = \kappa M / \rho$$

where  $V_m$  is the molar volume of the substance,  $M$  the molar mass, and  $\rho$  the mass density. When the cgs system is used, the customary units for  $\chi_m$  are  $\text{cm}^3 \text{mol}^{-1}$ ; the corresponding SI units are  $\text{m}^3 \text{mol}^{-1}$ .

Substances that have no unpaired electron orbital or spin angular momentum generally have negative values of  $\chi_m$  and are called diamagnetic. Their molar susceptibility varies only slightly with temperature. Substances with unpaired electrons, which are termed paramagnetic, have positive  $\chi_m$  and show a much stronger temperature dependence, varying roughly as  $1/T$ . The net susceptibility of a paramagnetic substance is the sum of the paramagnetic and diamagnetic contributions, but the former almost always dominates.

This table gives values of  $\chi_m$  for the elements and selected inorganic compounds. All values refer to nominal room temperature (285 to 300 K) unless otherwise indicated. When the physical state (s = solid, l = liquid, g = gas, aq = aqueous solution) is not given, the

most common crystalline form is understood. An entry of Ferro indicates a ferromagnetic substance.

Substances are arranged in alphabetical order by the most common name, except that compounds such as hydrides, oxides, and acids are grouped with the parent element (the same ordering used in the table "Physical Constants of Inorganic Compounds").

In keeping with customary practice, the molar susceptibility is given here in units appropriate to the cgs system. These values should be multiplied by  $4\pi$  to obtain values for use in SI equations (where the magnetic field strength  $H$  has units of  $\text{A m}^{-1}$ ).

## References

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4. *Tables de Constantes et Données Numérique, Volume 7, Relaxation Paramagnétique*, Masson, Paris, 1957.

Name	Formula	$\chi_m / 10^{-6} \text{cm}^3 \text{mol}^{-1}$
Aluminum	Al	+16.5
Aluminum trifluoride	AlF <sub>3</sub>	-13.9
Aluminum oxide	Al <sub>2</sub> O <sub>3</sub>	-37
Aluminum sulfate	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	-93
Ammonia (g)	NH <sub>3</sub>	-16.3
Ammonia (aq)	NH <sub>3</sub>	-18.3
Ammonium acetate	NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	-41.1
Ammonium bromide	NH <sub>4</sub> Br	-47
Ammonium carbonate	(NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>	-42.5
Ammonium chlorate	NH <sub>4</sub> ClO <sub>3</sub>	-42.1
Ammonium chloride	NH <sub>4</sub> Cl	-36.7
Ammonium fluoride	NH <sub>4</sub> F	-23
Ammonium iodate	NH <sub>4</sub> IO <sub>3</sub>	-62.3
Ammonium iodide	NH <sub>4</sub> I	-66
Ammonium nitrate	NH <sub>4</sub> NO <sub>3</sub>	-33
Ammonium sulfate	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	-67
Ammonium thiocyanate	NH <sub>4</sub> SCN	-48.1
Antimony	Sb	-99
Stibine (g)	SbH <sub>3</sub>	-34.6
Antimony(III) bromide	SbBr <sub>3</sub>	-111.4
Antimony(III) chloride	SbCl <sub>3</sub>	-86.7
Antimony(III) fluoride	SbF <sub>3</sub>	-46
Antimony(III) iodide	SbI <sub>3</sub>	-147.2
Antimony(III) oxide	Sb <sub>2</sub> O <sub>3</sub>	-69.4
Antimony(III) sulfide	Sb <sub>2</sub> S <sub>3</sub>	-86
Antimony(V) chloride	SbCl <sub>5</sub>	-120.5
Argon (g)	Ar	-19.32
Arsenic (gray)	As	-5.6
Arsenic (yellow)	As	-23.2
Arsine (g)	AsH <sub>3</sub>	-35.2

Name	Formula	$\chi_m / 10^{-6} \text{cm}^3 \text{mol}^{-1}$
Arsenic(III) bromide	AsBr <sub>3</sub>	-106
Arsenic(III) chloride	AsCl <sub>3</sub>	-72.5
Arsenic(III) iodide	AsI <sub>3</sub>	-142.2
Arsenic(III) oxide	As <sub>2</sub> O <sub>3</sub>	-30.34
Arsenic(III) sulfide	As <sub>2</sub> S <sub>3</sub>	-70
Barium	Ba	+20.6
Barium bromide	BaBr <sub>2</sub>	-92
Barium bromide dihydrate	BaBr <sub>2</sub> ·2H <sub>2</sub> O	-119.3
Barium carbonate	BaCO <sub>3</sub>	-58.9
Barium chloride	BaCl <sub>2</sub>	-72.6
Barium chloride dihydrate	BaCl <sub>2</sub> ·2H <sub>2</sub> O	-100
Barium fluoride	BaF <sub>2</sub>	-51
Barium hydroxide	Ba(OH) <sub>2</sub>	-53.2
Barium iodate	Ba(IO <sub>3</sub> ) <sub>2</sub>	-122.5
Barium iodide	BaI <sub>2</sub>	-124.4
Barium iodide dihydrate	BaI <sub>2</sub> ·2H <sub>2</sub> O	-163
Barium nitrate	Ba(NO <sub>3</sub> ) <sub>2</sub>	-66.5
Barium oxide	BaO	-29.1
Barium peroxide	BaO <sub>2</sub>	-40.6
Barium sulfate	BaSO <sub>4</sub>	-65.8
Beryllium	Be	-9.0
Beryllium chloride	BeCl <sub>2</sub>	-26.5
Beryllium hydroxide	Be(OH) <sub>2</sub>	-23.1
Beryllium oxide	BeO	-11.9
Beryllium sulfate	BeSO <sub>4</sub>	-37
Bismuth	Bi	-280.1
Bismuth tribromide	BiBr <sub>3</sub>	-147
Bismuth trichloride	BiCl <sub>3</sub>	-26.5
Bismuth fluoride	BiF <sub>3</sub>	-61.2
Bismuth hydroxide	Bi(OH) <sub>3</sub>	-65.8

Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
Bismuth triiodide	$\text{BiI}_3$	-200.5	Cesium iodide	$\text{CsI}$	-82.6
Bismuth nitrate pentahydrate	$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$	-159	Cesium superoxide	$\text{CsO}_2$	+1534
Bismuth oxide	$\text{Bi}_2\text{O}_3$	-83	Cesium sulfate	$\text{Cs}_2\text{SO}_4$	-116
Bismuth phosphate	$\text{BiPO}_4$	-77	Chlorine (l)	$\text{Cl}_2$	-40.4
Bismuth sulfate	$\text{Bi}_2(\text{SO}_4)_3$	-199	Chlorine trifluoride (g)	$\text{ClF}_3$	-26.5
Bismuth sulfide	$\text{Bi}_2\text{S}_3$	-123	Chromium	$\text{Cr}$	+167
Boron	$\text{B}$	-6.7	Chromium(II) chloride	$\text{CrCl}_2$	+7230
Diborane (g)	$\text{B}_2\text{H}_6$	-21.0	Chromium(III) chloride	$\text{CrCl}_3$	+6350
Boric acid (orthoboric acid)	$\text{H}_3\text{BO}_3$	-34.1	Chromium(III) fluoride	$\text{CrF}_3$	+4370
Boron trichloride	$\text{BCl}_3$	-59.9	Chromium(III) oxide	$\text{Cr}_2\text{O}_3$	+1960
Boron oxide	$\text{B}_2\text{O}_3$	-38.7	Chromium(III) sulfate	$\text{Cr}_2(\text{SO}_4)_3$	+11800
Bromine (l)	$\text{Br}_2$	-56.4	Chromium(VI) oxide	$\text{CrO}_3$	+40
Bromine (g)	$\text{Br}_2$	-73.5	Cobalt	$\text{Co}$	Ferro.
Bromine trifluoride	$\text{BrF}_3$	-33.9	Cobalt(II) bromide	$\text{CoBr}_2$	+13000
Bromine pentafluoride	$\text{BrF}_5$	-45.1	Cobalt(II) chloride	$\text{CoCl}_2$	+12660
Cadmium	$\text{Cd}$	-19.7	Cobalt(II) chloride hexahydrate	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	+9710
Cadmium bromide	$\text{CdBr}_2$	-87.3	Cobalt(II) cyanide	$\text{Co}(\text{CN})_2$	+3825
Cadmium bromide tetrahydrate	$\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$	-131.5	Cobalt(II) fluoride	$\text{CoF}_2$	+9490
Cadmium carbonate	$\text{CdCO}_3$	-46.7	Cobalt(II) iodide	$\text{CoI}_2$	+10760
Cadmium chloride	$\text{CdCl}_2$	-68.7	Cobalt(II) sulfate	$\text{CoSO}_4$	+10000
Cadmium chromate	$\text{CdCrO}_4$	-16.8	Cobalt(II) sulfide	$\text{CoS}$	+225
Cadmium cyanide	$\text{Cd}(\text{CN})_2$	-54	Cobalt(II,III) oxide	$\text{Co}_3\text{O}_4$	+7380
Cadmium fluoride	$\text{CdF}_2$	-40.6	Cobalt(III) fluoride	$\text{CoF}_3$	+1900
Cadmium hydroxide	$\text{Cd}(\text{OH})_2$	-41	Cobalt(III) oxide	$\text{Co}_2\text{O}_3$	+4560
Cadmium iodate	$\text{Cd}(\text{IO}_3)_2$	-108.4	Copper	$\text{Cu}$	-5.46
Cadmium iodide	$\text{CdI}_2$	-117.2	Copper(I) bromide	$\text{CuBr}$	-49
Cadmium nitrate	$\text{Cd}(\text{NO}_3)_2$	-55.1	Copper(I) chloride	$\text{CuCl}$	-40
Cadmium nitrate tetrahydrate	$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	-140	Copper(I) cyanide	$\text{CuCN}$	-24
Cadmium oxide	$\text{CdO}$	-30	Copper(I) iodide	$\text{CuI}$	-63
Cadmium sulfate	$\text{CdSO}_4$	-59.2	Copper(I) oxide	$\text{Cu}_2\text{O}$	-20
Cadmium sulfide	$\text{CdS}$	-50	Copper(II) bromide	$\text{CuBr}_2$	+685
Calcium	$\text{Ca}$	+40	Copper(II) chloride	$\text{CuCl}_2$	+1080
Calcium bromide	$\text{CaBr}_2$	-73.8	Copper(II) chloride dihydrate	$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$	+1420
Calcium carbonate	$\text{CaCO}_3$	-38.2	Copper(II) fluoride	$\text{CuF}_2$	+1050
Calcium chloride	$\text{CaCl}_2$	-54.7	Copper(II) fluoride dihydrate	$\text{CuF}_2 \cdot 2\text{H}_2\text{O}$	+1600
Calcium fluoride	$\text{CaF}_2$	-28	Copper(II) hydroxide	$\text{Cu}(\text{OH})_2$	+1170
Calcium hydroxide	$\text{Ca}(\text{OH})_2$	-22	Copper(II) nitrate trihydrate	$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$	+1570
Calcium iodate	$\text{Ca}(\text{IO}_3)_2$	-101.4	Copper(II) nitrate hexahydrate	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	+1625
Calcium iodide	$\text{CaI}_2$	-109	Copper(II) oxide	$\text{CuO}$	+238
Calcium oxide	$\text{CaO}$	-15.0	Copper(II) sulfate	$\text{CuSO}_4$	+1330
Calcium sulfate	$\text{CaSO}_4$	-49.7	Copper(II) sulfate pentahydrate	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	+1460
Calcium sulfate dihydrate	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	-74	Copper(II) sulfide	$\text{CuS}$	-2.0
Carbon (diamond)	$\text{C}$	-5.9	Dysprosium ( $\alpha$ )	$\text{Dy}$	+98000
Carbon (graphite)	$\text{C}$	-6.0	Dysprosium(III) oxide	$\text{Dy}_2\text{O}_3$	+89600
Carbon monoxide (g)	$\text{CO}$	-11.8	Dysprosium(III) sulfide	$\text{Dy}_2\text{S}_3$	+95200
Carbon dioxide (g)	$\text{CO}_2$	-21.0	Erbium	$\text{Er}$	+48000
Cerium ( $\beta$ )	$\text{Ce}$	+2500	Erbium oxide	$\text{Er}_2\text{O}_3$	+73920
Cerium(II) sulfide	$\text{CeS}$	+2110	Erbium sulfate octahydrate	$\text{Er}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$	+74600
Cerium(III) chloride	$\text{CeCl}_3$	+2490	Erbium sulfide	$\text{Er}_2\text{S}_3$	+77200
Cerium(III) fluoride	$\text{CeF}_3$	+2190	Europium	$\text{Eu}$	+30900
Cerium(III) sulfide	$\text{Ce}_2\text{S}_3$	+5080	Europium(II) bromide	$\text{EuBr}_2$	+26800
Cerium(IV) oxide	$\text{CeO}_2$	+26	Europium(II) chloride	$\text{EuCl}_2$	+26500
Cerium(IV) sulfate tetrahydrate	$\text{Ce}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$	-97	Europium(II) fluoride	$\text{EuF}_2$	+23750
Cesium	$\text{Cs}$	+29	Europium(II) iodide	$\text{EuI}_2$	+26000
Cesium bromate	$\text{CsBrO}_3$	-75.1	Europium(II) sulfide	$\text{EuS}$	+23800
Cesium bromide	$\text{CsBr}$	-67.2	Europium(III) oxide	$\text{Eu}_2\text{O}_3$	+10100
Cesium carbonate	$\text{Cs}_2\text{CO}_3$	-103.6	Europium(III) sulfate	$\text{Eu}_2(\text{SO}_4)_3$	+10400
Cesium chlorate	$\text{CsClO}_3$	-65	Fluorine	$\text{F}_2$	-9.63
Cesium chloride	$\text{CsCl}$	-56.7	Gadolinium (350 K)	$\text{Gd}$	+185000
Cesium fluoride	$\text{CsF}$	-44.5	Gadolinium(III) chloride	$\text{GdCl}_3$	+27930



Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
Gadolinium(III) oxide	Gd <sub>2</sub> O <sub>3</sub>	+53200	Iron(II) chloride tetrahydrate	FeCl <sub>2</sub> ·4H <sub>2</sub> O	+12900
Gadolinium(III) sulfate octahydrate	Gd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·8H <sub>2</sub> O	+53280	Iron(II) fluoride	FeF <sub>2</sub>	+9500
Gadolinium(III) sulfide	Gd <sub>2</sub> S <sub>3</sub>	+55500	Iron(II) iodide	FeI <sub>2</sub>	+13600
Gallium	Ga	-21.6	Iron(II) oxide	FeO	+7200
Gallium suboxide	Ga <sub>2</sub> O	-34	Iron(II) sulfate	FeSO <sub>4</sub>	+12400
Gallium(II) sulfide	GaS	-23	Iron(II) sulfate monohydrate	FeSO <sub>4</sub> ·H <sub>2</sub> O	+10500
Gallium(III) chloride	GaCl <sub>3</sub>	-63	Iron(II) sulfate heptahydrate	FeSO <sub>4</sub> ·7H <sub>2</sub> O	+11200
Gallium(III) sulfide	Ga <sub>2</sub> S <sub>3</sub>	-80	Iron(II) sulfide	FeS	+1074
Germanium	Ge	-11.6	Iron(III) chloride	FeCl <sub>3</sub>	+13450
Germane (g)	GeH <sub>4</sub>	-29.7	Iron(III) chloride hexahydrate	FeCl <sub>3</sub> ·6H <sub>2</sub> O	+15250
Germanium(II) oxide	GeO	-28.8	Iron(III) fluoride	FeF <sub>3</sub>	+13760
Germanium(II) sulfide	GeS	-40.9	Iron(III) fluoride trihydrate	FeF <sub>3</sub> ·3H <sub>2</sub> O	+7870
Germanium(IV) chloride	GeCl <sub>4</sub>	-72	Iron(III) nitrate nonahydrate	Fe(NO <sub>3</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	+15200
Germanium(IV) fluoride	GeF <sub>4</sub>	-50	Krypton (g)	Kr	-29.0
Germanium(IV) iodide	GeI <sub>4</sub>	-171	Lanthanum (α)	La	+95.9
Germanium(IV) oxide	GeO <sub>2</sub>	-34.3	Lanthanum oxide	La <sub>2</sub> O <sub>3</sub>	-78
Germanium(IV) sulfide	GeS <sub>2</sub>	-53.9	Lanthanum sulfate nonahydrate	La <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	-262
Gold	Au	-28	Lanthanum sulfide	La <sub>2</sub> S <sub>3</sub>	-37
Gold(I) bromide	AuBr	-61	Lead	Pb	-23
Gold(I) chloride	AuCl	-67	Lead(II) acetate	Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	-89.1
Gold(I) iodide	AuI	-91	Lead(II) bromide	PbBr <sub>2</sub>	-90.6
Gold(III) chloride	AuCl <sub>3</sub>	-112	Lead(II) carbonate	PbCO <sub>3</sub>	-61.2
Hafnium	Hf	+71	Lead(II) chloride	PbCl <sub>2</sub>	-73.8
Hafnium oxide	HfO <sub>2</sub>	-23	Lead(II) chromate	PbCrO <sub>4</sub>	-18
Helium (g)	He	-2.02	Lead(II) fluoride	PbF <sub>2</sub>	-58.1
Holmium	Ho	+72900	Lead(II) iodate	Pb(IO <sub>3</sub> ) <sub>2</sub>	-131
Holmium oxide	Ho <sub>2</sub> O <sub>3</sub>	+88100	Lead(II) iodide	PbI <sub>2</sub>	-126.5
Hydrazine (l)	N <sub>2</sub> H <sub>4</sub>	-201	Lead(II) nitrate	Pb(NO <sub>3</sub> ) <sub>2</sub>	-74
Hydrogen (l, 20.3 K)	H <sub>2</sub>	-5.44	Lead(II) oxide	PbO	-42
Hydrogen (g)	H <sub>2</sub>	-3.99	Lead(II) phosphate	Pb <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	-182
Hydrogen chloride (l)	HCl	-22.6	Lead(II) sulfate	PbSO <sub>4</sub>	-69.7
Hydrogen chloride (aq)	HCl	-22	Lead(II) sulfide	PbS	-83.6
Hydrogen fluoride (l)	HF	-8.6	Lithium	Li	+14.2
Hydrogen fluoride (aq)	HF	-9.3	Lithium bromide	LiBr	-34.3
Hydrogen iodide (s, 195 K)	HI	-47.3	Lithium carbonate	Li <sub>2</sub> CO <sub>3</sub>	-27
Hydrogen iodide (l, 233 K)	HI	-48.3	Lithium chloride	LiCl	-24.3
Hydrogen iodide (aq)	HI	-50.2	Lithium fluoride	LiF	-10.1
Hydrogen peroxide (l)	H <sub>2</sub> O <sub>2</sub>	-17.3	Lithium hydride	LiH	-4.6
Hydrogen sulfide (g)	H <sub>2</sub> S	-25.5	Lithium hydroxide (aq)	LiOH	-12.3
Indium	In	-10.2	Lithium iodide	LiI	-50
Indium(I) chloride	InCl	-30	Lithium sulfate	Li <sub>2</sub> SO <sub>4</sub>	-41.6
Indium(II) chloride	InCl <sub>2</sub>	-56	Lutetium	Lu	+182.9
Indium(II) sulfide	InS	-28	Magnesium	Mg	+13.1
Indium(III) bromide	InBr <sub>3</sub>	-107	Magnesium bromide	MgBr <sub>2</sub>	-72
Indium(III) chloride	InCl <sub>3</sub>	-86	Magnesium carbonate	MgCO <sub>3</sub>	-32.4
Indium(III) oxide	In <sub>2</sub> O <sub>3</sub>	-56	Magnesium chloride	MgCl <sub>2</sub>	-47.4
Indium(III) sulfide	In <sub>2</sub> S <sub>3</sub>	-98	Magnesium fluoride	MgF <sub>2</sub>	-22.7
Iodine	I <sub>2</sub>	-90	Magnesium hydroxide	Mg(OH) <sub>2</sub>	-22.1
Iodic acid	HIO <sub>3</sub>	-48	Magnesium iodide	MgI <sub>2</sub>	-111
Iodine pentoxide	I <sub>2</sub> O <sub>5</sub>	-79.4	Magnesium oxide	MgO	-10.2
Iodine chloride	ICl	-54.6	Magnesium sulfate	MgSO <sub>4</sub>	-42
Iodine trichloride	ICl <sub>3</sub>	-90.2	Magnesium sulfate monohydrate	MgSO <sub>4</sub> ·H <sub>2</sub> O	-61
Iodine pentafluoride	IF <sub>5</sub>	-58.1	Magnesium sulfate heptahydrate	MgSO <sub>4</sub> ·7H <sub>2</sub> O	-135.7
Iridium	Ir	+25	Manganese	Mn	+511
Iridium(III) chloride	IrCl <sub>3</sub>	-14.4	Manganese(II) bromide	MnBr <sub>2</sub>	+13900
Iridium(IV) oxide	IrO <sub>2</sub>	+224	Manganese(II) carbonate	MnCO <sub>3</sub>	+11400
Iron	Fe	Ferro	Manganese(II) chloride	MnCl <sub>2</sub>	+14350
Iron(II) bromide	FeBr <sub>2</sub>	+13600	Manganese(II) chloride tetrahydrate	MnCl <sub>2</sub> ·4H <sub>2</sub> O	+14600
Iron(II) carbonate	FeCO <sub>3</sub>	+11300	Manganese(II) fluoride	MnF <sub>2</sub>	+10700
Iron(II) chloride	FeCl <sub>2</sub>	+14750	Manganese(II) hydroxide	Mn(OH) <sub>2</sub>	+13500



Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
Manganese(II) iodide	MnI <sub>2</sub>	+14400	Niobium(V) oxide	Nb <sub>2</sub> O <sub>5</sub>	-10
Manganese(II) oxide	MnO	+4850	Nitrogen (g)	N <sub>2</sub>	-12.0
Manganese(II) sulfate	MnSO <sub>4</sub>	+13660	Nitric acid (l)	HNO <sub>3</sub>	-19.9
Manganese(II) sulfate monohydrate	MnSO <sub>4</sub> ·H <sub>2</sub> O	+14200	Nitrous oxide (g)	N <sub>2</sub> O	-18.9
Manganese(II) sulfate tetrahydrate	MnSO <sub>4</sub> ·4H <sub>2</sub> O	+14600	Nitric oxide (s, 90 K)	NO	+19.8
Manganese(II) sulfide (α form)	MnS	+5630	Nitric oxide (l, 118 K)	NO	+114.2
Manganese(II) sulfide (β form)	MnS	+3850	Nitric oxide (g)	NO	+1461
Manganese(II,III) oxide	Mn <sub>3</sub> O <sub>4</sub>	+12400	Nitrogen dioxide (g, 408 K)	NO <sub>2</sub>	+150
Manganese(III) fluoride	MnF <sub>3</sub>	+10500	Nitrogen trioxide (g)	N <sub>2</sub> O <sub>3</sub>	-16
Manganese(III) oxide	Mn <sub>2</sub> O <sub>3</sub>	+14100	Nitrogen tetroxide (g)	N <sub>2</sub> O <sub>4</sub>	-23.0
Manganese(IV) oxide	MnO <sub>2</sub>	+2280	Osmium	Os	+11
Mercury (s, 234 K)	Hg	-24.1	Oxygen (s, 54 K)	O <sub>2</sub>	+10200
Mercury (l)	Hg	-33.5	Oxygen (l, 90 K)	O <sub>2</sub>	+7699
Mercury(I) bromide	Hg <sub>2</sub> Br <sub>2</sub>	-105	Oxygen (g)	O <sub>2</sub>	+3415
Mercury(I) chloride	Hg <sub>2</sub> Cl <sub>2</sub>	-120	Ozone (l)	O <sub>3</sub>	+6.7
Mercury(I) fluoride	Hg <sub>2</sub> F <sub>2</sub>	-106	Palladium	Pd	+540
Mercury(I) iodide	Hg <sub>2</sub> I <sub>2</sub>	-166	Palladium(II) chloride	PdCl <sub>2</sub>	-38
Mercury(I) nitrate	Hg <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	-121	Phosphorus (white)	P	-26.66
Mercury(I) oxide	Hg <sub>2</sub> O	-76.3	Phosphorus (red)	P	-20.77
Mercury(I) sulfate	Hg <sub>2</sub> SO <sub>4</sub>	-123	Phosphine (g)	PH <sub>3</sub>	-26.2
Mercury(II) bromide	HgBr <sub>2</sub>	-94.2	Phosphoric acid (aq)	H <sub>3</sub> PO <sub>4</sub>	-43.8
Mercury(II) chloride	HgCl <sub>2</sub>	-82	Phosphorous acid (aq)	H <sub>3</sub> PO <sub>3</sub>	-42.5
Mercury(II) cyanide	Hg(CN) <sub>2</sub>	-67	Phosphorus(III) chloride (l)	PCl <sub>3</sub>	-63.4
Mercury(II) fluoride	HgF <sub>2</sub>	-57.3	Platinum	Pt	+193
Mercury(II) iodide	HgI <sub>2</sub>	-165	Platinum(II) chloride	PtCl <sub>2</sub>	-54
Mercury(II) nitrate	Hg(NO <sub>3</sub> ) <sub>2</sub>	-74	Platinum(III) chloride	PtCl <sub>3</sub>	-66.7
Mercury(II) oxide	HgO	-46	Platinum(IV) chloride	PtCl <sub>4</sub>	-93
Mercury(II) sulfate	HgSO <sub>4</sub>	-78.1	Platinum(IV) fluoride	PtF <sub>4</sub>	+445
Mercury(II) sulfide	HgS	-55.4	Plutonium	Pu	+525
Mercury(II) thiocyanate	Hg(SCN) <sub>2</sub>	-96.5	Plutonium(IV) fluoride	PuF <sub>4</sub>	+1760
Molybdenum	Mo	+72	Plutonium(IV) oxide	PuO <sub>2</sub>	+730
Molybdenum(III) bromide	MoBr <sub>3</sub>	+525	Plutonium(VI) fluoride	PuF <sub>6</sub>	+173
Molybdenum(III) chloride	MoCl <sub>3</sub>	+43	Potassium	K	+20.8
Molybdenum(III) oxide	Mo <sub>2</sub> O <sub>3</sub>	-42.0	Potassium bromate	KBrO <sub>3</sub>	-52.6
Molybdenum(IV) bromide	MoBr <sub>4</sub>	+520	Potassium bromide	KBr	-49.1
Molybdenum(IV) chloride	MoCl <sub>4</sub>	+1750	Potassium carbonate	K <sub>2</sub> CO <sub>3</sub>	-59
Molybdenum(IV) oxide	MoO <sub>2</sub>	+41	Potassium chlorate	KClO <sub>3</sub>	-42.8
Molybdenum(V) chloride	MoCl <sub>5</sub>	+990	Potassium chloride	KCl	-38.8
Molybdenum(VI) fluoride	MoF <sub>6</sub>	-26.0	Potassium chromate	K <sub>2</sub> CrO <sub>4</sub>	-3.9
Molybdenum(VI) oxide	MoO <sub>3</sub>	+3	Potassium cyanide	KCN	-37
Neodymium (α)	Nd	+5930	Potassium ferricyanide	K <sub>3</sub> Fe(CN) <sub>6</sub>	+2290
Neodymium fluoride	NdF <sub>3</sub>	+4980	Potassium ferrocyanide trihydrate	K <sub>4</sub> Fe(CN) <sub>6</sub> ·3H <sub>2</sub> O	-172.3
Neodymium oxide	Nd <sub>2</sub> O <sub>3</sub>	+10200	Potassium fluoride	KF	-23.6
Neodymium sulfate	Nd <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	+9990	Potassium hydrogen sulfate	KHSO <sub>4</sub>	-49.8
Neodymium sulfide	Nd <sub>2</sub> S <sub>3</sub>	+5550	Potassium hydroxide (aq)	KOH	-22
Neon (g)	Ne	-6.96	Potassium iodate	KIO <sub>3</sub>	-63.1
Neptunium	Np	+575	Potassium iodide	KI	-63.8
Nickel	Ni	Ferro.	Potassium nitrate	KNO <sub>3</sub>	-33.7
Nickel(II) bromide	NiBr <sub>2</sub>	+5600	Potassium nitrite	KNO <sub>2</sub>	-23.3
Nickel(II) chloride	NiCl <sub>2</sub>	+6145	Potassium permanganate	KMnO <sub>4</sub>	+20
Nickel(II) chloride hexahydrate	NiCl <sub>2</sub> ·6H <sub>2</sub> O	+4240	Potassium sulfate	K <sub>2</sub> SO <sub>4</sub>	-67
Nickel(II) fluoride	NiF <sub>2</sub>	+2410	Potassium sulfide	K <sub>2</sub> S	-60
Nickel(II) hydroxide	Ni(OH) <sub>2</sub>	+4500	Potassium superoxide	KO <sub>2</sub>	+3230
Nickel(II) iodide	NiI <sub>2</sub>	+3875	Potassium thiocyanate	KSCN	-48
Nickel(II) nitrate hexahydrate	Ni(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	+4300	Praseodymium (α)	Pr	+5530
Nickel(II) oxide	NiO	+660	Praseodymium chloride	PrCl <sub>3</sub>	+44.5
Nickel(II) sulfate	NiSO <sub>4</sub>	+4005	Praseodymium oxide	Pr <sub>2</sub> O <sub>3</sub>	+8994
Nickel(II) sulfide	NiS	+190	Praseodymium sulfide	Pr <sub>2</sub> S <sub>3</sub>	+10770
Nickel(III) sulfide	Ni <sub>3</sub> S <sub>2</sub>	+1030	Protactinium	Pa	+277
Niobium	Nb	+208	Rhenium	Re	+67

Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
Rhenium(IV) oxide	ReO <sub>2</sub>	+44	Sodium carbonate	Na <sub>2</sub> CO <sub>3</sub>	-41
Rhenium(IV) sulfide	ReS <sub>2</sub>	+38	Sodium chlorate	NaClO <sub>3</sub>	-34.7
Rhenium(V) chloride	ReCl <sub>5</sub>	+1225	Sodium chloride	NaCl	-30.2
Rhenium(VI) oxide	ReO <sub>3</sub>	+16	Sodium dichromate	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	+55
Rhenium(VII) oxide	Re <sub>2</sub> O <sub>7</sub>	-16	Sodium fluoride	NaF	-15.6
Rhodium	Rh	+102	Sodium hydrogen phosphate	Na <sub>2</sub> HPO <sub>4</sub>	-56.6
Rhodium(III) chloride	RhCl <sub>3</sub>	-7.5	Sodium hydroxide (aq)	NaOH	-15.8
Rhodium(III) oxide	Rh <sub>2</sub> O <sub>3</sub>	+104	Sodium iodate	NaIO <sub>3</sub>	-53
Rubidium	Rb	+17	Sodium iodide	NaI	-57
Rubidium bromide	RbBr	-56.4	Sodium nitrate	NaNO <sub>3</sub>	-25.6
Rubidium carbonate	Rb <sub>2</sub> CO <sub>3</sub>	-75.4	Sodium nitrite	NaNO <sub>2</sub>	-14.5
Rubidium chloride	RbCl	-46	Sodium oxide	Na <sub>2</sub> O	-19.8
Rubidium fluoride	RbF	-31.9	Sodium peroxide	Na <sub>2</sub> O <sub>2</sub>	-28.10
Rubidium iodide	RbI	-72.2	Sodium sulfate	Na <sub>2</sub> SO <sub>4</sub>	-52
Rubidium nitrate	RbNO <sub>3</sub>	-41	Sodium sulfate decahydrate	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	-184
Rubidium sulfate	Rb <sub>2</sub> SO <sub>4</sub>	-88.4	Sodium sulfide	Na <sub>2</sub> S	-39
Rubidium superoxide	RbO <sub>2</sub>	+1527	Sodium tetraborate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub>	-85
Ruthenium	Ru	+39	Strontium	Sr	+92
Ruthenium(III) chloride	RuCl <sub>3</sub>	+1998	Strontium bromide	SrBr <sub>2</sub>	-86.6
Ruthenium(IV) oxide	RuO <sub>2</sub>	+162	Strontium bromide hexahydrate	SrBr <sub>2</sub> ·6H <sub>2</sub> O	-160
Samarium (α)	Sm	+1278	Strontium carbonate	SrCO <sub>3</sub>	-47
Samarium(II) bromide	SmBr <sub>2</sub>	+5337	Strontium chlorate	Sr(ClO <sub>3</sub> ) <sub>2</sub>	-73
Samarium(III) bromide	SmBr <sub>3</sub>	+972	Strontium chloride	SrCl <sub>2</sub>	-61.5
Samarium(III) oxide	Sm <sub>2</sub> O <sub>3</sub>	+1988	Strontium chloride hexahydrate	SrCl <sub>2</sub> ·6H <sub>2</sub> O	-145
Samarium(III) sulfate octahydrate	Sm <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·8H <sub>2</sub> O	+1710	Strontium chromate	SrCrO <sub>4</sub>	-5.1
Samarium(III) sulfide	Sm <sub>2</sub> S <sub>3</sub>	+3300	Strontium fluoride	SrF <sub>2</sub>	-37.2
Scandium (α)	Sc	+295.2	Strontium hydroxide	Sr(OH) <sub>2</sub>	-40
Selenium	Se	-25	Strontium iodate	Sr(IO <sub>3</sub> ) <sub>2</sub>	-108
Selenium dioxide	SeO <sub>2</sub>	-27.2	Strontium iodide	SrI <sub>2</sub>	-112
Selenium bromide	Se <sub>2</sub> Br <sub>2</sub>	-113	Strontium nitrate	Sr(NO <sub>3</sub> ) <sub>2</sub>	-57.2
Selenium chloride (l)	Se <sub>2</sub> Cl <sub>2</sub>	-94.8	Strontium oxide	SrO	-35
Selenium hexafluoride (g)	SeF <sub>6</sub>	-51	Strontium peroxide	SrO <sub>2</sub>	-32.3
Silicon	Si	-3.12	Strontium sulfate	SrSO <sub>4</sub>	-57.9
Silane (g)	SiH <sub>4</sub>	-20.4	Sulfur (rhombic)	S	-15.5
Disilane (g)	Si <sub>2</sub> H <sub>6</sub>	-37.3	Sulfur (monoclinic)	S	-14.9
Tetramethylsilane (l)	(CH <sub>3</sub> ) <sub>4</sub> Si	-74.80	Sulfuric acid (l)	H <sub>2</sub> SO <sub>4</sub>	-39
Tetraethylsilane (l)	(C <sub>2</sub> H <sub>5</sub> ) <sub>4</sub> Si	-120.2	Sulfur dioxide (g)	SO <sub>2</sub>	-18.2
Tetrabromosilane (l)	SiBr <sub>4</sub>	-126	Sulfur trioxide (l)	SO <sub>3</sub>	-28.54
Tetrachlorosilane (l)	SiCl <sub>4</sub>	-87.5	Sulfur chloride (l)	SSCl <sub>2</sub>	-62.2
Silicon carbide	SiC	-12.8	Sulfur dichloride (l)	SCl <sub>2</sub>	-49.4
Silicon dioxide	SiO <sub>2</sub>	-29.6	Sulfur hexafluoride (g)	SF <sub>6</sub>	-44
Silver	Ag	-19.5	Thionyl chloride (l)	SOCl <sub>2</sub>	-44.3
Silver(I) bromide	AgBr	-61	Tantalum	Ta	+154
Silver(I) carbonate	Ag <sub>2</sub> CO <sub>3</sub>	-80.90	Tantalum(V) chloride	TaCl <sub>5</sub>	+140
Silver(I) chloride	AgCl	-49	Tantalum(V) oxide	Ta <sub>2</sub> O <sub>5</sub>	-32
Silver(I) chromate	Ag <sub>2</sub> CrO <sub>4</sub>	-40	Technetium	Tc	+115
Silver(I) cyanide	AgCN	-43.2	Tellurium	Te	-38
Silver(I) fluoride	AgF	-36.5	Tellurium dibromide	TeBr <sub>2</sub>	-106
Silver(I) iodide	AgI	-80	Tellurium dichloride	TeCl <sub>2</sub>	-94
Silver(I) nitrate	AgNO <sub>3</sub>	-45.7	Tellurium hexafluoride (g)	TeF <sub>6</sub>	-66
Silver(I) nitrite	AgNO <sub>2</sub>	-42	Terbium (α)	Tb	+170000
Silver(I) oxide	Ag <sub>2</sub> O	-134	Terbium oxide	Tb <sub>2</sub> O <sub>3</sub>	+78340
Silver(I) phosphate	Ag <sub>3</sub> PO <sub>4</sub>	-120	Thallium	Tl	-50
Silver(I) sulfate	Ag <sub>2</sub> SO <sub>4</sub>	-92.90	Thallium(I) bromate	TlBrO <sub>3</sub>	-75.9
Silver(I) thiocyanate	AgSCN	-61.8	Thallium(I) bromide	TlBr	-63.9
Silver(II) oxide	AgO	-19.6	Thallium(I) carbonate	Tl <sub>2</sub> CO <sub>3</sub>	-101.6
Sodium	Na	+16	Thallium(I) chlorate	TlClO <sub>3</sub>	-65.5
Sodium acetate	NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	-37.6	Thallium(I) chloride	TlCl	-57.8
Sodium bromate	NaBrO <sub>3</sub>	-44.2	Thallium(I) chromate	Tl <sub>2</sub> CrO <sub>4</sub>	-39.3
Sodium bromide	NaBr	-41	Thallium(I) cyanide	TlCN	-49

Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$	Name	Formula	$\chi_m/10^{-6} \text{ cm}^3 \text{ mol}^{-1}$
Thallium(I) fluoride	TlF	-44.4	Uranium(IV) bromide	U <sub>4</sub> Br <sub>4</sub>	+3530
Thallium(I) iodate	TlIO <sub>3</sub>	-86.8	Uranium(IV) chloride	UCl <sub>4</sub>	+3680
Thallium(I) iodide	TlI	-82.2	Uranium(IV) fluoride	UF <sub>4</sub>	+3530
Thallium(I) nitrate	TlNO <sub>3</sub>	-56.5	Uranium(IV) oxide	UO <sub>2</sub>	+2360
Thallium(I) nitrite	TlNO <sub>2</sub>	-50.8	Uranium(VI) fluoride	UF <sub>6</sub>	+43
Thallium(I) sulfate	Tl <sub>2</sub> SO <sub>4</sub>	-112.6	Uranium(VI) oxide	UO <sub>3</sub>	+128
Thallium(I) sulfide	Tl <sub>2</sub> S	-88.8	Vanadium	V	+285
Thorium	Th	+97	Vanadium(II) bromide	VBr <sub>2</sub>	+3230
Thorium(IV) oxide	ThO <sub>2</sub>	-16	Vanadium(II) chloride	VCl <sub>2</sub>	+2410
Thulium	Tm	+24700	Vanadium(III) bromide	VBr <sub>3</sub>	+2910
Thulium oxide	Tm <sub>2</sub> O <sub>3</sub>	+51444	Vanadium(III) chloride	VCl <sub>3</sub>	+3030
Tin (gray)	Sn	-37.4	Vanadium(III) fluoride	VF <sub>3</sub>	+2757
Tin(II) chloride	SnCl <sub>2</sub>	-69	Vanadium(III) oxide	V <sub>2</sub> O <sub>3</sub>	+1976
Tin(II) chloride dihydrate	SnCl <sub>2</sub> ·2H <sub>2</sub> O	-91.4	Vanadium(III) sulfide	V <sub>2</sub> S <sub>3</sub>	+1560
Tin(II) oxide	SnO	-19	Vanadium(IV) chloride	VCl <sub>4</sub>	+1215
Tin(IV) bromide	SnBr <sub>4</sub>	-149	Vanadium(IV) oxide	VO <sub>2</sub>	+99
Tin(IV) chloride (l)	SnCl <sub>4</sub>	-115	Vanadium(V) oxide	V <sub>2</sub> O <sub>5</sub>	+128
Tin(IV) oxide	SnO <sub>2</sub>	-41	Water (s, 273 K)	H <sub>2</sub> O	-12.63
Titanium	Ti	+151	Water (l, 293 K)	H <sub>2</sub> O	-12.96
Titanium(II) bromide	TiBr <sub>2</sub>	+720	Water (l, 373 K)	H <sub>2</sub> O	-13.09
Titanium(II) chloride	TiCl <sub>2</sub>	+484	Water (g, 373 K))	H <sub>2</sub> O	-13.1
Titanium(II) iodide	TiI <sub>2</sub>	+1790	Xenon (g)	Xe	-45.5
Titanium(II) sulfide	TiS	+432	Ytterbium (β)	Yb	+67
Titanium(III) bromide	TiBr <sub>3</sub>	+660	Yttrium (α)	Y	+187.7
Titanium(III) chloride	TiCl <sub>3</sub>	+1110	Yttrium oxide	Y <sub>2</sub> O <sub>3</sub>	+44.4
Titanium(III) fluoride	TiF <sub>3</sub>	+1300	Yttrium sulfide	Y <sub>2</sub> S <sub>3</sub>	+100
Titanium(III) oxide	Ti <sub>2</sub> O <sub>3</sub>	+132	Zinc	Zn	-9.15
Titanium(IV) chloride	TiCl <sub>4</sub>	-54	Zinc carbonate	ZnCO <sub>3</sub>	-34
Titanium(IV) oxide	TiO <sub>2</sub>	+5.9	Zinc chloride	ZnCl <sub>2</sub>	-55.33
Tungsten	W	+53	Zinc cyanide	Zn(CN) <sub>2</sub>	-46
Tungsten carbide	WC	+10	Zinc fluoride	ZnF <sub>2</sub>	-34.3
Tungsten(II) chloride	WCl <sub>2</sub>	-25	Zinc hydroxide	Zn(OH) <sub>2</sub>	-67
Tungsten(IV) oxide	WO <sub>2</sub>	+57	Zinc iodide	ZnI <sub>2</sub>	-108
Tungsten(IV) sulfide	WS <sub>2</sub>	+5850	Zinc oxide	ZnO	-27.2
Tungsten(V) bromide	WBr <sub>5</sub>	+270	Zinc phosphate	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	-141
Tungsten(V) chloride	WCl <sub>5</sub>	+387	Zinc sulfate	ZnSO <sub>4</sub>	-47.8
Tungsten(VI) chloride	WCl <sub>6</sub>	-71	Zinc sulfate monohydrate	ZnSO <sub>4</sub> ·H <sub>2</sub> O	-63
Tungsten(VI) fluoride (g)	WF <sub>6</sub>	-53	Zinc sulfate heptahydrate	ZnSO <sub>4</sub> ·7H <sub>2</sub> O	-138
Tungsten(VI) oxide	WO <sub>3</sub>	-15.8	Zinc sulfide	ZnS	-25
Uranium	U	+409	Zirconium	Zr	+120
Uranium(III) bromide	UBr <sub>3</sub>	+4740	Zirconium carbide	ZrC	-26
Uranium(III) chloride	UCl <sub>3</sub>	+3460	Zirconium nitrate pentahydrate	Zr(NO <sub>3</sub> ) <sub>4</sub> ·5H <sub>2</sub> O	-77
Uranium(III) hydride	UH <sub>3</sub>	+6244	Zirconium(IV) oxide	ZrO <sub>2</sub>	-13.8
Uranium(III) iodide	UI <sub>3</sub>	+4460			

# INDEX OF REFRACTION OF INORGANIC LIQUIDS

This table gives the index of refraction  $n$  of several inorganic substances in the liquid state at specified temperatures. The measurements refer to ambient atmospheric pressure except for substances whose normal boiling points are greater than the indicated temperature; in this case the pressure is the saturated vapor pressure of the substance. All values refer to a wavelength of 589 nm unless otherwise indicated. Entries are arranged in alphabetical order by chemical formula as normally written.

Data on the index of refraction at other temperatures and wavelengths may be found in Reference 1.

## References

1. Wohlfarth, C., and Wohlfarth, B., *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, New Series, III/38A*, Martienssen, W., Editor, Springer-Verlag, Heidelberg, 1996.
2. Francis, A.W., *J. Chem. Eng. Data*, 5, 534, 1960.

Formula	Name	$t/^\circ\text{C}$	$n$	Formula	Name	$t/^\circ\text{C}$	$n$
Ar	Argon	-188	1.2312	He	Helium	-269	1.02451 <sup>c</sup>
AsCl <sub>3</sub>	Arsenic(III) chloride	16	1.604	Kr	Krypton	-157	1.3032 <sup>c</sup>
BBr <sub>3</sub>	Boron tribromide	16	1.312	NH <sub>3</sub>	Ammonia	-77	1.3944 <sup>b</sup>
BrF <sub>3</sub>	Bromine trifluoride	25	1.4536			20	1.3327
BrF <sub>5</sub>	Bromine pentafluoride	25	1.3529	NO	Nitric oxide	-90	1.330
Br <sub>2</sub>	Bromine	15	1.659	N <sub>2</sub>	Nitrogen	-196	1.19876 <sup>b</sup>
COS	Carbon oxysulfide	25	1.3506	N <sub>2</sub> H <sub>4</sub>	Hydrazine	22	1.470
CO <sub>2</sub>	Carbon dioxide	24	1.6630	N <sub>2</sub> O	Nitrous oxide	25	1.238
CS <sub>2</sub>	Carbon disulfide	20	1.62774	O <sub>2</sub>	Oxygen	-183	1.2243 <sup>c</sup>
C <sub>3</sub> O <sub>2</sub>	Carbon suboxide	0	1.453	PBr <sub>3</sub>	Phosphorus(III) bromide	25	1.687
Cl <sub>2</sub>	Chlorine	20	1.3834	PCl <sub>3</sub>	Phosphorus(III) chloride	21	1.5122
CrO <sub>2</sub> Cl <sub>2</sub>	Chromyl chloride	23	1.524	PH <sub>3</sub>	Phosphine	17	1.317
Fe(CO) <sub>5</sub>	Iron pentacarbonyl	14	1.523	P <sub>2</sub> O <sub>3</sub>	Phosphorus(III) oxide	27	1.540
GeBr <sub>4</sub>	Germanium(IV) bromide	26	1.6269	S	Sulfur	125	1.9170
GeCl <sub>4</sub>	Germanium(IV) chloride	25	1.4614	SCl <sub>2</sub>	Sulfur dichloride	14	1.557
HBr	Hydrogen bromide	10	1.325	SF <sub>6</sub>	Sulfur hexafluoride	25	1.167
HCN	Hydrogen cyanide	20	1.26136	SOCl <sub>2</sub>	Thionyl chloride	10	1.527
HCl	Hydrogen chloride	18	1.3287 <sup>a</sup>	SO <sub>2</sub>	Sulfur dioxide	25	1.3396
HClO <sub>4</sub>	Perchloric acid	50	1.3819	SO <sub>2</sub> Cl <sub>2</sub>	Sulfuryl chloride	12	1.444
HF	Hydrogen fluoride	25	1.1574	SO <sub>3</sub>	Sulfur trioxide	20	1.40965
HI	Hydrogen iodide	16	1.466	SSCl <sub>2</sub>	Sulfur chloride	20	1.671
HNO <sub>3</sub>	Nitric acid	25	1.393	SbCl <sub>5</sub>	Antimony(V) chloride	22	1.5925
H <sub>2</sub>	Hydrogen	-253	1.1096	SiBr <sub>4</sub>	Tetrabromosilane	31	1.5685
H <sub>2</sub> O	Water	20	1.33336	SiCl <sub>4</sub>	Tetrachlorosilane	25	1.41156
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide	28	1.4061	SnBr <sub>4</sub>	Tin(IV) bromide	31	1.6628
H <sub>2</sub> S	Hydrogen sulfide	-80	1.460	SnCl <sub>4</sub>	Tin(IV) chloride	25	1.5086
		20	1.3682	TiCl <sub>4</sub>	Titanium(IV) chloride	18	1.6076
H <sub>2</sub> SO <sub>4</sub>	Sulfuric acid	20	1.4183	Xe	Xenon	-112	1.3918 <sup>c</sup>
H <sub>2</sub> S <sub>2</sub>	Hydrogen disulfide	20	1.630				

<sup>a</sup> At 581 nm

<sup>b</sup> At 578 nm

<sup>c</sup> At 546 nm

## PHYSICAL AND OPTICAL PROPERTIES OF MINERALS

The chemical formula, crystal system, density, hardness, and index of refraction of some common minerals are given in this table. Entries are arranged alphabetically by mineral name. The columns are:

- ◆ **Formula:** Chemical formula for a typical sample of the mineral. Composition often varies considerably with the origin of the sample.
- ◆ **Crystal system:** tricl = triclinic; monocl = monoclinic; orth = orthorhombic; tetr = tetragonal; hex = hexagonal; rhomb = rhombohedral; cub = cubic.
- ◆ **Density:** Typical density in g/cm<sup>3</sup>. Individual samples may vary by a few percent.
- ◆ **Hardness:** On the Mohs' scale (range of 1 to 10, with talc = 1 and diamond = 10).
- ◆ **Index of refraction:** Values are given for the three coordinate axes in the order of least, intermediate, and greatest

index. For cubic crystals there is only a single value. See Reference 1 for details on the axis systems. Variations of several percent, depending on the origin and exact composition of the sample, are common.

### References

1. Deer, W. A., Howie, R. A., and Zussman, J., *An Introduction to the Rock-Forming Minerals*, 2nd Edition, Longman Scientific & Technical, Harlow, Essex, 1992.
2. Carmichael, R. S., *Practical Handbook of Physical Properties of Rocks and Minerals*, CRC Press, Boca Raton, FL, 1989.
3. Donnay, J. D. H., and Ondik, H. M., *Crystal Data Determinative Tables, Third Edition, Volume 2, Inorganic Compounds*, Joint Committee on Powder Diffraction Standards, Swarthmore, PA, 1973.

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					n <sub>α</sub>	n <sub>β</sub>	n <sub>γ</sub>
Acanthite	Ag <sub>2</sub> S	orth	7.2	2.3			
Actinolite	Ca <sub>2</sub> (Mg,Fe) <sub>5</sub> Si <sub>8</sub> O <sub>22</sub> (OH,F) <sub>2</sub>	monocl	3.23	5.5	1.624	1.655	1.664
Aegirine	NaFe(SiO <sub>3</sub> ) <sub>2</sub>	monocl	3.58	6	1.763	1.800	1.815
Akermanite	Ca <sub>2</sub> MgSi <sub>2</sub> O <sub>7</sub>	tetr	2.94	5.5	1.632	1.640	
Alabandite	MnS	cub	4.0	3.8			
Albite	NaAlSi <sub>3</sub> O <sub>8</sub>	tricl	2.63	6.3	1.527	1.531	1.538
Allanite	(Ca,Mn,Ce,La,Y,Th) <sub>2</sub> (Fe,Ti)(Al,Fe)O·OH (Si <sub>2</sub> O <sub>7</sub> )(SiO <sub>4</sub> )	monocl	3.8	5.8	1.75	1.78	1.80
Allemontite	SbAs	hex	6.0	3.5			
Almandine	Fe <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	4.32	6.8	1.830		
Altaite	PbTe	cub	8.16	3			
Aluminite	Al <sub>2</sub> (SO <sub>4</sub> )(OH) <sub>7</sub> ·7H <sub>2</sub> O	monocl	1.74	1.5	1.459	1.464	1.470
Alunite	(K,Na)Al <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	rhomb	2.8	3.8	1.572	1.592	
Alunogen	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O	monocl	1.69	1.8	1.467	1.47	1.478
Amblygonite	(Li,Na)Al(PO <sub>4</sub> )(F,OH)	tricl	3.1	5.8	1.591	1.604	1.613
Analcite	NaAlSi <sub>2</sub> O <sub>6</sub> ·H <sub>2</sub> O	cub	2.27	5.5	1.486		
Anatase	TiO <sub>2</sub>	tetr	4.23	5.8	2.488	2.561	
Andalusite	Al <sub>2</sub> O <sub>3</sub> SiO <sub>4</sub>	orth	3.15	7.5	1.635	1.639	1.644
Andesine	NaAlSi <sub>3</sub> O <sub>8</sub> ·CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	tricl	2.67	6.3	1.550	1.553	1.557
Andorite	PbAgSb <sub>3</sub> S <sub>6</sub>	rhomb	5.35	3.3			
Andradite	Ca <sub>3</sub> (Fe,Ti) <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	3.86	6.8	1.887		
Anglesite	PbSO <sub>4</sub>	orth	6.29	2.8	1.877	1.883	1.894
Anhydrite	CaSO <sub>4</sub>	orth	2.96	3.5	1.570	1.575	1.614
Ankerite	Ca(Fe,Mg,Mn)(CO <sub>3</sub> ) <sub>2</sub>	rhomb	3.0	3.8	1.529	1.720	
Anorthite	CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	tricl	2.76	6.3	1.577	1.585	1.590
Anorthoclase	(Na,K)AlSi <sub>3</sub> O <sub>8</sub>	tricl	2.58	6	1.523	1.528	1.529
Anthophyllite	(Mg,Fe) <sub>7</sub> Si <sub>8</sub> O <sub>22</sub> (OH,F) <sub>2</sub>	rhomb	3.21	5.8	1.645	1.658	1.668
Apatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> (OH,F,Cl)	hex	3.2	5	1.645	1.648	
Apophyllite	KFCa <sub>4</sub> Si <sub>8</sub> O <sub>20</sub> ·8H <sub>2</sub> O	tetr	2.35	4.8	1.535	1.536	
Aragonite	CaCO <sub>3</sub>	orth	2.83	3.5	1.531	1.680	1.686
Arcanite	K <sub>2</sub> SO <sub>4</sub>	orth	2.66		1.494	1.494	1.497
Argentite	Ag <sub>2</sub> S	orth	7.2	2.3			
Arsenolite	As <sub>2</sub> O <sub>3</sub>	cub	3.86	1.5	1.755		
Arsenopyrite	FeAsS	monocl	6.1	5.8			
Atacamite	Cu <sub>2</sub> (OH) <sub>3</sub> Cl	rhomb	3.76	3.3	1.831	1.861	1.880
Augelite	Al <sub>2</sub> (PO <sub>4</sub> )(OH) <sub>3</sub>	monocl	2.70	4.8	1.574	1.576	1.588
Augite	(Ca,Mg,Fe,Ti,Al) <sub>2</sub> (Si,Al) <sub>2</sub> O <sub>6</sub>	monocl	3.38	6	1.703	1.707	1.738
Autunite	Ca(UO <sub>2</sub> ) <sub>2</sub> (PO <sub>4</sub> ) <sub>2</sub> ·10H <sub>2</sub> O	tetr	3.2	2.3	1.553	1.577	
Axinite	(Ca,Mn,Fe) <sub>3</sub> Al <sub>2</sub> BO <sub>3</sub> Si <sub>4</sub> O <sub>12</sub> (OH)	tricl	3.31	6.8	1.684	1.691	1.694

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					$n_\alpha$	$n_\beta$	$n_\gamma$
Azurite	$\text{Cu}_3(\text{OH})_2(\text{CO}_3)_2$	monocl	3.77	3.8	1.730	1.758	1.838
Baddeleyite	$\text{ZrO}_2$	monocl	5.7	6.5	2.13	2.19	2.20
Barite	$\text{BaSO}_4$	orth	4.49	3.3	1.636	1.637	1.648
Benitoite	$\text{BaTi}(\text{SiO}_3)_3$	rhomb	3.65	6.3	1.757	1.804	
Bertrandite	$\text{Be}_4\text{Si}_2\text{O}_7(\text{OH})_2$	rhomb	2.6	6	1.589	1.602	1.613
Beryl	$\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$	hex	2.64	7.8	1.582	1.589	
Beryllonite	$\text{NaBe}(\text{PO})_4$	monocl	2.81	5.8	1.552	1.558	1.561
Biotite	$\text{K}(\text{Mg},\text{Fe})_3\text{AlSi}_3\text{O}_{10}(\text{OH},\text{F})_2$	monocl	3.0	2.8	1.595	1.651	1.651
Bismuthinite	$\text{Bi}_2\text{S}_3$	orth	6.78	2			
Bixbyite	$(\text{Mn},\text{Fe})_2\text{O}_3$	cub	4.95	6.3			
Bloedite	$\text{Na}_2\text{Mg}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$	monocl	2.25	2.8	1.483	1.486	1.487
Boehmite	$\text{AlO}(\text{OH})$	orth	3.44	3.8	1.64	1.65	1.66
Boracite	$\text{Mg}_3\text{B}_7\text{O}_{13}\text{Cl}$	rhomb	2.94	7.3	1.66	1.66	1.67
Borax	$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	monocl	1.73	2.3	1.447	1.469	1.472
Bornite	$\text{Cu}_5\text{FeS}_4$	cub	5.07	3			
Boulangerite	$\text{Pb}_5\text{Sb}_4\text{S}_{11}$	monocl	6.1	2.8			
Bournonite	$\text{PbCuSbS}_3$	rhomb	5.83	2.8			
Braggite	$\text{PtS}$	tetr	10.2				
Braunite	$(\text{Mn},\text{Si})_2\text{O}_3$	tetr	4.78	6.3			
Bravoite	$(\text{Ni},\text{Fe})\text{S}_2$	cub	4.62	5.8			
Breithauptite	$\text{NiSb}$	hex	≈8.7	5.5			
Brochantite	$\text{Cu}_4(\text{SO}_4)(\text{OH})_6$	monocl	3.79	3.8	1.728	1.771	1.800
Bromyrite	$\text{AgBr}$	cub	6.47	2.5	2.253		
Brookite	$\text{TiO}_2$	orth	4.23	5.8	2.583	2.584	2.700
Brucite	$\text{Mg}(\text{OH})_2$	hex	2.37	2.5	1.575	1.59	
Bunsenite	$\text{NiO}$	cub	6.72	5.5			
Cacoxenite	$\text{Fe}_4(\text{PO}_4)_3(\text{OH})_3 \cdot 12\text{H}_2\text{O}$	hex	2.3	3.5	1.580	1.646	
Calcite	$\text{CaCO}_3$	hex	2.71	3	1.486	1.658	
Caledonite	$\text{Cu}_2\text{Pb}_5(\text{SO}_4)_3(\text{CO}_3)(\text{OH})_6$	rhomb	5.76	2.8	1.818	1.866	1.909
Calomel	$\text{Hg}_2\text{Cl}_2$	tetr	7.16	1.5	1.973	2.656	
Cancrinite	$(\text{Na},\text{Ca},\text{K})_7[\text{Al}_5\text{Si}_6\text{O}_{24}](\text{CO}_3,\text{SO}_4,\text{Cl},\text{OH})_2 \cdot \text{H}_2\text{O}$	hex	2.42	5.5	1.495	1.509	
Carnalite	$\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$	rhomb	1.60	2.5	1.466	1.475	1.494
Carnotite	$\text{K}_2(\text{UO}_2)_2(\text{VO}_4)_2 \cdot 3\text{H}_2\text{O}$	rhomb	1.5	1.5	1.75	1.92	1.95
Cassiterite	$\text{SnO}_2$	tetr	6.85	6.5	2.006	2.097	
Celestite	$\text{SrSO}_4$	orth	3.96	3.3	1.622	1.624	1.631
Celsian	$\text{BaAl}_2\text{Si}_2\text{O}_8$	monocl	3.25	6.3	1.583	1.588	1.594
Cerargyrite	$\text{AgCl}$	cub	5.56	2.5	2.071		
Cerussite	$\text{PbCO}_3$	orth	6.6	3.3	1.804	2.076	2.079
Cervantite	$\text{Sb}_2\text{O}_4$	orth	6.64	4.5			
Chabazite	$\text{Ca}[\text{Al}_2\text{Si}_4\text{O}_{12}] \cdot 6\text{H}_2\text{O}$	trig	2.08	4.5	1.482		
Chalcanthite	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	tricl	2.29	2.5	1.514	1.537	1.543
Chalcocite	$\text{Cu}_2\text{S}$	orth	5.6	2.8			
Chalcocopyrite	$\text{CuFeS}_2$	tetr	4.2	3.8			
Chiolite	$\text{Na}_5\text{Al}_3\text{F}_{14}$	tetr	3.00	3.8	1.342	1.349	
Chlorite	$(\text{Mg},\text{Al},\text{Fe})_{12}(\text{Si},\text{Al})_8\text{O}_{20}(\text{OH})_{16}$	monocl	3.0	2.5	1.61	1.62	1.62
Chloritoid	$\text{FeAl}_4\text{O}_2(\text{SiO}_4)_2(\text{OH})_4$	monocl	3.66	6.5	1.717	1.721	1.726
Chondrodite	$\text{Mg}(\text{OH},\text{F})_2 \cdot 2\text{Mg}_2\text{SiO}_4$	monocl	3.21	6.5	1.604	1.615	1.634
Chromite	$\text{FeCr}_2\text{O}_4$	cub	5.0	5.5	2.16		
Chrysoberyl	$\text{BeAl}_2\text{O}_4$	orth	3.65	8.5	1.746	1.748	1.756
Chrysocolla	$\text{CuSiO}_3 \cdot 2\text{H}_2\text{O}$	rhomb	2.4	2	1.575	1.597	1.598
Cinnabar	$\text{HgS}$	hex	8.17	2.3	2.814	3.143	
Claudette	$\text{As}_2\text{O}_3$	monocl	3.74	2.5	1.87	1.92	2.01
Clinohumite	$\text{Mg}(\text{OH},\text{F})_2 \cdot 4\text{Mg}_2\text{SiO}_4$	monocl	3.21	6	1.633	1.647	1.668
Clinozoisite	$\text{Ca}_2\text{Al}_3\text{Si}_3\text{O}_{12}(\text{OH})$	monocl	3.30	6.5	1.693	1.700	1.712
Cobaltite	$\text{CoAsS}$	cub	≈6.1	5.5			
Colemanite	$\text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$	monocl	2.42	4.5	1.586	1.592	1.614
Columbite	$(\text{Fe},\text{Mn})(\text{Nb},\text{Ta})_2\text{O}_6$	rhomb	5.20	6			
Connellite	$\text{Cu}_{19}(\text{SO}_4)\text{Cl}_4(\text{OH})_{32} \cdot 3\text{H}_2\text{O}$	hex	3.36	3	1.731	1.752	
Copiapite	$(\text{Fe},\text{Mg})\text{Fe}_4(\text{SO}_4)_6(\text{OH})_2 \cdot 20\text{H}_2\text{O}$	tricl	2.13	2.8	1.52	1.54	1.59
Coquimbite	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	hex	2.1	2.5	1.54	1.56	

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					$n_{\alpha}$	$n_{\beta}$	$n_{\gamma}$
Cordierite	Al <sub>3</sub> (Mg,Fe) <sub>2</sub> Si <sub>5</sub> AlO <sub>18</sub>	rhomb	2.66	7	1.540	1.549	1.553
Corundum	Al <sub>2</sub> O <sub>3</sub>	hex	3.97	9	1.761	1.769	
Cotunnite	PbCl <sub>2</sub>	orth	5.98	2.5	2.199	2.217	2.260
Covellite	CuS	hex	4.8	1.8			
Cristobalite	SiO <sub>2</sub>	hex	2.33	6.5	1.484	1.487	
Crocoite	PbCrO <sub>4</sub>	monocl	6.12	2.8	2.29	2.36	2.66
Cryolite	Na <sub>3</sub> AlF <sub>6</sub>	monocl	2.97	2.5	1.338	1.338	1.339
Cryolithionite	Na <sub>3</sub> Li <sub>3</sub> Al <sub>2</sub> F <sub>12</sub>	cub	2.77	2.8	1.340		
Cubanite	CuFe <sub>2</sub> S <sub>3</sub>	rhomb	4.11	3.5			
Cummingtonite	(Mg,Fe) <sub>7</sub> Si <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	monocl	3.4	5.5	1.650	1.660	1.676
Cuprite	Cu <sub>2</sub> O	cub	6.0	3.8			
Danburite	CaSi <sub>2</sub> B <sub>2</sub> O <sub>8</sub>	rhomb	3.0	7	1.63	1.63	1.63
Datolite	CaBSiO <sub>4</sub> (OH)	monocl	2.98	5.3	1.624	1.652	1.668
Daubreelite	Cr <sub>2</sub> FeS <sub>4</sub>	cub	3.81				
Derbylite	Fe <sub>6</sub> Ti <sub>6</sub> Sb <sub>2</sub> O <sub>23</sub>	rhomb	4.53	5	2.45	2.45	2.51
Diamond	C	cub	3.51	10	2.418		
Diaspore	AlO(OH)	orth	3.4	6.8	1.694	1.715	1.741
Digenite	Cu <sub>2-x</sub> S	cub	5.55	2.8			
Diopside	CaMgSi <sub>2</sub> O <sub>6</sub>	monocl	3.30	6	1.680	1.687	1.708
Diopside	CuSiO <sub>2</sub> (OH) <sub>2</sub>	rhomb	3.5	5	1.65	1.70	
Dolomite	CaMg(CO <sub>3</sub> ) <sub>2</sub>	rhomb	2.86	3.5	1.500	1.679	
Douglasite	K <sub>2</sub> FeCl <sub>4</sub> ·2H <sub>2</sub> O	orth	2.16		1.488	1.500	
Dyscrasite	Ag <sub>3</sub> Sb	rhomb	9.74	3.8			
Eddingtonite	BaAl <sub>2</sub> Si <sub>3</sub> O <sub>10</sub> ·4H <sub>2</sub> O	rhomb	2.8		1.541	1.553	1.557
Eglestonite	Hg <sub>2</sub> OCl <sub>2</sub>	cub	8.4	2.5	2.49		
Emplectite	CuBiS <sub>2</sub>	rhomb	6.38	2			
Enargite	Cu <sub>3</sub> AsS <sub>4</sub>	rhomb	4.5	3			
Enstatite	MgSiO <sub>3</sub>	monocl	3.19	5.5	1.656	1.662	1.669
Epidote	Ca <sub>2</sub> Al <sub>2</sub> (Al,Fe)OH(SiO <sub>4</sub> ) <sub>3</sub>	monocl	3.44	6	1.733	1.755	1.765
Epsomite	MgSO <sub>4</sub> ·7H <sub>2</sub> O	orth	1.67	2.3	1.433	1.455	1.461
Erythrite	(Co,Ni) <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	monocl	3.06	2	1.626	1.661	1.699
Eucairite	CuAgSe	orth	7.7	2.5			
Euclase	BeAlSiO <sub>4</sub> (OH)	monocl	3.1	7.5	1.651	1.655	1.671
Eudialite	(Na,Ca,Ce) <sub>5</sub> (Fe,Mn)(Zr,Ti)(Si <sub>3</sub> O <sub>9</sub> ) <sub>2</sub> (OH,Cl)	hex	3.0	5.5	1.623	1.600	1.615
Eulytite	Bi <sub>4</sub> Si <sub>3</sub> O <sub>12</sub>	cub	6.6	4.5	2.05		
Euxenite	(Y,Ca,Ce,U,Th)(Nb,Ta,Ti) <sub>2</sub> O <sub>6</sub>	rhomb	5.5	6	2.2		
Fayalite	Fe <sub>2</sub> SiO <sub>4</sub>	orth	4.30	6.5	1.827	1.869	1.879
Ferberite	FeWO <sub>4</sub>	monocl	7.51	4.3			
Fergusonite	(Y,Er,Ce,Fe)(Nb,Ta,Ti)O <sub>4</sub>	tetr	5.7	6	2.1		
Fluorite	CaF <sub>2</sub>	cub	3.18	4	1.434		
Forsterite	Mg <sub>2</sub> SiO <sub>4</sub>	orth	3.21	7	1.635	1.651	1.670
Franklinite	ZnFe <sub>2</sub> O <sub>4</sub>	cub	5.21	6	2.36		
Gahnite	ZnAl <sub>2</sub> O <sub>4</sub>	cub	4.62	7.8	1.805		
Galaxite	MnAl <sub>2</sub> O <sub>4</sub>	cub	4.04	7.8	1.92		
Galena	PbS	cub	7.60	2.5	3.91		
Galenabismuthite	PbBi <sub>2</sub> S <sub>4</sub>	rhomb	7.04	3			
Ganomalite	(Ca,Pb) <sub>10</sub> (OH,Cl) <sub>2</sub> (Si <sub>2</sub> O <sub>7</sub> ) <sub>3</sub>	hex	5.6	3.5	1.910	1.945	
Gaylussite	Na <sub>2</sub> Ca(CO <sub>3</sub> ) <sub>2</sub> ·5H <sub>2</sub> O	monocl	1.99	2.8	1.444	1.516	1.523
Gehlenite	Ca <sub>2</sub> Al <sub>2</sub> SiO <sub>7</sub>	tetr	3.04	5.5	1.658	1.669	
Geikielite	MgTiO <sub>3</sub>	hex	3.85	5.5	1.95	2.31	
Gibbsite	Al(OH) <sub>3</sub>	monocl	2.42	3	1.57	1.57	1.59
Glauberite	Na <sub>2</sub> Ca(SO <sub>4</sub> ) <sub>2</sub>	monocl	2.80	2.8	1.515	1.535	1.536
Glaucosite	(K,Na,Ca) <sub>1,6</sub> (Fe,Al,Mg) <sub>4,0-1,7,3</sub> Al <sub>0,7</sub> O <sub>20</sub> (OH) <sub>4</sub>	monocl	2.7	2	1.60	1.63	1.63
Glaucophane	Na <sub>2</sub> Mg <sub>3</sub> Al <sub>2</sub> Si <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	monocl	3.19	6	1.634	1.645	1.648
Gmelinite	(Ca,Na) <sub>2</sub> [Al <sub>2</sub> Si <sub>4</sub> O <sub>12</sub> ]·6H <sub>2</sub> O	hex	2.10	4.5	1.477	1.485	
Goethite	FeO(OH)	orth	4.3	5.3	2.268	2.401	2.457
Goslarite	ZnSO <sub>4</sub> ·7H <sub>2</sub> O	orth	1.97	2.3	1.457	1.480	1.484
Greenockite	CdS	hex	4.8	3.3	2.506	2.529	
Grossularite	Ca <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	3.59	6.8	1.734		
Gummite	UO <sub>3</sub> ·H <sub>2</sub> O	orth	7.05	3.8			

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					$n_\alpha$	$n_\beta$	$n_\gamma$
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	monocl	2.32	2	1.520	1.525	1.530
Halite	NaCl	cub	2.17	2	1.544		
Hamburgite	Be <sub>2</sub> (OH)(BO <sub>3</sub> )	rhomb	2.36	7.5	1.56	1.59	1.63
Hanksite	Na <sub>22</sub> K(SO <sub>4</sub> ) <sub>9</sub> (CO <sub>3</sub> ) <sub>2</sub> Cl	hex	2.56	3.3	1.461	1.481	
Harmotome	Ba[Al <sub>2</sub> Si <sub>6</sub> O <sub>16</sub> ]·6H <sub>2</sub> O	monocl	2.44	4.5	1.506	1.507	1.511
Hausmannite	Mn <sub>3</sub> O <sub>4</sub>	tetr	4.84	5.5	2.15	2.46	
Haüyne	(Na,Ca) <sub>4-8</sub> Al <sub>6</sub> Si <sub>6</sub> O <sub>24</sub> (SO <sub>4</sub> ,S) <sub>1-2</sub>	cub	2.47	5.8	1.502		
Hedenbergite	CaFeSi <sub>2</sub> O <sub>6</sub>	monocl	3.53	6	1.721	1.727	1.746
Helvite	Mn <sub>3</sub> Be <sub>3</sub> Si <sub>3</sub> O <sub>12</sub> S	cub	3.32	6	1.739		
Hematite	Fe <sub>2</sub> O <sub>3</sub>	hex	5.25	6	2.91	3.19	
Hemimorphite	Zn <sub>4</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> ·H <sub>2</sub> O	rhomb	3.45	5	1.614	1.617	1.636
Hercynite	Fe(AlO <sub>2</sub> ) <sub>2</sub>	cub	4.3	7.8	1.835		
Herderite	CaBe(PO <sub>4</sub> )(Fe,OH)	monocl	2.98	5.3	1.592	1.612	1.621
Hessite	Ag <sub>2</sub> Te	orth	8.4	2.5			
Heulandite	(Ca,Na,K) <sub>2</sub> [Al <sub>2</sub> Si <sub>7</sub> O <sub>18</sub> ]·6H <sub>2</sub> O	monocl	2.2	3.8	1.498	1.498	1.506
Hopeite	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	orth	3.0	3.2	1.58	1.59	1.59
Hornblende	Ca <sub>2</sub> (Mg,Fe)Al(Si <sub>7</sub> AlO <sub>22</sub> )(OH) <sub>2</sub>	monocl	3.24	5.5	1.67	1.67	1.69
Huebnerite	MnWO <sub>4</sub>	monocl	7.2	4.3	2.17	2.22	2.32
Humite	Mg(OH,F) <sub>2</sub> ·3Mg <sub>2</sub> SiO <sub>4</sub>	orth	3.3	6	1.625	1.636	1.657
Huntite	Mg <sub>3</sub> Ca(CO <sub>3</sub> ) <sub>4</sub>	trig	2.70				
Hydrogrossularite	Ca <sub>3</sub> Al <sub>2</sub> Si <sub>2</sub> O <sub>8</sub> (SiO <sub>4</sub> ) <sub>1-m</sub> (OH) <sub>4m</sub>	cub	3.4	6.8	1.70		
Hydromagnesite	3MgCO <sub>3</sub> ·Mg(OH) <sub>2</sub> ·3H <sub>2</sub> O	monocl	2.24	3.5	1.523	1.527	1.545
Illite	KAl <sub>4</sub> (Si <sub>7</sub> AlO <sub>20</sub> )(OH) <sub>4</sub>	monocl	2.8	1.5	1.56	1.59	1.59
Ilmenite	FeTiO <sub>3</sub>	rhomb	4.72	5.5			
Iodyrite	AgI	hex	5.68	1.5	2.21	2.22	
Jacobsite	MnFe <sub>2</sub> O <sub>4</sub>	cub	4.87	7.8	2.3		
Jadeite	NaAlSi <sub>2</sub> O <sub>6</sub>	monocl	3.34	6	1.649	1.654	1.663
Jamesonite	Pb <sub>4</sub> FeSb <sub>6</sub> S <sub>14</sub>	monocl	5.63	2.5			
Jarosite	KFe <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	rhomb	3.09	3	1.715	1.820	
Kainite	KMg(SO <sub>4</sub> )Cl·3H <sub>2</sub> O	monocl	2.15	2.8	1.494	1.505	1.516
Kaliophyllite	KAlSiO <sub>4</sub>	hex	2.61	6	1.532	1.537	
Kaolinite	Al <sub>4</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>8</sub>	tricl	2.65	2.3	1.549	1.564	1.565
Kernite	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·4H <sub>2</sub> O	monocl	1.95	2.5	1.454	1.472	1.488
Kieserite	MgSO <sub>4</sub> ·H <sub>2</sub> O	monocl	2.57	3.5	1.520	1.533	1.584
Kyanite	Al <sub>2</sub> O <sub>3</sub> SiO <sub>4</sub>	tricl	3.59	6.3	1.715	1.722	1.731
Lanarkite	Pb <sub>2</sub> (SO <sub>4</sub> )O	monocl	6.92	2.3	1.928	2.007	2.036
Lanthanite	(La,Ce) <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> ·8H <sub>2</sub> O	rhomb	2.72	2.8	1.52	1.587	1.613
Laumontite	Ca <sub>4</sub> [Al <sub>8</sub> Si <sub>16</sub> O <sub>48</sub> ]·16H <sub>2</sub> O	monocl	2.3	3.3	1.508	1.517	1.519
Laurionite	Pb(OH)Cl	rhomb	6.24	3.3	2.08	2.12	2.16
Lawsonite	CaAl <sub>2</sub> (OH) <sub>2</sub> Si <sub>2</sub> O <sub>7</sub> ·H <sub>2</sub> O	rhomb	3.08	6	1.655	1.675	1.685
Lazulite	(Mg,Fe)Al <sub>2</sub> (PO <sub>4</sub> ) <sub>2</sub> (OH) <sub>2</sub>	monocl	3.23	5.8	1.615	1.64	1.650
Lazurite	Na <sub>3</sub> SSi <sub>3</sub> Al <sub>3</sub> O <sub>12</sub>	cub	2.42	5.3	1.500		
Leadhillite	Pb <sub>4</sub> (SO <sub>4</sub> )(CO <sub>3</sub> ) <sub>2</sub> (OH) <sub>2</sub>	monocl	6.55	2.8	1.87	2.00	2.01
Lepidocrocite	FeO(OH)	orth	4.26	5	1.94	2.20	2.51
Lepidolite	K <sub>2</sub> (Li,Al) <sub>5-6</sub> [Si <sub>6-7</sub> Al <sub>2-1</sub> O <sub>20</sub> ](OH,F) <sub>4</sub>	monocl	2.85	3.3	1.536	1.565	1.566
Leucite	KAlSi <sub>2</sub> O <sub>6</sub>	tetr	2.49	5.8	1.510		
Levyne	(Ca,Na) <sub>2</sub> Al <sub>2</sub> Si <sub>4</sub> O <sub>12</sub> ·6H <sub>2</sub> O	rhomb	2.10	4.5	1.496	1.501	
Litharge	PbO	tetr	9.35	2	2.535	2.665	
Loellingite	FeAs <sub>2</sub>	rhomb	7.40	5.3			
Maghemite	Fe <sub>2</sub> O <sub>3</sub>	cub	4.88	7.8	2.63		
Magnesite	MgCO <sub>3</sub>	hex	3.05	4	1.536	1.741	
Magnetite	Fe <sub>3</sub> O <sub>4</sub>	cub	5.17	6	2.42		
Malachite	Cu <sub>2</sub> (OH) <sub>2</sub> (CO <sub>3</sub> )	monocl	4.05	3.8	1.655	1.875	1.909
Manganite	MnO(OH)	monocl	≈4.3	4	2.25	2.25	2.53
Manganosite	MnO	cub	5.37	5.5			
Marcasite	FeS <sub>2</sub>	cub	5.02	6.3			
Marialite	Na <sub>3</sub> Al <sub>3</sub> Si <sub>3</sub> O <sub>24</sub> Cl	tetr	2.56	5.5	1.541	1.548	
Marshite	CuI	cub	5.67	2.5	2.346		
Mascagnite	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	orth	1.77	2.3	1.520	1.523	1.533
Matlockite	PbClF	tetr	7.05	2.8	2.006	2.145	



Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					$n_\alpha$	$n_\beta$	$n_\gamma$
Meionite	$\text{Ca}_4\text{Al}_6\text{Si}_6\text{O}_{24}\text{CO}_3$	tetr	2.78	5.5	1.559	1.595	
Melanterite	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	monocl	1.89	2	1.47	1.48	1.49
Melilite	$(\text{Ca},\text{Na})_2(\text{Mg},\text{Fe},\text{Al},\text{Si})_3\text{O}_7$	tetr	3.00	5.5	1.639	1.645	
Mellite	$\text{Al}_2\text{C}_{12}\text{O}_{12} \cdot 18\text{H}_2\text{O}$	tetr	1.64	2.3	1.511	1.539	
Mendipite	$\text{Pb}_3\text{O}_2\text{Cl}_2$	rhomb	7.24	2.5	2.24	2.27	2.31
Mesolite	$\text{Na}_2\text{Ca}_2(\text{Al}_2\text{Si}_3\text{O}_{10})_3 \cdot 8\text{H}_2\text{O}$	orth	2.26	5	1.506		
Metacinnabar	$\text{HgS}$	cub	7.70	3			
Microcline	$\text{KAlSi}_3\text{O}_8$	monocl	2.56	6.3	1.522	1.526	1.530
Miersite	$\text{AgI}$	hex	5.68	2.5	2.20		
Millerite	$\text{NiS}$	hex	5.5	3.3			
Mimetite	$\text{Pb}_3(\text{AsO}_4\text{PO}_4)\text{Cl}$	hex	7.24	3.8	2.128	2.147	
Minium	$\text{Pb}_3\text{O}_4$	tetr	8.9	2.5			
Mirabilite	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	monocl	1.46	1.8	1.394	1.396	1.398
Moissanite	$\text{SiC}$	hex	3.16	9.5	2.648	2.691	
Molybdenite	$\text{MoS}_2$	hex	5.06	1.3			
Monazite	$(\text{Ce},\text{La},\text{Th})\text{PO}_4$	monocl	5.2	5	1.787	1.789	1.840
Monetite	$\text{CaHPO}_4$	tricl	2.92	3.5	1.587	1.61	1.640
Monticellite	$\text{Ca}(\text{Mg},\text{Fe})\text{SiO}_4$	orth	3.18	5.5	1.647	1.655	1.664
Montmorillonite	$(0.5\text{Ca},\text{Na})_{0.7}(\text{Al},\text{Mg},\text{Fe})_4[(\text{Si},\text{Al})_8\text{O}_{20}](\text{OH})_4 \cdot n\text{H}_2\text{O}$	monocl	2.5	1.5	1.55	1.57	1.57
Montroydite	$\text{HgO}$	orth	11.14	2.5	2.37	2.50	2.65
Mordenite	$(\text{Na},\text{K},\text{Ca})[\text{Al}_2\text{Si}_{10}\text{O}_{24}] \cdot 7\text{H}_2\text{O}$	orth	2.13	3.5	1.478	1.480	1.482
Muscovite	$\text{KAl}_2\text{Si}_3\text{AlO}_{10}(\text{OH},\text{F})_2$	monocl	2.83	2.8	1.563	1.596	1.602
Nantokite	$\text{CuCl}$	cub	4.14	2.5	1.930		
Natrolite	$\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10} \cdot 2\text{H}_2\text{O}$	orth	2.23	5	1.478	1.481	1.491
Nepheline	$\text{Na}_3\text{KAl}_4\text{Si}_4\text{O}_{16}$	hex	2.61	5.8	1.534	1.538	
Newberyite	$\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$	orth	2.13	3.3	1.514	1.517	1.533
Nicolite	$\text{NiAs}$	hex	7.77	5.3			
Norbergite	$\text{Mg}(\text{OH},\text{F})_2 \cdot \text{Mg}_2\text{SiO}_4$	orth	3.21	6.5	1.565	1.573	1.592
Nosean	$\text{Na}_8\text{Al}_6\text{Si}_6\text{O}_{24}\text{SO}_4$	cub	2.35	5.5	1.495		
Oldhamite	$\text{CaS}$	cub	2.59	4	2.137		
Oligoclase	$([\text{NaSi}]_{0.9-0.7}[\text{CaAl}]_{0.1-0.3})\text{AlSi}_2\text{O}_8$	tricl	2.64	6.3	1.539	1.543	1.547
Olivinite	$\text{Cu}_2(\text{AsO}_4)(\text{OH})$	rhomb	4.2	3	1.77	1.80	1.85
Olivine	$(\text{Mg},\text{Fe})\text{SiO}_4$	rhomb	3.81	6.8	1.73	1.76	1.78
Opal	$\text{SiO}_2 \cdot n\text{H}_2\text{O}$	amorp	1.9	5	1.44		
Orpiment	$\text{As}_2\text{S}_3$	monocl	3.46	1.8	2.40	2.81	3.02
Orthoclase	$\text{KAlSi}_3\text{O}_8$	monocl	2.56	6	1.523	1.527	1.531
Orthopyroxene	$(\text{Mg},\text{Fe})\text{SiO}_3$	rhomb	3.6	5.5	1.709	1.712	1.723
Paragonite	$\text{NaAl}_2\text{Si}_3\text{AlO}_{10}(\text{OH})_2$	monocl	2.85	2.5	1.572	1.602	1.605
Parisite	$(\text{Ce},\text{La},\text{Na})\text{FCO}_3 \cdot \text{CaCO}_3$	hex	4.42	4.5	1.672	1.771	
Pectolite	$\text{Ca}_2\text{NaH}(\text{SiO}_3)_3$	tricl	2.88	4.8	1.603	1.610	1.639
Penfieldite	$\text{Pb}_4\text{Cl}_6(\text{OH})_2$	hex	6.6		2.13	2.21	
Pentlandite	$(\text{Fe},\text{Ni})_9\text{S}_8$	cub	4.8	3.8			
Percylite	$\text{PbCuCl}_2(\text{OH})_2$	cub		2.5	2.05		
Periclase	$\text{MgO}$	cub	3.6	5.5	1.735		
Perovskite	$\text{CaTiO}_3$	cub	3.98	5.5	2.34		
Petalite	$\text{LiAlSi}_4\text{O}_{10}$	monocl	2.42	6.5	1.506	1.511	1.519
Pharmacosiderite	$\text{Fe}_3(\text{AsO}_4)_2(\text{OH})_3 \cdot 5\text{H}_2\text{O}$	cub	2.80	2.5	1.690		
Phenakite	$\text{Be}_2\text{SiO}_4$	rhomb	2.98	7.5	1.654	1.670	
Phillipsite	$\text{K}(\text{Ca}_{0.5},\text{Na})_2[\text{Al}_3\text{Si}_5\text{O}_{16}] \cdot 6\text{H}_2\text{O}$	monocl	2.2	4.3	1.494	1.497	1.505
Phlogopite	$\text{KMg}_3\text{AlSi}_3\text{O}_{10}(\text{OH},\text{F})_2$	monocl	2.83	2.3	1.560	1.597	1.598
Phosgenite	$\text{Pb}_2(\text{CO}_3)\text{Cl}_2$	tetr	6.13	2.5	2.118	2.145	
Piemontite	$\text{Ca}_2(\text{Mn},\text{Fe},\text{Al})_3\text{O}(\text{Si}_2\text{O}_7)(\text{SiO}_4)(\text{OH})$	monocl	3.49	6	1.762	1.773	1.796
Pigeonite	$(\text{Mg},\text{Fe},\text{Ca})(\text{Mg},\text{Fe})\text{Si}_2\text{O}_6$	monocl	3.38	6	1.702	1.703	1.728
Pollucite	$\text{CsAlSi}_2\text{O}_6$	tetr	2.9	6.5	1.517		
Polybasite	$(\text{Ag},\text{Cu})_{16}\text{Sb}_2\text{S}_{11}$	monocl	6.1	2.5			
Powellite	$\text{Ca}(\text{Mo},\text{W})\text{O}_4$	tetr	4.35	3.8	1.971	1.980	
Prehnite	$\text{Ca}_2\text{Al}_2\text{Si}_3\text{O}_{10}(\text{OH})_2$	rhomb	2.93	6.3	1.622	1.628	1.648
Proustite	$\text{Ag}_3\text{AsS}_3$	rhomb	5.57	2.3	2.792	3.088	
Pseudobrookite	$\text{Fe}_2\text{TiO}_5$	rhomb	4.36	6	2.38	2.39	2.42
Psilomelane	$\text{BaMn}_9\text{O}_{16}(\text{OH})_4$	rhomb	4.71	5.5			

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					<i>n</i> <sub>α</sub>	<i>n</i> <sub>β</sub>	<i>n</i> <sub>γ</sub>
Pumpellyite	Ca <sub>2</sub> Al <sub>2</sub> (Al,Fe,Mg)[Si <sub>2</sub> (O,OH) <sub>7</sub> ](SiO <sub>4</sub> )(OH,O) <sub>3</sub>	monocl	3.21	5.5	1.688	1.695	1.705
Pyrrargyrite	Ag <sub>3</sub> SbS <sub>3</sub>	rhombl	5.85	2.5	2.88	3.08	
Pyrite	FeS <sub>2</sub>	cub	5.02	6.3			
Pyrochlore	NaCaNb <sub>2</sub> O <sub>6</sub> F	cub	5.3	5.3			
Pyrochroite	Mn(OH) <sub>2</sub>	hex	3.26	2.5	1.68	1.72	
Pyrolusite	MnO <sub>2</sub>	tetr	5.08	6.3			
Pyromorphite	Pb <sub>5</sub> (PO <sub>4</sub> <sub>3</sub> AsO <sub>4</sub> ) <sub>3</sub> Cl	hex	7.04	3.8	2.048	2.058	
Pyrope	Mg <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	3.58	6.8	1.714		
Pyrophyllite	Al <sub>2</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2.78	1.5	1.545	1.579	1.599
Pyrrhotite	Fe <sub>7</sub> S <sub>8</sub>	hex	4.62	4			
Quartz	SiO <sub>2</sub>	hex	2.65	7	1.544	1.553	
Rammelsbergite	NiAs <sub>2</sub>	orth	7.1	5.8			
Raspite	PbWO <sub>4</sub>	monocl	8.46	2.8	1.27	1.27	1.30
Realgar	As <sub>4</sub> S <sub>4</sub>	monocl	3.5	1.8	2.538	2.684	2.704
Rhodochrosite	MnCO <sub>3</sub>	hex	3.70	3.8	1.597	1.816	
Rhodonite	(Mn,Fe,Ca)SiO <sub>3</sub>	orth	3.48	6	1.725	1.729	1.737
Riebeckite	Na <sub>2</sub> Fe <sub>5</sub> (Si <sub>8</sub> O <sub>22</sub> )(OH) <sub>2</sub>	monocl	3.3	5	1.675	1.683	1.694
Rutile	TiO <sub>2</sub>	tetr	4.23	6.2	2.609	2.900	
Safflorite	(Co,Fe)As <sub>2</sub>	rhombl	7.3	4.8			
Samarskite	(Y,Er,Ce,U,Ca,Fe,Pb,Th)(Nb,Ta,Ti,Sn) <sub>2</sub> O <sub>6</sub>	rhombl	5.69	5.5	2.200		
Sapphirine	(Mg,Fe) <sub>2</sub> Al <sub>4</sub> O <sub>6</sub> SiO <sub>4</sub>	monocl	3.49	7.5	1.709	1.712	1.715
Scapolite	(Na,Ca) <sub>4</sub> Al <sub>3</sub> (Al,Si) <sub>3</sub> Si <sub>6</sub> O <sub>24</sub> (Cl,F,OH,CO <sub>3</sub> ,SO <sub>4</sub> )	tetr	2.64	5.5	1.551	1.573	
Scheelite	CaWO <sub>4</sub>	tetr	6.06	4.8	1.920	1.936	
Scolecite	CaAl <sub>2</sub> Si <sub>3</sub> O <sub>10</sub> ·3H <sub>2</sub> O	monocl	2.27	5	1.510	1.518	1.519
Scorodite	Fe(AsO <sub>4</sub> )·2H <sub>2</sub> O	rhombl	3.28	3.8	1.784	1.795	1.814
Sellaite	MgF <sub>2</sub>	tetr	3.15	5	1.378	1.390	
Senarmontite	Sb <sub>2</sub> O <sub>3</sub>	cub	5.58	2.3	2.087		
Serpentine	Mg <sub>3</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	monocl	2.55	3	1.55	1.56	1.56
Siderite	FeCO <sub>3</sub>	hex	3.9	4.3	1.635	1.875	
Sillimanite	Al <sub>2</sub> O <sub>3</sub> SiO <sub>4</sub>	rhombl	3.25	7	1.658	1.660	1.660
Skutterudite	(Co,Ni)As <sub>3</sub>	cub	6.8	5.8			
Smithsonite	ZnCO <sub>3</sub>	rhombl	4.4	4.3	1.621	1.848	
Sodalite	Na <sub>8</sub> Al <sub>6</sub> Si <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub>	cub	2.30	5.8	1.485		
Sperrylite	PtAs <sub>2</sub>	cub	10.58	6.5			
Spessartite	Mn <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	4.19	6.8	1.800		
Sphalerite	ZnS	cub	4.0	3.8	2.369		
Sphene	CaTiSiO <sub>4</sub> (O,OH,F)	monocl	3.50	5	1.90	1.95	2.03
Spinel	MgAl <sub>2</sub> O <sub>4</sub>	cub	3.55	7.8	1.719		
Spodumene	LiAlSi <sub>2</sub> O <sub>6</sub>	monocl	3.13	6.8	1.656	1.662	1.671
Stannite	Cu <sub>2</sub> FeSn <sub>4</sub>	tetr	4.4	4			
Staurolite	(Fe,Mg,Zn) <sub>2</sub> (Al,Fe,Ti) <sub>3</sub> O <sub>6</sub> [(Si,Al) <sub>4</sub> O <sub>4</sub> ](O,OH) <sub>2</sub>	monocl	3.79	7.5	1.743	1.747	1.755
Stercorite	Na(NH <sub>4</sub> )H(PO <sub>4</sub> )·4H <sub>2</sub> O	tricl	1.62	2	1.439	1.442	1.469
Stibiotantalite	Sb(Ta,Nb)O <sub>4</sub>	rhombl	6.6	5.5	2.38	2.41	2.46
Stibnite	Sb <sub>2</sub> S <sub>3</sub>	orth	4.56	2			
Stilbite	NaCa <sub>2</sub> [Al <sub>5</sub> Si <sub>13</sub> O <sub>36</sub> ].14H <sub>2</sub> O	monocl	2.2	3.8	1.492	1.499	1.503
Stilpnomelane	(K,Na,Ca) <sub>0.6</sub> (Fe,Mg) <sub>6</sub> Si <sub>8</sub> Al(O,OH) <sub>27</sub> ·2H <sub>2</sub> O	monocl	2.8	3.5	1.585	1.665	1.665
Stolzite	PbWO <sub>4</sub>	tetr	8.2	2.8	2.19	2.27	
Strengite	FePO <sub>4</sub> ·2H <sub>2</sub> O	orth	2.87	4	1.707	1.719	1.741
Strontianite	SrCO <sub>3</sub>	orth	3.5	3.5	1.518	1.666	1.668
Struvite	Mg(NH <sub>4</sub> )(PO <sub>4</sub> )·6H <sub>2</sub> O	rhombl	1.71	2	1.495	1.496	1.504
Sulfur	S	orth	2.07	2	1.958	2.038	2.245
Sylvanite	(Ag,Au)Te <sub>2</sub>	monocl	8.16	1.8			
Sylvite	KCl	cub	1.99	2	1.490		
Talc	Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2.71	1	1.545	1.592	1.595
Tantalite	(Fe,Mn)(Ta,Nb) <sub>2</sub> O <sub>6</sub>	rhombl	7.95	6.5	2.26	2.32	2.43
Tapiolite	FeTa <sub>2</sub> O <sub>6</sub>	tetr	7.9	6.3	2.27	2.42	
Tellurobismuthite	Bi <sub>2</sub> Te <sub>3</sub>	hex	7.74	1.8			
Terlinguaite	Hg <sub>2</sub> OCl	monocl	8.73	2.5	2.35	2.64	2.66
Tetrahedrite	(Cu,Fe) <sub>12</sub> Sb <sub>4</sub> S <sub>13</sub>	cub	4.9	3.8			
Thenardite	Na <sub>2</sub> SO <sub>4</sub>	orth	2.7	2.8	1.468	1.475	1.483

Name	Formula	Crystal system	Density g/cm <sup>3</sup>	Hardness	Index of refraction		
					$n_\alpha$	$n_\beta$	$n_\gamma$
Thermonatrite	Na <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O	orth	2.25	1.3	1.420	1.506	1.524
Thomsenolite	NaCaAlF <sub>6</sub> ·H <sub>2</sub> O	monocl	2.98	2	1.407	1.414	1.415
Thorianite	ThO <sub>2</sub>	cub	10.0	6.5	2.200		
Thorite	ThSiO <sub>4</sub>	tetr	6.7	4.8	1.8		
Topaz	Al <sub>2</sub> SiO <sub>4</sub> (OH,F) <sub>2</sub>	rhomb	3.53	8	1.618	1.620	1.627
Torbernite	Cu(UO <sub>2</sub> ) <sub>2</sub> (PO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	tetr	3.22	2.3	1.582	1.592	
Tourmaline	Na(Mg,Fe,Mn,Li,Al) <sub>3</sub> Al <sub>6</sub> Si <sub>6</sub> O <sub>18</sub> (BO <sub>3</sub> ) <sub>3</sub>	rhomb	3.14	7	1.62	1.65	
Tremolite	Ca <sub>2</sub> Mg <sub>5</sub> Si <sub>8</sub> O <sub>22</sub> (OH,F) <sub>2</sub>	monocl	3.0	5.5	1.599	1.612	1.622
Trevorite	NiFe <sub>2</sub> O <sub>4</sub>	cub	5.33	7.8	2.3		
Tridymite	SiO <sub>2</sub>	hex	2.27	7	1.475	1.476	1.479
Triphyllite-Lithiophyllite	Li(Fe,Mn)PO <sub>4</sub>	rhomb	3.46	4.5	1.68	1.68	1.69
Troegerite	(UO <sub>2</sub> ) <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	tetr		2.5	1.59	1.630	
Troilite	FeS	hex	4.7	4			
Trona	Na <sub>3</sub> H(CO <sub>3</sub> ) <sub>2</sub> ·2H <sub>2</sub> O	monocl	2.14	2.8	1.412	1.492	1.540
Turquoise	Cu(Al,Fe) <sub>6</sub> (PO <sub>4</sub> ) <sub>4</sub> (OH) <sub>8</sub> ·4H <sub>2</sub> O	tricl	2.9	5.3	1.70	1.73	1.75
Ullmannite	NiSbS	cub	6.65	5.3			
Uraninite	UO <sub>2</sub>	cub	11.0	5.5			
Uvarovite	Ca <sub>3</sub> Cr <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cub	3.83	6.8	1.865		
Valentinite	Sb <sub>2</sub> O <sub>3</sub>	orth	5.7	2.8	2.18	2.35	2.35
Vanadinite	Pb <sub>5</sub> (VO <sub>4</sub> ) <sub>3</sub> Cl	hex	6.8	2.9	2.350	2.416	
Variseite-Strengite	(Al,Fe)(PO <sub>4</sub> ) <sub>3</sub> ·2H <sub>2</sub> O	rhomb	2.72	4	1.635	1.654	1.668
Vaterite	CaCO <sub>3</sub>	hex	2.71		1.550	1.645	
Vermiculite	(Mg,Ca) <sub>0.7</sub> (Mg,Fe,Al) <sub>6</sub> [(Al,Si) <sub>8</sub> O <sub>20</sub> ](OH) <sub>4</sub> ·8H <sub>2</sub> O	monocl	2.3	1.5	1.542	1.556	1.556
Vesuvianite	Ca <sub>10</sub> (Mg,Fe) <sub>2</sub> Al <sub>4</sub> (Si <sub>2</sub> O <sub>7</sub> ) <sub>2</sub> (SiO <sub>4</sub> ) <sub>5</sub> (OH,F) <sub>4</sub>	tetr	3.33	6.5	1.72	1.73	
Villiaumite	NaF	cub	2.78	2.3	1.327		
Vivianite	Fe <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	monocl	2.58	1.8	1.598	1.629	1.652
Wagnerite	Mg <sub>2</sub> (PO <sub>4</sub> )F	monocl	3.15	5.3	1.568	1.572	1.582
Wavellite	Al <sub>3</sub> (OH) <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> ·5H <sub>2</sub> O	rhomb	2.36	3.6	1.527	1.535	1.553
Whewellite	CaC <sub>2</sub> O <sub>4</sub> ·H <sub>2</sub> O	cub	2.2	2.8	1.491	1.554	1.650
Willemite	Zn <sub>2</sub> SiO <sub>4</sub>	hex	4.1	5.5	1.691	1.719	
Witherite	BaCO <sub>3</sub>	orth	4.29	3.5	1.529	1.676	1.677
Wolframite	(Fe,Mn)WO <sub>4</sub>	monocl	7.3	4.3	2.26	2.32	2.42
Wollastonite	CaSiO <sub>3</sub>	monocl	2.92	4.8	1.628	1.639	1.642
Wulfenite	PbMoO <sub>4</sub>	tetr	6.7	2.9	2.283	2.403	
Wurtzite	ZnS	hex	4.09	3.8	2.356	2.378	
Xenotime	YPO <sub>4</sub>	tetr	4.8	4.5	1.721	1.816	
Zeunerite	Cu(UO <sub>2</sub> ) <sub>2</sub> (AsO <sub>4</sub> ) <sub>2</sub> ·10H <sub>2</sub> O	tetr			1.606		
Zincite	ZnO	hex	5.6	4	2.013	2.029	
Zircon	ZrSiO <sub>4</sub>	tetr	4.6	7.5	1.94	1.99	
Zoisite	Ca <sub>2</sub> Al <sub>3</sub> Si <sub>3</sub> O <sub>12</sub> (OH)	rhomb	3.26	6	1.695	1.699	1.711

## CRYSTALLOGRAPHIC DATA ON MINERALS

This table contains x-ray crystallographic data on about 400 common minerals, as well as selected crystalline elements. Entries are arranged alphabetically by mineral name. The columns are:

Name: Common name of the mineral.

Formula: Chemical formula for a typical sample of the mineral.

Composition often varies considerably with the origin of the sample.

Crystal system: tricl = triclinic; monocl = monoclinic; orth = orthorhombic; tetr = tetragonal; hex = hexagonal; rhomb = rhombohedral; cubic = cubic.

Structure type: Prototype for the structural arrangement of the crystallographic cell.

Z: Number of formula units per the unit cell.

*a*, *b*, *c*: Lengths of the cell edges in Å (1 Å = 10<sup>-8</sup> cm).

α, β, γ : Angles between cell axes.

## References

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Name	Formula	Crystal system	Structure type	Z	<i>a</i> /Å	<i>b</i> /Å	<i>c</i> /Å	α	β	γ
Acanthite	Ag <sub>2</sub> S	monocl		4	4.228	6.928	7.862		99.58°	
Acmite (Aegirine)	NaFe(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.658	8.795	5.294		107.42°	
Akermanite	Ca <sub>2</sub> MgSi <sub>2</sub> O <sub>7</sub>	tetr	melilite	2	7.8435		5.010			
Alabandite	MnS	cubic	rock salt	4	5.223					
Almandine (Almandite)	Fe <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	11.526					
Altaite	PbTe	cubic	rock salt	4	6.4606					
Aluminum	Al	cubic	copper	4	4.049					
Alunite	KAl <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	rhomb		3	6.982		17.32			
Analcite	NaAlSi <sub>2</sub> O <sub>6</sub> ·H <sub>2</sub> O	cubic		16	13.733					
Anatase	TiO <sub>2</sub>	tetr		4	3.785		9.514			
Andalusite	Al <sub>2</sub> OSiO <sub>4</sub>	orth		4	7.7959	7.8983	5.5583			
Andradite	Ca <sub>3</sub> Fe <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	12.048					
Anglesite	PbSO <sub>4</sub>	orth	barite	4	8.480	5.398	6.958			
Anhydrite	CaSO <sub>4</sub>	orth	anhydrite	4	6.991	6.996	6.238			
Annite	KFe <sub>3</sub> [AlSi <sub>3</sub> O <sub>10</sub> ](OH) <sub>2</sub>	monocl	1M mica	2	10.29	9.33	5.39		105.1°	
Anorthite	CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	tricl	primitive cell	8	8.177	12.877	14.169	93.17°	115.85°	91.22°
Anthophyllite	Mg <sub>7</sub> Si <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	orth		4	18.61	18.01	5.24			
Antimony	Sb	rhomb	arsenic	6	4.2996		11.2516			
Aragonite	CaCO <sub>3</sub>	orth	aragonite	4	5.741	7.968	4.959			
Arcanite	K <sub>2</sub> SO <sub>4</sub>	orth	arcanite	4	5.772	10.072	7.483			
Argentite	Ag <sub>2</sub> S	cubic		2	4.870					
Argentopyrite	AgFe <sub>2</sub> S <sub>3</sub>	orth		4	6.64	11.47	6.45			
Arsenic	As	rhomb	arsenic	6	3.760		10.555			
Arsenolite	As <sub>2</sub> O <sub>3</sub>	cubic	diamond	16	11.074					
Arsenopyrite	FeAsS	tricl		4	5.760	5.690	5.785	90.00°	112.23°	90.00°
Azurite	Cu <sub>3</sub> (OH) <sub>2</sub> (CO <sub>3</sub> ) <sub>2</sub>	monocl		2	5.008	5.844	10.336		92.45°	
Baddeleyite	ZrO <sub>2</sub>	monocl	baddeleyite	4	5.1454	5.2075	5.3107		99.23°	
Banalsite	BaNa <sub>2</sub> Al <sub>4</sub> Si <sub>4</sub> O <sub>16</sub>	orth		4	8.50	9.97	16.72			
Barite	BaSO <sub>4</sub>	orth	barite	4	8.878	5.450	7.152			
Berlinite	AlPO <sub>4</sub>	hex	α-quartz	3	4.942		10.97			
Beryl	Be <sub>3</sub> Al <sub>2</sub> (SiO <sub>3</sub> ) <sub>6</sub>	hex	beryl	2	9.215		9.192			
Berzelianite	Cu <sub>2</sub> Se	cubic		4	5.85					
Bismite	Bi <sub>2</sub> O <sub>3</sub>	monocl	pseudo-orth	4	7.48	8.14	5.83		112.9°	
Bismuth	Bi	rhomb	arsenic	6	4.5367		11.8383			
Bismuthinite	Bi <sub>2</sub> S <sub>3</sub>	orth	stibnite	4	11.150	11.300	3.981			
Bixbyite	Mn <sub>2</sub> O <sub>3</sub>	cubic	thallium trioxide	16	9.411					
Boehmite	AlO(OH)	orth	lepidocrocite	4	2.868	12.227	3.700			
Borax	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·10H <sub>2</sub> O	monocl		4	11.858	10.674	12.197		106.68°	

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Bornite (metastable)	Cu <sub>5</sub> FeS <sub>4</sub>	cubic		8	10.94					
Breithauptite	NiSb	hex	niccolite	2	3.942		5.155			
Brochantite	Cu <sub>4</sub> SO <sub>4</sub> (OH) <sub>6</sub>	monocl		4	13.066	9.85	6.022		103.27°	
Bromargyrite	AgBr	cubic	rock salt	4	5.7745					
Bromellite	BeO	hex	zincite	2	2.6979		4.3772			
Brookite	TiO <sub>2</sub>	orth		8	5.456	9.182	5.143			
Brucite	Mg(OH) <sub>2</sub>	hex	cadmium iodide	1	3.147		4.769			
Bunsenite	NiO	cubic	rock salt	4	4.177					
Bustamite	CaMn(SiO <sub>3</sub> ) <sub>2</sub>	tricl		6	7.736	7.157	13.824	90.52°	94.58°	103.87°
Cadmium telluride	CdTe	cubic	sphalerite	4	6.4805					
Cadmoseelite	CdSe	hex	zincite	2	4.2977		7.0021			
Calcite	CaCO <sub>3</sub>	rhomb	calcite	6	4.9899		17.064			
Caromel	Hg <sub>2</sub> Cl <sub>2</sub>	tetr		4	4.478		10.910			
Carbonate-apatite	Ca <sub>10</sub> (PO <sub>4</sub> ) <sub>6</sub> CO <sub>3</sub> ·H <sub>2</sub> O	hex	apatite	1	9.436		6.883			
Cassiterite	SnO <sub>2</sub>	tetr	rutile	2	4.738		3.188			
Cattierite	CoS <sub>2</sub>	cubic	pyrite	4	5.5345					
Celestite	SrSO <sub>4</sub>	orth	barite	4	8.359	5.352	6.866			
Celsian	BaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	monocl		8	8.627	13.045	14.408		115.20°	
Cerianite	CeO <sub>2</sub>	cubic	fluorite	4	5.4110					
Cerussite	PbCO <sub>3</sub>	orth	aragonite	4	6.152	8.436	5.195			
Cervantite	Sb <sub>2</sub> O <sub>4</sub>	orth		4	5.424	11.76	4.804			
Chalcanthite	CuSO <sub>4</sub> ·5H <sub>2</sub> O	tricl		2	6.1045	10.72	5.949	97.57°	107.28°	77.43°
Chalcocite	Cu <sub>2</sub> S	orth		96	11.881	27.323	13.491			
Chalcopyrite	CuFeS <sub>2</sub>	tetr		4	5.2988		10.434			
Chlorapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> Cl	hex	apatite	2	9.629		6.777			
Chlorargyrite	AgCl	cubic	rock salt	4	5.5491					
Chloritoid	FeAl <sub>4</sub> O <sub>3</sub> (SiO <sub>4</sub> ) <sub>2</sub> (OH) <sub>4</sub>	monocl		8	9.48	5.48	18.18		101.77°	
Chloromagnesite	MgCl <sub>2</sub>	rhomb		3	3.632		17.795			
Chondrodite	2Mg <sub>2</sub> SiO <sub>4</sub> ·MgF <sub>2</sub>	monocl		2	7.89	4.743	10.29		109.03°	
Chrysoberyl	BeAl <sub>2</sub> O <sub>4</sub>	orth	olivine	4	5.4756	9.4041	4.4267			
Cinnabar	HgS	hex	cinnabar	3	4.149		9.495			
Claudetite	As <sub>2</sub> O <sub>3</sub>	monocl		4	5.339	12.984	4.5405		94.27°	
Clausthalite	PbSe	cubic	rock salt	4	6.1255					
Clinoenstatite	MgSiO <sub>3</sub>	monocl		8	9.620	8.825	5.188		108.33°	
Clinoferrosilite	FeSiO <sub>3</sub>	monocl		8	9.7085	9.0872	5.2284		108.43°	
Clinohumite	4Mg <sub>2</sub> SiO <sub>4</sub> ·MgF <sub>2</sub>	monocl		2	13.68	4.75	10.27		100.83°	
Clinzoisite	Ca <sub>2</sub> Al <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> OH	monocl		2	8.887	5.581	10.14		115.93°	
Cobalt olivine	Co <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	4.782	10.301	6.003			
Cobalt oxide	CoO	cubic	rock salt	4	4.260					
Cobalt sulfide	CoS	cubic	sphalerite	4	5.339					
Cobalt titanate	CoTiO <sub>3</sub>	rhomb	ilmenite	6	5.066		13.918			
Cobalticalcite	CoCO <sub>3</sub>	rhomb	calcite	6	4.6581		14.958			
Cobaltite	CoAsS	cubic	NiSbS	4	5.60					
Coesite	SiO <sub>2</sub>	monocl		16	7.152	12.379	7.152		120.00°	
Coffinite	USiO <sub>4</sub>	tetr	zircon	4	6.995		6.263			
Colemanite	Ca <sub>2</sub> B <sub>6</sub> O <sub>11</sub> ·5H <sub>2</sub> O	monocl		4	8.743	11.264	6.102		110.12°	
Coloradoite	HgTe	cubic	sphalerite	4	6.4600					
Cooperite	PtS	tetr		2	3.4699		6.1098			
Copper	Cu	cubic	face-centered cubic	4	3.6150					
Corundum	Al <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	4.7591		12.9894			
Cotunnite	PbCl <sub>2</sub>	orth		4	4.535	7.62	9.05			
Covellite	CuS	hex		6	3.792		16.34			
Cristobalite (α)	SiO <sub>2</sub>	tetr		4	4.971		6.918			
Cristobalite (β)	SiO <sub>2</sub>	cubic		8	7.1382					
Cryolite	Na <sub>3</sub> AlF <sub>6</sub>	monocl		2	5.40	5.60	7.776		90.18°	
Cubanite	CuFe <sub>2</sub> S <sub>3</sub>	orth		4	6.46	11.12	6.23			
Cumingtonite	(Mg,Fe,Mn) <sub>7</sub> (Si <sub>4</sub> O <sub>11</sub> ) <sub>2</sub> (OH) <sub>2</sub>	monocl	tremolite	2	9.522	18.223	5.332		101.92°	
Cuprite	Cu <sub>2</sub> O	cubic		2	4.2696					
Danburite	CaB <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	orth		4	8.04	8.77	7.74			

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Datolite	CaBSiO <sub>4</sub> (OH)	monocl		4	9.62	7.60	4.84		90.15°	
Daubreite	FeCr <sub>2</sub> S <sub>4</sub>	cubic	spinel	8	9.966					
Diamond	C	cubic	diamond	8	3.5670					
Diaspore	AlO(OH)	orth		4	4.401	9.421	2.845			
Dickite	Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	monocl		4	5.150	8.940	14.736		103.58°	
Digenite	Cu <sub>1.79</sub> S	cubic	deformed fluorite	4	5.5695					
Diopside	CaMg(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.743	8.923	5.251		105.93°	
Diopside	CuSiO <sub>2</sub> (OH) <sub>2</sub>	rhomb	phenacite	18	14.61		7.80			
Dolerophanite	Cu <sub>2</sub> O(SO <sub>4</sub> )	monocl		4	8.334	6.312	7.628		108.4°	
Dolomite	CaMg(CO <sub>3</sub> ) <sub>2</sub>	rhomb	calcite	3	4.8079		16.010			
Dravite	NaMg <sub>3</sub> Al <sub>6</sub> B <sub>3</sub> Si <sub>6</sub> O <sub>27</sub> (OH) <sub>4</sub>	rhomb	tourmaline	3	15.942		7.224			
Elbaite	NaLiAl <sub>1.67</sub> B <sub>3</sub> Si <sub>6</sub> O <sub>27</sub> (OH) <sub>4</sub>	rhomb	tourmaline	3	15.842		7.009			
Enargite	Cu <sub>3</sub> AsS <sub>4</sub>	orth		2	6.426	7.422	6.144			
Enstatite	MgSiO <sub>3</sub>	orth		16	8.829	18.22	5.192			
Epidote	Ca <sub>2</sub> Al <sub>2</sub> (Al,Fe)OH(SiO <sub>4</sub> ) <sub>3</sub>	monocl		2	8.89	5.63	10.19		115.40°	
Epsomite	MgSO <sub>4</sub> ·7H <sub>2</sub> O	orth		4	11.86	11.99	6.858			
Eskolaite	Cr <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	4.9607		13.599			
Eucairite	AgCuSe	orth		10	4.105	20.35	6.31			
Euclase	AlBeSiO <sub>4</sub> (OH)	monocl		4	4.763	14.29	4.618		100.25°	
Famatimite	Cu <sub>3</sub> SbS <sub>4</sub>	tetr		2	5.384		10.770			
Fayalite	Fe <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	4.817	10.477	6.105			
Fe-Cordierite	Fe <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	orth	cordierite	4	9.726	17.065	9.287			
Fe-Gehlenite	Ca <sub>2</sub> Fe <sub>2</sub> SiO <sub>7</sub>	tetr	melilite	2	7.54		4.855			
Fe-Indialite	Fe <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	hex	beryl	2	9.860		9.285			
Fe-Leucite	KFeSi <sub>2</sub> O <sub>6</sub>	tetr		16	13.205		13.970			
Fe-Microcline	KFeSi <sub>3</sub> O <sub>8</sub>	tricl		4	8.68	13.10	7.340	90.75°	116.05°	86.23°
Fe-Sanidine	KFeSi <sub>3</sub> O <sub>8</sub>	monocl		4	8.689	13.12	7.319		116.10°	
Fe-Skutterudite	FeAs <sub>2.95</sub>	cubic		8	8.1814					
Ferberite	FeWO <sub>4</sub>	monocl	wolframite	2	4.732	5.708	4.965		90.00°	
Ferriannite	KFe <sub>3</sub> [FeSi <sub>3</sub> O <sub>10</sub> ](OH) <sub>2</sub>	monocl		2	5.430	9.404	10.341		100.07°	
Ferroselite	FeSe <sub>2</sub>	orth	marcasite	2	4.801	5.778	3.587			
Ferrotremolite	Ca <sub>2</sub> Fe <sub>5</sub> [Si <sub>8</sub> O <sub>22</sub> ](OH) <sub>2</sub>	monocl	tremolite	2	9.97	18.34	5.30		104.50°	
Fluor-edenite	NaCa <sub>2</sub> Mg <sub>5</sub> [AlSi <sub>7</sub> O <sub>22</sub> ]F <sub>2</sub>	monocl	tremolite	2	9.847	18.00	5.282		104.83°	
Fluor-humite	3Mg <sub>2</sub> SiO <sub>4</sub> ·MgF <sub>2</sub>	orth		4	10.243	20.72	4.735			
Fluor-norbergite	Mg <sub>2</sub> SiO <sub>4</sub> ·MgF <sub>2</sub>	orth		4	8.727	10.271	4.709			
Fluor-phlogopite	KMg <sub>3</sub> [AlSi <sub>3</sub> O <sub>10</sub> ]F <sub>2</sub>	monocl	1M mica	2	5.299	9.188	10.135		99.92°	
Fluor-richterite	Na <sub>2</sub> CaMg <sub>5</sub> [Si <sub>8</sub> O <sub>22</sub> ]F <sub>2</sub>	monocl	tremolite	2	9.823	17.96	5.268		104.33°	
Fluor-tremolite	Ca <sub>2</sub> Mg <sub>5</sub> [Si <sub>8</sub> O <sub>22</sub> ]F <sub>2</sub>	monocl	tremolite	2	9.781	18.01	5.267		104.52°	
Fluorapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> F	hex	apatite	2	9.3684		6.8841			
Fluorite	CaF <sub>2</sub>	cubic	fluorite	4	5.4638					
Forsterite	Mg <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	4.758	10.214	5.984			
Frohbergite	FeTe <sub>2</sub>	orth	marcasite	2	5.265	6.265	3.869			
Gahnite	ZnAl <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.0848					
Galaxite	MnAl <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.258					
Galena	PbS	cubic	rock salt	4	5.9360					
Gallium oxide	Ga <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	4.9793		13.429			
Gehlenite	Ca <sub>2</sub> Al <sub>2</sub> SiO <sub>7</sub>	tetr	melilite	2	7.690		5.0675			
Geikielite	MgTiO <sub>3</sub>	rhomb	ilmenite	6	5.054		13.898			
Gerhardite	Cu <sub>2</sub> (NO <sub>3</sub> )(OH) <sub>3</sub>	orth		4	6.075	13.812	5.592			
Gersdorffite	NiAsS	cubic		4	5.693					
Gibbsite	Al(OH) <sub>3</sub>	monocl		8	9.719	5.0705	8.6412		94.57°	
Glauchroite	CaMnSiO <sub>4</sub>	orth	olivine	4	4.944	11.19	6.529			
Glaucodot	(Co,Fe)AsS	orth		24	6.64	28.39	5.64			
Glaucophane I	Na <sub>2</sub> Mg <sub>3</sub> Al <sub>2</sub> [Si <sub>8</sub> O <sub>22</sub> ](OH) <sub>2</sub>	monocl	tremolite	2	9.748	17.915	5.273		102.78°	
Glaucophane II	Na <sub>2</sub> Mg <sub>3</sub> Al <sub>2</sub> [Si <sub>8</sub> O <sub>22</sub> ](OH) <sub>2</sub>	monocl	tremolite	2	9.663	17.696	5.277		103.67°	
Goethite	FeO(OH)	orth		4	4.596	9.957	3.021			
Gold	Au	cubic	face-centered cubic	4	4.0786					
Goldmanite	Ca <sub>3</sub> V <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	12.070					
Goslarite	ZnSO <sub>4</sub> ·7H <sub>2</sub> O	orth	epsomite	4	11.779	12.050	6.822			

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Graphite	C	hex	graphite	4	2.4612		6.7079			
Greenockite	CdS	hex	zincite	2	4.1354		6.7120			
Greigite	Fe <sub>3</sub> S <sub>4</sub>	cubic	spinel	8	9.876					
Grossularite	Ca <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	11.851					
Grunerite	Fe <sub>7</sub> [Si <sub>8</sub> O <sub>22</sub> ](OH) <sub>2</sub>	monocl	tremolite	2	9.572	18.44	5.342		101.77°	
Gudmundite	FeSbS	monocl		8	10.00	5.93	6.73		90.00°	
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	monocl		4	5.68	15.18	6.29		113.83°	
Hafnia	HfO <sub>2</sub>	monocl	baddeleyite	4	5.1156	5.1722	5.2948		99.18°	
Halite	NaCl	cubic	rock salt	4	5.6402					
Hambergite	Be <sub>2</sub> (OH,F)BO <sub>3</sub>	orth		8	9.755	12.201	4.426			
Hardystonite	Ca <sub>2</sub> ZnSi <sub>2</sub> O <sub>7</sub>	tetr	melilite	2	7.87		5.01			
Hauerite	MnS <sub>2</sub>	cubic	pyrite	4	6.1014					
Hausmannite	Mn <sub>3</sub> O <sub>4</sub>	tetr		8	8.136		9.422			
Hawleyite	CdS	cubic	sphalerite	4	5.833					
Heazlewoodite	Ni <sub>3</sub> S <sub>2</sub>	rhomb		3	5.746		7.134			
Hedenbergite	CaFe(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.854	9.024	5.263		104.23°	
Hematite	Fe <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	5.025		13.735			
Hemimorphite	Zn <sub>4</sub> (OH) <sub>2</sub> Si <sub>2</sub> O <sub>7</sub> ·H <sub>2</sub> O	orth		2	8.370	10.719	5.120			
Hercynite	Fe(AlO <sub>2</sub> ) <sub>2</sub>	cubic	spinel	8	8.150					
Herzenbergite	SnS	orth	germanium sulfide	4	4.328	11.190	3.978			
Hessite	Ag <sub>2</sub> Te	monocl		4	8.13	4.48	8.09		111.9°	
Hexahydrate	MgSO <sub>4</sub> ·6H <sub>2</sub> O	monocl		8	10.110	7.212	24.41		98.30°	
High albite (Analbite)	NaAlSi <sub>3</sub> O <sub>8</sub>	tricl		4	8.160	12.870	7.106	93.54°	116.36°	90.19°
High argentite	Ag <sub>2</sub> S	cubic		4	6.269					
High bornite	Cu <sub>5</sub> FeS <sub>4</sub>	cubic		1	5.50					
High carnegite	NaAlSiO <sub>4</sub>	cubic		4	7.325					
High chalcocite	Cu <sub>2</sub> S	hex		2	3.961		6.722			
High clinoenstatite	MgSiO <sub>3</sub>	tricl		8	10.000	8.934	5.170	88.27°	70.03°	91.01°
High digenite	Cu <sub>2</sub> S	cubic		4	5.725					
High germania	GeO <sub>2</sub>	hex	α-quartz	3	4.987		5.652			
High leucite	KAlSi <sub>2</sub> O <sub>6</sub>	cubic		16	13.43					
High naumanite	Ag <sub>2</sub> Se	cubic		2	4.993					
High sanidine	KAlSi <sub>3</sub> O <sub>8</sub>	monocl		4	8.615	13.031	7.177		115.98°	
Huebnerite	MnWO <sub>4</sub>	monocl	wolframite	2	4.834	5.758	4.999		91.18°	
Huntite	Mg <sub>3</sub> Ca(CO <sub>3</sub> ) <sub>4</sub>	rhomb	calcite	3	9.498		7.816			
Hydroxylapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> OH	hex	apatite	2	9.418		6.883			
Ice	H <sub>2</sub> O	hex		4	4.5212		7.3666			
Ilmenite	FeTiO <sub>3</sub>	rhomb	ilmenite	6	5.093		14.055			
Indialite (Cordierite)	Mg <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	hex	beryl	2	9.7698		9.3517			
Iodargyrite	AgI	hex	zincite	2	4.5955		7.5005			
Iron (α)	Fe	cubic	body-centered cubic	2	2.8664					
Jacobsite	MnFe <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.499					
Jadeite	NaAl(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.409	8.564	5.220		107.50°	
Jalpaite	Ag <sub>155</sub> Cu <sub>0.45</sub> S	tetr		16	8.673		11.756			
Johannsenite	CaMn(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.83	9.04	5.27		105.00°	
Kaliophilite	KAlSiO <sub>4</sub>	hex		54	26.930		8.522			
Kalsilite	KAlSiO <sub>4</sub>	hex		2	5.1597		8.7032			
Kaolinite	Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	tricl		2	5.155	8.959	7.407	91.68°	104.87°	89.93°
Karelianite	V <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	4.952		14.002			
Keatite	SiO <sub>2</sub>	tetr		12	7.456		8.604			
Kernite	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·4H <sub>2</sub> O	monocl		4	7.022	9.151	15.676		108.83°	
Kerschsteinite	CaFeSiO <sub>4</sub>	orth	olivine	4	4.886	11.146	6.434			
Klockmannite	CuSe	hex	deformed covellite	78	14.206		17.25			
Knebelite	MnFeSiO <sub>4</sub>	orth	olivine	4	4.854	10.602	6.162			
Kyanite	Al <sub>2</sub> OSiO <sub>4</sub>	tricl		4	7.123	7.848	5.564	89.92°	101.25°	105.97°
Larnite	Ca <sub>2</sub> SiO <sub>4</sub>	monocl		4	5.48	6.76	9.28		94.55°	
Laurite	RuS <sub>2</sub>	cubic	pyrite	4	5.60					

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Lawrencite	FeCl <sub>2</sub>	rhomb		3	3.593		17.58			
Lawsonite	CaAl <sub>2</sub> Si <sub>2</sub> O <sub>7</sub> (OH) <sub>2</sub> ·H <sub>2</sub> O	orth		4	8.787	5.836	13.123			
Lead	Pb	cubic	face-centered cubic	4	4.9505					
Leonhardtite	MgSO <sub>4</sub> ·4H <sub>2</sub> O	monocl		4	5.922	13.604	7.905		90.85°	
Lepidocrocite	FeO(OH)	orth		4	3.868	12.525	3.066			
Lepidolite	K <sub>2</sub> Al <sub>3</sub> Li <sub>3</sub> AlSi <sub>7</sub> O <sub>20</sub> (OH) <sub>4</sub>	monocl	2M2 mica	2	9.2	5.3	20.0		98.00°	
Leucite	KAlSi <sub>2</sub> O <sub>6</sub>	tetr		16	13.074		13.738			
Lime	CaO	cubic	rock salt	4	4.8108					
Lime olivine	Ca <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	5.091	11.371	6.782			
Linnaeite	Co <sub>3</sub> S <sub>4</sub>	cubic	spinel	8	9.401					
Litharge	PbO	tetr		2	3.9759		5.023			
Loellingite	FeAs <sub>2</sub>	orth	marcasite	2	5.300	5.981	2.882			
Low albite	NaAlSi <sub>3</sub> O <sub>8</sub>	tricl		4	8.139	12.788	7.160	94.27°	116.57°	87.68°
Low bornite	Cu <sub>5</sub> FeS <sub>4</sub>	tetr		16	10.94		21.88			
Low cordierite	Mg <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	orth		4	9.721	17.062	9.339			
Low germania	GeO <sub>2</sub>	tetr	rutile	2	4.3963		2.8626			
Low nepheline	NaAlSiO <sub>4</sub>	hex		8	9.986		8.330			
Luzonite	Cu <sub>3</sub> AsS <sub>4</sub>	tetr		2	5.289		10.440			
Mackinawite	FeS	tetr		2	3.675		5.030			
Magnesioriebeckite	Na <sub>2</sub> Mg <sub>3</sub> Fe <sub>2</sub> [Si <sub>8</sub> O <sub>22</sub> ](OH) <sub>2</sub>	monocl	tremolite	2	9.733	17.946	5.299		103.30°	
Magnesite	MgCO <sub>3</sub>	rhomb	calcite	6	4.6330		15.016			
Magnetite	Fe <sub>3</sub> O <sub>4</sub>	cubic	spinel	8	8.3940					
Malachite	Cu <sub>2</sub> (OH) <sub>2</sub> CO <sub>3</sub>	monocl		4	9.502	11.974	3.240		98.75°	
Maldonite	Au <sub>2</sub> Bi	cubic		8	7.958					
Manganese sulfide (γ)	MnS	hex	zincite	2	3.976		6.432			
Manganese sulfide (β)	MnS	cubic	sphalerite	4	5.611					
Manganosite	MnO	cubic	rock salt	4	4.4448					
Marcasite	FeS <sub>2</sub>	orth	marcasite	2	4.443	5.423	3.3876			
Margarite	CaAl <sub>2</sub> [AlSi <sub>2</sub> O <sub>10</sub> ](OH) <sub>2</sub>	monocl	2M mica	4	5.13	8.92	19.50		95.00°	
Marialite	Na <sub>4</sub> Al <sub>3</sub> Si <sub>9</sub> O <sub>24</sub> Cl	tetr		2	12.064		7.514			
Marshite	CuI	cubic	sphalerite	4	6.0507					
Mascagnite	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	orth	arcanite	4	7.782	5.993	10.636			
Massicot	PbO	orth		4	5.489	4.755	5.891			
Matlockite	PbClF	tetr		2	4.106		7.23			
Maucherite	Ni <sub>11</sub> As <sub>8</sub>	tetr		4	6.870		21.81			
Meionite	Ca <sub>4</sub> Al <sub>6</sub> Si <sub>6</sub> O <sub>24</sub> CO <sub>3</sub>	tetr		2	12.174		7.652			
Melanophlogite	SiO <sub>2</sub>	cubic	clathrate type	46	13.402					
Melanterite	FeSO <sub>4</sub> ·7H <sub>2</sub> O	monocl		4	14.072	6.503	11.041		105.57°	
Melonite	NiTe <sub>2</sub>	hex	cadmium iodide	1	3.869		5.308			
Metacinnabar	HgS	cubic	sphalerite	4	5.8517					
Miargyrite	AgSbS <sub>2</sub>	monocl		8	12.862	4.111	13.220		98.63°	
Microcline	KAlSi <sub>3</sub> O <sub>8</sub>	tricl		4	8.582	12.964	7.222	90.62°	115.92°	87.68°
Miersite	AgI	cubic	sphalerite	4	6.4963					
Millerite	NiS	rhomb		9	9.616		3.152			
Minium	Pb <sub>3</sub> O <sub>4</sub>	tetr		4	8.815		6.565			
Minnesotaite	Fe <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl		4	5.4	9.42	19.4		100.00°	
Mirabilite	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	monocl		4	11.51	10.38	12.83		107.75°	
Mn-Indialite	Mn <sub>2</sub> Al <sub>3</sub> (AlSi <sub>5</sub> O <sub>18</sub> )	hex	beryl	2	9.925		9.297			
Molybdenite	MoS <sub>2</sub>	hex	molybdenite	2	3.1604		12.295			
Molybdenum	Mo	cubic		2	3.1653					
Molybdite	MoO <sub>3</sub>	orth		4	3.962	13.858	3.697			
Monteponite	CdO	cubic	rock salt	4	4.6953					
Monticellite	CaMgSiO <sub>4</sub>	orth	olivine	4	4.827	11.084	6.376			
Montroydite	HgO	orth		4	6.608	5.518	3.519			
Mullite (2:1)	2Al <sub>2</sub> O <sub>3</sub> ·SiO <sub>2</sub>	orth		6	7.5788	7.6909	2.8883			
Mullite (3:2)	3Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>	orth		3	7.557	7.6876	2.8842			
Muscovite	KAl <sub>2</sub> AlSi <sub>5</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2M2 mica	4	5.203	8.995	20.030		94.47°	



Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Nacrite	Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	monocl		4	8.909	5.146	15.697		113.70°	
Nantokite	CuCl	cubic	sphalerite	4	5.416					
Natroalunite	NaAl <sub>3</sub> (SO <sub>4</sub> ) <sub>2</sub> (OH) <sub>6</sub>	rhomb		3	6.974		16.69			
Natrolite	Na <sub>2</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>10</sub> ·2H <sub>2</sub> O	orth		8	18.30	18.63	6.60			
Neighborite	NaMgF <sub>3</sub>	orth	perovskite	4	5.363	7.676	5.503			
Ni-Skutterudite	NiAs <sub>2.95</sub>	cubic		8	8.3300					
Niccolite	NiAs	hex	niccolite	2	3.618		5.034			
Nickel	Ni	cubic	face-centered cubic	4	3.5238					
Nickel carbonate	NiCO <sub>3</sub>	rhomb	calcite	6	4.5975		14.723			
Nickel olivine	Ni <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	4.727	10.121	5.915			
Nickel selenide	NiSe <sub>2</sub>	cubic	pyrite	4	5.9604					
Niter	KNO <sub>3</sub>	orth	aragonite	4	6.431	9.164	5.414			
Norsethite	BaMg(CO <sub>3</sub> ) <sub>2</sub>	rhomb	calcite	3	5.020		16.75			
Oldhamite	CaS	cubic	rock salt	4	5.689					
Orpiment	As <sub>2</sub> S <sub>3</sub>	monocl		4	11.49	9.59	4.25		90.45°	
Orthoclase	KAlSi <sub>3</sub> O <sub>8</sub>	monocl		4	8.562	12.996	7.193		116.02°	
Orthoferrosilite	FeSiO <sub>3</sub>	orth	enstatite	16	9.080	18.431	5.238			
Otavite	CdCO <sub>3</sub>	rhomb	calcite	6	4.9204		16.298			
Paracelsian	BaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	monocl		4	8.58	9.583	9.08		90.00°	
Paragonite	NaAl <sub>2</sub> AlSi <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2M1 mica	4	5.13	8.89	19.32		95.17°	
Pararammelsbergite	NiAs <sub>2</sub>	orth		8	5.75	5.82	11.428			
Paratellurite	TeO <sub>2</sub>	tetr		4	4.810		7.613			
Parawollastonite	CaSiO <sub>3</sub>	monocl		12	15.417	7.321	7.066		95.40°	
Pectolite	Ca <sub>2</sub> NaH(SiO <sub>3</sub> ) <sub>3</sub>	tricl		2	7.99	7.04	7.02	90.05°	95.27°	102.47°
Pentlandite	Fe <sub>5.25</sub> Ni <sub>3.75</sub> S <sub>8</sub>	cubic		4	10.196					
Pentlandite	Fe <sub>4.75</sub> Ni <sub>5.25</sub> S <sub>8</sub>	cubic		4	10.095					
Periclase	MgO	cubic	rock salt	4	4.2117					
Perovskite	CaTiO <sub>3</sub>	orth	perovskite	4	5.3670	7.6438	5.4439			
Petalite	LiAlSi <sub>4</sub> O <sub>10</sub>	monocl		2	11.32	5.14	7.62		105.90°	
Petzite	Ag <sub>3</sub> AuTe <sub>2</sub>	cubic		8	10.38					
Phenacite	Be <sub>2</sub> SiO <sub>4</sub>	rhomb	phenacite	18	12.472		8.252			
Phlogopite	KMg <sub>3</sub> AlSi <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	1M mica	2	5.326	9.210	10.311		100.17°	
Picrochromite	MgCr <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.333					
Piemontite	Ca <sub>2</sub> Al <sub>1.5</sub> Mn <sub>1.5</sub> (SiO <sub>4</sub> ) <sub>3</sub> OH	monocl		2	8.95	5.70	9.41		115.70°	
Platinum	Pt	cubic	face-centered cubic	4	3.9231					
Polymidite	Ni <sub>3</sub> S <sub>4</sub>	cubic	spinel	8	9.480					
Portlandite	Ca(OH) <sub>2</sub>	hex	cadmium iodide	1	3.5933		4.9086			
Powellite	CaMoO <sub>4</sub>	tetr	scheelite	4	5.226		11.43			
Protoenstatite	MgSiO <sub>3</sub>	orth		8	9.25	8.74	5.32			
Proustite	Ag <sub>3</sub> AsS <sub>3</sub>	rhomb		6	10.816		8.6948			
Pseudowollastonite	CaSiO <sub>3</sub>	tricl		24	6.90	11.78	19.65	90.00°	90.80°	90.00°
Pyrrargyrite	Ag <sub>3</sub> SbS <sub>3</sub>	rhomb		6	11.052		8.7177			
Pyrite	FeS <sub>2</sub>	cubic	pyrite	4	5.4175					
Pyrolusite	MnO <sub>2</sub>	tetr	rutile	2	4.388		2.865			
Pyrope	Mg <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	11.459					
Pyrophanite	MnTiO <sub>3</sub>	rhomb	ilmenite	6	5.155		14.18			
Pyrophyllite	Al <sub>2</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2M1 mica	4	5.14	8.90	18.55		99.92°	
Pyroxmangite	MnFe(SiO <sub>3</sub> ) <sub>2</sub>	tricl		7	7.56	17.45	6.67	84.00°	94.30°	113.70°
Pyrrhotite	Fe <sub>0.980</sub> S	hex	defect niccolite	2	3.446		5.848			
Pyrrhotite	Fe <sub>0.885</sub> S	hex	defect niccolite	2	3.440		5.709			
Quartz (α)	SiO <sub>2</sub>	hex		3	4.9136		5.4051			
Quartz (β)	SiO <sub>2</sub>	hex		3	4.999		5.4592			
Rammelsbergite	NiAs <sub>2</sub>	orth	marcasite	2	4.757	5.797	3.542			
Realgar	As <sub>4</sub> S <sub>4</sub>	monocl		16	9.29	13.53	6.57		106.55°	
Retgersite	NiSO <sub>4</sub> ·4H <sub>2</sub> O	tetr		4	6.782		18.28			
Rhodochrosite	MnCO <sub>3</sub>	rhomb	calcite	6	4.7771		15.664			

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Rhodonite	MnSiO <sub>3</sub>	tricl		10	7.682	11.818	6.707	92.36°	93.95°	105.66°
Riebeckite	Na <sub>2</sub> Fe <sub>5</sub> FSi <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	monocl	tremolite	2	9.729	18.065	5.334		103.31°	
Rutile	TiO <sub>2</sub>	tetr		2	4.5937		2.9618			
Safflorite	Co <sub>0.5</sub> Fe <sub>0.5</sub> As <sub>2</sub>	orth	marcasite	2	5.231	5.953	2.962			
Sanmartinite	ZnWO <sub>4</sub>	monocl	wolframite	2	4.691	5.720	4.925		89.36°	
Sapphirine	Mg <sub>2</sub> Al <sub>4</sub> O <sub>6</sub> SiO <sub>4</sub>	monocl		8	9.96	28.60	9.85		110.5°	
Scacchite	MnCl <sub>2</sub>	rhomb		3	3.711		17.59			
Scheelite	CaWO <sub>4</sub>	tetr	scheelite	4	5.242		11.372			
Schorl	NaFe <sub>3</sub> Al <sub>6</sub> B <sub>3</sub> Si <sub>6</sub> O <sub>27</sub> (OH) <sub>4</sub>	rhomb	tourmaline	3	16.032		7.149			
Selenium	Se	hex		3	4.3642		4.9588			
Selenolite	SeO <sub>2</sub>	tetr		8	8.35		5.05			
Sellaite	MgF <sub>2</sub>	tetr	rutile	2	4.621		3.050			
Senarmontite	Sb <sub>2</sub> O <sub>3</sub>	cubic	arsenic trioxide	16	11.152					
Shandite	Ni <sub>3</sub> Pb <sub>2</sub> S <sub>2</sub>	rhomb		3	5.576		13.658			
Shortite	Na <sub>2</sub> Ca <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub>	orth		2	4.961	11.03	7.12			
Siderite	FeCO <sub>3</sub>	rhomb	calcite	6	4.6887		15.373			
Silicon	Si	cubic	diamond	8	5.4305					
Sillimanite	Al <sub>2</sub> OSiO <sub>4</sub>	orth		4	7.4843	7.6730	5.7711			
Silver	Ag	cubic	face-centered cubic	4	4.0862					
Silver telluride I	Ag <sub>2</sub> Te	cubic		2	5.29					
Silver telluride II	Ag <sub>2</sub> Te	cubic		4	6.585					
Smithsonite	ZnCO <sub>3</sub>	rhomb	calcite	6	4.6528		15.025			
Soda niter	NaNO <sub>3</sub>	rhomb	calcite	6	5.0696		16.829			
Sodium melilite	NaCaAlSi <sub>2</sub> O <sub>7</sub>	tetr	melilite	2	8.511		4.809			
Sperrylite	PtAs <sub>2</sub>	cubic	pyrite	4	5.968					
Spessartite	Mn <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	11.621					
Sphalerite	ZnS	cubic	sphalerite	4	5.4093					
Sphene	CaTiSiO <sub>5</sub>	monocl		4	7.07	8.72	6.56		113.95°	
Spinel	MgAl <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.080					
Spodumene	LiAl(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.451	8.387	5.208		110.07°	
Spodumene (β)	LiAl(SiO <sub>3</sub> ) <sub>2</sub>	tetr		4	7.5332		9.1540			
Staurolite	Fe <sub>2</sub> Al <sub>3</sub> Si <sub>4</sub> O <sub>22</sub> (OH) <sub>2</sub>	monocl		2	7.90	16.65	5.63		90.00°	
Sternbergite	AgFe <sub>2</sub> S <sub>3</sub>	orth		8	11.60	12.675	6.63			
Stibnite	Sb <sub>2</sub> S <sub>3</sub>	orth	stibnite	4	11.229	11.310	3.8389			
Stilleite	ZnSe	cubic	sphalerite	4	5.6685					
Stishovite	SiO <sub>2</sub>	tetr	rutile	2	4.1790		2.6649			
Stolzite	PbWO <sub>4</sub>	tetr	scheelite	4	5.4616		12.046			
Stromeyerite	Ag <sub>0.93</sub> Cu <sub>1.07</sub> S	orth		4	4.066	6.628	7.972			
Strontianite	SrCO <sub>3</sub>	orth	aragonite	4	6.029	8.414	5.107			
Sulfur (monoclinic)	S	monocl	S8 ring molecules	48	11.04	10.98	10.92		96.73°	
Sulfur (orthorhombic)	S	orth	S8 ring molecules	128	10.4646	12.8660	24.4860			
Sulfur (rhombohedral)	S	rhomb	S6 ring molecules	18	10.818		4.280			
Sylvite	KCl	cubic	rock salt	4	6.2931					
Syngenite	K <sub>2</sub> Ca(SO <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O	monocl		2	9.775	7.156	6.251		104.00°	
Synthetic anorthite	CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	hex		2	5.10		14.72			
Synthetic anorthite	CaAl <sub>2</sub> Si <sub>2</sub> O <sub>8</sub>	orth		2	8.22	8.60	4.83			
Talc	Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	monocl	2M1 mica	4	5.287	9.158	18.95		99.50°	
Tantalum	Ta	cubic	tungsten	2	3.3058					
Teallite	PbSnS <sub>2</sub>	orth	germanium sulfide	2	4.266	11.419	4.090			
Tellurite	TeO <sub>2</sub>	orth	tellurite	8	5.607	12.034	5.463			
Tellurium	Te	hex	selenium	3	4.4570		5.9290			
Tellurobismuthite	Bi <sub>2</sub> Te <sub>3</sub>	rhomb		3	4.3835		30.487			
Tennantite	Cu <sub>12</sub> As <sub>4</sub> S <sub>13</sub>	cubic	tetrahedrite	2	10.190					
Tenorite	CuO	monocl		4	4.684	3.425	5.129		99.47°	
Tephroite	Mn <sub>2</sub> SiO <sub>4</sub>	orth	olivine	4	4.871	10.636	6.232			

Name	Formula	Crystal system	Structure type	Z	a/Å	b/Å	c/Å	α	β	γ
Tetrahedrite	Cu <sub>12</sub> Sb <sub>4</sub> S <sub>13</sub>	cubic	tetrahedrite	2	10.327					
Thenardite	Na <sub>2</sub> SO <sub>4</sub>	orth	thenardite	8	5.863	12.304	9.821			
Thorianite	ThO <sub>2</sub>	cubic	fluorite	4	5.5952					
Thorite	ThSiO <sub>4</sub>	tetr	zircon	4	7.143		6.327			
Tiemannite	HgSe	cubic	sphalerite	4	6.0853					
Tin	Sn	tetr		4	5.8315		3.1813			
Titanium	Ti	hex		2	2.953		4.729			
Titanium(III) oxide	Ti <sub>2</sub> O <sub>3</sub>	rhomb	corundum	6	5.149		13.642			
Topaz	Al <sub>2</sub> SiO <sub>4</sub> (OH,F) <sub>2</sub>	orth		4	8.394	8.792	4.649			
Tremolite	Ca <sub>2</sub> Mg <sub>5</sub> Si <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	monocl	tremolite	2	9.840	18.052	5.275		104.70°	
Trevorite	NiFe <sub>2</sub> O <sub>4</sub>	cubic	spinel	8	8.339					
Tridymite (β)	SiO <sub>2</sub>	hex		4	5.0463		8.2563			
Trogtalite	CoSe <sub>2</sub>	cubic	pyrite	4	5.8588					
Troilite	FeS	hex	niccolite	2	3.446		5.877			
Tschermakite	CaAl <sub>2</sub> SiO <sub>6</sub>	monocl	diopside	4	9.615	8.661	5.272		106.12°	
Tungsten	W	cubic		2	3.1653					
Tungstenite	WS <sub>2</sub>	hex	molybdenite	2	3.154		12.362			
Turquoise	CuAl <sub>6</sub> (PO <sub>4</sub> ) <sub>4</sub> (OH) <sub>8</sub> ·4H <sub>2</sub> O	tricl		1	7.424	7.629	9.910	68.61°	69.71°	65.08°
Umangite	Cu <sub>3</sub> Se <sub>2</sub>	tetr		2	6.402		4.276			
Uraninite	UO <sub>2</sub>	cubic	fluorite	4	5.4682					
Ureyite	NaCr(SiO <sub>3</sub> ) <sub>2</sub>	monocl	diopside	4	9.550	8.712	5.273		107.44°	
Uvarovite	Ca <sub>3</sub> Cr <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	cubic	garnet	8	11.999					
Uvite	CaMg <sub>4</sub> Al <sub>3</sub> B <sub>3</sub> Si <sub>6</sub> O <sub>27</sub> (OH) <sub>4</sub>	rhomb	tourmaline	3	15.86		7.19			
Vaesite	NiS <sub>2</sub>	cubic	pyrite	4	5.6873					
Valentinite	Sb <sub>2</sub> O <sub>3</sub>	orth	antimony trioxide	4	4.914	12.468	5.421			
Vanthoffite	MgSO <sub>4</sub> ·3Na <sub>2</sub> SO <sub>4</sub>	monocl		2	9.797	9.217	8.199		113.50°	
Vaterite	CaCO <sub>3</sub>	hex		6	7.135		8.524			
Villiaumite	NaF	cubic	rock salt	4	4.6342					
Violarite	FeNi <sub>2</sub> S <sub>4</sub>	cubic	spinel	8	9.464					
Willemite	Zn <sub>2</sub> SiO <sub>4</sub>	rhomb	phenacite	18	13.94		9.309			
Witherite	BaCO <sub>3</sub>	orth	aragonite	4	6.430	8.904	5.314			
Wolframite	Fe <sub>0.5</sub> Mn <sub>0.5</sub> WO <sub>4</sub>	monocl	wolframite	2	4.782	5.731	4.982		90.57°	
Wollastonite	CaSiO <sub>3</sub>	tricl		6	7.94	7.32	7.07	90.03°	95.37°	103.43°
Wulfenite	PbMoO <sub>4</sub>	tetr	scheelite	4	5.435		12.110			
Wurtzite	ZnS	hex	zincite	2	3.8230		6.2565			
Wustite	Fe <sub>0.953</sub> O	cubic	defect rock salt	4	4.3088					
Xenotime	YPO <sub>4</sub>	tetr	zircon	4	6.885		5.982			
Zinc	Zn	hex	hexagonal close pack	2	2.665		4.947			
Zinc telluride	ZnTe	cubic	sphalerite	4	6.1020					
Zincite	ZnO	hex	zincite	2	3.2495		5.2069			
Zinkosite	ZnSO <sub>4</sub>	orth	barite	4	8.588	6.740	4.770			
Zircon	ZrSiO <sub>4</sub>	tetr	zircon	4	6.604		5.979			
Zoisite	Ca <sub>2</sub> Al <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> OH	orth		4	16.15	5.581	10.06			

## VAPOR PRESSURE OF THE METALLIC ELEMENTS — DATA

The following values of the vapor pressure of metallic elements are given in pascals. For conversion, note that 1 Pa = 7.50 μmHg are calculated from the equations in the preceding table. All values = 9.87·10<sup>-6</sup> atm.

Metal	mp/K	Vapor Pressure in Pa											
		400 K	600 K	800 K	1000 K	1200 K	1400 K	1600 K	1800 K	2000 K	2200 K	2400 K	
Aluminum	933			3.06×10 <sup>-10</sup>	5.08×10 <sup>-6</sup>	0.00256	0.218	6.10	81.4				
Americium	1449			3.88×10 <sup>-7</sup>	0.00167	0.423	21.35						
Barium	1000		7.97×10 <sup>-6</sup>	0.0450	7.11	162							
Beryllium	1560			3.04×10 <sup>-10</sup>	4.96×10 <sup>-6</sup>	0.00314	0.312	9.12	113				
Cadmium	594	0.000280	18.2										
Calcium	1115		2.36×10 <sup>-5</sup>	0.146	25.5								
Cerium	1071				2.47×10 <sup>-11</sup>	8.91×10 <sup>-8</sup>	2.97×10 <sup>-5</sup>	0.00233	0.0691	1.04	9.56	60.8	
Cesium	302	0.394											
Chromium	2180				2.45×10 <sup>-8</sup>	7.59×10 <sup>-5</sup>	0.0239	1.80	52.1	774			
Cobalt	1768				2.09×10 <sup>-10</sup>	1.00×10 <sup>-6</sup>	0.000419	0.0379	1.15	16.0			
Copper	1358			6.60×10 <sup>-11</sup>	1.53×10 <sup>-6</sup>	0.00122	0.135	3.94	54.4				
Curium	1618				1.90×10 <sup>-9</sup>	4.24×10 <sup>-6</sup>	0.00103	0.0629	1.17	12.1	82.1		
Dysprosium	1685			1.54×10 <sup>-8</sup>	8.21×10 <sup>-5</sup>	0.0241	1.362	27.5					
Erbium	1802			3.90×10 <sup>-10</sup>	4.30×10 <sup>-6</sup>	0.00205	0.163	4.23	52.5				
Europium	1095		1.74×10 <sup>-5</sup>	0.109	19.4								
Gadolinium	1586				5.70×10 <sup>-10</sup>	1.54×10 <sup>-6</sup>	0.000429	0.0279	0.618	7.39	56.2		
Gallium	303			1.94×10 <sup>-7</sup>	0.000565	0.114	4.98	84.4					
Gold	1337				3.72×10 <sup>-8</sup>	5.44×10 <sup>-5</sup>	0.00920	0.374	6.68	67.0			
Hafnium	2506						1.35×10 <sup>-11</sup>	9.81×10 <sup>-9</sup>	1.63×10 <sup>-6</sup>	9.69×10 <sup>-5</sup>	0.00272	0.0437	
Holmium	1747			3.20×10 <sup>-9</sup>	2.32×10 <sup>-5</sup>	0.00837	0.546	12.3					
Indium	430		8.31×10 <sup>-11</sup>	1.08×10 <sup>-5</sup>	0.0127	1.413	40.9						
Iridium	2719							1.48×10 <sup>-9</sup>	3.72×10 <sup>-7</sup>	3.06×10 <sup>-5</sup>	0.00112	0.0225	
Iron	1811				5.54×10 <sup>-9</sup>	2.51×10 <sup>-5</sup>	0.0104	0.961	32.7	36.8			
Lanthanum	1191					5.09×10 <sup>-8</sup>	2.02×10 <sup>-5</sup>	0.00181	0.0596	0.976	9.61	64.7	
Lead	601		5.54×10 <sup>-7</sup>	0.00618	1.64	68.1							
Lithium	454	7.90×10 <sup>-11</sup>	0.000489	1.08	109								
Lutetium	1936				3.28×10 <sup>-11</sup>	1.59×10 <sup>-7</sup>	6.79×10 <sup>-5</sup>	0.00628	0.211	3.18	26.7		
Magnesium	923	6.53×10 <sup>-9</sup>	0.0152	21.5									
Manganese	1519			5.55×10 <sup>-7</sup>	0.00221	0.524	24.9						
Mercury	234	140											
Molybdenum	2895							1.83×10 <sup>-9</sup>	4.07×10 <sup>-7</sup>	3.03×10 <sup>-5</sup>	0.00102	0.0189	
Neodymium	1294			4.55×10 <sup>-11</sup>	7.62×10 <sup>-7</sup>	0.000483	0.0412	1.07	13.4	101			
Neptunium	917					3.31×10 <sup>-9</sup>	1.63×10 <sup>-6</sup>	0.000168	0.00604	0.105	1.06	7.28	
Nickel	1728				2.19×10 <sup>-10</sup>	1.09×10 <sup>-6</sup>	0.000471	0.0438	1.37	19.5			
Niobium	2750							2.32×10 <sup>-11</sup>	9.54×10 <sup>-9</sup>	1.17×10 <sup>-6</sup>	5.98×10 <sup>-5</sup>	0.00158	
Osmium	3306								1.85×10 <sup>-10</sup>	3.46×10 <sup>-8</sup>	2.49×10 <sup>-6</sup>	8.75×10 <sup>-5</sup>	
Palladium	1828				8.27×10 <sup>-9</sup>	1.40×10 <sup>-5</sup>	0.00277	0.144	3.07				
Platinum	2041						2.34×10 <sup>-9</sup>	1.14×10 <sup>-5</sup>	0.00143	0.0689	0.153	1.59	
Plutonium	913				1.03×10 <sup>-8</sup>	6.17×10 <sup>-6</sup>	0.000594	0.0182	0.262	2.20	12.6	53.8	
Potassium	337	0.0188	96.9										
Praseodymium	1204				1.95×10 <sup>-8</sup>	2.16×10 <sup>-5</sup>	0.00257	0.0904	1.44	13.2	80.8		
Protactinium	1845							3.44×10 <sup>-10</sup>	8.06×10 <sup>-8</sup>	5.57×10 <sup>-6</sup>	0.000174	0.00306	
Rhenium	3459								1.37×10 <sup>-10</sup>	2.22×10 <sup>-8</sup>	1.41×10 <sup>-6</sup>	4.45×10 <sup>-5</sup>	
Rhodium	2236							1.69×10 <sup>-8</sup>	5.99×10 <sup>-6</sup>	0.000571	0.0217	0.422	4.41
Rubidium	312	0.165											
Ruthenium	2606							7.96×10 <sup>-9</sup>	1.77×10 <sup>-6</sup>	0.000133	0.00455	0.0858	
Samarium	1347		8.17×10 <sup>-8</sup>	0.00221	0.942	51.0							
Scandium	1814				6.31×10 <sup>-8</sup>	0.000129	0.0300	1.80	43.6	91.3			
Silver	1235			1.27×10 <sup>-7</sup>	0.000603	0.165	7.61	131					
Sodium	371	0.000185	5.60										
Strontium	1050	4.99×10 <sup>-11</sup>	0.000429	1.134	121								
Tantalum	3280									3.36×10 <sup>-10</sup>	1.87×10 <sup>-8</sup>	5.21×10 <sup>-7</sup>	
Terbium	1629				1.92×10 <sup>-9</sup>	4.18×10 <sup>-6</sup>	0.000988	0.0585	1.15	12.5	88.0		
Thallium	577		1.59×10 <sup>-5</sup>	0.0931	16.9								
Thorium	2023						3.33×10 <sup>-11</sup>	2.00×10 <sup>-8</sup>	2.89×10 <sup>-6</sup>	0.000154	0.00401	0.0610	
Thulium	1818		6.03×10 <sup>-10</sup>	5.94×10 <sup>-5</sup>	0.0561	5.22	130						
Tin	505			1.26×10 <sup>-9</sup>	8.62×10 <sup>-6</sup>	0.00310	0.207	4.85	56.3				
Titanium	1943					9.69×10 <sup>-9</sup>	7.44×10 <sup>-6</sup>	0.00106	0.0493	0.978	10.6	76.9	
Tungsten	3687									2.62×10 <sup>-10</sup>	3.01×10 <sup>-8</sup>	1.59×10 <sup>-6</sup>	
Uranium	1408					9.47×10 <sup>-10</sup>	2.87×10 <sup>-6</sup>	4.27×10 <sup>-6</sup>	0.000263	0.00678	0.0933	0.803	
Vanadium	2183					2.79×10 <sup>-10</sup>	4.35×10 <sup>-7</sup>	0.000107	0.00769	0.233	3.68	32.6	
Ytterbium	1092	1.03×10 <sup>-9</sup>	0.00384	6.74									
Yttrium	1795				6.66×10 <sup>-11</sup>	2.96×10 <sup>-7</sup>	0.000117	0.0102	0.316	4.27	35.9		
Zinc	693	1.47×10 <sup>-6</sup>	0.653										
Zirconium	2127						1.05×10 <sup>-10</sup>	6.17×10 <sup>-8</sup>	8.68×10 <sup>-6</sup>	0.000450	0.0110	0.155	

## CODATA KEY VALUES FOR THERMODYNAMICS

The Committee on Data for Science and Technology (CODATA) has conducted a project to establish internationally agreed values for the thermodynamic properties of key chemical substances. This table presents the final results of the project. Use of these recommended, internally consistent values is encouraged in the analysis of thermodynamic measurements, data reduction, and preparation of other thermodynamic tables.

The table includes the standard enthalpy of formation at 298.15 K, the entropy at 298.15 K, and the quantity  $H^\circ(298.15\text{ K}) - H^\circ(0)$ . A value of 0 in the  $\Delta_f H^\circ$  column for an element indicates the reference state for that element. The standard state pressure is 100000

Pa (1 bar). See the reference for information on the dependence of gas-phase entropy on the choice of standard state pressure.

Substances are listed in alphabetical order of their chemical formulas when written in the most common form.

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### Reference

Cox, J. D., Wagman, D. D., and Medvedev, V. A., *CODATA Key Values for Thermodynamics*, Hemisphere Publishing Corp., New York, 1989.

Substance	State	$\Delta_f H^\circ(298.15\text{ K})$ kJ·mol <sup>-1</sup>	$S^\circ(298.15\text{ K})$ J·K <sup>-1</sup> ·mol <sup>-1</sup>	$H^\circ(298.15\text{ K}) - H^\circ(0)$ kJ·mol <sup>-1</sup>
Ag	cr	0	42.55 ± 0.20	5.745 ± 0.020
Ag	g	284.9 ± 0.8	172.997 ± 0.004	6.197 ± 0.001
Ag <sup>+</sup>	aq	105.79 ± 0.08	73.45 ± 0.40	
AgCl	cr	-127.01 ± 0.05	96.25 ± 0.20	12.033 ± 0.020
Al	cr	0	28.30 ± 0.10	4.540 ± 0.020
Al	g	330.0 ± 4.0	164.554 ± 0.004	6.919 ± 0.001
Al <sup>3+</sup>	aq	-538.4 ± 1.5	-325 ± 10	
AlF <sub>3</sub>	cr	-1510.4 ± 1.3	66.5 ± 0.5	11.62 ± 0.04
Al <sub>2</sub> O <sub>3</sub>	cr, corundum	-1675.7 ± 1.3	50.92 ± 0.10	10.016 ± 0.020
Ar	g	0	154.846 ± 0.003	6.197 ± 0.001
B	cr, rhombic	0	5.90 ± 0.08	1.222 ± 0.008
B	g	565 ± 5	153.436 ± 0.015	6.316 ± 0.002
BF <sub>3</sub>	g	-1136.0 ± 0.8	254.42 ± 0.20	11.650 ± 0.020
B <sub>2</sub> O <sub>3</sub>	cr	-1273.5 ± 1.4	53.97 ± 0.30	9.301 ± 0.040
Be	cr	0	9.50 ± 0.08	1.950 ± 0.020
Be	g	324 ± 5	136.275 ± 0.003	6.197 ± 0.001
BeO	cr	-609.4 ± 2.5	13.77 ± 0.04	2.837 ± 0.008
Br	g	111.87 ± 0.12	175.018 ± 0.004	6.197 ± 0.001
Br <sup>-</sup>	aq	-121.41 ± 0.15	82.55 ± 0.20	
Br <sub>2</sub>	l	0	152.21 ± 0.30	24.52 ± 0.01
Br <sub>2</sub>	g	30.91 ± 0.11	245.468 ± 0.005	9.725 ± 0.001
C	cr, graphite	0	5.74 ± 0.10	1.050 ± 0.020
C	g	716.68 ± 0.45	158.100 ± 0.003	6.536 ± 0.001
CO	g	-110.53 ± 0.17	197.660 ± 0.004	8.671 ± 0.001
CO <sub>2</sub>	g	-393.51 ± 0.13	213.785 ± 0.010	9.365 ± 0.003
CO <sub>2</sub>	aq, undissoc.	-413.26 ± 0.20	119.36 ± 0.60	
CO <sub>3</sub> <sup>-2</sup>	aq	-675.23 ± 0.25	-50.0 ± 1.0	
Ca	cr	0	41.59 ± 0.40	5.736 ± 0.040
Ca	g	177.8 ± 0.8	154.887 ± 0.004	6.197 ± 0.001
Ca <sup>+2</sup>	aq	-543.0 ± 1.0	-56.2 ± 1.0	
CaO	cr	-634.92 ± 0.90	38.1 ± 0.4	6.75 ± 0.06
Cd	cr	0	51.80 ± 0.15	6.247 ± 0.015
Cd	g	111.80 ± 0.20	167.749 ± 0.004	6.197 ± 0.001
Cd <sup>+2</sup>	aq	-75.92 ± 0.60	-72.8 ± 1.5	
CdO	cr	-258.35 ± 0.40	54.8 ± 1.5	8.41 ± 0.08
CdSO <sub>4</sub> ·8/3H <sub>2</sub> O	cr	-1729.30 ± 0.80	229.65 ± 0.40	35.56 ± 0.04
Cl	g	121.301 ± 0.008	165.190 ± 0.004	6.272 ± 0.001
Cl <sup>-</sup>	aq	-167.080 ± 0.10	56.60 ± 0.20	
ClO <sub>4</sub> <sup>-</sup>	aq	-128.10 ± 0.40	184.0 ± 1.5	
Cl <sub>2</sub>	g	0	223.081 ± 0.010	9.181 ± 0.001
Cs	cr	0	85.23 ± 0.40	7.711 ± 0.020
Cs	g	76.5 ± 1.0	175.601 ± 0.003	6.197 ± 0.001
Cs <sup>+</sup>	aq	-258.00 ± 0.50	132.1 ± 0.5	
Cu	cr	0	33.15 ± 0.08	5.004 ± 0.008

Substance	State	$\Delta_f H^\circ (298.15 \text{ K})$	$S^\circ (298.15 \text{ K})$	$H^\circ (298.15 \text{ K}) - H^\circ (0)$
		$\text{kJ} \cdot \text{mol}^{-1}$	$\text{J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$	$\text{kJ} \cdot \text{mol}^{-1}$
Cu	g	337.4 ± 1.2	166.398 ± 0.004	6.197 ± 0.001
Cu <sup>+2</sup>	aq	64.9 ± 1.0	-98 ± 4	
CuSO <sub>4</sub>	cr	-771.4 ± 1.2	109.2 ± 0.4	16.86 ± 0.08
F	g	79.38 ± 0.30	158.751 ± 0.004	6.518 ± 0.001
F <sup>-</sup>	aq	-335.35 ± 0.65	-13.8 ± 0.8	
F <sub>2</sub>	g	0	202.791 ± 0.005	8.825 ± 0.001
Ge	cr	0	31.09 ± 0.15	4.636 ± 0.020
Ge	g	372 ± 3	167.904 ± 0.005	7.398 ± 0.001
GeF <sub>4</sub>	g	-1190.20 ± 0.50	301.9 ± 1.0	17.29 ± 0.10
GeO <sub>2</sub>	cr, tetragonal	-580.0 ± 1.0	39.71 ± 0.15	7.230 ± 0.020
H	g	217.998 ± 0.006	114.717 ± 0.002	6.197 ± 0.001
H <sup>+</sup>	aq	0	0	
HBr	g	-36.29 ± 0.16	198.700 ± 0.004	8.648 ± 0.001
HCO <sub>3</sub> <sup>-</sup>	aq	-689.93 ± 0.20	98.4 ± 0.5	
HCl	g	-92.31 ± 0.10	186.902 ± 0.005	8.640 ± 0.001
HF	g	-273.30 ± 0.70	173.779 ± 0.003	8.599 ± 0.001
HI	g	26.50 ± 0.10	206.590 ± 0.004	8.657 ± 0.001
HPO <sub>4</sub> <sup>-2</sup>	aq	-1299.0 ± 1.5	-33.5 ± 1.5	
HS <sup>-</sup>	aq	-16.3 ± 1.5	67 ± 5	
HSO <sub>4</sub> <sup>-</sup>	aq	-886.9 ± 1.0	131.7 ± 3.0	
H <sub>2</sub>	g	0	130.680 ± 0.003	8.468 ± 0.001
H <sub>2</sub> O	l	-285.830 ± 0.040	69.95 ± 0.03	13.273 ± 0.020
H <sub>2</sub> O	g	-241.826 ± 0.040	188.835 ± 0.010	9.905 ± 0.005
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	aq	-1302.6 ± 1.5	92.5 ± 1.5	
H <sub>2</sub> S	g	-20.6 ± 0.5	205.81 ± 0.05	9.957 ± 0.010
H <sub>2</sub> S	aq, undissoc.	-38.6 ± 1.5	126 ± 5	
H <sub>3</sub> BO <sub>3</sub>	cr	-1094.8 ± 0.8	89.95 ± 0.60	13.52 ± 0.04
H <sub>3</sub> BO <sub>3</sub>	aq, undissoc.	-1072.8 ± 0.8	162.4 ± 0.6	
He	g	0	126.153 ± 0.002	6.197 ± 0.001
Hg	l	0	75.90 ± 0.12	9.342 ± 0.008
Hg	g	61.38 ± 0.04	174.971 ± 0.005	6.197 ± 0.001
Hg <sup>+2</sup>	aq	170.21 ± 0.20	-36.19 ± 0.80	
HgO	cr, red	-90.79 ± 0.12	70.25 ± 0.30	9.117 ± 0.025
Hg <sub>2</sub> <sup>+2</sup>	aq	166.87 ± 0.50	65.74 ± 0.80	
Hg <sub>2</sub> Cl <sub>2</sub>	cr	-265.37 ± 0.40	191.6 ± 0.8	23.35 ± 0.20
Hg <sub>2</sub> SO <sub>4</sub>	cr	-743.09 ± 0.40	200.70 ± 0.20	26.070 ± 0.030
I	g	106.76 ± 0.04	180.787 ± 0.004	6.197 ± 0.001
I <sup>-</sup>	aq	-56.78 ± 0.05	106.45 ± 0.30	
I <sub>2</sub>	cr	0	116.14 ± 0.30	13.196 ± 0.040
I <sub>2</sub>	g	62.42 ± 0.08	260.687 ± 0.005	10.116 ± 0.001
K	cr	0	64.68 ± 0.20	7.088 ± 0.020
K	g	89.0 ± 0.8	160.341 ± 0.003	6.197 ± 0.001
K <sup>+</sup>	aq	-252.14 ± 0.08	101.20 ± 0.20	
Kr	g	0	164.085 ± 0.003	6.197 ± 0.001
Li	cr	0	29.12 ± 0.20	4.632 ± 0.040
Li	g	159.3 ± 1.0	138.782 ± 0.010	6.197 ± 0.001
Li <sup>+</sup>	aq	-278.47 ± 0.08	12.24 ± 0.15	
Mg	cr	0	32.67 ± 0.10	4.998 ± 0.030
Mg	g	147.1 ± 0.8	148.648 ± 0.003	6.197 ± 0.001
Mg <sup>+2</sup>	aq	-467.0 ± 0.6	-137 ± 4	
MgF <sub>2</sub>	cr	-1124.2 ± 1.2	57.2 ± 0.5	9.91 ± 0.06
MgO	cr	-601.60 ± 0.30	26.95 ± 0.15	5.160 ± 0.020
N	g	472.68 ± 0.40	153.301 ± 0.003	6.197 ± 0.001
NH <sub>3</sub>	g	-45.94 ± 0.35	192.77 ± 0.05	10.043 ± 0.010
NH <sub>4</sub> <sup>+</sup>	aq	-133.26 ± 0.25	111.17 ± 0.40	
NO <sub>3</sub> <sup>-</sup>	aq	-206.85 ± 0.40	146.70 ± 0.40	
N <sub>2</sub>	g	0	191.609 ± 0.004	8.670 ± 0.001
Na	cr	0	51.30 ± 0.20	6.460 ± 0.020
Na	g	107.5 ± 0.7	153.718 ± 0.003	6.197 ± 0.001
Na <sup>+</sup>	aq	-240.34 ± 0.06	58.45 ± 0.15	

Substance	State	$\Delta_f H^\circ$ (298.15 K)	$S^\circ$ (298.15 K)	$H^\circ$ (298.15 K) – $H^\circ$ (0)
		$\text{kJ} \cdot \text{mol}^{-1}$	$\text{J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$	$\text{kJ} \cdot \text{mol}^{-1}$
Ne	g	0	146.328 ± 0.003	6.197 ± 0.001
O	g	249.18 ± 0.10	161.059 ± 0.003	6.725 ± 0.001
OH <sup>-</sup>	aq	-230.015 ± 0.040	-10.90 ± 0.20	
O <sub>2</sub>	g	0	205.152 ± 0.005	8.680 ± 0.002
P	cr, white	0	41.09 ± 0.25	5.360 ± 0.015
P	g	316.5 ± 1.0	163.199 ± 0.003	6.197 ± 0.001
P <sub>2</sub>	g	144.0 ± 2.0	218.123 ± 0.004	8.904 ± 0.001
P <sub>4</sub>	g	58.9 ± 0.3	280.01 ± 0.50	14.10 ± 0.20
Pb	cr	0	64.80 ± 0.30	6.870 ± 0.030
Pb	g	195.2 ± 0.8	175.375 ± 0.005	6.197 ± 0.001
Pb <sup>+2</sup>	aq	0.92 ± 0.25	18.5 ± 1.0	
PbSO <sub>4</sub>	cr	-919.97 ± 0.40	148.50 ± 0.60	20.050 ± 0.040
Rb	cr	0	76.78 ± 0.30	7.489 ± 0.020
Rb	g	80.9 ± 0.8	170.094 ± 0.003	6.197 ± 0.001
Rb <sup>+</sup>	aq	-251.12 ± 0.10	121.75 ± 0.25	
S	cr, rhombic	0	32.054 ± 0.050	4.412 ± 0.006
S	g	277.17 ± 0.15	167.829 ± 0.006	6.657 ± 0.001
SO <sub>2</sub>	g	-296.81 ± 0.20	248.223 ± 0.050	10.549 ± 0.010
SO <sub>4</sub> <sup>-2</sup>	aq	-909.34 ± 0.40	18.50 ± 0.40	
S <sub>2</sub>	g	128.60 ± 0.30	228.167 ± 0.010	9.132 ± 0.002
Si	cr	0	18.81 ± 0.08	3.217 ± 0.008
Si	g	450 ± 8	167.981 ± 0.004	7.550 ± 0.001
SiF <sub>4</sub>	g	-1615.0 ± 0.8	282.76 ± 0.50	15.36 ± 0.05
SiO <sub>2</sub>	cr, alpha quartz	-910.7 ± 1.0	41.46 ± 0.20	6.916 ± 0.020
Sn	cr, white	0	51.18 ± 0.08	6.323 ± 0.008
Sn	g	301.2 ± 1.5	168.492 ± 0.004	6.215 ± 0.001
Sn <sup>+2</sup>	aq	-8.9 ± 1.0	-16.7 ± 4.0	
SnO	cr, tetragonal	-280.71 ± 0.20	57.17 ± 0.30	8.736 ± 0.020
SnO <sub>2</sub>	cr, tetragonal	-577.63 ± 0.20	49.04 ± 0.10	8.384 ± 0.020
Th	cr	0	51.8 ± 0.5	6.35 ± 0.05
Th	g	602 ± 6	190.17 ± 0.05	6.197 ± 0.003
ThO <sub>2</sub>	cr	-1226.4 ± 3.5	65.23 ± 0.20	10.560 ± 0.020
Ti	cr	0	30.72 ± 0.10	4.824 ± 0.015
Ti	g	473 ± 3	180.298 ± 0.010	7.539 ± 0.002
TiCl <sub>4</sub>	g	-763.2 ± 3.0	353.2 ± 4.0	21.5 ± 0.5
TiO <sub>2</sub>	cr, rutile	-944.0 ± 0.8	50.62 ± 0.30	8.68 ± 0.05
U	cr	0	50.20 ± 0.20	6.364 ± 0.020
U	g	533 ± 8	199.79 ± 0.10	6.499 ± 0.020
UO <sub>2</sub>	cr	-1085.0 ± 1.0	77.03 ± 0.20	11.280 ± 0.020
UO <sub>2</sub> <sup>+2</sup>	aq	-1019.0 ± 1.5	-98.2 ± 3.0	
UO <sub>3</sub>	cr, gamma	-1223.8 ± 1.2	96.11 ± 0.40	14.585 ± 0.050
U <sub>3</sub> O <sub>8</sub>	cr	-3574.8 ± 2.5	282.55 ± 0.50	42.74 ± 0.10
Xe	g	0	169.685 ± 0.003	6.197 ± 0.001
Zn	cr	0	41.63 ± 0.15	5.657 ± 0.020
Zn	g	130.40 ± 0.40	160.990 ± 0.004	6.197 ± 0.001
Zn <sup>+2</sup>	aq	-153.39 ± 0.20	-109.8 ± 0.5	
ZnO	cr	-350.46 ± 0.27	43.65 ± 0.40	6.933 ± 0.040

# STANDARD THERMODYNAMIC PROPERTIES OF CHEMICAL SUBSTANCES

This table gives the standard state chemical thermodynamic properties of about 2500 individual substances in the crystalline, liquid, and gaseous states. Substances are listed by molecular formula in a modified Hill order; all substances not containing carbon appear first, followed by those that contain carbon. The properties tabulated are:

- $\Delta_f H^\circ$  Standard molar enthalpy (heat) of formation at 298.15 K in kJ/mol
- $\Delta_f G^\circ$  Standard molar Gibbs energy of formation at 298.15 K in kJ/mol
- $S^\circ$  Standard molar entropy at 298.15 K in J/mol K
- $C_p$  Molar heat capacity at constant pressure at 298.15 K in J/mol K

The standard state pressure is 100 kPa (1 bar). The standard states are defined for different phases by:

- The standard state of a pure gaseous substance is that of the substance as a (hypothetical) ideal gas at the standard state pressure.
- The standard state of a pure liquid substance is that of the liquid under the standard state pressure.
- The standard state of a pure crystalline substance is that of the crystalline substance under the standard state pressure.

An entry of 0.0 for  $\Delta_f H^\circ$  for an element indicates the reference state of that element. See References 1 and 2 for further information on reference states. A blank means no value is available.

The data are derived from the sources listed in the references, from other papers appearing in the *Journal of Physical and Chemical Reference Data*, and from the primary research literature. We are indebted to M. V. Korobov for providing data on fullerene compounds.

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Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
<i>Substances not containing carbon:</i>													
Ac	Actinium	0.0		56.5	27.2					406.0	366.0	188.1	20.8
Ag	Silver	0.0		42.6	25.4					284.9	246.0	173.0	20.8
AgBr	Silver(I) bromide	-100.4	-96.9	107.1	52.4								
AgBrO <sub>3</sub>	Silver(I) bromate	-10.5	71.3	151.9									
AgCl	Silver(I) chloride	-127.0	-109.8	96.3	50.8								
AgClO <sub>3</sub>	Silver(I) chlorate	-30.3	64.5	142.0									
AgClO <sub>4</sub>	Silver(I) perchlorate	-31.1											
AgF	Silver(I) fluoride	-204.6											
AgF <sub>2</sub>	Silver(II) fluoride	-360.0											
AgI	Silver(I) iodide	-61.8	-66.2	115.5	56.8								
AgIO <sub>3</sub>	Silver(I) iodate	-171.1	-93.7	149.4	102.9								
AgNO <sub>3</sub>	Silver(I) nitrate	-124.4	-33.4	140.9	93.1								
Ag <sub>2</sub>	Disilver									410.0	358.8	257.1	37.0
Ag <sub>2</sub> CrO <sub>4</sub>	Silver(I) chromate	-731.7	-641.8	217.6	142.3								
Ag <sub>2</sub> O	Silver(I) oxide	-31.1	-11.2	121.3	65.9								
Ag <sub>2</sub> O <sub>2</sub>	Silver(II) oxide	-24.3	27.6	117.0	88.0								
Ag <sub>2</sub> O <sub>3</sub>	Silver(III) oxide	33.9	121.4	100.0									
Ag <sub>2</sub> O <sub>4</sub> S	Silver(I) sulfate	-715.9	-618.4	200.4	131.4								
Ag <sub>2</sub> S	Silver(I) sulfide (argentite)	-32.6	-40.7	144.0	76.5								
Al	Aluminum	0.0		28.3	24.2					330.0	289.4	164.6	21.4

















Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
F <sub>3</sub> Th	Thorium(III) fluoride									-1166.1	-1160.6	339.2	73.3
F <sub>3</sub> U	Uranium(III) fluoride	-1502.1	-1433.4	123.4	95.1					-1058.5	-1051.9	331.9	74.3
F <sub>3</sub> Y	Yttrium fluoride	-1718.8	-1644.7	100.0						-1288.7	-1277.8	311.8	70.3
F <sub>4</sub> Ge	Germanium(IV) fluoride									-1190.2	-1150.0	301.9	
F <sub>4</sub> Hf	Hafnium fluoride	-1930.5	-1830.4	113.0						-1669.8			
F <sub>4</sub> N <sub>2</sub>	Tetrafluorohydrazine									-8.4	79.9	301.2	79.2
F <sub>4</sub> Pb	Lead(IV) fluoride	-941.8											
F <sub>4</sub> S	Sulfur tetrafluoride									-763.2	-722.0	299.6	77.6
F <sub>4</sub> Si	Tetrafluorosilane									-1615.0	-1572.8	282.8	73.6
F <sub>4</sub> Th	Thorium(IV) fluoride	-2097.8	-2003.4	142.0	110.7					-1759.0	-1724.0	341.7	93.0
F <sub>4</sub> U	Uranium(IV) fluoride	-1914.2	-1823.3	151.7	116.0					-1598.7	-1572.7	368.0	91.2
F <sub>4</sub> V	Vanadium(IV) fluoride	-1403.3											
F <sub>4</sub> Xe	Xenon tetrafluoride	-261.5											
F <sub>4</sub> Zr	Zirconium(IV) fluoride	-1911.3	-1809.9	104.6	103.7								
F <sub>5</sub> I	Iodine pentafluoride					-864.8				-822.5	-751.7	327.7	99.2
F <sub>5</sub> Nb	Niobium(V) fluoride	-1813.8	-1699.0	160.2	134.7					-1739.7	-1673.6	321.9	97.1
F <sub>5</sub> P	Phosphorus(V) fluoride									-1594.4	-1520.7	300.8	84.8
F <sub>5</sub> Ta	Tantalum(V) fluoride	-1903.6											
F <sub>5</sub> V	Vanadium(V) fluoride					-1480.3	-1373.1	175.7		-1433.9	-1369.8	320.9	98.6
F <sub>6</sub> H <sub>8</sub> N <sub>2</sub> Si	Ammonium hexafluorosilicate	-2681.7	-2365.3	280.2	228.1								
F <sub>6</sub> Ir	Iridium(VI) fluoride	-579.7	-461.6	247.7						-544.0	-460.0	357.8	121.1
F <sub>6</sub> K <sub>2</sub> Si	Potassium hexafluorosilicate	-2956.0	-2798.6	226.0									
F <sub>6</sub> Mo	Molybdenum(VI) fluoride					-1585.5	-1473.0	259.7	169.8	-1557.7	-1472.2	350.5	120.6
F <sub>6</sub> Na <sub>2</sub> Si	Sodium hexafluorosilicate	-2909.6	-2754.2	207.1	187.1								
F <sub>6</sub> Os	Osmium(VI) fluoride			246.0								358.1	120.8
F <sub>6</sub> Pt	Platinum(VI) fluoride			235.6								348.3	122.8
F <sub>6</sub> S	Sulfur hexafluoride									-1220.5	-1116.5	291.5	97.0
F <sub>6</sub> Se	Selenium hexafluoride									-1117.0	-1017.0	313.9	110.5
F <sub>6</sub> Si <sub>2</sub>	Hexafluorodisilane	-2427.0	-2299.7	219.1	129.5					-2383.3	-2307.3	391.0	129.9
F <sub>6</sub> Te	Tellurium hexafluoride									-1318.0			
F <sub>6</sub> U	Uranium(VI) fluoride	-2197.0	-2068.5	227.6	166.8					-2147.4	-2063.7	377.9	129.6
F <sub>6</sub> W	Tungsten(VI) fluoride					-1747.7	-1631.4	251.5		-1721.7	-1632.1	341.1	119.0
Fe	Iron	0.0		27.3	25.1					416.3	370.7	180.5	25.7
FeI <sub>2</sub>	Iron(II) iodide	-113.0											
FeI <sub>3</sub>	Iron(III) iodide									71.0			
FeMoO <sub>4</sub>	Iron(II) molybdate	-1075.0	-975.0	129.3	118.5								
FeO	Iron(II) oxide	-272.0											
FeO <sub>4</sub> S	Iron(II) sulfate	-928.4	-820.8	107.5	100.6								
FeO <sub>4</sub> W	Iron(II) tungstate	-1155.0	-1054.0	131.8	114.6								
FeS	Iron(II) sulfide	-100.0	-100.4	60.3	50.5								
FeS <sub>2</sub>	Iron disulfide	-178.2	-166.9	52.9	62.2								
Fe <sub>2</sub> O <sub>3</sub>	Iron(III) oxide	-824.2	-742.2	87.4	103.9								
Fe <sub>2</sub> O <sub>4</sub> Si	Iron(II) orthosilicate	-1479.9	-1379.0	145.2	132.9								
Fe <sub>3</sub> O <sub>4</sub>	Iron(II,III) oxide	-1118.4	-1015.4	146.4	143.4								
Fm	Fermium	0.0											
Fr	Francium	0.0		95.4									
Ga	Gallium	0.0	0.0	40.8	26.1	5.6				272.0	233.7	169.0	25.3
GaH <sub>3</sub> O <sub>3</sub>	Gallium(III) hydroxide	-964.4	-831.3	100.0									
Gal <sub>3</sub>	Gallium(III) iodide	-238.9		205.0	100.0								
GaN	Gallium nitride	-110.5											
GaO	Gallium monoxide									279.5	253.5	231.1	32.1
GaP	Gallium phosphide	-88.0											
GaSb	Gallium antimonide	-41.8	-38.9	76.1	48.5								
Ga <sub>2</sub>	Digallium									438.5			
Ga <sub>2</sub> O	Gallium suboxide	-356.0											
Ga <sub>2</sub> O <sub>3</sub>	Gallium(III) oxide	-1089.1	-998.3	85.0	92.1								
Gd	Gadolinium	0.0		68.1	37.0					397.5	359.8	194.3	27.5
Gd <sub>2</sub> O <sub>3</sub>	Gadolinium(III) oxide	-1819.6			106.7								
Ge	Germanium	0.0		31.1	23.3					372.0	331.2	167.9	30.7
GeH <sub>3</sub> I	Iodogermane											283.2	57.5
GeH <sub>4</sub>	Germane									90.8	113.4	217.1	45.0
GeI <sub>4</sub>	Germanium(IV) iodide	-141.8	-144.3	271.1						-56.9	-106.3	428.9	104.1
GeO	Germanium(II) oxide	-261.9	-237.2	50.0						-46.2	-73.2	224.3	30.9
GeO <sub>2</sub>	Germanium(IV) oxide	-580.0	-521.4	39.7	52.1								
GeP	Germanium phosphide	-21.0	-17.0	63.0									
GeS	Germanium(II) sulfide	-69.0	-71.5	71.0						92.0	42.0	234.0	33.7











Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
O <sub>2</sub> S	Sulfur dioxide					-320.5				-296.8	-300.1	248.2	39.9
O <sub>2</sub> Se	Selenium dioxide	-225.4											
O <sub>2</sub> Si	Silicon dioxide ( $\alpha$ -quartz)	-910.7	-856.3	41.5	44.4					-322.0			
O <sub>2</sub> Sn	Tin(IV) oxide	-577.6	-515.8	49.0	52.6								
O <sub>2</sub> Te	Tellurium dioxide	-322.6	-270.3	79.5									
O <sub>2</sub> Th	Thorium(IV) oxide	-1226.4	-1169.2	65.2	61.8								
O <sub>2</sub> Ti	Titanium(IV) oxide	-944.0	-888.8	50.6	55.0								
O <sub>2</sub> U	Uranium(IV) oxide	-1085.0	-1031.8	77.0	63.6					-465.7	-471.5	274.6	51.4
O <sub>2</sub> W	Tungsten(IV) oxide	-589.7	-533.9	50.5	56.1								
O <sub>2</sub> Zr	Zirconium(IV) oxide	-1100.6	-1042.8	50.4	56.2								
O <sub>3</sub>	Ozone									142.7	163.2	238.9	39.2
O <sub>3</sub> PbS	Lead(II) sulfite	-669.9											
O <sub>3</sub> PbSi	Lead(II) metasilicate	-1145.7	-1062.1	109.6	90.0								
O <sub>3</sub> Pt <sub>2</sub>	Praseodymium oxide	-1809.6			117.4								
O <sub>3</sub> Rh <sub>2</sub>	Rhodium(III) oxide	-343.0			103.8								
O <sub>3</sub> S	Sulfur trioxide	-454.5	-374.2	70.7		-441.0	-373.8	113.8		-395.7	-371.1	256.8	50.7
O <sub>3</sub> Sc <sub>2</sub>	Scandium oxide	-1908.8	-1819.4	77.0	94.2								
O <sub>3</sub> SiSr	Strontium metasilicate	-1633.9	-1549.7	96.7	88.5								
O <sub>3</sub> Sm <sub>2</sub>	Samarium(III) oxide	-1823.0	-1734.6	151.0	114.5								
O <sub>3</sub> Tb <sub>2</sub>	Terbium oxide	-1865.2			115.9								
O <sub>3</sub> Ti <sub>2</sub>	Titanium(III) oxide	-1520.9	-1434.2	78.8	97.4								
O <sub>3</sub> Tm <sub>2</sub>	Thulium oxide	-1888.7	-1794.5	139.7	116.7								
O <sub>3</sub> U	Uranium(VI) oxide	-1223.8	-1145.7	96.1	81.7								
O <sub>3</sub> V <sub>2</sub>	Vanadium(III) oxide	-1218.8	-1139.3	98.3	103.2								
O <sub>3</sub> W	Tungsten(VI) oxide	-842.9	-764.0	75.9	73.8								
O <sub>3</sub> Y <sub>2</sub>	Yttrium oxide	-1905.3	-1816.6	99.1	102.5								
O <sub>3</sub> Yb <sub>2</sub>	Ytterbium(III) oxide	-1814.6	-1726.7	133.1	115.4								
O <sub>4</sub> Os	Osmium(VIII) oxide	-394.1	-304.9	143.9						-337.2	-292.8	293.8	74.1
O <sub>4</sub> PbS	Lead(II) sulfate	-920.0	-813.0	148.5	103.2								
O <sub>4</sub> PbSe	Lead(II) selenate	-609.2	-504.9	167.8									
O <sub>4</sub> Pb <sub>2</sub> Si	Lead(II) orthosilicate	-1363.1	-1252.6	186.6	137.2								
O <sub>4</sub> Pb <sub>3</sub>	Lead(II,IV) oxide	-718.4	-601.2	211.3	146.9								
O <sub>4</sub> RaS	Radium sulfate	-1471.1	-1365.6	138.0									
O <sub>4</sub> Rb <sub>2</sub> S	Rubidium sulfate	-1435.6	-1316.9	197.4	134.1								
O <sub>4</sub> Ru	Ruthenium(VIII) oxide	-239.3	-152.2	146.4									
O <sub>4</sub> SSr	Strontium sulfate	-1453.1	-1340.9	117.0									
O <sub>4</sub> STl <sub>2</sub>	Thallium(I) sulfate	-931.8	-830.4	230.5									
O <sub>4</sub> SZn	Zinc sulfate	-982.8	-871.5	110.5	99.2								
O <sub>4</sub> SiSr <sub>2</sub>	Strontium orthosilicate	-2304.5	-2191.1	153.1	134.3								
O <sub>4</sub> SiZn <sub>2</sub>	Zinc orthosilicate	-1636.7	-1523.2	131.4	123.3								
O <sub>4</sub> SiZr	Zirconium(IV) orthosilicate	-2033.4	-1919.1	84.1	98.7								
O <sub>4</sub> TiZr	Zirconium titanate	-2024.1	-1915.8	116.7	114.0								
O <sub>5</sub> Sb <sub>2</sub>	Antimony(V) oxide	-971.9	-829.2	125.1									
O <sub>5</sub> Ta <sub>2</sub>	Tantalum(V) oxide	-2046.0	-1911.2	143.1	135.1								
O <sub>5</sub> Ti <sub>3</sub>	Titanium(III,IV) oxide	-2459.4	-2317.4	129.3	154.8								
O <sub>5</sub> V <sub>2</sub>	Vanadium(V) oxide	-1550.6	-1419.5	131.0	127.7								
O <sub>5</sub> V <sub>3</sub>	Vanadium(III,IV) oxide	-1933.0	-1803.0	163.0									
O <sub>7</sub> Re <sub>2</sub>	Rhenium(VII) oxide	-1240.1	-1066.0	207.1	166.1					-1100.0	-994.0	452.0	
O <sub>7</sub> U <sub>3</sub>	Uranium(IV,VI) oxide	-3427.1	-3242.9	250.5	215.5								
O <sub>8</sub> S <sub>2</sub> Zr	Zirconium(IV) sulfate	-2217.1			172.0								
O <sub>8</sub> U <sub>3</sub>	Uranium(V,VI) oxide	-3574.8	-3369.5	282.6	238.4								
O <sub>9</sub> U <sub>4</sub>	Uranium(IV,V) oxide	-4510.4	-4275.1	334.1	293.3								
Os	Osmium	0.0		32.6	24.7					791.0	745.0	192.6	20.8
P	Phosphorus (white)	0.0		41.1	23.8					316.5	280.1	163.2	20.8
P	Phosphorus (red)	-17.6		22.8	21.2								
P	Phosphorus (black)	-39.3											
P <sub>2</sub>	Diphosphorus									144.0	103.5	218.1	32.1
P <sub>4</sub>	Tetraphosphorus									58.9	24.4	280.0	67.2
Pa	Protactinium	0.0		51.9						607.0	563.0	198.1	22.9
Pb	Lead	0.0		64.8	26.4					195.2	162.2	175.4	20.8
PbS	Lead(II) sulfide	-100.4	-98.7	91.2	49.5								
PbSe	Lead(II) selenide	-102.9	-101.7	102.5	50.2								
PbTe	Lead(II) telluride	-70.7	-69.5	110.0	50.5								
Pd	Palladium	0.0		37.6	26.0					378.2	339.7	167.1	20.8
PdS	Palladium(II) sulfide	-75.0	-67.0	46.0									
Pm	Promethium	0.0										187.1	24.3

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
Po	Polonium	0.0											
Pr	Praseodymium	0.0		73.2	27.2					355.6	320.9	189.8	21.4
Pt	Platinum	0.0		41.6	25.9					565.3	520.5	192.4	25.5
PtS	Platinum(II) sulfide	-81.6	-76.1	55.1	43.4								
PtS <sub>2</sub>	Platinum(IV) sulfide	-108.8	-99.6	74.7	65.9								
Pu	Plutonium	0.0											
Ra	Radium	0.0		71.0						159.0	130.0	176.5	20.8
Rb	Rubidium	0.0		76.8	31.1					80.9	53.1	170.1	20.8
Re	Rhenium	0.0		36.9	25.5					769.9	724.6	188.9	20.8
Rh	Rhodium	0.0		31.5	25.0					556.9	510.8	185.8	21.0
Rn	Radon								0.0			176.2	20.8
Ru	Ruthenium	0.0		28.5	24.1					642.7	595.8	186.5	21.5
S	Sulfur (rhombic)	0.0		32.1	22.6					277.2	236.7	167.8	23.7
S	Sulfur (monoclinic)	0.3											
SSi	Silicon monosulfide									112.5	60.9	223.7	32.3
SSn	Tin(II) sulfide	-100.0	-98.3	77.0	49.3								
SSr	Strontium sulfide	-472.4	-467.8	68.2	48.7								
STl <sub>2</sub>	Thallium(I) sulfide	-97.1	-93.7	151.0									
SZn	Zinc sulfide (wurtzite)	-192.6											
SZn	Zinc sulfide (sphalerite)	-206.0	-201.3	57.7	46.0								
S <sub>2</sub>	Disulfur									128.6	79.7	228.2	32.5
Sb	Antimony	0.0		45.7	25.2					262.3	222.1	180.3	20.8
Sb <sub>2</sub>	Diantimony									235.6	187.0	254.9	36.4
Sc	Scandium	0.0		34.6	25.5					377.8	336.0	174.8	22.1
Se	Selenium (gray)	0.0		42.4	25.4					227.1	187.0	176.7	20.8
Se	Selenium ( $\alpha$ form)	6.7								227.1			
Se	Selenium (vitreous)	5.0								227.1			
SeSr	Strontium selenide	-385.8											
SeTl <sub>2</sub>	Thallium(I) selenide	-59.0	-59.0	172.0									
SeZn	Zinc selenide	-163.0	-163.0	84.0									
Se <sub>2</sub>	Diselenium									146.0	96.2	252.0	35.4
Si	Silicon	0.0		18.8	20.0					450.0	405.5	168.0	22.3
Si <sub>2</sub>	Disilicon									594.0	536.0	229.9	34.4
Sm	Samarium	0.0		69.6	29.5					206.7	172.8	183.0	30.4
Sn	Tin (white)	0.0		51.2	27.0					301.2	266.2	168.5	21.3
Sn	Tin (gray)	-2.1	0.1	44.1	25.8								
Sr	Strontium	0.0		55.0	26.8					164.4	130.9	164.6	20.8
Ta	Tantalum	0.0		41.5	25.4					782.0	739.3	185.2	20.9
Tb	Terbium	0.0		73.2	28.9					388.7	349.7	203.6	24.6
Tc	Technetium	0.0								678.0		181.1	20.8
Te	Tellurium	0.0		49.7	25.7					196.7	157.1	182.7	20.8
Te <sub>2</sub>	Ditellurium									168.2	118.0	268.1	36.7
Th	Thorium	0.0		51.8	27.3					602.0	560.7	190.2	20.8
Ti	Titanium	0.0		30.7	25.0					473.0	428.4	180.3	24.4
Tl	Thallium	0.0		64.2	26.3					182.2	147.4	181.0	20.8
Tm	Thulium	0.0		74.0	27.0					232.2	197.5	190.1	20.8
U	Uranium	0.0		50.2	27.7					533.0	488.4	199.8	23.7
V	Vanadium	0.0		28.9	24.9					514.2	754.4	182.3	26.0
W	Tungsten	0.0		32.6	24.3					849.4	807.1	174.0	21.3
Xe	Xenon								0.0			169.7	20.8
Y	Yttrium	0.0		44.4	26.5					421.3	381.1	179.5	25.9
Yb	Ytterbium	0.0		59.9	26.7					152.3	118.4	173.1	20.8
Zn	Zinc	0.0		41.6	25.4					130.4	94.8	161.0	20.8
Zr	Zirconium	0.0		39.0	25.4					608.8	566.5	181.4	26.7
<b>Substances containing carbon:</b>													
C	Carbon (graphite)	0.0		5.7	8.5					716.7	671.3	158.1	20.8
C	Carbon (diamond)	1.9	2.9	2.4	6.1								
C <sub>Ag</sub> N	Silver(I) cyanide	146.0	156.9	107.2	66.7								
CAg <sub>2</sub> O <sub>3</sub>	Silver(I) carbonate	-505.8	-436.8	167.4	112.3								
CBaO <sub>3</sub>	Barium carbonate	-1213.0	-1134.4	112.1	86.0								
CBeO <sub>3</sub>	Beryllium carbonate	-1025.0		52.0	65.0								
CBrClF <sub>2</sub>	Bromochlorodifluoromethane											318.5	74.6
CBrCl <sub>2</sub> F	Bromodichlorofluoromethane											330.6	80.0
CBrCl <sub>3</sub>	Bromotrichloromethane									-41.1			85.3
CBrF <sub>3</sub>	Bromotrifluoromethane									-648.3			69.3

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
CBrN	Cyanogen bromide	140.5								186.2	165.3	248.3	46.9
CBrN <sub>3</sub> O <sub>6</sub>	Bromotrinitromethane					32.5				80.3			
CBr <sub>2</sub> ClF	Dibromochlorofluoromethane											342.8	82.4
CBr <sub>2</sub> Cl <sub>2</sub>	Dibromodichloromethane											347.8	87.1
CBr <sub>2</sub> F <sub>2</sub>	Dibromodifluoromethane											325.3	77.0
CBr <sub>2</sub> O	Carbonyl bromide					-127.2				-96.2	-110.9	309.1	61.8
CBr <sub>3</sub> Cl	Tribromochloromethane											357.8	89.4
CBr <sub>3</sub> F	Tribromofluoromethane											345.9	84.4
CBr <sub>4</sub>	Tetrabromomethane	29.4	47.7	212.5	144.3					83.9	67.0	358.1	91.2
CCaO <sub>3</sub>	Calcium carbonate (calcite)	-1207.6	-1129.1	91.7	83.5								
CCaO <sub>3</sub>	Calcium carbonate (aragonite)	-1207.8	-1128.2	88.0	82.3								
CCdO <sub>3</sub>	Cadmium carbonate	-750.6	-669.4	92.5									
CClFO	Carbonyl chloride fluoride											276.7	52.4
CClF <sub>3</sub>	Chlorotrifluoromethane									-706.3			66.9
CCIN	Cyanogen chloride					112.1				138.0	131.0	236.2	45.0
CCIN <sub>3</sub> O <sub>6</sub>	Chlorotrinitromethane					-27.1				18.4			
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane									-477.4	-439.4	300.8	72.3
CCl <sub>2</sub> O	Carbonyl chloride									-219.1	-204.9	283.5	57.7
CCl <sub>3</sub>	Trichloromethyl									59.0			
CCl <sub>3</sub> F	Trichlorofluoromethane					-301.3	-236.8	225.4	121.6	-268.3			78.1
CCl <sub>4</sub>	Tetrachloromethane					-128.2			130.7	-95.7			83.3
CCoO <sub>3</sub>	Cobalt(II) carbonate	-713.0											
CCs <sub>2</sub> O <sub>3</sub>	Cesium carbonate	-1139.7	-1054.3	204.5	123.9								
CCuN	Copper(I) cyanide	96.2	111.3	84.5									
CFN	Cyanogen fluoride											224.7	41.8
CF <sub>2</sub> O	Carbonyl fluoride									-639.8			46.8
CF <sub>3</sub>	Trifluoromethyl									-477.0	-464.0	264.5	49.6
CF <sub>3</sub> I	Trifluoroiodomethane									-587.8		307.4	70.9
CF <sub>4</sub>	Tetrafluoromethane									-933.6		261.6	61.1
CFeO <sub>3</sub>	Iron(II) carbonate	-740.6	-666.7	92.9	82.1								
CFe <sub>3</sub>	Iron carbide	25.1	20.1	104.6	105.9								
CH	Methylidyne									595.8			
CHBrClF	Bromochlorofluoromethane											304.3	63.2
CHBrCl <sub>2</sub>	Bromodichloromethane											316.4	67.4
CHBrF <sub>2</sub>	Bromodifluoromethane									-424.9		295.1	58.7
CHBr <sub>2</sub> Cl	Chlorodibromomethane											327.7	69.2
CHBr <sub>2</sub> F	Dibromofluoromethane											316.8	65.1
CHBr <sub>3</sub>	Tribromomethane					-22.3	-5.0	220.9	130.7	23.8	8.0	330.9	71.2
CHClF <sub>2</sub>	Chlorodifluoromethane									-482.6		280.9	55.9
CHCl <sub>2</sub> F	Dichlorofluoromethane											293.1	60.9
CHCl <sub>3</sub>	Trichloromethane					-134.1	-73.7	201.7	114.2	-102.7	6.0	295.7	65.7
CHCsO <sub>3</sub>	Cesium hydrogen carbonate	-966.1											
CHFO	Formyl fluoride											246.6	39.9
CHF <sub>3</sub>	Trifluoromethane									-695.4		259.7	51.0
CHI <sub>3</sub>	Triiodomethane	-181.1								251.0		356.2	75.0
CHKO <sub>2</sub>	Potassium formate	-679.7											
CHKO <sub>3</sub>	Potassium hydrogen carbonate	-963.2	-863.5	115.5									
CHN	Hydrogen cyanide					108.9	125.0	112.8	70.6	135.1	124.7	201.8	35.9
CHNO	Isocyanic acid (HNCO)											238.0	44.9
CHNS	Isothiocyanic acid									127.6	113.0	247.8	46.9
CHN <sub>3</sub> O <sub>6</sub>	Trinitromethane					-32.8				-13.4		435.6	134.1
CHNaO <sub>2</sub>	Sodium formate	-666.5	-599.9	103.8	82.7								
CHNaO <sub>3</sub>	Sodium hydrogen carbonate	-950.8	-851.0	101.7	87.6								
CHO	Oxomethyl (HCO)									43.1	28.0	224.7	34.6
CH <sub>2</sub>	Methylene									390.4	372.9	194.9	33.8
CH <sub>2</sub> BrCl	Bromochloromethane											287.6	52.7
CH <sub>2</sub> BrF	Bromofluoromethane											276.3	49.2
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane											293.2	54.7
CH <sub>2</sub> ClF	Chlorofluoromethane											264.4	47.0
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane					-124.2		177.8	101.2	-95.4		270.2	51.0
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane									-452.3		246.7	42.9
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane					68.5	90.4	174.1	134.0	119.5	95.8	309.7	57.7
CH <sub>2</sub> N <sub>2</sub>	Diazomethane											242.9	52.5
CH <sub>2</sub> N <sub>2</sub>	Cyanamide	58.8											
CH <sub>2</sub> N <sub>2</sub> O <sub>4</sub>	Dinitromethane					-104.9				-61.5		358.1	86.4
CH <sub>2</sub> O	Formaldehyde									-108.6	-102.5	218.8	35.4





Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>2</sub> ClF <sub>3</sub>	Chlorotrifluoroethene					-522.7				-505.5	-523.8	322.1	83.9
C <sub>2</sub> ClF <sub>5</sub>	Chloropentafluoroethane									-1118.8			184.2
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichloro-1,1,2,2-tetrafluoroethane					-960.2			111.7	-937.0			
C <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	Oxalyl chloride					-367.6				-335.8			
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichloro-1,1,2,2-trifluoroethane					-745.0			170.1	-716.8			
C <sub>2</sub> Cl <sub>3</sub> N	Trichloroacetoneitrile											336.6	96.1
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethene					-50.6	3.0	266.9	143.4	-10.9			
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,1,2-Tetrachloro-2,2-difluoroethane									-489.9	-407.0	382.9	123.4
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,2,2-Tetrachloro-1,2-difluoroethane								173.6				
C <sub>2</sub> Cl <sub>4</sub> O	Trichloroacetyl chloride					-280.8				-239.8			
C <sub>2</sub> Cl <sub>6</sub>	Hexachloroethane	-202.8		237.3	198.2					-143.6			
C <sub>2</sub> F <sub>3</sub> N	Trifluoroacetoneitrile									-497.9		298.1	77.9
C <sub>2</sub> F <sub>4</sub>	Tetrafluoroethene	-820.5								-658.9		300.1	80.5
C <sub>2</sub> F <sub>6</sub>	Hexafluoroethane									-1344.2		332.3	106.7
C <sub>2</sub> HBr	Bromoacetylene											253.7	55.7
C <sub>2</sub> HBrClF <sub>3</sub>	1-Bromo-2-chloro-1,1,2-trifluoroethane					-675.3				-644.8			
C <sub>2</sub> HBrClF <sub>3</sub>	2-Bromo-2-chloro-1,1,1-trifluoroethane					-720.0				-690.4			
C <sub>2</sub> HCl	Chloroacetylene											242.0	54.3
C <sub>2</sub> HClF <sub>2</sub>	1-Chloro-2,2-difluoroethene									-315.5	-289.1	303.0	72.1
C <sub>2</sub> HCl <sub>2</sub> F	1,1-Dichloro-2-fluoroethene											313.9	76.5
C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	2,2-Dichloro-1,1,1-trifluoroethane											352.8	102.5
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethene					-43.6		228.4	124.4	-9.0		324.8	80.3
C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde					-234.5			151.0	-196.6			
C <sub>2</sub> HCl <sub>3</sub> O	Dichloroacetyl chloride					-280.4				-241.0			
C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid	-503.3											
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane					-187.6			173.8	-142.0			
C <sub>2</sub> HF	Fluoroacetylene											231.7	52.4
C <sub>2</sub> HF <sub>3</sub>	Trifluoroethene									-490.5			
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid					-1069.9				-1031.4			
C <sub>2</sub> HF <sub>5</sub>	Pentafluoroethane									-1100.4			
C <sub>2</sub> H <sub>2</sub>	Acetylene									227.4	209.9	200.9	44.0
C <sub>2</sub> H <sub>2</sub> Br <sub>3</sub>	2-Bromo-1,1,1-trifluoroethane									-694.5			
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>cis</i> -1,2-Dibromoethene											311.3	68.8
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>trans</i> -1,2-Dibromoethene											313.5	70.3
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	1,2-Dibromo-1,2-dichloroethane									-36.9			
C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	1,1,2,2-Tetrabromoethane								165.7				
C <sub>2</sub> H <sub>2</sub> ClF <sub>3</sub>	2-Chloro-1,1,1-trifluoroethane											326.5	89.1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethene					-23.9	24.1	201.5	111.3	2.8	25.4	289.0	67.1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethene					-26.4		198.4	116.4	4.6		289.6	65.1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethene					-24.3	27.3	195.9	116.8	5.0	28.6	290.0	66.7
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	Chloroacetyl chloride					-283.7				-244.8			
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	Dichloroacetic acid					-496.3							
C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> NO	2,2,2-Trichloroacetamide	-358.0											
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,1,2-Tetrachloroethane											356.0	102.7
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane					-195.0		246.9	162.3	-149.2		362.8	100.8
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1,1-Difluoroethene									-335.0		266.2	60.1
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	<i>cis</i> -1,2-Difluoroethene											268.3	58.2
C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> I	1,1,1-Trifluoro-2-iodoethane									-644.5			
C <sub>2</sub> H <sub>2</sub> I <sub>2</sub>	<i>cis</i> -1,2-Diiodoethene									-207.4			
C <sub>2</sub> H <sub>2</sub> O	Ketene					-67.9				-47.5	-48.3	247.6	51.8
C <sub>2</sub> H <sub>2</sub> O <sub>2</sub>	Glyoxal									-212.0	-189.7	272.5	60.6
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	Oxalic acid	-829.9		109.8	91.0					-731.8	-662.7	320.6	86.2
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub> Sr	Strontium formate	-1393.3											
C <sub>2</sub> H <sub>2</sub> S	Thiirene									300.0	275.8	255.3	54.7
C <sub>2</sub> H <sub>3</sub> Br	Bromoethene									79.2	81.8	275.8	55.5
C <sub>2</sub> H <sub>3</sub> BrO	Acetyl bromide					-223.5				-190.4			
C <sub>2</sub> H <sub>3</sub> BrO <sub>2</sub>	Bromoacetic acid									-383.5	-338.3	337.0	80.5
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethene	-94.1			59.4	14.6				37.2	53.6	264.0	53.7
C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	1-Chloro-1,1-difluoroethane											307.2	82.5
C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride					-272.9	-208.0	200.8	117.0	-242.8	-205.8	295.1	67.8
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid	-509.7								-427.6	-368.5	325.9	78.8

Molecular formula	Name	Crystal				Liquid				Gas					
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K		
C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	1,1-Dichloro-1-fluoroethane											320.2	88.7		
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane					-177.4		227.4	144.3	-144.4		323.1	93.3		
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane					-190.8		232.6	150.9	-151.3		337.2	89.0		
C <sub>2</sub> H <sub>3</sub> F	Fluoroethene										-138.8				
C <sub>2</sub> H <sub>3</sub> FO	Acetyl fluoride					-467.2					-442.1				
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,1-Trifluoroethane										-744.6	279.9	78.2		
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,2-Trifluoroethane										-730.7				
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	2,2,2-Trifluoroethanol					-932.4					-888.4				
C <sub>2</sub> H <sub>3</sub> I	Iodoethene											285.0	57.9		
C <sub>2</sub> H <sub>3</sub> IO	Acetyl iodide					-163.5					-126.4				
C <sub>2</sub> H <sub>3</sub> KO <sub>2</sub>	Potassium acetate	-723.0													
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile					40.6	86.5	149.6	91.5	74.0	91.9	243.4	52.2		
C <sub>2</sub> H <sub>3</sub> N	Isocyanomethane					130.8	159.5	159.0		163.5	165.7	246.9	52.9		
C <sub>2</sub> H <sub>3</sub> NO	Methyl isocyanate					-92.0									
C <sub>2</sub> H <sub>3</sub> NO <sub>2</sub>	Nitroethene										33.3	300.5	73.7		
C <sub>2</sub> H <sub>3</sub> NO <sub>3</sub>	Oxamic acid	-661.2									-552.3				
C <sub>2</sub> H <sub>3</sub> NS	Methyl isothiocyanate	79.4													
C <sub>2</sub> H <sub>3</sub> NaO <sub>2</sub>	Sodium acetate	-708.8	-607.2	123.0	79.9										
C <sub>2</sub> H <sub>4</sub>	Ethylene									52.4	68.4	219.3	42.9		
C <sub>2</sub> H <sub>4</sub> BrCl	1-Bromo-2-chloroethane								130.1						
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,1-Dibromoethane					-66.2						327.7	80.8		
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane					-79.2		223.3	136.0		-37.5				
C <sub>2</sub> H <sub>4</sub> ClF	1-Chloro-1-fluoroethane											-313.4			
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane					-158.4	-73.8	211.8	126.3	-127.7	-70.8	305.1	76.2		
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane					-166.8			128.4	-126.4		308.4	78.7		
C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	1,1-Difluoroethane											-497.0	282.5	67.8	
C <sub>2</sub> H <sub>4</sub> I <sub>2</sub>	1,2-Diiodoethane	9.3									75.0				
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	Oxamide	-504.4										-387.1			
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	Ethanedial dioxime	-90.5													
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1,1-Dinitroethane					-148.2									
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1,2-Dinitroethane					-165.2									
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> S <sub>2</sub>	Ethanedithioamide	-20.8									83.0				
C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	1 <i>H</i> -1,2,4-Triazol-3-amine	76.8													
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde					-192.2	-127.6	160.2	89.0	-166.2	-133.0	263.8	55.3		
C <sub>2</sub> H <sub>4</sub> O	Oxirane					-78.0	-11.8	153.9	88.0	-52.6	-13.0	242.5	47.9		
C <sub>2</sub> H <sub>4</sub> OS	Thioacetic acid					-216.9						-175.1			
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid					-484.3	-389.9	159.8	123.3	-432.2	-374.2	283.5	63.4		
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate					-386.1			119.1	-357.4		285.3	64.4		
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Peroxyacetic acid												82.4		
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Glycolic acid										-583.0	-504.9	318.6	87.1	
C <sub>2</sub> H <sub>4</sub> S	Thiirane					51.6				82.0	96.8	255.2	53.3		
C <sub>2</sub> H <sub>4</sub> Si	Ethynylsilane												269.4	72.6	
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane					-90.5	-25.8	198.7	100.8	-61.9	-23.9	286.7	64.5		
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane					-136.8	-59.3	190.8	104.3	-112.1	-60.4	276.0	62.8		
C <sub>2</sub> H <sub>5</sub> ClO	2-Chloroethanol					-295.4									
C <sub>2</sub> H <sub>5</sub> F	Fluoroethane												264.5	58.6	
C <sub>2</sub> H <sub>5</sub> I	Iodoethane					-40.0	14.7	211.7	115.1	-8.1	19.2	306.0	66.9		
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine						91.9					126.5			
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	-317.0		115.0	91.3							-238.3			
C <sub>2</sub> H <sub>5</sub> NO	<i>N</i> -Methylformamide								123.8						
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane					-143.9			134.4	-103.8		320.5	79.0		
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Glycine	-528.5										-392.1			
C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	2-Nitroethanol					-350.7									
C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	Ethyl nitrate					-190.4						-154.1			
C <sub>2</sub> H <sub>5</sub> NS	Thioacetamide	-71.7										11.4			
C <sub>2</sub> H <sub>6</sub>	Ethane											-84.0	-32.0	229.2	52.5
C <sub>2</sub> H <sub>6</sub> Cd	Dimethyl cadmium					63.6	139.0	201.9	132.0	101.6	146.9	303.0			
C <sub>2</sub> H <sub>6</sub> Hg	Dimethyl mercury					59.8	140.3	209.0		94.4	146.1	306.0		83.3	
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	<i>N</i> -Methylurea	-332.8													
C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	1,2-Hydrazinedicarboxamide	-498.7													
C <sub>2</sub> H <sub>6</sub> N <sub>4</sub> O <sub>2</sub>	Oxalyl dihydrazide	-295.2													
C <sub>2</sub> H <sub>6</sub> O	Ethanol					-277.6	-174.8	160.7	112.3	-234.8	-167.9	281.6	65.6		
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether					-203.3						-184.1	-112.6	266.4	64.4
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide					-204.2	-99.9	188.3	153.0			-151.3			
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol					-460.0		163.2	148.6			-392.2	303.8	82.7	
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	Dimethyl sulfone	-450.1	-302.4	142.0								-373.1	-272.7	310.6	100.0

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>2</sub> H <sub>6</sub> O <sub>3</sub> S	Dimethyl sulfite					-523.6				-483.4			
C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	Dimethyl sulfate					-735.5				-687.0			
C <sub>2</sub> H <sub>6</sub> S	Ethaneethiol					-73.6	-5.5	207.0	117.9	-46.1	-4.8	296.2	72.7
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide					-65.3		196.4	118.1	-37.4		286.0	74.1
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	1,2-Ethanedithiol					-54.3				-9.7			
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide					-62.6		235.4	146.1	-24.7			
C <sub>2</sub> H <sub>6</sub> Zn	Dimethyl zinc					23.4		201.6	129.2	53.0			
C <sub>2</sub> H <sub>7</sub> N	Ethylamine					-74.1			130.0	-47.5	36.3	283.8	71.5
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine					-43.9	70.0	182.3	137.7	-18.8	68.5	273.1	70.7
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine								195.5				
C <sub>2</sub> H <sub>9</sub> ClN	Dimethylamine hydrochloride	-289.3											
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine					-63.0			172.6	-18.0			
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,1-Dimethylhydrazine					48.9	206.4	198.0	164.1	84.1			
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Dimethylhydrazine					52.7				92.2			
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	Ammonium oxalate	-1123.0			226.0								
C <sub>2</sub> HgO <sub>4</sub>	Mercury(II) oxalate	-678.2											
C <sub>2</sub> I <sub>2</sub>	Diodoacetylene										313.1	70.3	
C <sub>2</sub> I <sub>4</sub>	Tetraiodoethene	305.0											
C <sub>2</sub> K <sub>2</sub> O <sub>4</sub>	Potassium oxalate	-1346.0											
C <sub>2</sub> MgO <sub>4</sub>	Magnesium oxalate	-1269.0											
C <sub>2</sub> N <sub>2</sub>	Cyanogen					285.9				306.7		241.9	56.8
C <sub>2</sub> N <sub>4</sub> O <sub>6</sub>	Trinitroacetone					183.7							
C <sub>2</sub> Na <sub>2</sub> O <sub>4</sub>	Sodium oxalate									-1318.0			
C <sub>2</sub> O <sub>4</sub> Pb	Lead(II) oxalate	-851.4	-750.1	146.0	105.4								
C <sub>3</sub> F <sub>8</sub>	Perfluoropropane									-1783.2			
C <sub>3</sub> H <sub>2</sub> N <sub>2</sub>	Malononitrile	186.4								265.5			
C <sub>3</sub> H <sub>2</sub> O <sub>2</sub>	2-Propynoic acid					-193.2							
C <sub>3</sub> H <sub>2</sub> O <sub>3</sub>	1,3-Dioxol-2-one					-459.9				-418.6			
C <sub>3</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,3-Trichloropropene					-101.8							
C <sub>3</sub> H <sub>3</sub> F <sub>3</sub>	3,3,3-Trifluoropropene									-614.2			
C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile					147.1				180.6			
C <sub>3</sub> H <sub>3</sub> NO	Oxazole					-48.0				-15.5			
C <sub>3</sub> H <sub>3</sub> NO	Isoxazole					42.1				78.6			
C <sub>3</sub> H <sub>4</sub>	Allene									190.5			
C <sub>3</sub> H <sub>4</sub>	Propyne									184.9			
C <sub>3</sub> H <sub>4</sub>	Cyclopropene									277.1			
C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	2,3-Dichloropropene					-73.3							
C <sub>3</sub> H <sub>4</sub> Cl <sub>4</sub>	1,1,1,3-Tetrachloropropene					-208.7							
C <sub>3</sub> H <sub>4</sub> Cl <sub>4</sub>	1,2,2,3-Tetrachloropropene					-251.8							
C <sub>3</sub> H <sub>4</sub> F <sub>3</sub> O	2,2,3,3-Tetrafluoro-1-propanol					-1114.9				-1061.3			
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	1 <i>H</i> -Pyrazole	105.4			81.0					179.4			
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	Imidazole	49.8								132.9			
C <sub>3</sub> H <sub>4</sub> O	Acrolein												71.3
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	1,2-Propanedione					-309.1				-271.0			
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Acrylic acid					-383.8			145.7				
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	2-Oxetanone					-329.9		175.3	122.1	-282.9			
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Ethylene carbonate					-682.8			133.9	-508.4			
C <sub>3</sub> H <sub>5</sub> Br	<i>cis</i> -1-Bromopropene					7.9				40.8			
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene					12.2				45.2			
C <sub>3</sub> H <sub>5</sub> BrO	Bromoacetone									-181.0			
C <sub>3</sub> H <sub>5</sub> Cl	2-Chloropropene									-21.0			
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene								125.1				
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin					-148.4			131.6	-107.8			
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	2-Chloropropanoic acid					-522.5				-475.8			
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	3-Chloropropanoic acid	-549.3											
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Ethyl chloroformate					-505.3				-462.9			
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Methyl chloroacetate					-487.0				-444.0			
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,2,3-Trichloropropane					-230.6			183.6	-182.9			
C <sub>3</sub> H <sub>5</sub> I	3-Iodopropene					53.7				91.5			
C <sub>3</sub> H <sub>5</sub> IO	Iodoacetone									-130.5			
C <sub>3</sub> H <sub>5</sub> IO <sub>2</sub>	3-Iodopropanoic acid	-460.0											
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile					15.5			119.3	51.7			
C <sub>3</sub> H <sub>5</sub> N	2-Propyn-1-amine					205.7							
C <sub>3</sub> H <sub>5</sub> N	Ethyl isocyanide					108.6				141.7			
C <sub>3</sub> H <sub>5</sub> NO	Acrylamide	-212.1			110.6	-224.0				-130.2			
C <sub>3</sub> H <sub>5</sub> NO <sub>3</sub>	Nitroacetone					-278.6							



Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	Oxymethurea	-717.0											
C <sub>3</sub> H <sub>8</sub> O	1-Propanol					-302.6		193.6	143.9	-255.1		322.6	85.6
C <sub>3</sub> H <sub>8</sub> O	2-Propanol					-318.1		181.1	156.5	-272.6		309.2	89.3
C <sub>3</sub> H <sub>8</sub> O	Ethyl methyl ether									-216.4		309.2	93.3
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propylene glycol					-501.0			190.8	-429.8			
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propylene glycol					-480.8				-408.0			
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Ethylene glycol monomethyl ether								171.1				
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Dimethoxymethane					-377.8		244.0	162.0	-348.5			
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol					-669.6		206.3	218.9	-577.9			
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol					-99.9		242.5	144.6	-67.8			
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol					-105.9		233.5	145.3	-76.2			
C <sub>3</sub> H <sub>8</sub> S	Ethyl methyl sulfide					-91.6		239.1	144.6	-59.6			
C <sub>3</sub> H <sub>8</sub> S <sub>2</sub>	1,3-Propanedithiol					-79.4				-29.8			
C <sub>3</sub> H <sub>9</sub> Al	Trimethyl aluminum					-136.4	-9.9	209.4	155.6	-74.1			
C <sub>3</sub> H <sub>9</sub> B	Trimethylborane					-143.1	-32.1	238.9		-124.3	-35.9	314.7	88.5
C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	Trimethyl borate								189.9				
C <sub>3</sub> H <sub>9</sub> ClSi	Trimethylchlorosilane					-382.8	-246.4	278.2		-352.8	-243.5	369.1	
C <sub>3</sub> H <sub>9</sub> N	Propylamine					-101.5			164.1	-70.1	39.9	325.4	91.2
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine					-112.3		218.3	163.8	-83.7	32.2	312.2	97.5
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine					-45.7		208.5	137.9	-23.6		287.1	91.8
C <sub>3</sub> H <sub>10</sub> ClN	Propylamine hydrochloride	-354.7											
C <sub>3</sub> H <sub>10</sub> ClN	Trimethylamine hydrochloride	-282.9											
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	1,2-Propanediamine, (±)									-53.6			
C <sub>3</sub> H <sub>10</sub> Si	Trimethylsilane											331.0	117.9
C <sub>3</sub> H <sub>12</sub> BN	Trimethylamine borane	-142.5	70.7	187.0									
C <sub>3</sub> H <sub>12</sub> BN	Aminotrimethylboron	-284.1	-79.3	218.0									
C <sub>4</sub> Cl <sub>6</sub>	Hexachloro-1,3-butadiene					-24.5							
C <sub>4</sub> F <sub>8</sub>	Perfluorocyclobutane									-1542.6			
C <sub>4</sub> F <sub>10</sub>	Perfluorobutane								127.2				
C <sub>4</sub> H <sub>2</sub> N <sub>2</sub>	<i>trans</i> -2-Butenedinitrile	268.2								340.2			
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride	-469.8								-398.3			
C <sub>4</sub> H <sub>2</sub> O <sub>4</sub>	2-Butyenedioic acid	-577.3											
C <sub>4</sub> H <sub>3</sub> NO <sub>3</sub>	2-Nitrofurane	-104.1								-28.8			
C <sub>4</sub> H <sub>4</sub> BrNO <sub>2</sub>	<i>N</i> -Bromosuccinimide	-335.9											
C <sub>4</sub> H <sub>4</sub> ClNO <sub>2</sub>	<i>N</i> -Chlorosuccinimide	-357.9											
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Succinonitrile	139.7		191.6	145.6					209.7			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrazine	139.8								196.1			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine					145.9				195.7			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyridazine					224.9				278.3			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	Uracil	-429.4			120.5					-302.9			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	Barbituric acid	-634.7											
C <sub>4</sub> H <sub>4</sub> O	Furan					-62.3		177.0	114.8	-34.8		267.2	65.4
C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	Diketene					-233.1				-190.3			
C <sub>4</sub> H <sub>4</sub> O <sub>3</sub>	Succinic anhydride	-608.6								-527.9			
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Maleic acid	-789.4		160.8	137.0					-679.4			
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Fumaric acid	-811.7		168.0	142.0					-675.8			
C <sub>4</sub> H <sub>4</sub> S	Thiophene					80.2		181.2	123.8	114.9	126.1	278.8	72.8
C <sub>4</sub> H <sub>5</sub> N	<i>trans</i> -2-Butenenitrile					95.1				134.3			
C <sub>4</sub> H <sub>5</sub> N	3-Butenenitrile					117.8				159.7			
C <sub>4</sub> H <sub>5</sub> N	2-Methylacrylonitrile								126.3				
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole					63.1		156.4	127.7	108.2			
C <sub>4</sub> H <sub>5</sub> N	Cyclopropanecarbonitrile					140.8				182.8			
C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	Succinimide	-459.0								-375.4			
C <sub>4</sub> H <sub>5</sub> NS	4-Methylthiazole					67.9				111.8			
C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O	Cytosine	-221.3			132.6								
C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene					138.6				162.3			
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene					88.5		199.0	123.6	110.0			
C <sub>4</sub> H <sub>6</sub>	1-Butyne					141.4				165.2			
C <sub>4</sub> H <sub>6</sub>	2-Butyne					119.1				145.7			
C <sub>4</sub> H <sub>6</sub>	Cyclobutene									156.7			
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	2,5-Piperazinedione	-446.5											
C <sub>4</sub> H <sub>6</sub> O	Divinyl ether					-39.8				-13.6			
C <sub>4</sub> H <sub>6</sub> O	<i>trans</i> -2-Butenal					-138.7				-100.6			
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>trans</i> -2-Butenoic acid												
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid								161.1				
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate					-349.2				-314.4			

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate					-362.2		239.5	158.8	-333.0			
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	$\gamma$ -Butyrolactone					-420.9			141.4	-366.5			
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride					-624.4				-572.5			
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Propylene carbonate					-613.2			218.6	-582.5			
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Succinic acid	-940.5		167.3	153.1					-823.0			
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Dimethyl oxalate	-756.3								-708.9			
C <sub>4</sub> H <sub>6</sub> S	2,3-Dihydrothiophene					52.9				90.7	133.5	303.5	79.8
C <sub>4</sub> H <sub>6</sub> S	2,5-Dihydrothiophene					47.0				86.9	131.6	297.1	83.3
C <sub>4</sub> H <sub>7</sub> ClO	2-Chloroethyl vinyl ether					-208.1				-170.1			
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	2-Chlorobutanoic acid					-575.5							
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	3-Chlorobutanoic acid					-566.3							
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	4-Chlorobutanoic acid					-566.3							
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	Propyl chlorocarbonate					-533.4				-492.7			
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile					-5.8				33.6			
C <sub>4</sub> H <sub>7</sub> N	2-Methylpropanenitrile					-13.8				23.4			
C <sub>4</sub> H <sub>7</sub> NO	Acetone cyanohydrin					-120.9							
C <sub>4</sub> H <sub>7</sub> NO	2-Pyrrolidone					-286.2							
C <sub>4</sub> H <sub>7</sub> NO	2-Methyl-2-oxazoline					-169.5				-130.5			
C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	Iminodiacetic acid	-932.6											
C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	Ethyl nitroacetate					-487.1							
C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	L-Aspartic acid	-973.3											
C <sub>4</sub> H <sub>7</sub> N <sub>2</sub> O	Creatinine	-238.5											
C <sub>4</sub> H <sub>8</sub>	1-Butene					-20.8		227.0	118.0	0.1			
C <sub>4</sub> H <sub>8</sub>	cis-2-Butene					-29.8		219.9	127.0	-7.1			
C <sub>4</sub> H <sub>8</sub>	trans-2-Butene					-33.3				-11.4			
C <sub>4</sub> H <sub>8</sub>	Isobutene					-37.5				-16.9			
C <sub>4</sub> H <sub>8</sub>	Cyclobutane					3.7				27.7			
C <sub>4</sub> H <sub>8</sub>	Methylcyclopropane					1.7							
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,2-Dibromobutane					-142.1				-91.6			
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,3-Dibromobutane					-148.0							
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,4-Dibromobutane					-140.3				-87.8			
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	2,3-Dibromobutane					-139.6				-102.0			
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,2-Dibromo-2-methylpropane					-156.6				-113.3			
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,3-Dichlorobutane					-237.3				-195.0			
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,4-Dichlorobutane					-229.8				-183.4			
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	Bis(2-chloroethyl) ether								220.9				
C <sub>4</sub> H <sub>8</sub> I <sub>2</sub>	1,4-Diiodobutane					-30.0							
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	Succinamide	-581.2											
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	Dimethylglyoxime	-199.7											
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	L-Asparagine	-789.4											
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	N-Glycylglycine	-747.7											
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>4</sub>	1,4-Dinitrobutane					-237.5							
C <sub>4</sub> H <sub>8</sub> N <sub>6</sub> O <sub>6</sub>	Cyclotetramethylenetetranitramine									187.9		568.8	275.5
C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether					-167.4				-140.8			
C <sub>4</sub> H <sub>8</sub> O	1,2-Epoxybutane					-168.9		230.9	147.0				
C <sub>4</sub> H <sub>8</sub> O	Butanal					-239.2		246.6	163.7	-204.8		343.7	103.4
C <sub>4</sub> H <sub>8</sub> O	Isobutanal					-247.3				-215.7			
C <sub>4</sub> H <sub>8</sub> O	2-Butanone					-273.3		239.1	158.7	-238.5		339.9	101.7
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran					-216.2		204.3	124.0	-184.1		302.4	76.3
C <sub>4</sub> H <sub>8</sub> OS	S-Ethyl thioacetate					-268.2				-228.1			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid					-533.8		222.2	178.6	-475.9			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid								173.0				
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate					-500.3				-462.7			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate					-479.3		257.7	170.7	-443.6			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate								171.2				
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Dioxane					-379.7			143.9	-340.6			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane					-353.9		270.2	152.1	-315.3			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methyl-1,3-dioxolane					-386.9				-352.0			
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	Sulfolane								180.0				
C <sub>4</sub> H <sub>8</sub> S	Tetrahydrothiophene					-72.9				-34.1	45.8	309.6	92.5
C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	1,3-Dithiane									-10.0	72.4	333.5	110.4
C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	1,4-Dithiane									0.0	84.5	326.2	109.7
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane					-143.8				-107.1			
C <sub>4</sub> H <sub>9</sub> Br	2-Bromobutane, ( $\pm$ )					-154.9				-120.3			
C <sub>4</sub> H <sub>9</sub> Br	2-Bromo-2-methylpropane					-164.4				-132.4			
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane					-188.1				-154.4			



Molecular formula	Name	Crystal				Liquid				Gas				
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	
C <sub>4</sub> H <sub>12</sub> BrN	Tetramethylammonium bromide	-251.0												
C <sub>4</sub> H <sub>12</sub> ClN	Diethylamine hydrochloride	-358.6												
C <sub>4</sub> H <sub>12</sub> ClN	Tetramethylammonium chloride	-276.4												
C <sub>4</sub> H <sub>12</sub> I	Tetramethylammonium iodide	-203.9												
C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	2-Methyl-1,2-propanediamine					-133.9					-90.3			
C <sub>4</sub> H <sub>12</sub> Pb	Tetramethyl lead					97.9					135.9			
C <sub>4</sub> H <sub>12</sub> Si	Tetramethylsilane					-264.0	-100.0	277.3	204.1		-239.1	-99.9	359.0	143.9
C <sub>4</sub> H <sub>12</sub> Sn	Tetramethylstannane					-52.3					-18.8			
C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	Bis(2-aminoethyl)amine								254.0					
C <sub>4</sub> N <sub>2</sub>	2-Butynedinitrile					500.4					529.2			
C <sub>4</sub> NiO <sub>4</sub>	Nickel carbonyl					-633.0	-588.2	313.4	204.6		-602.9	-587.2	410.6	145.2
C <sub>5</sub> FeO <sub>5</sub>	Iron pentacarbonyl					-774.0	-705.3	338.1	240.6					
C <sub>5</sub> H <sub>2</sub> F <sub>6</sub> O <sub>2</sub>	Hexafluoroacetylacetone	-2286.7												
C <sub>5</sub> H <sub>3</sub> NO <sub>5</sub>	5-Nitro-2-furancarboxylic acid	-516.8												
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub>	1 <i>H</i> -Purine	169.4												
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	Hypoxanthine	-110.8		145.6	134.5									
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	Xanthine	-379.6		161.1	151.3									
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub>	Uric acid	-618.8		173.2	166.1									
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural					-201.6			163.2		-151.0			
C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	2-Furancarboxylic acid	-498.4									-390.0			
C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	3-Methyl-2,5-furandione					-504.5					-447.2			
C <sub>5</sub> H <sub>3</sub> F <sub>3</sub> O <sub>2</sub>	1,1,1-Trifluoro-2,4-pentanedione					-1040.2					-993.3			
C <sub>5</sub> H <sub>5</sub> N	Pyridine					100.2			132.7		140.4			
C <sub>5</sub> H <sub>5</sub> NO	1 <i>H</i> -Pyrrole-2-carboxaldehyde	-106.4												
C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	Adenine	96.9			147.0						205.7			
C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	Guanine	-183.9												
C <sub>5</sub> H <sub>6</sub>	<i>cis</i> -3-Penten-1-yne					226.5								
C <sub>5</sub> H <sub>6</sub>	<i>trans</i> -3-Penten-1-yne					228.2								
C <sub>5</sub> H <sub>6</sub>	1,3-Cyclopentadiene					105.9					134.3			
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	Thymine	-462.8			150.8						-328.7			
C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	Furfuryl alcohol					-276.2			204.0		-211.8			
C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	<i>trans</i> -1-Propene-1,2-dicarboxylic acid	-824.4												
C <sub>5</sub> H <sub>6</sub> S	2-Methylthiophene					44.6		218.5	149.8		83.5			
C <sub>5</sub> H <sub>6</sub> S	3-Methylthiophene					43.1					82.5			
C <sub>5</sub> H <sub>7</sub> N	<i>trans</i> -3-Pentenitrile					80.9					125.7			
C <sub>5</sub> H <sub>7</sub> N	Cyclobutanecarbonitrile					103.0					147.4			
C <sub>5</sub> H <sub>7</sub> N	1-Methylpyrrole					62.4					103.1			
C <sub>5</sub> H <sub>7</sub> N	2-Methylpyrrole					23.3					74.0			
C <sub>5</sub> H <sub>7</sub> N	3-Methylpyrrole					20.5					70.2			
C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl cyanoacetate								220.2					
C <sub>5</sub> H <sub>8</sub>	1,2-Pentadiene										140.7			
C <sub>5</sub> H <sub>8</sub>	<i>cis</i> -1,3-Pentadiene										81.4			
C <sub>5</sub> H <sub>8</sub>	<i>trans</i> -1,3-Pentadiene										76.1			
C <sub>5</sub> H <sub>8</sub>	1,4-Pentadiene										105.7			
C <sub>5</sub> H <sub>8</sub>	2,3-Pentadiene										133.1			
C <sub>5</sub> H <sub>8</sub>	3-Methyl-1,2-butadiene					101.2								
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene					48.2		229.3	152.6		75.5			
C <sub>5</sub> H <sub>8</sub>	Cyclopentene					4.3		201.2	122.4		34.0			
C <sub>5</sub> H <sub>8</sub>	Spiropentane					157.5		193.7	134.5		185.2			
C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane					93.8					121.6			
C <sub>5</sub> H <sub>8</sub> N <sub>4</sub> O <sub>12</sub>	Pentaerythritol tetranitrate	-538.6											614.7	294.8
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone					-235.9					-192.1			
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	4-Pentenoic acid					-430.6								
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Allyl acetate								184.1					
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acrylate					-370.6					-354.2			
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl <i>trans</i> -2-butenate					-382.9					-341.9			
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate								191.2					
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione					-423.8					-382.0			
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Dihydro-4-methyl-2(3 <i>H</i> )-furanone					-461.3					-406.5			
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Tetrahydro-2 <i>H</i> -pyran-2-one					-436.7					-379.6			
C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	Methyl acetoacetate					-623.2								
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Glutaric acid	-960.0												
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Propyl chloroacetate					-515.5					-467.0			
C <sub>5</sub> H <sub>9</sub> N	Pentanenitrile					-33.1					10.5			
C <sub>5</sub> H <sub>9</sub> N	2,2-Dimethylpropanenitrile					-39.8		232.0	179.4		-2.3			



Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>5</sub> H <sub>9</sub> N	1,2,5,6-Tetrahydropyridine					33.5							
C <sub>5</sub> H <sub>9</sub> NO	2-Piperidinone	-306.6											
C <sub>5</sub> H <sub>9</sub> NO	<i>N</i> -Methyl-2-pyrrolidone					-262.2			307.8				
C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	<i>L</i> -Proline	-515.2								-366.2			
C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	<i>D</i> -Glutamic acid	-1005.3											
C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	<i>L</i> -Glutamic acid	-1009.7											
C <sub>5</sub> H <sub>10</sub>	1-Pentene					-46.9		262.6	154.0	-21.1			
C <sub>5</sub> H <sub>10</sub>	<i>cis</i> -2-Pentene					-53.7		258.6	151.7	-27.6			
C <sub>5</sub> H <sub>10</sub>	<i>trans</i> -2-Pentene					-58.2		256.5	157.0	-31.9			
C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene					-61.1		254.0	157.2	-35.2			
C <sub>5</sub> H <sub>10</sub>	3-Methyl-1-butene					-51.5		253.3	156.1	-27.5			
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene					-68.6		251.0	152.8	-41.7			
C <sub>5</sub> H <sub>10</sub>	Cyclopentane					-105.1		204.5	128.8	-76.4			
C <sub>5</sub> H <sub>10</sub>	Methylcyclobutane					-44.5							
C <sub>5</sub> H <sub>10</sub>	Ethylcyclopropane					-24.8							
C <sub>5</sub> H <sub>10</sub>	1,1-Dimethylcyclopropane					-33.3				-8.2			
C <sub>5</sub> H <sub>10</sub>	<i>cis</i> -1,2-Dimethylcyclopropane					-26.3							
C <sub>5</sub> H <sub>10</sub>	<i>trans</i> -1,2-Dimethylcyclopropane					-30.7							
C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	2,3-Dibromo-2-methylbutane									-137.6			
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O	<i>N</i> -Nitrosopiperidine					-31.1				16.6			
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	<i>N</i> -Nitropiperidine					-93.0				-44.5			
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	<i>L</i> -Glutamine	-826.4											
C <sub>5</sub> H <sub>10</sub> O	Cyclopentanol					-300.1		204.1	182.5	-242.5		362.9	
C <sub>5</sub> H <sub>10</sub> O	Pentanal					-267.2				-228.4			
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone					-297.3			184.1	-258.8			
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone					-296.5		266.0	190.9	-257.9			
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone					-299.5		268.5	179.9	-262.6			
C <sub>5</sub> H <sub>10</sub> O	3,3-Dimethyloxetane					-182.2				-148.2			
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran					-258.3				-223.4			
C <sub>5</sub> H <sub>10</sub> OS	<i>S</i> -Propyl thioacetate					-294.5				-250.4			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid					-559.4		259.8	210.3	-491.9			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	2-Methylbutanoic acid					-554.5							
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	3-Methylbutanoic acid					-561.6				-510.0			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	2,2-Dimethylpropanoic acid	-564.5								-491.3			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate								200.2				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate								196.2				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate					-518.9			199.4	-481.6			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate					-502.7				-463.4			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate								198.2				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	(Ethoxymethyl)oxirane					-296.5							
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	4-Methyl-1,3-dioxane					-416.1				-376.9			
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	<i>cis</i> -1,2-Cyclopentanediol	-485.0											
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	<i>trans</i> -1,2-Cyclopentanediol	-490.1											
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Tetrahydrofurfuryl alcohol					-435.7				-369.1			
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Diethyl carbonate					-681.5				-637.9			
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Ethylene glycol monomethyl ether acetate								310.0				
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl lactate								254.0				
C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	Glycerol 1-acetate, ( <i>DL</i> )					-909.2							
C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	<i>D</i> -Ribose	-1047.2											
C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	<i>D</i> -Xylose	-1057.8											
C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	$\alpha$ - <i>D</i> -Arabinopyranose	-1057.9											
C <sub>5</sub> H <sub>10</sub> S	Thiacyclohexane					-106.3		218.2	163.3	-63.5	53.1	323.0	109.7
C <sub>5</sub> H <sub>10</sub> S	Cyclopentanethiol					-89.5		256.9	165.2	-48.1			
C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane					-170.2				-128.9			
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloropentane					-213.2				-174.9			
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloro-3-methylbutane					-216.0				-179.7			
C <sub>5</sub> H <sub>11</sub> Cl	2-Chloro-2-methylbutane					-235.7				-202.2			
C <sub>5</sub> H <sub>11</sub> Cl	2-Chloro-3-methylbutane					-226.6				-185.1			
C <sub>5</sub> H <sub>11</sub> N	Cyclopentylamine					-95.1		241.0	181.2	-54.9			
C <sub>5</sub> H <sub>11</sub> N	Piperidine					-86.4		210.0	179.9	-47.1			
C <sub>5</sub> H <sub>11</sub> NO	Pentanamide	-379.5								-290.2			
C <sub>5</sub> H <sub>11</sub> NO	2,2-Dimethylpropanamide	-399.7								-313.1			
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	1-Nitropentane					-215.4				-164.4		390.9	137.1
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>DL</i> -Valine	-628.9											
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Valine	-617.9								-455.1			

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	5-Aminopentanoic acid	-604.1								-460.0			
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	L-Methionine	-577.5								-413.5			
C <sub>5</sub> H <sub>11</sub> NO <sub>4</sub>	2-Ethyl-2-nitro-1,3-propanediol	-606.4											
C <sub>5</sub> H <sub>12</sub>	Pentane					-173.5			167.2	-146.9			
C <sub>5</sub> H <sub>12</sub>	Isopentane					-178.4		260.4	164.8	-153.6			
C <sub>5</sub> H <sub>12</sub>	Neopentane					-190.2				-168.0			
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Butylurea	-419.5											
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	tert-Butylurea	-417.4											
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	N,N-Diethylurea	-372.2											
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Tetramethylurea					-262.2							
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> S	Tetramethylthiourea	-38.1								44.9			
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol					-351.6			208.1	-294.6			
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol					-365.2				-311.0			
C <sub>5</sub> H <sub>12</sub> O	3-Pentanol					-368.9			239.7	-314.9			
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-1-butanol, (±)					-356.6				-301.4			
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol					-356.4				-300.7			
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol					-379.5			247.1	-329.3			
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol, (±)					-366.6				-313.5			
C <sub>5</sub> H <sub>12</sub> O	2,2-Dimethyl-1-propanol					-399.4							
C <sub>5</sub> H <sub>12</sub> O	Butyl methyl ether					-290.6		295.3	192.7	-258.1			
C <sub>5</sub> H <sub>12</sub> O	Methyl tert-butyl ether					-313.6		265.3	187.5	-283.7			
C <sub>5</sub> H <sub>12</sub> O	Ethyl propyl ether					-303.6		295.0	197.2	-272.0			
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,5-Pentenediol					-528.8				-450.8			
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	2,2-Dimethyl-1,3-propanediol	-551.2											
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	Diethoxymethane					-450.5				-414.7			
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,1-Dimethoxypropane					-443.6							
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	2,2-Dimethoxypropane					-459.4				-429.9			
C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	Diethylene glycol monomethyl ether								271.1				
C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	2-(Hydroxymethyl)-2-methyl-1,3-propanediol	-744.6											
C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	Pentaerythritol	-920.6								-776.7			
C <sub>5</sub> H <sub>12</sub> O <sub>5</sub>	Xylitol	-1118.5											
C <sub>5</sub> H <sub>12</sub> S	1-Pentanethiol					-151.3				-110.0			
C <sub>5</sub> H <sub>12</sub> S	2-Methyl-1-butanethiol, (+)					-154.4				-114.9			
C <sub>5</sub> H <sub>12</sub> S	3-Methyl-1-butanethiol					-154.4				-114.9			
C <sub>5</sub> H <sub>12</sub> S	2-Methyl-2-butanethiol					-162.8		290.1	198.1	-127.1			
C <sub>5</sub> H <sub>12</sub> S	3-Methyl-2-butanethiol					-158.8				-121.3			
C <sub>5</sub> H <sub>12</sub> S	2,2-Dimethyl-1-propanethiol					-165.4				-129.0			
C <sub>5</sub> H <sub>12</sub> S	Butyl methyl sulfide					-142.9		307.5	200.9	-102.4			
C <sub>5</sub> H <sub>12</sub> S	tert-Butyl methyl sulfide					-157.1		276.1	199.9	-121.3			
C <sub>5</sub> H <sub>12</sub> S	Ethyl propyl sulfide					-144.8		309.5	198.4	-104.8			
C <sub>5</sub> H <sub>12</sub> S	Ethyl isopropyl sulfide					-156.1				-118.3			
C <sub>5</sub> H <sub>13</sub> N	Pentylamine								218.0				
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	N,N,N',N'- Tetramethylmethanediamine					-51.1				-18.2			
C <sub>6</sub> ClF <sub>5</sub>	Chloropentafluorobenzene	-858.4								-809.3			
C <sub>6</sub> Cl <sub>6</sub>	Hexachlorobenzene	-127.6		260.2	201.2					-35.5			
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene					-991.3			280.8	221.6	-955.4		
C <sub>6</sub> F <sub>10</sub>	Perfluorocyclohexene					-1963.5				-1932.7			
C <sub>6</sub> F <sub>12</sub>	Perfluorocyclohexane					-2406.3				-2370.4			
C <sub>6</sub> HCl <sub>5</sub> O	Pentachlorophenol	-292.5		253.2	202.0								
C <sub>6</sub> HF <sub>5</sub>	Pentafluorobenzene	-852.7				-841.8				-806.5			
C <sub>6</sub> HF <sub>5</sub> O	Pentafluorophenol	-1024.1				-1007.7							
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,4,5-Tetrafluorobenzene					-683.8							
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,3-Trichlorobenzene	-70.8								3.8			
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,4-Trichlorobenzene					-63.1				-8.1			
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,3,5-Trichlorobenzene	-78.4								-13.4			
C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>6</sub>	1,3,5-Trinitrobenzene	-37.0			214.6								
C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	2,4,6-Trinitrophenol	-217.9			239.7								
C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>8</sub>	2,4,6-Trinitro-1,3-benzenediol	-467.5											
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-4-nitrobenzene	-48.7			250.2								
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	o-Dichlorobenzene					-17.5			162.4	30.2			
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	m-Dichlorobenzene					-20.7				25.7			
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	p-Dichlorobenzene	-42.3		175.4	147.8					22.5			
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	2,4-Dichlorophenol	-226.4								-156.3			
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	o-Difluorobenzene					-330.0			222.6	159.0	-293.8		
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	m-Difluorobenzene					-343.9			223.8	159.1	-309.2		



Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene					54.1				84.2			
C <sub>6</sub> H <sub>10</sub>	3,3-Dimethyl-1-butyne					78.4							
C <sub>6</sub> H <sub>10</sub>	Cyclohexene					-38.5		214.6	148.3	-5.0			
C <sub>6</sub> H <sub>10</sub>	1-Methylcyclopentene					-36.4				-3.8			
C <sub>6</sub> H <sub>10</sub>	3-Methylcyclopentene					-23.7				7.4			
C <sub>6</sub> H <sub>10</sub>	4-Methylcyclopentene					-17.6				14.6			
C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	Butyl dichloroacetate					-550.1				-497.8			
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone					-271.2			182.2	-226.1			
C <sub>6</sub> H <sub>10</sub> O	2-Methylcyclopentanone					-265.2							
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide								212.5				
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl <i>trans</i> -2-butenolate					-420.0				-375.6			
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Methyl cyclobutanecarboxylate					-395.0				-350.2			
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate								248.0				
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Propanoic anhydride					-679.1				-626.5			
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Adipic acid	-994.3											
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate					-805.5				-742.0			
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Ethylene glycol diacetate								310.0				
C <sub>6</sub> H <sub>11</sub> Cl	Chlorocyclohexane					-207.2				-163.7			
C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	Ethyl 4-chlorobutanolate					-566.5				-513.8			
C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	Propyl 3-chloropropanoate					-537.6				-485.7			
C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	Butyl chloroacetate					-538.4				-487.4			
C <sub>6</sub> H <sub>11</sub> NO	Caprolactam	-329.4			156.8					-239.6			
C <sub>6</sub> H <sub>11</sub> NO	1-Methyl-2-piperidinone					-293.0							
C <sub>6</sub> H <sub>12</sub>	1-Hexene					-74.2		295.2	183.3	-43.5			
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -2-Hexene					-83.9				-52.3			
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -2-Hexene					-85.5				-53.9			
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -3-Hexene					-78.9				-47.6			
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -3-Hexene					-86.1				-54.4			
C <sub>6</sub> H <sub>12</sub>	2-Methyl-1-pentene					-90.0				-59.4			
C <sub>6</sub> H <sub>12</sub>	3-Methyl-1-pentene					-78.2				-49.5			
C <sub>6</sub> H <sub>12</sub>	4-Methyl-1-pentene					-80.0				-51.3			
C <sub>6</sub> H <sub>12</sub>	2-Methyl-2-pentene					-98.5				-66.9			
C <sub>6</sub> H <sub>12</sub>	3-Methyl- <i>cis</i> -2-pentene					-94.5				-62.3			
C <sub>6</sub> H <sub>12</sub>	3-Methyl- <i>trans</i> -2-pentene					-94.6				-63.1			
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>cis</i> -2-pentene					-87.0				-57.5			
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>trans</i> -2-pentene					-91.6				-61.5			
C <sub>6</sub> H <sub>12</sub>	2-Ethyl-1-butene					-87.1				-56.0			
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-1-butene					-93.2				-62.4			
C <sub>6</sub> H <sub>12</sub>	3,3-Dimethyl-1-butene					-87.5				-60.3			
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-2-butene					-101.4		270.2	174.7	-68.1			
C <sub>6</sub> H <sub>12</sub>	Cyclohexane					-156.4			154.9	-123.4			
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane					-137.9				-106.2			
C <sub>6</sub> H <sub>12</sub>	Ethylcyclobutane					-59.0				-27.5			
C <sub>6</sub> H <sub>12</sub>	1,1,2-Trimethylcyclopropane					-96.2							
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	L-Cystine	-1032.7											
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub>	Thiram	40.2			301.7								
C <sub>6</sub> H <sub>12</sub> O	Butyl vinyl ether					-218.8			232.0	-182.6			
C <sub>6</sub> H <sub>12</sub> O	Hexanal							280.3	210.4				
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone					-322.0			213.3	-278.9			
C <sub>6</sub> H <sub>12</sub> O	3-Hexanone					-320.2		305.3	216.9	-277.6			
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone								213.3				
C <sub>6</sub> H <sub>12</sub> O	2-Methyl-3-pentanone					-325.9				-286.0			
C <sub>6</sub> H <sub>12</sub> O	3,3-Dimethyl-2-butanone					-328.6				-290.6			
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol					-348.2			208.2	-286.2			
C <sub>6</sub> H <sub>12</sub> O	<i>cis</i> -2-Methylcyclopentanol					-345.5							
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid					-583.8				-511.9			
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate					-529.2			227.8	-485.3			
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>tert</i> -Butyl acetate					-554.5			231.0	-516.5			
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate								233.8				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate								228.0				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl pentanoate					-514.2			229.3	-471.1			
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 2,2-dimethylpropanoate					-530.0			257.9	-491.2			
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol								221.3				
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Ethylene glycol monoethyl ether acetate								376.0				
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde					-673.1				-631.7			

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	$\beta$ -D-Fructose	-1265.6											
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	D-Galactose	-1286.3											
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	$\alpha$ -D-Glucose	-1273.3											
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	D-Mannose	-1263.0											
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	L-Sorbose	-1271.5											
C <sub>6</sub> H <sub>12</sub> S	Thiepane									-65.8	79.4	363.5	131.3
C <sub>6</sub> H <sub>12</sub> S	Cyclohexanethiol					-140.7		255.6	192.6				-96.2
C <sub>6</sub> H <sub>12</sub> S	Cyclopentyl methyl sulfide					-109.8							-64.7
C <sub>6</sub> H <sub>13</sub> Br	1-Bromohexane					-194.2		453.0	204.0				-148.3
C <sub>6</sub> H <sub>13</sub> Cl	2-Chlorohexane					-246.1							-204.3
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine					-147.6							-104.0
C <sub>6</sub> H <sub>13</sub> N	2-Methylpiperidine, ( $\pm$ )					-124.9							-84.4
C <sub>6</sub> H <sub>13</sub> NO	Hexanamide	-423.0											-324.2
C <sub>6</sub> H <sub>13</sub> NO	N-Butylacetamide					-380.9							-305.9
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	DL-Leucine	-640.6											
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	D-Leucine	-637.3											
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	L-Leucine	-637.4			200.1								-486.8
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	DL-Isoleucine	-635.3											
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	L-Isoleucine	-637.8											
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	L-Norleucine	-639.1											
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	6-Aminohexanoic acid	-637.3											
C <sub>6</sub> H <sub>14</sub>	Hexane					-198.7			195.6				-166.9
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane					-204.6		290.6	193.7				-174.6
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane					-202.4		292.5	190.7				-171.9
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane					-213.8		272.5	191.9				-185.9
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane					-207.4		287.8	189.7				-178.1
C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	Azopropane					11.5							51.3
C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	DL-Lysine	-678.7											
C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	D-Arginine	-623.5		250.6	232.0								
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol					-377.5		287.4	240.4				-315.9
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol					-392.0							-333.5
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol					-392.4			286.2				
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-1-pentanol								248.0				
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-2-pentanol								275.9				
C <sub>6</sub> H <sub>14</sub> O	4-Methyl-2-pentanol					-394.7			273.0				
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-3-pentanol					-396.4							
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-3-pentanol								293.4				
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether					-328.8		323.9	221.6				-293.0
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether					-351.5			216.8				-319.2
C <sub>6</sub> H <sub>14</sub> O	Butyl ethyl ether								159.0				
C <sub>6</sub> H <sub>14</sub> O	tert-Butyl ethyl ether												-313.9
C <sub>6</sub> H <sub>14</sub> OS	Dipropyl sulfoxide					-329.4							-254.9
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,2-Hexanediol					-577.1							-490.1
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,6-Hexanediol	-569.9				-548.6							-461.2
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	2-Methyl-2,4-pentanediol								336.0				
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	Ethylene glycol monobutyl ether								281.0				
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-Diethoxyethane					-491.4							-453.5
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	Ethylene glycol diethyl ether					-451.4			259.4				-408.1
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol monoethyl ether								301.0				
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol dimethyl ether								274.1				
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Trimethylolpropane	-750.9											
C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	Triethylene glycol					-804.3							-725.0
C <sub>6</sub> H <sub>14</sub> O <sub>4</sub> S	Dipropyl sulfate					-859.0							-792.0
C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	Galactitol					-1317.0							
C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	D-Mannitol					-1314.5							
C <sub>6</sub> H <sub>14</sub> S	1-Hexanethiol					-175.7							-129.9
C <sub>6</sub> H <sub>14</sub> S	2-Methyl-2-pentanethiol					-188.3							-148.3
C <sub>6</sub> H <sub>14</sub> S	2,3-Dimethyl-2-butanethiol					-187.1							-147.9
C <sub>6</sub> H <sub>14</sub> S	Diisopropyl sulfide					-181.6		313.0	232.0				-142.0
C <sub>6</sub> H <sub>14</sub> S	Butyl ethyl sulfide					-172.3							-127.8
C <sub>6</sub> H <sub>14</sub> S	Methyl pentyl sulfide					-167.1							-121.8
C <sub>6</sub> H <sub>14</sub> S <sub>2</sub>	Dipropyl disulfide					-171.5							-118.3
C <sub>6</sub> H <sub>15</sub> B	Triethylborane					-194.6	9.4	336.7	241.2			16.1	437.8
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine					-156.1							-116.0
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine					-178.5							-143.8
C <sub>6</sub> H <sub>15</sub> N	Triethylamine					-127.7			219.9				-92.7

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>6</sub> H <sub>12</sub> NO	2-Diethylaminoethanol					-305.9							
C <sub>6</sub> H <sub>12</sub> NO <sub>3</sub>	Triethanolamine	-664.2			389.0					-558.3			
C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	1,6-Hexanediamine	-205.0											
C <sub>6</sub> H <sub>16</sub> N <sub>2</sub> OP	Hexamethylphosphoric triamide								321.0				
C <sub>6</sub> H <sub>16</sub> OSi <sub>2</sub>	Hexamethyldisiloxane					-815.0	-541.5	433.8	311.4	-777.7	-534.5	535.0	238.5
C <sub>6</sub> MoO <sub>6</sub>	Molybdenum hexacarbonyl	-982.8	-877.7	325.9	242.3					-912.1	-856.0	490.0	205.0
C <sub>6</sub> N <sub>4</sub>	Tetracyanoethene	623.8								705.0			
C <sub>7</sub> F <sub>8</sub>	Perfluorotoluene					-1311.1		355.5	262.3				
C <sub>7</sub> F <sub>14</sub>	Perfluoromethylcyclohexane					-2931.1			353.1	-2897.2			
C <sub>7</sub> F <sub>16</sub>	Perfluoroheptane					-3420.0		561.8	419.0	-3383.6			
C <sub>7</sub> H <sub>3</sub> F <sub>5</sub>	2,3,4,5,6-Pentafluorotoluene					-883.8		306.4	225.8	-842.7			
C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	3-Chlorobenzoyl chloride					-189.7							
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	3,5-Dinitrobenzoic acid	-409.8											
C <sub>7</sub> H <sub>5</sub> ClO	Benzoyl chloride					-158.0				-103.2			
C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	2-Chlorobenzoic acid	-404.5								-325.0			
C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	3-Chlorobenzoic acid	-424.3								-342.3			
C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	4-Chlorobenzoic acid	-428.9			163.2					-341.0			
C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	(Trifluoromethyl)benzene								188.4				
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile					163.2		209.1	165.2	215.7			
C <sub>7</sub> H <sub>5</sub> NO	Benzoxazole	-24.2								44.8			
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	2-Nitrobenzoic acid	-378.8											
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	3-Nitrobenzoic acid	-394.7											
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	4-Nitrobenzoic acid	-392.2											
C <sub>7</sub> H <sub>3</sub> N <sub>2</sub> O <sub>6</sub>	2,4,6-Trinitrotoluene	-63.2			243.3								
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Benzimidazole	79.5								181.7			
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Indazole	151.9								243.0			
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1-Methyl-2,4-dinitrobenzene	-66.4								33.2			
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde					-87.0		221.2	172.0	-36.7			
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Benzoic acid	-385.2		167.6	146.8					-294.0			
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Salicylaldehyde								222.0				
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	3-(2-Furanyl)-2-propenal	-182.0								-105.9			
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	2-Hydroxybenzoic acid	-589.9								-494.8			
C <sub>7</sub> H <sub>7</sub> Br	4-Bromotoluene					12.0							
C <sub>7</sub> H <sub>7</sub> Cl	2-Chlorotoluene								166.8				
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene					-32.5				18.9			
C <sub>7</sub> H <sub>7</sub> F	4-Fluorotoluene					-186.9			171.2	-147.4			
C <sub>7</sub> H <sub>7</sub> NO	Benzamide	-202.6								-100.9			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-2-carboxylic acid	-401.1								-296.0			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-3-carboxylic acid	-417.3								-283.6			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-4-carboxylic acid	-410.0			177.8					-296.7			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitrotoluene					-9.7							
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	3-Nitrotoluene					-31.5							
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	4-Nitrotoluene	-48.1			172.3					31.0			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	(Nitromethyl)benzene					-22.8				30.7			
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Salicylaldoxime	-183.7											
C <sub>7</sub> H <sub>8</sub>	Toluene					12.4			157.3	50.5			
C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O	Phenylurea	-218.6											
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	-204.6		165.4	154.6					-128.6			
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol					-194.0		212.6	224.9	-132.3			
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	-199.3		167.3	150.2					-125.4			
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol					-160.7		216.7	217.9	-100.4			
C <sub>7</sub> H <sub>8</sub> O	Anisole					-114.8				-67.9			
C <sub>7</sub> H <sub>9</sub> N	Benzylamine					34.2			207.2	94.4			
C <sub>7</sub> H <sub>9</sub> N	2-Methylaniline					-6.3				56.4	167.6	351.0	130.2
C <sub>7</sub> H <sub>9</sub> N	3-Methylaniline					-8.1				54.6	165.4	352.5	125.5
C <sub>7</sub> H <sub>9</sub> N	4-Methylaniline	-23.5								55.3	167.7	347.0	126.2
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline								207.1				
C <sub>7</sub> H <sub>9</sub> N	1-Cyclohexenecarbonitrile					48.1				101.6			
C <sub>7</sub> H <sub>9</sub> N	2,3-Dimethylpyridine					19.4		243.7	189.5	67.1			
C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine					16.1		248.5	184.8	63.6			
C <sub>7</sub> H <sub>9</sub> N	2,5-Dimethylpyridine					18.7		248.8	184.7	66.5			
C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine					12.7		244.2	185.2	58.1			
C <sub>7</sub> H <sub>9</sub> N	3,4-Dimethylpyridine					18.3		240.7	191.8	68.8			
C <sub>7</sub> H <sub>9</sub> N	3,5-Dimethylpyridine					22.5		241.7	184.5	72.0			
C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl 2-pentynoate					-301.8				-250.3			
C <sub>7</sub> H <sub>10</sub> O <sub>2</sub>	Methyl 2-hexynoate					-242.7							

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>7</sub> H <sub>17</sub> Cl <sub>3</sub> O <sub>2</sub>	Isopentyl trichloroacetate					-580.9				-523.1			
C <sub>7</sub> H <sub>11</sub> N	Cyclohexanecarbonitrile					-47.2				4.8			
C <sub>7</sub> H <sub>12</sub>	Bicyclo[2.2.1]heptane	-95.1			151.0					-54.8			
C <sub>7</sub> H <sub>12</sub>	1-Methylbicyclo(3,1,0)hexane					-33.2				1.7			
C <sub>7</sub> H <sub>12</sub>	Methylenecyclohexane					-61.3				-25.2			
C <sub>7</sub> H <sub>12</sub>	Vinylcyclopentane					-34.8							
C <sub>7</sub> H <sub>12</sub>	1-Ethylcyclopentene					-53.3				-19.8			
C <sub>7</sub> H <sub>12</sub> O	2-Methylenecyclohexanol					-277.6							
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acrylate					-422.6			251.0	-375.3			
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl malonate								285.0				
C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	Butyl 2-chloropropanoate					-571.7				-517.3			
C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	Isobutyl 2-chloropropanoate					-603.1				-549.6			
C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	Butyl 3-chloropropanoate					-557.9				-502.3			
C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	Isobutyl 3-chloropropanoate					-572.6				-517.3			
C <sub>7</sub> H <sub>13</sub> ClO <sub>2</sub>	Propyl 2-chlorobutanoate					-630.7				-578.4			
C <sub>7</sub> H <sub>13</sub> N	Heptanenitrile					-82.8				-31.0			
C <sub>7</sub> H <sub>14</sub>	1-Heptene					-97.9		327.6	211.8	-62.3			
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -2-Heptene					-105.1							
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -2-Heptene					-109.5							
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -3-Heptene					-104.3							
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -3-Heptene					-109.3							
C <sub>7</sub> H <sub>14</sub>	5-Methyl-1-hexene					-100.0				-65.7			
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -3-Methyl-3-hexene					-115.9				-79.4			
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -3-Methyl-3-hexene					-112.7				-76.8			
C <sub>7</sub> H <sub>14</sub>	2,4-Dimethyl-1-pentene					-117.0				-83.8			
C <sub>7</sub> H <sub>14</sub>	4,4-Dimethyl-1-pentene					-110.6				-81.6			
C <sub>7</sub> H <sub>14</sub>	2,4-Dimethyl-2-pentene					-123.1				-88.7			
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -4,4-Dimethyl-2-pentene					-105.3				-72.6			
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -4,4-Dimethyl-2-pentene					-121.7				-88.8			
C <sub>7</sub> H <sub>14</sub>	2-Ethyl-3-methyl-1-butene					-114.1				-79.5			
C <sub>7</sub> H <sub>14</sub>	2,3,3-Trimethyl-1-butene					-117.7				-85.5			
C <sub>7</sub> H <sub>14</sub>	Cycloheptane					-156.6				-118.1			
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane					-190.1			184.8	-154.7			
C <sub>7</sub> H <sub>14</sub>	Ethylcyclopentane					-163.4		279.9		-126.9			
C <sub>7</sub> H <sub>14</sub>	1,1-Dimethylcyclopentane					-172.1				-138.2			
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -1,2-Dimethylcyclopentane					-165.3		269.2		-129.5			
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -1,2-Dimethylcyclopentane					-171.2				-136.6			
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -1,3-Dimethylcyclopentane					-170.1				-135.8			
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -1,3-Dimethylcyclopentane					-168.1				-133.6			
C <sub>7</sub> H <sub>14</sub>	1,1,2,2-Tetramethylcyclopropane					-119.8							
C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	1,2-Dibromoheptane					-212.3				-157.9			
C <sub>7</sub> H <sub>14</sub> O	1-Heptanal					-311.5		335.4	230.1	-263.8			
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone								232.6				
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone									-297.1			
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone									-298.3			
C <sub>7</sub> H <sub>14</sub> O	2,2-Dimethyl-3-pentanone					-356.1				-313.6			
C <sub>7</sub> H <sub>14</sub> O	2,4-Dimethyl-3-pentanone					-352.9		318.0	233.7	-311.3			
C <sub>7</sub> H <sub>14</sub> O	<i>cis</i> -2-Methylcyclohexanol					-390.2				-327.0			
C <sub>7</sub> H <sub>14</sub> O	<i>trans</i> -2-Methylcyclohexanol, ( $\pm$ )					-415.7				-352.5			
C <sub>7</sub> H <sub>14</sub> O	<i>cis</i> -3-Methylcyclohexanol, ( $\pm$ )					-416.1				-350.9			
C <sub>7</sub> H <sub>14</sub> O	<i>trans</i> -3-Methylcyclohexanol, ( $\pm$ )					-394.4				-329.1			
C <sub>7</sub> H <sub>14</sub> O	<i>cis</i> -4-Methylcyclohexanol					-413.2				-347.5			
C <sub>7</sub> H <sub>14</sub> O	<i>trans</i> -4-Methylcyclohexanol					-433.3				-367.2			
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid					-610.2			265.4	-536.2			
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Pentyl acetate								261.0				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopentyl acetate								248.5				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl pentanoate					-553.0				-505.9			
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl 3-methylbutanoate					-571.0				-527.0			
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl 2,2-dimethylpropanoate					-577.2				-536.0			
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Methyl hexanoate					-540.2				-492.2			
C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	$\alpha$ -Methylglucoside	-1233.3											
C <sub>7</sub> H <sub>15</sub> Br	1-Bromoheptane					-218.4				-167.8			
C <sub>7</sub> H <sub>16</sub>	Heptane					-224.2			224.7	-187.6			
C <sub>7</sub> H <sub>16</sub>	2-Methylhexane					-229.5		323.3	222.9	-194.5			
C <sub>7</sub> H <sub>16</sub>	3-Methylhexane					-226.4				-191.3			
C <sub>7</sub> H <sub>16</sub>	3-Ethylpentane					-224.9		314.5	219.6	-189.5			

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>7</sub> H <sub>16</sub>	2,2-Dimethylpentane					-238.3		300.3	221.1	-205.7			
C <sub>7</sub> H <sub>16</sub>	2,3-Dimethylpentane					-233.1				-198.7			
C <sub>7</sub> H <sub>16</sub>	2,4-Dimethylpentane					-234.6		303.2	224.2	-201.6			
C <sub>7</sub> H <sub>16</sub>	3,3-Dimethylpentane					-234.2				-201.0			
C <sub>7</sub> H <sub>16</sub>	2,2,3-Trimethylbutane					-236.5		292.2	213.5	-204.4			
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol					-403.3			272.1	-336.5			
C <sub>7</sub> H <sub>16</sub> O	<i>tert</i> -Butyl isopropyl ether					-392.8				-358.1			
C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	1,7-Heptanediol					-574.2							
C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	2,2-Diethoxypropane					-538.9				-506.9			
C <sub>7</sub> H <sub>16</sub> S	1-Heptanethiol					-200.5				-149.9			
C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	Phthalic anhydride	-460.1		180.0	160.0					-371.4			
C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	1 <i>H</i> -Indole-2,3-dione	-268.2											
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Phthalic acid	-782.0		207.9	188.1								
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Isophthalic acid	-803.0								-696.3			
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Terephthalic acid	-816.1								-717.9			
C <sub>8</sub> H <sub>6</sub> S	Benzo[b]thiophene	100.6								166.3			
C <sub>8</sub> H <sub>7</sub> N	1 <i>H</i> -Indole	86.6								156.5			
C <sub>8</sub> H <sub>8</sub>	Styrene					103.8			182.0	147.9			
C <sub>8</sub> H <sub>8</sub> O	Phenyl vinyl ether					-26.2				22.7			
C <sub>8</sub> H <sub>8</sub> O	Acetophenone					-142.5				-86.7			
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>o</i> -Toluic acid	-416.5			174.9								
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>m</i> -Toluic acid	-426.1			163.6								
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>p</i> -Toluic acid	-429.2			169.0								
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate					-343.5			221.3	-287.9			
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Methyl salicylate								249.0				
C <sub>8</sub> H <sub>9</sub> NO	Acetanilide	-209.4			179.3								
C <sub>8</sub> H <sub>10</sub>	1,7-Octadiyne					334.4							
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene					-12.3			183.2	29.9			
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene					-24.4			186.1	19.1			
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene					-25.4			183.0	17.3			
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene					-24.4			181.5	18.0			
C <sub>8</sub> H <sub>10</sub> O	2-Ethylphenol					-208.8				-145.2			
C <sub>8</sub> H <sub>10</sub> O	3-Ethylphenol					-214.3				-146.1			
C <sub>8</sub> H <sub>10</sub> O	4-Ethylphenol	-224.4			206.9					-144.1			
C <sub>8</sub> H <sub>10</sub> O	2,3-Xylenol	-241.1								-157.2			
C <sub>8</sub> H <sub>10</sub> O	2,4-Xylenol					-228.7				-163.8			
C <sub>8</sub> H <sub>10</sub> O	2,5-Xylenol	-246.6								-161.6			
C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	-237.4								-162.1			
C <sub>8</sub> H <sub>10</sub> O	3,4-Xylenol	-242.3								-157.3			
C <sub>8</sub> H <sub>10</sub> O	3,5-Xylenol	-244.4								-162.4			
C <sub>8</sub> H <sub>10</sub> O	Benzeneethanol								252.6				
C <sub>8</sub> H <sub>10</sub> O	Ethoxybenzene					-152.6			228.5	-101.6			
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	1,2-Dimethoxybenzene					-290.3				-223.3			
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline					8.2				56.3			
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline					46.0				100.5			
C <sub>8</sub> H <sub>11</sub> N	2,4-Dimethylaniline					-39.2							
C <sub>8</sub> H <sub>11</sub> N	2,5-Dimethylaniline					-38.9							
C <sub>8</sub> H <sub>11</sub> N	2,6-Dimethylaniline								238.9				
C <sub>8</sub> H <sub>12</sub>	1-Octen-3-yne					140.7							
C <sub>8</sub> H <sub>12</sub>	<i>cis</i> -1,2-Divinylcyclobutane					124.3				166.5			
C <sub>8</sub> H <sub>12</sub>	<i>trans</i> -1,2-Divinylcyclobutane					101.3				143.5			
C <sub>8</sub> H <sub>12</sub> N <sub>4</sub>	2,2'-Azobis(isobutyronitrile)	246.0			237.6								
C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	2,2,4,4-Tetramethyl-1,3-cyclobutanedione	-379.9								-307.6			
C <sub>8</sub> H <sub>14</sub>	Ethylidenecyclohexane					-103.5				-59.5			
C <sub>8</sub> H <sub>14</sub>	Allylcyclopentane					-64.5				-24.1			
C <sub>8</sub> H <sub>14</sub> ClN <sub>5</sub>	Atrazine	-125.4											
C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	Butanoic anhydride								283.7				
C <sub>8</sub> H <sub>15</sub> ClO <sub>2</sub>	3-Methylbutyl 2-chloropropanoate					-627.3				-575.0			
C <sub>8</sub> H <sub>15</sub> ClO <sub>2</sub>	3-Methylbutyl 3-chloropropanoate					-593.4				-539.4			
C <sub>8</sub> H <sub>15</sub> N	Octanenitrile					-107.3				-50.5			
C <sub>8</sub> H <sub>16</sub>	1-Octene					-124.5			241.0	-81.3			
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -2-Octene					-135.7			239.0				
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -2-Octene					-135.7			239.0				
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -2,2-Dimethyl-3-hexene					-126.4				-89.3			
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -2,2-Dimethyl-3-hexene					-144.9				-107.7			





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		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>8</sub> H <sub>18</sub> S	Di- <i>tert</i> -butyl sulfide					-232.6				-188.8			
C <sub>8</sub> H <sub>18</sub> S	Diisobutyl sulfide					-229.2				-180.5			
C <sub>8</sub> H <sub>18</sub> S <sub>2</sub>	Dibutyl disulfide					-222.9				-160.6			
C <sub>8</sub> H <sub>18</sub> S <sub>2</sub>	Di- <i>tert</i> -butyl disulfide					-255.2				-201.0			
C <sub>8</sub> H <sub>19</sub> N	Dibutylamine					-206.0			292.9	-156.6			
C <sub>8</sub> H <sub>19</sub> N	Diisobutylamine					-218.5				-179.2			
C <sub>8</sub> H <sub>20</sub> BrN	Tetraethylammonium bromide	-342.7											
C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si	Ethyl silicate							533.1	364.4				
C <sub>8</sub> H <sub>20</sub> Pb	Tetraethyl lead					52.7		464.6	307.4	109.6			
C <sub>8</sub> H <sub>20</sub> Si	Tetraethylsilane								298.1				
C <sub>9</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	Toluene-2,4-diisocyanate								287.8				
C <sub>9</sub> H <sub>7</sub> N	Quinoline					141.2				200.5			
C <sub>9</sub> H <sub>7</sub> N	Isoquinoline					144.3		216.0	196.2	204.6			
C <sub>9</sub> H <sub>7</sub> NO	2-Quinolinol	-144.9								-25.5			
C <sub>9</sub> H <sub>7</sub> NO	8-Quinolinol	82.1											
C <sub>9</sub> H <sub>8</sub>	Indene					110.6		215.3	186.9	163.4			
C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	2-(Acetyloxy)benzoic acid	-815.6											
C <sub>9</sub> H <sub>10</sub>	Cyclopropylbenzene					100.3				150.5			
C <sub>9</sub> H <sub>10</sub>	Indan					11.5		56.0	190.2	60.3			
C <sub>9</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O	Diuron	-329.0											
C <sub>9</sub> H <sub>10</sub> N <sub>2</sub>	2,2'-Dipyrrolylmethane	126.2											
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate								246.0				
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzyl acetate								148.5				
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Phenylalanine	-466.9		213.6	203.0					-312.9			
C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	<i>L</i> -Tyrosine	-685.1		214.0	216.4								
C <sub>9</sub> H <sub>12</sub>	Propylbenzene					-38.3		287.8	214.7	7.9			
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene					-41.1			210.7	4.0			
C <sub>9</sub> H <sub>12</sub>	2-Ethyltoluene					-46.4				1.3			
C <sub>9</sub> H <sub>12</sub>	3-Ethyltoluene					-48.7				-1.8			
C <sub>9</sub> H <sub>12</sub>	4-Ethyltoluene					-49.8				-3.2			
C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene					-58.5		267.9	216.4	-9.5			
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene					-61.8			215.0	-13.8			
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene					-63.4			209.3	-15.9			
C <sub>9</sub> H <sub>12</sub> O	2-Isopropylphenol					-233.7				-182.2			
C <sub>9</sub> H <sub>12</sub> O	3-Isopropylphenol					-252.5				-196.0			
C <sub>9</sub> H <sub>12</sub> O	4-Isopropylphenol	-270.0								-175.3			
C <sub>9</sub> H <sub>12</sub> O <sub>2</sub>	Isopropylbenzene hydroperoxide					-148.3				-78.4			
C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	Ethyl 3,5-dimethylpyrrole-2-carboxylate	-474.5											
C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	Ethyl 2,4-dimethylpyrrole-3-carboxylate	-463.2											
C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	Ethyl 2,5-dimethylpyrrole-3-carboxylate	-478.7											
C <sub>9</sub> H <sub>13</sub> NO <sub>2</sub>	Ethyl 4,5-dimethylpyrrole-3-carboxylate	-470.3											
C <sub>9</sub> H <sub>14</sub> O	Isophorone								253.5				
C <sub>9</sub> H <sub>14</sub> O <sub>6</sub>	Triacetin					-1330.8		458.3	384.7	-1245.0			
C <sub>9</sub> H <sub>15</sub> N	3-Ethyl-2,4,5-trimethylpyrrole	-89.2											
C <sub>9</sub> H <sub>16</sub>	1-Nonyne					16.3				62.3			
C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	Nonanedioic acid	-1054.3											
C <sub>9</sub> H <sub>17</sub> NO	2,2,6,6-Tetramethyl-4-piperidinone	-334.2								-273.4			
C <sub>9</sub> H <sub>18</sub>	Propylcyclohexane					-237.4		311.9	242.0	-192.3			
C <sub>9</sub> H <sub>18</sub>	1 $\alpha$ ,3 $\alpha$ ,5 $\beta$ -1,3,5-Trimethylcyclohexane									-212.1			
C <sub>9</sub> H <sub>18</sub> O	2-Nonanone					-397.2				-340.7			
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone					-398.2		401.4	303.6	-344.9			
C <sub>9</sub> H <sub>18</sub> O	2,6-Dimethyl-4-heptanone					-408.5			297.3	-357.6			
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid					-659.7			362.4	-577.3			
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Butyl pentanoate					-613.3				-560.2			
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	<i>sec</i> -Butyl pentanoate					-624.2				-573.2			
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Isobutyl pentanoate					-620.0				-568.6			
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Methyl octanoate					-590.3				-533.9			
C <sub>9</sub> H <sub>19</sub> N	<i>N</i> -Butylpiperidine					-171.8							
C <sub>9</sub> H <sub>19</sub> N	2,2,6,6-Tetramethylpiperidine					-206.9				-159.9			
C <sub>9</sub> H <sub>20</sub>	Nonane					-274.7			284.4	-228.2			
C <sub>9</sub> H <sub>20</sub>	2,2-Dimethylheptane					-288.1							
C <sub>9</sub> H <sub>20</sub>	2,2,3-Trimethylhexane					-282.7							



Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>10</sub> H <sub>16</sub> O	Camphor, (±)	-319.4			271.2							-267.5	
C <sub>10</sub> H <sub>18</sub>	1,1'-Bicyclopentyl					-178.9							
C <sub>10</sub> H <sub>18</sub>	<i>cis</i> -Decahydronaphthalene					-219.4		265.0	232.0			-169.2	
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene					-230.6		264.9	228.5			-182.1	
C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Sebacic acid	-1082.6										-921.9	
C <sub>10</sub> H <sub>15</sub> N	Decanenitrile					-158.4						-91.5	
C <sub>10</sub> H <sub>20</sub>	1-Decene					-173.8		425.0	300.8			-123.3	
C <sub>10</sub> H <sub>20</sub>	<i>cis</i> -1,2-Di- <i>tert</i> -butylethene					-163.6							
C <sub>10</sub> H <sub>20</sub>	Butylcyclohexane					-263.1		345.0	271.0			-213.7	
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Decanoic acid	-713.7				-684.3						-594.9	
C <sub>10</sub> H <sub>21</sub> O <sub>2</sub>	Methyl nonanoate					-616.2						-554.2	
C <sub>10</sub> H <sub>21</sub> NO <sub>2</sub>	1-Nitrodecane					-351.5							
C <sub>10</sub> H <sub>22</sub>	Decane					-300.9			314.4			-249.5	
C <sub>10</sub> H <sub>22</sub>	2-Methylnonane					-309.8		420.1	313.3			-260.2	
C <sub>10</sub> H <sub>22</sub>	5-Methylnonane					-307.9		423.8	314.4			-258.6	
C <sub>10</sub> H <sub>22</sub> O	1-Decanol					-478.1			370.6			-396.6	
C <sub>10</sub> H <sub>22</sub> O	Dipentyl ether								250.0				
C <sub>10</sub> H <sub>22</sub> O	Diisopentyl ether								379.0				
C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	1,10-Decanediol	-678.9											
C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	Ethylene glycol dibutyl ether								350.0				
C <sub>10</sub> H <sub>22</sub> S	1-Decanethiol	-309.9				-276.5		476.1	350.4			-211.5	
C <sub>10</sub> H <sub>22</sub> S	Dipentyl sulfide					-266.4						-204.9	
C <sub>10</sub> H <sub>22</sub> S	Diisopentyl sulfide					-281.8						-221.5	
C <sub>10</sub> H <sub>23</sub> N	Octyldimethylamine					-232.8							
C <sub>11</sub> H <sub>6</sub> O <sub>2</sub>	1-Naphthalenecarboxylic acid	-333.5										-223.1	
C <sub>11</sub> H <sub>6</sub> O <sub>2</sub>	2-Naphthalenecarboxylic acid	-346.1										-232.5	
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene					56.3		254.8	224.4			106.7	
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	44.9		220.0	196.0								
C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	<i>L</i> -Tryptophan	-415.3		251.0	238.1								
C <sub>11</sub> H <sub>14</sub>	1,1-Dimethylindan					-53.6						-1.6	
C <sub>11</sub> H <sub>16</sub>	1- <i>tert</i> -Butyl-3-methylbenzene					-109.7							
C <sub>11</sub> H <sub>16</sub>	1- <i>tert</i> -Butyl-4-methylbenzene					-109.7						-57.0	
C <sub>11</sub> H <sub>16</sub>	Pentamethylbenzene	-144.6										-67.2	
C <sub>11</sub> H <sub>20</sub>	Spiro[5.5]undecane					-244.5						-188.3	
C <sub>11</sub> H <sub>22</sub>	1-Undecene								344.9				
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Methyl decanoate					-640.5						-573.8	
C <sub>11</sub> H <sub>24</sub>	Undecane					-327.2			344.9			-270.8	
C <sub>11</sub> H <sub>24</sub> O	1-Undecanol					-504.8							
C <sub>12</sub> F <sub>27</sub> N	Tris(perfluorobutyl)amine								418.4				
C <sub>12</sub> H <sub>6</sub>	Acenaphthylene	186.7			166.4							259.7	
C <sub>12</sub> H <sub>6</sub> N <sub>2</sub>	Phenazine	237.0										328.8	
C <sub>12</sub> H <sub>6</sub> O	Dibenzofuran	-5.3										83.4	
C <sub>12</sub> H <sub>6</sub> S	Dibenzothiophene	120.0										205.1	
C <sub>12</sub> H <sub>6</sub> S <sub>2</sub>	Thianthrene	182.0										286.0	
C <sub>12</sub> H <sub>6</sub> N	Carbazole	101.7										200.7	
C <sub>12</sub> H <sub>10</sub>	Acenaphthene	70.3		188.9	190.4							156.0	
C <sub>12</sub> H <sub>10</sub>	Biphenyl	99.4		209.4	198.4							181.4	
C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	<i>trans</i> -Azoxybenzene	243.4										342.0	
C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	<i>N</i> -Nitrosodiphenylamine	227.2											
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether	-32.1		233.9	216.6	-14.9						52.0	
C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	1-Naphthaleneacetic acid	-359.2											
C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	2-Naphthaleneacetic acid	-371.9											
C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	130.2										219.3	
C <sub>12</sub> H <sub>11</sub> N	2-Aminobiphenyl	93.8										184.4	
C <sub>12</sub> H <sub>11</sub> N	4-Aminobiphenyl	81.0											
C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	<i>p</i> -Benzidine	70.7											
C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate					-776.6		425.1	366.1			-688.4	
C <sub>12</sub> H <sub>16</sub>	Cyclohexylbenzene					-76.6						-16.7	
C <sub>12</sub> H <sub>17</sub> NO <sub>4</sub>	Diethyl 3,5-dimethylpyrrole-2,4-dicarboxylate	-916.7											
C <sub>12</sub> H <sub>18</sub>	3,9-Dodecadiyne					197.8							
C <sub>12</sub> H <sub>18</sub>	5,7-Dodecadiyne					181.5							
C <sub>12</sub> H <sub>18</sub>	1- <i>tert</i> -Butyl-3,5-dimethylbenzene					-146.5							
C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	-162.4		306.3	245.6							-77.4	
C <sub>12</sub> H <sub>22</sub>	Cyclohexylcyclohexane					-273.7						-215.7	
C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	Dodecanedioic acid	-1130.0										-976.9	

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	Sucrose	-2226.1											
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	$\beta$ -D-Lactose	-2236.7											
C <sub>12</sub> H <sub>24</sub>	1-Dodecene					-226.2		484.8	360.7	-165.4			
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Dodecanoic acid	-774.6			404.3	-737.9				-642.0			
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Methyl undecanoate					-665.2				-593.8			
C <sub>12</sub> H <sub>22</sub> O <sub>12</sub>	$\alpha$ -Lactose monohydrate	-2484.1											
C <sub>12</sub> H <sub>26</sub> Br	1-Bromododecane					-344.7				-269.9			
C <sub>12</sub> H <sub>26</sub> Cl	1-Chlorododecane					-392.3				-321.1			
C <sub>12</sub> H <sub>26</sub>	Dodecane					-350.9			375.8	-289.4			
C <sub>12</sub> H <sub>26</sub> O	1-Dodecanol					-528.5			438.1	-436.6			
C <sub>12</sub> H <sub>26</sub> O <sub>3</sub>	Diethylene glycol dibutyl ether								452.0				
C <sub>12</sub> H <sub>27</sub> N	Tributylamine					-281.6							
C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	Tributyl phosphate								379.4				
C <sub>13</sub> H <sub>6</sub> O <sub>2</sub>	Xanthone	-191.5											
C <sub>13</sub> H <sub>6</sub> N	Acridine	179.4								273.9			
C <sub>13</sub> H <sub>6</sub> N	Phenanthridine	141.9								240.5			
C <sub>13</sub> H <sub>6</sub> N	Benzo[f]quinoline	150.6								233.7			
C <sub>13</sub> H <sub>10</sub>	9H-Fluorene	89.9	207.3	203.1						175.0			173.1
C <sub>13</sub> H <sub>10</sub> N <sub>2</sub>	9-Acridinamine	159.2											
C <sub>13</sub> H <sub>10</sub> O	Benzophenone	-34.5			224.8					54.9			
C <sub>13</sub> H <sub>11</sub> N	9-Methyl-9H-carbazole	105.5								201.0			
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	71.5	239.3			89.7				139.0			
C <sub>13</sub> H <sub>13</sub> N	N-Benzylaniline	101.4											
C <sub>13</sub> H <sub>14</sub> N <sub>2</sub>	4,4'-Diaminodiphenylmethane				270.9								
C <sub>13</sub> H <sub>24</sub> O <sub>4</sub>	Tridecanedioic acid	-1148.3											
C <sub>13</sub> H <sub>26</sub>	1-Tridecene								391.8				
C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	Methyl dodecanoate					-693.0				-614.9			
C <sub>13</sub> H <sub>28</sub>	Tridecane								406.7				
C <sub>13</sub> H <sub>28</sub> O	1-Tridecanol	-599.4											
C <sub>14</sub> H <sub>6</sub> O <sub>2</sub>	9,10-Anthracenedione	-188.5								-75.7			
C <sub>14</sub> H <sub>6</sub> O <sub>2</sub>	9,10-Phenanthrenedione	-154.7								-46.6			
C <sub>14</sub> H <sub>6</sub> O <sub>4</sub>	1,4-Dihydroxy-9,10-anthracenedione	-595.8								-471.7			
C <sub>14</sub> H <sub>10</sub>	Anthracene	129.2	207.5	210.5						230.9			
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	116.2	215.1	220.6						207.5			
C <sub>14</sub> H <sub>10</sub>	Diphenylacetylene	312.4		225.9									
C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	Benzil	-153.9								-55.5			
C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	Benzoyl peroxide	-369.4								-281.7			
C <sub>14</sub> H <sub>12</sub>	cis-Stilbene					183.3				252.3			
C <sub>14</sub> H <sub>12</sub>	trans-Stilbene	136.9								236.1			
C <sub>14</sub> H <sub>14</sub>	1,1-Diphenylethane					48.7							
C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	51.5								142.9			
C <sub>14</sub> H <sub>22</sub>	1,3-Di-tert-butylbenzene					-188.8							
C <sub>14</sub> H <sub>22</sub>	1,4-Di-tert-butylbenzene	-212.0											
C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O <sub>10</sub>	Pentetic acid	-2225.2											
C <sub>14</sub> H <sub>27</sub> N	Tetradecanenitrile					-260.2				-174.9			
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Tetradecanoic acid	-833.5			432.0	-788.8				-693.7			
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Methyl tridecanoate					-717.9				-635.3			
C <sub>14</sub> H <sub>30</sub> O	1-Tetradecanol	-629.6			388.0	-580.6							
C <sub>15</sub> H <sub>16</sub> O <sub>2</sub>	2,2-Bis(4-hydroxyphenyl)propane	-368.6											
C <sub>15</sub> H <sub>24</sub>	1,3-Di-tert-butyl-5-methylbenzene	-245.8											
C <sub>15</sub> H <sub>24</sub> O	2,6-Di-tert-butyl-4-methylphenol	-410.0								-296.9			
C <sub>15</sub> H <sub>30</sub>	Decylcyclopentane					-367.3							
C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Pentadecanoic acid	-861.7			443.3	-811.7				-699.0			
C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Methyl tetradecanoate					-743.9				-656.9			
C <sub>15</sub> H <sub>32</sub> O	1-Pentadecanol	-658.2											
C <sub>16</sub> H <sub>10</sub>	Fluoranthene	189.9	230.6	230.2						289.0			
C <sub>16</sub> H <sub>10</sub>	Pyrene	125.5	224.9	229.7						225.7			
C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Dibutyl phthalate					-842.6				-750.9			
C <sub>16</sub> H <sub>22</sub> O <sub>11</sub>	$\alpha$ -D-Glucose pentaacetate	-2249.4											
C <sub>16</sub> H <sub>22</sub> O <sub>11</sub>	$\beta$ -D-Glucose pentaacetate	-2232.6											
C <sub>16</sub> H <sub>26</sub>	Decylbenzene					-218.3				-138.6			
C <sub>16</sub> H <sub>32</sub>	1-Hexadecene					-328.7		587.9	488.9	-248.4			
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Hexadecanoic acid	-891.5	452.4	460.7		-838.1				-737.1			
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Methyl pentadecanoate					-771.0				-680.0			
C <sub>16</sub> H <sub>33</sub> Br	1-Bromohexadecane					-444.5				-350.2			

Molecular formula	Name	Crystal				Liquid				Gas			
		$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K	$\Delta_f H^\circ$ kJ/mol	$\Delta_f G^\circ$ kJ/mol	$S^\circ$ J/mol K	$C_p$ J/mol K
C <sub>16</sub> H <sub>34</sub>	Hexadecane					-456.1		501.6		-374.8			
C <sub>16</sub> H <sub>34</sub> O	1-Hexadecanol	-686.5			422.0					-517.0			
C <sub>16</sub> H <sub>38</sub> I <sub>4</sub> N	Tetrabutylammonium iodide	-498.6											
C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Heptadecanoic acid	-924.4			475.7	-865.6							
C <sub>18</sub> H <sub>12</sub>	Benz[ <i>a</i> ]anthracene	170.8								293.0			
C <sub>18</sub> H <sub>12</sub>	Chrysene	145.3								269.8			
C <sub>18</sub> H <sub>14</sub>	<i>o</i> -Terphenyl			298.8	274.8			337.1	369.1				
C <sub>18</sub> H <sub>14</sub>	<i>p</i> -Terphenyl	163.0		285.6	278.7					279.0			
C <sub>18</sub> H <sub>15</sub> N	Triphenylamine	234.7								326.8			
C <sub>18</sub> H <sub>15</sub> O <sub>4</sub> P	Triphenyl phosphate			397.5	356.2								
C <sub>18</sub> H <sub>15</sub> P	Triphenylphosphine				312.5								
C <sub>18</sub> H <sub>30</sub>	1,3,5-Tri- <i>tert</i> -butylbenzene	-320.0											
C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Oleic acid								577.0				
C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	Dibutyl sebacate								619.0				
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	-947.7			501.5	-884.7				-781.2			
C <sub>18</sub> H <sub>37</sub> Cl	1-Chlorooctadecane					-544.1				-446.0			
C <sub>18</sub> H <sub>38</sub>	Octadecane	-567.4		480.2	485.6					-414.6			
C <sub>18</sub> H <sub>39</sub> N	Trihexylamine					-433.0							
C <sub>19</sub> H <sub>16</sub> O	Triphenylmethanol	-2.5											
C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	Methyl oleate					-734.5				-649.9			
C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	Methyl <i>trans</i> -9-octadecenoate					-737.0							
C <sub>20</sub> H <sub>12</sub>	Perylene	182.8		264.6	274.9								
C <sub>20</sub> H <sub>12</sub>	Benzo[ <i>a</i> ]pyrene											254.8	
C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	Diphenyl phthalate	-489.2											
C <sub>20</sub> H <sub>36</sub> O <sub>2</sub>	Ethyl oleate					-775.8							
C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	Ethyl <i>trans</i> -9-octadecenoate					-773.3							
C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Eicosanoic acid	-1011.9			545.1	-940.0				-812.4			
C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	Tri- <i>o</i> -cresyl phosphate			570.0	578.0								
C <sub>22</sub> H <sub>14</sub>	Dibenz[ <i>a,h</i> ]anthracene											283.9	
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	<i>trans</i> -13-Docosenoic acid	-960.7											
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Butyl oleate					-816.9							
C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	Butyl stearate												
C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	Bis(2-ethylhexyl) phthalate								704.7				
C <sub>24</sub> H <sub>51</sub> N	Trioctylamine					-585.0							
C <sub>26</sub> H <sub>18</sub>	9,10-Diphenylanthracene	308.7								465.6			
C <sub>26</sub> H <sub>54</sub>	5-Butyldocosane					-713.5				-587.6			
C <sub>26</sub> H <sub>54</sub>	11-Butyldocosane					-716.0				-593.4			
C <sub>28</sub> H <sub>18</sub>	9,9'-Bianthracene	326.2								454.3			
C <sub>31</sub> H <sub>64</sub>	11-Decylheneicosane					-848.0				-705.8			
C <sub>32</sub> H <sub>66</sub>	Dotriacontane	-968.3								-697.2			
C <sub>60</sub>	Carbon (fullerene-C <sub>60</sub> )	2327.0	2302.0	426.0	520.0					2502.0	2442.0	544.0	512.0
C <sub>70</sub>	Carbon (fullerene-C <sub>70</sub> )	2555.0	2537.0	464.0	650.0					2755.0	2692.0	614.0	585.0

# THERMODYNAMIC PROPERTIES AS A FUNCTION OF TEMPERATURE

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The thermodynamic properties  $C_p^\circ(T)$ ,  $S^\circ(T)$ ,  $H^\circ(T)-H^\circ(T_r)$ ,  $-[G^\circ(T)-H^\circ(T_r)]/T$  and formation properties  $\Delta_f H^\circ(T)$ ,  $\Delta_f G^\circ(T)$ ,  $\log K_f^\circ(T)$  are tabulated as functions of temperature in the range 298.15 to 1500 K for 80 substances in the standard state. The reference temperature,  $T_r$ , is equal to 298.15 K. The standard state pressure is taken as 1 bar (100,000 Pa). The tables are presented in the JANAF Thermochemical Tables format (Reference 2). The numerical data are extracted from IVTANTHERMO databases except for  $C_2H_4O$ ,  $C_3H_6O$ ,  $C_6H_6$ ,  $C_6H_6O$ ,  $C_{10}H_8$ , and  $CH_5N$ , which

are based upon TRC Tables. See the references for information on standard states and other details.

## References

1. Gurvich, L. V., Veyts, I. V., and Alcock, C. B., Eds., *Thermodynamic Properties of Individual Substances, 4th ed.*, Hemisphere Publishing Corp., New York, 1989.
2. Chase, M. W., et al., *JANAF Thermochemical Tables, 3rd ed.*, *J. Phys. Chem. Ref. Data*, 14, Suppl. 1, 1985.

## Order of Listing of Tables

No.	Formula	Name	State	No.	Formula	Name	State
1	Ar	Argon	g	42	CuCl <sub>2</sub>	Copper dichloride	g
2	Br	Bromine	g	43	F	Fluorine	g
3	Br <sub>2</sub>	Dibromine	g	44	F <sub>2</sub>	Difluorine	g
4	BrH	Hydrogen bromide	g	45	FH	Hydrogen fluoride	g
5	C	Carbon (graphite)	cr	46	Ge	Germanium	cr, l
6	C	Carbon (diamond)	cr	47	Ge	Germanium	g
7	C <sub>2</sub>	Dicarbon	g	48	GeO <sub>2</sub>	Germanium dioxide	cr, l
8	C <sub>3</sub>	Tricarbon	g	49	GeCl <sub>4</sub>	Germanium tetrachloride	g
9	CO	Carbon oxide	g	50	H	Hydrogen	g
10	CO <sub>2</sub>	Carbon dioxide	g	51	H <sub>2</sub>	Dihydrogen	g
11	CH <sub>4</sub>	Methane	g	52	HO	Hydroxyl	g
12	C <sub>2</sub> H <sub>2</sub>	Acetylene	g	53	H <sub>2</sub> O	Water	l
13	C <sub>2</sub> H <sub>4</sub>	Ethylene	g	54	H <sub>2</sub> O	Water	g
14	C <sub>2</sub> H <sub>6</sub>	Ethane	g	55	I	Iodine	g
15	C <sub>3</sub> H <sub>6</sub>	Cyclopropane	g	56	I <sub>2</sub>	Diiodine	cr, l
16	C <sub>3</sub> H <sub>8</sub>	Propane	g	57	I <sub>2</sub>	Diiodine	g
17	C <sub>6</sub> H <sub>6</sub>	Benzene	l	58	IH	Hydrogen iodide	g
18	C <sub>6</sub> H <sub>6</sub>	Benzene	g	59	K	Potassium	cr, l
19	C <sub>10</sub> H <sub>8</sub>	Naphthalene	cr, l	60	K	Potassium	g
20	C <sub>10</sub> H <sub>8</sub>	Naphthalene	g	61	K <sub>2</sub> O	Dipotassium oxide	cr, l
21	CH <sub>2</sub> O	Formaldehyde	g	62	KOH	Potassium hydroxide	cr, l
22	CH <sub>3</sub> O	Methanol	g	63	KOH	Potassium hydroxide	g
23	C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	g	64	KCl	Potassium chloride	cr, l
24	C <sub>2</sub> H <sub>6</sub> O	Ethanol	g	65	KCl	Potassium chloride	g
25	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	g	66	N <sub>2</sub>	Dinitrogen	g
26	C <sub>3</sub> H <sub>6</sub> O	Acetone	g	67	NO	Nitric oxide	g
27	C <sub>6</sub> H <sub>6</sub> O	Phenol	g	68	NO <sub>2</sub>	Nitrogen dioxide	g
28	CF <sub>4</sub>	Carbon tetrafluoride	g	69	NH <sub>3</sub>	Ammonia	g
29	CHF <sub>3</sub>	Trifluoromethane	g	70	O	Oxygen	g
30	CClF <sub>3</sub>	Chlorotrifluoromethane	g	71	O <sub>2</sub>	Dioxygen	g
31	CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	g	72	S	Sulfur	cr, l
32	CHClF <sub>2</sub>	Chlorodifluoromethane	g	73	S	Sulfur	g
33	CH <sub>5</sub> N	Methylamine	g	74	S <sub>2</sub>	Disulfur	g
34	Cl	Chlorine	g	75	S <sub>8</sub>	Octasulfur	g
35	Cl <sub>2</sub>	Dichlorine	g	76	SO <sub>2</sub>	Sulfur dioxide	g
36	ClH	Hydrogen chloride	g	77	Si	Silicon	cr
37	Cu	Copper	cr, l	78	Si	Silicon	g
38	Cu	Copper	g	79	SiO <sub>2</sub>	Silicon dioxide	cr
39	CuO	Copper oxide	cr	80	SiCl <sub>4</sub>	Silicon tetrachloride	g
40	Cu <sub>2</sub> O	Dicopper oxide	cr				
41	CuCl <sub>2</sub>	Copper dichloride	cr, l				

<i>T</i> /K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>1. ARGON Ar (g)</b>							
298.15	20.786	154.845	154.845	0.000	0.000	0.000	0.000
300	20.786	154.973	154.845	0.038	0.000	0.000	0.000
400	20.786	160.953	155.660	2.117	0.000	0.000	0.000
500	20.786	165.591	157.200	4.196	0.000	0.000	0.000
600	20.786	169.381	158.924	6.274	0.000	0.000	0.000
700	20.786	172.585	160.653	8.353	0.000	0.000	0.000
800	20.786	175.361	162.322	10.431	0.000	0.000	0.000
900	20.786	177.809	163.909	12.510	0.000	0.000	0.000
1000	20.786	179.999	165.410	14.589	0.000	0.000	0.000
1100	20.786	181.980	166.828	16.667	0.000	0.000	0.000
1200	20.786	183.789	168.167	18.746	0.000	0.000	0.000
1300	20.786	185.453	169.434	20.824	0.000	0.000	0.000
1400	20.786	186.993	170.634	22.903	0.000	0.000	0.000
1500	20.786	188.427	171.773	24.982	0.000	0.000	0.000
<b>2. BROMINE Br (g)</b>							
298.15	20.786	175.017	175.017	0.000	111.870	82.379	-14.432
300	20.786	175.146	175.018	0.038	111.838	82.196	-14.311
400	20.787	181.126	175.833	2.117	96.677	75.460	-9.854
500	20.798	185.765	177.373	4.196	96.910	70.129	-7.326
600	20.833	189.559	179.097	6.277	97.131	64.752	-5.637
700	20.908	192.776	180.827	8.364	97.348	59.338	-4.428
800	21.027	195.575	182.499	10.461	97.568	53.893	-3.519
900	21.184	198.061	184.093	12.571	97.796	48.420	-2.810
1000	21.365	200.302	185.604	14.698	98.036	42.921	-2.242
1100	21.559	202.347	187.034	16.844	98.291	37.397	-1.776
1200	21.752	204.231	188.390	19.010	98.560	31.850	-1.386
1300	21.937	205.980	189.676	21.195	98.844	26.279	-1.056
1400	22.107	207.612	190.900	23.397	99.141	20.686	-0.772
1500	22.258	209.142	192.065	25.615	99.449	15.072	-0.525
<b>3. DIBROMINE Br<sub>2</sub> (g)</b>							
298.15	36.057	245.467	245.467	0.000	30.910	3.105	-0.544
300	36.074	245.690	245.468	0.067	30.836	2.933	-0.511
332.25	36.340	249.387	245.671	1.235		pressure = 1 bar	
400	36.729	256.169	246.892	3.711	0.000	0.000	0.000
500	37.082	264.406	249.600	7.403	0.000	0.000	0.000
600	37.305	271.188	252.650	11.123	0.000	0.000	0.000
700	37.464	276.951	255.720	14.862	0.000	0.000	0.000
800	37.590	281.962	258.694	18.615	0.000	0.000	0.000
900	37.697	286.396	261.530	22.379	0.000	0.000	0.000
1000	37.793	290.373	264.219	26.154	0.000	0.000	0.000
1100	37.883	293.979	266.763	29.938	0.000	0.000	0.000
1200	37.970	297.279	269.170	33.730	0.000	0.000	0.000
1300	38.060	300.322	271.451	37.532	0.000	0.000	0.000
1400	38.158	303.146	273.615	41.343	0.000	0.000	0.000
1500	38.264	305.782	275.673	45.164	0.000	0.000	0.000
<b>4. HYDROGEN BROMIDE HBr (g)</b>							
298.15	29.141	198.697	198.697	0.000	-36.290	-53.360	9.348
300	29.141	198.878	198.698	0.054	-36.333	-53.466	9.309
400	29.220	207.269	199.842	2.971	-52.109	-55.940	7.305
500	29.454	213.811	202.005	5.903	-52.484	-56.854	5.939
600	29.872	219.216	204.436	8.868	-52.844	-57.694	5.023
700	30.431	223.861	206.886	11.882	-53.168	-58.476	4.363
800	31.063	227.965	209.269	14.957	-53.446	-59.214	3.866
900	31.709	231.661	211.555	18.095	-53.677	-59.921	3.478
1000	32.335	235.035	213.737	21.298	-53.864	-60.604	3.166
1100	32.919	238.145	215.816	24.561	-54.012	-61.271	2.909



<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	$-(G^o-H^o(T_r))/T$	$H^o-H^o(T_r)$	$\Delta_f H^o$	$\Delta_f G^o$	
1200	33.454	241.032	217.799	27.880	-54.129	-61.925	2.696
1300	33.938	243.729	219.691	31.250	-54.220	-62.571	2.514
1400	34.374	246.261	221.499	34.666	-54.291	-63.211	2.358
1500	34.766	248.646	223.230	38.123	-54.348	-63.846	2.223
<b>5. CARBON (GRAPHITE) C (cr; graphite)</b>							
298.15	8.536	5.740	5.740	0.000	0.000	0.000	0.000
300	8.610	5.793	5.740	0.016	0.000	0.000	0.000
400	11.974	8.757	6.122	1.054	0.000	0.000	0.000
500	14.537	11.715	6.946	2.385	0.000	0.000	0.000
600	16.607	14.555	7.979	3.945	0.000	0.000	0.000
700	18.306	17.247	9.113	5.694	0.000	0.000	0.000
800	19.699	19.785	10.290	7.596	0.000	0.000	0.000
900	20.832	22.173	11.479	9.625	0.000	0.000	0.000
1000	21.739	24.417	12.662	11.755	0.000	0.000	0.000
1100	22.452	26.524	13.827	13.966	0.000	0.000	0.000
1200	23.000	28.502	14.968	16.240	0.000	0.000	0.000
1300	23.409	30.360	16.082	18.562	0.000	0.000	0.000
1400	23.707	32.106	17.164	20.918	0.000	0.000	0.000
1500	23.919	33.749	18.216	23.300	0.000	0.000	0.000
<b>6. CARBON (DIAMOND) C (cr; diamond)</b>							
298.15	6.109	2.362	2.362	0.000	1.850	2.857	-0.501
300	6.201	2.400	2.362	0.011	1.846	2.863	-0.499
400	10.321	4.783	2.659	0.850	1.645	3.235	-0.422
500	13.404	7.431	3.347	2.042	1.507	3.649	-0.381
600	15.885	10.102	4.251	3.511	1.415	4.087	-0.356
700	17.930	12.709	5.274	5.205	1.361	4.537	-0.339
800	19.619	15.217	6.361	7.085	1.338	4.993	-0.326
900	21.006	17.611	7.479	9.118	1.343	5.450	-0.316
1000	22.129	19.884	8.607	11.277	1.372	5.905	-0.308
1100	23.020	22.037	9.731	13.536	1.420	6.356	-0.302
1200	23.709	24.071	10.842	15.874	1.484	6.802	-0.296
1300	24.222	25.990	11.934	18.272	1.561	7.242	-0.291
1400	24.585	27.799	13.003	20.714	1.646	7.675	-0.286
1500	24.824	29.504	14.047	23.185	1.735	8.103	-0.282
<b>7. DICARBON C<sub>2</sub> (g)</b>							
298.15	43.548	197.095	197.095	0.000	830.457	775.116	-135.795
300	43.575	197.365	197.096	0.081	830.506	774.772	-134.898
400	42.169	209.809	198.802	4.403	832.751	755.833	-98.700
500	39.529	218.924	201.959	8.483	834.170	736.423	-76.933
600	37.837	225.966	205.395	12.342	834.909	716.795	-62.402
700	36.984	231.726	208.758	16.078	835.148	697.085	-52.016
800	36.621	236.637	211.943	19.755	835.020	677.366	-44.227
900	36.524	240.943	214.931	23.411	834.618	657.681	-38.170
1000	36.569	244.793	217.728	27.065	834.012	638.052	-33.328
1100	36.696	248.284	220.349	30.728	833.252	618.492	-29.369
1200	36.874	251.484	222.812	34.406	832.383	599.006	-26.074
1300	37.089	254.444	225.133	38.104	831.437	579.596	-23.288
1400	37.329	257.201	227.326	41.824	830.445	560.261	-20.903
1500	37.589	259.785	229.405	45.570	829.427	540.997	-18.839
<b>8. TRICARBON C<sub>3</sub> (g)</b>							
298.15	42.202	237.611	237.611	0.000	839.958	774.249	-135.643
300	42.218	237.872	237.611	0.078	839.989	773.841	-134.736
400	43.383	250.164	239.280	4.354	841.149	751.592	-98.147
500	44.883	260.003	242.471	8.766	841.570	729.141	-76.172
600	46.406	268.322	246.104	13.331	841.453	706.659	-61.519
700	47.796	275.582	249.807	18.042	840.919	684.230	-51.057
800	48.997	282.045	253.440	22.884	840.053	661.901	-43.217

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
900	50.006	287.876	256.948	27.835	838.919	639.698	-37.127
1000	50.844	293.189	260.310	32.879	837.572	617.633	-32.261
1100	51.535	298.069	263.524	37.999	836.059	595.711	-28.288
1200	52.106	302.578	266.593	43.182	834.420	573.933	-24.982
1300	52.579	306.768	269.524	48.417	832.690	552.295	-22.191
1400	52.974	310.679	272.326	53.695	830.899	530.793	-19.804
1500	53.307	314.346	275.006	59.010	829.068	509.421	-17.739
<b>9. CARBON OXIDE CO (g)</b>							
298.15	29.141	197.658	197.658	0.000	-110.530	-137.168	24.031
300	29.142	197.838	197.659	0.054	-110.519	-137.333	23.912
400	29.340	206.243	198.803	2.976	-110.121	-146.341	19.110
500	29.792	212.834	200.973	5.930	-110.027	-155.412	16.236
600	30.440	218.321	203.419	8.941	-110.157	-164.480	14.319
700	31.170	223.067	205.895	12.021	-110.453	-173.513	12.948
800	31.898	227.277	208.309	15.175	-110.870	-182.494	11.915
900	32.573	231.074	210.631	18.399	-111.378	-191.417	11.109
1000	33.178	234.538	212.851	21.687	-111.952	-200.281	10.461
1100	33.709	237.726	214.969	25.032	-112.573	-209.084	9.928
1200	34.169	240.679	216.990	28.426	-113.228	-217.829	9.482
1300	34.568	243.430	218.920	31.864	-113.904	-226.518	9.101
1400	34.914	246.005	220.763	35.338	-114.594	-235.155	8.774
1500	35.213	248.424	222.527	38.845	-115.291	-243.742	8.488
<b>10. CARBON DIOXIDE CO<sub>2</sub> (g)</b>							
298.15	37.135	213.783	213.783	0.000	-393.510	-394.373	69.092
300	37.220	214.013	213.784	0.069	-393.511	-394.379	68.667
400	41.328	225.305	215.296	4.004	-393.586	-394.656	51.536
500	44.627	234.895	218.280	8.307	-393.672	-394.914	41.256
600	47.327	243.278	221.762	12.909	-393.791	-395.152	34.401
700	49.569	250.747	225.379	17.758	-393.946	-395.367	29.502
800	51.442	257.492	228.978	22.811	-394.133	-395.558	25.827
900	53.008	263.644	232.493	28.036	-394.343	-395.724	22.967
1000	54.320	269.299	235.895	33.404	-394.568	-395.865	20.678
1100	55.423	274.529	239.172	38.893	-394.801	-395.984	18.803
1200	56.354	279.393	242.324	44.483	-395.035	-396.081	17.241
1300	57.144	283.936	245.352	50.159	-395.265	-396.159	15.918
1400	57.818	288.196	248.261	55.908	-395.488	-396.219	14.783
1500	58.397	292.205	251.059	61.719	-395.702	-396.264	13.799
<b>11. METHANE CH<sub>4</sub> (g)</b>							
298.15	35.695	186.369	186.369	0.000	-74.600	-50.530	8.853
300	35.765	186.590	186.370	0.066	-74.656	-50.381	8.772
400	40.631	197.501	187.825	3.871	-77.703	-41.827	5.462
500	46.627	207.202	190.744	8.229	-80.520	-32.525	3.398
600	52.742	216.246	194.248	13.199	-82.969	-22.690	1.975
700	58.603	224.821	198.008	18.769	-85.023	-12.476	0.931
800	64.084	233.008	201.875	24.907	-86.693	-1.993	0.130
900	69.137	240.852	205.773	31.571	-88.006	8.677	-0.504
1000	73.746	248.379	209.660	38.719	-88.996	19.475	-1.017
1100	77.919	255.607	213.511	46.306	-89.698	30.358	-1.442
1200	81.682	262.551	217.310	54.289	-90.145	41.294	-1.797
1300	85.067	269.225	221.048	62.630	-90.367	52.258	-2.100
1400	88.112	275.643	224.720	71.291	-90.390	63.231	-2.359
1500	90.856	281.817	228.322	80.242	-90.237	74.200	-2.584
<b>12. ACETYLENE C<sub>2</sub>H<sub>2</sub> (g)</b>							
298.15	44.036	200.927	200.927	0.000	227.400	209.879	-36.769
300	44.174	201.199	200.927	0.082	227.397	209.770	-36.524
400	50.388	214.814	202.741	4.829	227.161	203.928	-26.630
500	54.751	226.552	206.357	10.097	226.846	198.154	-20.701

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
600	58.121	236.842	210.598	15.747	226.445	192.452	-16.754
700	60.970	246.021	215.014	21.704	225.968	186.823	-13.941
800	63.511	254.331	219.418	27.931	225.436	181.267	-11.835
900	65.831	261.947	223.726	34.399	224.873	175.779	-10.202
1000	67.960	268.995	227.905	41.090	224.300	170.355	-8.898
1100	69.909	275.565	231.942	47.985	223.734	164.988	-7.835
1200	71.686	281.725	235.837	55.067	223.189	159.672	-6.950
1300	73.299	287.528	239.592	62.317	222.676	154.400	-6.204
1400	74.758	293.014	243.214	69.721	222.203	149.166	-5.565
1500	76.077	298.218	246.709	77.264	221.774	143.964	-5.013
<b>13. ETHYLENE <math>C_2H_4</math> (g)</b>							
298.15	42.883	219.316	219.316	0.000	52.400	68.358	-11.976
300	43.059	219.582	219.317	0.079	52.341	68.457	-11.919
400	53.045	233.327	221.124	4.881	49.254	74.302	-9.703
500	62.479	246.198	224.864	10.667	46.533	80.887	-8.450
600	70.673	258.332	229.441	17.335	44.221	87.982	-7.659
700	77.733	269.770	234.393	24.764	42.278	95.434	-7.121
800	83.868	280.559	239.496	32.851	40.655	103.142	-6.734
900	89.234	290.754	244.630	41.512	39.310	111.036	-6.444
1000	93.939	300.405	249.730	50.675	38.205	119.067	-6.219
1100	98.061	309.556	254.756	60.280	37.310	127.198	-6.040
1200	101.670	318.247	259.688	70.271	36.596	135.402	-5.894
1300	104.829	326.512	264.513	80.599	36.041	143.660	-5.772
1400	107.594	334.384	269.225	91.223	35.623	151.955	-5.669
1500	110.018	341.892	273.821	102.107	35.327	160.275	-5.581
<b>14. ETHANE <math>C_2H_6</math> (g)</b>							
298.15	52.487	229.161	229.161	0.000	-84.000	-32.015	5.609
300	52.711	229.487	229.162	0.097	-84.094	-31.692	5.518
400	65.459	246.378	231.379	5.999	-88.988	-13.473	1.759
500	77.941	262.344	235.989	13.177	-93.238	5.912	-0.618
600	89.188	277.568	241.660	21.545	-96.779	26.086	-2.271
700	99.136	292.080	247.835	30.972	-99.663	46.800	-3.492
800	107.936	305.904	254.236	41.334	-101.963	67.887	-4.433
900	115.709	319.075	260.715	52.525	-103.754	89.231	-5.179
1000	122.552	331.628	267.183	64.445	-105.105	110.750	-5.785
1100	128.553	343.597	273.590	77.007	-106.082	132.385	-6.286
1200	133.804	355.012	279.904	90.131	-106.741	154.096	-6.708
1300	138.391	365.908	286.103	103.746	-107.131	175.850	-7.066
1400	142.399	376.314	292.178	117.790	-107.292	197.625	-7.373
1500	145.905	386.260	298.121	132.209	-107.260	219.404	-7.640
<b>15. CYCLOPROPANE <math>C_3H_6</math> (g)</b>							
298.15	55.571	237.488	237.488	0.000	53.300	104.514	-18.310
300	55.941	237.832	237.489	0.103	53.195	104.832	-18.253
400	76.052	256.695	239.924	6.708	47.967	122.857	-16.043
500	93.859	275.637	245.177	15.230	43.730	142.091	-14.844
600	108.542	294.092	251.801	25.374	40.405	162.089	-14.111
700	120.682	311.763	259.115	36.854	37.825	182.583	-13.624
800	130.910	328.564	266.755	49.447	35.854	203.404	-13.281
900	139.658	344.501	274.516	62.987	34.384	224.441	-13.026
1000	147.207	359.616	282.277	77.339	33.334	245.618	-12.830
1100	153.749	373.961	289.965	92.395	32.640	266.883	-12.673
1200	159.432	387.588	297.538	108.060	32.249	288.197	-12.545
1300	164.378	400.549	304.967	124.257	32.119	309.533	-12.437
1400	168.689	412.892	312.239	140.915	32.215	330.870	-12.345
1500	172.453	424.662	319.344	157.976	32.507	352.193	-12.264
<b>16. PROPANE <math>C_3H_8</math> (g)</b>							
298.15	73.597	270.313	270.313	0.000	-103.847	-23.458	4.110

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
300	73.931	270.769	270.314	0.136	-103.972	-22.959	3.997
400	94.014	294.739	273.447	8.517	-110.33	15.029	-0.657
500	112.591	317.768	280.025	18.872	-115.658	34.507	-3.605
600	128.700	339.753	288.162	30.955	-119.973	64.961	-5.655
700	142.674	360.668	297.039	44.540	-123.384	96.065	-7.168
800	154.766	380.528	306.245	59.427	-126.016	127.603	-8.331
900	165.352	399.381	315.555	75.444	-127.982	159.430	-9.253
1000	174.598	417.293	324.841	92.452	-129.380	191.444	-10.000
1100	182.673	434.321	334.026	110.325	-130.296	223.574	-10.617
1200	189.745	450.526	343.064	128.954	-130.802	255.770	-11.133
1300	195.853	465.961	351.929	148.241	-130.961	287.993	-11.572
1400	201.209	480.675	360.604	168.100	-130.829	320.217	-11.947
1500	205.895	494.721	369.080	188.460	-130.445	352.422	-12.272
<b>17. BENZENE C<sub>6</sub>H<sub>6</sub> (l)</b>							
298.15	135.950	173.450	173.450	0.000	49.080	124.521	-21.815
300	136.312	174.292	173.453	.252	49.077	124.989	-21.762
400	161.793	216.837	179.082	15.102	48.978	150.320	-19.630
500	207.599	257.048	190.639	33.204	50.330	175.559	-18.340
<b>18. BENZENE C<sub>6</sub>H<sub>6</sub> (g)</b>							
298.15	82.430	269.190	269.190	0.000	82.880	129.750	-22.731
300	83.020	269.700	269.190	0.153	82.780	130.040	-22.641
400	113.510	297.840	272.823	10.007	77.780	146.570	-19.140
500	139.340	326.050	280.658	22.696	73.740	164.260	-17.160
600	160.090	353.360	290.517	37.706	70.490	182.680	-15.903
700	176.790	379.330	301.360	54.579	67.910	201.590	-15.042
800	190.460	403.860	312.658	72.962	65.910	220.820	-14.418
900	201.840	426.970	324.084	92.597	64.410	240.280	-13.945
1000	211.430	448.740	335.473	113.267	63.340	259.890	-13.575
1100	219.580	469.280	346.710	134.827	62.620	277.640	-13.184
1200	226.540	488.690	357.743	157.137	62.200	299.320	-13.029
1300	232.520	507.070	368.534	180.097	62.000	319.090	-12.821
1400	237.680	524.490	379.056	203.607	61.990	338.870	-12.643
1500	242.140	541.040	389.302	227.607	62.110	358.640	-12.489
<b>19. NAPHTHALENE C<sub>10</sub>H<sub>8</sub> (cr, l)</b>							
298.15	165.720	167.390	167.390	0.000	78.530	201.585	-35.316
300	167.001	168.419	167.393	0.308	78.466	202.349	-35.232
353.43	208.722	198.948	169.833	10.290	96.099	224.543	-33.186
PHASE TRANSITION: $\Delta_{\text{tr}} H = 18.980$ kJ/mol, $\Delta_{\text{tr}} S = 53.702$ J/Kmol, cr-l							
353.43	217.200	252.650	169.833	29.270	96.099	224.543	-33.186
400	241.577	280.916	181.124	39.917	96.067	241.475	-31.533
470	276.409	322.712	199.114	58.091	97.012	266.859	-29.658
<b>20. NAPHTHALENE C<sub>10</sub>H<sub>8</sub> (g)</b>							
298.15	131.920	333.150	333.150	0.000	150.580	224.100	-39.260
300	132.840	333.970	333.157	0.244	150.450	224.560	-39.098
400	180.070	378.800	338.950	15.940	144.190	250.270	-32.681
500	219.740	423.400	351.400	36.000	139.220	277.340	-28.973
600	251.530	466.380	367.007	59.624	135.350	305.330	-26.581
700	277.010	507.140	384.146	86.096	132.330	333.950	-24.919
800	297.730	545.520	401.935	114.868	130.050	362.920	-23.696
900	314.850	581.610	419.918	145.523	128.430	392.150	-22.759
1000	329.170	615.550	437.806	177.744	127.510	421.700	-22.027
1100	341.240	647.500	455.426	211.281	127.100	450.630	-21.398
1200	351.500	677.650	472.707	245.932	126.960	480.450	-20.913
1300	360.260	706.130	489.568	281.531	127.060	509.770	-20.482
1400	367.780	733.110	506.009	317.941	127.390	539.740	-20.137
1500	374.270	758.720	522.019	355.051	127.920	568.940	-19.812

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>21. FORMALDEHYDE <math>H_2CO</math> (g)</b>							
298.15	35.387	218.760	218.760	0.000	-108.700	-102.667	17.987
300	35.443	218.979	218.761	0.066	-108.731	-102.630	17.869
400	39.240	229.665	220.192	3.789	-110.438	-100.340	13.103
500	43.736	238.900	223.028	7.936	-112.073	-97.623	10.198
600	48.181	247.270	226.381	12.534	-113.545	-94.592	8.235
700	52.280	255.011	229.924	17.560	-114.833	-91.328	6.815
800	55.941	262.236	233.517	22.975	-115.942	-87.893	5.739
900	59.156	269.014	237.088	28.734	-116.889	-84.328	4.894
1000	61.951	275.395	240.603	34.792	-117.696	-80.666	4.213
1100	64.368	281.416	244.042	41.111	-118.382	-76.929	3.653
1200	66.453	287.108	247.396	47.655	-118.966	-73.134	3.183
1300	68.251	292.500	250.660	54.392	-119.463	-69.294	2.784
1400	69.803	297.616	253.833	61.297	-119.887	-65.418	2.441
1500	71.146	302.479	256.915	68.346	-120.249	-61.514	2.142
<b>22. METHANOL <math>CH_3OH</math> (g)</b>							
298.15	44.101	239.865	239.865	0.000	-201.000	-162.298	28.434
300	44.219	240.139	239.866	0.082	-201.068	-162.057	28.216
400	51.713	253.845	241.685	4.864	-204.622	-148.509	19.393
500	59.800	266.257	245.374	10.442	-207.750	-134.109	14.010
600	67.294	277.835	249.830	16.803	-210.387	-119.125	10.371
700	73.958	288.719	254.616	23.873	-212.570	-103.737	7.741
800	79.838	298.987	259.526	31.569	-214.350	-88.063	5.750
900	85.025	308.696	264.455	39.817	-215.782	-72.188	4.190
1000	89.597	317.896	269.343	48.553	-216.916	-56.170	2.934
1100	93.624	326.629	274.158	57.718	-217.794	-40.050	1.902
1200	97.165	334.930	278.879	67.262	-218.457	-23.861	1.039
1300	100.277	342.833	283.497	77.137	-218.936	-7.624	0.306
1400	103.014	350.367	288.007	87.304	-219.261	8.644	-0.322
1500	105.422	357.558	292.405	97.729	-219.456	24.930	-0.868
<b>23. ACETALDEHYDE <math>C_2H_4O</math> (g)</b>							
298.15	55.318	263.840	263.840	0.000	-166.190	-133.010	23.302
300	55.510	264.180	263.837	0.103	-166.250	-132.800	23.122
400	66.282	281.620	266.147	6.189	-169.530	-121.130	15.818
500	76.675	297.540	270.850	13.345	-172.420	-108.700	11.356
600	85.942	312.360	276.550	21.486	-174.870	-95.720	8.334
700	94.035	326.230	282.667	30.494	-176.910	-82.350	6.145
800	101.070	339.260	288.938	40.258	-178.570	-68.730	4.487
900	107.190	351.520	295.189	50.698	-179.880	-54.920	3.187
1000	112.490	363.100	301.431	61.669	-180.850	-40.930	2.138
1100	117.080	374.040	307.537	73.153	-181.560	-27.010	1.283
1200	121.060	384.400	313.512	85.065	-182.070	-12.860	0.560
1300	124.500	394.230	319.350	97.344	-182.420	1.240	-0.050
1400	127.490	403.570	325.031	109.954	-182.640	15.470	-0.577
1500	130.090	412.460	330.571	122.834	-182.750	29.580	-1.030
<b>24. ETHANOL <math>C_2H_5OH</math> (g)</b>							
298.15	65.652	281.622	281.622	0.000	-234.800	-167.874	29.410
300	65.926	282.029	281.623	0.122	-234.897	-167.458	29.157
400	81.169	303.076	284.390	7.474	-239.826	-144.216	18.832
500	95.400	322.750	290.115	16.318	-243.940	-119.820	12.517
600	107.656	341.257	297.112	26.487	-247.260	-94.672	8.242
700	118.129	358.659	304.674	37.790	-249.895	-69.023	5.151
800	127.171	375.038	312.456	50.065	-251.951	-43.038	2.810
900	135.049	390.482	320.276	63.185	-253.515	-16.825	0.976
1000	141.934	405.075	328.033	77.042	-254.662	9.539	-0.498
1100	147.958	418.892	335.670	91.543	-255.454	36.000	-1.709
1200	153.232	431.997	343.156	106.609	-255.947	62.520	-2.721

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
1300	157.849	444.448	350.473	122.168	-256.184	89.070	-3.579
1400	161.896	456.298	357.612	138.160	-256.206	115.630	-4.314
1500	165.447	467.591	364.571	154.531	-256.044	142.185	-4.951
<b>25. ACETIC ACID <math>C_2H_4O_2</math> (g)</b>							
298.15	63.438	283.470	283.470	0.000	-432.249	-374.254	65.567
300	63.739	283.863	283.471	0.118	-432.324	-373.893	65.100
400	79.665	304.404	286.164	7.296	-436.006	-353.840	46.206
500	93.926	323.751	291.765	15.993	-438.875	-332.950	34.783
600	106.181	341.988	298.631	26.014	-440.993	-311.554	27.123
700	116.627	359.162	306.064	37.169	-442.466	-289.856	21.629
800	125.501	375.331	313.722	49.287	-443.395	-267.985	17.497
900	132.989	390.558	321.422	62.223	-443.873	-246.026	14.279
1000	139.257	404.904	329.060	75.844	-443.982	-224.034	11.702
1100	144.462	418.429	336.576	90.039	-443.798	-202.046	9.594
1200	148.760	431.189	343.933	104.707	-443.385	-180.086	7.839
1300	152.302	443.240	351.113	119.765	-442.795	-158.167	6.355
1400	155.220	454.637	358.105	135.146	-442.071	-136.299	5.085
1500	157.631	465.432	364.903	150.793	-441.247	-114.486	3.987
<b>26. ACETONE <math>C_3H_6O</math> (g)</b>							
298.15	74.517	295.349	295.349	0.000	-217.150	-152.716	26.757
300	74.810	295.809	295.349	0.138	-217.233	-152.339	26.521
400	91.755	319.658	298.498	8.464	-222.212	-129.913	16.962
500	107.864	341.916	304.988	18.464	-226.522	-106.315	11.107
600	122.047	362.836	312.873	29.978	-230.120	-81.923	7.133
700	134.306	382.627	321.470	42.810	-233.049	-56.986	4.252
800	144.934	401.246	330.265	56.785	-235.350	-31.673	2.068
900	154.097	418.860	339.141	71.747	-237.149	-6.109	0.353
1000	162.046	435.513	347.950	87.563	-238.404	19.707	-1.030
1100	168.908	451.286	356.617	104.136	-239.283	45.396	-2.157
1200	174.891	466.265	365.155	121.332	-239.827	71.463	-3.110
1300	180.079	480.491	373.513	139.072	-240.120	97.362	-3.912
1400	184.556	493.963	381.596	157.314	-240.203	123.470	-4.607
1500	188.447	506.850	389.533	175.975	-240.120	149.369	-5.202
<b>27. PHENOL <math>C_6H_6O</math> (g)</b>							
298.15	103.220	314.810	314.810	0.000	-96.400	-32.630	5.720
300	103.860	315.450	314.810	0.192	-96.490	-32.230	5.610
400	135.790	349.820	319.278	12.217	-100.870	-10.180	1.330
500	161.910	383.040	328.736	27.152	-104.240	12.970	-1.360
600	182.480	414.450	340.430	44.412	-106.810	36.650	-3.190
700	198.840	443.860	353.134	63.508	-108.800	60.750	-4.530
800	212.140	471.310	366.211	84.079	-110.300	85.020	-5.550
900	223.190	496.950	379.327	105.861	-111.370	109.590	-6.360
1000	232.490	520.960	392.302	128.658	-111.990	134.280	-7.010
1100	240.410	543.500	405.033	152.314	-112.280	158.620	-7.530
1200	247.200	564.720	417.468	176.703	-112.390	183.350	-7.980
1300	253.060	584.740	429.568	201.723	-112.330	208.070	-8.360
1400	258.120	603.680	441.331	227.288	-112.120	233.050	-8.700
1500	262.520	621.650	452.767	253.325	-111.780	257.540	-8.970
<b>28. CARBON TETRAFLUORIDE <math>CF_4</math> (g)</b>							
298.15	61.050	261.455	261.455	0.000	-933.200	-888.518	155.663
300	61.284	261.833	261.456	0.113	-933.219	-888.240	154.654
400	72.399	281.057	264.001	6.822	-933.986	-873.120	114.016
500	80.713	298.153	269.155	14.499	-934.372	-857.852	89.618
600	86.783	313.434	275.284	22.890	-934.490	-842.533	73.348
700	91.212	327.162	281.732	31.801	-934.431	-827.210	61.726
800	94.479	339.566	288.199	41.094	-934.261	-811.903	53.011
900	96.929	350.842	294.542	50.670	-934.024	-796.622	46.234

<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	−( <i>G</i> <sup>o</sup> − <i>H</i> <sup>o</sup> ( <i>T<sub>i</sub></i> ))/ <i>T</i>	<i>H</i> <sup>o</sup> − <i>H</i> <sup>o</sup> ( <i>T<sub>i</sub></i> )	Δ <sub><i>f</i></sub> <i>H</i> <sup>o</sup>	Δ <sub><i>f</i></sub> <i>G</i> <sup>o</sup>	
1000	98.798	361.156	300.695	60.460	−933.745	−781.369	40.814
1100	100.250	370.643	306.629	70.416	−933.442	−766.146	36.381
1200	101.396	379.417	312.334	80.500	−933.125	−750.952	32.688
1300	102.314	387.571	317.811	90.687	−932.800	−735.784	29.564
1400	103.059	395.181	323.069	100.957	−932.470	−720.641	26.887
1500	103.671	402.313	328.116	111.295	−932.137	−705.522	24.568
<b>29. TRIFLUOROMETHANE CH<sub>3</sub>F<sub>3</sub> (g)</b>							
298.15	51.069	259.675	259.675	0.000	−696.700	−662.237	116.020
300	51.258	259.991	259.676	0.095	−696.735	−662.023	115.267
400	61.148	276.113	261.807	5.722	−698.427	−650.186	84.905
500	69.631	290.700	266.149	12.275	−699.715	−637.969	66.647
600	76.453	304.022	271.368	19.593	−700.634	−625.528	54.456
700	81.868	316.230	276.917	27.519	−701.253	−612.957	45.739
800	86.201	327.455	282.542	35.930	−701.636	−600.315	39.196
900	89.719	337.818	288.116	44.732	−701.832	−587.636	34.105
1000	92.617	347.426	293.572	53.854	−701.879	−574.944	30.032
1100	95.038	356.370	298.879	63.240	−701.805	−562.253	26.699
1200	97.084	364.730	304.022	72.849	−701.629	−549.574	23.922
1300	98.833	372.571	308.997	82.647	−701.368	−536.913	21.573
1400	100.344	379.952	313.804	92.607	−701.033	−524.274	19.561
1500	101.660	386.921	318.449	102.709	−700.635	−511.662	17.817
<b>30. CHLOROTRIFLUOROMETHANE CClF<sub>3</sub> (g)</b>							
298.15	66.886	285.419	285.419	0.000	−707.800	−667.238	116.896
300	67.111	285.834	285.421	0.124	−707.810	−666.986	116.131
400	77.528	306.646	288.187	7.383	−708.153	−653.316	85.313
500	85.013	324.797	293.734	15.532	−708.170	−639.599	66.818
600	90.329	340.794	300.271	24.314	−707.975	−625.901	54.489
700	94.132	355.020	307.096	33.547	−707.654	−612.246	45.686
800	96.899	367.780	313.897	43.106	−707.264	−598.642	39.087
900	98.951	379.317	320.536	52.903	−706.837	−585.090	33.957
1000	100.507	389.827	326.947	62.880	−706.396	−571.586	29.856
1100	101.708	399.465	333.108	72.993	−705.950	−558.126	26.503
1200	102.651	408.357	339.013	83.213	−705.505	−544.707	23.710
1300	103.404	416.604	344.668	93.517	−705.064	−531.326	21.349
1400	104.012	424.290	350.084	103.889	−704.628	−517.977	19.326
1500	104.512	431.484	355.273	114.316	−704.196	−504.660	17.574
<b>31. DICHLORODIFLUOROMETHANE CCl<sub>2</sub>F<sub>2</sub> (g)</b>							
298.15	72.476	300.903	300.903	0.000	−486.000	−447.030	78.317
300	72.691	301.352	300.905	0.134	−486.002	−446.788	77.792
400	82.408	323.682	303.883	7.919	−485.945	−433.716	56.637
500	89.063	342.833	309.804	16.514	−485.618	−420.692	43.949
600	93.635	359.500	316.729	25.663	−485.136	−407.751	35.497
700	96.832	374.189	323.909	35.196	−484.576	−394.897	29.467
800	99.121	387.276	331.027	44.999	−483.984	−382.126	24.950
900	100.801	399.053	337.942	55.000	−483.388	−369.429	21.441
1000	102.062	409.742	344.596	65.146	−482.800	−356.799	18.637
1100	103.030	419.517	350.969	75.402	−482.226	−344.227	16.346
1200	103.786	428.515	357.061	85.745	−481.667	−331.706	14.439
1300	104.388	436.847	362.882	96.154	−481.121	−319.232	12.827
1400	104.874	444.602	368.445	106.618	−480.588	−306.799	11.447
1500	105.270	451.851	373.767	117.126	−480.065	−294.404	10.252
<b>32. CHLORODIFLUOROMETHANE CHClF<sub>2</sub> (g)</b>							
298.15	55.853	280.915	280.915	0.000	−475.000	−443.845	77.759
300	56.039	281.261	280.916	0.104	−475.028	−443.652	77.246
400	65.395	298.701	283.231	6.188	−476.390	−432.978	56.540
500	73.008	314.145	287.898	13.123	−477.398	−422.001	44.086
600	78.940	328.003	293.448	20.733	−478.103	−410.851	35.767

<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	$-(G^o-H^o(T_f))/T$	<i>H</i> <sup>o</sup> - <i>H</i> <sup>o</sup> ( <i>T<sub>f</sub></i> )	$\Delta_f H^o$	$\Delta_f G^o$	
700	83.551	340.533	299.294	28.867	-478.574	-399.603	29.818
800	87.185	351.936	305.172	37.411	-478.870	-388.299	25.353
900	90.100	362.379	310.956	46.280	-479.031	-376.967	21.878
1000	92.475	371.999	316.586	55.413	-479.090	-365.622	19.098
1100	94.433	380.908	322.033	64.761	-479.068	-354.276	16.823
1200	96.066	389.196	327.289	74.289	-478.982	-342.935	14.927
1300	97.438	396.941	332.352	83.966	-478.843	-331.603	13.324
1400	98.601	404.206	337.228	93.769	-478.661	-320.283	11.950
1500	99.593	411.044	341.923	103.681	-478.443	-308.978	10.759
<b>33. METHYLAMINE CH<sub>5</sub>N (g)</b>							
298.15	50.053	242.881	242.881	0.000	-22.529	32.734	-5.735
300	50.227	243.196	242.893	0.091	-22.614	33.077	-5.759
400	60.171	258.986	244.975	5.604	-26.846	52.294	-6.829
500	70.057	273.486	249.244	12.121	-30.431	72.510	-7.575
600	78.929	287.063	254.431	19.579	-33.364	93.382	-8.129
700	86.711	299.826	260.008	27.873	-35.712	114.702	-8.559
800	93.545	311.865	265.749	36.893	-37.548	136.316	-8.900
900	99.573	323.239	271.511	46.555	-38.949	158.138	-9.178
1000	104.886	334.006	277.220	56.786	-39.967	180.098	-9.407
1100	109.576	344.233	282.861	67.509	-40.681	201.822	-9.584
1200	113.708	353.944	288.374	78.685	-41.136	224.240	-9.761
1300	117.341	363.190	293.775	90.239	-41.376	246.364	-9.899
1400	120.542	372.012	299.061	102.131	-41.451	268.504	-10.018
1500	123.353	380.426	304.209	114.326	-41.381	290.639	-10.121
<b>34. CHLORINE Cl (g)</b>							
298.15	21.838	165.190	165.190	0.000	121.302	105.306	-18.449
300	21.852	165.325	165.190	0.040	121.311	105.207	-18.318
400	22.467	171.703	166.055	2.259	121.795	99.766	-13.028
500	22.744	176.752	167.708	4.522	122.272	94.203	-9.841
600	22.781	180.905	169.571	6.800	122.734	88.546	-7.709
700	22.692	184.411	171.448	9.074	123.172	82.813	-6.179
800	22.549	187.432	173.261	11.337	123.585	77.019	-5.029
900	22.389	190.079	174.986	13.584	123.971	71.175	-4.131
1000	22.233	192.430	176.615	15.815	124.334	65.289	-3.410
1100	22.089	194.542	178.150	18.031	124.675	59.368	-2.819
1200	21.959	196.458	179.597	20.233	124.996	53.416	-2.325
1300	21.843	198.211	180.963	22.423	125.299	47.439	-1.906
1400	21.742	199.826	182.253	24.602	125.587	41.439	-1.546
1500	21.652	201.323	183.475	26.772	125.861	35.418	-1.233
<b>35. DICHLORINE Cl<sub>2</sub> (g)</b>							
298.15	33.949	223.079	223.079	0.000	0.000	0.000	0.000
300	33.981	223.290	223.080	0.063	0.000	0.000	0.000
400	35.296	233.263	224.431	3.533	0.000	0.000	0.000
500	36.064	241.229	227.021	7.104	0.000	0.000	0.000
600	36.547	247.850	229.956	10.736	0.000	0.000	0.000
700	36.874	253.510	232.926	14.408	0.000	0.000	0.000
800	37.111	258.450	235.815	18.108	0.000	0.000	0.000
900	37.294	262.832	238.578	21.829	0.000	0.000	0.000
1000	37.442	266.769	241.203	25.566	0.000	0.000	0.000
1100	37.567	270.343	243.692	29.316	0.000	0.000	0.000
1200	37.678	273.617	246.052	33.079	0.000	0.000	0.000
1300	37.778	276.637	248.290	36.851	0.000	0.000	0.000
1400	37.872	279.440	250.416	40.634	0.000	0.000	0.000
1500	37.961	282.056	252.439	44.426	0.000	0.000	0.000
<b>36. HYDROGEN CHLORIDE HCl (g)</b>							
298.15	29.136	186.902	186.902	0.000	-92.310	-95.298	16.696
300	29.137	187.082	186.902	0.054	-92.314	-95.317	16.596



$T/K$	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
400	29.175	195.468	188.045	2.969	-92.587	-96.278	12.573
500	29.304	201.990	190.206	5.892	-92.911	-97.164	10.151
600	29.576	207.354	192.630	8.835	-93.249	-97.983	8.530
700	29.988	211.943	195.069	11.812	-93.577	-98.746	7.368
800	30.500	215.980	197.435	14.836	-93.879	-99.464	6.494
900	31.063	219.604	199.700	17.913	-94.149	-100.145	5.812
1000	31.639	222.907	201.858	21.049	-94.384	-100.798	5.265
1100	32.201	225.949	203.912	24.241	-94.587	-101.430	4.816
1200	32.734	228.774	205.867	27.488	-94.760	-102.044	4.442
1300	33.229	231.414	207.732	30.786	-94.908	-102.645	4.124
1400	33.684	233.893	209.513	34.132	-95.035	-103.235	3.852
1500	34.100	236.232	211.217	37.522	-95.146	-103.817	3.615
<b>37. COPPER Cu (cr, l)</b>							
298.15	24.440	33.150	33.150	0.000	0.000	0.000	0.000
300	24.460	33.301	33.150	0.045	0.000	0.000	0.000
400	25.339	40.467	34.122	2.538	0.000	0.000	0.000
500	25.966	46.192	35.982	5.105	0.000	0.000	0.000
600	26.479	50.973	38.093	7.728	0.000	0.000	0.000
700	26.953	55.090	40.234	10.399	0.000	0.000	0.000
800	27.448	58.721	42.322	13.119	0.000	0.000	0.000
900	28.014	61.986	44.328	15.891	0.000	0.000	0.000
1000	28.700	64.971	46.245	18.726	0.000	0.000	0.000
1100	29.553	67.745	48.075	21.637	0.000	0.000	0.000
1200	30.617	70.361	49.824	24.644	0.000	0.000	0.000
1300	31.940	72.862	51.501	27.769	0.000	0.000	0.000
1358	32.844	74.275	52.443	29.647	0.000	0.000	0.000
PHASE TRANSITION: $\Delta_{\text{trs}} H = 13.141$ kJ/mol, $\Delta_{\text{trs}} S = 9.676$ J/K mol, cr-l							
1358	32.800	83.951	52.443	42.788	0.000	0.000	0.000
1400	32.800	84.950	53.403	44.166	0.000	0.000	0.000
1500	32.800	87.213	55.583	47.446	0.000	0.000	0.000
<b>38. COPPER Cu (g)</b>							
298.15	20.786	166.397	166.397	0.000	337.600	297.873	-52.185
300	20.786	166.525	166.397	0.038	337.594	297.626	-51.821
400	20.786	172.505	167.213	2.117	337.179	284.364	-37.134
500	20.786	177.143	168.752	4.196	336.691	271.215	-28.333
600	20.786	180.933	170.476	6.274	336.147	258.170	-22.475
700	20.786	184.137	172.205	8.353	335.554	245.221	-18.298
800	20.786	186.913	173.874	10.431	334.913	232.359	-15.171
900	20.786	189.361	175.461	12.510	334.219	219.581	-12.744
1000	20.786	191.551	176.963	14.589	333.463	206.883	-10.806
1100	20.788	193.532	178.380	16.667	332.631	194.265	-9.225
1200	20.793	195.341	179.719	18.746	331.703	181.726	-7.910
1300	20.803	197.006	180.986	20.826	330.657	169.270	-6.801
1400	20.823	198.548	182.186	22.907	316.342	157.305	-5.869
1500	20.856	199.986	183.325	24.991	315.146	145.987	-5.084
<b>39. COPPER OXIDE CuO (cr)</b>							
298.15	42.300	42.740	42.740	0.000	-162.000	-134.277	23.524
300	42.417	43.002	42.741	0.078	-161.994	-134.105	23.349
400	46.783	55.878	44.467	4.564	-161.487	-124.876	16.307
500	49.190	66.596	47.852	9.372	-160.775	-115.803	12.098
600	50.827	75.717	51.755	14.377	-159.973	-106.883	9.305
700	52.099	83.651	55.757	19.526	-159.124	-98.102	7.320
800	53.178	90.680	59.691	24.791	-158.247	-89.444	5.840
900	54.144	97.000	63.491	30.158	-157.356	-80.897	4.695
1000	55.040	102.751	67.134	35.617	-156.462	-72.450	3.784
1100	55.890	108.037	70.615	41.164	-155.582	-64.091	3.043
1200	56.709	112.936	73.941	46.794	-154.733	-55.812	2.429

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
1300	57.507	117.507	77.118	52.505	-153.940	-47.601	1.913
1400	58.288	121.797	80.158	58.295	-166.354	-39.043	1.457
1500	59.057	125.845	83.070	64.163	-165.589	-29.975	1.044
<b>40. DICOPPER OXIDE <math>\text{Cu}_2\text{O}</math> (cr)</b>							
298.15	62.600	92.550	92.550	0.000	-173.100	-150.344	26.339
300	62.721	92.938	92.551	0.116	-173.102	-150.203	26.152
400	67.587	111.712	95.078	6.654	-173.036	-142.572	18.618
500	70.784	127.155	99.995	13.580	-172.772	-134.984	14.101
600	73.323	140.291	105.643	20.789	-172.389	-127.460	11.096
700	75.552	151.764	111.429	28.235	-171.914	-120.009	8.955
800	77.616	161.989	117.121	35.894	-171.363	-112.631	7.354
900	79.584	171.245	122.629	43.755	-170.750	-105.325	6.113
1000	81.492	179.729	127.920	51.809	-170.097	-98.091	5.124
1100	83.360	187.584	132.992	60.052	-169.431	-90.922	4.317
1200	85.202	194.917	137.850	68.480	-168.791	-83.814	3.648
1300	87.026	201.808	142.507	77.092	-168.223	-76.756	3.084
1400	88.836	208.324	146.978	85.885	-194.030	-68.926	2.572
1500	90.636	214.515	151.276	94.858	-193.438	-60.010	2.090
<b>41. COPPER DICHLORIDE <math>\text{CuCl}_2</math> (cr, l)</b>							
298.15	71.880	108.070	108.070	0.000	-218.000	-173.826	30.453
300	71.998	108.515	108.071	0.133	-217.975	-173.552	30.218
400	76.338	129.899	110.957	7.577	-216.494	-158.962	20.758
500	78.654	147.204	116.532	15.336	-214.873	-144.765	15.123
600	80.175	161.687	122.884	23.282	-213.182	-130.901	11.396
675	81.056	171.183	127.732	29.329	-211.185	-120.693	9.340
PHASE TRANSITION: $\Delta_{\text{trs}} H = 0.700$ kJ/mol, $\Delta_{\text{trs}} S = 1.037$ J/K mol, crII-crI							
675	82.400	172.220	127.732	30.029	-211.185	-120.693	9.340
700	82.400	175.216	129.375	32.089	-210.719	-117.350	8.757
800	82.400	186.219	135.808	40.329	-208.898	-104.137	6.799
871	82.400	193.226	140.207	46.179	-192.649	-94.893	5.691
PHASE TRANSITION: $\Delta_{\text{trs}} H = 15.001$ kJ/mol, $\Delta_{\text{trs}} S = 17.221$ J/K mol, crI-l							
871	100.000	210.447	140.207	61.180	-192.649	-94.893	5.691
900	100.000	213.723	142.523	64.080	-191.640	-91.655	5.319
1000	100.000	224.259	150.179	74.080	-188.212	-80.730	4.217
1100	100.000	233.790	157.353	84.080	-184.873	-70.144	3.331
1130.75	100.000	236.547	159.470	87.155	-183.867	-66.951	3.093
<b>42. COPPER DICHLORIDE <math>\text{CuCl}_2</math> (g)</b>							
298.15	56.814	278.418	278.418	0.000	-43.268	-49.883	8.739
300	56.869	278.769	278.419	0.105	-43.271	-49.924	8.692
400	58.992	295.456	280.679	5.911	-43.428	-52.119	6.806
500	60.111	308.752	285.010	11.871	-43.606	-54.271	5.670
600	60.761	319.774	289.911	17.918	-43.814	-56.385	4.909
700	61.168	329.173	294.865	24.015	-44.060	-58.462	4.362
800	61.439	337.360	299.677	30.147	-44.349	-60.500	3.950
900	61.630	344.608	304.274	36.301	-44.688	-62.499	3.627
1000	61.776	351.109	308.638	42.471	-45.088	-64.457	3.367
1100	61.900	357.003	312.771	48.655	-45.566	-66.372	3.152
1200	62.022	362.394	316.685	54.851	-46.139	-68.239	2.970
1300	62.159	367.364	320.395	61.060	-46.829	-70.053	2.815
1400	62.325	371.976	323.916	67.284	-60.784	-71.404	2.664
1500	62.531	376.283	327.265	73.526	-61.613	-72.133	2.512
<b>43. FLUORINE <math>\text{F}</math> (g)</b>							
298.15	22.746	158.750	158.750	0.000	79.380	62.280	-10.911
300	22.742	158.891	158.750	0.042	79.393	62.173	-10.825
400	22.432	165.394	159.639	2.302	80.043	56.332	-7.356
500	22.100	170.363	161.307	4.528	80.587	50.340	-5.259

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
600	21.832	174.368	163.161	6.724	81.046	44.246	-3.852
700	21.629	177.717	165.008	8.897	81.442	38.081	-2.842
800	21.475	180.595	166.780	11.052	81.792	31.862	-2.080
900	21.357	183.117	168.458	13.193	82.106	25.601	-1.486
1000	21.266	185.362	170.039	15.324	82.391	19.308	-1.009
1100	21.194	187.386	171.525	17.447	82.654	12.986	-0.617
1200	21.137	189.227	172.925	19.563	82.897	6.642	-0.289
1300	21.091	190.917	174.245	21.675	83.123	0.278	-0.011
1400	21.054	192.479	175.492	23.782	83.335	-6.103	0.228
1500	21.022	193.930	176.673	25.886	83.533	-12.498	0.435
<b>44. DIFLUORINE F<sub>2</sub> (g)</b>							
298.15	31.304	202.790	202.790	0.000	0.000	0.000	0.000
300	31.337	202.984	202.790	0.058	0.000	0.000	0.000
400	32.995	212.233	204.040	3.277	0.000	0.000	0.000
500	34.258	219.739	206.453	6.643	0.000	0.000	0.000
600	35.171	226.070	209.208	10.117	0.000	0.000	0.000
700	35.839	231.545	212.017	13.669	0.000	0.000	0.000
800	36.343	236.365	214.765	17.279	0.000	0.000	0.000
900	36.740	240.669	217.409	20.934	0.000	0.000	0.000
1000	37.065	244.557	219.932	24.625	0.000	0.000	0.000
1100	37.342	248.103	222.334	28.346	0.000	0.000	0.000
1200	37.588	251.363	224.619	32.093	0.000	0.000	0.000
1300	37.811	254.381	226.794	35.863	0.000	0.000	0.000
1400	38.019	257.191	228.866	39.654	0.000	0.000	0.000
1500	38.214	259.820	230.843	43.466	0.000	0.000	0.000
<b>45. HYDROGEN FLUORIDE HF (g)</b>							
298.15	29.137	173.776	173.776	0.000	-273.300	-275.399	48.248
300	29.137	173.956	173.776	0.054	-273.302	-275.412	47.953
400	29.149	182.340	174.919	2.968	-273.450	-276.096	36.054
500	29.172	188.846	177.078	5.884	-273.679	-276.733	28.910
600	29.230	194.169	179.496	8.804	-273.961	-277.318	24.142
700	29.350	198.683	181.923	11.732	-274.277	-277.852	20.733
800	29.549	202.614	184.269	14.676	-274.614	-278.340	18.174
900	29.827	206.110	186.505	17.645	-274.961	-278.785	16.180
1000	30.169	209.270	188.626	20.644	-275.309	-279.191	14.583
1100	30.558	212.163	190.636	23.680	-275.652	-279.563	13.275
1200	30.974	214.840	192.543	26.756	-275.988	-279.904	12.184
1300	31.403	217.336	194.355	29.875	-276.315	-280.217	11.259
1400	31.831	219.679	196.081	33.037	-276.631	-280.505	10.466
1500	32.250	221.889	197.729	36.241	-276.937	-280.771	9.777
<b>46. GERMANIUM Ge (cr, l)</b>							
298.15	23.222	31.090	31.090	0.000	0.000	0.000	0.000
300	23.249	31.234	31.090	0.043	0.000	0.000	0.000
400	24.310	38.083	32.017	2.426	0.000	0.000	0.000
500	24.962	43.582	33.798	4.892	0.000	0.000	0.000
600	25.452	48.178	35.822	7.414	0.000	0.000	0.000
700	25.867	52.133	37.876	9.980	0.000	0.000	0.000
800	26.240	55.612	39.880	12.586	0.000	0.000	0.000
900	26.591	58.723	41.804	15.227	0.000	0.000	0.000
1000	26.926	61.542	43.639	17.903	0.000	0.000	0.000
1100	27.252	64.124	45.386	20.612	0.000	0.000	0.000
1200	27.571	66.509	47.048	23.353	0.000	0.000	0.000
1211.4	27.608	66.770	47.232	23.668	0.000	0.000	0.000
<b>PHASE TRANSITION: <math>\Delta_{\text{trs}} H = 37.030</math> kJ/mol, <math>\Delta_{\text{trs}} S = 30.568</math> J/Kmol, cr-l</b>							
1211.4	27.600	97.338	47.232	60.698	0.000	0.000	0.000
1300	27.600	99.286	50.714	63.143	0.000	0.000	0.000
1400	27.600	101.331	54.258	65.903	0.000	0.000	0.000
1500	27.600	103.236	57.460	68.663	0.000	0.000	0.000

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>47. GERMANIUM Ge (g)</b>							
298.15	30.733	167.903	167.903	0.000	367.800	327.009	-57.290
300	30.757	168.094	167.904	0.057	367.814	326.756	-56.893
400	31.071	177.025	169.119	3.162	368.536	312.959	-40.868
500	30.360	183.893	171.415	6.239	369.147	298.991	-31.235
600	29.265	189.334	173.965	9.222	369.608	284.914	-24.804
700	28.102	193.758	176.487	12.090	369.910	270.773	-20.205
800	27.029	197.439	178.882	14.845	370.060	256.598	-16.754
900	26.108	200.567	181.122	17.501	370.073	242.414	-14.069
1000	25.349	203.277	183.205	20.072	369.969	228.234	-11.922
1100	24.741	205.664	185.141	22.575	369.763	214.069	-10.165
1200	24.264	207.795	186.941	25.025	369.471	199.928	-8.703
1300	23.898	209.722	188.621	27.432	332.088	188.521	-7.575
1400	23.624	211.483	190.192	29.807	331.704	177.492	-6.622
1500	23.426	213.105	191.666	32.159	331.296	166.491	-5.798
<b>48. GERMANIUM DIOXIDE GeO<sub>2</sub> (cr, l)</b>							
298.15	50.166	39.710	39.710	0.000	-580.200	-521.605	91.382
300	50.475	40.021	39.711	0.093	-580.204	-521.242	90.755
400	61.281	56.248	41.850	5.759	-579.893	-501.610	65.503
500	66.273	70.519	46.191	12.164	-579.013	-482.134	50.368
600	69.089	82.872	51.299	18.943	-577.915	-462.859	40.295
700	70.974	93.671	56.597	25.952	-576.729	-443.776	33.115
800	72.449	103.247	61.841	33.125	-575.498	-424.866	27.741
900	73.764	111.857	66.928	40.436	-574.235	-406.113	23.570
1000	75.049	119.696	71.819	47.877	-572.934	-387.502	20.241
1100	76.378	126.910	76.504	55.447	-571.582	-369.024	17.523
1200	77.796	133.616	80.987	63.155	-570.166	-350.671	15.264
1300	79.332	139.903	85.279	71.010	-605.685	-329.732	13.249
1308	79.460	140.390	85.615	71.646	-584.059	-328.034	13.100
PHASE TRANSITION: $\Delta_{\text{trs}} H = 21.500$ kJ/mol, $\Delta_{\text{trs}} S = 16.437$ J/Kmol, crII-crI							
1308	80.075	156.827	85.615	93.146	-584.059	-328.034	13.100
1388	81.297	161.617	89.858	99.601	-565.504	-312.415	11.757
PHASE TRANSITION: $\Delta_{\text{trs}} H = 17.200$ kJ/mol, $\Delta_{\text{trs}} S = 12.392$ J/Kmol, crI-l							
1388	78.500	174.009	89.858	116.801	-565.504	-312.415	11.757
1400	78.500	174.685	90.582	117.743	-565.328	-310.228	11.575
1500	78.500	180.100	96.372	125.593	-563.882	-292.057	10.170
<b>49. GERMANIUM TETRACHLORIDE GeCl<sub>4</sub> (g)</b>							
298.15	95.918	348.393	348.393	0.000	-500.000	-461.582	80.866
300	96.041	348.987	348.395	0.178	-499.991	-461.343	80.326
400	100.750	377.342	352.229	10.045	-499.447	-448.540	58.573
500	103.206	400.114	359.604	20.255	-498.845	-435.882	45.536
600	104.624	419.067	367.980	30.652	-498.234	-423.347	36.855
700	105.509	435.266	376.463	41.162	-497.634	-410.914	30.662
800	106.096	449.396	384.715	51.744	-497.057	-398.565	26.023
900	106.504	461.917	392.611	62.375	-496.509	-386.287	22.419
1000	106.799	473.155	400.113	73.041	-495.993	-374.068	19.539
1100	107.020	483.344	407.224	83.733	-495.512	-361.899	17.185
1200	107.189	492.664	413.961	94.444	-495.067	-349.772	15.225
1300	107.320	501.249	420.349	105.169	-531.677	-334.973	13.459
1400	107.425	509.206	426.416	115.907	-531.265	-319.857	11.934
1500	107.509	516.621	432.185	126.654	-530.861	-304.771	10.613
<b>50. HYDROGEN H (g)</b>							
298.15	20.786	114.716	114.716	0.000	217.998	203.276	-35.613
300	20.786	114.845	114.716	0.038	218.010	203.185	-35.377
400	20.786	120.824	115.532	2.117	218.635	198.149	-25.875
500	20.786	125.463	117.071	4.196	219.253	192.956	-20.158

<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	−( <i>G</i> <sup>o</sup> − <i>H</i> <sup>o</sup> ( <i>T<sub>i</sub></i> ))/ <i>T</i>	<i>H</i> <sup>o</sup> − <i>H</i> <sup>o</sup> ( <i>T<sub>i</sub></i> )	Δ <sub><i>f</i></sub> <i>H</i> <sup>o</sup>	Δ <sub><i>f</i></sub> <i>G</i> <sup>o</sup>	
600	20.786	129.252	118.795	6.274	219.867	187.639	−16.335
700	20.786	132.457	120.524	8.353	220.476	182.219	−13.597
800	20.786	135.232	122.193	10.431	221.079	176.712	−11.538
900	20.786	137.680	123.780	12.510	221.670	171.131	−9.932
1000	20.786	139.870	125.282	14.589	222.247	165.485	−8.644
1100	20.786	141.852	126.700	16.667	222.806	159.781	−7.587
1200	20.786	143.660	128.039	18.746	223.345	154.028	−6.705
1300	20.786	145.324	129.305	20.824	223.864	148.230	−5.956
1400	20.786	146.864	130.505	22.903	224.360	142.393	−5.313
1500	20.786	148.298	131.644	24.982	224.835	136.522	−4.754
<b>51. DIHYDROGEN H<sub>2</sub> (g)</b>							
298.15	28.836	130.680	130.680	0.000	0.000	0.000	0.000
300	28.849	130.858	130.680	0.053	0.000	0.000	0.000
400	29.181	139.217	131.818	2.960	0.000	0.000	0.000
500	29.260	145.738	133.974	5.882	0.000	0.000	0.000
600	29.327	151.078	136.393	8.811	0.000	0.000	0.000
700	29.440	155.607	138.822	11.749	0.000	0.000	0.000
800	29.623	159.549	141.172	14.702	0.000	0.000	0.000
900	29.880	163.052	143.412	17.676	0.000	0.000	0.000
1000	30.204	166.217	145.537	20.680	0.000	0.000	0.000
1100	30.580	169.113	147.550	23.719	0.000	0.000	0.000
1200	30.991	171.791	149.460	26.797	0.000	0.000	0.000
1300	31.422	174.288	151.275	29.918	0.000	0.000	0.000
1400	31.860	176.633	153.003	33.082	0.000	0.000	0.000
1500	32.296	178.846	154.653	36.290	0.000	0.000	0.000
<b>52. HYDROXYL OH (g)</b>							
298.15	29.886	183.737	183.737	0.000	39.349	34.631	−6.067
300	29.879	183.922	183.738	0.055	39.350	34.602	−6.025
400	29.604	192.476	184.906	3.028	39.384	33.012	−4.311
500	29.495	199.067	187.104	5.982	39.347	31.422	−3.283
600	29.513	204.445	189.560	8.931	39.252	29.845	−2.598
700	29.655	209.003	192.020	11.888	39.113	28.287	−2.111
800	29.914	212.979	194.396	14.866	38.945	26.752	−1.747
900	30.265	216.522	196.661	17.874	38.763	25.239	−1.465
1000	30.682	219.731	198.810	20.921	38.577	23.746	−1.240
1100	31.135	222.677	200.848	24.012	38.393	22.272	−1.058
1200	31.603	225.406	202.782	27.149	38.215	20.814	−0.906
1300	32.069	227.954	204.621	30.332	38.046	19.371	−0.778
1400	32.522	230.347	206.374	33.562	37.886	17.941	−0.669
1500	32.956	232.606	208.048	36.836	37.735	16.521	−0.575
<b>53. WATER H<sub>2</sub>O (l)</b>							
298.15	75.300	69.950	69.950	0.000	−285.830	−237.141	41.546
300	75.281	70.416	69.951	0.139	−285.771	−236.839	41.237
373.21	76.079	86.896	71.715	5.666	−283.454	−225.160	31.513
<b>54. WATER H<sub>2</sub>O (g)</b>							
298.15	33.598	188.832	188.832	0.000	−241.826	−228.582	40.046
300	33.606	189.040	188.833	0.062	−241.844	−228.500	39.785
400	34.283	198.791	190.158	3.453	−242.845	−223.900	29.238
500	35.259	206.542	192.685	6.929	−243.822	−219.050	22.884
600	36.371	213.067	195.552	10.509	−244.751	−214.008	18.631
700	37.557	218.762	198.469	14.205	−245.620	−208.814	15.582
800	38.800	223.858	201.329	18.023	−246.424	−203.501	13.287
900	40.084	228.501	204.094	21.966	−247.158	−198.091	11.497
1000	41.385	232.792	206.752	26.040	−247.820	−192.603	10.060
1100	42.675	236.797	209.303	30.243	−248.410	−187.052	8.882
1200	43.932	240.565	211.753	34.574	−248.933	−181.450	7.898
1300	45.138	244.129	214.108	39.028	−249.392	−175.807	7.064

<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	$-(G^o-H^o(T_r))/T$	$H^o-H^o(T_r)$	$\Delta_f H^o$	$\Delta_f G^o$	
1400	46.281	247.516	216.374	43.599	-249.792	-170.132	6.348
1500	47.356	250.746	218.559	48.282	-250.139	-164.429	5.726
<b>55. IODINE I (g)</b>							
298.15	20.786	180.787	180.787	0.000	106.760	70.172	-12.294
300	20.786	180.915	180.787	0.038	106.748	69.945	-12.178
400	20.786	186.895	181.602	2.117	97.974	58.060	-7.582
500	20.786	191.533	183.142	4.196	75.988	50.202	-5.244
600	20.786	195.323	184.866	6.274	76.190	45.025	-3.920
700	20.786	198.527	186.594	8.353	76.385	39.816	-2.971
800	20.787	201.303	188.263	10.432	76.574	34.579	-2.258
900	20.789	203.751	189.851	12.510	76.757	29.319	-1.702
1000	20.795	205.942	191.352	14.589	76.936	24.038	-1.256
1100	20.806	207.924	192.770	16.669	77.109	18.740	-0.890
1200	20.824	209.735	194.110	18.751	77.277	13.426	-0.584
1300	20.851	211.403	195.377	20.835	77.440	8.098	-0.325
1400	20.889	212.950	196.577	22.921	77.596	2.758	-0.103
1500	20.936	214.392	197.717	25.013	77.745	-2.592	0.090
<b>56. DIIODINE I<sub>2</sub> (cr, l)</b>							
298.15	54.440	116.139	116.139	0.000	0.000	0.000	0.000
300	54.518	116.476	116.140	0.101	0.000	0.000	0.000
386.75	61.531	131.039	117.884	5.088	0.000	0.000	0.000
PHASE TRANSITION: $\Delta_{\text{trs}} H = 15.665$ kJ/mol, $\Delta_{\text{trs}} S = 40.504$ J/K mol, cr-l							
386.75	79.555	171.543	117.884	20.753	0.000	0.000	0.000
400	79.555	174.223	119.706	21.807	0.000	0.000	0.000
457.67	79.555	184.938	127.266	26.395	0.000	0.000	0.000
<b>57. DIIODINE I<sub>2</sub> (g)</b>							
298.15	36.887	260.685	260.685	0.000	62.420	19.324	-3.385
300	36.897	260.913	260.685	0.068	62.387	19.056	-3.318
400	37.256	271.584	262.138	3.778	44.391	5.447	-0.711
457.67	37.385	276.610	263.652	5.931		pressure = 1 bar	
500	37.464	279.921	264.891	7.515	0.000	0.000	0.000
600	37.613	286.765	267.983	11.269	0.000	0.000	0.000
700	37.735	292.573	271.092	15.037	0.000	0.000	0.000
800	37.847	297.619	274.099	18.816	0.000	0.000	0.000
900	37.956	302.083	276.965	22.606	0.000	0.000	0.000
1000	38.070	306.088	279.681	26.407	0.000	0.000	0.000
1100	38.196	309.722	282.249	30.220	0.000	0.000	0.000
1200	38.341	313.052	284.679	34.047	0.000	0.000	0.000
1300	38.514	316.127	286.981	37.890	0.000	0.000	0.000
1400	38.719	318.989	289.166	41.751	0.000	0.000	0.000
1500	38.959	321.668	291.245	45.635	0.000	0.000	0.000
<b>58. HYDROGEN IODIDE HI (g)</b>							
298.15	29.157	206.589	206.589	0.000	26.500	1.700	-0.298
300	29.158	206.769	206.589	0.054	26.477	1.546	-0.269
400	29.329	215.176	207.734	2.977	17.093	-6.289	0.821
500	29.738	221.760	209.904	5.928	-5.481	-9.946	1.039
600	30.351	227.233	212.348	8.931	-5.819	-10.806	0.941
700	31.070	231.965	214.820	12.002	-6.101	-11.614	0.867
800	31.807	236.162	217.230	15.145	-6.323	-12.386	0.809
900	32.511	239.950	219.548	18.362	-6.489	-13.133	0.762
1000	33.156	243.409	221.763	21.646	-6.608	-13.865	0.724
1100	33.735	246.597	223.878	24.991	-6.689	-14.586	0.693
1200	34.249	249.555	225.896	28.391	-6.741	-15.302	0.666
1300	34.703	252.314	227.823	31.839	-6.775	-16.014	0.643
1400	35.106	254.901	229.666	35.330	-6.797	-16.723	0.624
1500	35.463	257.336	231.430	38.858	-6.814	-17.432	0.607

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ-H^\circ(T_p))/T$	$H^\circ-H^\circ(T_p)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>59. POTASSIUM K (cr, l)</b>							
298.15	29.600	64.680	64.680	0.000	0.000	0.000	0.000
300	29.671	64.863	64.681	0.055	0.000	0.000	0.000
336.86	32.130	68.422	64.896	1.188	0.000	0.000	0.000
PHASE TRANSITION: $\Delta_{\text{trs}} H = 2.321$ kJ/mol, $\Delta_{\text{trs}} S = 6.891$ J/Kmol, cr-l							
336.86	32.129	75.313	64.896	3.509	0.000	0.000	0.000
400	31.552	80.784	66.986	5.519	0.000	0.000	0.000
500	30.741	87.734	70.469	8.632	0.000	0.000	0.000
600	30.158	93.283	73.824	11.675	0.000	0.000	0.000
700	29.851	97.905	76.943	14.673	0.000	0.000	0.000
800	29.838	101.887	79.818	17.655	0.000	0.000	0.000
900	30.130	105.415	82.470	20.651	0.000	0.000	0.000
1000	30.730	108.618	84.927	23.691	0.000	0.000	0.000
1039.4	31.053	109.812	85.847	24.908	0.000	0.000	0.000
<b>60. POTASSIUM K (g)</b>							
298.15	20.786	160.340	160.340	0.000	89.000	60.479	-10.596
300	20.786	160.468	160.340	0.038	88.984	60.302	-10.499
400	20.786	166.448	161.155	2.117	85.598	51.332	-6.703
500	20.786	171.086	162.695	4.196	84.563	42.887	-4.480
600	20.786	174.876	164.419	6.274	83.599	34.643	-3.016
700	20.786	178.080	166.148	8.353	82.680	26.557	-1.982
800	20.786	180.856	167.817	10.431	81.776	18.601	-1.215
900	20.786	183.304	169.404	12.510	80.859	10.759	-0.624
1000	20.786	185.494	170.905	14.589	79.897	3.021	-0.158
1039.4	20.786	186.297	171.474	15.408		pressure = 1 bar	
1100	20.786	187.475	172.323	16.667	0.000	0.000	0.000
1200	20.786	189.284	173.662	18.746	0.000	0.000	0.000
1300	20.789	190.948	174.929	20.825	0.000	0.000	0.000
1400	20.793	192.489	176.129	22.904	0.000	0.000	0.000
1500	20.801	193.923	177.268	24.983	0.000	0.000	0.000
<b>61. DIPOTASSIUM OXIDE K<sub>2</sub>O (cr, l)</b>							
298.15	72.000	96.000	96.000	0.000	-361.700	-321.171	56.267
300	72.130	96.446	96.001	0.133	-361.704	-320.920	55.876
400	79.154	118.158	98.914	7.698	-366.554	-306.416	40.013
500	86.178	136.575	104.647	15.964	-366.043	-291.423	30.444
590	92.500	151.348	110.662	24.005	-364.204	-278.079	24.619
PHASE TRANSITION: $\Delta_{\text{trs}} H = 0.700$ kJ/mol, $\Delta_{\text{trs}} S = 1.186$ J/Kmol, crIII-crII							
590	100.000	152.534	110.662	24.705	-364.204	-278.079	24.619
600	100.000	154.215	111.374	25.705	-363.968	-276.621	24.082
645	100.000	161.447	114.618	30.205	-358.901	-270.109	21.874
PHASE TRANSITION: $\Delta_{\text{trs}} H = 4.000$ kJ/mol, $\Delta_{\text{trs}} S = 6.202$ J/Kmol, crII-crI							
645	100.000	167.649	114.618	34.205	-358.901	-270.109	21.874
700	100.000	175.832	119.111	39.705	-357.592	-262.592	19.595
800	100.000	189.185	127.054	49.705	-355.224	-249.183	16.270
900	100.000	200.963	134.625	59.705	-352.919	-236.067	13.701
1000	100.000	211.499	141.794	69.705	-350.732	-223.202	11.659
1013	100.000	212.791	142.697	71.005	-323.459	-221.546	11.424
PHASE TRANSITION: $\Delta_{\text{trs}} H = 27.000$ kJ/mol, $\Delta_{\text{trs}} S = 26.654$ J/Kmol, crI-l							
1013	100.000	239.444	142.697	98.005	-323.459	-221.546	11.424
1100	100.000	247.684	150.679	106.705	-479.439	-203.633	9.670
1200	100.000	256.385	159.131	116.705	-475.371	-178.740	7.780
1300	100.000	264.389	166.924	126.705	-471.321	-154.185	6.195
1400	100.000	271.800	174.154	136.705	-467.287	-129.941	4.848
1500	100.000	278.699	180.896	146.705	-463.268	-105.986	3.691

T/K	J/Kmol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_r))/T$	$H^\circ - H^\circ(T_r)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>62. POTASSIUM HYDROXIDE KOH (cr, l)</b>							
298.15	64.900	78.870	78.870	0.000	-424.580	-378.747	66.354
300	65.038	79.272	78.871	0.120	-424.569	-378.463	65.895
400	72.519	99.007	81.512	6.998	-426.094	-362.765	47.372
500	80.000	115.993	86.745	14.624	-424.572	-347.093	36.260
520	81.496	119.159	87.931	16.239	-417.725	-344.002	34.555
PHASE TRANSITION: $\Delta_{\text{trs}} H = 6.450$ kJ/mol, $\Delta_{\text{trs}} S = 12.404$ J/Kmol, crII-crI							
520	79.000	131.563	87.931	22.689	-417.725	-344.002	34.555
600	79.000	142.868	94.520	29.009	-416.274	-332.766	28.969
678	79.000	152.523	100.649	35.171	-405.464	-321.998	24.807
PHASE TRANSITION: $\Delta_{\text{trs}} H = 9.400$ kJ/mol, $\Delta_{\text{trs}} S = 13.865$ J/Kmol, crI-l							
678	83.000	166.388	100.649	44.571	-405.464	-321.998	24.807
700	83.000	169.038	102.757	46.397	-404.981	-319.297	23.826
800	83.000	180.121	111.750	54.697	-402.808	-307.206	20.058
900	83.000	189.897	119.901	62.997	-400.694	-295.383	17.143
1000	83.000	198.642	127.345	71.297	-398.668	-283.791	14.824
1100	83.000	206.553	134.192	79.597	-475.618	-267.780	12.716
1200	83.000	213.775	140.527	87.897	-472.711	-249.014	10.839
1300	83.000	220.418	146.421	96.197	-469.843	-230.490	9.261
1400	83.000	226.569	151.929	104.497	-467.011	-212.184	7.917
1500	83.000	232.296	157.098	112.797	-464.217	-194.080	6.758
<b>63. POTASSIUM HYDROXIDE KOH (g)</b>							
298.15	49.184	238.283	238.283	0.000	-227.989	-229.685	40.239
300	49.236	238.588	238.284	0.091	-228.007	-229.696	39.993
400	51.178	253.053	240.243	5.124	-231.377	-229.667	29.991
500	52.178	264.591	243.998	10.296	-232.309	-229.129	23.937
600	52.804	274.163	248.251	15.547	-233.145	-228.413	19.885
700	53.296	282.340	252.551	20.853	-233.934	-227.562	16.981
800	53.758	289.487	256.730	26.206	-234.708	-226.599	14.795
900	54.229	295.846	260.730	31.605	-235.495	-225.538	13.090
1000	54.713	301.585	264.533	37.052	-236.322	-224.388	11.721
1100	55.203	306.823	268.143	42.548	-236.077	-218.535	10.377
1200	55.686	311.647	271.570	48.092	-315.925	-209.674	9.127
1300	56.153	316.122	274.827	53.684	-315.764	-200.826	8.069
1400	56.598	320.300	277.927	59.322	-315.595	-191.991	7.163
1500	57.016	324.220	280.884	65.003	-315.420	-183.169	6.378
<b>64. POTASSIUM CHLORIDE KCl (cr, l)</b>							
298.15	51.300	82.570	82.570	0.000	-436.490	-408.568	71.579
300	51.333	82.887	82.571	0.095	-436.481	-408.395	71.107
400	52.977	97.886	84.605	5.312	-438.463	-398.651	52.058
500	54.448	109.867	88.498	10.685	-437.990	-388.749	40.612
600	55.885	119.921	92.919	16.201	-437.332	-378.960	32.991
700	57.425	128.649	97.413	21.865	-436.502	-369.295	27.557
800	59.205	136.430	101.812	27.694	-435.505	-359.760	23.490
900	61.361	143.523	106.058	33.719	-434.337	-350.360	20.334
1000	64.032	150.121	110.138	39.983	-432.981	-341.100	17.817
1044	65.405	152.908	111.882	42.830	-485.450	-336.720	16.847
PHASE TRANSITION: $\Delta_{\text{trs}} H = 26.320$ kJ/mol, $\Delta_{\text{trs}} S = 25.210$ J/Kmol, cr-l							
1044	72.000	178.118	111.882	69.150	-485.450	-336.720	16.847
1100	72.000	181.880	115.351	73.182	-483.633	-328.790	15.613
1200	72.000	188.145	121.160	80.382	-480.393	-314.856	13.705
1300	72.000	193.908	126.537	87.582	-477.158	-301.192	12.102
1400	72.000	199.244	131.542	94.782	-473.928	-287.778	10.737
1500	72.000	204.211	136.223	101.982	-470.704	-274.594	9.562



T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
<b>65. POTASSIUM CHLORIDE KCl (g)</b>							
298.15	36.505	239.091	239.091	0.000	-214.575	-233.320	40.876
300	36.518	239.317	239.092	0.068	-214.594	-233.436	40.644
400	37.066	249.904	240.532	3.749	-218.112	-239.107	31.224
500	37.384	258.212	243.267	7.473	-219.287	-244.219	25.513
600	37.597	265.048	246.344	11.222	-220.396	-249.100	21.686
700	37.769	270.857	249.441	14.991	-221.461	-253.799	18.938
800	37.907	275.910	252.441	18.775	-222.509	-258.347	16.868
900	38.041	280.382	255.302	22.572	-223.568	-262.764	15.250
1000	38.162	284.397	258.014	26.383	-224.667	-267.061	13.950
1100	38.279	288.039	260.581	30.205	-304.696	-266.627	12.661
1200	38.401	291.375	263.010	34.039	-304.821	-263.161	11.455
1300	38.518	294.454	265.312	37.885	-304.941	-259.684	10.434
1400	38.639	297.313	267.496	41.743	-305.053	-256.199	9.559
1500	38.761	299.983	269.574	45.613	-305.159	-252.706	8.800
<b>66. DINITROGEN N<sub>2</sub> (g)</b>							
298.15	29.124	191.608	191.608	0.000	0.000	0.000	0.000
300	29.125	191.788	191.608	0.054	0.000	0.000	0.000
400	29.249	200.180	192.752	2.971	0.000	0.000	0.000
500	29.580	206.738	194.916	5.911	0.000	0.000	0.000
600	30.109	212.175	197.352	8.894	0.000	0.000	0.000
700	30.754	216.864	199.812	11.936	0.000	0.000	0.000
800	31.433	221.015	202.208	15.046	0.000	0.000	0.000
900	32.090	224.756	204.509	18.222	0.000	0.000	0.000
1000	32.696	228.169	206.706	21.462	0.000	0.000	0.000
1100	33.241	231.311	208.802	24.759	0.000	0.000	0.000
1200	33.723	234.224	210.801	28.108	0.000	0.000	0.000
1300	34.147	236.941	212.708	31.502	0.000	0.000	0.000
1400	34.517	239.485	214.531	34.936	0.000	0.000	0.000
1500	34.842	241.878	216.275	38.404	0.000	0.000	0.000
<b>67. NITRIC OXIDE NO (g)</b>							
298.15	29.862	210.745	210.745	0.000	91.277	87.590	-15.345
300	29.858	210.930	210.746	0.055	91.278	87.567	-15.247
400	29.954	219.519	211.916	3.041	91.320	86.323	-11.272
500	30.493	226.255	214.133	6.061	91.340	85.071	-8.887
600	31.243	231.879	216.635	9.147	91.354	83.816	-7.297
700	32.031	236.754	219.168	12.310	91.369	82.558	-6.160
800	32.770	241.081	221.642	15.551	91.386	81.298	-5.308
900	33.425	244.979	224.022	18.862	91.405	80.036	-4.645
1000	33.990	248.531	226.298	22.233	91.426	78.772	-4.115
1100	34.473	251.794	228.469	25.657	91.445	77.505	-3.680
1200	34.883	254.811	230.540	29.125	91.464	76.237	-3.318
1300	35.234	257.618	232.516	32.632	91.481	74.967	-3.012
1400	35.533	260.240	234.404	36.170	91.495	73.697	-2.750
1500	35.792	262.700	236.209	39.737	91.506	72.425	-2.522
<b>68. NITROGEN DIOXIDE NO<sub>2</sub> (g)</b>							
298.15	37.178	240.166	240.166	0.000	34.193	52.316	-9.165
300	37.236	240.397	240.167	0.069	34.181	52.429	-9.129
400	40.513	251.554	241.666	3.955	33.637	58.600	-7.652
500	43.664	260.939	244.605	8.167	33.319	64.882	-6.778
600	46.383	269.147	248.026	12.673	33.174	71.211	-6.199
700	48.612	276.471	251.575	17.427	33.151	77.553	-5.787
800	50.405	283.083	255.107	22.381	33.213	83.893	-5.478
900	51.844	289.106	258.555	27.496	33.334	90.221	-5.236
1000	53.007	294.631	261.891	32.741	33.495	96.534	-5.042
1100	53.956	299.729	265.102	38.090	33.686	102.828	-4.883
1200	54.741	304.459	268.187	43.526	33.898	109.105	-4.749

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
1300	55.399	308.867	271.148	49.034	34.124	115.363	-4.635
1400	55.960	312.994	273.992	54.603	34.360	121.603	-4.537
1500	56.446	316.871	276.722	60.224	34.604	127.827	-4.451
<b>69. AMMONIA NH<sub>3</sub> (g)</b>							
298.15	35.630	192.768	192.768	0.000	-45.940	-16.407	2.874
300	35.678	192.989	192.769	0.066	-45.981	-16.223	2.825
400	38.674	203.647	194.202	3.778	-48.087	-5.980	0.781
500	41.994	212.633	197.011	7.811	-49.908	4.764	-0.498
600	45.229	220.578	200.289	12.174	-51.430	15.846	-1.379
700	48.269	227.781	203.709	16.850	-52.682	27.161	-2.027
800	51.112	234.414	207.138	21.821	-53.695	38.639	-2.523
900	53.769	240.589	210.516	27.066	-54.499	50.231	-2.915
1000	56.244	246.384	213.816	32.569	-55.122	61.903	-3.233
1100	58.535	251.854	217.027	38.309	-55.589	73.629	-3.496
1200	60.644	257.039	220.147	44.270	-55.920	85.392	-3.717
1300	62.576	261.970	223.176	50.432	-56.136	97.177	-3.905
1400	64.339	266.673	226.117	56.779	-56.251	108.975	-4.066
1500	65.945	271.168	228.971	63.295	-56.282	120.779	-4.206
<b>70. OXYGEN O (g)</b>							
298.15	21.911	161.058	161.058	0.000	249.180	231.743	-40.600
300	21.901	161.194	161.059	0.041	249.193	231.635	-40.331
400	21.482	167.430	161.912	2.207	249.874	225.677	-29.470
500	21.257	172.197	163.511	4.343	250.481	219.556	-22.937
600	21.124	176.060	165.290	6.462	251.019	213.319	-18.571
700	21.040	179.310	167.067	8.570	251.500	206.997	-15.446
800	20.984	182.115	168.777	10.671	251.932	200.610	-13.098
900	20.944	184.584	170.399	12.767	252.325	194.171	-11.269
1000	20.915	186.789	171.930	14.860	252.686	187.689	-9.804
1100	20.893	188.782	173.372	16.950	253.022	181.173	-8.603
1200	20.877	190.599	174.733	19.039	253.335	174.628	-7.601
1300	20.864	192.270	176.019	21.126	253.630	168.057	-6.753
1400	20.853	193.815	177.236	23.212	253.908	161.463	-6.024
1500	20.845	195.254	178.389	25.296	254.171	154.851	-5.392
<b>71. DIOXYGEN O<sub>2</sub> (g)</b>							
298.15	29.378	205.148	205.148	0.000	0.000	0.000	0.000
300	29.387	205.330	205.148	0.054	0.000	0.000	0.000
400	30.109	213.873	206.308	3.026	0.000	0.000	0.000
500	31.094	220.695	208.525	6.085	0.000	0.000	0.000
600	32.095	226.454	211.045	9.245	0.000	0.000	0.000
700	32.987	231.470	213.612	12.500	0.000	0.000	0.000
800	33.741	235.925	216.128	15.838	0.000	0.000	0.000
900	34.365	239.937	218.554	19.244	0.000	0.000	0.000
1000	34.881	243.585	220.878	22.707	0.000	0.000	0.000
1100	35.314	246.930	223.096	26.217	0.000	0.000	0.000
1200	35.683	250.019	225.213	29.768	0.000	0.000	0.000
1300	36.006	252.888	227.233	33.352	0.000	0.000	0.000
1400	36.297	255.568	229.162	36.968	0.000	0.000	0.000
1500	36.567	258.081	231.007	40.611	0.000	0.000	0.000
<b>72. SULFUR S (cr, l)</b>							
298.15	22.690	32.070	32.070	0.000	0.000	0.000	0.000
300	22.737	32.210	32.070	0.042	0.000	0.000	0.000
368.3	24.237	37.030	32.554	1.649	0.000	0.000	0.000
<b>PHASE TRANSITION: <math>\Delta_{\text{trs}} H = 0.401</math> kJ/mol, <math>\Delta_{\text{trs}} S = 1.089</math> J/K mol, crII-crI</b>							
368.3	24.773	38.119	32.553	2.050	0.000	0.000	0.000
388.36	25.180	39.444	32.875	2.551	0.000	0.000	0.000

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
PHASE TRANSITION: $\Delta_{\text{trs}} H = 1.722$ kJ/mol, $\Delta_{\text{trs}} S = 4.431$ J/K mol, cri-1							
388.36	31.710	43.875	32.872	4.273	0.000	0.000	0.000
400	32.369	44.824	33.206	4.647	0.000	0.000	0.000
500	38.026	53.578	36.411	8.584	0.000	0.000	0.000
600	34.371	60.116	39.842	12.164	0.000	0.000	0.000
700	32.451	65.278	43.120	15.511	0.000	0.000	0.000
800	32.000	69.557	46.163	18.715	0.000	0.000	0.000
882.38	32.000	72.693	48.496	21.351	0.000	0.000	0.000
<b>73. SULFUR S (g)</b>							
298.15	23.673	167.828	167.828	0.000	277.180	236.704	-41.469
300	23.669	167.974	167.828	0.044	277.182	236.453	-41.170
400	23.233	174.730	168.752	2.391	274.924	222.962	-29.115
500	22.741	179.860	170.482	4.689	273.286	210.145	-21.953
600	22.338	183.969	172.398	6.942	271.958	197.646	-17.206
700	22.031	187.388	174.302	9.160	270.829	185.352	-13.831
800	21.800	190.314	176.125	11.351	269.816	173.210	-11.309
900	21.624	192.871	177.847	13.522	215.723	162.258	-9.417
1000	21.489	195.142	179.465	15.677	216.018	156.301	-8.164
1100	21.386	197.185	180.985	17.821	216.284	150.317	-7.138
1200	21.307	199.043	182.413	19.955	216.525	144.309	-6.282
1300	21.249	200.746	183.759	22.083	216.743	138.282	-5.556
1400	21.209	202.319	185.029	24.206	216.940	132.239	-4.934
1500	21.186	203.781	186.231	26.325	217.119	126.182	-4.394
<b>74. DISULFUR S<sub>2</sub> (g)</b>							
298.15	32.505	228.165	228.165	0.000	128.600	79.696	-13.962
300	32.540	228.366	228.165	0.060	128.576	79.393	-13.823
400	34.108	237.956	229.462	3.398	122.703	63.380	-8.276
500	35.133	245.686	231.959	6.863	118.296	49.031	-5.122
600	35.815	252.156	234.800	10.413	114.685	35.530	-3.093
700	36.305	257.715	237.686	14.020	111.599	22.588	-1.685
800	36.697	262.589	240.501	17.671	108.841	10.060	-0.657
882.38	36.985	266.200	242.734	20.706	pressure = 1 bar		
900	37.045	266.932	243.201	21.358	0.000	0.000	0.000
1000	37.377	270.852	245.773	25.079	0.000	0.000	0.000
1100	37.704	274.430	248.218	28.833	0.000	0.000	0.000
1200	38.030	277.725	250.541	32.620	0.000	0.000	0.000
1300	38.353	280.781	252.751	36.439	0.000	0.000	0.000
1400	38.669	283.635	254.856	40.290	0.000	0.000	0.000
1500	38.976	286.314	256.865	44.173	0.000	0.000	0.000
<b>75. OCTASULFUR S<sub>8</sub> (g)</b>							
298.15	156.500	432.536	432.536	0.000	101.277	48.810	-8.551
300	156.768	433.505	432.539	0.290	101.231	48.484	-8.442
400	167.125	480.190	438.834	16.542	80.642	32.003	-4.179
500	173.181	518.176	451.022	33.577	66.185	21.409	-2.237
600	177.936	550.180	464.951	51.137	55.101	13.549	-1.180
700	182.441	577.948	479.152	69.157	46.349	7.343	-0.548
800	186.764	602.596	493.071	87.620	39.177	2.263	-0.148
900	190.595	624.821	506.495	106.494	-392.062	6.554	-0.380
1000	193.618	645.067	519.355	125.712	-387.728	50.614	-2.644
1100	195.684	663.625	531.639	145.185	-383.272	94.233	-4.475
1200	196.825	680.707	543.359	164.817	-378.786	137.444	-5.983
1300	197.195	696.480	554.539	184.524	-374.356	180.283	-7.244
1400	196.988	711.089	565.206	204.237	-370.048	222.785	-8.312
1500	196.396	724.662	575.389	223.909	-365.905	264.984	-9.227
<b>76. SULFUR DIOXIDE SO<sub>2</sub> (g)</b>							
298.15	39.842	248.219	248.219	0.000	-296.810	-300.090	52.574
300	39.909	248.466	248.220	0.074	-296.833	-300.110	52.253

<i>T</i> /K	J/K mol			kJ/mol			Log <i>K<sub>f</sub></i>
	<i>C<sub>p</sub></i> <sup>o</sup>	<i>S</i> <sup>o</sup>	$-(G^o-H^o(T_r))/T$	<i>H</i> <sup>o</sup> - <i>H</i> <sup>o</sup> ( <i>T<sub>r</sub></i> )	$\Delta_f H^o$	$\Delta_f G^o$	
400	43.427	260.435	249.828	4.243	-300.240	-300.935	39.298
500	46.490	270.465	252.978	8.744	-302.735	-300.831	31.427
600	48.938	279.167	256.634	13.520	-304.699	-300.258	26.139
700	50.829	286.859	260.413	18.513	-306.308	-299.386	22.340
800	52.282	293.746	264.157	23.671	-307.691	-298.302	19.477
900	53.407	299.971	267.796	28.958	-362.075	-295.987	17.178
1000	54.290	305.646	271.301	34.345	-362.012	-288.647	15.077
1100	54.993	310.855	274.664	39.810	-361.934	-281.314	13.358
1200	55.564	315.665	277.882	45.339	-361.849	-273.989	11.926
1300	56.033	320.131	280.963	50.920	-361.763	-266.671	10.715
1400	56.426	324.299	283.911	56.543	-361.680	-259.359	9.677
1500	56.759	328.203	286.735	62.203	-361.605	-252.053	8.777
<b>77. SILICON Si (cr)</b>							
298.15	19.789	18.810	18.810	0.000	0.000	0.000	0.000
300	19.855	18.933	18.810	0.037	0.000	0.000	0.000
400	22.301	25.023	19.624	2.160	0.000	0.000	0.000
500	23.610	30.152	21.231	4.461	0.000	0.000	0.000
600	24.472	34.537	23.092	6.867	0.000	0.000	0.000
700	25.124	38.361	25.006	9.348	0.000	0.000	0.000
800	25.662	41.752	26.891	11.888	0.000	0.000	0.000
900	26.135	44.802	28.715	14.478	0.000	0.000	0.000
1000	26.568	47.578	30.464	17.114	0.000	0.000	0.000
1100	26.974	50.130	32.138	19.791	0.000	0.000	0.000
1200	27.362	52.493	33.737	22.508	0.000	0.000	0.000
1300	27.737	54.698	35.265	25.263	0.000	0.000	0.000
1400	28.103	56.767	36.728	28.055	0.000	0.000	0.000
1500	28.462	58.719	38.130	30.883	0.000	0.000	0.000
<b>78. SILICON Si (g)</b>							
298.15	22.251	167.980	167.980	0.000	450.000	405.525	-71.045
300	22.234	168.117	167.980	0.041	450.004	405.249	-70.559
400	21.613	174.416	168.843	2.229	450.070	390.312	-50.969
500	21.316	179.204	170.456	4.374	449.913	375.388	-39.216
600	21.153	183.074	172.246	6.497	449.630	360.508	-31.385
700	21.057	186.327	174.032	8.607	449.259	345.682	-25.795
800	21.000	189.135	175.748	10.709	448.821	330.915	-21.606
900	20.971	191.606	177.375	12.808	448.329	316.205	-18.352
1000	20.968	193.815	178.911	14.904	447.791	301.553	-15.751
1100	20.989	195.815	180.358	17.002	447.211	286.957	-13.626
1200	21.033	197.643	181.723	19.103	446.595	272.416	-11.858
1300	21.099	199.329	183.014	21.209	445.946	257.927	-10.364
1400	21.183	200.895	184.236	23.323	445.268	243.489	-9.085
1500	21.282	202.360	185.396	25.446	444.563	229.101	-7.978
<b>79. SILICON DIOXIDE SiO<sub>2</sub> (cr)</b>							
298.15	44.602	41.460	41.460	0.000	-910.700	-856.288	150.016
300	44.712	41.736	41.461	0.083	-910.708	-855.951	149.032
400	53.477	55.744	43.311	4.973	-910.912	-837.651	109.385
500	60.533	68.505	47.094	10.705	-910.540	-819.369	85.598
600	64.452	79.919	51.633	16.971	-909.841	-801.197	69.749
700	68.234	90.114	56.414	23.590	-908.958	-783.157	58.439
800	76.224	99.674	61.226	30.758	-907.668	-765.265	49.966
848	82.967	104.298	63.533	34.569	-906.310	-756.747	46.613
PHASE TRANSITION: $\Delta_{\text{trs}} H = 0.411$ kJ/mol, $\Delta_{\text{trs}} S = 0.484$ J/K mol, crII-crII'							
848	67.446	104.782	63.532	34.980	-906.310	-756.747	46.613
900	67.953	108.811	66.033	38.500	-905.922	-747.587	43.388
1000	68.941	116.021	70.676	45.345	-905.176	-730.034	38.133
1100	69.940	122.639	75.104	52.289	-904.420	-712.557	33.836
1200	70.947	128.768	79.323	59.333	-901.382	-695.148	30.259

T/K	J/K mol			kJ/mol			Log $K_f$
	$C_p^\circ$	$S^\circ$	$-(G^\circ - H^\circ(T_f))/T$	$H^\circ - H^\circ(T_f)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	
PHASE TRANSITION: $\Delta_{\text{trs}} H = 2.261$ kJ/mol, $\Delta_{\text{trs}} S = 1.883$ J/K mol, crII'-crI							
1200	71.199	130.651	79.323	61.594	-901.382	-695.148	30.259
1300	71.743	136.372	83.494	68.742	-900.574	-677.994	27.242
1400	72.249	141.707	87.463	75.941	-899.782	-660.903	24.658
1500	72.739	146.709	91.248	83.191	-899.004	-643.867	22.421
<b>80. SILICON TETRACHLORIDE <math>\text{SiCl}_4</math> (g)</b>							
298.15	90.404	331.446	331.446	0.000	-662.200	-622.390	109.039
300	90.562	332.006	331.448	0.167	-662.195	-622.143	108.323
400	96.893	359.019	335.088	9.572	-661.853	-608.841	79.505
500	100.449	381.058	342.147	19.456	-661.413	-595.637	62.225
600	102.587	399.576	350.216	29.616	-660.924	-582.527	50.713
700	103.954	415.500	358.432	39.948	-660.417	-569.501	42.496
800	104.875	429.445	366.455	50.392	-659.912	-556.548	36.338
900	105.523	441.837	374.155	60.914	-659.422	-543.657	31.553
1000	105.995	452.981	381.490	71.491	-658.954	-530.819	27.727
1100	106.349	463.101	388.456	82.109	-658.515	-518.027	24.599
1200	106.620	472.366	395.068	92.758	-658.107	-505.274	21.994
1300	106.834	480.909	401.347	103.431	-657.735	-492.553	19.791
1400	107.003	488.833	407.316	114.123	-657.400	-479.860	17.904
1500	107.141	496.220	413.000	124.830	-657.104	-467.189	16.269

## THERMODYNAMIC PROPERTIES OF AQUEOUS IONS

This table contains standard state thermodynamic properties of positive and negative ions in aqueous solution. It includes enthalpy and Gibbs energy of formation, entropy, and heat capacity, and thus serves as a companion to the preceding table, "Standard Thermodynamic Properties of Chemical Substances". The standard state is the hypothetical ideal solution with molality  $m = 1$  mol/kg (mean ionic molality  $m_{\pm}$  in the case of a species which is assumed to dissociate at infinite dilution). Further details on conventions may be found in Reference 1.

All values refer to standard conditions of 25 °C and 100 kPa pressure.

Species	$\Delta_f H^\circ /$ kJ mol <sup>-1</sup>	$\Delta_f G^\circ /$ kJ mol <sup>-1</sup>	$S^\circ /$ J mol <sup>-1</sup> K <sup>-1</sup>	$C_p /$ J mol <sup>-1</sup> K <sup>-1</sup>
<b>Cations</b>				
Ag <sup>+</sup>	105.6	77.1	72.7	21.8
Al <sup>3+</sup>	-531.0	-485.0	-321.7	
AlOH <sup>+2</sup>		-694.1		
Ba <sup>2+</sup>	-537.6	-560.8	9.6	
BaOH <sup>+</sup>		-730.5		
Be <sup>2+</sup>	-382.8	-379.7	-129.7	
Bi <sup>3+</sup>		82.8		
BiOH <sup>+2</sup>		-146.4		
Ca <sup>2+</sup>	-542.8	-553.6	-53.1	
CaOH <sup>+</sup>		-718.4		
Cd <sup>2+</sup>	-75.9	-77.6	-73.2	
CdOH <sup>+</sup>		-261.1		
Ce <sup>+3</sup>	-696.2	-672.0	-205.0	
Ce <sup>+4</sup>	-537.2	-503.8	-301.0	
Co <sup>+2</sup>	-58.2	-54.4	-113.0	
Co <sup>+3</sup>	92.0	134.0	-305.0	
Cr <sup>+2</sup>	-143.5			
Cs <sup>+</sup>	-258.3	-292.0	133.1	-10.5
Cu <sup>+</sup>	71.7	50.0	40.6	
Cu <sup>+2</sup>	64.8	65.5	-99.6	
Dy <sup>+3</sup>	-699.0	-665.0	-231.0	21.0
Er <sup>+3</sup>	-705.4	-669.1	-244.3	21.0
Eu <sup>+2</sup>	-527.0	-540.2	-8.0	
Eu <sup>+3</sup>	-605.0	-574.1	-222.0	8.0
Fe <sup>+2</sup>	-89.1	-78.9	-137.7	
Fe <sup>+3</sup>	-48.5	-4.7	-315.9	
FeOH <sup>+</sup>	-324.7	-277.4	-29.0	
FeOH <sup>+2</sup>	-290.8	-229.4	-142.0	
Fe(OH) <sub>2</sub> <sup>+</sup>		-438.0		
Ga <sup>+2</sup>		-88.0		
Ga <sup>+3</sup>	-211.7	-159.0	-331.0	
GaOH <sup>+2</sup>		-380.3		
Ga(OH) <sub>2</sub> <sup>+</sup>		-597.4		
Gd <sup>+3</sup>	-686.0	-661.0	-205.9	
H <sup>+</sup>	0	0	0	0
Hg <sup>+2</sup>	171.1	164.4	-32.2	
Hg <sub>2</sub> <sup>+2</sup>	172.4	153.5	84.5	
HgOH <sup>+</sup>	-84.5	-52.3	71.0	
Ho <sup>+3</sup>	-705.0	-673.7	-226.8	17.0
In <sup>+</sup>		-12.1		
In <sup>+2</sup>		-50.7		
In <sup>+3</sup>	-105.0	-98.0	-151.0	

## References

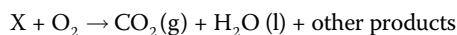
1. Wagman, D. D., Evans, W. H., Parker, V. B., Schumm, R. H., Halow, I., Bailey, S. M., Churney, K. L., and Nuttall, R. L., *The NBS Tables of Chemical Thermodynamic Properties*, *J. Phys. Chem. Ref. Data*, Vol. 11, Suppl. 2, 1982.
2. Zemaitis, J. F., Clark, D. M., Rafal, M., and Scrivner, N. C., *Handbook of Aqueous Electrolyte Thermodynamics*, American Institute of Chemical Engineers, New York, 1986.

Species	$\Delta_f H^\circ /$ kJ mol <sup>-1</sup>	$\Delta_f G^\circ /$ kJ mol <sup>-1</sup>	$S^\circ /$ J mol <sup>-1</sup> K <sup>-1</sup>	$C_p /$ J mol <sup>-1</sup> K <sup>-1</sup>
InOH <sup>+2</sup>	-370.3	-313.0	-88.0	
In(OH) <sub>2</sub> <sup>+</sup>	-619.0	-525.0	25.0	
K <sup>+</sup>	-252.4	-283.3	102.5	21.8
La <sup>+3</sup>	-707.1	-683.7	-217.6	-13.0
Li <sup>+</sup>	-278.5	-293.3	13.4	68.6
Lu <sup>+3</sup>	-665.0	-628.0	-264.0	25.0
LuF <sup>+2</sup>		-931.4		
Mg <sup>+2</sup>	-466.9	-454.8	-138.1	
MgOH <sup>+</sup>		-626.7		
Mn <sup>+2</sup>	-220.8	-228.1	-73.6	50.0
MnOH <sup>+</sup>	-450.6	-405.0	-17.0	
NH <sub>4</sub> <sup>+</sup>	-132.5	-79.3	113.4	79.9
N <sub>2</sub> H <sub>5</sub> <sup>+</sup>	-7.5	82.5	151.0	70.3
Na <sup>+</sup>	-240.1	-261.9	59.0	46.4
Nd <sup>+3</sup>	-696.2	-671.6	-206.7	-21.0
Ni <sup>+2</sup>	-54.0	-45.6	-128.9	
NiOH <sup>+</sup>	-287.9	-227.6	-71.0	
PH <sub>4</sub> <sup>+</sup>		92.1		
Pa <sup>+4</sup>	-619.0			
Pb <sup>+2</sup>	-1.7	-24.4	10.5	
PbOH <sup>+</sup>		-226.3		
Pd <sup>+2</sup>	149.0	176.5	-184.0	
Po <sup>+2</sup>		71.0		
Po <sup>+4</sup>		293.0		
Pr <sup>+3</sup>	-704.6	-679.1	-209.0	-29.0
Pt <sup>+2</sup>		254.8		
Ra <sup>+2</sup>	-527.6	-561.5	54.0	
Rb <sup>+</sup>	-251.2	-284.0	121.5	
Re <sup>+</sup>		-33.0		
Sc <sup>+3</sup>	-614.2	-586.6	-255.0	
ScOH <sup>+2</sup>	-861.5	-801.2	-134.0	
Sm <sup>+2</sup>		-497.5		
Sm <sup>+3</sup>	-691.6	-666.6	-211.7	-21.0
Sn <sup>+2</sup>	-8.8	-27.2	-17.0	
SnOH <sup>+</sup>	-286.2	-254.8	50.0	
Sr <sup>+2</sup>	-545.8	-559.5	-32.6	
SrOH <sup>+</sup>		-721.3		
Tb <sup>+3</sup>	-682.8	-651.9	-226.0	17.0
Te(OH) <sub>3</sub> <sup>+</sup>	-608.4	-496.1	111.7	
Th <sup>+4</sup>	-769.0	-705.1	-422.6	
Th(OH) <sup>+3</sup>	-1030.1	-920.5	-343.0	
Th(OH) <sub>2</sub> <sup>+2</sup>	-1282.4	-1140.9	-218.0	
Tl <sup>+</sup>	5.4	-32.4	125.5	

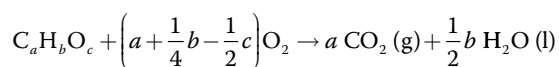
Species	$\Delta_f H^\circ /$ kJ mol <sup>-1</sup>	$\Delta_f G^\circ /$ kJ mol <sup>-1</sup>	$S^\circ /$ J mol <sup>-1</sup> K <sup>-1</sup>	$C_p /$ J mol <sup>-1</sup> K <sup>-1</sup>	Species	$\Delta_f H^\circ /$ kJ mol <sup>-1</sup>	$\Delta_f G^\circ /$ kJ mol <sup>-1</sup>	$S^\circ /$ J mol <sup>-1</sup> K <sup>-1</sup>	$C_p /$ J mol <sup>-1</sup> K <sup>-1</sup>
Tl <sup>3+</sup>	196.6	214.6	-192.0		HF <sub>2</sub> <sup>-</sup>	-649.9	-578.1	92.5	
TlOH <sup>+2</sup>		-15.9			HPO <sub>3</sub> F <sup>-</sup>		-1198.2		
Tl(OH) <sub>2</sub> <sup>+</sup>		-244.7			HPO <sub>4</sub> <sup>-2</sup>	-1292.1	-1089.2	-33.5	
Tm <sup>+3</sup>	-697.9	-662.0	-243.0	25.0	HP <sub>2</sub> O <sub>7</sub> <sup>-3</sup>	-2274.8	-1972.2	46.0	
U <sup>+3</sup>	-489.1	-476.2	-188.0		HS <sup>-</sup>	-17.6	12.1	62.8	
U <sup>+4</sup>	-591.2	-531.9	-410.0		HSO <sub>3</sub> <sup>-</sup>	-626.2	-527.7	139.7	
Y <sup>+3</sup>	-723.4	-693.8	-251.0		HSO <sub>4</sub> <sup>-</sup>	-887.3	-755.9	131.8	-84.0
Y <sub>2</sub> (OH) <sub>2</sub> <sup>+4</sup>		-1780.3			HS <sub>2</sub> O <sub>4</sub> <sup>-</sup>		-614.5		
Yb <sup>+2</sup>		-527.0			HSe <sup>-</sup>	15.9	44.0	79.0	
Yb <sup>+3</sup>	-674.5	-644.0	-238.0	25.0	HSeO <sub>3</sub> <sup>-</sup>	-514.6	-411.5	135.1	
Y(OH) <sup>+2</sup>		-879.1			HSeO <sub>4</sub> <sup>-</sup>	-581.6	-452.2	149.4	
Zn <sup>+2</sup>	-153.9	-147.1	-112.1	46.0	H <sub>2</sub> AsO <sub>3</sub> <sup>-</sup>	-714.8	-587.1	110.5	
ZnOH <sup>+</sup>		-330.1			H <sub>2</sub> AsO <sub>4</sub> <sup>-</sup>	-909.6	-753.2	117.0	
<i>Anions</i>					H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	-1296.3	-1130.2	90.4	
AlO <sub>2</sub> <sup>-</sup>	-930.9	-830.9	-36.8		H <sub>2</sub> P <sub>2</sub> O <sub>7</sub> <sup>-2</sup>	-2278.6	-2010.2	163.0	
Al(OH) <sub>4</sub> <sup>-</sup>	-1502.5	-1305.3	102.9		I <sup>-</sup>	-55.2	-51.6	111.3	-142.3
AsO <sub>2</sub> <sup>-</sup>	-429.0	-350.0	40.6		IO <sup>-</sup>	-107.5	-38.5	-5.4	
AsO <sub>4</sub> <sup>-3</sup>	-888.1	-648.4	-162.8		IO <sub>3</sub> <sup>-</sup>	-221.3	-128.0	118.4	
BF <sub>4</sub> <sup>-</sup>	-1574.9	-1486.9	180.0		IO <sub>4</sub> <sup>-</sup>	-151.5	-58.5	222.0	
BH <sub>4</sub> <sup>-</sup>	48.2	114.4	110.5		MnO <sub>4</sub> <sup>-</sup>	-541.4	-447.2	191.2	-82.0
BO <sub>2</sub> <sup>-</sup>	-772.4	-678.9	-37.2		MnO <sub>2</sub> <sup>-2</sup>	-653.0	-500.7	59.0	
B <sub>4</sub> O <sub>7</sub> <sup>-2</sup>		-2604.8			MoO <sub>4</sub> <sup>-2</sup>	-997.9	-836.3	27.2	
BeO <sub>2</sub> <sup>-2</sup>	-790.8	-640.1	-159.0		NO <sub>2</sub> <sup>-</sup>	-104.6	-32.2	123.0	-97.5
Br <sup>-</sup>	-121.6	-104.0	82.4	-141.8	NO <sub>3</sub> <sup>-</sup>	-207.4	-111.3	146.4	-86.6
BrO <sup>-</sup>	-94.1	-33.4	42.0		N <sub>3</sub> <sup>-</sup>	275.1	348.2	107.9	
BrO <sub>3</sub> <sup>-</sup>	-67.1	18.6	161.7		OCN <sup>-</sup>	-146.0	-97.4	106.7	
BrO <sub>4</sub> <sup>-</sup>	13.0	118.1	199.6		OH <sup>-</sup>	-230.0	-157.2	-10.8	-148.5
CHOO <sup>-</sup>	-425.6	-351.0	92.0	-87.9	PO <sub>4</sub> <sup>-3</sup>	-1277.4	-1018.7	-220.5	
CH <sub>3</sub> COO <sup>-</sup>	-486.0	-369.3	86.6	-6.3	P <sub>2</sub> O <sub>7</sub> <sup>-4</sup>	-2271.1	-1919.0	-117.0	
C <sub>2</sub> O <sub>4</sub> <sup>-2</sup>	-825.1	-673.9	45.6		Re <sup>-</sup>	46.0	10.1	230.0	
C <sub>2</sub> O <sub>4</sub> H <sup>-</sup>	-818.4	-698.3	149.4		S <sup>-2</sup>	33.1	85.8	-14.6	
Cl <sup>-</sup>	-167.2	-131.2	56.5	-136.4	SCN <sup>-</sup>	76.4	92.7	144.3	-40.2
ClO <sup>-</sup>	-107.1	-36.8	42.0		SO <sub>3</sub> <sup>-2</sup>	-635.5	-486.5	-29.0	
ClO <sub>2</sub> <sup>-</sup>	-66.5	17.2	101.3		SO <sub>4</sub> <sup>-2</sup>	-909.3	-744.5	20.1	-293.0
ClO <sub>3</sub> <sup>-</sup>	-104.0	-8.0	162.3		S <sub>2</sub> <sup>-2</sup>	30.1	79.5	28.5	
ClO <sub>4</sub> <sup>-</sup>	-129.3	-8.5	182.0		S <sub>2</sub> O <sub>3</sub> <sup>-2</sup>	-652.3	-522.5	67.0	
CN <sup>-</sup>	150.6	172.4	94.1		S <sub>2</sub> O <sub>4</sub> <sup>-2</sup>	-753.5	-600.3	92.0	
CO <sub>3</sub> <sup>-2</sup>	-677.1	-527.8	-56.9		S <sub>2</sub> O <sub>8</sub> <sup>-2</sup>	-1344.7	-1114.9	244.3	
CrO <sub>4</sub> <sup>-2</sup>	-881.2	-727.8	50.2		Se <sup>-2</sup>		129.3		
Cr <sub>2</sub> O <sub>7</sub> <sup>-2</sup>	-1490.3	-1301.1	261.9		SeO <sub>3</sub> <sup>-2</sup>	-509.2	-369.8	13.0	
F <sup>-</sup>	-332.6	-278.8	-13.8	-106.7	SeO <sub>4</sub> <sup>-2</sup>	-599.1	-441.3	54.0	
Fe(CN) <sub>6</sub> <sup>-3</sup>	561.9	729.4	270.3		VO <sub>3</sub> <sup>-</sup>	-888.3	-783.6	50.0	
Fe(CN) <sub>6</sub> <sup>-4</sup>	455.6	695.1	95.0		VO <sub>4</sub> <sup>-3</sup>		-899.0		
HB <sub>4</sub> O <sub>7</sub> <sup>-</sup>		-2685.1			WO <sub>4</sub> <sup>-2</sup>	-1075.7			
HCO <sub>3</sub> <sup>-</sup>	-692.0	-586.8	91.2						

## HEAT OF COMBUSTION

The heat of combustion of a substance at 25°C can be calculated from the enthalpy of formation ( $\Delta_f H^\circ$ ) data in the table "Standard Thermodynamic Properties of Chemical Substances" in this Section. We can write the general combustion reaction as



For a compound containing only carbon, hydrogen, and oxygen, the reaction is simply



and the standard heat of combustion  $\Delta_c H^\circ$ , which is defined as the negative of the enthalpy change for the reaction (i.e., the heat released in the combustion process), is given by

$$\begin{aligned} \Delta_c H^\circ &= -a\Delta_f H^\circ(CO_2, g) - \frac{1}{2}b\Delta_f H^\circ(H_2O, l) + \Delta_f H^\circ(C_a H_b O_c) \\ &= 393.51a + 142.915b + \Delta_f H^\circ(C_a H_b O_c) \end{aligned}$$

This equation applies if the reactants start in their standard states (25°C and one atmosphere pressure) and the products return to the same conditions. The same equation applies to a compound containing another element if that element ends in its standard reference state (e.g., nitrogen, if the product is  $N_2$ ); in general, however, the exact products containing the other elements must be known in order to calculate the heat of combustion.

The following table gives the standard heat of combustion calculated in this manner for a few representative substances.

Molecular formula	Name	$\Delta_c H^\circ / \text{kJ mol}^{-1}$	Molecular formula	Name	$\Delta_c H^\circ / \text{kJ mol}^{-1}$
<i>Inorganic substances</i>			<i>Carbonyl compounds</i>		
C	Carbon (graphite)	393.5	$C_3H_8O_3$	Glycerol (l)	1655.4
CO	Carbon monoxide (g)	283.0	$C_4H_{10}O$	Diethyl ether (l)	2723.9
$H_2$	Hydrogen (g)	285.8	$C_5H_{12}O$	1-Pentanol (l)	3330.9
$H_3N$	Ammonia (g)	382.8	$C_6H_6O$	Phenol (s)	3053.5
$H_4N_2$	Hydrazine (g)	667.1	<i>Acids and esters</i>		
$N_2O$	Nitrous oxide (g)	82.1	$CH_2O$	Formaldehyde (g)	570.7
<i>Hydrocarbons</i>			$C_2H_2O$	Ketene (g)	1025.4
$CH_4$	Methane (g)	890.8	$C_2H_4O$	Acetaldehyde (l)	1166.9
$C_2H_2$	Acetylene (g)	1301.1	$C_3H_6O$	Acetone (l)	1789.9
$C_2H_4$	Ethylene (g)	1411.2	$C_3H_6O$	Propanal (l)	1822.7
$C_2H_6$	Ethane (g)	1560.7	$C_4H_8O$	2-Butanone (l)	2444.1
$C_3H_6$	Propylene (g)	2058.0	<i>Nitrogen compounds</i>		
$C_3H_6$	Cyclopropane (g)	2091.3	CHN	Hydrogen cyanide (g)	671.5
$C_3H_8$	Propane (g)	2219.2	$CH_3NO_2$	Nitromethane (l)	709.2
$C_4H_6$	1,3-Butadiene (g)	2541.5	$CH_4N_2O$	Urea (s)	632.7
$C_4H_{10}$	Butane (g)	2877.6	$CH_5N$	Methylamine (g)	1085.6
$C_5H_{12}$	Pentane (l)	3509.0	$C_2H_3N$	Acetonitrile (l)	1247.2
$C_6H_6$	Benzene (l)	3267.6	$C_2H_5NO$	Acetamide (s)	1184.6
$C_6H_{12}$	Cyclohexane (l)	3919.6	$C_3H_7N$	Trimethylamine (g)	2443.1
$C_6H_{14}$	Hexane (l)	4163.2	$C_5H_5N$	Pyridine (l)	2782.3
$C_7H_8$	Toluene (l)	3910.3	$C_6H_7N$	Aniline (l)	3392.8
$C_7H_{16}$	Heptane (l)	4817.0			
$C_{10}H_8$	Naphthalene (s)	5156.3			
<i>Alcohols and ethers</i>					
$CH_4O$	Methanol (l)	726.1			
$C_2H_6O$	Ethanol (l)	1366.8			
$C_2H_6O$	Dimethyl ether (g)	1460.4			
$C_2H_6O_2$	Ethylene glycol (l)	1189.2			
$C_3H_8O$	1-Propanol (l)	2021.3			



## MOLAR CONDUCTIVITY OF AQUEOUS HF, HCl, HBr, AND HI

The molar conductivity  $\Lambda$  of an electrolyte solution is defined as the conductivity divided by amount-of-substance concentration. The customary unit is  $\text{S cm}^2 \text{ mol}^{-1}$  (i.e.,  $\Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$ ). The first part of this table gives the molar conductivity of the hydrohalogen acids at 25 °C as a function of the concentration in mol/L. The second part gives the temperature dependence of  $\Lambda$  for HCl and HBr. More extensive tables and mathematical representations may be found in the reference.

### Reference

Hamer, W. J., and DeWane, H. J., *Electrolytic Conductance and the Conductances of the Hydrohalogen Acids in Water*, Natl. Stand. Ref. Data Sys.- Natl. Bur. Standards (U.S.), No. 33, 1970.

$c/\text{mol L}^{-1}$	HF	HCl	HBr	HI
Inf. dil.	405.1	426.1	427.7	426.4
0.0001		424.5	425.9	424.6
0.0005		422.6	424.3	423.0
0.001		421.2	422.9	421.7
0.005	128.1	415.7	417.6	416.4
0.01	96.1	411.9	413.7	412.8
0.05	50.1	398.9	400.4	400.8
0.10	39.1	391.1	391.9	394.0
0.5	26.3	360.7	361.9	369.8
1.0	24.3	332.2	334.5	343.9
1.5		305.8	307.6	316.4
2.0		281.4	281.7	288.9
2.5		258.9	257.8	262.5
3.0		237.6	236.8	237.9

$c/\text{mol L}^{-1}$	HF	HCl	HBr	HI
3.5		218.3	217.5	215.4
4.0		200.0	199.4	195.1
4.5		183.1	182.4	176.8
5.0		167.4	166.5	160.4
5.5		152.9	151.8	145.5
6.0		139.7	138.2	131.7
6.5		127.7	125.7	118.6
7.0		116.9	114.2	105.7
7.5		107.0	103.8	
8.0		98.2	94.4	
8.5		90.3	85.8	
9.0		83.1		
9.5		76.6		
10.0		70.7		

$c/\text{mol L}^{-1}$	-20 °C	-10 °C	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C
<b>HCl</b>								
0.5			228.7	283.0	336.4	386.8	436.9	482.4
1.0			211.7	261.6	312.2	359.0	402.9	445.3
1.5			196.2	241.5	287.5	331.1	371.6	410.8
2.0			182.0	222.7	262.9	303.3	342.4	378.2
2.5		131.7	168.5	205.1	239.8	277.0	315.2	347.6
3.0		120.8	154.6	188.5	219.3	253.3	289.3	319.0
3.5	85.5	111.3	139.6	172.2	201.6	232.9	263.9	292.1
4.0	79.3	102.7	129.2	158.1	185.6	214.2	242.2	268.2
4.5	73.7	94.9	119.5	145.4	170.6	196.6	222.5	246.7
5.0	68.5	87.8	110.3	133.5	156.6	180.2	204.1	226.5
5.5	63.6	81.1	101.7	122.5	143.6	165.0	187.1	207.7
6.0	58.9	74.9	93.7	112.3	131.5	151.0	171.3	190.3
6.5	54.4	69.1	86.2	103.0	120.4	138.2	156.9	174.3
7.0	50.2	63.7	79.3	94.4	110.2	126.4	143.3	159.7
7.5	46.3	58.6	73.0	86.5	100.9	115.7	131.6	146.2
8.0	42.7	54.0	67.1	79.4	92.4	106.1	120.6	134.0
8.5	39.4	49.8	61.7	72.9	84.7	97.3	110.7	123.0
9.0	36.4	45.9	56.8	67.1	77.8	89.4	101.7	112.9
9.5	33.6	42.3	52.3	61.8	71.5	82.3	93.6	103.9
10.0	31.2	39.1	48.2	57.0	65.8	75.9	86.3	95.7
10.5	28.9	36.1	44.5	52.7	60.7	70.1	79.6	88.4
11.0	26.8	33.4	41.1	48.8	56.1	64.9	73.6	81.7
11.5	24.9	31.0	38.0	45.3	51.9	60.1	68.0	75.6
12.0	23.1	28.7	35.3	42.0	48.0	55.6	62.8	70.0
12.5	21.4	26.7	32.7	39.0	44.4	51.4	57.9	64.8

$c/\text{mol L}^{-1}$	-20 °C	-10 °C	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C	
<b>HBr</b>									
0.5				240.9	295.9	347.0	398.9	453.6	496.8
1.0				229.6	276.0	329.0	380.4	418.6	465.2
1.5				209.5	254.9	298.9	340.6	381.8	421.4
2.0		150.8	188.6	231.3	271.8	314.1	350.5	387.4	
2.5		136.8	171.7	208.3	244.8	281.7	316.0	349.1	
3.0		125.7	157.2	189.5	222.2	255.0	287.8	318.6	
3.5		116.1	144.1	174.6	203.2	234.4	263.7	291.9	
4.0	84.0	107.5	132.3	160.2	186.8	214.2	239.7	266.9	
4.5	78.0	99.0	123.0	146.4	171.2	195.1	218.8	242.6	
5.0	72.3	91.4	112.6	134.0	155.7	178.2	199.6	221.3	
5.5	67.0	84.2	103.1	122.7	142.1	162.8	181.4	201.8	
6.0	61.8	77.2	94.3	112.0	129.6	148.0	165.4	183.4	
6.5	56.8	70.7	86.0	102.0	118.0	134.1	150.5	166.3	
7.0	51.9	64.6	78.4	92.6	107.1	121.4	136.3	150.8	

## STANDARD KCl SOLUTIONS FOR CALIBRATING CONDUCTIVITY CELLS

This table presents recommended electrolytic conductivity ( $\kappa$ ) values for aqueous potassium chloride solutions with molalities of 0.01 mol/kg, 0.1 mol/kg and 1.0 mol/kg at temperatures from 0°C to 50°C. The values, which are based on measurements at the National Institute of Standards and Technology, provide primary standards for the calibration of conductivity cells. The measurements at 0.01 and 0.1 molal are described in Reference 1, while those at 1.0 molal are in Reference 2. Temperatures are given on the ITS-90 scale. The uncertainty in the conductivity is about 0.03% for the 0.01 molal values and about 0.04% for the 0.1 and 1.0 molal values. The conductivity of water saturated with atmospheric CO<sub>2</sub> is given in the last column. These values were subtracted from the original measurements to give the values in the second, third, and fourth columns. All  $\kappa$  values are given in units of 10<sup>-4</sup> S/m (numerically equal to  $\mu$ S/cm).

The assistance of Kenneth W. Pratt is appreciated.

$t/^\circ\text{C}$	$10^4 \kappa/\text{S m}^{-1}$			
	0.01 m KCl	0.1 m KCl	1.0 m KCl	H <sub>2</sub> O (CO <sub>2</sub> sat.)
0	772.92	7 116.85	63 488	0.58
5	890.96	8 183.70	72 030	0.68
10	1 013.95	9 291.72	80 844	0.79
15	1 141.45	10 437.1	89 900	0.89
18	1 219.93	11 140.6	—	0.95
20	1 273.03	11 615.9	99 170	0.99
25	1 408.23	12 824.6	108 620	1.10
30	1 546.63	14 059.2	118 240	1.20
35	1 687.79	15 316.0	127 970	1.30
40	1 831.27	16 591.0	137 810	1.40
45	1 976.62	17 880.6	147 720	1.51
50	2 123.43	19 180.9	157 670	1.61

### References

1. Wu, Y. C., Koch, W. F., and Pratt, K. W., *J. Res. Natl. Inst. Stand. Technol.* 96, 191, 1991.
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3. Pratt, K. W., Koch, W. F., Wu, Y. C., and Berezansky, P. A., *Pure Appl. Chem.* 73, 1783, 2001.

# EQUIVALENT CONDUCTIVITY OF ELECTROLYTES IN AQUEOUS SOLUTION

Petr Vanýsek

This table gives the equivalent (molar) conductivity  $\Lambda$  at 25 °C for some common electrolytes in aqueous solution at concentrations up to 0.1 mol/L. The units of  $\Lambda$  are  $10^{-4} \text{ m}^2 \text{ S mol}^{-1}$ .

For very dilute solutions, the equivalent conductivity for any electrolyte of concentration  $c$  can be approximately calculated using the Debye–Hückel–Onsager equation, which can be written for a symmetrical (equal charge on cation and anion) electrolyte as

$$\Lambda = \Lambda^\circ - (A + B\Lambda^\circ)c^{1/2}$$

For a solution at 25 °C and both cation and anion with charge  $|z|$ , the constants are  $A = 60.20$  and  $B = 0.229$ .  $\Lambda^\circ$  can be found from the next table, "Ionic Conductivity and Diffusion at Infinite Dilution." The equation is reliable for  $c < 0.001 \text{ mol/L}$ ; with higher concentration the error increases.

Compound	Infinite dilution $\Lambda^\circ$	Concentration (mol/L)						
		0.0005	0.001	0.005	0.01	0.02	0.05	0.1
$\Lambda (10^{-4} \text{ m}^2 \text{ S mol}^{-1})$								
AgNO <sub>3</sub>	133.29	131.29	130.45	127.14	124.70	121.35	115.18	109.09
1/2BaCl <sub>2</sub>	139.91	135.89	134.27	127.96	123.88	119.03	111.42	105.14
1/2CaCl <sub>2</sub>	135.77	131.86	130.30	124.19	120.30	115.59	108.42	102.41
1/2Ca(OH) <sub>2</sub>	258	—	—	233	226	214	—	—
CuSO <sub>4</sub>	133.6	121.6	115.20	94.02	83.08	72.16	59.02	50.55
HCl	425.95	422.53	421.15	415.59	411.80	407.04	398.89	391.13
KBr	151.9	149.8	148.9	146.02	143.36	140.41	135.61	131.32
KCl	149.79	147.74	146.88	143.48	141.20	138.27	133.30	128.90
KClO <sub>4</sub>	139.97	138.69	137.80	134.09	131.39	127.86	121.56	115.14
1/3K <sub>3</sub> Fe(CN) <sub>6</sub>	174.5	166.4	163.1	150.7	—	—	—	—
1/4K <sub>4</sub> Fe(CN) <sub>6</sub>	184	—	167.16	146.02	134.76	122.76	107.65	97.82
KHCO <sub>3</sub>	117.94	116.04	115.28	112.18	110.03	107.17	—	—
KI	150.31	148.2	143.32	144.30	142.11	139.38	134.90	131.05
KIO <sub>4</sub>	127.86	125.74	124.88	121.18	118.45	114.08	106.67	98.2
KNO <sub>3</sub>	144.89	142.70	141.77	138.41	132.75	132.34	126.25	120.34
KMnO <sub>4</sub>	134.8	132.7	131.9	—	126.5	—	—	113
KOH	271.5	—	234	230	228	—	219	213
KReO <sub>4</sub>	128.20	126.03	125.12	121.31	118.49	114.49	106.40	97.40
1/3LaCl <sub>3</sub>	145.9	139.6	137.0	127.5	121.8	115.3	106.2	99.1
LiCl	114.97	113.09	112.34	109.35	107.27	104.60	100.06	95.81
LiClO <sub>4</sub>	105.93	104.13	103.39	100.52	98.56	96.13	92.15	88.52
1/2MgCl <sub>2</sub>	129.34	125.55	124.15	118.25	114.49	109.99	103.03	97.05
NH <sub>4</sub> Cl	149.6	147.5	146.7	143.9	141.21	138.25	133.22	128.69
NaCl	126.39	124.44	123.68	120.59	118.45	115.70	111.01	106.69
NaClO <sub>4</sub>	117.42	115.58	114.82	111.70	109.54	106.91	102.35	98.38
NaI	126.88	125.30	124.19	121.19	119.18	116.64	112.73	108.73
NaOOCCH <sub>3</sub>	91.0	89.2	88.5	85.68	83.72	81.20	76.88	72.76
NaOH	247.7	245.5	244.6	240.7	237.9	—	—	—
Na picrate	80.45	78.7	78.6	75.7	73.7	—	66.3	61.8
1/2Na <sub>2</sub> SO <sub>4</sub>	129.8	125.68	124.09	117.09	112.38	106.73	97.70	89.94
1/2SrCl <sub>2</sub>	135.73	131.84	130.27	124.18	120.23	115.48	108.20	102.14
ZnSO <sub>4</sub>	132.7	121.3	114.47	95.44	84.87	74.20	61.17	52.61

# IONIC CONDUCTIVITY AND DIFFUSION AT INFINITE DILUTION

Petr Vanýšek

This table gives the molar (equivalent) conductivity  $\lambda$  for common ions at infinite dilution. All values refer to aqueous solutions at 25°C. It also lists the diffusion coefficient  $D$  of the ion in dilute aqueous solution, which is related to  $\lambda$  through the equation

$$D = (RT / F^2)(\lambda / |z|)$$

where  $R$  is the molar gas constant,  $T$  the temperature,  $F$  the Faraday constant, and  $z$  the charge on the ion. The variation with temperature is fairly sharp; for typical ions,  $\lambda$  and  $D$  increase by 2 to 3% per degree as the temperature increases from 25°C.

The diffusion coefficient for a salt,  $D_{\text{salt}}$ , may be calculated from the  $D_+$  and  $D_-$  values of the constituent ions by the relation

$$D_{\text{salt}} = \frac{(z_+ + |z_-|)D_+D_-}{z_+D_+ + |z_-|D_-}$$

For solutions of simple, pure electrolytes (one positive and one negative ionic species), such as NaCl, equivalent ionic conductivity  $\Lambda^\circ$ , which is the molar conductivity per unit concentration of charge, is defined as

$$\Lambda^\circ = \Lambda_+ + \Lambda_-$$

where  $\Lambda_+$  and  $\Lambda_-$  are equivalent ionic conductivities of the cation and anion. The more general formula is

$$\Lambda^\circ = \nu_+\Lambda_+ + \nu_-\Lambda_-$$

where  $\nu_+$  and  $\nu_-$  refer to the number of moles of cations and anions to which one mole of the electrolyte gives a rise in the solution.

## References

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Ion	$\Lambda_\pm$ $10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$D$ $10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ion	$\Lambda_\pm$ $10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$D$ $10^{-5} \text{ cm}^2 \text{ s}^{-1}$
<b>Inorganic Cations</b>			<b>Inorganic Anions</b>		
Ag <sup>+</sup>	61.9	1.648	Au(CN) <sub>2</sub> <sup>-</sup>	50	1.331
1/3Al <sup>3+</sup>	61	0.541	Au(CN) <sub>4</sub> <sup>-</sup>	36	0.959
1/2Ba <sup>2+</sup>	63.6	0.847	B(C <sub>6</sub> H <sub>5</sub> ) <sub>4</sub> <sup>-</sup>	21	0.559
1/2Be <sup>2+</sup>	45	0.599	Br <sup>-</sup>	78.1	2.080
1/2Ca <sup>2+</sup>	59.47	0.792	Br <sub>3</sub> <sup>-</sup>	43	1.145
1/2Cd <sup>2+</sup>	54	0.719	BrO <sub>3</sub> <sup>-</sup>	55.7	1.483
1/3Ce <sup>3+</sup>	69.8	0.620	CN <sup>-</sup>	78	2.077
1/2Co <sup>2+</sup>	55	0.732	CNO <sup>-</sup>	64.6	1.720
1/3[Co(NH <sub>3</sub> ) <sub>6</sub> ] <sup>3+</sup>	101.9	0.904	1/2CO <sub>3</sub> <sup>2-</sup>	69.3	0.923
1/3[Co(en) <sub>3</sub> ] <sup>3+</sup>	74.7	0.663	Cl <sup>-</sup>	76.31	2.032
1/6[Co <sub>2</sub> (trien) <sub>3</sub> ] <sup>6+</sup>	69	0.306	ClO <sub>2</sub> <sup>-</sup>	52	1.385
1/3Cr <sup>3+</sup>	67	0.595	ClO <sub>3</sub> <sup>-</sup>	64.6	1.720
Cs <sup>+</sup>	77.2	2.056	ClO <sub>4</sub> <sup>-</sup>	67.3	1.792
1/2Cu <sup>2+</sup>	53.6	0.714	1/3[Co(CN) <sub>6</sub> ] <sup>3-</sup>	98.9	0.878
D <sup>+</sup>	249.9	6.655	1/2CrO <sub>4</sub> <sup>2-</sup>	85	1.132
1/3Dy <sup>3+</sup>	65.6	0.582			
1/3Er <sup>3+</sup>	65.9	0.585			
1/3Eu <sup>3+</sup>	67.8	0.602			
1/2Fe <sup>2+</sup>	54	0.719			
1/3Fe <sup>3+</sup>	68	0.604			
1/3Gd <sup>3+</sup>	67.3	0.597			
H <sup>+</sup>	349.65	9.311			
1/2Hg <sup>2+</sup>	68.6	0.913			
1/2Hg <sup>2+</sup>	63.6	0.847			
1/3Ho <sup>3+</sup>	66.3	0.589			
K <sup>+</sup>	73.48	1.957			
1/3La <sup>3+</sup>	69.7	0.619			
Li <sup>+</sup>	38.66	1.029			
1/2Mg <sup>2+</sup>	53.0	0.706			
1/2Mn <sup>2+</sup>	53.5	0.712			
NH <sub>4</sub> <sup>+</sup>	73.5	1.957			
N <sub>2</sub> H <sub>5</sub> <sup>+</sup>	59	1.571			

Ion	$\Lambda_{\pm}$ $10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$D$ $10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ion	$\Lambda_{\pm}$ $10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$D$ $10^{-5} \text{ cm}^2 \text{ s}^{-1}$
F <sup>-</sup>	55.4	1.475	Histidyl <sup>+</sup>	23.0	0.612
1/4[Fe(CN) <sub>6</sub> ] <sup>4-</sup>	110.4	0.735	Hydroxyethyltrimethylarsonium <sup>+</sup>	39.4	1.049
1/3[Fe(CN) <sub>6</sub> ] <sup>3-</sup>	100.9	0.896	Methylammonium <sup>+</sup>	58.7	1.563
H <sub>2</sub> AsO <sub>4</sub> <sup>-</sup>	34	0.905	Octadecylpyridinium <sup>+</sup>	20	0.533
HCO <sub>3</sub> <sup>-</sup>	44.5	1.185	Octadecyltributylammonium <sup>+</sup>	16.6	0.442
HF <sub>2</sub> <sup>-</sup>	75	1.997	Octadecyltriethylammonium <sup>+</sup>	17.9	0.477
1/2HPO <sub>4</sub> <sup>2-</sup>	57	0.759	Octadecyltrimethylammonium <sup>+</sup>	19.9	0.530
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	36	0.959	Octadecyltripropylammonium <sup>+</sup>	17.2	0.458
H <sub>2</sub> PO <sub>2</sub> <sup>-</sup>	46	1.225	Octyltrimethylammonium <sup>+</sup>	26.5	0.706
HS <sup>-</sup>	65	1.731	Pentylammonium <sup>+</sup>	37	0.985
HSO <sub>3</sub> <sup>-</sup>	58	1.545	Piperidinium <sup>+</sup>	37.2	0.991
HSO <sub>4</sub> <sup>-</sup>	52	1.385	Propylammonium <sup>+</sup>	40.8	1.086
H <sub>2</sub> SbO <sub>4</sub> <sup>-</sup>	31	0.825	Pyrimidinium <sup>+</sup>	24.3	0.647
I <sup>-</sup>	76.8	2.045	Tetrabutylammonium <sup>+</sup>	19.5	0.519
IO <sub>3</sub> <sup>-</sup>	40.5	1.078	Tetradecyltrimethylammonium <sup>+</sup>	21.5	0.573
IO <sub>4</sub> <sup>-</sup>	54.5	1.451	Tetraethylammonium <sup>+</sup>	32.6	0.868
MnO <sub>4</sub> <sup>-</sup>	61.3	1.632	Tetramethylammonium <sup>+</sup>	44.9	1.196
1/2MoO <sub>4</sub> <sup>2-</sup>	74.5	1.984	Tetraispentylammonium <sup>+</sup>	17.9	0.477
N(CN) <sub>2</sub> <sup>-</sup>	54.5	1.451	Tetrapentylammonium <sup>+</sup>	17.5	0.466
NO <sub>2</sub> <sup>-</sup>	71.8	1.912	Tetrapropylammonium <sup>+</sup>	23.4	0.623
NO <sub>3</sub> <sup>-</sup>	71.42	1.902	Triethylammonium <sup>+</sup>	34.3	0.913
NH <sub>2</sub> SO <sub>3</sub> <sup>-</sup>	48.3	1.286	Triethylsulfonium <sup>+</sup>	36.1	0.961
N <sub>3</sub> <sup>-</sup>	69	1.837	Trimethylammonium <sup>+</sup>	47.23	1.258
OCN <sup>-</sup>	64.6	1.720	Trimethylhexylammonium <sup>+</sup>	34.6	0.921
OD <sup>-</sup>	119	3.169	Trimethylsulfonium <sup>+</sup>	51.4	1.369
OH <sup>-</sup>	198	5.273	Tripentylammonium <sup>+</sup>	26.1	0.695
PF <sub>6</sub> <sup>-</sup>	56.9	1.515			
1/2PO <sub>3</sub> F <sub>2</sub> <sup>-</sup>	63.3	0.843	<b>Organic Anions</b>		
1/3PO <sub>4</sub> <sup>3-</sup>	92.8	0.824	Acetate <sup>-</sup>	40.9	1.089
1/4P <sub>2</sub> O <sub>7</sub> <sup>4-</sup>	96	0.639	<i>p</i> -Anisate <sup>-</sup>	29.0	0.772
1/3P <sub>3</sub> O <sub>9</sub> <sup>3-</sup>	83.6	0.742	1/2Azelate <sup>2-</sup>	40.6	0.541
1/5P <sub>3</sub> O <sub>10</sub> <sup>5-</sup>	109	0.581	Benzoate <sup>-</sup>	32.4	0.863
ReO <sub>4</sub> <sup>-</sup>	54.9	1.462	Bromoacetate <sup>-</sup>	39.2	1.044
SCN <sup>-</sup>	66	1.758	Bromobenzoate <sup>-</sup>	30	0.799
1/2SO <sub>3</sub> <sup>2-</sup>	72	0.959	Butyrate <sup>-</sup>	32.6	0.868
1/2SO <sub>4</sub> <sup>2-</sup>	80.0	1.065	Chloroacetate <sup>-</sup>	39.8	1.060
1/2S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	85.0	1.132	<i>m</i> -Chlorobenzoate <sup>-</sup>	31	0.825
1/2S <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	66.5	0.885	<i>o</i> -Chlorobenzoate <sup>-</sup>	30.2	0.804
1/2S <sub>2</sub> O <sub>6</sub> <sup>2-</sup>	93	1.238	1/3Citrate <sup>3-</sup>	70.2	0.623
1/2S <sub>2</sub> O <sub>8</sub> <sup>2-</sup>	86	1.145	Crotonate <sup>-</sup>	33.2	0.884
Sb(OH) <sub>6</sub> <sup>-</sup>	31.9	0.849	Cyanoacetate <sup>-</sup>	43.4	1.156
SeCN <sup>-</sup>	64.7	1.723	Cyclohexane carboxylate <sup>-</sup>	28.7	0.764
1/2SeO <sub>4</sub> <sup>2-</sup>	75.7	1.008	1/2 1,1-Cyclopropanedicarboxylate <sup>2-</sup>	53.4	0.711
1/2WO <sub>4</sub> <sup>2-</sup>	69	0.919	Decylsulfate <sup>-</sup>	26	0.692
			Dichloroacetate <sup>-</sup>	38.3	1.020
<b>Organic Cations</b>			1/2Diethylbarbiturate <sup>2-</sup>	26.3	0.350
Benzyltrimethylammonium <sup>+</sup>	34.6	0.921	Dihydrogencitrate <sup>-</sup>	30	0.799
Isobutylammonium <sup>+</sup>	38	1.012	1/2Dimethylmalonate <sup>2-</sup>	49.4	0.658
Butyltrimethylammonium <sup>+</sup>	33.6	0.895	3,5-Dinitrobenzoate <sup>-</sup>	28.3	0.754
Decylpyridinium <sup>+</sup>	29.5	0.786	Dodecylsulfate <sup>-</sup>	24	0.639
Decyltrimethylammonium <sup>+</sup>	24.4	0.650	Ethylmalonate <sup>-</sup>	49.3	1.313
Diethylammonium <sup>+</sup>	42.0	1.118	Ethylsulfate <sup>-</sup>	39.6	1.055
Dimethylammonium <sup>+</sup>	51.8	1.379	Fluoroacetate <sup>-</sup>	44.4	1.182
Dipropylammonium <sup>+</sup>	30.1	0.802	Fluorobenzoate <sup>-</sup>	33	0.879
Dodecylammonium <sup>+</sup>	23.8	0.634	Formate <sup>-</sup>	54.6	1.454
Dodecyltrimethylammonium <sup>+</sup>	22.6	0.602	1/2Fumarate <sup>2-</sup>	61.8	0.823
Ethanolammonium <sup>+</sup>	42.2	1.124	1/2Glutarate <sup>2-</sup>	52.6	0.700
Ethylammonium <sup>+</sup>	47.2	1.257	Hydrogenoxalate <sup>-</sup>	40.2	1.070
Ethyltrimethylammonium <sup>+</sup>	40.5	1.078	Isovalerate <sup>-</sup>	32.7	0.871
Hexadecyltrimethylammonium <sup>+</sup>	20.9	0.557	Iodoacetate <sup>-</sup>	40.6	1.081
Hexyltrimethylammonium <sup>+</sup>	29.6	0.788	Lactate <sup>-</sup>	38.8	1.033

Ion	$\Lambda_{\pm}$	$D$	Ion	$\Lambda_{\pm}$	$D$
	$10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$10^{-5} \text{ cm}^2 \text{ s}^{-1}$		$10^{-4} \text{ m}^2 \text{ S mol}^{-1}$	$10^{-5} \text{ cm}^2 \text{ s}^{-1}$
1/2Malate <sup>2-</sup>	58.8	0.783	Picrate <sup>-</sup>	30.37	0.809
1/2Maleate <sup>2-</sup>	61.9	0.824	Pivalate <sup>-</sup>	31.9	0.849
1/2Malonate <sup>2-</sup>	63.5	0.845	Propionate <sup>-</sup>	35.8	0.953
Methylsulfate <sup>-</sup>	48.8	1.299	Propylsulfate <sup>-</sup>	37.1	0.988
Naphthylacetate <sup>-</sup>	28.4	0.756	Salicylate <sup>-</sup>	36	0.959
1/2Oxalate <sup>2-</sup>	74.11	0.987	1/2Suberate <sup>2-</sup>	36	0.479
Octylsulfate <sup>-</sup>	29	0.772	1/2Succinate <sup>2-</sup>	58.8	0.783
Phenylacetate <sup>-</sup>	30.6	0.815	<i>p</i> -Sulfonate	29.3	0.780
1/2 <i>o</i> -Phthalate <sup>2-</sup>	52.3	0.696	1/2Tartarate <sup>2-</sup>	59.6	0.794
1/2 <i>m</i> -Phthalate <sup>2-</sup>	54.7	0.728	Trichloroacetate <sup>-</sup>	35	0.932

# ACTIVITY COEFFICIENTS OF ACIDS, BASES, AND SALTS

Petr Vanýsek

This table gives mean activity coefficients at 25°C for molalities in the range 0.1 to 1.0. See the following table for definitions, refer-

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
AgNO <sub>3</sub>	0.734	0.657	0.606	0.567	0.536	0.509	0.485	0.464	0.446	0.429
AlCl <sub>3</sub>	0.337	0.305	0.302	0.313	0.331	0.356	0.388	0.429	0.479	0.539
Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	0.035	0.0225	0.0176	0.0153	0.0143	0.014	0.0142	0.0149	0.0159	0.0175
BaCl <sub>2</sub>	0.500	0.444	0.419	0.405	0.397	0.391	0.391	0.391	0.392	0.395
BeSO <sub>4</sub>	0.150	0.109	0.0885	0.0769	0.0692	0.0639	0.0600	0.0570	0.0546	0.0530
CaCl <sub>2</sub>	0.518	0.472	0.455	0.448	0.448	0.453	0.460	0.470	0.484	0.500
CdCl <sub>2</sub>	0.2280	0.1638	0.1329	0.1139	0.1006	0.0905	0.0827	0.0765	0.0713	0.0669
Cd(NO <sub>3</sub> ) <sub>2</sub>	0.513	0.464	0.442	0.430	0.425	0.423	0.423	0.425	0.428	0.433
CdSO <sub>4</sub>	0.150	0.103	0.0822	0.0699	0.0615	0.0553	0.0505	0.0468	0.0438	0.0415
CoCl <sub>2</sub>	0.522	0.479	0.463	0.459	0.462	0.470	0.479	0.492	0.511	0.531
CrCl <sub>3</sub>	0.331	0.298	0.294	0.300	0.314	0.335	0.362	0.397	0.436	0.481
Cr(NO <sub>3</sub> ) <sub>3</sub>	0.319	0.285	0.279	0.281	0.291	0.304	0.322	0.344	0.371	0.401
Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	0.0458	0.0300	0.0238	0.0207	0.0190	0.0182	0.0181	0.0185	0.0194	0.0208
CsBr	0.754	0.694	0.654	0.626	0.603	0.586	0.571	0.558	0.547	0.538
CsCl	0.756	0.694	0.656	0.628	0.606	0.589	0.575	0.563	0.553	0.544
CsI	0.754	0.692	0.651	0.621	0.599	0.581	0.567	0.554	0.543	0.533
CsNO <sub>3</sub>	0.733	0.655	0.602	0.561	0.528	0.501	0.478	0.458	0.439	0.422
CsOH	0.795	0.761	0.744	0.739	0.739	0.742	0.748	0.754	0.762	0.771
CsOAc	0.799	0.771	0.761	0.759	0.762	0.768	0.776	0.783	0.792	0.802
Cs <sub>2</sub> SO <sub>4</sub>	0.456	0.382	0.338	0.311	0.291	0.274	0.262	0.251	0.242	0.235
CuCl <sub>2</sub>	0.508	0.455	0.429	0.417	0.411	0.409	0.409	0.410	0.413	0.417
Cu(NO <sub>3</sub> ) <sub>2</sub>	0.511	0.460	0.439	0.429	0.426	0.427	0.431	0.437	0.445	0.455
CuSO <sub>4</sub>	0.150	0.104	0.0829	0.0704	0.0620	0.0559	0.0512	0.0475	0.0446	0.0423
FeCl <sub>2</sub>	0.5185	0.473	0.454	0.448	0.450	0.454	0.463	0.473	0.488	0.506
HBr	0.805	0.782	0.777	0.781	0.789	0.801	0.815	0.832	0.850	0.871
HCl	0.796	0.767	0.756	0.755	0.757	0.763	0.772	0.783	0.795	0.809
HClO <sub>4</sub>	0.803	0.778	0.768	0.766	0.769	0.776	0.785	0.795	0.808	0.823
HI	0.818	0.807	0.811	0.823	0.839	0.860	0.883	0.908	0.935	0.963
HNO <sub>3</sub>	0.791	0.754	0.735	0.725	0.720	0.717	0.717	0.718	0.721	0.724
H <sub>2</sub> SO <sub>4</sub>	0.2655	0.2090	0.1826	—	0.1557	—	0.1417	—	—	0.1316
KBr	0.772	0.722	0.693	0.673	0.657	0.646	0.636	0.629	0.622	0.617
KCl	0.770	0.718	0.688	0.666	0.649	0.637	0.626	0.618	0.610	0.604
KClO <sub>3</sub>	0.749	0.681	0.635	0.599	0.568	0.541	0.518	—	—	—
K <sub>2</sub> CrO <sub>4</sub>	0.456	0.382	0.340	0.313	0.292	0.276	0.263	0.253	0.243	0.235
KF	0.775	0.727	0.700	0.682	0.670	0.661	0.654	0.650	0.646	0.645
K <sub>3</sub> Fe(CN) <sub>6</sub>	0.268	0.212	0.184	0.167	0.155	0.146	0.140	0.135	0.131	0.128
K <sub>4</sub> Fe(CN) <sub>6</sub>	0.139	0.0993	0.0808	0.0693	0.0614	0.0556	0.0512	0.0479	0.0454	—
KH <sub>2</sub> PO <sub>4</sub>	0.731	0.653	0.602	0.561	0.529	0.501	0.477	0.456	0.438	0.421
KI	0.778	0.733	0.707	0.689	0.676	0.667	0.660	0.654	0.649	0.645
KNO <sub>3</sub>	0.739	0.663	0.614	0.576	0.545	0.519	0.496	0.476	0.459	0.443
KOAc	0.796	0.766	0.754	0.750	0.751	0.754	0.759	0.766	0.774	0.783
KOH	0.798	0.760	0.742	0.734	0.732	0.733	0.736	0.742	0.749	0.756
KSCN	0.769	0.716	0.685	0.663	0.646	0.633	0.623	0.614	0.606	0.599
K <sub>2</sub> SO <sub>4</sub>	0.441	0.360	0.316	0.286	0.264	0.246	0.232	—	—	—
LiBr	0.796	0.766	0.756	0.752	0.753	0.758	0.767	0.777	0.789	0.803
LiCl	0.790	0.757	0.744	0.740	0.739	0.743	0.748	0.755	0.764	0.774
LiClO <sub>4</sub>	0.812	0.794	0.792	0.798	0.808	0.820	0.834	0.852	0.869	0.887
LiI	0.815	0.802	0.804	0.813	0.824	0.838	0.852	0.870	0.888	0.910
LiNO <sub>3</sub>	0.788	0.752	0.736	0.728	0.726	0.727	0.729	0.733	0.737	0.743
LiOH	0.760	0.702	0.665	0.638	0.617	0.599	0.585	0.573	0.563	0.554
LiOAc	0.784	0.742	0.721	0.709	0.700	0.691	0.689	0.688	0.688	0.689
Li <sub>2</sub> SO <sub>4</sub>	0.468	0.398	0.361	0.337	0.319	0.307	0.297	0.289	0.282	0.277
MgCl <sub>2</sub>	0.529	0.489	0.477	0.475	0.481	0.491	0.506	0.522	0.544	0.570
MgSO <sub>4</sub>	0.150	0.107	0.0874	0.0756	0.0675	0.0616	0.0571	0.0536	0.0508	0.0485

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
MnCl <sub>2</sub>	0.516	0.469	0.450	0.442	0.440	0.443	0.448	0.455	0.466	0.479
MnSO <sub>4</sub>	0.150	0.105	0.0848	0.0725	0.0640	0.0578	0.0530	0.0493	0.0463	0.0439
NH <sub>4</sub> Cl	0.770	0.718	0.687	0.665	0.649	0.636	0.625	0.617	0.609	0.603
NH <sub>4</sub> NO <sub>3</sub>	0.740	0.677	0.636	0.606	0.582	0.562	0.545	0.530	0.516	0.504
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	0.439	0.356	0.311	0.280	0.257	0.240	0.226	0.214	0.205	0.196
NaBr	0.782	0.741	0.719	0.704	0.697	0.692	0.689	0.687	0.687	0.687
NaCl	0.778	0.735	0.710	0.693	0.681	0.673	0.667	0.662	0.659	0.657
NaClO <sub>3</sub>	0.772	0.720	0.688	0.664	0.645	0.630	0.617	0.606	0.597	0.589
NaClO <sub>4</sub>	0.775	0.729	0.701	0.683	0.668	0.656	0.648	0.641	0.635	0.629
Na <sub>2</sub> CrO <sub>4</sub>	0.464	0.394	0.353	0.327	0.307	0.292	0.280	0.269	0.261	0.253
NaF	0.765	0.710	0.676	0.651	0.632	0.616	0.603	0.592	0.582	0.573
NaH <sub>2</sub> PO <sub>4</sub>	0.744	0.675	0.629	0.593	0.563	0.539	0.517	0.499	0.483	0.468
NaI	0.787	0.751	0.735	0.727	0.723	0.723	0.724	0.727	0.731	0.736
NaNO <sub>3</sub>	0.762	0.703	0.666	0.638	0.617	0.599	0.583	0.570	0.558	0.548
NaOAc	0.791	0.757	0.744	0.737	0.735	0.736	0.740	0.745	0.752	0.757
NaOH	0.766	0.727	0.708	0.697	0.690	0.685	0.681	0.679	0.678	0.678
NaSCN	0.787	0.750	—	0.720	0.715	0.712	0.710	0.710	0.711	0.712
Na <sub>2</sub> SO <sub>4</sub>	0.445	0.365	0.320	0.289	0.266	0.248	0.233	0.221	0.210	0.201
NiCl <sub>2</sub>	0.522	0.479	0.463	0.460	0.464	0.471	0.482	0.496	0.515	0.563
NiSO <sub>4</sub>	0.150	0.105	0.0841	0.0713	0.0627	0.0562	0.0515	0.0478	0.0448	0.0425
Pb(NO <sub>3</sub> ) <sub>2</sub>	0.395	0.308	0.260	0.228	0.205	0.187	0.172	0.160	0.150	0.141
RbBr	0.763	0.706	0.673	0.650	0.632	0.617	0.605	0.595	0.586	0.578
RbCl	0.764	0.709	0.675	0.652	0.634	0.620	0.608	0.599	0.590	0.583
RbI	0.762	0.705	0.671	0.647	0.629	0.614	0.602	0.591	0.583	0.575
RbNO <sub>3</sub>	0.734	0.658	0.606	0.565	0.534	0.508	0.485	0.465	0.446	0.430
RbOAc	0.796	0.767	0.756	0.753	0.755	0.759	0.766	0.773	0.782	0.792
Rb <sub>2</sub> SO <sub>4</sub>	0.451	0.374	0.331	0.301	0.279	0.263	0.249	0.238	0.228	0.219
SrCl <sub>2</sub>	0.511	0.462	0.442	0.433	0.430	0.431	0.434	0.441	0.449	0.461
TlClO <sub>4</sub>	0.730	0.652	0.599	0.559	0.527	—	—	—	—	—
TlNO <sub>3</sub>	0.702	0.606	0.545	0.500	—	—	—	—	—	—
UO <sub>2</sub> Cl <sub>2</sub>	0.544	0.510	0.520	0.505	0.517	0.532	0.549	0.571	0.595	0.620
UO <sub>2</sub> SO <sub>4</sub>	0.150	0.102	0.0807	0.0689	0.0611	0.0566	0.0515	0.0483	0.0458	0.0439
ZnCl <sub>2</sub>	0.515	0.462	0.432	0.411	0.394	0.380	0.369	0.357	0.348	0.339
Zn(NO <sub>3</sub> ) <sub>2</sub>	0.531	0.489	0.474	0.469	0.473	0.480	0.489	0.501	0.518	0.535
ZnSO <sub>4</sub>	0.150	0.140	0.0835	0.0714	0.0630	0.0569	0.0523	0.0487	0.0458	0.0435



# MEAN ACTIVITY COEFFICIENTS OF ELECTROLYTES AS A FUNCTION OF CONCENTRATION

The mean activity coefficient  $\gamma$  of an electrolyte  $X_a Y_b$  is defined as

$$\gamma = (\gamma_+^a \gamma_-^b)^{1/(a+b)}$$

where  $\gamma_+$  and  $\gamma_-$  are activity coefficients of the individual ions (which cannot be directly measured). This table gives the mean activity coefficients of about 100 electrolytes in aqueous solution as a function of concentration, expressed in molality terms. All

values refer to a temperature of 25°C. Substances are arranged in alphabetical order by formula.

## References

1. Hamer, W. J., and Wu, Y. C., *J. Phys. Chem. Ref. Data*, 1, 1047, 1972.
2. Staples, B. R., *J. Phys. Chem. Ref. Data*, 6, 385, 1977; 10, 767, 1981; 10, 779, 1981.
3. Goldberg, R. N. et al., *J. Phys. Chem. Ref. Data*, 7, 263, 1978; 8, 923, 1979; 8, 1005, 1979; 10, 1, 1981; 10, 671, 1981.

### Mean Activity Coefficient at 25°C

<i>m</i> /mol kg <sup>-1</sup>	<b>AgNO<sub>3</sub></b>	<b>BaBr<sub>2</sub></b>	<b>BaCl<sub>2</sub></b>	<b>BaI<sub>2</sub></b>	<b>CaBr<sub>2</sub></b>	<b>CaCl<sub>2</sub></b>	<b>CaI<sub>2</sub></b>
0.001	0.964	0.881	0.887	0.890	0.890	0.888	0.890
0.002	0.950	0.850	0.849	0.853	0.853	0.851	0.853
0.005	0.924	0.785	0.782	0.792	0.791	0.787	0.791
0.010	0.896	0.727	0.721	0.737	0.735	0.727	0.736
0.020	0.859	0.661	0.653	0.678	0.674	0.664	0.677
0.050	0.794	0.573	0.559	0.600	0.594	0.577	0.600
0.100	0.732	0.517	0.492	0.551	0.540	0.517	0.552
0.200	0.656	0.463	0.436	0.520	0.502	0.469	0.524
0.500	0.536	0.435	0.391	0.536	0.500	0.444	0.554
1.000	0.430	0.470	0.393	0.664	0.604	0.495	0.729
2.000	0.316	0.654		1.242	1.125	0.784	
5.000	0.181				18.7	5.907	
10.000	0.108					43.1	
15.000	0.085						
<i>m</i> /mol kg <sup>-1</sup>	<b>Cd(NO<sub>2</sub>)<sub>2</sub></b>	<b>Cd(NO<sub>3</sub>)<sub>2</sub></b>	<b>CoBr<sub>2</sub></b>	<b>CoCl<sub>2</sub></b>	<b>CoI<sub>2</sub></b>	<b>Co(NO<sub>3</sub>)<sub>2</sub></b>	<b>CsBr</b>
0.001	0.881	0.888	0.890	0.889	0.887	0.888	0.965
0.002	0.837	0.851	0.854	0.852	0.849	0.850	0.951
0.005	0.759	0.787	0.794	0.789	0.783	0.786	0.925
0.010	0.681	0.728	0.740	0.732	0.724	0.728	0.898
0.020	0.589	0.664	0.681	0.670	0.661	0.663	0.864
0.050	0.451	0.576	0.605	0.586	0.582	0.576	0.806
0.100	0.344	0.515	0.556	0.528	0.540	0.516	0.752
0.200	0.247	0.465	0.523	0.483	0.527	0.469	0.691
0.500	0.148	0.428	0.538	0.465	0.596	0.446	0.605
1.000	0.098	0.437	0.685	0.532	0.845	0.492	0.540
2.000	0.069	0.517	1.421	0.864	2.287	0.722	0.485
5.000	0.054		13.9		55.3	3.338	0.454
10.000					196		
<i>m</i> /mol kg <sup>-1</sup>	<b>CsCl</b>	<b>CsF</b>	<b>CsI</b>	<b>CsNO<sub>3</sub></b>	<b>CsOH</b>	<b>Cs<sub>2</sub>SO<sub>4</sub></b>	<b>CuBr<sub>2</sub></b>
0.001	0.965	0.965	0.965	0.964	0.966	0.885	0.889
0.002	0.951	0.952	0.951	0.951	0.953	0.845	0.853
0.005	0.925	0.929	0.925	0.924	0.930	0.775	0.791
0.010	0.898	0.905	0.898	0.897	0.906	0.709	0.735
0.020	0.864	0.876	0.863	0.860	0.878	0.634	0.674
0.050	0.805	0.830	0.804	0.796	0.836	0.526	0.594
0.100	0.751	0.792	0.749	0.733	0.802	0.444	0.541
0.200	0.691	0.755	0.688	0.655	0.772	0.369	0.504
0.500	0.607	0.721	0.601	0.529	0.755	0.285	0.503
1.000	0.546	0.726	0.534	0.421	0.782	0.233	0.591
2.000	0.496	0.803	0.470				0.859
5.000	0.474						
10.000	0.508						

## Mean Activity Coefficients of Electrolytes as a Function of Concentration

$m/\text{mol kg}^{-1}$	$\text{CuCl}_2$	$\text{Cu}(\text{ClO}_4)_2$	$\text{Cu}(\text{NO}_3)_2$	$\text{FeCl}_2$	$\text{HBr}$	$\text{HCl}$	$\text{HClO}_4$
0.001	0.887	0.890	0.888	0.888	0.966	0.965	0.966
0.002	0.849	0.854	0.851	0.850	0.953	0.952	0.953
0.005	0.783	0.795	0.787	0.785	0.930	0.929	0.929
0.010	0.722	0.741	0.729	0.725	0.907	0.905	0.906
0.020	0.654	0.685	0.664	0.659	0.879	0.876	0.878
0.050	0.561	0.613	0.577	0.570	0.837	0.832	0.836
0.100	0.495	0.572	0.516	0.509	0.806	0.797	0.803
0.200	0.441	0.553	0.466	0.462	0.783	0.768	0.776
0.500	0.401	0.617	0.431	0.443	0.790	0.759	0.769
1.000	0.405	0.892	0.456	0.500	0.872	0.811	0.826
2.000	0.453	2.445	0.615	0.782	1.167	1.009	1.055
5.000	0.601		2.083		3.800	2.380	3.100
10.000					33.4	10.4	30.8
15.000							323

$m/\text{mol kg}^{-1}$	$\text{HF}$	$\text{HI}$	$\text{HNO}_3$	$\text{H}_2\text{SO}_4$	$\text{KBr}$	$\text{KCNS}$	$\text{KCl}$
0.001	0.551	0.966	0.965	0.804	0.965	0.965	0.965
0.002	0.429	0.953	0.952	0.740	0.952	0.951	0.951
0.005	0.302	0.931	0.929	0.634	0.927	0.927	0.927
0.010	0.225	0.909	0.905	0.542	0.902	0.901	0.901
0.020	0.163	0.884	0.875	0.445	0.870	0.869	0.869
0.050	0.106	0.847	0.829	0.325	0.817	0.815	0.816
0.100	0.0766	0.823	0.792	0.251	0.771	0.768	0.768
0.200	0.0550	0.811	0.756	0.195	0.772	0.716	0.717
0.500	0.0352	0.845	0.725	0.146	0.658	0.647	0.649
1.000	0.0249	0.969	0.730	0.125	0.617	0.598	0.604
2.000	0.0175	1.363	0.788	0.119	0.593	0.556	0.573
5.000	0.0110	4.760	1.063	0.197	0.626	0.525	0.593
10.000	0.0085	49.100	1.644	0.527			
15.000	0.0077		2.212	1.077			
20.000	0.0075		2.607	1.701			

$m/\text{mol kg}^{-1}$	$\text{KClO}_3$	$\text{K}_2\text{CrO}_4$	$\text{KF}$	$\text{KH}_2\text{PO}_4^*$	$\text{K}_2\text{HPO}_4^{**}$	$\text{KI}$	$\text{KNO}_3$
0.001	0.965	0.886	0.965	0.964	0.886	0.965	0.964
0.002	0.951	0.847	0.952	0.950	0.847	0.952	0.950
0.005	0.926	0.779	0.927	0.924	0.779	0.927	0.924
0.010	0.899	0.715	0.902	0.896	0.715	0.902	0.896
0.020	0.865	0.643	0.870	0.859	0.643	0.871	0.860
0.050	0.805	0.539	0.818	0.793	0.538	0.820	0.797
0.100	0.749	0.460	0.773	0.730	0.457	0.776	0.735
0.200	0.681	0.385	0.726	0.652	0.379	0.731	0.662
0.500	0.569	0.296	0.670	0.529	0.283	0.676	0.546
1.000		0.239	0.645	0.422		0.646	0.444
2.000		0.199	0.658			0.638	0.332
5.000			0.871				
10.000			1.715				
15.000			3.120				

$m/\text{mol kg}^{-1}$	$\text{KOH}$	$\text{K}_2\text{SO}_4$	$\text{LiBr}$	$\text{LiCl}$	$\text{LiClO}_4$	$\text{LiI}$	$\text{LiNO}_3$
0.001	0.965	0.885	0.965	0.965	0.966	0.966	0.965
0.002	0.952	0.844	0.952	0.952	0.953	0.953	0.952
0.005	0.927	0.772	0.929	0.928	0.931	0.930	0.928
0.010	0.902	0.704	0.905	0.904	0.908	0.908	0.904
0.020	0.871	0.625	0.877	0.874	0.882	0.882	0.874
0.050	0.821	0.511	0.832	0.827	0.843	0.843	0.827
0.100	0.779	0.424	0.797	0.789	0.815	0.817	0.788
0.200	0.740	0.343	0.767	0.756	0.795	0.802	0.753
0.500	0.710	0.251	0.754	0.739	0.806	0.824	0.726
1.000	0.733		0.803	0.775	0.887	0.912	0.743
2.000	0.860		1.012	0.924	1.161	1.197	0.837
5.000	1.697		2.696	2.000			1.298

$m/\text{mol kg}^{-1}$	<b>KOH</b>	<b>K<sub>2</sub>SO<sub>4</sub></b>	<b>LiBr</b>	<b>LiCl</b>	<b>LiClO<sub>4</sub></b>	<b>LiI</b>	<b>LiNO<sub>3</sub></b>
10.000	6.110		20.0	9.600			2.500
15.000	19.9		147	30.9			3.960
20.000	46.4		486				4.970
$m/\text{mol kg}^{-1}$	<b>LiOH</b>	<b>Li<sub>2</sub>SO<sub>4</sub></b>	<b>MgBr<sub>2</sub></b>	<b>MgCl<sub>2</sub></b>	<b>MgI<sub>2</sub></b>	<b>MnBr<sub>2</sub></b>	<b>MnCl<sub>2</sub></b>
0.001	0.964	0.887	0.889	0.889	0.889	0.889	0.888
0.002	0.950	0.847	0.852	0.852	0.853	0.853	0.850
0.005	0.923	0.780	0.790	0.790	0.791	0.791	0.786
0.010	0.895	0.716	0.733	0.734	0.736	0.735	0.727
0.020	0.858	0.645	0.672	0.672	0.677	0.674	0.662
0.050	0.794	0.544	0.593	0.590	0.602	0.595	0.574
0.100	0.735	0.469	0.543	0.535	0.556	0.543	0.513
0.200	0.668	0.400	0.512	0.493	0.535	0.508	0.464
0.500	0.579	0.325	0.540	0.485	0.594	0.519	0.437
1.000	0.522	0.284	0.715	0.577	0.858	0.650	0.477
2.000	0.484	0.270	1.590	1.065	2.326	1.224	0.661
5.000	0.493		36.1	14.40	109.8	6.697	1.539
$m/\text{mol kg}^{-1}$	<b>Mn(ClO<sub>4</sub>)<sub>2</sub></b>	<b>NH<sub>4</sub>Cl</b>	<b>NH<sub>4</sub>ClO<sub>4</sub></b>	<b>(NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub>**</b>	<b>NH<sub>4</sub>NO<sub>3</sub></b>	<b>NaBr</b>	<b>NaBrO<sub>3</sub></b>
0.001	0.892	0.965	0.964	0.882	0.964	0.965	0.965
0.002	0.858	0.952	0.950	0.839	0.951	0.952	0.951
0.005	0.801	0.927	0.924	0.763	0.925	0.928	0.926
0.010	0.752	0.901	0.895	0.688	0.897	0.903	0.900
0.020	0.700	0.869	0.859	0.600	0.862	0.873	0.867
0.050	0.637	0.816	0.794	0.469	0.801	0.824	0.811
0.100	0.604	0.769	0.734	0.367	0.744	0.783	0.759
0.200	0.596	0.718	0.663	0.273	0.678	0.742	0.698
0.500	0.686	0.649	0.560	0.171	0.582	0.697	0.605
1.000	1.030	0.603	0.479	0.114	0.502	0.687	0.528
2.000	3.072	0.569	0.399	0.074	0.419	0.730	0.449
5.000		0.563			0.303	1.083	
10.000					0.220		
15.000					0.179		
20.000					0.154		
$m/\text{mol kg}^{-1}$	<b>Na<sub>2</sub>CO<sub>3</sub></b>	<b>NaCl</b>	<b>NaClO<sub>3</sub></b>	<b>NaClO<sub>4</sub></b>	<b>Na<sub>2</sub>CrO<sub>4</sub></b>	<b>NaF</b>	<b>Na<sub>2</sub>HPO<sub>4</sub>*</b>
0.001	0.887	0.965	0.965	0.965	0.887	0.965	0.887
0.002	0.847	0.952	0.952	0.952	0.849	0.951	0.848
0.005	0.780	0.928	0.927	0.928	0.783	0.926	0.780
0.010	0.716	0.903	0.902	0.903	0.722	0.901	0.717
0.020	0.644	0.872	0.870	0.872	0.653	0.868	0.644
0.050	0.541	0.822	0.818	0.821	0.554	0.813	0.539
0.100	0.462	0.779	0.771	0.777	0.479	0.764	0.456
0.200	0.385	0.734	0.719	0.729	0.406	0.710	0.373
0.500	0.292	0.681	0.646	0.668	0.318	0.633	0.266
1.000	0.229	0.657	0.590	0.630	0.261	0.573	0.191
2.000	0.182	0.668	0.537	0.608	0.231		0.133
5.000		0.874		0.648			
$m/\text{mol kg}^{-1}$	<b>NaI</b>	<b>NaNO<sub>3</sub></b>	<b>NaOH</b>	<b>Na<sub>2</sub>SO<sub>3</sub></b>	<b>Na<sub>2</sub>SO<sub>4</sub></b>	<b>Na<sub>2</sub>WO<sub>4</sub></b>	<b>NiBr<sub>2</sub></b>
0.001	0.965	0.965	0.965	0.887	0.886	0.886	0.889
0.002	0.952	0.951	0.952	0.847	0.846	0.846	0.853
0.005	0.928	0.926	0.927	0.779	0.777	0.777	0.791
0.010	0.904	0.900	0.902	0.716	0.712	0.712	0.735
0.020	0.874	0.866	0.870	0.644	0.637	0.638	0.675
0.050	0.827	0.810	0.819	0.540	0.529	0.534	0.596
0.100	0.789	0.759	0.775	0.462	0.446	0.457	0.546
0.200	0.753	0.701	0.731	0.386	0.366	0.388	0.514
0.500	0.722	0.617	0.685	0.296	0.268	0.320	0.535
1.000	0.734	0.550	0.674	0.237	0.204	0.291	0.692
2.000	0.823	0.480	0.714	0.196	0.155	0.291	1.476

## Mean Activity Coefficients of Electrolytes as a Function of Concentration

$m/\text{mol kg}^{-1}$	NaI	NaNO <sub>3</sub>	NaOH	Na <sub>2</sub> SO <sub>3</sub>	Na <sub>2</sub> SO <sub>4</sub>	Na <sub>2</sub> WO <sub>4</sub>	NiBr <sub>2</sub>
5.000	1.402	0.388	1.076				
10.000	4.011	0.329	3.258				
15.000			9.796				
20.000			19.410				

$m/\text{mol kg}^{-1}$	NiCl <sub>2</sub>	Ni(ClO <sub>4</sub> ) <sub>2</sub>	Ni(NO <sub>3</sub> ) <sub>2</sub>	Pb(ClO <sub>4</sub> ) <sub>2</sub>	Pb(NO <sub>3</sub> ) <sub>2</sub>	RbBr	RbCl
0.001	0.889	0.891	0.889	0.889	0.882	0.965	0.965
0.002	0.852	0.855	0.851	0.851	0.840	0.951	0.951
0.005	0.789	0.797	0.787	0.787	0.764	0.926	0.926
0.010	0.732	0.745	0.730	0.729	0.690	0.900	0.900
0.020	0.669	0.690	0.666	0.666	0.604	0.866	0.867
0.050	0.584	0.621	0.581	0.580	0.476	0.811	0.811
0.100	0.527	0.582	0.524	0.522	0.379	0.760	0.761
0.200	0.482	0.567	0.481	0.476	0.291	0.705	0.707
0.500	0.465	0.639	0.467	0.458	0.195	0.630	0.633
1.000	0.538	0.946	0.528	0.516	0.136	0.578	0.583
2.000	0.915	2.812	0.797	0.799		0.535	0.546
5.000	4.785			4.043		0.514	0.544
10.000				33.8			

$m/\text{mol kg}^{-1}$	RbF	RbI	RbNO <sub>3</sub>	Rb <sub>2</sub> SO <sub>4</sub>	SrBr <sub>2</sub>	SrCl <sub>2</sub>	SrI <sub>2</sub>
0.001	0.965	0.965	0.964	0.886	0.889	0.888	0.890
0.002	0.952	0.951	0.950	0.845	0.852	0.850	0.854
0.005	0.927	0.926	0.924	0.776	0.790	0.785	0.793
0.010	0.902	0.900	0.896	0.710	0.734	0.725	0.740
0.020	0.871	0.866	0.859	0.635	0.673	0.659	0.681
0.050	0.821	0.810	0.795	0.526	0.591	0.569	0.606
0.100	0.780	0.759	0.733	0.443	0.535	0.506	0.557
0.200	0.739	0.703	0.657	0.365	0.492	0.455	0.526
0.500	0.701	0.627	0.536	0.274	0.476	0.421	0.542
1.000	0.697	0.574	0.430	0.217	0.545	0.451	0.686
2.000	0.724	0.532	0.320		0.921	0.650	
5.000		0.517					

$m/\text{mol kg}^{-1}$	UO <sub>2</sub> Cl <sub>2</sub>	UO <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	ZnBr <sub>2</sub>	ZnCl <sub>2</sub>	ZnI <sub>2</sub>
0.001	0.888	0.888	0.890	0.887	0.893
0.002	0.851	0.849	0.854	0.847	0.859
0.005	0.787	0.784	0.794	0.781	0.804
0.010	0.729	0.726	0.741	0.719	0.757
0.020	0.666	0.663	0.683	0.652	0.708
0.050	0.583	0.583	0.606	0.561	0.644
0.100	0.529	0.535	0.553	0.499	0.601
0.200	0.493	0.509	0.515	0.447	0.574
0.500	0.501	0.532	0.516	0.384	0.635
1.000	0.601	0.673	0.558	0.330	0.836
2.000	0.948	1.223	0.578	0.283	1.062
5.000		3.020	0.788	0.342	1.546
10.000			2.317	0.876	4.698
15.000			5.381	1.914	
20.000			7.965	2.968	

\* The anion is H<sub>2</sub>PO<sub>4</sub><sup>-</sup>.\*\* The anion is HPO<sub>4</sub><sup>-2</sup>.

## ENTHALPY OF DILUTION OF ACIDS

The quantity given in this table is  $-\Delta_{\text{dil}}H$ , the negative of the enthalpy (heat) of dilution to infinite dilution for aqueous solutions of several common acids; i.e., the negative of the enthalpy change when a solution of molality  $m$  at a temperature of 25°C is diluted with an infinite amount of water. The tabulated numbers thus represent the heat produced (or, if the value is negative, the heat absorbed) when the acid is diluted. The initial molality  $m$  is given in the first column. The second column gives the dilution ratio, which is the number of moles of water that must be added

to one mole of the acid to produce a solution of the molality in the first column.

### Reference

Parker, V. B., *Thermal Properties of Aqueous Uni-Univalent Electrolytes*, Natl. Stand. Ref. Data Ser. - Natl. Bur. Stand. (U.S.) 2, U.S. Government Printing Office, 1965.

$m$	Dil. ratio	$-\Delta_{\text{dil}}H$ in kJ/mol at 25°C							
		HF	HCl	HClO <sub>4</sub>	HBr	HI	HNO <sub>3</sub>	CH <sub>2</sub> O <sub>2</sub>	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>
55.506	1.0		45.61		48.83		19.73	0.046	2.167
20	2.775	14.88	19.87	13.81	19.92	21.71	9.498	0.038	2.075
15	3.700	14.34	15.40	7.920	14.29	14.02	6.883	0.109	1.962
10	5.551	13.87	10.24	2.013	8.694	7.615	3.933	0.205	1.824
9	6.167	13.81	9.213	1.280	7.719	6.569	3.368	0.230	1.782
8	6.938	13.77	8.201	0.611	6.786	5.607	2.791	0.255	1.724
7	7.929	13.73	7.217	0.046	5.925	4.728	2.251	0.272	1.648
6	9.251	13.69	6.268	-0.351	5.004	3.975	1.749	0.280	1.540
5.5506	10	13.66	5.841	-0.490	4.590	3.577	1.540	0.285	1.477
5	11.10	13.62	5.318	-0.628	4.113	3.197	1.310	0.289	1.393
4.5	12.33	13.58	4.899	-0.732	3.711	2.828	1.109	0.289	1.310
4	13.88	13.53	4.402	-0.787	3.330	2.460	0.958	0.289	1.218
3.5	15.86	13.47	3.958	-0.820	2.966	2.105	0.791	0.289	1.121
3	18.50	13.45	3.506	-0.782	2.611	1.787	0.665	0.289	1.025
2.5	22.20	13.43	3.063	-0.724	2.301	1.527	0.582	0.285	0.912
2	27.75	13.40	2.623	-0.623	1.996	1.318	0.527	0.276	0.803
1.5	37.00	13.36	2.167	-0.431	1.665	1.125	0.506	0.259	0.678
1	55.51	13.30	1.695	-0.201	1.314	0.933	0.506	0.226	0.544
0.5551	100	13.22	1.234	0.050	0.983	0.736	0.502	0.184	0.423
0.5	111.0	13.20	1.172	0.075	0.941	0.711	0.498	0.176	0.406
0.2	277.5	13.09	0.761	0.247	0.649	0.536	0.439	0.146	0.331
0.1	555.1	12.80	0.556	0.272	0.498	0.439	0.372	0.134	0.289
0.0925	600	12.79	0.540	0.272	0.481	0.427	0.368	0.134	0.285
0.0793	700	12.70	0.502	0.272	0.452	0.402	0.351	0.134	0.285
0.0694	800	12.61	0.473	0.268	0.427	0.385	0.339	0.130	0.280
0.0617	900	12.50	0.448	0.264	0.406	0.368	0.326	0.126	0.276
0.05551	1000	12.42	0.427	0.259	0.385	0.351	0.318	0.121	0.272
0.05	1110	12.24	0.406	0.259	0.372	0.339	0.305	0.121	0.272
0.02775	2000	11.29	0.310	0.226	0.285	0.264	0.247	0.117	0.264
0.01850	3000	10.66	0.251	0.197	0.234	0.218	0.213	0.117	0.259
0.01388	4000	10.25	0.226	0.180	0.205	0.192	0.192	0.113	0.259
0.01110	5000	9.874	0.197	0.167	0.184	0.172	0.176	0.109	0.255
0.00555	10000	8.912	0.142	0.126	0.130	0.121	0.130	0.105	0.243
0.00278	20000	7.531	0.105	0.092	0.092	0.084	0.096	0.096	0.230
0.00111	50000	5.439	0.067	0.059	0.054	0.050	0.063	0.084	0.222
0.000555	100000	3.766	0.042	0.042	0.038	0.038	0.046	0.054	0.209
0.000111	500000	1.255	0.021	0.021	0.021	0.021	0.021	0.038	0.167
0	∞	0	0	0	0	0	0	0	0

## ENTHALPY OF SOLUTION OF ELECTROLYTES

This table gives the molar enthalpy (heat) of solution at infinite dilution for some common uni-univalent electrolytes. This is the enthalpy change when 1 mol of solute in its standard state is dissolved in an infinite amount of water. Values are given in kilojoules per mole at 25°C.

### Reference

Parker, V. B., *Thermal Properties of Uni-Univalent Electrolytes*, Natl. Stand. Ref. Data Series — Natl. Bur. Stand.(U.S.), No.2, 1965.

Solute	State	$\Delta_{\text{sol}}H^\circ$ kJ/mol	Solute	State	$\Delta_{\text{sol}}H^\circ$ kJ/mol	Solute	State	$\Delta_{\text{sol}}H^\circ$ kJ/mol
HF	g	-61.50	LiBr · 2H <sub>2</sub> O	c	-9.41	KClO <sub>3</sub>	c	41.38
HCl	g	-74.84	LiBrO <sub>3</sub>	c	1.42	KClO <sub>4</sub>	c	51.04
HClO <sub>4</sub>	l	-88.76	LiI	c	-63.30	KBr	c	19.87
HClO <sub>4</sub> · H <sub>2</sub> O	c	-32.95	LiI · H <sub>2</sub> O	c	-29.66	KBrO <sub>3</sub>	c	41.13
HBr	g	-85.14	LiI · 2H <sub>2</sub> O	c	-14.77	KI	c	20.33
HI	g	-81.67	LiI · 3H <sub>2</sub> O	c	0.59	KIO <sub>3</sub>	c	27.74
HIO <sub>3</sub>	c	8.79	LiNO <sub>2</sub>	c	-11.00	KNO <sub>2</sub>	c	13.35
HNO <sub>3</sub>	l	-33.28	LiNO <sub>2</sub> · H <sub>2</sub> O	c	7.03	KNO <sub>3</sub>	c	34.89
HCOOH	l	-0.86	LiNO <sub>3</sub>	c	-2.51	KC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	c	-15.33
CH <sub>3</sub> COOH	l	-1.51	NaOH	c	-44.51	KCN	c	11.72
NH <sub>3</sub>	g	-30.50	NaOH · H <sub>2</sub> O	c	-21.41	KCNO	c	20.25
NH <sub>4</sub> Cl	c	14.78	NaF	c	0.91	KCNS	c	24.23
NH <sub>4</sub> ClO <sub>4</sub>	c	33.47	NaCl	c	3.88	KMnO <sub>4</sub>	c	43.56
NH <sub>4</sub> Br	c	16.78	NaClO <sub>2</sub>	c	0.33	RbOH	c	-62.34
NH <sub>4</sub> I	c	13.72	NaClO <sub>2</sub> · 3H <sub>2</sub> O	c	28.58	RbOH · H <sub>2</sub> O	c	-17.99
NH <sub>4</sub> IO <sub>3</sub>	c	31.80	NaClO <sub>3</sub>	c	21.72	RbOH · 2H <sub>2</sub> O	c	0.88
NH <sub>4</sub> NO <sub>2</sub>	c	19.25	NaClO <sub>4</sub>	c	13.88	RbF	c	-26.11
NH <sub>4</sub> NO <sub>3</sub>	c	25.69	NaClO <sub>4</sub> · H <sub>2</sub> O	c	22.51	RbF · H <sub>2</sub> O	c	-0.42
NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	c	-2.38	NaBr	c	-0.60	RbF · 1.5H <sub>2</sub> O	c	1.34
NH <sub>4</sub> CN	c	17.57	NaBr · 2H <sub>2</sub> O	c	18.64	RbCl	c	17.28
NH <sub>4</sub> CNS	c	22.59	NaBrO <sub>3</sub>	c	26.90	RbClO <sub>3</sub>	c	47.74
CH <sub>3</sub> NH <sub>3</sub> Cl	c	5.77	NaI	c	-7.53	RbClO <sub>4</sub>	c	56.74
(CH <sub>3</sub> ) <sub>3</sub> NHCl	c	1.46	NaI · 2H <sub>2</sub> O	c	21.83	RbBr	c	21.88
N(CH <sub>3</sub> ) <sub>4</sub> Cl	c	4.08	NaIO <sub>3</sub>	c	20.29	RbBrO <sub>3</sub>	c	48.95
N(CH <sub>3</sub> ) <sub>4</sub> Br	c	24.27	NaNO <sub>2</sub>	c	13.89	RbI	c	25.10
N(CH <sub>3</sub> ) <sub>4</sub> I	c	42.07	NaNO <sub>3</sub>	c	20.50	RbNO <sub>3</sub>	c	36.48
AgClO <sub>4</sub>	c	7.36	NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	c	-17.32	CsOH	c	-71.55
AgNO <sub>2</sub>	c	36.94	NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> · 3H <sub>2</sub> O	c	19.66	CsOH · H <sub>2</sub> O	c	-20.50
AgNO <sub>3</sub>	c	22.59	NaCN	c	1.21	CsF	c	-36.86
LiOH	c	-23.56	NaCN · 0.5H <sub>2</sub> O	c	3.31	CsF · H <sub>2</sub> O	c	-10.46
LiOH · H <sub>2</sub> O	c	-6.69	NaCN · 2H <sub>2</sub> O	c	18.58	CsF · 1.5H <sub>2</sub> O	c	-5.44
LiF	c	4.73	NaCNO	c	19.20	CsCl	c	17.78
LiCl	c	-37.03	NaCNS	c	6.83	CsClO <sub>4</sub>	c	55.44
LiCl · H <sub>2</sub> O	c	-19.08	KOH	c	-57.61	CsBr	c	25.98
LiClO <sub>4</sub>	c	-26.55	KOH · H <sub>2</sub> O	c	-14.64	CsBrO <sub>3</sub>	c	50.46
LiClO <sub>4</sub> · 3H <sub>2</sub> O	c	32.61	KOH · 1.5H <sub>2</sub> O	c	-10.46	CsI	c	33.35
LiBr	c	-48.83	KF	c	-17.73	CsNO <sub>3</sub>	c	40.00
LiBr · H <sub>2</sub> O	c	-23.26	KF · 2H <sub>2</sub> O	c	6.97			
			KCl	c	17.22			

# CHEMICAL KINETIC DATA FOR STRATOSPHERIC MODELING

The present compilation of kinetic data represents the 12th evaluation prepared by the NASA Panel for Data Evaluation. The Panel was established in 1977 by the NASA Upper Atmosphere Research Program Office for the purpose of providing a critical tabulation of the latest kinetic and photochemical data for use by modelers in computer simulations of stratospheric chemistry. The recommended rate data and cross sections are based on laboratory measurements. The major use of theoretical extrapolation of data is in connection with three-body reactions, in which the required pressure or temperature dependence is sometimes unavailable from laboratory measurements, and can be estimated by use of appropriate theoretical treatment. In the case of important rate constants for which no experimental data are available, the panel may provide estimates of rate constant parameters based on analogy to similar reactions for which data are available.

Rate constants are expressed in the form  $k(T) = A \exp(-E/RT)$ , where  $A$  is the pre-exponential factor,  $E$  the activation energy,  $R$  the gas constant, and  $T$  the absolute temperature. Uncertainties are expressed by the factor  $f$ , e.g., a value of  $4.2 \times 10^{-10}$  with  $f = 2$  indicates that the true value is believed to lie between  $2.1 \times 10^{-10}$  and  $8.4 \times 10^{-10}$ . The value of  $f$  at other temperatures may be calculated from  $f(298)$ , given in the last column, by:

$$f(T) = f(298) \exp[(\Delta E/R)(1/T - 1/298)],$$

where  $\Delta E/R$  is the uncertainty in  $E/R$ .

Table 1 covers rate constant data on second order reactions, grouped by class, while Table 2 covers association reactions. Relevant equilibrium constant data are given in Table 3. All concentrations are measured in molecules  $\text{cm}^{-3}$ . Notes on each reaction, as well as related photochemical data, may be found in the reference.

The assistance of Robert Hampson is gratefully acknowledged.

## Reference

DeMore, W. B., Sander, S. P., Golden, D. M., Hampson, R. F., Kurylo, M. J., Howard, C. J., Ravishankara, A. R., Kolb, C. E., and Molina, M. J., *Chemical Kinetics and Photochemical Data for Use in Atmospheric Modeling. Evaluation Number 12*, Jet Propulsion Laboratory Publication 97-4, Pasadena CA, 1997.

The report is also available at the World Wide Web site < <http://remus.jpl.nasa.gov/pub/jpl197> >.

TABLE 1. Rate Constants for Second Order Reactions

Reaction	A $\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	E/R K	k (298 K) $\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	f(298)
<i>O<sub>x</sub> Reactions</i>				
$\text{O} + \text{O}_3 \rightarrow \text{O}_2 + \text{O}_2$	$8.0 \times 10^{-12}$	2060±250	$8.0 \times 10^{-15}$	1.15
<i>O(<sup>1</sup>D) Reactions</i>				
$\text{O}(^1\text{D}) + \text{O}_2 \rightarrow \text{O} + \text{O}_2$	$3.2 \times 10^{-11}$	-(70±100)	$4.0 \times 10^{-11}$	1.2
$\text{O}(^1\text{D}) + \text{O}_3 \rightarrow \text{O}_2 + \text{O}_2$	$1.2 \times 10^{-10}$	0±100	$1.2 \times 10^{-10}$	1.3
$\rightarrow \text{O}_2 + \text{O} + \text{O}$	$1.2 \times 10^{-10}$	0±100	$1.2 \times 10^{-10}$	1.3
$\text{O}(^1\text{D}) + \text{H}_2 \rightarrow \text{OH} + \text{H}$	$1.1 \times 10^{-10}$	0±100	$1.1 \times 10^{-10}$	1.1
$\text{O}(^1\text{D}) + \text{H}_2\text{O} \rightarrow \text{OH} + \text{OH}$	$2.2 \times 10^{-10}$	0±100	$2.2 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{N}_2 \rightarrow \text{O} + \text{N}_2$	$1.8 \times 10^{-11}$	-(110±100)	$2.6 \times 10^{-11}$	1.2
$\text{O}(^1\text{D}) + \text{N}_2\text{O} \rightarrow \text{N}_2 + \text{O}_2$	$4.9 \times 10^{-11}$	0±100	$4.9 \times 10^{-11}$	1.3
$\rightarrow \text{NO} + \text{NO}$	$6.7 \times 10^{-11}$	0±100	$6.7 \times 10^{-11}$	1.3
$\text{O}(^1\text{D}) + \text{NH}_3 \rightarrow \text{OH} + \text{NH}_2$	$2.5 \times 10^{-10}$	0±100	$2.5 \times 10^{-10}$	1.3
$\text{O}(^1\text{D}) + \text{CO}_2 \rightarrow \text{O} + \text{CO}_2$	$7.4 \times 10^{-11}$	-(120±100)	$1.1 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{CH}_4 \rightarrow \text{products}$	$1.5 \times 10^{-10}$	0±100	$1.5 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{HCl} \rightarrow \text{products}$	$1.5 \times 10^{-10}$	0±100	$1.5 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{HF} \rightarrow \text{OH} + \text{F}$	$1.4 \times 10^{-10}$	0±100	$1.4 \times 10^{-10}$	2.0
$\text{O}(^1\text{D}) + \text{HBr} \rightarrow \text{products}$	$1.5 \times 10^{-10}$	0±100	$1.5 \times 10^{-10}$	2.0
$\text{O}(^1\text{D}) + \text{Cl}_2 \rightarrow \text{products}$	$2.8 \times 10^{-10}$	0±100	$2.8 \times 10^{-10}$	2.0
$\text{O}(^1\text{D}) + \text{CCl}_2\text{O} \rightarrow \text{products}$	$3.6 \times 10^{-10}$	0±100	$3.6 \times 10^{-10}$	2.0
$\text{O}(^1\text{D}) + \text{CClFO} \rightarrow \text{products}$	$1.9 \times 10^{-10}$	0±100	$1.9 \times 10^{-10}$	2.0
$\text{O}(^1\text{D}) + \text{CF}_2\text{O} \rightarrow \text{products}$	$7.4 \times 10^{-11}$	0±100	$7.4 \times 10^{-11}$	2.0
$\text{O}(^1\text{D}) + \text{CCl}_4 \rightarrow \text{products (CFC-10)}$	$3.3 \times 10^{-10}$	0±100	$3.3 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{CH}_3\text{Br} \rightarrow \text{products}$	$1.8 \times 10^{-10}$	0±100	$1.8 \times 10^{-10}$	1.3
$\text{O}(^1\text{D}) + \text{CH}_2\text{Br}_2 \rightarrow \text{products}$	$2.7 \times 10^{-10}$	0±100	$2.7 \times 10^{-10}$	1.3
$\text{O}(^1\text{D}) + \text{CHBr}_3 \rightarrow \text{products}$	$6.6 \times 10^{-10}$	0±100	$6.6 \times 10^{-10}$	1.5
$\text{O}(^1\text{D}) + \text{CH}_3\text{F} \rightarrow \text{products (HFC-41)}$	$1.5 \times 10^{-10}$	0±100	$1.5 \times 10^{-10}$	1.2
$\text{O}(^1\text{D}) + \text{CH}_2\text{F}_2 \rightarrow \text{products (HFC-32)}$	$5.1 \times 10^{-11}$	0±100	$5.1 \times 10^{-11}$	1.3
$\text{O}(^1\text{D}) + \text{CHF}_3 \rightarrow \text{products (HFC-23)}$	$9.1 \times 10^{-12}$	0±100	$9.1 \times 10^{-12}$	1.2

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
O( <sup>1</sup> D) + CHCl <sub>2</sub> F → products (HCFC-21)	1.9×10 <sup>-10</sup>	0±100	1.9×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CHClF <sub>2</sub> → products (HCFC-22)	1.0×10 <sup>-10</sup>	0±100	1.0×10 <sup>-10</sup>	1.2
O( <sup>1</sup> D) + CCl <sub>3</sub> F → products (CFC-11)	2.3×10 <sup>-10</sup>	0±100	2.3×10 <sup>-10</sup>	1.2
O( <sup>1</sup> D) + CCl <sub>2</sub> F <sub>2</sub> → products (CFC-12)	1.4×10 <sup>-10</sup>	0±100	1.4×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CClF <sub>3</sub> → products (CFC-13)	8.7×10 <sup>-11</sup>	0±100	8.7×10 <sup>-11</sup>	1.3
O( <sup>1</sup> D) + CClBrF <sub>2</sub> → products (Halon-1211)	1.5×10 <sup>-10</sup>	0±100	1.5×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CBr <sub>2</sub> F <sub>2</sub> → products (Halon-1202)	2.2×10 <sup>-10</sup>	0±100	2.2×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CBrF <sub>3</sub> → products (Halon-1301)	1.0×10 <sup>-10</sup>	0±100	1.0×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CF <sub>4</sub> → CF <sub>4</sub> + O (CFC-14)	–	–	2.0×10 <sup>-14</sup>	1.5
O( <sup>1</sup> D) + CH <sub>3</sub> CH <sub>2</sub> F → products (HFC-161)	2.6×10 <sup>-10</sup>	0±100	2.6×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CH <sub>3</sub> CHF <sub>2</sub> → products (HFC-152a)	2.0×10 <sup>-10</sup>	0±100	2.0×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CH <sub>3</sub> CCl <sub>2</sub> F → products (HCFC-141b)	2.6×10 <sup>-10</sup>	0±100	2.6×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CH <sub>3</sub> CClF <sub>2</sub> → products (HCFC-142b)	2.2×10 <sup>-10</sup>	0±100	2.2×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CH <sub>3</sub> CF <sub>3</sub> → products (HFC-143a)	1.0×10 <sup>-10</sup>	0±100	1.0×10 <sup>-10</sup>	3.0
O( <sup>1</sup> D) + CH <sub>2</sub> ClCClF <sub>2</sub> → products (HCFC-132b)	1.6×10 <sup>-10</sup>	0±100	1.6×10 <sup>-10</sup>	2.0
O( <sup>1</sup> D) + CH <sub>2</sub> ClCF <sub>3</sub> → products (HCFC-133a)	1.2×10 <sup>-10</sup>	0±100	1.2×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CH <sub>2</sub> FCF <sub>3</sub> → products (HFC-134a)	4.9×10 <sup>-11</sup>	0±100	4.9×10 <sup>-11</sup>	1.3
O( <sup>1</sup> D) + CHCl <sub>2</sub> CF <sub>3</sub> → products (HCFC-123)	2.0×10 <sup>-10</sup>	0±100	2.0×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CHClFCF <sub>3</sub> → products (HCFC-124)	8.6×10 <sup>-11</sup>	0±100	8.6×10 <sup>-11</sup>	1.3
O( <sup>1</sup> D) + CHF <sub>2</sub> CF <sub>3</sub> → products (HFC-125)	1.2×10 <sup>-10</sup>	0±100	1.2×10 <sup>-10</sup>	2.0
O( <sup>1</sup> D) + CCl <sub>3</sub> CF <sub>3</sub> → products (CFC-113a)	2×10 <sup>-10</sup>	0±100	2×10 <sup>-10</sup>	2.0
O( <sup>1</sup> D) + CCl <sub>2</sub> FCClF <sub>2</sub> → products (CFC-113)	2×10 <sup>-10</sup>	0±100	2×10 <sup>-10</sup>	2.0
O( <sup>1</sup> D) + CCl <sub>2</sub> FCF <sub>3</sub> → products (CFC-114a)	1×10 <sup>-10</sup>	0±100	1×10 <sup>-10</sup>	2.0
O( <sup>1</sup> D) + CClF <sub>2</sub> CClF <sub>2</sub> → products (CFC-114)	1.3×10 <sup>-10</sup>	0±100	1.3×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CClF <sub>2</sub> CF <sub>3</sub> → products (CFC-115)	5×10 <sup>-11</sup>	0±100	5×10 <sup>-11</sup>	1.3
O( <sup>1</sup> D) + CBrF <sub>2</sub> CBrF <sub>2</sub> → products (Halon-2402)	1.6×10 <sup>-10</sup>	0±100	1.6×10 <sup>-10</sup>	1.3
O( <sup>1</sup> D) + CF <sub>3</sub> CF <sub>3</sub> → O + CF <sub>3</sub> CF <sub>3</sub> (CFC-116)	–	–	1.5×10 <sup>-13</sup>	1.5
O( <sup>1</sup> D) + CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub> → products (HFC-338pcc)	1.8×10 <sup>-11</sup>	0±100	1.8×10 <sup>-11</sup>	1.5
O( <sup>1</sup> D) + c-C <sub>4</sub> F <sub>8</sub> → products	–	–	8×10 <sup>-13</sup>	1.3
O( <sup>1</sup> D) + CF <sub>3</sub> CHFCHFCF <sub>2</sub> CF <sub>3</sub> → products (HFC-43-10mee)	2.1×10 <sup>-10</sup>	0±100	2.1×10 <sup>-10</sup>	4
O( <sup>1</sup> D) + C <sub>5</sub> F <sub>12</sub> → products (CFC-41-12)	–	–	3.9×10 <sup>-13</sup>	2
O( <sup>1</sup> D) + C <sub>6</sub> F <sub>14</sub> → products (CFC-51-14)	–	–	1×10 <sup>-12</sup>	2
O( <sup>1</sup> D) + 1,2-(CF <sub>3</sub> ) <sub>2</sub> C-C <sub>4</sub> F <sub>6</sub> → products	–	–	2.8×10 <sup>-13</sup>	2
O( <sup>1</sup> D) + SF <sub>6</sub> → products	–	–	1.8×10 <sup>-14</sup>	1.5
<b>Singlet O<sub>2</sub> Reactions</b>				
O <sub>2</sub> ( <sup>1</sup> Δ) + O → products	–	–	<2×10 <sup>-16</sup>	–
O <sub>2</sub> ( <sup>1</sup> Δ) + O <sub>2</sub> → products	3.6×10 <sup>-18</sup>	220±100	1.7×10 <sup>-18</sup>	1.2
O <sub>2</sub> ( <sup>1</sup> Δ) + O <sub>3</sub> → O + 2O <sub>2</sub>	5.2×10 <sup>-11</sup>	2840±500	3.8×10 <sup>-15</sup>	1.2
O <sub>2</sub> ( <sup>1</sup> Δ) + H <sub>2</sub> O → products	–	–	4.8×10 <sup>-18</sup>	1.5
O <sub>2</sub> ( <sup>1</sup> Δ) + N → NO + O	–	–	<9×10 <sup>-17</sup>	–
O <sub>2</sub> ( <sup>1</sup> Δ) + N <sub>2</sub> → products	–	–	<10 <sup>-20</sup>	–
O <sub>2</sub> ( <sup>1</sup> Δ) + CO <sub>2</sub> → products	–	–	<2×10 <sup>-20</sup>	–
O <sub>2</sub> ( <sup>1</sup> Σ) + O → products	–	–	8×10 <sup>-14</sup>	5.0
O <sub>2</sub> ( <sup>1</sup> Σ) + O <sub>2</sub> → products	–	–	3.9×10 <sup>-17</sup>	1.5
O <sub>2</sub> ( <sup>1</sup> Σ) + O <sub>3</sub> → products	2.2×10 <sup>-11</sup>	0±200	2.2×10 <sup>-11</sup>	1.2
O <sub>2</sub> ( <sup>1</sup> Σ) + H <sub>2</sub> O → products	–	–	5.4×10 <sup>-12</sup>	1.3
O <sub>2</sub> ( <sup>1</sup> Σ) + N → products	–	–	<10 <sup>-13</sup>	–
O <sub>2</sub> ( <sup>1</sup> Σ) + N <sub>2</sub> → products	2.1×10 <sup>-15</sup>	0±200	2.1×10 <sup>-15</sup>	1.2
O <sub>2</sub> ( <sup>1</sup> Σ) + CO <sub>2</sub> → products	4.2×10 <sup>-13</sup>	0±200	4.2×10 <sup>-13</sup>	1.2
<b>HO<sub>x</sub> Reactions</b>				
O + OH → O <sub>2</sub> + H	2.2×10 <sup>-11</sup>	–(120±100)	3.3×10 <sup>-11</sup>	1.2
O + HO <sub>2</sub> → OH + O <sub>2</sub>	3.0×10 <sup>-11</sup>	–(200±100)	5.9×10 <sup>-11</sup>	1.2
O + H <sub>2</sub> O <sub>2</sub> → OH + HO <sub>2</sub>	1.4×10 <sup>-12</sup>	2000±1000	1.7×10 <sup>-15</sup>	2.0
H + O <sub>3</sub> → OH + O <sub>2</sub>	1.4×10 <sup>-10</sup>	470±200	2.9×10 <sup>-11</sup>	1.25
H + HO <sub>2</sub> → products	8.1×10 <sup>-11</sup>	0±100	8.1×10 <sup>-11</sup>	1.3
OH + O <sub>3</sub> → HO <sub>2</sub> + O <sub>2</sub>	1.6×10 <sup>-12</sup>	940±300	6.8×10 <sup>-14</sup>	1.3
OH + H <sub>2</sub> → H <sub>2</sub> O + H	5.5×10 <sup>-12</sup>	2000±100	6.7×10 <sup>-15</sup>	1.1



Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
OH + HD → products	5.0×10 <sup>-12</sup>	2130±200	4.0×10 <sup>-15</sup>	1.2
OH + OH → H <sub>2</sub> O + O	4.2×10 <sup>-12</sup>	240±240	1.9×10 <sup>-12</sup>	1.4
OH + HO <sub>2</sub> → H <sub>2</sub> O + O <sub>2</sub>	4.8×10 <sup>-11</sup>	-(250±200)	1.1×10 <sup>-10</sup>	1.3
OH + H <sub>2</sub> O <sub>2</sub> → H <sub>2</sub> O + HO <sub>2</sub>	2.9×10 <sup>-12</sup>	160±100	1.7×10 <sup>-12</sup>	1.2
HO <sub>2</sub> + O <sub>3</sub> → OH + 2O <sub>2</sub>	1.1×10 <sup>-14</sup>	500±	2.0×10 <sup>-15</sup>	1.3
HO <sub>2</sub> + HO <sub>2</sub> → H <sub>2</sub> O <sub>2</sub> + O <sub>2</sub>	2.3×10 <sup>-13</sup>	-(600±200)	1.7×10 <sup>-12</sup>	1.3
H <sub>2</sub> O <sub>2</sub> + O <sub>2</sub>	1.7×10 <sup>-33</sup> [M]	-(1000±400)	4.9×10 <sup>-32</sup> [M]	1.3
<b>NO<sub>x</sub> Reactions</b>				
O + NO <sub>2</sub> → NO + O <sub>2</sub>	6.5×10 <sup>-12</sup>	-(120±120)	9.7×10 <sup>-12</sup>	1.1
O + NO <sub>3</sub> → O <sub>2</sub> + NO <sub>2</sub>	1.0×10 <sup>-11</sup>	0±150	1.0×10 <sup>-11</sup>	1.5
O + N <sub>2</sub> O <sub>5</sub> → products			<3.0×10 <sup>-16</sup>	
O + HNO <sub>3</sub> → OH + NO <sub>3</sub>			<3.0×10 <sup>-17</sup>	
O + HO <sub>2</sub> NO <sub>2</sub> → products	7.8×10 <sup>-11</sup>	3400±750	8.6×10 <sup>-16</sup>	3.0
H + NO <sub>2</sub> → OH + NO	4.0×10 <sup>-10</sup>	340±300	1.3×10 <sup>-10</sup>	1.3
OH + NO <sub>3</sub> → products			2.2×10 <sup>-11</sup>	1.5
OH + HONO → H <sub>2</sub> O + NO <sub>2</sub>	1.8×10 <sup>-11</sup>	390±	4.5×10 <sup>-12</sup>	1.5
OH + HNO <sub>3</sub> → H <sub>2</sub> O + NO <sub>3</sub>	See reference	1.3		
OH + HO <sub>2</sub> NO <sub>2</sub> → products	1.3×10 <sup>-12</sup>	-(380±)	4.6×10 <sup>-12</sup>	1.5
OH + NH <sub>3</sub> → H <sub>2</sub> O + NH <sub>2</sub>	1.7×10 <sup>-12</sup>	710±200	1.6×10 <sup>-13</sup>	1.2
HO <sub>2</sub> + NO → NO <sub>2</sub> + OH	3.5×10 <sup>-12</sup>	-(250±50)	8.1×10 <sup>-12</sup>	1.15
HO <sub>2</sub> + NO <sub>2</sub> → HONO + O <sub>2</sub>	See reference			
HO <sub>2</sub> + NO <sub>3</sub> → products			3.5×10 <sup>-12</sup>	1.5
HO <sub>2</sub> + NH <sub>2</sub> → products			3.4×10 <sup>-11</sup>	2.0
N + O <sub>2</sub> → NO + O	1.5×10 <sup>-11</sup>	3600±400	8.5×10 <sup>-17</sup>	1.25
N + O <sub>3</sub> → NO + O <sub>2</sub>			<2.0×10 <sup>-16</sup>	
N + NO → N <sub>2</sub> + O	2.1×10 <sup>-11</sup>	-(100±100)	3.0×10 <sup>-11</sup>	1.3
N + NO <sub>2</sub> → N <sub>2</sub> O + O	5.8×10 <sup>-12</sup>	-(220±100)	1.2×10 <sup>-11</sup>	1.5
NO + O <sub>3</sub> → NO <sub>2</sub> + O <sub>2</sub>	2.0×10 <sup>-12</sup>	1400±200	1.8×10 <sup>-14</sup>	1.1
NO + NO <sub>3</sub> → 2NO <sub>2</sub>	1.5×10 <sup>-11</sup>	-(170±100)	2.6×10 <sup>-11</sup>	1.3
NO <sub>2</sub> + O <sub>3</sub> → NO <sub>3</sub> + O <sub>2</sub>	1.2×10 <sup>-13</sup>	2450±150	3.2×10 <sup>-17</sup>	1.15
NO <sub>2</sub> + NO <sub>3</sub> → NO + NO <sub>2</sub> + O <sub>2</sub>	See reference			
NO <sub>3</sub> + NO <sub>3</sub> → 2NO <sub>2</sub> + O <sub>2</sub>	8.5×10 <sup>-13</sup>	2450±500	2.3×10 <sup>-16</sup>	1.5
NH <sub>2</sub> + O <sub>2</sub> → products			<6.0×10 <sup>-21</sup>	
NH <sub>2</sub> + O <sub>3</sub> → products	4.3×10 <sup>-12</sup>	930±500	1.9×10 <sup>-13</sup>	3.0
NH <sub>2</sub> + NO → products	4.0×10 <sup>-12</sup>	-(450±150)	1.8×10 <sup>-11</sup>	1.3
NH <sub>2</sub> + NO <sub>2</sub> → products	2.1×10 <sup>-12</sup>	-(650±250)	1.9×10 <sup>-11</sup>	3.0
NH + NO → products	4.9×10 <sup>-11</sup>	0±300	4.9×10 <sup>-11</sup>	1.5
NH + NO <sub>2</sub> → products	3.5×10 <sup>-13</sup>	-(1140±500)	1.6×10 <sup>-11</sup>	2.0
O <sub>3</sub> + HNO <sub>2</sub> → O <sub>2</sub> + HNO <sub>3</sub>			<5.0×10 <sup>-19</sup>	
N <sub>2</sub> O <sub>5</sub> + H <sub>2</sub> O → 2HNO <sub>3</sub>			<2.0×10 <sup>-21</sup>	
N <sub>2</sub> (A,ν) + O <sub>2</sub> → products			2.5×10 <sup>-12</sup> , ν=0	1.5
N <sub>2</sub> (A,ν) + O <sub>3</sub> → products			4.1×10 <sup>-11</sup> , ν=0	2.0
<b>Reactions of Organic Compounds</b>				
O + CH <sub>3</sub> → products	1.1×10 <sup>-10</sup>	0±250	1.1×10 <sup>-10</sup>	1.3
O + HCN → products	1.0×10 <sup>-11</sup>	4000±1000	1.5×10 <sup>-17</sup>	10
O + C <sub>2</sub> H <sub>2</sub> → products	3.0×10 <sup>-11</sup>	1600±250	1.4×10 <sup>-13</sup>	1.3
O + H <sub>2</sub> CO → products	3.4×10 <sup>-11</sup>	1600±250	1.6×10 <sup>-13</sup>	1.25
O + CH <sub>3</sub> CHO → CH <sub>3</sub> CO + OH	1.8×10 <sup>-11</sup>	1100±200	4.5×10 <sup>-13</sup>	1.25
O <sub>3</sub> + C <sub>2</sub> H <sub>2</sub> → products	1.0×10 <sup>-14</sup>	4100±500	1.0×10 <sup>-20</sup>	3
O <sub>3</sub> + C <sub>2</sub> H <sub>4</sub> → products	1.2×10 <sup>-14</sup>	2630±100	1.7×10 <sup>-18</sup>	1.25
O <sub>3</sub> + C <sub>3</sub> H <sub>6</sub> → products	6.5×10 <sup>-15</sup>	1900±200	1.1×10 <sup>-17</sup>	1.2
OH + CO → products	1.5×10 <sup>-13</sup> x (1+0.6P <sub>atm</sub> )	0±300	1.5×10 <sup>-13</sup> x (1+0.6P <sub>atm</sub> )	1.3
OH + CH <sub>4</sub> → CH <sub>3</sub> + H <sub>2</sub> O	2.45×10 <sup>-12</sup>	1775±100	6.3×10 <sup>-15</sup>	1.1
OH + <sup>13</sup> CH <sub>4</sub> → <sup>13</sup> CH <sub>3</sub> + H <sub>2</sub> O	See reference			
OH + CH <sub>3</sub> D → products	3.5×10 <sup>-12</sup>	1950 ± 200	5.0×10 <sup>-15</sup>	1.15
OH + H <sub>2</sub> CO → H <sub>2</sub> O + HCO	1.0×10 <sup>-11</sup>	0±200	1.0×10 <sup>-11</sup>	1.25

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
OH + CH <sub>3</sub> OH → products	6.7×10 <sup>-12</sup>	600±300	8.9×10 <sup>-13</sup>	1.2
OH + CH <sub>3</sub> OOH → products	3.8×10 <sup>-12</sup>	-(200±200)	7.4×10 <sup>-12</sup>	1.5
OH + HC(O)OH → products	4.0×10 <sup>-13</sup>	0±200	4.0×10 <sup>-13</sup>	1.3
OH + HCN → products	1.2×10 <sup>-13</sup>	400±150	3.1×10 <sup>-14</sup>	3
OH + C <sub>2</sub> H <sub>6</sub> → H <sub>2</sub> O + C <sub>2</sub> H <sub>5</sub>	8.7 × 10 <sup>-12</sup>	1070±100	2.4×10 <sup>-13</sup>	1.1
OH + C <sub>3</sub> H <sub>8</sub> → H <sub>2</sub> O + C <sub>3</sub> H <sub>7</sub>	1.0 × 10 <sup>-11</sup>	660±100	1.1×10 <sup>-12</sup>	1.2
OH + CH <sub>3</sub> CHO → CH <sub>3</sub> CO + H <sub>2</sub> O	5.6×10 <sup>-12</sup>	-(270±200)	1.4×10 <sup>-11</sup>	1.2
OH + C <sub>2</sub> H <sub>5</sub> OH → products	7.0×10 <sup>-12</sup>	235±100	3.2×10 <sup>-12</sup>	1.3
OH + CH <sub>3</sub> C(O)OH → products	4.0×10 <sup>-13</sup>	-(200±400)	8.0×10 <sup>-13</sup>	1.3
OH + CH <sub>3</sub> C(O)CH <sub>3</sub> → CH <sub>3</sub> C(O)CH <sub>2</sub> + H <sub>2</sub> O	2.2 × 10 <sup>-12</sup>	685±100	2.2×10 <sup>-13</sup>	1.15
OH + CH <sub>3</sub> CN → products	7.8×10 <sup>-13</sup>	1050±200	2.3×10 <sup>-14</sup>	1.5
OH + CH <sub>3</sub> ONO <sub>2</sub> → products	5.0×10 <sup>-13</sup>	890±500	2.4×10 <sup>-14</sup>	3
OH + CH <sub>3</sub> C(O)O <sub>2</sub> NO <sub>2</sub> (PAN) → products			<4 × 10 <sup>-14</sup>	
OH + C <sub>2</sub> H <sub>5</sub> ONO <sub>2</sub> → products	8.2×10 <sup>-13</sup>	450±300	1.8×10 <sup>-13</sup>	3
HO <sub>2</sub> + CH <sub>2</sub> O → adduct	6.7×10 <sup>-15</sup>	-(600±600)	5.0×10 <sup>-14</sup>	5
HO <sub>2</sub> + CH <sub>3</sub> O <sub>2</sub> → CH <sub>3</sub> OOH + O <sub>2</sub>	3.8×10 <sup>-13</sup>	-(800±400)	5.6×10 <sup>-12</sup>	2
HO <sub>2</sub> + C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> → C <sub>2</sub> H <sub>5</sub> OOH + O <sub>2</sub>	7.5×10 <sup>-13</sup>	-(700±250)	8.0×10 <sup>-12</sup>	1.5
HO <sub>2</sub> + CH <sub>3</sub> C(O)O <sub>2</sub> → products	4.5×10 <sup>-13</sup>	-(1000±600)	1.3×10 <sup>-11</sup>	2
NO <sub>3</sub> + CO → products			<4.0×10 <sup>-19</sup>	
NO <sub>3</sub> + CH <sub>2</sub> O → products			5.8×10 <sup>-16</sup>	1.3
NO <sub>3</sub> + CH <sub>3</sub> CHO → products	1.4×10 <sup>-12</sup>	1900±300	2.4×10 <sup>-15</sup>	1.3
CH <sub>3</sub> + O <sub>2</sub> → products			<3.0×10 <sup>-16</sup>	
CH <sub>3</sub> + O <sub>3</sub> → products	5.4×10 <sup>-12</sup>	220±150	2.6×10 <sup>-12</sup>	2
HCO + O <sub>2</sub> → CO + HO <sub>2</sub>	3.5×10 <sup>-12</sup>	-(140±140)	5.5×10 <sup>-12</sup>	1.3
CH <sub>2</sub> OH + O <sub>2</sub> → CH <sub>2</sub> O + HO <sub>2</sub>	9.1×10 <sup>-12</sup>	0±200	9.1×10 <sup>-12</sup>	1.3
CH <sub>3</sub> O + O <sub>2</sub> → CH <sub>2</sub> O + HO <sub>2</sub>	3.9×10 <sup>-14</sup>	900±300	1.9×10 <sup>-15</sup>	1.5
CH <sub>3</sub> O + NO → CH <sub>2</sub> O + HNO	See reference			
CH <sub>3</sub> O + NO <sub>2</sub> → CH <sub>2</sub> O + HONO	1.1 × 10 <sup>-11</sup>	1200±600	2.0 × 10 <sup>-13</sup>	5
CH <sub>3</sub> O <sub>2</sub> + O <sub>3</sub> → products			<3.0×10 <sup>-17</sup>	
CH <sub>3</sub> O <sub>2</sub> + CH <sub>3</sub> O <sub>2</sub> → products	2.5×10 <sup>-13</sup>	-(190±190)	4.7×10 <sup>-13</sup>	1.5
CH <sub>2</sub> O <sub>2</sub> + NO → CH <sub>3</sub> O + NO <sub>2</sub>	3.0×10 <sup>-12</sup>	-(280±60)	7.7×10 <sup>-12</sup>	1.15
CH <sub>3</sub> O <sub>2</sub> + CH <sub>3</sub> C(O)O <sub>2</sub> → products	1.3×10 <sup>-12</sup>	-(640±200)	1.1×10 <sup>-11</sup>	1.5
C <sub>2</sub> H <sub>5</sub> + O <sub>2</sub> → C <sub>2</sub> H <sub>4</sub> + HO <sub>2</sub>			<2.0×10 <sup>-14</sup>	
C <sub>2</sub> H <sub>5</sub> O + O <sub>2</sub> → CH <sub>3</sub> CHO + HO <sub>2</sub>	6.3 × 10 <sup>-14</sup>	550±200	1.0×10 <sup>-14</sup>	1.5
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> + C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> → products	6.8×10 <sup>-14</sup>	0±300	6.8×10 <sup>-14</sup>	2
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> + NO → products	2.6×10 <sup>-12</sup>	-(365±150)	8.7×10 <sup>-12</sup>	1.2
CH <sub>3</sub> C(O)O <sub>2</sub> + CH <sub>3</sub> C(O)O <sub>2</sub> → products	2.9×10 <sup>-12</sup>	-(500±150)	1.5×10 <sup>-11</sup>	1.5
CH <sub>3</sub> C(O)O <sub>2</sub> + NO → products	5.3×10 <sup>-12</sup>	-(360±150)	1.8×10 <sup>-11</sup>	1.4
<b>FO<sub>x</sub> Reactions</b>				
O + FO → F + O <sub>2</sub>	2.7×10 <sup>-11</sup>	0±250	2.7×10 <sup>-11</sup>	3.0
O + FO <sub>2</sub> → FO + O <sub>2</sub>	5.0×10 <sup>-11</sup>	0±250	5.0×10 <sup>-11</sup>	5.0
OH + CH <sub>3</sub> F → CH <sub>2</sub> F + H <sub>2</sub> O (HFC-41)	3.0×10 <sup>-12</sup>	1500±300	2.0×10 <sup>-14</sup>	1.1
OH + CH <sub>2</sub> F <sub>2</sub> → CHF <sub>2</sub> + H <sub>2</sub> O (HFC-32)	1.9×10 <sup>-12</sup>	1550±200	1.0×10 <sup>-14</sup>	1.2
OH + CHF <sub>3</sub> → CF <sub>3</sub> + H <sub>2</sub> O (HFC-23)	1.0×10 <sup>-12</sup>	2440±200	2.8×10 <sup>-16</sup>	1.3
OH + CF <sub>3</sub> OH → CF <sub>3</sub> O + H <sub>2</sub> O			<2×10 <sup>-17</sup>	
OH + CH <sub>3</sub> CH <sub>2</sub> F → products (HFC-161)	7.0×10 <sup>-12</sup>	1100±300	1.7×10 <sup>-13</sup>	1.4
OH + CH <sub>3</sub> CHF <sub>2</sub> → products (HFC-152a)	2.4×10 <sup>-12</sup>	1260±200	3.5×10 <sup>-14</sup>	1.2
OH + CH <sub>2</sub> FCH <sub>2</sub> F → CHFCH <sub>2</sub> F (HFC-152) + H <sub>2</sub> O	1.7×10 <sup>-11</sup>	1500±500	1.1×10 <sup>-13</sup>	2.0
OH + CH <sub>3</sub> CF <sub>3</sub> → CH <sub>2</sub> CF <sub>3</sub> + H <sub>2</sub> O (HFC-143a)	1.8×10 <sup>-12</sup>	2170±150	1.2×10 <sup>-15</sup>	1.1
OH + CH <sub>2</sub> FCHF <sub>2</sub> → products (HFC-143)	4.0×10 <sup>-12</sup>	1650±300	1.6×10 <sup>-14</sup>	1.5
OH + CH <sub>2</sub> FCF <sub>3</sub> → CHF <sub>2</sub> CF <sub>3</sub> + H <sub>2</sub> O (HFC-134a)	1.5×10 <sup>-12</sup>	1750±200	4.2×10 <sup>-15</sup>	1.1
OH + CHF <sub>2</sub> CHF <sub>2</sub> → CF <sub>2</sub> CHF <sub>2</sub> (HFC-134) + H <sub>2</sub> O	1.6×10 <sup>-12</sup>	1680±300	5.7×10 <sup>-15</sup>	2.0
OH + CHF <sub>2</sub> CF <sub>3</sub> → CF <sub>2</sub> CF <sub>3</sub> + H <sub>2</sub> O (HFC-125)	5.6×10 <sup>-13</sup>	1700±300	1.9×10 <sup>-15</sup>	1.3
OH + CH <sub>3</sub> OCHF <sub>2</sub> → products (HFOC-152a)	6.0×10 <sup>-12</sup>	1530±150	3.5×10 <sup>-14</sup>	1.2
OH + CF <sub>3</sub> OCH <sub>3</sub> → CF <sub>3</sub> OCH <sub>2</sub> + H <sub>2</sub> O (HFOC-143a)	1.5×10 <sup>-12</sup>	1450±150	1.2×10 <sup>-14</sup>	1.1
OH + CF <sub>2</sub> HOCF <sub>2</sub> H → CF <sub>2</sub> OCHF <sub>2</sub> H (HFOC-134) + H <sub>2</sub> O	1.9×10 <sup>-12</sup>	2000±150	2.3×10 <sup>-15</sup>	1.2
OH + CF <sub>3</sub> OCHF <sub>2</sub> → CF <sub>3</sub> OCHF <sub>2</sub> + H <sub>2</sub> O (HFOC-125)	4.7×10 <sup>-13</sup>	2100±300	4.1×10 <sup>-16</sup>	1.2

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
OH + CF <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub> → products (HFC-263fb)	–	–	4.2×10 <sup>-14</sup>	1.5
OH + CH <sub>2</sub> FCF <sub>2</sub> CHF <sub>2</sub> → products (HFC-245ca)	2.4×10 <sup>-12</sup>	1660±150	9.1×10 <sup>-15</sup>	1.3
OH + CHF <sub>2</sub> CHFCHF <sub>2</sub> → products (HFC-245ea)	–	–	1.6×10 <sup>-14</sup>	2.0
OH + CF <sub>3</sub> CHFCH <sub>2</sub> F → products (HFC-245eb)	–	–	1.5×10 <sup>-14</sup>	2.0
OH + CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub> → products (HFC-245fa)	6.1×10 <sup>-13</sup>	1330±150	7.0×10 <sup>-15</sup>	1.2
OH + CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> F → CF <sub>3</sub> CF <sub>2</sub> CHF (HFC-236cb) + H <sub>2</sub> O	1.5×10 <sup>-12</sup>	1750±500	4.2×10 <sup>-15</sup>	2.0
OH + CF <sub>3</sub> CHFCHF <sub>2</sub> → products (HFC-236ea)	1.1×10 <sup>-12</sup>	1590±150	5.3×10 <sup>-15</sup>	1.1
OH + CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub> → CF <sub>3</sub> CHCF <sub>3</sub> (HFC-236fa) + H <sub>2</sub> O	1.3×10 <sup>-12</sup>	2480±150	3.2×10 <sup>-16</sup>	1.1
OH + CF <sub>3</sub> CHFCF <sub>3</sub> → CF <sub>3</sub> CF <sub>2</sub> CF <sub>3</sub> + H <sub>2</sub> O (HFC-227ea)	5.0×10 <sup>-13</sup>	1700±300	1.7×10 <sup>-15</sup>	1.1
OH + CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub> → products (HFOC-245fa)	2.6×10 <sup>-12</sup>	1610±150	1.2×10 <sup>-14</sup>	2.0
OH + CF <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> CH <sub>3</sub> → products (HFC-365mfc)	2.0×10 <sup>-12</sup>	1750±200	5.7×10 <sup>-15</sup>	1.3
OH + CF <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub> → products (HFC-356mff)	3.0×10 <sup>-12</sup>	1800±300	7.1×10 <sup>-15</sup>	1.3
OH + CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> F → products (HFC-356mcf)	1.7×10 <sup>-12</sup>	1110±200	4.2×10 <sup>-14</sup>	2.0
OH + CHF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub> H → products (HFC-338pcc)	7.8×10 <sup>-13</sup>	1530±200	4.6×10 <sup>-15</sup>	1.5
OH + CF <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub> → products (HFC-458mfcf)	1.2×10 <sup>-12</sup>	1830±200	2.6×10 <sup>-15</sup>	2.0
OH + CF <sub>3</sub> CHFCHF <sub>2</sub> CF <sub>3</sub> → products (HFC-43-10mee)	5.2×10 <sup>-13</sup>	1500±300	3.4×10 <sup>-15</sup>	1.3
OH + CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub> → (HFC-55-10-mcff) products	–	–	8.3×10 <sup>-15</sup>	1.5
F + O <sub>3</sub> → FO + O <sub>2</sub>	2.2×10 <sup>-11</sup>	230±200	1.0×10 <sup>-11</sup>	1.5
F + H <sub>2</sub> → HF + H	1.4×10 <sup>-10</sup>	500±200	2.6×10 <sup>-11</sup>	1.2
F + H <sub>2</sub> O → HF + OH	1.4×10 <sup>-11</sup>	0±200	1.4×10 <sup>-11</sup>	1.3
F + HNO <sub>3</sub> → HF + NO <sub>3</sub>	6.0×10 <sup>-12</sup>	–(400±200)	2.3×10 <sup>-11</sup>	1.3
F + CH <sub>4</sub> → HF + CH <sub>3</sub>	1.6×10 <sup>-10</sup>	260±200	6.7×10 <sup>-11</sup>	1.4
FO + O <sub>3</sub> → products			<1 × 10 <sup>-14</sup>	
FO + NO → NO <sub>2</sub> + F	8.2×10 <sup>-12</sup>	–(300±200)	2.2×10 <sup>-11</sup>	1.5
FO + FO → 2 F + O <sub>2</sub>	1.0×10 <sup>-11</sup>	0±250	1.0×10 <sup>-11</sup>	1.5
FO <sub>2</sub> + O <sub>3</sub> → products			<3.4×10 <sup>-16</sup>	
FO <sub>2</sub> + NO → FNO + O <sub>2</sub>	7.5×10 <sup>-12</sup>	690±400	7.5×10 <sup>-13</sup>	2.0
FO <sub>2</sub> + NO <sub>2</sub> → products	3.8×10 <sup>-11</sup>	2040±500	4.0×10 <sup>-14</sup>	2.0
FO <sub>2</sub> + CO → products			<5.1×10 <sup>-16</sup>	
FO <sub>2</sub> + CH <sub>4</sub> → products			<2×10 <sup>-16</sup>	
CF <sub>3</sub> O + O <sub>2</sub> → FO <sub>2</sub> + CF <sub>2</sub> O	<3 × 10 <sup>-11</sup>	5000	<1.5 × 10 <sup>-18</sup>	
CF <sub>3</sub> O + O <sub>3</sub> → CF <sub>3</sub> O <sub>2</sub> + O <sub>2</sub>	2 × 10 <sup>-12</sup>	1400±600	1.8 × 10 <sup>-14</sup>	1.3
CF <sub>3</sub> O + H <sub>2</sub> O → OH + CF <sub>3</sub> OH	3 × 10 <sup>-12</sup>	>3600	<2 × 10 <sup>-17</sup>	
CF <sub>3</sub> O + NO → CF <sub>2</sub> O + FNO	3.7 × 10 <sup>-11</sup>	–(110±70)	5.4 × 10 <sup>-11</sup>	1.2
CF <sub>3</sub> O + NO <sub>2</sub> → products	See reference			
CF <sub>3</sub> O + CO → products			<2 × 10 <sup>-15</sup>	
CF <sub>3</sub> O + CH <sub>4</sub> → CH <sub>3</sub> + CF <sub>3</sub> OH	2.6 × 10 <sup>-12</sup>	1420±200	2.2 × 10 <sup>-14</sup>	1.1
CF <sub>3</sub> O + C <sub>2</sub> H <sub>6</sub> → C <sub>2</sub> H <sub>5</sub> + CF <sub>3</sub> OH	4.9 × 10 <sup>-12</sup>	400±100	1.3 × 10 <sup>-12</sup>	1.2
CF <sub>3</sub> O <sub>2</sub> + O <sub>3</sub> → CF <sub>3</sub> O + 2O <sub>2</sub>			<3 × 10 <sup>-15</sup>	
CF <sub>3</sub> O <sub>2</sub> + CO → CF <sub>3</sub> O + CO <sub>2</sub>			<5 × 10 <sup>-16</sup>	
CF <sub>3</sub> O <sub>2</sub> + NO → CF <sub>3</sub> O + NO <sub>2</sub>	5.4 × 10 <sup>-12</sup>	–(320±150)	1.6 × 10 <sup>-11</sup>	1.1
<b>CIO<sub>x</sub> Reactions</b>				
O + ClO → Cl + O <sub>2</sub>	3.0×10 <sup>-11</sup>	–(70±70)	3.8×10 <sup>-11</sup>	1.2
O + OCIO → ClO + O <sub>2</sub>	2.4×10 <sup>-12</sup>	960±300	1.0×10 <sup>-13</sup>	2.0
O + Cl <sub>2</sub> O → ClO + ClO	2.7×10 <sup>-11</sup>	530±150	4.5×10 <sup>-12</sup>	1.3
O + HCl → OH + Cl	1.0×10 <sup>-11</sup>	3300±350	1.5×10 <sup>-16</sup>	2.0
O + HOCl → OH + ClO	1.7×10 <sup>-13</sup>	0±300	1.7×10 <sup>-13</sup>	3.0
O + ClONO <sub>2</sub> → products	2.9×10 <sup>-12</sup>	800±200	2.0×10 <sup>-13</sup>	1.5
O <sub>3</sub> + OCIO → products	2.1×10 <sup>-12</sup>	4700±1000	3.0×10 <sup>-19</sup>	2.5
O <sub>3</sub> + Cl <sub>2</sub> O → products	–	–	<1.0×10 <sup>-19</sup>	–
OH + Cl <sub>2</sub> → HOCl + Cl	1.4×10 <sup>-12</sup>	900±400	6.7×10 <sup>-14</sup>	1.2
OH + ClO → products	1.1×10 <sup>-11</sup>	–(120±150)	1.7×10 <sup>-11</sup>	1.5
OH + OCIO → HOCl + O <sub>2</sub>	4.5×10 <sup>-13</sup>	–(800±200)	6.8×10 <sup>-12</sup>	2.0
OH + HCl → H <sub>2</sub> O + Cl	2.6×10 <sup>-12</sup>	350±100	8.0×10 <sup>-13</sup>	1.2
OH + HOCl → H <sub>2</sub> O + ClO	3.0×10 <sup>-12</sup>	500±500	5.0×10 <sup>-13</sup>	3.0
OH + ClONO <sub>2</sub> → HOCl + NO <sub>2</sub>	2.4×10 <sup>-12</sup>	1250±300	3.6×10 <sup>-14</sup>	2.0
OH + ClONO <sub>2</sub> → products	1.2×10 <sup>-12</sup>	330±200	3.9×10 <sup>-13</sup>	1.5

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
OH + CH <sub>3</sub> Cl → CH <sub>2</sub> Cl + H <sub>2</sub> O	4.0×10 <sup>-12</sup>	1400±250	3.6×10 <sup>-14</sup>	1.2
OH + CH <sub>2</sub> Cl <sub>2</sub> → CHCl <sub>2</sub> + H <sub>2</sub> O	3.8×10 <sup>-12</sup>	1050±150	1.1×10 <sup>-13</sup>	1.4
OH + CHCl <sub>3</sub> → CCl <sub>3</sub> + H <sub>2</sub> O	2.0×10 <sup>-12</sup>	900±150	1.0×10 <sup>-13</sup>	1.2
OH + CCl <sub>4</sub> → products	~1.0×10 <sup>-12</sup>	>2300	<5.0×10 <sup>-16</sup>	–
OH + CFCl <sub>3</sub> → products (CFC-11)	~1.0×10 <sup>-12</sup>	>3700	<5.0×10 <sup>-18</sup>	–
OH + CF <sub>2</sub> Cl <sub>2</sub> → products (CFC-12)	~1.0×10 <sup>-12</sup>	>3600	<6.0×10 <sup>-18</sup>	–
OH + CH <sub>2</sub> CIF → CHCIF + H <sub>2</sub> O (HCFC-31)	2.8×10 <sup>-12</sup>	1270±200	3.9×10 <sup>-14</sup>	1.2
OH + CHFCl <sub>2</sub> → CFCl <sub>2</sub> + H <sub>2</sub> O (HCFC-21)	1.7×10 <sup>-12</sup>	1250±150	2.6×10 <sup>-14</sup>	1.2
OH + CHF <sub>2</sub> Cl → CF <sub>2</sub> Cl + H <sub>2</sub> O (HCFC-22)	1.0×10 <sup>-12</sup>	1600±150	4.7×10 <sup>-15</sup>	1.1
OH + CH <sub>3</sub> OCl → products	2.4×10 <sup>-12</sup>	360±200	7.2×10 <sup>-13</sup>	3.0
OH + CH <sub>3</sub> CCl <sub>3</sub> → CH <sub>2</sub> CCl <sub>3</sub> + H <sub>2</sub> O (HCC-140)	1.8×10 <sup>-12</sup>	1550±150	1.0×10 <sup>-14</sup>	1.1
OH + C <sub>2</sub> HCl <sub>3</sub> → products	4.9×10 <sup>-13</sup>	–(450±200)	2.2×10 <sup>-12</sup>	1.25
OH + C <sub>2</sub> Cl <sub>4</sub> → products	9.4×10 <sup>-12</sup>	1200±200	1.7×10 <sup>-13</sup>	1.25
OH + CCl <sub>3</sub> CHO → H <sub>2</sub> O + CCl <sub>3</sub> CO	8.2×10 <sup>-12</sup>	600±300	1.1×10 <sup>-12</sup>	1.5
OH + CH <sub>3</sub> CFCl <sub>2</sub> → CH <sub>2</sub> CFCl <sub>2</sub> + H <sub>2</sub> O (HCFC-141b)	1.7×10 <sup>-12</sup>	1700±150	5.7×10 <sup>-15</sup>	1.2
OH + CH <sub>3</sub> CF <sub>2</sub> Cl → CH <sub>2</sub> CF <sub>2</sub> Cl + H <sub>2</sub> O (HCFC-142b)	1.3×10 <sup>-12</sup>	1800±150	3.1×10 <sup>-15</sup>	1.2
OH + CH <sub>2</sub> CICF <sub>2</sub> Cl → CHClCF <sub>2</sub> Cl (HCFC-132b) + H <sub>2</sub> O	3.6×10 <sup>-12</sup>	1600±400	1.7×10 <sup>-14</sup>	2.0
OH + CHCl <sub>2</sub> CF <sub>2</sub> Cl → CCl <sub>2</sub> CF <sub>2</sub> Cl (HCFC-122) + H <sub>2</sub> O	1.0×10 <sup>-12</sup>	900±150	4.9×10 <sup>-14</sup>	1.2
OH + CHFClCFCl <sub>2</sub> → CFCICFCl <sub>2</sub> (HCFC-122a) + H <sub>2</sub> O	1.0×10 <sup>-12</sup>	1250±150	1.5×10 <sup>-14</sup>	1.1
OH + CH <sub>2</sub> CICF <sub>3</sub> → CHClCF <sub>3</sub> + H <sub>2</sub> O (HCFC-133a)	5.2×10 <sup>-13</sup>	1100±300	1.3×10 <sup>-14</sup>	1.3
OH + CHCl <sub>2</sub> CF <sub>3</sub> → CCl <sub>2</sub> CF <sub>3</sub> + H <sub>2</sub> O (HCFC-123)	7.0×10 <sup>-13</sup>	900±150	3.4×10 <sup>-14</sup>	1.2
OH + CHFClCF <sub>2</sub> Cl → CFCICF <sub>2</sub> Cl (HCFC-123a) + H <sub>2</sub> O	9.2×10 <sup>-13</sup>	1280±150	1.3×10 <sup>-14</sup>	1.2
OH + CHFClCF <sub>3</sub> → CFCICF <sub>3</sub> + H <sub>2</sub> O (HCFC-124)	8.0×10 <sup>-13</sup>	1350±150	8.6×10 <sup>-15</sup>	1.2
OH + CH <sub>3</sub> CF <sub>2</sub> CFCl <sub>2</sub> → products (HCFC-243cc)	7.7×10 <sup>-13</sup>	1700±300	2.6×10 <sup>-15</sup>	2.0
OH + CF <sub>3</sub> CF <sub>2</sub> CHCl <sub>2</sub> → products (HCFC-225ca)	1.0×10 <sup>-12</sup>	1100±200	2.5×10 <sup>-14</sup>	1.3
OH + CF <sub>2</sub> CICF <sub>2</sub> CHCl → products (HCFC-225cb)	5.5×10 <sup>-13</sup>	1250±200	8.3×10 <sup>-15</sup>	1.3
HO <sub>2</sub> + Cl → HCl + O <sub>2</sub>	1.8×10 <sup>-11</sup>	–(170±200)	3.2×10 <sup>-11</sup>	1.5
→ OH + ClO	4.1×10 <sup>-11</sup>	450±200	9.1×10 <sup>-12</sup>	2.0
HO <sub>2</sub> + ClO → HOCl + O <sub>2</sub>	4.8×10 <sup>-13</sup>	–(700±)	5.0×10 <sup>-12</sup>	1.4
H <sub>2</sub> O + ClONO <sub>2</sub> → products	–	–	<2.0×10 <sup>-21</sup>	–
NO + OClO → NO <sub>2</sub> + ClO	2.5×10 <sup>-12</sup>	600±300	3.4×10 <sup>-13</sup>	2.0
NO + Cl <sub>2</sub> O <sub>2</sub> → products	–	–	<2.0×10 <sup>-14</sup>	–
NO <sub>3</sub> + HCl → HNO <sub>3</sub> + Cl	–	–	<5.0×10 <sup>-17</sup>	–
HO <sub>2</sub> NO <sub>2</sub> + HCl → products	–	–	<1.0×10 <sup>-21</sup>	–
Cl + O <sub>3</sub> → ClO + O <sub>2</sub>	2.9×10 <sup>-11</sup>	260±100	1.2×10 <sup>-11</sup>	1.15
Cl + H <sub>2</sub> → HCl + H	3.7×10 <sup>-11</sup>	2300±200	1.6×10 <sup>-14</sup>	1.25
Cl + H <sub>2</sub> O <sub>2</sub> → HCl + HO <sub>2</sub>	1.1×10 <sup>-11</sup>	980±500	4.1×10 <sup>-13</sup>	1.5
Cl + NO <sub>3</sub> → ClO + NO <sub>2</sub>	2.4×10 <sup>-11</sup>	0±400	2.4×10 <sup>-11</sup>	1.5
Cl + N <sub>2</sub> O → ClO + N <sub>2</sub>	See reference	–	–	–
Cl + HNO <sub>3</sub> → products	–	–	<2.0×10 <sup>-16</sup>	–
Cl + CH <sub>4</sub> → HCl + CH <sub>3</sub>	1.1×10 <sup>-11</sup>	1400±150	1.0×10 <sup>-13</sup>	1.1
Cl + CH <sub>3</sub> D → products	–	–	7.4×10 <sup>-14</sup>	2.0
Cl + H <sub>2</sub> CO → HCl + HCO	8.1×10 <sup>-11</sup>	30±100	7.3×10 <sup>-11</sup>	1.15
Cl + CH <sub>3</sub> O <sub>2</sub> → products	–	–	1.6×10 <sup>-10</sup>	1.5
Cl + CH <sub>3</sub> OH → CH <sub>2</sub> OH + HCl	5.4×10 <sup>-11</sup>	0±250	5.4×10 <sup>-11</sup>	1.5
Cl + C <sub>2</sub> H <sub>6</sub> → HCl + C <sub>2</sub> H <sub>5</sub>	7.7×10 <sup>-11</sup>	90±90	5.7×10 <sup>-11</sup>	1.1
Cl + C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> → ClO + C <sub>2</sub> H <sub>5</sub> O	–	–	7.4×10 <sup>-11</sup>	2.0
→ HCl + C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	–	–	7.7×10 <sup>-11</sup>	2.0
Cl + CH <sub>3</sub> CN → products	1.6×10 <sup>-11</sup>	2140±300	1.2×10 <sup>-14</sup>	2.0
Cl + CH <sub>3</sub> CO <sub>3</sub> NO <sub>2</sub> → products	–	–	<1×10 <sup>-14</sup>	–
Cl + C <sub>3</sub> H <sub>8</sub> → HCl + C <sub>3</sub> H <sub>7</sub>	1.2×10 <sup>-10</sup>	–(40±250)	1.4×10 <sup>-10</sup>	1.3
Cl + OClO → ClO + ClO	3.4×10 <sup>-11</sup>	–(160±200)	5.8×10 <sup>-11</sup>	1.25
Cl + ClOO → Cl <sub>2</sub> + O <sub>2</sub>	2.3×10 <sup>-10</sup>	0±250	2.3×10 <sup>-10</sup>	3.0
→ ClO + ClO	1.2×10 <sup>-11</sup>	0±250	1.2×10 <sup>-11</sup>	3.0
Cl + Cl <sub>2</sub> O → Cl <sub>2</sub> + ClO	6.2×10 <sup>-11</sup>	–(130±130)	9.6×10 <sup>-11</sup>	1.2
Cl + Cl <sub>2</sub> O <sub>2</sub> → products	–	–	1.0×10 <sup>-10</sup>	2.0
Cl + HOCl → products	2.5×10 <sup>-12</sup>	130±250	1.6×10 <sup>-12</sup>	1.5
Cl + ClNO → NO + Cl <sub>2</sub>	5.8×10 <sup>-11</sup>	–(100±200)	8.1×10 <sup>-11</sup>	1.5

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
Cl + ClONO <sub>2</sub> → products	6.5×10 <sup>-12</sup>	-(135±50)	1.0×10 <sup>-11</sup>	1.2
Cl + CH <sub>3</sub> Cl → CH <sub>2</sub> Cl + HCl	3.2×10 <sup>-11</sup>	1250±200	4.8×10 <sup>-13</sup>	1.2
Cl + CH <sub>2</sub> Cl <sub>2</sub> → HCl + CHCl <sub>2</sub>	3.1×10 <sup>-11</sup>	1350±500	3.3×10 <sup>-13</sup>	1.5
Cl + CHCl <sub>3</sub> → HCl + CCl <sub>3</sub>	8.2×10 <sup>-12</sup>	1325±300	9.6×10 <sup>-14</sup>	1.3
Cl + CH <sub>3</sub> F → HCl + CH <sub>2</sub> F (HFC-41)	2.0×10 <sup>-11</sup>	1200±500	3.5×10 <sup>-13</sup>	1.3
Cl + CH <sub>2</sub> F <sub>2</sub> → HCl + CHF <sub>2</sub> (HFC-32)	1.2×10 <sup>-11</sup>	1630±500	5.0×10 <sup>-14</sup>	1.5
Cl + CF <sub>3</sub> H → HCl + CF <sub>3</sub> (HFC-23)	—	—	3.0×10 <sup>-18</sup>	5.0
Cl + CH <sub>2</sub> FCI → HCl + CHFCl (HCFC-31)	1.2×10 <sup>-11</sup>	1390±500	1.1×10 <sup>-13</sup>	2.0
Cl + CHFCl <sub>2</sub> → HCl + CFCl <sub>2</sub> (HCFC-21)	5.5×10 <sup>-12</sup>	1675±200	2.0×10 <sup>-14</sup>	1.3
Cl + CHF <sub>2</sub> Cl → HCl + CF <sub>2</sub> Cl (HCFC-22)	5.9×10 <sup>-12</sup>	2430±200	1.7×10 <sup>-15</sup>	1.3
Cl + CH <sub>3</sub> CCl <sub>3</sub> → CH <sub>2</sub> CCl <sub>3</sub> + HCl	2.8×10 <sup>-12</sup>	1790±400	7.0×10 <sup>-15</sup>	2.0
Cl + CH <sub>3</sub> CH <sub>2</sub> F → HCl + CH <sub>3</sub> CHF (HFC-161)	1.8×10 <sup>-11</sup>	290±500	6.8×10 <sup>-12</sup>	3.0
→ HCl + CH <sub>2</sub> CH <sub>2</sub> F	1.4×10 <sup>-11</sup>	880±500	7.3×10 <sup>-13</sup>	3.0
Cl + CH <sub>3</sub> CHF <sub>2</sub> → HCl + CH <sub>3</sub> CF <sub>2</sub> (HFC-152a)	6.4×10 <sup>-12</sup>	950±500	2.6×10 <sup>-13</sup>	1.3
→ HCl + CH <sub>2</sub> CHF <sub>2</sub>	7.2×10 <sup>-12</sup>	2390±500	2.4×10 <sup>-15</sup>	3.0
Cl + CH <sub>2</sub> FCH <sub>2</sub> F → HCl + CHFCH <sub>2</sub> F (HFC-152)	2.6×10 <sup>-11</sup>	1060±500	7.5×10 <sup>-13</sup>	3.0
Cl + CH <sub>3</sub> CFCl <sub>2</sub> → HCl + CH <sub>2</sub> CFCl <sub>2</sub> (HCFC-141b)	1.8×10 <sup>-12</sup>	2000±300	2.2×10 <sup>-15</sup>	1.2
Cl + CH <sub>3</sub> CF <sub>2</sub> Cl → HCl + CH <sub>2</sub> CF <sub>2</sub> Cl (HCFC-142b)	1.4×10 <sup>-12</sup>	2420±500	4.2×10 <sup>-16</sup>	1.2
Cl + CH <sub>3</sub> CF <sub>3</sub> → HCl + CH <sub>2</sub> CF <sub>3</sub> (HFC-143a)	1.2×10 <sup>-11</sup>	3880±500	2.6×10 <sup>-17</sup>	5.0
Cl + CH <sub>2</sub> FCHF <sub>2</sub> → HCl + CH <sub>2</sub> FCF <sub>2</sub> (HFC-143)	5.5×10 <sup>-12</sup>	1610±500	2.5×10 <sup>-14</sup>	3.0
→ HCl + CHFCHF <sub>2</sub>	7.7×10 <sup>-12</sup>	1720±500	2.4×10 <sup>-14</sup>	3.0
Cl + CH <sub>2</sub> ClCF <sub>3</sub> → HCl + CHClCF <sub>3</sub> (HCFC-133a)	1.8×10 <sup>-12</sup>	1710±500	5.9×10 <sup>-15</sup>	3.0
Cl + CH <sub>2</sub> FCF <sub>3</sub> → HCl + CHF <sub>2</sub> CF <sub>3</sub> (HFC-134a)	—	—	1.5×10 <sup>-15</sup>	1.2
Cl + CHF <sub>2</sub> CHF <sub>2</sub> → HCl + CF <sub>2</sub> CHF <sub>2</sub> (HCF-134)	7.5×10 <sup>-12</sup>	2430±500	2.2×10 <sup>-15</sup>	1.5
Cl + CHCl <sub>2</sub> CF <sub>3</sub> → HCl + CCl <sub>2</sub> CF <sub>3</sub> (HCFC-123)	4.4×10 <sup>-12</sup>	1750±500	1.2×10 <sup>-14</sup>	1.3
Cl + CHFClCF <sub>3</sub> → HCl + CFClCF <sub>3</sub> (HCFC-124)	1.1×10 <sup>-12</sup>	1800±500	2.7×10 <sup>-15</sup>	1.3
Cl + CHF <sub>2</sub> CF <sub>3</sub> → HCl + CF <sub>2</sub> CF <sub>3</sub> (HFC-125)	—	—	2.4×10 <sup>-16</sup>	1.3
ClO + O <sub>3</sub> → ClOO + O <sub>2</sub>	—	—	<1.4×10 <sup>-17</sup>	—
→ OClO + O <sub>2</sub>	1.0×10 <sup>-12</sup>	>4000	<1.0×10 <sup>-18</sup>	—
ClO + H <sub>2</sub> → products	~1.0×10 <sup>-12</sup>	>4800	<1.0×10 <sup>-19</sup>	—
ClO + NO → NO <sub>2</sub> + Cl	6.4×10 <sup>-12</sup>	-(290±100)	1.7×10 <sup>-11</sup>	1.15
ClO + NO <sub>3</sub> → ClOO + NO <sub>2</sub>	4.7×10 <sup>-13</sup>	0±400	4.7×10 <sup>-13</sup>	1.5
ClO + N <sub>2</sub> O → products	~1.0×10 <sup>-12</sup>	>4300	<6.0×10 <sup>-19</sup>	—
ClO + CO → products	~1.0×10 <sup>-12</sup>	>3700	<4.0×10 <sup>-18</sup>	—
ClO + CH <sub>4</sub> → products	~1.0×10 <sup>-12</sup>	>3700	<4.0×10 <sup>-18</sup>	—
ClO + H <sub>2</sub> CO → products	~1.0×10 <sup>-12</sup>	>2100	<1.0×10 <sup>-15</sup>	—
ClO + CH <sub>3</sub> O <sub>2</sub> → products	3.3×10 <sup>-12</sup>	115±115	2.2×10 <sup>-12</sup>	1.5
ClO + ClO → Cl <sub>2</sub> + O <sub>2</sub>	1.0×10 <sup>-12</sup>	1590±300	4.8×10 <sup>-15</sup>	1.5
→ ClOO + Cl	3.0×10 <sup>-11</sup>	2450±500	8.0×10 <sup>-15</sup>	1.5
→ OClO + Cl	3.5×10 <sup>-13</sup>	1370±300	3.5×10 <sup>-15</sup>	1.5
HCl + ClONO <sub>2</sub> → products	—	—	<1.0×10 <sup>-20</sup>	—
CH <sub>2</sub> ClO + O <sub>2</sub> → CHClO + HO <sub>2</sub>	—	—	6 × 10 <sup>-14</sup>	5
CH <sub>2</sub> ClO <sub>2</sub> + HO <sub>2</sub> → CH <sub>2</sub> ClO <sub>2</sub> H + O <sub>2</sub>	3.3 × 10 <sup>-13</sup>	-(820±200)	5.2 × 10 <sup>-12</sup>	1.5
CH <sub>2</sub> ClO <sub>2</sub> + NO → CH <sub>2</sub> ClO + NO <sub>2</sub>	7 × 10 <sup>-12</sup>	-(300±200)	1.9 × 10 <sup>-11</sup>	1.5
CCl <sub>3</sub> O <sub>2</sub> + NO → CCl <sub>2</sub> O + NO <sub>2</sub> + Cl	7.3 × 10 <sup>-12</sup>	-(270±200)	1.8 × 10 <sup>-11</sup>	1.3
CCl <sub>2</sub> FO <sub>2</sub> + NO → CClFO + NO <sub>2</sub> + Cl	4.5 × 10 <sup>-12</sup>	-(350±200)	1.5 × 10 <sup>-11</sup>	1.3
CClF <sub>2</sub> O <sub>2</sub> + NO → CF <sub>2</sub> O + NO <sub>2</sub> + Cl	3.8 × 10 <sup>-12</sup>	-(400±200)	1.5 × 10 <sup>-11</sup>	1.2
<b>BrO<sub>x</sub> Reactions</b>				
O + BrO → Br + O <sub>2</sub>	1.9×10 <sup>-11</sup>	-(230±150)	4.1×10 <sup>-11</sup>	1.5
O + HBr → OH + Br	5.8×10 <sup>-12</sup>	1500±200	3.8×10 <sup>-14</sup>	1.3
O + HOBr → OH + BrO	1.2×10 <sup>-10</sup>	430±300	2.8×10 <sup>-11</sup>	3.0
OH + Br <sub>2</sub> → HOBr + Br	4.2×10 <sup>-11</sup>	0±600	4.2×10 <sup>-11</sup>	1.3
OH + BrO → products	—	—	7.5×10 <sup>-11</sup>	3.0
OH + HBr → H <sub>2</sub> O + Br	1.1×10 <sup>-11</sup>	0±250	1.1×10 <sup>-11</sup>	1.2
OH + CH <sub>3</sub> Br → CH <sub>2</sub> Br + H <sub>2</sub> O	4.0×10 <sup>-12</sup>	1470±150	2.9×10 <sup>-14</sup>	1.1
OH + CH <sub>2</sub> Br <sub>2</sub> → CHBr <sub>2</sub> + H <sub>2</sub> O	2.4×10 <sup>-12</sup>	900±300	1.2×10 <sup>-13</sup>	1.1
OH + CHBr <sub>3</sub> → CBr <sub>3</sub> + H <sub>2</sub> O	1.6×10 <sup>-12</sup>	710±200	1.5×10 <sup>-13</sup>	2.0

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
OH + CHF <sub>2</sub> Br → CF <sub>2</sub> Br + H <sub>2</sub> O	1.1×10 <sup>-12</sup>	1400±200	1.0×10 <sup>-14</sup>	1.1
OH + CH <sub>2</sub> ClBr → CHClBr + H <sub>2</sub> O	2.3×10 <sup>-12</sup>	930±150	1.0×10 <sup>-13</sup>	1.2
OH + CF <sub>2</sub> ClBr → products	—	—	<1.5×10 <sup>-16</sup>	—
OH + CF <sub>2</sub> Br <sub>2</sub> → products	—	—	<5.0×10 <sup>-16</sup>	—
OH + CF <sub>3</sub> Br → products	—	—	<1.2×10 <sup>-16</sup>	—
OH + CH <sub>2</sub> BrCF <sub>3</sub> → CHBrCF <sub>3</sub> + H <sub>2</sub> O	1.4×10 <sup>-12</sup>	1340±200	1.6×10 <sup>-14</sup>	1.3
OH + CHFBrCF <sub>3</sub> → CFBrCF <sub>3</sub>	7.2×10 <sup>-13</sup>	1110±150	1.8×10 <sup>-14</sup>	1.5
OH + CHClBrCF <sub>3</sub> → CClBrCF <sub>3</sub> + H <sub>2</sub> O	1.3×10 <sup>-12</sup>	995±150	4.5×10 <sup>-14</sup>	1.5
OH + CF <sub>2</sub> BrCH <sub>2</sub> F → CF <sub>2</sub> BrCFCl + H <sub>2</sub> O	9.3×10 <sup>-13</sup>	1250±150	1.4×10 <sup>-14</sup>	1.5
OH + CF <sub>2</sub> BrCF <sub>2</sub> Br → products	—	—	<1.5×10 <sup>-16</sup>	—
HO <sub>2</sub> + Br → HBr + O <sub>2</sub>	1.5×10 <sup>-11</sup>	600±600	2.0×10 <sup>-12</sup>	2.0
HO <sub>2</sub> + BrO → products	3.4×10 <sup>-12</sup>	-(540±200)	2.1×10 <sup>-11</sup>	1.5
NO <sub>3</sub> + HBr → HNO <sub>3</sub> + Br	—	—	<1.0×10 <sup>-16</sup>	—
Cl + CH <sub>2</sub> ClBr → HCl + CHClBr	4.3×10 <sup>-11</sup>	1370±500	4.3×10 <sup>-13</sup>	3.0
Cl + CH <sub>3</sub> Br → HCl + CH <sub>2</sub> Br	1.5×10 <sup>-11</sup>	1060±100	4.3×10 <sup>-13</sup>	1.2
Cl + CH <sub>2</sub> Br <sub>2</sub> → HCl + CHBr <sub>2</sub>	6.4×10 <sup>-12</sup>	810±100	4.2×10 <sup>-13</sup>	1.2
Br + O <sub>3</sub> → BrO + O <sub>2</sub>	1.7×10 <sup>-11</sup>	800±200	1.2×10 <sup>-12</sup>	1.2
Br + H <sub>2</sub> O <sub>2</sub> → HBr + HO <sub>2</sub>	1.0×10 <sup>-11</sup>	>3000	<5.0×10 <sup>-16</sup>	—
Br + NO <sub>3</sub> → BrO + NO <sub>2</sub>	—	—	1.6×10 <sup>-11</sup>	2.0
Br + H <sub>2</sub> CO → HBr + HCO	1.7×10 <sup>-11</sup>	800±200	1.1×10 <sup>-12</sup>	1.3
Br + OClO → BrO + ClO	2.6×10 <sup>-11</sup>	1300±300	3.4×10 <sup>-13</sup>	2.0
Br + Cl <sub>2</sub> O → BrCl + ClO	2.1×10 <sup>-11</sup>	470±150	4.3×10 <sup>-12</sup>	1.3
Br + Cl <sub>2</sub> O <sub>2</sub> → products	—	—	3.0×10 <sup>-12</sup>	2.0
BrO + O <sub>3</sub> → products	~1.0×10 <sup>-12</sup>	>3200	<2.0×10 <sup>-17</sup>	—
BrO + NO → NO <sub>2</sub> + Br	8.8×10 <sup>-12</sup>	-(260±130)	2.1×10 <sup>-11</sup>	1.15
BrO + NO <sub>3</sub> → products	—	—	1.0×10 <sup>-12</sup>	3.0
BrO + ClO → Br + OClO	1.6×10 <sup>-12</sup>	-(430±200)	6.8×10 <sup>-12</sup>	1.25
→ Br + ClOO	2.9×10 <sup>-12</sup>	-(220±200)	6.1×10 <sup>-12</sup>	1.25
→ BrCl + O <sub>2</sub>	5.8×10 <sup>-13</sup>	-(170±200)	1.0×10 <sup>-12</sup>	1.25
BrO + BrO → products	1.5×10 <sup>-12</sup>	-(230±150)	3.2×10 <sup>-12</sup>	1.15
CH <sub>2</sub> BrO <sub>2</sub> + NO → CH <sub>2</sub> O + NO <sub>2</sub> + Br	4×10 <sup>-12</sup>	-(300±200)	1.1 × 10 <sup>-11</sup>	1.5
<b>IO<sub>x</sub> Reactions</b>				
O + I <sub>2</sub> → IO + I	1.4×10 <sup>-10</sup>	0±250	1.4×10 <sup>-10</sup>	1.4
O + IO → O <sub>2</sub> + I	—	—	1.2×10 <sup>-10</sup>	2.0
OH + I <sub>2</sub> → HOI + I	—	—	1.8×10 <sup>-10</sup>	2.0
OH + HI → H <sub>2</sub> O + I	—	—	3.0×10 <sup>-11</sup>	2.0
OH + CH <sub>3</sub> I → H <sub>2</sub> O + CH <sub>2</sub> I	3.1×10 <sup>-12</sup>	1120±500	7.2×10 <sup>-14</sup>	3.0
OH + CF <sub>3</sub> I → HOI + CF <sub>3</sub>	—	—	3.1×10 <sup>-14</sup>	5.0
HO <sub>2</sub> + I → HI + O <sub>2</sub>	1.5×10 <sup>-11</sup>	1090±500	3.8×10 <sup>-13</sup>	2.0
HO <sub>2</sub> + IO → HOI + O <sub>2</sub>	—	—	8.4×10 <sup>-11</sup>	1.5
NO <sub>3</sub> + HI → HNO <sub>3</sub> + I	See reference	—	—	—
I + O <sub>3</sub> → IO + O <sub>2</sub>	2.3×10 <sup>-11</sup>	870±200	1.2×10 <sup>-12</sup>	1.2
I + BrO → IO + Br	—	—	1.2×10 <sup>-11</sup>	2.0
IO + NO → I + NO <sub>2</sub>	9.1×10 <sup>-12</sup>	-(240±150)	2.0×10 <sup>-11</sup>	1.2
IO + ClO → products	5.1×10 <sup>-12</sup>	-(280±200)	1.3×10 <sup>-11</sup>	2.0
IO + BrO → products	—	—	6.9×10 <sup>-11</sup>	1.5
IO + IO → products	1.5×10 <sup>-11</sup>	-(500±500)	8.0×10 <sup>-11</sup>	1.5
INO + INO → I <sub>2</sub> + 2NO	8.4×10 <sup>-11</sup>	2620±600	1.3×10 <sup>-14</sup>	2.5
INO <sub>2</sub> + INO <sub>2</sub> → I <sub>2</sub> + 2NO <sub>2</sub>	2.9×10 <sup>-11</sup>	2600±1000	4.7×10 <sup>-15</sup>	3.0
<b>SO<sub>x</sub> Reactions</b>				
O + SH → SO + H	—	—	1.6×10 <sup>-10</sup>	5.0
O + CS → CO + S	2.7×10 <sup>-10</sup>	760±250	2.1×10 <sup>-11</sup>	1.1
O + H <sub>2</sub> S → OH + SH	9.2×10 <sup>-12</sup>	1800±550	2.2×10 <sup>-14</sup>	1.7
O + OCS → CO + SO	2.1×10 <sup>-11</sup>	2200±150	1.3×10 <sup>-14</sup>	1.2
O + CS <sub>2</sub> → CS + SO	3.2×10 <sup>-11</sup>	650±150	3.6×10 <sup>-12</sup>	1.2
O + CH <sub>3</sub> SCH <sub>3</sub> → CH <sub>3</sub> SO + CH <sub>3</sub>	1.3×10 <sup>-11</sup>	-(410±100)	5.0×10 <sup>-11</sup>	1.1
O + CH <sub>3</sub> SSCH <sub>3</sub> → CH <sub>3</sub> SO + CH <sub>3</sub> S	5.5×10 <sup>-11</sup>	-(250±100)	1.3×10 <sup>-10</sup>	1.3

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
O <sub>3</sub> + H <sub>2</sub> S → products	–	–	<2.0×10 <sup>-20</sup>	–
O <sub>3</sub> + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	<1.0×10 <sup>-18</sup>	–
O <sub>3</sub> + SO <sub>2</sub> → SO <sub>3</sub> + O <sub>2</sub>	3.0×10 <sup>-12</sup>	>7000	<2.0×10 <sup>-22</sup>	–
OH + H <sub>2</sub> S → SH + H <sub>2</sub> O	6.0×10 <sup>-12</sup>	75±75	4.7×10 <sup>-12</sup>	1.2
OH + OCS → products	1.1×10 <sup>-13</sup>	1200±500	1.9×10 <sup>-15</sup>	2.0
OH + CS <sub>2</sub> → products	See reference	–	–	–
OH + CH <sub>3</sub> SH → CH <sub>3</sub> S + H <sub>2</sub> O	9.9×10 <sup>-12</sup>	–(360±100)	3.3×10 <sup>-11</sup>	1.2
OH + CH <sub>3</sub> SCH <sub>3</sub> → H <sub>2</sub> O + CH <sub>2</sub> SCH <sub>3</sub>	1.2×10 <sup>-11</sup>	260±100	5.0×10 <sup>-12</sup>	1.15
OH + CH <sub>3</sub> SSCH <sub>3</sub> → products	6.0×10 <sup>-11</sup>	–(400±200)	2.3×10 <sup>-10</sup>	1.2
OH + S → H + SO	–	–	6.6×10 <sup>-11</sup>	3.0
OH + SO → H + SO <sub>2</sub>	–	–	8.6×10 <sup>-11</sup>	2.0
HO <sub>2</sub> + H <sub>2</sub> S → products	–	–	<3.0×10 <sup>-15</sup>	–
HO <sub>2</sub> + CH <sub>3</sub> SH → products	–	–	<4.0×10 <sup>-15</sup>	–
HO <sub>2</sub> + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	<5.0×10 <sup>-15</sup>	–
HO <sub>2</sub> + SO <sub>2</sub> → products	–	–	<1.0×10 <sup>-18</sup>	–
NO <sub>2</sub> + SO <sub>2</sub> → products	–	–	<2.0×10 <sup>-26</sup>	–
NO <sub>3</sub> + H <sub>2</sub> S → products	–	–	<8.0×10 <sup>-16</sup>	–
NO <sub>3</sub> + OCS → products	–	–	<1.0×10 <sup>-16</sup>	–
NO <sub>3</sub> + CS <sub>2</sub> → products	–	–	<4.0×10 <sup>-16</sup>	–
NO <sub>3</sub> + CH <sub>3</sub> SH → products	4.4×10 <sup>-13</sup>	–(210±210)	8.9×10 <sup>-13</sup>	1.25
NO <sub>3</sub> + CH <sub>3</sub> SCH <sub>3</sub> → CH <sub>3</sub> SCH <sub>2</sub> + HNO <sub>3</sub>	1.9×10 <sup>-13</sup>	–(500±200)	1.0×10 <sup>-12</sup>	1.2
NO <sub>3</sub> + CH <sub>3</sub> SSCH <sub>3</sub> → products	1.3×10 <sup>-12</sup>	270±270	5.3×10 <sup>-13</sup>	1.4
NO <sub>3</sub> + SO <sub>2</sub> → products	–	–	<7.0×10 <sup>-21</sup>	–
N <sub>2</sub> O <sub>5</sub> + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	<1.0×10 <sup>-17</sup>	–
CH <sub>3</sub> O <sub>2</sub> + SO <sub>2</sub> → products	–	–	<5.0×10 <sup>-17</sup>	–
F + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	2.4.×10 <sup>-10</sup>	2.0
Cl + H <sub>2</sub> S → HCl + SH	3.7×10 <sup>-11</sup>	–(210±100)	7.4×10 <sup>-11</sup>	1.25
Cl + OCS → products	–	–	<1.0×10 <sup>-16</sup>	–
Cl + CS <sub>2</sub> → products	–	–	<4.0×10 <sup>-15</sup>	–
Cl + CH <sub>3</sub> SH → CH <sub>3</sub> S + HCl	1.2×10 <sup>-10</sup>	–(150±50)	2.0×10 <sup>-10</sup>	1.25
Cl + CH <sub>3</sub> SCH <sub>3</sub> → products	See reference	–	–	–
ClO + OCS → products	–	–	<2.0×10 <sup>-16</sup>	–
ClO + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	9.5×10 <sup>-15</sup>	2.0
ClO + SO → Cl + SO <sub>2</sub>	2.8×10 <sup>-11</sup>	0±50	2.8×10 <sup>-11</sup>	1.3
ClO + SO <sub>2</sub> → Cl + SO <sub>3</sub>	–	–	<4.0×10 <sup>-18</sup>	–
Br + H <sub>2</sub> S → HBr + SH	1.4×10 <sup>-11</sup>	2750±300	1.4×10 <sup>-15</sup>	2.0
Br + CH <sub>3</sub> SH → CH <sub>3</sub> S + HBr	9.2×10 <sup>-12</sup>	390±100	2.5×10 <sup>-12</sup>	2.0
Br + CH <sub>3</sub> SCH <sub>3</sub> → products	See reference	–	–	–
BrO + CH <sub>3</sub> SCH <sub>3</sub> → products	1.5×10 <sup>-14</sup>	–(850±200)	2.6×10 <sup>-13</sup>	1.3
BrO + SO → Br + SO <sub>2</sub>	–	–	5.7×10 <sup>-11</sup>	1.4
IO + CH <sub>3</sub> SH → products	–	–	6.6×10 <sup>-16</sup>	2.0
IO + CH <sub>3</sub> SCH <sub>3</sub> → products	–	–	1.2×10 <sup>-14</sup>	1.5
S + O <sub>2</sub> → SO + O	2.3×10 <sup>-12</sup>	0±200	2.3×10 <sup>-12</sup>	1.2
S + O <sub>3</sub> → SO + O <sub>2</sub>	–	–	1.2×10 <sup>-11</sup>	2.0
SO + O <sub>2</sub> → SO <sub>2</sub> + O	2.6×10 <sup>-13</sup>	2400±500	8.4×10 <sup>-17</sup>	2.0
SO + O <sub>3</sub> → SO <sub>2</sub> + O <sub>2</sub>	3.6×10 <sup>-12</sup>	1100±200	9.0×10 <sup>-14</sup>	1.2
SO + NO <sub>2</sub> → SO <sub>2</sub> + NO	1.4×10 <sup>-11</sup>	0±50	1.4×10 <sup>-11</sup>	1.2
SO + OClO → SO <sub>2</sub> + ClO	–	–	1.9×10 <sup>-12</sup>	3.0
SO <sub>3</sub> + H <sub>2</sub> O → products	See reference	–	–	–
SO <sub>3</sub> + NO <sub>2</sub> → products	–	–	1.0×10 <sup>-19</sup>	10.0
SH + O <sub>2</sub> → OH + SO	–	–	<4.0×10 <sup>-19</sup>	–
SH + O <sub>3</sub> → HSO + O <sub>2</sub>	9.0×10 <sup>-12</sup>	280±200	3.5×10 <sup>-12</sup>	1.3
SH + H <sub>2</sub> O <sub>2</sub> → products	–	–	<5.0×10 <sup>-15</sup>	–
SH + NO <sub>2</sub> → HSO + NO	2.9×10 <sup>-11</sup>	–(240±50)	6.5×10 <sup>-11</sup>	1.2
SH + Cl <sub>2</sub> → ClSH + Cl	1.7×10 <sup>-11</sup>	690±200	1.7×10 <sup>-12</sup>	2.0
SH + BrCl → products	2.3×10 <sup>-11</sup>	–(350±200)	7.4×10 <sup>-11</sup>	2.0
SH + Br <sub>2</sub> → BrSH + Br	6.0×10 <sup>-11</sup>	–(160±160)	1.0×10 <sup>-10</sup>	2.0
SH + F <sub>2</sub> → FSH + F	4.3×10 <sup>-11</sup>	1390±200	4.0×10 <sup>-13</sup>	2.0

Reaction	A cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	E/R K	k (298 K) cm <sup>3</sup> molecule <sup>-1</sup> s <sup>-1</sup>	f(298)
HSO + O <sub>2</sub> → products			<2.0×10 <sup>-17</sup>	–
HSO + O <sub>3</sub> → products			1.0×10 <sup>-13</sup>	1.3
HSO + NO → products			<1.0×10 <sup>-15</sup>	–
HSO + NO <sub>2</sub> → HSO <sub>2</sub> + NO			9.6×10 <sup>-12</sup>	2.0
HSO <sub>2</sub> + O <sub>2</sub> → HO <sub>2</sub> + SO <sub>2</sub>			3.0×10 <sup>-13</sup>	3.0
HOSO <sub>2</sub> + O <sub>2</sub> → HO <sub>2</sub> + SO <sub>3</sub>	1.3×10 <sup>-12</sup>	330±200	4.4×10 <sup>-13</sup>	1.2
CS + O <sub>2</sub> → OCS + O			2.9×10 <sup>-19</sup>	2.0
CS + O <sub>3</sub> → OCS + O <sub>2</sub>			3.0×10 <sup>-16</sup>	3.0
CS + NO <sub>2</sub> → OCS + NO			7.6×10 <sup>-17</sup>	3.0
CH <sub>3</sub> S + O <sub>2</sub> → products			<3.0×10 <sup>-18</sup>	–
CH <sub>3</sub> S + O <sub>3</sub> → products	2.0×10 <sup>-12</sup>	–(290±100)	5.3×10 <sup>-12</sup>	1.15
CH <sub>3</sub> S + NO → products			<1.0×10 <sup>-13</sup>	–
CH <sub>3</sub> S + NO <sub>2</sub> → CH <sub>3</sub> SO + NO	2.1×10 <sup>-11</sup>	–(320±100)	6.1×10 <sup>-11</sup>	1.15
CH <sub>2</sub> SH + O <sub>2</sub> → products			6.5×10 <sup>-12</sup>	2.0
CH <sub>2</sub> SH + O <sub>3</sub> → products			3.5×10 <sup>-11</sup>	2.0
CH <sub>2</sub> SH + NO → products			1.9×10 <sup>-11</sup>	2.0
CH <sub>2</sub> SH + NO <sub>2</sub> → products			5.2×10 <sup>-11</sup>	2.0
CH <sub>3</sub> SO + O <sub>3</sub> → products			6.0×10 <sup>-13</sup>	1.5
CH <sub>3</sub> SO + NO <sub>2</sub> → CH <sub>3</sub> SO <sub>2</sub> + NO			1.2×10 <sup>-11</sup>	1.4
CH <sub>3</sub> SOO + O <sub>3</sub> → products			<8.0×10 <sup>-13</sup>	–
CH <sub>3</sub> SOO + NO → products	1.1×10 <sup>-11</sup>	0±100	1.1×10 <sup>-11</sup>	2.0
CH <sub>3</sub> SO <sub>2</sub> + NO <sub>2</sub> → products	2.2×10 <sup>-11</sup>	0±100	2.2×10 <sup>-11</sup>	2.0
CH <sub>3</sub> SCH <sub>2</sub> + NO <sub>3</sub> → products			3.0 × 10 <sup>-10</sup>	2.0
CH <sub>3</sub> SCH <sub>2</sub> O <sub>2</sub> + NO → CH <sub>3</sub> SCH <sub>2</sub> O + NO <sub>2</sub>			1.9 × 10 <sup>-11</sup>	2.0
CH <sub>3</sub> SS + O <sub>3</sub> → products			4.6×10 <sup>-13</sup>	2.0
CH <sub>3</sub> SS + NO <sub>2</sub> → products			1.8×10 <sup>-11</sup>	2.0
CH <sub>3</sub> SSO + NO <sub>2</sub> → products			4.5×10 <sup>-12</sup>	2.0
<b>Metal Reactions</b>				
Na + O <sub>3</sub> → NaO + O <sub>2</sub>	1.0×10 <sup>-9</sup>	95±50	7.3×10 <sup>-10</sup>	1.2
→ NaO <sub>2</sub> + O	–	–	<4.0×10 <sup>-11</sup>	–
Na + N <sub>2</sub> O → NaO + N <sub>2</sub>	2.8×10 <sup>-10</sup>	1600±400	1.3×10 <sup>-12</sup>	1.2
Na + Cl <sub>2</sub> → NaCl + Cl	7.3×10 <sup>-10</sup>	0±200	7.3×10 <sup>-10</sup>	1.3
NaO + O → Na + O <sub>2</sub>	3.7×10 <sup>-10</sup>	0±400	3.7×10 <sup>-10</sup>	3.0
NaO + O <sub>3</sub> → NaO <sub>2</sub> + O <sub>2</sub>	1.1×10 <sup>-9</sup>	570±300	1.6×10 <sup>-10</sup>	1.5
→ Na + 2O <sub>2</sub>	6.0×10 <sup>-11</sup>	0±800	6.0×10 <sup>-11</sup>	3.0
NaO + H <sub>2</sub> → NaOH + H	2.6×10 <sup>-11</sup>	0±600	2.6×10 <sup>-11</sup>	2.0
NaO + H <sub>2</sub> O → NaOH + OH	2.2×10 <sup>-10</sup>	0±400	2.2×10 <sup>-10</sup>	2.0
NaO + NO → Na + NO <sub>2</sub>	1.5×10 <sup>-10</sup>	0±400	1.5×10 <sup>-10</sup>	4.0
NaO + HCl → products	2.8×10 <sup>-10</sup>	0±400	2.8×10 <sup>-10</sup>	3.0
NaO <sub>2</sub> + O → NaO + O <sub>2</sub>	2.2×10 <sup>-11</sup>	0±600	2.2×10 <sup>-11</sup>	5.0
NaO <sub>2</sub> + NO → NaO + NO <sub>2</sub>	–	–	<10 <sup>-14</sup>	–
NaO <sub>2</sub> + HCl → products	2.3×10 <sup>-10</sup>	0±400	2.3×10 <sup>-10</sup>	3.0
NaOH + HCl → NaCl + H <sub>2</sub> O	2.8×10 <sup>-10</sup>	0±400	2.8×10 <sup>-10</sup>	3.0

TABLE 2. Rate Constants for Association Reactions

The values quoted are suitable for air as the third body, M. The integer in parentheses is the power of ten.

Reaction	Low pressure limit		High pressure limit	
	$k_a(T) = k_a(300) (T/300)^{-n} \text{ cm}^6 \text{ molecule}^{-2} \text{ s}^{-1}$	$n$	$k_{\infty}(T) = k_{\infty}(300) (T/300)^{-m} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	$m$
<i>O<sub>x</sub> Reactions</i>				
O + O <sub>2</sub> → O <sub>3</sub>	(6.0±0.5) (–34)	2.3±0.5	–	–
<i>O(<sup>1</sup>D) Reactions</i>				
O( <sup>1</sup> D) + N <sub>2</sub> → N <sub>2</sub> O	(3.5±3.0) (–37)	0.6	–	–



Reaction	Low pressure limit		High pressure limit	
	$k_0(T) = k_0(300) (T/300)^{-n} \text{ cm}^6 \text{ molecule}^{-2} \text{ s}^{-1}$	$n$	$k_\infty(T) = k_\infty(300) (T/300)^{-m} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	$m$
	$k_0(300)$		$k_\infty(300)$	
<i>HO<sub>x</sub> Reactions</i>				
H + O <sub>2</sub> → HO <sub>2</sub>	(5.7±0.5) (-32)	1.6±0.5	(7.5±4.0) (-11)	0±1.0
OH + OH → H <sub>2</sub> O <sub>2</sub>	(6.2±1.2) (-31)	1.0	(2.6±1.0) (-11)	0±0.5
<i>NO<sub>x</sub> Reactions</i>				
O + NO → NO <sub>2</sub>	(9.0±2.0) (-32)	1.5±0.3	(3.0±1.0) (-11)	0±1.0
O + NO <sub>2</sub> → NO <sub>3</sub>	(9.0±1.0) (-32)	2.0±1.0	(2.2±0.3) (-11)	0±1.0
OH + NO → HONO	(7.0±1.0) (-31)	2.6±0.3	(3.6±1.0) (-11)	0.1±0.5
OH + NO <sub>2</sub> → HNO <sub>3</sub>	(2.5±0.1) (-30)	4.4±0.3	(1.6±0.2) (-11)	1.7±0.2
HO <sub>2</sub> + NO <sub>2</sub> → HO <sub>2</sub> NO <sub>2</sub>	(1.8±0.3) (-31)	3.2±0.4	(4.7±1.0) (-12)	1.4±1.4
NO <sub>2</sub> + NO <sub>3</sub> → N <sub>2</sub> O <sub>5</sub>	(2.2±0.5) (-30)	3.9±1.0	(1.5±0.8) (-12)	0.7±0.4
NO <sub>3</sub> → NO + O <sub>2</sub>	See reference			
<i>Hydrocarbon Reactions</i>				
CH <sub>3</sub> + O <sub>2</sub> → CH <sub>3</sub> O <sub>2</sub>	(4.5±1.5) (-31)	3.0±1.0	(1.8±0.2) (-12)	1.7±1.7
C <sub>2</sub> H <sub>5</sub> + O <sub>2</sub> → C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	(1.5±1.0) (-28)	3.0±1.0	(8.0±1.0) (-12)	0±1.0
OH + C <sub>2</sub> H <sub>2</sub> → HOCHCH	(5.5±2.0) (-30)	0.0±0.2	(8.3±1.0) (-13)	-2
OH + C <sub>2</sub> H <sub>4</sub> → HOCH <sub>2</sub> CH <sub>2</sub>	(1.0±0.6) (-28)	0.8±2.0	(8.8±0.9) (-12)	0
CH <sub>3</sub> O + NO → CH <sub>3</sub> ONO	(1.4±0.5) (-29)	3.8±1.0	(3.6±1.6) (-11)	0.6±1.0
CH <sub>3</sub> O + NO <sub>2</sub> → CH <sub>3</sub> ONO <sub>2</sub>	(1.1±0.4) (-28)	4.0±2.0	(1.6±0.5) (-11)	1.0±1.0
C <sub>2</sub> H <sub>5</sub> O + NO → C <sub>2</sub> H <sub>5</sub> ONO	(2.8±1.0) (-27)	4.0±2.0	(5.0±1.0) (-11)	1.0±1.0
C <sub>2</sub> H <sub>5</sub> O + NO <sub>2</sub> → C <sub>2</sub> H <sub>5</sub> ONO <sub>2</sub>	(2.0±1.0) (-27)	4.0±2.0	(2.8±0.4) (-11)	1.0±1.0
CH <sub>3</sub> O <sub>2</sub> + NO <sub>2</sub> → CH <sub>3</sub> O <sub>2</sub> NO <sub>2</sub>	(1.5±0.8) (-30)	4.0±2.0	(6.5±3.2) (-12)	2.0±2.0
CH <sub>3</sub> C(O)O <sub>2</sub> + NO <sub>2</sub> → CH <sub>3</sub> C(O)O <sub>2</sub> NO <sub>2</sub>	(9.7±3.8) (-29)	5.6±2.8	(9.3±0.4) (-12)	1.5±0.3
<i>FO<sub>x</sub> Reactions</i>				
F + O <sub>2</sub> → FO <sub>2</sub>	(4.4±0.4) (-33)	1.2±0.5	-	-
F + NO → FNO	(1.8±0.3) (-31)	1.0±1.0	(2.8±1.4) (-10)	0.0±1.0
F + NO <sub>2</sub> → FNO <sub>2</sub>	(6.3±3.0) (-32)	2.0±2.0	(2.6±1.3) (-10)	0.0±1.0
FO + NO <sub>2</sub> → FONO <sub>2</sub>	(2.6±2.0) (-31)	1.3±1.3	(2.0±1.0) (-11)	1.5±1.5
CF <sub>3</sub> + O <sub>2</sub> → CF <sub>3</sub> O <sub>2</sub>	(3.0±0.3) (-29)	4.0±2.0	(4.0±1.0) (-12)	1.0±1.0
CF <sub>3</sub> O + NO <sub>2</sub> → CF <sub>3</sub> ONO <sub>2</sub>	See reference			
CF <sub>3</sub> O <sub>2</sub> + NO <sub>2</sub> CF <sub>3</sub> O <sub>2</sub> NO <sub>2</sub>	(2.2±0.5) (-29)	5.0±1.0	(6.0±1.0) (-12)	2.5±1.0
CF <sub>3</sub> O + CO → CF <sub>3</sub> OCO	(2.5±0.2) (-31)	-	(6.8±0.4) (-14)	-1.2
CF <sub>3</sub> O → CF <sub>2</sub> O + F	See reference			
<i>ClO<sub>x</sub> Reactions</i>				
Cl + O <sub>2</sub> → ClOO	(2.7±1.0) (-33)	1.5±0.5	-	-
Cl + NO → ClNO	(9.0±2.0) (-32)	1.6±0.5	-	-
Cl + NO <sub>2</sub> → ClONO	(1.3±0.2) (-30)	2.0±1.0	(1.0±0.5) (-10)	1.0±1.0
ClONO <sub>2</sub>	(1.8±0.3) (-31)	2.0±1.0	(1.0±0.5) (-10)	1.0±1.0
Cl + CO → ClCO	(1.3±0.5) (-33)	3.8±0.5	-	-
Cl + C <sub>2</sub> H <sub>2</sub> → ClC <sub>2</sub> H <sub>2</sub>	((5.9±1.0) (-30)	2.1±1.0	(2.1±0.4) (-10)	1.0±0.5
Cl + C <sub>2</sub> H <sub>4</sub> → ClC <sub>2</sub> H <sub>4</sub>	(1.6±1) (-29)	3.3±1.0	(3.1±2) (-10)	1.0±0.5
Cl + C <sub>2</sub> Cl <sub>4</sub> → C <sub>2</sub> Cl <sub>5</sub>	(1.4±0.6) (-28)	8.5±1.0	(4.0±1.0) (-11)	1.2±0.5
ClO + NO <sub>2</sub> → ClONO <sub>2</sub>	(1.8±0.3) (-31)	3.4±1.0	(1.5±0.7) (-11)	1.9±1.9
ClO + NO <sub>3</sub> → O <sub>2</sub> ClONO <sub>2</sub>	See reference			
ClO + ClO → Cl <sub>2</sub> O <sub>2</sub>	(2.2±0.4) (-32)	3.1±0.5	(3.5±2) (-12)	1.0±1.0
ClO + OClO → Cl <sub>2</sub> O <sub>3</sub>	(6.2±1.0) (-32)	4.7±0.6	(2.4±1.2) (-11)	0±1.0
OCIO + O → ClO <sub>3</sub>	(1.9±0.5) (-31)	1.1±1.0	(3.1±0.8) (-11)	0±1.0
CH <sub>2</sub> Cl + O <sub>2</sub> → CH <sub>2</sub> ClO <sub>2</sub>	(1.9±0.1) (-30)	3.2±0.2	(2.9±0.2) (-12)	1.2±0.6
CHCl <sub>2</sub> + O <sub>2</sub> → CHCl <sub>2</sub> O <sub>2</sub>	(1.3±0.1) (-30)	4.0±0.2	(2.8±0.2) (-12)	1.4±0.6
CCl <sub>3</sub> + O <sub>2</sub> → CCl <sub>3</sub> O <sub>2</sub>	(6.9±0.2) (-31)	6.4±0.3	(2.4±0.2) (-12)	2.1±0.6
CFCl <sub>2</sub> + O <sub>2</sub> → CFCl <sub>2</sub> O <sub>2</sub>	(5.0±0.8) (-30)	4.0±2.0	(6.0±1.0) (-12)	1.0±1.0
CF <sub>2</sub> Cl + O <sub>2</sub> → CF <sub>2</sub> ClO <sub>2</sub>	(3.0±1.5) (-30)	4.0±2.0	(3±2) (-12)	1.0±1.0
CCl <sub>3</sub> O <sub>2</sub> + NO <sub>2</sub> → CCl <sub>3</sub> O <sub>2</sub> NO <sub>2</sub>	(5.0±1.0) (-29)	5.0±1.0	(6.0±1.0) (-12)	2.5±1.0
CFCl <sub>2</sub> O <sub>2</sub> + NO <sub>2</sub> → CFCl <sub>2</sub> O <sub>2</sub> NO <sub>2</sub>	(3.5±0.5) (-29)	5.0±1.0	(6.0±1.0) (-12)	2.5±1.0
CF <sub>2</sub> ClO <sub>2</sub> + NO <sub>2</sub> → CF <sub>2</sub> ClO <sub>2</sub> NO <sub>2</sub>	(3.3±0.7) (-29)	6.7±1.3	(4.1±1.9) (-12)	2.8±0.7

Reaction	Low pressure limit		High pressure limit	
	$k_0(T) = k_0(300) (T/300)^{-n} \text{ cm}^6 \text{ molecule}^{-2} \text{ s}^{-1}$	$n$	$k_\infty(T) = k_\infty(300) (T/300)^{-m} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	$m$
	$k_0(300)$		$k_\infty(300)$	
<i>BrO<sub>3</sub> Reactions</i>				
Br + NO <sub>2</sub> → BrNO <sub>2</sub>	(4.2±0.8) (-31)	2.4±0.5	(2.7±0.5) (-11)	0±1.0
BrO + NO <sub>2</sub> → BrONO <sub>2</sub>	(5.2±0.6) (-31)	3.2±0.8	(6.9±1.0) (-12)	2.9±1.0
<i>IO<sub>x</sub> Reactions</i>				
I + NO → INO	(1.8±0.5) (-32)	1.0±0.5	(1.7±1.0) (-11)	0±1.0
I + NO <sub>2</sub> → INO <sub>2</sub>	(3.0±1.5) (-31)	1.0±1.0	(6.6±5.0) (-11)	0±1.0
IO + NO <sub>2</sub> → IONO <sub>2</sub>	(5.9±2.0) (-31)	3.5±1.0	(9.0±1.0) (-12)	1.5±1.0
<i>SO<sub>x</sub> Reactions</i>				
HS + NO → HSNO	(2.4±0.4) (-31)	3.0±1.0	(2.7±0.5) (-11)	0
CH <sub>3</sub> S + NO → CH <sub>3</sub> SNO	(3.2±0.4) (-29)	4.0±1.0	(3.9±0.6) (-11)	2.7±1.0
O + SO <sub>2</sub> → SO <sub>3</sub>	(1.3±)(-33)	-3.6±0.7		
OH + SO <sub>2</sub> → HOSO <sub>2</sub>	(3.0±1.0) (-31)	3.3±1.5	(1.5±0.5) (-12)	0
CH <sub>3</sub> SCH <sub>2</sub> + O <sub>2</sub> → CH <sub>3</sub> SCH <sub>2</sub> O <sub>2</sub>	See reference			
SO <sub>3</sub> + NH <sub>3</sub> → H <sub>3</sub> NSO <sub>3</sub>	(3.9±0.8) (-30)	3.0±3.0	(4.7±1.3) (-11)	0±1.0
<i>Metal Reactions</i>				
Na + O <sub>2</sub> → NaO <sub>2</sub>	(3.2±0.3) (-30)	1.4±0.3	(6.0±2.0) (-10)	0±1.0
NaO + O <sub>2</sub> → NaO <sub>3</sub>	(3.5±0.7) (-30)	2.0±2.0	(5.7±3.0) (-10)	0±1.0
NaO + CO <sub>2</sub> → NaCO <sub>3</sub>	(8.7±2.6) (-28)	2.0±2.0	(6.5±3.0) (-10)	0±1.0
NaOH + CO <sub>2</sub> → NaHCO <sub>3</sub>	(1.3±0.3) (-28)	2.0±2.0	(6.8±4.0) (-10)	0±1.0

TABLE 3. Equilibrium Constants

$$K(T)/\text{cm}^3 \text{ molecule}^{-1} = A \exp(B/T) \quad [200 < T/K < 300]$$

Reaction	$A/\text{cm}^3 \text{ molecule}^{-1}$	$B/K$	$K(298 \text{ K})$	$f(298 \text{ K})$
HO <sub>2</sub> + NO <sub>2</sub> → HO <sub>2</sub> NO <sub>2</sub>	2.1x10 <sup>-27</sup>	10900±1000	1.6x10 <sup>-11</sup>	5
NO + NO <sub>2</sub> → N <sub>2</sub> O <sub>3</sub>	3.3x10 <sup>-27</sup>	4667±100	2.1x10 <sup>-20</sup>	2
NO <sub>2</sub> + NO <sub>2</sub> → N <sub>2</sub> O <sub>4</sub>	5.2x10 <sup>-29</sup>	6643±250	2.5x10 <sup>-19</sup>	2
NO <sub>2</sub> + NO <sub>3</sub> → N <sub>2</sub> O <sub>5</sub>	2.7x10 <sup>-27</sup>	11000±500	2.9x10 <sup>-11</sup>	1.3
CH <sub>3</sub> O <sub>2</sub> + NO <sub>2</sub> → CH <sub>3</sub> O <sub>2</sub> NO <sub>2</sub>	1.3x10 <sup>-28</sup>	11200±1000	2.7x10 <sup>-12</sup>	2
CH <sub>3</sub> C(O)O <sub>2</sub> + NO <sub>2</sub> → CH <sub>3</sub> C(O)O <sub>2</sub> NO <sub>2</sub>	9.0x10 <sup>-29</sup>	14000±200	2.3x10 <sup>-8</sup>	2
F + O <sub>2</sub> → FOO	3.2x10 <sup>-25</sup>	6100±1200	2.5x10 <sup>-16</sup>	1.0
Cl + O <sub>2</sub> → ClOO	5.7x10 <sup>-25</sup>	2500±750	2.5x10 <sup>-21</sup>	2
Cl + CO → ClCO	1.6x10 <sup>-25</sup>	4000±500	1.1x10 <sup>-19</sup>	5
ClO + O <sub>2</sub> → ClOO <sub>2</sub>	2.9x10 <sup>-26</sup>	<3700	<7.2x10 <sup>-21</sup>	-
ClO + ClO → Cl <sub>2</sub> O <sub>2</sub>	1.3x10 <sup>-27</sup>	8744±850	7.2x10 <sup>-15</sup>	1.5
ClO + OClO → Cl <sub>2</sub> O <sub>3</sub>	1.1x10 <sup>-24</sup>	5455±300	9.8x10 <sup>-17</sup>	3
OClO + NO <sub>3</sub> → O <sub>2</sub> ClONO <sub>2</sub>	1x10 <sup>-28</sup>	9300±1000	3.6x10 <sup>-15</sup>	5
OH + CS <sub>2</sub> → CS <sub>2</sub> OH	4.5x10 <sup>-25</sup>	5140±500	1.4x10 <sup>-17</sup>	1.4
CH <sub>3</sub> S + O <sub>2</sub> → CH <sub>3</sub> SO <sub>2</sub>	1.8x10 <sup>-27</sup>	5545±300	2.2x10 <sup>-19</sup>	1.4

# KINETIC DATA FOR COMBUSTION MODELLING

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The following tables present evaluated rate constants and other chemical kinetic data required for modelling the combustion of hydrocarbons. The compilation was prepared as part of the project "Kinetics and Mechanisms of Chemical Processes in Combustion", which is one of the projects in the third European Community Energy Research and Development Program. The tables are reprinted from the *Journal of Physical and Chemical Reference Data* by permission of the authors and the American Institute of Physics.

Table 1 lists all the reactions studied and gives the recommended rate constant  $k$  for every bimolecular reaction, as well as the applicable temperature range and the associated error limits. Where more than one set of products is possible, rate constants or branching ratios are given for all channels considered feasible. The data for decomposition reactions and combination reactions are given in Tables 2 and 3, respectively. The reference includes a detailed data sheet for each reaction listed here, covering the thermodynamic data, kinetic measurements, and reliability assessments.

## REFERENCE

Baulch, D. L., et al., *J. Phys. Chem. Ref. Data*, 21, 411-734, 1992.

**Table 1**  
**BIMOLECULAR REACTIONS**

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i>O Atom Reactions</i>			
$\text{O} + \text{H}_2 \rightarrow \text{OH} + \text{H}$	$8.5 \times 10^{-20} T^{2.67} \exp(-3160/T)$	300-2500	$\pm 0.5$ at 300 K falling to $\pm 0.2$ for $T > 500$ K
$\text{O} + \text{OH} \rightarrow \text{O}_2 + \text{H}$	$2.0 \times 10^{-11} \exp(112/T)$ $2.4 \times 10^{-11} \exp(-353/T)$	220-500 1000-2000	$\pm 0.2$ $\pm 0.1$
$\text{O} + \text{HO}_2 \rightarrow \text{OH} + \text{O}_2$	$5.3 \times 10^{-11}$	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 1000 K.
$\text{O} + \text{H}_2\text{O}_2 \rightarrow \text{OH} + \text{HO}_2$	$1.1 \times 10^{-12} \exp(-2000/T)$	300-500	$\pm 0.3$
$\text{O} + \text{NH}_3 \rightarrow \text{OH} + \text{NH}_2$	$1.6 \times 10^{-11} \exp(-3670/T)$	500-2500	$\pm 0.5$
$\text{O} + \text{CH} \rightarrow \text{CO} + \text{H}$ $\quad \quad \quad \rightarrow \text{CHO}^+ + e$	$6.6 \times 10^{-11}$ $4.2 \times 10^{-13} \exp(-850/T)$	300-2000 300-2500	$\pm 0.5$ $\pm 0.5$
$\text{O} + {}^3\text{CH}_2 \rightarrow \text{CO} + 2\text{H}$ ] $\quad \quad \quad \rightarrow \text{CO} + \text{H}_2$ ]	$2 \times 10^{-10}$ $k_1/k = 0.6 \pm 0.3$ over whole range	300-2500	$\pm 0.2$ at 300 K rising to $\pm 0.7$ at 2500 K.
$\text{O} + \text{CH}_3 \rightarrow \text{HCHO} + \text{H}$	$1.4 \times 10^{-10}$	300-2500	$\pm 0.2$
$\text{O} + \text{CH}_4 \rightarrow \text{OH} + \text{CH}_3$	$1.5 \times 10^{-15} T^{1.56} \exp(-4270/T)$	300-2500	$\pm 0.3$ at 300 K falling to $\pm 0.15$ at 2500 K.
$\text{O} + \text{CHO} \rightarrow \text{OH} + \text{CO}$ $\quad \quad \quad \rightarrow \text{CO}_2 + \text{H}$	$5.0 \times 10^{-11}$ $5.0 \times 10^{-11}$	300-2500 300-2500	$\pm 0.3$ $\pm 0.3$
$\text{O} + \text{HCHO} \rightarrow \text{OH} + \text{CHO}$	$6.9 \times 10^{-13} T^{0.57} \exp(-1390/T)$	250-2200	$\pm 0.1$ at 250 K rising to $\pm 0.3$ at 2200 K.
$\text{O} + \text{CH}_3\text{O} \rightarrow \text{O}_2 + \text{CH}_3$ ] $\quad \quad \quad \rightarrow \text{OH} + \text{HCHO}$ ]	$2.5 \times 10^{-11}$ $k_2/k = (0.12 \pm 0.1)$ at 300 K	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.7$ at 1000 K.
$\text{O} + \text{CN} \rightarrow \text{CO} + \text{N}({}^4\text{S})$ ] $\quad \quad \quad \rightarrow \text{CO} + \text{N}({}^2\text{D})$ ]	$1.7 \times 10^{-11}$	300-5000	$\pm 0.2$ at 300 K rising to $\pm 0.6$ at 5000 K.
$\text{O} + \text{NCO} \rightarrow \text{NO} + \text{CO}$ ] $\quad \quad \quad \rightarrow \text{O}_2 + \text{CN}$ ]	$7.0 \times 10^{-11}$	1450-2600	$\pm 0.8$

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

Table 1  
BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{O} + \text{HCN} \rightarrow \text{NCO} + \text{H}$ $\rightarrow \text{CO} + \text{NH}$ $\rightarrow \text{OH} + \text{CN}$ ]	$2.3 \times 10^{-18} T^{2.1} \exp(-3075/T)$	450-2500	$\pm 0.2$ at 450 K rising to $\pm 0.3$ at 2500 K.
$\text{O} + \text{CH}_3\text{OOH} \rightarrow \text{OH} + \text{CH}_2\text{COOH}$ $\rightarrow \text{OH} + \text{CH}_3\text{O}_2$ ]	$6.9 \times 10^{-13} T^{0.57} \exp(-1390/T)$ [estimate]	250-2200	$\pm 0.1$ at 250 K rising to $\pm 0.3$ at 2200 K.
$\text{O} + \text{C}_2\text{H} \rightarrow \text{CO} + \text{CH}$	$1.7 \times 10^{-11}$	300-2500	$\pm 1.0$
$\text{O} + \text{C}_2\text{H}_2 \rightarrow \text{CO} + {}^3\text{CH}_2$ $\rightarrow \text{CHCO} + \text{H}$ ]	$3.6 \times 10^{-20} T^{2.8} \exp(-250/T)$ $k_1/k_2 = 0.5 \pm 0.3$ over whole range.	300-2500	$\pm 0.2$
$\text{O} + \text{C}_2\text{H}_3 \rightarrow \text{OH} + \text{C}_2\text{H}_2$ $\rightarrow \text{CO} + \text{CH}_3$ $\rightarrow \text{HCO} + \text{CH}_2$ ]	$5 \times 10^{-11}$	300-2000	$\pm 0.5$
$\text{O} + \text{C}_2\text{H}_4 \rightarrow \text{CH}_2\text{CHO} + \text{H}$ $\rightarrow \text{HCO} + \text{CH}_3$ $\rightarrow \text{HCHO} + \text{CH}_2$ $\rightarrow \text{CH}_2\text{CO} + \text{H}_2$ ]	$5.75 \times 10^{-18} T^{2.08}$ $k_1/k_2 = 0.35 \pm 0.05$ at $p > 3$ Torr $k_2/k_3 = 0.6 \pm 0.10$	300-2000 over whole temperature range	$\pm 0.1$ for $T < 1000$ K rising to $\pm 0.3$ at 2000 K.
$\text{O} + \text{C}_2\text{H}_5 \rightarrow \text{CH}_3\text{CHO} + \text{H}$ $\rightarrow \text{HCHO} + \text{CH}_3$ ]	$1.1 \times 10^{-10}$ $k_2/k_3 = 0.17 \pm 0.2$ at 300 K	300-2500	$\pm 0.3$ from 300 to 1000 K $\pm 0.5$ from 1000 to 2500 K
$\text{O} + \text{C}_2\text{H}_6 \rightarrow \text{OH} + \text{C}_2\text{H}_5$	$1.66 \times 10^{-15} T^{1.5} \exp(-2920/T)$	300-1200	$\pm 0.3$ at 300 K falling to $\pm 0.15$ at 1200 K.
$\text{O} + \text{CHCO} \rightarrow 2\text{CO} + \text{H}$	$1.6 \times 10^{-10}$	300-2500	$\pm 0.3$
$\text{O} + \text{CH}_2\text{CO} \rightarrow \text{CH}_2\text{O} + \text{CO}$ $\rightarrow \text{HCO} + \text{H} + \text{CO}$ $\rightarrow \text{HCO} + \text{HCO}$ ]	$3.8 \times 10^{-12} \exp(-680/T)$	230-500	$\pm 0.3$
$\text{O} + \text{CH}_3\text{CHO} \rightarrow \text{OH} + \text{CH}_3\text{CO}$ $\rightarrow \text{OH} + \text{CH}_2\text{CHO}$ ]	$9.7 \times 10^{-12} \exp(-910/T)$	300-1500	$\pm 0.05$ at 300 K rising to $\pm 0.5$ at 1500 K.
$\text{O} + \text{C}_2\text{H}_5\text{OOH} \rightarrow \text{OH} + \text{C}_2\text{H}_4\text{OOH}$ $\rightarrow \text{OH} + \text{C}_2\text{H}_5\text{OO}$ ]	$6.9 \times 10^{-13} T^{0.57} \exp(-1390/T)$ [estimate]	250-2200	$\pm 0.1$ at 150 K rising to $\pm 0.3$ at 2200 K.
$\text{O} + \text{C}_6\text{H}_6 \rightarrow \text{OH} + \text{C}_6\text{H}_5$ $\rightarrow \text{C}_6\text{H}_5\text{OH}$ ]	$1.2 \times 10^{-22} T^{3.7} \exp(-570/T)$	300-1000	$\pm 0.5$
$\text{O} + \text{C}_6\text{H}_5\text{CH}_2 \rightarrow \text{HCO} + \text{C}_6\text{H}_6$ $\rightarrow \text{C}_6\text{H}_5\text{CH} + \text{H}$ $\rightarrow \text{CH}_2\text{O} + \text{C}_6\text{H}_5$ ]	$5.5 \times 10^{-10}$ No recommendation	300	$\pm 0.3$
$\text{O} + \text{C}_6\text{H}_5\text{CH}_3 \rightarrow \text{products}$	$5.3 \times 10^{-15} T^{1.21} \exp(-1260/T)$	300-2800	$\pm 0.1$ at 300 K rising to $\pm 0.4$ at 2800 K
$\text{O} + p\text{-C}_6\text{H}_4(\text{CH}_3)_2 \rightarrow \text{products}$	$2.6 \times 10^{-11} \exp(-1409/T)$	300-600	$\pm 0.3$
$\text{O} + \text{C}_6\text{H}_5\text{C}_2\text{H}_5 \rightarrow \text{products}$	$1.0 \times 10^{-13}$	298	$\pm 0.3$
<i>O<sub>2</sub> Reactions</i>			
$\text{O}_2 + \text{CH}_4 \rightarrow \text{HO}_2 + \text{CH}_3$	$6.6 \times 10^{-11} \exp(-28630/T)$	500-2000	$\pm 0.5$ at 500 K rising to $\pm 1.0$ at 2000 K.

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{O}_2 + \text{C}_2\text{H}_6 \rightarrow \text{HO}_2 + \text{C}_2\text{H}_5$	$1.0 \times 10^{-10} \exp(-26100/T)$	500-2000	$\pm 0.5$ at 500 K rising to $\pm 1.0$ at 2000 K
$\text{O}_2 + \text{HCHO} \rightarrow \text{HO}_2 + \text{HCO}$	$1.0 \times 10^{-10} \exp(-20460/T)$	700-1000	$\pm 0.5$
$\text{O}_2 + \text{CH}_3\text{CHO} \rightarrow \text{HO}_2 + \text{CH}_3\text{CO}$	$5.0 \times 10^{-11} \exp(-19700/T)$	600-1100	$\pm 0.5$ at 600 K rising to $\pm 1.0$ at 1100 K.
<i>H Atom Reactions</i>			
$\text{H} + \text{O}_2 \rightarrow \text{OH} + \text{O}$	$3.3 \times 10^{-10} \exp(-8460/T)$	300-2500	$\pm 0.1$ at 300 K rising to $\pm 0.2$ at 2500 K.
$\text{H} + \text{O}_2 + \text{Ar} \rightarrow \text{HO}_2 + \text{Ar}$	See Table 3		
$\text{H} + \text{O}_2 + \text{H}_2 \rightarrow \text{HO}_2 + \text{H}_2$	See Table 3		
$\text{H} + \text{O}_2 + \text{N}_2 \rightarrow \text{HO}_2 + \text{N}_2$	See Table 3		
$\text{H} + \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{HO}_2 + \text{H}_2\text{O}$	See Table 3		
$\text{H} + \text{H} + \text{Ar} \rightarrow \text{H}_2 + \text{Ar}$	See Table 3		
$\text{H} + \text{H} + \text{H}_2 \rightarrow \text{H}_2 + \text{H}_2$	See Table 3		
$\text{H} + \text{OH} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O} + \text{H}_2\text{O}$	See Table 3		
$\text{H} + \text{OH} + \text{Ar} \rightarrow \text{H}_2\text{O} + \text{Ar}$	See Table 3		
$\text{H} + \text{HO} + \text{N}_2 \rightarrow \text{H}_2\text{O} + \text{N}_2$	See Table 3		
$\text{H} + \text{HO}_2 \rightarrow \text{H}_2 + \text{O}_2$	$7.1 \times 10^{-11} \exp(-710/T)$	300-1000	$\pm 0.3$
$\rightarrow 2 \text{OH}$	$2.8 \times 10^{-10} \exp(-440/T)$	300-1000	$\pm 0.3$
$\rightarrow \text{H}_2\text{O} + \text{O}$	$5.0 \times 10^{-11} \exp(-866/T)$	300-1000	$\pm 0.3$
$\text{H} + \text{H}_2\text{O} \rightarrow \text{OH} + \text{H}_2$	$7.5 \times 10^{-16} T^{1.6} \exp(-9270/T)$	300-2500	$\pm 0.2$
$\text{H} + \text{H}_2\text{O}_2 \rightarrow \text{H}_2 + \text{HO}_2$	$2.8 \times 10^{-12} \exp(-1890/T)$	300-1000	$\pm 0.3$
$\rightarrow \text{OH} + \text{H}_2\text{O}$	$1.7 \times 10^{-11} \exp(-1800/T)$	300-1000	$\pm 0.3$
$\text{H} + \text{NH} \rightarrow \text{H}_2 + \text{N}$	$1.7 \times 10^{-11}$	1500-2500	$\pm 1.0$
$\text{H} + \text{NH}_2 \rightarrow \text{H}_2 + \text{NH}$	$1.0 \times 10^{-11}$	2000-3000	$\pm 1.0$
$\text{H} + {}^3\text{CH}_2 \rightarrow \text{H}_2 + \text{CH}$	$1.0 \times 10^{-11} \exp(900/T)$	300-3000	$\pm 0.7$
$\text{H} + \text{CH}_3 \rightarrow \text{H}_2 + {}^1\text{CH}_2$	$1.0 \times 10^{-10} \exp(-7600/T)$	300-2500	$\pm 1.0$
$\rightarrow \text{CH}_4$	See Table 3		
$\text{H} + \text{CH}_4 \rightarrow \text{H}_2 + \text{CH}_3$	$2.2 \times 10^{-20} T^{3.0} \exp(-4045/T)$	300-2500	$\pm 0.2$
$\text{H} + \text{CHO} \rightarrow \text{H}_2 + \text{CO}$	$1.5 \times 10^{-10}$	300-2500	$\pm 0.3$
$\text{H} + \text{HCHO} \rightarrow \text{H}_2 + \text{HCO}$	$3.8 \times 10^{-14} T^{1.05} \exp(-1650/T)$	300-2200	$\pm 0.1$ at 300 K rising to $\pm 0.5$ at 2200 K
$\text{H} + \text{CH}_3\text{O} \rightarrow \text{H}_2 + \text{HCHO}$	$3.0 \times 10^{-11}$	300-1000	$\pm 0.5$
$\text{H} + \text{HNCO} \rightarrow \text{NH}_2 + \text{CO}$	No recommendation		
$\rightarrow \text{H}_2 + \text{NCO}$	$3.4 \times 10^{-10} T^{-0.27} \exp(-10190/T)$	500-1000	$\pm 1.0$
$\text{H} + \text{NCO} \rightarrow \text{NH} + \text{CO}$	$8.7 \times 10^{-11}$	1400-1500	$\pm 0.5$
$\rightarrow \text{HCN} + \text{O}$			

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{H} + \text{C}_2\text{H}_2 \rightarrow \text{H}_2 + \text{C}_2\text{H}$ $\quad \quad \quad \rightarrow \text{C}_2\text{H}_3$	$1.0 \times 10^{-10} \exp(-14000/T)$ See Table 3	1000–3000	$\pm 1.0$
$\text{H} + \text{C}_2\text{H}_3 \rightarrow \text{H}_2 + \text{C}_2\text{H}_2$ $\quad \quad \quad \rightarrow \text{C}_2\text{H}_4$	$2.0 \times 10^{-11}$ See Table 3	300–2500	$\pm 0.5$
$\text{H} + \text{C}_2\text{H}_4 \rightarrow \text{C}_2\text{H}_3 + \text{H}_2$ $\quad \quad \quad \rightarrow \text{C}_2\text{H}_5$	$9.0 \times 10^{-10} \exp(-7500/T)$ See Table 3	700–2000	$\pm 0.5$
$\text{H} + \text{C}_2\text{H}_5 \rightarrow 2\text{CH}_3$ $\quad \quad \quad \rightarrow \text{C}_2\text{H}_6$	$6.0 \times 10^{-11}$ See Table 3	300–2000	$\pm 0.3$
$\text{H} + \text{C}_2\text{H}_6 \rightarrow \text{H}_2 + \text{C}_2\text{H}_5$	$2.4 \times 10^{-15} T^{1.5} \exp(-3730/T)$	300–2000	$\pm 0.15$ at 300 K rising to $\pm 0.3$ at 2000 K
$\text{H} + \text{CHCO} \rightarrow \text{CH}_2 + \text{CO}$ $\quad \quad \quad \rightarrow \text{H}_2 + \text{C}_2\text{O}$ $\quad \quad \quad \rightarrow \text{HCCOH}$ ]	$2.5 \times 10^{-10}$	300–2500	$\pm 0.4$
$\text{H} + \text{CH}_2\text{CO} \rightarrow \text{CH}_3 + \text{CO}$ $\quad \quad \quad \rightarrow \text{CH}_2\text{CHO}$	$3.0 \times 10^{-11} \exp(-1700/T)$ $k_2/k$ very small	200–2000	$\pm 0.5$ at 200 K rising to $\pm 1.0$ at 2000 K.
$\text{H} + \text{CH}_3\text{CHO} \rightarrow \text{H}_2 + \text{CH}_3\text{CO}$ $\quad \quad \quad \rightarrow \text{H}_2 + \text{CH}_2\text{CHO}$ ]	$6.8 \times 10^{-15} T^{1.16} \exp(-1210/T)$	300–2000	$\pm 0.1$ at 300 rising to $\pm 0.4$ at 2000 K.
$\text{H} + \text{C}_6\text{H}_5 + \text{M} \rightarrow \text{C}_6\text{H}_6 + \text{M}$	See Table 3		
$\text{H} + \text{C}_6\text{H}_6 \rightarrow \text{H}_2 + \text{C}_6\text{H}_5$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_7$	No recommendation See Table 3		
$\text{H} + \text{C}_6\text{H}_5\text{O} + \text{M} \rightarrow \text{C}_6\text{H}_5\text{OH} + \text{M}$	See Table 3		
$\text{H} + \text{C}_6\text{H}_5\text{OH} \rightarrow \text{C}_6\text{H}_5\text{O} + \text{H}_2$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_6 + \text{OH}$	$1.9 \times 10^{-10} \exp(-6240/T)$ $3.7 \times 10^{-11} \exp(-3990/T)$	1000–1150 1000–1150	$\pm 0.3$ $\pm 0.3$
$\text{H} + \text{C}_6\text{H}_5\text{CH}_2 + \text{M} \rightarrow \text{C}_6\text{H}_5\text{CH}_3 + \text{M}$	See Table 3		
$\text{H} + \text{C}_6\text{H}_5\text{CH}_3 \rightarrow \text{H}_2 + \text{C}_6\text{H}_5\text{CH}_2$ $\quad \quad \quad \rightarrow \text{H}_2 + \text{C}_6\text{H}_4\text{CH}_3$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_6 + \text{CH}_3$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_6\text{CH}_3$	$6.6 \times 10^{-22} T^{3.44} \exp(-1570/T)$ No recommendation No recommendation See Table 3	600–2800	$\pm 0.3$ at 600 K rising to $\pm 0.5$ at 2800 K.
$\text{H} + p\text{-C}_6\text{H}_4(\text{CH}_3)_2 \rightarrow \text{products}$	$5.8 \times 10^{-13}$	298	$\pm 0.1$
$\text{H} + \text{C}_6\text{H}_5\text{C}_2\text{H}_5 \rightarrow \text{H}_2 + \text{C}_6\text{H}_5\text{C}_2\text{H}_4$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_6\text{C}_2\text{H}_5$	$2.4 \times 10^{-12}$ See Table 3	773	$\pm 0.1$
<i>H<sub>2</sub> Reactions</i>			
$\text{H}_2 + \text{Ar} \rightarrow 2\text{H} + \text{Ar}$	See Table 2		
$\text{H}_2 + \text{H}_2 \rightarrow 2\text{H} + \text{H}_2$	See Table 2		
<i>OH Radical Reactions</i>			
$\text{OH} + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{H}$	$1.7 \times 10^{-16} T^{1.6} \exp(-1660/T)$	300–2500	$\pm 0.1$ at 300 K rising to $\pm 0.3$ at 2500 K
$\text{OH} + \text{OH} \rightarrow \text{H}_2\text{O} + \text{O}$	$2.5 \times 10^{-15} T^{1.14} \exp(-50/T)$	250–2500	$\pm 0.2$
$\text{OH} + \text{OH} + \text{M} \rightarrow \text{H}_2\text{O}_2 + \text{M}$	See Table 3		

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{OH} + \text{HO}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$	$4.8 \times 10^{-11} \exp(250/T)$	300–2000	$\pm 0.2$ at 300 K rising to $\pm 0.5$ at 2000 K.
$\text{OH} + \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{HO}_2$	$1.3 \times 10^{-11} \exp(-670/T)$	300–1000	$\pm 0.2$
$\text{OH} + \text{NH} \rightarrow \text{NO} + \text{H}_2$ $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{N}$ ]	$8.0 \times 10^{-11}$	300–1000	$\pm 0.5$
$\text{OH} + \text{NH}_2 \rightarrow \text{O} + \text{NH}_3$ $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{NH}$	$3.3 \times 10^{-14} T^{0.405} \exp(-250/T)$ No recommendation	500–2500	$\pm 0.5$
$\text{OH} + \text{CO} \rightarrow \text{H} + \text{CO}_2$	$1.05 \times 10^{-17} T^{1.5} \exp(250/T)$	300–2000	$\pm 0.2$ at 300 K rising to $\pm 0.5$ at 2000 K.
$\text{OH} + \text{CH}_3 \rightarrow \text{H} + \text{CH}_2\text{OH}$ $\quad \quad \quad \rightarrow \text{H} + \text{CH}_3\text{O}$ ] $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{}^1\text{CH}_2$ $\quad \quad \quad \rightarrow \text{CH}_3\text{OH}$	$6.0 \times 10^{-11}$ See Table 3	300–2000	$\pm 0.7$
$\text{OH} + \text{CH}_4 \rightarrow \text{H}_2\text{O} + \text{CH}_3$	$2.6 \times 10^{-17} T^{1.83} \exp(-1400/T)$	250–2500	$\pm 0.07$ at 250 K rising to $\pm 0.15$ at 1200 K.
$\text{OH} + \text{CHO} \rightarrow \text{H}_2\text{O} + \text{CO}$	$1.7 \times 10^{-10}$	300–2500	$\pm 0.3$
$\text{OH} + \text{HCHO} \rightarrow \text{H}_2\text{O} + \text{CHO}$	$5.7 \times 10^{-15} T^{1.18} \exp(225/T)$	300–3000	$\pm 0.1$ at 300 K rising to $\pm 0.7$ at 3000 K.
$\text{OH} + \text{CN} \rightarrow \text{O} + \text{HCN}$ ] $\quad \quad \quad \rightarrow \text{NCO} + \text{H}$ ]	$1.0 \times 10^{-10}$	1500–3000	$\pm 0.5$
$\text{OH} + \text{HCN} \rightarrow \text{H}_2\text{O} + \text{CN}$ $\quad \quad \quad \rightarrow \text{HOCN} + \text{H}$ ] $\quad \quad \quad \rightarrow \text{HNCO} + \text{H}$ ]	$1.5 \times 10^{-11} \exp(-5400/T)$ No recommendation	1500–2500	$\pm 0.5$
$\text{OH} + \text{CH}_3\text{OOH} \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{OO}$ $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{CH}_2\text{OOH}$	$1.2 \times 10^{-12} \exp(130/T)$ $1.8 \times 10^{-12} \exp(220/T)$	300–1000 300–1000	$\pm 0.2$ at 300 K rising to $\pm 0.4$ at 1000 K $\pm 0.1$ at 300 K rising to $\pm 0.3$ at 1000 K.
$\text{OH} + \text{C}_2\text{H}_2 \rightarrow \text{H}_2\text{O} + \text{C}_2\text{H}$ ] $\quad \quad \quad \rightarrow \text{H} + \text{CH}_2\text{CO}$ ] $\quad \quad \quad \rightarrow \text{C}_2\text{H}_2\text{OH}$	$1.0 \times 10^{-10} \exp(-6500/T)$ See Table 3	1000–2000	$\pm 1.0$
$\text{OH} + \text{C}_2\text{H}_4 \rightarrow \text{H}_2\text{O} + \text{C}_2\text{H}_3$	$3.4 \times 10^{-11} \exp(-2990/T)$	650–1500	$\pm 0.5$
$\text{OH} + \text{C}_2\text{H}_6 \rightarrow \text{H}_2\text{O} + \text{C}_2\text{H}_5$	$1.2 \times 10^{-17} T^{2.0} \exp(-435/T)$	250–2000	$\pm 0.07$ at 250 K rising to $\pm 0.15$ at 2000 K.
$\text{OH} + \text{CH}_2\text{CO} \rightarrow \text{CH}_2\text{OH} + \text{CO}$ ] $\quad \quad \quad \rightarrow \text{H}_2\text{CO} + \text{HCO}$ ]	$1.7 \times 10^{-11}$	300–2000	$\pm 1.0$
$\text{OH} + \text{CH}_3\text{CHO} \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CO}$ ] $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{CH}_2\text{CHO}$ ]	$3.9 \times 10^{-14} T^{0.73} \exp(560/T)$	250–1200	$\pm 0.1$ at 250 K rising to $\pm 0.3$ at 1200 K.
$\text{OH} + \text{C}_2\text{H}_5\text{OOH} \rightarrow \text{H}_2\text{O} + \text{C}_2\text{H}_5\text{OO}$ ] $\quad \quad \quad \rightarrow \text{H}_2\text{O} + \text{C}_2\text{H}_4\text{OOH}$ ]	$3.0 \times 10^{-12} \exp(190/T)$ [estimate]	250–1000	$\pm 0.3$ at 250 K rising to $\pm 0.7$ at 1000 K.

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{OH} + \text{C}_6\text{H}_6 \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_5$	$2.7 \times 10^{-16} T^{1.42} \exp(-730/T)$	400–1500	$\pm 0.3$
$\quad \rightarrow \text{H} + \text{C}_6\text{H}_5\text{OH}$	$2.2 \times 10^{-11} \exp(-5330/T)$	1000–1150	$\pm 0.3$
$\quad \rightarrow \text{C}_6\text{H}_6\text{OH}$	See Table 3		
$\text{OH} + \text{C}_6\text{H}_5\text{OH} \rightarrow \text{C}_6\text{H}_5(\text{OH})_2$	See Table 3		
$\quad \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_5\text{O}$	$1.0 \times 10^{-11}$	1000–1150	$\pm 0.5$
$\quad \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_4\text{OH}$			
$\text{OH} + \text{C}_6\text{H}_5\text{CH}_3 \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_5\text{CH}_2$	$8.6 \cdot 10^{-15} T \exp(-1440/T)$	400–1200	$\pm 0.5$ at 400 K reducing to $\pm 0.3$ at 1200 K.
	See Table 3		
$\text{OH} + p\text{-C}_6\text{H}_4(\text{CH}_3)_2 \rightarrow \text{C}_6\text{H}_4\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$	$6.4 \times 10^{-11} \exp(-1440/T)$	500–960	$\pm 0.1$
$\quad \rightarrow p\text{-C}_6\text{H}_4(\text{CH}_3)_2\text{OH}$	See Table 3		
$\text{OH} + \text{C}_6\text{H}_5\text{C}_2\text{H}_5 \rightarrow \text{HOC}_6\text{H}_5\text{C}_2\text{H}_5$	See Table 3		
$\quad \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_5\text{C}_2\text{H}_4$	$8.7 \times 10^{-12}$	773	$\pm 0.1$
$\quad \rightarrow \text{H}_2\text{O} + \text{C}_6\text{H}_4\text{C}_2\text{H}_5$			
<i>H<sub>2</sub>O Reactions</i>			
$\text{H}_2\text{O} + \text{M} \rightarrow \text{H} + \text{OH} + \text{M}$	See Table 2		
<i>HO<sub>2</sub> Radical Reactions</i>			
$\text{HO}_2 + \text{HO}_2 \rightarrow \text{H}_2\text{O}_2 + \text{O}_2$	$3.1 \times 10^{-12} \exp(-775/T)$	550–1250	$\pm 0.15$ at 550 K rising to $\pm 0.3$ at 1250 K.
$\text{HO}_2 + \text{NH}_2 \rightarrow \text{NH}_3 + \text{O}_2$	$2.6 \times 10^{-11}$	300–400	$\pm 0.4$
$\quad \rightarrow \text{HNO} + \text{H}_2\text{O}$			
$\text{HO}_2 + \text{CH}_3 \rightarrow \text{OH} + \text{CH}_3\text{O}$	$3 \times 10^{-11}$	300–2500	$\pm 0.7$
$\quad \rightarrow \text{O}_2 + \text{CH}_4$	No recommendation		
$\text{HO}_2 + \text{CH}_4 \rightarrow \text{H}_2\text{O}_2 + \text{CH}_3$	$1.5 \times 10^{-11} \exp(-12400/T)$	600–1000	$\pm 0.2$ at 600 K rising to $\pm 0.3$ at 1000 K.
$\text{HO}_2 + \text{HCHO} \rightarrow \text{H}_2\text{O}_2 + \text{CHO}$	$5.0 \times 10^{-12} \exp(-6580/T)$	600–1000	$\pm 0.5$
$\text{HO}_2 + \text{C}_2\text{H}_4 \rightarrow \text{OH} + \text{C}_2\text{H}_4\text{O}$	$3.7 \times 10^{-12} \exp(-8650/T)$	600–900	$\pm 0.15$ at 600 K rising to $\pm 0.25$ at 900 K.
$\text{HO}_2 + \text{C}_2\text{H}_6 \rightarrow \text{H}_2\text{O}_2 + \text{C}_2\text{H}_5$	$2.2 \times 10^{-11} \exp(-10300/T)$	500–1000	$\pm 0.2$ at 500 K rising to $\pm 0.3$ at 1000 K.
$\text{HO}_2 + \text{CH}_3\text{CHO} \rightarrow \text{H}_2\text{O}_2 + \text{CH}_3\text{CO}$	$5.0 \times 10^{-12} \exp(-6000/T)$	900–1200	$\pm 0.7$
<i>H<sub>2</sub>O<sub>2</sub> Reactions</i>			
$\text{H}_2\text{O}_2 + \text{M} \rightarrow 2\text{OH} + \text{M}$	See Table 2		
<i>N Atom Reactions</i>			
$\text{N} + \text{CN} \rightarrow \text{N}_2 + \text{C}$	$3 \times 10^{-10}$	300–2500	$\pm 1.0$
$\text{N} + \text{NCO} \rightarrow \text{NO} + \text{CN}$	No recommendation		
$\quad \rightarrow \text{N}_2 + \text{CO}$	$3.3 \times 10^{-11}$	1700	$\pm 0.5$



## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i>NH Radical Reactions</i>			
$\text{NH} + \text{O}_2 \rightarrow \text{NO} + \text{OH}$ $\quad \rightarrow \text{NO}_2 + \text{H}$ $\quad \rightarrow \text{HNO} + \text{O}$	$1.26 \times 10^{-13} \exp(-770/T)$	270-550	$\pm 0.2$ at 270 K rising to $\pm 0.5$ at 550 K.
$\text{NH} + \text{NO} \rightarrow \text{N}_2\text{O} + \text{H}$ $\quad \rightarrow \text{HN}_2 + \text{O}$ $\quad \rightarrow \text{N}_2 + \text{OH}$	$5.0 \times 10^{-11}$	270-380	$\pm 0.2$
<i>NH<sub>2</sub> Radical Reactions</i>			
$\text{NH}_2 + \text{O}_2 \rightarrow \text{products}$	$< 3 \times 10^{-18}$	298	
$\text{NH}_2 + \text{NO} \rightarrow \text{N}_2 + \text{H}_2\text{O}$ $\quad \rightarrow \text{N}_2 + \text{H} + \text{OH}$ $\quad \rightarrow \text{N}_2\text{H} + \text{OH}$ $\quad \rightarrow \text{N}_2\text{O} + \text{H}_2$	$1.8 \times 10^{-12} \exp(650/T)$ $(k_2 + k_3)/k \approx 0.12$ at 298 K.	220-2000	$\pm 0.5$
<i><sup>1</sup>C<sub>2</sub> and <sup>3</sup>C<sub>2</sub> Radical Reactions</i>			
	See data sheets.		
<i>CH Radical Reactions</i>			
$\text{CH} + \text{O}_2 \rightarrow \text{CHO} + \text{O}$ $\quad \rightarrow \text{CO} + \text{OH}$	$5.5 \times 10^{-11}$	300-2000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 2000 K.
$\text{CH} + \text{H}_2 \rightarrow \text{CH}_2 + \text{H}$ $\quad \rightarrow \text{CH}_3$	$2.4 \times 10^{-10} \exp(-1760/T)$	300-1000	$\pm 0.3$
$\text{CH} + \text{H}_2\text{O} \rightarrow \text{products}$	$9.5 \times 10^{-12} \exp(380/T)$	300-1000	$\pm 1.0$
$\text{CH} + \text{CO} \rightarrow \text{products}$	$4.6 \times 10^{-13} \exp(860/T)$	300-1000	$\pm 1.0$
$\text{CH} + \text{CO}_2 \rightarrow \text{products}$	$5.7 \times 10^{-12} \exp(-345/T)$	300-1000	$\pm 1.0$
$\text{CH} + \text{CH}_4 \rightarrow \text{products}$	$5.0 \times 10^{-11} \exp(200/T)$	200-700	$\pm 1.0$
$\text{CH} + \text{C}_2\text{H}_2 \rightarrow \text{products}$	$3.5 \times 10^{-10} \exp(61/T)$	200-700	$\pm 1.0$
$\text{CH} + \text{C}_2\text{H}_4 \rightarrow \text{products}$	$2.2 \times 10^{-10} \exp(173/T)$	200-700	$\pm 1.0$
$\text{CH} + \text{C}_2\text{H}_6 \rightarrow \text{products}$	$1.8 \times 10^{-10} \exp(132/T)$	200-700	$\pm 1.0$
$\text{CH} + \text{C}_3\text{H}_8 \rightarrow \text{products}$	$1.9 \times 10^{-10} \exp(240/T)$	300-700	$\pm 1.0$
$\text{CH} + n\text{-C}_4\text{H}_{10} \rightarrow \text{products}$	$4.4 \times 10^{-10} \exp(28/T)$	250-700	$\pm 1.0$
$\text{CH} + i\text{-C}_4\text{H}_{10} \rightarrow \text{products}$	$2.0 \times 10^{-10} \exp(240/T)$	300-700	$\pm 1.0$
$\text{CH} + \text{neo-C}_5\text{H}_{12} \rightarrow \text{products}$	$1.6 \times 10^{-10} \exp(340/T)$	300-700	$\pm 1.0$
$\text{CH} + \text{CH}_3\text{C}_2\text{H} \rightarrow \text{products}$	No recommendation		
$\text{CH} + \text{CH}_2\text{O} \rightarrow \text{products}$	$1.6 \times 10^{-10} \exp(260/T)$	300-700	$\pm 1.0$

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i><sup>3</sup>CH<sub>2</sub> Radical Reactions</i>			
$\begin{array}{l} ^3\text{CH}_2 + \text{O}_2 \rightarrow \text{CO} + \text{H} + \text{OH} \\ \rightarrow \text{CO}_2 + \text{H} + \text{H} \\ \rightarrow \text{CO} + \text{H}_2\text{O} \\ \rightarrow \text{CO}_2 + \text{H}_2 \\ \rightarrow \text{HCHO} + \text{O} \end{array} \quad ]$	$4.1 \times 10^{-11} \exp(-750/T)$	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 1000 K.
$\begin{array}{l} ^3\text{CH}_2 + ^3\text{CH}_2 \rightarrow \text{C}_2\text{H}_2 + \text{H}_2 \\ \rightarrow \text{C}_2\text{H}_2 + 2\text{H} \end{array} \quad ]$	$2.0 \times 10^{-10} \exp(-400/T)$ $k_2/k = 0.9 \pm 0.1$ over range 300-3000 K.	300-3000	$\pm 0.5$
$^3\text{CH}_2 + \text{CH}_3 \rightarrow \text{C}_2\text{H}_4 + \text{H}$	$7.0 \times 10^{-11}$	300-3000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 3000 K.
$^3\text{CH}_2 + \text{C}_2\text{H}_2 \rightarrow \text{C}_3\text{H}_4$	See Table 3		
$\begin{array}{l} ^3\text{CH}_2 + \text{C}_2\text{H}_4 \rightarrow \text{C}_3\text{H}_6 \\ \rightarrow \text{c-C}_3\text{H}_6 \\ \rightarrow \text{CH}_2\text{CHCH}_2 + \text{H} \end{array} \quad ]$	See Table 3		
<i><sup>1</sup>CH<sub>2</sub> Radical Reactions</i>			
$^1\text{CH}_2 + \text{Ar} \rightarrow ^3\text{CH}_2 + \text{Ar}$	$6.0 \times 10^{-12}$	300-2000	$\pm 0.3$
$^1\text{CH}_2 + \text{N}_2 \rightarrow ^3\text{CH}_2 + \text{N}_2$	$1.0 \times 10^{-11}$	300-2000	$\pm 0.3$
$^1\text{CH}_2 + \text{CH}_4 \rightarrow ^3\text{CH}_2 + \text{CH}_4$	$1.2 \times 10^{-11}$	300-2000	$\pm 0.4$
$^1\text{CH}_2 + \text{C}_2\text{H}_2 \rightarrow ^3\text{CH}_2 + \text{C}_2\text{H}_2$	$8.0 \times 10^{-11}$	300-2000	$\pm 0.4$
$^1\text{CH}_2 + \text{C}_2\text{H}_4 \rightarrow ^3\text{CH}_2 + \text{C}_2\text{H}_4$	$2.3 \times 10^{-11}$	300-2000	$\pm 0.4$
$^1\text{CH}_2 + \text{C}_2\text{H}_6 \rightarrow ^3\text{CH}_2 + \text{C}_2\text{H}_6$	$3.6 \times 10^{-11}$	300-2000	$\pm 0.4$
$\begin{array}{l} ^1\text{CH}_2 + \text{O}_2 \rightarrow \text{CO} + \text{H} + \text{OH} \\ \rightarrow \text{CO}_2 + \text{H}_2 \\ \rightarrow \text{CO} + \text{H}_2\text{O} \\ \rightarrow ^3\text{CH}_2 + \text{O}_2 \end{array} \quad ]$	$5.2 \times 10^{-11}$	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 1000 K
$^1\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3 + \text{H}$	$1.2 \times 10^{-10}$	300-1000	$\pm 0.1$ at 300 K rising to $\pm 0.3$ at 1000 K
$\begin{array}{l} ^1\text{CH}_2 + \text{C}_2\text{H}_2 \rightarrow \text{CH}_2\text{CCH}_2 \\ \rightarrow \text{CH}_3\text{CCH} \\ \rightarrow \text{CH}_2\text{CCH} + \text{H} \\ \rightarrow ^3\text{CH}_2 + \text{C}_2\text{H}_2 \end{array} \quad ]$	See Table 3		
	See earlier entry		
$\begin{array}{l} ^1\text{CH}_2 + \text{C}_2\text{H}_4 \rightarrow \text{C}_3\text{H}_6 \\ \rightarrow ^3\text{CH}_2 + \text{C}_2\text{H}_4 \end{array}$	See Table 3 See earlier entry		
<i>CH<sub>3</sub> Radical Reactions</i>			
$\text{CH}_3 + \text{M} \rightarrow \text{CH}_2 + \text{H} + \text{M}$	See Table 2		
$\begin{array}{l} \text{CH}_3 + \text{O}_2 \rightarrow \text{CH}_3\text{O} + \text{O} \\ \rightarrow \text{HCHO} + \text{OH} \\ \rightarrow \text{CH}_3\text{O}_2 \end{array}$	$2.2 \times 10^{-10} \exp(-15800/T)$ $5.5 \times 10^{-13} \exp(-4500/T)$ See Table 3	300-2500 1000-2500	$\pm 0.5$ $\pm 0.5$

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{CH}_3 + \text{H}_2 \rightarrow \text{CH}_4 + \text{H}$	$1.14 \times 10^{-20} T^{2.74} \exp(-4740/T)$	300-2500	$\pm 0.15$ in the range 300-700 K. $\pm 0.3$ in the range 700-2500 K.
$\text{CH}_3 + \text{CH}_3 \rightarrow \text{C}_2\text{H}_5 + \text{H}$ $\rightarrow \text{C}_2\text{H}_4 + \text{H}_2$ $\rightarrow \text{C}_2\text{H}_6$	$5 \times 10^{-11} \exp(-6800/T)$ No recommendation (see data sheets) See Table 3	1300-2500	$\pm 0.6$
$\text{CH}_3 + \text{HCHO} \rightarrow \text{CH}_4 + \text{HCO}$	$6.8 \times 10^{-12} \exp(-4450/T)$	300-1000	$\pm 0.3$
$\text{CH}_3 + \text{C}_2\text{H}_2 + \text{M} \rightarrow \text{C}_3\text{H}_3 + \text{M}$ $\rightarrow \text{CH}_4 + \text{C}_2\text{H}$	See Table 3 No recommendation		
$\text{CH}_3 + \text{C}_2\text{H}_4 \rightarrow \text{CH}_4 + \text{C}_2\text{H}_3$ $\rightarrow n\text{-C}_3\text{H}_7$	$6.9 \times 10^{-12} \exp(-5600/T)$ See Table 3	400-3000	$\pm 0.5$
$\text{CH}_3 + \text{C}_2\text{H}_5 \rightarrow \text{CH}_4 + \text{C}_2\text{H}_4$ $\rightarrow \text{C}_3\text{H}_6$	$1.9 \times 10^{-12}$ See Table 3	300-800	$\pm 0.4$
$\text{CH}_3 + \text{C}_2\text{H}_6 \rightarrow \text{CH}_4 + \text{C}_2\text{H}_5$	$2.5 \times 10^{-31} T^{6.0} \exp(-3043/T)$	300-1500	$\pm 0.1$ at 300 K rising to $\pm 0.2$ at 1500 K.
$\text{CH}_3 + \text{CH}_3\text{CHO} \rightarrow \text{CH}_4 + \text{CH}_3\text{CO}$ $\rightarrow \text{CH}_4 + \text{CH}_2\text{CHO}$	$3.3 \times 10^{-30} T^{5.64} \exp(-1240/T)$ No recommendation (see data sheets)	300-1250	$\pm 0.3$
<i>CH<sub>4</sub> Reactions</i>			
$\text{CH}_4 + \text{M} \rightarrow \text{CH}_3 + \text{H} + \text{M}$	See Table 2		
<i>CHO Radical Reactions</i>			
$\text{CHO} + \text{O}_2 \rightarrow \text{CO} + \text{HO}_2$ $\rightarrow \text{OH} + \text{CO}_2$ $\rightarrow \text{HCO}_3$ ]	$5.0 \times 10^{-12}$	300-2500	$\pm 0.3$
$\text{CHO} + \text{CHO} \rightarrow \text{HCHO} + \text{CO}$	$5.0 \times 10^{-11}$	300	$\pm 0.3$
<i>HCHO Reactions</i>			
$\text{HCHO} + \text{M} \rightarrow \text{H} + \text{CHO} + \text{M}$ $\rightarrow \text{H}_2 + \text{CO} + \text{M}$ ]	See Table 2		
<i>CH<sub>2</sub>OH Reactions</i>			
$\text{CH}_2\text{OH} + \text{O}_2 \rightarrow \text{CH}_2\text{O} + \text{HO}_2$	$2.6 \times 10^{-9} T^{-1.0} +$ $1.2 \times 10^{-10} \exp(-1800/T)$	300-1200	$\pm 0.1$ at 300 K rising to $\pm 0.3$ at 1200 K.
<i>CH<sub>3</sub>O Radical Reactions</i>			
$\text{CH}_3\text{O} + \text{M} \rightarrow \text{HCHO} + \text{H} + \text{M}$	See Table 2		
$\text{CH}_3\text{O} + \text{O}_2 \rightarrow \text{HCHO} + \text{HO}_2$	$6.7 \times 10^{-14} \exp(-1070/T)$	300-1000	$\pm 0.2$ at 500 K rising to $\pm 0.3$ at 300 K and 1000 K.

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i>CH<sub>3</sub>OOH Reactions</i>			
$\text{CH}_3\text{OOH} + \text{M} \rightarrow \text{CH}_3\text{O} + \text{OH} + \text{M}$	See Table 2		
<i>CN Radical Reactions</i>			
$\text{CN} + \text{O}_2 \rightarrow \text{NCO} + \text{O}$	$1.1 \times 10^{-11} \exp(205/T)$	300–2500	$\pm 0.25$ at 300 K rising to $\pm 0.5$ at 2500 K.
$\text{CN} + \text{H}_2\text{O} \rightarrow \text{HCN} + \text{OH}$ $\quad \quad \quad \rightarrow \text{HOCN} + \text{H}$ ]	$1.3 \times 10^{-11} \exp(-3750/T)$	500–3000	$\pm 0.3$ at 500 K rising to $\pm 0.5$ at 3000 K.
$\text{CN} + \text{CH}_4 \rightarrow \text{HCN} + \text{CH}_3$	$1.5 \times 10^{-11} \exp(-940/T)$	260–400	$\pm 0.3$
<i>NCO Radical Reactions</i>			
$\text{NCO} + \text{M} \rightarrow \text{N} + \text{CO} + \text{M}$	See Table 2		
$\text{NCO} + \text{NO} \rightarrow \text{N}_2\text{O} + \text{CO}$ $\quad \quad \quad \rightarrow \text{N}_2 + \text{CO}_2$ $\quad \quad \quad \rightarrow \text{N}_2 + \text{CO} + \text{O}$ ]	$1.7 \times 10^{-11} \exp(200/T)$	300–600	$\pm 0.5$
<i>C<sub>2</sub>H Radical Reactions</i>			
$\text{C}_2\text{H} + \text{O}_2 \rightarrow \text{CO}_2 + \text{CH}$ $\quad \quad \quad \rightarrow 2\text{CO} + \text{H}$ $\quad \quad \quad \rightarrow \text{C}_2\text{HO} + \text{O}$ $\quad \quad \quad \rightarrow \text{CO} + \text{HCO}$ ]	$3.0 \times 10^{-11}$	300	$\pm 0.5$
$\text{C}_2\text{H} + \text{H}_2 \rightarrow \text{C}_2\text{H}_2 + \text{H}$	$2.5 \times 10^{-11} \exp(-1560/T)$	300–2500	$\pm 0.3$ at 300 K rising to $\pm 0.7$ at 2500 K
$\text{C}_2\text{H} + \text{C}_2\text{H}_2 \rightarrow \text{C}_4\text{H}_2 + \text{H}$	$5.0 \times 10^{-11}$	300–2700	$\pm 0.3$
$\text{C}_2\text{H} + \text{CH}_4 \rightarrow \text{products}$	$2.0 \times 10^{-12}$	298	$\pm 1$
$\text{C}_2\text{H} + \text{C}_2\text{H}_6 \rightarrow \text{products}$	No recommendation		
<i>C<sub>2</sub>H<sub>3</sub> Radical Reactions</i>			
$\text{C}_2\text{H}_3 + \text{M} \rightarrow \text{C}_2\text{H}_2 + \text{H} + \text{M}$	See Table 2		
$\text{C}_2\text{H}_3 + \text{O}_2 \rightarrow \text{HCHO} + \text{CHO}$	$9.0 \times 10^{-12}$	300–2000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 2000 K
<i>C<sub>2</sub>H<sub>5</sub> Radical Reactions</i>			
$\text{C}_2\text{H}_5 + \text{O}_2 \rightarrow \text{C}_2\text{H}_4 + \text{HO}_2$	$1.7 \times 10^{-14} \exp(1100/T)$	600–1200	$\pm 0.3$
$\text{C}_2\text{H}_5 + \text{C}_2\text{H}_5 \rightarrow \text{C}_2\text{H}_6 + \text{C}_2\text{H}_4$ $\quad \quad \quad \rightarrow n\text{-C}_4\text{H}_{10}$	$2.4 \times 10^{-12}$ See Table 3	300–1200	$\pm 0.4$
<i>C<sub>2</sub>H<sub>6</sub> Reactions</i>			
$\text{C}_2\text{H}_6 + \text{M} \rightarrow \text{CH}_3 + \text{CH}_3 + \text{M}$	See Table 2		

**KINETIC DATA FOR COMBUSTION MODELLING (continued)**

**Table 1  
BIMOLECULAR REACTIONS (continued)**

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i>CHCO Reactions</i>			
$\text{CHCO} + \text{O}_2 \rightarrow \text{CO}_2 + \text{HCO}$ $\quad \rightarrow 2\text{CO} + \text{OH}$ $\quad \rightarrow \text{C}_2\text{O} + \text{HO}_2$ $\quad \rightarrow \text{CHO}_2\text{CO}$	$2.7 \times 10^{-12} \exp(430/T)$ M = He, 2 Torr	300-550	$\pm 0.7$
<i>CH<sub>2</sub>CHO Radical Reactions</i>			
$\text{CH}_2\text{CHO} + \text{O}_2 \rightarrow \text{HO}_2 + \text{CH}_2\text{CHO}$ $\quad \rightarrow \text{HCHO} + \text{CO} + \text{OH}$ $\quad \rightarrow \text{O}_2\text{CH}_2\text{CHO}$	$k_\infty = 2.6 \times 10^{-13}$ $k_2 = 3.0 \times 10^{-14}$	250-1000 300	$\pm 0.2$ $\pm 0.3$
<i>CH<sub>3</sub>CO Radical Reactions</i>			
$\text{CH}_3\text{CO} + \text{O}_2 + \text{M} \rightarrow \text{CH}_3\text{CO}_3 + \text{M}$	See Table 3		
<i>CH<sub>3</sub>CHO Reactions</i>			
$\text{CH}_3\text{CHO} + \text{M} \rightarrow \text{CH}_3 + \text{HCO} + \text{M}$	See Table 2		
<i>C<sub>2</sub>H<sub>5</sub>O Reactions</i>			
$\text{C}_2\text{H}_5\text{O} + \text{M} \rightarrow \text{HCHO} + \text{CH}_3 + \text{M}$ $\quad \rightarrow \text{CH}_3\text{CHO} + \text{H} + \text{M}$	See Table 2		
$\text{C}_2\text{H}_5\text{O} + \text{O}_2 \rightarrow \text{CH}_3\text{CHO} + \text{HO}_2$	$1.0 \times 10^{-13} \exp(-830/T)$	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.5$ at 1000 K
<i>C<sub>2</sub>H<sub>5</sub>OOH Reactions</i>			
$\text{C}_2\text{H}_5\text{OOH} + \text{M} \rightarrow \text{C}_2\text{H}_5\text{O} + \text{OH} + \text{M}$	See Table 2		
<i>C<sub>6</sub>H<sub>5</sub> Radical Reactions</i>			
$\text{C}_6\text{H}_5 + \text{M} \rightarrow \text{C}_2\text{H}_2 + \text{C}_4\text{H}_3 + \text{M}$ $\quad \rightarrow \text{C}_2\text{H}_3 + \text{C}_4\text{H}_2 + \text{M}$ $\quad \rightarrow \text{linear-C}_6\text{H}_5 + \text{M}$	See Table 2		
<i>C<sub>6</sub>H<sub>6</sub> Reactions</i>			
$\text{C}_6\text{H}_6 + \text{M} \rightarrow \text{C}_6\text{H}_5 + \text{H} + \text{M}$ $\quad \rightarrow \text{C}_4\text{H}_4 + \text{C}_2\text{H}_2 + \text{M}$	See Table 2		
<i>C<sub>6</sub>H<sub>5</sub>O Radical Reactions</i>			
$\text{C}_6\text{H}_5\text{O} + \text{M} \rightarrow \text{C}_3\text{H}_5 + \text{CO} + \text{M}$	See Table 2		
<i>C<sub>6</sub>H<sub>5</sub>CH<sub>2</sub> Radical Reactions</i>			
$\text{C}_6\text{H}_5\text{CH}_2 + \text{M} \rightarrow \text{C}_3\text{H}_3 + 2\text{C}_2\text{H}_2 + \text{M}$ $\quad \rightarrow \text{C}_4\text{H}_4 + \text{C}_3\text{H}_3 + \text{M}$ $\quad \rightarrow \text{C}_3\text{H}_5 + \text{C}_2\text{H}_2 + \text{M}$ $\quad \rightarrow \text{C}_7\text{H}_7(\text{BCH}) + \text{M}$	See Table 2		

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 1  
 BIMOLECULAR REACTIONS (continued)

Reaction	$k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$	Temp/K	Error limits ( $\Delta \log k$ )
<i>C<sub>6</sub>H<sub>5</sub>CH<sub>3</sub> Reactions</i>			
$\text{C}_6\text{H}_5\text{CH}_3 + \text{M} \rightarrow \text{C}_6\text{H}_5\text{CH}_2 + \text{H} + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_5 + \text{CH}_3 + \text{M}$ ]	See Table 2		
<i>p-C<sub>6</sub>H<sub>4</sub>(CH<sub>3</sub>)<sub>2</sub> Reactions</i>			
$p\text{-C}_6\text{H}_4(\text{CH}_3)_2 + \text{M} \rightarrow \text{C}_6\text{H}_4\text{CH}_2\text{CH}_3 + \text{H} + \text{M}$	See Table 2		
<i>C<sub>6</sub>H<sub>5</sub>C<sub>2</sub>H<sub>5</sub> Reactions</i>			
$\text{C}_6\text{H}_5\text{C}_2\text{H}_5 + \text{M} \rightarrow \text{C}_6\text{H}_5\text{CH}_2 + \text{CH} + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_6 + \text{C}_2\text{H}_4 + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_5\text{CHCH}_2 + \text{H}_2 + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_5 + \text{C}_2\text{H}_5 + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_6\text{H}_5\text{CHCH}_3 + \text{H} + \text{M}$ ]	See Table 2		

 Table 2  
 DECOMPOSITION REACTIONS

Reaction	$k_\infty/\text{s}^{-1}$ $k_0/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ $F_c$ $k/\text{s}^{-1} = \frac{k_0 k_\infty [\text{M}]}{k_0[\text{M}] + k_\infty} F$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{H}_2 + \text{Ar} \rightarrow 2\text{H} + \text{Ar}$	$k_0 = 3.7 \times 10^{-10} \exp(-48350/T)$	2500-8000	$\pm 0.3$
$\text{H}_2 + \text{H}_2 \rightarrow 2\text{H} + \text{H}_2$	$k_0 = 1.5 \times 10^{-9} \exp(-48350/T)$	2500-8000	$\pm 0.5$
$\text{H}_2\text{O} + \text{N}_2 \rightarrow \text{H} + \text{OH} + \text{N}_2$	$k_0 = 5.8 \times 10^{-9} \exp(-52920/T)$	2000-6000	$\pm 0.5$
$\text{H}_2\text{O}_2 + \text{M} \rightarrow 2 \text{OH} + \text{M}$	$k_0(\text{Ar}) = 3 \times 10^{-8} \exp(-21600/T)$ $k_0(\text{N}_2) = 2 \times 10^{-7} \exp(-22900/T)$ $k_\infty = 3 \times 10^{14} \exp(-24400/T)$ $F_c(\text{Ar}) = 0.5$	1000-1500 700-1500 1000-1500 700-1500	$\pm 0.2$ $\pm 0.2$ $\pm 0.5$ $\Delta F_c = \pm 0.1$
$\text{CH}_3 + \text{M} \rightarrow \text{CH}_2 + \text{H} + \text{M}$	$k_0 = 1.7 \times 10^{-8} \exp(-45600/T)$	1500-3000	$\pm 0.5$
$\text{CH}_4 + \text{M} \rightarrow \text{CH}_3 + \text{H} + \text{M}$	$k_0(\text{Ar}) = 1.2 \times 10^{-6} \exp(-47000/T)$ $k_0(\text{CH}_4) = 1.4 \times 10^{-5} \exp(-48100/T)$ $k_\infty = 2.4 \times 10^{16} \exp(-52800/T)$ $F_c(\text{Ar}) = \exp(-0.45 - T/3231)$ $F_c(\text{CH}_4) = \exp(-0.37 - T/2210)$	1000-3000 1000-2000 1000-3000 1000-3000 1000-2000	$\pm 0.3$ $\pm 0.3$ $\pm 0.5$ $\Delta F_c = \pm 0.1$ $\Delta F_c = \pm 0.1$
$\text{HCHO} + \text{M} \rightarrow \text{H} + \text{CHO} + \text{M}$ $\quad \quad \quad \rightarrow \text{H}_2 + \text{CO} + \text{M}$ ]	$k_0(1) = 2.1 \times 10^{-8} \exp(-39200/T)$ $k_1/k_2 = 0.5$ at 2200 K	1500-2500	$\pm 0.3$
$\text{CH}_3\text{O} + \text{M} \rightarrow \text{HCHO} + \text{H} + \text{M}$	$k_0 = 3.16 \times 10^2 T^{-2.7} \exp(-15400/T)$ [estimate]	300-1000	$\pm 1.0$
$\text{CH}_3\text{OOH} + \text{M} \rightarrow \text{CH}_3\text{O} + \text{OH} + \text{M}$	$k_\infty = 4 \times 10^{15} \exp(-21600/T)$	400-1000	$\pm 0.5$ at 600 K rising to $\pm 1.0$ at 400 and 1000 K
$\text{NCO} + \text{Ar} \rightarrow \text{N} + \text{CO} + \text{Ar}$	$k_0 = 1.7 \times 10^{-9} \exp(-23500/T)$	1450-2600	$\pm 0.4$

KINETIC DATA FOR COMBUSTION MODELLING (continued)

Table 2  
DECOMPOSITION REACTIONS (continued)

Reaction	$k_{\infty}/s^{-1}$ $k_0/cm^3 \text{ molecule}^{-1} s^{-1}$ $F_c$ $k/s^{-1} = \frac{k_0 k_{\infty} [M]}{k_0[M] + k_{\infty}} F$	Temp/K	Error limits ( $\Delta \log k$ )
$C_2H_3 + M \rightarrow C_2H_2 + H + M$	$k_0 = 6.9 \times 10^{17} T^{-7.5} \exp(-22900/T)$ $k_{\infty} = 2 \times 10^{14} \exp(-20000/T)$ $F_c = 0.35$	500-2500 500-2500 500-2500	$\pm 0.5$ $\pm 0.5$ $\Delta F_c = \pm 0.1$
$C_2H_6 + M \rightarrow 2CH_3 + M$	$k_0(Ar) = 1.1 \times 10^{25} T^{-8.24} \exp(-47090/T)$ $k_0(C_2H_6) = 4.5 \times 10^{-2} \exp(-41930/T)$ $k_{\infty} = 1.8 \times 10^{21} T^{-1.24} \exp(-45700/T)$ $F_c(Ar) = 0.38 \exp(-T/73) + 0.62 \exp(-T/1180)$ $F_c(C_2H_6) = 0.54 \exp(-T/1250)$	300-2000 800-1000 300-2000 300-2000 800-1000	$\pm 0.5$ $\pm 0.5$ $\pm 0.3$ $\Delta F_c = \pm 0.1$ $\Delta F_c = \pm 0.1$
$CH_3CHO + M \rightarrow CH_3 + CHO + M$	$k(1 \text{ atm.}) = 7 \times 10^{15} \exp(-41100/T)$ (pressure dependent region)	750-1200	$\pm 0.4$
$C_2H_3O + M \rightarrow HCHO + CH_3 + M$	$k_{\infty} = 8 \times 10^{13} \exp(-10830/T)$ [estimate]	300-600	$\pm 1.0$
$C_2H_5OOH + M \rightarrow C_2H_5O + OH + M$	$k_{\infty} 4 \times 10^{15} \exp(-21600/T)$	400-1000	$\pm 1.0$
$C_6H_5 + M \rightarrow C_2H_2 + C_4H_3 + M$ $\rightarrow C_2H_3 + C_4H_2 + M$ $\rightarrow \text{linear-}CH_5 + M$	No recommendation $4.0 \times 10^{13} \exp(-36700/T)$	1450-1900	$\pm 0.4$
$C_6H_6 + M \rightarrow C_6H_5 + H + M$ $\rightarrow C_4H_4 + H_2 + M$	$9.0 \times 10^{15} \exp(-54060/T)$	1200-2500	$\pm 0.4$ at 1200 K reducing to $\pm 0.3$ at 2500 K
$C_6H_5O + M \rightarrow C_3H_5 + CO + M$	$2.5 \times 10^{11} \exp(-22100/T)$	1000-1580	$\pm 0.2$
$C_6H_5CH_2 + M \rightarrow C_3H_3 + 2C_2H_2 + M$ $\rightarrow C_4H_4 + C_3H_3 + M$ $\rightarrow C_5H_5 + C_2H_2 + M$ $\rightarrow C_7H_7 \text{ (BCH)} + M$	$5.1 \times 10^{13} \exp(-36370/T)$	1350-1900	$\pm 0.3$ at 1350 K rising to $\pm 0.5$ 1900 K
$C_6H_5CH_3 + M \rightarrow C_6H_5CH_2 + H + M$ $\rightarrow C_6H_5 + CH_3 + M$	$3.1 \times 10^{15} \exp(-44890/T)$ No recommendation	920-2200	$\pm 0.3$ at 900 K rising to $\pm 0.5$ at 2200 K
$p\text{-}C_6H_4(CH_3)_2 + M \rightarrow p\text{-}C_6H_4CH_2CH_3 + H + M$	$4.0 \times 10^{15} \exp(-42600/T)$	1400-1800	$\pm 0.5$
$C_6H_5C_2H_5 + M \rightarrow C_6H_5CH_2 + CH + M$ $\rightarrow C_6H_6 + C_2H_4 + M$ $\rightarrow C_6H_5CHCH_2 + H_2 + M$ $\rightarrow C_6H_5 + C_2H_5 + M$ $\rightarrow C_6H_5CHCH_3 + H + M$	$6.1 \times 10^{15} \exp(-37800/T)$ No recommendations	770-1800	$\pm 0.1$ at 770 K rising to $\pm 0.4$ at

Table 3  
COMBINATION REACTIONS

Reaction	$k_{\infty}/cm^3 \text{ molecule}^{-1} s^{-1}$ $k_0/cm^6 \text{ molecule}^{-2} s^{-1}$ $F_c$ $k/cm^3 \text{ molecule}^{-1} s^{-1} = \frac{k_0 k_{\infty} [M]}{k_0[M] + k_{\infty}} F$	Temp/K	Error limits ( $\Delta \log k$ )
$H + O_2 + Ar \rightarrow HO_2 + Ar$	$k_0 = 1.7 \times 10^{-30} T^{-0.8}$	300-2000	$\pm 0.5$

## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 3  
 COMBINATION REACTIONS (continued)

Reaction	$k_{\infty}/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ $k_0/\text{cm}^6 \text{ molecule}^{-2} \text{ s}^{-1}$ $F_c$ $k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1} = \frac{k_0 k_{\infty} [M]}{k_0 [M] + k_{\infty}} F$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{H} + \text{O}_2 + \text{H}_2 \rightarrow \text{HO}_2 + \text{H}_2$	$k_0 = 5.8 \times 10^{-30} T^{-0.8}$	300–2000	$\pm 0.5$
$\text{H} + \text{O}_2 + \text{N}_2 \rightarrow \text{HO}_2 + \text{N}_2$	$k_0 = 3.9 \times 10^{-30} T^{-0.8}$	300–2000	$\pm 0.5$
$\text{H} + \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{HO}_2 + \text{H}_2\text{O}$	$k_0 = 4.3 \times 10^{-30} T^{-0.8}$	300–2000	$\pm 0.5$
$\text{H} + \text{H} + \text{Ar} \rightarrow \text{H}_2 + \text{Ar}$	$k_0 = 1.8 \times 10^{-30} T^{-1.0}$	300–2500	$\pm 0.5$
$\text{H} + \text{H} + \text{H}_2 \rightarrow \text{H}_2 + \text{H}_2$	$k_0 = 2.7 \times 10^{-31} T^{-0.6}$	100–5000	$\pm 0.5$
$\text{H} + \text{OH} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O} + \text{H}_2\text{O}$	$k_0 = 3.9 \times 10^{-25} T^{-2.0}$	300–3000	$\pm 0.3$
$\text{H} + \text{OH} + \text{Ar} \rightarrow \text{H}_2\text{O} + \text{Ar}$	$k_0 = 2.3 \times 10^{-26} T^{-2.0}$	300–3000	$\pm 0.3$
$\text{H} + \text{OH} + \text{N}_2 \rightarrow \text{H}_2\text{O} + \text{N}_2$	$k_0 = 6.1 \times 10^{-26} T^{-2.0}$	300–3000	$\pm 0.3$
$\text{H} + \text{CH}_3 + \text{M} \rightarrow \text{CH}_4 + \text{M}$	$k_0(\text{He}) = 6.2 \times 10^{-29} (T/3000)^{-1.8}$ $k_0(\text{Ar}) = 6 \times 10^{-29} (T/300)^{-1.8}$ $k_0(\text{C}_2\text{H}_6) = 3 \times 10^{-28} (T/300)^{-1.8}$ $k_{\infty} = 3.5 \times 10^{-10}$ $F_c(\text{He,Ar}) = \exp(-0.45 - T/3231)$ $F_c(\text{C}_2\text{H}_6) = \exp(-0.34 - T/3053)$	300–1000 300–1000 300–1000 300–1000 300–1000	$\pm 0.3$ $\pm 0.5$ $\pm 0.5$ $\pm 0.3$ $\Delta F_c = \pm 0.1$ $\Delta F_c = \pm 0.1$
$\text{H} + \text{C}_2\text{H}_2 + \text{He} \rightarrow \text{C}_2\text{H}_3 + \text{He}$	$k_{\infty} = 1.4 \times 10^{-11} \exp(-1300/T)$ $k_0 = 3.3 \times 10^{-30} \exp(-740/T)$ $F_c = 0.44$	200–400 200–400 200–400	$\pm 0.3$ $\pm 0.5$ $\Delta F_c = \pm 0.1$
$\text{H} + \text{C}_2\text{H}_3 + \text{M} \rightarrow \text{C}_2\text{H}_4 + \text{M}$	No recommendation		
$\text{H} + \text{C}_2\text{H}_4 + \text{M} \rightarrow \text{C}_2\text{H}_5 + \text{M}$	No recommendation		
$\text{H} + \text{C}_2\text{H}_5 + \text{M} \rightarrow \text{C}_2\text{H}_6 + \text{M}$	No recommendation		
$\text{H} + \text{C}_6\text{H}_5 + \text{M} \rightarrow \text{C}_6\text{H}_6 + \text{M}$	$k_{\infty} = 1.3 \times 10^{-10}$	1400–1700	$\pm 0.5$
$\text{H} + \text{C}_6\text{H}_6 + \text{M} \rightarrow \text{C}_6\text{H}_7 + \text{M}$	$k_{\infty} = 6.7 \times 10^{-11} \exp(-2170/T)$	300–1000	$\pm 0.2$
$\text{H} + \text{C}_6\text{H}_5\text{O} + \text{M} \rightarrow \text{C}_6\text{H}_5\text{OH} + \text{M}$	$k_{\infty} = 4.2 \times 10^{-10}$	1000	$\pm 0.3$
$\text{H} + \text{C}_6\text{H}_5\text{CH}_2 + \text{M} \rightarrow \text{C}_6\text{H}_5\text{CH}_3 + \text{M}$	$k_{\infty} = 5.5 \times 10^{-10}$	300–2000	$\pm 0.2$ at 300 K rising to $\pm 0.7$ at 2000 K.
$\text{H} + \text{C}_6\text{H}_5\text{CH}_3 + \text{M} \rightarrow \text{C}_6\text{H}_6\text{CH}_3 + \text{M}$	$k_{\infty} = 1.2 \times 10^{-13}$	298	$\pm 0.2$
$\text{H} + \text{C}_6\text{H}_5\text{C}_2\text{H}_5 + \text{M} \rightarrow \text{C}_6\text{H}_6\text{C}_2\text{H}_5 + \text{M}$	$k_{\infty} = 3.3 \times 10^{-13}$	298	$\pm 0.1$
$\text{OH} + \text{OH} + \text{M} \rightarrow \text{H}_2\text{O}_2 + \text{M}$	$k_0(\text{N}_2) = 8 \times 10^{-31} (T/300)^{-0.76}$ $k_0(\text{H}_2\text{O}) = 4 \times 10^{-30}$ $k_{\infty} = 1.5 \times 10^{-11} (T/300)^{-0.37}$ $F_c(\text{N}_2) = 0.5$	250–1400 300–400 200–1500 200–1500	$\pm 0.4$ $\pm 0.5$ $\Delta F_c = \pm 0.2$
$\text{OH} + \text{CH}_3 + \text{M} \rightarrow \text{CH}_3\text{OH} + \text{M}$	No data available for this channel (See Table 1)		



## KINETIC DATA FOR COMBUSTION MODELLING (continued)

 Table 3  
 COMBINATION REACTIONS (continued)

Reaction	$k_{\infty}/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$ $k_0/\text{cm}^6 \text{ molecule}^{-2} \text{ s}^{-1}$ $F_c$ $k/\text{cm}^3 \text{ molecule}^{-1} \text{ s}^{-1} = \frac{k_0 k_{\infty} [M]}{k_0[M] + k_{\infty}} F$	Temp/K	Error limits ( $\Delta \log k$ )
$\text{OH} + \text{C}_2\text{H}_2 + \text{M} \rightarrow \text{C}_2\text{H}_2\text{OH} + \text{M}$	See data sheet		
$\text{OH} + \text{C}_6\text{H}_6 + \text{M} \rightarrow \text{C}_6\text{H}_6\text{OH} + \text{M}$	$k_{\infty} = 3.8 \times 10^{-12} \exp(-340/T)$	240-340	$\pm 0.2$
$\text{OH} + \text{C}_6\text{H}_5\text{OH} + \text{M} \rightarrow \text{C}_6\text{H}_5(\text{OH})_2 + \text{M}$	$k_{\infty} = 2.8 \times 10^{-11}$	298	$\pm 0.1$
$\text{OH} + \text{C}_6\text{H}_5\text{CH}_3 + \text{M} \rightarrow \text{HOC}_6\text{H}_5\text{CH}_3 + \text{M}$	$k_{\infty} = 3.8 \times 10^{-12} \exp(180/T)$	200-300	$\pm 0.4$
$\text{OH} + \text{C}_6\text{H}_4(\text{CH}_3)_2 + \text{M} \rightarrow \text{C}_6\text{H}_4(\text{CH}_3)_2\text{OH} + \text{M}$	$k_{\infty} = 1.4 \times 10^{-11}$	300-320	$\pm 0.1$
$\text{OH} + \text{C}_6\text{H}_3\text{C}_2\text{H}_5 + \text{M} \rightarrow \text{HOC}_6\text{H}_3\text{C}_2\text{H}_5 + \text{M}$	$7.5 \times 10^{-12}$ at $p \leq 1$ atm.	298	$\pm 0.1$
$^3\text{CH}_2 + \text{C}_2\text{H}_2 + \text{M} \rightarrow \text{C}_3\text{H}_4 + \text{M}$	$2.0 \times 10^{-11} \exp(-3330/T)$ at $p = \leq 10$ Torr.	300-1000	$\pm 0.3$
$^3\text{CH}_2 + \text{C}_2\text{H}_4 + \text{M} \rightarrow \text{C}_3\text{H}_6 + \text{M}$ $\quad \quad \quad \rightarrow \text{c-C}_3\text{H}_6 + \text{M}$ $\quad \quad \quad \rightarrow \text{C}_3\text{H}_5 + \text{H} + \text{M}$	$5.3 \times 10^{-12} \exp(-2660/T)$	300-1000	$\pm 0.2$ at 300 K rising to $\pm 0.3$ at 1000 K
$^1\text{CH}_2 + \text{C}_2\text{H}_2 + \text{M} \rightarrow \text{CH}_2\text{CCH}_2 + \text{M}$ $\quad \quad \quad \rightarrow \text{CH}_3\text{CCH} + \text{M}$ $\quad \quad \quad \rightarrow \text{CH}_2\text{CCH} + \text{H} + \text{M}$	$3.7 \times 10^{-10}$ independent of $p$	300-1000	$\pm 0.3$ at 300 K rising to $\pm 0.7$ at 1000 K.
$^1\text{CH}_2 + \text{C}_2\text{H}_4 + \text{M} \rightarrow \text{C}_3\text{H}_6$	$1.1 \times 10^{-10}$ independent of $p$	300-1000	$\pm 0.2$ at 300 K rising to $\pm 0.5$ at 1000 K.
$\text{CH}_3 + \text{O}_2 + \text{M} \rightarrow \text{CH}_3\text{O}_2 + \text{M}$	$k_0(\text{Ar}) = 1.5 \times 10^{-22} T^{-3.3}$ $k_0(\text{N}_2) = 1.6 \times 10^{-22} T^{-3.3}$ $k_{\infty} = 1.3 \times 10^{-15} T^{-1.2}$ $F_c = 0.466 - 1.30 \times 10^{-4} T$	300-800 300-800 300-800 300-800	$\pm 0.3$ $\pm 0.3$ $\pm 0.3$
$\text{CH}_3 + \text{CH}_3 + \text{Ar} \rightarrow \text{C}_2\text{H}_6 + \text{Ar}$	$k_{\infty} = 6 \times 10^{-11}$  $k_0 = 3.5 \times 10^{-7} T^{-7.0} \exp(-1390/T)$ $F_c = 0.38 \exp(-T/73)$ $\quad + 0.62 \exp(-T/1180)$	300-2000 300-2000 300-2000	$\pm 0.05$ at 300 K rising to $\pm 0.3$ at 2000 K $\pm 0.3$ $\Delta F_c = \pm 0.1$
$\text{CH}_3 + \text{C}_2\text{H}_2 + \text{M} \rightarrow \text{C}_3\text{H}_5 + \text{M}$	$k_{\infty} = 1 \times 10^{-12} \exp(-3900/T)$	300-600	$\pm 0.5$
$\text{CH}_3 + \text{C}_2\text{H}_4 + \text{M} \rightarrow n\text{-C}_3\text{H}_7 + \text{M}$	$3.5 \times 10^{-13} \exp(-3700/T)$	300-600	$\pm 0.3$
$\text{CH}_3 + \text{C}_2\text{H}_5 + \text{M} \rightarrow \text{C}_3\text{H}_8 + \text{M}$	$k_{\infty} = 4.7 \times 10^{-11}$	300-800	$\pm 0.3$
$\text{C}_2\text{H}_5 + \text{C}_2\text{H}_5 + \text{M} \rightarrow n\text{-C}_4\text{H}_{10} + \text{M}$	$k_{\infty} = 1.9 \times 10^{-11}$	300-1200	$\pm 0.3$
$\text{CH}_3\text{CO} + \text{O}_2 + \text{M} \rightarrow \text{CH}_3\text{CO}_3 + \text{M}$	$2 \times 10^{-12}$ for $p = 1-4$ Torr.	300	$\pm 0.3$

## ELECTRICAL CONDUCTIVITY OF WATER

This table gives the electrical conductivity of highly purified water over a range of temperature and pressure. The first column of conductivity data refers to water at its own vapor pressure. Equations for calculating the conductivity at any temperature and pressure may be found in the reference.

### Reference

Marshall, W. L., *J. Chem. Eng. Data* 32, 221, 1987.

#### Conductivity in $\mu\text{S}/\text{cm}$ at the Indicated Pressure

$t/^\circ\text{C}$	Sat. vapor	50 MPa	100 MPa	200 MPa	400 MPa	600 MPa
0	0.0115	0.0150	0.0189	0.0275	0.0458	0.0667
25	0.0550	0.0686	0.0836	0.117	0.194	0.291
100	0.765	0.942	1.13	1.53	2.45	3.51
200	2.99	4.08	5.22	7.65	13.1	19.5
300	2.41	4.87	7.80	14.1	28.9	46.5
400		1.17	4.91	14.3	39.2	71.3
600			0.134	4.65	33.8	85.7

## ELECTRICAL CONDUCTIVITY OF AQUEOUS SOLUTIONS

The following table gives the electrical conductivity of aqueous solutions of some acids, bases, and salts as a function of concentration. All values refer to 20 °C. The conductivity  $\kappa$  (often called specific conductance in older literature) is the reciprocal of the resistivity. The molar conductivity  $\Lambda$  is related to this by  $\Lambda = \kappa/c$ , where  $c$  is the amount-of-substance concentration of the electrolyte. Thus if  $\kappa$  has units of millisiemens per centimeter (mS/cm), as in this table, and  $c$  is expressed in mol/L, then  $\Lambda$  has units of S cm<sup>2</sup> mol<sup>-1</sup>. For these electrolytes the concentration  $c$  correspond-

ing to the mass percent values given here can be found in the table "Concentrative Properties of Aqueous Solutions" in Section 8.

### References

1. *CRC Handbook of Chemistry, and Physics, 70th Edition*, Weast, R. C., Ed., CRC Press, Boca Raton, FL, 1989, p. D-221.
2. Wolf, A. V., *Aqueous Solutions and Body Fluids*, Harper and Row, New York, 1966.

**Electrical Conductivity  $\kappa$  in mS/cm for the Indicated Concentration in Mass Percent**

Name	Formula	0.5%	1%	2%	5%	10%	15%	20%	25%	30%	40%	50%
Acetic acid	CH <sub>3</sub> COOH	0.3	0.6	0.8	1.2	1.5	1.7	1.7	1.6	1.4	1.1	0.8
Ammonia	NH <sub>3</sub>	0.5	0.7	1.0	1.1	1.0	0.7	0.5	0.4			
Ammonium chloride	NH <sub>4</sub> Cl	10.5	20.4	40.3	95.3	180						
Ammonium sulfate	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	7.4	14.2	25.7	57.4	105	147	185	215			
Barium chloride	BaCl <sub>2</sub>	4.7	9.1	17.4	40.4	76.7	109.0	137.0				
Calcium chloride	CaCl <sub>2</sub>	8.1	15.7	29.4	67.0	117	157	177	183	172	106	
Cesium chloride	CsCl	3.8	7.4	13.8	32.9	65.8	102	142				
Citric acid	H <sub>3</sub> C(OH)(COO) <sub>3</sub>	1.2	2.1	3.0	4.7	6.2	7.0	7.2	7.1			
Copper(II) sulfate	CuSO <sub>4</sub>	2.9	5.4	9.3	19.0	32.2	42.3					
Formic acid	HCOOH	1.4	2.4	3.5	5.6	7.8	9.0	9.9	10.4	10.5	9.9	8.6
Hydrogen chloride	HCl	45.1	92.9	183								
Lithium chloride	LiCl	10.1	19.0	34.9	76.4	127	155	170	165	146		
Magnesium chloride	MgCl <sub>2</sub>	8.6	16.6	31.2	66.9	108	129	134	122	98		
Magnesium sulfate	MgSO <sub>4</sub>	4.1	7.6	13.3	27.4	42.7	54.2	51.1	44.1			
Manganese(II) sulfate	MnSO <sub>4</sub>		6.2	10.6	21.6	34.5	43.7	47.6				
Nitric acid	HNO <sub>3</sub>	28.4	56.1	108								
Oxalic acid	H <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	14.0	21.8	35.3	65.6							
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	5.5	10.1	16.2	31.5	59.4	88.4	118	146	173	209	
Potassium bromide	KBr	5.2	10.2	19.5	47.7	95.6	144	194				
Potassium carbonate	K <sub>2</sub> CO <sub>3</sub>	7.0	13.6	25.4	58.0	109	152	188	223			
Potassium chloride	KCl	8.2	15.7	29.5	71.9	143	208					
Potassium dihydrogen phosphate	KH <sub>2</sub> PO <sub>4</sub>	3.0	5.9	11.0	25.0	44.6						
Potassium hydrogen carbonate	KHCO <sub>3</sub>	4.6	8.9	17.0	38.8	72.4	101	128				
Potassium hydrogen phosphate	K <sub>2</sub> HPO <sub>4</sub>	5.2	9.9	18.3	40.3							
Potassium hydroxide	KOH	20.0	38.5	75.0	178							
Potassium iodide	KI	3.8	7.5	14.2	35.2	71.8	110	188	224			
Potassium nitrate	KNO <sub>3</sub>	5.5	10.7	20.1	47.0	87.3	124	157	182			
Potassium permanganate	KMnO <sub>4</sub>	3.5	6.9	13.0	30.5							
Potassium sulfate	K <sub>2</sub> SO <sub>4</sub>	5.8	11.2	21.0	48.0	88.6						
Silver(I) nitrate	AgNO <sub>3</sub>	3.1	6.1	12.0	26.7	49.8	72.0	92.8	112	129	162	
Sodium acetate	NaCH <sub>3</sub> COO	3.9	7.6	14.4	30.9	53.4	64.1	69.3	69.2	64.3		
Sodium bromide	NaBr	5.0	9.7	18.4	44.0	84.6	122	157	191	216		
Sodium carbonate	Na <sub>2</sub> CO <sub>3</sub>	7.0	13.1	23.3	47.0	74.4	88.6					
Sodium chloride	NaCl	8.2	16.0	30.2	70.1	126	171	204	222			
Sodium citrate	Na <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>		7.4	12.8	26.2	42.1	52.0	57.1	57.3	53.5		
Sodium dihydrogen phosphate	NaH <sub>2</sub> PO <sub>4</sub>	2.2	4.4	9.1	21.0	33.2	43.3	49.6	53.1	54.0	46.1	
Sodium hydrogen carbonate	NaHCO <sub>3</sub>	4.2	8.2	15.0	31.4							
Sodium hydrogen phosphate	Na <sub>2</sub> HPO <sub>4</sub>	4.6	8.7	15.6	31.4							
Sodium hydroxide	NaOH	24.8	48.6	93.1	206							
Sodium nitrate	NaNO <sub>3</sub>	5.4	10.6	20.4	46.2	82.6	111	134	152	165	178	
Sodium phosphate	Na <sub>3</sub> PO <sub>4</sub>	7.3	14.1	22.7	43.5							
Sodium sulfate	Na <sub>2</sub> SO <sub>4</sub>	5.9	11.2	19.8	42.7	71.3	91.1	109				
Sodium thiosulfate	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	5.7	10.7	19.5	43.3	76.7	104	123	134	136	118	
Strontium chloride	SrCl <sub>2</sub>	5.9	11.4	22.0	49.1	91.5	127	153	168	178		
Sulfuric acid	H <sub>2</sub> SO <sub>4</sub>	24.3	47.8	92	211							
Trichloroacetic acid	CCl <sub>3</sub> COOH	10.3	19.6	37.2	84.7	148	193	221				
Zinc sulfate	ZnSO <sub>4</sub>	2.8	5.4	10.0	20.5	33.7	43.3					

## ENERGY CONTENT OF FUELS

Several fuels are compared in this table with respect to their energy content per unit mass and the amount of CO<sub>2</sub> released per unit of available energy. The energy content is taken to be the negative of the standard enthalpy of combustion (see the table "Heat of Combustion" in this section for more details). The energy is assumed to be released by combustion with oxygen at normal atmospheric pressure, with products of gaseous CO<sub>2</sub> and liquid H<sub>2</sub>O at room temperature. This quantity is often called the "gross heat of combustion" to distinguish it from the "net heat of combustion," for which the water remains in the gas state. The latter quantity is typically 5% to 10% less than the values given here.

The energy content is given both in SI units of MJ/kg and conventional units of BTU/lb. Values for the fossil fuels and other materials are typical; individual samples show wide variations.

The last column gives the grams of carbon released as carbon dioxide per megajoule of energy. Examination of the table shows

that the minimum CO<sub>2</sub> release occurs for fuels that have a high ratio of hydrogen to carbon. Furthermore, fuels containing oxygen have a lower energy content and higher CO<sub>2</sub> release than hydrocarbons with the same number of carbon atoms.

### References

1. Domalski, E. S., Jobe, T. L., and Milne, T. A., *Thermodynamic Data for Biomass Conversion and Waste Incineration*, SERI/SP-271-2839, Solar Technical Information Program, U. S. Department of Energy, September 1986; see also NBSIR 78-1479, National Bureau of Standards, August 1978.
2. Green, D. W., and Ackers, D. E., *Perry's Chemical Engineers' Handbook, Eighth Edition*, McGraw-Hill, New York, 2007.
3. *Transportation Energy Data Book*, U. S. Department of Energy, May 2007, <http://cta.ornl.gov/data/index.shtml>.
4. *Chemical Composition of Natural Gas*, Union Gas Limited, <http://www.uniongas.com/aboutus/aboutnrg/composition.asp>.

Fuel	Energy content		g of C per MJ
	MJ/kg	10 <sup>3</sup> BTU/lb	
<i>Pure compounds</i>			
Hydrogen	141.8	61.0	0.0
Methane	55.5	23.9	13.5
Ethane	51.9	22.3	15.4
Propane	50.3	21.7	16.2
Hexane	48.3	20.8	17.3
Heptane	48.1	20.7	17.5
Octane	47.9	20.6	17.6
Methanol	22.7	9.7	16.5
Ethanol	29.7	12.8	17.6
1-Propanol	33.6	14.5	17.8
1-Butanol	36.1	15.5	18.0
1-Octanol	40.7	17.5	18.1
Methyl <i>tert</i> -butyl ether	38.2	16.4	17.8

Fuel	Energy content		g of C per MJ
	MJ/kg	10 <sup>3</sup> BTU/lb	
<i>Fossil fuels</i>			
Natural gas <sup>a</sup>	54.0	23.2	13.9
Gasoline	46.5	20.0	17.6
Kerosene	46.4	20.0	18.5
Fuel oil	40.9	17.6	21.3
Coal, high bituminous	36.3	15.6	23.5
Coal, low bituminous	28.9	12.4	26.3
Coal, anthracite	34.6	14.9	27.3
<i>Other materials</i>			
Wood, oak	18.9	8.1	25.3
Wood, locust	19.7	8.5	25.7
Wood, Ponderosa pine	20.0	8.6	24.6
Wood, redwood	20.7	8.9	24.4
Charcoal, wood	34.7	14.9	26.8
Newsprint	18.6	8.0	26.5
Cellulose	17.3	7.5	25.6
Grass (lawn clippings)	19.3	8.3	24.9

<sup>a</sup> Assumed to be 95% methane, 2.5% ethane, and 2.5% inert compounds; however, the actual composition varies widely (see Reference 4).

## ENTHALPY OF HYDRATION OF GASES

The molar enthalpy of hydration  $\Delta_{\text{hyd}}H^\infty$  is defined as the enthalpy change when one mole of an ideal gas is dissolved in an infinite amount of water. Another term for this quantity is enthalpy (heat) of solvation in water at infinite dilution. The enthalpy of hydration influences the distribution of a volatile compound between the aqueous solution phase and air and is thus important in fields such as environmental science, geochemistry, and chemical engineering. It is related to the enthalpy of solution of the liquid or solid phase,  $\Delta_{\text{sol}}H^\infty$ , by

$$\Delta_{\text{hyd}}H^\infty = \Delta_{\text{sol}}H^\infty - \Delta_{\text{vap}}H^0$$

where  $\Delta_{\text{vap}}H^0$  is the molar enthalpy of vaporization. This table gives the molar enthalpy of hydration for a number of common substances.

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\infty/\text{kJ mol}^{-1}$ at 298.15 K
Acenaphthene	$\text{C}_{12}\text{H}_{10}$	-52.1
Acetic acid	$\text{C}_2\text{H}_4\text{O}_2$	-52.8
Acetone	$\text{C}_3\text{H}_6\text{O}$	-39.7
Acetonitrile	$\text{C}_2\text{H}_3\text{N}$	-34.9
Acetophenone	$\text{C}_8\text{H}_8\text{O}$	-53.3
Ammonia	$\text{H}_3\text{N}$	-35.4
Aniline	$\text{C}_6\text{H}_7\text{N}$	-56.5
Anisole	$\text{C}_7\text{H}_8\text{O}$	-41.4
Argon	Ar	-12.2
Benzaldehyde	$\text{C}_7\text{H}_6\text{O}$	-42.1
Benzene	$\text{C}_6\text{H}_6$	-28.1
Benzonitrile	$\text{C}_7\text{H}_5\text{N}$	-48.5
Benzyl alcohol	$\text{C}_7\text{H}_8\text{O}$	-66.9
Biphenyl	$\text{C}_{12}\text{H}_{10}$	-47.2
Bromobenzene	$\text{C}_6\text{H}_5\text{Br}$	-33.5
Bromodichloromethane	$\text{CHBrCl}_2$	-28.9
Bromoethane	$\text{C}_2\text{H}_5\text{Br}$	-29.5
Bromomethane	$\text{CH}_3\text{Br}$	-23.8
2-Bromo-2-methylpropane	$\text{C}_4\text{H}_9\text{Br}$	-25.4
1,3-Butadiene	$\text{C}_4\text{H}_6$	-31.4
Butane	$\text{C}_4\text{H}_{10}$	-24.8
1,4-Butanediamine	$\text{C}_4\text{H}_{12}\text{N}_2$	-91.6
1,4-Butanediol	$\text{C}_4\text{H}_{10}\text{O}_2$	-89.6
Butanenitrile	$\text{C}_4\text{H}_7\text{N}$	-42.1
1,2,3,4-Butanetetrol	$\text{C}_4\text{H}_{10}\text{O}_4$	-114
1-Butanethiol	$\text{C}_4\text{H}_{10}\text{S}$	-36.3
Butanoic acid	$\text{C}_4\text{H}_8\text{O}_2$	-59.5
1-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	-61.9
2-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	-62.7
2-Butanone	$\text{C}_4\text{H}_8\text{O}$	-41.9
1-Butene	$\text{C}_4\text{H}_8$	-24.1
2-Butoxyethanol	$\text{C}_6\text{H}_{14}\text{O}_2$	-73.6
Butyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	-52.7

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Name	Mol. Form.	$\Delta_{\text{hyd}}H^\infty/\text{kJ mol}^{-1}$ at 298.15 K
sec-Butyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	-51.9
tert-Butyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	-46.2
Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	-59.2
sec-Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	-57.1
tert-Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	-59.0
Butylbenzene	$\text{C}_{10}\text{H}_{14}$	-38.5
Butyl butanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	-63.5
Butyl ethyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-48.4
tert-Butyl ethyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-53.4
4-tert-Butylphenol	$\text{C}_{10}\text{H}_{14}\text{O}$	-63.8
Butyl propanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-57.8
1-Butyne	$\text{C}_4\text{H}_6$	-13.5
Carbon dioxide	$\text{CO}_2$	-17.9
Carbon monoxide	CO	-11.1
Chlorine	$\text{Cl}_2$	-23.4
Chlorine dioxide	$\text{ClO}_2$	-27.8
Chlorobenzene	$\text{C}_6\text{H}_5\text{Cl}$	-30.6
2-Chloro-1,1'-biphenyl	$\text{C}_{12}\text{H}_9\text{Cl}$	-42.8
1-Chlorobutane	$\text{C}_4\text{H}_9\text{Cl}$	-28.2
2-Chlorobutane	$\text{C}_4\text{H}_9\text{Cl}$	-34.6
Chlorodibromomethane	$\text{CHBr}_2\text{Cl}$	-33.3
Chlorodifluoromethane	$\text{CHClF}_2$	-22.8
Chloroethane	$\text{C}_2\text{H}_5\text{Cl}$	-22.0
Chlorofluoromethane	$\text{CH}_2\text{ClF}$	-21.7
1-Chlorohexane	$\text{C}_6\text{H}_{13}\text{Cl}$	-34.5
Chloromethane	$\text{CH}_3\text{Cl}$	-20.2
1-Chloropentane	$\text{C}_5\text{H}_{11}\text{Cl}$	-34.1
3-Chlorophenol	$\text{C}_6\text{H}_5\text{ClO}$	-50.3
1-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	-27.0
2-Chloropyridine	$\text{C}_5\text{H}_4\text{ClN}$	-42.6
3-Chloropyridine	$\text{C}_5\text{H}_4\text{ClN}$	-46.2
2-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	-38.3
3-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	-37.0

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K
4-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	-33.3
<i>o</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	-64.8
<i>m</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	-58.7
<i>p</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	-61.3
Cycloheptanol	$\text{C}_7\text{H}_{14}\text{O}$	-74.6
Cyclohexane	$\text{C}_6\text{H}_{12}$	-30.0
<i>cis</i> -1,2-Cyclohexanediol	$\text{C}_6\text{H}_{12}\text{O}_2$	-82.4
Cyclohexanol	$\text{C}_6\text{H}_{12}\text{O}$	-70.7
Cyclohexanone	$\text{C}_6\text{H}_{10}\text{O}$	-49.8
Cyclohexene	$\text{C}_6\text{H}_{10}$	-27.3
Cyclooctane	$\text{C}_8\text{H}_{16}$	-39.0
<i>cis</i> -Cyclooctene	$\text{C}_8\text{H}_{14}$	-45.5
Cyclopentane	$\text{C}_5\text{H}_{10}$	-30.3
Cyclopentanol	$\text{C}_5\text{H}_{10}\text{O}$	-58.5
Cyclopentanone	$\text{C}_5\text{H}_8\text{O}$	-44.3
Cyclopropane	$\text{C}_3\text{H}_6$	-15.4
Dibromomethane	$\text{CH}_2\text{Br}_2$	-33.0
Dibutylamine	$\text{C}_8\text{H}_{19}\text{N}$	-59.3
Dibutyl ether	$\text{C}_8\text{H}_{18}\text{O}$	-55.8
<i>o</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	-37.3
<i>m</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	-35.3
<i>p</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	-28.4
2,3-Dichloro-1,1'-biphenyl	$\text{C}_{12}\text{H}_8\text{Cl}_2$	-45.6
2,4-Dichloro-1,1'-biphenyl	$\text{C}_{12}\text{H}_8\text{Cl}_2$	-43.0
2,4'-Dichloro-1,1'-biphenyl	$\text{C}_{12}\text{H}_8\text{Cl}_2$	-44.2
2,5-Dichlorobiphenyl	$\text{C}_{12}\text{H}_8\text{Cl}_2$	-45.6
Dichlorodifluoromethane	$\text{CCl}_2\text{F}_2$	-26.0
2,2-Dichloro-1,1-difluoro-1-methoxyethane	$\text{C}_3\text{H}_4\text{Cl}_2\text{F}_2\text{O}$	-30.4
1,1-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	-30.3
1,2-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	-27.9
1,1-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	-28.5
<i>cis</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	-26.9
<i>trans</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	-29.3
Dichloromethane	$\text{CH}_2\text{Cl}_2$	-30.3
1,2-Dichloropropane	$\text{C}_3\text{H}_6\text{Cl}_2$	-31.1
1,3-Dichloropropane	$\text{C}_3\text{H}_6\text{Cl}_2$	-29.7
1,2-Dichloro-1,1,2,2-tetrafluoroethane	$\text{C}_2\text{Cl}_2\text{F}_4$	-20.2
1,2-Diethoxyethane	$\text{C}_6\text{H}_{14}\text{O}_2$	-71.9
Diethylamine	$\text{C}_4\text{H}_{11}\text{N}$	-64.3
<i>N,N</i> -Diethylaniline	$\text{C}_{10}\text{H}_{15}\text{N}$	-45.7
<i>p</i> -Diethylbenzene	$\text{C}_{10}\text{H}_{14}$	-46.4
Diethylene glycol dimethyl ether	$\text{C}_6\text{H}_{14}\text{O}_3$	-96.2
Diethyl ether	$\text{C}_4\text{H}_{10}\text{O}$	-46.4
Diethyl sulfide	$\text{C}_4\text{H}_{10}\text{S}$	-40.2
1,1-Difluoroethane	$\text{C}_2\text{H}_4\text{F}_2$	-20.7
Difluoromethane	$\text{CH}_2\text{F}_2$	-17.2
Diiodomethane	$\text{CH}_2\text{I}_2$	-41.6
Diisopropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-51.7
1,2-Dimethoxyethane	$\text{C}_4\text{H}_{10}\text{O}_2$	-59.3

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K
Dimethylamine	$\text{C}_2\text{H}_7\text{N}$	-53.1
2,4-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-58.7
2,5-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-61.5
2,6-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-60.5
<i>N,N</i> -Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-49.6
2,3-Dimethylbutane	$\text{C}_6\text{H}_{14}$	-32.4
3,3-Dimethyl-2-butanone	$\text{C}_6\text{H}_{12}\text{O}$	-47.5
<i>cis</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-38.3
<i>trans</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-36.1
Dimethyl ether	$\text{C}_2\text{H}_6\text{O}$	-34.0
<i>N,N</i> -Dimethylformamide	$\text{C}_3\text{H}_7\text{NO}$	-62.9
2,4-Dimethyl-3-pentanone	$\text{C}_7\text{H}_{14}\text{O}$	-54.0
2,3-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-57.7
2,4-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-60.7
2,5-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-54.9
2,6-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-52.3
3,4-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-50.5
3,5-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-51.3
Dimethyl sulfide	$\text{C}_2\text{H}_6\text{S}$	-31.5
Dimethyl sulfoxide	$\text{C}_2\text{H}_6\text{OS}$	-71.9
2,5-Dimethyltetrahydrofuran	$\text{C}_6\text{H}_{12}\text{O}$	-56.3
1,4-Dioxane	$\text{C}_4\text{H}_8\text{O}_2$	-48.4
1,2-Dipropoxyethane	$\text{C}_8\text{H}_{18}\text{O}_2$	-76.8
Dipropylamine	$\text{C}_6\text{H}_{15}\text{N}$	-65.2
Dipropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-49.9
Dipropyl sulfide	$\text{C}_6\text{H}_{14}\text{S}$	-47.7
1-Dodecanol	$\text{C}_{12}\text{H}_{26}\text{O}$	-81.9
Ethane	$\text{C}_2\text{H}_6$	-17.9
1,2-Ethanediamine	$\text{C}_2\text{H}_8\text{N}_2$	-76.1
1,2-Ethandiol	$\text{C}_2\text{H}_6\text{O}_2$	-77.3
Ethanethiol	$\text{C}_2\text{H}_6\text{S}$	-28.9
Ethanol	$\text{C}_2\text{H}_6\text{O}$	-50.6
2-Ethoxyethanol	$\text{C}_4\text{H}_{10}\text{O}_2$	-66.4
1-Ethoxy-2-methoxyethane	$\text{C}_5\text{H}_{12}\text{O}_2$	-66.1
Ethyl acetate	$\text{C}_4\text{H}_8\text{O}_2$	-45.3
Ethylamine	$\text{C}_2\text{H}_7\text{N}$	-53.7
2-Ethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-59.7
4-Ethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	-65.0
Ethylbenzene	$\text{C}_8\text{H}_{10}$	-39.4
Ethyl butanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	-52.7
Ethylcyclohexane	$\text{C}_8\text{H}_{16}$	-36.8
Ethyl 2,2-dimethylpropanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-50.3
Ethylene	$\text{C}_2\text{H}_4$	-13.7
Ethyl formate	$\text{C}_3\text{H}_6\text{O}_2$	-38.1
Ethyl hexanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	-60.2
Ethyl 3-methylbutanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-56.0
Ethyl 2-methylbutanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-55.4
Ethyl 2-methylpropanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	-51.3
Ethyl pentanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-56.5
Ethyl propanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	-49.5
2-Ethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-55.7

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K
3-Ethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-53.5
4-Ethylpyridine	$\text{C}_7\text{H}_9\text{N}$	-52.2
9H-Fluorene	$\text{C}_{13}\text{H}_{10}$	-42.7
Fluorobenzene	$\text{C}_6\text{H}_5\text{F}$	-29.3
Fluoromethane	$\text{CH}_3\text{F}$	-16.1
Glycerol	$\text{C}_3\text{H}_8\text{O}_3$	-103.5
Helium	He	-0.67
1,1,1,2,3,3,3-Heptafluoropropane	$\text{C}_3\text{HF}_7$	-24.8
Heptanal	$\text{C}_7\text{H}_{14}\text{O}$	-56.6
Heptane	$\text{C}_7\text{H}_{16}$	-34.0
1-Heptanol	$\text{C}_7\text{H}_{16}\text{O}$	-72.1
2-Heptanol	$\text{C}_7\text{H}_{16}\text{O}$	-72.6
4-Heptanol	$\text{C}_7\text{H}_{16}\text{O}$	-75.3
2-Heptanone	$\text{C}_7\text{H}_{14}\text{O}$	-54.9
4-Heptanone	$\text{C}_7\text{H}_{14}\text{O}$	-58.1
1,1,1,3,3,3-Hexafluoro-2-propanol	$\text{C}_3\text{H}_2\text{F}_6\text{O}$	-57.1
Hexanal	$\text{C}_6\text{H}_{12}\text{O}$	-55.2
Hexane	$\text{C}_6\text{H}_{14}$	-31.9
Hexanedinitrile	$\text{C}_6\text{H}_8\text{N}_2$	-66.6
1-Hexanol	$\text{C}_6\text{H}_{14}\text{O}$	-67.4
3-Hexanol	$\text{C}_6\text{H}_{14}\text{O}$	-69.6
2-Hexanone	$\text{C}_6\text{H}_{12}\text{O}$	-48.9
3-Hexanone	$\text{C}_6\text{H}_{12}\text{O}$	-46.0
1-Hexene	$\text{C}_6\text{H}_{12}$	-30.4
Hexyl acetate	$\text{C}_8\text{H}_{16}\text{O}_2$	-60.8
Hexylamine	$\text{C}_6\text{H}_{15}\text{N}$	-65.9
Hexylbenzene	$\text{C}_{12}\text{H}_{18}$	-52.7
Hydrogen	$\text{H}_2$	-0.402
Hydrogen selenide	$\text{H}_2\text{Se}$	-15.7
Hydrogen sulfide	$\text{H}_2\text{S}$	-18.0
3-Hydroxybenzaldehyde	$\text{C}_7\text{H}_6\text{O}_2$	-70.7
3-Hydroxybenzonitrile	$\text{C}_7\text{H}_5\text{NO}$	-70.7
4-Hydroxybenzonitrile	$\text{C}_7\text{H}_5\text{NO}$	-70.3
Iodoethane	$\text{C}_2\text{H}_5\text{I}$	-31.7
Iodomethane	$\text{CH}_3\text{I}$	-28.2
1-Iodopropane	$\text{C}_3\text{H}_7\text{I}$	-35.3
2-Iodopropane	$\text{C}_3\text{H}_7\text{I}$	-36.6
Isobutanal	$\text{C}_4\text{H}_8\text{O}$	-40.0
Isobutane	$\text{C}_4\text{H}_{10}$	-21.7
Isobutene	$\text{C}_4\text{H}_8$	-22.7
Isobutyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	-51.8
Isobutyl formate	$\text{C}_5\text{H}_{10}\text{O}_2$	-43.0
Isobutyl isobutanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	-55.3
Isobutyl propanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-54.7
Isoflurane	$\text{C}_3\text{H}_2\text{ClF}_5\text{O}$	-35.3
Isopentyl acetate	$\text{C}_7\text{H}_{14}\text{O}_2$	-53.8
Isopentyl formate	$\text{C}_6\text{H}_{12}\text{O}_2$	-47.7
Isophorone	$\text{C}_9\text{H}_{14}\text{O}$	-59.1
Isopropyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	-46.8
Isopropylamine	$\text{C}_3\text{H}_9\text{N}$	-55.0
Isopropylbenzene	$\text{C}_9\text{H}_{12}$	-33.7

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K
Isopropyl formate	$\text{C}_4\text{H}_8\text{O}_2$	-43.0
1-Isopropyl-4-methylbenzene	$\text{C}_{10}\text{H}_{14}$	-34.6
Krypton	Kr	-15.6
Methane	$\text{CH}_4$	-12.0
Methanethiol	$\text{CH}_3\text{S}$	-24.4
Methanol	$\text{CH}_3\text{O}$	-52.0
2-Methoxyethanol	$\text{C}_3\text{H}_8\text{O}_2$	-60.4
2-Methoxy-2-methylbutane	$\text{C}_6\text{H}_{14}\text{O}$	-52.5
2-Methoxyphenol	$\text{C}_7\text{H}_8\text{O}_2$	-62.6
Methyl acetate	$\text{C}_3\text{H}_6\text{O}_2$	-40.1
Methylamine	$\text{CH}_5\text{N}$	-45.3
Methyl benzoate	$\text{C}_8\text{H}_8\text{O}_2$	-50.3
Methyl butanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	-47.5
3-Methyl-1-butanol	$\text{C}_5\text{H}_{12}\text{O}$	-66.0
2-Methyl-2-butanol	$\text{C}_5\text{H}_{12}\text{O}$	-68.4
3-Methyl-2-butanone	$\text{C}_5\text{H}_{10}\text{O}$	-57.6
2-Methyl-2-butene	$\text{C}_5\text{H}_{10}$	-26.6
Methyl <i>tert</i> -butyl ether	$\text{C}_5\text{H}_{12}\text{O}$	-48.7
Methyl 2,2-dimethylpropanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	-46.2
Methyl formate	$\text{C}_2\text{H}_4\text{O}_2$	-32.0
Methyl hexanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-54.7
Methyl isobutanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	-46.0
4-Methylmorpholine	$\text{C}_5\text{H}_{11}\text{NO}$	-68.7
1-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	-45.0
2-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	-44.9
2-Methylpentane	$\text{C}_6\text{H}_{14}$	-30.5
3-Methylpentane	$\text{C}_6\text{H}_{14}$	-36.8
Methyl pentanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	-50.4
4-Methyl-2-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	-69.9
4-Methyl-2-pentanone	$\text{C}_6\text{H}_{12}\text{O}$	-44.6
1-Methylpiperidine	$\text{C}_6\text{H}_{13}\text{N}$	-65.8
2-Methylpropanenitrile	$\text{C}_4\text{H}_7\text{N}$	-40.0
Methyl propanoate	$\text{C}_4\text{H}_8\text{O}_2$	-44.5
2-Methyl-1-propanol	$\text{C}_4\text{H}_{10}\text{O}$	-60.2
2-Methyl-2-propanol	$\text{C}_4\text{H}_{10}\text{O}$	-62.9
Methyl propyl ether	$\text{C}_4\text{H}_{10}\text{O}$	-38.0
2-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	-50.3
3-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	-50.3
4-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	-51.8
<i>N</i> -Methylpyrrolidine	$\text{C}_5\text{H}_{11}\text{N}$	-63.4
2-Methyltetrahydrofuran	$\text{C}_5\text{H}_{10}\text{O}$	-51.4
Morpholine	$\text{C}_4\text{H}_9\text{NO}$	-69.5
Naphthalene	$\text{C}_{10}\text{H}_8$	-42.8
Neon	Ne	-3.90
Neopentane	$\text{C}_5\text{H}_{12}$	-23.4
Nitric oxide	NO	-11.9
Nitrobenzene	$\text{C}_6\text{H}_5\text{NO}_2$	-43.8
Nitroethane	$\text{C}_2\text{H}_5\text{NO}_2$	-32.5
Nitrogen	$\text{N}_2$	-1.04
Nitromethane	$\text{CH}_3\text{NO}_2$	-35.7
2-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	-49.8

Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K	Name	Mol. Form.	$\Delta_{\text{hyd}}H^\circ/\text{kJ mol}^{-1}$ at 298.15 K
3-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	-67.7	Propylbenzene	$\text{C}_9\text{H}_{12}$	-36.4
4-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	-68.6	Propyl butanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	-54.9
1-Nitropropane	$\text{C}_3\text{H}_7\text{NO}_2$	-34.4	Propyl formate	$\text{C}_4\text{H}_8\text{O}_2$	-40.5
2-Nitropropane	$\text{C}_3\text{H}_7\text{NO}_2$	-34.1	Propyl propanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	-51.2
2-Nitrotoluene	$\text{C}_7\text{H}_7\text{NO}_2$	-46.4	Propyne	$\text{C}_3\text{H}_4$	-15.6
3-Nitrotoluene	$\text{C}_7\text{H}_7\text{NO}_2$	-38.5	Pyridine	$\text{C}_5\text{H}_5\text{N}$	-42.1
Nitrous oxide	$\text{N}_2\text{O}$	-19.8	Quinoline	$\text{C}_9\text{H}_7\text{N}$	-58.2
5-Nonanone	$\text{C}_9\text{H}_{18}\text{O}$	-62.8	Radon	Rn	-24.0
2-Nonanone	$\text{C}_9\text{H}_{18}\text{O}$	-65.3	Styrene	$\text{C}_8\text{H}_8$	-28.4
Octanal	$\text{C}_8\text{H}_{16}\text{O}$	-48.8	Succinonitrile	$\text{C}_4\text{H}_4\text{N}_2$	-58.2
Octane	$\text{C}_8\text{H}_{18}$	-36.0	Sulfur hexafluoride	$\text{F}_6\text{S}$	-20.7
1-Octanol	$\text{C}_8\text{H}_{18}\text{O}$	-74.1	1,2,3,4-Tetrachlorobenzene	$\text{C}_6\text{H}_2\text{Cl}_4$	-35.0
2-Octanone	$\text{C}_8\text{H}_{16}\text{O}$	-58.3	1,1,2,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	-34.8
1-Octene	$\text{C}_8\text{H}_{16}$	-39.2	1,1,1,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	-36.2
Octylamine	$\text{C}_8\text{H}_{19}\text{N}$	-52.3	Tetrachloroethene	$\text{C}_2\text{Cl}_4$	-41.5
Oxygen	$\text{O}_2$	-1.20	Tetrachloromethane	$\text{CCl}_4$	-30.5
Pentachlorobenzene	$\text{C}_6\text{HCl}_5$	-39.9	Tetraethylene glycol dimethyl ether	$\text{C}_{10}\text{H}_{22}\text{O}_5$	-126
Pentafluoroethane	$\text{C}_2\text{HF}_5$	-21.5	1,1,1,2-Tetrafluoroethane	$\text{C}_2\text{H}_2\text{F}_4$	-22.2
2,2,3,3,3-Pentafluoro-1-propanol	$\text{C}_3\text{H}_3\text{F}_5\text{O}$	-51.9	Tetrafluoroethene	$\text{C}_2\text{F}_4$	-15.1
Pentanal	$\text{C}_5\text{H}_{10}\text{O}$	-42.9	Tetrafluoromethane	$\text{CF}_4$	-13.5
Pentane	$\text{C}_5\text{H}_{12}$	-28.3	2,2,3,3-Tetrafluoro-1-propanol	$\text{C}_3\text{H}_4\text{F}_4\text{O}$	-57.9
1,5-Pentanediamine	$\text{C}_5\text{H}_{14}\text{N}_2$	-95.1	Tetrahydrofuran	$\text{C}_4\text{H}_8\text{O}$	-47.3
Pentanedinitrile	$\text{C}_5\text{H}_6\text{N}_2$	-63.5	Tetrahydropyran	$\text{C}_5\text{H}_{10}\text{O}$	-48.9
Pentanenitrile	$\text{C}_5\text{H}_9\text{N}$	-45.6	Thiophene	$\text{C}_4\text{H}_4\text{S}$	-29.9
1-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	-61.9	Toluene	$\text{C}_7\text{H}_8$	-32.4
2-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	-63.3	Tribromomethane	$\text{CHBr}_3$	-35.8
3-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	-59.6	1,2,3-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	-32.6
2-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	-45.3	1,3,5-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	-34.2
3-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	-49.6	1,1,1-Trichloroethane	$\text{C}_2\text{H}_3\text{Cl}_3$	-28.7
Pentyl acetate	$\text{C}_7\text{H}_{14}\text{O}_2$	-55.3	1,1,2-Trichloroethane	$\text{C}_2\text{H}_3\text{Cl}_3$	-32.5
Pentylamine	$\text{C}_5\text{H}_{13}\text{N}$	-62.1	Trichloroethene	$\text{C}_2\text{HCl}_3$	-32.2
Pentylbenzene	$\text{C}_{11}\text{H}_{16}$	-49.5	Trichlorofluoromethane	$\text{CCl}_3\text{F}$	-19.8
Pentyl formate	$\text{C}_6\text{H}_{12}\text{O}_2$	-48.1	Trichloromethane	$\text{CHCl}_3$	-33.5
Perfluoropropene	$\text{C}_3\text{F}_6$	-17.4	1,1,2-Trichloro-1,2,2-trifluoroethane	$\text{C}_2\text{Cl}_3\text{F}_3$	-28.8
Phenol	$\text{C}_6\text{H}_6\text{O}$	-57.7	Triethylamine	$\text{C}_6\text{H}_{15}\text{N}$	-69.7
1-Phenyl-1-propanone	$\text{C}_9\text{H}_{10}\text{O}$	-61.9	Triethylene glycol dimethyl ether	$\text{C}_8\text{H}_{18}\text{O}_4$	-102.4
Piperidine	$\text{C}_5\text{H}_{11}\text{N}$	-65.4	2,2,2-Trifluoroethanol	$\text{C}_2\text{H}_3\text{F}_3\text{O}$	-50.2
Propanal	$\text{C}_3\text{H}_6\text{O}$	-39.4	Trifluoromethane	$\text{CHF}_3$	-22.6
Propanamide	$\text{C}_3\text{H}_7\text{NO}$	-73.4	1,1,1-Trifluoro-2-propanol	$\text{C}_3\text{H}_5\text{F}_3\text{O}$	-53.5
Propane	$\text{C}_3\text{H}_8$	-20.4	Trimethylamine	$\text{C}_3\text{H}_9\text{N}$	-52.7
1,3-Propanediamine	$\text{C}_3\text{H}_{10}\text{N}_2$	-85.6	1,2,3-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-37.4
1,3-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	-81.1	1,2,4-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-36.6
Propanenitrile	$\text{C}_3\text{H}_5\text{N}$	-39.5	1,3,5-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-39.1
1-Propanethiol	$\text{C}_3\text{H}_8\text{S}$	-30.2	2,2,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	-31.0
Propanoic acid	$\text{C}_3\text{H}_6\text{O}_2$	-56.5	2,3,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	-38.5
1-Propanol	$\text{C}_3\text{H}_8\text{O}$	-59.9	Xenon	Xe	-19.4
2-Propanol	$\text{C}_3\text{H}_8\text{O}$	-58.2	<i>o</i> -Xylene	$\text{C}_8\text{H}_{10}$	-37.7
Propene	$\text{C}_3\text{H}_6$	-21.6	<i>m</i> -Xylene	$\text{C}_8\text{H}_{10}$	-38.6
2-Propoxyethanol	$\text{C}_5\text{H}_{12}\text{O}_2$	-69.6	<i>p</i> -Xylene	$\text{C}_8\text{H}_{10}$	-34.8
Propyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	-48.7			
Propylamine	$\text{C}_3\text{H}_9\text{N}$	-56.0			



# THERMOPHYSICAL PROPERTIES OF AIR

Eric W. Lemmon

These tables summarize the thermophysical properties of air in the liquid and gaseous states as calculated from the pseudo-pure fluid equation of state of Lemmon et al. (2000). The first table refers to liquid and gaseous air at equilibrium as a function of temperature. The tabulated properties are the bubble-point pressure (i.e., pressure at which boiling begins as the pressure of the liquid is lowered); the dew-point pressure (i.e., pressure at which condensation begins as the pressure of the gas is raised); density ( $\rho$ ); enthalpy ( $H$ ); entropy ( $S$ ); isochoric heat capacity ( $C_v$ ); isobaric heat capacity ( $C_p$ ); speed of sound ( $u$ ); viscosity ( $\eta$ ); and thermal conductivity ( $\lambda$ ). The first line of identical temperatures is the bubble-point (liquid) and the second line is the dew point (vapor). The normal boiling point of air, i.e., the temperature at which the bubble-point pressure reaches 1 standard atmosphere (1.01325 bar), is 78.90 K (−194.25 °C).

The second table gives the properties of air along various isobars. An entry with non-integer temperatures in the isobar section indicates a phase transition (liquid–vapor) at these temperatures; property values are then given for both phases. These are identi-

fied by the high densities in the liquid and the low densities in the vapor. Additional calculations at state points not listed below can be obtained by using the NIST program REFPROP (<http://www.nist.gov/srd/nist23.htm>).

## References

1. Lemmon, E.W., Jacobsen, R.T, Penoncello, S.G., and Friend, D.G., Thermodynamic Properties of Air and Mixtures of Nitrogen, Argon, and Oxygen from 60 to 2000 K at Pressures to 2000 MPa, *J. Phys. Chem. Ref. Data*, 29, 331, 2000.
2. Lemmon, E.W. and Jacobsen, R.T, Viscosity and Thermal Conductivity Equations for Nitrogen, Oxygen, Argon, and Air, *Int. J. Thermophys.*, 25, 21, 2004.
3. Lemmon, E.W., Huber, M.L., McLinden, M.O., NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 8.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, Maryland, 2007 ([www.nist.gov/srd/nist23.htm](http://www.nist.gov/srd/nist23.htm)).

## Thermophysical Properties of Air along the Boiling and Condensation Curves

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
59.75	0.005265	957.6	-36.66	-0.5306	1.174	1.901	1030.	376.6	171.4
59.75	0.002432	0.1421	185.5	3.340	0.7184	1.009	154.8	4.220	5.294
60	0.005546	956.5	-36.19	-0.5226	1.173	1.901	1028.	371.9	171.0
60	0.002584	0.1504	185.8	3.326	0.7186	1.009	155.1	4.238	5.320
62	0.008270	948.2	-32.38	-0.4603	1.157	1.901	1012.	336.9	167.8
62	0.004111	0.2318	187.7	3.225	0.7198	1.012	157.6	4.386	5.529
64	0.01200	939.9	-28.58	-0.3999	1.143	1.902	995.8	306.3	164.5
64	0.006325	0.3460	189.6	3.132	0.7212	1.015	160.0	4.532	5.739
66	0.01699	931.5	-24.77	-0.3414	1.129	1.903	979.1	279.4	161.3
66	0.009442	0.5018	191.5	3.047	0.7230	1.019	162.3	4.679	5.950
68	0.02352	923.0	-20.95	-0.2846	1.115	1.906	962.2	255.7	158.0
68	0.01371	0.7089	193.4	2.968	0.7252	1.024	164.5	4.825	6.162
70	0.03191	914.4	-17.13	-0.2293	1.102	1.908	945.1	234.8	154.7
70	0.01943	0.9785	195.2	2.896	0.7277	1.030	166.7	4.970	6.376
72	0.04250	905.7	-13.31	-0.1756	1.090	1.912	927.7	216.3	151.4
72	0.02692	1.322	197.0	2.828	0.7305	1.037	168.7	5.115	6.592
74	0.05566	897.0	-9.468	-0.1232	1.078	1.917	910.0	199.9	148.1
74	0.03655	1.753	198.7	2.766	0.7338	1.046	170.6	5.260	6.810
76	0.07179	888.1	-5.617	-0.07209	1.067	1.923	892.1	185.2	144.8
76	0.04870	2.285	200.4	2.708	0.7375	1.055	172.5	5.405	7.031
78	0.09129	879.1	-1.751	-0.02217	1.056	1.930	873.9	172.1	141.5
78	0.06381	2.933	202.0	2.653	0.7416	1.066	174.2	5.549	7.256
80	0.1146	870.0	2.132	0.02665	1.045	1.938	855.4	160.4	138.2
80	0.08232	3.711	203.6	2.602	0.7460	1.078	175.8	5.694	7.485
82	0.1422	860.7	6.036	0.07444	1.035	1.948	836.7	149.8	134.8
82	0.1047	4.635	205.1	2.554	0.7510	1.092	177.4	5.839	7.719
84	0.1745	851.3	9.962	0.1213	1.025	1.959	817.6	140.2	131.4
84	0.1315	5.724	206.5	2.509	0.7563	1.108	178.8	5.984	7.959
86	0.2121	841.7	13.91	0.1673	1.016	1.972	798.2	131.5	128.1
86	0.1631	6.993	207.8	2.466	0.7620	1.125	180.0	6.131	8.206
88	0.2553	832.0	17.90	0.2125	1.007	1.986	778.6	123.6	124.8
88	0.2002	8.464	209.1	2.425	0.7682	1.144	181.2	6.278	8.461

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
90	0.3048	822.0	21.91	0.2569	0.9984	2.003	758.5	116.4	121.4
90	0.2432	10.16	210.3	2.386	0.7748	1.166	182.2	6.427	8.725
92	0.3609	811.8	25.97	0.3007	0.9902	2.022	738.2	109.7	118.0
92	0.2927	12.09	211.4	2.349	0.7817	1.190	183.1	6.578	9.001
94	0.4243	801.4	30.06	0.3439	0.9825	2.044	717.5	103.6	114.6
94	0.3493	14.29	212.3	2.313	0.7891	1.217	183.8	6.732	9.289
96	0.4954	790.7	34.21	0.3866	0.9752	2.069	696.5	97.88	111.2
96	0.4136	16.78	213.2	2.279	0.7969	1.248	184.5	6.889	9.593
98	0.5749	779.7	38.41	0.4288	0.9684	2.098	675.0	92.57	107.8
98	0.4861	19.60	214.0	2.246	0.8052	1.282	184.9	7.050	9.915
100	0.6631	768.4	42.66	0.4707	0.9619	2.131	653.3	87.61	104.4
100	0.5674	22.76	214.6	2.213	0.8138	1.320	185.3	7.215	10.26
102	0.7608	756.7	46.98	0.5122	0.9560	2.168	631.1	82.94	101.0
102	0.6582	26.32	215.1	2.182	0.8230	1.363	185.5	7.387	10.63
104	0.8684	744.6	51.38	0.5535	0.9505	2.212	608.5	78.53	97.62
104	0.7590	30.31	215.5	2.151	0.8326	1.413	185.6	7.566	11.02
106	0.9864	732.1	55.86	0.5947	0.9456	2.262	585.5	74.35	94.25
106	0.8706	34.78	215.7	2.120	0.8429	1.470	185.5	7.754	11.46
108	1.116	719.1	60.44	0.6358	0.9412	2.321	562.1	70.36	90.89
108	0.9934	39.79	215.8	2.089	0.8537	1.536	185.2	7.952	11.94
110	1.256	705.5	65.12	0.6769	0.9375	2.390	538.2	66.54	87.55
110	1.128	45.41	215.6	2.059	0.8653	1.614	184.9	8.163	12.47
112	1.409	691.2	69.93	0.7182	0.9345	2.472	513.9	62.87	84.24
112	1.276	51.73	215.2	2.028	0.8777	1.708	184.3	8.391	13.07
114	1.575	676.2	74.87	0.7598	0.9324	2.571	489.0	59.31	80.96
114	1.437	58.84	214.6	1.997	0.8912	1.821	183.6	8.637	13.76
116	1.755	660.3	79.98	0.8019	0.9312	2.693	463.5	55.85	77.72
116	1.612	66.88	213.8	1.965	0.9059	1.961	182.7	8.909	14.56
118	1.948	643.4	85.29	0.8447	0.9312	2.847	437.3	52.47	74.52
118	1.801	76.04	212.6	1.932	0.9220	2.139	181.7	9.210	15.50
120	2.156	625.1	90.83	0.8885	0.9327	3.048	410.2	49.13	71.36
120	2.007	86.55	211.0	1.898	0.9402	2.374	180.4	9.552	16.63
122	2.379	605.3	96.66	0.9338	0.9363	3.323	382.0	45.81	68.24
122	2.229	98.76	208.9	1.861	0.9608	2.694	179.1	9.946	18.04
124	2.617	583.3	102.9	0.9811	0.9427	3.723	352.3	42.46	65.17
124	2.468	113.2	206.3	1.821	0.9847	3.157	177.5	10.41	19.85
126	2.872	558.3	109.7	1.032	0.9537	4.367	320.4	39.01	62.18
126	2.727	130.6	202.9	1.777	1.013	3.882	175.8	10.98	22.29
128	3.143	528.3	117.3	1.088	0.9728	5.589	285.0	35.33	59.44
128	3.006	152.6	198.3	1.725	1.049	5.166	174.0	11.72	25.84
130	3.429	488.3	126.7	1.157	1.010	8.849	243.7	31.07	58.05
130	3.308	182.7	191.7	1.660	1.096	8.033	171.9	12.77	31.81
132	3.723	411.2	142.6	1.273	1.117	35.04	189.1	24.47	67.80
132	3.646	235.4	179.7	1.556	1.168	20.65	169.4	14.80	47.00
132.63	3.785	302.6	164.5	1.437				17.83	

### Thermophysical Properties of Air along Various Isobars

$T$ K	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
$P = 0.1 \text{ MPa (1 bar)}$								
60	956.7	-36.11	-0.5230	1.173	1.901	1029.	372.4	171.1
78.79	875.5	-0.2237	-0.002818	1.051	1.933	866.7	167.4	140.2
81.61	4.442	204.8	2.563	0.7500	1.089	177.1	5.811	7.673
100	3.557	224.3	2.779	0.7282	1.040	198.2	7.107	9.469

$T$ K	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
120	2.938	244.9	2.966	0.7211	1.022	218.3	8.457	11.38
140	2.507	265.2	3.123	0.7184	1.014	236.4	9.750	13.24
160	2.188	285.5	3.258	0.7172	1.011	253.2	10.99	15.05
180	1.942	305.6	3.377	0.7166	1.008	268.8	12.18	16.80
200	1.746	325.8	3.483	0.7163	1.007	283.5	13.33	18.50
220	1.586	345.9	3.579	0.7163	1.006	297.4	14.44	20.16
240	1.453	366.0	3.667	0.7164	1.006	310.7	15.51	21.77
260	1.341	386.2	3.747	0.7168	1.006	323.4	16.55	23.35
280	1.245	406.3	3.822	0.7173	1.006	335.6	17.56	24.88
300	1.161	426.4	3.891	0.7181	1.007	347.4	18.54	26.38
320	1.089	446.5	3.956	0.7192	1.007	358.7	19.49	27.85
340	1.024	466.7	4.018	0.7206	1.009	369.6	20.41	29.29
360	0.9674	486.9	4.075	0.7223	1.010	380.3	21.32	30.71
380	0.9164	507.1	4.130	0.7243	1.012	390.5	22.20	32.09
400	0.8706	527.4	4.182	0.7266	1.014	400.5	23.06	33.45
500	0.6964	629.5	4.410	0.7426	1.030	446.4	27.09	39.94
600	0.5803	733.6	4.599	0.7641	1.051	487.1	30.77	46.01
700	0.4974	839.9	4.763	0.7879	1.075	523.9	34.18	51.76
800	0.4352	948.6	4.908	0.8117	1.099	557.8	37.37	57.25
900	0.3869	1060.	5.039	0.8340	1.121	589.6	40.39	62.54
1000	0.3482	1173.	5.158	0.8540	1.141	619.6	43.28	67.68

$P = 0.5$  MPa (5 bar)

60	957.3	-35.80	-0.5248	1.173	1.900	1031.	374.6	171.4
80	870.9	2.387	0.02430	1.046	1.934	858.5	161.4	138.6
96.12	790.0	34.46	0.3892	0.9748	2.071	695.2	97.55	111.0
98.36	20.14	214.1	2.240	0.8067	1.288	185.0	7.079	9.974
100	19.65	216.2	2.261	0.7967	1.261	187.4	7.192	10.10
120	15.48	239.6	2.475	0.7461	1.115	212.4	8.542	11.81
140	12.94	261.4	2.643	0.7311	1.068	232.8	9.834	13.58
160	11.17	282.5	2.784	0.7245	1.045	250.9	11.07	15.32
180	9.842	303.3	2.906	0.7213	1.032	267.4	12.26	17.04
200	8.811	323.8	3.014	0.7195	1.025	282.6	13.41	18.71
220	7.981	344.3	3.112	0.7186	1.020	297.0	14.51	20.34
240	7.297	364.6	3.200	0.7182	1.017	310.6	15.58	21.94
260	6.724	385.0	3.282	0.7182	1.015	323.5	16.62	23.50
280	6.235	405.2	3.357	0.7185	1.014	335.9	17.62	25.02
300	5.813	425.5	3.427	0.7191	1.013	347.8	18.60	26.51
320	5.446	445.8	3.492	0.7200	1.013	359.3	19.54	27.97
340	5.123	466.0	3.553	0.7213	1.013	370.3	20.47	29.41
360	4.836	486.3	3.611	0.7229	1.014	381.0	21.37	30.81
380	4.580	506.6	3.666	0.7248	1.016	391.3	22.24	32.19
400	4.350	526.9	3.718	0.7271	1.018	401.3	23.10	33.55
500	3.477	629.3	3.947	0.7429	1.032	447.3	27.13	40.02
600	2.897	733.5	4.137	0.7643	1.053	488.0	30.80	46.07
700	2.483	840.0	4.301	0.7881	1.076	524.8	34.20	51.80
800	2.173	948.8	4.446	0.8119	1.100	558.7	37.40	57.29
900	1.932	1060.	4.577	0.8341	1.122	590.5	40.42	62.58
1000	1.739	1173.	4.696	0.8542	1.142	620.4	43.30	67.71

$P = 1$  MPa (10 bar)

60	958.0	-35.42	-0.5271	1.174	1.898	1033.	377.2	171.7
80	872.2	2.720	0.02129	1.047	1.930	862.5	162.8	139.1
100	770.1	42.76	0.4673	0.9623	2.119	658.2	88.33	105.0
106.22	730.7	56.36	0.5992	0.9451	2.268	583.0	73.90	93.88
108.10	40.07	215.8	2.088	0.8543	1.540	185.2	7.963	11.96

$T$ K	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
120	33.48	232.3	2.233	0.7844	1.285	204.0	8.718	12.59
140	27.02	256.3	2.419	0.7481	1.148	228.2	9.978	14.11
160	22.94	278.7	2.568	0.7341	1.093	248.1	11.20	15.74
180	20.03	300.2	2.695	0.7273	1.065	265.7	12.38	17.38
200	17.83	321.3	2.806	0.7236	1.048	281.7	13.51	19.00
220	16.09	342.2	2.906	0.7216	1.038	296.6	14.61	20.60
240	14.68	362.9	2.996	0.7204	1.031	310.6	15.67	22.17
260	13.50	383.5	3.078	0.7199	1.026	323.8	16.70	23.70
280	12.50	403.9	3.154	0.7199	1.023	336.4	17.70	25.21
300	11.64	424.4	3.224	0.7203	1.021	348.4	18.67	26.68
320	10.90	444.8	3.290	0.7211	1.020	360.0	19.62	28.13
340	10.25	465.2	3.352	0.7222	1.019	371.1	20.54	29.55
360	9.668	485.6	3.410	0.7237	1.019	381.9	21.43	30.95
380	9.153	506.0	3.465	0.7255	1.020	392.3	22.31	32.32
400	8.690	526.4	3.518	0.7277	1.022	402.3	23.16	33.67
500	6.943	629.1	3.747	0.7434	1.034	448.5	27.18	40.11
600	5.784	733.5	3.937	0.7646	1.054	489.2	30.84	46.15
700	4.957	840.0	4.101	0.7884	1.077	526.0	34.24	51.87
800	4.338	948.9	4.247	0.8121	1.100	559.9	37.43	57.35
900	3.857	1060.	4.378	0.8343	1.122	591.5	40.45	62.63
1000	3.472	1173.	4.497	0.8543	1.142	621.5	43.33	67.75

 **$P = 2$  MPa (20 bar)**

60.11 <sup>a</sup>	959.1	-34.44	-0.5282	1.175	1.895	1037.	380.5	172.2
80	874.6	3.390	0.01535	1.048	1.921	870.2	165.5	140.1
100	775.0	43.09	0.4576	0.9636	2.086	672.5	90.43	106.6
118.52	638.8	86.69	0.8559	0.9314	2.894	430.4	51.60	73.71
119.94	86.20	211.0	1.899	0.9396	2.365	180.5	9.540	16.59
120	86.03	211.2	1.900	0.9382	2.354	180.7	9.542	16.57
140	59.88	244.8	2.161	0.7883	1.387	218.3	10.44	15.68
160	48.61	270.5	2.333	0.7545	1.213	242.7	11.55	16.80
180	41.54	294.0	2.471	0.7396	1.139	262.8	12.67	18.21
200	36.52	316.3	2.589	0.7319	1.100	280.3	13.77	19.69
220	32.70	338.0	2.692	0.7275	1.076	296.2	14.84	21.19
240	29.66	359.4	2.785	0.7249	1.060	310.8	15.88	22.68
260	27.18	380.5	2.870	0.7235	1.050	324.6	16.89	24.16
280	25.11	401.4	2.947	0.7228	1.042	337.6	17.88	25.62
300	23.34	422.2	3.019	0.7227	1.037	349.9	18.84	27.06
320	21.82	442.9	3.086	0.7231	1.033	361.7	19.77	28.47
340	20.49	463.5	3.148	0.7240	1.031	373.0	20.68	29.87
360	19.32	484.1	3.207	0.7253	1.030	383.9	21.57	31.24
380	18.27	504.7	3.263	0.7269	1.029	394.4	22.44	32.59
400	17.34	525.3	3.315	0.7290	1.029	404.5	23.29	33.93
500	13.84	628.6	3.546	0.7442	1.039	450.8	27.28	40.31
600	11.52	733.4	3.737	0.7653	1.057	491.5	30.93	46.30
700	9.878	840.2	3.902	0.7889	1.079	528.3	34.32	52.00
800	8.646	949.3	4.047	0.8125	1.102	562.1	37.49	57.46
900	7.689	1061.	4.178	0.8346	1.123	593.7	40.50	62.73
1000	6.923	1174.	4.298	0.8546	1.143	623.6	43.38	67.84

 **$P = 5$  MPa (50 bar)**

60.64 <sup>a</sup>	961.4	-31.10	-0.5246	1.176	1.886	1048.	386.2	173.3
80	881.7	5.437	-0.001766	1.054	1.898	892.1	173.5	143.0
100	788.3	44.27	0.4311	0.9681	2.009	710.6	96.44	111.1
120	665.1	87.67	0.8256	0.9194	2.429	496.8	57.06	79.02
140	321.3	172.5	1.467	1.049	8.515	199.5	19.25	43.18

$T$ K	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
160	151.4	240.7	1.930	0.8269	1.916	231.8	13.80	22.96
180	116.7	273.4	2.123	0.7785	1.453	258.2	14.14	22.02
200	97.93	300.6	2.267	0.7569	1.288	279.4	14.90	22.54
220	85.43	325.5	2.385	0.7451	1.205	297.7	15.77	23.49
240	76.25	349.0	2.488	0.7381	1.155	314.0	16.68	24.62
260	69.12	371.8	2.579	0.7338	1.123	328.8	17.60	25.83
280	63.36	394.0	2.661	0.7312	1.101	342.7	18.52	27.09
300	58.59	415.8	2.736	0.7297	1.085	355.6	19.42	28.39
320	54.55	437.4	2.806	0.7291	1.074	367.9	20.31	29.69
340	51.07	458.8	2.871	0.7292	1.065	379.6	21.18	30.98
360	48.05	480.1	2.932	0.7298	1.059	390.7	22.04	32.27
380	45.38	501.2	2.989	0.7310	1.055	401.4	22.88	33.55
400	43.01	522.3	3.043	0.7327	1.052	411.7	23.70	34.81
500	34.21	627.4	3.277	0.7466	1.052	458.3	27.61	40.97
600	28.48	733.2	3.470	0.7671	1.066	498.9	31.20	46.83
700	24.42	840.8	3.636	0.7903	1.085	535.4	34.55	52.43
800	21.39	950.4	3.782	0.8136	1.106	569.0	37.69	57.83
900	19.03	1062.	3.914	0.8356	1.127	600.3	40.68	63.04
1000	17.14	1176.	4.034	0.8554	1.146	629.9	43.54	68.12

$P = 10$  MPa (100 bar)

61.52 <sup>a</sup>	965.2	-25.55	-0.5187	1.177	1.871	1064.	395.1	175.0
80	892.4	8.950	-0.02831	1.063	1.868	925.2	186.8	147.5
100	806.9	46.73	0.3930	0.9767	1.924	763.5	105.8	117.8
120	706.1	86.65	0.7565	0.9192	2.094	591.1	67.00	89.01
140	573.7	132.1	1.106	0.8916	2.517	418.1	41.82	63.61
160	397.0	188.0	1.479	0.8787	2.882	297.6	24.99	43.38
180	273.3	238.0	1.774	0.8267	2.098	283.1	19.31	32.89
200	214.1	274.8	1.968	0.7908	1.646	296.3	18.16	29.63
220	179.9	305.4	2.114	0.7701	1.434	312.4	18.17	28.80
240	157.0	332.8	2.233	0.7574	1.317	328.0	18.60	28.89
260	140.2	358.3	2.336	0.7492	1.245	342.7	19.20	29.38
280	127.3	382.7	2.426	0.7439	1.196	356.5	19.90	30.15
300	116.9	406.3	2.507	0.7404	1.162	369.5	20.64	31.12
320	108.3	429.3	2.582	0.7383	1.138	381.8	21.40	32.15
340	101.0	451.8	2.650	0.7372	1.120	393.5	22.17	33.22
360	94.80	474.1	2.714	0.7369	1.106	404.6	22.95	34.33
380	89.36	496.1	2.773	0.7374	1.096	415.3	23.72	35.45
400	84.57	517.9	2.829	0.7384	1.088	425.6	24.49	36.58
500	67.06	625.7	3.070	0.7505	1.073	471.8	28.19	42.26
600	55.82	733.3	3.266	0.7699	1.080	511.9	31.67	47.84
700	47.90	842.0	3.433	0.7926	1.095	547.8	34.94	53.26
800	42.00	952.4	3.581	0.8155	1.113	580.8	38.04	58.52
900	37.42	1065.	3.713	0.8372	1.132	611.6	40.99	63.64
1000	33.75	1179.	3.833	0.8568	1.150	640.7	43.81	68.64

$P = 20$  MPa (200 bar)

63.24 <sup>a</sup>	972.3	-14.49	-0.5069	1.180	1.847	1094.	411.4	178.4
80	911.3	16.25	-0.07568	1.081	1.825	982.1	213.1	155.4
100	836.2	52.71	0.3311	0.9948	1.827	846.0	123.1	128.7
120	755.9	89.57	0.6670	0.9334	1.864	711.9	82.28	103.9
140	668.7	127.4	0.9589	0.8906	1.926	589.6	58.52	82.08
160	575.8	166.5	1.220	0.8606	1.977	491.8	43.00	65.18
180	484.9	206.0	1.452	0.8365	1.946	428.0	33.22	53.43
200	407.6	243.6	1.651	0.8143	1.808	397.2	27.80	46.02
220	348.5	278.1	1.815	0.7956	1.642	387.6	25.12	41.70

$T$ K	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
240	304.6	309.5	1.952	0.7812	1.506	388.7	23.92	39.30
260	271.5	338.6	2.068	0.7705	1.405	394.7	23.48	37.98
280	245.7	365.9	2.169	0.7627	1.331	402.8	23.47	37.46
300	225.0	392.0	2.259	0.7572	1.277	412.0	23.70	37.57
320	208.0	417.1	2.340	0.7532	1.236	421.5	24.08	37.94
340	193.7	441.5	2.414	0.7506	1.204	431.1	24.56	38.47
360	181.5	465.3	2.482	0.7491	1.180	440.6	25.10	39.13
380	170.9	488.7	2.546	0.7485	1.161	450.0	25.68	39.88
400	161.7	511.7	2.605	0.7486	1.146	459.2	26.29	40.69
500	128.3	624.0	2.856	0.7575	1.108	501.8	29.49	45.27
600	107.0	734.4	3.057	0.7753	1.103	539.5	32.69	50.19
700	92.10	845.1	3.227	0.7969	1.112	573.7	35.78	55.18
800	80.99	957.0	3.377	0.8191	1.126	605.2	38.75	60.13
900	72.34	1070.	3.510	0.8402	1.142	634.8	41.61	65.02
1000	65.41	1185.	3.631	0.8594	1.157	662.8	44.36	69.84
<b><math>P = 50</math> MPa (500 bar)</b>								
68.21 <sup>a</sup>	991.5	18.30	-0.4728	1.192	1.793	1173.	450.9	187.5
80	955.5	39.24	-0.1896	1.128	1.761	1112.	292.7	174.1
100	895.9	73.98	0.1982	1.043	1.715	1012.	171.6	152.8
120	837.8	107.9	0.5077	0.9811	1.680	920.9	118.9	133.2
140	781.1	141.2	0.7643	0.9342	1.649	839.4	90.60	115.9
160	726.2	173.9	0.9826	0.8983	1.619	770.2	72.86	101.0
180	673.9	205.9	1.171	0.8706	1.586	714.1	60.73	88.73
200	624.9	237.3	1.337	0.8488	1.549	670.6	52.14	79.05
220	579.8	267.9	1.482	0.8313	1.509	638.1	45.98	71.65
240	539.0	297.7	1.612	0.8171	1.467	614.7	41.60	66.11
260	502.4	326.6	1.728	0.8057	1.425	598.5	38.49	61.97
280	470.0	354.7	1.832	0.7964	1.385	588.0	36.32	58.99
300	441.2	382.0	1.926	0.7890	1.349	581.7	34.82	57.07
320	415.6	408.7	2.012	0.7832	1.316	578.4	33.83	55.77
340	392.9	434.7	2.091	0.7787	1.287	577.4	33.19	54.93
360	372.7	460.2	2.164	0.7754	1.262	578.1	32.82	54.41
380	354.6	485.2	2.232	0.7731	1.241	580.0	32.66	54.15
400	338.2	509.8	2.295	0.7717	1.223	582.9	32.64	54.07
500	276.1	629.0	2.561	0.7749	1.168	604.1	33.85	55.45
600	234.6	744.6	2.772	0.7890	1.148	629.5	36.00	58.34
700	204.6	859.2	2.948	0.8080	1.147	655.5	38.46	61.93
800	181.8	974.2	3.102	0.8285	1.154	681.0	41.00	65.86
900	163.8	1090.	3.238	0.8483	1.164	705.9	43.55	69.98
1000	149.2	1207.	3.362	0.8665	1.175	730.1	46.07	74.20

<sup>a</sup> Freezing point for the liquid state.

## FIXED POINT PROPERTIES OF H<sub>2</sub>O AND D<sub>2</sub>O

Temperatures are given on the IPTS-68 scale.

### References

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	Unit	H <sub>2</sub> O	D <sub>2</sub> O
Molar mass	g/mol	18.01528	20.02748
Melting point(101.325 kPa)	°C	0.00	3.82
Boiling point(101.325 kPa)	°C	100.00	101.42
Triple point temperature	°C	0.01	3.82
Triple point pressure	Pa	611.73	661
Triple point density(l)	g/cm <sup>3</sup>	0.99978	1.1055
Triple point density(g)	mg/L	4.885	5.75
Critical temperature	°C	373.99	370.74
Critical pressure	MPa	22.064	21.671
Critical density	g/cm <sup>3</sup>	0.322	0.356
Critical specific volume	cm <sup>3</sup> /g	3.11	2.81
Maximum density(saturated liquid)	g/cm <sup>3</sup>	0.99995	1.1053
Temperature of maximum density	°C	4.0	11.2

## THERMAL CONDUCTIVITY OF SATURATED H<sub>2</sub>O AND D<sub>2</sub>O

This table gives the thermal conductivity  $\lambda$  for water (H<sub>2</sub>O or D<sub>2</sub>O) in equilibrium with its vapor. Values for the liquid ( $\lambda_l$ ) and vapor ( $\lambda_v$ ) are listed, as well as the vapor pressure.

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t/°C	H <sub>2</sub> O			D <sub>2</sub> O		
	P/kPa	$\lambda_l$ / (mW/K m)	$\lambda_v$ / (mW/K m)	P/kPa	$\lambda_l$ / (mW/K m)	$\lambda_v$ / (mW/K m)
0	0.6	561.0	16.49			
10	1.2	580.0	17.21	1.0	575	17.0
20	2.3	598.4	17.95	2.0	589	17.8
30	4.2	615.4	18.70	3.7	600	18.5
40	7.4	630.5	19.48	6.5	610	19.3
50	12.3	643.5	20.28	11.1	618	20.2
60	19.9	654.3	21.10	18.2	625	21.0
70	31.2	663.1	21.96	28.8	629	21.9
80	47.4	670.0	22.86	44.2	633	22.8
90	70.1	675.3	23.80	66.1	635	23.8
100	101.3	679.1	24.79	96.2	636	24.8
150	476	682.1	30.77	465	625	30.8
200	1555	663.4	39.10	1546	592	39.0
250	3978	621.4	51.18	3995	541	52.0
300	8593	547.7	71.78	8688	473	75.2
350	16530	447.6	134.59	16820	391	143.0

## STANDARD DENSITY OF WATER

This table gives the density  $\rho$  of water in the temperature range from 0°C to 100°C at a pressure of 101325 Pa (one standard atmosphere). From 0°C to 40°C the values are taken from the IUPAC publication in Reference 1 and refer to standard mean ocean water (SMOW), free from dissolved salts and gases. SMOW is a standard water sample of high purity and known isotopic composition. Methods of correcting for different isotopic compositions are discussed in Reference 1. The remaining values are taken from the NIST Chemistry WebBook, Reference 2.

Note that the IUPAC values refer to the IPTS-68 temperature scale, while the NIST values are based on the ITS-90 scale (where the normal boiling point is 99.974°C). The conversion between these scales can be found in Sec. 1. The difference between the scales leads to a difference in the density of water of about 20 ppm in the neighborhood of 100°C and much less at lower temperatures.

$t/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$
0.1	0.9998493	4.3	0.9999742	8.5	0.9998189	12.7	0.9994167	16.9	0.9987942
0.2	0.9998558	4.4	0.9999736	8.6	0.9998121	12.8	0.9994043	17.0	0.9987769
0.3	0.9998622	4.5	0.9999728	8.7	0.9998051	12.9	0.9993918	17.1	0.9987595
0.4	0.9998683	4.6	0.9999719	8.8	0.9997980	13.0	0.9993792	17.2	0.9987419
0.5	0.9998743	4.7	0.9999709	8.9	0.9997908	13.1	0.9993665	17.3	0.9987243
0.6	0.9998801	4.8	0.9999696	9.0	0.9997834	13.2	0.9993536	17.4	0.9987065
0.7	0.9998857	4.9	0.9999683	9.1	0.9997759	13.3	0.9993407	17.5	0.9986886
0.8	0.9998912	5.0	0.9999668	9.2	0.9997682	13.4	0.9993276	17.6	0.9986706
0.9	0.9998964	5.1	0.9999651	9.3	0.9997604	13.5	0.9993143	17.7	0.9986525
1.0	0.9999015	5.2	0.9999632	9.4	0.9997525	13.6	0.9993010	17.8	0.9986343
1.1	0.9999065	5.3	0.9999612	9.5	0.9997444	13.7	0.9992875	17.9	0.9986160
1.2	0.9999112	5.4	0.9999591	9.6	0.9997362	13.8	0.9992740	18.0	0.9985976
1.3	0.9999158	5.5	0.9999568	9.7	0.9997279	13.9	0.9992602	18.1	0.9985790
1.4	0.9999202	5.6	0.9999544	9.8	0.9997194	14.0	0.9992464	18.2	0.9985604
1.5	0.9999244	5.7	0.9999518	9.9	0.9997108	14.1	0.9992325	18.3	0.9985416
1.6	0.9999284	5.8	0.9999490	10.0	0.9997021	14.2	0.9992184	18.4	0.9985228
1.7	0.9999323	5.9	0.9999461	10.1	0.9996932	14.3	0.9992042	18.5	0.9985038
1.8	0.9999360	6.0	0.9999430	10.2	0.9996842	14.4	0.9991899	18.6	0.9984847
1.9	0.9999395	6.1	0.9999398	10.3	0.9996751	14.5	0.9991755	18.7	0.9984655
2.0	0.9999429	6.2	0.9999365	10.4	0.9996658	14.6	0.9991609	18.8	0.9984462
2.1	0.9999461	6.3	0.9999330	10.5	0.9996564	14.7	0.9991463	18.9	0.9984268
2.2	0.9999491	6.4	0.9999293	10.6	0.9996468	14.8	0.9991315	19.0	0.9984073
2.3	0.9999519	6.5	0.9999255	10.7	0.9996372	14.9	0.9991166	19.1	0.9983877
2.4	0.9999546	6.6	0.9999216	10.8	0.9996274	15.0	0.9991016	19.2	0.9983680
2.5	0.9999571	6.7	0.9999175	10.9	0.9996174	15.1	0.9990864	19.3	0.9983481
2.6	0.9999595	6.8	0.9999132	11.0	0.9996074	15.2	0.9990712	19.4	0.9983282
2.7	0.9999616	6.9	0.9999088	11.1	0.9995972	15.3	0.9990558	19.5	0.9983081
2.8	0.9999636	7.0	0.9999043	11.2	0.9995869	15.4	0.9990403	19.6	0.9982880
2.9	0.9999655	7.1	0.9998996	11.3	0.9995764	15.5	0.9990247	19.7	0.9982677
3.0	0.9999672	7.2	0.9998948	11.4	0.9995658	15.6	0.9990090	19.8	0.9982474
3.1	0.9999687	7.3	0.9998898	11.5	0.9995551	15.7	0.9989932	19.9	0.9982269
3.2	0.9999700	7.4	0.9998847	11.6	0.9995443	15.8	0.9989772	20.0	0.9982063
3.3	0.9999712	7.5	0.9998794	11.7	0.9995333	15.9	0.9989612	20.1	0.9981856
3.4	0.9999722	7.6	0.9998740	11.8	0.9995222	16.0	0.9989450	20.2	0.9981649
3.5	0.9999731	7.7	0.9998684	11.9	0.9995110	16.1	0.9989287	20.3	0.9981440
3.6	0.9999738	7.8	0.9998627	12.0	0.9994996	16.2	0.9989123	20.4	0.9981230
3.7	0.9999743	7.9	0.9998569	12.1	0.9994882	16.3	0.9988957	20.5	0.9981019
3.8	0.9999747	8.0	0.9998509	12.2	0.9994766	16.4	0.9988791	20.6	0.9980807
3.9	0.9999749	8.1	0.9998448	12.3	0.9994648	16.5	0.9988623	20.7	0.9980594
4.0	0.9999750	8.2	0.9998385	12.4	0.9994530	16.6	0.9988455	20.8	0.9980380
4.1	0.9999748	8.3	0.9998321	12.5	0.9994410	16.7	0.9988285	20.9	0.9980164
4.2	0.9999746	8.4	0.9998256	12.6	0.9994289	16.8	0.9988114	21.0	0.9979948

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$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$	$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$
21.1	0.9979731	26.1	0.9967604	31.1	0.9953139	36.1	0.9936531	51.0	0.98758
21.2	0.9979513	26.2	0.9967337	31.2	0.9952827	36.2	0.9936178	52.0	0.98712
21.3	0.9979294	26.3	0.9967069	31.3	0.9952514	36.3	0.9935825	53.0	0.98665
21.4	0.9979073	26.4	0.9966800	31.4	0.9952201	36.4	0.9935470	54.0	0.98617
21.5	0.9978852	26.5	0.9966530	31.5	0.9951887	36.5	0.9935115	55.0	0.98569
21.6	0.9978630	26.6	0.9966259	31.6	0.9951572	36.6	0.9934759	56.0	0.98521
21.7	0.9978406	26.7	0.9965987	31.7	0.9951255	36.7	0.9934403	57.0	0.98471
21.8	0.9978182	26.8	0.9965714	31.8	0.9950939	36.8	0.9934045	58.0	0.98421
21.9	0.9977957	26.9	0.9965441	31.9	0.9950621	36.9	0.9933687	59.0	0.98371
22.0	0.9977730	27.0	0.9965166	32.0	0.9950302	37.0	0.9933328	60.0	0.98320
22.1	0.9977503	27.1	0.9964891	32.1	0.9949983	37.1	0.9932968	61.0	0.98268
22.2	0.9977275	27.2	0.9964615	32.2	0.9949663	37.2	0.9932607	62.0	0.98216
22.3	0.9977045	27.3	0.9964337	32.3	0.9949342	37.3	0.9932246	63.0	0.98163
22.4	0.9976815	27.4	0.9964059	32.4	0.9949020	37.4	0.9931884	64.0	0.98109
22.5	0.9976584	27.5	0.9963780	32.5	0.9948697	37.5	0.9931521	65.0	0.98055
22.6	0.9976351	27.6	0.9963500	32.6	0.9948373	37.6	0.9931157	66.0	0.98000
22.7	0.9976118	27.7	0.9963219	32.7	0.9948049	37.7	0.9930793	67.0	0.97945
22.8	0.9975883	27.8	0.9962938	32.8	0.9947724	37.8	0.9930428	68.0	0.97890
22.9	0.9975648	27.9	0.9962655	32.9	0.9947397	37.9	0.9930062	69.0	0.97833
23.0	0.9975412	28.0	0.9962371	33.0	0.9947071	38.0	0.9929695	70.0	0.97776
23.1	0.9975174	28.1	0.9962087	33.1	0.9946743	38.1	0.9929328	71.0	0.97719
23.2	0.9974936	28.2	0.9961801	33.2	0.9946414	38.2	0.9928960	72.0	0.97661
23.3	0.9974697	28.3	0.9961515	33.3	0.9946085	38.3	0.9928591	73.0	0.97603
23.4	0.9974456	28.4	0.9961228	33.4	0.9945755	38.4	0.9928221	74.0	0.97544
23.5	0.9974215	28.5	0.9960940	33.5	0.9945423	38.5	0.9927850	75.0	0.97484
23.6	0.9973973	28.6	0.9960651	33.6	0.9945092	38.6	0.9927479	76.0	0.97424
23.7	0.9973730	28.7	0.9960361	33.7	0.9944759	38.7	0.9927107	77.0	0.97364
23.8	0.9973485	28.8	0.9960070	33.8	0.9944425	38.8	0.9926735	78.0	0.97303
23.9	0.9973240	28.9	0.9959778	33.9	0.9944091	38.9	0.9926361	79.0	0.97241
24.0	0.9972994	29.0	0.9959486	34.0	0.9943756	39.0	0.9925987	80.0	0.97179
24.1	0.9972747	29.1	0.9959192	34.1	0.9943420	39.1	0.9925612	81.0	0.97116
24.2	0.9972499	29.2	0.9958898	34.2	0.9943083	39.2	0.9925236	82.0	0.97053
24.3	0.9972250	29.3	0.9958603	34.3	0.9942745	39.3	0.9924860	83.0	0.96990
24.4	0.9972000	29.4	0.9958306	34.4	0.9942407	39.4	0.9924483	84.0	0.96926
24.5	0.9971749	29.5	0.9958009	34.5	0.9942068	39.5	0.9924105	85.0	0.96861
24.6	0.9971497	29.6	0.9957712	34.6	0.9941728	39.6	0.9923726	86.0	0.96796
24.7	0.9971244	29.7	0.9957413	34.7	0.9941387	39.7	0.9923347	87.0	0.96731
24.8	0.9970990	29.8	0.9957113	34.8	0.9941045	39.8	0.9922966	88.0	0.96664
24.9	0.9970735	29.9	0.9956813	34.9	0.9940703	39.9	0.9922586	89.0	0.96598
25.0	0.9970480	30.0	0.9956511	35.0	0.9940359	40.0	0.9922204	90.0	0.96531
25.1	0.9970223	30.1	0.9956209	35.1	0.9940015	41.0	0.99183	91.0	0.96463
25.2	0.9969965	30.2	0.9955906	35.2	0.9939671	42.0	0.99144	92.0	0.96396
25.3	0.9969707	30.3	0.9955602	35.3	0.9939325	43.0	0.99104	93.0	0.96327
25.4	0.9969447	30.4	0.9955297	35.4	0.9938978	44.0	0.99063	94.0	0.96258
25.5	0.9969186	30.5	0.9954991	35.5	0.9938631	45.0	0.99021	95.0	0.96189
25.6	0.9968925	30.6	0.9954685	35.6	0.9938283	46.0	0.98979	96.0	0.96119
25.7	0.9968663	30.7	0.9954377	35.7	0.9937934	47.0	0.98936	97.0	0.96049
25.8	0.9968399	30.8	0.9954069	35.8	0.9937585	48.0	0.98893	98.0	0.95978
25.9	0.9968135	30.9	0.9953760	35.9	0.9937234	49.0	0.98848	99.0	0.95907
26.0	0.9967870	31.0	0.9953450	36.0	0.9936883	50.0	0.98804	99.974	0.95837

# VOLUMETRIC PROPERTIES OF AQUEOUS SODIUM CHLORIDE SOLUTIONS

This table gives the following properties of aqueous solutions of NaCl as a function of temperature and concentration:

All data refer to a pressure of 100 kPa (1 bar). The reference gives properties over a wider range of temperature and pressure.

Specific volume  $v$  (reciprocal of density) in  $\text{cm}^3/\text{g}$   
 Isothermal compressibility  $\kappa_T = -(1/v)(\partial v/\partial P)_T$  in  $\text{GPa}^{-1}$   
 Cubic expansion coefficient  $\alpha_v = (1/v)(\partial v/\partial T)_P$  in  $\text{kK}^{-1}$

## Reference

Rogers, P. S. Z., and Pitzer, K. S., *J. Phys. Chem. Ref. Data*, 11, 15, 1982.

$t/^\circ\text{C}$	Molality in mol/kg								
	0.100	0.250	0.500	0.750	1.000	2.000	3.000	4.000	5.000
<b>Specific volume <math>v</math> in <math>\text{cm}^3/\text{g}</math></b>									
0	0.995732	0.989259	0.978889	0.968991	0.959525	0.925426	0.896292	0.870996	0.848646
10	0.995998	0.989781	0.979804	0.970256	0.961101	0.927905	0.899262	0.874201	0.851958
20	0.997620	0.991564	0.981833	0.972505	0.963544	0.930909	0.902565	0.877643	0.855469
25	0.998834	0.992832	0.983185	0.973932	0.965038	0.932590	0.904339	0.879457	0.857301
30	1.000279	0.994319	0.984735	0.975539	0.966694	0.934382	0.906194	0.881334	0.859185
40	1.003796	0.997883	0.988374	0.979243	0.970455	0.938287	0.910145	0.885276	0.863108
50	1.008064	1.002161	0.992668	0.983551	0.974772	0.942603	0.914411	0.889473	0.867241
60	1.0130	1.0071	0.9976	0.9885	0.9797	0.9474	0.9191	0.8940	0.8716
70	1.0186	1.0127	1.0031	0.9939	0.9851	0.9526	0.9240	0.8987	0.8762
80	1.0249	1.0188	1.0092	0.9999	0.9909	0.9581	0.9293	0.9037	0.8809
90	1.0317	1.0256	1.0157	1.0063	0.9972	0.9640	0.9348	0.9089	0.8858
100	1.0391	1.0329	1.0228	1.0133	1.0040	0.9703	0.9406	0.9144	0.8910
<b>Isothermal Compressibility <math>\kappa_T</math> in <math>\text{GPa}^{-1}</math></b>									
0	0.503	0.492	0.475	0.459	0.443	0.389	0.346	0.315	0.294
10	0.472	0.463	0.449	0.436	0.423	0.377	0.341	0.313	0.294
20	0.453	0.446	0.433	0.422	0.411	0.371	0.338	0.313	0.294
25	0.447	0.440	0.428	0.417	0.407	0.369	0.337	0.313	0.294
30	0.443	0.436	0.425	0.414	0.404	0.367	0.337	0.313	0.294
40	0.438	0.432	0.421	0.411	0.401	0.367	0.338	0.315	0.296
50	0.438	0.431	0.421	0.411	0.402	0.369	0.340	0.317	0.299
60	0.44	0.44	0.43	0.42	0.41	0.38	0.35	0.32	0.30
70	0.45	0.44	0.43	0.42	0.42	0.38	0.36	0.33	0.31
80	0.46	0.45	0.44	0.43	0.43	0.39	0.37	0.34	0.32
90	0.47	0.47	0.46	0.45	0.44	0.41	0.38	0.35	0.33
100	0.49	0.48	0.47	0.46	0.45	0.42	0.39	0.37	0.34
<b>Cubic expansion coefficient <math>\alpha_v</math> in <math>\text{kK}^{-1}</math></b>									
0	-0.058	-0.026	0.024	0.069	0.110	0.237	0.313	0.355	
10	0.102	0.123	0.156	0.186	0.213	0.297	0.349	0.380	
20	0.218	0.232	0.254	0.274	0.292	0.349	0.384	0.406	
25	0.267	0.278	0.296	0.312	0.327	0.373	0.401	0.420	
30	0.311	0.320	0.334	0.347	0.359	0.395	0.418	0.433	
40	0.389	0.394	0.402	0.410	0.417	0.438	0.451	0.460	
50	0.458	0.460	0.464	0.467	0.470	0.479	0.484	0.486	
60	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	
70	0.58	0.58	0.58	0.57	0.57	0.56	0.55	0.54	
80	0.64	0.63	0.63	0.62	0.61	0.60	0.58	0.56	
90	0.69	0.68	0.67	0.67	0.66	0.63	0.61	0.59	
100	0.74	0.73	0.72	0.71	0.70	0.66	0.64	0.61	

## VAPOR PRESSURE OF ICE

The values of the vapor (sublimation) pressure of ice in this table were calculated from the equation recommended by the International Association for the Properties of Steam (IAPS) in 1993. Temperature values correspond to the ITS-90 temperature scale. The uncertainty in the pressure is estimated to be 0.1% for  $t > -25^{\circ}\text{C}$  and 0.5% for  $t < -25^{\circ}\text{C}$ . The first entry in the table is the triple point of water.

### Reference

Wagner, W., Saul, A., and Pruss, A., *J. Phys. Chem. Ref. Data*, 23, 515, 1994.

$t/^{\circ}\text{C}$	$p/\text{Pa}$	$t/^{\circ}\text{C}$	$p/\text{Pa}$	$t/^{\circ}\text{C}$	$p/\text{Pa}$
0.01	611.657	-16	150.68	-33	27.71
0	611.15	-17	137.25	-34	24.90
-1	562.67	-18	124.92	-35	22.35
-2	517.72	-19	113.62	-36	20.04
-3	476.06	-20	103.26	-37	17.96
-4	437.47	-21	93.77	-38	16.07
-5	401.76	-22	85.10	-39	14.37
-6	368.73	-23	77.16	-40	12.84
-7	338.19	-24	69.91	-45	7.202
-8	309.98	-25	63.29	-50	3.936
-9	283.94	-26	57.25	-55	2.093
-10	259.90	-27	51.74	-60	1.080
-11	237.74	-28	46.73	-65	0.540
-12	217.32	-29	42.16	-70	0.261
-13	198.52	-30	38.01	-75	0.122
-14	181.22	-31	34.24	-80	0.055
-15	165.30	-32	30.82		

# VAPOR PRESSURE AND OTHER SATURATION PROPERTIES OF WATER

Eric W. Lemmon

This table summarizes the vapor pressure, enthalpy (heat) of vaporization, and surface tension of water as accepted by the International Association for the Properties of Water and Steam ([www.iapws.org](http://www.iapws.org)) for general and scientific use. The vapor pressure and heat of vaporization are calculated from the equation of state of Wagner and Pruss (Ref. 1). The temperature scale is ITS-90. Additional calculations at state points not listed below can be obtained by using the NIST Standard Reference Data program REFPROP ([www.nist.gov/srd/nist23.htm](http://www.nist.gov/srd/nist23.htm)) or the water-specific program Steam ([www.nist.gov/srd/nist10.htm](http://www.nist.gov/srd/nist10.htm)).

## References

1. Wagner, W. and Pruss, A., The IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use, *J. Phys. Chem. Ref. Data*, 31, 387, 2002.
2. International Association for the Properties of Water and Steam, Release on the surface tension of ordinary water substance, Physical Chemistry of Aqueous Systems: Proceedings of the 12th International Conference on the Properties of Water and Steam, Orlando, Florida, September 11–16, 1994, pp. A139–A142.

$t$ °C	$P$ kPa	$\Delta_{\text{vap}}H$ kJ kg <sup>-1</sup>	Surf. Ten. mN m <sup>-1</sup>	$t$ °C	$P$ kPa	$\Delta_{\text{vap}}H$ kJ kg <sup>-1</sup>	Surf. Ten. mN m <sup>-1</sup>
0.01	0.61165	2500.9	75.65	80	47.414	2308.0	62.67
2	0.70599	2496.2	75.37	82	51.387	2302.9	62.31
4	0.81355	2491.4	75.08	84	55.635	2297.9	61.94
6	0.93536	2486.7	74.80	86	60.173	2292.8	61.56
8	1.0730	2481.9	74.51	88	65.017	2287.6	61.19
10	1.2282	2477.2	74.22	90	70.182	2282.5	60.82
12	1.4028	2472.5	73.93	92	75.684	2277.3	60.44
14	1.5990	2467.7	73.63	94	81.541	2272.1	60.06
16	1.8188	2463.0	73.34	96	87.771	2266.9	59.68
18	2.0647	2458.3	73.04	98	94.390	2261.7	59.30
20	2.3393	2453.5	72.74	100	101.42	2256.4	58.91
22	2.6453	2448.8	72.43	102	108.87	2251.1	58.53
24	2.9858	2444.0	72.13	104	116.78	2245.8	58.14
25	3.1699	2441.7	71.97	106	125.15	2240.4	57.75
26	3.3639	2439.3	71.82	108	134.01	2235.1	57.36
28	3.7831	2434.6	71.51	110	143.38	2229.6	56.96
30	4.2470	2429.8	71.19	112	153.28	2224.2	56.57
32	4.7596	2425.1	70.88	114	163.74	2218.7	56.17
34	5.3251	2420.3	70.56	116	174.77	2213.2	55.77
36	5.9479	2415.5	70.24	118	186.41	2207.7	55.37
38	6.6328	2410.8	69.92	120	198.67	2202.1	54.97
40	7.3849	2406.0	69.60	122	211.59	2196.5	54.56
42	8.2096	2401.2	69.27	124	225.18	2190.9	54.16
44	9.1124	2396.4	68.94	126	239.47	2185.2	53.75
46	10.099	2391.6	68.61	128	254.50	2179.5	53.34
48	11.177	2386.8	68.28	130	270.28	2173.7	52.93
50	12.352	2381.9	67.94	132	286.85	2167.9	52.52
52	13.631	2377.1	67.61	134	304.23	2162.1	52.11
54	15.022	2372.3	67.27	136	322.45	2156.2	51.69
56	16.533	2367.4	66.93	138	341.54	2150.3	51.27
58	18.171	2362.5	66.58	140	361.54	2144.3	50.86
60	19.946	2357.7	66.24	142	382.47	2138.3	50.44
62	21.867	2352.8	65.89	144	404.37	2132.2	50.01
64	23.943	2347.8	65.54	146	427.26	2126.1	49.59
66	26.183	2342.9	65.19	148	451.18	2119.9	49.17
68	28.599	2338.0	64.84	150	476.16	2113.7	48.74
70	31.201	2333.0	64.48	152	502.25	2107.5	48.31
72	34.000	2328.1	64.12	154	529.46	2101.2	47.89
74	37.009	2323.1	63.76	156	557.84	2094.8	47.46
76	40.239	2318.1	63.40	158	587.42	2088.4	47.02
78	43.703	2313.0	63.04	160	618.23	2082.0	46.59

$t$ °C	$P$ kPa	$\Delta_{\text{vap}}H$ kJ kg <sup>-1</sup>	Surf. Ten. mN m <sup>-1</sup>	$t$ °C	$P$ kPa	$\Delta_{\text{vap}}H$ kJ kg <sup>-1</sup>	Surf. Ten. mN m <sup>-1</sup>
162	650.33	2075.5	46.16	270	5503.0	1604.4	21.34
164	683.73	2068.9	45.72	272	5677.2	1592.5	20.87
166	718.48	2062.3	45.28	274	5855.6	1580.4	20.40
168	754.62	2055.6	44.85	276	6038.3	1568.1	19.93
170	792.19	2048.8	44.41	278	6225.2	1555.6	19.46
172	831.22	2042.0	43.97	280	6416.6	1543.0	18.99
174	871.76	2035.1	43.52	282	6612.4	1530.1	18.53
176	913.84	2028.2	43.08	284	6812.8	1517.1	18.06
178	957.51	2021.2	42.64	286	7017.7	1503.8	17.59
180	1002.8	2014.2	42.19	288	7227.4	1490.4	17.13
182	1049.8	2007.0	41.74	290	7441.8	1476.7	16.66
184	1098.5	1999.8	41.30	292	7661.0	1462.7	16.20
186	1148.9	1992.6	40.85	294	7885.2	1448.6	15.74
188	1201.1	1985.3	40.40	296	8114.3	1434.2	15.28
190	1255.2	1977.9	39.95	298	8348.5	1419.5	14.82
192	1311.2	1970.4	39.49	300	8587.9	1404.6	14.36
194	1369.1	1962.8	39.04	302	8832.5	1389.4	13.90
196	1429.0	1955.2	38.59	304	9082.4	1374.0	13.45
198	1490.9	1947.5	38.13	306	9337.8	1358.2	12.99
200	1554.9	1939.7	37.67	308	9598.6	1342.1	12.54
202	1621.0	1931.9	37.22	310	9865.1	1325.7	12.09
204	1689.3	1923.9	36.76	312	10137.	1309.0	11.64
206	1759.8	1915.9	36.30	314	10415.	1291.9	11.19
208	1832.6	1907.8	35.84	316	10699.	1274.5	10.75
210	1907.7	1899.6	35.38	318	10989.	1256.6	10.30
212	1985.1	1891.4	34.92	320	11284.	1238.4	9.86
214	2065.0	1883.0	34.46	322	11586.	1219.7	9.43
216	2147.3	1874.6	33.99	324	11895.	1200.6	8.99
218	2232.2	1866.0	33.53	326	12209.	1180.9	8.56
220	2319.6	1857.4	33.07	328	12530.	1160.8	8.13
222	2409.6	1848.6	32.60	330	12858.	1140.2	7.70
224	2502.3	1839.8	32.14	332	13193.	1118.9	7.28
226	2597.8	1830.9	31.67	334	13534.	1097.1	6.86
228	2696.0	1821.8	31.20	336	13882.	1074.6	6.44
230	2797.1	1812.7	30.74	338	14238.	1051.3	6.03
232	2901.0	1803.5	30.27	340	14601.	1027.3	5.63
234	3008.0	1794.1	29.80	342	14971.	1002.5	5.22
236	3117.9	1784.7	29.33	344	15349.	976.7	4.83
238	3230.8	1775.1	28.86	346	15734.	949.9	4.43
240	3346.9	1765.4	28.39	348	16128.	922.0	4.05
242	3466.2	1755.6	27.92	350	16529.	892.7	3.67
244	3588.7	1745.7	27.45	352	16939.	862.1	3.29
246	3714.5	1735.6	26.98	354	17358.	829.8	2.93
248	3843.6	1725.5	26.51	356	17785.	795.5	2.57
250	3976.2	1715.2	26.04	358	18221.	759.0	2.22
252	4112.2	1704.7	25.57	360	18666.	719.8	1.88
254	4251.8	1694.2	25.10	362	19121.	677.3	1.55
256	4394.9	1683.5	24.63	364	19585.	630.5	1.23
258	4541.7	1672.6	24.16	366	20060.	578.2	0.93
260	4692.3	1661.6	23.69	368	20546.	517.8	0.65
262	4846.6	1650.5	23.22	370	21044.	443.8	0.39
264	5004.7	1639.2	22.75	372	21554.	340.3	0.16
266	5166.8	1627.8	22.28	373.95	22064.	0.0	0.0
268	5332.9	1616.2	21.81				

## MELTING POINT OF ICE AS A FUNCTION OF PRESSURE

This table gives values of the melting temperature of ice at various pressures, as calculated from the equation for the ice I - liquid water phase boundary recommended by the International Association for the Properties of Steam (IAPS). Temperatures are on the ITS-90 scale. See the Reference for information on forms of ice that exist at higher pressures. The transition points for transformations of the various forms of ice (in each case in equilibrium with liquid water) are:

ice I - ice III	209.9 MPa	-21.985 °C
ice III - ice V	350.1	-16.986
ice V - ice VI	632.4	0.16
ice VI - ice VII	2216	82

### Reference

Wagner, W., Saul, A., and Pruss, A., *J. Phys. Chem. Ref. Data*, 23, 515, 1994.

$p/\text{MPa}$	$t/^\circ\text{C}$	$p/\text{MPa}$	$t/^\circ\text{C}$	$p/\text{MPa}$	$t/^\circ\text{C}$
0.1	0.00	40	-3.15	130	-12.07
1	-0.06	50	-4.02	140	-13.22
2	-0.14	60	-4.91	150	-14.40
3	-0.21	70	-5.83	160	-15.62
4	-0.29	80	-6.79	170	-16.85
5	-0.36	90	-7.78	180	-18.11
10	-0.74	100	-8.80	190	-19.39
20	-1.52	110	-9.86	200	-20.69
30	-2.32	120	-10.95	210	-22.00

# THERMOPHYSICAL PROPERTIES OF WATER AND STEAM

Eric W. Lemmon

These tables summarize the thermophysical properties of water and steam at equilibrium as accepted by the International Association for the Properties of Water and Steam ([www.iapws.org](http://www.iapws.org)) for general and scientific use. The thermodynamic properties are calculated from the equation of state of Wagner and Pruss (Ref. 6). The reference state for these tables is the liquid at the triple point, at which the internal energy and entropy are taken as zero. These tables refer to states at 1 bar (100 kPa) pressure with temperatures in °C in the first section; liquid and gaseous states at equilibrium as a function of temperature in the second section; and properties along isobars in the third section. The tabulated properties are pressure ( $P$ ), density ( $\rho$ ), enthalpy ( $H$ ), entropy ( $S$ ), isochoric heat capacity ( $C_v$ ), isobaric heat capacity ( $C_p$ ), speed of sound ( $u$ ), viscosity ( $\eta$ ), thermal conductivity ( $\lambda$ ), and static dielectric constant ( $D$ ). In the saturation tables, the first line of identical temperatures is for the liquid state and the second line is for the vapor state. A duplicate entry in the isobar section indicates a phase transition (liquid-vapor) at that temperature; property values are then given for both phases. These are identified by the high densities in the liquid and the low densities in the vapor. The temperature scale is ITS-90. Additional calculations at state points not listed below can be obtained by using the NIST Standard Reference Data program REFPROP (Ref. 5) or the water-specific program Steam (Ref. 2).

## References

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6. Wagner, W. and Pruss, A., The IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use, *J. Phys. Chem. Ref. Data*, 31, 387, 2002.

$T$ °C	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ µPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b><math>P = 0.1</math> MPa (1 bar)</b>										
0.01	0.1	999.84	0.10186	0.000007	4.2170	4.2194	1402.4	87.899	1791.1	561.09
10	0.1	999.70	42.118	0.15108	4.1906	4.1952	1447.3	83.974	1305.9	580.05
20	0.1	998.21	84.006	0.29646	4.1567	4.1841	1482.3	80.223	1001.6	598.46
25	0.1	997.05	104.92	0.36720	4.1376	4.1813	1496.7	78.408	890.02	607.19
30	0.1	995.65	125.82	0.43673	4.1172	4.1798	1509.2	76.634	797.22	615.50
40	0.1	992.22	167.62	0.57237	4.0734	4.1794	1528.9	73.201	652.73	630.63
50	0.1	988.03	209.42	0.70377	4.0262	4.1813	1542.6	69.916	546.52	643.59
60	0.1	983.20	251.25	0.83125	3.9765	4.1850	1551.0	66.774	466.03	654.39
70	0.1	977.76	293.12	0.95509	3.9251	4.1901	1554.7	63.770	403.55	663.13
80	0.1	971.79	335.05	1.0755	3.8728	4.1968	1554.4	60.898	354.05	670.01
90	0.1	965.31	377.06	1.1928	3.8204	4.2052	1550.4	58.152	314.17	675.27
99.606	0.1	958.63	417.50	1.3028	3.7702	4.2152	1543.5	55.628	282.75	678.97
99.606	0.1	0.59034	2674.9	7.3588	1.5548	2.0784	471.99	1.0058	12.218	25.053
100	0.1	0.58967	2675.8	7.3610	1.5535	2.0766	472.28	1.0058	12.234	25.079
<b>Saturation</b>										
0.01	0.000612	999.79	0.000612	0.0	4.2174	4.2199	1402.3	87.895	1791.4	561.04
0.01	0.000612	0.0048546	2500.9	9.1555	1.4184	1.8844	409.00	1.00006	8.9458	17.071
10	0.0012282	999.65	42.021	0.15109	4.1910	4.1955	1447.1	83.971	1306.0	580.00
10	0.0012282	0.0094071	2519.2	8.8998	1.4269	1.8947	416.17	1.00012	9.2384	17.621
20	0.0023393	998.16	83.914	0.29648	4.1570	4.1844	1482.2	80.219	1001.6	598.42
20	0.0023393	0.017314	2537.4	8.6660	1.4359	1.9059	423.18	1.00021	9.5441	18.227
25	0.0031699	997.00	104.83	0.36722	4.1379	4.1816	1496.5	78.405	890.04	607.15
25	0.0031699	0.023075	2546.5	8.5566	1.4405	1.9118	426.63	1.00028	9.7009	18.550
30	0.0042470	995.61	125.73	0.43675	4.1175	4.1801	1509.0	76.630	797.22	615.46
30	0.0042470	0.030415	2555.5	8.4520	1.4452	1.9180	430.03	1.00036	9.8602	18.887
40	0.0073849	992.18	167.53	0.57240	4.0737	4.1796	1528.7	73.197	652.72	630.58

$T$ °C	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
40	0.0073849	0.051242	2573.5	8.2555	1.4552	1.9314	436.71	1.00059	10.185	19.599
50	0.012352	988.00	209.34	0.70381	4.0264	4.1815	1542.4	69.913	546.50	643.55
50	0.012352	0.083147	2591.3	8.0748	1.4663	1.9468	443.21	1.00094	10.516	20.365
60	0.019946	983.16	251.18	0.83129	3.9767	4.1851	1550.8	66.772	466.02	654.35
60	0.019946	0.13043	2608.8	7.9081	1.4789	1.9648	449.50	1.0014	10.854	21.187
70	0.031201	977.73	293.07	0.95513	3.9252	4.1902	1554.6	63.768	403.53	663.09
70	0.031201	0.19843	2626.1	7.7540	1.4937	1.9862	455.57	1.0021	11.195	22.068
80	0.047414	971.77	335.01	1.0756	3.8729	4.1969	1554.3	60.896	354.04	669.99
80	0.047414	0.29367	2643.0	7.6111	1.5111	2.0120	461.39	1.0030	11.539	23.011
90	0.070182	965.30	377.04	1.1929	3.8204	4.2053	1550.4	58.151	314.17	675.25
90	0.070182	0.42390	2659.5	7.4781	1.5316	2.0429	466.94	1.0043	11.885	24.019
100	0.10142	958.35	419.17	1.3072	3.7682	4.2157	1543.2	55.527	281.58	679.09
100	0.10142	0.59817	2675.6	7.3541	1.5558	2.0800	472.20	1.0059	12.232	25.096
100	0.10142	958.35	419.17	1.3072	3.7682	4.2157	1543.2	55.527	281.58	679.09
100	0.10142	0.59817	2675.6	7.3541	1.5558	2.0800	472.20	1.0059	12.232	25.096
120	0.19867	943.11	503.81	1.5279	3.6662	4.2435	1519.9	50.620	232.03	683.19
120	0.19867	1.1221	2705.9	7.1291	1.6177	2.1770	481.73	1.0105	12.927	27.467
140	0.36154	926.13	589.16	1.7392	3.5694	4.2826	1486.2	46.131	196.64	683.30
140	0.36154	1.9667	2733.4	6.9293	1.7002	2.3109	489.82	1.0177	13.618	30.140
160	0.61823	907.45	675.47	1.9426	3.4788	4.3354	1443.2	42.018	170.43	679.96
160	0.61823	3.2596	2757.4	6.7491	1.8044	2.4883	496.29	1.0282	14.304	33.131
180	1.0028	887.00	763.05	2.1392	3.3949	4.4050	1391.7	38.235	150.38	673.32
180	1.0028	5.1588	2777.2	6.5840	1.9279	2.7129	501.04	1.0431	14.985	36.449
200	1.5549	864.66	852.27	2.3305	3.3179	4.4958	1332.1	34.742	134.58	663.31
200	1.5549	7.8610	2792.0	6.4302	2.0666	2.9895	503.92	1.0636	15.666	40.113
220	2.3196	840.22	943.58	2.5177	3.2479	4.6146	1264.5	31.495	121.77	649.65
220	2.3196	11.615	2800.9	6.2840	2.2172	3.3289	504.77	1.0915	16.354	44.170
240	3.3469	813.37	1037.6	2.7020	3.1850	4.7719	1189.0	28.455	111.06	631.85
240	3.3469	16.749	2803.0	6.1423	2.3794	3.7537	503.32	1.1292	17.062	48.729
260	4.6923	783.63	1135.0	2.8849	3.1301	4.9856	1105.3	25.580	101.81	609.24
260	4.6923	23.712	2796.6	6.0016	2.5555	4.3075	499.21	1.1802	17.810	54.035
280	6.4166	750.28	1236.9	3.0685	3.0849	5.2889	1012.6	22.824	93.550	581.15
280	6.4166	33.165	2779.9	5.8579	2.7503	5.0731	491.93	1.2505	18.630	60.622
300	8.5879	712.14	1345.0	3.2552	3.0530	5.7504	909.40	20.135	85.855	547.43
300	8.5879	46.168	2749.6	5.7059	2.9708	6.2197	480.73	1.3504	19.580	69.667
320	11.284	667.09	1462.2	3.4494	3.0428	6.5373	793.16	17.440	78.310	509.21
320	11.284	64.638	2700.6	5.5372	3.2276	8.1589	464.43	1.5012	20.773	83.944
340	14.601	610.67	1594.5	3.6601	3.0781	8.2080	658.27	14.606	70.331	468.55
340	14.601	92.759	2621.8	5.3356	3.5430	12.236	440.72	1.7555	22.477	111.00
360	18.666	527.59	1761.7	3.9167	3.2972	15.004	479.74	11.225	60.306	425.77
360	18.666	143.90	2481.5	5.0536	4.0068	27.356	402.37	2.3096	25.638	181.77
373.95	22.064	322.00	2084.3	4.4070				5.3606	79.791	

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b><math>P = 0.1</math> MPa (1 bar)</b>										
273.16	0.1	999.84	0.10186	0.000007	4.2170	4.2194	1402.4	87.899	1791.1	561.09
280	0.1	999.91	28.894	0.10411	4.1998	4.2009	1434.3	85.192	1433.6	574.09
300	0.1	996.56	112.65	0.39306	4.1302	4.1806	1501.5	77.747	853.74	610.32
320	0.1	989.43	196.25	0.66281	4.0414	4.1805	1538.9	70.935	576.73	639.75
340	0.1	979.54	279.93	0.91646	3.9414	4.1883	1554.0	64.702	421.63	660.58
360	0.1	967.40	363.82	1.1562	3.8369	4.2023	1552.1	59.004	325.86	673.78
372.756	0.1	958.63	417.50	1.3028	3.7702	4.2152	1543.5	55.628	282.75	678.97
372.756	0.1	0.59034	2674.9	7.3588	1.5548	2.0784	471.99	1.0058	12.218	25.053
380	0.1	0.57824	2689.9	7.3986	1.5356	2.0507	477.08	1.0056	12.498	25.546



<i>T</i> K	<i>P</i> MPa	$\rho$ kg m <sup>-3</sup>	<i>H</i> kJ kg <sup>-1</sup>	<i>S</i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>C<sub>v</sub></i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>C<sub>p</sub></i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>u</i> m s <sup>-1</sup>	<i>D</i>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
400	0.1	0.54761	2730.4	7.5025	1.5082	2.0078	490.31	1.0051	13.278	27.008
450	0.1	0.48458	2829.7	7.7365	1.4943	1.9752	520.60	1.0040	15.267	31.168
500	0.1	0.43514	2928.6	7.9447	1.5082	1.9813	548.31	1.0033	17.299	35.861
550	0.1	0.39507	3028.1	8.1344	1.5319	2.0010	574.19	1.0027	19.356	40.953
600	0.1	0.36185	3128.8	8.3096	1.5600	2.0268	598.61	1.0023	21.425	46.367
650	0.1	0.33384	3230.8	8.4730	1.5903	2.0557	621.79	1.0020	23.496	52.049
700	0.1	0.30988	3334.4	8.6264	1.6222	2.0867	643.92	1.0017	25.562	57.964
750	0.1	0.28915	3439.5	8.7715	1.6553	2.1191	665.11	1.0015	27.617	64.083
800	0.1	0.27102	3546.3	8.9093	1.6892	2.1525	685.47	1.0013	29.657	70.385
900	0.1	0.24085	3765.0	9.1668	1.7589	2.2216	724.03	1.0011	33.680	83.466
1000	0.1	0.21673	3990.7	9.4045	1.8297	2.2921	760.17	1.00088	37.615	97.085
1100	0.1	0.19701	4223.4	9.6263	1.9000	2.3621	794.33	1.00074	41.453	111.15
1200	0.1	0.18058	4463.0	9.8348	1.9682	2.4302	826.85	1.00063	45.192	125.58

**P = 1 MPa (10 bar)**

273.16	1.0	1000.3	1.0180	0.000066	4.2127	4.2150	1403.9	87.937	1789.1	561.59
280	1.0	1000.3	29.783	0.10407	4.1960	4.1973	1435.7	85.228	1432.5	574.54
300	1.0	996.96	113.48	0.39281	4.1272	4.1781	1503.0	77.781	853.66	610.73
320	1.0	989.82	197.03	0.66242	4.0390	4.1784	1540.5	70.967	576.89	640.16
340	1.0	979.93	280.67	0.91594	3.9395	4.1863	1555.7	64.734	421.86	661.02
360	1.0	967.81	364.52	1.1556	3.8353	4.2004	1553.9	59.035	326.10	674.24
380	1.0	953.74	448.73	1.3832	3.7315	4.2220	1538.4	53.827	262.82	681.49
400	1.0	937.87	533.47	1.6005	3.6315	4.2535	1511.3	49.065	218.82	684.10
450	1.0	890.39	749.20	2.1086	3.4076	4.3924	1400.6	38.814	153.23	674.64
453.028	1.0	887.13	762.52	2.1381	3.3954	4.4045	1392.0	38.258	150.49	673.37
453.028	1.0	5.1450	2777.1	6.5850	1.9271	2.7114	501.02	1.0430	14.981	36.428
500	1.0	4.5323	2891.2	6.8250	1.6699	2.2795	535.74	1.0344	17.054	38.799
550	1.0	4.0581	3001.8	7.0359	1.6159	2.1647	565.75	1.0282	19.215	42.798
600	1.0	3.6871	3109.0	7.2224	1.6098	2.1292	592.58	1.0236	21.349	47.636
650	1.0	3.3843	3215.2	7.3925	1.6227	2.1254	617.34	1.0202	23.462	53.002
700	1.0	3.1305	3321.7	7.5504	1.6447	2.1368	640.55	1.0174	25.555	58.735
750	1.0	2.9140	3429.0	7.6984	1.6715	2.1566	662.53	1.0153	27.628	64.745
800	1.0	2.7265	3537.5	7.8384	1.7014	2.1816	683.48	1.0135	29.680	70.983
900	1.0	2.4174	3758.5	8.0986	1.7663	2.2402	722.85	1.0108	33.716	84.000
1000	1.0	2.1723	3985.7	8.3380	1.8346	2.3048	759.50	1.0088	37.655	97.573
1100	1.0	1.9729	4219.5	8.5608	1.9034	2.3713	794.01	1.0074	41.494	111.57
1200	1.0	1.8074	4460.0	8.7699	1.9708	2.4371	826.77	1.0063	45.231	125.89

**P = 10 MPa (100 bar)**

273.16	10.0	1004.8	10.111	0.00049	4.1721	4.1726	1418.4	88.311	1770.0	566.56
280	10.0	1004.7	38.613	0.10355	4.1593	4.1622	1450.3	85.588	1422.2	579.06
300	10.0	1001.0	121.73	0.39029	4.0984	4.1536	1518.2	78.113	852.99	614.81
320	10.0	993.70	204.84	0.65846	4.0157	4.1580	1556.4	71.284	578.57	644.31
340	10.0	983.84	288.08	0.91079	3.9205	4.1672	1572.6	65.044	424.17	665.40
360	10.0	971.85	371.56	1.1493	3.8198	4.1810	1572.0	59.345	328.53	678.93
380	10.0	957.99	455.37	1.3759	3.7188	4.2013	1558.0	54.140	265.22	686.53
400	10.0	942.42	539.67	1.5921	3.6210	4.2302	1532.7	49.385	221.17	689.57
450	10.0	896.16	753.94	2.0967	3.4010	4.3553	1428.4	39.172	155.48	681.51
500	10.0	838.02	977.18	2.5669	3.2211	4.6022	1271.3	30.794	119.83	651.64
550	10.0	761.82	1218.8	3.0270	3.0865	5.1407	1054.6	23.531	96.080	592.51
584.147	10.0	688.42	1408.1	3.3606	3.0438	6.1237	847.33	18.660	81.718	526.84
584.147	10.0	55.463	2725.5	5.6160	3.1065	7.1408	472.51	1.4248	20.194	76.569
600	10.0	49.773	2820.0	5.7756	2.6239	5.1365	503.34	1.3649	21.017	71.115
650	10.0	40.479	3022.6	6.1009	2.1103	3.3968	562.10	1.2672	23.472	67.341
700	10.0	35.355	3177.4	6.3305	1.9338	2.8741	602.20	1.2145	25.773	69.297
750	10.0	31.810	3314.6	6.5200	1.8625	2.6452	634.58	1.1793	27.973	73.331

$T$ K	$P$ MPa	$\rho$ $\text{kg m}^{-3}$	$H$ $\text{kJ kg}^{-1}$	$S$ $\text{kJ kg}^{-1} \text{K}^{-1}$	$C_v$ $\text{kJ kg}^{-1} \text{K}^{-1}$	$C_p$ $\text{kJ kg}^{-1} \text{K}^{-1}$	$u$ $\text{m s}^{-1}$	$D$	$\eta$ $\mu\text{Pa s}$	$\lambda$ $\text{mW m}^{-1} \text{K}^{-1}$
800	10.0	29.107	3443.7	6.6867	1.8367	2.5313	662.61	1.1536	30.101	78.476
900	10.0	25.123	3691.6	6.9787	1.8439	2.4458	710.98	1.1182	34.201	90.516
1000	10.0	22.241	3935.5	7.2357	1.8843	2.4397	753.03	1.0948	38.144	103.50
1100	10.0	20.017	4180.6	7.4693	1.9377	2.4661	791.02	1.0782	41.960	116.73
1200	10.0	18.230	4429.2	7.6855	1.9957	2.5070	826.16	1.0659	45.663	130.00
<b><math>P = 100 \text{ MPa (1000 bar)}</math></b>										
273.16	100.0	1045.3	95.444	-0.0083717	3.8761	3.9053	1575.5	91.834	1660.1	612.20
280	100.0	1043.6	122.26	0.088571	3.8869	3.9328	1603.8	88.976	1367.4	621.51
300	100.0	1037.2	201.44	0.36171	3.8751	3.9798	1667.9	81.216	859.19	654.50
320	100.0	1028.9	281.30	0.61941	3.8289	4.0043	1707.7	74.222	599.18	684.86
340	100.0	1019.0	361.55	0.86265	3.7637	4.0194	1728.7	67.891	448.03	707.90
360	100.0	1007.8	442.05	1.0927	3.6883	4.0309	1735.4	62.150	352.49	724.05
380	100.0	995.37	522.79	1.3110	3.6089	4.0427	1730.9	56.937	288.37	734.91
400	100.0	981.82	603.78	1.5187	3.5293	4.0569	1717.3	52.201	243.33	741.80
450	100.0	943.51	807.84	1.9993	3.3430	4.1105	1652.8	42.149	175.71	745.40
500	100.0	899.21	1015.4	2.4366	3.1820	4.1968	1555.7	34.149	139.57	730.42
550	100.0	848.78	1228.2	2.8421	3.0452	4.3234	1435.5	27.667	117.36	696.87
600	100.0	791.49	1448.6	3.2256	2.9295	4.5019	1300.4	22.290	101.85	645.83
650	100.0	726.21	1679.5	3.5952	2.8329	4.7503	1158.6	17.717	89.647	580.63
700	100.0	651.77	1925.0	3.9589	2.7538	5.0832	1020.0	13.754	79.123	510.19
750	100.0	568.52	2188.5	4.3223	2.6866	5.4492	898.84	10.336	69.732	433.71
800	100.0	482.23	2466.5	4.6811	2.6169	5.6108	813.97	7.5622	61.842	351.53
900	100.0	343.61	3000.1	5.3104	2.4386	4.8879	765.30	4.2835	52.771	257.05
1000	100.0	265.45	3440.1	5.7749	2.2950	3.9788	792.50	2.9559	50.506	232.07
1100	100.0	220.62	3809.8	6.1276	2.2276	3.4715	832.67	2.3472	51.089	223.70
1200	100.0	191.53	4142.5	6.4172	2.2098	3.2098	872.28	2.0111	52.802	219.07

## PERMITTIVITY (DIELECTRIC CONSTANT) OF WATER AT VARIOUS FREQUENCIES

The permittivity of liquid water in the radiofrequency and microwave regions can be represented by the Debye equation (References 1 and 2):

$$\epsilon' = \epsilon_{\infty} + \frac{\epsilon_s - \epsilon_{\infty}}{1 + \omega^2 \tau^2}$$

$$\epsilon'' = \frac{(\epsilon_s - \epsilon_{\infty}) \omega \tau}{1 + \omega^2 \tau^2}$$

where  $\epsilon = \epsilon' + i \epsilon''$  is the (complex) relative permittivity (i.e., the absolute permittivity divided by the permittivity of free space  $\epsilon_0 = 8.854 \cdot 10^{-12} \text{ F m}^{-1}$ ). Here  $\epsilon_s$  is the static permittivity (see Reference 3 and the table "Thermophysical Properties of Water and Steam" in this Section);  $\epsilon_{\infty}$  is a parameter describing the permittivity in the high frequency limit;  $\tau$  is the relaxation time for molecular orientation; and  $\omega = 2\pi f$  is the angular frequency. The values in this table have been calculated from parameters given in Reference 2:

	0 °C	25 °C	50 °C
$\epsilon_{\infty}$	5.7	5.2	4.0
$\tau/\text{ps}$	17.67	8.27	4.75

Other useful quantities that can be calculated from the values in the table are the loss tangent:

$$\tan \delta = \epsilon'' / \epsilon'$$

and the absorption coefficient  $\alpha$  which describes the power attenuation per unit length ( $P = P_0 e^{-\alpha l}$ ):

$$\alpha = \frac{\pi f \epsilon''}{c \sqrt{\epsilon'}}$$

and  $c$  is the speed of light. The last equation is valid when  $\epsilon''/\epsilon' \ll 1$ .

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Frequency	0 °C		25 °C		50 °C	
	$\epsilon'$	$\epsilon''$	$\epsilon'$	$\epsilon''$	$\epsilon'$	$\epsilon''$
0	87.90	0.00	78.36	0.00	69.88	0.00
1 kHz	87.90	0.00	78.36	0.00	69.88	0.00
1 MHz	87.90	0.01	78.36	0.00	69.88	0.00
10 MHz	87.90	0.09	78.36	0.04	69.88	0.02
100 MHz	87.89	0.91	78.36	0.38	69.88	0.20
200 MHz	87.86	1.82	78.35	0.76	69.88	0.39
500 MHz	87.65	4.55	78.31	1.90	69.87	0.98
1 GHz	86.90	9.01	78.16	3.79	69.82	1.96
2 GHz	84.04	17.39	77.58	7.52	69.65	3.92
3 GHz	79.69	24.64	76.62	11.13	69.36	5.85
4 GHz	74.36	30.49	75.33	14.58	68.95	7.75
5 GHz	68.54	34.88	73.73	17.81	68.45	9.62
10 GHz	42.52	40.88	62.81	29.93	64.49	18.05
20 GHz	19.56	30.78	40.37	36.55	52.57	28.99
30 GHz	12.50	22.64	26.53	33.25	40.57	32.74
40 GHz	9.67	17.62	18.95	28.58	31.17	32.43
50 GHz	8.28	14.34	14.64	24.53	24.42	30.47

# THERMOPHYSICAL PROPERTIES OF FLUIDS

Eric W. Lemmon

These tables give thermodynamic and transport properties of a variety of fluids, as generated from the equations of state presented in the references below. The properties tabulated are pressure ( $P$ ), density ( $\rho$ ), enthalpy ( $H$ ), entropy ( $S$ ), isochoric heat capacity ( $C_v$ ), isobaric heat capacity ( $C_p$ ), speed of sound ( $u$ ), viscosity ( $\eta$ ), thermal conductivity ( $\lambda$ ), and static dielectric constant ( $D$ ). All extensive properties are given on a mass basis. Not all properties are included for every substance. The references should be consulted for information on the uncertainties.

Values are given first along the saturation line. The first two points are the properties at the triple point. The final line gives the properties at the critical point. Two lines are given for each temperature (except at the critical point); the first line gives the values of the liquid phase (note the high density) and the second line gives the values of the vapor phase (at low densities). Following the saturation tables, values are given as a function of temperature for several isobars. A duplicate entry in the isobar section indicates a phase transition (liquid–vapor) at that temperature; property values are then given for both phases. The phase can be determined by noting the sharp decrease in density between two successive temperature entries; all lines above this point refer to the liquid phase, and all lines below refer to the gas phase. If there is no sharp discontinuity in density, all data in the table refer to the supercritical region (*i.e.*, the isobar is above the critical pressure). If the first temperature in the isobars is not an integer, this state point refers to the properties of the liquid at the melting line.

All temperatures are given on ITS-90, except those for oxygen (Ref. 16) and helium (Ref. 13), where the source equations of state still use the IPTS-68 temperature scale. Nitrogen, oxygen, and argon use a reference state based on zero enthalpy in the gas phase at 0 K; parahydrogen, helium, methane, and ethane use a reference state of zero enthalpy and entropy at the saturated liquid state at the normal boiling point; and propane and carbon dioxide use a reference state of 200 kJ kg<sup>-1</sup> and 1 kJ kg<sup>-1</sup> K<sup>-1</sup>, respectively, at -40 °C. Additional calculations at state points not listed below and for fluids not contained here can be obtained at the NIST Chemistry WebBook website ([webbook.nist.gov/chemistry/fluid/](http://webbook.nist.gov/chemistry/fluid/)), or by using the NIST Standard Reference Data program REFPROP (Ref. 9).

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Nitrogen (N<sub>2</sub>)

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
63.15	0.01252	867.2	-150.7	2.426	1.176	2.000	995.3	1.47003	311.6	173.2
63.15	0.01252	0.6743	64.78	5.838	0.7499	1.058	161.1	1.00032	4.376	5.621
70	0.03854	838.5	-137.0	2.632	1.130	2.014	925.7	1.45241	220.2	159.5
70	0.03854	1.896	71.10	5.605	0.7580	1.082	168.4	1.00089	4.883	6.355
80	0.1369	793.9	-116.6	2.903	1.069	2.056	824.4	1.42541	145.1	139.5
80	0.1369	6.089	79.10	5.349	0.7773	1.145	176.7	1.00286	5.652	7.506
90	0.3605	745.0	-95.52	3.147	1.020	2.141	719.0	1.39622	102.8	119.8
90	0.3605	15.08	84.97	5.153	0.8078	1.266	181.8	1.00710	6.482	8.868
100	0.7783	689.4	-73.21	3.376	0.9832	2.318	605.2	1.36351	75.76	100.1
100	0.7783	31.96	87.77	4.986	0.8548	1.503	183.3	1.01510	7.429	10.73
110	1.466	621.5	-48.49	3.601	0.9667	2.743	476.4	1.32430	55.99	80.44
110	1.466	62.58	85.84	4.823	0.9284	2.062	180.8	1.02974	8.626	13.83
120	2.511	523.4	-17.87	3.851	1.011	4.508	317.3	1.26895	38.43	61.01
120	2.511	125.1	74.17	4.618	1.099	4.631	172.6	1.06012	10.62	21.72
126.19	3.396	313.3	29.23	4.215				1.15559	18.30	
<b>P = 0.1 MPa (1 bar)</b>										
63.17	0.1	867.3	-150.6	2.426	1.176	2.000	995.6	1.47007	311.6	173.3
77.24	0.1	806.6	-122.2	2.831	1.085	2.041	852.5	1.43304	161.4	145.0
77.24	0.1	4.556	77.07	5.412	0.7710	1.123	174.7	1.00214	5.435	7.174
80	0.1	4.379	80.15	5.451	0.7666	1.112	178.3	1.00206	5.623	7.443
100	0.1	3.437	101.9	5.694	0.7514	1.071	201.6	1.00162	6.958	9.381
120	0.1	2.840	123.2	5.888	0.7466	1.057	222.0	1.00133	8.244	11.27
140	0.1	2.424	144.2	6.050	0.7447	1.050	240.4	1.00114	9.480	13.11
160	0.1	2.116	165.2	6.190	0.7438	1.047	257.3	1.00099	10.67	14.89
180	0.1	1.878	186.1	6.313	0.7433	1.045	273.2	1.00088	11.81	16.61
200	0.1	1.688	207.0	6.423	0.7430	1.043	288.1	1.00079	12.91	18.28
220	0.1	1.534	227.9	6.523	0.7429	1.043	302.3	1.00072	13.97	19.90
240	0.1	1.405	248.7	6.613	0.7428	1.042	315.8	1.00066	15.00	21.48
260	0.1	1.297	269.5	6.697	0.7428	1.042	328.7	1.00061	15.99	23.01
280	0.1	1.204	290.4	6.774	0.7429	1.041	341.2	1.00057	16.96	24.51
300	0.1	1.123	311.2	6.846	0.7432	1.041	353.2	1.00053	17.89	25.97
320	0.1	1.053	332.0	6.913	0.7436	1.042	364.7	1.00049	18.80	27.39
340	0.1	0.9909	352.9	6.976	0.7441	1.042	375.9	1.00047	19.68	28.79
360	0.1	0.9357	373.7	7.036	0.7450	1.043	386.8	1.00044	20.55	30.15
400	0.1	0.8421	415.5	7.146	0.7475	1.045	407.5	1.00040	22.21	32.81
500	0.1	0.6736	520.5	7.380	0.7592	1.056	454.6	1.00032	26.06	39.04
600	0.1	0.5613	627.0	7.574	0.7781	1.075	496.3	1.00026	29.58	44.84
700	0.1	0.4811	735.6	7.741	0.8011	1.098	533.9	1.00023	32.83	50.31
800	0.1	0.4210	846.6	7.890	0.8254	1.122	568.4	1.00020	35.89	55.51
900	0.1	0.3742	960.0	8.023	0.8488	1.146	600.7	1.00018	38.78	60.52
1000	0.1	0.3368	1076.	8.145	0.8705	1.167	631.1	1.00016	41.54	65.36
<b>P = 1 MPa (10 bar)</b>										
63.37	1.0	868.0	-149.5	2.427	1.177	1.995	998.9	1.47049	311.8	173.6
80	1.0	796.3	-116.0	2.896	1.071	2.044	832.3	1.42683	147.3	140.5
100	1.0	690.8	-73.18	3.373	0.9833	2.305	609.4	1.36432	76.26	100.6
103.75	1.0	665.8	-64.33	3.460	0.9739	2.431	559.2	1.34984	67.78	92.74
103.75	1.0	41.33	87.73	4.926	0.8786	1.652	182.8	1.01956	7.835	11.67
120	1.0	32.10	110.9	5.134	0.7980	1.297	208.9	1.01517	8.714	12.49
140	1.0	26.01	135.5	5.324	0.7701	1.177	232.8	1.01227	9.844	14.00
160	1.0	22.11	158.5	5.477	0.7588	1.127	252.9	1.01043	10.96	15.60
180	1.0	19.33	180.7	5.608	0.7531	1.101	270.6	1.00911	12.06	17.21
200	1.0	17.21	202.6	5.723	0.7500	1.085	286.9	1.00811	13.13	18.81
220	1.0	15.54	224.2	5.826	0.7480	1.075	301.9	1.00732	14.16	20.37
240	1.0	14.17	245.6	5.919	0.7468	1.067	316.1	1.00667	15.17	21.90
260	1.0	13.04	266.9	6.005	0.7460	1.062	329.5	1.00614	16.14	23.39

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
280	1.0	12.07	288.1	6.083	0.7456	1.059	342.4	1.00569	17.09	24.86
300	1.0	11.25	309.2	6.156	0.7454	1.056	354.6	1.00530	18.01	26.29
320	1.0	10.53	330.3	6.224	0.7455	1.054	366.4	1.00496	18.91	27.69
340	1.0	9.901	351.4	6.288	0.7458	1.053	377.8	1.00466	19.79	29.07
360	1.0	9.343	372.4	6.348	0.7464	1.052	388.8	1.00440	20.64	30.42
400	1.0	8.399	414.5	6.459	0.7486	1.052	409.7	1.00395	22.29	33.04
500	1.0	6.711	520.1	6.695	0.7600	1.061	457.0	1.00316	26.13	39.23
600	1.0	5.592	627.0	6.889	0.7786	1.078	498.7	1.00263	29.63	44.99
700	1.0	4.793	735.8	7.057	0.8015	1.100	536.2	1.00226	32.87	50.43
800	1.0	4.195	847.0	7.206	0.8257	1.124	570.7	1.00197	35.92	55.63
900	1.0	3.730	960.6	7.339	0.8492	1.147	602.9	1.00176	38.81	60.62
1000	1.0	3.358	1076.	7.461	0.8708	1.168	633.2	1.00158	41.57	65.45

$P = 10$  MPa (100 bar)

65.32	10.0	875.0	-138.3	2.441	1.186	1.955	1031.	1.47447	314.0	177.1
80	10.0	818.4	-109.6	2.837	1.093	1.960	904.1	1.43984	169.0	150.4
100	10.0	733.6	-69.89	3.280	0.9997	2.022	734.2	1.38918	93.65	115.9
120	10.0	632.9	-27.82	3.663	0.9401	2.218	559.6	1.33060	58.57	84.11
140	10.0	499.8	20.66	4.036	0.9127	2.676	392.0	1.25566	36.11	57.60
160	10.0	344.2	76.44	4.408	0.8849	2.668	300.8	1.17162	22.40	40.20
180	10.0	248.7	122.6	4.681	0.8407	1.990	294.7	1.12203	18.50	32.06
200	10.0	199.4	158.4	4.870	0.8107	1.628	307.7	1.09701	17.70	29.38
220	10.0	169.4	188.9	5.015	0.7927	1.445	323.2	1.08198	17.74	28.72
240	10.0	148.8	216.7	5.136	0.7813	1.340	338.4	1.07172	18.13	28.87
260	10.0	133.4	242.8	5.240	0.7737	1.273	352.9	1.06415	18.67	29.39
280	10.0	121.4	267.7	5.333	0.7685	1.227	366.6	1.05827	19.29	30.21
300	10.0	111.7	291.9	5.417	0.7649	1.195	379.5	1.05351	19.96	31.14
320	10.0	103.6	315.6	5.493	0.7623	1.171	391.8	1.04958	20.66	32.13
340	10.0	96.80	338.8	5.563	0.7606	1.153	403.6	1.04625	21.37	33.16
360	10.0	90.89	361.7	5.629	0.7596	1.138	414.8	1.04338	22.08	34.21
400	10.0	81.19	406.8	5.748	0.7593	1.119	436.0	1.03869	23.51	36.35
500	10.0	64.50	517.5	5.995	0.7672	1.100	483.1	1.03065	26.99	41.73
600	10.0	53.74	627.6	6.195	0.7841	1.104	523.9	1.02549	30.28	47.00
700	10.0	46.15	738.7	6.367	0.8059	1.118	560.4	1.02187	33.40	52.10
800	10.0	40.49	851.4	6.517	0.8294	1.137	593.8	1.01917	36.35	57.04
900	10.0	36.08	966.1	6.652	0.8523	1.157	625.0	1.01708	39.17	61.85
1000	10.0	32.56	1083.	6.775	0.8735	1.176	654.4	1.01540	41.88	66.54

Oxygen (O<sub>2</sub>)

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
Saturation										
54.36	0.0001463	1306.	-193.6	2.092	1.195	1.673	1123	1.56799	773.6	201.9
54.36	0.0001463	0.01036	49.11	6.557	0.6638	0.9260	140.3	1.00000	4.096	4.420
60	0.0007258	1282.	-184.2	2.257	1.089	1.673	1127.	1.55615	578.1	193.9
60	0.0007258	0.04659	54.19	6.230	0.6817	0.9475	147.0	1.00002	4.553	4.984
70	0.006262	1237.	-167.4	2.516	1.017	1.678	1066.	1.53399	371.8	179.7
70	0.006262	0.3457	63.09	5.809	0.7052	0.9780	158.1	1.00013	5.356	5.992
80	0.03012	1190.	-150.6	2.740	0.9697	1.682	987.4	1.51120	261.2	165.4
80	0.03012	1.468	71.69	5.519	0.6950	0.9743	168.4	1.00054	6.149	7.028
90	0.09935	1142.	-133.7	2.938	0.9296	1.699	905.9	1.48766	195.6	151.0
90	0.09935	4.387	79.55	5.308	0.6758	0.9705	177.3	1.00163	6.936	8.124
100	0.2540	1091.	-116.4	3.118	0.8949	1.738	822.2	1.46295	152.6	136.6
100	0.2540	10.42	86.16	5.144	0.6752	1.006	184.1	1.00387	7.728	9.336
110	0.5434	1035.	-98.64	3.286	0.8658	1.807	734.8	1.43650	121.5	121.9
110	0.5434	21.28	91.05	5.010	0.6988	1.101	188.1	1.00791	8.547	10.75
120	1.022	973.9	-79.90	3.444	0.8430	1.927	641.5	1.40746	97.43	107.2
120	1.022	39.31	93.75	4.892	0.7415	1.276	189.4	1.01465	9.427	12.51

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
130	1.749	902.5	-59.66	3.600	0.8293	2.153	539.5	1.37432	77.57	92.63
130	1.749	68.37	93.47	4.778	0.8002	1.600	187.8	1.02558	10.45	14.94
140	2.788	813.2	-36.70	3.761	0.8323	2.691	423.1	1.33363	60.22	78.22
140	2.788	116.8	88.47	4.655	0.8834	2.370	182.8	1.04395	11.82	18.98
150	4.219	675.5	-6.671	3.955	0.9057	5.464	273.8	1.27248	42.90	64.19
150	4.219	214.9	72.56	4.483	1.049	6.625	172.8	1.08192	14.72	29.67
154.58	5.043	436.1	32.42	4.201				1.17084	24.84	
<b><math>P = 0.1</math> MPa (1 bar)</b>										
54.37	0.1	1306.	-193.5	2.092	1.195	1.673	1124.	1.56802	773.8	201.9
60	0.1	1282.	-184.1	2.257	1.089	1.673	1128.	1.55621	578.5	194.0
80	0.1	1191.	-150.6	2.739	0.9699	1.681	987.7	1.51126	261.4	165.5
90.06	0.1	1142.	-133.6	2.939	0.9293	1.699	905.4	1.48751	195.3	151.0
90.06	0.1	4.413	79.60	5.307	0.6757	0.9705	177.4	1.00164	6.940	8.131
100	0.1	3.941	88.99	5.405	0.6527	0.9352	188.4	1.00146	7.712	9.085
120	0.1	3.252	107.6	5.575	0.6543	0.9280	207.3	1.00121	9.219	10.99
140	0.1	2.774	126.1	5.718	0.6530	0.9218	224.6	1.00103	10.67	12.86
160	0.1	2.420	144.5	5.841	0.6519	0.9180	240.5	1.00090	12.07	14.69
180	0.1	2.147	162.8	5.949	0.6513	0.9158	255.4	1.00080	13.41	16.48
200	0.1	1.930	181.1	6.045	0.6512	0.9146	269.3	1.00072	14.72	18.24
220	0.1	1.753	199.4	6.132	0.6516	0.9142	282.6	1.00065	15.98	19.95
240	0.1	1.606	217.7	6.212	0.6525	0.9146	295.2	1.00060	17.20	21.64
260	0.1	1.482	236.0	6.285	0.6539	0.9156	307.2	1.00055	18.38	23.28
280	0.1	1.376	254.3	6.353	0.6560	0.9174	318.7	1.00051	19.53	24.90
300	0.1	1.284	272.7	6.416	0.6587	0.9199	329.7	1.00048	20.65	26.49
320	0.1	1.203	291.1	6.476	0.6621	0.9231	340.3	1.00045	21.74	28.04
340	0.1	1.132	309.6	6.532	0.6661	0.9269	350.5	1.00042	22.80	29.58
360	0.1	1.069	328.2	6.585	0.6707	0.9313	360.4	1.00040	23.84	31.08
400	0.1	0.9622	365.7	6.684	0.6812	0.9416	379.0	1.00036	25.84	34.03
500	0.1	0.7696	461.3	6.897	0.7119	0.9722	421.3	1.00029	30.49	41.05
600	0.1	0.6413	560.1	7.077	0.7432	1.003	458.9	1.00024	34.73	47.66
700	0.1	0.5497	661.9	7.234	0.7710	1.031	493.3	1.00020	38.65	53.97
800	0.1	0.4809	766.2	7.373	0.7945	1.055	525.4	1.00018	42.33	60.02
900	0.1	0.4275	872.6	7.498	0.8140	1.074	555.6	1.00016	45.81	65.87
1000	0.1	0.3848	980.9	7.612	0.8301	1.090	584.3	1.00014	49.12	71.55
<b><math>P = 1</math> MPa (10 bar)</b>										
54.47	1.0	1307.	-192.8	2.093	1.190	1.669	1127.	1.56831	775.0	202.1
60	1.0	1283.	-183.6	2.254	1.089	1.671	1130.	1.55674	582.7	194.3
80	1.0	1192.	-150.1	2.736	0.9716	1.679	991.1	1.51204	263.6	166.0
100	1.0	1093.	-116.1	3.115	0.8964	1.731	826.8	1.46397	153.9	137.2
119.62	1.0	976.3	-80.64	3.438	0.8438	1.921	645.2	1.40862	98.25	107.8
119.62	1.0	38.46	93.70	4.896	0.7396	1.268	189.4	1.01433	9.392	12.43
120	1.0	38.25	94.18	4.900	0.7355	1.257	190.0	1.01425	9.421	12.45
140	1.0	30.39	116.8	5.075	0.6851	1.065	214.2	1.01131	10.89	13.90
160	1.0	25.65	137.5	5.213	0.6708	1.005	233.7	1.00954	12.29	15.54
180	1.0	22.33	157.2	5.329	0.6631	0.9743	250.8	1.00831	13.64	17.21
200	1.0	19.84	176.5	5.431	0.6590	0.9568	266.3	1.00738	14.94	18.88
220	1.0	17.88	195.5	5.521	0.6571	0.9462	280.6	1.00665	16.20	20.53
240	1.0	16.30	214.4	5.603	0.6566	0.9397	294.0	1.00606	17.41	22.15
260	1.0	14.98	233.1	5.678	0.6572	0.9359	306.6	1.00557	18.59	23.76
280	1.0	13.86	251.8	5.748	0.6586	0.9342	318.5	1.00515	19.73	25.34
300	1.0	12.91	270.5	5.812	0.6609	0.9340	329.9	1.00480	20.85	26.89
320	1.0	12.08	289.2	5.872	0.6640	0.9351	340.8	1.00449	21.93	28.43
340	1.0	11.35	307.9	5.929	0.6677	0.9373	351.2	1.00422	22.99	29.93
360	1.0	10.71	326.7	5.983	0.6720	0.9404	361.2	1.00398	24.02	31.42
400	1.0	9.623	364.5	6.082	0.6823	0.9487	380.1	1.00358	26.01	34.33
500	1.0	7.683	460.7	6.297	0.7126	0.9763	422.7	1.00286	30.63	41.29
600	1.0	6.398	559.8	6.478	0.7436	1.006	460.4	1.00238	34.85	47.86



$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
700	1.0	5.483	661.8	6.635	0.7713	1.033	494.9	1.00204	38.77	54.14
800	1.0	4.798	766.2	6.774	0.7948	1.056	526.9	1.00179	42.43	60.17
900	1.0	4.265	872.8	6.900	0.8142	1.075	557.1	1.00159	45.90	66.00
1000	1.0	3.839	981.1	7.014	0.8303	1.091	585.8	1.00143	49.20	71.67
<b><math>P = 10</math> MPa (100 bar)</b>										
55.50	10.0	1312.	-185.4	2.103	1.149	1.640	1158.	1.57109	786.0	203.9
60	10.0	1294.	-178.0	2.231	1.092	1.653	1155.	1.56193	625.3	197.9
80	10.0	1207.	-144.8	2.708	0.9885	1.654	1023.	1.51940	285.2	171.5
100	10.0	1116.	-111.6	3.078	0.9136	1.672	877.1	1.47515	169.5	144.8
120	10.0	1015.	-77.51	3.389	0.8571	1.755	727.0	1.42679	112.4	118.1
140	10.0	892.5	-40.64	3.673	0.8191	1.966	564.5	1.36967	75.70	91.70
160	10.0	716.0	4.057	3.970	0.8137	2.659	379.7	1.29022	47.96	66.52
180	10.0	423.3	70.35	4.360	0.8161	3.312	250.9	1.16550	26.07	42.24
200	10.0	277.6	119.7	4.621	0.7506	1.894	259.0	1.10662	20.74	31.77
220	10.0	219.9	152.6	4.778	0.7152	1.462	278.2	1.08384	20.24	29.46
240	10.0	186.7	179.8	4.896	0.6973	1.280	295.8	1.07090	20.67	29.19
260	10.0	164.2	204.3	4.995	0.6878	1.183	311.6	1.06220	21.40	29.67
280	10.0	147.6	227.3	5.080	0.6830	1.124	326.1	1.05578	22.25	30.48
300	10.0	134.6	249.4	5.156	0.6809	1.086	339.4	1.05078	23.15	31.47
320	10.0	124.0	270.8	5.225	0.6809	1.060	351.7	1.04675	24.07	32.56
340	10.0	115.2	291.9	5.289	0.6823	1.042	363.3	1.04339	25.00	33.74
360	10.0	107.8	312.6	5.348	0.6848	1.030	374.2	1.04054	25.92	34.96
400	10.0	95.67	353.5	5.456	0.6923	1.017	394.5	1.03595	27.74	37.45
500	10.0	75.32	454.8	5.682	0.7187	1.015	438.7	1.02825	32.07	43.71
600	10.0	62.44	557.1	5.869	0.7477	1.031	476.8	1.02339	36.10	49.86
700	10.0	53.46	661.2	6.029	0.7743	1.050	511.2	1.02002	39.87	55.84
800	10.0	46.79	767.1	6.170	0.7970	1.069	543.1	1.01752	43.43	61.66
900	10.0	41.63	874.8	6.297	0.8159	1.085	572.9	1.01558	46.80	67.32
1000	10.0	37.51	984.0	6.412	0.8316	1.098	601.2	1.01404	50.03	72.85

Parahydrogen (H<sub>2</sub>)

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
13.80	0.007041	76.98	-53.74	-3.084	5.131	6.924	1263.	1.25267	25.90	75.27
13.80	0.007041	0.1255	396.3	29.52	6.226	10.53	305.6	1.00038	0.6507	10.46
14	0.007884	76.82	-52.36	-2.986	5.158	6.981	1257.	1.25208	25.21	76.86
14	0.007884	0.1388	398.1	29.19	6.236	10.56	307.6	1.00042	0.6669	10.65
16	0.02155	75.13	-37.60	-2.013	5.334	7.659	1210.	1.24585	19.81	90.02
16	0.02155	0.3377	415.8	26.33	6.323	10.87	325.4	1.00102	0.8106	12.60
18	0.04815	73.25	-21.18	-1.068	5.472	8.513	1168.	1.23903	16.22	98.39
18	0.04815	0.6880	431.5	24.08	6.387	11.29	340.7	1.00207	0.9355	14.60
20	0.09341	71.14	-2.692	-1.281	5.637	9.569	1119.	1.23147	13.63	103.0
20	0.09341	1.244	444.5	22.23	6.450	11.92	353.5	1.00375	1.057	16.71
22	0.1635	68.74	18.32	0.8244	5.811	10.86	1059.	1.22301	11.65	104.9
22	0.1635	2.071	454.2	20.64	6.541	12.88	363.7	1.00625	1.182	18.98
24	0.2648	66.01	42.37	1.805	5.974	12.52	989.9	1.21345	10.06	104.7
24	0.2648	3.255	459.7	19.19	6.681	14.40	371.3	1.00984	1.315	21.54
26	0.4038	62.83	70.23	2.832	6.120	14.83	909.3	1.20242	8.725	102.6
26	0.4038	4.924	460.0	17.82	6.890	16.90	376.1	1.01491	1.463	24.53
28	0.5875	58.98	103.2	3.941	6.266	18.57	813.3	1.18922	7.533	98.79
28	0.5875	7.300	453.4	16.45	7.188	21.53	378.2	1.02216	1.634	28.26
30	0.8232	53.98	144.2	5.211	6.472	26.65	693.0	1.17223	6.390	92.78
30	0.8232	10.87	435.7	14.93	7.625	32.58	377.2	1.03313	1.865	33.47
32	1.120	45.90	204.1	6.945	7.010	68.19	522.6	1.14520	5.076	82.53
32	1.120	17.49	392.3	12.83	8.336	92.39	372.0	1.05368	2.337	43.17
32.94	1.286	31.32	295.6	9.625				1.09756	3.512	



$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b><math>P = 0.1</math> MPa (1 bar)</b>										
20	0.1	71.14	-2.629	-.1296	5.637	9.566	1119.	1.23150	13.63	103.1
20.23	0.1	70.88	-.4432	-.02096	5.657	9.702	1112.	1.23055	13.38	103.4
20.23	0.1	1.323	445.8	22.04	6.458	12.01	354.8	1.00399	1.071	16.95
40	0.1	0.6157	661.5	29.52	6.218	10.57	521.4	1.00186	2.039	31.85
60	0.1	0.4059	873.1	33.81	6.503	10.72	635.7	1.00122	2.865	45.53
80	0.1	0.3035	1096.	37.02	7.598	11.77	713.9	1.00091	3.566	61.36
100	0.1	0.2425	1348.	39.82	9.277	13.43	772.5	1.00073	4.190	80.43
120	0.1	0.2020	1633.	42.41	10.83	14.98	827.4	1.00061	4.763	101.4
140	0.1	0.1731	1943.	44.80	11.82	15.96	883.4	1.00052	5.301	119.7
160	0.1	0.1514	2267.	46.96	12.21	16.35	940.4	1.00046	5.814	134.8
180	0.1	0.1346	2594.	48.89	12.19	16.32	997.7	1.00041	6.306	146.5
200	0.1	0.1211	2918.	50.60	11.95	16.08	1054.	1.00037	6.780	155.6
220	0.1	0.1101	3237.	52.11	11.63	15.76	1110.	1.00033	7.239	163.4
240	0.1	0.1010	3549.	53.47	11.33	15.46	1163.	1.00030	7.684	170.6
260	0.1	0.09319	3856.	54.70	11.07	15.20	1214.	1.00028	8.118	177.7
280	0.1	0.08654	4157.	55.82	10.87	15.00	1263.	1.00026	8.540	184.9
300	0.1	0.08077	4456.	56.85	10.72	14.85	1310.	1.00024	8.953	192.3
320	0.1	0.07572	4752.	57.80	10.61	14.74	1355.	1.00023	9.357	200.0
340	0.1	0.07127	5045.	58.69	10.53	14.66	1398.	1.00022	9.752	208.0
360	0.1	0.06731	5338.	59.53	10.48	14.61	1439.	1.00020	10.14	216.4
400	0.1	0.06058	5921.	61.06	10.43	14.55	1518.	1.00018	10.89	233.1
500	0.1	0.04847	7374.	64.31	10.40	14.53	1698.	1.00015	12.67	275.0
600	0.1	0.04040	8828.	66.96	10.42	14.55	1859.	1.00012	14.34	317.6
700	0.1	0.03463	10290	69.20	10.48	14.60	2006.	1.00011	15.92	360.8
800	0.1	0.03030	11750	71.16	10.57	14.70	2142.	1.00009	17.43	404.7
900	0.1	0.02693	13230	72.90	10.71	14.83	2268.	1.00008	18.89	449.2
1000	0.1	0.02424	14720	74.47	10.87	14.99	2386.	1.00007	20.30	494.3
<b><math>P = 1</math> MPa (10 bar)</b>										
20	1.0	72.29	6.046	-.3233	5.634	9.187	1164.	1.23552	14.53	105.1
31.24	1.0	49.65	177.4	6.181	6.718	40.77	596.5	1.15769	5.627	87.27
31.24	1.0	14.31	414.3	13.76	8.017	52.90	374.7	1.04376	2.096	38.44
40	1.0	7.270	590.6	18.85	6.455	14.12	497.2	1.02207	2.228	37.28
60	1.0	4.228	838.4	23.90	6.588	11.70	634.2	1.01279	2.976	48.40
80	1.0	3.072	1075.	27.31	7.645	12.25	717.9	1.00929	3.648	63.68
100	1.0	2.429	1335.	30.19	9.307	13.72	778.4	1.00734	4.255	82.51
120	1.0	2.015	1624.	32.83	10.85	15.17	834.2	1.00609	4.817	103.1
140	1.0	1.723	1938.	35.24	11.84	16.09	890.7	1.00520	5.348	121.2
160	1.0	1.506	2264.	37.42	12.23	16.45	948.1	1.00455	5.854	136.1
180	1.0	1.338	2593.	39.36	12.20	16.40	1006.	1.00404	6.341	147.6
200	1.0	1.204	2918.	41.07	11.96	16.14	1062.	1.00364	6.812	156.7
220	1.0	1.095	3238.	42.60	11.64	15.81	1117.	1.00331	7.268	164.3
240	1.0	1.004	3551.	43.96	11.34	15.50	1171.	1.00303	7.711	171.5
260	1.0	0.9267	3858.	45.19	11.08	15.24	1222.	1.00280	8.143	178.6
280	1.0	0.8607	4161.	46.31	10.88	15.03	1271.	1.00260	8.563	185.7
300	1.0	0.8035	4460.	47.34	10.73	14.87	1317.	1.00243	8.975	193.0
320	1.0	0.7534	4756.	48.30	10.62	14.76	1362.	1.00228	9.377	200.7
340	1.0	0.7093	5050.	49.19	10.54	14.68	1405.	1.00215	9.771	208.7
360	1.0	0.6700	5343.	50.03	10.49	14.62	1446.	1.00203	10.16	217.0
400	1.0	0.6033	5927.	51.56	10.43	14.56	1525.	1.00183	10.91	233.7
500	1.0	0.4830	7381.	54.81	10.41	14.53	1704.	1.00146	12.68	275.5
600	1.0	0.4027	8835.	57.46	10.43	14.55	1865.	1.00122	14.35	318.0
700	1.0	0.3454	10290	59.71	10.48	14.61	2011.	1.00105	15.93	361.2
800	1.0	0.3023	11760	61.66	10.58	14.70	2147.	1.00092	17.44	405.0
900	1.0	0.2688	13230	63.40	10.71	14.83	2272.	1.00082	18.90	449.5
1000	1.0	0.2420	14720	64.97	10.87	15.00	2390.	1.00074	20.30	494.6

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b><math>P = 10</math> MPa (100 bar)</b>										
20	10.0	79.91	98.92	-1.567	5.529	7.566	1467.	1.26244	23.45	120.3
40	10.0	63.19	310.5	5.532	6.665	13.45	1154.	1.20345	8.791	121.8
60	10.0	42.86	617.0	11.71	6.960	16.19	923.2	1.13508	5.594	100.6
80	10.0	29.87	933.6	16.27	7.952	15.47	884.9	1.09289	5.034	96.74
100	10.0	23.01	1244.	19.73	9.546	15.76	904.3	1.07104	5.169	106.3
120	10.0	18.87	1567.	22.67	11.05	16.56	942.4	1.05803	5.497	121.6
140	10.0	16.08	1905.	25.27	12.00	17.11	990.1	1.04932	5.888	136.6
160	10.0	14.06	2249.	27.57	12.37	17.22	1042.	1.04303	6.303	149.4
180	10.0	12.51	2592.	29.59	12.32	17.01	1096.	1.03824	6.727	159.4
200	10.0	11.28	2928.	31.36	12.07	16.63	1150.	1.03445	7.151	167.3
220	10.0	10.28	3257.	32.93	11.74	16.22	1203.	1.03138	7.571	173.9
240	10.0	9.453	3577.	34.32	11.43	15.84	1254.	1.02883	7.985	180.4
260	10.0	8.751	3891.	35.58	11.17	15.52	1303.	1.02667	8.393	186.8
280	10.0	8.149	4199.	36.72	10.96	15.27	1350.	1.02483	8.795	193.3
300	10.0	7.626	4502.	37.77	10.80	15.08	1394.	1.02323	9.189	200.2
320	10.0	7.167	4802.	38.73	10.68	14.94	1437.	1.02183	9.577	207.4
340	10.0	6.762	5100.	39.64	10.60	14.84	1478.	1.02059	9.959	215.0
360	10.0	6.400	5396.	40.48	10.55	14.77	1518.	1.01948	10.33	223.0
400	10.0	5.784	5985.	42.03	10.49	14.68	1593.	1.01761	11.07	239.2
500	10.0	4.665	7447.	45.30	10.45	14.60	1764.	1.01420	12.81	280.0
600	10.0	3.911	8907.	47.96	10.46	14.59	1919.	1.01191	14.46	321.9
700	10.0	3.368	10370	50.21	10.51	14.63	2062.	1.01026	16.02	364.7
800	10.0	2.957	11830	52.17	10.60	14.72	2193.	1.00902	17.52	408.2
900	10.0	2.636	13310	53.91	10.73	14.84	2315.	1.00805	18.97	452.4
1000	10.0	2.378	14800	55.48	10.89	15.00	2430.	1.00727	20.37	497.3

**Helium (He-4)**

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
2.177	0.004856	146.2	-7.501	-2.177	6.287	6.318	216.8	1.07842	3.596	13.52
2.177	0.004856	1.146	15.73	8.494	3.470	6.061	83.22	1.00045	0.5376	3.977
2.5	0.01000	145.0	-6.180	-1.620	2.521	2.700	216.0	1.07491	3.746	14.89
2.5	0.01000	2.116	16.97	7.641	3.486	6.258	87.62	1.00082	0.6382	4.765
3	0.02373	141.3	-4.869	-1.177	2.061	2.598	214.3	1.06975	3.694	16.55
3	0.02373	4.428	18.66	6.666	3.452	6.592	93.04	1.00173	0.7961	5.893
3.5	0.04663	136.1	-3.258	-7.324	2.332	3.414	202.4	1.06471	3.511	17.75
3.5	0.04663	8.022	19.95	5.898	3.378	7.122	96.94	1.00315	0.9640	7.060
4	0.08100	128.9	-1.164	-2.439	2.504	4.523	185.7	1.05941	3.278	18.47
4	0.08100	13.41	20.68	5.217	3.284	8.179	99.47	1.00529	1.151	8.356
4.5	0.1292	118.8	1.586	0.3106	2.601	6.776	164.0	1.05319	3.010	18.77
4.5	0.1292	21.76	20.52	4.519	3.179	10.96	100.8	1.00865	1.372	10.04
5	0.1945	100.8	5.854	1.081	2.709	20.24	133.0	1.04367	2.634	19.28
5	0.1945	38.21	18.18	3.547	3.053	29.09	101.6	1.01543	1.687	13.60
5.195	0.2275	69.64	11.87	2.183				1.02904	2.129	
<b><math>P = 0.1</math> MPa (1 bar)</b>										
20	0.1	2.408	108.5	13.94	3.121	5.250	264.3	1.00093	3.582	26.20
40	0.1	1.200	212.9	17.56	3.119	5.206	373.4	1.00047	5.542	40.44
60	0.1	0.8006	317.0	19.67	3.118	5.198	456.9	1.00031	7.116	52.55
80	0.1	0.6007	420.9	21.16	3.117	5.195	527.2	1.00023	8.503	63.52
100	0.1	0.4807	524.8	22.32	3.117	5.194	589.2	1.00019	9.778	73.71
120	0.1	0.4007	628.7	23.27	3.117	5.194	645.3	1.00016	10.79	83.33
140	0.1	0.3435	732.6	24.07	3.116	5.193	696.9	1.00013	11.94	92.50
160	0.1	0.3006	836.4	24.76	3.116	5.193	744.9	1.00012	13.05	101.3
180	0.1	0.2672	940.3	25.37	3.116	5.193	790.0	1.00010	14.11	109.8
200	0.1	0.2405	1044.	25.92	3.116	5.193	832.7	1.00009	15.14	118.0

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
220	0.1	0.2187	1148.	26.42	3.116	5.193	873.3	1.00008	16.14	126.0
240	0.1	0.2005	1252.	26.87	3.116	5.193	912.0	1.00008	17.12	133.7
260	0.1	0.1851	1356.	27.28	3.116	5.193	949.2	1.00007	18.08	141.3
280	0.1	0.1718	1460.	27.67	3.116	5.193	985.0	1.00007	19.01	148.7
300	0.1	0.1604	1563.	28.03	3.116	5.193	1020.	1.00006	19.93	156.0
320	0.1	0.1504	1667.	28.36	3.116	5.193	1053.	1.00006	20.83	163.1
340	0.1	0.1415	1771.	28.68	3.116	5.193	1085.	1.00005	21.72	170.1
360	0.1	0.1337	1875.	28.97	3.116	5.193	1117.	1.00005	22.59	177.0
400	0.1	0.1203	2083.	29.52	3.116	5.193	1177.	1.00005	24.29	190.4
500	0.1	0.09626	2602.	30.68	3.116	5.193	1316.	1.00004	28.36	222.3
600	0.1	0.08022	3121.	31.63	3.116	5.193	1442.	1.00003	32.22	252.4
700	0.1	0.06876	3641.	32.43	3.116	5.193	1557.	1.00003	35.89	281.1
800	0.1	0.06017	4160.	33.12	3.116	5.193	1664.	1.00002	39.43	308.5
900	0.1	0.05348	4679.	33.73	3.116	5.193	1765.	1.00002	42.85	335.0
1000	0.1	0.04814	5199.	34.28	3.116	5.193	1861.	1.00002	46.16	360.6
<b><math>P = 1</math> MPa (10 bar)</b>										
20	1.0	24.02	104.1	8.936	3.156	5.728	276.4	1.00938	3.933	29.04
40	1.0	11.72	213.2	12.73	3.143	5.317	384.9	1.00455	5.740	42.01
60	1.0	7.850	318.6	14.87	3.133	5.242	466.8	1.00305	7.269	53.72
80	1.0	5.912	423.1	16.37	3.128	5.217	535.8	1.00229	8.633	64.50
100	1.0	4.745	527.4	17.54	3.125	5.206	596.9	1.00184	9.892	74.60
120	1.0	3.963	631.4	18.48	3.123	5.200	652.2	1.00154	10.90	84.16
140	1.0	3.403	735.4	19.29	3.121	5.197	703.2	1.00132	12.04	93.29
160	1.0	2.982	839.3	19.98	3.120	5.195	750.7	1.00116	13.13	102.1
180	1.0	2.653	943.2	20.59	3.120	5.194	795.4	1.00103	14.19	110.5
200	1.0	2.390	1047.	21.14	3.119	5.194	837.7	1.00093	15.21	118.7
220	1.0	2.174	1151.	21.63	3.119	5.193	878.0	1.00084	16.20	126.7
240	1.0	1.994	1255.	22.09	3.118	5.193	916.5	1.00077	17.17	134.4
260	1.0	1.842	1359.	22.50	3.118	5.193	953.5	1.00071	18.12	142.0
280	1.0	1.711	1463.	22.89	3.118	5.192	989.1	1.00066	19.05	149.4
300	1.0	1.597	1566.	23.24	3.118	5.192	1023.	1.00062	19.96	156.6
320	1.0	1.498	1670.	23.58	3.117	5.192	1057.	1.00058	20.86	163.8
340	1.0	1.410	1774.	23.89	3.117	5.192	1089.	1.00055	21.74	170.7
360	1.0	1.332	1878.	24.19	3.117	5.192	1120.	1.00052	22.61	177.6
400	1.0	1.200	2086.	24.74	3.117	5.192	1180.	1.00047	24.32	191.0
500	1.0	0.9604	2605.	25.90	3.117	5.192	1319.	1.00037	28.38	222.9
600	1.0	0.8007	3124.	26.84	3.116	5.192	1444.	1.00031	32.23	253.0
700	1.0	0.6866	3643.	27.64	3.116	5.192	1559.	1.00027	35.91	281.6
800	1.0	0.6009	4163.	28.34	3.116	5.192	1666.	1.00023	39.44	309.1
900	1.0	0.5342	4682.	28.95	3.116	5.193	1767.	1.00021	42.86	335.5
1000	1.0	0.4809	5201.	29.50	3.116	5.193	1863.	1.00019	46.17	361.1
<b><math>P = 10</math> MPa (100 bar)</b>										
20	10.0	147.2	111.0	3.756	3.286	5.413	497.6	1.06056	6.928	58.72
40	10.0	91.33	225.2	7.703	3.305	5.721	512.2	1.03614	7.483	59.90
60	10.0	65.36	337.4	9.980	3.251	5.506	566.3	1.02560	8.638	68.12
80	10.0	51.09	446.0	11.54	3.215	5.376	620.9	1.01993	9.802	76.83
100	10.0	42.05	552.8	12.74	3.192	5.303	672.3	1.01637	10.93	85.42
120	10.0	35.77	658.4	13.70	3.176	5.261	720.4	1.01391	11.82	93.82
140	10.0	31.14	763.3	14.51	3.165	5.235	765.6	1.01210	12.88	102.0
160	10.0	27.58	867.8	15.21	3.157	5.219	808.5	1.01071	13.89	110.1
180	10.0	24.75	972.1	15.82	3.151	5.208	849.2	1.00961	14.87	118.0
200	10.0	22.46	1076.	16.37	3.146	5.201	888.2	1.00872	15.82	125.7
220	10.0	20.55	1180.	16.86	3.142	5.196	925.6	1.00798	16.75	133.3
240	10.0	18.94	1284.	17.31	3.139	5.193	961.6	1.00735	17.65	140.7
260	10.0	17.57	1388.	17.73	3.137	5.190	996.4	1.00682	18.54	148.0
280	10.0	16.38	1492.	18.11	3.135	5.188	1030.	1.00635	19.41	155.2
300	10.0	15.34	1595.	18.47	3.133	5.187	1063.	1.00595	20.26	162.3

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
320	10.0	14.43	1699.	18.81	3.132	5.186	1094.	1.00560	21.14	169.2
340	10.0	13.62	1803.	19.12	3.130	5.186	1125.	1.00528	22.01	176.0
360	10.0	12.89	1907.	19.42	3.129	5.185	1155.	1.00500	22.86	182.8
400	10.0	11.65	2114.	19.96	3.127	5.185	1213.	1.00452	24.54	196.0
500	10.0	9.387	2632.	21.12	3.124	5.185	1347.	1.00364	28.56	227.6
600	10.0	7.860	3151.	22.07	3.122	5.186	1469.	1.00305	32.38	257.4
700	10.0	6.760	3670.	22.87	3.121	5.186	1582.	1.00262	36.04	285.9
800	10.0	5.930	4188.	23.56	3.120	5.187	1687.	1.00230	39.56	313.2
900	10.0	5.281	4707.	24.17	3.119	5.188	1786.	1.00205	42.96	339.6
1000	10.0	4.760	5226.	24.72	3.119	5.188	1880.	1.00185	46.26	365.1

Argon (Ar)

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
Saturation										
83.81	0.06889	1417.	-121.4	1.329	0.5496	1.116	862.4	1.51232	290.2	133.6
83.81	0.06889	4.055	42.28	3.283	0.3247	0.5550	168.1	1.00126	6.856	5.359
90	0.1335	1379.	-114.5	1.409	0.5268	1.121	819.5	1.49650	240.0	124.5
90	0.1335	7.436	44.57	3.176	0.3309	0.5757	172.8	1.00231	7.413	5.835
100	0.3238	1314.	-103.1	1.528	0.4976	1.154	746.9	1.46993	181.3	110.2
100	0.3238	16.86	47.40	3.032	0.3445	0.6269	178.9	1.00525	8.349	6.689
110	0.6653	1243.	-91.13	1.639	0.4747	1.218	669.2	1.44136	140.4	96.41
110	0.6653	33.29	48.84	2.911	0.3633	0.7122	183.0	1.01039	9.366	7.732
120	1.213	1163.	-78.35	1.746	0.4576	1.332	584.2	1.40965	110.2	83.13
120	1.213	60.14	48.41	2.802	0.3893	0.8627	185.1	1.01884	10.54	9.154
130	2.025	1068.	-64.16	1.854	0.4492	1.564	487.9	1.37273	85.86	70.43
130	2.025	103.6	45.30	2.696	0.4275	1.172	184.8	1.03259	12.03	11.45
140	3.168	943.7	-47.16	1.971	0.4598	2.225	371.6	1.32519	63.62	58.06
140	3.168	178.9	37.47	2.576	0.4940	2.104	181.5	1.05677	14.32	16.39
150	4.735	680.4	-17.88	2.159	0.7060	23.58	174.7	1.22816	36.78	57.63
150	4.735	394.5	11.52	2.355	0.8218	35.47	157.0	1.12827	21.18	55.88
150.69	4.863	535.6	-4.332	2.248				1.17684	27.63	
$P = 0.1$ MPa (1 bar)										
83.81	0.1	1417.	-121.4	1.329	0.5496	1.116	862.5	1.51233	290.2	133.6
87.18	0.1	1396.	-117.7	1.373	0.5366	1.117	839.2	1.50375	261.3	128.6
87.18	0.1	5.704	43.57	3.223	0.3279	0.5654	170.8	1.00178	7.157	5.614
100	0.1	4.915	50.69	3.299	0.3206	0.5470	184.2	1.00153	8.234	6.450
120	0.1	4.058	61.49	3.398	0.3161	0.5347	202.8	1.00126	9.878	7.735
140	0.1	3.461	72.12	3.480	0.3144	0.5293	219.6	1.00108	11.48	8.987
160	0.1	3.020	82.68	3.550	0.3135	0.5264	235.1	1.00094	13.03	10.21
180	0.1	2.680	93.19	3.612	0.3131	0.5247	249.6	1.00083	14.53	11.39
200	0.1	2.409	103.7	3.667	0.3128	0.5236	263.2	1.00075	16.00	12.54
220	0.1	2.189	114.1	3.717	0.3127	0.5229	276.2	1.00068	17.42	13.66
240	0.1	2.005	124.6	3.762	0.3125	0.5224	288.5	1.00062	18.80	14.74
260	0.1	1.850	135.0	3.804	0.3125	0.5220	300.3	1.00058	20.15	15.80
280	0.1	1.717	145.5	3.843	0.3124	0.5217	311.7	1.00053	21.46	16.83
300	0.1	1.603	155.9	3.879	0.3124	0.5215	322.7	1.00050	22.74	17.84
320	0.1	1.502	166.3	3.913	0.3124	0.5214	333.3	1.00047	23.99	18.82
340	0.1	1.414	176.8	3.944	0.3123	0.5212	343.5	1.00044	25.21	19.77
360	0.1	1.335	187.2	3.974	0.3123	0.5211	353.5	1.00042	26.40	20.71
400	0.1	1.201	208.0	4.029	0.3123	0.5209	372.7	1.00037	28.70	22.52
500	0.1	0.9608	260.1	4.145	0.3123	0.5207	416.6	1.00030	34.08	26.73
600	0.1	0.8006	312.2	4.240	0.3122	0.5206	456.4	1.00025	39.00	30.57
700	0.1	0.6862	364.2	4.320	0.3122	0.5205	493.0	1.00021	43.56	34.13
800	0.1	0.6004	416.3	4.390	0.3122	0.5205	527.0	1.00019	47.82	37.46
900	0.1	0.5337	468.3	4.451	0.3122	0.5204	558.9	1.00017	51.85	40.60
1000	0.1	0.4803	520.3	4.506	0.3122	0.5204	589.1	1.00015	55.69	43.58

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b><math>P = 1</math> MPa (10 bar)</b>										
84.04	1.0	1418.	-120.8	1.330	0.5498	1.113	865.3	1.51276	291.1	134.0
100	1.0	1316.	-102.8	1.525	0.4984	1.148	751.6	1.47104	183.1	110.9
116.60	1.0	1191.	-82.82	1.710	0.4627	1.285	614.1	1.42088	119.7	87.58
116.60	1.0	49.55	48.81	2.839	0.3795	0.8007	184.6	1.01550	10.12	8.608
120	1.0	47.20	51.45	2.861	0.3682	0.7559	189.3	1.01476	10.37	8.732
140	1.0	37.75	65.11	2.967	0.3375	0.6350	212.1	1.01179	11.87	9.704
160	1.0	31.93	77.31	3.048	0.3266	0.5907	230.5	1.00997	13.36	10.80
180	1.0	27.83	88.89	3.116	0.3214	0.5686	246.8	1.00868	14.83	11.90
200	1.0	24.74	100.1	3.176	0.3185	0.5556	261.6	1.00772	16.26	13.00
220	1.0	22.31	111.1	3.228	0.3168	0.5473	275.3	1.00696	17.65	14.07
240	1.0	20.33	122.0	3.275	0.3157	0.5417	288.3	1.00634	19.01	15.12
260	1.0	18.69	132.8	3.319	0.3149	0.5376	300.5	1.00583	20.34	16.15
280	1.0	17.30	143.5	3.358	0.3144	0.5346	312.2	1.00539	21.64	17.16
300	1.0	16.11	154.2	3.395	0.3140	0.5324	323.4	1.00502	22.90	18.14
320	1.0	15.08	164.8	3.429	0.3137	0.5306	334.2	1.00470	24.14	19.10
340	1.0	14.17	175.4	3.462	0.3135	0.5292	344.7	1.00441	25.35	20.04
360	1.0	13.37	186.0	3.492	0.3133	0.5280	354.7	1.00416	26.53	20.96
400	1.0	12.01	207.1	3.547	0.3131	0.5263	374.1	1.00374	28.82	22.75
500	1.0	9.593	259.6	3.664	0.3127	0.5239	418.3	1.00299	34.16	26.92
600	1.0	7.988	311.9	3.760	0.3126	0.5227	458.1	1.00249	39.06	30.73
700	1.0	6.846	364.1	3.840	0.3125	0.5220	494.6	1.00213	43.61	34.27
800	1.0	5.990	416.3	3.910	0.3124	0.5215	528.6	1.00186	47.87	37.58
900	1.0	5.325	468.4	3.971	0.3124	0.5212	560.5	1.00166	51.90	40.71
1000	1.0	4.793	520.6	4.026	0.3124	0.5210	590.7	1.00149	55.72	43.68
<b><math>P = 10</math> MPa (100 bar)</b>										
86.27	10.0	1428.	-114.2	1.333	0.5519	1.085	891.3	1.51685	300.0	137.1
100	10.0	1349.	-99.27	1.493	0.5089	1.093	805.9	1.48430	205.8	118.6
120	10.0	1222.	-76.82	1.698	0.4650	1.163	674.3	1.43296	130.0	93.55
140	10.0	1066.	-52.01	1.888	0.4374	1.349	527.4	1.37161	85.36	70.81
160	10.0	833.6	-20.15	2.100	0.4356	1.970	357.8	1.28395	50.84	49.64
180	10.0	491.9	26.15	2.373	0.4254	2.091	259.3	1.16159	27.88	30.35
200	10.0	337.7	57.55	2.539	0.3815	1.215	267.7	1.10910	23.43	23.57
220	10.0	270.9	78.52	2.639	0.3585	0.9257	283.7	1.08686	22.90	21.77
240	10.0	231.2	95.59	2.713	0.3457	0.7960	299.0	1.07382	23.22	21.31
260	10.0	204.0	110.7	2.774	0.3379	0.7240	313.1	1.06491	23.87	21.39
280	10.0	183.6	124.7	2.826	0.3327	0.6789	326.1	1.05829	24.68	21.73
300	10.0	167.6	138.0	2.872	0.3290	0.6481	338.4	1.05312	25.58	22.19
320	10.0	154.6	150.7	2.913	0.3264	0.6261	350.0	1.04892	26.53	22.78
340	10.0	143.7	163.1	2.950	0.3243	0.6095	361.0	1.04542	27.51	23.43
360	10.0	134.4	175.1	2.985	0.3228	0.5967	371.6	1.04245	28.49	24.11
400	10.0	119.4	198.6	3.046	0.3205	0.5784	391.5	1.03765	30.48	25.50
500	10.0	94.09	255.0	3.173	0.3174	0.5540	436.1	1.02957	35.35	29.04
600	10.0	78.03	309.8	3.272	0.3159	0.5423	475.7	1.02448	39.97	32.48
700	10.0	66.80	363.7	3.355	0.3151	0.5357	511.7	1.02093	44.34	35.76
800	10.0	58.47	417.0	3.427	0.3145	0.5317	545.1	1.01830	48.47	38.88
900	10.0	52.03	470.0	3.489	0.3142	0.5290	576.4	1.01628	52.40	41.86
1000	10.0	46.88	522.8	3.545	0.3139	0.5271	606.0	1.01466	56.16	44.71

**Methane (CH<sub>4</sub>)**

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
90.69	0.01170	451.5	-71.82	-7099	2.168	3.368	1539.	1.67721	193.4	211.2
90.69	0.01170	0.2507	472.4	5.291	1.574	2.110	249.1	1.00031	3.585	8.776
100	0.03438	438.9	-40.27	-3793	2.114	3.408	1452.	1.65478	151.1	199.6
100	0.03438	0.6746	490.2	4.925	1.589	2.146	260.1	1.00082	3.914	9.910

<i>T</i> K	<i>P</i> MPa	$\rho$ kg m <sup>-3</sup>	<i>H</i> kJ kg <sup>-1</sup>	<i>S</i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>C<sub>v</sub></i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>C<sub>p</sub></i> kJ kg <sup>-1</sup> K <sup>-1</sup>	<i>u</i> m s <sup>-1</sup>	<i>D</i>	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
110	0.08813	424.8	-5.813	-0.05217	2.064	3.469	1355.	1.62995	121.0	186.1
110	0.08813	1.598	508.0	4.619	1.611	2.205	270.0	1.00196	4.273	11.22
120	0.1914	409.9	29.41	0.2521	2.020	3.549	1253.	1.60408	98.68	172.0
120	0.1914	3.262	524.0	4.374	1.639	2.293	277.8	1.00399	4.636	12.66
130	0.3673	394.0	65.63	0.5385	1.980	3.658	1148.	1.57683	81.29	157.7
130	0.3673	5.980	537.7	4.170	1.674	2.421	283.1	1.00733	5.008	14.28
140	0.6412	376.9	103.2	0.8116	1.945	3.813	1038.	1.54771	67.35	143.5
140	0.6412	10.15	548.3	3.991	1.717	2.611	285.9	1.01248	5.398	16.15
150	1.040	357.9	142.6	1.076	1.919	4.047	920.8	1.51599	55.99	129.2
150	1.040	16.33	555.2	3.827	1.773	2.908	286.0	1.02013	5.827	18.38
160	1.592	336.3	184.8	1.338	1.904	4.435	795.4	1.48045	46.55	115.0
160	1.592	25.38	557.1	3.664	1.847	3.419	283.0	1.03144	6.335	21.23
170	2.328	310.5	231.2	1.605	1.910	5.187	657.5	1.43870	38.45	100.5
170	2.328	38.97	551.5	3.490	1.956	4.459	276.7	1.04861	7.012	25.34
180	3.285	276.2	285.9	1.899	1.967	7.292	497.0	1.38453	30.92	85.50
180	3.285	61.38	532.8	3.271	2.140	7.574	266.0	1.07739	8.127	33.50
190	4.519	200.8	378.3	2.369	2.602	94.01	250.3	1.27031	20.34	94.07
190	4.519	125.2	459.0	2.794	2.855	140.8	238.5	1.16274	12.24	120.5
190.56	4.599	162.7	415.6	2.562				1.21521	15.91	
<b><i>P</i> = 0.1 MPa (1 bar)</b>										
90.72	0.1	451.5	-71.60	-7.097	2.168	3.367	1539.	1.67726	193.6	211.2
100	0.1	438.9	-40.17	-3.798	2.114	3.408	1453.	1.65487	151.2	199.6
111.51	0.1	422.6	-5.573	-0.004967	2.057	3.480	1340.	1.62612	117.2	184.0
111.51	0.1	1.795	510.6	4.579	1.615	2.216	271.3	1.00220	4.327	11.43
120	0.1	1.655	529.2	4.740	1.594	2.174	282.8	1.00202	4.668	12.35
140	0.1	1.403	572.1	5.071	1.574	2.129	307.6	1.00172	5.449	14.65
160	0.1	1.221	614.5	5.354	1.568	2.110	330.0	1.00149	6.213	16.98
180	0.1	1.081	656.6	5.602	1.568	2.104	350.7	1.00132	6.963	19.32
200	0.1	0.9709	698.7	5.824	1.574	2.106	370.0	1.00119	7.697	21.65
220	0.1	0.8812	740.9	6.025	1.587	2.115	388.0	1.00108	8.416	23.99
240	0.1	0.8069	783.4	6.209	1.607	2.133	404.9	1.00099	9.117	26.39
260	0.1	0.7442	826.3	6.381	1.634	2.159	420.8	1.00091	9.803	28.88
280	0.1	0.6906	869.8	6.542	1.670	2.194	435.7	1.00085	10.47	31.47
300	0.1	0.6443	914.1	6.695	1.713	2.236	449.7	1.00079	11.13	34.19
320	0.1	0.6038	959.3	6.841	1.763	2.285	463.1	1.00074	11.77	37.04
340	0.1	0.5681	1006.	6.981	1.819	2.340	475.7	1.00070	12.39	40.03
360	0.1	0.5364	1053.	7.117	1.880	2.401	487.8	1.00066	13.00	43.15
400	0.1	0.4826	1152.	7.376	2.013	2.534	510.6	1.00059	14.18	49.80
500	0.1	0.3859	1423.	7.981	2.381	2.901	561.9	1.00047	16.92	68.34
600	0.1	0.3215	1732.	8.543	2.754	3.273	608.0	1.00039	19.41	88.80
700	0.1	0.2756	2077.	9.074	3.110	3.629	650.8	1.00034	21.68	110.4
800	0.1	0.2411	2457.	9.581	3.441	3.959	690.9	1.00030	23.76	132.5
900	0.1	0.2143	2868.	10.06	3.744	4.263	729.0	1.00026	25.70	154.7
1000	0.1	0.1929	3308.	10.53	4.020	4.538	765.2	1.00024	27.49	176.7
<b><i>P</i> = 1 MPa (10 bar)</b>										
90.95	1.0	451.8	-69.37	-7.070	2.169	3.363	1543.	1.67772	195.7	211.7
100	1.0	439.6	-38.76	-3.862	2.116	3.401	1460.	1.65604	153.4	200.5
120	1.0	410.8	30.49	0.2447	2.022	3.536	1262.	1.60560	99.86	173.0
140	1.0	377.5	103.5	0.8069	1.946	3.798	1044.	1.54879	67.81	144.0
149.14	1.0	359.6	139.2	1.054	1.920	4.023	931.2	1.51885	56.88	130.4
149.14	1.0	15.70	554.8	3.841	1.767	2.876	286.1	1.01935	5.788	18.17
160	1.0	13.97	584.2	4.031	1.682	2.588	305.2	1.01720	6.287	18.79
180	1.0	11.81	633.6	4.322	1.631	2.380	333.7	1.01453	7.089	20.65
200	1.0	10.33	680.2	4.568	1.613	2.289	357.8	1.01269	7.838	22.74
220	1.0	9.217	725.5	4.784	1.613	2.248	379.1	1.01133	8.558	24.90
240	1.0	8.344	770.3	4.978	1.626	2.234	398.2	1.01025	9.258	27.19
260	1.0	7.634	815.0	5.157	1.648	2.238	415.8	1.00938	9.939	29.60

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
280	1.0	7.043	859.9	5.324	1.681	2.258	432.0	1.00865	10.60	32.12
300	1.0	6.542	905.4	5.480	1.722	2.289	447.0	1.00803	11.25	34.79
320	1.0	6.110	951.5	5.629	1.770	2.330	461.1	1.00750	11.89	37.59
340	1.0	5.733	998.6	5.772	1.825	2.379	474.4	1.00704	12.51	40.54
360	1.0	5.402	1047.	5.910	1.885	2.434	487.0	1.00663	13.11	43.64
400	1.0	4.846	1147.	6.172	2.017	2.559	510.6	1.00595	14.28	50.23
500	1.0	3.860	1420.	6.781	2.383	2.915	563.0	1.00474	17.01	68.68
600	1.0	3.210	1730.	7.345	2.755	3.282	609.7	1.00394	19.48	89.08
700	1.0	2.750	2076.	7.878	3.110	3.635	652.8	1.00338	21.74	110.6
800	1.0	2.405	2456.	8.385	3.441	3.964	693.1	1.00296	23.82	132.7
900	1.0	2.137	2868.	8.870	3.744	4.266	731.2	1.00263	25.75	154.9
1000	1.0	1.924	3308.	9.334	4.020	4.541	767.5	1.00237	27.54	176.8

 **$P = 10$  MPa (100 bar)**

93.22	10.0	454.5	-47.07	-6806	2.176	3.325	1582.	1.68223	212.8	216.9
100	10.0	446.0	-24.48	-4466	2.139	3.344	1526.	1.66701	174.8	209.0
120	10.0	419.8	43.14	0.1696	2.047	3.424	1352.	1.62085	112.1	183.3
140	10.0	391.2	112.8	0.7062	1.969	3.552	1171.	1.57167	78.30	157.0
160	10.0	358.8	185.8	1.194	1.909	3.777	981.8	1.51718	56.70	131.5
180	10.0	319.6	265.3	1.661	1.873	4.226	780.8	1.45298	41.52	107.0
200	10.0	266.2	358.9	2.153	1.878	5.304	567.9	1.36870	29.55	83.93
220	10.0	187.6	482.7	2.742	1.903	6.713	404.4	1.25087	19.37	63.29
240	10.0	128.4	599.6	3.252	1.847	4.853	383.6	1.16707	14.89	49.74
260	10.0	101.0	683.8	3.589	1.803	3.730	402.8	1.12974	13.80	44.85
280	10.0	85.51	752.9	3.846	1.793	3.242	424.5	1.10902	13.61	43.81
300	10.0	75.18	815.1	4.060	1.807	3.002	444.5	1.09539	13.75	44.37
320	10.0	67.61	873.8	4.250	1.838	2.878	462.8	1.08549	14.04	45.79
340	10.0	61.75	930.6	4.422	1.880	2.817	479.5	1.07786	14.41	47.75
360	10.0	57.01	986.7	4.582	1.931	2.795	494.8	1.07173	14.82	50.09
400	10.0	49.74	1099.	4.877	2.051	2.819	522.6	1.06238	15.72	55.61
500	10.0	38.32	1391.	5.529	2.401	3.055	581.0	1.04783	18.06	72.56
600	10.0	31.47	1712.	6.113	2.766	3.370	630.6	1.03918	20.32	92.15
700	10.0	26.82	2066.	6.657	3.117	3.696	675.2	1.03334	22.44	113.2
800	10.0	23.41	2451.	7.171	3.445	4.008	716.3	1.02907	24.43	134.9
900	10.0	20.79	2866.	7.660	3.747	4.300	754.7	1.02581	26.28	156.8
1000	10.0	18.72	3310.	8.128	4.022	4.568	791.1	1.02323	28.02	178.5

**Ethane (C<sub>2</sub>H<sub>6</sub>)**

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
90.37	0.0000011	651.5	-219.2	-1.655	1.605	2.326	2009.	1.94483	1281.	255.6
90.37	0.0000011	0.0000457	375.6	4.927	0.8916	1.168	180.9	1.00000	3.043	2.908
100	0.0000111	640.9	-197.0	-1.422	1.541	2.283	1938.	1.92579	873.2	247.8
100	0.0000111	0.0004007	386.9	4.418	0.9107	1.187	189.9	1.00000	3.316	3.456
120	0.0003523	618.9	-151.5	-1.007	1.478	2.280	1794.	1.88657	485.8	229.9
120	0.0003523	0.01062	411.0	3.681	0.9528	1.230	206.9	1.00001	3.896	4.657
140	0.003814	596.6	-105.6	-0.6532	1.450	2.311	1649.	1.84725	319.8	210.6
140	0.003814	0.09880	435.6	3.213	1.003	1.284	222.0	1.00011	4.496	5.966
160	0.02141	573.6	-58.95	-0.3418	1.436	2.357	1501.	1.80737	231.2	190.8
160	0.02141	0.4890	460.3	2.904	1.048	1.338	235.1	1.00054	5.110	7.422
180	0.07864	549.5	-11.13	-0.06082	1.434	2.421	1350.	1.76641	176.2	171.3
180	0.07864	1.625	484.2	2.691	1.098	1.409	245.5	1.00181	5.739	9.079
200	0.2172	524.0	38.30	0.1981	1.444	2.512	1196.	1.72364	138.3	152.6
200	0.2172	4.170	506.2	2.538	1.179	1.537	252.3	1.00465	6.391	11.01
220	0.4920	496.3	90.01	0.4419	1.468	2.645	1037.	1.67809	110.1	134.6
220	0.4920	9.017	525.5	2.421	1.280	1.720	254.6	1.01008	7.089	13.32
240	0.9668	465.3	145.0	0.6767	1.507	2.847	873.3	1.62822	87.80	117.5



$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
240	0.9668	17.43	540.9	2.326	1.388	1.976	252.1	1.01957	7.881	16.18
260	1.712	429.1	204.9	0.9095	1.566	3.195	700.5	1.57121	69.30	101.2
260	1.712	31.58	550.2	2.238	1.516	2.418	243.8	1.03567	8.876	20.02
280	2.807	382.7	273.1	1.152	1.654	3.987	512.4	1.50037	52.84	85.43
280	2.807	56.37	548.6	2.136	1.696	3.522	228.1	1.06440	10.37	26.33
300	4.357	303.5	364.4	1.451	1.912	10.02	274.9	1.38458	34.97	71.49
300	4.357	114.5	514.1	1.950	2.089	13.30	200.5	1.13418	14.02	47.46
305.32	4.872	206.2	439.0	1.690				1.25115	21.80	
<b><math>P = 0.1</math> MPa (1 bar)</b>										
90.38	0.1	651.5	-219.0	-1.655	1.605	2.326	2009.	1.94485	1281.	255.6
100	0.1	641.0	-196.9	-1.422	1.541	2.283	1939.	1.92586	873.9	247.9
120	0.1	619.0	-151.4	-1.007	1.478	2.279	1795.	1.88665	486.1	230.0
140	0.1	596.6	-105.5	-0.6535	1.450	2.311	1650.	1.84735	320.0	210.6
160	0.1	573.6	-58.85	-0.3420	1.436	2.357	1502.	1.80747	231.3	190.9
180	0.1	549.5	-11.10	-0.06091	1.434	2.421	1351.	1.76644	176.2	171.4
184.33	0.1	544.1	-5954	-0.03215	1.435	2.438	1317.	1.75734	166.9	167.2
184.33	0.1	2.030	489.1	2.654	1.113	1.432	247.3	1.00226	5.877	9.471
200	0.1	1.856	511.8	2.771	1.149	1.457	257.9	1.00207	6.368	10.72
220	0.1	1.676	541.3	2.912	1.200	1.499	270.3	1.00187	6.991	12.47
240	0.1	1.529	571.8	3.045	1.260	1.554	281.8	1.00170	7.608	14.39
260	0.1	1.407	603.5	3.172	1.328	1.617	292.5	1.00157	8.217	16.48
280	0.1	1.303	636.5	3.294	1.401	1.688	302.6	1.00145	8.817	18.76
300	0.1	1.214	671.1	3.413	1.479	1.764	312.2	1.00135	9.408	21.22
320	0.1	1.137	707.1	3.530	1.560	1.844	321.4	1.00127	9.989	23.85
340	0.1	1.069	744.8	3.644	1.644	1.927	330.3	1.00119	10.56	26.65
360	0.1	1.009	784.2	3.756	1.729	2.011	338.8	1.00112	11.12	29.61
400	0.1	0.9067	868.1	3.977	1.901	2.181	355.2	1.00101	12.21	35.96
500	0.1	0.7242	1107.	4.509	2.315	2.594	393.1	1.00081	14.78	53.77
600	0.1	0.6031	1386.	5.015	2.689	2.967	427.6	1.00067	17.13	73.34
700	0.1	0.5167	1699.	5.498	3.021	3.298	459.6	1.00058	19.32	93.86
800	0.1	0.4520	2044.	5.958	3.314	3.591	489.6	1.00050	21.36	114.8
900	0.1	0.4018	2416.	6.396	3.572	3.849	517.9	1.00045	23.28	135.9
1000	0.1	0.3616	2813.	6.814	3.799	4.076	544.8	1.00040	25.10	156.8
<b><math>P = 1</math> MPa (10 bar)</b>										
90.53	1.0	651.7	-217.5	-1.653	1.605	2.324	2012.	1.94510	1283.	255.9
100	1.0	641.3	-195.7	-1.424	1.542	2.282	1942.	1.92644	880.2	248.3
120	1.0	619.4	-150.2	-1.010	1.480	2.278	1799.	1.88737	489.1	230.5
140	1.0	597.2	-104.4	-0.6563	1.452	2.309	1654.	1.84822	322.0	211.2
160	1.0	574.3	-57.80	-0.3452	1.437	2.354	1508.	1.80855	232.8	191.6
180	1.0	550.4	-10.13	-0.06458	1.435	2.416	1358.	1.76780	177.5	172.1
200	1.0	524.9	39.03	0.1943	1.445	2.505	1204.	1.72518	139.3	153.3
220	1.0	497.1	90.36	0.4388	1.468	2.637	1044.	1.67944	110.7	135.2
240	1.0	465.4	145.0	0.6764	1.507	2.846	873.9	1.62834	87.85	117.6
241.10	1.0	463.5	148.1	0.6894	1.510	2.861	864.0	1.62531	86.70	116.6
241.10	1.0	18.04	541.6	2.321	1.395	1.994	251.8	1.02025	7.929	16.36
260	1.0	15.93	577.9	2.466	1.400	1.880	268.9	1.01786	8.485	17.92
280	1.0	14.32	615.3	2.605	1.449	1.869	283.8	1.01604	9.072	19.91
300	1.0	13.07	652.9	2.735	1.513	1.898	296.9	1.01463	9.652	22.18
320	1.0	12.05	691.3	2.859	1.585	1.948	308.7	1.01349	10.22	24.67
340	1.0	11.21	730.9	2.979	1.663	2.010	319.6	1.01254	10.79	27.36
360	1.0	10.49	771.8	3.095	1.745	2.079	329.9	1.01173	11.34	30.24
400	1.0	9.312	857.9	3.322	1.911	2.230	348.8	1.01041	12.42	36.46
500	1.0	7.323	1101.	3.862	2.321	2.620	390.2	1.00818	14.95	54.08
600	1.0	6.058	1381.	4.372	2.693	2.983	426.6	1.00677	17.29	73.56
700	1.0	5.173	1696.	4.857	3.023	3.309	459.7	1.00578	19.46	94.03
800	1.0	4.518	2042.	5.318	3.315	3.598	490.3	1.00505	21.48	115.0



$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
900	1.0	4.011	2415.	5.757	3.573	3.855	519.0	1.00448	23.39	136.0
1000	1.0	3.608	2812.	6.175	3.800	4.081	546.2	1.00403	25.20	156.9
<b><math>P = 10</math> MPa (100 bar)</b>										
91.96	10.0	653.3	-202.5	-1.640	1.605	2.310	2034.	1.94751	1310.	258.6
100	10.0	644.8	-184.1	-1.448	1.553	2.275	1976.	1.93215	947.3	252.5
120	10.0	623.6	-138.8	-1.035	1.490	2.266	1839.	1.89429	520.6	235.4
140	10.0	602.2	-93.25	-0.6839	1.463	2.290	1701.	1.85661	342.0	216.9
160	10.0	580.4	-47.10	-0.3758	1.449	2.326	1564.	1.81879	248.1	197.9
180	10.0	558.1	-1206	-0.0918	1.447	2.374	1425.	1.78049	190.5	179.3
200	10.0	534.8	47.98	0.1542	1.456	2.439	1287.	1.74125	151.3	161.4
220	10.0	510.2	97.60	0.3905	1.478	2.527	1147.	1.70050	122.4	144.4
240	10.0	483.8	149.3	0.6152	1.511	2.646	1008.	1.65744	99.96	128.5
260	10.0	454.6	203.7	0.8331	1.557	2.809	866.9	1.61088	81.74	113.6
280	10.0	421.4	262.1	1.049	1.616	3.044	724.4	1.55888	66.38	99.57
300	10.0	381.3	326.4	1.271	1.689	3.419	579.3	1.49786	52.87	86.39
320	10.0	328.8	400.9	1.511	1.783	4.109	434.8	1.42048	40.36	73.81
340	10.0	255.9	493.3	1.791	1.888	5.070	319.9	1.31781	28.77	62.21
360	10.0	187.0	591.3	2.071	1.941	4.452	286.8	1.22573	21.62	53.36
400	10.0	126.2	738.6	2.460	2.025	3.205	310.4	1.14850	17.94	48.70
500	10.0	80.57	1035.	3.123	2.369	2.933	377.8	1.09293	17.95	59.52
600	10.0	62.41	1338.	3.675	2.722	3.150	427.4	1.07144	19.50	76.88
700	10.0	51.79	1666.	4.180	3.043	3.415	467.8	1.05903	21.26	96.40
800	10.0	44.59	2021.	4.653	3.330	3.672	502.9	1.05068	23.01	116.8
900	10.0	39.30	2400.	5.100	3.584	3.909	534.3	1.04457	24.73	137.5
1000	10.0	35.20	2802.	5.523	3.809	4.122	563.2	1.03988	26.40	158.2

**Propane (C<sub>3</sub>H<sub>8</sub>)**

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
<b>Saturation</b>										
85.53	0.17×10 <sup>-9</sup>	733.1	-196.6	-1.396	1.355	1.916	2136.	2.08838	10780	207.9
85.53	0.17×10 <sup>-9</sup>	0.11×10 <sup>-7</sup>	366.3	5.186	0.6907	0.8792	143.3	1.00000	2.641	1.706
100	0.25×10 <sup>-7</sup>	718.1	-168.8	-1.095	1.341	1.930	2038.	2.05908	3774.	203.2
100	0.25×10 <sup>-7</sup>	0.0000013	379.4	4.387	0.7475	0.9361	153.7	1.00000	2.979	2.417
120	0.0000030	697.8	-129.9	-0.7411	1.335	1.957	1901.	2.01930	1500.	194.4
120	0.0000030	0.0001310	398.9	3.666	0.8210	1.010	166.8	1.00000	3.467	3.500
140	0.0000790	677.6	-90.51	-0.4372	1.335	1.988	1767.	1.98025	822.2	183.9
140	0.0000790	0.002993	419.7	3.207	0.8878	1.076	178.9	1.00000	3.970	4.699
160	0.0008502	657.3	-50.38	-0.1693	1.342	2.025	1633.	1.94163	535.0	172.3
160	0.0008502	0.02821	441.8	2.907	0.9514	1.141	190.0	1.00003	4.483	6.013
180	0.005068	636.6	-9.433	0.07174	1.356	2.070	1499.	1.90310	382.2	160.2
180	0.005068	0.1499	464.9	2.707	1.017	1.209	200.1	1.00016	5.000	7.439
200	0.02019	615.4	32.53	0.2926	1.383	2.127	1366.	1.86434	288.0	147.8
200	0.02019	0.5417	488.6	2.573	1.088	1.287	208.7	1.00059	5.515	8.971
220	0.06057	593.4	75.80	0.4984	1.421	2.199	1233.	1.82499	224.2	135.7
220	0.06057	1.499	512.7	2.484	1.169	1.381	215.6	1.00164	6.026	10.61
240	0.1480	570.4	120.7	0.6932	1.469	2.289	1102.	1.78460	178.4	124.0
240	0.1480	3.438	536.6	2.426	1.259	1.494	220.1	1.00376	6.540	12.38
260	0.3107	545.8	167.7	0.8801	1.528	2.403	971.7	1.74256	143.9	112.9
260	0.3107	6.903	560.1	2.389	1.357	1.630	221.9	1.00755	7.073	14.32
280	0.5817	519.2	217.3	1.062	1.596	2.547	840.3	1.69800	117.1	102.5
280	0.5817	12.62	582.3	2.365	1.466	1.803	220.4	1.01383	7.655	16.54
300	0.9977	489.4	270.2	1.241	1.675	2.740	706.8	1.64961	95.28	92.86
300	0.9977	21.63	602.6	2.349	1.588	2.041	214.8	1.02381	8.340	19.24
320	1.599	454.9	327.3	1.421	1.764	3.028	569.1	1.59504	76.78	83.94
320	1.599	35.74	619.5	2.334	1.729	2.416	204.4	1.03957	9.230	22.78
340	2.431	411.8	390.9	1.608	1.872	3.585	422.5	1.52907	59.98	75.57

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
340	2.431	58.88	629.8	2.311	1.898	3.197	187.4	1.06579	10.57	28.20
360	3.555	345.6	468.2	1.820	2.049	5.984	251.0	1.43242	42.27	67.72
360	3.555	105.4	622.4	2.249	2.183	7.111	161.1	1.11995	13.38	41.36
369.89	4.251	220.5	555.2	2.052				1.26277	22.89	
<b><math>P = 0.1</math> MPa (1 bar)</b>										
85.53	0.1	733.1	-196.5	-1.396	1.355	1.916	2137.	2.08840	10790	207.9
100	0.1	718.2	-168.7	-1.096	1.341	1.930	2038.	2.05912	3778.	203.2
120	0.1	697.8	-129.8	-0.7413	1.335	1.957	1902.	2.01936	1502.	194.5
140	0.1	677.6	-90.39	-0.4374	1.335	1.988	1767.	1.98032	822.9	184.0
160	0.1	657.3	-50.27	-0.1695	1.342	2.025	1633.	1.94172	535.5	172.4
180	0.1	636.7	-9.328	0.07149	1.357	2.070	1500.	1.90320	382.5	160.2
200	0.1	615.5	32.62	0.2924	1.383	2.127	1366.	1.86444	288.2	147.9
220	0.1	593.5	75.84	0.4983	1.421	2.198	1234.	1.82505	224.3	135.7
230.74	0.1	581.2	99.69	0.6042	1.446	2.245	1163.	1.80347	197.9	129.4
230.74	0.1	2.387	525.6	2.450	1.216	1.439	218.3	1.00261	6.301	11.54
240	0.1	2.284	539.0	2.507	1.249	1.467	222.9	1.00249	6.559	12.40
260	0.1	2.092	569.0	2.627	1.324	1.535	232.3	1.00228	7.110	14.32
280	0.1	1.932	600.5	2.744	1.405	1.610	241.1	1.00211	7.656	16.36
300	0.1	1.796	633.5	2.857	1.490	1.692	249.4	1.00196	8.196	18.51
320	0.1	1.679	668.2	2.969	1.578	1.777	257.3	1.00183	8.732	20.78
340	0.1	1.576	704.6	3.080	1.668	1.865	264.9	1.00172	9.262	23.16
360	0.1	1.486	742.8	3.189	1.758	1.954	272.3	1.00162	9.787	25.66
400	0.1	1.334	824.5	3.404	1.937	2.130	286.2	1.00145	10.82	30.99
500	0.1	1.064	1059.	3.925	2.356	2.547	318.3	1.00116	13.29	46.36
600	0.1	0.8852	1332.	4.422	2.722	2.912	347.4	1.00096	15.59	64.63
700	0.1	0.7581	1640.	4.896	3.038	3.228	374.2	1.00082	17.70	85.81
800	0.1	0.6631	1976.	5.345	3.313	3.502	399.3	1.00072	19.62	109.9
900	0.1	0.5892	2339.	5.772	3.553	3.743	422.8	1.00064	21.36	136.9
1000	0.1	0.5302	2724.	6.177	3.764	3.953	445.1	1.00058	22.93	166.8
<b><math>P = 1</math> MPa (10 bar)</b>										
85.62	1.0	733.3	-195.3	-1.396	1.356	1.916	2139.	2.08856	10840	208.1
100	1.0	718.5	-167.6	-1.097	1.342	1.930	2041.	2.05953	3816.	203.5
120	1.0	698.2	-128.8	-0.7432	1.336	1.956	1905.	2.01987	1515.	194.8
140	1.0	678.1	-89.34	-0.4394	1.336	1.987	1771.	1.98096	829.3	184.3
160	1.0	657.8	-49.24	-0.1717	1.343	2.024	1638.	1.94249	539.4	172.8
180	1.0	637.3	-8.331	0.06918	1.358	2.068	1505.	1.90415	385.3	160.7
200	1.0	616.2	33.57	0.2899	1.384	2.124	1372.	1.86560	290.4	148.4
220	1.0	594.4	76.72	0.4955	1.422	2.194	1241.	1.82648	226.2	136.3
240	1.0	571.5	121.5	0.6901	1.470	2.284	1111.	1.78630	180.0	124.6
260	1.0	547.0	168.2	0.8771	1.528	2.395	980.1	1.74433	145.2	113.5
280	1.0	520.1	217.5	1.060	1.596	2.539	846.7	1.69945	117.9	102.9
300	1.0	489.5	270.2	1.241	1.675	2.740	706.9	1.64962	95.28	92.86
300.09	1.0	489.3	270.4	1.242	1.675	2.741	706.2	1.64937	95.19	92.82
300.09	1.0	21.68	602.7	2.349	1.588	2.042	214.8	1.02386	8.344	19.25
320	1.0	19.34	642.9	2.479	1.646	2.009	229.9	1.02125	8.877	21.49
340	1.0	17.61	683.2	2.601	1.717	2.032	242.4	1.01931	9.414	23.91
360	1.0	16.25	724.3	2.719	1.795	2.081	253.5	1.01779	9.948	26.46
400	1.0	14.17	810.1	2.944	1.958	2.211	272.6	1.01549	11.00	31.92
500	1.0	10.93	1050.	3.478	2.363	2.583	311.6	1.01191	13.48	47.56
600	1.0	8.964	1326.	3.980	2.725	2.933	344.1	1.00976	15.76	66.04
700	1.0	7.623	1635.	4.456	3.040	3.242	372.9	1.00830	17.86	87.38
800	1.0	6.641	1973.	4.907	3.315	3.512	399.1	1.00723	19.76	111.6
900	1.0	5.889	2336.	5.334	3.555	3.750	423.4	1.00641	21.49	138.7
1000	1.0	5.292	2722.	5.741	3.765	3.959	446.3	1.00576	23.04	168.7
<b><math>P = 10</math> MPa (100 bar)</b>										
86.45	10.0	735.2	-182.9	-1.394	1.362	1.914	2159.	2.09013	11310	209.8
100	10.0	721.5	-156.9	-1.115	1.350	1.927	2070.	2.06349	4212.	205.7

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
120	10.0	701.8	-118.1	-7615	1.344	1.951	1939.	2.02490	1649.	197.6
140	10.0	682.2	-78.80	-4586	1.345	1.979	1809.	1.98713	894.7	187.7
160	10.0	662.7	-38.90	-1922	1.352	2.012	1682.	1.94997	579.3	176.7
180	10.0	643.1	1.726	0.04696	1.367	2.052	1556.	1.91318	413.7	165.2
200	10.0	623.2	43.23	0.2656	1.393	2.101	1432.	1.87653	312.8	153.5
220	10.0	602.8	85.84	0.4686	1.430	2.162	1310.	1.83978	245.3	142.0
240	10.0	581.9	129.8	0.6598	1.478	2.236	1192.	1.80267	197.1	130.9
260	10.0	560.1	175.4	0.8422	1.535	2.325	1077.	1.76484	161.3	120.5
280	10.0	537.1	222.9	1.018	1.600	2.429	963.4	1.72590	133.7	110.7
300	10.0	512.7	272.7	1.190	1.673	2.550	852.7	1.68529	111.7	101.8
320	10.0	486.1	325.0	1.359	1.751	2.692	744.0	1.64228	93.65	93.68
340	10.0	456.7	380.5	1.527	1.833	2.865	637.1	1.59580	78.30	86.37
360	10.0	423.2	439.9	1.697	1.921	3.085	532.1	1.54422	64.77	79.79
400	10.0	334.5	576.0	2.054	2.111	3.790	339.0	1.41464	41.09	68.25
500	10.0	143.3	947.1	2.887	2.438	3.221	275.9	1.16393	19.83	58.85
600	10.0	99.02	1263.	3.462	2.755	3.183	330.8	1.11103	19.67	73.95
700	10.0	78.82	1591.	3.967	3.058	3.386	372.8	1.08759	20.88	95.32
800	10.0	66.46	1940.	4.434	3.328	3.610	407.1	1.07350	22.27	120.1
900	10.0	57.89	2312.	4.871	3.565	3.821	436.7	1.06382	23.62	148.0
1000	10.0	51.49	2704.	5.284	3.774	4.013	463.1	1.05665	24.89	178.8

Carbon Dioxide (CO<sub>2</sub>)

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
Saturation										
216.59	0.5180	1178.	80.04	0.5213	0.9747	1.953	975.8	1.75696	256.7	180.6
216.59	0.5180	13.76	430.4	2.139	0.6292	0.9087	222.8	1.00694	10.95	11.01
220	0.5991	1166.	86.73	0.5517	0.9698	1.962	951.2	1.74853	242.0	176.2
220	0.5991	15.82	431.6	2.119	0.6389	0.9303	223.1	1.00798	11.14	11.30
230	0.8929	1129.	106.6	0.6387	0.9567	1.997	879.1	1.72239	204.2	163.3
230	0.8929	23.27	434.6	2.065	0.6700	1.005	223.6	1.01178	11.69	12.22
240	1.282	1089.	126.8	0.7235	0.9454	2.051	806.4	1.69398	173.0	150.7
240	1.282	33.30	436.5	2.014	0.7053	1.103	223.0	1.01692	12.27	13.30
250	1.785	1046.	147.7	0.8068	0.9364	2.132	731.8	1.66298	146.7	138.5
250	1.785	46.64	437.0	1.964	0.7459	1.237	221.2	1.02382	12.90	14.61
260	2.419	998.9	169.4	0.8895	0.9323	2.255	652.6	1.62876	124.4	126.3
260	2.419	64.42	435.9	1.914	0.7943	1.429	218.2	1.03309	13.61	16.31
270	3.203	945.8	192.4	0.9732	0.9396	2.453	565.5	1.59026	105.0	114.3
270	3.203	88.37	432.6	1.863	0.8517	1.731	213.8	1.04574	14.47	18.69
280	4.161	883.6	217.3	1.060	0.9605	2.814	471.5	1.54547	87.73	102.0
280	4.161	121.7	425.9	1.805	0.9232	2.277	207.7	1.06363	15.60	22.47
290	5.318	804.7	245.6	1.154	0.9937	3.676	371.9	1.48961	71.41	89.55
290	5.318	172.0	413.8	1.734	1.026	3.614	199.4	1.09112	17.36	29.82
300	6.713	679.2	283.4	1.276	1.120	8.698	245.7	1.40346	53.11	80.59
300	6.713	268.6	387.1	1.622	1.248	11.92	185.3	1.14588	21.31	53.69
304.13	7.377	467.6	332.2	1.434				1.26600	33.04	
$P = 0.1$ MPa (1 bar)										
220	0.1	2.439	442.2	2.492	0.5791	0.7807	233.4	1.00122	11.06	10.90
240	0.1	2.228	458.0	2.561	0.5981	0.7962	243.2	1.00112	12.07	12.24
260	0.1	2.052	474.1	2.625	0.6184	0.8142	252.3	1.00103	13.06	13.68
280	0.1	1.902	490.6	2.686	0.6390	0.8333	261.0	1.00095	14.05	15.20
300	0.1	1.773	507.4	2.745	0.6593	0.8525	269.4	1.00089	15.02	16.79
320	0.1	1.661	524.7	2.800	0.6791	0.8715	277.4	1.00083	15.98	18.42
340	0.1	1.562	542.3	2.854	0.6982	0.8900	285.2	1.00078	16.93	20.09
360	0.1	1.474	560.3	2.905	0.7165	0.9079	292.8	1.00074	17.87	21.77
400	0.1	1.326	597.3	3.002	0.7510	0.9417	307.3	1.00066	19.70	25.14
500	0.1	1.059	695.2	3.221	0.8255	1.015	340.6	1.00053	24.02	33.49
600	0.1	0.8824	799.9	3.411	0.8867	1.076	370.8	1.00044	28.00	41.55

$T$ K	$P$ MPa	$\rho$ kg m <sup>-3</sup>	$H$ kJ kg <sup>-1</sup>	$S$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_v$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$C_p$ kJ kg <sup>-1</sup> K <sup>-1</sup>	$u$ m s <sup>-1</sup>	$D$	$\eta$ μPa s	$\lambda$ mW m <sup>-1</sup> K <sup>-1</sup>
700	0.1	0.7562	910.2	3.581	0.9375	1.127	398.7	1.00038	31.68	49.30
800	0.1	0.6616	1025.	3.735	0.9800	1.169	424.7	1.00033	35.09	56.71
900	0.1	0.5880	1144.	3.874	1.015	1.205	449.2	1.00029	38.27	63.80
1000	0.1	0.5292	1266.	4.003	1.045	1.234	472.4	1.00027	41.26	70.57
<b><math>P = 1</math> MPa (10 bar)</b>										
216.70	1.0	1179.	80.37	0.5210	0.9751	1.950	977.8	1.75735	257.2	180.9
220	1.0	1167.	86.83	0.5506	0.9703	1.959	953.6	1.74911	242.8	176.5
233.03	1.0	1117.	112.7	0.6646	0.9530	2.011	857.2	1.71404	194.1	159.5
233.03	1.0	26.01	435.3	2.049	0.6803	1.032	223.5	1.01318	11.86	12.53
240	1.0	24.86	442.4	2.079	0.6733	0.9991	228.5	1.01259	12.20	12.94
260	1.0	22.21	461.7	2.157	0.6656	0.9450	241.2	1.01123	13.18	14.26
280	1.0	20.20	480.4	2.226	0.6709	0.9252	252.3	1.01019	14.15	15.71
300	1.0	18.58	498.8	2.289	0.6822	0.9209	262.4	1.00937	15.11	17.25
320	1.0	17.23	517.3	2.349	0.6960	0.9243	271.8	1.00868	16.07	18.84
340	1.0	16.09	535.8	2.405	0.7111	0.9320	280.6	1.00810	17.01	20.47
360	1.0	15.11	554.6	2.459	0.7266	0.9421	289.0	1.00760	17.94	22.12
400	1.0	13.48	592.7	2.559	0.7575	0.9655	304.7	1.00677	19.76	25.46
500	1.0	10.66	692.4	2.781	0.8282	1.027	339.8	1.00535	24.06	33.74
600	1.0	8.845	798.0	2.974	0.8881	1.083	370.9	1.00444	28.04	41.76
700	1.0	7.564	908.8	3.144	0.9384	1.132	399.2	1.00379	31.71	49.47
800	1.0	6.610	1024.	3.298	0.9805	1.173	425.5	1.00332	35.12	56.86
900	1.0	5.872	1143.	3.438	1.016	1.207	450.2	1.00295	38.30	63.93
1000	1.0	5.283	1265.	3.567	1.046	1.236	473.6	1.00265	41.28	70.69
<b><math>P = 10</math> MPa (100 bar)</b>										
218.60	10.0	1190.	86.78	0.5155	0.9827	1.902	1012.	1.76433	266.3	185.4
220	10.0	1186.	89.44	0.5277	0.9806	1.904	1003.	1.76113	260.2	183.6
240	10.0	1115.	127.9	0.6949	0.9536	1.949	870.9	1.71160	189.4	159.2
260	10.0	1035.	167.8	0.8545	0.9340	2.052	735.5	1.65372	139.5	136.0
280	10.0	938.2	210.8	1.014	0.9263	2.280	588.7	1.58337	102.2	113.1
300	10.0	801.6	261.8	1.189	0.9496	2.991	414.3	1.48612	71.03	88.91
320	10.0	448.3	362.9	1.514	1.058	7.617	219.1	1.25290	32.39	60.44
340	10.0	258.6	443.4	1.759	0.9025	2.402	238.1	1.13908	22.80	35.70
360	10.0	208.2	483.0	1.873	0.8526	1.707	257.8	1.11030	21.83	31.88
400	10.0	161.5	542.1	2.029	0.8287	1.333	286.9	1.08425	22.23	31.58
500	10.0	113.1	663.8	2.301	0.8552	1.162	337.4	1.05801	25.39	37.26
600	10.0	89.94	779.3	2.511	0.9017	1.156	375.4	1.04580	28.94	44.39
700	10.0	75.49	895.9	2.691	0.9465	1.178	407.4	1.03828	32.39	51.59
800	10.0	65.35	1015.	2.850	0.9859	1.205	435.8	1.03305	35.66	58.65
900	10.0	57.76	1137.	2.993	1.020	1.231	461.8	1.02916	38.75	65.48
1000	10.0	51.82	1261.	3.124	1.048	1.255	485.9	1.02613	41.66	72.05

# VIRIAL COEFFICIENTS OF SELECTED GASES

Henry V. Kehiaian

This table gives second virial coefficients of about 110 inorganic and organic gases as a function of temperature. Selected data from the literature have been fitted by least squares to the equation

$$B / \text{cm}^3 \text{mol}^{-1} = \sum_{i=1}^n a(i) [(T_0 / T) - 1]^{i-1}$$

where  $T_0 = 298.15$  K. The table gives the coefficients  $a(i)$  and values of  $B$  at fixed temperature increments, as calculated from this smoothing equation.

The equation may be used with the tabulated coefficients for interpolation within the indicated temperature range. It should not be used for extrapolation beyond this range.

Compounds are listed in the modified Hill order (see Introduction), with carbon-containing compounds following those compounds not containing carbon.

A useful compilation of virial coefficient data from the literature may be found in the reference.

## Reference

J. H. Dymond and E. B. Smith, *The Virial Coefficients of Pure Gases and Mixtures, A Critical Compilation*, Oxford University Press, Oxford, 1980.

Compounds Not Containing Carbon				Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>		
Ar	Argon	100	-184	F <sub>2</sub>	Fluorine	500	-97		
		120	-131			600	-59		
140	-98	700	-36						
$a(1) = -16$	160	-76	800			-22			
$a(2) = -60$	180	-60	900			-12			
$a(3) = -9.7$	200	-48	80			-378			
$a(4) = -1.5$	300	-16	110			-165			
	400	-1	140			-109			
	500	7	170			-79			
	600	12	200			-55			
	700	15	230	-33					
	800	18	260	-14					
	900	20	210	-268					
	1000	22	240	-213					
BF <sub>3</sub>	Boron trifluoride	200	-338	F <sub>4</sub> Si	Silicon tetrafluoride	270	-170		
		240	-202			300	-138		
		280	-129			330	-108		
		$a(1) = -106$	320			-85	360	-84	
		$a(2) = -330$	360			-56	390	-64	
		$a(3) = -251$	400			-37	420	-47	
		$a(4) = -80$	440			-23	450	-32	
ClH	Hydrogen chloride	190	-451			F <sub>5</sub> I	Iodine pentafluoride	320	-2540
		230	-269					330	-2344
		270	-181					340	-2172
		$a(1) = -144$	310	-132	350			-2021	
		$a(2) = -325$	350	-102	360			-1890	
		$a(3) = -277$	390	-81	370			-1775	
		$a(4) = -170$	430	-66	380			-1674	
			470	-54	390			-1587	
					400			-1510	
					410			-1443	
Cl <sub>2</sub>	Chlorine	210	-508	F <sub>5</sub> P	Phosphorus pentafluoride	320	-162		
		220	-483			340	-143		
		230	-457			360	-127		
		$a(1) = -303$	240			-432	380	-112	
		$a(2) = -555$	250			-407	400	-98	
		$a(3) = 9$	260			-383	420	-86	
		$a(4) = 329$	270			-360	440	-75	
		$a(5) = 68$	280			-339	460	-64	
			290			-318			
			300			-299			
			350	-221	F <sub>6</sub> Mo	Molybdenum hexafluoride	300	-896	
			400	-166			310	-810	
			450	-126			320	-737	

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
	$a(1) = -914$	330	-677			1100	-14
	$a(2) = -2922$	340	-627			1200	-11
	$a(3) = -4778$	350	-586	H <sub>3</sub> N	Ammonia	290	-302
		360	-553			300	-265
		370	-527			310	-236
		380	-506		$a(1) = -271$	320	-213
F <sub>6</sub> S	Sulfur hexafluoride	390	-491		$a(2) = -1022$	330	-194
		200	-685		$a(3) = -2715$	340	-179
		250	-416		$a(4) = -4189$	350	-166
		300	-275			360	-154
	$a(1) = -279$	350	-190			370	-144
	$a(2) = -647$	400	-135			380	-135
	$a(3) = -335$	450	-96			400	-118
	$a(4) = -72$	500	-68			420	-101
F <sub>6</sub> U	Uranium hexafluoride	320	-1030	H <sub>3</sub> P	Phosphine	190	-457
		340	-905			200	-404
		360	-805			210	-364
	$a(1) = -1204$	380	-724		$a(1) = -146$	220	-332
	$a(2) = -2690$	400	-658		$a(2) = -733$	230	-305
	$a(3) = -2144$	420	-604		$a(3) = 1022$	240	-281
		440	-560		$a(4) = -1220$	250	-258
F <sub>6</sub> W	Tungsten hexafluoride	320	-641			260	-235
		340	-578			270	-213
		360	-523			280	-190
	$a(1) = -719$	380	-473			290	-166
	$a(2) = -1143$	400	-428	He	Helium	2	-172
		420	-387			6	-48
		440	-350			10	-24
		460	-317		$a(1) = 12.44$	14	-13
H <sub>2</sub>	Hydrogen	15	-230		$a(2) = -1.25$	18	-7
		20	-151			22	-3
		25	-108			26	-1
	$a(1) = 15.4$	30	-82			30	1
	$a(2) = -9.0$	35	-64			50	6
	$a(3) = -0.21$	40	-52			70	8
		45	-42			90	10
		50	-35			110	10
		60	-24			150	11
		70	-16			250	12
		80	-11			650	13
		90	-7			700	13
		100	-3	Kr	Krypton	110	-363
		200	11			120	-307
		300	15			130	-263
		400	18		$a(1) = -51$	140	-229
H <sub>2</sub> O	Water	300	-1126		$a(2) = -118$	150	-201
		320	-850		$a(3) = -29$	160	-178
		340	-660		$a(4) = -5$	170	-159
	$a(1) = -1158$	360	-526			180	-143
	$a(2) = -5157$	380	-428			190	-129
	$a(3) = -10301$	400	-356			200	-117
	$a(4) = -10597$	420	-301			250	-75
	$a(5) = -4415$	440	-258			300	-51
		460	-224			400	-23
		480	-197			500	-8
		500	-175			600	2
		600	-104			700	8
		700	-67	NO	Nitric oxide	120	-232
		800	-44			130	-176
		900	-30			140	-138
		1000	-20		$a(1) = -12$	150	-113

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
	<i>a</i> (2) = -119	160	-96		<i>a</i> (1) = -430	380	-221
	<i>a</i> (3) = 89	170	-83		<i>a</i> (2) = -1193	410	-181
	<i>a</i> (4) = -73	180	-73		<i>a</i> (3) = -1029	440	-153
		190	-65			470	-132
		200	-58	Xe	Xenon	160	-421
		210	-52			170	-377
		230	-42			180	-340
		250	-32		<i>a</i> (1) = -130	190	-307
		270	-24		<i>a</i> (2) = -262	200	-280
N <sub>2</sub>	Nitrogen	75	-274		<i>a</i> (3) = -87	210	-255
		100	-161			220	-234
		125	-104			230	-215
	<i>a</i> (1) = -4.3	150	-71			240	-199
	<i>a</i> (2) = -55.7	175	-49			250	-184
	<i>a</i> (3) = -11.8	200	-34			300	-129
		225	-24			350	-93
		250	-15			400	-69
		300	-4			500	-39
		400	9			600	-21
		500	16			650	-14
		600	21				
		700	24				
N <sub>2</sub> O	Nitrous oxide	240	-219				
		260	-181				
		280	-151				
	<i>a</i> (1) = -130	300	-128				
	<i>a</i> (2) = -307	320	-110				
	<i>a</i> (3) = -248	340	-96				
		360	-85				
		380	-76				
		400	-68				
Ne	Neon	60	-25				
		80	-13				
		100	-6				
	<i>a</i> (1) = 10.8	120	-1				
	<i>a</i> (2) = -7.5	140	2				
	<i>a</i> (3) = -0.4	160	4				
		180	6				
		200	7				
		300	11				
		400	13				
		500	14				
		600	15				
O <sub>2</sub>	Oxygen	90	-241				
		110	-161				
		130	-117				
	<i>a</i> (1) = -16	150	-88				
	<i>a</i> (2) = -62	170	-69				
	<i>a</i> (3) = -8	190	-55				
	<i>a</i> (4) = -3	210	-44				
		230	-36				
		250	-29				
		270	-23				
		290	-18				
		310	-14				
		330	-10				
		350	-7				
		400	-1				
O <sub>2</sub> S	Sulfur dioxide	290	-465				
		320	-354				
		350	-276				

Compounds Containing Carbon			
Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
CClF <sub>3</sub>	Chlorotrifluoromethane	240	-369
		290	-237
		340	-165
	<i>a</i> (1) = -223	390	-119
	<i>a</i> (2) = -504	440	-86
	<i>a</i> (3) = -340	490	-60
	<i>a</i> (4) = -291	540	-39
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	250	-769
		280	-570
		310	-441
	<i>a</i> (1) = -486	340	-353
	<i>a</i> (2) = -1217	370	-289
	<i>a</i> (3) = -1188	400	-241
	<i>a</i> (4) = -698	430	-204
		460	-174
CCl <sub>3</sub> F	Trichlorofluoromethane	240	-1140
		280	-879
		320	-689
	<i>a</i> (1) = -786	360	-545
	<i>a</i> (2) = -1428	400	-431
	<i>a</i> (3) = -142	440	-340
		480	-265
CCl <sub>4</sub>	Tetrachloromethane	320	-1345
		340	-1171
		360	-1040
	<i>a</i> (1) = -1600	380	-942
	<i>a</i> (2) = -4059	400	-868
	<i>a</i> (3) = -4653	420	-814
CF <sub>4</sub>	Tetrafluoromethane	250	-137
		300	-87
		350	-55
	<i>a</i> (1) = -88	400	-32
	<i>a</i> (2) = -238	450	-16
	<i>a</i> (3) = -70	500	-4
		600	14
		700	25

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
		800	33	CH <sub>3</sub> Cl	Chloromethane	280	-466
CHClF <sub>2</sub>	Chlorodifluoromethane	300	-343			300	-402
		325	-298			320	-348
		350	-257		<i>a</i> (1) = -407	340	-304
	<i>a</i> (1) = -347	375	-221		<i>a</i> (2) = -887	360	-266
	<i>a</i> (2) = -575	400	-188		<i>a</i> (3) = -385	380	-234
	<i>a</i> (3) = 187	425	-158			400	-206
CHCl <sub>2</sub> F	Dichlorofluoromethane	250	-728			420	-182
		275	-634			440	-161
		300	-557			460	-142
	<i>a</i> (1) = -562	325	-491			480	-126
	<i>a</i> (2) = -862	350	-434			500	-112
		375	-385			600	-58
		400	-343	CH <sub>3</sub> F	Fluoromethane	280	-244
		425	-305			300	-205
		450	-271			320	-174
CHCl <sub>3</sub>	Trichloromethane	320	-1001		<i>a</i> (1) = -209	340	-150
		330	-926		<i>a</i> (2) = -525	360	-129
		340	-858		<i>a</i> (3) = -365	380	-112
	<i>a</i> (1) = -1193	350	-797			400	-99
	<i>a</i> (2) = -2936	360	-740			420	-87
	<i>a</i> (3) = -1751	370	-689	CH <sub>3</sub> I	Iodomethane	310	-725
		380	-642			320	-646
		390	-599			330	-582
		400	-559		<i>a</i> (1) = -844	340	-531
CHF <sub>3</sub>	Trifluoromethane	200	-433		<i>a</i> (2) = -3353	350	-492
		220	-350		<i>a</i> (3) = -6590	360	-462
		240	-288			370	-441
	<i>a</i> (1) = -177	260	-241			380	-427
	<i>a</i> (2) = -399	280	-204	CH <sub>4</sub>	Methane	110	-328
	<i>a</i> (3) = -250	300	-174			120	-276
		320	-151			130	-237
		340	-132		<i>a</i> (1) = -43	140	-206
		360	-116		<i>a</i> (2) = -114	150	-181
		380	-103		<i>a</i> (3) = -19	160	-160
		400	-91		<i>a</i> (4) = -7	170	-143
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	320	-706			180	-128
		330	-634			190	-116
		340	-574			200	-105
	<i>a</i> (1) = -913	350	-524			250	-66
	<i>a</i> (2) = -3371	360	-482			300	-43
	<i>a</i> (3) = -5013	370	-447			350	-27
		380	-420			400	-16
		400	-380			500	0
		420	-357			600	10
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane	280	-375	CH <sub>4</sub> O	Methanol	320	-1431
		290	-343			330	-1299
		300	-316			340	-1174
	<i>a</i> (1) = -321	310	-294		<i>a</i> (1) = -1752	350	-1056
	<i>a</i> (2) = -754	320	-275		<i>a</i> (2) = -4694	360	-945
	<i>a</i> (3) = -1300	330	-260			370	-840
		340	-248			380	-741
		350	-238			390	-646
CH <sub>3</sub> Br	Bromomethane	280	-645			400	-557
		290	-596	CH <sub>3</sub> N	Methylamine	300	-451
		300	-551			325	-367
	<i>a</i> (1) = -559	310	-509			350	-304
	<i>a</i> (2) = -1324	320	-469		<i>a</i> (1) = -459	375	-257
		340	-396		<i>a</i> (2) = -1191	400	-220
		360	-332		<i>a</i> (3) = -995	425	-192
		380	-274			450	-170



Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
		500	-140			270	-263
		550	-122	C <sub>2</sub> H <sub>3</sub> N	Ethanenitrile	330	-3468
CO	Carbon monoxide	210	-36			340	-2971
		240	-24			350	-2563
		270	-15		<i>a</i> (1) = -5840	360	-2233
	<i>a</i> (1) = -9	300	-8		<i>a</i> (2) = -29175	370	-1970
	<i>a</i> (2) = -58	330	-3		<i>a</i> (3) = -47611	380	-1765
	<i>a</i> (3) = -18	360	1			390	-1610
		420	7			400	-1499
		480	11			410	-1425
CO <sub>2</sub>	Carbon dioxide	220	-244	C <sub>2</sub> H <sub>4</sub>	Ethene	240	-218
		240	-204			270	-172
		260	-172			300	-139
	<i>a</i> (1) = -127	280	-146		<i>a</i> (1) = -140	330	-113
	<i>a</i> (2) = -288	300	-126		<i>a</i> (2) = -296	360	-92
	<i>a</i> (3) = -118	320	-108		<i>a</i> (3) = -101	390	-76
		340	-94			420	-63
		360	-81			450	-52
		380	-71	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	370	-812
		400	-62			390	-716
		500	-30			410	-635
		600	-13		<i>a</i> (1) = -1362	430	-566
		700	-1		<i>a</i> (2) = -3240	450	-508
		800	7		<i>a</i> (3) = -2100	470	-458
		900	12			490	-416
		1000	16			510	-379
		1100	19			530	-347
CS <sub>2</sub>	Carbon disulfide	280	-932			550	-319
		310	-740			570	-295
		340	-603	C <sub>2</sub> H <sub>4</sub> O	Ethanal	290	-1352
	<i>a</i> (1) = -807	370	-504			320	-927
	<i>a</i> (2) = -1829	400	-431			350	-654
	<i>a</i> (3) = -1371	430	-375		<i>a</i> (1) = -1217	380	-482
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichloro-1,1,2,2-tetrafluoroethane	300	-801		<i>a</i> (2) = -4647	410	-375
		320	-695		<i>a</i> (3) = -5725	440	-314
		340	-608			470	-283
	<i>a</i> (1) = -812	360	-536	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl methanoate	320	-821
	<i>a</i> (2) = -1773	380	-475			330	-744
	<i>a</i> (3) = -963	400	-423			340	-677
		420	-379		<i>a</i> (1) = -1035	350	-620
		440	-341		<i>a</i> (2) = -3425	360	-571
		460	-307		<i>a</i> (3) = -4203	370	-528
		480	-279			380	-492
		500	-253			390	-461
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichloro-1,1,2,2-trifluoroethane	290	-1041			400	-435
		310	-943	C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	320	-634
		330	-856			360	-450
		350	-780		<i>a</i> (1) = -777	400	-330
	<i>a</i> (1) = -999	370	-712		<i>a</i> (2) = -2205	440	-249
	<i>a</i> (2) = -1479	390	-651		<i>a</i> (3) = -1764	480	-195
		410	-596			520	-157
		430	-546			560	-131
		450	-500			600	-114
C <sub>2</sub> H <sub>2</sub>	Ethyne	200	-573			200	-409
		210	-500			220	-337
		220	-440			240	-284
	<i>a</i> (1) = -216	230	-390		<i>a</i> (1) = -184	260	-242
	<i>a</i> (2) = -375	240	-349		<i>a</i> (2) = -376	280	-209
	<i>a</i> (3) = -716	250	-315		<i>a</i> (3) = -143	300	-181
		260	-287		<i>a</i> (4) = -54	320	-159
						340	-140

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
		360	-123			440	-146
		380	-109			460	-131
		400	-96			480	-118
		500	-52			500	-106
C <sub>2</sub> H <sub>6</sub> O	Ethanol	600	-24	C <sub>3</sub> H <sub>6</sub> O	2-Propanone	300	-1996
		320	-2710			320	-1522
		330	-2135			340	-1198
		340	-1676		<i>a</i> (1) = -2051	360	-971
	<i>a</i> (1) = -4475	350	-1317		<i>a</i> (2) = -8903	380	-806
	<i>a</i> (2) = -29719	360	-1043		<i>a</i> (3) = -18056	400	-683
	<i>a</i> (3) = -56716	370	-843		<i>a</i> (4) = -16448	420	-586
		380	-705			440	-506
		390	-622			460	-437
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	275	-536			480	-375
		280	-517	C <sub>3</sub> H <sub>6</sub> O	Ethyl methanoate	330	-1003
		285	-499			340	-916
	<i>a</i> (1) = -455	290	-482			350	-839
	<i>a</i> (2) = -965	295	-465		<i>a</i> (1) = -1371	360	-771
		300	-449		<i>a</i> (2) = -4231	370	-712
		305	-433		<i>a</i> (3) = -4312	380	-660
		310	-418			390	-614
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	310	-606	C <sub>3</sub> H <sub>6</sub> O	Methyl ethanoate	320	-1320
		320	-563			330	-1186
		330	-523			340	-1074
	<i>a</i> (1) = -662	340	-487		<i>a</i> (1) = -1709	350	-980
	<i>a</i> (2) = -1504	350	-454		<i>a</i> (2) = -6348	360	-903
	<i>a</i> (3) = -667	360	-423		<i>a</i> (3) = -9650	370	-840
		370	-395			380	-789
		380	-369			390	-749
		390	-345	C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	310	-1001
		400	-322			340	-772
C <sub>2</sub> H <sub>7</sub> N	Ethylamine	300	-773			370	-614
		310	-710		<i>a</i> (1) = -1121	400	-501
		320	-654		<i>a</i> (2) = -3271	430	-417
	<i>a</i> (1) = -785	330	-604		<i>a</i> (3) = -3786	460	-352
	<i>a</i> (2) = -2012	340	-558		<i>a</i> (4) = -1974	490	-302
	<i>a</i> (3) = -1397	350	-517			520	-261
		360	-480			550	-227
		370	-447			580	-198
		380	-416	C <sub>3</sub> H <sub>8</sub>	Propane	240	-641
		390	-389			260	-527
		400	-363			280	-444
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	300	-383		<i>a</i> (1) = -386	300	-381
		310	-356		<i>a</i> (2) = -844	320	-331
		320	-332		<i>a</i> (3) = -720	340	-292
	<i>a</i> (1) = -388	330	-310		<i>a</i> (4) = -574	360	-259
	<i>a</i> (2) = -861	340	-290			380	-232
	<i>a</i> (3) = -538	350	-272			400	-208
		360	-256			440	-169
		370	-241			480	-138
		380	-227			520	-112
		390	-215			560	-90
		400	-204	C <sub>3</sub> H <sub>8</sub> O	1-Propanol	380	-873
C <sub>3</sub> H <sub>6</sub>	Propene	280	-395			385	-826
		300	-342			390	-783
		320	-299		<i>a</i> (1) = -2690	395	-744
	<i>a</i> (1) = -347	340	-262		<i>a</i> (2) = -12040	400	-709
	<i>a</i> (2) = -727	360	-232		<i>a</i> (3) = -16738	405	-679
	<i>a</i> (3) = -325	380	-205			410	-651
		400	-183			415	-627
		420	-163			420	-606

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>			
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	380	-821	C <sub>4</sub> H <sub>10</sub>	Butane	250	-1170			
		385	-766			280	-863			
		390	-717			310	-668			
		<i>a</i> (1) = -3165	395			-674	340	-536		
		<i>a</i> (2) = -16092	400			-636	370	-442		
		<i>a</i> (3) = -24197	405			-604	400	-371		
			410			-576	430	-315		
			415			-552	460	-270		
			420			-533	490	-232		
			310			-675	520	-199		
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	320	-628	C <sub>4</sub> H <sub>10</sub>	2-Methylpropane	270	-900			
		330	-585			300	-697			
		<i>a</i> (1) = -737	340			-547	330	-553		
		<i>a</i> (2) = -1669	350			-512	360	-450		
		<i>a</i> (3) = -986	360			-480	390	-374		
			370			-450	420	-317		
			300			-624	450	-273		
			320			-539	480	-240		
			340			-470	510	-215		
			360			-413	350	-1693		
C <sub>4</sub> H <sub>8</sub>	1-Butene	300	-624	C <sub>4</sub> H <sub>10</sub> O	1-Butanol	360	-1544			
		320	-539			370	-1402			
		340	-470			<i>a</i> (1) = -2629	380	-1268		
		<i>a</i> (1) = -633	360			-413	<i>a</i> (2) = -6315	390	-1141	
		<i>a</i> (2) = -1442	380			-366	400	-1021		
		<i>a</i> (3) = -932	400			-327	420	-796		
			420			-294	440	-593		
			310			-2056	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	390	-1076
			320			-1878			400	-979
			330			-1712			410	-887
<i>a</i> (1) = -2282	340	-1555	<i>a</i> (1) = -2269	420	-800					
<i>a</i> (2) = -5907	350	-1407	<i>a</i> (2) = -5065	430	-716					
	360	-1267	440	-636						
	370	-1135	C <sub>4</sub> H <sub>10</sub> O	2-Butanol	380	-1110				
	330	-1496			390	-1005				
	340	-1354			400	-906				
<i>a</i> (1) = -2118	350	-1231			<i>a</i> (1) = -2232	410			-811	
<i>a</i> (2) = -7299	360	-1126			<i>a</i> (2) = -5209	420	-721			
<i>a</i> (3) = -8851	370	-1035			C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	380	-924		
	380	-957					390	-827		
	390	-890					400	-736		
	400	-834					<i>a</i> (1) = -1952	410	-649	
	330	-1543					<i>a</i> (2) = -4775	420	-567	
	340	-1385	C <sub>4</sub> H <sub>10</sub> O	Diethyl ether			280	-1550		
	350	-1254					300	-1199		
<i>a</i> (1) = -2272	360	-1144					320	-954		
<i>a</i> (2) = -8818	370	-1055					<i>a</i> (1) = -1226	340	-776	
<i>a</i> (3) = -13130	380	-982					<i>a</i> (2) = -4458	360	-638	
	390	-923			<i>a</i> (3) = -7746	380	-525			
	400	-878			<i>a</i> (4) = -10005	400	-428			
	330	-1588			420	-340				
	340	-1444			C <sub>4</sub> H <sub>11</sub> N	Diethylamine	320	-1228		
	350	-1319					330	-1134		
<i>a</i> (1) = -2216	360	-1211	340	-1056						
<i>a</i> (2) = -7339	370	-1117	<i>a</i> (1) = -1522	350			-988			
<i>a</i> (3) = -8658	380	-1037	<i>a</i> (2) = -5204	360			-926			
	390	-968	<i>a</i> (3) = -15047	370			-868			
	400	-908	<i>a</i> (4) = -28835	380			-812			
	330	-1224	390	-755						
	370	-898								
	410	-691								
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	330	-1224							
		370	-898							
		410	-691							
		<i>a</i> (1) = -1643	450	-551						
		<i>a</i> (2) = -4897	490	-449						
		<i>a</i> (3) = -6178	530	-371						
		<i>a</i> (4) = -3718	570	-309						

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>		
C <sub>5</sub> H <sub>5</sub> N	Pyridine	400	-697	C <sub>6</sub> H <sub>6</sub>	Benzene	390	-492		
		350	-1257			400	-464		
		360	-1176			450	-357		
		370	-1099			500	-279		
		<i>a</i> (1) = -1765	380			-1026	550	-218	
		<i>a</i> (2) = -3431	390			-957	290	-1588	
			400			-892	300	-1454	
			420			-770	310	-1335	
			440			-659	<i>a</i> (1) = -1477	320	-1231
			300			-1049	<i>a</i> (2) = -3851	330	-1139
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	305	-1015	<i>a</i> (3) = -3683	340	-1056			
		310	-981	<i>a</i> (4) = -1423	350	-983			
		<i>a</i> (1) = -1062	315	-949	400	-712			
		<i>a</i> (2) = -2116	320	-918	450	-542			
			310	-966	500	-429			
C <sub>5</sub> H <sub>10</sub>	1-Pentene	320	-898	550	-349				
		330	-836	600	-291				
		<i>a</i> (1) = -1055	340	-780	C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	360	-1656	
		<i>a</i> (2) = -2377	350	-729	370	-1523			
		<i>a</i> (3) = -1189	360	-681	380	-1404			
			370	-638	<i>a</i> (1) = -2940	390	-1297		
			380	-598	<i>a</i> (2) = -8813	400	-1202		
			390	-561	<i>a</i> (3) = -7809	410	-1117		
			400	-527	420	-1040			
			410	-495	430	-972			
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	330	-2850	C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine	380	-1819		
		340	-2420	390	-1612				
		350	-2076	400	-1448				
		<i>a</i> (1) = -4962	360	-1804	<i>a</i> (1) = -6304	410	-1322		
		<i>a</i> (2) = -26372	370	-1595	<i>a</i> (2) = -30415	420	-1230		
		<i>a</i> (3) = -46537	380	-1440	<i>a</i> (3) = -44549	430	-1166		
			390	-1332	C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	380	-1787	
C <sub>5</sub> H <sub>12</sub>	Pentane	300	-1234	390	-1578				
		310	-1130	400	-1417				
		320	-1038	<i>a</i> (1) = -6553	410	-1297			
		<i>a</i> (1) = -1254	330	-957	<i>a</i> (2) = -32873	420	-1214		
		<i>a</i> (2) = -3345	340	-884	<i>a</i> (3) = -49874	430	-1163		
		<i>a</i> (3) = -2726	350	-818	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	300	-1698	
			400	-579	320	-1391			
			450	-436	340	-1170			
			500	-348	<i>a</i> (1) = -1733	360	-1007		
			550	-294	<i>a</i> (2) = -5618	380	-883		
C <sub>5</sub> H <sub>12</sub>	2-Methylbutane	280	-1263	<i>a</i> (3) = -9486	400	-786			
		290	-1166	<i>a</i> (4) = -7936	420	-707			
		300	-1079	440	-641				
		<i>a</i> (1) = -1095	310	-1001	460	-584			
		<i>a</i> (2) = -2503	320	-931	480	-534			
		<i>a</i> (3) = -1534	330	-867	500	-488			
			340	-810	520	-446			
			350	-757	540	-406			
			400	-557	560	-368			
			450	-424	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	305	-1447	
C <sub>5</sub> H <sub>12</sub>	2,2-Dimethylpropane	300	-916	315	-1357				
		310	-843	325	-1272				
		320	-780	<i>a</i> (1) = -1512	335	-1192			
		<i>a</i> (1) = -931	330	-724	<i>a</i> (2) = -2910	345	-1117		
		<i>a</i> (2) = -2387	340	-674	C <sub>6</sub> H <sub>14</sub>	Hexane	300	-1920	
		<i>a</i> (3) = -2641	350	-629	310	-1724			
		<i>a</i> (4) = -1810	360	-590	320	-1561			
			370	-554	<i>a</i> (1) = -1961	330	-1424		
			380	-521	<i>a</i> (2) = -6691	340	-1309		

Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>	Mol. form.	Name	T/K	B/cm <sup>3</sup> mol <sup>-1</sup>
	$a(3) = -13167$	350	-1209			500	-702
	$a(4) = -15273$	360	-1123			540	-583
		370	-1046			580	-490
		380	-978			620	-416
		390	-916			660	-355
		400	-859			700	-304
		410	-806	C <sub>8</sub> H <sub>10</sub>	1,2-Dimethylbenzene	380	-2046
		430	-707			390	-1848
		450	-616			400	-1681
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	330	-1562		$a(1) = -5632$	410	-1543
		340	-1444		$a(2) = -22873$	420	-1428
		350	-1340		$a(3) = -28900$	430	-1335
	$a(1) = -2061$	360	-1249			440	-1261
	$a(2) = -5735$	370	-1169	C <sub>8</sub> H <sub>10</sub>	1,3-Dimethylbenzene	380	-2082
	$a(3) = -5899$	380	-1099			390	-1865
		390	-1037			400	-1679
		400	-983		$a(1) = -5808$	410	-1521
C <sub>7</sub> H <sub>8</sub>	Toluene	350	-1641		$a(2) = -23244$	420	-1388
		360	-1511		$a(3) = -27607$	430	-1276
		370	-1394			440	-1184
	$a(1) = -2620$	380	-1289	C <sub>8</sub> H <sub>10</sub>	1,4-Dimethylbenzene	380	-2043
	$a(2) = -7548$	390	-1195			390	-1851
	$a(3) = -6349$	400	-1110			400	-1680
		410	-1034		$a(1) = -4921$	410	-1529
		420	-965		$a(2) = -16843$	420	-1395
		430	-903		$a(3) = -16159$	430	-1276
		340	-1781			440	-1171
C <sub>7</sub> H <sub>14</sub>	1-Heptene	350	-1651	C <sub>8</sub> H <sub>16</sub>	1-Octene	360	-2147
		360	-1532			370	-2000
	$a(1) = -2491$	370	-1424			380	-1861
	$a(2) = -6230$	380	-1324		$a(1) = -3273$	390	-1729
	$a(3) = -3780$	390	-1233		$a(2) = -6557$	400	-1604
		400	-1150			410	-1485
		410	-1073			300	-4042
		300	-2782	C <sub>8</sub> H <sub>18</sub>	Octane	350	-2511
		320	-2297			400	-1704
		340	-1928		$a(1) = -4123$	450	-1234
	$a(1) = -2834$	360	-1641		$a(2) = -13120$	500	-936
	$a(2) = -8523$	380	-1415		$a(3) = -16408$	550	-732
	$a(3) = -10068$	400	-1233		$a(4) = -8580$	600	-583
	$a(4) = -5051$	420	-1085			650	-468
		440	-963			700	-375
		460	-862				
		480	-775				

## VAN DER WAALS CONSTANTS FOR GASES

The van der Waals equation of state for a real gas is

$$(P + n^2 a/V^2)(V - nb) = nRT$$

where  $P$  is the pressure,  $V$  the volume,  $T$  the temperature,  $n$  the amount of substance (in moles), and  $R$  the gas constant. The van der Waals constants  $a$  and  $b$  are characteristic of the substance and are independent of temperature. They are related to the critical temperature and pressure,  $T_c$  and  $P_c$ , by

$$a = 27R^2T_c^2/64P_c \quad b = RT_c/8P_c$$

Substance	$a$ bar L <sup>2</sup> /mol <sup>2</sup>	$b$ L/mol
Acetic acid	17.71	0.1065
Acetone	16.02	0.1124
Acetylene	4.516	0.0522
Ammonia	4.225	0.0371
Aniline	29.14	0.1486
Argon	1.355	0.0320
Benzene	18.82	0.1193
Bromine	9.75	0.0591
Butane	13.89	0.1164
1-Butanol	20.94	0.1326
2-Butanone	19.97	0.1326
Carbon dioxide	3.658	0.0429
Carbon disulfide	11.25	0.0726
Carbon monoxide	1.472	0.0395
Chlorine	6.343	0.0542
Chlorobenzene	25.80	0.1454
Chloroethane	11.66	0.0903
Chloromethane	7.566	0.0648
Cyclohexane	21.92	0.1411
Cyclopropane	8.34	0.0747
Decane	52.74	0.3043
1-Decanol	59.51	0.3086
Diethyl ether	17.46	0.1333
Dimethyl ether	8.690	0.0774
Dodecane	69.38	0.3758
1-Dodecanol	75.70	0.3750
Ethane	5.580	0.0651
Ethanol	12.56	0.0871
Ethylene	4.612	0.0582
Fluorine	1.171	0.0290
Furan	12.74	0.0926
Helium	0.0346	0.0238
Heptane	31.06	0.2049
1-Heptanol	38.17	0.2150
Hexane	24.84	0.1744
1-Hexanol	31.79	0.1856
Hydrazine	8.46	0.0462
Hydrogen	0.2452	0.0265
Hydrogen bromide	4.500	0.0442
Hydrogen chloride	3.700	0.0406
Hydrogen cyanide	11.29	0.0881
Hydrogen fluoride	9.565	0.0739
Hydrogen iodide	6.309	0.0530

This table gives values of  $a$  and  $b$  for some common gases. Most of the values have been calculated from the critical temperature and pressure values given in the table "Critical Constants" in this section. Van der Waals constants for other gases may easily be calculated from the data in that table.

To convert the van der Waals constants to SI units, note that 1 bar L<sup>2</sup>/mol<sup>2</sup> = 0.1 Pa m<sup>6</sup>/mol<sup>2</sup> and 1 L/mol = 0.001 m<sup>3</sup>/mol.

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Reid, R. C., Prausnitz, J. M., and Poling, B. E., *The Properties of Gases and Liquids, Fourth Edition*, McGraw-Hill, New York, 1987.

Substance	$a$ bar L <sup>2</sup> /mol <sup>2</sup>	$b$ L/mol
Hydrogen sulfide	4.544	0.0434
Isobutane	13.32	0.1164
Krypton	5.193	0.0106
Methane	2.303	0.0431
Methanol	9.476	0.0659
Methylamine	7.106	0.0588
Neon	0.208	0.0167
Neopentane	17.17	0.1411
Nitric oxide	1.46	0.0289
Nitrogen	1.370	0.0387
Nitrogen dioxide	5.36	0.0443
Nitrogen trifluoride	3.58	0.0545
Nitrous oxide	3.852	0.0444
Octane	37.88	0.2374
1-Octanol	44.71	0.2442
Oxygen	1.382	0.0319
Ozone	3.570	0.0487
Pentane	19.09	0.1449
1-Pentanol	25.88	0.1568
Phenol	22.93	0.1177
Propane	9.39	0.0905
1-Propanol	16.26	0.1079
2-Propanol	15.82	0.1109
Propene	8.442	0.0824
Pyridine	19.77	0.1137
Pyrrole	18.82	0.1049
Silane	4.38	0.0579
Sulfur dioxide	6.865	0.0568
Sulfur hexafluoride	7.857	0.0879
Tetrachloromethane	20.01	0.1281
Tetrachlorosilane	20.96	0.1470
Tetrafluoroethylene	6.954	0.0809
Tetrafluoromethane	4.040	0.0633
Tetrafluorosilane	5.259	0.0724
Tetrahydrofuran	16.39	0.1082
Thiophene	17.21	0.1058
Toluene	24.86	0.1497
1,1,1-Trichloroethane	20.15	0.1317
Trichloromethane	15.34	0.1019
Trifluoromethane	5.378	0.0640
Trimethylamine	13.37	0.1101
Water	5.537	0.0305
Xenon	4.192	0.0516

## MEAN FREE PATH AND RELATED PROPERTIES OF GASES

In the simplest version of the kinetic theory of gases, molecules are treated as hard spheres of diameter  $d$  which make binary collisions only. In this approximation the mean distance traveled by a molecule between successive collisions, the mean free path  $l$ , is related to the collision diameter by:

$$l = \frac{kT}{\pi\sqrt{2}Pd^2}$$

where  $P$  is the pressure,  $T$  the absolute temperature, and  $k$  the Boltzmann constant. At standard conditions ( $P = 100,000$  Pa and  $T = 298.15$  K) this relation becomes:

$$l = \frac{9.27 \cdot 10^{-27}}{d^2}$$

where  $l$  and  $d$  are in meters.

Using the same model and the same standard pressure, the collision diameter can be calculated from the viscosity  $\eta$  by the kinetic theory relation:

$$\eta = \frac{2.67 \cdot 10^{-20} (MT)^{1/2}}{d^2}$$

where  $\eta$  is in units of  $\mu\text{Pa s}$  and  $M$  is the molar mass in g/mol. Kinetic theory also gives a relation for the mean velocity  $\bar{v}$  of molecules of mass  $m$ :

$$\bar{v} = \left( \frac{8kT}{\pi m} \right)^{1/2} = 145.5(T/M)^{1/2} \text{ m/s}$$

Finally, the mean time  $\tau$  between collisions can be calculated from the relation  $\tau\bar{v} = l$ .

The table below gives values of  $l$ ,  $\bar{v}$ , and  $\tau$  for some common gases at 25 °C and atmospheric pressure, as well as the value of  $d$ , all calculated from measured gas viscosities (see References 2 and 3 and the table "Viscosity of Gases" in this section). It is seen from the above equations that the mean free path varies directly with  $T$  and inversely with  $P$ , while the mean velocity varies as the square root of  $T$  and, in this approximation, is independent of  $P$ .

A more accurate model, in which molecular interactions are described by a Lennard-Jones potential, gives mean free path values about 5% lower than this table (see Reference 4).

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Gas	$d/m$	$l/m$	$\bar{v}/m \text{ s}^{-1}$	$\tau/\text{ps}$
Air	$3.66 \cdot 10^{-10}$	$6.91 \cdot 10^{-8}$	467	148
Ar	3.58	7.22	397	182
CO <sub>2</sub>	4.53	4.51	379	119
H <sub>2</sub>	2.71	12.6	1769	71
He	2.15	20.0	1256	159
Kr	4.08	5.58	274	203
N <sub>2</sub>	3.70	6.76	475	142
NH <sub>3</sub>	4.32	4.97	609	82
Ne	2.54	14.3	559	256
O <sub>2</sub>	3.55	7.36	444	166
Xe	4.78	4.05	219	185

## INFLUENCE OF PRESSURE ON FREEZING POINTS

This table illustrates the variation of the freezing point of representative types of liquids with pressure. Substances are listed in alphabetical order. Note that 1 MPa = 0.01 kbar = 9.87 atm.

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Substance	Molecular formula	Freezing point in °C at:		
		0.1 MPa	100 MPa	1000 MPa
Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	16.6	37	
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	20.0	41.2	
Aniline	C <sub>6</sub> H <sub>7</sub> N	-6.0	13.5	140
Benzene	C <sub>6</sub> H <sub>6</sub>	5.5	33.4	
Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	-12.8	7.6	
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	-15.2	0.2	
Bromobenzene	C <sub>6</sub> H <sub>5</sub> Br	-30.6	-12	108
Bromoethane	C <sub>2</sub> H <sub>5</sub> Br	-118.6	-108	
1-Bromonaphthalene	C <sub>10</sub> H <sub>7</sub> Br	-1.8	6.1	
1-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	-110	-98	
<i>p</i> -Bromotoluene	C <sub>7</sub> H <sub>7</sub> Br	28.0	56.7	
Butanoic acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	-5.7	13.8	
1-Butanol	C <sub>4</sub> H <sub>10</sub> O	-89.8	-77.2	
Carbon disulfide	CS <sub>2</sub>	-111.5	-98	
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	-45.2	-28	84
<i>p</i> -Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	6.9	33.1	
<i>o</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	29.8	47.7	
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	11.8	25.6	
<i>p</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	35.8	56.2	
Cyclohexane	C <sub>6</sub> H <sub>12</sub>	6.6	32.5	
Cyclohexanol	C <sub>6</sub> H <sub>12</sub> O	25.5	62.3	
1,2-Dibromoethane	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	9.9	34.0	
<i>p</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	52.7	79.1	
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	-95.1	-83	
<i>N,N</i> -Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	2.5	26.3	
1,4-Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	11	23	
Ethanol	C <sub>2</sub> H <sub>6</sub> O	-114.1	-108	
Formamide	CH <sub>3</sub> NO	-15.5	10.8	
Formic acid	CH <sub>2</sub> O <sub>2</sub>	8.3	20.6	
Furan	C <sub>4</sub> H <sub>4</sub> O	-85.6	-73	
Hexamethyldisiloxane	C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	-66	-37	
Menthol	C <sub>10</sub> H <sub>20</sub> O	42	60	
Methyl benzoate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	-15	31.8	
2-Methyl-2-butanol	C <sub>5</sub> H <sub>12</sub> O	-8.8	13.4	
2-Methyl-2-propanol	C <sub>4</sub> H <sub>10</sub> O	25.4	58.1	
Naphthalene	C <sub>10</sub> H <sub>8</sub>	78.2	115.7	
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	5.7	13.5	
<i>m</i> -Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	15.5	40.6	
Pentachloroethane	C <sub>2</sub> HCl <sub>5</sub>	-29.0	-6.3	
Potassium	K	63.7	78	170
Potassium chloride	ClK	771		945
Propanoic acid	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	-20.7	-1.2	
Silver chloride	AgCl	455		545
Sodium	Na	97.8	106	167
Sodium chloride	ClNa	800.7		997
Sodium fluoride	FNa	996		1115
Tetrachloromethane	CCl <sub>4</sub>	-23.0	14.2	
Tribromomethane	CHBr <sub>3</sub>	8.1	31.5	
Trichloromethane	CHCl <sub>3</sub>	-63.6	-45.2	
Water	H <sub>2</sub> O	0.0	-9.0	
<i>o</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	-25.2	-3.5	
<i>m</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	-47.8	-25.2	
<i>p</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	13.2	46.0	



## CRITICAL CONSTANTS

The parameters of the liquid–gas critical point are important constants in determining the behavior of fluids. This table lists the critical temperature, pressure, and molar volume, as well as the normal boiling point, for over 1000 inorganic and organic substances. The properties and their units are:

$T_b$ : Normal boiling point in kelvins at a pressure of 101.325 kPa (1 atmosphere); an “s” following the value indicates a sublimation point (temperature at which the solid is in equilibrium with the gas at a pressure of 101.325 kPa)

$T_c$ : Critical temperature in kelvins

$P_c$ : Critical pressure in megapascals

$V_c$ : Critical molar volume in cm<sup>3</sup>/mol

The number of digits given for  $T_b$ ,  $T_c$ , and  $P_c$  indicates the estimated accuracy of these quantities; however, values of  $T_c$  greater than 750 K may be in error by 10 K or more. Although most  $V_c$  values are given to three figures, they cannot be assumed accurate to better than a few percent. All values are experimentally determined except for a few values, indicated by an asterisk\*, that are based on extrapolations. Methods of measurement are described and critiqued in Reference 1.

Some of the compounds in the table undergo thermal decomposition at temperatures near the critical temperature. The listed values were obtained by pulse heating methods, as described in the references by Nikitin, et al. (References 16, 31, 48, 50, etc.).

Many of the critical constants in this table are taken from reviews produced by the IUPAC Commission on Thermodynamics (References 1–9). Compounds are listed alphabetically by name, with compounds not containing carbon preceding those that do contain carbon.

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Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>Compounds not containing carbon</i>						
Aluminum bromide	AlBr <sub>3</sub>	528	763	2.89	310	49
Aluminum chloride	AlCl <sub>3</sub>	453 s	620	2.63	257	49
Aluminum iodide	AlI <sub>3</sub>	655	983		408	49
Ammonia	H <sub>3</sub> N	239.82	405.56	11.357	69.8	49,73
Ammonium chloride	CH <sub>4</sub> N	611 s	1155	163.5		49
Antimony(III) bromide	Br <sub>3</sub> Sb	561	904		300	49
Antimony(III) chloride	Cl <sub>3</sub> Sb	493.5	794		272	49
Antimony(III) iodide	I <sub>3</sub> Sb	673	1102			49
Argon	Ar	87.30	150.87	4.898	75	49
Arsenic	As	889 s	1673		35	49
Arsenic(III) chloride	AsCl <sub>3</sub>	403	654		252	49
Arsine	AsH <sub>3</sub>	210.7	373.1			49
Beryllium	Be	2744	5205*			71
Bismuth	Bi	1837	4620*			71
Bismuth tribromide	BiBr <sub>3</sub>	735	1220		301	49
Bismuth trichloride	BiCl <sub>3</sub>	714	1179	12.0	261	49
Boron tribromide	BBr <sub>3</sub>	364.4	581		272	49
Boron trichloride	BCl <sub>3</sub>	285.80	455	3.87	239	49
Boron trifluoride	BF <sub>3</sub>	173.3	260.8	4.98	115	49
Boron triiodide	BI <sub>3</sub>	482.7	773		356	49
Bromine	Br <sub>2</sub>	332.0	588	10.34	127	49
Cesium	Cs	944	1938	9.4	341	43
Chlorine	Cl <sub>2</sub>	239.11	416.9	7.991	123	49
Chlorine pentafluoride	ClF <sub>5</sub>	260.1	416	5.27	233	49
Chlorotrifluorosilane	ClF <sub>3</sub> Si	203.2	307.7	3.46		49
Diborane	B <sub>2</sub> H <sub>6</sub>	180.8	289.8	4.05		49
Dichlorodifluorosilane	Cl <sub>2</sub> F <sub>2</sub> Si	241	369.0	3.5		49
Difluoramine	F <sub>2</sub> HN	250	403			49
cis-Difluorodiazine	F <sub>2</sub> N <sub>2</sub>	167.40	272	7.09		49

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>trans</i> -Difluorodiazine	F <sub>2</sub> N <sub>2</sub>	161.70	260	5.57		49
Fluorine	F <sub>2</sub>	85.03	144.13	5.172	66	49
Fluorine monoxide	F <sub>2</sub> O	128.8	215			49
Gallium(III) bromide	Br <sub>3</sub> Ga	552	806.7		303	49
Gallium(III) chloride	Cl <sub>3</sub> Ga	474	694		263	49
Gallium(III) iodide	Gal <sub>3</sub>	613	951		395	49
Germane	GeH <sub>4</sub>	185.1	312.2	4.95	147	49
Germanium	Ge	3106	9802*			71
Germanium(IV) bromide	Br <sub>4</sub> Ge	459.50	718		392	49
Germanium(IV) chloride	Cl <sub>4</sub> Ge	359.70	553.2	3.861	330	49
Germanium(IV) iodide	GeI <sub>4</sub>	621	973		500	49
Hafnium(IV) bromide	Br <sub>4</sub> Hf	596 s	746		415	49
Hafnium(IV) chloride	Cl <sub>4</sub> Hf	590 s	725.7	5.42	314	49
Hafnium(IV) iodide	HfI <sub>4</sub>	667 s	916		528	49
Helium	He	4.22	5.19	0.227	57	49
Hydrazine	H <sub>4</sub> N <sub>2</sub>	386.70	653	14.7		49
Hydrogen	H <sub>2</sub>	20.28	32.97	1.293	65	49
Hydrogen bromide	BrH	206.77	363.2	8.55		49
Hydrogen chloride	ClH	188	324.7	8.31	81	49
Hydrogen fluoride	FH	293	461	6.48	69	49
Hydrogen iodide	HI	237.60	424.0	8.31		49
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	423.4	728*	22*		31
Hydrogen selenide	H <sub>2</sub> Se	231.90	411	8.92		49
Hydrogen sulfide	H <sub>2</sub> S	213.60	373.1	9.00	99	49,54
Iodine	I <sub>2</sub>	457.6	819		155	49
Iodine bromide	BrI	389	719		139	49
Iron	Fe	3134	9340*			71
Krypton	Kr	119.93	209.48	5.525	91	49,54
Lithium	Li	1615	3223*	67*	66*	20
Manganese	Mn	2334	4325*			71
Mercury	Hg	629.77	1764	167	43	49,83
Mercury(II) bromide	Br <sub>2</sub> Hg	591	1012			49
Mercury(II) chloride	Cl <sub>2</sub> Hg	577	973		174	49
Mercury(II) iodide	HgI <sub>2</sub>	624	1072			49
Molybdenum(V) chloride	Cl <sub>5</sub> Mo	541	850		369	49
Molybdenum(VI) fluoride	F <sub>6</sub> Mo	307.2	473	4.75	226	49
Neon	Ne	27.10	44.4	2.76	42	49
Niobium(V) chloride	Cl <sub>5</sub> Nb	520.6	803.5	4.88	397	49
Niobium(V) fluoride	F <sub>5</sub> Nb	507	737	6.28	155	49
Nitric oxide	NO	121.41	180	6.48	58	49
Nitrogen	N <sub>2</sub>	77.35	126.21	3.39	90	49
Nitrogen chloride difluoride	ClF <sub>2</sub> N	206	337.5	5.15		49
Nitrogen tetroxide	N <sub>2</sub> O <sub>4</sub>	294.30	431	10.1	167	49
Nitrogen trifluoride	F <sub>3</sub> N	144.40	234.0	4.46	126	49
Nitrosyl chloride	ClNO	267.7	440			49
Nitrous oxide	N <sub>2</sub> O	184.67	309.52	7.245	97	49,54
Nitryl fluoride	FNO <sub>2</sub>	200.8	349.5			49
Osmium(VIII) oxide	O <sub>4</sub> Os	404.4	678			49
Oxygen	O <sub>2</sub>	90.20	154.59	5.043	73	49
Ozone	O <sub>3</sub>	161.80	261.1	5.57	89	49
Perchloryl fluoride	ClFO <sub>3</sub>	226.40	368.4	5.37	161	49
Phosphine	H <sub>3</sub> P	185.40	324.5	6.54		49
Phosponium chloride	ClH <sub>4</sub> P	246 s	322.3	7.37		49
Phosphorothioc chloride difluoride	ClF <sub>2</sub> PS	279.5	439.2	4.14		49
Phosphorothioc trifluoride	F <sub>3</sub> PS	220.90	346.0	3.82		49

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Phosphorus	P	553.7	994			49
Phosphorus(III) bromide	Br <sub>3</sub> P	446.4	711		300	49
Phosphorus(III) chloride	Cl <sub>3</sub> P	349.3	563		264	49
Phosphorus(V) chloride	Cl <sub>5</sub> P	433 s	646			49
Phosphorus(III) chloride difluoride	ClF <sub>2</sub> P	225.9	362.4	4.52		49
Phosphorus(III) dichloride fluoride	Cl <sub>2</sub> FP	287.00	463.0	4.96		49
Phosphorus(III) fluoride	F <sub>3</sub> P	171.4	271.2	4.33		49
Potassium	K	1032	2223*	16*	209*	20
Radon	Rn	211.5	377	6.28		49
Rhenium(VII) oxide	O <sub>7</sub> Re	633	942		334	49
Rhenium(VI) oxytetrachloride	Cl <sub>4</sub> ORe	496	781		362	49
Rubidium	Rb	961	2093*	16*	247*	20
Selenium	Se	958	1766	27.2		49
Selenium hexafluoride	F <sub>6</sub> Se	226.55 s	345.5			49
Selenium oxychloride	Cl <sub>2</sub> OSe	450	730	7.09	235	49
Silver	Ag	2435	6410*			71
Sodium	Na	1156	2573*	35*	116*	20
Sulfur	S	717.76	1314	20.7		49
Sulfur chloride pentafluoride	ClF <sub>5</sub> S	254.10	390.9			49
Sulfur dioxide	O <sub>2</sub> S	263.10	430.64	7.884	122	49,54
Sulfur hexafluoride	F <sub>6</sub> S	209.35 s	318.723	3.77	197	49,70
Sulfur tetrafluoride	F <sub>4</sub> S	232.70	364			49
Sulfur trioxide	O <sub>3</sub> S	317.7	491.0	8.2	127	49
Tantalum(V) bromide	Br <sub>5</sub> Ta	622	974		461	49
Tantalum(V) chloride	Cl <sub>5</sub> Ta	512.50	767		402	49
Tellurium	Te	1261	2329*			71
Tellurium hexafluoride	F <sub>6</sub> Te	234.25 s	356			49
Tellurium tetrachloride	Cl <sub>4</sub> Te	660	1002	8.56	310	49
Tetrabromosilane	Br <sub>4</sub> Si	427	663		382	49
Tetrachlorosilane	Cl <sub>4</sub> Si	330.80	508.1	3.593	326	49
Tetrafluorohydrazine	F <sub>4</sub> N <sub>2</sub>	199	309	3.75		49
Tetrafluorosilane	F <sub>4</sub> Si	187	259.0	3.72		49
Tetraiodosilane	I <sub>4</sub> Si	560.50	944		558	49
Tin(IV) bromide	Br <sub>4</sub> Sn	478	744		417	49
Tin(IV) chloride	Cl <sub>4</sub> Sn	387.30	591.9	3.75	351	49
Tin(IV) iodide	I <sub>4</sub> Sn	637.50	968		531	49
Titanium(IV) bromide	Br <sub>4</sub> Ti	506.7	795.7		391	49
Titanium(IV) chloride	Cl <sub>4</sub> Ti	409.60	638	4.66	339	49
Titanium(IV) iodide	I <sub>4</sub> Ti	650	1040		505	49
Tribromosilane	Br <sub>3</sub> HSi	382	610.0		305	49
Trichlorofluorosilane	Cl <sub>3</sub> FSi	285.40	438.6	3.58		49
Trichlorosilane	Cl <sub>3</sub> HSi	306	479		268	49
Trifluorammine oxide	F <sub>3</sub> NO	185.7	303	6.43	147	49
Tungsten(VI) chloride	Cl <sub>6</sub> W	610	923		422	49
Tungsten(VI) fluoride	F <sub>6</sub> W	290.3	444	4.34	233	49
Tungsten(VI) oxytetrachloride	Cl <sub>4</sub> OW	503	782		338	49
Uranium(VI) fluoride	F <sub>6</sub> U	329.65 s	505.8	4.66	250	49
Vanadyl chloride	ClOV	400	636		171	49
Water	H <sub>2</sub> O	373.2	647.14	22.06	56	49
Xenon	Xe	165.03	289.733	5.842	118	34,54
Xenon difluoride	F <sub>2</sub> Xe	387.50 s	631	9.32	148	49
Xenon tetrafluoride	F <sub>4</sub> Xe	388.90 s	612	7.04	188	49
Zirconium(IV) bromide	Br <sub>4</sub> Zr	633 s	805		424	49
Zirconium(IV) chloride	Cl <sub>4</sub> Zr	604 s	778	5.77	319	49
Zirconium(IV) iodide	I <sub>4</sub> Zr	704 s	960		530	49

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>Compounds containing carbon</i>						
Acenaphthylene	C <sub>12</sub> H <sub>8</sub>	553	792	3.20		21
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	293.3	466		154	7
Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	391.1	590.7	5.78	171	7
Acetic anhydride	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	412.7	606	4.0		7
Acetone	C <sub>3</sub> H <sub>6</sub> O	329.20	508.1	4.70	213	7,54
Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	354.80	545.5	4.85	171	9,14
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	475	709.6	4.01	388	7,23
Acetylene	C <sub>2</sub> H <sub>2</sub>	188.45 s	308.3	6.138	112.2	6
Acridine	C <sub>13</sub> H <sub>9</sub> N	618.01	891.1	3.21	548	10
Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	350.5	540	4.66		9,11,12
Allene	C <sub>3</sub> H <sub>4</sub>	238.8	394	5.25		6
Allyl alcohol	C <sub>3</sub> H <sub>6</sub> O	370.5	547.1	5.64		60,4
Allylamine	C <sub>3</sub> H <sub>7</sub> N	326.5	540.0	4.83		9
Allyl ethyl ether	C <sub>5</sub> H <sub>10</sub> O	340.8	518			7
2-Aminobiphenyl	C <sub>12</sub> H <sub>11</sub> N	572	838	3.93	584	9
2-(2-Aminoethoxy)ethanol	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	494	721.2	4.80		82
N-(2-Aminoethyl)ethanolamine	C <sub>4</sub> H <sub>12</sub> N <sub>2</sub> O	512	739.2	4.65		17
Aniline	C <sub>6</sub> H <sub>7</sub> N	457.32	705	5.63	291	9,49
Anisole	C <sub>7</sub> H <sub>8</sub> O	426.9	646.5	4.24	341	7,11,12
Anthracene	C <sub>14</sub> H <sub>10</sub>	613.1	869.3		554	49
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	452.0	695	4.7		7
Benzene	C <sub>6</sub> H <sub>6</sub>	353.24	562.05	4.895	256	3
Benzeneacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	538.7	766	3.95		50
Benzenebutanoic acid	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	563	783	3.21		50
Benzeneethanol	C <sub>8</sub> H <sub>10</sub> O	491.9	723.5	3.99		60
Benzeneheptanoic acid	C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>		798	2.47		50
Benzenehexanoic acid	C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>		794	2.60		50
Benzenepentanoic acid	C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>		790	2.95		50
Benzenepropanoic acid	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	553.0	776	3.46		50
Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	464.3	700	4.2		9,49
Benzophenone	C <sub>13</sub> H <sub>10</sub> O	578.6	830	3.35	568	7
Benzo[b]thiophene	C <sub>8</sub> H <sub>6</sub> S	494	764	4.76	379	8
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	478.46	715	4.3		49
[1,1'-Bicyclohexyl]-2-one	C <sub>12</sub> H <sub>20</sub> O	537	787			7
Biphenyl	C <sub>12</sub> H <sub>10</sub>	529.3	773	3.38	497	3
Bis(2-aminoethyl)amine	C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	480	710	4.4		9,14,17
1,1-Bis(difluoromethoxy)-1,2,2,2-tetrafluoroethane	C <sub>4</sub> H <sub>2</sub> F <sub>8</sub> O <sub>2</sub>	319.95	449.81	2.421		63
Bis(difluoromethyl) ether [HFE-134]	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> O	275	420.25	4.228	223	46
Bis(2-ethylhexyl) phthalate	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	657	835	1.07		51
Bis(2-hydroxyethyl)methylamine	C <sub>5</sub> H <sub>13</sub> NO <sub>2</sub>	520	741.9	4.16		82
Bis(2,2,2-trifluoroethyl) ether	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	336.91	476.31	2.783		65
Bis(trimethylsilyl)methane	C <sub>4</sub> H <sub>20</sub> Si <sub>2</sub>	406	573.9	1.99		8
Bromobenzene	C <sub>6</sub> H <sub>5</sub> Br	429.21	670	4.52	324	49
1-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	374.8	572		325	74
Bromochlorodifluoromethane [R-12B1]	CBrClF <sub>2</sub>	269.5	426.88	4.254	246	49
Bromodifluoromethane [R-22B1]	CHBrF <sub>2</sub>	258.6	411.98	5.132	275	47
Bromoethane	C <sub>2</sub> H <sub>5</sub> Br	311.7	503.9	6.23	215	49
1-Bromo-2-fluorobenzene	C <sub>6</sub> H <sub>4</sub> BrF	427	669.6			13
1-Bromo-3-fluorobenzene	C <sub>6</sub> H <sub>4</sub> BrF	423	652.0			13
1-Bromo-4-fluorobenzene	C <sub>6</sub> H <sub>4</sub> BrF	424.7	654.8			13
Bromomethane	CH <sub>3</sub> Br	276.7	464		153	74
Bromopentafluorobenzene	C <sub>6</sub> BrF <sub>5</sub>	410	601	3.0		49
1-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	344.3	536		270	74
2-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	332.7	521		266	74



Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Bromotrifluoromethane [R-13B1]	CBrF <sub>3</sub>	215.4	340.2	3.97	196	49
1-Bromo-2-(trifluoromethyl)benzene	C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	440.7	656.5			13
1-Bromo-3-(trifluoromethyl)benzene	C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	424.7	627.1			13
1-Bromo-4-(trifluoromethyl)benzene	C <sub>7</sub> H <sub>4</sub> BrF <sub>3</sub>	433	629.8			13
1,3-Butadiene	C <sub>4</sub> H <sub>6</sub>	268.74	425	4.32	221	6
Butanal	C <sub>4</sub> H <sub>8</sub> O	348.0	537	4.32	258	7
Butane	C <sub>4</sub> H <sub>10</sub>	272.7	425.16	3.787	255	2,67
1,4-Butanediamine	C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	431.7	651	4.54		9,56
1,2-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	463.7	680	5.21	303	7,23
1,3-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	480.7	692.4	5.18	305	7,23,81
1,4-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	508	723.8	5.52		17
Butanenitrile	C <sub>4</sub> H <sub>7</sub> N	390.8	585.4	3.88		9,49
1-Butanethiol	C <sub>4</sub> H <sub>10</sub> S	371.7	570	4.0	324	8
Butanoic acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	436.90	615.2	4.06	292	7
1-Butanol	C <sub>4</sub> H <sub>10</sub> O	390.88	563.0	4.414	274	4
2-Butanol	C <sub>4</sub> H <sub>10</sub> O	372.66	536.2	4.202	269	4
2-Butanone	C <sub>4</sub> H <sub>8</sub> O	352.74	536.7	4.207	267	7
1-Butene	C <sub>4</sub> H <sub>8</sub>	266.89	419.29	4.005	235.8	6,72
<i>cis</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	276.86	435.75	4.226	235.6	6,72
<i>trans</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	274.03	428.61	4.027	237.3	6,72
2-Butoxyethanol	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	441.6	634	3.27	424	7
1- <i>tert</i> -Butoxy-2-ethoxyethane	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	421.2	585			7
2-Butoxyethyl acetate	C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	465	640.7	2.694	549	7
1- <i>tert</i> -Butoxy-2-methoxyethane	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>		574			7
1-Butoxy-2-propanol	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	444.7	624.9	2.739		14
Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	399.3	575.6	3.14		7
<i>sec</i> -Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	385	571	3.01		7
<i>tert</i> -Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	368.3	541.2	3.04		82
Butyl acrylate	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	418	601.2	2.84		82
Butylamine	C <sub>4</sub> H <sub>11</sub> N	350.15	531.9	4.20		9,10
<i>sec</i> -Butylamine	C <sub>4</sub> H <sub>11</sub> N	335.88	514	5.0		9,10
<i>tert</i> -Butylamine	C <sub>4</sub> H <sub>11</sub> N	317.19	483.7	3.85	293	9,10
Butylbenzene	C <sub>10</sub> H <sub>14</sub>	456.46	660.5	2.89	497	3
<i>sec</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	446.5	652.5	3.025	490	75
<i>tert</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	442.3	647.5	2.90	485	75
Butyl butanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	439	612.1			7
Butylcyclohexane	C <sub>10</sub> H <sub>20</sub>	453	653.1	2.56		58,59
<i>tert</i> -Butylcyclohexane	C <sub>10</sub> H <sub>20</sub>	444.7	652.0			59
<i>tert</i> -Butyl ethyl ether	C <sub>6</sub> H <sub>14</sub> O	345.8	509.4	2.934	395	7
Butyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	343.31	512.7	3.37	329	7
Butyl propanoate	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	420.0	594.5			7
Butyl vinyl ether	C <sub>6</sub> H <sub>12</sub> O	367	540	3.20	384	7
1-Butyne	C <sub>4</sub> H <sub>6</sub>	281.23	440	4.60	208	6
2-Butyne	C <sub>4</sub> H <sub>6</sub>	300.1	488.7			49
γ-Butyrolactone	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	477	732.5	5.10		7,11,82
Carbazole	C <sub>12</sub> H <sub>9</sub> N	627.84	901.8	3.13	454	10
Carbon dioxide	CO <sub>2</sub>	194.6 s	304.13	7.375	94	22
Carbon disulfide	CS <sub>2</sub>	319	552	7.90	173	49
Carbon monoxide	CO	81.7	132.86	3.494	93	49,54,55
Carbon oxysulfide	COS	223	375	5.88	137	49,54
Carbonyl chloride	CCl <sub>2</sub> O	281	455	5.67	190	49
3-Carene	C <sub>10</sub> H <sub>16</sub>	444	658		487	6
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	404.87	633.4	4.52	308	13,49
1-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	351.6	539.2			13
2-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	341.4	518.6			13

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Chlorocyclohexane	C <sub>6</sub> H <sub>11</sub> Cl	415	586			13
1-Chloro-2,4-difluorobenzene	C <sub>6</sub> H <sub>3</sub> ClF <sub>2</sub>	400	609.6			13
1-Chloro-2,5-difluorobenzene	C <sub>6</sub> H <sub>3</sub> ClF <sub>2</sub>	401	612.5			13
1-Chloro-3,4-difluorobenzene	C <sub>6</sub> H <sub>3</sub> ClF <sub>2</sub>	400	609.2			13
1-Chloro-3,5-difluorobenzene	C <sub>6</sub> H <sub>3</sub> ClF <sub>2</sub>	391.7	592.0			13
1-Chloro-1,1-difluoroethane [R-142b]	C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	264.1	410.34	4.048	226	19,32,65
1-Chloro-2,2-difluoroethene	C <sub>2</sub> HClF <sub>2</sub>	254.7	400.6	4.46	197	49
Chlorodifluoromethane [R-22]	CHClF <sub>2</sub>	232.5	369.5	5.035	164	18
Chloroethane [R-160]	C <sub>2</sub> H <sub>5</sub> Cl	285.5	460.4	5.3		49
Chloroethene [R-1140]	C <sub>2</sub> H <sub>3</sub> Cl	259.4	432	5.67	179	12
1-Chloro-2-fluorobenzene	C <sub>6</sub> H <sub>4</sub> ClF	410.8	633.8			13
1-Chloro-3-fluorobenzene	C <sub>6</sub> H <sub>4</sub> ClF	400.8	615.9			13
1-Chloro-4-fluorobenzene	C <sub>6</sub> H <sub>4</sub> ClF	403	620.1			13
Chlorofluoromethane [R-31]	CH <sub>2</sub> ClF	264.1	427	5.70		37
1-Chloroheptane	C <sub>7</sub> H <sub>15</sub> Cl	433.6	614			13
1-Chlorohexane	C <sub>6</sub> H <sub>13</sub> Cl	408.3	599			13
Chloromethane [R-40]	CH <sub>3</sub> Cl	249.06	416.25	6.679	139	49
2-Chloro-2-methylbutane	C <sub>5</sub> H <sub>11</sub> Cl	358.8	509.1			13
3-Chloro-3-methylpentane	C <sub>6</sub> H <sub>13</sub> Cl	389	528			13
2-Chloro-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Cl	324.1	500			13
Chloromethylsilane	CH <sub>3</sub> ClSi	280	517.8			49
1-Chlorooctane	C <sub>8</sub> H <sub>17</sub> Cl	456.7	643			13
Chloropentafluoroacetone	C <sub>3</sub> ClF <sub>5</sub> O	281	410.6	2.878		49
Chloropentafluorobenzene	C <sub>6</sub> ClF <sub>5</sub>	391.11	570.81	3.238	376	49
Chloropentafluoroethane [R-115]	C <sub>2</sub> ClF <sub>5</sub>	234.1	353.2	3.229	252	49
1-Chloropentane	C <sub>5</sub> H <sub>11</sub> Cl	381.6	571.2			13
1-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	319.7	503	4.58		49
2-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	308.9	484			13
3-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	318.3	514			49
1-Chloro-1,1,2,2-tetrafluoroethane [R-124a]	C <sub>2</sub> HClF <sub>4</sub>	261.5	399.9	3.72	244	49
1-Chloro-1,2,2,2-tetrafluoroethane [R-124]	C <sub>2</sub> HClF <sub>4</sub>	261	395.65	3.643	244	42
2-Chloro-1,1,1-trifluoroethane [R-133a]	C <sub>2</sub> H <sub>2</sub> ClF <sub>3</sub>	279.3	425.01		228	40
Chlorotrifluoroethene [R-1113]	C <sub>2</sub> ClF <sub>3</sub>	245.4	379	4.05	212	49
Chlorotrifluoromethane [R-13]	CClF <sub>3</sub>	191.8	302	3.870	180	49
<i>o</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	464.19	697.6	4.17		7
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	475.42	705.8	4.36		7
<i>p</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	475.13	704.6	4.07		7
Cyanogen	C <sub>2</sub> N <sub>2</sub>	252.1	400	6.0		9,49
Cyclobutane	C <sub>4</sub> H <sub>8</sub>	285.8	460.0	4.98	210	49
Cycloheptane	C <sub>7</sub> H <sub>14</sub>	391.6	604.2	3.82	353	5
Cyclohexane	C <sub>6</sub> H <sub>12</sub>	353.88	553.8	4.08	308	5,58,59
Cyclohexanethiol	C <sub>6</sub> H <sub>12</sub> S	432.0	684		401	8
Cyclohexanol	C <sub>6</sub> H <sub>12</sub> O	433.99	647.1	4.401		11,12
Cyclohexanone	C <sub>6</sub> H <sub>10</sub> O	428.58	665	4.6		7
Cyclohexene	C <sub>6</sub> H <sub>10</sub>	356.13	560.4			6
Cyclohexylamine	C <sub>6</sub> H <sub>13</sub> N	407	626.8			9,59
Cyclononane	C <sub>9</sub> H <sub>18</sub>	451.6	682	3.34		21
Cyclooctane	C <sub>8</sub> H <sub>16</sub>	422	647.2	3.56	410	5,59
Cyclopentane	C <sub>5</sub> H <sub>10</sub>	322.5	511.7	4.51	260	5
Cyclopentanol	C <sub>5</sub> H <sub>10</sub> O	413.57	619.5	4.9		4
Cyclopentanone	C <sub>5</sub> H <sub>8</sub> O	403.72	624	4.60		7
Cyclopentene	C <sub>5</sub> H <sub>8</sub>	317.4	506.5	4.80	245	6
Cyclopropane	C <sub>3</sub> H <sub>6</sub>	240.34	398.0	5.54	162	5
1,3-Decadiene	C <sub>10</sub> H <sub>18</sub>	442	615			49
<i>cis</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	469.0	702.3	3.20		49

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>trans</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	460.5	687.1			49
Decanal	C <sub>10</sub> H <sub>20</sub> O	481.7	674	2.60	599	7
Decane	C <sub>10</sub> H <sub>22</sub>	447.30	617.7	2.11	624	2,54
1,10-Decanediamine	C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>		736	2.43		9,56
Decanedioic acid	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	627.0	845	2.50		57
Decanoic acid	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	541.9	722	2.10	638	7
1-Decanol	C <sub>10</sub> H <sub>22</sub> O	504.3	687.3	2.315	649	4
2-Decanol	C <sub>10</sub> H <sub>22</sub> O	484	668.6		646	4
3-Decanol	C <sub>10</sub> H <sub>22</sub> O	486	666.1		643	4
4-Decanol	C <sub>10</sub> H <sub>22</sub> O	483.7	663.7		643	4
5-Decanol	C <sub>10</sub> H <sub>22</sub> O	474	663.2		646	4
2-Decanone	C <sub>10</sub> H <sub>20</sub> O	483	671.8		625	7
3-Decanone	C <sub>10</sub> H <sub>20</sub> O	476	667.6		628	7
4-Decanone	C <sub>10</sub> H <sub>20</sub> O	479.7	662.9		628	7
5-Decanone	C <sub>10</sub> H <sub>20</sub> O	477	661.0		628	7
1-Decene	C <sub>10</sub> H <sub>20</sub>	443.7	617	2.22	584	6
Decylbenzene	C <sub>16</sub> H <sub>26</sub>	566	752	1.72		16
Diallyl sulfide	C <sub>6</sub> H <sub>10</sub> S	411.8	653			8
Dibenzofuran	C <sub>12</sub> H <sub>8</sub> O	560	824	3.64	495	7
Dibenzothiophene	C <sub>12</sub> H <sub>8</sub> S	605.7	897	3.86	512	8
1,2-Dibromo-1-chloro-1,2,2-trifluoroethane	C <sub>2</sub> Br <sub>2</sub> ClF <sub>3</sub>	366	560.7	3.61	368	49
Dibromodifluoromethane [R-12B2]	CBr <sub>2</sub> F <sub>2</sub>	295.91	471.3	4.45		49
1,2-Dibromoethane	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	404.8	583.0	7.2		49
1,4-Dibromooctafluorobutane	C <sub>4</sub> Br <sub>2</sub> F <sub>8</sub>	370	532.5	2.39		49
1,2-Dibromotetrafluoroethane [R-114B2]	C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	320.50	487.8	3.393	341	49
Dibutylamine	C <sub>8</sub> H <sub>19</sub> N	432.8	607.5	3.11		9,59
Dibutyl disulfide	C <sub>8</sub> H <sub>18</sub> S <sub>2</sub>	499	711	2.5		82
Dibutyl ether	C <sub>8</sub> H <sub>18</sub> O	413.43	584	3.0		7
Di- <i>tert</i> -butyl ether	C <sub>8</sub> H <sub>18</sub> O	380.38	550			49
Dibutyl phthalate	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	613	797	1.66		51
Dibutyl sulfide	C <sub>8</sub> H <sub>18</sub> S	458	650	2.48		8
<i>m</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	446	685.7			13
Dichlorodifluoromethane [R-12]	CCl <sub>2</sub> F <sub>2</sub>	243.4	384.95	4.136	217	49
Dichlorodimethylsilane	C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	343.5	520.4	3.49	350	49
1,1-Dichloroethane [R-150a]	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	330.5	523	5.07	236	49
1,2-Dichloroethane [R-150]	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	356.7	561	5.4	225	49
<i>cis</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	333.3	544.2			49
<i>trans</i> -1,2-Dichloroethene [R-1130]	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	321.9	516.5	5.51		49
1,1-Dichloro-1-fluoroethane [R-141b]	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	305.2	477.5	4.194	255	26,42
Dichlorofluoromethane [R-21]	CHCl <sub>2</sub> F	282.1	451.58	5.18	196	49
1,2-Dichloro-1,2,3,3,4,4-hexafluorocyclobutane [R-C316]	C <sub>4</sub> Cl <sub>2</sub> F <sub>6</sub>	332.7	497*	2.73*	386*	12
1,3-Dichloro-1,1,2,2,3,3-hexafluoropropane [R-216ca]	C <sub>3</sub> Cl <sub>2</sub> F <sub>6</sub>	308.9	453	2.753		41
Dichloromethane [R-30]	CH <sub>2</sub> Cl <sub>2</sub>	313	510	6.10		49
1,2-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	369.6	578.5			13
1,3-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	394.1	614.6			13
1,2-Dichloro-3,4,5,6-tetrafluorobenzene	C <sub>6</sub> Cl <sub>2</sub> F <sub>4</sub>	430.9	626	5.32		49
1,1-Dichloro-1,2,2,2-tetrafluoroethane [R-114a]	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	276.6	418.6	3.30	294	49
1,2-Dichloro-1,1,2,2-tetrafluoroethane [R-114]	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	276.7	418.78	3.252	297	42
1,2-Dichloro-1,1,2-trifluoroethane [R-123a]	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	302.7	461.6		278	19
2,2-Dichloro-1,1,1-trifluoroethane [R-123]	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	300.97	456.83	3.661	278	35
Didecyl phthalate	C <sub>28</sub> H <sub>46</sub> O <sub>4</sub>		870	0.94		51
1,1-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	375.40	540	3.22		7
1,2-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	394.4	542			7
Diethoxymethane	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	361	531.7			7
2,2-Diethoxypropane	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	387	510.7			7



Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Diethylamine	C <sub>4</sub> H <sub>11</sub> N	328.7	499.7	3.754	304	9,49
<i>p</i> -Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	456.9	657.9	2.803		3
Diethyl disulfide	C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	427.2	642			8
Diethylene glycol	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	519.0	750	4.7		7
Diethylene glycol diethyl ether	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	461	612			7
Diethylene glycol dimethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	435	617			7
Diethylene glycol monobutyl ether acetate	C <sub>10</sub> H <sub>20</sub> O <sub>4</sub>	518	693.9	2.15		17
Diethylene glycol monobutyl ether	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	504	692	2.79		7
Diethylene glycol monoethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	469	670	3.167		11,12
Diethylene glycol monoethyl ether acetate	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	491.7	673.5	2.59		17
Diethylene glycol monomethyl ether	C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	466	672	3.67		11,12
Diethylene glycol monopropyl ether	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	486	680	3.00	489	7
Diethyl ether	C <sub>4</sub> H <sub>10</sub> O	307.7	466.7	3.644	281	7
Diethyl oxalate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	458.9	645.8	3.06		82
Diethyl phthalate	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	568	776	2.26		51
Diethyl succinate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	490.9	663			7
Diethyl sulfide	C <sub>4</sub> H <sub>10</sub> S	365.3	557.8	3.90	317.6	8,15
<i>o</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	367	566.0			13
<i>m</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	355.8	548.4			13
<i>p</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	362	556.9	4.40		13,49
1,1-Difluoroethane [R-152a]	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	249.10	386.7	4.50	179	19,49
1,1-Difluoroethene [R-1132a]	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	187.5	302.9	4.46	154	49
2,2-Difluoroethylbis(trifluoromethyl)amine	C <sub>4</sub> H <sub>3</sub> F <sub>8</sub> N	324.50	460.20	2.642		61
Difluoromethane [R-32]	CH <sub>2</sub> F <sub>2</sub>	221.6	351.56	5.83	123	42
3-Difluoromethoxy-1,1,1,2,2-pentafluoropropane	C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	319.09	455.10	2.773		65
3-Difluoromethoxy-1,1,2,2-tetrafluoropropane	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	348.6	505.35	3.279		65
2-(Difluoromethoxy)-1,1,1-trifluoroethane	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> O	302.15	445	3.46		65
Difluoromethyl 2,2,2-trifluoroethyl ether [HFE-245mf]	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> O	302.39	443.99			38
2,4-Difluorotoluene	C <sub>7</sub> H <sub>6</sub> F <sub>2</sub>	390	581.4			13
2,5-Difluorotoluene	C <sub>7</sub> H <sub>6</sub> F <sub>2</sub>	391	587.8			13
2,6-Difluorotoluene	C <sub>7</sub> H <sub>6</sub> F <sub>2</sub>	385	581.8			13
3,4-Difluorotoluene	C <sub>7</sub> H <sub>6</sub> F <sub>2</sub>	385	598.5			13
Diheptyl phthalate	C <sub>22</sub> H <sub>34</sub> O <sub>4</sub>	633	830	1.24		51
Dihexyl phthalate	C <sub>20</sub> H <sub>30</sub> O <sub>4</sub>		817	1.34		51
3,4-Dihydro-2 <i>H</i> -pyran	C <sub>5</sub> H <sub>8</sub> O	359	562	4.56	268	7
Diisobutylamine	C <sub>8</sub> H <sub>19</sub> N	412.8	584.4	3.20		9,49
Diisopentyl sulfide	C <sub>10</sub> H <sub>22</sub> S	484	664			8
Diisopropylamine	C <sub>6</sub> H <sub>15</sub> N	357.1	523.1	3.02		9,49
1,4-Diisopropylbenzene	C <sub>12</sub> H <sub>18</sub>	483.5	675	2.33	617	77
1,4-Diisopropylbenzene	C <sub>12</sub> H <sub>18</sub>	483.5	676.2	2.36		82
Diisopropyl ether	C <sub>6</sub> H <sub>14</sub> O	341.6	500.3	2.832	386	7
1,2-Dimethoxyethane	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	357.7	540	3.90	308	7
Dimethoxymethane	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	315	491	3.96	213	7
1,2-Dimethoxypropane	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	369	543.0			7
2,2-Dimethoxypropane	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	356	510			7
Dimethylamine	C <sub>2</sub> H <sub>7</sub> N	280.03	437.2	5.34		9,49
<i>N,N</i> -Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	467.30	688	3.6		9,49
2,2-Dimethylbutane	C <sub>6</sub> H <sub>14</sub>	322.88	489.0	3.10	358	5
2,3-Dimethylbutane	C <sub>6</sub> H <sub>14</sub>	331.08	500.0	3.15	361	5
3,3-Dimethyl-2-butanone	C <sub>6</sub> H <sub>12</sub> O	379.3	570.9	3.43	382	7
2,3-Dimethyl-1-butene	C <sub>6</sub> H <sub>12</sub>	328.8	497.7			59
3,3-Dimethyl-1-butene	C <sub>6</sub> H <sub>12</sub>	314.4	477.4			59
2,3-Dimethyl-2-butene	C <sub>6</sub> H <sub>12</sub>	346.5	521.0			59
Dimethyl carbonate	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	363.7	557	4.80	252	7
<i>cis</i> -1,2-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	403.0	606	2.95		21

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>trans</i> -1,2-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	396.7	596	2.94		21
<i>cis</i> -1,3-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	393.3	591	2.94		21
<i>trans</i> -1,3-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	397.7	598	2.94		21
<i>trans</i> -1,4-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	392.6	587.7			5
1,1-Dimethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	360.7	547	3.45		21
<i>cis</i> -1,2-Dimethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	372.7	565	3.45		21
<i>trans</i> -1,2-Dimethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	365.1	553	3.45		21
<i>cis</i> -1,3-Dimethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	364.0	551	3.45		21
<i>trans</i> -1,3-Dimethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	364.9	553	3.45		21
Dimethyl disulfide	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	382.89	607.8	5.07		8,81
Dimethyl ether	C <sub>2</sub> H <sub>6</sub> O	248.4	400.378	5.356	169	7,62,67
<i>N,N</i> -Dimethylformamide	C <sub>3</sub> H <sub>7</sub> NO	426	649.6		262	49
2,2-Dimethylheptane	C <sub>9</sub> H <sub>20</sub>	405.9	576.7	2.35		5
2,2-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	380.01	549.8	2.53	478	5
2,3-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	388.77	563.5	2.63	468	5
2,4-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	382.7	553.5	2.56	472	5
2,5-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	382.27	550.0	2.49	482	5
3,3-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	385.12	562.0	2.65	443	5
3,4-Dimethylhexane	C <sub>8</sub> H <sub>18</sub>	390.88	568.8	2.69	466	5
Dimethyl malonate	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	454.6	647	3.60	377	77
2,7-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	538	775	3.23	601	3
2,2-Dimethyloxirane	C <sub>3</sub> H <sub>8</sub> O	325	499.9	4.35		82
2,2-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	352.4	520.5	2.77	416	5
2,3-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	362.93	537.3	2.91	393	5
2,4-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	353.64	519.8	2.74	418	5
3,3-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	359.21	536.4	2.95	414	5
2,3-Dimethyl-1-pentene	C <sub>7</sub> H <sub>14</sub>	357.5	533.6			59
4,4-Dimethyl-1-pentene	C <sub>7</sub> H <sub>14</sub>	345.7	516			59
Dimethyl phthalate	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	556.9	772	2.77		51
2,3-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	434.27	655.5	4.10	356	9,23
2,4-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	431.53	647	3.95	361	9,23
2,5-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	430.13	644.3	3.85	361	9,23
2,6-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	417.16	624.0	3.85	361	9,23
3,4-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	452.25	683.7	4.20	355	9,23
3,5-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	444.99	667.7	4.05	361	9,23
Dimethyl sulfide	C <sub>2</sub> H <sub>6</sub> S	310.48	503	5.53	203.7	8
1,3-Dimethyltricyclo[3.3.1.1 <sup>3,7</sup> ]decane	C <sub>12</sub> H <sub>20</sub>	476.53	704	2.75	566	69
Dinonyl phthalate	C <sub>26</sub> H <sub>42</sub> O <sub>4</sub>	686	858	1.02		51
Diocetyl phthalate	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>		840	1.08		51
1,4-Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	374.7	588	5.21	238	7
Dipentyl phthalate	C <sub>18</sub> H <sub>26</sub> O <sub>4</sub>		811	1.43		51
Diphenyl ether	C <sub>12</sub> H <sub>10</sub> O	531.2	767			7
Diphenylmethane	C <sub>13</sub> H <sub>12</sub>	538.2	760	2.71	563	3
Dipropylamine	C <sub>6</sub> H <sub>15</sub> N	382.5	555.8	3.63		9,59
Dipropylene glycol	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	503.7	705.2	3.38		82
Dipropyl ether	C <sub>6</sub> H <sub>14</sub> O	363.23	530.6	3.028		7
Dipropyl phthalate	C <sub>14</sub> H <sub>18</sub> O <sub>4</sub>	577.7	784	1.90		51
Diundecyl phthalate	C <sub>30</sub> H <sub>50</sub> O <sub>4</sub>		886	0.89		51
Docosane	C <sub>22</sub> H <sub>46</sub>	641.8	786	0.98		2
Docosanoic acid	C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>		837	1.11		48
1-Docosanol	C <sub>22</sub> H <sub>46</sub> O		827	1.07		80
Dodecane	C <sub>12</sub> H <sub>26</sub>	489.47	658	1.82	754	2
1,12-Dodecanediamine	C <sub>12</sub> H <sub>28</sub> N <sub>2</sub>		767	2.01		9,56
Dodecanedioic acid	C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>		859	2.15		57
1-Dodecanethiol	C <sub>12</sub> H <sub>26</sub> S	549.9	733.7	1.81		60

Name	Mol. Form.	$T_b/K$	$T_c/K$	$P_c/MPa$	$V_c/cm^3mol^{-1}$	Ref.
Dodecanoic acid	$C_{12}H_{24}O_2$		743	1.93		48
1-Dodecanol	$C_{12}H_{26}O$	533	719.4	1.994		4
2-Dodecanone	$C_{12}H_{24}O$	519.7	702		752	7
3-Dodecanone	$C_{12}H_{24}O$		701		752	7
4-Dodecanone	$C_{12}H_{24}O$		697		759	7
5-Dodecanone	$C_{12}H_{24}O$		695		759	7
6-Dodecanone	$C_{12}H_{24}O$		694		762	7
1-Dodecene	$C_{12}H_{24}$	487.0	658	1.93		6
Eicosane	$C_{20}H_{42}$	616	768	1.07		3
Eicosanoic acid	$C_{20}H_{40}O_2$	601	820	1.20		48
1-Eicosanol	$C_{20}H_{42}O$	629	809	1.30		49
Ethane	$C_2H_6$	184.6	305.32	4.872	145.5	2
1,2-Ethanediamine	$C_2H_8N_2$	390	613.1	6.71		9,11,12
1,2-Ethandiol	$C_2H_6O_2$	470.5	720	8		7,14
1,1-Ethandiol, diacetate	$C_6H_{10}O_4$	442	618.2	2.97		82
Ethanthiol	$C_2H_6S$	308.2	499	5.49	207	8
Ethanol	$C_2H_6O$	351.44	514.0	6.137	168	4
Ethoxybenzene	$C_8H_{10}O$	442.96	647	3.4		7
2-Ethoxyethyl acetate	$C_6H_{12}O_3$	429.6	608.0	3.17	441	7,23
2-Ethoxy-2-methylbutane	$C_8H_{16}O$	374.6	546	2.935	463	7
4-Ethoxy-1,1,1,2,2,3,3,4,4-nonafluorobutane	$C_4H_5F_9O$	350.04	482.02	1.976		65
Ethyl acetate	$C_4H_8O_2$	350.26	523.3	3.87	286	7
Ethylamine	$C_2H_7N$	289.7	456	5.6	180	9,49
<i>N</i> -Ethylaniline	$C_8H_{11}N$	476.2	700			9,49
Ethylbenzene	$C_8H_{10}$	409.34	617.15	3.609	374	3,15
Ethyl butanoate	$C_6H_{12}O_2$	394.5	568.8	3.1	415	7
Ethyl <i>trans</i> -2-butenoate	$C_6H_{10}O_2$	411	599			7
Ethylcyclohexane	$C_8H_{16}$	405.1	606.9	3.25		21,58,59
Ethylcyclopentane	$C_7H_{14}$	376.7	569.5	3.40	375	5
Ethyl 2,2-dimethylpropanoate	$C_7H_{14}O_2$	391.6	566	2.95	465	79
Ethylene	$C_2H_4$	169.38	282.34	5.041	131	6
Ethyl 3-ethoxypropanoate	$C_7H_{14}O_3$	439	621.0	2.66	458	7
Ethyl formate	$C_3H_6O_2$	327.6	508.54	4.74	229	7
Ethyl heptanoate	$C_9H_{18}O_2$	460	634			7
3-Ethylhexane	$C_8H_{18}$	391.8	565.5	2.61	455	5
Ethyl hexanoate	$C_8H_{16}O_2$	440	615.2			7
2-Ethylhexanoic acid	$C_8H_{16}O_2$	501	674	2.78	528	7
2-Ethyl-1-hexanol	$C_8H_{18}O$	457.8	640.6	2.8		4
2-Ethylhexyl acetate	$C_{10}H_{20}O_2$	472	642	2.09	681	7
Ethyl 3-methylbutanoate	$C_7H_{14}O_2$	408.2	582.4			7
Ethyl methyl ether	$C_3H_8O$	280.6	437.9	4.38	222	7
3-Ethyl-2-methylpentane	$C_8H_{18}$	388.81	567.1	2.70	442	5
3-Ethyl-3-methylpentane	$C_8H_{18}$	391.42	576.5	2.81	455	5
Ethyl 2-methylpropanoate	$C_6H_{12}O_2$	383.3	554	3.1	415	7
Ethyl methyl sulfide	$C_3H_8S$	339.9	533	4.25		8
Ethyl nonanoate	$C_{11}H_{22}O_2$	500.2	664			7
Ethyl octanoate	$C_{10}H_{20}O_2$	481.7	649			7
3-Ethylpentane	$C_7H_{16}$	366.7	540.6	2.89	416	5
Ethyl pentanoate	$C_7H_{14}O_2$	419.3	593.3			7
2-Ethylphenol	$C_8H_{10}O$	477.7	703.0			7
3-Ethylphenol	$C_8H_{10}O$	491.6	716.4			7
4-Ethylphenol	$C_8H_{10}O$	491.1	716.4			7
Ethyl propanoate	$C_5H_{10}O_2$	372.3	546.7	3.45	342	7
Ethyl propyl ether	$C_5H_{12}O$	336.36	500.2	3.370	339	7
<i>S</i> -Ethyl thioacetate	$C_4H_8OS$	389.6	590.55	4.075	319	11,12

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
2-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	438.4	651	3.38		21
3-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	434.5	637	3.25		21
4-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	435	640.2	3.23		3
Ethyl vinyl ether	C <sub>4</sub> H <sub>8</sub> O	308.7	475	4.07		7
Fluorobenzene	C <sub>6</sub> H <sub>5</sub> F	357.88	560.09	4.551	269	49
Fluoroethane [R-161]	C <sub>2</sub> H <sub>5</sub> F	235.5	375.31	5.028		49
Fluoroethene [R-1141]	C <sub>2</sub> H <sub>3</sub> F	201	327.9	5.24	144	49
Fluoromethane [R-41]	CH <sub>3</sub> F	194.8	317.28	5.897	108	49,54
2-Fluorotoluene	C <sub>7</sub> H <sub>7</sub> F	388	591.2			13
3-Fluorotoluene	C <sub>7</sub> H <sub>7</sub> F	388	591.8			13
4-Fluorotoluene	C <sub>7</sub> H <sub>7</sub> F	389.8	592.1			13
Formic acid	CH <sub>2</sub> O <sub>2</sub>	374	588			7
Furan	C <sub>4</sub> H <sub>4</sub> O	304.7	490.2	5.3	218	7
Furfural	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	434.9	670*	5.89*		7
Glycerol	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	563	850	7.5		7
Heneicosane	C <sub>21</sub> H <sub>44</sub>	629.7	778	1.03		2
Heptadecane	C <sub>17</sub> H <sub>36</sub>	575.2	736	1.34	1103	2
Heptadecanoic acid	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>		792	1.37		48
1-Heptadecanol	C <sub>17</sub> H <sub>36</sub> O	597	780	1.50		49
2,2,3,3,5,5,6-Heptafluoro-1,4-dioxane	C <sub>4</sub> HF <sub>7</sub> O <sub>2</sub>	312.72	452.88	2.866		63
1,1,1,2,2,3,3-Heptafluoropentan-4-one	C <sub>5</sub> H <sub>3</sub> F <sub>7</sub> O	337.40	476.55	2.578		61
1,1,1,2,3,3,3-Heptafluoropropane [HFC-227ea]	C <sub>3</sub> HF <sub>7</sub>	257.65	375.00	2.930	284	39,47,66
1,1,1,2,4,4,4-Heptafluoro-2-trifluoromethoxybutane	C <sub>5</sub> H <sub>12</sub> F <sub>10</sub> O	322.72	447.40	2.140		63
2,2,4,4,6,8,8-Heptamethylnonane	C <sub>16</sub> H <sub>34</sub>	519.5	692			5
Heptanal	C <sub>7</sub> H <sub>14</sub> O	426.0	617	3.16	434	7
2-Heptanamine	C <sub>7</sub> H <sub>17</sub> N	415	598.0			9,59
Heptane	C <sub>7</sub> H <sub>16</sub>	371.6	540.2	2.74	428	2
Heptanedioic acid	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	615.1	842	3.28		57
Heptanoic acid	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	495.4	678	3.16		7
1-Heptanol	C <sub>7</sub> H <sub>16</sub> O	449.60	632.6	3.058	435	4
2-Heptanol	C <sub>7</sub> H <sub>16</sub> O	432	608.3	3.021	442	4
3-Heptanol	C <sub>7</sub> H <sub>16</sub> O	430	605.4		434	4
4-Heptanol	C <sub>7</sub> H <sub>16</sub> O	429	602.6		432	4
2-Heptanone	C <sub>7</sub> H <sub>14</sub> O	424.20	611.4	2.97	436	7
3-Heptanone	C <sub>7</sub> H <sub>14</sub> O	420	606.6		433	7
4-Heptanone	C <sub>7</sub> H <sub>14</sub> O	417	602.0		434	7
1-Heptene	C <sub>7</sub> H <sub>14</sub>	366.79	537.3	2.92	409	6
<i>cis</i> -2-Heptene	C <sub>7</sub> H <sub>14</sub>	371.6	548.5			59
<i>trans</i> -2-Heptene	C <sub>7</sub> H <sub>14</sub>	371	542.8			59
<i>trans</i> -3-Heptene	C <sub>7</sub> H <sub>14</sub>	368.9	538.6			59
Heptylbenzene	C <sub>13</sub> H <sub>20</sub>	513	708	2.14		16
Hexachloroethane [R-110]	C <sub>2</sub> Cl <sub>6</sub>	457.85 s	695	3.34*	412*	12
Hexadecane	C <sub>16</sub> H <sub>34</sub>	560.01	723	1.40	1034	2
Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	624.7	785	1.49		48
1-Hexadecanol	C <sub>16</sub> H <sub>34</sub> O	585	770	1.61		49
1,5-Hexadiene	C <sub>6</sub> H <sub>10</sub>	332.6	508			6
Hexafluoroacetylacetone	C <sub>5</sub> H <sub>2</sub> F <sub>6</sub> O <sub>2</sub>	327.30	485.1	2.767		49
Hexafluorobenzene	C <sub>6</sub> F <sub>6</sub>	353.41	516.73	3.273	335	49
Hexafluoroethane [HFC-116]	C <sub>2</sub> F <sub>6</sub>	195.1	293.03	3.048	222	49,54
1,1,1,2,3,3-Hexafluoro-3-(2,2,3,3,3-pentafluoropropoxy)propane	C <sub>8</sub> H <sub>3</sub> F <sub>11</sub> O	360.64	486.48	1.950		65
1,1,1,2,3,3-Hexafluoropropane [HFC-236ea]	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	277.65	412.41	3.416	271	33,64,66
1,1,1,3,3,3-Hexafluoropropane [HFC-236fa]	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	272.2	398.07			45
1,1,1,2,3,3-Hexafluoro-3-(2,2,3,3-tetrafluoropropoxy)propane	C <sub>6</sub> H <sub>4</sub> F <sub>10</sub> O	379.07	516.2	2.17		65
1,1,1,2,3,3-Hexafluoro-3-(2,2,2-trifluoroethoxy)propane	C <sub>5</sub> H <sub>3</sub> F <sub>9</sub> O	345.87	475.74	2.233		65
1,1,1,3,3,3-Hexafluoro-2-trifluoromethyl-2-methoxypropane	C <sub>5</sub> H <sub>3</sub> F <sub>9</sub> O	326.50	462.72	2.366		63

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Hexamethylbenzene	C <sub>12</sub> H <sub>18</sub>	536.6	758			3
Hexanal	C <sub>6</sub> H <sub>12</sub> O	404	592	3.46	378	7
Hexane	C <sub>6</sub> H <sub>14</sub>	341.88	507.6	3.025	368	2
1,6-Hexanediamine	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	477.7	685	3.59		9,56
1,6-Hexanedioic acid	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	610.5	841	3.85		57
1,6-Hexanediol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	481	740.8	4.08		81
Hexanenitrile	C <sub>6</sub> H <sub>11</sub> N	436.80	633.8	3.30		9,49
Hexanoic acid	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	478.4	655	3.38	413	7
1-Hexanol	C <sub>6</sub> H <sub>14</sub> O	430.8	610.3	3.417	387	4
2-Hexanol	C <sub>6</sub> H <sub>14</sub> O	413	585.9	3.31	384	4
3-Hexanol	C <sub>6</sub> H <sub>14</sub> O	408	582.4	3.36	383	4
2-Hexanone	C <sub>6</sub> H <sub>12</sub> O	400.8	587.1	3.30	377	7
3-Hexanone	C <sub>6</sub> H <sub>12</sub> O	396.7	583.0	3.320	378	7
1-Hexene	C <sub>6</sub> H <sub>12</sub>	336.63	504.0	3.21	355.1	6
<i>cis</i> -2-Hexene	C <sub>6</sub> H <sub>12</sub>	342.0	513.4			59
<i>trans</i> -2-Hexene	C <sub>6</sub> H <sub>12</sub>	341.1	509.0			59
<i>cis</i> -3-Hexene	C <sub>6</sub> H <sub>12</sub>	339.6	510.2			59
<i>trans</i> -3-Hexene	C <sub>6</sub> H <sub>12</sub>	340.3	507.4			59
Hexyl acetate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	444.7	618.4			7
Hexylamine	C <sub>6</sub> H <sub>15</sub> N	406.0	592.3			9,59
Hexylbenzene	C <sub>12</sub> H <sub>18</sub>	499.3	695	2.35		16
Hydrogen cyanide	CHN	299	457	5.4	135	9,49
Indan	C <sub>9</sub> H <sub>10</sub>	451.12	684.9	3.95		3
1 <i>H</i> -Indole	C <sub>8</sub> H <sub>7</sub> N	526.8	794	4.8	356	10
Iodobenzene	C <sub>6</sub> H <sub>5</sub> I	461.6	721	4.52	351	49
Iodomethane	CH <sub>3</sub> I	315.58	528			49
Isobutanal	C <sub>4</sub> H <sub>8</sub> O	337.7	544	5.1		7
Isobutane	C <sub>4</sub> H <sub>10</sub>	261.42	407.885	3.6390	255.5	5,52,68
Isobutene	C <sub>4</sub> H <sub>8</sub>	266.3	418.09	4.010	239.8	6,72
Isobutyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	389.7	561	2.99	401	7
Isobutylamine	C <sub>4</sub> H <sub>11</sub> N	340.90	519	4.07	278	10
Isobutylbenzene	C <sub>10</sub> H <sub>14</sub>	445.94	650	3.05		4
Isobutyl butanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	430.1	611			7
Isobutylcyclohexane	C <sub>10</sub> H <sub>20</sub>	444.5	642.1			59
Isobutyl formate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	371.4	551	3.88	355	7
Isobutyl isobutanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	421.8	602			7
Isobutyl 3-methylbutanoate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	441.7	621			7
Isobutyl propanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	410	584			7
Isopentane	C <sub>5</sub> H <sub>12</sub>	301.03	460.4	3.38	306	5
Isopentyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	415.7	586.1	2.76		7
Isopentyl butanoate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	452	619			7
Isopentyl formate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	396.7	578			7
Isopentyl propanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	433.4	611			7
Isopropyl acetate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	361.8	531.0	3.31	344	7
Isopropylamine	C <sub>3</sub> H <sub>9</sub> N	304.91	472.2	4.55	219	9,59
Isopropylbenzene	C <sub>9</sub> H <sub>12</sub>	425.56	631.0	3.209		3
Isopropylcyclohexane	C <sub>9</sub> H <sub>18</sub>	428.0	632.2			59
Isopropyl formate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	341.4	535	3.95		7
1-Isopropyl-4-methylbenzene	C <sub>10</sub> H <sub>14</sub>	450.3	652	2.8		3
Isopropyl methyl ether	C <sub>4</sub> H <sub>10</sub> O	303.92	464.4	3.762		7
Isoquinoline	C <sub>9</sub> H <sub>7</sub> N	516.37	803			9,10
Isoxazole	C <sub>3</sub> H <sub>3</sub> NO	368	552.0			49
<i>d</i> -Limonene	C <sub>10</sub> H <sub>16</sub>	451	653		470	6
Maleic acid	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>		620			7
Mesityl oxide	C <sub>6</sub> H <sub>10</sub> O	403	605	4.00	353	7

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Methane	CH <sub>4</sub>	111.67	190.56	4.599	98.60	2
Methanethiol	CH <sub>4</sub> S	279.1	470	7.23	147	8
Methanol	CH <sub>4</sub> O	337.8	512.5	8.084	117	4
2-Methoxy-1,4-dimethylbenzene	C <sub>9</sub> H <sub>12</sub> O	467	677.3			7
1-Methoxy-2,4-dimethylbenzene	C <sub>9</sub> H <sub>12</sub> O	465	682			7
2-Methoxyethanol	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	397.3	597.6	5.285	263	7,11,12
2-Methoxyethyl acetate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	416	630.0			7
4-Methoxy-1,1,1,2,2,3,3-heptafluorobutane	C <sub>5</sub> H <sub>5</sub> F <sub>7</sub> O	344.13	481.54	2.381		65
3-Methoxy-1,1,2,2,3,3-hexafluoropropane	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	341.02	487	3.1		65
2-Methoxy-2-methylbutane	C <sub>6</sub> H <sub>14</sub> O	359.3	535	3.20	374	7
5-Methoxy-1,1,2,2,3,3,4,4-octafluoropentane	C <sub>5</sub> H <sub>6</sub> F <sub>8</sub> O	395.83	546.1	2.5		65
Methyl acetate	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	330.02	506.5	4.750	228	7
Methylamine	CH <sub>5</sub> N	266.83	430.8	7.62	141	9,49
2-Methylaniline	C <sub>8</sub> H <sub>9</sub> N	473.5	717	4.7	346	9,49
3-Methylaniline	C <sub>8</sub> H <sub>9</sub> N	476.5	709	4.2		9,49
4-Methylaniline	C <sub>8</sub> H <sub>9</sub> N	473.6	667	2.4		9,49
<i>N</i> -Methylaniline	C <sub>8</sub> H <sub>9</sub> N	469.4	702	5.2		9,49
2-Methylanisole	C <sub>8</sub> H <sub>10</sub> O	444	662.0			7
3-Methylanisole	C <sub>8</sub> H <sub>10</sub> O	448.7	665.3			7
4-Methylanisole	C <sub>8</sub> H <sub>10</sub> O	448.7	666			7
$\alpha$ -Methylbenzenemethanol	C <sub>8</sub> H <sub>10</sub> O	478	699	3.77		14
Methyl benzoate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	472	702	4.02	408	76
4-Methylbenzonitrile	C <sub>8</sub> H <sub>7</sub> N	490.2	723			9,49
3-Methyl-1-butanethiol	C <sub>5</sub> H <sub>12</sub> S	389	594			8
Methyl butanoate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	376.0	554.5	3.47	340	7
3-Methylbutanoic acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	449.7	629	3.40		7
2-Methyl-1-butanol	C <sub>5</sub> H <sub>12</sub> O	400.7	575.4	3.94		4
3-Methyl-1-butanol	C <sub>5</sub> H <sub>12</sub> O	404.3	577.2	3.93		4
2-Methyl-2-butanol	C <sub>5</sub> H <sub>12</sub> O	375.6	543.7	3.71		4
3-Methyl-2-butanol	C <sub>5</sub> H <sub>12</sub> O	386.1	556.1	3.87		4
3-Methyl-2-butanone	C <sub>5</sub> H <sub>10</sub> O	367.48	553.0	3.80	308	7
2-Methyl-1-butene	C <sub>5</sub> H <sub>10</sub>	304.4	467.0	3.8		49,59
3-Methyl-1-butene	C <sub>5</sub> H <sub>10</sub>	293.3	452.7	3.53	304.9	6
2-Methyl-2-butene	C <sub>5</sub> H <sub>10</sub>	311.71	470	3.42		6
Methyl <i>tert</i> -butyl ether	C <sub>5</sub> H <sub>12</sub> O	328.2	497.1	3.430		7
9-Methyl-9 <i>H</i> -carbazole	C <sub>13</sub> H <sub>11</sub> N	616.79	890	3.38	572	10
Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	374.08	572.1	3.48	369	5,58
Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	345.0	532.7	3.79	318	5
2-Methylcyclopentanone	C <sub>6</sub> H <sub>10</sub> O	412.7	631			7
2-Methyl- <i>N,N</i> -dimethylaniline	C <sub>9</sub> H <sub>13</sub> N	467.3	668	3.1		9,49
Methyl dodecanoate	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	540	712			7
Methyl formate	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	304.9	487.2	6.00	172	7
2-Methylfuran	C <sub>5</sub> H <sub>6</sub> O	337.9	528	4.7	247	7
2-Methylheptane	C <sub>8</sub> H <sub>18</sub>	390.81	559.7	2.50	488	5
3-Methylheptane	C <sub>8</sub> H <sub>18</sub>	392.1	563.6	2.55	464	5
4-Methylheptane	C <sub>8</sub> H <sub>18</sub>	390.87	561.7	2.54	476	5
Methyl heptanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	447	628			7
4-Methyl-3-heptanol	C <sub>8</sub> H <sub>18</sub> O	443	623.5			4
5-Methyl-3-heptanol	C <sub>8</sub> H <sub>18</sub> O	445	621.2			4
2-Methyl-3-heptanone	C <sub>8</sub> H <sub>16</sub> O	431	614.9			7
5-Methyl-3-heptanone	C <sub>8</sub> H <sub>16</sub> O	434	619.0			7
2-Methyl-1-heptene	C <sub>8</sub> H <sub>16</sub>	392.5	567.5			59
2-Methyl-2-heptene	C <sub>8</sub> H <sub>16</sub>	395.8	568.9			59
2-Methylhexane	C <sub>7</sub> H <sub>16</sub>	363.19	530.4	2.74	421	5
3-Methylhexane	C <sub>7</sub> H <sub>16</sub>	365	535.2	2.81	404	5

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
5-Methyl-2-hexanone	C <sub>7</sub> H <sub>14</sub> O	417	604.1			7
2-Methyl-3-hexanone	C <sub>7</sub> H <sub>14</sub> O	408	593.3			7
2-Methyl-1-hexene	C <sub>7</sub> H <sub>14</sub>	365	541.8			59
5-Methyl-1-hexene	C <sub>7</sub> H <sub>14</sub>	358.5	528.7			59
<i>N</i> -Methylhexylamine	C <sub>7</sub> H <sub>17</sub> N		592			9,59
Methylhydrazine	CH <sub>6</sub> N <sub>2</sub>	360.7	567	8.24	271	49
Methyl isobutanoate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	365.7	540.7	3.43	339	7
5-Methyl-2-isopropylcyclohexanol	C <sub>10</sub> H <sub>20</sub> O	489	694			49
1-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	517.9	772	3.60		3
2-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	514.3	761			3
2-Methyloctane	C <sub>9</sub> H <sub>20</sub>	416.4	582.8	2.31		5
Methyloxirane	C <sub>3</sub> H <sub>6</sub> O	308	485	5.2	190	7
Methyl pentafluoroethyl ether [HFE-245mc]	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> O	278.74	406.80	2.887	301	32,64
2-Methylpentane	C <sub>6</sub> H <sub>14</sub>	333.41	497.7	3.04	368	5
3-Methylpentane	C <sub>6</sub> H <sub>14</sub>	336.42	504.6	3.12	368	5
Methyl pentanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	400.6	590	3.20	422	7
2-Methyl-1-pentanol	C <sub>6</sub> H <sub>14</sub> O	422	604.4	3.45		4
4-Methyl-1-pentanol	C <sub>6</sub> H <sub>14</sub> O	425.1	603.5			4
2-Methyl-2-pentanol	C <sub>6</sub> H <sub>14</sub> O	394.3	559.5			4
4-Methyl-2-pentanol	C <sub>6</sub> H <sub>14</sub> O	404.8	574.4			4
2-Methyl-3-pentanol	C <sub>6</sub> H <sub>14</sub> O	399.7	576.0	3.46		4
3-Methyl-3-pentanol	C <sub>6</sub> H <sub>14</sub> O	395.6	575.6	3.52		4
4-Methyl-2-pentanone	C <sub>6</sub> H <sub>12</sub> O	389.7	574.6	3.270		7
2-Methyl-1-pentene	C <sub>6</sub> H <sub>12</sub>	335.3	521.0			59
4-Methyl-1-pentene	C <sub>6</sub> H <sub>12</sub>	327.1	493.1			59
2-Methyl-2-pentene	C <sub>6</sub> H <sub>12</sub>	340.5	509.3			59
4-Methyl- <i>cis</i> -2-pentene	C <sub>6</sub> H <sub>12</sub>	329.5	496.3			59
Methyl pentyl ether	C <sub>6</sub> H <sub>14</sub> O	372	546.5	3.042	391	7
2-Methyl-1,3-propanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	484.8	708.0	5.35		17
Methyl propanoate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	353.0	530.7	4.00	282	7
2-Methylpropanoic acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	427.60	605.0	3.70	290	7
2-Methyl-1-propanol	C <sub>4</sub> H <sub>10</sub> O	381.04	547.8	4.295	274	4
2-Methyl-2-propanol	C <sub>4</sub> H <sub>10</sub> O	355.6	506.2	3.972	275	4
Methylpropylamine	C <sub>4</sub> H <sub>11</sub> N	336	550	3.1		9
Methyl propyl ether	C <sub>4</sub> H <sub>10</sub> O	312.3	476.2	3.801		7
2-Methylpyrazine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	410	634	5.01	285	9,49
2-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	402.53	621	4.62	300	9,10
3-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	417.29	644.6	4.65	300	9,10
4-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	418.51	646.0	4.67	300	9,10
1-Methylpyrrole	C <sub>5</sub> H <sub>7</sub> N	385.96	596.0	4.86	271	10
2-Methylpyrrole	C <sub>5</sub> H <sub>7</sub> N	420.8	654	5.08	266	10
3-Methylpyrrole	C <sub>5</sub> H <sub>7</sub> N	416.1	647	5.08	266	10
<i>N</i> -Methyl-2-pyrrolidinone	C <sub>5</sub> H <sub>9</sub> NO	475	721.8		311	49
2-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	519.7	778	4.0	447	9
8-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	520.7	787	4.3	434	9
Methyl salicylate	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	496.1	709			7
Methylsilane	CH <sub>6</sub> Si	215.7	352.4			8
2-Methyltetrahydrofuran	C <sub>5</sub> H <sub>10</sub> O	351	537	3.76	267	7
(Methylthio)benzene	C <sub>6</sub> H <sub>8</sub> S	467.5	705.9	4.05		60
Trichloromethylsilane	CH <sub>3</sub> Cl <sub>3</sub> Si	338.8	517	3.28	348	49
Methyl trifluoromethyl ether [HFE-143m]	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	249.15	377.92	3.640	218	47,66
4-Morpholinecarboxaldehyde	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	512	779.3	5.08		82
Naphthalene	C <sub>10</sub> H <sub>8</sub>	491.1	748.4	4.05	407	3,60
1-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	573.9	850	5.0	438	10
2-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	579.4	850	4.9	438	10



Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Neopentane	C <sub>5</sub> H <sub>12</sub>	282.63	433.74	3.196	307	5,54
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	374.34	588	5.87	173	49
Nonadecane	C <sub>19</sub> H <sub>40</sub>	603.1	755	1.16		3
1,1,1,2,2,3,3,3,4,4-Nonafluorohexan-5-one	C <sub>6</sub> H <sub>3</sub> F <sub>9</sub> O	360.47	498.97	2.198		61
Nonanal	C <sub>9</sub> H <sub>18</sub> O	464	659	2.68	543	7
Nonane	C <sub>9</sub> H <sub>20</sub>	423.97	594.55	2.281	555	2,54
1,9-Nonanediamine	C <sub>9</sub> H <sub>22</sub> N <sub>2</sub>	531.8	726	2.63		9,56
Nonanedioic acid	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	630.2	844	2.72		57
Nonanoic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	527.7	712	2.35		7
1-Nonanol	C <sub>9</sub> H <sub>20</sub> O	486.52	670.7	2.528	572	4
2-Nonanol	C <sub>9</sub> H <sub>20</sub> O	466.7	649.6	2.53	575	4
3-Nonanol	C <sub>9</sub> H <sub>20</sub> O	468	648.0		577	4
4-Nonanol	C <sub>9</sub> H <sub>20</sub> O	465.7	645.1		575	4
2-Nonanone	C <sub>9</sub> H <sub>18</sub> O	468.5	652.2	2.48	560	7,11,12
3-Nonanone	C <sub>9</sub> H <sub>18</sub> O	463	648.1		560	7
4-Nonanone	C <sub>9</sub> H <sub>18</sub> O	460.7	643.7		560	7
5-Nonanone	C <sub>9</sub> H <sub>18</sub> O	461.60	641.4	2.32	560	7
1-Nonene	C <sub>9</sub> H <sub>18</sub>	420.1	594.0		526	6
Octadecane	C <sub>18</sub> H <sub>38</sub>	589.5	747	1.29	1189	2
1-Octadecanol	C <sub>18</sub> H <sub>38</sub> O	608	790	1.44		49
Octanal	C <sub>8</sub> H <sub>16</sub> O	444	639	2.96	488	7
Octane	C <sub>8</sub> H <sub>18</sub>	398.82	568.7	2.49	492	2
1,8-Octanediamine	C <sub>8</sub> H <sub>20</sub> N <sub>2</sub>	498.7	712	2.80		9,56
Octanedioic acid	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	618.6	843	2.97		57
Octanenitrile	C <sub>8</sub> H <sub>15</sub> N	478.40	674.4	2.85		9,49
1-Octanethiol	C <sub>8</sub> H <sub>18</sub> S	472.3	667		504	8
Octanoic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	512	693	2.87	519	7
1-Octanol	C <sub>8</sub> H <sub>18</sub> O	468.31	652.5	2.777	497	4
2-Octanol	C <sub>8</sub> H <sub>18</sub> O	452.5	629.6	2.754	519	4
3-Octanol	C <sub>8</sub> H <sub>18</sub> O	444	628.5		515	4
4-Octanol	C <sub>8</sub> H <sub>18</sub> O	449.5	625.1		515	4
2-Octanone	C <sub>8</sub> H <sub>16</sub> O	445.7	632.7		497	7
3-Octanone	C <sub>8</sub> H <sub>16</sub> O	440.7	627.7		497	7
4-Octanone	C <sub>8</sub> H <sub>16</sub> O	436	623.8		497	7
1-Octene	C <sub>8</sub> H <sub>16</sub>	394.44	567.0	2.68	468	6
<i>trans</i> -2-Octene	C <sub>8</sub> H <sub>16</sub>	398	569.8			59
<i>trans</i> -4-Octene	C <sub>8</sub> H <sub>16</sub>	395.5	566.3			59
Octylamine	C <sub>8</sub> H <sub>19</sub> N	452.8	641	2.6	517	9
Octylbenzene	C <sub>14</sub> H <sub>22</sub>	537	725	1.98		16
Oxazole	C <sub>3</sub> H <sub>3</sub> NO	342.7	550.8	6.77		82
Oxirane	C <sub>2</sub> H <sub>4</sub> O	283.8	469	7.2	142	7
Paraldehyde	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	397.5	563			7
1 <i>H</i> -Pentadecafluoroheptane	C <sub>7</sub> HF <sub>15</sub>	369.2	495.8			49
Pentadecane	C <sub>15</sub> H <sub>32</sub>	543.8	708	1.48	966	2
Pentadecanoic acid	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>		777	1.57		48
1-Pentadecanol	C <sub>15</sub> H <sub>32</sub> O	573	757	1.60		80
Pentafluorobenzene	C <sub>6</sub> HF <sub>5</sub>	358.89	530.97	3.531	324	49
3,3,4,4,4-Pentafluorobutan-2-one	C <sub>4</sub> H <sub>3</sub> F <sub>5</sub> O	314.37	453.03	2.912		63
Pentafluoroethane [HFC-125]	C <sub>2</sub> HF <sub>5</sub>	224.65	339.20	3.617	214	30,64,66
1,1,1,2,2-Pentafluoropentan-3-one	C <sub>5</sub> H <sub>5</sub> F <sub>5</sub> O	335.24	475.54	2.642		61
Pentafluorophenol	C <sub>6</sub> HF <sub>5</sub> O	418.8	609	4.0	348	49
1,1,1,2,2-Pentafluoropropane [R-245cb]	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	255.8	380.11	3.137	273	49
1,1,2,2,3-Pentafluoropropane [HFC-245ca]	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	298.2	447.57			45
1,1,1,3,3-Pentafluoropropane [HFC-245fa]	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	288.5	427.16	3.651	260	45,54
1,1,1,2,2-Pentafluoro-3-(1,1,2,2-tetrafluoroethoxy)propane	C <sub>5</sub> H <sub>3</sub> F <sub>9</sub> O	343.4	473.01	2.244		65



Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
2,3,4,5,6-Pentafluorotoluene	C <sub>7</sub> H <sub>3</sub> F <sub>5</sub>	390.7	566.52	3.126	384	49
Pentanal	C <sub>5</sub> H <sub>10</sub> O	376	567	3.97	313	7
Pentane	C <sub>5</sub> H <sub>12</sub>	309.21	469.7	3.370	311	2
Pentanedioic acid	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	576.0	840	4.27		57
Pentanenitrile	C <sub>5</sub> H <sub>9</sub> N	414.5	610.3	3.58		9,49
Pentanoic acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	459.3	637.2	3.63	346	7
1-Pentanol	C <sub>5</sub> H <sub>12</sub> O	411.13	588.1	3.897	326	4
2-Pentanol	C <sub>5</sub> H <sub>12</sub> O	392.5	560.3	3.675	329	4
3-Pentanol	C <sub>5</sub> H <sub>12</sub> O	389.40	559.6		325	4
2-Pentanone	C <sub>5</sub> H <sub>10</sub> O	375.41	561.1	3.683	321	7
3-Pentanone	C <sub>5</sub> H <sub>10</sub> O	374.9	561.4	3.729	331	7
1-Pentene	C <sub>5</sub> H <sub>10</sub>	303.11	464.8	3.56	298.4	6
<i>cis</i> -2-Pentene	C <sub>5</sub> H <sub>10</sub>	310.08	475	3.69		6
<i>trans</i> -2-Pentene	C <sub>5</sub> H <sub>10</sub>	309.49	471	3.52		49
Pentyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	422.4	599	2.73	470	7,23
Pentylbenzene	C <sub>11</sub> H <sub>16</sub>	478.6	675	2.58		16
Pentyl formate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	403.6	576	3.46	412	7
1-Pentyne	C <sub>5</sub> H <sub>8</sub>	313.3	493.5			49
Perfluoroacetone	C <sub>3</sub> F <sub>6</sub> O	245.8	357.14	2.84	329	49
Perfluorobutane	C <sub>4</sub> F <sub>10</sub>	271.3	386.4	2.323	378	49
Perfluoro-2-butyltetrahydrofuran	C <sub>8</sub> F <sub>16</sub> O	375.8	500.2	1.607	588	49
Perfluorocyclobutane [R-C318]	C <sub>4</sub> F <sub>8</sub>	267.3	388.46	2.784	324	49
Perfluorocyclohexane	C <sub>6</sub> F <sub>12</sub>	325.95 s	457.2	2.43		49
Perfluorocyclohexene	C <sub>6</sub> F <sub>10</sub>	325.2	461.8			49
Perfluorodecalin	C <sub>10</sub> F <sub>18</sub>	415	566	1.52		49
Perfluorodecane	C <sub>10</sub> F <sub>22</sub>	417.4	542	1.45		49
Perfluorodimethoxymethane	C <sub>3</sub> F <sub>8</sub> O <sub>2</sub>	263	372.3	2.333	363	18
Perfluoro-2,3-dimethylbutane	C <sub>6</sub> F <sub>14</sub>	333.0	463	1.87	525	49
Perfluoroethyl ethyl ether	C <sub>4</sub> H <sub>5</sub> F <sub>5</sub> O	301.26	431.23	2.533	366	32
Perfluoroethyl 2,2,2-trifluoroethyl ether	C <sub>4</sub> H <sub>2</sub> F <sub>8</sub> O	301.04	421.68	2.330	409	32
Perfluoroheptane	C <sub>7</sub> F <sub>16</sub>	355.7	474.8	1.62	664	49
Perfluoro-1-heptene	C <sub>7</sub> F <sub>14</sub>	354.2	478.2			49
Perfluorohexane	C <sub>6</sub> F <sub>14</sub>	330.3	448.77	1.868	606	49
Perfluoro-1-hexene	C <sub>6</sub> F <sub>12</sub>	330.2	454.4			49
Perfluoroisobutane	C <sub>4</sub> F <sub>10</sub>	273	395.4			49
Perfluoroisopropyl methyl ether [HFE-347mmy]	C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	302.49	433.30	2.553	369	32
Perfluoromethylcyclohexane	C <sub>7</sub> F <sub>14</sub>	349.5	485.91	2.019	570	49
Perfluoro-2-methylpentane	C <sub>6</sub> F <sub>14</sub>	330.8	455.3	1.923	532	49
Perfluoro-3-methylpentane	C <sub>6</sub> F <sub>14</sub>	331.6	450	1.69		49
Perfluoronaphthalene	C <sub>10</sub> F <sub>8</sub>	482	673.1			49
Perfluorononane	C <sub>9</sub> F <sub>20</sub>	390.76	524	1.56		49
Perfluorooctane	C <sub>8</sub> F <sub>18</sub>	379.1	502	1.66		49
Perfluorooxetane	C <sub>3</sub> F <sub>6</sub> O	244.8	361.8	3.03	272	18,47
Perfluoropentane	C <sub>5</sub> F <sub>12</sub>	302.4	420.59	2.045	473	49
Perfluoropropane [HFC-218]	C <sub>3</sub> F <sub>8</sub>	236.6	345.1	2.680	299	49
Perfluoropropyl methyl ether [HFE-347mcc]	C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	307.38	437.70	2.481	377	32
Perfluorotoluene	C <sub>7</sub> F <sub>8</sub>	376.70	534.47	2.705	428	49
Phenanthrene	C <sub>14</sub> H <sub>10</sub>	613	869			4
Phenanthridine	C <sub>13</sub> H <sub>9</sub> N	622.1	895	3.6	548	10
Phenol	C <sub>6</sub> H <sub>6</sub> O	455.02	694.2	5.93		7
Phenyl acetate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	469	685.7	3.59		17
Phenyl isocyanate	C <sub>7</sub> H <sub>5</sub> NO	436	656.9	4.00		82
α-Pinene	C <sub>10</sub> H <sub>16</sub>	429.4	644		454	6
Piperazine	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub>	421.8	656.3	5.42	269	9,81
Piperidine	C <sub>5</sub> H <sub>11</sub> N	379.37	594.1			9,10

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Propanal	C <sub>3</sub> H <sub>6</sub> O	321	505	5.26	204	7
Propane	C <sub>3</sub> H <sub>8</sub>	231.1	369.83	4.248	203	2,67
1,3-Propanediamine	C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	413.2	632	5.59		9,56
Propanenitrile	C <sub>3</sub> H <sub>5</sub> N	370.29	561.3	4.26	246	9,49
1-Propanethiol	C <sub>3</sub> H <sub>8</sub> S	341.0	537	4.6	286	8
Propanoic acid	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	414.30	598.5	4.67	233	7
1-Propanol	C <sub>3</sub> H <sub>8</sub> O	370.4	536.8	5.169	218	4
2-Propanol	C <sub>3</sub> H <sub>8</sub> O	355.5	508.3	4.764	222	4
Propene	C <sub>3</sub> H <sub>6</sub>	225.46	364.9	4.60	185	6
2-Propoxyethanol	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	423.0	615	3.65	364	7
1-Propoxy-2-propanol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	423	605.1	3.051		14
Propyl acetate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	374.69	549.7	3.36	345	7
Propylamine	C <sub>3</sub> H <sub>9</sub> N	320.37	499.2	4.74		9,59
Propylbenzene	C <sub>9</sub> H <sub>12</sub>	432.39	638.35	3.200	440	3
Propyl butanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	416.2	593.1	2.72		7
Propylcyclohexane	C <sub>9</sub> H <sub>18</sub>	429	630.8	2.86		58,59
Propylene carbonate	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	515	762.7	4.14		17
1,2-Propanediol	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	460.8	676.4	5.941		7,14
1,3-Propanediol	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	487.6	718.2	6.55		14,17
1,2-Propylene glycol 1- <i>tert</i> -butyl ether	C <sub>7</sub> H <sub>16</sub> O <sub>2</sub>	425.2	600.7	2.72		60
1-Methoxy-2-propanol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	392	579.8	4.113		11,12
1,2-Propylene glycol monomethyl ether acetate	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	420	597.8	3.01	432	7
Propyl formate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	354.1	538.0	4.06	285	7
Propyl isobutanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	408.6	579.4			7
Propyl 3-methylbutanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	429.1	609			7
Propyl propanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	395.7	570	3.06		7
Propyne	C <sub>3</sub> H <sub>4</sub>	250.0	402.4	5.63	163.5	6
Pyrazine	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	388	627	6.70	229	9
Pyridine	C <sub>5</sub> H <sub>5</sub> N	388.38	620.0	5.65	247	9,10
Pyrocatechol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	518	800	6.24		81
Pyrrole	C <sub>4</sub> H <sub>5</sub> N	402.94	640	5.7		9,10
Pyrrolidine	C <sub>4</sub> H <sub>9</sub> N	359.71	569	5.7	245	9,10
Quinoline	C <sub>9</sub> H <sub>7</sub> N	510.31	782			9,10
Resorcinol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	549.7	836	6.24		81
Squalene	C <sub>30</sub> H <sub>50</sub>	694.5	795.9	0.59		15
Stearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	623	803	1.33		48
Styrene	C <sub>8</sub> H <sub>8</sub>	418	635.2	3.87		15
Succinic acid	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	508.2	851	6.59		57
Sulfolane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	560.5	868	6.0		82
<i>o</i> -Terphenyl	C <sub>18</sub> H <sub>14</sub>	605	857	2.99	731	3
<i>m</i> -Terphenyl	C <sub>18</sub> H <sub>14</sub>	636	883	2.48	724	3
<i>p</i> -Terphenyl	C <sub>18</sub> H <sub>14</sub>	649	908	2.99	729	3
1,1,2,2-Tetrachloro-1,2-difluoroethane [R-112]	C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	366.0	551			49
1,1,2,2-Tetrachloroethane [R-130]	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	418.4	661.15			49
Tetrachloroethene	C <sub>2</sub> Cl <sub>4</sub>	394.5	620.2			49
Tetrachloromethane [R-10]	CCl <sub>4</sub>	350.0	556.6	4.516	276	49
Tetracosane	C <sub>24</sub> H <sub>50</sub>	664.5	800	0.87		2
Tetradecane	C <sub>14</sub> H <sub>30</sub>	526.73	693	1.57	894	2
Tetradecanedioic acid	C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>		862	1.90		57
Tetradecanoic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>		763	1.64		48
1-Tetradecanol	C <sub>14</sub> H <sub>30</sub> O	560	747	1.81		49
2-Tetradecanone	C <sub>14</sub> H <sub>28</sub> O		728		896	7
3-Tetradecanone	C <sub>14</sub> H <sub>28</sub> O		727		896	7
4-Tetradecanone	C <sub>14</sub> H <sub>28</sub> O		725		900	7
7-Tetradecanone	C <sub>14</sub> H <sub>28</sub> O		723		904	7

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Tetraethylene glycol	C <sub>8</sub> H <sub>18</sub> O <sub>5</sub>	601	800	3.2		7
Tetraethylsilane	C <sub>8</sub> H <sub>20</sub> Si	427.9	605	2.50	587	8
1,2,3,4-Tetrafluorobenzene	C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	367.5	550.83	3.791	313	49
1,2,3,5-Tetrafluorobenzene	C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	357.6	535.25	3.747		49
1,2,4,5-Tetrafluorobenzene	C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	363.4	543.35	3.801		49
1,1,2,2-Tetrafluoro-2-(2,2-difluoromethoxy)ethane	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	352.13	501.08	3.090		65
1,1,1,2-Tetrafluoroethane [HFC-134a]	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	246.6	374.13	4.053	201	36,64,66
1,1,2,2-Tetrafluoroethane [HFC-134]	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	253.3	391.74	4.615	191	19,42
Tetrafluoroethene [HFC-1114]	C <sub>2</sub> F <sub>4</sub>	197.3	306.5	3.94	172	49
1,2,2,2-Tetrafluoroethyl difluoromethyl ether [HFE-236me]	C <sub>2</sub> H <sub>2</sub> F <sub>6</sub> O	296.50	428.95	3.050	315	32
1,1,2,2-Tetrafluoroethyl 1,1,1-trifluoroethyl ether	C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	329.37	463.89	2.713		65
Tetrafluoromethane [R-14]	CF <sub>4</sub>	145.2	227.6	3.74	140	49
1,1,2,2-Tetrafluoro-3-(1,1,2,2-tetrafluoroethoxy)propane	C <sub>5</sub> H <sub>4</sub> F <sub>8</sub> O	366.32	510.07	2.581		65
4,4,5,5-Tetrafluoro-2-trifluoromethyl-1,3-dioxolane	C <sub>4</sub> HF <sub>7</sub> O <sub>2</sub>	304.98	435.06	2.645		63
3,4,4,4-Tetrafluoro-3-trifluoromethylbutan-2-one	C <sub>5</sub> H <sub>3</sub> F <sub>7</sub> O	328.78	467.64	2.522		63
Tetrahydrofuran	C <sub>4</sub> H <sub>8</sub> O	338	540.5	5.19	224	7
1,2,3,4-Tetrahydronaphthalene	C <sub>10</sub> H <sub>12</sub>	480.8	720	3.65	408	4
Tetrahydropyran	C <sub>5</sub> H <sub>10</sub> O	361	572	4.77	263	7
Tetrahydrothiophene	C <sub>4</sub> H <sub>8</sub> S	394.3	632	5.4		8
1,2,4,5-Tetraisopropylbenzene	C <sub>18</sub> H <sub>30</sub>	532	703	1.60	913	77
1,2,4,5-Tetramethylbenzene	C <sub>10</sub> H <sub>14</sub>	470.0	676	2.9		3
2,2,3,3-Tetramethylbutane	C <sub>8</sub> H <sub>18</sub>	379.60	567.8	2.87	461	49
2,2,3,3-Tetramethylhexane	C <sub>10</sub> H <sub>22</sub>	433.5	623.0	2.51		5
2,2,5,5-Tetramethylhexane	C <sub>10</sub> H <sub>22</sub>	410.6	581.4	2.19		5
2,2,3,3-Tetramethylpentane	C <sub>9</sub> H <sub>20</sub>	413.4	607.5	2.74		5
2,2,3,4-Tetramethylpentane	C <sub>9</sub> H <sub>20</sub>	406.2	592.6	2.60		5
2,2,4,4-Tetramethylpentane	C <sub>9</sub> H <sub>20</sub>	395.44	574.6	2.49		5
2,3,3,4-Tetramethylpentane	C <sub>9</sub> H <sub>20</sub>	414.7	607.5	2.72		5
Tetramethylsilane	C <sub>4</sub> H <sub>12</sub> Si	299.8	448.6	2.821	361.6	8
Tetramethylstannane	C <sub>4</sub> H <sub>12</sub> Sn	351	521.8	2.981		8
Thiophene	C <sub>4</sub> H <sub>4</sub> S	357.2	580	5.70	219	8
Thymol	C <sub>10</sub> H <sub>14</sub> O	505.7	698			7
Toluene	C <sub>7</sub> H <sub>8</sub>	383.78	591.80	4.110	316	3,15
Triacontane	C <sub>30</sub> H <sub>62</sub>	725.1	842	0.64		60
1,1,1-Trichloroethane [R-140a]	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	347.24	545	4.30		49
1,1,2-Trichloroethane [R-140]	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	387.0	602*	4.48*	281*	12
Trichloroethene [R-1120]	C <sub>2</sub> HCl <sub>3</sub>	360.36	544.2	5.02		49
Trichlorofluoromethane [R-11]	CCl <sub>3</sub> F	296.9	471.1	4.47	247	18
Trichloromethane [R-20]	CHCl <sub>3</sub>	334.32	536.4	5.47	239	49
1,3,5-Trichloro-2,4,6-trifluorobenzene	C <sub>6</sub> Cl <sub>3</sub> F <sub>3</sub>	471.6	684.8	3.27	448	49
1,1,1-Trichloro-2,2,2-trifluoroethane [R-113a]	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	318.7	482.9			40
1,1,2-Trichloro-1,2,2-trifluoroethane [R-113]	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	320.9	487.3	3.42	325	49
Tricosane	C <sub>23</sub> H <sub>48</sub>	653	790	0.92		2
Tridecane	C <sub>13</sub> H <sub>28</sub>	508.62	675	1.68	823	2
1-Tridecanol	C <sub>13</sub> H <sub>28</sub> O	547	734	1.935		49
2-Tridecanone	C <sub>13</sub> H <sub>26</sub> O	536	717		820	7
3-Tridecanone	C <sub>13</sub> H <sub>26</sub> O		716		823	7
4-Tridecanone	C <sub>13</sub> H <sub>26</sub> O		712		823	7
5-Tridecanone	C <sub>13</sub> H <sub>26</sub> O		710		826	7
6-Tridecanone	C <sub>13</sub> H <sub>26</sub> O		709		826	7
7-Tridecanone	C <sub>13</sub> H <sub>26</sub> O	534	708		830	7
Tridecylbenzene	C <sub>19</sub> H <sub>32</sub>	619	790	1.54		16
Triethylamine	C <sub>6</sub> H <sub>15</sub> N	362	535.6	3.03	389	9,49
Triethylene glycol	C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	558	780	3.3		7
Trifluoroacetic acid	C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	346	491.3	3.258	204	49

Name	Mol. Form.	$T_b$ /K	$T_c$ /K	$P_c$ /MPa	$V_c$ /cm <sup>3</sup> mol <sup>-1</sup>	Ref.
Trifluoroacetonitrile	C <sub>2</sub> F <sub>3</sub> N	204.4	311.11	3.618	202	49
1,2,3-Trifluorobenzene	C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	368	560.3			13
1,2,4-Trifluorobenzene	C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	363	551.1			13
1,3,5-Trifluorobenzene	C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	348.7	530.9			13
1,1,1-Trifluoroethane [R-143a]	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	225.90	345.86	3.764	194	27,28
1,1,2-Trifluoroethane [R-143]	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	276.9	429.8	5.241	207	40
2,2,2-Trifluoroethyl methyl ether [HFE-143a]	C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> O	304.77	448.98	3.513	277	32
Trifluoroiodomethane	CF <sub>3</sub> I	250.7	396.44	3.953	226	24
Trifluoromethane [R-23]	CHF <sub>3</sub>	191.1	298.98	4.82	135	42,78
Trifluoromethyl difluoromethyl ether [HFE-125]	C <sub>2</sub> H <sub>2</sub> F <sub>5</sub> O	235	354.0	3.33	192	25,45,46
Trifluoromethyl 1,1,2,2-tetrafluoroethyl ether [HFE-227ca2]	C <sub>2</sub> H <sub>2</sub> F <sub>7</sub> O	270	387.78	2.293	337	18,47
3,3,3-Trifluoropropene	C <sub>3</sub> H <sub>3</sub> F <sub>3</sub>	256	376.2	3.80	211	49
Trimethylamine	C <sub>3</sub> H <sub>9</sub> N	276.02	433	4.08	257	9,49
1,2,3-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	449.27	664.5	3.454		3
1,2,4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	442.53	649.1	3.232		3
1,3,5-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	437.89	637.3	3.127		3
Trimethyl borate	C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	340.7	501.7	3.59		49
2,2,3-Trimethylbutane	C <sub>8</sub> H <sub>16</sub>	354.01	531.1	2.95	398	5
Trimethylchlorosilane	C <sub>3</sub> H <sub>9</sub> ClSi	333	497.8	3.20	366	49
1 $\alpha$ ,3 $\alpha$ ,5 $\beta$ -1,3,5-Trimethylcyclohexane	C <sub>9</sub> H <sub>18</sub>	413.7	602.2			5
3,3,5-Trimethylheptane	C <sub>10</sub> H <sub>22</sub>	428.9	609.5	2.32		5
2,2,5-Trimethylhexane	C <sub>9</sub> H <sub>20</sub>	397.24	569.8			5
2,2,3-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	383	563.5	2.73	436	5
2,2,4-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	372.37	543.8	2.57	468	5
2,3,3-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	388.0	573.5	2.82	455	5
2,3,4-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	386.7	566.4	2.73	461	5
Tripropylamine	C <sub>9</sub> H <sub>21</sub> N	429	637.9			9
Undecafluorocyclohexane	C <sub>6</sub> HF <sub>11</sub>	335.2	477.7			49
Undecane	C <sub>11</sub> H <sub>24</sub>	469.1	639	1.98	689	2
Undecanoic acid	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	553	728	2.13		48
1-Undecanol	C <sub>11</sub> H <sub>24</sub> O	518	703.6	2.147	718	4
2-Undecanone	C <sub>11</sub> H <sub>22</sub> O	504.7	688		692	7
3-Undecanone	C <sub>11</sub> H <sub>22</sub> O	500	685		692	7
4-Undecanone	C <sub>11</sub> H <sub>22</sub> O		681		692	7
5-Undecanone	C <sub>11</sub> H <sub>22</sub> O	500	679		692	7
6-Undecanone	C <sub>11</sub> H <sub>22</sub> O	501	678		692	7
Undecylbenzene	C <sub>17</sub> H <sub>28</sub>	589	763	1.64		16
Vinyl acetate	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	346.0	519.2	4.185		7
<i>o</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	417.7	630.3	3.732	370	3
<i>m</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	412.27	617.0	3.541	375	3
<i>p</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	411.52	616.2	3.511	378	3
2,3-Xylenol	C <sub>8</sub> H <sub>10</sub> O	490.1	722.8			7
2,4-Xylenol	C <sub>8</sub> H <sub>10</sub> O	484.13	707.6			7
2,5-Xylenol	C <sub>8</sub> H <sub>10</sub> O	484.3	706.9			7
2,6-Xylenol	C <sub>8</sub> H <sub>10</sub> O	474.22	701.0			7
3,4-Xylenol	C <sub>8</sub> H <sub>10</sub> O	500	729.8			7
3,5-Xylenol	C <sub>8</sub> H <sub>10</sub> O	494.89	715.6			7

## SUBLIMATION PRESSURE OF SOLIDS

This table gives the sublimation (vapor) pressure of some representative solids as a function of temperature. Entries include simple inorganic and organic substances in their solid phase below room temperature, as well as polycyclic organic compounds which show measurable sublimation pressure only at elevated temperatures. Substances are listed by molecular formula in the Hill order. Values marked by \* represent the solid-liquid-gas triple point. Note that some pressure values are in pascals (Pa) and others are in kilopascals (kPa). For conversion, 1 kPa = 7.506 mmHg = 0.0098692 atm.

### References

1. Lide, D. R. and Kehiaian, H. V., *CRC Handbook of Thermophysical and Thermochemical Data*, CRC Press, Boca Raton, FL, 1994.
2. *TRC Thermodynamic Tables*, Thermodynamic Research Center, Texas A&M University, College Station, TX.
3. Oja, V. and Suuberg, E. M., *J. Chem. Eng. Data*, 43, 486, 1998.

Ar	<i>T/K</i>	55	60	65	70	75	80	83.81*	
Argon	<i>p/kPa</i>	0.2	0.8	2.8	7.7	18.7	40.7	68.8*	
BrH	<i>T/K</i>	135	140	150	160	170	180	185.1*	
Hydrogen bromide	<i>p/kPa</i>	0.1	0.3	1.1	3.3	8.7	20.1	27.4*	
Br <sub>2</sub>	<i>T/K</i>	170	180	190	200	210	220	230	240*
Bromine	<i>p/Pa</i>	0.069	0.416	2.04	8.45	30.3	96.0	273	710*
ClH	<i>T/K</i>	120	130	140	150	155	159.0*		
Hydrogen chloride	<i>p/kPa</i>	0.1	0.5	1.9	5.8	9.5	13.5*		
Cl <sub>2</sub>	<i>T/K</i>	120	130	140	150	160	170*		
Chlorine	<i>p/Pa</i>	0.144	1.52	11.2	63.1	283	1054*		
F <sub>4</sub> Si	<i>T/K</i>	130	140	150	160	170	175	180	186.3*
Tetrafluorosilane	<i>p/kPa</i>	0.2	0.9	3.9	14.0	43.8	74.2	122.4	220.8*
F <sub>6</sub> S	<i>T/K</i>	150	165	180	190	200	210	220	223.1*
Sulfur hexafluoride	<i>p/kPa</i>	0.4	2.6	11.3	25.9	54.5	106.1	195.1	232.7*
HI	<i>T/K</i>	160	170	180	190	200	210	220	222.4*
Hydrogen iodide	<i>p/kPa</i>	0.2	0.8	2.2	5.3	11.7	23.6	44.1	49.3*
H <sub>2</sub> O	<i>T/K</i>	190	210	225	240	250	260	270	273.16*
Water	<i>p/Pa</i>	0.032	0.702	4.942	27.28	76.04	195.8	470.1	611.66*
H <sub>2</sub> S	<i>T/K</i>	140	150	160	165	170	175	180	187.6*
Hydrogen sulfide	<i>p/kPa</i>	0.2	0.6	1.9	3.2	5.2	8.3	12.7	22.7*
H <sub>3</sub> N	<i>T/K</i>	160	170	180	190	195	195.4*		
Ammonia	<i>p/kPa</i>	0.1	0.4	1.2	3.5	5.8	6.12*		
I <sub>2</sub>	<i>T/K</i>	240	250	260	270	280	290	300	310*
Iodine	<i>p/Pa</i>	0.081	0.297	0.971	2.89	7.92	20.1	47.9	107*
Kr	<i>T/K</i>	80	90	95	100	105	110	115.8*	
Krypton	<i>p/kPa</i>	0.4	2.7	6.0	12.1	22.8	40.4	73.1*	
NO	<i>T/K</i>	85	90	95	100	105	109.5*		
Nitric oxide	<i>p/kPa</i>	0.1	0.4	1.3	3.8	10.0	21.9*		
Xe	<i>T/K</i>	110	120	130	140	150	155	160	161.4*
Xenon	<i>p/kPa</i>	0.3	1.5	4.9	14.0	34.2	51.1	74.2	81.7*
CHN	<i>T/K</i>	200	210	220	230	240	250	255	259.83*
Hydrogen cyanide	<i>p/kPa</i>	0.2	0.4	1.0	2.2	4.8	9.7	13.6	18.62*
CH <sub>4</sub>	<i>T/K</i>	65	70	75	80	85	90.69*		
Methane	<i>p/kPa</i>	0.1	0.3	0.8	2.1	4.9	11.70*		
CO	<i>T/K</i>	50	55	60	65	68.13*			
Carbon monoxide	<i>p/kPa</i>	0.1	0.6	2.6	8.2	15.4*			
CO <sub>2</sub>	<i>T/K</i>	130	140	155	170	185	194.7	205	216.58*
Carbon dioxide	<i>p/kPa</i>	0.032	0.187	1.674	9.987	44.02	101.3	227.1	518.0*
C <sub>2</sub> Cl <sub>6</sub>	<i>T/K</i>	275	300	325	350	375	400	425	459.9*
Hexachloroethane	<i>p/Pa</i>	0.004	0.056	0.383	1.62	5.30	14.8	36.4	107.4*
C <sub>2</sub> H <sub>2</sub>	<i>T/K</i>	130	140	150	160	170	180	190	192.4*
Acetylene	<i>p/kPa</i>	0.2	0.7	2.6	7.8	20.6	49.0	106.3	126.0*
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	<i>T/K</i>	250	260	270	280	289.7*			
Acetic acid	<i>p/kPa</i>	0.092	0.199	0.406	0.79	1.29*			
C <sub>5</sub> H <sub>12</sub>	<i>T/K</i>	200	210	220	230	240	250	255	256.58*
Neopentane	<i>p/kPa</i>	0.7	1.6	3.6	7.3	13.9	24.8	32.4	35.8*

$C_6H_6Cl_6$ 1,2,3,4,5,6-Hexa- chlorocyclohexane (Lindane)	<i>T</i> /K <i>p</i> /Pa	300 0.01	320 0.13	330 0.39	340 1.04	350 2.66	360 6.42	370 14.8	380 32.7
$C_6H_6O_2$ Resorcinol	<i>T</i> /K <i>p</i> /Pa	330 1.03	340 2.78	350 7.09	360 17.2	370 39.6	380 87.6		
$C_6H_6O_2$ <i>p</i> -Hydroquinone	<i>T</i> /K <i>p</i> /Pa	350 1.20	360 3.18	370 7.96	380 19.0	390 43.4	400 95.1		
$C_{10}H_8$ Naphthalene	<i>T</i> /K <i>p</i> /Pa	250 0.036	270 0.514	280 1.662	290 4.918	300 13.43	310 34.15	330 182.9	353.43* 999.6*
$C_{12}H_8N_2$ Phenazine	<i>T</i> /K <i>p</i> /Pa	290 0.0013	300 0.0046	310 0.0150	320 0.0448				
$C_{12}H_8O$ Dibenzofuran	<i>T</i> /K <i>p</i> /Pa	300 0.408	310 1.21	320 3.35	330 8.71	340 21.4	350 50.0		
$C_{12}H_9N$ Carbazole	<i>T</i> /K <i>p</i> /Pa	350 0.086	355 0.140	360 0.245					
$C_{13}H_7NO_2$ Benz[ <i>g</i> ]isoquinoline-5,10-dione	<i>T</i> /K <i>p</i> /Pa	330 0.006	340 0.018	350 0.053	360 0.148	370 0.394	380 0.994		
$C_{13}H_8O$ 1 <i>H</i> -Phenalen-1-one	<i>T</i> /K <i>p</i> /Pa	330 0.040	340 0.113	350 0.302					
$C_{13}H_8O_2$ 3-Hydroxy-1 <i>H</i> -phenalen-1-one	<i>T</i> /K <i>p</i> /Pa	400 0.006	410 0.018	420 0.053	430 0.144				
$C_{13}H_9N$ Acridine	<i>T</i> /K <i>p</i> /Pa	290 0.0024	300 0.0085	310 0.0278	320 0.0845				
$C_{13}H_9N$ Phenanthridine	<i>T</i> /K <i>p</i> /Pa	310 0.020	320 0.066	330 0.206	340 0.603				
$C_{14}H_{10}$ Anthracene	<i>T</i> /K <i>p</i> /Pa	320 0.014	330 0.043	340 0.125	350 0.342	360 1.01	370 2.38	380 5.35	390 11.5
$C_{14}H_{10}$ Phenanthrene	<i>T</i> /K <i>p</i> /Pa	300 0.025	310 0.085	320 0.270	330 0.796	340 2.02	350 4.89	360 11.2	
$C_{16}H_{10}$ Pyrene	<i>T</i> /K <i>p</i> /Pa	320 0.008	330 0.024	340 0.073	350 0.208	360 0.556	370 1.32	380 2.86	390 6.30
$C_{16}H_{10}O$ 1-Pyrenol	<i>T</i> /K <i>p</i> /Pa	360 0.005	370 0.016	380 0.047	390 0.135	400 0.364			
$C_{16}H_{12}S$ Benzo[ <i>b</i> ]naphtho-(2,1- <i>d</i> )thiophene	<i>T</i> /K <i>p</i> /Pa	330 0.001	340 0.004	350 0.012	360 0.036	370 0.098	380 0.255	390 0.631	
$C_{17}H_{12}$ 11 <i>H</i> -Benzo[ <i>b</i> ]fluorene	<i>T</i> /K <i>p</i> /Pa	340 0.003	350 0.009	360 0.029	370 0.085	380 0.235	390 0.619	400 1.55	
$C_{18}H_{10}O_4$ 6,11-Dihydroxy-5,12- naphthacenedione	<i>T</i> /K <i>p</i> /Pa	420 0.008	430 0.022	440 0.055	450 0.131				
$C_{18}H_{12}$ Chrysene	<i>T</i> /K <i>p</i> /Pa	390 0.087	400 0.221	410 0.539	420 1.26				
$C_{18}H_{12}$ Naphthacene	<i>T</i> /K <i>p</i> /Pa	390 0.005	400 0.014	410 0.035	420 0.084	430 0.194	440 0.432	450 0.928	460 1.929
$C_{20}H_{12}$ Perylene	<i>T</i> /K <i>p</i> /Pa	390 0.006	400 0.015	410 0.040	420 0.102	430 0.246			
$C_{22}H_{14}$ Pentacene	<i>T</i> /K <i>p</i> /Pa	450 0.002	460 0.006	470 0.013	480 0.031	490 0.069			
$C_{24}H_{12}$ Coronene	<i>T</i> /K <i>p</i> /Pa	430 0.004	440 0.010	450 0.021	460 0.046	470 0.097	480 0.197	490 0.389	500 0.747

## VAPOR PRESSURE

This table gives vapor pressure data for about 1800 inorganic and organic substances. In order to accommodate elements and compounds ranging from refractory to highly volatile in a single table, the temperature at which the vapor pressure reaches specified pressure values is listed. The pressure values run in decade steps from 1 Pa (about 7.5  $\mu\text{m Hg}$ ) to 100 kPa (about 750 mm Hg). All temperatures are given in  $^{\circ}\text{C}$ .

The data used in preparing the table came from a large number of sources; the main references used for each substance are indicated in the last column. Since the data were refit in most cases, values appearing in this table may not be identical with values in the source cited. The temperature entry in the 100 kPa column is close to, but not identical with, the normal boiling point (which is defined as the temperature at which the vapor pressure reaches 101.325 kPa). Although some temperatures are quoted to 0.1  $^{\circ}\text{C}$ , uncertainties of several degrees should generally be assumed. Values followed by an "e" were obtained by extrapolating (usually with an Antoine equation) beyond the region for which experimental measurements were available and are thus subject to even greater uncertainty.

Compounds are listed by molecular formula following the Hill convention. Substances not containing carbon are listed first, followed by those that contain carbon. To locate an organic compound by name or CAS Registry Number when the molecular formula is not known, use the table "Physical Constants of Organic Compounds" in Section 3 and its indexes to determine the molecular formula. The indexes to "Physical Constants of Inorganic Compounds" in Section 4 can be used in a similar way.

More extensive and detailed vapor pressure data on selected important substances appear in other tables in this section of the *Handbook*. These substances are flagged by a symbol following the name as follows:

- \* See "Vapor Pressure of Fluids at Temperatures below 300 K"
- \*\* See "IUPAC Recommended Data for Vapor Pressure Calibration"
- \*\*\* See "Vapor Pressure of Ice" and "Vapor Pressure and other Saturation Properties of Water"

The following notations appear after individual temperature entries:

- s — Indicates the substance is a solid at this temperature.
- e — Indicates an extrapolation beyond the region where experimental measurements exist.
- i — Indicates the value was calculated from ideal gas thermodynamic functions, such as those in the *JANAF Thermochemical Tables* (see Reference 8).

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Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
<i>Substances not containing carbon:</i>								
Ag	Silver	1010	1140	1302	1509	1782	2160	2
AgBr	Silver(I) bromide	569 i	656 i	765 i	905 i	1093 i	1359 i	9
AgCl	Silver(I) chloride	670	769	873	1052	1264	1561	4
AgI	Silver(I) iodide	594	686	803	959	1177	1503	4
Al	Aluminum	1209	1359	1544	1781	2091	2517	2
AlB <sub>3</sub> H <sub>12</sub>	Aluminum borohydride				-46.8	-9.4	45.5	4
AlCl <sub>3</sub>	Aluminum trichloride	58.4 s	76.5 s	97.1 s	120.7 s	148.2 s	180.5 s	4
AlF <sub>3</sub>	Aluminum trifluoride	744 s	819 s	906 s	1008 s	1130 s	1276 s	8
AlI <sub>3</sub>	Aluminum triiodide				218	285	385	4
Al <sub>2</sub> O <sub>3</sub>	Aluminum oxide			2122	2351	2629	2975	4
Ar	Argon*		-226.4 s	-220.3 s	-212.4 s	-201.7 s	-186.0	1,5,31
As	Arsenic	280 s	323 s	373 s	433 s	508 s	601 s	3
AsCl <sub>3</sub>	Arsenic(III) chloride			-8 e	21.3	63.1	129.4	1
AsF <sub>3</sub>	Arsenic(III) fluoride					8.1	56.0	4
AsI <sub>3</sub>	Arsenic(III) iodide				187	261	367 e	7
As <sub>2</sub> O <sub>3</sub>	Arsenic(III) oxide (arsenolite)	133.7 s	163.0 s	196.8 s	236.2 s	283.0		34
At	Astatine	88 s	119 s	156 s	202 s	258 s	334	2
Au	Gold	1373	1541	1748	2008	2347	2805	2
B	Boron	2075	2289	2549	2868	3272	3799	2
BBr <sub>3</sub>	Boron tribromide			-45 e	-15 e	27.5	90.4	1
BCl <sub>3</sub>	Boron trichloride*			-94.0	-70.5	-37.4	12.3	4
BF <sub>3</sub>	Boron trifluoride*	-173.9 s	-166.0 s	-156.0 s	-143.0 s	-125.9	-101.1	4
B <sub>2</sub> F <sub>4</sub>	Tetrafluorodiborane						-34	1
B <sub>2</sub> H <sub>6</sub>	Diborane			-162 e	-147.0	-125.8	-92.6	1
B <sub>5</sub> H <sub>9</sub>	Pentaborane(9)				-34.8	3.8	57.6	4
Ba	Barium	638 s	765	912	1115	1413	1897	9
Be	Beryllium	1189 s	1335	1518	1750	2054	2469	2
BeBr <sub>2</sub>	Beryllium bromide	203 s	240 s	283 s	335 s	397 s	473 s	4
BeCl <sub>2</sub>	Beryllium chloride	196 s	237 s	284 s	339 s	402 s	487	4
BeF <sub>2</sub>	Beryllium fluoride		686 e	767 e	869	999	1172 e	7
BeI <sub>2</sub>	Beryllium iodide	188 s	229 s	276 s	333 s	402 s	487	4
Bi	Bismuth	668	768	892	1052	1265	1562	2
BiBr <sub>3</sub>	Bismuth tribromide			217 s	273 i	348 i	455 i	4,9
BiCl <sub>3</sub>	Bismuth trichloride				248.9	328.6	438.7	1,4
BrCs	Cesium bromide	531 s	601 s	701 i	834 i	1019 i	1293 e	9
BrH	Hydrogen bromide*		-153.3 s	-140.4 s	-123.8 s	-101.5 s	-67.0	5
BrH <sub>3</sub> Si	Bromosilane				-81.0	-47.3	2.2	4
BrH <sub>4</sub> N	Ammonium bromide	121 s	154 s	195 s	246 s	310.4 s	395.1 s	5
BrK	Potassium bromide	597 s	674 s	773				25
BrLi	Lithium bromide		630	733	868	1049	1308	4
BrNa	Sodium bromide			791	931	1120	1389	4
BrRb	Rubidium bromide			766	903	1087	1350	4
BrTl	Thallium(I) bromide				509	635	817	4
Br <sub>2</sub>	Bromine*	-87.7 s	-71.8 s	-52.7 s	-29.3 s	2.5	58.4	1
Br <sub>2</sub> Cd	Cadmium bromide	373 s	435 s	509 s				27
Br <sub>2</sub> Hg	Mercury(II) bromide	71 s	98 s	132 s	174 s	227 s	318	4
Br <sub>2</sub> OS	Thionyl bromide	-49 e	-29 e	-5 e	27.8	72.9	139.6	5
Br <sub>2</sub> Pb	Lead(II) bromide	374	431	502	597	726	914	4
Br <sub>2</sub> S <sub>2</sub>	Sulfur bromide	-7 e	15 e	42 e	78.4	128.1	200.9	5
Br <sub>3</sub> In	Indium(III) bromide			304.6 s	328.7 s	364.8 s		1
Br <sub>3</sub> OP	Phosphorus(V) oxybromide				64 e	115.5	191.4	5
Br <sub>3</sub> P	Phosphorus(III) bromide		-23 e	5 e	42.3	94.6	172.6	5
Br <sub>3</sub> Sb	Antimony(III) bromide				136.5	196.9	286.5	1
Br <sub>4</sub> Ge	Germanium(IV) bromide				51	105	188	4
Br <sub>4</sub> Sn	Tin(IV) bromide				67	122	204	4
Br <sub>4</sub> Zr	Zirconium(IV) bromide	136 s	167 s	203 s	245 s	295 s	356 s	4
Br <sub>5</sub> P	Phosphorus(V) bromide		-19 s	4 s	31 s	65.5 s	110.1	5
Ca	Calcium	591 s	683 s	798 s	954	1170	1482	2
Cd	Cadmium	257 s	310 s	381	472	594	767	2



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
CdCl <sub>2</sub>	Cadmium chloride	412 s	471 s	541 s	634	768	959	23, 27
CdF <sub>2</sub>	Cadmium fluoride				1257	1461	1742	4
CdI <sub>2</sub>	Cadmium iodide	296 s	344 s	406	498	622	795	4,27
CdO	Cadmium oxide	770 s	866 s	983 s	1128 s	1314 s	1558 s	4
Ce	Cerium	1719	1921	2169	2481	2886	3432	14
ClCs	Cesium chloride			730	864	1043	1297	4
ClCu	Copper(I) chloride		459	543	675	914	1477	4
ClF	Chlorine fluoride*				-144.4	-122.6	-90.2	5
ClF <sub>2</sub> P	Phosphorus(III) chloride difluoride				-119.5	-91.1	-47.6	5
ClF <sub>3</sub>	Chlorine trifluoride				-63.7	-33.0	11.4	5
ClF <sub>5</sub>	Chlorine pentafluoride				-88 e	-59	-14	7
ClH	Hydrogen chloride*				-138.2 s	-118.0	-85.2	1,5
ClHO <sub>3</sub> S	Chlorosulfonic acid	-40 e	-20 e	5 e	38.7	85.0	153.6	5
ClH <sub>4</sub> N	Ammonium chloride	91 s	121 s	159 s	204.7 s	263.1 s	339.5 s	5
ClK	Potassium chloride	625 s	704 s	804	945	1137	1411	23,25
ClLi	Lithium chloride		649 i	761 i	905 i	1101 i	1381 i	8
ClNO	Nitrosyl chloride		-116 s	-100 s	-78.7 s	-50.2	-5.7	5
ClNO <sub>2</sub>	Nitryl chloride	-121 e	-113 e	-102 e	-86.1	-60.9	-15.7	5
ClNa	Sodium chloride	653 s	733 s	835	987	1182	1461	23,25
ClO <sub>2</sub>	Chlorine dioxide*					-34.3	10.5	5
ClRb	Rubidium chloride			777	916	1105	1379	4
ClTl	Thallium(I) chloride				504	626	806	4
Cl <sub>2</sub>	Chlorine*	-145 s	-133.7 s	-120.2 s	-103.6 s	-76.1	-34.2	1
Cl <sub>2</sub> Co	Cobalt(II) chloride					818	1048	4
Cl <sub>2</sub> FP	Phosphorus(III) dichloride fluoride				-71.1	-37.4	13.5	5
Cl <sub>2</sub> F <sub>3</sub> P	Phosphorus(V) dichloride trifluoride		-120 e	-101 e	-77.1	-44.3	3 e	7
Cl <sub>2</sub> Fe	Iron(II) chloride				685	821	1025	4
Cl <sub>2</sub> Hg	Mercury(II) chloride	64.4 s	94.7 s	130.8 s	174.5 s	228.5 s	304.0	4
Cl <sub>2</sub> Mg	Magnesium chloride			762	908	1111	1414	4
Cl <sub>2</sub> Mn	Manganese(II) chloride				760	933	1189	4
Cl <sub>2</sub> Ni	Nickel(II) chloride	534 s	592 s	662 s	747 s	852 s	985 s	4
Cl <sub>2</sub> OS	Thionyl chloride	-99 e	-81 e	-58 e	-27.1	14.6	75.2	5
Cl <sub>2</sub> O <sub>2</sub> S	Sulfuryl chloride				-27 e	11.8	69.0	5
Cl <sub>2</sub> Pb	Lead(II) chloride			541 e	637	765	949	23
Cl <sub>2</sub> S	Sulfur dichloride	-76 e	-61 e	-41 e	-16.7	15.3	58.7	5
Cl <sub>2</sub> S <sub>2</sub>	Sulfur chloride	-55 e	-36 e	-12 e	21.0	67.2	137.1	5
Cl <sub>2</sub> Sn	Tin(II) chloride		253	308	381	479	622	4
Cl <sub>2</sub> Zn	Zinc chloride	305 i	356 i	419 i	497 i	596 i	726 i	4,9,12
Cl <sub>3</sub> Fe	Iron(III) chloride	118 s	153 s	190 s	229 s	268 s	319	4
Cl <sub>3</sub> HSi	Trichlorosilane			-81 e	-56 e	-21 e	31.6	7
Cl <sub>3</sub> N	Nitrogen trichloride				-25 e	13.2	70.6	5
Cl <sub>3</sub> OP	Phosphorus(V) oxychloride					39.9	105.0	5
Cl <sub>3</sub> P	Phosphorus(III) chloride	-93 e	-77 e	-55 e	-26.0	14.5	75.7	5
Cl <sub>4</sub> Po	Polonium(IV) chloride					300.6	389.4	5
Cl <sub>4</sub> Se	Selenium tetrachloride	23 s	45 s	71 s	102 s	141.4 s	191.1 s	5
Cl <sub>4</sub> Si	Tetrachlorosilane*				-39 e	0 e	57.3	1
Cl <sub>4</sub> Te	Tellurium tetrachloride				237 e	299.4	387.8	5
Cl <sub>4</sub> Zr	Zirconium(IV) chloride	117 s	146 s	181 s	222 s	272 s	336 s	9
Cl <sub>5</sub> P	Phosphorus(V) chloride	-2 s	19 s	44 s	74 s	111.4 s	158.9 s	5
Co	Cobalt	1517	1687	1892	2150	2482	2925	2
Cr	Chromium	1383 s	1534 s	1718 s	1950	2257	2669	2
Cs	Cesium	144.5	195.6	260.9	350.0	477.1	667.0	13,30
CsF	Cesium fluoride				825	999	1249	4
CsI	Cesium iodide	523 s	595 s	692	854	1029	1278	4,25
Cu	Copper	1236	1388	1577	1816	2131	2563	2
CuI	Copper(I) iodide				636	864	1331	4
Dy	Dysprosium	1105 s	1250 s	1431 i	1681 i	2031 i	2558 i	3
Er	Erbium	1231 s	1390 s	1612 i	1890 i	2279 i	2859 i	3

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
Eu	Europium	590 s	684 s	799 s	961	1179	1523	14
FH	Hydrogen fluoride*				-71.1	-33.7	19.2	1,5
FHO <sub>3</sub> S	Fluorosulfonic acid	-14 e	4 e	28 e	59.1	101.3	162.2	5
FK	Potassium fluoride			869	1017	1216	1499	4
FLi	Lithium fluoride	801 s	896	1024	1188	1395	1672	4,12,25
FNO	Nitrosyl fluoride			-131 e	-116.1	-94.3	-60.1	5
FNO <sub>2</sub>	Nitryl fluoride		-156 e	-144 e	-128.1	-106.0	-72.6	5
FNO <sub>3</sub>	Fluorine nitrate	-160 e	-149 e	-135 e	-115.1	-87.4	-45.0	5
FNa	Sodium fluoride		920 s	1058	1218	1426	1702	4,12,24
FRb	Rubidium fluoride			910	1001	1145	1409	4,12
F <sub>2</sub>	Fluorine*	-235 s	-229.5 s	-222.9 s	-214.8	-204.3	-188.3	1,5
F <sub>2</sub> O	Fluorine monoxide*	-211.7	-204.7	-195.9	-184.2	-168.2	-144.9	5
F <sub>2</sub> OS	Thionyl fluoride			-124 e	-106.5	-81.5	-44.1	5
F <sub>2</sub> O <sub>2</sub> Re	Rhenium(VI) dioxidydifluoride				89.2	131.9	185 e	26
F <sub>2</sub> Pb	Lead(II) fluoride				865	1054	1292	4
F <sub>2</sub> Xe	Xenon difluoride			2.9 s	31.8 s	67.9 s	114 s	1,5
F <sub>2</sub> Zn	Zinc fluoride	731 s	813 s	911 i	1048 i	1237 i	1503 i	9
F <sub>3</sub> N	Nitrogen trifluoride*	-201 e	-194 e	-185 e	-172.8	-155.5	-129.2	5
F <sub>3</sub> OP	Phosphorus(V) oxyfluoride	-124 s	-113 s	-100 s	-83.7 s	-64.1 s	-39.7 s	5
F <sub>3</sub> P	Phosphorus(III) fluoride*				-152 e	-132.6	-101.4	5
F <sub>4</sub> MoO	Molybdenum(VI) oxytetrafluoride	-21 s	3 s	33 s	69.3 s	117.3	184.1	26
F <sub>4</sub> ORe	Rhenium(VI) oxytetrafluoride	5 s	26 s	50.7 s	80.1 s	117.1	171.2	26
F <sub>4</sub> OW	Tungsten(VI) oxytetrafluoride	2 s	25 s	52.1 s	84.3 s	126.7	185.4	26
F <sub>4</sub> S	Sulfur tetrafluoride				-110.0	-82.1	-40.3	5
F <sub>4</sub> Se	Selenium tetrafluoride				13.6	51.6	104.7	5
F <sub>4</sub> Si	Tetrafluorosilane*	-166 s	-157 s	-145.6 s	-132.3 s	-115.7 s	-94.9 s	4,7
F <sub>5</sub> Mo	Molybdenum(V) fluoride				86.6	140.3	213 e	26
F <sub>5</sub> Nb	Niobium(V) fluoride				80	140	224	4
F <sub>5</sub> ORe	Rhenium(VII) oxypentafluoride	-103 s	-84 s	-59 s	-28 s	13.7 s	72.8	26
F <sub>5</sub> Os	Osmium(V) fluoride			74.1	113.2	162.3	226 e	26
F <sub>5</sub> P	Phosphorus(V) fluoride	-157 s	-148 s	-137 s	-124.5 s	-108.6 s	-84.8	5
F <sub>5</sub> Re	Rhenium(V) fluoride			58.8	99.5	152 e	221 e	26
F <sub>5</sub> Ta	Tantalum(V) fluoride					119	229	4
F <sub>5</sub> Ir	Iridium(VI) fluoride	-88 s	-71 s	-51 s	-27 s	3.8 s	53.1	26
F <sub>6</sub> Mo	Molybdenum(VI) fluoride	-98 s	-82 s	-64 s	-41.2 s	-13.4 s	33.5	26
F <sub>6</sub> Os	Osmium(VI) fluoride	-89 s	-73 s	-54 s	-30.6 s	-1.7 s	47.4	26
F <sub>6</sub> Re	Rhenium(VI) fluoride	-97 s	-82 s	-63 s	-40.2 s	-11.9 s	33.4	26
F <sub>6</sub> S	Sulfur hexafluoride*	-158 s	-147 s	-133.6 s	-116.6 s	-94.4 s	-64.1 s	5
F <sub>6</sub> Se	Selenium hexafluoride	-143 s	-132 s	-118 s	-100.7 s	-77.8 s	-46.5 s	5
F <sub>6</sub> Te	Tellurium hexafluoride	-142 s	-130 s	-115 s	-96 s	-71.8 s	-39.1 s	5
F <sub>6</sub> W	Tungsten(VI) fluoride	-107 s	-92 s	-74 s	-52.1 s	-24.8 s	16.9	26
F <sub>10</sub> S <sub>2</sub>	Sulfur decafluoride					-22.0	28.5	5
Fe	Iron	1455 s	1617	1818	2073	2406	2859	2
Fr	Francium	131 e	181 e	246 e	335 e	465 e	673 e	2
Ga	Gallium	1037	1175	1347	1565	1852	2245	2
Gd	Gadolinium	1563 i	1755 i	1994 i	2300 i	2703 i	3262 i	3
Ge	Germanium	1371	1541	1750	2014	2360	2831	2
HI	Hydrogen iodide*	-146 s	-135.2 s	-120.8 s	-101.9 s	-75.9 s	-35.9	5
HKO	Potassium hydroxide	520 e	601 e	704	842	1035	1325	4
HNO <sub>3</sub>	Nitric acid			-37 e	-9 e	28.4	82.2	5
HN <sub>3</sub>	Hydrazoic acid			-79 e	-54 e	-18.0	35.7	5
HNaO	Sodium hydroxide	513	605	722	874	1080	1377	4
H <sub>2</sub>	Hydrogen*					-258.6	-252.8	1
H <sub>2</sub> I <sub>2</sub> Si	Diiodosilane				11.8	70.5	149.4	4
H <sub>2</sub> O	Water***	-60.7 s	-42.2 s	-20.3 s	7.0	45.8	99.6	36,37
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide			13 e	45 e	89.0	149.8	5
H <sub>2</sub> O <sub>4</sub> S	Sulfuric acid	72	103	140	187	248	330	4
H <sub>2</sub> S	Hydrogen sulfide*		-149 s	-136 s	-118.9 s	-95.9 s	-60.5	1,5
H <sub>2</sub> S <sub>2</sub>	Hydrogen disulfide				-27 e	12.2	70.7	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
H <sub>2</sub> Se	Hydrogen selenide	-145 s	-134 s	-120 s	-102.8 s	-78.9 s	-41.5	5
H <sub>2</sub> Te	Hydrogen telluride					-46.6	-2.3	5
H <sub>3</sub> ISi	Iodosilane				-47.7	-10.1	45.2	4
H <sub>3</sub> N	Ammonia*	-139 s	-127 s	-112 s	-94.5 s	-71.3	-33.6	1,5,6
H <sub>3</sub> NO	Hydroxylamine				43.7	73.3	109.8	4
H <sub>3</sub> P	Phosphine*	-182 s	-173 s	-161 s	-145 s	-122.7	-88.0	5
H <sub>4</sub> IN	Ammonium iodide	125 s	159 s	201 s	253 s	318.4 s	405.2 s	5
H <sub>4</sub> N <sub>2</sub>	Hydrazine				14.7	55.6	113 e	5
H <sub>4</sub> Si	Silane*			-181	-165.4	-143.7	-111.8	4
He	Helium*					-270.6	-268.9	2
Hf	Hafnium	2416	2681	3004	3406	3921	4603	9
Hg	Mercury**	42.0	76.6	120.0	175.6	250.3	355.9	29,30
HgI <sub>2</sub>	Mercury(II) iodide	85.1 s	115.6 s	152.4 s	197.8 s	255.1 s	353.6	4
Ho	Holmium	1159 s	1311 s	1502 i	1767 i	2137 i	2691 i	3
IK	Potassium iodide			731	866	1052	1322	4
ILi	Lithium iodide	545	619	710	824	972	1170	4
INa	Sodium iodide			753	883	1058	1301	4
IRb	Rubidium iodide			733	866	1045	1302	4
ITl	Thallium(I) iodide				520	644	821	4
I <sub>2</sub>	Iodine (rhombic)	-12.8 s	9.3 s	35.9 s	68.7 s	108 s	184.0	1,2
I <sub>2</sub> Pb	Lead(II) iodide			470	558	682	869	4
I <sub>2</sub> Zn	Zinc iodide	301 s	351 s	409 s	488 i	598 i	750 i	9
I <sub>3</sub> Sb	Antimony(III) iodide				214.9	292.0	401.2	4
I <sub>4</sub> Sn	Tin(IV) iodide				167.1	242.7	347.7	4
I <sub>4</sub> Zr	Zirconium(IV) iodide	187 s	220 s	259 s	305 s	361 s	430 s	4
In	Indium	923	1052	1212	1417	1689	2067	2
Ir	Iridium	2440 s	2684	2979	3341	3796	4386	2
K	Potassium	200.2	256.5	328	424	559	756.2	13,30
Kr	Krypton*	-214.0 s	-208.0 s	-199.4 s	-188.9 s	-174.6 s	-153.6	5
La	Lanthanum	1732 i	1935 i	2185 i	2499 i	2905 i	3453 i	3
Li	Lithium	524.3	612.3	722.1	871.2	1064.3	1337.1	13,30
Lu	Lutetium	1633 s	1829.8	2072.8	2380 i	2799 i	3390 i	3
Mg	Magnesium	428 s	500 s	588 s	698	859	1088	2
Mn	Manganese	955 s	1074 s	1220 s	1418	1682	2060	2
Mo	Molybdenum	2469 s	2721	3039	3434	3939	4606	2
MoO <sub>3</sub>	Molybdenum(VI) oxide				801	935	1151	4
NO	Nitric oxide*	-201 s	-195 s	-188 s	-179.3 s	-168.1 s	-151.9	5
N <sub>2</sub>	Nitrogen*	-236 s	-232 s	-226.8 s	-220.2 s	-211.1 s	-195.9	1,5
N <sub>2</sub> O	Nitrous oxide*	-167 s	-157 s	-145.4 s	-131.1 s	-112.9 s	-88.7	5
N <sub>2</sub> O <sub>4</sub>	Nitrogen tetroxide	-92 s	-78 s	-61 s	-41.1 s	-16.6 s	28.7	5
N <sub>2</sub> O <sub>5</sub>	Nitrogen pentoxide	-71 s	-56 s	-40 s	-19.9 s	3.9 s	33.2	5
Na	Sodium	280.6	344.2	424.3	529	673	880.2	13,30
Nb	Niobium	2669	2934	3251	3637	4120	4740	2
Nd	Neodymium	1322.3	1501.2	1725.3	2023 i	2442 i	3063 i	3
Ne	Neon*	-261 s	-260 s	-258 s	-255 s	-252 s	-246.1	2
Ni	Nickel	1510	1677	1881	2137	2468	2911	2
OPb	Lead(II) oxide	724	816	928	1065	1241	1471	4
OSr	Strontium oxide	1789 s	1903 s	2047 s	2235 s	2488 s		4
O <sub>2</sub>	Oxygen*				-211.9	-200.5	-183.1	1,28
O <sub>2</sub> S	Sulfur dioxide*			-98 s	-80 s	-52.2	-10.3	1,5
O <sub>2</sub> Se	Selenium dioxide	124.5 s	153.9 s	188 s	228 s	275 s	315 s	38
O <sub>2</sub> Si	Silicon dioxide	1966 i	2149 i	2368 i				8
O <sub>3</sub>	Ozone*	-189 e	-182 e	-172 e	-158 e	-139.7	-111.5	5
O <sub>3</sub> P <sub>2</sub>	Phosphorus(III) oxide				47.3	100.3	172.8	4
O <sub>3</sub> S	Sulfur trioxide				-20 s	6.6 s	44.5	5
O <sub>3</sub> Sb <sub>2</sub>	Antimony(III) oxide (valentinite)	426.1 s	478 s	539 s	610 s	907	1420	4,35
O <sub>5</sub> P <sub>2</sub>	Phosphorus(V) oxide	285 s	328 s	377.5 s	434.4 s	500.5 s	591	4
O <sub>7</sub> Re <sub>2</sub>	Rhenium(VII) oxide	147 s	176 s	208 s	244 s	284 s	362	4
Os	Osmium	2887 s	3150	3478	3875	4365	4983	2

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
P	Phosphorus (white)	6 s	34 s	69	115	180	276	3,9
P	Phosphorus (red)	182 s	216 s	256 s	303 s	362 s	431 s	2,3
Pb	Lead	705	815	956	1139	1387	1754	2
PbS	Lead(II) sulfide	656 s	741 s	838 s	953 s	1088 s	1280	4
Pd	Palladium	1448 s	1624	1844	2122	2480	2961	2
Po	Polonium				573 e	730.2	963.3	5
Pr	Praseodymium	1497.7	1699.4	1954 i	2298 i	2781 i	3506 i	3
Pt	Platinum	2057	2277 e	2542	2870	3283	3821	2
Pu	Plutonium	1483	1680	1925	2238	2653	3226	2
Ra	Radium	546 s	633 s	764	936	1173	1526	2
Rb	Rubidium	160.4	212.5	278.9	368	496.1	685.3	13,30
Re	Rhenium	3030 s	3341	3736	4227	4854	5681	2
Rh	Rhodium	2015	2223	2476	2790	3132	3724	2
Rn	Radon*	-163 s	-152 s	-139 s	-121.4 s	-97.6 s	-62.3	5
Ru	Ruthenium	2315 s	2538	2814	3151	3572	4115	2
S	Sulfur	102 s	135	176	235	318	444	3
Sb	Antimony	534 s	603 s	738	946	1218	1585	2,3
Sc	Scandium	1372 s	1531 s	1733 i	1993 i	2340 i	2828 i	3
Se	Selenium	227	279	344	431	540	685	3
Si	Silicon	1635	1829	2066	2363	2748	3264	2
Sm	Samarium	728 s	833 s	967 s	1148 i	1402 i	1788 i	3
Sn	Tin	1224	1384	1582	1834	2165	2620	2
Sr	Strontium	523 s	609 s	717 s	866	1072	1373	2
Ta	Tantalum	3024	3324	3684	4122	4666	5361	2
Tb	Terbium	1516.1	1706.1	1928 i	2232 i	2640 i	3218 i	3
Tc	Technetium	2454 e	2725 e	3051 e	3453 e	3961 e	4621 e	2
Te	Tellurium			502 e	615 e	768.8	992.4	5
Th	Thorium	2360	2634	2975	3410	3986	4782	2
Ti	Titanium	1709	1898	2130 e	2419	2791	3285	2
Tl	Thallium	609	704	824	979	1188	1485	2
Tm	Thulium	844 s	962 s	1108 s	1297 s	1548 i	1944 i	3
U	Uranium	2052	2291	2586	2961	3454	4129	2
V	Vanadium	1828 s	2016	2250	2541	2914	3406	2
W	Tungsten	3204 s	3500	3864	4306	4854	5550	2
Xe	Xenon*	-190 s	-181 s	-170 s	-155.8 s	-136.6 s	-108.4	5,32
Y	Yttrium	1610.1	1802.3	2047 i	2354 i	2763 i	3334 i	3
Yb	Ytterbium	463 s	540 s	637 s	774 s	993 i	1192 i	3
Zn	Zinc	337 s	397 s	477	579	717	912 e	2
Zr	Zirconium	2366	2618	2924	3302	3780	4405	2

*Substances containing carbon:*

C	Carbon (graphite)		2566 s	2775 s	3016 s	3299 s	3635 s	15
CBrClF <sub>2</sub>	Bromochloro-difluoromethane	-136 e	-123 e	-106 e	-83.4	-51.8	-4.3	1
CBrCl <sub>3</sub>	Bromotrichloromethane				-6 e	38.9	104.4	5
CBrF <sub>3</sub>	Bromotrifluoromethane*	-168 e	-156 e	-142 e	-122.8	-96.6	-58.1	5
CBrN	Cyanogen bromide				-13 s	17.7 s	61.0	1
CBr <sub>2</sub> F <sub>2</sub>	Dibromodifluoromethane		-110 e	-91 e	-66 e	-30 e	22.5	1
CBr <sub>4</sub>	Tetrabromomethane			25.6 s	65.8 s	111.6	188.9	5
CClF <sub>3</sub>	Chlorotrifluoromethane	-176 e	-167 e	-155 e	-139 e	-116 e	-81.7	5
CClN	Cyanogen chloride		-94.6 s	-78.1 s	-57 s	-29 s	13.0	5
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane*	-150 e	-138 e	-122 e	-101.8	-73.1	-30.0	5
CCl <sub>2</sub> O	Carbonyl chloride	-127 e	-113 e	-96 e	-73 e	-40.6	7.2	5
CCl <sub>3</sub> F	Trichlorofluoromethane*		-107 e	-89 e	-63 e	-28.5	23.3	1,5
CCl <sub>3</sub> NO <sub>2</sub>	Trichloronitromethane		-59 e	-30 e	4.4	47.8	112.0	5
CCl <sub>4</sub>	Tetrachloromethane*	-79.4 s	-70.8 s	-53.5 s	-24.4 s	15.8	76.2	1,5
CFN	Cyanogen fluoride		-135 s	-121.2 s	-104.1 s	-82.8 s	-46.2	1,5
CF <sub>4</sub>	Tetrafluoromethane*	-199.9 s	-193 s	-183.9 s	-171.6	-153.9	-128.3	1,5
CHBrF <sub>2</sub>	Bromodifluoromethane		-128 s	-111.4 s	-89.7 s	-59.7 s	-16 s	5
CHBr <sub>3</sub>	Tribromomethane				30.5	78.3	148.8	1
CHClF <sub>2</sub>	Chlorodifluoromethane*	-152 e	-141 e	-126 e	-107.1	-80.5	-41.1	5
CHCl <sub>2</sub> F	Dichlorofluoromethane	-76 e	-70 e	-61 e	-49 e	-28.7	8.6	1

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
CHCl <sub>3</sub>	Trichloromethane*			-61 e	-34 e	4.3	60.8	1
CHF <sub>3</sub>	Trifluoromethane*			-152 e	-136 e	-114.4	-82.3	1
CHI <sub>3</sub>	Triiodomethane	51.1 s	82.7 s	121 e			218.0	5
CHN	Hydrogen cyanide*			-77 s	-52.6 s	-22.7 s	25.4	1,5
CHNO	Cyanic acid			-81.1	-56.8	-23.9	23 e	5
CH <sub>2</sub> BrCl	Bromochloromethane	-83 e	-69 e	-50 e	-25 e	11.4	67.7	1
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane			-37 e	-7 e	35.2	96.5	5
CH <sub>2</sub> ClF	Chlorofluoromethane		-124 e	-108 e	-86.2	-55.7	-9.4	5
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane*		-92 e	-73 e	-48 e	-12.5	39.3	1
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane*	-156.7	-145.8	-131.9	-113.6	-88.6	-51.9	1
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane			17 e	55 e	106.1	181.6	5
CH <sub>2</sub> O	Formaldehyde*				-91 e	-61.7	-19.3	1
CH <sub>2</sub> O <sub>2</sub>	Formic acid	-56 s	-40.4 s	-22.3 s	-0.8 s	37.0	100.2	1,5
CH <sub>3</sub> AsF <sub>2</sub>	Methyldifluoroarsine				-15 e	22.1	76.1	5
CH <sub>3</sub> BO	Borane carbonyl				-124	-99	-64	4
CH <sub>3</sub> Br	Bromomethane				-77 e	-44.3	3.3	1
CH <sub>3</sub> Cl	Chloromethane*	-140.2 s	-128.6 s	-114.7 s	-96 e	-67.1	-24.4	1,33
CH <sub>3</sub> Cl <sub>3</sub> Si	Methyltrichlorosilane		-83 e	-61 e	-33 e	7 e	65.7	1
CH <sub>3</sub> F	Fluoromethane*				-130 e	-111 e	-78.6	1
CH <sub>3</sub> I	Iodomethane				-49 e	-12.4	42.1	1
CH <sub>3</sub> NO	Formamide		22 e	53 e	93 e	145.0	218 e	5
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane				-2 e	40 e	100.8	1
CH <sub>3</sub> NO <sub>3</sub>	Methyl nitrate		-75 e	-55 e	-27 e	9.8	63 e	5
CH <sub>4</sub>	Methane*	-220 s	-214.2 s	-206.8 s	-197 s	-183.6 s	-161.7	5,41
CH <sub>4</sub> Cl <sub>2</sub> Si	Dichloromethylsilane			-77 e	-51 e	-14 e	40.5	1
CH <sub>4</sub> O	Methanol*	-87 e	-69 e	-47.5	-20.4	15.2	64.2	11
CH <sub>4</sub> S	Methanethiol		-115 e	-97 e	-74 e	-41.7	5.7	1
CH <sub>5</sub> ClSi	Chloromethylsilane	-129 e	-115 e	-97.9	-74.4	-41.5	8.3	5
CH <sub>5</sub> N	Methylamine				-76.7	-48.1	-6.6	1
CH <sub>6</sub> N <sub>2</sub>	Methylhydrazine			-31 e	-4.7	32.9	91 e	1
CH <sub>6</sub> OSi	Methyl silyl ether				-90.2	-61.8	-18 e	1
CH <sub>6</sub> Si	Methylsilane			-144 e	-124.6	-97.5	-57.5	5
CIN	Cyanogen iodide						153.8	5
CNNa	Sodium cyanide		672 e	798	961	1182	1497	4
CN <sub>4</sub> O <sub>8</sub>	Tetranitromethane				18.0	61.8	124 e	5
CO	Carbon monoxide*			-223 s	-216.5 s	-207.2 s	-191.7	40
COS	Carbon oxysulfide*			-136 e	-117 e	-90.0	-50.4	1
COSe	Carbon oxyselenide			-120	-98	-67	-22	4
CO <sub>2</sub>	Carbon dioxide*	-159.1 s	-148.9 s	-136.7 s	-121.6 s	-103.1 s	-78.6 s	5
CS <sub>2</sub>	Carbon disulfide		-96 e	-76 e	-49 e	-10.9	45.9	1
CSe <sub>2</sub>	Carbon diselenide			-24 e	9.4	56.2	127 e	1
C <sub>2</sub> Br <sub>2</sub> ClF <sub>3</sub>	1,2-Dibromo-1-chloro-1,2,2-trifluoroethane						92.3	5
C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	1,2-Dibromotetrafluoroethane		-97 e	-75 e	-46 e	-7.2	47.1	5
C <sub>2</sub> Br <sub>4</sub>	Tetrabromoethylene		-54.5 s	-31.7 s	-3.5 s	32.2 s	226.0	5
C <sub>2</sub> ClF <sub>3</sub>	Chlorotrifluoroethylene	-146 e	-134 e	-119 e	-99 e	-71 e	-28.4	1
C <sub>2</sub> ClF <sub>5</sub>	Chloropentafluoroethane					-80.3	-39.4	1
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,1-Dichlorotetrafluoroethane					-45.4	2.7	5
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichlorotetrafluoroethane				-76.8	-44.9	3.2	5
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,1-Trichlorotrifluoroethane						45.6	1,5
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichlorotrifluoroethane					-8.2	47.3	1,5
C <sub>2</sub> Cl <sub>3</sub> N	Trichloroacetonitrile				-16 e	25.3	85.1	1
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene			-22 e	10 e	54.4	120.7	1
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,1,2-Tetrachloro-2,2-difluoroethane				-7 e	31.0	91.1	5
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,2,2-Tetrachloro-1,2-difluoroethane					32.3	92.5	1
C <sub>2</sub> Cl <sub>4</sub> O	Trichloroacetyl chloride			-25 e	7 e	51.7	117.8	1,5
C <sub>2</sub> Cl <sub>6</sub>	Hexachloroethane	-7.6 s	9.9 s	33.6 s	67.7 s	116.9 s	184.2 s	5
C <sub>2</sub> F <sub>3</sub> N	Trifluoroacetonitrile				-126.1	-102.5	-67.8	1
C <sub>2</sub> F <sub>4</sub>	Tetrafluoroethylene				-132.3	-109.7	-75.8	1
C <sub>2</sub> F <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1,1,2,2-Tetrafluoro-1,2-dinitroethane				-30 e	6.4	59.5	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>2</sub> F <sub>6</sub>	Hexafluoroethane**			-155.2 s	-137.5 s	-113.4 s	-78.4 s	1,5
C <sub>2</sub> HBrClF <sub>3</sub>	2-Bromo-2-chloro-1,1,1-trifluoroethane				-41.4	-4.8	49.8	1
C <sub>2</sub> HBr <sub>3</sub> O	Tribromoacetaldehyde			15.0	52.7	103.0	173.5	5
C <sub>2</sub> HClF <sub>4</sub>	1-Chloro-1,1,2,2-tetrafluoroethane			-110 e	-87.6	-57.0	-12.1	5
C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	2,2-Dichloro-1,1,1-trifluoroethane		-101.0	-82.2	-57.4	-23.3	26.7	18
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	-74 e	-59 e	-39 e	-12 e	26.7	86.8	1
C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde			-41.6	-9.8	33.8	97.4	5
C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid				83.8	130.0	197.2	1,5
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane		-23 e	3 e	37.4	86.0	159.4	1
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid					16.8	71.4	1,5
C <sub>2</sub> HF <sub>5</sub> O	Trifluoromethyl difluoromethyl ether	-147 e	-136 e	-121 e	-102 e	-75.0	-35.4	20
C <sub>2</sub> H <sub>2</sub>	Acetylene*			-146.6 s	-130.7 s	-110.6 s	-84.8 s	5
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>cis</i> -1,2-Dibromoethylene		-45 e	-21 e	10 e	52.2	114.8	1
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>trans</i> -1,2-Dibromoethylene				-4 e	42.2	107.4	5
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	1,2-Dibromo-1,1-dichloroethane					103.6	177.8	5
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	1,2-Dibromo-1,2-dichloroethane		-11 e	22 e	64.1	119 e	193 e	5
C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	1,1,2,2-Tetrabromoethane	14 e	38 e	69 e	109 e	163.7	242.9	5
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethylene	-116 e	-101 e	-82 e	-57 e	-21.4	31.2	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene			-62 e	-34 e	3.8	60.3	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene				-44 e	-7.5	47.3	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	1,2-Dichloro-1,1-difluoroethane	-101 e	-87 e	-68 e	-42.2	-6.8	46.3	5
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	Chloroacetyl chloride			-23.7	5.6	46.1	105.6	5
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,1,2-Tetrachloroethane	-58 e	-40 e	-15 e	17 e	62.2	129.7	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane		-22 e	1 e	32.4	76.9	144.7	1
C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	1,1,1,2-Tetrafluoroethane				-94.3	-66.8	-26.4	17
C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	1,1,2,2-Tetrafluoroethane				-96.0	-66.9	-23.3	5
C <sub>2</sub> H <sub>2</sub> O	Ketene		-151 e	-135 e	-115 e	-88.2	-50.0	1
C <sub>2</sub> H <sub>3</sub> Br	Bromoethylene	-124 e	-110 e	-92 e	-68 e	-34.5	15.4	5
C <sub>2</sub> H <sub>3</sub> BrO	Acetyl bromide	-78 e	-65 e	-49 e	-25 e	13.9	84 e	5
C <sub>2</sub> H <sub>3</sub> Br <sub>3</sub>	1,1,2-Tribromoethane	-18 e	4 e	32 e	68 e	117.1	188.4	5
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	-139 e	-127 e	-110 e	-89 e	-59.0	-14.1	1
C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	1-Chloro-1,1-difluoroethane		-123 e	-107 e	-85.3	-55.4	-10.5	5
C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride	-100 e	-85 e	-66 e	-40 e	-3.6	50.4	1
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid				78.4	123.9	188.9	1
C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	1,1-Dichloro-1-fluoroethane		-101 e	-83 e	-57.9	-22.7	31.4	5
C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	1,2-Dichloro-1-fluoroethane			-50 e	-23.8	14.1	73.4	5
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane				-25.3	14.2	73.7	5
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane			-23 e	7 e	49.9	113.4	1
C <sub>2</sub> H <sub>3</sub> F	Fluoroethylene			-153.3	-135.2	-109.9	-72.2	5
C <sub>2</sub> H <sub>3</sub> FO	Acetyl fluoride					-64.1	17.0	5
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,1-Trifluoroethane				-113 e	-86.6	-47.8	1
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	2,2,2-Trifluoroethanol			-33 e	-8 e	26.0	74 e	5
C <sub>2</sub> H <sub>3</sub> I	Iodoethylene				-41 e	-3 e	55.6	5
C <sub>2</sub> H <sub>3</sub> IO	Acetyl iodide				-0.6	47 e	107.0	5
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile				-20 e	21.4	81.2	1
C <sub>2</sub> H <sub>3</sub> NO	Methylisocyanate				-43.5	-10.2	38.8	1
C <sub>2</sub> H <sub>3</sub> NS	Methyl thiocyanate			-18.4	16.2	63.5	132.5	5
C <sub>2</sub> H <sub>4</sub>	Ethylene*				-155.6	-135.1	-104.0	1,10
C <sub>2</sub> H <sub>4</sub> BrCl	1-Bromo-2-chloroethane				-0.4	41.7	105.7	6
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,1-Dibromoethane		-49 e	-26 e	5 e	46.4	107.6	5
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane				18 e	62.2	130.9	1
C <sub>2</sub> H <sub>4</sub> ClF	1-Chloro-1-fluoroethane				-69.9	-36.1	15.8	5
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane		-84 e	-64 e	-36.7	1.0	56.9	1
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane				-16.4	23.7	83.1	1
C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	1,1-Difluoroethane			-115.2	-94.6	-66.1	-24.3	19
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	Ethylene glycol dinitrate	4 e	25.6	51.0	81 e	117 e	162 e	5
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde		-105 e	-87 e	-62.8	-29.4	20.0	5
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide		-111 e	-93 e	-70 e	-37.0	10.2	1
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	-42.8 s	-26.7 s	-8 s	14.2 s	55.9	117.5	1,5
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate		-95 e	-76 e	-51.8	-18.1	31.4	5



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Peroxyacetic acid				14.4	55.3	109.7	5
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Glycolic acid						99.9	5
C <sub>2</sub> H <sub>5</sub> AsF <sub>2</sub>	Ethyl difluoroarsine			-36 e	-6.0	35.0	93.1	5
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	-111 e	-96 e	-77 e	-51.3	-15.5	38.0	5
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	-126 e	-112 e	-94 e	-70 e	-37.0	12.0	1
C <sub>2</sub> H <sub>5</sub> ClO	2-Chloroethanol	-61 e	-39 e	-12 e	23 e	67.1	127.3	5
C <sub>2</sub> H <sub>5</sub> ClO	Chloromethyl methyl ether	-96 e	-80 e	-59 e	-32 e	6 e	61 e	5
C <sub>2</sub> H <sub>5</sub> Cl <sub>3</sub> OSi	Trichloroethoxysilane	-78 e	-60 e	-36.0	-4.6	38.7	102.0	5
C <sub>2</sub> H <sub>5</sub> Cl <sub>3</sub> Si	Trichloroethylsilane	-79 e	-61 e	-38 e	-8 e	34.9	98.7	5
C <sub>2</sub> H <sub>5</sub> F	Fluoroethane		-142 e	-127 e	-106.3	-78.7	-37.9	1
C <sub>2</sub> H <sub>5</sub> FO	2-Fluoroethanol			-22 e	8.3	47.5	99 e	5
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	-94 e	-78 e	-56 e	-27.9	11.9	71.9	5
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine		-74 e	-55 e	-30 e	4.1	55 e	5
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	16.7 s	39.1 s	65.2 s	102.8	150.8	218.2	5
C <sub>2</sub> H <sub>5</sub> NO	<i>N</i> -Methylformamide		13 e	41 e	78 e	127.9	199.1	1
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	-61 e	-44 e	-21 e	8.3	50.1	113.5	5
C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	Ethyl nitrate	-81 e	-63 e	-41 e	-12 e	28.2	87 e	1
C <sub>2</sub> H <sub>6</sub>	Ethane*	-183.3 s	-173.2	-161.3	-145.3	-122.8	-88.8	41
C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	Dichlorodimethylsilane					11.1	70.1	5
C <sub>2</sub> H <sub>6</sub> Hg	Dimethyl mercury				-13.5	29.0	92.1	5
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	<i>N</i> -Nitrosodimethylamine				30.7	80.5	149.8	5
C <sub>2</sub> H <sub>6</sub> O	Ethanol	-73 e	-56 e	-34 e	-7 e	29.2	78.0	1,5
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether*		-135 e	-118 e	-96.8	-67.6	-25.1	1,5
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide			27.4	65.0	115.9	188.6	1
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	2 e	24 e	51.1	86.1	132.5	196.9	1
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl hydroperoxide	-70 e	-49 e	-25 e	6.8	47.0	101 e	5
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	Dimethyl sulfone				109 e	166.8	248.9	5
C <sub>2</sub> H <sub>6</sub> S	Ethane thiol	-112 e	-97 e	-78 e	-53 e	-18 e	34.7	1
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide		-96 e	-77 e	-51.2	-16.0	37.0	1,5
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide	-71 e	-53 e	-29 e	1.7	45.0	109.3	5
C <sub>2</sub> H <sub>7</sub> BO <sub>2</sub>	Dimethoxyborane	-116 e	-101.9	-83.5	-59.2	-25.4	25 e	5
C <sub>2</sub> H <sub>7</sub> N	Ethylamine			-71 e	-53 e	-27 e	16.4	1
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine			-88 e	-66.9	-37.2	6.6	1
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine		11 e	35 e	66.2	109.0	170.6	1
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine				17.0	57.5	116.6	1,5
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,1-Dimethylhydrazine			-52 e	-25.6	10.5	63 e	5
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Dimethylhydrazine		-49 e	-33 e	-9 e	26.4	88 e	1
C <sub>2</sub> N <sub>2</sub>	Cyanogen	-127 s	-114.1 s	-98.5 s	-79.2 s	-54.9 s	-21.4	5
C <sub>3</sub> ClF <sub>5</sub> O	Chloropentafluoroacetone	-122 e	-109 e	-93 e	-71 e	-39.4	7.4	5
C <sub>3</sub> Cl <sub>6</sub>	Hexachloropropene	-12 e	11 e	40 e	79 e	132.8	213.6	5
C <sub>3</sub> F <sub>6</sub>	Perfluoropropene	-150 e	-138 e	-122 e	-101 e	-72 e	-30.6	5
C <sub>3</sub> F <sub>6</sub> O	Perfluoroacetone			-113 e	-94 e	-67.8	-27.6	5
C <sub>3</sub> F <sub>8</sub>	Perfluoropropane		-139 e	-124 e	-105 e	-77.5	-37.0	1
C <sub>3</sub> HN	Cyanoacetylene			-58.7 s	-35.6 s	-7 s	42.0	5
C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	1,1,1,3,3,3-Hexafluoro-2-propanol					12.7	57.1	5
C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	1,1,1,2,2-Pentafluoropropane					-60 e	-17.9	5
C <sub>3</sub> H <sub>3</sub> N	2-Propenenitrile		-72 e	-50 e	-22 e	17.7	77.0	1
C <sub>3</sub> H <sub>3</sub> NS	Thiazole					54.4	117.8	5
C <sub>3</sub> H <sub>4</sub>	Allene*		-129 e	-118 e	-101.4	-76.7	-34.7	5
C <sub>3</sub> H <sub>4</sub>	Propyne				-94 e	-65.3	-23.2	1
C <sub>3</sub> H <sub>4</sub> ClF <sub>3</sub>	3-Chloro-1,1,1-trifluoropropane	-102 e	-87 e	-68 e	-43 e	-8 e	45.3	5
C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O	1,1-Dichloroacetone				1 e	47.8	118.0	5
C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	Methyl dichloroacetate	-44 e	-25 e	0 e	33 e	77.7	142.3	5
C <sub>3</sub> H <sub>4</sub> Cl <sub>4</sub>	1,1,1,2-Tetrachloropropane	-48 e	-28 e	-2 e	32 e	79.1	149.5	5
C <sub>3</sub> H <sub>4</sub> F <sub>4</sub> O	2,2,3,3-Tetrafluoro-1-propanol			-10 e	17 e	53.9	107.2	5
C <sub>3</sub> H <sub>4</sub> O	Acrolein		-87 e	-67 e	-40 e	-3.0	52.8	1
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Propenoic acid				35 e	78.0	140.7	1
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Vinyl formate			-58 e	-34 e	-1.6	46.2	1
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	2-Oxetanone		-21 e	8 e	45.5	93.8	159.3	5
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Ethylene carbonate	12.7 s	37 e				247	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>3</sub> H <sub>5</sub> Br	<i>cis</i> -1-Bromopropene	-100 e	-84 e	-64 e	-37 e	1.0	57.4	5
C <sub>3</sub> H <sub>5</sub> Br	2-Bromopropene	-112 e	-95 e	-75 e	-47 e	-9 e	48.0	5
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	-98 e	-80 e	-58 e	-28 e	12 e	69.6	5
C <sub>3</sub> H <sub>5</sub> Cl	<i>cis</i> -1-Chloropropene	-114 e	-100 e	-81 e	-55 e	-20.1	32.4	5
C <sub>3</sub> H <sub>5</sub> Cl	<i>trans</i> -1-Chloropropene		-97 e	-77 e	-52 e	-16.2	37.0	5
C <sub>3</sub> H <sub>5</sub> Cl	2-Chloropropene	-120 e	-106 e	-87 e	-63 e	-28.7	22.3	5
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene	-107 e	-92 e	-72.4	-46.3	-9.8	44.6	5
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin			-21 e	11 e	53.8	115.5	5
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Methyl chloroacetate		-28 e	-5 e	25 e	66.9	129.1	5
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,1,3-Trichloropropene	-51 e	-31 e	-5 e	28 e	75.3	145.1	5
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,2,3-Trichloropropene			2 e	37 e	84.9	156.3	5
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub> Si	Trichloro-2-propenylsilane					53.0	116.5	5
C <sub>3</sub> H <sub>5</sub> I	3-Iodopropene	-80 e	-62 e	-39 e	-8 e	36 e	101.5	5
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	-69.4	-55.3	-36.0	-7.9	35.2	97.4	1,5
C <sub>3</sub> H <sub>5</sub> NO	Acrylamide			109.6	161 e			5
C <sub>3</sub> H <sub>5</sub> NO	3-Hydroxypropanenitrile	-11 e	18 e	53 e	96.1	150.3	220.8	5
C <sub>3</sub> H <sub>5</sub> NS	Ethyl thiocyanate	-39 e	-20 e	4 e	35 e	79.1	143.4	5
C <sub>3</sub> H <sub>5</sub> NS	Ethyl isothiocyanate				17.4	66 e	136 e	5
C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>9</sub>	Trinitroglycerol	48.6	75.7	118 e	191 e	353 e	1007 e	5
C <sub>3</sub> H <sub>6</sub>	Propene*	-160.6	-149.0	-134.3	-114.9	-88.2	-47.9	1,5
C <sub>3</sub> H <sub>6</sub>	Cyclopropane			-124 e	-104 e	-75.7	-33.1	1
C <sub>3</sub> H <sub>6</sub> BrCl	1-Bromo-3-chloropropene	-51 e	-31 e	-6 e	28 e	74.1	142.9	5
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,2-Dibromopropene	-46 e	-26 e	-2 e	31 e	75.3	139.5	5
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,3-Dibromopropene	-30 e	-9 e	17 e	52 e	98.7	166.8	5
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,1-Dichloropropene				-14 e	27.0	87.7	5
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropene	-78 e	-61 e	-38.1	-8.1	33.7	95.9	5
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,3-Dichloropropene	-65 e	-46 e	-22 e	10 e	54.0	119.9	5
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	2,2-Dichloropropene				-28 e	10.8	68.9	5
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub> O	1,3-Dichloro-2-propanol			21.8	59.0	107.6	173.9	5
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1,1-Dinitropropane	-9 e	12 e	39 e	73.2	120 e	187 e	5
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	-63 e	-48 e	-21.9	6.8	44.5	96.2	5
C <sub>3</sub> H <sub>6</sub> O	Methyl vinyl ether			-114 e	-89 e	-52.7	4.6	1
C <sub>3</sub> H <sub>6</sub> O	Propanal			-69 e	-42 e	-6 e	47.7	1
C <sub>3</sub> H <sub>6</sub> O	Acetone	-95	-81.8	-62.8	-35.6	1.3	55.7	1,5
C <sub>3</sub> H <sub>6</sub> O	Methyloxirane	-109 e	-95 e	-76 e	-51.5	-17.2	33.9	5
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid			0 e	35.1	79.9	140.8	1,5
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate		-80 e	-61 e	-35 e	1 e	54.0	1
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	-95 e	-79 e	-59 e	-33 e	3.3	56.6	1
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1,3-Dioxolane		-72 e	-50 e	-22 e	17.0	75.3	1
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	1,3,5-Trioxane					53 e	113.7	1
C <sub>3</sub> H <sub>6</sub> S	Thietane		-62 e	-40 e	-9 e	32.5	94.5	5
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	-95 e	-78 e	-57 e	-28 e	11.6	70.6	1
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane		-84 e	-65 e	-39.6	-1.7	59.1	1,5
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	-106 e	-90 e	-71 e	-44.5	-8.1	46.2	1
C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane		-91 e	-74 e	-51.1	-17.8	35.4	1,5
C <sub>3</sub> H <sub>7</sub> ClO	2-Chloro-1-propanol				23 e	63.8	125.7	5
C <sub>3</sub> H <sub>7</sub> F	1-Fluoropropane	-133 e	-120 e	-103 e	-80.7	-49.4	-2.8	5
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	-78 e	-60 e	-37 e	-6 e	36.9	102.0	5
C <sub>3</sub> H <sub>7</sub> I	2-Iodopropane	-89 e	-71 e	-47 e	-16.3	26.5	89.2	5
C <sub>3</sub> H <sub>7</sub> N	Allylamine		-88 e	-65 e	-37 e	0.4	52 e	5
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	-39 e	-20 e	5 e	38.0	83.9	152.6	1
C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -Methylacetamide	-13.3 s	13 s	43 e	83.8	136.1	206.3	5
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	-56 e	-37 e	-13 e	20 e	64.8	130.8	1
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane		-48 e	-22 e	10.7	55.6	119.8	1
C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	Propyl nitrate			-23.9	6.1	48.1	111 e	5
C <sub>3</sub> H <sub>8</sub>	Propane*	-156.9	-145.6	-130.9	-111.4	-83.8	-42.3	1,41
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	-54 e	-38 e	-16 e	10 e	47 e	96.9	1,5
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	-65 e	-49 e	-28 e	-1.3	33.6	82.0	1,5
C <sub>3</sub> H <sub>8</sub> O	Ethyl methyl ether	-98 e	-89 e	-77 e	-60 e	-34.8	7.0	5
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propylene glycol	-11 e	13 e	42 e	78 e	125.0	187.2	5



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propylene glycol	4 e	30 e	62 e	101 e	149.9	214.0	5
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Ethylene glycol monomethyl ether	-57 e	-37 e	-12 e	21 e	63.8	124.3	1
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Dimethoxymethane	-93 e	-81 e	-64 e	-42 e	-9.3	41.7	5
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol	96 e	113 e	136 e	168 e	213.4	287 e	1
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol	-94 e	-78 e	-57 e	-29.1	9.6	67.4	1,5
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol	-102 e	-87 e	-67 e	-41 e	-3 e	52.2	1
C <sub>3</sub> H <sub>8</sub> S	Ethyl methyl sulfide	-94 e	-78 e	-57 e	-29.7	8.8	66.3	1
C <sub>3</sub> H <sub>8</sub> S <sub>2</sub>	1,3-Propanedithiol	-53 e	-28 e	3 e	43 e	97 e	172.4	5
C <sub>3</sub> H <sub>9</sub> As	Trimethylarsine			-74 e	-45 e	-5.4	52.0	5
C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	Trimethyl borate				-14 e	15.6	67.9	5
C <sub>3</sub> H <sub>9</sub> BS	Methyl dimethylthioborane			-62 e	-30.4	11.4	70.7	5
C <sub>3</sub> H <sub>9</sub> ClSi	Trimethylchlorosilane				-37.8	0.4	57.3	5
C <sub>3</sub> H <sub>9</sub> N	Propylamine		-81 e	-63 e	-38.3	-4.1	46.9	1,5
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine		-91 e	-74 e	-50.4	-17.6	31.5	1,5
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine		-114 e	-97 e	-75.0	-43.8	2.6	1,5
C <sub>3</sub> H <sub>9</sub> NO	1-Amino-2-propanol			18 e	53.2	98.2	157.9	5
C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P	Trimethyl phosphate	-31 e	-7 e	23.6	62.8	116.0	192.0	5
C <sub>3</sub> H <sub>9</sub> P	Trimethylphosphine			-81 e	-53 e	-15.0	37.1	5
C <sub>3</sub> H <sub>9</sub> Sb	Trimethylstibine			-56 e	-23.8	19 e	80 e	5
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	1,2-Propanediamine		-35.4	-12.0	18.8	61 e	119 e	5
C <sub>3</sub> N <sub>2</sub> O	Carbonyl dicyanide				-21.7	15.3	65.2	5
C <sub>4</sub> Cl <sub>6</sub>	Hexachloro-1,3-butadiene	-1 e	22 e	50 e	86.7	137.0	209.7	5
C <sub>4</sub> F <sub>6</sub> O <sub>3</sub>	Trifluoroacetic acid anhydride			-63 e	-39 e	-7.1	38.8	5
C <sub>4</sub> F <sub>8</sub>	Perfluorocyclobutane						-6.2	1
C <sub>4</sub> F <sub>10</sub>	Perfluorobutane		-122 e	-105 e	-82 e	-49.8	-2.5	1,5
C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	<i>trans</i> -2-Butenediyl dichloride			8.0	45.6	94.3	159.8	5
C <sub>4</sub> H <sub>2</sub> Cl <sub>2</sub> S	2,5-Dichlorothiophene			-20 e	22 e	81.4	171 e	5
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride				73.7	127.9	201.7	5
C <sub>4</sub> H <sub>3</sub> ClS	2-Chlorothiophene		-62 e	-35 e	2 e	51.8	123 e	5
C <sub>4</sub> H <sub>3</sub> IS	2-Iodothiophene			-25 e	23 e	94.9	181.0	5
C <sub>4</sub> H <sub>4</sub>	1-Buten-3-yne			-96.1	-73.4	-41.8	4.9	5
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Succinonitrile	24.8 s					266.0	5
C <sub>4</sub> H <sub>4</sub> O	Furan			-78 e	-54 e	-20 e	31.0	1
C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	Diketene				19.3	63.3	126 e	5
C <sub>4</sub> H <sub>4</sub> O <sub>3</sub>	Succinic anhydride				121 e	180.8	260.8	5
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Fumaric acid	123.9 s	150 s	180 s				5
C <sub>4</sub> H <sub>4</sub> S	Thiophene				-17 e	23.7	83.7	5
C <sub>4</sub> H <sub>5</sub> Cl	2-Chloro-1,3-butadiene	-113 e	-95 e	-71 e	-41 e	0.3	59.0	5
C <sub>4</sub> H <sub>5</sub> ClO	2-Methyl-2-propenyl chloride		-57 e	-35 e	-5 e	36.4	98.2	5
C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>2</sub>	Ethyl trichloroacetate			15.3	51.9	100.1	166.6	5
C <sub>4</sub> H <sub>5</sub> N	3-Butenenitrile	-67 e	-48 e	-23.1	9.3	53.7	118.4	5
C <sub>4</sub> H <sub>5</sub> N	Methylacrylonitrile				-12 e	29.0	89.8	5
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole			-8 e	24 e	66.7	129.4	1
C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	Methyl cyanoacetate	-3 e	19 e	48 e	84 e	134.0	204.6	5
C <sub>4</sub> H <sub>5</sub> NS	Allyl isothiocyanate	-45 e	-27 e	-3 e	32.1	89 e	198 e	5
C <sub>4</sub> H <sub>5</sub> NS	4-Methylthiazole						67.0	5
C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene	-132 e	-117 e	-98 e	-72.8	-38.9	10.5	5
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene*			-106 e	-83 e	-51.9	-4.7	1
C <sub>4</sub> H <sub>6</sub>	1-Butyne	-125 e	-111 e	-94 e	-71.2	-39.4	7.8	1
C <sub>4</sub> H <sub>6</sub>	2-Butyne		-89.2 s	-73.8 s	-53.5 s	-23.9	26.6	5
C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	Ethyl dichloroacetate			2.6	40.1	89.1	156.3	5
C <sub>4</sub> H <sub>6</sub> O	Divinyl ether		-99 e	-80 e	-56 e	-22.1	28.0	5
C <sub>4</sub> H <sub>6</sub> O	<i>trans</i> -2-Butenal	-74 e	-56 e	-33 e	-3 e	39.7	102.4	5
C <sub>4</sub> H <sub>6</sub> O	3-Buten-2-one					21 e	81.0	5
C <sub>4</sub> H <sub>6</sub> O	Cyclobutanone			-34 e	-4 e	37.1	97 e	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>cis</i> -Crotonic acid			30 e	63 e	106.7	168.9	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>trans</i> -Crotonic acid				74 e	120.8	184.9	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	3-Butenoic acid	-19 e	2 e	27 e	61 e	105.6	168.6	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid			22 e	56 e	99.9	161.5	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	-88 e	-71 e	-50 e	-22 e	16.2	72.2	1

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate		-71 e	-48 e	-18 e	22 e	79.9	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Butanedione					30.7	84.8	5
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	gamma-Butyrolactone		-17 e	24 e	72 e	130.2	203 e	5
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	-44 e	-25 e	-1 e	31 e	75.1	139.7	1
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Propylene carbonate	-40 e	-5 e	43 e	112 e	220 e	410 e	5
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Dimethyl oxalate				50.5	98.1	163.0	5
C <sub>4</sub> H <sub>7</sub> Br	<i>trans</i> -1-Bromo-1-butene	-87 e	-68 e	-43.3	-11.4	31.9	94.4	5
C <sub>4</sub> H <sub>7</sub> Br	2-Bromo-1-butene	-87 e	-70 e	-48 e	-20 e	20.7	80.6	5
C <sub>4</sub> H <sub>7</sub> Br	<i>cis</i> -2-Bromo-2-butene	-90 e	-72 e	-49.0	-18.5	23.5	85.2	5
C <sub>4</sub> H <sub>7</sub> Br	<i>trans</i> -2-Bromo-2-butene	-86 e	-67 e	-43.4	-12.0	31.0	93.5	5
C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	1,2,3-Tribromobutane	0 e	23 e	53 e	91 e	143.7	219.5	5
C <sub>4</sub> H <sub>7</sub> Br <sub>3</sub>	1,2,4-Tribromobutane	-3 e	20 e	49 e	87 e	139.4	214.5	5
C <sub>4</sub> H <sub>7</sub> Cl	3-Chloro-1-butene			-64 e	-36 e	4 e	63.6	5
C <sub>4</sub> H <sub>7</sub> Cl	<i>cis</i> -2-Chloro-2-butene	-100 e	-83 e	-62 e	-34 e	6 e	66.4	5
C <sub>4</sub> H <sub>7</sub> Cl	<i>trans</i> -2-Chloro-2-butene	-102 e	-86 e	-65 e	-37 e	3 e	62.2	5
C <sub>4</sub> H <sub>7</sub> Cl	3-Chloro-2-methylpropene		-75 e	-54 e	-25 e	13.8	71.5	5
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	Ethyl chloroacetate			-2.6	32.6	79.1	143.8	5
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	-67 e	-48 e	-24 e	8 e	52.3	117.2	1
C <sub>4</sub> H <sub>8</sub>	1-Butene	-139.0	-125.2	-107.8	-85.3	-53.7	-6.6	1,5
C <sub>4</sub> H <sub>8</sub>	<i>cis</i> -2-Butene	-131.2	-117.4	-99.8	-76.7	-44.8	3.4	1,5
C <sub>4</sub> H <sub>8</sub>	<i>trans</i> -2-Butene			-102 e	-80 e	-47.6	0.6	1
C <sub>4</sub> H <sub>8</sub>	Isobutene	-139.1	-125.5	-108.2	-85.5	-54.5	-7.3	1,5
C <sub>4</sub> H <sub>8</sub>	Cyclobutane				-71.8	-38.1	12.1	5
C <sub>4</sub> H <sub>8</sub>	Methylcyclopropane	-130 e	-116 e	-99.3	-76.3	-44.2	4.2	5
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,2-Dibromobutane	-54 e	-30 e	0.4	39.6	92.1	166.1	5
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,4-Dibromobutane	-13 e	9 e	37 e	74 e	124.0	196.5	5
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,1-Dichlorobutane			-25 e	6 e	49.3	113.4	5
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,2-Dichlorobutane			-28.4	5.8	53.1	123.1	5
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,4-Dichlorobutane		-26 e	0 e	35 e	82.4	153.4	5
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	2,2-Dichlorobutane		-58 e	-35 e	-5 e	37.8	102.1	5
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	Bis(2-chloroethyl) ether	-32 e	-9 e	19.8	56.9	106.9	177.9	5
C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether		-102 e	-81 e	-53.1	-16.5	34.7	5
C <sub>4</sub> H <sub>8</sub> O	1,2-Epoxybutane	-135 e	-114 e	-87 e	-53 e	-5.5	62.1	5
C <sub>4</sub> H <sub>8</sub> O	Butanal	-88 e	-72 e	-50 e	-22 e	16.6	74.5	1,5
C <sub>4</sub> H <sub>8</sub> O	Isobutanal			-56 e	-29 e	8 e	63.8	1
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	-85 e	-68 e	-46 e	-18.1	21.2	79.2	1
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	-94 e	-78 e	-57.3	-29.8	9 e	65.6	1
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid			12.9	52.2	101.4	163.3	1,5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid	-30.1	-8.2	18.1	50.5	92.9	154.0	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	-78 e	-62 e	-42 e	-15.1	23.0	80.4	1,5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Isopropyl formate	-80 e	-65 e	-47 e	-22.2	13.2	67.7	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	-83 e	-66 e	-45 e	-18 e	20.4	76.8	1
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	-80 e	-64 e	-43 e	-15.8	22.2	79.0	1
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	<i>cis</i> -2-Butene-1,4-diol	17 e	44 e	77 e	117.4	168.5	234.9	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Dioxane			-37 e	-3 e	43.4	106.0	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane					39.6	101.0	1
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	Sulfolane		49 e	87 e	135 e	198.0	283.5	5
C <sub>4</sub> H <sub>8</sub> S	Tetrahydrothiophene	-66 e	-47 e	-23 e	9.4	54.1	120.5	1
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	-68.4	-53.9	-34.1	-5.4	37.6	101.1	1,5
C <sub>4</sub> H <sub>9</sub> Br	2-Bromobutane	-86 e	-68 e	-46 e	-16 e	26.6	90.7	5
C <sub>4</sub> H <sub>9</sub> Br	1-Bromo-2-methylpropane	-85 e	-68 e	-46 e	-16 e	26.8	91.1	5
C <sub>4</sub> H <sub>9</sub> Br	2-Bromo-2-methylpropane					11.7	72.4	1,5
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	-87 e	-71 e	-49 e	-21 e	18.4	78.1	1
C <sub>4</sub> H <sub>9</sub> Cl	2-Chlorobutane	-96 e	-80 e	-59 e	-31.0	8.5	67.9	1
C <sub>4</sub> H <sub>9</sub> Cl	1-Chloro-2-methylpropane	-94 e	-78 e	-56.6	-28.7	10.2	68.5	5
C <sub>4</sub> H <sub>9</sub> Cl	2-Chloro-2-methylpropane					-4.2	50.3	5
C <sub>4</sub> H <sub>9</sub> Cl <sub>3</sub> Si	Butyltrichlorosilane					77.2	148.4	5
C <sub>4</sub> H <sub>9</sub> F	1-Fluorobutane	-114 e	-99 e	-80 e	-55 e	-20.0	32.1	5
C <sub>4</sub> H <sub>9</sub> F	2-Fluorobutane	-117 e	-103 e	-85 e	-60.7	-26.7	24.7	5
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	-62 e	-43 e	-19 e	14 e	60.5	130.0	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>4</sub> H <sub>9</sub> I	2-Iodobutane	-70 e	-51 e	-27 e	5 e	50 e	119.5	5
C <sub>4</sub> H <sub>9</sub> I	1-Iodo-2-methylpropane		-47 e	-21.4	12.0	56.8	120.0	5
C <sub>4</sub> H <sub>9</sub> I	2-Iodo-2-methylpropane	-75.1 s	-58.8 s	-39.5 s	-5.2	41 e	100.0	5
C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine		-59 e	-38 e	-10 e	28.5	86.2	1
C <sub>4</sub> H <sub>9</sub> NO	<i>N</i> -Methylpropanamide				81.1	105 e		5
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide	-8 e	8 e	28.0	56.4	98.2	165.7	1
C <sub>4</sub> H <sub>9</sub> NO	2-Butanone oxime		-18 e	7 e	38.9	81.9	142.9	5
C <sub>4</sub> H <sub>9</sub> NO	Morpholine				21 e	64.5	128.5	1
C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	Isobutyl nitrate			-18 e	15.1	59.2	123.0	5
C <sub>4</sub> H <sub>10</sub>	Butane*	-134.3	-121.0	-103.9	-81.1	-49.1	-0.8	1,41
C <sub>4</sub> H <sub>10</sub>	Isobutane*		-129.0	-113.0	-90.9	-59.4	-12.0	1,41
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	-37 e	-20 e	0 e	28 e	64 e	117.4	1
C <sub>4</sub> H <sub>10</sub> O	2-Butanol	-50 e	-34 e	-14 e	12.6	48.2	99.2	1,5
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	-39 e	-24 e	-5 e	20.9	56.0	107.6	1,5
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol					34.4	82.1	1,5
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	-111 e	-96 e	-77 e	-52.6	-17.8	34.1	1
C <sub>4</sub> H <sub>10</sub> O	Methyl propyl ether				-40 e	-11.3	38.7	5
C <sub>4</sub> H <sub>10</sub> O	Isopropyl methyl ether				-56 e	-21.2	30.4	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Butanediol	-4 e	23 e	55 e	94 e	142.9	206.1	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Butanediol		45 e	77 e	116 e	164.7	227.6	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	2,3-Butanediol		15 e	43 e	77 e	121.2	180.3	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol monoethyl ether	-49 e	-29 e	-3 e	30 e	73.6	135.3	1
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol dimethyl ether			-44 e	-15 e	25.2	85.2	1
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Dimethylacetal	-89 e	-74 e	-55 e	-29 e	7.7	64.1	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Diethylperoxide				-39 e	3.6	65.0	5
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S	Bis(2-hydroxyethyl) sulfide			31 e	114.2		282.0	5
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	Diethylene glycol	35 e	58 e	86 e	123 e	173.6	245.2	1
C <sub>4</sub> H <sub>10</sub> O <sub>4</sub> S	Diethyl sulfate		3 e	36 e	79 e	134 e	208.3	5
C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	-77 e	-59 e	-37 e	-6 e	35.4	98.0	5
C <sub>4</sub> H <sub>10</sub> S	2-Butanethiol	-86 e	-69 e	-47 e	-17 e	23.4	84.5	5
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-1-propanethiol		-66 e	-44 e	-15 e	26.5	88.1	5
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-2-propanethiol					5.8	63.8	5
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	-80 e	-62 e	-40 e	-10.8	30.3	91.7	1
C <sub>4</sub> H <sub>10</sub> S	Methyl propyl sulfide	-78 e	-61 e	-38 e	-8 e	33.1	95.1	5
C <sub>4</sub> H <sub>10</sub> S	Isopropyl methyl sulfide	-85 e	-68 e	-46 e	-17 e	23.4	84.3	5
C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	1,4-Butanedithiol	-17 e	5 e	32 e	69.1	119.9	195.1	5
C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	Diethyl disulfide	-46 e	-26 e	0 e	35 e	82.4	153.5	5
C <sub>4</sub> H <sub>11</sub> N	Butylamine			-46 e	-18.1	20.0	75.9	5
C <sub>4</sub> H <sub>11</sub> N	<i>sec</i> -Butylamine			-55 e	-29.1	7.5	62.3	5
C <sub>4</sub> H <sub>11</sub> N	<i>tert</i> -Butylamine			-67 e	-42.4	-8.1	43.7	5
C <sub>4</sub> H <sub>11</sub> N	Isobutylamine	-85 e	-70 e	-50 e	-24.5	12.0	67.3	5
C <sub>4</sub> H <sub>11</sub> N	Diethylamine			-46 e	-26 e	5 e	55.2	1
C <sub>4</sub> H <sub>11</sub> NO	<i>N,N</i> -Dimethylethanolamine	-52 e	-31 e	-6 e	27 e	70.9	133 e	5
C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	Diethanolamine	53 e	77 e	107 e	146 e	197.3	268 e	5
C <sub>4</sub> H <sub>12</sub> BN	(Dimethylamino)dimethyl-borane		-81 e	-60.1	-31.9	7.0	64.2	5
C <sub>4</sub> H <sub>12</sub> Cl <sub>2</sub> OSi <sub>2</sub>	1,3-Dichloro-1,1,3,3-tetramethyldisiloxane		-33 e	-9 e	23.8	69.1	136.5	5
C <sub>4</sub> H <sub>12</sub> O <sub>4</sub> Si	Tetramethyl silicate				14.4	59.3	119.7	5
C <sub>4</sub> H <sub>12</sub> Si	Tetramethylsilane			-83 e	-59 e	-25 e	26.7	5
C <sub>4</sub> H <sub>12</sub> Sn	Tetramethylstannane			-55.0	-25.6	16.6	77.7	5
C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	Diethylenetriamine	-10 e	13 e	43 e	80 e	129.6	198 e	5
C <sub>4</sub> NiO <sub>4</sub>	Nickel carbonyl					-12	42	4
C <sub>5</sub> F <sub>12</sub>	Perfluoropentane				-54.7	-20.9	28.6	5
C <sub>5</sub> FeO <sub>5</sub>	Iron pentacarbonyl				0	44	105	4
C <sub>5</sub> H <sub>4</sub> ClN	2-Chloropyridine			7.4	45.8	97.3	169.9	5
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural	-26 e	-8 e	16 e	47 e	92.4	161.4	1
C <sub>5</sub> H <sub>5</sub> N	Pyridine			-23 e	8 e	51.0	114.9	1
C <sub>5</sub> H <sub>6</sub>	1,3-Cyclopentadiene			-77 e	-51 e	-14 e	39.8	5
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	Pentanedinitrile	24.1	52 e	85 e	126 e	178 e	245 e	5
C <sub>5</sub> H <sub>6</sub> O	2-Methylfuran			-66 e	-35 e	6 e	64.5	1

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	Furfuryl alcohol	-30 e	-5 e	25 e	62.6	109.3	169.7	5
C <sub>5</sub> H <sub>6</sub> S	2-Methylthiophene		-58 e	-32 e	2 e	47.9	112.2	1
C <sub>5</sub> H <sub>6</sub> S	3-Methylthiophene		-53 e	-28 e	6 e	50.6	115.1	1
C <sub>5</sub> H <sub>7</sub> N	1-Methylpyrrole				8 e	49.9	112.3	5
C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl cyanoacetate	16 e	39 e	67.0	102.1	146.7	205.6	5
C <sub>5</sub> H <sub>8</sub>	1,2-Pentadiene	-109 e	-93 e	-73 e	-46.1	-9.7	44.5	5
C <sub>5</sub> H <sub>8</sub>	<i>cis</i> -1,3-Pentadiene	-109 e	-93 e	-73 e	-47.0	-10.5	43.7	1,5
C <sub>5</sub> H <sub>8</sub>	<i>trans</i> -1,3-Pentadiene			-75 e	-49.0	-13 e	42 e	1
C <sub>5</sub> H <sub>8</sub>	1,4-Pentadiene	-120 e	-105 e	-86 e	-60.9	-26.2	25.6	5
C <sub>5</sub> H <sub>8</sub>	2,3-Pentadiene	-106 e	-90 e	-70 e	-42.9	-6.3	47.9	5
C <sub>5</sub> H <sub>8</sub>	3-Methyl-1,2-butadiene	-111 e	-95 e	-75 e	-49.2	-13.1	40.4	5
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	-115 e	-100 e	-81 e	-55.4	-19.7	33.7	1,5
C <sub>5</sub> H <sub>8</sub>	1-Pentyne			-75 e	-49.1	-13.5	39.9	5
C <sub>5</sub> H <sub>8</sub>	2-Pentyne	-100 e	-85 e	-65 e	-37.9	-0.5	55.7	5
C <sub>5</sub> H <sub>8</sub>	3-Methyl-1-butyne			-82 e	-57.5	-23.1	28.6	5
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	-109 e	-94 e	-74 e	-48 e	-11.1	43.8	5
C <sub>5</sub> H <sub>8</sub>	Spiropentane	-110 e	-95 e	-76 e	-51 e	-15 e	38.6	5
C <sub>5</sub> H <sub>8</sub> O	3-Methyl-3-buten-2-one			-35 e	-5 e	36.0	97.3	5
C <sub>5</sub> H <sub>8</sub> O	Cyclopropyl methyl ketone		-57 e	-31 e	3 e	49 e	112 e	5
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone		-39 e	-14 e	19 e	64 e	130.3	1
C <sub>5</sub> H <sub>8</sub> O	3,4-Dihydro-2H-pyran				-22 e	22.0	84.9	5
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	4-Pentenoic acid	0 e	19 e	44 e	77 e	122.0	187.5	5
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Vinyl propanoate					31.2	94 e	5
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acrylate		-55 e	-32.7	-2.8	38.5	99.2	5
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate			-31 e	-1 e	39.7	100.0	1
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione			-5 e	24.7	67.8	137.4	1
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Tetrahydro-2H-pyran-2-one		5 e	35.1	74.4	128.3	207.0	5
C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	Methyl acetoacetate				50.1	101.1	171.3	5
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Glutaric acid		121 e	153.2	191.9	240.3	302.5	5
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Dimethyl malonate	-22 e	1 e	30.0	66.7	114.7	180.2	5
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Ethyl 2-chloropropanoate			1.4	36.4	82.5	146.0	5
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Isopropyl chloroacetate			-2 e	35.0	83.3	148.1	5
C <sub>5</sub> H <sub>9</sub> N	Pentanenitrile	-54 e	-34 e	-8 e	26 e	72.2	140.9	1
C <sub>5</sub> H <sub>9</sub> N	2,2-Dimethylpropanenitrile					41.1	104.8	5
C <sub>5</sub> H <sub>9</sub> NO	<i>N</i> -Methyl-2-pyrrolidone	1 e	24 e	53.1	92.3	147.2	229 e	5
C <sub>5</sub> H <sub>10</sub>	1-Pentene	-118.9	-103.4	-84.0	-58.8	-23.3	29.6	1,5
C <sub>5</sub> H <sub>10</sub>	<i>cis</i> -2-Pentene	-113.8	-98.1	-78.4	-52.7	-16.8	36.6	1,5
C <sub>5</sub> H <sub>10</sub>	<i>trans</i> -2-Pentene	-114.5	-98.9	-79.1	-53.3	-17.5	36.0	1,5
C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene	-117.7	-102.2	-82.7	-57.2	-21.9	30.8	1,5
C <sub>5</sub> H <sub>10</sub>	3-Methyl-1-butene	-125.0	-110.1	-91.2	-66.7	-32.1	19.7	1,5
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	-113.4	-97.6	-77.7	-51.6	-15.8	38.2	1,5
C <sub>5</sub> H <sub>10</sub>	Cyclopentane			-77.0	-45.4	-7.1	48.8	5
C <sub>5</sub> H <sub>10</sub>	Ethylcyclopropane	-118 e	-102 e	-83 e	-57 e	-20 e	35.5	5
C <sub>5</sub> H <sub>10</sub>	<i>cis</i> -1,2-Dimethylcyclo-propane	-118 e	-103 e	-83 e	-57 e	-20 e	36.6	5
C <sub>5</sub> H <sub>10</sub>	<i>trans</i> -1,2-Dimethylcyclo-propane	-122 e	-108 e	-89 e	-63 e	-27 e	27.8	5
C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	1,5-Dibromopentane	1 e	25 e	54 e	93 e	145.6	221.8	5
C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	1,2-Dichloropentane				30 e	77.4	147.8	5
C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	1,5-Dichloropentane	-31 e	-10 e	17 e	54 e	104.1	178.9	5
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub>	3-(Dimethylamino)-propanenitrile				51.1	101.8	171.4	5
C <sub>5</sub> H <sub>10</sub> O	Cyclopentanol		-13 e	11.5	42.2	82.5	140.0	5
C <sub>5</sub> H <sub>10</sub> O	Allyl ethyl ether			-56 e	-28.7	9.8	67.2	5
C <sub>5</sub> H <sub>10</sub> O	Pentanal	-71 e	-53 e	-31 e	-1 e	40.8	102.6	5
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone				-1 e	40.3	101.9	1,5
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone			-31 e	-1 e	40 e	101.6	1
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone	-69 e	-54 e	-34 e	-6.9	32.2	94.0	1,5
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran				-15 e	26.0	88 e	5
C <sub>5</sub> H <sub>10</sub> O	2-Methyltetrahydrofuran				-20 e	19.7	79.8	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid	-7.4	15.3	42.7	76.3	122.1	185.7	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	2-Methylbutanoic acid	-10 e	10 e	36 e	69 e	112.8	175.2	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	3-Methylbutanoic acid	-15.8	4 e	30.0	64.7	110.6	176.1	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate			-29 e	2 e	44.4	105.7	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isobutyl formate	-69 e	-53 e	-31 e	-3 e	37.4	97.6	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	-69 e	-51 e	-29 e	0 e	40.9	101.2	1
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate		-61 e	-40 e	-11 e	29.8	88.2	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	-69 e	-52 e	-30 e	-1 e	38.9	98.7	1
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate	-68 e	-50 e	-28 e	0.9	41.7	102.3	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl isobutanoate	-83 e	-65 e	-41 e	-11 e	31 e	92.1	5
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Tetrahydrofurfuryl alcohol	-40 e	-16 e	15 e	55 e	106 e	176.8	5
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Diethyl carbonate		-42 e	-17 e	17 e	61.6	125.9	5
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Ethylene glycol monomethyl ether acetate	-47 e	-26 e	0 e	34 e	79.4	144.1	5
C <sub>5</sub> H <sub>10</sub> S	Thiacyclohexane				24 e	71.1	141.2	5
C <sub>5</sub> H <sub>10</sub> S	Cyclopentanethiol				18 e	64 e	131.7	5
C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane	-60 e	-41 e	-16 e	16 e	61.5	129.1	5
C <sub>5</sub> H <sub>11</sub> Br	2-Bromopentane	-69 e	-51 e	-27 e	5 e	49.7	116.9	5
C <sub>5</sub> H <sub>11</sub> Br	3-Bromopentane	-68 e	-50 e	-26 e	6 e	50.8	118.1	5
C <sub>5</sub> H <sub>11</sub> Br	1-Bromo-3-methylbutane	-67 e	-49 e	-25 e	8 e	52.4	119.9	5
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloropentane	-73 e	-55 e	-32 e	-1 e	42.5	107.9	5
C <sub>5</sub> H <sub>11</sub> Cl	2-Chloropentane	-80 e	-62 e	-39 e	-9 e	33.2	96.1	5
C <sub>5</sub> H <sub>11</sub> Cl	3-Chloropentane	-77 e	-60 e	-37 e	-7 e	34.9	97.3	5
C <sub>5</sub> H <sub>11</sub> Cl	2-Chloro-2-methylbutane			-52 e	-21 e	21.8	85.2	5
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloro-2,2-dimethyl-propane				-17 e	23.5	83.9	5
C <sub>5</sub> H <sub>11</sub> F	1-Fluoropentane	-97 e	-80 e	-60 e	-32 e	5.7	62.4	5
C <sub>5</sub> H <sub>11</sub> I	1-Iodopentane	-47 e	-27 e	-1 e	34 e	83.0	156.5	5
C <sub>5</sub> H <sub>11</sub> I	1-Iodo-3-methylbutane		-34 e	-6.6	28.8	77.3	147.8	5
C <sub>5</sub> H <sub>11</sub> N	Cyclopentylamine	-66 e	-48 e	-26 e	4 e	45.8	108 e	5
C <sub>5</sub> H <sub>11</sub> N	Piperidine				2 e	43.3	105.8	5
C <sub>5</sub> H <sub>11</sub> N	<i>N</i> -Methylpyrrolidine				-23 e	18.5	78 e	5
C <sub>5</sub> H <sub>11</sub> NO <sub>3</sub>	3-Methylbutyl nitrate		-26 e	1.0	35.5	81.7	147.0	5
C <sub>5</sub> H <sub>12</sub>	Pentane**	-115.5	-99.8	-80.0	-54.0	-18.1	35.7	16
C <sub>5</sub> H <sub>12</sub>	Isopentane	-119 e	-105 e	-86 e	-61 e	-26 e	27.5	1
C <sub>5</sub> H <sub>12</sub>	Neopentane*		-107.5 s	-90.8 s	-68.8 s	-38.5 s	9.2	1,5
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Tetramethylurea			20.7	58.0	106.7	179.5	5
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	-27 e	-10 e	12 e	41 e	79.8	137.4	5
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	-35 e	-19 e	1 e	28.0	64.9	118.7	1
C <sub>5</sub> H <sub>12</sub> O	3-Pentanol	-41 e	-25 e	-4 e	24 e	61.1	114.9	5
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-1-butanol	-27 e	-11 e	9 e	36.2	73.4	128.3	1
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	-22 e	-7 e	13 e	39.1	75.7	130.1	5
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol			-5 e	17.7	50.6	101.7	1,5
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol			-3 e	22.7	58.2	111.1	5
C <sub>5</sub> H <sub>12</sub> O	2,2-Dimethyl-1-propanol					59.2	112.7	5
C <sub>5</sub> H <sub>12</sub> O	Butyl methyl ether			-54 e	-27 e	12 e	69.8	1
C <sub>5</sub> H <sub>12</sub> O	Methyl <i>tert</i> -butyl ether			-66 e	-39 e	-2 e	54.8	1
C <sub>5</sub> H <sub>12</sub> O	Ethyl propyl ether	-92 e	-77 e	-57 e	-30.5	6.7	63.4	1,5
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,5-Pentanediol	25 e	52 e	85 e	125 e	175.1	238.9	5
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	Ethylene glycol monopropyl ether				40 e	85.6	149.3	5
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	Diethoxymethane		-65 e	-43 e	-14 e	27.3	87.7	5
C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	Diethylene glycol monomethyl ether		12 e	40 e	76 e	124.2	193.7	1
C <sub>5</sub> H <sub>12</sub> S	1-Pentanethiol	-60 e	-41 e	-17 e	15 e	60 e	126.2	1
C <sub>5</sub> H <sub>12</sub> S	2-Pentanethiol	-70 e	-52 e	-28 e	3 e	46.6	111.9	5
C <sub>5</sub> H <sub>12</sub> S	3-Pentanethiol	-70 e	-51 e	-28 e	4 e	47.7	113.4	5
C <sub>5</sub> H <sub>12</sub> S	2-Methyl-1-butanethiol				8.0	52.3	118.5	5
C <sub>5</sub> H <sub>12</sub> S	3-Methyl-1-butanethiol				7.8	51.9	117.9	5
C <sub>5</sub> H <sub>12</sub> S	2-Methyl-2-butanethiol				-8.0	34.6	98.7	5
C <sub>5</sub> H <sub>12</sub> S	Butyl methyl sulfide		-43 e	-19 e	13 e	57 e	123.0	1
C <sub>5</sub> H <sub>12</sub> S	<i>tert</i> -Butyl methyl sulfide				-7.8	34.7	98.4	5
C <sub>5</sub> H <sub>12</sub> S	Ethyl propyl sulfide	-64 e	-46 e	-23 e	9 e	52.7	118.0	5
C <sub>5</sub> H <sub>12</sub> S	Ethyl isopropyl sulfide	-72 e	-54 e	-31 e	0 e	42.7	106.9	5
C <sub>5</sub> H <sub>13</sub> N	Pentylamine		-52 e	-29 e	1 e	42.8	104.0	5
C <sub>6</sub> BrF <sub>5</sub>	Bromopentafluorobenzene			-10 e	23 e	68 e	136.0	5
C <sub>6</sub> ClF <sub>5</sub>	Chloropentafluorobenzene		-44 e	-21 e	11 e	53.8	117.6	1

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>6</sub> Cl <sub>3</sub> F <sub>3</sub>	1,3,5-Trichloro-2,4,6-trifluorobenzene	-19 e	4 e	32 e	70 e	121.7	197.9	1
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene		-56.9 s	-36 s	-11.5 s	22.6	79.9	1,5
C <sub>6</sub> F <sub>12</sub>	Perfluorocyclohexane				-46.2 s	-7.6 s	48.9 s	5
C <sub>6</sub> F <sub>14</sub>	Perfluorohexane		-75 e	-57 e	-32 e	2.8	56.8	5
C <sub>6</sub> F <sub>14</sub>	Perfluoro-2-methylpentane				-33 e	2.9	57.1	5
C <sub>6</sub> F <sub>14</sub>	Perfluoro-3-methylpentane	-95 e	-80 e	-60 e	-34 e	2.8	57.9	5
C <sub>6</sub> F <sub>14</sub>	Perfluoro-2,3-dimethylbutane					4.3	59.3	5
C <sub>6</sub> HF <sub>5</sub>	Pentafluorobenzene			-41 e	-13 e	27 e	85.3	5
C <sub>6</sub> HF <sub>5</sub> O	Pentafluorophenol				39 e	82 e	145.2	5
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,4-Tetrafluorobenzene			-36 e	-7 e	33.8	94.0	1
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,5-Tetrafluorobenzene			-43 e	-14 e	25.5	84.1	1
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,4,5-Tetrafluorobenzene					30.7	89.9	1
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	2,4,6-Trichlorophenol			71.8	114.0	169.5	245.7	5
C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	1,3,5-Trifluorobenzene					18.2	75.0	5
C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	<i>m</i> -Dibromobenzene	-7 e	16 e	44 e	83 e	137.0	218.2	5
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-4-nitrobenzene	15.4 s	35.8 s		97 e	156.0	238 e	5
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene		-13 e	16.3	53.9	104.6	180.0	1,5
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene		-22 e	8.0	46.7	97.8	172.5	1,5
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene	-45.5 s	-21.8 s	8 s	46.7 s	99.0	173.6	1,5
C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	<i>p</i> -Benzoquinone	-4.1 s	17.8 s	43.5 s	74.3 s	111.6 s		5
C <sub>6</sub> H <sub>3</sub> AsCl <sub>2</sub>	Dichlorophenylarsine	6.9	35.2	70 e	113 e	170 e	245 e	5
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene		-25 e	1 e	34.9	83.1	155.4	1
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene		-43 e	-17 e	16.8	62.9	131.3	1,5
C <sub>6</sub> H <sub>5</sub> ClO	<i>o</i> -Chlorophenol				45.8	97.9	173.9	5
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol			39.7	80.2	135.1	213.4	5
C <sub>6</sub> H <sub>5</sub> ClO	<i>p</i> -Chlorophenol			45.0	86.5	142.0	219.9	5
C <sub>6</sub> H <sub>5</sub> Cl <sub>3</sub> Si	Trichlorophenylsilane			33 e	70.2	122.6	201 e	5
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene				-16.9	24.2	84.4	1
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	-30 e	-7 e	20.9	58.5	110.6	187.8	1
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene		10 e	40 e	78 e	132 e	210.3	1
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>p</i> -Nitrophenol	72.6 s	97.4 s					5
C <sub>6</sub> H <sub>6</sub>	1,5-Hexadien-3-yne	-82 e	-66 e	-44.3	-16.0	23.7	83.6	5
C <sub>6</sub> H <sub>6</sub>	Benzene**			-40 s	-15.1 s	20.0	79.7	1,5
C <sub>6</sub> H <sub>6</sub> ClN	<i>o</i> -Chloroaniline		10 e	39.0	75.2	131.4	208.3	5
C <sub>6</sub> H <sub>6</sub> ClN	<i>m</i> -Chloroaniline	-5 e	19.7	49.4	94.2	162 e	1069 e	5
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>p</i> -Nitroaniline	87.8 s			192.0	252.6	331.2	5
C <sub>6</sub> H <sub>6</sub> O	Phenol	-9.7 s	9.6 s	34.1 s	68.9	113.7	181.4	1,5
C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	1,2,3-Benzenetriol				162.0	222.8	308.3	5
C <sub>6</sub> H <sub>6</sub> S	Benzenethiol		-15 e	12 e	47 e	96.0	168.6	5
C <sub>6</sub> H <sub>7</sub> N	Aniline		-2.5	26.7	63.5	112.5	183.5	1,5
C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	-56.5	-37.8	-13.9	18.3	62.9	129.0	1,5
C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine			-5 e	28.8	75.2	143.7	1
C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	-58.2 s	-43.1 s	-3.9 s	29.6	76.1	144.9	1,5
C <sub>6</sub> H <sub>8</sub>	<i>cis</i> -1,3,5-Hexatriene					21 e	78 e	5
C <sub>6</sub> H <sub>8</sub>	1,3-Cyclohexadiene	-88 e	-71 e	-50 e	-21 e	19 e	79.9	5
C <sub>6</sub> H <sub>8</sub>	1,4-Cyclohexadiene				-15 e	27.3	85.0	5
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Adiponitrile	30 e	61 e	100 e	148.6	211.8	297 e	5
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>m</i> -Phenylenediamine			94.5	140.2	200.8	285.0	5
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Phenylhydrazine		38 e	69 e	109 e	163.9	242.5	5
C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	Dimethyl maleate		5 e	36 e	76 e	127.3	197 e	5
C <sub>6</sub> H <sub>8</sub> S	2,5-Dimethylthiophene		-43 e	-16 e	20 e	67.5	134.8	5
C <sub>6</sub> H <sub>10</sub>	<i>trans</i> -1,3-Hexadiene	-86 e	-70 e	-51 e	-24 e	14 e	72 e	5
C <sub>6</sub> H <sub>10</sub>	<i>trans</i> -1,4-Hexadiene	-98 e	-81 e	-60 e	-33 e	7 e	65 e	5
C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene	-99 e	-84 e	-64 e	-37 e	0.9	59.2	5
C <sub>6</sub> H <sub>10</sub>	<i>cis,cis</i> -2,4-Hexadiene					18 e	79.6	5
C <sub>6</sub> H <sub>10</sub>	<i>trans,cis</i> -2,4-Hexadiene	-89 e	-73 e	-52 e	-23 e	18 e	79.6	5
C <sub>6</sub> H <sub>10</sub>	<i>trans,trans</i> -2,4-Hexadiene				-23 e	18 e	79.6	5
C <sub>6</sub> H <sub>10</sub>	<i>trans</i> -2-Methyl-1,3-pentadiene	-92 e	-75 e	-54 e	-26 e	14 e	75.6	5
C <sub>6</sub> H <sub>10</sub>	2,3-Dimethyl-1,3-butadiene			-59 e	-30 e	9.7	68.1	5
C <sub>6</sub> H <sub>10</sub>	1-Hexyne	-91 e	-75 e	-54 e	-26 e	12.8	71.0	5



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>6</sub> H <sub>10</sub>	2-Hexyne	-84 e	-67 e	-46 e	-17 e	23.6	84.1	5
C <sub>6</sub> H <sub>10</sub>	3-Hexyne	-86 e	-69 e	-48 e	-19.1	21.0	81.0	1,5
C <sub>6</sub> H <sub>10</sub>	4-Methyl-1-pentyne	-97 e	-81 e	-61 e	-34 e	4.1	60.7	5
C <sub>6</sub> H <sub>10</sub>	4-Methyl-2-pentyne	-91 e	-74 e	-54 e	-26 e	13.8	72.7	5
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	-87 e	-70 e	-49 e	-19 e	21 e	82.6	1
C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub>	1,1-Dichlorocyclohexane	-39 e	-19 e	8 e	43 e	93.5	170.5	5
C <sub>6</sub> H <sub>10</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichlorocyclohexane			27 e	69 e	125.7	206.2	5
C <sub>6</sub> H <sub>10</sub> O	4-Methyl-4-penten-2-one	-59 e	-41 e	-17 e	14 e	57.0	121.0	5
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone		-25 e	1 e	36 e	84 e	155.2	1
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide	-56 e	-37 e	-13 e	19 e	63.5	129.3	5
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Vinyl butanoate					53 e	114.5	5
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl methacrylate				8 e	53.2	116.8	5
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Allyl glycidyl ether				40.1	85.7	152.8	5
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate	-25 e	-3 e	25.7	62.3	111.3	180.2	5
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Propanoic anhydride	-32 e	-15 e	6 e	36 e	77.6	142.9	5
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate	-5 e	18 e	44.9	79.4	124.3	185.2	5
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl succinate			30 e	70.4	123.3	195.4	5
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Ethylene glycol diacetate	-17 e	6 e	35.0	71.9	121.1	190.0	5
C <sub>6</sub> H <sub>10</sub> S	Diallylsulfide	-58 e	-38 e	-12.4	21.7	68.8	138.1	5
C <sub>6</sub> H <sub>11</sub> Cl	Chlorocyclohexane		-35 e	-9 e	25 e	71.6	142.1	5
C <sub>6</sub> H <sub>11</sub> N	Hexanenitrile	-40 e	-19 e	8 e	43 e	91.5	163.2	1,5
C <sub>6</sub> H <sub>11</sub> N	4-Methylpentanenitrile		-50 e	-20 e	20 e	75.2	155.2	5
C <sub>6</sub> H <sub>11</sub> NO	Caprolactam	36.8 s	58.9 s	86.6 s			270	5
C <sub>6</sub> H <sub>12</sub>	1-Hexene	-99.8	-82.8	-61.4	-33.7	5.2	63.1	1,5
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -2-Hexene	-97 e	-80 e	-58 e	-30 e	9.9	68.5	5
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -2-Hexene	-94 e	-78 e	-57 e	-30 e	9.3	67.5	5
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -3-Hexene	-96 e	-79 e	-59 e	-30.8	7.9	66.0	5
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -3-Hexene	-95 e	-79 e	-58 e	-30.0	8.8	66.7	5
C <sub>6</sub> H <sub>12</sub>	2-Methyl-1-pentene	-98 e	-82 e	-62 e	-34.2	4.1	61.7	5
C <sub>6</sub> H <sub>12</sub>	3-Methyl-1-pentene	-104 e	-88 e	-68 e	-41.5	-3.6	53.8	5
C <sub>6</sub> H <sub>12</sub>	4-Methyl-1-pentene	-105 e	-89 e	-69 e	-41.6	-3.6	53.5	5
C <sub>6</sub> H <sub>12</sub>	2-Methyl-2-pentene	-95 e	-78 e	-58 e	-30 e	9.0	66.9	5
C <sub>6</sub> H <sub>12</sub>	3-Methyl- <i>cis</i> -2-pentene	-95 e	-79 e	-58 e	-30 e	8.9	67.3	5
C <sub>6</sub> H <sub>12</sub>	3-Methyl- <i>trans</i> -2-pentene	-93 e	-77 e	-55 e	-27.4	11.7	70.0	5
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>cis</i> -2-pentene	-102 e	-86 e	-66 e	-38.7	-0.9	56.0	5
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>trans</i> -2-pentene	-100 e	-84 e	-64 e	-36.8	1.2	58.2	5
C <sub>6</sub> H <sub>12</sub>	2-Ethyl-1-butene	-98 e	-81 e	-60 e	-32 e	6.6	64.3	5
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-1-butene	-103 e	-87 e	-67 e	-39.9	-1.9	55.2	5
C <sub>6</sub> H <sub>12</sub>	3,3-Dimethyl-1-butene	-110 e	-95 e	-76 e	-50.8	-14.5	40.8	5
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-2-butene		-75 e	-54 e	-25 e	14 e	72.9	1
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	-85.6 s	-68.9 s	-47.6 s	-19.8 s	19.3	80.4	1,5
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	-97 e	-80 e	-58 e	-28.8	11.6	71.4	1,5
C <sub>6</sub> H <sub>12</sub>	Ethylcyclobutane	-99 e	-82 e	-61 e	-32 e	9 e	70.2	5
C <sub>6</sub> H <sub>12</sub>	Isopropylcyclopropane	-104 e	-88 e	-68 e	-40 e	-1 e	57.9	5
C <sub>6</sub> H <sub>12</sub>	1-Ethyl-1-methylcyclopropane	-105 e	-89 e	-69 e	-41 e	-3 e	56.3	5
C <sub>6</sub> H <sub>12</sub>	1,1,2-Trimethylcyclopropane	-109 e	-94 e	-73 e	-46 e	-7 e	52.0	5
C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub>	1,2-Dichlorohexane				49 e	98.1	171.7	5
C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> O	2,2'-Dichlorodiisopropyl ether		-1 e	27.3	63.4	112.3	182.1	5
C <sub>6</sub> H <sub>12</sub> O	Butyl vinyl ether	-87 e	-67 e	-42 e	-9.3	33.6	93.2	5
C <sub>6</sub> H <sub>12</sub> O	Isobutyl vinyl ether	-87 e	-68 e	-44 e	-13 e	26.5	80.7	5
C <sub>6</sub> H <sub>12</sub> O	Hexanal	-56 e	-37 e	-13 e	19 e	62.6	127.8	5
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	-43 e	-21 e	4.2	34.5	61.9	127.2	1,5
C <sub>6</sub> H <sub>12</sub> O	3-Hexanone		-40 e	-16 e	15 e	58.5	123.1	1
C <sub>6</sub> H <sub>12</sub> O	3-Methyl-2-pentanone				8.5	52.7	117.0	5
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone	-61 e	-43 e	-21 e	9 e	51.5	116.1	5
C <sub>6</sub> H <sub>12</sub> O	2-Methyl-3-pentanone					50.2	113.0	5
C <sub>6</sub> H <sub>12</sub> O	3,3-Dimethyl-2-butanone			-30 e	0 e	42.5	105.7	1
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol			34 e	61 e	99.2	160.7	1
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid		33 e	59 e	93 e	139.3	204.5	1
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4-Methylpentanoic acid	36 e	49 e	67.1	92.9	133.6	206.8	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diethylacetic acid	-9 e	16 e	46 e	83 e	130.7	192.5	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isopentyl formate	-60 e	-41 e	-17 e	15 e	59.1	124 e	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	-63 e	-43 e	-19 e	14 e	61.0	125.6	1,5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate	-63 e	-45 e	-21 e	10 e	53.4	116 e	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Propyl propanoate	-62 e	-42 e	-18 e	14 e	58.3	122.0	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate	-49 e	-34 e	-14 e	14.3	55.2	121.1	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl 2-methylpropanoate	-65 e	-47 e	-24.6	5.4	47.3	109.8	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl pentanoate				19.2	63.7	127.4	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl isopentanoate					53.3	116.3	5
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol	-41 e	-17 e	13 e	50.1	98.5	164 e	5
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Ethylene glycol monoethyl ether acetate	-25 e	-8 e	14 e	44.6	88.0	155.6	5
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde				17 e	62.2	124 e	5
C <sub>6</sub> H <sub>12</sub> S	Cyclohexanethiol					84.8	158.3	5
C <sub>6</sub> H <sub>12</sub> S	<i>cis</i> -Tetrahydro-2,5-dimethylthiophene	-53 e	-34 e	-8 e	25 e	72.0	142.1	5
C <sub>6</sub> H <sub>12</sub> S	Tetrahydro-3-methyl-2H-thiopyran	-48 e	-27 e	0 e	35 e	84.1	157.5	5
C <sub>6</sub> H <sub>13</sub> Br	1-Bromohexane	-45 e	-25 e	2 e	36 e	83.7	154.8	5
C <sub>6</sub> H <sub>13</sub> Cl	1-Chlorohexane	-55 e	-36 e	-11 e	21 e	66.7	134.6	5
C <sub>6</sub> H <sub>13</sub> F	1-Fluorohexane	-80 e	-62 e	-40 e	-11 e	30.4	91.1	5
C <sub>6</sub> H <sub>13</sub> I	1-Iodohexane	-33 e	-11 e	16 e	53 e	104.0	180.8	5
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine			-9 e	22 e	66.6	133.5	1
C <sub>6</sub> H <sub>14</sub>	Hexane	-96.4 s	-79.2	-57.6	-29.3	9.8	68.3	16
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	-100 e	-84 e	-64 e	-36 e	2 e	59.9	1
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	-99 e	-83 e	-62 e	-34.3	4.6	62.9	1
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane		-90 e	-71.5	-45.5	-7.7	49.4	1
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	-103 e	-87 e	-66 e	-39.0	-0.4	57.6	1
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol		5 e	28 e	56.8	97.3	157.1	1
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol	-28 e	-10 e	12 e	41.4	81.5	139.6	1
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol	-43 e	-23 e	1 e	33 e	75.4	135.1	1
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-1-pentanol			14 e	45.9	88.3	147.6	5
C <sub>6</sub> H <sub>14</sub> O	4-Methyl-1-pentanol			24 e	53 e	92.4	151.4	5
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-2-pentanol	-29 e	-15 e	3 e	27.1	63.0	120.9	5
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-2-pentanol				36.5	76.1	133.8	5
C <sub>6</sub> H <sub>14</sub> O	4-Methyl-2-pentanol	-43 e	-24 e	0 e	30 e	71.9	131.3	5
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-3-pentanol				29.8	68.8	126.0	5
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-3-pentanol		-23 e	-4 e	22.9	61.1	121.1	5
C <sub>6</sub> H <sub>14</sub> O	2-Ethyl-1-butanol		-5 e	17 e	46 e	85.7	146.1	5
C <sub>6</sub> H <sub>14</sub> O	3,3-Dimethyl-1-butanol	-37 e	-16 e	9 e	42 e	84.3	142.5	5
C <sub>6</sub> H <sub>14</sub> O	2,3-Dimethyl-2-butanol			-5 e	23 e	61.3	118.2	5
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	-80 e	-63 e	-41 e	-12 e	28.8	89.7	1
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether		-76 e	-55 e	-28 e	11 e	68.1	1
C <sub>6</sub> H <sub>14</sub> O	Butyl ethyl ether	-78 e	-61 e	-39 e	-10 e	31.0	91.9	1
C <sub>6</sub> H <sub>14</sub> O	<i>tert</i> -Butyl ethyl ether	-90 e	-74 e	-53 e	-24.6	14.4	72.6	5
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	2-Methyl-2,4-pentanediol	-8 e	17 e	48 e	86 e	134.4	197.5	5
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	Ethylene glycol monobutyl ether	-31 e	-8 e	20 e	55 e	103.2	170.2	5
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-Diethoxyethane	-68 e	-49 e	-26 e	3.7	44.2	101.9	5
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	Ethylene glycol diethyl ether		-59 e	-35.3	-2.8	44.4	118.8	5
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	1,2,6-Hexanetriol	92 e	114.8	146.0	191 e			5
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Dipropylene glycol				110 e	162.6	231.4	5
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol monoethyl ether			40 e	80.3	132.4	201.4	5
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol dimethyl ether	-42 e	-20 e	8.3	44.3	92.3	159.4	5
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Trimethylolpropane	73 e	98 e	128 e	167.8	220.5	295 e	5
C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	Triethylene glycol	44 e	74 e	109.0	152.6	207.2	277.9	5
C <sub>6</sub> H <sub>14</sub> S	1-Hexanethiol	-45 e	-25 e	1 e	35 e	81.7	152.2	5
C <sub>6</sub> H <sub>14</sub> S	2-Hexanethiol	-50 e	-32 e	-8 e	25 e	69.9	138.4	5
C <sub>6</sub> H <sub>14</sub> S	Dipropyl sulfide	-50 e	-30 e	-6 e	28 e	73.6	142.4	5
C <sub>6</sub> H <sub>14</sub> S	Diisopropyl sulfide	-65 e	-47 e	-23 e	9 e	53.1	119.6	5
C <sub>6</sub> H <sub>14</sub> S	Isopropyl propyl sulfide				18.5	63.8	131.6	5
C <sub>6</sub> H <sub>14</sub> S	Butyl ethyl sulfide	-49 e	-30 e	-5 e	29 e	74.8	143.8	5
C <sub>6</sub> H <sub>15</sub> N	Hexylamine			-10 e	22 e	66.0	130.6	5
C <sub>6</sub> H <sub>15</sub> N	Butylethylamine				6.1	47.7	107.0	5



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine		-48 e	-25 e	6 e	47.5	108.8	5
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine			-47 e	-17.5	23.5	84.0	5
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	-58 e	-45 e	-29 e	-5 e	29.9	88.5	1
C <sub>6</sub> H <sub>15</sub> NO	2-Diethylaminoethanol					97 e	160.6	5
C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub>	Triethanolamine	75 e	108 e	148 e	196 e	256.7	334 e	5
C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> P	Triethyl phosphate			34	76	132	211	4
C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	Hexamethylenediamine				76.0	128.2	199.0	5
C <sub>6</sub> H <sub>16</sub> O <sub>2</sub> Si	Diethoxydimethylsilane	-62 e	-44 e	-21.2	9.1	51.0	113.0	5
C <sub>6</sub> H <sub>18</sub> Cl <sub>2</sub> O <sub>2</sub> Si <sub>3</sub>	1,5-Dichloro-1,1,3,3,5,5-hexamethyltrisiloxane	-29 e	-7 e	22.2	59.7	110.5	183.4	5
C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	Hexamethyldisiloxane		-56 e	-34 e	-5 e	37.1	100.1	5
C <sub>6</sub> MoO <sub>6</sub>	Molybdenum hexacarbonyl		17.4 s	42.8 s	73.1 s	109.9 s	155.4 s	5
C <sub>7</sub> F <sub>14</sub>	Perfluoromethylcyclohexane				-21 e	18 e	75.9	1
C <sub>7</sub> F <sub>16</sub>	Perfluoroheptane		-62 e	-41 e	-14 e	24.7	82.1	1
C <sub>7</sub> HF <sub>15</sub>	1H-Pentadecafluoroheptane				-7 e	35.9	96.0	5
C <sub>7</sub> H <sub>3</sub> ClF <sub>3</sub> NO <sub>2</sub>	1-Chloro-2-nitro-4-(trifluoromethyl)benzene	3 e	26 e	55 e	92.8	145.2	222.0	5
C <sub>7</sub> H <sub>3</sub> F <sub>5</sub>	2,3,4,5,6-Pentafluorotoluene			-20 e	11 e	53.6	117.0	5
C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	1-Chloro-2-(trifluoromethyl) benzene			1 e	34.5	81.8	151.8	5
C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	1-Chloro-3-(trifluoromethyl) benzene	-53 e	-34 e	-9 e	24.2	69.8	137.2	5
C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	1-Chloro-4-(trifluoromethyl) benzene			-9 e	24.2	70.4	138.1	5
C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	<i>o</i> -Chlorobenzoyl chloride				93 e	149 e	237.0	5
C <sub>7</sub> H <sub>4</sub> Cl <sub>2</sub> O	<i>m</i> -Chlorobenzoyl chloride				87.8	147 e	225.0	5
C <sub>7</sub> H <sub>4</sub> F <sub>3</sub> NO <sub>2</sub>	1-Nitro-3-(trifluoromethyl) benzene		11 e	39 e	76.2	127.3	202.2	5
C <sub>7</sub> H <sub>4</sub> F <sub>4</sub>	1-Fluoro-4-(trifluoromethyl) benzene			-38 e	-6 e	38.6	102.3	5
C <sub>7</sub> H <sub>5</sub> BrO	Benzoyl bromide	-15 e	11 e	42.6	83.9	139.5	218.0	5
C <sub>7</sub> H <sub>5</sub> ClO	Benzoyl chloride			27.5	67.0	120.4	196.7	5
C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub>	(Trichloromethyl)benzene		9 e	40.6	81.5	136.2	213.0	5
C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	(Trifluoromethyl)benzene				-3 e	39 e	101.6	5
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile		-6 e	23.9	63.1	115.7	190.0	5
C <sub>7</sub> H <sub>5</sub> NS	Phenyl isothiocyanate				79.4	105 e	117 e	5
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	2,4-Dichlorotoluene		6 e	33 e	68.3	119.5	199.1	5
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	3,4-Dichlorotoluene	-13 e	9 e	38 e	76 e	129.3	208.4	5
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	(Dichloromethyl)benzene			31	72	130	213	4
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde		-9 e	19 e	54.6	104.6	178.3	1
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Salicylaldehyde		-1 e	29 e	68 e	120.7	196.2	5
C <sub>7</sub> H <sub>7</sub> Br	<i>o</i> -Bromotoluene		-10 e	17 e	54 e	104.8	181.1	5
C <sub>7</sub> H <sub>7</sub> Br	<i>m</i> -Bromotoluene	-34 e	-11 e	19.4	58.1	109.9	183.1	5
C <sub>7</sub> H <sub>7</sub> Br	<i>p</i> -Bromotoluene				57 e	107.8	183.8	5
C <sub>7</sub> H <sub>7</sub> Br	(Bromomethyl)benzene			25.4	66.8	121.7	198.3	5
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene		-24 e	3 e	38 e	86.3	158.7	1,5
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene	-41 e	-21 e	6 e	41 e	89 e	161.8	5
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene				40 e	88.9	161.5	1,5
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene	-34 e	-11 e	17.7	55.4	106.3	178.9	5
C <sub>7</sub> H <sub>7</sub> ClO	1-Chloro-2-methoxy-benzene	-22 e	2 e	33 e	72 e	125.2	201 e	5
C <sub>7</sub> H <sub>7</sub> F	<i>o</i> -Fluorotoluene		-50 e	-26 e	5 e	49.0	113.9	5
C <sub>7</sub> H <sub>7</sub> F	<i>m</i> -Fluorotoluene	-67 e	-48 e	-25 e	7 e	51.0	116.1	5
C <sub>7</sub> H <sub>7</sub> F	<i>p</i> -Fluorotoluene		-48 e	-24 e	7 e	51 e	116.2	5
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>o</i> -Nitrotoluene	23 e	40 e	62 e	94 e	141.9	221.9	5
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>m</i> -Nitrotoluene			45 e	89.7	148.7	231.3	5
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	2-Nitroanisole	15 e	45 e	82 e	129 e	189.4	271.8	5
C <sub>7</sub> H <sub>8</sub>	Toluene	-78.1	-57.1	-31.3	1.5	45.2	110.1	5
C <sub>7</sub> H <sub>8</sub>	Bicyclo[2.2.1]hepta-2,5-diene				-15 e	27.4	91 e	5
C <sub>7</sub> H <sub>8</sub> Cl <sub>2</sub> Si	Dichloromethylphenylsilane			32.4	71.8	126.0	205.0	5
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	-6.4 s	12.8 s	40.2	72.3	120.3	190.5	1,5
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	20.8	33.6	52.4	82.6	130.6	201.8	1,5
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	-0.2 s	20.7 s	52.7	83.1	130.7	201.5	1,5
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	8 e	28 e	54 e	88 e	134.7	204.9	1
C <sub>7</sub> H <sub>8</sub> O	Anisole		-21 e	4 e	38 e	84 e	153.2	1,5
C <sub>7</sub> H <sub>8</sub> S	3-Methylbenzenethiol		0 e	29 e	66 e	117.9	194.6	5
C <sub>7</sub> H <sub>9</sub> N	Benzylamine			25.6	62.6	112.7	183.9	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methylaniline	1.0	18.8	42.6	76.1	125.6	199.9	1,5
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methylaniline	3.8	22.0	46.2	80.1	128.8	202.9	1,5
C <sub>7</sub> H <sub>9</sub> N	<i>p</i> -Methylaniline				77.1	126.2	199.9	5
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline	-16 e	6 e	34 e	70.3	121.1	195.8	1
C <sub>7</sub> H <sub>9</sub> N	2-Ethylpyridine	-46 e	-26 e	-1 e	33 e	79.3	149.0	5
C <sub>7</sub> H <sub>9</sub> N	3-Ethylpyridine	-38 e	-17 e	9 e	44 e	92.7	166.5	5
C <sub>7</sub> H <sub>9</sub> N	4-Ethylpyridine	-35 e	-15 e	11 e	46 e	94.4	168.6	5
C <sub>7</sub> H <sub>9</sub> N	2,3-Dimethylpyridine				42 e	89.9	160.6	5
C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine		-25 e	3.7	40.0	87.5	157.9	1,5
C <sub>7</sub> H <sub>9</sub> N	2,5-Dimethylpyridine			4 e	39 e	86.2	156.6	1
C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine			-3 e	29.9	75.8	143.6	1
C <sub>7</sub> H <sub>9</sub> N	3,4-Dimethylpyridine		-9 e	19 e	55 e	104.8	178.6	5
C <sub>7</sub> H <sub>9</sub> N	3,5-Dimethylpyridine			11 e	48 e	98 e	171.5	1
C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	Toluene-2,4- diamine			100.4	145.3	202.9	279.5	5
C <sub>7</sub> H <sub>12</sub>	1-Heptyne	-75 e	-57 e	-35 e	-5 e	37.1	99.5	5
C <sub>7</sub> H <sub>12</sub>	2-Heptyne		-51 e	-27 e	4 e	46.9	111.5	5
C <sub>7</sub> H <sub>12</sub>	3-Heptyne	-71 e	-53 e	-31 e	0 e	42.7	106.4	5
C <sub>7</sub> H <sub>12</sub>	5-Methyl-1-hexyne	-80 e	-62 e	-40 e	-11 e	30.1	91.4	5
C <sub>7</sub> H <sub>12</sub>	5-Methyl-2-hexyne	-75 e	-57 e	-34 e	-4 e	38.6	102.0	5
C <sub>7</sub> H <sub>12</sub>	2-Methyl-3-hexyne	-78 e	-61 e	-39 e	-9 e	32.6	94.8	5
C <sub>7</sub> H <sub>12</sub>	4,4-Dimethyl-1-pentyne		-73 e	-52 e	-24 e	15.9	75.6	5
C <sub>7</sub> H <sub>12</sub>	4,4-Dimethyl-2-pentyne		-70 e	-48 e	-19 e	21.4	82.6	5
C <sub>7</sub> H <sub>12</sub>	Bicyclo[4.1.0]heptane					49.9	116.3	5
C <sub>7</sub> H <sub>12</sub>	Cycloheptene			-30.0	3.4	47.5	108 e	5
C <sub>7</sub> H <sub>12</sub>	1-Methylbicyclo(3,1,0)hexane					29.8	92.6	5
C <sub>7</sub> H <sub>12</sub>	Methylenecyclohexane	-76 e	-58 e	-35 e	-5 e	38 e	103.0	5
C <sub>7</sub> H <sub>12</sub>	1-Methylcyclohexene	-72 e	-53 e	-30 e	1 e	45 e	109.8	5
C <sub>7</sub> H <sub>12</sub>	4-Methylcyclohexene	-76 e	-59 e	-36 e	-5 e	37.9	102.3	5
C <sub>7</sub> H <sub>12</sub>	1-Ethylcyclopentene	-75 e	-57 e	-34 e	-3 e	40.7	105.8	5
C <sub>7</sub> H <sub>12</sub>	1,2-Dimethylcyclopentene	-75 e	-57 e	-34 e	-3 e	40.2	105.3	5
C <sub>7</sub> H <sub>12</sub>	1,5-Dimethylcyclopentene	-77 e	-59 e	-36 e	-5.5	37.3	101.5	5
C <sub>7</sub> H <sub>12</sub> O	Cycloheptanone			18 e	53.7	104.0	178.7	5
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acrylate	-52 e	-31 e	-4.5	30.4	78.0	146.9	5
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Propyl methacrylate				26 e	73.8	139.7	5
C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	Ethyl levulinate		17 e	45.3	82.6	133.2	205.7	5
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl malonate	-23 e	4 e	36.0	76.4	128.5	198.3	5
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Dimethyl glutarate	-11 e	15 e	47 e	87.7	139.8	209.5	5
C <sub>7</sub> H <sub>13</sub> ClO	Heptanoyl chloride	-17 e	4 e	29.4	59.7	96.9	144.0	5
C <sub>7</sub> H <sub>14</sub>	1-Heptene	-82.1	-63.8	-40.6	-10.7	31.1	93.2	1,5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -2-Heptene	-79 e	-61 e	-38 e	-8 e	34.3	98.0	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -2-Heptene	-79 e	-61 e	-39 e	-8 e	34.0	97.5	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -3-Heptene	-80 e	-62 e	-40 e	-10 e	32.3	95.3	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -3-Heptene	-80 e	-62 e	-40 e	-10 e	32.2	95.2	5
C <sub>7</sub> H <sub>14</sub>	2-Methyl-1-hexene	-81 e	-64 e	-42 e	-12 e	29.3	91.6	5
C <sub>7</sub> H <sub>14</sub>	4-Methyl-1-hexene	-84 e	-67 e	-45 e	-16 e	25.3	86.3	5
C <sub>7</sub> H <sub>14</sub>	2-Methyl-2-hexene	-80 e	-63 e	-40 e	-10 e	32.0	95.0	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -3-Methyl-2-hexene	-79 e	-62 e	-39 e	-9 e	33.4	96.8	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -4-Methyl-2-hexene	-83 e	-66 e	-44 e	-15 e	25.9	87.1	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -5-Methyl-2-hexene	-83 e	-66 e	-44 e	-15 e	26.3	87.7	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -2-Methyl-3-hexene	-84 e	-67 e	-45 e	-16 e	24.6	85.5	5
C <sub>7</sub> H <sub>14</sub>	3-Ethyl-1-pentene	-85 e	-68 e	-46 e	-17 e	23.2	83.7	5
C <sub>7</sub> H <sub>14</sub>	2,3-Dimethyl-1-pentene	-85 e	-68 e	-46 e	-17 e	23.4	83.8	5
C <sub>7</sub> H <sub>14</sub>	2,4-Dimethyl-1-pentene	-88 e	-71 e	-50 e	-21 e	20.0	81.2	5
C <sub>7</sub> H <sub>14</sub>	3,3-Dimethyl-1-pentene	-87 e	-71 e	-50 e	-21 e	18.1	77.1	5
C <sub>7</sub> H <sub>14</sub>	4,4-Dimethyl-1-pentene	-94 e	-78 e	-57 e	-28 e	11.5	72.1	5
C <sub>7</sub> H <sub>14</sub>	2,3-Dimethyl-2-pentene	-79 e	-62 e	-39 e	-9 e	33.5	96.9	5
C <sub>7</sub> H <sub>14</sub>	2,4-Dimethyl-2-pentene	-84 e	-68 e	-46 e	-18 e	22.6	82.9	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -3,4-Dimethyl-2-pentene	-83 e	-65 e	-43 e	-14 e	27.2	88.8	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -3,4-Dimethyl-2-pentene	-82 e	-64 e	-42 e	-13 e	29.0	91.1	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -4,4-Dimethyl-2-pentene	-90 e	-73 e	-51 e	-22 e	18.6	80.0	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -4,4-Dimethyl-2-pentene	-90 e	-73 e	-52 e	-23 e	16.6	76.3	5
C <sub>7</sub> H <sub>14</sub>	2,3,3-Trimethyl-1-butene	-91 e	-75 e	-53 e	-24.2	16.3	77.5	5
C <sub>7</sub> H <sub>14</sub>	Cycloheptane				6 e	51.1	118.4	1
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	-79 e	-62 e	-39 e	-7.9	35.5	100.5	1
C <sub>7</sub> H <sub>14</sub>	Ethylcyclopentane	-76 e	-59 e	-35 e	-5 e	38.4	103.0	5
C <sub>7</sub> H <sub>14</sub>	1,1-Dimethylcyclopentane		-69 e	-47 e	-17 e	24.8	87.4	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -1,2-Dimethylcyclopentane			-38 e	-8 e	34.9	99.0	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -1,2-Dimethylcyclopentane	-83 e	-66 e	-43 e	-13 e	28.4	91.4	5
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -1,3-Dimethylcyclopentane	-84 e	-66 e	-44 e	-14 e	28.2	91.1	5
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -1,3-Dimethylcyclopentane	-84 e	-67 e	-44 e	-14 e	27.4	90.3	5
C <sub>7</sub> H <sub>14</sub> O	1-Heptanal	-41 e	-21 e	4 e	37 e	83.7	152.3	5
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone		-22 e	3 e	36 e	82.2	150.6	1
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone		-28 e	0 e	36 e	83.2	147.0	5
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone	-27 e	-6 e	18.8	50.2	90.3	143.4	5
C <sub>7</sub> H <sub>14</sub> O	5-Methyl-2-hexanone		-27 e	-2 e	31.0	76.6	144.4	5
C <sub>7</sub> H <sub>14</sub> O	2,4-Dimethyl-3-pentanone	-61 e	-42 e	-18 e	14 e	58.5	124.8	1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid	24 e	46 e	72 e	107 e	154.6	222.6	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Pentyl acetate	-58 e	-39 e	-14 e	20 e	70.1	149 e	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopentyl acetate	-51 e	-30 e	-4 e	30.3	76.2	141.4	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isobutyl propanoate	-35 e	-19 e	2 e	31 e	72.0	136.1	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Propyl butanoate	-35 e	-19 e	3 e	32.0	74.9	142.8	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Propyl isobutanoate		-28 e	-5.7	24.5	67.5	133.3	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopropyl isobutanoate		-44 e	-19.7	12.2	56.0	120.1	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl 3-methylbutanoate	-57 e	-36 e	-10 e	23.9	69.5	134.4	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Methyl hexanoate	-47 e	-26 e	2 e	36.6	83.3	149 e	5
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	4-Methoxy-4-methyl-2-pentanone			43 e	89.8	160 e	5	
C <sub>7</sub> H <sub>15</sub> Br	1-Bromoheptane	-30 e	-9 e	18 e	54 e	104.4	178.4	5
C <sub>7</sub> H <sub>15</sub> Cl	1-Chloroheptane	-39 e	-19 e	7 e	41 e	88.6	159.9	5
C <sub>7</sub> H <sub>15</sub> F	1-Fluoroheptane	-64 e	-45 e	-22 e	10 e	53.3	117.4	5
C <sub>7</sub> H <sub>15</sub> I	1-Iodoheptane	-19 e	3 e	32 e	71 e	123.8	203.4	5
C <sub>7</sub> H <sub>16</sub>	Heptane	-78.6	-60.2	-37.0	-6.6	35.4	98.0	16
C <sub>7</sub> H <sub>16</sub>	2-Methylhexane	-82 e	-65 e	-43 e	-13 e	27.8	89.7	1
C <sub>7</sub> H <sub>16</sub>	3-Methylhexane	-81 e	-64 e	-42 e	-12 e	29.2	91.5	1
C <sub>7</sub> H <sub>16</sub>	3-Ethylpentane	-81 e	-63 e	-41 e	-11 e	30.5	93.1	1
C <sub>7</sub> H <sub>16</sub>	2,2-Dimethylpentane	-90 e	-73 e	-52 e	-22.9	17.6	78.8	1
C <sub>7</sub> H <sub>16</sub>	2,3-Dimethylpentane	-87 e	-68.4	-45.3	-14.9	26.8	89.3	5
C <sub>7</sub> H <sub>16</sub>	2,4-Dimethylpentane	-89 e	-72 e	-50 e	-21.3	19.2	80.1	1
C <sub>7</sub> H <sub>16</sub>	3,3-Dimethylpentane	-88 e	-71 e	-49 e	-18.8	22.9	85.6	1
C <sub>7</sub> H <sub>16</sub>	2,2,3-Trimethylbutane				-23.2	18.1	80.4	5
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol		17 e	40 e	70.1	112.5	176 e	1
C <sub>7</sub> H <sub>16</sub> O	2-Heptanol	-9 e	7 e	27 e	55.0	95.2	158.7	5
C <sub>7</sub> H <sub>16</sub> O	3-Heptanol	-8 e	7 e	27 e	54.5	93.9	156.3	5
C <sub>7</sub> H <sub>16</sub> O	4-Heptanol	-16 e	1 e	22 e	51 e	91.9	154.6	5
C <sub>7</sub> H <sub>16</sub> O	2,2-Dimethyl-3-pentanol			9 e	35 e	73.1	135.5	5
C <sub>7</sub> H <sub>16</sub> S	1-Heptanethiol	-30 e	-9 e	18 e	53 e	102.7	176.4	5
C <sub>7</sub> H <sub>17</sub> N	Heptylamine			5 e	39 e	86.7	156.4	5
C <sub>7</sub> H <sub>18</sub> N <sub>2</sub>	<i>N,N</i> -Diethyl-1,3-propanediamine			50.1	99.9	167.7	5	
C <sub>8</sub> F <sub>18</sub>	Perfluorooctane			5 e	45.0	105.6	5	
C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	Phthalic anhydride	48.2 s	72.4 s			192.7	284.2	5
C <sub>8</sub> H <sub>6</sub> O	Benzofuran		-16 e	12 e	47.9	97.7	170.7	5
C <sub>8</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorostyrene	-33 e	-10 e	20 e	58 e	110.8	188 e	5
C <sub>8</sub> H <sub>7</sub> N	2-Methylbenzotrile		1 e	32.1	72.2	126.6	204.7	5
C <sub>8</sub> H <sub>7</sub> N	4-Methylbenzotrile			40.1	78.7	134.3	221.3	5
C <sub>8</sub> H <sub>7</sub> N	Benzeneacetonitrile	-3 e	23 e	55.3	97.4	153.7	233.1	5
C <sub>8</sub> H <sub>7</sub> N	Indole	20.6 s	44.5 s				254.0	5
C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	Methyl 2-nitrobenzoate	17 e	49 e	89 e	140 e	208 e	302 e	5
C <sub>8</sub> H <sub>8</sub>	Styrene		-31 e	-5 e	28.6	75.4	144.7	1
C <sub>8</sub> H <sub>8</sub>	1,3,5,7-Cyclooctatetraene				24.3	71.0	140.1	5
C <sub>8</sub> H <sub>8</sub> O	Acetophenone			36 e	73 e	125.3	201.5	5
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Phenyl acetate		3 e	33.1	72.2	123.9	195.5	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate		-1 e	29 e	68 e	121.2	198.9	5
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	4-Methoxybenzaldehyde	9 e	35 e	68.1	110.8	167.9	248.5	5
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Methyl salicylate	-1 e	22 e	51 e	88.8	141.8	219.9	5
C <sub>8</sub> H <sub>9</sub> Cl	1-Chloro-2-ethylbenzene	-30 e	-9 e	18 e	54 e	103.7	177.9	5
C <sub>8</sub> H <sub>9</sub> Cl	1-Chloro-4-ethylbenzene	-27 e	-6 e	22 e	58 e	108.7	183.9	5
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	1-Ethyl-4-nitrobenzene	10 e	36 e	69 e	111.6	168 e	245 e	5
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	-56.2	-36.8	-12.0	21.1	67.1	135.7	1
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene			-7 e	27 e	74.2	143.9	1
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene		-35 e	-10 e	23.4	69.8	138.7	1
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene				22.4	68.9	137.9	1
C <sub>8</sub> H <sub>10</sub> O	<i>o</i> -Ethylphenol		16.9	44.5	81.1	130.9	204.0	5
C <sub>8</sub> H <sub>10</sub> O	<i>m</i> -Ethylphenol	5.6	29.2	57.5	91.9	144.8	217.9	5
C <sub>8</sub> H <sub>10</sub> O	<i>p</i> -Ethylphenol			60 e	95.5	144.6	217.5	5
C <sub>8</sub> H <sub>10</sub> O	2,3-Xylenol	14.3 s	34.3 s	57.2 s	91.4	141.7	216.4	1,5
C <sub>8</sub> H <sub>10</sub> O	2,4-Xylenol			50.2	85.5	137.2	210.5	1,5
C <sub>8</sub> H <sub>10</sub> O	2,5-Xylenol	13.4 s	33.2 s	55.9 s	87.4	137.0	210.6	5
C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	-3.1 s	16.7 s	39.6 s	75.3	125.9	200.6	1,5
C <sub>8</sub> H <sub>10</sub> O	3,4-Xylenol	19.7 s	40.2 s	63.7 s	102.1	152.3	226.4	1,5
C <sub>8</sub> H <sub>10</sub> O	3,5-Xylenol	16.5 s	37.2 s	61.1 s	98.0	147.9	221.3	1,5
C <sub>8</sub> H <sub>10</sub> O	Benzeneethanol	2 e	25 e	54 e	92 e	143.6	217.7	5
C <sub>8</sub> H <sub>10</sub> O	Phenetole		-9 e	17 e	51 e	99 e	169.3	5
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	2-Phenoxyethanol	21 e	46 e	75.9	115.4	168.7	244.8	5
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Dimethoxybenzene	18 e	34 e	56 e	86.7	135.5	223 e	5
C <sub>8</sub> H <sub>11</sub> N	<i>p</i> -Ethylaniline	-2 e	21 e	49 e	87 e	139.4	216.7	5
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline	-15 e	8 e	38 e	76.4	128.8	204.2	5
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline			28 e	66 e	118.1	193.6	1
C <sub>8</sub> H <sub>11</sub> N	2,4-Xylidine	-2 e	21 e	51 e	88 e	139.1	210.9	5
C <sub>8</sub> H <sub>11</sub> N	2,6-Xylidine			37 e	80 e	137.7	217.7	5
C <sub>8</sub> H <sub>11</sub> N	5-Ethyl-2-picoline	-33 e	-9.3	20 e			178.0	5
C <sub>8</sub> H <sub>11</sub> NO	<i>o</i> -Phenetidine	0 e	27 e	60 e	102.2	156.0	228.1	5
C <sub>8</sub> H <sub>12</sub>	1,5-Cyclooctadiene		-37 e	-8 e	30 e	80.2	150 e	5
C <sub>8</sub> H <sub>12</sub>	4-Vinylcyclohexene	-62 e	-43 e	-19 e	14.1	59.9	129 e	5
C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl maleate	-6 e	20 e	52.2	93.5	148.4	224.8	5
C <sub>8</sub> H <sub>14</sub>	2,5-Dimethyl-1,5-hexadiene	-38 e	-26 e	-10 e	14 e	50.8	115.1	5
C <sub>8</sub> H <sub>14</sub>	1-Octyne	-59 e	-40 e	-16 e	16 e	60.3	125.8	1
C <sub>8</sub> H <sub>14</sub>	2-Octyne	-52 e	-33 e	-8 e	25 e	70.6	137.8	1
C <sub>8</sub> H <sub>14</sub>	3-Octyne	-55 e	-35 e	-11 e	22 e	66.8	132.8	1
C <sub>8</sub> H <sub>14</sub>	4-Octyne	-56 e	-36 e	-12 e	21 e	65.6	131.4	1
C <sub>8</sub> H <sub>14</sub>	1-Ethylcyclohexene	-55 e	-35 e	-11 e	22 e	68 e	136.5	5
C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	Cyclohexyl acetate					103.1	172.9	5
C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	Butyl methacrylate				47 e	93.3	159.0	5
C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	Butanoic anhydride	-28 e	-2 e	30 e	71 e	123.8	196.5	5
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Ethyl succinate	-6 e	20 e	51.0	91.1	143.7	216.1	5
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Dipropyl oxalate	-4 e	20 e	49.9	88.6	140.4	213.0	5
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Dimethyl adipate		28 e	61 e	103 e	156.1	227.3	5
C <sub>8</sub> H <sub>15</sub> Br	(2-Bromoethyl)cyclohexane	-14 e	8 e	36.9	75.3	129.7	212.5	5
C <sub>8</sub> H <sub>15</sub> ClO	Octanoyl chloride	1 e	22 e	46 e	74.7	109 e	150 e	5
C <sub>8</sub> H <sub>15</sub> N	Octanenitrile	-15 e	8 e	37 e	75 e	127.7	204.4	5
C <sub>8</sub> H <sub>16</sub>	1-Octene	-65.7	-46.1	-21.4	10.5	54.9	120.9	1,5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -2-Octene	-59 e	-41 e	-17 e	15 e	59 e	125.2	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -2-Octene	-59 e	-41 e	-17 e	14 e	59 e	124.5	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -3-Octene	-65 e	-46 e	-22 e	10 e	55.1	122.4	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -3-Octene	-61 e	-43 e	-19 e	13 e	57 e	122.8	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -4-Octene	-63 e	-44 e	-20 e	11 e	56 e	122.1	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -4-Octene	-65 e	-46 e	-22 e	10 e	54.6	121.8	5
C <sub>8</sub> H <sub>16</sub>	2-Methyl-1-heptene	-66 e	-48 e	-24 e	8 e	52.3	118.7	5
C <sub>8</sub> H <sub>16</sub>	2,2-Dimethyl- <i>cis</i> -3-hexene	-74 e	-56 e	-33 e	-3 e	40.1	105.0	5
C <sub>8</sub> H <sub>16</sub>	2,3-Dimethyl-2-hexene	-65 e	-47 e	-23 e	10 e	54.3	121.3	5
C <sub>8</sub> H <sub>16</sub>	2,3,3-Trimethyl-1-pentene		-53 e	-30 e	1 e	43.8	107.9	5
C <sub>8</sub> H <sub>16</sub>	2,4,4-Trimethyl-1-pentene	-79 e	-61 e	-38 e	-7 e	36.2	101.0	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>8</sub> H <sub>16</sub>	2,3,4-Trimethyl-2-pentene	-68 e	-49 e	-26 e	6 e	50.0	115.8	5
C <sub>8</sub> H <sub>16</sub>	2,4,4-Trimethyl-2-pentene	-73 e	-56 e	-33 e	-2 e	40.4	104.5	5
C <sub>8</sub> H <sub>16</sub>	Cyclooctane				30 e	78 e	150.7	1
C <sub>8</sub> H <sub>16</sub>	Ethylcyclohexane	-61 e	-42 e	-17 e	15.8	61.9	131.3	5
C <sub>8</sub> H <sub>16</sub>	1,1-Dimethylcyclohexane			-27 e	5 e	50.6	119.1	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,2-Dimethylcyclohexane		-44 e	-20 e	14 e	59.7	129.2	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,2-Dimethylcyclohexane	-68 e	-49 e	-25 e	8 e	53.9	122.9	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,3-Dimethylcyclohexane	-68 e	-48 e	-23 e	10 e	55.6	123.1	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,3-Dimethylcyclohexane	-62 e	-45 e	-23 e	8 e	51.5	120.9	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,4-Dimethylcyclohexane	-66 e	-47 e	-23 e	10 e	55.3	123.8	5
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,4-Dimethylcyclohexane			-27 e	5 e	50.6	118.9	5
C <sub>8</sub> H <sub>16</sub>	Propylcyclopentane	-60 e	-41 e	-16 e	16.5	62.1	130.5	5
C <sub>8</sub> H <sub>16</sub>	Isopropylcyclopentane	-65 e	-46 e	-21 e	12 e	57.3	125.9	5
C <sub>8</sub> H <sub>16</sub>	1-Ethyl-1-methylcyclopentane	-67 e	-49 e	-24 e	8 e	53.2	121.0	5
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1-Ethyl-2-methylcyclopentane	-63 e	-44 e	-19 e	13.3	59.1	127.6	5
C <sub>8</sub> H <sub>16</sub>	1,1,2-Trimethylcyclopentane				2 e	46.2	113.2	5
C <sub>8</sub> H <sub>16</sub>	1,1,3-Trimethylcyclopentane	-77 e	-59 e	-36 e	-5 e	38.7	104.4	5
C <sub>8</sub> H <sub>16</sub>	1',2',4a-1,2,4-Trimethylcyclo-pentane	-70 e	-52 e	-28 e	4 e	48.9	116.2	5
C <sub>8</sub> H <sub>16</sub>	1',2a,4'-1,2,4-Trimethylcyclo-pentane	-74 e	-56 e	-33 e	-1 e	42.8	108.8	5
C <sub>8</sub> H <sub>16</sub> O	1-Propylcyclopentanol	9 e	24 e	43 e	69.0	108.4	173.5	5
C <sub>8</sub> H <sub>16</sub> O	Octanal			6 e	45.7	97.8	170.2	5
C <sub>8</sub> H <sub>16</sub> O	2-Octanone		-3 e	23 e	57 e	103.8	172.1	5
C <sub>8</sub> H <sub>16</sub> O	3-Octanone			8 e	47.7	97 e	161 e	5
C <sub>8</sub> H <sub>16</sub> O	2,2,4-Trimethyl-3-pentanone			11.3	42.1	81.7	134.6	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid	37 e	58 e	85 e	120 e	165.5	238.4	1,5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	2-Ethylhexanoic acid				108 e	159.6	226.6	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Hexyl acetate	-37 e	-13 e	16 e	52.8	100.4	164 e	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Isopentyl propanoate			3.1	40.7	90.6	159.8	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Isobutyl isobutanoate	-47 e	-26 e	0.4	34.8	81.1	147.0	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Propyl 3-methylbutanoate			1.8	38.9	87.9	155.6	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Ethyl hexanoate	-31 e	-9 e	18.7	53.9	100.7	166.2	5
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Methyl heptanoate	-30 e	-9 e	19 e	54.2	102.4	172 e	5
C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	Diethylene glycol monoethyl ether acetate	-16 e	10.6	43.9	86.2	141.3	216.6	5
C <sub>8</sub> H <sub>17</sub> Br	1-Bromooctane	-17 e	6 e	34 e	72 e	123.8	200.3	5
C <sub>8</sub> H <sub>17</sub> Cl	1-Chlorooctane	-25 e	-4 e	23 e	59 e	108.8	182.9	5
C <sub>8</sub> H <sub>17</sub> Cl	3-(Chloromethyl)heptane					100.3	172.4	5
C <sub>8</sub> H <sub>17</sub> F	1-Fluorooctane				29 e	74.6	141.8	5
C <sub>8</sub> H <sub>17</sub> I	1-Iodoctane	-6 e	18 e	48 e	87 e	142.5	224.5	5
C <sub>8</sub> H <sub>18</sub>	Octane		-42.6	-17.9	14.4	58.9	125.3	16
C <sub>8</sub> H <sub>18</sub>	2-Methylheptane	-69 e	-49.1	-24.5	7.6	51.6	117.2	1,5
C <sub>8</sub> H <sub>18</sub>	3-Methylheptane	-67 e	-48.1	-23.6	8.5	52.7	118.5	1,5
C <sub>8</sub> H <sub>18</sub>	4-Methylheptane	-65 e	-47 e	-24 e	7.8	51.6	117.2	5
C <sub>8</sub> H <sub>18</sub>	3-Ethylhexane				8 e	52.1	118.1	5
C <sub>8</sub> H <sub>18</sub>	2,2-Dimethylhexane	-73 e	-55 e	-32 e	-1.5	41.6	106.4	5
C <sub>8</sub> H <sub>18</sub>	2,3-Dimethylhexane				5 e	49.2	115.1	5
C <sub>8</sub> H <sub>18</sub>	2,4-Dimethylhexane				0.6	43.9	109.0	5
C <sub>8</sub> H <sub>18</sub>	2,5-Dimethylhexane	-71 e	-53 e	-30 e	0.7	43.8	108.6	5
C <sub>8</sub> H <sub>18</sub>	3,3-Dimethylhexane	-72 e	-54 e	-30 e	1.4	45.4	111.5	5
C <sub>8</sub> H <sub>18</sub>	3,4-Dimethylhexane				7 e	50.9	117.3	5
C <sub>8</sub> H <sub>18</sub>	3-Ethyl-2-methylpentane	-69 e	-50 e	-27 e	5 e	48.9	115.2	5
C <sub>8</sub> H <sub>18</sub>	3-Ethyl-3-methylpentane	-70 e	-51 e	-27 e	5 e	50.2	117.8	5
C <sub>8</sub> H <sub>18</sub>	2,2,3-Trimethylpentane	-74 e	-56 e	-32 e	-0.8	43.1	109.4	5
C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	-81.9	-63.4	-39.8	-8.9	34.0	98.8	5
C <sub>8</sub> H <sub>18</sub>	2,3,3-Trimethylpentane	-72 e	-54 e	-30 e	2.1	46.9	114.3	5
C <sub>8</sub> H <sub>18</sub>	2,3,4-Trimethylpentane	-74 e	-54.5	-30.0	2.2	46.7	113.1	1,5
C <sub>8</sub> H <sub>18</sub>	2,2,3,3-Tetramethylbutane	-62.5 s	-44 s	-20.9 s	8.9 s	48.8 s	105.8	5
C <sub>8</sub> H <sub>18</sub> O	1-Octanol	12 e	30 e	53 e	84 e	128.2	194.8	1,39
C <sub>8</sub> H <sub>18</sub> O	2-Octanol			40 e	69.9	112.5	179.4	1,39
C <sub>8</sub> H <sub>18</sub> O	3-Octanol	12 e	24 e	40 e	64 e	102.8	174.1	1

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>8</sub> H <sub>18</sub> O	4-Octanol			40 e	66.9	107.3	176.0	1,39
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-3-heptanol	-52 e	-28 e	1 e	39 e	87.6	155.0	5
C <sub>8</sub> H <sub>18</sub> O	5-Methyl-3-heptanol	-35 e	-16 e	8 e	40 e	84.8	153.0	5
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-4-heptanol	-17 e	1 e	24 e	55 e	97.2	160.7	5
C <sub>8</sub> H <sub>18</sub> O	2-Ethyl-1-hexanol			45 e	75 e	118.3	184.2	1
C <sub>8</sub> H <sub>18</sub> O	2-Ethyl-2-hexanol	-13 e	4 e	26 e	55 e	96.3	160.3	5
C <sub>8</sub> H <sub>18</sub> O	2,4,4-Trimethyl-2-pentanol		-7 e	13 e	40 e	79.8	146.1	5
C <sub>8</sub> H <sub>18</sub> O	2,2,4-Trimethyl-3-pentanol	-2 e	9 e	24 e	47 e	82.6	150.4	5
C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether	-55 e	-35 e	-8 e	26 e	73.0	141.2	5
C <sub>8</sub> H <sub>18</sub> O	Di- <i>sec</i> -butyl ether			-19 e	12.1	55.4	120.6	5
C <sub>8</sub> H <sub>18</sub> O	Di- <i>tert</i> -butyl ether			-33 e	-2 e	41.7	106.8	1
C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	Ethylene glycol monohexyl ether	-13 e	14 e	46 e	86 e	137.7	206.9	5
C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	1,2-Dipropoxyethane			-44.2	-2.0	63.6	179.2	5
C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	Di- <i>tert</i> -butyl peroxide			-26 e	4.3	46.6	110.5	5
C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Diethylene glycol monobutyl ether	14 e	37 e	66.8	104.9	153 e	230.4	5
C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Diethylene glycol diethyl ether	-32 e	-7 e	25 e	64.9	117.1	189 e	5
C <sub>8</sub> H <sub>18</sub> O <sub>5</sub>	Tetraethylene glycol	89 e	117 e	151.1	192.2	242.9	307.3	5
C <sub>8</sub> H <sub>18</sub> S	1-Octanethiol	-15 e	6 e	34 e	71 e	122.1	198.5	5
C <sub>8</sub> H <sub>18</sub> S	Dibutyl sulfide	-22 e	0 e	27 e	63 e	113.5	188.4	5
C <sub>8</sub> H <sub>19</sub> N	Dibutylamine	-37 e	-16 e	10 e	44 e	90.8	159.1	5
C <sub>8</sub> H <sub>19</sub> N	Diisobutylamine	-57 e	-36 e	-9.0	25.5	72.2	139.0	5
C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si	Ethyl silicate	-77 e	-52 e	-21 e	21.6	80.5	164.1	5
C <sub>8</sub> H <sub>20</sub> Si	Tetraethylsilane			-6.5	30.5	80.6	152.6	5
C <sub>9</sub> F <sub>20</sub>	Perfluorononane					40 e	114.7	5
C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	Toluene-2,4-diisocyanate		39 e	72 e	113.9	169.7	247 e	5
C <sub>9</sub> H <sub>7</sub> N	Quinoline	-1.3	23.7	55.4	96.8	153.4	236.5	1,5
C <sub>9</sub> H <sub>7</sub> N	Isoquinoline		30.2	60.7	101.3	157.9	242.7	1,5
C <sub>9</sub> H <sub>8</sub>	Indene			12 e	53.0	106.8	181.0	5
C <sub>9</sub> H <sub>10</sub>	<i>cis</i> -1-Propenylbenzene	-38 e	-15.4	13.3	51.4	103.7	178.4	5
C <sub>9</sub> H <sub>10</sub>	<i>trans</i> -1-Propenylbenzene		-16 e	13.3	51.6	103.7	178.4	5
C <sub>9</sub> H <sub>10</sub>	Isopropenylbenzene			3.2	41.5	92.8	164.9	5
C <sub>9</sub> H <sub>10</sub>	Indan	-33 e	-12 e	16 e	52 e	102.3	177.5	1
C <sub>9</sub> H <sub>10</sub> O	2,4-Dimethylbenzaldehyde	-3 e	23 e	54 e	93.2	144.6	214.5	5
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate	-18 e	8 e	39 e	80.1	135.1	212.8	5
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzyl acetate	-11 e	15 e	46.6	86.9	139.5	211 e	5
C <sub>9</sub> H <sub>11</sub> Br	1-Bromo-4-isopropylbenzene	-8 e	15 e	45 e	84 e	138.1	218.5	5
C <sub>9</sub> H <sub>11</sub> Cl	1-Chloro-2-isopropylbenzene	-23 e	-1 e	27 e	64 e	114.6	190.5	5
C <sub>9</sub> H <sub>11</sub> Cl	1-Chloro-4-isopropylbenzene		3 e	31 e	69 e	120.5	197.8	5
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	-43 e	-23 e	4 e	38 e	86.7	158.8	1
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	-46 e	-26 e	-1 e	33 e	80.9	152.0	1
C <sub>9</sub> H <sub>12</sub>	<i>o</i> -Ethyltoluene	-40 e	-19 e	8 e	43 e	92.1	164.7	5
C <sub>9</sub> H <sub>12</sub>	<i>m</i> -Ethyltoluene	-42 e	-21 e	5 e	40.4	88.9	160.8	5
C <sub>9</sub> H <sub>12</sub>	<i>p</i> -Ethyltoluene	-41 e	-21 e	6 e	41 e	89.2	161.5	5
C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene		-12 e	15 e	52 e	101.5	175.6	1
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene	-37 e	-16 e	11 e	47 e	95.9	168.9	1
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	-39 e	-18 e	9 e	43.7	92.4	164.3	1
C <sub>9</sub> H <sub>12</sub> O	Benzyl ethyl ether		-10 e	20.4	59.3	111.3	184.5	5
C <sub>9</sub> H <sub>12</sub> O	Phenyl propyl ether		-10 e	21 e	61 e	113.9	189.3	5
C <sub>9</sub> H <sub>12</sub> O	Phenyl isopropyl ether	-20 e	-1 e	23 e	56 e	103.7	176.9	5
C <sub>9</sub> H <sub>13</sub> N	2,4,6-Trimethylaniline	12 e	36 e	66 e	104.1	154.9	226 e	5
C <sub>9</sub> H <sub>13</sub> N	<i>N,N</i> -Dimethyl- <i>o</i> -toluidine	-25 e	-3 e	24.4	60.6	110.7	184.5	5
C <sub>9</sub> H <sub>13</sub> N	Amphetamine			33 e	70.1	118 e	202.0	5
C <sub>9</sub> H <sub>14</sub> O	Isophorone		1 e	33.1	75.1	132.4	215.1	5
C <sub>9</sub> H <sub>14</sub> O <sub>6</sub>	Triacetin	37.6	62 e	90 e	124 e	165 e	214 e	5
C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	Diethyl glutarate	-1 e	26 e	60.2	103.3	159.6	236.5	5
C <sub>9</sub> H <sub>17</sub> N	Nonanenitrile	-3 e	21 e	50.9	90.7	145.4	225.1	5
C <sub>9</sub> H <sub>18</sub>	1-Nonene	-50.1	-29.4	-3.3	30.4	77.1	146.4	1,5
C <sub>9</sub> H <sub>18</sub>	2-Methyl-1-octene	-53 e	-34 e	-9 e	25 e	72 e	144.1	5
C <sub>9</sub> H <sub>18</sub>	Butylcyclopentane	-45 e	-24 e	1 e	36 e	84 e	156.1	5
C <sub>9</sub> H <sub>18</sub>	Propylcyclohexane	-46 e	-26 e	0 e	35.1	83.6	156.2	5



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>9</sub> H <sub>18</sub>	Isopropylcyclohexane	-48 e	-28 e	-2 e	33 e	81.3	154.0	5
C <sub>9</sub> H <sub>18</sub>	<i>trans</i> -1-Ethyl-4-methylcyclo-hexane	-53 e	-33 e	-8 e	25 e	71.8	141.5	5
C <sub>9</sub> H <sub>18</sub>	1,1,2-Trimethylcyclohexane			-12 e	23 e	71.5	145.5	5
C <sub>9</sub> H <sub>18</sub>	1,1,3-Trimethylcyclohexane	-60 e	-41 e	-16 e	18 e	65.2	136.1	5
C <sub>9</sub> H <sub>18</sub>	1',2a,4a-1,2,4-Trimethylcyclo-hexane	-71 e	-50 e	-22 e	15 e	65.7	140.7	5
C <sub>9</sub> H <sub>18</sub>	1',3',5'-1,3,5-Trimethylcyclo-hexane	-72 e	-50 e	-22 e	14 e	65.1	140.0	5
C <sub>9</sub> H <sub>18</sub>	Isobutylcyclopentane	-105 e	-88 e	-64 e	-28 e	31 e	147.0	5
C <sub>9</sub> H <sub>18</sub>	<i>cis</i> -1-Methyl-2-propylcyclo-pentane	-52 e	-33 e	-7 e	28 e	77 e	152.0	5
C <sub>9</sub> H <sub>18</sub>	<i>trans</i> -1-Methyl-2-propylcyclo-pentane	-56 e	-36 e	-11 e	23 e	72 e	145.8	5
C <sub>9</sub> H <sub>18</sub>	1,1,3,3-Tetramethylcyclo-pentane	-72 e	-54 e	-30 e	2 e	47 e	117.4	5
C <sub>9</sub> H <sub>18</sub> O	Nonanal		-3 e	27.4	65.5	115.6	184.6	5
C <sub>9</sub> H <sub>18</sub> O	2-Nonanone		8 e	35 e	71 e	121.0	194.0	5
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone			-1 e	39.1	94 e	188 e	5
C <sub>9</sub> H <sub>18</sub> O	2,6-Dimethyl-4-heptanone	-32 e	-12 e	14 e	48 e	96.2	167.7	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid	48 e	69 e	97 e	133 e	182.7	255.1	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Heptyl acetate	-16 e	6 e	34 e	70 e	119.9	191.9	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Isopentyl butanoate				55 e	105.6	178.4	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Isobutyl 3-methylbutanoate			11.3	48.3	97.9	168.3	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Propyl hexanoate	-26 e	-2 e	28 e	65.1	113.4	178 e	5
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Methyl octanoate	-26 e	-9 e	13 e	40 e	76 e	127.9	5
C <sub>9</sub> H <sub>19</sub> Cl	1-Chlorononane	-11 e	11 e	39 e	76 e	127.8	204.7	5
C <sub>9</sub> H <sub>20</sub>	Nonane	-46.8	-26.0	0.0	34.0	80.8	150.3	16
C <sub>9</sub> H <sub>20</sub>	2-Methyloctane	-49 e	-30 e	-5 e	28 e	73.9	142.8	5
C <sub>9</sub> H <sub>20</sub>	3-Methyloctane	-49 e	-29 e	-5 e	29 e	74.7	143.7	5
C <sub>9</sub> H <sub>20</sub>	4-Methyloctane	-50 e	-30 e	-6 e	27 e	73.2	141.9	5
C <sub>9</sub> H <sub>20</sub>	2,2-Dimethylheptane	-58 e	-39 e	-15 e	18 e	63.6	132.3	5
C <sub>9</sub> H <sub>20</sub>	2,3-Dimethylheptane	-53 e	-33 e	-9 e	25 e	70.8	140.0	5
C <sub>9</sub> H <sub>20</sub>	2,6-Dimethylheptane	-55 e	-36 e	-12 e	21 e	66.4	134.7	5
C <sub>9</sub> H <sub>20</sub>	3-Ethyl-4-methylhexane			-9 e	24 e	70.6	139.9	5
C <sub>9</sub> H <sub>20</sub>	2,2,4-Trimethylhexane	-66.1	-46.4	-21.3	11.8	57.7	126.0	5
C <sub>9</sub> H <sub>20</sub>	2,2,5-Trimethylhexane	-65.1	-45.8	-21.2	11.2	56.2	123.7	1,5
C <sub>9</sub> H <sub>20</sub>	2,3,3-Trimethylhexane	-58 e	-38 e	-13 e	20 e	66.7	137.2	5
C <sub>9</sub> H <sub>20</sub>	2,3,5-Trimethylhexane	-60 e	-41 e	-16 e	17 e	62.3	130.9	5
C <sub>9</sub> H <sub>20</sub>	2,4,4-Trimethylhexane	-62 e	-43 e	-18 e	15 e	61.0	130.2	5
C <sub>9</sub> H <sub>20</sub>	3,3,4-Trimethylhexane	-53 e	-33 e	-7 e	28 e	76.3	148.9	5
C <sub>9</sub> H <sub>20</sub>	3,3-Diethylpentane			-9 e	26 e	73.7	145.7	1
C <sub>9</sub> H <sub>20</sub>	3-Ethyl-2,4-dimethylpentane	-58 e	-38 e	-13 e	20 e	66.7	136.2	5
C <sub>9</sub> H <sub>20</sub>	2,2,3,3-Tetramethylpentane			21 e	68.5	139.8	139.8	1
C <sub>9</sub> H <sub>20</sub>	2,2,3,4-Tetramethylpentane	-61 e	-42 e	-17 e	16 e	62.5	132.6	1
C <sub>9</sub> H <sub>20</sub>	2,2,4,4-Tetramethylpentane		-49 e	-25 e	8 e	53.2	121.8	1
C <sub>9</sub> H <sub>20</sub>	2,3,3,4-Tetramethylpentane	-57 e	-37 e	-12 e	22 e	69.7	141.1	1
C <sub>9</sub> H <sub>20</sub> O	1-Nonanol		40 e	64 e	96.9	141.0	213.0	5,39
C <sub>9</sub> H <sub>20</sub> O	3-Nonanol		24 e	47 e	78 e	123.0	194.2	5
C <sub>9</sub> H <sub>20</sub> O	4-Nonanol			45 e	76.4	121.3	192.0	5
C <sub>9</sub> H <sub>20</sub> O	5-Nonanol	13 e	31 e	54 e	84.5	128.1	194.7	5
C <sub>9</sub> H <sub>20</sub> O	2,2,4,4-Tetramethyl-3-pentanol				58	100	167	5
C <sub>9</sub> H <sub>20</sub> S	1-Nonanethiol	-2 e	21 e	49 e	87 e	140.4	219.2	5
C <sub>9</sub> H <sub>21</sub> BO <sub>3</sub>	Triisopropyl borate					73.1	139.0	5
C <sub>9</sub> H <sub>21</sub> N	Nonylamine		9 e	37 e	75 e	126.2	202.1	5
C <sub>9</sub> H <sub>21</sub> N	Tripropylamine	-39 e	-18 e	8 e	42 e	88.2	156.0	5
C <sub>10</sub> F <sub>8</sub>	Perfluoronaphthalene	5.2 s	25.1 s	48.1 s				5
C <sub>10</sub> F <sub>22</sub>	Perfluorodecane					52 e	132.9	5
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene	17 e	45 e	80.3	126.7	189.8	280.5	5
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene	14 e	39 e	70.5	112.8	171.6	258.6	5
C <sub>10</sub> H <sub>8</sub>	Naphthalene**	3.2 s	24.1 s	49.3 s	80.7	135.6	217.5	1,5
C <sub>10</sub> H <sub>8</sub>	Azulene	24.1 s	46 s	71.5 s	103.3	162.6	244.0	5
C <sub>10</sub> H <sub>8</sub> O	1-Naphthol				137.2	196.7	281.8	5
C <sub>10</sub> H <sub>8</sub> O	2-Naphthol				140.7	200.5	286.8	5
C <sub>10</sub> H <sub>9</sub> N	1-Naphthalenamine		62 e	99.0	146.9	210.7	300.1	5
C <sub>10</sub> H <sub>9</sub> N	2-Naphthalenamine	36.3 s	65.9 s	103 s	150.9	215.1	305.5	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>10</sub> H <sub>9</sub> N	2-Methylquinoline	5.3	31.9	63.8	102.9	165.8	247.2	5
C <sub>10</sub> H <sub>9</sub> N	4-Methylquinoline	29 e	54 e	85 e	127 e	183.0	265.1	5
C <sub>10</sub> H <sub>9</sub> N	6-Methylquinoline	27 e	51 e	81 e	122 e	179.2	264.5	5
C <sub>10</sub> H <sub>9</sub> N	8-Methylquinoline	15 e	40 e	70 e	111 e	166.1	247.3	5
C <sub>10</sub> H <sub>10</sub>	<i>m</i> -Divinylbenzene	-29 e	-4 e	27.1	67.6	122.1	199 e	5
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl phthalate	27 e	56 e	92.7	137.8	195.8	272.7	5
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl isophthalate			85 e	129.5	189.2	273 e	5
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl terephthalate	56.6 s	79.4 s	106.1 s	137.9 s	197.9	282 e	5
C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	-21 e	3 e	33.2	74.1	127.4	207.8	5
C <sub>10</sub> H <sub>12</sub>	2-Ethylstyrene	-31 e	-8 e	21 e	60 e	111.7	187 e	5
C <sub>10</sub> H <sub>12</sub>	3-Ethylstyrene	-28 e	-5.3	24.1	62.6	116 e	193 e	5
C <sub>10</sub> H <sub>12</sub>	4-Ethylstyrene	-31 e	-8.2	21.3	60.5	115 e	196 e	5
C <sub>10</sub> H <sub>12</sub> O	Estragole			48.5	88.0	140.7	214.6	5
C <sub>10</sub> H <sub>12</sub> O	4-Isopropylbenzaldehyde			54.1	96.0	152.2	231.5	5
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	4-Allyl-2-methoxyphenol	9 e	37 e	72 e	115.9	173.8	252.9	5
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	2-Phenylethyl acetate	-4 e	22 e	54 e	96 e	152.3	232.0	5
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Propyl benzoate	-8 e	18 e	50.2	92.3	149.2	230.5	5
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl phenylacetate	-9 e	19 e	52 e	95 e	150.2	225 e	5
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Isoeugenol				125 e	185.3	267.1	5
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	-28 e	-7 e	21 e	56.9	107.6	182.8	1,5
C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	-35 e	-14 e	13 e	48 e	98.3	172.8	5
C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	-37 e	-16 e	10 e	46 e	94.9	168.6	5
C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	-36 e	-15 e	12 e	47.9	97.8	172.3	5
C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Cymene	-39 e	-16 e	13 e	51 e	103.1	177.8	5
C <sub>10</sub> H <sub>14</sub>	<i>m</i> -Cymene	-34 e	-13 e	14 e	50 e	99.9	174.6	5
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Cymene	-33 e	-12 e	16 e	52 e	102.2	176.6	5
C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Diethylbenzene	-28 e	-6 e	21 e	58 e	107.9	182.9	5
C <sub>10</sub> H <sub>14</sub>	<i>m</i> -Diethylbenzene	-28 e	-7 e	20 e	56 e	106.2	180.6	5
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Diethylbenzene	-28 e	-6 e	21 e	57 e	108.1	183.3	5
C <sub>10</sub> H <sub>14</sub>	3-Ethyl-1,2-dimethylbenzene	-22 e	0 e	28 e	66 e	117.2	193.4	5
C <sub>10</sub> H <sub>14</sub>	4-Ethyl-1,2-dimethylbenzene	-24 e	-2 e	26 e	63 e	113.6	189.2	5
C <sub>10</sub> H <sub>14</sub>	2-Ethyl-1,3-dimethylbenzene		-2 e	26 e	63 e	113.7	189.5	5
C <sub>10</sub> H <sub>14</sub>	2-Ethyl-1,4-dimethylbenzene	-27 e	-5 e	23 e	60 e	110.6	186.4	5
C <sub>10</sub> H <sub>14</sub>	1-Ethyl-2,4-dimethylbenzene	-25 e	-4 e	24 e	61 e	112.2	187.9	5
C <sub>10</sub> H <sub>14</sub>	1-Ethyl-3,5-dimethylbenzene	-28 e	-6 e	21 e	58 e	108.3	183.2	5
C <sub>10</sub> H <sub>14</sub>	1-Methyl-2-propylbenzene	-27 e	-6 e	22 e	58.2	108.9	184.3	5
C <sub>10</sub> H <sub>14</sub>	1-Methyl-3-propylbenzene	-29 e	-8 e	20 e	56.1	106.5	181.3	5
C <sub>10</sub> H <sub>14</sub>	1-Methyl-4-propylbenzene	-29 e	-7 e	20 e	56.6	107.4	182.8	5
C <sub>10</sub> H <sub>14</sub>	1,2,3,4-Tetramethylbenzene		7 e	36 e	74 e	126.6	204.5	5
C <sub>10</sub> H <sub>14</sub>	1,2,3,5-Tetramethylbenzene	-19 e	3 e	32 e	69 e	120.9	197.5	5
C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene					119.9	196.3	5
C <sub>10</sub> H <sub>14</sub> O	2-Butylphenol	7 e	31 e	61 e	101 e	155.2	234.4	5
C <sub>10</sub> H <sub>14</sub> O	Butyl phenyl ether	-16 e	8 e	38 e	77 e	131.3	209.7	5
C <sub>10</sub> H <sub>14</sub> O	Thymol	18.9 s	37.9 s	59.5	101.2	155.0	230.4	5
C <sub>10</sub> H <sub>15</sub> N	2-Methyl-5-isopropylaniline	19 e	43 e	72 e	107.4	150 e	204 e	5
C <sub>10</sub> H <sub>15</sub> N	<i>N</i> -Butylaniline	11 e	35 e	66 e	106 e	160.9	241.0	5
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> -Diethylaniline	-11 e	14 e	44.3	84.2	138.4	216.3	5
C <sub>10</sub> H <sub>16</sub>	Dipentene	-42 e	-19 e	10.6	48.7	100.2	173.9	5
C <sub>10</sub> H <sub>16</sub>	<i>d</i> -Limonene	-45 e	-21 e	9.1	48.0	100.4	174.5	5
C <sub>10</sub> H <sub>16</sub>	<i>l</i> -Limonene	-33 e	-12 e	16 e	52.0	102.3	177.0	21
C <sub>10</sub> H <sub>16</sub>	β-Myrcene			9.4	47.3	98.3	171.0	5
C <sub>10</sub> H <sub>16</sub>	α-Pinene	-48 e	-27 e	-1 e	33.6	82.2	155.1	21
C <sub>10</sub> H <sub>16</sub>	β-Pinene	-43 e	-22 e	5.0	40.6	90.5	165.5	21
C <sub>10</sub> H <sub>16</sub>	Camphene					90.7	160.1	4
C <sub>10</sub> H <sub>16</sub>	Terpinolene			26.5	64.9	115.4	184.6	5
C <sub>10</sub> H <sub>16</sub>	β-Phellandrene			16 e	53.2	104 e	171.0	5
C <sub>10</sub> H <sub>16</sub> O	(+)-Camphor	-15.8 s	10 s	41.5 s	80.8 s	131.4 s	207.6	5
C <sub>10</sub> H <sub>16</sub> O	Pulegone	37 e	49.1	66.4	92.2	135.1	220.2	5
C <sub>10</sub> H <sub>18</sub>	1-Decyne	-34 e	-13 e	14 e	51 e	100.3	173.5	5
C <sub>10</sub> H <sub>18</sub>	<i>cis</i> -Decahydronaphthalene	-26 e	-4 e	24 e	62.4	115.5	195.3	1



Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene		-10 e	18 e	55.3	107.9	186.8	1
C <sub>10</sub> H <sub>18</sub> O	α-Terpineol			48	89	142	217	4
C <sub>10</sub> H <sub>18</sub> O	Eucalyptol			10.6	48.5	100.3	175.4	5
C <sub>10</sub> H <sub>18</sub> O	<i>trans</i> -Geraniol	4 e	31 e	63.2	104.3	157.7	229.6	5
C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Sebacic acid	125.9 s						5
C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Dipropyl succinate	11 e	38 e	72.1	115.4	172.3	250.4	5
C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Diethyl adipate	4 e	35 e	72 e	116.6	171.2	239.5	5
C <sub>10</sub> H <sub>19</sub> N	Decanenitrile	13 e	36 e	66 e	105.8	160.6	241.6	5
C <sub>10</sub> H <sub>20</sub>	1-Decene	-35.5	-13.7	13.7	49.0	97.9	170.1	1,5
C <sub>10</sub> H <sub>20</sub>	Cyclodecane			29 e	68 e	121.3	201.8	1
C <sub>10</sub> H <sub>20</sub>	Butylcyclohexane	-31 e	-9 e	18 e	54 e	104.7	180.4	5
C <sub>10</sub> H <sub>20</sub>	Isobutylcyclohexane	-37 e	-16 e	10 e	46 e	95.9	170.8	5
C <sub>10</sub> H <sub>20</sub>	<i>tert</i> -Butylcyclohexane	-39 e	-18 e	9 e	45 e	95.3	171.1	5
C <sub>10</sub> H <sub>20</sub> O	Decanal		16 e	47.2	86.3	137.7	208.0	5
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Decanoic acid	58 e	80 e	108 e	145 e	195.2	269.5	5
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Octyl acetate	-26 e	-3 e	27 e	66.3	120.0	198.2	5
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2-Ethylhexyl acetate	-11 e	5 e	26 e	57.6	107.1	197.2	5
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Isopentyl isopentanoate			22 e	62.8	116.9	193.6	5
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Ethyl octanoate	-17 e	9 e	41 e	81.4	133.2	203 e	5
C <sub>10</sub> H <sub>20</sub> O <sub>4</sub>	Diethylene glycol monobutyl ether acetate	6 e	34 e	69 e	112.6	169.2	245.4	5
C <sub>10</sub> H <sub>21</sub> Br	1-Bromodecane	9 e	33 e	63 e	104 e	159.2	240.0	5
C <sub>10</sub> H <sub>21</sub> Cl	1-Chlorodecane	2 e	25 e	54 e	92 e	145.7	225.3	5
C <sub>10</sub> H <sub>21</sub> F	1-Fluorodecane	-22 e	0 e	27 e	64 e	113.3	185.7	5
C <sub>10</sub> H <sub>22</sub>	Decane		-10.6	16.7	52.3	101.1	173.7	16
C <sub>10</sub> H <sub>22</sub>	2-Methylnonane	-34 e	-14 e	12 e	47 e	94.8	166.5	5
C <sub>10</sub> H <sub>22</sub>	3-Methylnonane	-34 e	-14 e	12 e	47 e	95.1	167.3	5
C <sub>10</sub> H <sub>22</sub>	4-Methylnonane	-36 e	-16 e	10 e	45 e	93.1	165.2	5
C <sub>10</sub> H <sub>22</sub>	5-Methylnonane	-36 e	-16 e	10 e	45 e	92.6	164.6	5
C <sub>10</sub> H <sub>22</sub>	2,4-Dimethyloctane				38 e	84.9	155.4	5
C <sub>10</sub> H <sub>22</sub>	2,7-Dimethyloctane	-39 e	-19 e	7 e	41 e	88.4	159.4	5
C <sub>10</sub> H <sub>22</sub>	2,2,6-Trimethylheptane	-46 e	-27 e	-2 e	32 e	78.5	148.4	5
C <sub>10</sub> H <sub>22</sub>	3,3,5-Trimethylheptane			0 e	35 e	82.7	155.2	5
C <sub>10</sub> H <sub>22</sub>	2,2,3,3-Tetramethylhexane	-46 e	-25 e	1 e	36 e	85.6	159.8	5
C <sub>10</sub> H <sub>22</sub>	2,2,5,5-Tetramethylhexane			-10 e	22 e	68.3	137.0	5
C <sub>10</sub> H <sub>22</sub>	2,4-Dimethyl-3-isopropylpentane	-46 e	-26 e	0 e	35 e	83.2	156.5	5
C <sub>10</sub> H <sub>22</sub>	2,2,3,3,4-Pentamethylpentane		-24 e	3 e	39 e	89.1	165.5	5
C <sub>10</sub> H <sub>22</sub>	2,2,3,4,4-Pentamethylpentane		-29 e	-3 e	33 e	82.8	158.7	5
C <sub>10</sub> H <sub>22</sub> O	1-Decanol	30 e	50 e	75 e	109 e	157.3	230.6	1,39
C <sub>10</sub> H <sub>22</sub> O	4-Decanol	18 e	37 e	61 e	93 e	139 e	210 e	5
C <sub>10</sub> H <sub>22</sub> O	Dipentyl ether	-31 e	-8 e	22 e	60 e	111.6	186.2	5
C <sub>10</sub> H <sub>22</sub> O	Diisopentyl ether			14.0	51.5	101.8	172.8	5
C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	Ethylene glycol dibutyl ether	0 e	20 e	44 e	78.4	127.1	202.9	5
C <sub>10</sub> H <sub>22</sub> O <sub>5</sub>	Tetraethylene glycol dimethyl ether				138 e	200.9	275.3	5
C <sub>10</sub> H <sub>22</sub> S	1-Decanethiol	11 e	34 e	64 e	103 e	157.5	238.6	5
C <sub>10</sub> H <sub>22</sub> S	Diisopentylsulfide			7 e	82 e	118 e	139 e	5
C <sub>10</sub> H <sub>23</sub> N	Dipentylamine			77 e	127.7	202.0		5
C <sub>10</sub> H <sub>30</sub> O <sub>3</sub> Si <sub>4</sub>	Decamethyltetrasiloxane	-31 e	-6 e	26 e	66.8	118.8	193.9	5
C <sub>10</sub> H <sub>30</sub> O <sub>5</sub> Si <sub>5</sub>	Decamethylcyclopentasiloxane	-2 e	19 e	46 e	82 e	132.9	210.4	5
C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	1-Naphthalenecarboxylic acid				191.9	239.3	299.6	5
C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	2-Naphthalenecarboxylic acid				197.9	246.0	308.1	5
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	5 e	29 e	60 e	102 e	159.1	244.1	1
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene			57 e	99 e	156.0	240.5	1
C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl <i>trans</i> -cinnamate			79	125	187	271	4
C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	Myristicin	23 e	53 e	88.9	135.2	196.0	279.4	5
C <sub>11</sub> H <sub>14</sub>	4-Isopropylstyrene	-25 e	-1 e	30.2	70.3	124.5	202.1	5
C <sub>11</sub> H <sub>14</sub>	1,2,3,4-Tetrahydro-5-methylnaphthalene	9 e	31 e	60 e	99 e	153.1	233.8	5
C <sub>11</sub> H <sub>14</sub>	1,2,3,4-Tetrahydro-6-methylnaphthalene	17 e	36 e	62 e	97 e	147.8	228.5	5
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Butyl benzoate	6 e	34 e	67.9	110.3	165 e	237 e	5
C <sub>11</sub> H <sub>16</sub>	Pentylbenzene	-14 e	8 e	37 e	74 e	126.7	204.9	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>11</sub> H <sub>16</sub>	<i>p</i> -tert-Butyltoluene	-24 e	-2 e	27 e	64.1	115.5	190.8	5
C <sub>11</sub> H <sub>16</sub>	1,3-Diethyl-5-methylbenzene	-26 e	-1 e	29.5	69.5	123.5	200.2	5
C <sub>11</sub> H <sub>16</sub>	2-Ethyl-1,3,5-trimethylbenzene		6 e	36 e	75.7	129.6	207.6	5
C <sub>11</sub> H <sub>16</sub>	1-Ethyl-2,4,5-trimethylbenzene	-13 e	11 e	40 e	79.4	132.1	207.7	5
C <sub>11</sub> H <sub>20</sub>	1-Undecyne	-22 e	0 e	29 e	67 e	118.5	194.5	5
C <sub>11</sub> H <sub>20</sub>	2-Undecyne	-17 e	6 e	35 e	74 e	127.4	205.4	5
C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>	10-Undecenoic acid	35 e	67 e	105 e	150.0	205.4	274.5	5
C <sub>11</sub> H <sub>20</sub> O <sub>4</sub>	Ethyl diethylmalonate			74 e	105 e	149.4	219 e	5
C <sub>11</sub> H <sub>21</sub> N	Undecanenitrile			78.6	120.3	177.3	259.9	5
C <sub>11</sub> H <sub>22</sub>	1-Undecene	-21.6	1.2	29.7	66.4	117.1	192.2	5
C <sub>11</sub> H <sub>22</sub>	<i>cis</i> -2-Undecene	-14 e	7 e	34 e	70.2	120.6	196 e	5
C <sub>11</sub> H <sub>22</sub>	<i>trans</i> -2-Undecene	-14 e	7 e	33 e	69.3	119.6	195 e	5
C <sub>11</sub> H <sub>22</sub>	<i>cis</i> -4-Undecene	-19 e	3 e	30 e	66.6	117.1	192 e	5
C <sub>11</sub> H <sub>22</sub>	<i>trans</i> -4-Undecene	-17 e	4 e	31 e	67.1	117.4	193 e	5
C <sub>11</sub> H <sub>22</sub>	<i>cis</i> -5-Undecene	-19 e	2 e	30 e	66.2	116.7	191 e	5
C <sub>11</sub> H <sub>22</sub>	<i>trans</i> -5-Undecene	-18 e	3 e	31 e	67.0	117.4	192 e	5
C <sub>11</sub> H <sub>22</sub>	Pentylcyclohexane	-17 e	6 e	34 e	72 e	124.2	202.7	5
C <sub>11</sub> H <sub>22</sub>	Hexylcyclopentane	-15 e	7 e	36 e	73 e	125.0	202.5	5
C <sub>11</sub> H <sub>22</sub> O	2-Undecanone	17 e	37 e	64.3	103.0	153.6	232.6	1,5
C <sub>11</sub> H <sub>22</sub> O	6-Undecanone		28 e	57 e	95 e	148.4	226.9	1
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Undecanoic acid	68 e	90 e	118 e	156 e	207.2	283.6	5
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Heptyl butanoate	2 e	29 e	62 e	102.6	155.1	224.7	5
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Propyl octanoate	-2 e	23 e	55 e	94.0	145.2	215 e	5
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Methyl decanoate	10 e	33 e	62 e	100.9	154.0	232 e	5
C <sub>11</sub> H <sub>24</sub>	Undecane	-18.4	4.3	32.6	69.5	120.2	195.4	16
C <sub>11</sub> H <sub>24</sub>	2-Methyldecane	-20 e	1 e	28 e	64 e	114.0	188.7	5
C <sub>11</sub> H <sub>24</sub>	3-Methyldecane	-35 e	-10 e	22 e	61.9	115.6	190.4	5
C <sub>11</sub> H <sub>24</sub>	4-Methyldecane	-38 e	-12 e	20 e	60.8	113.9	186.4	5
C <sub>11</sub> H <sub>24</sub>	2,4,7-Trimethyloctane				43 e	94 e	170.4	5
C <sub>11</sub> H <sub>24</sub> O	1-Undecanol	52.2	80.0	82 e	118 e	167.6	244.1	5
C <sub>11</sub> H <sub>24</sub> S	1-Undecanethiol	23 e	47 e	77 e	118 e	173.6	256.8	5
C <sub>12</sub> F <sub>27</sub> N	Trinonafluorobutylamine		3 e	29.0	63.3	109.9	176.8	5
C <sub>12</sub> H <sub>8</sub>	Acenaphthylene	24 s	49.8 s	80.6 s				5
C <sub>12</sub> H <sub>9</sub> N	Carbazole					254.7	354.0	5
C <sub>12</sub> H <sub>10</sub>	Acenaphthene				126.2	187 e	276 e	1
C <sub>12</sub> H <sub>10</sub>	Biphenyl			69.0	111.1	169.5	254.7	1
C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	Azobenzene			98.1	144.8	206.7	292.7	4
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether		44 e	75 e	116 e	173 e	257.4	5
C <sub>12</sub> H <sub>10</sub> O	1-Acetonaphthone	37 e	69 e	107.0	154.6	215.2	294.9	5
C <sub>12</sub> H <sub>10</sub> O	2-Acetonaphthone	48.3 s		118.7	163.0	221.1	300.3	5
C <sub>12</sub> H <sub>10</sub> S	Diphenyl sulfide	20 e	51 e	88.7	137.5	202.2	291.8	5
C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	48 s		102.8	150.5	213.7	301.4	5
C <sub>12</sub> H <sub>12</sub>	1-Ethyl-naphthalene	16 e	41 e	72 e	114 e	171.8	257.7	5
C <sub>12</sub> H <sub>12</sub>	2-Ethyl-naphthalene	14 e	39 e	71 e	113 e	171.2	257.3	5
C <sub>12</sub> H <sub>12</sub>	1,2-Dimethylnaphthalene	26 e	51 e	82 e	123 e	180.5	265.7	5
C <sub>12</sub> H <sub>12</sub>	2,7-Dimethylnaphthalene	31.5 s	53.1 s	78.8 s	115.9	175 e	260 e	5
C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate	12 e	51 e	96 e	150.5	215.9	296.2	5
C <sub>12</sub> H <sub>16</sub>	<i>p</i> -Isopropenylisopropylbenzene	-11 e	15 e	46 e	87 e	142.4	221 e	5
C <sub>12</sub> H <sub>16</sub>	Cyclohexylbenzene		28 e	58 e	98 e	154.7	239.5	5
C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	3-Methylbutyl benzoate			66 e	115.0	177.7	261.4	5
C <sub>12</sub> H <sub>18</sub>	Hexylbenzene	-2 e	22 e	51 e	90 e	144.5	225.5	5
C <sub>12</sub> H <sub>18</sub>	1,2-Diisopropylbenzene	-14 e	9 e	37 e	74 e	125.9	203.2	5
C <sub>12</sub> H <sub>18</sub>	1,3-Diisopropylbenzene	-14 e	8 e	36 e	74 e	125.5	202.6	5
C <sub>12</sub> H <sub>18</sub>	1,4-Diisopropylbenzene	-6 e	18 e	49 e	90 e	148.8	238 e	5
C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	46.3 s	72.5 s	81.7 s	121.8 s	178.3	263.7	5
C <sub>12</sub> H <sub>18</sub>	1,5,9-Cyclododecatriene	-14 e	11 e	44 e	87 e	145.0	229.8	5
C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	Geranyl acetate			67.7	110.8	166.9	242.9	5
C <sub>12</sub> H <sub>20</sub> O <sub>4</sub>	Dibutyl maleate	12.3	50.4	94.0	144.2	203 e	272 e	5
C <sub>12</sub> H <sub>22</sub>	1-Dodecane	-11 e	13 e	43 e	82 e	135.8	214.4	5
C <sub>12</sub> H <sub>22</sub>	Cyclohexylcyclohexane		20 e	53.1	96.0	154.1	237.2	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	Methyl 10-undecenoate	10 e	38 e	73 e	116 e	172.2	247.1	5
C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	Dimethyl sebacate		53 e	97	150	214	293	4
C <sub>12</sub> H <sub>23</sub> N	Dodecanenitrile	36 e	60 e	92 e	133 e	190.5	275.5	5
C <sub>12</sub> H <sub>24</sub>	1-Dodecene	-8.3	15.2	44.8	82.9	135.4	212.8	5
C <sub>12</sub> H <sub>24</sub>	Hexylcyclohexane	-3 e	20 e	50 e	89 e	143.1	224.2	5
C <sub>12</sub> H <sub>24</sub>	Heptylcyclopentane	-1 e	22 e	51 e	90 e	143.5	223.5	5
C <sub>12</sub> H <sub>24</sub> O	Dodecanal			70 e	116.2	175.9	256.6	5
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Dodecanoic acid	78 e	100 e	128 e	166 e	219.1	298.1	5
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Decyl acetate	12 e	40 e	74 e	115.1	168.1	238 e	5
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Ethyl decanoate	8 e	35 e	69 e	111.8	166.1	238 e	5
C <sub>12</sub> H <sub>25</sub> Br	1-Bromododecane	31 e	57 e	90 e	132 e	190.8	275.3	5
C <sub>12</sub> H <sub>25</sub> Cl	1-Chlorododecane	27 e	51 e	81 e	122 e	178.7	262.6	5
C <sub>12</sub> H <sub>26</sub>	Dodecane	-5.4	18.2	47.6	85.8	138.2	215.8	16
C <sub>12</sub> H <sub>26</sub> O	1-Dodecanol				133 e	185.0	264.1	1
C <sub>12</sub> H <sub>26</sub> O <sub>3</sub>	Diethylene glycol dibutyl ether	5 e	34.4	70.2	115.3	174.1	253.8	5
C <sub>12</sub> H <sub>27</sub> N	Tributylamine	-26 e	1 e	35 e	77.7	134.5	213.4	5
C <sub>12</sub> H <sub>27</sub> N	Triisobutylamine		1 e	28.9	64.9	112.5	178.5	5
C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	Tributyl phosphate					205 e	288.3	5
C <sub>12</sub> H <sub>36</sub> O <sub>5</sub> Si <sub>6</sub>	Dodecamethylcyclohexasiloxane	18 e	41 e	69 e	108 e	162.2	244.7	5
C <sub>13</sub> H <sub>9</sub> N	Acridine			124.4	176.2	246.0	345.4	5
C <sub>13</sub> H <sub>9</sub> N	Phenanthridine	79 s						5
C <sub>13</sub> H <sub>10</sub>	Fluorene	48.4 s			137.4	205.4	295 e	5
C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	Phenyl benzoate			102.3	151.4	217.9	313.3	5
C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	Phenyl salicylate				166.0	224.8	312.4	5
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane		45 e	77 e	119.3	177.7	263.6	1,5
C <sub>13</sub> H <sub>13</sub> N	Methyldiphenylamine	35 e	63 e	98.4	143.1	201.6	281.6	5
C <sub>13</sub> H <sub>14</sub>	1-Isopropyl-naphthalene	27 e	51 e	82 e	123.2	180.8	267.3	5
C <sub>13</sub> H <sub>20</sub>	Heptylbenzene	12 e	36 e	66 e	107 e	162.7	246.2	5
C <sub>13</sub> H <sub>24</sub> O <sub>2</sub>	Ethyl 10-undecenoate	32 e	55 e	86 e	125.2	179.5	258.4	5
C <sub>13</sub> H <sub>26</sub>	1-Tridecene	4.1	28.5	59.0	98.3	152.5	232.3	5
C <sub>13</sub> H <sub>26</sub>	Heptylcyclohexane	11 e	34 e	65 e	105 e	160.9	244.3	5
C <sub>13</sub> H <sub>26</sub>	Octylcyclopentane	13 e	36 e	66 e	106 e	160.9	243.1	5
C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	Tridecanoic acid	87 e	109 e	138 e	176 e	230.3	311.5	5
C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	Methyl dodecanoate	38 e	61 e	90 e	130 e	184.9	269 e	5
C <sub>13</sub> H <sub>28</sub>	Tridecane	7.2	31.5	61.8	101.1	155.1	234.9	16
C <sub>13</sub> H <sub>28</sub> O	1-Tridecanol	71.6	101.0	103 e	140 e	192.3	273.1	5
C <sub>14</sub> H <sub>10</sub>	Anthracene	89.2 s	125.9 s	151.5 s	165 s	238.8	340.2	1,5
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	53 s	83 s	120.8	170.4	238.4	337.7	5
C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	Benzil			123	175	246	346	4
C <sub>14</sub> H <sub>12</sub>	<i>cis</i> -Stilbene	26 e	54 e	88 e	130.4	183 e	253 e	5
C <sub>14</sub> H <sub>12</sub>	<i>trans</i> -Stilbene				155.6	218.1	305.8	5
C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	Benzoin				181	248	342	4
C <sub>14</sub> H <sub>14</sub>	1,1-Diphenylethane	19 e	47 e	82.0	125.3	181 e	254 e	5
C <sub>14</sub> H <sub>15</sub> N	Dibenzylamine	48 e	77 e	113.1	158.9	218.5	299.4	5
C <sub>14</sub> H <sub>16</sub>	1-Butyl-naphthalene	67 e	82 e	103 e	135 e	186.7	288.6	5
C <sub>14</sub> H <sub>16</sub>	2-Butyl-naphthalene	44 e	67 e	98 e	139 e	197.5	287.4	5
C <sub>14</sub> H <sub>22</sub>	Octylbenzene	20.1	46.2	79.1	121.9	178.1	263.8	5
C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	Diethyl sebacate		83 e	120	166	225	305	4
C <sub>14</sub> H <sub>27</sub> N	Tetradecanenitrile	52 e	79 e	114.0	159.0	219.7	306.3	5
C <sub>14</sub> H <sub>28</sub>	1-Tetradecene	16.1	41.3	72.7	113.2	168.7	250.6	5
C <sub>14</sub> H <sub>28</sub>	Octylcyclohexane	16.9	44.3	77.8	120.0	177.6	263.2	5
C <sub>14</sub> H <sub>28</sub>	Nonylcyclopentane	25 e	49 e	80 e	120 e	177.2	261.5	5
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Tetradecanoic acid	96 e	118 e	147 e	186 e	241.3	325.6	5
C <sub>14</sub> H <sub>30</sub>	Tetradecane	19.1	44.1	75.3	115.7	171.1	253.0	16
C <sub>14</sub> H <sub>30</sub> O	1-Tetradecanol	80.0	110.5	149.6	152 e	205.3	286.7	5
C <sub>14</sub> H <sub>31</sub> N	Tetradecylamine			104 e	147 e	206.1	290.9	5
C <sub>14</sub> H <sub>42</sub> O <sub>5</sub> Si <sub>6</sub>	Tetradecamethylhexasiloxane	6 e	36 e	72 e	117 e	176.0	259.1	5
C <sub>15</sub> H <sub>18</sub>	1-Pentyl-naphthalene	34 e	62 e	96 e	141.3	202.2	289 e	5
C <sub>15</sub> H <sub>24</sub>	Nonylbenzene	33.0	58.9	92.0	135.4	193.7	281.4	5
C <sub>15</sub> H <sub>30</sub>	Nonylcyclohexane	35 e	60 e	92 e	134 e	193.4	280.9	5

Mol. form.	Name	Temperature in °C for the indicated pressure						Ref.
		1 Pa	10 Pa	100 Pa	1 kPa	10 kPa	100 kPa	
C <sub>15</sub> H <sub>30</sub>	Decylcyclopentane	37 e	61 e	93 e	134 e	192.5	278.8	5
C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Methyl tetradecanoate		75 e	110	155	214	295	4
C <sub>15</sub> H <sub>32</sub>	Pentadecane	30.5	56.1	88.1	129.6	186.3	270.1	16
C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Dibutyl phthalate		104.0	142.7	191.5	254.5	339.4	4
C <sub>16</sub> H <sub>32</sub>	1-Hexadecene	38.4	65.0	98.1	140.5	198.8	284.3	5
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Hexadecanoic acid		136 e	165 e	205 e	261.9	350.2	5
C <sub>16</sub> H <sub>34</sub>	Hexadecane	41.1	67.4	100.3	142.7	200.7	286.3	16
C <sub>16</sub> H <sub>34</sub> O	1-Hexadecanol	99.5	130.6	171.9	175 e	229.0	311.7	5
C <sub>16</sub> H <sub>35</sub> N	Hexadecylamine	63 e	91 e	126 e	171 e	232.6	320.5	5
C <sub>17</sub> H <sub>10</sub> O	Benzanthrone		184 e	229.3	290.3	377.2	511 e	5
C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Methyl hexadecanoate	65 e	93	129	177			4
C <sub>17</sub> H <sub>36</sub>	Heptadecane	51.5	78.5	112.0	155.3	214.5	302 e	16
C <sub>17</sub> H <sub>36</sub> O	1-Heptadecanol	94 e	117 e	146 e	185 e	240.1	323.3	5
C <sub>18</sub> H <sub>14</sub>	<i>o</i> -Terphenyl	66 e	94 e	129 e	176 e	241.3	336.3	5
C <sub>18</sub> H <sub>14</sub>	<i>m</i> -Terphenyl	87 e	118 e	156 e	206.6	275.3	374.6	5
C <sub>18</sub> H <sub>14</sub>	<i>p</i> -Terphenyl	127.1 s	154.7 s		217.2	284.0	383.0	5
C <sub>18</sub> H <sub>30</sub>	Hexaethylbenzene				144.1	206.8	297.5	5
C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Oleic acid	94 e	126 e	165.5	214.5	277.0	359.7	5
C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Elaidic acid		124 e	166	216	280	361	4
C <sub>18</sub> H <sub>36</sub> O	Stearaldehyde			142 e	186 e	246.9	336.7	5
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid		153 e	183 e	223 e	281.6	374.5	5
C <sub>18</sub> H <sub>38</sub>	Octadecane	61.5	89.0	123.1	167.3	227.6	316 e	16
C <sub>18</sub> H <sub>38</sub> O	1-Octadecanol	106 e	130 e	160 e	200.5	257.3	343.0	5
C <sub>19</sub> H <sub>16</sub>	Triphenylmethane	81 s		112 e	175 e	254.6	360.0	5
C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	Methyl oleate	85 e	114 e	149.7	195.6	256 e	340 e	5
C <sub>19</sub> H <sub>40</sub>	Nonadecane	71.1	99.1	133.8	178.8	240.1	330 e	16
C <sub>20</sub> H <sub>42</sub>	Eicosane	80.4	108.9	144.2	189.8	252.1	344 e	16
C <sub>20</sub> H <sub>42</sub> O	1-Eicosanol	119 e	143 e	173 e	213 e	270.0	355.1	5
C <sub>20</sub> H <sub>60</sub> O <sub>8</sub> Si <sub>9</sub>	Eicosamethylnonasiloxane			141 e	183.1	236.7	307.1	5
C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	Tri- <i>o</i> -cresyl phosphate	119.0	156.1	201.0	256.3	326.3	418 e	5
C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	Tri- <i>m</i> -cresyl phosphate	147.8	177.3	211.4	251.3	298 e	355 e	5
C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	Tri- <i>p</i> -cresyl phosphate	140.6	174 e	214 e	262 e	320 e	392 e	5
C <sub>21</sub> H <sub>44</sub>	Heneicosane	82.3	113.5	152.2	201.6	263.8	355.9	5
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Brassicic acid	134 e	166 e	203.6	249.8	307.6	382.0	5
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Erucic acid	126 e	160 e	199.4	247.4	306.5	381.1	5
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Butyl oleate	95.5	124.2	158 e	198 e	245 e	304 e	5
C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	Behenic acid	145.4	176.5	213.7	259.3	316.2	390 e	5
C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	Butyl stearate	99.6	128 e	162 e	201 e	249 e	307 e	5
C <sub>22</sub> H <sub>46</sub>	Docosane	83.5	115.0	154.0	203.6	274.8	368.0	5
C <sub>23</sub> H <sub>48</sub>	Tricosane	102.9	135.1	174.8	221 e	285.3	379.5	5
C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	Dioctyl phthalate	130 e	163.7	203.8	252 e	311 e	385 e	5
C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	Bis(2-ethylhexyl) phthalate	122.0	153.2	189.2	231.3	281.1	341.1	5
C <sub>24</sub> H <sub>50</sub>	Tetracosane	115.0	148.1	188.5	239.1	295.4	390.6	5
C <sub>25</sub> H <sub>52</sub>	Pentacosane	119.7	152.7	193.2	244.4	305.0	401.1	5
C <sub>26</sub> H <sub>54</sub>	Hexacosane	125.1	158.8	200.1	252.1	314.3	411.3	5
C <sub>27</sub> H <sub>56</sub>	Heptacosane	136.7	168.8	206.5	255.8	323.3	421.2	5
C <sub>28</sub> H <sub>58</sub>	Octacosane	136.5	169.8	210.9	263.1	332.0	430.6	5
C <sub>29</sub> H <sub>60</sub>	Nonacosane	148.2	182.8	221.2	271.5	340.2	439.7	5
C <sub>30</sub> H <sub>62</sub>	Squalane	66 e	84 e	105.8	131.9	163.7	203.2	5
C <sub>70</sub>	Carbon (fullerene-C <sub>70</sub> )	598 s	662 s					22

## VAPOR PRESSURE OF FLUIDS AT TEMPERATURES BELOW 300 K

This table gives vapor pressures of 67 important fluids in the temperature range 2 to 300 K. Helium (<sup>4</sup>He), hydrogen (H<sub>2</sub>), and neon (Ne) are covered on this page. The remaining fluids are listed on subsequent pages by molecular formula in the Hill order (see Introduction). The data have been taken from evaluated sources; references are listed at the end of the table.

Pressures are given in kilopascals (kPa). Note that:

1 kPa = 7.50062 Torr

100 kPa = 1 bar

101.325 kPa = 1 atm

“s” following an entry indicates that the compound is solid at that temperature.

Helium		Hydrogen		Neon		Helium		Hydrogen		Neon	
T/K	P/kPa	T/K	P/kPa	T/K	P/kPa	T/K	P/kPa	T/K	P/kPa	T/K	P/kPa
2.2	5.3	14.0	7.90	25.0	51.3	4.2	99.0	24.0	264.2		
2.3	6.7	14.5	10.38	26.0	71.8	4.3	108.7	24.5	295.1		
2.4	8.3	15.0	13.43	27.0	98.5	4.4	119.0	25.0	328.5		
2.5	10.2	15.5	17.12	28.0	132.1	4.5	129.9	25.5	364.3		
2.6	12.4	16.0	21.53	29.0	173.5	4.6	141.6	26.0	402.9		
2.7	14.8	16.5	26.74	30.0	223.8	4.7	153.9	26.5	444.3		
2.8	17.5	17.0	32.84	31.0	284.0	4.8	167.0	27.0	488.5		
2.9	20.6	17.5	39.92	32.0	355.2	4.9	180.8	27.5	535.7		
3.0	24.0	18.0	48.08	33.0	438.6	5.0	195.4	28.0	586.1		
3.1	27.8	18.5	57.39	34.0	535.2	5.1	210.9	28.5	639.7		
3.2	32.0	19.0	67.96	35.0	646.2			29.0	696.7		
3.3	36.5	19.5	79.89	36.0	772.8			29.5	757.3		
3.4	41.5	20.0	93.26	37.0	916.4			30.0	821.4		
3.5	47.0	20.5	108.2	38.0	1078			30.5	889.5		
3.6	52.9	21.0	124.7	39.0	1260			31.0	961.5		
3.7	59.3	21.5	143.1	40.0	1462			31.5	1038.0		
3.8	66.1	22.0	163.2	41.0	1688			32.0	1119.0		
3.9	73.5	22.5	185.3	42.0	1939			32.5	1204.0		
4.0	81.5	23.0	209.4	43.0	2216	Ref.	17,18		1		13
4.1	90.0	23.5	235.7	44.0	2522						

T/K	Ar Argon	BCl <sub>3</sub> Boron trichloride	BF <sub>3</sub> Boron trifluoride	BrH Hydrogen bromide	Br <sub>2</sub> Bromine	ClF Chlorine fluoride	ClH Hydrogen chloride
50	0.1	s					
55	0.2	s					
60	0.8	s					
65	2.8	s					
70	7.7	s					
75	18.7	s					
80	40.7	s					
85	79.0						
90	134						
95	213						
100	324						
105	473						
110	666						
115	910					0.1	
120	1214					0.3	0.1 s
125	1584					0.6	0.3 s
130	2027					1.2	0.5 s
135	2553			0.1	s	2.1	1.0 s
140	3170			0.3	s	3.6	1.9 s
145	3892		7.7	0.6	s	6.0	3.4 s
150	4736		13.4	1.1	s	9.5	5.8 s
155			22.3	1.9	s	14.6	9.5 s
160			35.2	3.3	s	21.8	14.7
165			53.7	5.4	s	31.7	22.0
170			79.1	8.7	s	44.8	31.9
175			113	13.4	s	62.0	45.1

T/K	Ar Argon	BCl <sub>3</sub> Boron trichloride	BF <sub>3</sub> Boron trifluoride	BrH Hydrogen bromide	Br <sub>2</sub> Bromine	ClF Chlorine fluoride	ClH Hydrogen chloride
180		0.1	157	20.1 s		84.2	62.5
185		0.2	214	29.5 s		112	84.7
190		0.3	285	37.9		147	113
195		0.5	372	51.8		190	148
200		0.8	479	69.5		242	190
205		1.2	608	91.8		304	242
210		1.8	762	119		378	304
215		2.6	944	153		464	377
220		3.8	1160	194	0.1 s	564	463
225		5.2	1413	242	0.2 s	680	563
230		7.2	1709	299	0.3 s	812	678
235		9.7	2056	366	0.4 s	961	811
240		12.9	2460	443	0.7 s	1130	961
245		17.0	2913	532	1.1 s	1319	1132
250		22.0	3481	633	1.7 s	1529	1325
255		28.1	4123	748	2.6 s	1762	1542
260		35.6	4874	878	3.8 s	2019	1784
265		44.5		1023	5.5 s	2301	2054
270		55.1		1185	7.3	2608	2354
275		67.6		1364	9.5	2941	2686
280		82.2		1562	12.3	3303	3053
285		99.1		1780	15.6	3693	3457
290		119		2018	19.7	4111	3901
295		141		2278	24.6	4560	4388
300		166		2561	30.5	5039	4921
Ref.	8,15	12	12	12	12	12	12

T/K	ClO <sub>2</sub> Chlorine dioxide	Cl <sub>2</sub> Chlorine	Cl <sub>4</sub> Si Silicon tetrachloride	FH Hydrogen fluoride	F <sub>2</sub> Fluorine	F <sub>2</sub> O Difluorine oxide	F <sub>3</sub> N Nitrogen trifluoride
50							
55					0.4		
60					1.5		
65					4.8		
70					12.3		
75					27.6	0.1	
80					55.3	0.2	
85					101	0.5	0.1
90					172	1.2	0.2
95					276	2.6	0.4
100					420	5.3	0.9
105					615	10.1	2.0
110					870	18.0	4.0
115					1196	30.5	7.3
120					1605	49.3	12.8
125					2108	76.7	21.1
130					2721	115	33.5
135					3458	168	51.1
140					4339	237	75.4
145						328	108
150						444	150
155						588	205
160						766	273
165						981	357
170						1238	459
175		1.8				1541	581
180		2.8				1895	726
185		4.2				2303	896
190		6.1		0.3		2771	1092
195	0.1	8.7		0.5		3302	1319
200	0.3	12.3		0.8		3899	1578
205	0.5	16.9		1.2		4567	1871
210	0.9	22.9	0.1	1.7		5308	2203

T/K	ClO <sub>2</sub> Chlorine dioxide	Cl <sub>2</sub> Chlorine	Cl <sub>4</sub> Si Silicon tetrachloride	FH Hydrogen fluoride	F <sub>2</sub> Fluorine	F <sub>2</sub> O Difluorine oxide	F <sub>3</sub> N Nitrogen trifluoride
215	1.4	30.5	0.2	2.3			2577
220	2.3	40.1	0.3	3.2			2995
225	3.5	51.9	0.5	4.4			3464
230	5.3	66.4	0.7	5.9			3991
235	7.6	84.0	1.0	7.9			
240	10.8	105	1.5	10.3			
245	14.9	130	2.0	13.4			
250	20.1	160	2.8	17.2			
255	26.6	194	3.8	21.8			
260	34.6	234	5.0	27.4			
265	44.4	280	6.6	34.2			
270	56.1	332	8.6	42.2			
275	69.9	392	11.1	51.8			
280	86.2	459	14.2	63.1			
285	105	535	17.9	76.3			
290	127	619	22.3	91.7			
295	151	714	27.7	110			
300	179	818	34.0	130			
Ref.	12	5	12	12	12	12	1

T/K	F <sub>3</sub> P Phosphorus trifluoride	F <sub>4</sub> Si Silicon tetrafluoride	F <sub>6</sub> S Sulfur hexafluoride	HI Hydrogen iodide	H <sub>2</sub> S Hydrogen sulfide	H <sub>3</sub> N Ammonia	H <sub>3</sub> P Phosphine
105	0.1						
110	0.2						0.1
115	0.5						0.2
120	1.0						0.4
125	1.9	0.1 s					0.7
130	3.5	0.2 s					1.3
135	5.9	0.4 s			0.1 s		2.3
140	9.5	0.9 s	0.1 s		0.2 s		3.9
145	14.9	1.9 s	0.2 s		0.3 s		6.2
150	22.5	3.8 s	0.4 s		0.6 s		9.6
155	33.1	7.5 s	0.8 s	0.1 s	1.1 s		14.5
160	47.3	14.0 s	1.5 s	0.2 s	1.9 s	0.1 s	21.1
165	66.0	25.2 s	2.6 s	0.4 s	3.2 s	0.2 s	30.0
170	90.1	43.8 s	4.4 s	0.8 s	5.2 s	0.3 s	41.6
175	121	74.2 s	7.1 s	1.3 s	8.3 s	0.6 s	56.6
180	159	122 s	11.3 s	2.2 s	12.7 s	1.2 s	75.6
185	206	197 s	17.3 s	3.4 s	18.9 s	2.1 s	99.2
190	262	280	25.9 s	5.3 s	26.6	3.5 s	128
195	330	376	38.0 s	8.0 s	36.7	5.8 s	163
200	410	488	54.4 s	11.7 s	49.8	8.7	205
205	503	618	76.6 s	16.8 s	66.4	12.6	254
210	611	766	106 s	23.6 s	87.1	17.9	312
215	736	932	145 s	32.5 s	113	24.9	379
220	877	1117	195 s	44.0 s	144	34.1	456
225	1037	1324	249	56.2	182	45.9	544
230	1217	1555	305	71.4	227	60.8	644
235	1418	1816	371	89.7	281	79.6	756
240	1640	2111	448	112	344	103	881
245	1885	2449	536	137	416	131	1019
250	2154	2841	636	168	500	165	1172
255	2448	3301	750	203	597	207	1341
260	2767		878	244	706	256	1525
265	3112		1021	290	830	313	1725
270			1181	343	969	381	1942
275			1358	404	1124	460	2176
280			1554	472	1297	552	2428
285			1768	548	1488	655	2699
290			2003	633	1698	774	2987
295			2258	727	1929	909	3295
300			2534	831	2181	1062	3621
Ref.	12	12	12,15	12	12,15	11	12

<i>T</i> /K	H <sub>4</sub> Si Silane	Kr Krypton	NO Nitric oxide	N <sub>2</sub> Nitrogen	N <sub>2</sub> O Nitrous oxide	O <sub>2</sub> Oxygen	O <sub>2</sub> S Sulfur dioxide
50				0.4 s			
55				1.8 s		0.2	
60				6.3 s		0.7	
65				17.4		2.3	
70				38.6		6.3	
75		0.1 s		76.1		14.5	
80		0.4 s		137		30.1	
85		1.1 s	0.1 s	229		56.8	
90		2.7 s	0.4 s	361		99.3	
95	0.1	6.0 s	1.3 s	541		163	
100	0.2	12.1 s	3.8 s	779		254	
105	0.4	22.8 s	10.0 s	1084		379	
110	1.0	40.4 s	23.5	1467		543	
115	1.9	68.0 s	46.8	1939	0.1	756	
120	3.5	103	86.5	2513	0.1	1022	
125	6.1	150	151	3209	0.3	1351	
130	10.0	211	248		0.7	1749	
135	15.8	290	391		1.3	2225	
140	24.1	388	592		2.5	2788	
145	35.3	509	867		4.3	3448	
150	50.3	655	1231		7.1	4219	
155	69.8	830	1703		11.4		
160	94.6	1037	2302		17.6		
165	126	1278	3050		26.4		
170	164	1557	3971		38.5		0.1
175	210	1877	5089		54.7		0.2
180	265	2241	6433		75.9		0.3
185	331	2655			103		0.5
190	408	3120			138		0.8
195	498	3641			181		1.3
200	602	4223			234		2.0
205	722	4870			298		3.0
210	859				374		4.4
215	1017				465		6.3
220	1196				571		9.0
225	1398				694		12.6
230	1628				835		17.3
235	1888				996		23.3
240	2180				1179		31.1
245	2509				1385		40.9
250	2880				1615		53.2
255	3296				1870		68.3
260	3763				2152		86.7
265	4288				2462		109
270					2802		136
275					3172		168
280					3573		205
285					4006		249
290					4473		300
295					4973		359
300					5508		426
Ref.	12	13, 15	12, 15	1	12	3	12

<i>T</i> /K	O <sub>3</sub> Ozone	Rn Radon	Xe Xenon	CBrF <sub>3</sub> Bromotri- fluoromethane	CClF <sub>3</sub> Chlorotri- fluoromethane	CCl <sub>2</sub> F <sub>2</sub> Dichlorodi- fluoromethane	CCl <sub>3</sub> F Trichloro- fluoromethane
100	0.1		0.1 s				
105	0.2		0.1 s				
110	0.4		0.3 s				
115	1.0		0.7 s		0.1		
120	2.0		1.5 s		0.2		
125	3.8		2.7 s		0.3		
130	6.8	0.1	4.9 s		0.6		



<i>T</i> /K	O <sub>3</sub> Ozone	Rn Radon	Xe Xenon	CBrF <sub>3</sub> Bromotri- fluoromethane	CClF <sub>3</sub> Chlorotri- fluoromethane	CCl <sub>2</sub> F <sub>2</sub> Dichlorodi- fluoromethane	CCl <sub>3</sub> F Trichloro- fluoromethane
135	11.5	0.3	8.5 s	0.1	1.1		
140	18.7	0.5	14.0 s	0.3	2.0		
145	29.1	0.9	22.2 s	0.5	3.3		
150	43.7	1.5	34.2 s	0.9	5.3		
155	63.6	2.4	51.1 s	1.5	8.3	0.1	
160	89.9	3.8	74.2 s	2.5	12.6	0.3	
165	124	5.8	101	3.9	18.6	0.5	
170	168	8.6	134	5.9	26.8	0.8	
175	222	12.5	173	8.8	37.6	1.3	
180	289	17.7	222	12.8	51.7	2.1	
185	367	24.5	280	18.1	69.7	3.2	
190	468	33.2	348	25.1	92.3	4.8	0.2
195	584	44.4	428	34.1	120	6.9	0.3
200	721	58.2	521	45.6	155	9.9	0.4
205	881	75.3	628	60.0	196	13.7	0.6
210	1068	96	750	77.8	246	18.8	1.0
215	1285	121	889	99.5	304	25.2	1.4
220	1536	151	1045	126	372	33.3	2.0
225	1824	185	1220	157	451	43.3	2.9
230	2155		1416	194	542	55.5	4.1
235	2534		1633	237	646	70.4	5.6
240	2968		1872	287	763	88.1	7.6
245	3464		2136	344	896	109	10.1
250	4031		2425	410	1044	134	13.3
255	4678		2742	485	1210	163	17.2
260	5417		3087	570	1394	196	22.1
265			3462	665	1598	234	28.0
270			3869	771	1823	278	35.1
275			4310	889	2071	327	43.7
280			4786	1021	2343	383	53.8
285			5299	1166	2641	445	65.7
290				1325	2968	515	79.6
295				1501	3325	593	95.6
300				1692	3716	679	114.1
Ref.	12	15	12,13	12	12	12	12

<i>T</i> /K	CCl <sub>4</sub> Tetrachloro- methane	CF <sub>4</sub> Tetrafluoro- methane	CO Carbon monoxide	COS Carbon oxysulfide	CO <sub>2</sub> Carbon dioxide	CHClF <sub>2</sub> Chlorodifluoro- methane	CHCl <sub>3</sub> Trichloro- methane
50			0.1 s				
55			0.6 s				
60			2.6 s				
65			8.2 s				
70			21.0				
75			44.4				
80			83.7				
85			147				
90		0.1	239				
95		0.3	371				
100		0.8	545				
105		1.7	771				
110		3.4	1067				
115		6.5	1428				
120		11.5	1877				
125		19.3	2400				
130		30.8	3064				
135		47.4			0.1 s		
140		70.2		0.1	0.2 s		
145		101		0.2	0.4 s		
150		141		0.4	0.8 s	0.1	
155		191		0.8	1.7 s	0.3	

$T/K$	$\text{CCl}_4$ Tetrachloro- methane	$\text{CF}_4$ Tetrafluoro- methane	$\text{CO}$ Carbon monoxide	$\text{COS}$ Carbon oxysulfide	$\text{CO}_2$ Carbon dioxide	$\text{CHClF}_2$ Chlorodifluoro- methane	$\text{CHCl}_3$ Trichloro- methane
160		254		1.3	3.1 s	0.5	
165		332		2.2	5.7 s	0.8	
170		425		3.4	9.9 s	1.4	
175		537		5.2	16.8 s	2.3	
180		669		7.8	27.6 s	3.6	
185		824		11.3	44.0 s	5.5	
190		1005		15.9	68.4 s	8.1	
195		1216		22.1	104 s	11.8	
200		1460		30.0	155 s	16.7	
205		1743		40.1	227 s	23.1	
210		2073		52.7	327 s	31.5	
215		2457		68.2	465 s	42.1	0.1
220		2907		87.2	599	55.3	0.2
225		3438		110	734	71.7	0.3
230				137	893	91.6	0.4
235				169	1075	116	0.7
240				207	1283	144	1.0
245				250	1519	178	1.4
250				301	1785	218	2.0
255	1.5			358	2085	264	2.7
260	2.1			423	2419	317	3.7
265	2.8			497	2790	377	5.0
270	3.7			580	3203	446	6.6
275	4.9			673	3658	525	8.7
280	6.4			777	4161	613	11.3
285	8.2			892	4714	711	14.4
290	10.5			1019	5318	821	18.3
295	13.2			1159	5984	944	22.9
300	16.5			1313	6713	1080	28.5
Ref.	12	12	9	12	6, 19	12	12

$T/K$	$\text{CHF}_3$ Trifluoro- methane	$\text{CHN}$ Hydrogen cyanide	$\text{CH}_2\text{Cl}_2$ Dichloro- methane	$\text{CH}_2\text{F}_2$ Difluoro- methane	$\text{CH}_2\text{O}$ Formaldehyde	$\text{CH}_3\text{Cl}$ Chloromethane	$\text{CH}_3\text{F}$ Fluoromethane
120	0.1						
125	0.2						
130	0.4						
135	0.7						0.6
140	1.4			0.1			1.2
145	2.5			0.2			2.1
150	4.3			0.3			3.6
155	7.1			0.6			5.9
160	11.1			1.0			9.3
165	17.0			1.7			14.1
170	25.3			2.8			20.9
175	36.5			4.4			29.9
180	51.4			6.8			42.0
185	70.9			10.2	1.3	2.1	57.6
190	95.8			14.8	2.0	3.1	77.4
195	127			21.2	3.0	4.6	102
200	166	0.1 s	0.1	29.5	4.4	6.7	133
205	214	0.2 s	0.2	40.5	6.4	9.5	171
210	271	0.4 s	0.3	54.5	9.1	13.1	216
215	340	0.6 s	0.4	72.1	12.7	17.9	270
220	421	1 s	0.6	94.1	17.4	24.0	333
225	516	1.5 s	0.9	121	23.4	31.8	408
230	626	2.2 s	1.4	154	31.0	41.4	495
235	754	3.3 s	2.0	193	40.6	53.3	595
240	900	4.7 s	2.8	240	52.5	67.7	711
245	1067	6.8 s	3.8	295	67.0	85.1	843
250	1257	9.7 s	5.3	360	84.6	106	993
255	1472	13.6 s	7.1	434	106	131	1163
260	1713	18.8	9.5	521	131	159	1355

T/K	CHF <sub>3</sub> Trifluoro- methane	CHN Hydrogen cyanide	CH <sub>2</sub> Cl <sub>2</sub> Dichloro- methane	CH <sub>2</sub> F <sub>2</sub> Difluoro- methane	CH <sub>2</sub> O Formaldehyde	CH <sub>3</sub> Cl Chloromethane	CH <sub>3</sub> F Fluoromethane
265	1984	24.1	12.4	620	161	193	1571
270	2287	30.5	16.1	732	196	232	1813
275	2624	38.3	20.7	860	236	277	2084
280	3000	47.7	26.3	1004	283	327	2387
285	3418	58.8	33.0	1165	337	385	2724
290	3881	72.1	41.1	1346	399	450	3099
295	4393	87.6	50.8	1547	470	524	3516
300		105.9	62.1	1770	549	606	3978
Ref.	12	12,16	12	12	12	12	12

T/K	CH <sub>4</sub> Methane	CH <sub>4</sub> O Methanol	C <sub>2</sub> H <sub>2</sub> Acetylene	C <sub>2</sub> H <sub>4</sub> Ethylene	C <sub>2</sub> H <sub>6</sub> Ethane	C <sub>2</sub> H <sub>6</sub> O Dimethyl ether	C <sub>3</sub> H <sub>4</sub> Propadiene
65	0.1						
70	0.3						
75	0.8						
80	2.1						
85	4.9						
90	10.6						
95	20.0						
100	34.5						
105	57.0						
110	88.4			0.3			
115	133			0.8	0.1		
120	192			1.4	0.4		
125	269			2.7	0.7		
130	368		0.1 s	4.5	1.3		
135	491		0.3 s	7.7	2.2		
140	642		0.7 s	11.9	3.8		
145	824		1.3 s	18.3	6.0		
150	1041		2.6 s	27.5	9.7		0.1
155	1297		4.6 s	39.9	15.0	0.1	0.2
160	1594		7.8 s	56.4	21.5	0.2	0.3
165	1937		12.8 s	77.9	31.0	0.3	0.6
170	2331		20.6 s	105	42.9	0.5	1.0
175	2779		32.2 s	140	59.0	0.9	1.7
180	3288		49.0 s	182	78.7	1.4	2.7
185	3865		72.9 s	234	104	2.1	4.1
190	4520		106 s	296	135	3.2	6.1
195			146	369	172	4.7	8.9
200			190	456	217	6.8	12.5
205			244	557	271	9.6	17.4
210			309	673	334	13.3	23.7
215			385	806	407	18.1	31.6
220			475	958	492	24.3	41.4
225			579	1128	590	32.1	53.5
230		0.1	699	1321	700	41.9	68.2
235		0.2	837	1535	826	53.9	85.8
240		0.4	993	1774	967	68.6	107
245		0.5	1170	2039	1125	86.3	131
250		0.8	1370	2331	1301	108	160
255		1.2	1593	2652	1496	133	193
260		1.7	1843	3005	1712	162	230
265		2.4	2121	3391	1949	197	273
270		3.3	2429	3813	2210	237	322
275		4.5	2771	4275	2495	283	376
280		6.2	3150		2806	335	438
285		8.3	3567		3146	395	506
290		11	4028		3515	463	582
295		14.4	4535		3917	538	666
300		18.7	5093		4355	623	759
Ref.	2,16	12	12,16	4	2	12	12

T/K	C <sub>3</sub> H <sub>6</sub> Propylene	C <sub>3</sub> H <sub>8</sub> Propane	C <sub>4</sub> H <sub>6</sub> Buta-1,3- diene	C <sub>4</sub> H <sub>10</sub> Butane	C <sub>4</sub> H <sub>10</sub> Isobutane	C <sub>5</sub> H <sub>12</sub> Pentane	C <sub>5</sub> H <sub>12</sub> Neopentane
140	0.1						
145	0.2						
150	0.4						
155	0.7						
160	1.2	0.8			0.1		
165	2.0	1.4			0.1		
170	3.1	2.2	0.1	0.1	0.3		
175	4.7	3.3	0.2	0.2	0.4		
180	7.0	5.0	0.4	0.3	0.7		
185	10.1	7.3	0.6	0.5	1.1		0.1 s
190	14.2	10.5	1.0	0.8	1.7		0.2 s
195	19.7	15.0	1.5	1.3	2.5		0.4 s
200	26.9	20.1	2.3	1.9	3.7		0.7 s
205	35.9	27.0	3.4	2.8	5.3		1.1 s
210	47.3	36.0	4.8	4.0	7.4		1.6 s
215	61.3	47.0	6.7	5.7	10.2		2.4 s
220	78.5	60.0	9.2	7.8	13.8	1.0	3.6 s
225	99.2	77.0	12.5	10.6	18.3	1.5	5.2 s
230	124	97.0	16.7	14.1	24.0	2.1	7.3 s
235	153	120	21.9	18.5	31.1	3.0	10.2 s
240	188	148	28.4	24.1	39.8	4.2	13.9 s
245	228	180	36.3	30.9	50.3	5.7	18.7 s
250	274	218	46.0	39.1	62.9	7.6	24.8 s
255	327	261	57.6	49.1	77.8	10.0	32.4 s
260	387	311	71.3	61.0	95.4	13.0	41.6
265	456	367	87.6	75.0	116	16.6	51.4
270	533	431	107	91.5	140	21.1	63.0
275	619	502	129	111	167	26.6	76.6
280	715	582	154	133	198	33.1	92.3
285	822	671	184	159	234	40.8	111
290	940	769	217	188	274	50.0	131
295	1069	878	255	221	319	60.7	155
300	1212	998	297	258	370	73.2	182
Ref.	7	2	12	2	2	14	12,16

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# IUPAC RECOMMENDED DATA FOR VAPOR PRESSURE CALIBRATION

These precise vapor pressure values are recommended as secondary standards. Values are given in kPa (1 kPa = 0.0098692 atm = 7.5006 Torr). Reprinted by permission of IUPAC.

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T/K	CO <sub>2</sub> (s)	H <sub>2</sub> O(s)	C <sub>10</sub> H <sub>8</sub> (s)	n-C <sub>5</sub> H <sub>12</sub>	C <sub>6</sub> H <sub>6</sub>	C <sub>6</sub> F <sub>6</sub>	H <sub>2</sub> O	Hg
180	27.62		3.04·10 <sup>-11</sup>					
190	68.44		4.33·10 <sup>-10</sup>					
200	155.11	0.0002	4.69·10 <sup>-9</sup>					
210	327.17	0.0007	4.02·10 <sup>-8</sup>					
220		0.0026	2.82·10 <sup>-7</sup>					
230		0.0089	1.66·10 <sup>-6</sup>					
240		0.0273	8.37·10 <sup>-6</sup>					
250		0.0760	3.69·10 <sup>-5</sup>	7.60				
260		0.1958	1.446·10 <sup>-4</sup>	12.98				
270		0.4701	5.09·10 <sup>-4</sup>	21.15			0.485	
280			0.00163	33.11	5.148	4.322	0.991	
290			0.004798	50.01	8.606	7.463	1.919	
300			0.01308	73.17	13.816	12.328	3.535	
310			0.03328	104.07	21.389	19.576	6.228	
320			0.07956	144.3	32.054	30.009	10.540	
330			0.1797	195.7	46.656	44.578	17.202	
340			0.3854	260.1	66.152	64.380	27.167	
350			0.7884	339.4	91.609	90.664	41.647	
360				435.9	124.192	124.816	62.139	
370				551.5	165.2	168.4	90.453	
380				688.8	215.9	223.0	128.74	
390				850.2	277.7	290.4	179.48	
400				1038	353.2	372.6	245.54	0.138
410				1256	441.0	471.5	330.15	0.215
420				1507	545.5	589.3	436.89	0.329
430				1793	667.6	728.3	569.73	0.493
440				2120	808.8	890.9	732.99	0.724
450				2490	971.1	1080	931.36	1.045
460				2910	1156	1297	1169.9	1.485
470					1366	1547	1453.9	2.078
480					1602	1833	1789.0	2.866
490					1868	2159	2181.4	3.899
500					2164	2530	2637.3	5.239
510					2494	2954	3163.3	6.955
520					2861		3766.4	9.131
530					3267		4453.9	11.861
540					3717		5233.5	15.256
550					4216		6113.4	19.438
560					4770		7102.0	25.547
570							8208.6	30.74
580							9443.0	38.19
590							10816	47.09
600							12339	57.64

## ENTHALPY OF VAPORIZATION

The molar enthalpy (heat) of vaporization  $\Delta_{\text{vap}}H$ , which is defined as the enthalpy change in the conversion of one mole of liquid to gas at constant temperature, is tabulated here for about 950 inorganic and organic compounds. Values are given, when available, both at the normal boiling point  $t_b$ , referred to a pressure of 101.325 kPa (760 mmHg), and at 25°C.

The values in this table were measured either by calorimetric techniques or by application of the Claperyon equation to the variation of vapor pressure with temperature. See Reference 1 for a discussion of the accuracy of different experimental techniques and methods of estimating enthalpy of vaporization at other temperatures. Several of the references present empirical techniques for correlating enthalpy of vaporization with molecular structure.

Compounds are listed by systematic name, with compounds not containing carbon preceding those that do contain carbon. To locate a compound by molecular formula or CAS Registry Number, use the indexes to the table "Physical Constants of Organic Compounds" in Section 3, which point to the entry in that table from which the name can be determined.

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#### *Compounds not containing carbon*

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Aluminum	Al	2519	294	
Aluminum borohydride	AlB <sub>3</sub> H <sub>12</sub>	44.5	30	
Aluminum bromide	AlBr <sub>3</sub>	255	23.5	
Aluminum iodide	AlI <sub>3</sub>	382	32.2	
Ammonia	H <sub>3</sub> N	-33.33	23.33	19.86
Antimony(III) bromide	Br <sub>3</sub> Sb	288	59	
Antimony(III) chloride	Cl <sub>3</sub> Sb	220.3	45.19	
Antimony(III) iodide	I <sub>3</sub> Sb	400	68.6	
Argon	Ar	-185.85	6.43	
Arsenic(III) bromide	AsBr <sub>3</sub>	221	41.8	
Arsenic(III) chloride	AsCl <sub>3</sub>	130	35.01	
Arsenic(III) fluoride	AsF <sub>3</sub>	57.13	29.7	
Arsenic(V) fluoride	AsF <sub>5</sub>	-52.8	20.8	
Arsenic(III) iodide	AsI <sub>3</sub>	424	59.3	
Arsine	AsH <sub>3</sub>	-62.5	16.69	
Barium	Ba	1897	140	
Beryllium chloride	BeCl <sub>2</sub>	482	105	
Beryllium iodide	BeI <sub>2</sub>	590	70.5	
Bismuth	Bi	1564	151	
Bismuth tribromide	BiBr <sub>3</sub>	462	75.4	
Bismuth trichloride	BiCl <sub>3</sub>	441	72.61	
Boron	B	4000	480	
Boron tribromide	BBr <sub>3</sub>	91.3	30.5	
Boron trichloride	BCl <sub>3</sub>	12.5	23.77	23.1
Boron trifluoride	BF <sub>3</sub>	-99.9	19.33	
Boron triiodide	BI <sub>3</sub>	209.5	40.5	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Bromine	Br <sub>2</sub>	58.8	29.96	30.91
Bromine fluoride	BrF	20	25.1	
Bromine pentafluoride	BrF <sub>5</sub>	41.3	30.6	
Bromine trifluoride	BrF <sub>3</sub>	125.8	47.57	
Bromosilane	BrH <sub>3</sub> Si	1.9	24.4	
Cadmium	Cd	767	99.87	
Cadmium bromide	Br <sub>2</sub> Cd	863	115	
Cadmium chloride	CdCl <sub>2</sub>	964	124.3	
Cadmium fluoride	CdF <sub>2</sub>	1750	214	
Cadmium iodide	CdI <sub>2</sub>	744	115	
Chlorine	Cl <sub>2</sub>	-34.04	20.41	17.65
Chlorine dioxide	ClO <sub>2</sub>	11	30	
Chlorine fluoride	ClF	-101.1	24	
Chlorine monoxide	Cl <sub>2</sub> O	2.2	25.9	
Chlorine trifluoride	ClF <sub>3</sub>	11.75	27.53	
Chlorosilane	ClH <sub>3</sub> Si	-30.4	21	
Chlorotrifluorosilane	ClF <sub>3</sub> Si	-70.0	18.7	
Chromium(II) chloride	Cl <sub>2</sub> Cr	1120	197	
Chromium(VI) dichloride dioxide	Cl <sub>2</sub> CrO <sub>2</sub>	117	35.1	
Diborane	B <sub>2</sub> H <sub>6</sub>	-92.49	14.28	
Dibromosilane	Br <sub>2</sub> H <sub>2</sub> Si	66	31	
Dichlorodifluorosilane	Cl <sub>2</sub> F <sub>2</sub> Si	-32	21.2	
Dichlorosilane	Cl <sub>2</sub> H <sub>2</sub> Si	8.3	25	24.2
Difluorine dioxide	F <sub>2</sub> O <sub>2</sub>	-57	19.1	
Difluorosilane	F <sub>2</sub> H <sub>2</sub> Si	-77.8	16.3	
Digermane	Ge <sub>2</sub> H <sub>6</sub>	29	25.1	
Diphosphine	H <sub>4</sub> P <sub>2</sub>	63.5	28.8	
Disilane	H <sub>6</sub> Si <sub>2</sub>	-14.8	21.2	
Fluorine	F <sub>2</sub>	-188.12	6.62	
Fluorine monoxide	F <sub>2</sub> O	-144.3	11.09	
Fluorosilane	FH <sub>3</sub> Si	-98.6	18.8	
Gallium	Ga	2204	254	
Gallium(III) bromide	Br <sub>3</sub> Ga	279	38.9	
Gallium(III) chloride	Cl <sub>3</sub> Ga	201	23.9	
Gallium(III) iodide	GaI <sub>3</sub>	340	56.5	
Germane	GeH <sub>4</sub>	-88.1	14.06	
Germanium	Ge	2833	334	
Germanium(IV) bromide	Br <sub>4</sub> Ge	186.35	41.4	
Germanium(IV) chloride	Cl <sub>4</sub> Ge	86.55	27.9	
Gold	Au	2856	324	
Helium	He	-268.93	0.08	
Hydrazine	H <sub>4</sub> N <sub>2</sub>	113.55	41.8	44.7
Hydrazoic acid	HN <sub>3</sub>	35.7	30.5	
Hydrogen	H <sub>2</sub>	-252.76	0.90	
Hydrogen bromide	BrH	-66.38		12.69
Hydrogen chloride	ClH	-85	16.15	9.08
Hydrogen disulfide	H <sub>2</sub> S <sub>2</sub>	70.7		33.78
Hydrogen iodide	HI	-35.55	19.76	17.36
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	150.2		51.6
Hydrogen selenide	H <sub>2</sub> Se	-41.25	19.7	
Hydrogen sulfide	H <sub>2</sub> S	-59.55	18.67	14.08
Hydrogen telluride	H <sub>2</sub> Te	-2	19.2	
Indium(I) bromide	BrIn	656	92	
Indium(I) iodide	IIn	712	90.8	
Iodine	I <sub>2</sub>	184.4	41.57	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Iodine pentafluoride	F <sub>5</sub> I	100.5	41.3	
Iridium(VI) fluoride	F <sub>6</sub> Ir	53.6	30.9	
Krypton	Kr	-153.34	9.08	
Lead	Pb	1749	179.5	
Lead(II) bromide	Br <sub>2</sub> Pb	892	133	
Lead(II) chloride	Cl <sub>2</sub> Pb	951	127	
Lead(II) fluoride	F <sub>2</sub> Pb	1293	160.4	
Lead(II) iodide	I <sub>2</sub> Pb	872	104	
Lithium fluoride	FLi	1673	147	
Lithium hydroxide	HLiO	1626	188	
Mercury	Hg	356.62	59.11	
Mercury(II) bromide	Br <sub>2</sub> Hg	318	58.89	
Mercury(II) chloride	Cl <sub>2</sub> Hg	304	58.9	
Mercury(II) iodide	HgI <sub>2</sub>	351	59.2	
Molybdenum(V) chloride	Cl <sub>5</sub> Mo	268	62.8	
Molybdenum(V) fluoride	F <sub>5</sub> Mo	213.6	51.8	
Molybdenum(VI) fluoride	F <sub>6</sub> Mo	34.0	29.0	
Molybdenum(VI) oxide	MoO <sub>3</sub>	1155	138	
Molybdenum(VI) oxytetrafluoride	F <sub>4</sub> MoO	186.0	50.6	
Neon	Ne	-246.05	1.71	
Niobium(V) chloride	Cl <sub>5</sub> Nb	247.4	52.7	
Niobium(V) fluoride	F <sub>5</sub> Nb	234	52.3	
Nitric acid	HNO <sub>3</sub>	83		39.1
Nitric oxide	NO	-151.74	13.83	
Nitrogen	N <sub>2</sub>	-195.79	5.57	
Nitrogen tetroxide	N <sub>2</sub> O <sub>4</sub>	21.15	38.12	
Nitrogen trifluoride	F <sub>3</sub> N	-128.75	11.56	
Nitrosyl chloride	ClNO	-5.5	25.78	
Nitrosyl fluoride	FNO	-59.9	19.28	
Nitrous oxide	N <sub>2</sub> O	-88.48	16.53	
Nitryl chloride	ClNO <sub>2</sub>	-15	25.7	
Nitryl fluoride	FNO <sub>2</sub>	-72.4	18.05	
Osmium(V) fluoride	F <sub>5</sub> Os	233	65.6	
Osmium(VI) fluoride	F <sub>6</sub> Os	47.5	28.1	
Oxygen	O <sub>2</sub>	-182.95	6.82	
Pentaborane(11)	B <sub>5</sub> H <sub>11</sub>	65	31.8	
Perchloryl fluoride	ClFO <sub>3</sub>	-46.75	19.33	
Phosphine	H <sub>3</sub> P	-87.75	14.6	
Phosphorothioc trifluoride	F <sub>3</sub> PS	-52.25	19.6	
Phosphorus	P	280.5	12.4	14.2
Phosphorus(III) bromide	Br <sub>3</sub> P	173.2	38.8	
Phosphorus(III) chloride	Cl <sub>3</sub> P	76	30.5	32.1
Phosphorus(III) chloride difluoride	ClF <sub>2</sub> P	-47.3	17.6	
Phosphorus(III) dichloride fluoride	Cl <sub>2</sub> FP	13.85	24.9	
Phosphorus(III) fluoride	F <sub>3</sub> P	-101.8	16.5	
Phosphorus(V) fluoride	F <sub>5</sub> P	-84.6	17.2	
Phosphorus(III) iodide	I <sub>3</sub> P	227	43.9	
Phosphoryl bromide	Br <sub>3</sub> OP	191.7	38	
Phosphoryl chloride	Cl <sub>3</sub> OP	105.5	34.35	38.6
Rhenium(VII) dioxytrifluoride	F <sub>3</sub> O <sub>2</sub> Re	185.4	65.7	
Rhenium(V) fluoride	F <sub>5</sub> Re	221.3	58.1	
Rhenium(VI) fluoride	F <sub>6</sub> Re	33.8	28.7	
Rhenium(VI) oxytetrafluoride	F <sub>4</sub> ORe	171.7	61.0	
Selenium	Se	685	95.48	
Selenium tetrafluoride	F <sub>4</sub> Se	101.6	47.2	



Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Silane	H <sub>4</sub> Si	-111.9	12.1	
Silver(I) bromide	AgBr	1502	198	
Silver(I) chloride	AgCl	1547	199	
Silver(I) iodide	AgI	1506	143.9	
Sodium hydroxide	HNaO	1388	175	
Stannane	H <sub>4</sub> Sn	-51.8	19.05	
Stibine	H <sub>3</sub> Sb	-17	21.3	
Sulfur	S	444.61	45	
Sulfur dioxide	O <sub>2</sub> S	-10.05	24.94	22.92
Sulfur hexafluoride	F <sub>6</sub> S			8.99
Sulfur tetrafluoride	F <sub>4</sub> S	-40.45	26.44	
Sulfur trioxide	O <sub>3</sub> S	44.5	40.69	43.14
Sulfuryl chloride	Cl <sub>2</sub> O <sub>2</sub> S	69.4	31.4	30.1
Tantalum(V) bromide	Br <sub>5</sub> Ta	348.8	62.3	
Tantalum(V) chloride	Cl <sub>5</sub> Ta	239	54.8	
Tantalum(V) fluoride	F <sub>5</sub> Ta	229.5	56.9	
Tellurium	Te	988	114.1	
Tellurium tetrachloride	Cl <sub>4</sub> Te	387	77	
Tetraborane(10)	B <sub>4</sub> H <sub>10</sub>	18	27.1	
Tetrabromosilane	Br <sub>4</sub> Si	154	37.9	
Tetrachlorosilane	Cl <sub>4</sub> Si	57.65	28.7	29.7
Tetrafluorodiborane	B <sub>2</sub> F <sub>4</sub>	-34.0	28	
Tetrafluorohydrazine	F <sub>4</sub> N <sub>2</sub>	-74	13.27	
Tetraiodosilane	I <sub>4</sub> Si	287.35	50.2	
Thallium(I) bromide	BrTl	819	99.56	
Thallium(I) chloride	ClTl	720	102.2	
Thallium(I) iodide	ITl	824	104.7	
Thallium(I) sulfide	STl <sub>2</sub>	1367	154	
Thionitrosyl fluoride (NSF)	FNS	4.8	22.2	
Thionyl chloride	Cl <sub>2</sub> OS	75.6	31.7	31
Thionyl fluoride	F <sub>2</sub> OS	-43.8	21.8	
Thorium(IV) chloride	Cl <sub>4</sub> Th	921	146.4	
Thorium(IV) fluoride	F <sub>4</sub> Th	1680	258	
Tin(II) bromide	Br <sub>2</sub> Sn	639	102	
Tin(IV) bromide	Br <sub>4</sub> Sn	205	43.5	
Tin(II) chloride	Cl <sub>2</sub> Sn	623	86.8	
Tin(IV) chloride	Cl <sub>4</sub> Sn	114.15	34.9	
Tin(II) iodide	I <sub>2</sub> Sn	714	105	
Tin(IV) iodide	I <sub>4</sub> Sn	364.35	56.9	
Titanium(IV) bromide	Br <sub>4</sub> Ti	233.5	44.37	
Titanium(II) chloride	Cl <sub>2</sub> Ti	1500	232	
Titanium(III) chloride	Cl <sub>3</sub> Ti	960	124	
Titanium(IV) chloride	Cl <sub>4</sub> Ti	136.45	36.2	
Titanium(IV) iodide	I <sub>4</sub> Ti	377	58.4	
Tribromosilane	Br <sub>3</sub> HSi	109	34.8	
Trichlorosilane	Cl <sub>3</sub> HSi	33		25.7
Trifluorosilane	F <sub>3</sub> HSi	-95	16.2	
Trigermane	Ge <sub>3</sub> H <sub>8</sub>	110.5	32.2	
Trisilane	H <sub>8</sub> Si <sub>3</sub>	52.9	28.5	
Tungsten(VI) chloride	Cl <sub>6</sub> W	337	52.7	
Tungsten(VI) fluoride	F <sub>6</sub> W	17.1	26.5	
Tungsten(VI) oxytetrachloride	Cl <sub>4</sub> OW	230	67.8	
Tungsten(VI) oxytetrafluoride	F <sub>4</sub> OW	185.9	59.5	
Vanadium(IV) chloride	Cl <sub>4</sub> V	151	41.4	42.5
Vanadium(V) fluoride	F <sub>5</sub> V	48.3	44.52	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Vanadyl trichloride	Cl <sub>3</sub> OV	127	36.78	
Water	H <sub>2</sub> O	99.97	40.65	43.98
Xenon	Xe	-108.09	12.57	
Zinc bromide	Br <sub>2</sub> Zn	670	118	
Zinc chloride	Cl <sub>2</sub> Zn	732	126	
Zinc fluoride	F <sub>2</sub> Zn	1500	190.1	
<i>Compounds containing carbon</i>				
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	20.1	25.76	25.47
Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	117.9	23.70	23.36
Acetic anhydride	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	139.5	38.2	
Acetone	C <sub>3</sub> H <sub>6</sub> O	56.05	29.10	30.99
Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	81.65	29.75	32.94
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	202	43.98	55.40
Acrolein	C <sub>3</sub> H <sub>4</sub> O	52.6	28.3	
Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	77.3	32.6	
Allyl acetate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	103.5	36.3	
Allyl alcohol	C <sub>3</sub> H <sub>6</sub> O	97.4	40.0	
2-Amino-2-methyl-1-propanol	C <sub>4</sub> H <sub>11</sub> NO	165.5	50.6	
Aniline	C <sub>6</sub> H <sub>7</sub> N	184.17	42.44	55.83
Anisole	C <sub>7</sub> H <sub>8</sub> O	153.7	38.97	46.90
Azobutane	C <sub>8</sub> H <sub>18</sub> N <sub>2</sub>			49.31
Azopropane	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	114		39.88
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	178.8	42.5	
Benzene	C <sub>6</sub> H <sub>6</sub>	80.09	30.72	33.83
Benzenethiol	C <sub>6</sub> H <sub>6</sub> S	169.1	39.93	47.56
Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	191.1	45.9	
Benzyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	213	49.4	
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	205.31	50.48	
Benzylamine	C <sub>7</sub> H <sub>9</sub> N	185		60.16
N-Benzylaniline	C <sub>13</sub> H <sub>13</sub> N	306.5		79.6
Benzyl benzoate	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	323.5	53.6	
Bis(2-chloroethyl) ether	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	178.5	45.2	
Bis(ethoxymethyl) ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	140.6	36.17	44.69
Bromobenzene	C <sub>6</sub> H <sub>5</sub> Br	156.06		44.54
1-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	101.6	32.51	36.64
2-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	91.3	30.77	34.41
Bromochloromethane	CH <sub>2</sub> BrCl	68.0	30.0	
2-Bromo-2-chloro-1,1,1-trifluoroethane	C <sub>2</sub> HBrClF <sub>3</sub>	50.2	28.08	29.61
Bromoethane	C <sub>2</sub> H <sub>5</sub> Br	38.5	27.04	28.03
Bromoethene	C <sub>2</sub> H <sub>3</sub> Br	15.8	23.4	
1-Bromoheptane	C <sub>7</sub> H <sub>15</sub> Br	178.9		50.60
1-Bromohexane	C <sub>6</sub> H <sub>13</sub> Br	155.3		45.89
Bromomethane	CH <sub>3</sub> Br	3.5	23.91	22.81
1-Bromo-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Br	91.1	31.33	34.82
2-Bromo-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Br	73.3	29.23	31.81
1-Bromonaphthalene	C <sub>10</sub> H <sub>7</sub> Br	281	39.3	
1-Bromooctane	C <sub>8</sub> H <sub>17</sub> Br	200.8		55.77
1-Bromopentane	C <sub>5</sub> H <sub>11</sub> Br	129.8	35.01	41.28
1-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	71.1	29.84	32.01
2-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	59.5	28.33	30.17
3-Bromopropene	C <sub>3</sub> H <sub>5</sub> Br	70.1	30.24	32.73
1,2-Butadiene	C <sub>4</sub> H <sub>6</sub>	10.9	24.02	23.21
1,3-Butadiene	C <sub>4</sub> H <sub>6</sub>	-4.41	22.47	20.86
Butanal	C <sub>4</sub> H <sub>8</sub> O	74.8	31.5	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Butane	C <sub>4</sub> H <sub>10</sub>	-0.5	22.44	21.02
1,2-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	190.5	52.84	71.55
1,3-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	207.5	54.31	74.46
1,4-Butanediol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	235		77.1
1,4-Butanedithiol	C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	195.5		55.10
Butanenitrile	C <sub>4</sub> H <sub>7</sub> N	117.6	33.68	39.33
1-Butanethiol	C <sub>4</sub> H <sub>10</sub> S	98.5	32.23	36.63
2-Butanethiol	C <sub>4</sub> H <sub>10</sub> S	85.0	30.59	33.99
Butanoic acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	163.75		40.45
Butanoic anhydride	C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	200	50.0	
1-Butanol	C <sub>4</sub> H <sub>10</sub> O	117.73	43.29	52.35
2-Butanol	C <sub>4</sub> H <sub>10</sub> O	99.51	40.75	49.72
2-Butanone	C <sub>4</sub> H <sub>8</sub> O	79.59	31.30	34.79
1-Butene	C <sub>4</sub> H <sub>8</sub>	-6.26	22.07	20.22
<i>cis</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	3.71	23.34	22.16
<i>trans</i> -2-Butene	C <sub>4</sub> H <sub>8</sub>	0.88	22.72	21.40
2-Butoxyethanol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	168.4		56.59
Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	126.1	36.28	43.86
<i>tert</i> -Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	95.1	33.07	38.03
Butylamine	C <sub>4</sub> H <sub>11</sub> N	77.00	31.81	35.72
<i>sec</i> -Butylamine	C <sub>4</sub> H <sub>11</sub> N	62.73	29.92	32.85
<i>tert</i> -Butylamine	C <sub>4</sub> H <sub>11</sub> N	44.04	28.27	29.64
Butylbenzene	C <sub>10</sub> H <sub>14</sub>	183.31	38.87	50.8
<i>sec</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	173.3		48.1
<i>tert</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	169.1		47.6
Butylcyclohexane	C <sub>10</sub> H <sub>20</sub>	180		49.36
Butylcyclopentane	C <sub>9</sub> H <sub>18</sub>	156.6	36.16	45.89
Butylethylamine	C <sub>6</sub> H <sub>15</sub> N	107.5	33.97	40.15
Butyl ethyl ether	C <sub>6</sub> H <sub>14</sub> O	92.3	31.63	36.32
Butyl ethyl sulfide	C <sub>6</sub> H <sub>14</sub> S	144.3	37.01	44.51
Butyl formate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	106.1	36.58	41.11
<i>tert</i> -Butyl isobutyl ether	C <sub>8</sub> H <sub>18</sub> O	112.0	33.11	40.5
Butyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	70.16	29.55	32.37
<i>sec</i> -Butyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	59.1	28.09	30.23
Butyl methyl sulfide	C <sub>5</sub> H <sub>12</sub> S	123.4	34.47	40.46
<i>tert</i> -Butyl methyl sulfide	C <sub>5</sub> H <sub>12</sub> S	98.9	31.47	35.84
Butyl propyl ether	C <sub>7</sub> H <sub>16</sub> O	118.1	33.72	40.22
Butyl vinyl ether	C <sub>6</sub> H <sub>12</sub> O	94	31.58	36.17
1-Butyne	C <sub>4</sub> H <sub>6</sub>	8.08	24.52	23.35
2-Butyne-1,4-diol	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	238		81.5
$\gamma$ -Butyrolactone	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	204	52.2	
Camphor, (+)	C <sub>10</sub> H <sub>16</sub> O	207.4	59.5	
Carbon disulfide	CS <sub>2</sub>	46	26.74	27.51
Carbon monoxide	CO	-191.5	6.04	
2-Chloroaniline	C <sub>6</sub> H <sub>6</sub> ClN	208.8	44.4	
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	131.72	35.19	40.97
1-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	78.4	30.39	33.51
2-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	68.2	29.17	31.53
Chlorodifluoromethane	CHClF <sub>2</sub>	-40.7	20.2	
Chloroethane	C <sub>2</sub> H <sub>5</sub> Cl	12.3	24.65	
2-Chloroethanol	C <sub>2</sub> H <sub>5</sub> ClO	128.6	41.4	
Chloroethene	C <sub>2</sub> H <sub>3</sub> Cl	-13.8	20.8	
1-Chloroheptane	C <sub>7</sub> H <sub>15</sub> Cl	160.4		47.66
1-Chlorohexane	C <sub>6</sub> H <sub>13</sub> Cl	135.1	35.67	42.83
Chloromethane	CH <sub>3</sub> Cl	-24.09	21.40	18.92

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
1-Chloro-3-methylbutane	C <sub>5</sub> H <sub>11</sub> Cl	98.9	32.02	36.24
1-Chloro-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Cl	68.5	29.22	31.67
2-Chloro-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Cl	50.9	27.55	28.98
1-Chloronaphthalene	C <sub>10</sub> H <sub>7</sub> Cl	259	52.1	
1-Chlorooctane	C <sub>8</sub> H <sub>17</sub> Cl	183.5		52.42
Chloropentafluorobenzene	C <sub>6</sub> ClF <sub>5</sub>	117.96	34.76	41.07
Chloropentafluoroethane	C <sub>2</sub> ClF <sub>5</sub>	-39.1	19.41	
1-Chloropentane	C <sub>5</sub> H <sub>11</sub> Cl	108.4	33.15	38.24
2-Chloropentane	C <sub>5</sub> H <sub>11</sub> Cl	97.0	31.79	36.03
1-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	46.5	27.18	28.35
2-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	35.7	26.30	26.90
3-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	45.1	29.0	
2-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	159.0	37.5	
4-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	162.4	38.7	
Chlorotrifluoromethane	CClF <sub>3</sub>	-81.37	15.8	
Cholesterol	C <sub>27</sub> H <sub>46</sub> O	360 dec		148.0
<i>o</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	191.04	45.19	
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	202.27	47.40	61.71
<i>p</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	201.98	47.45	
Cyanogen	C <sub>2</sub> N <sub>2</sub>	-21.1	23.33	19.75
Cyclobutane	C <sub>4</sub> H <sub>8</sub>	12.6	24.19	23.51
Cyclobutanecarbonitrile	C <sub>5</sub> H <sub>7</sub> N	149.6	36.88	44.34
Cyclohexane	C <sub>6</sub> H <sub>12</sub>	80.73	29.97	33.01
Cyclohexanecarbonitrile	C <sub>7</sub> H <sub>11</sub> N	184		51.92
Cyclohexanethiol	C <sub>6</sub> H <sub>12</sub> S	158.8	37.06	44.57
Cyclohexanol	C <sub>6</sub> H <sub>12</sub> O	160.84		62.01
Cyclohexanone	C <sub>6</sub> H <sub>10</sub> O	155.43		45.06
Cyclohexene	C <sub>6</sub> H <sub>10</sub>	82.98	30.46	33.47
1-Cyclohexenecarbonitrile	C <sub>7</sub> H <sub>9</sub> N			53.55
Cyclohexylamine	C <sub>6</sub> H <sub>13</sub> N	134	36.14	43.67
Cyclohexylbenzene	C <sub>12</sub> H <sub>16</sub>	240.1		60.8
Cyclohexylcyclohexane	C <sub>12</sub> H <sub>22</sub>	238		57.98
Cyclopentane	C <sub>5</sub> H <sub>10</sub>	49.3	27.30	28.52
Cyclopentanecarbonitrile	C <sub>6</sub> H <sub>9</sub> N	170		43.43
Cyclopentanethiol	C <sub>5</sub> H <sub>10</sub> S	132.1	35.32	41.42
Cyclopentanol	C <sub>5</sub> H <sub>10</sub> O	140.42		57.05
Cyclopentanone	C <sub>5</sub> H <sub>8</sub> O	130.57	36.35	42.72
1-Cyclopentenecarbonitrile	C <sub>6</sub> H <sub>7</sub> N			44.98
Cyclopropane	C <sub>3</sub> H <sub>6</sub>	-32.81	20.05	16.93
Cyclopropanecarbonitrile	C <sub>4</sub> H <sub>5</sub> N	135.1	35.55	41.94
Cyclopropylbenzene	C <sub>9</sub> H <sub>10</sub>	173.6		50.22
Cyclopropyl methyl ketone	C <sub>5</sub> H <sub>8</sub> O	111.3	34.07	39.41
<i>cis</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	195.8	41.0	
<i>trans</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	187.3	40.2	
Decane	C <sub>10</sub> H <sub>22</sub>	174.15	39.58	51.42
1,10-Decanediol	C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>			120.0
Decanenitrile	C <sub>10</sub> H <sub>19</sub> N	243		66.84
1-Decanethiol	C <sub>10</sub> H <sub>22</sub> S	240.6		65.48
1-Decanol	C <sub>10</sub> H <sub>22</sub> O	231.1		81.50
1-Decene	C <sub>10</sub> H <sub>20</sub>	170.5		50.43
Decylbenzene	C <sub>16</sub> H <sub>26</sub>	293		78.2
1,4-Dibromobutane	C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	197		53.09
1,2-Dibromo-1-chloro-1,2,2-trifluoroethane	C <sub>2</sub> Br <sub>2</sub> ClF <sub>3</sub>	93	31.17	35.04
1,2-Dibromoethane	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	131.6	34.77	41.73
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	97	32.92	36.97

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
1,2-Dibromopropane	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	141.9	35.61	41.67
1,3-Dibromopropane	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	167.3		47.45
1,2-Dibromotetrafluoroethane	C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	47.35	27.03	28.39
Dibutylamine	C <sub>8</sub> H <sub>19</sub> N	159.6	38.44	49.45
Dibutyl ether	C <sub>8</sub> H <sub>18</sub> O	140.28	36.49	44.97
Di- <i>sec</i> -butyl ether	C <sub>8</sub> H <sub>18</sub> O	121.1	34.06	40.84
Di- <i>tert</i> -butyl ether	C <sub>8</sub> H <sub>18</sub> O	107.23	32.15	37.61
Dibutyl phthalate	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	340	79.2	
Dibutyl sulfide	C <sub>8</sub> H <sub>18</sub> S	185		52.96
Di- <i>tert</i> -butyl sulfide	C <sub>8</sub> H <sub>18</sub> S	149.1	33.26	43.76
<i>o</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	180	39.66	50.21
<i>m</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	173	38.62	48.58
<i>p</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	174	38.79	49.0
1,2-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	124.1	33.90	39.58
1,4-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	161		46.36
Dichlorodifluoromethane	CCl <sub>2</sub> F <sub>2</sub>	-29.8	20.1	
1,1-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	57.3	28.85	30.62
1,2-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	83.5	31.98	35.16
1,1-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	31.6	26.14	26.48
<i>cis</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	60.1	30.2	
<i>trans</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	48.7	28.9	
1,1-Dichloro-1-fluoroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	32.0	26.06	26.48
Dichlorofluoromethane	CHCl <sub>2</sub> F	8.9	25.2	
1,2-Dichloro-1,1,2,3,3,3-hexafluoropropane	C <sub>3</sub> Cl <sub>2</sub> F <sub>6</sub>	34.1	26.28	26.93
1,2-Dichlorohexane	C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub>	173		48.16
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	40	28.06	28.82
1,2-Dichloropentane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	148.3	36.45	43.89
1,5-Dichloropentane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	179		50.71
1,3-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	120.9	35.18	40.75
1,2-Dichloro-1,1,2,2-tetrafluoroethane	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	3.5	23.3	
Dicyclopropyl ketone	C <sub>7</sub> H <sub>10</sub> O	161		53.70
Diethanolamine	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	268.8	65.2	
1,1-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	102.25	36.28	43.20
1,2-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	121.2	36.28	43.20
Diethoxymethane	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	88	31.33	35.65
Diethylamine	C <sub>4</sub> H <sub>11</sub> N	55.5	29.06	31.31
Diethyl carbonate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	126		43.60
Diethyl disulfide	C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	154.0	37.58	45.18
Diethylene glycol	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	245.8	52.3	
Diethylene glycol diethyl ether	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	188		58.40
Diethylene glycol dimethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	162	36.17	44.69
Diethylene glycol monoethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	196	47.5	
Diethylene glycol monomethyl ether	C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	193	46.6	
Diethyl ether	C <sub>4</sub> H <sub>10</sub> O	34.5	26.52	27.10
Diethyl malonate	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	200	54.8	
Diethyl oxalate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	185.7	42.0	
3,3-Diethylpentane	C <sub>9</sub> H <sub>20</sub>	146.3	34.61	42.0
Diethyl sulfide	C <sub>4</sub> H <sub>10</sub> S	92.1	31.77	35.80
<i>o</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	94	32.21	36.18
<i>m</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	82.6	31.10	34.59
<i>p</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	89	31.77	35.54
1,1-Difluoroethane	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	-24.05	21.56	19.08
2,3-Dihydrothiophene	C <sub>4</sub> H <sub>6</sub> S	112.1	33.24	37.74
2,5-Dihydrothiophene	C <sub>4</sub> H <sub>6</sub> S	122.4	34.83	39.95
Diiodomethane	CH <sub>2</sub> I <sub>2</sub>	182	42.5	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Diisobutyl sulfide	$\text{C}_8\text{H}_{18}\text{S}$	171		48.71
Diisopentyl ether	$\text{C}_{10}\text{H}_{22}\text{O}$	172.5	35.1	
Diisopropylamine	$\text{C}_6\text{H}_{15}\text{N}$	83.9	30.40	34.61
Diisopropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	68.4	29.10	32.12
Diisopropyl sulfide	$\text{C}_6\text{H}_{14}\text{S}$	120.0	33.80	39.60
Diketene	$\text{C}_4\text{H}_4\text{O}_2$	126.1	36.80	42.89
1,2-Dimethoxyethane	$\text{C}_4\text{H}_{10}\text{O}_2$	84.5	32.42	36.39
<i>N,N</i> -Dimethylacetamide	$\text{C}_4\text{H}_9\text{NO}$	165		50.24
Dimethylamine	$\text{C}_2\text{H}_7\text{N}$	6.88	26.40	25.05
2,4-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	214		61.3
2,5-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	214		61.7
<i>N,N</i> -Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	194.15		52.83
2,2-Dimethylbutane	$\text{C}_6\text{H}_{14}$	49.73	26.31	27.68
2,3-Dimethylbutane	$\text{C}_6\text{H}_{14}$	57.93	27.38	29.12
2,3-Dimethyl-2-butanethiol	$\text{C}_6\text{H}_{14}\text{S}$	126.1		39.3
3,3-Dimethyl-2-butanone	$\text{C}_6\text{H}_{12}\text{O}$	106.1	33.39	37.91
2,3-Dimethyl-1-butene	$\text{C}_6\text{H}_{12}$	55.6		29.18
3,3-Dimethyl-1-butene	$\text{C}_6\text{H}_{12}$	41.2		26.61
2,3-Dimethyl-2-butene	$\text{C}_6\text{H}_{12}$	73.3	29.64	32.51
1,1-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	119.6	32.51	37.92
<i>cis</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	129.8	33.47	39.70
<i>trans</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	123.5	32.96	38.36
<i>cis</i> -1,3-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	120.1	32.91	38.26
<i>trans</i> -1,3-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	124.5	33.39	39.16
<i>cis</i> -1,4-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	124.4	33.28	39.02
<i>trans</i> -1,4-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	119.4	32.56	37.90
<i>cis</i> -1,3-Dimethylcyclopentane	$\text{C}_7\text{H}_{14}$	90.8	30.40	34.20
Dimethyl decanedioate	$\text{C}_{12}\text{H}_{22}\text{O}_4$			86.4
Dimethyl disulfide	$\text{C}_2\text{H}_6\text{S}_2$	109.74	33.78	37.86
Dimethyl ether	$\text{C}_2\text{H}_6\text{O}$	-24.8	21.51	18.51
<i>N,N</i> -Dimethylformamide	$\text{C}_3\text{H}_7\text{NO}$	153		46.89
Dimethyl glutarate	$\text{C}_7\text{H}_{12}\text{O}_4$	214		65.7
Dimethyl heptanedioate	$\text{C}_9\text{H}_{16}\text{O}_4$			73.5
2,6-Dimethyl-4-heptanol	$\text{C}_9\text{H}_{20}\text{O}$	174.5		65.17
2,6-Dimethyl-4-heptanone	$\text{C}_9\text{H}_{18}\text{O}$	169.4		50.92
2,2-Dimethylhexane	$\text{C}_8\text{H}_{18}$	106.86	32.07	37.28
2,3-Dimethylhexane	$\text{C}_8\text{H}_{18}$	115.62	33.17	38.78
2,4-Dimethylhexane	$\text{C}_8\text{H}_{18}$	109.5	32.51	37.76
2,5-Dimethylhexane	$\text{C}_8\text{H}_{18}$	109.12	32.54	37.85
3,3-Dimethylhexane	$\text{C}_8\text{H}_{18}$	111.97	32.31	37.53
3,4-Dimethylhexane	$\text{C}_8\text{H}_{18}$	117.73	33.24	38.97
Dimethyl 1,6-hexanedioate	$\text{C}_8\text{H}_{14}\text{O}_4$			69.0
2,5-Dimethyl-2,5-hexanediol	$\text{C}_8\text{H}_{18}\text{O}_2$	214		85.2
<i>cis</i> -2,2-Dimethyl-3-hexene	$\text{C}_8\text{H}_{16}$	105.5		36.86
<i>trans</i> -2,2-Dimethyl-3-hexene	$\text{C}_8\text{H}_{16}$	100.8		37.03
2,5-Dimethyl-3-hexyne-2,5-diol	$\text{C}_8\text{H}_{14}\text{O}_2$	205		82.8
1,1-Dimethylhydrazine	$\text{C}_2\text{H}_8\text{N}_2$	63.9	32.55	35.0
Dimethyl malonate	$\text{C}_5\text{H}_8\text{O}_4$	181.4		57.5
Dimethyl nonanedioate	$\text{C}_{11}\text{H}_{20}\text{O}_4$			82.3
2,4-Dimethyloctane	$\text{C}_{10}\text{H}_{22}$	156	36.47	47.13
Dimethyl octanedioate	$\text{C}_{10}\text{H}_{18}\text{O}_4$	268		78.1
Dimethyl oxalate	$\text{C}_4\text{H}_6\text{O}_4$	163.5		54.7
3,3-Dimethyloxetane	$\text{C}_5\text{H}_{10}\text{O}$	80.6	30.85	33.94
2,2-Dimethylpentane	$\text{C}_7\text{H}_{16}$	79.2	29.23	32.42
2,3-Dimethylpentane	$\text{C}_7\text{H}_{16}$	89.78	30.46	34.26

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
2,4-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	80.49	29.55	32.88
3,3-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	86.06	29.62	33.03
2,2-Dimethyl-3-pentanone	C <sub>7</sub> H <sub>14</sub> O	125.6	36.09	42.34
2,4-Dimethyl-3-pentanone	C <sub>7</sub> H <sub>14</sub> O	125.4	34.64	41.51
2,4-Dimethyl-1-pentene	C <sub>7</sub> H <sub>14</sub>	81.6		33.03
4,4-Dimethyl-1-pentene	C <sub>7</sub> H <sub>14</sub>	72.5		31.13
2,4-Dimethyl-2-pentene	C <sub>7</sub> H <sub>14</sub>	83.4		34.19
<i>cis</i> -4,4-Dimethyl-2-pentene	C <sub>7</sub> H <sub>14</sub>	80.4		32.56
<i>trans</i> -4,4-Dimethyl-2-pentene	C <sub>7</sub> H <sub>14</sub>	76.7		32.81
2,2-Dimethylpropanenitrile	C <sub>5</sub> H <sub>9</sub> N	106.1	32.40	37.35
2,2-Dimethyl-1-propanethiol	C <sub>5</sub> H <sub>12</sub> S	103.7		36.4
2,3-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	161.12	39.08	47.82
2,4-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	158.38	38.53	47.49
2,5-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	156.98	38.68	47.04
2,6-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	144.01	37.46	45.34
3,4-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	179.10	39.99	50.50
3,5-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	171.84	39.46	49.33
Dimethyl succinate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	196.4		61.0
Dimethyl sulfide	C <sub>2</sub> H <sub>6</sub> S	37.33	27.0	27.65
Dimethyl sulfoxide	C <sub>2</sub> H <sub>6</sub> OS	189	43.1	
1,3-Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	106.1	34.37	39.09
1,4-Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	101.5	34.16	38.60
Diphenyl ether	C <sub>12</sub> H <sub>10</sub> O	258.0	48.2	
1,2-Dipropoxyethane	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	163.2		50.62
Dipropylamine	C <sub>6</sub> H <sub>15</sub> N	109.3	33.47	40.04
Dipropyl ether	C <sub>6</sub> H <sub>14</sub> O	90.08	31.31	35.69
Dipropyl sulfide	C <sub>6</sub> H <sub>14</sub> S	142.9	36.60	44.21
1-Docosanol	C <sub>22</sub> H <sub>46</sub> O			135.9
Dodecane	C <sub>12</sub> H <sub>26</sub>	216.32	44.09	61.52
1,12-Dodecanediol	C <sub>12</sub> H <sub>26</sub> O <sub>2</sub>			135
Dodecanenitrile	C <sub>12</sub> H <sub>23</sub> N	277		76.12
1-Dodecanol	C <sub>12</sub> H <sub>26</sub> O	260		90.8
1-Dodecene	C <sub>12</sub> H <sub>24</sub>	213.8		60.78
Dodecylbenzene	C <sub>18</sub> H <sub>30</sub>	328		86.6
Eicosane	C <sub>20</sub> H <sub>42</sub>	343	58.49	101.81
1-Eicosanol	C <sub>20</sub> H <sub>42</sub> O	356		125.9
1,2-Epoxybutane	C <sub>4</sub> H <sub>8</sub> O	63.4	30.3	
Ethane	C <sub>2</sub> H <sub>6</sub>	-88.6	14.69	5.16
1,2-Ethanediamine	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	117	37.98	44.98
1,2-Ethanediol	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	197.3	50.5	63.9
1,2-Ethanediol, diacetate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	190		61.44
1,2-Ethanedithiol	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	146.1	37.93	44.68
Ethanethiol	C <sub>2</sub> H <sub>6</sub> S	35.0	26.79	27.30
Ethanol	C <sub>2</sub> H <sub>6</sub> O	78.29	38.56	42.32
Ethanolamine	C <sub>2</sub> H <sub>7</sub> NO	171	49.83	
Ethoxybenzene	C <sub>8</sub> H <sub>10</sub> O	169.81		51.04
2-Ethoxyethanol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	135	39.22	48.21
2-Ethoxyethyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	156.4	40.76	52.61
1-Ethoxy-2-methoxyethane	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	103.5	34.33	39.83
<i>N</i> -Ethylacetamide	C <sub>4</sub> H <sub>9</sub> NO	205		64.89
Ethyl acetate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	77.11	31.94	35.60
Ethyl acrylate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	99.4	34.7	
<i>N</i> -Ethylaniline	C <sub>8</sub> H <sub>11</sub> N	203.0		58.3
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	136.16	35.57	42.24
Ethyl butanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	121.3	35.47	42.68

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
2-Ethyl-1-butanol	$\text{C}_6\text{H}_{14}\text{O}$	147	43.2	
2-Ethyl-1-butene	$\text{C}_6\text{H}_{12}$	64.7		31.13
Ethyl chloroacetate	$\text{C}_4\text{H}_7\text{ClO}_2$	144.3	40.43	49.47
Ethylcyclobutane	$\text{C}_6\text{H}_{12}$	70.8	28.67	31.24
Ethylcyclohexane	$\text{C}_8\text{H}_{16}$	131.9	34.04	40.56
Ethylcyclopentane	$\text{C}_7\text{H}_{14}$	103.5	31.96	36.40
Ethyl dichloroacetate	$\text{C}_4\text{H}_6\text{Cl}_2\text{O}_2$	155		50.60
Ethyl 2,2-dimethylpropanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	118.4	34.51	41.25
Ethylene	$\text{C}_2\text{H}_4$	-103.77	13.53	
<i>N</i> -Ethylformamide	$\text{C}_3\text{H}_7\text{NO}$	198		58.44
Ethyl formate	$\text{C}_3\text{H}_6\text{O}_2$	54.4	29.91	31.96
3-Ethylhexane	$\text{C}_8\text{H}_{18}$	118.6	33.59	39.64
Ethyl hexanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	167		51.72
2-Ethylhexanoic acid	$\text{C}_8\text{H}_{16}\text{O}_2$	228		75.60
2-Ethyl-1-hexanol	$\text{C}_8\text{H}_{18}\text{O}$	184.6	54.2	68.51
2-Ethylhexyl acetate	$\text{C}_{10}\text{H}_{20}\text{O}_2$	199	43.5	
2-Ethylhexylamine	$\text{C}_8\text{H}_{19}\text{N}$	169.2	40.0	
Ethylisopropylamine	$\text{C}_5\text{H}_{13}\text{N}$	69.6	29.94	33.13
Ethyl isopropyl ether	$\text{C}_5\text{H}_{12}\text{O}$	54.1	28.21	30.08
Ethyl isopropyl sulfide	$\text{C}_5\text{H}_{12}\text{S}$	107.5	32.74	37.78
Ethyl 3-methylbutanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	135.0	37.0	
2-Ethyl-3-methyl-1-butene	$\text{C}_7\text{H}_{14}$	89		34.35
1-Ethyl-1-methylcyclopentane	$\text{C}_8\text{H}_{16}$	121.6	33.20	38.85
3-Ethyl-2-methylpentane	$\text{C}_8\text{H}_{18}$	115.66	32.93	38.52
3-Ethyl-3-methylpentane	$\text{C}_8\text{H}_{18}$	118.27	32.78	37.99
3-Ethyl-2-methyl-1-pentene	$\text{C}_8\text{H}_{16}$	109.5		37.27
Ethyl 2-methylpropanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	110.1	33.67	39.83
Ethyl methyl sulfide	$\text{C}_3\text{H}_8\text{S}$	66.7	29.53	31.85
3-Ethylpentane	$\text{C}_7\text{H}_{16}$	93.5	31.12	35.22
Ethyl pentanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	146.1	36.96	47.01
3-Ethyl-3-pentanol	$\text{C}_7\text{H}_{16}\text{O}$	142		57.34
Ethyl pentyl ether	$\text{C}_7\text{H}_{16}\text{O}$	117.6	34.41	41.01
Ethyl propanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	99.1	33.88	39.21
Ethyl propyl ether	$\text{C}_5\text{H}_{12}\text{O}$	63.21	28.94	31.43
Ethyl propyl sulfide	$\text{C}_5\text{H}_{12}\text{S}$	118.6	34.24	39.97
Ethyl trichloroacetate	$\text{C}_4\text{H}_5\text{Cl}_3\text{O}_2$	167.5		50.97
Ethyl vinyl ether	$\text{C}_4\text{H}_8\text{O}$	35.5	26.2	
Fluorobenzene	$\text{C}_6\text{H}_5\text{F}$	84.73	31.19	34.58
1-Fluorooctane	$\text{C}_8\text{H}_{17}\text{F}$	142.3	40.43	49.65
2-Fluorotoluene	$\text{C}_7\text{H}_7\text{F}$	115	35.4	
4-Fluorotoluene	$\text{C}_7\text{H}_7\text{F}$	116.6	34.08	39.42
Formamide	$\text{CH}_3\text{NO}$	220		60.15
Formic acid	$\text{CH}_2\text{O}_2$	101	22.69	20.10
Furan	$\text{C}_4\text{H}_4\text{O}$	31.5	27.10	27.45
Furfural	$\text{C}_5\text{H}_4\text{O}_2$	161.7	43.2	
Furfuryl alcohol	$\text{C}_5\text{H}_6\text{O}_2$	171	53.6	
Glycerol	$\text{C}_3\text{H}_8\text{O}_3$	290	61.0	
Glycerol triacetate	$\text{C}_9\text{H}_{14}\text{O}_6$	259		85.74
Heptadecane	$\text{C}_{17}\text{H}_{36}$	302.0	53.58	86.47
1-Heptadecanol	$\text{C}_{17}\text{H}_{36}\text{O}$	324		112.5
6-Heptadecanol	$\text{C}_{17}\text{H}_{36}\text{O}$			108.6
7-Heptadecanol	$\text{C}_{17}\text{H}_{36}\text{O}$			108.2
9-Heptadecanol	$\text{C}_{17}\text{H}_{36}\text{O}$			108.5
Heptane	$\text{C}_7\text{H}_{16}$	98.4	31.77	36.57
1,7-Heptanediol	$\text{C}_7\text{H}_{16}\text{O}_2$	262		97.9



Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
1-Heptanol	C <sub>7</sub> H <sub>16</sub> O	176.45		66.81
3-Heptanol	C <sub>7</sub> H <sub>16</sub> O	157	42.5	
2-Heptanone	C <sub>7</sub> H <sub>14</sub> O	151.05		47.24
1-Heptene	C <sub>7</sub> H <sub>14</sub>	93.64		35.49
<i>cis</i> -2-Heptene	C <sub>7</sub> H <sub>14</sub>	98.4		36.26
<i>trans</i> -2-Heptene	C <sub>7</sub> H <sub>14</sub>	98		36.27
<i>cis</i> -3-Heptene	C <sub>7</sub> H <sub>14</sub>	95.8		35.81
<i>trans</i> -3-Heptene	C <sub>7</sub> H <sub>14</sub>	95.7		35.84
Heptylamine	C <sub>7</sub> H <sub>17</sub> N	156		49.96
Heptylbenzene	C <sub>13</sub> H <sub>20</sub>	240		64.2
1-Hexacosanol	C <sub>26</sub> H <sub>54</sub> O			153.7
Hexadecane	C <sub>16</sub> H <sub>34</sub>	286.86	51.84	81.35
1,16-Hexadecanediol	C <sub>16</sub> H <sub>34</sub> O <sub>2</sub>			163
1-Hexadecanol	C <sub>16</sub> H <sub>34</sub> O	312		107.7
1-Hexadecene	C <sub>16</sub> H <sub>32</sub>	284.9		80.25
Hexadecylbenzene	C <sub>22</sub> H <sub>38</sub>	385		104.8
Hexafluoroacetylacetone	C <sub>5</sub> H <sub>2</sub> F <sub>6</sub> O <sub>2</sub>	54.15	27.05	30.58
Hexafluorobenzene	C <sub>6</sub> F <sub>6</sub>	80.32	31.66	35.71
Hexafluoroethane	C <sub>2</sub> F <sub>6</sub>	-78.1	16.15	
Hexane	C <sub>6</sub> H <sub>14</sub>	68.73	28.85	31.56
1,6-Hexanediol	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	208		90.2
Hexanenitrile	C <sub>6</sub> H <sub>11</sub> N	163.65		47.91
1-Hexanol	C <sub>6</sub> H <sub>14</sub> O	157.6	44.50	61.61
2-Hexanol	C <sub>6</sub> H <sub>14</sub> O	140	41.01	58.46
2-Hexanone	C <sub>6</sub> H <sub>12</sub> O	127.6	36.35	43.14
3-Hexanone	C <sub>6</sub> H <sub>12</sub> O	123.5	35.36	42.47
1-Hexene	C <sub>6</sub> H <sub>12</sub>	63.48		30.61
<i>cis</i> -2-Hexene	C <sub>6</sub> H <sub>12</sub>	68.8		32.19
<i>trans</i> -2-Hexene	C <sub>6</sub> H <sub>12</sub>	67.9		31.60
<i>cis</i> -3-Hexene	C <sub>6</sub> H <sub>12</sub>	66.4		31.23
<i>trans</i> -3-Hexene	C <sub>6</sub> H <sub>12</sub>	67.1		31.55
Hexylamine	C <sub>6</sub> H <sub>15</sub> N	132.8	36.54	45.10
Hexylbenzene	C <sub>12</sub> H <sub>18</sub>	226.1		60.4
Hexyl methyl ether	C <sub>7</sub> H <sub>16</sub> O	126.1	34.93	42.07
Indan	C <sub>9</sub> H <sub>10</sub>	177.97	39.63	48.79
Iodobenzene	C <sub>6</sub> H <sub>5</sub> I	188.4	39.5	
1-Iodobutane	C <sub>4</sub> H <sub>9</sub> I	130.5	34.66	40.63
2-Iodobutane	C <sub>4</sub> H <sub>9</sub> I	120.1	33.27	38.46
Iodoethane	C <sub>2</sub> H <sub>5</sub> I	72.3	29.44	31.93
1-Iodoheptane	C <sub>6</sub> H <sub>13</sub> I	181.3		49.75
Iodomethane	CH <sub>3</sub> I	42.43	27.34	27.97
1-Iodo-2-methylpropane	C <sub>4</sub> H <sub>9</sub> I	121.1	33.54	38.83
2-Iodo-2-methylpropane	C <sub>4</sub> H <sub>9</sub> I	100.1	31.43	35.41
1-Iodopentane	C <sub>5</sub> H <sub>11</sub> I	157.0		45.27
1-Iodopropane	C <sub>3</sub> H <sub>7</sub> I	102.5	32.08	36.25
2-Iodopropane	C <sub>3</sub> H <sub>7</sub> I	89.5	30.68	34.06
Isobutane	C <sub>4</sub> H <sub>10</sub>	-11.73	21.30	19.23
Isobutyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.5	35.9	
Isobutylamine	C <sub>4</sub> H <sub>11</sub> N	67.75	30.61	33.85
Isobutylbenzene	C <sub>10</sub> H <sub>14</sub>	172.79		48.0
Isobutyl formate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	98.2	33.6	
Isobutyl isobutanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	148.6	38.2	
Isobutyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	58.6	28.02	30.13
Isopentane	C <sub>5</sub> H <sub>12</sub>	27.88	24.69	24.85
Isopentyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	142.5	37.5	

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Isopentyl isopentanoate	$\text{C}_{10}\text{H}_{20}\text{O}_2$	190.4	45.9	
Isopropyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	88.7	32.93	37.20
Isopropylamine	$\text{C}_3\text{H}_9\text{N}$	31.76	27.83	28.36
Isopropylbenzene	$\text{C}_9\text{H}_{12}$	152.41		45.13
Isopropylcyclohexane	$\text{C}_9\text{H}_{18}$	154.8		44.02
Isopropylcyclopentane	$\text{C}_8\text{H}_{16}$	126.5	33.56	39.44
Isopropylmethylamine	$\text{C}_4\text{H}_{11}\text{N}$	50.4	28.71	30.69
1-Isopropyl-4-methylbenzene	$\text{C}_{10}\text{H}_{14}$	177.1	38.2	
Isopropyl methyl ether	$\text{C}_4\text{H}_{10}\text{O}$	30.77	26.05	26.41
Isopropyl methyl sulfide	$\text{C}_4\text{H}_{10}\text{S}$	84.8	30.71	34.15
Isopropylpropylamine	$\text{C}_6\text{H}_{15}\text{N}$	96.9	32.14	37.23
Isopropyl propyl sulfide	$\text{C}_6\text{H}_{14}\text{S}$	132.1	35.11	41.78
Isoquinoline	$\text{C}_9\text{H}_7\text{N}$	243.22	49.0	60.26
Mesityl oxide	$\text{C}_6\text{H}_{10}\text{O}$	130	36.1	
Methane	$\text{CH}_4$	-161.48	8.19	
Methanol	$\text{CH}_3\text{O}$	64.6	35.21	37.43
2-Methoxyethanol	$\text{C}_3\text{H}_8\text{O}_2$	124.1	37.54	45.17
2-Methoxyethyl acetate	$\text{C}_5\text{H}_{10}\text{O}_3$	143	43.9	
Methyl acetate	$\text{C}_3\text{H}_6\text{O}_2$	56.87	30.32	32.29
Methyl acrylate	$\text{C}_4\text{H}_6\text{O}_2$	80.7	33.1	
2-Methylacrylonitrile	$\text{C}_4\text{H}_5\text{N}$	90.3	31.8	
Methylamine	$\text{CH}_5\text{N}$	-6.32	25.60	23.37
2-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	200.3	44.6	
3-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	203.3	44.9	
4-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	200.4	44.3	
Methyl benzoate	$\text{C}_8\text{H}_8\text{O}_2$	199		55.57
1-Methylbicyclo[3,1,0]hexane	$\text{C}_7\text{H}_{12}$	93.1	31.07	34.77
3-Methylbutanenitrile	$\text{C}_5\text{H}_9\text{N}$	127.5	35.10	41.64
2-Methyl-1-butanethiol	$\text{C}_5\text{H}_{12}\text{S}$	119.1	33.79	39.45
2-Methyl-2-butanethiol	$\text{C}_5\text{H}_{12}\text{S}$	99.1	31.37	35.67
3-Methyl-2-butanethiol	$\text{C}_5\text{H}_{12}\text{S}$	109.8		37.5
Methyl butanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	102.8	33.79	39.28
2-Methylbutanoic acid	$\text{C}_5\text{H}_{10}\text{O}_2$	177		46.91
2-Methyl-1-butanol	$\text{C}_5\text{H}_{12}\text{O}$	127.5		55.16
3-Methyl-1-butanol	$\text{C}_5\text{H}_{12}\text{O}$	131.1	44.07	55.61
2-Methyl-2-butanol	$\text{C}_5\text{H}_{12}\text{O}$	102.4	39.04	50.10
3-Methyl-2-butanol	$\text{C}_5\text{H}_{12}\text{O}$	112.9		53.0
3-Methyl-2-butanone	$\text{C}_5\text{H}_{10}\text{O}$	94.33	32.35	36.78
2-Methyl-1-butene	$\text{C}_5\text{H}_{10}$	31.2	25.50	25.92
3-Methyl-1-butene	$\text{C}_5\text{H}_{10}$	20.1		23.77
2-Methyl-2-butene	$\text{C}_5\text{H}_{10}$	38.56	26.31	27.06
(1-Methylbutyl)benzene	$\text{C}_{11}\text{H}_{16}$	199		53.0
Methyl <i>tert</i> -butyl ether	$\text{C}_5\text{H}_{12}\text{O}$	55.0	27.94	29.82
Methyl chloroacetate	$\text{C}_3\text{H}_5\text{ClO}_2$	129.5	39.23	46.73
Methyl cyanoacetate	$\text{C}_4\text{H}_5\text{NO}_2$	200.5	48.2	
Methyl cyclobutanecarboxylate	$\text{C}_6\text{H}_{10}\text{O}_2$	135.5	37.13	44.72
Methylcyclohexane	$\text{C}_7\text{H}_{14}$	100.93	31.27	35.36
1-Methylcyclohexanol	$\text{C}_7\text{H}_{14}\text{O}$	155	79.0	
<i>cis</i> -2-Methylcyclohexanol	$\text{C}_7\text{H}_{14}\text{O}$	165	48.5	
<i>trans</i> -2-Methylcyclohexanol	$\text{C}_7\text{H}_{14}\text{O}$	167.5	53.0	
Methylcyclopentane	$\text{C}_6\text{H}_{12}$	71.8	29.08	31.64
Methyl cyclopropanecarboxylate	$\text{C}_5\text{H}_8\text{O}_2$	114.9	35.25	41.27
2-Methyldecane	$\text{C}_{11}\text{H}_{24}$	189.3	40.25	54.28
4-Methyldecane	$\text{C}_{11}\text{H}_{24}$	187	40.70	53.76
Methyl dichloroacetate	$\text{C}_3\text{H}_4\text{Cl}_2\text{O}_2$	142.9	39.28	47.72

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Methyl 2,2-dimethylpropanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	101.1	33.42	38.76
Methyl dodecanoate	$\text{C}_{13}\text{H}_{26}\text{O}_2$	267		77.17
<i>N</i> -Methylformamide	$\text{C}_2\text{H}_5\text{NO}$	199.51		56.19
Methyl formate	$\text{C}_2\text{H}_4\text{O}_2$	31.7	27.92	28.35
2-Methylheptane	$\text{C}_8\text{H}_{18}$	117.66	33.26	39.67
3-Methylheptane	$\text{C}_8\text{H}_{18}$	118.9	33.66	39.83
4-Methylheptane	$\text{C}_8\text{H}_{18}$	117.72	33.35	39.69
Methyl heptanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	174		51.62
2-Methyl-2-heptanol	$\text{C}_8\text{H}_{18}\text{O}$	156		62.87
2-Methylhexane	$\text{C}_7\text{H}_{16}$	90.04	30.62	34.87
3-Methylhexane	$\text{C}_7\text{H}_{16}$	92	30.9	
Methyl hexanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	149.5	38.55	48.04
2-Methyl-2-hexanol	$\text{C}_7\text{H}_{16}\text{O}$	143		58.57
5-Methyl-3-hexanol	$\text{C}_7\text{H}_{16}\text{O}$	147		59.82
<i>cis</i> -3-Methyl-3-hexene	$\text{C}_7\text{H}_{14}$	95.4		36.31
<i>trans</i> -3-Methyl-3-hexene	$\text{C}_7\text{H}_{14}$	93.5		35.70
Methylhydrazine	$\text{CH}_6\text{N}_2$	87.5	36.12	40.37
Methyl isobutanoate	$\text{C}_5\text{H}_{10}\text{O}_2$	92.5	32.61	37.32
Methyl methacrylate	$\text{C}_5\text{H}_8\text{O}_2$	100.5	36.0	
1-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	244.7	45.5	
2-Methylnonane	$\text{C}_{10}\text{H}_{22}$	167.1	38.23	49.63
3-Methylnonane	$\text{C}_{10}\text{H}_{22}$	167.9	38.26	49.71
5-Methylnonane	$\text{C}_{10}\text{H}_{22}$	165.1	38.14	49.34
Methyl octanoate	$\text{C}_9\text{H}_{18}\text{O}_2$	192.9		56.41
Methyloxirane	$\text{C}_3\text{H}_6\text{O}$	35	27.35	27.89
2-Methylpentane	$\text{C}_6\text{H}_{14}$	60.26	27.79	29.89
3-Methylpentane	$\text{C}_6\text{H}_{14}$	63.27	28.06	30.28
2-Methyl-2,4-pentanediol	$\text{C}_6\text{H}_{14}\text{O}_2$	197.1	57.3	
Methyl pentanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	127.4	35.36	43.10
2-Methyl-1-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	149	50.2	
4-Methyl-1-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	151.9	44.46	60.47
2-Methyl-2-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	121.1	39.59	54.77
4-Methyl-2-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	131.6	44.2	
3-Methyl-2-pentanone	$\text{C}_6\text{H}_{12}\text{O}$	117.5	34.16	40.53
4-Methyl-2-pentanone	$\text{C}_6\text{H}_{12}\text{O}$	116.5	34.49	40.61
2-Methyl-3-pentanone	$\text{C}_6\text{H}_{12}\text{O}$	113.5	33.84	39.79
2-Methyl-1-pentene	$\text{C}_6\text{H}_{12}$	62.1		30.48
3-Methyl-1-pentene	$\text{C}_6\text{H}_{12}$	54.2		28.62
4-Methyl-1-pentene	$\text{C}_6\text{H}_{12}$	53.9		28.71
2-Methyl-2-pentene	$\text{C}_6\text{H}_{12}$	67.3		31.60
3-Methyl- <i>cis</i> -2-pentene	$\text{C}_6\text{H}_{12}$	67.7		32.09
3-Methyl- <i>trans</i> -2-pentene	$\text{C}_6\text{H}_{12}$	70.4		31.35
4-Methyl- <i>cis</i> -2-pentene	$\text{C}_6\text{H}_{12}$	56.3		29.48
4-Methyl- <i>trans</i> -2-pentene	$\text{C}_6\text{H}_{12}$	58.6		29.97
Methyl pentyl ether	$\text{C}_6\text{H}_{14}\text{O}$	99	32.02	36.85
Methyl pentyl sulfide	$\text{C}_6\text{H}_{14}\text{S}$	145.1	37.41	45.24
2-Methylpropanenitrile	$\text{C}_4\text{H}_7\text{N}$	103.9	32.39	37.13
2-Methyl-1-propanethiol	$\text{C}_4\text{H}_{10}\text{S}$	88.5	31.01	34.63
2-Methyl-2-propanethiol	$\text{C}_4\text{H}_{10}\text{S}$	64.2	28.45	30.78
Methyl propanoate	$\text{C}_4\text{H}_8\text{O}_2$	79.8	32.24	35.85
2-Methylpropanoic acid	$\text{C}_4\text{H}_8\text{O}_2$	154.45		35.30
2-Methyl-1-propanol	$\text{C}_4\text{H}_{10}\text{O}$	107.89	41.82	50.82
2-Methyl-2-propanol	$\text{C}_4\text{H}_{10}\text{O}$	82.4	39.07	46.69
Methyl propyl ether	$\text{C}_4\text{H}_{10}\text{O}$	39.1	26.75	27.60
Methyl propyl sulfide	$\text{C}_4\text{H}_{10}\text{S}$	95.6	32.08	36.24

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
2-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	129.38	36.17	42.48
3-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	144.14	37.35	44.44
4-Methylpyridine	C <sub>6</sub> H <sub>7</sub> N	145.36	37.51	44.56
2-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	246.5		66.1
4-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	262		67.6
6-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	258.6		67.7
8-Methylquinoline	C <sub>10</sub> H <sub>9</sub> N	247.5		65.7
Methyl salicylate	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	222.9	46.7	
4-Methylthiazole	C <sub>4</sub> H <sub>5</sub> NS	133.3	37.58	43.85
2-Methylthiophene	C <sub>5</sub> H <sub>6</sub> S	112.6	33.90	38.87
3-Methylthiophene	C <sub>5</sub> H <sub>6</sub> S	115.5	34.24	39.43
Methyl trichloroacetate	C <sub>3</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	153.8		48.33
Molybdenum carbonyl	C <sub>6</sub> MoO <sub>6</sub>	701	72.51	
Morpholine	C <sub>4</sub> H <sub>9</sub> NO	128	37.1	
Naphthalene	C <sub>10</sub> H <sub>8</sub>	217.9	43.2	
Neopentane	C <sub>5</sub> H <sub>12</sub>	9.48	22.74	21.84
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	210.8		55.01
Nitroethane	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	114.0	38.0	
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	101.19	33.99	38.27
1-Nitropropane	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	131.1	38.5	
2-Nitropropane	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	120.2	36.8	
Nonadecane	C <sub>19</sub> H <sub>40</sub>	329.9	56.93	96.4
Nonane	C <sub>9</sub> H <sub>20</sub>	150.82	37.18	46.55
1,9-Nonanediol	C <sub>9</sub> H <sub>20</sub> O <sub>2</sub>			112.5
1-Nonanol	C <sub>9</sub> H <sub>20</sub> O	213.37		76.86
2-Nonanone	C <sub>9</sub> H <sub>18</sub> O	195.3		56.44
5-Nonanone	C <sub>9</sub> H <sub>18</sub> O	188.45		53.30
Nonylbenzene	C <sub>15</sub> H <sub>24</sub>	280.5		74.1
Octadecane	C <sub>18</sub> H <sub>38</sub>	316.3	55.23	91.44
1-Octadecanol	C <sub>18</sub> H <sub>38</sub> O	335		116.8
<i>cis</i> -9-Octadecenoic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	360	67.4	
Octane	C <sub>8</sub> H <sub>18</sub>	125.67	34.41	41.49
1,8-Octanediol	C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>			104.9
Octanenitrile	C <sub>8</sub> H <sub>15</sub> N	205.25		56.80
Octanoic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	239	58.5	
1-Octanol	C <sub>8</sub> H <sub>18</sub> O	195.16		70.98
2-Octanol	C <sub>8</sub> H <sub>18</sub> O	179.3	44.4	
1-Octene	C <sub>8</sub> H <sub>16</sub>	121.29	34.07	40.34
Octylbenzene	C <sub>14</sub> H <sub>22</sub>	264		69.1
1-Octyne	C <sub>8</sub> H <sub>14</sub>	126.3	35.83	42.30
2-Octyne	C <sub>8</sub> H <sub>14</sub>	137.6	37.26	44.49
3-Octyne	C <sub>8</sub> H <sub>14</sub>	133.1	36.94	43.92
4-Octyne	C <sub>8</sub> H <sub>14</sub>	131.6	36.0	42.73
Oxetane	C <sub>3</sub> H <sub>6</sub> O	47.6	28.67	29.85
2-Oxetanone	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	162		47.03
Oxirane	C <sub>2</sub> H <sub>4</sub> O	10.6	25.54	24.75
Pentachloroethane	C <sub>2</sub> HCl <sub>5</sub>	162.0	36.9	
Pentadecane	C <sub>15</sub> H <sub>32</sub>	270.6	50.08	76.77
1,15-Pentadecanediol	C <sub>15</sub> H <sub>32</sub> O <sub>2</sub>			139
1-Pentadecanol	C <sub>15</sub> H <sub>32</sub> O	300		103.5
Pentadecylbenzene	C <sub>21</sub> H <sub>36</sub>	373		100.3
Pentafluorobenzene	C <sub>6</sub> HF <sub>5</sub>	85.74	32.15	36.27
2,3,4,5,6-Pentafluorotoluene	C <sub>7</sub> H <sub>3</sub> F <sub>5</sub>	117.5	34.75	41.12
2,2,4,6,6-Pentamethylheptane	C <sub>12</sub> H <sub>26</sub>	177.8		48.97
Pentane	C <sub>5</sub> H <sub>12</sub>	36.06	25.79	26.43

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
1,5-Pentanediol	$\text{C}_5\text{H}_{12}\text{O}_2$	239	60.7	83.0
2,4-Pentanedione	$\text{C}_5\text{H}_8\text{O}_2$	138	34.30	41.77
Pentanenitrile	$\text{C}_5\text{H}_9\text{N}$	141.3	36.09	43.60
1-Pentanethiol	$\text{C}_5\text{H}_{12}\text{S}$	126.6	34.88	41.24
Pentanoic acid	$\text{C}_5\text{H}_{10}\text{O}_2$	186.1	44.1	
1-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	137.98	44.36	57.02
2-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	119.3	41.40	54.21
3-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	116.25		54.0
2-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	102.26	33.44	38.40
3-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	101.7	33.45	38.52
1-Pentene	$\text{C}_5\text{H}_{10}$	29.96	25.20	25.47
<i>cis</i> -2-Pentene	$\text{C}_5\text{H}_{10}$	36.93		26.86
<i>trans</i> -2-Pentene	$\text{C}_5\text{H}_{10}$	36.34		26.76
<i>trans</i> -3-Pentenenitrile	$\text{C}_5\text{H}_7\text{N}$	144	37.09	44.77
Pentyl acetate	$\text{C}_7\text{H}_{14}\text{O}_2$	149.2	38.42	48.56
Pentylamine	$\text{C}_5\text{H}_{13}\text{N}$	104.3	34.01	40.08
Pentylbenzene	$\text{C}_{11}\text{H}_{16}$	205.4		55.1
Pentylcyclohexane	$\text{C}_{11}\text{H}_{22}$	203.7		53.88
Perfluorobutane	$\text{C}_4\text{F}_{10}$	-1.9	22.9	
Perfluorocyclobutane	$\text{C}_4\text{F}_8$	-5.91	23.2	
Perfluorodecalin	$\text{C}_{10}\text{F}_{18}$	142.02		41.54
Perfluorohexane	$\text{C}_6\text{F}_{14}$	57.14		32.47
Perfluorononane	$\text{C}_9\text{F}_{20}$	117.61		45.27
Perfluorooctane	$\text{C}_8\text{F}_{18}$	105.9	33.38	41.13
Perfluorotoluene	$\text{C}_7\text{F}_8$	103.55		40.52
Phenanthrene	$\text{C}_{14}\text{H}_{10}$	340		75.50
Phenol	$\text{C}_6\text{H}_6\text{O}$	181.87	45.69	57.82
Piperidine	$\text{C}_5\text{H}_{11}\text{N}$	106.22		39.29
Propanal	$\text{C}_3\text{H}_6\text{O}$	48	28.31	29.62
Propane	$\text{C}_3\text{H}_8$	-42.1	19.04	14.79
1,3-Propanediamine	$\text{C}_3\text{H}_{10}\text{N}_2$	139.8	40.85	50.16
1,2-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	187.6	52.4	
1,3-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	214.4	57.9	69.8
1,3-Propanedithiol	$\text{C}_3\text{H}_8\text{S}_2$	172.9		49.66
Propanenitrile	$\text{C}_3\text{H}_5\text{N}$	97.14	31.81	36.03
1-Propanethiol	$\text{C}_3\text{H}_8\text{S}$	67.8	29.54	31.89
2-Propanethiol	$\text{C}_3\text{H}_8\text{S}$	52.6	27.91	29.45
Propanoic acid	$\text{C}_3\text{H}_6\text{O}_2$	141.15		32.14
Propanoic anhydride	$\text{C}_6\text{H}_{10}\text{O}_3$	170	41.7	
1-Propanol	$\text{C}_3\text{H}_8\text{O}$	97.2	41.44	47.45
2-Propanol	$\text{C}_3\text{H}_8\text{O}$	82.3	39.85	45.39
Propene	$\text{C}_3\text{H}_6$	-47.69	18.42	14.24
2-Propoxyethanol	$\text{C}_5\text{H}_{12}\text{O}_2$	149.8	41.40	52.12
Propyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	101.3	33.92	39.72
Propylamine	$\text{C}_3\text{H}_9\text{N}$	47.22	29.55	31.27
Propylbenzene	$\text{C}_9\text{H}_{12}$	159.24		46.22
Propylcyclohexane	$\text{C}_9\text{H}_{18}$	156		45.08
Propylcyclopentane	$\text{C}_8\text{H}_{16}$	131	34.70	41.08
Propyl formate	$\text{C}_4\text{H}_8\text{O}_2$	80.9	33.61	37.53
Propyl propanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	122.5	35.54	43.45
Pyridazine	$\text{C}_4\text{H}_4\text{N}_2$	208		53.47
Pyridine	$\text{C}_5\text{H}_5\text{N}$	115.23	35.09	40.21
Pyrimidine	$\text{C}_4\text{H}_4\text{N}_2$	123.8	43.09	49.79
Pyrrole	$\text{C}_4\text{H}_5\text{N}$	129.79	38.75	45.09
Pyrrolidine	$\text{C}_4\text{H}_9\text{N}$	86.56	33.01	37.52

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
Quinoline	C <sub>9</sub> H <sub>7</sub> N	237.16	49.7	59.30
Salicylaldehyde	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	197	38.2	
Spiro[2.2]pentane	C <sub>5</sub> H <sub>8</sub>	39	26.76	27.49
Styrene	C <sub>8</sub> H <sub>8</sub>	145	38.7	
Succinonitrile	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	266	48.5	
1,1,2,2-Tetrabromoethane	C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	243.5	48.7	
1,1,2,2-Tetrachloroethane	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	145.2	37.64	45.71
Tetrachloroethene	C <sub>2</sub> Cl <sub>4</sub>	121.3	34.68	39.68
Tetrachloromethane	CCl <sub>4</sub>	76.8	29.82	32.43
Tetradecane	C <sub>14</sub> H <sub>30</sub>	253.58	48.16	71.73
1,14-Tetradecanediol	C <sub>14</sub> H <sub>30</sub> O <sub>2</sub>			149.7
Tetradecanenitrile	C <sub>14</sub> H <sub>27</sub> N			85.29
1-Tetradecanol	C <sub>14</sub> H <sub>30</sub> O	287		98.9
Tetradecylbenzene	C <sub>20</sub> H <sub>34</sub>	359		95.8
Tetrahydrofuran	C <sub>4</sub> H <sub>8</sub> O	65	29.81	31.99
Tetrahydrofurfuryl alcohol	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	178	45.2	
1,2,3,4-Tetrahydronaphthalene	C <sub>10</sub> H <sub>12</sub>	207.6	43.9	
Tetrahydropyran	C <sub>5</sub> H <sub>10</sub> O	88	31.17	34.58
Tetrahydrothiophene	C <sub>4</sub> H <sub>8</sub> S	121.1	34.66	39.43
2,2,3,3-Tetramethylbutane	C <sub>8</sub> H <sub>18</sub>	106.45		42.90
2,2,4,4-Tetramethylpentane	C <sub>9</sub> H <sub>20</sub>	122.29	32.51	38.49
Tetranitromethane	CN <sub>4</sub> O <sub>8</sub>	126.1	40.74	49.93
Thiacyclohexane	C <sub>5</sub> H <sub>10</sub> S	141.8	35.96	42.58
Thietane	C <sub>3</sub> H <sub>6</sub> S	95.0	32.32	35.97
Thiophene	C <sub>4</sub> H <sub>4</sub> S	84.0	31.48	34.70
Toluene	C <sub>7</sub> H <sub>8</sub>	110.63	33.18	38.01
Triacetamide	C <sub>6</sub> H <sub>9</sub> NO <sub>3</sub>			60.41
Tribromomethane	CHBr <sub>3</sub>	149.1	39.66	46.05
Tributylamine	C <sub>12</sub> H <sub>27</sub> N	216.5	46.9	
Tributyl borate	C <sub>12</sub> H <sub>27</sub> BO <sub>3</sub>	234	56.1	
1,1,1-Trichloroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	74.09	29.86	32.50
1,1,2-Trichloroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	113.8	34.82	40.24
Trichloroethene	C <sub>2</sub> HCl <sub>3</sub>	87.21	31.40	34.54
Trichlorofluoromethane	CCl <sub>3</sub> F	23.7	25.1	
Trichloromethane	CHCl <sub>3</sub>	61.17	29.24	31.28
1,2,3-Trichloropropane	C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	157	37.1	
1,1,1-Trichloro-2,2,2-trifluoroethane	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	45.5	26.85	28.08
1,1,2-Trichloro-1,2,2-trifluoroethane	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	47.7	27.04	28.40
Tridecane	C <sub>13</sub> H <sub>28</sub>	235.47	46.20	66.68
1,13-Tridecanediol	C <sub>13</sub> H <sub>28</sub> O <sub>2</sub>			133
1-Tridecanol	C <sub>13</sub> H <sub>28</sub> O	274		94.7
Tridecylbenzene	C <sub>19</sub> H <sub>32</sub>	346		91.8
Triethylamine	C <sub>6</sub> H <sub>15</sub> N	89	31.01	34.84
Triethylene glycol	C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	285	71.4	
Trifluoroacetic acid	C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	73	33.3	
1,1,1-Trifluoroethane	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	-47.25	18.99	
(Trifluoromethyl)benzene	C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	102.1	32.63	37.60
Trimethylamine	C <sub>3</sub> H <sub>9</sub> N	2.87	22.94	21.66
1,2,3-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	176.12		49.05
1,2,4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	169.38		47.93
1,3,5-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	164.74		47.50
2,2,3-Trimethylbutane	C <sub>7</sub> H <sub>16</sub>	80.86	28.90	32.05
2,3,3-Trimethyl-1-butene	C <sub>7</sub> H <sub>14</sub>	77.9		32.09
2,2,5-Trimethylhexane	C <sub>9</sub> H <sub>20</sub>	124.09	33.65	40.16
2,3,5-Trimethylhexane	C <sub>9</sub> H <sub>20</sub>	131.4	34.43	41.41

Name	Mol. Form.	$t_b$ °C	$\Delta_{\text{vap}}H(t_b)$ kJ/mol	$\Delta_{\text{vap}}H(25^\circ\text{C})$ kJ/mol
3,5,5-Trimethyl-1-hexanol	$\text{C}_9\text{H}_{20}\text{O}$	194		67.86
2,4,7-Trimethyloctane	$\text{C}_{11}\text{H}_{24}$	168.1	38.22	49.91
2,2,3-Trimethylpentane	$\text{C}_8\text{H}_{18}$	110	31.94	36.91
2,2,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	99.22	30.79	35.14
2,3,3-Trimethylpentane	$\text{C}_8\text{H}_{18}$	114.8	32.12	37.27
2,3,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	113.5	32.36	37.75
2,2,4-Trimethyl-3-pentanone	$\text{C}_8\text{H}_{16}\text{O}$	135.1	35.64	43.30
2,4,4-Trimethyl-1-pentene	$\text{C}_8\text{H}_{16}$	101.4		35.59
2,4,4-Trimethyl-2-pentene	$\text{C}_8\text{H}_{16}$	104.9		37.23
2,3,6-Trimethylpyridine	$\text{C}_8\text{H}_{11}\text{N}$	171.6	39.95	50.61
2,4,6-Trimethylpyridine	$\text{C}_8\text{H}_{11}\text{N}$	170.6	39.87	50.33
Tris(perfluorobutyl)amine	$\text{C}_{12}\text{F}_{27}\text{N}$	178	46.4	
Undecane	$\text{C}_{11}\text{H}_{24}$	195.9	41.91	56.58
1,11-Undecanediol	$\text{C}_{11}\text{H}_{24}\text{O}_2$			132
Undecanenitrile	$\text{C}_{11}\text{H}_{21}\text{N}$	253		71.14
1-Undecanol	$\text{C}_{11}\text{H}_{24}\text{O}$	245		85.8
Undecylbenzene	$\text{C}_{17}\text{H}_{28}$	316		82.4
Vinyl acetate	$\text{C}_4\text{H}_6\text{O}_2$	72.8	34.6	
<i>o</i> -Xylene	$\text{C}_8\text{H}_{10}$	144.5	36.24	43.43
<i>m</i> -Xylene	$\text{C}_8\text{H}_{10}$	139.07	35.66	42.65
<i>p</i> -Xylene	$\text{C}_8\text{H}_{10}$	138.23	35.67	42.40
2,4-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	210.98		64.96
2,5-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	211.1	46.9	
2,6-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	201.07		75.31
3,4-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	227		85.03
3,5-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	221.74		82.01



## ENTHALPY OF FUSION

This table lists the molar enthalpy (heat) of fusion,  $\Delta_{\text{fus}}H$ , of over 1100 inorganic and organic compounds. All values refer to the enthalpy change at equilibrium between the liquid phase and the most stable solid phase at the phase transition temperature. Most values of  $\Delta_{\text{fus}}H$  are given at the normal melting point  $t_m$ . However, a "t" following the entry in the melting point column indicates a triple-point temperature, where the solid, liquid, and gas phases are in equilibrium. Temperatures are given on the ITS-90 scale.

A \* following an entry indicates that the value includes the enthalpy of transition between crystalline phases whose transformation occurs within 1 °C of the melting point.

Substances are listed by name, either an IUPAC systematic name or, in the case of drugs and other complex compounds, a common synonym. Inorganic compounds, including metal salts of organic acids, are listed first, followed by organic compounds. The molecular formula in the Hill convention is included.

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Name	Molecular formula	$t_m$ /°C	$\Delta_{\text{fus}}H$ /kJ mol <sup>-1</sup>
<i>Inorganic compounds (including salts of organic acids)</i>			
Actinium	Ac	1050	12.0
Aluminum	Al	660.32	10.71
Aluminum bromide	AlBr <sub>3</sub>	97.5	11.25
Aluminum chloride	AlCl <sub>3</sub>	192.6	35.35
Aluminum fluoride	AlF <sub>3</sub>	2250 t	98
Aluminum iodide	AlI <sub>3</sub>	188.28	15.90
Aluminum oxide ( $\alpha$ )	Al <sub>2</sub> O <sub>3</sub>	2054	111.1
Aluminum sulfide	Al <sub>2</sub> S <sub>3</sub>	1100	66
Americium	Am	1176	14.39
Ammonia	H <sub>3</sub> N	-77.73	5.66
Ammonium chloride	ClH <sub>4</sub> N	520.1	10.6
Ammonium fluoride	FH <sub>4</sub> N	238	12.6
Ammonium iodide	H <sub>4</sub> IN	551	21
Ammonium nitrate	H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	169.7	5.86
Antimony (gray)	Sb	630.628	19.79
Antimony(III) bromide	Br <sub>3</sub> Sb	97	14.6
Antimony(III) chloride	Cl <sub>3</sub> Sb	73.4	12.97
Antimony(III) fluoride	F <sub>3</sub> Sb	287	22.8
Antimony(III) iodide	I <sub>3</sub> Sb	171	22.8
Antimony(III) oxide (valentinite)	O <sub>3</sub> Sb <sub>2</sub>	655	54
Antimony(III) sulfide	S <sub>3</sub> Sb <sub>2</sub>	550	47.9
Argon	Ar	-189.36	1.18
Arsenic (gray)	As	817	24.44
Arsenic(III) bromide	AsBr <sub>3</sub>	31.1	11.7
Arsenic(III) chloride	AsCl <sub>3</sub>	-16	10.1
Arsenic(III) fluoride	AsF <sub>3</sub>	-5.9	10.4
Arsenic(III) iodide	AsI <sub>3</sub>	141	21.8

Name	Molecular formula	$t_m$ /°C	$\Delta_{\text{fus}}H$ /kJ mol <sup>-1</sup>
Arsenic(III) oxide (claudetite)	As <sub>2</sub> O <sub>3</sub>	314	18
Arsenic(V) oxide	As <sub>2</sub> O <sub>5</sub>	730	60
Arsenic(III) selenide	As <sub>2</sub> Se <sub>3</sub>	377	40.8
Arsenic(III) sulfide	As <sub>2</sub> S <sub>3</sub>	312	28.7
Arsenic sulfide	As <sub>4</sub> S <sub>4</sub>	307	25.4
Arsenic(III) telluride	As <sub>2</sub> Te <sub>3</sub>	375	46.0
Barium	Ba	727	7.12
Barium bromide	BaBr <sub>2</sub>	857	32.2
Barium carbonate	CBaO <sub>3</sub>	1555 (high pres.)	40
Barium chloride	BaCl <sub>2</sub>	961	15.85
Barium fluoride	BaF <sub>2</sub>	1368	23.36
Barium hydride	BaH <sub>2</sub>	1200	25
Barium hydroxide	BaH <sub>2</sub> O <sub>2</sub>	408	16
Barium iodide	BaI <sub>2</sub>	711	26.5
Barium oxide	BaO	1973	46
Barium sulfate	BaO <sub>4</sub> S	1580	40
Barium sulfide	BaS	2227	63
Beryllium	Be	1287	7.895
Beryllium bromide	BeBr <sub>2</sub>	508	18
Beryllium carbide	CBe <sub>2</sub>	2127	75.3
Beryllium chloride	BeCl <sub>2</sub>	415	8.66
Beryllium fluoride	BeF <sub>2</sub>	552	4.77
Beryllium iodide	BeI <sub>2</sub>	480	20.92
Beryllium nitride	Be <sub>3</sub> N <sub>2</sub>	2200	111
Beryllium oxide	BeO	2578	86
Beryllium sulfate	BeO <sub>4</sub> S	1127	6
Bismuth	Bi	271.406	11.106
Bismuth oxide	Bi <sub>2</sub> O <sub>3</sub>	825	14.7



Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Bismuth sulfide	$\text{Bi}_2\text{S}_3$	777	78.2	Chromium(II) fluoride	$\text{CrF}_2$	894	34
Bismuth tribromide	$\text{BiBr}_3$	219	21.7	Chromium(III) fluoride	$\text{CrF}_3$	1425	66
Bismuth trichloride	$\text{BiCl}_3$	234	23.6	Chromium(II) iodide	$\text{CrI}_2$	867	46
Bismuth trifluoride	$\text{BiF}_3$	649	21.6	Chromium(III) iodide	$\text{CrI}_3$	857	61
Bismuth triiodide	$\text{BiI}_3$	408.6	39.1	Chromium(III) oxide	$\text{Cr}_2\text{O}_3$	2432	125
Boric acid	$\text{BH}_3\text{O}_3$	170.9	22.3	Chromium(VI) oxide	$\text{CrO}_3$	197	14.2
Boron	B	2075	50.2	Chromium(II) sulfide	$\text{CrS}$	1567	25.5
Boron nitride	BN	2967	81	Cobalt	Co	1495	16.20
Boron oxide	$\text{B}_2\text{O}_3$	450	24.56	Cobalt(II) bromide	$\text{Br}_2\text{Co}$	678	43
Boron sulfide	$\text{B}_2\text{S}_3$	563	48.12	Cobalt(II) chloride	$\text{Cl}_2\text{Co}$	737	46.0
Boron trichloride	$\text{BCl}_3$	-107.3	2.10	Cobalt(II) fluoride	$\text{CoF}_2$	1127	58.1
Boron trifluoride	$\text{BF}_3$	-126.8	4.20	Cobalt(II) iodide	$\text{CoI}_2$	520	35
Bromine	$\text{Br}_2$	-7.2	10.57	Cobalt(II) selenite	$\text{CoO}_3\text{Se}$	659	16.3
Bromine pentafluoride	$\text{BrF}_5$	-60.5	5.67	Cobalt(II) sulfide	$\text{CoS}$	1117	30
Cadmium	Cd	321.069	6.21	Copper	Cu	1084.62	13.26
Cadmium bromide	$\text{Br}_2\text{Cd}$	568	33.35	Copper(I) bromide	$\text{BrCu}$	483	5.1
Cadmium chloride	$\text{CdCl}_2$	568	48.58	Copper(I) chloride	$\text{ClCu}$	423	7.08
Cadmium fluoride	$\text{CdF}_2$	1075	22.6	Copper(II) chloride	$\text{Cl}_2\text{Cu}$	598	15.0
Cadmium iodide	$\text{CdI}_2$	388	15.3	Copper(II) fluoride	$\text{CuF}_2$	836	55
Cadmium nitrate	$\text{CdN}_2\text{O}_6$	360	18.3	Copper(I) iodide	$\text{CuI}$	591	7.93
Calcium	Ca	842	8.54	Copper(I) oxide	$\text{Cu}_2\text{O}$	1244	65.6
Calcium bromide	$\text{Br}_2\text{Ca}$	742	29.1	Copper(II) oxide	$\text{CuO}$	1227	49
Calcium carbonate (calcite)	$\text{CCaO}_3$	800	36	Copper(I) sulfide	$\text{Cu}_3\text{S}$	1129	9.62
Calcium chloride	$\text{CaCl}_2$	775	28.05	Curium	Cm	1345	14.64
Calcium fluoride	$\text{CaF}_2$	1418	30	Decaborane(14)	$\text{B}_{10}\text{H}_{14}$	98.78	21.97
Calcium hydride	$\text{CaH}_2$	1000	6.7	Dysprosium	Dy	1412	11.35
Calcium iodide	$\text{CaI}_2$	783	41.8	Dysprosium(III) fluoride	$\text{DyF}_3$	1157	58.6
Calcium nitrate	$\text{CaN}_2\text{O}_6$	561	23.4	Dysprosium(III) oxide	$\text{Dy}_2\text{O}_3$	2408	120
Calcium oxide	$\text{CaO}$	2613	80	Einsteinium	Es	860	9.41
Calcium sulfate	$\text{CaO}_4\text{S}$	1460	28	Erbium	Er	1529	19.90
Calcium sulfide	$\text{CaS}$	2524	70	Erbium chloride	$\text{Cl}_3\text{Er}$	776	32.6
Carbon (graphite)	C	4489	117.4	Erbium fluoride	$\text{ErF}_3$	1146	28.2
Cerium	Ce	799	5.460	Erbium oxide	$\text{Er}_2\text{O}_3$	2418	130
Cerium(III) bromide	$\text{Br}_2\text{Ce}$	732	51.9	Europium	Eu	822	9.21
Cerium(III) chloride	$\text{CeCl}_3$	807	53.1	Europium(II) bromide	$\text{Br}_2\text{Eu}$	683	25.1
Cerium(III) fluoride	$\text{CeF}_3$	1430	55.6	Europium(III) chloride	$\text{Cl}_3\text{Eu}$	623	33.1
Cerium(III) iodide	$\text{CeI}_3$	760	51.0	Europium(III) fluoride	$\text{EuF}_3$	647	6.40
Cerium(III) oxide	$\text{Ce}_2\text{O}_3$	2250	120	Europium(II) oxide	$\text{EuO}$	1967	40
Cerium(IV) oxide	$\text{CeO}_2$	2480	80	Europium(III) oxide	$\text{Eu}_2\text{O}_3$	2350	117
Cesium	Cs	28.5	2.09	Fluorine	$\text{F}_2$	-219.67	0.51
Cesium carbonate	$\text{CCs}_2\text{O}_3$	793	31	Gadolinium	Gd	1313	9.67
Cesium chloride	$\text{ClCs}$	646	20.4	Gadolinium(III) bromide	$\text{Br}_3\text{Gd}$	785	38.1
Cesium chromate	$\text{CrCs}_2\text{O}_4$	963	35.3	Gadolinium(III) chloride	$\text{Cl}_3\text{Gd}$	602	40.6
Cesium fluoride	$\text{CsF}$	703	21.7	Gadolinium(III) fluoride	$\text{F}_3\text{Gd}$	1232	52.4
Cesium hydride	$\text{CsH}$	528	15	Gadolinium(III) iodide	$\text{GdI}_3$	930	54.0
Cesium hydroxide	$\text{CsHO}$	342.3	7.78	Gadolinium(III) oxide	$\text{Gd}_2\text{O}_3$	2425	60
Cesium iodide	$\text{CsI}$	632	25.7	Gallium	Ga	29.7666	5.585
Cesium metaborate	$\text{BCsO}_2$	732	27	Gallium antimonide	$\text{GaSb}$	712	25.1
Cesium molybdate	$\text{Cs}_2\text{MoO}_4$	956.3	31.8	Gallium arsenide	$\text{AsGa}$	1238	87.64
Cesium nitrate	$\text{CsNO}_3$	409	13.8	Gallium(III) bromide	$\text{Br}_3\text{Ga}$	123	11.7
Cesium nitrite	$\text{CsNO}_2$	406	10.9	Gallium(III) chloride	$\text{Cl}_3\text{Ga}$	77.9	11.51
Cesium oxide	$\text{Cs}_2\text{O}$	495	20	Gallium(III) iodide	$\text{GaI}_3$	212	12.9
Cesium peroxide	$\text{Cs}_2\text{O}_2$	594	22	Gallium(III) oxide	$\text{Ga}_2\text{O}_3$	1807	100
Cesium sulfate	$\text{Cs}_2\text{O}_4\text{S}$	1005	35.7	Germanium	Ge	938.25	36.94
Chlorine	$\text{Cl}_2$	-101.5	6.40	Germanium(IV) bromide	$\text{Br}_4\text{Ge}$	26.1	12
Chromium	Cr	1907	21.00	Germanium(II) iodide	$\text{GeI}_2$	428	33.3
Chromium(II) bromide	$\text{Br}_2\text{Cr}$	842	45	Germanium(IV) iodide	$\text{GeI}_4$	146	19.1
Chromium(III) bromide	$\text{Br}_3\text{Cr}$	812	60	Germanium(IV) oxide	$\text{GeO}_2$	1116	12.6
Chromium(II) chloride	$\text{Cl}_2\text{Cr}$	824	45.0	Germanium(II) selenide	$\text{GeSe}$	675	24.7
Chromium(III) chloride	$\text{Cl}_3\text{Cr}$	827	60	Germanium(II) sulfide	$\text{GeS}$	658	21.3

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Germanium(IV) sulfide	GeS <sub>2</sub>	840	16.3	Lead(II) oxide (massicot)	OPb	887	25.6
Germanium(II) telluride	GeTe	724	47.3	Lead(II) sulfate	O <sub>4</sub> PbS	1087	40.2
Gold	Au	1064.18	12.55	Lead(II) sulfide	PbS	1113	49.4
Hafnium	Hf	2233	27.20	Lithium	Li	180.50	3.00
Hafnium nitride	HfN	3310	62.8	Lithium aluminate	AlliO <sub>2</sub>	1610	87.9
Hafnium(IV) oxide	HfO <sub>2</sub>	2800	96	Lithium bromide	BrLi	550	17.66
Holmium	Ho	1472	11.76	Lithium carbonate	CLi <sub>2</sub> O <sub>3</sub>	732	44.8
Holmium bromide	Br <sub>3</sub> Ho	919	50.1	Lithium chloride	CLi	610	19.8
Holmium chloride	Cl <sub>3</sub> Ho	720	30.5	Lithium chromate	CrLi <sub>2</sub> O <sub>4</sub>	482	30.5
Holmium fluoride	F <sub>3</sub> Ho	1143	56.3	Lithium fluoride	FLi	848.2	27.09
Holmium oxide	Ho <sub>2</sub> O <sub>3</sub>	2415	130	Lithium hexafluoroaluminate	AlF <sub>6</sub> Li <sub>3</sub>	785	86.19
Hydrazine	H <sub>4</sub> N <sub>2</sub>	1.54	12.66	Lithium hydride	HLi	692	21.8
Hydrogen	H <sub>2</sub>	-259.198 t	0.12	Lithium hydride- <i>d</i>	DLi	694	22
Hydrogen bromide	BrH	-86.80	2.41	Lithium hydroxide	HLiO	473	20.9
Hydrogen chloride	ClH	-114.17	2.00	Lithium iodide	ILi	469	14.6
Hydrogen fluoride	FH	-83.36	4.58	Lithium metasilicate	Li <sub>2</sub> O <sub>3</sub> Si	1201	28
Hydrogen iodide	HI	-50.76	2.87	Lithium nitrate	LiNO <sub>3</sub>	253	26.7
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	-0.43	12.50	Lithium nitrite	LiNO <sub>2</sub>	222	9.2
Hydrogen sulfide	H <sub>2</sub> S	-85.5	2.38	Lithium oxide	Li <sub>2</sub> O	1438	35.6
Indium	In	156.60	3.291	Lithium perchlorate	CLiO <sub>4</sub>	236	29.3
Indium antimonide	InSb	524	47.7	Lithium sulfate	Li <sub>2</sub> O <sub>4</sub> S	860	9.00
Indium arsenide	AsIn	942	77.0	Lutetium	Lu	1663	18.65
Indium(I) bromide	BrIn	285	24.3	Lutetium oxide	Lu <sub>2</sub> O <sub>3</sub>	2490	133
Indium(III) bromide	Br <sub>3</sub> In	420	26	Magnesium	Mg	650	8.48
Indium(I) chloride	ClIn	225	9.20	Magnesium bromide	Br <sub>2</sub> Mg	711	39.3
Indium(III) chloride	Cl <sub>3</sub> In	583	27	Magnesium carbonate	CMgO <sub>3</sub>	990	59
Indium(III) fluoride	F <sub>3</sub> In	1172	64	Magnesium chloride	Cl <sub>2</sub> Mg	714	43.1
Indium(I) iodide	IIn	364.4	17.26	Magnesium fluoride	F <sub>2</sub> Mg	1263	58.7
Indium(II) iodide	I <sub>2</sub> In	155	1.29	Magnesium hydride	H <sub>2</sub> Mg	327	14
Indium(III) iodide	I <sub>3</sub> In	207	18.48	Magnesium iodide	I <sub>2</sub> Mg	634	26
Indium(III) oxide	In <sub>2</sub> O <sub>3</sub>	1912	105	Magnesium orthosilicate	Mg <sub>2</sub> O <sub>4</sub> Si	1897	71
Indium(II) sulfide	InS	692	36.0	Magnesium oxide	MgO	2825	77
Iodine	I <sub>2</sub>	113.7	15.52	Magnesium phosphate	Mg <sub>3</sub> O <sub>4</sub> P <sub>2</sub>	1348	121
Iodine chloride	ClI	27.38	11.6	Magnesium sulfate	MgO <sub>4</sub> S	1137	14.6
Iridium	Ir	2446	41.12	Magnesium sulfide	MgS	2226	63
Iridium(VI) fluoride	F <sub>6</sub> Ir	44	8.40	Magnesium tetraboride	B <sub>4</sub> Mg	727	0.0
Iron	Fe	1538	13.81	Manganese	Mn	1246	12.91
Iron boride (FeB)	BFe	1658	62.66	Manganese(II) bromide	Br <sub>2</sub> Mn	698	33.5
Iron(II) bromide	Br <sub>2</sub> Fe	691	43.0	Manganese(II) chloride	Cl <sub>2</sub> Mn	650	30.7
Iron(II) chloride	Cl <sub>2</sub> Fe	677	42.83	Manganese(II) fluoride	F <sub>2</sub> Mn	900	30
Iron(III) chloride	Cl <sub>3</sub> Fe	307.6	40	Manganese(II) iodide	I <sub>2</sub> Mn	638	41.8
Iron(II) fluoride	F <sub>2</sub> Fe	1100	50	Manganese(II) oxide	MnO	1842	43.9
Iron(III) fluoride	F <sub>3</sub> Fe	367	0.58	Manganese(II) sulfide ( $\alpha$ form)	MnS	1530	26.1
Iron(II) iodide	FeI <sub>2</sub>	594	39	Mercury	Hg	-38.829	2.295
Iron(II) oxide	FeO	1377	24.1	Mercury(II) bromide	Br <sub>2</sub> Hg	241	17.9
Iron(II,III) oxide	Fe <sub>3</sub> O <sub>4</sub>	1597	138	Mercury(II) chloride	Cl <sub>2</sub> Hg	277	19.41
Iron(III) oxide	Fe <sub>2</sub> O <sub>3</sub>	1539	87	Mercury(II) fluoride	F <sub>2</sub> Hg	645	23.0
Iron sodium oxide	FeNaO <sub>2</sub>	1347	49.4	Mercury(I) iodide	Hg <sub>2</sub> I <sub>2</sub>	290	31.4
Iron(II) sulfide	FeS	1188	31.5	Mercury(II) iodide (yellow)	HgI <sub>2</sub>	256	15.6
Krypton	Kr	-157.38	1.64	Mercury(II) sulfide (black)	HgS	820	40
Lanthanum	La	920	6.20	Metaboric acid ( $\gamma$ form)	BHO <sub>2</sub>	236	14.3
Lanthanum bromide	Br <sub>3</sub> La	788	54.0	Molybdenum	Mo	2623	37.48
Lanthanum chloride	Cl <sub>3</sub> La	858	54.4	Molybdenum boride (Mo <sub>2</sub> B <sub>5</sub> )	B <sub>5</sub> Mo <sub>2</sub>	2210	226
Lanthanum fluoride	F <sub>3</sub> La	1493	50.2	Molybdenum(IV) chloride	Cl <sub>4</sub> Mo	317	16.7
Lanthanum iodide	I <sub>3</sub> La	778	56.1	Molybdenum(V) chloride	Cl <sub>5</sub> Mo	194	19
Lead	Pb	327.462	4.774	Molybdenum(VI)	Cl <sub>6</sub> MoO <sub>2</sub>	176	17.0
Lead(II) bromide	Br <sub>2</sub> Pb	371	16.44	dioxydichloride			
Lead(II) chloride	Cl <sub>2</sub> Pb	501	21.88	Molybdenum(V) fluoride	F <sub>5</sub> Mo	45.67	6.1
Lead(II) fluoride	F <sub>2</sub> Pb	830	14.7	Molybdenum(VI) fluoride	F <sub>6</sub> Mo	17.5	4.33
Lead(II) iodide	I <sub>2</sub> Pb	410	23.4	Molybdenum monoboride	BMo	2600	55.23
				Molybdenum(VI) oxide	MoO <sub>3</sub>	802	48.7

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Molybdenum(VI) oxytetrachloride	$\text{Cl}_4\text{MoO}$	105	14.3	Plutonium(III) iodide	$\text{I}_3\text{Pu}$	777	50.2
Molybdenum(VI) oxytetrafluoride	$\text{F}_4\text{MoO}$	97.2	4	Plutonium(III) oxide	$\text{O}_3\text{Pu}_2$	2085	113
Molybdenum(V) oxytrichloride	$\text{Cl}_3\text{MoO}$	310	22	Plutonium(IV) oxide	$\text{O}_2\text{Pu}$	2390	67
Molybdenum(III) sulfide	$\text{Mo}_2\text{S}_3$	1807	0.13	Polonium	Po	254	10.0
Neodymium	Nd	1016	7.14	Potassium	K	63.5	2.335
Neodymium(III) bromide	$\text{Br}_3\text{Nd}$	682	45.3	Potassium aluminate	$\text{AlKO}_2$	1713	82
Neodymium(III) chloride	$\text{Cl}_3\text{Nd}$	759	48.5	Potassium bromide	BrK	734	25.52
Neodymium(III) fluoride	$\text{F}_3\text{Nd}$	1377	54.8	Potassium carbonate	$\text{CK}_2\text{O}_3$	899	27.6
Neodymium(III) iodide	$\text{I}_3\text{Nd}$	787	41.5	Potassium chloride	ClK	771	26.28
Neon	Ne	-248.609	0.328	Potassium chromate	$\text{CrK}_2\text{O}_4$	974	33.0
Neptunium	Np	644	3.20	Potassium cyanide	CKN	622	14.6
Nickel	Ni	1455	17.48	Potassium fluoride	FK	858	27.2
Nickel boride ( $\text{Ni}_2\text{B}$ )	$\text{BNi}_2$	1125	42.15	Potassium fluoroborate	$\text{BF}_4\text{K}$	570	17.66
Nickel boride ( $\text{Ni}_3\text{B}$ )	$\text{BNi}_3$	1166	72.28	Potassium hydride	HK	619	21
Nickel(II) bromide	$\text{Br}_2\text{Ni}$	963	56	Potassium hydrogen fluoride	$\text{F}_2\text{HK}$	238.8	6.62
Nickel(II) chloride	$\text{Cl}_2\text{Ni}$	1031	77.9	Potassium hydroxide	HKO	406	7.90
Nickel(II) fluoride	$\text{F}_2\text{Ni}$	1380	69	Potassium iodide	IK	681	24.0
Nickel(II) iodide	$\text{I}_2\text{Ni}$	800	48	Potassium metaborate	$\text{BKO}_2$	947	31.38
Nickel(II) oxide	NiO	1957	50.7	Potassium nitrate	$\text{KNO}_3$	334	9.6
Nickel(II) sulfide	NiS	976	30.1	Potassium nitrite	$\text{KNO}_2$	438	16.7
Nickel disulfide	$\text{NiS}_2$	1007	65.7	Potassium oxide	$\text{K}_2\text{O}$	740	27
Nickel subsulfide	$\text{Ni}_3\text{S}_2$	789	19.7	Potassium peroxide	$\text{K}_2\text{O}_2$	545	20.5
Niobium	Nb	2477	30	Potassium sulfate	$\text{K}_2\text{O}_4\text{S}$	1069	36.6
Niobium(V) bromide	$\text{Br}_5\text{Nb}$	254	24.0	Potassium sulfide	$\text{K}_2\text{S}$	948	16.15
Niobium(V) chloride	$\text{Cl}_5\text{Nb}$	205.8	33.9	Potassium superoxide	$\text{KO}_2$	535	20.6
Niobium(V) fluoride	$\text{F}_5\text{Nb}$	80	12.2	Praseodymium	Pr	931	6.89
Niobium(V) iodide	$\text{I}_5\text{Nb}$	327	37.7	Praseodymium(III) bromide	$\text{Br}_3\text{Pr}$	693	47.3
Niobium nitride	NNb	2050	46.0	Praseodymium(III) chloride	$\text{Cl}_3\text{Pr}$	786	50.6
Niobium(II) oxide	NbO	1937	85.4	Praseodymium(III) fluoride	$\text{F}_3\text{Pr}$	1399	57.3
Niobium(IV) oxide	$\text{NbO}_2$	1901	92	Praseodymium(III) iodide	$\text{I}_3\text{Pr}$	738	53.1
Niobium(V) oxide	$\text{Nb}_2\text{O}_5$	1512	104.3	Protactinium	Pa	1572	12.34
Nitric acid	$\text{HNO}_3$	-41.6	10.5	Radium	Ra	696	7.7
Nitric oxide	NO	-163.6	2.30	Rhenium	Re	3185	34.08
Nitrogen	$\text{N}_2$	-210.0	0.71	Rhenium(VII) oxide	$\text{O}_7\text{Re}_2$	327	65.7
Nitrogen tetroxide	$\text{N}_2\text{O}_4$	-9.3	14.65	Rhodium	Rh	1964	26.59
Nitrous oxide	$\text{N}_2\text{O}$	-90.8	6.54	Rubidium	Rb	39.30	2.19
Osmium	Os	3033	57.85	Rubidium bromide	BrRb	692	23.3
Osmium(VIII) oxide	$\text{O}_4\text{Os}$	40.6	14.3	Rubidium carbonate	$\text{CO}_3\text{Rb}_2$	873	30
Oxygen	$\text{O}_2$	-218.79	0.44	Rubidium chloride	ClRb	724	24.4
Palladium	Pd	1554.8	16.74	Rubidium fluoride	FRb	795	25.8
Palladium(II) chloride	$\text{Cl}_2\text{Pd}$	679	18.41	Rubidium hydride	HRb	585	22
Phosphinic acid	$\text{H}_3\text{O}_2\text{P}$	26.5	9.7	Rubidium hydroxide	HORb	385	8.0
Phosphonic acid	$\text{H}_3\text{O}_3\text{P}$	74.4	12.8	Rubidium iodide	IRb	656	22.1
Phosphoric acid	$\text{H}_3\text{O}_4\text{P}$	42.4	13.4	Rubidium metaborate	$\text{BO}_2\text{Rb}$	860	31
Phosphorus (white)	P	44.15	0.659	Rubidium nitrate	$\text{NO}_3\text{Rb}$	310	4.6
Phosphorus (red)	P	579.2	18.54	Rubidium nitrite	$\text{NO}_2\text{Rb}$	422	12.1
Phosphorus(III) chloride	$\text{Cl}_3\text{P}$	-93	7.10	Rubidium oxide	$\text{ORb}_2$	505	20
Phosphorus heptasulfide	$\text{P}_7\text{S}_7$	308	36.6	Rubidium peroxide	$\text{O}_2\text{Rb}_2$	570	21
Phosphorus(V) oxide	$\text{O}_5\text{P}_2$	562	27.2	Rubidium sulfate	$\text{O}_4\text{Rb}_2\text{S}$	1066	37.3
Phosphorus sesquisulfide	$\text{P}_4\text{S}_3$	173	20.1	Rubidium superoxide	$\text{O}_2\text{Rb}$	540	21
Phosphoryl chloride	$\text{Cl}_3\text{OP}$	1.18	13.1	Ruthenium	Ru	2333	38.59
Platinum	Pt	1768.2	22.175	Ruthenium(V) fluoride	$\text{F}_5\text{Ru}$	101	74.5
Plutonium	Pu	640	2.824	Samarium	Sm	1072	8.62
Plutonium(III) bromide	$\text{Br}_3\text{Pu}$	681	58.6	Samarium(III) oxide	$\text{O}_3\text{Sm}_2$	2335	119
Plutonium(III) chloride	$\text{Cl}_3\text{Pu}$	760	63.6	Scandium	Sc	1541	14.10
Plutonium(III) fluoride	$\text{F}_3\text{Pu}$	1396	59.8	Scandium chloride	$\text{Cl}_3\text{Sc}$	967	67.4
Plutonium(IV) fluoride	$\text{F}_4\text{Pu}$	1037	42.7	Scandium fluoride	$\text{F}_3\text{Sc}$	1552	62.6
Plutonium(VI) fluoride	$\text{F}_6\text{Pu}$	51.6	18.6	Scandium oxide	$\text{O}_3\text{Sc}_2$	2489	127
				Selenium (gray)	Se	220.8	6.69
				Selenium dioxide	$\text{O}_2\text{Se}$	360	17.6

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Silicon	Si	1414	50.21	Tantalum(V) oxide	O <sub>5</sub> Ta <sub>2</sub>	1875	120
Silicon dioxide (cristobalite)	O <sub>2</sub> Si	1722	9.6	Technetium	Tc	2157	33.29
Silicon monosulfide	SSi	1090	31	Tellurium	Te	449.51	17.38
Silver	Ag	961.78	11.30	Tellurium dioxide	O <sub>2</sub> Te	733	28.9
Silver(I) bromide	AgBr	430	9.163	Tellurium tetrabromide	Br <sub>4</sub> Te	380	24.7
Silver(I) chloride	AgCl	455	13.054	Tellurium tetrachloride	Cl <sub>4</sub> Te	224	18.9
Silver(I) iodide	AgI	558	9.414	Terbium	Tb	1359	10.15
Silver(I) nitrate	AgNO <sub>3</sub>	210	11.72	Terbium(III) bromide	Br <sub>3</sub> Tb	830	31.5
Silver(I) oxide	Ag <sub>2</sub> O	827	15	Terbium(III) chloride	Cl <sub>3</sub> Tb	582	19.5
Silver(I) sulfate	Ag <sub>2</sub> O <sub>4</sub> S	660	17.99	Tetrachlorosilane	Cl <sub>4</sub> Si	-68.74	7.60
Silver(I) sulfide	Ag <sub>2</sub> S	836	7.9	Tetraiodosilane	I <sub>4</sub> Si	120.5	19.7
Sodium	Na	97.794	2.60	Thallium	Tl	304	4.142
Sodium bromate	BrNaO <sub>3</sub>	381	28.11	Thallium(I) bromide	BrTl	460	16.4
Sodium bromide	BrNa	747	26.23	Thallium(I) carbonate	CO <sub>3</sub> Tl <sub>2</sub>	273	18
Sodium carbonate	CNa <sub>2</sub> O <sub>3</sub>	856	29.7	Thallium(I) chloride	ClTl	431	15.56
Sodium chlorate	ClNaO <sub>3</sub>	248	22.6	Thallium(I) fluoride	FTl	326	13.87
Sodium chloride	ClNa	800.7	28.16	Thallium(I) formate	CHO <sub>2</sub> Tl	101	10.9
Sodium chromate	CrNa <sub>2</sub> O <sub>4</sub>	794	24.7	Thallium(I) iodide	ITl	441.7	14.7
Sodium cyanide	CNNa	562	8.79	Thallium(I) nitrate	NO <sub>3</sub> Tl	206	9.6
Sodium fluoride	FNa	996	33.35	Thallium(I) oxide	OTl <sub>2</sub>	579	30.3
Sodium formate	CHNaO <sub>2</sub>	257.3	17.7	Thallium(III) oxide	O <sub>3</sub> Tl <sub>2</sub>	834	53
Sodium hexafluoroaluminate	AlF <sub>6</sub> Na <sub>3</sub>	1013	114.4	Thallium(I) sulfate	O <sub>3</sub> STl <sub>2</sub>	632	23.8
Sodium hexafluorosilicate	F <sub>6</sub> Na <sub>2</sub> Si	847	99.6	Thallium(I) sulfide	STl <sub>2</sub>	457	23.0
Sodium hydride	HNa	638	26	Thorium	Th	1750	13.81
Sodium hydroxide	HNaO	323	6.60	Thorium(IV) bromide	Br <sub>4</sub> Th	679	54.4
Sodium iodate	INaO <sub>3</sub>	422	35.1	Thorium(IV) chloride	Cl <sub>4</sub> Th	770	43.9
Sodium iodide	INa	661	23.7	Thorium(IV) fluoride	F <sub>4</sub> Th	1110	41.8
Sodium metaborate	BNaO <sub>2</sub>	966	36.2	Thorium(IV) iodide	I <sub>4</sub> Th	566	48.1
Sodium metasilicate	Na <sub>2</sub> O <sub>3</sub> Si	1089	51.8	Thorium(IV) oxide	O <sub>2</sub> Th	3350	90
Sodium nitrate	NNaO <sub>3</sub>	306.5	15.5	Thulium	Tm	1545	16.84
Sodium nitrite	NNaO <sub>2</sub>	284	14.9	Thulium(III) chloride	Cl <sub>3</sub> Tm	845	34.9
Sodium oxide	Na <sub>2</sub> O	1134	47.7	Thulium(III) fluoride	F <sub>3</sub> Tm	1158	28.9
Sodium peroxide	Na <sub>2</sub> O <sub>2</sub>	675	24.5	Tin (white)	Sn	231.93	7.15
Sodium sulfate	Na <sub>2</sub> O <sub>4</sub> S	884	23.85	Tin(II) bromide	Br <sub>2</sub> Sn	232	18.0
Sodium sulfide	Na <sub>2</sub> S	1172	19	Tin(IV) bromide	Br <sub>4</sub> Sn	29.1	12.2
Sodium sulfite	Na <sub>2</sub> O <sub>3</sub> S	911	25.9	Tin(II) chloride	Cl <sub>2</sub> Sn	247.0	14.52
Strontium	Sr	777	7.43	Tin(IV) chloride	Cl <sub>4</sub> Sn	-34.07	9.20
Strontium bromide	Br <sub>2</sub> Sr	657	10.5	Tin(II) fluoride	F <sub>2</sub> Sn	215	10.5
Strontium carbonate	CO <sub>3</sub> Sr	1494	40	Tin(IV) fluoride	F <sub>4</sub> Sn	442	27.6
Strontium chloride	Cl <sub>2</sub> Sr	874	16.22	Tin(II) iodide	I <sub>2</sub> Sn	320	18.0
Strontium fluoride	F <sub>2</sub> Sr	1477	29.7	Tin(IV) iodide	I <sub>4</sub> Sn	402	0.16
Strontium hydride	H <sub>2</sub> Sr	1050	23	Tin(II) oxide	OSn	977	27.7
Strontium hydroxide	H <sub>2</sub> O <sub>2</sub> Sr	535	23	Tin(IV) oxide	O <sub>2</sub> Sn	1630	23.4
Strontium iodide	I <sub>2</sub> Sr	538	19.7	Tin(II) sulfide	SSn	881	31.6
Strontium nitrate	N <sub>2</sub> O <sub>6</sub> Sr	570	44.6	Tin(II) telluride	SnTe	806	45.2
Strontium oxide	OSr	2531	81	Titanium	Ti	1668	14.15
Strontium sulfate	O <sub>4</sub> SSr	1606	36	Titanium boride	B <sub>2</sub> Ti	2920	100.4
Strontium sulfide	SSr	2226	63	Titanium(IV) bromide	Br <sub>4</sub> Ti	38.3	12.9
Sulfur (monoclinic)	S	115.21	1.721	Titanium(II) chloride	Cl <sub>2</sub> Ti	1035	34.3
Sulfur hexafluoride	F <sub>6</sub> S	-49.596	5.02	Titanium(IV) chloride	Cl <sub>4</sub> Ti	-24.12	9.97
Sulfuric acid	H <sub>2</sub> O <sub>4</sub> S	10.31	10.71	Titanium(IV) fluoride	F <sub>4</sub> Ti	377	41
Sulfur trioxide (γ-form)	O <sub>3</sub> S	16.8	8.60	Titanium(IV) iodide	I <sub>4</sub> Ti	155	19.8
Tantalum	Ta	3017	36.57	Titanium nitride	NTi	2947	66.9
Tantalum boride (TaB <sub>2</sub> )	B <sub>2</sub> Ta	3100	83.68	Titanium(III) oxide	O <sub>3</sub> Ti <sub>2</sub>	1842	104.6
Tantalum(V) bromide	Br <sub>5</sub> Ta	240	37.7	Titanium(IV) oxide (rutile)	O <sub>2</sub> Ti	1912	68
Tantalum(V) chloride	Cl <sub>5</sub> Ta	216.6	35.1	Titanium(II) sulfide	STi	1927	32
Tantalum(V) fluoride	F <sub>5</sub> Ta	96.9	12	Tungsten	W	3422	52.31
Tantalum(V) iodide	I <sub>5</sub> Ta	496	7.74	Tungsten boride (WB)	BW	2800	80
Tantalum nitride (Ta <sub>2</sub> N)	N <sub>2</sub> Ta	3090	6.7	Tungsten boride (W <sub>2</sub> B)	BW <sub>2</sub>	2740	117
Tantalum nitride (Ta <sub>2</sub> N)	NTa <sub>2</sub>	2727	92.0	Tungsten boride (W <sub>2</sub> B <sub>3</sub> )	B <sub>5</sub> W <sub>2</sub>	2370	240

Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Tungsten(V) bromide	Br <sub>5</sub> W	286	17.2	Zirconium(II) iodide	I <sub>2</sub> Zr	827	28
Tungsten(V) chloride	Cl <sub>5</sub> W	253	20.6	Zirconium(III) iodide	I <sub>3</sub> Zr	727	33
Tungsten(VI) chloride	Cl <sub>6</sub> W	282	6.69	Zirconium(IV) iodide	I <sub>4</sub> Zr	500	32
Tungsten(VI) fluoride	F <sub>6</sub> W	1.9	4.10	Zirconium nitride	NZr	2952	67.4
Tungsten(VI) oxide	O <sub>3</sub> W	1473	73	Zirconium(IV) oxide	O <sub>2</sub> Zr	2710	90
Tungsten(VI) oxytetrachloride	Cl <sub>4</sub> OW	210	18.8	Zirconium(IV) sulfide	S <sub>2</sub> Zr	1550	45
Tungsten(VI) oxytetrafluoride	F <sub>4</sub> OW	105	6				
Uranium	U	1135	9.14				
Uranium(III) bromide	Br <sub>3</sub> U	727	43.9	<i>Organic compounds</i>			
Uranium(IV) bromide	Br <sub>4</sub> U	519	55.2	Acenaphthene	C <sub>12</sub> H <sub>10</sub>	93.4	21.49
Uranium(IV) chloride	Cl <sub>4</sub> U	590	44.8	Acenaphthylene	C <sub>12</sub> H <sub>8</sub>	91.8	6.9
Uranium(III) fluoride	F <sub>3</sub> U	1495	36.8	Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	-123.37	2.31
Uranium(IV) fluoride	F <sub>4</sub> U	1036	47	Acetamide	C <sub>2</sub> H <sub>5</sub> NO	80.16	15.59
Uranium(V) fluoride	F <sub>5</sub> U	348	35	Acetaminophen	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	169.3	30.5
Uranium(VI) fluoride	F <sub>6</sub> U	64.06	19.2	Acetanilide	C <sub>8</sub> H <sub>9</sub> NO	114.3	21.3
Uranium(IV) iodide	I <sub>4</sub> U	506	42.1	Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	16.64	11.73
Uranium(IV) oxide	O <sub>2</sub> U	2847	74.2	Acetic anhydride	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	-74.1	10.5
Uranyl chloride	Cl <sub>2</sub> O <sub>2</sub> U	577	44.06	Acetone	C <sub>3</sub> H <sub>6</sub> O	-94.7	5.77
Vanadium	V	1910	21.5	Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	-43.82	8.16
Vanadium(II) chloride	Cl <sub>2</sub> V	1350	35.0	Acrylic acid	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	12.5	9.51
Vanadium(IV) chloride	Cl <sub>4</sub> V	-28	2.30	Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	-83.48	6.23
Vanadium(II) fluoride	F <sub>2</sub> V	1490	44	Allene	C <sub>3</sub> H <sub>4</sub>	-136.6	4.40
Vanadium(III) fluoride	F <sub>3</sub> V	1395	57	Allobarbital	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	172	32.3
Vanadium(V) fluoride	F <sub>5</sub> V	19.5	49.96	2-Aminobenzoic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	146	20.5
Vanadium(II) oxide	OV	1790	50	4-Aminobenzoic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	188.2	22.5
Vanadium(III) oxide	O <sub>3</sub> V <sub>2</sub>	1957	140	3-Amino-1-propanol	C <sub>3</sub> H <sub>9</sub> NO	12.4	19.7
Vanadium(IV) oxide	O <sub>2</sub> V	1545	56.0	Aminopyrine	C <sub>13</sub> H <sub>17</sub> N <sub>3</sub> O	107.5	27.6
Vanadium(V) oxide	O <sub>5</sub> V <sub>2</sub>	681	64	Ampyrone	C <sub>11</sub> H <sub>13</sub> N <sub>3</sub> O	109	24.9
Water	H <sub>2</sub> O	0.00	6.01	Aniline	C <sub>6</sub> H <sub>7</sub> N	-6.02	10.54
Xenon	Xe	-111.745 t	2.27	Anisole	C <sub>7</sub> H <sub>8</sub> O	-37.13	12.9
Xenon difluoride	F <sub>2</sub> Xe	129.03	16.8	Anthracene	C <sub>14</sub> H <sub>10</sub>	215.76	29.4
Xenon tetrafluoride	F <sub>4</sub> Xe	117.1	16.3	Antipyrine	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O	112	27.3
Xenon hexafluoride	F <sub>6</sub> Xe	49.48	5.74	<i>trans</i> -Azobenzene	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	67.88	22.52
Ytterbium	Yb	824	7.66	<i>trans</i> -Azoxybenzene	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	34.6	17.9
Ytterbium(III) chloride	Cl <sub>3</sub> Yb	854	35.4	Barbital	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	190	24.7
Yttrium	Y	1522	11.39	Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	-57.1	9.32
Yttrium chloride	Cl <sub>3</sub> Y	721	31.5	Benzamide	C <sub>7</sub> H <sub>7</sub> NO	127.3	19.5
Yttrium fluoride	F <sub>3</sub> Y	1155	27.9	Benz[a]anthracene	C <sub>18</sub> H <sub>12</sub>	160.5	21.4
Yttrium oxide	O <sub>3</sub> Y <sub>2</sub>	2439	81	Benzene	C <sub>6</sub> H <sub>6</sub>	5.49	9.87
Zinc	Zn	419.53	7.068	Benzeneacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	76.5	16.3
Zinc bromide	Br <sub>2</sub> Zn	402	15.7	1,2-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	102.1	23.1
Zinc chloride	Cl <sub>2</sub> Zn	325	10.30	1,3-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	66.0	15.57
Zinc fluoride	F <sub>2</sub> Zn	872	40	1,4-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	141.1	23.8
Zinc iodide	I <sub>2</sub> Zn	450	17	Benzenethiol	C <sub>6</sub> H <sub>6</sub> S	-14.93	11.48
Zinc oxide	OZn	1974	70	<i>p</i> -Benzidine	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	127	19.1
Zinc phosphide (ZnP <sub>2</sub> )	P <sub>2</sub> Zn	980	92.9	Benzil	C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	94.87	23.5
Zinc selenite	O <sub>3</sub> SeZn	621	46.4	Benzocaine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	89.7	22.3
Zinc sulfide (wurtzite)	SZn	1827	30	Benzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	122.35	18.02
Zinc telluride	TeZn	1295	63	Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	-13.99	9.1
Zirconium	Zr	1854.7	21.00	Benzo[c]phenanthrene	C <sub>18</sub> H <sub>12</sub>	68	16.3
Zirconium boride	B <sub>2</sub> Zr	3050	104.6	Benzophenone	C <sub>13</sub> H <sub>10</sub> O	47.9	18.19
Zirconium(II) bromide	Br <sub>2</sub> Zr	827	28	Benzo[a]pyrene	C <sub>20</sub> H <sub>12</sub>	181.1	17.3
Zirconium(III) bromide	Br <sub>3</sub> Zr	727	33	Benzo[e]pyrene	C <sub>20</sub> H <sub>12</sub>	181.4	16.6
Zirconium(IV) bromide	Br <sub>4</sub> Zr	450		<i>p</i> -Benzoquinone	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	115	18.5
Zirconium(II) chloride	Cl <sub>2</sub> Zr	722	27.0	Benzoyl chloride	C <sub>7</sub> H <sub>5</sub> ClO	-0.4	19.2
Zirconium(III) chloride	Cl <sub>3</sub> Zr	627	30	Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	-15.4	8.97
Zirconium(IV) chloride	Cl <sub>4</sub> Zr	437	29	2,2'-Binaphthalene	C <sub>20</sub> H <sub>14</sub>	187.9	38.9
Zirconium(II) fluoride	F <sub>2</sub> Zr	902	37.7	Biphenyl	C <sub>12</sub> H <sub>10</sub>	68.93	18.57
Zirconium(III) fluoride	F <sub>3</sub> Zr	927	50	Bromobenzene	C <sub>6</sub> H <sub>5</sub> Br	-30.72	10.70
Zirconium(IV) fluoride	F <sub>4</sub> Zr	910	61	1-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	-112.6	9.23
				2-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	-112.65	6.89



Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Bromoethane	$\text{C}_2\text{H}_5\text{Br}$	-118.6	7.47	2-Chlorophenol	$\text{C}_6\text{H}_5\text{ClO}$	9.4	13.0
Bromoethene	$\text{C}_2\text{H}_3\text{Br}$	-139.54	5.12	3-Chlorophenol	$\text{C}_6\text{H}_4\text{ClO}$	32.6	14.9
1-Bromoheptane	$\text{C}_7\text{H}_{15}\text{Br}$	-56.1	21.8	4-Chlorophenol	$\text{C}_6\text{H}_3\text{ClO}$	42.8	14.1
1-Bromohexane	$\text{C}_6\text{H}_{13}\text{Br}$	-83.7	18.1	1-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	-122.9	5.54
Bromomethane	$\text{CH}_3\text{Br}$	-93.68	5.98	2-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	-117.18	7.39
1-Bromonaphthalene	$\text{C}_{10}\text{H}_7\text{Br}$	6.1	15.2	2-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	-35.8	9.6
2-Bromonaphthalene	$\text{C}_{10}\text{H}_7\text{Br}$	55.9	14.4	Chlorotrifluoroethene	$\text{C}_2\text{ClF}_3$	-158.2	5.55
1-Bromooctane	$\text{C}_8\text{H}_{17}\text{Br}$	-55.0	24.7	Chrysene	$\text{C}_{18}\text{H}_{12}$	255.5	26.2
1-Bromopentane	$\text{C}_5\text{H}_{11}\text{Br}$	-88.0	14.37	Coronene	$\text{C}_{24}\text{H}_{12}$	437.4	19.2
1-Bromopropane	$\text{C}_3\text{H}_7\text{Br}$	-110.3	6.44	<i>o</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	31.03	15.82
2-Bromopropane	$\text{C}_3\text{H}_7\text{Br}$	-89.0	6.53	<i>m</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	12.24	10.71
Bromotrichloromethane	$\text{CBrCl}_3$	-5.65	2.53	<i>p</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	34.77	12.71
1,2-Butadiene	$\text{C}_4\text{H}_6$	-136.2	6.96	Cyanamide	$\text{CH}_2\text{N}_2$	45.56	7.27
1,3-Butadiene	$\text{C}_4\text{H}_6$	-108.91	7.98	Cyanogen	$\text{C}_2\text{N}_2$	-27.83	8.11
Butanal	$\text{C}_4\text{H}_8\text{O}$	-96.86	10.77	Cyclobutane	$\text{C}_4\text{H}_8$	-90.7	1.09
Butane	$\text{C}_4\text{H}_{10}$	-138.3	4.66	Cycloheptane	$\text{C}_7\text{H}_{14}$	-8.46	1.88
1,4-Butanediol	$\text{C}_4\text{H}_{10}\text{O}_2$	20.4	18.70	Cycloheptanol	$\text{C}_7\text{H}_{14}\text{O}$	7.2	1.60
1-Butanethiol	$\text{C}_4\text{H}_{10}\text{S}$	-115.7	10.46	Cyclohexane	$\text{C}_6\text{H}_{12}$	6.59	2.68
Butanoic acid	$\text{C}_4\text{H}_8\text{O}_2$	-5.1	11.59	Cyclohexanol	$\text{C}_6\text{H}_{12}\text{O}$	25.93	1.78
1-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	-88.6	9.37	Cyclohexanone	$\text{C}_6\text{H}_{10}\text{O}$	-27.9	1.328
2-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	-88.5	5.97	Cyclohexene	$\text{C}_6\text{H}_{10}$	-103.5	3.29
2-Butanone	$\text{C}_4\text{H}_8\text{O}$	-86.64	8.39	Cyclohexylamine	$\text{C}_6\text{H}_{13}\text{N}$	-17.8	17.5
1-Butene	$\text{C}_4\text{H}_8$	-185.34	3.96	Cyclohexylbenzene	$\text{C}_{12}\text{H}_{16}$	7.07	15.6
<i>cis</i> -2-Butene	$\text{C}_4\text{H}_8$	-138.88	7.31	Cyclooctane	$\text{C}_8\text{H}_{16}$	14.59	2.41
<i>trans</i> -2-Butene	$\text{C}_4\text{H}_8$	-105.52	9.76	Cyclopentane	$\text{C}_5\text{H}_{10}$	-93.4	0.61
<i>cis</i> -2-Butenoic acid	$\text{C}_4\text{H}_6\text{O}_2$	15	12.6	Cyclopentanol	$\text{C}_5\text{H}_{10}\text{O}$	-17.5	1.535
<i>trans</i> -2-Butenoic acid	$\text{C}_4\text{H}_6\text{O}_2$	71.5	13.0	Cyclopentene	$\text{C}_5\text{H}_8$	-135.0	3.36
<i>tert</i> -Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	-66.94	0.882	Cyclopentylamine	$\text{C}_5\text{H}_{11}\text{N}$	-82.7	8.31
Butylbenzene	$\text{C}_{10}\text{H}_{14}$	-87.85	11.22	Cyclopropane	$\text{C}_3\text{H}_6$	-127.58	5.44
Butylcyclohexane	$\text{C}_{10}\text{H}_{20}$	-74.73	14.16	Cyclopropylamine	$\text{C}_3\text{H}_7\text{N}$	-35.39	13.18
Butyl methyl ether	$\text{C}_5\text{H}_{12}\text{O}$	-115.7	10.85	<i>cis</i> -Decahydronaphthalene	$\text{C}_{10}\text{H}_{18}$	-42.9	9.49
1-Butyne	$\text{C}_4\text{H}_6$	-125.7	6.03	<i>trans</i> -Decahydronaphthalene	$\text{C}_{10}\text{H}_{18}$	-30.4	14.41
2-Butyne	$\text{C}_4\text{H}_6$	-32.2	9.23	Decanal	$\text{C}_{10}\text{H}_{20}\text{O}$	-4.0	34.5
$\gamma$ -Butyrolactone	$\text{C}_4\text{H}_6\text{O}_2$	-43.61	9.57	Decane	$\text{C}_{10}\text{H}_{22}$	-29.6	28.72
Caffeine	$\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$	236.3	22.0	Decanoic acid	$\text{C}_{10}\text{H}_{20}\text{O}_2$	31.4	27.8
Carbazole	$\text{C}_{12}\text{H}_9\text{N}$	246.3	24.1	1-Decanol	$\text{C}_{10}\text{H}_{22}\text{O}$	6.9	43
Carbon dioxide	$\text{CO}_2$	-56.558	9.02	1-Decene	$\text{C}_{10}\text{H}_{20}$	-66.3	13.81
Carbon diselenide	$\text{CSe}_2$	-43.7	6.36	1,2-Dibromoethane	$\text{C}_2\text{H}_2\text{Br}_2$	9.84	10.89
Carbon disulfide	$\text{CS}_2$	-112.1	4.39	1,2-Dibromopropane	$\text{C}_3\text{H}_4\text{Br}_2$	-55.49	8.94
Carbon monoxide	$\text{CO}$	-205.02	0.833	1,3-Dibromopropane	$\text{C}_3\text{H}_4\text{Br}_2$	-34.5	14.6
Carbon oxysulfide	$\text{COS}$	-138.8	4.73	1,2-Dibromotetrafluoroethane	$\text{C}_2\text{Br}_2\text{F}_4$	-110.32	7.04
Carbonyl chloride	$\text{CCl}_2\text{O}$	-127.78	5.74	<i>o</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	-17.0	12.4
Chloroacetic acid	$\text{C}_2\text{H}_3\text{ClO}_2$	63	12.28	<i>m</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	-24.8	12.6
2-Chloroaniline	$\text{C}_6\text{H}_6\text{ClN}$	-1.9	11.9	<i>p</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	53.09	18.19
3-Chloroaniline	$\text{C}_6\text{H}_6\text{ClN}$	-10.28	10.15	1,1-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	-96.9	7.87
4-Chloroaniline	$\text{C}_6\text{H}_6\text{ClN}$	70.5	20.0	1,2-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	-35.7	8.84
Chlorobenzene	$\text{C}_6\text{H}_5\text{Cl}$	-45.31	9.6	1,1-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	-122.56	6.51
2-Chlorobenzoic acid	$\text{C}_7\text{H}_5\text{ClO}_2$	140.2	25.6	<i>cis</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	-80.0	7.2
Chlorocyclohexane	$\text{C}_6\text{H}_{11}\text{Cl}$	-43.81	2.043	Dichloromethane	$\text{CH}_2\text{Cl}_2$	-97.2	4.60
Chlorodifluoromethane	$\text{CHClF}_2$	-157.42	4.12	1,2-Dichloropropane	$\text{C}_3\text{H}_4\text{Cl}_2$	-100.53	6.40
Chloroethane	$\text{C}_2\text{H}_5\text{Cl}$	-138.4	4.45	2,2-Dichloropropane	$\text{C}_3\text{H}_6\text{Cl}_2$	-33.9	2.30
Chloroethene	$\text{C}_2\text{H}_3\text{Cl}$	-153.84	4.92	1,2-Dichloro-1,1,2,2-tetrafluoroethane	$\text{C}_2\text{Cl}_2\text{F}_4$	-92.53	1.51
Chloromethane	$\text{CH}_3\text{Cl}$	-97.7	6.43	Diethyl ether	$\text{C}_4\text{H}_{10}\text{O}$	-116.2	7.19
2-Chloro-2-methylpropane	$\text{C}_4\text{H}_9\text{Cl}$	-25.60	2.07	3,3-Diethylpentane	$\text{C}_9\text{H}_{20}$	-33.1	10.09
1-Chloronaphthalene	$\text{C}_{10}\text{H}_7\text{Cl}$	-2.5	12.9	Diethyl sulfide	$\text{C}_4\text{H}_{10}\text{S}$	-103.91	10.90
2-Chloronaphthalene	$\text{C}_{10}\text{H}_7\text{Cl}$	58.0	14.0	<i>o</i> -Difluorobenzene	$\text{C}_6\text{H}_4\text{F}_2$	-47.1	11.05
1-Chloro-2-nitrobenzene	$\text{C}_6\text{H}_4\text{ClNO}_2$	32.1	17.9	<i>m</i> -Difluorobenzene	$\text{C}_6\text{H}_4\text{F}_2$	-69.12	8.58
1-Chloro-3-nitrobenzene	$\text{C}_6\text{H}_4\text{ClNO}_2$	44.4	19.4	Diisopropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-85.4	12.04
1-Chloro-4-nitrobenzene	$\text{C}_6\text{H}_4\text{ClNO}_2$	82	14.1	1,2-Dimethoxyethane	$\text{C}_4\text{H}_{10}\text{O}_2$	-69.20	12.6
Chloropentafluoroethane	$\text{C}_2\text{ClF}_5$	-99.4	1.86	Dimethoxymethane	$\text{C}_3\text{H}_8\text{O}_2$	-105.1	8.33

Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Dimethylamine	$\text{C}_2\text{H}_7\text{N}$	-92.18	5.94	Formamide	$\text{CH}_3\text{NO}$	2.49	8.44
2,2-Dimethylbutane	$\text{C}_6\text{H}_{14}$	-98.8	0.58	Formic acid	$\text{CH}_2\text{O}_2$	8.3	12.68
2,3-Dimethylbutane	$\text{C}_6\text{H}_{14}$	-128.10	0.79	Furan	$\text{C}_4\text{H}_4\text{O}$	-85.61	3.80
2,3-Dimethyl-2-butene	$\text{C}_6\text{H}_{12}$	-74.19	6.45	Furfural	$\text{C}_5\text{H}_4\text{O}_2$	-38.1	14.37
1,1-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-33.3	2.07	Furfuryl alcohol	$\text{C}_5\text{H}_6\text{O}_2$	-14.6	13.13
<i>cis</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-49.8	1.64	Glycerol	$\text{C}_3\text{H}_8\text{O}_3$	18.1	18.3
<i>trans</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-88.15	10.49	Heneicosane	$\text{C}_{21}\text{H}_{44}$	40.01	45.21
<i>cis</i> -1,3-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-75.53	10.82	Heptacosane	$\text{C}_{27}\text{H}_{56}$	59.23	61.9
<i>trans</i> -1,3-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-90.07	9.87	Heptadecane	$\text{C}_{17}\text{H}_{36}$	22.0	40.16
<i>cis</i> -1,4-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-87.39	9.31	Heptanal	$\text{C}_7\text{H}_{14}\text{O}$	-43.4	23.2
<i>trans</i> -1,4-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	-36.93	12.33	Heptane	$\text{C}_7\text{H}_{16}$	-90.55	14.03
Dimethyl disulfide	$\text{C}_2\text{H}_6\text{S}_2$	-84.67	9.19	Heptanoic acid	$\text{C}_7\text{H}_{14}\text{O}_2$	-7.17	15.13
Dimethyl ether	$\text{C}_2\text{H}_6\text{O}$	-141.5	4.94	1-Heptanol	$\text{C}_7\text{H}_{16}\text{O}$	-33.2	18.17
<i>N,N</i> -Dimethylformamide	$\text{C}_3\text{H}_7\text{NO}$	-60.48	7.90	1-Heptene	$\text{C}_7\text{H}_{14}$	-118.9	12.41
1,1-Dimethylhydrazine	$\text{C}_2\text{H}_8\text{N}_2$	-57.20	10.07	Hexachlorobenzene	$\text{C}_6\text{Cl}_6$	228.83	25.2
1,2-Dimethylhydrazine	$\text{C}_2\text{H}_8\text{N}_2$	-8.9	13.64	Hexachloroethane	$\text{C}_2\text{Cl}_6$	186.8t	9.75
Dimethyl oxalate	$\text{C}_4\text{H}_6\text{O}_4$	54.8	21.1	Hexacontane	$\text{C}_{60}\text{H}_{122}$	99.3	193.2
2,2-Dimethylpentane	$\text{C}_7\text{H}_{16}$	-123.7	5.82	Hexacosane	$\text{C}_{26}\text{H}_{54}$	56.1	60.0
2,4-Dimethylpentane	$\text{C}_7\text{H}_{16}$	-119.2	6.85	Hexadecane	$\text{C}_{16}\text{H}_{34}$	18.12	53.36
3,3-Dimethylpentane	$\text{C}_7\text{H}_{16}$	-134.4	6.85	Hexadecanoic acid	$\text{C}_{16}\text{H}_{32}\text{O}_2$	62.5	53.7
Dimethyl sulfide	$\text{C}_2\text{H}_6\text{S}$	-98.24	7.99	1-Hexadecanol	$\text{C}_{16}\text{H}_{34}\text{O}$	49.2	33.6
Dimethyl sulfone	$\text{C}_2\text{H}_6\text{O}_2\text{S}$	108.9	18.30	Hexafluorobenzene	$\text{C}_6\text{F}_6$	5.03	11.59
Dimethyl sulfoxide	$\text{C}_2\text{H}_6\text{OS}$	17.89	14.37	Hexafluoroethane	$\text{C}_2\text{F}_6$	-100.05	2.69
<i>N,N</i> -Dimethylurea	$\text{C}_3\text{H}_8\text{N}_2\text{O}$	182.1	23.0	Hexamethylbenzene	$\text{C}_{12}\text{H}_{18}$	165.5	20.6
<i>N,N'</i> -Dimethylurea	$\text{C}_3\text{H}_8\text{N}_2\text{O}$	106.6	13.0	Hexanal	$\text{C}_6\text{H}_{12}\text{O}$	-56	13.3
Dimethyl zinc	$\text{C}_2\text{H}_6\text{Zn}$	-43.0	6.83	Hexane	$\text{C}_6\text{H}_{14}$	-95.35	13.08
1,4-Dioxane	$\text{C}_4\text{H}_8\text{O}_2$	11.85	12.84	1,6-Hexanedioic acid	$\text{C}_6\text{H}_{10}\text{O}_4$	152.5	36.3
1,3-Dioxolane	$\text{C}_3\text{H}_6\text{O}_2$	-97.22	6.57	1,6-Hexanediol	$\text{C}_6\text{H}_{14}\text{O}_2$	41.5	22.2
Diphenylamine	$\text{C}_{12}\text{H}_{11}\text{N}$	53.2	18.5	1-Hexanol	$\text{C}_6\text{H}_{14}\text{O}$	-47.4	15.38
Diphenyl ether	$\text{C}_{12}\text{H}_{10}\text{O}$	26.864	17.22	2-Hexanone	$\text{C}_6\text{H}_{12}\text{O}$	-55.5	14.9
Diphenylmethane	$\text{C}_{13}\text{H}_{12}$	25.4	18.6	3-Hexanone	$\text{C}_6\text{H}_{12}\text{O}$	-55.4	13.49
Dipropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	-114.8	10.8	Hexatetracontane	$\text{C}_{46}\text{H}_{94}$	87.6	176.0
Divinyl ether	$\text{C}_4\text{H}_6\text{O}$	-100.6	7.9	Hexatriacontane	$\text{C}_{36}\text{H}_{74}$	75.8	87.7
Docosane	$\text{C}_{22}\text{H}_{46}$	43.6	48.8	1-Hexene	$\text{C}_6\text{H}_{12}$	-139.76	9.35
Dodecane	$\text{C}_{12}\text{H}_{26}$	-9.57	36.8	<i>cis</i> -2-Hexene	$\text{C}_6\text{H}_{12}$	-141.11	8.88
Dodecanoic acid	$\text{C}_{12}\text{H}_{24}\text{O}_2$	43.8	36.3	Hydrogen cyanide	$\text{CHN}$	-13.29	8.41
1-Dodecanol	$\text{C}_{12}\text{H}_{26}\text{O}$	23.9	40.2	<i>p</i> -Hydroquinone	$\text{C}_6\text{H}_6\text{O}_2$	172.4	26.8
1-Dodecene	$\text{C}_{12}\text{H}_{24}$	-35.2	19.9	2-Hydroxybenzoic acid	$\text{C}_7\text{H}_6\text{O}_3$	159.0	14.2
Dotriacontane	$\text{C}_{32}\text{H}_{66}$	69.4	75.8	Imidazole	$\text{C}_3\text{H}_4\text{N}_2$	89.5	12.82
Eicosane	$\text{C}_{20}\text{H}_{42}$	36.6	69.9	Indan	$\text{C}_9\text{H}_{10}$	-51.38	8.60
1-Eicosanol	$\text{C}_{20}\text{H}_{42}\text{O}$	65.4	42	Indene	$\text{C}_9\text{H}_8$	-1.5	10.20
Estradiol benzoate	$\text{C}_{25}\text{H}_{28}\text{O}_3$	193	41.8	Indomethacin	$\text{C}_{19}\text{H}_{16}\text{ClNO}_4$	160	36.9
Ethane	$\text{C}_2\text{H}_6$	-182.79	2.72*	Iodobenzene	$\text{C}_6\text{H}_5\text{I}$	-31.3	9.75
1,2-Ethanediamine	$\text{C}_2\text{H}_8\text{N}_2$	11.14	22.58	Isobutane	$\text{C}_4\text{H}_{10}$	-159.4	4.54
1,2-Ethandiol	$\text{C}_2\text{H}_6\text{O}_2$	-12.69	9.96	Isobutene	$\text{C}_4\text{H}_8$	-140.7	5.92
Ethanethiol	$\text{C}_2\text{H}_6\text{S}$	-147.88	4.98	Isopentane	$\text{C}_5\text{H}_{12}$	-159.77	5.15
Ethanol	$\text{C}_2\text{H}_6\text{O}$	-114.14	4.931	Isopropylamine	$\text{C}_3\text{H}_7\text{N}$	-95.13	7.33
Ethinylestradiol	$\text{C}_{20}\text{H}_{24}\text{O}_2$	183.5	27.9	Isopropylbenzene	$\text{C}_9\text{H}_{12}$	-96.02	7.33
Ethyl acetate	$\text{C}_4\text{H}_8\text{O}_2$	-83.8	10.48	1-Isopropyl-4-methylbenzene	$\text{C}_{10}\text{H}_{14}$	-67.94	9.66
Ethylbenzene	$\text{C}_8\text{H}_{10}$	-94.96	9.18	Isoquinoline	$\text{C}_9\text{H}_7\text{N}$	26.47	13.54
Ethylcyclohexane	$\text{C}_8\text{H}_{16}$	-111.3	8.33	Khellin	$\text{C}_{14}\text{H}_{12}\text{O}_5$	154	32.3
Ethylene	$\text{C}_2\text{H}_4$	-169.15	3.35	Maleic anhydride	$\text{C}_4\text{H}_2\text{O}_3$	52.56	13.60
Ethyl methyl sulfide	$\text{C}_3\text{H}_8\text{S}$	-105.93	9.76	Methane	$\text{CH}_4$	-182.47	0.94
3-Ethylpentane	$\text{C}_7\text{H}_{16}$	-118.55	9.55	Methanethiol	$\text{CH}_3\text{S}$	-123	5.91
2-Ethyltoluene	$\text{C}_9\text{H}_{12}$	-79.83	9.96	Methanol	$\text{CH}_3\text{O}$	-97.53	3.215
3-Ethyltoluene	$\text{C}_9\text{H}_{12}$	-95.6	7.6	Methyl acetate	$\text{C}_3\text{H}_6\text{O}_2$	-98.25	7.49
4-Ethyltoluene	$\text{C}_9\text{H}_{12}$	-62.35	12.7	Methylamine	$\text{CH}_5\text{N}$	-93.5	6.13
Fluoranthene	$\text{C}_{16}\text{H}_{10}$	110.19	18.69	2-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	-14.41	11.66
9 <i>H</i> -Fluorene	$\text{C}_{13}\text{H}_{10}$	114.77	19.58	3-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	-31.3	7.9
Fluorobenzene	$\text{C}_6\text{H}_5\text{F}$	-42.18	11.31	4-Methylaniline	$\text{C}_7\text{H}_9\text{N}$	43.6	18.9

Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Methyl benzoate	$\text{C}_8\text{H}_8\text{O}_2$	-12.4	9.74	1-Octene	$\text{C}_8\text{H}_{16}$	-101.7	15.31
2-Methyl-1,3-butadiene	$\text{C}_5\text{H}_8$	-145.9	4.93	2-Oxepanone	$\text{C}_6\text{H}_{10}\text{O}_2$	-1.0	13.83
2-Methyl-2-butanol	$\text{C}_5\text{H}_{12}\text{O}$	-9.1	4.46	Oxetane	$\text{C}_3\text{H}_6\text{O}$	-97	6.5
3-Methyl-2-butanone	$\text{C}_5\text{H}_{10}\text{O}$	-93.1	9.34	Oxirane	$\text{C}_2\text{H}_4\text{O}$	-112.5	5.17
2-Methyl-1-butene	$\text{C}_5\text{H}_{10}$	-137.53	7.91	4-Oxopentanoic acid	$\text{C}_5\text{H}_8\text{O}_3$	33	9.22
3-Methyl-1-butene	$\text{C}_5\text{H}_{10}$	-168.43	5.36	Paraldehyde	$\text{C}_6\text{H}_{12}\text{O}_3$	12.6	13.5
2-Methyl-2-butene	$\text{C}_5\text{H}_{10}$	-133.72	7.60	Pentachloroethane	$\text{C}_2\text{HCl}_5$	-28.78	11.3
Methyl <i>tert</i> -butyl ether	$\text{C}_5\text{H}_{12}\text{O}$	-108.6	7.60	Pentacontane	$\text{C}_{50}\text{H}_{102}$	92.1	162.4
Methylcyclohexane	$\text{C}_7\text{H}_{14}$	-126.6	6.75	Pentacosane	$\text{C}_{25}\text{H}_{52}$	53.93	56.9
Methylcyclopentane	$\text{C}_6\text{H}_{12}$	-142.42	6.93	Pentadecane	$\text{C}_{15}\text{H}_{32}$	9.95	34.6
Methylcyclopropane	$\text{C}_4\text{H}_8$	-177.6	2.8	<i>cis</i> -1,3-Pentadiene	$\text{C}_5\text{H}_8$	-140.8	5.64
2-Methylfuran	$\text{C}_5\text{H}_8\text{O}$	-91.3	8.55	<i>trans</i> -1,3-Pentadiene	$\text{C}_5\text{H}_8$	-87.4	7.14
2-Methylheptane	$\text{C}_8\text{H}_{18}$	-109.02	11.92	1,4-Pentadiene	$\text{C}_5\text{H}_8$	-148.2	6.12
3-Methylheptane	$\text{C}_8\text{H}_{18}$	-120.48	11.69	Pentaerythritol	$\text{C}_5\text{H}_{12}\text{O}_4$	258	4.8
4-Methylheptane	$\text{C}_8\text{H}_{18}$	-121.0	10.8	Pentafluorobenzene	$\text{C}_6\text{HF}_5$	-47.4	10.87
2-Methylhexane	$\text{C}_7\text{H}_{16}$	-118.2	9.19	Pentafluorophenol	$\text{C}_6\text{HF}_5\text{O}$	37.5	16.41
Methylhydrazine	$\text{CH}_6\text{N}_2$	-52.36	10.42	2,3,4,5,6-Pentafluorotoluene	$\text{C}_7\text{HF}_5$	-29.78	13.1
Methyl methacrylate	$\text{C}_5\text{H}_8\text{O}_2$	-47.55	14.4	Pentane	$\text{C}_5\text{H}_{12}$	-129.67	8.40
1-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	-30.43	6.95	Pentanedioic acid	$\text{C}_5\text{H}_8\text{O}_4$	97.8	20.3
2-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	34.6	12.13	Pentanenitrile	$\text{C}_5\text{H}_9\text{N}$	-96.2	9
Methyl nitrate	$\text{CH}_3\text{NO}_3$	-83.0	8.24	1-Pentanethiol	$\text{C}_5\text{H}_{12}\text{S}$	-75.65	17.53
Methyloxirane	$\text{C}_3\text{H}_6\text{O}$	-111.9	6.53	Pentanoic acid	$\text{C}_5\text{H}_{10}\text{O}_2$	-33.6	14.16
2-Methylpentane	$\text{C}_6\text{H}_{14}$	-153.6	6.27	1-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	-77.6	10.50
3-Methylpentane	$\text{C}_6\text{H}_{14}$	-162.90	5.30	2-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	-76.8	10.63
2-Methyl-1-propanol	$\text{C}_4\text{H}_{10}\text{O}$	-101.9	6.32	3-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	-39	11.59
2-Methyl-2-propanol	$\text{C}_4\text{H}_{10}\text{O}$	25.69	6.70	Pentatriacontane	$\text{C}_{35}\text{H}_{72}$	74.6	86.3
2-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	-66.68	9.72	1-Pentene	$\text{C}_5\text{H}_{10}$	-165.12	5.94
3-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	-18.14	14.18	<i>cis</i> -2-Pentene	$\text{C}_5\text{H}_{10}$	-151.36	7.11
4-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	3.67	12.58	<i>trans</i> -2-Pentene	$\text{C}_5\text{H}_{10}$	-140.21	8.35
<i>N</i> -Methylurea	$\text{C}_2\text{H}_6\text{N}_2\text{O}$	104.9	14.0	Perfluoroacetone	$\text{C}_3\text{F}_6\text{O}$	-125.45	8.38
Morpholine	$\text{C}_4\text{H}_9\text{NO}$	-4.8	14.5	Perfluorobutane	$\text{C}_4\text{F}_{10}$	-129.1	7.66
Naphthalene	$\text{C}_{10}\text{H}_8$	80.26	19.01	Perfluorocyclobutane	$\text{C}_4\text{F}_8$	-40.19	2.77
1-Naphthol	$\text{C}_{10}\text{H}_8\text{O}$	95.0	23.1	Perfluoroheptane	$\text{C}_7\text{F}_{16}$	-51.2	6.95
2-Naphthol	$\text{C}_{10}\text{H}_8\text{O}$	121.5	18.1	Perfluorohexane	$\text{C}_6\text{F}_{14}$	-88.2	6.84
Neopentane	$\text{C}_5\text{H}_{12}$	-16.4	3.10	Perfluoropropane	$\text{C}_3\text{F}_8$	-147.70	0.477
Niacinamide	$\text{C}_6\text{H}_6\text{N}_2\text{O}$	130	23.2	Perfluorotoluene	$\text{C}_7\text{F}_8$	-65.49	11.54
2-Nitroaniline	$\text{C}_6\text{H}_6\text{N}_2\text{O}_2$	71.0	16.1	Perylene	$\text{C}_{20}\text{H}_{12}$	277.76	31.9
3-Nitroaniline	$\text{C}_6\text{H}_6\text{N}_2\text{O}_2$	113.4	23.6	Phenacetin	$\text{C}_{10}\text{H}_{13}\text{NO}_2$	134	33.0
4-Nitroaniline	$\text{C}_6\text{H}_6\text{N}_2\text{O}_2$	147.5	21.2	Phenanthrene	$\text{C}_{14}\text{H}_{10}$	99.24	16.46
Nitrobenzene	$\text{C}_6\text{H}_5\text{NO}_2$	5.7	12.12	Phenobarbital	$\text{C}_{12}\text{H}_{12}\text{N}_2\text{O}_3$	174.0	27.8
Nitroethane	$\text{C}_2\text{H}_5\text{NO}_2$	-89.5	9.85	Phenol	$\text{C}_6\text{H}_6\text{O}$	40.89	11.51
Nitromethane	$\text{CH}_3\text{NO}_2$	-28.38	9.70	$\alpha$ -Phenylbenzeneacetic acid	$\text{C}_{14}\text{H}_{12}\text{O}_2$	147.29	31.3
2-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	44.8	17.7	Phenylbutazone	$\text{C}_{19}\text{H}_{20}\text{N}_2\text{O}_2$	105	27.7
3-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	96.8	20.6	Phenylhydrazine	$\text{C}_6\text{H}_8\text{N}_2$	20.6	14.05
4-Nitrophenol	$\text{C}_6\text{H}_5\text{NO}_3$	113.6	18.8	Piperidine	$\text{C}_5\text{H}_{11}\text{N}$	-11.02	14.85
Nitrosobenzene	$\text{C}_6\text{H}_5\text{NO}$	67	31.0	Potassium acetate	$\text{C}_2\text{H}_3\text{KO}_2$	309	7.65
4-Nitrotoluene	$\text{C}_7\text{H}_7\text{NO}_2$	51.63	16.81	Propane	$\text{C}_3\text{H}_8$	-187.63	3.50
Nonacosane	$\text{C}_{29}\text{H}_{60}$	63.7	66.9	1,3-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	-27.7	7.1
Nonadecane	$\text{C}_{19}\text{H}_{40}$	32.0	45.8	Propanenitrile	$\text{C}_3\text{H}_7\text{N}$	-92.78	5.03
Nonanal	$\text{C}_9\text{H}_{18}\text{O}$	-19.3	30.5	1-Propanethiol	$\text{C}_3\text{H}_7\text{S}$	-113.13	5.48
Nonane	$\text{C}_9\text{H}_{20}$	-53.46	15.47	2-Propanethiol	$\text{C}_3\text{H}_7\text{S}$	-130.5	5.74
Nonanoic acid	$\text{C}_9\text{H}_{18}\text{O}_2$	12.4	19.82	Propanoic acid	$\text{C}_3\text{H}_6\text{O}_2$	-20.5	10.66
5-Nonanone	$\text{C}_9\text{H}_{18}\text{O}$	-3.8	24.93	1-Propanol	$\text{C}_3\text{H}_8\text{O}$	-124.39	5.37
Octacosane	$\text{C}_{28}\text{H}_{58}$	61.1	65.1	2-Propanol	$\text{C}_3\text{H}_8\text{O}$	-87.9	5.41
Octadecane	$\text{C}_{18}\text{H}_{38}$	28.2	61.7	Propene	$\text{C}_3\text{H}_6$	-185.24	3.003
1-Octadecanol	$\text{C}_{18}\text{H}_{38}\text{O}$	57.9	45	Propylamine	$\text{C}_3\text{H}_9\text{N}$	-84.75	10.97
Octane	$\text{C}_8\text{H}_{18}$	-56.82	20.73	Propylbenzene	$\text{C}_9\text{H}_{12}$	-99.6	9.27
Octanoic acid	$\text{C}_8\text{H}_{16}\text{O}_2$	16.5	21.35	Propylcyclohexane	$\text{C}_9\text{H}_{18}$	-94.9	10.37
1-Octanol	$\text{C}_8\text{H}_{18}\text{O}$	-14.8	23.7	Pyrazine	$\text{C}_4\text{H}_4\text{N}_2$	51.0	12.9
Octatriacontane	$\text{C}_{38}\text{H}_{78}$	78.6	133.2	1 <i>H</i> -Pyrazole	$\text{C}_3\text{H}_4\text{N}_2$	70.7	14.0



Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$	Name	Molecular formula	$t_m/^\circ\text{C}$	$\Delta_{\text{fus}}H/\text{kJ mol}^{-1}$
Pyrene	$\text{C}_{16}\text{H}_{10}$	150.62	17.36	Thiazole	$\text{C}_3\text{H}_3\text{NS}$	-33.62	9.57
Pyridine	$\text{C}_5\text{H}_5\text{N}$	-41.70	8.28	Thietane	$\text{C}_3\text{H}_6\text{S}$	-73.24	8.25
Pyrocatechol	$\text{C}_6\text{H}_6\text{O}_2$	104.6	22.8	Thiophene	$\text{C}_4\text{H}_4\text{S}$	-38.21	5.07
Pyrrole	$\text{C}_4\text{H}_5\text{N}$	-23.39	7.91	Thiourea	$\text{CH}_4\text{N}_2\text{S}$	178	14.0
Pyrrolidine	$\text{C}_4\text{H}_9\text{N}$	-57.79	8.58	Thymol	$\text{C}_{10}\text{H}_{14}\text{O}$	49.5	21.3
Quinoline	$\text{C}_9\text{H}_7\text{N}$	-14.78	10.66	Toluene	$\text{C}_7\text{H}_8$	-94.95	6.64
Resorcinol	$\text{C}_6\text{H}_6\text{O}_2$	109.4	20.4	<i>o</i> -Toluic acid	$\text{C}_8\text{H}_8\text{O}_2$	103.5	19.5
Sebacic acid	$\text{C}_{10}\text{H}_{18}\text{O}_4$	130.9	40.8	<i>m</i> -Toluic acid	$\text{C}_8\text{H}_8\text{O}_2$	109.9	15.7
Sodium acetate	$\text{C}_2\text{H}_3\text{NaO}_2$	328.2	17.9	<i>p</i> -Toluic acid	$\text{C}_8\text{H}_8\text{O}_2$	179.6	22.7
Sodium hydrogen carbonate	$\text{CHNaO}_3$	527	25	Triacontane	$\text{C}_{30}\text{H}_{62}$	65.1	68.3
Spiro[2.2]pentane	$\text{C}_5\text{H}_8$	-107.0	6.43	1,3,5-Triazine	$\text{C}_3\text{H}_3\text{N}_3$	80.3	14.56
Stearic acid	$\text{C}_{18}\text{H}_{36}\text{O}_2$	69.3	61.2	Tribromomethane	$\text{CHBr}_3$	8.69	11.05
<i>trans</i> -Stilbene	$\text{C}_{14}\text{H}_{12}$	124.2	27.7	Trichloroacetic acid	$\text{C}_2\text{HCl}_3\text{O}_2$	59.2	5.90
Styrene	$\text{C}_8\text{H}_8$	-30.65	10.9	1,2,3-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	51.3	17.9
Succinic acid	$\text{C}_4\text{H}_6\text{O}_4$	187.9	32.4	1,2,4-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	16.92	16.4
Succinic anhydride	$\text{C}_4\text{H}_4\text{O}_3$	119	20.4	1,3,5-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	62.8	18.1
Succinonitrile	$\text{C}_4\text{H}_4\text{N}_2$	58.06	3.70	1,1,1-Trichloroethane	$\text{C}_2\text{H}_2\text{Cl}_3$	-30.01	2.35
Sulfacetamide	$\text{C}_8\text{H}_{10}\text{N}_2\text{O}_3\text{S}$	183	22.4	1,1,2-Trichloroethane	$\text{C}_2\text{H}_2\text{Cl}_3$	-36.3	11.46
Sulfadiazine	$\text{C}_{10}\text{H}_{10}\text{N}_4\text{O}_2\text{S}$	258	42.6	Trichloroethene	$\text{C}_2\text{HCl}_3$	-84.7	8.45
Sulfamerazine	$\text{C}_{11}\text{H}_{12}\text{N}_4\text{O}_2\text{S}$	236	38.7	Trichlorofluoromethane	$\text{CCl}_3\text{F}$	-110.44	6.89
Sulfamethoxazole	$\text{C}_{10}\text{H}_{11}\text{N}_3\text{O}_3\text{S}$	170	32.2	Trichloromethane	$\text{CHCl}_3$	-63.41	9.5
Sulfamethoxypyridazine	$\text{C}_{11}\text{H}_{12}\text{N}_4\text{O}_3\text{S}$	182.5	31.3	1,1,2-Trichloro-1,2,2-trifluoroethane	$\text{C}_2\text{Cl}_3\text{F}_3$	-36.22	2.47
Sulfapyridine	$\text{C}_{11}\text{H}_{11}\text{N}_3\text{O}_2\text{S}$	192	34.4	Tricosane	$\text{C}_{23}\text{H}_{48}$	47.76	50.86
Sulfathiazole	$\text{C}_9\text{H}_9\text{N}_3\text{O}_2\text{S}_2$	202	26.4	Tridecane	$\text{C}_{13}\text{H}_{28}$	-5.4	28.50
Sulfisoxazole	$\text{C}_{11}\text{H}_{13}\text{N}_3\text{O}_3\text{S}$	196	30.2	1-Tridecanol	$\text{C}_{13}\text{H}_{28}\text{O}$	31.7	41.4
<i>o</i> -Terphenyl	$\text{C}_{18}\text{H}_{14}$	56.20	17.19	1,1,1-Trifluoroethane	$\text{C}_2\text{H}_2\text{F}_3$	-111.3	6.19
<i>p</i> -Terphenyl	$\text{C}_{18}\text{H}_{14}$	213.9	35.3	Trifluoromethane	$\text{CHF}_3$	-155.2	4.06
Tetrabromomethane	$\text{CBr}_4$	92.3	3.76	Triiodomethane	$\text{CHI}_3$	121.2	16.44
1,1,2,2-Tetrachloro-1,2-difluoroethane	$\text{C}_2\text{Cl}_4\text{F}_2$	24.8	3.67	Trimethoprim	$\text{C}_{14}\text{H}_{18}\text{N}_4\text{O}_3$	199	49.4
1,1,2,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	-42.4	9.17	Trimethylamine	$\text{C}_3\text{H}_9\text{N}$	-117.1	7
Tetrachloroethene	$\text{C}_2\text{Cl}_4$	-22.3	10.88	1,2,3-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-25.4	8.18
Tetrachloromethane	$\text{CCl}_4$	-22.62	2.56	1,2,4-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-43.77	13.19
Tetracontane	$\text{C}_{40}\text{H}_{82}$	81.5	135.5	1,3,5-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	-44.72	9.51
Tetracosane	$\text{C}_{24}\text{H}_{50}$	50.4	54.4	2,2,3-Trimethylbutane	$\text{C}_7\text{H}_{16}$	-24.6	2.26
Tetradecane	$\text{C}_{14}\text{H}_{30}$	5.82	45.07	2,2,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	-107.3	9.20
Tetradecanoic acid	$\text{C}_{14}\text{H}_{28}\text{O}_2$	54.2	45.1	1,3,5-Trinitrobenzene	$\text{C}_6\text{H}_3\text{N}_3\text{O}_6$	122.9	15.4
1-Tetradecanol	$\text{C}_{14}\text{H}_{30}\text{O}$	38.2	25.1*	Trinitroglycerol	$\text{C}_3\text{H}_5\text{N}_3\text{O}_9$	13.5	21.87
1,2,3,5-Tetrafluorobenzene	$\text{C}_6\text{H}_2\text{F}_4$	-46.25	6.36	2,4,6-Trinitrotoluene	$\text{C}_7\text{H}_5\text{N}_3\text{O}_6$	80.5	22.9
1,2,4,5-Tetrafluorobenzene	$\text{C}_6\text{H}_2\text{F}_4$	3.88	15.05	1,3,5-Trioxane	$\text{C}_3\text{H}_6\text{O}_3$	60.29	15.11
Tetrafluoroethene	$\text{C}_2\text{F}_4$	-131.15	7.72	Triphenylamine	$\text{C}_{18}\text{H}_{15}\text{N}$	126.5	24.9
Tetrafluoromethane	$\text{CF}_4$	-183.60	0.704	Triphenylene	$\text{C}_{18}\text{H}_{12}$	197.8	24.74
Tetrahydrofuran	$\text{C}_4\text{H}_8\text{O}$	-108.44	8.54	Trtriacontane	$\text{C}_{33}\text{H}_{68}$	71.2	79.5
Tetrahydropyran	$\text{C}_5\text{H}_{10}\text{O}$	-49.1	1.8	Undecane	$\text{C}_{11}\text{H}_{24}$	-25.5	22.2
Tetrahydrothiophene	$\text{C}_4\text{H}_8\text{S}$	-96.2	7.35	Urea	$\text{CH}_4\text{N}_2\text{O}$	133.3	13.9
1,2,4,5-Tetramethylbenzene	$\text{C}_{10}\text{H}_{14}$	79.3	21	<i>o</i> -Xylene	$\text{C}_8\text{H}_{10}$	-25.2	13.6
Tetramethyl lead	$\text{C}_4\text{H}_{12}\text{Pb}$	-30.2	10.80	<i>m</i> -Xylene	$\text{C}_8\text{H}_{10}$	-47.8	11.6
2,2,3,3-Tetramethylpentane	$\text{C}_9\text{H}_{20}$	-9.75	2.33	<i>p</i> -Xylene	$\text{C}_8\text{H}_{10}$	13.25	17.12
2,2,4,4-Tetramethylpentane	$\text{C}_9\text{H}_{20}$	-66.54	9.74	2,3-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	72.5	21.0
Tetramethylsilane	$\text{C}_4\text{H}_{12}\text{Si}$	-99.06	6.87	2,5-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	74.8	23.4
Tetramethylstannane	$\text{C}_4\text{H}_{12}\text{Sn}$	-55.1	9.30	2,6-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	45.8	18.9
Tetratetracontane	$\text{C}_{44}\text{H}_{90}$	85.6	149.6	3,4-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	65.1	18.1
Tetratriacontane	$\text{C}_{34}\text{H}_{70}$	72.5	79.4	3,5-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	63.4	17.4
1 <i>H</i> -Tetrazole	$\text{CH}_2\text{N}_4$	157.3	18.2				

## PRESSURE AND TEMPERATURE DEPENDENCE OF LIQUID DENSITY

This table gives data on the variation of the density of some common liquids with pressure and temperature. The pressure dependence is described to first order by the isothermal compressibility coefficient  $\kappa$  defined as

$$\kappa = -(1/V) (\partial V/\partial P)_T$$

where  $V$  is the volume, and the temperature dependence by the cubic expansion coefficient  $\alpha$ ,

$$\alpha = (1/V) (\partial V/\partial T)_P$$

Substances are listed by molecular formula in the Hill order. More precise data on the variation of density with temperature over a wide temperature range can be found in Reference 1.

### References

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4. Riddick, J.A., Bunger, W.B., and Sakano, T.K., *Organic Solvents, Fourth Edition*, John Wiley & Sons, New York, 1986.
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Molecular formula	Name	Isothermal compressibility		Cubic expansion coefficient	
		$t/^\circ\text{C}$	$\kappa \times 10^4/\text{MPa}^{-1}$	$t/^\circ\text{C}$	$\alpha \times 10^3/^\circ\text{C}^{-1}$
Cl <sub>3</sub> P	Phosphorus trichloride	20	9.45	20	1.9
H <sub>2</sub> O	Water	20	4.591	20	0.206
		25	4.524	25	0.256
		30	4.475	30	0.302
Hg	Mercury	20	0.401	20	0.1811
CCl <sub>4</sub>	Tetrachloromethane	20	10.50	20	1.14
		40	12.20	40	1.21
		70	15.6	70	1.33
CHBr <sub>3</sub>	Tribromomethane	50	8.76	25	0.91
CHCl <sub>3</sub>	Trichloromethane	20	9.96	20	1.21
		50	12.9	50	1.33
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	27	6.85		
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	25	10.3	25	1.39
CH <sub>3</sub> I	Iodomethane	27	10.3	25	1.26
CH <sub>4</sub> O	Methanol	20	12.14	20	1.49
		40	13.83	40	1.59
CS <sub>2</sub>	Carbon disulfide	20	9.38	20	1.12
		40	10.6	35	1.16
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene	25	7.56	25	1.02
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	25	8.57	25	1.17
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	25	11.2	25	1.36
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	20	7.97	25	0.93
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	30	8.46	20	1.14
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	20	9.08	20	1.08
		80	13.7	80	1.38
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	20	11.53	20	1.31
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	20	9.82	25	1.17
C <sub>2</sub> H <sub>6</sub> O	Ethanol	20	11.19	20	1.40
		70	15.93	70	1.67
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	20	3.64	20	0.626
C <sub>3</sub> H <sub>6</sub> O	Acetone	20	12.62	20	1.46
		40	15.6	40	1.57
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	0	10.22	25	1.2
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	0	12.09	20	1.4
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	0	10.22	25	1.09
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	0	8.43	0	1.22
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	40	13.32	40	1.55
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propanediol	0	4.45	20	0.695
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propanediol	0	4.09	20	0.61
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol	0	2.54	20	0.520
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	20	11.32	20	1.35
		60	16.2	60	1.54

Molecular formula	Name	Isothermal compressibility		Cubic expansion coefficient	
		$t/^\circ\text{C}$	$\kappa \times 10^4/\text{MPa}^{-1}$	$t/^\circ\text{C}$	$\alpha \times 10^3/^\circ\text{C}^{-1}$
$\text{C}_4\text{H}_9\text{Br}$	1-Bromobutane	25	10.26	20	1.13
$\text{C}_4\text{H}_9\text{I}$	1-Iodobutane	0	7.73	25	1.02
$\text{C}_4\text{H}_{10}\text{O}$	1-Butanol	0	8.10	0	1.12
$\text{C}_4\text{H}_{10}\text{O}$	Diethyl ether	20	18.65	20	1.65
		30	20.85	30	1.72
$\text{C}_4\text{H}_{10}\text{O}_3$	Diethylene glycol	0	3.34	20	0.635
$\text{C}_5\text{H}_{10}$	Cyclopentane	20	13.31	20	1.35
$\text{C}_5\text{H}_{11}\text{Br}$	1-Bromopentane	0	8.42	25	1.04
$\text{C}_5\text{H}_{11}\text{I}$	1-Iodopentane	0	7.56		
$\text{C}_5\text{H}_{12}$	Pentane	25	21.80	25	1.64
$\text{C}_5\text{H}_{12}\text{O}$	1-Pentanol	0	7.71	0	1.02
$\text{C}_6\text{H}_5\text{Br}$	Bromobenzene	20	6.46	20	0.86
$\text{C}_6\text{H}_5\text{Cl}$	Chlorobenzene	20	7.45	20	0.94
$\text{C}_6\text{H}_5\text{NO}_2$	Nitrobenzene	20	4.93	25	0.833
$\text{C}_6\text{H}_6$	Benzene	25	9.66	25	1.14
		45	11.28	45	1.21
$\text{C}_6\text{H}_6\text{O}$	Phenol	60	6.05	60	0.82
$\text{C}_6\text{H}_7\text{N}$	Aniline	20	4.53	20	0.81
		80	6.32	80	0.91
$\text{C}_6\text{H}_{12}$	Cyclohexane	20	11.30	20	1.15
		60	15.2	60	1.29
$\text{C}_6\text{H}_{14}$	Hexane	25	16.69	25	1.41
		45	20.27	45	1.52
$\text{C}_6\text{H}_{14}$	2-Methylpentane	0	13.97	25	1.43
$\text{C}_6\text{H}_{14}$	3-Methylpentane	0	14.57	25	1.40
$\text{C}_6\text{H}_{14}$	2,3-Dimethylbutane	20	17.97	25	1.39
$\text{C}_6\text{H}_{14}\text{O}$	1-Hexanol	25	8.24	25	1.03
$\text{C}_6\text{H}_{15}\text{NO}_3$	Triethanolamine	0	3.61	55	0.53
$\text{C}_7\text{H}_8$	Toluene	20	8.96	20	1.05
		50	11.0	50	1.13
$\text{C}_7\text{H}_8\text{O}$	Anisole	20	6.60	20	0.951
$\text{C}_7\text{H}_{14}$	Cycloheptane	20	9.22		
$\text{C}_7\text{H}_{16}$	Heptane	25	14.38	25	1.26
$\text{C}_8\text{H}_{10}$	<i>o</i> -Xylene	25	8.10	25	0.96
$\text{C}_8\text{H}_{10}$	<i>m</i> -Xylene	20	8.46	20	0.99
$\text{C}_8\text{H}_{10}$	<i>p</i> -Xylene	25	8.59	25	1.00
$\text{C}_8\text{H}_{16}$	Cyclooctane	20	8.03		
$\text{C}_8\text{H}_{18}$	Octane	25	12.82	25	1.16
		45	15.06	45	1.23
$\text{C}_8\text{H}_{18}\text{O}$	1-Octanol	25	7.64	25	0.827
$\text{C}_9\text{H}_{12}$	Mesitylene	25	8.14	25	0.94
$\text{C}_9\text{H}_{14}\text{O}_6$	Triacetin	0	4.49	25	0.94
$\text{C}_9\text{H}_{20}$	Nonane	25	11.75	25	1.08
$\text{C}_{10}\text{H}_{22}$	Decane	25	10.94	25	1.02
$\text{C}_{11}\text{H}_{24}$	Undecane	25	10.31	25	0.97
$\text{C}_{12}\text{H}_{26}$	Dodecane	25	9.88	25	0.93
$\text{C}_{13}\text{H}_{28}$	Tridecane	25	9.48	25	0.90
$\text{C}_{14}\text{H}_{30}$	Tetradecane	25	9.10	25	0.87
$\text{C}_{15}\text{H}_{32}$	Pentadecane	25	8.82		
$\text{C}_{16}\text{H}_{22}\text{O}_4$	Butyl phthalate	0	5.0	25	0.86
$\text{C}_{16}\text{H}_{34}$	Hexadecane	25	8.57		
		45	9.78		
$\text{C}_{19}\text{H}_{36}\text{O}_2$	Methyl oleate	0	6.18	60	0.85

## PROPERTIES OF CRYOGENIC FLUIDS

This table gives physical and thermodynamic properties of eight cryogenic fluids. The properties are:

$M$	Molar mass in grams per mole
$T_t$	Triple point temperature in kelvins
$P_t$	Triple point pressure in kilopascals
$\rho_t$ (l)	Liquid density at the triple point in grams per milliliter
$\Delta_{\text{fus}}H @ T_t$	Enthalpy of fusion at the triple point in joules per gram
$T_b$	Normal boiling point in kelvins at a pressure of 101325 pascals (760 mmHg)
$\Delta_{\text{vap}}H @ T_b$	Enthalpy of vaporization at the normal boiling point in joules per gram
$\rho$ (l) @ $T_b$	Liquid density at the normal boiling point in grams per milliliter
$\rho$ (g) @ $T_b$	Vapor density at the normal boiling point in grams per liter
$C_p$ (l) @ $T_b$	Liquid heat capacity at constant pressure at the normal boiling point in joules per gram kelvin
$C_p$ (g) @ $T_b$	Vapor heat capacity at constant pressure at the normal boiling point in joules per gram kelvin
$T_c$	Critical temperature in kelvins
$P_c$	Critical pressure in megapascals
$\rho_c$	Critical density in grams per milliliter

In the case of air, the value given for the triple point temperature is the incipient solidification temperature, and the normal boiling point value is the incipient boiling (bubble) point. See Reference 3 for more details.

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Property	Units	Air	N <sub>2</sub>	O <sub>2</sub>	H <sub>2</sub>	He	Ne	Ar	Kr	Xe	CH <sub>4</sub>
$M$	g/mol	28.96	28.014	31.999	2.0159	4.0026	20.180	39.948	83.800	131.290	16.043
$T_t$	K	59.75	63.15	54.3584	13.8		24.5561	83.8058	115.8	161.4	90.694
$P_t$	kPa		12.463	0.14633	7.042		50	68.95	72.92	81.59	11.696
$\rho_t$ (l)	g/mL	0.959	0.870	1.306	0.0770		1.251	1.417	2.449	2.978	0.4515
$\Delta_{\text{fus}}H @ T_t$	J/g		25.3	13.7	59.5		16.8	28.0	16.3	13.8	58.41
$T_b$	K	78.67	77.35	90.188	20.28	4.2221	27.07	87.293	119.92	165.10	111.668
$\Delta_{\text{vap}}H @ T_b$	J/g	198.7	198.8	213.1	445	20.7	84.8	161.0	108.4	96.1	510.83
$\rho$ (l) @ $T_b$	g/mL	0.8754	0.807	1.141	0.0708	0.124901	1.204	1.396	2.418	2.953	0.4224
$\rho$ (g) @ $T_b$	g/L	3.199	4.622	4.467	1.3390	16.89	9.51	5.79	8.94		1.816
$C_p$ (l) @ $T_b$	J/g K	1.865	2.042	1.699	9.668	4.545	1.877	1.078	0.533	0.340	3.481
$C_p$ (g) @ $T_b$	J/g K		1.341	0.980	12.24	9.78		0.570	0.248	0.158	2.218
$T_c$	K	132.5	126.20	154.581	32.98	5.1953	44.40	150.663	209.40	289.73	190.56
$P_c$	MPa	3.766	3.390	5.043	1.293	0.227460	2.760	4.860	5.500	5.840	4.592
$\rho_c$	g/mL	0.316	0.313	0.436	0.031	0.06964	0.484	0.531	0.919	1.110	0.1627

## PROPERTIES OF REFRIGERANTS

This table gives physical properties of compounds that have been used as working fluids in traditional refrigeration systems or are under consideration as replacements in newer systems. Some are also used as solvents and blowing agents. Many of the compounds listed are believed to be less harmful to the environment than the traditional halocarbon refrigerants.

Compounds are listed by their ASHRAE standard refrigerant designations (Reference 1), which appear in the first column. These codes are often prefixed by symbols such as CFC- (for chlorofluorocarbon), HCFC- (for hydrochlorofluorocarbon), or simply R- (for refrigerant). The "R" number assigned to refrigerants is specified by ANSI/ASHRAE Standard 34. This system is most useful for the hydrocarbons and halocarbons with one to three carbons; for such molecules the chemical composition can be determined from the number and vice versa. The first digit on the far right is the number of fluorine atoms in the compound. The second digit from the right is one more than the number of hydrogen atoms. The third digit from the right is one less than the number of carbon atoms; for single-carbon compounds, this digit is omitted. The fourth digit from the right is equal to the number of unsaturated carbon-carbon bonds; for saturated compounds, this digit is omitted. The number of bromine and iodine atoms is indicated, if needed, by appending "Bn" or "In" to the digits specified by the above rules, where "n" is the number of bromine or iodine atoms. All atoms not specified by the above are assumed to be chlorine. Appended lowercase letter(s) designate different isomers. Additional rules are used to specify cyclic compounds, ethers, inorganic fluids (R700- and R7000-series), miscellaneous organic compounds (R600-series), and blends (R400- and R500-series).

The properties tabulated are

$t_m$	normal melting point in °C
$t_b$	normal boiling point in °C (at 101.325 kPa or 760 mmHg)
$t_c$	critical temperature in °C
TLV	Threshold Limit Value, which is the maximum safe concentration in air in the workplace, expressed as the time-weighted average (TWA) in parts per million by volume, over an 8-hr workday and 40-hr workweek.

Many of the critical temperatures and normal boiling points have been calculated from the equations of state described in References 9 and 10. These values differ slightly in some cases (generally no more than about 0.1 °C) from values elsewhere in this book, but the differences are probably within the experimental uncertainty. Further references and additional data on the critical properties may be found in the table "Critical Constants" in this Section.

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Code	Name	Molecular Formula	CAS Reg. No.	$t_m$ /°C	$t_b$ /°C	$t_c$ /°C	TLV/ppm
10	Tetrachloromethane	CCl <sub>4</sub>	56-23-5	-22.62	76.8	283.4	5
11	Trichlorofluoromethane	CCl <sub>3</sub> F	75-69-4	-110.47	23.71	197.96	1000
12	Dichlorodifluoromethane	CCl <sub>2</sub> F <sub>2</sub>	75-71-8	-157.05	-29.75	111.97	1000
12B1	Bromochlorodifluoromethane	CBrClF <sub>2</sub>	353-59-3	-159.5	-3.7	153.73	
12B2	Dibromodifluoromethane	CBr <sub>2</sub> F <sub>2</sub>	75-61-6	-110.1	22.76	198.1	100
13	Chlorotrifluoromethane	CClF <sub>3</sub>	75-72-9	-181.15	-81.48	28.85	
13B1	Bromotrifluoromethane	CBrF <sub>3</sub>	75-63-8	-172	-57.8	67.0	1000
14	Tetrafluoromethane	CF <sub>4</sub>	75-73-0	-183.61	-128.05	-45.64	
20	Trichloromethane	CHCl <sub>3</sub>	67-66-3	-63.41	61.17	263.2	10
21	Dichlorofluoromethane	CHCl <sub>2</sub> F	75-43-4	-130.35	8.86	178.33	10
22	Chlorodifluoromethane	CHClF <sub>2</sub>	75-45-6	-157.42	-40.81	96.15	1000
22B1	Bromodifluoromethane	CHBrF <sub>2</sub>	1511-62-2	-145	-14.6	138.83	
23	Trifluoromethane	CHF <sub>3</sub>	75-46-7	-155.13	-82.02	26.14	
30	Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	75-09-2	-97.2	40	237	50

Code	Name	Molecular Formula	CAS Reg. No.	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$t_c/^\circ\text{C}$	TLV/ ppm
31	Chlorofluoromethane	$\text{CH}_2\text{ClF}$	593-70-4	-135.1	-9.1	154	
32	Difluoromethane	$\text{CH}_2\text{F}_2$	75-10-5	-136.81	-51.65	78.11	
40	Chloromethane	$\text{CH}_3\text{Cl}$	74-87-3	-97.7	-24.09	143.10	50
41	Fluoromethane	$\text{CH}_3\text{F}$	593-53-3	-143.33	-78.31	44.13	
50	Methane	$\text{CH}_4$	74-82-8	-182.43	-161.48	-82.59	1000
110	Hexachloroethane	$\text{C}_2\text{Cl}_6$	67-72-1	186.8	184.7 sp	422	1
111	Pentachlorofluoroethane	$\text{C}_2\text{Cl}_5\text{F}$	354-56-3	101.3	138		
112	1,1,2,2-Tetrachloro-1,2-difluoroethane	$\text{C}_2\text{Cl}_4\text{F}_2$	76-12-0	24.8	92.8	278	50
112a	1,1,1,2-Tetrachloro-2,2-difluoroethane	$\text{C}_2\text{Cl}_4\text{F}_2$	76-11-9	41.0	92.8		100
113	1,1,2-Trichloro-1,2,2-trifluoroethane	$\text{C}_2\text{Cl}_3\text{F}_3$	76-13-1	-36.22	47.59	214.06	1000
113a	1,1,1-Trichloro-2,2,2-trifluoroethane	$\text{C}_2\text{Cl}_3\text{F}_3$	354-58-5	14.37	45.5	209.7	
114	1,2-Dichloro-1,1,2,2-tetrafluoroethane	$\text{C}_2\text{Cl}_2\text{F}_4$	76-14-2	-92.52	3.59	145.68	1000
114a	1,1-Dichloro-1,2,2,2-tetrafluoroethane	$\text{C}_2\text{Cl}_2\text{F}_4$	374-07-2	-56.6	3.4	145.4	
114B2	1,2-Dibromotetrafluoroethane	$\text{C}_2\text{Br}_2\text{F}_4$	124-73-2	-110.32	47.35	214.6	
115	Chloropentafluoroethane	$\text{C}_2\text{ClF}_5$	76-15-3	-99.4	-39.22	79.95	1000
116	Hexafluoroethane	$\text{C}_2\text{F}_6$	76-16-4	-100.05	-78.09	19.88	
120	Pentachloroethane	$\text{C}_2\text{HCl}_5$	76-01-7	-28.78	162.0		
121	1,1,2,2-Tetrachloro-1-fluoroethane	$\text{C}_2\text{HCl}_4\text{F}$	354-14-3	-82.6	116.7		
121a	1,1,1,2-Tetrachloro-2-fluoroethane	$\text{C}_2\text{HCl}_4\text{F}$	354-11-0	-95.3	117.1		
122	1,2,2-Trichloro-1,1-difluoroethane	$\text{C}_2\text{HCl}_3\text{F}_2$	354-21-2	-140	71.9		
122a	1,2,2-Trichloro-1,2-difluoroethane	$\text{C}_2\text{HCl}_3\text{F}_2$	354-15-4	-174	72.5		
122b	1,1,1-Trichloro-2,2-difluoroethane	$\text{C}_2\text{HCl}_3\text{F}_2$	354-12-1		73		
123	2,2-Dichloro-1,1,1-trifluoroethane	$\text{C}_2\text{HCl}_2\text{F}_3$	306-83-2	-107.15	27.82	183.68	
123a	1,2-Dichloro-1,1,2-trifluoroethane	$\text{C}_2\text{HCl}_2\text{F}_3$	354-23-4	-78	29.5	188.4	
124	1-Chloro-1,2,2,2-tetrafluoroethane	$\text{C}_2\text{HClF}_4$	2837-89-0	-199.15	-11.96	122.28	
124a	1-Chloro-1,1,2,2-tetrafluoroethane	$\text{C}_2\text{HClF}_4$	354-25-6	-117	-11.7	126.7	
125	Pentafluoroethane	$\text{C}_2\text{HF}_5$	354-33-6	-100.63	-48.09	66.02	
E125	Trifluoromethyl difluoromethyl ether	$\text{C}_2\text{HF}_5\text{O}$	3822-68-2	-157	-38	80.8	
130	1,1,2,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	79-34-5	-42.4	145.2	388.00	1
131	1,1,2-Trichloro-2-fluoroethane	$\text{C}_2\text{H}_2\text{Cl}_3\text{F}$	359-28-4		102.4		
132	1,2-Dichloro-1,2-difluoroethane	$\text{C}_2\text{H}_2\text{Cl}_2\text{F}_2$	431-06-1	-101.2	59.6		
132b	1,2-Dichloro-1,1-difluoroethane	$\text{C}_2\text{H}_2\text{Cl}_2\text{F}_2$	1649-08-7	-101.2	46.2		
133	1-Chloro-1,2,2-trifluoroethane	$\text{C}_2\text{H}_2\text{ClF}_3$	431-07-2		17.3		
133a	2-Chloro-1,1,1-trifluoroethane	$\text{C}_2\text{H}_2\text{ClF}_3$	75-88-7	-105.5	6.1	151.86	
133b	1-Chloro-1,1,2-trifluoroethane	$\text{C}_2\text{H}_2\text{ClF}_3$	421-04-5		12		
134	1,1,2,2-Tetrafluoroethane	$\text{C}_2\text{H}_2\text{F}_4$	359-35-3	-89	-19.9	118.59	
134a	1,1,1,2-Tetrafluoroethane	$\text{C}_2\text{H}_2\text{F}_4$	811-97-2	-103.3	-26.07	101.06	
E134	Bis(difluoromethyl) ether	$\text{C}_2\text{H}_2\text{F}_4\text{O}$	1691-17-4		2	147.10	
140	1,1,2-Trichloroethane	$\text{C}_2\text{H}_3\text{Cl}_3$	79-00-5	-36.3	113.8	329	10
140a	1,1,1-Trichloroethane	$\text{C}_2\text{H}_3\text{Cl}_3$	71-55-6	-30.01	74.09	272	350
141	1,2-Dichloro-1-fluoroethane	$\text{C}_2\text{H}_3\text{Cl}_2\text{F}$	430-57-9	-60	73.8		
141b	1,1-Dichloro-1-fluoroethane	$\text{C}_2\text{H}_3\text{Cl}_2\text{F}$	1717-00-6	-103.47	32.05	204.35	
142	1-Chloro-2,2-difluoroethane	$\text{C}_2\text{H}_3\text{ClF}_2$	338-65-8		35.1		
142b	1-Chloro-1,1-difluoroethane	$\text{C}_2\text{H}_3\text{ClF}_2$	75-68-3	-130.43	-9.12	137.11	
143	1,1,2-Trifluoroethane	$\text{C}_2\text{H}_3\text{F}_3$	430-66-0	-84	3.7	156.6	
143a	1,1,1-Trifluoroethane	$\text{C}_2\text{H}_3\text{F}_3$	420-46-2	-111.81	-47.24	72.71	
143m	Methyl trifluoromethyl ether	$\text{C}_2\text{H}_3\text{F}_3\text{O}$	421-14-7	-149	-23.66	104.77	
E143a	2,2,2-Trifluoroethyl methyl ether	$\text{C}_3\text{H}_5\text{F}_3\text{O}$	460-43-5		31.62	175.83	
150	1,2-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	107-06-2	-35.7	83.5	288	10
150a	1,1-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	75-34-3	-96.9	57.3	250	100
151	1-Chloro-2-fluoroethane	$\text{C}_2\text{H}_4\text{ClF}$	762-50-5		52.8		

Code	Name	Molecular Formula	CAS Reg. No.	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$t_c/^\circ\text{C}$	TLV/ ppm
151a	1-Chloro-1-fluoroethane	$\text{C}_2\text{H}_4\text{ClF}$	1615-75-4		16.2		
152	1,2-Difluoroethane	$\text{C}_2\text{H}_4\text{F}_2$	624-72-6		26		
152a	1,1-Difluoroethane	$\text{C}_2\text{H}_4\text{F}_2$	75-37-6	-118.59	-24.02	113.26	
160	Chloroethane	$\text{C}_2\text{H}_5\text{Cl}$	75-00-3	-138.4	12.3	187.2	100
161	Fluoroethane	$\text{C}_2\text{H}_5\text{F}$	353-36-6	-143.2	-37.7	102.16	
170	Ethane	$\text{C}_2\text{H}_6$	74-84-0	-182.77	-88.58	32.17	1000
E170	Dimethyl ether	$\text{C}_2\text{H}_6\text{O}$	115-10-6	-141.50	-24.81	127.15	
216ca	1,3-Dichloro-1,1,2,2,3,3-hexafluoropropane	$\text{C}_3\text{Cl}_2\text{F}_6$	662-01-1	-125.4	35.7	180	
218	Perfluoropropane	$\text{C}_3\text{F}_8$	76-19-7	-147.70	-36.79	71.87	
227ca2	Trifluoromethyl 1,1,2,2-tetrafluoroethyl ether	$\text{C}_3\text{HF}_7\text{O}$	2356-61-8	-141	-3	114.63	
227ea	1,1,1,2,3,3,3-Heptafluoropropane	$\text{C}_3\text{HF}_7$	431-89-0	-126.80	-16.34	101.75	
227me	Trifluoromethyl 1,2,2,2-tetrafluoroethyl ether	$\text{C}_3\text{HF}_7\text{O}$	2356-62-9		-9.6		
236ea	1,1,1,2,3,3-Hexafluoropropane	$\text{C}_3\text{H}_2\text{F}_6$	431-63-0		6.20	139.29	
236fa	1,1,1,3,3,3-Hexafluoropropane	$\text{C}_3\text{H}_2\text{F}_6$	690-39-1	-93.63	-1.44	124.92	
236me	1,2,2,2-Tetrafluoroethyl difluoromethyl ether	$\text{C}_3\text{H}_2\text{F}_6\text{O}$	57041-67-5		23.35	155.80	
245ca	1,1,2,2,3-Pentafluoropropane	$\text{C}_3\text{H}_3\text{F}_5$	679-86-7		25.13	174.42	
245cb	1,1,1,2,2-Pentafluoropropane	$\text{C}_3\text{H}_3\text{F}_5$	1814-88-6		-17.4	106.96	
245fa	1,1,1,3,3-Pentafluoropropane	$\text{C}_3\text{H}_3\text{F}_5$	460-73-1	-102.10	15.14	154.01	
245mc	Methyl pentafluoroethyl ether	$\text{C}_3\text{H}_3\text{F}_5\text{O}$	22410-44-2		5.59	133.65	
245mf	Difluoromethyl 2,2,2-trifluoroethyl ether	$\text{C}_3\text{H}_3\text{F}_5\text{O}$	1885-48-9		29.24	170.84	
245qc	Difluoromethyl 1,1,2-trifluoroethyl ether	$\text{C}_3\text{H}_3\text{F}_5\text{O}$	69948-24-9		43.1		
254pc	Methyl 1,1,2,2-tetrafluoroethyl ether	$\text{C}_3\text{H}_4\text{F}_4\text{O}$	425-88-7	-107	37.1		
290	Propane	$\text{C}_3\text{H}_8$	74-98-6	-187.62	-42.11	96.74	1000
C316	1,2-Dichloro-1,2,3,3,4,4-hexafluorocyclobutane	$\text{C}_4\text{Cl}_2\text{F}_6$	356-18-3	-24.2	59.5	224	
C317	1-Chloro-1,2,2,3,3,4,4-heptafluorocyclobutane	$\text{C}_4\text{ClF}_7$	377-41-3	-39.1	25		
C318	Perfluorocyclobutane	$\text{C}_4\text{F}_8$	115-25-3	-40.19	-5.9	115.31	
347mcc	Perfluoropropyl methyl ether	$\text{C}_4\text{H}_3\text{F}_7\text{O}$	375-03-1		34.23	164.55	
347mmy	Perfluoroisopropyl methyl ether	$\text{C}_4\text{H}_3\text{F}_7\text{O}$	22052-84-2		29.34	160.15	
600	Butane	$\text{C}_4\text{H}_{10}$	106-97-8	-138.24	-0.49	151.98	1000
600a	Isobutane	$\text{C}_4\text{H}_{10}$	75-28-5	-159.38	-11.75	134.66	1000
610	Diethyl ether	$\text{C}_4\text{H}_{10}\text{O}$	60-29-7	-116.2	34.5	193.5	400
611	Methyl formate	$\text{C}_2\text{H}_4\text{O}_2$	107-31-3	-99	31.7	214.0	100
717	Ammonia	$\text{H}_3\text{N}$	7664-41-7	-77.65	-33.33	132.25	25
744	Carbon dioxide	$\text{CO}_2$	124-38-9	-56.56	-78.46 sp	30.98	5000
764	Sulfur dioxide	$\text{O}_2\text{S}$	7446-09-5	-75.45	-10.02	157.49	2
1112a	1,1-Dichloro-2,2-difluoroethene	$\text{C}_2\text{Cl}_2\text{F}_2$	79-35-6	-116	19		
1113	Chlorotrifluoroethene	$\text{C}_2\text{ClF}_3$	79-38-9	-158.2	-27.8	106	
1114	Tetrafluoroethene	$\text{C}_2\text{F}_4$	116-14-3	-131.15	-75.9	33.3	2
1120	Trichloroethene	$\text{C}_2\text{HCl}_3$	79-01-6	-84.7	87.21	271.0	10
1130	<i>trans</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	156-60-5	-49.8	48.7	243.3	200
1132a	1,1-Difluoroethene	$\text{C}_2\text{H}_2\text{F}_2$	75-38-7	-144	-85.7	29.7	500
1140	Chloroethene	$\text{C}_2\text{H}_3\text{Cl}$	75-01-4	-153.84	-13.8	159	1
1141	Fluoroethene	$\text{C}_2\text{H}_3\text{F}$	75-02-5	-160.5	-72	54.7	1
1150	Ethylene	$\text{C}_2\text{H}_4$	74-85-1	-169.15	-103.77	9.20	200
1270	Propene	$\text{C}_3\text{H}_6$	115-07-1	-185.19	-47.62	91.06	500



## DENSITY AND SPECIFIC VOLUME OF MERCURY

The data in this table have been adjusted to the ITS-90 temperature scale. The uncertainty in density values is 0.0003 g/mL between -20 and -10°C; 0.0001 or less between -10 and 200°C; and 0.0002 between 200 and 300°C.

### Reference

Ambrose, D., *Metrologia*, 27, 245, 1990.

$t/^\circ\text{C}$	$\rho/(\text{g/mL})$	$\nu/(\text{mL/kg})$	$t/^\circ\text{C}$	$\rho/(\text{g/mL})$	$\nu/(\text{mL/kg})$	$t/^\circ\text{C}$	$\rho/(\text{g/mL})$	$\nu/(\text{mL/kg})$
-20	13.64461	73.2890	30	13.52134	73.9572	80	13.39971	74.6285
-19	13.64212	73.3024	31	13.51889	73.9705	81	13.39729	74.6420
-18	13.63964	73.3157	32	13.51645	73.9839	82	13.39487	74.6554
-17	13.63716	73.3291	33	13.51400	73.9973	83	13.39245	74.6689
-16	13.63468	73.3424	34	13.51156	74.0107	84	13.39003	74.6824
-15	13.63220	73.3558	35	13.50911	74.0241	85	13.38762	74.6959
-14	13.62972	73.3691	36	13.50667	74.0375	86	13.38520	74.7094
-13	13.62724	73.3824	37	13.50422	74.0509	87	13.38278	74.7229
-12	13.62476	73.3958	38	13.50178	74.0643	88	13.38037	74.7364
-11	13.62228	73.4091	39	13.49934	74.0777	89	13.37795	74.7498
-10	13.61981	73.4225	40	13.49690	74.0911	90	13.37554	74.7633
-9	13.61733	73.4358	41	13.49446	74.1045	91	13.37313	74.7768
-8	13.61485	73.4492	42	13.49202	74.1179	92	13.37071	74.7903
-7	13.61238	73.4625	43	13.48958	74.1313	93	13.36830	74.8038
-6	13.60991	73.4759	44	13.48714	74.1447	94	13.36589	74.8173
-5	13.60743	73.4892	45	13.48470	74.1581	95	13.36347	74.8308
-4	13.60496	73.5026	46	13.48226	74.1715	96	13.36106	74.8443
-3	13.60249	73.5160	47	13.47982	74.1850	97	13.35865	74.8579
-2	13.60002	73.5293	48	13.47739	74.1984	98	13.35624	74.8714
-1	13.59755	73.5427	49	13.47495	74.2118	99	13.35383	74.8849
0	13.59508	73.5560	50	13.47251	74.2252	100	13.35142	74.8984
1	13.59261	73.5694	51	13.47008	74.2386	110	13.3273	75.0337
2	13.59014	73.5827	52	13.46765	74.2520	120	13.3033	75.1693
3	13.58768	73.5961	53	13.46521	74.2655	130	13.2793	75.3052
4	13.58521	73.6095	54	13.46278	74.2789	140	13.2553	75.4413
5	13.58275	73.6228	55	13.46035	74.2923	150	13.2314	75.5778
6	13.58028	73.6362	56	13.45791	74.3057	160	13.2075	75.7147
7	13.57782	73.6495	57	13.45548	74.3192	170	13.1836	75.8519
8	13.57535	73.6629	58	13.45305	74.3326	180	13.1597	75.9895
9	13.57289	73.6763	59	13.45062	74.3460	190	13.1359	76.1274
10	13.57043	73.6896	60	13.44819	74.3594	200	13.1120	76.2659
11	13.56797	73.7030	61	13.44576	74.3729	210	13.0882	76.4047
12	13.56551	73.7164	62	13.44333	74.3863	220	13.0644	76.5440
13	13.56305	73.7297	63	13.44090	74.3998	230	13.0406	76.6838
14	13.56059	73.7431	64	13.43848	74.4132	240	13.0167	76.8241
15	13.55813	73.7565	65	13.43605	74.4266	250	12.9929	76.9650
16	13.55567	73.7698	66	13.43362	74.4401	260	12.9691	77.1064
17	13.55322	73.7832	67	13.43120	74.4535	270	12.9453	77.2484
18	13.55076	73.7966	68	13.42877	74.4670	280	12.9214	77.3909
19	13.54831	73.8100	69	13.42635	74.4804	290	12.8975	77.5341
20	13.54585	73.8233	70	13.42392	74.4939	300	12.8736	77.6779
21	13.54340	73.8367	71	13.42150	74.5073			
22	13.54094	73.8501	72	13.41908	74.5208			
23	13.53849	73.8635	73	13.41665	74.5342			
24	13.53604	73.8769	74	13.41423	74.5477			
25	13.53359	73.8902	75	13.41181	74.5612			
26	13.53114	73.9036	76	13.40939	74.5746			
27	13.52869	73.9170	77	13.40697	74.5881			
28	13.52624	73.9304	78	13.40455	74.6016			
29	13.52379	73.9438	79	13.40213	74.6150			



# THERMAL PROPERTIES OF MERCURY

Lev R. Fokin

The first of these tables gives the molar heat capacity at constant pressure of liquid and gaseous mercury as a function of temperature. To convert to specific heat in units of J/g K, divide these values by 200.59, the atomic weight of mercury.

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$	
	Liquid	Gas
-38.84	28.2746	20.786
-20	28.1466	20.786
0	28.0190	20.786
20	27.9002	20.786
25	27.8717	20.786
40	27.7897	20.786
60	27.6880	20.786
80	27.5952	20.786
100	27.5106	20.786
120	27.4349	20.786

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$	
	Liquid	Gas
140	27.3675	20.786
160	27.3090	20.786
180	27.2588	20.790
200	27.2169	20.790
220	27.1834	20.794
240	27.1583	20.794
260	27.1412	20.799
280	27.1320	20.807
300	27.1303	20.815
320	27.1366	20.824

## Reference

Douglas, T. B., Ball, A. T., and Ginnings, D. C., *J. Res. Natl. Bur. Stand.*, 46, 334, 1951.

## References

1. Busey and Giaque, *J. Am. Chem. Soc.*, 75, 806, 1953.
2. Amitin, Lebedeva, and Paukov, *Rus. J. Phys. Chem.*, 2666, 1979.

The second table gives the molar heat capacity of solid mercury in its rhombohedral ( $\alpha$ -mercury) form.

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$
-268.99	0.99*
-268.99	0.97**
-268.15	1.6
-263.15	4.6
-258.15	7.6
-253.15	10.33

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$
-248.15	12.74
-243.15	14.78
-233.15	17.90
-223.15	19.94
-213.15	21.40
-203.15	22.42

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$
-193.15	23.16
-183.15	23.76
-173.15	24.24
-153.15	25.00
-133.15	25.61
-113.15	26.15

$t/^{\circ}\text{C}$	$C_p/(\text{J/mol K})$
-93.15	26.69
-73.15	27.28
-53.15	27.96
-38.87	28.5

\* Superconducting state  
\*\*Normal state

The final table gives the cubic thermal expansion coefficient  $\alpha$ , the isothermal compressibility coefficient  $\kappa_T$ , and the speed of sound  $u$  for liquid mercury as a function of temperature. These properties are defined as follows:

$$\alpha = \frac{1}{v} \left( \frac{\partial v}{\partial T} \right)_p \quad \kappa_T = -\frac{1}{v} \left( \frac{\partial v}{\partial P} \right)_T \quad u^2 = \left( \frac{\partial P}{\partial \rho} \right)_s \quad \rho = v^{-1}$$

where  $v$  is the specific volume (given in the table on the preceding page).

## Reference

Vukalovich, M. P., et al., *Thermophysical Properties of Mercury*, Moscow Standard Press, 1971.

$t/^{\circ}\text{C}$	$\alpha \times 10^4/\text{K}^{-1}$	$\kappa_T \times 10^6/\text{bar}^{-1}$		$u/\text{m s}^{-1}$
		At 1 bar	At 1000 bar	
-20	1.818	3.83		1470
0	1.8144	3.918	3.78	1460.8
20	1.8110	4.013	3.87	1451.4
40	1.8083	4.109	3.96	1442.0
60	1.8064	4.207		1432.7
80	1.8053	4.308	4.14	1423.4
100	1.8051	4.410		1414.1

$t/^{\circ}\text{C}$	$\alpha \times 10^4/\text{K}^{-1}$	$\kappa_T \times 10^6/\text{bar}^{-1}$		$u/\text{m s}^{-1}$
		At 1 bar	At 1000 bar	
120	1.8058	4.513	4.33	1404.7
140	1.8074	4.622		1395.4
160	1.8100	4.731	4.53	1386.1
180	1.8136	4.844		1376.7
200	1.818	4.96		1367
250	1.834	5.26		1344
300	1.856	5.59		1321

## SURFACE TENSION OF COMMON LIQUIDS

The surface tension  $\gamma$  of about 200 liquids is tabulated here as a function of temperature. Values of  $\gamma$  are given in units of millinewtons per meter (mN/m), which is equivalent to dyn/cm in cgs units. The values refer to a nominal pressure of one atmosphere (about 100 kPa) except in cases where the indicated temperature is above the normal boiling point of the substance; in those cases, the applicable pressure is the saturation vapor pressure at the temperature in question.

The uncertainty of the values is 0.1 to 0.2 mN/m or less in most cases. Values at temperatures between the points tabulated can be obtained by linear interpolation to a good approximation.

Substances are listed by molecular formula in the modified Hill order, with substances not containing carbon appearing before those that do contain carbon. A more extensive compilation of surface tension may be found in Reference 1.

### References

1. Jasper, J. J., *J. Phys. Chem. Ref. Data*, 1, 841, 1972.
2. Kahl, H., Wadewitz, T., and Winkelmann, J., *J. Chem. Eng. Data*, 48, 580, 2003.

Mol. formula	Name	$\gamma$ in mN/m				
		10°C	25°C	50°C	75°C	100°C
Br <sub>2</sub>	Bromine	43.68	40.95	36.40		
Cl <sub>2</sub> O <sub>2</sub> S	Sulfuryl chloride		28.78			
Cl <sub>3</sub> OP	Phosphoryl chloride		32.03	28.85	25.66	
Cl <sub>3</sub> P	Phosphorus trichloride		27.98	24.81		
Cl <sub>4</sub> Si	Silicon tetrachloride	19.78	18.29	15.80		
H <sub>2</sub> O	Water	74.23	71.99	67.94	63.57	58.91
H <sub>4</sub> N <sub>2</sub>	Hydrazine		66.39			
Hg	Mercury	488.55	485.48	480.36	475.23	470.11
CCl <sub>4</sub>	Tetrachloromethane		26.43	23.37	20.31	17.25
CS <sub>2</sub>	Carbon disulfide	33.81	31.58	27.87		
CHBr <sub>3</sub>	Tribromomethane		44.87	41.60	38.33	
CHCl <sub>3</sub>	Trichloromethane		26.67	23.44	20.20	
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane		39.05	35.33	31.61	
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane		27.20			
CH <sub>2</sub> O <sub>2</sub>	Formic acid		37.13	34.38	31.64	
CH <sub>3</sub> I	Iodomethane	32.19	30.34			
CH <sub>3</sub> NO	Formamide		57.03	54.92	52.82	50.71
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	39.04	36.53	32.33		
CH <sub>3</sub> O	Methanol	23.23	22.07	20.14		
CH <sub>3</sub> N	Methylamine		19.15			
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane		34.15	31.20	28.26	
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid		13.53	11.42		
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane		35.58	32.41	29.24	26.07
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane		25.18	22.07		
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane		34.02	30.65	27.27	23.89
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile		28.66	25.51		
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane		39.55	36.25	32.95	
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane		24.07			
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane		31.86	28.29	24.72	
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	22.54	20.50	17.10		
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid		27.10	24.61	22.13	
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	26.72	24.36	20.43	16.50	12.57
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	25.36	23.62			
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	30.38	28.46	25.24		
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	34.02	32.13	29.00		
C <sub>2</sub> H <sub>6</sub> O	Ethanol	23.22	21.97	19.89		
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide		42.92	40.06		
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol		47.99	45.76	43.54	41.31
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	25.27	24.06			
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol		23.08			
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide		33.39	30.04		
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine		26.34			
C <sub>2</sub> H <sub>7</sub> N	Ethylamine		19.20			
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine		48.32	45.53	42.73	
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene		26.31	23.17		

Mol. formula	Name	$\gamma$ in mN/m				
		10°C	25°C	50°C	75°C	100°C
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene		23.14			
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	38.40	36.36	32.96	29.56	26.16
C <sub>3</sub> H <sub>7</sub> N	Propanenitrile		26.75	23.87		
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropane		28.32	25.22	22.12	
C <sub>3</sub> H <sub>6</sub> O	Acetone	24.57	22.72	19.65		
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	26.63	25.28	23.02	20.77	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	25.16	23.18			
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	26.66	24.73	21.51		
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid		26.20	23.72	21.23	
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	27.08	25.26	22.21		
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	25.03	23.25	20.30		
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	23.16	21.30			
C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane	20.49	19.16			
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	37.56	35.74	32.70	29.66	26.62
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane	31.02	29.29	26.39		
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	24.48	23.32	21.38	19.43	
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	22.11	20.93	18.96	16.98	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyethanol	32.32	30.84	28.38	25.92	23.46
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol		24.20	21.02		
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol		21.33	18.39		
C <sub>3</sub> H <sub>9</sub> N	Propylamine		21.75			
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine		13.41			
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyridazine	49.51	47.96	45.37	42.78	40.19
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine		30.33	27.80	25.28	22.75
C <sub>4</sub> H <sub>4</sub> S	Thiophene		30.68	27.36		
C <sub>4</sub> H <sub>5</sub> N	Pyrrole	38.71	37.06	34.31		
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	34.08	31.93	28.34	24.75	21.16
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile		26.92	24.33	21.73	
C <sub>4</sub> H <sub>8</sub> O	2-Butanone		23.97	21.16		
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane		32.75	29.28	25.80	22.32
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	25.13	23.39	20.49	17.58	14.68
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	26.32	24.44	21.29		
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid		26.05	23.75	21.45	
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	27.58	25.90	23.08	20.27	17.45
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	24.85	23.18	20.39		
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	29.79	28.24	25.67	23.09	20.51
C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine	30.58	29.23	26.98		
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	26.28	24.93	22.69	20.44	18.20
C <sub>4</sub> H <sub>10</sub> O	2-Butanol	23.74	22.54	20.56	18.57	16.58
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol		19.96	17.71		
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether		16.65			
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	2-Ethoxyethanol		28.35	26.11	23.86	21.62
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	Diethylene glycol		44.77	42.57	40.37	38.17
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	26.22	24.57	21.80		
C <sub>4</sub> H <sub>11</sub> N	Butylamine		23.44	20.63		
C <sub>4</sub> H <sub>11</sub> N	Isobutylamine		21.75	19.02		
C <sub>4</sub> H <sub>11</sub> N	<i>tert</i> -Butylamine		16.87			
C <sub>4</sub> H <sub>11</sub> N	Diethylamine		19.85			
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural	45.08	43.09	39.78	36.46	33.14
C <sub>5</sub> H <sub>5</sub> N	Pyridine		36.56	33.29	30.03	
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	24.45	22.20			
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone	34.45	32.80	30.05	27.30	24.55
C <sub>5</sub> H <sub>9</sub> NO	<i>N</i> -Methyl-2-pyrrolidinone	41.94	40.21	37.33	34.45	31.57
C <sub>5</sub> H <sub>10</sub>	1-Pentene		17.10	15.45		
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	18.61	17.15			
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	24.07	21.88	18.22		
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone		23.25	21.62		
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone		24.74	22.13		
C <sub>5</sub> H <sub>10</sub> O	Pentanal	26.95	25.44	22.91		
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	26.05	24.52	21.95	19.39	16.82

Mol. formula	Name	$\gamma$ in mN/m				
		10°C	25°C	50°C	75°C	100°C
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	25.48	23.80	21.00	18.20	15.40
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate	23.37	21.76	19.08	16.40	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	25.55	23.80	20.88	17.96	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate	26.34	24.62	21.76	18.89	16.03
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloropentane	26.01	24.40	21.71	19.02	16.33
C <sub>5</sub> H <sub>11</sub> N	Piperidine	30.64	28.91	26.03	23.14	20.26
C <sub>5</sub> H <sub>12</sub>	Pentane	17.15	15.49			
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	26.67	25.36	23.17	20.99	18.80
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	24.96	23.45	20.94	18.43	15.92
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	24.94	23.71	21.66	19.61	17.56
C <sub>5</sub> H <sub>13</sub> N	Pentylamine		24.69	22.14	19.58	
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene	37.15	35.43	32.57	29.70	26.83
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	36.98	35.24	32.34	29.44	26.54
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	34.78	32.99	30.02	27.04	24.06
C <sub>6</sub> H <sub>5</sub> ClO	<i>o</i> -Chlorophenol		39.70	36.89	34.09	31.28
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol		41.18	38.66	36.13	33.61
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	28.47	26.66	23.65	20.64	
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	40.40	38.71	35.91	33.10	30.29
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene			40.56	37.66	34.77
C <sub>6</sub> H <sub>6</sub>	Benzene		28.22	25.00	21.77	
C <sub>6</sub> H <sub>6</sub> O	Phenol			38.20	35.53	32.86
C <sub>6</sub> H <sub>7</sub> N	Aniline		42.12	39.41	36.69	
C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine		33.00	29.90	26.79	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Adiponitrile		45.45	43.02	40.58	
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	28.01	26.17	23.12		
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	36.43	34.57	31.46	28.36	25.25
C <sub>6</sub> H <sub>11</sub> N	Hexanenitrile		27.37	25.11	22.84	
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	25.91	24.16	21.26	15.44	
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	23.47	21.72	18.82		
C <sub>6</sub> H <sub>12</sub>	1-Hexene	19.44	17.90	15.33		
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol		32.92	30.50	28.09	25.67
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone		25.45	22.72		
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	26.48	24.88	22.21	19.54	16.87
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate	24.58	23.06	20.53	17.99	15.46
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate	25.51	23.94	21.33	18.71	16.10
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde	27.22	25.63	22.97	20.32	17.66
C <sub>6</sub> H <sub>13</sub> Cl	1-Chlorohexane	27.28	25.73	23.13	20.54	17.94
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine		31.22	28.25	25.28	
C <sub>6</sub> H <sub>14</sub>	Hexane	19.42	17.89	15.33		
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	18.37	16.88	14.39		
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	19.20	17.61	14.96		
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether		17.27	14.65		
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol		25.81	23.81	21.80	19.80
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-Diethoxyethane		20.89	18.31	15.74	
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	2-Butoxyethanol	27.36	26.14	24.10	22.06	20.02
C <sub>6</sub> H <sub>15</sub> N	Triethylamine		20.22	17.74		
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine		22.31	19.75	17.20	
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine		19.14	16.45		
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile		38.79	35.90	33.00	
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	39.63	38.00	35.27	32.55	29.82
C <sub>7</sub> H <sub>8</sub>	Toluene	29.46	27.73	24.85	21.98	19.10
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol		36.90	34.38	31.85	29.32
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol		35.69	33.38	31.07	28.76
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol				27.89	24.44
C <sub>7</sub> H <sub>8</sub> O	Anisole		35.10	32.09	29.08	
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline		36.90	34.47	32.05	
C <sub>7</sub> H <sub>9</sub> N	2,3-Dimethylpyridine		32.71	30.04	27.36	
C <sub>7</sub> H <sub>9</sub> N	Benzylamine		39.30	36.27	33.23	
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	24.98	23.29	20.46		
C <sub>7</sub> H <sub>14</sub>	1-Heptene	21.29	19.80	17.33	14.85	

Mol. formula	Name	$\gamma$ in mN/m				
		10°C	25°C	50°C	75°C	100°C
$C_7H_{14}O$	2-Heptanone		26.12	23.48		
$C_7H_{14}O_2$	Pentyl acetate	26.67	25.17	22.69	20.20	17.72
$C_7H_{14}O_2$	Heptanoic acid		27.76	25.64		
$C_7H_{16}$	Heptane	21.14	19.66	17.19	14.73	
$C_7H_{16}$	3-Methylhexane	20.76	19.31	16.88	14.46	
$C_8H_8O$	Acetophenone		39.04	36.15	33.27	
$C_8H_8O_2$	Methyl benzoate		37.17	34.25	31.32	
$C_8H_8O_3$	Methyl salicylate	40.98	39.22	36.28	33.35	30.41
$C_8H_{10}$	Ethylbenzene	30.39	28.75	26.01	23.28	20.54
$C_8H_{10}$	<i>o</i> -Xylene	31.41	29.76	27.01	24.25	21.50
$C_8H_{10}$	<i>m</i> -Xylene	30.13	28.47	25.71	22.95	20.19
$C_8H_{10}$	<i>p</i> -Xylene		28.01	25.32	22.64	19.95
$C_8H_{10}O$	Phenetole		32.41	29.65	26.89	
$C_8H_{11}N$	<i>N,N</i> -Dimethylaniline		35.52	32.90	30.27	
$C_8H_{11}N$	<i>N</i> -Ethylaniline		36.33	33.65	30.98	
$C_8H_{16}$	Ethylcyclohexane	26.73	25.15	22.51		
$C_8H_{18}$	Octane	22.57	21.14	18.77	16.39	14.01
$C_8H_{18}$	2,5-Dimethylhexane	20.77	19.40	17.12	14.84	12.56
$C_8H_{18}O$	1-Octanol	28.30	27.10	25.12		
$C_8H_{19}N$	Dibutylamine		24.12	21.74	19.36	
$C_8H_{19}N$	Diisobutylamine		21.72	19.44	17.16	
$C_9H_7N$	Quinoline	44.19	42.59	39.94	37.28	34.62
$C_9H_{12}$	Cumene	29.27	27.69	25.05	22.42	19.78
$C_9H_{12}$	1,2,4-Trimethylbenzene	30.74	29.20	26.64	24.07	21.51
$C_9H_{12}$	Mesitylene	28.89	27.55	25.31	23.07	20.82
$C_9H_{18}O$	5-Nonanone		26.28	23.85		
$C_9H_{20}$	Nonane	23.79	22.38	20.05	17.71	15.37
$C_9H_{20}O$	1-Nonanol	29.03	27.89	26.00	24.10	22.20
$C_{10}H_{12}$	1,2,3,4-Tetrahydronaphthalene		33.17	30.78	28.40	
$C_{10}H_{22}$	Decane	24.75	23.37	21.07	18.77	16.47
$C_{10}H_{22}O$	1-Decanol	29.61	28.51	26.68	24.85	23.02
$C_{11}H_{24}$	Undecane	25.56	24.21	21.96	19.70	17.45
$C_{12}H_{10}O$	Diphenyl ether		26.75	24.80		
$C_{12}H_{27}N$	Tributylamine		24.39	22.32	20.24	
$C_{13}H_{28}$	Tridecane	26.86	25.55	23.37	21.19	19.01
$C_{14}H_{12}O_2$	Benzyl benzoate	44.47	42.82	40.06	37.31	34.55
$C_{14}H_{30}$	Tetradecane	27.43	26.13	23.96	21.78	19.61
$C_{16}H_{34}$	Hexadecane		27.05	24.91	22.78	20.64
$C_{18}H_{38}$	Octadecane		27.87	25.77	23.66	21.55

# PERMITTIVITY (DIELECTRIC CONSTANT) OF LIQUIDS

Christian Wohlfarth

The permittivity of a substance (often called the dielectric constant) is the ratio of the electric displacement  $D$  to the electric field strength  $E$  when an external field is applied to the substance. The quantity tabulated here is the relative permittivity, which is the ratio of the actual permittivity to the permittivity of a vacuum; it is a dimensionless number.

The table gives the static relative permittivity  $\epsilon_r$ , i.e., the relative permittivity measured in static fields or at low frequencies where no relaxation effects occur. The fourth column of the table lists the value of  $\epsilon_r$  at the temperature specified in the third column, usually 293.15 or 298.15 K. Otherwise, the temperature closest to 293.15 K was chosen, or (as it is the case for many of the substances included here)  $\epsilon_r$  is given at the only temperature for which data are available.

The static permittivity refers to nominal atmospheric pressure as long as the corresponding temperature is below the normal boiling point. Otherwise, at temperatures above the normal boiling point, the pressure is understood to be the saturated vapor pressure of the substance considered.

For substances where information on the temperature dependence of the permittivity is available, the table gives the coefficients of a simple polynomial fitting of permittivity to temperature with an equation of the form

$$\epsilon_r(T) = a + bT + cT^2 + dT^3$$

where  $T$  is the absolute temperature in K. Since the parameter  $d$  was used in only a few cases where the quadratic fit was not satisfactory, only  $a$ ,  $b$ , and  $c$  are listed as columns in the table, while the  $d$  values are given at the end of this introduction. For all other substances,  $d = 0$ . The temperature range of the fit is given in the last column. The coefficients of the fitting equation can be used to

calculate dielectric constants within the fitted temperature range but should not be used for extrapolation outside this range. The user who needs dielectric constant data with more accuracy than can be provided by this equation is referred to Reference 1, which gives the original data together with their literature source.

Substances are listed by molecular formula in modified Hill order, with substances not containing carbon preceding those that do contain carbon.

\* Indicates that the isomer was not specified in the original reference.

\*\* Indicates a compound for which the cubic term is needed:

Ethanol	$d = -0.15512E-05$
<i>N</i> -Methylacetamide	$d = -0.12998E-04$
1,2-Propylene glycol	$d = -0.32544E-05$
1-Butanol	$d = -0.48841E-06$
2-Butanol	$d = -0.89512E-06$
2-Methyl-1-propanol	$d = -0.45229E-06$
2-Methyl-2-propanol	$d = -0.25968E-05$
<i>N</i> -Butylacetamide	$d = -0.48716E-05$

## References

1. Wohlfarth, Ch., Static Dielectric Constants of Pure Liquids and Binary Liquid Mixtures, *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, New Series*, Editor in Chief, O. Madelung, Group IV, Macroscopic and Technical Properties of Matter, Volume 6, Springer-Verlag, Berlin, 1991.
2. Marsh, K. N., Ed., *Recommended Reference Materials for the Realization of Physicochemical Properties*, Blackwell Scientific Publications, Oxford, 1987.

Mol. form.	Name	T/K	$\epsilon_r$	$a$	$b$	$c$	Range/K
AlBr <sub>3</sub>	Aluminum tribromide	373.2	3.38				
Ar	Argon	140.00	1.3247	0.12408E+01	0.68755E-02	-0.45344E-04	87-149
AsH <sub>3</sub>	Arsine	200.9	2.40	0.37674E+01	-0.97454E-02	0.14537E-04	157-201
BBr <sub>3</sub>	Boron tribromide	273.2	2.58				
B <sub>2</sub> H <sub>6</sub>	Diborane	180.66	1.8725	0.23848E+01	-0.29501E-02	0.64189E-06	108-181
B <sub>5</sub> H <sub>9</sub>	Pentaborane(9)	298.2	21.1	0.40952E+03	-0.24414E+01	0.38225E-02	226-298
BrF <sub>3</sub>	Bromine trifluoride	298.2	106.8				
BrF <sub>5</sub>	Bromine pentafluoride	297.7	7.91	0.11428E+02	-0.11822E-01		262-298
BrH	Hydrogen bromide	186.8	8.23				
BrNO	Nitrosyl bromide	288.4	13.4				
Br <sub>2</sub>	Bromine	297.9	3.1484	0.32701E+01	-0.12535E-03		273-327
Br <sub>2</sub> OS	Thionyl bromide	293.2	9.06				
Br <sub>3</sub> OV	Vanadyl tribromide	298.2	3.6	0.61112E+01	-0.84211E-02		203-298
Br <sub>4</sub> Ge	Germanium(IV) bromide	299.9	2.955	0.34450E+01	-0.16083E-02		300-316
Br <sub>4</sub> Sn	Tin(IV) bromide	303.45	3.169	0.50001E+01	-0.60383E-02		304-316
ClFO <sub>3</sub>	Perchloryl fluoride	150.2	2.194	0.23808E+01	-0.38629E-03	-0.57143E-05	125-150
ClF <sub>3</sub>	Chlorine trifluoride	293.2	4.394	0.96716E+01	-0.18000E-01		273-313
ClF <sub>5</sub>	Chlorine pentafluoride	193.2	4.28	0.78192E+01	-0.20860E-01	0.13132E-04	193-256
ClH	Hydrogen chloride	158.9	14.3	0.47316E+02	-0.28455E+00	0.48650E-03	159-258
ClNO	Nitrosyl chloride	285.2	18.2				
Cl <sub>2</sub>	Chlorine	208.0	2.147	0.29440E+01	-0.44649E-02	0.30388E-05	208-240
Cl <sub>2</sub> F <sub>3</sub> P	Phosphorus(V) dichloride trifluoride	228.63	2.8129	0.46501E+01	-0.80358E-02		172-229
Cl <sub>2</sub> OS	Thionyl chloride	298.2	8.675				
Cl <sub>2</sub> OSe	Selenium oxychloride	293.2	46.2				
Cl <sub>2</sub> O <sub>2</sub> S	Sulfuryl chloride	293.2	9.1				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
Cl <sub>2</sub> S	Sulfur dichloride	298.2	2.915				
Cl <sub>2</sub> S <sub>2</sub>	Sulfur chloride	288.2	4.79				
Cl <sub>3</sub> F <sub>2</sub> P	Phosphorus(V) trichloride difluoride	268.0	2.3752	0.28905E+01	-0.19228E-02		215-268
Cl <sub>3</sub> OP	Phosphorus(V) oxychloride	293.2	14.1				
Cl <sub>3</sub> OV	Vanadyl trichloride	298.2	3.4				
Cl <sub>3</sub> P	Phosphorus(III) chloride	290.2	3.498	0.59098E+01	-0.83322E-02		290-333
Cl <sub>3</sub> PS	Phosphorus(V) sulfide trichloride	298.2	4.94				
Cl <sub>4</sub> FP	Phosphorus(V) tetrachloride fluoride	272.64	2.6499	0.33503E+01	-0.29651E-02		244-273
Cl <sub>4</sub> Ge	Germanium(IV) chloride	273.2	2.463	-0.55078E+01	0.64881E-01	-0.13091E-03	246-273
Cl <sub>4</sub> Pb	Lead(IV) chloride	293.2	2.78				
Cl <sub>4</sub> Si	Tetrachlorosilane	273.2	2.248	0.58041E+01	-0.27129E-01	0.51678E-04	207-273
Cl <sub>4</sub> Sn	Tin(IV) chloride	273.2	3.014	0.43951E+01	-0.48805E-02		234-273
Cl <sub>4</sub> Ti	Titanium(IV) chloride	257.4	2.843	0.33668E+01	-0.19675E-02		237-257
Cl <sub>4</sub> V	Vanadium(IV) chloride	298.2	3.05				
Cl <sub>3</sub> P	Phosphorus(V) chloride	433.2	2.85				
Cl <sub>3</sub> Sb	Antimony(V) chloride	293.0	3.222	0.45413E+01	-0.45078E-02		276-320
FH	Hydrogen fluoride	273.2	83.6	0.50352E+03	-0.19297E+01	0.14372E-02	200-273
F <sub>2</sub>	Fluorine	53.48	1.4913	0.14144E+01	0.26387E-02	-0.28356E-04	54-144
F <sub>5</sub> I	Iodine pentafluoride	293.2	37.13	0.95184E+02	-0.19800E+00		273-313
F <sub>6</sub> S	Sulfur hexafluoride	223.2	1.81				
F <sub>6</sub> Xe	Xenon hexafluoride	328.2	4.10				
F <sub>7</sub> I	Iodine heptafluoride	298.2	1.75				
F <sub>10</sub> S <sub>2</sub>	Sulfur decafluoride	293.2	2.0202				
HI	Hydrogen iodide	220.2	3.87	0.51557E+03	-0.44552E+01	0.96795E-02	220-236
H <sub>2</sub>	Hydrogen	13.52	1.2792	0.13327E+01	-0.51946E-02		14-19
H <sub>2</sub> O	Water	293.2	80.100	0.24921E+03	-0.79069E+00	0.72997E-03	273-372
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide	290.2	74.6	0.48511E+03	-0.23145E+01	0.31020E-02	233-303
H <sub>2</sub> S	Hydrogen sulfide	283.2	5.93	0.14736E+02	-0.33675E-01	0.96740E-05	212-363
H <sub>3</sub> N	Ammonia	293.2	16.61	0.66756E+02	-0.24696E+00	0.25913E-03	238-323
H <sub>4</sub> N <sub>2</sub>	Hydrazine	298.2	51.7	0.22061E+03	-0.89633E+00	0.11066E-02	278-323
He	Helium	2.055	1.0555	0.10640E+01	-0.35584E-02		2-4
I <sub>2</sub>	Iodine	391.25	11.08	0.64730E+02	-0.29266E+00	0.39759E-03	391-441
Kr	Krypton	119.80	1.664				
Mn <sub>2</sub> O <sub>7</sub>	Manganese(VII) oxide	293.2	3.28	0.37655E+01	-0.16463E-02		283-312
NO	Nitric oxide	1.997					
N <sub>2</sub>	Nitrogen	63.15	1.4680	0.12550E+01	0.67949E-02	-0.56704E-04	63-126
N <sub>2</sub> O <sub>3</sub>	Nitrogen trioxide	203.2	31.13	0.92287E+02	-0.43306E+00	0.65000E-03	203-243
N <sub>2</sub> O <sub>4</sub>	Nitrogen tetroxide	293.2	2.44	0.28212E+01	-0.13000E-02		253-293
Ne	Neon	26.11	1.1907	0.12667E+01	-0.29064E-02		26-29
O <sub>2</sub>	Oxygen	54.478	1.5684	0.15434E+01	0.14615E-02	-0.21964E-04	55-154
O <sub>3</sub> S	Sulfur dioxide	298.2	16.3	0.52045E+02	-0.16125E+00	0.11042E-03	213-449
O <sub>3</sub>	Ozone	90.2	4.75	0.86344E+01	-0.54807E-01	0.12596E-03	90-185
O <sub>3</sub> S	Sulfur trioxide	291.2	3.11				
P	Phosphorus	307.2	4.096	0.79018E+00	0.23911E-01	-0.42826E-04	307-358
S	Sulfur	407.2	3.4991	0.51651E+01	-0.77381E-02	0.89120E-05	407-479
Se	Selenium	510.65	5.44	0.67569E+01	-0.25829E-02		511-575
Xe	Xenon	161.35	1.880				
CBrClF <sub>2</sub>	Bromochlorodifluoromethane	123.2	3.920	0.52442E+01	-0.11000E-01		123-223
CBrCl <sub>3</sub>	Bromotrichloromethane	293.2	2.405	0.29249E+01	-0.17650E-02		273-333
CBrF <sub>3</sub>	Bromotrifluoromethane	123.2	3.730	0.54154E+01	-0.13680E-01		123-173
CBr <sub>2</sub> Cl <sub>2</sub>	Dibromodichloromethane	298.2	2.542	0.32330E+01	-0.23162E-02		298-333
CBr <sub>2</sub> F <sub>2</sub>	Dibromodifluoromethane	273.2	2.939	0.67296E+01	-0.22133E-01	0.30213E-04	139-273
CBr <sub>3</sub> Cl	Tribromochloromethane	333.2	2.601				
CBr <sub>3</sub> F	Tribromofluoromethane	293.2	3.00	0.53203E+01	-0.11061E-01	0.10688E-04	206-323
CBr <sub>3</sub> NO <sub>2</sub>	Tribromonitromethane	298.2	9.034	0.16079E+02	-0.23630E-01		298-328
CClF <sub>3</sub>	Chlorotrifluoromethane	123.2	3.010	0.43677E+01	-0.11020E-01		123-173
CCL <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	123.2	3.500	0.46984E+01	-0.97600E-02		123-223
CCl <sub>2</sub> O	Carbonyl chloride	295.2	4.30				
CCl <sub>3</sub> D	Trichloromethane- <i>d</i>	298.2	4.67				
CCl <sub>3</sub> F	Trichlorofluoromethane	293.2	3.00	0.53203E+01	-0.11061E-01	0.10688E-04	206-323
CCl <sub>3</sub> NO <sub>2</sub>	Trichloronitromethane	293.2	7.319	0.14403E+02	-0.24178E-01		276-333
CCl <sub>4</sub>	Tetrachloromethane	293.2	2.2379	0.28280E+01	-0.20339E-02	0.71795E-07	283-333
CF <sub>4</sub>	Tetrafluoromethane	126.3	1.685	0.20350E+01	-0.27616E-02		126-142

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
CHBr <sub>3</sub>	Tribromomethane	283.2	4.404	0.71707E+01	-0.98000E-02		283-343
CHCl <sub>3</sub>	Trichloromethane	293.2	4.8069	0.15115E+02	-0.51830E-01	0.56803E-04	218-323
CHF <sub>3</sub>	Trifluoromethane	294.0	5.2	0.11442E+03	-0.75600E+00	0.13562E-02	130-263
CHN	Hydrogen cyanide	293.2	114.9	0.37331E+04	-0.23180E+02	0.36963E-01	258-299
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	283.2	7.77	0.18060E+02	-0.36333E-01		283-313
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	298.0	8.93	0.40452E+02	-0.17748E+00	0.23942E-03	184-306
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane	152.2	53.74	0.19428E+03	-0.12939E+01	0.24280E-02	152-224
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane	298.2	5.32				
CH <sub>2</sub> O <sub>2</sub>	Formic acid	298.2	51.1	0.14040E+03	-0.24673E+00	-0.17151E-03	287-358
CH <sub>3</sub> Br	Bromomethane	275.7	9.71	0.40580E+02	-0.18418E+00	0.26219E-03	195-276
CH <sub>3</sub> Cl	Chloromethane	295.2	10.0	0.42775E+02	-0.16175E+00	0.17108E-03	190-392
CH <sub>3</sub> ClO <sub>2</sub> S	Methanesulfonyl chloride	293.2	34.0	0.10384E+03	-0.33838E+00	0.34156E-03	293-373
CH <sub>3</sub> DO	Methan- <i>d</i> <sub>1</sub> -ol	297.5	31.68	0.20839E+03	-0.10318E+01	0.14740E-02	176-298
CH <sub>3</sub> F	Fluoromethane	131.0	51.0	0.11338E+03	-0.63979E+00	0.96983E-03	150-299
CH <sub>3</sub> I	Iodomethane	293.2	6.97	0.24264E+02	-0.93914E-01	0.11926E-03	223-303
CH <sub>3</sub> NO	Formamide	293.2	111.0	0.26076E+03	-0.61145E+00	0.34296E-03	278-333
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	293.2	37.27	0.11227E+03	-0.35591E+00	0.34206E-03	288-343
CH <sub>3</sub> NO <sub>2</sub>	Methyl nitrite	200.0	20.77	0.11071E+03	-0.73428E+00	0.14054E-02	110-260
CH <sub>3</sub> NO <sub>3</sub>	Methyl nitrate	293.2	23.9				
CH <sub>4</sub>	Methane	91.0	1.6761	0.15996E+01	0.27434E-02	-0.22086E-04	91-184
CH <sub>4</sub> O	Methanol	293.2	33.0	0.19341E+03	-0.92211E+00	0.12839E-02	177-293
CH <sub>5</sub> N	Methylamine	215.2	16.7	0.34398E+02	-0.73630E-01	-0.41279E-04	198-258
CN <sub>4</sub> O <sub>8</sub>	Tetranitromethane	293.2	2.317				
COS	Carbon oxysulfide	185.0	4.47	0.84702E+01	-0.21488E-01		143-185
COSe	Carbon oxyselenide	283.2	3.47	0.48740E+01	-0.49425E-02		219-283
CO <sub>2</sub>	Carbon dioxide	295.0	1.4492	0.79062E+00	0.10639E-01	-0.28510E-04	220-300
CS <sub>2</sub>	Carbon disulfide	293.2	2.6320	0.45024E+01	-0.12054E-01	0.19147E-04	154-319
C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	1,2-Dibromotetrafluoroethane	298.2	2.34				
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichlorotetrafluoroethane	273.2	2.4842	0.36663E+01	-0.42271E-02	-0.36255E-06	193-273
C <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	Oxalyl chloride	294.35	3.470				
C <sub>2</sub> Cl <sub>3</sub> N	Trichloroacetonitrile	292.2	7.85				
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene	303.2	2.268				
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,2,2-Tetrachloro-1,2-difluoroethane	308.2	2.52				
C <sub>2</sub> HBr <sub>3</sub> O	Tribromoacetaldehyde	293.2	7.6				
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	301.5	3.390	0.58319E+01	-0.80828E-02		302-338
C <sub>2</sub> HCl <sub>3</sub> F <sub>2</sub>	1,2,2-Trichloro-1,1-difluoroethane	303.2	4.01	0.75423E+01	-0.11667E-01		303-333
C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde	298.2	6.8				
C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid	333.2	4.34	0.13412E+01	0.90000E-02	-0.24130E-14	333-393
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane	298.2	3.716	0.65972E+01	-0.96800E-02		298-338
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid	293.2	8.42	0.21652E+02	-0.68146E-01	0.78571E-04	263-323
C <sub>2</sub> H <sub>2</sub>	Acetylene	195.0	2.4841				
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>cis</i> -1,2-Dibromoethylene	298.2	7.08				
C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub>	<i>trans</i> -1,2-Dibromoethylene	298.2	2.88				
C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	1,1,2,2-Tetrabromoethane	303.2	6.72	0.16246E+02	-0.31500E-01		303-333
C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub>	1,1-Dichloroethylene	293.2	4.60				
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene	298.2	9.20				
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	293.2	2.14				
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	Dichloroacetic acid	293.2	8.33	0.11014E+02	-0.10859E-01	0.49242E-05	284-363
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,1,2-Tetrachloroethane	207.2	9.22	0.19606E+02	-0.49847E-01		207-233
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane	293.2	8.50				
C <sub>2</sub> H <sub>2</sub> I <sub>2</sub>	<i>cis</i> -1,2-Diiodoethylene	345.65	4.46				
C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride	295.2	15.8				
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid	338.2	12.35	0.17310E+02	-0.14674E-01		338-393
C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	1,1-Dichloro-1-nitroethane	303.2	16.3	0.37576E+02	-0.70400E-01		303-333
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane	293.2	7.243	0.27705E+02	-0.10621E+00	0.12424E-03	258-318
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane	298.2	7.1937	0.17147E+02	-0.33371E-01		288-318
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	2,2,2-Trifluoroethanol	293.2	27.68	0.90593E+02	-0.21421E+00		293-318
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	293.2	36.64	0.29724E+03	-0.15508E+01	0.22591E-02	288-333
C <sub>2</sub> H <sub>3</sub> NO	Methyl isocyanate	288.7	21.75				
C <sub>2</sub> H <sub>4</sub>	Ethylene	270.0	1.4833	0.13546E+01	0.62614E-02	-0.21374E-04	200-270
C <sub>2</sub> H <sub>4</sub> BrCl	1-Bromo-2-chloroethane	283.2	7.41	0.19493E+02	-0.59054E-01	0.58036E-04	263-363
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane	293.2	4.9612	0.67142E+01	-0.59800E-02		293-313
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	298.2	10.10	0.24429E+02	-0.48000E-01		288-318



Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	293.2	10.42	0.24404E+02	-0.47892E-01		293-343
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	Bis(chloromethyl) ether	293.2	3.51				
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	Ethylene glycol dinitrate	293.2	28.26				
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	291.2	21.0				
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	293.2	12.42	0.52661E+02	-0.21337E+00	0.25947E-03	293-243
C <sub>2</sub> H <sub>4</sub> OS	Thioacetic acid	298.2	14.30				
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	293.2	6.20	-0.15731E+02	0.12662E+00	-0.17738E-03	293-363
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	288.2	9.20	0.19699E+02	-0.36429E-01		288-302
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub> S	Ethylene glycol sulfite	298.2	39.6	0.85483E+02	-0.15400E+00		298-328
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	298.2	9.01	0.28473E+02	-0.85495E-01	0.67971E-04	243-308
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	293.2	9.45	0.60693E+02	-0.31290E+00	0.47154E-03	237-293
C <sub>2</sub> H <sub>5</sub> ClO	2-Chloroethanol	293.2	25.80	0.11155E+03	-0.30149E+00		140-175
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	293.2	7.82	0.25598E+02	-0.94367E-01	0.11424E-03	183-343
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine	298.2	18.3	0.61405E+02	-0.14474E+00		273-298
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	363.7	67.6	-0.20055E+03	0.15515E+01	-0.22392E-02	364-448
C <sub>2</sub> H <sub>5</sub> NO	N-Methylformamide	293.2	189.0	0.10383E+04	-0.43165E+01	0.48398E-02	276-353
C <sub>2</sub> H <sub>5</sub> NO	Acetaldoxime	298.2	4.70				
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	288.2	29.11	0.57406E+02	-0.97657E-01		276-333
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Methyl carbamate	328.2	18.48	0.36773E+02	-0.55700E-01		328-368
C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	Ethyl nitrate	293.2	19.7				
C <sub>2</sub> H <sub>6</sub>	Ethane	95.0	1.9356	0.20185E+01	-0.51493E-03	-0.48148E-05	95-295
C <sub>2</sub> H <sub>6</sub> O	Ethanol**	293.2	25.3	0.15145E+03	-0.87020E+00	0.19570E-02	163-523
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	258.0	6.18	0.22389E+02	-0.86524E-01	0.91291E-04	155-258
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide	293.2	47.24	0.38478E+02	0.16939E+00	-0.47423E-03	288-343
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	293.2	41.4	0.14355E+03	-0.48573E+00	0.46703E-03	293-423
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	Dimethyl sulfone	383.2	47.39	0.10830E+03	-0.15900E+00		383-398
C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	Dimethyl sulfate	298.2	55.0				
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol	298.2	6.667				
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	294.2	6.70				
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	1,2-Ethanedithiol	293.2	7.26	0.11228E+02	-0.13500E-01		293-333
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide	298.2	9.6	0.19109E+02	-0.32000E-01		298-323
C <sub>2</sub> H <sub>7</sub> N	Ethylamine	273.2	8.7	0.30163E+02	-0.79000E-01		233-273
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine	293.2	31.94	0.14890E+03	-0.62491E+00	0.77143E-03	253-293
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	293.2	13.82	0.48922E+02	-0.17021E+00	0.17262E-03	273-333
C <sub>3</sub> Cl <sub>6</sub> O	Hexachloroacetone	291.9	3.925	0.76423E+01	-0.15838E-01	0.10618E-04	269-303
C <sub>3</sub> F <sub>6</sub> O	Perfluoroacetone	202.2	2.104	0.34809E+01	-0.92883E-02	0.12282E-04	151-238
C <sub>3</sub> HN	Cyanoacetylene	291.9	72.3	0.91803E+03	-0.49149E+01	0.69104E-02	281-314
C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	1,1,1,3,3,3-Hexafluoro-2-propanol	293.2	16.70				
C <sub>3</sub> H <sub>3</sub> ClO <sub>3</sub>	4-Chloro-1,3-dioxolan-2-one	313.2	62.0				
C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile	293.2	33.0	0.11109E+03	-0.36806E+00	0.34879E-03	233-413
C <sub>3</sub> H <sub>3</sub> NO <sub>2</sub>	Cyanoacetic acid	277.2	33.4				
C <sub>3</sub> H <sub>4</sub>	Allene	269.0	2.025	0.26049E+01	-0.44147E-03	-0.63420E-05	156-269
C <sub>3</sub> H <sub>4</sub>	Propyne	246.0	3.218	0.60871E+01	-0.11730E-01		185-246
C <sub>3</sub> H <sub>4</sub> ClF <sub>3</sub>	3-Chloro-1,1,1-trifluoropropane	295.2	7.32	0.22361E+02	-0.68840E-01	0.60594E-04	275-313
C <sub>3</sub> H <sub>4</sub> ClNO	2-Chloroethyl isocyanate	288.2	29.1	0.64311E+02	-0.12217E+00		288-403
C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O	1,1-Dichloroacetone	293.2	14.6				
C <sub>3</sub> H <sub>4</sub> F <sub>4</sub> O	2,2,3,3-Tetrafluoro-1-propanol	298.2	21.03				
C <sub>3</sub> H <sub>4</sub> O	Propargyl alcohol	293.2	20.8	0.99895E+02	-0.38911E+00	0.40776E-03	213-293
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Ethylene carbonate	313.2	89.78	0.20746E+03	-0.37610E+00		313-343
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	293.2	7.0				
C <sub>3</sub> H <sub>5</sub> BrO <sub>2</sub>	2-Bromopropanoic acid	294.2	11.0				
C <sub>3</sub> H <sub>5</sub> Br <sub>3</sub>	1,2,3-Tribromopropane	303.2	6.00	0.11024E+02	-0.16596E-01		303-358
C <sub>3</sub> H <sub>5</sub> Cl	2-Chloropropene	299.25	8.92				
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene	293.2	8.2				
C <sub>3</sub> H <sub>5</sub> ClN <sub>2</sub> O <sub>6</sub>	3-Chloro-1,2-propanediol dinitrate	293.2	17.50				
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	293.2	22.6				
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Ethyl chloroformate	308.7	9.736	0.15356E+02	-0.18250E-01		309-349
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Methyl chloroacetate	293.2	12.0				
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,2,3-Trichloropropane	293.2	7.5				
C <sub>3</sub> H <sub>5</sub> I	3-Iodopropene	292.2	6.1				
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	293.2	29.7	0.82222E+02	-0.22937E+00	0.17424E-03	213-473
C <sub>3</sub> H <sub>5</sub> NO	Ethyl isocyanate	293.2	19.7				
C <sub>3</sub> H <sub>5</sub> NS	Ethyl isothiocyanate	293.2	19.6				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>9</sub>	Trinitroglycerol	293.2	19.25				
C <sub>3</sub> H <sub>6</sub>	Propene	220.0	2.1365	0.29623E+01	-0.37564E-02		220-250
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,2-Dibromopropane	283.2	4.60	0.54973E+01	-0.31695E-02		283-333
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,3-Dibromopropane	293.2	9.482	0.29193E+02	-0.94450E-01	0.92800E-04	293-368
C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	2-Chloro-2-nitropropane	250.4	31.90				
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropane	293.2	8.37	0.18915E+02	-0.35907E-01		281-323
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,3-Dichloropropane	303.2	10.27	0.21609E+02	-0.37333E-01		303-333
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	2,2-Dichloropropane	293.2	11.37	0.32421E+02	-0.72188E-01		245-293
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	2,2-Dinitropropane	325.1	42.4				
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	293.2	19.7	0.62714E+02	-0.14771E+00	0.37879E-05	213-303
C <sub>3</sub> H <sub>6</sub> O	Propanal	290.2	18.5				
C <sub>3</sub> H <sub>6</sub> O	Acetone	293.2	21.01	0.88157E+02	-0.34300E+00	0.38925E-03	273-323
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	298.2	3.44	0.18793E+01	0.46841E-02	0.19983E-05	289-408
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	288.2	8.57	0.15884E+02	-0.25333E-01		288-318
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	288.2	7.07	0.13190E+02	-0.21226E-01		276-318
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	3-Hydroxypropanoic acid	296.2	30.0				
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	Dimethyl carbonate	298.2	3.087				
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	1,3,5-Trioxane	338.2	15.55				
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	293.2	8.09	0.17769E+02	-0.32599E-01		274-328
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	293.2	9.46	0.26195E+02	-0.72995E-01	0.55454E-04	186-328
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	293.2	8.588	0.21214E+02	-0.43130E-01		273-313
C <sub>3</sub> H <sub>7</sub> ClO	3-Chloro-1-propanol	215.2	36.0	0.12436E+03	-0.60841E+00	0.92060E-03	145-215
C <sub>3</sub> H <sub>7</sub> ClO	1-Chloro-2-propanol	153.2	59.0	-0.19169E+02	0.13605E+01	-0.55567E-02	153-177
C <sub>3</sub> H <sub>7</sub> ClO <sub>2</sub>	3-Chloro-1,2-propanediol	293.2	31.0				
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	293.2	7.07	0.13744E+02	-0.22745E-01		293-323
C <sub>3</sub> H <sub>7</sub> I	2-Iodopropane	298.2	8.19				
C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -Ethylformamide	298.2	102.7	0.64764E+03	-0.28499E+01	0.34286E-02	298-338
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	293.2	38.25	0.15364E+03	-0.60367E+00	0.71505E-03	213-353
C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -Methylacetamide**	303.2	179.0	0.15975E+04	-0.90451E+01	0.18345E-01	303-473
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	288.2	24.70	0.94999E+02	-0.38358E+00	0.48480E-03	276-333
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane	288.2	26.74	0.60138E+02	-0.11566E+00		276-303
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Propyl nitrite	250.0	12.35	0.70552E+02	-0.40362E+00	0.66687E-03	110-310
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Isopropyl nitrite	260.0	13.92	0.74578E+02	-0.38283E+00	0.57071E-03	150-300
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl carbamate	328.2	14.14	0.32431E+02	-0.65097E-01	0.28571E-04	328-368
C <sub>3</sub> H <sub>8</sub>	Propane	293.19	1.6678	0.22883E+01	-0.23276E-02	0.84710E-06	90-300
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	293.2	20.8	0.98045E+02	-0.36860E+00	0.36422E-03	193-493
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	293.2	20.18	0.10416E+03	-0.41011E+00	0.42049E-03	193-493
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propylene glycol**	303.2	27.5	0.24546E+03	-0.15738E+01	0.38068E-02	193-403
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propylene glycol	293.2	35.1	0.11365E+03	-0.36680E+00	0.33766E-03	288-328
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Ethylene glycol monomethyl ether	298.2	17.2	0.11803E+03	-0.58000E+00	0.81001E-03	254-318
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Dimethoxymethane	293.2	2.644	0.25877E+01	-0.93019E-03	0.38472E-05	171-293
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol	293.2	46.53	0.77503E+02	-0.37984E-01	-0.23107E-03	288-343
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol	288.2	5.937	0.11602E+02	-0.19580E-01		273-318
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol	298.2	5.952				
C <sub>3</sub> H <sub>8</sub> S <sub>2</sub>	1,2-Propanedithiol	293.2	7.24	0.14667E+02	-0.32660E-01	0.25000E-04	293-333
C <sub>3</sub> H <sub>8</sub> S <sub>2</sub>	1,3-Propanedithiol	303.2	8.11	0.66607E+01	0.31310E-01	-0.87500E-04	303-343
C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	Trimethyl borate	293.2	2.2762				
C <sub>3</sub> H <sub>9</sub> ClSi	Trimethylchlorosilane	273.2	10.21	-0.19492E+02	0.29806E+00	-0.69284E-03	223-273
C <sub>3</sub> H <sub>9</sub> N	Propylamine	296.2	5.08	0.17719E+02	-0.59022E-01	0.54780E-04	204-296
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine	293.2	5.6268	0.40429E+02	-0.21441E+00	0.32634E-03	213-298
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	298.2	2.440	0.39745E+01	-0.51331E-02		273-298
C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P	Trimethyl phosphate	293.2	20.6				
C <sub>4</sub> Cl <sub>6</sub>	Hexachloro-1,3-butadiene	293.2	2.55				
C <sub>4</sub> Cl <sub>6</sub> O <sub>3</sub>	Trichloroacetic anhydride	298.2	5.0				
C <sub>4</sub> F <sub>6</sub> O <sub>3</sub>	Trifluoroacetic acid anhydride	298.2	2.7				
C <sub>4</sub> H <sub>2</sub> Cl <sub>4</sub> O <sub>3</sub>	Dichloroacetic anhydride	298.2	15.8				
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride	326.2	52.75				
C <sub>4</sub> H <sub>7</sub> F <sub>7</sub> O	2,2,3,3,4,4,4-Heptafluoro-1-butanol	298.2	14.4				
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Succinonitrile	298.2	62.6	0.17724E+03	-0.54654E+00	0.54046E-03	236-351
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrazine	323.2	2.80				
C <sub>4</sub> H <sub>4</sub> O	Furan	277.1	2.88	0.13636E+01	0.12864E-01	-0.22701E-04	188-277
C <sub>4</sub> H <sub>4</sub> S	Thiophene	293.2	2.739	0.32941E+01	-0.19019E-02		253-293
C <sub>4</sub> H <sub>5</sub> Cl	2-Chloro-1,3-butadiene	293.2	4.914				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>2</sub>	Ethyl trichloroacetate	293.2	8.428				
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole	293.0	8.00	0.12672E+02	-0.14075E-01	-0.62671E-05	293-357
C <sub>4</sub> H <sub>5</sub> NO	Allyl isocyanate	288.2	15.15	0.34299E+02	-0.66444E-01		288-333
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	265.0	2.050	0.27674E+01	-0.26738E-02		185-265
C <sub>4</sub> H <sub>6</sub> O	Divinyl ether	288.2	3.94				
C <sub>4</sub> H <sub>6</sub> O	Ethoxyacetylene	298.2	8.05				
C <sub>4</sub> H <sub>6</sub> O	Cyclobutanone	298.2	14.27	0.43974E+02	-0.15712E+00	0.19264E-03	220-317
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate	303.2	7.03	0.11968E+02	-0.16500E-01		303-333
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Butanedione	298.2	4.04	0.46907E+01	-0.22302E-02		278-348
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	$\gamma$ -Butyrolactone	293.2	39.0				
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	293.2	22.45				
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Propylene carbonate	293.0	66.14	0.15940E+03	-0.39530E+00	0.26284E-03	273-333
C <sub>4</sub> H <sub>7</sub> Br	<i>cis</i> -2-Bromo-2-butene	293.2	5.38				
C <sub>4</sub> H <sub>7</sub> Br	<i>trans</i> -2-Bromo-2-butene	293.2	6.76				
C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	2-Bromobutanoic acid	293.2	7.2				
C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	Ethyl bromoacetate	303.2	9.75	0.15627E+02	-0.19600E-01		303-333
C <sub>4</sub> H <sub>7</sub> BrO <sub>2</sub>	Methyl 3-bromopropanoate	303.2	5.81	0.36001E+01	0.72500E-02		303-343
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	Propyl chlorocarbonate	293.2	11.2				
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	Methyl 2-chloropropanoate	303.2	11.45	0.22449E+02	-0.36250E-01		303-343
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	293.2	24.83	0.53884E+02	-0.99257E-01		293-333
C <sub>4</sub> H <sub>7</sub> N	2-Methylpropanenitrile	293.2	24.42	0.52554E+02	-0.96000E-01		293-313
C <sub>4</sub> H <sub>7</sub> NO	2-Pyrrolidone	298.2	28.18	0.11054E+03	-0.47945E+00	0.68182E-03	298-338
C <sub>4</sub> H <sub>8</sub>	1-Butene	220.0	2.2195	0.29354E+01	-0.32580E-02		220-250
C <sub>4</sub> H <sub>8</sub>	<i>cis</i> -2-Butene	296.0	1.960	0.28802E+01	-0.31064E-02		197-296
C <sub>4</sub> H <sub>8</sub>	Isobutene	288.7	2.1225	0.33701E+01	-0.43295E-02		220-289
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,2-Dibromobutane	293.2	4.74	0.11199E+03	-0.63334E+00	0.91250E-03	293-333
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,3-Dibromobutane	293.2	9.14	0.34031E+02	-0.13254E+00	0.16250E-03	293-333
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,4-Dibromobutane	303.2	8.68	0.20944E+02	-0.55620E-01	0.50000E-04	303-333
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	2,3-Dibromobutane	298.2	6.245	0.23849E+02	-0.96300E-01	0.12500E-03	293-333
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,2-Dibromo-2-methylpropane	293.2	4.1				
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,2-Dichlorobutane	293.2	7.74	0.31925E+02	-0.13232E+00	0.17007E-03	293-356
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,4-Dichlorobutane	308.2	9.30	0.59766E+01	0.49300E-01	-0.12500E-03	308-338
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,2-Dichloro-2-methylpropane	296.0	7.15	0.39429E+02	-0.20028E+00	0.30917E-03	165-296
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	Bis(2-chloroethyl) ether	293.2	21.20				
C <sub>4</sub> H <sub>8</sub> O	Butanal	298.2	13.45				
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	293.2	18.56	0.15457E+02	0.90152E-01	-0.27100E-03	293-333
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	295.2	7.52	0.30739E+02	-0.12946E+00	0.17195E-03	224-295
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid	287.2	2.98	0.15010E+01	0.50046E-02		287-403
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid	293.2	2.58				
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	303.2	6.92				
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	293.2	6.0814	0.15646E+02	-0.44066E-01	0.39137E-04	293-433
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	293.2	6.200	0.12798E+02	-0.22540E-01		293-333
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	293.2	2.2189	0.27299E+01	-0.17440E-02		293-313
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	2-Hydroxybutanoic acid	296.2	37.7				
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	3-Hydroxybutanoic acid	296.2	31.5				
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	Ethyl methyl carbonate	293.2	2.985				
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	Ethylene glycol monoacetate	303.2	12.95				
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	283.2	7.315	0.22542E+02	-0.79306E-01	0.89867E-04	183-363
C <sub>4</sub> H <sub>9</sub> Br	2-Bromobutane	298.2	8.64	0.18461E+02	-0.32933E-01		274-328
C <sub>4</sub> H <sub>9</sub> Br	1-Bromo-2-methylpropane	273.2	7.70	0.37558E+02	-0.20571E+00	0.35496E-03	112-273
C <sub>4</sub> H <sub>9</sub> Br	2-Bromo-2-methylpropane	293.0	10.98	0.35085E+02	-0.14075E+00	0.19960E-03	258-293
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	293.2	7.276	0.13565E+02	-0.10161E-01	-0.38750E-04	273-323
C <sub>4</sub> H <sub>9</sub> Cl	2-Chlorobutane	293.2	8.564	0.30376E+02	-0.11377E+00	0.13429E-03	273-323
C <sub>4</sub> H <sub>9</sub> Cl	1-Chloro-2-methylpropane	293.2	7.027	0.14945E+02	-0.33747E-01	0.23036E-04	273-323
C <sub>4</sub> H <sub>9</sub> Cl	2-Chloro-2-methylpropane	293.2	9.663	0.35077E+02	-0.12867E+00	0.14304E-03	273-323
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	293.2	6.27	0.16493E+02	-0.50262E-01	0.52485E-04	293-323
C <sub>4</sub> H <sub>9</sub> I	2-Iodobutane	293.2	7.873	0.10883E+02	-0.14680E-02	-0.30000E-04	293-323
C <sub>4</sub> H <sub>9</sub> I	2-Iodo-2-methylpropane	283.2	6.65	0.76780E+01	0.69900E-02	-0.37500E-04	283-323
C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine	293.0	8.30	0.38191E+02	-0.15462E+00	0.17941E-03	274-333
C <sub>4</sub> H <sub>9</sub> NO	<i>N</i> -Methylpropanamide	293.2	170.0				
C <sub>4</sub> H <sub>9</sub> NO	<i>N</i> -Ethylacetamide	293.2	135.0	0.74494E+03	-0.31400E+01	0.36131E-02	213-353
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide	294.2	38.85	0.15420E+03	-0.57506E+00	0.61911E-03	294-433
C <sub>4</sub> H <sub>9</sub> NO	2-Butanone oxime	293.2	3.4				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>4</sub> H <sub>9</sub> NO	Morpholine	298.2	7.42				
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	<i>tert</i> -Butyl nitrite	298.2	11.47				
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	Propyl carbamate	338.2	12.06	0.24356E+02	-0.36400E-01		338-378
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	Ethyl- <i>N</i> -methyl carbamate	298.2	21.10	0.11477E+03	-0.47568E+00	0.54127E-03	298-373
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	<i>N</i> -Acetyethanolamine	298.2	96.6	0.37016E+03	-0.13113E+01	0.13214E-02	298-348
C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	Butyl nitrate	293.2	13.10				
C <sub>4</sub> H <sub>10</sub>	Butane	295.0	1.7697	0.22379E+01	-0.13884E-02	-0.66711E-06	135-303
C <sub>4</sub> H <sub>10</sub>	Isobutane	295.0	1.7518	0.23295E+01	-0.19953E-02	0.14197E-06	115-303
C <sub>4</sub> H <sub>10</sub> O	1-Butanol**	293.2	17.84	0.10578E+03	-0.50587E+00	0.84733E-03	193-553
C <sub>4</sub> H <sub>10</sub> O	2-Butanol**	293.2	17.26	0.13850E+03	-0.75146E+00	0.14086E-02	172-533
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol**	293.2	17.93	0.10762E+03	-0.51398E+00	0.83702E-03	173-533
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol**	298.2	12.47	0.22541E+03	-0.14990E+01	0.34050E-02	298-503
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	293.2	4.2666	0.79725E+01	-0.12519E-01		283-301
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,2-Butanediol	298.2	22.4	0.63702E+02	-0.13807E+00		278-323
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Butanediol	298.2	28.8	0.72883E+02	-0.14770E+00		278-323
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Butanediol	298.2	31.9	0.13079E+03	-0.46985E+00	0.46320E-03	288-328
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol monoethyl ether	298.2	13.38				
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol dimethyl ether	296.7	7.30	0.48832E+02	-0.24218E+00	0.34413E-03	256-318
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub> S	Bis(2-hydroxyethyl) sulfide	293.2	28.61	0.13128E+03	-0.52719E+00	0.60465E-03	253-333
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	Diethylene glycol	293.2	31.82	0.13973E+03	-0.54725E+00	0.61149E-03	288-343
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub> S	Diethyl sulfite	293.2	15.6				
C <sub>4</sub> H <sub>10</sub> O <sub>4</sub>	1,2,3,4-Butanetetrol	393.2	28.2				
C <sub>4</sub> H <sub>10</sub> O <sub>4</sub> S	Diethyl sulfate	293.2	29.2				
C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	288.2	5.204	0.11201E+02	-0.20767E-01		273-318
C <sub>4</sub> H <sub>10</sub> S	2-Butanethiol	288.2	5.645	0.10866E+02	-0.17993E-01		273-318
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-1-propanethiol	298.2	4.961				
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-2-propanethiol	293.2	5.475	0.10597E+02	-0.17500E-01		283-313
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	298.2	5.723				
C <sub>4</sub> H <sub>11</sub> N	Butylamine	293.2	4.71	0.13322E+02	-0.44176E-01	0.50250E-04	223-333
C <sub>4</sub> H <sub>11</sub> N	Diethylamine	293.2	3.680	0.26462E+02	-0.13750E+00	0.20373E-03	243-323
C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	Diethanolamine	293.2	25.75	0.73435E+02	-0.21377E+00	0.17500E-03	273-323
C <sub>4</sub> H <sub>12</sub> O <sub>2</sub> Si	Dimethoxydimethylsilane	298.2	3.663				
C <sub>4</sub> H <sub>12</sub> O <sub>3</sub> Si	Trimethoxymethylsilane	298.2	4.9				
C <sub>4</sub> H <sub>12</sub> O <sub>4</sub> Si	Tetramethyl silicate	293.2	6.0				
C <sub>4</sub> H <sub>12</sub> Si	Diethylsilane	293.2	2.544				
C <sub>4</sub> H <sub>12</sub> Si	Tetramethylsilane	293.2	1.921				
C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	Diethylenetriamine	293.2	12.62	0.57840E+02	-0.23873E+00	0.28841E-03	213-333
C <sub>5</sub> FeO <sub>5</sub>	Iron pentacarbonyl	293.2	2.602				
C <sub>5</sub> H <sub>4</sub> BrN	2-Bromopyridine	298.2	23.18	0.73391E+02	-0.23678E+00	0.22930E-03	298-398
C <sub>5</sub> H <sub>4</sub> ClN	2-Chloropyridine	298.2	27.32	0.98702E+02	-0.34237E+00	0.34502E-03	298-398
C <sub>5</sub> H <sub>4</sub> F <sub>8</sub> O	2,2,3,3,4,4,5,5-Octafluoro-1-pentanol	298.2	15.30				
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural	293.2	42.1				
C <sub>5</sub> H <sub>5</sub> N	Pyridine	293.2	13.260	0.43991E+02	-0.15150E+00	0.15925E-03	293-323
C <sub>5</sub> H <sub>5</sub> NO	Pyridine-1-oxide	343.0	35.94	0.20878E+02	0.16450E+00	-0.35269E-03	343-398
C <sub>5</sub> H <sub>6</sub> O	2-Methylfuran	293.2	2.76				
C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	Furfuryl alcohol	298.2	16.85				
C <sub>5</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>2</sub>	Propyl trichloroacetate	298.2	8.32				
C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	Ethyl cyanoacetate	263.2	31.62				
C <sub>5</sub> H <sub>8</sub>	1,3-Pentadiene*	298.2	2.319				
C <sub>5</sub> H <sub>8</sub>	1,4-Pentadiene	294.0	2.054	0.29994E+01	-0.34578E-02	0.85300E-06	178-294
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	293.2	2.098	0.28170E+01	-0.23147E-02	-0.43975E-06	198-293
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	295.0	2.083	0.28177E+01	-0.27597E-02	0.89346E-06	171-319
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone	298.2	13.58	0.24083E+02	-0.30286E-01	-0.16802E-04	219-298
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acrylate	303.2	6.05	0.47827E+02	-0.24394E+00	0.35000E-03	303-343
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl <i>trans</i> -2-butenate	293.2	6.6645				
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	303.2	6.32	0.32098E+02	-0.14568E+00	0.20000E-03	303-343
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione	303.2	26.524				
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Dimethyl malonate	293.2	9.82	0.26470E+02	-0.76656E-01	0.67888E-04	293-433
C <sub>5</sub> H <sub>9</sub> BrO <sub>2</sub>	Ethyl 2-bromopropanoate	293.2	9.4				
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Isobutyl chlorocarbonate	293.2	9.1				
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Ethyl 2-chloropropanoate	303.2	11.95	0.25965E+02	-0.46250E-01		303-343
C <sub>5</sub> H <sub>9</sub> ClO <sub>3</sub>	Ethyl 3-chloropropanoate	303.2	10.19	0.21951E+02	-0.38750E-01		303-343
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	Methyl 4-chlorobutanoate	303.2	9.51	0.17127E+02	-0.25000E-01		303-343

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>5</sub> H <sub>9</sub> N	Pentanenitrile	293.2	20.04	0.55793E+02	-0.15750E+00	0.12432E-03	183-333
C <sub>5</sub> H <sub>9</sub> N	2,2-Dimethylpropanenitrile	293.2	21.1	0.58418E+02	-0.16884E+00	0.14131E-03	293-453
C <sub>5</sub> H <sub>9</sub> NO	Isobutyl isocyanate	293.2	11.638	0.38026E+02	-0.12714E+00	0.12679E-03	293-353
C <sub>5</sub> H <sub>9</sub> NO	N-Methyl-2-pyrrolidone	293.2	32.55				
C <sub>5</sub> H <sub>10</sub>	1-Pentene	293.2	2.011	-0.11438E+01	0.25420E-01	-0.50000E-04	273-293
C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene	293.2	2.180				
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	296.0	1.979	0.26064E+01	-0.19578E-02	-0.53908E-06	225-296
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	293.2	1.9687	0.24287E+01	-0.15304E-02	-0.13095E-06	278-313
C <sub>5</sub> H <sub>10</sub>	Ethylcyclopropane	293.2	1.933				
C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	1,2-Dibromopentane	298.2	4.39				
C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	1,4-Dibromopentane	293.2	9.05	0.26443E+02	-0.88640E-01	0.10000E-03	293-333
C <sub>5</sub> H <sub>10</sub> Br <sub>2</sub>	1,5-Dibromopentane	303.2	9.14	0.38192E+02	-0.15648E+00	0.20000E-03	303-333
C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	1,2-Dichloropentane	293.2	6.89	0.19016E+02	-0.57954E-01	0.56801E-04	293-356
C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	1,5-Dichloropentane	298.2	9.92				
C <sub>5</sub> H <sub>10</sub> O	Cyclopentanol	288.2	18.5	0.10565E+03	-0.44244E+00	0.48657E-03	258-323
C <sub>5</sub> H <sub>10</sub> O	Pentanal	293.2	10.00				
C <sub>5</sub> H <sub>10</sub> O	2,2-Dimethylpropanal	293.2	9.051	0.18645E+02	-0.32395E-01	-0.16157E-05	280-333
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	293.2	15.45	0.40893E+02	-0.10423E+00	0.60557E-04	204-353
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	293.2	17.00	0.12690E+02	0.95177E-01	-0.27321E-03	233-353
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone	293.2	10.37	0.30695E+02	-0.10962E+00	0.13810E-03	293-328
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran	293.2	5.66	0.19793E+02	-0.76071E-01	0.94852E-04	234-333
C <sub>5</sub> H <sub>10</sub> O	2-Methyltetrahydrofuran	298.2	6.97				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid	294.4	2.661	0.33491E+01	-0.75156E-02	0.17820E-04	250-344
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	303.2	6.10	0.21532E+02	-0.84106E-01	0.10952E-03	288-323
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isobutyl formate	293.2	6.41				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	293.2	5.62	0.17677E+02	-0.61404E-01	0.69196E-04	253-353
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	293.2	5.76				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate	301.2	5.48	0.38604E+02	-0.19171E+00	0.27128E-03	301-343
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Tetrahydrofurfuryl alcohol	303.2	13.48				
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub> S	3-Methyl sulfolane	298.2	29.4	0.53158E+02	-0.93730E-01	0.47275E-04	298-398
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Diethyl carbonate	297.2	2.820				
C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl lactate	303.2	15.4	0.31225E+02	-0.43531E-01	-0.28571E-04	273-373
C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	1,2,3-Propanetriol-1-acetate	242.2	38.57	0.10653E+03	-0.26439E+00	-0.62371E-04	215-242
C <sub>5</sub> H <sub>11</sub> Br	2-Bromo-2-methylbutane	298.2	9.21				
C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane	299.2	6.31	0.20954E+02	-0.78743E-01	0.98908E-04	183-328
C <sub>5</sub> H <sub>11</sub> Br	3-Bromopentane	298.2	8.37				
C <sub>5</sub> H <sub>11</sub> Br	1-Bromo-3-methylbutane	291.5	6.33	0.27743E+02	-0.13927E+00	0.22627E-03	123-292
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloropentane	293.2	6.654	0.18626E+02	-0.54719E-01	0.47143E-04	273-323
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloro-3-methylbutane	292.0	6.10	0.22228E+02	-0.93189E-01	0.12991E-03	171-297
C <sub>5</sub> H <sub>11</sub> Cl	2-Chloro-2-methylbutane	222.75	12.31	0.55104E+02	-0.29866E+00	0.47840E-03	201-223
C <sub>5</sub> H <sub>11</sub> F	1-Fluoropentane	293.2	3.931				
C <sub>5</sub> H <sub>11</sub> I	1-Iodopentane	293.2	5.78	0.15753E+02	-0.50543E-01	0.56401E-04	293-323
C <sub>5</sub> H <sub>11</sub> I	3-Iodopentane	293.2	7.432				
C <sub>5</sub> H <sub>11</sub> I	1-Iodo-3-methylbutane	292.2	5.6				
C <sub>5</sub> H <sub>11</sub> I	2-Iodo-2-methylbutane	293.2	8.192				
C <sub>5</sub> H <sub>11</sub> N	Piperidine	293.0	4.33	0.82317E+01	-0.11229E-01	-0.71429E-05	293-333
C <sub>5</sub> H <sub>11</sub> N	N-Methylpyrrolidine	298.2	32.2				
C <sub>5</sub> H <sub>11</sub> NO	2,2-Dimethylpropanamide	298.2	20.13	0.10400E+03	-0.46017E+00	0.60000E-03	298-328
C <sub>5</sub> H <sub>11</sub> NO	N,N-Diethylformamide	293.2	29.6				
C <sub>5</sub> H <sub>11</sub> NO	2-Pentanone oxime	293.2	3.3				
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	Pentyl nitrite	298.2	7.21				
C <sub>5</sub> H <sub>12</sub>	Pentane	293.2	1.8371				
C <sub>5</sub> H <sub>12</sub>	Isopentane	293.2	1.845	0.22384E+01	-0.12985E-02	-0.16182E-06	143-293
C <sub>5</sub> H <sub>12</sub>	Neopentane	296.0	1.769	0.10949E+02	-0.63057E-01	0.10835E-03	251-296
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Tetramethylurea	293.2	23.10				
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	298.2	15.13	0.73397E+02	-0.28165E+00	0.28427E-03	213-513
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	298.2	13.71	0.16437E+03	-0.86506E+00	0.11955E-02	273-323
C <sub>5</sub> H <sub>12</sub> O	3-Pentanol	298.2	13.35	0.12838E+03	-0.60980E+00	0.75000E-03	288-318
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-1-butanol	298.2	15.63	0.14020E+02	0.13948E+00	-0.45000E-03	288-318
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	293.2	15.63	0.79733E+02	-0.31272E+00	0.32014E-03	173-513
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol	298.2	5.78	0.11662E+03	-0.69756E+00	0.10920E-02	268-318
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol	298.2	12.1				
C <sub>5</sub> H <sub>12</sub> O	2,2-Dimethyl-1-propanol	333.2	8.35	0.92350E+02	-0.41870E+00	0.50000E-03	333-373



Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,2-Pentanediol	296.8	17.31	0.18436E+03	-0.10682E+01	0.17037E-02	197-297
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,4-Pentanediol	295.7	26.74	0.13568E+03	-0.59198E+00	0.75398E-03	193-318
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,5-Pentanediol	293.2	26.2	0.11858E+03	-0.45920E+00	0.49341E-03	243-343
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	2,3-Pentanediol	296.9	17.37	0.95876E+02	-0.46463E+00	0.67434E-03	238-297
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	2,4-Pentanediol	294.2	24.69	0.11914E+03	-0.52569E+00	0.69607E-03	224-294
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	Diethoxymethane	293.2	2.527	0.25294E+01	0.73988E-04	-0.28331E-06	227-293
C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	Tetramethoxymethane	293.2	2.40				
C <sub>5</sub> H <sub>12</sub> O <sub>5</sub>	Xylitol	293.2	40.0				
C <sub>5</sub> H <sub>12</sub> S	1-Pentanethiol	293.2	4.847	0.71131E+01	-0.30228E-02	-0.16414E-04	273-333
C <sub>5</sub> H <sub>12</sub> S	2-Methyl-2-butanethiol	293.2	5.087	0.15116E+02	-0.50700E-01	0.56250E-04	273-333
C <sub>5</sub> H <sub>12</sub> S <sub>4</sub>	Tetrakis(methylthio)methane	343.2	2.818				
C <sub>5</sub> H <sub>13</sub> N	Pentylamine	293.2	4.27	0.11274E+02	-0.34965E-01	0.37706E-04	223-353
C <sub>5</sub> H <sub>13</sub> N <sub>3</sub>	1,1,3,3-Tetramethylguanidine	298.2	11.5				
C <sub>5</sub> H <sub>14</sub> OSi	Ethoxytrimethylsilane	298.2	3.013				
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene	298.2	2.029	0.24041E+01	-0.83086E-03	-0.14286E-05	298-338
C <sub>6</sub> F <sub>14</sub>	Perfluorohexane	298.2	1.76				
C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	2,4,6-Trinitrophenol	294.2	4.0				
C <sub>6</sub> H <sub>4</sub> BrF	1-Bromo-2-fluorobenzene	298.2	4.72				
C <sub>6</sub> H <sub>4</sub> BrF	1-Bromo-3-fluorobenzene	298.2	4.85				
C <sub>6</sub> H <sub>4</sub> BrF	1-Bromo-4-fluorobenzene	298.2	2.60				
C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	1-Bromo-3-nitrobenzene	328.2	20.2	0.81413E+02	-0.27645E+00	0.27367E-03	328-413
C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	<i>o</i> -Dibromobenzene	293.2	7.86	-0.81849E-02	0.62671E-01	-0.12222E-03	293-353
C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	<i>m</i> -Dibromobenzene	293.2	4.81	0.93214E+01	-0.20273E-01	0.16667E-04	293-353
C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	<i>p</i> -Dibromobenzene	368.2	2.57				
C <sub>6</sub> H <sub>4</sub> ClF	1-Chloro-2-fluorobenzene	298.2	6.10				
C <sub>6</sub> H <sub>4</sub> ClF	1-Chloro-3-fluorobenzene	298.2	4.96				
C <sub>6</sub> H <sub>4</sub> ClF	1-Chloro-4-fluorobenzene	298.2	3.34				
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-2-nitrobenzene	323.2	37.7	0.16800E+03	-0.59708E+00	0.59957E-03	323-436
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-3-nitrobenzene	323.2	20.9	0.77193E+02	-0.25118E+00	0.23798E-03	323-433
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-4-nitrobenzene	393.2	8.09				
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene	293.2	10.12	0.13629E+02	0.10622E-02	-0.44444E-04	293-353
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene	293.2	5.02	0.77565E+01	-0.93333E-02	-0.26880E-14	293-353
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene	328.2	2.3943	0.26999E+01	-0.35325E-03	-0.17619E-05	328-363
C <sub>6</sub> H <sub>4</sub> FI	1-Fluoro-2-iodobenzene	298.2	8.22				
C <sub>6</sub> H <sub>4</sub> FI	1-Fluoro-4-iodobenzene	298.2	3.12				
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>o</i> -Difluorobenzene	301.2	13.38	0.59107E+02	-0.23611E+00	0.27987E-03	273-323
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>m</i> -Difluorobenzene	301.2	5.01	0.14448E+02	-0.46982E-01	0.51948E-04	273-323
C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	<i>o</i> -Diiodobenzene	323.2	5.41	0.31150E+02	-0.14428E+00	0.20000E-03	323-353
C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	<i>m</i> -Diiodobenzene	323.2	4.11				
C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	<i>p</i> -Diiodobenzene	393.2	2.88				
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	2-Pyridinecarbonitrile	303.2	93.77	0.45596E+03	-0.17746E+01	0.19105E-02	303-398
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	3-Pyridinecarbonitrile	323.2	20.54	0.60484E+02	-0.17280E+00	0.15218E-03	323-398
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	4-Pyridinecarbonitrile	353.2	5.23	0.12533E+02	-0.30115E-01	0.26674E-04	353-398
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1,3-Dinitrobenzene	365.2	22.9	0.10406E+03	-0.34133E+00	0.32609E-03	365-413
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	293.2	5.45	0.94100E+01	-0.12537E-01	-0.31127E-05	234-333
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	293.2	5.6895	0.19471E+02	-0.70786E-01	0.82466E-04	293-430
C <sub>6</sub> H <sub>5</sub> ClO	<i>o</i> -Chlorophenol	296.2	7.40	0.29755E+02	-0.11256E+00	0.12390E-03	296-448
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol	293.2	6.255				
C <sub>6</sub> H <sub>5</sub> ClO	<i>p</i> -Chlorophenol	314.2	11.18	0.31997E+02	-0.94241E-01	0.88392E-04	314-453
C <sub>6</sub> H <sub>5</sub> ClO <sub>2</sub> S	Benzenesulfonyl chloride	323.2	28.90	0.83886E+02	-0.23405E+00	0.19713E-03	323-473
C <sub>6</sub> H <sub>5</sub> ClS	4-Chlorobenzenethiol	338.2	3.59				
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	293.2	5.465				
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	293.2	4.59	0.89442E+01	-0.20008E-01	0.17641E-04	243-323
C <sub>6</sub> H <sub>5</sub> NOS	<i>N</i> -Sulfinylaniline	298.2	6.97				
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene	293.0	35.6	0.11212E+03	-0.35211E+00	0.31128E-03	279-533
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	<i>o</i> -Nitrophenol	323.2	16.50	0.33827E+02	-0.62123E-01	0.26774E-04	323-453
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>m</i> -Nitrophenol	373.2	35.45	0.18967E+03	-0.66144E+00	0.66532E-03	373-458
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>p</i> -Nitrophenol	393.2	42.20	0.22901E+03	-0.74264E+00	0.68006E-03	393-463
C <sub>6</sub> H <sub>6</sub>	Benzene	293.2	2.2825	0.26706E+01	-0.91648E-03	-0.14257E-05	293-513
C <sub>6</sub> H <sub>6</sub> BrN	<i>m</i> -Bromoaniline	293.2	13.0				
C <sub>6</sub> H <sub>6</sub> ClN	<i>o</i> -Chloroaniline	293.2	13.40				
C <sub>6</sub> H <sub>6</sub> ClN	<i>m</i> -Chloroaniline	293.2	13.3				
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>o</i> -Nitroaniline	353.0	47.3	0.18900E+03	-0.56977E+00	0.47484E-03	353-468

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>m</i> -Nitroaniline	398.0	35.6	0.20352E+03	-0.66582E+00	0.61310E-03	398-468
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>p</i> -Nitroaniline	428.0	78.5	0.48673E+03	-0.15040E+01	0.12857E-02	428-468
C <sub>6</sub> H <sub>6</sub> O	Phenol	303.2	12.40	0.63391E+02	-0.24988E+00	0.26930E-03	303-433
C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Pyrocatechol	388.2	17.57	0.74930E+02	-0.22142E+00	0.18919E-03	388-463
C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Resorcinol	393.2	13.55	0.30252E+02	-0.56443E-01	0.35578E-04	393-463
C <sub>6</sub> H <sub>6</sub> S	Benzenethiol	303.2	4.26	0.57155E+01	-0.70336E-02	0.73617E-05	303-358
C <sub>6</sub> H <sub>7</sub> N	Aniline	293.2	7.06	0.89534E+01	0.38990E-02	-0.36310E-04	293-413
C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	293.2	10.18	0.34560E+02	-0.11980E+00	0.12500E-03	293-333
C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine	303.0	11.10	0.19643E+03	-0.11167E+01	0.16667E-02	303-333
C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	293.0	12.2	0.33765E+02	-0.10113E+00	0.93860E-04	274-333
C <sub>6</sub> H <sub>7</sub> NO	2-Methylpyridine-1-oxide	323.2	36.4	0.11705E+03	-0.35301E+00	0.32000E-03	323-398
C <sub>6</sub> H <sub>7</sub> NO	3-Methylpyridine-1-oxide	318.2	28.26	0.59851E+02	-0.12682E+00	0.86622E-04	318-398
C <sub>6</sub> H <sub>8</sub>	1,3-Cyclohexadiene	184.2	2.68				
C <sub>6</sub> H <sub>8</sub>	1,4-Cyclohexadiene	296.0	2.211	0.27459E+01	-0.16975E-02	-0.36461E-06	232-356
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Phenylhydrazine	293.2	7.15				
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	2,5-Dimethylpyrazine	293.2	2.436				
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	2,6-Dimethylpyrazine	308.2	2.653				
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Cyclohexanedione	351.2	4.40				
C <sub>6</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	Butyl trichloroacetate	293.2	7.480				
C <sub>6</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	Isobutyl trichloroacetate	293.2	7.667				
C <sub>6</sub> H <sub>9</sub> N	Cyclopentanecarbonitrile	293.2	22.68	0.69830E+02	-0.25303E+00	0.31491E-03	201-293
C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene	294.0	2.125	0.30014E+01	-0.28668E-02	-0.31026E-06	151-294
C <sub>6</sub> H <sub>10</sub>	<i>cis,cis</i> -2,4-Hexadiene	297.0	2.163	0.27284E+01	-0.17178E-02	-0.62926E-06	234-351
C <sub>6</sub> H <sub>10</sub>	<i>trans,trans</i> -2,4-Hexadiene	297.0	2.123	0.26774E+01	-0.16977E-02	-0.55637E-06	232-353
C <sub>6</sub> H <sub>10</sub>	2-Methyl-1,3-pentadiene*	298.2	2.422				
C <sub>6</sub> H <sub>10</sub>	3-Methyl-1,3-pentadiene	298.2	2.426				
C <sub>6</sub> H <sub>10</sub>	4-Methyl-1,3-pentadiene	293.2	2.599	0.51328E+01	-0.12774E-01	0.14215E-04	198-323
C <sub>6</sub> H <sub>10</sub>	2,3-Dimethyl-1,3-butadiene	293.2	2.102	0.26258E+01	-0.17990E-02	0.12035E-06	223-323
C <sub>6</sub> H <sub>10</sub>	1-Hexyne	296.0	2.621	0.58591E+01	-0.17099E-01	0.20856E-04	184-296
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	293.2	2.2176	0.30598E+01	-0.39841E-02	0.37554E-05	141-313
C <sub>6</sub> H <sub>10</sub> O	Butoxyacetylene	298.2	6.62				
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	293.0	16.1	0.41577E+02	-0.11463E+00	0.92454E-04	253-423
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide	273.2	15.6				
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl 2-butenolate	293.2	5.4				
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl methacrylate	303.2	5.68	0.40962E+02	-0.20520E+00	0.29286E-03	303-343
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate	293.2	14.0				
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Propanoic anhydride	293.2	18.30				
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Monomethyl glutarate	293.2	8.37	0.16779E+02	-0.39839E-01	0.38095E-04	293-363
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate	293.2	8.266	0.21938E+02	-0.66226E-01	0.66800E-04	293-368
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl succinate	293.2	7.19	0.13551E+02	-0.23109E-01	0.55440E-05	293-433
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Ethylene glycol diacetate	290.2	7.7	0.25093E+02	-0.95171E-01	0.12224E-03	223-290
C <sub>6</sub> H <sub>11</sub> Br	Bromocyclohexane	303.2	8.0026				
C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	Ethyl 2-bromobutanoate	303.2	8.57	0.49005E+02	-0.23193E+00	0.32500E-03	303-333
C <sub>6</sub> H <sub>11</sub> BrO <sub>2</sub>	Ethyl 2-bromo-2-methylpropanoate	303.2	8.55	0.77044E+02	-0.40784E+00	0.60000E-03	303-333
C <sub>6</sub> H <sub>11</sub> Cl	Chlorocyclohexane	303.2	7.9505				
C <sub>6</sub> H <sub>11</sub> N	Hexanenitrile	298.2	17.26				
C <sub>6</sub> H <sub>11</sub> N	4-Methylpentanenitrile	295.2	17.5				
C <sub>6</sub> H <sub>11</sub> NO	Cyclohexanone oxime	362.2	3.04				
C <sub>6</sub> H <sub>12</sub>	1-Hexene	294.0	2.077	0.31476E+01	-0.50003E-02	0.46673E-05	149-294
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -2-Hexene	295.0	1.978	0.24338E+01	-0.11323E-02	-0.13720E-05	157-295
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -3-Hexene	296.0	2.069	0.30691E+01	-0.45458E-02	0.39898E-05	155-296
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -3-Hexene	293.2	1.954				
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	293.2	2.0243	0.24293E+01	-0.12095E-02	-0.58741E-06	283-333
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	293.2	1.9853	0.21587E+01	-0.22450E-03	-0.12500E-05	293-323
C <sub>6</sub> H <sub>12</sub>	Ethylcyclobutane	293.2	1.965				
C <sub>6</sub> H <sub>12</sub> Br <sub>2</sub>	1,6-Dibromohexane	298.2	8.52	-0.55185E+01	0.11746E+00	-0.23658E-03	274-328
C <sub>6</sub> H <sub>12</sub> Br <sub>2</sub>	3,4-Dibromohexane	298.2	6.732				
C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub>	1,6-Dichlorohexane	308.2	8.60	0.11277E+02	0.67200E-02	-0.50000E-04	308-338
C <sub>6</sub> H <sub>12</sub> O	1-Methylcyclopentanol	310.1	7.11	0.75444E+02	-0.36617E+00	0.47021E-03	310-333
C <sub>6</sub> H <sub>12</sub> O	Isobutyl vinyl ether	293.2	3.34	0.48060E+01	-0.50000E-02	-0.41495E-14	293-323
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	293.2	14.56	0.70378E+02	-0.29385E+00	0.35289E-03	243-293
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone	293.2	13.11	0.36341E+02	-0.97119E-01	0.61896E-04	204-373
C <sub>6</sub> H <sub>12</sub> O	3,3-Dimethyl-2-butanone	293.2	12.73	0.66857E+02	-0.28552E+00	0.34422E-03	243-293

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol	293.2	16.40	0.10173E+03	-0.43072E+00	0.47926E-03	293-423
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid	298.2	2.600	0.21730E+01	0.14840E-02	-0.16526E-06	298-433
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	2-Ethylbutanoic acid	296.2	2.72				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>tert</i> -Butylacetic acid	296.2	2.85				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Pentyl formate	292.2	5.7				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isopentyl formate	288.2	5.44	0.29257E+02	-0.14028E+00	0.20000E-03	288-323
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	293.2	5.07	0.13825E+02	-0.43994E-01	0.48214E-04	253-353
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>sec</i> -Butyl acetate	293.2	5.135	0.12427E+02	-0.32035E-01	0.24286E-04	273-323
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>tert</i> -Butyl acetate	293.2	5.672	0.55435E+02	-0.30494E+00	0.46107E-03	273-323
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate	293.2	5.068	0.14323E+02	-0.46048E-01	0.49286E-04	273-323
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Propyl propanoate	293.2	5.249				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate	301.2	5.18	0.48698E+02	-0.25660E+00	0.37237E-03	301-343
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl pentanoate	293.2	4.992				
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol	298.2	18.2				
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Ethylene glycol monoethyl ether acetate	303.2	7.567	0.23290E+02	-0.71566E-01	0.65000E-04	303-323
C <sub>6</sub> H <sub>12</sub> S	Cyclohexanethiol	298.2	5.420				
C <sub>6</sub> H <sub>13</sub> Br	1-Bromohexane	298.2	5.82	0.15233E+02	-0.44385E-01	0.43039E-04	274-328
C <sub>6</sub> H <sub>13</sub> Cl	1-Chlorohexane	293.2	6.104	0.15994E+02	-0.43647E-01	0.33393E-04	273-323
C <sub>6</sub> H <sub>13</sub> ClO	6-Chloro-1-hexanol	242.2	21.6	-0.73364E+01	0.46377E+00	-0.14202E-02	195-242
C <sub>6</sub> H <sub>13</sub> I	1-Iodohexane	293.3	5.35	0.16685E+02	-0.61309E-01	0.77262E-04	293-323
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	293.2	4.547				
C <sub>6</sub> H <sub>13</sub> NO	<i>N</i> -Propylpropanamide	298.2	118.1	0.58846E+03	-0.22012E+01	0.20870E-02	298-328
C <sub>6</sub> H <sub>13</sub> NO	<i>N</i> -Butylacetamide**	293.2	104.0	0.70739E+03	-0.37369E+01	0.71585E-02	253-493
C <sub>6</sub> H <sub>13</sub> NO	<i>N,N</i> -Diethylacetamide	293.2	32.1				
C <sub>6</sub> H <sub>14</sub>	Hexane	293.2	1.8865	0.19768E+01	0.70933E-03	-0.34470E-05	293-473
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	293.2	1.886	0.20745E+01	0.50871E-03	-0.39286E-05	273-323
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	293.2	1.886	0.24739E+01	-0.23190E-02	0.10714E-05	273-323
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane	293.2	1.869	0.22740E+01	-0.96229E-03	-0.14286E-05	273-313
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	293.2	1.889	0.24305E+01	-0.20081E-02	0.53571E-06	273-323
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	293.2	13.03	0.62744E+02	-0.24214E+00	0.24704E-03	233-513
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol	298.2	11.06				
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol	298.2	9.66				
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-1-pentanol	298.2	15.2				
C <sub>6</sub> H <sub>14</sub> O	3-Methyl-3-pentanol	293.2	4.322				
C <sub>6</sub> H <sub>14</sub> O	2-Ethyl-1-butanol	362.2	6.19				
C <sub>6</sub> H <sub>14</sub> O	2,2-Dimethyl-1-butanol	293.2	10.5	0.14054E+03	-0.72925E+00	0.97821E-03	243-393
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	297.0	3.38	0.14600E+02	-0.72670E-01	0.11742E-03	161-297
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether	303.2	3.805				
C <sub>6</sub> H <sub>14</sub> OS	Dipropyl sulfoxide	303.2	30.37	0.84868E+02	-0.23486E+00	0.18198E-03	303-373
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	2-Methyl-2,4-pentanediol	293.2	25.86	0.14531E+03	-0.65285E+00	0.83503E-03	203-333
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	Ethylene glycol diethyl ether	293.2	3.90	0.99099E+01	-0.33403E-01	0.44048E-04	223-303
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> S	Dipropyl sulfone	303.2	32.62	0.70195E+02	-0.15008E+00	0.86506E-04	303-398
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	1,2,6-Hexanetriol	285.3	31.5	0.26127E+03	-0.14552E+01	0.22765E-02	261-285
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol dimethyl ether	298.2	7.23	0.28291E+02	-0.11236E+00	0.14000E-03	298-333
C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	Triethylene glycol	293.2	23.69	0.91845E+02	-0.33827E+00	0.36062E-03	253-333
C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	<i>D</i> -Glucitol	353.2	35.5				
C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	<i>D</i> -Mannitol	443.2	24.6				
C <sub>6</sub> H <sub>14</sub> S	1-Hexanethiol	293.2	4.436	0.11774E+02	-0.37298E-01	0.41875E-04	273-333
C <sub>6</sub> H <sub>15</sub> B	Triethylborane	293.2	1.974				
C <sub>6</sub> H <sub>15</sub> N	Hexylamine	293.2	4.08	0.80244E+01	-0.16627E-01	0.10874E-04	253-373
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine	293.2	2.923	0.11376E+02	-0.49796E-01	0.71792E-04	243-323
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	293.2	2.418	0.29205E+01	-0.14007E-02	-0.13469E-05	233-323
C <sub>6</sub> H <sub>15</sub> OP	Triethylphosphine oxide	323.2	35.5				
C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> P	Triethyl phosphate	298.2	13.20	0.61230E+02	-0.26047E+00	0.33333E-03	298-333
C <sub>6</sub> H <sub>15</sub> PS	Triethylphosphine sulfide	371.2	39.0				
C <sub>6</sub> H <sub>16</sub> O <sub>2</sub> Si	Diethoxydimethylsilane	298.2	3.216				
C <sub>6</sub> H <sub>16</sub> Si	Triethylsilane	293.2	2.323				
C <sub>6</sub> H <sub>18</sub> N <sub>3</sub> OP	Hexamethylphosphoric triamide	293.2	31.3	0.95666E+02	-0.29769E+00	0.26407E-03	283-363
C <sub>6</sub> H <sub>18</sub> N <sub>4</sub>	<i>N,N'</i> -Bis(2-aminoethyl)-1,2-ethanediamine	293.2	10.76	0.50699E+02	-0.21730E+00	0.27582E-03	213-333
C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	Hexamethyldisiloxane	293.2	2.179	0.34537E+01	-0.61530E-02	0.61544E-05	213-313
C <sub>6</sub> H <sub>18</sub> O <sub>3</sub> Si <sub>3</sub>	Hexamethylcyclotrisiloxane	343.2	2.139				



Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>6</sub> H <sub>19</sub> NSi <sub>2</sub>	Hexamethyldisilazane	294.2	2.273	0.23358E+01	0.16127E-02	-0.62078E-05	294-333
C <sub>7</sub> F <sub>14</sub>	Perfluoromethylcyclohexane	298.2	1.82				
C <sub>7</sub> F <sub>16</sub>	Perfluoroheptane	289.2	1.847				
C <sub>7</sub> H <sub>3</sub> Cl <sub>5</sub>	2,3,4,5,6-Pentachlorotoluene	293.2	4.8				
C <sub>7</sub> H <sub>4</sub> ClNO	4-Chlorophenyl isocyanate	288.2	3.177	0.40896E+01	-0.31667E-02		288-348
C <sub>7</sub> H <sub>5</sub> BrO	Benzoyl bromide	293.2	21.33	0.84231E+02	-0.31089E+00	0.32857E-03	283-313
C <sub>7</sub> H <sub>5</sub> ClO	Benzoyl chloride	293.2	23.0				
C <sub>7</sub> H <sub>5</sub> FO	Benzoyl fluoride	293.2	22.7				
C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	(Trifluoromethyl)benzene	298.2	9.22				
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile	293.2	25.9	0.57605E+02	-0.13354E+00	0.87767E-04	273-453
C <sub>7</sub> H <sub>5</sub> NO	Phenyl isocyanate	293.2	8.940	0.17541E+02	-0.29790E-01	0.15476E-05	293-353
C <sub>7</sub> H <sub>6</sub> ClNO <sub>2</sub>	4-Chloro-3-nitrotoluene	301.2	28.07				
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	2,4-Dichlorotoluene	301.2	5.68				
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	2,6-Dichlorotoluene	301.2	3.36				
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	3,4-Dichlorotoluene	301.2	9.39				
C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	(Dichloromethyl)benzene	293.2	6.9				
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	293.2	17.85	0.35046E+02	-0.61271E-01	0.16222E-04	301-346
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Salicylaldehyde	293.2	18.35	0.51315E+02	-0.15379E+00	0.14111E-03	289-453
C <sub>7</sub> H <sub>7</sub> Br	<i>o</i> -Bromotoluene	293.2	4.641	0.10229E+02	-0.25050E-01	0.20357E-04	273-323
C <sub>7</sub> H <sub>7</sub> Br	<i>m</i> -Bromotoluene	293.2	5.566	0.11522E+02	-0.24946E-01	0.15714E-04	273-323
C <sub>7</sub> H <sub>7</sub> Br	<i>p</i> -Bromotoluene	293.2	5.503	0.10014E+02	-0.13918E-01	-0.50000E-05	273-293
C <sub>7</sub> H <sub>7</sub> Br	(Bromomethyl)benzene	293.2	6.658	0.18482E+02	-0.57207E-01	0.57321E-04	273-323
C <sub>7</sub> H <sub>7</sub> BrO	<i>o</i> -Bromoanisole	303.2	8.96	0.12023E+02	-0.59116E-02	-0.13787E-04	303-358
C <sub>7</sub> H <sub>7</sub> BrO	<i>p</i> -Bromoanisole	303.2	7.40	0.74367E+01	0.12648E-01	-0.42128E-04	303-358
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene	293.2	4.721	0.11507E+02	-0.31148E-01	0.27143E-04	273-323
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene	293.2	5.763	0.13921E+02	-0.37186E-01	0.31786E-04	273-323
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene	293.2	6.25	0.20265E+01	0.40060E-01	-0.87500E-04	293-333
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene	293.2	6.854	0.17108E+02	-0.45285E-01	0.35000E-04	273-323
C <sub>7</sub> H <sub>7</sub> ClO	<i>p</i> -Chloroanisole	293.2	7.84	0.64019E+01	0.30560E-01	-0.87500E-04	293-333
C <sub>7</sub> H <sub>7</sub> ClO <sub>2</sub> S	<i>p</i> -Toluenesulfonyl chloride	343.2	22.6				
C <sub>7</sub> H <sub>7</sub> ClO <sub>3</sub> S	4-Methoxybenzenesulfonyl chloride	314.2	27.2				
C <sub>7</sub> H <sub>7</sub> F	<i>o</i> -Fluorotoluene	298.2	4.23				
C <sub>7</sub> H <sub>7</sub> F	<i>m</i> -Fluorotoluene	298.2	5.41				
C <sub>7</sub> H <sub>7</sub> F	<i>p</i> -Fluorotoluene	298.2	5.88				
C <sub>7</sub> H <sub>7</sub> I	<i>p</i> -Iodotoluene	308.2	4.4				
C <sub>7</sub> H <sub>7</sub> N	2-Vinylpyridine	293.2	9.126				
C <sub>7</sub> H <sub>7</sub> N	4-Vinylpyridine	293.2	10.50				
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Benzyl nitrite	298.2	7.78				
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>o</i> -Nitrotoluene	293.0	26.26	0.10420E+03	-0.41726E+00	0.51607E-03	273-323
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>m</i> -Nitrotoluene	303.2	24.95	0.62492E+02	-0.16235E+00	0.12844E-03	303-403
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>p</i> -Nitrotoluene	331.2	22.2				
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub> S	4-Nitrothioanisole	346.0	21.7				
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	2-Nitroanisole	293.2	45.75	0.16684E+03	-0.58196E+00	0.57382E-03	293-423
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	3-Nitroanisole	318.2	25.7	0.65402E+02	-0.16460E+00	0.12560E-03	318-443
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	4-Nitroanisole	338.2	26.95	0.59811E+02	-0.10955E+00	0.36042E-04	338-443
C <sub>7</sub> H <sub>8</sub>	Toluene	296.35	2.379	0.32584E+01	-0.34410E-02	0.15937E-05	207-316
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	298.2	6.76	0.21633E+02	-0.71069E-01	0.70590E-04	298-453
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	298.2	12.44	0.81716E+02	-0.35039E+00	0.39878E-03	274-463
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	298.2	13.05	0.70253E+02	-0.28870E+00	0.31979E-03	298-453
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	303.2	11.916	0.13661E+03	-0.72127E+00	0.10225E-02	303-333
C <sub>7</sub> H <sub>8</sub> O	Anisole	294.2	4.30	0.10887E+02	-0.32372E-01	0.33629E-04	294-413
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyphenol	298.2	11.95	0.31751E+02	-0.88173E-01	0.72953E-04	291-448
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	3-Methoxyphenol	298.2	11.59	0.37279E+02	-0.12113E+00	0.11698E-03	298-433
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	4-Methoxyphenol	333.7	11.05	0.39483E+02	-0.12142E+00	0.10841E-03	334-453
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub> S	Ethyl thiophene-2-carboxylate	293.2	6.18				
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub> S	Methyl phenyl sulfone	373.2	37.9				
C <sub>7</sub> H <sub>8</sub> S	Benzenemethanethiol	298.2	4.705	0.16628E+02	-0.68276E-01	0.94636E-04	298-358
C <sub>7</sub> H <sub>8</sub> S	4-Methylbenzenethiol	323.2	4.74	0.87052E+01	-0.15347E-01	0.95238E-05	323-358
C <sub>7</sub> H <sub>8</sub> S <sub>2</sub>	(Methylthio)benzene	303.2	4.88	0.21841E+02	-0.97630E-01	0.13750E-03	303-343
C <sub>7</sub> H <sub>9</sub> N	Benzylamine	293.2	5.18				
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methylaniline	298.2	6.138	0.10988E+02	-0.18976E-01	0.91958E-05	298-398
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methylaniline	298.2	5.816	0.13477E+02	-0.35551E-01	0.33135E-04	298-398
C <sub>7</sub> H <sub>9</sub> N	<i>p</i> -Methylaniline	333.2	5.058	0.78897E+01	-0.10196E-01	0.51190E-05	333-403

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline	293.2	5.96				
C <sub>7</sub> H <sub>9</sub> N	2-Ethylpyridine	293.2	8.33	0.36397E+02	-0.15070E+00	0.18750E-03	293-333
C <sub>7</sub> H <sub>9</sub> N	4-Ethylpyridine	293.2	10.98	-0.73831E+01	0.14326E+00	-0.27500E-03	293-333
C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine	293.2	9.60	0.25895E+02	-0.73900E-01	0.62500E-04	293-333
C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	293.2	7.33	0.17714E+02	-0.39080E-01	0.12500E-04	293-333
C <sub>7</sub> H <sub>9</sub> NO	2,6-Dimethylpyridine-1-oxide	298.2	46.11	0.22765E+03	-0.90760E+00	0.10011E-02	298-398
C <sub>7</sub> H <sub>9</sub> NO	<i>o</i> -Methoxyaniline	303.2	5.230	0.79911E+01	-0.92183E-02	0.37879E-06	303-393
C <sub>7</sub> H <sub>9</sub> NO	<i>m</i> -Methoxyaniline	298.2	8.76	0.28179E+02	-0.97840E-01	0.11027E-03	289-393
C <sub>7</sub> H <sub>9</sub> NO	<i>p</i> -Methoxyaniline	333.2	7.85	0.30149E+02	-0.10523E+00	0.11467E-03	333-453
C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	1-Methyl-1-phenylhydrazine	292.2	7.3				
C <sub>7</sub> H <sub>11</sub> Cl <sub>3</sub> O <sub>2</sub>	Isopentyl trichloroacetate	293.2	7.287				
C <sub>7</sub> H <sub>12</sub>	1,6-Heptadiene	293.0	2.161	0.30815E+01	-0.36095E-02	0.16354E-05	184-293
C <sub>7</sub> H <sub>12</sub>	Cycloheptene	295.0	2.265	0.32309E+01	-0.42373E-02	0.32572E-05	227-363
C <sub>7</sub> H <sub>12</sub> O	Cycloheptanone	298.2	13.16	0.17511E+03	-0.11221E+01	0.19417E-02	258-298
C <sub>7</sub> H <sub>12</sub> O	2-Methylcyclohexanone	293.2	14.0				
C <sub>7</sub> H <sub>12</sub> O	3-Methylcyclohexanone	293.2	12.4				
C <sub>7</sub> H <sub>12</sub> O	4-Methylcyclohexanone	293.2	12.35				
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Cyclohexanecarboxylic acid	304.2	2.67				
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Cyclohexyl formate	293.2	6.47				
C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acrylate	301.2	5.25	0.38296E+02	-0.19109E+00	0.27006E-03	301-343
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Monomethyl adipate	293.2	6.69	0.11962E+02	-0.23973E-01	0.20608E-04	293-433
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl malonate	304.2	7.550	0.14809E+02	-0.31207E-01	0.24066E-04	304-393
C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Dimethyl glutarate	293.2	7.87	0.20697E+02	-0.57794E-01	0.48405E-04	293-433
C <sub>7</sub> H <sub>12</sub> O <sub>5</sub>	1,2,3-Propanetriol-1,3-diacetate	288.2	9.80	0.28321E+02	-0.89073E-01	0.86891E-04	258-374
C <sub>7</sub> H <sub>14</sub>	1-Heptene	293.2	2.092	0.21755E+01	0.13896E-02	-0.57049E-05	273-323
C <sub>7</sub> H <sub>14</sub>	2-Methyl-2-hexene	293.2	2.962				
C <sub>7</sub> H <sub>14</sub>	3-Ethyl-2-pentene	293.2	2.051				
C <sub>7</sub> H <sub>14</sub>	Cycloheptane	293.2	2.0784	0.25136E+01	-0.15089E-02	0.84915E-07	278-333
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	293.2	2.024				
C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	1,2-Dibromoheptane	298.2	3.77				
C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	2,3-Dibromoheptane	298.2	5.08				
C <sub>7</sub> H <sub>14</sub> Br <sub>2</sub>	3,4-Dibromoheptane	298.2	4.70				
C <sub>7</sub> H <sub>14</sub> Cl <sub>2</sub>	1,7-Dichloroheptane	298.2	8.34				
C <sub>7</sub> H <sub>14</sub> O	1-Heptanal	295.2	9.07				
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone	293.2	11.95	0.38348E+02	-0.12531E+00	0.12005E-03	253-413
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone	293.2	12.7				
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone	293.2	12.60	0.41520E+02	-0.13839E+00	0.13497E-03	253-393
C <sub>7</sub> H <sub>14</sub> O	5-Methyl-2-hexanone	293.2	13.53	0.52353E+02	-0.17695E+00	0.15195E-03	293-333
C <sub>7</sub> H <sub>14</sub> O	Cyclohexanemethanol	333.2	9.70	0.10164E+03	-0.45839E+00	0.54762E-03	333-368
C <sub>7</sub> H <sub>14</sub> O	2-Methylcyclohexanol*	293.2	9.375	0.17315E+03	-0.98794E+00	0.14634E-02	273-323
C <sub>7</sub> H <sub>14</sub> O	3-Methylcyclohexanol*	293.2	13.79	0.65896E+02	-0.21954E+00	0.14107E-03	273-323
C <sub>7</sub> H <sub>14</sub> O	4-Methylcyclohexanol*	293.2	13.45	0.65021E+02	-0.22896E+00	0.17946E-03	273-323
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid	288.2	3.04	0.36423E+01	-0.31996E-02	0.39362E-05	288-423
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Pentyl acetate	293.2	4.79	0.12091E+02	-0.36536E-01	0.39732E-04	253-353
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopentyl acetate	293.2	4.72				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Butyl propanoate	293.2	4.838				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Propyl butanoate	293.2	4.3				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl pentanoate	291.2	4.71				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl 3-methylbutanoate	293.2	4.71				
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Methyl hexanoate	293.2	4.615				
C <sub>7</sub> H <sub>15</sub> Br	1-Bromoheptane	303.2	5.255	0.15289E+02	-0.50621E-01	0.57753E-04	203-343
C <sub>7</sub> H <sub>15</sub> Br	2-Bromoheptane	295.2	6.46				
C <sub>7</sub> H <sub>15</sub> Br	4-Bromoheptane	295.2	6.81				
C <sub>7</sub> H <sub>15</sub> Cl	1-Chloroheptane	293.2	5.521	0.14279E+02	-0.39431E-01	0.32321E-04	273-323
C <sub>7</sub> H <sub>15</sub> Cl	2-Chloroheptane	295.2	6.52				
C <sub>7</sub> H <sub>15</sub> Cl	3-Chloroheptane	295.2	6.70				
C <sub>7</sub> H <sub>15</sub> Cl	4-Chloroheptane	295.2	6.54				
C <sub>7</sub> H <sub>15</sub> I	1-Iodoheptane	298.2	4.92	0.11856E+02	-0.33493E-01	0.34368E-04	294-323
C <sub>7</sub> H <sub>15</sub> I	3-Iodoheptane	295.2	6.39				
C <sub>7</sub> H <sub>16</sub>	Heptane	293.2	1.9209	0.24740E+01	-0.22577E-02	0.12428E-05	273-373
C <sub>7</sub> H <sub>16</sub>	2-Methylhexane	293.2	1.9221	0.24759E+01	-0.22535E-02	0.12500E-05	293-323
C <sub>7</sub> H <sub>16</sub>	3-Methylhexane	293.2	1.920	0.27089E+01	-0.37908E-02	0.37500E-05	273-323
C <sub>7</sub> H <sub>16</sub>	3-Ethylpentane	293.2	1.942	0.23771E+01	-0.15140E-02	0.10093E-06	163-363

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>7</sub> H <sub>16</sub>	2,2-Dimethylpentane	293.2	1.915	0.23414E+01	-0.14362E-02	-0.51322E-07	153-353
C <sub>7</sub> H <sub>16</sub>	2,3-Dimethylpentane	293.2	1.929	0.25637E+01	-0.26328E-02	0.16071E-05	273-323
C <sub>7</sub> H <sub>16</sub>	2,4-Dimethylpentane	293.2	1.902	0.23979E+01	-0.17436E-02	0.17857E-06	273-323
C <sub>7</sub> H <sub>16</sub>	3,3-Dimethylpentane	291.3	1.9419	0.24007E+01	-0.16802E-02	0.36069E-06	291-322
C <sub>7</sub> H <sub>16</sub>	2,2,3-Trimethylbutane	293.2	1.930				
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	293.2	11.75	0.60662E+02	-0.24049E+00	0.25155E-03	239-513
C <sub>7</sub> H <sub>16</sub> O	2-Heptanol	293.7	9.72	0.10050E+03	-0.49793E+00	0.64504E-03	207-365
C <sub>7</sub> H <sub>16</sub> O	3-Heptanol	296.1	7.07	0.19586E+03	-0.11465E+01	0.17175E-02	248-349
C <sub>7</sub> H <sub>16</sub> O	4-Heptanol	296.2	6.18	0.28995E+03	-0.18499E+01	0.30109E-02	270-301
C <sub>7</sub> H <sub>16</sub> O	2-Methyl-2-hexanol	297.0	3.257				
C <sub>7</sub> H <sub>16</sub> O	3-Methyl-2-hexanol	297.2	4.990	0.59724E+02	-0.32417E+00	0.47058E-03	244-372
C <sub>7</sub> H <sub>16</sub> O	3-Methyl-3-hexanol	298.2	3.248				
C <sub>7</sub> H <sub>16</sub> O	3-Ethyl-3-pentanol	293.2	3.158				
C <sub>7</sub> H <sub>16</sub> O	2,2-Dimethyl-1-pentanol	293.2	6.020	0.37318E+02	-0.17095E+00	0.22022E-03	283-393
C <sub>7</sub> H <sub>16</sub> O	Ethyl pentyl ether	296.2	3.6				
C <sub>7</sub> H <sub>16</sub> O	Ethyl isopentyl ether	293.2	3.955	0.66541E+01	-0.55450E-02	-0.12500E-04	293-323
C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	Triethoxymethane	293.2	4.779				
C <sub>7</sub> H <sub>16</sub> S	1-Heptanethiol	293.2	4.194	0.71333E+01	-0.97320E-02	-0.12500E-05	273-333
C <sub>7</sub> H <sub>17</sub> N	Heptylamine	293.2	3.81	0.87794E+01	-0.24363E-01	0.25325E-04	253-373
C <sub>7</sub> H <sub>18</sub> O <sub>3</sub> Si	Triethoxymethylsilane	298.2	3.845				
C <sub>8</sub> H <sub>6</sub> F <sub>6</sub>	1,3-Bis(trifluoromethyl)benzene	303.2	5.98				
C <sub>8</sub> H <sub>6</sub>	Phenylacetylene	298.2	2.98				
C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub>	2,5-Dichlorostyrene	298.2	2.58				
C <sub>8</sub> H <sub>6</sub> Cl <sub>4</sub>	1,2,3,4-Tetrachloro-5,6-dimethylbenzene	293.2	8.0				
C <sub>8</sub> H <sub>6</sub> Cl <sub>4</sub>	1,2,3,5-Tetrachloro-4,6-dimethylbenzene	293.2	5.4				
C <sub>8</sub> H <sub>6</sub> O	Phenoxyacetylene	298.2	4.76				
C <sub>8</sub> H <sub>7</sub> N	Benzeneacetonitrile	299.2	17.87	0.82175E+02	-0.37416E+00	0.53220E-03	299-343
C <sub>8</sub> H <sub>7</sub> NO <sub>2</sub>	4-Methoxyphenyl isocyanate	333.2	10.26	0.20780E+02	-0.31571E-01		333-403
C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	Methyl 2-nitrobenzoate	300.1	27.76				
C <sub>8</sub> H <sub>8</sub>	Styrene	293.2	2.4737	0.44473E+01	-0.11422E-01	0.16000E-04	293-313
C <sub>8</sub> H <sub>8</sub> O	Acetophenone	298.2	17.44	0.26099E+02	0.64048E-02	-0.11905E-03	298-333
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzeneacetic acid	353.2	3.47	0.24104E+01	0.30000E-02		353-393
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzyl formate	303.2	6.34	0.26162E+02	-0.11026E+00	0.14787E-03	303-358
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Phenyl acetate	298.2	5.403	0.11327E+02	-0.26707E-01	0.22938E-04	298-404
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate	302.7	6.642	0.17486E+02	-0.51027E-01	0.50222E-04	303-393
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	(Hydroxyacetyl)benzene	298.2	21.33	0.42286E+02	-0.69215E-01	-0.35714E-05	298-368
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	4-Methoxybenzaldehyde	303.2	22.0				
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Methyl salicylate	314.4	8.80	0.20501E+02	-0.39045E-01	0.68298E-05	223-398
C <sub>8</sub> H <sub>9</sub> Br	1-Bromo-2-ethylbenzene	298.2	5.55				
C <sub>8</sub> H <sub>9</sub> Br	1-Bromo-3-ethylbenzene	298.2	5.56				
C <sub>8</sub> H <sub>9</sub> Br	1-Bromo-4-ethylbenzene	298.2	5.42				
C <sub>8</sub> H <sub>9</sub> BrO	1-Bromo-2-ethoxybenzene	313.2	7.04	0.23146E+02	-0.75753E-01	0.77778E-04	313-358
C <sub>8</sub> H <sub>9</sub> Cl	1-Chloro-2-ethylbenzene	298.2	4.36				
C <sub>8</sub> H <sub>9</sub> Cl	1-Chloro-3-ethylbenzene	298.2	5.18				
C <sub>8</sub> H <sub>9</sub> Cl	1-Chloro-4-ethylbenzene	298.2	5.16				
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	1-Ethyl-2-nitrobenzene	273.4	21.9				
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	Methyl 2-aminobenzoate	298.2	21.9				
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	Ethyl 4-pyridinecarboxylate	293.2	8.95				
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	293.2	2.4463	0.35969E+01	-0.53169E-02	0.47500E-05	293-323
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	293.2	2.562	0.36163E+01	-0.40177E-02	0.14286E-05	273-323
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	293.2	2.359	0.28421E+01	-0.10191E-02	-0.21429E-05	273-323
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	293.2	2.2735	0.23140E+01	0.97221E-03	-0.37500E-05	293-363
C <sub>8</sub> H <sub>10</sub> O	2,3-Xylenol	343.2	4.81	0.14399E+02	-0.41438E-01	0.39244E-04	343-433
C <sub>8</sub> H <sub>10</sub> O	2,4-Xylenol	303.2	5.060	0.22125E+02	-0.85543E-01	0.96548E-04	303-363
C <sub>8</sub> H <sub>10</sub> O	2,5-Xylenol	338.2	5.36	0.18049E+02	-0.54991E-01	0.51656E-04	338-455
C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	313.2	4.90	0.12284E+02	-0.32996E-01	0.29867E-04	313-453
C <sub>8</sub> H <sub>10</sub> O	3,4-Xylenol	333.2	9.02	0.54423E+02	-0.21153E+00	0.22508E-03	333-453
C <sub>8</sub> H <sub>10</sub> O	3,5-Xylenol	323.2	9.06	0.54251E+02	-0.21647E+00	0.23542E-03	323-453
C <sub>8</sub> H <sub>10</sub> O	Benzeneethanol	293.2	12.31	0.12170E+03	-0.63124E+00	0.87776E-03	278-333
C <sub>8</sub> H <sub>10</sub> O	1-Phenylethanol	293.2	8.77	0.32971E+02	-0.12042E+00	0.12809E-03	293-423
C <sub>8</sub> H <sub>10</sub> O	Phenetole	293.2	4.216	-0.15043E+02	0.13752E+00	-0.24500E-03	293-313

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>8</sub> H <sub>10</sub> O	2-Methylanisole	293.2	3.502	0.50825E+01	-0.62297E-02	0.28571E-05	293-333
C <sub>8</sub> H <sub>10</sub> O	3-Methylanisole	293.2	3.967	0.12830E+02	-0.49701E-01	0.66429E-04	293-333
C <sub>8</sub> H <sub>10</sub> O	4-Methylanisole	293.2	3.914	0.86608E+01	-0.23510E-01	0.25000E-04	293-333
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	1,2-Dimethoxybenzene	293.2	4.45	0.74604E+01	-0.13445E-01	0.10737E-04	293-443
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Dimethoxybenzene	298.2	5.363	0.11911E+02	-0.30804E-01	0.29643E-04	298-358
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Dimethoxybenzene	333.7	5.60	0.11289E+02	-0.20765E-01	0.11987E-04	334-463
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub> S	Ethyl phenyl sulfone	348.2	39.0				
C <sub>8</sub> H <sub>10</sub> S	(Ethylthio)benzene	298.2	4.95				
C <sub>8</sub> H <sub>11</sub> N	<i>p</i> -Ethylaniline	298.2	4.84				
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline	293.2	5.87				
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline	298.2	4.90	0.84052E+01	-0.13549E-01	0.62835E-05	289-453
C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine	298.2	7.807	0.20990E+02	-0.57419E-01	0.44286E-04	298-358
C <sub>8</sub> H <sub>11</sub> NO	4-Ethoxyaniline	298.2	7.43				
C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	Hexamethylene diisocyanate	288.2	14.41	0.26715E+02	-0.42696E-01		288-403
C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl maleate	298.2	7.560	0.13953E+02	-0.21969E-01	0.17817E-05	298-343
C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	Diethyl fumarate	296.2	6.56				
C <sub>8</sub> H <sub>14</sub>	1,7-Octadiene	293.0	2.186	0.28376E+01	-0.17442E-02	-0.16141E-05	214-293
C <sub>8</sub> H <sub>14</sub>	<i>cis</i> -Cyclooctene	296.0	2.306	0.31115E+01	-0.32058E-02	0.16713E-05	269-406
C <sub>8</sub> H <sub>14</sub>	1,2-Dimethylcyclohexene	296.0	2.144	0.26443E+01	-0.17973E-02	0.35815E-06	211-374
C <sub>8</sub> H <sub>14</sub>	1,3-Dimethylcyclohexene	296.0	2.182	0.29951E+01	-0.34615E-02	0.24026E-05	213-373
C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	Methyl cyclohexanecarboxylate	293.2	4.87				
C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	Cyclohexyl acetate	293.2	5.08				
C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	Butanoic anhydride	293.2	12.8				
C <sub>8</sub> H <sub>14</sub> O <sub>3</sub>	2-Methylpropanoic anhydride	292.2	13.6				
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Diisopropyl oxalate	293.2	6.403	0.10709E+02	-0.16328E-01	0.56000E-05	293-368
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl succinate	293.2	6.098	0.80213E+01	0.11810E-02	-0.26400E-04	293-343
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Dimethyl adipate	293.2	6.84	0.11739E+02	-0.17281E-01	0.11447E-05	293-433
C <sub>8</sub> H <sub>15</sub> N	Octanenitrile	293.2	13.90				
C <sub>8</sub> H <sub>16</sub>	1-Octene	293.2	2.113	0.24348E+01	0.34200E-03	-0.50000E-05	273-323
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -3-Octene	298.2	2.062				
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -3-Octene	298.2	2.002				
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -4-Octene	298.2	2.053				
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -4-Octene	298.2	2.004				
C <sub>8</sub> H <sub>16</sub>	3-Methyl-2-heptene*	293.2	2.436				
C <sub>8</sub> H <sub>16</sub>	2,5-Dimethyl-2-hexene	293.2	2.431				
C <sub>8</sub> H <sub>16</sub>	2,4,4-Trimethyl-1-pentene	298.2	2.0908				
C <sub>8</sub> H <sub>16</sub>	Cyclooctane	295.0	2.116	0.25036E+01	-0.12460E-02	-0.23175E-06	295-411
C <sub>8</sub> H <sub>16</sub> Br <sub>2</sub>	1,8-Dibromooctane	298.2	7.43	0.94117E+00	0.61520E-01	-0.13333E-03	298-328
C <sub>8</sub> H <sub>16</sub> Cl <sub>2</sub>	1,8-Dichlorooctane	298.2	7.64				
C <sub>8</sub> H <sub>16</sub> O	2-Octanone	293.2	9.51	-0.16219E+02	0.18799E+00	-0.34156E-03	293-333
C <sub>8</sub> H <sub>16</sub> O	3-Octanone	303.2	10.50				
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid	288.2	2.85	0.29391E+01	-0.38721E-03		288-423
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	2-Ethylhexanoic acid	296.2	2.64				
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Hexyl acetate	293.2	4.42				
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Pentyl propanoate	293.2	4.552				
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Isopentyl propanoate	273.2	5.21	0.17665E+02	-0.71718E-01	0.95635E-04	273-373
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Butyl butanoate	298.2	4.39	0.79684E+01	-0.12000E-01	0.15266E-13	298-318
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Propyl pentanoate	292.2	4.0				
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Ethyl hexanoate	293.2	4.45	0.11007E+02	-0.32800E-01	0.35714E-04	253-353
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Methyl heptanoate	293.2	4.355				
C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	Isopentyl lactate	273.2	11.2	0.48649E+02	-0.21253E+00	0.27619E-03	273-373
C <sub>8</sub> H <sub>17</sub> Br	1-Bromooctane	293.2	5.0957	0.12404E+02	-0.35050E-01	0.34542E-04	283-353
C <sub>8</sub> H <sub>17</sub> Br	2-Bromooctane	293.2	5.44				
C <sub>8</sub> H <sub>17</sub> Cl	1-Chlorooctane	298.2	5.05	0.11346E+02	-0.25120E-01	0.13450E-04	274-328
C <sub>8</sub> H <sub>17</sub> Cl	2-Chlorooctane	293.2	5.42				
C <sub>8</sub> H <sub>17</sub> F	1-Fluorooctane	293.2	3.89				
C <sub>8</sub> H <sub>17</sub> I	1-Iodoctane	293.2	4.67	0.12452E+02	-0.41229E-01	0.50108E-04	233-313
C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	1-Nitrooctane	293.2	11.46				
C <sub>8</sub> H <sub>18</sub>	Octane	293.2	1.948	0.22590E+01	-0.84212E-03	-0.75758E-06	233-393
C <sub>8</sub> H <sub>18</sub>	2-Methylheptane	293.2	1.9519				
C <sub>8</sub> H <sub>18</sub>	3-Ethylhexane	293.2	1.9617				
C <sub>8</sub> H <sub>18</sub>	2,2-Dimethylhexane	293.2	1.9498				
C <sub>8</sub> H <sub>18</sub>	2,5-Dimethylhexane	293.95	1.9619	0.25821E+01	-0.26804E-02	0.19404E-05	294-324

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>8</sub> H <sub>18</sub>	3,3-Dimethylhexane	293.2	1.9645				
C <sub>8</sub> H <sub>18</sub>	3,4-Dimethylhexane	292.1	1.9814	0.26849E+01	-0.33712E-02	0.32949E-05	292-324
C <sub>8</sub> H <sub>18</sub>	3-Ethyl-3-methylpentane	291.49	1.9869	0.25983E+01	-0.28027E-02	0.24195E-05	292-324
C <sub>8</sub> H <sub>18</sub>	2,2,3-Trimethylpentane	293.2	1.960				
C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	293.2	1.943	0.23677E+01	-0.14768E-02	0.94261E-07	173-373
C <sub>8</sub> H <sub>18</sub>	2,3,3-Trimethylpentane	293.2	1.9780				
C <sub>8</sub> H <sub>18</sub>	2,3,4-Trimethylpentane	293.2	1.9738				
C <sub>8</sub> H <sub>18</sub> O	1-Octanol	293.2	10.30	0.51647E+02	-0.20371E+00	0.21320E-03	258-513
C <sub>8</sub> H <sub>18</sub> O	2-Octanol	293.2	8.13	0.63760E+02	-0.27643E+00	0.31075E-03	213-513
C <sub>8</sub> H <sub>18</sub> O	3-Octanol	293.2	5.55	0.12505E+03	-0.70646E+00	0.10245E-02	223-383
C <sub>8</sub> H <sub>18</sub> O	4-Octanol	293.2	4.48	0.51049E+02	-0.26664E+00	0.37280E-03	243-403
C <sub>8</sub> H <sub>18</sub> O	2-Methyl-1-heptanol	293.1	5.16	0.61698E+02	-0.33647E+00	0.49066E-03	236-328
C <sub>8</sub> H <sub>18</sub> O	3-Methyl-1-heptanol	290.3	2.884	0.84687E+01	-0.33712E-01	0.49793E-04	241-316
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-1-heptanol	290.6	4.63	0.48612E+02	-0.26773E+00	0.39972E-03	237-332
C <sub>8</sub> H <sub>18</sub> O	5-Methyl-1-heptanol	290.4	7.68	0.54581E+02	-0.24772E+00	0.29734E-03	235-328
C <sub>8</sub> H <sub>18</sub> O	6-Methyl-1-heptanol	290.3	10.54	0.57997E+02	-0.23517E+00	0.24663E-03	265-328
C <sub>8</sub> H <sub>18</sub> O	2-Methyl-2-heptanol	292.2	3.43				
C <sub>8</sub> H <sub>18</sub> O	3-Methyl-2-heptanol	289.6	7.47	0.39178E+02	-0.17976E+00	0.24218E-03	229-329
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-2-heptanol	290.0	3.59	0.39715E+02	-0.23115E+00	0.36771E-03	240-333
C <sub>8</sub> H <sub>18</sub> O	5-Methyl-2-heptanol	278.5	7.5	0.68568E+02	-0.40706E+00	0.67433E-03	230-279
C <sub>8</sub> H <sub>18</sub> O	6-Methyl-2-heptanol	290.1	6.41	0.77520E+02	-0.41724E+00	0.59448E-03	239-329
C <sub>8</sub> H <sub>18</sub> O	2-Methyl-3-heptanol	293.2	3.260	-0.59739E+01	0.56700E-01	-0.83125E-04	343-403
C <sub>8</sub> H <sub>18</sub> O	3-Methyl-3-heptanol	293.2	3.013	-0.38440E+01	0.42327E-01	-0.61250E-04	343-403
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-3-heptanol	293.2	3.312	-0.48003E+01	0.50740E-01	-0.75000E-04	343-403
C <sub>8</sub> H <sub>18</sub> O	5-Methyl-3-heptanol	293.2	3.832	0.61967E+01	-0.63750E-02		343-383
C <sub>8</sub> H <sub>18</sub> O	6-Methyl-3-heptanol	293.2	4.992	0.23037E+02	-0.98029E-01	0.12479E-03	283-383
C <sub>8</sub> H <sub>18</sub> O	2-Methyl-4-heptanol	296.3	3.338	0.42102E+00	0.10427E-01	-0.20438E-05	230-333
C <sub>8</sub> H <sub>18</sub> O	3-Methyl-4-heptanol	290.0	7.46	0.33354E+02	-0.14077E+00	0.17750E-03	230-330
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-4-heptanol	296.2	2.902				
C <sub>8</sub> H <sub>18</sub> O	2-Ethyl-1-hexanol	298.2	7.58	0.86074E+02	-0.42636E+00	0.55078E-03	208-318
C <sub>8</sub> H <sub>18</sub> O	2,2-Dimethyl-1-hexanol	293.2	4.50	0.91244E+01	-0.21785E-01	0.21018E-04	283-393
C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether	293.2	3.0830	0.65383E+01	-0.16172E-01	0.14969E-04	293-314
C <sub>8</sub> H <sub>18</sub> OS	Dibutyl sulfoxide	313.2	24.73	0.67156E+02	-0.16448E+00	0.92275E-04	313-393
C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>	2-Ethyl-1,3-hexanediol	293.2	18.73	0.57919E+02	-0.17128E+00	0.12949E-03	233-333
C <sub>8</sub> H <sub>18</sub> O <sub>2</sub> S	Dibutyl sulfone	323.2	25.72	0.66248E+02	-0.16417E+00	0.12001E-03	323-398
C <sub>8</sub> H <sub>18</sub> O <sub>4</sub>	Triethylene glycol dimethyl ether	298.2	7.62				
C <sub>8</sub> H <sub>18</sub> O <sub>5</sub>	Tetraethylene glycol	293.2	20.44	0.83547E+02	-0.31691E+00	0.34689E-03	253-333
C <sub>8</sub> H <sub>18</sub> S	1-Octanethiol	293.2	3.949	0.63667E+01	-0.87920E-02	0.18750E-05	273-333
C <sub>8</sub> H <sub>18</sub> S	Dibutyl sulfide	298.2	4.29				
C <sub>8</sub> H <sub>19</sub> N	Octylamine	293.2	3.58	0.77931E+01	-0.20015E-01	0.19347E-04	273-373
C <sub>8</sub> H <sub>19</sub> N	Dibutylamine	293.2	2.765	0.52504E+01	-0.10538E-01	0.71485E-05	243-323
C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si	Ethyl silicate	293.2	2.50				
C <sub>8</sub> H <sub>20</sub> Si	Tetraethylsilane	293.2	2.090				
C <sub>8</sub> H <sub>20</sub> Sn	Tetraethylstannane	293.2	2.241				
C <sub>8</sub> H <sub>23</sub> N <sub>5</sub>	Tetraethylenepentamine	293.2	9.40	0.40553E+02	-0.16681E+00	0.20659E-03	213-333
C <sub>8</sub> H <sub>24</sub> O <sub>4</sub> Si <sub>4</sub>	Octamethylcyclotetrasiloxane	296.2	2.390	0.36286E+01	-0.56885E-02	0.50874E-05	296-333
C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	Toluene-2,4-diisocyanate	293.2	8.433	0.22174E+02	-0.66982E-01	0.68571E-04	293-353
C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	2 <i>H</i> -1-Benzopyran-2-one	343.2	34.04	0.11311E+03	-0.33804E+00	0.31324E-03	343-423
C <sub>9</sub> H <sub>7</sub> N	Quinoline	293.2	9.16	0.33432E+02	-0.13497E+00	0.17788E-03	258-323
C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	298.2	11.0	0.14412E+03	-0.79935E+00	0.11839E-02	298-323
C <sub>9</sub> H <sub>8</sub> O	Cinnamaldehyde	305.8	17.72	0.41837E+02	-0.11060E+00	0.10401E-03	306-354
C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	2-(Acetyloxy)benzoic acid	333.2	6.55	0.69994E+01	-0.14553E-02		333-416
C <sub>9</sub> H <sub>10</sub>	1-Propenylbenzene	293.2	2.73				
C <sub>9</sub> H <sub>10</sub>	Allylbenzene	293.2	2.63				
C <sub>9</sub> H <sub>10</sub>	Isopropenylbenzene	293.2	2.28				
C <sub>9</sub> H <sub>10</sub> OS	4-Acetylthioanisole	355.2	11.34				
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate	293.2	6.20	0.18216E+02	-0.62361E-01	0.72884E-04	288-343
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Methyl 4-methylbenzoate	306.2	4.3				
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzyl acetate	303.2	5.34	0.11727E+02	-0.30869E-01	0.32340E-04	303-358
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Phenyl propanoate	293.2	4.77				
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	4-Acetylanisole	313.2	17.3				
C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl salicylate	308.2	8.48	0.18910E+02	-0.35623E-01	0.46529E-05	225-321
C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	Methyl 2-methoxybenzoate	294.2	7.7				



Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>9</sub> H <sub>11</sub> Br	(3-Bromopropyl)benzene	302.2	5.41	0.11360E+02	-0.27471E-01	0.25775E-04	302-358
C <sub>9</sub> H <sub>11</sub> NO	<i>N</i> -Ethylbenzamide	352.7	42.6	-0.20109E+03	0.17866E+01	-0.31065E-02	353-389
C <sub>9</sub> H <sub>11</sub> NO	<i>N,N</i> -Dimethylbenzamide	318.2	20.77	0.76725E+02	-0.26908E+00	0.29409E-03	318-443
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	Ethyl 2-aminobenzoate	298.2	4.14				
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	293.2	2.370	0.26933E+01	0.21679E-03	-0.44643E-05	273-323
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	293.2	2.381	0.31149E+01	-0.30801E-02	0.19643E-05	273-323
C <sub>9</sub> H <sub>12</sub>	<i>o</i> -Ethyltoluene	293.2	2.595				
C <sub>9</sub> H <sub>12</sub>	<i>m</i> -Ethyltoluene	293.2	2.365				
C <sub>9</sub> H <sub>12</sub>	<i>p</i> -Ethyltoluene	293.2	2.265				
C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene	293.2	2.656	0.76006E+01	-0.29118E-01	0.41786E-04	273-323
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene	293.2	2.377	0.31517E+01	-0.30634E-02	0.14286E-05	273-323
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	293.2	2.279	0.38998E+01	-0.88072E-02	0.11149E-04	288-358
C <sub>9</sub> H <sub>12</sub> O	Benzenepropanol	293.2	11.97	0.94482E+02	-0.45540E+00	0.59307E-03	213-303
C <sub>9</sub> H <sub>12</sub> O	$\alpha$ -Ethylbenzenemethanol	293.2	6.68	0.44520E+02	-0.21505E+00	0.29443E-03	233-373
C <sub>9</sub> H <sub>12</sub> O	$\alpha,\alpha$ -Dimethylbenzenemethanol	303.2	5.61	0.57072E+01	0.86568E-02	-0.29580E-04	303-373
C <sub>9</sub> H <sub>12</sub> O	1-Phenyl-2-propanol	293.2	9.35	0.10762E+03	-0.56026E+00	0.76915E-03	233-373
C <sub>9</sub> H <sub>12</sub> O	Benzyl ethyl ether	298.2	3.90				
C <sub>9</sub> H <sub>12</sub> O	2,6-Dimethylanisole	293.2	3.780	0.76700E+01	-0.18298E-01	0.17143E-04	293-333
C <sub>9</sub> H <sub>12</sub> O	3,5-Dimethylanisole	293.2	3.711	0.54981E+01	-0.56651E-02	-0.14286E-05	293-333
C <sub>9</sub> H <sub>12</sub> O <sub>2</sub> S	Butyl thiophene-2-carboxylate	293.2	6.40				
C <sub>9</sub> H <sub>12</sub> S	Benzenepropanethiol	303.2	4.36	0.82411E+01	-0.15034E-01	0.73617E-05	303-358
C <sub>9</sub> H <sub>13</sub> N	Benzylethylamine	293.2	4.3				
C <sub>9</sub> H <sub>13</sub> N	<i>N</i> -Propylaniline	293.2	5.48				
C <sub>9</sub> H <sub>13</sub> N	2-Methyl- <i>N,N</i> -dimethylaniline	293.2	3.4				
C <sub>9</sub> H <sub>13</sub> N	4-Methyl- <i>N,N</i> -dimethylaniline	293.2	3.9				
C <sub>9</sub> H <sub>14</sub> OSi	Trimethylphenoxysilane	298.2	3.3953				
C <sub>9</sub> H <sub>14</sub> O <sub>6</sub>	Triacetin	293.6	7.11	0.17819E+02	-0.53656E-01	0.57759E-04	219-304
C <sub>9</sub> H <sub>14</sub> Si	Trimethylphenylsilane	298.2	2.3533	0.21463E+01	0.32711E-02	-0.86264E-05	288-323
C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	2-Nonenoic acid	296.2	2.5				
C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	Cyclohexyl propanoate	293.2	4.82				
C <sub>9</sub> H <sub>16</sub> O <sub>2</sub>	Ethyl cyclohexanecarboxylate	293.2	4.64				
C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	Diethyl glutarate	303.2	6.659				
C <sub>9</sub> H <sub>17</sub> N	Nonanenitrile	293.2	12.08				
C <sub>9</sub> H <sub>18</sub>	1-Nonene	293.2	2.180	0.22710E+01	0.15797E-02	-0.64286E-05	273-323
C <sub>9</sub> H <sub>18</sub> Br <sub>2</sub>	1,9-Dibromononane	293.2	7.153	0.18931E+02	-0.57764E-01	0.60000E-04	293-343
C <sub>9</sub> H <sub>18</sub> O	2-Nonanone	295.2	9.14				
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone	293.2	10.6				
C <sub>9</sub> H <sub>18</sub> O	Di- <i>tert</i> -butyl ketone	287.65	10.0				
C <sub>9</sub> H <sub>18</sub> O	2,6-Dimethyl-4-heptanone	293.2	9.91	0.33178E+02	-0.11290E+00	0.11454E-03	273-393
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid	294.9	2.475	0.25039E+01	0.67274E-03	-0.24180E-05	295-365
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	2-Methyloctanoic acid	293.2	2.39				
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	2-Ethylheptanoic acid	293.2	1.98				
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Heptyl acetate	293.2	4.2				
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Pentyl butanoate	301.2	4.08	0.59029E+01	-0.49905E-02	-0.34292E-05	301-343
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Isopentyl butanoate	293.2	4.0				
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Isobutyl pentanoate	292.2	3.8				
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Methyl octanoate	293.2	4.101				
C <sub>9</sub> H <sub>19</sub> Br	1-Bromononane	298.2	4.74	0.79870E+01	-0.10488E-01	-0.13450E-05	274-328
C <sub>9</sub> H <sub>19</sub> Cl	1-Chlorononane	293.2	4.803	0.95528E+01	-0.16200E-01	-0.16365E-13	293-323
C <sub>9</sub> H <sub>19</sub> NO	<i>N,N</i> -Dibutylformamide	293.2	18.4				
C <sub>9</sub> H <sub>20</sub>	Nonane	293.2	1.9722	0.23894E+01	-0.14830E-02	0.14881E-06	253-393
C <sub>9</sub> H <sub>20</sub>	2-Methyloctane	293.2	1.967				
C <sub>9</sub> H <sub>20</sub>	4-Methyloctane	293.2	1.967				
C <sub>9</sub> H <sub>20</sub>	2,4-Dimethylheptane	293.2	1.89				
C <sub>9</sub> H <sub>20</sub>	2,5-Dimethylheptane	293.2	1.89				
C <sub>9</sub> H <sub>20</sub>	2,6-Dimethylheptane	293.2	1.987				
C <sub>9</sub> H <sub>20</sub> N <sub>2</sub> O	Tetraethylurea	296.8	14.29	0.52820E+02	-0.18790E+00	0.19580E-03	205-411
C <sub>9</sub> H <sub>20</sub> O	1-Nonanol	293.2	8.83	0.97467E+02	-0.51103E+00	0.71429E-03	288-343
C <sub>9</sub> H <sub>20</sub> O	2-Nonanol	298.2	6.66	0.10136E+03	-0.55612E+00	0.80000E-03	288-308
C <sub>9</sub> H <sub>20</sub> O	3-Nonanol	298.2	4.49	0.55214E+02	-0.31920E+00	0.50000E-03	288-308
C <sub>9</sub> H <sub>20</sub> O	4-Nonanol	298.2	3.69	0.27954E+01	0.30000E-02	-0.52375E-13	288-308
C <sub>9</sub> H <sub>20</sub> O	5-Nonanol	298.2	3.54	-0.25463E+01	0.35320E-01	-0.50000E-04	288-308
C <sub>9</sub> H <sub>21</sub> B	Tripropylborane	293.2	2.026				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>9</sub> H <sub>21</sub> N	Nonylamine	293.2	3.42	0.53575E+01	-0.71982E-02	0.19481E-05	293-373
C <sub>9</sub> H <sub>21</sub> N	Tripropylamine	293.2	2.380	0.33380E+01	-0.86332E-02	0.18322E-04	243-293
C <sub>9</sub> H <sub>21</sub> O <sub>4</sub> P	Tripropyl phosphate	293.2	10.93	0.33166E+02	-0.10514E+00	0.10000E-03	293-373
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene	298.2	4.768	0.10561E+02	-0.27671E-01	0.27655E-04	293-323
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene	298.2	5.04	0.84861E+01	-0.12357E-01	0.26899E-05	274-328
C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitronaphthalene	333.2	19.68	0.36267E+02	-0.41283E-01	-0.25595E-04	333-403
C <sub>10</sub> H <sub>8</sub>	Naphthalene	363.2	2.54				
C <sub>10</sub> H <sub>8</sub> O	1-Naphthol	373.0	5.03	0.16489E+02	-0.46700E-01	0.42857E-04	373-453
C <sub>10</sub> H <sub>8</sub> O	2-Naphthol	413.0	4.95	0.92865E+01	-0.10500E-01	0.42501E-15	413-453
C <sub>10</sub> H <sub>9</sub> N	1-Naphthylamine	333.2	5.20	0.10577E+02	-0.22114E-01	0.17857E-04	333-453
C <sub>10</sub> H <sub>9</sub> N	2-Naphthylamine	393.0	5.26	0.19722E+02	-0.60679E-01	0.60714E-04	393-473
C <sub>10</sub> H <sub>9</sub> N	2-Methylquinoline	293.2	7.24	0.11688E+02	-0.78400E-02	-0.25000E-04	293-333
C <sub>10</sub> H <sub>9</sub> N	4-Methylquinoline	293.2	9.31	0.17788E+02	-0.32580E-01	0.12500E-04	293-333
C <sub>10</sub> H <sub>9</sub> N	6-Methylquinoline	293.2	8.48	0.21696E+02	-0.63400E-01	0.62500E-04	293-333
C <sub>10</sub> H <sub>9</sub> N	8-Methylquinoline	293.2	6.58	0.19356E+02	-0.61900E-01	0.62500E-04	293-333
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Methyl 2-(acetyloxy)benzoate	328.9	5.31	0.19579E+02	-0.69970E-01	0.80889E-04	329-371
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl phthalate	293.2	8.66				
C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	298.2	2.771	0.29172E+01	0.12832E-02	-0.59453E-05	298-343
C <sub>10</sub> H <sub>12</sub>	4-Ethylstyrene	298.2	3.350				
C <sub>10</sub> H <sub>12</sub>	Dicyclopentadiene	313.2	2.43	0.30564E+01	-0.20000E-02	0.82443E-15	313-373
C <sub>10</sub> H <sub>12</sub> O	Tetrahydro-2-naphthol*	293.2	11.70	0.98978E+02	-0.48267E+00	0.63008E-03	293-363
C <sub>10</sub> H <sub>12</sub> O	4-Isopropylbenzaldehyde	288.2	10.68				
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	4-Allyl-2-methoxyphenol	293.2	9.55	0.52377E+02	-0.24380E+00	0.33333E-03	273-323
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	2-Phenylethyl acetate	297.2	4.93				
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Benzyl propanoate	303.0	5.11	0.42301E+01	0.13962E-01	-0.36426E-04	303-358
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Phenyl butanoate	293.2	4.48				
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Propyl benzoate	303.2	5.78	0.10927E+02	-0.20535E-01	0.11745E-04	303-358
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl phenylacetate	293.2	5.320				
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	293.2	2.359				
C <sub>10</sub> H <sub>14</sub>	sec-Butylbenzene	293.2	2.357	0.28348E+01	-0.68586E-03	-0.32143E-05	273-323
C <sub>10</sub> H <sub>14</sub>	tert-Butylbenzene	293.2	2.359	0.27924E+01	-0.38350E-03	-0.37500E-05	273-323
C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	293.2	2.318	0.28055E+01	-0.92614E-03	-0.25000E-05	273-323
C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-4-methylbenzene	298.2	2.2322	0.25266E+01	-0.25121E-03	-0.24867E-05	277-333
C <sub>10</sub> H <sub>14</sub>	o-Diethylbenzene	293.2	2.594				
C <sub>10</sub> H <sub>14</sub>	m-Diethylbenzene	293.2	2.369				
C <sub>10</sub> H <sub>14</sub>	p-Diethylbenzene	293.2	2.259				
C <sub>10</sub> H <sub>14</sub>	1-Ethyl-3,5-dimethylbenzene	293.2	2.275				
C <sub>10</sub> H <sub>14</sub>	1,2,3,4-Tetramethylbenzene	296.0	2.538	0.33822E+01	-0.33630E-02	0.17475E-05	273-412
C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	356.0	2.223	0.26834E+01	-0.10327E-02	-0.73533E-06	356-430
C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	L-Nicotine	293.2	8.937	0.21347E+02	-0.57177E-01	0.50655E-04	293-363
C <sub>10</sub> H <sub>14</sub> O	1-Phenyl-2-methyl-2-propanol	298.2	5.71	0.21922E+02	-0.84231E-01	0.99475E-04	298-423
C <sub>10</sub> H <sub>14</sub> O	Butyl phenyl ether	293.2	3.734				
C <sub>10</sub> H <sub>14</sub> O	Thymol	333.2	4.259				
C <sub>10</sub> H <sub>15</sub> N	N,N-Diethylaniline	303.2	5.15	0.50773E+01	0.15399E-01	-0.50000E-04	303-328
C <sub>10</sub> H <sub>16</sub>	$\gamma$ -Terpinene	298.2	2.2738				
C <sub>10</sub> H <sub>16</sub>	d-Limonene	298.2	2.3746				
C <sub>10</sub> H <sub>16</sub>	l-Limonene	298.2	2.3738				
C <sub>10</sub> H <sub>16</sub>	Terpinolene	298.2	2.2918				
C <sub>10</sub> H <sub>16</sub>	$\alpha$ -Pinene	298.2	2.1787				
C <sub>10</sub> H <sub>16</sub>	$\beta$ -Pinene	298.2	2.4970				
C <sub>10</sub> H <sub>16</sub>	$\alpha$ -Terpinene	298.2	2.4526				
C <sub>10</sub> H <sub>16</sub>	$\beta$ -Myrcene	298.2	2.3				
C <sub>10</sub> H <sub>16</sub> O	Carvenone	293.2	18.8				
C <sub>10</sub> H <sub>16</sub> O	d-Fenchone	294.2	12.8				
C <sub>10</sub> H <sub>17</sub> Cl	2-Chlorobornane	368.2	5.21				
C <sub>10</sub> H <sub>18</sub>	Pinane	298.2	2.1456				
C <sub>10</sub> H <sub>18</sub>	cis-Decahydronaphthalene	293.2	2.219	0.25410E+01	-0.11420E-02	0.15092E-06	293-373
C <sub>10</sub> H <sub>18</sub>	trans-Decahydronaphthalene	293.2	2.184	0.26615E+01	-0.21241E-02	0.16864E-05	293-373
C <sub>10</sub> H <sub>18</sub> O	Eucalyptol	298.2	4.57				
C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	Cyclohexyl butanoate	293.2	4.58				
C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Diethyl adipate	293.2	6.109	0.14824E+02	-0.40749E-01	0.37600E-04	293-343
C <sub>10</sub> H <sub>20</sub>	1-Decene	293.2	2.136	0.19091E+01	0.33442E-02	-0.87500E-05	273-323
C <sub>10</sub> H <sub>20</sub>	cis-5-Decene	298.2	2.071				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>10</sub> H <sub>20</sub>	<i>trans</i> -5-Decene	298.2	2.030				
C <sub>10</sub> H <sub>20</sub>	5-Methyl-4-nonene	293.2	2.175				
C <sub>10</sub> H <sub>20</sub>	2,4,6-Trimethyl-3-heptene	293.2	2.293				
C <sub>10</sub> H <sub>20</sub> Br <sub>2</sub>	1,10-Dibromodecane	303.2	6.56	0.17350E+02	-0.50328E-01	0.48633E-04	303-368
C <sub>10</sub> H <sub>20</sub> Cl <sub>2</sub>	1,10-Dichlorodecane	308.2	6.68	-0.57423E+01	0.94220E-01	-0.17500E-03	308-338
C <sub>10</sub> H <sub>20</sub> O	2-Decanone	287.2	8.3				
C <sub>10</sub> H <sub>20</sub> O	Menthol	309.3	3.90	0.68202E+01	-0.15894E-01	0.20837E-04	309-358
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2,2-Dimethyloctanoic acid	296.2	2.8				
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Octyl acetate	288.2	4.18	-0.34691E+01	0.58106E-01	-0.10952E-03	288-323
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	2-Methylheptyl acetate	288.2	4.27	0.23285E+02	-0.11538E+00	0.17143E-03	288-323
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Pentyl pentanoate	305.6	4.076	0.77641E+01	-0.14335E-01	0.73740E-05	306-393
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Isopentyl pentanoate	292.2	3.6				
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Isopentyl isopentanoate	288.2	4.39	0.14698E+02	-0.57726E-01	0.76190E-04	288-323
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Methyl nonanoate	293.2	3.943				
C <sub>10</sub> H <sub>21</sub> Br	1-Bromodecane	298.2	4.44	0.11202E+02	-0.33491E-01	0.36314E-04	274-328
C <sub>10</sub> H <sub>21</sub> Cl	1-Chlorodecane	293.2	4.581	0.68741E+01	-0.12210E-02	-0.22500E-04	293-323
C <sub>10</sub> H <sub>21</sub> NO	<i>N,N</i> -Dibutylacetamide	293.2	19.1				
C <sub>10</sub> H <sub>22</sub>	Decane	293.2	1.9853	0.24054E+01	-0.15445E-02	0.44643E-06	253-393
C <sub>10</sub> H <sub>22</sub>	2,7-Dimethyloctane	293.2	1.98				
C <sub>10</sub> H <sub>22</sub>	4-Propylheptane	293.2	1.9955				
C <sub>10</sub> H <sub>22</sub> O	1-Decanol	293.2	7.93	0.47195E+02	-0.20740E+00	0.24942E-03	293-343
C <sub>10</sub> H <sub>22</sub> O	2-Decanol	298.2	5.82	0.13621E+03	-0.81000E+00	0.12500E-02	288-308
C <sub>10</sub> H <sub>22</sub> O	3-Decanol	298.2	4.05	0.52090E+02	-0.31020E+00	0.50000E-03	288-308
C <sub>10</sub> H <sub>22</sub> O	4-Decanol	298.2	3.42	-0.11260E+02	0.93960E-01	-0.15000E-03	288-308
C <sub>10</sub> H <sub>22</sub> O	5-Decanol	298.2	3.24	-0.25832E+01	0.31456E-01	-0.40000E-04	288-308
C <sub>10</sub> H <sub>22</sub> O	2,2-Dimethyl-1-octanol	293.2	7.86	0.69536E+02	-0.34596E+00	0.46250E-03	293-333
C <sub>10</sub> H <sub>22</sub> O	Dipentyl ether	298.2	2.798				
C <sub>10</sub> H <sub>22</sub> O	Diisopentyl ether	293.2	2.817	0.44690E+01	-0.63710E-02	0.25000E-05	293-323
C <sub>10</sub> H <sub>22</sub> OS	Dipentyl sulfoxide	348.2	18.8				
C <sub>10</sub> H <sub>22</sub> O <sub>5</sub>	Tetraethylene glycol dimethyl ether	298.2	7.68				
C <sub>10</sub> H <sub>22</sub> S	Dipentyl sulfide	298.2	3.826				
C <sub>10</sub> H <sub>25</sub> N	Decylamine	293.2	3.31	0.61497E+01	-0.12801E-01	0.10606E-04	293-373
C <sub>10</sub> H <sub>30</sub> O <sub>3</sub> Si <sub>4</sub>	Decamethyltetrasiloxane	293.2	2.370				
C <sub>10</sub> H <sub>30</sub> O <sub>5</sub> Si <sub>5</sub>	Decamethylcyclopentasiloxane	293.2	2.50				
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	293.2	2.915	0.45126E+01	-0.76480E-02	0.75000E-05	293-333
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	313.2	2.747				
C <sub>11</sub> H <sub>10</sub> O	1-Methoxynaphthalene	293.2	4.020	0.71885E+01	-0.14838E-01	0.13750E-04	293-333
C <sub>11</sub> H <sub>10</sub> O	2-Methoxynaphthalene	353.2	3.563	0.56702E+01	-0.69754E-02	0.28571E-05	353-373
C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl <i>trans</i> -cinnamate	293.2	5.63				
C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	Ethyl benzoylacetate	303.2	13.50	0.93644E+01	0.74280E-01	-0.20000E-03	303-323
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Benzyl butanoate	301.2	4.55				
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Phenyl pentanoate	293.2	4.30				
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Butyl benzoate	303.2	5.52	0.77854E+01	-0.34972E-02	-0.13149E-04	303-358
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Isobutyl benzoate	291.2	5.39				
C <sub>11</sub> H <sub>16</sub>	1,3-Diethyl-5-methylbenzene	293.2	2.264				
C <sub>11</sub> H <sub>16</sub>	Pentamethylbenzene	334.0	2.358	0.30196E+01	-0.22619E-02	0.83831E-06	334-413
C <sub>11</sub> H <sub>22</sub>	1-Undecene	293.2	2.137	0.22132E+01	0.13121E-02	-0.53571E-05	273-323
C <sub>11</sub> H <sub>22</sub> O	2-Undecanone	285.3	8.3				
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Nonyl acetate	293.2	3.87				
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Pentyl hexanoate	288.2	4.22	0.83503E+01	-0.18449E-01	0.14286E-04	288-323
C <sub>11</sub> H <sub>23</sub> Br	1-Bromoundecane	272.6	4.61				
C <sub>11</sub> H <sub>24</sub>	Undecane	293.2	1.9972	0.23637E+01	-0.12500E-02	-0.85869E-16	283-363
C <sub>11</sub> H <sub>24</sub> O	1-Undecanol	313.2	5.98				
C <sub>11</sub> H <sub>25</sub> N	Undecylamine	293.2	3.25	0.54945E+01	-0.96161E-02	0.66017E-05	293-373
C <sub>12</sub> F <sub>27</sub> N	Tris(perfluorobutyl)amine	293.2	2.15				
C <sub>12</sub> H <sub>8</sub> O	Dibenzofuran	373.2	3.00				
C <sub>12</sub> H <sub>10</sub>	Biphenyl	348.2	2.53	0.26869E+01	0.63072E-03	-0.30995E-05	348-428
C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	<i>trans</i> -Azoxybenzene	311.2	5.2				
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether	283.2	3.726				
C <sub>12</sub> H <sub>10</sub> O	2-Acetonaphthone	333.2	13.03	0.14538E+03	-0.73040E+00	0.10000E-02	333-363
C <sub>12</sub> H <sub>10</sub> OS	Diphenyl sulfoxide	344.7	16.6				
C <sub>12</sub> H <sub>10</sub> O <sub>2</sub> S	Diphenyl sulfone	406.2	21.1				
C <sub>12</sub> H <sub>10</sub> S	Diphenyl sulfide	298.2	5.43				



Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	323.2	3.73				
C <sub>12</sub> H <sub>11</sub> NO	<i>N</i> -1-Naphthylacetamide	433.2	24.3	0.84739E+02	-0.12391E+00	-0.35714E-04	433-533
C <sub>12</sub> H <sub>12</sub>	1,6-Dimethylnaphthalene	293.2	2.7250				
C <sub>12</sub> H <sub>12</sub> O	1-Ethoxynaphthalene	292.2	3.3				
C <sub>12</sub> H <sub>14</sub> O <sub>2</sub>	Propyl cinnamate	293.2	5.45				
C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate	293.2	7.86				
C <sub>12</sub> H <sub>16</sub> O	2-Cyclohexylphenol	328.2	3.97				
C <sub>12</sub> H <sub>16</sub> O	4-Cyclohexylphenol	404.2	4.42				
C <sub>12</sub> H <sub>16</sub> O <sub>2</sub>	Pentyl benzoate	293.2	5.07				
C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	Pentyl salicylate	301.2	6.25				
C <sub>12</sub> H <sub>16</sub> O <sub>3</sub>	Isopentyl salicylate	293.12	7.26	0.13129E+02	-0.19190E-01	-0.36060E-05	225-397
C <sub>12</sub> H <sub>17</sub> NO	<i>N</i> -Butyl- <i>N</i> -phenylacetamide	298.2	11.66				
C <sub>12</sub> H <sub>18</sub>	Hexylbenzene	293.2	2.3				
C <sub>12</sub> H <sub>18</sub>	1,3,5-Triethylbenzene	293.2	2.256				
C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	449.0	2.172	0.35710E+01	-0.46912E-02	0.35088E-05	449-489
C <sub>12</sub> H <sub>20</sub> O <sub>2</sub>	<i>l</i> -Bornyl acetate	303.2	4.46	0.60791E+01	0.98200E-02	-0.50000E-04	303-323
C <sub>12</sub> H <sub>22</sub> O	Dicyclohexyl ether	293.2	3.45	0.95324E+01	-0.31740E-01	0.37500E-04	293-333
C <sub>12</sub> H <sub>22</sub> O	Cyclododecanone	303.2	11.4	0.39327E+02	-0.13248E+00	0.13298E-03	303-423
C <sub>12</sub> H <sub>22</sub> O <sub>6</sub>	Dibutyl tartrate	314.2	9.4				
C <sub>12</sub> H <sub>24</sub>	1-Dodecene	293.2	2.152	0.22581E+01	0.11106E-02	-0.50000E-05	273-323
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Decyl acetate	293.2	3.75				
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Ethyl decanoate	293.2	3.75	0.70969E+01	-0.15080E-01	0.12500E-04	293-353
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Methyl undecanoate	293.2	3.671				
C <sub>12</sub> H <sub>25</sub> Br	1-Bromododecane	298.2	4.07	0.86103E+01	-0.20891E-01	0.18994E-04	274-328
C <sub>12</sub> H <sub>25</sub> Cl	1-Chlorododecane	298.2	4.17	0.10002E+02	-0.27798E-01	0.27559E-04	274-328
C <sub>12</sub> H <sub>25</sub> I	1-Iodododecane	298.2	3.91	0.34641E+01	0.97404E-02	-0.27602E-04	293-323
C <sub>12</sub> H <sub>26</sub>	Dodecane	293.2	2.0120	0.23697E+01	-0.12200E-02	-0.36375E-16	283-363
C <sub>12</sub> H <sub>26</sub> O	1-Dodecanol	303.2	5.82	0.18518E+02	-0.44859E-01	0.99900E-05	303-358
C <sub>12</sub> H <sub>26</sub> O	2-Butyl-1-octanol	363.2	3.28				
C <sub>12</sub> H <sub>27</sub> BO <sub>3</sub>	Tributyl borate	293.2	2.23				
C <sub>12</sub> H <sub>27</sub> N	Dodecylamine	303.2	3.07	0.27999E+01	0.44810E-02	-0.11905E-04	303-373
C <sub>12</sub> H <sub>27</sub> N	Tributylamine	293.2	2.340	0.19846E+01	0.28108E-02	-0.54545E-05	233-293
C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	Tributyl phosphate	293.2	8.34	0.26304E+02	-0.88480E-01	0.92857E-04	293-373
C <sub>12</sub> H <sub>28</sub> O <sub>4</sub> Si	Tetrapropoxysilane	298.2	3.21				
C <sub>12</sub> H <sub>28</sub> Sn	Tetrapropylstannane	293.2	2.267				
C <sub>12</sub> H <sub>30</sub> OSi <sub>2</sub>	Hexaethylsiloxane	298.2	2.259	0.36559E+01	-0.72406E-02	0.85714E-05	298-333
C <sub>13</sub> H <sub>10</sub> O	Benzophenone	300.2	12.62	0.34130E+02	-0.10249E+00	0.10268E-03	300-420
C <sub>13</sub> H <sub>10</sub> O <sub>3</sub>	Phenyl salicylate	290.2	6.92	0.26545E+02	-0.11180E+00	0.15220E-03	290-358
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	303.2	2.540	0.30638E+01	-0.17286E-02		303-333
C <sub>13</sub> H <sub>12</sub> O	Benzyl phenyl ether	313.2	3.748				
C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	Hexyl benzoate	293.2	4.80				
C <sub>13</sub> H <sub>20</sub>	Heptylbenzene	293.2	2.26				
C <sub>13</sub> H <sub>20</sub> O	$\alpha$ -Ionone*	292.4	10.78				
C <sub>13</sub> H <sub>20</sub> O	$\beta$ -Ionone*	297.65	11.66				
C <sub>13</sub> H <sub>24</sub> O <sub>4</sub>	Diethyl nonanedioate	303.2	5.133				
C <sub>13</sub> H <sub>26</sub>	1-Tridecene	293.2	2.139	0.14154E+01	0.66514E-02	-0.14286E-04	273-323
C <sub>13</sub> H <sub>26</sub> O	7-Tridecanone	303.2	7.6				
C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	Ethyl undecanoate	293.2	3.55				
C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	Methyl dodecanoate	293.2	3.539				
C <sub>13</sub> H <sub>27</sub> Br	1-Bromotridecane	281.15	4.19				
C <sub>13</sub> H <sub>28</sub>	Tridecane	293.2	2.0213	0.23731E+01	-0.12000E-02	-0.21841E-15	283-363
C <sub>13</sub> H <sub>28</sub>	5-Butylnonane	293.2	2.0319				
C <sub>13</sub> H <sub>28</sub> O	1-Tridecanol	333.2	4.02				
C <sub>14</sub> H <sub>10</sub>	Anthracene	502.0	2.649	0.20571E+02	-0.69169E-01	0.66667E-04	502-516
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	383.2	2.72				
C <sub>14</sub> H <sub>10</sub> O <sub>2</sub>	Benzil	368.2	13.04	-0.23599E+02	0.22715E+00	-0.34667E-03	368-393
C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	Benzyl benzoate	303.2	5.26	0.76856E+01	-0.80000E-02	-0.80361E-15	303-358
C <sub>14</sub> H <sub>12</sub> O <sub>3</sub>	Benzyl salicylate	301.2	4.12				
C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	331.2	2.47	0.31178E+01	-0.21572E-02	0.59800E-06	331-451
C <sub>14</sub> H <sub>14</sub> O	Dibenzyl ether	293.2	3.821	0.80154E+01	-0.20536E-01	0.21250E-04	293-333
C <sub>14</sub> H <sub>15</sub> N	Dibenzylamine	293.2	3.446				
C <sub>14</sub> H <sub>16</sub> O <sub>2</sub> Si	Dimethyldiphenoxysilane	298.2	3.500	0.51669E+01	-0.77001E-02	0.70156E-05	283-353
C <sub>14</sub> H <sub>18</sub> O <sub>2</sub>	Pentyl cinnamate	293.2	4.89				

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>14</sub> H <sub>22</sub>	Octylbenzene	293.2	2.26				
C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	Diisobutyl adipate	293.2	5.19				
C <sub>14</sub> H <sub>26</sub> O <sub>4</sub>	Diethyl sebacate	303.2	4.995	0.39143E+02	-0.20965E+00	0.32000E-03	303-313
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Dodecyl acetate	293.2	3.6				
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Ethyl laurate	273.2	3.94				
C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Methyl tridecanoate	293.2	3.442				
C <sub>14</sub> H <sub>29</sub> Br	1-Bromotetradecane	293.2	3.84	0.10058E+02	-0.33905E-01	0.43528E-04	274-328
C <sub>14</sub> H <sub>30</sub>	Tetradecane	293.2	2.0343	0.23832E+01	-0.11900E-02	-0.51229E-16	283-363
C <sub>14</sub> H <sub>30</sub> O	1-Tetradecanol	318.2	4.42	0.12272E+02	-0.24667E-01	-0.13168E-13	318-358
C <sub>14</sub> H <sub>31</sub> N	Tetradecylamine	312.55	2.90				
C <sub>15</sub> H <sub>12</sub> O <sub>4</sub>	Phenyl 2-(acetyloxy)benzoate	384.2	4.33				
C <sub>15</sub> H <sub>26</sub> O <sub>6</sub>	Tributylin	282.8	5.72	0.13152E+02	-0.36684E-01	0.36795E-04	199-283
C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	Methyl tetradecanoate	293.2	3.352				
C <sub>15</sub> H <sub>31</sub> Br	1-Bromopentadecane	293.35	3.88				
C <sub>15</sub> H <sub>32</sub>	Pentadecane	293.2	2.0391	0.23792E+01	-0.11600E-02	-0.71069E-16	283-363
C <sub>15</sub> H <sub>32</sub> O	1-Pentadecanol	333.2	3.70				
C <sub>15</sub> H <sub>33</sub> N	Pentadecylamine	313.25	2.85				
C <sub>15</sub> H <sub>33</sub> N	Triisopentylamine	294.2	2.29				
C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Dibutyl phthalate	293.2	6.58	0.12444E+02	-0.20000E-01		293-333
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Hexadecanoic acid	338.2	2.417				
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Ethyl myristate	293.2	3.50	0.52642E+01	-0.60000E-02	-0.47358E-15	293-353
C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Methyl pentadecanoate	293.2	3.296				
C <sub>16</sub> H <sub>33</sub> Br	1-Bromohexadecane	298.2	3.68	0.58668E+01	-0.73333E-02	-0.52666E-14	298-328
C <sub>16</sub> H <sub>33</sub> I	1-Iodohexadecane	293.2	3.57	0.79531E+01	-0.22859E-01	0.26955E-04	293-323
C <sub>16</sub> H <sub>34</sub>	Hexadecane	293.2	2.0460	0.23861E+01	-0.11600E-02	0.25555E-15	293-363
C <sub>16</sub> H <sub>34</sub> O	1-Hexadecanol	333.2	3.69	0.85935E+01	-0.14714E-01	-0.45533E-13	333-363
C <sub>16</sub> H <sub>35</sub> N	Hexadecylamine	328.35	2.71				
C <sub>16</sub> H <sub>36</sub> Sn	Tetrabutylstannane	293.2	9.74	0.56115E+02	-0.24812E+00	0.30682E-03	293-313
C <sub>17</sub> H <sub>12</sub> O <sub>3</sub>	2-Naphthyl salicylate	293.0	6.30	0.11229E+02	-0.18857E-01	0.70332E-05	293-353
C <sub>17</sub> H <sub>34</sub> O	9-Heptadecanone	328.2	5.43	0.44176E+02	-0.21183E+00	0.28571E-03	328-363
C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	Methyl palmitate	313.2	3.124				
C <sub>17</sub> H <sub>36</sub>	Heptadecane	293.2	2.0578	0.23627E+01	-0.10400E-02	-0.10397E-12	293-308
C <sub>17</sub> H <sub>36</sub> O	1-Heptadecanol	333.2	3.41				
C <sub>18</sub> H <sub>26</sub> O <sub>4</sub>	Dipentyl phthalate	293.2	6.00				
C <sub>18</sub> H <sub>28</sub> O <sub>2</sub>	Phenyl laurate	293.2	3.28				
C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	Linolenic acid	293.2	2.825	0.33867E+01	-0.19181E-02		274-368
C <sub>18</sub> H <sub>30</sub> O <sub>4</sub>	Dicyclohexyl adipate	308.2	4.84				
C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	Linoleic acid	293.2	2.754	0.32073E+01	-0.15477E-02		275-368
C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Oleic acid	293.2	2.336	0.25385E+01	-0.69448E-03		275-368
C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	Dibutyl sebacate	293.2	4.54				
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	293.2	2.314	0.27159E+01	-0.13300E-02		293-373
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Hexadecyl acetate	308.2	3.19	0.47310E+01	-0.50000E-02	0.41338E-14	308-348
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Ethyl palmitate	303.2	3.07	0.57938E+01	-0.12294E-01	0.10919E-04	303-455
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Methyl heptadecanoate	313.2	3.07				
C <sub>18</sub> H <sub>37</sub> Br	1-Bromooctadecane	303.35	3.53	0.46790E+01	-0.30355E-02	-0.24798E-05	303-332
C <sub>18</sub> H <sub>38</sub> O	1-Octadecanol	333.2	3.38	0.73784E+01	-0.12000E-01	-0.22871E-13	333-363
C <sub>18</sub> H <sub>39</sub> BO <sub>3</sub>	Trihexyl borate	293.2	2.22				
C <sub>18</sub> H <sub>39</sub> N	Octadecylamine	326.35	2.67				
C <sub>19</sub> H <sub>16</sub>	Triphenylmethane	367.2	2.46	0.40201E+01	-0.66507E-02	0.65329E-05	367-448
C <sub>19</sub> H <sub>18</sub> O <sub>3</sub> Si	Methyltriphenoxysilane	298.2	3.628				
C <sub>19</sub> H <sub>32</sub> O <sub>2</sub>	Methyl linolenate	293.2	3.355				
C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>	Methyl linoleate	293.2	3.466				
C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	Methyl oleate	293.2	3.211				
C <sub>19</sub> H <sub>38</sub> O	10-Nonadecanone	353.2	5.37				
C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	Methyl stearate	313.2	3.021				
C <sub>19</sub> H <sub>40</sub>	Nonadecane	293.2	2.0706				
C <sub>20</sub> H <sub>30</sub> O <sub>4</sub>	Dihexyl phthalate	293.2	5.62				
C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	Ethyl oleate	301.2	3.17	0.57033E+01	-0.11223E-01	0.93447E-05	301-423
C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Octadecyl acetate	308.2	3.07	0.44569E+01	-0.45000E-02	0.33923E-14	308-348
C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Ethyl stearate	313.2	2.958	0.70930E+01	-0.19081E-01	0.19555E-04	331-440
C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Methyl nonadecanoate	313.2	2.982				
C <sub>20</sub> H <sub>42</sub> O	1-Eicosanol	338.2	3.13	0.21700E+01	0.12497E-01	-0.28571E-04	338-363
C <sub>20</sub> H <sub>42</sub> O	Didecyl ether	293.2	2.644	0.41465E+01	-0.62240E-02	0.37500E-05	293-333

Mol. form.	Name	T/K	$\epsilon_r$	<i>a</i>	<i>b</i>	<i>c</i>	Range/K
C <sub>20</sub> H <sub>60</sub> O <sub>8</sub> Si <sub>9</sub>	Eicosamethylnonasiloxane	293.2	2.645	0.57840E+01	-0.16568E-01	0.20000E-04	293-323
C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	Tricresyl phosphate*	298.2	6.7				
C <sub>21</sub> H <sub>38</sub> O <sub>6</sub>	1,2,3-Propanetriyl hexanoate	293.2	4.476				
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Butyl oleate	298.2	4.00				
C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	Butyl stearate	298.2	3.120	0.73894E+02	-0.46261E+00	0.75500E-03	298-343
C <sub>22</sub> H <sub>46</sub>	Docosane	293.2	2.0840				
C <sub>22</sub> H <sub>46</sub> O	1-Docosanol	348.2	2.94	0.82062E+01	-0.25069E-01	0.28571E-04	348-373
C <sub>24</sub> H <sub>20</sub> O <sub>4</sub> Si	Tetraphenoxysilane	333.2	3.4915				
C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	Diocetyl phthalate	293.2	5.22				
C <sub>26</sub> H <sub>50</sub> O <sub>4</sub>	Diocetyl sebacate	299.2	4.01				
C <sub>27</sub> H <sub>50</sub> O <sub>6</sub>	1,2,3-Propanetriyl octanoate	293.2	3.931				
C <sub>30</sub> H <sub>58</sub> O <sub>4</sub>	Ethylene glycol ditetradecanoate	343.2	2.98				
C <sub>30</sub> H <sub>62</sub>	Triacotane	373.2	1.9112				
C <sub>30</sub> H <sub>62</sub>	2,6,10,15,19,23-Hexamethyltetracosane	373.2	1.9106				
C <sub>34</sub> H <sub>66</sub> O <sub>4</sub>	Ethylene glycol dipalmitate	348.2	2.89				
C <sub>34</sub> H <sub>68</sub> O <sub>2</sub>	Hexadecyl stearate	333.2	2.61				
C <sub>38</sub> H <sub>74</sub> O <sub>4</sub>	Ethylene glycol distearate	353.2	2.79				
C <sub>39</sub> H <sub>74</sub> O <sub>6</sub>	Glycerol trilaurate	313.2	3.287				
C <sub>51</sub> H <sub>98</sub> O <sub>6</sub>	Glycerol tripalmitate	328.2	2.901	-0.29131E+01	0.32206E-01	-0.44154E-04	328-393
C <sub>57</sub> H <sub>104</sub> O <sub>6</sub>	Glycerol trioleate	293.2	3.109				
C <sub>57</sub> H <sub>104</sub> O <sub>6</sub>	Glycerol trielaidate	313.2	2.980				
C <sub>57</sub> H <sub>110</sub> O <sub>6</sub>	Glycerol tristearate	353.2	2.740				

\* Isomer was not specified in the original reference.

\*\* Cubic term is needed; see introduction.

## PERMITTIVITY (DIELECTRIC CONSTANT) OF GASES

This table gives the relative permittivity  $\epsilon$  (often called the dielectric constant) of some common gases at a temperature of 20 °C and pressure of one atmosphere (101.325 kPa). Values of the permanent dipole moment  $\mu$  in Debye Units (1 D =  $3.33564 \times 10^{-30}$  C m) are also included.

The density dependence of the permittivity is given by the equation

$$\frac{\epsilon - 1}{\epsilon - 2} = \rho_m \left( \frac{4\pi N\alpha}{3} + \frac{4\pi N\mu^2}{9kT} \right)$$

where  $\rho_m$  is the molar density,  $N$  is Avogadro's number,  $k$  is the Boltzmann constant,  $T$  is the temperature, and  $\alpha$  is the molecular polarizability. Therefore, in regions where the gas can be considered ideal,  $\epsilon - 1$  is approximately proportional to the pressure at constant temperature. For nonpolar gases ( $\mu = 0$ ),  $\epsilon - 1$  is inversely proportional to temperature at constant pressure.

The number of significant figures indicates the accuracy of the values given. The values of  $\epsilon$  for air, Ar, H<sub>2</sub>, He, N<sub>2</sub>, O<sub>2</sub>, and CO<sub>2</sub> are recommended as reference values; these are accurate to 1 ppm or better.

The second part of the table gives the permittivity of water vapor in equilibrium with liquid water as a function of temperature (derived from Reference 4).

### References

1. A. A. Maryott and F. Buckley, *Table of Dielectric Constants and Electric Dipole Moments of Substances in the Gaseous State*, National Bureau of Standards Circular 537, 1953.
2. B. A. Younglove, *J. Phys. Chem. Ref. Data*, 11, Suppl. 1, 1982; 16, 577, 1987 (for data on N<sub>2</sub>, H<sub>2</sub>, O<sub>2</sub>, and hydrocarbons over a range of pressure and temperature).
3. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology*, New Series, Group IV, Vol. 4, Springer-Verlag, Heidelberg, 1980 (for data at high pressures).
4. G. Birnbaum and S. K. Chatterjee, *J. Appl. Phys.*, 23, 220, 1952 (for data on water vapor).

Mol. form.	Name	$\epsilon$	$\mu/D$
<i>Compounds not containing carbon</i>			
	Air (dry, CO <sub>2</sub> free)	1.0005364	
Ar	Argon	1.0005172	0
BF <sub>3</sub>	Boron trifluoride	1.0011	0
BrH	Hydrogen bromide	1.00279	0.827
ClH	Hydrogen chloride	1.00390	1.109
F <sub>3</sub> N	Nitrogen trifluoride	1.0013	0.235
F <sub>6</sub> S	Sulfur hexafluoride	1.00200	0
HI	Hydrogen iodide	1.00214	0.448
H <sub>2</sub>	Hydrogen	1.0002538	0
H <sub>2</sub> S	Hydrogen sulfide	1.00344	0.97
H <sub>3</sub> N	Ammonia	1.00622	1.471
He	Helium	1.0000650	0
Kr	Krypton	1.00078	0
NO	Nitric oxide	1.00060	0.159
N <sub>2</sub>	Nitrogen	1.0005480	0
N <sub>2</sub> O	Nitrous oxide	1.00104	0.161
Ne	Neon	1.00013	0
O <sub>2</sub>	Oxygen	1.0004947	0
O <sub>2</sub> S	Sulfur dioxide	1.00825	1.633
O <sub>3</sub>	Ozone	1.0017	0.534
Xe	Xenon	1.00126	0

Mol. form.	Name	$\epsilon$	$\mu/D$
<i>Compounds containing carbon</i>			
CF <sub>4</sub>	Tetrafluoromethane	1.00121	0
CO	Carbon monoxide	1.00065	0.110
CO <sub>2</sub>	Carbon dioxide	1.000922	0
CH <sub>3</sub> Br	Bromomethane	1.01028	1.822
CH <sub>3</sub> Cl	Chloromethane	1.01080	1.892
CH <sub>3</sub> F	Fluoromethane	1.00973	1.858
CH <sub>3</sub> I	Iodomethane	1.00914	1.62
CH <sub>4</sub>	Methane	1.00081	0
C <sub>2</sub> H <sub>2</sub>	Acetylene	1.00124	0
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	1.0075	1.45
C <sub>2</sub> H <sub>4</sub>	Ethylene	1.00134	0
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	1.01325	2.05
C <sub>2</sub> H <sub>6</sub>	Ethane	1.00140	0
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	1.0062	1.30
C <sub>3</sub> H <sub>6</sub>	Propene	1.00228	0.366
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	1.00178	0
C <sub>3</sub> H <sub>8</sub>	Propane	1.00200	0.084
C <sub>4</sub> H <sub>10</sub>	Butane	1.00258	0
C <sub>4</sub> H <sub>10</sub>	Isobutane	1.00260	0.132

### Permittivity of Saturated Water Vapor

$t/^\circ\text{C}$	$\epsilon$	$t/^\circ\text{C}$	$\epsilon$
0	1.00006	60	1.00143
10	1.00012	70	1.00211
20	1.00021	80	1.00304
30	1.00036	90	1.00428
40	1.00059	100	1.00589
50	1.00094		

# AZEOTROPIC DATA FOR BINARY MIXTURES

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Binary homogeneous (single-phase) liquid mixtures having an extremum (maximum or minimum) vapor pressure  $P$  at constant temperature  $T$ , as a function of composition, are called azeotropic mixtures, or simply azeotropes. The composition is usually expressed as mole fractions, where  $x_1$  for component 1 in the liquid phase and  $y_1$  for component 1 in the vapor phase are identical. Mixtures that do not show a maximum or minimum are called zeotropic. A maximum (minimum) of the  $P(x_1)$  or  $P(y_1)$  curves corresponds to a minimum (maximum) of the boiling temperature  $T$  at constant  $P$ , plotted as a function of  $x_1$  or  $y_1$  [see  $T(x_1)$  and  $T(y_1)$  curves, Types I and III, in Fig.1]. Azeotropes in which the pressure is a maximum (temperature is a minimum) are often called positive azeotropes, while pressure-minimum (temperature-maximum) azeotropes are called negative azeotropes. The coordinates of an azeotropic point are the azeotropic temperature  $T_{Az}$ , pressure  $P_{Az}$ , and the vapor-phase composition  $y_{1,Az}$ , which is the same as the liquid-phase composition  $x_{1,Az}$ .

In the two-phase liquid-liquid region of partially miscible (heterogeneous) mixtures, the vapor pressure at constant  $T$  (or the boiling temperature at constant  $P$ ) is independent of the global composition  $x_1$  of the two coexisting liquid phases between the equilibrium compositions  $x_1'$  and  $x_1''$  ( $x_1' < x_1''$ ).

The constant vapor pressure (boiling temperature) above the two-phase region of certain partially miscible mixtures is usually larger (smaller) than the vapor pressure (boiling temperature) at any other liquid-phase composition in the homogeneous region. In this case, the vapor-phase composition is inside the miscibility gap. Mixtures of this type are called heteroazeotropic mixtures, or simply heteroazeotropes. (Fig. 1, Type II), as opposed to the other types of azeotropes, called homoazeotropes.

Only in a few cases partially miscible mixtures present a positive or negative azeotropic point in the single-phase region, outside the miscibility gap, similar to the azeotropic points of homogeneous mixtures (Fig. 1, Types IV and VI).

A few binary mixtures, for example the system perfluorobenzene + benzene, may present two azeotropic points at constant temperature (pressure), a positive and a negative one. They are called double azeotropic mixtures, or simply double azeotropes. (Fig. 1, Type V).

The knowledge of the occurrence of azeotropic points in binary and higher systems is of special importance for the design of distillation processes. The number of theoretical stages of a distillation column required for the separation depends on the separation factor  $\alpha_{12}$ , i.e. the ratio of the  $K_i$ -factors ( $K_i = y_i/x_i$ ) of the components  $i$  ( $i = 1, 2$ ). The required separation factor can be calculated with the following simplified relation (Reference 1):

$$\alpha_{12} = K_1/K_2 = (y_1/x_1)/(y_2/x_2) = (\gamma_1 P_1^s)/(\gamma_2 P_2^s) \quad (1)$$

where  $\gamma_i$  is the activity coefficient of component  $i$  in the liquid phase and  $P_i^s$  is the vapor pressure of the pure component  $i$ .

In distillation processes, only the difference between the separation factor and unity ( $\alpha_{12} - 1$ ) can be exploited for the separation. If the separation factor is close to unity, a large number of theoretical stages is required for the separation. If the binary system to be separated shows an azeotropic point ( $\alpha_{12} = 1$ ), the separation

is impossible by ordinary distillation, even with an infinitely large number of stages.

Following eq. (1) azeotropic behavior will always occur in homogeneous binary systems when the vapor pressure ratio  $P_1^s/P_2^s$  is equal to the ratio of the activity coefficients  $\gamma_2/\gamma_1$ .

Various thermodynamic methods based on  $g^E$ -models (Wilson, NRTL, UNIQUAC) or group contribution methods (UNIFAC, modified UNIFAC, ASOG, PSRK) can be used for either calculating or predicting the required activity coefficients for the components under given conditions of temperature and composition (Reference 2).

Because of the importance of azeotropic data for the design of distillation processes, compilations have been available in book form for quite some time (References 3-7). The most recent printed data collection was published in 1994 (Reference 8). A revised and extended version appeared in 2004 (Reference 9).

A collection of approximately 47,400 zeotropic and azeotropic data sets, compiled from 6600 references, are stored in a comprehensive computerized data bank (Reference 10). The references from the above-mentioned compilations and from the vapor-liquid equilibrium part of the Dortmund Data Bank (Reference 11) were supplemented by references found from CAS online searches, private communications, data from industry, etc.. Over 24,000 zeotropic data and over 20,000 azeotropic data are available for binary systems. Nearly 90% of the binary azeotropic data show a pressure maximum. In most cases (ca. 90%) these are homogeneous azeotropes, and in approximately 7-8% of the cases heterogeneous azeotropes are reported. Less than 10% of the data stored show a pressure minimum. Approximately 21,000 of the data sets stored were published after 1970.

The table below provides information about azeotropes for 808 selected binary systems. Compounds are listed in the modified Hill order, with carbon-containing compounds following those compounds not containing carbon. In columns 1 and 2 are the molecular formulas of components 1 and 2 written in the Hill convention. In column 3 the names of the components are given, either a systematic IUPAC name or a name in ubiquitous use. Columns 4, 5, and 6 contain the azeotropic coordinates of the mixtures: temperature  $T_{Az}$ , pressure  $P_{Az}$ , and vapor-phase composition  $y_{1,Az}$ . The explanation of the type of azeotrope (column 7) is given by the following codes:

- O: homogeneous azeotrope in a completely miscible system
- L: homogeneous azeotrope in a partially miscible system
- E: heterogeneous azeotrope
- X: pressure maximum
- N: pressure minimum
- D: double azeotrope
- C: system contains a supercritical compound

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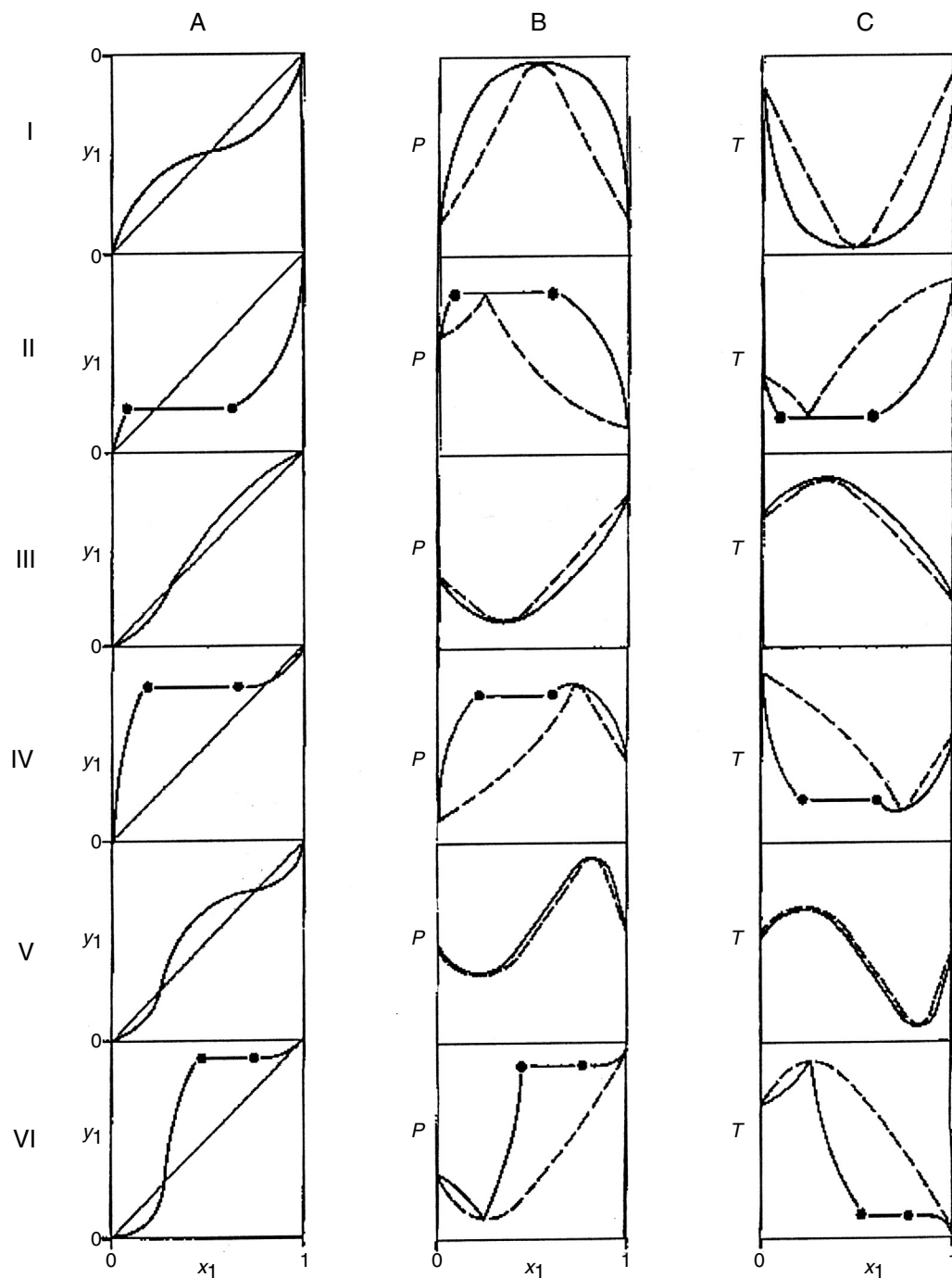


Figure 1 Different types of binary azeotropic systems: I - homogeneous pressure-maximum azeotrope in a completely miscible system (OX); II - heterogeneous pressure-maximum azeotrope (EX); III - homogeneous pressure-minimum azeotrope in a completely miscible system (ON); IV - homogeneous pressure-maximum azeotrope in a partially miscible system (LX); V - D: double azeotrope (OND, OXD); VI - homogeneous pressure-minimum azeotrope in a partially miscible system (LN). A -  $y_1(x_1)$ ; B -  $P(x_1)$  and  $P(y_1)$ ; C -  $T(x_1)$  and  $T(y_1)$ . Continuous line -  $(x_1)$ ; Dashed line -  $(y_1)$ .

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Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
<b>AlCl<sub>3</sub></b>		<b>Aluminum chloride</b>				
	Cl <sub>3</sub> OP	Phosphoryl trichloride	660.15	0.5150	101.33	ONC
<b>ClH</b>		<b>Hydrogen chloride</b>				
	H <sub>2</sub> O	Water	389.34	0.1083	133.32	ONC
<b>Cl<sub>2</sub>OS</b>		<b>Thionyl chloride</b>				
	Cl <sub>3</sub> P	Phosphorus(III) chloride	345.85	0.4200	101.33	OX
<b>Cl<sub>2</sub>O<sub>2</sub>S</b>		<b>Sulfuryl chloride</b>				
	Cl <sub>3</sub> P	Phosphorus(III) chloride	364.15	0.5000	101.33	ON
<b>Cl<sub>3</sub>OP</b>		<b>Phosphoryl trichloride</b>				
	Cl <sub>5</sub> Nb	Niobium(V) chloride	536.15	0.4020	101.33	ON
	Cl <sub>5</sub> Ta	Tantalum(V) chloride	558.85	0.4650	101.33	ON
<b>Cl<sub>4</sub>Ge</b>		<b>Germanium(IV) chloride</b>				
	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	350.75	0.4630	101.33	OX
<b>Cl<sub>4</sub>Si</b>		<b>Tetrachlorosilane</b>				
	C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	321.05	0.6900	101.33	EX
<b>Cl<sub>5</sub>Mo</b>		<b>Molybdenum(V) chloride</b>				
	Cl <sub>6</sub> W	Tungsten(VI) chloride	274.70	0.9750	101.33	OX
<b>FH</b>		<b>Hydrogen fluoride</b>				
	H <sub>2</sub> O	Water	382.15	0.3508	101.33	ON
	CCl <sub>3</sub> F	Trichlorofluoromethane	283.15	0.7840	129.45	EX
<b>HNO<sub>3</sub></b>		<b>Nitric acid</b>				
	H <sub>2</sub> O	Water	393.20	0.3820	101.33	ON
<b>H<sub>2</sub>O</b>		<b>Water</b>				
	CHCl <sub>3</sub>	Trichloromethane	329.27	0.1603	101.33	EX
	CH <sub>2</sub> O	Formaldehyde	355.75	0.9300	53.33	OX
	CH <sub>2</sub> O <sub>2</sub>	Formic acid	380.35	0.4272	101.33	ON
	CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	356.90	0.5160	101.33	EX
	C <sub>2</sub> HCl <sub>3</sub>	Trichloroethene	346.55	0.3560	101.33	EX
	C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	349.95	0.3100	101.33	OX
	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	345.43	0.3570	101.33	EX
	C <sub>2</sub> H <sub>6</sub> O	Ethanol	351.25	0.1030	101.33	OX
	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	391.85	0.4450	101.33	ON
	C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile	344.05	0.2850	101.33	EX
	C <sub>3</sub> H <sub>4</sub> O	Acrolein	325.45	0.0730	101.33	LX
	C <sub>3</sub> H <sub>6</sub> O	Propanal	320.65	0.0600	101.33	LX
	C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	361.15	0.5562	101.33	OX
	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	330.05	0.1060	103.62	LX
	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1,3-Dioxolane	344.95	0.2520	101.30	OX
	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	325.75	0.0700	101.33	EX
	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	373.05	0.9500	101.33	OX
	C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	336.35	0.2210	101.33	EX
	C <sub>3</sub> H <sub>8</sub> O	1-Propanol	360.80	0.5680	101.33	OX
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	353.70	0.3260	101.33	OX
	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyethanol	372.65	0.9441	99.99	OX
	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Dimethoxymethane	315.05	0.0269	101.38	LX
	C <sub>4</sub> H <sub>5</sub> N	<i>cis</i> -2-Butenenitrile	358.45	0.3832	101.33	EX
	C <sub>4</sub> H <sub>5</sub> N	<i>trans</i> -2-Butenenitrile	363.05	0.6843	101.33	EX
	C <sub>4</sub> H <sub>5</sub> N	Pyrrole	348.15	0.7514	50.13	EX
	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid	372.25	0.9464	98.93	OX
	C <sub>4</sub> H <sub>8</sub> O	2-Butanone	346.54	0.3480	101.33	LX
	C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	336.67	0.1828	101.33	OX
	C <sub>4</sub> H <sub>8</sub> O	Isobutanal	332.80	0.1698	100.99	EX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	343.55	0.2990	101.33	EX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid	372.95	0.9559	101.33	OX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	360.65	0.5280	101.33	OX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	344.85	0.3090	101.33	EX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	344.75	0.3050	101.33	EX
	C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	353.95	0.4950	101.33	EX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>4</sub> H <sub>9</sub> Br	1-Bromo-2-methylpropane	348.45	0.3730	101.33	EX
	C <sub>4</sub> H <sub>9</sub> Cl	1-Chloro-2-methylpropane	333.95	0.1970	101.33	LX
	C <sub>4</sub> H <sub>10</sub> O	1-Butanol	365.45	0.7540	101.33	EX
	C <sub>4</sub> H <sub>10</sub> O	2-Butanol	360.50	0.6200	101.33	LX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	353.00	0.4011	101.33	OX
	C <sub>4</sub> H <sub>11</sub> N	Butylamine	349.85	0.0700	101.33	OX
	C <sub>5</sub> H <sub>5</sub> N	Pyridine	367.30	0.7500	101.33	OX
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	305.85	0.0520	101.33	EX
	C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane	313.15	0.0212	101.30	EX
	C <sub>5</sub> H <sub>8</sub> O	Cyclopropyl methyl ketone	361.65	0.7060	101.19	EX
	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	354.45	0.4996	101.33	EX
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	309.75	0.0650	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-buten-1-ol	369.55	0.9141	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O	3-Methyl-3-buten-1-ol	333.15	0.8680	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O	2-Methyl-3-buten-2-ol	359.25	0.5770	101.33	LX
	C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	356.05	0.4750	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate	349.75	0.3960	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	355.91	0.5228	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	356.95	0.5360	101.33	EX
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isobutyl formate	352.75	0.4460	101.33	EX
	C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	367.97	0.8265	101.33	EX
	C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol	360.85	0.6355	101.75	EX
	C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	369.08	0.8633	101.33	EX
	C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	363.15	0.7550	92.49	EX
	C <sub>6</sub> H <sub>6</sub>	Benzene	342.35	0.2980	101.33	EX
	C <sub>6</sub> H <sub>7</sub> N	Aniline	372.55	0.9580	101.33	EX
	C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	370.50	0.8972	101.33	OX
	C <sub>6</sub> H <sub>10</sub>	Cyclohexene	343.95	0.3090	101.33	EX
	C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	369.45	0.8694	101.33	EX
	C <sub>6</sub> H <sub>10</sub> O	Methyl-dihydropyran (unspecified isomer)	360.75	0.5841	100.93	EX
	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	4-Vinyl-1,3-dioxane	367.65	0.8955	101.33	EX
	C <sub>6</sub> H <sub>12</sub>	1-Hexene	318.15	0.1510	63.35	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	363.35	0.7013	101.33	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate	361.05	0.6440	101.33	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4,4-Dimethyl-1,3-dioxane	366.00	0.7779	101.33	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4,5-Dimethyl-1,3-dioxane (unspecified isomer)	365.05	0.7966	101.50	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4-Ethyl-1,3-dioxane	365.75	0.7257	101.30	EX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol	370.00	0.9900	90.79	OX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Propyl propanoate	362.05	0.6600	101.33	EX
	C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	369.55	0.8692	101.33	OX
	C <sub>6</sub> H <sub>14</sub>	Hexane	334.75	0.2110	101.33	EX
	C <sub>6</sub> H <sub>14</sub> O	Butyl ethyl ether	349.85	0.4070	101.33	EX
	C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	367.89	0.9432	101.33	EX
	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Di(ethylene glycol) dimethyl ether	372.70	0.9679	101.33	OX
	C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine	347.25	0.3654	101.33	EX
	C <sub>6</sub> H <sub>15</sub> N	Dipropylamine	359.00	0.6046	101.33	EX
	C <sub>7</sub> H <sub>8</sub>	Toluene	357.25	0.5230	101.33	EX
	C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	373.05	0.9840	101.33	EX
	C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	369.17	0.8647	101.33	EX
	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	1,2-Propanediol diacetate	358.15	0.9740	59.41	EX
	C <sub>7</sub> H <sub>14</sub>	1-Heptene	350.20	0.4100	101.33	EX
	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Isopentyl acetate	367.05	0.7990	101.46	EX
	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Butyl propanoate	367.95	0.8340	101.33	EX
	C <sub>7</sub> H <sub>16</sub>	Heptane	352.35	0.4510	101.33	EX
	C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	371.99	0.9703	101.33	EX
	C <sub>8</sub> H <sub>8</sub>	Styrene	367.15	0.8000	101.33	EX
	C <sub>8</sub> H <sub>8</sub> O	Acetophenone	371.15	0.9675	101.19	EX
	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	365.15	0.7667	101.33	EX



Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	$C_8H_{10}$	<i>p</i> -Xylene	365.15	0.7450	101.33	EX
	$C_8H_{10}$	Ethylbenzene	364.15	0.7221	101.33	EX
	$C_8H_{16}O_2$	Butyl butanoate	369.85	0.9110	101.33	EX
	$C_8H_{18}$	Octane	362.75	0.6850	101.33	EX
	$C_8H_{18}$	2,2,4-Trimethylpentane	351.95	0.4420	101.33	EX
	$C_8H_{18}O$	Dibutyl ether	368.65	0.7628	101.33	EX
	$C_8H_{18}O$	1-Octanol	372.75	0.9820	101.33	EX
	$C_8H_{19}N$	Dibutylamine	370.05	0.8850	101.33	EX
	$C_9H_{10}$	Isopropenylbenzene	369.95	0.8880	101.33	EX
	$C_9H_{12}$	Isopropylbenzene	368.15	0.8340	101.33	EX
	$C_9H_{12}O$	2-Phenyl-2-propanol	371.25	0.9718	101.33	EX
	$C_9H_{20}$	Nonane	367.95	0.8280	101.33	EX
	$C_9H_{20}O$	1-Nonanol	373.00	0.9846	101.33	EX
	$C_{10}H_{22}$	Decane	370.75	0.9180	101.33	EX
	$C_{10}H_{22}O$	1-Decanol	373.13	0.9865	101.33	EX
	$C_{12}H_{27}N$	Tributylamine	372.80	0.9762	101.46	EX
<b>CCl<sub>4</sub></b>		<b>Tetrachloromethane</b>				
	$C_2H_6O$	Ethanol	338.19	0.6140	101.33	OX
	$C_3H_6O$	Acetone	341.25	0.0337	149.93	OX
	$C_3H_8O$	1-Propanol	346.28	0.8032	101.33	OX
	$C_3H_8O$	2-Propanol	341.83	0.6686	101.33	OX
	$C_4H_6O$	2-Butenal	348.15	0.6500	97.86	OX
	$C_4H_6O$	2-Methylpropenal	339.15	0.6000	97.86	OX
	$C_4H_8O$	2-Butanone	346.99	0.6630	101.33	OX
	$C_4H_8O_2$	Ethyl acetate	347.95	0.5700	101.33	OX
	$C_4H_{10}O$	1-Butanol	349.71	0.9500	101.33	OX
	$C_4H_{10}O$	2-Methyl-1-propanol	348.95	0.9080	101.33	OX
	$C_5H_{10}O$	2-Methyl-3-buten-2-ol	348.45	0.9009	101.06	OX
<b>CS<sub>2</sub></b>		<b>Carbon disulfide</b>				
	$CH_4O$	Methanol	310.65	0.7000	101.33	LX
<b>CHCl<sub>3</sub></b>		<b>Trichloromethane</b>				
	$CH_4O$	Methanol	328.15	0.6480	107.99	OX
	$C_2H_6O$	Ethanol	332.45	0.8410	101.33	OX
	$C_3H_6O$	Acetone	337.58	0.6398	101.33	ON
	$C_3H_6O_2$	Methyl acetate	337.51	0.6760	101.33	ON
	$C_3H_8O$	2-Propanol	334.15	0.9500	101.33	OX
	$C_4H_6O$	2-Butenal	329.15	0.9950	97.86	OX
	$C_6H_{12}$	2-Methyl-1-pentene	333.95	0.6235	101.19	OX
	$C_6H_{14}$	Hexane	333.45	0.7840	101.33	OX
<b>CHN</b>		<b>Hydrogen cyanide</b>				
	$C_3H_5Cl$	3-Chloropropene	296.45	0.8016	101.33	OX
<b>CH<sub>2</sub>Cl<sub>2</sub></b>		<b>Dichloromethane</b>				
	$C_2H_6O$	Ethanol	312.05	0.9600	101.33	OX
<b>CH<sub>2</sub>O<sub>2</sub></b>		<b>Formic acid</b>				
	$C_2H_4Cl_2$	1,2-Dichloroethane	350.17	0.4275	101.33	OX
	$C_5H_{10}O_2$	Butyl formate	372.15	0.8700	101.33	OX
	$C_8H_{10}$	<i>m</i> -Xylene	365.95	0.8545	101.33	EX
<b>CH<sub>3</sub>NO<sub>2</sub></b>		<b>Nitromethane</b>				
	$C_2H_6O$	Ethanol	333.15	0.2850	53.61	OX
	$C_3H_7Br$	1-Bromopropane	343.25	0.1020	99.82	OX
	$C_4H_8O_2$	1,4-Dioxane	373.25	0.4101	101.48	OX
	$C_5H_{10}$	2-Methyl-2-butene	311.15	0.0570	101.33	LX
	$C_7H_{14}$	Methylcyclohexane	354.85	0.5123	101.33	EX
	$C_7H_{16}$	Heptane	353.25	0.4790	101.33	EX
	$C_8H_{18}$	Octane	363.38	0.6964	99.73	EX
	$C_9H_{20}$	Nonane	369.29	0.8403	99.73	EX
	$C_{10}H_{22}$	Decane	371.96	0.9239	99.73	EX
	$C_{11}H_{24}$	Undecane	373.16	0.9619	99.73	EX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	$C_{12}H_{26}$	Dodecane	373.75	0.9846	99.73	EX
$CH_4O$		<b>Methanol</b>				
	$C_2HBrClF_3$	2-Bromo-2-chloro-1,1,1-trifluoroethane	317.25	0.1890	93.33	OX
	$C_2H_5Br$	Bromoethane	308.05	0.1610	101.33	OX
	$C_3H_5Cl$	3-Chloropropene	312.15	0.2570	100.39	OX
	$C_3H_6O$	Acetone	328.29	0.2400	101.33	OX
	$C_3H_6O_2$	Methyl acetate	328.15	0.3480	107.19	OX
	$C_3H_6O_2$	1,3-Dioxolane	334.66	0.6910	101.30	OX
	$C_3H_6O_2$	Ethyl formate	318.15	0.3000	81.34	OX
	$C_3H_6O_3$	Dimethyl carbonate	337.25	0.8504	102.52	OX
	$C_3H_7Cl$	1-Chloropropane	313.35	0.2500	101.59	OX
	$C_4H_4F_6O$	Bis(2,2,2-trifluoroethyl) ether	326.28	0.4450	101.30	OX
	$C_4H_6O_2$	Vinyl acetate	332.05	0.6182	101.33	OX
	$C_4H_8O$	2-Butanone	323.15	0.8020	58.80	OX
	$C_4H_8O$	Tetrahydrofuran	332.75	0.5040	101.33	OX
	$C_4H_8O_2$	Ethyl acetate	335.66	0.7120	101.33	OX
	$C_4H_{10}O$	Diethyl ether	305.15	0.0500	93.33	OX
	$C_4H_{10}O_2$	Dimethylacetal	330.35	0.4700	101.33	OX
	$C_5H_3F_9O$	1,1,1,2,3,3-Hexafluoro-3-(2,2,2-trifluoroethoxy)propane	330.67	0.5600	101.30	OX
	$C_5H_6$	1,3-Cyclopentadiene	309.05	0.2120	101.33	OX
	$C_5H_8$	2-Methyl-1,3-butadiene	303.55	0.1670	101.33	OX
	$C_5H_8$	Methylenecyclobutane	309.05	0.2190	101.33	OX
	$C_5H_8$	1-Methylcyclobutene	304.85	0.1900	101.33	OX
	$C_5H_8$	<i>cis</i> -1,3-Pentadiene	311.10	0.2300	101.33	OX
	$C_5H_8$	<i>trans</i> -1,3-Pentadiene	309.65	0.2110	101.33	OX
	$C_5H_{10}$	2-Methyl-1-butene	300.55	0.1720	101.33	OX
	$C_5H_{10}$	3-Methyl-1-butene	291.05	0.0890	101.33	OX
	$C_5H_{10}$	2-Methyl-2-butene	306.25	0.2160	101.33	OX
	$C_5H_{10}$	1-Pentene	300.05	0.1469	102.47	OX
	$C_5H_{10}O$	2,3-Epoxy-2-methylbutane	334.95	0.6590	101.33	OX
	$C_5H_{12}$	Isopentane	297.05	0.0930	101.33	OX
	$C_5H_{12}$	Pentane	303.20	0.1930	101.30	OX
	$C_5H_{12}O$	Butyl methyl ether	330.00	0.5515	100.08	OX
	$C_5H_{12}O$	Methyl <i>tert</i> -butyl ether	325.00	0.3140	103.15	OX
	$C_5H_{12}O$	Ethyl propyl ether	330.00	0.4050	112.25	OX
	$C_5H_{12}O_2$	Diethoxymethane	336.03	0.8127	101.52	OX
	$C_5H_{12}O_2$	2,2-Dimethoxypropane	334.15	0.7250	100.00	OX
	$C_5H_{14}N_2$	<i>N,N,N',N'</i> -Tetramethylmethanedi-amine	335.15	0.7670	101.33	OX
	$C_6F_6$	Hexafluorobenzene	318.15	0.6100	61.73	OX
	$C_6H_5F$	Fluorobenzene	333.35	0.6625	101.62	OX
	$C_6H_6$	Benzene	331.56	0.6090	101.33	OX
	$C_6H_{12}$	Cyclohexane	328.75	0.6090	106.66	OX
	$C_6H_{12}$	2-Methyl-1-pentene	330.00	0.4517	141.80	OX
	$C_6H_{14}$	2,3-Dimethylbutane	313.15	0.3620	85.50	OX
	$C_6H_{14}$	Hexane	333.15	0.5160	149.64	OX
	$C_6H_{14}O$	<i>tert</i> -Butyl ethyl ether	330.95	0.6002	101.54	OX
	$C_6H_{14}O$	Diisopropyl ether	330.00	0.5390	101.61	OX
	$C_6H_{14}O$	Butyl ethyl ether	335.00	0.8010	98.84	OX
	$C_6H_{14}O$	2-Methoxy-2-methylbutane	335.55	0.7735	101.69	OX
	$C_7H_8$	Toluene	336.65	0.8820	101.33	OX
	$C_7H_{14}$	Methylcyclohexane	333.15	0.7520	102.87	EX
	$C_7H_{16}$	Heptane	331.95	0.7279	101.33	OX
	$C_7H_{16}O$	2-Ethoxy-2-methylbutane	335.15	0.8736	97.28	OX
	$C_8H_{18}$	Octane	335.55	0.8830	101.33	LX
	$C_9H_{20}$	Nonane	337.25	0.9526	101.33	OX
$C_2Cl_3F_3$		<b>1,1,2-Trichloro-1,2,2-trifluoroethane</b>				
	$C_2H_3F_3O$	2,2,2-Trifluoroethanol	316.58	0.7770	101.33	EX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>2</sub> H <sub>6</sub> O	Ethanol	317.75	0.8456	101.42	OX
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	319.35	0.9159	100.95	OX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	319.95	0.9426	101.09	OX
C <sub>2</sub> Cl <sub>4</sub>		<b>Tetrachloroethene</b>				
	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane	385.95	0.2115	101.33	OX
	C <sub>8</sub> H <sub>16</sub>	1-Octene	393.15	0.5900	101.33	OX
	C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -4-Octene	393.65	0.7100	101.33	OX
	C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -4-Octene	393.45	0.6700	101.33	OX
	C <sub>8</sub> H <sub>18</sub>	Octane	371.90	0.8781	53.44	OX
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>		<b>1,1,2,2-Tetrachloro-1,2-difluoroethane</b>				
	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	353.80	0.2700	101.33	OX
C <sub>2</sub> HBrClF <sub>3</sub>		<b>2-Bromo-2-chloro-1,1,1-trifluoroethane</b>				
	C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	323.65	0.7200	93.33	ON
C <sub>2</sub> HCl <sub>3</sub>		<b>Trichloroethene</b>				
	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	355.35	0.3324	101.36	OX
	C <sub>2</sub> H <sub>6</sub> O	Ethanol	343.85	0.4741	101.33	OX
	C <sub>4</sub> H <sub>6</sub> O	2-Butenal	360.15	0.9000	97.86	OX
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	353.40	0.0975	101.32	OX
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>		<b><i>trans</i>-1,2-Dichloroethene</b>				
	C <sub>3</sub> H <sub>3</sub> F <sub>9</sub> O	1,1,1,2,3,3-Hexafluoro-3-(2,2,2-trifluoroethoxy)propane	318.50	0.8390	101.30	OX
C <sub>2</sub> H <sub>3</sub> N		<b>Acetonitrile</b>				
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	348.15	0.5287	100.81	OX
	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	344.65	0.1948	98.33	OX
	C <sub>4</sub> H <sub>8</sub> O	2-Butanone	352.15	0.3195	101.15	OX
	C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	338.95	0.0784	101.13	OX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	333.15	0.6200	56.93	OX
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	306.75	0.0410	101.33	OX
	C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane	312.45	0.1450	101.33	OX
	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	355.25	0.9866	102.07	OX
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	308.95	0.1320	101.33	OX
	C <sub>5</sub> H <sub>10</sub>	1-Pentene	301.85	0.0830	101.33	OX
	C <sub>5</sub> H <sub>12</sub>	Isopentane	298.45	0.1040	101.33	EX
	C <sub>6</sub> H <sub>6</sub>	Benzene	328.15	0.4560	54.65	OX
	C <sub>6</sub> H <sub>14</sub> O	2-Methoxy-2-methylbutane	346.13	0.5835	100.56	OX
	C <sub>7</sub> H <sub>16</sub> O	2-Ethoxy-2-methylbutane	348.85	0.7219	98.99	OX
	C <sub>10</sub> H <sub>20</sub>	1-Decene	354.55	0.9924	100.51	OX
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>		<b>1,1-Dichloroethane</b>				
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	329.55	0.8928	101.60	OX
	C <sub>6</sub> H <sub>14</sub>	Hexane	329.30	0.8025	101.21	OX
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>		<b>1,2-Dichloroethane</b>				
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	347.25	0.5258	100.32	OX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	356.05	0.9173	101.26	OX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	349.45	0.5336	101.43	OX
	C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	354.65	0.8036	101.21	OX
	C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	343.15	0.7600	73.13	OX
C <sub>2</sub> H <sub>4</sub> O		<b>Acetaldehyde</b>				
	C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	268.15	0.0520	101.33	OX
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	292.23	0.8140	101.33	OX
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>		<b>Acetic acid</b>				
	C <sub>5</sub> H <sub>5</sub> N	Pyridine	411.25	0.5780	101.33	ON
	C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol	392.65	0.7210	101.33	ON
	C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	417.27	0.5120	101.33	ON
	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Vinyl butanoate	386.45	0.5750	101.33	OX
	C <sub>6</sub> H <sub>14</sub>	Hexane	341.40	0.0839	101.33	OX
	C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine	435.45	0.3022	101.33	ON
	C <sub>7</sub> H <sub>16</sub>	Heptane	364.95	0.4490	101.33	OX
	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	389.75	0.8640	101.33	OX

Molecular formula							
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type	
	$C_8H_{10}$	<i>p</i> -Xylene	388.40	0.8200	101.33	OX	
	$C_8H_{18}$	Octane	378.85	0.6870	101.33	OX	
	$C_9H_{20}$	Nonane	386.05	0.8250	101.33	OX	
	$C_{10}H_{22}$	Decane	390.05	0.9250	101.33	OX	
	$C_{11}H_{24}$	Undecane	391.15	0.9720	101.33	OX	
$C_2H_4O_2$		<b>Methyl formate</b>					
	$C_2H_5Br$	Bromoethane	303.05	0.7360	101.33	OX	
	$C_4H_{10}O$	Diethyl ether	301.55	0.6030	101.33	OX	
	$C_5H_8$	2-Methyl-1,3-butadiene	298.90	0.5150	101.33	OX	
	$C_5H_{10}$	2-Methyl-2-butene	297.75	0.5760	101.33	OX	
	$C_5H_{12}$	Isopentane	291.55	0.4920	101.33	OX	
	$C_5H_{12}$	Pentane	294.85	0.5740	101.33	OX	
	$C_6H_{14}$	Hexane	302.65	0.8490	101.33	OX	
$C_2H_5Br$		<b>Bromoethane</b>					
	$C_5H_{10}$	2-Methyl-2-butene	308.55	0.5110	101.33	OX	
	$C_5H_{12}$	Isopentane	300.55	0.2180	101.33	OX	
$C_2H_5NO_2$		<b>Nitroethane</b>					
	$C_4H_{10}O$	2-Methyl-1-propanol	375.81	0.4080	101.33	OX	
	$C_7H_{16}$	Heptane	362.95	0.3520	101.33	OX	
$C_2H_6O$		<b>Ethanol</b>					
	$C_3H_3N$	Acrylonitrile	343.95	0.4440	101.33	OX	
	$C_3H_6O_2$	Methyl acetate	329.79	0.0362	101.33	OX	
	$C_4H_3F_7O$	1,1,2,2-Tetrafluoroethyl 1,1,1-trifluoroethyl ether	326.67	0.2000	101.30	OX	
	$C_4H_4F_6O$	Bis(2,2,2-trifluoroethyl) ether	331.90	0.2840	101.30	OX	
	$C_4H_8O$	Butanal	345.45	0.3690	101.33	OX	
	$C_4H_8O$	2-Butanone	347.15	0.5080	101.33	OX	
	$C_4H_8O$	Tetrahydrofuran	344.95	0.1290	125.00	OX	
	$C_4H_8O_2$	Ethyl acetate	344.85	0.4590	101.33	OX	
	$C_4H_8O_2$	1,4-Dioxane	351.33	0.9480	101.33	OX	
	$C_4H_8O_2$	Methyl propanoate	346.30	0.5140	103.91	OX	
	$C_4H_{11}N$	Butylamine	354.99	0.5900	101.33	ON	
	$C_5H_3F_9O$	1,1,1,2,3,3-Hexafluoro-3-(2,2,2-trifluoroethoxy)propane	337.88	0.3980	101.30	OX	
	$C_5H_8$	2-Methyl-1,3-butadiene	305.95	0.1500	101.33	OX	
	$C_5H_8$	Cyclopentene	323.40	0.1440	134.00	OX	
	$C_5H_{10}$	2-Methyl-2-butene	309.79	0.0795	101.33	OX	
	$C_5H_{10}$	Cyclopentane	323.44	0.1800	121.00	OX	
	$C_5H_{10}O$	2,3-Epoxy-2-methylbutane	343.45	0.2930	101.33	OX	
	$C_5H_{10}O$	3-Methyl-2-butanone	350.85	0.8250	101.33	OX	
	$C_5H_{10}O$	2-Pentanone	351.15	0.9779	100.50	OX	
	$C_5H_{10}O$	3-Pentanone	351.33	0.9590	101.33	OX	
	$C_5H_{10}O_2$	Isopropyl acetate	349.85	0.7010	101.33	OX	
	$C_5H_{10}O_2$	Methyl butanoate	346.30	0.8800	83.88	OX	
	$C_5H_{12}$	Isopentane	299.95	0.0540	101.33	OX	
	$C_5H_{12}$	Pentane	307.15	0.0537	101.33	OX	
	$C_5H_{12}O$	Methyl <i>tert</i> -butyl ether	327.75	0.0380	101.33	OX	
	$C_5H_{12}O_2$	Diethoxymethane	348.30	0.6497	102.35	OX	
	$C_6H_5F$	Fluorobenzene	343.85	0.4752	101.54	OX	
	$C_6H_6$	Benzene	341.25	0.4600	101.33	OX	
	$C_6H_{12}$	Cyclohexane	337.95	0.4540	102.26	OX	
	$C_6H_{14}$	Hexane	331.65	0.3410	101.33	OX	
	$C_6H_{14}O$	<i>tert</i> -Butyl ethyl ether	339.95	0.3728	101.72	OX	
	$C_6H_{14}O$	2-Methoxy-2-methylbutane	346.81	0.5820	101.32	OX	
	$C_7H_8$	Toluene	349.75	0.8152	101.33	OX	
	$C_7H_{16}O$	2-Ethoxy-2-methylbutane	349.35	0.7644	101.54	OX	
	$C_8H_{18}$	Octane	349.85	0.8250	101.33	OX	
	$C_8H_{18}$	2,2,4-Trimethylpentane	344.42	0.6450	101.33	OX	

Molecular formula							
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type	
	C <sub>9</sub> H <sub>20</sub>	Nonane	351.35	0.9400	101.33	OX	
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>		<b>1,2-Ethanediol</b>					
	C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	Di(ethylene glycol) monomethyl ether	463.95	0.4388	101.33	OX	
	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Di(ethylene glycol) monoethyl ether	467.15	0.6480	101.33	OX	
	C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	462.67	0.3797	101.33	OX	
	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	Di(ethylene glycol) monoisopropyl ether	466.35	0.6964	101.33	OX	
	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	Di(ethylene glycol) monopropyl ether	468.55	0.8448	101.33	OX	
	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	Di(propylene glycol) monomethyl ether (unspecified isomer)	457.65	0.3500	101.33	OX	
	C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine	443.65	0.1734	101.33	OX	
	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Di(ethylene glycol) monobutyl ether	469.15	0.9102	101.33	OX	
	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Di(ethylene glycol) monoisobutyl ether	467.55	0.8355	101.33	OX	
	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Di(propylene glycol) monoethyl ether (unspecified isomer)	458.65	0.4800	101.33	OX	
	C <sub>9</sub> H <sub>20</sub> O <sub>3</sub>	Di(propylene glycol) monopropyl ether (unspecified isomer)	463.15	0.6590	101.33	OX	
	C <sub>10</sub> H <sub>22</sub> O <sub>3</sub>	Di(propylene glycol) monobutyl ether (unspecified isomer)	465.75	0.8130	101.33	OX	
C <sub>3</sub> H <sub>3</sub> N		<b>Acrylonitrile</b>					
	C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane	313.80	0.1275	101.33	OX	
	C <sub>6</sub> H <sub>6</sub>	Benzene	347.45	0.5575	101.46	OX	
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	337.75	0.4836	101.94	OX	
	C <sub>6</sub> H <sub>14</sub>	Hexane	330.90	0.4048	101.05	OX	
C <sub>3</sub> H <sub>4</sub> O		<b>Acrolein</b>					
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	306.45	0.1980	101.33	OX	
C <sub>3</sub> H <sub>6</sub> O		<b>Propanal</b>					
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	306.35	0.1700	101.33	OX	
	C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane	311.30	0.3600	101.33	OX	
C <sub>3</sub> H <sub>6</sub> O		<b>Acetone</b>					
	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	328.85	0.6470	101.33	OX	
	C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	328.75	0.9915	99.75	OX	
	C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	328.85	0.9603	100.35	OX	
	C <sub>4</sub> H <sub>9</sub> Cl	2-Chloro-2-methylpropane	322.05	0.1944	102.11	OX	
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	306.95	0.0610	101.33	OX	
	C <sub>5</sub> H <sub>8</sub>	Methylenecyclobutane	311.25	0.2800	101.33	OX	
	C <sub>5</sub> H <sub>8</sub>	1-Methylcyclobutene	307.75	0.2220	101.33	OX	
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene	303.25	0.1400	101.33	OX	
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	308.75	0.2440	101.33	OX	
	C <sub>5</sub> H <sub>12</sub>	Isopentane	298.75	0.1730	101.33	OX	
	C <sub>5</sub> H <sub>12</sub> O	Methyl <i>tert</i> -butyl ether	324.35	0.4824	102.19	OX	
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	330.05	0.7590	109.32	OX	
	C <sub>6</sub> H <sub>12</sub>	1-Hexene	323.35	0.5973	101.40	OX	
	C <sub>6</sub> H <sub>12</sub>	2-Methyl-1-pentene	333.40	0.5793	140.60	OX	
	C <sub>6</sub> H <sub>14</sub>	Hexane	322.95	0.6480	101.33	OX	
	C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether	327.10	0.7424	100.17	OX	
	C <sub>6</sub> H <sub>15</sub> N	Triethylamine	318.15	0.9800	68.13	OX	
	C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	318.15	0.9500	68.66	OX	
C <sub>3</sub> H <sub>6</sub> O		<b>Allyl alcohol</b>					
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	367.65	0.5597	99.79	OX	
	C <sub>6</sub> H <sub>6</sub>	Benzene	349.90	0.2203	101.33	OX	
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	333.15	0.2790	63.98	OX	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>		<b>Methyl acetate</b>					
	C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	329.60	0.9727	99.56	OX	
	C <sub>6</sub> H <sub>10</sub>	Cyclohexene	330.35	0.9121	102.87	OX	
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	328.65	0.8000	101.33	OX	
	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	325.85	0.6917	99.50	OX	
	C <sub>6</sub> H <sub>12</sub>	1-Hexene	323.15	0.6340	92.08	OX	
	C <sub>6</sub> H <sub>12</sub>	2-Methyl-1-pentene	325.15	0.5931	100.38	OX	

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>6</sub> H <sub>14</sub>	Hexane	326.65	0.6590	106.66	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	323.15	0.9570	79.48	OX
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>		<b>Ethyl formate</b>				
	C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	326.15	0.7090	101.33	OX
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	323.15	0.8210	91.46	OX
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>		<b>Propanoic acid</b>				
	C <sub>5</sub> H <sub>5</sub> N	Pyridine	421.75	0.6860	101.33	ON
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>		<b>Dimethyl carbonate</b>				
	C <sub>3</sub> H <sub>12</sub> O <sub>2</sub>	Diethoxymethane	358.71	0.4437	100.42	OX
	C <sub>6</sub> H <sub>6</sub>	Benzene	353.50	0.1366	100.48	OX
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	346.95	0.3780	101.49	OX
	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	342.35	0.2680	103.46	OX
	C <sub>6</sub> H <sub>14</sub>	Hexane	338.15	0.2540	98.46	OX
	C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	356.45	0.5044	100.73	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	355.15	0.5930	99.67	OX
C <sub>3</sub> H <sub>7</sub> Br		<b>1-Bromopropane</b>				
	C <sub>3</sub> H <sub>8</sub> O	2-Propanol	339.15	0.7349	99.97	OX
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	343.35	0.9219	98.84	OX
C <sub>3</sub> H <sub>7</sub> NO		<b>N,N-Dimethylformamide</b>				
	C <sub>7</sub> H <sub>16</sub>	Heptane	370.15	0.0800	101.33	OX
	C <sub>10</sub> H <sub>16</sub>	1,4-Dimethyl-4-vinylcyclohexene	415.65	0.5880	101.33	OX
	C <sub>10</sub> H <sub>16</sub>	1-Methyl-3-(1-methylethylidene)cyclohexene	419.05	0.7250	101.33	OX
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>		<b>1-Nitropropane</b>				
	C <sub>7</sub> H <sub>16</sub>	Heptane	369.25	0.1630	101.33	OX
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>		<b>2-Nitropropane</b>				
	C <sub>7</sub> H <sub>16</sub>	Heptane	367.55	0.2920	101.33	OX
C <sub>3</sub> H <sub>8</sub> O		<b>1-Propanol</b>				
	C <sub>4</sub> H <sub>3</sub> F <sub>7</sub> O	1,1,2,2-Tetrafluoroethyl 1,1,1-trifluoroethyl ether	329.23	0.0350	101.30	OX
	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	Bis(2,2,2-trifluoroethyl) ether	336.22	0.1100	101.30	OX
	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Butanedione	359.30	0.3600	100.67	OX
	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	365.30	0.6418	101.30	OX
	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	367.88	0.6190	101.33	OX
	C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	Diethoxymethane	359.01	0.2320	99.43	OX
	C <sub>6</sub> H <sub>6</sub>	Benzene	350.20	0.2060	101.33	OX
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	347.68	0.2490	101.33	OX
	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	340.85	0.1729	101.19	OX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4,4-Dimethyl-1,3-dioxane	368.20	0.9597	101.30	OX
	C <sub>6</sub> H <sub>14</sub>	Hexane	348.15	0.1900	137.23	OX
	C <sub>7</sub> H <sub>8</sub>	Toluene	365.35	0.6770	101.33	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	357.65	0.4830	101.33	OX
	C <sub>8</sub> H <sub>8</sub>	Styrene	369.08	0.9884	98.13	OX
	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	369.85	0.9886	98.66	OX
	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	369.90	0.9531	99.06	OX
	C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	369.60	0.9531	99.99	OX
	C <sub>8</sub> H <sub>14</sub>	1-Octyne	369.00	0.8600	101.33	OX
	C <sub>8</sub> H <sub>18</sub>	Octane	366.85	0.7483	101.33	OX
	C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	357.89	0.4580	101.30	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	369.95	0.9225	101.33	OX
C <sub>3</sub> H <sub>8</sub> O		<b>2-Propanol</b>				
	C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	Bis(2,2,2-trifluoroethyl) ether	334.16	0.2230	101.30	OX
	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Butanedione	350.85	0.6454	100.95	OX
	C <sub>4</sub> H <sub>8</sub> O	2-Butanone	350.55	0.3830	101.33	OX
	C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	343.05	0.5551	60.27	ON
	C <sub>5</sub> H <sub>3</sub> F <sub>9</sub> O	1,1,1,2,3,3-Hexafluoro-3-(2,2,2-trifluoroethoxy)propane	341.23	0.3420	101.30	OX
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	307.05	0.0150	101.33	OX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	$C_5H_{10}$	2-Methyl-2-butene	310.95	0.0460	101.33	OX
	$C_5H_{10}O$	2,3-Epoxy-2-methylbutane	346.10	0.1400	101.33	OX
	$C_5H_{10}O$	3-Methyl-2-butanone	354.75	0.8500	101.33	OX
	$C_5H_{12}$	Isopentane	298.15	0.1370	101.33	OX
	$C_5H_{12}O_2$	Diethoxymethane	351.45	0.6107	98.61	OX
	$C_6H_5F$	Fluorobenzene	347.75	0.4666	101.25	OX
	$C_6H_6$	Benzene	345.03	0.3960	101.33	OX
	$C_6H_{10}$	Cyclohexene	344.65	0.4271	101.40	OX
	$C_6H_{12}$	Cyclohexane	342.75	0.4050	101.33	OX
	$C_6H_{12}$	Methylcyclopentane	336.45	0.2900	98.14	OX
	$C_6H_{14}$	Hexane	338.15	0.2900	112.66	OX
	$C_6H_{14}O$	Diisopropyl ether	340.00	0.2050	103.36	OX
	$C_6H_{15}N$	Diisopropylamine	352.94	0.4890	101.33	OX
	$C_7H_8$	Toluene	354.65	0.8370	101.33	OX
	$C_7H_{14}$	Methylcyclohexane	350.85	0.6530	101.33	OX
	$C_7H_{16}$	Heptane	349.55	0.6023	101.33	OX
	$C_7H_{16}O$	<i>tert</i> -Butyl isopropyl ether	349.95	0.5306	102.70	OX
	$C_8H_{18}$	Octane	354.63	0.8990	101.33	OX
	$C_8H_{18}$	2,2,4-Trimethylpentane	349.58	0.6350	101.30	OX
$C_3H_8O_2$		<b>2-Methoxyethanol</b>				
	$C_8H_8$	Styrene	393.95	0.7787	98.93	OX
	$C_8H_{10}$	<i>o</i> -Xylene	392.65	0.7127	98.79	OX
	$C_8H_{10}$	<i>m</i> -Xylene	392.15	0.6397	99.73	OX
	$C_8H_{10}$	<i>p</i> -Xylene	392.65	0.6303	99.99	OX
	$C_8H_{16}$	1-Octene	380.75	0.4700	101.33	OX
	$C_8H_{16}$	<i>cis</i> -4-Octene	381.25	0.4900	101.33	OX
	$C_8H_{16}$	<i>trans</i> -4-Octene	381.05	0.4900	101.33	OX
$C_3H_8O_2$		<b>Dimethoxymethane</b>				
	$C_5H_6$	1,3-Cyclopentadiene	313.65	0.3350	101.33	OX
	$C_5H_8$	2-Methyl-1,3-butadiene	306.80	0.0160	101.33	OX
	$C_5H_8$	Methylenecyclobutane	310.35	0.4630	101.33	OX
	$C_5H_8$	1-Methylcyclobutene	309.05	0.2900	101.33	OX
$C_3H_8O_2$		<b>1,2-Propanediol</b>				
	$C_7H_{16}O_3$	Di(propylene glycol) monomethyl ether (unspecified isomer)	456.85	0.5691	101.33	OX
	$C_8H_{18}O_3$	Di(propylene glycol) monoethyl ether (unspecified isomer)	458.75	0.7778	101.33	OX
	$C_9H_{20}O_3$	Di(propylene glycol) monoisopropyl ether (unspecified isomer)	458.95	0.8130	101.33	OX
	$C_9H_{20}O_3$	Di(propylene glycol) monopropyl ether (unspecified isomer)	458.95	0.9010	101.33	OX
	$C_{10}H_{22}O_3$	Di(propylene glycol) monobutyl ether (unspecified isomer)	459.65	0.9721	101.33	OX
	$C_{10}H_{22}O_3$	Di(propylene glycol) monoisobutyl ether (unspecified isomer)	459.05	0.9255	101.33	OX
$C_3H_8O_2$		<b>1,3-Propanediol</b>				
	$C_5H_{12}O_3$	Di(ethylene glycol) monomethyl ether	455.25	0.6300	101.33	OX
	$C_6H_{14}O_3$	Di(ethylene glycol) monoethyl ether	459.25	0.9350	101.33	OX
$C_4H_6$		<b>1,3-Butadiene</b>				
	$C_4H_8$	2-Butene (unspecified isomer)	267.59	0.7650	101.33	OX
$C_4H_6O$		<b>2-Butenal</b>				
	$C_7H_8$	Toluene	374.15	0.5950	97.86	OX
	$C_8H_{18}$	Octane	353.15	0.4950	97.86	OX
$C_4H_6O_2$		<b>Vinyl acetate</b>				
	$C_6H_{12}$	Cyclohexane	340.45	0.6200	101.33	OX
	$C_6H_{14}$	Hexane	335.25	0.4450	101.33	OX
$C_4H_6O_2$		<b>2,3-Butanedione</b>				
	$C_7H_8$	Toluene	362.70	0.9513	101.34	OX

Molecular formula							
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type	
$C_4H_6O_3$		<b>Acetic anhydride</b>					
	$C_8H_{16}$	1-Octene	367.53	0.2840	53.88	OX	
	$C_8H_{18}$	Octane	397.65	0.3500	129.80	OX	
$C_4H_8O$		<b>Butanal</b>					
	$C_6H_{12}$	2-Methyl-1-pentene	334.15	0.2293	101.48	OX	
$C_4H_8O$		<b>2-Butanone</b>					
	$C_4H_8O_2$	Ethyl acetate	349.55	0.1700	101.33	OX	
	$C_6H_6$	Benzene	351.53	0.4790	101.33	OX	
	$C_6H_{10}$	Cyclohexene	343.29	0.5110	89.35	OX	
	$C_6H_{12}$	1-Hexene	334.75	0.1760	100.58	OX	
	$C_6H_{14}$	Hexane	337.15	0.3280	101.33	OX	
	$C_6H_{14}O$	Diisopropyl ether	340.55	0.1938	101.56	OX	
	$C_6H_{14}O$	Dipropyl ether	351.40	0.7785	100.88	OX	
	$C_7H_{14}$	Methylcyclohexane	350.50	0.7984	98.93	OX	
	$C_7H_{16}$	Heptane	350.15	0.7670	101.33	OX	
$C_4H_8O$		<b>Tetrahydrofuran</b>					
	$C_6H_{12}$	2-Methyl-1-pentene	334.65	0.2867	101.29	OX	
	$C_6H_{14}$	Hexane	323.15	0.5900	65.83	OX	
$C_4H_8O_2$		<b>Ethyl acetate</b>					
	$C_4H_{10}O$	2-Methyl-2-propanol	349.75	0.7778	101.28	OX	
	$C_6H_6$	Benzene	350.55	0.9453	102.45	OX	
	$C_6H_{10}$	Cyclohexene	347.45	0.6183	100.87	OX	
	$C_6H_{12}$	Cyclohexane	345.00	0.5390	102.45	OX	
	$C_6H_{12}$	1-Hexene	333.15	0.1230	91.47	OX	
	$C_6H_{14}$	Hexane	338.00	0.3430	101.32	OX	
	$C_7H_{14}$	Methylcyclohexane	349.90	0.9001	101.83	OX	
$C_4H_8O_2$		<b>Butanoic acid</b>					
	$C_5H_5N$	Pyridine	436.35	0.9117	101.33	ON	
	$C_8H_{16}O_2$	Butyl butanoate	434.60	0.6532	93.33	OXD	
	$C_8H_{16}O_2$	Butyl butanoate	434.78	0.8639	93.33	OND	
	$C_{11}H_{24}$	Undecane	435.55	0.9060	101.33	OX	
$C_4H_8O_2$		<b>1,4-Dioxane</b>					
	$C_4H_{10}O$	2-Butanol	371.75	0.4732	100.77	OX	
	$C_5H_{10}O_2$	Propyl acetate	373.35	0.6334	101.13	OX	
	$C_5H_{12}O$	2-Methyl-2-butanol	373.75	0.8119	99.62	OX	
	$C_6H_{10}$	Cyclohexene	355.75	0.1065	101.44	OX	
	$C_6H_{12}$	Methylcyclopentane	343.85	0.0538	99.79	OX	
	$C_6H_{15}N$	Triethylamine	343.15	0.2500	56.80	OX	
	$C_7H_{16}$	Heptane	364.30	0.4868	101.06	OX	
	$C_7H_{16}O$	2-Ethoxy-2-methylbutane	369.15	0.5452	100.27	OX	
$C_4H_8O_2$		<b>Propyl formate</b>					
	$C_6H_6$	Benzene	343.15	0.3770	76.08	OX	
$C_4H_8O_2$		<b>Methyl propanoate</b>					
	$C_7H_{14}$	Methylcyclohexane	352.45	0.8956	101.33	OX	
$C_4H_9Cl$		<b>1-Chlorobutane</b>					
	$C_6H_{12}$	Cyclohexane	348.31	0.5800	95.85	OX	
$C_4H_9NO$		<b><i>N,N</i>-Dimethylacetamide</b>					
	$C_8H_{10}$	<i>o</i> -Xylene	416.95	0.0591	103.40	OX	
	$C_8H_{10}$	Ethylbenzene	408.95	0.0037	101.70	OX	
$C_4H_{10}O$		<b>1-Butanol</b>					
	$C_5H_5N$	Pyridine	392.00	0.7050	101.33	ON	
	$C_5H_{10}O_3$	Diethyl carbonate	370.85	0.6346	53.20	OX	
	$C_6H_5Cl$	Chlorobenzene	388.25	0.6950	101.33	OX	
	$C_6H_{12}$	Cyclohexane	352.68	0.0787	101.33	OX	
	$C_6H_{12}O_2$	Butyl acetate	389.97	0.7700	101.33	OX	
	$C_6H_{12}O_2$	Isobutyl acetate	387.15	0.5980	101.33	OX	
	$C_6H_{14}$	Hexane	341.35	0.0370	101.33	OX	
	$C_7H_8$	Toluene	378.85	0.3320	101.33	OX	



Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	$C_7H_{12}$	3-Ethylcyclopentene	367.65	0.1900	101.33	OX
	$C_7H_{16}$	Heptane	366.55	0.2272	101.38	OX
	$C_8H_8$	Styrene	388.71	0.8923	98.39	OX
	$C_8H_{10}$	<i>o</i> -Xylene	388.05	0.8671	100.13	OX
	$C_8H_{10}$	<i>m</i> -Xylene	387.75	0.7865	101.46	OX
	$C_8H_{10}$	<i>p</i> -Xylene	387.85	0.7823	99.73	OX
	$C_8H_{14}$	1-Octyne	386.50	0.6200	101.33	OX
	$C_8H_{14}$	2-Octyne	398.30	0.7910	101.33	OX
	$C_8H_{16}$	1-Octene	363.45	0.4530	53.33	OX
	$C_8H_{16}$	<i>cis</i> -4-Octene	382.35	0.5300	101.33	OX
	$C_8H_{16}$	<i>trans</i> -4-Octene	382.15	0.5310	101.33	OX
	$C_8H_{18}$	Octane	383.15	0.5500	102.79	OX
	$C_8H_{18}O$	Dibutyl ether	390.59	0.8754	101.33	OX
	$C_9H_{16}$	1-Butylcyclopentene	356.70	0.8450	79.99	OX
	$C_9H_{16}$	1-Nonyne	390.60	0.9400	101.33	OX
	$C_9H_{20}$	Nonane	389.05	0.8128	101.33	OX
$C_4H_{10}O$		<b>2-Butanol</b>				
	$C_5H_{10}O$	3-Pentanone	370.50	0.6075	99.98	OX
	$C_6H_{10}$	Cyclohexene	352.75	0.2046	101.25	OX
	$C_6H_{12}$	Cyclohexane	349.90	0.1892	101.02	OX
	$C_6H_{14}$	Hexane	348.15	0.1010	128.66	OX
	$C_6H_{14}O$	2-Methoxy-2-methylbutane	359.15	0.0991	102.12	OX
	$C_7H_8$	Toluene	353.44	0.5550	56.67	OX
	$C_7H_{16}$	Heptane	361.95	0.4116	102.70	OX
	$C_7H_{16}O$	2-Ethoxy-2-methylbutane	367.75	0.4931	102.89	OX
	$C_8H_{10}$	<i>m</i> -Xylene	369.85	0.9717	101.06	OX
	$C_8H_{10}$	<i>p</i> -Xylene	369.55	0.9646	101.46	OX
	$C_8H_{18}$	Octane	371.05	0.8001	101.30	OX
$C_4H_{10}O$		<b>Diethyl ether</b>				
	$C_5H_{12}$	Pentane	306.85	0.5500	101.33	OX
$C_4H_{10}O$		<b>2-Methyl-1-propanol</b>				
	$C_5H_{10}O_2$	Isobutyl formate	370.90	0.1930	101.33	OX
	$C_6H_6$	Benzene	352.45	0.0780	101.33	OX
	$C_6H_{10}$	Cyclohexene	353.75	0.1363	100.31	OX
	$C_6H_{12}$	Cyclohexane	351.35	0.1325	101.45	OX
	$C_6H_{12}$	Methylcyclopentane	343.15	0.0567	100.35	OX
	$C_7H_8$	Toluene	374.35	0.4941	101.33	OX
	$C_8H_{10}$	<i>m</i> -Xylene	380.35	0.9300	101.33	OX
	$C_8H_{10}$	<i>p</i> -Xylene	380.30	0.9200	101.33	OX
	$C_8H_{18}$	Octane	376.58	0.6700	101.30	OX
$C_4H_{10}O$		<b>2-Methyl-2-propanol</b>				
	$C_5H_8$	Methylenecyclobutane	314.65	0.0150	101.33	OX
	$C_6H_{10}$	Cyclohexene	346.00	0.4172	99.61	OX
	$C_6H_{12}$	Methylcyclopentane	339.35	0.2559	99.93	OX
	$C_6H_{12}$	1-Hexene	333.25	0.2650	101.30	OX
	$C_6H_{14}$	Hexane	337.70	0.2502	101.30	OX
	$C_6H_{14}O$	<i>tert</i> -Butyl ethyl ether	342.85	0.2512	101.44	OX
	$C_6H_{14}O$	Diisopropyl ether	340.45	0.1058	101.72	OX
	$C_6H_{14}O$	2-Methoxy-2-methylbutane	353.20	0.5617	101.80	OX
	$C_7H_8$	Toluene	353.44	0.9200	93.61	OX
	$C_7H_{16}O$	<i>tert</i> -Butyl isopropyl ether	350.90	0.5390	102.94	OX
	$C_8H_{18}$	Octane	343.15	0.9680	61.18	OX
	$C_8H_{18}$	2,2,4-Trimethylpentane	339.28	0.6040	59.49	OX
$C_4H_{10}O_2$		<b>1,4-Butanediol</b>				
	$C_{15}H_{32}O$	1-Pentadecanol	502.75	0.9980	101.33	OX
$C_4H_{10}O_2$		<b>1,2-Dimethoxyethane</b>				
	$C_7H_{14}$	Methylcyclohexane	350.00	0.8190	79.42	OX
$C_4H_{10}O_2$		<b>2-Ethoxyethanol</b>				

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>8</sub> H <sub>8</sub>	Styrene	405.75	0.6438	101.33	OX
	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	404.95	0.5965	101.36	OX
	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	401.75	0.5159	101.33	OX
	C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	402.55	0.5042	102.19	OX
	C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	401.05	0.4632	100.94	OX
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>		<b>Di(ethylene glycol)</b>				
	C <sub>9</sub> H <sub>20</sub> O	1-Nonanol	486.65	0.0095	101.33	OX
C <sub>4</sub> H <sub>11</sub> N		<b>Butylamine</b>				
	C <sub>6</sub> H <sub>6</sub>	Benzene	343.15	0.7000	80.89	OX
C <sub>5</sub> H <sub>5</sub> N		<b>Pyridine</b>				
	C <sub>7</sub> H <sub>8</sub>	Toluene	383.19	0.2250	101.33	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	368.61	0.3002	101.33	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	388.15	0.9350	101.33	OX
C <sub>5</sub> H <sub>6</sub>		<b>2-Methyl-1-buten-3-yne</b>				
	C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	305.88	0.7210	101.33	OX
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene	303.15	0.3450	101.33	OX
	C <sub>5</sub> H <sub>12</sub>	Isopentane	299.35	0.3620	101.33	OX
C <sub>5</sub> H <sub>6</sub>		<b>1,3-Cyclopentadiene</b>				
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	310.85	0.3000	101.33	OX
	C <sub>5</sub> H <sub>12</sub>	Pentane	307.75	0.1959	101.30	OX
C <sub>5</sub> H <sub>8</sub>		<b>2-Methyl-1,3-butadiene</b>				
	C <sub>5</sub> H <sub>12</sub>	Pentane	310.55	0.7421	114.66	OX
	C <sub>6</sub> F <sub>15</sub> N	Tris(perfluoroethyl)amine	303.35	0.8200	101.33	EX
C <sub>5</sub> H <sub>8</sub>		<b>3-Methyl-1-butyne</b>				
	C <sub>5</sub> H <sub>12</sub>	Isopentane	297.15	0.5650	101.33	OX
C <sub>5</sub> H <sub>8</sub>		<b>1-Pentyne</b>				
	C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	310.95	0.3300	101.33	OX
	C <sub>5</sub> H <sub>12</sub>	Pentane	307.55	0.3050	101.33	OX
C <sub>5</sub> H <sub>8</sub> O		<b>Cyclopentanone</b>				
	C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	402.02	0.5944	101.33	OX
	C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	403.84	0.9196	101.33	OX
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>		<b>Methyl methacrylate</b>				
	C <sub>7</sub> H <sub>16</sub>	Heptane	366.35	0.4597	99.94	OX
	C <sub>8</sub> H <sub>18</sub>	Octane	373.70	0.9651	100.16	OX
C <sub>5</sub> H <sub>10</sub>		<b>2-Methyl-1-butene</b>				
	C <sub>6</sub> F <sub>15</sub> N	Tris(perfluoroethyl)amine	301.95	0.8450	101.33	OX
C <sub>5</sub> H <sub>10</sub>		<b>2-Methyl-2-butene</b>				
	C <sub>6</sub> F <sub>15</sub> N	Tris(perfluoroethyl)amine	307.65	0.8170	101.33	OX
C <sub>5</sub> H <sub>10</sub> O		<b>3-Methyl-3-buten-1-ol</b>				
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	352.65	0.0215	101.10	OX
	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4,4-Dimethyl-1,3-dioxane	403.05	0.7590	102.26	OX
	C <sub>7</sub> H <sub>8</sub>	Toluene	381.55	0.2391	101.60	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	370.00	0.2100	101.30	OX
C <sub>5</sub> H <sub>10</sub> O		<b>2-Methyl-3-buten-2-ol</b>				
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	350.15	0.1904	101.20	OX
	C <sub>6</sub> H <sub>12</sub>	1-Hexene	336.55	0.0479	101.30	OX
	C <sub>7</sub> H <sub>8</sub>	Toluene	366.55	0.7788	101.20	OX
C <sub>5</sub> H <sub>10</sub> O		<b>3-Pentanone</b>				
	C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	366.95	0.4441	99.82	OX
	C <sub>7</sub> H <sub>16</sub> O	2-Ethoxy-2-methylbutane	371.15	0.4764	100.21	OX
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>		<b>Propyl acetate</b>				
	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	353.15	0.0598	100.43	OX
	C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	368.40	0.4746	100.90	OX
	C <sub>7</sub> H <sub>16</sub>	Heptane	366.75	0.4215	101.38	OX
	C <sub>7</sub> H <sub>16</sub> O	2-Ethoxy-2-methylbutane	370.95	0.6529	100.03	OX
C <sub>5</sub> H <sub>12</sub>		<b>Isopentane</b>				
	C <sub>6</sub> F <sub>15</sub> N	Tris(perfluoroethyl)amine	299.65	0.9020	101.33	OX
C <sub>5</sub> H <sub>12</sub> O		<b>2-Methyl-1-butanol</b>				

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	$C_8H_{10}$	<i>o</i> -Xylene	402.05	0.7417	101.87	OX
	$C_8H_{10}$	<i>m</i> -Xylene	400.65	0.6316	101.85	OX
	$C_8H_{10}$	<i>p</i> -Xylene	400.15	0.6273	101.07	OX
	$C_8H_{10}$	Ethylbenzene	398.75	0.5657	99.46	OX
$C_5H_{12}O$		<b>3-Methyl-1-butanol</b>				
	$C_6H_{10}O$	Cyclohexanone	404.87	0.9094	101.33	OX
	$C_7H_8$	Toluene	383.15	0.1250	101.33	OX
	$C_7H_{14}O_2$	Isopentyl acetate	403.95	0.9900	101.33	OX
	$C_7H_{16}$	Heptane	368.15	0.1016	95.06	OX
$C_5H_{12}O$		<b>2-Methyl-2-butanol</b>				
	$C_6H_6$	Benzene	352.35	0.1500	101.33	OX
	$C_6H_{12}$	Cyclohexane	351.95	0.1100	101.33	OX
	$C_6H_{12}$	Methylcyclopentane	344.75	0.0551	101.80	OX
	$C_6H_{14}$	Hexane	339.06	0.0436	93.55	OX
	$C_7H_{14}$	Methylcyclohexane	366.60	0.3965	99.87	OX
	$C_7H_{16}$	Heptane	348.15	0.3140	56.83	OX
	$C_7H_{16}O$	2-Ethoxy-2-methylbutane	369.85	0.3904	100.52	OX
$C_5H_{12}O$		<b>1-Pentanol</b>				
	$C_6H_{10}O$	Cyclohexanone	392.37	0.9748	53.32	OX
	$C_7H_{14}O_2$	Isopentyl acetate	407.45	0.6000	101.33	OX
	$C_7H_{16}$	Heptane	371.45	0.0576	101.33	OX
	$C_8H_{18}$	Octane	393.15	0.2847	101.33	OX
	$C_9H_{20}$	Nonane	404.45	0.6242	101.33	OX
	$C_{10}H_{22}$	Decane	410.65	0.9221	101.33	OX
$C_5H_{12}O$		<b>3-Pentanol</b>				
	$C_7H_{16}$	Heptane	368.15	0.2001	98.62	OX
$C_5H_{12}O_2$		<b>Diethoxymethane</b>				
	$C_6H_{12}$	Cyclohexane	353.21	0.1774	101.39	OX
	$C_6H_{14}$	Hexane	361.27	0.9101	102.30	OX
$C_6F_6$		<b>Hexafluorobenzene</b>				
	$C_6H_6$	Benzene	353.60	0.7600	101.33	OND
	$C_6H_6$	Benzene	352.50	0.1832	101.33	OXD
$C_6F_{15}N$		<b>Tris(perfluoroethyl)amine</b>				
	$C_6H_6$	Benzene	329.95	0.5900	101.33	EX
	$C_6H_{12}$	Cyclohexane	329.35	0.5690	101.33	EX
	$C_6H_{14}$	Hexane	327.65	0.4840	101.33	OX
$C_6H_5Br$		<b>Bromobenzene</b>				
	$C_6H_{12}O$	Cyclohexanol	403.15	0.7390	52.45	OX
$C_6H_6$		<b>Benzene</b>				
	$C_6H_{12}$	Cyclohexane	353.15	0.5460	109.18	OX
	$C_6H_{12}$	Methylcyclopentane	333.15	0.1390	69.93	OX
	$C_6H_{14}$	Hexane	341.45	0.0500	101.33	OX
	$C_7H_{16}$	Heptane	353.25	0.9922	101.32	OX
	$C_8H_{18}$	2,2,4-Trimethylpentane	353.25	0.9751	101.32	OX
$C_6H_6O$		<b>Phenol</b>				
	$C_6H_7N$	Aniline	459.09	0.3884	101.33	ON
	$C_6H_7N$	2-Methylpyridine	458.33	0.7852	101.32	ON
	$C_6H_7N$	3-Methylpyridine	462.93	0.6918	101.32	ON
	$C_7H_5N$	Benzonitrile	465.11	0.2345	101.33	ON
	$C_7H_6O$	Benzaldehyde	447.00	0.6001	73.00	ON
	$C_7H_9N$	2,6-Dimethylpyridine	459.32	0.7539	101.32	ON
	$C_8H_{18}$	Octane	398.17	0.0690	101.32	OX
	$C_9H_{12}$	Propylbenzene	428.15	0.1150	91.85	OX
	$C_9H_{12}$	1,2,3-Trimethylbenzene	443.45	0.3936	101.33	OX
	$C_9H_{12}$	1,2,4-Trimethylbenzene	440.65	0.2409	101.33	OX
	$C_9H_{12}$	1,3,5-Trimethylbenzene	436.95	0.1828	101.33	OX
	$C_9H_{18}$	1-Nonene	413.15	0.1297	86.57	OX
	$C_9H_{20}$	Nonane	419.18	0.2180	101.32	OX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	448.15	0.9031	84.25	OX
	C <sub>10</sub> H <sub>14</sub>	Butylbenzene	447.05	0.5535	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	441.15	0.3129	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	439.95	0.2773	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Diethylbenzene (unspecified isomer)	446.45	0.4705	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Diethylbenzene	447.15	0.5565	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>m</i> -Diethylbenzene	445.95	0.5152	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Ethyl-3,5-dimethylbenzene	447.95	0.5840	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	2-Ethyl-1,4-dimethylbenzene	447.95	0.5840	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	441.75	0.3522	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-2-methylbenzene	443.75	0.4643	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-3-methylbenzene	443.05	0.4027	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-4-methylbenzene	443.65	0.4430	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-2-propylbenzene	447.75	0.5801	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-3-propylbenzene	446.35	0.5264	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-4-propylbenzene	447.15	0.5575	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,3,5-Tetramethylbenzene	454.25	0.7957	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	453.36	0.7857	101.33	OX
	C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene	443.15	0.5419	99.85	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	434.15	0.4450	101.32	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-2-methylbenzene	455.55	0.8504	101.33	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-3-methylbenzene	454.15	0.8099	101.33	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-4-methylbenzene	454.55	0.8230	101.33	OX
	C <sub>11</sub> H <sub>22</sub>	1-Undecene	443.15	0.6426	92.31	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	450.73	0.7900	101.32	OX
	C <sub>14</sub> H <sub>30</sub>	Tetradecane	452.48	0.9650	101.32	OX
C <sub>6</sub> H <sub>7</sub> N		<b>Aniline</b>				
	C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	464.29	0.0953	101.33	ON
	C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene	444.65	0.3331	101.33	OX
	C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene	441.80	0.1850	101.33	OX
	C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	437.68	0.1071	101.33	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	422.35	0.1770	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Butylbenzene	448.65	0.4993	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	443.15	0.3021	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	438.25	0.2104	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Diethylbenzene	448.75	0.5024	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>m</i> -Diethylbenzene	447.45	0.4584	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Diethylbenzene	448.85	0.5086	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Ethyl-3,5-dimethylbenzene	449.65	0.5310	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	2-Ethyl-1,4-dimethylbenzene	449.65	0.5310	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	442.75	0.2890	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-2-methylbenzene	445.95	0.4052	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-3-methylbenzene	444.15	0.3419	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-4-methylbenzene	445.35	0.3829	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-2-propylbenzene	449.45	0.5270	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-3-propylbenzene	447.85	0.4711	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1-Methyl-4-propylbenzene	448.75	0.5035	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,3,5-Tetramethylbenzene	456.55	0.7504	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	455.36	0.7349	101.33	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	440.43	0.4660	101.33	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-2-methylbenzene	458.15	0.8091	101.33	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-3-methylbenzene	456.55	0.7661	101.33	OX
	C <sub>11</sub> H <sub>16</sub>	1-Butyl-4-methylbenzene	457.05	0.7807	101.33	OX
	C <sub>11</sub> H <sub>24</sub>	Undecane	449.05	0.6970	101.33	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	453.52	0.8220	101.33	OX
	C <sub>13</sub> H <sub>28</sub>	Tridecane	456.22	0.9300	101.33	OX
	C <sub>14</sub> H <sub>30</sub>	Tetradecane	457.05	0.9770	101.33	OX
C <sub>6</sub> H <sub>7</sub> N		<b>2-Methylpyridine</b>				

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>8</sub> H <sub>18</sub>	Octane	394.27	0.4610	101.33	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	402.35	0.8790	101.33	OX
C <sub>6</sub> H <sub>7</sub> N		<b>3-Methylpyridine</b>				
	C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	477.01	0.1556	101.32	ON
	C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	416.64	0.2940	101.33	OX
C <sub>6</sub> H <sub>7</sub> N		<b>4-Methylpyridine</b>				
	C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	477.74	0.1822	101.32	ON
	C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	417.08	0.2000	101.32	OX
C <sub>6</sub> H <sub>10</sub> O		<b>Methyldihydropyran (unspecified isomer)</b>				
	C <sub>7</sub> H <sub>8</sub>	Toluene	381.85	0.0207	101.30	OX
C <sub>6</sub> H <sub>10</sub> O		<b>4-Methylenetetrahydropyran</b>				
	C <sub>7</sub> H <sub>8</sub>	Toluene	381.15	0.5253	101.20	OX
C <sub>6</sub> H <sub>12</sub> O		<b>Cyclohexanol</b>				
	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	415.95	0.1426	101.33	OX
	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	411.85	0.0503	101.33	OX
	C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	410.95	0.0505	101.33	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	410.20	0.3350	79.99	OX
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>		<b>Butyl acetate</b>				
	C <sub>8</sub> H <sub>16</sub>	1-Octene	393.00	0.3030	101.33	OX
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>		<b>4,4-Dimethyl-1,3-dioxane</b>				
	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	404.65	0.9662	101.30	OX
	C <sub>8</sub> H <sub>18</sub>	Octane	393.95	0.3343	101.20	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	402.15	0.8864	101.30	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	405.35	0.9999	100.60	OX
C <sub>6</sub> H <sub>14</sub> O		<b>1-Hexanol</b>				
	C <sub>8</sub> H <sub>18</sub>	Octane	398.55	0.0886	101.33	OX
	C <sub>9</sub> H <sub>20</sub>	Nonane	416.95	0.3649	101.33	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	427.05	0.7123	101.33	OX
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>		<b>2,2-Dimethoxybutane</b>				
	C <sub>7</sub> H <sub>8</sub>	Toluene	380.15	0.9180	101.44	OX
C <sub>7</sub> F <sub>16</sub>		<b>Perfluoroheptane</b>				
	C <sub>7</sub> H <sub>16</sub>	Heptane	328.16	0.6100	53.60	OX
C <sub>7</sub> H <sub>5</sub> N		<b>Benzonitrile</b>				
	C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	468.91	0.5100	101.33	ON
	C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	476.10	0.1441	101.33	ON
	C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	476.95	0.0898	101.33	ON
	C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	477.15	0.0807	101.33	ON
C <sub>7</sub> H <sub>8</sub> O		<b><i>o</i>-Cresol</b>				
	C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine	470.35	0.6561	101.33	ON
	C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	444.65	0.0938	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Diethylbenzene (unspecified isomer)	453.10	0.2694	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	462.37	0.6273	101.33	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	433.15	0.3100	78.71	OX
	C <sub>11</sub> H <sub>22</sub>	1-Undecene	448.15	0.5516	83.07	OX
	C <sub>11</sub> H <sub>24</sub>	Undecane	433.15	0.5800	56.40	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	458.15	0.8466	93.55	OX
C <sub>7</sub> H <sub>8</sub> O		<b><i>m</i>-Cresol</b>				
	C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	475.66	0.9869	101.32	ON
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	511.20	0.0356	101.33	ON
	C <sub>9</sub> H <sub>20</sub>	Nonane	413.15	0.0400	76.54	OX
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	474.65	0.9680	101.33	OX
	C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	468.45	0.5900	93.10	OX
	C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	445.85	0.0136	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Diethylbenzene (unspecified isomer)	454.10	0.1010	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	466.87	0.3591	101.33	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	433.15	0.2170	75.85	OX
C <sub>7</sub> H <sub>8</sub> O		<b><i>p</i>-Cresol</b>				
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	474.55	0.9414	101.33	OX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
	C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	446.05	0.0186	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	Diethylbenzene (unspecified isomer)	454.50	0.1105	101.33	OX
C <sub>7</sub> H <sub>8</sub> O		<b>Benzyl alcohol</b>				
	C <sub>10</sub> H <sub>22</sub>	Decane	445.75	0.2490	101.33	OX
C <sub>7</sub> H <sub>9</sub> N		<b>2-Methylaniline</b>				
	C <sub>10</sub> H <sub>22</sub>	Decane	446.91	0.1770	101.33	OX
	C <sub>11</sub> H <sub>24</sub>	Undecane	461.40	0.4930	101.33	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	468.90	0.7650	101.33	OX
	C <sub>13</sub> H <sub>28</sub>	Tridecane	472.55	0.9070	101.33	OX
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>		<b>Pentyl acetate</b>				
	C <sub>9</sub> H <sub>20</sub>	Nonane	419.20	0.5380	101.32	OX
C <sub>7</sub> H <sub>16</sub> O		<b>1-Heptanol</b>				
	C <sub>9</sub> H <sub>20</sub>	Nonane	423.45	0.1071	101.33	OX
	C <sub>10</sub> H <sub>22</sub>	Decane	438.75	0.4308	101.33	OX
	C <sub>11</sub> H <sub>24</sub>	Undecane	447.85	0.8014	101.33	OX
C <sub>8</sub> H <sub>10</sub>		<i>o</i> -Xylene				
	C <sub>9</sub> H <sub>20</sub>	Nonane	417.40	0.8498	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>2,6-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	511.00	0.0890	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	475.70	0.9381	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	468.85	0.3480	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>2,3-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	513.30	0.2684	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	485.45	0.4123	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>2,4-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	512.30	0.1717	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	481.25	0.6435	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	474.05	0.1869	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>2,5-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	512.30	0.1717	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	481.25	0.6435	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	474.35	0.1763	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>3,4-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	519.75	0.2955	101.33	ON
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	514.77	0.3907	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	490.95	0.1158	101.33	OX
	C <sub>10</sub> H <sub>9</sub> N	3-Methylisoquinoline	524.35	0.0811	101.33	ON
	C <sub>10</sub> H <sub>9</sub> N	2-Methylquinoline	521.17	0.1647	101.33	ON
	C <sub>10</sub> H <sub>9</sub> N	3-Methylquinoline	523.60	0.1152	101.33	ON
	C <sub>10</sub> H <sub>9</sub> N	7-Methylquinoline	525.85	0.0466	101.33	ON
	C <sub>11</sub> H <sub>11</sub> N	2,3-Dimethylquinoline	521.60	0.2113	101.33	ON
C <sub>8</sub> H <sub>10</sub> O		<b>3,5-Xylenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	518.05	0.1915	101.33	ON
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	513.58	0.3287	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	489.33	0.2601	101.33	OX
	C <sub>10</sub> H <sub>9</sub> N	2-Methylquinoline	520.65	0.0094	101.33	ON
	C <sub>11</sub> H <sub>11</sub> N	2,3-Dimethylquinoline	520.70	0.0530	101.33	ON
C <sub>8</sub> H <sub>10</sub> O		<b>2-Ethylphenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	511.75	0.1041	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	478.35	0.8005	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	471.45	0.3707	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>3-Ethylphenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	512.70	0.2089	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	483.45	0.5551	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	475.95	0.1249	101.33	OX
C <sub>8</sub> H <sub>10</sub> O		<b>4-Ethylphenol</b>				
	C <sub>9</sub> H <sub>7</sub> N	Quinoline	513.45	0.2832	101.33	ON
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	486.10	0.3762	101.33	OX

Molecular formula						
Comp. 1	Comp. 2	Name	$T_{Az}/K$	$y_{1,Az}$	$P_{Az}/kPa$	Type
<b>C<sub>8</sub>H<sub>11</sub>N</b>		<b>2,4-Dimethylaniline</b>				
	C <sub>11</sub> H <sub>24</sub>	Undecane	468.13	0.1490	101.33	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	482.95	0.4520	101.33	OX
	C <sub>13</sub> H <sub>28</sub>	Tridecane	488.43	0.7880	101.33	OX
<b>C<sub>8</sub>H<sub>18</sub>O</b>	C <sub>14</sub> H <sub>30</sub>	Tetradecane	490.53	0.9840	101.33	OX
		<b>1-Octanol</b>				
	C <sub>10</sub> H <sub>22</sub>	Decane	446.45	0.1029	101.33	OX
	C <sub>11</sub> H <sub>24</sub>	Undecane	460.05	0.4772	101.33	OX
<b>C<sub>9</sub>H<sub>7</sub>N</b>	C <sub>12</sub> H <sub>26</sub>	Dodecane	466.95	0.8836	101.33	OX
		<b>Isoquinoline</b>				
<b>C<sub>9</sub>H<sub>7</sub>N</b>	C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	513.90	0.2074	101.33	OX
<b>C<sub>9</sub>H<sub>7</sub>N</b>		<b>Quinoline</b>				
	C <sub>9</sub> H <sub>12</sub> O	3-Isopropylphenol	514.70	0.6109	101.33	ON
	C <sub>9</sub> H <sub>12</sub> O	2-Isopropylphenol	512.75	0.8015	101.33	ON
	C <sub>9</sub> H <sub>12</sub> O	2-Propylphenol	513.60	0.7243	101.33	ON
	C <sub>9</sub> H <sub>12</sub> O	3-Propylphenol	514.70	0.6109	101.33	ON
	C <sub>9</sub> H <sub>12</sub> O	4-Propylphenol	515.35	0.5451	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	2-Butylphenol	515.70	0.5350	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	2- <i>tert</i> -Butylphenol	513.70	0.7299	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	3- <i>tert</i> -Butylphenol	517.05	0.4315	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	4-Isobutylphenol	515.95	0.5061	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	2- <i>sec</i> -Butylphenol	514.70	0.6339	101.33	ON
	C <sub>10</sub> H <sub>14</sub> O	4- <i>sec</i> -Butylphenol	516.45	0.4551	101.33	ON
	C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	511.05	0.9213	101.33	OX
	C <sub>11</sub> H <sub>16</sub> O	2- <i>tert</i> -Butyl-5-methylphenol	515.45	0.5854	101.33	ON
	C <sub>11</sub> H <sub>16</sub> O	2- <i>sec</i> -Butyl-4-methylphenol	516.10	0.5139	101.33	ON
	<b>C<sub>9</sub>H<sub>12</sub></b>		<b>1,2,3-Trimethylbenzene</b>			
C <sub>10</sub> H <sub>22</sub>		Decane	433.35	0.4010	72.54	OX
<b>C<sub>9</sub>H<sub>12</sub></b>		<b>1,2,4-Trimethylbenzene</b>				
	C <sub>10</sub> H <sub>22</sub>	Decane	433.35	0.8600	80.25	OX
<b>C<sub>9</sub>H<sub>12</sub>O</b>		<b>2-Ethyl-4-methylphenol</b>				
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	488.20	0.2218	101.33	OX
<b>C<sub>9</sub>H<sub>12</sub>O</b>		<b>2-Ethyl-5-methylphenol</b>				
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	489.45	0.1710	101.33	OX
<b>C<sub>9</sub>H<sub>12</sub>O</b>		<b>2-Isopropylphenol</b>				
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	483.15	0.5102	101.33	OX
	C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	476.25	0.1036	101.33	OX
<b>C<sub>9</sub>H<sub>12</sub>O</b>		<b>2,4,6-Trimethylphenol</b>				
	C <sub>10</sub> H <sub>8</sub>	Naphthalene	486.70	0.3161	101.33	OX
<b>C<sub>9</sub>H<sub>20</sub>O</b>		<b>1-Nonanol</b>				
	C <sub>11</sub> H <sub>24</sub>	Undecane	468.45	0.0925	101.33	OX
	C <sub>12</sub> H <sub>26</sub>	Dodecane	480.65	0.5235	101.33	OX
<b>C<sub>10</sub>H<sub>22</sub>O</b>		<b>1-Decanol</b>				
	C <sub>12</sub> H <sub>26</sub>	Dodecane	489.25	0.1068	101.33	OX

## VISCOSITY OF GASES

The following table gives the viscosity of some common gases as a function of temperature. Unless otherwise noted, the viscosity values refer to a pressure of 100 kPa (1 bar). The notation  $P=0$  indicates the low pressure limiting value is given. The difference

between the viscosity at 100 kPa and the limiting value is generally less than 1%. Viscosity is given in units of  $\mu\text{Pa s}$ ; note that  $1 \mu\text{Pa s} = 10^{-5}$  poise. Substances are listed in the modified Hill order (see Introduction).

		Viscosity in micropascal seconds ( $\mu\text{Pa s}$ )						
		100 K	200 K	300 K	400 K	500 K	600 K	Ref.
	Air	7.1	13.3	18.6	23.1	27.1	30.8	1
Ar	Argon	8.0	15.9	22.9	28.8	34.2	39.0	2,8
$\text{BF}_3$	Boron trifluoride		12.3	17.1	21.7	26.1	30.2	13
ClH	Hydrogen chloride			14.6	19.7	24.3		13
$\text{F}_6\text{S}$	Sulfur hexafluoride ( $P=0$ )			15.3	19.8	23.9	27.7	10
$\text{H}_2$	Hydrogen ( $P=0$ )	4.2	6.8	9.0	10.9	12.7	14.4	4
$\text{D}_2$	Deuterium ( $P=0$ )	5.9	9.6	12.6	15.4	17.9	20.3	11
$\text{H}_2\text{O}$	Water			10.0	13.3	17.3	21.4	6
$\text{D}_2\text{O}$	Deuterium oxide			11.1	13.7	17.7	22.0	7
He	Helium ( $P=0$ )	9.7	15.3	20.0	24.4	28.4	32.3	8
Kr	Krypton ( $P=0$ )	8.8	17.1	25.6	33.1	39.8	45.9	8
NO	Nitric oxide		13.8	19.2	23.8	28.0	31.9	13
$\text{N}_2$	Nitrogen ( $P=0$ )		12.9	17.9	22.2	26.1	29.6	12
$\text{N}_2\text{O}$	Nitrous oxide		10.0	15.0	19.4	23.6	27.4	13
Ne	Neon ( $P=0$ )	14.4	24.3	32.1	38.9	45.0	50.8	8
$\text{O}_2$	Oxygen ( $P=0$ )	7.5	14.6	20.8	26.1	30.8	35.1	12
$\text{O}_2\text{S}$	Sulfur dioxide			8.6	12.9	17.5	21.7	13
Xe	Xenon ( $P=0$ )	8.3	15.4	23.2	30.7	37.6	44.0	8
CO	Carbon monoxide	6.7	12.9	17.8	22.1	25.8	29.1	13
$\text{CO}_2$	Carbon dioxide		10.0	15.0	19.7	24.0	28.0	9,10
$\text{CHCl}_3$	Chloroform			10.2	13.7	16.9	20.1	13
$\text{CH}_4$	Methane		7.7	11.2	14.3	17.0	19.4	10
$\text{CH}_4\text{O}$	Methanol				13.2	16.5	19.6	13
$\text{C}_2\text{H}_2$	Acetylene			10.4	13.5	16.5		13
$\text{C}_2\text{H}_4$	Ethylene		7.0	10.4	13.6	16.5	19.1	3
$\text{C}_2\text{H}_6$	Ethane		6.4	9.5	12.3	14.9	17.3	5
$\text{C}_2\text{H}_6\text{O}$	Ethanol				11.6	14.5	17.0	13
$\text{C}_3\text{H}_8$	Propane			8.3	10.9	13.4	15.8	5
$\text{C}_4\text{H}_{10}$	Butane			7.5	10.0	12.3	14.6	5
$\text{C}_4\text{H}_{10}$	Isobutane			7.6	10.0	12.3	14.6	5
$\text{C}_4\text{H}_{10}\text{O}$	Diethyl ether			7.6	10.1	12.4		13
$\text{C}_5\text{H}_{12}$	Pentane			6.7	9.2	11.4	13.4	13
$\text{C}_6\text{H}_{14}$	Hexane				8.6	10.8	12.8	13

### References

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# VISCOSITY OF LIQUIDS

The absolute viscosity of some common liquids at temperatures between  $-25$  and  $100^{\circ}\text{C}$  is given in this table. Values were derived by fitting experimental data to suitable expressions for the temperature dependence. The substances are arranged by molecular formula in the modified Hill order (see Preface). All values are given in units of millipascal seconds (mPa s); this unit is identical to centipoise (cp).

Viscosity values correspond to a nominal pressure of 1 atmosphere. If a value is given at a temperature above the normal boiling point, the applicable pressure is understood to be the vapor pressure of the liquid at that temperature. A few values are given at a temperature slightly below the normal freezing point; these refer to the supercooled liquid.

The accuracy ranges from 1% in the best cases to 5 to 10% in the worst cases. Additional significant figures are included in the table to facilitate interpolation.

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Molecular formula	Name	Viscosity in mPa s					
		$-25^{\circ}\text{C}$	$0^{\circ}\text{C}$	$25^{\circ}\text{C}$	$50^{\circ}\text{C}$	$75^{\circ}\text{C}$	$100^{\circ}\text{C}$
<i>Compounds not containing carbon</i>							
$\text{Br}_2$	Bromine		1.252	0.944	0.746		
$\text{Cl}_3\text{HSi}$	Trichlorosilane		0.415	0.326			
$\text{Cl}_3\text{P}$	Phosphorous trichloride	0.870	0.662	0.529	0.439		
$\text{Cl}_4\text{Si}$	Tetrachlorosilane			99.4	96.2		
$\text{H}_2\text{O}$	Water		1.793	0.890	0.547	0.378	0.282
$\text{H}_4\text{N}_2$	Hydrazine			0.876	0.628	0.480	0.384
Hg	Mercury			1.526	1.402	1.312	1.245
$\text{NO}_2$	Nitrogen dioxide		0.532	0.402			
<i>Compounds containing carbon</i>							
$\text{CCl}_3\text{F}$	Trichlorofluoromethane	0.740	0.539	0.421			
$\text{CCl}_4$	Tetrachloromethane		1.321	0.908	0.656	0.494	
$\text{CS}_2$	Carbon disulfide		0.429	0.352			
$\text{CHBr}_3$	Tribromomethane			1.857	1.367	1.029	
$\text{CHCl}_3$	Trichloromethane	0.988	0.706	0.537	0.427		
CHN	Hydrogen cyanide		0.235	0.183			
$\text{CH}_2\text{Br}_2$	Dibromomethane	1.948	1.320	0.980	0.779	0.652	
$\text{CH}_2\text{Cl}_2$	Dichloromethane	0.727	0.533	0.413			
$\text{CH}_2\text{O}_2$	Formic acid			1.607	1.030	0.724	0.545
$\text{CH}_3\text{I}$	Iodomethane		0.594	0.469			
$\text{CH}_3\text{NO}$	Formamide		7.114	3.343	1.833		
$\text{CH}_3\text{NO}_2$	Nitromethane	1.311	0.875	0.630	0.481	0.383	0.317
$\text{CH}_4\text{O}$	Methanol	1.258	0.793	0.544			
$\text{CH}_5\text{N}$	Methylamine	0.319	0.231				
$\text{C}_2\text{Cl}_3\text{F}_3$	1,1,2-Trichlorotrifluoro-ethane	1.465	0.945	0.656	0.481		
$\text{C}_2\text{Cl}_4$	Tetrachloroethylene		1.114	0.844	0.663	0.535	0.442
$\text{C}_2\text{HCl}_3$	Trichloroethylene		0.703	0.545	0.444	0.376	
$\text{C}_2\text{HCl}_5$	Pentachloroethane		3.761	2.254	1.491	1.061	
$\text{C}_2\text{HF}_3\text{O}_2$	Trifluoroacetic acid			0.808	0.571		
$\text{C}_2\text{H}_2\text{Cl}_2$	<i>cis</i> -1,2-Dichloroethylene	0.786	0.575	0.445			
$\text{C}_2\text{H}_2\text{Cl}_2$	<i>trans</i> -1,2-Dichloroethylene	0.522	0.398	0.317	0.261		
$\text{C}_2\text{H}_2\text{Cl}_4$	1,1,1,2-Tetrachloroethane	3.660	2.200	1.437	1.006	0.741	0.570
$\text{C}_2\text{H}_3\text{ClF}_2$	1-Chloro-1,1-difluoro-ethane	0.477	0.376				
$\text{C}_2\text{H}_3\text{ClO}$	Acetyl chloride			0.368	0.294		
$\text{C}_2\text{H}_3\text{Cl}_3$	1,1,1-Trichloroethane	1.847	1.161	0.793	0.578	0.428	
$\text{C}_2\text{H}_3\text{N}$	Acetonitrile		0.400	0.369	0.284	0.234	
$\text{C}_2\text{H}_4\text{Br}_2$	1,2-Dibromoethane			1.595	1.116	0.837	0.661

Molecular formula	Name	Viscosity in mPa s					
		-25°C	0°C	25°C	50°C	75°C	100°C
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane			0.464	0.362		
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane		1.125	0.779	0.576	0.447	
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid			1.056	0.786	0.599	0.464
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate		0.424	0.325			
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	0.635	0.477	0.374			
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	0.416	0.319				
C <sub>2</sub> H <sub>5</sub> I	Iodoethane		0.723	0.556	0.444	0.365	
C <sub>2</sub> H <sub>5</sub> NO	<i>N</i> -Methylformamide		2.549	1.678	1.155	0.824	0.606
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	1.354	0.940	0.688	0.526	0.415	0.337
C <sub>2</sub> H <sub>6</sub> O	Ethanol	3.262	1.786	1.074	0.694	0.476	
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide			1.987	1.290		
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol			16.1	6.554	3.340	1.975
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide		0.356	0.284			
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol		0.364	0.287			
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	0.300	0.232				
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine			21.1	8.560	3.935	1.998
C <sub>3</sub> H <sub>3</sub> Br	3-Bromopropene		0.620	0.471	0.373		
C <sub>3</sub> H <sub>3</sub> Cl	3-Chloropropene		0.408	0.314			
C <sub>3</sub> H <sub>3</sub> ClO	Epichlorohydrin	2.492	1.570	1.073	0.781	0.597	0.474
C <sub>3</sub> H <sub>3</sub> N	Propanenitrile			0.294	0.240	0.202	
C <sub>3</sub> H <sub>6</sub> O	Acetone	0.540	0.395	0.306	0.247		
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol			1.218	0.759	0.505	
C <sub>3</sub> H <sub>6</sub> O	Propanal			0.321	0.249		
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate		0.506	0.380	0.300		
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate		0.477	0.364	0.284		
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid		1.499	1.030	0.749	0.569	0.449
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane		0.645	0.489	0.387		
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane		0.612	0.458	0.359		
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane		0.436	0.334			
C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane		0.401	0.303			
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane		0.970	0.703	0.541	0.436	0.363
C <sub>3</sub> H <sub>7</sub> I	2-Iodopropane		0.883	0.653	0.506	0.407	
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide		1.176	0.794	0.624		
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	1.851	1.160	0.798	0.589	0.460	0.374
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	8.645	3.815	1.945	1.107	0.685	
C <sub>3</sub> H <sub>8</sub> O	2-Propanol		4.619	2.038	1.028	0.576	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propylene glycol		248	40.4	11.3	4.770	2.750
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol			934	152	39.8	14.8
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol		0.503	0.385			
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol		0.477	0.357	0.280		
C <sub>3</sub> H <sub>9</sub> N	Propylamine			0.376			
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine		0.454	0.325			
C <sub>4</sub> H <sub>4</sub> O	Furan	0.661	0.475	0.361			
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole		2.085	1.225	0.828	0.612	
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride		1.241	0.843	0.614	0.472	0.377
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile			0.553	0.418	0.330	0.268
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	0.720	0.533	0.405	0.315	0.249	
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	0.849	0.605	0.456	0.359		
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane			1.177	0.787	0.569	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate		0.578	0.423	0.325	0.259	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propionate		0.581	0.431	0.333	0.266	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate		0.669	0.485	0.370	0.293	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid		2.215	1.426	0.982	0.714	0.542
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid		1.857	1.226	0.863	0.639	0.492
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	Sulfolane				6.280	3.818	2.559
C <sub>4</sub> H <sub>8</sub> S	Tetrahydrothiophene			0.973	0.912		
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane		0.815	0.606	0.471	0.379	
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane		0.556	0.422	0.329	0.261	
C <sub>4</sub> H <sub>9</sub> N	Pyrrrolidine	1.914	1.071	0.704	0.512		
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide			1.927			

Molecular formula	Name	Viscosity in mPa s					
		-25°C	0°C	25°C	50°C	75°C	100°C
C <sub>4</sub> H <sub>9</sub> NO	Morpholine			2.021	1.247	0.850	0.627
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	12.19	5.185	2.544	1.394	0.833	0.533
C <sub>4</sub> H <sub>10</sub> O	2-Butanol			3.096	1.332	0.698	0.419
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol			4.312	1.421	0.678	
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether		0.283	0.224			
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	Diethylene glycol			30.200	11.130	4.917	2.505
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide		0.558	0.422	0.331	0.267	
C <sub>4</sub> H <sub>11</sub> N	Butylamine		0.830	0.574	0.409	0.298	
C <sub>4</sub> H <sub>11</sub> N	Isobutylamine		0.770	0.571	0.367		
C <sub>4</sub> H <sub>11</sub> N	Diethylamine			0.319	0.239		
C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	Diethanolamine				109.5	28.7	9.100
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural		2.501	1.587	1.143	0.906	0.772
C <sub>5</sub> H <sub>5</sub> N	Pyridine		1.361	0.879	0.637	0.497	0.409
C <sub>5</sub> H <sub>10</sub>	1-Pentene	0.313	0.241	0.195			
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene		0.255	0.203			
C <sub>5</sub> H <sub>10</sub>	Cyclopentane		0.555	0.413	0.321		
C <sub>5</sub> H <sub>10</sub> O	Mesityl oxide	1.291	0.838	0.602	0.465	0.381	0.326
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone		0.641	0.470	0.362	0.289	0.238
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone		0.592	0.444	0.345	0.276	0.227
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate		0.937	0.644	0.472	0.362	0.289
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate		0.768	0.544	0.406	0.316	0.255
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate		0.691	0.501	0.380	0.299	0.242
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate		0.759	0.541	0.406	0.318	0.257
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl isobutanoate		0.672	0.488	0.373	0.296	
C <sub>5</sub> H <sub>11</sub> N	Piperidine			1.573	0.958	0.649	0.474
C <sub>5</sub> H <sub>12</sub>	Pentane	0.351	0.274	0.224			
C <sub>5</sub> H <sub>12</sub>	Isopentane	0.376	0.277	0.214			
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	25.4	8.512	3.619	1.820	1.035	0.646
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol			3.470	1.447	0.761	0.465
C <sub>5</sub> H <sub>12</sub> O	3-Pentanol			4.149	1.473	0.727	0.436
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-1-butanol			4.453	1.963	1.031	0.612
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol		8.627	3.692	1.842	1.031	0.631
C <sub>5</sub> H <sub>13</sub> N	Pentylamine		1.030	0.702	0.493	0.356	
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene			2.789	1.730	1.151	
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene		1.958	1.324	0.962	0.739	0.593
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene		1.492	1.044	0.787	0.628	0.525
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene		1.560	1.074	0.798	0.627	0.512
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	1.703	1.058	0.753	0.575	0.456	0.369
C <sub>6</sub> H <sub>5</sub> ClO	<i>o</i> -Chlorophenol			3.589	1.835	1.131	0.786
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol				4.041		
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene		0.749	0.550	0.423	0.338	
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene		2.354	1.554	1.117	0.854	0.683
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene		3.036	1.863	1.262	0.918	0.704
C <sub>6</sub> H <sub>6</sub>	Benzene			0.604	0.436	0.335	
C <sub>6</sub> H <sub>6</sub> ClN	<i>o</i> -Chloroaniline			3.316	1.913	1.248	0.887
C <sub>6</sub> H <sub>6</sub> O	Phenol				3.437	1.784	1.099
C <sub>6</sub> H <sub>7</sub> N	Aniline			3.847	2.029	1.247	0.850
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Phenylhydrazine			13.0	4.553	1.850	0.848
C <sub>6</sub> H <sub>10</sub>	Cyclohexene		0.882	0.625	0.467	0.364	
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone			2.017	1.321	0.919	0.671
C <sub>6</sub> H <sub>11</sub> N	Hexanenitrile			0.912	0.650	0.488	0.382
C <sub>6</sub> H <sub>12</sub>	Cyclohexane			0.894	0.615	0.447	
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	0.927	0.653	0.479	0.364		
C <sub>6</sub> H <sub>12</sub>	1-Hexene	0.441	0.326	0.252	0.202		
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol			57.5	12.3	4.274	1.982
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	1.300	0.840	0.583	0.429	0.329	0.262
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone			0.545	0.406		
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate		1.002	0.685	0.500	0.383	0.305
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Isobutyl acetate			0.676	0.493	0.370	0.286
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate			0.639	0.453		

Molecular formula	Name	Viscosity in mPa s					
		-25°C	0°C	25°C	50°C	75°C	100°C
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol	28.7	6.621	2.798	1.829	1.648	
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde			1.079	0.692	0.485	0.362
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine			1.944	1.169	0.782	0.565
C <sub>6</sub> H <sub>14</sub>	Hexane		0.405	0.300	0.240		
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane		0.372	0.286	0.226		
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane		0.395	0.306			
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether		0.542	0.396	0.304	0.242	
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol			4.578	2.271	1.270	0.781
C <sub>6</sub> H <sub>15</sub> N	Triethylamine		0.455	0.347	0.273	0.221	
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine		0.751	0.517	0.377	0.288	0.228
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine			0.393	0.300	0.237	
C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub>	Triethanolamine			609	114	31.5	11.7
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile			1.267	0.883	0.662	0.524
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene		1.390	0.964	0.710	0.547	0.437
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene		1.165	0.823	0.616	0.482	0.391
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene			0.837	0.621	0.483	0.390
C <sub>7</sub> H <sub>8</sub>	Toluene	1.165	0.778	0.560	0.424	0.333	0.270
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol				3.035	1.562	0.961
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol			12.9	4.417	2.093	1.207
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol			5.474	2.760	1.618	1.055
C <sub>7</sub> H <sub>8</sub> O	Anisole			1.056	0.747	0.554	0.427
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline		4.120	2.042	1.222	0.825	0.606
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methyl aniline		10.3	3.823	1.936	1.198	0.839
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methyl aniline		8.180	3.306	1.679	1.014	0.699
C <sub>7</sub> H <sub>9</sub> N	Benzylamine			1.624	1.080	0.769	0.577
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane		0.991	0.679	0.501	0.390	0.316
C <sub>7</sub> H <sub>14</sub>	1-Heptene		0.441	0.340	0.273	0.226	
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone			0.714	0.407	0.297	
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid			3.840	2.282	1.488	1.041
C <sub>7</sub> H <sub>16</sub>	Heptane	0.757	0.523	0.387	0.301	0.243	
C <sub>7</sub> H <sub>16</sub>	3-Methylhexane			0.350			
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol			5.810	2.603	1.389	0.849
C <sub>7</sub> H <sub>16</sub> O	2-Heptanol			3.955	1.799	0.987	0.615
C <sub>7</sub> H <sub>16</sub> O	3-Heptanol				1.957	0.976	0.584
C <sub>7</sub> H <sub>16</sub> O	4-Heptanol			4.207	1.695	0.882	0.539
C <sub>7</sub> H <sub>17</sub> N	Heptylamine			1.314	0.865	0.600	0.434
C <sub>8</sub> H <sub>8</sub>	Styrene		1.050	0.695	0.507	0.390	0.310
C <sub>8</sub> H <sub>8</sub> O	Acetophenone			1.681			0.634
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate			1.857			
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Methyl salicylate					1.102	0.815
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene		0.872	0.631	0.482	0.380	0.304
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene		1.084	0.760	0.561	0.432	0.345
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene		0.795	0.581	0.445	0.353	0.289
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene			0.603	0.457	0.359	0.290
C <sub>8</sub> H <sub>10</sub> O	Phenetole			1.197	0.817	0.594	0.453
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline		1.996	1.300	0.911	0.675	0.523
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline		3.981	2.047	1.231	0.825	0.596
C <sub>8</sub> H <sub>16</sub>	Ethylcyclohexane		1.139	0.784	0.579		
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid			5.020	2.656	1.654	1.147
C <sub>8</sub> H <sub>18</sub>	Octane		0.700	0.508	0.385	0.302	0.243
C <sub>8</sub> H <sub>18</sub> O	1-Octanol			7.288	3.232	1.681	0.991
C <sub>8</sub> H <sub>18</sub> O	4-Methyl-3-heptanol		1.904	1.085	0.702	0.497	0.375
C <sub>8</sub> H <sub>18</sub> O	5-Methyl-3-heptanol		2.052	1.178	0.762	0.536	0.401
C <sub>8</sub> H <sub>18</sub> O	2-Ethyl-1-hexanol		20.7	6.271	2.631	1.360	0.810
C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether	1.417	0.918	0.637	0.466	0.356	0.281
C <sub>8</sub> H <sub>19</sub> N	Dibutylamine		1.509	0.918	0.619	0.449	0.345
C <sub>8</sub> H <sub>19</sub> N	Diisobutylamine		1.115	0.723	0.511	0.384	0.303
C <sub>9</sub> H <sub>7</sub> N	Quinoline			3.337	1.892	1.201	0.833
C <sub>9</sub> H <sub>10</sub>	Indane		2.230	1.357	0.931	0.692	0.545
C <sub>9</sub> H <sub>12</sub>	Cumene		1.075	0.737	0.547		

Molecular formula	Name	Viscosity in mPa s					
		-25°C	0°C	25°C	50°C	75°C	100°C
C <sub>9</sub> H <sub>14</sub> O	Isophorone		4.201	2.329	1.415	0.923	0.638
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone			1.199	0.834	0.619	0.484
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid			7.011	3.712	2.234	1.475
C <sub>9</sub> H <sub>20</sub>	Nonane		0.964	0.665	0.488	0.375	0.300
C <sub>9</sub> H <sub>20</sub> O	1-Nonanol			9.123	4.032		
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl phthalate		63.2	14.4	5.309	2.824	1.980
C <sub>10</sub> H <sub>14</sub>	Butylbenzene			0.950	0.683	0.515	
C <sub>10</sub> H <sub>18</sub>	<i>cis</i> -Decahydronaphthalene	12.8	5.645	3.042	1.875	1.271	0.924
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene	6.192	3.243	1.948	1.289	0.917	0.689
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Decanoic acid				4.327	2.651	
C <sub>10</sub> H <sub>22</sub>	Decane	2.188	1.277	0.838	0.598	0.453	0.359
C <sub>10</sub> H <sub>22</sub> O	1-Decanol			10.9	4.590		
C <sub>11</sub> H <sub>24</sub>	Undecane		1.707	1.098	0.763	0.562	0.433
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether				2.130	1.407	1.023
C <sub>12</sub> H <sub>26</sub>	Dodecane		2.277	1.383	0.930	0.673	0.514
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane					1.265	0.929
C <sub>13</sub> H <sub>28</sub>	Tridecane		2.909	1.724	1.129	0.796	0.594
C <sub>14</sub> H <sub>30</sub>	Tetradecane			2.128	1.376	0.953	0.697
C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Dibutyl phthalate	483	66.4	16.6	6.470	3.495	2.425
C <sub>16</sub> H <sub>34</sub>	Hexadecane			3.032	1.879	1.260	0.899
C <sub>18</sub> H <sub>38</sub>	Octadecane				2.487	1.609	1.132

## THERMAL CONDUCTIVITY OF GASES

This table gives the thermal conductivity of several gases as a function of temperature. Unless otherwise noted, the values refer to a pressure of 100 kPa (1 bar) or to the saturation vapor pressure if that is less than 100 kPa. The notation  $P = 0$  indicates the low

pressure limiting value is given. In general, the  $P = 0$  and  $P = 100$  kPa values differ by less than 1%. Units are milliwatts per meter kelvin. Substances are listed in the modified Hill order.

MF	Name	Thermal conductivity in mW/m K						Ref.
		100 K	200 K	300 K	400 K	500 K	600 K	
	Air	9.4	18.4	26.2	33.3	39.7	45.7	1
Ar	Argon	6.2	12.4	17.9	22.6	26.8	30.6	2,8
BF <sub>3</sub>	Boron trifluoride			19.0	24.6			11
ClH	Hydrogen chloride		9.2	14.5	19.5	24.0	28.1	11
F <sub>6</sub> S	Sulfur hexafluoride ( $P = 0$ )			13.0	20.6	27.5	33.8	16
H <sub>2</sub>	Hydrogen ( $P = 0$ )	68.6	131.7	186.9	230.4			4
H <sub>2</sub> O	Water			18.7	27.1	35.7	47.1	6
	Deuterium oxide				27.0	36.5	47.6	7
H <sub>2</sub> S	Hydrogen sulfide			14.6	20.5	26.4	32.4	11
H <sub>3</sub> N	Ammonia			24.4	37.4	51.6	66.8	11
He	Helium ( $P = 0$ )	75.5	119.3	156.7	190.6	222.3	252.4	8
Kr	Krypton ( $P = 0$ )	3.3	6.4	9.5	12.3	14.8	17.1	8
NO	Nitric oxide		17.8	25.9	33.1	39.6	46.2	11
N <sub>2</sub>	Nitrogen	9.8	18.7	26.0	32.3	38.3	44.0	12
N <sub>2</sub> O	Nitrous oxide		9.8	17.4	26.0	34.1	41.8	11
Ne	Neon ( $P = 0$ )	22.3	37.6	49.8	60.3	69.9	78.7	8
O <sub>2</sub>	Oxygen	9.3	18.4	26.3	33.7	41.0	48.1	10
O <sub>2</sub> S	Sulfur dioxide			9.6	14.3	20.0	25.6	11
Xe	Xenon ( $P = 0$ )	2.0	3.6	5.5	7.3	8.9	10.4	8
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane			9.9	15.0	20.1	25.2	13
CF <sub>4</sub>	Tetrafluoromethane ( $P = 0$ )			16.0	24.1	32.2	39.9	16
CO	Carbon monoxide ( $P = 0$ )			25.0	32.3	39.2	45.7	14
CO <sub>2</sub>	Carbon dioxide		9.6	16.8	25.1	33.5	41.6	9
CHCl <sub>3</sub>	Trichloromethane			7.5	11.1	15.1		11
CH <sub>4</sub>	Methane		22.5	34.1	49.1	66.5	84.1	5,15
CH <sub>4</sub> O	Methanol				26.2	38.6	53.0	11
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichlorotetrafluoroethane			10.25	15.7	21.1		13
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichlorotrifluoroethane			9.0	13.6	18.3		13
C <sub>2</sub> H <sub>2</sub>	Acetylene			21.4	33.3	45.4	56.8	11
C <sub>2</sub> H <sub>4</sub>	Ethylene		11.1	20.5	34.6	49.9	68.6	3
C <sub>2</sub> H <sub>6</sub>	Ethane		11.0	21.3	35.4	52.2	70.5	5
C <sub>2</sub> H <sub>6</sub> O	Ethanol			14.4	25.8	38.4	53.2	11
C <sub>3</sub> H <sub>6</sub> O	Acetone			11.5	20.2	30.6	42.7	11
C <sub>3</sub> H <sub>8</sub>	Propane			18.0	30.6	45.5	61.9	5
C <sub>4</sub> F <sub>8</sub>	Perfluorocyclobutane			12.5	19.5			13
C <sub>4</sub> H <sub>10</sub>	Butane			16.4	28.4	43.0	59.1	5
C <sub>4</sub> H <sub>10</sub>	Isobutane			16.1	27.9	42.1	57.6	5
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether			15.1	25.0	37.1		11
C <sub>5</sub> H <sub>12</sub>	Pentane			14.4	24.9	37.8	52.7	11
C <sub>6</sub> H <sub>14</sub>	Hexane				23.4	35.4	48.7	11

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## THERMAL CONDUCTIVITY OF LIQUIDS

This table gives the thermal conductivity of about 275 liquids at temperatures between  $-25$  and  $100$  °C. Values refer to nominal atmospheric pressure; when an entry is given for a temperature above the normal boiling point of the liquid, the pressure is understood to be the saturation vapor pressure at that temperature. Reference 1 contains data on many of these liquids at high pressures. Data on halocarbon refrigerants over a wide range of temperature and pressure may be found in Reference 6.

Values given to three decimal places (i.e., to  $0.001$  W/m K) have an uncertainty of 2% to 5%. Values given to  $0.0001$  W/m K should be accurate to 1% or better.

Substances are arranged by molecular formula in Hill order, except that compounds not containing carbon precede those that do contain carbon.

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Molecular formula	Name	Thermal conductivity in W/m K						Ref.
		$-25$ °C	$0$ °C	$25$ °C	$50$ °C	$75$ °C	$100$ °C	
Cl <sub>4</sub> Ge	Germanium(IV) chloride	0.111	0.105	0.100	0.095	0.090	0.084	1
Cl <sub>4</sub> Si	Tetrachlorosilane			0.099	0.096			2
Cl <sub>4</sub> Sn	Tin(IV) chloride	0.123	0.117	0.112	0.106	0.101	0.095	1
Cl <sub>4</sub> Ti	Titanium(IV) chloride		0.143	0.138	0.134	0.129	0.124	1
H <sub>2</sub> O	Water		0.5562	0.6062	0.6423	0.6643	0.6729	8
Hg	Mercury	7.85	8.175	8.514	8.842	9.161	9.475	11
CCl <sub>3</sub> F	Trichlorofluoromethane	0.102	0.096	0.089	0.083	0.076	0.070	1
CCl <sub>4</sub>	Tetrachloromethane		0.109	0.103	0.098	0.092	0.087	1
CHCl <sub>3</sub>	Trichloromethane	0.127	0.122	0.117	0.112	0.107	0.102	2
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	0.120	0.114	0.108	0.103	0.097		2
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	0.158	0.149	0.140	0.133	0.128	0.127	1
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane			0.098	0.093	0.088	0.083	1
CH <sub>2</sub> O <sub>2</sub>	Formic acid			0.267	0.265	0.263	0.261	1
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	0.226	0.215	0.204	0.193	0.182	0.171	1
CH <sub>4</sub> O	Methanol	0.218	0.210	0.202	0.195	0.189	0.182	1
CS <sub>2</sub>	Carbon disulfide		0.154	0.149				2
C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	1,2-Dibromotetrafluoroethane	0.071	0.066	0.061	0.057	0.053	0.049	1
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichloro-1,2,2-trifluoroethane	0.0847	0.0790	0.0736	0.0683			6
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethene		0.117	0.110	0.104	0.098	0.093	1
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,2,2-Tetrachloro-1,2-difluoroethane			0.082	0.078	0.074	0.069	1
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethene	0.128	0.121	0.114	0.106	0.098	0.090	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane	0.124	0.118	0.111	0.104	0.098	0.091	1
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane		0.106	0.101	0.096			2
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	0.208	0.198	0.188	0.178	0.168		2
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane			0.100	0.096	0.092	0.088	1
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	0.144	0.139	0.133	0.128	0.122	0.117	1
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid			0.158	0.153	0.149	0.144	2
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate		0.194	0.187				1
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	0.107	0.104	0.101				1
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	0.145	0.132	0.119	0.106	0.093		2
C <sub>2</sub> H <sub>5</sub> I	Iodoethane		0.091	0.087	0.083	0.079		1
C <sub>2</sub> H <sub>5</sub> NO	N-Methylformamide			0.203	0.201	0.199	0.196	2
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane			0.173	0.161	0.149		1
C <sub>2</sub> H <sub>6</sub> O	Ethanol	0.181	0.174	0.167	0.160	0.153	0.148	1
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	1,2-Ethanediol		0.248	0.254	0.258	0.261	0.261	1
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine			0.240	0.238	0.236		1



Molecular formula	Name	Thermal conductivity in W/m K							Ref.
		-25 °C	0° C	25 °C	50 °C	75 °C	100 °C		
C <sub>3</sub> F <sub>8</sub>	Perfluoropropane	0.062	0.056	0.051	0.046	0.041	0.035	1	
C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile	0.186	0.176	0.166	0.156	0.146	0.136	1	
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	0.142	0.137	0.131	0.125	0.119	0.114	2	
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol			0.162				1	
C <sub>3</sub> H <sub>6</sub> O	Acetone		0.169	0.161				2	
C <sub>3</sub> H <sub>6</sub> O	Methyloxirane		0.181	0.171				1	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid		0.147	0.144	0.141	0.139	0.136	1	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	0.181	0.171	0.160	0.149	0.138		1	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	0.174	0.164	0.153	0.143	0.133	0.122	2	
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	0.108	0.104	0.099	0.094			1	
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	0.129	0.123	0.116	0.110	0.104	0.098	1	
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	0.096	0.092	0.087	0.083	0.078	0.074	1	
C <sub>3</sub> H <sub>7</sub> I	2-Iodopropane	0.089	0.085	0.082	0.078	0.074	0.071	1	
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide			0.183	0.175	0.167	0.159	1	
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane			0.152	0.144	0.137		1	
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	0.162	0.158	0.154	0.149	0.145	0.141	2	
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	0.146	0.141	0.135	0.129	0.124	0.118	2	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Propanediol	0.199	0.200	0.200	0.200	0.199	0.197	1	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyethanol			0.190	0.180	0.170		1	
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol			0.285	0.288	0.292	0.296	1	
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	0.143	0.133					2	
C <sub>4</sub> F <sub>8</sub>	Perfluorocyclobutane	0.082	0.072	0.063	0.053	0.044	0.034	1	
C <sub>4</sub> H <sub>4</sub> O	Furan	0.142	0.134	0.126				2	
C <sub>4</sub> H <sub>4</sub> S	Thiophene			0.199	0.195	0.191	0.186	2	
C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene	0.147	0.134					1	
C <sub>4</sub> H <sub>6</sub>	2-Butyne	0.137	0.129	0.121				2	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate			0.151	0.141	0.131	0.120	1	
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride		0.170	0.164	0.158	0.152	0.146	1	
C <sub>4</sub> H <sub>8</sub> O	Butanal		0.155	0.147	0.140	0.132		1	
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	0.158	0.151	0.145	0.139	0.133		2	
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	0.132	0.126	0.120	0.114			2	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate		0.151	0.144	0.137	0.130		1	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate		0.151	0.144	0.136			1	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate			0.141	0.137			1	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane			0.159	0.147	0.135	0.123	2	
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	0.112	0.107	0.103	0.098	0.093	0.088	1	
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane		0.094	0.090	0.085	0.081	0.077	1	
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide			0.175	0.172	0.168		1	
C <sub>4</sub> H <sub>10</sub> O	1-Butanol		0.158	0.153	0.147	0.142	0.137	1	
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol			0.112	0.110	0.109	0.108	1	
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	0.150	0.140	0.130	0.120	0.110	0.100	2	
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	2-Ethoxyethanol			0.190	0.182	0.174	0.165	1	
C <sub>5</sub> H <sub>5</sub> N	Pyridine		0.171	0.166	0.162	0.157	0.153	1	
C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	Furfuryl alcohol			0.179				1	
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	0.141	0.130	0.119				1	
C <sub>5</sub> H <sub>8</sub>	1-Pentyne	0.144	0.136	0.127	0.119			1	
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	0.143	0.136	0.129				2	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate		0.156	0.147	0.137	0.127	0.117	1	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione			0.154	0.150	0.146	0.143	1	
C <sub>5</sub> H <sub>9</sub> NO	<i>N</i> -Methyl-2-pyrrolidone			0.167	0.162	0.157		1	
C <sub>5</sub> H <sub>10</sub>	1-Pentene	0.131	0.124	0.116				2	
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	0.140	0.133	0.126				2	
C <sub>5</sub> H <sub>10</sub> O	Pentanal		0.146	0.139	0.133	0.127	0.121	1	
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone		0.149	0.142	0.135	0.128	0.121	1	
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone		0.151	0.144	0.137	0.129	0.122	1	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid			0.140	0.137	0.133	0.130	1	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate			0.136	0.130	0.123	0.117	1	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate		0.146	0.140	0.135	0.130	0.124	1	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate				0.133	0.121		1	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate			0.140				1	
C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane	0.113	0.109	0.105	0.101	0.097	0.093	1	
C <sub>5</sub> H <sub>11</sub> Cl	1-Chloropentane		0.125	0.120	0.115	0.109		1	

Molecular formula	Name	Thermal conductivity in W/m K							Ref.
		-25 °C	0° C	25 °C	50 °C	75 °C	100 °C		
C <sub>5</sub> H <sub>11</sub> I	1-Iodopentane		0.096	0.092	0.088	0.084	0.081	1	
C <sub>5</sub> H <sub>12</sub>	Pentane	0.130	0.1207	0.1113	0.1018	0.0923	0.083	4	
C <sub>5</sub> H <sub>12</sub>	Isopentane			0.111				1	
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	0.159	0.155	0.150	0.145	0.141	0.136	1	
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol		0.119	0.116	0.113	0.109	0.106	1	
C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	1,5-Pentanediol		0.221	0.222				1	
C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	Diethylene glycol monomethyl ether			0.190	0.185	0.180	0.175	1	
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene				0.083			1	
C <sub>6</sub> F <sub>14</sub>	Perfluorohexane		0.067	0.065	0.064			1	
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,3-Trichlorobenzene				0.110	0.108	0.106	1	
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,4-Trichlorobenzene			0.112	0.109	0.106		1	
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene		0.125	0.121	0.117	0.113	0.109	1	
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene		0.120	0.116	0.113	0.109		1	
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene				0.112	0.108	0.105	1	
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	0.119	0.115	0.111	0.107	0.103	0.099	1	
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	0.137	0.132	0.127	0.123	0.118	0.113	1	
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene			0.136	0.131	0.126		1	
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	0.106	0.103	0.101	0.098	0.095	0.092	1	
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene			0.149	0.145	0.142	0.139	1	
C <sub>6</sub> H <sub>6</sub>	Benzene			0.1411	0.1329	0.1247		7	
C <sub>6</sub> H <sub>6</sub> ClN	2-Chloroaniline			0.148				1	
C <sub>6</sub> H <sub>6</sub> O	Phenol				0.153	0.149	0.147	1	
C <sub>6</sub> H <sub>7</sub> N	Aniline		0.175					1	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Hexanedinitrile			0.174	0.168			1	
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	0.142	0.136	0.130	0.124	0.118		2	
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone			0.138	0.134	0.130	0.126	1	
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide	0.170	0.163	0.156	0.149	0.142	0.134	2	
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate			0.155	0.152	0.148	0.144	1	
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate			0.157				1	
C <sub>6</sub> H <sub>12</sub>	1-Hexene	0.138	0.129	0.121	0.113			1	
C <sub>6</sub> H <sub>12</sub>	Cyclohexane			0.123	0.117	0.111		2	
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone		0.156	0.145	0.134	0.124	0.115	1	
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol			0.138	0.134	0.130	0.126	1	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid		0.148	0.142	0.137	0.131		1	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate		0.143	0.136	0.130	0.123	0.116	1	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Propyl propanoate				0.133			1	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Ethyl butanoate		0.143	0.137	0.131	0.126		1	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl pentanoate		0.143	0.138	0.132	0.127		1	
C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Paraldehyde			0.130				1	
C <sub>6</sub> H <sub>13</sub> Br	1-Bromohexane	0.115	0.111	0.108	0.104	0.101	0.097	1	
C <sub>6</sub> H <sub>13</sub> I	1-Iodohexane		0.098	0.095	0.091	0.088	0.084	1	
C <sub>6</sub> H <sub>14</sub>	Hexane	0.133	0.1250	0.1167	0.1083	0.0999	0.092	4	
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	0.120	0.1127	0.1050	0.0972	0.0894	0.082	3	
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	0.122	0.1142	0.1064	0.0986	0.0909	0.083	3	
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane	0.108	0.1006	0.0934	0.0861	0.0788	0.072	3	
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	0.115	0.1076	0.1003	0.0930	0.0857	0.078	3	
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	0.161	0.157	0.152	0.147	0.142	0.137	1	
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether		0.137	0.130	0.123	0.117		1	
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,2-Diethoxyethane				0.140	0.133	0.125	1	
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol monoethyl ether				0.188	0.184	0.180	1	
C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	Triethylene glycol		0.193	0.195	0.196	0.196	0.196	1	
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	0.146	0.139	0.132	0.125	0.118	0.111	1	
C <sub>7</sub> F <sub>16</sub>	Perfluoroheptane	0.068	0.064	0.060	0.056	0.053		1	
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile			0.148	0.142	0.136	0.130	1	
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde			0.153	0.148	0.143	0.139	1	
C <sub>7</sub> H <sub>8</sub>	Toluene	0.1455	0.1385	0.1310	0.1235	0.1162	0.1095	9	
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol							1	
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol			0.149	0.147	0.145		1	
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol			0.159	0.158	0.156	0.154	1	
C <sub>7</sub> H <sub>8</sub> O	Anisole			0.145	0.142	0.139	0.136	1	
C <sub>7</sub> H <sub>9</sub> N	2-Methylaniline			0.162				1	
C <sub>7</sub> H <sub>9</sub> N	3-Methylaniline			0.161				1	

Molecular formula	Name	Thermal conductivity in W/m K							Ref.
		-25 °C	0° C	25 °C	50 °C	75 °C	100 °C		
C <sub>7</sub> H <sub>14</sub>	1-Heptene	0.139	0.132	0.125	0.118	0.111			1
C <sub>7</sub> H <sub>14</sub>	Cycloheptane			0.123	0.118	0.112	0.108		1
C <sub>7</sub> H <sub>14</sub> O	Heptanal			0.140					1
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone		0.143	0.137	0.131	0.125	0.119		1
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone			0.136	0.131	0.125	0.120		1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Hexyl formate			0.141	0.133	0.126	0.119		1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid			0.140	0.137	0.133			1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Pentyl acetate		0.141	0.134	0.126	0.120	0.113		1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Butyl propanoate			0.139	0.133	0.126	0.121		1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Ethyl pentanoate			0.132					1
C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Methyl hexanoate			0.136	0.131	0.126	0.121		1
C <sub>7</sub> H <sub>16</sub>	Heptane	0.1378	0.1303	0.1228	0.1152	0.1077			5
C <sub>7</sub> H <sub>16</sub>	2-Methylhexane	0.125	0.1177	0.1105	0.1033	0.0961	0.089		3
C <sub>7</sub> H <sub>16</sub>	3-Methylhexane	0.126	0.1184	0.1112	0.1040	0.0968	0.090		3
C <sub>7</sub> H <sub>16</sub>	3-Ethylpentane	0.128	0.1203	0.1128	0.1053	0.0978	0.090		3
C <sub>7</sub> H <sub>16</sub>	2,2-Dimethylpentane	0.111	0.1046	0.0980	0.0913	0.0847	0.078		3
C <sub>7</sub> H <sub>16</sub>	2,3-Dimethylpentane	0.120	0.1127	0.1059	0.0990	0.0922	0.085		3
C <sub>7</sub> H <sub>16</sub>	2,4-Dimethylpentane	0.116	0.1089	0.1020	0.0951	0.0882	0.081		3
C <sub>7</sub> H <sub>16</sub>	3,3-Dimethylpentane	0.113	0.1068	0.1001	0.0934	0.0867	0.080		3
C <sub>7</sub> H <sub>16</sub>	2,2,3-Trimethylbutane	0.107	0.1011	0.0950	0.0889	0.0828	0.077		3
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	0.160	0.158	0.153	0.149	0.144	0.139		1
C <sub>8</sub> F <sub>18</sub>	Perfluorooctane		0.066	0.062	0.059	0.055	0.052		1
C <sub>8</sub> H <sub>8</sub>	Styrene	0.148	0.142	0.137	0.131	0.126	0.120		2
C <sub>8</sub> H <sub>8</sub> O	Acetophenone			0.147	0.146	0.144	0.142		1
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate			0.147					1
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	0.143	0.137	0.130	0.123	0.116	0.110		1
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene			0.131	0.126	0.120	0.114		2
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene			0.130	0.124	0.118	0.113		2
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene			0.130	0.124	0.118	0.112		2
C <sub>8</sub> H <sub>10</sub> O	Ethoxybenzene	0.151	0.145	0.140	0.135	0.130			1
C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	2-Phenoxyethanol			0.169	0.168	0.166	0.165		1
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline			0.150					1
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline			0.122	0.119	0.115			1
C <sub>8</sub> H <sub>16</sub>	1-Octene	0.139	0.133	0.126	0.120	0.114	0.107		1
C <sub>8</sub> H <sub>16</sub> O	2-Octanone		0.141	0.135	0.129	0.124	0.118		1
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Heptyl formate		0.141	0.137	0.132	0.128	0.123		1
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid			0.146	0.143	0.139	0.135		1
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Hexyl acetate			0.135	0.129	0.123	0.118		1
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Pentyl propanoate			0.138	0.132				1
C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Ethyl hexanoate		0.142	0.137	0.133	0.128	0.123		1
C <sub>8</sub> H <sub>17</sub> Cl	1-Chlorooctane		0.130	0.127	0.124	0.121	0.119		1
C <sub>8</sub> H <sub>18</sub>	Octane	0.139	0.1317	0.1244	0.1171	0.1097	0.102		4
C <sub>8</sub> H <sub>18</sub>	2-Methylheptane	0.127	0.1206	0.1139	0.1072	0.1005	0.094		3
C <sub>8</sub> H <sub>18</sub>	3-Methylheptane	0.128	0.1216	0.1149	0.1081	0.1014	0.095		3
C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	0.107	0.1007	0.0948	0.0888	0.0829	0.077		3
C <sub>8</sub> H <sub>18</sub>	2,3,4-Trimethylpentane	0.115	0.1093	0.1035	0.0976	0.0918	0.086		3
C <sub>8</sub> H <sub>18</sub> O	Ethyl hexyl ether		0.131	0.126	0.120	0.114	0.109		1
C <sub>8</sub> H <sub>18</sub> O	1-Octanol		0.162	0.158	0.153	0.148	0.143		1
C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether		0.139	0.132	0.125	0.118	0.112		1
C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Diethylene glycol monobutyl ether			0.163	0.158	0.153	0.148		1
C <sub>8</sub> H <sub>18</sub> O <sub>4</sub>	Triethylene glycol dimethyl ether			0.169	0.158	0.147			1
C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>	Tetraethylene glycol			0.191	0.192				1
C <sub>9</sub> H <sub>7</sub> N	Quinoline			0.147	0.144	0.141	0.138		1
C <sub>9</sub> H <sub>10</sub>	Indan			0.135					1
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate			0.141					1
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	0.134	0.130	0.125	0.120	0.115	0.109		1
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	0.132	0.128	0.123	0.118	0.112	0.107		1
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene			0.129	0.124	0.118	0.114		1
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	0.143	0.139	0.134	0.129	0.123	0.117		1
C <sub>9</sub> H <sub>18</sub>	1-Nonene	0.136	0.130	0.123	0.116	0.110	0.104		1
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid			0.150	0.146	0.142	0.138		1
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Heptyl acetate			0.135	0.128	0.122	0.116		1

Molecular formula	Name	Thermal conductivity in W/m K						Ref.
		-25 °C	0° C	25 °C	50 °C	75 °C	100 °C	
C <sub>9</sub> H <sub>19</sub> Br	1-Bromononane		0.116	0.112	0.109	0.106	0.103	1
C <sub>9</sub> H <sub>19</sub> Cl	1-Chlorononane		0.132	0.128	0.124	0.120	0.115	1
C <sub>9</sub> H <sub>19</sub> I	1-Iodononane		0.105	0.102	0.099	0.095	0.092	1
C <sub>9</sub> H <sub>20</sub>	Nonane	0.141	0.1337	0.1269	0.1201	0.1133	0.106	4
C <sub>9</sub> H <sub>20</sub> O	1-Nonanol		0.164	0.159	0.155	0.150	0.145	1
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene			0.110	0.109	0.108	0.106	1
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene			0.126				1
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl phthalate			0.1473	0.1443	0.1409	0.1373	10
C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene			0.131	0.129	0.128	0.126	1
C <sub>10</sub> H <sub>14</sub>	Butylbenzene			0.126	0.121	0.116	0.111	1
C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene, (±)-		0.129	0.124	0.119	0.114	0.108	1
C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene			0.117	0.114	0.110	0.106	1
C <sub>10</sub> H <sub>14</sub>	1-Isopropyl-4-methylbenzene	0.132	0.127	0.122	0.117	0.112	0.107	2
C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Diethylbenzene		0.133	0.127	0.122	0.116	0.111	1
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene			0.113				1
C <sub>10</sub> H <sub>20</sub>	1-Decene	0.138	0.132	0.126	0.120	0.114	0.109	1
C <sub>10</sub> H <sub>20</sub> O	Decanal		0.149	0.144	0.139	0.134	0.129	1
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Heptyl propanoate			0.137	0.132	0.127	0.122	1
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Hexyl butanoate			0.137	0.132	0.127	0.121	1
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Decanoic acid				0.148	0.144	0.140	1
C <sub>10</sub> H <sub>22</sub>	Decane	0.142	0.1360	0.1296	0.1232	0.1167	0.110	4
C <sub>10</sub> H <sub>22</sub> O	1-Decanol			0.162	0.159	0.155	0.151	1
C <sub>10</sub> H <sub>22</sub> O	Dipentyl ether			0.131	0.125	0.121	0.116	1
C <sub>10</sub> H <sub>22</sub> O <sub>2</sub>	1,2-Dibutoxyethane			0.140	0.134	0.127	0.120	1
C <sub>11</sub> H <sub>16</sub>	Pentylbenzene		0.135	0.130	0.125	0.120	0.115	1
C <sub>11</sub> H <sub>22</sub>	1-Undecene			0.126	0.118	0.114	0.108	1
C <sub>11</sub> H <sub>22</sub> O	6-Undecanone			0.137	0.132	0.127		1
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Undecanoic acid				0.153	0.149		1
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Octyl propanoate			0.135	0.130	0.125	0.120	1
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Heptyl butanoate			0.139	0.134	0.129	0.123	1
C <sub>11</sub> H <sub>24</sub>	Undecane			0.136	0.128	0.122	0.116	1
C <sub>11</sub> H <sub>24</sub> O	1-Undecanol			0.169	0.165	0.161	0.158	1
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether				0.139	0.135	0.131	2
C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	Diethyl phthalate			0.172	0.169	0.166		1
C <sub>12</sub> H <sub>16</sub>	Cyclohexylbenzene			0.121	0.119	0.117		1
C <sub>12</sub> H <sub>18</sub>	Hexylbenzene		0.141	0.137	0.132	0.128	0.124	1
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Decyl acetate			0.146	0.136	0.126		1
C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Octyl butanoate			0.139	0.134	0.129	0.125	1
C <sub>12</sub> H <sub>26</sub>	Dodecane			0.135	0.130	0.124	0.119	1
C <sub>12</sub> H <sub>26</sub> O	1-Dodecanol				0.167	0.163	0.159	1
C <sub>12</sub> H <sub>26</sub> O <sub>3</sub>	Diethylene glycol dibutyl ether		0.150	0.146	0.143	0.139	0.135	1
C <sub>12</sub> H <sub>27</sub> N	Tributylamine			0.129				1
C <sub>13</sub> H <sub>26</sub>	1-Tridecene			0.130	0.125	0.120	0.115	1
C <sub>13</sub> H <sub>28</sub>	Tridecane			0.130	0.125	0.120	0.115	1
C <sub>14</sub> H <sub>28</sub>	1-Tetradecene			0.136	0.131	0.126	0.121	1
C <sub>14</sub> H <sub>30</sub>	Tetradecane			0.139	0.134	0.129	0.124	1
C <sub>14</sub> H <sub>30</sub> O	1-Tetradecanol				0.167	0.162	0.157	2
C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	Dibutyl phthalate		0.139	0.136	0.134	0.131	0.129	1
C <sub>16</sub> H <sub>34</sub>	Hexadecane			0.140	0.135	0.130	0.125	2
C <sub>18</sub> H <sub>38</sub>	Octadecane				0.146	0.142	0.137	2
C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Butyl palmitate			0.151	0.148	0.144	0.140	1
C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	Butyl oleate			0.157	0.153	0.149	0.145	1
C <sub>22</sub> H <sub>42</sub> O <sub>4</sub>	Diocetyl hexanedioate			0.157	0.153	0.149	0.145	1

## DIFFUSION IN GASES

This table gives binary diffusion coefficients  $D_{12}$  for a number of common gases as a function of temperature. Values refer to atmospheric pressure. The diffusion coefficient is inversely proportional to pressure as long as the gas is in a regime where binary collisions dominate. See Reference 1 for a discussion of the dependence of  $D_{12}$  on temperature and composition.

The first part of the table gives data for several gases in the presence of a large excess of air. The remainder applies to equimolar

mixtures of gases. Each gas pair is ordered alphabetically according to the most common way of writing the formula. The listing of pairs then follows alphabetical order by the first constituent.

### References

1. Marrero, T. R., and Mason, E. A., *J. Phys. Chem. Ref. Data*, 1, 1, 1972.
2. Kestin, J., et al., *J. Phys. Chem. Ref. Data*, 13, 229, 1984.

### $D_{12}/\text{cm}^2 \text{ s}^{-1}$ for $p = 101.325 \text{ kPa}$ and the Specified $T/\text{K}$

System	200	273.15	293.15	373.15	473.15	573.15	673.15
<i>Large Excess of Air</i>							
Ar-air		0.167	0.189	0.289	0.437	0.612	0.810
CH <sub>4</sub> -air			0.210	0.321	0.485	0.678	0.899
CO-air			0.208	0.315	0.475	0.662	0.875
CO <sub>2</sub> -air			0.160	0.252	0.390	0.549	0.728
H <sub>2</sub> -air		0.668	0.756	1.153	1.747	2.444	3.238
H <sub>2</sub> O-air			0.242	0.399	0.638	0.873	1.135
He-air		0.617	0.697	1.057	1.594	2.221	2.933
SF <sub>6</sub> -air				0.150	0.233	0.329	0.438
<i>Equimolar Mixture</i>							
Ar-CH <sub>4</sub>				0.306	0.467	0.657	0.876
Ar-CO		0.168	0.190	0.290	0.439	0.615	0.815
Ar-CO <sub>2</sub>		0.129	0.148	0.235	0.365	0.517	0.689
Ar-H <sub>2</sub>		0.698	0.794	1.228	1.876	2.634	3.496
Ar-He	0.381	0.645	0.726	1.088	1.617	2.226	2.911
Ar-Kr	0.064	0.117	0.134	0.210	0.323	0.456	0.605
Ar-N <sub>2</sub>		0.168	0.190	0.290	0.439	0.615	0.815
Ar-Ne	0.160	0.277	0.313	0.475	0.710	0.979	1.283
Ar-O <sub>2</sub>		0.166	0.187	0.285	0.430	0.600	0.793
Ar-SF <sub>6</sub>				0.128	0.202	0.290	0.389
Ar-Xe	0.052	0.095	0.108	0.171	0.264	0.374	0.498
CH <sub>4</sub> -H <sub>2</sub>			0.708	1.084	1.648	2.311	3.070
CH <sub>4</sub> -He			0.650	0.992	1.502	2.101	2.784
CH <sub>4</sub> -N <sub>2</sub>			0.208	0.317	0.480	0.671	0.890
CH <sub>4</sub> -O <sub>2</sub>			0.220	0.341	0.523	0.736	0.978
CH <sub>4</sub> -SF <sub>6</sub>				0.167	0.257	0.363	0.482
CO-CO <sub>2</sub>			0.162	0.250	0.384		
CO-H <sub>2</sub>	0.408	0.686	0.772	1.162	1.743	2.423	3.196
CO-He	0.365	0.619	0.698	1.052	1.577	2.188	2.882
CO-Kr		0.131	0.149	0.227	0.346	0.485	0.645
CO-N <sub>2</sub>	0.133	0.208	0.231	0.336	0.491	0.673	0.878
CO-O <sub>2</sub>			0.202	0.307	0.462	0.643	0.849
CO-SF <sub>6</sub>				0.144	0.226	0.323	0.432
CO <sub>2</sub> -C <sub>3</sub> H <sub>8</sub>			0.084	0.133	0.209		
CO <sub>2</sub> -H <sub>2</sub>	0.315	0.552	0.627	0.964	1.470	2.066	2.745
CO <sub>2</sub> -H <sub>2</sub> O			0.162	0.292	0.496	0.741	1.021
CO <sub>2</sub> -He	0.300	0.513	0.580	0.878	1.321		
CO <sub>2</sub> -N <sub>2</sub>			0.160	0.253	0.392	0.553	0.733
CO <sub>2</sub> -N <sub>2</sub> O	0.055	0.099	0.113	0.177	0.276		
CO <sub>2</sub> -Ne	0.131	0.227	0.258	0.395	0.603	0.847	
CO <sub>2</sub> -O <sub>2</sub>			0.159	0.248	0.380	0.535	0.710
CO <sub>2</sub> -SF <sub>6</sub>				0.099	0.155		
D <sub>2</sub> -H <sub>2</sub>	0.631	1.079	1.219	1.846	2.778	3.866	5.103
H <sub>2</sub> -He	0.775	1.320	1.490	2.255	3.394	4.726	6.242
H <sub>2</sub> -Kr	0.340	0.601	0.682	1.053	1.607	2.258	2.999

System	200	273.15	293.15	373.15	473.15	573.15	673.15
H <sub>2</sub> -N <sub>2</sub>	0.408	0.686	0.772	1.162	1.743	2.423	3.196
H <sub>2</sub> -Ne	0.572	0.982	1.109	1.684	2.541	3.541	4.677
H <sub>2</sub> -O <sub>2</sub>		0.692	0.782	1.188	1.792	2.497	3.299
H <sub>2</sub> -SF <sub>6</sub>			0.412	0.649	0.998	1.400	1.851
H <sub>2</sub> -Xe		0.513	0.581	0.890	1.349	1.885	2.493
H <sub>2</sub> O-N <sub>2</sub>			0.242	0.399			
H <sub>2</sub> O-O <sub>2</sub>			0.244	0.403	0.645	0.882	1.147
He-Kr	0.330	0.559	0.629	0.942	1.404	1.942	2.550
He-N <sub>2</sub>	0.365	0.619	0.698	1.052	1.577	2.188	2.882
He-Ne	0.563	0.948	1.066	1.592	2.362	3.254	4.262
He-O <sub>2</sub>		0.641	0.723	1.092	1.640	2.276	2.996
He-SF <sub>6</sub>			0.400	0.592	0.871	1.190	1.545
He-Xe	0.282	0.478	0.538	0.807	1.201	1.655	2.168
Kr-N <sub>2</sub>		0.131	0.149	0.227	0.346	0.485	0.645
Kr-Ne	0.131	0.228	0.258	0.392	0.587	0.812	1.063
Kr-Xe	0.035	0.064	0.073	0.116	0.181	0.257	0.344
N <sub>2</sub> -Ne			0.317	0.483	0.731	1.021	1.351
N <sub>2</sub> -O <sub>2</sub>			0.202	0.307	0.462	0.643	0.849
N <sub>2</sub> -SF <sub>6</sub>				0.148	0.231	0.328	0.436
N <sub>2</sub> -Xe		0.107	0.122	0.188	0.287	0.404	0.539
Ne-Xe	0.111	0.193	0.219	0.332	0.498	0.688	0.901
O <sub>2</sub> -SF <sub>6</sub>			0.097	0.154	0.238	0.334	0.441

## DIFFUSION COEFFICIENTS IN LIQUIDS AT INFINITE DILUTION

This table lists diffusion coefficients  $D_{AB}$  at infinite dilution for some binary liquid mixtures. Values are given at 25°C when available; it should be noted that the diffusion coefficient generally increases by 10% to 20% for a 10°C increase above ambient temperature.

Solvents are listed in alphabetical order, as are the solutes within each solvent group.

Solute	Solvent	t/°C	$D_{AB}/10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ref.
Acetic acid	Acetone	25	3.31	5
Benzene	Acetone	25	4.25	2
Benzoic acid	Acetone	25	2.62	5
Formic acid	Acetone	25	3.77	5
Nitrobenzene	Acetone	20	2.94	5
Tetrachloromethane	Acetone	25	3.29	5
Trichloromethane	Acetone	25	3.64	5
Water	Acetone	25	4.56	5
Acetic acid	Benzene	25	2.09	5
Aniline	Benzene	25	1.96	5
Benzoic acid	Benzene	25	1.38	5
Bromobenzene	Benzene	8	1.45	5
2-Butanone	Benzene	30	2.09	5
Chloroethene	Benzene	8	1.77	5
Cyclohexane	Benzene	25	2.09	3
Ethanol	Benzene	25	3.02	5
Formic acid	Benzene	25	2.28	5
Heptane	Benzene	25	1.79	3
Methanol	Benzene	25	3.80	5
Toluene	Benzene	25	1.85	3
1,2,4-Trichlorobenzene	Benzene	8	1.34	5
Trichloromethane	Benzene	25	2.26	5
Benzene	1-Butanol	25	1.00	5
Biphenyl	1-Butanol	25	0.63	5
Butanoic acid	1-Butanol	30	0.51	5
<i>p</i> -Dichlorobenzene	1-Butanol	25	0.82	5
1,6-Hexanedioic acid	1-Butanol	30	0.40	5
Methanol	1-Butanol	30	0.59	5
<i>cis</i> -9-Octadecenoic acid	1-Butanol	30	0.25	5
Propane	1-Butanol	25	1.57	5
Water	1-Butanol	25	0.56	5
Benzene	Cyclohexane	25	1.92	1
Chlorobenzene	Cyclohexane	25	1.34	1
<i>p</i> -Chlorotoluene	Cyclohexane	25	1.28	1
Ethylbenzene	Cyclohexane	25	1.36	1
Naphthalene	Cyclohexane	25	1.18	1

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Solute	Solvent	t/°C	$D_{AB}/10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ref.
Perylene	Cyclohexane	25	0.79	1
Pyrene	Cyclohexane	25	0.95	1
Tetrachloromethane	Cyclohexane	25	1.49	3
Toluene	Cyclohexane	25	1.66	1
Benzene	Decane	25	2.16	1
Chlorobenzene	Decane	25	1.98	1
<i>p</i> -Chlorotoluene	Decane	25	1.80	1
Ethylbenzene	Decane	25	1.79	1
Naphthalene	Decane	25	1.65	1
Perylene	Decane	25	1.08	1
Pyrene	Decane	25	1.23	1
Toluene	Decane	25	1.93	1
Trichloromethane	Diethyl ether	25	4.48	3
Allyl alcohol	Ethanol	20	0.98	5
Benzene	Ethanol	25	1.88	2
Iodine	Ethanol	25	1.32	5
Iodobenzene	Ethanol	20	1.00	5
3-Methyl-1-butanol	Ethanol	20	0.81	5
Pyridine	Ethanol	20	1.10	5
Tetrachloromethane	Ethanol	25	1.50	5
Water	Ethanol	25	1.24	5
Acetic acid	Ethyl acetate	20	2.18	5
Acetone	Ethyl acetate	20	3.18	5
2-Butanone	Ethyl acetate	30	2.93	5
Ethyl benzoate	Ethyl acetate	20	1.85	5
Nitrobenzene	Ethyl acetate	20	2.25	5
Water	Ethyl acetate	25	3.20	5
Benzene	Heptane	25	3.75	1
Chlorobenzene	Heptane	25	3.42	1
<i>p</i> -Chlorotoluene	Heptane	25	3.11	1
Ethylbenzene	Heptane	25	3.15	1
Naphthalene	Heptane	25	2.81	1
Perylene	Heptane	25	1.89	1
Pyrene	Heptane	25	2.16	1
Toluene	Heptane	25	3.42	1
Benzene	Hexane	25	4.70	1
Bromobenzene	Hexane	8	2.60	5

Solute	Solvent	t/°C	$D_{AB}/10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ref.	Solute	Solvent	t/°C	$D_{AB}/10^{-5} \text{ cm}^2 \text{ s}^{-1}$	Ref.
2-Butanone	Hexane	30	3.74	5	Ethylbenzene	2,2,4-Trimethylpentane	30	2.63	4
Chlorobenzene	Hexane	25	4.16	1	Toluene	2,2,4-Trimethylpentane	30	3.15	4
<i>p</i> -Chlorotoluene	Hexane	25	3.74	1	1,3,5-Trimethylbenzene	2,2,4-Trimethylpentane	30	2.26	4
Dodecane	Hexane	25	2.73	5	<i>o</i> -Xylene	2,2,4-Trimethylpentane	30	2.62	4
Ethylbenzene	Hexane	25	3.73	1	<i>p</i> -Xylene	2,2,4-Trimethylpentane	30	3.03	4
Iodine	Hexane	25	4.45	5	Acetic acid	Water	25	1.29	5
Methane	Hexane	25	0.09	5	Acetone	Water	25	1.28	5
Naphthalene	Hexane	25	3.55	1	Acetonitrile	Water	15	1.26	5
Perylene	Hexane	25	2.30	1	<i>L</i> -Alanine	Water	25	0.91	5
Propane	Hexane	25	4.87	5	Allyl alcohol	Water	15	0.90	5
Pyrene	Hexane	25	2.58	1	Aniline	Water	20	0.92	5
Tetrachloromethane	Hexane	25	3.70	5	<i>DL</i> -Arabinose	Water	20	0.69	5
Toluene	Hexane	25	4.12	1	Benzene	Water	20	1.02	5
Benzene	Octane	25	3.19	1	1-Butanol	Water	25	0.56	5
Chlorobenzene	Octane	25	2.89	1	Caprolactam	Water	25	0.87	5
<i>p</i> -Chlorotoluene	Octane	25	2.62	1	Chloroethene	Water	25	1.34	5
Ethylbenzene	Octane	25	2.58	1	Cyclohexane	Water	20	0.84	5
Naphthalene	Octane	25	2.35	1	Diethylamine	Water	20	0.97	5
Perylene	Octane	25	1.58	1	1,2-Ethanediol	Water	25	1.16	5
Pyrene	Octane	25	1.81	1	Ethanol	Water	25	1.24	5
Toluene	Octane	25	2.83	1	Ethanolamine	Water	25	1.08	5
1,3,5-Trimethylbenzene	Octane	30	2.21	4	Ethyl acetate	Water	20	1.00	5
<i>o</i> -Xylene	Octane	30	2.65	4	Ethylbenzene	Water	20	0.81	5
<i>p</i> -Xylene	Octane	30	2.82	4	Ethyl carbamate	Water	15	0.80	5
Acetone	Tetrachloromethane	25	1.75	5	$\alpha$ - <i>D</i> -Glucose	Water	25	0.67	5
Benzene	Tetrachloromethane	25	1.42	5	Glycerol	Water	25	1.06	5
Cyclohexane	Tetrachloromethane	25	1.30	5	Glycine	Water	25	1.05	5
Ethanol	Tetrachloromethane	25	1.90	5	$\beta$ - <i>D</i> -Lactose	Water	15	0.38	5
Iodine	Tetrachloromethane	30	1.63	5	$\alpha$ -Maltose	Water	15	0.38	5
Trichloromethane	Tetrachloromethane	25	1.66	5	<i>D</i> -Mannitol	Water	15	0.50	5
Acetic acid	Toluene	25	2.26	5	Methane	Water	25	1.49	5
Benzene	Toluene	25	2.54	3	Methanol	Water	15	1.28	5
Benzoic acid	Toluene	25	1.49	5	3-Methyl-1-butanol	Water	10	0.69	5
Cyclohexane	Toluene	25	2.42	3	Methylcyclopentane	Water	20	0.85	5
Formic acid	Toluene	25	2.65	5	Phenol	Water	20	0.89	5
Water	Toluene	25	6.19	5	1-Propanol	Water	15	0.87	5
Acetone	Trichloromethane	25	2.55	5	Propene	Water	25	1.44	5
Benzene	Trichloromethane	25	2.89	5	Pyridine	Water	25	0.58	5
2-Butanone	Trichloromethane	25	2.13	5	Raffinose	Water	15	0.33	5
Butyl acetate	Trichloromethane	25	1.71	5	Sucrose	Water	25	0.52	5
Cyclohexane	Trichloromethane	25	1.28	3	Toluene	Water	20	0.85	5
Diethyl ether	Trichloromethane	25	2.13	3	Urea	Water	25	1.38	5
Ethanol	Trichloromethane	15	2.20	5					
Ethyl acetate	Trichloromethane	25	2.02	5					
Benzene	2,2,4-Trimethylpentane	30	3.46	4					



## VAPOR PRESSURE OF SATURATED SALT SOLUTIONS

This table gives the vapor pressure of water above saturated solutions of some common salts at ambient temperatures. Data on pure water are given on the last line for comparison.

The references provide additional information on water activity, osmotic coefficient, and enthalpy of vaporization.

### References

1. Apelblat, A., *J. Chem. Thermodynamics*, 24, 619, 1992.
2. Apelblat, A., *J. Chem. Thermodynamics*, 25, 63, 1993.
3. Apelblat, A., *J. Chem. Thermodynamics*, 25, 1513, 1993.
4. Apelblat, A. and Korin, E., *J. Chem. Thermodynamics*, 30, 59, 1998.

Salt	Vapor Pressure in kPa							Ref.
	10°C	15°C	20°C	25°C	30°C	35°C	40°C	
BaCl <sub>2</sub>	0.971	1.443	2.073	2.887	3.903	5.133	6.576	1
Ca(NO <sub>3</sub> ) <sub>2</sub>	0.701	1.015	1.381	1.772	2.154	2.487		1
CuSO <sub>4</sub>	1.113	1.574	2.189	2.996	4.037	5.363		3
FeSO <sub>4</sub>	0.978	1.516	2.208	3.035	3.950	4.884		3
KBr	0.953	1.338	1.853	2.533	3.419	4.563		3
KIO <sub>3</sub>	1.100	1.564	2.177	2.970	3.979	5.236	6.778	4
K <sub>2</sub> CO <sub>3</sub>	0.541	0.802	1.134	1.536	1.997	2.499	3.016	1
LiCl	0.128	0.193	0.279	0.384				2
Mg(NO <sub>3</sub> ) <sub>2</sub>	0.726	0.999	1.339	1.749	2.231	2.782	3.397	1
MnCl <sub>2</sub>	0.697	1.064	1.515	2.020	2.535	3.002		3
NH <sub>4</sub> Cl	0.971	1.328	1.836	2.481				2
NH <sub>4</sub> NO <sub>3</sub>	0.853	1.152	1.524	1.972				2
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	0.901	1.319	1.871	2.573	3.439	4.474		3
NaBr	0.722	1.004	1.376	1.858	2.475	3.255	4.229	4
NaCl	0.921	1.285	1.768	2.401	3.218	4.262	5.581	4
NaNO <sub>2</sub>	0.703	0.994	1.381	1.888	2.540	3.368	4.403	4
NaNO <sub>3</sub>	0.884	1.244	1.719	2.335	3.121	4.109	5.333	4
RbCl	0.862	1.215	1.684	2.298	3.088	4.089	5.343	4
ZnSO <sub>4</sub>	0.945	1.401	1.986	2.698	3.523	4.431	5.382	1
Water	1.228	1.706	2.339	3.169	4.246	5.627	7.381	

## DIFFUSION OF GASES IN WATER

This table gives values of the diffusion coefficient,  $D$ , for diffusion of several common gases in water at various temperatures. For simple one-dimensional transport, the diffusion coefficient describes the time-rate of change of concentration,  $dc/dt$ , through the equation

$$dc/dt = D d^2c/dx^2$$

where  $x$  is, for example, the perpendicular distance from a gas-liquid interface. The values below have been selected from the references indicated; in some cases data have been refitted to permit interpolation in temperature.

Gas-liquid diffusion coefficients are difficult to measure, and large differences are found between values obtained by differ-

ent authors and through different experimental methods. See References 1 and 2 for a discussion of measurement techniques.

### References

1. Jähne, B., Heinz, G., and Dietrich, W., *J. Geophys. Res.*, 92, 10767, 1987.
2. Himmelblau, D. M., *Chem. Rev.*, 64, 527, 1964.
3. Boerboom, A. J. H., and Kleyn, G., *J. Chem. Phys.*, 50, 1086, 1969.
4. O'Brien, R. N., and Hyslop, W. F., *Can. J. Chem.*, 55, 1415, 1977.
5. Maharajh, D. M., and Walkley, J., *Can. J. Chem.*, 51, 944, 1973.
6. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, Sixth Edition, II/5a, Transport Phenomena I (Viscosity and Diffusion)*, Springer-Verlag, Heidelberg, 1969.

	$D/10^{-5} \text{ cm}^2 \text{ s}^{-1}$						Ref.
	10°C	15°C	20°C	25°C	30°C	35°C	
Ar				2.5			3,4
CHCl <sub>2</sub> F				1.80			5
CH <sub>2</sub> Br				1.35			5
CH <sub>2</sub> Cl				1.40			5
CH <sub>4</sub>	1.24	1.43	1.62	1.84	2.08	2.35	1
CO <sub>2</sub>	1.26	1.45	1.67	1.91	2.17	2.47	1
C <sub>2</sub> H <sub>2</sub>	1.43	1.59	1.78	1.99	2.23		2
Cl <sub>2</sub>		1.13	1.5	1.89			2,6
HBr				3.15			6
HCl				3.07			6
H <sub>2</sub>	3.62	4.08	4.58	5.11	5.69	6.31	1
H <sub>2</sub> S				1.36			2,6
He	5.67	6.18	6.71	7.28	7.87	8.48	1,3
Kr	1.20	1.39	1.60	1.84	2.11	2.40	1,3
NH <sub>3</sub>		1.3	1.5				2
NO <sub>2</sub>			1.23	1.4	1.59		2,6
N <sub>2</sub>				2.0			2
N <sub>2</sub> O		1.62	2.11	2.57			2,6
Ne	2.93	3.27	3.64	4.03	4.45	4.89	1,3
O <sub>2</sub>		1.67	2.01	2.42			2,6
Rn	0.81	0.96	1.13	1.33	1.55	1.80	1
SO <sub>2</sub>			1.62	1.83	2.07	2.32	2
Xe	0.93	1.08	1.27	1.47	1.70	1.95	1,3

## PROPERTIES OF ICE AND SUPERCOOLED WATER

The common form of ice at ambient temperature and pressure is hexagonal ice, designated as ice Ih (see phase diagram in Section 12). The data given here refer to that form. Data have been taken from the references indicated; values have been interpolated and smoothed in some cases. All properties are sensitive to the method of preparation of the sample, since air or other gases are sometimes occluded. For this reason there is often disagreement among values found in the literature.

Density values (except at 0 °C) and the thermal expansion coefficient were calculated from the temperature variation in the crystal lattice constants of ice (see Ref. 1). The thermal expansion coefficient appears to become negative around -200 °C, but there is considerable scatter in the data.

### Density of ice Ih and supercooled water in g cm<sup>-3</sup>

<i>t</i> /°C	$\rho$ (ice)	$\rho$ (supercooled water)
0	0.9167	0.9998
-10	0.9187	0.9982
-20	0.9203	0.9935
-30	0.9216	0.9839
-40	0.9228	
-50	0.9240	
-60	0.9252	
-80	0.9274	
-100	0.9292	
-120	0.9305	
-140	0.9314	
-160	0.9331	
-180	0.9340	
Ref.	1	8

### Phase transition properties:

$$\Delta_{\text{fus}}H(0\text{ °C}) = 333.6\text{ J/g (Ref. 2)}$$

$$\Delta_{\text{sub}}H(0\text{ °C}) = 2838\text{ J/g (Ref. 2)}$$

### Other properties of ice I<sub>h</sub>:

$\alpha_v$ : cubic expansion coefficient,  $\alpha_v = -(1/V)(\partial V/\partial t)_p$   
 $\kappa_s$ : isentropic compressibility,  $\kappa_s = -(1/V)(\partial V/\partial p)_s$   
 $\epsilon$ : relative permittivity (dielectric constant)  
 $k$ : thermal conductivity  
 $c_p$ : specific heat capacity at constant pressure

<i>t</i> /°C	$\alpha_v/10^{-6}\text{ °C}^{-1}$	$\kappa/10^{-5}\text{ MPa}^{-1}$	$\epsilon$	$k/\text{W cm}^{-1}\text{ °C}^{-1}$	$c_p/\text{J g}^{-1}\text{ °C}^{-1}$
0	159	13.0	91.6	0.0214	2.11
-10	155	12.8	94.4	0.023	2.03
-20	149	12.7	97.5	0.024	1.96
-30	143	12.5	99.7	0.025	1.88
-40	137	12.4	101.9	0.026	1.80
-50	130	12.2	106.9	0.028	1.72
-60	122	12.1	119.5	0.030	1.65
-80	105	11.9		0.033	1.50
-100	85	11.6		0.037	1.36
-120	77	11.4		0.042	1.23
-140	60	11.3		0.049	1.10
-160	45	11.2		0.057	0.97
-180	30	11.1		0.070	0.83
-200		11.0		0.087	0.67
-220		10.9		0.118	0.50
-240		10.9		0.20	0.29
-250		10.9		0.32	0.17
Ref.	1,2,3,5	1,5	6	7	1

## References

- Eisenberg, D., and Kauzmann, W., *The Structure and Properties of Water*, Oxford University Press, Oxford, 1969.
- Landolt-Börnstein, *Numerical Data and Functional Relationships in Science and Technology, New Series*, V/1b, Springer-Verlag, Heidelberg, 1982.
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- Hobbs, P. V., *Ice Physics*, Clarendon Press, Oxford, 1974.

## PROPERTIES OF LIQUID HELIUM

The following data were obtained by a critical evaluation of all existing experimental measurements on liquid helium, using a fitting procedure described in the reference. All values refer to liquid helium at saturated vapor pressure; temperatures are on the ITS-90 scale. Several properties show a singularity at the lambda point (2.1768 K).

$\epsilon$ : relative permittivity (dielectric constant)

$\sigma$ : surface tension

$\alpha_v$ : cubic expansion coefficient

$\eta$ : viscosity

$\lambda$ : thermal conductivity

$p$ : vapor pressure

$\rho$ : density

$C_s$ : molar heat capacity

$\Delta_{\text{vap}}H$ : molar enthalpy of vaporization

### Reference

Donnelly, R. J., and Barenghi, C. F., *J. Phys. Chem. Ref. Data*, 27, 1217, 1998.

$T/\text{K}$	$p/\text{kPa}$	$\rho/\text{g cm}^{-3}$	$C_s/\text{J mol}^{-1} \text{K}^{-1}$	$\Delta_{\text{vap}}H/\text{J mol}^{-1}$	$\epsilon$	$\sigma/\text{mN m}^{-1}$	$10^3\alpha_v/\text{K}^{-1}$	$\eta/\mu\text{Pa s}$	$\lambda/\text{W cm}^{-1} \text{K}^{-1}$
0.0		0.1451397	0	59.83	1.057255		0.000		
0.5		0.1451377	0.010	70.24	1.057254	0.3530	0.107		
1.0	0.01558	0.1451183	0.415	80.33	1.057246	0.3471	0.309	3.873	
1.5	0.4715	0.1451646	4.468	89.35	1.057265	0.3322	-2.36	1.346	
2.0	3.130	0.1456217	21.28	93.07	1.057449	0.3021	-12.2	1.468	
2.5	10.23	0.1448402	9.083	92.50	1.057135	0.2623	39.4	3.259	0.1497
3.0	24.05	0.1412269	9.944	94.11	1.055683	0.2161	61.5	3.517	0.1717
3.5	47.05	0.1360736	12.37	92.84	1.053615	0.1626	88.7	3.509	0.1868
4.0	81.62	0.1289745	15.96	87.00	1.050770	0.1095	129	3.319	0.1965
4.5	130.3	0.1188552	21.8	75.86	1.046725	0.0609	211		
5.0	196.0		44.7	47.67		0.0157			

## SURFACE TENSION OF AQUEOUS MIXTURES

The composition dependence of the surface tension of binary mixtures of several compounds with water is given in this table. The data are tabulated as a function of the mass percent of the non-aqueous component. Data for methanol, ethanol, 1-propanol, and 2-propanol are taken from Reference 1, which also gives values at other temperatures.

### References

1. Vazquez, G., Alvarez, E., and Navaza, J. M., *J. Chem. Eng. Data*, 40, 611, 1995.
2. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, New Series, IV/16, Surface Tension*, Springer-Verlag, Heidelberg, 1997.

Compound	<i>t</i> /°C	Surface Tension in mN/m for the Specified Mass %										
		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Acetic acid	30	71.2	51.4	43.3	41.2	38.2	37.4	36.1	33.5	31.5	30.2	26.3
Acetone	25	72.0	44.9	40.5	36.7	33.0	30.1	29.4	29.4	27.6	24.5	23.1
Acetonitrile	20	72.8	48.5	40.2	34.1	31.6	30.6	30.0	29.6	29.1	28.7	28.4
1,2-Butanediol	25	72.0	66.1	60.4	55.1	50.1	45.6	43.3	41.9	40.8	39.2	35.8
1,3-Butanediol	30	71.2	58.1	51.6	48.7	45.8	43.9	42.4	41.2	40.0	39.0	37.0
1,4-Butanediol	30	71.2	61.2	56.9	54.2	52.0	50.7	49.5	47.9	46.6	45.2	43.8
Butanoic acid	30	71.2	42.4	37.5	35.5	34.8	32.2	30.8	29.2	27.4	26.3	25.5
2-Butanone	20	72.8	41.6	32.2				25.2				24.6
γ-Butyrolactone	30	71.2	64	58	53	50	48	46	45	44	42.8	42.7
Chloroacetic acid	25	72.0	59.8	53.6	51.3	49.7	48.3	47.5	46.1			
Diethanolamine	25	72.0	66.8	63.2	60.7	58.8	57.2	55.7	54.3	52.7	50.6	47.2
<i>N,N</i> -Dimethylacetamide	25	72.0	72.0	72.0	72.4	73.5	74.9	75.4	73.0	65.7	54.7	36.4
<i>N,N</i> -Dimethylformamide	25	72.0	65.4	59.2	53.8	49.6	47.3	46.9	44.9	42.3	38.4	35.2
1,4-Dioxane	25	72.0					41.2	39.6	37.9	36.2	34.5	33.7
Ethanol	25	72.01	47.53	37.97	32.98	30.16	27.96	26.23	25.01	23.82	22.72	21.82
Ethylene glycol	20	72.8	68.5	64.9	61.9		57.0					48.2
Formic acid	20	72.8	66	60	55.7	52.2	50.3	48.8	47.1	44.7	40.9	38.0
Glycerol	25	72.0	70.5	69.5	68.5	67.9	67.4	66.9	66.5	65.7	64.5	62.5
Methanol	25	72.01	56.18	47.21	41.09	36.51	32.86	29.83	27.48	25.54	23.93	22.51
Morpholine	20	72.8	65.1	60.7	58.9	56.7	53.0	49.6	47.0	43.7	41.8	38.7
Nitric acid	20	72.8	71.9	70.7	68.9	66.6	63.8	60.6	56.8	52.6	47.9	42.6
Propanoic acid	30	71.2	46.6	42.2	37.7	35.6	33.1	31.7	30.2	28.2	27.4	25.8
1-Propanol	25	72.01	34.32	27.84	25.98	25.26	24.80	24.49	24.08	23.86	23.59	23.28
2-Propanol	25	72.01	40.42	30.57	26.82	25.27	24.26	23.51	22.68	22.14	21.69	21.22
1,2-Propylene glycol	30	71.2	60.5	54.9	50.7	47.2	44.5	41.5	38.6	37.6	36.3	35.5
1,3-Propylene glycol	30	71.2	62.6	58.8	55.7	53.8	52.8	51.7	50.8	49.6	48.2	47.0
Pyridine	25	72.0	52.8	51.2	48.0	46.8	46.6	45.8	45.0	43.6	40.9	37.0
Sulfolane	20	72.8					62.5	61.6	59.6	57.1	54.9	50.9
Sulfuric acid	50	67.9	73.5	75.1	73.6	71.2	68.0	64.1	60.0	56.4	53.6	51.7
Trichloroacetaldehyde	25	72.0	56.7	51.0	46.7	44.1	43.0	42.5	41.5	38.9	34.7	29.4
Trichloroacetic acid	25	72.0	55.8	46.5	42.8	41.6	40.6	39.4	38.3	37.4	36.5	

## VISCOSITY OF CARBON DIOXIDE ALONG THE SATURATION LINE

The table below gives the viscosity of gas and liquid CO<sub>2</sub> along the liquid–vapor saturation line.

### References

1. Feghhour, A., Wakeham, W. A., and Vesovic, V., *J. Phys. Chem. Ref. Data*, 27, 31, 1998.
2. Angus, S., et al., *International Tables for the Fluid State: Carbon Dioxide*, Pergamon Press, Oxford, 1976.

<i>T</i> /K	<i>P</i> /kPa	Gas $\eta/\mu\text{Pa s}$	Liquid $\eta/\mu\text{Pa s}$
205	227	10.33	
210	327	10.60	
215	465	10.87	
220	600	11.13	241.68
225	735	11.41	221.72
230	894	11.69	203.75
235	1075	11.98	187.48
240	1283	12.27	172.67
245	1519	12.58	159.13
250	1786	12.90	146.69
255	2085	13.24	135.20
260	2419	13.61	124.30
265	2790	14.02	114.63
270	3203	14.47	105.21
275	3658	14.99	96.44
280	4160	15.61	87.89
285	4712	16.37	79.64
290	5315	17.36	71.47
295	5984	18.79	63.01
300	6710	21.29	53.33
302	6997	23.52	48.30

## VISCOSITY AND DENSITY OF AQUEOUS HYDROXIDE SOLUTIONS

The viscosity and density of aqueous hydroxide solutions at 25°C is tabulated here as a function of concentration. Viscosity is given in millipascal second, which is equal to the c.g.s. unit centipoise (cP). The last entry in each column refers to the saturated solution.

### Reference

Sipos, P. M., Hefter, G., and May, P. M., *J. Chem. Eng. Data*, 45, 613, 2000.

### Viscosity in mPa s

$c/\text{mol L}^{-1}$	LiOH	NaOH	KOH	CsOH	$(\text{CH}_3)_4\text{NOH}$
0.5	1.017	0.997	0.937	0.91	1.017
1.0	1.169	1.116	0.990	0.94	1.186
1.5	1.340	1.248	1.050	0.97	1.430
2.0	1.537	1.396	1.116	1.03	1.762
3.0	2.050	1.754	1.269	1.19	3.031
4.0	2.734	2.228	1.448	1.41	7.238
5.0		2.867	1.657	1.67	
6.0		3.727	1.902	1.98	
7.0		4.869	2.196	2.40	
8.0		6.351	2.554	3.09	
9.0		8.230	3.005	4.31	
10.0		10.554	3.581	6.46	
11.0		13.362	4.328		
12.0		16.677	5.303		
13.0		20.503	6.577		
14.0		24.826	8.235		
15.0		29.604			
16.0		34.767			
17.0		40.212			
18.0		45.800			
19.0		51.354			
Sat.	3.311	51.911	8.526		8.850

### Density in $\text{g}/\text{cm}^3$

$c/\text{mol L}^{-1}$	LiOH	NaOH	KOH	CsOH	$(\text{CH}_3)_4\text{NOH}$
0.5	1.012	1.019	1.022	1.063	0.999
1.0	1.025	1.040	1.045	1.128	1.002
1.5	1.038	1.059	1.068	1.193	1.005
2.0	1.050	1.078	1.090	1.257	1.009
3.0	1.072	1.115	1.133	1.383	1.019
4.0	1.093	1.149	1.174	1.508	1.030
5.0		1.182	1.214	1.632	
6.0		1.213	1.253	1.755	
7.0		1.243	1.290	1.876	
8.0		1.271	1.326	1.997	
9.0		1.299	1.362	2.117	
10.0		1.325	1.396	2.236	
11.0		1.350	1.429	2.354	
12.0		1.374	1.462	2.471	
13.0		1.397	1.494	2.587	
14.0		1.419	1.524	2.703	
15.0		1.441			
16.0		1.461			
17.0		1.481			
18.0		1.499			
19.0		1.517			
Sat.	1.109	1.519	1.529	2.800	1.032

## VAPOR PRESSURE OF MERCURY

The following table gives the vapor pressure of mercury in kilopascals (100 kPa = 1 bar) from the triple point (234.3156 K) to the critical point (1764 K). The data are generated from the formulation of Huber, Laesecke, and Friend in Reference 1, which is based on a critical evaluation of all the published data on mercury vapor pressure and related thermodynamic properties. The estimated uncertainty in the vapor pressure is:

–38 to –10°C	3%
0 to 130°C	1%
140 to 350°C	0.15%
360 to 620°C	0.5%
630 to 1491°C	5%

Most of the entries in this table carry one significant figure beyond the estimated accuracy.

Note that the table refers to mercury vapor in equilibrium with liquid mercury, in the absence of air or other gases.

### References

1. Huber, M. L., Laesecke, A., and Friend, D. G., *The Vapor Pressure of Mercury*, NISTIR 6643, National Institute of Standards and Technology, Boulder, CO, March 2006.
2. Huber, M. L., Laesecke, A., and Friend, D. G., *Ind. Eng. Chem. Res.* 45, 7351, 2006.
3. Vargaftik, N. B., Vinogradov, Y. K., and Yargin, V. S., *Handbook of Physical Properties of Liquids and Gases, Third Edition*, Begell House, New York, 1996.

<i>t</i> /°C	<i>p</i> /kPa	<i>t</i> /°C	<i>p</i> /kPa	<i>t</i> /°C	<i>p</i> /kPa	<i>t</i> /°C	<i>p</i> /kPa
–38.83	2.985 × 10 <sup>–7</sup>	38	0.0007350	300	32.965	720	6254
–30	9.451 × 10 <sup>–7</sup>	39	0.0007929	310	40.856	730	6718
–20	3.160 × 10 <sup>–6</sup>	40	0.0008551	320	50.260	740	7205
–10	9.625 × 10 <sup>–6</sup>	41	0.0009216	330	61.396	750	7718
0	2.699 × 10 <sup>–5</sup>	42	0.0009928	340	74.498	760	8258
1	2.979 × 10 <sup>–5</sup>	43	0.001069	350	89.823	770	8824
2	3.287 × 10 <sup>–5</sup>	44	0.001151	360	107.65	780	9417
3	3.623 × 10 <sup>–5</sup>	45	0.001238	370	128.26	790	10040
4	3.991 × 10 <sup>–5</sup>	46	0.001331	380	151.99	800	10690
5	4.393 × 10 <sup>–5</sup>	47	0.001430	390	179.17	810	11370
6	4.833 × 10 <sup>–5</sup>	48	0.001537	400	210.15	820	12080
7	5.312 × 10 <sup>–5</sup>	49	0.001650	410	245.32	830	12820
8	5.836 × 10 <sup>–5</sup>	50	0.001771	420	285.07	840	13600
9	6.406 × 10 <sup>–5</sup>	55	0.002506	430	329.82	850	14410
10	7.028 × 10 <sup>–5</sup>	60	0.003508	440	380.00	860	15250
11	7.705 × 10 <sup>–5</sup>	65	0.004862	450	436.07	870	16120
12	8.441 × 10 <sup>–5</sup>	70	0.006673	460	498.51	880	17030
13	9.242 × 10 <sup>–5</sup>	75	0.009075	470	567.81	890	17980
14	0.0001011	80	0.01223	480	644.46	900	18960
15	0.0001106	85	0.01635	490	729.01	910	19980
16	0.0001208	90	0.02167	500	821.99	920	21040
17	0.0001320	95	0.02850	510	923.96	930	22140
18	0.0001440	100	0.03721	520	1035.5	940	23270
19	0.0001571	110	0.06209	530	1157.2	950	24450
20	0.0001713	120	0.1009	540	1289.6	960	25670
21	0.0001866	130	0.1599	550	1433.3	970	26930
22	0.0002032	140	0.2478	560	1589.1	980	28230
23	0.0002211	150	0.3759	570	1757.4	990	29580
24	0.0002404	160	0.5592	580	1939	1000	30970
25	0.0002613	170	0.8168	590	2135	1050	38600
26	0.0002839	180	1.1728	600	2345	1100	47450
27	0.0003082	190	1.6573	610	2570	1150	57590
28	0.0003344	200	2.3071	620	2811	1200	69100
29	0.0003627	210	3.1670	630	3069	1250	82100
30	0.0003931	220	4.2906	640	3344	1300	96600
31	0.0004259	230	5.7414	650	3637	1350	112700
32	0.0004611	240	7.5939	660	3949	1400	130000
33	0.0004990	250	9.9347	670	4281	1450	150000
34	0.0005398	260	12.863	680	4632	1491	167000
35	0.0005835	270	16.494	690	5005		
36	0.0006305	280	20.955	700	5399		
37	0.0006809	290	26.392	710	5815		



## VISCOSITY OF LIQUID METALS

This table gives the viscosity of several liquid metals as a function of temperature. Experimental data from some of the references were smoothed to produce the table. Viscosity is given in millipascal second (mPa s), which equals the c.g.s. unit centipoise (cP).

### References

1. Shpil'rain, E. E., Yakimovich, K. A., Fomin, V. A., Skovorodjko, S. N., and Mozgovoï, A. G., in *Handbook of Thermodynamic and Transport Properties of the Alkali Metals*, Ohse, R. H., Ed., Blackwell Scientific Publishers, Oxford, 1985. [Li, Na, K, Rb, Cs]
2. Rothwell, E., *J. Inst. Metals*, 90, 389, 1961. [Al]
3. Culpin, M. F., *Proc. Phys. Soc.*, 70, 1079, 1957. [Ca]
4. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, Sixth Edition*, II/5a, *Transport Phenomena I (Viscosity and Diffusion)*, Springer-Verlag, Heidelberg, 1961 [Co, Au, Mg, Ni, Ag]
5. Spells, K. E., *Proc. Phys. Soc.*, 48, 299, 1936. [Ga]
6. Walsdorfer, H., Arpshofen, I., and Predel, B., *Z. Met.*, 79, 503, 1988. [In]

<i>t</i> /°C	Viscosity in mPa s					
	Lithium	Sodium	Potassium	Rubidium	Cesium	Gallium
50				0.542	0.598	1.921
100		0.687	0.441	0.435	0.469	1.608
150		0.542	0.358	0.365	0.389	1.397
200	0.566	0.451	0.303	0.316	0.334	1.245
250	0.503	0.387	0.263	0.280	0.294	1.130
300	0.453	0.341	0.234	0.252	0.264	1.040
350	0.412	0.306	0.211	0.230	0.240	0.968
400	0.379	0.278	0.193	0.212	0.221	0.909
450	0.352	0.255	0.178	0.197	0.206	0.859
500	0.328	0.237	0.166	0.185	0.192	0.817
550	0.308	0.221	0.155	0.174	0.181	0.781
600	0.290	0.208	0.146	0.165	0.171	0.750
650	0.275	0.196	0.138	0.157	0.163	0.722
700	0.261	0.186	0.132	0.150	0.156	0.698
750	0.249	0.177	0.126	0.143	0.149	0.677
800	0.238	0.170	0.120	0.138	0.143	0.657
850	0.228	0.163	0.115	0.133	0.138	0.640
900	0.219	0.156	0.111	0.128	0.134	0.624
950	0.211	0.151	0.107	0.124	0.129	0.610
1000	0.204	0.146	0.104	0.120	0.125	0.597
1050	0.197	0.141	0.101	0.117	0.122	0.585
1100	0.191	0.137	0.098	0.114	0.119	0.574
1150	0.185	0.133	0.095	0.111	0.116	
1200	0.180	0.129	0.092	0.108	0.113	
1250	0.175	0.126	0.090	0.105	0.110	
1300	0.170	0.123	0.088	0.103	0.108	
1350	0.166	0.120	0.086	0.101	0.106	
1400	0.162	0.117	0.084	0.099	0.104	
1450	0.158	0.115	0.082	0.097	0.102	
1500	0.155	0.113	0.081	0.095	0.100	
1550	0.151	0.110	0.079	0.093	0.098	
1600	0.148	0.108	0.078	0.092	0.097	
1650	0.145	0.106	0.076	0.090	0.095	
1700	0.142	0.105	0.075		0.094	
1750	0.139	0.103	0.074		0.092	
1800	0.137	0.101			0.091	
1850	0.135	0.100			0.090	
1900	0.132	0.098			0.089	
1950	0.130	0.097			0.088	
2000	0.128	0.096			0.086	

<i>t</i> /°C	Viscosity in mPa s							
	Aluminum	Calcium	Cobalt	Gold	Indium	Magnesium	Nickel	Silver
250					1.35			
300					1.22			
350					1.12			
400					1.04			
450					0.98			
700	1.289					1.10		
750	1.200					0.96		
800	1.115					0.84		
850	1.028	1.107				0.74		
900		0.959				0.67		
1000								3.80
1050								3.56
1100				5.130				3.31
1150				4.874				3.06
1200				4.640				2.82
1250				4.429				2.61
1300				4.240				2.42
1350								2.28
1400								2.20
1450								2.19
1500			4.15				4.35	
1550			3.89				4.09	
1600			3.64				3.87	
1650			3.41				3.67	
1700			3.20				3.49	
1750			2.99				3.32	

## IONIC LIQUIDS

Ionic liquids are a class of organic salts with relatively low melting points. The term usually implies a melting point of 100 °C or lower, and many are liquid at room temperature. They offer several advantages as solvents, such as very low vapor pressure, good thermal stability, and nonflammable behavior. For these reasons they are attractive as constituents of environmentally friendly chemical processes.

This table lists some of the ionic liquids that have been studied. The following properties are given:

**Mol. Form.** — molecular formula in the Hill convention

**CASRN** — Chemical Abstracts Service Registry Number

**Mol. Wt.** — molecular weight (relative molar mass)

$t_m$  — normal melting point in °C; the notation “gl” indicates a glass–liquid transition, rather than a crystal–liquid transition

$\rho$  — density in g/cm<sup>3</sup>. The superscript indicates the temperature in °C; if there is no superscript, room temperature can be assumed.

$\eta$  — viscosity in mPa s. The superscript indicates the temperature in °C; if there is no superscript, room temperature can be assumed.

The phase behavior of ionic liquids can be complicated. Some are crystalline at low temperatures and show a sharp transition from crystal to liquid state (a true melting point) as the temperature is raised, but others exist as a glass at low temperatures and convert to a liquid at the glass–liquid transition temperature, denoted by a small change in heat capacity. Still others are glasses at very low temperatures, transform to crystals as the temperature is raised, and finally become liquid at a still higher temperature. See Reference 3 for a discussion of the types of phase behavior.

## References

1. *Ionic Liquids Database-(ILThermo)*, NIST Standard Reference Database #147, 2006, National Institute of Standards and Technology, Gaithersburg, MD, <ilthermo.boulder.nist.gov>.
2. *Ionic Liquids — New Materials for New Applications*, 2006, <ildd.merck.de/ionicliquids/en/startpage.htm >.
3. Crosthwaite, J. M., Muldoon, M. J., Dixon, J. K., Anderson, J. L., and Brennecke, J. F., *J. Chem. Thermodynamics* 37, 559, 2005.
4. Sun, J., Forsyth, M., and MacFarlane, D. R., *J. Phys. Chem. B* 102, 8858, 1998.
5. Fredlake, C. P., Crosthwaite, J. M., Hert, D. G., Aki, S. N. V. K., and Brennecke, J. F., *J. Chem. Eng. Data* 49, 954, 2004.

Name	Mol. Form.	CASRN	Mol. Wt	$t_m$ /°C	$\rho$ /g cm <sup>-3</sup>	$\eta$ /mPa s
1-Benzyl-3-methylimidazolium tetrafluoroborate	C <sub>11</sub> H <sub>13</sub> BF <sub>4</sub> N <sub>2</sub>	500996-04-3	260.039	63		
1-Butyl-4-(dimethylamino)pyridinium bromide	C <sub>11</sub> H <sub>19</sub> BrN <sub>2</sub>		259.186	222		
1-Butyl-2,3-dimethylimidazolium chloride	C <sub>9</sub> H <sub>17</sub> ClN <sub>2</sub>	98892-75-2	188.697	99		
1-Butyl-2,3-dimethylimidazolium hexafluorophosphate	C <sub>9</sub> H <sub>17</sub> F <sub>6</sub> N <sub>2</sub> P	227617-70-1	298.208	-58 gl	1.2416 <sup>23</sup>	
1-Butyl-2,3-dimethylimidazolium iodide	C <sub>9</sub> H <sub>17</sub> IN <sub>2</sub>	108203-70-9	280.148	97		
1-Butyl-2,3-dimethylimidazolium octylsulfate	C <sub>17</sub> H <sub>34</sub> N <sub>2</sub> O <sub>4</sub> S		362.528	90		
1-Butyl-2,3-dimethylimidazolium tetrafluoroborate	C <sub>9</sub> H <sub>17</sub> N <sub>2</sub> BF <sub>4</sub>	402846-78-0	240.049	37	1.0762 <sup>40</sup>	
1-Butyl-2,3-dimethylimidazolium trifluoromethanesulfonate	C <sub>10</sub> H <sub>18</sub> F <sub>3</sub> N <sub>2</sub> O <sub>3</sub> S		303.321	41		
1-Butyl-3,5-dimethylpyridinium bromide	C <sub>11</sub> H <sub>18</sub> BrN		244.172	95		
1-Butyl-3,4-dimethylpyridinium chloride	C <sub>11</sub> H <sub>18</sub> ClN		199.721	72		
1-Butyl-3,5-dimethylpyridinium chloride	C <sub>11</sub> H <sub>18</sub> ClN		199.721	100		
1-Butyl-3-methylimidazolium acetate	C <sub>10</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>		198.262			440 <sup>25</sup>
1-Butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	C <sub>10</sub> H <sub>15</sub> F <sub>6</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	174899-83-3	419.364	-2	1.4370 <sup>25</sup>	70 <sup>25</sup>
1-Butyl-3-methylimidazolium bromide	C <sub>8</sub> H <sub>15</sub> BrN <sub>2</sub>	85100-77-2	219.122	78		
1-Butyl-3-methylimidazolium chloride	C <sub>8</sub> H <sub>15</sub> ClN <sub>2</sub>	79917-90-1	174.671	67	1.08 <sup>25</sup>	
1-Butyl-3-methylimidazolium dicyanamide	C <sub>10</sub> H <sub>15</sub> N <sub>5</sub>	448245-52-1	205.260	-6	1.0580 <sup>24</sup>	
1-Butyl-3-methylimidazolium (diethylene glycol monomethyl ether)sulfate	C <sub>13</sub> H <sub>27</sub> N <sub>2</sub> O <sub>6</sub> S		339.427	-62 gl		1033 <sup>25</sup>
1-Butyl-3-methylimidazolium hexafluorophosphate	C <sub>8</sub> H <sub>15</sub> F <sub>6</sub> N <sub>2</sub> P	174501-64-5	284.182	11	1.367 <sup>20</sup>	382 <sup>20</sup>
1-Butyl-3-methylimidazolium iodide	C <sub>8</sub> H <sub>15</sub> IN <sub>2</sub>	65039-05-6	266.122	-72	1.44 <sup>25</sup>	1100 <sup>25</sup>
1-Butyl-3-methylimidazolium methide	C <sub>12</sub> H <sub>15</sub> F <sub>9</sub> N <sub>2</sub> O <sub>6</sub> S <sub>2</sub>	731774-32-6	550.437		1.57 <sup>25</sup>	
1-Butyl-3-methylimidazolium methylsulfate	C <sub>9</sub> H <sub>18</sub> N <sub>2</sub> O <sub>4</sub> S	401788-98-5	250.315	13	1.212 <sup>25</sup>	
1-Butyl-3-methylimidazolium nitrate	C <sub>8</sub> H <sub>15</sub> N <sub>3</sub> O <sub>3</sub>	179075-88-8	201.223		1.15 <sup>40</sup>	67 <sup>35</sup>
1-Butyl-3-methylimidazolium octylsulfate	C <sub>16</sub> H <sub>32</sub> N <sub>2</sub> O <sub>4</sub> S	445473-58-5	348.501	31	1.07	
1-Butyl-3-methylimidazolium tetrafluoroborate	C <sub>8</sub> H <sub>15</sub> BF <sub>4</sub> N <sub>2</sub>	174501-65-6	226.023	-85 gl	1.2048 <sup>22</sup>	120 <sup>25</sup>
1-Butyl-3-methylimidazolium tosylate	C <sub>15</sub> H <sub>22</sub> N <sub>2</sub> O <sub>3</sub> S	410522-18-8	310.412	72		
1-Butyl-3-methylimidazolium trifluoroacetate	C <sub>10</sub> H <sub>15</sub> F <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	174899-94-6	252.233			70 <sup>25</sup>
1-Butyl-3-methylimidazolium trifluoromethanesulfonate	C <sub>9</sub> H <sub>15</sub> F <sub>3</sub> N <sub>2</sub> O <sub>3</sub> S	174899-66-2	288.286	13	1.3013 <sup>23</sup>	
1-Butyl-3-methylpyridinium bis(trifluoromethylsulfonyl)imide	C <sub>12</sub> H <sub>16</sub> F <sub>6</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>		430.386	-84 gl		63 <sup>25</sup>
1-Butyl-3-methylpyridinium bromide	C <sub>10</sub> H <sub>16</sub> BrN		230.145	-36 gl		
1-Butyl-3-methylpyridinium chloride	C <sub>10</sub> H <sub>16</sub> ClN	125652-55-3	185.694	117		
1-Butyl-3-methylpyridinium hexafluorophosphate	C <sub>10</sub> H <sub>16</sub> F <sub>6</sub> NP		295.205	46		

Name	Mol. Form.	CASRN	Mol. Wt	$t_m/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$\eta/\text{mPa s}$
1-Butyl-4-methylpyridinium hexafluorophosphate	$\text{C}_{10}\text{H}_{16}\text{F}_6\text{NP}$	401788-99-6	295.205	44		
1-Butyl-3-methylpyridinium methylsulfate	$\text{C}_{11}\text{H}_{19}\text{NO}_4\text{S}$		261.339	<-50	1.19	
1-Butyl-4-methylpyridinium tetrafluoroborate	$\text{C}_{10}\text{H}_{16}\text{BF}_4\text{N}$	343952-33-0	237.046		1.1842 <sup>25</sup>	
1-Butyl-3-methylpyridinium tetrafluoroborate	$\text{C}_{10}\text{H}_{16}\text{BF}_4\text{N}$		237.046	-76 gl		177 <sup>25</sup>
1-Butyl-1-methylpyrrolidinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{11}\text{H}_{20}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	223437-11-4	422.408		1.394 <sup>25</sup>	
1-Butyl-1-methylpyrrolidinium dicyanamide	$\text{C}_{11}\text{H}_{20}\text{N}_4$	370865-80-8	208.304	<-50	1.02	
1-Butyl-1-methylpyrrolidinium hexafluorophosphate	$\text{C}_9\text{H}_{20}\text{F}_6\text{NP}$	330671-29-9	287.226	85		
1-Butyl-1-methylpyrrolidinium methylsulfate	$\text{C}_{10}\text{H}_{23}\text{NO}_4\text{S}$		253.360	10	1.17	
1-Butyl-1-methylpyrrolidinium trifluoroacetate	$\text{C}_{11}\text{H}_{20}\text{F}_3\text{NO}_2$		255.278	31		
1-Butyl-1-methylpyrrolidinium trifluoromethanesulfonate	$\text{C}_{10}\text{H}_{20}\text{F}_3\text{NO}_3\text{S}$	367522-96-1	291.331	3	1.25	
1-Butyl-1-methylpyrrolidinium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{15}\text{H}_{20}\text{F}_{18}\text{NP}$	851856-47-8	587.272	4	1.59	
1-Butylnicotinic acid	$\text{C}_{16}\text{H}_{22}\text{F}_6\text{N}_2\text{O}_6\text{S}_2$		516.475	15		531 <sup>25</sup>
1-Butylpyridinium bromide	$\text{C}_9\text{H}_{14}\text{BrN}$	874-80-6	216.118	105		
1-Butylpyridinium chloride	$\text{C}_9\text{H}_{14}\text{ClN}$	1124-64-7	171.667	127		
1-Butylpyridinium hexafluorophosphate	$\text{C}_9\text{H}_{14}\text{F}_6\text{NP}$	186088-50-6	281.178	75		
1-Butylpyridinium methylsulfate	$\text{C}_{10}\text{H}_{17}\text{NO}_4\text{S}$		247.312	<-50	1.22	
1-Butylpyridinium tetrafluoroborate	$\text{C}_9\text{H}_{14}\text{BF}_4\text{N}$	203389-28-0	223.019		1.214 <sup>25</sup>	
1-Butylpyridinium trifluoromethanesulfonate	$\text{C}_{10}\text{H}_{14}\text{F}_3\text{NO}_3\text{S}$	390423-43-5	285.283	35		
Cocosalky pentaethoxi methylammonium methylsulfate	$\text{C}_{23}\text{H}_{51}\text{NO}_9\text{S}$		517.718			2800 <sup>25</sup>
1-Decyl-3-methylimidazolium bromide	$\text{C}_{14}\text{H}_{27}\text{BrN}_2$	188589-32-4	303.281	16	112 <sup>20</sup>	
1-Decyl-3-methylimidazolium chloride	$\text{C}_{14}\text{H}_{27}\text{ClN}_2$	171058-18-7	258.830	38		
1,1-Dibutylpyrrolidinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{14}\text{H}_{26}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		464.487	41		
<i>N,N</i> -Diethyl- <i>N</i> -(1-methylethyl)-2-propanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{12}\text{H}_{24}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-41-4	438.450	148		
1,3-Dimethylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_7\text{H}_9\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	174899-81-1	377.284		1.570 <sup>25</sup>	
1,3-Dimethylimidazolium chloride	$\text{C}_5\text{H}_9\text{ClN}_2$	79917-88-7	132.591	126		
1,3-Dimethylimidazolium dimethylphosphate	$\text{C}_7\text{H}_{15}\text{N}_2\text{O}_4\text{P}$	654058-04-5	222.178		1.253 <sup>30</sup>	
1,3-Dimethylimidazolium methoxyethylsulfate	$\text{C}_8\text{H}_{16}\text{N}_2\text{O}_5\text{S}$	790663-78-4	252.288		1.314 <sup>25</sup>	
1,3-Dimethylimidazolium methylsulfate	$\text{C}_6\text{H}_{12}\text{N}_2\text{O}_4\text{S}$	97345-90-9	208.235			
1,3-Dimethylimidazolium trifluoromethylsulfonate	$\text{C}_6\text{H}_9\text{F}_3\text{N}_2\text{O}_3\text{S}$	121091-30-3	246.206	43		
1,2-Dimethyl-3-propylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{10}\text{H}_{15}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	169051-76-7	419.364	11	1.457 <sup>22</sup>	90.0 <sup>25</sup>
1,1-Dimethylpyrrolidinium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{12}\text{H}_{14}\text{F}_{18}\text{NP}$		545.191	107	1.81	
1-Dodecyl-3-methylimidazolium chloride	$\text{C}_{16}\text{H}_{31}\text{ClN}_2$	114569-84-5	286.883	97		
1-Dodecyl-3-methylimidazolium hexafluorophosphate	$\text{C}_{16}\text{H}_{31}\text{F}_6\text{N}_2\text{P}$	219947-93-0	396.394			
1-Dodecyl-3-methylimidazolium tetrafluoroborate	$\text{C}_{16}\text{H}_{31}\text{BF}_4\text{N}_2$	244193-59-7	338.235			
<i>N</i> -Ethyl- <i>N,N</i> -bis(1-methylethyl)-1-heptanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{17}\text{H}_{34}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-53-8	508.583	-82 gl	1.27 <sup>20</sup>	362 <sup>25</sup>
1-Ethyl-2,3-dimethylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_9\text{H}_{13}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	174899-90-2	405.337	25	1.4913 <sup>23</sup>	
1-Ethyl-2,3-dimethylimidazolium bromide	$\text{C}_7\text{H}_{13}\text{BrN}_2$	98892-76-3	205.095	138		
1-Ethyl-2,3-dimethylimidazolium methylsulfate	$\text{C}_8\text{H}_{16}\text{N}_2\text{O}_4\text{S}$		236.289	46		
1-Ethyl-2,3-dimethylimidazolium tetrafluoroborate	$\text{C}_7\text{H}_{13}\text{BF}_4\text{N}_2$	307492-75-7	211.996	94		
1-Ethyl-2,3-dimethylimidazolium trifluoromethanesulfonate	$\text{C}_8\text{H}_{13}\text{F}_3\text{N}_2\text{O}_3\text{S}$	174899-72-0	274.260	110		
1-Ethyl-3-methylimidazolium bis(pentafluoroethyl)phosphinate	$\text{C}_{10}\text{H}_{11}\text{F}_{10}\text{N}_2\text{O}_2\text{P}$		412.164	20	1.53	
1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_8\text{H}_{11}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	174899-82-2	391.311	-17	1.5213 <sup>23</sup>	32 <sup>25</sup>
1-Ethyl-3-methylimidazolium bromide	$\text{C}_6\text{H}_{11}\text{BrN}_2$	65039-08-9	191.068	77		
1-Ethyl-3-methylimidazolium chloride	$\text{C}_6\text{H}_{11}\text{ClN}_2$	65039-09-0	146.617	85		
1-Ethyl-3-methylimidazolium ethylsulfate	$\text{C}_8\text{H}_{16}\text{N}_2\text{O}_4\text{S}$	342573-75-5	236.289		1.2388 <sup>25</sup>	100 <sup>25</sup>
1-Ethyl-3-methylimidazolium hexafluorophosphate	$\text{C}_6\text{H}_{11}\text{F}_6\text{N}_2\text{P}$	155371-19-0	256.128	59.6		
1-Ethyl-3-methylimidazolium methanesulfonate	$\text{C}_7\text{H}_{14}\text{N}_2\text{O}_3\text{S}$	145022-45-3	206.262		1.2437 <sup>25</sup>	
1-Ethyl-3-methylimidazolium octyl sulfate	$\text{C}_{14}\text{H}_{28}\text{N}_2\text{O}_4\text{S}$	790663-79-5	320.448			
1-Ethyl-3-methylimidazolium tetrafluoroborate	$\text{C}_6\text{H}_{11}\text{BF}_4\text{N}_2$	143314-16-3	197.969	14	1.2526 <sup>60</sup>	36.1 <sup>25</sup>
1-Ethyl-3-methylimidazolium thiocyanate	$\text{C}_7\text{H}_{11}\text{N}_3\text{S}$	331717-63-6	169.247	<-50	1.11	
1-Ethyl-3-methylimidazolium tosylate	$\text{C}_{13}\text{H}_{18}\text{N}_2\text{O}_3\text{S}$	328090-25-1	282.358	56		
1-Ethyl-3-methylimidazolium trifluoromethanesulfonate	$\text{C}_7\text{H}_{11}\text{F}_3\text{N}_2\text{O}_3\text{S}$	145022-44-2	260.233		1.385 <sup>25</sup>	
<i>N</i> -Ethyl- <i>N</i> -methyl- <i>N</i> -(1-methylethyl)-2-propanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{11}\text{H}_{22}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-42-5	424.424	140		

Name	Mol. Form.	CASRN	Mol. Wt	$t_m/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$\eta/\text{mPa s}$
1-Ethyl-3-methylpyridinium ethylsulfate	$\text{C}_{10}\text{H}_{17}\text{NO}_4\text{S}$		247.312	-71 gl		150 <sup>25</sup>
1-Ethyl-1-methylpyrrolidinium methylsulfate	$\text{C}_8\text{H}_{19}\text{NO}_4\text{S}$		225.307	23	1.23	
1-Ethyl-1-methylpyrrolidinium tetrafluoroborate	$\text{C}_7\text{H}_{16}\text{BF}_4\text{N}$	15302-90-6	201.014	69		
1-Ethylnicotinic acid ethyl ester ethylsulfate	$\text{C}_{12}\text{H}_{19}\text{NO}_6\text{S}$		305.347	-44 gl		3200 <sup>25</sup>
1-Ethylpyridinium bromide	$\text{C}_7\text{H}_{10}\text{BrN}$	1906-79-2	188.065	122		
1-Ethylpyridinium chloride	$\text{C}_7\text{H}_{10}\text{ClN}$	2294-38-4	143.614	119		
1-Ethylpyridinium ethylsulfate	$\text{C}_9\text{H}_{15}\text{NO}_4\text{S}$		233.285			137 <sup>25</sup>
1-Ethylpyridinium tetrafluoroborate	$\text{C}_7\text{H}_{10}\text{BF}_4\text{N}$	350-48-1	194.966		1.302 <sup>20</sup>	
1-Ethylpyridinium trifluoroacetate	$\text{C}_9\text{H}_{10}\text{F}_3\text{NO}_2$	474461-33-1	221.176		1.273 <sup>20</sup>	
1-Ethylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_9\text{H}_{10}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	712354-97-7	388.306		1.536 <sup>25</sup>	
1-Heptyl-3-methylimidazolium hexafluorophosphate	$\text{C}_{11}\text{H}_{21}\text{F}_6\text{N}_2\text{P}$	357915-04-9	326.262	-84 gl	1.274 <sup>21</sup>	
1-Hexadecyl-2,3-dimethylimidazolium chloride	$\text{C}_{21}\text{H}_{41}\text{ClN}_2$		357.017	210		
1-Hexadecyl-3-methylimidazolium chloride	$\text{C}_{20}\text{H}_{39}\text{ClN}_2$	61546-01-8	342.990	222		
1-Hexyl-4-(dimethylamino)pyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{15}\text{H}_{23}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$		487.482	-69		111 <sup>25</sup>
1-Hexyl-4-(dimethylamino)pyridinium bromide	$\text{C}_{13}\text{H}_{23}\text{BrN}_2$		287.239	196		
1-Hexyl-2,3-dimethylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{13}\text{H}_{21}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	384347-22-2	461.444	-5	1.361 <sup>25</sup>	131 <sup>25</sup>
1-Hexyl-2,3-dimethylimidazolium chloride	$\text{C}_{11}\text{H}_{21}\text{ClN}_2$	455270-59-4	216.751	46		
1-Hexyl-2,3-dimethylimidazolium tetrafluoroborate	$\text{C}_{11}\text{H}_{21}\text{BF}_4\text{N}_2$	384347-21-1	268.103	14	1.15	
1-Hexyl-3,5-dimethylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{15}\text{H}_{22}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		472.467	10		104 <sup>25</sup>
1-Hexyl-2-ethyl-3,5-dimethylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{17}\text{H}_{26}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		500.519	-66 gl		245 <sup>25</sup>
1-Hexyl-3-methyl-4-(dimethylamino)pyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{16}\text{H}_{25}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$		501.508	-2		112 <sup>25</sup>
1-Hexyl-3-methyl-4-(dimethylamino)pyridinium bromide	$\text{C}_{14}\text{H}_{25}\text{BrN}_2$		301.266	119		
1-Hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{12}\text{H}_{19}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	382150-50-7	447.417	-7	1.3708 <sup>25</sup>	68 <sup>25</sup>
1-Hexyl-3-methylimidazolium bromide	$\text{C}_{10}\text{H}_{19}\text{BrN}_2$		247.175	-49 gl		
1-Hexyl-3-methylimidazolium chloride	$\text{C}_{10}\text{H}_{19}\text{ClN}_2$	171058-17-6	202.724	-75 gl	1.0400 <sup>25</sup>	3400000 <sup>40</sup>
1-Hexyl-3-methylimidazolium hexafluorophosphate	$\text{C}_{10}\text{H}_{19}\text{F}_6\text{N}_2\text{P}$	304680-35-1	312.235	-79 gl	1.294 <sup>25</sup>	585 <sup>25</sup>
1-Hexyl-3-methylimidazolium tetrafluoroborate	$\text{C}_{10}\text{H}_{19}\text{BF}_4\text{N}_2$	244193-50-8	254.076	-79 gl	1.136 <sup>37</sup>	
1-Hexyl-3-methylimidazolium trifluoromethanesulfonate	$\text{C}_{11}\text{H}_{19}\text{F}_3\text{N}_2\text{O}_3\text{S}$	460345-16-8	316.340	28	1.24	
1-Hexyl-4-(4-methylpiperidino)pyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{19}\text{H}_{29}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$		541.571	37		
1-Hexyl-4-(4-methylpiperidino)pyridinium bromide	$\text{C}_{17}\text{H}_{29}\text{BrN}_2$		341.329	33 gl		
1-Hexyl-3-methylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{14}\text{H}_{20}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		458.440	-82 gl		85 <sup>25</sup>
1-Hexyl-3-methylpyridinium bromide	$\text{C}_{12}\text{H}_{20}\text{BrN}$		258.198	-37 gl		
1-Hexyl-2-propyl-3,5-diethylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{20}\text{H}_{32}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		542.599	-67 gl		206 <sup>25</sup>
1-Hexylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{13}\text{H}_{18}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		444.413	0		80 <sup>25</sup>
1-Hexylpyridinium bromide	$\text{C}_{11}\text{H}_{18}\text{BrN}$	74440-81-6	244.172	46		
1-Hexylpyridinium hexafluorophosphate	$\text{C}_{11}\text{H}_{18}\text{F}_6\text{NP}$		309.232	48		
1-Hexylpyridinium trifluoromethanesulfonate	$\text{C}_{12}\text{H}_{18}\text{F}_3\text{NO}_3\text{S}$		313.336	62		
1-Methylimidazolium tetrafluoroborate	$\text{C}_4\text{H}_7\text{BF}_4\text{N}_2$	151200-14-5	169.917	63		
1-Methylimidazolium tosylate	$\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}_3\text{S}$	63458-90-2	254.305	89		
1-Methyl-3-octadecylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{24}\text{H}_{43}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	404001-51-0	615.736	52		
1-Methyl-3-octadecylimidazolium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{28}\text{H}_{43}\text{F}_{18}\text{N}_2\text{P}$		780.599	43		
1-Methyl-3-octylimidazolium bromide	$\text{C}_{12}\text{H}_{23}\text{BrN}_2$	61545-99-1	275.228			
1-Methyl-3-octylimidazolium chloride	$\text{C}_{12}\text{H}_{23}\text{ClN}_2$	64697-40-1	230.777	-87 gl	1.0088 <sup>25</sup>	4100000 <sup>40</sup>
1-Methyl-3-octylimidazolium 2-(2-methoxyethoxy)ethyl sulfate	$\text{C}_{17}\text{H}_{34}\text{N}_2\text{O}_6\text{S}$	595565-55-2	394.526			
1-Methyl-3-octylimidazolium nitrate	$\text{C}_{12}\text{H}_{23}\text{N}_3\text{O}_3$	203389-27-9	257.329			1240 <sup>20</sup>
1-Methyl-3-octylimidazolium octylsulfate	$\text{C}_{20}\text{H}_{40}\text{N}_2\text{O}_4\text{S}$		404.608	76		
1-Methyl-3-octylimidazolium tetrafluoroborate	$\text{C}_{12}\text{H}_{23}\text{BF}_4\text{N}_2$	244193-52-0	282.129	-81 gl	1.104 <sup>25</sup>	341 <sup>25</sup>
1-Methyl-3-octylimidazolium trifluoromethanesulfonate	$\text{C}_{13}\text{H}_{23}\text{F}_3\text{N}_2\text{O}_3\text{S}$	403842-84-2	344.393	14	1.19	
1-Methyl-3-octylpyridinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{16}\text{H}_{24}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		486.493	-80		112 <sup>25</sup>
1-Methyl-3-octylpyrrolidinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{15}\text{H}_{24}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$		478.514	-12	1.29	
1-Methyl-3-pentylimidazolium hexafluorophosphate	$\text{C}_9\text{H}_{17}\text{F}_6\text{N}_2\text{P}$	280779-52-4	298.208	-80 gl	1.333 <sup>21</sup>	
1-Methyl-3-propylimidazolium chloride	$\text{C}_7\text{H}_{13}\text{ClN}_2$	79917-89-8	160.644	62		

Name	Mol. Form.	CASRN	Mol. Wt	$t_m/^\circ\text{C}$	$\rho/\text{g cm}^{-3}$	$\eta/\text{mPa s}$
1-Methyl-1-propylpyrrolidinium bis(trifluoromethylsulfonyl)imide	$\text{C}_{10}\text{H}_{18}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	223437-05-6	408.381			
3-Methyl-1-tetradecylimidazolium chloride	$\text{C}_{18}\text{H}_{35}\text{ClN}_2$	171058-21-2	314.937	195		
1-Methyl-3-tetradecylimidazolium tetrafluoroborate	$\text{C}_{18}\text{H}_{35}\text{BF}_4\text{N}_2$	244193-61-1	366.289	116		
Methyltrioctylammonium trifluoroacetate	$\text{C}_{27}\text{H}_{54}\text{F}_3\text{NO}_2$	121107-16-2	481.719	<-50	0.97	
Methyltrioctylammonium trifluoromethanesulfonate	$\text{C}_{26}\text{H}_{54}\text{F}_3\text{NO}_3\text{S}$	121107-18-4	517.772	56		
1-Nonyl-3-methylimidazolium hexafluorophosphate	$\text{C}_{13}\text{H}_{25}\text{F}_6\text{N}_2\text{P}$	343952-29-4	354.315	14	1.20 <sup>21</sup>	
1-Octyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{14}\text{H}_{25}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	178631-04-4	475.471	-84 gl	1.325 <sup>25</sup>	
1-Octyl-3-methylimidazolium hexafluorophosphate	$\text{C}_{12}\text{H}_{23}\text{F}_6\text{N}_2\text{P}$	304680-36-2	340.288	-82 gl	1.237 <sup>25</sup>	734 <sup>25</sup>
1-Octylpyridinium chloride	$\text{C}_{13}\text{H}_{22}\text{ClN}$	4086-73-1	227.774	46		
1-Pentyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{10}\text{H}_{15}\text{F}_6\text{N}_3\text{O}_4\text{S}_2$	280779-53-5	419.364			
1-(3,4,5,6-Perfluorohexyl)-3-methylimidazolium bis(trifluoromethylsulfonyl)imide	$\text{C}_{12}\text{H}_{10}\text{F}_{15}\text{N}_3\text{O}<\text{s}$		609.331	-56		
1-Propyl-3-methylimidazolium bromide	$\text{C}_7\text{H}_{13}\text{BrN}_2$		205.095	37		
1-Propyl-3-methylimidazolium tetrafluoroborate	$\text{C}_7\text{H}_{13}\text{BF}_4\text{N}_2$		211.996	-17	1.240 <sup>25</sup>	103 <sup>25</sup>
Pyridinium ethoxyethylsulfate	$\text{C}_9\text{H}_{15}\text{NO}_5\text{S}$	630393-27-0	249.284		1.281 <sup>25</sup>	
Tetrabutylammonium bis(trifluoromethylsulfonyl)imide	$\text{C}_{18}\text{H}_{35}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-40-3	522.610	92		
Tetrabutylammonium docusate	$\text{C}_{36}\text{H}_{73}\text{NO}_7\text{S}$		664.033	-62 gl		12000 <sup>25</sup>
Tetrabutylammonium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{22}\text{H}_{36}\text{F}_{18}\text{NP}$		687.473	58		
Tetrabutylammonium tris(trifluoromethylsulfonyl)methide	$\text{C}_{20}\text{H}_{36}\text{F}_9\text{NO}_6\text{S}_3$	196958-57-3	653.684	96		
Tetramethylammonium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{14}\text{H}_{20}\text{F}_{18}\text{NP}$	394692-80-9	575.261	97		
<i>N,N,N</i> -Tributyl-1-heptanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{21}\text{H}_{42}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-50-5	564.689	-67 gl	1.17 <sup>20</sup>	606 <sup>25</sup>
<i>N,N,N</i> -Tributyl-1-heptanaminium trifluoromethanesulfonate	$\text{C}_{20}\text{H}_{42}\text{F}_3\text{NO}_3\text{S}$	210230-54-9	433.612	-55 gl		
<i>N,N,N</i> -Tributyl-1-hexanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{20}\text{H}_{40}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-49-2	550.663	26	1.15 <sup>20</sup>	595 <sup>25</sup>
Tributylmethylammonium bis(trifluoromethylsulfonyl)imide	$\text{C}_{15}\text{H}_{30}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	405514-94-5	480.530		1.266 <sup>24</sup>	
<i>N,N,N</i> -Tributyl-1-octanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{22}\text{H}_{44}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-51-6	578.715	-63 gl	1.12 <sup>20</sup>	574 <sup>25</sup>
<i>N,N,N</i> -Tributyl-1-octanaminium trifluoromethanesulfonate	$\text{C}_{21}\text{H}_{44}\text{F}_3\text{NO}_3\text{S}$	210230-58-3	447.639	-57 gl	1.02 <sup>20</sup>	2000 <sup>25</sup>
<i>N,N,N</i> -Triethylethanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{10}\text{H}_{20}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	161401-26-9	410.397			
<i>N,N,N</i> -Triethyl-1-heptanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{15}\text{H}_{30}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-47-0	480.530	-79 gl	1.26 <sup>20</sup>	76 <sup>25</sup>
<i>N,N,N</i> -Triethyl-1-hexanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{14}\text{H}_{28}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-46-9	466.503	20	1.27 <sup>20</sup>	167 <sup>25</sup>
<i>N,N,N</i> -Triethyl-1-octanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{16}\text{H}_{32}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-48-1	494.556	-74 gl	1.25 <sup>20</sup>	202 <sup>25</sup>
Trihexyl(tetradecyl)phosphonium acetate	$\text{C}_{34}\text{H}_{71}\text{O}_2\text{P}$	460092-04-0	542.901		0.890 <sup>25</sup>	
Trihexyl(tetradecyl)phosphonium bis(trifluoromethylsulfonyl)imide	$\text{C}_{34}\text{H}_{68}\text{F}_6\text{NO}_4\text{PS}_2$	460092-03-9	764.002		1.067 <sup>25</sup>	
Trihexyl(tetradecyl)phosphonium chloride	$\text{C}_{32}\text{H}_{68}\text{ClP}$	258864-54-9	519.309		0.89 <sup>25</sup>	
Trihexyltetradecylphosphonium hexafluorophosphate	$\text{C}_{32}\text{H}_{68}\text{F}_6\text{P}_2$	374683-44-0	628.820	39		
Trihexyltetradecylphosphonium tetrafluoroborate	$\text{C}_{32}\text{H}_{68}\text{BF}_4\text{P}$	374683-55-3	570.661	25	0.94	
Trihexyl(tetradecyl)phosphonium tris(pentafluoroethyl)trifluorophosphate	$\text{C}_{38}\text{H}_{68}\text{F}_{18}\text{P}_2$		928.866	<-50	1.18	
Triisobutylmethylphosphonium <i>p</i> -toluenesulfonate	$\text{C}_{20}\text{H}_{37}\text{O}_3\text{PS}$	344774-05-6	388.545		1.069 <sup>25</sup>	
<i>N,N,N</i> -Trimethyl-1-heptanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{12}\text{H}_{24}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-44-7	438.450	-73 gl	1.28 <sup>20</sup>	153 <sup>25</sup>
<i>N,N,N</i> -Trimethyl-1-hexanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{11}\text{H}_{22}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-43-6	424.424	-74 gl	1.33 <sup>20</sup>	153 <sup>25</sup>
<i>N,N,N</i> -Trimethylmethanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_6\text{H}_{12}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	161401-25-8	354.290	133		
<i>N,N,N</i> -Trimethyl-1-octanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{13}\text{H}_{26}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-45-8	452.476	-73 gl	1.27 <sup>20</sup>	181 <sup>25</sup>
<i>N,N,N</i> -Tripropyl-1-propanaminium bis(trifluoromethylsulfonyl)imide	$\text{C}_{14}\text{H}_{28}\text{F}_6\text{N}_2\text{O}_4\text{S}_2$	210230-39-0	466.503	105		

## MELTING CURVE OF MERCURY

The solid–liquid phase boundary of mercury provides a convenient means of calibrating pressures up to 1 GPa in the neighborhood of room temperature. The best representation of this curve is given by:

$$p/\text{GPa} = 1.932845 \cdot 10^{-2}d + 1.8333 \cdot 10^{-6}d^2 + 5.9791 \cdot 10^{-8}d^3$$

where  $d = t/^\circ\text{C} - 38.8344$ . Temperature is on the ITS-90 scale, and the relation is valid for pressures up to about 1.2 GPa. The following table is calculated from this equation.

<i>p vs. t</i>		<i>t vs. p</i>	
<i>t/°C</i>	<i>P/GPa</i>	<i>P/GPa</i>	<i>t/°C</i>
-38.83	0.000	0.010	-38.32
-35.00	0.074	0.020	-37.80
-30.00	0.171	0.050	-36.25
-25.00	0.268	0.100	-33.66
-20.00	0.365	0.200	-28.50
-15.00	0.463	0.300	-23.35
-10.00	0.560	0.400	-18.21
-5.00	0.658	0.500	-13.08
0.00	0.757	0.600	-7.97
5.00	0.856	0.700	-2.88
10.00	0.955	0.800	2.18
15.00	1.055	0.900	7.23
20.00	1.156	1.000	12.24
25.00	1.257	1.100	17.23
30.00	1.359	1.200	22.19

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# PROPERTIES OF GAS CLATHRATE HYDRATES

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Gas clathrate hydrates (also known as gas hydrates) are crystalline inclusion compounds composed of hydrogen-bonded water cavities (host) which encage small gas (guest) molecules. Generally, a maximum of one guest molecule occupies each water cavity. Typical guest molecules that form gas hydrates are meth-

ane, ethane, carbon dioxide, and propane (see gas hydrate phase equilibria data in Table II). The structural and physical properties of gas hydrates are given in Tables Ia and Ib. Data have been taken from the references indicated.

**Table Ia. Gas Hydrate Structural Properties (Ref. 1)**

Structure	sI		sII		sH		
Crystal system	Cubic		Cubic		Hexagonal		
Space group	Pm3n (No. 223) <sup>b</sup>		Fd3m (No. 227) <sup>b</sup>		P6/mmm (No. 191) <sup>b</sup>		
Lattice description	Primitive		Face centered		Hexagonal		
Lattice parameters <sup>a</sup>	a = 12 Å α = β = γ = 90°		a = 17.3 Å α = β = γ = 90°		a = 12.2 Å, c = 10.1 Å α = β = 90°, γ = 120°		
Ideal unit cell formula	6(5 <sup>12</sup> 6 <sup>2</sup> )·2(5 <sup>12</sup> )·46H <sub>2</sub> O		8(5 <sup>12</sup> 6 <sup>4</sup> )·16(5 <sup>12</sup> )·136H <sub>2</sub> O		1(5 <sup>12</sup> 6 <sup>8</sup> )·3(5 <sup>12</sup> )·2(4 <sup>3</sup> 5 <sup>6</sup> 6 <sup>3</sup> )·34H <sub>2</sub> O		
Cavity	Small	Large	Small	Large	Small	Medium	Large
Description	5 <sup>12</sup>	5 <sup>12</sup> 6 <sup>2</sup>	5 <sup>12</sup>	5 <sup>12</sup> 6 <sup>4</sup>	5 <sup>12</sup>	4 <sup>3</sup> 5 <sup>6</sup> 6 <sup>3</sup>	5 <sup>12</sup> 6 <sup>8</sup>
Number of cavities/unit cell	2	6	16	8	3	2	1
Average cavity radius <sup>c</sup> (Å)	3.95	4.33	3.91	4.73	3.94 <sup>d</sup>	4.04 <sup>d</sup>	5.79 <sup>d</sup>
H <sub>2</sub> O molecules/cavity <sup>e</sup>	20	24	20	28	20	20	36

<sup>a</sup> Lattice parameters are a function of temperature, pressure, and guest composition. Typical average values given.

<sup>b</sup> Space group reference numbers from the International Tables of Crystallography.

<sup>c</sup> The average cavity radius will vary with temperature, pressure, and guest composition.

<sup>d</sup> From the atomic coordinates measured using single crystal x-ray diffraction on 2,2-dimethylpentane-5(Xe,H<sub>2</sub>S)·34H<sub>2</sub>O at 173 K (Ref. 2). The Rietveld refinement package, GSAS was used to determine the atomic distances for each cage oxygen to the cage center.

<sup>e</sup> Number of oxygen atoms at the periphery of each cavity.

**Table Ib. Physical Properties of sI, sII Hydrates Compared to Ice, Ih (Ref. 1,3,4,5)**

Property	Ice	sI	sII
Dielectric constant at 273 K	94	~58	~58
H <sub>2</sub> O reorientation time at 273 K (μs)	21	~10	~10
H <sub>2</sub> O diffusion jump time (μs)	2.7	>200	>200
Isothermal Young's modulus at 268 K (10 <sup>9</sup> Pa)	9.5	8.4 <sup>est</sup>	8.2 <sup>est</sup>
Poisson's ratio	0.3301 <sup>f</sup>	0.31403 <sup>f</sup>	0.31119 <sup>f</sup>
Bulk modulus (GPa)	9.097 <sup>f</sup>	8.762 <sup>f</sup>	8.482 <sup>f</sup>
Shear modulus (GPa)	3.488 <sup>f</sup>	3.574 <sup>f</sup>	3.6663 <sup>f</sup>
Compressional velocity, V <sub>p</sub> (m/s)	3870.1 <sup>f</sup>	3778 <sup>f</sup>	3821.8 <sup>f</sup>
Shear velocity, V <sub>s</sub> (m/s)	1949 <sup>f</sup>	1963.6	2001.14 <sup>g</sup>
Linear thermal expansion at 200 K (K <sup>-1</sup> )	56 x 10 <sup>-6</sup>	77 x 10 <sup>-6</sup>	52 x 10 <sup>-6</sup>
Thermal conductivity (W m <sup>-1</sup> K <sup>-1</sup> ) at 263 K	2.18±0.01 <sup>h</sup>	0.51±0.01 <sup>h</sup>	0.50±0.01 <sup>h</sup>
Adiabatic bulk compression at 273 K (GPa)	12	14 <sup>est</sup>	14 <sup>est</sup>
Heat capacity (J kg <sup>-1</sup> K <sup>-1</sup> )	1700±200 <sup>h</sup>	2080	2130±40 <sup>h</sup>
Refractive index (632.8 nm, -3 °C)	1.3082 (Ref. 9)	1.346 (Ref. 9)	1.350 (Ref. 9)
Density (g/cm <sup>3</sup> )	0.91 <sup>j</sup>	0.94	1.291 <sup>k</sup>

<sup>f</sup> At 253–268 K, 22.4–32.8 MPa (ice, Ih), 258–288 K, 27.1–62.1 MPa (CH<sub>4</sub>, sI), 258–288 K, 30.5–91.6 MPa (CH<sub>4</sub>-C<sub>2</sub>H<sub>6</sub>, sII), Ref. 6.

<sup>g</sup> At 258–288 K, 26.6–62.1 MPa, Ref. 7.

<sup>h</sup> At 248–268 K (ice, Ih), 253–288 K (CH<sub>4</sub>, sI), 248–265.5 K (THF, sII), Ref. 8.

<sup>j</sup> Fractional occupancy (calculated from a theoretical model) in small (S) and large (L) cavities: sI = CH<sub>4</sub>: 0.87 (S) and CH<sub>4</sub>: 0.973 (L); sII = CH<sub>4</sub>: 0.672 (S), 0.057 (L); C<sub>2</sub>H<sub>6</sub>: 0.096 (L) only; C<sub>3</sub>H<sub>8</sub>: 0.84 (L) only.

<sup>k</sup> Calculated for 2,2-dimethylpentane-5(Xe,H<sub>2</sub>S)·34H<sub>2</sub>O, Ref. 2; est = estimated.



**References for Table I**

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**Table II: Phase Equilibria Data of Gas Clathrate Hydrates**

This table gives measured phase equilibria data of sI and sII gas clathrate hydrates (see Table I for gas hydrate structure and physical property data). The temperature and pressure conditions at which gas hydrates are stable are listed here for typical guest molecules (Tables IIa–d). For example, data for methane hydrate show that at 277.1 K methane hydrate will dissociate at pressures below 3.81 MPa.

**Table IIa. Methane Hydrate (Ref. 1)**

I–H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
262.4	1.79	266.5	2.08	268.6	2.22	270.9	2.39
264.2	1.90						

I <sub>w</sub> –H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
273.7	2.77	275.9	3.43	280.4	5.35	282.6	6.77
274.3	2.90	277.1	3.81	280.9	5.71	284.3	8.12
275.4	3.24	279.3	4.77	281.5	6.06	285.9	9.78
275.9	3.42						

Ref. 2

I <sub>w</sub> –H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
295.7	33.99	295.9	35.30	301.0	64.81	302.0	77.50

Ref. 3

I <sub>w</sub> –H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
285.7	9.62	285.7	9.62	295.9	34.75	300.9	62.40
286.3	10.31	289.0	13.96	298.7	48.68	301.6	68.09
286.1	10.10	292.1	21.13				

Ref. 4

I <sub>w</sub> –H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
275.4	2.87	277.2	3.90	279.2	4.90	281.2	6.10
276.2	3.37	278.2	4.50				

Ref. 5

I–H–V							
<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)	<i>T</i> (K)	<i>P</i> (MPa)
190.2	0.08251	208.2	0.222	243.2	0.9550	262.4	1.798
198.2	0.1314	218.2	0.3571				

Ref. 6

**Table IIb. Ethane Hydrate (Ref. 1)**

<i>T</i> (K)	<i>P</i> (kPa)	Phases	<i>T</i> (K)	<i>P</i> (kPa)	Phases		
260.8	294	I-H-V	285.8	2537	L <sub>w</sub> -H-V		
260.9	290	I-H-V	287.0	3054	L <sub>w</sub> -H-V		
269.3	441	I-H-V	287.7	4909	L <sub>w</sub> -H-L <sub>E</sub>		
273.4	545	L <sub>w</sub> -H-V	287.8	3413	L <sub>w</sub> -H-L <sub>E</sub>		
275.4	669	L <sub>w</sub> -H-V	287.8	4289	L <sub>w</sub> -H-L <sub>E</sub>		
277.6	876	L <sub>w</sub> -H-V	288.1	3716	L <sub>w</sub> -H-L <sub>E</sub>		
279.1	1048	L <sub>w</sub> -H-V	288.1	6840	L <sub>w</sub> -H-L <sub>E</sub>		
219.7	1131	L <sub>w</sub> -H-V	288.2	4944	L <sub>w</sub> -H-L <sub>E</sub>		
281.1	1317	L <sub>w</sub> -H-V	288.2	5082	L <sub>w</sub> -H-L <sub>E</sub>		
282.8	1641	L <sub>w</sub> -H-V	288.3	4358	L <sub>w</sub> -H-L <sub>E</sub>		
284.4	2137	L <sub>w</sub> -H-V	288.4	6840	L <sub>w</sub> -H-L <sub>E</sub>		Ref. 7
284.6	2055	L <sub>w</sub> -H-V					

I-H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
263.6	313	266.5	357	269.3	405	272.0	457

L <sub>w</sub> -H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
273.7	510	278.7	931	280.4	1165	283.2	1689
273.7	503	278.7	931	280.9	1255	284.3	1986
274.8	579	279.3	1007	281.5	1345	285.4	2303
275.9	662	279.8	1083	282.1	1448	285.4	2310
277.6	814	280.4	1165	282.6	1558	286.5	2730

L <sub>w</sub> -H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
277.5	780	279.9	1040	283.3	1660	286.5	2620
278.1	840	281.5	1380	284.5	2100		

**Table IIc. Propane Hydrate (Ref. 1)**

I-H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
261.2	100	267.4	132	269.8	149	272.9	172
264.2	115	267.6	135	272.2	167		

L <sub>w</sub> -H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
273.7	183	274.8	232	275.9	301	277.1	386
273.7	183	275.4	270				

I-H-V							
<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)	<i>T</i> (K)	<i>P</i> (kPa)
247.9	48.2	251.6	58.3	258.2	81.1	260.9	94.5
251.4	58.3	255.4	69.6	260.8	90.5	262.1	99.4

Feed composition:  $x_{H_2O} = 0.9503$ ,  $x_{C_3H_8} = 0.0407$   
 $Q_2$  at  $T = 278.62$ ,  $P = 0.6$  MPa

$I_w-H-V$		$I_w-H-L$ $x_{C_3H_8}$	
$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)
276.77	0.368	278.71	0.643
277.01	0.377	278.75	0.893
277.22	0.405	278.75	1.393
277.36	0.425	278.75	1.891
277.44	0.433	278.78	1.893
277.87	0.473	278.80	2.391
278.01	0.527	278.80	2.891
278.22	0.483	278.79	2.893
278.55	0.547	278.75	3.891
		278.77	3.391
		278.81	4.391
		278.79	5.892
		278.86	6.392
		278.88	6.892
		278.80	8.393
		278.84	8.893
		278.89	9.893

Ref. 10

**Table IId. Carbon Dioxide Hydrate (Ref. 1)**

$I_w-H-V$					
$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)
279.6	2.74	282.1	4.01	282.8	4.36

$L_w-H-L_{CO_2}$							
$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)
282.9	5.03	283.1	6.47	283.6	11.98	283.9	14.36
282.9	5.62	283.2	9.01				

Ref. 11

Overall feed composition:  
 $x_{H_2O} = 0.8668$ ,  $x_{CO_2} = 0.1332$   
 $Q_2$  at 283.27 K and 4.48 MPa

$I_w-H-V$		$L_w-H-L_{CO_2}$	
$T$ (K)	$P$ (MPa)	$T$ (K)	$P$ (MPa)
276.52	1.82	283.33	5.97
277.85	1.95	283.36	7.35
278.52	2.21		
279.49	2.62		
280.44	2.88		
281.49	3.35		
281.97	3.68		
282.00	3.69		
282.45	3.85		
282.50	4.01		

Ref. 12

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# PROPERTIES OF SATURATED LIQUID D<sub>2</sub>O

Allan H. Harvey

Properties of saturated liquid heavy water, D<sub>2</sub>O, are given in this table as a function of temperature from the melting point to the critical point. The vapor pressure was calculated from the formulation of Harvey and Lemmon (Ref. 2). The other properties were generated from the NIST REFPROP program (Ref. 1) and are consistent with formulations adopted for general and scientific use by The International Association for the Properties of Water and Steam (IAPWS). The background for the equation of state used for density and heat capacity is given by Hill et al. (Ref. 3), and the background for the transport property correlations is given by Matsunaga and Nagashima (Ref. 4). The unpublished surface tension correlation and the other IAPWS formulations may be found on the IAPWS Web site (<http://www.iapws.org>). The temperature scale is ITS-90. Additional calculations at state points not listed below can be obtained by using the REFPROP program (<http://www.nist.gov/srd/nist23.htm>). The properties are

$P$ : vapor pressure                       $\eta$ : viscosity  
 $\rho$ : density                                       $\lambda$ : thermal conductivity  
 $C_p$ : isobaric heat capacity               $\sigma$ : surface tension

## References

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$t/^\circ\text{C}$	$P/\text{kPa}$	$\rho/\text{kg m}^{-3}$	$C_p/\text{kJ kg}^{-1}\text{K}^{-1}$	$\eta/\text{mPa s}$	$\lambda/\text{W m}^{-1}\text{K}^{-1}$	$\sigma/\text{mN m}^{-1}$
3.82	0.661	1105.5	4.211	2.086	0.565	74.93
10	1.026	1106.0	4.231	1.679	0.575	74.06
20	1.999	1105.3	4.243	1.247	0.589	72.61
30	3.702	1103.2	4.240	0.972	0.600	71.09
40	6.550	1099.9	4.232	0.785	0.610	69.52
50	11.12	1095.6	4.220	0.651	0.618	67.89
60	18.20	1090.5	4.207	0.552	0.625	66.21
70	28.81	1084.6	4.194	0.476	0.629	64.47
80	44.24	1078.1	4.181	0.416	0.633	62.67
90	66.09	1071.0	4.170	0.368	0.635	60.82
100	96.30	1063.3	4.161	0.329	0.636	58.93
110	137.1	1055.1	4.155	0.296	0.636	56.98
120	191.3	1046.4	4.153	0.269	0.635	54.99
130	261.8	1037.2	4.155	0.247	0.632	52.95
140	352.0	1027.5	4.162	0.227	0.629	50.87
150	465.8	1017.2	4.174	0.210	0.625	48.75
160	607.3	1006.5	4.190	0.195	0.620	46.59
170	781.1	995.2	4.212	0.182	0.614	44.39
180	992.0	983.4	4.240	0.171	0.607	42.16
190	1246	971.1	4.273	0.161	0.600	39.90
200	1547	958.2	4.313	0.152	0.592	37.61
210	1903	944.7	4.360	0.144	0.583	35.29
220	2319	930.5	4.415	0.136	0.574	32.95
230	2802	915.7	4.479	0.130	0.563	30.59
240	3359	900.1	4.554	0.123	0.553	28.22
250	3998	883.7	4.643	0.118	0.541	25.84
260	4725	866.4	4.750	0.112	0.529	23.45
270	5550	848.0	4.880	0.107	0.516	21.07
280	6480	828.4	5.038	0.103	0.502	18.69
290	7525	807.5	5.237	0.098	0.488	16.33
300	8694	784.8	5.490	0.094	0.473	13.99
310	9998	760.1	5.823	0.089	0.458	11.68

$t/^\circ\text{C}$	$P/\text{kPa}$	$\rho/\text{kg m}^{-3}$	$C_p/\text{kJ kg}^{-1}\text{K}^{-1}$	$\eta/\text{mPa s}$	$\lambda/\text{W m}^{-1}\text{K}^{-1}$	$\sigma/\text{mN m}^{-1}$
320	11449	732.7	6.281	0.085	0.442	9.428
330	13059	702.0	6.952	0.080	0.425	7.238
340	14845	666.5	8.041	0.075	0.408	5.141
350	16824	623.3	10.17	0.069	0.391	3.173
360	19024	565.1	16.41	0.062	0.382	1.405
370	21487	430.7	268.8	0.046	0.548	0.0467
370.697	21671	356.0				0

## PROPERTIES OF AMINO ACIDS

This table gives selected properties of some important amino acids and closely related compounds. The first part of the table lists the 20 "standard" amino acids that are the basic constituents of proteins. The second part includes other amino acids and related compounds of biochemical importance. Within each part of the table the compounds are listed by name in alphabetical order. Structures are given in the following table.

Symbol: Three-letter symbol for the standard amino acids  
 $M_r$ : Molecular weight  
 $t_m$ : Melting point  
 $pK_a$ ,  $pK_b$ ,  $pK_c$ ,  $pK_d$ : Negative of the logarithm of the acid dissociation constants for the COOH and NH<sub>2</sub> groups (and, in some cases, other groups) in the molecule (at 25 °C)  
 pI: pH at the isoelectric point  
 S: Solubility in water in units of grams of compound per kilogram of water; a temperature of 25 °C is understood unless otherwise stated in a superscript. When quantitative data are not available, the notations s.l. (for slightly soluble), s. (for soluble), and v.s. (for very soluble) are used.  
 $V_2^0$ : Partial molar volume in aqueous solution at infinite dilution (at 25 °C)

Data on the enthalpy of formation of many of these compounds are included in the table "Standard Thermodynamic Properties of

Chemical Substances" in Section 5 of this *Handbook*. Absorption spectra and optical rotation data can be found in Reference 3. Partial molar volume is taken from Reference 5; other thermodynamic properties, including solubility as a function of temperature, are given in References 3 and 5. Most of the pK values come from References 1, 6, and 7.

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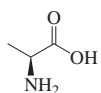
Symbol	Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$pK_a$	$pK_b$	$pK_c$	$pK_d$	pI	S/g kg <sup>-1</sup>	$V_2^0/\text{cm}^3 \text{mol}^{-1}$
Ala	L-Alanine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.09	297	2.33	9.71			6.00	166.9	60.54
Arg	L-Arginine	C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	174.20	244	2.03	9.00	12.10		10.76	182.6	127.42
Asn	L-Asparagine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	132.12	235	2.16	8.73			5.41	25.1	78.0
Asp	L-Aspartic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	133.10	270	1.95	9.66	3.71		2.77	5.04	74.8
Cys	L-Cysteine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub> S	121.16	240	1.91	10.28	8.14		5.07	v.s.	73.45
Gln	L-Glutamine	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	146.14	185	2.18	9.00			5.65	42	
Glu	L-Glutamic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	147.13	160	2.16	9.58	4.15		3.22	8.6	89.85
Gly	Glycine	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	75.07	290	2.34	9.58			5.97	239	43.26
His	L-Histidine	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	155.15	287	1.70	9.09	6.04		7.59	43.5	98.3
Ile	L-Isoleucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.17	284	2.26	9.60			6.02	34.2	105.80
Leu	L-Leucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.17	293	2.32	9.58			5.98	23.8	107.77
Lys	L-Lysine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	146.19	224	2.15	9.16	10.67		9.74	5.8	108.5
Met	L-Methionine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	149.21	281	2.16	9.08			5.74	56	105.57
Phe	L-Phenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	165.19	283	2.18	9.09			5.48	27.9	121.5
Pro	L-Proline	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	115.13	221	1.95	10.47			6.30	1625	82.76
Ser	L-Serine	C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	105.09	228	2.13	9.05			5.68	250	60.62
Thr	L-Threonine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119.12	256	2.20	8.96			5.60	90.6	76.90
Trp	L-Tryptophan	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	204.23	289	2.38	9.34			5.89	13.2	143.8
Tyr	L-Tyrosine	C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	181.19	343	2.24	9.04	10.10		5.66	0.51	
Val	L-Valine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117.15	315	2.27	9.52			5.96	88	90.75

Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$pK_a$	$pK_b$	$pK_c$	$pK_d$	pI	S/g kg <sup>-1</sup>	$V_2^0/\text{cm}^3 \text{mol}^{-1}$
N-Acetylglutamic acid	C <sub>7</sub> H <sub>11</sub> NO <sub>5</sub>	189.17	199						s.	
N6-Acetyl-L-lysine	C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	188.22	265	2.12	9.51					
β-Alanine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.09	200	3.51	10.08					58.28
2-Aminoadipic acid	C <sub>6</sub> H <sub>11</sub> NO <sub>4</sub>	161.16	207	2.14	4.21	9.77		3.18	2.2 <sup>40</sup>	
DL-2-Aminobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.12	304	2.30	9.63			6.06	210	75.6
DL-3-Aminobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.12	194.3	3.43	10.05			7.30	1250	76.3
4-Aminobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.12	203	4.02	10.35				971	73.2
10-Aminodecanoic acid	C <sub>10</sub> H <sub>21</sub> NO <sub>2</sub>	187.28	188.5							167.3

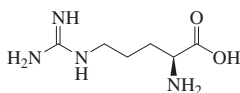
Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$pK_a$	$pK_b$	$pK_c$	$pK_d$	pI	S/g kg <sup>-1</sup>	$V_2^0/\text{cm}^3 \text{mol}^{-1}$
7-Aminoheptanoic acid	C <sub>7</sub> H <sub>15</sub> NO <sub>2</sub>	145.20	195						v.s.	120.0
6-Aminohexanoic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.17	205					7.29	850	104.2
L-3-Amino-2-methylpropanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.12	185						s.	
2-Amino-2-methylpropanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.12	335	2.36	10.21			5.72	137	77.55
9-Aminononanoic acid	C <sub>9</sub> H <sub>19</sub> NO <sub>2</sub>	173.26	191							151.3
8-Aminooctanoic acid	C <sub>8</sub> H <sub>17</sub> NO <sub>2</sub>	159.23	192							136.1
5-Amino-4-oxopentanoic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	131.13	118	4.05	8.90					
5-Aminopentanoic acid	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117.15	157 dec						s.	87.6
<i>o</i> -Anthranilic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.14	146	2.05	4.95				3.5 <sup>14</sup>	
Azaserine	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O <sub>4</sub>	173.13	150		8.55				v.s.	
Canavanine	C <sub>5</sub> H <sub>11</sub> N <sub>4</sub> O <sub>3</sub>	176.17	172	2.50	6.60	9.25		7.93	v.s.	
L- $\gamma$ -Carboxyglutamic acid	C <sub>6</sub> H <sub>9</sub> NO <sub>6</sub>	191.14	167	1.70	9.90	4.75	3.20			
Carnosine	C <sub>9</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub>	226.23	260	2.51	9.35	6.76			322	
Citrulline	C <sub>6</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub>	175.19	222	2.32	9.30			5.92	s.	
Creatine	C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	131.13	303	2.63	14.30				16	
L-Cysteic acid	C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub> S	169.16	260	1.89	8.70	1.30			v.s.	
L-Cystine	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	240.30	260	1.50	8.80	2.05	8.03		0.17	
2,4-Diaminobutanoic acid	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	118.13	118.1	1.85	8.24	10.44		9.27	s.	
3,5-Dibromo-L-tyrosine	C <sub>9</sub> H <sub>9</sub> Br <sub>2</sub> NO <sub>3</sub>	338.98	245						2.72	
3,5-Dichloro-L-tyrosine	C <sub>9</sub> H <sub>9</sub> Cl <sub>2</sub> NO <sub>3</sub>	250.08	247						1.97	
3,5-Diiodo-L-tyrosine	C <sub>9</sub> H <sub>9</sub> I <sub>2</sub> NO <sub>3</sub>	432.98	213	2.12	9.10	6.16			0.62	
Dopamine	C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	153.18			10.36	8.88			s.	
L-Ethionine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub> S	163.24	273	2.18	9.05	13.10				
N-Glycylglycine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	132.12	263	3.13	8.10				231	
Guanidinoacetic acid	C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	117.11	282	2.82					5	
Histamine	C <sub>5</sub> H <sub>9</sub> N <sub>3</sub>	111.15	83		9.83	6.11			v.s.	
L-Homocysteine	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub> S	135.19	232	2.15	8.57	10.38		5.55	s.	
Homocystine	C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	268.35	264	1.59	9.44	2.54	8.52		0.2	
L-Homoserine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119.12	203	2.27	9.28			6.17	1100	
3-Hydroxy-DL-glutamic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>5</sub>	163.13	209						3.28	
5-Hydroxylysine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	162.19		2.13	8.85	9.83		9.15		
<i>trans</i> -4-Hydroxy-L-proline	C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	131.13	274	1.82	9.47			5.74	361	84.49
L-3-Iodotyrosine	C <sub>9</sub> H <sub>10</sub> INO <sub>3</sub>	307.08	205	2.20	9.10	8.70			sl.s.	
L-Kynurenine	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	208.21	194						sl.s.	
L-Lanthionine	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S	208.24	294						1.5	
Levodopa	C <sub>9</sub> H <sub>11</sub> NO <sub>4</sub>	197.19	277	2.32	8.72	9.96	11.79		1.65 <sup>20</sup>	
L-1-Methylhistidine	C <sub>7</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	169.18	249	1.69	8.85	6.48			200	
L-Norleucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.17	301	2.31	9.68			6.09	15	107.7
L-Norvaline	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117.15	307	2.31	9.65				107	91.8
L-Ornithine	C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	132.16	140	1.94	8.78	10.52		9.73	v.s.	
O-Phosphoserine	C <sub>3</sub> H <sub>8</sub> NO <sub>6</sub> P	185.07	166	2.14	9.80	5.70				
L-Pyroglutamic acid	C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	129.12	162	3.32						
Sarcosine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.09	212	2.18	9.97				428	
Taurine	C <sub>2</sub> H <sub>7</sub> NO <sub>3</sub> S	125.15	328	-0.3	9.06				105	
L-Thyroxine	C <sub>15</sub> H <sub>11</sub> I <sub>4</sub> NO <sub>4</sub>	776.87	235	2.20	10.01	6.45			sl.s.	



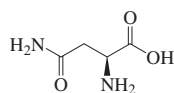
## STRUCTURES OF COMMON AMINO ACIDS



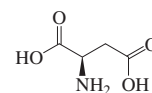
*L*-Alanine (Ala)



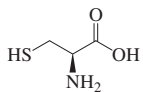
*L*-Arginine (Arg)



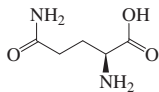
*L*-Asparagine (Asn)



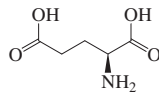
*L*-Aspartic acid (Asp)



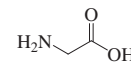
*L*-Cysteine (Cys)



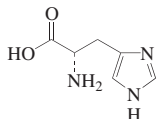
*L*-Glutamine (Gln)



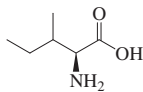
*L*-Glutamic acid (Glu)



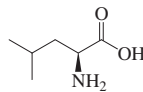
Glycine (Gly)



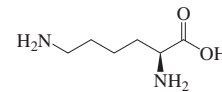
*L*-Histidine (His)



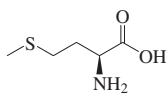
*L*-Isoleucine (Ile)



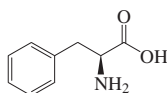
*L*-Leucine (Leu)



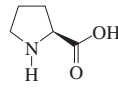
*L*-Lysine (Lys)



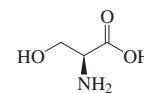
*L*-Methionine (Met)



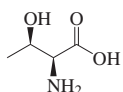
*L*-Phenylalanine (Phe)



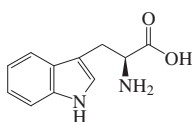
*L*-Proline (Pro)



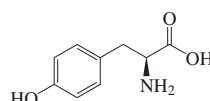
*L*-Serine (Ser)



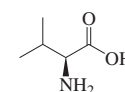
*L*-Threonine (Thr)



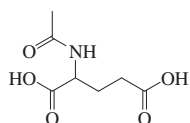
*L*-Tryptophan (Trp)



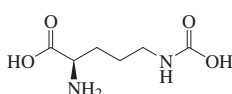
*L*-Tyrosine (Tyr)



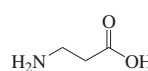
*L*-Valine (Val)



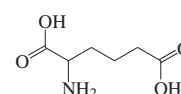
*N*-Acetylglutamic acid



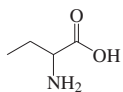
*N*<sub>6</sub>-Acetyl-*L*-lysine



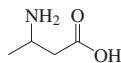
$\beta$ -Alanine



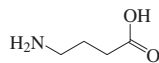
2-Amino adipic acid



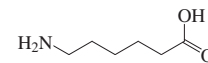
*DL*-2-Aminobutanoic acid



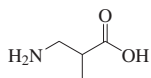
*DL*-3-Aminobutanoic acid



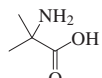
4-Aminobutanoic acid



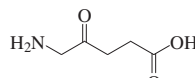
6-Aminohexanoic acid



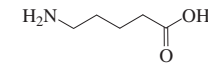
*L*-3-Amino-2-methylpropanoic acid



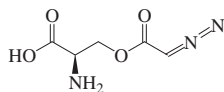
2-Amino-2-methylpropanoic acid



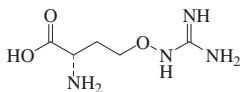
5-Amino-4-oxopentanoic acid



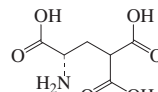
5-Aminopentanoic acid



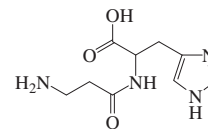
Azaserine



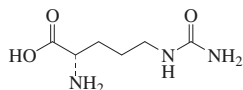
Canavanine



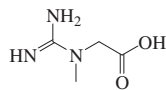
*L*- $\gamma$ -Carboxyglutamic acid



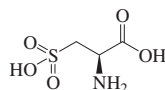
Carnosine



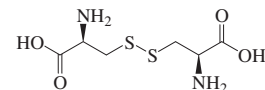
Citrulline



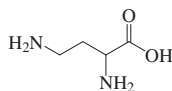
Creatine



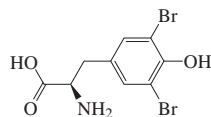
L-Cysteic acid



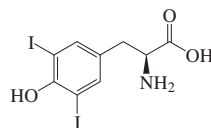
L-Cystine



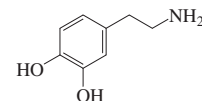
2,4-Diaminobutanoic acid



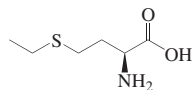
3,5-Dibromo-L-tyrosine



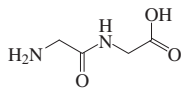
3,5-Diiodo-L-tyrosine



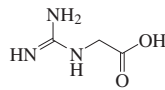
Dopamine



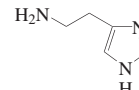
L-Ethionine



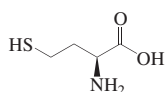
N-Glycylglycine



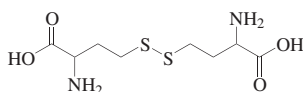
Guanidinoacetic acid



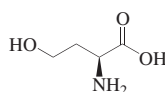
Histamine



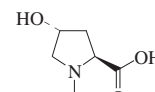
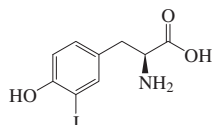
L-Homocysteine



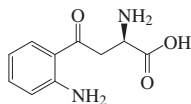
Homocystine



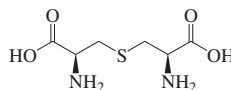
L-Homoserine

*trans*-4-Hydroxy-L-proline

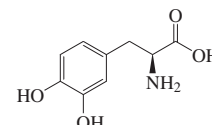
L-3-Iodotyrosine



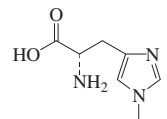
L-Kynurenine



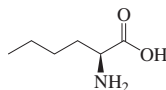
L-Lanthionine



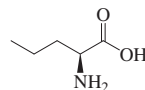
Levodopa



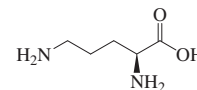
L-1-Methylhistidine



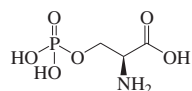
L-Norleucine



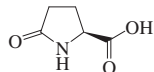
L-Norvaline



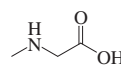
L-Ornithine



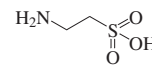
O-Phosphoserine



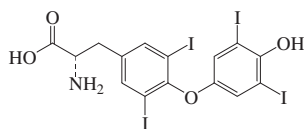
L-Pyroglutamic acid



Sarcosine



Taurine

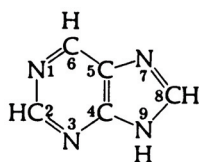


L-Thyroxine

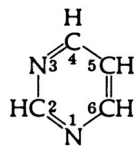
## PROPERTIES OF PURINE AND PYRIMIDINE BASES

This table lists some of the important purine and pyrimidine bases that occur in nucleic acids. The  $pK_a$  values (negative logarithm of the acid dissociation constant) are given for each ioniza-

tion stage. The last column gives the aqueous solubility  $S$  at the indicated temperature in units of grams per 100 grams of solution. The numbering system in the rings is:



Purine



Pyrimidine

### References

1. Dawson, R. M. C., et al., *Data for Biochemical Research*, 3rd ed., Clarendon Press, Oxford, 1986.
2. O'Neil, M. J., Ed., *The Merck Index*, 13th ed., Merck and Co., Rahway, NJ, 2001.

Common name	Systematic name	Mol. form.	Mol. wt.	$pK_a$ values			$S$ /mass % (temp.)
<b>Pyrimidines</b>							
Cytosine	4-Amino-2-hydroxypyrimidine	$C_4H_5N_3O$	111.10	4.60	12.16		0.73 (25°C)
5-Methylcytosine	4-Amino-2-hydroxy-5-methylpyrimidine	$C_5H_7N_3O$	125.13	4.6	12.4		0.45 (25°C)
5-Hydroxymethylcytosine	4-Amino-2-hydroxy-5-hydroxymethylpyrimidine	$C_5H_7N_3O_2$	141.13	4.3	13		
Uracil	2,4-Dihydroxypyrimidine	$C_4H_4N_2O_2$	112.09	0.5	9.5	>13	0.27 (25°C)
Thymine	5-Methyluracil	$C_5H_6N_2O_2$	126.11	9.94	>13		0.35 (25°C)
Orotic acid	Uracil-6-carboxylic acid	$C_5H_4N_2O_4$	156.10	2.4	9.5	>13	0.18 (18°C)
<b>Purines</b>							
Adenine	6-Aminopurine	$C_5H_5N_5$	135.14	<1	4.3	9.83	0.104 (25°C)
Guanine	2-Amino-6-hydroxypurine	$C_5H_5N_5O$	151.13	3.3	9.2	12.3	0.0068 (40°C)
7-Methylguanine	7-Methyl-2-amino-6-hydroxypurine	$C_6H_7N_5O$	165.16	3.5	9.9		
Isoguanine	6-Amino-2-hydroxypurine	$C_5H_5N_5O$	151.13	4.5	9.0		0.006 (25°C)
Xanthine	2,6-Dioxypurine	$C_5H_4N_4O_2$	152.11	0.8	7.4	11.1	0.05 (20°C)
Hypoxanthine	6-Hydroxypurine	$C_5H_4N_4O$	136.11	2.0	8.9	12.1	0.07 (19°C)
Uric acid	2,6,8-Trihydroxypurine	$C_5H_4N_4O_3$	168.11	5.4	11.3		0.002 (20°C)

## THE GENETIC CODE

This table gives the correspondence between a messenger RNA codon and the amino acid which it specifies. The symbols for bases in the codon are:

U: uracil  
 C: cytosine  
 A: adenine  
 G: guanine

The amino acid symbols are given in the table entitled "Structures of Common Amino Acids". A chain-initiating codon is indicated by **init** and a chain-terminating codon by **term**.

Example: UCA codes for **Ser**, UAC codes for **Tyr**, etc.

First position	Second position				Third position
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	<b>term</b>	<b>term</b>	A
	Leu	Ser	<b>term</b>	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met ( <b>init</b> )	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val ( <b>init</b> )	Ala	Glu	Gly	G

## PROPERTIES OF FATTY ACIDS AND THEIR METHYL ESTERS

This table gives the names and selected properties of some important fatty acids and their methyl esters. It includes most of the acids that are significant constituents of naturally occurring oils and fats. Compounds are listed first by number of carbon atoms and, secondly, by the degree of unsaturation. Both the systematic name and the common or trivial name are given, as well as the Chemical Abstracts Service Registry Number and the shorthand acid code that is frequently used. The first number in this code gives the number of carbon atoms; the number following the colon is the number of unsaturated centers (mainly double bonds). The location and orientation of the unsaturated centers follow. The symbols used are: c = *cis*; t = *trans*; a = acetylenic center; e = ethylenic center at end of chain; ep = *epoxy*. Thus 9c,11t indicates a double bond with *cis* orientation at the No. 9 carbon and another with *trans* orientation at the No. 11 carbon. More details on the codes can be found in Reference 1.

The table gives the molecular weight and melting point of the acid and the melting and boiling points of the methyl ester of the acid when available. A superscript on the boiling point indicates the pressure in mmHg (torr); if there is no superscript, the value refers

to one atmosphere (760 mmHg). The references cover many other fatty acids beyond those listed here and give additional properties.

We are indebted to Frank D. Gunstone for advice on the content of the table.

### References

1. Gunstone, F. D., Harwood, J. L., and Dijkstra, A. J., eds., *The Lipid Handbook, Third Edition*, CRC Press, Boca Raton, FL, 2006.
2. Gunstone, F. D., and Adlof, R. O., *Common (non-systematic) Names for Fatty Acids*, [www.aocs.org/member/division/analytic/fanames.asp](http://www.aocs.org/member/division/analytic/fanames.asp), 2003.
3. Firestone, D., *Physical and Chemical Characteristics of Oils, Fats, and Waxes*, 2nd Edition, AOCS Press, Urbana, IL, 2006.
4. Dawson, R. M. C., Elliott, D. C., Elliott, W. H., and Jones, K. M., *Data for Biochemical Research*, Third Edition, Clarendon Press, Oxford, 1986.
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Systematic name	Common name	Mol. form.	Acid code	CAS RN	Mol. weight	Methyl ester		
						mp/°C	mp/°C	bp/°C
Butanoic acid	Butyric acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	4:0	107-92-6	88.106	-5.1	-85.8	102.8
Pentanoic acid	Valeric acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	5:0	109-52-4	102.132	-33.6		127.4
3-Methylbutanoic acid	Isovaleric acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	4:0 3-Me	503-74-2	102.132	-29.3		116.5
Hexanoic acid	Caproic acid	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	6:0	142-62-1	116.158	-3	-71	149.5
Heptanoic acid	Enanthic acid	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	7:0	111-14-8	130.185	-7.2	-56	174
Octanoic acid	Caprylic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	8:0	124-07-2	144.212	16.5	-40	192.9
Nonanoic acid	Pelargonic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	9:0	112-05-0	158.238	12.4		213.5
Decanoic acid	Capric acid	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	10:0	334-48-5	172.265	31.4	-18	224
9-Decenoic acid	Caproleic acid	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	10:1 9e	14436-32-9	170.249	26.5		120 <sup>20</sup>
Undecanoic acid		C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	11:0	112-37-8	186.292	28.6		123 <sup>10</sup>
Dodecanoic acid	Lauric acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	12:0	143-07-7	200.318	43.8	5.2	267
<i>cis</i> -9-Dodecenoic acid	Lauroleic acid	C <sub>12</sub> H <sub>22</sub> O <sub>2</sub>	12:1 9c	2382-40-3	198.302			
Tridecanoic acid		C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	13:0	638-53-9	214.344	41.5	6.5	92 <sup>1</sup>
Tetradecanoic acid	Myristic acid	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	14:0	544-63-8	228.371	54.2	19	295
<i>cis</i> -9-Tetradecenoic acid	Myristoleic acid	C <sub>14</sub> H <sub>26</sub> O <sub>2</sub>	14:1 9c	13147-06-3	226.355	-4		
Pentadecanoic acid		C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	15:0	1002-84-2	242.398	52.3	18.5	153.5
Hexadecanoic acid	Palmitic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	16:0	57-10-3	256.424	62.5	30	417
<i>cis</i> -9-Hexadecenoic acid	Palmitoleic acid	C <sub>16</sub> H <sub>30</sub> O <sub>2</sub>	16:1 9c	373-49-9	254.408	0.5		140 <sup>5</sup>
Heptadecanoic acid	Margaric acid	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	17:0	506-12-7	270.451	61.3	30	185 <sup>9</sup>
Octadecanoic acid	Stearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	18:0	57-11-4	284.478	69.3	39.1	443
<i>cis</i> -6-Octadecenoic acid	Petroselinic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	18:1 6c	593-39-5	282.462	29.8		
<i>cis</i> -9-Octadecenoic acid	Oleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	18:1 9c	112-80-1	282.462	13.4	-19.9	218.5 <sup>20</sup>
<i>trans</i> -9-Octadecenoic acid	Elaidic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	18:1 9t	112-79-8	282.462	45	13.5	218 <sup>24</sup>
<i>cis</i> -11-Octadecenoic acid	<i>cis</i> -Vaccenic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	18:1 11c	506-17-2	282.462	15		163 <sup>01</sup>
<i>trans</i> -11-Octadecenoic acid	Vaccenic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	18:1 11t	693-72-1	282.462	44		172 <sup>3</sup>
<i>cis</i> -12,13-Epoxy- <i>cis</i> -9-octadecenoic acid	Vernolic acid	C <sub>18</sub> H <sub>32</sub> O <sub>3</sub>	18:1 12,13-ep,9c	503-07-1	296.445	32.5		
12-Hydroxy- <i>cis</i> -9-octadecenoic acid	Ricinoleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>3</sub>	18:1 12-OH,9c	141-22-0	298.461	5.5		226 <sup>15</sup>
<i>cis,trans</i> -9,11-Octadecadienoic acid	Rumenic (CLA)	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	18:2 9c,11t	1839-11-8	280.446	20		
<i>cis,cis</i> -9,12-Octadecadienoic acid	Linoleic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	18:2 9c,12c	60-33-3	280.446	-7	-35	215 <sup>20</sup>

Systematic name	Common name	Mol. form.	Acid code	CAS RN	Mol. weight	mp/°C	Methyl ester	
							mp/°C	bp/°C
<i>trans,cis</i> -10,12-Octadecadienoic acid	(CLA)	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	18:2 10t,12c	22880-03-1	280.446	23	-12	
<i>cis</i> -9-Octadecen-12-ynoic acid	Crepenynic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:2 9c,12a	2277-31-8	278.430			
<i>cis,cis,cis</i> -5,9,12-Octadecatrienoic acid	Pinolenic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 5c,9c,12c	27213-43-0	278.430			
<i>trans,cis,cis</i> -5,9,12-Octadecatrienoic acid	Columbinic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 5t,9c,12c	2441-53-4	278.430			
<i>cis,cis,cis</i> -6,9,12-Octadecatrienoic acid	γ-Linolenic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 6c,9c,12c	506-26-3	278.430			162 <sup>0.5</sup>
<i>trans,trans,cis</i> -8,10,12-Octadecatrienoic acid	Calendic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 8t,10t,12c	28872-28-8	278.430	40		
<i>cis,trans,cis</i> -9,11,13-Octadecatrienoic acid	Punicic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 9c,11t,13c	544-72-9	278.430	45		
<i>cis,trans,trans</i> -9,11,13-Octadecatrienoic acid	α-Eleostearic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 9c,11t,13t	506-23-0	278.430	49		148 <sup>1</sup>
<i>trans,trans,cis</i> -9,11,13-Octadecatrienoic acid	Catalpic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 9t,11t,13c	4337-71-7	278.430	32		
<i>trans,trans,trans</i> -9,11,13-Octadecatrienoic acid	β-Eleostearic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 9t,11t,13t	544-73-0	278.430	71.5	13	162 <sup>1</sup>
<i>cis,cis,cis</i> -9,12,15-Octadecatrienoic acid	α-Linolenic acid	C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	18:3 9c,12c,15c	463-40-1	278.430	-11.3	-52	109 <sup>0.018</sup>
6,9,12,15-Octadecatetraenoic acid, all <i>cis</i>	Stearidonic acid	C <sub>18</sub> H <sub>28</sub> O <sub>2</sub>	18:4 6c,9c,12c,15c	20290-75-9	276.414	-57		
<i>cis,trans,trans,cis</i> -9,11,13,15-Octadecatetraenoic acid	Parinaric acid	C <sub>18</sub> H <sub>28</sub> O <sub>2</sub>	18:4 9c,11t,13t,15c	593-38-4	276.414	86		
Nonadecanoic acid		C <sub>19</sub> H <sub>38</sub> O <sub>2</sub>	19:0	646-30-0	298.504	69.4	41.3	190 <sup>4</sup>
Eicosanoic acid	Arachidic acid	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	20:0	506-30-9	312.531	76.5	54.5	215 <sup>10</sup>
3,7,11,15-Tetramethylhexadecanoic acid	Phytanic acid	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	16:0 3,7,11,15-tetramethyl	14721-66-5	312.531	-65		
<i>cis</i> -5-Eicosenoic acid		C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	20:1 5c	7050-07-9	310.515	27		
<i>cis</i> -9-Eicosenoic acid	Gadoleic acid	C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	20:1 9c	29204-02-2	310.515	24.5		
<i>cis</i> -11-Eicosenoic acid	Gondoic acid	C <sub>20</sub> H <sub>38</sub> O <sub>2</sub>	20:1 11c	2462-94-4	310.515	24		
<i>cis,cis,cis</i> -8,11,14-Eicosatrienoic acid	Dihomo-γ-linolenic acid	C <sub>20</sub> H <sub>34</sub> O <sub>2</sub>	20:3 8c,11c,14c	1783-84-2				
5,8,11,14-Eicosatetraenoic acid, all <i>cis</i>	Arachidonic acid	C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	20:4 5c,8c,11c,14c	506-32-1	304.467	-49.5		195 <sup>0.7</sup>
5,8,11,14,17-Eicosapentanoic acid, all <i>cis</i>	Timnodonic acid, EPA	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	20:5 5c,8c,11c,14c,17c	10417-94-4	302.451	-54		
Heneicosanoic acid		C <sub>21</sub> H <sub>42</sub> O <sub>2</sub>	21:0	2363-71-5	326.557	82	49	207 <sup>4</sup>
Docosanoic acid	Behenic acid	C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	22:0	112-85-6	340.583	81.5	54	
<i>cis</i> -11-Docosenoic acid	Cetolic acid	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	22:1 11c	506-36-5	338.567	33		
<i>cis</i> -13-Docosenoic acid	Erucic acid	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	22:1 13c	112-86-7	338.567	34.7		221 <sup>5</sup>
<i>trans</i> -13-Docosenoic acid	Brassicidic acid	C <sub>22</sub> H <sub>42</sub> O <sub>2</sub>	22:1 13t	506-33-2	338.567	61.9	35	
<i>cis,cis</i> -5,13-Docosadienoic acid		C <sub>22</sub> H <sub>40</sub> O <sub>2</sub>	22:2 5c,13c	676-39-1	336.552	-4		
7,10,13,16,19-Docosapentanoic acid, all <i>cis</i>		C <sub>22</sub> H <sub>34</sub> O <sub>2</sub>	22:5 7c,10c,13c,16c,19c					
4,7,10,13,16,19-Docosahexanoic acid, all <i>cis</i>	Cervonic acid, DHA	C <sub>22</sub> H <sub>32</sub> O <sub>2</sub>	22:6 4c,7c,10c,13c,16c,19c	2091-24-9		-45		
Tricosanoic acid		C <sub>23</sub> H <sub>46</sub> O <sub>2</sub>	23:0	2433-96-7		79.6	53.4	
Tetracosanoic acid	Lignoceric acid	C <sub>24</sub> H <sub>48</sub> O <sub>2</sub>	24:0	557-59-5	368.637	87.5	60	
<i>cis</i> -15-Tetracosenoic acid	Nervonic acid	C <sub>24</sub> H <sub>46</sub> O <sub>2</sub>	24:1 15c	506-37-6	366.621	43	15	165 <sup>0.02</sup>
Pentacosanoic acid		C <sub>25</sub> H <sub>50</sub> O <sub>2</sub>	25:0	506-38-7	382.664	77.5	62	
Hexacosanoic acid	Cerotic acid	C <sub>26</sub> H <sub>52</sub> O <sub>2</sub>	26:0	506-46-7	396.690	88.5	63.8	286 <sup>15</sup>
Heptacosanoic acid		C <sub>27</sub> H <sub>54</sub> O <sub>2</sub>	27:0	7138-40-1		87.6	64	
Octacosanoic acid	Montanic acid	C <sub>28</sub> H <sub>56</sub> O <sub>2</sub>	28:0	506-48-9	424.744	90.9	67	
Nonacosanoic acid		C <sub>29</sub> H <sub>58</sub> O <sub>2</sub>	29:0	4250-38-8	438.770	90.3	69	
Triacosanoic acid	Melissic acid	C <sub>30</sub> H <sub>60</sub> O <sub>2</sub>	30:0	506-50-3	452.796	93.6	72	
Hentriacontanoic acid		C <sub>31</sub> H <sub>62</sub> O <sub>2</sub>	31:0	38232-01-8	466.823	93.1		
Dotriacontanoic acid	Lacceric acid	C <sub>32</sub> H <sub>64</sub> O <sub>2</sub>	32:0	3625-52-3	480.849	96.2		192 <sup>0.01</sup>

## CARBOHYDRATE NAMES AND SYMBOLS

The following table lists the systematic names and symbols for selected carbohydrates and some of their derivatives. The symbols for monosaccharide residues and derivatives are recommended by IUPAC for use in describing the structures of oligosaccharide chains. A more complete list can be found in the reference.

### Reference

McNaught, A. D., *Pure Appl. Chem.*, 68, 1919-2008, 1996.

Common name	Symbol	Systematic name
Abequose	Abe	3,6-Dideoxy-D-xylo-hexose
N-Acetyl-2-deoxyneur-2-enaminic acid	Neu2en5Ac	
N-Acetylgalactosamine	GalNAc	
N-Acetylglucosamine	GlcNAc	
N-Acetylneuraminic acid	Neu5Ac	
Allose	All	<i>allo</i> -Hexose
Altrose	Alt	<i>altro</i> -Hexose
Apiose	Api	3-C-(Hydroxymethyl)-glycero-tetrose
Arabinitol	Ara-ol	Arabinitol
Arabinose	Ara	<i>arabino</i> -Pentose
Arcanose		2,6-Dideoxy-3-C-methyl-3-O-methyl-xylo-hexose
Ascarylose		3,6-Dideoxy-L- <i>arabino</i> -hexose
Boivinose		2,6-Dideoxy-D-gulose
Chalcase		4,6-Dideoxy-3-O-methyl-D-xylo-hexose
Cladinose		2,6-Dideoxy-3-C-methyl-3-O-methyl-L- <i>ribo</i> -hexose
Colitose		3,6-Dideoxy-L-xylo-hexose
Cymarose		6-Deoxy-3-O-methyl- <i>ribo</i> -hexose
3-Deoxy-D-manno-oct-2-ulosonic acid	Kdo	
2-Deoxyribose	dRib	2-Deoxy- <i>erythro</i> -pentose
2,3-Diamino-2,3-dideoxy-D-glucose	GlcN3N	
Diginose		2,6-Dideoxy-3-O-methyl- <i>lyxo</i> -hexose
Digitalose		6-Deoxy-3-O-methyl-D-galactose
Digitoxose		2,6-Dideoxy-D- <i>ribo</i> -hexose
3,4-Di-O-methylramnose	Rha3,4Me <sub>2</sub>	
Ethyl glucopyranuronate	Glc <sub>p</sub> A6Et	
Evalose		6-Deoxy-3-C-methyl-D-mannose
Fructose	Fru	<i>arabino</i> -Hex-2-ulose
Fucitol	Fuc-ol	6-Deoxy-D-galactitol
Fucose	Fuc	6-Deoxygalactose
β-D-Galactopyranose 4-sulfate	β-D-Galp4S	
Galactosamine	GalN	2-Amino-2-deoxygalactose
Galactose	Gal	<i>galacto</i> -Hexose
Glucitol	Glc-ol	
Glucosamine	GlcN	2-Amino-2-deoxyglucose
Glucose	Glc	<i>gluco</i> -Hexose
Glucuronic acid	GlcA	
N-Glycoloylneuraminic acid	Neu5Gc	
Gulose	Gul	<i>gulo</i> -Hexose
Hamamelose		2-C-(Hydroxymethyl)-D-ribose
Idose	Ido	<i>ido</i> -Hexose
Iduronic acid	IdoA	
Lactose	Lac	β-D-Galactopyranosyl-(1→4)-D-glucose
Lyxose	Lyx	<i>lyxo</i> -Pentose
Maltose		α-D-Glucopyranosyl-(1→4)-D-glucose
Mannose	Man	<i>manno</i> -Hexose
2-C-Methylxylose	Xyl2CMe	
Muramic acid	Mur	2-Amino-3-O-[(R)-1-carboxyethyl]-2-deoxy-D-glucose
Mycarose		2,6-Dideoxy-3-C-methyl-L- <i>ribo</i> -hexose
Mycinose		6-Deoxy-2,3-di-O-methyl-D-allose

Common name	Symbol	Systematic name
Neuraminic acid	Neu	5-Amino-3,5-dideoxy-D-glycero-D-galacto-non-2-ulosonic acid
Panose		$\alpha$ -D-Glucopyranosyl-(1 $\rightarrow$ 6)- $\alpha$ -D-glucopyranosyl-(1 $\rightarrow$ 4)-D-glucose
Paratose		3,6-Dideoxy-D-ribo-hexose
Primeverose		$\beta$ -D-Xylopyranosyl-(1 $\rightarrow$ 6)-D-glucose
Psicose	Psi	<i>ribo</i> -Hex-2-ulose
Quinovose	Qui	6-Deoxyglucose
Raffinose		$\beta$ -D-Fructofuranosyl- $\alpha$ -D-galactopyranosyl-(1 $\rightarrow$ 6)- $\alpha$ -D-glucopyranoside
Rhamnose	Rha	6-Deoxymannose
Rhodinose		2,3,6-Trideoxy-L- <i>threo</i> -hexose
Ribose	Rib	<i>ribo</i> -Pentose
Ribose 5-phosphate	Rib5P	
Ribulose	Ribulo (Rul)	<i>erythro</i> -Pent-2-ulose
Rutinose		$\alpha$ -L-Rhamnopyranosyl-(1 $\rightarrow$ 6)-D-glucose
Sarmentose		2,6-Dideoxy-3-O-methyl-D- <i>xylo</i> -hexose
Sedoheptulose		D- <i>altro</i> -Hept-2-ulose
Sorbose	Sor	<i>xylo</i> -Hex-2-ulose
Streptose		5-Deoxy-3-C-formyl-L-lyxose
Sucrose		$\beta$ -D-Fructofuranosyl- $\alpha$ -D-glucopyranoside
Tagatose	Tag	<i>lyxo</i> -Hex-2-ulose
Talose	Tal	<i>talo</i> -Hexose
Turanose		$\alpha$ -D-Glucopyranosyl-(1 $\rightarrow$ 3)-D-fructose
Tyvelose	Tyv	3,6-Dideoxy-D- <i>arabino</i> -hexose
Xylose	Xyl	<i>xylo</i> -Pentose
Xylulose	Xylulo (Xul)	<i>threo</i> -Pent-2-ulose



## BIOLOGICAL BUFFERS

This table of frequently used buffers gives the  $pK_a$  value at 25°C and the useful pH range of each buffer. The buffers are listed in order of increasing pH. The table is reprinted with permission of Sigma Chemical Company, St. Louis, Mo.

Acronym	Name	Mol. wt.	$pK_a$	Useful pH range
MES	2-( <i>N</i> -Morpholino)ethanesulfonic acid	195.2	6.1	5.5–6.7
BIS TRIS	Bis(2-hydroxyethyl)iminotris(hydroxymethyl)methane	209.2	6.5	5.8–7.2
ADA	<i>N</i> -(2-Acetamido)-2-iminodiacetic acid	190.2	6.6	6.0–7.2
ACES	2-[(2-Amino-2-oxoethyl)amino]ethanesulfonic acid	182.2	6.8	6.1–7.5
PIPES	Piperazine- <i>N,N'</i> -bis(2-ethanesulfonic acid)	302.4	6.8	6.1–7.5
MOPSO	3-( <i>N</i> -Morpholino)-2-hydroxypropanesulfonic acid	225.3	6.9	6.2–7.6
BIS TRISPROPANE	1,3-Bis[tris(hydroxymethyl)methylamino]propane	282.3	6.8 <sup>a</sup>	6.3–9.5
BES	<i>N,N</i> -Bis(2-hydroxyethyl)-2-aminoethanesulfonic acid	213.2	7.1	6.4–7.8
MOPS	3-( <i>N</i> -Morpholino)propanesulfonic acid	209.3	7.2	6.5–7.9
HEPES	<i>N</i> -(2-Hydroxyethyl)piperazine- <i>N'</i> -(2-ethanesulfonic acid)	238.3	7.5	6.8–8.2
TES	<i>N</i> -Tris(hydroxymethyl)methyl-2-aminoethanesulfonic acid	229.2	7.5	6.8–8.2
DIPSO	3-[ <i>N,N</i> -Bis(2-hydroxyethyl)amino]-2-hydroxypropanesulfonic acid	243.3	7.6	7.0–8.2
TAPSO	3-[ <i>N</i> -Tris(hydroxymethyl)methylamino]-2-hydroxypropanesulfonic acid	259.3	7.6	7.0–8.2
TRIZMA	Tris(hydroxymethyl)aminomethane	121.1	8.1	7.0–9.1
HEPPSO	<i>N</i> -(2-hydroxyethyl)piperazine- <i>N'</i> -(2-hydroxypropanesulfonic acid)	268.3	7.8	7.1–8.5
POPSO	Piperazine- <i>N,N'</i> -bis(2-hydroxypropanesulfonic acid)	362.4	7.8	7.2–8.5
EPPS	<i>N</i> -(2-Hydroxyethyl)piperazine- <i>N'</i> -(3-propanesulfonic acid)	252.3	8.0	7.3–8.7
TEA	Triethanolamine	149.2	7.8	7.3–8.3
TRICINE	<i>N</i> -Tris(hydroxymethyl)methylglycine	179.2	8.1	7.4–8.8
BICINE	<i>N,N</i> -Bis(2-hydroxyethyl)glycine	163.2	8.3	7.6–9.0
TAPS	<i>N</i> -Tris(hydroxymethyl)methyl-3-aminopropanesulfonic acid	243.3	8.4	7.7–9.1
AMPSO	3-[(1,1-Dimethyl-2-hydroxyethyl)amino]-2-hydroxypropanesulfonic acid	227.3	9.0	8.3–9.7
CHES	2-( <i>N</i> -Cyclohexylamino)ethanesulfonic acid	207.3	9.3	8.6–10.0
CAPSO	3-(Cyclohexylamino)-2-hydroxy-1-propanesulfonic acid	237.3	9.6	8.9–10.3
AMP	2-Amino-2-methyl-1-propanol	89.1	9.7	9.0–10.5
CAPS	3-(Cyclohexylamino)-1-propanesulfonic acid	221.3	10.4	9.7–11.1

<sup>a</sup>  $pK_a = 9.0$  for the second dissociation stage.

## TYPICAL pH VALUES OF BIOLOGICAL MATERIALS AND FOODS

This table gives typical pH ranges for various biological fluids and common foods. All values refer to 25°C.

Biological Materials			
Blood, human	7.35–7.45	Hominy (lye)	6.8–8.0
Blood, dog	6.9–7.2	Jams, fruit	3.5–4.0
Spinal fluid, human	7.3–7.5	Jellies, fruit	2.8–3.4
Saliva, human	6.5–7.5	Lemons	2.2–2.4
Gastric contents, human	1.0–3.0	Limes	1.8–2.0
Duodenal contents, human	4.8–8.2	Maple syrup	6.5–7.0
Feces, human	4.6–8.4	Milk, cows	6.3–6.6
Urine, human	4.8–8.4	Olives	3.6–3.8
Milk, human	6.6–7.6	Oranges	3.0–4.0
Bile, human	6.8–7.0	Oysters	6.1–6.6
		Peaches	3.4–3.6
Foods		Pears	3.6–4.0
Apples	2.9–3.3	Peas	5.8–6.4
Apricots	3.6–4.0	Pickles, dill	3.2–3.6
Asparagus	5.4–5.8	Pickles, sour	3.0–3.4
Bananas	4.5–4.7	Pimento	4.6–5.2
Beans	5.0–6.0	Plums	2.8–3.0
Beers	4.0–5.0	Potatoes	5.6–6.0
Beets	4.9–5.5	Pumpkin	4.8–5.2
Blackberries	3.2–3.6	Raspberries	3.2–3.6
Bread, white	5.0–6.0	Rhubarb	3.1–3.2
Butter	6.1–6.4	Salmon	6.1–6.3
Cabbage	5.2–5.4	Sauerkraut	3.4–3.6
Carrots	4.9–5.3	Shrimp	6.8–7.0
Cheese	4.8–6.4	Soft drinks	2.0–4.0
Cherries	3.2–4.0	Spinach	5.1–5.7
Cider	2.9–3.3	Squash	5.0–5.4
Corn	6.0–6.5	Strawberries	3.0–3.5
Crackers	6.5–8.5	Sweet potatoes	5.3–5.6
Dates	6.2–6.4	Tomatoes	4.0–4.4
Eggs, fresh white	7.6–8.0	Tuna	5.9–6.1
Flour, wheat	5.5–6.5	Turnips	5.2–5.6
Gooseberries	2.8–3.0	Vinegar	2.4–3.4
Grapefruit	3.0–3.3	Water, drinking	6.5–8.0
Grapes	3.5–4.5	Wines	2.8–3.8

## CHEMICAL COMPOSITION OF THE HUMAN BODY

The elemental composition of the “standard man” of mass 70 kg is given below.

### References

1. Padikal, T. N., and Fivozinsky, S. P., *Medical Physics Data Book, National Bureau of Standards Handbook 138*, U. S. Government Printing Office, Washington, DC, 1981.
2. Snyder, W. S., et al., *Reference Man: Anatomical, Physiological, and Metabolic Characteristics*, Pergamon, New York, 1975.

Element	Amount (g)	Percent of total body mass
Oxygen	43,000	61
Carbon	16,000	23
Hydrogen	7000	10
Nitrogen	1800	2.6
Calcium	1000	1.4
Phosphorus	780	1.1
Sulfur	140	0.20
Potassium	140	0.20
Sodium	100	0.14
Chlorine	95	0.12
Magnesium	19	0.027
Silicon	18	0.026
Iron	4.2	0.006
Fluorine	2.6	0.0037
Zinc	2.3	0.0033
Rubidium	0.32	0.00046
Strontium	0.32	0.00046
Bromine	0.20	0.00029
Lead	0.12	0.00017
Copper	0.072	0.00010
Aluminum	0.061	0.00009
Cadmium	0.050	0.00007
Boron	<0.048	0.00007
Barium	0.022	0.00003
Tin	<0.017	0.00002
Manganese	0.012	0.00002
Iodine	0.013	0.00002
Nickel	0.010	0.00001
Gold	<0.010	0.00001
Molybdenum	<0.0093	0.00001
Chromium	<0.0018	0.000003
Cesium	0.0015	0.000002
Cobalt	0.0015	0.000002
Uranium	0.00009	0.0000001
Beryllium	0.000036	
Radium	$3.1 \cdot 10^{-11}$	

# STANDARD TRANSFORMED GIBBS ENERGIES OF FORMATION FOR BIOCHEMICAL REACTANTS

Robert N. Goldberg and Robert A. Alberty

This table contains values of the standard transformed Gibbs energies of formation  $\Delta_f G'^{\circ}$  for 130 biochemical reactants. Values of  $\Delta_f G'^{\circ}$  are given at pH 7.0, the temperature 298.15 K, and the pressure 100 kPa for three ionic strengths:  $I = 0$ ,  $I = 0.1$  mol/L and  $I = 0.25$  mol/L. The table can be used for calculating apparent equilibrium constants  $K'$  and standard apparent reduction potentials  $E'^{\circ}$  for biochemical reactions. Such a listing is more compact than tabulating the actual apparent equilibrium constants or standard apparent reduction potentials, which would require a very large number of reactant-product combinations. In the table, all reactants are in aqueous solution unless indicated otherwise.

A biochemical reactant is a sum of species. For example, ATP consists of an equilibrium mixture of the aqueous species  $\text{ATP}^4$ ,  $\text{HATP}^3$ ,  $\text{H}_2\text{ATP}^2$ ,  $\text{MgATP}^2$ , etc. Similarly, phosphate refers to the equilibrium mixture of the aqueous species  $\text{PO}_4^{3-}$ ,  $\text{HPO}_4^{2-}$ ,  $\text{H}_2\text{PO}_4^-$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{MgHPO}_4$ , etc. Biochemical reactions are written using biochemical reactants in terms of an apparent equilibrium constant  $K'$ , which is distinct from the standard equilibrium constant  $K$ . This subject is discussed in an IUPAC report (see Reference 1 below).

The apparent equilibrium constant  $K'$  and the standard transformed Gibbs energy change  $\Delta_r G'^{\circ}$  for a biochemical reaction can be calculated from the  $\Delta_f G'^{\circ}$  values by using the relationship

$$-RT \ln K' = \Delta_r G'^{\circ} = \sum \nu_i' \Delta_f G'^{\circ},$$

where the summation is over all of the biochemical reactants. The quantity  $\nu_i'$  is the stoichiometric number of reactant  $i$  ( $\nu_i'$  is positive for reactants on the right side of the equation and negative for reactants on the left side);  $R$  is the gas constant. As an example, the hydrolysis reaction of ATP is

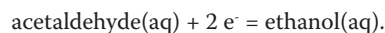


At pH 7.00 and  $I = 0.25$  M,  $\Delta_r G'^{\circ}$  and  $K'$  are calculated as follows:

$$\Delta_r G'^{\circ} = \{-1424.70 - 1059.49 - (-2292.50 - 155.66)\} \cdot (\text{kJ mol}^{-1}) = -36.03 \text{ kJ mol}^{-1}$$

$$K' = \exp[-(-36030 \text{ J mol}^{-1}) / \{(8.3145 \text{ J mol}^{-1} \text{ K}^{-1}) \cdot (298.15 \text{ K})\}] = 2.05 \cdot 10^6$$

An example involving a biochemical half-cell reaction is



At 298.15 K, pH 7.00, and  $I = 0$ , the standard apparent reduction potential  $E'^{\circ}$  can be calculated as follows

$$E'^{\circ} = -(1/nF) \cdot \{\Delta_f G'^{\circ}(\text{ethanol}) - \Delta_f G'^{\circ}(\text{acetaldehyde})\},$$

where  $n$  is the number of electrons in the half-cell reaction and  $F$  is the Faraday constant. Then,

$$E'^{\circ} = [-1 / (2 \cdot 9.6485 \cdot 10^4 \text{ C mol}^{-1})] \cdot (58.10 \cdot 10^3 \text{ J mol}^{-1} - 20.83 \cdot 10^3 \text{ J mol}^{-1}) = -0.193 \text{ V}$$

## References

1. Alberty, R.A., Cornish-Bowden, A., Gibson, Q.H., Goldberg, R.N., Hammes, G., Jencks, W., Tipton, K.F., Veech, R., Westerhoff, H.V., and Webb, E.C. *Pure Appl. Chem.* 66, 1641-1666, 1994.
2. Alberty, R.A., *Arch. Biochem. Biophys.*, 353, 116-130, 1998; 358, 25-39, 1998.
3. Alberty, R.A., *Thermodynamics of Biochemical Reactions*, Wiley-Interscience, New York, 2003.
4. Alberty, R.A., *BasicBiochemData2: Data and Programs for Biochemical Thermodynamics*, <<http://library.wolfram.com/infocenter/MathSource/797>>.

Reactant	$\Delta_f G'^{\circ}(I = 0)$ kJ mol <sup>-1</sup>	$\Delta_f G'^{\circ}(I = 0.1 \text{ M})$ kJ mol <sup>-1</sup>	$\Delta_f G'^{\circ}(I = 0.25 \text{ M})$ kJ mol <sup>-1</sup>
Acetaldehyde	20.83	23.27	24.06
Acetate	-249.46	-248.23	-247.83
Acetone	80.04	83.71	84.90
Acetyl Coenzyme A	-60.49	-58.65	-58.06
Acetylphosphate	-1109.34	-1107.57	-1107.02
cis-Aconitate	-797.26	-800.93	-802.12
Adenine	510.45	513.51	514.50
Adenosine	324.93	332.89	335.46
Adenosine 5'-diphosphate (ADP)	-1428.93	-1425.55	-1424.70
Adenosine 5'-monophosphate (AMP)	-562.04	-556.53	-554.83
Adenosine 5'-triphosphate (ATP)	-2292.61	-2292.16	-2292.50
D-Alanine	-91.31	-87.02	-85.64
Ammonia	80.50	82.34	82.93
D-Arabinose	-342.67	-336.55	-334.57
L-Asparagine	-206.28	-201.38	-199.80
L-Aspartate	-456.14	-453.08	-452.09
1,3-Biphosphoglycerate	-2202.06	-2205.69	-2207.30
Butanoate	-72.94	-69.26	-68.08
1-Butanol	227.72	233.84	235.82

Reactant	$\Delta_f G^{\circ}(I = 0)$ kJ mol <sup>-1</sup>	$\Delta_f G^{\circ\prime}(I = 0.1 \text{ M})$ kJ mol <sup>-1</sup>	$\Delta_f G^{\circ\prime\prime}(I = 0.25 \text{ M})$ kJ mol <sup>-1</sup>
Citrate	-963.46	-965.49	-966.23
Isocitrate	-956.82	-958.84	-959.58
Coenzyme A (CoA)	-7.98	-7.43	-7.26
CO(aq)	-119.90	-119.90	-119.90
CO(g)	-137.17	-137.17	-137.17
CO <sub>2</sub> (aq)[total]	-547.33	-547.15	-547.10
CO <sub>2</sub> (g)	-394.36	-394.36	-394.36
Creatine	100.41	105.92	107.69
Creatinine	256.55	260.84	262.22
<i>L</i> -Cysteine	-59.23	-55.01	-53.65
<i>L</i> -Cystine	-187.03	-179.69	-177.32
Cytochrome c [oxidized]	0.00	-5.51	-7.29
Cytochrome c [reduced]	-24.51	-26.96	-27.75
Dihydroxyacetone phosphate	-1096.60	-1095.91	-1095.70
Ethanol	58.10	61.77	62.96
Ethyl acetate	-18.00	-13.10	-11.52
Ferredoxin [oxidized]	0.00	-0.61	-0.81
Ferredoxin [reduced]	38.07	38.07	38.07
Flavine adenine dinucleotide (FAD) [oxidized]	1238.65	1255.17	1260.51
Flavine adenine dinucleotide (FAD) [reduced]	1279.68	1297.43	1303.16
Flavin adenine dinucleotide-enzyme (FADenz) [oxidized]	1238.65	1255.17	1260.51
Flavin adenine dinucleotide-enzyme (FADenz) [reduced]	1229.96	1247.71	1253.44
Flavin mononucleotide (FMN) [oxidized]	759.17	768.35	771.32
Flavin mononucleotide (FMN) [reduced]	800.20	810.61	813.97
Formate	-311.04	-311.04	-311.04
<i>D</i> -Fructose	-436.03	-428.69	-426.32
<i>D</i> -Fructose 1,6-diphosphate	-2202.84	-2205.66	-2206.78
<i>D</i> -Fructose 6-phosphate	-1321.71	-1317.16	-1315.74
Fumarate	-521.97	-523.19	-523.58
<i>D</i> -Galactose	-429.45	-422.11	-419.74
$\alpha$ - <i>D</i> -Galactose 1-phosphate	-1317.50	-1313.01	-1311.60
<i>D</i> -Glucose	-436.42	-429.08	-426.71
$\alpha$ - <i>D</i> -Glucose 1-phosphate	-1318.03	-1313.34	-1311.89
<i>D</i> -Glucose 6-phosphate	-1325.00	-1320.37	-1318.92
Glutamate	-377.82	-373.54	-372.16
<i>D</i> -Glutamine	-128.46	-122.34	-120.36
Glutathione [oxidized]	1198.69	1214.60	1219.74
Glutathione [reduced]	625.75	634.76	637.62
Glutathione-coenzyme A	563.49	572.06	574.83
<i>D</i> -Glyceraldehyde 3-phosphate	-1088.94	-1088.25	-1088.04
Glycerol	-177.83	-172.93	-171.35
<i>sn</i> -Glycerol 3-phosphate	-1080.22	-1077.83	-1077.13
Glycine	-180.13	-177.07	-176.08
Glycolate	-411.08	-409.86	-409.46
Glycylglycine	-200.55	-195.65	-194.07
Glyoxylate	-428.64	-428.64	-428.64
H <sub>2</sub> (aq)	97.51	98.74	99.13
H <sub>2</sub> (g)	79.91	81.14	81.53
H <sub>2</sub> O(l)	-157.28	-156.05	-155.66
H <sub>2</sub> O <sub>2</sub> (aq)	-54.12	-52.89	-52.50
3-Hydroxypropanoate	-318.62	-316.17	-315.38
Hypoxanthine	249.33	251.77	252.56
Indole	503.49	507.78	509.16
Lactate	-316.94	-314.49	-313.70
Lactose	-688.29	-674.83	-670.48
<i>L</i> -Leucine	167.18	175.14	177.71
<i>L</i> -Isoleucine	175.53	183.49	186.06
<i>D</i> -Lyxose	-349.58	-343.46	-341.48
Malate	-682.88	-682.85	-682.85
Maltose	-695.65	-682.19	-677.84

Reactant	$\Delta_f G'^{\circ}(I = 0)$ kJ mol <sup>-1</sup>	$\Delta_f G'^{\circ}(I = 0.1 \text{ M})$ kJ mol <sup>-1</sup>	$\Delta_f G'^{\circ}(I = 0.25 \text{ M})$ kJ mol <sup>-1</sup>
<i>D</i> -Mannitol	-383.22	-374.65	-371.89
Mannose	-430.52	-423.18	-420.81
Methane(aq)	125.50	127.94	128.73
Methane(g)	109.11	111.55	112.34
Methanol	-15.48	-13.04	-12.25
<i>L</i> -Methionine	-63.40	-56.67	-54.49
N <sub>2</sub> (aq)	18.70	18.70	18.70
N <sub>2</sub> (g)	0.00	0.00	0.00
Nicotinamide Adenine Dinucleotide (NAD) [oxidized]	1038.86	1054.17	1059.11
Nicotinamide Adenine Dinucleotide (NAD) [reduced]	1101.47	1115.55	1120.09
Nicotinamide Adenine Dinucleotide Phosphate (NADP) [oxidized]	163.73	173.52	176.68
Nicotinamide Adenine Dinucleotide Phosphate (NADP) [reduced]	229.67	235.79	237.77
O <sub>2</sub> (aq)	16.40	16.40	16.40
O <sub>2</sub> (g)	0.00	0.00	0.00
Oxalate	-673.90	-676.35	-677.14
Oxaloacetate	-713.38	-714.60	-715.00
Oxalosuccinate	-979.05	-979.05	-979.05
2-Oxoglutarate	-633.58	-633.58	-633.58
Palmitate	979.25	997.61	1003.54
<i>L</i> -Phenylalanine	232.42	239.15	241.33
Phosphate	-1058.56	-1059.17	-1059.49
2-Phospho- <i>D</i> -glycerate	-1340.72	-1341.32	-1341.79
3-Phospho- <i>D</i> -glycerate	-1346.38	-1347.19	-1347.73
Phosphoenolpyruvate	-1185.46	-1188.53	-1189.73
1-Propanol	143.84	148.74	150.32
2-Propanol	134.42	139.32	140.90
Pyrophosphate	-1934.95	-1939.13	-1940.66
Pyruvate	-352.40	-351.18	-350.78
Retinal	1118.78	1135.91	1141.45
Retinol	1170.78	1189.14	1195.07
Ribose	-339.23	-333.11	-331.13
Ribose 1-phosphate	-1215.87	-1212.24	-1211.14
Ribose 5-phosphate	-1223.95	-1220.32	-1219.22
Ribulose	-336.38	-330.26	-328.28
<i>L</i> -Serine	-231.18	-226.89	-225.51
Sorbose	-432.47	-425.13	-422.76
Succinate	-530.72	-530.65	-530.64
Succinyl Coenzyme A	-349.90	-348.06	-347.47
Sucrose	-685.66	-672.20	-667.85
Thioredoxin [oxidized]	0.00	0.00	0.00
Thioredoxin [reduced]	54.32	55.41	55.74
<i>L</i> -Tryptophan	364.78	372.12	374.49
<i>L</i> -Tyrosine	68.82	75.55	77.73
Ubiquinone [oxidized]	3596.07	3651.15	3668.94
Ubiquinone [reduced]	3586.06	3642.37	3660.55
Urate	-206.03	-204.81	-204.41
Urea	-42.97	-40.53	-39.74
Uric acid	-197.07	-194.63	-193.84
<i>L</i> -Valine	80.87	87.60	89.78
<i>D</i> -Xylose	-350.93	-344.81	-342.83
<i>D</i> -Xylulose	-346.59	-340.47	-338.49

# THERMODYNAMIC QUANTITIES FOR THE IONIZATION REACTIONS OF BUFFERS IN WATER

Robert N. Goldberg, Nand Kishore, and Rebecca M. Lennen

This table contains selected values for the  $pK$ , standard molar enthalpy of reaction  $\Delta_r H^\circ$ , and standard molar heat-capacity change  $\Delta_r C_p^\circ$  for the ionization reactions of 64 buffers many of which are relevant to biochemistry and to biology.<sup>1</sup> The values pertain to the temperature  $T = 298.15$  K and the pressure  $p = 0.1$  MPa. The standard state is the hypothetical ideal solution of unit molality. These data permit one to calculate values of the  $pK$  and of  $\Delta_r H^\circ$  at temperatures in the vicinity  $\{T \approx (274 \text{ K to } 350 \text{ K})\}$  of the reference temperature  $\theta = 298.15$  K by using the following equations<sup>2</sup>

$$\Delta_r G_T^\circ = -RT \ln K_T = \ln(10) \cdot RT \cdot pK_T, \quad (1)$$

$$R \ln K_T = -(\Delta_r G_\theta^\circ / \theta) + \Delta_r H_\theta^\circ \{(1/\theta) - (1/T)\} + \Delta_r C_{p\theta}^\circ \{(\theta/T) - 1 + \ln(T/\theta)\}, \quad (2)$$

$$\Delta_r H_T^\circ = \Delta_r H_\theta^\circ + \Delta_r C_{p\theta}^\circ (T - \theta). \quad (3)$$

Here,  $\Delta_r G^\circ$  is the standard molar Gibbs energy change and  $K$  is the equilibrium constant for a reaction;  $R$  is the gas constant (8.314 472 J K<sup>-1</sup> mol<sup>-1</sup>). The subscripts  $T$  and  $\theta$  denote the temperature to which a quantity pertains, the subscript  $p$  denotes constant pres-

sure, and the subscript  $r$  denotes that the quantity refers to a reaction. Combination of equations (1) and (2) yields the following equation that gives  $pK$  as a function of temperature:

$$pK_T = -\{R \ln(10)\}^{-1} [-\{\ln(10) \cdot RT \cdot pK_\theta / \theta\} + \Delta_r H_\theta^\circ \{(1/\theta) - (1/T)\} + \Delta_r C_{p\theta}^\circ \{(\theta/T) - 1 + \ln(T/\theta)\}]. \quad (4)$$

The above equations neglect higher order terms that involve temperature derivatives of  $\Delta_r C_p^\circ$ . Also, it is important to recognize that the values of  $pK$  and  $\Delta_r H^\circ$  effectively pertain to ionic strength  $I = 0$ . However, the values of  $pK$  and  $\Delta_r H^\circ$  are almost always dependent on the ionic strength and the actual composition of the solution. These issues are discussed in Reference 1, which also gives an approximate method for making appropriate corrections.

## References

- Goldberg, R. N., Kishore, N., and Lennen, R. M., "Thermodynamic Quantities for the Ionization Reactions of Buffers," *J. Phys. Chem. Ref. Data*, 31, 231, 2002.
- Clarke, E. C. W., and Glew, D. N., *Trans. Faraday Soc.*, 62, 539-547, 1966.

### Selected Values of Thermodynamic Quantities for the Ionization Reactions of Buffers in Water at $T = 298.15$ K and $p = 0.1$ MPa

Buffer	Reaction	$pK$	$\Delta_r H^\circ$	$\Delta_r C_p^\circ$
			kJ mol <sup>-1</sup>	J mol <sup>-1</sup> K <sup>-1</sup>
ACES	$HL^\pm = H^+ + L^-$ , (HL = C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub> S)	6.847	30.43	-49
Acetate	$HL = H^+ + L^-$ , (HL = C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> )	4.756	-0.41	-142
ADA	$H_3L^+ = H^+ + H_2L^+$ , (H <sub>2</sub> L = C <sub>6</sub> H <sub>10</sub> N <sub>2</sub> O <sub>5</sub> )	1.59		
	$H_2L^\pm = H^+ + HL^-$	2.48	16.7	
	$HL^- = H^+ + L^{2-}$	6.844	12.23	-144
2-Amino-2-methyl-1,3-propanediol	$HL^+ = H^+ + L$ , (L = C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub> )	8.801	49.85	-44
2-Amino-2-methyl-1-propanol	$HL^+ = H^+ + L$ , (L = C <sub>4</sub> H <sub>11</sub> NO)	9.694	54.05	≈-21
3-Amino-1-propanesulfonic acid	$HL = H^+ + L^-$ , (HL = C <sub>3</sub> H <sub>9</sub> NO <sub>3</sub> S)	10.2		
Ammonia	$NH_4^+ = H^+ + NH_3$	9.245	51.95	8
AMPSO	$HL^\pm = H^+ + L^-$ , (HL = C <sub>7</sub> H <sub>17</sub> NO <sub>5</sub> S)	9.138	43.19	-61
Arsenate	$H_3AsO_4 = H^+ + H_2AsO_4^-$	2.31	-7.8	
	$H_2AsO_4^- = H^+ + HAsO_4^{2-}$	7.05	1.7	
	$HAsO_4^{2-} = H^+ + AsO_4^{3-}$	11.9	15.9	
Barbital	$H_2L = H^+ + HL^-$ , (H <sub>2</sub> L = C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub> )	7.980	24.27	-135
	$HL^- = H^+ + L^{2-}$	12.8		
BES	$HL^\pm = H^+ + L^-$ , (HL = C <sub>6</sub> H <sub>15</sub> NO <sub>5</sub> S)	7.187	24.25	-2
Bicine	$H_2L^+ = H^+ + HL^\pm$ , (HL = C <sub>6</sub> H <sub>13</sub> NO <sub>4</sub> )	2.0		
	$HL^\pm = H^+ + L^-$	8.334	26.34	0
Bis-tris	$H_3L^+ = H^+ + H_2L^+$ , (H <sub>2</sub> L = C <sub>8</sub> H <sub>19</sub> NO <sub>5</sub> )	6.484	28.4	27
Bis-tris propane	$H_2L^{2+} = H^+ + HL^+$ , (L = C <sub>11</sub> H <sub>26</sub> N <sub>2</sub> O <sub>6</sub> )	6.65		
	$HL^+ = H^+ + L$	9.10		
Borate	$H_3BO_3 = H^+ + H_2BO_3^-$	9.237	13.8	≈-240
Cacodylate	$H_2L^+ = H^+ + HL$ , (HL = C <sub>2</sub> H <sub>6</sub> AsO <sub>2</sub> )	1.78	-3.5	
	$HL = H^+ + L^-$	6.28	-3.0	-86
CAPS	$HL^\pm = H^+ + L^-$ , (HL = C <sub>9</sub> H <sub>19</sub> NO <sub>3</sub> S)	10.499	48.1	57
CAPSO	$HL^\pm = H^+ + L^-$ , (HL = C <sub>9</sub> H <sub>19</sub> NO <sub>4</sub> S)	9.825	46.67	21
Carbonate	$H_2CO_3 = H^+ + HCO_3^-$	6.351	9.15	-371
	$HCO_3^- = H^+ + CO_3^{2-}$	10.329	14.70	-249
CHES	$HL^\pm = H^+ + L^-$ , (HL = C <sub>8</sub> H <sub>17</sub> NO <sub>3</sub> S)	9.394	39.55	9

Buffer	Reaction	pK	$\Delta_r H^\circ$	$\Delta_r C_p^\circ$
			kJ mol <sup>-1</sup>	J mol <sup>-1</sup> K <sup>-1</sup>
Citrate	$H_3L = H^+ + H_2L^-$ , ( $H_3L = C_6H_8O_7$ )	3.128	4.07	-131
	$H_2L^- = H^+ + HL^{2-}$	4.761	2.23	-178
	$HL^{2-} = H^+ + L^{3-}$	6.396	-3.38	-254
L-Cysteine	$H_3L^+ = H^+ + H_2L$ , ( $H_2L = C_3H_7NO_2S$ )	1.71	≈-0.6	
	$H_2L = H^+ + HL^-$	8.36	36.1	≈-66
	$HL^- = H^+ + L^{2-}$	10.75	34.1	≈-204
Diethanolamine	$HL^+ = H^+ + L$ , ( $L = C_4H_{11}NO_2$ )	8.883	42.08	36
Diglycolate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_4H_6O_5$ )	3.05	-0.1	≈-142
	$HL^- = H^+ + L^{2-}$	4.37	-7.2	≈-138
3,3-Dimethylglutarate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_7H_{12}O_4$ )	3.70		
	$HL^- = H^+ + L^{2-}$	6.34		
DIPSO	$HL^\pm = H^+ + L^-$ , ( $HL = C_7H_{17}NO_6S$ )	7.576	30.18	42
Ethanolamine	$HL^+ = H^+ + L$ , ( $L = C_2H_7NO$ )	9.498	50.52	26
N-Ethylmorpholine	$HL^+ = H^+ + L$ , ( $L = C_6H_{13}NO$ )	7.77	27.4	
Glycerol 2-phosphate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_3H_9NO_6P$ )	1.329	-12.2	-330
	$HL^- = H^+ + L^{2-}$	6.650	-1.85	-212
Glycine	$H_2L^+ = H^+ + HL^\pm$ , ( $HL = C_2H_5NO_2$ )	2.351	4.00	-139
	$HL^\pm = H^+ + L^-$	9.780	44.2	-57
Glycine amide	$HL^+ = H^+ + L$ , ( $L = C_2H_6N_2O$ )	8.04	42.9	
Glycylglycine	$H_2L^+ = H^+ + HL^\pm$ , ( $HL = C_4H_8N_2O_3$ )	3.140	0.11	-128
	$HL^\pm = H^+ + L^-$	8.265	43.4	-16
Glycylglycylglycine	$H_2L^+ = H^+ + HL^\pm$ , ( $HL = C_6H_{11}N_3O_4$ )	3.224	0.84	
	$HL^\pm = H^+ + L^-$	8.090	41.7	
HEPES	$H_2L^+ = H^+ + HL^\pm$ , ( $HL = C_8H_{18}N_2O_4S$ )	≈3.0		
	$HL^\pm = H^+ + L^-$	7.564	20.4	47
HEPPS	$HL^\pm = H^+ + L^-$ , ( $HL = C_6H_{20}N_2O_4S$ )	7.957	21.3	48
HEPPSO	$HL^\pm = H^+ + L^-$ , ( $HL = C_9H_{20}N_2O_5S$ )	8.042	23.70	47
L-Histidine	$H_3L^{2+} = H^+ + H_2L^+$ , ( $HL = C_6H_9N_3O_2$ )	1.5 <sub>4</sub>	3.6	
	$H_2L^+ = H^+ + HL$	6.07	29.5	176
	$HL = H^+ + L^-$	9.34	43.8	-233
Hydrazine	$H_2L^{2+} = H^+ + HL^+$ , ( $L = H_4N_2$ )	-0.99	38.1	
	$HL^+ = H^+ + L$	8.02	41.7	
Imidazole	$HL^+ = H^+ + L$ , ( $L = C_3H_4N_2$ )	6.993	36.64	-9
Maleate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_4H_4O_4$ )	1.92	1.1	≈-21
	$HL^- = H^+ + L^{2-}$	6.27	-3.6	≈-31
2-Mercaptoethanol	$HL = H^+ + L^-$ , ( $HL = C_2H_6OS$ )	9.7 <sub>5</sub>	26.2	
MES	$HL^\pm = H^+ + L^-$ , ( $HL = C_6H_{13}NO_4S$ )	6.270	14.8	5
Methylamine	$HL^+ = H^+ + L$ , ( $L = CH_5N$ )	10.645	55.34	33
2-Methylimidazole	$HL^+ = H^+ + L$ , ( $L = C_4H_6N_2$ )	8.0 <sub>1</sub>	36.8	
MOPS	$HL^\pm = H^+ + L^-$ , ( $HL = C_7H_{15}NO_4S$ )	7.184	21.1	25
MOPSO	$H_2L^+ = H^+ + HL^\pm$ , ( $HL = C_7H_{15}NO_5S$ )	0.060		
	$HL^\pm = H^+ + L^-$	6.90	25.0	≈38
Oxalate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_2H_2O_4$ )	1.27	-3.9	≈-231
	$HL^- = H^+ + L^{2-}$	4.266	7.00	-231
Phosphate	$H_3PO_4 = H^+ + H_2PO_4^-$	2.148	-8.0	-141
	$H_2PO_4^- = H^+ + HPO_4^{2-}$	7.198	3.6	-230
	$HPO_4^{2-} = H^+ + PO_4^{3-}$	12.35	16.0	-242
Phthalate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_8H_6O_4$ )	2.950	-2.70	-91
	$HL^- = H^+ + L^{2-}$	5.408	-2.17	-295
Piperazine	$H_2L^{2+} = H^+ + HL^+$ , ( $L = C_4H_{10}N_2$ )	5.333	31.11	86
	$HL^+ = H^+ + L$	9.731	42.89	75
PIPES	$HL^\pm = H^+ + L^-$ , ( $HL = C_8H_{18}N_2O_6S_2$ )	7.141	11.2	22
POPSO	$HL^\pm = H^+ + L^-$ , ( $HL = C_{10}H_{22}N_2O_8S_2$ )	≈8.0		
Pyrophosphate	$H_4P_2O_7 = H^+ + H_3P_2O_7^-$	0.83	-9.2	≈-90
	$H_3P_2O_7^- = H^+ + H_2P_2O_7^{2-}$	2.26	-5.0	≈-130
	$H_2P_2O_7^{2-} = H^+ + HP_2O_7^{3-}$	6.72	0.5	-136
	$HP_2O_7^{3-} = H^+ + P_2O_7^{4-}$	9.46	1.4	-141
Succinate	$H_2L = H^+ + HL^-$ , ( $H_2L = C_4H_6O_4$ )	4.207	3.0	-121
	$HL^- = H^+ + L^{2-}$	5.636	-0.5	-217
Sulfate	$HSO_4^- = H^+ + SO_4^{2-}$	1.987	-22.4	-258



Buffer	Reaction	pK	$\Delta_r H^\circ$	$\Delta_r C_p^\circ$
			$\text{kJ mol}^{-1}$	$\text{J mol}^{-1} \text{K}^{-1}$
Sulfite	$\text{H}_2\text{SO}_3 = \text{H}^+ + \text{HSO}_3^-$	1.857	-17.80	-272
	$\text{HSO}_3^- = \text{H}^+ + \text{SO}_3^{2-}$	7.172	-3.65	-262
TAPS	$\text{HL}^\pm = \text{H}^+ + \text{L}^-$ , (HL = $\text{C}_7\text{H}_{17}\text{NO}_6\text{S}$ )	8.44	40.4	15
TAPSO	$\text{HL}^\pm = \text{H}^+ + \text{L}^-$ , (HL = $\text{C}_7\text{H}_{17}\text{NO}_7\text{S}$ )	7.635	39.09	-16
L(+)-Tartaric acid	$\text{H}_2\text{L} = \text{H}^+ + \text{HL}^-$ , ( $\text{H}_2\text{L} = \text{C}_4\text{H}_6\text{O}_6$ )	3.036	3.19	-147
	$\text{HL}^- = \text{H}^+ + \text{L}^{2-}$	4.366	0.93	-218
TES	$\text{HL}^\pm = \text{H}^+ + \text{L}^-$ , (HL = $\text{C}_6\text{H}_{15}\text{NO}_6\text{S}$ )	7.550	32.13	0
Tricine	$\text{H}_2\text{L}^+ = \text{H}^+ + \text{HL}^\pm$ , (HL = $\text{C}_6\text{H}_{13}\text{NO}_2$ )	2.023	5.85	-196
	$\text{HL}^\pm = \text{H}^+ + \text{L}^-$	8.135	31.37	-53
Triethanolamine	$\text{HL}^+ = \text{H}^+ + \text{L}$ , (L = $\text{C}_6\text{H}_{15}\text{NO}_3$ )	7.762	33.6	50
Triethylamine	$\text{HL}^+ = \text{H}^+ + \text{L}$ , (L = $\text{C}_6\text{H}_{15}\text{N}$ )	10.72	43.13	151
Tris	$\text{HL}^+ = \text{H}^+ + \text{L}$ , (L = $\text{C}_4\text{H}_{11}\text{NO}_3$ )	8.072	47.45	-59

## NUTRIENT VALUES OF FOODS

The U. S. Department of Agriculture maintains the USDA National Nutrient Database for Standard Reference, which contains over 7000 food items with data on the energy content, minerals, vitamins, and other properties of nutritional interest. The table here includes about 600 common foods extracted from that database. The properties listed are the energy content (in effect, the enthalpy of combustion); the content of carbohydrates, proteins, and lipids (fats); the cholesterol content; and the amount of sodium, potassium, calcium, magnesium, iron, copper, zinc, manganese, phosphorus, and selenium. All values are given for a 100 gram sample of the food.

To conform with common practice in nutritional science, the energy content is given in kilocalories. For conversion to kilojoules, this number should be multiplied by 4.184. For conversion to the avoirdupois units frequently used in the United States, note that:

1 oz = 28.35 g (thus the 100 g basis in this table is approximately 3.5 oz)

1 lb = 453.6 g

The full USDA database covers specific proprietary brands of many processed foods, and it includes vitamin content as well as the minerals given in this table.

### Reference

U.S. Department of Agriculture, Agricultural Research Service. 2005. USDA National Nutrient Database for Standard Reference, Release 18. Nutrient Data Laboratory Home Page, <http://www.ars.usda.gov/ba/bhnrc/ndl>

Food description	Energy kcal/100 g	Carb. g/100 g	Protein g/100 g	Fat g/100 g	Chol. mg/100 g	Na mg/100 g	K mg/100 g	Ca mg/100 g	Mg mg/100 g	Fe mg/100 g	Cu mg/100 g	Zn mg/100 g	Mn mg/100 g	P mg/100 g	Se µg/100 g
Alcoholic beverage, beer, light	29	1.6	0.2	0.0	0	4	21	4	5	0.03	0.006	0.01	0.006	12	0.4
Alcoholic beverage, beer, regular	43	3.6	0.5	0.0	0	4	27	4	6	0.02	0.005	0.01	0.008	14	0.6
Alcoholic beverage, dessert wine, sweet	160	13.7	0.2	0.0	0	9	92	8	9	0.24	0.045	0.07	0.119	9	0.5
Alcoholic beverage, distilled (gin, rum, vodka, whiskey), 80 proof	231	0.0	0.0	0.0	0	1	2	0	0	0.04	0.021	0.04	0.018	4	0.0
Alcoholic beverage, distilled (gin, rum, vodka, whiskey), 90 proof	263	0.0	0.0	0.0	0	1	2	0	0	0.04	0.021	0.04	0.018	4	0.0
Alcoholic beverage, distilled, all, 100 proof	295	0.0	0.0	0.0	0	1	2	0	0	0.04	0.021	0.04	0.018	4	0.0
Alcoholic beverage, liqueur, coffee, 63 proof	308	32.2	0.1	0.3	0	8	30	1	3	0.06	0.040	0.03	0.017	6	0.3
Alcoholic beverage, table wine, red	85	2.6	0.1	0.0	0	4	127	8	12	0.46	0.011	0.14	0.132	23	0.2
Alcoholic beverage, table wine, white	83	2.6	0.1	0.0	0	5	71	9	10	0.27	0.004	0.12	0.117	18	0.1
Almonds, dry roasted, w/o salt	597	19.3	22.1	52.8	0	1	746	266	286	4.51	1.170	3.54	2.620	489	2.8
Almonds, oil roasted, w/o salt	607	17.7	21.2	55.2	0	1	699	291	274	3.68	0.955	3.07	2.460	466	2.8
Apple juice, canned or bottled, unsweetened, w/o vitamin C	47	11.7	0.1	0.1	0	3	119	7	3	0.37	0.022	0.03	0.113	7	0.1
Apples, raw, w/o skin	48	12.8	0.3	0.1	0	0	90	5	4	0.07	0.031	0.05	0.038	11	0.0
Apples, raw, with skin	52	13.8	0.3	0.2	0	1	107	6	5	0.12	0.027	0.04	0.035	11	0.0
Apricots, dried, sulfured, stewed, w. sugar	113	29.3	1.2	0.2	0	3	443	15	15	1.52	0.138	0.24	0.088	38	
Apricots, dried, sulfured, stewed, w/o sugar	85	22.2	1.2	0.2	0	4	411	19	11	0.94	0.121	0.14	0.083	25	0.8
Artichokes, (globe or French), boiled, w/o salt	50	11.2	3.5	0.2	0	95	354	45	60	1.29	0.233	0.49	0.259	86	0.2
Arugula, raw	25	3.7	2.6	0.7	0	27	369	160	47	1.46	0.076	0.47	0.321	52	0.3
Asparagus, boiled	22	4.1	2.4	0.2	0	14	224	23	14	0.91	0.165	0.60	0.154	54	6.1
Asparagus, raw	20	3.9	2.2	0.1	0	2	202	24	14	2.14	0.189	0.54	0.158	52	2.3
Avocados, raw, all commercial varieties	160	8.5	2.0	14.7	0	7	485	12	29	0.55	0.190	0.64	0.142	52	0.4
Bagel, plain, toasted, enriched w. calcium propionate	257	50.5	10.0	1.6	0	448	75	89	22	6.05	0.130	1.90	0.515	87	22.8
Bagels, cinnamon-raisin, toasted	294	59.3	10.6	1.8	0	346	163	20	23	4.09	0.160	0.81	0.328	83	33.3
Baked beans, canned, no salt	105	20.6	4.8	0.4	0	1	296	50	32	0.29	0.206	1.40		104	4.5
Bamboo shoots, boiled, w/o salt	12	1.9	1.5	0.2	0	4	533	12	3	0.24	0.082	0.47	0.113	20	0.4
Bananas, raw	89	22.8	1.1	0.3	0	1	358	5	27	0.26	0.078	0.15	0.270	22	1.0
Bass, freshwater, mixed species, cooked, dry heat	146	0.0	24.2	4.7	87	90	456	103	38	1.91	0.119	0.83	1.140	256	16.2
Bass, striped, cooked, dry heat	124	0.0	22.7	3.0	103	88	328	19	51	1.08	0.040	0.51	0.019	254	46.8
Beans, French, mature seeds, boiled, w/o salt	129	24.0	7.1	0.8	0	6	370	63	56	1.08	0.115	0.64	0.382	102	1.2
Beans, kidney, all types, mature seeds, boiled, w/o salt	127	22.8	8.7	0.5	0	1	405	35	42	2.22	0.216	1.00	0.430	138	1.1
Beans, lima, immature seeds, canned	71	13.3	4.1	0.3	0	252	285	28	34	1.61	0.162	0.64	0.700	71	1.1
Beans, navy, mature seeds, canned	113	20.5	7.5	0.4	0	448	288	47	47	1.85	0.208	0.77	0.375	134	5.8
Beans, pinto, mature seeds, boiled, w/o salt	143	26.2	9.0	0.7	0	1	436	46	50	2.09	0.219	0.98	0.453	147	6.2

Food description	Energy kcal/ 100 g	Carb. g/ 100 g	Protein g/ 100 g	Fat g/ 100 g	Chol. mg/ 100 g	Na mg/ 100 g	K mg/ 100 g	Ca mg/ 100 g	Mg mg/ 100 g	Fe mg/ 100 g	Cu mg/ 100 g	Zn mg/ 100 g	Mn mg/ 100 g	P mg/ 100 g	Se µg/ 100 g
Beans, snap, green, boiled, w/o salt	35	7.9	1.9	0.3	0	1	146	44	18	0.65	0.057	0.25	0.285	29	0.2
Beef, bottom sirloin, tri-tip roast, lean & fat, 0" fat, choice, roasted	218	0.0	25.7	12.4	94	50	308	17	20	1.70	0.083	4.52	0.009	189	27.3
Beef, brisket, flat half, lean & fat, 1/8" fat, select, braised	280	0.0	29.0	17.4	71	49	237	17	19	2.40	0.090	6.92	0.010	180	28.1
Beef, chuck, arm pot roast, lean, 1/8" fat, choice, braised	224	0.0	34.7	8.4	81	56	275	15	23	3.04	0.129	8.20	0.012	213	34.7
Beef, ground, 75% lean meat / 25% fat, patty, broiled	278	0.0	25.6	18.7	89	78	289	30	20	2.37	0.075	6.19	0.010	189	21.4
Beef, ground, 95% lean meat / 5% fat, patty, broiled	171	0.0	26.3	6.6	76	65	348	7	22	2.83	0.096	6.43	0.014	206	21.7
Beef, loin, porterhouse steak, lean & fat, 1/4" fat, all grades, broiled	329	0.0	22.5	25.8	72	62	255	8	20	2.68	0.118	4.13	0.014	177	19.3
Beef, loin, T-bone steak, lean & fat, 1/4" fat, all grades, broiled	306	0.0	23.5	22.8	65	67	282	7	22	3.09	0.122	4.30	0.014	185	11.6
Beef, rib, eye, small end (ribs 10-12), lean, 0" fat, choice, broiled	205	0.0	28.9	9.0	91	60	363	16	25	1.98	0.092	5.49	0.011	227	33.6
Beef, rib, large end (ribs 6-9), lean & fat, 1/4" fat, choice, roasted	383	0.0	22.3	32.0	85	63	283	10	19	2.27	0.086	5.58	0.013	168	21.9
Beef, round, bottom round roast, lean, 0" fat, select, roasted	169	0.0	28.3	5.3	72	38	238	6	19	2.35	0.079	4.92	0.010	183	35.7
Beef, round, bottom round, lean & fat, 1/8" fat, all grades, roasted	218	0.0	26.4	11.6	75	35	214	6	17	2.16	0.063	4.43	0.009	164	27.0
Beef, round, eye of round, lean & fat, 1/8" fat, all grades, roasted	208	0.0	28.3	9.7	62	37	227	7	18	2.29	0.067	4.70	0.010	174	28.7
Beef, tenderloin, lean & fat, 1/8" fat, all grades, broiled	267	0.0	26.5	17.1	90	54	329	19	22	1.69	0.079	4.76	0.009	205	28.6
Beef, top sirloin, lean & fat, 1/8" fat, select, broiled	230	0.0	27.1	12.7	67	57	345	22	23	1.66	0.074	4.93	0.009	217	29.3
Beets, boiled	44	10.0	1.7	0.2	0	77	305	16	23	0.79	0.074	0.35	0.326	38	0.7
Blackberries, raw	43	9.6	1.4	0.5	0	1	162	29	20	0.62	0.165	0.53	0.646	22	0.4
Blueberries, raw	57	14.5	0.7	0.3	0	1	77	6	6	0.28	0.057	0.16	0.336	12	0.1
Bluefish, cooked, dry heat	159	0.0	25.7	5.4	76	77	477	9	42	0.62	0.068	1.04	0.027	291	46.8
Bologna, beef	314	4.0	10.3	28.2	56	1080	172	31	14	1.10	0.068	9.10	0.044	172	0.0
Bologna, pork	247	0.7	15.3	19.9	59	1184	281	11	14	0.77	0.080	2.03	0.036	139	12.7
Bratwurst, beef & pork, smoked	297	2.0	12.2	26.3	78	848	283	7	15	1.00	0.080	2.47	0.041	130	14.1
Bratwurst, pork, cooked	333	2.9	13.7	29.2	74	846	259	28	21	0.53	0.079	2.49	0.012	225	26.9
Brazil nuts, dried, unblanched	656	12.3	14.3	66.4	0	3	659	160	376	2.43	1.743	4.06	1.223	725	1917.0
Bread, cracked-wheat	260	49.5	8.7	3.9	0	538	177	43	52	2.81	0.222	1.24	1.371	153	25.3
Bread, Italian	271	50.0	8.8	3.5	0	584	110	78	27	2.94	0.191	0.86	0.464	103	27.2
Bread, mixed-grain, toasted (includes whole-grain, 7-grain)	272	50.4	10.9	4.1	0	530	222	99	58	3.77	0.276	1.38	1.615	191	32.1
Bread, oatmeal	269	48.5	8.4	4.4	0	599	142	66	37	2.70	0.209	1.02	0.940	126	24.6
Bread, pita, white, enriched	275	55.7	9.1	1.2	0	536	120	86	26	2.62	0.168	0.84	0.481	97	27.1
Bread, pumpernickel	250	47.5	8.7	3.1	0	671	208	68	54	2.87	0.287	1.48	1.305	178	24.5
Bread, rye	259	48.3	8.5	3.3	0	660	166	73	40	2.83	0.186	1.14	0.824	125	30.9
Bread, white, commercially prepared	266	50.6	7.6	3.3	0	681	100	151	23	3.74	0.253	0.74	0.478	99	17.3
Bread, whole-wheat, commercially prepared	246	46.1	9.7	4.2	0	527	252	72	86	3.30	0.284	1.94	2.324	229	36.6
Broccoli, boiled, w/o salt	35	7.2	2.4	0.4	0	41	293	40	21	0.67	0.061	0.45	0.194	67	1.6
Broccoli, raw	34	6.6	2.8	0.4	0	33	316	47	21	0.73	0.049	0.41	0.210	66	2.5
Brussels sprouts, boiled, w/o salt	36	7.1	2.6	0.5	0	21	317	36	20	1.20	0.083	0.33	0.227	56	1.5
Butter, w. salt	717	0.1	0.9	81.1	215	576	24	24	2	0.02	0.000	0.09	0.000	24	1.0
Butter, w/o salt	717	0.1	0.9	81.1	215	11	24	24	2	0.02	0.016	0.09	0.004	24	1.0
Cabbage, boiled, w/o salt	22	4.5	1.0	0.4	0	8	97	31	8	0.17	0.012	0.09	0.117	15	0.6
Cabbage, raw	24	5.6	1.4	0.1	0	18	246	47	15	0.59	0.023	0.18	0.159	23	0.9
Cake, angel food, commercially prepared	258	57.8	5.9	0.8	0	749	93	140	12	0.52	0.078	0.07	0.085	32	7.3
Cake, carrot, dry mix, pudding-type	415	79.2	5.1	9.8	0	567	169	172	8	1.80	0.050	0.20	0.528	247	14.9
Cake, fruitcake, commercially prepared	324	61.6	2.9	9.1	5	270	153	33	16	2.07	0.050	0.27	0.220	52	2.0
Cake, pound, commercially prepared, butter	388	48.8	5.5	19.9	221	398	119	35	11	1.38	0.035	0.46	0.090	137	8.8
Cake, white, dry mix	426	78.0	4.5	10.9	0	664	117	192	11	1.39	0.081	0.46	0.205	337	8.6
Cake, yellow, dry mix, enriched	432	78.1	4.4	11.6	2	657	82	135	10	1.50	0.072	0.27	0.191	310	3.0
Candies, fudge, chocolate, prepared-from-recipe	411	76.5	2.4	10.4	14	47	131	45	36	1.77	0.333	1.10	0.423	69	2.5

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Candies, gumdrops, starch jelly pieces	396	98.9	0.0	0.0	0	44	5	3	1	0.40	0.012	0.00	0.010	1	0.8
Candies, hard	394	98.0	0.0	0.2	0	38	5	3	3	0.30	0.029	0.01	0.010	3	0.6
Candies, marshmallows	318	81.3	1.8	0.2	0	80	5	3	2	0.23	0.097	0.04	0.008	8	1.7
Candies, milk chocolate	535	59.4	7.7	29.7	23	79	372	189	63	2.35	0.491	2.01	0.471	208	4.5
Candies, milk chocolate w. almond bites	550	51.0	9.8	35.7	19	74	471	220	59	1.50	0.200	1.34	0.010	227	3.4
Candies, peanut brittle, prepared-from-recipe	486	71.2	7.6	19.0	12	445	168	27	42	1.22	0.254	0.87	0.593	106	2.6
Candies, semisweet chocolate	479	63.1	4.2	30.0	0	11	365	32	115	3.13	0.700	1.62	0.800	132	4.2
Candies, sweet chocolate	505	59.6	3.9	34.2	0	16	290	24	113	2.76	0.574	1.50	0.494	147	2.8
Candies, white chocolate	539	59.2	5.9	32.1	14	90	286	199	12	0.24	0.060	0.74	0.008	176	4.5
Capers, canned	23	4.9	2.4	0.9	0	2964	40	40	33	1.67	0.374	0.32	0.078	10	1.2
Carbonated beverage, cola, contains caffeine	37	9.6	0.1	0.0	0	4	2	2	0	0.11	0.001	0.02	0.002	10	0.1
Carbonated beverage, ginger ale	34	8.8	0.0	0.0	0	7	1	3	1	0.18	0.018	0.05	0.013	0	0.1
Carbonated beverage, orange	48	12.3	0.0	0.0	0	12	2	5	1	0.06	0.015	0.10	0.013	1	0.0
Carbonated beverage, root beer	41	10.6	0.0	0.0	0	13	1	5	1	0.05	0.007	0.07	0.013	0	0.1
Carbonated beverage, tonic water	34	8.8	0.0	0.0	0	12	0	1	0	0.01	0.006	0.10	0.001	0	0.0
Carrots, boiled, w/o salt	35	8.2	0.8	0.2	0	58	235	30	10	0.34	0.017	0.20	0.155	30	0.7
Carrots, raw	41	9.6	0.9	0.2	0	69	320	33	12	0.30	0.045	0.24	0.143	35	0.1
Cashew nuts, dry roasted, w. salt	574	32.7	15.3	46.4	0	640	565	45	260	6.00	2.220	5.60	0.826	490	11.7
Cashew nuts, oil roasted, w. salt	581	30.2	16.8	47.8	0	308	632	43	273	6.05	2.043	5.35	1.668	531	20.3
Cashew nuts, raw	553	30.2	18.2	43.9	0	12	660	37	292	6.68	2.195	5.78	1.655	593	19.9
Catfish, channel, farmed, cooked, dry heat	152	0.0	18.7	8.0	64	80	321	9	26	0.82	0.122	1.05	0.020	245	14.5
Catsup	97	25.1	1.7	0.4	0	1114	382	18	19	0.51	0.181	0.26	0.128	33	0.3
Cauliflower, boiled, w/o salt	23	4.1	1.8	0.5	0	15	142	16	9	0.33	0.027	0.18	0.138	32	0.5
Cauliflower, raw	25	5.3	2.0	0.1	0	30	303	22	15	0.44	0.042	0.28	0.156	44	0.6
Celery, raw	14	3.0	0.7	0.2	0	80	260	40	11	0.20	0.035	0.13	0.103	24	0.4
Cereals, corn grits, white, enriched, cooked w. water, w/o salt	59	12.9	1.4	0.2	0	2	21	3	5	0.60	0.018	0.07	0.018	11	3.1
Chard, Swiss, boiled, w/o salt	20	4.1	1.9	0.1	0	179	549	58	86	2.26	0.163	0.33	0.334	33	0.9
Chard, Swiss, raw	19	3.7	1.8	0.2	0	213	379	51	81	1.80	0.179	0.36	0.366	46	0.9
Cheese, American cheddar, imitation	239	11.6	16.7	14.0	36	1345	242	562	29	0.33	0.033	2.59		712	15.2
Cheese, blue	353	2.3	21.4	28.7	75	1395	256	528	23	0.31	0.040	2.66	0.009	387	14.5
Cheese, brie	334	0.5	20.8	27.7	100	629	152	184	20	0.50	0.019	2.38	0.034	188	14.5
Cheese, camembert	300	0.5	19.8	24.3	72	842	187	388	20	0.33	0.021	2.38	0.038	347	14.5
Cheese, cheddar	403	1.3	24.9	33.1	105	621	98	721	28	0.68	0.031	3.11	0.010	512	13.9
Cheese, cheshire	387	4.8	23.4	30.6	103	700	95	643	21	0.21	0.042	2.79	0.012	464	14.5
Cheese, colby	394	2.6	23.8	32.1	95	604	127	685	26	0.76	0.042	3.07	0.012	457	14.5
Cheese, cottage, creamed, large or small curd	103	2.7	12.5	4.5	15	405	84	60	5	0.14	0.028	0.37	0.003	132	9.0
Cheese, cottage, low fat, 1% milkfat	72	2.7	12.4	1.0	4	406	86	61	5	0.14	0.028	0.38	0.003	134	9.0
Cheese, cream	349	2.7	7.6	34.9	110	296	119	80	6	1.20	0.016	0.54	0.004	104	2.4
Cheese, cream, low fat	231	7.0	10.6	17.6	56	296	167	112	8	1.68	0.022	0.76		146	4.0
Cheese, edam	357	1.4	25.0	27.8	89	965	188	731	30	0.44	0.036	3.75	0.011	536	14.5
Cheese, feta	264	4.1	14.2	21.3	89	1116	62	493	19	0.65	0.032	2.88	0.028	337	15.0
Cheese, gouda	356	2.2	24.9	27.4	114	819	121	700	29	0.24	0.036	3.90	0.011	546	14.5
Cheese, gruyere	413	0.4	29.8	32.3	110	336	81	1011	36	0.17	0.032	3.90	0.017	605	14.5
Cheese, mozzarella, whole milk	300	2.2	22.2	22.4	79	627	76	505	20	0.44	0.011	2.92	0.030	354	17.0
Cheese, muenster	368	1.1	23.4	30.0	96	628	134	717	27	0.41	0.031	2.81	0.008	468	14.5
Cheese, parmesan, grated	431	4.1	38.5	28.6	88	1529	125	1109	38	0.90	0.238	3.87	0.085	729	17.7
Cheese, pimento	375	1.7	22.1	31.2	94	1428	162	614	22	0.42	0.033	2.98	0.016	744	14.5
Cheese, provolone	351	2.1	25.6	26.6	69	876	138	756	28	0.52	0.026	3.23	0.010	496	14.5
Cheese, Swiss	380	5.4	26.9	27.8	92	192	77	791	38	0.20	0.043	4.36	0.005	567	18.2
Cheese, tilsit	340	1.9	24.4	26.0	102	753	65	700	13	0.23	0.026	3.50	0.013	500	14.5
Cheesecake, commercially prepared	321	25.5	5.5	22.5	55	207	90	51	11	0.63	0.020	0.51	0.140	93	5.2
Cherries, sour, red, raw	50	12.2	1.0	0.3	0	3	173	16	9	0.32	0.104	0.10	0.112	15	0.0
Cherries, sweet, raw	63	16.0	1.1	0.2	0	0	222	13	11	0.36	0.060	0.07	0.070	21	0.0

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Chestnuts, European, boiled & steamed	131	27.8	2.0	1.4	0	27	715	46	54	1.73	0.472	0.25	0.854	99	
Chestnuts, European, roasted	245	53.0	3.2	2.2	0	2	592	29	33	0.91	0.507	0.57	1.180	107	1.2
Chicken, broilers or fryers, breast, meat & skin, fried	222	1.6	31.8	8.9	89	76	259	16	30	1.19	0.057	1.10	0.026	233	23.9
Chicken, broilers or fryers, breast, meat & skin, roasted	197	0.0	29.8	7.8	84	71	245	14	27	1.07	0.050	1.02	0.018	214	24.7
Chicken, broilers or fryers, breast, meat only, fried	187	0.5	33.4	4.7	91	79	276	16	31	1.14	0.054	1.08	0.021	246	26.2
Chicken, broilers or fryers, breast, meat only, roasted	165	0.0	31.0	3.6	85	74	256	15	29	1.04	0.049	1.00	0.017	228	27.6
Chicken, broilers or fryers, dark meat, meat only, roasted	205	0.0	27.4	9.7	93	93	240	15	23	1.33	0.080	2.80	0.021	179	18.0
Chicken, broilers or fryers, drumstick, meat & skin, fried	245	1.6	27.0	13.7	90	89	229	12	23	1.34	0.080	2.89	0.028	176	18.4
Chicken, broilers or fryers, thigh, meat & skin, roasted	247	0.0	25.1	15.5	93	84	222	12	22	1.34	0.078	2.36	0.021	174	19.5
Chicken, broilers or fryers, thigh, meat only, roasted	209	0.0	25.9	10.9	95	88	238	12	24	1.31	0.081	2.57	0.021	183	29.0
Chicken, broilers or fryers, wing, meat & skin, fried	321	2.4	26.1	22.2	81	77	177	15	19	1.25	0.061	1.76	0.028	150	21.3
Chicken, Cornish game hens, meat & skin, roasted	260	0.0	22.3	18.2	131	64	245	13	18	0.91	0.061	1.49	0.015	146	15.5
Chicken, Cornish game hens, meat only, roasted	134	0.0	23.3	3.9	106	63	250	13	19	0.77	0.059	1.53	0.015	149	20.8
Chickpeas, mature seeds, boiled, w/o salt	164	27.4	8.9	2.6	0	7	291	49	48	2.89	0.352	1.53	1.030	168	3.7
Chicory greens, raw	23	4.7	1.7	0.3	0	45	420	100	30	0.90	0.295	0.42	0.429	47	0.3
Chocolate syrup	279	65.1	2.1	1.1	0	72	224	14	65	2.11	0.512	0.73	0.382	129	2.7
Clam, mixed species, breaded & fried	202	10.3	14.2	11.2	61	364	326	63	14	13.91	0.356	1.46	0.540	188	28.9
Clam, mixed species, raw	74	2.6	12.8	1.0	34	56	314	46	9	13.98	0.344	1.37	0.500	169	24.3
Cocoa, dry powder, unsweetened	229	54.3	19.6	13.7	0	21	1524	128	499	13.86	3.788	6.81	3.837	734	14.3
Coconut meat, raw	354	15.2	3.3	33.5	0	20	356	14	32	2.43	0.435	1.10	1.500	113	10.1
Cod, Atlantic, cooked, dry heat	105	0.0	22.8	0.9	55	78	244	14	42	0.49	0.036	0.58	0.020	138	37.6
Cod, Atlantic, dried & salted	290	0.0	62.8	2.4	152	7027	1458	160	133	2.50	0.176	1.59	0.050	950	147.8
Coffee, brewed from grounds, prep w. tap h2o	1	0.0	0.1	0.0	0	2	49	2	3	0.01	0.002	0.02	0.023	3	0.0
Coffee, brewed, espresso, rest-prep	2	0.0	0.1	0.2	0	14	115	2	80	0.13	0.050	0.05	0.050	7	0.0
Coleslaw, home-prepared	69	12.4	1.3	2.6	8	23	181	45	10	0.59	0.023	0.20	0.097	32	0.7
Collards, boiled, w/o salt	26	4.9	2.1	0.4	0	16	116	140	20	1.16	0.038	0.23	0.436	30	0.5
Cookies, brownies, commercially prepared	405	63.9	4.8	16.3	17	312	149	29	31	2.25	0.224	0.72	0.128	101	6.3
Cookies, chocolate chip, commercially prepared, higher fat, unenriched	481	66.8	5.4	22.6	0	315	135	25	31	1.00	0.212	0.64	0.449	108	
Cookies, chocolate sandwich, w/creme filling	466	71.6	5.3	19.1	0	483	187	21	48	3.93	0.431	0.98	0.629	92	8.1
Cookies, fig bars	348	70.9	3.7	7.3	0	350	207	64	27	2.90	0.147	0.39	0.343	62	3.3
Cookies, gingersnaps	416	76.9	5.6	9.8	0	654	346	77	49	6.40	0.305	0.55	1.555	83	5.1
Cookies, graham crackers, plain or honey	423	76.8	6.9	10.1	0	605	135	24	30	3.73	0.202	0.81	0.804	104	10.2
Cookies, oatmeal, commercially prepared	450	68.7	6.2	18.1	0	383	142	37	33	2.58	0.134	0.79	0.839	138	9.8
Cookies, peanut butter sandwich, regular	478	65.6	8.8	21.1	0	368	192	53	49	2.60	0.237	1.06	0.912	188	7.7
Cookies, shortbread, commercially prepared, plain	502	64.5	6.1	24.1	20	455	100	35	17	2.74	0.144	0.53	0.428	108	7.3
Cookies, vanilla wafers, higher fat	473	71.1	4.3	19.4	0	306	107	25	12	2.21	0.124	0.33	0.384	64	11.3
Cookies, vanilla wafers, lower fat	441	73.6	5.0	15.2	51	312	97	48	14	2.38	0.100	0.36	0.262	104	11.3
Corn, sweet, white, boiled, w. salt	108	25.1	3.3	1.3	0	253	249	2	32	0.61	0.053	0.48	0.194	103	0.8
Corn, sweet, yellow, boiled, w. salt	108	25.1	3.3	1.3	0	253	249	2	32	0.61	0.053	0.48	0.194	103	0.2
Couscous, cooked	112	23.2	3.8	0.2	0	5	58	8	8	0.38	0.041	0.26	0.084	22	27.5
Cowpeas (black-eyed), immature seeds, boiled, w. salt	97	20.3	3.2	0.4	0	240	418	128	52	1.12	0.133	1.03	0.572	51	2.5
Crab, Alaska king, cooked, moist heat	97	0.0	19.4	1.5	53	1072	262	59	63	0.76	1.182	7.62	0.040	280	40.0
Crab, Alaska king, raw	84	0.0	18.3	0.6	42	836	204	46	49	0.59	0.922	5.95	0.035	219	36.4
Crab, blue, cooked, moist heat	102	0.0	20.2	1.8	100	279	324	104	33	0.91	0.645	4.22	0.190	206	40.2
Crab, blue, raw	87	0.0	18.1	1.1	78	293	329	89	34	0.74	0.669	3.54	0.150	229	37.4
Crab, Dungeness, cooked, moist heat	110	1.0	22.3	1.2	76	378	408	59	58	0.43	0.734	5.47	0.097	175	47.6
Crackers, cheese, regular	503	58.2	10.1	25.3	13	995	145	151	36	4.77	0.210	1.13	0.629	218	8.6
Crackers, matzo, plain	395	83.7	10.0	1.4	0	2	112	13	25	3.16	0.060	0.68	0.650	89	36.9
Crackers, saltines (includes oyster, soda, soup)	428	70.9	9.2	11.4	0	1072	154	68	22	5.64	0.298	0.83	0.653	101	10.3

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Crackers, wheat, regular	473	64.9	8.6	20.6	0	795	183	49	62	4.40	0.318	1.60	1.781	220	6.3
Cranberries, raw	46	12.2	0.4	0.1	0	2	85	8	6	0.25	0.061	0.10	0.360	13	0.1
Cranberry juice, unsweetened	46	12.2	0.4	0.1	0	2	77	8	6	0.25	0.055	0.10		13	0.1
Crayfish, mixed species, farmed, cooked, moist heat	87	0.0	17.5	1.3	137	97	238	51	33	1.11	0.580	1.48	0.217	241	34.2
Cream, fluid, half and half	130	4.3	3.0	11.5	37	41	130	105	10	0.07	0.010	0.51	0.001	95	1.8
Cream, half & half, fat free	59	9.0	2.6	1.4	5	144	206	96	16	0.00	0.016	0.81	0.002	151	2.9
Cream, sour, cultured	214	4.3	3.2	21.0	44	53	144	116	11	0.06	0.019	0.27	0.003	85	2.2
Cream, whipped, cream topping, pressurized	257	12.5	3.2	22.2	76	130	147	101	11	0.05	0.010	0.37	0.001	89	1.4
Croissants, butter	406	45.8	8.2	21.0	67	744	118	37	16	2.03	0.080	0.75	0.330	105	22.7
Croutons, plain	407	73.5	11.9	6.6	0	698	124	76	31	4.08	0.163	0.89	0.500	115	37.5
Cucumber, peeled, raw	12	2.2	0.6	0.2	0	2	136	14	12	0.22	0.071	0.17	0.073	21	0.1
Cucumber, with peel, raw	15	3.6	0.7	0.1	0	2	147	16	13	0.28	0.041	0.20	0.079	24	0.3
Curry powder	325	58.2	12.7	13.8	0	52	1543	478	254	29.59	0.815	4.05	4.289	349	17.1
Dandelion greens, boiled, w/o salt	33	6.4	2.0	0.6	0	44	232	140	24	1.80	0.115	0.28	0.230	42	0.3
Dandelion greens, raw	45	9.2	2.7	0.7	0	76	397	187	36	3.10	0.171	0.41	0.342	66	0.5
Duck, domesticated, meat & skin, roasted	337	0.0	19.0	28.4	84	59	204	11	16	2.70	0.227	1.86	0.019	156	20.0
Duck, domesticated, meat only, roasted	201	0.0	23.5	11.2	89	65	252	12	20	2.70	0.231	2.60	0.019	203	22.4
Egg, white, raw, fresh	52	0.7	10.9	0.2	0	166	163	7	11	0.08	0.023	0.03	0.011	15	20.0
Egg, whole, fried	201	0.9	13.6	15.3	457	204	147	59	13	1.98	0.111	1.20	0.041	208	34.2
Egg, whole, hard-boiled	155	1.1	12.6	10.6	424	124	126	50	10	1.19	0.013	1.05	0.026	172	30.8
Egg, whole, poached	147	0.8	12.5	9.9	422	294	133	53	12	1.83	0.102	1.10	0.039	190	31.6
Egg, whole, scrambled	166	2.2	11.1	12.2	352	280	138	71	12	1.20	0.014	1.00	0.022	170	22.5
Egg, yolk, raw, fresh	322	3.6	15.9	26.5	1234	48	109	129	5	2.73	0.077	2.30	0.055	390	56.0
Eggplant, boiled, w/o salt	35	8.7	0.8	0.2	0	1	123	6	11	0.25	0.059	0.12	0.113	15	0.1
Eggplant, raw	24	5.7	1.0	0.2	0	2	230	9	14	0.24	0.082	0.16	0.250	25	0.3
Endive, raw	17	3.4	1.3	0.2	0	22	314	52	15	0.83	0.099	0.79	0.420	28	0.2
English muffins, whole-wheat, toasted	221	44.1	9.6	2.3	0	692	228	288	77	2.66	0.225	1.74	1.946	307	43.8
English, muffins, plain, toasted, enriched, w. calcium propanoate (includes sourdough)	270	52.7	10.3	2.0	0	477	129	197	28	4.65	0.160	1.40	0.630	107	26.3
Fat, beef tallow	902	0.0	0.0	100.0	109	0	0	0	0	0.00	0.000	0.00		0	0.2
Fat, chicken	900	0.0	0.0	99.8	85	0	0	0	0	0.00	0.000	0.00		0	0.2
Fat, duck	900	0.0	0.0	99.8	100	0	0	0	0	0.00	0.000	0.00		0	0.2
Fat, goose	900	0.0	0.0	99.8	100	0	0	0	0	0.00		0.00		0	0.2
Fat, turkey	900	0.0	0.0	99.8	102	0	0	0	0	0.00	0.000	0.00		0	0.2
Fennel, bulb, raw	31	7.3	1.2	0.2	0	52	414	49	17	0.73	0.066	0.20	0.191	50	0.7
Figs, dried, stewed	107	27.6	1.4	0.4	0	4	294	70	29	0.88	0.124	0.24	0.220	29	0.2
Figs, raw	74	19.2	0.8	0.3	0	1	232	35	17	0.37	0.070	0.15	0.128	14	0.2
Fish oil, cod liver	902	0.0	0.0	100.0	570	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Frankfurter beef	330	4.1	11.2	29.6	53	1140	156	14	14	1.51	0.184	2.46	0.082	160	8.2
Frankfurter, chick	257	6.8	12.9	19.5	101	1370	84	95	10	2.00	0.050	1.04	0.015	107	18.4
Frankfurter, pork	269	0.3	12.8	23.7	66	816	264	267	15	3.70	0.074	2.09	0.016	171	27.8
Frankfurter, turkey	226	1.5	14.3	17.7	107	1426	179	106	14	1.84	0.100	3.11	0.016	134	15.4
Game meat, beaver, roasted	212	0.0	34.9	7.0	117	59	403	22	29	10.00	0.189	2.27		292	43.1
Game meat, beefalo, roasted	188	0.0	30.7	6.3	58	82	459	24		3.05		6.40		250	13.1
Game meat, bison, lean, roasted	143	0.0	28.4	2.4	82	57	361	8	26	3.42	0.107	3.68	0.008	209	35.5
Game meat, boar, wild, roasted	160	0.0	28.3	4.4	77	60	396	16	27	1.12	0.056	3.01		134	13.0
Game meat, deer, roasted	158	0.0	30.2	3.2	112	54	335	7	24	4.47	0.300	2.75	0.046	226	12.9
Game meat, elk, roasted	146	0.0	30.2	1.9	73	61	328	5	24	3.63	0.142	3.16	0.013	180	13.0
Game meat, moose, roasted	134	0.0	29.3	1.0	78	69	334	6	24	4.22	0.079	3.68	0.009	176	12.8
Game meat, rabbit, domesticated, roasted	197	0.0	29.1	8.1	82	47	383	19	21	2.27	0.189	2.27	0.032	263	38.5
Game meat, raccoon, roasted	255	0.0	29.2	14.5	97	79	398	14	30	7.10	0.189	2.27		261	18.0
Game meat, squirrel, roasted	173	0.0	30.8	4.7	121	119	352	3	28	6.81	0.148	1.78	0.032	211	15.1
Goose, domesticated, meat & skin, roasted	305	0.0	25.2	21.9	91	70	329	13	22	2.83	0.264	2.62	0.023	270	21.8
Goose, domesticated, meat only, roasted	238	0.0	29.0	12.7	96	76	388	14	25	2.87	0.276	3.17	0.024	309	25.5

Food description	Energy kcal/ 100 g	Carb. g/ 100 g	Protein g/ 100 g	Fat g/ 100 g	Chol. mg/ 100 g	Na mg/ 100 g	K mg/ 100 g	Ca mg/ 100 g	Mg mg/ 100 g	Fe mg/ 100 g	Cu mg/ 100 g	Zn mg/ 100 g	Mn mg/ 100 g	P mg/ 100 g	Se µg/ 100 g
Goose, liver, raw	133	6.3	16.4	4.3	515	140	230	43	24	30.53	7.522	3.07	0.000	261	68.1
Gooseberries, raw	44	10.2	0.9	0.6	0	1	198	25	10	0.31	0.070	0.12	0.144	27	0.6
Grape juice, canned or bottled, unsweetened, w/o vitamin C	61	15.0	0.6	0.1	0	3	132	9	10	0.24	0.028	0.05	0.360	11	0.1
Grapefruit juice, white, canned, unsweetened	38	9.0	0.5	0.1	0	1	153	7	10	0.20	0.038	0.09	0.020	11	0.1
Grapefruit, raw, pink & red, all areas	42	10.7	0.8	0.1	0	0	135	22	9	0.08	0.032	0.07	0.022	18	0.1
Grapefruit, raw, white, all areas	33	8.4	0.7	0.1	0	0	148	12	9	0.06	0.050	0.07	0.013	8	1.4
Grapes, American type (slip skin), raw	67	17.2	0.6	0.4	0	2	191	14	5	0.29	0.040	0.04	0.718	10	0.1
Grouper, mixed species, cooked, dry heat	118	0.0	24.8	1.3	47	53	475	21	37	1.14	0.045	0.51	0.012	143	46.8
Haddock, cooked, dry heat	112	0.0	24.2	0.9	74	87	399	42	50	1.35	0.033	0.48	0.030	241	40.5
Haddock, smoked	116	0.0	25.2	1.0	77	763	415	49	54	1.40	0.042	0.50	0.030	251	42.9
Halibut, Atlantic & Pacific, cooked, dry heat	140	0.0	26.7	2.9	41	69	576	60	107	1.07	0.035	0.53	0.020	285	46.8
Ham, sliced, regular (approx 11% fat)	163	3.8	16.6	8.6	57	1304	287	24	22	1.02	0.089	1.35	0.557	153	20.7
Herring, Atlantic, kippered	217	0.0	24.6	12.4	82	918	447	84	46	1.51	0.135	1.36	0.050	325	52.6
Hominy, canned, white or yellow	72	14.3	1.5	0.9	0	210	9	10	16	0.62	0.030	1.05	0.070	35	3.0
Hummus, commercial	166	14.3	7.9	9.6	0	379	228	38	71	2.44	0.527	1.83	0.773	176	2.6
Ice creams, chocolate	216	28.2	3.8	11.0	34	76	249	109	29	0.93	0.135	0.58	0.140	107	2.5
Ice creams, French vanilla, soft-serve	222	22.2	4.1	13.0	91	61	177	131	12	0.21	0.030	0.52	0.005	116	3.0
Ice creams, strawberry	192	27.6	3.2	8.4	29	60	188	120	14	0.21	0.037	0.34	0.078	100	1.9
Ice creams, vanilla	201	23.6	3.5	11.0	44	80	199	128	14	0.09	0.023	0.69	0.008	105	1.8
Jams and preserves	278	68.9	0.4	0.1	0	32	77	20	4	0.49	0.100	0.06	0.040	19	2.0
Jellies	266	70.0	0.2	0.0	0	30	54	7	6	0.19	0.011	0.03	0.132	6	0.4
Kale, boiled, w/o salt	28	5.6	1.9	0.4	0	23	228	72	18	0.90	0.156	0.24	0.416	28	0.9
Kale, raw	50	10.0	3.3	0.7	0	43	447	135	34	1.70	0.290	0.44	0.774	56	0.9
Kiwi fruit, (Chinese gooseberries), fresh, raw	61	14.7	1.1	0.5	0	3	312	34	17	0.31	0.130	0.14	0.098	34	0.2
Knockwurst, pork or beef	307	3.2	11.1	27.7	60	930	199	11	11	0.66	0.060	1.66	0.021	98	13.5
Kumquats, raw	71	15.9	1.9	0.9	0	10	186	62	20	0.86	0.095	0.17	0.135	19	0.0
Lamb, domestic, composite of retail cuts, lean & fat, 1/4" fat, choice, cooked	294	0.0	24.5	20.9	97	72	310	17	23	1.88	0.119	4.46	0.022	188	26.4
Lamb, domestic, composite of retail cuts, lean & fat, 1/8" fat, choice, cooked	271	0.0	25.5	18.0	96	72	318	16	24	1.93	0.121	4.74	0.024	193	27.2
Lamb, domestic, composite of retail cuts, lean, 1/4" fat, choice, cooked	206	0.0	28.2	9.5	92	76	344	15	26	2.05	0.128	5.27	0.028	210	26.1
Lamb, domestic, leg, shank half, lean & fat, 1/8" fat, choice, roasted	217	0.0	26.7	11.4	90	65	329	9	25	1.99	0.118	4.72	0.026	200	29.7
Lamb, domestic, loin, lean & fat, 1/4" fat, choice, roasted	309	0.0	22.6	23.6	95	64	246	18	23	2.12	0.119	3.41	0.020	180	24.6
Lamb, domestic, rib, lean & fat, 1/8" fat, choice, roasted	341	0.0	21.8	27.5	96	74	277	22	20	1.62	0.117	3.62	0.021	170	22.3
Lamb, ground, broiled	283	0.0	24.8	19.7	97	81	339	22	24	1.79	0.128	4.67	0.024	201	27.7
Lard	902	0.0	0.0	100.0	95	0	0	0	0	0.00	0.000	0.11	0.000	0	0.2
Leeks, (bulb & lower leaf-portion), boiled, w/o salt	31	7.6	0.8	0.2	0	10	87	30	14	1.10	0.062	0.06	0.247	17	0.5
Lemon juice, canned or bottled	21	6.5	0.4	0.3	0	21	102	11	8	0.13	0.037	0.06	0.020	9	0.1
Lemons, raw, with peel	20	10.7	1.2	0.3	0	3	145	61	12	0.70	0.260	0.10		15	
Lemons, raw, without peel	29	9.3	1.1	0.3	0	2	138	26	8	0.60	0.037	0.06	0.030	16	0.4
Lentils, mature seeds, boiled, w. salt	116	20.1	9.0	0.4	0	238	369	19	36	3.33	0.251	1.27	0.494	180	2.8
Lentils, sprouted, stir-fried, w. salt	101	21.3	8.8	0.5	0	246	284	14	35	3.10	0.337	1.60	0.502	153	0.6
Lettuce, iceberg (includes crisp head types), raw	14	3.0	0.9	0.1	0	10	141	18	7	0.41	0.025	0.15	0.125	20	0.1
Lettuce, romaine, raw	17	3.3	1.2	0.3	0	8	247	33	14	0.97	0.048	0.23	0.155	30	0.4
Lima beans, large, mature seeds, boiled, w/o salt	115	20.9	7.8	0.4	0	2	508	17	43	2.39	0.235	0.95	0.516	111	4.5
Lima beans, thin seeded (baby), mature seeds, boiled, w/o salt	126	23.3	8.0	0.4	0	3	401	29	53	2.40	0.215	1.03	0.585	127	4.9
Limes, raw	30	10.5	0.7	0.2	0	2	102	33	6	0.60	0.065	0.11	0.008	18	0.4
Liverwurst spread	305	5.9	12.4	25.5	118	700	170	22	12	8.85	0.240	2.30	0.155	230	58.0
Lobster, northern, cooked, moist heat	98	1.3	20.5	0.6	72	380	352	61	35	0.39	1.940	2.92	0.061	185	42.7
Macadamia nuts, dry roasted, w/o salt	718	13.4	7.8	76.1	0	4	363	70	118	2.65	0.570	1.29	3.036	198	3.6
Macaroni, cooked, enriched	158	30.9	5.8	0.9	0	1	45	7	18	1.33	0.103	0.50	0.317	58	26.4
Mackerel, Atlantic, cooked, dry heat	262	0.0	23.9	17.8	75	83	401	15	97	1.57	0.094	0.94	0.020	278	51.6

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Mackerel, king, cooked, dry heat	134	0.0	26.0	2.6	68	203	558	40	41	2.28	0.033	0.72	0.006	318	46.8
Mackerel, Pacific & jack, mixed species, cooked, dry heat	201	0.0	25.7	10.1	60	110	521	29	36	1.49	0.119	0.86	0.019	160	46.8
Mackerel, salted	305	0.0	18.5	25.1	95	4450	520	66	60	1.40	0.100	1.10		254	73.4
Mackerel, Spanish, cooked, dry heat	158	0.0	23.6	6.3	73	66	554	13	38	0.74	0.065	0.62	0.012	271	40.6
Mangos, raw	65	17.0	0.5	0.3	0	2	156	10	9	0.13	0.110	0.04	0.027	11	0.6
Margarine, regular, hard, corn (hydrogenated)	719	0.9	0.9	80.5	0	943	42	30	3	0.00				23	0.0
Margarine, regular, hard, soybean (hydrogenated) & palm (hydrogenated)	719	0.9	0.9	80.5	0	943	42	30	3	0.00		0.00		23	0.0
Margarine, regular, stick, unsalted, 80% fat	719	0.9	0.9	80.5	0	2	25	17	2	0.00	0.000	0.00		13	0.0
Margarine, regular, tub, unsalted, 80% fat	716	0.5	0.8	80.4	0	28	38	26	2	0.00	0.000	0.00		20	0.0
Marmalade, orange	246	66.3	0.3	0.0	0	56	37	38	2	0.15	0.090	0.04	0.020	4	0.6
Mayonnaise dressing, no cholesterol	688	0.3	0.0	77.8	0	486	14	7	1	0.23	0.000	0.13		25	1.6
Mayonnaise, low sodium, diet	231	16.0	0.3	19.2	24	110	10	0	0	0.00	0.000	0.11	0.000	0	1.6
Melons, honeydew, raw	36	9.1	0.5	0.1	0	18	228	6	10	0.17	0.024	0.09	0.027	11	0.7
Milk, buttermilk, fluid, cultured, reduced fat	56	5.3	4.1	2.0	8	86	180	143	13	0.06	0.008	0.24		82	2.3
Milk, goat, fluid	69	4.5	3.6	4.1	11	50	204	134	14	0.05	0.046	0.30	0.018	111	1.4
Milk, low fat, fluid, 1% milkfat, w. vitamin A	42	5.0	3.4	1.0	5	44	150	119	11	0.03	0.010	0.42	0.003	95	3.3
Milk, low sodium, fluid	61	4.5	3.1	3.5	14	3	253	101	5	0.05	0.010	0.38	0.004	86	2.0
Milk, reduced fat, fluid, 2% milkfat, w. added vitamin A	50	4.7	3.3	2.0	8	41	150	117	11	0.03	0.012	0.43	0.003	94	2.5
Muffins, blueberry, commercially prepared	277	48.0	5.5	6.5	30	447	123	57	16	1.61	0.074	0.49	0.440	197	11.2
Muffins, corn, commercially prepared	305	50.9	5.9	8.4	26	521	69	74	32	2.81	0.299	0.54	0.355	284	15.2
Muffins, oat bran	270	48.3	7.0	7.4	0	393	507	63	157	4.20	0.330	1.84	2.630	376	11.0
Mullet, striped, cooked, dry heat	150	0.0	24.8	4.9	63	71	458	31	33	1.41	0.141	0.88	0.022	244	46.8
Mushrooms, boiled, w/o salt	28	5.3	2.2	0.5	0	2	356	6	12	1.74	0.504	0.87	0.115	87	11.9
Mushrooms, oyster, raw	35	6.4	3.3	0.4	0	18	420	3	18	1.33	0.244	0.77	0.113	120	2.6
Mushrooms, portabella, grilled	35	5.1	4.1	0.8	0	10	521	4	15	0.56	0.499	0.73	0.075	150	17.7
Mushrooms, raw	22	3.3	3.1	0.3	0	5	318	3	9	0.50	0.318	0.52	0.047	86	9.3
Mushrooms, shiitake, cooked, w/o salt	56	14.4	1.6	0.2	0	4	117	3	14	0.44	0.896	1.33	0.204	29	24.8
Mussels, blue, cooked, moist heat	172	7.4	23.8	4.5	56	369	268	33	37	6.72	0.149	2.67	6.800	285	89.6
Mussels, blue, raw	86	3.7	11.9	2.2	28	286	320	26	34	3.95	0.094	1.60	3.400	197	44.8
Mustard greens, boiled, w/o salt	15	2.1	2.3	0.2	0	16	202	74	15	0.70	0.084	0.11	0.274	41	0.6
Nectarines, raw	44	10.6	1.1	0.3	0	0	201	6	9	0.28	0.086	0.17	0.054	26	0.0
Noodles, egg, cooked, enriched, w. salt	138	25.2	4.5	2.1	29	165	38	12	21	1.47	0.098	0.65	0.315	76	23.9
Noodles, Japanese, soba, cooked	99	21.4	5.1	0.1	0	60	35	4	9	0.48	0.008	0.12	0.374	25	
Nutmeg, ground	525	49.3	5.8	36.3	0	16	350	184	183	3.04	1.027	2.15	2.900	213	1.6
Ocean perch, Atlantic, cooked, dry heat	121	0.0	23.9	2.1	54	96	350	137	39	1.18	0.033	0.61	0.020	277	55.5
Oil, avocado	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, canola	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, canola and soybean	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00		0	0.0
Oil, coconut	862	0.0	0.0	100.0	0	0	0	0	0	0.04	0.000	0.00	0.000	0	0.0
Oil, corn and canola	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00		0	0.0
Oil, mustard	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, olive, salad or cooking	884	0.0	0.0	100.0	0	2	1	1	0	0.56	0.000	0.00	0.000	0	0.0
Oil, palm	884	0.0	0.0	100.0	0	0	0	0	0	0.01	0.000	0.00		0	0.0
Oil, palm kernel	862	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, peanut, salad or cooking	884	0.0	0.0	100.0	0	0	0	0	0	0.03	0.000	0.01		0	0.0
Oil, safflower, salad or cooking, linoleic >70%	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00		0	0.0
Oil, safflower, salad or cooking, oleic >70%	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, sesame, salad or cooking	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00		0	0.0
Oil, soybean lecithin	763	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Oil, soybean, salad or cooking	884	0.0	0.0	100.0	0	0	0	0	0	0.02	0.000	0.00		0	0.0
Oil, sunflower, linoleic, approx. 65%	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00		0	0.0
Okra, boiled, w/o salt	22	4.6	1.9	0.2	0	6	135	77	36	0.28	0.085	0.43	0.294	32	0.4



Food description	Energy kcal/100 g	Carb. g/100 g	Protein g/100 g	Fat g/100 g	Chol. mg/100 g	Na mg/100 g	K mg/100 g	Ca mg/100 g	Mg mg/100 g	Fe mg/100 g	Cu mg/100 g	Zn mg/100 g	Mn mg/100 g	P mg/100 g	Se µg/100 g
Olives, pickled, canned or bottled, green	145	3.8	1.0	15.3	0	1556	42	52	11	0.49	0.120	0.04		4	0.9
Olives, ripe, canned (small-extra large)	115	6.3	0.8	10.7	0	872	8	88	4	3.30	0.251	0.22	0.020	3	0.9
Onions, boiled, w/o salt	44	10.2	1.4	0.2	0	3	166	22	11	0.24	0.067	0.21	0.153	35	0.6
Onions, raw	42	10.1	0.9	0.1	0	3	144	22	10	0.19	0.038	0.16	0.132	27	0.5
Orange juice, includes from concentrate	44	10.1	0.8	0.3	0	1	190	10	11	0.17	0.040	0.04	0.023	11	0.1
Oranges, raw, all commercial varieties	47	11.8	0.9	0.1	0	0	181	40	10	0.10	0.045	0.07	0.025	14	0.5
Oranges, raw, California, Valencias	49	11.9	1.0	0.3	0	0	179	40	10	0.09	0.037	0.06	0.023	17	
Oranges, raw, Florida	46	11.5	0.7	0.2	0	0	169	43	10	0.09	0.039	0.08	0.024	12	0.5
Oranges, raw, navels	49	12.5	0.9	0.2	0	1	166	43	11	0.13	0.039	0.08	0.029	23	0.0
Ostrich, ground, cooked, pan-broiled	175	0.0	26.2	7.1	83	80	323	8	23	3.43	0.136	4.33	0.017	224	33.5
Ostrich, inside leg, cooked	141	0.0	29.0	1.9	73	83	352	6	25	3.12	0.148	4.71	0.018	244	36.5
Ostrich, top loin, cooked	155	0.0	28.1	3.9	93	77	353	6	25	3.31	0.148	4.72	0.018	245	36.6
Oyster, eastern, breaded & fried	197	11.6	8.8	12.6	81	417	244	62	58	6.95	4.294	87.13	0.490	159	66.5
Oyster, eastern, farmed, raw	59	5.5	5.2	1.6	25	178	124	44	33	5.78	0.738	37.92	0.394	93	63.7
Oyster, eastern, wild, raw	68	3.9	7.1	2.5	53	211	156	45	47	6.66	4.452	90.81	0.367	135	63.7
Oyster, Pacific, cooked, moist heat	163	9.9	18.9	4.6	100	212	302	16	44	9.20	2.679	33.24	1.222	243	154.0
Oyster, Pacific, raw	81	5.0	9.5	2.3	50	106	168	8	22	5.11	1.576	16.62	0.643	162	77.0
Palm hearts, raw	115	25.6	2.7	0.2	0	14	1806	18	10	1.69	0.644	3.73		140	0.7
Papayas, raw	39	9.8	0.6	0.1	0	3	257	24	10	0.10	0.016	0.07	0.011	5	0.6
Parsley, raw	36	6.3	3.0	0.8	0	56	554	138	50	6.20	0.149	1.07	0.160	58	0.1
Pastrami beef 98% fat-free	95	1.5	19.6	1.2	47	1010	228	9	18	2.78	0.079	4.26	0.013	150	10.4
Pate de foie gras, canned, smoked	462	4.7	11.4	43.8	150	697	138	70	13	5.50	0.400	0.92	0.120	200	44.0
Pate, liver, not specified, canned	319	1.5	14.2	28.0	255	697	138	70	13	5.50	0.400	2.85	0.120	200	41.6
Peaches, raw	39	9.5	0.9	0.3	0	0	190	6	9	0.25	0.068	0.17	0.061	20	0.1
Peanut butter, chunk style, w/o salt	589	21.6	24.1	49.9	0	17	745	45	160	1.90	0.578	2.79	1.800	319	8.2
Peanut butter, smooth style, w/o salt	588	19.6	25.1	50.4	0	17	649	43	154	1.87	0.473	2.91	1.466	358	5.6
Peanuts, all types, dry-roasted, w. salt	585	21.5	23.7	49.7	0	813	658	54	176	2.26	0.671	3.31	2.083	358	7.5
Peanuts, all types, oil-roasted, w. salt	599	15.3	28.0	52.5	0	320	726	61	176	1.52	0.533	3.28	1.845	397	3.3
Pears, raw	58	15.5	0.4	0.1	0	1	119	9	7	0.17	0.082	0.10	0.049	11	0.1
Peas, edible-podded, boiled, w. salt	42	7.1	3.3	0.2	0	240	240	42	26	1.97	0.077	0.37	0.168	55	0.7
Peas, edible-podded, raw	42	7.6	2.8	0.2	0	4	200	43	24	2.08	0.079	0.27	0.244	53	0.7
Peas, green, boiled, w/o salt	84	15.6	5.4	0.2	0	3	271	27	39	1.54	0.173	1.19	0.525	117	1.9
Pecans, dry roasted, w. salt	710	13.6	9.5	74.3	0	383	424	72	132	2.80	1.167	5.07	3.933	293	4.0
Pecans, oil roasted, w. salt	715	13.0	9.2	75.2	0	393	392	67	121	2.47	1.200	4.47	3.700	263	6.0
Peppers, hot chili, green, raw	40	9.5	2.0	0.2	0	7	340	18	25	1.20	0.174	0.30	0.237	46	0.5
Peppers, hot chili, red, raw	40	8.8	1.9	0.4	0	9	322	14	23	1.03	0.129	0.26	0.187	43	0.5
Peppers, jalapeno, raw	30	5.9	1.4	0.6	0	1	215	10	19	0.70	0.133	0.23	0.250	31	0.3
Peppers, sweet, green, boiled, w/o salt	28	6.7	0.9	0.2	0	2	166	9	10	0.46	0.065	0.12	0.115	18	0.3
Peppers, sweet, green, raw	20	4.6	0.9	0.2	0	3	175	10	10	0.34	0.066	0.13	0.122	20	0.0
Peppers, sweet, red, boiled, w/o salt	28	6.7	0.9	0.2	0	2	166	9	10	0.46	0.065	0.12	0.115	18	0.3
Peppers, sweet, red, raw	26	6.0	1.0	0.3	0	2	211	7	12	0.43	0.017	0.25	0.112	26	0.1
Peppers, sweet, yellow, raw	27	6.3	1.0	0.2	0	2	212	11	12	0.46	0.107	0.17	0.117	24	0.3
Persimmons, native, raw	127	33.5	0.8	0.4	0	1	310	27		2.50				26	
Pheasant, cooked, total edible	247	0.0	32.4	12.1	89	43	271	16	22	1.43	0.084	1.37		242	20.7
Pickle, cucumber, sour	11	2.3	0.3	0.2	0	1208	23	0	4	0.40	0.085	0.02	0.011	14	0.0
Pickle, cucumber, sweet	117	31.8	0.4	0.3	0	939	32	4	4	0.59	0.105	0.08	0.015	12	0.0
Pickles, cucumber, dill	18	4.1	0.6	0.2	0	1282	116	9	11	0.53	0.079	0.14	0.015	21	0.0
Pie, apple, commercially prepared, enriched flour	237	34.0	1.9	11.0	0	266	65	11	7	0.45	0.046	0.16	0.182	24	1.0
Pie, blueberry, commercially prepared	232	34.9	1.8	10.0	0	325	50	8	5	0.30	0.046	0.16	0.176	23	1.4
Pie, cherry, commercially prepared	260	39.8	2.0	11.0	0	246	81	12	8	0.48	0.040	0.18	0.140	29	1.2
Pie, chocolate creme, commercially prepared	304	33.6	2.6	19.4	5	136	127	36	21	1.07	0.050	0.23	0.200	68	7.5
Pie, coconut creme, commercially prepared	298	37.2	2.1	16.6	0	255	65	29	20	0.80	0.068	0.47	0.438	85	5.3
Pie, egg custard, commercially prepared	210	20.8	5.5	11.6	33	240	106	80	11	0.58	0.024	0.52	0.060	112	7.1
Pie, lemon meringue, commercially prepared	268	47.2	1.5	8.7	45	146	89	56	15	0.61	0.001	0.49	0.060	105	3.0

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Pie, mince, prepared from recipe	289	48.0	2.6	10.8	0	254	203	22	14	1.49	0.113	0.22	0.263	42	6.6
Pie, peach	223	32.9	1.9	10.0	0	270	125	8	6	0.50	0.053	0.09	0.152	22	1.3
Pie, pecan, commercially prepared	400	57.2	4.0	18.5	32	424	74	17	18	1.04	0.195	0.57	0.789	77	5.0
Pie, pumpkin, commercially prepared	210	27.3	3.9	9.5	20	282	154	60	15	0.79	0.048	0.45	0.240	71	2.6
Pike, northern, cooked, dry heat	113	0.0	24.7	0.9	50	49	331	73	40	0.71	0.065	0.86	0.310	282	16.2
Pike, walleye, raw	93	0.0	19.1	1.2	86	51	389	110	30	1.30	0.178	0.62	0.800	210	12.6
Pimento, canned	23	5.1	1.1	0.3	0	14	158	6	6	1.68	0.049	0.19	0.092	17	0.2
Pine nuts, pinyon, dried	629	19.3	11.6	61.0	0	72	628	8	234	3.06	1.035	4.28	4.333	35	
Pineapple juice, canned, unsweetened, w/o vitamin C	53	12.9	0.4	0.1	0	2	130	13	12	0.31	0.069	0.11	0.504	8	0.1
Pineapple, raw, all variety	48	12.6	0.5	0.1	0	1	115	13	12	0.28	0.099	0.10	1.177	8	0.1
Pineapple, raw, traditional variety	45	11.8	0.6	0.1		1	125	13	12	0.25	0.081	0.08	1.593	9	0.0
Pistachio nuts, dry roasted, w/o salt	571	27.7	21.4	46.0	0	10	1042	110	120	4.20	1.325	2.30	1.275	485	9.3
Plantains, cooked	116	31.2	0.8	0.2	0	5	465	2	32	0.58	0.066	0.13		28	1.4
Plums, dried (prunes), uncooked	240	63.9	2.2	0.4	0	2	732	43	41	0.93	0.281	0.44	0.299	69	0.3
Plums, raw	46	11.4	0.7	0.3	0	0	157	6	7	0.17	0.057	0.10	0.052	16	0.0
Pollock, Atlantic, cooked, dry heat	118	0.0	24.9	1.3	91	110	456	77	86	0.59	0.064	0.60	0.019	283	46.8
Pollock, walleye, cooked, dry heat	113	0.0	23.5	1.1	96	116	387	6	73	0.28	0.055	0.60	0.020	482	43.4
Pomegranates, raw	68	17.2	1.0	0.3	0	3	259	3	3	0.30	0.070	0.12		8	0.6
Pompano, Florida, cooked, dry heat	211	0.0	23.7	12.1	64	76	636	43	31	0.67	0.078	0.69	0.025	341	46.8
Popcorn, air-popped	387	77.8	12.9	4.5	0	8	329	7	144	3.19	0.262	3.08	1.113	358	0.0
Pork sausage, fresh, cooked	339	0.0	19.4	28.4	84	749	294	13	17	1.36	0.086	2.08	0.005	163	0.0
Pork, cured, bacon, broiled, pan-fried or roasted	541	1.4	37.0	41.8	110	2310	565	11	33	1.44	0.164	3.50	0.022	533	62.0
Pork, cured, breakfast strips, cooked	459	1.1	29.0	36.7	105	2099	466	14	26	1.97	0.153	3.68	0.044	265	24.7
Pork, cured, Canadian-style bacon, grilled	185	1.4	24.2	8.4	58	1546	390	10	21	0.82	0.054	1.70	0.027	296	24.7
Pork, cured, ham, boneless, extra lean (approx 5% fat), roasted	145	1.5	20.9	5.5	53	1203	287	8	14	1.48	0.079	2.88	0.054	196	19.5
Pork, cured, ham, boneless, regular (approx 11% fat), roasted	178	0.0	22.6	9.0	59	1500	409	8	22	1.34	0.145	2.47	0.041	281	19.8
Pork, cured, ham, whole, lean & fat, roasted	243	0.0	21.6	16.8	62	1187	286	7	19	0.87	0.083	2.32	0.014	214	22.7
Pork, cured, salt pork, raw	748	0.0	5.1	80.5	86	1424	66	6	7	0.44	0.050	0.90	0.005	52	5.8
Pork, fresh, composite of retail cuts (leg, loin, & shoulder), lean, cooked	212	0.0	29.3	9.7	86	59	375	21	26	1.10	0.061	2.97	0.018	237	45.0
Pork, fresh, leg (ham), rump half, lean & fat, roasted	252	0.0	28.9	14.3	96	62	374	12	27	1.05	0.103	2.82	0.023	272	46.8
Pork, fresh, leg (ham), shank half, lean & fat, roasted	289	0.0	25.3	20.1	92	59	338	15	22	0.98	0.098	3.06	0.028	257	43.3
Pork, fresh, loin, blade (chops), bone-in, lean & fat, broiled	320	0.0	22.5	24.9	86	70	344	29	22	0.93	0.083	3.37	0.008	212	37.1
Pork, fresh, loin, center loin (chops), bone-in, lean & fat, broiled	240	0.0	28.7	13.1	82	58	358	33	25	0.80	0.046	2.26	0.003	232	44.3
Pork, fresh, loin, center rib (chops), bone-in, lean, broiled	219	0.0	30.8	9.7	81	65	420	31	28	0.82	0.070	2.38	0.020	245	47.3
Pork, fresh, loin, center rib (chops), boneless, lean & fat, broiled	260	0.0	27.6	15.8	82	62	401	28	26	0.77	0.068	2.26	0.018	237	44.0
Pork, fresh, loin, center rib (roasts), boneless, lean & fat, roasted	252	0.0	27.0	15.2	81	48	346	6	22	0.93	0.016	2.64	0.010	214	40.3
Pork, fresh, loin, country-style ribs, lean & fat, braised	296	0.0	23.9	21.5	87	59	328	29	17	1.22	0.093	3.56	0.012	167	39.7
Pork, fresh, loin, sirloin (chops), bone-in, lean & fat, broiled	259	0.0	26.7	16.1	86	68	383	17	29	0.99	0.058	2.57	0.010	246	47.7
Pork, fresh, loin, sirloin (chops), boneless, lean & fat, broiled	208	0.0	30.5	8.6	91	56	372	18	27	1.21	0.053	2.62	0.003	243	50.5
Pork, fresh, loin, tenderloin, lean & fat, broiled	201	0.0	29.9	8.1	94	64	444	5	35	1.39	0.067	2.89	0.012	290	47.7
Pork, fresh, spareribs, lean & fat, braised	397	0.0	29.1	30.3	121	93	320	47	24	1.85	0.142	4.60	0.014	261	37.4
Potato chips, plain, salted	547	49.7	6.6	37.5	0	525	1642	24	70	1.61	0.398	2.39	0.664	155	8.1
Potatoes, baked, flesh & skin, w. salt	93	21.2	2.5	0.1	0	244	535	15	28	1.08	0.118	0.36	0.219	70	0.4
Potatoes, boiled in skin, flesh, w. salt	87	20.1	1.9	0.1	0	240	379	5	22	0.31	0.188	0.30	0.138	44	0.3
Potatoes, boiled w/o skin, flesh, w. salt	86	20.0	1.7	0.1	0	241	328	8	20	0.31	0.167	0.27	0.140	40	0.3
Potatoes, French fried, all types, frozen, oven-heated	172	28.7	2.7	5.2	0	32	451	12	26	0.74	0.135	0.38	0.210	97	0.2

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Potatoes, hashed brown, home-prepared	265	35.1	3.0	12.5	0	342	576	14	35	0.55	0.293	0.47	0.247	70	0.5
Potatoes, mashed, home-prepared, whole milk & margarine added	113	16.9	2.0	4.2	1	333	328	22	19	0.26	0.153	0.30	0.112	49	0.8
Potatoes, red, flesh & skin, baked	89	19.6	2.3	0.2	0	8	545	9	28	0.70	0.174	0.40	0.173	72	0.5
Potatoes, white, flesh & skin, baked	94	21.1	2.1	0.2	0	7	544	10	27	0.64	0.127	0.35	0.189	75	0.5
Pretzels, hard, plain, salted	380	79.8	10.3	2.6	0	1357	146	18	29	5.20	0.264	1.43	1.789	113	6.0
Prunes, dehydrated (low-moisture), stewed	113	29.7	1.2	0.2	0	2	353	24	21	1.17	0.204	0.25	0.104	37	
Pumpkin, boiled, w/o salt	20	4.9	0.7	0.1	0	1	230	15	9	0.57	0.091	0.23	0.089	30	0.2
Pumpkin, raw	26	6.5	1.0	0.1	0	1	340	21	12	0.80	0.127	0.32	0.125	44	0.3
Quail, cooked, total edible	234	0.0	25.1	14.1	86	52	216	15	22	4.43	0.592	3.10		279	21.8
Quinces, raw	57	15.3	0.4	0.1	0	4	197	11	8	0.70	0.130	0.04		17	0.6
Radicchio, raw	23	4.5	1.4	0.3	0	22	302	19	13	0.57	0.341	0.62	0.138	40	0.9
Radishes, raw	16	3.4	0.7	0.1	0	39	233	25	10	0.34	0.050	0.28	0.069	20	0.6
Raisins, golden seedless	302	79.5	3.4	0.5	0	12	746	53	35	1.79	0.363	0.32	0.308	115	0.7
Raisins, seeded	296	78.5	2.5	0.5	0	28	825	28	30	2.59	0.302	0.18	0.267	75	0.6
Raisins, seedless	299	79.2	3.1	0.5	0	11	749	50	32	1.88	0.318	0.22	0.299	101	0.6
Raspberries, raw	52	11.9	1.2	0.7	0	1	151	25	22	0.69	0.090	0.42	0.670	29	0.2
Rhubarb, frozen, cooked, w/sugar	116	31.2	0.4	0.1	0	1	96	145	12	0.21	0.027	0.08	0.073	8	0.9
Rhubarb, raw	21	4.5	0.9	0.2	0	4	288	86	12	0.22	0.021	0.10	0.196	14	1.1
Rice, brown, long-grain, cooked	111	23.0	2.6	0.9	0	5	43	10	43	0.42	0.100	0.63	0.905	83	9.8
Rice, brown, medium-grain, cooked	112	23.5	2.3	0.8	0	1	79	10	44	0.53	0.081	0.62	1.097	77	
Rice, white, glutinous, cooked	97	21.1	2.0	0.2	0	5	10	2	5	0.14	0.049	0.41	0.262	8	5.6
Rice, white, long-grain, regular, cooked	130	28.2	2.7	0.3	0	1	35	10	12	1.20	0.069	0.49	0.472	43	7.5
Rice, white, medium-grain, cooked	130	28.6	2.4	0.2	0	0	29	3	13	1.49	0.038	0.42	0.377	37	7.5
Rice, white, short-grain, cooked	130	28.7	2.4	0.2	0	0	26	1	8	1.46	0.072	0.40	0.357	33	7.5
Rockfish, Pacific, mixed species, cooked, dry heat	121	0.0	24.0	2.0	44	77	520	12	34	0.53	0.037	0.53	0.020	228	46.8
Rolls, hamburger or hotdog, plain	279	49.5	9.5	4.3	0	479	94	138	21	3.32	0.220	0.66	0.272	62	19.5
Rutabagas, boiled, w/o salt	39	8.7	1.3	0.2	0	20	326	48	23	0.53	0.041	0.35	0.174	56	0.7
Sablefish, cooked, dry heat	250	0.0	17.2	19.6	63	72	459	45	71	1.64	0.028	0.41	0.019	215	46.8
Sablefish, smoked	257	0.0	17.7	20.1	64	737	471	50	74	1.69	0.036	0.43	0.020	222	50.2
Salami, cooked, turkey	152	0.4	15.3	9.4	76	1004	216	40	22	1.25	0.190	2.32	0.020	266	26.4
Salami, dry or hard, pork	407	1.6	22.6	33.7	79	2260	378	13	22	1.30	0.160	4.20	0.070	229	25.4
Salami, dry or hard, pork, beef	385	3.8	23.2	30.1	100	2010	378	8	17	1.51	0.080	3.23		142	26.1
Salami, Italian, pork	425	1.2	21.7	37.0	80	1890	340	10	22	1.52	0.160	4.20	0.070	229	25.4
Salmon, Atlantic, farmed, cooked, dry heat	206	0.0	22.1	12.4	63	61	384	15	30	0.34	0.049	0.43	0.016	252	41.4
Salmon, Atlantic, farmed, raw	183	0.0	19.9	10.9	59	59	362	12	28	0.36	0.049	0.40	0.015	233	36.5
Salmon, Atlantic, wild, cooked, dry heat	182	0.0	25.4	8.1	71	56	628	15	37	1.03	0.321	0.82	0.021	256	46.8
Salmon, Atlantic, wild, raw	142	0.0	19.8	6.3	55	44	490	12	29	0.80	0.250	0.64	0.016	200	36.5
Salmon, Chinook, cooked, dry heat	231	0.0	25.7	13.4	85	60	505	28	122	0.91	0.053	0.56	0.019	371	46.8
Salmon, Chinook, raw	179	0.0	19.9	10.4	50	47	394	26	95	0.25	0.041	0.44	0.015	289	36.5
Salmon, Chinook, smoked	117	0.0	18.3	4.3	23	784	175	11	18	0.85	0.230	0.31	0.017	164	32.4
Salmon, Chinook, smoked (lox)	117	0.0	18.3	4.3	23	2000	175	11	18	0.85	0.230	0.31	0.017	164	38.1
Salmon, chum, cooked, dry heat	154	0.0	25.8	4.8	95	64	550	14	28	0.71	0.071	0.60	0.019	363	46.8
Salmon, coho, farmed, cooked, dry heat	178	0.0	24.3	8.2	63	52	460	12	34	0.39	0.089	0.47	0.021	332	14.1
Salmon, coho, farmed, raw	160	0.0	21.3	7.7	51	47	450	12	31	0.34	0.048	0.43	0.012	292	12.6
Salmon, coho, wild, cooked, dry heat	139	0.0	23.5	4.3	55	58	434	45	33	0.61	0.071	0.56	0.019	322	38.0
Salmon, coho, wild, raw	146	0.0	21.6	5.9	45	46	423	36	31	0.56	0.051	0.41	0.014	262	36.5
Salmon, pink, cooked, dry heat	149	0.0	25.6	4.4	67	86	414	17	33	0.99	0.099	0.71	0.019	295	57.2
Salmon, pink, raw	116	0.0	19.9	3.5	52	67	323	13	26	0.77	0.077	0.55	0.015	230	44.6
Salmon, sockeye, cooked, dry heat	216	0.0	27.3	11.0	87	66	375	7	31	0.55	0.067	0.51	0.020	276	37.8
Salmon, sockeye, raw	168	0.0	21.3	8.6	62	47	391	6	24	0.47	0.052	0.54	0.014	215	33.7
Sausage, chicken, beef, pork, skinless, smoked	216	8.1	13.6	14.3	120	1034	246	100	14	4.80	0.063	2.68	0.015	132	20.2
Sausage, Italian, pork, cooked	344	4.3	19.1	27.3	57	1207	304	21	18	1.43	0.080	2.39		170	22.0
Sausage, Italian, sweet, links	149	2.1	16.1	8.4	30	570	194	25	12	1.19	0.040	1.52	0.007	103	10.8

Food description	Energy kcal/ 100 g	Carb. g/ 100 g	Protein g/ 100 g	Fat g/ 100 g	Chol. mg/ 100 g	Na mg/ 100 g	K mg/ 100 g	Ca mg/ 100 g	Mg mg/ 100 g	Fe mg/ 100 g	Cu mg/ 100 g	Zn mg/ 100 g	Mn mg/ 100 g	P mg/ 100 g	Se µg/ 100 g
Sausage, Polish, beef w. chicken, hot	259	3.6	17.6	19.4	66	1540	237	12	14	0.88	0.090	1.93	0.049	136	17.7
Sausage, smoked link sausage, pork & beef	320	2.4	12.0	28.7	58	911	179	12	13	0.75	0.077	1.26	0.048	121	0.0
Sausage, turkey, breakfast links, mild	235	1.6	15.4	18.1	60	585	197	32	25	1.07	0.111	2.13	0.066	185	22.2
Scallops, (bay & sea), steamed	112	0.0	23.2	1.4	53	265	476	115	55	3.00	0.300	3.00		338	27.9
Scrapple, pork	213	14.1	8.1	13.9	49	659	158	7	13	1.89	0.212	1.06		76	17.4
Sea bass, mixed species, cooked, dry heat	124	0.0	23.6	2.6	53	87	328	13	53	0.37	0.024	0.52	0.020	248	46.8
Shad, American, cooked, dry heat	252	0.0	21.7	17.7	96	65	492	60	38	1.24	0.082	0.47	0.054	349	46.8
Shark, mixed species, batter-dipped & fried	228	6.4	18.6	13.8	59	122	155	50	43	1.11	0.042	0.48	0.050	194	34.0
Shortening, frying (heavy duty), beef tallow & cottonseed	900	0.0	0.0	100.0	100	0	0	0	0	0.00		0.00		0	0.0
Shortening, household, soybean (hydrogenated) & palm	884	0.0	0.0	100.0	0	0	0	0	0	0.00	0.000	0.00	0.000	0	0.0
Shrimp, mixed species, cooked, moist heat	99	0.0	20.9	1.1	195	224	182	39	34	3.09	0.193	1.56	0.034	137	39.6
Shrimp, mixed species, imitation, made from surimi	101	9.1	12.4	1.5	36	705	89	19	43	0.60	0.032	0.33	0.011	282	22.9
Shrimp, mixed species, raw	106	0.9	20.3	1.7	152	148	185	52	37	2.41	0.264	1.11	0.050	205	38.0
Smelt, rainbow, cooked, dry heat	124	0.0	22.6	3.1	90	77	372	77	38	1.15	0.178	2.12	0.900	295	46.8
Snails, raw	90	2.0	16.1	1.4	50	70	382	10	250	3.50	0.400	1.00		272	27.4
Snapper, mixed species, cooked, dry heat	128	0.0	26.3	1.7	47	57	522	40	37	0.24	0.046	0.44	0.017	201	49.0
Sour cream, light	136	7.1	3.5	10.6	35	71	212	141	10	0.07	0.016	0.50		71	3.1
Sour cream, reduced fat	181	7.0	7.0	14.1	35	70	211	141	11	0.06	0.010	0.27		85	4.1
Soybeans, green, boiled, w/o salt	141	11.1	12.4	6.4	0	14	539	145	60	2.50	0.117	0.91	0.502	158	1.4
Soybeans, green, raw	147	11.1	13.0	6.8	0	15	620	197	65	3.55	0.128	0.99	0.547	194	1.5
Soybeans, mature cooked, boiled, w/o salt	173	9.9	16.6	9.0	0	1	515	102	86	5.14	0.407	1.15	0.824	245	7.3
Spaghetti, cooked, enriched, w. salt	157	30.6	5.8	0.9	0	128	45	7	18	1.33	0.103	0.50	0.317	58	26.4
Spaghetti, whole-wheat, cooked	124	26.5	5.3	0.5	0	3	44	15	30	1.06	0.167	0.81	1.379	89	25.9
Spinach, boiled, w/o salt	23	3.8	3.0	0.3	0	70	466	136	87	3.57	0.174	0.76	0.935	56	1.5
Spinach, raw	23	3.6	2.9	0.4	0	79	558	99	79	2.71	0.130	0.53	0.897	49	1.0
Squash, summer, all varieties, boiled, w/o salt	20	4.3	0.9	0.3	0	1	192	27	24	0.36	0.103	0.39	0.213	39	0.2
Squash, summer, all varieties, raw	16	3.4	1.2	0.2	0	2	262	15	17	0.35	0.051	0.29	0.175	38	0.2
Squash, summer, zucchini, includes skin, boiled, w/o salt	16	3.9	0.6	0.1	0	3	253	13	22	0.35	0.086	0.18	0.178	40	0.2
Squash, summer, zucchini, includes skin, raw	16	3.4	1.2	0.2	0	10	262	15	17	0.35	0.051	0.29	0.175	38	0.2
Squash, winter, acorn, baked, w/o salt	56	14.6	1.1	0.1	0	4	437	44	43	0.93	0.086	0.17	0.242	45	0.7
Squash, winter, butternut, baked, w/o salt	40	10.5	0.9	0.1	0	4	284	41	29	0.60	0.065	0.13	0.172	27	0.5
Squash, winter, Hubbard, baked, w/o salt	50	10.8	2.5	0.6	0	8	358	17	22	0.47	0.045	0.15	0.170	23	0.6
Squash, zucchini, baby, raw	21	3.1	2.7	0.4	0	3	459	21	33	0.79	0.097	0.83	0.196	93	0.3
Strawberries, raw	32	7.7	0.7	0.3	0	1	153	16	13	0.42	0.048	0.14	0.386	24	0.4
Sturgeon, mixed species, cooked, dry heat	135	0.0	20.7	5.2	77	69	364	17	45	0.90	0.053	0.54	0.030	271	16.2
Sturgeon, mixed species, raw	105	0.0	16.1	4.0	60	54	284	13	35	0.70	0.041	0.42	0.025	211	12.6
Sturgeon, mixed species, smoked	173	0.0	31.2	4.4	80	739	379	17	47	0.93	0.050	0.56	0.030	281	20.1
Sugars, brown	377	97.3	0.0	0.0	0	39	346	85	29	1.91	0.298	0.18	0.320	22	1.2
Sugars, granulated	387	100.0	0.0	0.0	0	0	2	1	0	0.01	0.000	0.00	0.000	0	0.6
Sugars, maple	354	90.9	0.1	0.2	0	11	274	90	19	1.61	0.099	6.06	4.422	3	0.8
Sweet potato, baked in skin, w/o salt	90	20.7	2.0	0.2	0	36	475	38	27	0.69	0.161	0.32	0.497	54	0.2
Sweet potato, boiled, w/o skin	76	17.7	1.4	0.1	0	27	230	27	18	0.72	0.094	0.20	0.266	32	0.2
Swordfish, cooked, dry heat	155	0.0	25.4	5.1	50	115	369	6	34	1.04	0.162	1.47	0.020	337	61.7
Swordfish, raw	121	0.0	19.8	4.0	39	90	288	4	27	0.81	0.126	1.15	0.019	263	48.1
Syrups, corn, dark	286	77.6	0.0	0.0	0	155	44	18	8	0.37	0.053	0.04	0.100	11	2.9
Syrups, corn, high-fructose	281	76.0	0.0	0.0	0	2	0	0	0	0.03	0.029	0.02	0.094	0	0.7
Syrups, maple	261	67.1	0.0	0.2	0	9	204	67	14	1.20	0.074	4.16	3.298	2	0.6
Syrups, table blends, cane & 15% maple	278	69.5	0.0	0.0	0	104	53	12	2	0.19	0.017	0.63	0.495	0	0.5
Tangerines, (mandarin oranges), raw	53	13.3	0.8	0.3	0	2	166	37	12	0.15	0.042	0.07	0.039	20	0.1
Tempeh, cooked	196	9.4	18.2	11.4		14	401	96	77	2.13	0.540	1.57	1.285	253	0.0
Tilefish, cooked, dry heat	147	0.0	24.5	4.7	64	59	512	26	33	0.31	0.052	0.53	0.015	236	51.5
Tilefish, raw	96	0.0	17.5	2.3	50	53	433	26	28	0.25	0.041	0.37	0.010	187	36.5

Food description	Energy kcal/100 g	Carb. g/100 g	Protein g/100 g	Fat g/100 g	Chol. mg/100 g	Na mg/100 g	K mg/100 g	Ca mg/100 g	Mg mg/100 g	Fe mg/100 g	Cu mg/100 g	Zn mg/100 g	Mn mg/100 g	P mg/100 g	Se µg/100 g
Tofu, fried	271	10.5	17.2	20.2	0	16	146	372	60	4.87	0.398	1.99	1.495	287	28.5
Tomato juice, canned, w. salt	17	4.2	0.8	0.1	0	269	229	10	11	0.43	0.061	0.15	0.070	18	0.3
Tomatoes, green, raw	23	5.1	1.2	0.2	0	13	204	13	10	0.51	0.090	0.07	0.100	28	0.4
Tomatoes, orange, raw	16	3.2	1.2	0.2	0	42	212	5	8	0.47	0.062	0.14	0.088	29	0.4
Tomatoes, red, ripe, cooked	18	4.0	1.0	0.1	0	11	218	11	9	0.68	0.075	0.14	0.105	28	0.5
Tomatoes, red, ripe, raw, year-round average	18	3.9	0.9	0.2	0	5	237	10	11	0.27	0.059	0.17	0.114	24	0.0
Tomatoes, sun-dried	258	55.8	14.1	3.0	0	2095	3427	110	194	9.09	1.423	1.99	1.846	356	5.5
Tomatoes, yellow, raw	15	3.0	1.0	0.3	0	23	258	11	12	0.49	0.101	0.28	0.120	36	0.4
Trout, mixed species, cooked, dry heat	190	0.0	26.6	8.5	74	67	463	55	28	1.92	0.241	0.85	1.091	314	16.2
Trout, rainbow, farmed, cooked, dry heat	169	0.0	24.3	7.2	68	42	441	86	32	0.33	0.061	0.49	0.020	266	15.0
Trout, rainbow, wild, cooked, dry heat	150	0.0	22.9	5.8	69	56	448	86	31	0.38	0.058	0.51	0.021	269	13.2
Tuna, fresh, bluefin, cooked, dry heat	184	0.0	29.9	6.3	49	50	323	10	64	1.31	0.110	0.77	0.020	326	46.8
Tuna, fresh, bluefin, raw	144	0.0	23.3	4.9	38	39	252	8	50	1.02	0.086	0.60	0.015	254	36.5
Tuna, fresh, skipjack, raw	103	0.0	22.0	1.0	47	37	407	29	34	1.25	0.086	0.82	0.015	222	36.5
Tuna, fresh, yellowfin, raw	108	0.0	23.4	1.0	45	37	444	16	50	0.73	0.064	0.52	0.015	191	36.5
Tuna, skipjack, fresh, cooked, dry heat	132	0.0	28.2	1.3	60	47	522	37	44	1.60	0.110	1.05	0.019	285	46.8
Tuna, white, canned in oil	186	0.0	26.5	8.1	31	396	333	4	34	0.65	0.130	0.47	0.016	267	60.1
Tuna, white, canned in water	128	0.0	23.6	3.0	42	377	237	14	33	0.97	0.039	0.48	0.019	217	65.7
Tuna, yellowfin, fresh, cooked, dry heat	139	0.0	30.0	1.2	58	47	569	21	64	0.94	0.082	0.67	0.019	245	46.8
Turbot, European, cooked, dry heat	122	0.0	20.6	3.8	62	192	305	23	65	0.46	0.047	0.28	0.022	165	46.8
Turkey breast meat	104	4.2	17.1	1.7	43	1015	302	8	21	1.44	0.057	1.33	0.018	162	22.8
Turkey, all classes, breast, meat & skin, roasted	189	0.0	28.7	7.4	74	63	288	21	27	1.40	0.047	2.03	0.020	210	29.1
Turkey, all classes, dark meat, meat & skin, raw	160	0.0	18.9	8.8	72	71	261	17	20	1.69	0.137	2.95	0.021	170	26.4
Turkey, all classes, leg, meat & skin, roasted	208	0.0	27.9	9.8	85	77	280	32	23	2.30	0.154	4.27	0.023	199	37.8
Turkey, all classes, meat only, roasted	170	0.0	29.3	5.0	76	70	298	25	26	1.78	0.094	3.10	0.021	213	36.8
Turkey, all classes, wing, meat & skin, roasted	229	0.0	27.4	12.4	81	61	266	24	25	1.46	0.056	2.10	0.020	197	29.9
Turnip greens, boiled, w/o salt	20	4.4	1.1	0.2	0	29	203	137	22	0.80	0.253	0.14	0.337	29	0.9
Turnips, boiled, w/o salt	22	5.1	0.7	0.1	0	16	177	33	9	0.18	0.002	0.12	0.071	26	0.2
Turnips, raw	28	6.4	0.9	0.1	0	67	191	30	11	0.30	0.085	0.27	0.134	27	0.7
Veal, composite of retail cuts, fat, cooked	642	0.0	9.4	66.7	73	57	173	4	10	1.00	0.044	0.87	0.012	116	5.5
Veal, composite of retail cuts, lean & fat, cooked	231	0.0	30.1	11.4	114	87	325	22	26	1.15	0.114	4.76	0.036	239	12.3
Veal, composite of retail cuts, lean, cooked	196	0.0	31.9	6.6	118	89	338	24	28	1.16	0.120	5.10	0.038	250	13.0
Veal, ground, broiled	172	0.0	24.4	7.6	103	83	337	17	24	0.99	0.103	3.87	0.035	217	13.7
Veal, leg (top round), lean & fat, roasted	160	0.0	27.7	4.7	103	68	389	6	28	0.91	0.129	3.04	0.030	234	11.2
Veal, loin, lean & fat, roasted	217	0.0	24.8	12.3	103	93	325	19	25	0.87	0.110	3.03	0.029	212	11.0
Veal, rib, lean & fat, roasted	228	0.0	24.0	14.0	110	92	295	11	22	0.97	0.099	4.09	0.030	197	10.5
Veal, shoulder, arm, lean & fat, roasted	183	0.0	25.5	8.3	108	90	348	26	26	1.15	0.141	4.18	0.030	221	11.1
Veal, sirloin, lean & fat, roasted	202	0.0	25.1	10.5	102	83	351	13	26	0.92	0.129	3.35	0.029	223	11.1
Veal, sirloin, lean, roasted	168	0.0	26.3	6.2	104	85	365	14	27	0.91	0.136	3.54	0.030	231	11.5
Vinegar, distilled	18	0.0	0.0	0.0	0	2	2	6	1	0.03	0.006	0.01	0.055	4	0.5
Watercress, raw	11	1.3	2.3	0.1	0	41	330	120	21	0.20	0.077	0.11	0.244	60	0.9
Watermelon, raw	30	7.6	0.6	0.2	0	1	112	7	10	0.24	0.042	0.10	0.038	11	0.4
Wheat flour, whole-grain	339	72.6	13.7	1.9	0	5	405	34	138	3.88	0.382	2.93	3.799	346	70.7
Wheat flours, bread, unenriched	361	72.5	12.0	1.7	0	2	100	15	25	0.90	0.182	0.85	0.792	97	39.7
Wolffish, Atlantic, cooked, dry heat	123	0.0	22.4	3.1	59	109	385	8	38	0.12	0.037	1.00	0.019	256	46.8
Wolffish, Atlantic, raw	96	0.0	17.5	2.4	46	85	300	6	30	0.09	0.029	0.78	0.015	200	36.5
Yam, boiled, or baked, w/o salt	116	27.6	1.5	0.1	0	8	670	14	18	0.52	0.152	0.20	0.371	49	0.7
Yellowtail, mixed species, cooked, dry heat	187	0.0	29.7	6.7	71	50	538	29	38	0.63	0.058	0.67	0.019	201	46.8
Yogurt, fruit varieties, non-fat	94	19.0	4.4	0.2	2	58	194	152	15	0.07	0.011	0.74	0.035	119	6.0
Yogurt, plain, low fat, 12 grams protein per 8 oz	63	7.0	5.3	1.6	6	70	234	183	17	0.08	0.013	0.89	0.004	144	3.3
Yogurt, plain, skim milk, 13 grams protein per 8 oz	56	7.7	5.7	0.2	2	77	255	199	19	0.09	0.015	0.97	0.005	157	3.6
Yogurt, plain, whole milk, 8 grams protein per 8 oz	61	4.7	3.5	3.3	13	46	155	121	12	0.05	0.009	0.59	0.004	95	2.2

## COMPOSITION AND PROPERTIES OF COMMON OILS AND FATS

This table lists some of the most common naturally occurring oils and fats. The list is separated into those of plant origin, fish and other marine life origin, and land animal origin. The oils and fats consist mainly of esters of glycerol (i.e., triglycerides) with fatty acids of 10 to 22 carbon atoms. The four fatty acids with the highest concentration are given for each oil; concentrations are given in weight percent. Because there is often a wide variation in composition depending on the source of the oil sample, a range (or sometimes an average) is generally given. More complete data on composition, including minor fatty acids, sterols, and tocopherols, can be found in the references.

The acids are labeled by the codes described in the previous table, "Properties of Fatty Acids and Their Methyl Esters," which gives the systematic and common names of the acids. Thus 18:2 9c,12c indicates a C<sub>18</sub> acid with two double bonds in the 9 and 12 positions, both with a *cis* configuration (*cis,cis*-9,12-octadecadienoic acid, or linoleic acid).

The density and refractive index of the oils are typical values; superscripts indicate the temperature in °C.

### Notes:

- The composition figure given for oleic acid (18:1 9c) often includes low levels of other 18:1 isomers.

- In some oils where a concentration is given for 18:2 9c,12c (linoleic acid), other isomers of 18:2 may be included.
- Likewise, where a concentration is given for 18:3 9c,12c,15c ( $\alpha$ -linolenic acid), other isomers of 18:3 may be included.
- The acid 20:5 6c,9c,12c,15c,17c, which is prevalent in many fish oils, is often abbreviated as 20:5  $\omega$ -3 or 20:5 n-3.

The assistance of Frank D. Gunstone in preparing this table is gratefully acknowledged.

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Type of oil	Principal fatty acid components in weight %				mp/ °C	Density/ g cm <sup>-3</sup>	Refractive index	Iodine value	Saponification value
<i>Plants</i>									
Almond kernel oil	18:1 9c	43–70%	18:2 9c,12c	24–30%		0.910 <sup>25</sup>	1.467 <sup>26</sup>	89–101	188–200
	16:0	4–13%	18:0	1–10%					
Apricot kernel oil	18:1 9c	58–66%	18:2 9c,12c	29–33%		0.910 <sup>25</sup>	1.469 <sup>25</sup>	97–110	185–199
	16:0	4.6–6%	18:0	1%					
Argan seed oil	18:1 9c	42–55%	18:2 9c,12c	30–34%		0.912 <sup>20</sup>	1.467 <sup>20</sup>	92–102	189–195
	16:0	12–16%	18:0	2–7%					
Avocado pulp oil	18:1 9c	56–74%	18:2 9c,12c	10–17%		0.912 <sup>25</sup>	1.466 <sup>25</sup>	85–90	177–198
	16:0	9–18%	16:1 9c	3–9%					
Babassu palm oil	12:0	40–55%	14:0	11–27%	24	0.914 <sup>25</sup>	1.450 <sup>40</sup>	10–18	245–256
	18:1 9c	9–20%	16:0	5.2–11%					
Blackcurrant oil	18:2 9c,12c	45–50%	18:3 6c,9c,12c	14–20%		0.923 <sup>20</sup>	1.480 <sup>20</sup>	173–182	185–195
	18:3 9c,12c,15c	12–15%	18:1 9c	9–13%					
Borage (star-flower) oil	18:2 9c,12c	36–40%	18:3 6c,9c,12c	17–25%				141–160	189–192
	18:1 9c	14–21%	16:0	9.4–12%					
Borneo tallow	18:0	39–43%	18:1 9c	34–37%	38	0.855 <sup>100</sup>	1.456 <sup>40</sup>	29–38	189–200
	16:0	18–21%	20:0	1.0%					
Cameline oil	18:3 9c,12c,15c	33–38%	18:2 9c,12c	15–16%		0.924 <sup>15</sup>	1.477 <sup>20</sup>	127–155	180–190
	20:1 total	14–16%	18:1 9c	12–24%					
Canola (rapeseed) oil (low linolenic)	18:1 9c	59–66%	18:2 9c,12c	24–29%	–10			91	
	16:0	4–5%	18:3 9c,12c,15c	2–3%					
Canola (rapeseed) oil (low erucic)	18:1 9c	52–67%	18:2 9c,12c	16–25%	–10	0.915 <sup>20</sup>	1.466 <sup>40</sup>	110–126	182–193
	18:3 9c,12c,15c	6–14%	16:0	3.3–6.0%					
Caraway seed oil	18:1 9c	40%	18:2 9c,12c	30%			1.471 <sup>35</sup>	128	178
	18:1 6c	26%	16:0	3%					
Cashew nut oil	18:1 9c	57–80%	18:2 9c,12c	16–22%		0.914 <sup>15</sup>	1.463 <sup>40</sup>	79–89	180–196
	16:0	4–17%	18:0	2–12%					

Type of oil	Principal fatty acid components in weight %				mp/ °C	Density/ g cm <sup>-3</sup>	Refractive index	Iodine value	Saponification value
Castor oil	18:1 12-OH,9c	88%	18:2 9c,12c	3-5%	-18	0.952 <sup>25</sup>	1.475 <sup>25</sup>	81-91	176-187
	18:1 9c	2.9-6%	22:0	2.1%					
Cherry kernel oil	18:2 9c,12c	42-45%	18:1 9c	35-49%		0.918 <sup>25</sup>	1.468 <sup>40</sup>	110-118	190-198
	16:0	4-9%	18:3 9c,11t,13t	3-10%					
Chinese vegetable tallow	16:0	58-72%	18:1 9c	20-35%	44	0.887 <sup>25</sup>	1.456 <sup>40</sup>	16-29	200-218
	18:0	1-8%	14:0	0.5-3.7%					
Cocoa butter	18:0	31-37%	18:1 9c	31-35%	34	0.974 <sup>25</sup>	1.457 <sup>40</sup>	32-40	192-200
	16:0	25-27%	18:2 9c,12c	2.8-4.0%					
Coconut oil	12:0	45-51%	14:0	17-21%	25	0.913 <sup>40</sup>	1.449 <sup>40</sup>	5-13	248-265
	16:0	7.7-10.2%	18:1 9c	5.4-9.9%					
Cohune nut oil	12:0	44-48%	14:0	16-17%		0.914 <sup>25</sup>	1.450 <sup>40</sup>	9-14	251-260
	18:1 9c	8-10%	16:0	7-10%					
Coriander seed oil	18:1 6c	53%	18:1 9c	32%		0.908 <sup>25</sup>	1.464 <sup>25</sup>	86-100	182-191
	18:2 9c,12c	7-14%	16:0	3-8%					
Corn oil	18:2 9c,12c	40-66%	18:1 9c	20-42%	-20	0.919 <sup>20</sup>	1.472 <sup>25</sup>	107-135	187-195
	16:0	9-16%	18:0	0-3%					
Cottonseed oil	18:2 9c,12c	47-58%	16:0	18-26%	-1	0.920 <sup>20</sup>	1.462 <sup>40</sup>	96-115	189-198
	18:1 9c	14-22%	18:0	2.1-3.3%					
Crambe oil	22:1 13c	55-60%	18:1 9c	12-15%		0.906 <sup>25</sup>	1.470 <sup>25</sup>	87-113	
	18:2 9c,12c	8-10%	18:3 9c,12c,15c	6-7%					
Cuphea seed oil (caprylic acid rich)	8:0	65-78%	10:0	19-24%					
	18:2 9c,12c	1-4%	16:0	0.6-3%					
Euphorbia lagascae seed oil	18:1 12,13-ep,9c	64%	18:1 other	19%		0.952 <sup>25</sup>	1.473 <sup>25</sup>	102	
	18:2 9c,12c	9%	16:0	4%					
Evening primrose oil	18:2 9c,12c	65-80%	18:3 6c,9c,12c	8-14%			1.479 <sup>20</sup>	147-155	193-198
	16:0	6-10%	18:1 9c	5-12%					
Grape seed oil	18:2 9c,12c	58-78%	18:1 9c	12-28%		0.923 <sup>20</sup>	1.475 <sup>40</sup>	130-138	188-194
	16:0	5.5-11%	18:0	3-6%					
Hazelnut oil (Chilean)	18:1 9c	39%	16:1 11c	22.7%					
	20:1 total	9.7%	22:1 total	9.5%					
Hazelnut oil (Filbert)	18:1 9c	72-84%	18:2 9c,12c	5.7-22%	0.909 <sup>25</sup>		1.473 <sup>25</sup>	83-90	188-197
	16:0	4.1-7.2%	18:0	1.5-2.4%					
Hempseed oil	18:2 9c,12c	45-60%	18:3 9c,12c,15c	15-30%		0.921 <sup>25</sup>	1.472 <sup>40</sup>	145-166	190-195
	18:1 9c	11-16%	16:0	6-12%					
Illipe (mowrah) butter	18:1 9c	34%	16:0	23%	27	0.862 <sup>100</sup>	1.460 <sup>40</sup>	53-70	188-207
	18:0	23%	18:2 9c,12c	14%					
Jojoba oil <sup>a</sup>	20:1 total	66-74%	22:1 undefined	9-19%					
	18:1 9c	5-12%	24:1 15c	1-5%					
Kapok seed oil <sup>b</sup>	18:1 9c	45-65%	16:0	10-28%	30	0.926 <sup>15</sup>	1.469 <sup>25</sup>	86-110	189-197
	18:2 9c,12c	7-35%	18:0	2-9%					
Kokum butter	18:0	49-56%	18:1 9c	39-49%	41		1.456 <sup>40</sup>	33-37	192
	16:0	2-5%	18:2 9c,12c	1-2%					
Kusum oil	18:1 9c	57-62%	20:0	20-25%			1.461 <sup>40</sup>	48-58	220-230
	16:0	5-8%	18:0	2-6%					
Linola oil	18:2 9c,12c	72%	18:1 9c	16%				142	
	16:0	5.6%	18:0	4.0%					
Linseed oil	18:3 9c,12c,15c	52-58%	18:1 9c	18-20%	-24	0.924 <sup>25</sup>	1.480 <sup>25</sup>	170-203	188-196
	18:2 9c,12c	17%	18:2 9c,12c	16%					
Macadamia nut oil	18:1 9c	56-59%	16:1 9c	21-22%					
	16:0	8-9%	18:0	2-4%					

Type of oil	Principal fatty acid components in weight %				mp/ °C	Density/ g cm <sup>-3</sup>	Refractive index	Iodine value	Saponification value
Mango seed oil	18:1 9c	38–50%	18:0	31–49%		0.912 <sup>15</sup>	1.461 <sup>25</sup>	39–48	188–195
	18:2 9c,12c	3–6%	20:0	2–6%					
Meadowfoam seed oil	20:1 5c	58–77%	22:1 total	8–24%			1.464 <sup>40</sup>	86–91	168
	22:2 5c,13c	7–15%	18:1 9c	1–3%					
Melon oil	18:2 9c,12c	67% (av.)	18:1 9c	12% (av.)					
	16:0	11% (av.)	18:0	9% (av.)					
Moringa peregrina seed oil	18:1 9c	70%	16:0	9%		0.903 <sup>24</sup>	1.460 <sup>40</sup>	70	185
	18:0	3.8%	22:0	2.4%					
Mustard seed oil	22:1 13c	43%	22:1 13c	22–50%		0.913 <sup>20</sup>	1.465 <sup>40</sup>	92–125	170–184
	18:3 9c,12c,15c	12%	18:2 9c,12c	10–24%					
Neem oil	18:1 9c	49–62%	18:0	14–24%	–3	0.912 <sup>30</sup>	1.462 <sup>40</sup>	68–71	195–205
	16:0	13–18%	18:2 9c,12c	7–15%					
Niger seed oil	18:2 9c,12c	52–78%	16:0	5–12%		0.924 <sup>15</sup>	1.468 <sup>40</sup>	126–135	188–193
	18:1 9c	4–10%	18:0	2–12%					
Nutmeg butter	14:0	76–83%	18:1 9c	5–11%	45		1.468 <sup>40</sup>	48–85	170–190
	16:0	4–10%	12:0	3–6%					
Oat oil	18:2 9c,12c	24–48%	18:1 9c	18–53%		0.917 <sup>25</sup>	1.467 <sup>40</sup>	105–116	190–199
	16:0	13–39%	18:0	0.5–4%					
Oiticica oil	18:3 9c,11t,13t, 4-oxo	70–80%	16:0	7%		0.972 <sup>20</sup>	1.514 <sup>25</sup>	140–150	188–193
	18:0	5%	18:1 9c	4–7%					
Olive oil	18:1 9c	55–83%	18:2 9c,12c	9%	–6	0.911 <sup>20</sup>	1.469 <sup>20</sup>	75–94	184–196
	16:0	7.5–20%	18:2 9c,12c	3.5–21%					
Palm kernel oil	12:0	40–55%	14:0	14–18%	24	0.922 <sup>15</sup>	1.450 <sup>40</sup>	14–21	230–250
	18:1 9c	12–21%	16:0	6.5–10%					
Palm oil	16:0	40–48%	18:1 9c	36–44%	35	0.914 <sup>15</sup>	1.455 <sup>40</sup>	49–55	190–209
	18:2 9c,12c	6.5–12%	18:0	3.5–6.5%					
Palm olein	18:1 9c	40–44%	16:0	38–43%		0.91 <sup>40</sup>	1.459 <sup>40</sup>	>56	194–202
	18:2 9c,12c	10–13%	18:0	3.7–4.8%					
Palm stearin	16:0	48–74%	18:1 9c	16–36%		0.884 <sup>60</sup>	1.449 <sup>40</sup>	<48	193–205
	18:0	3.9–5.6%	18:2 9c,12c	3.2–9.8%					
Parsley seed oil	18:1 6c	69–76%	18:1 9c	12–15%			1.4800 <sup>40</sup>	110–120	
	18:2 9c,12c	6–14%	16:0	2%					
Peanut oil	18:1 9c	36–67%	18:2 9c,12c	14–43%	3	0.914 <sup>20</sup>	1.463 <sup>40</sup>	86–107	187–196
	16:0	8.3–14%	22:0	2.1–4.4%					
Perilla oil	18:3 9c,12c,15c	59%	18:2 9c,12c	14–18%		0.924 <sup>25</sup>	1.477 <sup>25</sup>	192–208	188–197
	18:1 9c	11–13%	16:0	6–9%					
Phulwara butter	16:0	57–61%	18:1 9c	30–36%	43	0.862 <sup>100</sup>	1.458 <sup>40</sup>	40–51	188–200
	18:2 9c,12c	3–4%	18:0	3–4%					
Pine nut oil	18:2 9c,12c	47–51%	18:1 9c	36–39%		0.919 <sup>15</sup>		118–121	193–197
	16:0	6–8%	18:0	2–3%					
Poppy seed oil	18:2 9c,12c	62–73%	18:1 9c	16–30%	–15	0.916 <sup>25</sup>	1.469 <sup>40</sup>	132–146	188–196
	16:0	7–11%	18:0	1–4%					
Rice bran oil	18:1 9c	38–48%	18:2 9c,12c	16–36%		0.916 <sup>25</sup>	1.472 <sup>25</sup>	92–108	181–189
	16:0	16–28%	18:0	2–4%					
Safflower seed oil	18:2 9c,12c	68–83%	18:1 9c	8.4–30%		0.924 <sup>15</sup>	1.474 <sup>25</sup>	136–148	186–198
	16:0	5.3–8.0%	18:0	1.9–2.9%					
Safflower seed oil (high oleic)	18:1 9c	74–80%	18:2 9c,12c	13–18%		0.921 <sup>20</sup>	1.470 <sup>25</sup>	91–95	
	16:0	5–6%	18:0	1.5–2.0%					
Sal fat	18:0	33–57%	18:1 9c	31–52%	33		1.456 <sup>40</sup>	31–45	175–192
	16:0	6–23%	20:0	1–8%					



Type of oil	Principal fatty acid components in weight %				mp/ °C	Density/ g cm <sup>-3</sup>	Refractive index	Iodine value	Saponification value
Sesame seed oil	18:2 9c,12c	40–51%	18:1 9c	33–44%	–6	0.917 <sup>20</sup>	1.467 <sup>40</sup>	104–120	187–195
	16:0	7.9–10.2%	18:0	4.4–6.7%					
Sheanut butter	18:1 9c	45–50%	18:0	36–41%	38	0.863 <sup>100</sup>	1.465 <sup>40</sup>	52–66	178–198
	16:0	4–8%	18:2 9c,12c	4–8%					
Soybean oil	18:2 9c,12c	50–57%	18:1 9c	18–28%	–16	0.920 <sup>20</sup>	1.468 <sup>40</sup>	118–139	189–195
	16:0	9–13%	18:3 9c,12c,15c	5.5–9.5%					
Stillingia seed kernel oil <sup>c</sup>	18:3 total	41–54%	18:2 9c,12c	24–30%		0.937 <sup>25</sup>	1.483 <sup>25</sup>	169–191	202–212
	18:1 9c	7–10%	16:0	6–9%					
Sunflower seed oil	18:2 9c,12c	48–74%	18:1 9c	13–40%	–17	0.919 <sup>20</sup>	1.474 <sup>25</sup>	118–145	188–194
	16:0	5–8%	18:0	2.5–7.0%					
Sunflower oil, high-oleic (HO)	18:1 9c	80%	18:2 9c,12c	10%		0.911 <sup>25</sup>	1.468 <sup>25</sup>	81	
	18:0	4.4%	16:0	3.5%					
Sunflower oil, mid-Oleic (NuSun oil)	18:1 9c	65%	18:2, 18:3	25%					
	16:0, 18:0	10%							
Tall oil	18:2 9c,12c	41–52%	18:1 9c	41–48%		0.969 <sup>25</sup>	1.494 <sup>25</sup>	140–180	154–180
	16:0	5–6%	18:0	2–3%					
Tung oil	18:3 9c,11t,13t	71–82%	18:2 9c,12c	8–15%	–2	0.912 <sup>25</sup>	1.517 <sup>25</sup>	160–175	189–195
	18:1 9c	4–10%	18:0	3%					
Ucuhuba butter oil	14:0	64–73%	12:0	13–15%		0.870 <sup>100</sup>	1.451 <sup>50</sup>	11–17	221–229
	18:1 9c	6–8%	16:0	3–9%					
Vernonia seed oil	18:1 12,13-ep,9c	62–72%	18:2 9c,12c	9–17%		0.901 <sup>30</sup>	1.486 <sup>32</sup>	55	176
	16:0	3–7%	18:0	2–6%					
Walnut oil	18:2 9c,12c	56–60%	18:1 9c	17–19%		0.921 <sup>25</sup>	1.474 <sup>25</sup>	138–162	189–197
	18:3 9c,12c,15c	13–14%	16:0	6–8%					
Wheatgerm oil	18:2 9c,12c	50–59%	18:1 9c	13–23%		0.926 <sup>25</sup>	1.479 <sup>25</sup>	100–128	179–217
	16:0	12–20%	18:3 9c,12c,15c	2–9%					
<i>Marine animals</i>									
Anchovy oil	20:5	22%	16:0	17%				163–169	191–194
	6c,9c,12c,15c,17c								
Capelin oil <sup>d</sup>	16:1 undefined	13%	18:1 undefined	10%			1.463 <sup>50</sup>	94–164	185–202
	20:1 undefined	17%	22:1 undefined	15%					
Cod liver oil	18:1 undefined	14%	16:0	10%		0.924 <sup>15</sup>	1.482 <sup>25</sup>	142–176	180–192
	22:6 4c,7c,10c,13c, 16c,19c	11%	20:1 undefined	13%					
Herring oil	22:1 undefined	19%	16:0	17%		0.914 <sup>20</sup>	1.474 <sup>25</sup>	115–160	161–192
	20:1 undefined	15%	18:1 undefined	14%					
Mackerel oil	22:1 undefined	15%	16:0	14%		0.929 <sup>15</sup>	1.481 <sup>20</sup>	136–167	
	18:1 undefined	13%	20:1 undefined	12%					
Menhaden oil	16:0	19%	20:5 6c,9c,12c,15c, 17c	14%		0.920 <sup>15</sup>		150–200	192–199
	16:1 undefined	12%	18:1 undefined	11%					
Salmon oil	22:6 4c,7c,10c,13c, 16c,19c	18%	20:5 6c,9c,12c,15c, 17c	13%		0.924 <sup>15</sup>	1.475 <sup>25</sup>	130–160	183–186
	16:0	9.8%	16:1	4.8%					
Sardine oil	16:0	18%	20:5 6c,9c,12c,15c, 17c	16%		0.915 <sup>25</sup>	1.464 <sup>65</sup>	159–192	188–199
	18:1 undefined	13%	16:1 undefined	10%					
Seal blubber oil, harp	18:1 9c	21%	20:1	12%					
	22:6 4c,7c,10c,13c, 16c,19c	7.6%	20:5 6c,9c,12c,15c, 17c	6.4%					

Type of oil	Principal fatty acid components in weight %				mp/ °C	Density/ g cm <sup>-3</sup>	Refractive index	Iodine value	Saponification value
Shark liver oil	18:1 undefined	45%	16:0	21%		0.917 <sup>25</sup>	1.476 <sup>25</sup>	150–300	170–190
	20:1	12%	22:1	9%					
Tuna oil	22:6 4c,7c,10c,13c, 16c,19c	22%	16:0	22%					
	18:1 undefined	21%	20:5 6c,9c,12c,15c, 17c	6%					
Trout lipids	16:0	21–24%	18:1 undefined	18–31%					
	18:2	7–16%	16:1	4–10%					
Whale oil, minke	18:1 undefined	18%	20:1	17%					
	22:1	11%	16:1	9%					
<b>Land animals</b>									
Beef tallow	18:1 undefined	31–50%	18:0	25–40%	47	0.902 <sup>25</sup>	1.454 <sup>40</sup>	33–47	190–200
	16:0	20–37%	14:0	1–6%					
Butterfat	16:0	28.1% (av.)	18:1 9c	20.8% (av.)	32	0.934 <sup>15</sup>	1.455 <sup>40</sup>	26–40	210–232
	14:0	10.8% (av.)	18:0	10.6% (av.)					
Chicken egg lipids, yolk	16:0	28%	18:1 9c	25%					
	18:0	17%	18:2 9c,12c	16%					
Chicken fat	18:1 undefined	37%	16:0	22%		0.918 <sup>15</sup>	1.456 <sup>40</sup>	76–80	
	18:2	20%	18:0	6%					
Milk fats, cow	16:0	28.2% (av.)	18:1 9c	21.4% (av.)					
	18:0	12.6% (av.)	14:0	10.6% (av.)					
Milk fats, human	18:1 9c	31.1% (av.)	16:0	21.6% (av.)					
	18:2 9c,12c	11.7% (av.)	14:0	6.6% (av.)					
Mutton tallow	18:1 undefined	30–42%	18:0	22–34%	48	0.946 <sup>15</sup>	1.455 <sup>40</sup>	35–46	
	16:0	20–27%	14:0	2–4%					
Pork lard	18:1 undefined	35–62%	16:0	20–32%	30	0.898 <sup>20</sup>			
	18:0	5–24%	18:2	3–16%					

<sup>a</sup> Jojoba oil consists primarily of wax esters of the acids listed here and long-chain alcohols.

<sup>b</sup> Kapok oil also contains up to 15% cyclopropene acids.

<sup>c</sup> Stillingia oil also contains 5–10% *trans,cis*-2,4-decadienoic acid (stilingic acid, 10:2 2t,4c).

<sup>d</sup> Capelin oil also contains about 10% 16:1.

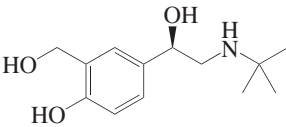
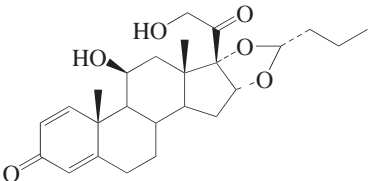
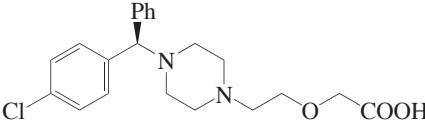
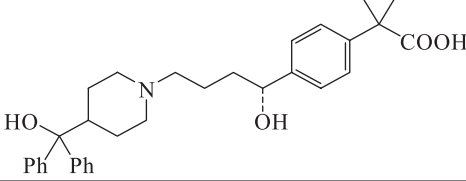
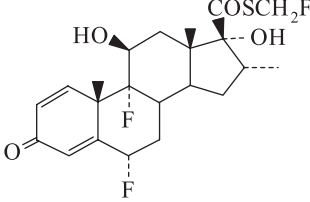
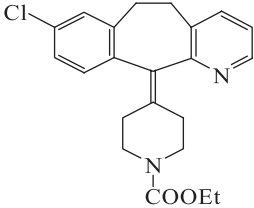
## STRUCTURE AND FUNCTIONS OF SOME COMMON DRUGS

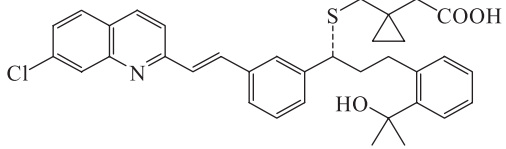
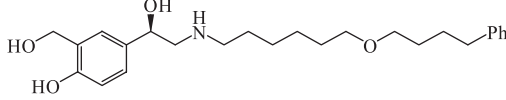
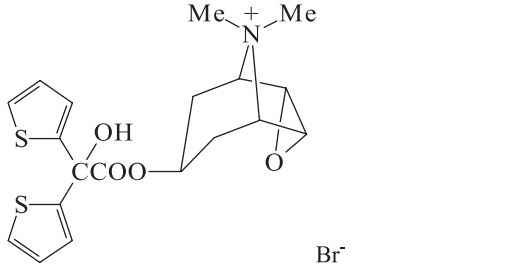
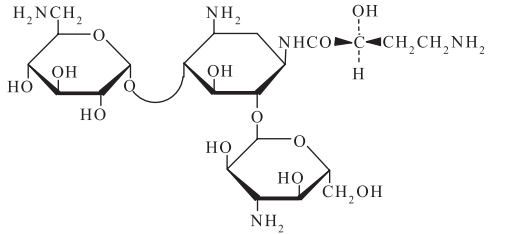
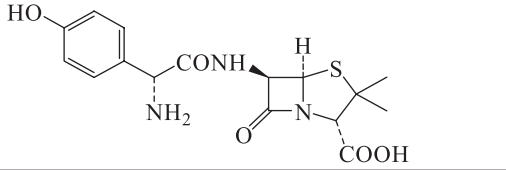
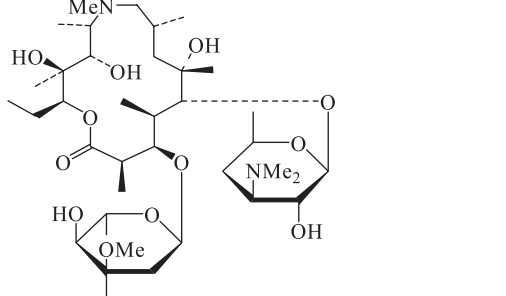
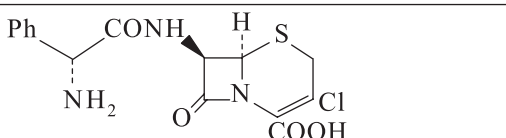
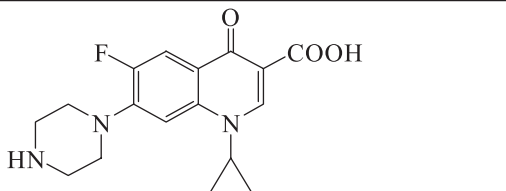
This table lists the names, categories, therapeutic uses, and chemical structures of selected drugs. The generic (chemical) name of each drug is given, along with some of the trade names under which it is sold. When available, physical properties are given in italics in the fourth column. The structure given refers to the active drug, but many of these are packaged as salts or other derivatives. The drugs have been selected to represent a variety of categories; most are widely used throughout the world.

The list is divided into therapeutic categories; within each category the listing is alphabetical by generic name. The index that follows the table can be used to locate a drug by either generic or trade name.

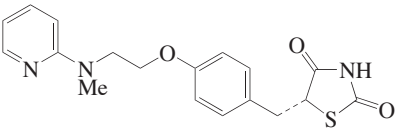
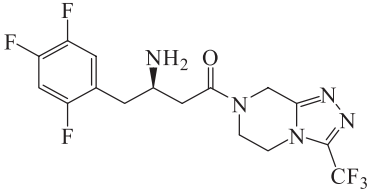
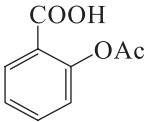
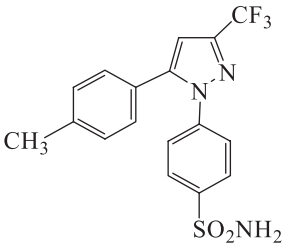
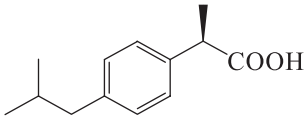
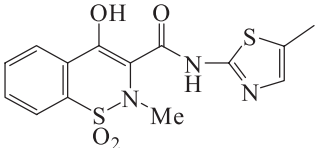
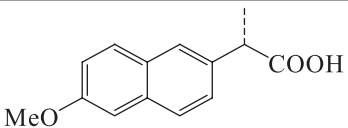
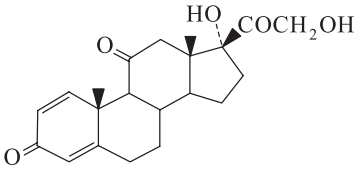
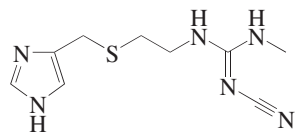
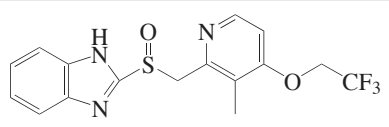
### References

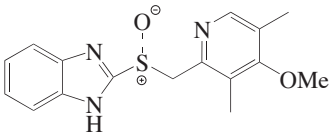
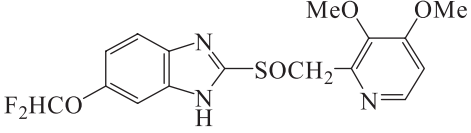
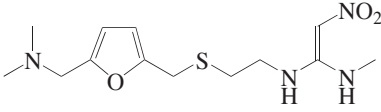
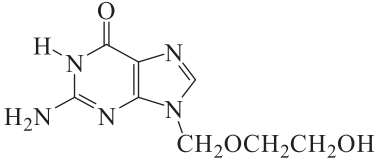
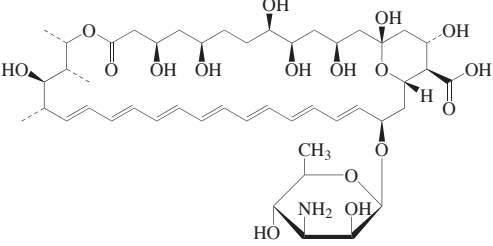
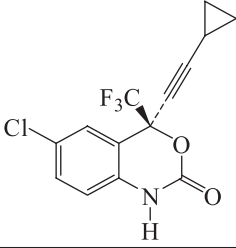
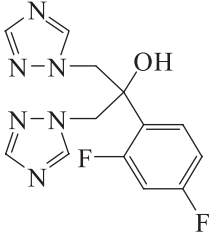
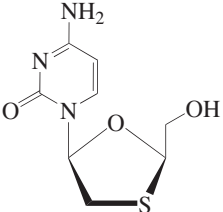
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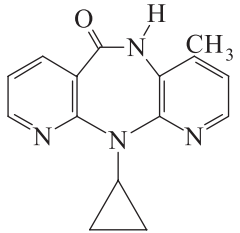
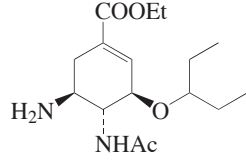
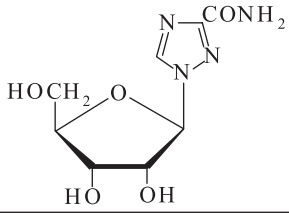
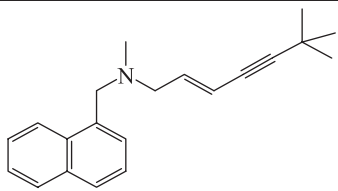
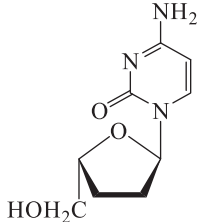
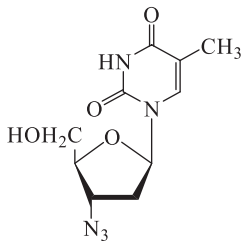
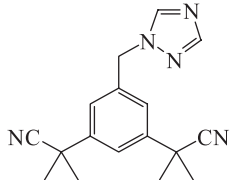
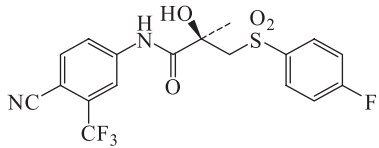
Generic Name	Trade Names	Category and Properties	Applications	Structure
<i>Antiallergic Agents</i>				
1 Albuterol	Proventil; Ventolin; Volmax	$\beta_2$ -Adrenergic receptor agonist	Treatment of troubled breathing caused by asthma, emphysema, and other lung diseases	
2 Budesonide	Budeson; Budamax; Rhinocort; Pulmicort; Inflammide	Glucocorticoid <i>mp</i> 226 °C	Management of asthma and treatment of inflammatory bowel disease	
3 Cetirizine	Zyrtec	Histamine H <sub>1</sub> -receptor antagonist	Treatment of seasonal allergies and hives	
4 Fexofenadine	Carboxyterfenadine; Allegra; Telfast	Histamine H <sub>1</sub> -receptor antagonist	Treatment of allergic rhinitis	
5 Fluticasone	Flovent (as propanoate); Flonase (as propanoate); Advair (with salmeterol)	Anti-inflammatory glucocorticoid	Treatment of asthma & rhinitis	
6 Loratadine	Claritin; Claratyne; Alavert	Long-acting antihistamine <i>mp</i> 132 °C	Relief of allergy symptoms	

Generic Name	Trade Names	Category and Properties	Applications	Structure
7 Montelukast	Singulair	Leukotriene LTD <sub>4</sub> receptor antagonist	Control of asthma and relief of seasonal allergies	
8 Salmeterol	Serevent	β <sub>2</sub> -Adrenergic receptor agonist	Treatment of asthma & chronic obstructive pulmonary disease	
9 Tiotropium bromide	Spiriva	Long-acting antimuscarinic bronchodilator	Treatment of chronic obstructive pulmonary disease	
<b>Antibiotics</b>				
10 Amikacin	Amikin; Biclin; Chemacin; Flexilite; Negasin	Aminoglycoside antibiotic	Treatment of serious infections resistant to other antibiotics	
11 Amoxicillin	Amoxil; Isimoxin; Ospamox	β-Lactam/penicillin	Treatment of a broad spectrum of bacterial infections	
12 Azithromycin	Zithromax; Vinzam; Zmax; Azitrocin	Azalide/macrolide antibiotic <i>mp</i> 155 °C	Treatment of bacterial skin, ear, and respiratory infections	
13 Cefaclor	Ceclor; Kefolar; Panacef; Panoral	β-Lactam/cephalosporin	Treatment of bacterial infections, pneumonia, and urinary tract infections	
14 Ciprofloxacin	Cipro; Ciproxin; Ciprobay; Flociprin; Uniflox	Fluoroquinolone/broad-spectrum antibiotic <i>mp</i> 256 °C	Treatment of urinary & respiratory tract infections, anthrax, and sexually-transmitted diseases	

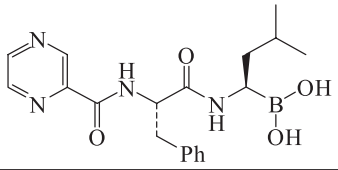
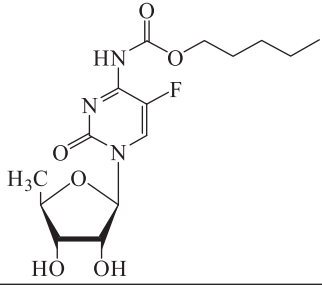
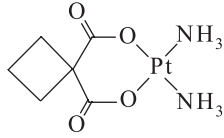
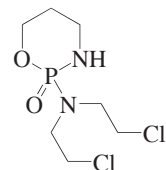
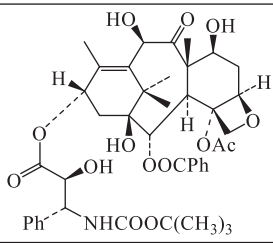
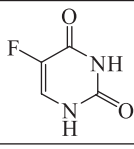
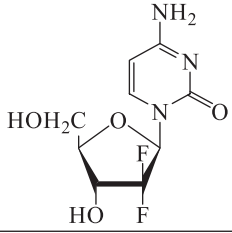
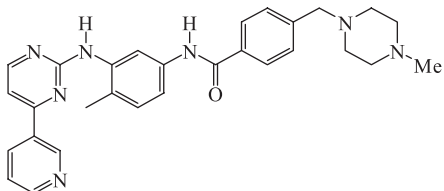
Generic Name	Trade Names	Category and Properties	Applications	Structure
15 Doxycycline	Vibramycin; Adoxa; Doryx; Liviatin; Deoxymykoin	Tetracycline/ broad-spectrum antibiotic	Treatment of urinary tract, respiratory tract, and eye infections; anthrax, syphilis, cholera, etc.	
16 Erythromycin	E-Mycin; Erythrocin; Ilosone	Macrolide antibiotic <i>mp</i> 191 °C	Treatment of bacterial infections, including diphtheria, pertussis, rheumatic fever, venereal disease, etc.	
17 Isoniazid	Laniazid	Antimycobacterial agent <i>mp</i> 171 °C	Treatment of tuberculosis; reduction of tremors from multiple sclerosis	
18 Linezolid	Zyvox	Oxazolidinone <i>mp</i> 182 °C	Treatment of serious Gram-positive infections resistant to other antibiotics	
19 Trimethoprim	Triprim; Proloprim; Monotrim	Dihydrofolate reductase inhibitor <i>mp</i> 199 °C	Treatment of urinary tract infections, diarrhea, and ear infections	
<b>Antidiabetic Drugs</b>				
20 Glipizide	Glucotrol; Glydiazinamide; Glibenese; Minodiab	Potassium channel blocker/sulfonylurea <i>mp</i> 208 °C	Treatment of type 2 diabetes by stimulating insulin secretion in pancreas $\beta$ -cells	
21 Metformin	Glucophage; Diabex; Diaformin; Fortamet	Antidiabetic biguanide	Treatment of type 2 diabetes by enhancing transport of glucose into muscle cells	$\text{Me}_2\text{NCNHCNH}_2$ $\begin{array}{c} \parallel \quad \parallel \\ \text{NH} \quad \text{NH} \end{array}$
22 Pioglitazone	Actos	Peroxisome proliferator-activated receptor <i>mp</i> 174 °C	Treatment of type 2 diabetes by increasing glucose metabolism and insulin sensitivity	

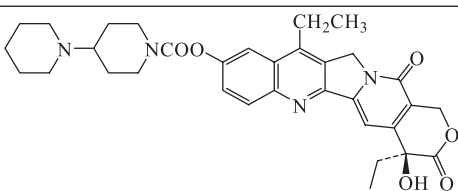
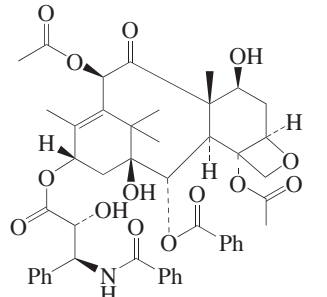
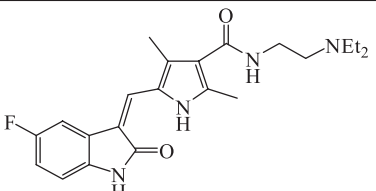
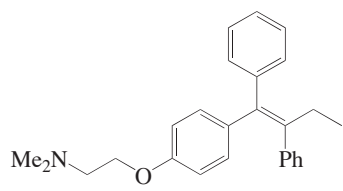
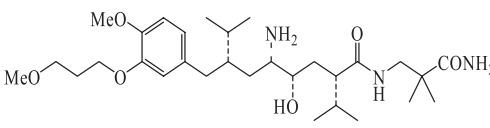
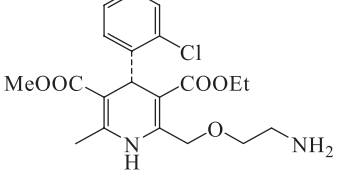
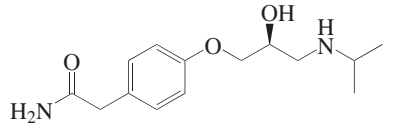
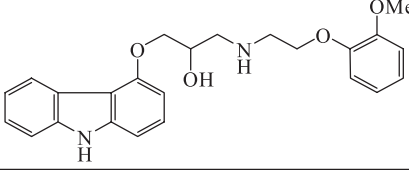
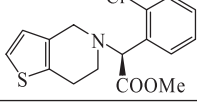
Generic Name	Trade Names	Category and Properties	Applications	Structure
23 Rosiglitazone	Avandia	Thiazolidinedione	Treatment of type 2 diabetes by increasing insulin sensitivity. Possible adverse effects on patients with heart problems.	
24 Sitagliptin	Januvia	Dipeptidyl peptidase IV inhibitor	Treatment of type 2 diabetes by enhancing the body's ability to lower elevated glucose levels	
<b>Anti-Inflammatory Agents</b>				
25 Acetylsalicylic acid	Aspirin	NSAID	Pain and fever relief; anticlotting agent	
26 Celecoxib	Celebrex; Onsenal	NSAID (COX-2 inhibitor) <i>mp</i> 158 °C	Treatment of osteoarthritis and rheumatoid arthritis	
27 Ibuprofen	Advil	NSAID (cyclooxygenase inhibitor) <i>mp</i> 76 °C	Relief of inflammation and pain	
28 Meloxicam	Mobic; Metacam; Metacain	NSAID (cyclooxygenase inhibitor) <i>mp</i> 254 °C	Treatment of osteoarthritis and rheumatoid arthritis	
29 Naproxen	Aleve; Naprelan; Anaprox; Naprogesic	NSAID <i>mp</i> 155 °C	Relief of inflammation and pain	
30 Prednisone	Meticorten; Deltasone	Adrenocortical steroid; anti-inflammatory agent; immunosuppressant	Treatment of asthma and other inflammatory diseases	
<b>Anti-Ulcer Drugs</b>				
31 Cimetidine	Tagamet; Cimetimax; Gastromet; Peptimax	Histamine H <sub>2</sub> -receptor antagonist <i>mp</i> 142 °C	Treatment of peptic ulcer, gastrointestinal bleeding, and gastroesophageal reflux disease	
32 Lansoprazole	Prevacid; SoluTab; Prevpac; Zoton; Prezal	Proton pump inhibitor <i>mp</i> 180 °C	Treatment of duodenal ulcers & gastroesophageal reflux disease	

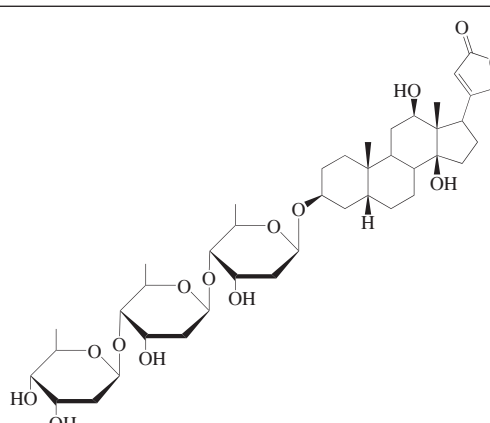
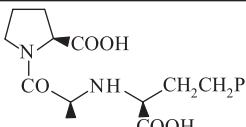
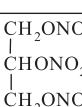
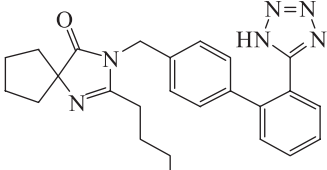
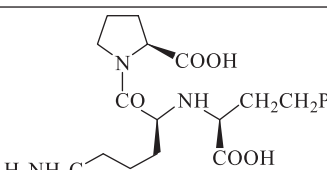
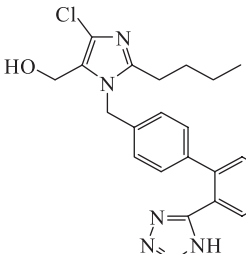
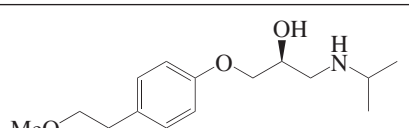
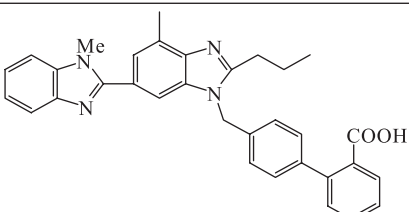
Generic Name	Trade Names	Category and Properties	Applications	Structure
33 Omeprazole	Prilosec; Nexium (Mg salt); Losec; Mepral; Mopral; Zoltum	Proton pump inhibitor <i>mp</i> 156 °C	Treatment of peptic ulcer, dyspepsia, and gastroesophageal reflux disease	
34 Pantoprazole	Protonix; Pantozol; Rifun	Proton pump inhibitor	Treatment of gastric acid-related conditions	
35 Ranitidine	Zantac; Azantac; Melfax; Rantec; Sostril; Taural	Histamine H <sub>2</sub> -receptor antagonist <i>mp</i> 70 °C	Treatment of peptic ulcer, gastrointestinal bleeding, and gastroesophageal reflux disease	
<b>Antiviral and Antifungal Agents</b>				
36 Acyclovir	Zovirax; Zovir; Avirax; Mirolex	Viral DNA synthesis inhibitor <i>mp</i> 225 °C	Treatment of cold sores, genital herpes, chicken pox, etc.	
37 Amphotericin	Fungizone; Amfostet; Amphozone	Polyene macrolide antifungal agent <i>mp</i> 170 °C	Intravenous treatment of systemic fungal infections	
38 Efavirenz	Sustiva	Non-nucleoside HIV reverse transcriptase inhibitor <i>mp</i> 131 °C	Treatment of HIV-1 infections (as part of combination therapy)	
39 Fluconazole	Diflucan; Biozolen; Elazor; Triflucan	Cytochrome P450 14α-demethylase inhibitor <i>mp</i> 139 °C	Treatment and prevention of superficial & systemic fungal infections	
40 Lamivudine	Epivir; Heptodin; Zeffix	HIV reverse transcriptase inhibitor	Treatment of hepatitis B and human immunodeficiency virus	

Generic Name	Trade Names	Category and Properties	Applications	Structure
41 Nevirapine	Viramune	Non-nucleoside HIV reverse transcriptase inhibitor <i>mp</i> 250 °C	Treatment of HIV infections (as part of combination therapy)	
42 Oseltamivir	Tamiflu	Neuraminidase inhibitor <i>Foam</i>	Prevention & treatment of influenza A and B	
43 Ribavirin	Virazole; Rebetol; Copegus; Ribasphere; Viratek; Cotronak	Nucleoside antimetabolite <i>mp</i> 175 °C	Treatment of hepatitis C	
44 Terbinafine	Lamisil	Squalene epoxidase inhibitor	Treatment of fungal infections of the skin & nails	
45 Zalcitabine	Hivid	Pyrimidine nucleoside reverse transcriptase inhibitor	Treatment of HIV infection & AIDS	
46 Zidovudine	Retrovir; AZT; Azidothymidine; Zidovir	Pyrimidine nucleoside reverse transcriptase inhibitor <i>mp</i> 121 °C	Treatment of HIV infection & prevention of mother-to-child transmission	
<b>Cancer Chemotherapy Drugs</b>				
47 Anastrozole	Arimidex	Aromatase inhibitor; antineoplastic agent <i>mp</i> 81 °C	Treatment of breast cancer in postmenopausal women	
48 Bicalutamide	Casodex	Antiandrogen <i>mp</i> 180 °C	Treatment of advanced prostate cancer	

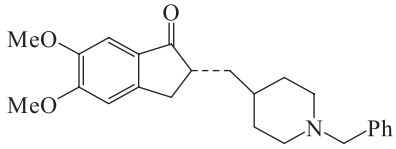
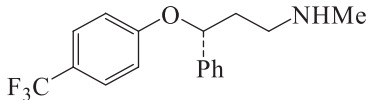
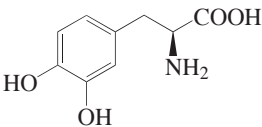
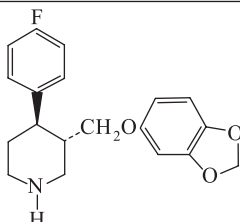
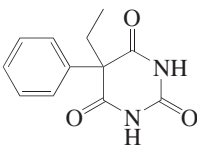
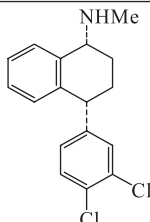
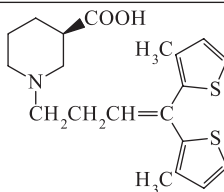
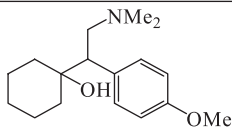
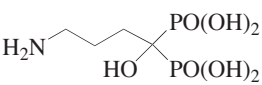


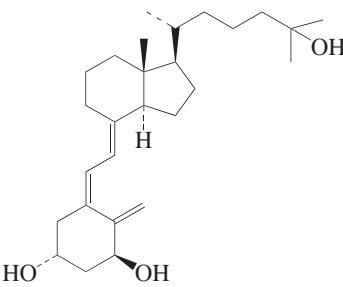
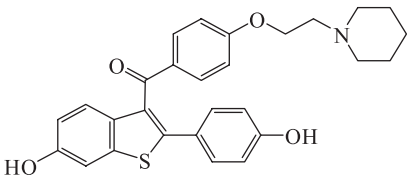
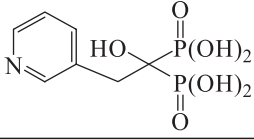
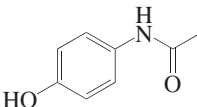
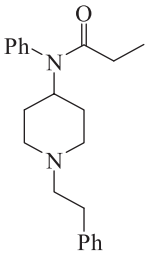
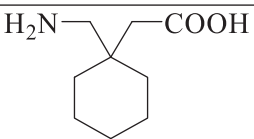
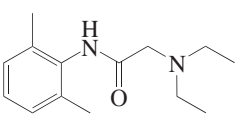
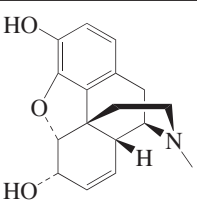
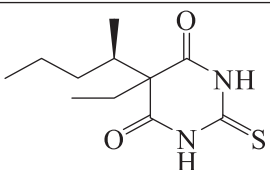
Generic Name	Trade Names	Category and Properties	Applications	Structure
49 Bortezomib	Velcade	Proteasome inhibitor	Treatment of lymphomas and multiple myeloma	
50 Capecitabine	Xeloda	Antimetabolite	Treatment of breast & colon cancer	
51 Carboplatin	Paraplatin; Carboplat; Erbakar; Nonoplat	Platinum-based anticancer agent	Treatment of ovarian cancer	
52 Cyclophosphamide	Cytoxan; Neosar; Cytophosphan; Endoxan; Clafen	Oxazaphosphorine alkylating agent ("Nitrogen mustard") <i>mp 143 °C</i>	Treatment of lymphomas & leukemias, multiple myeloma, and other cancers	
53 Docetaxel	Taxotere	Antineoplastic agent <i>mp 232 °C</i>	Treatment of ovarian, breast and bronchial carcinomas	
54 Fluorouracil	Efudex; Carac; Fluoroplex; Adrucil	Thymidylate synthesis inhibitor <i>mp 243 °C</i>	Constituent of several antineoplastic combinations	
55 Gemcitabine	Gemzar (as hydrochloride)	Antineoplastic and antiviral agent <i>mp 290 °C</i>	Treatment of lung and pancreatic tumors	
56 Imatinib	Gleevec; Glivec	Protein kinase inhibitor <i>mp 212 °C</i>	Treatment of myelogenous leukemia and gastrointestinal tumors	

Generic Name	Trade Names	Category and Properties	Applications	Structure
57 Irinotecan	Camptosar; Camptetin; Topotecin	Topoisomerase I inhibitor	Treatment of colorectal cancer	
58 Paclitaxel	Taxol; Abraxane; Yewtaxan	Microtubule-stabilizing agent <i>mp</i> 214 °C	Treatment of ovarian, breast, and lung cancer	
59 Sunitinib	Sutent	Tyrosine kinases inhibitor	Treatment of gastrointestinal & kidney tumors	
60 Tamoxifen	Nolvadex; Soltamox; Tamaxin; Tamoplex; Valodex	Selective estrogen receptor modulator <i>mp</i> 97 °C	Treatment of breast cancer	
<b>Cardiovascular Agents</b>				
61 Aliskiren	Tekturna; Rasilex	Renin inhibitor	Treatment of hypertension	
62 Amlodipine	Norvasc	Calcium channel blocker	Treatment of hypertension, atrial fibrillation, and angina	
63 Atenolol	Tenormin	$\beta$ -blocker <i>mp</i> 147 °C	Treatment of hypertension and excessive heart rate	
64 Carvedilol	Coreg; Dilatrend; Eucardic	Calcium channel blocker; $\beta$ -adrenoceptor blocker	Treatment of heart failure and hypertension	
65 Clopidogrel	Plavix; Isocover; Meilax; Tipidyl	Antiplatelet agent	Prevention of blood clots after stroke or myocardial infarction	

Generic Name	Trade Names	Category and Properties	Applications	Structure
66 Digoxin	Lanoxin; Davoxin; Digacin; Dilanacin; Rougoxin; Digosin; Cordioxil	Cardiac glycoside <i>mp</i> 249 °C	Treatment of congestive heart failure	
67 Enalaprilat	Vasotec	Angiotensin-converting enzyme inhibitor; antihypertensive agent <i>mp</i> 150 °C	Treatment of hypertension, atherosclerosis, and congestive heart failure	
68 Glycerol trinitrate	Nitroglycerin	Cardiac stimulant and vasodilator	Treatment of angina and congestive heart failure	
69 Irbesartan	Aprovel; Avapro; Avalide (in combination with hydrochlorothiazide)	Angiotensin II AT <sub>1</sub> -receptor antagonist <i>mp</i> 180 °C	Treatment of hypertension and diabetes-related kidney disease	
70 Lisinopril	Acecomb; Alapril; Carace; Novatec; Novazyd; Vivatec; Zestoretic; Zestril	Angiotensin-converting enzyme inhibitor; antihypertensive agent <i>mp</i> 159 °C	Treatment of hypertension	
71 Losartan	Cozaar; Hyzaar (with hydrochlorothiazide)	Angiotensin II AT <sub>1</sub> -receptor antagonist <i>mp</i> 184 °C	Treatment of congestive heart failure and hypertension	
72 Metoprolol	Lopressor; Toprol XL	β-Adrenergic blocker	Treatment of angina and hypertension	
73 Telmisartan	Micardis	Angiotensin II (AT <sub>1</sub> ) receptor antagonist <i>mp</i> 262 °C	Treatment of hypertension	

Generic Name	Trade Names	Category and Properties	Applications	Structure
74 Terazosin	Hytrin; Itrin; Hytrinex; Magnurol; Teraprost; Vasocard; Uroflo; etc.	Antihypertensive agent ( $\alpha_1$ -adrenoceptor antagonist)	Treatment of hypertension and benign prostatic hyperplasia	
75 Warfarin	Coumadin	Anticlotting agent <i>mp</i> 161 °C	Reduction of possibility of stroke or coronary	
<b>Cholesterol-Lowering Drugs</b>				
76 Atorvastatin	Lipitor; Caduet (in combination with amlodipine)	HMG-CoA reductase inhibitor (statin)	Reduction of LDL cholesterol levels by inhibiting cholesterol biosynthesis	
77 Ezetimibe	Zetia	Selective cholesterol absorption inhibitor <i>mp</i> 165 °C	Reduction of LDL cholesterol levels by inhibiting dietary cholesterol absorption	
78 Nicotinic acid	Niacin	Lipoprotein synthesis inhibitor	Reduction of LDL cholesterol levels	
79 Pravastatin	Pravochol	HMG-CoA reductase inhibitor (statin)	Reduction of LDL cholesterol levels by inhibiting cholesterol biosynthesis	
80 Simvastatin	Zocor; Vytorin (combination with Ezetimibe)	HMG-CoA reductase inhibitor (statin) <i>mp</i> 136 °C	Reduction of LDL cholesterol levels by inhibiting cholesterol biosynthesis	
<b>Depression and Anxiety Drugs</b>				
81 Bupropion	Wellbutrin; Amfebutamone; Zyban	Dopamine reuptake inhibitor <i>Pale yellow oil</i>	Antidepressant; smoking cessation aid	
82 Diazepam	Valium; Stesolid; Seduxen; Antenex; Calmpose; Livotensin	Benzodiazepine central nervous system depressant <i>mp</i> 125 °C	Treatment of anxiety, seizures, muscular spasms, and insomnia	

Generic Name	Trade Names	Category and Properties	Applications	Structure
83 Donepezil	Aricept	Acetylcholine esterase inhibitor	Treatment of Alzheimer's disease	
84 Fluoxetine	Prozac; Sarafem; Adofen; Fontex; Lorient	Selective serotonin reuptake inhibitor	Treatment of depression, panic attacks, and obsessive-compulsive disorder	
85 Levodopa	L-Dopa; Larodopa; Bendopa; Veldopa	Precursor to the neurotransmitter dopamine <i>mp</i> 277 °C	Treatment of Parkinson's disease	
86 Paroxetine	Paxil; Seroxat; Tagonis; Aropax; Motivan	Selective serotonin reuptake inhibitor	Treatment of depression, panic attacks, and obsessive-compulsive disorder	
87 Phenobarbital	Luminal; Fenemal; Gardenal; Barbivis	Anticonvulsant <i>mp</i> 174 °C	Epilepsy control; also used as a sedative	
88 Sertraline	Zoloft; Lustral; Serad; Serlain; Tatig	Selective serotonin reuptake inhibitor	Treatment of depression, panic attacks, and obsessive-compulsive disorder	
89 Tiagabine	Gabitril	GABA reuptake inhibitor; anticonvulsant	Treatment of epileptic seizures	
90 Venlafaxine	Effexor; Trewilor; Vandral; Dobupal	Selective serotonin & norepinephrine reuptake inhibitor	Treatment of anxiety and panic disorders	
<b>Osteoporosis Drugs</b>				
91 Alendronic acid	Fosamax; Adronat; Alendros; Dronal	Farnesyl pyrophosphate synthase inhibitor	Prevention and treatment of osteoporosis and Paget's disease	

Generic Name	Trade Names	Category and Properties	Applications	Structure
92 Calcitriol	Rocaltrol; Calcijex	Calcium and phosphate metabolism regulator <i>mp 170 °C</i>	Treatment of rickets and osteoporosis	
93 Raloxifene	Evista (as hydrochloride)	Selective estrogen receptor modulator	Prevention and treatment of osteoporosis	
94 Risedronic acid	Actonel (as Na salt); Optinate	Calcium regulator	Treatment of osteoporosis & Paget's disease	
<b>Pain Relief Drugs</b>				
95 Acetaminophen	Tylenol; APAP; Paracetamol; Hedrex; Tramil	Analgesic/antipyretic <i>mp 170 °C</i>	Relief of musculoskeletal, neuralgic, and other types of pain	
96 Fentanyl	Duragesic; Actiq; Fentora; Sublimaze	Opioid $\mu$ -receptor agonist <i>mp 87.5 °C</i>	Treatment of severe pain; spinal and epidural anesthesia	
97 Gabapentin	Neurotin; Aclonium	Anticonvulsant/analgesic; CNS depressant <i>mp 164 °C</i>	Treatment of neuralgia, pain from shingles, migraine, and epilepsy	
98 Lidocaine	Xylocaine; Xylocard; Lidamantle	Aminoamide anesthetic/antiarrhythmic agent	Local anesthetic for dental procedures	
99 Morphine	Avinza; Contin; Kadian; Roxanol; Meconium; Morfine	Opioid analgesic <i>mp 255 °C</i>	Pain management, especially in malignant diseases	
100 Thiopental	Pentothal; Penthiobarbital; Thiopentone	Short-acting barbiturate/anesthetic	Induction of presurgical anesthesia	

Generic Name	Trade Names	Category and Properties	Applications	Structure
101 Sumatriptan	Imitrex; Imigrane; Megrelan; Permicran; Sumadol	Selective 5-HT <sub>1D</sub> receptor agonist	Treatment of severe migraine headaches	
<i>Reproductive and Urinary System Drugs</i>				
102 Finasteride	Proscar; Propecia; Andozac; Finastid; Procure; Urprosan	5 $\alpha$ Reductase inhibitor <i>mp</i> 252 °C	Treatment of benign prostatic hyperplasia and male hair loss	
103 Mestranol	Devocin; Norinyl; Ovastol; Tranel	Estrogen, used in combination as oral contraceptive <i>mp</i> 151 °C	Prevention of unplanned pregnancy	
104 Mifepristone	Mifeprex; Mifegyne; Corlux; RU 486	Progesterone receptor modulator <i>mp</i> 150 °C	Termination of pregnancy	
105 Sildenafil	Viagra; Revatio	Cyclic GMP phosphodiesterase inhibitor	Treatment of erectile dysfunction and pulmonary hypertension	
106 Tamsulosin	Flomax; Amsulosin; Harnal; Omix	Prostate selective $\alpha_1$ -adrenoceptor antagonist	Treatment of benign prostatic hyperplasia	
107 Testosterone	Androderm; Androgel; Testrim; Striant	Anabolic steroid hormone	Treatment of male hypogonadism	

## Index

The index below lists the trade and generic names for the drugs in this table; the generic names are in bold face. Each entry is referred to by its generic name and the identification number in the

table. An asterisk\* beside the trade name indicates a product that is a combination of two drugs.

Name	Generic Name
Abraxane	Paclitaxel (58)
Acecomb	Lisinopril (70)
<b>Acetaminophen</b>	Acetaminophen (95)
<b>Acetylsalicylic acid</b>	Acetylsalicylic acid (25)
Aclonium	Gabapentin (97)

Name	Generic Name
Actiq	Fentanyl (96)
Actonel	Risedronic acid (94)
Actos	Pioglitazone (22)
Acyclovir	Acyclovir (36)
Adofen	Fluoxetine (84)

Name	Generic Name
Adoxa	Doxycycline (15)
Adronat	Alendronic acid (91)
Adrucil	Fluorouracil (54)
Advair*	Fluticasone (5)
Advil	Ibuprofen (27)
Alapril	Lisinopril (70)
Alavert	Loratadine (6)
<b>Albuterol</b>	Albuterol (1)
<b>Alendronic acid</b>	Alendronic acid (91)
Alendros	Alendronic acid (91)
Aleve	Naproxen (29)
<b>Aliskiren</b>	Aliskiren (61)
Allegra	Fexofenadine (4)
Amfebutamone	Bupropion (81)
Amfostet	Amphotericin (37)
<b>Amikacin</b>	Amikacin (10)
Amikin	Amikacin (10)
<b>Amlodipine</b>	Amlodipine (62)
<b>Amoxicillin</b>	Amoxicillin (11)
Amoxil	Amoxicillin (11)
<b>Amphotericin</b>	Amphotericin (37)
Amphozone	Amphotericin (37)
Amsulosin	Tamsulosin (106)
Anaprox	Naproxen (29)
<b>Anastrozole</b>	Anastrozole (47)
Andozac	Finasteride (102)
Androderm	Testosterone (107)
Androgel	Testosterone (107)
Antenex	Diazepam (82)
APAP	Acetaminophen (95)
Aprovel	Irbesartan (69)
Aricept	Donepezil (83)
Arimidex	Anastrozole (47)
Aropax	Paroxetine (86)
Aspirin	Acetylsalicylic acid (25)
<b>Atenolol</b>	Atenolol (63)
<b>Atorvastatin</b>	Atorvastatin (76)
Avalide*	Irbesartan (69)
Avandia	Rosiglitazone (23)
Avapro	Irbesartan (69)
Avinza	Morphine (99)
Avirax	Acyclovir (36)
Azantac	Ranitidine (35)
Azidothymidine	Zidovudine (46)
<b>Azithromycin</b>	Azithromycin (12)
Azitrocin	Azithromycin (12)
AZT	Zidovudine (46)
Barbivis	Phenobarbital (87)
Bendopa	Levodopa (85)
<b>Bicalutamide</b>	Bicalutamide (48)
Biclin	Amikacin (10)
Biozolene	Fluconazole (39)
<b>Bortezomib</b>	Bortezomib (49)
Budamax	Budesonide (2)
Budeson	Budesonide (2)

Name	Generic Name
<b>Budesonide</b>	Budesonide (2)
<b>Bupropion</b>	Bupropion (81)
Caduet*	Atorvastatin (76)
Calcijex	Calcitriol (92)
<b>Calcitriol</b>	Calcitriol (92)
Calmpose	Diazepam (82)
Camptetin	Irinotecan (57)
Camptosar	Irinotecan (57)
Capecitabine	Capecitabine (50)
Carac	Fluorouracil (54)
Carace	Lisinopril (70)
Carboplat	Carboplatin (51)
<b>Carboplatin</b>	Carboplatin (51)
Carboxyterfenadine	Fexofenadine (4)
<b>Carvedilol</b>	Carvedilol (64)
Casodex	Bicalutamide (48)
Ceclor	Cefaclor (13)
<b>Cefaclor</b>	Cefaclor (13)
Celebrex	Celecoxib (26)
<b>Celecoxib</b>	Celecoxib (26)
<b>Cetirizine</b>	Cetirizine (3)
Chemacin	Amikacin (10)
<b>Cimetidine</b>	Cimetidine (31)
Cimetimax	Cimetidine (31)
Cipro	Ciprofloxacin (14)
Ciprobay	Ciprofloxacin (14)
<b>Ciprofloxacin</b>	Ciprofloxacin (14)
Ciproxin	Ciprofloxacin (14)
Clafen	Cyclophosphamide (52)
Claratyne	Loratadine (6)
Claritin	Loratadine (6)
<b>Clopidogrel</b>	Clopidogrel (65)
Contin	Morphine (99)
Copegus	Ribavirin (43)
Cordioxil	Digoxin (66)
Coreg	Carvedilol (64)
Corlux	Mifepristone (104)
Cotronak	Ribavirin (43)
Coumadin	Warfarin (75)
Cozaar	Losartan (71)
<b>Cyclophosphamide</b>	Cyclophosphamide (52)
Cytophosphan	Cyclophosphamide (52)
Cytoxan	Cyclophosphamide (52)
<b>Davoxin</b>	Digoxin (66)
Deltasone	Prednisone (30)
Deoxyomykoin	Doxycycline (15)
Devocin	Mestranol (103)
Diabex	Metformin (21)
Diaformin	Metformin (21)
<b>Diazepam</b>	Diazepam (82)
Diflucan	Fluconazole (39)
Digacin	Digoxin (66)
Digosin	Digoxin (66)
<b>Digoxin</b>	Digoxin (66)
Dilanacin	Digoxin (66)



Name	Generic Name
Dilatrend	Carvedilol (64)
Dobupal	Venlafaxine (90)
<b>Docetaxel</b>	Docetaxel (53)
<b>Donepezil</b>	Donepezil (83)
Doryx	Doxycycline (15)
Doxycycline	Doxycycline (15)
Dronal	Alendronic acid (91)
Duragesic	Fentanyl (96)
E-Mycin	Erythromycin (16)
<b>Efavirenz</b>	Efavirenz (38)
Effexor	Venlafaxine (90)
Efudex	Fluorouracil (54)
Elazor	Fluconazole (39)
<b>Enalaprilat</b>	Enalaprilat (67)
Endoxan	Cyclophosphamide (52)
Epivir	Lamivudine (40)
Erbakar	Carboplatin (51)
Erythrocin	Erythromycin (16)
<b>Erythromycin</b>	Erythromycin (16)
Eucardic	Carvedilol (64)
Evista	Raloxifene (93)
<b>Ezetimibe</b>	Ezetimibe (77)
Fenemal	Phenobarbital (87)
<b>Fentanyl</b>	Fentanyl (96)
Fentora	Fentanyl (96)
<b>Fexofenadine</b>	Fexofenadine (4)
<b>Finasteride</b>	Finasteride (102)
Finastid	Finasteride (102)
Flexilite	Amikacin (10)
Flociprin	Ciprofloxacin (14)
Flomax	Tamsulosin (106)
Flonase	Fluticasone (5)
Flovent	Fluticasone (5)
<b>Fluconazole</b>	Fluconazole (39)
Fluoroplex	Fluorouracil (54)
<b>Fluorouracil</b>	Fluorouracil (54)
<b>Fluoxetine</b>	Fluoxetine (84)
<b>Fluticasone</b>	Fluticasone (5)
Fontex	Fluoxetine (84)
Fortamet	Metformin (21)
Fosamax	Alendronic acid (91)
Fungizone	Amphotericin (37)
<b>Gabapentin</b>	Gabapentin (97)
Gabitril	Tiagabine (89)
Gardenal	Phenobarbital (87)
Gastromet	Cimetidine (31)
<b>Gemcitabine</b>	Gemcitabine (55)
Gemzar	Gemcitabine (55)
Gleevec	Imatinib (56)
Glibenese	Glipizide (20)
<b>Glipizide</b>	Glipizide (20)
Glivec	Imatinib (56)
Glucophage	Metformin (21)
Glucotrol	Glipizide (20)
<b>Glycerol trinitrate</b>	Glycerol trinitrate (68)

Name	Generic Name
Glydiazinamide	Glipizide (20)
Harnal	Tamsulosin (106)
Hedrex	Acetaminophen (95)
Heptodin	Lamivudine (40)
Hivid	Zalcitabine (45)
Hytrin	Terazosin (74)
Hytrinex	Terazosin (74)
Hyzaar*	Losartan (71)
<b>Ibuprofen</b>	Ibuprofen (27)
Ilosone	Erythromycin (16)
<b>Imatinib</b>	Imatinib (56)
Imigrane	Sumatriptan (101)
Imitrex	Sumatriptan (101)
Inflammid	Budesonide (2)
<b>Irbesartan</b>	Irbesartan (69)
Irinotecan	Irinotecan (57)
Isimoxin	Amoxicillin (11)
Isocover	Clopidogrel (65)
<b>Isoniazid</b>	Isoniazid (17)
Itrin	Terazosin (74)
Januvia	Sitagliptin (24)
Kadian	Morphine (99)
Kefolar	Cefaclor (13)
L-Dopa	Levodopa (85)
Lamisil	Terbinafine (44)
<b>Lamivudine</b>	Lamivudine (40)
Laniazid	Isoniazid (17)
Lanoxin	Digoxin (66)
<b>Lansoprazole</b>	Lansoprazole (32)
Larodopa	Levodopa (85)
<b>Levodopa</b>	Levodopa (85)
Lidamantle	Lidocaine (98)
<b>Lidocaine</b>	Lidocaine (98)
<b>Linezolid</b>	Linezolid (18)
Lipitor	Atorvastatin (76)
<b>Lisinopril</b>	Lisinopril (70)
Liviatin	Doxycycline (15)
Livotensin	Diazepam (82)
Lopressor	Metoprolol (72)
<b>Loratadine</b>	Loratadine (6)
Lorien	Fluoxetine (84)
<b>Losartan</b>	Losartan (71)
Losec	Omeprazole (33)
Luminal	Phenobarbital (87)
Lustral	Sertraline (88)
Magnurol	Terazosin (74)
Meconium	Morphine (99)
Megrelan	Sumatriptan (101)
Meilax	Clopidogrel (65)
Melfax	Ranitidine (35)
<b>Meloxicam</b>	Meloxicam (28)
Mepral	Omeprazole (33)
<b>Mestranol</b>	Mestranol (103)
Metacain	Meloxicam (28)
Metacam	Meloxicam (28)

Name	Generic Name	Name	Generic Name
<b>Metformin</b>	Metformin (21)	Plavix	Clopidogrel (65)
Meticorten	Prednisone (30)	<b>Pravastatin</b>	Pravastatin (79)
<b>Metoprolol</b>	Metoprolol (72)	Pravochol	Pravastatin (79)
Micardis	Telmisartan (73)	<b>Prednisone</b>	Prednisone (30)
Mifegyne	Mifepristone (104)	Prevacid	Lansoprazole (32)
Mifeprex	Mifepristone (104)	Prevpac	Lansoprazole (32)
<b>Mifepristone</b>	Mifepristone (104)	Prezal	Lansoprazole (32)
Minodiab	Glipizide (20)	Prilosec	Omeprazole (33)
Mirolex	Acyclovir (36)	Procure	Finasteride (102)
Mobic	Meloxicam (28)	Proloprim	Trimethoprim (19)
Monotrim	Trimethoprim (19)	Propesia	Finasteride (102)
<b>Montelukast</b>	Montelukast (7)	Proscar	Finasteride (102)
Mopral	Omeprazole (33)	Protonix	Pantoprazole (34)
Morfine	Morphine (99)	Proventil	Albuterol (1)
<b>Morphine</b>	Morphine (99)	Prozac	Fluoxetine (84)
Motivan	Paroxetine (86)	Pulmicort	Budesonide (2)
Naprelan	Naproxen (29)	<b>Raloxifene</b>	Raloxifene (93)
Naprogesic	Naproxen (29)	<b>Ranitidine</b>	Ranitidine (35)
<b>Naproxen</b>	Naproxen (29)	Rantec	Ranitidine (35)
Negasin	Amikacin (10)	Rasilex	Aliskiren (61)
Neosar	Cyclophosphamide (52)	Rebetol	Ribavirin (43)
Neurotin	Gabapentin (97)	Retrovir	Zidovudine (46)
<b>Nevirapine</b>	Nevirapine (41)	Revatio	Sildenafil (105)
Nexium	Omeprazole (33)	Rhinocort	Budesonide (2)
Niacin	Nicotinic acid (78)	Ribasphere	Ribavirin (43)
<b>Nicotinic acid</b>	Nicotinic acid (78)	<b>Ribavirin</b>	Ribavirin (43)
Nitroglycerin	Glycerol trinitrate (68)	Rifun	Pantoprazole (34)
Nolvadex	Tamoxifen (60)	<b>Risedronic acid</b>	Risedronic acid (94)
Nonoplat	Carboplatin (51)	Rocaltrol	Calcitriol (92)
Norinyl	Mestranol (103)	<b>Rosiglitazone</b>	Rosiglitazone (23)
Norvasc	Amlodipine (62)	Rougoxin	Digoxin (66)
Novatec	Lisinopril (70)	Roxanol	Morphine (99)
Novazyd	Lisinopril (70)	RU 486	Mifepristone (104)
<b>Omeprazole</b>	Omeprazole (33)	<b>Salmeterol</b>	Salmeterol (8)
Omix	Tamsulosin (106)	Sarafem	Fluoxetine (84)
Onsenal	Celecoxib (26)	Seduxen	Diazepam (82)
Optinate	Risedronic acid (94)	Serad	Sertraline (88)
<b>Oseltamivir</b>	Oseltamivir (42)	Serevent	Salmeterol (8)
Ospamox	Amoxicillin (11)	Serlain	Sertraline (88)
Ovastol	Mestranol (103)	Seroxat	Paroxetine (86)
Paclitaxel	Paclitaxel (58)	<b>Sertraline</b>	Sertraline (88)
Panacef	Cefaclor (13)	<b>Sildenafil</b>	Sildenafil (105)
Panoral	Cefaclor (13)	<b>Simvastatin</b>	Simvastatin (80)
<b>Pantoprazole</b>	Pantoprazole (34)	Singulair	Montelukast (7)
Pantozol	Pantoprazole (34)	<b>Sitagliptin</b>	Sitagliptin (24)
Paracetamol	Acetaminophen (95)	Soltamox	Tamoxifen (60)
Paraplatin	Carboplatin (51)	SoluTab	Lansoprazole (32)
<b>Paroxetine</b>	Paroxetine (86)	Sostril	Ranitidine (35)
Paxil	Paroxetine (86)	Spiriva	Tiotropium bromide (9)
Penthiobarbital	Thiopental (100)	Stesolid	Diazepam (82)
Pentothal	Thiopental (100)	Striant	Testosterone (107)
Peptimax	Cimetidine (31)	Sublimaze	Fentanyl (96)
Permicran	Sumatriptan (101)	Sumadol	Sumatriptan (101)
<b>Phenobarbital</b>	Phenobarbital (87)	<b>Sumatriptan</b>	Sumatriptan (101)
Pioglitazone	Pioglitazone (22)	<b>Sunitinib</b>	Sunitinib (59)

Name	Generic Name	Name	Generic Name
Sustiva	Efavirenz (38)	Vandral	Venlafaxine (90)
Sutent	Sunitinib (59)	Vasocard	Terazosin (74)
Tagamet	Cimetidine (31)	Vasotec	Enalaprilat (67)
Tagonis	Paroxetine (86)	Velcade	Bortezomib (49)
Tamaxin	Tamoxifen (60)	Veldopa	Levodopa (85)
Tamiflu	Oseltamivir (42)	<b>Venlafaxine</b>	Venlafaxine (90)
Tamoplex	Tamoxifen (60)	Ventolin	Albuterol (1)
<b>Tamoxifen</b>	Tamoxifen (60)	Viagra	Sildenafil (105)
Tamsulosin	Tamsulosin (106)	Vibramycin	Doxycycline (15)
Tatig	Sertraline (88)	Vinzam	Azithromycin (12)
Taural	Ranitidine (35)	Viramune	Nevirapine (41)
Taxol	Paclitaxel (58)	Viratek	Ribavirin (43)
Taxotere	Docetaxel (53)	Virazole	Ribavirin (43)
Tekturna	Aliskiren (61)	Vivatec	Lisinopril (70)
Telfast	Fexofenadine (4)	Volmax	Albuterol (1)
<b>Telmisartan</b>	Telmisartan (73)	Vytorin*	Simvastatin (80)
Tenormin	Atenolol (63)	<b>Warfarin</b>	Warfarin (75)
Teraprost	Terazosin (74)	Wellbutrin	Bupropion (81)
<b>Terazosin</b>	Terazosin (74)	Xeloda	Capecitabine (50)
<b>Terbinafine</b>	Terbinafine (44)	Xylocaine	Lidocaine (98)
<b>Testosterone</b>	Testosterone (107)	Xylocard	Lidocaine (98)
Testrim	Testosterone (107)	Yewtaxan	Paclitaxel (58)
<b>Thiopental</b>	Thiopental (100)	<b>Zalcitabine</b>	Zalcitabine (45)
Thiopentone	Thiopental (100)	Zantac	Ranitidine (35)
<b>Tiagabine</b>	Tiagabine (89)	Zeffix	Lamivudine (40)
Tiotropium bromide	Tiotropium bromide (9)	Zestoretic	Lisinopril (70)
Tipidyl	Clopidogrel (65)	Zestril	Lisinopril (70)
Topotecin	Irinotecan (57)	Zetia	Ezetimibe (77)
Toprol XL	Metoprolol (72)	Zidovir	Zidovudine (46)
Tramil	Acetaminophen (95)	<b>Zidovudine</b>	Zidovudine (46)
Tranel	Mestranol (103)	Zithromax	Azithromycin (12)
Trewilor	Venlafaxine (90)	Zmax	Azithromycin (12)
Triflucan	Fluconazole (39)	Zocor	Simvastatin (80)
<b>Trimethoprim</b>	Trimethoprim (19)	Zoloft	Sertraline (88)
Triprim	Trimethoprim (19)	Zoltum	Omeprazole (33)
Tylenol	Acetaminophen (95)	Zoton	Lansoprazole (32)
Uniflox	Ciprofloxacin (14)	Zovir	Acyclovir (36)
Uroflo	Terazosin (74)	Zovirax	Acyclovir (36)
Urprosan	Finasteride (102)	Zyban	Bupropion (81)
Valium	Diazepam (82)	Zyrtec	Cetirizine (3)
Valodex	Tamoxifen (60)	Zyvox	Linezolid (18)

## CHEMICAL CONSTITUENTS OF HUMAN BLOOD

This table lists typical concentrations of some of the chemical constituents of human blood. The table covers elements and compounds of relatively low molecular weight. References 1 and 4 give extensive information on enzymes, hormones, vitamins, and other blood constituents.

The values given for the normal range refer to healthy adults who have not been exposed to unusual environmental agents. In keeping with IUPAC practice, all values refer to a volume of one liter, and thus are stated in units of g/L, mg/L, µg/L or mmol/L. Many clinical test results, especially in the United States, are reported on a deciliter (dL) rather than a liter basis; thus the values in this table should be divided by 10 to place them on a dL basis. The symbols S (for serum), P (plasma), and WB (whole blood) in the second column indicate the nature of the blood sample to which the values apply. In some cases only a single mean value has been reported, rather than a range; these are given in italics.

The total volume of blood in a 100 kg (220 lb) adult is 7.5 L for a male and 6.7 L for a female. The corresponding volume of plasma is 4.4 L and 4.3 L, respectively (Reference 1).

Values from Reference 1 are so-called "reference values" against which clinical tests of blood chemistry are compared. In these cases the "normal range" is understood to include about 95% of the population. The remaining 5% may show values outside the normal range without necessarily implying a medical problem. Note that these reference values may vary slightly from one testing laboratory to another, depending on the detailed test procedure.

Accurate measurements on trace elements are very difficult to make, and wide variations can be found in the literature. Preferred measurement methods are discussed in References 2 and 6. Values

for the trace elements can also vary from one country to another, depending on dietary or environmental factors. Thus cadmium levels tend to be higher in Japan because of the prevalence of sea-food in the diet, and lead levels are higher in regions where lead additives are still used in gasoline. Variations with gender, age, geography, and occurrence of diseases are reviewed in Reference 6.

The Critical Values column gives levels that deviate far enough from the normal range to suggest a probable medical issue. Such values from Reference 3 are the Biological Exposure Indexes (BEI) that are specified by the American Council of Government Industrial Hygienists (ACGIH) as danger signals for the levels of pollutants in the workplace.

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Component	Unit	Normal Range		Critical Values	Ref.
		Low	High		
<i>Inorganic</i>					
Aluminum	S µg/L	1	10	>60	6,2
Ammonia	P µg/L	190	600	>700	1
Antimony	S,P µg/L		<i>1</i>		6
Arsenic	S µg/L	0.5	5		6,2
Barium	S,P µg/L		79		4,5
Beryllium	S,P µg/L		<4		4,5
Bicarbonate (HCO <sub>3</sub> <sup>-</sup> )	WB mmol/L	22	28	<10 or >40	1
Bromine	S,P mg/L	2	11		6,4
Cadmium	S µg/L	0.1	1	>5	6,2,3
Calcium, total	S mg/L	90	105	<65 or >140	1
Calcium ion (Ca <sup>++</sup> )	WB mg/L	30	45		1
Carbon dioxide	P mmol/L	21	30	<11 or >40	1
Carbon monoxide*	WB %CO-Hb	0	5%	30%	1
Cesium	S,P µg/L	0.5	2.0		6
Chloride (Cl <sup>-</sup> )	S mmol/L	98	106	<80 or >115	1
Chromium	S µg/L	0.1	0.4		6,2
Cobalt	S µg/L	0.05	0.35	>1	6,2,3
Copper	S mg/L	0.7	1.4		1,2,6
Fluorine	S,P µg/L	33	236		6
Hydrogen ion (H <sup>+</sup> )	WB pH	7.38	7.44	<7.10 or >7.59	1
Iodine (total)	S,P µg/L	59	76		4
Iron	S mg/L	0.5	1.7		1
Lead	S µg/L	5	100	>300	1,3,6

Component		Unit	Normal Range		Critical Values	Ref.
			Low	High		
Lithium	S,P	µg/L		8		6
Magnesium	S	mg/L	18	30	<10 or >47	1
Manganese	S	µg/L	0.3	1.0		6,2
Mercury	S	µg/L	0.5	3	>15	2,3
Molybdenum	S,P	µg/L	0.3	1.3		6
Nickel	S	µg/L	0.1	1.3		6,2
Oxygen (arterial)	WB	% saturation	96%	100%		1
Oxygen (venous)	WB	% saturation	60%	85%		1
Phosphorus (inorganic)	S	mg/L	30	45	<11	1
Potassium	S	mmol/L	3.5	5.0	<2.8 or >6.2	1
		mg/L	137	196		
Rubidium	S,P	µg/L	100	300		6
Selenium	S,P	µg/L	40	160		2,6
Silver	S,P	µg/L		1		6
Sodium	S	mmol/L	135	145	<120 or >160	1
		g/L	3.11	3.34		
Strontium	S,P	µg/L		57		4,5
Sulfur (total)	S,P	mg/L		780		4
Tellurium	S,P	µg/L		30		4,5
Titanium	S,P	µg/L		33		4,5
Tin	S,P	µg/L		1		4,5
Vanadium	S,P	µg/L	0.02	1.0		6
Zinc	S,P	mg/L	0.5	1.2		6,2,4
Zirconium	S,P	µg/L		400		4,5
<i>Organic</i>						
Acetoacetate ion	P	mg/L		<10		1
Acetone	S,P	mg/L	3	20		1
Alanine	S,P	mg/L	30	37		4
Arginine	S,P	mg/L	12	19		4
Asparagine	S,P	mg/L	5.4	6.5		4
Cholesterol, total	P	mg/L	1000	2000**	>2400	1,4
HDL Cholesterol	P	mg/L	400	600		1
LDL Cholesterol	P	mg/L	0	1000	>1900	1
Citrulline	S,P	mg/L	2.1	9.7		4
Creatine	S,P	mg/L	2.8	6.2		4
Creatinine	S	mg/L	5	15	>50	1
Fructose	WB	mg/L	5	50		4
Glucosamine	S,P	mg/L	760	1110		4
Glucose (fasting)	S	mg/L	600	1000	<450 or >1300	1
Glutamic acid	S,P	mg/L	4.3	11.5		4
Glutamine	S,P	mg/L	61	102		4
Glycine	S,P	mg/L	13.4	17.3		4
Histidine	S,P	mg/L	7.9	14.8		4
Homocysteine	P	mg/L	0.54	1.62		1
Isoleucine	S,P	mg/L	6.9	12.8		4
Lactate (venous)	P	mg/L	50	150		1
Leucine	S,P	mg/L	14	23		4
Lysine	S,P	mg/L	25	30		4
Methionine	S,P	mg/L	3.3	4.3		4
Ornithine	S,P	mg/L	6.2	8.0		4
Phenylalanine	S,P	mg/L	5.8	14.0		1
Proline	S,P	mg/L	20	33		4
Serine	S,P	mg/L	10.1	12.5		4

Component		Unit	Normal Range		Critical Values	Ref.
			Low	High		
Taurine	S,P	mg/L	4.1	8.2		4
Threonine	S,P	mg/L	12	17		4
Triglyceride	S	mg/L	250	1750		1
Tyrosine	S,P	mg/L	8.1	14.5		4
Urea	S	mmol/L	3.5	7.0	<0.7 or >28	1
Urea nitrogen (BUN)	S	mg/L (of N)	100	200	<20 or >800	1
Uric acid (males)	S	mg/L	25	80		1
Uric acid (females)	S	mg/L	13	60		1
Valine	S,P	mg/L	24	37		4

\* Measured as the percent of hemoglobin bound to CO. Typical value for heavy smokers is 5%–10%. Major symptoms begin around 30%, and respiratory failure sets in at >60%.

\*\* This is the desirable upper limit. Values between 2000 and 2400 mg/L are considered borderline high.

# APPARENT EQUILIBRIUM CONSTANTS FOR ENZYME-CATALYZED REACTIONS

Robert N. Goldberg

This table contains values of apparent equilibrium constants  $K'$  for selected enzyme-catalyzed reactions at specified temperatures  $T$  and pHs. In those cases where the ionic strength  $I$  and/or the pMg ( $\text{pMg} = -\log_{10}[\text{Mg}^{2+}]$ ) have been reported, the values of these quantities are given. The Enzyme Commission numbers [Webb (1992)] of the enzymes that were used to catalyze the reactions are also given.

There are two fundamentally different types of equilibrium constants. This is illustrated by the following example for the hydrolysis of adenosine 5'-triphosphate (ATP) to adenosine 5'-diphosphate (ADP) and phosphate:



The apparent equilibrium constant for the overall biochemical reaction (1) is

$$K' = [\text{ADP}][\text{phosphate}]/([\text{ATP}]c^\circ) \quad (2)$$

The biochemical reactants ATP, ADP, and phosphate each exist in several different ionized and metal bound forms. For example, ATP is an equilibrium mixture of the species  $\text{ATP}^{4-}$ ,  $\text{HATP}^{3-}$ ,  $\text{H}_2\text{ATP}^{2-}$ ,  $\text{MgATP}^{2-}$ ,  $\text{MgHATP}^-$ ,  $\text{Mg}_2\text{ATP}^0$ . Additional species would also have to be considered if  $\text{Ca}^{2+}$  were present. Thus, ATP has often been denoted in the literature as  $\Sigma\text{ATP}$  or as  $(\text{ATP})_{\text{tot}}$ . When it is clear that one is dealing with total amounts of substances, it is not necessary to use either the  $\Sigma$  or "tot." Thus, these designations are not used in this table. In the above equation,  $c^\circ = 1 \text{ mol dm}^{-3}$ ; it is included to make  $K'$  dimensionless. The standard transformed Gibbs energy of reaction  $\Delta_r G'^\circ$  at specified conditions of temperature  $T$ , pressure  $P$ , ionic strength  $I$ , pH, and pMg can be calculated from  $K'$ :

$$\Delta_r G'^\circ = -RT \ln K' \quad (3)$$

The molar gas constant,  $R$ , is equal to  $8.314\,472 \text{ J K}^{-1} \text{ mol}^{-1}$ .  $\Delta_r G'^\circ$  and the apparent equilibrium constant,  $K'$ , can be used to calculate the position of equilibrium of overall biochemical reactions.

It is also possible to choose a chemical reference reaction that involves selected solute species:



The equilibrium constant for this reference reaction is

$$K = [\text{ADP}^{3-}][\text{HPO}_4^{2-}][\text{H}^+]/\{[\text{ATP}^{4-}](c^\circ)^2\} \quad (5)$$

Equations and algorithms that relate these two different types of equilibrium constants have been published [Alberty (1969), Akers and Goldberg (2001), Alberty (2003)]. To calculate the equilibrium constant  $K$  for the reference reaction from the apparent equilibrium constant  $K'$ , or vice versa, one needs the equilibrium constants for the binding of  $\text{H}^+$  and for the relevant metal ions to  $\text{ATP}^{4-}$ ,  $\text{ADP}^{3-}$ , and  $\text{HPO}_4^{2-}$ .

To avoid confusion between the two different types of equilibrium constants ( $K'$  and  $K$ ) and to avoid ambiguity about whether specific species or sums of species are intended, the word "ammonia," for example, rather than  $\text{NH}_3$  or  $\text{NH}_4^+$ , is used for total ammonia, and chemical formulas are used for specific chemical species. Other substances such as carbon dioxide ( $\text{CO}_2$ ,  $\text{HCO}_3^-$ , and  $\text{CO}_3^{2-}$ ), and phosphate ( $\text{H}_2\text{PO}_4^-$ ,  $\text{HPO}_4^{2-}$ , and  $\text{PO}_4^{3-}$ ) are treated in

the same manner. Exceptions are made for water, which is always written as  $\text{H}_2\text{O}$ , and for gaseous hydrogen and oxygen, which are written as  $\text{H}_2(\text{g})$  and  $\text{O}_2(\text{g})$ , respectively.

For symmetrical reactions, there is no concern about the units used to calculate the value of an equilibrium constant. However, care must be exercised for reactions that are not symmetrical. In such cases, the units " $\text{mol dm}^{-3}$ " have been used for all concentrations. As stated above, a  $c^\circ$  ( $1 \text{ mol dm}^{-3}$ ) is then used to make all equilibrium constants dimensionless.

All substances are assumed to be in aqueous solutions unless specified otherwise.

Values of  $\Delta_r G'^\circ$  and  $K'$  can also be calculated for many biochemical reactions by using the table "Standard Transformed Gibbs Energies of Formation for Biochemical Reactants" in Section 7 of this Handbook.

## Abbreviations

ADP	adenosine 5'-diphosphate
AMP	adenosine 5'-monophosphate
ATP	adenosine 5'-triphosphate
CoA	coenzyme A
GDP	guanosine 5'-diphosphate
GMP	guanosine 5'-monophosphate
GTP	guanosine 5'-triphosphate
IDP	inosine 5'-diphosphate
IMP	inosine 5'-monophosphate
ITP	inosine 5'-triphosphate
NAD <sub>ox</sub>	$\beta$ -nicotinamide-adenine dinucleotide, oxidized form
NAD <sub>red</sub>	$\beta$ -nicotinamide-adenine dinucleotide, reduced form
NADP <sub>ox</sub>	$\beta$ -nicotinamide-adenine dinucleotide phosphate, oxidized form
NADP <sub>red</sub>	$\beta$ -nicotinamide-adenine dinucleotide phosphate, reduced form
UDP	uridine 5'-diphosphate
UTP	uridine 5'-triphosphate

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See also <www.chem.qmul.ac.uk/iubmb/enzyme/>.



Reaction	$K'$	Enzyme Commission Number	$T$ $K$	pH	$I$ mol-dm <sup>-3</sup>	pMg
benzyl alcohol + NAD <sub>ox</sub> = benzaldehyde + NAD <sub>red</sub>	9.8·10 <sup>-4</sup>	1.1.1.1	298.15	7.5		
1-butanol + NAD <sub>ox</sub> = butanal + NAD <sub>red</sub>	1.8·10 <sup>-3</sup>	1.1.1.1	298.15	8.3		
cyclohexanol + NAD <sub>ox</sub> = cyclohexanone + NADH <sub>red</sub>	0.090	1.1.1.1	298.15	7.2		
1-hexanol + NAD <sub>ox</sub> = hexanal + NAD <sub>red</sub>	2.87·10 <sup>-3</sup>	1.1.1.1	298.15	8.3		
1-octanol + NAD <sub>ox</sub> = octanal + NAD <sub>red</sub>	1.1·10 <sup>-3</sup>	1.1.1.1	298.15	8.3		
L-homoserine + NADP <sub>ox</sub> = L-aspartate 4-semialdehyde + NADP <sub>red</sub>	6.3·10 <sup>-4</sup>	1.1.1.3	298.15	7.9		
xylitol + NAD <sub>ox</sub> = L-xylulose + NAD <sub>red</sub>	2.97·10 <sup>-4</sup>	1.1.1.10	298.15	7.00		
D-sorbitol + NAD <sub>ox</sub> = D-fructose + NAD <sub>red</sub>	0.032	1.1.1.14	298.15	7.0		
quininate + NAD <sub>ox</sub> = 5-dehydroquininate + NAD <sub>red</sub>	4.61·10 <sup>-3</sup>	1.1.1.24	305.15	7.2		
shikimate + NADP <sub>ox</sub> = 5-dehydroshikimate + NADP <sub>red</sub>	0.036	1.1.1.25	303.15	7.0		
2-hydroxybutanoate + NAD <sub>ox</sub> = 2-oxobutanoate + NAD <sub>red</sub>	3.0·10 <sup>-3</sup>	1.1.1.27	298.65	8.0		
(R)-3-hydroxybutanoate + NAD <sub>ox</sub> = 3-oxobutanoate + NAD <sub>red</sub>	1.9·10 <sup>-3</sup>	1.1.1.30	298.15	7.0		
D-glucose 6-phosphate + NADP <sub>ox</sub> = D-glucono-1,5-lactone 6-phosphate + NADP <sub>red</sub>	1.50	1.1.1.49	301.15	6.40		
5 $\alpha$ -androstane-3 $\alpha$ -ol-17-one + NAD <sub>ox</sub> = 5 $\alpha$ -androstane-3,17-dione + NAD <sub>red</sub>	0.058	1.1.1.50	298.15	7.0		
5 $\alpha$ -pregnane-3 $\alpha$ ,17 $\alpha$ ,21-triol-20-one + NAD <sub>ox</sub> = 5 $\alpha$ -pregnane-17 $\alpha$ ,21-diol-3,20-dione + NAD <sub>red</sub>	0.0113	1.1.1.50	298.15	7.0		
5 $\alpha$ -androstane-3 $\beta$ ,17 $\alpha$ -diol + NAD <sub>ox</sub> = 5 $\alpha$ -androstane-17 $\alpha$ -ol-3-one + NAD <sub>red</sub>	0.0211	1.1.1.51	298.15	7.0		
4-androstene-17 $\beta$ -ol-3-one + NAD <sub>ox</sub> = 4-androstene-3,17-dione + NAD <sub>red</sub>	0.378	1.1.1.51	298.15	7.0		
1,2-propanediol + NADP <sub>ox</sub> = L-lactaldehyde + NADP <sub>red</sub>	6.0·10 <sup>-5</sup>	1.1.1.55	298.15	8.4		
ribitol + NAD <sub>ox</sub> = D-ribulose + NAD <sub>red</sub>	3.1·10 <sup>-3</sup>	1.1.1.56	310.15	7.4		
3-hydroxypropanoate + NAD <sub>ox</sub> = 3-oxopropanoate + NAD <sub>red</sub>	9.0·10 <sup>-3</sup>	1.1.1.59	298.15	9.0		
estradiol-17 $\beta$ + NAD <sub>ox</sub> = estrone + NAD <sub>red</sub>	0.18	1.1.1.62	298.15	7.00		
benzyl alcohol + NAD <sub>ox</sub> = benzaldehyde + NAD <sub>red</sub>	0.097	1.1.1.90	300.15	9.5		
L-carnitine + NAD <sub>ox</sub> = 3-dehydrocarnitine + NAD <sub>red</sub>	1.3·10 <sup>-4</sup>	1.1.1.108	303.15	7.0		
L-threonate + NAD <sub>ox</sub> = 3-oxo-L-threonate + NAD <sub>red</sub>	3.42·10 <sup>-4</sup>	1.1.1.129	298.15	7.0		
prostaglandin E <sub>1</sub> + NAD <sub>ox</sub> = 15-oxo-prostaglandin E <sub>1</sub> + NAD <sub>red</sub>	0.65	1.1.1.141	298.15	7.0		
7,8-dihydrobiopterin + NADP <sub>ox</sub> = sepiapterin + NADP <sub>red</sub>	0.045	1.1.1.153	298.15	8.0		
glycine + acetaldehyde = L-threonine	56	2.1.2.1	310.15	7.6		
sedoheptulose 7-phosphate + D-glyceraldehyde 3-phosphate = D-ribose 5-phosphate + D-xylulose 5-phosphate	0.48	2.2.1.1	311.15	7.0	0.25	3.0
acetyl-CoA + choline = CoA + O-acetylcholine	1.60	2.3.1.7	298.15	7.0	0.25	
acetyl-CoA + acyl-carrier protein = CoA + acetyl-[acyl-carrier protein]	2.09	2.3.1.38	311.15	6.5		
UDPglucose + D-fructose = UDP + sucrose	6.7	2.4.1.13	298.15	7.5		
cellobiose + orthophosphate = D-glucose + $\alpha$ -D-glucose 1-phosphate	0.23	2.4.1.20	310.15	7.0		
laminaritriose + orthophosphate = laminaribiose + $\alpha$ -D-glucose 1-phosphate	0.26	2.4.1.31	310.15	6.5		
$\alpha,\alpha$ -trehalose + orthophosphate = D-glucose + $\beta$ -D-glucose 1-phosphate	0.24	2.4.1.64	310.15	7.0		
UDPglucose + sinapate = UDP + 1-sinapoyl-D-glucose	0.21	2.4.1.120	303.15	6.0		
inosine + orthophosphate = hypoxanthine + $\alpha$ -D-ribose 1-phosphate	0.0164	2.4.2.1	311.15	7.0	0.25	3.0
xanthosine + orthophosphate = xanthine + $\alpha$ -D-ribose 1-phosphate	0.0156	2.4.2.1	311.15	7.0	0.25	3.0
uridine + orthophosphate = uracil + $\alpha$ -D-ribose 1-phosphate	0.44	2.4.2.2	310.15	7.0		
adenine + 5-phospho- $\alpha$ -D-ribose 1-diphosphate = AMP + pyrophosphate	2·10 <sup>3</sup>	2.4.2.7	311.15	7.4	0.25	3.0
GMP + hypoxanthine = IMP + guanine	0.38	2.4.2.8	310.15	7.4		
guanine + 5-phospho- $\alpha$ -D-ribose 1-diphosphate = GMP + pyrophosphate	1·10 <sup>5</sup>	2.4.2.8	311.15	7.4	0.25	3.0
hypoxanthine + 5-phospho- $\alpha$ -D-ribose 1-diphosphate = IMP + pyrophosphate	1·10 <sup>5</sup>	2.4.2.8	311.15	7.4	0.25	3.0
ATP + ammonium carbamate = ADP + carbamoyl phosphate	0.042	2.7.2.2	283.15	9.4		
ATP + creatine = ADP + phosphocreatine	5.78·10 <sup>-3</sup>	2.7.3.2	310.15	7.11	0.25	2.47
ATP + L-arginine = ADP + N <sup>o</sup> -phospho-L-arginine	0.10	2.7.3.3	285.15	7.25		
ATP + sulfate = adenosine 5'-phosphosulfate + pyrophosphate	4·10 <sup>-8</sup>	2.7.7.4	303.15	7.5		
UTP + $\alpha$ -D-glucose 1-phosphate = pyrophosphate + UDPglucose	0.48	2.7.7.9	310.15	8.0		
succinyl-CoA + acetoacetate = succinate + acetoacetyl-CoA	2.8·10 <sup>-3</sup>	2.8.3.5	303.15	7.0		



Reaction	$K'$	Enzyme Commission Number	$T$		$I$	
			$K$	pH	mol-dm <sup>-3</sup>	pMg
acetylcholine + H <sub>2</sub> O = acetate + choline	5.38·10 <sup>2</sup>	3.1.1.7	296.15	5.1		
IMP + H <sub>2</sub> O = inosine + orthophosphate	1.58·10 <sup>2</sup>	3.1.3.1	298.15	8.55	1.53	4.44
phosphorylcholine + H <sub>2</sub> O = choline + orthophosphate	49.9	3.1.3.1	311.15	6.90		
L-O-phosphoserine + H <sub>2</sub> O = L-serine + orthophosphate	56	3.1.3.1	308.15	7.0		
cytidine 2':3'-(cyclic)phosphate + H <sub>2</sub> O = cytidine 3'-monophosphate	1.06·10 <sup>3</sup>	3.1.27.5	298.15	6.0		
isomaltose + H <sub>2</sub> O = 2 D-glucose	17.2	3.2.1.3	298.15	5.65		
β-gentiobiose + H <sub>2</sub> O = 2 D-glucose	17.7	3.2.1.21	298.15	5.65		
3-O-β-D-galactopyranosyl-D-arabinose + H <sub>2</sub> O = D-galactose + D-arabinose	1.04·10 <sup>2</sup>	3.2.1.23	298.15	5.65		
lactulose + H <sub>2</sub> O = D-galactose + D-fructose	1.28·10 <sup>2</sup>	3.2.1.23	298.15	5.65		
4',5'-anhydroadenosine + H <sub>2</sub> O = adenosine	0.48	3.3.1.1	310.15	7.0		
pteroylglutamate + H <sub>2</sub> O = pterate + L-glutamate	15.6	3.4.19.9	310.15	7.3		
N-acetyl-L-phenylalanine methyl ester + H <sub>2</sub> O = N-acetyl-L-phenylalanine + methanol	5.88·10 <sup>3</sup>	3.4.21.1	293.15	5.5		
hippurylanilide + H <sub>2</sub> O = hippuric acid + aniline	11	3.4.22.2	312.15	5.0		
ammonium carbamate + H <sub>2</sub> O = 2 ammonia + carbon dioxide	1.92·10 <sup>3</sup>	3.5.1.5	293.15	6.5		
ampicillin + H <sub>2</sub> O = 6-aminopenicillanic acid + D(-)-α-aminophenylacetic acid	0.013	3.5.1.11	298.15	5.0		
cephalexin + H <sub>2</sub> O = 7-aminodeacetoxycephalosporanic acid + D(-)-α-aminophenylacetic acid	0.044	3.5.1.11	298.15	5.8		
cephaloridine + H <sub>2</sub> O = 2-thienylacetic acid + 7-amino-3-(1-pyridyl-methyl)-3-cephem-4-carboxylic acid	0.015	3.5.1.11	298.15	5.0		
penicillin G + H <sub>2</sub> O = 6-aminopenicillanic acid + phenylacetic acid	0.445	3.5.1.11	298.15	6.71		
N-acetyl-L-alanine + H <sub>2</sub> O = acetate + L-alanine	7	3.5.1.14	298.15	6.0		
ampicillin + H <sub>2</sub> O = ampicillinic acid	95	3.5.2.6	282.35	5.55		
penicillin G + H <sub>2</sub> O = penicillinic acid	2.9	3.5.2.6	298.15	6.01		
cytidine + H <sub>2</sub> O = uridine + ammonia	1.03·10 <sup>4</sup>	3.5.4.5	298.15	7.00		
N <sup>3</sup> -methylcytidine + H <sub>2</sub> O = uridine + methylamine	4.88·10 <sup>2</sup>	3.5.4.5	298.15	7.50		
5,10-methenyltetrahydrofolate + H <sub>2</sub> O = 10-formyltetrahydrofolate	50	3.5.4.9	298.15	7.0		
ITP + oxaloacetate + H <sub>2</sub> O = IDP + phosphoenolpyruvate + carbon dioxide	12	4.1.1.32	303.15	7.6		
2-deoxy-D-ribose 5-phosphate = D-glyceraldehyde 3-phosphate + acetaldehyde	2.5·10 <sup>-4</sup>	4.1.2.4	295.15	7.5		
6-phospho-2-dehydro-3-deoxy-D-gluconate = pyruvate + D-glyceraldehyde 3-phosphate	1.2·10 <sup>-3</sup>	4.1.2.14	298.15	8.0	0.37	
L-fuculose 1-phosphate = glycerone phosphate + (S)-lactaldehyde	4.6·10 <sup>-4</sup>	4.1.2.17	310.15	7.2		
L-rhamnulose 1-phosphate = glycerone phosphate + (S)-lactaldehyde	0.083	4.1.2.19	310.15	7.5		
isocitrate = succinate + glyoxylate	2.3·10 <sup>-3</sup>	4.1.3.1	303.15	7.7		
(S)-2-methylmalate = acetate + pyruvate	0.151	4.1.3.22	298.15	7.4	0.845	
isocitrate = citrate	14.7	4.2.1.3	298.15	7.4		
3-dehydroquinate = 3-dehydroshikimate + H <sub>2</sub> O	15	4.2.1.10	302.15	7.4		
(3R)-3-hydroxybutanoyl-CoA = <i>cis</i> -but-2-enoyl-CoA + H <sub>2</sub> O	0.18	4.2.1.17	298.15	7.5		
indole + D-glyceraldehyde 3-phosphate = 1-(indol-3-yl)glycerol 3-phosphate	1.2·10 <sup>4</sup>	4.2.1.20	298.15	7.54		
(R)-malate = maleate + H <sub>2</sub> O	4.88·10 <sup>-4</sup>	4.2.1.31	298.15	7.00	0.10	
(R)-2-methylmalate = 2-methylmaleate + H <sub>2</sub> O	0.0962	4.2.1.35	298.15	7.0	0.10	
D-glutamate = 5-oxo-D-proline + H <sub>2</sub> O	24.3	4.2.1.48	293.4	7.9		
L-threo-3-methylaspartate = 2-methylfumarate + ammonia	0.238	4.3.1.2	298.15	7.9		
L-histidine = urocanate + ammonia	3.01	4.3.1.3	298.25	8.41	0.167	
L-phenylalanine = <i>trans</i> -cinnamate + ammonia	2.47	4.3.1.5	298.05	7.69		
ATP = adenosine 3':5'-(cyclic)phosphate + diphosphate	0.065	4.6.1.1	298.15	7.0		
L,L-2,6-diaminoheptanedioate = <i>meso</i> -diaminoheptanedioate	1.9	5.1.1.7	310.15	7.0		
D-ribose 5-phosphate = D-xylulose 5-phosphate	1.82	5.1.3.1	311.15	7.0	0.25	3.0
UDPglucose = UDPgalactose	0.33	5.1.3.2	298.15	8.7		
GDPmannose = GDP-L-galactose	0.52	5.1.3.18	310.15	8.0		
all- <i>trans</i> -retinal = 11- <i>cis</i> -retinal	0.05	5.2.1.3	309.15	7.0		

Reaction	$K'$	Enzyme Commission Number	$T$		$I$	
			$K$	pH	mol-dm <sup>-3</sup>	pMg
9- <i>cis</i> ,12- <i>cis</i> -octadecadienoate = 9- <i>cis</i> ,11- <i>trans</i> -octadecadienoate	61	5.2.1.5	308.15	7.0		
D-erythrose = D-erythrulose	2.3	5.3.1.2	308.15	5.8		
D-arabinose = D-ribulose	0.146	5.3.1.3	320.25	7.4		
L-fucose = L-fuculose	0.12	5.3.1.3	310.15	8.0		
L-arabinose = L-ribulose	0.11	5.3.1.4	298.15	7.0		
D-psicose = $\beta$ -D-allose	2.15	5.3.1.4	317.25	7.4		
D-ribose 5-phosphate = D-ribulose 5-phosphate	0.83	5.3.1.6	311.15	7.0	0.25	3.0
D-rhamnose = D-rhamnulose	0.58	5.3.1.7	303.15	7.4		
D-mannose 6-phosphate = D-fructose 6-phosphate	0.99	5.3.1.8	298.15	8.50		
6-amino-D-glucose 6-phosphate = 6-amino-D-fructose 6-phosphate	0.202	5.3.1.9	278.85	8.7		
D-glucosamine 6-phosphate + H <sub>2</sub> O = D-fructose 6-phosphate + ammonia	0.15	5.3.1.10	310.15	8.4		
D-lyxose = D-xylulose	0.23	5.3.1.15	298.15	7.0		
D-ribose = D-ribulose	0.391	5.3.1.20	313.15	7.4		
<i>keto</i> -phenylpyruvate = <i>enol</i> -phenylpyruvate	0.1	5.3.2.1	298.15	7.8		
L-lysine = (3 <i>S</i> )-3,6-diaminohexanoate	5.3	5.4.3.2	303.15	7.7		
( <i>R</i> )-methylmalonyl-CoA = succinyl-CoA	23.1	5.4.99.2	298.15	7.4		
(-)-4-carboxymethyl- $\Delta^{\alpha}$ -but-2-en-4-olide = <i>cis,trans</i> -hexadienedioate	4.0	5.5.1.1	303.15	8.0		
ATP + heptanoate + CoA = AMP + diphosphate + <i>n</i> -heptanoyl-CoA	1.11	6.2.1.2	311.15	8.0		
GTP + succinate + CoA = GDP + phosphate + succinyl-CoA	1.68	6.2.1.4	298.15	7.15	0.25	2.91
GTP + IMP + L-aspartate = GDP + phosphate + adenylosuccinate	2.9	6.3.4.4	310.15	8.0		
ATP + L-citrulline + L-aspartate = AMP + diphosphate + L-arginosuccinate	2.14	6.3.4.5	311.15	6.91		
ATP + propanoyl-CoA + carbon dioxide = ADP + phosphate + ( <i>S</i> )-methylmalonyl-CoA	8.1·10 <sup>-3</sup>	6.4.1.3	310.15	8.15		

## PREPARATION OF SPECIAL ANALYTICAL REAGENTS

**Aluminon (qualitative test for aluminum).** Aluminon is a trade name for the ammonium salt of aurintricarboxylic acid. Dissolve 1 g of the salt in 1 L of distilled water. Shake the solution well to insure thorough mixing.

**Bang's reagent (for glucose estimation).** Dissolve 100 g of  $K_2CO_3$ , 66 g of KCl and 160 g of  $KHCO_3$  in the order given in about 700 mL of water at 30°C. Add 4.4 g of  $CuSO_4$  and dilute to 1 L after the  $CO_2$  is evolved. This solution should be shaken only in such a manner as not to allow entry of air. After 24 hours 300 mL are diluted to 1 L with saturated KCl solution, shaken gently and used after 24 hours; 50 mL is equivalent to 10 mg glucose.

**Barfoed's reagent (test for glucose).** See Cupric acetate.

**Baudisch's reagent.** See Cupferron.

**Benedict's solution (qualitative reagent for glucose).** With the aid of heat, dissolve 173 g of sodium citrate and 100 g of  $Na_2CO_3$  in 800 mL of water. Filter, if necessary, and dilute to 850 mL. Dissolve 17.3 g of  $CuSO_4 \cdot 5H_2O$  in 100 mL of water. Pour the latter solution, with constant stirring, into the carbonate-citrate solution, and dilute to 1 L.

**Benzidine hydrochloride solution (for sulfite determination).** Make a paste of 8 g of benzidine hydrochloride ( $C_{12}H_8(NH_3)_2 \cdot 2HCl$ ) and 20 mL of water, add 20 mL of HCl (sp. gr. 1.12) and dilute to 1 L with water. Each mL of this solution is equivalent to 0.00357 g of  $H_2SO_4$ .

**Bertrand's reagent (glucose estimation).** Consists of the following solutions:

1. Dissolve 200 g of Rochelle salt and 150 g of NaOH in sufficient water to make 1 L of solution.
2. Dissolve 40 g of  $CuSO_4$  in enough water to make 1 L of solution.
3. Dissolve 50 g of  $Fe_2(SO_4)_3$  and 200 g of  $H_2SO_4$  (sp. gr. 1.84) in sufficient water to make 1 L of solution.
4. Dissolve 5 g of  $KMnO_4$  in sufficient water to make 1 L of solution.

**Bial's reagent (for pentose).** Dissolve 1 g of orcinol (5-methyl-1,3-benzenediol) in 500 mL of 30% HCl to which 30 drops of a 10% solution of  $FeCl_3$  has been added.

**Boutron — Boudet soap solution:**

1. Dissolve 100 g of pure castile soap in about 2.5 L of 56% ethanol.
2. Dissolve 0.59 g of  $Ba(NO_3)_2$  in 1 L of water.

Adjust the castile soap solution so that 2.4 mL of it will give a permanent lather with 40 mL of solution (b). When adjusted, 2.4 mL of soap solution is equivalent to 220 parts per million of hardness (as  $CaCO_3$ ) for a 40 mL sample. See also Soap solution.

**Brucke's reagent (protein precipitation).** See Potassium iodide-mercuric iodide.

**Clarke's soap solution (estimation of hardness in water).**

1. Dissolve 100 g of pure powdered castile soap in 1 L of 80% ethanol and allow to stand over night.
2. Prepare a solution of  $CaCl_2$  by dissolving 0.5 g of  $CaCO_3$  in HCl (sp. gr. 1.19), neutralize with  $NH_4OH$  and make slightly alkaline to litmus, and dilute to 500 mL. One mL is equivalent to 1 mg of  $CaCO_3$ .

Titrate (1) against (2) and dilute (1) with 80% ethanol until 1 mL of the resulting solution is equivalent to 1 mL of (2) after making allowance for the lather factor (the amount of standard soap solution required to produce a permanent lather in 50 mL of distilled water). One mL of the adjusted solution after subtracting the lather factor is equivalent to 1 mg of  $CaCO_3$ . See also Soap solution.

**Cobalticyanide paper (Rinnmann's test for Zn).** Dissolve 4 g of  $K_3Co(CN)_6$  and 1 g of  $KClO_3$  in 100 mL of water. Soak filter paper in solution and dry at 100°C. Apply drop of zinc solution and burn in an evaporating dish. A green disk is obtained if zinc is present.

**Cochineal.** Extract 1 g of cochineal for 4 days with 20 mL of alcohol and 60 mL of distilled water. Filter.

**Congo red.** Dissolve 0.5 g of congo red in 90 mL of distilled water and 10 mL of alcohol.

**Cupferron (Baudisch's reagent for iron analysis).** Dissolve 6 g of the ammonium salt of *N*-hydroxy-*N*-nitrosoaniline (cupferron) in 100 mL of  $H_2O$ . Reagent good for 1 week only and must be kept in the dark.

**Cupric acetate (Barfoed's reagent for reducing monosaccharides).** Dissolve 66 g of cupric acetate and 10 mL of glacial acetic acid in water and dilute to 1 L.

**Cupric oxide, ammoniacal; Schweitzer's reagent (dissolves cotton, linen, and silk, but not wool).**

1. Dissolve 5 g of cupric sulfate in 100 mL of boiling water, and add sodium hydroxide until precipitation is complete. Wash the precipitate well, and dissolve it in a minimum quantity of ammonium hydroxide.
2. Bubble a slow stream of air through 300 mL of strong ammonium hydroxide containing 50 g of fine copper turnings. Continue for 1 hour.

**Cupric sulfate in glycerin-potassium hydroxide (reagent for silk).** Dissolve 10 g of cupric sulfate,  $CuSO_4 \cdot 5H_2O$ , in 100 mL of water and add 5 g of glycerol. Add KOH solution slowly until a deep blue solution is obtained.

**Cupron (precipitates copper).** Dissolve 5 g of benzoinoxime in 100 mL of 95% ethanol.

**Cuprous chloride, acidic (reagent for CO in gas analysis).**

1. Cover the bottom of a 2-L flask with a layer of cupric oxide about 0.5 inch deep, suspend a coil of copper wire so as to reach from the bottom to the top of the solution, and fill the flask with hydrochloric acid (sp. gr. 1.10). Shake occasionally. When the solution becomes nearly colorless, transfer to reagent bottles, which should also contain copper wire. The stock bottle may be refilled with dilute hydrochloric acid until either the cupric oxide or the copper wire is used up. Copper sulfate may be substituted for copper oxide in the above procedure.
2. Dissolve 340 g of  $CuCl_2 \cdot 2H_2O$  in 600 mL of conc. HCl and reduce the cupric chloride by adding 190 mL of a saturated solution of stannous chloride or until the solution is colorless. The stannous chloride is prepared by treating 300 g of metallic tin in a 500 mL flask with conc. HCl until no more tin goes into solution.
3. (Winkler method). Add a mixture of 86 g of CuO and 17 g of finely divided metallic Cu, made by the reduction of CuO with hydrogen, to a solution of HCl, made by dilut-

ing 650 mL of conc. HCl with 325 mL of water. After the mixture has been added slowly and with frequent stirring, a spiral of copper wire is suspended in the bottle, reaching all the way to the bottom. Shake occasionally, and when the solution becomes colorless, it is ready for use.

**Cuprous chloride, ammoniacal (reagent for CO in gas analysis).**

1. The acid solution of cuprous chloride as prepared above is neutralized with ammonium hydroxide until an ammonia odor persists. An excess of metallic copper must be kept in the solution.
2. Pour 800 mL of acidic cuprous chloride, prepared by the Winkler method, into about 4 L of water. Transfer the precipitate to a 250 mL graduate. After several hours, siphon off the liquid above the 50 mL mark and refill with 7.5%  $\text{NH}_4\text{OH}$  solution which may be prepared by diluting 50 mL of conc.  $\text{NH}_4\text{OH}$  with 150 mL of water. The solution is well shaken and allowed to stand for several hours. It should have a faint odor of ammonia.

**Dichlorofluorescein indicator.** Dissolve 1 g in 1 L of 70% alcohol or 1 g of the sodium salt in 1 L of water.

**Dimethylglyoxime, 0.01 N.** Dissolve 0.6 g of dimethylglyoxime (2,3-butanedione oxime) in 500 mL of 95% ethanol. This is an especially sensitive test for nickel, a very definite crimson color being produced.

**Diphenylamine (reagent for rayon).** Dissolve 0.2 g in 100 mL of concentrated sulfuric acid.

**Diphenylamine sulfonate (for titration of iron with  $\text{K}_2\text{Cr}_2\text{O}_7$ ).** Dissolve 0.32 g of the barium salt of diphenylamine sulfonic acid in 100 mL of water, add 0.5 g of sodium sulfate and filter off the precipitate of  $\text{BaSO}_4$ .

**Diphenylcarbazide.** Dissolve 0.2 g of diphenylcarbazide in 10 mL of glacial acetic acid and dilute to 100 mL with 95% ethanol.

**Esbach's reagent (estimation of protein).** To a water solution of 10 g of picric acid and 20 g of citric acid, add sufficient water to make 1 L of solution.

**Eschka's compound.** Two parts of calcined ("light") magnesia are thoroughly mixed with 1 part of anhydrous sodium carbonate.

**Fehling's solution (reagent for reducing sugars.)**

1. Copper sulfate solution. Dissolve 34.66 g of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  in water and dilute to 500 mL.
2. Alkaline tartrate solution. Dissolve 173 g of potassium sodium tartrate (Rochelle salt,  $\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ ) and 50 g of NaOH in water and dilute when cold to 500 mL.

Mix equal volumes of the two solutions at the time of using.

**Ferric-alum indicator.** Dissolve 140 g of ferric ammonium sulfate crystals in 400 mL of hot water. When cool, filter, and make up to a volume of 500 mL with dilute nitric acid.

**Folin's mixture (for uric acid).** To 650 mL of water add 500 g of  $(\text{NH}_4)_2\text{SO}_4$ , 5 g of uranium acetate, and 6 g of glacial acetic acid. Dilute to 1 L.

**Formaldehyde — sulfuric acid (Marquis' reagent for alkaloids).** Add 10 mL of formaldehyde solution to 50 mL of sulfuric acid.

**Froehde's reagent.** See Sulfomolybdic acid.

**Fuchsin (reagent for linen).** Dissolve 1 g of fuchsin in 100 mL of alcohol.

**Fuchsin — sulfurous acid (Schiff's reagent for aldehydes).**

Dissolve 0.5 g of fuchsin and 9 g of sodium bisulfite in 500 mL of water, and add 10 mL of HCl. Keep in well-stoppered bottles and protect from light.

**Gunzberg's reagent (detection of HCl in gastric juice).** Prepare as needed a solution containing 4 g of phloroglucinol (1,3,5-benzenetriol) and 2 g of vanillin in 100 mL of absolute ethanol.

**Hager's reagent.** See Picric acid.

**Hanus solution (for iodine number).** Dissolve 13.2 g of resublimed iodine in 1 L of glacial acetic acid which will pass the dichromate test for reducible matter. Add sufficient bromine to double the halogen content, determined by titration (3 mL is about the proper amount). The iodine may be dissolved by the aid of heat, but the solution should be cold when the bromine is added.

**Iodine, tincture of.** To 50 mL of water add 70 g of  $\text{I}_2$  and 50 g of KI. Dilute to 1 L with alcohol.

**Iodo-potassium iodide (Wagner's reagent for alkaloids).** Dissolve 2 g of iodine and 6 g of KI in 100 mL of water.

**Litmus (indicator).** Extract litmus powder three times with boiling alcohol, each treatment consuming an hour. Reject the alcoholic extract. Treat residue with an equal weight of cold water and filter; then exhaust with five times its weight of boiling water, cool and filter. Combine the aqueous extracts.

**Magnesia mixture (reagent for phosphates and arsenates).** Dissolve 55 g of magnesium chloride and 105 g of ammonium chloride in water, barely acidify with hydrochloric acid, and dilute to 1 L. The ammonium hydroxide may be omitted until just previous to use. The reagent, if completely mixed and stored for any period of time, becomes turbid.

**Magnesium uranyl acetate.** Dissolve 100 g of  $\text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$  in 60 mL of glacial acetic acid and dilute to 500 mL. Dissolve 330 g of  $\text{Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$  in 60 mL of glacial acetic acid and dilute to 200 mL. Heat solutions to the boiling point until clear, pour the magnesium solution into the uranyl solution, cool and dilute to 1 L. Let stand over night and filter if necessary.

**Marme's reagent.** See Potassium-cadmium iodide.

**Marquis' reagent.** See Formaldehyde-sulfuric acid.

**Mayer's reagent (white precipitate with most alkaloids in slightly acid solutions).** Dissolve 1.358 g of  $\text{HgCl}_2$  in 60 mL of water and pour into a solution of 5 g of KI in 10 mL of  $\text{H}_2\text{O}$ . Add sufficient water to make 100 mL.

**Methyl orange indicator.** Dissolve 1 g of methyl orange in 1 L of water. Filter, if necessary.

**Methyl orange, modified.** Dissolve 2 g of methyl orange and 2.8 g of xylene cyanole FF in 1 L of 50% alcohol.

**Methyl red indicator.** Dissolve 1 g of methyl red in 600 mL of alcohol and dilute with 400 mL of water.

**Methyl red, modified.** Dissolve 0.50 g of methyl red and 1.25 g of xylene cyanole FF in 1 L of 90% alcohol. Or, dissolve 1.25 g of methyl red and 0.825 g of methylene blue in 1 L of 90% alcohol.

**Millon's reagent (for albumins and phenols).** Dissolve 1 part of mercury in 1 part of cold fuming nitric acid. Dilute with twice the volume of water and decant the clear solution after several hours.

**Molisch's reagent.** See 1-Naphthol.

**1-Naphthol (Molisch's reagent for wool).** Dissolve 15 g of 1-naphthol in 100 mL of alcohol or chloroform.

**Nessler's reagent (for ammonia).** Dissolve 50 g of KI in the smallest possible quantity of cold water (50 mL). Add a saturated solution of mercuric chloride (about 22 g in 350 mL of water will be needed) until an excess is indicated by the formation of a precipitate. Then add 200 mL of 5 N NaOH and dilute to 1 L. Let settle, and draw off the clear liquid.

**Nickel oxide, ammoniacal (reagent for silk).** Dissolve 5 g of nickel sulfate in 100 mL of water, and add sodium hydroxide solution until nickel hydroxide is completely precipitated. Wash the precipitate well and dissolve in 25 mL of concentrated ammonium hydroxide and 25 mL of water.

**Nitron (detection of nitrate radical).** Dissolve 10 g of nitron (1,4-diphenyl-3-(phenylamino)-1,2,4-triazolium hydroxide) in 5 mL of glacial acetic acid and 95 mL of water. The solution may be filtered with slight suction through an alundum crucible and kept in a dark bottle.

**1-Nitroso-2-naphthol.** Make a saturated solution in 50% acetic acid (1 part of glacial acetic acid with 1 part of water). Does not keep well.

**Nylander's solution (carbohydrates).** Dissolve 20 g of bismuth subnitrate and 40 g of Rochelle salt in 1 L of 8% NaOH solution. Cool and filter.

**Obermayer's reagent (for indoxyl in urine).** Dissolve 4 g of  $\text{FeCl}_3$  in 1 L of HCl (sp. gr. 1.19).

**Oxine.** Dissolve 14 g of 8-hydroxyquinoline in 30 mL of glacial acetic acid. Warm slightly, if necessary. Dilute to 1 L.

**Oxygen absorbent.** Dissolve 300 g of ammonium chloride in 1 L of water and add 1 L of concentrated ammonium hydroxide solution. Shake the solution thoroughly. For use as an oxygen absorbent, a bottle half full of copper turnings is filled nearly full with the  $\text{NH}_4\text{Cl-NH}_4\text{OH}$  solution and the gas passed through.

**Pasteur's salt solution.** To 1 L of distilled water add 2.5 g of potassium phosphate, 0.25 g of calcium phosphate, 0.25 g of magnesium sulfate, and 12.00 g of ammonium tartrate.

**Pavy's solution (glucose reagent).** To 120 mL of Fehling's solution, add 300 mL of  $\text{NH}_4\text{OH}$  (sp. gr. 0.88) and dilute to 1 L with water.

**Phenanthroline ferrous ion indicator.** Dissolve 1.485 g of 1,10-phenanthroline monohydrate in 100 mL of 0.025 M ferrous sulfate solution.

**Phenolphthalein.** Dissolve 1 g of phenolphthalein in 50 mL of alcohol and add 50 mL of water.

**Phenolsulfonic acid (determination of nitrogen as nitrate).** Dissolve 25 g of phenol in 150 mL of conc.  $\text{H}_2\text{SO}_4$ , add 75 mL of fuming  $\text{H}_2\text{SO}_4$  (15%  $\text{SO}_3$ ), stir well and heat for 2 hours at  $100^\circ\text{C}$ .

**Phloroglucinol solution (pentosans).** Make a 3% phloroglucinol (1,3,5-benzenetriol) solution in alcohol. Keep in a dark bottle.

**Phosphomolybdic acid (Sonnenschein's reagent for alkaloids).**

1. Prepare ammonium phosphomolybdate and after washing with water, boil with nitric acid and expel  $\text{NH}_3$ ; evaporate to dryness and dissolve in 2 M nitric acid.
2. Dissolve ammonium molybdate in  $\text{HNO}_3$  and treat with phosphoric acid. Filter, wash the precipitate, and boil with aqua regia until the ammonium salt is decomposed. Evaporate to dryness. The residue dissolved in 10%  $\text{HNO}_3$  constitutes Sonnenschein's reagent.

**Phosphoric acid — sulfuric acid mixture.** Dilute 150 mL of conc.  $\text{H}_2\text{SO}_4$  and 100 mL of conc.  $\text{H}_3\text{PO}_4$  (85%) with water to a volume of 1 L.

**Phosphotungstic acid (Schcibicr's reagent for alkaloids).**

1. Dissolve 20 g of sodium tungstate and 15 g of sodium phosphate in 100 mL of water containing a little nitric acid.
2. The reagent is a 10% solution of phosphotungstic acid in water. The phosphotungstic acid is prepared by evaporating a mixture of 10 g of sodium tungstate dissolved in 5 g of phosphoric acid (sp. gr. 1.13) and enough boiling water to effect solution. Crystals of phosphotungstic acid separate.

**Picric acid (Hager's reagent for alkaloids, wool and silk).** Dissolve 1 g of picric acid in 100 mL of water.

**Potassium antimonate (reagent for sodium).** Boil 22 g of potassium antimonate with 1 L of water until nearly all of the salt has dissolved, cool quickly, and add 35 mL of 10% potassium hydroxide. Filter after standing overnight.

**Potassium-cadmium iodide (Marme's reagent for alkaloids).** Add 2 g of  $\text{CdI}_2$  to a boiling solution of 4 g of KI in 12 mL of water, and then mix with 12 mL of saturated KI solution.

**Potassium hydroxide (for  $\text{CO}_2$  absorption).** Dissolve 360 g of KOH in water and dilute to 1 L.

**Potassium iodide — mercuric iodide (Brucke's reagent for proteins).** Dissolve 50 g of KI in 500 mL of water, and saturate with mercuric iodide (about 120 g). Dilute to 1 L.

**Potassium pyrogallate (for oxygen absorption).** For mixtures of gases containing less than 28% oxygen, add 100 mL of KOH solution (50 g of KOH to 100 mL of water) to 5 g of pyrogallol. For mixtures containing more than 28% oxygen the KOH solution should contain 120 g of KOH to 100 mL of water.

**Pyrogallol, alkaline.**

1. Dissolve 75 g of pyrogallol in 75 mL of water.
2. Dissolve 500 g of KOH in 250 mL of water. When cool, adjust until sp. gr. is 1.55.

For use, add 270 mL of solution (2) to 30 mL of solution (1).

**Rosolic acid (indicator).** Dissolve 1 g of rosolic acid in 10 mL of alcohol and add 100 mL of water.

**Scheibler's reagent.** See Phosphotungstic acid.

**Schiff's reagent.** See Fuchsin-sulfurous acid.

**Schweitzer's reagent.** See Cupric oxide, ammoniacal.

**Soap solution (reagent for hardness in water).** Dissolve 100 g of dry castile soap in 1 L of 80% alcohol (5 parts alcohol to 1 part water). Allow to stand several days and dilute with 70% to 80% alcohol until 6.4 mL produces a permanent lather with 20 mL of standard calcium solution. The latter solution is made by dissolving 0.2 g of  $\text{CaCO}_3$  in a small amount of dilute HCl, evaporating to dryness and making up to 1 L.

**Sodium bismuthate (oxidation of manganese).** Heat 20 parts of NaOH nearly to redness in an iron or nickel crucible and add slowly 10 parts of basic bismuth nitrate which has been previously dried. Add 2 parts of sodium peroxide, and pour the brownish-yellow fused mass onto an iron plate to cool. When cold, break up in a mortar, extract with water, and collect on an asbestos filter.

**Sodium hydroxide (for  $\text{CO}_2$  absorption).** Dissolve 330 g of NaOH in water and dilute to 1 L.

**Sodium nitroprusside (reagent for hydrogen sulfide and wool).**

Use a freshly prepared solution of 1 g of sodium nitroferricyanide in 10 mL of water.

**Sodium oxalate (primary standard).** Dissolve 30 g of the commercial salt in 1 L of water, make slightly alkaline with sodium hydroxide, and let stand until perfectly clear. Filter and evaporate the filtrate to 100 mL. Cool and filter. Pulverize the residue and wash it several times with small volumes of water. The procedure is repeated until the mother liquor is free from sulfate and is neutral to phenolphthalein.

**Sodium plumbite (reagent for wool).** Dissolve 5 g of sodium hydroxide in 100 mL of water. Add 5 g of litharge (PbO) and boil until dissolved.

**Sodium polysulfide.** Dissolve 480 g of  $\text{Na}_2\text{S}\cdot 9\text{H}_2\text{O}$  in 500 mL of water, add 40 g of NaOH and 18 g of sulfur. Stir thoroughly and dilute to 1 L with water.

**Sonnenschein's reagent.** See Phosphomolybdic acid.

**Starch solution.**

1. Make a paste with 2 g of soluble starch and 0.01 g of  $\text{HgI}_2$  with a small amount of water. Add the mixture slowly to 1 L of boiling water and boil for a few minutes. Keep in a glass stoppered bottle. If other than soluble starch is used, the solution will not clear on boiling; it should be allowed to stand and the clear liquid decanted.
2. A solution of starch which keeps indefinitely is made as follows: Mix 500 mL of saturated NaCl solution (filtered), 80 mL of glacial acetic acid, 20 mL of water and 3 g of starch. Bring slowly to a boil and boil for 2 minutes.
3. Make a paste with 1 g of soluble starch and 5 mg of  $\text{HgI}_2$ , using as little cold water as possible. Then pour about 200 mL of boiling water on the paste and stir immediately. This will give a clear solution if the paste is prepared correctly and the water actually boiling. Cool and add 4 g of KI. Starch solution decomposes on standing due to bacterial action, but this solution will keep well if stored under a layer of toluene.

**Stoke's reagent.** Dissolve 30 g of  $\text{FeSO}_4$  and 20 g of tartaric acid in water and dilute to 1 L. Just before using, add concentrated  $\text{NH}_4\text{OH}$  until the precipitate first formed is redissolved.

**Sulfanilic acid (reagent for nitrites).** Dissolve 0.5 g of sulfanilic acid in a mixture of 15 mL of glacial acetic acid and 135 mL of recently boiled water.

**Sulfomolybdic acid (Froehde's reagent for alkaloids and glucosides).** Dissolve 10 g of molybdic acid or sodium molybdate in 100 mL of conc.  $\text{H}_2\text{SO}_4$ .

**Tannic acid (reagent for albumin, alkaloids, and gelatin).** Dissolve 10 g of tannic acid in 10 mL of alcohol and dilute with water to 100 mL.

**Titration mixture (residual chlorine in water analysis).** Prepare 1 L of dilute HCl (100 mL of HCl (sp. gr. 1.19) in sufficient water to make 1 L). Dissolve 1 g of *o*-tolidine in 100 mL of the dilute HCl and dilute to 1 L with dilute HCl solution.

**Trinitrophenol solution.** See Picric acid.

**Turmeric tincture (reagent for borates).** Digest ground turmeric root with several quantities of water which are discarded. Dry the residue and digest it several days with six times its weight of alcohol. Filter.

**Uffelmann's reagent (turns yellow in presence of lactic acid).** To a 2% solution of pure phenol in water, add a water solution of  $\text{FeCl}_3$  until the phenol solution becomes violet in color.

**Wagner's reagent.** See Iodo-potassium iodide.

**Wagner's solution (used in phosphate rock analysis to prevent precipitation of iron and aluminum).** Dissolve 25 g of citric acid and 1 g of salicylic acid in water and dilute to 1 L. Use 50 mL of the reagent.

**Wij's iodine monochloride solution (for iodine number).** Dissolve 13 g of resublimed iodine in 1 L of glacial acetic acid which will pass the dichromate test for reducible matter. Set aside 25 mL of this solution. Pass into the remainder of the solution dry chlorine gas (dried and washed by passing through  $\text{H}_2\text{SO}_4$  (sp. gr. 1.84)) until the characteristic color of free iodine has been discharged. Now add the iodine solution which was reserved, until all free chlorine has been destroyed. A slight excess of iodine does little or no harm, but an excess of chlorine must be avoided. Preserve in well stoppered, amber colored bottles. Avoid use of solutions which have been prepared for more than 30 days.

**Wij's special solution (for iodine number).** To 200 mL of glacial acetic acid that will pass the dichromate test for reducible matter, add 12 g of dichloramine T (*N,N*-dichloro-4-methylbenzenesulfonamide), and 16.6 g of dry KI (in small quantities with continual shaking until all the KI has dissolved). Make up to 1 L with the same quality of acetic acid used above and preserve in a dark colored bottle.

**Zimmermann-Reinhardt reagent (determination of iron).** Dissolve 70 g of  $\text{MnSO}_4\cdot 4\text{H}_2\text{O}$  in 500 mL of water, add 125 mL of conc.  $\text{H}_2\text{SO}_4$  and 125 mL of 85%  $\text{H}_3\text{PO}_4$ , and dilute to 1 L.

**Zinc chloride solution, basic (reagent for silk).** Dissolve 1000 g of zinc chloride in 850 mL of water, and add 40 g of zinc oxide. Heat until solution is complete.

**Zinc uranyl acetate (reagent for sodium).** Dissolve 10 g of  $\text{UO}_2(\text{C}_2\text{H}_3\text{O}_2)_2\cdot 2\text{H}_2\text{O}$  in 6 g of 30% acetic acid with heat, if necessary, and dilute to 50 mL. Dissolve 30 g of  $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2\cdot \text{H}_2\text{O}$  in 3 g of 30% acetic acid and dilute to 50 mL. Mix the two solutions, add 50 mg of NaCl, allow to stand overnight and filter.

## STANDARD SOLUTIONS OF ACIDS, BASES, AND SALTS

For each compound listed, the last column of this table gives the mass in grams which is contained in 1 liter of a solution whose amount-of-substance concentration divided by the equivalence factor of the compound equals 0.1 mol/L. In the older literature such a solution is often referred to as a "decinormal solution" (0.1 N).

### Reference

*Compendium of Analytical Nomenclature (IUPAC)*, Pergamon Press, Oxford, 1978.

Name	Formula	Atomic or molecular weight	Equivalence factor	Mass in grams
Acetic acid	$\text{HC}_2\text{H}_3\text{O}_2$	60.0530	1	6.0053
Ammonia	$\text{NH}_3$	17.0306	1	1.7031
Ammonium ion	$\text{NH}_4^+$	18.0386	1	1.8039
Ammonium chloride	$\text{NH}_4\text{Cl}$	53.4916	1	5.3492
Ammonium sulfate	$(\text{NH}_4)_2\text{SO}_4$	132.1388	1/2	6.6069
Ammonium thiocyanate	$\text{NH}_4\text{CNS}$	76.1204	1	7.6120
Barium	Ba	137.34	1/2	6.867
Barium carbonate	$\text{BaCO}_3$	197.3494	1/2	9.8675
Barium chloride hydrate	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	244.2767	1/2	12.2138
Barium hydroxide	$\text{Ba}(\text{OH})_2$	171.3547	1/2	8.5677
Barium oxide	BaO	153.3394	1/2	7.6670
Bromine	Br	79.909	1	7.9909
Calcium	Ca	40.08	1/2	2.004
Calcium carbonate	$\text{CaCO}_3$	100.0894	1/2	5.0045
Calcium chloride	$\text{CaCl}_2$	110.9860	1/2	5.5493
Calcium chloride hydrate	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	219.0150	1/2	10.9508
Calcium hydroxide	$\text{Ca}(\text{OH})_2$	74.0947	1/2	3.7047
Calcium oxide	CaO	56.0794	1/2	2.8040
Chlorine	Cl	35.453	1	3.5453
Citric acid	$\text{C}_6\text{H}_8\text{O}_7 \cdot \text{H}_2\text{O}$	210.1418	1/3	7.0047
Cobalt	Co	58.9332	1/2	2.9466
Copper	Cu	63.54	1/2	3.177
Copper oxide (cupric)	CuO	79.5394	1/2	3.9770
Copper sulfate hydrate	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	249.6783	1/2	12.4839
Hydrochloric acid	HCl	36.4610	1	3.6461
Hydrocyanic acid	HCN	27.0258	1	2.7026
Iodine	I	126.9044	1	12.6904
Lactic acid	$\text{C}_3\text{H}_6\text{O}_3$	90.0795	1	9.0080
Malic acid	$\text{C}_4\text{H}_6\text{O}_5$	134.0894	1/2	6.7045
Magnesium	Mg	24.312	1/2	1.2156
Magnesium carbonate	$\text{MgCO}_3$	84.3214	1/2	4.2161
Magnesium chloride	$\text{MgCl}_2$	95.2180	1/2	4.7609
Magnesium chloride hydrate	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	203.2370	1/2	10.1623
Magnesium oxide	MgO	40.3114	1/2	2.0156
Manganese	Mn	54.938	1/2	2.7469
Manganese sulfate	$\text{MnSO}_4$	150.9996	1/2	7.5500
Mercuric chloride	$\text{HgCl}_2$	271.4960	1/2	13.5748
Nickel	Ni	58.71	1/2	2.9356
Nitric acid	$\text{HNO}_3$	63.0129	1	6.3013
Oxalic acid	$\text{H}_2\text{C}_2\text{O}_4$	90.0358	1/2	4.5018
Oxalic acid hydrate	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	126.0665	1/2	6.3033
Oxalic acid anhydride	$\text{C}_2\text{O}_3$	72.0205	1/2	3.6010
Phosphoric acid	$\text{H}_3\text{PO}_4$	97.9953	1/3	3.2665
Potassium	K	39.102	1	3.9102
Potassium bicarbonate	$\text{KHCO}_3$	100.1193	1	10.0119
Potassium carbonate	$\text{K}_2\text{CO}_3$	138.2134	1/2	6.9106
Potassium chloride	KCl	74.5550	1	7.4555
Potassium cyanide	KCN	65.1199	1	6.5120
Potassium hydroxide	KOH	56.1094	1	5.6109

Name	Formula	Atomic or molecular weight	Equivalence factor	Mass in grams
Potassium oxide	$K_2O$	94.2034	1/2	4.7102
Potassium tartrate	$K_2H_4C_4O_6$	226.2769	1/2	11.3139
Silver	Ag	107.87	1	10.787
Silver nitrate	$AgNO_3$	169.8749	1	16.9875
Sodium	Na	22.9898	1	2.2990
Sodium bicarbonate	$NaHCO_3$	84.0071	1	8.4007
Sodium carbonate	$Na_2CO_3$	105.9890	1/2	5.2995
Sodium chloride	NaCl	58.4428	1	5.8443
Sodium hydroxide	NaOH	39.9972	1	3.9997
Sodium oxide	$Na_2O$	61.9790	1/2	3.0990
Sodium sulfide	$Na_2S$	78.0436	1/2	3.9022
Succinic acid	$H_2C_4H_4O_4$	118.0900	1/2	5.9045
Sulfuric acid	$H_2SO_4$	98.0775	1/2	4.9039
Tartaric acid	$C_4H_6O_6$	150.0888	1/2	7.5044
Zinc	Zn	65.37	1/2	3.269
Zinc sulfate hydrate	$ZnSO_4 \cdot 7H_2O$	287.5390	1/2	14.3769



## STANDARD SOLUTIONS OF OXIDATION AND REDUCTION REAGENTS

For each reagent listed, the last column of this table gives the mass in grams which is contained in a solution whose amount-of-substance concentration divided by the equivalence factor of the compound equals 0.1 mol/L. The equivalence factor given refers to the most common reactions of the reagent. In the older literature such a solution is often called a "decinormal solution" (0.1 N).

### Reference

*Compendium of Analytical Nomenclature (IUPAC)*, Pergamon Press, Oxford, 1978.

Name	Formula	Atomic or molecular weight	Equivalence factor	Mass in grams
Antimony	Sb	121.75	1/2	6.0875
Arsenic	As	74.9216	1/2	3.7461
Arsenic trisulfide	As <sub>2</sub> S <sub>3</sub>	246.0352	1/4	6.1509
Arsenous oxide	As <sub>2</sub> O <sub>3</sub>	197.8414	1/4	4.9460
Barium peroxide	BaO <sub>2</sub>	169.3388	1/2	8.4669
Barium peroxide hydrate	BaO <sub>2</sub> · 8H <sub>2</sub> O	313.4615	1/2	15.6730
Calcium	Ca	40.08	1/2	2.004
Calcium carbonate	CaCO <sub>3</sub>	100.0894	1/2	5.0045
Calcium hypochlorite	Ca(OCl) <sub>2</sub>	142.9848	1/4	3.5746
Calcium oxide	CaO	56.0794	1/2	2.8040
Chlorine	Cl	35.453	1	3.5453
Chromium trioxide	CrO <sub>3</sub>	99.9942	1/3	3.3331
Ferrous ammonium sulfate	FeSO <sub>4</sub> (NH <sub>4</sub> )SO <sub>4</sub> · 6H <sub>2</sub> O	392.0764	1	39.2076
Hydroferrocyanic acid	H <sub>4</sub> Fe(CN) <sub>6</sub>	215.9860	1	21.5986
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	34.0147	1/2	1.7007
Hydrogen sulfide	H <sub>2</sub> S	34.0799	1/2	1.7040
Iodine	I	126.9044	1	12.6904
Iron	Fe	55.847	1	5.5847
Iron oxide (ferrous)	FeO	71.8464	1	7.1846
Iron oxide (ferric)	Fe <sub>2</sub> O <sub>3</sub>	159.6922	1/2	7.9846
Lead peroxide	PbO <sub>2</sub>	239.1888	1/2	11.9594
Manganese dioxide	MnO <sub>2</sub>	86.9368	1/2	4.3468
Nitric acid	HNO <sub>3</sub>	63.0129	1/3	2.1004
Nitrogen trioxide	N <sub>2</sub> O <sub>3</sub>	76.0116	1/4	1.9002
Nitrogen pentoxide	N <sub>2</sub> O <sub>5</sub>	108.0104	1/6	1.8001
Oxalic acid	C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	90.0358	1/2	4.5018
Oxalic acid hydrate	C <sub>2</sub> H <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	126.0665	1/2	6.3033
Oxygen	O	15.9994	1/2	0.8000
Potassium dichromate	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	294.1918	1/6	4.9032
Potassium chlorate	KClO <sub>3</sub>	122.5532	1/6	2.0425
Potassium chromate	K <sub>2</sub> CrO <sub>4</sub>	194.1076	1/3	6.4733
Potassium ferrocyanide	K <sub>4</sub> Fe(CN) <sub>6</sub>	368.3621	1	36.8362
Potassium ferrocyanide hydrate	K <sub>4</sub> Fe(CN) <sub>6</sub> · 3H <sub>2</sub> O	422.4081	1	42.2408
Potassium iodide	KI	166.0064	1	16.6006
Potassium nitrate	KNO <sub>3</sub>	101.1069	1/3	3.3702
Potassium perchlorate	KClO <sub>4</sub>	138.5526	1/8	1.7319
Potassium permanganate	KMnO <sub>4</sub>	158.0376	1/5	3.1608
Sodium chlorate	NaClO <sub>3</sub>	106.4410	1/6	1.7740
Sodium nitrate	NaNO <sub>3</sub>	84.9947	1/3	2.8332
Sodium thiosulfate hydrate	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> · 5H <sub>2</sub> O	248.1825	1	24.8183
Stannous chloride	SnCl <sub>2</sub>	189.5960	1/2	9.4798
Stannous oxide	SnO	134.6894	1/2	6.7345
Sulfur dioxide	SO <sub>2</sub>	64.0628	1/2	3.2031
Tin	Sn	118.69	1/2	5.935

# ORGANIC ANALYTICAL REAGENTS FOR THE DETERMINATION OF INORGANIC SUBSTANCES

**G. Ackermann, L. Sommer, and D. Thorburn Burns**

Determination	Reagents	Ref.
Aluminium	Alizarin Red S	Onishi, Part II a, p 28. (5), Snell, <i>Metals I</i> , p 587. (7)
	Aluminon	Fries/Getrost, p 16. (2), Onishi, Ila, p 21. (5), Snell, <i>Metals I</i> , p 590. (7)
	Aluminon + Cetyltrimethylammonium bromide	Huaxue Shiji, 8, 85, (1986)
	Chrome Azurol S	Onishi, Part Ila, p 26. (5), Snell, <i>Metals I</i> , p 605. (7)
	Chrome Azurol S + Cetyltrimethylammonium bromide	Marczenko, p 133. (3), Snell, <i>Metals I</i> , p 606. (7)
	Chromazol KS + Cetylpyridinium bromide	<i>Analyst</i> , 107, 428, (1982).
	Eriochrome Cyanine R	Fries/Getrost, p 19. (2), Onishi, Part Ila, p 25. (5), Snell, <i>Metals I</i> , p 611. (7)
	Eriochrome Cyanine R + Cetyltrimethylammonium bromide	Snell, <i>Metals I</i> , p 613. (7), <i>Analyst</i> , 107, 1431, (1982).
8-Hydroxyquinoline		Fries/Getrost, p 22. (2), Marczenko, p 131. (3), Onishi, Part Ila, p 31. (5), Snell, <i>Metals I</i> , p 622. (7)
		Boltz, p 210 (1), Marczenko, p 413. (3), Snell, <i>Nonmetals</i> , p 604. (9)
Ammonia	Phenol + Sodium hypochlorite	Onishi, Part Ila, p 102. (5), Snell, <i>Metals I</i> , p 384. (7)
Antimony	Brilliant Green	<i>Talanta</i> , 13, 507, (1966).
	Bromopyrogallol Red	Fries/Getrost, p 32. (2), Marczenko, p 141. (3), Onishi, Part Ila, p 93. (5), Snell, <i>Metals I</i> , p 404. (7)
Arsenic	Rhodamine B	Fries/Getrost, p 36. (2)
	Silver diethyldithiocarbamate	Fries/Getrost, p 41. (2), Marczenko, p 153. (3), Onishi, Part Ila, p 153. (5), Snell, <i>Metals I</i> , p 370. (7)
Barium	Sulfonazo III	Fries/Getrost, p 46. (2), Snell, <i>Metals II</i> , p 1782. (8), Onishi, Part Ila, p 202. (5)
		Snell, <i>Metals I</i> , p 667. (7)
Beryllium	Beryllon II	Marczenko, p 163. (3), Snell, <i>Metals I</i> , p 672. (7)
	Chrome Azurol S	Marczenko, p 164. (3), Snell, <i>Metals I</i> , p 673. (7)
	Chrome Azurol S + Cetyltrimethylammonium bromide	Snell, <i>Metals I</i> , p 675. (7), <i>Talanta</i> , 31, 249, (1984).
	Eriochrome Cyanine R	Zh. <i>Anal. Khim.</i> , 33, 1298, (1978).
	Eriochrome Cyanine R + Cetyltrimethylammonium bromide	
Bismuth	Dithizone	Onishi, Part Ila, p 262. (5), Snell, <i>Metals I</i> , p 303. (7)
	Pyrocatechol Violet	Fres. <i>Z. Anal. Chem.</i> , 186, 418, (1962).
	Pyrocatechol Violet + Cetyltrimethylammonium bromide	Zh. <i>Anal. Khim.</i> , 38, 216, (1983).
	Thiourea	Onishi, Part Ila, p 260. (5), Snell, <i>Metals I</i> , p 317. (7)
Boron	Xylenol Orange	Fries/Getrost, p 57. (2), Marczenko, p 172. (3), Snell, <i>Metals I</i> , p 320. (7)
	Azomethine H	Snell, <i>Nonmetals</i> , p 165. (9)
	Carminic acid	Boltz, p 14. (1), Fries/Getrost, p 65. (2), Snell, <i>Nonmetals</i> , p 170. (9), Williams, p 35. (11)
	Curcumin	Boltz, p 8. (1), Fries/Getrost, p 68. (2), Marczenko, p 180. (3), Snell, <i>Nonmetals</i> , p 180. (9), Fres. <i>Z. Anal. Chem.</i> , 323, 266, (1986).
	Methylene Blue	Boltz, p 21. (1), Marczenko, p 183. (3), Snell, <i>Nonmetals</i> , p 205. (9), <i>Talanta</i> , 31, 547, (1984).
Bromide	Fluorescein	Boltz, p 48. (1), Snell, <i>Nonmetals</i> , p 276., Fres. <i>Z. Anal. Chem.</i> , 301, 28 (1980).
	Phenol Red	Boltz, p 44. (1), Marczenko, p 190. (3), Snell, <i>Nonmetals</i> , p 28. (9)
Cadmium	2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	Marczenko, p 197. (3)
	Cadion	Onishi, Part Ila, p 323. (5)
	Dithizone	Fries/Getrost, p 78. (2), Onishi, Part Ila, p 315. (5), Snell, <i>Metals I</i> , p 279. (7), West, p 25. (10).
Calcium	4-(2-Pyridylazo)resorcinol	Fres. <i>Z. Anal. Chem.</i> , 310, 51, (1982).
	Chlorophosphonazo III	Marczenko, p 207. (3), Snell, <i>Metals II</i> , p 1744. (8)
	Glyoxal-bis(2-hydroxyanil)	Fries/Getrost, p 86. (2), Onishi, Part Ila, p 352. (5), Snell, <i>Metals I</i> , p 1762. (8)
	Murexide	Onishi, Part Ila, p 357. (5), Snell, <i>Metals II</i> , p 1769. (8)
Cerium	Phthalein Purple	<i>Anal. Chim. Acta</i> , 34, 71 (1966).
	N-benzoyl-N-phenylhydroxylamine	<i>Anal. Chim. Acta</i> , 48, 155, (1969).

Determination	Reagents	Ref.
	8-Hydroxyquinoline	Fries/Getrost, p 93. (2), Marczenko, p 220. (3), Onishi, Part IIa, p 383. (7)
Chlorine	<i>N,N</i> -Diethyl-1,4-phenylenediamine	Boltz, p 92. (1), Fries/Getrost, p 101. (2), Snell, <i>Nonmetals</i> , p 225. (9), <i>Analyst</i> , 90, 187, (1965).
Chromium	1,5-Diphenylcarbazide	Fries/Getrost, p 105. (2), Onishi, Part IIa, p 412. (5), Snell, <i>Metals I</i> , p 714. (7), West, p 12. (10)
	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals I</i> , p 736. (7), West, p 17. (10)
	4-(2-Pyridylazo)resorcinol + Tetradecyldimethylbenzylammonium chloride	West, p 17. (10), <i>Anal. Chim. Acta</i> , 67, 297, (1973).
	4-(2-Pyridylazo)resorcinol + Hydrogen peroxide	Fres. <i>Z. Anal. Chem.</i> , 304, 382, (1980).
Cobalt	Nitroso-R salt	Fries/Getrost, p 118. (2), Onishi, Part IIa, p 454. (5), Snell, <i>Metals I</i> , p 953. (7)
	1-Nitroso-2-naphthol	Fries/Getrost, p 111. (2), Marczenko, p 246. (3), Snell, <i>Metals I</i> , p 947. (5)
	2-Nitroso-1-naphthol	Fries/Getrost, p 113. (2), Onishi, Part IIa, p 459. (5), Snell, <i>Metals I</i> , p 949. (7), West, p 45. (10)
	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals I</i> , p 969. (7), West, p 44. (10)
	4-(2-Pyridylazo)resorcinol + Diphenylguanidine	<i>Zh. Anal. Khim.</i> , 35, 1306, (1980).
Copper	Bathocuproine	Fries/Getrost, p 135. (2), Snell, <i>Metals I</i> , p 148. (7)
	Bathocuproine disulfonic acid	Fries/Getrost, p 137. (2), West, p 52. (10)
	Dithizone	Marczenko, p 258. (3), Onishi, Part IIa, p 529. (5), Snell, <i>Metals I</i> , p 199. (7)
	Neocuproine	Snell, <i>Metals I</i> , p 217. (5), West, p 51. (10)
	Cuprizone	Onishi, Part IIa, p 534. (5), Snell, <i>Metals I</i> , p 157. (7), West, p 53. (10)
	4-(2-pyridylazo)resorcinol + Tetradecyldimethylbenzylammonium chloride	<i>Anal. Chim. Acta</i> , 138, 321, (1982).
Cyanide	Barbituric Acid + Pyridine	Fries/Getrost, p 153. (2), Snell, <i>Nonmetals</i> , p 653. (9)
	Barbituric Acid + Pyridine-4-carboxylic acid	<i>Anal. Chim. Acta</i> , 99, 197, (1978).
Fluoride	Alizarin Fluorine blue + Lanthanum(III) ion	Boltz, p 129. (1), Fries/Getrost, p 158. (2), Snell, <i>Nonmetals</i> , p 333. (9), Williams, p 354. (11)
	Eriochrome Cyanine R + Zirconium(IV) ion	Boltz, p 119. (1), Snell, <i>Nonmetals</i> , p 359. (2), Williams, p 357. (11)
Gallium	Pyrocatechol violet + Diphenylguanidine	Snell, <i>Metals I</i> , p 500. (7)
	8-Hydroxyquinoline	Onishi Pt IIa, p 582. (5), Snell, <i>Metals I</i> , p 505. (7)
	1-(2-Pyridylazo)-2-naphthol	Snell, <i>Metals I</i> , p 512. (7)
	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals I</i> , p 513. (7)
	Rhodamine B	Marczenko, p 284. (3), Onishi, Part IIa, p 578. (5), Snell, <i>Metals I</i> , p 515. (7)
	Xylenol Orange	Fries/Getrost, p 166. (2), Snell, <i>Metals I</i> , p 523. (7)
	Xylenol Orange + 8-Hydroxyquinoline	<i>Zh. Anal. Khim.</i> , 26, 75, (1971).
Germanium	Brilliant Green + Molybdate	Snell, <i>Metals I</i> , p 562. (7)
	Phenylfluorone	Fries/Getrost, p 168. (2), Marczenko, p 292. (3), Onishi, Part IIa, p 607. (5), Snell, <i>Metals I</i> , p 570. (7)
Gold	5-(4-Diethylaminobenzylidene) rhodanine	Fries/Getrost, p 173. (2), Onishi, Part IIa, p 631. (5), Snell, <i>Metals II</i> , p 1516. (8)
	Rhodamine B	Fries/Getrost, p 175. (2), Marczenko, p 301. (3), Onishi, Part IIa, p 637. (5), Snell, <i>Metals II</i> , p 513. (8)
Hafnium	Arsenazo III	Snell, <i>Metals II</i> , p 1184. (8), <i>Talanta</i> , 19, 807, (1972).
Indium	Bromopyrogallol Red	Snell, <i>Metals I</i> , p 469. (7)
	Chrome Azurol S	Snell, <i>Metals I</i> , p 474. (7)
	Chrome Azurol S + Cetyltrimethylammonium bromide	<i>Anal. Chim. Acta</i> , 67, 107, (1973).
	Dithizone	Fries/Getrost, p 179. (2), Onishi, Part IIa, p 672. (5), Snell, <i>Metals I</i> , p 474. (7)
	8-Hydroxyquinoline	Onishi, Part IIa, p 670. (5), Snell, <i>Metals I</i> , p 475. (7)
	1-(2-Pyridylazo)-2-naphthol	Snell, <i>Metals I</i> , p 480. (7)
	4-(2-Pyridylazo)resorcinol	Marczenko, p 309. (3), Snell, <i>Metals I</i> , p 480. (7)
Iodide	Neocuproine + Copper(II)	<i>Anal. Chim. Acta</i> , 69, 321, (1974).
Iodine	Starch	Boltz, p 162. (1), Marczenko, p 316. (3), Snell, <i>Nonmetals</i> , p 307. (9)
Iridium	Rhodamine 6G + Tin(II)	Marczenko, p 323. (3)
	<i>N,N</i> -Dimethyl-4-nitrosoaniline	<i>Anal. Chem.</i> , 27, 1776, (1955).
Iron	Bathophenanthroline	Fries/Getrost, p 189. (2), Onishi, Part IIa, p 729. (5), Snell, <i>Metals I</i> , p 763. (7)
	Bathophenanthroline disulfonic acid	Fries/Getrost, p 191. (2), Snell, <i>Metals I</i> , p 772. (7)

Determination	Reagents	Ref.
	2,2'-Bipyridyl	Snell, <i>Metals I</i> , p 750. (7)
	Chrome Azurol S + Cetyltrimethylammonium bromide	Snell, <i>Metals I</i> , p 757. (7), <i>Coll. Czech. Chem. Comm.</i> , 45, 2656, (1980).
	1,10-Phenanthroline	Fries/Getrost, p 199. (2), Marczenko, p 331. (3), Onishi, Part IIa, p 725. (5), Snell, <i>Metals I</i> , p 795. (7)
	1,10-Phenanthroline + Bromothymol Blue	<i>Zh. Anal. Khim.</i> , 25, 1348, (1970).
	Ferrozine	Onishi, Part IIa, p 730. (5), Snell, <i>Metals I</i> , p 783. (7)
Lanthanum	Arsenazo III	Marczenko, p 468. (3), Snell, <i>Metals II</i> , p 1910. (8)
Lead	Dithizone	Fries/Getrost, p 207. (2), Onishi, Part IIa, p 824. (5), Snell, <i>Metals I</i> , p 2. (7), West, p 34. (10)
	Sodium diethyldithiocarbamate	Fries/Getrost, p 214. (2), Snell, <i>Metals I</i> , p 27. (7)
	4-(2-Pyridylazo)resorcinol	Fries/Getrost, p 220. (2), Marczenko, p 347. (3), Snell, <i>Metals I</i> , p 34. (7)
Lithium	Thoron	Onishi, Part IIa, p 863. (5), Snell, <i>Metals II</i> , p 1726. (8), <i>Talanta</i> , 30, 587, (1983).
Magnesium	Eriochrome Black T	Fries/Getrost, p 226. (2), Marczenko, p 355. (3), Onishi, Part IIb, p 13. (6), Snell, <i>Metals II</i> , p 1932. (8)
	8-Hydroxyquinoline	Onishi, Part IIb, p 11. (6), Snell, <i>Metals II</i> , p 1938. (8)
	8-Hydroxyquinoline + Butylamine	Fries/Getrost, p 228. (2), Snell, <i>Metals II</i> , p 1938. (8)
	Titan Yellow	Fries/Getrost, p 234. (2), Marczenko, p 352. (3), Snell, <i>Metals II</i> , p 1945. (8)
	Xylidyl Blue	Fries/Getrost, p 231. (2), Onishi, Part IIb, p 14. (6), Snell, <i>Metals II</i> , p 1950. (8)
Manganese	Formaldehyde	Fries/Getrost, p 236. (2), Marczenko, p 364. (3), Onishi Part IIb, p 38. (6), Snell, <i>Metals II</i> , 1010. (8)
Mercury	Dithizone	Fries/Getrost, p 243. (2), Marczenko, p 373. (3), Onishi, Part IIb, p 66. (6), Snell, <i>Metals I</i> , p 107. (7), West, p 29. (10)
	Michler's thioiketone	Marczenko, p 375. (3), Snell, <i>Metals I</i> , p 126. (7)
	Xylenol Orange	<i>Talanta</i> , 16, 1023, (1969)
Molybdenum	Bromopyrogallol Red + Cetylpyridium chloride	West, p 58. (10)
	Phenylfluorone	Snell, <i>Metals II</i> , p 1311. (8), <i>Microchem. J.</i> , 31, 56, (1985).
	Toluene-3,4-dithiol	Fries/Getrost, p 251. (2), Marczenko, p 384. (3), Onishi, Part IIb, p 96. (6), Snell, <i>Metals II</i> , p 1301. (8)
Nickel	2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	Marczenko, p 397. (3), <i>Talanta</i> 28, 189, (1981).
	Dimethylglyoxime	Fries/Getrost, p 263. (2), Marczenko, p 393. (3), Onishi, Part IIb, p 125. (6), Snell, <i>Metals I</i> , p 887. (7)
	Dimethylglyoxime + Oxidant	Fries/Getrost, p 263. (2), Onishi, Part IIb, p 125. (6), Snell, <i>Metals I</i> , p 887. (7)
	2,2'-Furildioxime	Marczenko, p 396. (3), Snell, <i>Metals I</i> , p 904. (7)
	2-(2-Pyridylazo)-2-naphthol	Snell, <i>Metals I</i> , p 910. (7)
	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals I</i> , p 911. (7), West, p 39. (10), <i>Anal. Chim. Acta</i> , 82, 431, (1976).
Niobium	<i>N</i> -Benzoyl- <i>N</i> -phenylhydroxylamine	Snell, <i>Metals II</i> , p 1425. (8)
	Pyrocatechol + EDTA or 2,2'-Bipyridyl or 1-(2-thenoyl)-3,3,3-trifluoroacetone	Snell, <i>Metals II</i> , p 1427. (8)
	Bromopyrogallol red	Marczenko, p 407. (3), Snell, <i>Metals II</i> , p 1426. (8)
	Bromopyrogallol red + Cetylpyridinium chloride	<i>Talanta</i> , 32, 189, (1985).
	4-(2-Pyridylazo)resorcinol	Fries/Getrost, p 274. (2), Marczenko, p 406. (3), Onishi, Part IIb, p 160. (7), Snell, <i>Metals II</i> , p 1447. (8)
	Sulfochlorophenol S	Onishi, Part IIb, p 161. (7), Snell, <i>Metals II</i> , p 1430. (8)
	Xylenol Orange	Onishi, Part IIb, p 164. (7)
Nitrate	Brucine	Boltz, p 227. (1), Fries/Getrost, p 280. (2), Snell, <i>Nonmetals</i> , p 546. (9)
	Chromotropic acid	Boltz, p 229. (1), Fries/Getrost, p 281. (2), Snell, <i>Nonmetals</i> , p 548. (9), Williams, p 132. (11), <i>Fres. Z. Anal. Chem.</i> , 320, 490, (1985).
	Sulfanilamide + <i>N</i> -(1-Naphthyl)ethylenediamine dihydrochloride	Fries/Getrost, p 279. (2), Snell, <i>Nonmetals</i> , p 559. (9)
Nitrite	Sulfanilamide + <i>N</i> -(1-Naphthyl)ethylenediamine dihydrochlorine	Boltz, p 241. (1), Snell, <i>Nonmetals</i> , p 585. (8), <i>Analyst</i> , 109, 1281, (1984).
	Sulfanilic acid + 1-Naphthylamine	Boltz, p 237. (1), Fries/Getrost, p 285. (2), Marczenko, p 419. (3), Snell, <i>Nonmetals</i> , p 586. (9)
Osmium	1,5-Diphenylcarbazine	Marczenko, p 428. (3)
Palladium	2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	<i>Talanta</i> , 33, 939, (1986).

Determination	Reagents	Ref.
	Dithizone	Marczenko, p 440. (3), Onishi, Part IIB, p 227. (6), Snell, <i>Metals II</i> , p 1577. (8)
	2-Nitroso-1-naphthol	Fries/Getrost, p 294. (2), Onishi, Part IIB, p 226. (6), Snell, <i>Metals II</i> , p 1581. (8)
Phosphate	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals II</i> , p 1583. (8) <i>Analyst</i> , 107, 708, (1982).
	Rhodamine B + Molybdate	Snell, <i>Nonmetals</i> , p 103. (9)
	Malachite Green + Molybdate	Snell, <i>Nonmetals</i> , p 12. (9), <i>Analyst</i> , 108, 361, (1983).
Platinum	Sulfochlorophenolazorhodamine	Onishi, Part IIB, p 253. (6), <i>Talanta</i> , 34, 87, (1987).
	Dithizone	Fries/Getrost, p 300. (2), Onishi, Part IIB, p 253. (6), Snell, <i>Metals II</i> , p 1534. (8)
Rare Earths	2-Mercaptobenzothiazole	Fries/Getrost, p 302. (2), <i>Zh. Anal. Khim.</i> , 24, 1172, (1969).
	Arsenazo I	Marczenko, p 470. (3), Onishi, Part IIA, p 785. (5), Snell, <i>Metals II</i> , p 1857. (8)
	Arsenazo III	Fries/Getrost, p 309. (2), Marczenko, p 468. (3), Onishi, Part IIA, p 786. (5), Snell, <i>Metals II</i> , p 1862. (8)
	Xylenol Orange	Onishi, Part IIA, p 787. (5), Snell, <i>Metals II</i> , p 1874. (8)
Rhenium	2,2'-Furildioxime	Fries/Getrost, p 310. (2), Marczenko, p 481. (3), Onishi, Part IIB, p 288. (6), Snell, <i>Metals II</i> , p 1659. (8)
Rhodium	1-(2-Pyridylazo)-2-naphthol	Fries/Getrost, p 311. (2), Snell, <i>Metals II</i> , p 1553. (8)
Ruthenium	1,10-Phenanthroline	Onishi, Part IIB, p 331. (6), Snell, <i>Metals II</i> , p 1623. (8)
	Thiourea	Fries/Getrost, p 318. (2), Onishi, Part IIB, 329. (6), Snell, <i>Metals II</i> , p 1626. (8)
Scandium	1,4-Diphenylthiosemicarbazide	Marczenko, p 493. (3), Onishi, Part IIB, p 330. (8)
	Alizarin red S	Fries/Getrost, p 319. (2), Onishi, Part IIB, p 360. (6), Snell, <i>Metals I</i> , p 536. (7)
	Arsenazo III	Onishi, Part IIB, p 359. (6), Snell, <i>Metals I</i> , p 539. (7)
	Chrome Azurol S	Snell, <i>Metals I</i> , p 551. (7), <i>Anal. Chim. Acta</i> , 159, 309, (1984).
	Xylenol Orange	Marczenko, p 501. (3), Onishi, Part IIB, p 357. (6), Snell, <i>Metals I</i> , p 547. (7)
Selenium	3,3'-Diaminobenzidine	Boltz, p 391. (1), Fries/Getrost, p 323. (2), Marczenko, p 508. (3), Snell, <i>Nonmetals</i> , p 490. (9), West, p 4. (10).
	2,3-Diaminonaphthaline	Snell, <i>Nonmetals</i> , p 501. (9)
Silver	Dithizone	Fries/Getrost, p 328. (2), Marczenko, p 524. (3), Onishi, Part IIB, p 379. (6), Snell, <i>Metals I</i> , p 82. (7)
	Eosin + 1,10-Phenanthroline	Snell, <i>Metals I</i> , p 93. (7)
Sulfate	Methylthymol blue + Barium (II)	Snell, <i>Nonmetals</i> , p 457. (9)
Sulfide	N,N'-Dimethyl-1,4-phenylenediamine	Boltz, p 483. (1), Fries/Getrost, p 344. (2), Snell, <i>Nonmetals</i> , p 400. (9), Williams, p 578. (11)
Sulfite	Pararosaniline + Formaldehyde	Boltz, p 478. (1), Marczenko, p 540. (3), Snell, <i>Nonmetals</i> , p 430. (9), Williams, p 591. (11)
Tantalum	Methyl Violet	Marczenko, p 551. (3), Snell, <i>Metals II</i> , p 1485. (8)
	4-(2-Pyridylazo)resorcinol	Snell, <i>Metals II</i> , p 1488. (8)
	Phenylfluorone	Onishi, Part IIB, p 166. (6), Snell, <i>Metals II</i> , p 1486. (8)
Tellurium	Diethyldithiocarbamate	Boltz, p 402. (1), Fries/Getrost, p 348. (2), Snell, <i>Nonmetals</i> , p 533. (9), Williams, p 220. (10)
	Bismuthiol II	Boltz, p 401. (1), Marczenko, p 557. (3), Snell, <i>Nonmetals</i> , p 524. (9)
Thallium	Brilliant green	Fries/Getrost, p 352. (2), Marczenko, p 567. (3), Onishi, Part IIB, p 426. (6), Snell, <i>Metals I</i> , p 45. (7)
	Dithizone	Fries/Getrost, p 355. (2), Onishi, Part IIB, p 426. (6), Snell, <i>Metals I</i> , p 54. (7)
	Rhodamine B	Fries/Getrost, p 354. (2), Marczenko, p 566. (3), Onishi, Part IIB, p 424. (6), Snell, <i>Metals I</i> , p 63. (7)
Thorium	Arsenazo III	Fries/Getrost, p 360. (2), Marczenko, p 575. (3), Onishi, Part IIB, p 460. (6), Snell, <i>Metals II</i> , p 1820. (8)
	Thoron	Marczenko, p 574. (3), Onishi, Part IIB, p 463. (6), Snell, <i>Metals I</i> , p 1835. (7)
	Xylenol Orange	Snell, <i>Metals I</i> , p 1852. (7)
	Xylenol Orange + Cetyltrimethylammonium bromide	<i>Talanta</i> , 26, 499, (1979).
Tin	Pyrocatechol violet (and + Cetyltrimethylammonium bromide)	Marczenko, p 585. (3), Onishi, Part IIB, p 501. (6), Snell, <i>Metals I</i> , p 422. (7)
	Gallein	Onishi, Part IIB, p 507, 510. (6), Snell, <i>Metals I</i> , p 432. (7)
	Phenylfluorone	Fries/Getrost, p 368. (2), Marczenko, p 582. (3), Onishi, Part IIB, p 497. (6), Snell, <i>Metals I</i> , p 444. (7)

Determination	Reagents	Ref.
	Toluene-3,4-dithiol + Dispersant	Fries/Getrost, p 366. (2), Onishi, Part IIb, p 502. (6), Snell, <i>Metals I</i> , p 427. (7)
Titanium	Chromotropic acid	Marczenko, p 593. (3), Onishi, Part IIb, p 551. (6), Snell, <i>Metals II</i> , p 1080. (8)
	Diantipyrinylmethane	Onishi, Part IIb, p 545. (6), Snell, <i>Metals II</i> , 1085. (8)
	Tiron	Fries/Getrost, p 376. (2), Onishi, Part IIb, p 549. (6), Snell, <i>Metals II</i> , p 1114. (8)
Tungsten	Pyrocatechol Violet	Snell, <i>Metals II</i> , p 1265. (8)
	Tetraphenylarsonium chloride + Thiocyanate	Onishi, Part IIb, p 596. (6), Snell, <i>Metals II</i> , p 1278. (8)
	Toluene-3,5-dithiol	Marczenko, p 605. (3), Onishi, Part IIb, p 590. (6), Snell, <i>Metals II</i> , p 1267. (8)
Uranium	Arsenazo III	Marczenko, p 611. (3), Onishi, Part IIb, p 627. (6), Snell, <i>Metals II</i> , p 1356. (8)
	2-(5-Bromo-2-pyridylazo)diethylaminophenol	Fries/Getrost, p 388. (2), Onishi, Part IIb, p 625. (6)
	Chlorophosphonazo III	Snell, <i>Metals II</i> , p 1367. (8), <i>Fres. Z. Anal. Chem.</i> , 306, 110, (1981).
	1-(2-Pyridylazo)-2-naphthol	Fries/Getrost, p 386. (2), Onishi, Part IIb, p 625. (6), Snell, <i>Metals II</i> , p 1387. (8)
Vanadium	N-Benzoyl-N-phenylhydroxylamine	Fries/Getrost, p 395. (2), Marczenko, p 625. (3), Snell, <i>Metals II</i> , p 1196. (8)
	8-Hydroxyquinoline	Marczenko, p 623. (3), Snell, <i>Metals II</i> , p 1209. (8)
	4-(2-pyridylazo)resorcinol	Fries/Getrost, p 404. (2), Marczenko, p 628. (3), Onishi, Part IIb, p 625. (6), Snell, <i>Metals II</i> , p 1226. (8)
Yttrium	Alizarin Red S	Fries/Getrost, p 406. (2), Onishi, Part IIa, p 784. (5), Snell, <i>Metals II</i> , p 1919. (8)
	Arsenazo III	Marczenko, p 468. (3), Onishi, Part IIa, p 786. (5), Snell, <i>Metals II</i> , p 1921. (8)
	Xylenol Orange	Fries/Getrost, p 406. (2), Onishi, Part IIa, p 787. (5), Snell, <i>Metals II</i> , p 1923. (8)
Zinc	Dithizone	Fries/Getrost, p 408. (2), Marczenko, p 637. (3), Onishi, Part IIb, p 708. (6), Snell, <i>Metals II</i> , p 1042. (8)
	1-(2-Pyridylazo)-2-naphthol	Marczenko, p 639. (3), Onishi, Part IIb, p 719. (6), Snell, <i>Metals II</i> , p 1056. (8)
	Xylenol Orange	Fries/Getrost, p 417. (2), Snell, <i>Metals II</i> , p 1062. (8), Talanta, 26, 693, (1979).
	Zircon	Fries/Getrost, p 412. (2), Onishi, Part IIb, p 719. (6), Snell, <i>Metals II</i> , p 1063. (8), West, p 23. (10)
Zirconium	Alizarin Red S	Fries/Getrost, p 421. (2), Marczenko, p 647. (3), Onishi, Part IIb, p 763. (6), Snell, <i>Metals II</i> , p 1136. (8)
	Arsenazo III	Fries/Getrost, p 421. (2), Onishi, Part IIb, p 770. (6), Snell, <i>Metals II</i> , p 1143. (8)
	Pyrocatechol Violet	Onishi, Part IIb, p 771. (6), Snell, <i>Metals II</i> , p 1149. (8)
	Morin	Fries/Getrost, p 424. (2), Onishi, Part IIb, p 765. (6), Snell, <i>Metals II</i> , p 1158. (8)
	Xylenol Orange	Fries/Getrost, p 419. (2), Marczenko, p 648. (3), Onishi, Part IIb, p 767. (6), Snell, <i>Metals II</i> , p 1167. (8)

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# ACID-BASE INDICATORS

A. K. Covington

The first part of this table lists some common acid-base indicators in alphabetical order along with the approximate pH range(s) at which a color change occurs. Following this is a table of the same indicators ordered by pH range, which includes the nature of the color change, instructions on preparation of the indicator solution, and the acid dissociation constant  $pK$ , when available.

The color code is:

C = colorless      A = amber      B/G = blue-green  
 Pk = pink          Y = yellow      V = violet  
 R = red            B = blue        P = purple  
 O = orange

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Indicator	pH Range	Indicator	pH Range
Alizarin	5.6-7.2; 11.0-12.4	Ethyl bis(2,4-dimethylphenyl)ethanoate	8.4-9.6
Alizarin Red S	4.6-6.0	Ethyl Orange	3.4-4.8
Alizarin Yellow R	10.1-12.0	Ethyl Red	4.0-5.8
Benzopurpurine 4B	2.2-4.2	Ethyl Violet	0.0-2.4
4,4'-Bis(2-amino-1-naphthylazo)-2,2'-stilbenedisulfonic acid	3.0-4.0	5,5'-Indigodisulfonic acid, disodium salt	11.4-13.0
4,4'-Bis(4-amino-1-naphthylazo)-2,2'-stilbenedisulfonic acid	8.0-9.0	Malachite Green	0.2-1.8
Brilliant Yellow	6.6-7.8	Metacresol Purple	1.2-2.8; 7.4-9.0
Bromocresol Green	3.8-5.4	Metanil Yellow	1.2-2.4
Bromocresol Purple	5.2-6.8	Methyl Green	0.2-1.8
Bromophenol Blue	3.0-4.6	Methyl Orange	3.2-4.4
Bromothymol Blue	6.0-7.6	Methyl Red	4.8-6.0
Chlorophenol Red	5.2-6.8	Methyl Violet	0.0-1.6
Clayton Yellow	12.2-13.2	<i>p</i> -Naphtholbenzein	8.2-10.0
Congo Red	3.0-5.0	Neutral Red	6.8-8.0
<i>o</i> -Cresolphthalein	8.2-9.8	<i>p</i> -Nitrophenol	5.4-6.6
Cresol Red	0.0-1.0; 7.0-8.8	<i>m</i> -Nitrophenol	6.8-8.6
Crystal Violet	0.0-1.8	Orange IV	1.4-2.8
Curcumin (Turmeric)	7.4-8.6	Paramethyl Red	1.0-3.0
<i>p</i> -(2,4-Dihydroxyphenylazo) benzenesulfonic acid, sodium salt	11.4-12.6	Phenolphthalein	8.2-10.0
<i>p</i> -Dimethylaminoazobenzene	2.8-4.4	Phenol Red	6.6-8.0
4-(4-Dimethylamino-1-naphylazo)-3-methoxybenzenesulfonic acid	3.5-4.8	4-Phenylazodiphenylamine	1.2-2.6
2-( <i>p</i> -Dimethylamino-phenylazo)pyridine	0.2-1.8; 4.4-5.6	4-Phenylazo-1-naphthylamine	4.0-5.6
<i>N,N</i> -Dimethyl- <i>p</i> -( <i>m</i> -tolylazo)aniline	2.6-4.8	Propyl Red	4.8-6.6
2,4-Dinitrophenol	2.0-4.7	Quinaldine Red	1.4-3.2
2-(2,4-Dinitrophenylazo)-1-naphthol-3,6-disulfonic acid, disodium salt	6.0-7.0	Resazurin	3.8-6.4
6,8-Dinitro-2,4-(1 <i>H</i> )quinazolinone	6.4-8.0	Resorcin Blue	4.4-6.2
Erythrosin, disodium salt	2.2-3.6	Tetrabromophenolphthalein ethyl ester, potassium salt	3.0-4.2
4-( <i>p</i> -Ethoxyphenylazo)- <i>m</i> -phenylene-diamine monohydrochloride	4.4-5.8	Thymol Blue	1.2-2.8; 8.0-9.6
		Thymolphthalein	9.4-10.6
		4- <i>o</i> -Tolylazo- <i>o</i> -toluidine	1.4-2.8
		1,3,5-Trinitrobenzene	12.0-14.0
		2,4,6-Trinitrotoluene	11.5-13.0
		Turmeric	7.4-8.6

pH range	Color change	Indicator	pK	Preparation
0.0-1.0	R-Y	Cresol Red		0.1 g in 26.2 mL 0.01 M NaOH + 223.8 mL water
0.0-1.6	Y-B	Methyl Violet		0.01-0.05% in water
0.0-1.8	Y-B	Crystal Violet		0.02% in water
0.0-2.4	Y-B	Ethyl Violet		0.1 g in 50 mL 50% v/v methanol-water
0.2-1.8	Y-B/G	Malachite Green	1.3	water
0.2-1.8	Y-B	Methyl Green		0.1% in water
0.2-1.8	Y-R	2-( <i>p</i> -Dimethylaminophenylazo)pyridine		0.1% in ethanol
1.0-3.0	R-Y	Paramethyl Red		ethanol
1.2-2.4	R-Y	Metanil Yellow		0.01% in water
1.2-2.6	R-Y	4-Phenylazodiphenylamine		0.01 g in 1 mL 1 M HCl + 50 mL ethanol + 49 mL water
1.2-2.8	R-Y	Thymol Blue	1.65	0.1 g in 21.5 mL 0.01 M NaOH + 228.5 mL water
1.2-2.8	R-Y	Metacresol Purple	1.51	0.1 g in 26.2 mL 0.01 M NaOH + 223.8 mL water
1.4-2.8	R-Y	Orange IV		0.01% in water
1.4-2.8	O-Y	4- <i>o</i> -Tolylazo- <i>o</i> -toluidine		water
1.4-3.2	C-R	Quinaldine Red	2.63	1% in ethanol
2.0-4.7	C-Y	2,4-Dinitrophenol	3.96	sat. solution in water
2.2-3.6	O-R	Erythrosin, disodium salt		0.1% in water
2.2-4.2	V-R	Benzopurpurine 4B		0.1% in water
2.6-4.8	R-Y	<i>N,N</i> -Dimethyl- <i>p</i> -( <i>m</i> -tolylazo)aniline		0.1% in water
2.8-4.4	R-Y	<i>p</i> -Dimethylaminoazobenzene		0.1 g in 100 mL 90% v/v ethanol-water
3.0-4.0	P-R	4,4'-Bis(2-amino-1-naphthylazo)-2,2'-stilbenedisulfonic acid		0.1 g in 5.9 mL 0.05 M NaOH + 94.1 mL water
3.0-4.2	Y-B	Tetrabromophenolphthalein ethyl ester, potassium salt		0.1% in ethanol
3.0-4.6	Y-B	Bromophenol Blue	4.10	0.1 g in 14.9 mL 0.01 M NaOH + 235.1 mL water
3.0-5.0	B-R	Congo Red		0.1% in water
3.2-4.4	R-Y	Methyl Orange	3.46	0.1% in water
3.4-4.8	R-Y	Ethyl Orange	4.34	0.05-0.2% in water or aqueous ethanol
3.5-4.8	V-Y	4-(4-Dimethylamino-1-naphthylazo)-3-methoxybenzenesulfonic acid		0.1% in 60% ethanol-water
3.8-5.4	Y-B	Bromocresol Green	4.90	0.1 g in 14.3 mL 0.01 M NaOH + 235.7 mL water
3.8-6.4	O-V	Resazurin		water
4.0-5.6	R-Y	4-Phenylazo-1-naphthylamine		0.1% in ethanol
4.0-5.8	C-R	Ethyl Red	5.42	0.1 g in 100 mL 50% v/v methanol-water 0.1% in ethanol
4.4-5.6	R-Y	2-( <i>p</i> -Dimethylaminophenylazo)pyridine		0.1% in ethanol
4.4-5.8	O-Y	4-( <i>p</i> -Ethoxyphenylazo)- <i>m</i> -phenylenediamine monohydrochloride		0.1% in water
4.4-6.2	R-B	Resorcin Blue		0.2% in ethanol
4.6-6.0	Y-R	Alizarin Red S		water
4.8-6.0	R-Y	Methyl Red	5.00	0.02 g in 100 mL 60% v/v ethanol-water
4.8-6.6	R-Y	Propyl Red	5.48	ethanol
5.2-6.8	Y-P	Bromocresol Purple	6.40	0.1 g in 18.5 mL 0.01 M NaOH + 231.5 mL water
5.2-6.8	Y-R	Chlorophenol Red	6.25	0.1 g in 23.6 mL 0.01 M NaOH + 226.4 mL water
5.4-6.6	C-Y	<i>p</i> -Nitrophenol	7.15	0.1% in water
5.6-7.2	Y-R	Alizarin		0.1% in methanol
6.0-7.0	Y-B	2-(2,4-Dinitrophenylazo)-1-naphthol-3,6-disulfonic acid, disodium salt		0.1% in water
6.0-7.6	Y-B	Bromothymol Blue	7.30	0.1 g in 16 mL 0.01 M NaOH + 234 mL water
6.4-8.0	C-Y	6,8-Dinitro-2,4-(1 <i>H</i> )quinazolinone		25 g in 115 mL 1 M NaOH + 50 mL water at 100°C
6.6-7.8	Y-R	Brilliant Yellow		1% in water
6.6-8.0	Y-R	Phenol Red	8.00	0.1 g in 28.2 mL 0.01 M NaOH + 221.8 mL water
6.8-8.0	R-A	Neutral Red		0.01 g in 100 mL 50% v/v ethanol-water
6.8-8.6	C-Y	<i>m</i> -Nitrophenol	8.28	0.3% in water
7.0-8.8	Y-R	Cresol Red	8.46	0.1 g in 26.2 mL 0.01 M NaOH + 223.8 mL water
7.4-8.6	Y-R	Turmaric (Curcumin)		ethanol
7.4-9.0	Y-P	Metacresol Purple	8.3	0.1 g in 26.2 mL 0.01 M NaOH + 223.8 mL water
8.0-9.0	B-R	4,4'-Bis(4-amino-1-naphthylazo)-2,2'-stilbenedisulfonic acid		0.1 g in 5.9 mL 0.05 M NaOH + 94.1 mL water
8.0-9.6	Y-B	Thymol Blue	9.20	0.1 g in 21.5 mL 0.01 M NaOH + 228.5 mL water
8.2-10.0	O-B	<i>p</i> -Naphtholbenzein		1% in dil. alkali



pH range	Color change	Indicator	p <i>K</i>	Preparation
8.2-10.0	C-Pk	Phenolphthalein	9.5	0.5 g in 100 mL 50% v/v ethanol-water
8.2-9.8	C-R	<i>o</i> -Cresolphthalein		0.04% in ethanol
8.4-9.6	C-B	Ethyl bis(2,4-dimethylphenyl)ethanoate		sat. solution in 50% acetone-ethanol
9.4-10.6	C-B	Thymolphthalein		0.04 g in 100 mL 50% v/v ethanol-water
10.1-12.0	Y-R	Alizarin Yellow R		0.01% in water
11.0-12.4	R-P	Alizarin		0.1% in methanol
11.4-12.6	Y-O	<i>p</i> -(2,4-Dihydroxyphenylazo) benzenesulfonic acid, sodium salt		0.1% in water
11.4-13.0	B-Y	5,5'-Indigodisulfonic acid, disodium salt		water
11.5-13.0	C-O	2,4,6-Trinitrotoluene		0.1-0.5% in ethanol
12.0-14.0	C-O	1,3,5-Trinitrobenzene		0.1-0.5% in ethanol
12.2-13.2	Y-A	Clayton Yellow		0.1% in water

# FLUORESCENT INDICATORS

Jack DeMent

Fluorescent indicators are substances that show definite changes in fluorescence with change in pH. Some fluorescent materials are not suitable for indicators since their change in fluorescence is too gradual. Fluorescent indicators find greatest utility in the titration of opaque, highly turbid or deeply colored solutions. A long wavelength ultraviolet ("black light") lamp in a dimly lighted room provides the best environment for titrations involving fluorescent indicators, although bright daylight is sometimes sufficient to evoke a response in the bright green, yellow and orange fluores-

cent indicators. Titrations are carried out in non-fluorescent glassware. One should check the glassware prior to use to make certain that it does not fluoresce due to the wavelengths of light involved in the titration. The meniscus of the liquid in the burette can be followed when a few particles of an insoluble fluorescent solid are dropped onto its surface.

In this table the indicators are arranged by approximate pH range covered. In the case of some of the dyestuffs the end point may vary slightly with the source or manufacturer.

Indicator	C.I.	pH 0 to 2	
		From pH	To pH
Benzoflavine	—	0.3, yellow fl.	1.7, green fl.
3,6-Dioxypthalimide	—	0, blue fl.	2.4, green fl.
Eosine YS	768	0,yellow colored	3.0, yellow fl.
Erythrosine	772	0, yellow colored	3.6, yellow fl.
Esculin	—	1.5, colorless	2, blue fl.
4-Ethoxyacridone	—	1.2, green fl.	3.2, blue fl.
3,6-Tetramethyldiaminooxanthone	—	1.2, green fl.	3.4, blue fl.
<b>pH 2 to 4</b>			
Chromotropic acid	—	3.5, colorless	4.5, blue fl
Fluorescein	766	4, colorless	4.5, green fl.
Magdala Red	—	3.0, purple colored	4.0, fl
$\alpha$ -Naphthylamine	—	3.4, colorless	4.8, blue fl.
$\beta$ -Naphthylamine	—	2.8, colorless	4.4, violet fl.
Phloxine	774	3.4, colorless	5.0, bright yellow fl.
Salicylic acid	—	2.5, colorless	3.5, blue fl.
<b>pH 4 to 6</b>			
Acridine	788	4.9, green fl.	5.1, violet colored
Dichlorofluorescein	—	4.0, colorless	5.0, green fl.
3,6-Dioxyxanthone	—	5.4, colorless	7.6, blue-violet fl.
Erythrosine	772	4.0, colorless	4.5, yellow-green fl.
$\beta$ -Methylesculetin	—	4.0, colorless	6.2, blue fl
Neville-Winther acid	—	6.0, colorless	6.5, blue fl.
Resorufin	—	4.4, yellow fl	6.4, weak orange fl.
Quininic acid	—	4.4, yellow colored	5.0, blue fl.
Quinine [first end point]	—	5.0, blue fl.	6.1, violet fl.
<b>pH 6 to 8</b>			
(claimed for range pH 6.0–7.0)			
Acid R Phosphine	—	6.5, colorless	7.5, violet, fl.
Brilliant Diazol Yellow	—	6.5, colorless	7.5, green fl.
Cleves acid	—	6.5, colorless	9.0, green fl.
Coumaric acid	—	7.2, colorless	8.2, green fl.
3,6-Dioxypthalic dinitrile	—	5.8, blue fl.	7.5, golden fl.
Magnesium 8-hydroxyquinolate	—	6.5, colorless	7.5, blue fl.
$\beta$ -Methylumbelliferone	—	7.0, colorless	6.5, blue fl.
1-Naphthol-4-sulfonic acid	—	6.0, colorless	8.0, green fl.
Orcinaurine	—	6.5, colorless	(for the range pH 6.0–7.0, green-yellow fl.)
Patent Phosphine	789		(for the region pH 6.5–7.0, yellow fl.)
Thioflavine	816		
Umbelliferone	—	6.5, colorless	7.6, blue fl.
<b>pH 8 to 10</b>			
Acridine Orange	788	8.4, orange colored	10.4, green fl.
Ethoxyphenylnaphthostilbazonium chloride	—	9, green fl.	11, non-fl.

G Salt	—	9.0, dull blue fl.	9.5, bright blue fl.
Naphthazol derivatives	—	8.2, colorless	10.0, yellow or green fl.
α-Naphthionic acid	—	9, blue fl.	11, green fl.
2-Naphthol-3,6-disulfonic acid	—	9.5, dark blue fl	Light blue fl. at higher pH
β-Naphthol	—	8.6, colorless	Blue fl. at higher pH
α-Naphtholsulfonic acid	—	8.0, dark blue fl.	9.0, bright violet fl.
1,4-Naphtholsulfonic acid	—	8.2, dark blue fl.	Light blue fl. at higher pH
Orcinsulfonphthalein	—	8.6, yellow colored	10.0 fl.
Quinine [second end point]	—	9.5, violet fl.	10.0, colorless
R-Salt	—	9.0, dull blue fl.	9.5, bright blue fl.
Sodium 1-naphthol-2-sulfonate	—	9.0, dark blue fl.	10.0, bright violet fl.
<b>pH 10 to 12</b>			
Courmarin	—	9.8, deep green fl.	12, light green fl.
Eosine BN	771	10.5, colorless	14.0, yellow fl.
Papaverine (permanganate oxidized)	—	9.5, yellow fl.	11.0, blue fl.
Schaffers Salt	—	5.0, violet fl.	11.0, green-blue fl.
SS-Acid (sodium salt)	—	10.0, violet fl.	12.0, yellow-colored
<b>pH 12 to 14</b>			
Cotarnine	—	12.0, yellow fl.	13.0, white fl.
α-Naphthionic acid	—	12, blue fl.	13, green fl.
β-Naphthionic acid	—	12, blue fl.	13, violet fl.

## CONVERSION FORMULAS FOR CONCENTRATION OF SOLUTIONS

*A* = Weight percent of solute  
*B* = Molecular weight of solvent  
*E* = Molecular weight of solute  
*F* = Grams of solute per liter of solution

*G* = Molality  
*M* = Molarity  
*N* = Mole fraction  
*R* = Density of solution in grams per milliliter

Concentration of solute—SOUGHT	Concentration of solute—GIVEN				
	<i>A</i>	<i>N</i>	<i>G</i>	<i>M</i>	<i>F</i>
<i>A</i>	—	$\frac{100N \times E}{N \times E + (1 - N)B}$	$\frac{100G \times E}{1000 + G \times E}$	$\frac{M \times E}{10R}$	$\frac{F}{10R}$
<i>N</i>	$\frac{\frac{A}{E}}{\frac{A}{E} + \frac{100 - A}{B}}$	—	$\frac{B \times G}{B \times G + 1000}$	$\frac{B \times M}{M(B - E) + 1000R}$	$\frac{B \times F}{F(B - E) + 1000R \times E}$
<i>G</i>	$\frac{1000A}{E(100 - A)}$	$\frac{1000N}{B - N \times B}$	—	$\frac{1000M}{1000R - (M \times E)}$	$\frac{1000F}{E(1000R - F)}$
<i>M</i>	$\frac{10R \times A}{E}$	$\frac{1000R \times N}{N \times E + (1 - N)B}$	$\frac{1000R \times G}{1000 + E \times G}$	—	$\frac{F}{E}$
<i>F</i>	10AR	$\frac{1000R \times N \times E}{N \times E + (1 - N)B}$	$\frac{1000R \times G \times E}{1000 + G \times E}$	<i>M</i> × <i>E</i>	—

## CONVERSION FORMULAS FOR CONCENTRATION OF SOLUTIONS

*A* = Weight percent of solute  
*B* = Molecular weight of solvent  
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*F* = Grams of solute per liter of solution

*G* = Molality  
*M* = Molarity  
*N* = Mole fraction  
*R* = Density of solution in grams per milliliter

Concentration of solute—SOUGHT	Concentration of solute—GIVEN				
	<i>A</i>	<i>N</i>	<i>G</i>	<i>M</i>	<i>F</i>
<i>A</i>	—	$\frac{100N \times E}{N \times E + (1 - N)B}$	$\frac{100G \times E}{1000 + G \times E}$	$\frac{M \times E}{10R}$	$\frac{F}{10R}$
<i>N</i>	$\frac{\frac{A}{E} + \frac{100 - A}{B}}{\frac{A}{E} + \frac{100 - A}{B}}$	—	$\frac{B \times G}{B \times G + 1000}$	$\frac{B \times M}{M(B - E) + 1000R}$	$\frac{B \times F}{F(B - E) + 1000R \times E}$
<i>G</i>	$\frac{1000A}{E(100 - A)}$	$\frac{1000N}{B - N \times B}$	—	$\frac{1000M}{1000R - (M \times E)}$	$\frac{1000F}{E(1000R - F)}$
<i>M</i>	$\frac{10R \times A}{E}$	$\frac{1000R \times N}{N \times E + (1 - N)B}$	$\frac{1000R \times G}{1000 + E \times G}$	—	$\frac{F}{E}$
<i>F</i>	10AR	$\frac{1000R \times N \times E}{N \times E + (1 - N)B}$	$\frac{1000R \times G \times E}{1000 + G \times E}$	$M \times E$	—

# ELECTROCHEMICAL SERIES

Petr Vanýsek

There are three tables for this electrochemical series. Each table lists standard reduction potentials,  $E^\circ$  values, at 298.15 K (25 °C), and at a pressure of 101.325 kPa (1 atm). Table 1 is an alphabetical listing of the elements, according to the symbol of the elements. Thus, data for silver (Ag) precede those for aluminum (Al). Table 2 lists only those reduction reactions that have  $E^\circ$  values positive in respect to the standard hydrogen electrode. In Table 2, the reactions are listed in the order of increasing positive potential, and they range from 0.0000 V to + 3.4 V. Table 3 lists only those reduction potentials which have  $E^\circ$  negative with respect to the standard hydrogen electrode. In Table 3, the reactions are listed in the order of decreasing potential and range from 0.0000 V to -4.10 V. The reliability of the potentials is not the same for all the data. Typically, the values with fewer significant figures have lower

reliability. The values of reduction potentials, in particular those of less common reactions, are not definite; they are subject to occasional revisions.

*Abbreviations:* ac = acetate; bipy = 2,2'-dipyridine, or bipyridine; en = ethylenediamine; phen = 1,10-phenanthroline.

## References

1. Milazzo, G., Caroli, S., and Sharma, V. K. *Tables of Standard Electrode Potentials*, Wiley, Chichester, 1978.
2. Bard, A. J., Parsons, R., and Jordan, J. *Standard Potentials in Aqueous Solutions*, Marcel Dekker, New York, 1985.
3. Bratsch, S. G. *J. Phys. Chem. Ref. Data*, 18, 1–21, 1989.

TABLE 1. Alphabetical Listing

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$\text{Ac}^{3+} + 3 e \rightleftharpoons \text{Ac}$	-2.20	$\text{As} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{AsH}_3$	-0.608
$\text{Ag}^+ + e \rightleftharpoons \text{Ag}$	0.7996	$\text{As}_2\text{O}_3 + 6 \text{H}^+ + 6 e \rightleftharpoons 2 \text{As} + 3 \text{H}_2\text{O}$	0.234
$\text{Ag}^{2+} + e \rightleftharpoons \text{Ag}^+$	1.980	$\text{HAsO}_2 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{As} + 2 \text{H}_2\text{O}$	0.248
$\text{Ag}(\text{ac}) + e \rightleftharpoons \text{Ag} + (\text{ac})^-$	0.643	$\text{AsO}_2^- + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{As} + 4 \text{OH}^-$	-0.68
$\text{AgBr} + e \rightleftharpoons \text{Ag} + \text{Br}^-$	0.07133	$\text{H}_3\text{AsO}_4 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{HAsO}_2 + 2 \text{H}_2\text{O}$	0.560
$\text{AgBrO}_3 + e \rightleftharpoons \text{Ag} + \text{BrO}_3^-$	0.546	$\text{AsO}_4^{3-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{AsO}_2^- + 4 \text{OH}^-$	-0.71
$\text{Ag}_2\text{C}_2\text{O}_4 + 2 e \rightleftharpoons 2 \text{Ag} + \text{C}_2\text{O}_4^{2-}$	0.4647	$\text{At}_2 + 2 e \rightleftharpoons 2 \text{At}^-$	0.3
$\text{AgCl} + e \rightleftharpoons \text{Ag} + \text{Cl}^-$	0.22233	$\text{Au}^+ + e \rightleftharpoons \text{Au}$	1.692
$\text{AgCN} + e \rightleftharpoons \text{Ag} + \text{CN}^-$	-0.017	$\text{Au}^{3+} + 2 e \rightleftharpoons \text{Au}^+$	1.401
$\text{Ag}_2\text{CO}_3 + 2 e \rightleftharpoons 2 \text{Ag} + \text{CO}_3^{2-}$	0.47	$\text{Au}^{3+} + 3 e \rightleftharpoons \text{Au}$	1.498
$\text{Ag}_2\text{CrO}_4 + 2 e \rightleftharpoons 2 \text{Ag} + \text{CrO}_4^{2-}$	0.4470	$\text{Au}^{2+} + e \rightleftharpoons \text{Au}^+$	1.8
$\text{AgF} + e \rightleftharpoons \text{Ag} + \text{F}^-$	0.779	$\text{AuOH}^{2+} + \text{H}^+ + 2 e \rightleftharpoons \text{Au}^+ + \text{H}_2\text{O}$	1.32
$\text{Ag}_3[\text{Fe}(\text{CN})_6] + 4 e \rightleftharpoons 4 \text{Ag} + [\text{Fe}(\text{CN})_6]^{4-}$	0.1478	$\text{AuBr}_2^- + e \rightleftharpoons \text{Au} + 2 \text{Br}^-$	0.959
$\text{AgI} + e \rightleftharpoons \text{Ag} + \text{I}^-$	-0.15224	$\text{AuBr}_4^- + 3 e \rightleftharpoons \text{Au} + 4 \text{Br}^-$	0.854
$\text{AgIO}_3 + e \rightleftharpoons \text{Ag} + \text{IO}_3^-$	0.354	$\text{AuCl}_4^- + 3 e \rightleftharpoons \text{Au} + 4 \text{Cl}^-$	1.002
$\text{Ag}_2\text{MoO}_4 + 2 e \rightleftharpoons 2 \text{Ag} + \text{MoO}_4^{2-}$	0.4573	$\text{Au}(\text{OH})_3 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{Au} + 3 \text{H}_2\text{O}$	1.45
$\text{AgNO}_2 + e \rightleftharpoons \text{Ag} + 2 \text{NO}_2^-$	0.564	$\text{H}_2\text{BO}_3^- + 5 \text{H}_2\text{O} + 8 e \rightleftharpoons \text{BH}_4^- + 8 \text{OH}^-$	-1.24
$\text{Ag}_2\text{O} + \text{H}_2\text{O} + 2 e \rightleftharpoons 2 \text{Ag} + 2 \text{OH}^-$	0.342	$\text{H}_2\text{BO}_3^- + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{B} + 4 \text{OH}^-$	-1.79
$\text{Ag}_2\text{O}_3 + \text{H}_2\text{O} + 2 e \rightleftharpoons 2 \text{AgO} + 2 \text{OH}^-$	0.739	$\text{H}_3\text{BO}_3 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{B} + 3 \text{H}_2\text{O}$	-0.8698
$\text{Ag}^{3+} + 2 e \rightleftharpoons \text{Ag}^+$	1.9	$\text{B}(\text{OH})_3 + 7 \text{H}^+ + 8 e \rightleftharpoons \text{BH}_4^- + 3 \text{H}_2\text{O}$	-0.481
$\text{Ag}^{3+} + e \rightleftharpoons \text{Ag}^{2+}$	1.8	$\text{Ba}^{2+} + 2 e \rightleftharpoons \text{Ba}$	-2.912
$\text{Ag}_2\text{O}_2 + 4 \text{H}^+ + e \rightleftharpoons 2 \text{Ag} + 2 \text{H}_2\text{O}$	1.802	$\text{Ba}^{2+} + 2 e \rightleftharpoons \text{Ba}(\text{Hg})$	-1.570
$2 \text{AgO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Ag}_2\text{O} + 2 \text{OH}^-$	0.607	$\text{Ba}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ba} + 2 \text{OH}^-$	-2.99
$\text{AgOCN} + e \rightleftharpoons \text{Ag} + \text{OCN}^-$	0.41	$\text{Be}^{2+} + 2 e \rightleftharpoons \text{Be}$	-1.847
$\text{Ag}_2\text{S} + 2 e \rightleftharpoons 2 \text{Ag} + \text{S}^{2-}$	-0.691	$\text{Be}_2\text{O}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons 2 \text{Be} + 6 \text{OH}^-$	-2.63
$\text{Ag}_2\text{S} + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{Ag} + \text{H}_2\text{S}$	-0.0366	$p\text{-benzoquinone} + 2 \text{H}^+ + 2 e \rightleftharpoons$ hydroquinone	0.6992
$\text{AgSCN} + e \rightleftharpoons \text{Ag} + \text{SCN}^-$	0.08951	$\text{Bi}^+ + e \rightleftharpoons \text{Bi}$	0.5
$\text{Ag}_2\text{SeO}_3 + 2 e \rightleftharpoons 2 \text{Ag} + \text{SeO}_4^{2-}$	0.3629	$\text{Bi}^{3+} + 3 e \rightleftharpoons \text{Bi}$	0.308
$\text{Ag}_2\text{SO}_4 + 2 e \rightleftharpoons 2 \text{Ag} + \text{SO}_4^{2-}$	0.654	$\text{Bi}^{3+} + 2 e \rightleftharpoons \text{Bi}^+$	0.2
$\text{Ag}_2\text{WO}_4 + 2 e \rightleftharpoons 2 \text{Ag} + \text{WO}_4^{2-}$	0.4660	$\text{Bi} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{BiH}_3$	-0.8
$\text{Al}^{3+} + 3 e \rightleftharpoons \text{Al}$	-1.662	$\text{BiCl}_4^- + 3 e \rightleftharpoons \text{Bi} + 4 \text{Cl}^-$	0.16
$\text{Al}(\text{OH})_3 + 3 e \rightleftharpoons \text{Al} + 3 \text{OH}^-$	-2.31	$\text{Bi}_2\text{O}_3 + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons 2 \text{Bi} + 6 \text{OH}^-$	-0.46
$\text{Al}(\text{OH})_4^- + 3 e \rightleftharpoons \text{Al} + 4 \text{OH}^-$	-2.328	$\text{Bi}_2\text{O}_4 + 4 \text{H}^+ + 2 e \rightleftharpoons 2 \text{BiO}^+ + 2 \text{H}_2\text{O}$	1.593
$\text{H}_2\text{AlO}_3^- + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Al} + 4 \text{OH}^-$	-2.33	$\text{BiO}^+ + 2 \text{H}^+ + 3 e \rightleftharpoons \text{Bi} + \text{H}_2\text{O}$	0.320
$\text{AlF}_6^{3-} + 3 e \rightleftharpoons \text{Al} + 6 \text{F}^-$	-2.069	$\text{BiOCl} + 2 \text{H}^+ + 3 e \rightleftharpoons \text{Bi} + \text{Cl}^- + \text{H}_2\text{O}$	0.1583
$\text{Am}^{4+} + e \rightleftharpoons \text{Am}^{3+}$	2.60	$\text{Bk}^{4+} + e \rightleftharpoons \text{Bk}^{3+}$	1.67
$\text{Am}^{2+} + 2 e \rightleftharpoons \text{Am}$	-1.9	$\text{Bk}^{2+} + 2 e \rightleftharpoons \text{Bk}$	-1.6
$\text{Am}^{3+} + 3 e \rightleftharpoons \text{Am}$	-2.048	$\text{Bk}^{3+} + e \rightleftharpoons \text{Bk}^{2+}$	-2.8
$\text{Am}^{3+} + e \rightleftharpoons \text{Am}^{2+}$	-2.3		

Reaction	$E^\circ/V$
$\text{Br}_2(\text{aq}) + 2 e \rightleftharpoons 2 \text{Br}^-$	1.0873
$\text{Br}_2(\text{l}) + 2 e \rightleftharpoons 2 \text{Br}^-$	1.066
$\text{HBrO} + \text{H}^+ + 2 e \rightleftharpoons \text{Br}^- + \text{H}_2\text{O}$	1.331
$\text{HBrO} + \text{H}^+ + e \rightleftharpoons 1/2 \text{Br}_2(\text{aq}) + \text{H}_2\text{O}$	1.574
$\text{HBrO} + \text{H}^+ + e \rightleftharpoons 1/2 \text{Br}_2(\text{l}) + \text{H}_2\text{O}$	1.596
$\text{BrO}^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Br}^- + 2 \text{OH}^-$	0.761
$\text{BrO}_3^- + 6 \text{H}^+ + 5 e \rightleftharpoons 1/2 \text{Br}_2 + 3 \text{H}_2\text{O}$	1.482
$\text{BrO}_3^- + 6 \text{H}^+ + 6 e \rightleftharpoons \text{Br}^- + 3 \text{H}_2\text{O}$	1.423
$\text{BrO}_3^- + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons \text{Br}^- + 6 \text{OH}^-$	0.61
$(\text{CN})_2 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{HCN}$	0.373
$2 \text{HCNO} + 2 \text{H}^+ + 2 e \rightleftharpoons (\text{CN})_2 + 2 \text{H}_2\text{O}$	0.330
$(\text{CNS})_2 + 2 e \rightleftharpoons 2 \text{CNS}^-$	0.77
$\text{CO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{HCOOH}$	-0.199
$\text{Ca}^+ + e \rightleftharpoons \text{Ca}$	-3.80
$\text{Ca}^{2+} + 2 e \rightleftharpoons \text{Ca}$	-2.868
$\text{Ca}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ca} + 2 \text{OH}^-$	-3.02
Calomel electrode, 1 molal KCl	0.2800
Calomel electrode, 1 molar KCl (NCE)	0.2801
Calomel electrode, 0.1 molar KCl	0.3337
Calomel electrode, saturated KCl (SCE)	0.2412
Calomel electrode, saturated NaCl (SSCE)	0.2360
$\text{Cd}^{2+} + 2 e \rightleftharpoons \text{Cd}$	-0.4030
$\text{Cd}^{2+} + 2 e \rightleftharpoons \text{Cd}(\text{Hg})$	-0.3521
$\text{Cd}(\text{OH})_2 + 2 e \rightleftharpoons \text{Cd}(\text{Hg}) + 2 \text{OH}^-$	-0.809
$\text{CdSO}_4 + 2 e \rightleftharpoons \text{Cd} + \text{SO}_4^{2-}$	-0.246
$\text{Cd}(\text{OH})_4^{2-} + 2 e \rightleftharpoons \text{Cd} + 4 \text{OH}^-$	-0.658
$\text{CdO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Cd} + 2 \text{OH}^-$	-0.783
$\text{Ce}^{3+} + 3 e \rightleftharpoons \text{Ce}$	-2.336
$\text{Ce}^{3+} + 3 e \rightleftharpoons \text{Ce}(\text{Hg})$	-1.4373
$\text{Ce}^{4+} + e \rightleftharpoons \text{Ce}^{3+}$	1.72
$\text{CeOH}^{3+} + \text{H}^+ + e \rightleftharpoons \text{Ce}^{3+} + \text{H}_2\text{O}$	1.715
$\text{Ce}^{IV} + e \rightleftharpoons \text{Ce}^{III}$	3.3
$\text{Ce}^{IV} + e \rightleftharpoons \text{Ce}^{IV}$	-1.6
$\text{Ce}^{IV} + 3 e \rightleftharpoons \text{Ce}$	-1.94
$\text{Ce}^{IV} + 2 e \rightleftharpoons \text{Ce}$	-2.12
$\text{Cl}_2(\text{g}) + 2 e \rightleftharpoons 2 \text{Cl}^-$	1.35827
$\text{HClO} + \text{H}^+ + e \rightleftharpoons 1/2 \text{Cl}_2 + \text{H}_2\text{O}$	1.611
$\text{HClO} + \text{H}^+ + 2 e \rightleftharpoons \text{Cl}^- + \text{H}_2\text{O}$	1.482
$\text{ClO}^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Cl}^- + 2 \text{OH}^-$	0.81
$\text{ClO}_2 + \text{H}^+ + e \rightleftharpoons \text{HClO}_2$	1.277
$\text{HClO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{HClO} + \text{H}_2\text{O}$	1.645
$\text{HClO}_2 + 3 \text{H}^+ + 3 e \rightleftharpoons 1/2 \text{Cl}_2 + 2 \text{H}_2\text{O}$	1.628
$\text{HClO}_2 + 3 \text{H}^+ + 4 e \rightleftharpoons \text{Cl}^- + 2 \text{H}_2\text{O}$	1.570
$\text{ClO}_2^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{ClO}^- + 2 \text{OH}^-$	0.66
$\text{ClO}_2^- + 2 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Cl}^- + 4 \text{OH}^-$	0.76
$\text{ClO}_2(\text{aq}) + e \rightleftharpoons \text{ClO}_2^-$	0.954
$\text{ClO}_3^- + 2 \text{H}^+ + e \rightleftharpoons \text{ClO}_2 + \text{H}_2\text{O}$	1.152
$\text{ClO}_3^- + 3 \text{H}^+ + 2 e \rightleftharpoons \text{HClO}_2 + \text{H}_2\text{O}$	1.214
$\text{ClO}_3^- + 6 \text{H}^+ + 5 e \rightleftharpoons 1/2 \text{Cl}_2 + 3 \text{H}_2\text{O}$	1.47
$\text{ClO}_3^- + 6 \text{H}^+ + 6 e \rightleftharpoons \text{Cl}^- + 3 \text{H}_2\text{O}$	1.451
$\text{ClO}_3^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{ClO}_2^- + 2 \text{OH}^-$	0.33
$\text{ClO}_3^- + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons \text{Cl}^- + 6 \text{OH}^-$	0.62
$\text{ClO}_4^- + 2 \text{H}^+ + 2 e \rightleftharpoons \text{ClO}_3^- + \text{H}_2\text{O}$	1.189
$\text{ClO}_4^- + 8 \text{H}^+ + 7 e \rightleftharpoons 1/2 \text{Cl}_2 + 4 \text{H}_2\text{O}$	1.39
$\text{ClO}_4^- + 8 \text{H}^+ + 8 e \rightleftharpoons \text{Cl}^- + 4 \text{H}_2\text{O}$	1.389
$\text{ClO}_4^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{ClO}_3^- + 2 \text{OH}^-$	0.36
$\text{Cm}^{4+} + e \rightleftharpoons \text{Cm}^{3+}$	3.0
$\text{Cm}^{3+} + 3 e \rightleftharpoons \text{Cm}$	-2.04
$\text{Co}^{2+} + 2 e \rightleftharpoons \text{Co}$	-0.28
$\text{Co}^{3+} + e \rightleftharpoons \text{Co}^{2+}$	1.92

Reaction	$E^\circ/V$
$[\text{Co}(\text{NH}_3)_6]^{3+} + e \rightleftharpoons [\text{Co}(\text{NH}_3)_6]^{2+}$	0.108
$\text{Co}(\text{OH})_2 + 2 e \rightleftharpoons \text{Co} + 2 \text{OH}^-$	-0.73
$\text{Co}(\text{OH})_3 + e \rightleftharpoons \text{Co}(\text{OH})_2 + \text{OH}^-$	0.17
$\text{Cr}^{2+} + 2 e \rightleftharpoons \text{Cr}$	-0.913
$\text{Cr}^{3+} + e \rightleftharpoons \text{Cr}^{2+}$	-0.407
$\text{Cr}^{3+} + 3 e \rightleftharpoons \text{Cr}$	-0.744
$\text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+ + 6 e \rightleftharpoons 2 \text{Cr}^{3+} + 7 \text{H}_2\text{O}$	1.36
$\text{CrO}_2^- + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Cr} + 4 \text{OH}^-$	-1.2
$\text{HCrO}_4^- + 7 \text{H}^+ + 3 e \rightleftharpoons \text{Cr}^{3+} + 4 \text{H}_2\text{O}$	1.350
$\text{CrO}_2 + 4 \text{H}^+ + e \rightleftharpoons \text{Cr}^{3+} + 2 \text{H}_2\text{O}$	1.48
$\text{Cr}(\text{V}) + e \rightleftharpoons \text{Cr}(\text{IV})$	1.34
$\text{CrO}_4^{2-} + 4 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Cr}(\text{OH})_3 + 5 \text{OH}^-$	-0.13
$\text{Cr}(\text{OH})_3 + 3 e \rightleftharpoons \text{Cr} + 3 \text{OH}^-$	-1.48
$\text{Cs}^+ + e \rightleftharpoons \text{Cs}$	-3.026
$\text{Cu}^+ + e \rightleftharpoons \text{Cu}$	0.521
$\text{Cu}^{2+} + e \rightleftharpoons \text{Cu}^+$	0.153
$\text{Cu}^{2+} + 2 e \rightleftharpoons \text{Cu}$	0.3419
$\text{Cu}^{2+} + 2 e \rightleftharpoons \text{Cu}(\text{Hg})$	0.345
$\text{Cu}^{3+} + e \rightleftharpoons \text{Cu}^{2+}$	2.4
$\text{Cu}_2\text{O}_3 + 6 \text{H}^+ + 2 e \rightleftharpoons 2 \text{Cu}^{2+} + 3 \text{H}_2\text{O}$	2.0
$\text{Cu}^{2+} + 2 \text{CN}^- + e \rightleftharpoons [\text{Cu}(\text{CN})_2]^-$	1.103
$\text{CuI}_2^- + e \rightleftharpoons \text{Cu} + 2 \text{I}^-$	0.00
$\text{Cu}_2\text{O} + \text{H}_2\text{O} + 2 e \rightleftharpoons 2 \text{Cu} + 2 \text{OH}^-$	-0.360
$\text{Cu}(\text{OH})_2 + 2 e \rightleftharpoons \text{Cu} + 2 \text{OH}^-$	-0.222
$2 \text{Cu}(\text{OH})_2 + 2 e \rightleftharpoons \text{Cu}_2\text{O} + 2 \text{OH}^- + \text{H}_2\text{O}$	-0.080
$2 \text{D}^+ + 2 e \rightleftharpoons \text{D}_2$	-0.013
$\text{Dy}^{2+} + 2 e \rightleftharpoons \text{Dy}$	-2.2
$\text{Dy}^{3+} + 3 e \rightleftharpoons \text{Dy}$	-2.295
$\text{Dy}^{3+} + e \rightleftharpoons \text{Dy}^{2+}$	-2.6
$\text{Er}^{2+} + 2 e \rightleftharpoons \text{Er}$	-2.0
$\text{Er}^{3+} + 3 e \rightleftharpoons \text{Er}$	-2.331
$\text{Er}^{3+} + e \rightleftharpoons \text{Er}^{2+}$	-3.0
$\text{Es}^{3+} + e \rightleftharpoons \text{Es}^{2+}$	-1.3
$\text{Es}^{3+} + 3 e \rightleftharpoons \text{Es}$	-1.91
$\text{Es}^{2+} + 2 e \rightleftharpoons \text{Es}$	-2.23
$\text{Eu}^{2+} + 2 e \rightleftharpoons \text{Eu}$	-2.812
$\text{Eu}^{3+} + 3 e \rightleftharpoons \text{Eu}$	-1.991
$\text{Eu}^{3+} + e \rightleftharpoons \text{Eu}^{2+}$	-0.36
$\text{F}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{HF}$	3.053
$\text{F}_2 + 2 e \rightleftharpoons 2 \text{F}^-$	2.866
$\text{F}_2\text{O} + 2 \text{H}^+ + 4 e \rightleftharpoons \text{H}_2\text{O} + 2 \text{F}^-$	2.153
$\text{Fe}^{2+} + 2 e \rightleftharpoons \text{Fe}$	-0.447
$\text{Fe}^{3+} + 3 e \rightleftharpoons \text{Fe}$	-0.037
$\text{Fe}^{3+} + e \rightleftharpoons \text{Fe}^{2+}$	0.771
$2 \text{HFeO}_4^- + 8 \text{H}^+ + 6 e \rightleftharpoons \text{Fe}_2\text{O}_3 + 5 \text{H}_2\text{O}$	2.09
$\text{HFeO}_4^- + 4 \text{H}^+ + 3 e \rightleftharpoons \text{FeOOH} + 2 \text{H}_2\text{O}$	2.08
$\text{HFeO}_4^- + 7 \text{H}^+ + 3 e \rightleftharpoons \text{Fe}^{3+} + 4 \text{H}_2\text{O}$	2.07
$\text{Fe}_2\text{O}_3 + 4 \text{H}^+ + 2 e \rightleftharpoons 2 \text{FeOH}^+ + \text{H}_2\text{O}$	0.16
$[\text{Fe}(\text{CN})_6]^{3-} + e \rightleftharpoons [\text{Fe}(\text{CN})_6]^{4-}$	0.358
$\text{FeO}_4^{2-} + 8 \text{H}^+ + 3 e \rightleftharpoons \text{Fe}^{3+} + 4 \text{H}_2\text{O}$	2.20
$[\text{Fe}(\text{bipy})_2]^{3+} + e \rightleftharpoons [\text{Fe}(\text{bipy})_2]^{2+}$	0.78
$[\text{Fe}(\text{bipy})_3]^{3+} + e \rightleftharpoons [\text{Fe}(\text{bipy})_3]^{2+}$	1.03
$\text{Fe}(\text{OH})_3 + e \rightleftharpoons \text{Fe}(\text{OH})_2 + \text{OH}^-$	-0.56
$[\text{Fe}(\text{phen})_3]^{3+} + e \rightleftharpoons [\text{Fe}(\text{phen})_3]^{2+}$	1.147
$[\text{Fe}(\text{phen})_3]^{3+} + e \rightleftharpoons [\text{Fe}(\text{phen})_3]^{2+}$ (1 molar $\text{H}_2\text{SO}_4$ )	1.06
$[\text{Ferricinium}]^+ + e \rightleftharpoons \text{ferrocene}$	0.400
$\text{Fm}^{3+} + e \rightleftharpoons \text{Fm}^{2+}$	-1.1
$\text{Fm}^{3+} + 3 e \rightleftharpoons \text{Fm}$	-1.89
$\text{Fm}^{2+} + 2 e \rightleftharpoons \text{Fm}$	-2.30

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$\text{Fr}^+ + e \rightleftharpoons \text{Fr}$	-2.9	$\text{La}(\text{OH})_3 + 3 e \rightleftharpoons \text{La} + 3 \text{OH}^-$	-2.90
$\text{Ga}^{3+} + 3 e \rightleftharpoons \text{Ga}$	-0.549	$\text{Li}^+ + e \rightleftharpoons \text{Li}$	-3.0401
$\text{Ga}^+ + e \rightleftharpoons \text{Ga}$	-0.2	$\text{Lu}^{3+} + 3 e \rightleftharpoons \text{Lu}$	-1.96
$\text{GaOH}^{2+} + \text{H}^+ + 3 e \rightleftharpoons \text{Ga} + \text{H}_2\text{O}$	-0.498	$\text{Lu}^{3+} + 3 e \rightleftharpoons \text{Lu}$	-2.28
$\text{H}_2\text{GaO}_3 + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Ga} + 4 \text{OH}^-$	-1.219	$\text{Md}^{3+} + e \rightleftharpoons \text{Md}^{2+}$	-0.1
$\text{Gd}^{3+} + 3 e \rightleftharpoons \text{Gd}$	-2.279	$\text{Md}^{3+} + 3 e \rightleftharpoons \text{Md}$	-1.65
$\text{Ge}^{2+} + 2 e \rightleftharpoons \text{Ge}$	0.24	$\text{Md}^{2+} + 2 e \rightleftharpoons \text{Md}$	-2.40
$\text{Ge}^{4+} + 4 e \rightleftharpoons \text{Ge}$	0.124	$\text{Mg}^+ + e \rightleftharpoons \text{Mg}$	-2.70
$\text{Ge}^{4+} + 2 e \rightleftharpoons \text{Ge}^{2+}$	0.00	$\text{Mg}^{2+} + 2 e \rightleftharpoons \text{Mg}$	-2.372
$\text{GeO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{GeO} + \text{H}_2\text{O}$	-0.118	$\text{Mg}(\text{OH})_2 + 2 e \rightleftharpoons \text{Mg} + 2 \text{OH}^-$	-2.690
$\text{H}_2\text{GeO}_3 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Ge} + 3 \text{H}_2\text{O}$	-0.182	$\text{Mn}^{2+} + 2 e \rightleftharpoons \text{Mn}$	-1.185
$2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2$	0.00000	$\text{Mn}^{3+} + e \rightleftharpoons \text{Mn}^{2+}$	1.5415
$\text{H}_2 + 2 e \rightleftharpoons 2 \text{H}^-$	-2.23	$\text{MnO}_2 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Mn}^{2+} + 2 \text{H}_2\text{O}$	1.224
$\text{HO}_2 + \text{H}^+ + e \rightleftharpoons \text{H}_2\text{O}_2$	1.495	$\text{MnO}_4^- + e \rightleftharpoons \text{MnO}_4^{2-}$	0.558
$2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{H}_2 + 2 \text{OH}^-$	-0.8277	$\text{MnO}_4^- + 4 \text{H}^+ + 3 e \rightleftharpoons \text{MnO}_2 + 2 \text{H}_2\text{O}$	1.679
$\text{H}_2\text{O}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{H}_2\text{O}$	1.776	$\text{MnO}_4^- + 8 \text{H}^+ + 5 e \rightleftharpoons \text{Mn}^{2+} + 4 \text{H}_2\text{O}$	1.507
$\text{Hf}^{4+} + 4 e \rightleftharpoons \text{Hf}$	-1.55	$\text{MnO}_4^- + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{MnO}_2 + 4 \text{OH}^-$	0.595
$\text{HfO}^{2+} + 2 \text{H}^+ + 4 e \rightleftharpoons \text{Hf} + \text{H}_2\text{O}$	-1.724	$\text{MnO}_4^{2-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{MnO}_2 + 4 \text{OH}^-$	0.60
$\text{HfO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Hf} + 2 \text{H}_2\text{O}$	-1.505	$\text{Mn}(\text{OH})_2 + 2 e \rightleftharpoons \text{Mn} + 2 \text{OH}^-$	-1.56
$\text{HfO}(\text{OH})_2 + \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Hf} + 4 \text{OH}^-$	-2.50	$\text{Mn}(\text{OH})_3 + e \rightleftharpoons \text{Mn}(\text{OH})_2 + \text{OH}^-$	0.15
$\text{Hg}^{2+} + 2 e \rightleftharpoons \text{Hg}$	0.851	$\text{Mn}_2\text{O}_3 + 6 \text{H}^+ + e \rightleftharpoons 2 \text{Mn}^{2+} + 3 \text{H}_2\text{O}$	1.485
$2 \text{Hg}^{2+} + 2 e \rightleftharpoons \text{Hg}_2^{2+}$	0.920	$\text{Mo}^{3+} + 3 e \rightleftharpoons \text{Mo}$	-0.200
$\text{Hg}_2^{2+} + 2 e \rightleftharpoons 2 \text{Hg}$	0.7973	$\text{MoO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Mo} + 4 \text{H}_2\text{O}$	-0.152
$\text{Hg}_2(\text{ac})_2 + 2 e \rightleftharpoons 2 \text{Hg} + 2(\text{ac})^-$	0.51163	$\text{H}_3\text{Mo}_7\text{O}_{24}^{3-} + 45 \text{H}^+ + 42 e \rightleftharpoons 7 \text{Mo} + 24 \text{H}_2\text{O}$	0.082
$\text{Hg}_2\text{Br}_2 + 2 e \rightleftharpoons 2 \text{Hg} + 2 \text{Br}^-$	0.13923	$\text{MoO}_3 + 6 \text{H}^+ + 6 e \rightleftharpoons \text{Mo} + 3 \text{H}_2\text{O}$	0.075
$\text{Hg}_2\text{Cl}_2 + 2 e \rightleftharpoons 2 \text{Hg} + 2 \text{Cl}^-$	0.26808	$\text{N}_2 + 2 \text{H}_2\text{O} + 6 \text{H}^+ + 6 e \rightleftharpoons 2 \text{NH}_4\text{OH}$	0.092
$\text{Hg}_2\text{HPO}_4 + 2 e \rightleftharpoons 2 \text{Hg} + \text{HPO}_4^{2-}$	0.6359	$3 \text{N}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{HN}_3$	-3.09
$\text{Hg}_2\text{I}_2 + 2 e \rightleftharpoons 2 \text{Hg} + 2 \text{I}^-$	-0.0405	$\text{N}_5^+ + 3 \text{H}^+ + 2 e \rightleftharpoons 2 \text{NH}_4^+$	1.275
$\text{Hg}_2\text{O} + \text{H}_2\text{O} + 2 e \rightleftharpoons 2 \text{Hg} + 2 \text{OH}^-$	0.123	$\text{N}_2\text{O} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{N}_2 + \text{H}_2\text{O}$	1.766
$\text{HgO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Hg} + 2 \text{OH}^-$	0.0977	$\text{H}_2\text{N}_2\text{O}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{N}_2 + 2 \text{H}_2\text{O}$	2.65
$\text{Hg}(\text{OH})_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{Hg} + 2 \text{H}_2\text{O}$	1.034	$\text{N}_2\text{O}_4 + 2 e \rightleftharpoons 2 \text{NO}_2^-$	0.867
$\text{Hg}_2\text{SO}_4 + 2 e \rightleftharpoons 2 \text{Hg} + \text{SO}_4^{2-}$	0.6125	$\text{N}_2\text{O}_4 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{NHO}_2$	1.065
$\text{Ho}^{2+} + 2 e \rightleftharpoons \text{Ho}$	-2.1	$\text{N}_2\text{O}_4 + 4 \text{H}^+ + 4 e \rightleftharpoons 2 \text{NO} + 2 \text{H}_2\text{O}$	1.035
$\text{Ho}^{3+} + 3 e \rightleftharpoons \text{Ho}$	-2.33	$2 \text{NH}_3\text{OH}^+ + \text{H}^+ + 2 e \rightleftharpoons \text{N}_2\text{H}_5^+ + 2 \text{H}_2\text{O}$	1.42
$\text{Ho}^{3+} + e \rightleftharpoons \text{Ho}^{2+}$	-2.8	$2 \text{NO} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{N}_2\text{O} + \text{H}_2\text{O}$	1.591
$\text{I}_2 + 2 e \rightleftharpoons 2 \text{I}^-$	0.5355	$2 \text{NO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{N}_2\text{O} + 2 \text{OH}^-$	0.76
$\text{I}_3^- + 2 e \rightleftharpoons 3 \text{I}^-$	0.536	$\text{HNO}_2 + \text{H}^+ + e \rightleftharpoons \text{NO} + \text{H}_2\text{O}$	0.983
$\text{H}_3\text{IO}_6^{2-} + 2 e \rightleftharpoons \text{IO}_3^- + 3 \text{OH}^-$	0.7	$2 \text{HNO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{H}_2\text{N}_2\text{O}_2 + 2 \text{H}_2\text{O}$	0.86
$\text{H}_5\text{IO}_6 + \text{H}^+ + 2 e \rightleftharpoons \text{IO}_3^- + 3 \text{H}_2\text{O}$	1.601	$2 \text{HNO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{N}_2\text{O} + 3 \text{H}_2\text{O}$	1.297
$2 \text{HIO} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{I}_2 + 2 \text{H}_2\text{O}$	1.439	$\text{NO}_2^- + \text{H}_2\text{O} + e \rightleftharpoons \text{NO} + 2 \text{OH}^-$	-0.46
$\text{HIO} + \text{H}^+ + 2 e \rightleftharpoons \text{I}^- + \text{H}_2\text{O}$	0.987	$2 \text{NO}_2^- + 2 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{N}_2\text{O}_4^{2-} + 4 \text{OH}^-$	-0.18
$\text{IO}^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{I}^- + 2 \text{OH}^-$	0.485	$2 \text{NO}_2^- + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{N}_2\text{O} + 6 \text{OH}^-$	0.15
$2 \text{IO}_3^- + 12 \text{H}^+ + 10 e \rightleftharpoons \text{I}_2 + 6 \text{H}_2\text{O}$	1.195	$\text{NO}_3^- + 3 \text{H}^+ + 2 e \rightleftharpoons \text{HNO}_2 + \text{H}_2\text{O}$	0.934
$\text{IO}_3^- + 6 \text{H}^+ + 6 e \rightleftharpoons \text{I}^- + 3 \text{H}_2\text{O}$	1.085	$\text{NO}_3^- + 4 \text{H}^+ + 3 e \rightleftharpoons \text{NO} + 2 \text{H}_2\text{O}$	0.957
$\text{IO}_3^- + 2 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{IO}^- + 4 \text{OH}^-$	0.15	$2 \text{NO}_3^- + 4 \text{H}^+ + 2 e \rightleftharpoons \text{N}_2\text{O}_4 + 2 \text{H}_2\text{O}$	0.803
$\text{IO}_3^- + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons \text{IO}^- + 6 \text{OH}^-$	0.26	$\text{NO}_3^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{NO}_2^- + 2 \text{OH}^-$	0.01
$\text{In}^+ + e \rightleftharpoons \text{In}$	-0.14	$2 \text{NO}_3^- + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{N}_2\text{O}_4 + 4 \text{OH}^-$	-0.85
$\text{In}^{2+} + e \rightleftharpoons \text{In}^+$	-0.40	$\text{Na}^+ + e \rightleftharpoons \text{Na}$	-2.71
$\text{In}^{3+} + e \rightleftharpoons \text{In}^{2+}$	-0.49	$\text{Nb}^{3+} + 3 e \rightleftharpoons \text{Nb}$	-1.099
$\text{In}^{3+} + 2 e \rightleftharpoons \text{In}^+$	-0.443	$\text{NbO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{NbO} + \text{H}_2\text{O}$	-0.646
$\text{In}^{3+} + 3 e \rightleftharpoons \text{In}$	-0.3382	$\text{NbO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Nb} + 2 \text{H}_2\text{O}$	-0.690
$\text{In}(\text{OH})_3 + 3 e \rightleftharpoons \text{In} + 3 \text{OH}^-$	-0.99	$\text{NbO} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{Nb} + \text{H}_2\text{O}$	-0.733
$\text{In}(\text{OH})_4^- + 3 e \rightleftharpoons \text{In} + 4 \text{OH}^-$	-1.007	$\text{Nb}_2\text{O}_5 + 10 \text{H}^+ + 10 e \rightleftharpoons 2 \text{Nb} + 5 \text{H}_2\text{O}$	-0.644
$\text{In}_2\text{O}_3 + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons 2 \text{In} + 6 \text{OH}^-$	-1.034	$\text{Nd}^{3+} + 3 e \rightleftharpoons \text{Nd}$	-2.323
$\text{Ir}^{3+} + 3 e \rightleftharpoons \text{Ir}$	1.156	$\text{Nd}^{2+} + 2 e \rightleftharpoons \text{Nd}$	-2.1
$[\text{IrCl}_6]^{2-} + e \rightleftharpoons [\text{IrCl}_6]^{3-}$	0.8665	$\text{Nd}^{3+} + e \rightleftharpoons \text{Nd}^{2+}$	-2.7
$[\text{IrCl}_6]^{3-} + 3 e \rightleftharpoons \text{Ir} + 6 \text{Cl}^-$	0.77	$\text{Ni}^{2+} + 2 e \rightleftharpoons \text{Ni}$	-0.257
$\text{Ir}_2\text{O}_3 + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons 2 \text{Ir} + 6 \text{OH}^-$	0.098	$\text{Ni}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ni} + 2 \text{OH}^-$	-0.72
$\text{K}^+ + e \rightleftharpoons \text{K}$	-2.931	$\text{NiO}_2 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Ni}^{2+} + 2 \text{H}_2\text{O}$	1.678
$\text{La}^{3+} + 3 e \rightleftharpoons \text{La}$	-2.379	$\text{NiO}_2 + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Ni}(\text{OH})_2 + 2 \text{OH}^-$	-0.490

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$\text{No}^{3+} + e \rightleftharpoons \text{No}^{2+}$	1.4	$\text{Pr}^{3+} + e \rightleftharpoons \text{Pr}^{2+}$	-3.1
$\text{No}^{3+} + 3 e \rightleftharpoons \text{No}$	-1.20	$\text{Pt}^{2+} + 2 e \rightleftharpoons \text{Pt}$	1.18
$\text{No}^{2+} + 2 e \rightleftharpoons \text{No}$	-2.50	$[\text{PtCl}_4]^{2-} + 2 e \rightleftharpoons \text{Pt} + 4 \text{Cl}^-$	0.755
$\text{Np}^{3+} + 3 e \rightleftharpoons \text{Np}$	-1.856	$[\text{PtCl}_6]^{2-} + 2 e \rightleftharpoons [\text{PtCl}_4]^{2-} + 2 \text{Cl}^-$	0.68
$\text{Np}^{4+} + e \rightleftharpoons \text{Np}^{3+}$	0.147	$\text{Pt}(\text{OH})_2 + 2 e \rightleftharpoons \text{Pt} + 2 \text{OH}^-$	0.14
$\text{NpO}_2 + \text{H}_2\text{O} + \text{H}^+ + e \rightleftharpoons \text{Np}(\text{OH})_3$	-0.962	$\text{PtO}_3 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{PtO}_2 + \text{H}_2\text{O}$	1.7
$\text{O}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{O}_2$	0.695	$\text{PtO}_3 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Pt}(\text{OH})_2^{2+} + \text{H}_2\text{O}$	1.5
$\text{O}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons 2 \text{H}_2\text{O}$	1.229	$\text{PtOH}^+ + \text{H}^+ + 2 e \rightleftharpoons \text{Pt} + \text{H}_2\text{O}$	1.2
$\text{O}_2 + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{HO}_2^- + \text{OH}^-$	-0.076	$\text{PtO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{PtO} + \text{H}_2\text{O}$	1.01
$\text{O}_2 + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{H}_2\text{O}_2 + 2 \text{OH}^-$	-0.146	$\text{PtO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Pt} + 2 \text{H}_2\text{O}$	1.00
$\text{O}_2 + 2 \text{H}_2\text{O} + 4 e \rightleftharpoons 4 \text{OH}^-$	0.401	$\text{Pu}^{3+} + 3 e \rightleftharpoons \text{Pu}$	-2.031
$\text{O}_3 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{O}_2 + \text{H}_2\text{O}$	2.076	$\text{Pu}^{4+} + e \rightleftharpoons \text{Pu}^{3+}$	1.006
$\text{O}_3 + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{O}_2 + 2 \text{OH}^-$	1.24	$\text{Pu}^{5+} + e \rightleftharpoons \text{Pu}^{4+}$	1.099
$\text{O}(\text{g}) + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{O}$	2.421	$\text{PuO}_2(\text{OH})_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{Pu}(\text{OH})_4$	1.325
$\text{OH} + e \rightleftharpoons \text{OH}^-$	2.02	$\text{PuO}_2(\text{OH})_2 + \text{H}^+ + e \rightleftharpoons \text{PuO}_2\text{OH} + \text{H}_2\text{O}$	1.062
$\text{HO}_2^- + \text{H}_2\text{O} + 2 e \rightleftharpoons 3 \text{OH}^-$	0.878	$\text{Ra}^{2+} + 2 e \rightleftharpoons \text{Ra}$	-2.8
$\text{OsO}_4 + 8 \text{H}^+ + 8 e \rightleftharpoons \text{Os} + 4 \text{H}_2\text{O}$	0.838	$\text{Rb}^+ + e \rightleftharpoons \text{Rb}$	-2.98
$\text{OsO}_4 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{OsO}_2 + 2 \text{H}_2\text{O}$	1.02	$\text{Re}^{3+} + 3 e \rightleftharpoons \text{Re}$	0.300
$[\text{Os}(\text{bipy})_2]^{3+} + e \rightleftharpoons [\text{Os}(\text{bipy})_2]^{2+}$	0.81	$\text{ReO}_4^- + 4 \text{H}^+ + 3 e \rightleftharpoons \text{ReO}_2 + 2 \text{H}_2\text{O}$	0.510
$[\text{Os}(\text{bipy})_3]^{3+} + e \rightleftharpoons [\text{Os}(\text{bipy})_3]^{2+}$	0.80	$\text{ReO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Re} + 2 \text{H}_2\text{O}$	0.2513
$\text{P}(\text{red}) + 3 \text{H}^+ + 3 e \rightleftharpoons \text{PH}_3(\text{g})$	-0.111	$\text{ReO}_4^- + 2 \text{H}^+ + e \rightleftharpoons \text{ReO}_3 + \text{H}_2\text{O}$	0.768
$\text{P}(\text{white}) + 3 \text{H}^+ + 3 e \rightleftharpoons \text{PH}_3(\text{g})$	-0.063	$\text{ReO}_4^- + 4 \text{H}_2\text{O} + 7 e \rightleftharpoons \text{Re} + 8 \text{OH}^-$	-0.584
$\text{P} + 3 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{PH}_3(\text{g}) + 3 \text{OH}^-$	-0.87	$\text{ReO}_4^- + 8 \text{H}^+ + 7 e \rightleftharpoons \text{Re} + 4 \text{H}_2\text{O}$	0.368
$\text{H}_2\text{P}_2^- + e \rightleftharpoons \text{P} + 2 \text{OH}^-$	-1.82	$\text{Rh}^+ + e \rightleftharpoons \text{Rh}$	0.600
$\text{H}_3\text{PO}_2 + \text{H}^+ + e \rightleftharpoons \text{P} + 2 \text{H}_2\text{O}$	-0.508	$\text{Rh}^{3+} + 3 e \rightleftharpoons \text{Rh}$	0.758
$\text{H}_3\text{PO}_3 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_3\text{PO}_2 + \text{H}_2\text{O}$	-0.499	$[\text{RhCl}_6]^{3-} + 3 e \rightleftharpoons \text{Rh} + 6 \text{Cl}^-$	0.431
$\text{H}_3\text{PO}_3 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{P} + 3 \text{H}_2\text{O}$	-0.454	$\text{RhOH}^{2+} + \text{H}^+ + 3 e \rightleftharpoons \text{Rh} + \text{H}_2\text{O}$	0.83
$\text{HPO}_3^{2-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{H}_2\text{PO}_2^- + 3 \text{OH}^-$	-1.65	$\text{Ru}^{2+} + 2 e \rightleftharpoons \text{Ru}$	0.455
$\text{HPO}_3^{2-} + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{P} + 5 \text{OH}^-$	-1.71	$\text{Ru}^{3+} + e \rightleftharpoons \text{Ru}^{2+}$	0.2487
$\text{H}_3\text{PO}_4 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_3\text{PO}_3 + \text{H}_2\text{O}$	-0.276	$\text{RuO}_2 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Ru}^{2+} + 2 \text{H}_2\text{O}$	1.120
$\text{PO}_4^{3-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{HPO}_3^{2-} + 3 \text{OH}^-$	-1.05	$\text{RuO}_4^- + e \rightleftharpoons \text{RuO}_4^{2-}$	0.59
$\text{Pa}^{3+} + 3 e \rightleftharpoons \text{Pa}$	-1.34	$\text{RuO}_4 + e \rightleftharpoons \text{RuO}_4^-$	1.00
$\text{Pa}^{4+} + 4 e \rightleftharpoons \text{Pa}$	-1.49	$\text{RuO}_4 + 6 \text{H}^+ + 4 e \rightleftharpoons \text{Ru}(\text{OH})_2^{2+} + 2 \text{H}_2\text{O}$	1.40
$\text{Pa}^{4+} + e \rightleftharpoons \text{Pa}^{3+}$	-1.9	$\text{RuO}_4 + 8 \text{H}^+ + 8 e \rightleftharpoons \text{Ru} + 4 \text{H}_2\text{O}$	1.038
$\text{Pb}^{2+} + 2 e \rightleftharpoons \text{Pb}$	-0.1262	$[\text{Ru}(\text{bipy})_3]^{3+} + e^- \rightleftharpoons [\text{Ru}(\text{bipy})_3]^{2+}$	1.24
$\text{Pb}^{2+} + 2 e \rightleftharpoons \text{Pb}(\text{Hg})$	-0.1205	$[\text{Ru}(\text{H}_2\text{O})_6]^{3+} + e^- \rightleftharpoons [\text{Ru}(\text{H}_2\text{O})_6]^{2+}$	0.23
$\text{PbBr}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{Br}^-$	-0.284	$[\text{Ru}(\text{NH}_3)_6]^{3+} + e^- \rightleftharpoons [\text{Ru}(\text{NH}_3)_6]^{2+}$	0.10
$\text{PbCl}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{Cl}^-$	-0.2675	$[\text{Ru}(\text{en})_3]^{3+} + e^- \rightleftharpoons [\text{Ru}(\text{en})_3]^{2+}$	0.210
$\text{PbF}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{F}^-$	-0.3444	$[\text{Ru}(\text{CN})_6]^{3-} + e^- \rightleftharpoons [\text{Ru}(\text{CN})_6]^{4-}$	0.86
$\text{PbHPO}_4 + 2 e \rightleftharpoons \text{Pb} + \text{HPO}_4^{2-}$	-0.465	$\text{S} + 2 e \rightleftharpoons \text{S}^{2-}$	-0.47627
$\text{PbI}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{I}^-$	-0.365	$\text{S} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{S}(\text{aq})$	0.142
$\text{PbO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Pb} + 2 \text{OH}^-$	-0.580	$\text{S} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{SH}^- + \text{OH}^-$	-0.478
$\text{PbO}_2 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Pb}^{2+} + 2 \text{H}_2\text{O}$	1.455	$2 \text{S} + 2 e \rightleftharpoons \text{S}_2^{2-}$	-0.42836
$\text{HPbO}_2^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Pb} + 3 \text{OH}^-$	-0.537	$\text{S}_2\text{O}_6^{2-} + 4 \text{H}^+ + 2 e \rightleftharpoons 2 \text{H}_2\text{SO}_3$	0.564
$\text{PbO}_2 + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{PbO} + 2 \text{OH}^-$	0.247	$\text{S}_2\text{O}_8^{2-} + 2 e \rightleftharpoons 2 \text{SO}_4^{2-}$	2.010
$\text{PbO}_2 + \text{SO}_4^{2-} + 4 \text{H}^+ + 2 e \rightleftharpoons \text{PbSO}_4 + 2 \text{H}_2\text{O}$	1.6913	$\text{S}_2\text{O}_8^{2-} + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{HSO}_4^-$	2.123
$\text{PbSO}_4 + 2 e \rightleftharpoons \text{Pb} + \text{SO}_4^{2-}$	-0.3588	$\text{S}_4\text{O}_6^{2-} + 2 e \rightleftharpoons 2 \text{S}_2\text{O}_3^{2-}$	0.08
$\text{PbSO}_4 + 2 e \rightleftharpoons \text{Pb}(\text{Hg}) + \text{SO}_4^{2-}$	-0.3505	$2 \text{H}_2\text{SO}_3 + \text{H}^+ + 2 e \rightleftharpoons \text{HS}_2\text{O}_4^- + 2 \text{H}_2\text{O}$	-0.056
$\text{Pd}^{2+} + 2 e \rightleftharpoons \text{Pd}$	0.951	$\text{H}_2\text{SO}_3 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{S} + 3 \text{H}_2\text{O}$	0.449
$[\text{PdCl}_4]^{2-} + 2 e \rightleftharpoons \text{Pd} + 4 \text{Cl}^-$	0.591	$2 \text{SO}_3^{2-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{S}_2\text{O}_4^{2-} + 4 \text{OH}^-$	-1.12
$[\text{PdCl}_6]^{2-} + 2 e \rightleftharpoons [\text{PdCl}_4]^{2-} + 2 \text{Cl}^-$	1.288	$2 \text{SO}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 6 \text{OH}^-$	-0.571
$\text{Pd}(\text{OH})_2 + 2 e \rightleftharpoons \text{Pd} + 2 \text{OH}^-$	0.07	$\text{SO}_4^{2-} + 4 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	0.172
$\text{Pm}^{2+} + 2 e \rightleftharpoons \text{Pm}$	-2.2	$2 \text{SO}_4^{2-} + 4 \text{H}^+ + 2 e \rightleftharpoons \text{S}_2\text{O}_6^{2-} + \text{H}_2\text{O}$	-0.22
$\text{Pm}^{3+} + 3 e \rightleftharpoons \text{Pm}$	-2.30	$\text{SO}_4^{2-} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{SO}_3^{2-} + 2 \text{OH}^-$	-0.93
$\text{Pm}^{3+} + e \rightleftharpoons \text{Pm}^{2+}$	-2.6	$\text{Sb} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{SbH}_3$	-0.510
$\text{Po}^{4+} + 2 e \rightleftharpoons \text{Po}^{2+}$	0.9	$\text{Sb}_2\text{O}_3 + 6 \text{H}^+ + 6 e \rightleftharpoons 2 \text{Sb} + 3 \text{H}_2\text{O}$	0.152
$\text{Po}^{4+} + 4 e \rightleftharpoons \text{Po}$	0.76	$\text{Sb}_2\text{O}_5$ (senarmontite) + $4 \text{H}^+ + 4 e \rightleftharpoons \text{Sb}_2\text{O}_3 + 2 \text{H}_2\text{O}$	0.671
$\text{Pr}^{4+} + e \rightleftharpoons \text{Pr}^{3+}$	3.2	$\text{Sb}_2\text{O}_5$ (valentinite) + $4 \text{H}^+ + 4 e \rightleftharpoons \text{Sb}_2\text{O}_3 + 2 \text{H}_2\text{O}$	0.649
$\text{Pr}^{2+} + 2 e \rightleftharpoons \text{Pr}$	-2.0		
$\text{Pr}^{3+} + 3 e \rightleftharpoons \text{Pr}$	-2.353		



Reaction	$E^\circ/V$
$\text{Sb}_2\text{O}_5 + 6 \text{H}^+ + 4 \text{e} \rightleftharpoons 2 \text{SbO}^+ + 3 \text{H}_2\text{O}$	0.581
$\text{SbO}^+ + 2 \text{H}^+ + 3 \text{e} \rightleftharpoons \text{Sb} + 2 \text{H}_2\text{O}$	0.212
$\text{SbO}_2^- + 2 \text{H}_2\text{O} + 3 \text{e} \rightleftharpoons \text{Sb} + 4 \text{OH}^-$	-0.66
$\text{SbO}_3^- + \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{SbO}_2^- + 2 \text{OH}^-$	-0.59
$\text{Sc}^{3+} + 3 \text{e} \rightleftharpoons \text{Sc}$	-2.077
$\text{Se} + 2 \text{e} \rightleftharpoons \text{Se}^{2-}$	-0.924
$\text{Se} + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{H}_2\text{Se}(\text{aq})$	-0.399
$\text{H}_2\text{SeO}_3 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{Se} + 3 \text{H}_2\text{O}$	0.74
$\text{Se} + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{H}_2\text{Se}$	-0.082
$\text{SeO}_3^{2-} + 3 \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons \text{Se} + 6 \text{OH}^-$	-0.366
$\text{SeO}_4^{2-} + 4 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{H}_2\text{SeO}_3 + \text{H}_2\text{O}$	1.151
$\text{SeO}_4^{2-} + \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{SeO}_3^{2-} + 2 \text{OH}^-$	0.05
$\text{SiF}_6^{2-} + 4 \text{e} \rightleftharpoons \text{Si} + 6 \text{F}^-$	-1.24
$\text{SiO} + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{Si} + \text{H}_2\text{O}$	-0.8
$\text{SiO}_2$ (quartz) + 4 $\text{H}^+$ + 4 $\text{e} \rightleftharpoons \text{Si} + 2 \text{H}_2\text{O}$	0.857
$\text{SiO}_3^{2-} + 3 \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons \text{Si} + 6 \text{OH}^-$	-1.697
$\text{Sm}^{3+} + \text{e} \rightleftharpoons \text{Sm}^{2+}$	-1.55
$\text{Sm}^{3+} + 3 \text{e} \rightleftharpoons \text{Sm}$	-2.304
$\text{Sm}^{2+} + 2 \text{e} \rightleftharpoons \text{Sm}$	-2.68
$\text{Sn}^{2+} + 2 \text{e} \rightleftharpoons \text{Sn}$	-0.1375
$\text{Sn}^{4+} + 2 \text{e} \rightleftharpoons \text{Sn}^{2+}$	0.151
$\text{Sn}(\text{OH})_3^+ + 3 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{Sn}^{2+} + 3 \text{H}_2\text{O}$	0.142
$\text{SnO}_2 + 4 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{Sn}^{2+} + 2 \text{H}_2\text{O}$	-0.094
$\text{SnO}_2 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{Sn} + 2 \text{H}_2\text{O}$	-0.117
$\text{SnO}_2 + 3 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{SnOH}^+ + \text{H}_2\text{O}$	-0.194
$\text{SnO}_2 + 2 \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons \text{Sn} + 4 \text{OH}^-$	-0.945
$\text{HSnO}_2^- + \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{Sn} + 3 \text{OH}^-$	-0.909
$\text{Sn}(\text{OH})_6^{2-} + 2 \text{e} \rightleftharpoons \text{HSnO}_2^- + 3 \text{OH}^- + \text{H}_2\text{O}$	-0.93
$\text{Sr}^+ + \text{e} \rightleftharpoons \text{Sr}$	-4.10
$\text{Sr}^{2+} + 2 \text{e} \rightleftharpoons \text{Sr}$	-2.899
$\text{Sr}^{2+} + 2 \text{e} \rightleftharpoons \text{Sr}(\text{Hg})$	-1.793
$\text{Sr}(\text{OH})_2 + 2 \text{e} \rightleftharpoons \text{Sr} + 2 \text{OH}^-$	-2.88
$\text{Ta}_2\text{O}_5 + 10 \text{H}^+ + 10 \text{e} \rightleftharpoons 2 \text{Ta} + 5 \text{H}_2\text{O}$	-0.750
$\text{Ta}^{3+} + 3 \text{e} \rightleftharpoons \text{Ta}$	-0.6
$\text{Tc}^{2+} + 2 \text{e} \rightleftharpoons \text{Tc}$	0.400
$\text{TcO}_4^- + 4 \text{H}^+ + 3 \text{e} \rightleftharpoons \text{TcO}_2 + 2 \text{H}_2\text{O}$	0.782
$\text{Tc}^{3+} + \text{e} \rightleftharpoons \text{Tc}^{2+}$	0.3
$\text{TcO}_4^- + 8 \text{H}^+ + 7 \text{e} \rightleftharpoons \text{Tc} + 4 \text{H}_2\text{O}$	0.472
$\text{Tb}^{4+} + \text{e} \rightleftharpoons \text{Tb}^{3+}$	3.1
$\text{Tb}^{3+} + 3 \text{e} \rightleftharpoons \text{Tb}$	-2.28
$\text{Te} + 2 \text{e} \rightleftharpoons \text{Te}^{2-}$	-1.143
$\text{Te} + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{H}_2\text{Te}$	-0.793
$\text{Te}^{4+} + 4 \text{e} \rightleftharpoons \text{Te}$	0.568
$\text{TeO}_2 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{Te} + 2 \text{H}_2\text{O}$	0.593
$\text{TeO}_3^{2-} + 3 \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons \text{Te} + 6 \text{OH}^-$	-0.57
$\text{TeO}_4^- + 8 \text{H}^+ + 7 \text{e} \rightleftharpoons \text{Te} + 4 \text{H}_2\text{O}$	0.472
$\text{H}_6\text{TeO}_6 + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{TeO}_2 + 4 \text{H}_2\text{O}$	1.02
$\text{Th}^{4+} + 4 \text{e} \rightleftharpoons \text{Th}$	-1.899
$\text{ThO}_2 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{Th} + 2 \text{H}_2\text{O}$	-1.789
$\text{Th}(\text{OH})_4 + 4 \text{e} \rightleftharpoons \text{Th} + 4 \text{OH}^-$	-2.48
$\text{Ti}^{2+} + 2 \text{e} \rightleftharpoons \text{Ti}$	-1.630
$\text{Ti}^{3+} + \text{e} \rightleftharpoons \text{Ti}^{2+}$	-0.9
$\text{TiO}_2 + 4 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{Ti}^{2+} + 2 \text{H}_2\text{O}$	-0.502
$\text{Ti}^{3+} + 3 \text{e} \rightleftharpoons \text{Ti}$	-1.37
$\text{TiOH}^{3+} + \text{H}^+ + \text{e} \rightleftharpoons \text{Ti}^{3+} + \text{H}_2\text{O}$	-0.055

Reaction	$E^\circ/V$
$\text{Tl}^+ + \text{e} \rightleftharpoons \text{Tl}$	-0.336
$\text{Tl}^+ + \text{e} \rightleftharpoons \text{Tl}(\text{Hg})$	-0.3338
$\text{Tl}^{3+} + 2 \text{e} \rightleftharpoons \text{Tl}^+$	1.252
$\text{Tl}^{3+} + 3 \text{e} \rightleftharpoons \text{Tl}$	0.741
$\text{TlBr} + \text{e} \rightleftharpoons \text{Tl} + \text{Br}^-$	-0.658
$\text{TlCl} + \text{e} \rightleftharpoons \text{Tl} + \text{Cl}^-$	-0.5568
$\text{TlI} + \text{e} \rightleftharpoons \text{Tl} + \text{I}^-$	-0.752
$\text{Tl}_2\text{O}_3 + 3 \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons 2 \text{Tl}^+ + 6 \text{OH}^-$	0.02
$\text{TlOH} + \text{e} \rightleftharpoons \text{Tl} + \text{OH}^-$	-0.34
$\text{Tl}(\text{OH})_3 + 2 \text{e} \rightleftharpoons \text{TlOH} + 2 \text{OH}^-$	-0.05
$\text{Tl}_2\text{SO}_4 + 2 \text{e} \rightleftharpoons \text{Tl} + \text{SO}_4^{2-}$	-0.4360
$\text{Tm}^{3+} + \text{e} \rightleftharpoons \text{Tm}^{2+}$	-2.2
$\text{Tm}^{3+} + 3 \text{e} \rightleftharpoons \text{Tm}$	-2.319
$\text{Tm}^{2+} + 2 \text{e} \rightleftharpoons \text{Tm}$	-2.4
$\text{U}^{3+} + 3 \text{e} \rightleftharpoons \text{U}$	-1.798
$\text{U}^{4+} + \text{e} \rightleftharpoons \text{U}^{3+}$	-0.607
$\text{UO}_2^+ + 4 \text{H}^+ + \text{e} \rightleftharpoons \text{U}^{4+} + 2 \text{H}_2\text{O}$	0.612
$\text{UO}_2^{2+} + \text{e} \rightleftharpoons \text{UO}_2^+$	0.062
$\text{UO}_2^{2+} + 4 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{U}^{4+} + 2 \text{H}_2\text{O}$	0.327
$\text{UO}_2^{2+} + 4 \text{H}^+ + 6 \text{e} \rightleftharpoons \text{U} + 2 \text{H}_2\text{O}$	-1.444
$\text{V}^{2+} + 2 \text{e} \rightleftharpoons \text{V}$	-1.175
$\text{V}^{3+} + \text{e} \rightleftharpoons \text{V}^{2+}$	-0.255
$\text{VO}^{2+} + 2 \text{H}^+ + \text{e} \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	0.337
$\text{VO}_2^+ + 2 \text{H}^+ + \text{e} \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O}$	0.991
$\text{V}_2\text{O}_5 + 6 \text{H}^+ + 2 \text{e} \rightleftharpoons 2 \text{VO}^{2+} + 3 \text{H}_2\text{O}$	0.957
$\text{V}_2\text{O}_5 + 10 \text{H}^+ + 10 \text{e} \rightleftharpoons 2 \text{V} + 5 \text{H}_2\text{O}$	-0.242
$\text{V}(\text{OH})_4^+ + 2 \text{H}^+ + \text{e} \rightleftharpoons \text{VO}^{2+} + 3 \text{H}_2\text{O}$	1.00
$\text{V}(\text{OH})_4^+ + 4 \text{H}^+ + 5 \text{e} \rightleftharpoons \text{V} + 4 \text{H}_2\text{O}$	-0.254
$[\text{V}(\text{phen})_3]^{3+} + \text{e} \rightleftharpoons [\text{V}(\text{phen})_3]^{2+}$	0.14
$\text{W}^{3+} + 3 \text{e} \rightleftharpoons \text{W}$	0.1
$\text{W}_2\text{O}_5 + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons 2 \text{WO}_2 + \text{H}_2\text{O}$	-0.031
$\text{WO}_2 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{W} + 2 \text{H}_2\text{O}$	-0.119
$\text{WO}_3 + 6 \text{H}^+ + 6 \text{e} \rightleftharpoons \text{W} + 3 \text{H}_2\text{O}$	-0.090
$\text{WO}_3 + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{WO}_2 + \text{H}_2\text{O}$	0.036
$2 \text{WO}_3 + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{W}_2\text{O}_5 + \text{H}_2\text{O}$	-0.029
$\text{H}_4\text{XeO}_6 + 2 \text{H}^+ + 2 \text{e} \rightleftharpoons \text{XeO}_3 + 3 \text{H}_2\text{O}$	2.42
$\text{XeO}_3 + 6 \text{H}^+ + 6 \text{e} \rightleftharpoons \text{Xe} + 3 \text{H}_2\text{O}$	2.10
$\text{XeF} + \text{e} \rightleftharpoons \text{Xe} + \text{F}^-$	3.4
$\text{Y}^{3+} + 3 \text{e} \rightleftharpoons \text{Y}$	-2.372
$\text{Yb}^{3+} + \text{e} \rightleftharpoons \text{Yb}^{2+}$	-1.05
$\text{Yb}^{3+} + 3 \text{e} \rightleftharpoons \text{Yb}$	-2.19
$\text{Yb}^{2+} + 2 \text{e} \rightleftharpoons \text{Yb}$	-2.76
$\text{Zn}^{2+} + 2 \text{e} \rightleftharpoons \text{Zn}$	-0.7618
$\text{Zn}^{2+} + 2 \text{e} \rightleftharpoons \text{Zn}(\text{Hg})$	-0.7628
$\text{ZnO}_2^{2-} + 2 \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{Zn} + 4 \text{OH}^-$	-1.215
$\text{ZnSO}_4 \cdot 7 \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{Zn}(\text{Hg}) + \text{SO}_4^{2-} + 7 \text{H}_2\text{O}$ (Saturated $\text{ZnSO}_4$ )	-0.7993
$\text{ZnOH}^+ + \text{H}^+ + 2 \text{e} \rightleftharpoons \text{Zn} + \text{H}_2\text{O}$	-0.497
$\text{Zn}(\text{OH})_4^{2-} + 2 \text{e} \rightleftharpoons \text{Zn} + 4 \text{OH}^-$	-1.199
$\text{Zn}(\text{OH})_2 + 2 \text{e} \rightleftharpoons \text{Zn} + 2 \text{OH}^-$	-1.249
$\text{ZnO} + \text{H}_2\text{O} + 2 \text{e} \rightleftharpoons \text{Zn} + 2 \text{OH}^-$	-1.260
$\text{ZrO}_2 + 4 \text{H}^+ + 4 \text{e} \rightleftharpoons \text{Zr} + 2 \text{H}_2\text{O}$	-1.553
$\text{ZrO}(\text{OH})_2 + \text{H}_2\text{O} + 4 \text{e} \rightleftharpoons \text{Zr} + 4 \text{OH}^-$	-2.36
$\text{Zr}^{4+} + 4 \text{e} \rightleftharpoons \text{Zr}$	-1.45

TABLE 2. Reduction Reactions Having  $E^\circ$  Values More Positive than That of the Standard Hydrogen Electrode

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$2\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2$	0.00000	$\text{Hg}_2\text{Cl}_2 + 2\text{e} \rightleftharpoons 2\text{Hg} + 2\text{Cl}^-$	0.26808
$\text{CuI}_2^- + \text{e} \rightleftharpoons \text{Cu} + 2\text{I}^-$	0.00	Calomel electrode, 1 molal KCl	0.2800
$\text{Ge}^{4+} + 2\text{e} \rightleftharpoons \text{Ge}^{2+}$	0.00	Calomel electrode, 1 molar KCl (NCE)	0.2801
$\text{NO}_3^- + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{NO}_2^- + 2\text{OH}^-$	0.01	$\text{At}_2 + 2\text{e} \rightleftharpoons 2\text{At}^-$	0.3
$\text{Tl}_2\text{O}_3 + 3\text{H}_2\text{O} + 4\text{e} \rightleftharpoons 2\text{Tl}^+ + 6\text{OH}^-$	0.02	$\text{Re}^{3+} + 3\text{e} \rightleftharpoons \text{Re}$	0.300
$\text{SeO}_4^{2-} + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{SeO}_3^{2-} + 2\text{OH}^-$	0.05	$\text{Tc}^{3+} + \text{e} \rightleftharpoons \text{Tc}^{2+}$	0.3
$\text{WO}_3 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{WO}_2 + \text{H}_2\text{O}$	0.036	$\text{Bi}^{3+} + 3\text{e} \rightleftharpoons \text{Bi}$	0.308
$\text{UO}_2^{2+} + \text{e} \rightleftharpoons \text{UO}_2^+$	0.062	$\text{BiO}^+ + 2\text{H}^+ + 3\text{e} \rightleftharpoons \text{Bi} + \text{H}_2\text{O}$	0.320
$\text{Pd}(\text{OH})_2 + 2\text{e} \rightleftharpoons \text{Pd} + 2\text{OH}^-$	0.07	$\text{UO}_2^{2+} + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{U}^{4+} + 2\text{H}_2\text{O}$	0.327
$\text{AgBr} + \text{e} \rightleftharpoons \text{Ag} + \text{Br}^-$	0.07133	$\text{ClO}_3^- + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{ClO}_2^- + 2\text{OH}^-$	0.33
$\text{MoO}_3 + 6\text{H}^+ + 6\text{e} \rightleftharpoons \text{Mo} + 3\text{H}_2\text{O}$	0.075	$2\text{HCNO} + 2\text{H}^+ + 2\text{e} \rightleftharpoons (\text{CN})_2 + 2\text{H}_2\text{O}$	0.330
$\text{S}_4\text{O}_6^{2-} + 2\text{e} \rightleftharpoons 2\text{S}_2\text{O}_3^{2-}$	0.08	Calomel electrode, 0.1 molar KCl	0.3337
$\text{H}_3\text{Mo}_7\text{O}_{24}^{3-} + 45\text{H}^+ + 42\text{e} \rightleftharpoons 7\text{Mo} + 24\text{H}_2\text{O}$	0.082	$\text{VO}^{2+} + 2\text{H}^+ + \text{e} \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	0.337
$\text{AgSCN} + \text{e} \rightleftharpoons \text{Ag} + \text{SCN}^-$	0.8951	$\text{Cu}^{2+} + 2\text{e} \rightleftharpoons \text{Cu}$	0.3419
$\text{N}_2 + 2\text{H}_2\text{O} + 6\text{H}^+ + 6\text{e} \rightleftharpoons 2\text{NH}_4\text{OH}$	0.092	$\text{Ag}_2\text{O} + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons 2\text{Ag} + 2\text{OH}^-$	0.342
$\text{HgO} + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{Hg} + 2\text{OH}^-$	0.0977	$\text{Cu}^{2+} + 2\text{e} \rightleftharpoons \text{Cu}(\text{Hg})$	0.345
$\text{Ir}_2\text{O}_3 + 3\text{H}_2\text{O} + 6\text{e} \rightleftharpoons 2\text{Ir} + 6\text{OH}^-$	0.098	$\text{AgIO}_3 + \text{e} \rightleftharpoons \text{Ag} + \text{IO}_3^-$	0.354
$2\text{NO} + 2\text{e} \rightleftharpoons \text{N}_2\text{O}_2^{2-}$	0.10	$[\text{Fe}(\text{CN})_6]^{3-} + \text{e} \rightleftharpoons [\text{Fe}(\text{CN})_6]^{4-}$	0.358
$[\text{Ru}(\text{NH}_3)_6]^{3+} + \text{e} \rightleftharpoons [\text{Ru}(\text{NH}_3)_6]^{2+}$	0.10	$\text{ClO}_4^- + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{ClO}_3^- + 2\text{OH}^-$	0.36
$\text{W}^{3+} + 3\text{e} \rightleftharpoons \text{W}$	0.1	$\text{Ag}_2\text{SeO}_3 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{SeO}_3^{2-}$	0.3629
$[\text{Co}(\text{NH}_3)_6]^{3+} + \text{e} \rightleftharpoons [\text{Co}(\text{NH}_3)_6]^{2+}$	0.108	$\text{ReO}_4^- + 8\text{H}^+ + 7\text{e} \rightleftharpoons \text{Re} + 4\text{H}_2\text{O}$	0.368
$\text{Hg}_2\text{O} + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons 2\text{Hg} + 2\text{OH}^-$	0.123	$(\text{CN})_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{HCN}$	0.373
$\text{Ge}^{4+} + 4\text{e} \rightleftharpoons \text{Ge}$	0.124	$[\text{Fericinium}]^+ + \text{e} \rightleftharpoons \text{ferrocene}$	0.400
$\text{Hg}_2\text{Br}_2 + 2\text{e} \rightleftharpoons 2\text{Hg} + 2\text{Br}^-$	0.13923	$\text{Tc}^{2+} + 2\text{e} \rightleftharpoons \text{Tc}$	0.400
$\text{Pt}(\text{OH})_2 + 2\text{e} \rightleftharpoons \text{Pt} + 2\text{OH}^-$	0.14	$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e} \rightleftharpoons 4\text{OH}^-$	0.401
$[\text{V}(\text{phen})_3]^{3+} + \text{e} \rightleftharpoons [\text{V}(\text{phen})_3]^{2+}$	0.14	$\text{AgOCN} + \text{e} \rightleftharpoons \text{Ag} + \text{OCN}^-$	0.41
$\text{S} + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2\text{S}(\text{aq})$	0.142	$[\text{RhCl}_6]^{3-} + 3\text{e} \rightleftharpoons \text{Rh} + 6\text{Cl}^-$	0.431
$\text{Sn}(\text{OH})_3^+ + 3\text{H}^+ + 2\text{e} \rightleftharpoons \text{Sn}^{2+} + 3\text{H}_2\text{O}$	0.142	$\text{Ag}_2\text{CrO}_4 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{CrO}_4^{2-}$	0.4470
$\text{Np}^{4+} + \text{e} \rightleftharpoons \text{Np}^{3+}$	0.147	$\text{H}_2\text{SO}_3 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{S} + 3\text{H}_2\text{O}$	0.449
$\text{Ag}_4[\text{Fe}(\text{CN})_6] + 4\text{e} \rightleftharpoons 4\text{Ag} + [\text{Fe}(\text{CN})_6]^{4-}$	0.1478	$\text{Ru}^{2+} + 2\text{e} \rightleftharpoons \text{Ru}$	0.455
$\text{IO}_3^- + 2\text{H}_2\text{O} + 4\text{e} \rightleftharpoons \text{I}^- + 4\text{OH}^-$	0.15	$\text{Ag}_2\text{MoO}_4 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{MoO}_4^{2-}$	0.4573
$\text{Mn}(\text{OH})_3 + \text{e} \rightleftharpoons \text{Mn}(\text{OH})_2 + \text{OH}^-$	0.15	$\text{Ag}_2\text{C}_2\text{O}_4 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{C}_2\text{O}_4^{2-}$	0.4647
$2\text{NO}_2^- + 3\text{H}_2\text{O} + 4\text{e} \rightleftharpoons \text{N}_2\text{O} + 6\text{OH}^-$	0.15	$\text{Ag}_2\text{WO}_4 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{WO}_4^{2-}$	0.4660
$\text{Sn}^{4+} + 2\text{e} \rightleftharpoons \text{Sn}^{2+}$	0.151	$\text{Ag}_2\text{CO}_3 + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{CO}_3^{2-}$	0.47
$\text{Sb}_2\text{O}_3 + 6\text{H}^+ + 6\text{e} \rightleftharpoons 2\text{Sb} + 3\text{H}_2\text{O}$	0.152	$\text{TcO}_4^- + 8\text{H}^+ + 7\text{e} \rightleftharpoons \text{Tc} + 4\text{H}_2\text{O}$	0.472
$\text{Cu}^{2+} + \text{e} \rightleftharpoons \text{Cu}^+$	0.153	$\text{TeO}_4^- + 8\text{H}^+ + 7\text{e} \rightleftharpoons \text{Te} + 4\text{H}_2\text{O}$	0.472
$\text{BiOCl} + 2\text{H}^+ + 3\text{e} \rightleftharpoons \text{Bi} + \text{Cl}^- + \text{H}_2\text{O}$	0.1583	$\text{IO}^- + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{I}^- + 2\text{OH}^-$	0.485
$\text{BiCl}_4^- + 3\text{e} \rightleftharpoons \text{Bi} + 4\text{Cl}^-$	0.16	$\text{NiO}_2 + 2\text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{Ni}(\text{OH})_2 + 2\text{OH}^-$	0.490
$\text{Fe}_2\text{O}_3 + 4\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{FeOH}^+ + \text{H}_2\text{O}$	0.16	$\text{Bi}^+ + \text{e} \rightleftharpoons \text{Bi}$	0.5
$\text{Co}(\text{OH})_3 + \text{e} \rightleftharpoons \text{Co}(\text{OH})_2 + \text{OH}^-$	0.17	$\text{ReO}_4^- + 4\text{H}^+ + 3\text{e} \rightleftharpoons \text{ReO}_2 + 2\text{H}_2\text{O}$	0.510
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	0.172	$\text{Hg}_2(\text{ac})_2 + 2\text{e} \rightleftharpoons 2\text{Hg} + 2(\text{ac})^-$	0.51163
$\text{Bi}^{3+} + 2\text{e} \rightleftharpoons \text{Bi}^+$	0.2	$\text{Cu}^+ + \text{e} \rightleftharpoons \text{Cu}$	0.521
$[\text{Ru}(\text{en})_3]^{3+} + \text{e} \rightleftharpoons [\text{Ru}(\text{en})_3]^{2+}$	0.210	$\text{I}_2 + 2\text{e} \rightleftharpoons 2\text{I}^-$	0.5355
$\text{SbO}^+ + 2\text{H}^+ + 3\text{e} \rightleftharpoons \text{Sb} + 2\text{H}_2\text{O}$	0.212	$\text{I}_3^- + 2\text{e} \rightleftharpoons 3\text{I}^-$	0.536
$\text{AgCl} + \text{e} \rightleftharpoons \text{Ag} + \text{Cl}^-$	0.22233	$\text{AgBrO}_3 + \text{e} \rightleftharpoons \text{Ag} + \text{BrO}_3^-$	0.546
$[\text{Ru}(\text{H}_2\text{O})_6]^{3+} + \text{e} \rightleftharpoons [\text{Ru}(\text{H}_2\text{O})_6]^{2+}$	0.23	$\text{MnO}_4^- + \text{e} \rightleftharpoons \text{MnO}_4^{2-}$	0.558
$\text{As}_2\text{O}_3 + 6\text{H}^+ + 6\text{e} \rightleftharpoons 2\text{As} + 3\text{H}_2\text{O}$	0.234	$\text{H}_3\text{AsO}_4 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{HAsO}_2 + 2\text{H}_2\text{O}$	0.560
Calomel electrode, saturated NaCl (SSCE)	0.2360	$\text{S}_2\text{O}_6^{2-} + 4\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{H}_2\text{SO}_3$	0.564
$\text{Ge}^{2+} + 2\text{e} \rightleftharpoons \text{Ge}$	0.24	$\text{AgNO}_2 + \text{e} \rightleftharpoons \text{Ag} + \text{NO}_2^-$	0.564
$\text{Ru}^{3+} + \text{e} \rightleftharpoons \text{Ru}^{2+}$	0.24	$\text{Te}^{4+} + 4\text{e} \rightleftharpoons \text{Te}$	0.568
Calomel electrode, saturated KCl	0.2412	$\text{Sb}_2\text{O}_3 + 6\text{H}^+ + 4\text{e} \rightleftharpoons 2\text{SbO}^+ + 3\text{H}_2\text{O}$	0.581
$\text{PbO}_2 + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{PbO} + 2\text{OH}^-$	0.247	$\text{RuO}_4^- + \text{e} \rightleftharpoons \text{RuO}_4^{2-}$	0.59
$\text{HAsO}_2 + 3\text{H}^+ + 3\text{e} \rightleftharpoons \text{As} + 2\text{H}_2\text{O}$	0.248	$[\text{PdCl}_4]^{2-} + 2\text{e} \rightleftharpoons \text{Pd} + 4\text{Cl}^-$	0.591
$\text{Ru}^{3+} + \text{e} \rightleftharpoons \text{Ru}^{2+}$	0.2487	$\text{TeO}_2 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{Te} + 2\text{H}_2\text{O}$	0.593
$\text{ReO}_2 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{Re} + 2\text{H}_2\text{O}$	0.2513	$\text{MnO}_4^- + 2\text{H}_2\text{O} + 3\text{e} \rightleftharpoons \text{MnO}_2 + 4\text{OH}^-$	0.595
$\text{IO}_3^- + 3\text{H}_2\text{O} + 6\text{e} \rightleftharpoons \text{I}^- + \text{OH}^-$	0.26	$\text{Rh}^{2+} + 2\text{e} \rightleftharpoons \text{Rh}$	0.600

Reaction	$E^{\circ}/V$	Reaction	$E^{\circ}/V$
$Rh^{+} + e \rightleftharpoons Rh$	0.600	$HIO + H^{+} + 2e \rightleftharpoons I^{-} + H_2O$	0.987
$MnO_4^{2-} + 2H_2O + 2e \rightleftharpoons MnO_2 + 4OH^{-}$	0.60	$VO_2^{+} + 2H^{+} + e \rightleftharpoons VO^{2+} + H_2O$	0.991
$2AgO + H_2O + 2e \rightleftharpoons Ag_2O + 2OH^{-}$	0.607	$PtO_2 + 4H^{+} + 4e \rightleftharpoons Pt + 2H_2O$	1.00
$BrO_3^{-} + 3H_2O + 6e \rightleftharpoons Br^{-} + 6OH^{-}$	0.61	$RuO_4 + e \rightleftharpoons RuO_4^{-}$	1.00
$UO_2^{+} + 4H^{+} + e \rightleftharpoons U^{4+} + 2H_2O$	0.612	$V(OH)_4^{+} + 2H^{+} + e \rightleftharpoons VO^{2+} + 3H_2O$	1.00
$Hg_2SO_4 + 2e \rightleftharpoons 2Hg + SO_4^{2-}$	0.6125	$AuCl_4^{-} + 3e \rightleftharpoons Au + 4Cl^{-}$	1.002
$ClO_3^{-} + 3H_2O + 6e \rightleftharpoons Cl^{-} + 6OH^{-}$	0.62	$Pu^{4+} + e \rightleftharpoons Pu^{3+}$	1.006
$Hg_2HPO_4 + 2e \rightleftharpoons 2Hg + HPO_4^{2-}$	0.6359	$PtO_2 + 2H^{+} + 2e \rightleftharpoons PtO + H_2O$	1.01
$Ag(ac) + e \rightleftharpoons Ag + (ac)^{-}$	0.643	$OsO_4 + 4H + 4e \rightleftharpoons OsO_2 + 2H_2O$	1.02
$Sb_2O_5(\text{valentinite}) + 4H^{+} + 4e \rightleftharpoons Sb_2O_3 + 2H_2O$	0.649	$H_6TeO_6 + 2H^{+} + 2e \rightleftharpoons TeO_2 + 4H_2O$	1.02
$Ag_2SO_4 + 2e \rightleftharpoons 2Ag + SO_4^{2-}$	0.654	$[Fe(bipy)_3]^{3+} + e \rightleftharpoons [Fe(bipy)_3]^{2+}$	1.03
$ClO_2^{-} + H_2O + 2e \rightleftharpoons ClO^{-} + 2OH^{-}$	0.66	$Hg(OH)_2 + 2H^{+} + 2e \rightleftharpoons Hg + 2H_2O$	1.034
$Sb_2O_5(\text{senarmontite}) + 4H^{+} + 4e \rightleftharpoons Sb_2O_3 + 2H_2O$	0.671	$N_2O_4 + 4H^{+} + 4e \rightleftharpoons 2NO + 2H_2O$	1.035
$[PtCl_6]^{2-} + 2e \rightleftharpoons [PtCl_4]^{2-} + 2Cl^{-}$	0.68	$RuO_4 + 8H^{+} + 8e \rightleftharpoons Ru + 4H_2O$	1.038
$O_2 + 2H^{+} + 2e \rightleftharpoons H_2O_2$	0.695	$[Fe(phen)_3]^{3+} + e \rightleftharpoons [Fe(phen)_3]^{2+}$ (1 molar $H_2SO_4$ )	1.06
$p$ -benzoquinone + $2H^{+} + 2e \rightleftharpoons$ hydroquinone	0.6992	$PuO_2(OH)_2 + H^{+} + e \rightleftharpoons PuO_2OH + H_2O$	1.062
$H_3IO_6^{2-} + 2e \rightleftharpoons IO_3^{-} + 3OH^{-}$	0.7	$N_2O_4 + 2H^{+} + 2e \rightleftharpoons 2HNO_2$	1.065
$Ag_2O_3 + H_2O + 2e \rightleftharpoons 2AgO + 2OH^{-}$	0.739	$Br_2(l) + 2e \rightleftharpoons 2Br^{-}$	1.066
$Tl^{3+} + 3e \rightleftharpoons Tl$	0.741	$IO_3^{-} + 6H^{+} + 6e \rightleftharpoons I^{-} + 3H_2O$	1.085
$[PtCl_4]^{2-} + 2e \rightleftharpoons Pt + 4Cl^{-}$	0.755	$Br_2(aq) + 2e \rightleftharpoons 2Br^{-}$	1.0873
$Rh^{3+} + 3e \rightleftharpoons Rh$	0.758	$Pu^{5+} + e \rightleftharpoons Pu^{4+}$	1.099
$ClO_2^{-} + 2H_2O + 4e \rightleftharpoons Cl^{-} + 4OH^{-}$	0.76	$Cu^{2+} + 2CN^{-} + e \rightleftharpoons [Cu(CN)_2]^{-}$	1.103
$2NO + H_2O + 2e \rightleftharpoons N_2O + 2OH^{-}$	0.76	$RuO_2 + 4H^{+} + 2e \rightleftharpoons Ru^{2+} + 2H_2O$	1.120
$Po^{4+} + 4e \rightleftharpoons Po$	0.76	$[Fe(phen)_3]^{3+} + e \rightleftharpoons [Fe(phen)_3]^{2+}$	1.147
$BrO^{-} + H_2O + 2e \rightleftharpoons Br^{-} + 2OH^{-}$	0.761	$SeO_4^{2-} + 4H^{+} + 2e \rightleftharpoons H_2SeO_3 + H_2O$	1.151
$ReO_4^{-} + 2H^{+} + e \rightleftharpoons ReO_3 + H_2O$	0.768	$ClO_3^{-} + 2H^{+} + e \rightleftharpoons ClO_2 + H_2O$	1.152
$(CNS)_2 + 2e \rightleftharpoons 2CNS^{-}$	0.77	$Ir^{3+} + 3e \rightarrow Ir$	1.156
$[IrCl_6]^{3-} + 3e \rightleftharpoons Ir + 6Cl^{-}$	0.77	$Pt^{2+} + 2e \rightleftharpoons Pt$	1.18
$Fe^{3+} + e \rightleftharpoons Fe^{2+}$	0.771	$ClO_4^{-} + 2H^{+} + 2e \rightleftharpoons ClO_3^{-} + H_2O$	1.189
$AgF + e \rightleftharpoons Ag + F^{-}$	0.779	$2IO_3^{-} + 12H^{+} + 10e \rightleftharpoons I_2 + 6H_2O$	1.195
$[Fe(bipy)_2]^{3+} + e \rightleftharpoons [Fe(bipy)_2]^{2+}$	0.78	$PtOH^{+} + H^{+} + 2e \rightleftharpoons Pt + H_2O$	1.2
$TcO_4^{-} + 4H^{+} + 3e \rightleftharpoons TcO_2 + 2H_2O$	0.782	$ClO_3^{-} + 3H^{+} + 2e \rightleftharpoons HClO_2 + H_2O$	1.214
$Hg_2^{2+} + 2e \rightleftharpoons 2Hg$	0.7973	$MnO_2 + 4H^{+} + 2e \rightleftharpoons Mn^{2+} + 2H_2O$	1.224
$Ag^{+} + e \rightleftharpoons Ag$	0.7996	$O_2 + 4H^{+} + 4e \rightleftharpoons 2H_2O$	1.229
$[Os(bipy)_3]^{3+} + e \rightleftharpoons [Os(bipy)_3]^{2+}$	0.80	$O_3 + H_2O + 2e \rightleftharpoons O_2 + 2OH^{-}$	1.24
$2NO_3^{-} + 4H^{+} + 2e \rightleftharpoons N_2O_4 + 2H_2O$	0.803	$[Ru(bipy)_3]^{3+} + e \rightleftharpoons [Ru(bipy)_3]^{2+}$	1.24
$[Os(bipy)_2]^{3+} + e \rightleftharpoons [Os(bipy)_2]^{2+}$	0.81	$Tl^{3+} + 2e \rightleftharpoons Tl^{+}$	1.252
$RhOH^{2+} + H + 3e \rightleftharpoons Rh + H_2O$	0.83	$N_2H_5^{+} + 3H^{+} + 2e \rightleftharpoons 2NH_4^{+}$	1.275
$OsO_4 + 8H^{+} + 8e \rightleftharpoons Os + 4H_2O$	0.838	$ClO_2 + H^{+} + e \rightleftharpoons HClO_2$	1.277
$ClO^{-} + H_2O + 2e \rightleftharpoons Cl^{-} + 2OH^{-}$	0.841	$[PdCl_6]^{2-} + 2e \rightleftharpoons [PdCl_4]^{2-} + 2Cl^{-}$	1.288
$Hg_2^{2+} + 2e \rightleftharpoons Hg$	0.851	$2HNO_2 + 4H^{+} + 4e \rightleftharpoons N_2O + 3H_2O$	1.297
$AuBr_4^{-} + 3e \rightleftharpoons Au + 4Br^{-}$	0.854	$AuOH^{2+} + H^{+} + 2e \rightleftharpoons Au^{+} + H_2O$	1.32
$SiO_2(\text{quartz}) + 4H^{+} + 4e \rightleftharpoons Si + 2H_2O$	0.857	$PuO_2(OH)_2 + 2H^{+} + 2e \rightleftharpoons Pu(OH)_4$	1.325
$2HNO_2 + 4H^{+} + 4e \rightleftharpoons H_2N_2O_2 + H_2O$	0.86	$HBrO + H^{+} + 2e \rightleftharpoons Br^{-} + H_2O$	1.331
$[Ru(CN)_6]^{3-} + e^{-} \rightleftharpoons [Ru(CN)_6]^{4-}$	0.86	$Cr(V) + e \rightleftharpoons Cr(IV)$	1.34
$[IrCl_6]^{2-} + e \rightleftharpoons [IrCl_6]^{3-}$	0.8665	$HCrO_4^{-} + 7H^{+} + 3e \rightleftharpoons Cr^{3+} + 4H_2O$	1.350
$N_2O_4 + 2e \rightleftharpoons 2NO_2^{-}$	0.867	$Cl_2(g) + 2e \rightleftharpoons 2Cl^{-}$	1.35827
$HO_2^{-} + H_2O + 2e \rightleftharpoons 3OH^{-}$	0.878	$Cr_2O_7^{2-} + 14H^{+} + 6e \rightleftharpoons 2Cr^{3+} + 7H_2O$	1.36
$Po^{4+} + 2e \rightleftharpoons Po^{2+}$	0.9	$ClO_4^{-} + 8H^{+} + 8e \rightleftharpoons Cl^{-} + 4H_2O$	1.389
$2Hg_2^{2+} + 2e \rightleftharpoons Hg_2^{2+}$	0.920	$ClO_4^{-} + 8H^{+} + 7e \rightleftharpoons 1/2Cl_2 + 4H_2O$	1.39
$NO_3^{-} + 3H^{+} + 2e \rightleftharpoons HNO_2 + H_2O$	0.934	$No^{3+} + e \rightleftharpoons No^{2+}$	1.4
$Pd^{2+} + 2e \rightleftharpoons Pd$	0.951	$RuO_4 + 6H^{+} + 4e \rightleftharpoons Ru(OH)_2^{2+} + 2H_2O$	1.40
$ClO_2(aq) + e \rightleftharpoons ClO_2^{-}$	0.954	$Au^{3+} + 2e \rightleftharpoons Au^{+}$	1.401
$NO_3^{-} + 4H^{+} + 3e \rightleftharpoons NO + 2H_2O$	0.957	$2NH_3OH^{+} + H^{+} + 2e \rightleftharpoons N_2H_5^{+} + 2H_2O$	1.42
$V_2O_5 + 6H^{+} + 2e \rightleftharpoons 2VO^{2+} + 3H_2O$	0.957	$BrO_3^{-} + 6H^{+} + 6e \rightleftharpoons Br^{-} + 3H_2O$	1.423
$AuBr_2^{-} + e \rightleftharpoons Au + 2Br^{-}$	0.959	$2HIO + 2H^{+} + 2e \rightleftharpoons I_2 + 2H_2O$	1.439
$HNO_2 + H^{+} + e \rightleftharpoons NO + H_2O$	0.983	$Au(OH)_3 + 3H^{+} + 3e \rightleftharpoons Au^{-} + 3H_2O$	1.45

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$3\text{IO}_3^- + 6\text{H}^+ + 6\text{e} \rightleftharpoons \text{Cl}^- + 3\text{H}_2\text{O}$	1.451	$\text{Ag}^{3+} + \text{e} \rightleftharpoons \text{Ag}^{2+}$	1.8
$\text{PbO}_2 + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{Pb}^{2+} + 2\text{H}_2\text{O}$	1.455	$\text{Au}^{2+} + \text{e}^- \rightleftharpoons \text{Au}^+$	1.8
$\text{ClO}_3^- + 6\text{H}^+ + 5\text{e} \rightleftharpoons 1/2\text{Cl}_2 + 3\text{H}_2\text{O}$	1.47	$\text{Ag}_2\text{O}_2 + 4\text{H}^+ + \text{e} \rightleftharpoons 2\text{Ag} + 2\text{H}_2\text{O}$	1.802
$\text{CrO}_2 + 4\text{H}^+ + \text{e} \rightleftharpoons \text{Cr}^{3+} + 2\text{H}_2\text{O}$	1.48	$\text{Co}^{3+} + \text{e} \rightleftharpoons \text{Co}^{2+} \text{ (2 molar } \text{H}_2\text{SO}_4\text{)}$	1.83
$\text{BrO}_3^- + 6\text{H}^+ + 5\text{e} \rightleftharpoons 1/2\text{Br}_2 + 3\text{H}_2\text{O}$	1.482	$\text{Ag}^{3+} + 2\text{e} \rightleftharpoons \text{Ag}^+$	1.9
$\text{HClO} + \text{H}^+ + 2\text{e} \rightleftharpoons \text{Cl}^- + \text{H}_2\text{O}$	1.482	$\text{Co}^{3+} + \text{e} \rightleftharpoons \text{Co}^{2+}$	1.92
$\text{Mn}_2\text{O}_3 + 6\text{H}^+ + \text{e} \rightleftharpoons 2\text{Mn}^{2+} + 3\text{H}_2\text{O}$	1.485	$\text{Ag}^{2+} + \text{e} \rightleftharpoons \text{Ag}^+$	1.980
$\text{HO}_2 + \text{H}^+ + \text{e} \rightleftharpoons \text{H}_2\text{O}_2$	1.495	$\text{Cu}_2\text{O}_3 + 6\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{Cu}^{2+} + 3\text{H}_2\text{O}$	2.0
$\text{Au}^{3+} + 3\text{e} \rightleftharpoons \text{Au}$	1.498	$\text{S}_2\text{O}_8^{2-} + 2\text{e} \rightleftharpoons 2\text{SO}_4^{2-}$	2.010
$\text{PtO}_3 + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{Pt}(\text{OH})_2 + \text{H}_2\text{O}$	1.5	$\text{OH} + \text{e} \rightleftharpoons \text{OH}^-$	2.02
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e} \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.507	$\text{HFeO}_4^- + 7\text{H}^+ + 3\text{e} \rightleftharpoons \text{Fe}^{3+} + 4\text{H}_2\text{O}$	2.07
$\text{Mn}^{3+} + \text{e} \rightleftharpoons \text{Mn}^{2+}$	1.5415	$\text{O}_3 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{O}_2 + \text{H}_2\text{O}$	2.076
$\text{HClO}_2 + 3\text{H}^+ + 4\text{e} \rightleftharpoons \text{Cl}^- + 2\text{H}_2\text{O}$	1.570	$\text{HFeO}_4^- + 4\text{H}^+ + 3\text{e} \rightleftharpoons \text{FeOOH} + 2\text{H}_2\text{O}$	2.08
$\text{HBrO} + \text{H}^+ + \text{e} \rightleftharpoons 1/2\text{Br}_2(\text{aq}) + \text{H}_2\text{O}$	1.574	$2\text{HFeO}_4^- + 8\text{H}^+ + 6\text{e} \rightleftharpoons \text{Fe}_2\text{O}_3 + 5\text{H}_2\text{O}$	2.09
$2\text{NO} + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{N}_2\text{O} + \text{H}_2\text{O}$	1.591	$\text{XeO}_3 + 6\text{H}^+ + 6\text{e} \rightleftharpoons \text{Xe} + 3\text{H}_2\text{O}$	2.10
$\text{Bi}_2\text{O}_4 + 4\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{BiO}^+ + 2\text{H}_2\text{O}$	1.593	$\text{S}_2\text{O}_8^{2-} + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{HSO}_4^-$	2.123
$\text{HBrO} + \text{H}^+ + \text{e} \rightleftharpoons 1/2\text{Br}_2(\text{l}) + \text{H}_2\text{O}$	1.596	$\text{F}_2\text{O} + 2\text{H}^+ + 4\text{e} \rightleftharpoons \text{H}_2\text{O} + 2\text{F}^-$	2.153
$\text{H}_3\text{IO}_6 + \text{H}^+ + 2\text{e} \rightleftharpoons \text{IO}_3^- + 3\text{H}_2\text{O}$	1.601	$\text{FeO}_4^{2-} + 8\text{H}^+ + 3\text{e} \rightleftharpoons \text{Fe}^{3+} + 4\text{H}_2\text{O}$	2.20
$\text{HClO} + \text{H}^+ + \text{e} \rightleftharpoons 1/2\text{Cl}_2 + \text{H}_2\text{O}$	1.611	$\text{Cu}^{3+} + \text{e} \rightleftharpoons \text{Cu}^{2+}$	2.4
$\text{HClO}_2 + 3\text{H}^+ + 3\text{e} \rightleftharpoons 1/2\text{Cl}_2 + 2\text{H}_2\text{O}$	1.628	$\text{H}_4\text{XeO}_6 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{XeO}_3 + 3\text{H}_2\text{O}$	2.42
$\text{HClO}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{HClO} + \text{H}_2\text{O}$	1.645	$\text{O}(\text{g}) + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2\text{O}$	2.421
$\text{Bk}^{4+} + \text{e} \rightleftharpoons \text{Bk}^{3+}$	1.67	$\text{Am}^{4+} + \text{e} \rightleftharpoons \text{Am}^{3+}$	2.60
$\text{NiO}_2 + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{Ni}^{2+} + 2\text{H}_2\text{O}$	1.678	$\text{H}_2\text{N}_2\text{O}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{N}_2 + 2\text{H}_2\text{O}$	2.65
$\text{MnO}_4^- + 4\text{H}^+ + 3\text{e} \rightleftharpoons \text{MnO}_2 + 2\text{H}_2\text{O}$	1.679	$\text{F}_2 + 2\text{e} \rightleftharpoons 2\text{F}^-$	2.866
$\text{PbO}_2 + \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{PbSO}_4 + 2\text{H}_2\text{O}$	1.6913	$\text{Cm}^{4+} + \text{e} \rightleftharpoons \text{Cm}^{3+}$	3.0
$\text{Au}^+ + \text{e} \rightleftharpoons \text{Au}$	1.692	$\text{F}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{HF}$	3.053
$\text{PtO}_3 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{PtO}_2 + \text{H}_2\text{O}$	1.7	$\text{Tb}^{4+} + \text{e} \rightleftharpoons \text{Tb}^{3+}$	3.1
$\text{CeOH}^{3+} + \text{H}^+ + \text{e} \rightleftharpoons \text{Ce}^{3+} + \text{H}_2\text{O}$	1.715	$\text{Pr}^{4+} + \text{e} \rightleftharpoons \text{Pr}^{3+}$	3.2
$\text{Ce}^{4+} + \text{e} \rightleftharpoons \text{Ce}^{3+}$	1.72	$\text{Cf}^{4+} + \text{e} \rightleftharpoons \text{Cf}^{3+}$	3.3
$\text{N}_2\text{O} + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{N}_2 + \text{H}_2\text{O}$	1.766	$\text{XeF} + \text{e} \rightleftharpoons \text{Xe} + \text{F}^-$	3.4
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{H}_2\text{O}$	1.776		

TABLE 3. Reduction Reactions Having  $E^\circ$  Values More Negative than That of the Standard Hydrogen Electrode

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$2\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2$	0.00000	$\text{WO}_2 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{W} + 2\text{H}_2\text{O}$	-0.119
$2\text{D}^+ + 2\text{e} \rightleftharpoons \text{D}_2$	-0.013	$\text{Pb}^{2+} + 2\text{e} \rightleftharpoons \text{Pb}(\text{Hg})$	-0.1205
$\text{AgCN} + \text{e} \rightleftharpoons \text{Ag} + \text{CN}^-$	-0.017	$\text{Pb}^{2+} + 2\text{e} \rightleftharpoons \text{Pb}$	-0.1262
$2\text{WO}_3 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{W}_2\text{O}_5 + \text{H}_2\text{O}$	-0.029	$\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3\text{e} \rightleftharpoons \text{Cr}(\text{OH})_3 + 5\text{OH}^-$	-0.13
$\text{W}_2\text{O}_5 + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{WO}_2 + \text{H}_2\text{O}$	-0.031	$\text{Sn}^{2+} + 2\text{e} \rightleftharpoons \text{Sn}$	-0.1375
$\text{Ag}_2\text{S} + 2\text{H}^+ + 2\text{e} \rightleftharpoons 2\text{Ag} + \text{H}_2\text{S}$	-0.0366	$\text{In}^+ + \text{e} \rightleftharpoons \text{In}$	-0.14
$\text{Fe}^{3+} + 3\text{e} \rightleftharpoons \text{Fe}$	-0.037	$\text{O}_2 + 2\text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{H}_2\text{O}_2 + 2\text{OH}^-$	-0.146
$\text{Hg}_2\text{I}_2 + 2\text{e} \rightleftharpoons 2\text{Hg} + 2\text{I}^-$	-0.0405	$\text{MoO}_2 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{Mo} + 4\text{H}_2\text{O}$	-0.152
$\text{Tl}(\text{OH})_3 + 2\text{e} \rightleftharpoons \text{TlOH} + 2\text{OH}^-$	-0.05	$\text{AgI} + \text{e} \rightleftharpoons \text{Ag} + \text{I}^-$	-0.15224
$\text{TiOH}^{3+} + \text{H}^+ + \text{e} \rightleftharpoons \text{Ti}^{3+} + \text{H}_2\text{O}$	-0.055	$2\text{NO}_2^- + 2\text{H}_2\text{O} + 4\text{e} \rightleftharpoons \text{N}_2\text{O}_2^{2-} + 4\text{OH}^-$	-0.18
$2\text{H}_2\text{SO}_3 + \text{H}^+ + 2\text{e} \rightleftharpoons \text{HS}_2\text{O}_4^- + 2\text{H}_2\text{O}$	-0.056	$\text{H}_2\text{GeO}_3 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{Ge} + 3\text{H}_2\text{O}$	-0.182
$\text{P}(\text{white}) + 3\text{H}^+ + 3\text{e} \rightleftharpoons \text{PH}_3(\text{g})$	-0.063	$\text{SnO}_2 + 3\text{H}^+ + 2\text{e} \rightleftharpoons \text{SnOH}^+ + \text{H}_2\text{O}$	-0.194
$\text{O}_2 + \text{H}_2\text{O} + 2\text{e} \rightleftharpoons \text{HO}_2^- + \text{OH}^-$	-0.076	$\text{CO}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{HCOOH}$	-0.199
$2\text{Cu}(\text{OH})_2 + 2\text{e} \rightleftharpoons \text{Cu}_2\text{O} + 2\text{OH}^- + \text{H}_2\text{O}$	-0.080	$\text{Mo}^{3+} + 3\text{e} \rightleftharpoons \text{Mo}$	-0.200
$\text{Se} + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{H}_2\text{Se}$	-0.082	$\text{Ga}^+ + \text{e} \rightleftharpoons \text{Ga}$	-0.2
$\text{WO}_3 + 6\text{H}^+ + 6\text{e} \rightleftharpoons \text{W} + 3\text{H}_2\text{O}$	-0.090	$2\text{SO}_2^{2-} + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{S}_2\text{O}_6^{2-} + \text{H}_2\text{O}$	-0.22
$\text{SnO}_2 + 4\text{H}^+ + 2\text{e} \rightleftharpoons \text{Sn}^{2+} + 2\text{H}_2\text{O}$	-0.094	$\text{Cu}(\text{OH})_2 + 2\text{e} \rightleftharpoons \text{Cu} + 2\text{OH}^-$	-0.222
$\text{Md}^{3+} + \text{e} \rightleftharpoons \text{Md}^{2+}$	-0.1	$\text{V}_2\text{O}_5 + 10\text{H}^+ + 10\text{e} \rightleftharpoons 2\text{V} + 5\text{H}_2\text{O}$	-0.242
$\text{P}(\text{red}) + 3\text{H}^+ + 3\text{e} \rightleftharpoons \text{PH}_3(\text{g})$	-0.111	$\text{CdSO}_4 + 2\text{e} \rightleftharpoons \text{Cd} + \text{SO}_4^{2-}$	-0.246
$\text{SnO}_2 + 4\text{H}^+ + 4\text{e} \rightleftharpoons \text{Sn} + 2\text{H}_2\text{O}$	-0.117	$\text{V}(\text{OH})_4^+ + 4\text{H}^+ + 5\text{e} \rightleftharpoons \text{V} + 4\text{H}_2\text{O}$	-0.254
$\text{GeO}_2 + 2\text{H}^+ + 2\text{e} \rightleftharpoons \text{GeO} + \text{H}_2\text{O}$	-0.118	$\text{V}^{3+} + \text{e} \rightleftharpoons \text{V}^{2+}$	-0.255

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$\text{Ni}^{2+} + 2 e \rightleftharpoons \text{Ni}$	-0.257	$\text{NbO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Nb} + 2 \text{H}_2\text{O}$	-0.690
$\text{PbCl}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{Cl}^-$	-0.2675	$\text{Ag}_2\text{S} + 2 e \rightleftharpoons 2 \text{Ag} + \text{S}^{2-}$	-0.691
$\text{H}_3\text{PO}_4 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_3\text{PO}_3 + \text{H}_2\text{O}$	-0.276	$\text{AsO}_4^{3-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{AsO}_2^- + 4 \text{OH}^-$	-0.71
$\text{Co}^{2+} + 2 e \rightleftharpoons \text{Co}$	-0.28	$\text{Ni}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ni} + 2 \text{OH}^-$	-0.72
$\text{PbBr}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{Br}^-$	-0.284	$\text{Co}(\text{OH})_2 + 2 e \rightleftharpoons \text{Co} + 2 \text{OH}^-$	-0.73
$\text{Tl}^+ + e \rightleftharpoons \text{Tl}(\text{Hg})$	-0.3338	$\text{NbO} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{Nb} + \text{H}_2\text{O}$	-0.733
$\text{Tl}^+ + e \rightleftharpoons \text{Tl}$	-0.336	$\text{H}_2\text{SeO}_3 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Se} + 3 \text{H}_2\text{O}$	-0.74
$\text{In}^{3+} + 3 e \rightleftharpoons \text{In}$	-0.3382	$\text{Cr}^{3+} + 3 e \rightleftharpoons \text{Cr}$	-0.744
$\text{TlOH} + e \rightleftharpoons \text{Tl} + \text{OH}^-$	-0.34	$\text{Ta}_2\text{O}_5 + 10 \text{H}^+ + 10 e \rightleftharpoons 2 \text{Ta} + 5 \text{H}_2\text{O}$	-0.750
$\text{PbF}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{F}^-$	-0.3444	$\text{TlI} + e \rightleftharpoons \text{Tl} + \text{I}^-$	-0.752
$\text{PbSO}_4 + 2 e \rightleftharpoons \text{Pb}(\text{Hg}) + \text{SO}_4^{2-}$	-0.3505	$\text{Zn}^{2+} + 2 e \rightleftharpoons \text{Zn}$	-0.7618
$\text{Cd}^{2+} + 2 e \rightleftharpoons \text{Cd}(\text{Hg})$	-0.3521	$\text{Zn}^{2+} + 2 e \rightleftharpoons \text{Zn}(\text{Hg})$	-0.7628
$\text{PbSO}_4 + 2 e \rightleftharpoons \text{Pb} + \text{SO}_4^{2-}$	-0.3588	$\text{CdO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Cd} + 2 \text{OH}^-$	-0.783
$\text{Cu}_2\text{O} + \text{H}_2\text{O} + 2 e \rightleftharpoons 2 \text{Cu} + 2 \text{OH}^-$	-0.360	$\text{Te} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{Te}$	-0.793
$\text{Eu}^{3+} + e \rightleftharpoons \text{Eu}^{2+}$	-0.36	$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O} + 2 e \rightleftharpoons \text{Zn}(\text{Hg}) + \text{SO}_4^{2-} + 7 \text{H}_2\text{O}$ (Saturated $\text{ZnSO}_4$ )	-0.7993
$\text{PbI}_2 + 2 e \rightleftharpoons \text{Pb} + 2 \text{I}^-$	-0.365	$\text{Bi} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{BiH}_3$	-0.8
$\text{SeO}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Se} + 6 \text{OH}^-$	-0.366	$\text{SiO} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{Si} + \text{H}_2\text{O}$	-0.8
$\text{Se} + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_2\text{Se}(\text{aq})$	-0.399	$\text{Cd}(\text{OH})_2 + 2 e \rightleftharpoons \text{Cd}(\text{Hg}) + 2 \text{OH}^-$	-0.809
$\text{In}^{2+} + e \rightleftharpoons \text{In}^+$	-0.40	$2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{H}_2 + 2 \text{OH}^-$	-0.8277
$\text{Cd}^{2+} + 2 e \rightleftharpoons \text{Cd}$	-0.4030	$2 \text{NO}_3^- + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{N}_2\text{O}_4 + 4 \text{OH}^-$	-0.85
$\text{Cr}^{3+} + e \rightleftharpoons \text{Cr}^{2+}$	-0.407	$\text{H}_3\text{BO}_3 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{B} + 3 \text{H}_2\text{O}$	-0.8698
$2 \text{S} + 2 e \rightleftharpoons \text{S}_2^{2-}$	-0.42836	$\text{P} + 3 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{PH}_3(\text{g}) + 3 \text{OH}^-$	-0.87
$\text{Ti}_2\text{SO}_4 + 2 e \rightleftharpoons \text{Ti} + \text{SO}_4^{2-}$	-0.4360	$\text{Ti}^{3+} + e \rightleftharpoons \text{Ti}^{2+}$	-0.9
$\text{In}^{3+} + 2 e \rightleftharpoons \text{In}^+$	-0.443	$\text{HSnO}_2^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Sn} + 3 \text{OH}^-$	-0.909
$\text{Fe}^{2+} + 2 e \rightleftharpoons \text{Fe}$	-0.447	$\text{Cr}^{2+} + 2 e \rightleftharpoons \text{Cr}$	-0.913
$\text{H}_3\text{PO}_3 + 3 \text{H}^+ + 3 e \rightleftharpoons \text{P} + 3 \text{H}_2\text{O}$	-0.454	$\text{Se} + 2 e \rightleftharpoons \text{Se}^{2-}$	-0.924
$\text{Bi}_2\text{O}_3 + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons 2 \text{Bi} + 6 \text{OH}^-$	-0.46	$\text{SO}_4^{2-} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{SO}_3^{2-} + 2 \text{OH}^-$	-0.93
$\text{NO}_2^- + \text{H}_2\text{O} + e \rightleftharpoons \text{NO} + 2 \text{OH}^-$	-0.46	$\text{Sn}(\text{OH})_6^{2-} + 2 e \rightleftharpoons \text{HSnO}_2^- + 3 \text{OH}^- + \text{H}_2\text{O}$	-0.93
$\text{PbHPO}_4 + 2 e \rightleftharpoons \text{Pb} + \text{HPO}_4^{2-}$	-0.465	$\text{SnO}_2 + 2 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Sn} + 4 \text{OH}^-$	-0.945
$\text{S} + 2 e \rightleftharpoons \text{S}^{2-}$	-0.47627	$\text{In}(\text{OH})_3 + 3 e \rightleftharpoons \text{In} + 3 \text{OH}^-$	-0.99
$\text{S} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{HS}^- + \text{OH}^-$	-0.478	$\text{NpO}_2 + \text{H}_2\text{O} + \text{H}^+ + e \rightleftharpoons \text{Np}(\text{OH})_3$	-0.962
$\text{B}(\text{OH})_3 + 7 \text{H}^+ + 8 e \rightleftharpoons \text{BH}_4^- + 3 \text{H}_2\text{O}$	-0.481	$\text{In}(\text{OH})_4^- + 3 e \rightleftharpoons \text{In} + 4 \text{OH}^-$	-1.007
$\text{In}^{3+} + e \rightleftharpoons \text{In}^{2+}$	-0.49	$\text{In}_2\text{O}_3 + 3 \text{H}_2\text{O} + 6 e \rightleftharpoons 2 \text{In} + 6 \text{OH}^-$	-1.034
$\text{ZnOH}^+ + \text{H}^+ + 2 e \rightleftharpoons \text{Zn} + \text{H}_2\text{O}$	-0.497	$\text{PO}_4^{3-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{HPO}_3^{2-} + 3 \text{OH}^-$	-1.05
$\text{GaOH}^{2+} + \text{H}^+ + 3 e \rightleftharpoons \text{Ga} + \text{H}_2\text{O}$	-0.498	$\text{Yb}^{3+} + e \rightleftharpoons \text{Yb}^{2+}$	-1.05
$\text{H}_3\text{PO}_3 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{H}_3\text{PO}_2 + \text{H}_2\text{O}$	-0.499	$\text{Nb}^{3+} + 3 e \rightleftharpoons \text{Nb}$	-1.099
$\text{TiO}_2 + 4 \text{H}^+ + 2 e \rightleftharpoons \text{Ti}^{2+} + 2 \text{H}_2\text{O}$	-0.502	$\text{Fm}^{3+} + e \rightleftharpoons \text{Fm}^{2+}$	-1.1
$\text{H}_3\text{PO}_2 + \text{H}^+ + e \rightleftharpoons \text{P} + 2 \text{H}_2\text{O}$	-0.508	$2 \text{SO}_3^{2-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{S}_2\text{O}_4^{2-} + 4 \text{OH}^-$	-1.12
$\text{Sb} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{SbH}_3$	-0.510	$\text{Te} + 2 e \rightleftharpoons \text{Te}^{2-}$	-1.143
$\text{HPbO}_2^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Pb} + 3 \text{OH}^-$	-0.537	$\text{V}^{2+} + 2 e \rightleftharpoons \text{V}$	-1.175
$\text{Ga}^{3+} + 3 e \rightleftharpoons \text{Ga}$	-0.549	$\text{Mn}^{2+} + 2 e \rightleftharpoons \text{Mn}$	-1.185
$\text{TlCl} + e \rightleftharpoons \text{Tl} + \text{Cl}^-$	-0.5568	$\text{Zn}(\text{OH})_4^{2-} + 2 e \rightleftharpoons \text{Zn} + 4 \text{OH}^-$	-1.199
$\text{Fe}(\text{OH})_3 + e \rightleftharpoons \text{Fe}(\text{OH})_2 + \text{OH}^-$	-0.56	$\text{CrO}_2 + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Cr} + 4 \text{OH}^-$	-1.2
$\text{TeO}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Te} + 6 \text{OH}^-$	-0.57	$\text{No}^{3+} + 3 e \rightleftharpoons \text{No}$	-1.20
$2 \text{SO}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 6 \text{OH}^-$	-0.571	$\text{ZnO}_2^- + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Zn} + 4 \text{OH}^-$	-1.215
$\text{PbO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Pb} + 2 \text{OH}^-$	-0.580	$\text{H}_2\text{GaO}_3^- + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Ga} + 4 \text{OH}^-$	-1.219
$\text{ReO}_2^- + 4 \text{H}_2\text{O} + 7 e \rightleftharpoons \text{Re} + 8 \text{OH}^-$	-0.584	$\text{H}_2\text{BO}_3^- + 5 \text{H}_2\text{O} + 8 e \rightleftharpoons \text{BH}_4^- + 8 \text{OH}^-$	-1.24
$\text{SbO}_3^- + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{SbO}_2^- + 2 \text{OH}^-$	-0.59	$\text{SiF}_6^{2-} + 4 e \rightleftharpoons \text{Si} + 6 \text{F}^-$	-1.24
$\text{Ta}^{3+} + 3 e \rightleftharpoons \text{Ta}$	-0.6	$\text{Zn}(\text{OH})_2 + 2 e \rightleftharpoons \text{Zn} + 2 \text{OH}^-$	-1.249
$\text{U}^{4+} + e \rightleftharpoons \text{U}^{3+}$	-0.607	$\text{ZnO} + \text{H}_2\text{O} + 2 e \rightleftharpoons \text{Zn} + 2 \text{OH}^-$	-1.260
$\text{As} + 3 \text{H}^+ + 3 e \rightleftharpoons \text{AsH}_3$	-0.608	$\text{Es}^{3+} + e \rightleftharpoons \text{Es}^{2+}$	-1.3
$\text{Nb}_2\text{O}_5 + 10 \text{H}^+ + 10 e \rightleftharpoons 2 \text{Nb} + 5 \text{H}_2\text{O}$	-0.644	$\text{Pa}^{3+} + 3 e \rightleftharpoons \text{Pa}$	-1.34
$\text{NbO}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons \text{NbO} + \text{H}_2\text{O}$	-0.646	$\text{Ti}^{3+} + 3 e \rightleftharpoons \text{Ti}$	-1.37
$\text{Cd}(\text{OH})_4^{2-} + 2 e \rightleftharpoons \text{Cd} + 4 \text{OH}^-$	-0.658	$\text{Ce}^{3+} + 3 e \rightleftharpoons \text{Ce}(\text{Hg})$	-1.4373
$\text{TlBr} + e \rightleftharpoons \text{Tl} + \text{Br}^-$	-0.658	$\text{UO}_2^{2+} + 4 \text{H}^+ + 6 e \rightleftharpoons \text{U} + 2 \text{H}_2\text{O}$	-1.444
$\text{SbO}_2^- + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Sb} + 4 \text{OH}^-$	-0.66	$\text{Zr}^{4+} + 4 e \rightleftharpoons \text{Zr}$	-1.45
$\text{AsO}_2^- + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{As} + 4 \text{OH}^-$	-0.68		

Reaction	$E^\circ/V$	Reaction	$E^\circ/V$
$\text{Cr}(\text{OH})_3 + 3 e \rightleftharpoons \text{Cr} + 3 \text{OH}^-$	-1.48	$\text{Am}^{3+} + e \rightleftharpoons \text{Am}^{2+}$	-2.3
$\text{Pa}^{4+} + 4 e \rightleftharpoons \text{Pa}$	-1.49	$\text{Fm}^{2+} + 2 e \rightleftharpoons \text{Fm}$	-2.30
$\text{HfO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Hf} + 2 \text{H}_2\text{O}$	-1.505	$\text{Pm}^{3+} + 3 e \rightleftharpoons \text{Pm}$	-2.30
$\text{Hf}^{4+} + 4 e \rightleftharpoons \text{Hf}$	-1.55	$\text{Sm}^{3+} + 3 e \rightleftharpoons \text{Sm}$	-2.304
$\text{Sm}^{3+} + e \rightleftharpoons \text{Sm}^{2+}$	-1.55	$\text{Al}(\text{OH})_3 + 3 e \rightleftharpoons \text{Al} + 3 \text{OH}^-$	-2.31
$\text{ZrO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Zr} + 2 \text{H}_2\text{O}$	-1.553	$\text{Tm}^{3+} + 3 e \rightleftharpoons \text{Tm}$	-2.319
$\text{Mn}(\text{OH})_2 + 2 e \rightleftharpoons \text{Mn} + 2 \text{OH}^-$	-1.56	$\text{Nd}^{3+} + 3 e \rightleftharpoons \text{Nd}$	-2.323
$\text{Ba}^{2+} + 2 e \rightleftharpoons \text{Ba}(\text{Hg})$	-1.570	$\text{Al}(\text{OH})^- + 3 e \rightleftharpoons \text{Al} + 4 \text{OH}^-$	-2.328
$\text{Bk}^{2+} + 2 e \rightleftharpoons \text{Bk}$	-1.6	$\text{H}_2\text{AlO}_3^- + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{Al} + 4 \text{OH}^-$	-2.33
$\text{Cf}^{3+} + e \rightleftharpoons \text{Cf}^{2+}$	-1.6	$\text{Ho}^{3+} + 3 e \rightleftharpoons \text{Ho}$	-2.33
$\text{Ti}^{2+} + 2 e \rightleftharpoons \text{Ti}$	-1.630	$\text{Er}^{3+} + 3 e \rightleftharpoons \text{Er}$	-2.331
$\text{Md}^{3+} + 3 e \rightleftharpoons \text{Md}$	-1.65	$\text{Ce}^{3+} + 3 e \rightleftharpoons \text{Ce}$	-2.336
$\text{HPO}_3^{2-} + 2 \text{H}_2\text{O} + 2 e \rightleftharpoons \text{H}_2\text{PO}_2^- + 3 \text{OH}^-$	-1.65	$\text{Pr}^{3+} + 3 e \rightleftharpoons \text{Pr}$	-2.353
$\text{Al}^{3+} + 3 e \rightleftharpoons \text{Al}$	-1.662	$\text{ZrO}(\text{OH})_2 + \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Zr} + 4 \text{OH}^-$	-2.36
$\text{SiO}_3^{2-} + \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Si} + 6 \text{OH}^-$	-1.697	$\text{Mg}^{2+} + 2 e \rightleftharpoons \text{Mg}$	-2.372
$\text{HPO}_3^{2-} + 2 \text{H}_2\text{O} + 3 e \rightleftharpoons \text{P} + 5 \text{OH}^-$	-1.71	$\text{Y}^{3+} + 3 e \rightleftharpoons \text{Y}$	-2.372
$\text{HfO}^{2+} + 2 \text{H}^+ + 4 e \rightleftharpoons \text{Hf} + \text{H}_2\text{O}$	-1.724	$\text{La}^{3+} + 3 e \rightleftharpoons \text{La}$	-2.379
$\text{ThO}_2 + 4 \text{H}^+ + 4 e \rightleftharpoons \text{Th} + 2 \text{H}_2\text{O}$	-1.789	$\text{Tm}^{2+} + 2 e \rightleftharpoons \text{Tm}$	-2.4
$\text{H}_2\text{BO}_3^- + \text{H}_2\text{O} + 3 e \rightleftharpoons \text{B} + 4 \text{OH}^-$	-1.79	$\text{Md}^{2+} + 2 e \rightleftharpoons \text{Md}$	-2.40
$\text{Sr}^{2+} + 2 e \rightleftharpoons \text{Sr}(\text{Hg})$	-1.793	$\text{Th}(\text{OH})_4 + 4 e \rightleftharpoons \text{Th} + 4 \text{OH}^-$	-2.48
$\text{U}^{3+} + 3 e \rightleftharpoons \text{U}$	-1.798	$\text{HfO}(\text{OH})_2 + \text{H}_2\text{O} + 4 e \rightleftharpoons \text{Hf} + 4 \text{OH}^-$	-2.50
$\text{H}_2\text{PO}_2^- + e \rightleftharpoons \text{P} + 2 \text{OH}^-$	-1.82	$\text{No}^{2+} + 2 e \rightleftharpoons \text{No}$	-2.50
$\text{Be}^{2+} + 2 e \rightleftharpoons \text{Be}$	-1.847	$\text{Dy}^{3+} + e \rightleftharpoons \text{Dy}^{2+}$	-2.6
$\text{Np}^{3+} + 3 e \rightleftharpoons \text{Np}$	-1.856	$\text{Pm}^{3+} + e \rightleftharpoons \text{Pm}^{2+}$	-2.6
$\text{Fm}^{3+} + 3 e \rightleftharpoons \text{Fm}$	-1.89	$\text{Be}_2\text{O}_3^{2-} + 3 \text{H}_2\text{O} + 4 e \rightleftharpoons 2 \text{Be} + 6 \text{OH}^-$	-2.63
$\text{Th}^{4+} + 4 e \rightleftharpoons \text{Th}$	-1.899	$\text{Sm}^{2+} + 2 e \rightleftharpoons \text{Sm}$	-2.68
$\text{Am}^{2+} + 2 e \rightleftharpoons \text{Am}$	-1.9	$\text{Mg}(\text{OH})_2 + 2 e \rightleftharpoons \text{Mg} + 2 \text{OH}^-$	-2.690
$\text{Pa}^{4+} + e \rightleftharpoons \text{Pa}^{3+}$	-1.9	$\text{Nd}^{3+} + e \rightleftharpoons \text{Nd}^{2+}$	-2.7
$\text{Es}^{3+} + 3 e \rightleftharpoons \text{Es}$	-1.91	$\text{Mg}^+ + e \rightleftharpoons \text{Mg}$	-2.70
$\text{Cf}^{3+} + 3 e \rightleftharpoons \text{Cf}$	-1.94	$\text{Na}^+ + e \rightleftharpoons \text{Na}$	-2.71
$\text{Lr}^{3+} + 3 e \rightleftharpoons \text{Lr}$	-1.96	$\text{Yb}^{2+} + 2 e \rightleftharpoons \text{Yb}$	-2.76
$\text{Eu}^{3+} + 3 e \rightleftharpoons \text{Eu}$	-1.991	$\text{Bk}^{3+} + e \rightleftharpoons \text{Bk}^{2+}$	-2.8
$\text{Er}^{2+} + 2 e \rightleftharpoons \text{Er}$	-2.0	$\text{Ho}^{3+} + e \rightleftharpoons \text{Ho}^{2+}$	-2.8
$\text{Pr}^{2+} + 2 e \rightleftharpoons \text{Pr}$	-2.0	$\text{Ra}^{2+} + 2 e \rightleftharpoons \text{Ra}$	-2.8
$\text{Pu}^{3+} + 3 e \rightleftharpoons \text{Pu}$	-2.031	$\text{Eu}^{2+} + 2 e \rightleftharpoons \text{Eu}$	-2.812
$\text{Cm}^{3+} + 3 e \rightleftharpoons \text{Cm}$	-2.04	$\text{Ca}^{2+} + 2 e \rightleftharpoons \text{Ca}$	-2.868
$\text{Am}^{3+} + 3 e \rightleftharpoons \text{Am}$	-2.048	$\text{Sr}(\text{OH})_2 + 2 e \rightleftharpoons \text{Sr} + 2 \text{OH}^-$	-2.88
$\text{AlF}_6^{3-} + 3 e \rightleftharpoons \text{Al} + 6 \text{F}^-$	-2.069	$\text{Sr}^{2+} + 2 e \rightleftharpoons \text{Sr}$	-2.899
$\text{Sc}^{3+} + 3 e \rightleftharpoons \text{Sc}$	-2.077	$\text{Fr}^+ + e \rightleftharpoons \text{Fr}$	-2.9
$\text{Ho}^{2+} + 2 e \rightleftharpoons \text{Ho}$	-2.1	$\text{La}(\text{OH})_3 + 3 e \rightleftharpoons \text{La} + 3 \text{OH}^-$	-2.90
$\text{Nd}^{2+} + 2 e \rightleftharpoons \text{Nd}$	-2.1	$\text{Ba}^{2+} + 2 e \rightleftharpoons \text{Ba}$	-2.912
$\text{Cf}^{2+} + 2 e \rightleftharpoons \text{Cf}$	-2.12	$\text{K}^+ + e \rightleftharpoons \text{K}$	-2.931
$\text{Yb}^{3+} + 3 e \rightleftharpoons \text{Yb}$	-2.19	$\text{Rb}^+ + e \rightleftharpoons \text{Rb}$	-2.98
$\text{Ac}^{3+} + 3 e \rightleftharpoons \text{Ac}$	-2.20	$\text{Ba}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ba} + 2 \text{OH}^-$	-2.99
$\text{Dy}^{2+} + 2 e \rightleftharpoons \text{Dy}$	-2.2	$\text{Er}^{3+} + e \rightleftharpoons \text{Er}^{2+}$	-3.0
$\text{Tm}^{3+} + e \rightleftharpoons \text{Tm}^{2+}$	-2.2	$\text{Ca}(\text{OH})_2 + 2 e \rightleftharpoons \text{Ca} + 2 \text{OH}^-$	-3.02
$\text{Pm}^{2+} + 2 e \rightleftharpoons \text{Pm}$	-2.2	$\text{Cs}^+ + e \rightleftharpoons \text{Cs}$	-3.026
$\text{Es}^{2+} + 2 e \rightleftharpoons \text{Es}$	-2.23	$\text{Li}^+ + e \rightleftharpoons \text{Li}$	-3.0401
$\text{H}_2 + 2 e \rightleftharpoons 2 \text{H}^-$	-2.23	$3 \text{N}_2 + 2 \text{H}^+ + 2 e \rightleftharpoons 2 \text{HN}_3$	-3.09
$\text{Gd}^{3+} + 3 e \rightleftharpoons \text{Gd}$	-2.279	$\text{Pr}^{3+} + e \rightleftharpoons \text{Pr}^{2+}$	-3.1
$\text{Tb}^{3+} + 3 e \rightleftharpoons \text{Tb}$	-2.28	$\text{Ca}^+ + e \rightleftharpoons \text{Ca}$	-3.80
$\text{Lu}^{3+} + 3 e \rightleftharpoons \text{Lu}$	-2.28	$\text{Sr}^+ + e \rightleftharpoons \text{Sr}$	-4.10
$\text{Dy}^{3+} + 3 e \rightleftharpoons \text{Dy}$	-2.295		

# REDUCTION AND OXIDATION POTENTIALS FOR CERTAIN ION RADICALS

Petr Vanýsek

There are two tables for ion radicals. The first table lists reduction potentials for organic compounds which produce anion radicals during reduction, a process described as  $A + e^- \rightleftharpoons A^-$ . The second table lists oxidation potentials for organic compounds which produce cation radicals during oxidation, a process described as  $A \rightleftharpoons A^+ + e^-$ . To obtain reduction potential for a reverse reaction, the sign for the potential is changed.

Unlike the table of the Electrochemical Series, which lists *standard* potentials, values for radicals are experimental values with experimental conditions given in the second column. Since the measurements leading to potentials for ion radicals are very dependent on conditions, an attempt to report standard potentials for radicals would serve no useful purpose. For the same reason, the potentials are also reported as experimental values, usually a half-wave potential ( $E_{1/2}$  in polarography) or a peak potential ( $E_p$  in cyclic voltammetry). Unless otherwise stated, the values are reported vs. SCE (saturated calomel electrode). To obtain a value vs.

normal hydrogen electrode, 0.241 V has to be added to the SCE values. All the ion radicals chosen for inclusion in the tables result from electrochemically reversible reactions. More detailed data on ion radicals can be found in the *Encyclopedia of Electrochemistry of Elements*, (A. J. Bard, Ed.), Vol. XI and XII in particular, Marcel Dekker, New York, 1978.

Abbreviations are: CV — cyclic voltammetry; DMF — *N,N*-Dimethylformamide; *E* swp — potential sweep;  $E^\circ$  — standard potential;  $E_p$  — peak potential;  $E_{p/2}$  — half-peak potential;  $E_{1/2}$  — half wave potential; *M* — mol/L; MeCN — acetonitrile; pol — polarography; rot Pt disk — rotated Pt disk; SCE — saturated calomel electrode; TBABF<sub>4</sub> — tetrabutylammonium tetrafluoroborate; TBAl — tetrabutylammonium iodide; TBAP — tetrabutylammonium perchlorate; TEABr — tetraethylammonium bromide; TEAP — tetraethylammonium perchlorate; THF — tetrahydrofuran; TPACF<sub>3</sub>SO<sub>3</sub> — tetrapropylammonium trifluoromethanesulfite; TPAP — tetrapropylammonium perchlorate; and wr — wire.

## Reduction Potentials (Products are Anion Radicals)

Substance	Conditions/electrode/technique	Potential V (vs. SCE)
Acetone	DMF, 0.1 M TEABr/Hg/pol	$E_{1/2} = -2.84$
1-Naphthylphenylacetylene	DMF, 0.03 M TBAl/Hg/pol	$E_{1/2} = -1.91$
1-Naphthalenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.91$
2-Naphthalenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.96$
2-Phenanthrenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -1.00$
3-Phenanthrenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.94$
9-Phenanthrenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.83$
1-Anthracenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.75$
1-Pyrenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -0.76$
2-Pyrenecarboxaldehyde	-/Hg/pol	$E_{1/2} = -1.00$
Anthracene	DMF, 0.1 M TBAP/Pt disk/CV	$E_p = -2.00$
	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.93$
	MeCN, 0.1 M TEAP/Hg/CV	$E_{1/2} = -2.07$
	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.92$
9,10-Dimethylantracene	DMF, 0.1 M TBAP/Pt/CV	$E_p = -2.08$
	MeCN, 0.1 M TBAP/Pt/CV	$E_p = -2.10$
1-Phenylantracene	DMF, 0.5 M TBABF <sub>2</sub> /Hg/CV	$E_{1/2} = -1.91$
	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.878$
2-Phenylantracene	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.875$
8-Phenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.91$
9-Phenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.93$
	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.863$
1,8-Diphenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.88$
1,9-Diphenylantracene	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.846$
1,10-Diphenylantracene	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.786$
8,9-Diphenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.90$
9,10-Diphenylantracene	MeCN, 0.1 M TBAP/rot Pt/E swp	$E_{1/2} = -1.83$
	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.835$
1,8,9-Triphenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.85$
1,8,10-Triphenylantracene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -1.81$
9,10-Dibiphenylantracene	MeCN, 0.1 M TBAP/rot Pt/E swp	$E_{1/2} = -1.94$
Benz(a)anthracene	MeCN, 0.1 M TEAP/Hg/CV	$E_{1/2} = -2.11$
	MeCN, 0.1 M TEAP/Hg/pol	$E_{1/2} = -2.40^a$
Azulene	DMF, 0.1 M TBAl/Hg/pol	$E_{1/2} = -1.10^c$
Annulene	DMF, 0.5 M TBAP 0°C/Hg/pol	$E_{1/2} = -1.23$
Benzaldehyde	DMF, 0.1 M TBAP/Hg/pol	$E_{1/2} = -1.67$
Benzil	DMSO, 0.1 M TBAP/Hg/pol	$E_{1/2} = -1.04$
Benzophenone	-/Hg/pol	$E_{1/2} = -1.80$
	DMF/Pt disk/CV	$E^\circ = -1.72$
Chrysene	MeCN, 0.1 M TEAP/Hg/pol	$E_{1/2} = -2.73^a$
Fluoranthrene	DMF, 0.1 M TBAP/Pt disk/CV	$E_p = -1.76$
Cyclohexanone	DMF, 0.1 M TEABr/Hg/pol	$E_{1/2} = -2.79$

Substance	Conditions/electrode/technique	Potential V (vs. SCE)
5,5-Dimethyl-3-phenyl-2-cyclohexen-1-one	DMF, 0.5 M/Hg/pol	$E_{1/2} = -1.71$
1,2,3-Indanetrione hydrate (ninhydrin)	DMF, 0.2 M NaNO <sub>3</sub> /Hg/pol	$E_{1/2} = -0.039$
Naphthacene	DMF, 0.1 M TBAI/Hg/pol	$E_{1/2} = -1.53$
Naphthalene	DMF, 0.1 M TBAP/Pt dsk/CV	$E_p = -2.55$
	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -2.56$
	DMF, MeCN, 0.1 M TEAP/Hg/CV	$E_{1/2} = -2.63$
	DMF, 0.1 M TBAI/Hg/pol	$E_{1/2} = -2.50$
1-Phenylnaphthalene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -2.36$
1,2-Diphenylnaphthalene	DMF, 0.5 M TBABF <sub>4</sub> /Hg/CV	$E_{1/2} = -2.25$
Cyclopentanone	DMF, 0.1 M TEABr/Hg/pol	$E_{1/2} = -2.82$
Phenanthrene	MeCN, 0.1 M TBAP/Pt wr/CV	$E_{1/2} = -2.47$
	MeCN, 0.1 M TEAP/Hg/pol	$E_{1/2} = -2.88^a$
Pentacene	THF, 0.1 M TBAP/rot Pt dsk/E swp	$E_{1/2} = -1.40$
Perylene	MeCN, 0.1 M TEAP/Hg/CV	$E_{1/2} = -1.73$
1,3-Diphenyl-1,3-propanedione	DMSO, 0.2 M TBAP/Hg/CV	$E_{1/2} = -1.42$
2,2-Dimethyl-1,3-diphenyl-1,3-propanedione	DMSO, TBAP/Hg/CV	$E_{1/2} = -1.80$
Pyrene	DMF, 0.1 M TBAP/Pt/CV	$E_p = -2.14$
	MeCN, 0.1 M TEAP/Hg/pol	$E_{1/2} = -2.49^a$
Diphenylsulfone	DMF, TEABr	$E_{1/2} = -2.16$
Triphenylene	MeCN, 0.1 M TEAP/Hg/pol	$E_{1/2} = -2.87^a$
9,10-Anthraquinone	DMF, 0.5 M TBAP, 20°/Pt dsk/CV	$E_{1/2} = -1.01$
1,4-Benzoquinone	MeCN, 0.1 M TEAP/Pt/CV	$E_p = -0.54$
1,4-Naphthohydroquinone, dipotassium salt	DMF, 0.5 M TBAP, 20°/Pt dsk/CV	$E_{1/2} = -1.55$
Rubrene	DMF, 0.1 M TBAP/Pt dsk/CV	$E_p = -1.48$
	DMF, 0.1 M TBAI/Hg/pol	$E_{1/2} = -1.410$
Benzocyclooctatetraene	THF, 0.1 M TBAP/Hg/pol	$E_{1/2} = -2.13$
<i>sym</i> -Dibenzocyclooctatetraene	THF, 0.1 M TBAP/Hg/pol	$E_{1/2} = -2.29$
Ubiquinone-6	MeCN, 0.1 M TEAP/Pt/CV	$E_p = -1.05^c$
(9-Phenyl-fluorenyl) <sup>+</sup>	10.2 M H <sub>2</sub> SO <sub>4</sub> /Hg/CV	$E_p = -0.01^b$
(Triphenylcyclopropenyl) <sup>+</sup>	MeCN, 0.1 M TEAP/Hg/CV	$E_p = -1.87$
(Triphenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.27$
	H <sub>2</sub> SO <sub>4</sub> , 10.2 M/Hg/CV	$E_p = -0.58^b$
(Tribiphenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.19$
(Tri-4- <i>t</i> -butyl-5-phenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.13$
(Tri-4-isopropylphenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.07$
(Tri-4-methylphenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.05$
(Tri-4-cyclopropylphenylmethyl) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = 0.01$
(Tropylium) <sup>+</sup>	MeCN, 0.1 M TBAP/Hg/pol	$E_{1/2} = -0.17$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.55$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.55$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.57$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.60$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.87$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -1.96$
	DMF, 0.15 M TBAI/Hg/pol	$E_{1/2} = -2.05$

## Oxidation Potentials (Products are Cation Radicals)

Anthracene	CH <sub>2</sub> Cl <sub>2</sub> , 0.2 M TBABF <sub>4</sub> , -70°C/Pt dsk/CV	$E_p = +0.73^d$
9,10-Dimethylantracene	MeCN, 0.1 M LiClO <sub>4</sub> /Pt wr/CV	$E_p = +1.0$
9,10-Dipropylantracene	MeCN, 0.1 M TEAP/Pt/CV	$E_p = +1.08$
1,8-Diphenylantracene	CH <sub>2</sub> Cl <sub>2</sub> , 0.2 M TPrACF <sub>3</sub> SO <sub>3</sub> /rot Pt wr/E swp	$E_{1/2} = +1.34$
8,9-Diphenylantracene	CH <sub>2</sub> Cl <sub>2</sub> , 0.2 M TPrACF <sub>3</sub> SO <sub>3</sub> /rot Pt wr/E swp	$E_{1/2} = +1.30$
9,10-Diphenylantracene	MeCN/Pt/CV	$E_p = +1.22$
Perylene	MeCN, 0.1 M TBAP/Pt/CV	$E_p = +1.34$
Pyrene	DMF, 0.1 M TBAP/Pt dsk/CV	$E_p = +1.25$
Rubrene	DMF, 0.1 M TBAP/Pt dsk/CV	$E_p = +1.10$
Tetracene	CH <sub>2</sub> Cl <sub>2</sub> , 0.2 M TBABF <sub>4</sub> , -70°C/Pt wr/CV	$E_p = +0.35^d$
1,4-Dithiabenzene	MeCN, 0.1 M TEAP/Pt dsk/rot	$E_{1/2} = +0.69$
1,4-Dithianaphthalene	MeCN, 0.1 M TEAP/Pt dsk/rot	$E_{1/2} = +0.80$
Thianthrene	0.1 M TPAP/Pt/CV	$E_{1/2} = +1.28$

<sup>a</sup> vs 0.01 M Ag/AgClO<sub>4</sub>

<sup>b</sup> vs. Hg/Hg<sub>2</sub>SO<sub>4</sub>, 17 M H<sub>2</sub>SO<sub>4</sub>

<sup>c</sup> vs Hg pool

<sup>d</sup> vs Ag/saturated AgNO<sub>3</sub>

<sup>e</sup> vs Ag/0.01 M Ag<sup>+</sup>



# pH SCALE FOR AQUEOUS SOLUTIONS

A.K. Covington

A Working Party of IUPAC, after extensive considerations over five years, has recently produced a report (1) which sets pH firmly within the International System of Units (SI). A summary of these important developments is given below.

The concept of pH is unique amongst the commonly encountered physicochemical quantities in that, in terms of its definition,

$$\text{pH} = -\lg a_{\text{H}} \quad (1)$$

it involves a single ion quantity, the activity of the hydrogen ion, which is immeasurable by any thermodynamically valid method and requires a convention for its evaluation.

pH was originally defined by Sørensen (2) in terms of the concentration of hydrogen ions (in modern nomenclature) as  $\text{pH} = -\lg(c_{\text{H}}/c^\circ)$  where  $c_{\text{H}}$  is the hydrogen ion concentration in  $\text{mol dm}^{-3}$ , and  $c^\circ = 1 \text{ mol dm}^{-3}$  is the standard amount concentration. Subsequently (3), it was accepted as more satisfactory to define pH in terms of the relative activity of hydrogen ions in solution

$$\text{pH} = -\lg a_{\text{H}} = -\lg(m_{\text{H}}\gamma_{\text{H}}/m^\circ) \quad (2)$$

where  $a_{\text{H}}$  is the relative (molality basis) activity and  $\gamma_{\text{H}}$  is the molal activity coefficient of the hydrogen ion  $\text{H}^+$  at the molality  $m_{\text{H}}$ , and  $m^\circ$  the standard molality. The quantity pH is intended to be a measure of the activity of hydrogen ions in solution. However, since it is defined in terms of a quantity that cannot be measured by a thermodynamically valid method, eqn.(2) can only be considered a *notional definition* of pH.

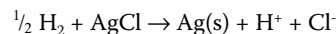
pH being a single ion quantity, it is not determinable in terms of a fundamental (or base) unit of any measurement system, and there is difficulty providing a proper basis for the traceability of pH measurements. A satisfactory approach is now available in that pH determinations can be incorporated into the International System (SI) if they can be traced to measurements made using a method that fulfils the definition of a 'primary method of measurement' (4).

The essential feature of a primary method is that it must operate according to a well-defined measurement equation in which all of the variables can be determined experimentally in terms of SI units. Any limitation in the determination of the experimental variables, or in the theory, must be included within the estimated uncertainty of the method if traceability to the SI is to be established. If a convention were used without an estimate of its uncertainty, true traceability to SI would not be established. The electrochemical cell without liquid junction, known as the Harned cell (5), fulfils the definition of a primary method for the measurement of the acidity function,  $p(a_{\text{H}}\gamma_{\text{Cl}})$ , and subsequently of the pH of buffer solutions.

The Harned cell is written as



and contains a standard buffer, S, with chloride ions, as potassium or sodium chloride, added in order to use the silver-silver chloride electrode as reference electrode. The application of the Nernst equation to the spontaneous cell reaction of Cell I:



yields the potential difference  $E_1$  of the cell (corrected to 1 atm (101.325 kPa), the partial pressure of hydrogen gas used in electrochemistry in preference to 100 kPa) as

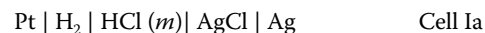
$$E_1 = E^\circ - (RT/F)\ln 10 \lg [(m_{\text{H}}\gamma_{\text{H}}/m^\circ)(m_{\text{Cl}}\gamma_{\text{Cl}}/m^\circ)] \quad (3)$$

which can be rearranged, since  $a_{\text{H}} = m_{\text{H}}\gamma_{\text{H}}/m^\circ$ , to give the acidity function

$$p(a_{\text{H}}\gamma_{\text{Cl}}) = -\lg(a_{\text{H}}\gamma_{\text{Cl}}) = (E_1 - E^\circ)/[(RT/F)\ln 10] + \lg(m_{\text{Cl}}/m^\circ) \quad (4)$$

where  $E^\circ$  is the standard potential difference of the cell, and hence of the silver-silver chloride electrode, and  $\gamma_{\text{Cl}}$  is the activity coefficient of the chloride ion.

The standard potential difference of the silver/silver chloride electrode,  $E^\circ$ , is determined from a Harned cell in which only HCl is present at a fixed molality (e.g.  $m = 0.01 \text{ mol kg}^{-1}$ )



The application of the Nernst equation to the HCl cell (Ia) gives

$$E_{\text{Ia}} = E^\circ - (2RT/F)\ln 10 \lg[(m_{\text{HCl}}/m^\circ)(\gamma_{\pm\text{HCl}})] \quad (5)$$

where  $E_{\text{Ia}}$  has been corrected to 1 atmosphere partial pressure of hydrogen gas (101.325 kPa) and  $\gamma_{\pm\text{HCl}}$  is the mean ionic activity coefficient of HCl.

Values of the activity coefficient ( $\gamma_{\pm\text{HCl}}$ ) at molality 0.01  $\text{mol kg}^{-1}$  and various temperatures were given by Bates and Robinson (6). The standard potential difference depends on the method of preparation of the electrodes, but individual determinations of the activity coefficient of HCl at 0.01  $\text{mol kg}^{-1}$  are more uniform than values of  $E^\circ$ . Hence the practical determination of the potential difference of the cell with HCl at 0.01  $\text{mol kg}^{-1}$  is recommended at 298.15 K at which the mean ionic activity coefficient is 0.904. (It is unnecessary to repeat the measurement of  $E^\circ$  at other temperatures but simply to correct published smoothed values by the observed difference in  $E^\circ$  at 298.15 K)

In national metrology institutes (NMIs), measurements of Cells I and Ia are often done simultaneously in a thermostat bath. Subtracting eqn.(5) from (3) gives

$$\Delta E = E_1 - E_{\text{Ia}} = - (RT/F)\ln 10 \{ \lg[(m_{\text{H}}\gamma_{\text{H}}/m^\circ)(m_{\text{Cl}}\gamma_{\text{Cl}}/m^\circ)] - \lg[(m_{\text{HCl}}/m^\circ)^2\gamma_{\pm\text{HCl}}] \} \quad (6)$$

which is independent of the standard potential difference. Therefore, the subsequently calculated pH does not depend on the standard potential difference and hence does not depend on the assumption that the standard potential of the hydrogen electrode is zero at all temperatures. Therefore, the Harned cell gives an exact comparison between hydrogen ion activities at different temperatures.

The quantity  $p(a_{\text{H}}\gamma_{\text{Cl}}) = -\lg(a_{\text{H}}\gamma_{\text{Cl}})$ , on the left hand side of (4), is called the acidity function (5). To obtain the quantity pH according to eqn. (2) from the acidity function, it is necessary to evaluate  $\lg \gamma_{\text{Cl}}$  independently. This is done in two steps: (i) the

value of  $\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-})$  at zero chloride molality,  $\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-})^0$ , is evaluated and (ii) a value for the activity of the chloride ion  $\gamma_{\text{Cl}^-}^0$ , at zero chloride molality (sometimes referred to as the limiting or 'trace' activity coefficient) is calculated using the Bates-Guggenheim convention (7). The value of  $\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-})^0$  corresponding to zero chloride molality is determined by linear extrapolation of measurements using Harned cells with at least three added molalities of sodium or potassium chloride ( $I < 0.1 \text{ mol kg}^{-1}$ ).

The value of  $\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-})^0$  corresponding to zero chloride molality is determined by linear extrapolation of measurements using Harned cells with at least three added molalities of sodium or potassium chloride ( $I < 0.1 \text{ mol kg}^{-1}$ ) in accord with eqn. (7):

$$-\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-}) = -\lg(a_{\text{H}^+}\gamma_{\text{Cl}^-})^0 + Sm_{\text{Cl}^-} \quad (7)$$

where  $S$  is an empirical, temperature dependent, constant.

The Bates-Guggenheim convention (7) assumes that the trace activity coefficient of the chloride ion  $\gamma_{\text{Cl}^-}^0$  is given by

$$\lg \gamma_{\text{Cl}^-}^0 = -A I^{1/2} / (1 + Ba I^{1/2}) \quad (8)$$

where  $A$  is the Debye-Hückel temperature dependent constant (limiting slope),  $a$  is the mean distance of closest approach of the ions (ion size parameter),  $Ba$  is set equal to  $1.5 (\text{mol kg}^{-1})^{-1/2}$  at all temperatures in the range  $5\text{--}50^\circ\text{C}$ , and  $I$  is the ionic strength of the buffer (which for its evaluation requires knowledge of appropriate acid dissociation constants).

The various stages in the assignment of primary standard pH values are combined in eqn. (9), which is derived from eqns. (4), (5) and (8)

$$\text{pH(PS)} = \lim_{m_{\text{Cl}^-} \rightarrow 0} \{ (E_1 - E_0) / [(RT/F) \ln 10] + \lg(m_{\text{Cl}^-}/m^0) \} - AI^{1/2} / [1 + 1.5 (I/m^0)^{1/2}] \quad (9)$$

In order for a particular buffer solution to be considered a primary buffer solution, it must be of the "highest metrological" quality (4) in accordance with the definition of a primary standard. It is recommended that it have the following attributes (9):

1. High buffer value in the range  $0.016\text{--}0.07 (\text{mol OH}^-)/\text{pH}$ .
2. Small dilution value at half concentration (change in pH with change in buffer concentration) in the range  $0.01\text{--}0.20$ .
3. Small dependence of pH on temperature less than  $\pm 0.01 \text{ K}^{-1}$ .
4. Low residual liquid junction potential  $< 0.01$  in pH.
5. Ionic strength  $\leq 0.1 \text{ mol kg}^{-1}$  to permit applicability of Bates-Guggenheim convention.
6. NMI certificate for specific batch.
7. Reproducible purity of preparation (lot to lot differences of  $|\Delta\text{pH(PS)}| < 0.003$ ).
8. Long term stability of stored solid material.

Values for the above and other important parameters for the primary and secondary buffer materials are given in Table 1.

### Primary Standard Buffers

As there can be significant variations in the purity of samples of a buffer of the same nominal chemical composition, it is essential that the primary buffer material used has been certified with values that have been measured with Cell I. The Harned cell is used

by many national metrological institutes for accurate measurements of pH of buffer solutions.

Typical values of the pH(PS) of the seven solutions from the six accepted primary standard reference buffers, which meet the conditions stated above, are listed in Table 2. Batch-to-batch variations in purity can result in changes in the pH value of samples of at most 0.003. The typical values in Table 2 should not be used in place of the certified value (from a Harned cell measurement) for a specific batch of buffer material.

The required attributes listed above effectively limit the range of primary buffers available to between pH 3 and 10 (at  $25^\circ\text{C}$ ). Calcium hydroxide and potassium tetraoxalate are excluded because the contribution of hydroxide or hydrogen ions to the ionic strength is significant. Also excluded are the nitrogen bases of the type  $\text{BH}^+$  (such as tris(hydroxymethyl)aminomethane and piperazine phosphate) and the zwitterionic buffers (e.g. HEPES and MOPS (10)). These do not comply because either the Bates-Guggenheim convention is not applicable, or the liquid junction potentials are high. This means the choice of primary standards is restricted to buffers derived from oxy-carbon, -phosphorus, -boron and mono, di- and tri-protic carboxylic acids. The uncertainties (11) associated with Harned cell measurements are calculated (1) to be 0.004 in pH at NMIs, with typical variation between batches of primary standard buffers of 0.003.

### Secondary Standards

Substances that do not fulfil all the criteria for primary standards, but to which pH values can be assigned using Cell I are considered to be secondary standards (Table 3). Reasons for their exclusion as primary standards include difficulties in achieving consistent and suitable chemical quality (e.g. acetic acid is a liquid), suspected high liquid junction potential, or inappropriateness of the Bates-Guggenheim convention (e.g. other charge-type buffers). The uncertainty is higher (e.g. 0.01) for biological buffers. Certain other substances, which cannot be used in cells containing hydrogen gas electrodes, are also classed as secondary standards.

### Calibration Procedures

#### (a) One-point calibration

A single point calibration is insufficient to determine both slope and one-point parameters. The theoretical value for the slope can be assumed but the practical slope may be up to 5% lower. Alternatively, a value for the practical slope can be assumed from the manufacturer's prior calibration. The one-point calibration therefore yields only an estimate of pH(X). Since both parameters may change with age of the electrodes, this is not a reliable procedure.

#### (b) Two-point calibration [target uncertainty: $0.02\text{--}0.03$ at $25^\circ\text{C}$ ]

In the majority of practical applications, glass electrodes cells are calibrated by a two-point calibration, or bracketing, procedure using two standard buffer solutions, with pH values,  $\text{pH}(S_1)$  and  $\text{pH}(S_2)$ , bracketing the unknown  $\text{pH}(X)$ . Bracketing is often taken to mean that the  $\text{pH}(S_1)$  and  $\text{pH}(S_2)$  buffers selected from Table 2 should be those that are immediately above and below  $\text{pH}(X)$ . This may not be appropriate in all situations and choice of a wider range may be better.

- (c) Multi-point calibration [target uncertainty: 0.01-0.03 at 25 °C].

Multi-point calibration is carried out using up to five standard buffers. The use of more than five points yields no significant improvement in the statistical information obtainable.

Details of uncertainty computations (11) have been given (1).

### Measurement of pH and choice of pH Standard Solutions

- 1a) If pH is not required to better than  $\pm 0.05$  any pH standard solution may be selected.
- 1b) If pH is required to  $\pm 0.002$  and interpretation in terms of hydrogen ion concentration or activity is desired, choose a standard solution, pH(PS), to match X as closely as possible in terms of pH, composition and ionic strength.
- 2) Alternatively, a bracketing procedure may be adopted whereby two standard solutions are chosen whose pH values, pH(S1), pH(S2) are on either side of pH(X). Then if the corresponding potential difference measurements are  $E(S1)$ ,  $E(S2)$ ,  $E(X)$ , then pH(X) is obtained from

$$\text{pH}(X) = \text{pH}(S1) + [E(X) - E(S1)] / \%k$$

where  $\%k = 100[E(S2) - E(S1)] / [pH(S2) - pH(S1)]$  is the apparent percentage slope. This procedure is very easily done on some pH meters simply by adjusting downwards the slope factor control with the electrodes in S2. The purpose of the bracketing procedure is to compensate for deficiencies in the electrodes and measuring system.

### Information to be given about the measurement of pH(X)

The standard solutions selected for calibration of the pH meter system should be reported with the measurement as follows:

System calibrated with pH(S) = .... at ...K.

System calibrated with two primary standards, pH(PS1) = .... and pH(PS2) = .... at ....K.

System calibrated with  $n$  standards, pH(S1) = ...., pH(S2) = .... etc. at ....K.

### Interpretation of pH(X) in terms of hydrogen ion concentration

The defined pH has no simple interpretation in terms of hydrogen ion concentration but the mean ionic activity coefficient of a typical 1:1 electrolyte can be used to obtain hydrogen ion concentration subject to an uncertainty of 3.9% in concentration, corresponding to 0.02 in pH.

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TABLE 1. Summary of Useful Properties of Some Primary and Secondary Standard Buffer Substances and Solutions

Salt or solid substance	Formula	Molality/ mol kg <sup>-1</sup>	Molar mass/ g mol <sup>-1</sup>	Density/ g/mL	Amount conc. at 20°C/ mol dm <sup>-3</sup>	Mass/g to make 1 dm <sup>3</sup>	Dilution value $\Delta\text{pH}_{12}$	Buffer value ( $\beta$ )/ mol OH <sup>-</sup> / dm <sup>-3</sup>	pH Temperature coefficient/ K <sup>-1</sup>
Potassium tetroxalate dihydrate	KH <sub>3</sub> C <sub>4</sub> O <sub>8</sub> ·2H <sub>2</sub> O	0.1	254.191	1.0091	0.09875	25.101			
Potassium tetraoxalate dihydrate	KH <sub>3</sub> C <sub>4</sub> O <sub>8</sub> ·2H <sub>2</sub> O	0.05	254.191	1.0032	0.04965	12.620	0.186	0.070	0.001
Potassium hydrogen tartrate (sat at 25°C)	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	0.0341	188.18	1.0036	0.034	6.4	0.049	0.027	- 0.0014
Potassium dihydrogen citrate	KH <sub>2</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	0.05	230.22	1.0029	0.04958	11.41	0.024	0.034	- 0.022
Potassium hydrogen phthalate	KHC <sub>8</sub> H <sub>4</sub> O <sub>4</sub>	0.05	204.44	1.0017	0.04958	10.12	0.052	0.016	0.00012
Disodium hydrogen orthophosphate +	Na <sub>2</sub> HPO <sub>4</sub>	0.025	141.958	1.0038	0.02492	3.5379	0.080	0.029	- 0.0028

Salt or solid substance	Formula	Molality/ mol kg <sup>-1</sup>	Molar mass/ g mol <sup>-1</sup>	Density/ g/mL	Amount conc. at 20°C/ mol dm <sup>-3</sup>	Mass/g to make 1 dm <sup>3</sup>	Dilution value ΔpH <sub>1/2</sub>	Buffer value (β)/ mol OH <sup>-</sup> / dm <sup>-3</sup>	pH Temperature coefficient/ K <sup>-1</sup>
potassium dihydrogen orthophosphate	KH <sub>2</sub> PO <sub>4</sub>	0.025	136.085			3.3912			
Disodium hydrogen orthophosphate + potassium dihydrogen orthophosphate	Na <sub>2</sub> HPO <sub>4</sub>	0.03043	141.959	1.0020	0.08665	4.302	0.07	0.016	- 0.0028
Disodium tetraborate decahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·10H <sub>2</sub> O	0.05	381.367	1.0075	0.04985	19.012			
Disodium tetraborate decahydrate	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·10H <sub>2</sub> O	0.01	381.367	1.0001	0.00998	3.806	0.01	0.020	- 0.0082
Sodium hydrogen carbonate + sodium carbonate	NaHCO <sub>3</sub>	0.025	84.01	1.0013	0.02492	2.092	0.079	0.029	-0.0096
	Na <sub>2</sub> CO <sub>3</sub>	0.025	105.99			2.640			
Calcium hydroxide (sat. at 25°C)	Ca(OH) <sub>2</sub>	0.0203	74.09	0.9991	0.02025	1.5	-0.28	0.09	-0.033

TABLE 2. Typical Values of pH(PS) for Primary Standards at 0–50°C

Primary standards (PS)	Temperature in °C										
	0	5	10	15	20	25	30	35	37	40	50
Sat. potassium hydrogen tartrate (at 25°C)						3.557	3.552	3.549	3.548	3.547	3.549
0.05 mol kg <sup>-1</sup> potassium dihydrogen citrate	3.863	3.840	3.820	3.802	3.788	3.776	3.766	3.759	3.756	3.754	3.749
0.05 mol kg <sup>-1</sup> potassium hydrogen phthalate	4.000	3.998	3.997	3.998	4.000	4.005	4.011	4.018	4.022	4.027	4.050
0.025 mol kg <sup>-1</sup> disodium hydrogen phosphate + 0.025 mol kg <sup>-1</sup> potassium dihydrogen phosphate	6.984	6.951	6.923	6.900	6.881	6.865	6.853	6.844	6.841	6.838	6.833
0.03043 mol kg <sup>-1</sup> disodium hydrogen phosphate + 0.008695 mol kg <sup>-1</sup> potassium dihydrogen phosphate	7.534	7.500	7.472	7.448	7.429	7.413	7.400	7.389	7.386	7.380	7.367
0.01 mol kg <sup>-1</sup> disodium tetraborate	9.464	9.395	9.332	9.276	9.225	9.180	9.139	9.102	9.088	9.068	9.011
0.025 mol kg <sup>-1</sup> sodium hydrogen carbonate + 0.025 mol kg <sup>-1</sup> sodium carbonate	10.317	10.245	10.179	10.118	10.062	10.012	9.966	9.926	9.910	9.889	9.828

TABLE 3. Values of pH(SS) of Some Secondary Standards from Harned Cell I Measurements

Secondary standards	Temperature in °C									
	0	5	10	15	20	25	30	37	40	50
0.05 mol kg <sup>-1</sup> potassium tetroxalate <sup>a</sup>	1.67	1.67	1.67	1.67	1.68	1.68	1.68	1.69	1.69	1.71
0.05 mol kg <sup>-1</sup> sodium hydrogen diglycolate <sup>b</sup>		3.47	3.47	3.48	3.48	3.49	3.50	3.52	3.53	3.56
0.1 mol dm <sup>-3</sup> acetic acid + 0.1 mol dm <sup>-3</sup> sodium acetate	4.68	4.67	4.67	4.66	4.66	4.65	4.65	4.66	4.66	4.68
mol dm <sup>-3</sup> acetic acid + 0.1 mol dm <sup>-3</sup> sodium acetate	4.74	4.73	4.73	4.72	4.72	4.72	4.72	4.73	4.73	4.75
0.02 mol kg <sup>-1</sup> piperazine phosphate <sup>c</sup>	6.58	6.51	6.45	6.39	6.34	6.29	6.24	6.16	6.14	6.06
0.05 mol kg <sup>-1</sup> tris hydrochloride + 0.01667 mol kg <sup>-1</sup> tris <sup>c</sup>	8.47	8.30	8.14	7.99	7.84	7.70	7.56	7.38	7.31	7.07
0.05 mol kg <sup>-1</sup> disodium tetraborate	9.51	9.43	9.36	9.30	9.25	9.19	9.15	9.09	9.07	9.01
Saturated (at 25 °C) calcium hydroxide	13.42	13.21	13.00	12.81	12.63	12.45	12.29	12.07	11.98	11.71

<sup>a</sup> Potassium trihydrogen dioxalate (KH<sub>3</sub>C<sub>4</sub>O<sub>8</sub>)

<sup>b</sup> Sodium hydrogen 2,2'-oxydiacetate

<sup>c</sup> 2-Amino-2-(hydroxymethyl)-1,3 propanediol or tris(hydroxymethyl)aminomethane

# PRACTICAL pH MEASUREMENTS ON NATURAL WATERS

A. K. Covington and W. Davison

(1) Dilute solutions and freshwater including 'acid-rain' samples ( $I < 0.02 \text{ mol kg}^{-1}$ )

Major problems could be encountered due to errors associated with the liquid junction. It is recommended that either a free diffusion junction is used or it is verified that the junction is working correctly using dilute solutions as follows. For commercial electrodes calibrated with IUPAC aqueous RVS or PS standards, the  $\text{pH}(X)$  of dilute solutions should be within  $\pm 0.02$  of those given in Table 1. The difference in determined  $\text{pH}(X)$  between a stirred and unstirred dilute solution should be  $< 0.02$ . The characteristics of glass electrodes are such that below  $\text{pH } 5$  the readings should be stable within 2 min, but for  $\text{pH } 5$  to 8.8 or so minutes may be necessary to attain stability. Interpretation of  $\text{pH}(X)$  measured in this way in terms of activity of hydrogen ion,  $a_{\text{H}^+}$ , is subject<sup>1</sup> to an uncertainty of  $\pm 0.02$  in  $\text{pH}$ .

(2) Seawater

Measurements made by calibration of electrodes with IUPAC aqueous RVS or PS standards to obtain  $\text{pH}(X)$  are perfectly valid. However, the interpretation of  $\text{pH}(X)$  in terms of the activity of hydrogen ion is complicated by the non zero residual liquid junction potential as well as by systematic differences between electrode pairs, principally attributable to the reference electrode. For 35‰ salinity seawater ( $S = 0.035$ )  $a_{\text{H}^+}$  calculated from  $\text{pH}(X)$  is typically 12% too low. Special seawater  $\text{pH}$  scales have been devised to overcome this problem:

(i) The total hydrogen ion scale,  $\text{pH}_T$ , is defined in terms of the sum of free and complexed (total) hydrogen ion concentrations, where

$${}^T C_{\text{H}} = [\text{H}^+] + [\text{HSO}_4^-] + [\text{HF}].$$

$$\text{So, } \text{pH}_T = -\log {}^T C_{\text{H}}$$

Calibration of the electrodes with a buffer having a composition similar to that of seawater, to which  $\text{pH}_T$  has been assigned, results in values of  $\text{pHT}(X)$  (Tables 2, 3) which are accurately interpretable in terms of  ${}^T C_{\text{H}}$ .

(ii) The free hydrogen ion scale,  $\text{pH}_F$ , is defined, and fully interpretable, in terms of the concentration of free hydrogen ions.

$$\text{pH}_F = -\log [\text{H}^+]$$

Values of  $\text{pH}_F$  as a function of temperature have been assigned to the same set of  $\text{pH}_T$  seawater buffers, and so alternatively can be used for calibration (Tables 2, 3)<sup>2,3</sup>

(3) Estuarine water

Prescriptions for seawater scale buffers are available for a range of salinities. Reliable estuarine  $\text{pH}$  measurements can be made by calibrating with a buffer of the same salinity as the sample. However, these buffers are difficult to prepare and their use presumes prior knowledge of salinity of the sample. Interpretable measurements of estuarine  $\text{pH}$  can be made by calibration with IUPAC aqueous RVS or PS standards if the electrode pair is additionally calibrated using a 20‰ salinity seawater buffer.<sup>4</sup> The difference between the assigned  $\text{pH}_{\text{sws}}$  of the seawater buffer and its measured  $\text{pH}(X)$  value using RVS or PS standards is

$$\Delta\text{pH} = \text{pH}_{\text{sws}} - \text{pH}(X)$$

Values of  $\Delta\text{pH}$  should be in the range of 0.08 to 0.18. It empirically corrects for differences between the two  $\text{pH}$  scales and for measurement errors associated with the electrode pair. The  $\text{pH}(X)$  of samples measured using IUPAC aqueous buffers, can be converted to  $\text{pH}_T$  or  $\text{pH}_F$  using the appropriate measured  $\Delta\text{pH}$ :

$$\text{pH}_T = \text{pH}(X) - \Delta\text{pH}$$

$$\text{or } \text{pH}_F = \text{pH}(X) - \Delta\text{pH}$$

This simple procedure is appropriate to  $\text{pH}$  measurement at salinities from 2‰ to 35‰. For salinities lower than 2‰ the procedures for freshwaters should be adopted.

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**TABLE 1. pH of Dilute Solutions at 25°C, Degassed and Equilibrated with Air, Suitable as Quality Control Standards**

	Ionic strength	Concentration(x)	pH	pH
	mmol kg <sup>-1</sup>	mmol kg <sup>-1</sup>	$p_{\text{CO}_2} = 0$	$p_{\text{CO}_2} = \text{air}$
Potassium hydrogen phthalate	10.7	10	4.12	4.12
	1.1	1	4.33	4.33
$x\text{KH}_2\text{PO}_4 + x\text{Na}_2\text{HPO}_4$	9.9	2.5	7.07	7.05
$x\text{KH}_2\text{PO}_4 + 3.5x\text{Na}_2\text{HPO}_4$	10	0.87	7.61	7.58
$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	10	5	9.20	—
HCl	0.1	0.1	4.03	4.03
SRM2694-I <sup>a</sup>	—	—	4.30	—
SRM2694-II <sup>a</sup>	—	—	3.59	—

Note: The pH of solutions near to pH 4 is virtually independent of temperature over the range of 5 to 30°C.

<sup>a</sup> Simulated rainwater samples are available (Reference 5) from NIST containing sulfate, nitrate, chloride, fluoride, sodium, potassium, calcium and magnesium.

**TABLE 2. Composition of Seawater Buffer of Salinity S = 35‰ at 25°C (Reference 3)**

Solute	mol dm <sup>-3</sup>	mol kg <sup>-1</sup>	g kg <sup>-1</sup>	g dm <sup>-3</sup>
NaCl	0.3666	0.3493	20.416	20.946
$\text{Na}_2\text{SO}_4$	0.02926	0.02788	3.96	4.063
KCl	0.01058	0.01008	0.752	0.772
$\text{CaCl}_2$	0.01077	0.01026	1.139	1.169
$\text{MgCl}_2$	0.05518	0.05258	5.006	5.139
Tris	0.06	0.05717	6.926	7.106
Tris · HCl	0.06	0.05717	9.010	9.244

Tris = tris(hydroxymethyl)aminomethane ( $\text{HOCH}_2)_3\text{CNH}_2$ .

A 20‰ buffer is made by diluting the 35‰ in the ratio 20:35.

**TABLE 3. Assigned Values of 20‰ and 35‰ Buffers on Free and Total Hydrogen Ion Scales. Calculated from Equations Provided by Millero (Reference 3)**

Temp (°C)	$\text{pH}_T$	$\text{pH}_T$	$\text{pH}_F$	$\text{pH}_F$
	S = 20‰	S = 35‰	S = 20‰	S = 35‰
5	8.683	8.718	8.759	8.81
10	8.513	8.542	8.597	8.647
15	8.351	8.374	8.442	8.491
20	8.195	8.212	8.292	8.341
25	8.045	8.057	8.149	8.197
30	7.901	7.908	8.011	8.059
35	7.762	7.764	7.879	7.926

## BUFFER SOLUTIONS GIVING ROUND VALUES OF pH AT 25 °C

A		B		C		D		E	
pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>
1.00	67.0	2.20	49.5	4.10	1.3	5.80	3.6	7.00	46.6
1.10	52.8	2.30	45.8	4.20	3.0	5.90	4.6	7.10	45.7
1.20	42.5	2.40	42.2	4.30	4.7	6.00	5.6	7.20	44.7
1.30	33.6	2.50	38.8	4.40	6.6	6.10	6.8	7.30	43.4
1.40	26.6	2.60	35.4	4.50	8.7	6.20	8.1	7.40	42.0
1.50	20.7	2.70	32.1	4.60	11.1	6.30	9.7	7.50	40.3
1.60	16.2	2.80	28.9	4.70	13.6	6.40	11.6	7.60	38.5
1.70	13.0	2.90	25.7	4.80	16.5	6.50	13.9	7.70	36.6
1.80	10.2	3.00	22.3	4.90	19.4	6.60	16.4	7.80	34.5
1.90	8.1	3.10	18.8	5.00	22.6	6.70	19.3	7.90	32.0
2.00	6.5	3.20	15.7	5.10	25.5	6.80	22.4	8.00	29.2
2.10	5.10	3.30	12.9	5.20	28.8	6.90	25.9	8.10	26.2
2.20	3.9	3.40	10.4	5.30	31.6	7.00	29.1	8.20	22.9
		3.50	8.2	5.40	34.1	7.10	32.1	8.30	19.9
		3.60	6.3	5.50	36.6	7.20	34.7	8.40	17.2
		3.70	4.5	5.60	38.8	7.30	37.0	8.50	14.7
		3.80	2.9	5.70	40.6	7.40	39.1	8.60	12.2
		3.90	1.4	5.80	42.3	7.50	40.9	8.70	10.3
		4.00	0.1	5.90	43.7	7.60	42.4	8.80	8.5
						7.70	43.5	8.90	7.0
						7.80	44.5	9.00	5.7
						7.90	45.3		
						8.00	46.1		

F		G		H		I		J	
pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>	pH	<i>x</i>
8.00	20.5	9.20	0.9	9.60	5.0	10.90	3.3	12.00	6.0
8.10	19.7	9.30	3.6	9.70	6.2	11.00	4.1	12.10	8.0
8.20	18.8	9.40	6.2	9.80	7.6	11.10	5.1	12.20	10.2
8.30	17.7	9.50	8.8	9.90	9.1	11.20	6.3	12.30	12.8
8.40	16.6	9.60	11.1	10.00	10.7	11.30	7.6	12.40	16.2
8.50	15.2	9.70	13.1	10.10	12.2	11.40	9.1	12.50	20.4
8.60	13.5	9.80	15.0	10.20	13.8	11.50	11.1	12.60	25.6
8.70	11.6	9.90	16.7	10.30	15.2	11.60	13.5	12.70	32.2
8.80	9.6	10.00	18.3	10.40	16.5	11.70	16.2	12.80	41.2
8.90	7.1	10.10	19.5	10.50	17.8	11.80	19.4	12.90	53.0
9.00	4.6	10.20	20.5	10.60	19.1	11.90	23.0	13.00	66.0
9.10	2.0	10.30	21.3	10.70	20.2	12.00	26.9		
		10.40	22.1	10.80	21.2				
		10.50	22.7	10.90	22.0				
		10.60	23.3	11.00	22.7				
		10.70	23.8						
		10.80	24.25						

- A. 25 ml of 0.2 molar KCl + *x* ml of 0.2 molar HCl.  
 B. 50 ml of 0.1 molar potassium hydrogen phthalate + *x* ml of 0.1 molar HCl.  
 C. 50 ml of 0.1 molar potassium hydrogen phthalate + *x* ml of 0.1 molar NaOH.  
 D. 50 ml of 0.1 molar potassium dihydrogen phosphate + *x* ml of 0.1 molar NaOH.  
 E. 50 ml of 0.1 molar tris(hydroxymethyl)aminomethane + *x* ml of 0.1 M HCl.  
 F. 50 ml of 0.025 molar borax + *x* ml of 0.1 molar HCl.  
 G. 50 ml of 0.025 molar borax + *x* ml of 0.1 molar NaOH.  
 H. 50 ml of 0.05 molar sodium bicarbonate + *x* ml of 0.1 molar NaOH.  
 I. 50 ml of 0.05 molar disodium hydrogen phosphate + *x* ml of 0.1 molar NaOH.  
 J. 25 ml of 0.2 molar KCl + *x* ml of 0.2 molar NaOH.

Final volume of mixtures = 100 ml.

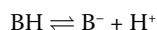
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## DISSOCIATION CONSTANTS OF INORGANIC ACIDS AND BASES

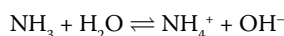
The data in this table are presented as values of  $pK_a$ , defined as the negative logarithm of the acid dissociation constant  $K_a$  for the reaction



Thus  $pK_a = -\log K_a$ , and the hydrogen ion concentration  $[H^+]$  can be calculated from

$$K_a = \frac{[H^+][B^-]}{[BH]}$$

In the case of bases, the entry in the table is for the conjugate acid; e.g., ammonium ion for ammonia. The  $OH^-$  concentration in the system



can be calculated from the equation

$$K_b = K_{\text{water}}/K_a = \frac{[OH^-][NH_4^+]}{[NH_3]}$$

where  $K_{\text{water}} = 1.01 \times 10^{-14}$  at 25 °C. Note that  $pK_a + pK_b = pK_{\text{water}}$ .

All values refer to dilute aqueous solutions at zero ionic strength at the temperature indicated. The table is arranged alphabetically by compound name.

### Reference

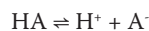
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Name	Formula	Step	t/°C	pK <sub>a</sub>
Aluminum(III) ion	Al <sup>3+</sup>		25	5.0
Ammonia	NH <sub>3</sub>		25	9.25
Arsenic acid	H <sub>3</sub> AsO <sub>4</sub>	1	25	2.26
		2	25	6.76
		3	25	11.29
Arsenious acid	H <sub>2</sub> AsO <sub>3</sub>		25	9.29
Barium(II) ion	Ba <sup>2+</sup>		25	13.4
Boric acid	H <sub>3</sub> BO <sub>3</sub>	1	20	9.27
		2	20	>14
Calcium(II) ion	Ca <sup>2+</sup>		25	12.6
Carbonic acid	H <sub>2</sub> CO <sub>3</sub>	1	25	6.35
		2	25	10.33
Chlorous acid	HClO <sub>2</sub>		25	1.94
Chromic acid	H <sub>2</sub> CrO <sub>4</sub>	1	25	0.74
		2	25	6.49
Cyanic acid	HCNO		25	3.46
Germanic acid	H <sub>2</sub> GeO <sub>3</sub>	1	25	9.01
		2	25	12.3
Hydrazine	N <sub>2</sub> H <sub>4</sub>		25	8.1
Hydrazoic acid	HN <sub>3</sub>		25	4.6
Hydrocyanic acid	HCN		25	9.21
Hydrofluoric acid	HF		25	3.20
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>		25	11.62
Hydrogen selenide	H <sub>2</sub> Se	1	25	3.89
		2	25	11.0
Hydrogen sulfide	H <sub>2</sub> S	1	25	7.05
		2	25	19
Hydrogen telluride	H <sub>2</sub> Te	1	18	2.6
		2	25	11
Hydroxylamine	NH <sub>2</sub> OH		25	5.94
Hypobromous acid	HBrO		25	8.55
Hypochlorous acid	HClO		25	7.40
Hypoiodous acid	HIO		25	10.5
Iodic acid	HIO <sub>3</sub>		25	0.78
Lithium ion	Li <sup>+</sup>		25	13.8
Magnesium(II) ion	Mg <sup>2+</sup>		25	11.4
Nitrous acid	HNO <sub>2</sub>		25	3.25
Perchloric acid	HClO <sub>4</sub>		20	-1.6
Periodic acid	HIO <sub>4</sub>		25	1.64
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	1	25	2.16

Name	Formula	Step	$t/^\circ\text{C}$	$\text{p}K_a$
Phosphorous acid	$\text{H}_3\text{PO}_3$	2	25	7.21
		3	25	12.32
		1	20	1.3
Pyrophosphoric acid	$\text{H}_4\text{P}_2\text{O}_7$	2	20	6.70
		1	25	0.91
		2	25	2.10
		3	25	6.70
Selenic acid	$\text{H}_2\text{SeO}_4$	4	25	9.32
		2	25	1.7
Selenious acid	$\text{H}_2\text{SeO}_3$	1	25	2.62
		2	25	8.32
Silicic acid	$\text{H}_4\text{SiO}_4$	1	30	9.9
		2	30	11.8
		3	30	12
		4	30	12
Sodium ion	$\text{Na}^+$		25	14.8
Strontium(II) ion	$\text{Sr}^{+2}$		25	13.2
Sulfamic acid	$\text{NH}_2\text{SO}_3\text{H}$		25	1.05
Sulfuric acid	$\text{H}_2\text{SO}_4$	2	25	1.99
Sulfurous acid	$\text{H}_2\text{SO}_3$	1	25	1.85
		2	25	7.2
Telluric acid	$\text{H}_2\text{TeO}_4$	1	18	7.68
		2	18	11.0
Tellurous acid	$\text{H}_2\text{TeO}_3$	1	25	6.27
		2	25	8.43
Tetrafluoroboric acid	$\text{HBF}_4$		25	0.5
Thiocyanic acid	$\text{HSCN}$		25	-1.8
Water	$\text{H}_2\text{O}$		25	13.995

## DISSOCIATION CONSTANTS OF ORGANIC ACIDS AND BASES

This table lists the dissociation (ionization) constants of over 1070 organic acids, bases, and amphoteric compounds. All data apply to dilute aqueous solutions and are presented as values of  $pK_a$ , which is defined as the negative of the logarithm of the equilibrium constant  $K_a$  for the reaction

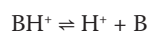


i.e.,

$$K_a = [H^+][A^-]/[HA]$$

where  $[H^+]$ , etc. represent the concentrations of the respective species in mol/L. It follows that  $pK_a = pH + \log[HA] - \log[A^-]$ , so that a solution with 50% dissociation has pH equal to the  $pK_a$  of the acid.

Data for bases are presented as  $pK_a$  values for the conjugate acid, i.e., for the reaction



In older literature, an ionization constant  $K_b$  was used for the reaction  $B + H_2O$

$\rightleftharpoons BH^+ + OH^-$ . This is related to  $K_a$  by

$$pK_a + pK_b = pK_{\text{water}} = 14.00 \quad (\text{at } 25^\circ\text{C})$$

Compounds are listed by molecular formula in Hill order.

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Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
CHNO	Cyanic acid		25	3.7
CH <sub>2</sub> N <sub>2</sub>	Cyanamide		29	1.1
CH <sub>2</sub> O	Formaldehyde		25	13.27
CH <sub>2</sub> O <sub>2</sub>	Formic acid		25	3.75
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane		25	10.21
CH <sub>3</sub> NS <sub>2</sub>	Carbamodithioic acid		25	2.95
CH <sub>4</sub> N <sub>2</sub> O	Urea		25	0.10
CH <sub>4</sub> N <sub>2</sub> S	Thiourea		25	-1
CH <sub>4</sub> O	Methanol		25	15.5
CH <sub>4</sub> S	Methanethiol		25	10.33
CH <sub>5</sub> N	Methylamine		25	10.66
CH <sub>5</sub> NO	O-Methylhydroxylamine			12.5
CH <sub>5</sub> N <sub>3</sub>	Guanidine		25	13.6
C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde		25	10.04
C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid		20	0.66
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid		25	0.52
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	Dichloroacetic acid		25	1.35
C <sub>2</sub> H <sub>2</sub> O <sub>3</sub>	Glyoxylic acid		25	3.18
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	Oxalic acid	1	25	1.25
		2	25	3.81
C <sub>2</sub> H <sub>3</sub> BrO <sub>2</sub>	Bromoacetic acid		25	2.90
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid		25	2.87
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> O	2,2,2-Trichloroethanol		25	12.24
C <sub>2</sub> H <sub>3</sub> FO <sub>2</sub>	Fluoroacetic acid		25	2.59
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	2,2,2-Trifluoroethanol		25	12.37
C <sub>2</sub> H <sub>3</sub> IO <sub>2</sub>	Iodoacetic acid		25	3.18
C <sub>2</sub> H <sub>3</sub> NO <sub>4</sub>	Nitroacetic acid		24	1.48
C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	1H-1,2,3-Triazole		20	1.17
C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	1H-1,2,4-Triazole		20	2.27
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub>	Aminoacetonitrile		25	5.34
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde		25	13.57
C <sub>2</sub> H <sub>4</sub> OS	Thioacetic acid		25	3.33
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid		25	4.756
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> S	Thioglycolic acid		25	3.68
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Glycolic acid		25	3.83
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine		25	8.04

Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
C <sub>2</sub> H <sub>5</sub> NO	Acetamide		25	15.1
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Acetohydroxamic acid			8.70
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane		25	8.46
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Glycine	1	25	2.35
		2	25	9.78
C <sub>2</sub> H <sub>5</sub> N <sub>2</sub>	Ethanimidamide		25	12.1
C <sub>2</sub> H <sub>6</sub> O	Ethanol		25	15.5
C <sub>2</sub> H <sub>6</sub> OS	2-Mercaptoethanol		25	9.72
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethyleneglycol		25	15.1
C <sub>2</sub> H <sub>7</sub> AsO <sub>2</sub>	Dimethylarsinic acid	1	25	1.57
		2	25	6.27
C <sub>2</sub> H <sub>7</sub> N	Ethylamine		25	10.65
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine		25	10.73
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine		25	9.50
C <sub>2</sub> H <sub>7</sub> NO <sub>3</sub> S	2-Aminoethanesulfonic acid	1	25	1.5
		2	25	9.06
C <sub>2</sub> H <sub>7</sub> NS	Cysteamine	1	25	8.27
		2	25	10.53
C <sub>2</sub> H <sub>7</sub> N <sub>5</sub>	Biguanide	1		11.52
		2		2.93
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	1	25	9.92
		2	25	6.86
C <sub>2</sub> H <sub>8</sub> O <sub>7</sub> P <sub>2</sub>	1-Hydroxy-1,1-diphosphonoethane	1		1.35
		2		2.87
		3		7.03
		4		11.3
C <sub>3</sub> H <sub>2</sub> O <sub>2</sub>	2-Propynoic acid		25	1.84
C <sub>3</sub> H <sub>3</sub> NO	Oxazole		33	0.8
C <sub>3</sub> H <sub>3</sub> NO	Isoxazole		25	-2.0
C <sub>3</sub> H <sub>3</sub> NO <sub>2</sub>	Cyanoacetic acid		25	2.47
C <sub>3</sub> H <sub>3</sub> NS	Thiazole		25	2.52
C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	Cyanuric acid	1		6.88
		2		11.40
		3		13.5
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	1H-Pyrazole		25	2.49
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	Imidazole		25	6.99

Mol. form.	Name	Step	t/°C	pK <sub>a</sub>	Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> S	2-Thiazolamine		20	5.36	C <sub>4</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	5-Nitropyrimidinamine		20	0.35
C <sub>3</sub> H <sub>4</sub> O	Propargyl alcohol		25	13.6	C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	2-Butynoic acid		25	2.62
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Acrylic acid		25	4.25	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Maleic acid	1	25	1.92
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Pyruvic acid		25	2.39			2	25	6.23
C <sub>3</sub> H <sub>4</sub> O <sub>4</sub>	Malonic acid	1	25	2.85	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Fumaric acid	1	25	3.02
		2	25	5.70			2	25	4.38
C <sub>3</sub> H <sub>4</sub> O <sub>5</sub>	Hydroxypropanedioic acid	1	25	2.42	C <sub>4</sub> H <sub>4</sub> O <sub>5</sub>	Oxaloacetic acid	1	25	2.55
		2		4.54			2	25	4.37
C <sub>3</sub> H <sub>5</sub> BrO <sub>2</sub>	3-Bromopropanoic acid		25	4.00			3	25	13.03
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	2-Chloropropanoic acid		25	2.83	C <sub>4</sub> H <sub>5</sub> N	Pyrrole		25	-3.8
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	3-Chloropropanoic acid		25	3.98	C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	Succinimide		25	9.62
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	3-Aminopropanenitrile		20	7.80	C <sub>4</sub> H <sub>5</sub> N <sub>3</sub>	2-Pyrimidinamine		20	3.45
C <sub>3</sub> H <sub>6</sub> N <sub>6</sub>	1,3,5-Triazine-2,4,6-triamine		25	5.00	C <sub>4</sub> H <sub>5</sub> N <sub>3</sub>	4-Pyrimidinamine		20	5.71
					C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O	Cytosine	1		4.60
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol		25	15.5			2		12.16
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid		25	4.87	C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	6-Methyl-1,2,4-triazine-3,5(2H,4H)-dione			7.6
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> S	(Methylthio)acetic acid		25	3.66				25	6.95
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	Lactic acid		25	3.86	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	1-Methylimidazol		25	6.95
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	3-Hydroxypropanoic acid		25	4.51	C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>3</sub>	Allantoin		25	8.96
C <sub>3</sub> H <sub>6</sub> O <sub>4</sub>	Glyceric acid		25	3.52	C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	Acetazolamide			7.2
C <sub>3</sub> H <sub>7</sub> N	Allylamine		25	9.49	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>trans</i> -Crotonic acid		25	4.69
C <sub>3</sub> H <sub>7</sub> N	Azetidine		25	11.29	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	3-Butenoic acid		25	4.34
C <sub>3</sub> H <sub>7</sub> NO	2-Propanone oxime		25	12.42	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Cyclopropanecarboxylic acid		25	4.83
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	<i>L</i> -Alanine	1	25	2.34	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	2-Oxobutanoic acid		25	2.50
		2	25	9.87	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetoacetic acid		25	3.6
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	$\beta$ -Alanine	1	25	3.55	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Succinic acid	1	25	4.21
		2	25	10.24			2	25	5.64
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Sarcosine	1	25	2.21	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Methylmalonic acid	1	25	3.07
		2	25	10.1			2	25	5.76
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub> S	<i>L</i> -Cysteine	1	25	1.5	C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	Malic acid	1	25	3.40
		2	25	8.7			2	25	5.11
		3	25	10.2	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	<i>DL</i> -Tartaric acid	1	25	3.03
C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	<i>L</i> -Serine	1	25	2.19			2	25	4.37
		2	25	9.21	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	<i>meso</i> -Tartaric acid	1	25	3.17
C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub> S	<i>DL</i> -Cysteic acid	1	25	1.3			2	25	4.91
		2	25	1.9	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	<i>L</i> -Tartaric acid	1	25	2.98
		3	25	8.70			2	25	4.34
C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	Glycocyanine		25	2.82	C <sub>4</sub> H <sub>6</sub> O <sub>8</sub>	Dihydroxytartaric acid		25	1.92
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Ethylene glycol monomethyl ether		25	14.8	C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	2-Chlorobutanoic acid			2.86
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol		25	14.15	C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	3-Chlorobutanoic acid			4.05
C <sub>3</sub> H <sub>9</sub> N	Propylamine		25	10.54	C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	4-Chlorobutanoic acid			4.52
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine		25	10.63	C <sub>4</sub> H <sub>7</sub> NO <sub>2</sub>	4-Cyanobutanoic acid		25	2.42
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine		25	9.80	C <sub>4</sub> H <sub>7</sub> NO <sub>3</sub>	<i>N</i> -Acetylglycine		25	3.67
C <sub>3</sub> H <sub>9</sub> NO	2-Methoxyethylamine		25	9.40	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	Iminodiacetic acid	1		2.98
C <sub>3</sub> H <sub>9</sub> NO	Trimethylamine oxide		20	4.65			2		9.89
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	1,2-Propanediamine, ( $\pm$ )	1	25	9.82	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	<i>L</i> -Aspartic acid	1	25	1.99
		2	25	6.61			2	25	3.90
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	1,3-Propanediamine	1	25	10.55			3	25	9.90
		2	25	8.88	C <sub>4</sub> H <sub>7</sub> N <sub>3</sub> O	Creatinine	1	25	4.8
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub> O	1,3-Diamino-2-propanol	1	20	9.69			2		9.2
		2	20	7.93	C <sub>4</sub> H <sub>7</sub> N <sub>5</sub>	2,4,6-Pyrimidinetriamine		20	6.84
C <sub>3</sub> H <sub>11</sub> N <sub>3</sub>	1,2,3-Triaminopropane	1	20	9.59	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	<i>L</i> -Asparagine	1	20	2.1
		2	20	7.95			2	20	8.80
C <sub>4</sub> H <sub>4</sub> FN <sub>3</sub> O	Flucytosine			3.26	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	<i>N</i> -Glycylglycine	1	25	3.14
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrazine		20	0.65			2		8.17
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine		20	1.23	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid		25	4.83
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyridazine		20	2.24	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid		20	4.84
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	Uracil		25	9.45	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	3-Hydroxybutanoic acid, ( $\pm$ )		25	4.70
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	Barbituric acid		25	4.01	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	4-Hydroxybutanoic acid		25	4.72
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	Alloxanic acid		25	6.64	C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	Ethoxyacetic acid		18	3.65
					C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine		25	11.31

Mol. form.	Name	Step	t/°C	pK <sub>a</sub>	Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
C <sub>4</sub> H <sub>9</sub> NO	Morpholine		25	8.50	C <sub>5</sub> H <sub>5</sub> NO <sub>2</sub>	1 <i>H</i> -Pyrrole-3-carboxylic acid		20	5.00
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	2-Methylalanine	1	25	2.36	C <sub>5</sub> H <sub>5</sub> N <sub>3</sub> O	Pyrazinecarboxamide			0.5
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	<i>N,N</i> -Dimethylglycine		25	9.89	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	Adenine	1		4.3
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	<i>DL</i> -2-Aminobutanoic acid	1	25	2.29			2		9.83
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	4-Aminobutanoic acid	2	25	9.83	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	Guanine		40	9.92
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>		1	25	4.031	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	2-Pyridinamine		20	6.82
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub> S	<i>DL</i> -Homocysteine	2	25	10.556	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	3-Pyridinamine		25	6.04
		1	25	2.22	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	4-Pyridinamine		25	9.11
		2	25	8.87	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	2-Methylpyrazine		27	1.45
		3	25	10.86	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	Thymine		25	9.94
C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	<i>L</i> -Threonine	1	25	2.09	C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	1,1-Cyclopropanedi-carboxylic acid	1	25	1.82
		2	25	9.10			2	25	7.43
C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	<i>L</i> -Homoserine	1	25	2.71	C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	<i>trans</i> -1-Propene-1,2-dicarboxylic acid	1	25	3.09
		2	25	9.62			2	25	4.75
C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	Creatine	1	25	2.63	C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	1-Propene-2,3-dicarboxylic acid	1	25	3.85
		2	25	14.3			2	25	5.45
C <sub>4</sub> H <sub>10</sub> N <sub>2</sub>	Piperazine	1	25	9.73	C <sub>5</sub> H <sub>6</sub> O <sub>5</sub>	2-Oxoglutaric acid	1	25	2.47
		2	25	5.33			2	25	4.68
C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	2,4-Diaminobutanoic acid	1	25	1.85	C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	5,5-Dimethyl-2,4-oxazolinedione		37	6.13
		2	25	8.24					
		3	25	10.44	C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	<i>L</i> -Pyroglutamic acid		25	3.32
C <sub>4</sub> H <sub>10</sub> O <sub>4</sub>	1,2,3,4-Butanetetrol			13.9	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub>	2,5-Pyridinediamine		20	6.48
C <sub>4</sub> H <sub>11</sub> N	Butylamine		25	10.60	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub>	Methylaminopyrazine		25	3.39
C <sub>4</sub> H <sub>11</sub> N	<i>sec</i> -Butylamine		25	10.56	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O <sub>4</sub>	Azaserine			8.55
C <sub>4</sub> H <sub>11</sub> N	<i>tert</i> -Butylamine		25	10.68	C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	2,4-Dimethylimidazole		25	8.36
C <sub>4</sub> H <sub>11</sub> N	Diethylamine		25	10.84	C <sub>5</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub> S <sub>2</sub>	Methazolamide			7.30
C <sub>4</sub> H <sub>11</sub> NO <sub>3</sub>	Tris(hydroxymethyl)methylamine		20	8.3	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	<i>trans</i> -3-Pentenoic acid		25	4.51
					C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Dimethylmalonic acid		25	3.15
C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	1,4-Butanediamine	1	25	10.80	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Glutaric acid	1	18	4.32
		2	25	9.63			2	25	5.42
C <sub>5</sub> H <sub>4</sub> BrN	3-Bromopyridine		25	2.84	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Methylsuccinic acid	1	25	4.13
C <sub>5</sub> H <sub>4</sub> ClN	2-Chloropyridine		25	0.49			2	25	5.64
C <sub>5</sub> H <sub>4</sub> ClN	3-Chloropyridine		25	2.81	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	<i>L</i> -Proline	1	25	1.95
C <sub>5</sub> H <sub>4</sub> ClN	4-Chloropyridine		25	3.83			2	25	10.64
C <sub>5</sub> H <sub>4</sub> FN	2-Fluoropyridine		25	-0.44	C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	5-Amino-4-oxopentanoic acid	1	25	4.05
C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	4-Nitropyridine		25	1.61			2	25	8.90
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub>	1 <i>H</i> -Purine	1	20	2.30	C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	<i>trans</i> -4-Hydroxyproline	1	25	1.82
		2	20	8.96			2	25	9.66
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	Hypoxanthine		25	8.7	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	<i>L</i> -Glutamic acid	1	25	2.13
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	Allopurinol			10.2			2	25	4.31
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub>	Uric acid		12	3.89			3		9.67
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> S	1,7-Dihydro-6 <i>H</i> -purine-6-thione	1		7.77	C <sub>5</sub> H <sub>9</sub> N <sub>3</sub>	Histamine	1	25	6.04
		2		11.17			2	25	9.75
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub> S	2-Thiophenecarboxylic acid		25	3.49	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	Glycylalanine		25	3.15
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub> S	3-Thiophenecarboxylic acid		25	4.1	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	<i>L</i> -Glutamine	1	25	2.17
C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	2-Furancarboxylic acid		25	3.16			2	25	9.13
C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	3-Furancarboxylic acid		25	3.9	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>4</sub>	Glycylserine	1	25	2.98
C <sub>5</sub> H <sub>5</sub> N	Pyridine		25	5.23			2	25	8.38
C <sub>5</sub> H <sub>5</sub> NO	2-Pyridinol	1	20	0.75	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid		20	4.83
		2	20	11.65	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	2-Methylbutanoic acid		25	4.80
C <sub>5</sub> H <sub>5</sub> NO	3-Pyridinol	1	20	4.79	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	3-Methylbutanoic acid		25	4.77
		2	20	8.75	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	2,2-Dimethylpropanoic acid		20	5.03
C <sub>5</sub> H <sub>5</sub> NO	4-Pyridinol	1	20	3.20	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	<i>D</i> -2-Deoxyribose		25	12.61
		2	20	11.12	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	<i>L</i> -Ribose		25	12.22
C <sub>5</sub> H <sub>5</sub> NO	2(1 <i>H</i> )-Pyridinone	1	20	0.75	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	<i>D</i> -Xylose		18	12.14
		2	20	11.65	C <sub>5</sub> H <sub>11</sub> N	Piperidine		25	11.123
C <sub>5</sub> H <sub>5</sub> NO	Pyridine-1-oxide		24	0.79	C <sub>5</sub> H <sub>11</sub> N	<i>N</i> -Methylpyrrolidine		25	10.46
C <sub>5</sub> H <sub>5</sub> NO <sub>2</sub>	1 <i>H</i> -Pyrrole-2-carboxylic acid		20	4.45	C <sub>5</sub> H <sub>11</sub> NO	4-Methylmorpholine		25	7.38
					C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Valine	1	25	2.29
							2	25	9.74

Mol. form.	Name	Step	t/°C	pK <sub>a</sub>	Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>DL</i> -Norvaline	1		2.36			3	20	9.31
		2		9.72	C <sub>6</sub> H <sub>6</sub> BrN	2-Bromoaniline		25	2.53
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Norvaline	1	25	2.32	C <sub>6</sub> H <sub>6</sub> BrN	3-Bromoaniline		25	3.53
		2	25	9.81	C <sub>6</sub> H <sub>6</sub> BrN	4-Bromoaniline		25	3.89
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>N</i> -Propylglycine	1	25	2.35	C <sub>6</sub> H <sub>6</sub> ClN	2-Chloroaniline		25	2.66
		2	25	10.19	C <sub>6</sub> H <sub>6</sub> ClN	3-Chloroaniline		25	3.52
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	5-Aminopentanoic acid	1	25	4.27	C <sub>6</sub> H <sub>6</sub> ClN	4-Chloroaniline		25	3.98
		2	25	10.77	C <sub>6</sub> H <sub>6</sub> FN	2-Fluoroaniline		25	3.20
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	Betaine		0	1.83	C <sub>6</sub> H <sub>6</sub> FN	3-Fluoroaniline		25	3.59
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	<i>L</i> -Methionine	1	25	2.13	C <sub>6</sub> H <sub>6</sub> FN	4-Fluoroaniline		25	4.65
		2	25	9.27	C <sub>6</sub> H <sub>6</sub> IN	2-Iodoaniline		25	2.54
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Tetramethylurea			2	C <sub>6</sub> H <sub>6</sub> IN	3-Iodoaniline		25	3.58
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	<i>L</i> -Ornithine	1	25	1.71	C <sub>6</sub> H <sub>6</sub> IN	4-Iodoaniline		25	3.81
		2	25	8.69	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	3-Pyridinecarboxamide		20	3.3
		3	25	10.76	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	2-Pyridinecarboxaldehyde oxime	1	20	3.59
C <sub>5</sub> H <sub>13</sub> N	Pentylamine		25	10.63			2	20	10.18
C <sub>5</sub> H <sub>13</sub> N	3-Pentanamine		17	10.59	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	2-Nitroaniline		25	-0.25
C <sub>5</sub> H <sub>13</sub> N	3-Methyl-1-butanamine		25	10.60	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	3-Nitroaniline		25	2.46
C <sub>5</sub> H <sub>13</sub> N	2-Methyl-2-butanamine		19	10.85	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	4-Nitroaniline		25	1.02
C <sub>5</sub> H <sub>13</sub> N	2,2-Dimethylpropylamine		25	10.15	C <sub>6</sub> H <sub>6</sub> O	Phenol		25	9.99
C <sub>5</sub> H <sub>13</sub> N	Diethylmethylamine		25	10.35	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	<i>p</i> -Hydroquinone	1	25	9.85
C <sub>5</sub> H <sub>14</sub> NO	Choline		25	13.9			2	25	11.4
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	1,5-Pentanediamine	1	25	10.05	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Pyrocatechol	1	25	9.34
		2	25	10.93			2	25	12.6
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid			3.6	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	Resorcinol	1	25	9.32
							2	25	11.1
C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	2,4,6-Trinitrophenol		24	0.42	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub> S	Benzenesulfinic acid		20	1.3
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	2,3-Dichlorophenol		25	7.44	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub> S	Benzenesulfonic acid		25	0.70
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	2,4-Dinitrophenol		25	4.07	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub>	5-Hydroxy-2-(hydroxymethyl)-4H-pyran-4-one			7.9
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	2,5-Dinitrophenol		15	5.15	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub> S	3-Hydroxybenzenesulfonic acid		25	9.07
C <sub>6</sub> H <sub>4</sub> N <sub>4</sub>	Pteridine		20	4.05	C <sub>6</sub> H <sub>6</sub> O <sub>4</sub> S	4-Hydroxybenzenesulfonic acid		25	9.11
C <sub>6</sub> H <sub>5</sub> BrO	2-Bromophenol		25	8.45	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	<i>cis</i> -1-Propene-1,2,3-tricarboxylic acid		25	1.95
C <sub>6</sub> H <sub>5</sub> BrO	3-Bromophenol		25	9.03	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	<i>trans</i> -1-Propene-1,2,3-tricarboxylic acid	1	25	2.80
C <sub>6</sub> H <sub>5</sub> BrO	4-Bromophenol		25	9.37			2	25	4.46
C <sub>6</sub> H <sub>5</sub> Br <sub>2</sub> N	3,5-Dibromoaniline		25	2.34	C <sub>6</sub> H <sub>6</sub> S	Benzenethiol		25	6.62
C <sub>6</sub> H <sub>5</sub> ClO	2-Chlorophenol		25	8.56	C <sub>6</sub> H <sub>7</sub> BO <sub>2</sub>	Benzeneboronic acid			8.83
C <sub>6</sub> H <sub>5</sub> ClO	3-Chlorophenol		25	9.12	C <sub>6</sub> H <sub>7</sub> N	Aniline		25	4.87
C <sub>6</sub> H <sub>5</sub> ClO	4-Chlorophenol		25	9.41	C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine		25	6.00
C <sub>6</sub> H <sub>5</sub> Cl <sub>2</sub> N	2,4-Dichloroaniline		22	2.05	C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine		25	5.70
C <sub>6</sub> H <sub>5</sub> FO	2-Fluorophenol		25	8.73	C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine		25	5.99
C <sub>6</sub> H <sub>5</sub> FO	3-Fluorophenol		25	9.29	C <sub>6</sub> H <sub>7</sub> NO	2-Aminophenol	1	20	4.78
C <sub>6</sub> H <sub>5</sub> FO	4-Fluorophenol		25	9.89			2	20	9.97
C <sub>6</sub> H <sub>5</sub> IO	2-Iodophenol		25	8.51	C <sub>6</sub> H <sub>7</sub> NO	3-Aminophenol	1	20	4.37
C <sub>6</sub> H <sub>5</sub> IO	3-Iodophenol		25	9.03			2	20	9.82
C <sub>6</sub> H <sub>5</sub> IO	4-Iodophenol		25	9.33	C <sub>6</sub> H <sub>7</sub> NO	4-Aminophenol	1	25	5.48
C <sub>6</sub> H <sub>5</sub> NO	2-Pyridinecarboxaldehyde		25	12.68			2	25	10.30
C <sub>6</sub> H <sub>5</sub> NO	4-Pyridinecarboxaldehyde		30	12.05	C <sub>6</sub> H <sub>7</sub> NO	2-Methoxy-pyridine		20	3.28
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene		0	3.98	C <sub>6</sub> H <sub>7</sub> NO	3-Methoxy-pyridine		25	4.78
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	2-Pyridinecarboxylic acid	1	20	0.99	C <sub>6</sub> H <sub>7</sub> NO	4-Methoxy-pyridine		25	6.58
		2	20	5.39	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	2-Aminobenzenesulfonic acid		25	2.46
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	3-Pyridinecarboxylic acid	1	25	2.00	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	3-Aminobenzenesulfonic acid		25	3.74
		2	25	4.82	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	4-Aminobenzenesulfonic acid		25	3.23
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	4-Pyridinecarboxylic acid	1	25	1.77	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	<i>N</i> -Methylpyridinamine		20	9.65
		2	25	4.84	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>o</i> -Phenylenediamine	1	20	4.57
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	2-Nitrophenol		25	7.23					
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	3-Nitrophenol		25	8.36					
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	4-Nitrophenol		25	7.15					
C <sub>6</sub> H <sub>5</sub> N <sub>3</sub>	1 <i>H</i> -Benzotriazole		20	1.6					
C <sub>6</sub> H <sub>5</sub> N <sub>5</sub> O	2-Amino-4-hydroxypteridine	1	20	2.27					
		2	20	7.96					
C <sub>6</sub> H <sub>5</sub> N <sub>5</sub> O <sub>2</sub>	Xanthopterin	2	20	6.59					

Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>	Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>
		2	20	0.80	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	<i>L</i> -Leucine	1	25	2.33
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>m</i> -Phenylenediamine	1	20	5.11	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	<i>L</i> -Isoleucine	2	25	9.74
		2	20	2.50	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	<i>L</i> -Norleucine	1	25	2.32
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>p</i> -Phenylenediamine	1	20	6.31			2	25	9.76
		2	20	2.97	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	6-Aminohexanoic acid	1	25	2.34
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	Phenylhydrazine	15	8.79				2	25	9.83
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Hexadienoic acid	25	4.76		C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	<i>N,N</i> -Bis(2-hydroxyethyl)glycine	1	25	4.37
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Cyclohexanedione	25	5.26				2	25	10.80
C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	2,2-Dimethyl-1,3-dioxane-4,6-dione		5.1		C <sub>6</sub> H <sub>13</sub> NO <sub>4</sub>	Citrulline	2	20	8.35
C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	<i>L</i> -Ascorbic acid	1	25	4.04	C <sub>6</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub>		1	25	2.43
		2	16	11.7			2	25	9.69
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	Citric acid	1	25	3.13	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	<i>cis</i> -1,2-Cyclohexanediamine	1	20	9.93
		2	25	4.76			2	20	6.13
		3	25	6.40	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	<i>trans</i> -1,2-Cyclohexanediamine	1	20	9.94
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	Isocitric acid	1	25	3.29			2	20	6.47
		2	25	4.71	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub>	<i>cis</i> -2,5-Dimethylpiperazine	1	25	9.66
		3	25	6.40			2	25	5.20
C <sub>6</sub> H <sub>9</sub> NO <sub>6</sub>	Nitrilotriacetic acid	1	20	3.03	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	<i>L</i> -Lysine	1	25	2.16
		2	20	3.07			2	25	9.06
		3	20	10.70			3	25	10.54
C <sub>6</sub> H <sub>9</sub> NO <sub>6</sub>	<i>L</i> -γ-Carboxyglutamic acid	1	25	1.7	C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	<i>L</i> -Arginine	1	25	1.82
		2	25	3.2			2	25	8.99
		3	25	4.75			3	25	12.5
		4	25	9.9	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	<i>D</i> -Mannitol	18		13.5
C <sub>6</sub> H <sub>9</sub> N <sub>3</sub>	4,6-Dimethylpyrimidinamine		20	4.82	C <sub>6</sub> H <sub>15</sub> N	Hexylamine	25		10.56
C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	<i>L</i> -Histidine	1	25	1.80	C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine	25		11.05
		2	25	6.04	C <sub>6</sub> H <sub>15</sub> N	Triethylamine	25		10.75
		3	25	9.33	C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub>	Triethanolamine	25		7.76
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Cyclopentanecarboxylic acid	25	4.99		C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	1,6-Hexanediamine	1	0	11.86
C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	Ethyl acetoacetate	25	10.68				2	0	10.76
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	3-Methylglutaric acid	25	4.24		C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	<i>N,N,N',N'</i> -Tetramethyl-1,2-ethanediamine	1	25	10.40
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Adipic acid	1	18	4.41			2	25	8.26
		2	18	5.41	C <sub>6</sub> H <sub>19</sub> NSi <sub>2</sub>	Hexamethyldisilazane			7.55
C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	2-Piperidinecarboxylic acid	1	25	2.28	C <sub>7</sub> HF <sub>5</sub> O <sub>2</sub>	Pentafluorobenzoic acid	25		1.75
		2	25	10.72	C <sub>7</sub> H <sub>3</sub> Br <sub>2</sub> NO	3,5-Dibromo-4-hydroxybenzotrile			4.06
C <sub>6</sub> H <sub>11</sub> NO <sub>3</sub>	Adipamic acid	25	4.63		C <sub>7</sub> H <sub>3</sub> N <sub>3</sub> O <sub>8</sub>	2,4,6-Trinitrobenzoic acid	25		0.65
C <sub>6</sub> H <sub>11</sub> NO <sub>4</sub>	2-Amino adipic acid	1	25	2.14	C <sub>7</sub> H <sub>4</sub> Cl <sub>3</sub> NO <sub>3</sub>	Triclopyr	25		2.68
		2	25	4.21	C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	2,4-Dinitrobenzoic acid	25		1.43
		3	25	9.77	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	2-Bromobenzoic acid	25		2.85
C <sub>6</sub> H <sub>11</sub> N <sub>3</sub> O <sub>4</sub>	<i>N</i> -( <i>N</i> -Glycylglycyl)glycine	1	25	3.225	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	3-Bromobenzoic acid	25		3.81
		2	25	8.09	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	4-Bromobenzoic acid	25		3.96
C <sub>6</sub> H <sub>11</sub> N <sub>3</sub> O <sub>4</sub>	Glycylasparagine	1	25	2.942	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	2-Chlorobenzoic acid	25		2.90
		2	18	8.44	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	3-Chlorobenzoic acid	25		3.84
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	Triethylenediamine	1		3.0	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	4-Chlorobenzoic acid	25		4.00
		2		8.7	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	2-Fluorobenzoic acid	25		3.27
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	<i>L</i> -Cystine	1		1	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	3-Fluorobenzoic acid	25		3.86
		2		2.1	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	4-Fluorobenzoic acid	25		4.15
		3		8.02	C <sub>7</sub> H <sub>5</sub> F <sub>3</sub> O	2-(Trifluoromethyl)phenol	25		8.95
		4		8.71	C <sub>7</sub> H <sub>5</sub> F <sub>3</sub> O	3-(Trifluoromethyl)phenol	25		8.68
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid	25	4.85		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	2-Iodobenzoic acid	25		2.86
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4-Methylpentanoic acid	18	4.84		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	3-Iodobenzoic acid	25		3.87
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	β- <i>D</i> -Fructose	25	12.27		C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	4-Iodobenzoic acid	25		4.00
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	α- <i>D</i> -Glucose	25	12.46		C <sub>7</sub> H <sub>5</sub> NO	2-Hydroxybenzotrile	25		6.86
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	<i>D</i> -Mannose	25	12.08		C <sub>7</sub> H <sub>5</sub> NO	3-Hydroxybenzotrile	25		8.61
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	25	10.64		C <sub>7</sub> H <sub>5</sub> NO	4-Hydroxybenzotrile	25		7.97
C <sub>6</sub> H <sub>13</sub> N	1-Methylpiperidine	25	10.38		C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub> S	Saccharin	18		11.68
C <sub>6</sub> H <sub>13</sub> N	1,2-Dimethylpyrrolidine	26	10.20		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	2-Nitrobenzoic acid	25		2.17
C <sub>6</sub> H <sub>13</sub> NO	<i>N</i> -Ethylmorpholine	25	7.67		C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	3-Nitrobenzoic acid	25		3.46
					C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	4-Nitrobenzoic acid	25		3.43



Mol. form.	Name	Step	t/°C	pK <sub>a</sub>	Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	2,3-Pyridinedicarboxylic acid	1	25	2.43	C <sub>7</sub> H <sub>9</sub> N	2-Methylaniline		25	4.45
		2	25	4.78	C <sub>7</sub> H <sub>9</sub> N	3-Methylaniline		25	4.71
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	2,4-Pyridinedicarboxylic acid	1	25	2.15	C <sub>7</sub> H <sub>9</sub> N	4-Methylaniline		25	5.08
					C <sub>7</sub> H <sub>9</sub> N	N-Methylaniline		25	4.85
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	2,6-Pyridinedicarboxylic acid	1	25	2.16	C <sub>7</sub> H <sub>9</sub> N	2-Ethylpyridine		25	5.89
		2	25	4.76	C <sub>7</sub> H <sub>9</sub> N	2,3-Dimethylpyridine		25	6.57
C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	3,5-Pyridinedicarboxylic acid	1	25	2.80	C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine		25	6.99
	Chlorothiazide	1		6.85	C <sub>7</sub> H <sub>9</sub> N	2,5-Dimethylpyridine		25	6.40
		2		9.45	C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine		25	6.65
C <sub>7</sub> H <sub>6</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>					C <sub>7</sub> H <sub>9</sub> N	3,4-Dimethylpyridine		25	6.46
C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	3-(Trifluoromethyl)aniline		25	3.49	C <sub>7</sub> H <sub>9</sub> N	3,5-Dimethylpyridine		25	6.15
C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	4-(Trifluoromethyl)aniline		25	2.45	C <sub>7</sub> H <sub>9</sub> NO	2-Methoxyaniline		25	4.53
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Benzimidazole		25	5.53	C <sub>7</sub> H <sub>9</sub> NO	3-Methoxyaniline		25	4.20
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	2-Aminobenzonitrile		25	0.77	C <sub>7</sub> H <sub>9</sub> NO	4-Methoxyaniline		25	5.36
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	3-Aminobenzonitrile		25	2.75	C <sub>7</sub> H <sub>9</sub> NS	2-(Methylthio)aniline		25	3.45
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	4-Aminobenzonitrile		25	1.74	C <sub>7</sub> H <sub>9</sub> NS	4-(Methylthio)aniline		25	4.35
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde		25	14.90	C <sub>7</sub> H <sub>9</sub> N <sub>5</sub>	2-Dimethylaminopurine	1	20	4.00
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Benzoic acid		25	4.204			2	20	10.24
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Salicylaldehyde		25	8.37	C <sub>7</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	L-1-Methylhistidine	1	25	1.69
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	3-Hydroxybenzaldehyde		25	8.98			2	25	6.48
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	4-Hydroxybenzaldehyde		25	7.61			3	25	8.85
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	2-Hydroxybenzoic acid	1	20	2.98	C <sub>7</sub> H <sub>11</sub> N <sub>3</sub> O <sub>2</sub>	L-3-Methylhistidine	1	25	1.92
		2	20	13.6			2	25	6.56
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	3-Hydroxybenzoic acid	1	25	4.08			3	25	8.73
		2	19	9.92	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	Cyclohexanecarboxylic acid		25	4.91
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	4-Hydroxybenzoic acid	1	25	4.57	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Heptanedioic acid	1	25	4.71
		2	25	9.46			2	25	5.58
C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	2,4-Dihydroxybenzoic acid	1	25	3.11	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	Butylpropanedioic acid	1	5	2.96
		2	25	8.55	C <sub>7</sub> H <sub>13</sub> NO <sub>4</sub>	α-Ethylglutamic acid	1	25	3.846
		3	25	14.0			2	25	7.838
C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	2,5-Dihydroxybenzoic acid	1	25	2.97	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	Heptanoic acid		25	4.89
C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	3,4-Dihydroxybenzoic acid	1	25	4.48	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	α-Methylglucoside		25	13.71
		2	25	8.83	C <sub>7</sub> H <sub>15</sub> N	1-Ethylpiperidine		23	10.45
		3	25	12.6	C <sub>7</sub> H <sub>15</sub> N	1,2-Dimethylpiperidine,(±)		25	10.22
C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	3,5-Dihydroxybenzoic acid	1	25	4.04	C <sub>7</sub> H <sub>15</sub> NO <sub>3</sub>	Carnitine		25	3.80
C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	2,4,6-Trihydroxybenzoic acid		25	1.68	C <sub>7</sub> H <sub>17</sub> N	Heptylamine		25	10.67
					C <sub>7</sub> H <sub>17</sub> N	2-Heptanamine		19	10.7
C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	3,4,5-Trihydroxybenzoic acid		25	4.41	C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	3-Cyanobenzoic acid		25	3.60
					C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	4-Cyanobenzoic acid		25	3.55
C <sub>7</sub> H <sub>7</sub> NO	Benzamide		25	13	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	Cinnoline		20	2.37
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-2-carboxylic acid	1	25	2.17	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	Quinazoline		29	3.43
		2	25	4.85	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	Quinoxaline		20	0.56
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-3-carboxylic acid	1	25	3.07	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	Phthalazine		20	3.47
		2	25	4.79	C <sub>8</sub> H <sub>6</sub> N <sub>4</sub> O <sub>5</sub>	Nitrofurantoin			7.2
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-4-carboxylic acid	1	25	2.50	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	3-Formylbenzoic acid		25	3.84
		2	25	4.87	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	4-Formylbenzoic acid		25	3.77
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	4-Amino-2-hydroxybenzoic acid			3.25	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Phthalic acid	1	25	2.943
							2	25	5.432
C <sub>7</sub> H <sub>8</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	Hydrochlorothiazide	1		7.9	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Isophthalic acid	1	25	3.70
		2		9.2			2	25	4.60
C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	Theobromine		18	7.89	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Terephthalic acid	1	25	3.54
C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	Theophylline	1	25	8.77			2	25	4.34
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol		25	10.29	C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	2-Chlorobenzeneacetic acid		25	4.07
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol		25	10.09	C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	3-Chlorobenzeneacetic acid		25	4.14
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol		25	10.26	C <sub>8</sub> H <sub>7</sub> ClO <sub>2</sub>	4-Chlorobenzeneacetic acid		25	4.19
C <sub>7</sub> H <sub>8</sub> OS	4-(Methylthio)phenol		25	9.53	C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	2-Chlorophenoxyacetic acid		25	3.05
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyphenol		25	9.98	C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	3-Chlorophenoxyacetic acid		25	3.10
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	3-Methoxyphenol		25	9.65	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	2-Nitrobenzeneacetic acid		25	4.00
C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	4-Methoxyphenol		25	10.21	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	3-Nitrobenzeneacetic acid		25	3.97
C <sub>7</sub> H <sub>8</sub> S	Benzenemethanethiol		25	9.43	C <sub>8</sub> H <sub>7</sub> NO <sub>4</sub>	4-Nitrobenzeneacetic acid		25	3.85
C <sub>7</sub> H <sub>9</sub> N	Benzylamine		25	9.34	C <sub>8</sub> H <sub>8</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	Hydroflumethiazide	1		8.9



Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>	Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>
		2		9.7			2	25	8.2
C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	2-Methyl-1 <i>H</i> -benzimidazole	1	25	6.19	C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	Homocystine	1	25	1.59
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>o</i> -Toluic acid		25	3.91			2	25	2.54
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>m</i> -Toluic acid		25	4.25			3	25	8.52
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>p</i> -Toluic acid		25	4.37			4	25	9.44
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzeneacetic acid		25	4.31	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid		25	4.89
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	1-(2-Hydroxyphenyl)ethanone		25	10.06	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	2-Propylpentanoic acid			4.6
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	1-(3-Hydroxyphenyl)ethanone		25	9.19	C <sub>8</sub> H <sub>17</sub> N	2-Propylpiperidine,( <i>S</i> )			10.9
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	1-(4-Hydroxyphenyl)ethanone		25	8.05	C <sub>8</sub> H <sub>17</sub> N	2,2,4-Trimethylpiperidine		30	11.04
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	2-Methoxybenzoic acid		25	4.08	C <sub>8</sub> H <sub>17</sub> NO	<i>trans</i> -6-Propyl-3-piperidinol,(3 <i>S</i> )			10.3
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	3-Methoxybenzoic acid		25	4.10	C <sub>8</sub> H <sub>19</sub> N	Octylamine		25	10.65
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	4-Methoxybenzoic acid		25	4.50	C <sub>8</sub> H <sub>19</sub> N	<i>N</i> -Methyl-2-heptanamine		17	10.99
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Phenoxyacetic acid		25	3.17	C <sub>8</sub> H <sub>19</sub> N	Dibutylamine		21	11.25
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	Mandelic acid		25	3.37	C <sub>8</sub> H <sub>20</sub> N <sub>2</sub>	1,8-Octanediamine	1	20	11.00
C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	2,5-Hydroxybenzeneacetic acid		25	4.40			2	20	10.1
C <sub>8</sub> H <sub>9</sub> NO	Acetanilide		25	0.5	C <sub>9</sub> H <sub>6</sub> BrN	3-Bromoquinoline		25	2.69
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	2-(Methylamino)benzoic acid		25	5.34	C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	<i>trans</i> - <i>o</i> -Chlorocinnamic acid		25	4.23
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	3-(Methylamino)benzoic acid		25	5.10	C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	<i>trans</i> - <i>m</i> -Chlorocinnamic acid		25	4.29
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	4-(Methylamino)benzoic acid		25	5.04	C <sub>9</sub> H <sub>7</sub> ClO <sub>2</sub>	<i>trans</i> - <i>p</i> -Chlorocinnamic acid		25	4.41
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	<i>N</i> -Phenylglycine	1	25	1.83	C <sub>9</sub> H <sub>7</sub> N	Quinoline		20	4.90
		2		4.39	C <sub>9</sub> H <sub>7</sub> N	Isoquinoline		20	5.40
C <sub>8</sub> H <sub>10</sub> BrN	4-Bromo- <i>N,N</i> -dimethylaniline		25	4.23	C <sub>9</sub> H <sub>7</sub> NO	2-Quinolinol	1	20	-0.31
C <sub>8</sub> H <sub>10</sub> ClN	3-Chloro- <i>N,N</i> -dimethylaniline		20	3.83			2	20	11.76
C <sub>8</sub> H <sub>10</sub> ClN	4-Chloro- <i>N,N</i> -dimethylaniline		20	4.39	C <sub>9</sub> H <sub>7</sub> NO	3-Quinolinol	1	20	4.28
C <sub>8</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	<i>N,N</i> -Dimethyl-3-nitroaniline		25	2.62			2	20	8.08
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline		25	5.12	C <sub>9</sub> H <sub>7</sub> NO	4-Quinolinol	1	20	2.23
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline		25	5.07			2	20	11.28
C <sub>8</sub> H <sub>11</sub> N	2,6-Dimethylaniline		25	3.89	C <sub>9</sub> H <sub>7</sub> NO	6-Quinolinol	1	20	5.15
C <sub>8</sub> H <sub>11</sub> N	Benzeneethanamine		25	9.83			2	20	8.90
C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine		25	7.43	C <sub>9</sub> H <sub>7</sub> NO	8-Quinolinol	1	25	4.91
C <sub>8</sub> H <sub>11</sub> NO	2-Ethoxyaniline		28	4.43			2	25	9.81
C <sub>8</sub> H <sub>11</sub> NO	3-Ethoxyaniline		25	4.18	C <sub>9</sub> H <sub>7</sub> NO	7-Isoquinolinol	1	20	5.68
C <sub>8</sub> H <sub>11</sub> NO	4-Ethoxyaniline		28	5.20			2	20	8.90
C <sub>8</sub> H <sub>11</sub> NO	4-(2-Aminoethyl)phenol	1	25	9.74	C <sub>9</sub> H <sub>7</sub> NO <sub>3</sub>	2-Cyanophenoxyacetic acid		25	2.98
		2	25	10.52	C <sub>9</sub> H <sub>7</sub> NO <sub>3</sub>	3-Cyanophenoxyacetic acid		25	3.03
C <sub>8</sub> H <sub>11</sub> NO	2-(2-Methoxyethyl)pyridine			5.5	C <sub>9</sub> H <sub>7</sub> NO <sub>3</sub>	4-Cyanophenoxyacetic acid		25	2.93
C <sub>8</sub> H <sub>11</sub> NO <sub>2</sub>	Dopamine	1	25	8.9	C <sub>9</sub> H <sub>7</sub> N <sub>2</sub> O <sub>2</sub> S	Azathioprine			8.2
		2	25	10.6	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	2-Quinolinamine		20	7.34
C <sub>8</sub> H <sub>11</sub> NO <sub>3</sub>	Norepinephrine	1	25	8.64	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	3-Quinolinamine		20	4.91
		2	25	9.70	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	4-Quinolinamine		20	9.17
C <sub>8</sub> H <sub>11</sub> N <sub>3</sub> O <sub>6</sub>	6-Azauridine			6.70	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	1-Isoquinolinamine		20	7.62
C <sub>8</sub> H <sub>11</sub> N <sub>5</sub>	Phenylbiguanide	1		10.76	C <sub>9</sub> H <sub>8</sub> N <sub>2</sub>	3-Isoquinolinamine		20	5.05
		2		2.13	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	<i>cis</i> -Cinnamic acid		25	3.88
C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	Barbital		25	7.43	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	<i>trans</i> -Cinnamic acid		25	4.44
C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	5,5-Dimethyl-1,3-cyclohexanedione		25	5.15	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	α-Methylenebenzeneacetic acid			4.35
C <sub>8</sub> H <sub>13</sub> NO <sub>2</sub>	Arecoline			6.84	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	2-(Acetyloxy)benzoic acid		25	3.48
C <sub>8</sub> H <sub>14</sub> O <sub>2</sub> S <sub>2</sub>	Thioctic acid			5.4	C <sub>9</sub> H <sub>9</sub> Br <sub>2</sub> NO <sub>3</sub>	3,5-Dibromo- <i>L</i> -tyrosine	1		2.17
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	Octanedioic acid	1	25	4.52			2		6.45
C <sub>8</sub> H <sub>15</sub> NO	Tropine		15	3.80			3		7.60
C <sub>8</sub> H <sub>15</sub> NO	Pseudotropine		15	3.80	C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	3-(2-Chlorophenyl)propanoic acid		25	4.58
C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	<i>N</i> -Glycylleucine		25	3.18	C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	3-(3-Chlorophenyl)propanoic acid		25	4.59
C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub>	<i>N</i> -Leucylglycine	1	25	3.25	C <sub>9</sub> H <sub>9</sub> ClO <sub>2</sub>	3-(4-Chlorophenyl)propanoic acid		25	4.61
					C <sub>9</sub> H <sub>9</sub> I <sub>2</sub> NO <sub>3</sub>	<i>L</i> -3,5-Diiodotyrosine	1	25	2.12

Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>	Mol. form.	Name	Step	<i>t</i> /°C	p <i>K</i> <sub>a</sub>
		2	25	5.32	C <sub>10</sub> H <sub>8</sub> O	1-Naphthol		25	9.39
		3	25	9.48	C <sub>10</sub> H <sub>8</sub> O	2-Naphthol		25	9.63
C <sub>9</sub> H <sub>9</sub> NO <sub>3</sub>	<i>N</i> -Benzoylglycine		25	3.62	C <sub>10</sub> H <sub>9</sub> N	1-Naphthylamine		25	3.92
C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	3-(2-Nitrophenyl)-propanoic acid		25	4.50	C <sub>10</sub> H <sub>9</sub> N	2-Naphthylamine		25	4.16
C <sub>9</sub> H <sub>9</sub> NO <sub>4</sub>	3-(4-Nitrophenyl)-propanoic acid		25	4.47	C <sub>10</sub> H <sub>9</sub> N	2-Methylquinoline		20	5.83
C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	Carbendazim			4.48	C <sub>10</sub> H <sub>9</sub> N	4-Methylquinoline		20	5.67
C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	Sulfathiazole			7.2	C <sub>10</sub> H <sub>9</sub> N	5-Methylquinoline		20	5.20
C <sub>9</sub> H <sub>10</sub> INO <sub>3</sub>	<i>L</i> -3-Iodotyrosine	1	25	2.2	C <sub>10</sub> H <sub>9</sub> NO	5-Amino-1-naphthol		25	3.97
		2	25	8.7	C <sub>10</sub> H <sub>9</sub> NO	6-Methoxyquinoline		20	5.03
		3	25	9.1	C <sub>10</sub> H <sub>9</sub> NO <sub>2</sub>	1 <i>H</i> -Indole-3-acetic acid			4.75
C <sub>9</sub> H <sub>10</sub> N <sub>2</sub>	2-Ethylbenzimidazole		25	6.18	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	<i>o</i> -Methylcinnamic acid		25	4.50
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	3,5-Dimethylbenzoic acid		25	4.32	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	<i>m</i> -Methylcinnamic acid		25	4.44
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzenepropanoic acid		25	4.66	C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	<i>p</i> -Methylcinnamic acid		25	4.56
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	$\alpha$ -Methylbenzeneacetic acid		25	4.64	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub>	Tryptamine		25	10.2
C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	$\alpha$ -Hydroxy- $\alpha$ -methylbenzeneacetic acid		25	3.47	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O	5-Hydroxytryptamine	1	25	9.8
							2	25	11.1
C <sub>9</sub> H <sub>11</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	Methylclothiazide			9.4	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>5</sub>	Dinoseb			4.62
C <sub>9</sub> H <sub>11</sub> N	<i>N</i> -Allylaniline		25	4.17	C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> O <sub>3</sub>	Dideoxyinosine			9.12
C <sub>9</sub> H <sub>11</sub> N	1-Indanamine		22	9.21	C <sub>10</sub> H <sub>12</sub> O	5,6,7,8-Tetrahydro-2-naphthalenol		25	10.48
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	4-(Dimethylamino)-benzoic acid	1		6.03	C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Benzenebutanoic acid		25	4.76
		2		11.49	C <sub>10</sub> H <sub>12</sub> O <sub>5</sub>	Propyl 3,4,5-trihydroxybenzoate			8.11
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	Ethyl 4-aminobenzoate			2.5	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	Adenosine	1	25	3.6
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Phenylalanine	1	25	2.20			2	25	12.4
		2	25	9.31	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	<i>L</i> -Nicotine	1		8.02
C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	<i>L</i> -Tyrosine	1	25	2.20			2		3.12
		2	25	9.11	C <sub>10</sub> H <sub>14</sub> N <sub>5</sub> O <sub>7</sub> P	5'-Adenylic acid	1		3.8
		3	25	10.1			2		6.2
C <sub>9</sub> H <sub>11</sub> NO <sub>4</sub>	Levodopa	1	25	2.32	C <sub>10</sub> H <sub>14</sub> O	2- <i>tert</i> -Butylphenol		25	10.62
		2	25	8.72	C <sub>10</sub> H <sub>14</sub> O	3- <i>tert</i> -Butylphenol		25	10.12
		3	25	9.96	C <sub>10</sub> H <sub>14</sub> O	4- <i>tert</i> -Butylphenol		25	10.23
		4	25	11.79	C <sub>10</sub> H <sub>15</sub> N	<i>N</i> - <i>tert</i> -Butylaniline		25	7.00
C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	Tyrosineamide		25	7.33	C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> -Diethylaniline		25	6.57
C <sub>9</sub> H <sub>13</sub> N	<i>N</i> -Isopropylaniline		25	5.77	C <sub>10</sub> H <sub>15</sub> NO	<i>d</i> -Ephedrine		10	10.139
C <sub>9</sub> H <sub>13</sub> NO <sub>3</sub>	Epinephrine	1	25	8.66	C <sub>10</sub> H <sub>15</sub> NO	<i>l</i> -Ephedrine		10	9.958
		2	25	9.95	C <sub>10</sub> H <sub>17</sub> N <sub>3</sub> O <sub>6</sub> S	<i>l</i> -Glutathione	1	25	2.12
C <sub>9</sub> H <sub>13</sub> N <sub>2</sub> O <sub>9</sub> P	5'-Uridylic acid	1		6.4			2	25	3.59
		2		9.5			3	25	8.75
C <sub>9</sub> H <sub>13</sub> N <sub>3</sub> O <sub>5</sub>	Cytidine	1		4.22			4	25	9.65
		2		12.5	C <sub>10</sub> H <sub>18</sub> N <sub>4</sub> O <sub>5</sub>	<i>L</i> -Argininosuccinic acid	1	25	1.62
C <sub>9</sub> H <sub>14</sub> ClNO	Phenylpropanolamine hydrochloride			9.44			2	25	2.70
							3	25	4.26
C <sub>9</sub> H <sub>14</sub> N <sub>2</sub> O <sub>3</sub>	Metharbital			8.45			4	25	9.58
C <sub>9</sub> H <sub>14</sub> N <sub>3</sub> O <sub>8</sub> P	3'-Cytidylic acid	1		0.8	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	Sebacic acid	1		4.59
		2		4.28			2		5.59
		3		6.0	C <sub>10</sub> H <sub>19</sub> N	Bornylamine		25	10.17
C <sub>9</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub>	Carnosine	1	20	2.73	C <sub>10</sub> H <sub>19</sub> N	Neobornylamine		25	10.01
		2	20	6.87	C <sub>10</sub> H <sub>21</sub> N	Butylcyclohexylamine		25	11.23
		3	20	9.73	C <sub>10</sub> H <sub>21</sub> N	1,2,2,6,6-Pentamethylpiperidine		30	11.25
C <sub>9</sub> H <sub>15</sub> NO <sub>3</sub> S	Captopril	1		3.7					
		2		9.8	C <sub>10</sub> H <sub>23</sub> N	Decylamine		25	10.64
C <sub>9</sub> H <sub>15</sub> N <sub>5</sub> O	Minoxidil			4.61	C <sub>11</sub> H <sub>8</sub> N <sub>2</sub>	1 <i>H</i> -Perimidine		20	6.35
C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	Nonanedioic acid	1	25	4.53	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	1-Naphthalenecarboxylic acid		25	3.69
		2	25	5.33					
C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	Nonanoic acid		25	4.96	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	2-Naphthalenecarboxylic acid		25	4.16
C <sub>9</sub> H <sub>19</sub> N	<i>N</i> -Butylpiperidine		23	10.47	C <sub>11</sub> H <sub>11</sub> N	Methyl-1-naphthylamine		27	3.67
C <sub>9</sub> H <sub>19</sub> N	2,2,6,6-Tetramethylpiperidine		25	11.07	C <sub>11</sub> H <sub>12</sub> INO <sub>2</sub>	Iopanoic acid			4.8
C <sub>9</sub> H <sub>21</sub> N	Nonylamine		25	10.64	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	<i>L</i> -Tryptophan	1	25	2.46
C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	8-Quinolincarboxylic acid		25	1.82			2	25	9.41

Mol. form.	Name	Step	$t/^{\circ}\text{C}$	$\text{p}K_{\text{a}}$	Mol. form.	Name	Step	$t/^{\circ}\text{C}$	$\text{p}K_{\text{a}}$
$\text{C}_{11}\text{H}_{12}\text{N}_4\text{O}_3\text{S}$	Sulfamethoxypyridazine			6.7	$\text{C}_{13}\text{H}_{10}\text{O}_2$	2-Phenylbenzoic acid		25	3.46
$\text{C}_{11}\text{H}_{13}\text{F}_3\text{N}_2\text{O}_3\text{S}$	Mefluidide			4.6	$\text{C}_{13}\text{H}_{10}\text{O}_3$	2-Phenoxybenzoic acid		25	3.53
$\text{C}_{11}\text{H}_{13}\text{NO}_3$	Hydrastinine			11.38	$\text{C}_{13}\text{H}_{10}\text{O}_3$	3-Phenoxybenzoic acid		25	3.95
$\text{C}_{11}\text{H}_{13}\text{N}_3\text{O}_3\text{S}$	Sulfisoxazole			5	$\text{C}_{13}\text{H}_{10}\text{O}_3$	4-Phenoxybenzoic acid		25	4.57
$\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}$	Cytisine	1		6.11	$\text{C}_{13}\text{H}_{11}\text{N}_3$	3,6-Acridinediamine		20	9.65
		2		13.08	$\text{C}_{13}\text{H}_{12}\text{Cl}_2\text{O}_4$	Ethacrynic acid			3.50
$\text{C}_{11}\text{H}_{14}\text{O}_2$	2- <i>tert</i> -Butylbenzoic acid		25	3.54	$\text{C}_{13}\text{H}_{12}\text{N}_2\text{O}$	Harmine			7.70
$\text{C}_{11}\text{H}_{14}\text{O}_2$	3- <i>tert</i> -Butylbenzoic acid		25	4.20	$\text{C}_{13}\text{H}_{12}\text{N}_2\text{O}_3\text{S}$	Sulfabenzamide		25	4.57
$\text{C}_{11}\text{H}_{14}\text{O}_2$	4- <i>tert</i> -Butylbenzoic acid		25	4.38	$\text{C}_{13}\text{H}_{13}\text{N}$	4-Benzylaniline		25	2.17
$\text{C}_{11}\text{H}_{16}\text{N}_2\text{O}_2$	Pilocarpine	1	25	1.6	$\text{C}_{13}\text{H}_{14}\text{N}_2\text{O}_{13}$	Harmaline			4.2
		2	25	6.9	$\text{C}_{13}\text{H}_{15}\text{N}_3\text{O}_3$	Imazapyr	1		1.9
$\text{C}_{11}\text{H}_{16}\text{N}_4\text{O}_4$	Pentostatin			5.2			2		3.6
$\text{C}_{11}\text{H}_{17}\text{N}$	<i>N,N</i> -Diethyl-2-methyl- aniline		25	7.24	$\text{C}_{13}\text{H}_{16}\text{ClNO}$	Ketamine			7.5
$\text{C}_{11}\text{H}_{17}\text{NO}_3$	Isoproterenol			8.64	$\text{C}_{13}\text{H}_{19}\text{NO}_4\text{S}$	4-[(Dipropylamino)- sulfonyl]benzoic acid			5.8
$\text{C}_{11}\text{H}_{17}\text{N}_3\text{O}_8$	Tetrodotoxin			8.76	$\text{C}_{13}\text{H}_{21}\text{N}$	2,6-Di- <i>tert</i> -butylpyridine			3.58
$\text{C}_{11}\text{H}_{18}\text{ClNO}_3$	Methoxamine hydrochloride		25	9.2	$\text{C}_{13}\text{H}_{29}\text{N}$	(Tridecyl)amine		25	10.63
$\text{C}_{11}\text{H}_{18}\text{N}_2\text{O}_3$	Amobarbital		25	8.0	$\text{C}_{14}\text{H}_{12}\text{F}_3\text{NO}_4\text{S}_2$	Perfluidone			2.5
$\text{C}_{11}\text{H}_{25}\text{N}$	Undecylamine		25	10.63	$\text{C}_{14}\text{H}_{12}\text{O}_2$	$\alpha$ -Phenylbenzeneacetic acid		25	3.94
$\text{C}_{11}\text{H}_{26}\text{NO}_2\text{PS}$	Methylphosphonothioic acid S[2-[bis(1-isopropylamino)- ethyl], <i>O</i> -ethylester			7.9	$\text{C}_{14}\text{H}_{12}\text{O}_3$	$\alpha$ -Hydroxy- $\alpha$ -phenyl- benzeneacetic acid		25	3.04
$\text{C}_{12}\text{H}_6\text{Cl}_4\text{O}_2\text{S}$	Bithionol	1		4.82	$\text{C}_{14}\text{H}_{18}\text{N}_4\text{O}_3$	Trimethoprim			6.6
		2		10.50	$\text{C}_{14}\text{H}_{19}\text{NO}_2$	Methylphenidate			8.9
$\text{C}_{12}\text{H}_8\text{N}_2$	1,10-Phenanthroline		25	4.84	$\text{C}_{14}\text{H}_{21}\text{N}_3\text{O}_3\text{S}$	Tolazamide		25	3.6
$\text{C}_{12}\text{H}_8\text{N}_2$	Phenazine		20	1.20	$\text{C}_{14}\text{H}_{22}\text{N}_2\text{O}_3$	Atenolol			9.6
$\text{C}_{12}\text{H}_{10}\text{O}$	2-Hydroxybiphenyl		25	10.01	$\text{C}_{14}\text{H}_{31}\text{N}$	Tetradecylamine		25	10.62
$\text{C}_{12}\text{H}_{10}\text{O}$	3-Hydroxybiphenyl		25	9.64	$\text{C}_{15}\text{H}_{10}\text{ClN}_3\text{O}_3$	Clonazepam			1.5
$\text{C}_{12}\text{H}_{10}\text{O}$	4-Hydroxybiphenyl		25	9.55			2		10.5
$\text{C}_{12}\text{H}_{11}\text{N}$	Diphenylamine		25	0.79	$\text{C}_{15}\text{H}_{11}\text{I}_4\text{NO}_4$	<i>L</i> -Thyroxine	1	25	2.2
$\text{C}_{12}\text{H}_{11}\text{N}$	2-Aminobiphenyl		25	3.83			2	25	6.45
$\text{C}_{12}\text{H}_{11}\text{N}$	3-Aminobiphenyl		18	4.25			3	25	10.1
$\text{C}_{12}\text{H}_{11}\text{N}$	4-Aminobiphenyl		18	4.35	$\text{C}_{15}\text{H}_{14}\text{O}_3$	Fenopropfen			4.5
$\text{C}_{12}\text{H}_{11}\text{N}$	2-Benzylpyridine		25	5.13	$\text{C}_{15}\text{H}_{15}\text{NO}_2$	Mefenamic acid			4.2
$\text{C}_{12}\text{H}_{11}\text{N}_3$	4-Aminoazobenzene		25	2.82	$\text{C}_{15}\text{H}_{15}\text{N}_3\text{O}_2$	Methyl Red	1		2.5
$\text{C}_{12}\text{H}_{12}\text{N}_2$	<i>p</i> -Benzidine	1	20	4.65			2		9.5
		2	20	3.43	$\text{C}_{15}\text{H}_{17}\text{ClN}_4$	NeutralRed			6.7
$\text{C}_{12}\text{H}_{12}\text{N}_2\text{O}_3$	Phenobarbital	1		7.3	$\text{C}_{15}\text{H}_{19}\text{NO}_2$	Tropacocaine		15	4.32
		2		11.8	$\text{C}_{15}\text{H}_{19}\text{N}_3\text{O}_3$	Imazethapyr	1		2.1
$\text{C}_{12}\text{H}_{13}\text{I}_3\text{N}_2\text{O}_3$	Iocetamic acid			4			2		3.9
$\text{C}_{12}\text{H}_{13}\text{N}$	<i>N,N</i> -Dimethyl-1- naphthylamine		25	4.83	$\text{C}_{15}\text{H}_{21}\text{N}_3\text{O}_2$	Physostigmine	1		6.12
$\text{C}_{12}\text{H}_{13}\text{N}$	<i>N,N</i> -Dimethyl-2- naphthylamine		25	4.566			2		12.24
$\text{C}_{12}\text{H}_{14}\text{N}_4\text{O}_2\text{S}$	Sulfamethazine	1		7.4	$\text{C}_{15}\text{H}_{26}\text{N}_2$	Sparteine	1	20	2.24
		2		2.65			2	20	9.46
$\text{C}_{12}\text{H}_{14}\text{N}_4\text{O}_3\text{S}$	Sulfacytine			6.9	$\text{C}_{15}\text{H}_{33}\text{N}$	Pentadecylamine		25	10.61
$\text{C}_{12}\text{H}_{17}\text{N}_3\text{O}_4$	Agaritine	1		3.4	$\text{C}_{16}\text{H}_{13}\text{ClN}_2\text{O}$	Valium			3.4
		2		8.86	$\text{C}_{16}\text{H}_{14}\text{ClN}_3\text{O}$	Chlorodiazepoxide			4.8
$\text{C}_{12}\text{H}_{20}\text{N}_2\text{O}_2$	Aspergillilic acid			5.5	$\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_2$	Lysergic acid	1		3.44
$\text{C}_{12}\text{H}_{21}\text{N}_5\text{O}_2\text{S}_2$	Nizatidine	1		2.1			2		7.68
		2		6.8	$\text{C}_{16}\text{H}_{17}\text{N}_3\text{O}_4\text{S}$	Cephalexin	1		5.2
$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	Sucrose		25	12.7			2		7.3
$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	$\alpha$ -Maltose		21	12.05	$\text{C}_{16}\text{H}_{19}\text{N}_3\text{O}_4\text{S}$	Cephadrine	1		2.63
$\text{C}_{12}\text{H}_{23}\text{N}$	Dicyclohexylamine			10.4			2		7.27
$\text{C}_{12}\text{H}_{27}\text{N}$	Dodecylamine		25	10.63	$\text{C}_{16}\text{H}_{22}\text{N}_2$	Lycodine	1		3.97
$\text{C}_{13}\text{H}_9\text{N}$	Acridine		20	5.58			2		8.08
$\text{C}_{13}\text{H}_9\text{N}$	Phenanthridine		20	5.58	$\text{C}_{16}\text{H}_{35}\text{N}$	Hexadecylamine		25	10.61
$\text{C}_{13}\text{H}_{10}\text{N}_2$	9-Acridinamine		20	9.99	$\text{C}_{17}\text{H}_{17}\text{NO}_2$	Apomorphine	1		7.0
$\text{C}_{13}\text{H}_{10}\text{N}_2$	2-Phenylbenzimidazole	1	25	5.23			2		8.92
		2	25	11.91	$\text{C}_{17}\text{H}_{19}\text{NO}_3$	Piperine		18	12.22
					$\text{C}_{17}\text{H}_{19}\text{NO}_3$	Morphine	1	25	8.21
							2	20	9.85
					$\text{C}_{17}\text{H}_{20}\text{N}_4\text{O}_6$	Riboflavin	1		1.7

Mol. form.	Name	Step	t/°C	pK <sub>a</sub>	Mol. form.	Name	Step	t/°C	pK <sub>a</sub>
		2	25	9.69	C <sub>21</sub> H <sub>23</sub> ClFNO <sub>2</sub>	Haloperidol			8.3
C <sub>17</sub> H <sub>20</sub> O <sub>6</sub>	Mycophenolic acid			4.5	C <sub>21</sub> H <sub>31</sub> NO <sub>4</sub>	Furethidine			7.48
C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub>	Hyoscyamine		21	9.7	C <sub>21</sub> H <sub>35</sub> N <sub>3</sub> O <sub>7</sub>	Lisinopril	1		2.5
C <sub>17</sub> H <sub>27</sub> NO <sub>4</sub>	Nadolol			9.67			2		4.0
C <sub>18</sub> H <sub>19</sub> ClN <sub>4</sub>	Clozapine	1		3.70			3		6.7
		2		7.60			4		10.1
C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	Codeine			8.21	C <sub>22</sub> H <sub>18</sub> O <sub>4</sub>	o-Cresolphthalein			9.4
C <sub>18</sub> H <sub>21</sub> N <sub>3</sub> O	Dibenzepin			8.25	C <sub>22</sub> H <sub>22</sub> FN <sub>3</sub> O <sub>2</sub>	Droperidol			7.64
C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	Linoleic acid		25	4.77	C <sub>22</sub> H <sub>23</sub> NO <sub>7</sub>	Noscapine			7.8
C <sub>18</sub> H <sub>33</sub> ClN <sub>2</sub> O <sub>5</sub> S	Clindamycin			7.6	C <sub>22</sub> H <sub>25</sub> NO <sub>6</sub>	Colchicine		20	12.36
C <sub>18</sub> H <sub>39</sub> N	Octadecylamine		25	10.60	C <sub>22</sub> H <sub>25</sub> N <sub>3</sub> O	Benzpiperylon	1		6.73
C <sub>19</sub> H <sub>10</sub> Br <sub>4</sub> O <sub>5</sub> S	Bromophenol Blue			4.0			2		9.13
C <sub>19</sub> H <sub>14</sub> O <sub>5</sub> S	Phenol Red			7.9	C <sub>22</sub> H <sub>33</sub> NO <sub>2</sub>	Atisine			12.2
C <sub>19</sub> H <sub>16</sub> ClNO <sub>4</sub>	Indomethacin			4.5	C <sub>23</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub>	Brucine	1		6.04
C <sub>19</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	Cephaloridine			3.2			2		11.07
C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	Phenylbutazone			4.5	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	Deoxycholic acid		20	5.15
C <sub>19</sub> H <sub>21</sub> N	Protriptyline			8.2	C <sub>24</sub> H <sub>40</sub> O <sub>5</sub>	Cholic acid		20	4.98
C <sub>19</sub> H <sub>21</sub> NO <sub>3</sub>	Thebaine		15	6.05	C <sub>25</sub> H <sub>29</sub> I <sub>2</sub> NO <sub>3</sub>	Amiodarone		25	6.56
C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O	Cinchonine	1		5.85	C <sub>25</sub> H <sub>41</sub> NO <sub>9</sub>	Aconine			9.52
		2		9.92	C <sub>26</sub> H <sub>43</sub> NO <sub>6</sub>	Glycocholic acid			4.4
C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O	Cinchonidine	1		5.80	C <sub>26</sub> H <sub>45</sub> NO <sub>7</sub> S	Taurocholic acid			1.4
		2		10.03	C <sub>27</sub> H <sub>28</sub> Br <sub>2</sub> O <sub>5</sub> S	Bromothymol Blue			7.0
C <sub>19</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	Cupreine			6.57	C <sub>27</sub> H <sub>38</sub> N <sub>2</sub> O <sub>4</sub>	Verapamil			8.6
C <sub>19</sub> H <sub>22</sub> O <sub>6</sub>	Gibberellic acid			4.0	C <sub>29</sub> H <sub>32</sub> O <sub>13</sub>	Etoposide			9.8
C <sub>19</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub>	Ergometrine			7.3	C <sub>29</sub> H <sub>40</sub> N <sub>2</sub> O <sub>4</sub>	Emetine	1		5.77
C <sub>19</sub> H <sub>23</sub> N <sub>3</sub> O <sub>2</sub>	Ergonovine			6.8			2		6.64
C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	Phenolphthalein		25	9.7	C <sub>30</sub> H <sub>23</sub> BrO <sub>4</sub>	Bromadiolone		21	4.04
C <sub>20</sub> H <sub>21</sub> NO <sub>4</sub>	Papaverine			6.4	C <sub>30</sub> H <sub>48</sub> O <sub>3</sub>	Oleanolic acid			2.52
C <sub>20</sub> H <sub>23</sub> N	Amitriptyline			9.4	C <sub>31</sub> H <sub>36</sub> N <sub>2</sub> O <sub>11</sub>	Novobiocin	1		4.3
C <sub>20</sub> H <sub>23</sub> N <sub>7</sub> O <sub>7</sub>	Folinic acid	1		3.1			2		9.1
		2		4.8	C <sub>32</sub> H <sub>32</sub> O <sub>13</sub> S	Teniposide			10.13
		3		10.4	C <sub>33</sub> H <sub>40</sub> N <sub>2</sub> O <sub>9</sub>	Reserpine			6.6
C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	Quinine	1	25	8.52	C <sub>34</sub> H <sub>47</sub> NO <sub>11</sub>	Aconitine			5.88
		2	25	4.13	C <sub>36</sub> H <sub>51</sub> NO <sub>11</sub>	Veratridine			9.54
C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	Quinidine	1	20	5.4	C <sub>37</sub> H <sub>67</sub> NO <sub>13</sub>	Erythromycin			8.8
		2	20	10.0	C <sub>43</sub> H <sub>58</sub> N <sub>4</sub> O <sub>12</sub>	Rifampin	1		1.7
C <sub>20</sub> H <sub>26</sub> N <sub>2</sub> O <sub>2</sub>	Hydroquinine			5.33			2		7.9
C <sub>21</sub> H <sub>14</sub> Br <sub>4</sub> O <sub>5</sub> S	Bromocresol Green			4.7	C <sub>45</sub> H <sub>73</sub> NO <sub>15</sub>	Solanine		15	6.66
C <sub>21</sub> H <sub>16</sub> Br <sub>2</sub> O <sub>5</sub> S	Bromocresol Purple			6.3	C <sub>46</sub> H <sub>56</sub> N <sub>4</sub> O <sub>10</sub>	Vincristine			5.4
C <sub>21</sub> H <sub>18</sub> O <sub>5</sub> S	CresolRed			8.3	C <sub>46</sub> H <sub>58</sub> N <sub>4</sub> O <sub>9</sub>	Vinblastine	1		5.4
C <sub>21</sub> H <sub>21</sub> NO <sub>6</sub>	Hydrastine			7.8			2		7.4
C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	Strychnine		25	8.26					

## CONCENTRATIVE PROPERTIES OF AQUEOUS SOLUTIONS: DENSITY, REFRACTIVE INDEX, FREEZING POINT DEPRESSION, AND VISCOSITY

This table gives properties of aqueous solutions of 66 substances as a function of concentration. All data refer to a temperature of 20°C. The properties are:

Mass %: Mass of solute divided by total mass of solution, expressed as percent.

$m$  Molality (moles of solute per kg of water).

$c$  Molarity (moles of solute per liter of solution).

$\rho$  Density of solution in g/cm<sup>3</sup>.

$n$  Index of refraction, relative to air, at a wavelength of 589 nm (sodium D line); the index of pure water at 20°C is 1.3330.

$\Delta$  Freezing point depression in °C relative to pure water.

$\eta$  Absolute (dynamic) viscosity in mPa s (equal to centipoise, cP); the viscosity of pure water at 20°C is 1.002 mPa s.

Density data for aqueous solutions over a wider range of temperatures and pressures (and for other compounds) may be found in Reference 2. Solutes are listed in the following order:

Acetic acid	Lithium chloride	2-Propanol
Acetone	Magnesium chloride	Silver nitrate
Ammonia	Magnesium sulfate	Sodium acetate
Ammonium chloride	Maltose	Sodium bicarbonate
Ammonium sulfate	Manganese(II) sulfate	Sodium bromide
Barium chloride	<i>D</i> -Mannitol	Sodium carbonate
Calcium chloride	Methanol	Sodium chloride
Cesium chloride	Nitric acid	Sodium citrate
Citric acid	Oxalic acid	Sodium hydroxide
Copper sulfate	Phosphoric acid	Sodium nitrate
Disodium ethylenediamine tetraacetate (EDTA sodium)	Potassium bicarbonate	Sodium phosphate
Ethanol	Potassium bromide	Sodium hydrogen phosphate
Ethylene glycol	Potassium carbonate	Sodium dihydrogen phosphate
Ferric chloride	Potassium chloride	Sodium sulfate
Formic acid	Potassium hydroxide	Sodium thiosulfate
<i>D</i> -Fructose	Potassium iodide	Strontium chloride
<i>D</i> -Glucose	Potassium nitrate	Sucrose
Glycerol	Potassium permanganate	Sulfuric acid
Hydrochloric acid	Potassium hydrogen phosphate	Trichloroacetic acid
Lactic acid	Potassium dihydrogen phosphate	Tris(hydroxymethyl)methylamine
Lactose	Potassium sulfate	Urea
	1-Propanol	Zinc sulfate

### References

1. Wolf, A. V., *Aqueous Solutions and Body Fluids*, Hoeber, 1966.
2. Söhnel, O., and Novotny, P., *Densities of Aqueous Solutions of Inorganic Substances*, Elsevier, Amsterdam, 1985.

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
Acetic acid	0.5	0.084	0.083	0.9989	1.3334	0.16	1.012
CH <sub>3</sub> COOH	1.0	0.168	0.166	0.9996	1.3337	0.32	1.022
	2.0	0.340	0.333	1.0011	1.3345	0.63	1.042
	3.0	0.515	0.501	1.0025	1.3352	0.94	1.063
	4.0	0.694	0.669	1.0038	1.3359	1.26	1.084
	5.0	0.876	0.837	1.0052	1.3366	1.58	1.105
	6.0	1.063	1.006	1.0066	1.3373	1.90	1.125
	7.0	1.253	1.175	1.0080	1.3381	2.23	1.143
	8.0	1.448	1.345	1.0093	1.3388	2.56	1.162
	9.0	1.647	1.515	1.0107	1.3395	2.89	1.186
	10.0	1.850	1.685	1.0121	1.3402	3.23	1.210
	12.0	2.271	2.028	1.0147	1.3416	3.91	1.253
	14.0	2.711	2.372	1.0174	1.3430	4.61	1.298
	16.0	3.172	2.718	1.0200	1.3444	5.33	1.341
	18.0	3.655	3.065	1.0225	1.3458	6.06	1.380
20.0	4.163	3.414	1.0250	1.3472	6.81	1.431	
22.0	4.697	3.764	1.0275	1.3485	7.57	1.478	
24.0	5.259	4.116	1.0299	1.3498	8.36	1.525	

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	26.0	5.851	4.470	1.0323	1.3512	9.17	1.572
	28.0	6.476	4.824	1.0346	1.3525	10.00	1.613
	30.0	7.137	5.180	1.0369	1.3537	10.84	1.669
	32.0	7.837	5.537	1.0391	1.3550	11.70	1.715
	34.0	8.579	5.896	1.0413	1.3562	12.55	1.762
	36.0	9.367	6.255	1.0434	1.3574	13.38	1.812
	38.0	10.207	6.615	1.0454	1.3586		1.852
	40.0	11.102	6.977	1.0474	1.3598		1.912
	50.0	16.653	8.794	1.0562	1.3653		2.158
	60.0	24.979	10.620	1.0629	1.3700		2.409
	70.0	38.857	12.441	1.0673	1.3738		2.629
	80.0	66.611	14.228	1.0680	1.3767		2.720
	90.0	149.875	15.953	1.0644	1.3771		2.386
	92.0	191.507	16.284	1.0629	1.3766		2.240
	94.0	260.894	16.602	1.0606	1.3759		2.036
	96.0	399.667	16.911	1.0578	1.3748		1.813
	98.0	815.987	17.198	1.0538	1.3734		1.535
	100.0		17.447	1.0477	1.3716		1.223
Acetone (CH <sub>3</sub> ) <sub>2</sub> CO	0.5	0.087	0.086	0.9975	1.3334	0.16	1.013
	1.0	0.174	0.172	0.9968	1.3337	0.32	1.024
	2.0	0.351	0.343	0.9954	1.3344	0.65	1.047
	3.0	0.533	0.513	0.9940	1.3352	0.97	1.072
	4.0	0.717	0.684	0.9926	1.3359	1.30	1.099
	5.0	0.906	0.853	0.9912	1.3366	1.63	1.125
	6.0	1.099	1.023	0.9899	1.3373	1.96	1.150
	7.0	1.296	1.191	0.9886	1.3381	2.29	1.174
	8.0	1.497	1.360	0.9874	1.3388	2.62	1.198
	9.0	1.703	1.528	0.9861	1.3395	2.95	1.221
	10.0	1.913	1.696	0.9849	1.3402	3.29	1.244
Ammonia NH <sub>3</sub>	0.5	0.295	0.292	0.9960	1.3332	0.55	1.009
	1.0	0.593	0.584	0.9938	1.3335	1.14	1.015
	2.0	1.198	1.162	0.9895	1.3339	2.32	1.029
	3.0	1.816	1.736	0.9853	1.3344	3.53	1.043
	4.0	2.447	2.304	0.9811	1.3349	4.78	1.057
	5.0	3.090	2.868	0.9770	1.3354	6.08	1.071
	6.0	3.748	3.428	0.9730	1.3359	7.43	1.085
	7.0	4.420	3.983	0.9690	1.3365	8.95	1.099
	8.0	5.106	4.533	0.9651	1.3370	10.34	1.113
	9.0	5.807	5.080	0.9613	1.3376	11.90	1.127
	10.0	6.524	5.622	0.9575	1.3381	13.55	1.141
	12.0	8.007	6.695	0.9502	1.3393	17.13	1.169
	14.0	9.558	7.753	0.9431	1.3404	21.13	1.195
	16.0	11.184	8.794	0.9361	1.3416	25.63	1.218
	18.0	12.889	9.823	0.9294	1.3428	30.70	1.237
	20.0	14.679	10.837	0.9228	1.3440	36.42	1.254
	22.0	16.561	11.838	0.9164	1.3453	43.36	1.268
	24.0	18.542	12.826	0.9102	1.3465	51.38	1.280
	26.0	20.630	13.801	0.9040	1.3477	60.77	1.288
	28.0	22.834	14.764	0.8980	1.3490	71.66	
	30.0	25.164	15.713	0.8920	1.3502	84.06	
Ammonium chloride NH <sub>4</sub> Cl	0.5	0.094	0.093	0.9998	1.3340	0.32	0.999
	1.0	0.189	0.187	1.0014	1.3349	0.64	0.996
	2.0	0.382	0.376	1.0045	1.3369	1.27	0.992
	3.0	0.578	0.565	1.0076	1.3388	1.91	0.988
	4.0	0.779	0.756	1.0107	1.3407	2.57	0.985
	5.0	0.984	0.948	1.0138	1.3426	3.25	0.982
	6.0	1.193	1.141	1.0168	1.3445	3.94	0.979
	7.0	1.407	1.335	1.0198	1.3464	4.66	0.976

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	8.0	1.626	1.529	1.0227	1.3483	5.40	0.974
	9.0	1.849	1.726	1.0257	1.3502	6.16	0.972
	10.0	2.077	1.923	1.0286	1.3521	6.95	0.970
	12.0	2.549	2.320	1.0344	1.3559	8.60	0.969
	14.0	3.043	2.722	1.0401	1.3596		0.969
	16.0	3.561	3.128	1.0457	1.3634		0.971
	18.0	4.104	3.537	1.0512	1.3671		0.973
	20.0	4.674	3.951	1.0567	1.3708		0.978
	22.0	5.273	4.368	1.0621	1.3745		0.986
	24.0	5.903	4.789	1.0674	1.3782		0.996
Ammonium sulfate (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	0.5	0.038	0.038	1.0012	1.3338	0.17	1.008
	1.0	0.076	0.076	1.0042	1.3346	0.33	1.014
	2.0	0.154	0.153	1.0101	1.3363	0.63	1.027
	3.0	0.234	0.231	1.0160	1.3379	0.92	1.041
	4.0	0.315	0.309	1.0220	1.3395	1.21	1.057
	5.0	0.398	0.389	1.0279	1.3411	1.49	1.073
	6.0	0.483	0.469	1.0338	1.3428	1.77	1.090
	7.0	0.570	0.551	1.0397	1.3444	2.05	1.108
	8.0	0.658	0.633	1.0456	1.3460	2.33	1.127
	9.0	0.748	0.716	1.0515	1.3476	2.61	1.147
	10.0	0.841	0.800	1.0574	1.3492	2.89	1.168
	12.0	1.032	0.971	1.0691	1.3523	3.47	1.210
	14.0	1.232	1.145	1.0808	1.3555	4.07	1.256
	16.0	1.441	1.323	1.0924	1.3586	4.69	1.305
	18.0	1.661	1.504	1.1039	1.3616		1.359
	20.0	1.892	1.688	1.1154	1.3647		1.421
	22.0	2.134	1.876	1.1269	1.3677		1.490
	24.0	2.390	2.067	1.1383	1.3707		1.566
	26.0	2.659	2.262	1.1496	1.3737		1.650
	28.0	2.943	2.460	1.1609	1.3766		1.743
	30.0	3.243	2.661	1.1721	1.3795		1.847
	32.0	3.561	2.866	1.1833	1.3824		1.961
	34.0	3.898	3.073	1.1945	1.3853		2.086
	36.0	4.257	3.284	1.2056	1.3881		2.222
	38.0	4.638	3.499	1.2166	1.3909		2.371
	40.0	5.045	3.716	1.2277	1.3938		2.530
Barium chloride BaCl <sub>2</sub>	0.5	0.024	0.024	1.0026	1.3337	0.12	1.009
	1.0	0.049	0.048	1.0070	1.3345	0.23	1.016
	2.0	0.098	0.098	1.0159	1.3360	0.46	1.026
	3.0	0.149	0.148	1.0249	1.3375	0.69	1.037
	4.0	0.200	0.199	1.0341	1.3391	0.93	1.049
	5.0	0.253	0.251	1.0434	1.3406	1.18	1.062
	6.0	0.307	0.303	1.0528	1.3422	1.44	1.075
	7.0	0.361	0.357	1.0624	1.3438	1.70	1.087
	8.0	0.418	0.412	1.0721	1.3454	1.98	1.101
	9.0	0.475	0.468	1.0820	1.3470	2.27	1.114
	10.0	0.534	0.524	1.0921	1.3487	2.58	1.129
	12.0	0.655	0.641	1.1128	1.3520	3.22	1.161
	14.0	0.782	0.763	1.1342	1.3555	3.92	1.195
	16.0	0.915	0.889	1.1564	1.3591	4.69	1.234
	18.0	1.054	1.019	1.1793	1.3627		1.277
	20.0	1.201	1.156	1.2031	1.3664		1.325
	22.0	1.355	1.297	1.2277	1.3703		1.378
	24.0	1.517	1.444	1.2531	1.3741		1.437
	26.0	1.687	1.597	1.2793	1.3781		1.503
Calcium chloride CaCl <sub>2</sub>	0.5	0.045	0.045	1.0024	1.3342	0.22	1.015
	1.0	0.091	0.091	1.0065	1.3354	0.44	1.028
	2.0	0.184	0.183	1.0148	1.3378	0.88	1.050

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	3.0	0.279	0.277	1.0232	1.3402	1.33	1.078
	4.0	0.375	0.372	1.0316	1.3426	1.82	1.110
	5.0	0.474	0.469	1.0401	1.3451	2.35	1.143
	6.0	0.575	0.567	1.0486	1.3475	2.93	1.175
	7.0	0.678	0.667	1.0572	1.3500	3.57	1.208
	8.0	0.784	0.768	1.0659	1.3525	4.28	1.242
	9.0	0.891	0.872	1.0747	1.3549	5.04	1.279
	10.0	1.001	0.976	1.0835	1.3575	5.86	1.319
	12.0	1.229	1.191	1.1014	1.3625	7.70	1.408
	14.0	1.467	1.413	1.1198	1.3677	9.83	1.508
	16.0	1.716	1.641	1.1386	1.3730	12.28	1.625
	18.0	1.978	1.878	1.1579	1.3784	15.11	1.764
	20.0	2.253	2.122	1.1775	1.3839	18.30	1.930
	22.0	2.541	2.374	1.1976	1.3895	21.70	2.127
	24.0	2.845	2.634	1.2180	1.3951	25.30	2.356
	26.0	3.166	2.902	1.2388	1.4008	29.70	2.645
	28.0	3.504	3.179	1.2600	1.4066	34.70	3.000
	30.0	3.862	3.464	1.2816	1.4124	41.00	3.467
	32.0	4.240	3.759	1.3036	1.4183	49.70	4.035
	34.0	4.642	4.062	1.3260	1.4242		4.820
	36.0	5.068	4.375	1.3488	1.4301		5.807
	38.0	5.522	4.698	1.3720	1.4361		7.321
	40.0	6.007	5.030	1.3957	1.4420		8.997
Cesium chloride	0.5	0.030	0.030	1.0020	1.3334	0.10	1.000
	1.0	0.060	0.060	1.0058	1.3337	0.20	0.997
CsCl	2.0	0.121	0.120	1.0135	1.3345	0.40	0.992
	3.0	0.184	0.182	1.0214	1.3353	0.61	0.988
	4.0	0.247	0.245	1.0293	1.3361	0.81	0.984
	5.0	0.313	0.308	1.0374	1.3369	1.02	0.980
	6.0	0.379	0.373	1.0456	1.3377	1.22	0.977
	7.0	0.447	0.438	1.0540	1.3386	1.43	0.974
	8.0	0.516	0.505	1.0625	1.3394	1.64	0.971
	9.0	0.587	0.573	1.0711	1.3403	1.85	0.969
	10.0	0.660	0.641	1.0798	1.3412	2.06	0.966
	12.0	0.810	0.782	1.0978	1.3430	2.51	0.961
	14.0	0.967	0.928	1.1163	1.3448	2.97	0.955
	16.0	1.131	1.079	1.1355	1.3468	3.46	0.950
	18.0	1.304	1.235	1.1552	1.3487	3.96	0.945
	20.0	1.485	1.397	1.1756	1.3507	4.49	0.939
	22.0	1.675	1.564	1.1967	1.3528		0.934
	24.0	1.876	1.737	1.2185	1.3550		0.930
	26.0	2.087	1.917	1.2411	1.3572		0.926
	28.0	2.310	2.103	1.2644	1.3594		0.924
	30.0	2.546	2.296	1.2885	1.3617		0.922
	32.0	2.795	2.497	1.3135	1.3641		0.922
	34.0	3.060	2.705	1.3393	1.3666		0.924
	36.0	3.341	2.921	1.3661	1.3691		0.926
	38.0	3.640	3.146	1.3938	1.3717		0.930
	40.0	3.960	3.380	1.4226	1.3744		0.934
	42.0	4.301	3.624	1.4525	1.3771		0.940
	44.0	4.667	3.877	1.4835	1.3800		0.947
	46.0	5.060	4.142	1.5158	1.3829		0.956
	48.0	5.483	4.418	1.5495	1.3860		0.967
	50.0	5.940	4.706	1.5846	1.3892		0.981
	60.0	8.910	6.368	1.7868	1.4076		1.120
	64.0	10.560	7.163	1.8842	1.4167		1.238
Citric acid (HO)C(COOH) <sub>3</sub>	0.5	0.026	0.026	1.0002	1.3336	0.05	1.013
	1.0	0.053	0.052	1.0022	1.3343	0.11	1.024
	2.0	0.106	0.105	1.0063	1.3356	0.21	1.048



Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	3.0	0.161	0.158	1.0105	1.3368	0.32	1.073
	4.0	0.217	0.211	1.0147	1.3381	0.43	1.098
	5.0	0.274	0.265	1.0189	1.3394	0.54	1.125
	6.0	0.332	0.320	1.0232	1.3407	0.65	1.153
	7.0	0.392	0.374	1.0274	1.3420	0.76	1.183
	8.0	0.453	0.430	1.0316	1.3433	0.88	1.214
	9.0	0.515	0.485	1.0359	1.3446	1.00	1.247
	10.0	0.578	0.541	1.0402	1.3459	1.12	1.283
	12.0	0.710	0.655	1.0490	1.3486	1.38	1.357
	14.0	0.847	0.771	1.0580	1.3514	1.66	1.436
	16.0	0.991	0.889	1.0672	1.3541	1.95	1.525
	18.0	1.143	1.008	1.0764	1.3569	2.26	1.625
	20.0	1.301	1.130	1.0858	1.3598	2.57	1.740
	22.0	1.468	1.254	1.0953	1.3626	2.88	1.872
	24.0	1.644	1.380	1.1049	1.3655	3.21	2.017
	26.0	1.829	1.508	1.1147	1.3684	3.55	2.178
	28.0	2.024	1.639	1.1246	1.3714	3.89	2.356
	30.0	2.231	1.772	1.1346	1.3744	4.25	2.549
Copper sulfate	0.5	0.031	0.031	1.0033	1.3339	0.08	1.017
$\text{CuSO}_4$	1.0	0.063	0.063	1.0085	1.3348	0.14	1.036
	2.0	0.128	0.128	1.0190	1.3367	0.26	1.084
	3.0	0.194	0.194	1.0296	1.3386	0.37	1.129
	4.0	0.261	0.261	1.0403	1.3405	0.48	1.173
	5.0	0.330	0.329	1.0511	1.3424	0.59	1.221
	6.0	0.400	0.399	1.0620	1.3443	0.70	1.276
	7.0	0.472	0.471	1.0730	1.3462	0.82	1.336
	8.0	0.545	0.543	1.0842	1.3481	0.93	1.400
	9.0	0.620	0.618	1.0955	1.3501	1.05	1.469
	10.0	0.696	0.694	1.1070	1.3520	1.18	1.543
	12.0	0.854	0.850	1.1304	1.3560	1.45	1.701
	14.0	1.020	1.013	1.1545	1.3601	1.75	1.889
	16.0	1.193	1.182	1.1796	1.3644		2.136
	18.0	1.375	1.360	1.2059	1.3689		2.449
Disodium ethylenediamine tetraacetate (EDTA sodium)	0.5	0.015	0.015	1.0009	1.3339	0.07	1.017
$\text{Na}_2\text{C}_{10}\text{H}_{14}\text{N}_2\text{O}_8$	1.0	0.030	0.030	1.0036	1.3348	0.14	1.032
	1.5	0.045	0.045	1.0062	1.3356	0.21	1.046
	2.0	0.061	0.060	1.0089	1.3365	0.27	1.062
	2.5	0.076	0.075	1.0115	1.3374	0.33	1.077
	3.0	0.092	0.090	1.0142	1.3383	0.40	1.093
	3.5	0.108	0.106	1.0169	1.3392	0.46	1.109
	4.0	0.124	0.121	1.0196	1.3400	0.52	1.125
	4.5	0.140	0.137	1.0223	1.3409	0.58	1.142
	5.0	0.157	0.152	1.0250	1.3418	0.65	1.160
	5.5	0.173	0.168	1.0277	1.3427	0.71	1.178
	6.0	0.190	0.184	1.0305	1.3436	0.77	1.197
Ethanol	0.5	0.109	0.108	0.9973	1.3333	0.20	1.023
$\text{CH}_3\text{CH}_2\text{OH}$	1.0	0.219	0.216	0.9963	1.3336	0.40	1.046
	2.0	0.443	0.432	0.9945	1.3342	0.81	1.095
	3.0	0.671	0.646	0.9927	1.3348	1.23	1.140
	4.0	0.904	0.860	0.9910	1.3354	1.65	1.183
	5.0	1.142	1.074	0.9893	1.3360	2.09	1.228
	6.0	1.385	1.286	0.9878	1.3367	2.54	1.279
	7.0	1.634	1.498	0.9862	1.3374	2.99	1.331
	8.0	1.887	1.710	0.9847	1.3381	3.47	1.385
	9.0	2.147	1.921	0.9833	1.3388	3.96	1.442
	10.0	2.412	2.131	0.9819	1.3395	4.47	1.501
	12.0	2.960	2.551	0.9792	1.3410	5.56	1.627
	14.0	3.534	2.967	0.9765	1.3425	6.73	1.761

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	16.0	4.134	3.382	0.9739	1.3440	8.01	1.890
	18.0	4.765	3.795	0.9713	1.3455	9.40	2.019
	20.0	5.427	4.205	0.9687	1.3469	10.92	2.142
	22.0	6.122	4.613	0.9660	1.3484	12.60	2.259
	24.0	6.855	5.018	0.9632	1.3498	14.47	2.370
	26.0	7.626	5.419	0.9602	1.3511	16.41	2.476
	28.0	8.441	5.817	0.9571	1.3524	18.43	2.581
	30.0	9.303	6.212	0.9539	1.3535	20.47	2.667
	32.0	10.215	6.601	0.9504	1.3546	22.44	2.726
	34.0	11.182	6.987	0.9468	1.3557	24.27	2.768
	36.0	12.210	7.370	0.9431	1.3566	25.98	2.803
	38.0	13.304	7.747	0.9392	1.3575	27.62	2.829
	40.0	14.471	8.120	0.9352	1.3583	29.26	2.846
	42.0	15.718	8.488	0.9311	1.3590	30.98	2.852
	44.0	17.055	8.853	0.9269	1.3598	32.68	2.850
	46.0	18.490	9.213	0.9227	1.3604	34.36	2.843
	48.0	20.036	9.568	0.9183	1.3610	36.04	2.832
	50.0	21.706	9.919	0.9139	1.3616	37.67	2.813
	60.0	32.559	11.605	0.8911	1.3638	44.93	2.547
	70.0	50.648	13.183	0.8676	1.3652		2.214
	80.0	86.824	14.649	0.8436	1.3658		1.881
	90.0	195.355	15.980	0.8180	1.3650		1.542
	92.0	249.620	16.225	0.8125	1.3646		1.475
	94.0	340.062	16.466	0.8070	1.3642		1.407
	96.0	520.946	16.697	0.8013	1.3636		1.342
	98.0		16.920	0.7954	1.3630		1.273
	100.0		17.133	0.7893	1.3614		1.203
Ethylene glycol (CH <sub>2</sub> OH) <sub>2</sub>	0.5	0.081	0.080	0.9988	1.3335	0.15	1.010
	1.0	0.163	0.161	0.9995	1.3339	0.30	1.020
	2.0	0.329	0.322	1.0007	1.3348	0.61	1.048
	3.0	0.498	0.484	1.0019	1.3358	0.92	1.074
	4.0	0.671	0.646	1.0032	1.3367	1.24	1.099
	5.0	0.848	0.809	1.0044	1.3377	1.58	1.125
	6.0	1.028	0.972	1.0057	1.3386	1.91	1.153
	7.0	1.213	1.136	1.0070	1.3396	2.26	1.182
	8.0	1.401	1.299	1.0082	1.3405	2.62	1.212
	9.0	1.593	1.464	1.0095	1.3415	2.99	1.243
	10.0	1.790	1.628	1.0108	1.3425	3.37	1.277
	12.0	2.197	1.959	1.0134	1.3444	4.16	1.348
	14.0	2.623	2.292	1.0161	1.3464	5.01	1.424
	16.0	3.069	2.626	1.0188	1.3484	5.91	1.500
	18.0	3.537	2.962	1.0214	1.3503	6.89	1.578
	20.0	4.028	3.300	1.0241	1.3523	7.93	1.661
	24.0	5.088	3.981	1.0296	1.3564	10.28	1.843
	28.0	6.265	4.669	1.0350	1.3605	13.03	2.047
	32.0	7.582	5.364	1.0405	1.3646	16.23	2.280
	36.0	9.062	6.067	1.0460	1.3687	19.82	2.537
	40.0	10.741	6.776	1.0514	1.3728	23.84	2.832
	44.0	12.659	7.491	1.0567	1.3769	28.32	3.166
	48.0	14.872	8.212	1.0619	1.3811	33.30	3.544
	52.0	17.453	8.939	1.0670	1.3851	38.81	3.981
	56.0	20.505	9.671	1.0719	1.3892	44.83	4.475
	60.0	24.166	10.406	1.0765	1.3931	51.23	5.026
Ferric chloride FeCl <sub>3</sub>	0.5	0.031	0.031	1.0025	1.3344	0.21	1.024
	1.0	0.062	0.062	1.0068	1.3358	0.39	1.047
	2.0	0.126	0.125	1.0153	1.3386	0.75	1.093
	3.0	0.191	0.189	1.0238	1.3413	1.15	1.139
	4.0	0.257	0.255	1.0323	1.3441	1.56	1.187
	5.0	0.324	0.321	1.0408	1.3468	2.00	1.238

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	6.0	0.394	0.388	1.0493	1.3496	2.48	1.292
	7.0	0.464	0.457	1.0580	1.3524	2.99	1.350
	8.0	0.536	0.526	1.0668	1.3552	3.57	1.412
	9.0	0.610	0.597	1.0760	1.3581	4.19	1.480
	10.0	0.685	0.669	1.0853	1.3611	4.85	1.553
	12.0	0.841	0.817	1.1040	1.3670	6.38	1.707
	14.0	1.004	0.969	1.1228	1.3730	8.22	1.879
	16.0	1.174	1.126	1.1420		10.45	2.080
	18.0	1.353	1.289	1.1615		13.08	2.311
	20.0	1.541	1.457	1.1816		16.14	2.570
	24.0	1.947	1.810	1.2234		23.79	3.178
	28.0	2.398	2.189	1.2679		33.61	4.038
	32.0	2.901	2.595	1.3153		49.16	5.274
	36.0	3.468	3.030	1.3654			7.130
	40.0	4.110	3.496	1.4176			9.674
Formic acid HCOOH	0.5	0.109	0.109	0.9994	1.3333	0.21	1.006
	1.0	0.219	0.217	1.0006	1.3336	0.42	1.011
	2.0	0.443	0.436	1.0029	1.3342	0.82	1.017
	3.0	0.672	0.655	1.0053	1.3348	1.24	1.195
	4.0	0.905	0.876	1.0077	1.3354	1.67	1.032
	5.0	1.143	1.097	1.0102	1.3359	2.10	1.039
	6.0	1.387	1.320	1.0126	1.3365	2.53	1.046
	7.0	1.635	1.544	1.0150	1.3371	2.97	1.052
	8.0	1.889	1.768	1.0175	1.3376	3.40	1.058
	9.0	2.149	1.994	1.0199	1.3382	3.84	1.064
	10.0	2.414	2.221	1.0224	1.3387	4.27	1.070
	12.0	2.962	2.678	1.0273	1.3397	5.19	1.082
	14.0	3.537	3.139	1.0322	1.3408	6.11	1.094
	16.0	4.138	3.605	1.0371	1.3418	7.06	1.106
	18.0	4.769	4.074	1.0419	1.3428	8.08	1.119
	20.0	5.431	4.548	1.0467	1.3437	9.11	1.132
	28.0	8.449	6.481	1.0654	1.3475	13.10	1.179
	36.0	12.220	8.477	1.0839	1.3511	17.65	1.227
	44.0	17.070	10.529	1.1015	1.3547	22.93	1.281
	52.0	23.535	12.633	1.1183	1.3581	29.69	1.340
	60.0	32.587	14.813	1.1364	1.3612	38.26	1.410
	68.0	46.166	17.054	1.1544	1.3641		1.490
<i>D</i> -Fructose $\text{C}_6\text{H}_{12}\text{O}_6$	0.5	0.028	0.028	1.0002	1.3337	0.05	1.015
	1.0	0.056	0.056	1.0021	1.3344	0.10	1.028
	2.0	0.113	0.112	1.0061	1.3358	0.21	1.054
	3.0	0.172	0.168	1.0101	1.3373	0.32	1.080
	4.0	0.231	0.225	1.0140	1.3387	0.43	1.106
	5.0	0.292	0.283	1.0181	1.3402	0.54	1.134
	6.0	0.354	0.340	1.0221	1.3417	0.66	1.165
	7.0	0.418	0.399	1.0262	1.3431	0.78	1.198
	8.0	0.483	0.458	1.0303	1.3446	0.90	1.232
	9.0	0.549	0.517	1.0344	1.3461	1.03	1.270
	10.0	0.617	0.576	1.0385	1.3476	1.16	1.309
	12.0	0.757	0.697	1.0469	1.3507	1.43	1.391
	14.0	0.904	0.820	1.0554	1.3538	1.71	1.483
	16.0	1.057	0.945	1.0640	1.3569	2.01	1.587
	18.0	1.218	1.072	1.0728	1.3601	2.32	1.703
	20.0	1.388	1.201	1.0816	1.3634	2.64	1.837
	22.0	1.566	1.332	1.0906	1.3667	3.05	1.986
	24.0	1.753	1.465	1.0996	1.3700	3.43	2.154
	26.0	1.950	1.600	1.1089	1.3734	3.82	2.348
	28.0	2.159	1.738	1.1182	1.3768	4.20	2.562
	30.0	2.379	1.878	1.1276	1.3803		2.817
	32.0	2.612	2.020	1.1372	1.3839		3.112

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	34.0	2.859	2.164	1.1469	1.3874		3.462
	36.0	3.122	2.312	1.1568	1.3911		3.899
	38.0	3.402	2.461	1.1668	1.3948		4.418
	40.0	3.700	2.613	1.1769	1.3985		5.046
	42.0	4.019	2.767	1.1871	1.4023		5.773
	44.0	4.361	2.925	1.1975	1.4062		6.644
	46.0	4.728	3.084	1.2080	1.4101		7.753
	48.0	5.124	3.247	1.2187	1.4141		9.060
<i>D</i> -Glucose	0.5	0.028	0.028	1.0001	1.3337	0.05	1.010
$\text{C}_6\text{H}_{12}\text{O}_6$	1.0	0.056	0.056	1.0020	1.3344	0.11	1.021
	2.0	0.113	0.112	1.0058	1.3358	0.21	1.052
	3.0	0.172	0.168	1.0097	1.3373	0.32	1.083
	4.0	0.231	0.225	1.0136	1.3387	0.43	1.113
	5.0	0.292	0.282	1.0175	1.3402	0.55	1.145
	6.0	0.354	0.340	1.0214	1.3417	0.67	1.179
	7.0	0.418	0.398	1.0254	1.3432	0.79	1.214
	8.0	0.483	0.457	1.0294	1.3447	0.91	1.250
	9.0	0.549	0.516	1.0334	1.3462	1.04	1.289
	10.0	0.617	0.576	1.0375	1.3477	1.17	1.330
	12.0	0.757	0.697	1.0457	1.3508	1.44	1.416
	14.0	0.904	0.819	1.0540	1.3539	1.73	1.512
	16.0	1.057	0.944	1.0624	1.3571	2.03	1.625
	18.0	1.218	1.070	1.0710	1.3603	2.35	1.757
	20.0	1.388	1.199	1.0797	1.3635	2.70	1.904
	22.0	1.566	1.329	1.0884	1.3668	3.07	2.063
	24.0	1.753	1.462	1.0973	1.3702	3.48	2.242
	26.0	1.950	1.597	1.1063	1.3736	3.90	2.458
	28.0	2.159	1.734	1.1154	1.3770	4.34	2.707
	30.0	2.379	1.873	1.1246	1.3805	4.79	2.998
	32.0	2.612	2.014	1.1340	1.3840		3.324
	34.0	2.859	2.158	1.1434	1.3876		3.704
	36.0	3.122	2.304	1.1529	1.3912		4.193
	38.0	3.402	2.452	1.1626	1.3949		4.786
	40.0	3.700	2.603	1.1724	1.3986		5.493
	42.0	4.019	2.756	1.1823	1.4024		6.288
	44.0	4.361	2.912	1.1924	1.4062		7.235
	46.0	4.728	3.071	1.2026	1.4101		8.454
	48.0	5.124	3.232	1.2130	1.4141		9.883
	50.0	5.551	3.396	1.2235	1.4181		11.884
	52.0	6.013	3.562	1.2342	1.4222		14.489
	54.0	6.516	3.732	1.2451	1.4263		17.916
	56.0	7.064	3.905	1.2562	1.4306		22.886
	58.0	7.665	4.081	1.2676	1.4349		29.389
	60.0	8.326	4.261	1.2793	1.4394		37.445
Glycerol	0.5	0.055	0.054	0.9994	1.3336	0.07	1.011
$\text{CH}_2\text{OHCHOHCH}_2\text{OH}$	1.0	0.110	0.109	1.0005	1.3342	0.18	1.022
	2.0	0.222	0.218	1.0028	1.3353	0.41	1.048
	3.0	0.336	0.327	1.0051	1.3365	0.63	1.074
	4.0	0.452	0.438	1.0074	1.3376	0.85	1.100
	5.0	0.572	0.548	1.0097	1.3388	1.08	1.127
	6.0	0.693	0.659	1.0120	1.3400	1.32	1.157
	7.0	0.817	0.771	1.0144	1.3412	1.56	1.188
	8.0	0.944	0.883	1.0167	1.3424	1.81	1.220
	9.0	1.074	0.996	1.0191	1.3436	2.06	1.256
	10.0	1.207	1.109	1.0215	1.3448	2.32	1.291
	12.0	1.481	1.337	1.0262	1.3472	2.88	1.365
	14.0	1.768	1.568	1.0311	1.3496	3.47	1.445
	16.0	2.068	1.800	1.0360	1.3521	4.09	1.533
	18.0	2.384	2.035	1.0409	1.3547	4.76	1.630

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	20.0	2.715	2.271	1.0459	1.3572	5.46	1.737
	24.0	3.429	2.752	1.0561	1.3624	7.01	1.988
	28.0	4.223	3.242	1.0664	1.3676	8.77	2.279
	32.0	5.110	3.742	1.0770	1.3730	10.74	2.637
	36.0	6.108	4.252	1.0876	1.3785	12.96	3.088
	40.0	7.239	4.771	1.0984	1.3841	15.50	3.653
	44.0	8.532	5.300	1.1092	1.3897		4.443
	48.0	10.024	5.838	1.1200	1.3954		5.413
	52.0	11.764	6.385	1.1308	1.4011		6.666
	56.0	13.820	6.944	1.1419	1.4069		8.349
	60.0	16.288	7.512	1.1530	1.4129		10.681
	64.0	19.305	8.092	1.1643	1.4189		13.657
	68.0	23.075	8.680	1.1755	1.4249		18.457
	72.0	27.923	9.277	1.1866	1.4310		27.625
	76.0	34.387	9.884	1.1976	1.4370		40.571
	80.0	43.436	10.498	1.2085	1.4431		59.900
	84.0	57.009	11.121	1.2192	1.4492		84.338
	88.0	79.632	11.753	1.2299	1.4553		147.494
	92.0	124.878	12.392	1.2404	1.4613		384.467
	96.0	260.615	13.039	1.2508	1.4674		780.458
	100.0		13.694	1.2611	1.4735		
Hydrochloric acid	0.5	0.138	0.137	1.0007	1.3341	0.49	1.008
	1.0	0.277	0.275	1.0031	1.3353	0.99	1.015
HCl	2.0	0.560	0.553	1.0081	1.3376	2.08	1.029
	3.0	0.848	0.833	1.0130	1.3399	3.28	1.044
	4.0	1.143	1.117	1.0179	1.3422	4.58	1.059
	5.0	1.444	1.403	1.0228	1.3445	5.98	1.075
	6.0	1.751	1.691	1.0278	1.3468	7.52	1.091
	7.0	2.064	1.983	1.0327	1.3491	9.22	1.108
	8.0	2.385	2.277	1.0377	1.3515	11.10	1.125
	9.0	2.713	2.574	1.0426	1.3538	13.15	1.143
	10.0	3.047	2.873	1.0476	1.3561	15.40	1.161
	12.0	3.740	3.481	1.0576	1.3607	20.51	1.199
	14.0	4.465	4.099	1.0676	1.3653		1.239
	16.0	5.224	4.729	1.0777	1.3700		1.282
	18.0	6.020	5.370	1.0878	1.3746		1.326
	20.0	6.857	6.023	1.0980	1.3792		1.374
	22.0	7.736	6.687	1.1083	1.3838		1.426
	24.0	8.661	7.362	1.1185	1.3884		1.483
	26.0	9.636	8.049	1.1288	1.3930		1.547
	28.0	10.666	8.748	1.1391	1.3976		1.620
	30.0	11.754	9.456	1.1492	1.4020		1.705
	32.0	12.907	10.175	1.1594	1.4066		1.799
	34.0	14.129	10.904	1.1693	1.4112		1.900
	36.0	15.427	11.642	1.1791	1.4158		2.002
	38.0	16.810	12.388	1.1886	1.4204		2.105
	40.0	18.284	13.140	1.1977	1.4250		
Lactic acid	0.5	0.056	0.055	0.9992	1.3335	0.10	1.014
CH <sub>3</sub> CHOHCOOH	1.0	0.112	0.111	1.0002	1.3340	0.19	1.027
	2.0	0.227	0.223	1.0023	1.3350	0.38	1.056
	3.0	0.343	0.334	1.0043	1.3360	0.57	1.084
	4.0	0.463	0.447	1.0065	1.3370	0.76	1.110
	5.0	0.584	0.560	1.0086	1.3380	0.95	1.138
	6.0	0.709	0.673	1.0108	1.3390	1.16	1.167
	7.0	0.836	0.787	1.0131	1.3400	1.36	1.198
	8.0	0.965	0.902	1.0153	1.3410	1.57	1.229
	9.0	1.098	1.017	1.0176	1.3420	1.79	1.262
	10.0	1.233	1.132	1.0199	1.3430	2.02	1.296
	12.0	1.514	1.365	1.0246	1.3450	2.49	1.366

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	14.0	1.807	1.600	1.0294	1.3470	2.99	1.441
	16.0	2.115	1.837	1.0342	1.3491	3.48	1.522
	18.0	2.437	2.076	1.0390	1.3511	3.96	1.607
	20.0	2.775	2.318	1.0439	1.3532	4.44	1.699
	24.0	3.506	2.807	1.0536	1.3573		1.902
	28.0	4.317	3.305	1.0632	1.3615		2.136
	32.0	5.224	3.811	1.0728	1.3657		2.414
	36.0	6.244	4.325	1.0822	1.3700		2.730
	40.0	7.401	4.847	1.0915	1.3743		3.114
	44.0	8.722	5.377	1.1008	1.3786		3.566
	48.0	10.247	5.917	1.1105	1.3828		4.106
	52.0	12.026	6.466	1.1201	1.3871		4.789
	56.0	14.129	7.023	1.1297	1.3914		5.579
	60.0	16.652	7.588	1.1392	1.3958		6.679
	64.0	19.736	8.161	1.1486	1.4001		8.024
	68.0	23.590	8.741	1.1579	1.4045		9.863
	72.0	28.546	9.328	1.1670	1.4088		12.866
	76.0	35.154	9.922	1.1760	1.4131		16.974
	80.0	44.405	10.522	1.1848	1.4173		22.164
Lactose	0.5	0.015	0.015	1.0002	1.3337	0.03	1.013
$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	1.0	0.030	0.029	1.0021	1.3345	0.06	1.026
	2.0	0.060	0.059	1.0061	1.3359	0.11	1.058
	3.0	0.090	0.089	1.0102	1.3375	0.17	1.089
	4.0	0.122	0.119	1.0143	1.3390	0.23	1.120
	5.0	0.154	0.149	1.0184	1.3406	0.29	1.154
	6.0	0.186	0.179	1.0225	1.3421	0.35	1.191
	7.0	0.220	0.210	1.0267	1.3437	0.42	1.232
	8.0	0.254	0.241	1.0308	1.3453	0.50	1.276
	9.0	0.289	0.272	1.0349	1.3468		1.321
	10.0	0.325	0.304	1.0390	1.3484		1.370
	12.0	0.398	0.367	1.0473	1.3515		1.476
	14.0	0.476	0.432	1.0558	1.3548		1.593
	16.0	0.556	0.498	1.0648	1.3582		1.724
	18.0	0.641	0.565	1.0746	1.3619		1.869
Lithium chloride	0.5	0.119	0.118	1.0012	1.3341	0.42	1.019
	1.0	0.238	0.237	1.0041	1.3351	0.84	1.037
LiCl	2.0	0.481	0.476	1.0099	1.3373	1.72	1.072
	3.0	0.730	0.719	1.0157	1.3394	2.68	1.108
	4.0	0.983	0.964	1.0215	1.3415	3.73	1.146
	5.0	1.241	1.211	1.0272	1.3436	4.86	1.185
	6.0	1.506	1.462	1.0330	1.3457	6.14	1.226
	7.0	1.775	1.715	1.0387	1.3478	7.56	1.269
	8.0	2.051	1.971	1.0444	1.3499	9.11	1.313
	9.0	2.333	2.230	1.0502	1.3520	10.79	1.360
	10.0	2.621	2.491	1.0560	1.3541	12.61	1.411
	12.0	3.217	3.022	1.0675	1.3583	16.59	1.522
	14.0	3.840	3.564	1.0792	1.3625	21.04	1.647
	16.0	4.493	4.118	1.0910	1.3668		1.787
	18.0	5.178	4.683	1.1029	1.3711		1.942
	20.0	5.897	5.260	1.1150	1.3755		2.128
	22.0	6.653	5.851	1.1274	1.3799		2.341
	24.0	7.449	6.453	1.1399	1.3844		2.600
	26.0	8.288	7.069	1.1527	1.3890		2.925
	28.0	9.173	7.700	1.1658	1.3936		3.318
	30.0	10.109	8.344	1.1791	1.3983		3.785
Magnesium chloride	0.5	0.053	0.053	1.0022	1.3343	0.26	1.024
	1.0	0.106	0.106	1.0062	1.3356	0.52	1.046
$\text{MgCl}_2$	2.0	0.214	0.213	1.0144	1.3381	1.06	1.091

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	3.0	0.325	0.322	1.0226	1.3406	1.65	1.139
	4.0	0.438	0.433	1.0309	1.3432	2.30	1.188
	5.0	0.553	0.546	1.0394	1.3457	3.01	1.241
	6.0	0.670	0.660	1.0479	1.3483		1.298
	7.0	0.791	0.777	1.0564	1.3508		1.358
	8.0	0.913	0.895	1.0651	1.3534		1.423
	9.0	1.039	1.015	1.0738	1.3560		1.493
	10.0	1.167	1.137	1.0826	1.3587		1.570
	12.0	1.432	1.387	1.1005	1.3641		1.745
	14.0	1.710	1.645	1.1189	1.3695		1.956
	16.0	2.001	1.911	1.1372	1.3749		2.207
	18.0	2.306	2.184	1.1553	1.3804		2.507
	20.0	2.626	2.467	1.1742	1.3859		2.867
	22.0	2.962	2.758	1.1938	1.3915		3.323
	24.0	3.317	3.060	1.2140	1.3972		3.917
	26.0	3.690	3.371	1.2346	1.4030		4.694
	28.0	4.085	3.692	1.2555	1.4089		5.709
	30.0	4.501	4.022	1.2763	1.4148		7.017
Magnesium sulfate	0.5	0.042	0.042	1.0033	1.3340	0.10	1.027
$\text{MgSO}_4$	1.0	0.084	0.084	1.0084	1.3350	0.19	1.054
	2.0	0.170	0.169	1.0186	1.3371	0.36	1.112
	3.0	0.257	0.256	1.0289	1.3391	0.52	1.177
	4.0	0.346	0.345	1.0392	1.3411	0.69	1.249
	5.0	0.437	0.436	1.0497	1.3431	0.87	1.328
	6.0	0.530	0.528	1.0602	1.3451	1.05	1.411
	7.0	0.625	0.623	1.0708	1.3471	1.24	1.498
	8.0	0.722	0.719	1.0816	1.3492	1.43	1.593
	9.0	0.822	0.817	1.0924	1.3512	1.64	1.702
	10.0	0.923	0.917	1.1034	1.3532	1.85	1.829
	12.0	1.133	1.122	1.1257	1.3572	2.31	2.104
	14.0	1.352	1.336	1.1484	1.3613	2.86	2.412
	16.0	1.582	1.557	1.1717	1.3654	3.67	2.809
	18.0	1.824	1.788	1.1955	1.3694		3.360
	20.0	2.077	2.027	1.2198	1.3735		4.147
	22.0	2.343	2.275	1.2447	1.3776		5.199
	24.0	2.624	2.532	1.2701	1.3817		6.498
	26.0	2.919	2.800	1.2961	1.3858		8.066
Maltose	0.5	0.015	0.015	1.0003	1.3337	0.03	1.016
$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	1.0	0.030	0.029	1.0023	1.3345	0.06	1.030
	2.0	0.060	0.059	1.0063	1.3359	0.11	1.060
	3.0	0.090	0.089	1.0104	1.3374	0.17	1.092
	4.0	0.122	0.119	1.0144	1.3389	0.23	1.126
	5.0	0.154	0.149	1.0184	1.3404	0.29	1.162
	6.0	0.186	0.179	1.0224	1.3420	0.35	1.200
	7.0	0.220	0.210	1.0265	1.3435	0.42	1.239
	8.0	0.254	0.241	1.0305	1.3450	0.48	1.281
	9.0	0.289	0.272	1.0345	1.3466	0.55	1.325
	10.0	0.325	0.303	1.0385	1.3482	0.62	1.372
	12.0	0.398	0.367	1.0465	1.3513	0.77	1.474
	14.0	0.476	0.431	1.0545	1.3546	0.92	1.588
	16.0	0.556	0.497	1.0629	1.3578	1.08	1.715
	18.0	0.641	0.564	1.0716	1.3612	1.25	1.859
	20.0	0.730	0.631	1.0801	1.3644	1.43	2.021
	22.0	0.824	0.700	1.0894	1.3678	1.64	2.216
	24.0	0.923	0.770	1.0984	1.3714	1.85	2.463
	26.0	1.026	0.842	1.1080	1.3749	2.08	2.753
	28.0	1.136	0.914	1.1171	1.3785	2.34	3.066
	30.0	1.252	0.988	1.1269	1.3821	2.62	3.427
	40.0	1.948	1.375	1.1769	1.4013	4.41	6.926

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	50.0	2.921	1.797	1.2304	1.4217		17.786
	52.0	3.165	1.886	1.2416	1.4260		22.034
	54.0	3.429	1.976	1.2528	1.4308		28.757
	56.0	3.718	2.068	1.2638	1.4350		38.226
	58.0	4.034	2.159	1.2740	1.4394		49.298
	60.0	4.382	2.253	1.2855	1.4440		
Manganese(II) sulfate $\text{MnSO}_4$	1.0	0.067	0.067	1.0080	1.3348	0.16	1.046
	2.0	0.135	0.135	1.0178	1.3366	0.31	1.090
	3.0	0.205	0.204	1.0277	1.3384	0.44	1.137
	4.0	0.276	0.275	1.0378	1.3402	0.57	1.187
	5.0	0.349	0.347	1.0480	1.3420	0.70	1.242
	6.0	0.423	0.421	1.0583	1.3438	0.84	1.301
	7.0	0.498	0.495	1.0688	1.3457	0.98	1.363
	8.0	0.576	0.572	1.0794	1.3475	1.12	1.431
	9.0	0.655	0.650	1.0902	1.3494	1.28	1.505
	10.0	0.736	0.729	1.1012	1.3513	1.44	1.587
	12.0	0.903	0.893	1.1236	1.3551	1.80	1.779
	14.0	1.078	1.063	1.1467	1.3589	2.21	2.005
	16.0	1.261	1.240	1.1705	1.3629	2.67	2.272
	18.0	1.454	1.424	1.1950	1.3668	3.19	2.580
	20.0	1.656	1.616	1.2203	1.3708	3.80	2.938
<i>D</i> -Mannitol $\text{CH}_2(\text{CHOH})_4\text{CH}_2\text{OH}$	0.5	0.028	0.027	1.0000	1.3337	0.05	1.019
	1.0	0.055	0.055	1.0017	1.3345	0.10	1.032
	2.0	0.112	0.110	1.0053	1.3359	0.21	1.057
	3.0	0.170	0.166	1.0088	1.3374	0.32	1.081
	4.0	0.229	0.222	1.0124	1.3389	0.43	1.107
	5.0	0.289	0.279	1.0159	1.3403	0.54	1.135
	6.0	0.350	0.336	1.0195	1.3418	0.66	1.166
	7.0	0.413	0.393	1.0230	1.3433	0.77	1.200
	8.0	0.477	0.451	1.0266	1.3447	0.90	1.236
	9.0	0.543	0.509	1.0302	1.3462	1.02	1.275
	10.0	0.610	0.567	1.0338	1.3477	1.15	1.314
	11.0	0.678	0.626	1.0375	1.3491	1.28	1.355
	12.0	0.749	0.686	1.0412	1.3506	1.41	1.398
	13.0	0.820	0.746	1.0450	1.3521	1.55	1.443
	14.0	0.894	0.806	1.0489	1.3536	1.69	1.489
	15.0	0.969	0.867	1.0529	1.3552	1.84	1.537
Methanol $\text{CH}_3\text{OH}$	0.5	0.157	0.156	0.9973	1.3331	0.28	1.022
	1.0	0.315	0.311	0.9964	1.3332	0.56	1.040
	2.0	0.637	0.621	0.9947	1.3334	1.14	1.070
	3.0	0.965	0.930	0.9930	1.3336	1.75	1.100
	4.0	1.300	1.238	0.9913	1.3339	2.37	1.131
	5.0	1.643	1.544	0.9896	1.3341	3.02	1.163
	6.0	1.992	1.850	0.9880	1.3343	3.71	1.196
	7.0	2.349	2.155	0.9864	1.3346	4.41	1.229
	8.0	2.714	2.459	0.9848	1.3348	5.13	1.264
	9.0	3.087	2.762	0.9832	1.3351	5.85	1.297
	10.0	3.468	3.064	0.9816	1.3354	6.60	1.329
	12.0	4.256	3.665	0.9785	1.3359	8.14	1.389
	14.0	5.081	4.262	0.9755	1.3365	9.72	1.446
	16.0	5.945	4.856	0.9725	1.3370	11.36	1.501
	18.0	6.851	5.447	0.9695	1.3376	13.13	1.554
	20.0	7.803	6.034	0.9666	1.3381	15.02	1.604
	22.0	8.803	6.616	0.9636	1.3387	16.98	1.652
	24.0	9.856	7.196	0.9606	1.3392	19.04	1.697
	26.0	10.966	7.771	0.9576	1.3397	21.23	1.735
	28.0	12.138	8.341	0.9545	1.3402	23.59	1.769
	30.0	13.376	8.908	0.9514	1.3407	25.91	1.795



Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	32.0	14.688	9.470	0.9482	1.3411	28.15	1.814
	34.0	16.078	10.028	0.9450	1.3415	30.48	1.827
	36.0	17.556	10.580	0.9416	1.3419	32.97	1.835
	38.0	19.129	11.127	0.9382	1.3422	35.60	1.839
	40.0	20.807	11.669	0.9347	1.3425	38.60	1.837
	50.0	31.211	14.288	0.9156	1.3431	54.50	1.761
	60.0	46.816	16.749	0.8944	1.3426	74.50	1.600
	70.0	72.826	19.040	0.8715	1.3411		1.368
	80.0	124.844	21.144	0.8468	1.3385		1.128
	90.0	280.899	23.045	0.8204	1.3348		0.861
	100.0		24.710	0.7917	1.3290		0.586
Nitric acid	0.5	0.080	0.079	1.0009	1.3336	0.28	1.004
HNO <sub>3</sub>	1.0	0.160	0.159	1.0037	1.3343	0.56	1.005
	2.0	0.324	0.320	1.0091	1.3356	1.12	1.007
	3.0	0.491	0.483	1.0146	1.3368	1.70	1.010
	4.0	0.661	0.648	1.0202	1.3381	2.32	1.014
	5.0	0.835	0.814	1.0257	1.3394	2.96	1.018
	6.0	1.013	0.982	1.0314	1.3407	3.63	1.022
	7.0	1.194	1.152	1.0370	1.3421	4.33	1.027
	8.0	1.380	1.324	1.0427	1.3434	5.05	1.032
	9.0	1.570	1.498	1.0485	1.3447	5.81	1.038
	10.0	1.763	1.673	1.0543	1.3460	6.60	1.044
	12.0	2.164	2.030	1.0660	1.3487	8.27	1.058
	14.0	2.583	2.395	1.0780	1.3514	10.08	1.075
	16.0	3.023	2.768	1.0901	1.3541	12.04	1.094
	18.0	3.484	3.149	1.1025	1.3569	14.16	1.116
	20.0	3.967	3.539	1.1150	1.3596		1.141
	22.0	4.476	3.937	1.1277	1.3624		1.169
	24.0	5.011	4.344	1.1406	1.3652		1.199
	26.0	5.576	4.760	1.1536	1.3680		1.233
	28.0	6.172	5.185	1.1668	1.3708		1.271
	30.0	6.801	5.618	1.1801	1.3736		1.311
	32.0	7.468	6.060	1.1934	1.3763		1.354
	34.0	8.175	6.512	1.2068	1.3790		1.400
	36.0	8.927	6.971	1.2202	1.3817		1.450
	38.0	9.727	7.439	1.2335	1.3842		1.504
	40.0	10.580	7.913	1.2466	1.3867		1.561
Oxalic acid	0.5	0.056	0.056	1.0006	1.3336	0.16	1.013
(COOH) <sub>2</sub>	1.0	0.112	0.111	1.0030	1.3342	0.30	1.023
	1.5	0.169	0.167	1.0054	1.3347	0.44	1.033
	2.0	0.227	0.224	1.0079	1.3353	0.57	1.044
	2.5	0.285	0.281	1.0103	1.3359	0.71	1.055
	3.0	0.343	0.337	1.0126	1.3364	0.84	1.065
	3.5	0.403	0.395	1.0150	1.3370	0.97	1.076
	4.0	0.463	0.452	1.0174	1.3375	1.09	1.086
	4.5	0.523	0.510	1.0197	1.3381		1.097
	5.0	0.585	0.568	1.0220	1.3386		1.108
	6.0	0.709	0.684	1.0265	1.3397		1.129
	7.0	0.836	0.802	1.0310	1.3407		1.150
	8.0	0.966	0.920	1.0355	1.3418		1.172
Phosphoric acid	0.5	0.051	0.051	1.0010	1.3335	0.12	1.010
H <sub>3</sub> PO <sub>4</sub>	1.0	0.103	0.102	1.0038	1.3340	0.24	1.020
	2.0	0.208	0.206	1.0092	1.3349	0.46	1.050
	3.0	0.316	0.311	1.0146	1.3358	0.69	1.079
	4.0	0.425	0.416	1.0200	1.3367	0.93	1.108
	5.0	0.537	0.523	1.0254	1.3376	1.16	1.138
	6.0	0.651	0.631	1.0309	1.3385	1.38	1.169
	7.0	0.768	0.740	1.0363	1.3394	1.62	1.200

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	8.0	0.887	0.850	1.0418	1.3403	1.88	1.232
	9.0	1.009	0.962	1.0474	1.3413	2.16	1.267
	10.0	1.134	1.075	1.0531	1.3422	2.45	1.303
	12.0	1.392	1.304	1.0647	1.3441	3.01	1.382
	14.0	1.661	1.538	1.0765	1.3460	3.76	1.469
	16.0	1.944	1.777	1.0885	1.3480	4.45	1.565
	18.0	2.240	2.022	1.1009	1.3500	5.25	1.671
	20.0	2.551	2.273	1.1135	1.3520	6.23	1.788
	22.0	2.878	2.529	1.1263	1.3540	7.38	1.914
	24.0	3.223	2.791	1.1395	1.3561	8.69	2.049
	26.0	3.585	3.059	1.1528	1.3582	10.12	2.198
	28.0	3.968	3.333	1.1665	1.3604	11.64	2.365
	30.0	4.373	3.614	1.1804	1.3625	13.23	2.553
	32.0	4.802	3.901	1.1945	1.3647	14.94	2.766
	34.0	5.257	4.194	1.2089	1.3669	16.81	3.001
	36.0	5.740	4.495	1.2236	1.3691	18.85	3.260
	38.0	6.254	4.803	1.2385	1.3713	21.09	3.544
	40.0	6.803	5.117	1.2536	1.3735	23.58	3.856
Potassium bicarbonate $\text{KHCO}_3$	0.5	0.050	0.050	1.0014	1.3335	0.18	1.009
	1.0	0.101	0.100	1.0046	1.3341	0.34	1.015
	2.0	0.204	0.202	1.0114	1.3353	0.67	1.027
	3.0	0.309	0.305	1.0181	1.3365	0.98	1.040
	4.0	0.416	0.409	1.0247	1.3376	1.29	1.053
	5.0	0.526	0.515	1.0310	1.3386	1.60	1.067
	6.0	0.638	0.622	1.0379	1.3397	1.91	1.081
	7.0	0.752	0.730	1.0446	1.3409	2.22	1.096
	8.0	0.869	0.840	1.0514	1.3419	2.53	1.112
	9.0	0.988	0.951	1.0581	1.3430	2.84	1.128
	10.0	1.110	1.064	1.0650	1.3441	3.16	1.145
	12.0	1.362	1.293	1.0788	1.3462	3.79	1.183
	14.0	1.626	1.528	1.0929	1.3484	4.41	1.224
	16.0	1.903	1.770	1.1073	1.3506		1.270
	18.0	2.193	2.017	1.1221	1.3528		1.319
	20.0	2.497	2.272	1.1372	1.3550		1.373
	22.0	2.817	2.533	1.1527	1.3572		1.432
	24.0	3.154	2.801	1.1685	1.3595		1.497
Potassium bromide $\text{KBr}$	0.5	0.042	0.042	1.0018	1.3336	0.15	1.000
	1.0	0.085	0.084	1.0054	1.3342	0.29	0.998
	2.0	0.171	0.170	1.0127	1.3354	0.59	0.994
	3.0	0.260	0.257	1.0200	1.3366	0.88	0.990
	4.0	0.350	0.345	1.0275	1.3379	1.18	0.985
	5.0	0.442	0.435	1.0350	1.3391	1.48	0.981
	6.0	0.536	0.526	1.0426	1.3403	1.78	0.977
	7.0	0.633	0.618	1.0503	1.3416	2.10	0.974
	8.0	0.731	0.711	1.0581	1.3429	2.42	0.970
	9.0	0.831	0.806	1.0660	1.3441	2.74	0.967
	10.0	0.934	0.903	1.0740	1.3454	3.07	0.964
	12.0	1.146	1.099	1.0903	1.3481	3.76	0.958
	14.0	1.368	1.302	1.1070	1.3507	4.49	0.953
	16.0	1.601	1.512	1.1242	1.3535	5.25	0.949
	18.0	1.845	1.727	1.1419	1.3562	6.04	0.946
	20.0	2.101	1.950	1.1601	1.3591	6.88	0.944
	22.0	2.370	2.179	1.1788	1.3620	7.76	0.943
	24.0	2.654	2.416	1.1980	1.3650	8.70	0.943
	26.0	2.952	2.661	1.2179	1.3680	9.68	0.944
	28.0	3.268	2.914	1.2383	1.3711	10.72	0.947
	30.0	3.601	3.175	1.2593	1.3743	11.82	0.952
	32.0	3.954	3.445	1.2810	1.3776	12.98	0.959
	34.0	4.329	3.724	1.3033	1.3809		0.968

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	36.0	4.727	4.012	1.3263	1.3843		0.979
	38.0	5.150	4.311	1.3501	1.3878		0.993
	40.0	5.602	4.620	1.3746	1.3914		1.010
Potassium carbonate $\text{K}_2\text{CO}_3$	0.5	0.036	0.036	1.0027	1.3339	0.18	1.013
	1.0	0.073	0.073	1.0072	1.3347	0.34	1.025
	2.0	0.148	0.147	1.0163	1.3365	0.66	1.048
	3.0	0.224	0.223	1.0254	1.3382	0.99	1.071
	4.0	0.301	0.299	1.0345	1.3399	1.32	1.094
	5.0	0.381	0.378	1.0437	1.3416	1.67	1.119
	6.0	0.462	0.457	1.0529	1.3433	2.03	1.146
	7.0	0.545	0.538	1.0622	1.3450	2.40	1.174
	8.0	0.629	0.620	1.0715	1.3467	2.77	1.204
	9.0	0.716	0.704	1.0809	1.3484	3.17	1.235
	10.0	0.804	0.789	1.0904	1.3501	3.57	1.269
	12.0	0.987	0.963	1.1095	1.3535	4.45	1.339
	14.0	1.178	1.144	1.1291	1.3569	5.39	1.414
	16.0	1.378	1.330	1.1490	1.3603	6.42	1.497
	18.0	1.588	1.523	1.1692	1.3637	7.55	1.594
	20.0	1.809	1.722	1.1898	1.3671	8.82	1.707
	24.0	2.285	2.139	1.2320	1.3739	11.96	1.978
	28.0	2.814	2.584	1.2755	1.3807	16.01	2.331
	32.0	3.405	3.057	1.3204	1.3874	21.46	2.834
	36.0	4.070	3.559	1.3665	1.3940	28.58	3.503
	40.0	4.824	4.093	1.4142	1.4006	37.55	4.360
	50.0	7.236	5.573	1.5404	1.4168		9.369
Potassium chloride KCl	0.5	0.067	0.067	1.0014	1.3337	0.23	1.000
	1.0	0.135	0.135	1.0046	1.3343	0.46	0.999
	2.0	0.274	0.271	1.0110	1.3357	0.92	0.999
	3.0	0.415	0.409	1.0174	1.3371	1.38	0.998
	4.0	0.559	0.549	1.0239	1.3384	1.85	0.997
	5.0	0.706	0.691	1.0304	1.3398	2.32	0.996
	6.0	0.856	0.835	1.0369	1.3411	2.80	0.994
	7.0	1.010	0.980	1.0434	1.3425	3.29	0.992
	8.0	1.166	1.127	1.0500	1.3438	3.80	0.990
	9.0	1.327	1.276	1.0566	1.3452	4.30	0.989
	10.0	1.490	1.426	1.0633	1.3466	4.81	0.988
	12.0	1.829	1.733	1.0768	1.3493	5.88	0.990
	14.0	2.184	2.048	1.0905	1.3521		0.994
	16.0	2.555	2.370	1.1043	1.3549		0.999
	18.0	2.944	2.701	1.1185	1.3577		1.004
	20.0	3.353	3.039	1.1328	1.3606		1.012
	22.0	3.783	3.386	1.1474	1.3635		1.024
	24.0	4.236	3.742	1.1623	1.3665		1.040
Potassium hydroxide KOH	0.5	0.090	0.089	1.0025	1.3340	0.30	1.010
	1.0	0.180	0.179	1.0068	1.3350	0.61	1.019
	2.0	0.364	0.362	1.0155	1.3369	1.24	1.038
	3.0	0.551	0.548	1.0242	1.3388	1.89	1.058
	4.0	0.743	0.736	1.0330	1.3408	2.57	1.079
	5.0	0.938	0.929	1.0419	1.3427	3.36	1.102
	6.0	1.138	1.124	1.0509	1.3445	4.14	1.126
	7.0	1.342	1.322	1.0599	1.3464	4.92	1.151
	8.0	1.550	1.524	1.0690	1.3483		1.177
	9.0	1.763	1.729	1.0781	1.3502		1.205
	10.0	1.980	1.938	1.0873	1.3520		1.233
	12.0	2.431	2.365	1.1059	1.3558		1.294
	14.0	2.902	2.806	1.1246	1.3595		1.361
	16.0	3.395	3.261	1.1435	1.3632		1.436
	18.0	3.913	3.730	1.1626	1.3670		1.521

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	20.0	4.456	4.213	1.1818	1.3707		1.619
	22.0	5.027	4.711	1.2014	1.3744		1.732
	24.0	5.629	5.223	1.2210	1.3781		1.861
	26.0	6.262	5.750	1.2408	1.3818		2.006
	28.0	6.931	6.293	1.2609	1.3854		2.170
	30.0	7.639	6.851	1.2813	1.3889		2.357
	40.0	11.882	9.896	1.3881	1.4068		3.879
	50.0	17.824	13.389	1.5024	1.4247		7.892
Potassium iodide	0.5	0.030	0.030	1.0019	1.3337	0.11	0.999
	1.0	0.061	0.061	1.0056	1.3343	0.22	0.997
KI	2.0	0.123	0.122	1.0131	1.3357	0.43	0.991
	3.0	0.186	0.184	1.0206	1.3370	0.64	0.986
	4.0	0.251	0.248	1.0282	1.3384	0.86	0.981
	5.0	0.317	0.312	1.0360	1.3397	1.08	0.976
	6.0	0.385	0.377	1.0438	1.3411	1.30	0.969
	7.0	0.453	0.443	1.0517	1.3425	1.53	0.963
	8.0	0.524	0.511	1.0598	1.3440	1.77	0.957
	9.0	0.596	0.579	1.0679	1.3454	2.01	0.951
	10.0	0.669	0.648	1.0762	1.3469	2.26	0.946
	12.0	0.821	0.790	1.0931	1.3498	2.77	0.937
	14.0	0.981	0.937	1.1105	1.3529	3.30	0.929
	16.0	1.147	1.088	1.1284	1.3560	3.87	0.921
	18.0	1.322	1.244	1.1469	1.3593	4.46	0.915
	20.0	1.506	1.405	1.1659	1.3626	5.09	0.910
	22.0	1.699	1.571	1.1856	1.3661	5.76	0.905
	24.0	1.902	1.744	1.2060	1.3696	6.46	0.901
	26.0	2.117	1.922	1.2270	1.3733	7.21	0.898
	28.0	2.343	2.106	1.2487	1.3771	8.01	0.895
	30.0	2.582	2.297	1.2712	1.3810	8.86	0.892
	32.0	2.835	2.495	1.2944	1.3851	9.76	0.891
	34.0	3.103	2.700	1.3185	1.3893	10.72	0.890
	36.0	3.388	2.913	1.3434	1.3936	11.73	0.890
	38.0	3.692	3.134	1.3692	1.3981	12.81	0.893
	40.0	4.016	3.364	1.3959	1.4027	13.97	0.897
Potassium nitrate	0.5	0.050	0.050	1.0014	1.3335	0.17	0.999
	1.0	0.100	0.099	1.0045	1.3339	0.33	0.996
KNO <sub>3</sub>	2.0	0.202	0.200	1.0108	1.3349	0.64	0.990
	3.0	0.306	0.302	1.0171	1.3358	0.94	0.986
	4.0	0.412	0.405	1.0234	1.3368	1.22	0.983
	5.0	0.521	0.509	1.0298	1.3377	1.50	0.980
	6.0	0.631	0.615	1.0363	1.3386	1.76	0.977
	7.0	0.744	0.722	1.0428	1.3396	2.02	0.975
	8.0	0.860	0.830	1.0494	1.3405	2.27	0.973
	9.0	0.978	0.940	1.0560	1.3415	2.52	0.971
	10.0	1.099	1.051	1.0627	1.3425	2.75	0.970
	12.0	1.349	1.277	1.0762	1.3444		0.970
	14.0	1.610	1.509	1.0899	1.3463		0.972
	16.0	1.884	1.747	1.1039	1.3482		0.976
	18.0	2.171	1.991	1.1181	1.3502		0.982
	20.0	2.473	2.240	1.1326	1.3521		0.990
	22.0	2.790	2.497	1.1473	1.3541		0.999
	24.0	3.123	2.759	1.1623	1.3561		1.010
Potassium permanganate	0.5	0.032	0.032	1.0017		0.11	1.001
	1.0	0.064	0.064	1.0051		0.22	1.000
KMnO <sub>4</sub>	1.5	0.096	0.096	1.0085		0.32	0.999
	2.0	0.129	0.128	1.0118		0.43	0.998
	3.0	0.196	0.193	1.0186			0.995
	4.0	0.264	0.260	1.0254			0.992

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	5.0	0.333	0.327	1.0322			0.989
	6.0	0.404	0.394	1.0390			0.985
Potassium hydrogen phosphate $\text{K}_2\text{HPO}_4$	0.5	0.029	0.029	1.0025	1.3338	0.13	1.013
	1.0	0.058	0.058	1.0068	1.3345	0.25	1.023
	1.5	0.087	0.087	1.0110	1.3353	0.37	1.034
	2.0	0.117	0.117	1.0153	1.3361	0.49	1.046
	2.5	0.147	0.146	1.0195	1.3368	0.61	1.057
	3.0	0.178	0.176	1.0238	1.3376	0.73	1.069
	3.5	0.208	0.207	1.0281	1.3384	0.86	1.081
	4.0	0.239	0.237	1.0324	1.3392	0.97	1.094
	4.5	0.271	0.268	1.0368	1.3399	1.10	1.107
	5.0	0.302	0.299	1.0412	1.3407	1.22	1.120
	6.0	0.366	0.362	1.0500	1.3422	1.46	1.147
	7.0	0.432	0.426	1.0590	1.3438	1.70	1.177
	8.0	0.499	0.491	1.0680	1.3453	1.95	1.209
Potassium dihydrogen phosphate $\text{KH}_2\text{PO}_4$	0.5	0.037	0.037	1.0018	1.3336	0.13	1.010
	1.0	0.074	0.074	1.0053	1.3342	0.25	1.019
	1.5	0.112	0.111	1.0089	1.3348	0.37	1.028
	2.0	0.150	0.149	1.0125	1.3354	0.49	1.038
	3.0	0.227	0.225	1.0197	1.3365	0.72	1.060
	4.0	0.306	0.302	1.0269	1.3377	0.96	1.083
	5.0	0.387	0.380	1.0342	1.3388	1.19	1.108
	6.0	0.469	0.459	1.0414	1.3400	1.41	1.133
	7.0	0.553	0.539	1.0486	1.3411	1.63	1.160
	8.0	0.639	0.621	1.0558	1.3422	1.84	1.187
	9.0	0.727	0.703	1.0630	1.3434	2.04	1.215
	10.0	0.816	0.786	1.0703	1.3445	2.23	1.245
Potassium sulfate $\text{K}_2\text{SO}_4$	0.5	0.029	0.029	1.0022	1.3336	0.14	1.006
	1.0	0.058	0.058	1.0062	1.3343	0.26	1.011
	2.0	0.117	0.116	1.0143	1.3355	0.50	1.021
	3.0	0.177	0.176	1.0224	1.3368	0.73	1.033
	4.0	0.239	0.237	1.0306	1.3380	0.95	1.045
	5.0	0.302	0.298	1.0388	1.3393	1.17	1.058
	6.0	0.366	0.360	1.0470	1.3405		1.072
	7.0	0.432	0.424	1.0553	1.3417		1.087
	8.0	0.499	0.488	1.0637	1.3428		1.102
	9.0	0.568	0.554	1.0721	1.3440		1.117
	10.0	0.638	0.620	1.0806	1.3452		1.132
1-Propanol $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	1.0	0.168	0.166	0.9963	1.3339	0.31	1.051
	2.0	0.340	0.331	0.9946	1.3348	0.61	1.100
	3.0	0.515	0.496	0.9928	1.3357	0.93	1.152
	4.0	0.693	0.660	0.9911	1.3366	1.24	1.208
	5.0	0.876	0.823	0.9896	1.3376	1.57	1.267
	6.0	1.062	0.987	0.9882	1.3385	1.91	1.325
	7.0	1.252	1.149	0.9868	1.3394	2.26	1.387
	8.0	1.447	1.312	0.9855	1.3404	2.61	1.449
	9.0	1.646	1.474	0.9842	1.3414	2.99	1.514
	10.0	1.849	1.635	0.9829	1.3423	3.36	1.577
	12.0	2.269	1.958	0.9804	1.3442	4.09	1.710
	14.0	2.709	2.278	0.9779	1.3460	4.91	1.849
	16.0	3.169	2.595	0.9749	1.3477	5.78	1.986
	18.0	3.652	2.911	0.9719	1.3494	6.67	2.106
	20.0	4.160	3.223	0.9686	1.3510	7.76	2.218
	24.0	5.254	3.838	0.9612	1.3539	9.12	2.432
	28.0	6.471	4.441	0.9533	1.3566	10.17	2.612
	32.0	7.830	5.033	0.9452	1.3592	10.66	2.765
	36.0	9.359	5.613	0.9370	1.3614		2.900

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	40.0	11.093	6.182	0.9288	1.3635		3.010
	60.0	24.958	8.860	0.8875	1.3734		3.186
	80.0	66.556	11.275	0.8470	1.3812		2.822
	100.0		13.368	0.8034	1.3852		2.227
2-Propanol	1.0	0.168	0.166	0.9960	1.3338	0.30	1.056
$\text{CH}_3\text{CHOHCH}_3$	2.0	0.340	0.331	0.9939	1.3346	0.60	1.112
	3.0	0.515	0.495	0.9920	1.3355	0.93	1.166
	4.0	0.693	0.659	0.9902	1.3364	1.26	1.225
	5.0	0.876	0.822	0.9884	1.3373	1.61	1.287
	6.0	1.062	0.985	0.9871	1.3382	1.96	1.352
	7.0	1.252	1.148	0.9855	1.3392	2.32	1.417
	8.0	1.447	1.310	0.9843	1.3400	2.68	1.485
	9.0	1.646	1.472	0.9831	1.3410	3.06	1.553
	10.0	1.849	1.633	0.9816	1.3420	3.48	1.629
	12.0	2.269	1.955	0.9793	1.3439	4.43	1.794
	14.0	2.709	2.276	0.9772	1.3459	5.29	1.970
	16.0	3.169	2.596	0.9751	1.3478	6.36	2.160
	18.0	3.652	2.913	0.9725	1.3496	7.40	2.352
	20.0	4.160	3.227	0.9696	1.3514	8.52	2.550
	40.0	11.093	6.191	0.9302	1.3642		
	60.0	24.958	8.809	0.8824	1.3717		
	80.0	66.556	11.103	0.8341	1.3742		
	100.0		13.058	0.7848	1.3776		
Silver nitrate	0.5	0.030	0.030	1.0027	1.3336	0.10	1.003
$\text{AgNO}_3$	1.0	0.059	0.059	1.0070	1.3342	0.20	1.005
	2.0	0.120	0.120	1.0154	1.3352	0.40	1.009
	3.0	0.182	0.181	1.0239	1.3363	0.59	1.013
	4.0	0.245	0.243	1.0327	1.3374	0.78	1.016
	5.0	0.310	0.307	1.0417	1.3385	0.96	1.020
	6.0	0.376	0.371	1.0506	1.3396	1.15	1.024
	7.0	0.443	0.437	1.0597	1.3407	1.33	1.027
	8.0	0.512	0.503	1.0690	1.3419	1.51	1.031
	9.0	0.582	0.571	1.0785	1.3431	1.69	1.035
	10.0	0.654	0.641	1.0882	1.3443	1.87	1.039
	12.0	0.803	0.783	1.1079	1.3467	2.21	1.049
	14.0	0.958	0.930	1.1284	1.3493	2.55	1.060
	16.0	1.121	1.083	1.1496	1.3519	2.86	1.072
	18.0	1.292	1.241	1.1715	1.3546		1.086
	20.0	1.472	1.406	1.1942	1.3574		1.101
	22.0	1.660	1.577	1.2177	1.3602		1.117
	24.0	1.859	1.755	1.2420	1.3632		1.135
	26.0	2.068	1.940	1.2672	1.3662		1.154
	28.0	2.289	2.132	1.2933	1.3694		1.176
	30.0	2.523	2.332	1.3204	1.3726		1.200
	32.0	2.770	2.541	1.3487	1.3760		1.227
	34.0	3.033	2.758	1.3780	1.3795		1.257
	36.0	3.311	2.985	1.4087	1.3832		1.290
	38.0	3.608	3.223	1.4407	1.3871		1.326
	40.0	3.925	3.472	1.4743	1.3911		1.366
Sodium acetate	0.5	0.061	0.061	1.0008	1.3337	0.22	1.021
$\text{CH}_3\text{COONa}$	1.0	0.123	0.122	1.0034	1.3344	0.43	1.040
	2.0	0.249	0.246	1.0085	1.3358	0.88	1.080
	3.0	0.377	0.371	1.0135	1.3372	1.34	1.124
	4.0	0.508	0.497	1.0184	1.3386	1.82	1.171
	5.0	0.642	0.624	1.0234	1.3400	2.32	1.222
	6.0	0.778	0.752	1.0283	1.3414	2.85	1.278
	7.0	0.918	0.882	1.0334	1.3428	3.40	1.337
	8.0	1.060	1.013	1.0386	1.3442	3.98	1.401

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	9.0	1.206	1.145	1.0440	1.3456	4.57	1.468
	10.0	1.354	1.279	1.0495	1.3470		1.539
	12.0	1.662	1.552	1.0607	1.3498		1.688
	14.0	1.984	1.829	1.0718	1.3526		1.855
	16.0	2.322	2.112	1.0830	1.3554		2.054
	18.0	2.676	2.400	1.0940	1.3583		2.284
	20.0	3.047	2.694	1.1050	1.3611		2.567
	22.0	3.438	2.993	1.1159	1.3639		2.948
	24.0	3.849	3.297	1.1268	1.3666		3.400
	26.0	4.283	3.606	1.1377	1.3693		3.877
	28.0	4.741	3.921	1.1488	1.3720		4.388
	30.0	5.224	4.243	1.1602	1.3748		4.940
Sodium bicarbonate $\text{NaHCO}_3$	0.5	0.060	0.060	1.0018	1.3337	0.20	1.015
	1.0	0.120	0.120	1.0054	1.3344	0.40	1.028
	1.5	0.181	0.180	1.0089	1.3351	0.59	1.042
	2.0	0.243	0.241	1.0125	1.3357	0.78	1.057
	2.5	0.305	0.302	1.0160	1.3364	0.98	1.071
	3.0	0.368	0.364	1.0196	1.3370	1.16	1.086
	3.5	0.432	0.426	1.0231	1.3377	1.35	1.102
	4.0	0.496	0.489	1.0266	1.3383	1.54	1.118
	4.5	0.561	0.552	1.0301	1.3390	1.72	1.134
	5.0	0.627	0.615	1.0337	1.3396	1.90	1.151
	5.5	0.693	0.679	1.0372	1.3403	2.08	1.168
	6.0	0.760	0.743	1.0408	1.3409	2.26	1.185
Sodium bromide $\text{NaBr}$	0.5	0.049	0.049	1.0021	1.3337	0.17	1.004
	1.0	0.098	0.098	1.0060	1.3344	0.34	1.007
	2.0	0.198	0.197	1.0139	1.3358	0.69	1.012
	3.0	0.301	0.298	1.0218	1.3372	1.04	1.017
	4.0	0.405	0.400	1.0298	1.3386	1.39	1.022
	5.0	0.512	0.504	1.0380	1.3401	1.76	1.028
	6.0	0.620	0.610	1.0462	1.3415	2.14	1.034
	7.0	0.732	0.717	1.0546	1.3430	2.53	1.040
	8.0	0.845	0.826	1.0630	1.3445	2.93	1.046
	9.0	0.961	0.937	1.0716	1.3460	3.34	1.053
	10.0	1.080	1.050	1.0803	1.3475	3.77	1.060
	12.0	1.325	1.281	1.0981	1.3506	4.67	1.077
	14.0	1.582	1.519	1.1164	1.3538	5.65	1.096
	16.0	1.851	1.765	1.1352	1.3570	6.74	1.119
	18.0	2.133	2.020	1.1546	1.3604		1.144
	20.0	2.430	2.283	1.1745	1.3638		1.174
	22.0	2.741	2.555	1.1951	1.3673		1.207
	24.0	3.069	2.837	1.2163	1.3708		1.244
	26.0	3.415	3.129	1.2382	1.3745		1.287
	28.0	3.780	3.431	1.2608	1.3783		1.336
	30.0	4.165	3.744	1.2842	1.3822		1.395
	32.0	4.574	4.069	1.3083	1.3862		1.465
	34.0	5.007	4.406	1.3333	1.3903		1.546
	36.0	5.467	4.755	1.3592	1.3946		1.639
	38.0	5.957	5.119	1.3860	1.3990		1.745
	40.0	6.479	5.496	1.4138	1.4035		1.866
Sodium carbonate $\text{Na}_2\text{CO}_3$	0.5	0.047	0.047	1.0034	1.3341	0.22	1.025
	1.0	0.095	0.095	1.0086	1.3352	0.43	1.049
	2.0	0.193	0.192	1.0190	1.3375	0.75	1.102
	3.0	0.292	0.291	1.0294	1.3397	1.08	1.159
	4.0	0.393	0.392	1.0398	1.3419	1.42	1.222
	5.0	0.497	0.495	1.0502	1.3440	1.77	1.292
	6.0	0.602	0.600	1.0606	1.3462	2.13	1.367
	7.0	0.710	0.707	1.0711	1.3483		1.448

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	8.0	0.820	0.816	1.0816	1.3504		1.538
	9.0	0.933	0.927	1.0922	1.3525		1.638
	10.0	1.048	1.041	1.1029	1.3547		1.754
	11.0	1.166	1.156	1.1136	1.3568		1.884
	12.0	1.287	1.273	1.1244	1.3589		2.028
	13.0	1.410	1.392	1.1353	1.3610		2.186
	14.0	1.536	1.514	1.1463	1.3631		2.361
	15.0	1.665	1.638	1.1574	1.3652		2.551
Sodium chloride	0.5	0.086	0.086	1.0018	1.3339	0.30	1.011
NaCl	1.0	0.173	0.172	1.0053	1.3347	0.59	1.020
	2.0	0.349	0.346	1.0125	1.3365	1.19	1.036
	3.0	0.529	0.523	1.0196	1.3383	1.79	1.052
	4.0	0.713	0.703	1.0268	1.3400	2.41	1.068
	5.0	0.901	0.885	1.0340	1.3418	3.05	1.085
	6.0	1.092	1.069	1.0413	1.3435	3.70	1.104
	7.0	1.288	1.256	1.0486	1.3453	4.38	1.124
	8.0	1.488	1.445	1.0559	1.3470	5.08	1.145
	9.0	1.692	1.637	1.0633	1.3488	5.81	1.168
	10.0	1.901	1.832	1.0707	1.3505	6.56	1.193
	12.0	2.333	2.229	1.0857	1.3541	8.18	1.250
	14.0	2.785	2.637	1.1008	1.3576	9.94	1.317
	16.0	3.259	3.056	1.1162	1.3612	11.89	1.388
	18.0	3.756	3.486	1.1319	1.3648	14.04	1.463
	20.0	4.278	3.928	1.1478	1.3684	16.46	1.557
	22.0	4.826	4.382	1.1640	1.3721	19.18	1.676
	24.0	5.403	4.847	1.1804	1.3757		1.821
	26.0	6.012	5.326	1.1972	1.3795		1.990
Sodium citrate	1.0	0.039	0.039	1.0049	1.3348	0.20	1.043
(HO)C(COONa) <sub>3</sub>	2.0	0.079	0.078	1.0120	1.3366	0.39	1.081
	3.0	0.120	0.118	1.0186	1.3383	0.59	1.122
	4.0	0.161	0.159	1.0260	1.3401	0.79	1.166
	5.0	0.204	0.200	1.0331	1.3419	0.97	1.210
	6.0	0.247	0.242	1.0405	1.3437	1.17	1.263
	7.0	0.292	0.284	1.0482	1.3455	1.36	1.314
	8.0	0.337	0.327	1.0557	1.3473	1.57	1.371
	9.0	0.383	0.371	1.0632	1.3491	1.77	1.427
	10.0	0.431	0.415	1.0708	1.3509	1.96	1.499
	12.0	0.528	0.505	1.0861	1.3546	2.38	1.649
	14.0	0.631	0.598	1.1019	1.3583	2.82	1.832
	16.0	0.738	0.693	1.1173	1.3618	3.27	2.045
	18.0	0.851	0.790	1.1327	1.3656	3.82	2.290
	20.0	0.969	0.891	1.1492	1.3693	4.39	2.596
	24.0	1.224	1.099	1.1813	1.3767		3.409
	28.0	1.507	1.318	1.2151	1.3845		4.586
	32.0	1.823	1.548	1.2487	1.3923		6.541
	36.0	2.180	1.792	1.2843	1.4001		9.788
Sodium hydroxide	0.5	0.126	0.125	1.0039	1.3344	0.43	1.027
NaOH	1.0	0.253	0.252	1.0095	1.3358	0.86	1.054
	2.0	0.510	0.510	1.0207	1.3386	1.74	1.112
	3.0	0.773	0.774	1.0318	1.3414	2.64	1.176
	4.0	1.042	1.043	1.0428	1.3441	3.59	1.248
	5.0	1.316	1.317	1.0538	1.3467	4.57	1.329
	6.0	1.596	1.597	1.0648	1.3494	5.60	1.416
	7.0	1.882	1.883	1.0758	1.3520	6.69	1.510
	8.0	2.174	2.174	1.0869	1.3546	7.87	1.616
	9.0	2.473	2.470	1.0979	1.3572	9.12	1.737
	10.0	2.778	2.772	1.1089	1.3597	10.47	1.882
	12.0	3.409	3.393	1.1309	1.3648	13.42	2.201



Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	14.0	4.070	4.036	1.1530	1.3697	16.76	2.568
	15.0	4.412	4.365	1.1640	1.3722		2.789
	16.0	4.762	4.701	1.1751	1.3746		3.043
	18.0	5.488	5.387	1.1971	1.3793		3.698
	20.0	6.250	6.096	1.2192	1.3840		4.619
	22.0	7.052	6.827	1.2412	1.3885		5.765
	24.0	7.895	7.579	1.2631	1.3929		7.100
	26.0	8.784	8.352	1.2848	1.3971		8.744
	28.0	9.723	9.145	1.3064	1.4012		10.832
	30.0	10.715	9.958	1.3277	1.4051		13.517
	32.0	11.766	10.791	1.3488	1.4088		16.844
	34.0	12.880	11.643	1.3697	1.4123		20.751
	36.0	14.064	12.512	1.3901	1.4156		25.290
	38.0	15.324	13.398	1.4102	1.4186		30.461
	40.0	16.668	14.300	1.4299	1.4215		36.312
Sodium nitrate $\text{NaNO}_3$	0.5	0.059	0.059	1.0016	1.3336	0.20	1.004
	1.0	0.119	0.118	1.0050	1.3341	0.40	1.007
	2.0	0.240	0.238	1.0117	1.3353	0.79	1.012
	3.0	0.364	0.359	1.0185	1.3364	1.18	1.018
	4.0	0.490	0.483	1.0254	1.3375	1.56	1.025
	5.0	0.619	0.607	1.0322	1.3387	1.94	1.032
	6.0	0.751	0.734	1.0392	1.3398	2.32	1.040
	7.0	0.886	0.862	1.0462	1.3409	2.70	1.049
	8.0	1.023	0.991	1.0532	1.3421	3.08	1.059
	9.0	1.164	1.123	1.0603	1.3432	3.46	1.069
	10.0	1.307	1.256	1.0674	1.3443	3.84	1.081
	12.0	1.604	1.527	1.0819	1.3466	4.60	1.107
	14.0	1.915	1.806	1.0967	1.3489	5.37	1.138
	18.0	2.583	2.387	1.1272	1.3536	6.98	1.215
	20.0	2.941	2.689	1.1429	1.3559	7.81	1.263
	30.0	5.042	4.326	1.2256	1.3678		1.609
	40.0	7.844	6.200	1.3175	1.3802		2.226
Sodium phosphate $\text{Na}_3\text{PO}_4$	0.5	0.031	0.031	1.0042	1.3343	0.19	1.033
	1.0	0.062	0.062	1.0100	1.3356	0.37	1.064
	1.5	0.093	0.093	1.0158	1.3369	0.53	1.094
	2.0	0.124	0.125	1.0216	1.3381	0.67	1.126
	2.5	0.156	0.157	1.0275	1.3394	0.79	1.161
	3.0	0.189	0.189	1.0335	1.3406		1.198
	3.5	0.221	0.222	1.0395	1.3419		1.238
	4.0	0.254	0.255	1.0456	1.3432		1.281
	4.5	0.287	0.289	1.0517	1.3444		1.327
	5.0	0.321	0.323	1.0579	1.3457		1.375
	5.5	0.355	0.357	1.0642	1.3470		1.426
	6.0	0.389	0.392	1.0705	1.3482		1.480
	6.5	0.424	0.427	1.0768	1.3495		1.538
	7.0	0.459	0.462	1.0832	1.3507		1.598
	7.5	0.495	0.498	1.0896	1.3519		1.662
	8.0	0.530	0.535	1.0961	1.3532		1.729
Sodium hydrogen phosphate $\text{Na}_2\text{HPO}_4$	0.5	0.035	0.035	1.0032	1.3340	0.17	1.021
	1.0	0.071	0.071	1.0082	1.3349	0.32	1.042
	1.5	0.107	0.107	1.0131	1.3358	0.46	1.064
	2.0	0.144	0.143	1.0180	1.3368		1.088
	2.5	0.181	0.180	1.0229	1.3377		1.113
	3.0	0.218	0.217	1.0279	1.3386		1.138
	3.5	0.255	0.255	1.0328	1.3396		1.165
	4.0	0.293	0.292	1.0378	1.3405		1.193
	4.5	0.332	0.331	1.0428	1.3414		1.223
	5.0	0.371	0.369	1.0478	1.3424		1.254

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	5.5	0.410	0.408	1.0528	1.3433		1.286
Sodium dihydrogen phosphate $\text{NaH}_2\text{PO}_4$	0.5	0.042	0.042	1.0019	1.3336	0.14	1.018
	1.0	0.084	0.084	1.0056	1.3343	0.28	1.035
	1.5	0.127	0.126	1.0094	1.3349	0.42	1.051
	2.0	0.170	0.169	1.0131	1.3356	0.56	1.068
	2.5	0.214	0.212	1.0168	1.3362	0.70	1.085
	3.0	0.258	0.255	1.0206	1.3369	0.84	1.103
	3.5	0.302	0.299	1.0244	1.3375	0.98	1.121
	4.0	0.347	0.343	1.0281	1.3382	1.12	1.140
	4.5	0.393	0.387	1.0319	1.3388	1.25	1.160
	5.0	0.439	0.432	1.0358	1.3395	1.39	1.180
	6.0	0.532	0.522	1.0434	1.3408	1.65	1.223
	7.0	0.627	0.613	1.0511	1.3421	1.89	1.270
	8.0	0.725	0.706	1.0589	1.3434	2.12	1.319
	9.0	0.824	0.800	1.0668	1.3447	2.35	1.371
	10.0	0.926	0.896	1.0747	1.3460	2.58	1.428
	12.0	1.137	1.091	1.0907	1.3486	3.06	1.552
	14.0	1.357	1.292	1.1070	1.3512	3.53	1.694
	16.0	1.588	1.499	1.1236	1.3538	4.03	1.861
	18.0	1.830	1.711	1.1404	1.3565	4.55	2.050
	20.0	2.084	1.930	1.1576	1.3592	5.10	2.283
	22.0	2.351	2.155	1.1752	1.3618		2.550
	24.0	2.632	2.387	1.1931	1.3646		2.850
	26.0	2.929	2.625	1.2113	1.3673		3.214
	28.0	3.242	2.870	1.2299	1.3700		3.682
	30.0	3.572	3.123	1.2488	1.3728		4.300
	32.0	3.923	3.383	1.2682	1.3756		5.079
	34.0	4.294	3.650	1.2879	1.3784		6.008
	36.0	4.689	3.925	1.3080	1.3812		7.098
	38.0	5.109	4.208	1.3285	1.3840		8.363
	40.0	5.557	4.499	1.3493	1.3869		9.814
Sodium sulfate $\text{Na}_2\text{SO}_4$	0.5	0.035	0.035	1.0027	1.3338	0.17	1.013
	1.0	0.071	0.071	1.0071	1.3345	0.32	1.026
	2.0	0.144	0.143	1.0161	1.3360	0.61	1.058
	3.0	0.218	0.217	1.0252	1.3376	0.87	1.091
	4.0	0.293	0.291	1.0343	1.3391	1.13	1.126
	5.0	0.371	0.367	1.0436	1.3406	1.36	1.163
	6.0	0.449	0.445	1.0526	1.3420	1.56	1.202
	7.0	0.530	0.523	1.0619	1.3435		1.244
	8.0	0.612	0.603	1.0713	1.3449		1.289
	9.0	0.696	0.685	1.0808	1.3464		1.337
	10.0	0.782	0.768	1.0905	1.3479		1.390
	12.0	0.960	0.938	1.1101	1.3509		1.508
	14.0	1.146	1.114	1.1301	1.3539		1.646
	16.0	1.341	1.296	1.1503	1.3567		1.812
	18.0	1.545	1.483	1.1705	1.3595		2.005
	20.0	1.760	1.677	1.1907	1.3620		2.227
	22.0	1.986	1.875	1.2106	1.3643		2.481
Sodium thiosulfate $\text{Na}_2\text{S}_2\text{O}_3$	0.5	0.032	0.032	1.0024	1.3340	0.14	1.012
	1.0	0.064	0.064	1.0065	1.3351	0.28	1.023
	2.0	0.129	0.128	1.0148	1.3371	0.57	1.044
	3.0	0.196	0.194	1.0231	1.3392	0.84	1.066
	4.0	0.264	0.261	1.0315	1.3413	1.09	1.090
	5.0	0.333	0.329	1.0399	1.3434	1.34	1.115
	6.0	0.404	0.398	1.0483	1.3454	1.59	1.141
	7.0	0.476	0.468	1.0568	1.3475	1.83	1.169
	8.0	0.550	0.539	1.0654	1.3496	2.06	1.199
	9.0	0.626	0.611	1.0740	1.3517	2.30	1.231

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	10.0	0.703	0.685	1.0827	1.3538	2.55	1.267
	12.0	0.862	0.835	1.1003	1.3581	3.06	1.345
	14.0	1.030	0.990	1.1182	1.3624	3.60	1.435
	16.0	1.205	1.150	1.1365	1.3667	4.17	1.537
	18.0	1.388	1.315	1.1551	1.3711	4.76	1.657
	20.0	1.581	1.485	1.1740	1.3756	5.37	1.798
	30.0	2.711	2.417	1.2739	1.3987		2.903
	40.0	4.216	3.498	1.3827	1.4229		5.758
Strontium chloride	0.5	0.032	0.032	1.0027	1.3339	0.16	1.012
	1.0	0.064	0.064	1.0071	1.3348	0.31	1.021
SrCl <sub>2</sub>	2.0	0.129	0.128	1.0161	1.3366	0.62	1.039
	3.0	0.195	0.194	1.0252	1.3384	0.93	1.057
	4.0	0.263	0.261	1.0344	1.3402	1.26	1.076
	5.0	0.332	0.329	1.0437	1.3421	1.61	1.096
	6.0	0.403	0.399	1.0532	1.3440	1.98	1.116
	7.0	0.475	0.469	1.0628	1.3459	2.38	1.136
	8.0	0.549	0.541	1.0726	1.3478	2.80	1.157
	9.0	0.624	0.615	1.0825	1.3498	3.25	1.180
	10.0	0.701	0.689	1.0925	1.3518	3.74	1.204
	12.0	0.860	0.843	1.1131	1.3558	4.81	1.258
	14.0	1.027	1.002	1.1342	1.3599	6.03	1.317
	16.0	1.202	1.167	1.1558	1.3641	7.41	1.383
	18.0	1.385	1.338	1.1780	1.3684	8.98	1.460
	20.0	1.577	1.515	1.2008	1.3728	10.74	1.549
	22.0	1.779	1.699	1.2241	1.3772	12.74	1.650
	24.0	1.992	1.890	1.2481	1.3817	14.99	1.765
	26.0	2.216	2.087	1.2728	1.3864		1.897
	28.0	2.453	2.293	1.2983	1.3911		2.056
	30.0	2.703	2.507	1.3248	1.3961		2.245
	32.0	2.968	2.730	1.3523	1.4013		2.527
	34.0	3.250	2.962	1.3811	1.4067		2.846
	36.0	3.548	3.205	1.4114	1.4124		3.206
Sucrose	0.5	0.015	0.015	1.0002	1.3337	0.03	1.015
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	1.0	0.030	0.029	1.0021	1.3344	0.06	1.028
	2.0	0.060	0.059	1.0060	1.3359	0.11	1.055
	3.0	0.090	0.089	1.0099	1.3373	0.17	1.084
	4.0	0.122	0.118	1.0139	1.3388	0.23	1.114
	5.0	0.154	0.149	1.0178	1.3403	0.29	1.146
	6.0	0.186	0.179	1.0218	1.3418	0.35	1.179
	7.0	0.220	0.210	1.0259	1.3433	0.42	1.215
	8.0	0.254	0.241	1.0299	1.3448	0.49	1.254
	9.0	0.289	0.272	1.0340	1.3463	0.55	1.294
	10.0	0.325	0.303	1.0381	1.3478	0.63	1.336
	12.0	0.398	0.367	1.0465	1.3509	0.77	1.429
	14.0	0.476	0.431	1.0549	1.3541	0.93	1.534
	16.0	0.556	0.497	1.0635	1.3573	1.10	1.653
	18.0	0.641	0.564	1.0722	1.3606	1.27	1.790
	20.0	0.730	0.632	1.0810	1.3639	1.47	1.945
	22.0	0.824	0.700	1.0899	1.3672	1.67	2.124
	24.0	0.923	0.771	1.0990	1.3706	1.89	2.331
	26.0	1.026	0.842	1.1082	1.3741	2.12	2.573
	28.0	1.136	0.914	1.1175	1.3776	2.37	2.855
	30.0	1.252	0.988	1.1270	1.3812	2.64	3.187
	32.0	1.375	1.063	1.1366	1.3848	2.94	3.762
	34.0	1.505	1.139	1.1464	1.3885	3.27	4.052
	36.0	1.643	1.216	1.1562	1.3922	3.63	4.621
	38.0	1.791	1.295	1.1663	1.3960	4.02	5.315
	40.0	1.948	1.375	1.1765	1.3999	4.45	6.162
	42.0	2.116	1.456	1.1868	1.4038	4.93	7.234

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	44.0	2.295	1.539	1.1972	1.4078		8.596
	46.0	2.489	1.623	1.2079	1.4118		10.301
	48.0	2.697	1.709	1.2186	1.4159		12.515
	50.0	2.921	1.796	1.2295	1.4201		15.431
	60.0	4.382	2.255	1.2864	1.4419		58.487
	70.0	6.817	2.755	1.3472	1.4654		481.561
	80.0	11.686	3.299	1.4117	1.4906		
Sulfuric acid	0.5	0.051	0.051	1.0016	1.3336	0.21	1.010
$\text{H}_2\text{SO}_4$	1.0	0.103	0.102	1.0049	1.3342	0.42	1.019
	2.0	0.208	0.206	1.0116	1.3355	0.80	1.036
	3.0	0.315	0.311	1.0183	1.3367	1.17	1.059
	4.0	0.425	0.418	1.0250	1.3379	1.60	1.085
	5.0	0.537	0.526	1.0318	1.3391	2.05	1.112
	6.0	0.651	0.635	1.0385	1.3403	2.50	1.136
	7.0	0.767	0.746	1.0453	1.3415	2.95	1.159
	8.0	0.887	0.858	1.0522	1.3427	3.49	1.182
	9.0	1.008	0.972	1.0591	1.3439	4.08	1.206
	10.0	1.133	1.087	1.0661	1.3451	4.64	1.230
	12.0	1.390	1.322	1.0802	1.3475	5.93	1.282
	14.0	1.660	1.563	1.0947	1.3500	7.49	1.337
	16.0	1.942	1.810	1.1094	1.3525	9.26	1.399
	18.0	2.238	2.064	1.1245	1.3551	11.29	1.470
	20.0	2.549	2.324	1.1398	1.3576	13.64	1.546
	22.0	2.876	2.592	1.1554	1.3602	16.48	1.624
	24.0	3.220	2.866	1.1714	1.3628	19.85	1.706
	26.0	3.582	3.147	1.1872	1.3653	24.29	1.797
	28.0	3.965	3.435	1.2031	1.3677	29.65	1.894
	30.0	4.370	3.729	1.2191	1.3701	36.21	2.001
	32.0	4.798	4.030	1.2353	1.3725	44.76	2.122
	34.0	5.252	4.339	1.2518	1.3749	55.28	2.255
	36.0	5.735	4.656	1.2685	1.3773		2.392
	38.0	6.249	4.981	1.2855	1.3797		2.533
	40.0	6.797	5.313	1.3028	1.3821		2.690
	42.0	7.383	5.655	1.3205	1.3846		2.872
	44.0	8.011	6.005	1.3386	1.3870		3.073
	46.0	8.685	6.364	1.3570	1.3895		3.299
	48.0	9.411	6.734	1.3759	1.3920		3.546
	50.0	10.196	7.113	1.3952	1.3945		3.826
	52.0	11.045	7.502	1.4149	1.3971		4.142
	54.0	11.969	7.901	1.4351	1.3997		4.499
	56.0	12.976	8.312	1.4558	1.4024		4.906
	58.0	14.080	8.734	1.4770	1.4050		5.354
	60.0	15.294	9.168	1.4987	1.4077		5.917
	70.0	23.790	11.494	1.6105			
	80.0	40.783	14.088	1.7272			
	90.0	91.762	16.649	1.8144			
	92.0	117.251	17.109	1.8240			
	94.0	159.734	17.550	1.8312			
	96.0	244.698	17.966	1.8355			
	98.0	499.592	18.346	1.8361			
	100.0		18.663	1.8305			
Trichloroacetic acid	0.5	0.031	0.031	1.0008	1.3337	0.11	1.011
$\text{CCl}_3\text{COOH}$	1.0	0.062	0.061	1.0034	1.3343	0.21	1.021
	2.0	0.125	0.123	1.0083	1.3356	0.42	1.044
	3.0	0.189	0.186	1.0133	1.3369	0.64	1.069
	4.0	0.255	0.249	1.0182	1.3381	0.86	1.096
	5.0	0.322	0.313	1.0230	1.3394	1.08	1.123
	6.0	0.391	0.377	1.0279	1.3406	1.30	1.150
	7.0	0.461	0.442	1.0328	1.3418	1.53	1.177

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	8.0	0.532	0.508	1.0378	1.3431	1.76	1.204
	9.0	0.605	0.574	1.0428	1.3444	1.99	1.233
	10.0	0.680	0.641	1.0479	1.3456	2.23	1.263
	12.0	0.835	0.777	1.0583	1.3483	2.73	1.326
	14.0	0.996	0.916	1.0692	1.3510	3.26	1.393
	16.0	1.166	1.058	1.0806	1.3539	3.82	1.462
	18.0	1.343	1.203	1.0921	1.3568		1.533
	20.0	1.530	1.351	1.1035	1.3597		1.608
	24.0	1.933	1.654	1.1260	1.3652		1.768
	28.0	2.380	1.968	1.1485	1.3705		1.935
	32.0	2.880	2.294	1.1713	1.3759		2.118
	36.0	3.443	2.632	1.1947	1.3813		2.320
	40.0	4.080	2.984	1.2188	1.3868		1.543
	44.0	4.809	3.349	1.2435	1.3923		2.797
	48.0	5.650	3.726	1.2682	1.3977		3.076
Tris	0.5	0.041	0.041	0.9994	1.3337	0.08	1.014
(hydroxymethyl)-	1.0	0.083	0.083	1.0006	1.3344	0.16	1.027
methylamine	2.0	0.168	0.166	1.0030	1.3359	0.31	1.054
$\text{H}_2\text{NC}(\text{CH}_2\text{OH})_3$	3.0	0.255	0.249	1.0054	1.3374	0.47	1.083
	4.0	0.344	0.333	1.0078	1.3388	0.64	1.115
	5.0	0.434	0.417	1.0103	1.3403	0.80	1.148
	6.0	0.527	0.502	1.0128	1.3418	0.97	1.182
	7.0	0.621	0.587	1.0153	1.3433	1.15	1.218
	8.0	0.718	0.672	1.0179	1.3448	1.33	1.256
	9.0	0.816	0.758	1.0204	1.3463	1.51	1.295
	10.0	0.917	0.844	1.0230	1.3478	1.70	1.337
	12.0	1.126	1.019	1.0282	1.3508	2.08	1.427
	14.0	1.344	1.194	1.0335	1.3539	2.47	1.527
	16.0	1.572	1.372	1.0389	1.3570	2.90	1.642
	18.0	1.812	1.552	1.0443	1.3601	3.36	1.772
	20.0	2.064	1.733	1.0498	1.3633	3.85	1.920
	30.0	3.538	2.670	1.0781	1.3797		2.998
	40.0	5.503	3.657	1.1076	1.3970		5.208
Urea	0.5	0.084	0.083	0.9995	1.3337	0.16	1.007
$(\text{NH}_2)_2\text{CO}$	1.0	0.168	0.167	1.0007	1.3344	0.31	1.010
	2.0	0.340	0.334	1.0033	1.3358	0.62	1.012
	3.0	0.515	0.502	1.0058	1.3372	0.93	1.017
	4.0	0.694	0.672	1.0085	1.3387	1.24	1.025
	5.0	0.876	0.842	1.0111	1.3401	1.55	1.033
	6.0	1.063	1.013	1.0138	1.3416	1.88	1.041
	7.0	1.253	1.185	1.0165	1.3431	2.22	1.049
	8.0	1.448	1.358	1.0192	1.3446	2.56	1.057
	9.0	1.647	1.531	1.0220	1.3461	2.91	1.065
	10.0	1.850	1.706	1.0248	1.3476	3.26	1.074
	12.0	2.270	2.059	1.0304	1.3506	3.95	1.091
	14.0	2.710	2.415	1.0360	1.3537	4.66	1.109
	16.0	3.171	2.775	1.0417	1.3568	5.40	1.130
	18.0	3.655	3.139	1.0473	1.3599	6.19	1.153
	20.0	4.163	3.506	1.0530	1.3629	7.00	1.178
	22.0	4.696	3.878	1.0586	1.3661	7.81	1.205
	24.0	5.258	4.253	1.0643	1.3692	8.64	1.235
	26.0	5.850	4.632	1.0699	1.3723	9.52	1.266
	28.0	6.475	5.014	1.0756	1.3754	10.45	1.298
	30.0	7.136	5.401	1.0812	1.3785	11.40	1.332
	32.0	7.835	5.791	1.0869	1.3817	12.34	1.371
	34.0	8.577	6.185	1.0926	1.3848	13.27	1.413
	36.0	9.366	6.584	1.0984	1.3881	14.20	1.459
	38.0	10.205	6.988	1.1044	1.3913	15.11	1.509
	40.0	11.100	7.397	1.1106	1.3947	15.99	1.565

Solute	Mass %	$m/\text{mol kg}^{-1}$	$c/\text{mol L}^{-1}$	$\rho/\text{g cm}^{-3}$	$n$	$\Delta/^\circ\text{C}$	$\eta/\text{mPa s}$
	42.0	12.057	7.812	1.1171	1.3982	16.83	1.629
	44.0	13.082	8.234	1.1239	1.4018	17.62	1.700
	46.0	14.183	8.665	1.1313	1.4056		1.780
Zinc sulfate	0.5	0.031	0.031	1.0034	1.3339	0.08	1.021
ZnSO <sub>4</sub>	1.0	0.063	0.062	1.0085	1.3348	0.15	1.040
	2.0	0.126	0.126	1.0190	1.3366	0.28	1.081
	3.0	0.192	0.191	1.0296	1.3384	0.41	1.126
	4.0	0.258	0.258	1.0403	1.3403	0.53	1.175
	5.0	0.326	0.326	1.0511	1.3421	0.65	1.227
	6.0	0.395	0.395	1.0620	1.3439	0.77	1.283
	7.0	0.466	0.465	1.0730	1.3457	0.89	1.341
	8.0	0.539	0.537	1.0842	1.3475	1.01	1.403
	9.0	0.613	0.611	1.0956	1.3494	1.14	1.470
	10.0	0.688	0.686	1.1071	1.3513	1.27	1.545
	12.0	0.845	0.840	1.1308	1.3551	1.55	1.716
	14.0	1.008	1.002	1.1553	1.3590	1.89	1.918
	16.0	1.180	1.170	1.1806	1.3630	2.31	2.152

# ION PRODUCT OF WATER SUBSTANCE

William L. Marshall and E. U. Franck

Pressure (bars)	Temperature (°C)								
	0	25	50	75	100	150	200	250	300
Saturated vapor	14.938	13.995	13.275	12.712	12.265	11.638	11.289	11.191	11.406
250	14.83	13.90	13.19	12.63	12.18	11.54	11.16	11.01	11.14
500	14.72	13.82	13.11	12.55	12.10	11.45	11.05	10.85	10.86
750	14.62	13.73	13.04	12.48	12.03	11.36	10.95	10.72	10.66
1,000	14.53	13.66	12.96	12.41	11.96	11.29	10.86	10.60	10.50
1,500	14.34	13.53	12.85	12.29	11.84	11.16	10.71	10.43	10.26
2,000	14.21	13.40	12.73	12.18	11.72	11.04	10.57	10.27	10.08
2,500	14.08	13.28	12.62	12.07	11.61	10.92	10.45	10.12	9.91
3,000	13.97	13.18	12.53	11.98	11.53	10.83	10.34	9.99	9.76
3,500	13.87	13.09	12.44	11.90	11.44	10.74	10.24	9.88	9.63
4,000	13.77	13.00	12.35	11.82	11.37	10.66	10.16	9.79	9.52
5,000	13.60	12.83	12.19	11.66	11.22	10.52	10.00	9.62	9.34
6,000	13.44	12.68	12.05	11.53	11.09	10.39	9.87	9.48	9.18
7,000	13.31	12.55	11.93	11.41	10.97	10.27	9.75	9.35	9.04
8,000	13.18	12.43	11.82	11.30	10.86	10.17	9.64	9.24	8.93
9,000	13.04	12.31	11.71	11.20	10.77	10.07	9.54	9.13	8.82
10,000	12.91	12.21	11.62	11.11	10.68	9.98	9.45	9.04	8.71

Pressure (bars)	Temperature (°C)								
	350	400	450	500	600	700	800	900	1000
Saturated vapor	12.30	—	—	—	—	—	—	—	—
250	11.77	19.43	21.59	22.40	23.27	23.81	24.23	24.59	24.93
500	11.14	11.88	13.74	16.13	18.30	19.29	19.92	20.39	20.80
750	10.79	11.17	11.89	13.01	15.25	16.55	17.35	17.93	18.39
1,000	10.54	10.77	11.19	11.81	13.40	14.70	15.58	16.22	16.72
1,500	10.22	10.29	10.48	10.77	11.59	12.50	13.30	13.97	14.50
2,000	9.98	9.98	10.07	10.23	10.73	11.36	11.98	12.54	12.97
2,500	9.79	9.74	9.77	9.86	10.18	10.63	11.11	11.59	12.02
3,000	9.61	9.54	9.53	9.57	9.78	10.11	10.49	10.89	11.24
3,500	9.47	9.37	9.33	9.34	9.48	9.71	10.02	10.35	10.62
4,000	9.34	9.22	9.16	9.15	9.23	9.41	9.65	9.93	10.13
5,000	9.13	8.99	8.90	8.85	8.85	8.95	9.11	9.30	9.42
6,000	8.96	8.80	8.69	8.62	8.57	8.61	8.72	8.86	8.97
7,000	8.81	8.64	8.51	8.42	8.34	8.34	8.40	8.51	8.64
8,000	8.68	8.50	8.36	8.25	8.13	8.10	8.13	8.21	8.38
9,000	8.57	8.37	8.22	8.10	7.95	7.89	7.89	7.95	8.12
10,000	8.46	8.25	8.09	7.96	7.78	7.70	7.68	7.70	7.85

Data in this table were calculated from the equation,  $\log_{10} K_w^* = A + B/T + C/T^2 + D/T^3 + (E + F/T + G/T^2) \log_{10} \rho_w^*$ , where  $K_w^* = K_w / (\text{mol kg}^{-1})$ , and  $\rho_w^* = \rho_w / (\text{g cm}^{-3})$ . The parameters are:

$$\begin{aligned}
 A &= -4.098 & E &= +13.957 \\
 B &= -3245.2 \text{ K} & F &= 1262.3 \text{ K} \\
 C &= +2.2362 \times 10^5 \text{ K}^2 & G &= +8.5641 \times 10^5 \text{ K}^2 \\
 D &= -3.984 \times 10^7 \text{ K}^3
 \end{aligned}$$

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## IONIZATION CONSTANT OF NORMAL AND HEAVY WATER

This table gives the ionization constant in molality terms for H<sub>2</sub>O and D<sub>2</sub>O at temperatures from 0 to 100°C at the saturated vapor pressure. The quantity tabulated is  $-\log K_w$ , where  $K_w$  is defined by

$$K_w = m_+ \times m_-$$

and  $m_+$  and  $m_-$  are the molalities, in mol/kg of water, for H<sup>+</sup> and OH<sup>-</sup>, respectively.

### References

1. Marshall W. L., and Franck, E. U., *J. Phys. Chem. Ref. Data*, 10, 295, 1981.
2. Mesmer R. E., and Herting, D. L., *J. Solution Chem.*, 7, 901, 1978.

$t/^\circ\text{C}$	$-\log K_w$	
	H <sub>2</sub> O	D <sub>2</sub> O
0	14.938	15.972
5	14.727	15.743
10	14.528	15.527
15	14.340	15.324
20	14.163	15.132
25	13.995	14.951
30	13.836	14.779
35	13.685	14.616
40	13.542	14.462
45	13.405	14.316
50	13.275	14.176
55	13.152	14.044
60	13.034	13.918
65	12.921	13.798
70	12.814	13.683
75	12.712	13.574
80	12.613	13.470
85	12.520	13.371
90	12.428	13.276
95	12.345	13.186
100	12.265	13.099



# SOLUBILITY OF SELECTED GASES IN WATER

L. H. Gevantman

The values in this table are taken almost exclusively from the International Union of Pure and Applied Chemistry "Solubility Data Series". Unless noted, they comprise evaluated data fitted to a smoothing equation. The data at each temperature are then derived from the smoothing equation which expresses the mole fraction solubility  $X_1$  of the gas in solution as:

$$\ln X_1 = A + B/T^* + C \ln T^*$$

where

$$T^* = T/100 \text{ K}$$

All values refer to a partial pressure of the gas of 101.325 kPa (one atmosphere).

The equation constants, the standard deviation for  $\ln X_1$  (except where noted), and the temperature range over which the equation applies are given in the column headed Equation constants. There are two exceptions. The equation for methane has an added term,  $DT^*$ . The equation for  $\text{H}_2\text{Se}$  and  $\text{H}_2\text{S}$  takes the form,

$$\ln X_1 = A + B/T + C \ln T + DT$$

where  $T$  is the temperature in kelvin.

Solubilities given for those gases which react with water, namely ozone, nitrogen oxides, chlorine and its oxides, carbon dioxide, hydrogen sulfide, hydrogen selenide and sulfur dioxide, are recorded as bulk solubilities; i.e., all chemical species of the gas and its reaction products with water are included.

Gas	$T/\text{K}$	Solubility ( $X_1$ )	Equation constants	Ref.
Hydrogen ( $\text{H}_2$ ) $M_r = 2.01588$	288.15	$1.510 \times 10^{-5}$	$A = -48.1611$	1
	293.15	$1.455 \times 10^{-5}$	$B = 55.2845$	
	298.15	$1.411 \times 10^{-5}$	$C = 16.8893$	
	303.15	$1.377 \times 10^{-5}$	Std. dev. = $\pm 0.54\%$	
	308.15	$1.350 \times 10^{-5}$	Temp. range = 273.15–353.15	
Deuterium ( $\text{D}_2$ ) $M_r = 4.0282$	283.15	$1.675 \times 10^{-5} \pm 0.57\%$	Averaged experimental values	1
	288.15	$1.595 \times 10^{-5} \pm 0.57\%$		
	293.15	$1.512 \times 10^{-5} \pm 0.78\%$	Temp. range = 278.15–303.15	
	298.15	$1.460 \times 10^{-5} \pm 0.52\%$		
	303.15	$1.395 \times 10^{-5} \pm 0.37\%$		
Helium (He) $A_r = 4.0026$	288.15	$7.123 \times 10^{-6}$	$A = -41.4611$	2
	293.15	$7.044 \times 10^{-6}$	$B = 42.5962$	
	298.15	$6.997 \times 10^{-6}$	$C = 14.0094$	
	303.15	$6.978 \times 10^{-6}$	Std. dev. = $\pm 0.54\%$	
	308.15	$6.987 \times 10^{-6}$	Temp. range = 273.15–348.15	
Neon (Ne) $A_r = 20.1797$	288.15	$8.702 \times 10^{-6}$	$A = -52.8573$	2
	293.15	$8.395 \times 10^{-6}$	$B = 61.0494$	
	298.15	$8.152 \times 10^{-6}$	$C = 18.9157$	
	303.15	$7.966 \times 10^{-6}$	Std. dev. = $\pm 0.47\%$	
	308.15	$7.829 \times 10^{-6}$	Temp. range = 273.15–348.15	
Argon (Ar) $A_r = 39.948$	288.15	$3.025 \times 10^{-5}$	$A = -57.6661$	3
	293.15	$2.748 \times 10^{-5}$	$B = 74.7627$	
	298.15	$2.519 \times 10^{-5}$	$C = 20.1398$	
	303.15	$2.328 \times 10^{-5}$	Std. dev. = $\pm 0.26\%$	
	308.15	$2.169 \times 10^{-5}$	Temp. range = 273.15–348.15	
Krypton (Kr) $A_r = 83.80$	288.15	$5.696 \times 10^{-5}$	$A = -66.9928$	4
	293.15	$5.041 \times 10^{-5}$	$B = 91.0166$	
	298.15	$4.512 \times 10^{-5}$	$C = 24.2207$	
	303.15	$4.079 \times 10^{-5}$	Std. dev. = $\pm 0.32\%$	
	308.15	$3.725 \times 10^{-5}$	Temp. range = 273.15–353.15	
Xenon (Xe) $A_r = 131.29$	288.15	$10.519 \times 10^{-5}$	$A = -74.7398$	4
	293.15	$9.051 \times 10^{-5}$	$B = 105.210$	
	298.15	$7.890 \times 10^{-5}$	$C = 27.4664$	
	303.15	$6.961 \times 10^{-5}$	Std. dev. = $\pm 0.35\%$	
	308.15	$6.212 \times 10^{-5}$	Temp. range = 273.15–348.15	

Gas	T/K	Solubility ( $X_1$ )	Equation constants	Ref.
Radon-222( <sup>222</sup> Rn) $M_r = 222$	288.15	$2.299 \times 10^{-4}$	$A = -90.5481$	
	293.15	$1.945 \times 10^{-4}$	$B = 130.026$	
	298.15	$1.671 \times 10^{-4}$	$C = 35.0047$	
	303.15	$1.457 \times 10^{-4}$	Std. dev. = $\pm 1.02\%$	
	308.15	$1.288 \times 10^{-4}$	Temp. range = 273.15–373.15	
Oxygen (O <sub>2</sub> ) $M_r = 31.9988$	288.15	$2.756 \times 10^{-5}$	$A = -66.7354$	5
	293.15	$2.501 \times 10^{-5}$	$B = 87.4755$	
	298.15	$2.293 \times 10^{-5}$	$C = 24.4526$	
	303.15	$2.122 \times 10^{-5}$	Std. dev. = $\pm 0.36\%$	
	308.15	$1.982 \times 10^{-5}$	Temp. range = 273.15–348.15	
Ozone (O <sub>3</sub> ) $M_r = 47.9982$	293.15	$1.885 \times 10^{-6} \pm 10\%$ pH = 7.0	Experimental value derived from Henry's Law Constant Equation	5
Nitrogen (N <sub>2</sub> ) $M_r = 28.0134$	288.15	$1.386 \times 10^{-5}$	$A = -67.3877$	6
	293.15	$1.274 \times 10^{-5}$	$B = 86.3213$	
	298.15	$1.183 \times 10^{-5}$	$C = 24.7981$	
	303.15	$1.108 \times 10^{-5}$	Std. dev. = $\pm 0.72\%$	
	308.15	$1.047 \times 10^{-5}$	Temp. range = 273.15–348.15	
Nitrous oxide (N <sub>2</sub> O) $M_r = 44.0129$	288.15	$5.948 \times 10^{-4}$	$A = -60.7467$	7
	293.15	$5.068 \times 10^{-4}$	$B = 88.8280$	
	298.15	$4.367 \times 10^{-4}$	$C = 21.2531$	
	303.15	$3.805 \times 10^{-4}$	Std. dev. = $\pm 1.2\%$	
	308.15	$3.348 \times 10^{-4}$	Temp. range = 273.15–313.15	
Nitric oxide (NO) $M_r = 30.0061$	288.15	$4.163 \times 10^{-5}$	$A = -62.8086$	7
	293.15	$3.786 \times 10^{-5}$	$B = 82.3420$	
	298.15	$3.477 \times 10^{-5}$	$C = 22.8155$	
	303.15	$3.222 \times 10^{-5}$	Std. dev. = $\pm 0.76\%$	
	308.15	$3.012 \times 10^{-5}$	Temp. range = 273.15–358.15	
Carbon monoxide (CO) $M_r = 28.0104$	288.15	$2.095 \times 10^{-5}$	Derived from Henry's Law Constant Equation	8
	293.15	$1.918 \times 10^{-5}$	Std. dev. = $\pm 0.043\%$	
	298.15	$1.774 \times 10^{-5}$	Temp. range = 273.15–328.15	
	303.15	$1.657 \times 10^{-5}$		
	308.15	$1.562 \times 10^{-5}$		
Carbon dioxide (CO <sub>2</sub> ) $M_r = 44.0098$	288.15	$8.21 \times 10^{-4}$	Derived from Henry's Law Constant Equation	9
	293.15	$7.07 \times 10^{-4}$	Std. dev. = $\pm 1.1\%$	
	298.15	$6.15 \times 10^{-4}$	Temp. range = 273.15–353.15	
	303.15	$5.41 \times 10^{-4}$		
	308.15	$4.80 \times 10^{-4}$		
Hydrogen selenide (H <sub>2</sub> Se) $M_r = 80.976$	288.15	$1.80 \times 10^{-3}$	$A = 9.15$	10
	298.15	$1.49 \times 10^{-3}$	$B = 974$	
	308.15	$1.24 \times 10^{-3}$	$C = -3.542$ $D = 0.0042$ Std. dev. = $\pm 2.3 \times 10^{-5}$ Temp. range = 288.15–343.15	
Hydrogen sulfide (H <sub>2</sub> S) $M_r = 34.082$	288.15	$2.335 \times 10^{-3}$	$A = -24.912$	10
	293.15	$2.075 \times 10^{-3}$	$B = 3477$	
	298.15	$1.85 \times 10^{-3}$	$C = 0.3993$	
	303.15	$1.66 \times 10^{-3}$	$D = 0.0157$	
	308.15	$1.51 \times 10^{-3}$	Std. dev. = $\pm 6.5 \times 10^{-5}$ Temp. range = 283.15–603.15	
Sulfur dioxide (SO <sub>2</sub> ) $M_r = 64.0648$	288.15	$3.45 \times 10^{-2}$	$A = -25.2629$	11
	293.15	$2.90 \times 10^{-2}$	$B = 45.7552$	

Gas	T/K	Solubility ( $X_1$ )	Equation constants	Ref.
	298.15	$2.46 \times 10^{-2}$	$C = 5.6855$	
	303.15	$2.10 \times 10^{-2}$	Std. dev. = $\pm 1.8\%$	
	308.15	$1.80 \times 10^{-2}$	Temp. range = 278.15—328.15	
Chlorine ( $\text{Cl}_2$ ) $M_r = 70.9054$	283.15	$2.48 \times 10^{-3} \pm 2\%$	Experimental data	11
	293.15	$1.88 \times 10^{-3} \pm 2\%$	Temp. range = 283.15—333.15	
	303.15	$1.50 \times 10^{-3} \pm 2\%$		
	313.15	$1.23 \times 10^{-3} \pm 2\%$		
Chlorine monoxide ( $\text{Cl}_2\text{O}$ ) $M_r = 86.9048$	273.15	$5.25 \times 10^{-1} \pm 1\%$	Experimental data	11
	276.61	$4.54 \times 10^{-1} \pm 1\%$	Temp. range = 273.15—293.15	
	283.15	$4.273 \times 10^{-1} \pm 1\%$		
	293.15	$3.353 \times 10^{-1} \pm 1\%$		
Chlorine dioxide ( $\text{ClO}_2$ ) $M_r = 67.4515$	288.15	$2.67 \times 10^{-2}$	$A = 7.9163$	11
	293.15	$2.20 \times 10^{-2}$	$B = 0.4791$	
	298.15	$1.823 \times 10^{-2}$	$C = 11.0593$	
	303.15	$1.513 \times 10^{-2}$	Std. dev. = $\pm 4.6\%$	
	308.15	$1.259 \times 10^{-2}$	Temp. range = 283.15—333.15	
Methane ( $\text{CH}_4$ ) $M_r = 16.0428$	288.15	$3.122 \times 10^{-5}$	$A = -115.6477$	12
	293.15	$2.806 \times 10^{-5}$	$B = 155.5756$	
	298.15	$2.552 \times 10^{-5}$	$C = 65.2553$	
	303.15	$2.346 \times 10^{-5}$	$D = -6.1698$	
	308.15	$2.180 \times 10^{-5}$	Std. dev. = $\pm 0.056\%$ Temp. range = 273.15—328.15	
Ethane ( $\text{C}_2\text{H}_6$ ) $M_r = 30.0696$	288.15	$4.556 \times 10^{-5}$	$A = -90.8225$	13
	293.15	$3.907 \times 10^{-5}$	$B = 126.9559$	
	298.15	$3.401 \times 10^{-5}$	$C = 34.7413$	
	303.15	$3.002 \times 10^{-5}$	Std. dev. = $\pm 0.13\%$	
	308.15	$2.686 \times 10^{-5}$	Temp. range = 273.15—323.15	
Propane ( $\text{C}_3\text{H}_8$ ) $M_r = 44.097$	288.15	$3.813 \times 10^{-5}$	$A = -102.044$	14
	293.15	$3.200 \times 10^{-5}$	$B = 144.345$	
	298.15	$2.732 \times 10^{-5}$	$C = 39.4740$	
	303.15	$2.370 \times 10^{-5}$	Std. dev. = $\pm 0.012\%$	
	308.15	$2.088 \times 10^{-5}$	Temp. range = 273.15—347.15	
Butane ( $\text{C}_4\text{H}_{10}$ ) $M_r = 58.123$	288.15	$3.274 \times 10^{-5}$	$A = -102.029$	14
	293.15	$2.687 \times 10^{-5}$	$B = 146.040$	
	298.15	$2.244 \times 10^{-5}$	$C = 38.7599$	
	303.15	$1.906 \times 10^{-5}$	Std. dev. = $\pm 0.026\%$	
	308.15	$1.645 \times 10^{-5}$	Temp. range = 273.15—349.15	
2-Methyl propane (Isobutane) ( $\text{C}_4\text{H}_{10}$ ) $M_r = 58.123$	288.15	$2.333 \times 10^{-5}$	$A = -129.714$	14
	293.15	$1.947 \times 10^{-5}$	$B = 183.044$	
	298.15	$1.659 \times 10^{-5}$	$C = 53.4651$	
	303.15	$1.443 \times 10^{-5}$	Std. dev. = $\pm 0.034\%$	
	308.15	$1.278 \times 10^{-5}$	Temp. range = 278.15—318.15	

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## SOLUBILITY OF CARBON DIOXIDE IN WATER AT VARIOUS TEMPERATURES AND PRESSURES

The solubility of CO<sub>2</sub> in water, expressed as mole fraction of CO<sub>2</sub> in the liquid phase, is given for pressures up to atmospheric and temperatures of 0 to 100 °C. Note that 1 standard atmosphere equals 101.325 kPa. The references give data over a wider range of temperature and pressure. The estimated uncertainty is about 2%.

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t/°C	1000 × mole fraction of CO <sub>2</sub> in liquid phase						
	Partial pressure of CO <sub>2</sub> in kPa						
	5	10	20	30	40	50	100
0	0.067	0.135	0.269	0.404	0.538	0.671	1.337
5	0.056	0.113	0.226	0.338	0.451	0.564	1.123
10	0.048	0.096	0.191	0.287	0.382	0.477	0.950
15	0.041	0.082	0.164	0.245	0.327	0.409	0.814
20	0.035	0.071	0.141	0.212	0.283	0.353	0.704
25	0.031	0.062	0.123	0.185	0.247	0.308	0.614
30	0.027	0.054	0.109	0.163	0.218	0.271	0.541
35	0.024	0.048	0.097	0.145	0.193	0.242	0.481
40	0.022	0.043	0.087	0.130	0.173	0.216	0.431
45	0.020	0.039	0.078	0.117	0.156	0.196	0.389
50	0.018	0.036	0.071	0.107	0.142	0.178	0.354
55	0.016	0.033	0.065	0.098	0.131	0.163	0.325
60	0.015	0.030	0.060	0.090	0.121	0.150	0.300
65	0.014	0.028	0.056	0.084	0.112	0.140	0.279
70	0.013	0.026	0.052	0.079	0.105	0.131	0.261
75	0.012	0.025	0.049	0.074	0.099	0.123	0.245
80	0.012	0.023	0.047	0.070	0.093	0.116	0.232
85	0.011	0.022	0.044	0.067	0.089	0.111	0.221
90	0.011	0.021	0.042	0.064	0.085	0.106	0.211
95	0.010	0.020	0.041	0.061	0.082	0.102	0.203
100	0.010	0.020	0.039	0.059	0.079	0.098	0.196

## AQUEOUS SOLUBILITY AND HENRY'S LAW CONSTANTS OF ORGANIC COMPOUNDS

The solubility in water of about 1300 organic compounds, including many compounds of environmental interest, is tabulated here. When data are available, values are given at several temperatures between 0 °C and 100 °C. Solids, liquids, and gases are included; additional data on gases can be found in the table "Solubility of Selected Gases in Water" in Section 8.

Solubility of solids is defined as the concentration of the compound in a solution that is in equilibrium with the solid phase at the specified temperature and one atmosphere pressure. For liquids whose water mixtures separate into two phases, the solubility given here is the concentration of the specified compound in the water-rich phase at equilibrium. In the case of gases (i.e., compounds whose vapor pressure at the specified temperature exceeds one atmosphere) the solubility is defined here as the concentration in the water phase when the partial pressure of the compound above the solution is 101.325 kPa (1 atm). Values for gases are marked with an asterisk.

The solubility values in this table are expressed as mass percent of solute,  $s = 100w_2$ , where the mass fraction  $w_2$  is defined as

$$w_2 = m_2 / (m_1 + m_2)$$

where  $m_2$  is the mass of solute and  $m_1$  the mass of water. For convenience, the solubility expressed in grams of solute that will dissolve in 1 kilogram of water is tabulated in the adjacent column to mass percent. For compounds with low solubility (e.g.,  $s < 1\%$ ), that column is, to a high approximation, numerically identical to the solubility expressed in grams of solute per liter of solution.

The mass fraction  $w_2$  is related to other common measures of solubility as follows:

Molality:	$m_2 = 1000 w_2 / M_2 (1 - w_2)$
Molarity:	$c_2 = 1000 \rho w_2 / M_2$
Mole fraction:	$x_2 = (w_2 / M_2) / \{ (w_2 / M_2) + (1 - w_2) / M_1 \}$
Mass of solute per 100 g of H <sub>2</sub> O:	$100w_2 / (1 - w_2)$
Mass of solute per liter of solution:	$1000\rho w_2$

Here,  $M_2$  is the molar mass of the solute,  $M_1 = 18.015$  g/mol is the molar mass of water, and  $\rho$  is the density of the solution in g/mL.

Data have been selected from evaluated sources wherever possible, in particular the *IUPAC Solubility Data Series*. Many values come from experimental measurements reported in the *Journal of Chemical and Engineering Data* and the *Journal of Chemical Thermodynamics*, as well as critical review papers in the *Journal of Physical and Chemical Reference Data*. The primary source for each value is listed in the column following the solubility values; additional references of interest are sometimes given. Many of the references contain solubility data at other temperatures and pH values and in the presence of other compounds. The user is cautioned that wide variations of data are found in the literature for the lower solubility compounds. The references should be consulted for more information on these compounds.

The table also contains values of the Henry's Law constant  $k_H$ , which provides a measure of the partition of a substance between the atmosphere and the aqueous phase. Here,  $k_H$  is defined as the limit of  $p_2/c_2$  as the concentration approaches zero, where  $p_2$  is the

partial pressure of the solute above the solution and  $c_2$  is the concentration in the solution at equilibrium (other formulations of Henry's Law are often used; see Reference 5). The values of  $k_H$  listed here are based on direct experimental measurement whenever available, but many of them are simply calculated as the ratio of the pure compound vapor pressure to the solubility. This approximation is reliable only for compounds of very low solubility. In fact, values of  $k_H$  found in the literature frequently differ by a factor of two or three, and variations over an order of magnitude are not unusual (Reference 5). Therefore, the data given here should be taken only as a rough indication of the true Henry's Law constant, which is difficult to measure precisely.

All values of  $k_H$  refer to 25 °C. If the vapor pressure of the compound at 25 °C is greater than one atmosphere, it can be assumed that the  $k_H$  value has been calculated as  $101.325/c_2$ . The source of the Henry's Law data is given in the last column. The air-water partition coefficient (i.e., ratio of air concentration to water concentration when both are expressed in the same units) is equal to  $k_H/RT$  or  $k_H/2.48$  in the units used here.

Compounds are listed by systematic name. To locate a compound by molecular formula or CAS Registry Number, use the indexes to the table "Physical Constants of Organic Compounds" in Section 3, which point to the entry in that table from which the name can be determined.

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\* Indicates a value of  $s$  for a gas at a partial pressure of 101.325 kPa (1 atm) in equilibrium with the solution.



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Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Acenaphthene	C <sub>12</sub> H <sub>10</sub>	154.207	0	0.00015	0.0015	4		
			25	0.000380	0.00380	22	0.01217	22
			50	0.00092	0.0092	4		
Acenaphthylene	C <sub>12</sub> H <sub>8</sub>	152.192	20	0.0016	0.016	28	0.012	28
Acephate	C <sub>4</sub> H <sub>10</sub> NO <sub>3</sub> PS	183.166	20	≈28	≈390	40		
Acetamide	C <sub>2</sub> H <sub>5</sub> NO	59.067	20	40.8	689	10		
Acetanilide	C <sub>8</sub> H <sub>9</sub> NO	135.163	20	0.52	5.2	27		
			70	2.7	28	27		
Acetazolamide	C <sub>4</sub> H <sub>6</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	222.246	30	0.10	1.0	40		
Acetohexamide	C <sub>15</sub> H <sub>20</sub> N <sub>2</sub> O <sub>4</sub> S	324.396	37	0.0013	0.013	40		
Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	41.052	-3	40.5	681	39		
			-10	31.7	464	39		
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	120.149	20	0.67	6.7	84	0.00108	28
			50	0.81	8.2	84	0.00108	28
			80	1.16	11.7	84	0.00108	28
Acetylene	C <sub>2</sub> H <sub>2</sub>	26.037	25	0.108*	1.08*	19		
2-(Acetyloxy)benzoic acid	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	180.158		0.25	2.5	27		
2-(Acetyloxy)-5-bromobenzoic acid	C <sub>9</sub> H <sub>7</sub> BrO <sub>4</sub>	259.054		0.07	0.7	30		
Acridine	C <sub>13</sub> H <sub>9</sub> N	179.217	25	0.00466	0.0466	6		
Acrolein	C <sub>3</sub> H <sub>4</sub> O	56.063	20	20.8	263	10		
Acrylamide	C <sub>3</sub> H <sub>5</sub> NO	71.078	20	≈27	≈370	40		
Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	53.063	20	7.35	79.3	10		
Adenine	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	135.128	25	0.104	1.04	29		
Adenosine	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	267.242	25	0.51	5.1	29		
Alachlor	C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	269.768	23	0.024	0.24	40		
<i>L</i> -Alanine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	25	14.30	167	26		
β-Alanine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	25	47.1	890	26		
Aldicarb	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub> S	190.263	20	0.60	6.0	40		
Aldrin	C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub>	364.910	25	0.00002	0.0002	67		
Allopurinol	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	136.112	25	0.057	0.57	40		
Ametryn	C <sub>9</sub> H <sub>17</sub> N <sub>5</sub> S	227.330	20	0.0190	0.190	40		
2-Amino-9,10-anthracenedione	C <sub>14</sub> H <sub>9</sub> NO <sub>2</sub>	223.227	25	0.000016	0.00016	40		
4-Aminoazobenzene	C <sub>12</sub> H <sub>11</sub> N <sub>3</sub>	197.235	25	0.0030	0.030	40		
			97	0.068	0.68	40		
4-Aminobenzenesulfonamide	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub> S	172.205	20	0.71	7.2	40		
4-Aminobenzenesulfonic acid	C <sub>6</sub> H <sub>7</sub> NO <sub>3</sub> S	173.190	7	0.59	5.9	27		
<i>DL</i> -2-Aminobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.120	25	17.4	211	26		
<i>DL</i> -3-Aminobutanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.120	25	55.6	1250	26		
4-Amino- <i>N</i> -[(butylamino)carbonyl]benzenesulfonamide	C <sub>11</sub> H <sub>17</sub> N <sub>3</sub> O <sub>3</sub> S	271.336	37	0.053	0.53	40		
3-Amino-2,5-dichlorobenzoic acid	C <sub>7</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	206.027	25	0.070	0.70	40		
6-Amino-1,3-dihydro-2 <i>H</i> -purin-2-one	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	151.127	25	0.006	0.06	26		
4-(2-Aminoethyl)phenol	C <sub>8</sub> H <sub>11</sub> NO	137.179	15	1.03	10.4	40		
6-Aminohexanoic acid	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.173	25	46	852	29		
4-Amino-2-hydroxybenzoic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	153.136	20	0.20	2.0	40		
2-Amino-2-methylpropanoic acid	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.120	25	12.1	138	26		
4-Amino-5-methyl-2(1 <i>H</i> )-pyrimidinone	C <sub>5</sub> H <sub>7</sub> N <sub>3</sub> O	125.129	25	0.45	4.5	26		
2-Aminophenol	C <sub>6</sub> H <sub>7</sub> NO	109.126	20	1.92	19.6	40		
3-Aminophenol	C <sub>6</sub> H <sub>7</sub> NO	109.126	20	2.56	26.3	40		



Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
			70	≈24	≈320	40		
4-Aminophenol	C <sub>6</sub> H <sub>7</sub> NO	109.126	20	1.55	15.7	40		
Aminopyrine	C <sub>13</sub> H <sub>17</sub> N <sub>3</sub> O	231.293	25	4.8	50	40		
Amitriptyline	C <sub>20</sub> H <sub>23</sub> N	277.404	24	0.00097	0.0097	40		
Amobarbital	C <sub>11</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub>	226.272	25	0.06	0.6	40		
Anilazine	C <sub>9</sub> H <sub>5</sub> Cl <sub>3</sub> N <sub>4</sub>	275.522	20	0.001	0.01	40		
Aniline	C <sub>6</sub> H <sub>7</sub> N	93.127	25	3.38	35.0	10	14	15
Aniline-2-carboxylic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	20	0.349	3.49	40		
Aniline-4-carboxylic acid	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	25	0.54	5.4	40		
Aniline hydrochloride	C <sub>6</sub> H <sub>8</sub> ClN	129.588	15	15.1	178	27		
Anisole	C <sub>7</sub> H <sub>8</sub> O	108.138	20	0.203	2.03	20	0.025	13
			40	0.184	1.84	20	0.025	13
			81	0.294	2.95	20	0.025	13
Anthracene	C <sub>14</sub> H <sub>10</sub>	178.229	0	0.000022	0.000022	42,4		
			25	0.000044	0.000044	42,22	0.00396	22
			50	0.000029	0.00029	42		
9,10-Anthracenedione	C <sub>14</sub> H <sub>8</sub> O <sub>2</sub>	208.213	25	0.00014	0.0014	40		
Apomorphine	C <sub>17</sub> H <sub>17</sub> NO <sub>2</sub>	267.323	25	2.0	20	40		
<i>L</i> -Arginine	C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	174.201	25	15.44	183	26		
<i>L</i> -Ascorbic acid	C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	176.124	25	25.2	337	33		
			50	41.0	695	33		
<i>L</i> -Asparagine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	132.118	25	2.45	25.1	26		
<i>L</i> -Aspartic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	133.104	10	0.29	2.9	77		
			25	0.49	4.9	77		
			50	1.31	13.3	77		
Atrazine	C <sub>8</sub> H <sub>14</sub> ClN <sub>5</sub>	215.684	25	0.007	0.07	26		
Atropine	C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub>	289.370	20	0.3	3	40		
Azinphos-methyl	C <sub>10</sub> H <sub>12</sub> N <sub>3</sub> O <sub>3</sub> PS <sub>2</sub>	317.324	20	0.00209	0.0209	40		
<i>trans</i> -Azobenzene	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	182.220	20	0.03	0.3	27		
Bayleton	C <sub>14</sub> H <sub>16</sub> ClN <sub>3</sub> O <sub>2</sub>	293.749	20	0.026	0.26	40		
Bendiocarb	C <sub>11</sub> H <sub>13</sub> NO <sub>4</sub>	223.226	25	0.004	0.04	40		
Bentazon	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub> S	240.278	20	0.050	0.50	40		
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	106.122	20	0.3	3	10		
Benzamide	C <sub>7</sub> H <sub>7</sub> NO	121.137	12	0.577	5.77	27		
Benz[a]anthracene	C <sub>18</sub> H <sub>12</sub>	228.288	10	0.0000038	0.0000038	42		
			25	0.0000093	0.0000093	42,22	0.00058	22
Benzene	C <sub>6</sub> H <sub>6</sub>	78.112	10	0.174	1.74	22		
			20	0.177	1.77	22		
			30	0.183	1.83	22		
			40	0.192	1.92	22		
			50	0.206	2.06	22		
			70	0.249	2.50	65		
			101	0.398	4.00	65		
Benzeneacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	25	1.71	17.4	27		
1,2-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108.141	20	3.02	31.1	40		
1,3-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108.141	20	3.48	36.1	40		
1,4-Benzenediamine	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108.141	24	3.45	35.7	40		
1,2-Benzenedicarboxamide	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	164.162	30	0.59	5.9	40		
Benzeneethanol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	1.72	17.5	40		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Benzenehexacarboxylic acid	C <sub>12</sub> H <sub>6</sub> O <sub>12</sub>	342.169	25	49.3	972	76		
Benzenepentacarboxylic acid	C <sub>11</sub> H <sub>6</sub> O <sub>10</sub>	298.160	10	11.9	135	76		
			25	21.1	267	76		
			50	36.2	567	76		
1,2,3,4-Benzenetetracarboxylic acid	C <sub>10</sub> H <sub>6</sub> O <sub>8</sub>	254.150	10	11.0	124	76		
			25	20.9	264	76		
			50	39.5	653	76		
1,2,3,5-Benzenetetracarboxylic acid	C <sub>10</sub> H <sub>6</sub> O <sub>8</sub>	254.150	10	7.50	81.1	76		
			25	10.1	112	76		
			50	15.8	188	76		
1,2,4,5-Benzenetetracarboxylic acid	C <sub>10</sub> H <sub>6</sub> O <sub>8</sub>	254.150	10	0.51	5.1	76		
			25	1.06	10.7	76		
			50	3.82	39.7	76		
1,2,3-Benzenetricarboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>6</sub>	210.140	10	2.39	24.5	76		
			25	4.78	50.2	76		
			50	17.4	211	76		
1,2,4-Benzenetricarboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>6</sub>	210.140	10	1.02	10.3	76		
			25	1.92	19.6	76		
			50	5.45	57.6	76		
1,3,5-Benzenetricarboxylic acid	C <sub>9</sub> H <sub>6</sub> O <sub>6</sub>	210.140	10	0.110	1.10	76		
			25	0.207	2.07	76		
			50	0.598	6.02	76		
1,2,3-Benzenetriol	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	126.110	25	38.5	626	27		
1,3,5-Benzenetriol	C <sub>6</sub> H <sub>6</sub> O <sub>3</sub>	126.110	20	1.12	11.3	27		
<i>p</i> -Benzidine	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	184.236	24	0.0360	0.360	40		
1 <i>H</i> -Benzimidazole	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	118.136	15	0.33	3.3	54		
			20	0.201	2.01	6		
1,3-Benzodioxole-5-carboxaldehyde	C <sub>8</sub> H <sub>6</sub> O <sub>3</sub>	150.132	20	0.35	3.5	40		
Benzo[b]fluoranthene	C <sub>20</sub> H <sub>12</sub>	252.309	20	0.0000002	0.000002	40		
Benzo[k]fluoranthene	C <sub>20</sub> H <sub>12</sub>	252.309		0.00000008	0.0000008	40		
11 <i>H</i> -Benzo[a]fluorene	C <sub>17</sub> H <sub>12</sub>	216.277	25	0.0000045	0.000045	42,4		
11 <i>H</i> -Benzo[b]fluorene	C <sub>17</sub> H <sub>12</sub>	216.277	25	0.0000002	0.000002	42,4		
Benzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	122.122	10	0.209	2.09	76		
			25	0.343	3.44	76		
			50	0.842	8.49	76		
Benzoin	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	212.244	25	0.03	0.3	40		
Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	103.122	25	0.2	2	10		
Benzo[ghi]perylene	C <sub>22</sub> H <sub>12</sub>	276.330	25	0.000000026	0.00000026	42,4	0.000075	12
Benzophenone	C <sub>13</sub> H <sub>10</sub> O	182.217	20	0.0075	0.075	40		
2 <i>H</i> -1-Benzopyran-2-one	C <sub>9</sub> H <sub>6</sub> O <sub>2</sub>	146.143	20	0.190	1.90	40		
			60	0.69	6.9	40		
Benzo[a]pyrene	C <sub>20</sub> H <sub>12</sub>	252.309	25	0.00000043	0.0000043	42,22	0.0000465	22
Benzo[e]pyrene	C <sub>20</sub> H <sub>12</sub>	252.309	8	0.00000032	0.0000032	42		
			17	0.00000044	0.0000044	42,22	0.0000467	22
			25	0.00000048	0.0000048	42		
Benzo[f]quinoline	C <sub>13</sub> H <sub>9</sub> N	179.217	25	0.0079	0.079	6		
<i>p</i> -Benzoquinone	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	108.095	25	1.36	13.8	27		
Benzo[b]thiophene	C <sub>8</sub> H <sub>6</sub> S	134.199	20	0.0130	0.130	6		
Benzo[b]triphenylene	C <sub>22</sub> H <sub>14</sub>	278.346	25	0.0000027	0.000027	4		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Benzoxazole	C <sub>7</sub> H <sub>5</sub> NO	119.121	20	0.834	8.34	6		
<i>N</i> -Benzoylglycine	C <sub>9</sub> H <sub>9</sub> NO <sub>3</sub>	179.172	25	0.37	3.7	29		
Benzoyl peroxide	C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	242.227	20	0.000016	0.00016	40		
<i>N</i> -Benzoyl- <i>L</i> -phenylalanine	C <sub>16</sub> H <sub>15</sub> NO <sub>3</sub>	269.295	25	0.085	0.85	29		
Benzyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	150.174	25	0.150	1.50	40		
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	108.138	20	0.08	0.8	10		
Benzyl formate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	20	1.07	10.8	20		
			80	1.43	14.5	20		
Bifenthrin	C <sub>23</sub> H <sub>22</sub> ClF <sub>3</sub> O <sub>2</sub>	422.868	25	0.00001	0.0001	32		
Biotin	C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>3</sub> S	244.310	25	0.035	0.35	40		
Biphenyl	C <sub>12</sub> H <sub>10</sub>	154.207	0	0.000272	0.00272	4		
			25	0.00054	0.0054	58,22	0.0280	22
			50	0.0022	0.022	4		
2,2'-Bipyridine	C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	156.184	25	0.61	6.1	40		
2,2'-Biquinoline	C <sub>18</sub> H <sub>12</sub> N <sub>2</sub>	256.301	24	0.000102	0.00102	6		
Bis(4-aminophenyl) sulfone	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub> S	248.300	25	0.016	0.16	40		
Bis(2-chloroethyl) ether	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	143.012	20	1.04	10.5	20	0.003	13
			81	1.26	12.8	20		
1,1-Bis(4-chlorophenyl)-2,2,2-trichloroethanol	C <sub>14</sub> H <sub>9</sub> Cl <sub>5</sub> O	370.485	25	0.00013	0.0013	40		
Bis(2-ethylhexyl) phthalate	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	390.557	25	0.000027	0.00027	40		
2,2-Bis(4-hydroxyphenyl)propane	C <sub>15</sub> H <sub>16</sub> O <sub>2</sub>	228.287	25	0.0300	0.30	49		
1,3-Bis(trifluoromethyl)benzene	C <sub>8</sub> H <sub>4</sub> F <sub>6</sub>	214.108	25	0.0041	0.041	2		
Borneol	C <sub>10</sub> H <sub>18</sub> O	154.249	25	0.046	0.46	52		
Bromacil	C <sub>9</sub> H <sub>13</sub> BrN <sub>2</sub> O <sub>2</sub>	261.115	25	0.082	0.82	40		
Bromobenzene	C <sub>6</sub> H <sub>5</sub> Br	157.008	10	0.0387	0.387	2		
			25	0.0445	0.445	2	0.250	28
			40	0.0516	0.516	2		
2-Bromobenzoic acid	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	201.018	25	0.185	1.85	27		
3-Bromobenzoic acid	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	201.018	25	0.040	0.40	27		
4-Bromobenzoic acid	C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	201.018	25	0.0056	0.056	27		
1-Bromobutane	C <sub>4</sub> H <sub>9</sub> Br	137.018	25	0.087	0.87	35	1.2	13
4-Bromo-1-butene	C <sub>4</sub> H <sub>7</sub> Br	135.003	25	0.076	0.76	35		
1-Bromo-2-chlorobenzene	C <sub>6</sub> H <sub>4</sub> BrCl	191.453	25	0.0124	0.124	2		
1-Bromo-3-chlorobenzene	C <sub>6</sub> H <sub>4</sub> BrCl	191.453	25	0.0118	0.118	2		
1-Bromo-4-chlorobenzene	C <sub>6</sub> H <sub>4</sub> BrCl	191.453	25	0.00442	0.0442	2		
1-Bromo-2-chloroethane	C <sub>2</sub> H <sub>4</sub> BrCl	143.410	30	0.683	6.83	25		
Bromochloromethane	CH <sub>2</sub> BrCl	129.384	25	1.7	17	10	0.18	13
1-Bromo-3-chloropropane	C <sub>3</sub> H <sub>6</sub> BrCl	157.437	25	0.223	2.23	35		
2-Bromo-2-chloro-1,1,1-trifluoroethane	C <sub>2</sub> HBrClF <sub>3</sub>	197.381	10	0.52	5.2	25		
			25	0.41	4.1	25		
			40	0.40	4.0	25		
Bromodichloromethane	CHBrCl <sub>2</sub>	163.829	30	0.300	3.00	40		
Bromoethane	C <sub>2</sub> H <sub>5</sub> Br	108.965	0	1.05	10.6	25		
			25	0.90	9.0	25	1.23	13
1-Bromoheptane	C <sub>7</sub> H <sub>15</sub> Br	179.098	25	0.00067	0.0067	35		
1-Bromohexane	C <sub>6</sub> H <sub>13</sub> Br	165.071	25	0.00258	0.0258	35		
1-Bromo-4-iodobenzene	C <sub>6</sub> H <sub>4</sub> BrI	282.904	25	0.000794	0.00794	2		
Bromomethane	CH <sub>3</sub> Br	94.939	20	1.80*	18.3*	5	0.63	13
1-Bromo-3-methylbutane	C <sub>5</sub> H <sub>11</sub> Br	151.045	16	0.020	0.20	35		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
1-Bromo-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Br	137.018	18	0.051	0.51	35		
1-Bromooctane	C <sub>8</sub> H <sub>17</sub> Br	193.125	25	0.000167	0.00167	35		
1-Bromopentane	C <sub>5</sub> H <sub>11</sub> Br	151.045	25	0.0127	0.127	35		
4-Bromophenol	C <sub>6</sub> H <sub>5</sub> BrO	173.007	25	1.86	19.0	2		
1-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	122.992	0	0.298	2.98	35		
			25	0.234	2.34	35	3.8	13
2-Bromopropane	C <sub>3</sub> H <sub>7</sub> Br	122.992	20	0.32	3.2	35	1.27	13
3-Bromopropene	C <sub>3</sub> H <sub>5</sub> Br	120.976	25	0.38	3.8	35		
4-Bromotoluene	C <sub>7</sub> H <sub>7</sub> Br	171.035	25	0.011	0.11	2		
Bromotrifluoromethane	CBrF <sub>3</sub>	148.910	25	0.032*	0.32*	14		
5-Bromouracil	C <sub>4</sub> H <sub>3</sub> BrN <sub>2</sub> O <sub>2</sub>	190.983	25	0.288	2.89	72		
Brucine	C <sub>23</sub> H <sub>26</sub> N <sub>2</sub> O <sub>4</sub>	394.463	20	0.012	0.12	27		
1,3-Butadiene	C <sub>4</sub> H <sub>6</sub>	54.091	25	0.0735*	0.735*	5	20.7	13
Butanal	C <sub>4</sub> H <sub>8</sub> O	72.106	25	7.1	76	10		
Butanamide	C <sub>4</sub> H <sub>9</sub> NO	87.120	25	≈19	≈230	40		
Butane	C <sub>4</sub> H <sub>10</sub>	58.122	25	0.00724*	0.0724*	18	95.9	5
2,3-Butanedione	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	20	31.7	464	20		
			80	21.8	279	20		
Butanenitrile	C <sub>4</sub> H <sub>7</sub> N	69.106	20	3.3	34	10		
1,2,3,4-Butanetetrol	C <sub>4</sub> H <sub>10</sub> O <sub>4</sub>	122.120	20	38.0	613	27		
1-Butanethiol	C <sub>4</sub> H <sub>10</sub> S	90.187	20	0.0597	0.597	10		
1-Butanol	C <sub>4</sub> H <sub>10</sub> O	74.121	0	10.5	117	78,1		
			25	7.3	79	78,1		
			50	6.4	68	78,1		
			100	8.8	96	78		
2-Butanol	C <sub>4</sub> H <sub>10</sub> O	74.121	10	23.9	314	1,87		
			25	18.1	221	1,87		
			50	14.0	163	1,87		
2-Butanone	C <sub>4</sub> H <sub>8</sub> O	72.106	0	35.9	560	82		
			25	25.6	344	82		
			40	21.5	274	82		
			70	18.1	221	20		
			100	19.3	239	82		
<i>trans</i> -2-Butenal	C <sub>4</sub> H <sub>6</sub> O	70.090	20	15.6	185	10		
1-Butene	C <sub>4</sub> H <sub>8</sub>	56.107	25	0.0222*	0.222*	5	25.6	13
<i>trans</i> -2-Butenoic acid	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	20	7.1	76	26		
<i>cis</i> -2-Buten-1-ol	C <sub>4</sub> H <sub>8</sub> O	72.106	20	16.6	199	10		
3-Buten-2-one	C <sub>4</sub> H <sub>6</sub> O	70.090	28	54.3	1190	82		
			50	35.6	553	82		
			80	37.6	603	82		
Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	20	0.68	6.8	10		
<i>sec</i> -Butyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	20	0.62	6.2	10		
Butyl 4-aminobenzoate	C <sub>11</sub> H <sub>15</sub> NO <sub>2</sub>	193.243	25	0.018	0.18	40		
Butylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.00138	0.0138	22,89	1.33	22
<i>sec</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.0014	0.014	4,89	1.89	11
<i>tert</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.0032	0.032	4	1.28	11
Butyl ethyl ether	C <sub>6</sub> H <sub>14</sub> O	102.174	20	0.65	6.5	20		
			70	0.39	3.9	20		
Butyl 4-hydroxybenzoate	C <sub>11</sub> H <sub>14</sub> O <sub>3</sub>	194.227	25	0.020	0.20	40		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Butyl methyl ether	C <sub>5</sub> H <sub>12</sub> O	88.148	0	2.51	25.7	79		
			25	0.89	9.0	79		
4- <i>tert</i> -Butylphenol	C <sub>10</sub> H <sub>14</sub> O	150.217	25	0.058	0.58	40		
Butyl propanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	22	0.572	5.72	27		
Butyl stearate	C <sub>22</sub> H <sub>44</sub> O <sub>2</sub>	340.583	25	0.2	2	10		
Butyl vinyl ether	C <sub>6</sub> H <sub>12</sub> O	100.158	20	0.3	3	10		
1-Butyne	C <sub>4</sub> H <sub>6</sub>	54.091	25	0.287*	2.87*	5	1.91	5
Caffeine	C <sub>8</sub> H <sub>10</sub> N <sub>4</sub> O <sub>2</sub>	194.191	25	2.12	21.7	29		
Camphor, (+)	C <sub>10</sub> H <sub>16</sub> O	152.233	20	0.01	0.1	10		
<i>trans</i> -Camphoric acid	C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	200.232	25	0.8	8	27		
Cantharidin	C <sub>10</sub> H <sub>12</sub> O <sub>4</sub>	196.200	20	0.003	0.03	40		
Caprolactam	C <sub>6</sub> H <sub>11</sub> NO	113.157	25	84.0	5250	10		
Captafol	C <sub>10</sub> H <sub>9</sub> Cl <sub>4</sub> NO <sub>2</sub> S	349.061	20	0.000142	0.00142	40		
Captan	C <sub>9</sub> H <sub>8</sub> Cl <sub>3</sub> NO <sub>2</sub> S	300.590	20	0.00005	0.0005	40		
Carbaryl	C <sub>12</sub> H <sub>11</sub> NO <sub>2</sub>	201.221	20	0.0102	0.102	40		
Carbazole	C <sub>12</sub> H <sub>9</sub> N	167.206	22	0.000120	0.00120	6		
Carbofuran	C <sub>12</sub> H <sub>15</sub> NO <sub>3</sub>	221.252	20	0.032	0.32	40		
Carbon dioxide	CO <sub>2</sub>	44.010	25	0.150*	1.50*	18		
Carbon disulfide	CS <sub>2</sub>	76.141	20	0.210	2.10	10		
Carbon monoxide	CO	28.010	25	0.00276*	0.0276*	18		
Carboxin	C <sub>12</sub> H <sub>13</sub> NO <sub>2</sub> S	235.302	25	0.017	0.17	40		
Carminic acid	C <sub>22</sub> H <sub>20</sub> O <sub>13</sub>	492.386	20	0.13	1.3	40		
Carnosine	C <sub>9</sub> H <sub>14</sub> N <sub>4</sub> O <sub>3</sub>	226.232	25	24.4	323	26		
Carvenol	C <sub>10</sub> H <sub>16</sub> O	152.233	25	0.29	2.9	52		
Carvenone, (S)-	C <sub>10</sub> H <sub>16</sub> O	152.233	15	0.22	2.2	27		
Carvone	C <sub>10</sub> H <sub>14</sub> O	150.217	15	0.13	1.3	27		
(S)-Carvone	C <sub>10</sub> H <sub>14</sub> O	150.217	25	0.13	1.3	52		
Cephalexin	C <sub>16</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub> S	347.389	25	1.2	12	40		
Chloramphenicol	C <sub>11</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>5</sub>	323.129	25	0.38	3.8	40		
Chlordane	C <sub>10</sub> H <sub>6</sub> Cl <sub>8</sub>	409.779	25	0.00006	0.0006	67		
2-Chloroaniline	C <sub>6</sub> H <sub>6</sub> ClN	127.572	25	0.876	8.76	10		
3-Chloroaniline	C <sub>6</sub> H <sub>6</sub> ClN	127.572	20	0.54	5.4	40		
4-Chloroaniline	C <sub>6</sub> H <sub>6</sub> ClN	127.572	20	0.275	2.75	40		
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	112.557	5	0.050	0.50	61		
			25	0.050	0.50	61		
			45	0.055	0.55	61,2		
Chlorobenzilate	C <sub>16</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>3</sub>	325.186	20	0.001	0.01	32		
2-Chlorobenzoic acid	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	156.567	25	0.209	2.09	27		
3-Chlorobenzoic acid	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	156.567	25	0.040	0.40	27		
4-Chlorobenzoic acid	C <sub>7</sub> H <sub>5</sub> ClO <sub>2</sub>	156.567	25	0.072	0.72	27		
2-Chlorobiphenyl	C <sub>12</sub> H <sub>9</sub> Cl	188.652	25	0.00055	0.0055	7	0.0701	7
1-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	92.567	1	0.062	0.62	35		
			25	0.087	0.87	35	1.54	13
2-Chlorobutane	C <sub>4</sub> H <sub>9</sub> Cl	92.567	0	0.107	1.07	35		
			25	0.092	0.92	35		
3-Chloro-2-butanone	C <sub>4</sub> H <sub>7</sub> ClO	106.551	19	2.80	28.8	20		
			92	3.38	35.0	20		
Chlorodiazepoxide	C <sub>16</sub> H <sub>14</sub> ClN <sub>3</sub> O	299.754	20	0.2	2	40		
Chlorodibromomethane	CHBr <sub>2</sub> Cl	208.280	30	0.251	2.51	40		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Chlorodifluoromethane	CHClF <sub>2</sub>	86.469	25	0.30*	3.0*	10	3.0	13
4-Chloro-2,5-dimethylphenol	C <sub>8</sub> H <sub>9</sub> ClO	156.609	25	0.89	8.9	2		
4-Chloro-2,6-dimethylphenol	C <sub>8</sub> H <sub>9</sub> ClO	156.609	25	0.52	5.2	2		
4-Chloro-3,5-dimethylphenol	C <sub>8</sub> H <sub>9</sub> ClO	156.609	25	0.34	3.4	2		
1-Chloro-2,4-dinitrobenzene	C <sub>6</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>4</sub>	202.552	25	0.00092	0.0092	40		
Chloroethane	C <sub>2</sub> H <sub>5</sub> Cl	64.514	0	0.45	4.5	25		
			25	0.67*	6.7*	25	1.02	13
Chloroethene	C <sub>2</sub> H <sub>3</sub> Cl	62.498	25	0.27*	2.7*	5	2.68	13
1-Chloro-2-fluorobenzene	C <sub>6</sub> H <sub>4</sub> ClF	130.547	25	0.0502	0.502	40		
Chlorofluoromethane	CH <sub>2</sub> ClF	68.478	25	1.05*	10.6*	14		
1-Chloroheptane	C <sub>7</sub> H <sub>15</sub> Cl	134.647	25	0.00136	0.0136	35		
1-Chlorohexane	C <sub>6</sub> H <sub>13</sub> Cl	120.620	5	0.0047	0.047	35		
			25	0.0064	0.064	35		
2-Chloro-4-hydroxy-5-methoxybenzaldehyde	C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	186.593	25	0.013	0.13	8		
3-Chloro-4-hydroxy-5-methoxybenzaldehyde	C <sub>8</sub> H <sub>7</sub> ClO <sub>3</sub>	186.593	25	0.093	0.93	8		
1-Chloro-2-iodobenzene	C <sub>6</sub> H <sub>4</sub> ClI	238.453	25	0.00689	0.0689	2		
1-Chloro-3-iodobenzene	C <sub>6</sub> H <sub>4</sub> ClI	238.453	25	0.00674	0.0674	2		
1-Chloro-4-iodobenzene	C <sub>6</sub> H <sub>4</sub> ClI	238.453	25	0.00311	0.0311	2		
Chloromethane	CH <sub>3</sub> Cl	50.488	25	0.535*	5.35*	5	0.98	13
1-Chloro-2-methoxyethane	C <sub>3</sub> H <sub>7</sub> ClO	94.540	20	7.79	84.5	20		
			70	6.31	67.3	20		
(Chloromethyl)benzene	C <sub>7</sub> H <sub>7</sub> Cl	126.584	20	0.0493	0.493	10		
3-(Chloromethyl)heptane	C <sub>8</sub> H <sub>17</sub> Cl	148.674	20	0.01	0.1	10		
2-Chloro-6-methylphenol	C <sub>7</sub> H <sub>7</sub> ClO	142.583	25	0.36	3.6	2		
4-Chloro-2-methylphenol	C <sub>7</sub> H <sub>7</sub> ClO	142.583	25	0.68	6.8	2		
4-Chloro-3-methylphenol	C <sub>7</sub> H <sub>7</sub> ClO	142.583	25	0.40	4.0	2		
(4-Chloro-2-methylphenoxy)acetic acid	C <sub>9</sub> H <sub>9</sub> ClO <sub>3</sub>	200.618	25	0.117	1.17	40		
1-Chloro-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Cl	92.567	25	0.92	9.2	35		
2-Chloro-2-methylpropane	C <sub>4</sub> H <sub>9</sub> Cl	92.567	15	0.29	2.9	35		
1-Chloro-2-methylpropene	C <sub>4</sub> H <sub>7</sub> Cl	90.552	25	0.916	9.16	5	0.12	5
1-Chloronaphthalene	C <sub>10</sub> H <sub>7</sub> Cl	162.616	25	0.00224	0.0224	5	0.0363	28
2-Chloronaphthalene	C <sub>10</sub> H <sub>7</sub> Cl	162.616	25	0.00117	0.0117	5	0.0335	28
1-Chloro-2-nitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	157.555	20	0.0441	0.441	40		
1-Chloro-3-nitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	157.555	20	0.0273	0.273	40		
1-Chloro-4-nitrobenzene	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	157.555	20	0.0453	0.453	40		
3-Chloro-2-nitrobenzoic acid	C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	201.565	25	0.047	0.47	27		
5-Chloro-2-nitrobenzoic acid	C <sub>7</sub> H <sub>4</sub> ClNO <sub>4</sub>	201.565	25	0.96	9.6	27		
1-Chlorooctane	C <sub>8</sub> H <sub>17</sub> Cl	148.674	25	0.0345	0.345	35		
Chloropentafluoroethane	C <sub>2</sub> ClF <sub>5</sub>	154.466	25	0.006*	0.06*	10	260	13
1-Chloropentane	C <sub>5</sub> H <sub>11</sub> Cl	106.594	5	0.020	0.20	35		
			25	0.0201	0.201	35	2.37	13
3-Chloropentane	C <sub>5</sub> H <sub>11</sub> Cl	106.594	25	0.025	0.25	35		
5-Chloro-2-pentanone	C <sub>5</sub> H <sub>9</sub> ClO	120.577	22	4.7	49	20		
			71	13.5	156	20		
2-Chlorophenol	C <sub>6</sub> H <sub>5</sub> ClO	128.556	25	2.27	23.2	48,51,2		
3-Chlorophenol	C <sub>6</sub> H <sub>5</sub> ClO	128.556	25	2.2	22	2		
4-Chlorophenol	C <sub>6</sub> H <sub>5</sub> ClO	128.556	25	2.55	26.2	48,51,2		
<i>N</i> '-(4-Chlorophenyl)- <i>N,N</i> -dimethylurea	C <sub>9</sub> H <sub>11</sub> ClN <sub>2</sub> O	198.648	25	0.023	0.23	26		
1-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	78.541	25	0.250	2.50	35	1.41	13

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	78.541	0	0.44	4.4	35		
			20	0.30	3.0	35		
3-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	76.525	25	0.40	4.0	35	1.10	5
			50	0.13	1.3	35		
Chloropropham	C <sub>10</sub> H <sub>12</sub> ClNO <sub>2</sub>	213.661	25	0.0080	0.080	40		
1-Chlorotetradecane	C <sub>14</sub> H <sub>29</sub> Cl	232.833	25	0.0232	0.232	35		
Chlorothalonil	C <sub>8</sub> Cl <sub>4</sub> N <sub>2</sub>	265.911	25	0.00006	0.0006	40		
Chlorothiazide	C <sub>7</sub> H <sub>6</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	295.724	25	0.0283	0.283	40		
2-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	126.584	25	0.0117	0.117	61		
3-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	126.584	25	0.0117	0.117	61		
4-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	126.584	25	0.0123	0.123	61		
Chlorotrifluoromethane	CClF <sub>3</sub>	104.459	25	0.009*	0.09*	10	6.9	13
3-Chloro-1,1,1-trifluoropropane	C <sub>3</sub> H <sub>4</sub> ClF <sub>3</sub>	132.512	20	0.133	1.33	35		
2-Chloro-1,3,5-trinitrobenzene	C <sub>6</sub> H <sub>2</sub> ClN <sub>3</sub> O <sub>6</sub>	247.549	15	0.018	0.18	40		
5-Chlorouracil	C <sub>4</sub> H <sub>3</sub> ClN <sub>2</sub> O <sub>2</sub>	146.532	25	0.250	2.51	72		
Chlorpyrifos	C <sub>9</sub> H <sub>11</sub> Cl <sub>3</sub> NO <sub>3</sub> PS	350.586	20	0.000073	0.00073	40		
Chlorsulfuron	C <sub>12</sub> H <sub>12</sub> ClN <sub>5</sub> O <sub>4</sub> S	357.773	25	2.71	27.9	32		
Cholic acid	C <sub>24</sub> H <sub>40</sub> O <sub>5</sub>	408.572	20	0.028	0.28	26		
Chrysene	C <sub>18</sub> H <sub>12</sub>	228.288	7	0.00000007	0.0000007	42		
			25	0.00000019	0.0000019	42,22	0.000065	22
<i>trans</i> -Cinnamaldehyde	C <sub>9</sub> H <sub>8</sub> O	132.159	25	0.135	1.35	40		
<i>trans</i> -Cinnamic acid	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	148.159	20	0.1	1	26		
			98	0.59	5.9	26		
Citric acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	192.124	20	59	1440	26		
Clopyralid	C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	192.000	20	0.1	1	40		
Clorophene	C <sub>13</sub> H <sub>11</sub> ClO	218.678	20	0.42	4.2	40		
Cocaine	C <sub>17</sub> H <sub>21</sub> NO <sub>4</sub>	303.354	25	0.17	1.7	27		
Codeine	C <sub>18</sub> H <sub>21</sub> NO <sub>3</sub>	299.365	25	0.79	7.9	27		
Colchicine	C <sub>22</sub> H <sub>25</sub> NO <sub>6</sub>	399.437	20	4	42	26		
Coronene	C <sub>24</sub> H <sub>12</sub>	300.352	25	0.000000014	0.00000014	42,4		
Creatine	C <sub>4</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	131.133	25	1.6	16	26		
<i>o</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	108.138	40	3.08	31.8	10		
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	108.138	40	2.51	25.7	10		
<i>p</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	108.138	40	2.26	23.1	10		
Crufomate	C <sub>12</sub> H <sub>19</sub> ClNO <sub>3</sub> P	291.711	20	0.50	5.0	40		
Cyanazine	C <sub>9</sub> H <sub>13</sub> ClN <sub>6</sub>	240.692	25	0.0171	0.171	40		
2-Cyanoacetamide	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> O	84.076	20	11.5	130	40		
Cyanogen	C <sub>2</sub> N <sub>2</sub>	52.034	25	0.8*	8*	30		
Cyanogen chloride	CClN	61.471	0	5.7	60	40		
Cyanoguanidine	C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	84.080	25	3.8	40	40		
Cyanuric acid	C <sub>3</sub> H <sub>3</sub> N <sub>3</sub> O <sub>3</sub>	129.074	25	0.259	2.59	40		
Cycloheptane	C <sub>7</sub> H <sub>14</sub>	98.186	25	0.0030	0.030	3	9.59	13
			92	2.82	29.0	20		
1,3,5-Cycloheptatriene	C <sub>7</sub> H <sub>8</sub>	92.139	25	0.064	0.64	3	0.47	13
Cycloheptene	C <sub>7</sub> H <sub>12</sub>	96.170	25	0.0066	0.066	3	4.9	13
1,4-Cyclohexadiene	C <sub>6</sub> H <sub>8</sub>	80.128	25	0.08	0.8	3	1.03	13
Cyclohexane	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0058	0.058	3	19.4	13
			70	0.0092	0.092	65		

Name	Mol. Form.	Mol. Wt.	t/°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
			100	0.0163	0.163	65		
Cyclohexanecarboxylic acid	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	128.169	15	0.201	2.01	27		
Cyclohexanol	C <sub>6</sub> H <sub>12</sub> O	100.158	10	4.62	48.4	1		
			25	3.8	40	1		
			40	3.30	34.1	1		
Cyclohexanone	C <sub>6</sub> H <sub>10</sub> O	98.142	10	12.2	139	83		
			25	9.5	105	83		
			50	7.6	82	83		
			80	6.8	73	20		
Cyclohexanone oxime	C <sub>6</sub> H <sub>11</sub> NO	113.157	25	1.57	16.0	40		
Cyclohexene	C <sub>6</sub> H <sub>10</sub>	82.143	25	0.016	0.16	3	4.57	13
Cyclohexyl butanoate	C <sub>10</sub> H <sub>18</sub> O <sub>2</sub>	170.249	20	0.11	1.1	20		
			90	0.09	0.90	20		
Cyclooctane	C <sub>8</sub> H <sub>16</sub>	112.213	25	0.00079	0.0079	4	10.7	13
1,3-Cyclopentadiene	C <sub>5</sub> H <sub>6</sub>	66.102	25	0.068	0.68	3		
Cyclopentane	C <sub>5</sub> H <sub>10</sub>	70.133	25	0.0157	0.157	3	19.1	13
Cyclopentanol	C <sub>5</sub> H <sub>10</sub> O	86.132	19	10.6	119	88		
			50	8.3	91	88		
			90	9.2	101	88		
Cyclopentanone	C <sub>5</sub> H <sub>8</sub> O	84.117	0	37.7	605	20		
			20	31.0	449	20		
			80	24.8	330	20		
Cyclopentene	C <sub>5</sub> H <sub>8</sub>	68.118	25	0.054	0.54	3	6.56	13
Cyclopropane	C <sub>3</sub> H <sub>6</sub>	42.080	25	0.0484*	0.484*	19		
Cyfluthrin	C <sub>22</sub> H <sub>18</sub> Cl <sub>2</sub> FNO <sub>3</sub>	434.287	20	0.0000002	0.000002	32		
Cygon	C <sub>5</sub> H <sub>12</sub> NO <sub>3</sub> PS <sub>2</sub>	229.258	20	2.6	27	40		
Cyhalothrin	C <sub>23</sub> H <sub>19</sub> ClF <sub>3</sub> NO <sub>3</sub>	449.850	20	0.0000005	0.000005	32		
Cypermethrin	C <sub>22</sub> H <sub>19</sub> Cl <sub>2</sub> NO <sub>3</sub>	416.297	20	0.000001	0.00001	32		
<i>L</i> -Cystine	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	240.300	25	0.0166	0.166	62		
Cytisine	C <sub>11</sub> H <sub>14</sub> N <sub>2</sub> O	190.241	16	≈30	≈430	40		
Cytosine	C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O	111.102	25	0.73	7.3	29		
Daminozide	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	160.170	25	9.1	100	40		
Dazomet	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> S <sub>2</sub>	162.276	25	0.12	1.2	40		
Decabromobiphenyl ether	C <sub>12</sub> Br <sub>10</sub> O	959.167	25	0.0000025	0.000025	40		
Decachlorobiphenyl	C <sub>12</sub> Cl <sub>10</sub>	498.658	25	0.0000000012	0.000000012	7	0.0208	7
<i>cis</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	138.250	25	0.000089	0.00089	37		
<i>trans</i> -Decahydronaphthalene	C <sub>10</sub> H <sub>18</sub>	138.250	25	0.000089	0.00089	4	3	13
Decane	C <sub>10</sub> H <sub>22</sub>	142.282	0	0.0000015	0.000015	4	479	13
Decanedioic acid	C <sub>10</sub> H <sub>18</sub> O <sub>4</sub>	202.248	20	0.10	1.0	40		
Decanoic acid	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	172.265	20	0.015	0.15	26		
1-Decanol	C <sub>10</sub> H <sub>22</sub> O	158.281	25	0.0037	0.037	1		
2-Decanone	C <sub>10</sub> H <sub>20</sub> O	156.265	25	0.0079	0.079	84		
4-Decanone	C <sub>10</sub> H <sub>20</sub> O	156.265	20	0.0238	0.238	20		
			80	0.0064	0.064	20		
1-Decene	C <sub>10</sub> H <sub>20</sub>	140.266	25	0.00057	0.0057	4		
2'-Deoxyadenosine	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>3</sub>	251.242	25	0.67	6.7	29		
Dexamethasone	C <sub>22</sub> H <sub>29</sub> FO <sub>5</sub>	392.460	25	0.009	0.09	40		
Dibenz[a,j]acridine	C <sub>21</sub> H <sub>13</sub> N	279.335	25	0.000016	0.00016	6		
Dibenz[a,h]anthracene	C <sub>22</sub> H <sub>14</sub>	278.346	25	0.00000005	0.0000005	42,4		



Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Dibenz[a,j]anthracene	C <sub>22</sub> H <sub>14</sub>	278.346	27	0.0000012	0.000012	42,4		
13 <i>H</i> -Dibenzo[a,i]carbazole	C <sub>20</sub> H <sub>13</sub> N	267.324	24	0.00000104	0.0000104	6		
Dibenzo[b,e][1,4]dioxin	C <sub>12</sub> H <sub>8</sub> O <sub>2</sub>	184.191	25	0.000126	0.00126	68		
Dibenzofuran	C <sub>12</sub> H <sub>8</sub> O	168.191	25	0.000475	0.00475	41	0.011	12
Dibenzothiophene	C <sub>12</sub> H <sub>8</sub> S	184.257	25	0.000103	0.00103	6		
Dibenzyl ether	C <sub>14</sub> H <sub>14</sub> O	198.260	35	0.0040	0.040	10		
<i>o</i> -Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	235.904	25	0.00748	0.0748	2		
<i>m</i> -Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	235.904	25	0.0064	0.064	2		
<i>p</i> -Dibromobenzene	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub>	235.904	25	0.0020	0.020	2		
1,4-Dibromobutane	C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	215.915	25	0.035	0.35	35		
1,2-Dibromo-1-chloroethane	C <sub>2</sub> H <sub>3</sub> Br <sub>2</sub> Cl	222.306	20	0.060	0.60	25		
1,2-Dibromo-3-chloropropane	C <sub>3</sub> H <sub>5</sub> Br <sub>2</sub> Cl	236.333	20	0.123	1.23	35		
1,2-Dibromo-1,2-dichloroethane	C <sub>2</sub> H <sub>2</sub> Br <sub>2</sub> Cl <sub>2</sub>	256.751	20	0.070	0.70	25		
1,2-Dibromoethane	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	187.861	20	0.412	4.14	20		
			50	0.493	4.95	20	0.066	13
			80	0.572	5.75	20		
1,2-Dibromo-1,1,2,3,3,3-hexafluoropropane	C <sub>3</sub> Br <sub>2</sub> F <sub>6</sub>	309.830	21	0.0068	0.068	35		
3,5-Dibromo-4-hydroxybenzonitrile	C <sub>7</sub> H <sub>3</sub> Br <sub>2</sub> NO	276.913	25	0.013	0.13	40		
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	173.835	20	1.28	13.0	20	0.086	13
			90	1.51	15.3	20		
2,4-Dibromophenol	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> O	251.903	25	0.2	2	2		
1,2-Dibromopropane	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	201.888	25	0.143	1.43	10		
1,3-Dibromopropane	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	201.888	25	0.169	1.69	35		
1,2-Dibromotetrafluoroethane	C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	259.823	25	0.00030	0.0030	25		
Dibutylamine	C <sub>8</sub> H <sub>19</sub> N	129.244	20	0.47	4.7	10		
Dibutyl ether	C <sub>8</sub> H <sub>18</sub> O	130.228	0	0.040	0.40	20	0.48	13
			20	0.023	0.23	20	0.48	13
			90	0.010	0.10	20		
Dibutyl phthalate	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	278.344	25	0.00112	0.0112	15		
Dibutyl sebacate	C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	314.461	20	0.004	0.04	10		
<i>o</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	147.002	5	0.012	0.12	61,58,2		
			25	0.015	0.15	61,58,2		
			45	0.020	0.20	61,58,2		
<i>m</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	147.002	10	0.0103	0.103	41,2		
			25	0.0120	0.120	41,2	0.376	11
			45	0.0141	0.141	61,2		
<i>p</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	147.002	10	0.00512	0.0512	2		
			25	0.0080	0.080	41	0.244	28
			50	0.0167	0.167	2		
3,5-Dichloro-1,2-benzenediol	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	179.001	25	0.78	7.8	8		
4,5-Dichloro-1,2-benzenediol	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	179.001	25	1.19	12.0	8		
3,3'-Dichloro- <i>p</i> -benzidine	C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	253.126	25	0.00031	0.0031	40		
2,5-Dichlorobiphenyl	C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	223.098	25	0.0002	0.002	7	0.0201	7
2,6-Dichlorobiphenyl	C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	223.098	25	0.00014	0.0014	7		
1,1-Dichloro-2,2-bis( <i>p</i> -chlorophenyl)ethane	C <sub>14</sub> H <sub>10</sub> Cl <sub>4</sub>	320.041	25	0.000009	0.00009	40		
			45	0.000024	0.00024	40		
1,1-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	127.013	25	0.050	0.50	35		
1,4-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	127.013	25	0.16	1.6	35		
2,3-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	127.013	20	0.056	0.56	35		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2,7-Dichlorodibenzo- <i>p</i> -dioxin	C <sub>12</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>2</sub>	253.081	25	0.00000041	0.0000041	68		
1,2-Dichloro-1,1-difluoroethane	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	134.940	24	0.49	4.9	25		
Dichlorodifluoromethane	CCl <sub>2</sub> F <sub>2</sub>	120.914	20	0.028*	0.28*	5	41	13
1,3-Dichloro-5,5-dimethyl hydantoin	C <sub>5</sub> H <sub>6</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	197.019	20	0.050	0.50	40		
1,1-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	98.959	0	0.62	6.2	25		
			25	0.50	5.0	25	0.63	13
			50	0.50	5.0	25		
1,2-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	98.959	0	0.92	9.2	25		
			25	0.86	8.6	25	0.14	13
			50	1.05	10.6	25		
			100	2.17	22.2	25		
1,1-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	96.943	5	0.310	3.10	25		
			25	0.242	2.42	25	2.62	13
			50	0.225	2.25	25		
			90	0.355	3.55	25		
<i>cis</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	96.943	10	0.76	7.6	25		
			25	0.64	6.4	25	0.46	13
			40	0.66	6.6	25		
<i>trans</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	96.943	10	0.53	5.3	25		
			25	0.45	4.5	25	0.96	13
			40	0.41	4.1	25		
1,1-Dichloro-1-fluoroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	116.949	25	0.042	0.42	25		
Dichlorofluoromethane	CHCl <sub>2</sub> F	102.923	25	0.95*	9.5*	10		
1,2-Dichloro-1,1,2,3,3,3-hexafluoropropane	C <sub>3</sub> Cl <sub>2</sub> F <sub>6</sub>	220.928	21	0.0096	0.096	35		
1,4-Dichloro-5-isopropyl-2-methylbenzene	C <sub>10</sub> H <sub>12</sub> Cl <sub>2</sub>	203.108	25	0.00049	0.0049	23		
Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	84.933	25	1.73	17.6	20	0.30	13
3,6-Dichloro-2-methoxybenzoic acid	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	221.038	25	0.45	4.5	40		
(Dichloromethyl)benzene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	161.029	30	0.025	0.25	10		
2,3-Dichloro-2-methylbutane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	141.038	25	0.029	0.29	35		
2,4-Dichloro-6-methylphenol	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	177.028	25	0.0283	0.283	2		
2,6-Dichloro-4-methylphenol	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub> O	177.028	25	0.0673	0.673	2		
2,3-Dichloro-1,4-naphthalenedione	C <sub>10</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	227.044	25	0.00001	0.0001	40		
1,2-Dichloro-4-nitrobenzene	C <sub>6</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	192.000	20	0.0121	0.121	40		
1,2-Dichloropentane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	141.038	25	0.029	0.29	35		
1,5-Dichloropentane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	141.038	19	0.02	0.2	35		
2,3-Dichloropentane	C <sub>5</sub> H <sub>10</sub> Cl <sub>2</sub>	141.038	25	0.029	0.29	35		
Dichlorophene	C <sub>13</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	269.123	25	0.003	0.03	40		
2,3-Dichlorophenol	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	163.001	25	0.82	8.3	40		
2,4-Dichlorophenol	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	163.001	25	0.55	5.5	48,51,24		
2,6-Dichlorophenol	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	163.001	25	0.262	2.62	40		
(2,4-Dichlorophenoxy)acetic acid	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	221.038	25	0.07	0.7	40		
4-(2,4-Dichlorophenoxy)butanoic acid	C <sub>10</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>3</sub>	249.090	25	0.0046	0.046	40		
2-(2,4-Dichlorophenoxy)propanoic acid	C <sub>9</sub> H <sub>8</sub> Cl <sub>2</sub> O <sub>3</sub>	235.064	25	0.083	0.83	40		
1,2-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	112.986	5	0.270	2.70	35		
			25	0.274	2.74	35	0.29	13
			40	0.297	2.97	35		
1,3-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	112.986	5	0.218	2.18	35		
			25	0.280	2.80	35		
<i>cis</i> -1,3-Dichloropropene	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	110.970	20	0.27	2.7	5	0.24	5

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>trans</i> -1,3-Dichloropropene	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	110.970	20	0.28	2.8	5	0.18	5
2,3-Dichloropropene	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	110.970	25	0.215	2.15	5	0.36	5
1,2-Dichloro-1,1,2,2-tetrafluoroethane	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	170.921	25	0.013*	0.13*	10	127	13
2,4-Dichlorotoluene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	161.029	25	0.00260	0.0260	61		
2,6-Dichlorotoluene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	161.029	25	0.00233	0.0233	61		
2,2-Dichloro-1,1,1-trifluoroethane	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	152.930	25	0.46	4.6	25		
Diclofop-methyl	C <sub>16</sub> H <sub>14</sub> Cl <sub>2</sub> O <sub>4</sub>	341.186	20	0.0003	0.003	32		
Dieldrin	C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub> O	380.909	25	0.000020	0.00020	67		
Diethanolamine	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	105.136	20	95.4	20700	10		
1,1-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	118.174	25	5	53	10		
1,2-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	118.174	20	21.0	266	10		
2-(Diethylamino)- <i>N</i> -(2,6-dimethylphenyl)acetamide	C <sub>14</sub> H <sub>22</sub> N <sub>2</sub> O	234.337	25	0.38	3.8	40		
<i>o</i> -Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	20	0.0071	0.071	40		
<i>p</i> -Diethylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	20	0.0025	0.025	40		
Diethyl carbonate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	118.131	20	1.8	18	40		
Diethyl ether	C <sub>4</sub> H <sub>10</sub> O	74.121	0	12.5	143	79	0.088	13
			25	5.9	63	79	0.088	13
			38	4.6	48	79	0.088	13
			82	3.1	32	79	0.088	13
Diethyl glutarate	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	188.221	30	1.20	12.1	20		
			91	0.91	9.2	20		
Diethyl maleate	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>	172.179	20	1.56	15.8	20		
			91	1.75	17.8	20		
Diethyl malonate	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	160.168	20	2.26	23.1	20		
			91	2.47	25.3	20		
Diethyl phthalate	C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	222.237	25	0.12	1.2	40		
<i>trans</i> -Diethylstilbestrol	C <sub>18</sub> H <sub>20</sub> O <sub>2</sub>	268.351	20	0.01	0.1	40		
Diethyl succinate	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	174.195	20	0.19	1.9	40		
Diethyl sulfide	C <sub>4</sub> H <sub>10</sub> S	90.187	25	0.307	3.07	40		
Diflubenzuron	C <sub>14</sub> H <sub>9</sub> ClF <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	310.683	20	0.00002	0.0002	40		
<i>o</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	114.093	25	0.114	1.14	2		
<i>m</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	114.093	25	0.114	1.14	2		
<i>p</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	114.093	25	0.122	1.22	2		
1,1-Difluoroethane	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	66.050	20	0.29*	2.9*	50		
Digitoxin	C <sub>41</sub> H <sub>64</sub> O <sub>13</sub>	764.939	25	0.0004	0.004	40		
Diglycolic acid	C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	134.088	24	40.0	667	34		
			50	59.9	1490	34		
Digoxin	C <sub>41</sub> H <sub>64</sub> O <sub>14</sub>	780.939	25	0.0059	0.059	40		
Dihexyl ether	C <sub>12</sub> H <sub>26</sub> O	186.333	20	0.019	0.19	20		
			90	0.019	0.19	20		
1,2-Dihydrobenz[j]aceanthrylene	C <sub>20</sub> H <sub>14</sub>	254.325	27	0.00000035	0.0000035	42,6		
1,3-Dihydro-2 <i>H</i> -benzimidazol-2-one	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O	134.135	24	0.37	3.7	54		
1,2-Dihydro-3-methylbenz[j]aceanthrylene	C <sub>21</sub> H <sub>16</sub>	268.352	25	0.00000022	0.0000022	42,6		
			27	0.00000028	0.0000028	42		
2,3-Dihydro-6-propyl-2-thioxo-4(1 <i>H</i> )-pyrimidinone	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub> OS	170.231	25	0.120	1.20	40		
1,7-Dihydro-6 <i>H</i> -purine-6-thione	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> S	152.178	25	0.0124	0.124	40		
3,4-Dihydro-2 <i>H</i> -pyran	C <sub>5</sub> H <sub>8</sub> O	84.117	20	1.04	10.5	20		
			82	2.26	23.1	20		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
1,4-Dihydroxy-9,10-anthracenedione	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>	240.212	25	0.0000096	0.000096	40		
3,4-Dihydroxybenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	154.121	14	1.8	18	26		
			80	21.3	271	26		
3,12-Dihydroxycholan-24-oic acid, (3 $\alpha$ ,5 $\beta$ ,12 $\alpha$ )	C <sub>24</sub> H <sub>40</sub> O <sub>4</sub>	392.573	20	0.001	0.01	40		
17,21-Dihydroxypregna-1,4-diene-3,11,20-trione	C <sub>21</sub> H <sub>26</sub> O <sub>5</sub>	358.428	25	0.012	0.12	40		
17,21-Dihydroxypregn-4-ene-3,11,20-trione	C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	360.444	25	0.028	0.28	30		
<i>o</i> -Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	329.905	25	0.00192	0.0192	2		
<i>m</i> -Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	329.905	25	0.00185	0.00185	2		
<i>p</i> -Diiodobenzene	C <sub>6</sub> H <sub>4</sub> I <sub>2</sub>	329.905	25	0.000893	0.00893	2		
<i>cis</i> -1,2-Diiodoethene	C <sub>2</sub> H <sub>2</sub> I <sub>2</sub>	279.846	25	0.046	0.46	25		
<i>trans</i> -1,2-Diiodoethene	C <sub>2</sub> H <sub>2</sub> I <sub>2</sub>	279.846	25	0.015	0.15	25		
Diiodomethane	CH <sub>2</sub> I <sub>2</sub>	267.836	30	0.124	1.24	10	0.032	13
3,5-Diiodo- <i>L</i> -tyrosine	C <sub>9</sub> H <sub>9</sub> I <sub>2</sub> NO <sub>3</sub>	432.981	25	0.062	0.62	26		
Diisopentyl ether	C <sub>10</sub> H <sub>22</sub> O	158.281	20	0.02	0.2	10		
Diisopropyl ether	C <sub>6</sub> H <sub>14</sub> O	102.174	20	0.79	8.0	20	0.26	13
			61	0.22	2.2	20		
1,2-Dimethoxybenzene	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	138.164	20	0.716	7.21	20		
			92	1.073	10.85*	20		
3,3'-Dimethoxybenzidine	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub> O <sub>2</sub>	244.289	25	0.006	0.06	40		
Dimethoxymethane	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	76.095	16	24.4	323	10		
4-(Dimethylamino)azobenzene	C <sub>14</sub> H <sub>15</sub> N <sub>3</sub>	225.289	20	0.00014	0.0014	40		
2',3-Dimethyl-4-aminoazobenzene	C <sub>14</sub> H <sub>15</sub> N <sub>3</sub>	225.289	37	0.0007	0.007	40		
2,5-Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	121.180	20	0.66	6.6	27		
<i>N,N</i> -Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	121.180	25	0.111	1.11	40		
9,10-Dimethylanthracene	C <sub>16</sub> H <sub>14</sub>	206.282	25	0.0000056	0.000056	42,4		
Dimethylarsinic acid	C <sub>2</sub> H <sub>7</sub> AsO <sub>2</sub>	137.998	25	≈41	≈700	40		
7,12-Dimethylbenz[a]anthracene	C <sub>20</sub> H <sub>16</sub>	256.341	25	0.0000061	0.000061	42		
2,2-Dimethylbutane	C <sub>6</sub> H <sub>14</sub>	86.175	25	0.0021	0.021	3	199	13
2,3-Dimethylbutane	C <sub>6</sub> H <sub>14</sub>	86.175	25	0.0021	0.021	3	144	13
2,2-Dimethyl-1-butanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	0.78	7.9	78,1		
2,3-Dimethyl-2-butanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	4.2	44	1		
3,3-Dimethyl-2-butanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	2.4	25	1		
3,3-Dimethyl-2-butanone	C <sub>6</sub> H <sub>12</sub> O	100.158	0	2.92	30.1	83		
			19	1.97	20.1	20		
			25	1.85	18.8	83		
			50	1.46	14.8	83		
			90	1.14	11.5	20		
2,3-Dimethyl-1-butene	C <sub>6</sub> H <sub>12</sub>	84.159	30	0.046	0.46	3		
<i>cis</i> -1,2-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	112.213	25	0.00060	0.0060	4	36	5
<i>trans</i> -1,2-Dimethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	112.213	30	0.00050	0.0050	57,4	88.2	5
			100	0.00293	0.0293	57,4		
Dimethyl ether	C <sub>2</sub> H <sub>6</sub> O	46.068	25	35.3*	546	79		
			50	29.2*	412	79		
Dimethylglyoxime	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	116.119	20	0.06	0.6	40		
3,5-Dimethyl-4-heptanol	C <sub>9</sub> H <sub>20</sub> O	144.254	15	0.072	0.72	1		
2,6-Dimethyl-4-heptanone	C <sub>9</sub> H <sub>18</sub> O	142.238	21	0.045	0.45	20		
			91	0.037	0.37	20		
1,2-Dimethyl-1 <i>H</i> -imidazole	C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	96.131	19	94.3	16500	54		
Dimethyl maleate	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	144.126	25	8.0	87	10		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Dimethyl malonate	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	132.116	19	14.9	175	20		
			90	29.8	425	20		
1,3-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.0008	0.008	4		
1,4-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00114	0.0114	4		
1,5-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00031	0.0031	4	0.036	28
2,3-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00025	0.0025	4		
2,6-Dimethylnaphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00017	0.0017	4		
Dimethyl oxalate	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	118.089	20	5.82	61.8	27		
2,2-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00044	0.0044	3	318	5
2,3-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00052	0.0052	3	175	5
2,4-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00042	0.0042	3	323	13
3,3-Dimethylpentane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00059	0.0059	3	186	5
2,3-Dimethyl-2-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.5	15	1		
2,4-Dimethyl-2-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.3	13	1		
2,2-Dimethyl-3-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	0.82	8.2	1		
2,3-Dimethyl-3-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.6	16	1		
2,4-Dimethyl-3-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	0.70	7.0	1		
2,4-Dimethyl-3-pentanone	C <sub>7</sub> H <sub>14</sub> O	114.185	20	0.52	5.2	20		
			90	0.30	3.0	20		
<i>N,N</i> -Dimethyl- <i>N'</i> -phenylurea	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O	164.203	25	0.32	3.2	40		
Dimethyl phthalate	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	194.184	25	0.40	4.0	15		
2,2-Dimethyl-1-propanol	C <sub>5</sub> H <sub>12</sub> O	88.148	12	3.87	40.3	78,1		
			25	3.26	33.7	78,1		
			80	2.84	29.2	78,1		
4-(1,1-Dimethylpropyl)phenol	C <sub>11</sub> H <sub>16</sub> O	164.244	25	0.017	0.17	40		
Dimethyl succinate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	146.141	21	12.4	142	20		
			92	17.1	206	20		
Dimethyl sulfate	C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	126.132	18	2.7	28	27		
Dimethyl sulfide	C <sub>2</sub> H <sub>6</sub> S	62.134	25	2	20	10		
Dimethyl sulfoxide	C <sub>2</sub> H <sub>6</sub> OS	78.133	25	25.3	339	10		
Dimethyl terephthalate	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	194.184	25	0.00328	0.0328	40		
Dimethyl tetrachloroterephthalate	C <sub>10</sub> H <sub>6</sub> Cl <sub>4</sub> O <sub>4</sub>	331.965	25	0.00005	0.0005	40		
<i>N,N</i> -Dimethyl- <i>N'</i> -[3-(trifluoromethyl)phenyl]urea	C <sub>10</sub> H <sub>11</sub> F <sub>3</sub> N <sub>2</sub> O	232.201	20	0.0105	0.105	40		
2,4-Dinitroaniline	C <sub>6</sub> H <sub>5</sub> N <sub>3</sub> O <sub>4</sub>	183.122	25	0.0078	0.078	40		
1,2-Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	168.107	20	0.21	2.1	27		
1,3-Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	168.107	20	2.09	21.3	27		
1,4-Dinitrobenzene	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	168.107	20	1.30	13.2	27		
3,5-Dinitrobenzoic acid	C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	212.116	25	0.134	1.34	27		
2,4-Dinitrophenol	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>5</sub>	184.106	25	0.069	0.69	48,51		
			35	0.098	0.98	48,51		
Dipentyl ether	C <sub>10</sub> H <sub>22</sub> O	158.281	25	0.11	1.1	81		
Diphenamid	C <sub>16</sub> H <sub>17</sub> NO	239.312	27	0.026	0.26	32		
Diphenylamine	C <sub>12</sub> H <sub>11</sub> N	169.222	20	0.0055	0.055	40		
			50	0.0058	0.058	40		
1,2-Diphenylethane	C <sub>14</sub> H <sub>14</sub>	182.261	25	0.00044	0.0044	6	0.017	12
Diphenyl ether	C <sub>12</sub> H <sub>10</sub> O	170.206	25	0.0018	0.0180	6	0.027	13
Diphenylmethane	C <sub>13</sub> H <sub>12</sub>	168.234	25	0.00014	0.0014	42,4	0.001	12
Diphenyl phthalate	C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	318.323	24	0.000008	0.00008	40		
1,3-Diphenyl-1-triazene	C <sub>12</sub> H <sub>11</sub> N <sub>3</sub>	197.235	20	0.050	0.50	40		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>N,N'</i> -Diphenylurea	C <sub>13</sub> H <sub>12</sub> N <sub>2</sub> O	212.246	20	0.015	0.15	40		
Dipropylamine	C <sub>6</sub> H <sub>15</sub> N	101.190	20	2.5	26	10		
Dipropyl ether	C <sub>6</sub> H <sub>14</sub> O	102.174	0	2.67	27.4	80	0.26	13
			25	0.91	9.2	80	0.26	13
Diuron	C <sub>9</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O	233.093	25	0.0042	0.042	40		
Docosane	C <sub>22</sub> H <sub>46</sub>	310.600	22	0.0000006	0.000006	37		
Dodecane	C <sub>12</sub> H <sub>26</sub>	170.334	25	0.00000037	0.0000037	4	750	5
Dodecanedioic acid	C <sub>12</sub> H <sub>22</sub> O <sub>4</sub>	230.301	20	0.004	0.04	40		
Dodecanoic acid	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	200.318	20	0.0055	0.055	26		
1-Dodecanol	C <sub>12</sub> H <sub>26</sub> O	186.333	25	0.0004	0.004	1		
Droperidol	C <sub>22</sub> H <sub>22</sub> FN <sub>3</sub> O <sub>2</sub>	379.427	30	0.00041	0.0041	40		
Eicosane	C <sub>20</sub> H <sub>42</sub>	282.547	25	0.00000019	0.0000019	42,4		
Emetine	C <sub>29</sub> H <sub>40</sub> N <sub>2</sub> O <sub>4</sub>	480.639	15	0.096	0.96	40		
Endrin	C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub> O	380.909	25	0.000025	0.00025	67		
<i>l</i> -Ephedrine	C <sub>10</sub> H <sub>15</sub> NO	165.232	25	0.57	5.7	40		
Epichlorohydrin	C <sub>3</sub> H <sub>5</sub> ClO	92.524	20	6.58	70.4	10	0.003	13
			65	7.2	78	40		
Epinephrine	C <sub>9</sub> H <sub>13</sub> NO <sub>3</sub>	183.204	20	0.018	0.18	40		
1,2-Epoxy-4-(epoxyethyl)cyclohexane	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	140.180	20	13.4	155	40		
2,3-Epoxy- $\alpha$ -pinane	C <sub>10</sub> H <sub>16</sub> O	152.233	25	0.039	0.39	52		
Erythromycin	C <sub>37</sub> H <sub>67</sub> NO <sub>13</sub>	733.927	30	0.12	1.2	40		
			80	0.04	0.4	40		
Estra-1,3,5(10)-triene-3,17-diol (17 $\beta$ )	C <sub>18</sub> H <sub>24</sub> O <sub>2</sub>	272.383	25	0.000151	0.00151	49		
Estrone	C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>	270.367	25	0.000130	0.00130	49		
Ethane	C <sub>2</sub> H <sub>6</sub>	30.069	25	0.00568*	0.0568*	18	50.6	5
1,2-Ethandiol, diacetate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	146.141	25	13.3	153	40		
Ethinylestradiol	C <sub>20</sub> H <sub>24</sub> O <sub>2</sub>	296.404	25	0.000921	0.00921	49		
Ethoxybenzene	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.12	1.2	10		
2-Ethoxyethyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	132.157		14	163	30		
<i>N</i> -(4-Ethoxyphenyl)acetamide	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	179.216	25	0.0502	0.502	40		
Ethyl acetate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	88.106	25	8.08	87.9	10		
Ethyl acetoacetate	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	130.141	25	12	136	10		
Ethyl acrylate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	100.117	25	1.50	15.2	10		
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	106.165	0	0.020	0.20	4,89		
			25	0.0161	0.161	22,89	0.843	22
			40	0.0200	0.200	4,89		
Ethyl benzoate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	150.174	25	0.083	0.83	20		
Ethyl butanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	20	0.49	4.9	10		
2-Ethyl-1-butanol	C <sub>6</sub> H <sub>14</sub> O	102.174	20	0.92	9.3	78		
			50	0.80	8.1	78		
Ethyl carbamate	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	15	48	920	27		
Ethyl cyanoacetate	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	113.116	20	25.9	350	10		
Ethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	112.213	30	0.00061	0.0061	57,4		
			100	0.00212	0.0212	57,4		
Ethylcyclopentane	C <sub>7</sub> H <sub>14</sub>	98.186	20	0.012	0.12	3		
Ethyl decanoate	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	200.318	20	0.0015	0.015	27		
Ethylene	C <sub>2</sub> H <sub>4</sub>	28.053	25	0.01336*	0.1336*	19	21.7	5
Ethyleneimine	C <sub>2</sub> H <sub>5</sub> N	43.068	20	0.90	9.1	40		
Ethyl formate	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	74.079	25	11.8	134	10		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Ethyl heptanoate	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	158.238	20	0.029	0.29	27		
Ethyl hexanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	20	0.063	0.63	27		
2-Ethyl-1-hexanol	C <sub>8</sub> H <sub>18</sub> O	130.228	25	0.071	0.71	78		
			50	0.074	0.74	78		
2-Ethylhexylamine	C <sub>8</sub> H <sub>19</sub> N	129.244	20	0.25	2.5	10		
Ethyl 4-hydroxybenzoate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	166.173	25	0.0080	0.080	40		
Ethyl isopropyl ether	C <sub>5</sub> H <sub>12</sub> O	88.148	25	0.52	5.2	79		
Ethyl 2-methylbutanoate, (+)	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	19	0.257	2.58	20		
			91	0.151	1.51	20		
Ethyl 3-methylbutanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	20	0.2	2	10		
Ethyl <i>N</i> -methylcarbamate	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	103.120	15	69	2230	27		
1-Ethyl-naphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00101	0.0101	4	0.039	12
2-Ethyl-naphthalene	C <sub>12</sub> H <sub>12</sub>	156.223	25	0.00080	0.0080	4	0.078	12
<i>O</i> -Ethyl <i>O-p</i> -nitrophenyl benzenethiophosphonate	C <sub>14</sub> H <sub>14</sub> NO <sub>4</sub> PS	323.304	22	0.00031	0.0031	40		
<i>N</i> -Ethyl- <i>N</i> -nitrosourea	C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	117.107	20	1.3	13	40		
Ethyl nonanoate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	186.292	20	0.003	0.03	27		
Ethyl octanoate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	172.265	20	0.007	0.07	27		
Ethyl pentanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	25	0.3	3	27		
3-Ethyl-3-pentanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.7	17	1		
4-Ethylphenol	C <sub>8</sub> H <sub>10</sub> O	122.164	20	0.59	5.9	40		
Ethyl propanoate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	20	1.92	19.6	10		
Ethyl <i>N</i> -propylcarbamate	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.173	15	7.70	83.4	27		
Ethyl propyl ether	C <sub>5</sub> H <sub>12</sub> O	88.148	25	1.87	19.2	79		
2-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0075	0.075	89,5	0.529	13
4-Ethyltoluene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0094	0.094	5	0.500	13
Ethyl vinyl ether	C <sub>4</sub> H <sub>8</sub> O	72.106	20	0.9	9	10		
Etoposide	C <sub>29</sub> H <sub>32</sub> O <sub>13</sub>	588.556	20	0.02	0.2	40		
Eucalyptol	C <sub>10</sub> H <sub>18</sub> O	154.249	21	0.379	3.79	40		
			50	0.170	1.70	40		
Fenamiphos	C <sub>13</sub> H <sub>22</sub> NO <sub>3</sub> PS	303.358	20	0.0329	0.329	40		
Fenbutatin oxide	C <sub>60</sub> H <sub>78</sub> OSn <sub>2</sub>	1052.68	23	0.0000005	0.000005	32		
$\alpha$ -Fenchol, (+)-	C <sub>10</sub> H <sub>18</sub> O	154.249	25	0.083	0.83	52		
Fenchone	C <sub>10</sub> H <sub>16</sub> O	152.233	20	0.2	2	84		
Fenoxycarb	C <sub>17</sub> H <sub>19</sub> NO <sub>4</sub>	301.338	20	0.0006	0.006	32		
Ferbam	C <sub>9</sub> H <sub>18</sub> FeN <sub>3</sub> S <sub>6</sub>	416.494	20	0.013	0.13	40		
Fluoranthene	C <sub>16</sub> H <sub>10</sub>	202.250	20	0.000017	0.00017	42		
			25	0.000021	0.00021	42,22	0.00096	22
			50	0.000019	0.00019	42,22	0.00787	22
9 <i>H</i> -Fluorene	C <sub>13</sub> H <sub>10</sub>	166.218	0	0.00007	0.0007	42,4		
			25	0.00019	0.0019	42,22	0.00787	22
			50	0.00063	0.0063	42,4		
Fluorescein	C <sub>20</sub> H <sub>12</sub> O <sub>5</sub>	332.306	20	0.005	0.05	27		
Fluorobenzene	C <sub>6</sub> H <sub>5</sub> F	96.102	19	0.170	1.70	20	0.70	11
			80	0.188	1.88	20	0.70	11
2-Fluorobenzoic acid	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	140.112	25	0.72	7.2	27		
3-Fluorobenzoic acid	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	140.112	25	0.15	1.5	27		
4-Fluorobenzoic acid	C <sub>7</sub> H <sub>5</sub> FO <sub>2</sub>	140.112	25	0.12	1.2	27		
Fluoroethane	C <sub>2</sub> H <sub>5</sub> F	48.059	25	0.216*	2.16*	14		
Fluoromethane	CH <sub>3</sub> F	34.033	0	0.420*	4.20*	50		
			25	0.201*	2.01*	50		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
			80	0.082*	0.82*	50		
1-Fluoropropane	C <sub>3</sub> H <sub>7</sub> F	62.086	14	0.386*	3.86*	14		
2-Fluoropropane	C <sub>3</sub> H <sub>7</sub> F	62.086	15	0.366*	3.66*	14		
5-Fluorouracil	C <sub>4</sub> H <sub>3</sub> FN <sub>2</sub> O <sub>2</sub>	130.077	25	1.77	18.0	72		
Folic acid	C <sub>19</sub> H <sub>19</sub> N <sub>7</sub> O <sub>6</sub>	441.397	0	0.001	0.01	26		
			100	0.05	0.5	26		
Folpet	C <sub>9</sub> H <sub>4</sub> Cl <sub>3</sub> NO <sub>2</sub> S	296.558	20	0.00010	0.0010	40		
β- <i>D</i> -Fructose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	180.155	20	≈31	≈450	40		
Furan	C <sub>4</sub> H <sub>4</sub> O	68.074	25	1	10	10	0.54	13
2-Furancarboxylic acid	C <sub>5</sub> H <sub>4</sub> O <sub>3</sub>	112.084	25	4.76	50.0	33		
			50	25.2	337	33		
Furfural	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	96.085	20	8.2	89	10		
Galactaric acid	C <sub>6</sub> H <sub>10</sub> O <sub>8</sub>	210.138	14	0.33	3.3	40		
<i>D</i> -Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	180.155	20	40.6	684	27		
<i>D</i> -Glucitol	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	182.171	20	≈41	≈700	40		
α- <i>D</i> -Glucose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	180.155	15	45.0	818	27		
			30	54.6	1200	27		
			80	81.5	4400	27		
<i>DL</i> -Glutamic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	147.130	25	2.30	23.5	29		
<i>L</i> -Glutamic acid	C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	147.130	10	0.444	4.46	75		
			25	0.824	8.31	75		
			50	2.13	21.8	75		
<i>L</i> -Glutamine	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	146.144	25	4.0	42	26		
Glycerol triacetate	C <sub>9</sub> H <sub>14</sub> O <sub>6</sub>	218.203	25	5.8	62	10		
Glycine	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	75.067	25	18.5	227	70		
			36	22.1	284	70		
			50	26.1	353	70		
Glycolic acid	C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	76.051	25	71.2	2470	34		
			55	77.9	3520	34		
<i>N</i> -Glycylglycine	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	132.118	25	18.8	232	47,29		
Glyphosate	C <sub>3</sub> H <sub>8</sub> NO <sub>5</sub> P	169.074	25	1.2	12	32		
Guanidinoacetic acid	C <sub>3</sub> H <sub>7</sub> N <sub>3</sub> O <sub>2</sub>	117.107	25	0.5	5	26		
Guanine	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	151.127	25	0.0068	0.068	29		
Guanosine	C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub>	283.241	25	0.0500	0.500	29		
Haloperidol	C <sub>21</sub> H <sub>23</sub> ClFNO <sub>2</sub>	375.865	30	0.0003	0.003	40		
Heptachlor	C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub>	373.318	25	0.000018	0.00018	67		
2,2',3,3',4,4',6-Heptachlorobiphenyl	C <sub>12</sub> H <sub>3</sub> Cl <sub>7</sub>	395.323	25	0.0000002	0.000002	7	0.0054	7
Heptadecanoic acid	C <sub>17</sub> H <sub>34</sub> O <sub>2</sub>	270.451	20	0.00042	0.0042	26		
1,6-Heptadiyne	C <sub>7</sub> H <sub>8</sub>	92.139	25	0.125	1.25	3		
Heptanal	C <sub>7</sub> H <sub>14</sub> O	114.185	11	0.124	1.24	27		
Heptane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.000242	0.00242	46		
			50	0.000341	0.00341	46	209	13
			75	0.000570	0.00570	46		
			100	0.00108	0.0108	46		
Heptanedioic acid	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	160.168	25	6.347	67.77	33		
			50	42.80	748	33		
Heptanoic acid	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	15	0.24	2.4	27		
1-Heptanol	C <sub>7</sub> H <sub>16</sub> O	116.201	0	0.236	2.37	78		
			25	0.164	1.64	78,1	0.00562	28



Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
			50	0.164	1.64	78,1		
			90	0.245	2.46	78		
2-Heptanol	C <sub>7</sub> H <sub>16</sub> O	116.201	30	0.33	3.3	1		
3-Heptanol, (S)-	C <sub>7</sub> H <sub>16</sub> O	116.201	25	0.43	4.3	1		
4-Heptanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	0.47	4.7	1		
2-Heptanone	C <sub>7</sub> H <sub>14</sub> O	114.185	25	0.435	4.37	20	0.0171	28
			90	0.353	3.53	20	0.0171	28
3-Heptanone	C <sub>7</sub> H <sub>14</sub> O	114.185	20	0.479	4.81	20		
			90	0.309	3.10	20		
4-Heptanone	C <sub>7</sub> H <sub>14</sub> O	114.185	20	0.457	4.57	20		
			90	0.316	3.16	20		
1-Heptene	C <sub>7</sub> H <sub>14</sub>	98.186	25	0.032	0.32	3	40.3	13
<i>trans</i> -2-Heptene	C <sub>7</sub> H <sub>14</sub>	98.186	25	0.015	0.15	3	42.2	13
Heptyl butanoate	C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	186.292	20	0.028	0.28	20		
			80	0.020	0.20	20		
1-Heptyne	C <sub>7</sub> H <sub>12</sub>	96.170	25	0.0094	0.094	3	4.47	13
Hesperetin	C <sub>16</sub> H <sub>14</sub> O <sub>6</sub>	302.278	15	0.00004	0.0004	71		
			25	0.00014	0.0014	71		
			35	0.00052	0.0052	71		
Hexachlorobenzene	C <sub>6</sub> Cl <sub>6</sub>	284.782	25	0.0000096	0.0000096	58	0.131	11
			35	0.000018	0.000018	58		
			55	0.000038	0.000038	58		
2,2',3,3',4,4'-Hexachlorobiphenyl	C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	360.878	25	0.0000006	0.0000006	7	0.0354	31
2,2',4,4',6,6'-Hexachlorobiphenyl	C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	360.878	25	0.0000003	0.0000003	41	0.818	7
2,2',3,3',6,6'-Hexachlorobiphenyl	C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	360.878	25	0.0000004	0.0000004	41		
Hexachloro-1,3-butadiene	C <sub>4</sub> Cl <sub>6</sub>	260.761	25	0.41	4.1	35		
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\alpha$ ,6 $\beta$ )	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	290.830	25	0.00078	0.0078	60		
			45	0.0015	0.015	60		
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\beta$ ,6 $\beta$ )	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	290.830	25	0.00018	0.0018	60		
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\beta$ ,3 $\alpha$ ,4 $\beta$ ,5 $\alpha$ ,6 $\beta$ )	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	290.830	25	0.00002	0.0002	60		
Hexachloroethane	C <sub>2</sub> Cl <sub>6</sub>	236.739	25	0.005	0.05	25	0.85	13
Hexachloropropene	C <sub>3</sub> Cl <sub>6</sub>	248.750	20	0.00118	0.0118	35		
Hexacosafuorododecane	C <sub>12</sub> F <sub>26</sub>	638.086	20	0.00000096	0.0000096	35		
Hexacosane	C <sub>26</sub> H <sub>54</sub>	366.707	25	0.00000017	0.0000017	42,37		
Hexadecane	C <sub>16</sub> H <sub>34</sub>	226.441	25	0.0000004	0.0000004	42,37		
Hexadecanoic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	256.424	20	0.00072	0.0072	26		
1-Hexadecanol	C <sub>16</sub> H <sub>34</sub> O	242.440	25	0.000003	0.000003	1		
1,5-Hexadiene	C <sub>6</sub> H <sub>10</sub>	82.143	25	0.017	0.17	3		
Hexafluorobenzene	C <sub>6</sub> F <sub>6</sub>	186.054	8	0.0778	0.778	53		
			28	0.0616	0.616	53		
			67	0.0636	0.636	53		
Hexahydro-1,3,5-trinitro-1,3,5-triazine	C <sub>3</sub> H <sub>6</sub> N <sub>6</sub> O <sub>6</sub>	222.116	3	0.0014	0.014	59		
			20	0.0037	0.037	59		
			25	0.0060	0.060	17		
			34	0.0086	0.086	59		
Hexamethylenetetramine	C <sub>6</sub> H <sub>12</sub> N <sub>4</sub>	140.186	12	44.8	812	27		
Hexane	C <sub>6</sub> H <sub>14</sub>	86.175	25	0.00098	0.0098	46		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
			50	0.00114	0.0114	46		
			75	0.00167	0.0167	46	183	13
			100	0.00291	0.0291	46		
1,6-Hexanediamine	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	116.204	5	≈42	≈720	40		
Hexanedinitrile	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108.141	20	0.80	8.0	16		
1,6-Hexanedioic acid	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	146.141	15	1.48	15.0	26		
			100	61.5	1600	26		
Hexanoic acid	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	25	1.01	10.2	64		
			35	1.09	11.0	64		
			60	1.16	11.7	26		
1-Hexanol	C <sub>6</sub> H <sub>14</sub> O	102.174	0	0.79	7.9	1		
			10	0.70	7.0	78		
			25	0.59	5.9	78,1		
			50	0.55	5.5	78,1		
2-Hexanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	1.4	14	1		
3-Hexanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	1.6	16	1		
2-Hexanone	C <sub>6</sub> H <sub>12</sub> O	100.158	10	1.91	19.5	83		
			25	1.49	15.1	83		
			50	1.17	11.8	83		
3-Hexanone	C <sub>6</sub> H <sub>12</sub> O	100.158	25	1.47	14.9	83		
Hexatriacontane	C <sub>36</sub> H <sub>74</sub>	506.973	25	0.00000017	0.0000017	42,37		
Hexazinone	C <sub>12</sub> H <sub>20</sub> N <sub>4</sub> O <sub>2</sub>	252.313	25	3.2	33	40		
1-Hexene	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0053	0.053	3	41.8	5
<i>trans</i> -2-Hexene	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0067	0.067	3		
1-Hexen-3-ol	C <sub>6</sub> H <sub>12</sub> O	100.158	25	2.52	25.9	1		
4-Hexen-2-ol	C <sub>6</sub> H <sub>12</sub> O	100.158	25	3.81	39.6	1		
Hexyl acetate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	20	0.02	0.2	10		
<i>sec</i> -Hexyl acetate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	20	0.13	1.3	10		
Hexylbenzene	C <sub>12</sub> H <sub>18</sub>	162.271	25	0.00021	0.0021	4		
4-Hexyl-1,3-benzenediol	C <sub>12</sub> H <sub>18</sub> O <sub>2</sub>	194.270	18	0.05	0.5	40		
Hexyl butanoate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	172.265	29	0.021	0.21	20		
1-Hexyne	C <sub>6</sub> H <sub>10</sub>	82.143	25	0.036	0.36	3	4.14	13
<i>L</i> -Histidine	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	155.154	25	4.17	43.5	26		
Homocystine	C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	268.354	25	0.02	0.2	26		
<i>L</i> -Homoserine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119.119	25	52.4	1100	26		
Hydramethylnon	C <sub>25</sub> H <sub>24</sub> F <sub>6</sub> N <sub>4</sub>	494.476	20	0.0000006	0.000006	32		
Hydrochlorothiazide	C <sub>7</sub> H <sub>8</sub> ClN <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	297.740	25	0.007	0.07	40		
Hydrocortisone	C <sub>21</sub> H <sub>30</sub> O <sub>5</sub>	362.460	25	0.029	0.29	40		
Hydroflumethiazide	C <sub>8</sub> H <sub>8</sub> F <sub>3</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	331.293	37	0.068	0.68	40		
<i>p</i> -Hydroquinone	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	110.111	25	7.42	80.1	27		
17-Hydroxyandrost-4-en-3-one, (17β)	C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	288.424	25	0.0024	0.024	40		
4-Hydroxybenzaldehyde	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	122.122	30	1.27	12.9	40		
2-Hydroxybenzamide	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	10	0.122	1.22	44		
			25	0.241	2.42	44		
			50	0.737	7.42	44		
α-Hydroxybenzeneacetic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152.148	25	11.3	127	27		
2-Hydroxybenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	138.121	10	0.119	1.19	43,33		
			25	0.189	1.89	43,33		
			50	0.521	5.24	43,33		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
4-Hydroxybenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	138.121	15	0.8	8	26		
			75	2.5	26	27		
2-Hydroxybiphenyl	C <sub>12</sub> H <sub>10</sub> O	170.206	25	0.07	0.7	40		
4-Hydroxybiphenyl	C <sub>12</sub> H <sub>10</sub> O	170.206	25	0.0056	0.056	40		
4-Hydroxy-3-methoxybenzaldehyde	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152.148	25	0.247	2.47	8		
3-Hydroxy-4-oxo-4 <i>H</i> -pyran-2,6-dicarboxylic acid	C <sub>7</sub> H <sub>4</sub> O <sub>7</sub>	200.103	25	0.84	8.4	27		
<i>N</i> -(4-Hydroxyphenyl)acetamide	C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	151.163	25	1.3	13	40		
<i>trans</i> -4-Hydroxy- <i>L</i> -proline	C <sub>5</sub> H <sub>9</sub> NO <sub>3</sub>	131.130	25	26.5	361	26		
Hyoscyamine	C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub>	289.370	20	0.36	3.6	40		
Hypoxanthine	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	136.112	25	0.070	0.70	29		
Ibuprofen	C <sub>13</sub> H <sub>18</sub> O <sub>2</sub>	206.281	25	0.0011	0.011	40		
			60	0.0048	0.048	40		
Imazaquin	C <sub>17</sub> H <sub>17</sub> N <sub>3</sub> O <sub>3</sub>	311.335	20	0.009	0.09	32		
Imidacloprid	C <sub>9</sub> H <sub>10</sub> ClN <sub>5</sub> O <sub>2</sub>	255.66	30	0.038	0.38	73		
			51	0.117	1.17	73		
Imidazole	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	68.077	19	67.3	2060	54		
2,4-Imidazolidinedione	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	100.076	25	3.93	40.9	29		
Imidodicarbonic diamide	C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	103.080	15	1.5	15	40		
Iminodiacetic acid	C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	133.104	5	2.32	23.8	40		
Indan	C <sub>9</sub> H <sub>10</sub>	118.175	25	0.010	0.10	4		
1 <i>H</i> -Indazole	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	118.136	20	0.0827	0.827	6		
Indeno[1,2,3- <i>cd</i> ]pyrene	C <sub>22</sub> H <sub>12</sub>	276.330	20	0.0000002	0.0000002	40		
1 <i>H</i> -Indole	C <sub>8</sub> H <sub>7</sub> N	117.149	20	0.187	1.87	6		
Indomethacin	C <sub>19</sub> H <sub>16</sub> ClNO <sub>4</sub>	357.788	25	0.001	0.01	40		
Inosine	C <sub>10</sub> H <sub>12</sub> N <sub>4</sub> O <sub>5</sub>	268.226	20	1.6	16	29		
Iodobenzene	C <sub>6</sub> H <sub>5</sub> I	204.008	10	0.0193	0.193	2		
			25	0.0226	0.226	2	0.078	11
			45	0.0279	0.279	2		
2-Iodobenzoic acid	C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	248.018	25	0.095	0.95	27		
3-Iodobenzoic acid	C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	248.018	25	0.016	0.16	27		
4-Iodobenzoic acid	C <sub>7</sub> H <sub>5</sub> IO <sub>2</sub>	248.018	25	0.0027	0.027	27		
1-Iodobutane	C <sub>4</sub> H <sub>9</sub> I	184.018	17	0.021	0.21	10	1.87	13
Iodoethane	C <sub>2</sub> H <sub>5</sub> I	155.965	0	0.44	4.4	25		
			25	0.40	4.0	25	0.52	13
1-Iodoheptane	C <sub>7</sub> H <sub>15</sub> I	226.098	25	0.00035	0.0035	35		
Iodomethane	CH <sub>3</sub> I	141.939	20	1.4	14	10	0.54	13
1-Iodopropane	C <sub>3</sub> H <sub>7</sub> I	169.992	0	0.114	1.14	35		
			20	0.100	1.00	35	0.93	13
2-Iodopropane	C <sub>3</sub> H <sub>7</sub> I	169.992	0	0.167	1.67	35		
			20	0.140	1.40	35		
5-Iodouracil	C <sub>4</sub> H <sub>3</sub> IN <sub>2</sub> O <sub>2</sub>	237.983	25	0.49	4.9	72		
<i>trans</i> -β-Ionone	C <sub>13</sub> H <sub>20</sub> O	192.297	25	0.017	0.17	52		
Iopanoic acid	C <sub>11</sub> H <sub>12</sub> I <sub>3</sub> NO <sub>2</sub>	570.932	37	0.034	0.34	40		
Iprodione	C <sub>13</sub> H <sub>13</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub>	330.166	20	0.0013	0.013	40		
Isobutanal	C <sub>4</sub> H <sub>8</sub> O	72.106	20	9.1	100	10		
Isobutane	C <sub>4</sub> H <sub>10</sub>	58.122	25	0.00535*	0.0535*	18	120	5
Isobutene	C <sub>4</sub> H <sub>8</sub>	56.107	25	0.0263*	0.263*	5	21.6	13
Isobutyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	20	0.63	6.3	10		
Isobutylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.0010	0.010	4	3.32	11

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Isobutyl formate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	22	1.0	10	10		
Isobutyl isobutanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	20	0.5	5	10		
Isobutyl propanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	19	0.225	2.26	20		
			91	0.142	1.42	20		
1 <i>H</i> -Isoindole-1,3(2 <i>H</i> )-dione	C <sub>8</sub> H <sub>5</sub> NO <sub>2</sub>	147.132	25	0.036	0.36	40		
<i>L</i> -Isoleucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.173	25	3.31	34.2	26		
Isoniazid	C <sub>6</sub> H <sub>7</sub> N <sub>3</sub> O	137.139	25	11.0	124	40		
Isopentane	C <sub>5</sub> H <sub>12</sub>	72.149	25	0.00485	0.0485	3	479	13
Isopentyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	20	0.2	2	10		
Isopentyl formate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	22	0.3	3	27		
Isophorone	C <sub>9</sub> H <sub>14</sub> O	138.206	20	1.57	16.0	20		
			80	1.27	12.9	20		
Isophthalic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	166.132	10	0.0062	0.062	76		
			25	0.0154	0.154	56		
			50	0.0395	0.395	56		
			80	0.123	1.23	56		
Isopropenylbenzene	C <sub>9</sub> H <sub>10</sub>	118.175	20	0.0116	0.116	40		
Isopropyl acetate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	20	2.9	30	10		
Isopropylbenzene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0050	0.050	22	1.466	22
1-Isopropyl-2-methylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.00482	0.0482	23		
1-Isopropyl-3-methylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.00425	0.0425	23		
1-Isopropyl-4-methylbenzene	C <sub>10</sub> H <sub>14</sub>	134.218	25	0.0051	0.051	23	0.80	5
Isopropyl phenylcarbamate	C <sub>10</sub> H <sub>13</sub> NO <sub>2</sub>	179.216	20	0.01	0.1	40		
Isoquinoline	C <sub>9</sub> H <sub>7</sub> N	129.159	20	0.452	4.52	6		
Isosorbide dinitrate	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O <sub>8</sub>	236.136	25	0.055	0.55	40		
Kepone	C <sub>10</sub> Cl <sub>10</sub> O	490.636	100	0.4	4	40		
<i>L</i> -Lanthionine	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S	208.235	25	0.15	1.5	26		
Lasiocarpine	C <sub>21</sub> H <sub>33</sub> NO <sub>7</sub>	411.490	20	0.67	6.7	40		
<i>L</i> -Leucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.173	25	2.32	23.8	62		
Levodopa	C <sub>9</sub> H <sub>11</sub> NO <sub>4</sub>	197.188	20	0.165	1.65	63		
<i>d</i> -Limonene	C <sub>10</sub> H <sub>16</sub>	136.234	0	0.001	0.01	4		
			25	0.0020	0.020	52		
Linalol	C <sub>10</sub> H <sub>18</sub> O	154.249	25	0.156	1.56	52		
Linuron	C <sub>9</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	249.093	25	0.0075	0.075	40		
<i>L</i> -Lysine	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	146.187	25	0.58	5.8	26		
Maleic acid	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	116.073	25	44.1	789	26		
Malic acid	C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	134.088	26	59	1440	26		
			20	42.4	736	26		
			50	48.1	927	26		
Malonic acid	C <sub>3</sub> H <sub>4</sub> O <sub>4</sub>	104.062	0	37.9	610	26		
Malononitrile	C <sub>3</sub> H <sub>2</sub> N <sub>2</sub>	66.061	20	10.6	119	40		
α-Maltose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	342.296	20	51.9	1080	27		
<i>D</i> -Mannitol	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub>	182.171	25	17.7	215	27		
Mefenamic acid	C <sub>15</sub> H <sub>15</sub> NO <sub>2</sub>	241.286	20	0.0026	0.026	40		
Melphalan	C <sub>13</sub> H <sub>18</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	305.200	30	0.44	4.4	40		
Mercury(II) phenyl acetate	C <sub>8</sub> H <sub>8</sub> HgO <sub>2</sub>	336.74	20	0.2	2	30		
Mesityl oxide	C <sub>6</sub> H <sub>10</sub> O	98.142	20	2.8	29	83		
Methacrylic acid	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	20	8.9	98	10		
Methane	CH <sub>4</sub>	16.043	25	0.00227*	0.0227*	18	67.4	5

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Methazolamide	C <sub>5</sub> H <sub>8</sub> N <sub>4</sub> O <sub>3</sub> S <sub>2</sub>	236.273	15	0.0472	0.472	40		
Methazole	C <sub>9</sub> H <sub>6</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>3</sub>	261.061	24	0.00015	0.0015	40		
Methodathion	C <sub>6</sub> H <sub>11</sub> N <sub>2</sub> O <sub>4</sub> PS <sub>3</sub>	302.330	20	0.0187	0.187	40		
<i>L</i> -Methionine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	149.212	25	5.3	56	26		
Methomyl	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> S	162.210	25	5.5	58	40		
Methoxsalen	C <sub>12</sub> H <sub>8</sub> O <sub>4</sub>	216.190	30	0.0048	0.048	40		
2-Methoxyaniline	C <sub>7</sub> H <sub>9</sub> NO	123.152	25	1.24	12.6	40		
4-Methoxyaniline	C <sub>7</sub> H <sub>9</sub> NO	123.152	20	1.14	11.5	40		
4-Methoxybenzaldehyde	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	25	0.429	4.29	40		
4-Methoxybenzoic acid	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152.148	25	0.023	0.23	27		
Methoxychlor	C <sub>16</sub> H <sub>15</sub> Cl <sub>3</sub> O <sub>2</sub>	345.648	25	0.000005	0.00005	40		
2-Methoxy-2-methylbutane	C <sub>6</sub> H <sub>14</sub> O	102.174	20	1.10	11.1	20		
			79	0.36	3.6	20		
4-Methoxyphenol	C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	124.138	20	2.51	25.7	40		
Methyclothiazide	C <sub>9</sub> H <sub>11</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>4</sub> S <sub>2</sub>	360.237	20	0.005	0.05	40		
Methyl acetate	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	74.079	20	24.5	325	10		
Methyl acrylate	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	25	4.94	52.0	10		
2-Methylacrylonitrile	C <sub>4</sub> H <sub>5</sub> N	67.090	20	2.57	26.4	10		
2-Methylaniline	C <sub>7</sub> H <sub>9</sub> N	107.153	20	1.66	16.9	10		
4-Methylaniline	C <sub>7</sub> H <sub>9</sub> N	107.153	21	7.35	79.3	10		
<i>N</i> -Methylaniline	C <sub>7</sub> H <sub>9</sub> N	107.153	25	0.56	5.6	40		
2-Methylanthracene	C <sub>15</sub> H <sub>12</sub>	192.256	6	0.0000007	0.000007	42		
			25	0.0000021	0.000021	42,22		
9-Methylanthracene	C <sub>15</sub> H <sub>12</sub>	192.256	25	0.000026	0.00026	42,4		
9-Methylbenz[a]anthracene	C <sub>19</sub> H <sub>14</sub>	242.314	27	0.0000066	0.000066	42,4		
10-Methylbenz[a]anthracene	C <sub>19</sub> H <sub>14</sub>	242.314	25	0.0000055	0.000055	42,4		
2-Methylbenzenesulfonamide	C <sub>7</sub> H <sub>9</sub> NO <sub>2</sub> S	171.217	25	0.162	1.62	27		
3-Methylbenzenesulfonamide	C <sub>7</sub> H <sub>9</sub> NO <sub>2</sub> S	171.217	25	0.78	7.8	27		
4-Methylbenzenesulfonamide	C <sub>7</sub> H <sub>9</sub> NO <sub>2</sub> S	171.217	25	0.316	3.16	27		
2-Methyl-1 <i>H</i> -benzimidazole	C <sub>8</sub> H <sub>8</sub> N <sub>2</sub>	132.163	20	0.145	1.45	6		
Methyl benzoate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	20	0.21	2.1	10		
2-Methyl-1,3-butadiene	C <sub>5</sub> H <sub>8</sub>	68.118	25	0.061	0.61	3	7.78	5
			50	0.076*	0.76*	3		
Methyl butanoate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132		1.6	16	30		
3-Methylbutanoic acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	20	4.0	42	26		
2-Methyl-1-butanol	C <sub>5</sub> H <sub>12</sub> O	88.148	10	3.38	35.0	78		
			25	2.75	28.3	78		
			50	2.35	24.1	78		
3-Methyl-1-butanol	C <sub>5</sub> H <sub>12</sub> O	88.148	10	3.17	32.7	78,1		
			25	2.59	26.6	78,1		
			70	2.24	22.9	78,1		
2-Methyl-2-butanol	C <sub>5</sub> H <sub>12</sub> O	88.148	25	11.0	124	88,1		
			60	6.6	71	88,1		
3-Methyl-2-butanol	C <sub>5</sub> H <sub>12</sub> O	88.148	25	5.6	59	1		
3-Methyl-2-butanone	C <sub>5</sub> H <sub>10</sub> O	86.132	0	9.4	104	82		
			25	6.1	65	82		
			40	5.2	55	82		
3-Methyl-1-butene	C <sub>5</sub> H <sub>10</sub>	70.133	25	0.013*	0.13*	3	54.7	5

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2-Methyl-2-butene	C <sub>5</sub> H <sub>10</sub>	70.133	25	0.041	0.41	3		
2-Methyl-3-buten-2-ol	C <sub>5</sub> H <sub>10</sub> O	86.132	18	27.4	377	88		
			29	18.4	225	88		
Methyl <i>tert</i> -butyl ether	C <sub>5</sub> H <sub>12</sub> O	88.148	0	7.72	83.7	79		
			25	3.25	33.6	79		
			35	2.56	26.3	79		
			70	1.64	16.7	79		
Methyl carbamate	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	75.067	15	69	2230	27		
5-Methylchrysene	C <sub>19</sub> H <sub>14</sub>	242.314	27	0.000062	0.000062	42,4		
Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	98.186	26	0.00161	0.0161	3	43.3	13
			100	0.00548	0.0548	3		
2-Methylcyclohexanone	C <sub>7</sub> H <sub>12</sub> O	112.169	0	2.93	30.2	84		
			20	1.98	20.2	20		
			31	1.72	17.5	84		
			60	1.44	14.6	84		
			90	1.54	15.6	20		
4-Methylcyclohexanone	C <sub>7</sub> H <sub>12</sub> O	112.169	20	2.43	24.9	20		
			80	1.95	19.9	20		
1-Methylcyclohexene	C <sub>7</sub> H <sub>12</sub>	96.170	25	0.0052	0.052	3		
Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0043	0.043	3	36.7	5
1-Methyl-2,4-dinitrobenzene	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	182.134	12	0.0130	0.130	55		
			32	0.0270	0.270	85		
			62	0.098	0.98	85		
2-Methyl-4,6-dinitrophenol	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>5</sub>	198.133		0.0130	0.130	40		
Methyl formate	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	60.052	25	23	300	10		
3-Methylheptane	C <sub>8</sub> H <sub>18</sub>	114.229	25	0.000079	0.00079	4	376	5
2-Methyl-2-heptanol	C <sub>8</sub> H <sub>18</sub> O	130.228	30	0.25	2.5	1		
5-Methyl-3-heptanone	C <sub>8</sub> H <sub>16</sub> O	128.212	20	0.192	1.92	20		
			90	0.131	1.31	20		
2-Methylhexane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00025	0.0025	3	346	5
3-Methylhexane	C <sub>7</sub> H <sub>16</sub>	100.202	25	0.00026	0.0026	3	249	13
2-Methyl-2-hexanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.0	10	1		
5-Methyl-2-hexanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	0.49	4.9	1		
3-Methyl-3-hexanol	C <sub>7</sub> H <sub>16</sub> O	116.201	25	1.2	12	1		
5-Methyl-2-hexanone	C <sub>7</sub> H <sub>14</sub> O	114.185	19	0.537	5.40	20		
			90	0.417	4.19	20		
5-Methyl-3-hexanone	C <sub>7</sub> H <sub>14</sub> O	114.185	20	0.47	4.7	20		
			81	0.32	3.2	20		
Methyl 4-hydroxybenzoate	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152.148	25	0.24	2.4	40		
2-Methyl-1 <i>H</i> -imidazole	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	82.104	18	23.2	302	54		
3-Methyl-1 <i>H</i> -indole	C <sub>9</sub> H <sub>9</sub> N	131.174	20	0.050	0.50	6		
3-Methylisoquinoline	C <sub>10</sub> H <sub>9</sub> N	143.185	20	0.092	0.92	6		
Methyl isothiocyanate	C <sub>2</sub> H <sub>3</sub> NS	73.117	20	0.75	7.6	40		
Methylmalonic acid	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	118.089	0	30.1	431	26		
			20	40	670	26		
Methyl methacrylate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	100.117	20	1.56	15.8	10		
2-Methyl-3-(2-methylphenyl)-4(3 <i>H</i> )-quinazolinone	C <sub>16</sub> H <sub>14</sub> N <sub>2</sub> O	250.294	23	0.03	0.3	40		
1-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	142.197	25	0.00281	0.0281	22	0.045	22

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	142.197	25	0.0025	0.025	4	0.051	12
2-Methyl-1,4-naphthalenedione	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	172.181	25	0.016	0.16	40		
<i>N</i> -Methyl- <i>N</i> -nitrosoarea	C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	103.080	14	2.3	24	40		
4-Methyloctane	C <sub>9</sub> H <sub>20</sub>	128.255	25	0.0000115	0.000115	4	1000	5
Methyloxirane	C <sub>3</sub> H <sub>6</sub> O	58.079	20	40.5	681	10	0.0087	13
Methyl parathion	C <sub>8</sub> H <sub>10</sub> NO <sub>5</sub> PS	263.208	10	0.00218	0.0218	40		
			20	0.00380	0.0380	40		
			30	0.0059	0.059	40		
2-Methylpentane	C <sub>6</sub> H <sub>14</sub>	86.175	25	0.00137	0.0137	3	176	13
3-Methylpentane	C <sub>6</sub> H <sub>14</sub>	86.175	25	0.00129	0.0129	3	170	13
2-Methyl-1-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	0.76	7.7	78,1		
			50	0.70	7.0	78		
4-Methyl-1-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	0.76	7.6	1		
2-Methyl-2-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	3.2	33	1		
3-Methyl-2-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	1.9	19	1		
4-Methyl-2-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	27	1.5	15	1		
2-Methyl-3-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	2.0	20	1		
3-Methyl-3-pentanol	C <sub>6</sub> H <sub>14</sub> O	102.174	25	4.3	45	1		
4-Methyl-2-pentanone	C <sub>6</sub> H <sub>12</sub> O	100.158	0	2.92	30.1	83		
			25	1.85	18.8	83		
			50	1.46	14.8	83		
2-Methyl-3-pentanone	C <sub>6</sub> H <sub>12</sub> O	100.158	25	1.5	15	83		
2-Methyl-1-pentene	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0078	0.078	3	28.1	5
4-Methyl-1-pentene	C <sub>6</sub> H <sub>12</sub>	84.159	25	0.0048	0.048	3	63.2	5
1-Methylphenanthrene	C <sub>15</sub> H <sub>12</sub>	192.256	7	0.0000095	0.000095	42		
			25	0.0000269	0.000269	42,4		
Methylprednisolone	C <sub>22</sub> H <sub>30</sub> O <sub>5</sub>	374.470	25	0.012	0.12	40		
Methyl propanoate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	88.106		6	60	30		
2-Methylpropanoic acid	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	88.106	20	22.8	295	10		
2-Methyl-1-propanol	C <sub>4</sub> H <sub>10</sub> O	74.121	0	12.2	139	78,1		
			25	8.1	88	78,1	0.00273	28
			50	7.0	70	78,1		
Methyl propyl ether	C <sub>4</sub> H <sub>10</sub> O	74.121	0	5.4	57	79		
			25	3.0	31	79		
2-Methyl-2-propyl-1,3-propanediol dicarbamate	C <sub>9</sub> H <sub>18</sub> N <sub>2</sub> O <sub>4</sub>	218.250	25	0.33	3.3	40		
Methyl salicylate	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	152.148	30	0.74	7.4	10		
17-Methyltestosterone	C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	302.451	25	0.0033	0.033	40		
2-Methyltetrahydrofuran	C <sub>5</sub> H <sub>10</sub> O	86.132	19	14.4	168	20	0.67	13
			71	6.0	64	20		
<i>N</i> -Methyl- <i>N</i> ,2,4,6-tetranitroaniline	C <sub>7</sub> H <sub>5</sub> N <sub>5</sub> O <sub>8</sub>	287.144	20	0.0074	0.074	40		
Methylthiouracil	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> OS	142.179	25	0.0533	0.533	40		
1-Methyl-2,3,4-trinitrobenzene	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>6</sub>	227.131	14	0.0091	0.091	85,59		
			23	0.0116	0.116	85,59		
			61	0.0643	0.643	85,59		
Metronidazole	C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>3</sub>	171.153	20	0.93	9.4	40		
Mirex	C <sub>10</sub> Cl <sub>12</sub>	545.543	25	0.0000085	0.000085	40		
Morphine	C <sub>17</sub> H <sub>19</sub> N <sub>3</sub> O <sub>3</sub>	285.338	20	0.015	0.15	27		
β-Myrcene	C <sub>10</sub> H <sub>16</sub>	136.234	25	0.030	0.30	52		
Naphthacene	C <sub>18</sub> H <sub>12</sub>	228.288	25	0.00000007	0.0000007	42,4	0.000004	12

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Naphthalene	C <sub>10</sub> H <sub>8</sub>	128.171	10	0.0019	0.019	4	0.043	22
			25	0.00316	0.0316	22		
			50	0.0082	0.082	4		
1-Naphthaleneacetic acid	C <sub>12</sub> H <sub>10</sub> O <sub>2</sub>	186.206	25	0.0415	0.415	40		
1-Naphthalenecarboxylic acid	C <sub>11</sub> H <sub>8</sub> O <sub>2</sub>	172.181	25	0.0058	0.058	27		
1-Naphthalenylthiourea	C <sub>11</sub> H <sub>10</sub> N <sub>2</sub> S	202.275	20	0.06	0.6	40		
1-Naphthol	C <sub>10</sub> H <sub>8</sub> O	144.170	20	0.111	1.11	40		
2-Naphthol	C <sub>10</sub> H <sub>8</sub> O	144.170	20	0.064	0.64	40		
			80	0.67	6.7	40		
1-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	143.185	20	0.17	1.7	40		
2-Naphthylamine	C <sub>10</sub> H <sub>9</sub> N	143.185	20	0.0189	0.189	40		
Narceine	C <sub>23</sub> H <sub>27</sub> NO <sub>8</sub>	445.462	13	0.078	0.78	27		
Neopentane	C <sub>5</sub> H <sub>12</sub>	72.149	25	0.00332*	0.0332*	3	220	13
Nitrapyrin	C <sub>6</sub> H <sub>3</sub> Cl <sub>4</sub> N	230.907	20	0.0040	0.040	40		
2-Nitroaniline	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	138.124	30	1.47	14.9	27		
3-Nitroaniline	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	138.124	30	0.121	1.21	27		
4-Nitroaniline	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	138.124	30	0.073	0.73	27		
2-Nitroanisole	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	153.136	30	0.169	1.69	10		
4-Nitroanisole	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	153.136	30	0.059	0.59	27		
3-Nitrobenzaldehyde	C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	151.120	25	0.16	1.6	27		
4-Nitrobenzaldehyde	C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	151.120	25	0.23	2.3	27		
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	123.110	25	0.21	2.1	17		
3-Nitro-1,2-benzenedicarboxylic acid	C <sub>8</sub> H <sub>5</sub> NO <sub>6</sub>	211.129	25	1.63	16.6	69		
			40	2.97	30.6	69		
4-Nitro-1,2-benzenedicarboxylic acid	C <sub>8</sub> H <sub>5</sub> NO <sub>6</sub>	211.129	25	60.9	1560	69		
			40	68.0	2125	69		
2-Nitrobenzoic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	167.120	25	0.55	5.5	40		
3-Nitrobenzoic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	167.120	10	0.197	1.97	75		
			25	0.313	3.14	75		
			50	0.90	9.1	75		
4-Nitrobenzoic acid	C <sub>7</sub> H <sub>5</sub> NO <sub>4</sub>	167.120	25	0.0422	0.422	40		
Nitroethane	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	75.067	25	4.4	46	38		
			50	5.3	56	38		
Nitrofen	C <sub>12</sub> H <sub>7</sub> Cl <sub>2</sub> NO <sub>3</sub>	284.095	22	0.00095	0.0095	40		
Nitrofurantoin	C <sub>8</sub> H <sub>6</sub> N <sub>4</sub> O <sub>5</sub>	238.158	30	0.011	0.11	40		
Nitrofurazone	C <sub>6</sub> H <sub>6</sub> N <sub>4</sub> O <sub>4</sub>	198.137	20	0.0238	0.238	40		
Nitroguanidine	CH <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	104.069	25	1.2	12	40		
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	61.041	0	9.2	101	36		
			25	11.0	124	36		
			50	14.8	174	36		
1-Nitronaphthalene	C <sub>10</sub> H <sub>7</sub> NO <sub>2</sub>	173.169	18	0.005	0.05	40		
2-Nitrophenol	C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	139.109	25	0.170	1.70	48,51		
3-Nitrophenol	C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	139.109	20	2.14	21.9	27		
4-Nitrophenol	C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	139.109	20	1.56	15.8	48,51		
1-Nitropropane	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	25	1.54	15.6	38		
			90	2.29	23.4	20		
2-Nitropropane	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	25	1.75	17.8	38		
			90	2.36	24.2	20		
<i>N</i> -Nitrosodiethylamine	C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O	102.134	24	9.6	106	40		



Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
<i>N</i> -Nitrosodiphenylamine	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	198.219	25	0.0035	0.035	17		
2-Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	30	0.065	0.65	27		
3-Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	30	0.050	0.50	27		
4-Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	137.137	30	0.044	0.44	27		
2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	C <sub>12</sub> HCl <sub>9</sub>	464.213	25	0.000000018	0.000000018	7		
1,8-Nonadiyne	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0125	0.125	4		
Nonane	C <sub>9</sub> H <sub>20</sub>	128.255	25	0.000017	0.00017	4	333	13
			50	0.000022	0.00022	4		
Nonanedioic acid	C <sub>9</sub> H <sub>16</sub> O <sub>4</sub>	188.221	25	0.1780	1.780	34		
			65	1.322	13.40	34		
Nonanoic acid	C <sub>9</sub> H <sub>18</sub> O <sub>2</sub>	158.238	20	0.0284	0.284	26		
1-Nonanol	C <sub>9</sub> H <sub>20</sub> O	144.254	25	0.0129	0.129	78,1		
			90	0.0291	0.291	78		
2-Nonanol	C <sub>9</sub> H <sub>20</sub> O	144.254	15	0.026	0.26	1		
3-Nonanol	C <sub>9</sub> H <sub>20</sub> O	144.254	15	0.032	0.32	1		
4-Nonanol	C <sub>9</sub> H <sub>20</sub> O	144.254	15	0.0026	0.026	1		
5-Nonanol	C <sub>9</sub> H <sub>20</sub> O	144.254	15	0.0032	0.032	1		
2-Nonanone	C <sub>9</sub> H <sub>18</sub> O	142.238	20	0.038	0.38	20		
			70	0.034	0.34	20		
3-Nonanone	C <sub>9</sub> H <sub>18</sub> O	142.238	30	0.056	0.56	20		
			80	0.046	0.46	20		
5-Nonanone	C <sub>9</sub> H <sub>18</sub> O	142.238	20	0.054	0.54	20		
			80	0.029	0.29	20		
1-Nonene	C <sub>9</sub> H <sub>18</sub>	126.239	25	0.000112	0.00112	40		
Nonyl formate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	172.265	10	0.012	0.12	20		
			90	0.039	0.39	20		
4-Nonylphenol	C <sub>15</sub> H <sub>24</sub> O	220.351	25	0.000636	0.00636	40		
1-Nonyne	C <sub>9</sub> H <sub>16</sub>	124.223	25	0.00072	0.0072	4		
Norethisterone	C <sub>20</sub> H <sub>26</sub> O <sub>2</sub>	298.419	25	0.00063	0.0063	40		
Norflurazon	C <sub>12</sub> H <sub>9</sub> ClF <sub>3</sub> N <sub>3</sub> O	303.666	25	0.0028	0.028	40		
<i>L</i> -Norleucine	C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	131.173	25	1.5	15	26		
<i>L</i> -Norvaline	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117.147	25	9.7	107	26		
Noscapine	C <sub>22</sub> H <sub>23</sub> NO <sub>7</sub>	413.421	25	0.03	0.3	40		
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	C <sub>12</sub> H <sub>2</sub> Cl <sub>8</sub>	429.768	25	0.00000015	0.0000015	41	0.0381	7
Octachlorodibenzo- <i>p</i> -dioxin	C <sub>12</sub> Cl <sub>8</sub> O <sub>2</sub>	459.751	25	2.3•10 <sup>-11</sup>	2.3•10 <sup>-10</sup>	68		
Octachloro-1,3-pentadiene	C <sub>5</sub> Cl <sub>8</sub>	343.678	20	0.000020	0.00020	35		
Octacosane	C <sub>28</sub> H <sub>58</sub>	394.761	22	0.0000006	0.000006	37		
Octadecane	C <sub>18</sub> H <sub>38</sub>	254.495	25	0.00000021	0.0000021	42,37		
1-Octadecanol	C <sub>18</sub> H <sub>38</sub> O	270.494	34	0.000011	0.00011	1		
Octane	C <sub>8</sub> H <sub>18</sub>	114.229	25	0.000073	0.00073	46	311	13
			50	0.000102	0.00102	47		
			75	0.000179	0.00179	46		
			100	0.000377	0.00377	46		
Octanedioic acid	C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	174.195	25	0.242	2.43	34		
			50	0.557	5.570	34		
Octanoic acid	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	25	0.080	0.80	26		
1-Octanol	C <sub>8</sub> H <sub>18</sub> O	130.228	25	0.0460	0.460	78		
			60	0.0536	0.536	78		
2-Octanol	C <sub>8</sub> H <sub>18</sub> O	130.228	25	0.4	4	1		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2-Octanone	C <sub>8</sub> H <sub>16</sub> O	128.212	20	0.134	1.34	84		
			50	0.098	0.98	84		
			80	0.091	0.91	84		
3-Octanone	C <sub>8</sub> H <sub>16</sub> O	128.212	20	0.137	1.37	20		
			91	0.106	1.06	20		
1-Octene	C <sub>8</sub> H <sub>16</sub>	112.213	25	0.00027	0.0027	4	96.3	13
Octyl acetate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	172.265	19	0.020	0.20	20		
			92	0.012	0.12	20		
1-Octyne	C <sub>8</sub> H <sub>14</sub>	110.197	25	0.0024	0.024	4	7.87	13
Orotic acid	C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	156.097	18	0.18	1.8	26		
Oryzalin	C <sub>12</sub> H <sub>18</sub> N <sub>4</sub> O <sub>6</sub> S	346.359	25	0.00024	0.0024	40		
Ouabain	C <sub>29</sub> H <sub>44</sub> O <sub>12</sub>	584.652	25	1.3	13	40		
Oxalic acid	C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	90.035	20	8.69	95.2	27		
			80	45.8	845	27		
Oxamyl	C <sub>7</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> S	219.261	25	≈21	≈270	40		
4-Oxopentanoic acid	C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>	116.116	10	63.6	1750	34		
			25	84.0	5250	34		
4-Oxo-4 <i>H</i> -pyran-2,6-dicarboxylic acid	C <sub>7</sub> H <sub>4</sub> O <sub>6</sub>	184.103	25	1.45	14.7	27		
Papaverine	C <sub>20</sub> H <sub>21</sub> NO <sub>4</sub>	339.386	37	0.0037	0.037	40		
Paraldehyde	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	132.157	25	11	124	30		
Parathion	C <sub>10</sub> H <sub>14</sub> NO <sub>5</sub> PS	291.261	20	0.00129	0.0129	40		
Pendimethalin	C <sub>13</sub> H <sub>19</sub> N <sub>3</sub> O <sub>4</sub>	281.308	20	0.00003	0.0003	40		
Pentachlorobenzene	C <sub>6</sub> HCl <sub>5</sub>	250.337	25	0.000050	0.00050	41	0.085	11
2,3,4,5,6-Pentachlorobiphenyl	C <sub>12</sub> H <sub>5</sub> Cl <sub>5</sub>	326.433	25	0.000008	0.000008	7		
2,2',4,5,5'-Pentachlorobiphenyl	C <sub>12</sub> H <sub>5</sub> Cl <sub>5</sub>	326.433	25	0.000001	0.00001	7	0.0421	31
Pentachloroethane	C <sub>2</sub> HCl <sub>5</sub>	202.294	25	0.049	0.49	25	0.25	13
Pentachloronitrobenzene	C <sub>6</sub> Cl <sub>5</sub> NO <sub>2</sub>	295.335	20	0.000044	0.00044	40		
Pentachlorophenol	C <sub>6</sub> HCl <sub>5</sub> O	266.336	25	0.0021	0.021	48,51,24		
2,3,4,5,6-Pentachlorotoluene	C <sub>7</sub> H <sub>3</sub> Cl <sub>5</sub>	264.364	25	0.0000028	0.000028	61		
Pentadecanoic acid	C <sub>15</sub> H <sub>30</sub> O <sub>2</sub>	242.398	20	0.0012	0.012	26		
1-Pentadecanol	C <sub>15</sub> H <sub>32</sub> O	228.414	25	0.000010	0.00010	1		
1,4-Pentadiene	C <sub>5</sub> H <sub>8</sub>	68.118	25	0.056	0.56	3	12	5
Pentaerythritol	C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	136.147	15	5.3	56	30		
Pentaerythritol tetranitrate	C <sub>5</sub> H <sub>8</sub> N <sub>4</sub> O <sub>12</sub>	316.138	20	0.0002	0.002	40		
Pentanal	C <sub>5</sub> H <sub>10</sub> O	86.132	25	1.2	12	40		
Pentane	C <sub>5</sub> H <sub>12</sub>	72.149	25	0.0041	0.041	3	128	13
			50	1.83	18.6	78,1		
			90	2.12	21.7	78		
Pentanedioic acid	C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	132.116	25	58.3	1400	33		
			50	78.1	3570	33		
2,4-Pentanedione	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	100.117	20	16.1	192	20		
			80	32.2	475	20		
Pentanoic acid	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	16	3.6	37	26		
			25	4.32	45.2	90		
			35	5.26	55.5	90		
1-Pentanol	C <sub>5</sub> H <sub>12</sub> O	88.148	0	3.23	33.4	78,1		
			25	2.14	21.9	78,1		
			50	1.83	18.6	78,1		
			90	2.12	21.7	78		
2-Pentanol	C <sub>5</sub> H <sub>12</sub> O	88.148	25	4.3	45	21		
3-Pentanol	C <sub>5</sub> H <sub>12</sub> O	88.148	25	5.6	59	21		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>		Ref.
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.	
2-Pentanone	C <sub>5</sub> H <sub>10</sub> O	86.132	0	8.7	95	20	0.00847	28	
			25	5.5	58	20	0.00847	28	
			80	3.8	40	20	0.00847	28	
3-Pentanone	C <sub>5</sub> H <sub>10</sub> O	86.132	0	7.6	82	82			
			25	4.9	52	82			
			80	3.6	37	82			
1-Pentene	C <sub>5</sub> H <sub>10</sub>	70.133	25	0.0148	0.148	3	40.3	5	
<i>cis</i> -2-Pentene	C <sub>5</sub> H <sub>10</sub>	70.133	25	0.0203	0.203	3	22.8	5	
Pentyl acetate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	20	0.17	1.7	10			
<i>sec</i> -Pentyl acetate (S)-	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	25	0.2	2	27			
Pentylbenzene	C <sub>11</sub> H <sub>16</sub>	148.245	25	0.00043	0.0043	89,5	1.69	11	
Pentylcyclopentane	C <sub>10</sub> H <sub>20</sub>	140.266	25	0.0000115	0.000115	4	185	5	
Pentyl propanoate	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	144.212	20	0.1	1	27			
1-Pentyne	C <sub>5</sub> H <sub>8</sub>	68.118	25	0.157	1.57	3	2.5	5	
Perfluorocyclobutane	C <sub>4</sub> F <sub>8</sub>	200.030	5	0.00638*	0.0638*	50			
			25	0.00247*	0.0247*	50			
			45	0.00158*	0.0158*	50			
Perfluorodecane	C <sub>10</sub> F <sub>22</sub>	538.072	20	0.000031	0.00031	35			
Perfluoroheptane	C <sub>7</sub> F <sub>16</sub>	388.049	25	0.0000013	0.000013	35			
Perfluorohexane	C <sub>6</sub> F <sub>14</sub>	338.042	25	0.0000098	0.000098	35			
Perfluoro-2-methylpentane	C <sub>6</sub> F <sub>14</sub>	338.042	25	0.000017	0.00017	35			
Perfluorooctane	C <sub>8</sub> F <sub>18</sub>	438.057	25	0.00000017	0.0000017	35			
Perfluoropentane	C <sub>5</sub> F <sub>12</sub>	288.035	25	0.00012	0.0012	35			
Perfluoropropane	C <sub>3</sub> F <sub>8</sub>	188.019	15	0.0015*	0.015*	14			
Perfluoropropene	C <sub>3</sub> F <sub>6</sub>	150.022	25	0.0194*	0.194*	14			
Permethrin	C <sub>21</sub> H <sub>20</sub> Cl <sub>2</sub> O <sub>3</sub>	391.288	20	0.00002	0.0002	32			
Perylene	C <sub>20</sub> H <sub>12</sub>	252.309	25	0.00000004	0.0000004	42,4	0.000003	12	
Phenanthrene	C <sub>14</sub> H <sub>10</sub>	178.229	0	0.000039	0.00039	42			
			10	0.000047	0.00047	42,4			
			25	0.00012	0.0012	42,22	0.00324	22	
			50	0.00042	0.0042	42,4			
Phenmedipham	C <sub>16</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub>	300.309	25	0.00047	0.0047	32			
Phenobarbital	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	232.234	25	0.12	1.2	40			
			45	0.26	2.6	40			
Phenol	C <sub>6</sub> H <sub>6</sub> O	94.111	15	7.60	82.3	48,51			
			25	8.40	91.7	48,51			
			35	9.31	102.7	48,51			
Phenolphthalein	C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>	318.323	20	0.018	0.18	27			
10 <i>H</i> -Phenothiazine	C <sub>12</sub> H <sub>9</sub> NS	199.271	25	0.00016	0.0016	40			
2-Phenoxyethanol	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	138.164	20	2.53	26.0	40			
Phenyl acetate	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	20	0.59	5.9	20			
			91	0.91	9.2	20			
<i>DL</i> -Phenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	165.189	25	1.40	14.2	29			
<i>L</i> -Phenylalanine	C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	165.189	25	2.71	27.9	26			
Phenylbutazone	C <sub>19</sub> H <sub>20</sub> N <sub>2</sub> O <sub>2</sub>	308.374	25	0.0034	0.034	40			
1-Phenyl-1-propanone	C <sub>9</sub> H <sub>10</sub> O	134.174	19	0.32	3.2	20			
			80	0.24	2.4	20			
Phenylthiourea	C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> S	152.217	25	2.55	26.2	27			
Phenytoin	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	252.268	37	0.0038	0.038	40			

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Phosalone	C <sub>12</sub> H <sub>15</sub> ClNO <sub>4</sub> PS <sub>2</sub>	367.808	20	0.00026	0.0026	40		
Phosmet	C <sub>11</sub> H <sub>12</sub> NO <sub>4</sub> PS <sub>2</sub>	317.321	25	0.0025	0.025	40		
Phthalic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	166.132	10	0.464	4.66	76		
			25	0.719	7.24	76		
			50	1.76	17.9	76		
			65	3.57	37.0	33		
Phthalic anhydride	C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	148.116	27	0.62	6.20	40		
Picene	C <sub>22</sub> H <sub>14</sub>	278.346	27	0.0000025	0.0000025	42,4		
α-Pinene, (-)	C <sub>10</sub> H <sub>16</sub>	136.234	25	0.00050	0.0050	52		
β-Pinene, (1 <i>S</i> )-	C <sub>10</sub> H <sub>16</sub>	136.234	25	0.00110	0.0110	52		
2,5-Piperazinedione	C <sub>4</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	114.103	25	1.64	16.7	29		
2-Pivaloyl-1,3-indandione	C <sub>14</sub> H <sub>14</sub> O <sub>3</sub>	230.259	25	0.0018	0.018	40		
Prednisolone	C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	360.444	25	0.03	0.3	40		
Progesterone	C <sub>21</sub> H <sub>30</sub> O <sub>2</sub>	314.462	25	0.00088	0.0088	40		
			41	0.00206	0.0206	40		
<i>L</i> -Proline	C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	115.131	25	61.9	1625	26		
Prometone	C <sub>10</sub> H <sub>19</sub> N <sub>5</sub> O	225.291	20	0.075	0.75	40		
Prometryn	C <sub>10</sub> H <sub>19</sub> N <sub>5</sub> S	241.357	20	0.0048	0.048	32		
Propachlor	C <sub>11</sub> H <sub>14</sub> ClNO	211.688	20	0.07	0.7	40		
Propanal	C <sub>3</sub> H <sub>6</sub> O	58.079	25	30.6	441	10		
Propane	C <sub>3</sub> H <sub>8</sub>	44.096	25	0.00669*	0.0669*	18	71.6	5
Propanenitrile	C <sub>3</sub> H <sub>5</sub> N	55.079	25	10.3	115	10		
Propanil	C <sub>9</sub> H <sub>9</sub> Cl <sub>2</sub> NO	218.079	20	0.013	0.13	40		
Propazine	C <sub>9</sub> H <sub>16</sub> ClN <sub>5</sub>	229.710	20	0.00086	0.0086	40		
Propene	C <sub>3</sub> H <sub>6</sub>	42.080	25	0.0200*	0.200*	5	21.3	5
1-Propene-2,3-dicarboxylic acid	C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	130.100	20	7.7	83	26		
<i>trans</i> -1-Propene-1,2,3-tricarboxylic acid	C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	174.108	25	20.9	264	26		
			90	52.5	1105	26		
Propoxur	C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	209.242	20	0.193	1.93	40		
Propyl acetate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	102.132	20	2.3	24	10		
Propylbenzene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0052	0.052	22	1.041	22
Propyl butanoate	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	130.185	17	0.162	1.62	27		
Propylcyclopentane	C <sub>8</sub> H <sub>16</sub>	112.213	25	0.00020	0.0020	4	90.2	5
Propyl formate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	88.106	22	2.05	20.9	10		
Propyl 4-hydroxybenzoate	C <sub>10</sub> H <sub>12</sub> O <sub>3</sub>	180.200	25	0.04	0.4	40		
Propyl propanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	116.158	25	0.6	6	27		
Propyne	C <sub>3</sub> H <sub>4</sub>	40.064	25	0.364*	3.64*	5	1.11	5
Propyzamide	C <sub>12</sub> H <sub>11</sub> Cl <sub>2</sub> NO	256.127	25	0.0015	0.015	32		
Pyrene	C <sub>16</sub> H <sub>10</sub>	202.250	0	0.0000049	0.000049	42		
			15	0.0000069	0.000069	42		
			25	0.0000139	0.000139	42,22	0.00092	22
			50	0.000053	0.00053	42,4		
			75	0.000231	0.00231	42		
3-Pyridinecarboxamide	C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	122.124	20	≈33	≈490	40		
3-Pyridinecarboxylic acid	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	123.110	24	1.63	16.6	66		
			52	3.40	35.2	66		
			72	5.20	54.9	66		
Pyrocatechol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	110.111	20	31.1	451	27		
Pyrrole	C <sub>4</sub> H <sub>5</sub> N	67.090	25	4.5	47	10		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>		
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.	
Quinic acid	C <sub>7</sub> H <sub>12</sub> O <sub>6</sub>	192.166	9	29	410	26			
Quinidine	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	324.417	20	0.020	0.20	27			
Quinine	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>2</sub>	324.417	25	0.057	0.57	27			
Quinoline	C <sub>9</sub> H <sub>7</sub> N	129.159	20	0.633	6.33	6			
8-Quinololol	C <sub>9</sub> H <sub>7</sub> NO	145.158	25	0.065	0.65	40			
Quinoxaline	C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	130.147	50	54	1170	6			
Raffinose	C <sub>18</sub> H <sub>32</sub> O <sub>16</sub>	504.437	20	12.5	143	27			
Reserpine	C <sub>33</sub> H <sub>40</sub> N <sub>2</sub> O <sub>9</sub>	608.679	30	0.0073	0.073	40			
Resorcinol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	110.111	20	63.7	1750	27			
Riboflavin	C <sub>17</sub> H <sub>20</sub> N <sub>4</sub> O <sub>6</sub>	376.364	25	0.0075	0.075	40			
Ronnel	C <sub>8</sub> H <sub>8</sub> Cl <sub>3</sub> O <sub>3</sub> PS	321.546	20	0.00011	0.0011	40			
Rotenone	C <sub>23</sub> H <sub>22</sub> O <sub>6</sub>	394.417	25	0.000017	0.00017	40			
Saccharin	C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub> S	183.185	25	0.40	4.0	27			
				100	4.0	42	27		
Salicylaldehyde	C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	122.122	86	1.68	17.1	10			
Sarcosine	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	89.094	25	30.0	429	26			
<i>L</i> -Serine	C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	105.093	25	20	250	26			
Shikimic acid	C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	174.151		15	176	26			
Silvex	C <sub>9</sub> H <sub>7</sub> Cl <sub>3</sub> O <sub>3</sub>	269.509	25	0.014	0.14	40			
Solanine	C <sub>45</sub> H <sub>73</sub> NO <sub>15</sub>	868.060	15	0.0026	0.026	40			
<i>L</i> -Sorbosc	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	180.155	17	≈26	≈350	40			
Stearic acid	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	284.478	20	0.00029	0.0029	26			
<i>trans</i> -Stilbene	C <sub>14</sub> H <sub>12</sub>	180.245	25	0.000029	0.00029	42,4	0.040	12	
Streptozotocin	C <sub>8</sub> H <sub>15</sub> N <sub>3</sub> O <sub>7</sub>	265.221	25	0.50	5.0	40			
Strychnine	C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	334.412	20	0.013	0.13	27			
Styrene	C <sub>8</sub> H <sub>8</sub>	104.150	25	0.032	0.32	22	0.286	22	
				50	0.046	0.46	4,89	0.30	13
Succinamide	C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	116.119	50	18.4	225	27			
Succinic acid	C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	118.089	25	7.71	83.5	27			
				100	55	1220	27		
Succinonitrile	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	80.088	25	11.5	130	10			
Sucrose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	342.296	20	67.1	2040	27			
				50	72.3	2610	27		
				100	83.0	4880	27		
Sulfamethazine	C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub> S	278.330	20	0.053	0.53	40			
Sulfamethoxazole	C <sub>10</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub> S	253.277	25	0.0281	0.281	40			
Sulfathiazole	C <sub>9</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub> S <sub>2</sub>	255.316	20	0.048	0.48	40			
Sulfisoxazole	C <sub>11</sub> H <sub>13</sub> N <sub>3</sub> O <sub>3</sub> S	267.304	37	0.03	0.3	40			
<i>DL</i> -Tartaric acid	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	150.087	0	8.95	98.3	26			
				20	17.1	206	26		
				100	65	1860	26		
<i>L</i> -Tartaric acid	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	150.087	20	58	1380	26			
				100	77	3350	26		
Tebuthiuron	C <sub>9</sub> H <sub>16</sub> N <sub>4</sub> OS	228.314	20	0.23	2.3	40			
Terbacil	C <sub>9</sub> H <sub>13</sub> ClN <sub>2</sub> O <sub>2</sub>	216.664	25	0.071	0.71	40			
Terephthalic acid	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	166.132	10	0.0082	0.082	76			
				25	0.0065	0.065	76		
				50	0.0074	0.074	76		
<i>o</i> -Terphenyl	C <sub>18</sub> H <sub>14</sub>	230.304	25	0.000124	0.00124	42,40			

Name	Mol. Form.	Mol. Wt.	$t/^{\circ}\text{C}$	Solubility, $s$			Henry Const., $k_{\text{H}}$	
				100 $w_2$ (mass%)	g per kg $\text{H}_2\text{O}$	Ref.	kPa $\text{m}^3\text{mol}^{-1}$	Ref.
<i>m</i> -Terphenyl	$\text{C}_{18}\text{H}_{14}$	230.304	25	0.000152	0.00152	42,40		
<i>p</i> -Terphenyl	$\text{C}_{18}\text{H}_{14}$	230.304	25	0.00000180	0.000018	42,40		
$\alpha$ -Terpineol	$\text{C}_{10}\text{H}_{18}\text{O}$	154.249	25	0.189	1.89	52		
1,2,4,5-Tetrabromobenzene	$\text{C}_6\text{H}_2\text{Br}_4$	393.696	25	0.00000434	0.0000434	2		
1,1,2,2-Tetrabromoethane	$\text{C}_2\text{H}_2\text{Br}_4$	345.653	0	0.052	0.52	25		
			25	0.068	0.68	25		
			50	0.106	1.06	25		
			100	0.307	3.07	25		
Tetrabromomethane	$\text{CBr}_4$	331.627	30	0.024	0.24	14		
1,2,3,4-Tetrachlorobenzene	$\text{C}_6\text{H}_2\text{Cl}_4$	215.892	25	0.0007	0.007	41	0.144	11
1,2,3,5-Tetrachlorobenzene	$\text{C}_6\text{H}_2\text{Cl}_4$	215.892	25	0.00035	0.0035	41	0.59	11
1,2,4,5-Tetrachlorobenzene	$\text{C}_6\text{H}_2\text{Cl}_4$	215.892	25	0.000060	0.00060	41	0.122	11
3,4,5,6-Tetrachloro-1,2-benzenediol	$\text{C}_6\text{H}_2\text{Cl}_4\text{O}_2$	247.891	25	0.071	0.71	8		
2,2',4',5'-Tetrachlorobiphenyl	$\text{C}_{12}\text{H}_6\text{Cl}_4$	291.988	25	0.0000016	0.000016	9		
2,3,4,5-Tetrachlorobiphenyl	$\text{C}_{12}\text{H}_6\text{Cl}_4$	291.988	25	0.000002	0.00002	7		
2,3,5,6-Tetrachloro-2,5-cyclohexadiene-1,4-dione	$\text{C}_6\text{Cl}_4\text{O}_2$	245.875	20	0.025	0.25	40		
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin	$\text{C}_{12}\text{H}_4\text{Cl}_4\text{O}_2$	321.971	22	0.000000019	0.000000019	40		
1,1,2,2-Tetrachloro-1,2-difluoroethane	$\text{C}_2\text{Cl}_4\text{F}_2$	203.830	27	0.016	0.16	25		
1,1,1,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	167.849	0	0.120	1.20	25		
			25	0.107	1.07	25	0.24	13
			50	0.123	1.23	25		
1,1,2,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	167.849	5	0.302	3.02	25		
			25	0.283	2.83	25	0.026	13
			50	0.318	3.18	25		
Tetrachloroethene	$\text{C}_2\text{Cl}_4$	165.833	0	0.0273	0.273	20		
			20	0.0286	0.286	20	1.73	13
			80	0.0380	0.380	20		
Tetrachloromethane	$\text{CCl}_4$	153.823	25	0.065	0.65	20	2.99	13
			75	0.115	1.15	20	2.99	13
2,3,4,6-Tetrachloro-5-methylphenol	$\text{C}_7\text{H}_4\text{Cl}_4\text{O}$	245.918	25	0.00061	0.0061	2		
2,3,4,6-Tetrachlorophenol	$\text{C}_6\text{H}_2\text{Cl}_4\text{O}$	231.891	25	0.017	0.17	24		
1,1,1,3-Tetrachloro-2,2,3,3-tetrafluoropropane	$\text{C}_3\text{Cl}_4\text{F}_4$	253.838	21	0.0052	0.052	35		
Tetracosane	$\text{C}_{24}\text{H}_{50}$	338.654	22	0.0000004	0.000004	37		
Tetradecane	$\text{C}_{14}\text{H}_{30}$	198.388	25	0.00000023	0.0000023	42,5		
Tetradecanoic acid	$\text{C}_{14}\text{H}_{28}\text{O}_2$	228.371	20	0.0020	0.020	26		
1-Tetradecanol	$\text{C}_{14}\text{H}_{30}\text{O}$	214.387	25	0.000031	0.00031	1		
Tetraethylsilane	$\text{C}_8\text{H}_{20}\text{Si}$	144.331	25	0.0000325	0.000325	10		
Tetrafluoroethene	$\text{C}_2\text{F}_4$	100.015	25	0.0158*	0.158*	19,50		
			70	0.0090*	0.090*	50		
Tetrafluoromethane	$\text{CF}_4$	88.005	0	0.00390*	0.0390*	50		
			25	0.00185*	0.0185*	50,19		
			50	0.00134*	0.0134*	50		
Tetrahydro-2,5-dimethoxyfuran	$\text{C}_6\text{H}_{12}\text{O}_3$	132.157	21	32	470	20		
			90	19	235	20		
1,2,3,4-Tetrahydronaphthalene	$\text{C}_{10}\text{H}_{12}$	132.202	20	0.0045	0.045	40		
Tetrahydropyran	$\text{C}_5\text{H}_{10}\text{O}$	86.132	20	8.57	93.7	20		
			81	4.29	44.8	20		
1,2,4,5-Tetramethylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	25	0.000348	0.00348	4	2.55	11
<i>N,N,N',N'</i> -Tetramethyl-4,4'-diaminobenzophenone	$\text{C}_{17}\text{H}_{20}\text{N}_2\text{O}$	268.353	20	0.04	0.4	40		

Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
Tetramethylsilane	C <sub>4</sub> H <sub>12</sub> Si	88.224	25	0.00196	0.0196	10		
Theophylline	C <sub>7</sub> H <sub>8</sub> N <sub>4</sub> O <sub>2</sub>	180.165	20	0.52	5.2	29		
Thioacetamide	C <sub>2</sub> H <sub>5</sub> NS	75.133	25	12.3	140	40		
Thiourea	CH <sub>4</sub> N <sub>2</sub> S	76.121	20	10.6	119	40		
			80	≈37	≈590	40		
2-Thioxo-4-thiazolidinone	C <sub>3</sub> H <sub>3</sub> NOS <sub>2</sub>	133.192	25	0.225	2.25	40		
Thiram	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub>	240.432	20	0.003	0.03	40		
<i>DL</i> -Threonine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119.119	10	14.34	167	45		
			20	15.69	186	45		
			40	19.84	248	45		
<i>L</i> -Threonine	C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	119.119	10	7.34	79.2	45		
			20	8.31	90.6	45		
			40	10.78	121	45		
Thymidine	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	242.228	25	5.1	54	29		
Thymine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	126.114	25	0.35	3.5	29		
Thymol	C <sub>10</sub> H <sub>14</sub> O	150.217		0.1	1	30		
Tolazamide	C <sub>14</sub> H <sub>21</sub> N <sub>3</sub> O <sub>3</sub> S	311.400	30	0.0065	0.065	40		
Tolbutamide	C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub> S	270.347	25	0.011	0.11	40		
<i>o</i> -Tolidine	C <sub>14</sub> H <sub>16</sub> N <sub>2</sub>	212.290	25	0.13	1.3	40		
Toluene	C <sub>7</sub> H <sub>8</sub>	92.139	5	0.054	0.54	61		
			25	0.0519	0.519	61,22	0.660	22
			45	0.063	0.63	61		
			90	0.12	1.2	22		
<i>p</i> -Toluenesulfonic acid	C <sub>7</sub> H <sub>8</sub> O <sub>3</sub> S	172.202	40	≈33	≈490	40		
<i>o</i> -Toluic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	25	0.118	1.18	27		
<i>m</i> -Toluic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	25	0.098	0.98	27		
<i>p</i> -Toluic acid	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	136.149	10	0.030	0.30	75		
			25	0.036	0.36	75		
			50	0.089	0.89	75		
1,3,5-Triazine-2,4,6-triamine	C <sub>3</sub> H <sub>6</sub> N <sub>6</sub>	126.120	20	0.323	3.23	40		
			95	4.2	44	40		
1 <i>H</i> -1,2,4-Triazol-3-amine	C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	84.080	23	22	280	26		
1,2,4-Tribromobenzene	C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub>	314.800	25	0.0010	0.010	2		
1,3,5-Tribromobenzene	C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub>	314.800	25	0.0000789	0.000789	2		
1,1,2-Tribromoethane	C <sub>2</sub> H <sub>3</sub> Br <sub>3</sub>	266.757	20	0.050	0.50	25		
Tribromofluoromethane	CBr <sub>3</sub> F	270.721	25	0.040	0.40	14		
Tribromomethane	CHBr <sub>3</sub>	252.731	25	0.30	3.0	5	0.047	13
2,4,6-Tribromophenol	C <sub>6</sub> H <sub>3</sub> Br <sub>3</sub> O	330.799	15	0.0007	0.007	2		
Tributylamine	C <sub>12</sub> H <sub>27</sub> N	185.349	25	0.0142	0.142	40		
Tributyl phosphate	C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	266.313	25	0.039	0.39	10		
Tributyryn	C <sub>15</sub> H <sub>26</sub> O <sub>6</sub>	302.363	20	0.010	0.10	40		
Trichloroacetaldehyde	C <sub>2</sub> HCl <sub>3</sub> O	147.387	25	≈39	≈640	40		
Trichloroacetic acid	C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	163.387	25	92.3	11990	27		
1,2,3-Trichlorobenzene	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	181.447	25	0.0021	0.021	41	0.242	11
1,2,4-Trichlorobenzene	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	181.447	15	0.0029	0.029	61		
			25	0.0037	0.037	61,41	0.277	11
			45	0.0047	0.047	61		
1,3,5-Trichlorobenzene	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	181.447	25	0.0008	0.008	41	1.1	11
3,4,5-Trichloro-1,2-benzenediol	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O <sub>2</sub>	213.446	25	0.051	0.51	8		

Name	Mol. Form.	Mol. Wt.	t/°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2,4,5-Trichlorobiphenyl	C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	257.543	25	0.000014	0.00014	7	0.0379	31
2,4,6-Trichlorobiphenyl	C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	257.543	25	0.00002	0.0002	7	0.0495	7
1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane	C <sub>14</sub> H <sub>9</sub> Cl <sub>5</sub>	354.486	25	0.0000004	0.000004	67		
2,4,6-Trichloro-3,5-dimethylphenol	C <sub>8</sub> H <sub>7</sub> Cl <sub>3</sub> O	225.500	25	0.00050	0.0050	2		
1,1,1-Trichloroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	133.404	0	0.134	1.34	25		
			25	0.129	1.29	25	1.76	13
			50	0.138	1.38	25		
1,1,2-Trichloroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	133.404	0	0.425	4.25	25		
			25	0.459	4.59	25	0.092	13
			50	0.536	5.36	25		
Trichloroethene	C <sub>2</sub> HCl <sub>3</sub>	131.388	0	0.145	1.45	25		
			25	0.128	1.28	25	1.03	13
			60	0.133	1.33	25		
Trichlorofluoromethane	CCl <sub>3</sub> F	137.368	20	0.11	1.1	5	10.2	13
Trichloromethane	CHCl <sub>3</sub>	119.378	25	0.80	8.0	20	0.43	13
			59	0.79	7.9	20	0.43	13
1,2,4-Trichloro-5-methylbenzene	C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub>	195.474	25	0.00023	0.0023	61		
(Trichloromethyl)benzene	C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub>	195.474	5	0.0053	0.053	10		
2,4,6-Trichloro-3-methylphenol	C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub> O	211.473	25	0.0112	0.112	2		
Trichloronitromethane	CCl <sub>3</sub> NO <sub>2</sub>	164.376	0	0.227	2.27	40		
			25	0.162	1.62	40		
1,1,1-Trichloro-2,2,3,3,3-pentafluoropropane	C <sub>3</sub> Cl <sub>3</sub> F <sub>5</sub>	237.383	21	0.0058	0.058	35		
2,4,5-Trichlorophenol	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	197.446	25	0.1	1	2		
2,4,6-Trichlorophenol	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> O	197.446	25	0.069	0.69	48,51,24		
2,4,5-Trichlorophenoxyacetic acid	C <sub>8</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>3</sub>	255.483	25	0.028	0.28	40		
1,2,3-Trichloropropane	C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	147.431	10	0.14	1.4	35		
			25	0.20	2.0	35	0.038	13
1,1,2-Trichloro-1,2,2-trifluoroethane	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	187.375	25	0.017	0.17	25	32	13
Tri- <i>p</i> -cresyl phosphate	C <sub>21</sub> H <sub>21</sub> O <sub>4</sub> P	368.363	25	0.00004	0.0004	40		
Tridecane	C <sub>13</sub> H <sub>28</sub>	184.361	25	0.00000033	0.00000033	37		
Tridecanoic acid	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub>	214.344	20	0.0033	0.033	26		
Triethylamine	C <sub>6</sub> H <sub>15</sub> N	101.190	20	5.5	58	10		
Triethylamine hydrochloride	C <sub>6</sub> H <sub>16</sub> ClN	137.651	25	57.8	1370	27		
Trifluoromethane	CHF <sub>3</sub>	70.014	25	0.15*	1.5*	50,14		
3,4,5-Trihydroxybenzoic acid	C <sub>7</sub> H <sub>6</sub> O <sub>5</sub>	170.120	25	1.52	15.4	74		
			50	3.82	39.7	74		
			100	25.0	333	27		
Triiodomethane	CHI <sub>3</sub>	393.732	25	0.012	0.12	14		
Trimethoprim	C <sub>14</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub>	290.318	25	0.04	0.4	40		
1,2,3-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0070	0.070	22	0.343	22
1,2,4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0057	0.057	22	0.569	22
1,3,5-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	120.191	25	0.0050	0.050	22	0.781	22
2,3,3-Trimethyl-2-butanol	C <sub>7</sub> H <sub>16</sub> O	116.201	40	2.2	22	1		
1,1,3-Trimethylcyclohexane	C <sub>9</sub> H <sub>18</sub>	126.239	25	0.000177	0.00177	4	105	13
1,1,3-Trimethylcyclopentane	C <sub>8</sub> H <sub>16</sub>	112.213	25	0.00037	0.0037	4	159	5
2,2,5-Trimethylhexane	C <sub>9</sub> H <sub>20</sub>	128.255	25	0.00008	0.0008	4	246	13
1,4,5-Trimethylnaphthalene	C <sub>13</sub> H <sub>14</sub>	170.250	25	0.00021	0.0021	42,4		
2,6,8-Trimethyl-4-nonanone	C <sub>12</sub> H <sub>24</sub> O	184.318	10	0.012	0.12	20		
			80	0.014	0.14	20		



Name	Mol. Form.	Mol. Wt.	<i>t</i> /°C	Solubility, <i>s</i>			Henry Const., <i>k<sub>H</sub></i>	
				100 <i>w</i> <sub>2</sub> (mass%)	g per kg H <sub>2</sub> O	Ref.	kPa m <sup>3</sup> mol <sup>-1</sup>	Ref.
2,2,4-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	114.229	25	0.00022	0.0022	4	307	13
2,3,4-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	114.229	25	0.00018	0.0018	4	206	13
Trimethyl phosphate	C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P	140.074	25	≈33	≈490	40		
1,3,5-Trinitrobenzene	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>6</sub>	213.104	15	0.028	0.28	40		
2,4,6-Trinitrobenzoic acid	C <sub>7</sub> H <sub>3</sub> N <sub>3</sub> O <sub>8</sub>	257.114	23	1.97	20.1	40		
Trinitroglycerol	C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>9</sub>	227.087	25	0.13	1.3	40		
			80	0.34	3.4	40		
2,4,6-Trinitrophenol	C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub>	229.104	25	1.25	12.7	40		
			90	4.9	52	40		
2,4,6-Trinitrotoluene	C <sub>7</sub> H <sub>5</sub> N <sub>3</sub> O <sub>6</sub>	227.131	20	0.012	0.12	40		
			100	0.15	1.5	40		
2,4,6-Trinitro- <i>N</i> -(2,4,6-trinitrophenyl)aniline	C <sub>12</sub> H <sub>5</sub> N <sub>7</sub> O <sub>12</sub>	439.208	17	0.0060	0.060	40		
1,3,5-Trioxane	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	90.078	25	17.4	211	30		
Triphenylene	C <sub>18</sub> H <sub>12</sub>	228.288	25	0.0000043	0.000043	42,4	0.00001	12
Triphenyl phosphate	C <sub>18</sub> H <sub>15</sub> O <sub>4</sub> P	326.283	24	0.000073	0.00073	40		
Triphenyltin hydroxide	C <sub>18</sub> H <sub>16</sub> OSn	367.029	20	0.0001	0.001	32		
Tris(hydroxymethyl)methylamine	C <sub>4</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub>	121.135	25	≈41	≈700	40		
<i>L</i> -Tryptophan	C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	204.225	25	1.30	13.2	26		
<i>DL</i> -Tyrosine	C <sub>9</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub>	181.188	25	0.35	3.5	30		
<i>L</i> -Tyrosine	C <sub>9</sub> H <sub>11</sub> N <sub>3</sub> O <sub>3</sub>	181.188	25	0.0507	0.507	62		
Undecane	C <sub>11</sub> H <sub>24</sub>	156.309	25	0.0000004	0.000004	37		
Uracil	C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	112.087	25	0.460	4.62	72		
Urea	CH <sub>4</sub> N <sub>2</sub> O	60.055	5	44	790	26		
			25	54.4	1200	26		
Uric acid	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub>	168.111	20	0.002	0.02	26		
<i>L</i> -Valine	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	117.147	25	8.13	88.5	26		
Valium	C <sub>16</sub> H <sub>13</sub> ClN <sub>2</sub> O	284.739	25	0.005	0.05	40		
Vidarabine	C <sub>10</sub> H <sub>15</sub> N <sub>5</sub> O <sub>5</sub>	285.257	20	0.051	0.51	40		
Vinclozolin	C <sub>12</sub> H <sub>9</sub> Cl <sub>2</sub> N <sub>3</sub> O <sub>3</sub>	286.110	20	0.1	1	32		
Vinyl acetate	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	20	2.0	20	10		
4-Vinylcyclohexene	C <sub>8</sub> H <sub>12</sub>	108.181	25	0.005	0.05	4		
Warfarin	C <sub>19</sub> H <sub>16</sub> O <sub>4</sub>	308.328	20	0.004	0.04	40		
Xanthine	C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>2</sub>	152.112	20	0.05	0.5	26		
<i>o</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	106.165	25	0.0171	0.171	22	0.551	22
			45	0.021	0.21	4		
<i>m</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	106.165	0	0.0203	0.203	4		
			25	0.0161	0.161	22	0.730	22
			40	0.022	0.22	4		
<i>p</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	106.165	0	0.0160	0.160	4		
			25	0.0181	0.181	22	0.690	22
			40	0.022	0.22	4		
2,3-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.457	4.57	40		
2,4-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.787	7.87	10		
2,5-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.354	3.54	40		
2,6-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.60	6.0	40		
3,4-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	25	0.477	4.77	40		
3,5-Xylenol	C <sub>8</sub> H <sub>10</sub> O	122.164	29	0.62	6.2	10		
<i>D</i> -Xylose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	150.130	25	≈30	≈430	40		
Ziram	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub> Zn	305.841	20	0.0065	0.065	40		

# AQUEOUS SOLUBILITY OF INORGANIC COMPOUNDS AT VARIOUS TEMPERATURES

The solubility of over 300 common inorganic compounds in water is tabulated here as a function of temperature. Solubility is defined as the concentration of the compound in a solution that is in equilibrium with a solid phase at the specified temperature. In this table the solid phase is generally the most stable crystalline phase at the temperature in question. An asterisk \* on solubility values in adjacent columns indicates that the solid phase changes between those two temperatures (usually from one hydrated phase to another or from a hydrate to the anhydrous solid). In such cases the slope of the solubility vs. temperature curve may show a discontinuity.

All solubility values are expressed as mass percent of solute,  $100w_2$ , where

$$w_2 = m_2 / (m_1 + m_2)$$

and  $m_2$  is the mass of solute and  $m_1$  the mass of water. This quantity is related to other common measures of solubility as follows:

$$\text{Molarity: } c_2 = 1000 \rho w_2 / M_2$$

$$\text{Molality: } m_2 = 1000 w_2 / M_2 (1 - w_2)$$

$$\text{Mole fraction: } x_2 = (w_2 / M_2) / \{ (w_2 / M_2) + (1 - w_2) / M_1 \}$$

$$\text{Mass of solute per 100 g of H}_2\text{O: } r_2 = 100 w_2 / (1 - w_2)$$

Here  $M_2$  is the molar mass of the solute and  $M_1 = 18.015$  g/mol is the molar mass of water.  $\rho$  is the density of the solution in  $\text{g cm}^{-3}$ .

The data in the table have been derived from the references indicated; in many cases the data have been refitted or interpolated in order to present solubility at rounded values of temperature. Where available, values were taken from the IUPAC *Solubility Data Series* (Reference 1) or the related papers in the *Journal of Physical and Chemical Reference Data* (References 2 to 5), which present carefully evaluated data.

The solubility of sparingly soluble compounds that do not appear in this table may be calculated from the data in the table "Solubility Product Constants". Solubility of inorganic gases may be found in the table "Solubility of Selected Gases in Water".

Compounds are listed alphabetically by chemical formula in the most commonly used form (e.g., NaCl,  $\text{NH}_4\text{NO}_3$ , etc.).

## References

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Compound	0°C	10°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C	Ref.
AgBrO <sub>3</sub>				0.193							1.32		7
AgClO <sub>2</sub>	0.17	0.31	0.47	0.55	0.64	0.82	1.02	1.22	1.44	1.66	1.88	2.11	7
AgClO <sub>3</sub>				15									7
AgClO <sub>4</sub>	81.6	83.0	84.2	84.8	85.3	86.3	86.9	87.5	87.9	88.3	88.6	88.8	6
AgNO <sub>2</sub>	0.155			0.413									7
AgNO <sub>3</sub>	55.9	62.3	67.8	70.1	72.3	76.1	79.2	81.7	83.8	85.4	86.7	87.8	6
Ag <sub>2</sub> SO <sub>4</sub>	0.56	0.67	0.78	0.83	0.88	0.97	1.05	1.13	1.20	1.26	1.32	1.39	7
AlCl <sub>3</sub>	30.84	30.91	31.03	31.10	31.18	31.37	31.60	31.87	32.17	32.51	32.90	33.32	7
Al(ClO <sub>4</sub> ) <sub>3</sub>	54.9										64.4		7
AlF <sub>3</sub>	0.25	0.34	0.44	0.50	0.56	0.68	0.81	0.96	1.11	1.28	1.45	1.64	7
Al(NO <sub>3</sub> ) <sub>3</sub>	37.0	38.2	39.9	40.8	42.0	44.5	47.3	50.4	53.8*			61.5*	6
Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	27.5			27.8	28.2	29.2	30.7	32.6	34.9	37.6	40.7	44.2	7
As <sub>2</sub> O <sub>3</sub>	1.19	1.48	1.80	2.01	2.27	2.86	3.43	4.11	4.89	5.77	6.72	7.71	10
BaBr <sub>2</sub>	47.6	48.5	49.5	50.0	50.4	51.4	52.5	53.5	54.5	55.5	56.6	57.6	6
Ba(BrO <sub>3</sub> ) <sub>2</sub>	0.285	0.442	0.656	0.788	0.935	1.30	1.74	2.27	2.90	3.61	4.40	5.25	1:14
Ba(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	37.0			44.2									7
BaCl <sub>2</sub>	23.30	24.88	26.33	27.03	27.70	29.00	30.27	31.53	32.81	34.14	35.54	37.05	8
Ba(ClO <sub>2</sub> ) <sub>2</sub>	30.5			31.3								44.7	7
Ba(ClO <sub>3</sub> ) <sub>2</sub>	16.90	21.23	23.66	27.50	29.43	33.16	36.69	40.05	43.04	45.90	48.70	51.17	1:14
Ba(ClO <sub>4</sub> ) <sub>2</sub>	67.30	70.96	74.30	75.75	77.05	79.23	80.92	82.21	83.16	83.88	84.43	84.90	7
BaF <sub>2</sub>		0.158		0.161									7
BaI <sub>2</sub>	62.5	64.7	67.3	68.8	69.1	69.5	70.1	70.7	71.3	72.0	72.7	73.4	6

Compound	0°C	10°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C	Ref.
Ba(IO <sub>3</sub> ) <sub>2</sub>	0.0182	0.0262	0.0342	0.0396	0.045*	0.058*	0.073	0.090	0.109	0.131	0.156	0.182	1:14
Ba(NO <sub>2</sub> ) <sub>2</sub>	31.1	36.6	41.8	44.3	46.8	51.6	56.2	60.5	64.6	68.5	72.1	75.6	10
Ba(NO <sub>3</sub> ) <sub>2</sub>	4.7	6.3	8.2	9.3	10.2	12.4	14.7	17.0	19.3	21.5	23.5	25.5	6
Ba(OH) <sub>2</sub>	1.67			4.68	8.4	19	33	52	74	100			7
BaS	2.79	4.78	6.97	8.21	9.58	12.67	16.18	20.05	24.19	28.55	33.04	37.61	7
Ba(SCN) <sub>2</sub>				62.6									7
BaSO <sub>3</sub>				0.0011									1:26
BeCl <sub>2</sub>	40.5			41.7									7
Be(ClO <sub>4</sub> ) <sub>2</sub>				59.5									7
BeSO <sub>4</sub>	26.69	27.58	28.61	29.22	29.90	31.51	33.39	35.50	37.78	40.21	42.72	45.28	7
CaBr <sub>2</sub>	55	56	59	61	63	68	71	73					10
CaCl <sub>2</sub>	36.70	39.19	42.13	44.83*	49.12*	52.85*	56.05*	56.73	57.44	58.21	59.04	59.94	8
Ca(ClO <sub>3</sub> ) <sub>2</sub>	63.2	64.2	65.5	66.3	67.2	69.0	71.0	73.2	75.5*	77.4*	77.7	78.0	1:14
Ca(ClO <sub>4</sub> ) <sub>2</sub>				65.3									7
CaF <sub>2</sub>	0.0013			0.0016									10
CaI <sub>2</sub>	64.6	66.0	67.6	68.3	69.0	70.8	72.4	74.0	76.0	78.0	79.6	81.0	7
Ca(IO <sub>3</sub> ) <sub>2</sub>	0.082	0.155	0.243	0.305	0.384*	0.517*	0.590	0.652	0.811*	0.665*	0.668		1:14
Ca(NO <sub>2</sub> ) <sub>2</sub>	38.6	39.5	44.5	48.6									7
Ca(NO <sub>3</sub> ) <sub>2</sub>	50.1	53.1	56.7	59.0	60.9	65.4	77.8	78.1	78.2	78.3	78.4	78.5	6
CaSO <sub>3</sub>			0.0059	0.0054	0.0049	0.0041	0.0035	0.0030	0.0026	0.0023	0.0020	0.0019	1:26
CaSO <sub>4</sub>	0.174	0.191	0.202	0.205	0.208	0.210	0.207	0.201	0.193	0.184	0.173	0.163	9
CdBr <sub>2</sub>	36.0	43.0	49.9	53.4	56.4	60.3*	60.3*	60.5	60.7	60.9	61.3	61.6	6
CdC <sub>2</sub> O <sub>4</sub>				0.0060									5
CdCl <sub>2</sub>	47.2	50.1	53.2	54.6	56.3*	57.3*	57.5	57.8	58.1	58.51	58.98	59.5	6
Cd(ClO <sub>4</sub> ) <sub>2</sub>				58.7								66.9	7
CdF <sub>2</sub>		5.82	4.65	4.18	3.76								5
CdI <sub>2</sub>	44.1	44.9	45.8	46.3	46.8	47.9	49.0	50.2	51.5	52.7	54.1	55.4	6
Cd(IO <sub>3</sub> ) <sub>2</sub>				0.091									5
Cd(NO <sub>3</sub> ) <sub>2</sub>	55.4	57.1	59.6	61.0	62.8	66.5	70.6	86.1	86.5	86.8	87.1	87.4	6
CdSO <sub>4</sub>	43.1	43.1	43.2	43.4	43.6	44.1	43.5	42.5	41.4	40.2	38.5	36.7	6
CdSeO <sub>4</sub>	42.04	40.59	39.02	38.18	37.29	35.35	33.15	30.65	27.84	24.69	21.24	17.49	5
Ce(NO <sub>3</sub> ) <sub>3</sub>	57.99	59.80	61.89	63.05	64.31*	67.0*	68.6	71.1*	74.9*	79.2	80.9	83.1	1:13
CoCl <sub>2</sub>	30.30	32.60	34.87	35.99	37.10	39.27	41.38	43.46	45.50	47.51	49.51	51.50	7
Co(ClO <sub>4</sub> ) <sub>2</sub>	50.0			53.0									7
CoF <sub>2</sub>				1.4									7
CoI <sub>2</sub>	58.00	61.78	65.35	66.99	68.51	71.17	73.41	75.29	76.89	78.28	79.52	80.70	7
Co(NO <sub>2</sub> ) <sub>2</sub>	0.076			0.49									7
Co(NO <sub>3</sub> ) <sub>2</sub>	45.5	47.0	49.4	50.8	52.4	56.0	60.1	62.6	64.9	67.7			6
CoSO <sub>4</sub>	19.9	23.0	26.1	27.7	29.2	32.3	34.4	35.9	35.5	33.2	30.6	27.8	6
Co(SCN) <sub>2</sub>				50.7									7
CrO <sub>3</sub>	62.2	62.3	62.6	62.8	63.0	63.5	64.1	64.7	65.5	66.2	67.1	67.9	6
CsBr				55.2									7
CsBrO <sub>3</sub>	1.16	1.93	3.01	3.69	4.46	6.32	8.60	11.32	14.45	17.96	21.83	25.98	1:30
CsCl	61.83	63.48	64.96	65.64	66.29	67.50	68.60	69.61	70.54	71.40	72.21	72.96	1:47
CsClO <sub>3</sub>	2.40	3.87	5.94	7.22	8.69	12.15	16.33	21.14	26.45	32.10	37.89	43.42	1:30
CsClO <sub>4</sub>	0.79	1.01	1.51	1.96	2.57	4.28	6.55	9.29	12.41	15.80	19.39	23.07	7
CsI	30.9	37.2	43.2	45.9	48.6	53.3	57.3	60.7	63.6	65.9	67.7	69.2	6
CsIO <sub>3</sub>	1.08	1.58	2.21	2.59	3.02	3.96	5.06	6.29	7.70	9.20	10.79	12.45	1:30
CsNO <sub>3</sub>	8.46	13.0	18.6	21.8	25.1	32.0	39.0	45.7	51.9	57.3	62.1	66.2	6
CsOH				75									7
Cs <sub>2</sub> SO <sub>4</sub>	62.6	63.4	64.1	64.5	64.8	65.5	66.1	66.7	67.3	67.8	68.3	68.8	6
CuBr <sub>2</sub>				55.8									7
CuCl <sub>2</sub>	40.8	41.7	42.6	43.1	43.7	44.8	46.0	47.2	48.5	49.9	51.3	52.7	6
Cu(ClO <sub>4</sub> ) <sub>2</sub>	54.3			59.3									7
CuF <sub>2</sub>				0.075									7
Cu(NO <sub>3</sub> ) <sub>2</sub>	45.2	49.8	56.3	59.2	61.1	62.0	63.1	64.5	65.9	67.5	69.2	71.0	6
CuSO <sub>4</sub>	12.4	14.4	16.7	18.0	19.3	22.2	25.4	28.8	32.4	36.3	40.3	43.5	6
CuSeO <sub>4</sub>	10.6			16.0									7
Dy(NO <sub>3</sub> ) <sub>3</sub>	58.79	59.99	61.49	62.35	63.29	65.43	68.04	71.58					1:13
Er(NO <sub>3</sub> ) <sub>3</sub>	61.58	63.15	64.84	65.75	66.69	68.70	70.96	73.64	77.75				1:13
Eu(NO <sub>3</sub> ) <sub>3</sub>	55.2	56.7	58.5	59.4	60.4	62.5	64.6						1:13

Compound	0°C	10°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C	Ref.
FeBr <sub>2</sub>				54.6								64.8*	7
FeCl <sub>2</sub>	33.2*			39.4*								48.7*	7
FeCl <sub>3</sub>	42.7	44.9	47.9	47.7	51.6	74.8	76.7	84.6	84.3	84.3	84.4	84.7	6
Fe(ClO <sub>4</sub> ) <sub>2</sub>	63.39			67.76									7
FeF <sub>3</sub>				5.59									7
Fe(NO <sub>3</sub> ) <sub>3</sub>	40.15			46.57									7
Fe(NO <sub>3</sub> ) <sub>2</sub>	41.44			46.67									7
FeSO <sub>4</sub>	13.5	17.0	20.8	22.8	24.8	28.8	32.8	35.5	33.6	30.4	27.1	24.0	6
Gd(NO <sub>3</sub> ) <sub>3</sub>	56.3	57.7	59.2	60.1	61.0	62.9	65.2	67.9	71.5				1:13
HIO <sub>3</sub>	73.45	74.10	74.98	75.48	76.03	77.20	78.46	79.78	81.13	82.48	83.82	85.14	1:30
H <sub>3</sub> BO <sub>3</sub>	2.61	3.57	4.77	5.48	6.27	8.10	10.3	12.9	15.9	19.3	23.1	27.3	6
HgBr <sub>2</sub>	0.26	0.37	0.52	0.61	0.72	0.96	1.26	1.63	2.08	2.61	3.23	3.95	4
Hg(CN) <sub>2</sub>	6.57	7.83	9.33	10.2	11.1	13.1	15.5	18.2	21.2	24.6	28.3	32.3	6
HgCl <sub>2</sub>	4.24	5.05	6.17	6.81	7.62	9.53	12.02	15.18	19.16	24.06	29.90	36.62	4
HgI <sub>2</sub>			0.0041	0.0055	0.0072	0.0122	0.0199						4
Hg(SCN) <sub>2</sub>				0.070									4
Hg <sub>2</sub> Cl <sub>2</sub>				0.0004									3
Hg <sub>2</sub> (ClO <sub>4</sub> ) <sub>2</sub>	73.8			79.8*								85.3*	7
Hg <sub>2</sub> SO <sub>4</sub>	0.038	0.043	0.048	0.051	0.054	0.059	0.065	0.070	0.076	0.082	0.088	0.093	4
Ho(NO <sub>3</sub> ) <sub>3</sub>				63.8									1:13
KBF <sub>4</sub>	0.28	0.34	0.45	0.55	0.75	1.38	2.09	2.82	3.58	4.34	5.12	5.90	10
KBr	35.0	37.3	39.4	40.4	41.4	43.2	44.8	46.2	47.6	48.8	49.8	50.8	6
KBrO <sub>3</sub>	2.97	4.48	6.42	7.55	8.79	11.57	14.71	18.14	21.79	25.57	29.42	33.28	1:30
KC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	68.40	70.29	72.09	72.92	73.70	75.08	76.27	77.31	78.22	79.04	79.80	80.55	7
KCl	21.74	23.61	25.39	26.22	27.04	28.59	30.04	31.40	32.66	33.86	34.99	36.05	1:47
KClO <sub>3</sub>	3.03	4.67	6.74	7.93	9.21	12.06	15.26	18.78	22.65	26.88	31.53	36.65	1:30
KClO <sub>4</sub>	0.70	1.10	1.67	2.04	2.47	3.54	4.94	6.74	8.99	11.71	14.94	18.67	6
KF	30.90	39.8	47.3	50.41	53.2					60.0			7
KHCO <sub>3</sub>	18.62	21.73	24.92	26.6	28.13	31.32	34.46	37.51	40.45				6
KHSO <sub>4</sub>	27.1	29.7	32.3	33.6	35.0	37.8	40.5	43.4	46.2	49.02	51.82	54.6	6
KH <sub>2</sub> PO <sub>4</sub>	11.74	14.91	18.25	19.97	21.77	25.28	28.95	32.76	36.75	40.96	45.41	50.12	1:31
KI	56.0	57.6	59.0	59.7	60.4	61.6	62.8	63.8	64.8	65.7	66.6	67.4	6
KIO <sub>3</sub>	4.53	5.96	7.57	8.44	9.34	11.09	13.22	15.29	17.41	19.58	21.78	24.03	1:30
KIO <sub>4</sub>	0.16	0.22	0.37	0.51	0.70	1.24	1.96	2.83	3.82	4.89	6.02	7.17	7
KMnO <sub>4</sub>	2.74	4.12	5.96	7.06	8.28	11.11	14.42	18.16					6
KNO <sub>2</sub>	73.7	74.6	75.3	75.7	76.0	76.7	77.4	78.0	78.5	79.1	79.6	80.1	6
KNO <sub>3</sub>	12.0	17.6	24.2	27.7	31.3	38.6	45.7	52.2	58.0	63.0	67.3	70.8	6
KOH	48.7	50.8	53.2	54.7	56.1	57.9	58.6	59.5	60.6	61.8	63.1	64.6	6
KSCN	63.8	66.4	69.1	70.4	71.6	74.1	76.5	78.9	81.1	83.3	85.3	87.3	6
K <sub>2</sub> CO <sub>3</sub>	51.3	51.7	52.3	52.7	53.1	54.0	54.9	56.0	57.2	58.4	59.6	61.0	6
K <sub>2</sub> CrO <sub>4</sub>	37.1	38.1	38.9	39.4	39.8	40.5	41.3	41.9	42.6	43.2	43.8	44.3	6
K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	4.30	7.12	10.9	13.1	15.5	20.8	26.3	31.7	36.9	41.5	45.5	48.9	6
K <sub>2</sub> HAsO <sub>4</sub>	48.5*			63.6*								79.8*	7
K <sub>2</sub> HPO <sub>4</sub>	57.0	59.1	61.5	62.7	64.1	67.7*		72.7*					1:31
K <sub>2</sub> MoO <sub>4</sub>				64.7							66.5		7
K <sub>2</sub> SO <sub>3</sub>	51.30	51.39	51.49	51.55	51.62	51.76	51.93	52.11	52.32	52.54	52.79	53.06	1:26
K <sub>2</sub> SO <sub>4</sub>	7.11	8.46	9.95	10.7	11.4	12.9	14.2	15.5	16.7	17.7	18.6	19.3	6
K <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	49.0*			62.3*							75.7*		7
K <sub>2</sub> S <sub>2</sub> O <sub>5</sub>	22.1	26.7	31.1	33.1	35.2	39.0	42.6	46.0	49.1	52.0	54.6		1:26
K <sub>2</sub> SeO <sub>3</sub>	68.4*			68.5*								68.5*	7
K <sub>2</sub> SeO <sub>4</sub>	52.70	52.93	53.17	53.30	53.43	53.70	53.99	54.30	54.61	54.94	55.26	55.60	7
K <sub>3</sub> AsO <sub>4</sub>	51.5*			55.6*								73*	7
K <sub>3</sub> Fe(CN) <sub>6</sub>	23.9	27.6	31.1	32.8	34.3	37.2	39.6	41.7	43.5	45.0	46.1	47.0	6
K <sub>3</sub> PO <sub>4</sub>	44.3			51.4									7
K <sub>4</sub> Fe(CN) <sub>6</sub>	12.5	17.3	22.0	23.9	25.6	29.2	32.5	35.5	38.2	40.6	41.4	43.1	6
LaCl <sub>3</sub>	49.0	48.5	48.6	48.9	49.3	50.5	52.1	54.0	56.3	58.9	61.7		6
La(NO <sub>3</sub> ) <sub>3</sub>	55.0	56.9	58.9	60.0	61.1	63.6	66.3	69.9*	74.1*				1:13
LiBr	58.4	60.1	62.7	64.4	65.9	67.8	68.3	69.0	69.8	70.7	71.7	72.8	6
LiBrO <sub>3</sub>	61.03	62.62	64.44	65.44	66.51	68.90	71.68*	73.24*	74.43	75.66	76.93	78.32	1:30
LiC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	23.76	26.49	29.42	31.02	32.72	36.48	40.65	45.15	49.93	54.91	60.04	65.26	7
LiCl	40.45	42.46*	45.29*	45.81	46.25	47.30	48.47	49.78	51.27	52.98	54.98*	56.34*	1:47

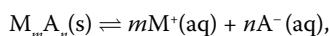


Compound	0°C	10°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C	Ref.
NaBr	44.4	45.9	47.7	48.6	49.6	51.6	53.7	54.1	54.3	54.5	54.7	54.9	6
NaBrO <sub>3</sub>	20.0	23.22	26.65	28.28	29.86	32.83	35.55	38.05	40.37	42.52			1:30
NaCHO <sub>2</sub>	30.8	37.9	45.7	48.7	50.6	52.0	53.5	55.0					6
NaC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	26.5	28.8	31.8	33.5	35.5	39.9	45.1	58.3	59.3	60.5	61.7	62.9	6
NaCl	26.28	26.32	26.41	26.45	26.52	26.67	26.84	27.03	27.25	27.50	27.78	28.05	1:47
NaClO	22.7			44.4									7
NaClO <sub>2</sub>				97.0*				95.3*					7
NaClO <sub>3</sub>	44.27	46.67	49.3	50.1	51.2	53.6	55.5	57.0	58.5	60.5	63.3	67.1	1:30
NaClO <sub>4</sub>	61.9	64.1	66.2	67.2	68.3	70.4	72.5	74.1	74.7	75.4	76.1	76.7	6
NaF	3.52	3.72	3.89	3.97	4.05	4.20	4.34	4.46	4.57	4.66	4.75	4.82	6
NaHCO <sub>3</sub>	6.48	7.59	8.73	9.32	9.91	11.13	12.40	13.70	15.02	16.37	17.73	19.10	7
NaHSO <sub>4</sub>				22.2								33.3	10
NaH <sub>2</sub> PO <sub>4</sub>	36.54	41.07	46.00	48.68	51.54	57.89*	61.7*	62.3*	65.9	68.7			1:31
NaI	61.2	62.4	63.9	64.8	65.7	67.7	69.8	72.0	74.7	74.8	74.9	75.1	6
NaIO <sub>3</sub>	2.43	4.40	7.78*	8.65*	9.60	11.67	13.99	16.52	19.25*	21.1*	22.9	24.7	1:30
NaIO <sub>4</sub>				12.62									7
NaNO <sub>2</sub>	41.9	43.4	45.1	45.9	46.8	48.7	50.7	52.8	55.0	57.2	59.5	61.8	6
NaNO <sub>3</sub>	42.2	44.4	46.6	47.7	48.8	51.0	53.2	55.3	57.5	59.6	61.7	63.8	6
NaOH	30	39	46	50	53	58	63	67	71	74	76	79	10
NaSCN		52.9	57.1	60.2	62.7	63.5	64.2	65.0	65.9	66.9	67.9	69.0	6
Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub>	1.23	1.71	2.50	3.07	3.82	6.02	9.7	14.9	17.1	19.9	23.5	28.0	6
Na <sub>2</sub> CO <sub>3</sub>	6.44	10.8	17.9	23.5	28.7	32.8	32.2	31.7	31.3	31.1	30.9	30.9	6
Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	2.62	2.95	3.30	3.48	3.65	4.00	4.36	4.71	5.06	5.41	5.75	6.08	6
Na <sub>2</sub> CrO <sub>4</sub>	22.6	32.3	44.6	46.7	46.9	48.9	51.0	53.4	55.3	55.5	55.8	56.1	6
Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	62.1	63.1	64.4	65.2	66.1	68.0	70.1	72.3	74.6	77.0	79.6	80.7	6
Na <sub>2</sub> HAsO <sub>4</sub>	5.6*			29.3*								67*	7
Na <sub>2</sub> HPO <sub>4</sub>	1.66	4.19	7.51	10.55	16.34*	35.17*	44.64*	45.20	46.81	48.78	50.52	51.53	1:31
Na <sub>2</sub> MoO <sub>4</sub>	30.6	38.8	39.4	39.4	39.8	40.3	41.0	41.7	42.6	43.5	44.5	45.5	6
Na <sub>2</sub> S	11.1	13.2	15.7	17.1	18.6	22.1	26.7	28.1	30.2	33.0	36.4	41.0	6
Na <sub>2</sub> SO <sub>3</sub>	12.0	16.1	20.9	23.5	26.3*	27.3*	25.9	24.8	23.7	22.8	22.1	21.5	1:26
Na <sub>2</sub> SO <sub>4</sub>			16.13	21.94	29.22*	32.35*	31.55	30.90	30.39	30.02	29.79	29.67	8
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	33.1	36.3	40.6	43.3	45.9	52.0	62.3	65.7	68.8	69.4	70.1	71.0	6
Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub>		38.4	39.5	40.0	40.6	41.8	43.0	44.2	45.5	46.8	48.1	49.5	1:26
Na <sub>2</sub> SeO <sub>3</sub>				47.3*								45*	7
Na <sub>2</sub> SeO <sub>4</sub>	11.7			36.9*								42.1*	7
Na <sub>2</sub> WO <sub>4</sub>	41.6	41.9	42.3	42.6	42.9	43.6	44.4	45.3	46.2	47.3	48.4	49.5	6
Na <sub>3</sub> PO <sub>4</sub>	4.28	7.30	10.8	12.6	14.1	16.6	22.9	28.4	32.4	37.6	40.4	43.5	6
Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub>	2.23	3.28	4.81	6.62	7.00	10.10	14.38	20.07	27.31	36.03	32.37	30.67	6
NdCl <sub>3</sub>	49.0	49.3	49.7	50.0	50.4	51.2	52.2	53.3	54.5	55.8	57.1	58.5	6
Nd(NO <sub>3</sub> ) <sub>3</sub>	55.76	57.49	59.37	60.38	61.43	63.69	66.27	69.47					1:13
NiCl <sub>2</sub>	34.7	36.1	38.5	40.3	41.7	42.1	43.2	45.0	46.1	46.2	46.4	46.6	6
Ni(ClO <sub>4</sub> ) <sub>2</sub>	51.1			52.8									7
NiF <sub>2</sub>				2.50							2.52		7
NiI <sub>2</sub>	55.40	57.68	59.78	60.69	61.50	62.80	63.73	64.38	64.80	65.09	65.30		7
Ni(NO <sub>3</sub> ) <sub>2</sub>	44.1	46.0	48.4	49.8	51.3	54.6	58.3	61.0	63.1	65.6	67.9	69.0	6
NiSO <sub>4</sub>	21.4	24.4	27.4	28.8	30.3*	32.0*	34.1	35.8	37.7	39.9	42.3	44.8	6
Ni(SCN) <sub>2</sub>				35.48									7
NiSeO <sub>4</sub>	21.6		26.2*									45.6*	7
PbBr <sub>2</sub>	0.449	0.620	0.841	0.966	1.118	1.46	1.89						2
PbCl <sub>2</sub>	0.66	0.81	0.98	1.07	1.17	1.39	1.64	1.93	2.24	2.60	2.99	3.42	2
Pb(ClO <sub>4</sub> ) <sub>2</sub>				81.5									7
PbF <sub>2</sub>		0.0603	0.0649	0.0670	0.0693								2
PbI <sub>2</sub>	0.041	0.052	0.067	0.076	0.086	0.112	0.144	0.187	0.243	0.315			2
Pb(IO <sub>3</sub> ) <sub>2</sub>				0.0025									7
Pb(NO <sub>3</sub> ) <sub>2</sub>	28.46	32.13	35.67	37.38	39.05	42.22	45.17	47.90	50.42	52.72	54.82	56.75	2
PbSO <sub>4</sub>	0.0033	0.0038	0.0042	0.0044	0.0047	0.0052	0.0058						2
PrCl <sub>3</sub>	48.0	48.1	48.6	49.0	49.5	50.8	52.3	54.1	56.1	58.3			6
Pr(NO <sub>3</sub> ) <sub>3</sub>	57.50	59.20	61.16	62.24	63.40*	65.7*	67.8	70.2	73.4				1:13
RbBr	47.4	50.1	52.6	53.8	54.9	57.0	58.8	60.6	62.1	63.5	64.8	65.9	6
RbBrO <sub>3</sub>	0.97	1.55	2.36	2.87	3.45	4.87	6.64	8.78	11.29	14.15	17.32	20.76	1:30
RbCl	43.58	45.65	47.53	48.42	49.27	50.86	52.34	53.67	54.92	56.08	57.16	58.15	1:47



## SOLUBILITY PRODUCT CONSTANTS

The solubility product constant  $K_{sp}$  is a useful parameter for calculating the aqueous solubility of sparingly soluble compounds under various conditions. It may be determined by direct measurement or calculated from the standard Gibbs energies of formation  $\Delta_f G^\circ$  of the species involved at their standard states. Thus if  $K_{sp} = [M^+]^m [A^-]^n$  is the equilibrium constant for the reaction



where  $M_m A_n$  is the slightly soluble substance and  $M^+$  and  $A^-$  are the ions produced in solution by the dissociation of  $M_m A_n$ , then the Gibbs energy change is

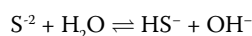
$$\Delta G^\circ = m \Delta_f G^\circ (M^+, aq) + n \Delta_f G^\circ (A^-, aq) - \Delta_f G^\circ (M_m A_n, s)$$

The solubility product constant is calculated from the equation

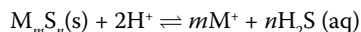
$$\ln K_{sp} = -\Delta G^\circ / RT$$

The first table below gives selected values of  $K_{sp}$  at 25°C. Many of these have been calculated from standard state thermodynamic data in References 1 and 2; other values are taken from publications of the IUPAC Solubility Data Project (References 3 to 7).

The above formulation is not convenient for treating sulfides because the  $S^{2-}$  ion is usually not present in significant concentrations (see Reference 8). This is due to the hydrolysis reaction



which is strongly shifted to the right except in very basic solutions. Furthermore, the equilibrium constant for this reaction, which depends on the second ionization constant of  $H_2S$ , is poorly known. Therefore it is more useful in the case of sulfides to define a different solubility product  $K_{spa}$  based on the reaction



Values of  $K_{spa}$ , taken from Reference 8, are given for several sulfides in the auxiliary table following the main table. Additional discussion of sulfide equilibria may be found in References 7 and 9.

### References

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Compound	Formula	$K_{sp}$
Aluminum phosphate	AlPO <sub>4</sub>	$9.84 \cdot 10^{-21}$
Barium bromate	Ba(BrO <sub>3</sub> ) <sub>2</sub>	$2.43 \cdot 10^{-4}$
Barium carbonate	BaCO <sub>3</sub>	$2.58 \cdot 10^{-9}$
Barium chromate	BaCrO <sub>4</sub>	$1.17 \cdot 10^{-10}$
Barium fluoride	BaF <sub>2</sub>	$1.84 \cdot 10^{-7}$
Barium hydroxide octahydrate	Ba(OH) <sub>2</sub> · 8H <sub>2</sub> O	$2.55 \cdot 10^{-4}$
Barium iodate	Ba(IO <sub>3</sub> ) <sub>2</sub>	$4.01 \cdot 10^{-9}$
Barium iodate monohydrate	Ba(IO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	$1.67 \cdot 10^{-9}$
Barium molybdate	BaMoO <sub>4</sub>	$3.54 \cdot 10^{-8}$
Barium nitrate	Ba(NO <sub>3</sub> ) <sub>2</sub>	$4.64 \cdot 10^{-3}$
Barium selenate	BaSeO <sub>4</sub>	$3.40 \cdot 10^{-8}$
Barium sulfate	BaSO <sub>4</sub>	$1.08 \cdot 10^{-10}$
Barium sulfite	BaSO <sub>3</sub>	$5.0 \cdot 10^{-10}$
Beryllium hydroxide	Be(OH) <sub>2</sub>	$6.92 \cdot 10^{-22}$
Bismuth arsenate	BiAsO <sub>4</sub>	$4.43 \cdot 10^{-10}$
Bismuth iodide	BiI <sub>3</sub>	$7.71 \cdot 10^{-19}$
Cadmium arsenate	Cd <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	$2.2 \cdot 10^{-33}$
Cadmium carbonate	CdCO <sub>3</sub>	$1.0 \cdot 10^{-12}$
Cadmium fluoride	CdF <sub>2</sub>	$6.44 \cdot 10^{-3}$
Cadmium hydroxide	Cd(OH) <sub>2</sub>	$7.2 \cdot 10^{-15}$
Cadmium iodate	Cd(IO <sub>3</sub> ) <sub>2</sub>	$2.5 \cdot 10^{-8}$
Cadmium oxalate trihydrate	CdC <sub>2</sub> O <sub>4</sub> · 3H <sub>2</sub> O	$1.42 \cdot 10^{-8}$
Cadmium phosphate	Cd <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	$2.53 \cdot 10^{-33}$
Calcium carbonate (calcite)	CaCO <sub>3</sub>	$3.36 \cdot 10^{-9}$
Calcium fluoride	CaF <sub>2</sub>	$3.45 \cdot 10^{-11}$
Calcium hydroxide	Ca(OH) <sub>2</sub>	$5.02 \cdot 10^{-6}$

Compound	Formula	$K_{sp}$
Calcium iodate	Ca(IO <sub>3</sub> ) <sub>2</sub>	$6.47 \cdot 10^{-6}$
Calcium iodate hexahydrate	Ca(IO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	$7.10 \cdot 10^{-7}$
Calcium molybdate	CaMoO <sub>4</sub>	$1.46 \cdot 10^{-8}$
Calcium oxalate monohydrate	CaC <sub>2</sub> O <sub>4</sub> · H <sub>2</sub> O	$2.32 \cdot 10^{-9}$
Calcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	$2.07 \cdot 10^{-33}$
Calcium sulfate	CaSO <sub>4</sub>	$4.93 \cdot 10^{-5}$
Calcium sulfate dihydrate	CaSO <sub>4</sub> · 2H <sub>2</sub> O	$3.14 \cdot 10^{-5}$
Calcium sulfite hemihydrate	CaSO <sub>3</sub> · 0.5H <sub>2</sub> O	$3.1 \cdot 10^{-7}$
Cesium perchlorate	CsClO <sub>4</sub>	$3.95 \cdot 10^{-3}$
Cesium periodate	CsIO <sub>4</sub>	$5.16 \cdot 10^{-6}$
Cobalt(II) arsenate	Co <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	$6.80 \cdot 10^{-29}$
Cobalt(II) hydroxide (blue)	Co(OH) <sub>2</sub>	$5.92 \cdot 10^{-15}$
Cobalt(II) iodate dihydrate	Co(IO <sub>3</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	$1.21 \cdot 10^{-2}$
Cobalt(II) phosphate	Co <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	$2.05 \cdot 10^{-35}$
Copper(I) bromide	CuBr	$6.27 \cdot 10^{-9}$
Copper(I) chloride	CuCl	$1.72 \cdot 10^{-7}$
Copper(I) cyanide	CuCN	$3.47 \cdot 10^{-20}$
Copper(I) iodide	CuI	$1.27 \cdot 10^{-12}$
Copper(I) thiocyanate	CuSCN	$1.77 \cdot 10^{-13}$
Copper(II) arsenate	Cu <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	$7.95 \cdot 10^{-36}$
Copper(II) iodate monohydrate	Cu(IO <sub>3</sub> ) <sub>2</sub> · H <sub>2</sub> O	$6.94 \cdot 10^{-8}$
Copper(II) oxalate	CuC <sub>2</sub> O <sub>4</sub>	$4.43 \cdot 10^{-10}$
Copper(II) phosphate	Cu <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	$1.40 \cdot 10^{-37}$
Europium(III) hydroxide	Eu(OH) <sub>3</sub>	$9.38 \cdot 10^{-27}$
Gallium(III) hydroxide	Ga(OH) <sub>3</sub>	$7.28 \cdot 10^{-36}$
Iron(II) carbonate	FeCO <sub>3</sub>	$3.13 \cdot 10^{-11}$



Compound	Formula	$K_{sp}$
Iron(II) fluoride	$\text{FeF}_2$	$2.36 \cdot 10^{-6}$
Iron(II) hydroxide	$\text{Fe}(\text{OH})_2$	$4.87 \cdot 10^{-17}$
Iron(III) hydroxide	$\text{Fe}(\text{OH})_3$	$2.79 \cdot 10^{-39}$
Iron(III) phosphate dihydrate	$\text{FePO}_4 \cdot 2\text{H}_2\text{O}$	$9.91 \cdot 10^{-16}$
Lanthanum iodate	$\text{La}(\text{IO}_3)_3$	$7.50 \cdot 10^{-12}$
Lead(II) bromide	$\text{PbBr}_2$	$6.60 \cdot 10^{-6}$
Lead(II) carbonate	$\text{PbCO}_3$	$7.40 \cdot 10^{-14}$
Lead(II) chloride	$\text{PbCl}_2$	$1.70 \cdot 10^{-5}$
Lead(II) fluoride	$\text{PbF}_2$	$3.3 \cdot 10^{-8}$
Lead(II) hydroxide	$\text{Pb}(\text{OH})_2$	$1.43 \cdot 10^{-20}$
Lead(II) iodate	$\text{Pb}(\text{IO}_3)_2$	$3.69 \cdot 10^{-13}$
Lead(II) iodide	$\text{PbI}_2$	$9.8 \cdot 10^{-9}$
Lead(II) selenate	$\text{PbSeO}_4$	$1.37 \cdot 10^{-7}$
Lead(II) sulfate	$\text{PbSO}_4$	$2.53 \cdot 10^{-8}$
Lithium carbonate	$\text{Li}_2\text{CO}_3$	$8.15 \cdot 10^{-4}$
Lithium fluoride	$\text{LiF}$	$1.84 \cdot 10^{-3}$
Lithium phosphate	$\text{Li}_3\text{PO}_4$	$2.37 \cdot 10^{-11}$
Magnesium carbonate	$\text{MgCO}_3$	$6.82 \cdot 10^{-6}$
Magnesium carbonate trihydrate	$\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$	$2.38 \cdot 10^{-6}$
Magnesium carbonate pentahydrate	$\text{MgCO}_3 \cdot 5\text{H}_2\text{O}$	$3.79 \cdot 10^{-6}$
Magnesium fluoride	$\text{MgF}_2$	$5.16 \cdot 10^{-11}$
Magnesium hydroxide	$\text{Mg}(\text{OH})_2$	$5.61 \cdot 10^{-12}$
Magnesium oxalate dihydrate	$\text{MgC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	$4.83 \cdot 10^{-6}$
Magnesium phosphate	$\text{Mg}_3(\text{PO}_4)_2$	$1.04 \cdot 10^{-24}$
Manganese(II) carbonate	$\text{MnCO}_3$	$2.24 \cdot 10^{-11}$
Manganese(II) iodate	$\text{Mn}(\text{IO}_3)_2$	$4.37 \cdot 10^{-7}$
Manganese(II) oxalate dihydrate	$\text{MnC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	$1.70 \cdot 10^{-7}$
Mercury(I) bromide	$\text{Hg}_2\text{Br}_2$	$6.40 \cdot 10^{-23}$
Mercury(I) carbonate	$\text{Hg}_2\text{CO}_3$	$3.6 \cdot 10^{-17}$
Mercury(I) chloride	$\text{Hg}_2\text{Cl}_2$	$1.43 \cdot 10^{-18}$
Mercury(I) fluoride	$\text{Hg}_2\text{F}_2$	$3.10 \cdot 10^{-6}$
Mercury(I) iodide	$\text{Hg}_2\text{I}_2$	$5.2 \cdot 10^{-29}$
Mercury(I) oxalate	$\text{Hg}_2\text{C}_2\text{O}_4$	$1.75 \cdot 10^{-13}$
Mercury(I) sulfate	$\text{Hg}_2\text{SO}_4$	$6.5 \cdot 10^{-7}$
Mercury(I) thiocyanate	$\text{Hg}_2(\text{SCN})_2$	$3.2 \cdot 10^{-20}$
Mercury(II) bromide	$\text{HgBr}_2$	$6.2 \cdot 10^{-20}$
Mercury(II) iodide	$\text{HgI}_2$	$2.9 \cdot 10^{-29}$
Neodymium carbonate	$\text{Nd}_2(\text{CO}_3)_3$	$1.08 \cdot 10^{-33}$
Nickel(II) carbonate	$\text{NiCO}_3$	$1.42 \cdot 10^{-7}$
Nickel(II) hydroxide	$\text{Ni}(\text{OH})_2$	$5.48 \cdot 10^{-16}$
Nickel(II) iodate	$\text{Ni}(\text{IO}_3)_2$	$4.71 \cdot 10^{-5}$
Nickel(II) phosphate	$\text{Ni}_3(\text{PO}_4)_2$	$4.74 \cdot 10^{-32}$
Palladium(II) thiocyanate	$\text{Pd}(\text{SCN})_2$	$4.39 \cdot 10^{-23}$
Potassium hexachloroplatinate	$\text{K}_2\text{PtCl}_6$	$7.48 \cdot 10^{-6}$
Potassium perchlorate	$\text{KClO}_4$	$1.05 \cdot 10^{-2}$
Potassium periodate	$\text{KIO}_4$	$3.71 \cdot 10^{-4}$
Praseodymium hydroxide	$\text{Pr}(\text{OH})_3$	$3.39 \cdot 10^{-24}$

Compound	Formula	$K_{sp}$
Radium iodate	$\text{Ra}(\text{IO}_3)_2$	$1.16 \cdot 10^{-9}$
Radium sulfate	$\text{RaSO}_4$	$3.66 \cdot 10^{-11}$
Rubidium perchlorate	$\text{RbClO}_4$	$3.00 \cdot 10^{-3}$
Scandium fluoride	$\text{ScF}_3$	$5.81 \cdot 10^{-24}$
Scandium hydroxide	$\text{Sc}(\text{OH})_3$	$2.22 \cdot 10^{-31}$
Silver(I) acetate	$\text{AgCH}_3\text{COO}$	$1.94 \cdot 10^{-3}$
Silver(I) arsenate	$\text{Ag}_3\text{AsO}_4$	$1.03 \cdot 10^{-22}$
Silver(I) bromate	$\text{AgBrO}_3$	$5.38 \cdot 10^{-5}$
Silver(I) bromide	$\text{AgBr}$	$5.35 \cdot 10^{-13}$
Silver(I) carbonate	$\text{Ag}_2\text{CO}_3$	$8.46 \cdot 10^{-12}$
Silver(I) chloride	$\text{AgCl}$	$1.77 \cdot 10^{-10}$
Silver(I) chromate	$\text{Ag}_2\text{CrO}_4$	$1.12 \cdot 10^{-12}$
Silver(I) cyanide	$\text{AgCN}$	$5.97 \cdot 10^{-17}$
Silver(I) iodate	$\text{AgIO}_3$	$3.17 \cdot 10^{-8}$
Silver(I) iodide	$\text{AgI}$	$8.52 \cdot 10^{-17}$
Silver(I) oxalate	$\text{Ag}_2\text{C}_2\text{O}_4$	$5.40 \cdot 10^{-12}$
Silver(I) phosphate	$\text{Ag}_3\text{PO}_4$	$8.89 \cdot 10^{-17}$
Silver(I) sulfate	$\text{Ag}_2\text{SO}_4$	$1.20 \cdot 10^{-5}$
Silver(I) sulfite	$\text{Ag}_2\text{SO}_3$	$1.50 \cdot 10^{-14}$
Silver(I) thiocyanate	$\text{AgSCN}$	$1.03 \cdot 10^{-12}$
Strontium arsenate	$\text{Sr}_3(\text{AsO}_4)_2$	$4.29 \cdot 10^{-19}$
Strontium carbonate	$\text{SrCO}_3$	$5.60 \cdot 10^{-10}$
Strontium fluoride	$\text{SrF}_2$	$4.33 \cdot 10^{-9}$
Strontium iodate	$\text{Sr}(\text{IO}_3)_2$	$1.14 \cdot 10^{-7}$
Strontium iodate monohydrate	$\text{Sr}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$	$3.77 \cdot 10^{-7}$
Strontium iodate hexahydrate	$\text{Sr}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$	$4.55 \cdot 10^{-7}$
Strontium sulfate	$\text{SrSO}_4$	$3.44 \cdot 10^{-7}$
Thallium(I) bromate	$\text{TlBrO}_3$	$1.10 \cdot 10^{-4}$
Thallium(I) bromide	$\text{TlBr}$	$3.71 \cdot 10^{-6}$
Thallium(I) chloride	$\text{TlCl}$	$1.86 \cdot 10^{-4}$
Thallium(I) chromate	$\text{Tl}_2\text{CrO}_4$	$8.67 \cdot 10^{-13}$
Thallium(I) iodate	$\text{TlIO}_3$	$3.12 \cdot 10^{-6}$
Thallium(I) iodide	$\text{TlI}$	$5.54 \cdot 10^{-8}$
Thallium(I) thiocyanate	$\text{TlSCN}$	$1.57 \cdot 10^{-4}$
Thallium(III) hydroxide	$\text{Tl}(\text{OH})_3$	$1.68 \cdot 10^{-44}$
Tin(II) hydroxide	$\text{Sn}(\text{OH})_2$	$5.45 \cdot 10^{-27}$
Yttrium carbonate	$\text{Y}_2(\text{CO}_3)_3$	$1.03 \cdot 10^{-31}$
Yttrium fluoride	$\text{YF}_3$	$8.62 \cdot 10^{-21}$
Yttrium hydroxide	$\text{Y}(\text{OH})_3$	$1.00 \cdot 10^{-22}$
Yttrium iodate	$\text{Y}(\text{IO}_3)_3$	$1.12 \cdot 10^{-10}$
Zinc arsenate	$\text{Zn}_3(\text{AsO}_4)_2$	$2.8 \cdot 10^{-28}$
Zinc carbonate	$\text{ZnCO}_3$	$1.46 \cdot 10^{-10}$
Zinc carbonate monohydrate	$\text{ZnCO}_3 \cdot \text{H}_2\text{O}$	$5.42 \cdot 10^{-11}$
Zinc fluoride	$\text{ZnF}_2$	$3.04 \cdot 10^{-2}$
Zinc hydroxide	$\text{Zn}(\text{OH})_2$	$3 \cdot 10^{-17}$
Zinc iodate dihydrate	$\text{Zn}(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$	$4.1 \cdot 10^{-6}$
Zinc oxalate dihydrate	$\text{ZnC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	$1.38 \cdot 10^{-9}$
Zinc selenide	$\text{ZnSe}$	$3.6 \cdot 10^{-26}$
Zinc selenite monohydrate	$\text{ZnSeO}_3 \cdot \text{H}_2\text{O}$	$1.59 \cdot 10^{-7}$

*Sulfides*

Compound	Formula	$K_{\text{spa}}$
Cadmium sulfide	CdS	$8 \cdot 10^{-7}$
Copper(II) sulfide	CuS	$6 \cdot 10^{-16}$
Iron(II) sulfide	FeS	$6 \cdot 10^2$
Lead(II) sulfide	PbS	$3 \cdot 10^{-7}$
Manganese(II) sulfide (green)	MnS	$3 \cdot 10^7$
Mercury(II) sulfide (red)	HgS	$4 \cdot 10^{-33}$
Mercury(II) sulfide (black)	HgS	$2 \cdot 10^{-32}$
Silver(I) sulfide	Ag <sub>2</sub> S	$6 \cdot 10^{-30}$
Tin(II) sulfide	SnS	$1 \cdot 10^{-5}$
Zinc sulfide (sphalerite)	ZnS	$2 \cdot 10^{-4}$
Zinc sulfide (wurtzite)	ZnS	$3 \cdot 10^{-2}$

# SOLUBILITY CHART

Abbreviations: **W**, soluble in water; **A**, insoluble in water but soluble in acids; **w**, sparingly soluble in water but soluble in acids; **a**, insoluble in water and only sparingly soluble in acids; **I**, insoluble in water and acids; **d**, decomposes in water. \* Indicates two modifications of the salt.

No.	AI	NH <sub>4</sub>	Sb	Ba	Bi	Cd	Ca	Cr	Co	Cu	Au (I)	Au (II)	H	Fe (II)	Fe (III)	
1	Acetate —(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> )	W Al(—) <sub>3</sub>	W NH <sub>4</sub> (—)		W Ba(—) <sub>2</sub>	W Bi(—) <sub>3</sub>	W Cd(—) <sub>2</sub>	W Ca(—) <sub>2</sub>	W Cr(—) <sub>3</sub>	W Co(—) <sub>2</sub>	W Cu(—) <sub>2</sub>	W W	W C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	W Fe(—) <sub>2</sub>	W Fe <sub>2</sub> (—) <sub>6</sub>	
2	Arsenate —(AsO <sub>4</sub> )	a Al(—)	W (NH <sub>4</sub> ) <sub>3</sub> (—)	A Sb(—)	w Ba <sub>3</sub> (—) <sub>2</sub>	A Bi(—)	A Cd <sub>3</sub> (—) <sub>2</sub>	w Ca <sub>3</sub> (—) <sub>2</sub>	A Co <sub>3</sub> (—) <sub>2</sub>	A Cu <sub>3</sub> (—) <sub>2</sub>			W H <sub>3</sub> AsO <sub>4</sub>	A Fe <sub>3</sub> (—) <sub>2</sub>	A Fe(—)	
3	Arsenite —(AsO <sub>3</sub> )		W NH <sub>4</sub> AsO <sub>2</sub>	A Sb(—)				w Ca <sub>3</sub> (—) <sub>2</sub>	A Co <sub>3</sub> H <sub>6</sub> (—) <sub>4</sub>	A CuH(—)						
4	Benzoate —(C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> )		W NH <sub>4</sub> (—)		W Ba(—) <sub>2</sub>	A Bi(—) <sub>3</sub>	W Cd(—) <sub>2</sub>	W Ca(—) <sub>2</sub>		W Co(—) <sub>2</sub>	w Cu(—) <sub>2</sub>		W C <sub>7</sub> H <sub>5</sub> O <sub>2</sub>	W Fe(—) <sub>2</sub>	A Fe <sub>2</sub> (—) <sub>6</sub>	
5	Bromide	W AlBr <sub>2</sub>	W NH <sub>4</sub> Br	d SbBr <sub>3</sub>	W BaBr <sub>2</sub>	d BiBr <sub>3</sub>	W CdBr <sub>2</sub>	W CaBr <sub>2</sub>	W(I)* CrBr <sub>3</sub>	W CoBr <sub>2</sub>	W CuBr <sub>2</sub>	w AuBr	W AuBr <sub>3</sub>	W HBr	W FeBr <sub>2</sub>	W FeBr <sub>3</sub>
6	Carbonate		W (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>		w BaCO <sub>3</sub>		A CdCO <sub>3</sub>	w CaCO <sub>3</sub>	W CrCO <sub>3</sub>	A CoCO <sub>3</sub>				w FeCO <sub>3</sub>		
7	Chlorate —(ClO <sub>3</sub> )	W Al(—) <sub>3</sub>	W NH <sub>4</sub> (—)		W Ba(—) <sub>2</sub>	W Bi(—) <sub>3</sub>	W Cd(—) <sub>2</sub>	W Ca(—) <sub>2</sub>		W Co(—) <sub>2</sub>	W Cu(—) <sub>2</sub>		W HClO <sub>3</sub>	W Fe(—) <sub>2</sub>	W Fe(—) <sub>3</sub>	
8	Chloride	W AlCl <sub>3</sub>	W NH <sub>4</sub> Cl	W SbCl <sub>3</sub>	W BaCl <sub>2</sub>	d BiCl <sub>3</sub>	W CdCl <sub>2</sub>	W CaCl <sub>2</sub>	I CrCl <sub>3</sub>	W CoCl <sub>2</sub>	W CuCl <sub>2</sub>	w AuCl	W AuCl <sub>3</sub>	W HCl	W FeCl <sub>2</sub>	W FeCl <sub>3</sub>
9	Chromate —(CrO <sub>4</sub> )		W (NH <sub>4</sub> ) <sub>2</sub> (—)		A Ba(—)		A Cd(—)	W Ca(—)		A Co(—)					A Fe <sub>2</sub> (—) <sub>3</sub>	
10	Citrate —(C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> )	W Al(—)	W (NH <sub>4</sub> ) <sub>3</sub> (—)		w Ba <sub>3</sub> (—) <sub>2</sub>	A Bi(—)	A Cd <sub>3</sub> (—) <sub>2</sub>	w Ca <sub>3</sub> (—) <sub>2</sub>		w Co <sub>3</sub> (—) <sub>2</sub>			W C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>		W Fe(—)	
11	Cyanide		W NH <sub>4</sub> CN		W Ba(CN) <sub>2</sub>	w Bi(CN) <sub>3</sub>	W Cd(CN) <sub>2</sub>	W Ca(CN) <sub>2</sub>	A Cr(CN) <sub>3</sub>	A Co(CN) <sub>2</sub>	A Cu(CN) <sub>2</sub>	w AuCN	W Au(CN) <sub>3</sub>	W HCN	a Fe(CN) <sub>2</sub>	
12	Ferricyde —(Fe(CN) <sub>6</sub> )		W (NH <sub>4</sub> ) <sub>3</sub> (—)		W Ba <sub>3</sub> (—) <sub>2</sub>		A Cd <sub>3</sub> (—) <sub>2</sub>	W Ca <sub>3</sub> (—) <sub>2</sub>		I Co <sub>3</sub> (—) <sub>2</sub>	I Cu <sub>3</sub> (—) <sub>2</sub>		W H <sub>3</sub> (—)	W Fe <sub>3</sub> (—) <sub>2</sub>		
13	Ferrocycde —(Fe(CN) <sub>5</sub> )	w Al <sub>4</sub> (—) <sub>3</sub>	W (NH <sub>4</sub> ) <sub>4</sub> (—)		W Ba <sub>2</sub> (—)		A Cd <sub>2</sub> (—)	W Ca <sub>3</sub> (—)		I Co <sub>2</sub> (—)	I Cu <sub>2</sub> (—)		W H <sub>4</sub> (—)	W Fe <sub>2</sub> (—)	a Fe <sub>4</sub> (—) <sub>3</sub>	
14	Fluoride	W AlF <sub>3</sub>	W NH <sub>4</sub> F	W SbF <sub>3</sub>	w BaF <sub>2</sub>	W BiF <sub>3</sub>	W CdF <sub>2</sub>	w CaF <sub>2</sub>	W(a)* CrF <sub>3</sub>	W CoF <sub>2</sub>	w CuF <sub>2</sub>		W HF	W FeF <sub>2</sub>	W FeF <sub>3</sub>	
15	Formate —(CHO <sub>2</sub> )	W Al(—) <sub>3</sub>	W NH <sub>4</sub> (—)		W Ba(—) <sub>2</sub>	A Bi(—) <sub>3</sub>	A Cd(—) <sub>2</sub>	W Ca(—) <sub>2</sub>		W Co(—) <sub>2</sub>	W Cu(—) <sub>2</sub>		W CH <sub>2</sub> O <sub>2</sub>	W Fe(—) <sub>2</sub>	W Fe(—) <sub>3</sub>	
16	Hydroxide	A Al(OH) <sub>3</sub>	W NH <sub>4</sub> OH		W Ba(OH) <sub>2</sub>	A Bi(OH) <sub>3</sub>	A Cd(OH) <sub>2</sub>	W Ca(OH) <sub>2</sub>	A Cr(OH) <sub>3</sub>	A Co(OH) <sub>2</sub>	A Cu(OH) <sub>2</sub>	W AuOH	A Au(OH) <sub>3</sub>	W Fe(OH) <sub>2</sub>	W Fe(OH) <sub>3</sub>	
17	Iodide	W AlI <sub>3</sub>	W NH <sub>4</sub> I	d SbI <sub>3</sub>	W BaI <sub>2</sub>	A BiI <sub>3</sub>	W CdI <sub>2</sub>	W CaI <sub>2</sub>	W CrI <sub>3</sub>	W CoI <sub>2</sub>	a CuI	a AuI	a AuI <sub>3</sub>	W HI	W FeI <sub>2</sub>	W FeI <sub>3</sub>
18	Nitrate	W Al(NO <sub>3</sub> ) <sub>3</sub>	W NH <sub>4</sub> NO <sub>3</sub>		W Ba(NO <sub>3</sub> ) <sub>2</sub>	d Bi(NO <sub>3</sub> ) <sub>3</sub>	W Cd(NO <sub>3</sub> ) <sub>2</sub>	W Ca(NO <sub>3</sub> ) <sub>2</sub>	W Cr(NO <sub>3</sub> ) <sub>3</sub>	W Co(NO <sub>3</sub> ) <sub>2</sub>	W Cu(NO <sub>3</sub> ) <sub>2</sub>		W HNO <sub>3</sub>	W Fe(NO <sub>3</sub> ) <sub>2</sub>	W Fe(NO <sub>3</sub> ) <sub>3</sub>	
19	Oxalate —(C <sub>2</sub> O <sub>4</sub> )	A Al <sub>2</sub> (—) <sub>3</sub>	W (NH <sub>4</sub> ) <sub>2</sub> (—)		w Ba(—)	A Bi <sub>2</sub> (—) <sub>3</sub>	w Cd(—)	A Ca(—)	W Cr(—)	A Co(—)	A Cu(—)		W C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	W Fe(—)	W Fe <sub>2</sub> (—) <sub>3</sub>	
20	Oxide	a Al <sub>2</sub> O <sub>3</sub>		w Sb <sub>2</sub> O <sub>3</sub>	W BaO	A Bi <sub>2</sub> O <sub>3</sub>	A CdO	w CaO	a Cr <sub>2</sub> O <sub>3</sub>	A CoO	A CuO	W Au <sub>2</sub> O	A Au <sub>2</sub> O <sub>3</sub>	W H <sub>2</sub> O <sub>2</sub>	W FeO	W Fe <sub>2</sub> O <sub>3</sub>
21	Phosphate	A AlPO <sub>4</sub>	W NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>		A Ba <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	A BiPO <sub>4</sub>	A Cd <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	w Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	w Cr <sub>2</sub> (PO <sub>4</sub> ) <sub>2</sub>	A Co <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	A Cu <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>		W H <sub>3</sub> PO <sub>4</sub>	W Fe <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	W FePO <sub>4</sub>	
22	Silicate, —(SiO <sub>3</sub> )	I Al <sub>2</sub> (—) <sub>3</sub>			W Ba(—)		A Cd(—)	w Ca(—)		A Co <sub>2</sub> SiO <sub>4</sub>	A Cu(—)		W H <sub>2</sub> SiO <sub>3</sub>			
23	Sulfate	W Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	W (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	A Sb <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	a BaSO <sub>4</sub>	d Bi <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	W CdSO <sub>4</sub>	W CaSO <sub>4</sub>	W(I)* Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	W CoSO <sub>4</sub>	W CuSO <sub>4</sub>		W H <sub>2</sub> SO <sub>4</sub>	W FeSO <sub>4</sub>	W Fe(SO <sub>4</sub> ) <sub>3</sub>	
24	Sulfide	d Al <sub>2</sub> S <sub>3</sub>	W (NH <sub>4</sub> ) <sub>2</sub> S	A Sb <sub>2</sub> S <sub>3</sub>	d BaS	A Bi <sub>2</sub> S <sub>3</sub>	A CdS	w CaS	d Cr <sub>2</sub> S <sub>3</sub>	A CoS	A CuS	I Au <sub>2</sub> S	I Au <sub>2</sub> S <sub>3</sub>	W H <sub>2</sub> S	A FeS	d Fe <sub>2</sub> S <sub>3</sub>
25	Tartrate —(C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> )	w Al <sub>2</sub> (—) <sub>3</sub>	W (NH <sub>4</sub> ) <sub>2</sub> (—)	W Sb <sub>2</sub> (—) <sub>3</sub>	W Ba(—)	A Bi <sub>2</sub> (—) <sub>3</sub>	A Cd(—)	w Ca(—)		A Co(—)	A Cu(—)		W C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	W Fe(—)	W Fe <sub>2</sub> (—) <sub>3</sub>	
26	Thiocyete		W NH <sub>4</sub> CNS		W Ba(CNS) <sub>2</sub>			W Ca(CNS)		W Co(CNS) <sub>2</sub>	W CuCNS		W CNSH	W Fe(CNS) <sub>2</sub>	W Fe(CNS) <sub>3</sub>	

No.		Pb	Mg	Mn	Hg (I)	Hg (II)	Ni	K	Pt	Ag	Na	Sn (IV)	Sn (II)	Sr	Zn
1	Acetate	W	W	W	w	W	W	W		w	W	W	d	W	W
	—(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> )	Pb(—) <sub>2</sub>	Mg(—) <sub>2</sub>	Mn(—) <sub>2</sub>	Hg(—)	Hg(—) <sub>2</sub>	Ni(—) <sub>2</sub>	K(—)		Ag(—)	Na(—)	Sn(—) <sub>4</sub>	Sn(—) <sub>2</sub>	Sr(—) <sub>2</sub>	Zn(—) <sub>2</sub>
2	Arsenate	A	A	w	A	w	A	W		A	W			w	A
	—(AsO <sub>4</sub> )	PbH(—)	Mg <sub>3</sub> (—)	MnH(—)	Hg <sub>3</sub> (—)	Hg <sub>3</sub> (—) <sub>2</sub>	Ni <sub>3</sub> (—) <sub>2</sub>	K <sub>3</sub> (—)		Ag <sub>3</sub> (—)	Na <sub>3</sub> (—)			SrH(—)	Zn <sub>3</sub> (—) <sub>2</sub>
3	Arsenite		W	A	A	A	A	W		A	W		A	w	
	—(AsO <sub>3</sub> )		Mg <sub>3</sub> (—) <sub>2</sub>	Mn <sub>3</sub> H <sub>6</sub> (—) <sub>4</sub>	Hg <sub>3</sub> (—)	Hg <sub>3</sub> (—)	Ni <sub>3</sub> H <sub>6</sub> (—) <sub>4</sub>	K <sub>3</sub> AsO <sub>3</sub>		Ag <sub>3</sub> (—)	Na <sub>3</sub> H(—)		Sn <sub>3</sub> (—) <sub>2</sub>	Sr <sub>3</sub> (—) <sub>2</sub>	
4	Benzoate	w	W	W	A	w	w	W		w	W				W
	—(C <sub>7</sub> H <sub>5</sub> O <sub>2</sub> )	Pb(—) <sub>2</sub>	Mg(—) <sub>2</sub>	Mn(—) <sub>2</sub>	Hg <sub>3</sub> (—) <sub>2</sub>	Hg(—) <sub>2</sub>	Ni(—) <sub>2</sub>	K(—)		Ag(—)	Na(—)				Zn(—) <sub>2</sub>
5	Bromide	W	W	W	A	W	W	W	w	a	W	W	W	W	W
		PbBr <sub>2</sub>	MgBr <sub>2</sub>	MnBr <sub>2</sub>	HgBr	HgBr <sub>2</sub>	NiBr <sub>2</sub>	KBr	PtBr <sub>4</sub>	AgBr	NaBr	SnBr <sub>4</sub>	SnBr <sub>2</sub>	SrBr <sub>2</sub>	ZnBr <sub>2</sub>
6	Carbonate	A	w	w	A		w	W		A	W			w	w
		PbCO <sub>3</sub>	MgCO <sub>3</sub>	MnCO <sub>3</sub>	HgCO <sub>3</sub>		NiCO <sub>3</sub>	K <sub>2</sub> CO <sub>3</sub>		Ag <sub>2</sub> CO <sub>3</sub>	Na <sub>2</sub> CO <sub>3</sub>			SrCO <sub>3</sub>	ZnCO <sub>3</sub>
7	Chlorate	W	W	W	W	W	W	W		W	W		W	W	W
	—(ClO <sub>3</sub> )	Pb(—) <sub>2</sub>	Mg(—) <sub>2</sub>	Mn(—) <sub>2</sub>	Hg(—)	Hg(—) <sub>2</sub>	Ni(—) <sub>2</sub>	K(—)		Ag(—)	Na(—)		Sn(—) <sub>2</sub>	Sr(—) <sub>2</sub>	Zn(—) <sub>2</sub>
8	Chloride	W	W	W	a	W	W	W	W	a	W	W	W	W	W
		PbCl <sub>2</sub>	MgCl <sub>2</sub>	MnCl <sub>2</sub>	HgCl	HgCl <sub>2</sub>	NiCl <sub>2</sub>	KCl	PtCl <sub>4</sub>	AgCl	NaCl	SnCl <sub>4</sub>	SnCl <sub>2</sub>	SrCl <sub>2</sub>	ZnCl <sub>2</sub>
9	Chromate	A	W		w	w	A	W		w	W	W	A	w	w
	—(CrO <sub>4</sub> )	Pb(—)	Mg(—)		Hg <sub>2</sub> (—)	Hg(—)	Ni(—)	K <sub>2</sub> (—)		Ag <sub>2</sub> (—)	Na <sub>2</sub> (—)	Sn(—) <sub>2</sub>	Sn(—)	Sr(—)	Zn(—)
10	Citrate	W	W	w	w		W	W		w	W			A	w
	—(C <sub>6</sub> H <sub>5</sub> O <sub>7</sub> )	Pb <sub>3</sub> (—) <sub>2</sub>	Mg <sub>3</sub> (—) <sub>2</sub>	MnH(—)	Hg <sub>3</sub> (—)		Ni <sub>3</sub> (—) <sub>2</sub>	K <sub>3</sub> (—)		Ag <sub>3</sub> (—)	Na <sub>3</sub> (—)			SrH(—)	Zn <sub>3</sub> (—) <sub>2</sub>
11	Cyanide	w	W		A	W	a	W	I	a	W			W	A
		Pb(CN) <sub>2</sub>	Mg(CN) <sub>2</sub>		HgCN	Hg(CN) <sub>2</sub>	Ni(CN) <sub>2</sub>	KCN	Pt(CN) <sub>2</sub>	AgCN	NaCN			Sr(CN) <sub>2</sub>	Zn(CN) <sub>2</sub>
12	Ferricy'de	w	W			A	I	W		I	W		A	W	A
	—Fe(CN) <sub>6</sub>	Pb <sub>3</sub> (—) <sub>2</sub>	Mg <sub>3</sub> (—) <sub>2</sub>			Hg <sub>3</sub> (—) <sub>2</sub>	Ni <sub>3</sub> (—) <sub>2</sub>	K <sub>3</sub> (—)		Ag <sub>3</sub> (—)	Na <sub>3</sub> (—)		Sn <sub>3</sub> (—) <sub>2</sub>	Sr <sub>3</sub> (—) <sub>2</sub>	Zn <sub>3</sub> (—) <sub>2</sub>
13	Ferroc'y'de	a	W	A		I	I	W		I	W		a	W	I
	—Fe(CN) <sub>6</sub>	Pb <sub>2</sub> (—)	Mg <sub>2</sub> (—)	Mn <sub>2</sub> (—)		Hg <sub>2</sub> (—)	Ni <sub>2</sub> (—)	K <sub>4</sub> (—)		Ag <sub>4</sub> (—)	Na <sub>4</sub> (—)		Sn <sub>2</sub> (—)	Sr <sub>2</sub> (—)	Zn <sub>2</sub> (—)
14	Fluoride	w	w	A	d	d	w	W	W	W	W	W	W	w	w
		PbF <sub>2</sub>	MgF <sub>2</sub>	MnF <sub>2</sub>	HgF	HgF <sub>2</sub>	NiF <sub>2</sub>	KF	PtF <sub>4</sub>	AgF	NaF	SnF <sub>4</sub>	SnF <sub>2</sub>	SrF <sub>2</sub>	ZnF <sub>2</sub>
15	Formate	W	W	W	w	W	W	W		W	W			W	W
	—(CHO <sub>2</sub> )	Pb(—) <sub>2</sub>	Mg(—) <sub>2</sub>	Mn(—) <sub>2</sub>	Hg(—)	Hg(—) <sub>2</sub>	Ni(—) <sub>2</sub>	K(—)		Ag(—)	Na(—)			Sr(—) <sub>2</sub>	Zn(—) <sub>2</sub>
16	Hydroxide	w	A	A		A	w	W	A	W	w	A	W	W	A
		Pb(OH) <sub>2</sub>	Mg(OH) <sub>2</sub>	Mn(OH) <sub>2</sub>		Hg(OH) <sub>2</sub>	Ni(OH) <sub>2</sub>	KOH	Pt(OH) <sub>4</sub>		NaOH	Sn(OH) <sub>4</sub>	Sn(OH) <sub>2</sub>	Sr(OH) <sub>2</sub>	Zn(OH) <sub>2</sub>
17	Iodide	w	W	W	A	w	W	W	I	I	W	d	W	W	W
		PbI <sub>2</sub>	MgI <sub>2</sub>	MnI <sub>2</sub>	HgI	HgI <sub>2</sub>	NiI <sub>2</sub>	KI	PtI <sub>2</sub>	AgI	NaI	SnI <sub>4</sub>	SnI <sub>2</sub>	SrI <sub>2</sub>	ZnI <sub>2</sub>
18	Nitrate	W	W	W	W	W	W	W	W	W	W		d	W	W
		Pb(NO <sub>3</sub> ) <sub>2</sub>	Mg(NO <sub>3</sub> ) <sub>2</sub>	Mn(NO <sub>3</sub> ) <sub>2</sub>	HgNO <sub>3</sub>	Hg(NO <sub>3</sub> ) <sub>2</sub>	Ni(NO <sub>3</sub> ) <sub>2</sub>	KNO <sub>3</sub>	Pt(NO <sub>3</sub> ) <sub>4</sub>	AgNO <sub>3</sub>	NaNO <sub>3</sub>		Sn(NO <sub>3</sub> ) <sub>2</sub>	Sr(NO <sub>3</sub> ) <sub>2</sub>	Zn(NO <sub>3</sub> ) <sub>2</sub>
19	Oxalate	A	w	w	a	A	A	W		a	W		A	w	A
	—(C <sub>2</sub> O <sub>4</sub> )	Pb(—)	Mg(—)	Mn(—)	Hg <sub>2</sub> (—)	Hg(—)	Ni(—)	K <sub>2</sub> (—)		Ag <sub>2</sub> (—)	Na <sub>2</sub> (—)		Sn(—)	Sr(—)	Zn(—)
20	Oxide	w	A	A	A	W	A	W	A	w	d	A	A	W	w
		PbO	MgO	MnO	Hg <sub>2</sub> O	HgO	NiO	K <sub>2</sub> O	PtO	Ag <sub>2</sub> O	Na <sub>2</sub> O	SnO <sub>2</sub>	SnO	SrO	ZnO
21	Phosphate	A	w	w	A	A	A	W		A	W		A	A	A
		Pb <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Mg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Mn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Hg <sub>3</sub> PO <sub>4</sub>	Hg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Ni <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	K <sub>3</sub> PO <sub>4</sub>		Ag <sub>3</sub> PO <sub>4</sub>	Na <sub>3</sub> PO <sub>4</sub>		Sn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Sr <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Zn <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>
22	Silicate	A	A	I				W			W			A	A
	—(SiO <sub>3</sub> )	Pb(—)	Mg(—)	Mn(—)				K <sub>2</sub> (—)			Na <sub>2</sub> (—)			Sr(—)	Zn(—)
23	Sulfate	w	W	W	w	d	W	W	W	w	W	W	W	w	W
		PbSO <sub>4</sub>	MgSO <sub>4</sub>	MnSO <sub>4</sub>	Hg <sub>2</sub> SO <sub>4</sub>	HgSO <sub>4</sub>	NiSO <sub>4</sub>	K <sub>2</sub> SO <sub>4</sub>	Pt(SO <sub>4</sub> ) <sub>2</sub>	Ag <sub>2</sub> SO <sub>4</sub>	Na <sub>2</sub> SO <sub>4</sub>	Sn(SO <sub>4</sub> ) <sub>2</sub>	SnSO <sub>4</sub>	SrSO <sub>4</sub>	ZnSO <sub>4</sub>
24	Sulfide	A	d	A	I	I	A	W	I	A	W	A	A	W	A
		PbS	MgS	MnS	Hg <sub>2</sub> S	HgS	NiS	K <sub>2</sub> S	PtS	Ag <sub>2</sub> S	Na <sub>2</sub> S	SnS <sub>2</sub>	SnS	SrS	ZnS
25	Tartrate	A	w	w	I	I	A	W	I	A	W	A	A	W	A
	—(C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> )	Pb(—)	Mg(—)	Mn(—)	Hg <sub>2</sub> (—)		Ni(—)	K <sub>2</sub> (—)		Ag <sub>2</sub> (—)	Na <sub>2</sub> (—)		Sn(—)	Sr(—)	Zn(—)
26	Thiocy'te	w	W	W	A	w		W		I	W			W	W
		Pb(CNS) <sub>2</sub>	Mg(CNS) <sub>2</sub>	Mn(CNS) <sub>2</sub>	HgCNS	Hg(CNS) <sub>2</sub>		KCNS		AgCNS	NaCNS			Sr(CNS) <sub>2</sub>	Zn(CNS) <sub>2</sub>

## REDUCTION OF WEIGHINGS IN AIR TO VACUO

When the mass  $M$  of a body is determined in air, a correction is necessary for the buoyancy of the air. The corrected mass is given by  $M + kM/1000$ , where  $k$  is a function of the material used for the weights, given by

$$k = 1000\rho_{\text{air}}(1/\rho_{\text{body}} - 1/\rho_{\text{weight}})$$

and  $\rho$  is density. The table below is computed for an air density of 0.0012 g/cm<sup>3</sup> and for densities of three common weights:

Density of body (g/cm <sup>3</sup> )	Value of $k$ for weights of:		
	Pt-Ir	Brass	Quartz or Al
0.5	2.34	2.26	1.95
0.6	1.94	1.86	1.55
0.7	1.66	1.57	1.26
0.8	1.44	1.36	1.05
0.9	1.28	1.19	0.88
1.0	1.14	1.06	0.75
1.1	1.04	0.95	0.64
1.2	0.94	0.86	0.55
1.3	0.87	0.78	0.47
1.4	0.80	0.72	0.40
1.5	0.74	0.66	0.35
1.6	0.69	0.61	0.30
1.7	0.65	0.56	0.25

platinum-iridium (21.6 g/cm<sup>3</sup>), brass (8.5 g/cm<sup>3</sup>), and aluminum or quartz (2.65 g/cm<sup>3</sup>).

### References

1. Kaye, G. W. C., and Laby, T. H., *Tables of Physical and Chemical Constants, 16th Edition*, pp. 25-28, Longman, London, 1995.
2. Giacomo, P., *Metrologia*, 18, 33, 1982.
3. Davis, R. S., *Metrologia*, 29, 67, 1992.

Density of body (g/cm <sup>3</sup> )	Value of $k$ for weights of:		
	Pt-Ir	Brass	Quartz or Al
1.8	0.61	0.53	0.21
1.9	0.58	0.49	0.18
2.0	0.54	0.46	0.15
2.5	0.42	0.34	0.03
3.0	0.34	0.26	-0.05
4.0	0.24	0.16	-0.15
6.0	0.14	0.06	-0.25
8.0	0.09	0.01	-0.30
10.0	0.06	-0.02	-0.33
15.0	0.02	-0.06	-0.37
20.0	0.00	-0.08	-0.39
22.0	0.00	-0.09	-0.40

For a more accurate calculation, use the following values of the density of air (assuming 50% relative humidity and 0.04% CO<sub>2</sub>):

$P/\text{kPa}$	Air temperature		
	10°C	20°C	30°C
85	0.001043	0.001005	0.000968
90	0.001105	0.001065	0.001025
95	0.001166	0.001124	0.001083
100	0.001228	0.001184	0.001140
105	0.001290	0.001243	0.001198

Formulas for calculating the density of air over more extended ranges of temperature, pressure, and humidity may be found in the references.

## VOLUME OF ONE GRAM OF WATER

The following table, which is designed for gravimetric calibration of volumetric apparatus, gives the specific volume of water at standard atmospheric pressure as a function of temperature.

### Reference

Marsh, K. N., Ed., *Recommended Reference Materials for the Realization of Physicochemical Properties*, pp. 25-27, Blackwell Scientific Publications, Oxford, 1987.

t/°C	Volume of 1 g H <sub>2</sub> O in cm <sup>3</sup>
10	1.0002980
11	1.0003928
12	1.0005007
13	1.0006212
14	1.0007542
15	1.0008992
16	1.0010561
17	1.0012246
18	1.0014044
19	1.0015952
20	1.0017969
21	1.0020092
22	1.0022320
23	1.0024649
24	1.0027079
25	1.0029607
26	1.0032234
27	1.0034956
28	1.0037771
29	1.0040679
30	1.0043679

## PROPERTIES OF CARRIER GASES FOR GAS CHROMATOGRAPHY

The following is a list of carrier gases sometimes used in gas chromatography, with properties relevant to the design of chromatographic systems. All data refer to normal atmospheric pressure (101.325 kPa).

$M_r$ : Molecular weight (relative molar mass)  
 $\rho_{25}$ : Density at 25 °C in g/L  
 $\lambda$ : Thermal conductivity in mW/m °C  
 $\eta$ : Viscosity in  $\mu\text{Pa s}$  (equal to  $10^{-3}$  cP)  
 $c_p$ : Specific heat at 25 °C in J/g °C

### References

1. Lide, D. R., and Kehiaian, H. V., *CRC Handbook of Thermophysical and Thermochemical Data*, CRC Press, Boca Raton, FL, 1994.
2. Bruno, T. J., and Svoronos, P. D. N., *CRC Handbook of Basic Tables for Chemical Analysis*, CRC Press, Boca Raton, FL, 1989.

Gas	$M_r$	$\rho_{25}$ g L <sup>-1</sup>	At 25 °C		At 250 °C		$c_p$ (25 °C) J/g °C
			$\lambda$ mW/m °C	$\eta$ $\mu\text{Pa s}$	$\lambda$ mW/m °C	$\eta$ $\mu\text{Pa s}$	
Hydrogen	2.016	0.0824	185.9	8.9	280	13.1	14.3
Helium	4.003	0.1636	154.6	19.9	230	29.5	5.20
Argon	39.95	1.6329	17.8	22.7	27.7	35.3	0.521
Nitrogen	28.01	1.1449	25.9	17.9	39.6	26.8	1.039
Oxygen	32.00	1.3080	26.2	20.7	42.6	31.8	0.919
Carbon monoxide	28.01	1.1449	24.8	17.8	40.7	26.5	1.039
Carbon dioxide	44.01	1.7989	16.7	14.9	35.5	24.9	0.843
Sulfur hexafluoride	146.05	5.9696	13.1	28.1	15.3	24.8	0.664
Methane	16.04	0.6556	34.5	11.1	75.0	17.6	2.23
Ethane	30.07	1.2291	20.9	9.4	57.7	15.5	1.75
Ethylene	28.05	1.1465	20.5	10.3	53.8	17.2	1.53
Propane	44.10	1.8025	17.9	8.3	49.2	14.0	1.67

## SOLVENTS FOR ULTRAVIOLET SPECTROPHOTOMETRY

This table lists some solvents commonly used for sample preparation for ultraviolet spectrophotometry. The properties given are:

- $\lambda_c$ : cutoff wavelength, below which the solvent absorption becomes excessive.  
 $\epsilon$ : dielectric constant (relative permittivity); the temperature in °C is given as a superscript.  
 $t_b$ : normal boiling point.

### References

1. Bruno, T. J., and Svoronos, P. D. N., *CRC Handbook of Basic Tables for Chemical Analysis*, CRC Press, Boca Raton, FL, 1989.
2. *Landolt-Börnstein, Numerical Data and Functional Relationships in Science and Technology, New Series, IV/6, Static Dielectric Constants of Pure Liquids and Binary Liquid Mixtures*, Springer-Verlag, Heidelberg, 1991.

Name	$\lambda_c$ /nm	$\epsilon$	$t_b$ /°C
Acetic acid	260	6.20 <sup>20</sup>	117.9
Acetone	330	21.01 <sup>20</sup>	56.0
Acetonitrile	190	36.64 <sup>20</sup>	81.6
Benzene	280	2.28 <sup>20</sup>	80.0
2-Butanol	260	17.26 <sup>20</sup>	99.5
Butyl acetate	254	5.07 <sup>20</sup>	126.1
Carbon disulfide	380	2.63 <sup>20</sup>	46
Carbon tetrachloride	265	2.24 <sup>20</sup>	76.8
1-Chlorobutane	220	7.28 <sup>20</sup>	78.6
Chloroform	245	4.81 <sup>20</sup>	61.1
Cyclohexane	210	2.02 <sup>20</sup>	80.7
1,2-Dichloroethane	226	10.42 <sup>20</sup>	83.5
Dichloromethane	235	8.93 <sup>25</sup>	40
Diethyl ether	218	4.27 <sup>20</sup>	34.5
<i>N,N</i> -Dimethylacetamide	268	38.85 <sup>21</sup>	165
<i>N,N</i> -Dimethylformamide	270	38.25 <sup>20</sup>	153
Dimethyl sulfoxide	265	47.24 <sup>20</sup>	189
1,4-Dioxane	215	2.22 <sup>20</sup>	101.5
Ethanol	210	25.3 <sup>20</sup>	78.2
Ethyl acetate	255	6.08 <sup>20</sup>	77.1
Ethylene glycol dimethyl ether	240	7.30 <sup>24</sup>	85
Ethylene glycol monoethyl ether	210	13.38 <sup>25</sup>	135
Ethylene glycol monomethyl ether	210	17.2 <sup>25</sup>	124.1
Glycerol	207	46.53 <sup>20</sup>	290
Heptane	197	1.92 <sup>20</sup>	98.5
Hexadecane	200	2.05 <sup>20</sup>	286.8
Hexane	210	1.89 <sup>20</sup>	68.7
Methanol	210	33.0 <sup>20</sup>	64.6
Methylcyclohexane	210	2.02 <sup>20</sup>	100.9
Methyl ethyl ketone	330	18.56 <sup>20</sup>	79.5
Methyl isobutyl ketone	335	13.11 <sup>20</sup>	116.5
2-Methyl-1-propanol	230	17.93 <sup>20</sup>	107.8
<i>N</i> -Methyl-2-pyrrolidone	285	32.55 <sup>20</sup>	202
Nitromethane	380	37.27 <sup>20</sup>	101.1
Pentane	210	1.84 <sup>20</sup>	36.0
Pentyl acetate	212	4.79 <sup>20</sup>	149.2
1-Propanol	210	20.8 <sup>20</sup>	97.2
2-Propanol	210	20.18 <sup>20</sup>	82.3
Pyridine	330	13.26 <sup>20</sup>	115.2
Tetrachloroethylene	290	2.27 <sup>30</sup>	121.3
Tetrahydrofuran	220	7.52 <sup>22</sup>	65
Toluene	286	2.38 <sup>23</sup>	110.6
1,1,2-Trichloro-1,2,2-trifluoroethane	231	2.41 <sup>25</sup>	47.7
2,2,4-Trimethylpentane	215	1.94 <sup>20</sup>	99.2
Water	191	80.10 <sup>20</sup>	100.0
<i>o</i> -Xylene	290	2.56 <sup>20</sup>	144.5
<i>m</i> -Xylene	290	2.36 <sup>20</sup>	139.1
<i>p</i> -Xylene	290	2.27 <sup>20</sup>	138.3



## <sup>13</sup>C CHEMICAL SHIFTS OF USEFUL NMR SOLVENTS

The following table gives the expected carbon-13 chemical shifts, relative to tetramethylsilane, for various useful NMR solvents. In some solvents, slight changes can occur with change of concentration.<sup>2,3</sup>

### References

1. Bruno, T. J., and Svoronos, P. D. N., *CRC Handbook of Basic Tables for Chemical Analysis*, CRC Press, Boca Raton, FL, 1989.
2. Silverstein, R. M., Bassler, G. C., and Morrill, T. C., *Spectrometric Identification of Organic Compounds*, John Wiley & Sons, New York, 1981.
3. Rahman, A. U., *Nuclear Magnetic Resonance. Basic Principles*, Springer-Verlag, New York, 1986.
4. Pretsch, E., Clerc, T., Seibl, J., and Simon, W., *Spectral Data for Structure Determination of Organic Compounds, Second Edition*, Springer-Verlag, Heidelberg, 1989.

Solvent	Formula	Chemical shift (ppm)
Acetic acid- <i>d</i> <sub>4</sub>	CD <sub>3</sub> COOD	20.0 (CD <sub>3</sub> ) 205.8 (C=O)
Acetone	(CH <sub>3</sub> ) <sub>2</sub> C=O	30.7 (CH <sub>3</sub> ) 206.7 (C=O)
Acetone- <i>d</i> <sub>6</sub>	(CD <sub>3</sub> ) <sub>2</sub> C=O	29.2 (CD <sub>3</sub> ) 204.1 (C=O)
Acetonitrile- <i>d</i> <sub>3</sub>	CD <sub>3</sub> C≡N	1.3 (CD <sub>3</sub> ) 117.1 (C≡N)
Benzene	C <sub>6</sub> H <sub>6</sub>	128.5
Benzene- <i>d</i> <sub>6</sub>	C <sub>6</sub> D <sub>6</sub>	128.4
Carbon disulfide	CS <sub>2</sub>	192.3
Carbon tetrachloride	CCl <sub>4</sub>	96.0
Chloroform	CHCl <sub>3</sub>	77.2
Chloroform- <i>d</i> <sub>3</sub>	CDCl <sub>3</sub>	77.05
Cyclohexane- <i>d</i> <sub>12</sub>	C <sub>6</sub> D <sub>12</sub>	27.5
Dichloromethane- <i>d</i> <sub>2</sub>	CD <sub>2</sub> Cl <sub>2</sub>	53.6
Dimethylformamide- <i>d</i> <sub>7</sub>	(CD <sub>3</sub> ) <sub>2</sub> NCDO	31 (CD <sub>3</sub> ) 36 (CD <sub>3</sub> ) 162.4 (C=O)
Dimethylsulfoxide- <i>d</i> <sub>6</sub>	(CD <sub>3</sub> ) <sub>2</sub> S=O	39.6
Dioxane- <i>d</i> <sub>8</sub>	C <sub>4</sub> D <sub>3</sub> O <sub>2</sub>	67.4
Formic acid- <i>d</i> <sub>2</sub>	DCOOD	165.5
Methanol- <i>d</i> <sub>4</sub>	CD <sub>3</sub> OD	49.3
Nitromethane- <i>d</i> <sub>3</sub>	CD <sub>3</sub> NO <sub>2</sub>	57.3
Pyridine	C <sub>5</sub> H <sub>5</sub> N	123.6 (C <sub>3</sub> ) 135.7 (C <sub>4</sub> ) 149.8 (C <sub>2</sub> )
Pyridine- <i>d</i> <sub>5</sub>	C <sub>5</sub> D <sub>5</sub> N	123.9 (C <sub>3</sub> ) 135.9 (C <sub>4</sub> ) 150.2 (C <sub>2</sub> )
1,1,2,2-Tetrachloroethane- <i>d</i> <sub>2</sub>	CDCl <sub>2</sub> CDCl <sub>2</sub>	75.5
Tetrahydrofuran- <i>d</i> <sub>8</sub>	C <sub>4</sub> D <sub>8</sub> O	25.8 (C <sub>2</sub> ) 67.9 (C <sub>1</sub> )
Trichlorofluoromethane	CFCl <sub>3</sub>	117.6

## MASS SPECTRAL PEAKS OF COMMON ORGANIC SOLVENTS

The strongest peaks in the mass spectra of 375 important organic solvents and other liquid reagents are listed in this table. The *m/z* value for each peak is followed by the relative intensity in parentheses, with the strongest peak assigned an intensity of 100. The peaks for each compound are listed in order of decreasing intensity. Compounds are listed by the name used in this *Handbook*, with other common names given in parentheses.

Data on the physical properties of the same compounds may be found in Section 15 in the table *Laboratory Solvents and Other Liquid Reagents*.

### References

1. NIST/EPA/NIH Mass Spectral Database, National Institute of Standards and Technology, Gaithersburg, MD, 20899.
2. Lide, D. R., and Milne, G. W. A., Editors, *Handbook of Data on Organic Compounds, Third Edition*, CRC Press, Boca Raton, FL, 1994. (Also available as a CD-ROM database.)
3. Lide, D. R., Editor, *Properties of Organic Compounds*, <[www.chem-netbase.com/scripts/pocweb.exe](http://www.chem-netbase.com/scripts/pocweb.exe)>.

Compound	<i>m/z</i> (intensity)									
Acetic acid	43(100)	45(87)	60(57)	15(42)	42(14)	29(13)	14(13)	28(7)	18(6)	16(6)
Acetic anhydride	43(100)	42(35)	45(29)	60(18)	29(9)	41(8)	40(2)	26(2)	87(1)	61(1)
Acetone	43(100)	15(34)	58(23)	27(9)	14(9)	42(8)	26(7)	29(5)	28(5)	39(4)
Acetonitrile	41(100)	40(46)	39(13)	14(9)	38(6)	28(4)	26(4)	25(3)	42(2)	27(2)
Acrolein (2-Propenal)	27(100)	56(74)	28(65)	26(54)	55(52)	29(37)	25(8)	53(5)	38(5)	57(4)
Acrylonitrile	53(100)	26(85)	52(79)	51(34)	27(13)	50(8)	25(7)	38(5)	54(3)	37(3)
Allyl alcohol	57(100)	31(34)	29(32)	28(31)	58(25)	39(22)	27(20)	30(16)	32(14)	26(11)
Allylamine	30(100)	56(80)	28(76)	57(33)	39(21)	29(20)	27(18)	26(13)	41(8)	18(8)
2-Amino-2-methyl-1-propanol (2-Aminoisobutanol)	58(100)	41(18)	18(17)	42(13)	28(11)	56(10)	30(10)	29(8)	43(6)	59(5)
Aniline (Benzenamine)	93(100)	66(32)	65(16)	39(13)	92(10)	94(7)	41(5)	40(5)	67(4)	64(3)
Anisole (Methoxybenzene)	108(100)	65(76)	78(60)	39(44)	51(21)	77(20)	93(16)	79(14)	50(13)	63(12)
Benzaldehyde	51(100)	77(81)	50(55)	106(44)	105(43)	52(26)	78(16)	39(13)	27(10)	74(8)
Benzene	78(100)	77(20)	52(19)	51(17)	50(15)	39(12)	79(6)	76(5)	74(4)	38(4)
Benzeneacetonitrile (Benzyl cyanide)	117(100)	90(43)	116(35)	89(22)	51(13)	39(11)	63(10)	118(9)	91(8)	50(8)
Benzenethiol (Phenyl mercaptan)	110(100)	66(28)	109(23)	39(15)	77(14)	51(14)	84(13)	69(11)	50(11)	45(11)
Benzonitrile	103(100)	76(34)	50(13)	104(9)	75(7)	51(7)	77(5)	52(4)	39(4)	74(3)
Benzyl acetate	108(100)	43(76)	91(60)	90(48)	79(27)	107(17)	77(17)	65(15)	51(15)	89(14)
Benzyl alcohol	79(100)	108(83)	77(74)	107(66)	51(35)	105(23)	106(22)	50(17)	78(16)	39(16)
Bis(2-aminoethyl)amine (Diethylenetriamine)	44(100)	73(59)	30(35)	19(18)	56(16)	28(16)	27(16)	42(11)	99(8)	43(8)
Bis(2-chloroethyl) ether	93(100)	63(74)	27(38)	95(32)	65(24)	31(9)	49(4)	28(4)	94(3)	62(3)
Bis(2-ethylhexyl) phthalate	149(100)	57(32)	167(29)	71(21)	43(21)	70(18)	150(11)	113(10)	55(10)	41(9)
Bis(2-hydroxyethyl) sulfide	61(100)	45(68)	31(38)	104(36)	91(34)	47(26)	44(26)	27(24)	60(18)	43(17)
Bromobenzene	77(100)	158(64)	156(64)	51(39)	50(17)	78(8)	76(6)	75(6)	28(5)	159(4)
1-Bromobutane (Butyl bromide)	57(100)	41(56)	29(45)	27(29)	56(13)	39(12)	28(12)	55(7)	43(7)	138(6)
2-Bromobutane (sec-Butyl bromide)	57(100)	41(60)	29(57)	27(34)	39(20)	28(9)	26(9)	136(1)		
1-Bromo-2-chloroethane	63(100)	27(85)	65(31)	26(23)	144(8)	81(8)	79(8)	28(7)	142(6)	93(6)
Bromochloromethane	49(100)	130(67)	128(52)	51(31)	93(23)	81(20)	79(20)	95(17)	132(16)	47(8)
1-Bromodecane (Decyl bromide)	43(100)	135(94)	137(91)	57(81)	41(58)	55(56)	71(38)	69(36)	85(33)	29(27)
Bromoethane (Ethyl bromide)	108(100)	110(97)	29(62)	27(51)	28(35)	26(14)	93(6)	32(6)	95(5)	81(5)
2-Bromo-2-methylpropane (tert-Butyl bromide)	57(100)	41(67)	29(45)	39(30)	27(18)	28(8)	40(5)	38(5)	58(4)	55(4)
1-Bromonaphthalene	44(100)	206(39)	127(39)	208(37)	36(31)	69(29)	131(13)	29(13)	126(12)	63(12)
1-Bromopentane (Pentyl bromide)	43(100)	71(80)	41(56)	27(51)	42(37)	29(34)	55(33)	39(30)	28(12)	26(9)
1-Bromopropane (Propyl bromide)	43(100)	41(77)	28(69)	27(60)	39(49)	124(42)	122(41)	42(34)	32(20)	29(15)
2-Bromopropane (Isopropyl bromide)	43(100)	27(47)	41(43)	39(22)	124(8)	122(8)	26(7)	81(6)	79(6)	38(6)
2-Bromopropene	41(100)	39(58)	122(37)	120(36)	38(12)	37(8)	40(6)	81(5)	79(5)	42(4)
Butanal	44(100)	43(74)	72(57)	41(56)	27(55)	29(48)	57(23)	39(22)	28(15)	42(11)
Butanenitrile	41(100)	29(62)	27(37)	28(10)	39(9)	26(7)	40(5)	42(4)	38(4)	15(4)
1-Butanethiol (Butyl mercaptan)	56(100)	41(74)	90(66)	47(43)	27(43)	28(36)	29(33)	57(17)	39(16)	61(15)
Butanoic acid	60(100)	27(50)	73(27)	42(25)	41(24)	43(22)	29(21)	45(19)	39(15)	28(11)
Butanoic anhydride	71(100)	43(59)	27(26)	41(19)	42(10)	39(10)	73(9)	28(7)	72(5)	55(5)
1-Butanol (Butyl alcohol)	31(100)	56(81)	41(62)	43(60)	27(50)	42(31)	29(31)	28(17)	39(16)	55(12)
2-Butanol (sec-Butyl alcohol)	45(100)	31(22)	27(22)	59(20)	29(18)	43(13)	41(12)	44(8)	18(8)	28(5)
2-Butanone (Methyl ethyl ketone)	43(100)	72(24)	29(19)	27(12)	57(7)	42(5)	26(4)	28(3)	44(2)	39(2)
trans-2-Butenal (trans-Crotonaldehyde)	41(100)	39(97)	70(82)	69(65)	27(49)	29(39)	42(30)	38(29)	40(27)	37(18)
2-Butoxyethanol (Ethylene glycol monobutyl ether)	57(100)	45(38)	29(35)	41(31)	87(16)	27(12)	56(11)	31(9)	75(7)	28(7)
2-Butoxyethyl acetate (Ethylene glycol monobutyl ether acetate)	57(100)	43(86)	56(50)	87(33)	41(26)	29(22)	85(18)	88(11)	44(11)	27(7)
Butyl acetate	43(100)	56(34)	41(17)	27(16)	29(15)	73(11)	61(10)	28(7)	55(6)	39(6)

Compound	<i>m/z</i> (intensity)									
	43	56	87	141	29	57	73	61	55	27
<i>sec</i> -Butyl acetate	43(100)	56(21)	87(15)	41(14)	29(8)	57(6)	73(4)	61(4)	55(4)	27(4)
Butylamine	30(100)	73(10)	28(5)	41(3)	27(3)	18(3)	44(2)	42(2)	31(2)	29(2)
<i>tert</i> -Butylamine	58(100)	41(21)	42(15)	18(9)	30(8)	15(8)	39(7)	57(6)	28(6)	59(4)
Butylbenzene	91(100)	92(55)	134(20)	65(13)	27(10)	39(9)	105(8)	51(7)	78(6)	41(6)
<i>sec</i> -Butylbenzene	105(100)	134(18)	91(14)	77(10)	27(9)	106(9)	51(7)	79(7)		
<i>tert</i> -Butylbenzene	119(100)	91(65)	41(40)	134(24)	39(15)	79(14)	77(13)	51(13)	120(11)	65(7)
Butyl butanoate	43(100)	71(90)	56(80)	89(69)	41(67)	27(52)	29(47)	57(29)	39(22)	60(19)
Butyl formate	56(100)	41(60)	31(58)	29(53)	27(45)	43(34)	28(21)	39(19)	55(11)	42(11)
1- <i>tert</i> -Butyl-4-methylbenzene	133(100)	105(38)	41(23)	148(18)	93(16)	91(14)	115(13)	134(11)	39(11)	116(10)
Butyl vinyl ether	29(100)	41(74)	56(56)	57(43)	27(42)	44(26)	15(16)	85(14)	39(14)	43(13)
$\gamma$ -Butyrolactone	28(100)	42(74)	29(48)	27(33)	41(27)	56(25)	86(24)	26(18)	85(10)	39(10)
Caprolactam	55(100)	113(87)	30(81)	56(66)	84(60)	85(57)	42(51)	41(33)	28(26)	43(17)
Carbon disulfide	76(100)	32(22)	44(17)	78(9)	38(6)	28(5)	77(3)	64(1)	46(1)	39(1)
2-Chloroaniline	127(100)	129(32)	92(17)	65(16)	128(10)	91(9)	64(9)	39(8)	63(7)	99(6)
Chlorobenzene	112(100)	77(63)	114(33)	51(29)	50(14)	75(8)	113(7)	78(5)	76(5)	28(4)
1-Chlorobutane (Butyl chloride)	56(100)	41(65)	27(50)	43(35)	29(24)	39(18)	28(16)	26(11)	55(8)	15(8)
2-Chlorobutane ( <i>sec</i> -Butyl chloride)	56(100)	57(100)	41(90)	27(77)	29(57)	63(46)	39(34)	92(1)		
1-Chloro-1,1-difluoroethane	65(100)	45(31)	85(14)	31(10)	64(8)	44(7)	35(6)	26(6)	87(5)	81(4)
Chloroethane (Ethyl chloride)	64(100)	28(91)	29(84)	27(75)	66(32)	26(28)	49(25)	51(8)	63(6)	65(4)
2-Chloroethanol (Ethylene chlorohydrin)	31(100)	15(13)	29(10)	28(10)	27(9)	43(8)	44(7)	26(5)	18(5)	14(5)
(Chloromethyl)benzene (Benzyl chloride)	91(100)	126(20)	65(14)	92(9)	39(9)	63(8)	128(6)	45(6)	89(5)	125(3)
1-Chloro-3-methylbutane (Isopentyl chloride)	43(100)	55(56)	41(55)	27(51)	70(49)	42(37)	29(34)	57(30)	39(30)	56(15)
1-Chloro-2-methylpropane (Isobutyl chloride)	43(100)	41(67)	42(50)	27(33)	39(26)	15(11)	29(10)	56(7)	49(6)	38(5)
2-Chloro-2-methylpropane ( <i>tert</i> -Butyl chloride)	57(100)	41(80)	77(44)	29(26)	39(24)	79(14)	27(14)	59(7)	56(7)	38(6)
1-Chloronaphthalene	162(100)	127(36)	164(30)	126(20)	163(10)	77(8)	101(6)	75(6)	128(5)	28(4)
1-Chlorooctane (Octyl chloride)	91(100)	41(83)	43(76)	27(62)	29(56)	55(55)	39(34)	93(32)	57(32)	69(29)
Chloropentafluoroethane	85(100)	69(61)	31(38)	87(32)	50(17)	35(8)	119(6)	66(4)	100(3)	47(3)
1-Chloropentane (Pentyl chloride)	42(100)	41(90)	70(89)	55(87)	27(73)	29(55)	43(40)	39(40)	28(19)	57(18)
1-Chloropropane (Propyl chloride)	42(100)	29(46)	27(37)	41(23)	28(15)	43(14)	39(12)	78(6)	63(6)	49(5)
3-Chloropropene (Allyl chloride)	41(100)	39(73)	76(28)	38(16)	37(13)	40(12)	27(12)	26(11)	78(9)	49(5)
2-Chlorotoluene	91(100)	126(68)	89(23)	128(22)	90(18)	65(17)	125(15)	92(13)	127(10)	63(6)
3-Chlorotoluene	91(100)	126(27)	63(15)	65(12)	89(11)	39(11)	128(9)	125(8)	92(8)	62(6)
Cyclohexane	56(100)	84(71)	41(70)	27(37)	55(36)	39(35)	42(30)	69(23)	28(18)	43(14)
Cyclohexanol	57(100)	44(68)	41(68)	39(51)	32(40)	43(38)	31(32)	42(22)	67(18)	82(16)
Cyclohexanone	55(100)	42(85)	41(34)	27(33)	98(31)	39(27)	69(26)	70(20)	43(14)	28(14)
Cyclohexene	67(100)	54(72)	82(37)	41(35)	39(33)	27(15)	53(12)	81(9)	51(8)	79(6)
Cyclohexylamine	56(100)	43(23)	28(17)	99(10)	70(8)	57(6)	30(6)	93(5)	54(4)	41(4)
Cyclopentane	42(100)	70(30)	55(29)	41(29)	39(22)	27(15)	40(7)	29(5)	28(4)	43(3)
Cyclopentanone	55(100)	28(50)	84(42)	41(38)	56(29)	27(24)	39(19)	42(15)	26(9)	29(7)
<i>cis</i> -Decahydronaphthalene ( <i>cis</i> -Decalin)	67(100)	81(87)	41(81)	138(67)	96(62)	82(62)	39(50)	55(45)	27(44)	95(42)
<i>trans</i> -Decahydronaphthalene ( <i>trans</i> -Decalin)	41(100)	68(91)	67(88)	82(67)	27(65)	96(61)	95(55)	138(51)	81(51)	29(51)
Decane	43(100)	57(90)	41(41)	71(33)	29(30)	85(24)	27(20)	56(17)	55(14)	42(14)
Diacetone alcohol	43(100)	59(41)	58(17)	101(10)	41(9)	31(9)	83(6)	56(6)	55(6)	29(6)
1,2-Dibromoethane	27(100)	107(77)	109(72)	26(24)	28(10)	81(5)	79(5)	25(5)	95(4)	93(4)
Dibromofluoromethane	111(100)	113(98)	192(29)	43(16)	41(16)	190(15)	194(14)	81(9)	79(9)	122(7)
Dibromomethane	174(100)	93(96)	95(84)	172(53)	176(50)	91(11)	81(9)	79(9)	94(5)	65(5)
1,2-Dibromopropane	41(100)	121(66)	123(65)	39(48)	27(28)	107(11)	38(10)	26(10)	109(9)	42(9)
1,2-Dibromotetrafluoroethane	179(100)	181(97)	129(34)	131(33)	100(17)	31(13)	260(12)	50(8)	69(7)	262(6)
Dibutylamine	86(100)	72(52)	30(48)	44(40)	29(31)	57(24)	41(21)	73(15)	28(15)	43(13)
Dibutyl ether	57(100)	41(34)	29(30)	56(25)	87(21)	27(9)	58(8)	55(6)	39(5)	28(5)
Dibutyl oxalate	57(100)	41(61)	56(24)	44(9)	55(8)	43(7)	58(5)	42(4)	103(2)	73(2)
Dibutyl phthalate	149(100)	86(18)	57(18)	223(17)	205(17)	150(17)	104(17)	56(17)	41(17)	65(16)
Dibutyl sebacate	241(100)	185(71)	41(37)	56(35)	55(32)	57(31)	242(23)	143(21)	98(21)	125(20)
<i>o</i> -Dichlorobenzene	146(100)	148(64)	111(38)	75(23)	113(12)	74(12)	50(11)	150(10)	73(9)	147(7)
<i>m</i> -Dichlorobenzene	146(100)	148(65)	111(36)	75(25)	50(19)	74(16)	150(11)	113(11)	73(11)	147(8)
1,1-Dichloroethane	63(100)	27(71)	65(31)	26(19)	83(11)	85(7)	61(7)	35(6)	98(5)	62(5)
1,2-Dichloroethane	62(100)	27(91)	49(40)	64(32)	26(31)	63(19)	98(14)	51(13)	61(12)	100(9)
1,1-Dichloroethene	61(100)	96(61)	98(38)	63(32)	26(16)	60(15)	62(7)	25(7)	100(6)	35(6)
<i>cis</i> -1,2-Dichloroethene	61(100)	96(73)	98(47)	63(32)	26(30)	60(21)	25(13)	35(12)	62(9)	100(8)
<i>trans</i> -1,2-Dichloroethene	61(100)	96(67)	98(43)	26(34)	63(32)	60(24)	25(15)	62(10)	100(7)	47(7)
Dichlorofluoromethane	67(100)	69(32)	47(13)	35(13)	31(9)	32(8)	48(7)	83(5)	102(4)	49(4)

Compound	<i>m/z</i> (intensity)									
	41	55	69	83	97	111	125	139	153	167
Dichloromethane (Methylene chloride)	49(100)	84(64)	86(39)	51(31)	47(14)	48(8)	88(6)	50(3)	85(2)	83(2)
(Dichloromethyl)benzene (Benzal chloride)	125(100)	127(32)	160(14)	89(13)	162(9)	63(9)	126(8)	62(7)	105(5)	39(5)
1,2-Dichloropropane	63(100)	62(71)	27(57)	41(49)	39(32)	65(31)	76(27)	64(25)	49(13)	77(12)
1,2-Dichloro-1,1,2,2-tetrafluoroethane	85(100)	135(52)	87(33)	137(17)	101(9)	31(9)	103(6)	100(6)	50(5)	69(4)
2,4-Dichlorotoluene	125(100)	160(61)	162(40)	127(32)	89(23)	159(16)	161(14)	63(13)	62(11)	126(10)
3,4-Dichlorotoluene	125(100)	160(47)	127(32)	162(31)	89(15)	159(11)	161(10)	63(10)	126(8)	62(8)
Diethanolamine	30(100)	74(82)	28(77)	56(69)	18(50)	42(46)	29(36)	27(34)	45(30)	43(19)
1,1-Diethoxyethane (Acetal)	44(100)	43(92)	29(77)	31(76)	45(74)	27(52)	72(48)	73(23)	28(17)	46(15)
1,2-Diethoxyethane (Ethylene glycol diethyl ether)	31(100)	59(71)	29(58)	45(43)	27(33)	74(27)	43(15)	15(14)	28(12)	44(10)
Diethylamine	30(100)	58(81)	44(28)	73(18)	29(18)	28(17)	72(12)	42(11)	27(11)	59(4)
Diethyl carbonate	29(100)	45(70)	31(53)	27(39)	91(24)	28(15)	63(11)	26(10)	30(6)	43(5)
Diethylene glycol	45(100)	75(23)	31(20)	44(16)	27(14)	76(12)	29(12)	43(11)	42(9)	41(4)
Diethylene glycol dimethyl ether (Diglyme)	59(100)	58(43)	31(34)	29(32)	45(28)	28(19)	89(15)	43(9)	27(5)	60(4)
Diethylene glycol monobutyl ether acetate	43(100)	87(93)	57(82)	41(28)	45(25)	56(18)	29(18)	72(14)	85(12)	101(10)
Diethylene glycol monoethyl ether (Carbitol)	45(100)	59(56)	72(37)	73(22)	60(14)	31(13)	75(11)	44(9)	104(8)	103(7)
Diethylene glycol monoethyl ether acetate	43(100)	29(51)	31(42)	45(40)	59(24)	72(18)	44(10)	73(9)	42(9)	30(6)
Diethylene glycol monomethyl ether	45(100)	31(42)	59(41)	29(38)	28(32)	58(21)	43(14)	27(13)	44(11)	32(10)
Diethyl ether	31(100)	29(63)	59(40)	27(35)	45(33)	74(23)	15(17)	43(9)	28(9)	26(9)
Diethyl oxalate	29(100)	31(16)	45(14)	27(14)	74(11)	28(9)	43(4)	30(4)	73(3)	75(2)
Diethyl sulfide	75(100)	47(81)	90(73)	62(60)	29(55)	61(54)	27(48)	28(23)	46(17)	45(17)
Diisopropylamine	44(100)	86(30)	58(14)	42(13)	28(13)	41(12)	43(11)	27(11)	15(11)	39(6)
Diisopropyl ether	45(100)	43(39)	87(15)	41(12)	59(10)	27(8)	39(4)	69(3)	42(3)	31(3)
1,2-Dimethoxybenzene (Veratrole)	138(100)	95(65)	77(48)	123(44)	52(42)	41(33)	65(30)	51(29)	39(19)	63(17)
1,2-Dimethoxyethane (Ethylene glycol dimethyl ether)	45(100)	60(13)	29(13)	90(7)	58(6)	31(5)	28(5)	43(4)	59(3)	46(2)
Dimethoxymethane (Methylal)	45(100)	75(61)	29(59)	31(13)	30(6)	15(6)	47(5)	76(2)	46(2)	44(2)
<i>N,N</i> -Dimethylacetamide	44(100)	87(69)	43(46)	45(23)	42(19)	72(15)	15(11)	30(8)	28(5)	88(4)
Dimethylamine	44(100)	45(81)	18(32)	28(30)	43(19)	42(15)	15(9)	46(5)	41(5)	27(5)
2,4-Dimethylaniline (2,4-Xylidine)	121(100)	120(78)	106(57)	77(15)	28(15)	91(12)	122(9)	18(8)	93(6)	118(5)
2,2-Dimethylbutane (Neohexane)	43(100)	57(98)	71(73)	41(61)	29(51)	27(36)	56(29)	39(25)	55(15)	15(12)
2,3-Dimethylbutane	43(100)	42(97)	41(27)	71(25)	27(11)	86(10)	39(9)	29(6)	55(5)	44(4)
Dimethyl disulfide	94(100)	45(63)	79(59)	46(38)	47(26)	15(18)	48(14)	61(12)	64(11)	96(9)
<i>N,N</i> -Dimethylformamide	73(100)	44(86)	42(36)	30(22)	28(20)	29(8)	43(7)	72(6)	58(5)	74(4)
Dimethyl glutarate	59(100)	100(51)	55(49)	42(33)	129(32)	101(32)	41(26)	43(22)	128(19)	87(15)
2,6-Dimethyl-4-heptanone (Isovalerone)	57(100)	85(82)	41(46)	43(39)	58(33)	28(30)	26(30)	39(22)	42(12)	142(11)
2,5-Dimethylhexane	57(100)	43(93)	42(31)	41(26)	99(19)	71(19)	29(11)	70(10)	55(9)	27(9)
Dimethyl maleate	113(100)	59(83)	26(72)	29(40)	85(37)	54(31)	114(25)	53(24)	55(13)	82(9)
2,2-Dimethylpentane	57(100)	43(73)	41(46)	56(40)	85(34)	29(31)	27(23)	39(15)	15(7)	55(6)
2,4-Dimethylpentane	43(100)	57(73)	56(41)	41(35)	42(24)	85(17)	29(16)	27(12)	39(9)	58(3)
2,4-Dimethyl-3-pentanone (Diisopropyl ketone)	43(100)	71(31)	41(13)	27(9)	70(6)	39(6)	114(5)	42(5)	44(3)	72(2)
2,4-Dimethylpyridine (2,4-Lutidine)	107(100)	106(63)	79(44)	92(22)	65(22)	51(19)	77(17)	80(12)	52(11)	50(11)
2,6-Dimethylpyridine (2,6-Lutidine)	107(100)	39(39)	106(29)	66(22)	92(18)	65(18)	38(12)	27(11)	79(9)	63(9)
Dimethyl sulfoxide	63(100)	78(70)	15(40)	45(35)	29(16)	61(13)	46(12)	31(11)	48(10)	47(10)
1,4-Dioxane	28(100)	29(37)	88(31)	58(24)	31(17)	15(17)	27(15)	30(13)	43(11)	26(9)
1,3-Dioxolane	73(100)	29(56)	44(53)	45(28)	28(21)	43(20)	27(13)	31(7)	74(5)	42(3)
Dipentene	68(100)	93(50)	67(44)	94(22)	39(22)	107(18)	92(18)	53(18)	136(16)	79(16)
Dipentyl ether (Amyl ether)	71(100)	43(92)	29(43)	70(40)	41(36)	27(34)	42(23)	69(17)	55(16)	39(16)
Dipropylamine	30(100)	72(79)	44(40)	43(32)	27(25)	28(24)	41(22)	86(11)	58(10)	42(10)
Dodecane	57(100)	43(91)	71(53)	41(45)	85(31)	29(27)	55(19)	56(18)	28(16)	42(14)
1-Dodecene	43(100)	56(83)	55(83)	41(75)	69(62)	70(58)	57(57)	83(47)	29(38)	84(33)
Epichlorohydrin	57(100)	27(39)	29(32)	49(25)	31(22)	62(18)	28(16)	92(1)		
1,2-Epoxybutane (Ethylloxirane)	43(100)	44(58)	27(52)	29(50)	45(46)	26(27)	28(27)	72(5)		
1,2-Ethanediamine	30(100)	18(13)	42(6)	43(5)	27(5)	44(4)	29(4)	17(4)	15(4)	41(3)
1,2-Ethandiol (Ethylene glycol)	31(100)	33(35)	29(13)	32(11)	43(6)	27(5)	28(4)	62(3)	30(3)	44(2)
1,2-Ethandiol, diacetate (Ethylene glycol diacetate)	43(100)	86(11)	42(7)	15(7)	116(4)	73(4)	44(3)	29(3)	103(2)	45(2)
Ethanol	31(100)	45(44)	46(18)	27(18)	29(15)	43(14)	30(6)	42(3)	19(3)	14(3)
Ethanolamine	30(100)	18(30)	28(15)	42(7)	31(6)	17(6)	61(5)	15(5)	43(3)	29(3)
Ethoxybenzene (Phenetole)	94(100)	122(39)	28(12)	66(11)	39(9)	77(8)	95(7)	65(7)	51(7)	29(6)
2-Ethoxyethanol (Ethylene glycol monoethyl ether; Cellosolve)	31(100)	29(52)	59(50)	27(27)	45(26)	72(14)	43(14)	15(14)	28(8)	26(6)
2-Ethoxyethyl acetate (Ethylene glycol monoethyl ether acetate)	43(100)	31(34)	59(31)	72(28)	44(25)	29(24)	45(12)	27(11)	15(11)	87(7)
Ethyl acetate	43(100)	29(46)	27(33)	45(32)	61(28)	28(25)	42(18)	73(11)	88(10)	70(10)
Ethyl acetoacetate	43(100)	29(24)	88(18)	28(16)	85(14)	27(12)	42(11)	60(9)	130(6)	45(6)

Compound	<i>m/z</i> (intensity)									
	41	55	71	85	101	117	133	149	165	181
Ethyl acrylate (Ethyl propenoate)	55(100)	27(32)	29(15)	56(12)	45(9)	73(8)	28(8)	26(6)	99(5)	85(5)
Ethylamine	30(100)	28(32)	44(20)	45(19)	27(13)	15(10)	42(9)	29(8)	41(5)	40(5)
Ethylbenzene	91(100)	106(31)	51(14)	39(10)	77(8)	65(8)	105(7)	92(7)	78(7)	27(6)
Ethyl benzoate	105(100)	77(65)	122(34)	51(34)	27(17)	150(16)	29(14)	50(13)	106(12)	78(6)
Ethyl butanoate	43(100)	71(88)	29(83)	27(43)	88(40)	41(28)	60(22)	45(20)	73(17)	42(17)
Ethyl cyanoacetate	29(100)	68(59)	27(34)	40(21)	28(16)	41(14)	15(13)	45(10)	43(9)	26(9)
Ethylcyclohexane	83(100)	55(65)	82(42)	41(36)	112(23)	56(11)	67(10)	39(10)	42(9)	84(8)
Ethylene carbonate	29(100)	44(62)	43(54)	88(40)	30(16)	28(11)	45(7)	58(6)	42(6)	73(4)
Ethyl formate	31(100)	28(73)	27(51)	29(38)	45(34)	26(17)	74(11)	43(9)	47(8)	56(4)
2-Ethyl-1,3-hexanediol	56(100)	55(71)	41(60)	43(55)	29(46)	27(44)	31(34)	57(33)	73(32)	39(20)
2-Ethyl-1-hexanol	57(100)	43(41)	41(40)	29(29)	55(28)	83(27)	56(23)	70(20)	27(17)	31(13)
<i>N</i> -Ethyl- <i>N</i> -isopropyl-2-propanamine	72(100)	114(77)	44(41)	129(22)	42(21)	30(20)	43(18)	41(17)	27(15)	70(11)
Ethyl 3-methylbutanoate	29(100)	41(52)	27(51)	57(43)	43(42)	60(39)	88(38)	85(38)	61(26)	45(24)
3-Ethyl-2-methylpentane	43(100)	70(50)	41(27)	71(25)	29(19)	27(19)	85(18)	55(18)	57(15)	42(14)
Ethyl propanoate	57(100)	29(84)	102(17)	27(17)	75(15)	28(14)	45(13)	74(12)	73(7)	43(6)
Fluorobenzene	96(100)	70(17)	97(7)	95(6)	75(6)	50(6)	51(4)	39(4)	69(3)	57(3)
2-Fluorotoluene	109(100)	110(55)	83(18)	57(11)	63(10)	39(9)	51(6)	50(6)	107(5)	62(5)
3-Fluorotoluene	109(100)	110(54)	83(11)	57(5)	111(4)	107(4)	63(3)	39(3)	108(2)	89(2)
4-Fluorotoluene	109(100)	110(60)	83(13)	57(10)	108(8)	39(8)	63(7)	107(5)	51(5)	50(5)
Furan	68(100)	39(64)	40(9)	38(9)	42(6)	29(6)	37(5)	69(4)	34(2)	67(1)
Furfural	39(100)	96(55)	95(52)	38(38)	29(35)	37(29)	40(11)	97(9)	50(7)	42(7)
Furfuryl alcohol	98(100)	41(65)	39(59)	81(55)	53(53)	97(51)	42(49)	69(39)	70(36)	29(28)
Glycerol	61(100)	43(90)	31(57)	44(54)	29(38)	18(32)	27(12)	42(11)	60(10)	45(10)
Glycerol triacetate (Triacetin)	43(100)	103(44)	145(34)	116(17)	115(13)	44(10)	86(9)	28(8)	73(7)	42(7)
Heptane	43(100)	41(56)	29(49)	57(47)	27(46)	71(45)	56(27)	42(26)	39(23)	70(18)
1-Heptanol	41(100)	70(87)	56(86)	31(78)	43(72)	29(70)	55(67)	27(65)	42(54)	69(41)
3-Heptanol	59(100)	69(73)	87(37)	41(37)	29(33)	55(30)	31(24)	116(0)		
2-Heptanone (Methyl pentyl ketone)	43(100)	58(60)	71(14)	41(11)	27(11)	59(9)	39(8)	29(8)	42(5)	114(4)
3-Heptanone (Ethyl butyl ketone)	57(100)	29(76)	41(32)	85(29)	72(22)	43(15)	39(11)	114(10)	27(7)	55(5)
1-Heptene	41(100)	56(88)	29(70)	55(59)	42(52)	27(45)	39(41)	70(37)	69(27)	57(27)
Hexane	57(100)	43(78)	41(77)	29(61)	27(57)	56(45)	42(39)	39(27)	28(16)	86(14)
Hexanedinitrile (Adiponitrile)	41(100)	68(50)	54(42)	40(21)	55(20)	27(17)	39(16)	28(13)	52(7)	42(6)
Hexanenitrile	41(100)	54(68)	27(59)	55(55)	29(44)	39(35)	57(30)	43(30)	68(24)	28(22)
Hexanoic acid (Caproic acid)	60(100)	73(42)	27(36)	41(33)	43(27)	29(26)	45(20)	39(16)	42(15)	55(14)
1-Hexanol	56(100)	43(78)	31(74)	41(71)	27(64)	29(59)	55(58)	42(53)	39(37)	69(27)
2-Hexanone (Butyl methyl ketone)	43(100)	58(60)	57(17)	100(16)	29(15)	41(13)	85(8)	27(8)	71(7)	59(5)
Hexyl acetate	43(100)	56(66)	41(38)	55(37)	61(35)	42(33)	84(31)	69(19)	73(17)	57(7)
3-Hydroxypropanenitrile (Hydracrylonitrile)	41(100)	31(97)	29(20)	42(17)	52(15)	40(13)	53(10)	51(9)	39(7)	26(7)
Iodobenzene	204(100)	77(82)	51(32)	50(20)	127(8)	205(6)	78(6)	74(6)	102(5)	76(5)
1-Iodobutane (Butyl iodide)	57(100)	29(78)	41(56)	27(39)	184(36)	39(17)	28(16)	26(7)	127(6)	55(6)
2-Iodobutane ( <i>sec</i> -Butyl iodide)	57(100)	29(36)	184(36)	41(36)	27(10)	39(9)	127(6)	58(4)		
Iodoethane (Ethyl iodide)	156(100)	29(75)	27(63)	127(31)	26(14)	28(9)	128(8)	141(2)	25(2)	140(1)
Iodomethane (Methyl iodide)	142(100)	127(38)	141(14)	15(13)	139(5)	140(4)	128(3)	14(1)	13(1)	71(0)
1-Iodopropane (Propyl iodide)	43(100)	170(68)	41(35)	27(26)	127(14)	39(11)	44(4)	141(3)	128(3)	42(3)
2-Iodopropane (Isopropyl iodide)	43(100)	170(46)	41(45)	27(44)	39(19)	127(17)	42(4)	38(4)	128(3)	44(3)
Isobutanal (2-Methyl-1-propanal)	43(100)	41(84)	27(47)	72(46)	39(30)	29(25)	42(10)	70(5)	38(5)	28(5)
Isobutyl acetate	43(100)	56(26)	73(15)	41(10)	29(5)	71(3)	57(3)	39(3)	27(3)	86(2)
Isobutylamine	30(100)	28(9)	41(6)	73(5)	27(5)	39(4)	29(3)	15(3)	58(2)	56(2)
Isobutylbenzene	91(100)	92(58)	43(22)	134(20)	65(12)	41(12)	39(11)	27(8)	51(7)	93(5)
Isobutyl formate	43(100)	56(82)	41(78)	31(65)	29(64)	27(53)	60(39)	39(36)	42(26)	15(14)
Isobutyl isobutanoate	43(100)	41(94)	56(76)	71(70)	57(68)	27(62)	29(59)	89(37)	39(32)	42(17)
Isopentyl acetate	43(100)	70(49)	55(38)	61(15)	42(15)	41(14)	27(12)	87(11)	29(10)	73(9)
Isophorone	82(100)	39(20)	138(17)	54(13)	27(12)	41(10)	53(8)	83(7)	29(7)	55(6)
Isopropyl acetate	43(100)	61(17)	41(14)	87(9)	59(8)	27(8)	42(7)	39(4)	45(3)	44(2)
Isopropylbenzene (Cumene)	105(100)	120(25)	77(13)	51(12)	79(10)	106(9)	39(9)	27(8)	103(6)	91(5)
1-Isopropyl-4-methylbenzene ( <i>p</i> -Cymene)	119(100)	91(42)	134(33)	39(27)	41(20)	117(18)	65(18)	77(17)	27(16)	120(15)
Isoquinoline	129(100)	102(26)	51(20)	128(18)	50(11)	130(10)	75(10)	76(9)	103(8)	74(7)
<i>α</i> -Limonene (Citrene)	68(100)	93(50)	67(49)	41(22)	94(21)	79(21)	39(21)	136(20)	53(19)	121(16)
Mesityl oxide	55(100)	83(89)	43(73)	29(42)	98(36)	39(32)	27(28)	53(11)	41(10)	56(5)
Methanol	31(100)	29(72)	32(67)	15(42)	28(12)	14(10)	30(9)	13(6)	12(3)	16(2)
2-Methoxyethanol (Ethylene glycol monomethyl ether)	45(100)	31(15)	29(14)	28(11)	47(9)	76(6)	43(6)	58(4)	46(4)	27(4)

Compound	<i>m/z</i> (intensity)									
	43	45	58	29	42	31	73	27	59	26
2-Methoxyethyl acetate (Ethylene glycol monomethyl ether acetate)	43(100)	45(48)	58(42)	29(10)	42(4)	31(4)	73(3)	27(3)	59(2)	26(2)
Methyl acetate	43(100)	74(52)	28(38)	42(19)	59(17)	44(8)	32(8)	29(6)	31(4)	75(2)
2-Methylacrylonitrile	41(100)	39(54)	67(44)	40(26)	38(24)	52(23)	27(23)	37(20)	66(17)	51(12)
Methylamine	30(100)	31(87)	28(56)	29(19)	32(15)	15(12)	27(9)			
2-Methylaniline ( <i>o</i> -Toluidine)	106(100)	107(83)	77(17)	79(13)	39(12)	53(10)	52(10)	54(9)	51(9)	28(9)
3-Methylaniline ( <i>m</i> -Toluidine)	106(100)	107(84)	79(17)	77(17)	108(7)	78(6)	80(5)	89(4)	65(4)	53(4)
<i>N</i> -Methylaniline	106(100)	107(79)	77(23)	51(12)	79(11)	65(9)	39(9)	78(8)	108(7)	50(6)
Methyl benzoate	105(100)	77(81)	51(45)	136(24)	50(18)	106(8)	78(6)	28(6)	39(5)	27(5)
Methyl butanoate	43(100)	74(90)	71(66)	41(32)	27(31)	59(28)	87(19)	42(15)	28(15)	39(14)
3-Methylbutanoic acid (Isovaleric acid)	60(100)	43(61)	41(54)	27(33)	45(31)	29(27)	74(24)	39(24)	87(21)	57(20)
3-Methyl-1-butanol (Isopentyl alcohol)	55(100)	42(90)	43(82)	41(81)	70(71)	31(61)	29(59)	27(59)	39(44)	57(31)
Methyl <i>tert</i> -butyl ether	41(100)	73(78)	57(71)	29(60)	43(48)	39(34)	28(28)	56(23)	55(18)	45(16)
Methyl cyanoacetate	59(100)	15(65)	68(60)	40(38)	28(17)	29(16)	55(11)	54(10)	39(10)	67(8)
Methylcyclohexane	83(100)	55(82)	41(60)	98(44)	42(35)	56(30)	27(29)	39(27)	69(23)	70(22)
<i>cis</i> -4-Methylcyclohexanol	57(100)	58(54)	70(38)	81(36)	96(33)	55(25)	41(23)	114(17)	71(15)	56(12)
<i>N</i> -Methylformamide	59(100)	30(54)	28(34)	29(13)	58(8)	15(7)	60(3)	41(3)	27(3)	31(2)
Methyl formate	31(100)	29(63)	32(34)	60(28)	30(7)	28(7)	44(2)	18(2)	61(1)	59(1)
2-Methylheptane	43(100)	57(91)	42(39)	41(27)	29(16)	70(15)	27(13)	71(12)	99(10)	55(9)
4-Methylheptane	43(100)	71(53)	70(46)	41(27)	29(23)	27(23)	55(15)	57(14)	42(14)	39(10)
6-Methyl-1-heptanol (Isooctyl alcohol)	41(100)	55(94)	43(93)	69(84)	57(81)	56(73)	29(50)	84(48)	70(47)	27(46)
2-Methylhexane	43(100)	42(38)	41(35)	85(32)	57(26)	29(22)	27(22)	56(20)	39(11)	55(5)
5-Methyl-2-hexanone (Methyl isopentyl ketone)	43(100)	58(34)	27(14)	41(13)	15(13)	57(11)	39(9)	71(8)	59(8)	29(8)
Methyl methacrylate (Methyl 2-methyl-2-propenoate)	41(100)	69(66)	39(40)	100(34)	15(20)	40(10)	59(8)	99(6)	38(6)	55(5)
2-Methyloctane	43(100)	57(51)	41(35)	71(28)	42(28)	29(23)	27(21)	85(17)	56(15)	84(13)
2-Methylpentane	43(100)	42(53)	41(35)	27(31)	71(29)	39(20)	29(18)	57(11)	15(10)	70(7)
3-Methylpentane	57(100)	56(76)	41(68)	29(60)	27(40)	43(29)	39(22)	55(9)	15(9)	28(8)
2-Methyl-2,4-pentanediol (Hexylene glycol)	59(100)	43(61)	56(25)	45(17)	41(16)	57(13)	42(13)	85(11)	61(10)	31(10)
4-Methylpentanenitrile	55(100)	41(52)	43(46)	27(39)	39(29)	57(27)	54(26)	29(22)	82(13)	28(12)
4-Methyl-2-pentanol	45(100)	43(47)	69(30)	41(27)	27(19)	39(13)	29(12)	87(11)	84(10)	57(10)
3-Methyl-3-pentanol	73(100)	55(38)	43(35)	45(28)	27(25)	29(21)	41(12)	87(11)	31(11)	15(9)
4-Methyl-2-pentanone (Methyl isobutyl ketone)	43(100)	58(84)	29(65)	41(56)	57(44)	27(42)	39(31)	85(19)	100(14)	42(14)
2-Methylpropanenitrile (Isobutyronitrile)	42(100)	68(45)	28(45)	54(26)	41(26)	27(26)	29(25)	26(15)	39(13)	15(13)
Methyl propanoate	57(100)	29(72)	59(31)	88(26)	27(18)	28(9)	31(5)	44(4)	26(4)	58(3)
2-Methylpropanoic acid (Isobutyric acid)	43(100)	41(42)	27(40)	73(22)	39(15)	45(14)	42(11)	29(9)	88(7)	28(6)
2-Methyl-1-propanol (Isobutyl alcohol)	43(100)	33(73)	31(72)	41(66)	42(60)	27(43)	29(18)	39(17)	28(8)	74(6)
2-Methyl-2-propanol ( <i>tert</i> -Butyl alcohol)	59(100)	31(33)	41(22)	43(18)	29(13)	27(11)	57(10)	42(4)	60(3)	28(3)
2-Methylpyridine (2-Picoline)	93(100)	66(41)	39(31)	92(20)	78(19)	51(19)	65(16)	38(13)	50(12)	52(11)
3-Methylpyridine (3-Picoline)	93(100)	39(51)	66(46)	92(31)	65(29)	40(19)	38(18)	67(13)	63(11)	51(11)
<i>N</i> -Methyl-2-pyrrolidinone	99(100)	44(89)	98(80)	42(60)	41(38)	43(17)	28(17)	71(13)	39(11)	70(10)
Methyl salicylate	120(100)	92(59)	152(47)	121(32)	65(22)	39(22)	93(15)	64(14)	18(14)	63(13)
2-Methylthiophene	97(100)	98(57)	45(22)	39(14)	53(9)	99(8)	27(8)	69(6)	58(6)	59(5)
Morpholine	57(100)	29(100)	87(69)	28(69)	30(38)	56(33)	86(28)	31(28)	27(12)	15(7)
Nitrobenzene	77(100)	51(59)	123(42)	50(25)	30(15)	65(14)	39(10)	93(9)	74(7)	78(6)
Nitroethane	29(100)	30(12)	28(11)	26(9)	27(8)	43(5)	41(5)	14(5)	15(3)	46(2)
Nitromethane	30(100)	61(64)	46(39)	28(30)	45(8)	27(8)	44(7)	29(7)	60(5)	43(4)
1-Nitropropane	43(100)	27(93)	41(90)	39(34)	30(25)	44(20)	42(20)	26(20)	28(13)	54(12)
2-Nitropropane	43(100)	41(73)	27(71)	39(30)	30(18)	15(11)	42(9)	28(8)	26(8)	38(6)
Nonane	43(100)	57(75)	41(29)	84(26)	85(22)	29(22)	71(18)	56(16)	27(13)	42(12)
Octane	43(100)	57(30)	85(25)	41(25)	71(19)	29(17)	56(14)	70(10)	42(10)	27(10)
1-Octanol	41(100)	56(85)	43(82)	55(81)	31(69)	27(69)	29(68)	42(62)	70(53)	69(48)
2-Octanone (Hexyl methyl ketone)	43(100)	58(79)	41(56)	59(52)	71(49)	27(46)	29(36)	39(27)	57(18)	55(17)
1-Octene	43(100)	41(82)	55(80)	56(67)	42(67)	70(54)	29(44)	27(31)	69(30)	39(29)
Pentachloroethane	167(100)	165(91)	117(90)	119(89)	83(58)	169(54)	130(43)	132(42)	60(40)	85(37)
Pentane	43(100)	42(55)	41(45)	27(42)	29(26)	39(19)	57(13)	28(9)	15(9)	72(8)
1,5-Pentanediol (Pentamethylene glycol)	31(100)	56(85)	41(67)	57(59)	55(51)	44(45)	29(37)	43(31)	68(29)	27(26)
2,4-Pentanedione (Acetylacetone)	43(100)	85(31)	100(20)	27(12)	42(10)	29(10)	41(7)	39(7)	31(5)	26(5)
Pentanenitrile (Valeronitrile)	41(100)	43(97)	54(54)	27(34)	55(21)	28(19)	29(16)	39(15)	42(5)	26(5)
Pentanoic acid (Valeric acid)	60(100)	73(34)	27(33)	29(28)	41(21)	43(17)	45(16)	28(14)	42(12)	39(12)
1-Pentanol (Amyl alcohol)	42(100)	70(72)	55(65)	41(56)	31(47)	29(41)	27(26)	57(22)	28(22)	43(21)
2-Pentanol (sec-Amyl alcohol)	45(100)	43(20)	55(18)	27(17)	29(11)	41(9)	31(9)	15(9)	44(8)	39(8)
3-Pentanol (Diethyl carbinol)	59(100)	31(83)	41(42)	27(35)	29(34)	58(15)	43(15)	57(14)	39(12)	15(9)



Compound	<i>m/e</i> (intensity)									
	43	57	71	85	99	113	127	141	155	169
2-Pentanone (Methyl propyl ketone)	43(100)	41(17)	86(12)	42(12)	27(11)	39(8)	71(7)	58(7)	45(7)	44(3)
3-Pentanone (Diethyl ketone)	57(100)	29(50)	86(26)	27(13)	58(4)	56(4)	28(4)	26(3)	43(2)	42(2)
Pentyl acetate (Amyl acetate)	43(100)	70(90)	42(52)	28(51)	61(50)	55(41)	73(21)	41(20)	29(14)	69(11)
Pentylamine (Amylamine)	30(100)	87(8)	41(4)	28(4)	45(3)	42(3)	27(3)	56(2)	44(2)	43(2)
Pentyl lactate	43(100)	70(44)	71(32)	55(28)	41(22)	29(20)	27(15)	45(12)	42(9)	57(7)
$\alpha$ -Pinene	93(100)	92(30)	39(24)	41(23)	77(22)	91(21)	27(21)	79(18)	121(13)	53(10)
$\beta$ -Pinene	93(100)	41(64)	69(47)	39(33)	27(31)	79(20)	77(18)	53(14)	94(13)	91(13)
Piperidine	84(100)	85(53)	56(46)	57(43)	28(41)	29(37)	44(34)	42(30)	30(30)	43(25)
Propanal	29(100)	58(59)	28(58)	27(39)	57(20)	31(4)	30(4)	42(3)	39(3)	59(2)
1,2-Propanediol (1,2-Propylene glycol)	45(100)	18(46)	29(21)	43(19)	31(18)	27(17)	28(11)	19(8)	44(6)	61(5)
1,3-Propanediol (Trimethylene glycol)	28(100)	58(93)	31(76)	57(70)	29(40)	27(26)	45(24)	43(23)	19(18)	30(17)
Propanenitrile	28(100)	54(63)	26(20)	27(17)	52(11)	55(10)	51(9)	15(9)	53(7)	25(7)
Propanoic acid	28(100)	29(84)	74(79)	27(62)	45(56)	73(48)	57(30)	26(21)	55(17)	56(16)
Propanoic anhydride	57(100)	29(55)	28(20)	27(20)	74(19)	73(12)	45(11)	26(5)	30(4)	58(3)
1-Propanol (Propyl alcohol)	31(100)	27(19)	29(18)	59(11)	42(9)	60(7)	41(7)	28(7)	43(3)	32(3)
2-Propanol (Isopropyl alcohol)	45(100)	43(19)	27(17)	29(12)	41(7)	31(6)	19(6)	42(5)	44(4)	59(3)
Propargyl alcohol (3-Hydroxy-1-propyne)	55(100)	39(25)	28(20)	27(19)	29(16)	38(14)	26(11)	37(8)	53(6)	56(4)
Propyl acetate	43(100)	61(19)	31(18)	27(15)	42(11)	73(9)	41(9)	29(9)	59(5)	39(5)
Propylamine	30(100)	28(13)	59(8)	27(7)	41(5)	42(3)	39(3)	29(3)	26(3)	18(3)
Propylbenzene	91(100)	120(21)	92(10)	38(10)	65(9)	78(6)	51(6)	27(5)	63(4)	105(3)
Propylene carbonate	28(100)	57(69)	43(66)	29(51)	27(45)	30(42)	26(19)	42(17)	31(16)	58(13)
Propyl formate	27(100)	29(92)	31(81)	42(60)	41(53)	43(29)	39(29)	26(28)	47(22)	30(16)
Pyridine	79(100)	52(62)	51(31)	50(19)	78(11)	53(7)	39(7)	80(6)	27(3)	77(2)
Pyrrole	67(100)	41(58)	39(58)	40(51)	28(42)	38(20)	37(12)	66(7)	68(5)	27(3)
Pyrrolidine	43(100)	28(52)	70(33)	71(26)	42(22)	41(20)	27(16)	39(15)	29(10)	30(9)
2-Pyrrolidone	85(100)	42(43)	41(36)	28(33)	30(29)	56(16)	84(14)	40(12)	27(12)	29(9)
Quinoline	129(100)	51(28)	76(25)	128(24)	44(24)	50(20)	32(19)	75(18)	74(12)	103(11)
Salicylaldehyde (2-Hydroxybenzaldehyde)	28(100)	122(98)	121(92)	39(79)	65(52)	76(31)	32(31)	44(30)	93(26)	38(23)
Styrene	104(100)	103(41)	78(32)	51(28)	77(23)	105(12)	50(12)	52(11)	39(11)	102(10)
Sulfolane	41(100)	28(94)	56(82)	55(72)	120(37)	27(32)	39(19)	29(17)	26(11)	48(5)
$\alpha$ -Terpinene	121(100)	93(85)	136(43)	91(40)	77(34)	39(33)	27(33)	79(27)	41(26)	43(18)
1,1,1,2-Tetrachloro-2,2-difluoroethane	167(100)	169(96)	117(85)	119(82)	171(31)	85(29)	121(26)	82(14)	47(14)	101(13)
1,1,2,2-Tetrachloro-1,2-difluoroethane	101(100)	103(64)	167(54)	169(52)	117(19)	119(18)	171(17)	105(11)	31(11)	132(9)
1,1,1,2-Tetrachloroethane	131(100)	133(96)	117(76)	119(73)	95(34)	135(31)	121(23)	97(23)	61(19)	60(18)
1,1,2,2-Tetrachloroethane	83(100)	85(63)	95(11)	87(10)	168(8)	133(8)	131(8)	96(8)	61(8)	60(8)
Tetrachloroethene	166(100)	164(82)	131(71)	129(71)	168(45)	94(38)	47(31)	96(24)	133(20)	59(17)
Tetrachloromethane (Carbon tetrachloride)	117(100)	119(98)	121(31)	82(24)	47(23)	84(16)	35(14)	49(8)	28(8)	36(6)
Tetraethylene glycol	45(100)	89(10)	44(8)	43(6)	31(6)	29(6)	27(6)	101(5)	75(5)	28(5)
Tetrahydrofuran	42(100)	41(52)	27(33)	72(29)	71(27)	39(24)	43(22)	29(22)	40(13)	15(10)
1,2,3,4-Tetrahydronaphthalene	104(100)	132(53)	91(43)	51(17)	39(17)	131(15)	117(15)	115(14)	78(13)	77(13)
Tetrahydropyran	41(100)	28(64)	56(57)	45(57)	29(51)	27(49)	85(47)	86(42)	39(28)	55(23)
Tetrahydrothiophene	60(100)	88(54)	45(37)	46(32)	47(26)	27(24)	59(18)	87(16)	39(14)	54(13)
Tetramethylsilane	73(100)	43(14)	45(12)	74(8)	29(7)	15(5)	75(4)	44(4)	42(4)	31(4)
Tetramethylurea	72(100)	44(27)	116(24)	42(13)	15(13)	17(7)	28(5)	73(4)	56(4)	18(4)
1 <i>H</i> -Tetrazole	42(100)	28(60)	27(25)	29(24)	41(13)	43(11)	70(8)	26(7)	40(2)	38(2)
Thiophene	84(100)	58(65)	45(58)	39(29)	57(13)	38(8)	69(7)	37(7)	83(6)	50(6)
Toluene	91(100)	92(73)	39(20)	65(14)	63(11)	51(11)	50(7)	27(6)	93(5)	90(5)
Tribromomethane (Bromoform)	173(100)	171(50)	175(49)	93(22)	91(22)	79(18)	81(17)	94(13)	92(13)	254(11)
Tributylamine	142(100)	100(19)	143(11)	29(8)	185(7)	57(6)	44(6)	41(6)	30(5)	86(4)
1,2,4-Trichlorobenzene	180(100)	182(96)	184(30)	145(30)	109(26)	147(19)	75(11)	74(9)	111(8)	181(7)
1,1,1-Trichloroethane	97(100)	99(64)	61(58)	26(31)	27(24)	117(19)	63(19)	119(18)	35(17)	62(11)
1,1,2-Trichloroethane	97(100)	83(95)	99(62)	85(60)	61(58)	26(23)	96(21)	63(19)	27(17)	98(15)
Trichloroethene	95(100)	130(90)	132(85)	60(65)	97(64)	35(40)	134(27)	47(26)	62(21)	59(13)
Trichloroethylsilane	135(100)	133(100)	126(67)	128(46)	137(37)	98(22)	63(21)	35(16)	100(14)	127(11)
Trichlorofluoromethane	101(100)	103(66)	66(13)	105(11)	35(11)	47(9)	31(8)	82(4)	68(4)	37(4)
Trichloromethane (Chloroform)	83(100)	85(64)	47(35)	35(19)	48(16)	49(12)	87(10)	37(6)	50(5)	84(4)
(Trichloromethyl)benzene (Benzotrifluoride)	159(100)	161(64)	89(14)	163(11)	28(10)	63(9)	160(8)	123(8)	62(8)	124(6)
1,2,3-Trichloropropane	75(100)	39(58)	49(42)	110(38)	61(34)	77(33)	112(22)	27(16)	97(15)	38(15)
1,1,2-Trichloro-1,2,2-trifluoroethane	101(100)	151(68)	103(64)	85(45)	31(45)	153(44)	35(20)	66(19)	47(18)	87(14)
Tridecane	57(100)	43(91)	71(51)	41(34)	85(24)	29(23)	56(14)	55(12)	27(11)	42(10)
Triethanolamine	118(100)	56(69)	45(60)	42(56)	44(27)	43(25)	41(14)	116(8)	57(8)	86(7)

Compound	<i>m/e</i> (intensity)										
	41	55	69	83	97	111	125	139	153	167	181
Triethylamine	86(100)	30(68)	58(37)	28(24)	29(23)	27(19)	44(18)	101(17)	42(16)	56(8)	
Triethylene glycol	45(100)	58(11)	89(9)	31(8)	29(8)	75(7)	44(7)	43(7)	27(7)	28(5)	
Triethyl phosphate	99(100)	81(71)	155(56)	82(45)	45(45)	109(44)	127(41)	43(24)	125(16)	111(14)	
Trifluoroacetic acid	45(100)	69(70)	51(36)	28(28)	50(15)	44(11)	43(7)	97(5)	31(5)	29(5)	
2,2,2-Trifluoroethanol	31(100)	33(24)	61(19)	29(19)	51(16)	69(9)	32(6)	49(5)	83(4)	81(4)	
(Trifluoromethyl)benzene (Benzotrifluoride)	146(100)	145(40)	127(34)	96(28)	77(10)	51(10)	147(8)	75(6)	50(6)	128(3)	
Trimethylamine	58(100)	59(47)	30(29)	42(26)	44(17)	15(14)	28(10)	18(10)	43(8)	57(7)	
1,2,3-Trimethylbenzene (Hemimellitene)	105(100)	120(47)	39(22)	77(17)	91(14)	51(14)	27(14)	79(12)	119(11)	106(9)	
1,2,4-Trimethylbenzene (Pseudocumene)	105(100)	120(56)	119(17)	77(15)	39(15)	51(11)	91(10)	27(10)	106(9)	79(7)	
1,3,5-Trimethylbenzene (Mesitylene)	105(100)	120(64)	119(15)	77(13)	39(11)	106(9)	91(9)	51(8)	27(7)	121(6)	
2,2,3-Trimethylbutane (Triptane)	57(100)	43(71)	56(63)	41(53)	85(30)	29(26)	27(18)	39(14)	15(6)	55(5)	
2,2,5-Trimethylhexane	57(100)	56(35)	71(18)	41(17)	43(14)	29(8)	70(4)	58(4)	113(3)	55(3)	
2,2,4-Trimethylpentane (Isooctane)	57(100)	41(31)	56(28)	43(24)	29(16)	27(9)	39(7)	58(4)	55(4)	99(2)	
2,3,3-Trimethylpentane	43(100)	71(45)	70(36)	57(36)	41(29)	85(25)	27(18)	55(16)	29(16)	39(11)	
2,3,4-Trimethylpentane	43(100)	71(62)	70(41)	41(25)	27(18)	55(17)	57(16)	29(14)	39(10)	42(7)	
Trimethyl phosphate	110(100)	109(35)	79(34)	95(25)	80(23)	15(20)	140(18)	47(10)	31(7)	139(5)	
2,4,6-Trimethylpyridine (2,4,6-Collidine)	121(100)	39(27)	79(26)	120(24)	106(17)	27(16)	77(13)	51(11)	42(11)	122(10)	
1-Undecene	41(100)	43(87)	55(80)	70(67)	56(67)	69(55)	29(55)	83(51)	57(50)	27(46)	
Vinyl acetate	43(100)	28(45)	42(26)	44(24)	86(20)	31(10)	32(7)	29(7)	45(2)	41(2)	
<i>o</i> -Xylene	91(100)	106(40)	39(21)	105(17)	51(17)	77(15)	27(12)	65(10)	92(8)	79(8)	
<i>m</i> -Xylene	91(100)	106(65)	105(29)	39(18)	51(15)	77(14)	27(10)	92(8)	79(8)	78(8)	
<i>p</i> -Xylene	91(100)	106(62)	105(30)	51(16)	39(16)	77(13)	27(11)	92(7)	78(7)	65(7)	



## SOLUBILITY OF COMMON SALTS AT AMBIENT TEMPERATURES

This table gives the aqueous solubility of selected salts at temperatures from 10°C to 40°C. Values are given in molality terms.

### References

1. Apelblat, A., *J. Chem. Thermodynamics*, 24, 619, 1992.
2. Apelblat, A., *J. Chem. Thermodynamics*, 25, 63, 1993.
3. Apelblat, A., *J. Chem. Thermodynamics*, 25, 1513, 1993.
4. Apelblat, A. and Korin, E., *J. Chem. Thermodynamics*, 30, 59, 1998.

Salt	10°C	15°C	20°C	25°C	30°C	35°C	40°C	Ref.
BaCl <sub>2</sub>	1.603	1.659	1.716	1.774	1.834	1.895	1.958	1
Ca(NO <sub>3</sub> ) <sub>2</sub>	6.896	7.398	7.986	8.675	9.480	10.421		1
CuSO <sub>4</sub>	1.055	1.153	1.260	1.376	1.502	1.639		3
FeSO <sub>4</sub>	1.352	1.533	1.729	1.940	2.165	2.405		3
KBr	5.002	5.237	5.471	5.703	5.932	6.157		3
KIO <sub>3</sub>	0.291	0.333	0.378	0.426	0.478	0.534	0.593	4
K <sub>2</sub> CO <sub>3</sub>	7.756	7.846	7.948	8.063	8.191	8.331	8.483	1
LiCl	19.296	19.456	19.670	19.935				2
Mg(NO <sub>3</sub> ) <sub>2</sub>	4.403	4.523	4.656	4.800	4.958	5.130	5.314	1
MnCl <sub>2</sub>	5.421	5.644	5.884	6.143	6.422	6.721		3
NH <sub>4</sub> Cl	6.199	6.566	6.943	7.331				2
NH <sub>4</sub> NO <sub>3</sub>	18.809	21.163	23.721	26.496				2
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	5.494	5.589	5.688	5.790	5.896	6.005		3
NaBr	8.258	8.546	8.856	9.191	9.550	9.937	10.351	4
NaCl	6.110	6.121	6.136	6.153	6.174	6.197	6.222	4
NaNO <sub>2</sub>	11.111	11.484	11.883	12.310	12.766	13.253	13.772	4
NaNO <sub>3</sub>	9.395	9.819	10.261	10.723	11.204	11.706	12.230	4
RbCl	6.911	7.180	7.449	7.717	7.986	8.253	8.520	4
ZnSO <sub>4</sub>	2.911	3.116	3.336	3.573	3.827	4.099	4.194	1

## FLAME AND BEAD TESTS

### Flame Colorations

#### Violet

Potassium compounds. Purple red through blue glass. Easily obscured by sodium flame. Bluish-green through green glass. Rubidium and cesium compounds impart same flame as potassium compounds.

#### Blues

Azure — Copper chloride. Copper bromide gives azure blue followed by green. Other copper compounds give same coloration when moistened with hydrochloric acid.  
Light blue — Lead, arsenic, selenium.

#### Greens

Emerald — Copper compounds except the halides, and when not moistened with hydrochloric acid.  
Pure green — Compounds of thallium and tellurium.  
Yellowish — Barium compounds. Some molybdenum compounds. Borates, especially when treated with sulfuric acid or when burned with alcohol.

Bluish — Phosphates with sulfuric acid.

Feeble — Antimony compounds. Ammonium compounds.

Whitish — Zinc.

#### Reds

Carmine — Lithium compounds. Violet through blue glass. Invisible through green glass. Masked by barium flame.  
Scarlet — Strontium compounds. Violet through blue glass. Yellowish through green glass. Masked by barium flame.  
Yellowish — Calcium compounds. Greenish through blue glass. Green through green glass. Masked by barium flame.

#### Yellow

Yellow — All sodium compounds. Invisible with blue glass.

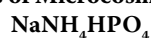
### Bead Tests

Abbreviations employed: s = saturated; ss = supersaturated; ns = not saturated; h = hot; c = cold

#### Borax Beads

Substance	Oxidizing flame	Reducing flame
Aluminum	Colorless (h, c, ns); opaque (ss)	Colorless; opaque (s)
Antimony	Colorless; yellow or brownish (h, ss)	Gray and opaque
Barium	Colorless (ns)	
Bismuth	Colorless; yellow or brownish (h, ss)	Gray and opaque
Cadmium	Colorless	Gray and opaque
Calcium	Colorless (ns)	
Cerium	Red (h)	Colorless (h, c)
Chromium	Green (c)	Green
Cobalt	Blue (h, c)	Blue (h, c)
Copper	Green (h); blue (c)	Red (c); opaque (ss); colorless (h)
Iron	Yellow or brownish red (h, ns)	Green (ss)
Lead	Colorless; yellow or brownish (h, ss)	Gray and opaque
Magnesium	Colorless (ns)	
Manganese	Violet (h, c)	Colorless (h, c)
Molybdenum	Colorless	Yellow or brown (h)
Nickel	Brown; red (c)	Gray and opaque
Silicon	Colorless (h, c); opaque (ss)	Colorless; opaque (s)
Silver	Colorless (ns)	Gray and opaque
Strontium	Colorless (ns)	
Tin	Colorless (h, c); opaque (ss)	Colorless; opaque (s)
Titanium	Colorless	Yellow (h); violet (c)
Tungsten	Colorless	Brown
Uranium	Yellow or brownish (h, ns)	Green
Vanadium	Colorless	Green

#### Beads of Microcosmic Salt



Substance	Oxidizing flame	Reducing flame
Aluminum	Colorless; opaque (s)	Colorless; not clear (ss)
Antimony	Colorless (ns)	Gray and opaque
Barium	Colorless; opaque (s)	Colorless; not clear (ss)
Bismuth	Colorless (ns)	Gray and opaque
Cadmium	Colorless (ns)	Gray and opaque
Calcium	Colorless; opaque (s)	Colorless; not clear (ss)

**Beads of Microcosmic Salt**

<b>Substance</b>	<b>Oxidizing flame</b>	<b>Reducing flame</b>
Cerium	Yellow or brownish red (h, s)	Colorless
Chromium	Red (h, s); green (c)	Green (c)
Cobalt	Blue (h, c)	Blue (h, c)
Copper	Blue (c); green (h)	Red and opaque (c)
Iron	Yellow or brown (h, s)	Colorless; yellow or brownish (h)
Lead	Colorless (ns)	Gray and opaque
Magnesium	Colorless; opaque (s)	Colorless; not clear (ss)
Manganese	Violet (h, c)	Colorless
Molybdenum	Colorless; green (h)	Green (h)
Nickel	Yellow (c); red (h, s)	Yellow (c); red (h); gray and opaque
Silver		Gray and opaque
Strontium	Colorless; opaque (s)	Colorless; not clear (ss)
Tin	Colorless; opaque (s)	Colorless
Titanium	Colorless (ns)	Violet (c); yellow or brownish (h)
Uranium	Green; yellow or brownish	Green (h) (h, s)
Vanadium	Yellow	Green
Zinc	Colorless (ns)	Gray and opaque

**Sodium Carbonate Bead**

<b>Substance</b>	<b>Oxidizing flame</b>	<b>Reducing flame</b>
Manganese	Green	Colorless

## SOLUBILITY OF HYDROCARBONS IN SEAWATER

Concern about pollution of the oceans has stimulated measurements of the solubility of organic compounds in seawater. This table gives the solubility of several hydrocarbons in seawater. The data are derived from a review in the IUPAC Solubility Data Series (Reference 1).

Solubility is expressed in this table as parts per million by mass, i.e.,

$$S/\text{ppm}(\text{mass}) = 10^6 \times w_2 = 10^6 \times m_2/(m_1 + m_2)$$

where  $m_1$  and  $m_2$  are the masses of solvent (seawater) and solute, respectively, under saturation conditions, and  $w_2$  is the mass fraction. Since the solubilities in this table are very low, the value of  $S$  is effectively the mass of hydrocarbon in grams per 1000 kg of seawater.

The temperature and salinity of each measurement are given in the table. Salinity is a standardized measure of the concentration of dissolved salts, as explained in the table "Properties of Seawater" in Section 14. Salinity values in the open oceans at mid-latitude typically fall between 34 and 36.

Reference 1 gives details of the method of measurement and an indication of the reliability of the measurements.

### Reference

1. Shaw, David G., and Maczynski, A., IUPAC-NIST Solubility Data Series 81. Hydrocarbons with Water and Seawater — Revised and Updated. Part 12. C<sub>5</sub>-C<sub>26</sub> Hydrocarbons with Seawater, *J. Phys. Chem. Ref. Data* 35, 785, 2006.

Name	Mol. Form.	Salinity	<i>t</i> /°C	<i>S</i> /ppm (mass)
Acenaphthene	C <sub>12</sub> H <sub>10</sub>	35	15	0.21
Acenaphthene	C <sub>12</sub> H <sub>10</sub>	35	25	1.8
Anthracene	C <sub>14</sub> H <sub>10</sub>	35	25	0.031
Benz[a]anthracene	C <sub>18</sub> H <sub>12</sub>	35	25	0.0056
Benzene	C <sub>6</sub> H <sub>6</sub>	34.4	0	1320
Benzene	C <sub>6</sub> H <sub>6</sub>	35	25	1360
Benzo[ghi]perylene	C <sub>22</sub> H <sub>12</sub>	6	25	0.00021
Benzo[a]pyrene	C <sub>20</sub> H <sub>12</sub>	6	25	0.00013
Benzo[e]pyrene	C <sub>20</sub> H <sub>12</sub>	30	25	0.0033
Benzo[b]triphenylene	C <sub>22</sub> H <sub>14</sub>	6	25	0.027
Biphenyl	C <sub>12</sub> H <sub>10</sub>	35	25	4.76
Butylbenzene	C <sub>10</sub> H <sub>14</sub>	34.5	25	7.1
<i>sec</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	34.5	25	12
<i>tert</i> -Butylbenzene	C <sub>10</sub> H <sub>14</sub>	34.5	25	21
Chrysene	C <sub>18</sub> H <sub>12</sub>	35	25	0.0011
Dibenz[a,h]anthracene	C <sub>22</sub> H <sub>14</sub>	6	25	0.021
Dibenz[a,j]anthracene	C <sub>22</sub> H <sub>14</sub>	6	25	0.010
Dodecane	C <sub>12</sub> H <sub>26</sub>	35	25	0.0029
Eicosane	C <sub>20</sub> H <sub>42</sub>	35	25	0.0008
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	34.4	0	140
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	34.4	10	129
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	34.4	25	111
Fluoranthene	C <sub>16</sub> H <sub>10</sub>	35	25	0.124
9 <i>H</i> -Fluorene	C <sub>13</sub> H <sub>10</sub>	35	25	1.2
Heptane	C <sub>7</sub> H <sub>16</sub>	6	25	10.3
Hexacosane	C <sub>26</sub> H <sub>54</sub>	35	25	0.0001
Hexadecane	C <sub>16</sub> H <sub>34</sub>	35	25	0.0004
Hexane	C <sub>6</sub> H <sub>14</sub>	35.3	25	7.9
Isopropylbenzene	C <sub>9</sub> H <sub>12</sub>	34.5	25	43
2-Methylanthracene	C <sub>15</sub> H <sub>12</sub>	35	25	0.013
Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	34.5	25	29
1-Methylnaphthalene	C <sub>11</sub> H <sub>10</sub>	30	25	23
1-Methylphenanthrene	C <sub>15</sub> H <sub>12</sub>	35	25	0.20
Naphthalene	C <sub>10</sub> H <sub>8</sub>	35	25	22.8
Nonane	C <sub>9</sub> H <sub>20</sub>	6	25	0.43
Octadecane	C <sub>18</sub> H <sub>38</sub>	35	25	0.0008
Pentane	C <sub>5</sub> H <sub>12</sub>	34.5	25	28
Phenanthrene	C <sub>14</sub> H <sub>10</sub>	34	25	0.69

Name	Mol. Form.	Salinity	<i>t</i> /°C	S/ppm (mass)
Pyrene	C <sub>16</sub> H <sub>10</sub>	35	25	0.086
Tetradecane	C <sub>14</sub> H <sub>30</sub>	35	25	0.0017
Toluene	C <sub>7</sub> H <sub>8</sub>	34.4	0	450
Toluene	C <sub>7</sub> H <sub>8</sub>	35	25	387
1,2,3-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	34.5	25	49
1,2,4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	34.5	25	40
1,3,5-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	34.5	25	31
Undecane	C <sub>11</sub> H <sub>24</sub>	6	25	0.01
<i>o</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	34.5	25	130
<i>m</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	34.5	25	106
<i>p</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	34.5	25	111

# SOLUBILITY OF ORGANIC COMPOUNDS IN PRESSURIZED HOT WATER

Liquid water at elevated temperatures and pressures, but still in the subcritical region, is of interest as a solvent in various laboratory and industrial processes. In effect, this means water at a temperature between about 100°C and 373°C, the critical temperature, and at pressures up to 400 bar or greater. Since the dielectric constant of water decreases with increasing temperature, the solubility of many compounds, especially non-polar compounds, increases dramatically at higher temperature. The fact that solubility can be fine-tuned by controlling temperature and pressure makes pressurized hot water a useful tool in various extraction and reaction processes.

This table gives a sample of the variations of solubility with temperature and pressure for several compounds, mostly hydrocarbons. The solubility is expressed in both mole fraction of solute,  $x_2$ , and mass percent,  $100w_2$ , where  $w_2$  is the mass fraction. More information is available in the references.

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Name	Mol. Form.	$t/^\circ\text{C}$	$p/\text{bar}$	Solubility		Ref.
				$10^3x_2$	Mass%	
Acenaphthene	$\text{C}_{12}\text{H}_{10}$	25	1	0.000444	0.000380	13
		250	50	1.25	1.06	11
Anthracene	$\text{C}_{14}\text{H}_{10}$	25	1	0.0000074	0.0000044	2
		50	50	0.000017	0.000017	5
		100	45	0.00032	0.00032	5
		100	39	0.000457	0.00045	12
		150	50	0.0102	0.0101	11
		200	77	0.13	0.13	12
		250	50	0.497	0.49	11
Benz[a]anthracene	$\text{C}_{18}\text{H}_{12}$	300	100	3.78	3.62	11
		25	1	0.00000073	0.00000093	2
		60	50	0.00000846	0.0000107	12
		100	50	0.000113	0.000143	12
		120	52	0.000418	0.00053	12
Benzene	$\text{C}_6\text{H}_6$	150	49	0.00296	0.00375	12
		25	1	0.40	0.178	13
		25	65	0.40	0.173	6
		25	400	0.33	0.143	6
		50	65	0.47	0.203	6
		100	65	0.89	0.38	6
		150	65	2.2	0.95	6
Carbazole	$\text{C}_{12}\text{H}_9\text{N}$	200	65	5.0	2.13	6
		200	400	4.1	1.75	6
		25	1	0.00013	0.00012	5
		25	54	0.00011	0.000102	5
		50	56	0.00045	0.00042	5
		100	54	0.0099	0.0092	5
Chrysene	$\text{C}_{18}\text{H}_{12}$	150	54	0.162	0.150	5
		200	52	1.9	1.74	5
		25	1	0.00000016	0.00000019	2
		25	54	0.00011	0.000102	5

Name	Mol. Form.	$t/^\circ\text{C}$	$p/\text{bar}$	Solubility		Ref.
				$10^3x_2$	Mass%	
<i>o</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	25	32	0.00000063	0.0000008	5
		50	36	0.000001	0.0000013	5
		100	38	0.000013	0.000016	5
		150	43	0.00060	0.00076	5
		200	45	0.0158	0.020	5
		225	62	0.0758	0.096	5
		25	1	0.018	0.0094	9
<i>trans</i> -1,2-Dimethylcyclohexane	$\text{C}_8\text{H}_{16}$	50	65	0.023	0.019	6
		100	65	0.055	0.045	6
		150	65	0.18	0.15	6
		200	65	0.57	0.46	6
		25	1	0.008	0.00050	10
Ethylcyclohexane	$\text{C}_8\text{H}_{16}$	101	7	0.0047	0.0029	10
		131	7	0.0108	0.0067	10
		151	7	0.0223	0.0139	10
		170	7	0.0356	0.0222	10
		25	1	0.00098	0.00061	10
Heptane	$\text{C}_7\text{H}_{16}$	100	7	0.00340	0.00212	10
		131	7	0.0085	0.0053	10
		151	7	0.01665	0.0104	10
		171	7	0.0334	0.0208	10
		25	1	0.0004352	0.000242	8
Hexane	$\text{C}_6\text{H}_{14}$	50	7	0.000613	0.00034096	8
		100	7	0.001938	0.00108	8
		125	7	0.00400	0.00222	8
		150	7	0.00878	0.00488	8
		170	7	0.01701	0.00946	8
1-Isopropyl-4-methylbenzene	$\text{C}_{10}\text{H}_{14}$	25	1	0.002045	0.00098	8
		100	7	0.006074	0.0029	8
		125	7	0.01192	0.0057	8
		150	7	0.02555	0.0122	8
		170	7	0.04935	0.0236	8
Methylcyclohexane	$\text{C}_7\text{H}_{14}$	25	1	0.0030	0.0051	4
		50	60	0.0040	0.0030	6
		100	60	0.011	0.0082	6
		150	60	0.043	0.032	6
		200	60	0.20	0.15	6
Naphthalene	$\text{C}_{10}\text{H}_8$	25	1	0.00293	0.00151	10
		100	7	0.01006	0.0055	10
		131	7	0.0244	0.0133	10
		151	7	0.0423	0.0231	10
		171	7	0.0708	0.0386	10
Octane	$\text{C}_8\text{H}_{18}$	25	1	0.00444	0.00316	13
		40	50	0.00692	0.0049	12
		50	50	0.0114	0.0081	12
		65	50	0.0264	0.0188	12
		75	50	0.0435	0.0309	12
Perylene	$\text{C}_{20}\text{H}_{12}$	25	1	0.0001158	0.000073	8
		100	7	0.0005943	0.000377	8
		125	7	0.0014163	0.000898	8
		150	7	0.0036957	0.00234	8
		170	7	0.0083483	0.00529	8
200	65	0.029	0.018	6		
25	1	0.00000003	0.00000004	2		

Name	Mol. Form.	<i>t</i> /°C	<i>p</i> /bar	Solubility		Ref.
				10 <sup>3</sup> <i>x</i> <sub>2</sub>	Mass%	
Pyrene	C <sub>16</sub> H <sub>10</sub>	50	50	0.00000029	0.0000004	5
		100	45	0.00000210	0.00000294	5
		150	47	0.000120	0.000168	5
		200	48	0.0050	0.0070	5
		25	1	0.000012	0.0000139	2
		100	50	0.000637	0.00072	11
		100	200	0.00078	0.00087	5
		140	50	0.0054	0.0061	11
		200	50	0.0492	0.055	11
<i>p</i> -Terphenyl	C <sub>18</sub> H <sub>14</sub>	250	50	0.205	0.23	11
		300	50	1.41	1.56	11
		25	1	0.00000141	0.00000180	2
		100	49	0.0000219	0.000028	12
		140	51	0.000372	0.000476	12
		180	55	0.00626	0.0080	12
		200	53	0.0241	0.0308	12
Tetrachloroethene	C <sub>2</sub> Cl <sub>4</sub>	210	54	0.0393	0.0502	12
		25	1	0.0285	0.0286	3
		50	65	0.027	0.025	6
		100	65	0.059	0.054	6
		150	65	0.18	0.17	6
Toluene	C <sub>7</sub> H <sub>8</sub>	200	65	0.59	0.54	6
		25	1	0.107	0.0519	7,13
		50	50	0.125	0.064	6
		100	50	0.27	0.138	6
		150	50	0.66	0.337	6
2,2,4-Trimethylpentane	C <sub>8</sub> H <sub>18</sub>	200	50	1.9	0.96	6
		25	1	0.00035	0.00022	1
		50	65	0.00052	0.00033	6
		100	65	0.0020	0.00127	6
		150	65	0.0102	0.0065	6
Triphenylene	C <sub>18</sub> H <sub>12</sub>	200	65	0.061	0.0387	6
		25	1	0.0000034	0.0000043	2
		100	51	0.0000899	0.000114	12
		140	50	0.00126	0.00160	12
		180	64	0.0123	0.0156	12
<i>m</i> -Xylene	C <sub>8</sub> H <sub>10</sub>	195	60	0.0283	0.0359	12
		25	1	0.028	0.0161	13
		50	60	0.036	0.021	6
		100	60	0.085	0.050	6
		150	60	0.27	0.159	6
200	60	0.88	0.516	6		



## PROTON NMR SHIFTS OF COMMON ORGANIC SOLVENTS

The table below lists the  $^1\text{H}$  chemical shifts for over 300 organic solvents and liquid reagents. The solvent in which the shift was measured is given in the second column. Shifts are given in parts per million relative to tetramethylsilane (TMS) and are listed in order of smallest to largest shift. In many cases the peaks show additional small splittings. Compounds are listed by the name used in this *Handbook*, with other common names given in parentheses.

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Compound	Solvent	HNMR shifts (ppm relative to TMS)					Ref.
Acetic acid	$\text{CDCl}_3$	2.10	11.4				2
Acetic anhydride	$\text{CCl}_4$	2.2					1
Acetone	$\text{CDCl}_3$	2.1					1
Acetonitrile	$\text{CCl}_4$	1.9					1
Acrolein (2-Propenal)	$\text{CDCl}_3$	6.4	9.5				1
Acrylonitrile	$\text{CDCl}_3$	6.3					1
Allyl alcohol	$\text{CDCl}_3$	3.6	4.1	5.1	5.3	6.0	1
Allylamine	$\text{CDCl}_3$	1.5	3.3	5.0	5.1	5.9	1
2-Amino-2-methyl-1-propanol (2-Aminoisobutanol)	$\text{CCl}_4$	1.1	2.8	3.2			1
Aniline (Benzenamine)	$\text{CCl}_4$	3.3	6.4	6.6	7.0		1
Anisole (Methoxybenzene)	$\text{CDCl}_3$	3.8	7.1				1
Benzaldehyde	$\text{CDCl}_3$	7.7	10.0				1
Benzene	$\text{CDCl}_3$	7.34					2
Benzeneacetonitrile (Benzyl cyanide)	$\text{CCl}_4$	0.8	0.9	1.6	2.3		1
Benzenethiol (Phenyl mercaptan)	$\text{CCl}_4$	3.2	6.9				1
Benzonitrile	$\text{CCl}_4$	7.5					1
Benzyl acetate	$\text{CDCl}_3$	2.1	5.1	7.3			1
Benzyl alcohol	$\text{CDCl}_3$	2.4	4.6	7.3			1
Bis(2-aminoethyl)amine (Diethylenetriamine)	$\text{CDCl}_3$	1.23	2.69	2.79			2
Bis(2-chloroethyl) ether	$\text{CDCl}_3$	3.66	3.77				2
Bis(2-ethylhexyl) phthalate	$\text{CCl}_4$	0.9	1.5	4.2	7.4	7.7	1
Bis(2-hydroxyethyl) sulfide	$\text{CDCl}_3$	2.8	3.8	4.2			1
Bromobenzene	$\text{CCl}_4$	7.1	7.4				1
1-Bromobutane (Butyl bromide)	$\text{CCl}_4$	1.0	1.4	1.8	3.4		1
2-Bromobutane ( <i>sec</i> -Butyl bromide)	$\text{CDCl}_3$	1.1	1.7	1.8	4.1		1
1-Bromo-2-chloroethane	$\text{CDCl}_3$	3.3	4.0				1
Bromochloromethane	$\text{CCl}_4$	5.2					1
1-Bromodecane (Decyl bromide)	$\text{CCl}_4$	0.9	1.8	3.3			1
Bromoethane (Ethyl bromide)	$\text{CDCl}_3$	1.7	3.4				1
2-Bromo-2-methylpropane ( <i>tert</i> -Butyl bromide)	$\text{CCl}_4$	1.8					1
1-Bromonaphthalene	$\text{CCl}_4$	7.4	8.1				1
1-Bromopentane (Pentyl bromide)	$\text{CCl}_4$	0.9	1.4	1.9	3.3		1
1-Bromopropane (Propyl bromide)	$\text{CCl}_4$	1.0	1.9	3.4			1
2-Bromopropane (Isopropyl bromide)	$\text{CDCl}_3$	1.7	4.3				1
2-Bromopropene	$\text{CDCl}_3$	2.3	5.3	5.5			1
Butanal	$\text{CDCl}_3$	1.0	1.7	2.4	9.7		1
Butanenitrile	$\text{CCl}_4$	1.1	1.7	2.3			1
1-Butanethiol (Butyl mercaptan)	$\text{CDCl}_3$	0.9	1.2	1.5	2.5		1
Butanoic acid	$\text{CCl}_4$	0.9	1.7	2.3	12.0		1
Butanoic anhydride	$\text{CCl}_4$	1.0	1.7	2.4			1

Compound	Solvent	HNMR shifts (ppm relative to TMS)						Ref.
1-Butanol (Butyl alcohol)	CDCl <sub>3</sub>	0.94	1.39	1.53	2.24	3.63		2
2-Butanol ( <i>sec</i> -Butyl alcohol)	CDCl <sub>3</sub>	0.93	1.17	1.46	2.37	3.71		2
2-Butanone (Methyl ethyl ketone)	CDCl <sub>3</sub>	1.06	2.14	2.45				2
<i>trans</i> -2-Butenal ( <i>trans</i> -Crotonaldehyde)	CDCl <sub>3</sub>	2.0	6.1	6.9	9.5			1
2-Butoxyethanol (Ethylene glycol monobutyl ether)	CCl <sub>4</sub>	0.9	1.3	3.3	3.7			1
Butyl acetate	CDCl <sub>3</sub>	0.9	1.4	2.0	4.1			1
Butylamine	CDCl <sub>3</sub>	0.92	1.33	1.43	1.77	2.68		2
<i>tert</i> -Butylamine	CDCl <sub>3</sub>	1.1	1.2					1
Butylbenzene	CCl <sub>4</sub>	0.9	1.4	2.6	7.1			1
<i>sec</i> -Butylbenzene	CCl <sub>4</sub>	0.8	1.2	1.6	2.5	7.1		1
<i>tert</i> -Butylbenzene	CCl <sub>4</sub>	1.3	7.2					1
Butyl formate	CDCl <sub>3</sub>	0.9	1.5	4.2	8.1			1
1- <i>tert</i> -Butyl-4-methylbenzene	CDCl <sub>3</sub>	1.30	2.31	7.11	7.26			2
Butyl vinyl ether	CCl <sub>4</sub>	0.9	1.4	3.6	3.8	4.0	6.3	1
$\gamma$ -Butyrolactone	CDCl <sub>3</sub>	4.4						1
Caprolactam	CDCl <sub>3</sub>	1.7	2.4	3.2	7.8			1
2-Chloroaniline	CCl <sub>4</sub>	3.8	6.8					1
Chlorobenzene	CDCl <sub>3</sub>	7.3						2
2-Chlorobutane ( <i>sec</i> -Butyl chloride)	CCl <sub>4</sub>	1.1	1.5	1.7	3.9			1
Chloroethane (Ethyl chloride)	CDCl <sub>3</sub>	1.5	3.6					1
2-Chloroethanol (Ethylene chlorohydrin)	CDCl <sub>3</sub>	2.8	3.7	3.8				1
(Chloromethyl)benzene (Benzyl chloride)	CCl <sub>4</sub>	4.5	7.3					1
1-Chloro-3-methylbutane (Isopentyl chloride)	CDCl <sub>3</sub>	0.9	1.7	3.6				1
1-Chloro-2-methylpropane (Isobutyl chloride)	CCl <sub>4</sub>	1.0	1.9	3.3				1
2-Chloro-2-methylpropane ( <i>tert</i> -Butyl chloride)	CCl <sub>4</sub>	1.6						1
1-Chloronaphthalene	CCl <sub>4</sub>	7.1	7.5	8.2				1
1-Chlorooctane (Octyl chloride)	CCl <sub>4</sub>	0.9	1.3	1.8	3.5			1
1-Chloropentane (Pentyl chloride)	CCl <sub>4</sub>	0.9	1.6	3.4				1
1-Chloropropane (Propyl chloride)	CCl <sub>4</sub>	1.0	1.8	3.4				1
3-Chloropropene (Allyl chloride)	CCl <sub>4</sub>	4.0	5.2	5.3	5.9			1
2-Chlorotoluene	CDCl <sub>3</sub>	2.4	7.2					1
3-Chlorotoluene	CCl <sub>4</sub>	2.3	7.1					1
Cyclohexane	CDCl <sub>3</sub>	1.43						2
Cyclohexanol	CCl <sub>4</sub>	1.6	3.5	4.2				1
Cyclohexanone	CCl <sub>4</sub>	1.8	2.3					1
Cyclohexene	CCl <sub>4</sub>	1.6	2.0	5.6				1
Cyclohexylamine	CCl <sub>4</sub>	1.4	1.5	2.6				1
Cyclopentane	CCl <sub>4</sub>	1.5						1
Cyclopentanone	CCl <sub>4</sub>	2.0						1
<i>cis</i> -Decahydronaphthalene ( <i>cis</i> -Decalin)	CDCl <sub>3</sub>	1.42	1.62					2
<i>trans</i> -Decahydronaphthalene ( <i>trans</i> -Decalin)	CDCl <sub>3</sub>	0.87	0.93	1.23	1.54	1.67		2
Decane	CCl <sub>4</sub>	0.9	1.3					1
Diacetone alcohol	CDCl <sub>3</sub>	1.3	2.2	2.6	3.7			1
1,2-Dibromoethane	CDCl <sub>3</sub>	3.65						2
Dibromomethane	CCl <sub>4</sub>	4.9						1
1,2-Dibromopropane	CCl <sub>4</sub>	1.8	3.5	3.8	4.2			1
Dibutylamine	CCl <sub>4</sub>	0.5	0.9	1.4	2.5			1
Dibutyl ether	CCl <sub>4</sub>	0.9	1.4	3.3				1
Dibutyl sebacate	CCl <sub>4</sub>	1.0	1.5	2.2	4.0			1
<i>o</i> -Dichlorobenzene	CCl <sub>4</sub>	7.2						1
<i>m</i> -Dichlorobenzene	CCl <sub>4</sub>	7.2	7.4					1
1,1-Dichloroethane	CDCl <sub>3</sub>	2.06	5.90					2

Compound	Solvent	HNMR shifts (ppm relative to TMS)					Ref.
1,2-Dichloroethane	CCl <sub>4</sub>	3.7					1
1,1-Dichloroethene	CCl <sub>4</sub>	5.5					1
<i>cis</i> -1,2-Dichloroethene	CDCl <sub>3</sub>	6.28					2
<i>trans</i> -1,2-Dichloroethene	(CH <sub>3</sub> ) <sub>4</sub> Si	6.24					2
Dichloromethane (Methylene chloride)	CCl <sub>4</sub>	5.3					1
(Dichloromethyl)benzene (Benzal chloride)	CCl <sub>4</sub>	6.6	7.4				1
1,2-Dichloropropane	CDCl <sub>3</sub>	1.61	3.59	3.74	4.14		2
2,4-Dichlorotoluene	CCl <sub>4</sub>	2.3	7.0	7.3			1
3,4-Dichlorotoluene	CCl <sub>4</sub>	2.3	7.0				1
Diethanolamine	D <sub>2</sub> O	2.7	3.7				1
1,1-Diethoxyethane (Acetal)	CDCl <sub>3</sub>	1.2	1.3	3.5	3.7	4.7	2
1,2-Diethoxyethane (Ethylene glycol diethyl ether)	CDCl <sub>3</sub>	1.22	3.54	3.58			1
Diethylamine	CCl <sub>4</sub>	0.9	1.0	2.6			1
Diethyl carbonate	CDCl <sub>3</sub>	1.3	4.2				1
Diethylene glycol	CDCl <sub>3</sub>	3.7	4.2				1
Diethylene glycol dimethyl ether (Diglyme)	CDCl <sub>3</sub>	3.3	3.5				1
Diethylene glycol monoethyl ether (Carbitol)	CCl <sub>4</sub>	1.2	3.1	3.5	3.6		1
Diethylene glycol monoethyl ether acetate	CDCl <sub>3</sub>	1.22	2.08	3.54	3.71	4.23	2
Diethylene glycol monomethyl ether	CDCl <sub>3</sub>	3.3	3.4	3.6			1
Diethyl ether	CDCl <sub>3</sub>	1.21	3.47				2
Diethyl sulfide	CCl <sub>4</sub>	1.2	2.5				1
Diisopropylamine	CCl <sub>4</sub>	0.7	1.0	2.9			1
Diisopropyl ether	CCl <sub>4</sub>	1.0	3.5				1
1,2-Dimethoxybenzene (Veratrole)	CCl <sub>4</sub>	3.7	6.8				1
1,2-Dimethoxyethane (Ethylene glycol dimethyl ether)	CCl <sub>4</sub>	3.3	3.4				1
Dimethoxymethane (Methylal)	CCl <sub>4</sub>	3.2	4.4				1
<i>N,N</i> -Dimethylacetamide	CDCl <sub>3</sub>	2.1	2.9	3.0			1
2,4-Dimethylaniline (2,4-Xylidine)	CCl <sub>4</sub>	2.0	2.2	3.4	6.4	6.7	1
2,2-Dimethylbutane (Neohexane)	CCl <sub>4</sub>	0.9	1.1	1.3	1.1	1.3	1
2,3-Dimethylbutane	CCl <sub>4</sub>	0.9	1.5				1
Dimethyl disulfide		2.45					3
<i>N,N</i> -Dimethylformamide	CDCl <sub>3</sub>	2.9	3.0	8.0			1
Dimethyl glutarate	CDCl <sub>3</sub>	2.0	2.4	3.7			1
2,6-Dimethyl-4-heptanone (Isovalerone)	CCl <sub>4</sub>	0.9	2.1				1
2,5-Dimethylhexane	CCl <sub>4</sub>	0.9	1.4				1
Dimethyl maleate	CCl <sub>4</sub>	3.7	6.2				1
2,2-Dimethylpentane	CDCl <sub>3</sub>	0.9	0.9	1.2			1
2,4-Dimethylpentane	CCl <sub>4</sub>	0.9	1.1	1.6			1
2,4-Dimethyl-3-pentanone (Diisopropyl ketone)	CCl <sub>4</sub>	1.0	2.6				1
2,4-Dimethylpyridine (2,4-Lutidine)	CDCl <sub>3</sub>	2.3	2.5	7.0	7.0	8.4	1
2,6-Dimethylpyridine (2,6-Lutidine)	CDCl <sub>3</sub>	2.51	6.93	7.42			2
Dimethyl sulfoxide	CDCl <sub>3</sub>	2.62					2
1,4-Dioxane	CDCl <sub>3</sub>	3.69					2
1,3-Dioxolane	CDCl <sub>3</sub>	3.88	4.90				2
Dipentyl ether (Amyl ether)	CDCl <sub>3</sub>	0.9	1.4	3.4			1
Dipropylamine	CDCl <sub>3</sub>	1.5	2.6				1
Dodecane	CCl <sub>4</sub>	0.9	1.3				1
1-Dodecene	CCl <sub>4</sub>	0.9	1.3	2.0	5.4		1
Epichlorohydrin	CCl <sub>4</sub>	2.6	2.8	3.2	3.5	3.6	1
1,2-Epoxybutane (Ethloxirane)	CCl <sub>4</sub>	1.0	1.5	2.3	2.6	2.7	1
1,2-Ethanediamine	CCl <sub>4</sub>	1.2	2.6				1
1,2-Ethandiol (Ethylene glycol)	D <sub>2</sub> O	3.7					1

Compound	Solvent	HNMR shifts (ppm relative to TMS)						Ref.
1,2-Ethanediol, diacetate (Ethylene glycol diacetate)	CCl <sub>4</sub>	2.0	4.2					1
Ethanol	CDCl <sub>3</sub>	1.23	2.61	3.69				2
Ethanolamine	CDCl <sub>3</sub>	2.7	2.8	3.5				1
Ethoxybenzene (Phenetole)	CCl <sub>4</sub>	1.3	3.9	6.9				1
2-Ethoxyethanol (Ethylene glycol monoethyl ether (Cellosolve))	CDCl <sub>3</sub>	1.22	2.70	3.55	3.72			2
2-Ethoxyethyl acetate (Ethylene glycol monoethyl ether acetate)	CCl <sub>4</sub>	1.2	2.0	3.4	3.5	4.1		1
Ethyl acetate	CDCl <sub>3</sub>	1.26	2.04	4.12				2
Ethyl acetoacetate	CDCl <sub>3</sub>	1.3	1.9	2.2	3.3	4.1	4.9	1
Ethyl acrylate (Ethyl propenoate)	CCl <sub>4</sub>	1.3	4.1	5.7	6.1	6.3		1
Ethylamine	D <sub>2</sub> O	1.1	2.6					1
Ethylbenzene	CDCl <sub>3</sub>	1.3	2.7	7.2				1
Ethyl benzoate	CCl <sub>4</sub>	1.3	4.3	7.4	8.0			1
Ethyl butanoate	CCl <sub>4</sub>	0.9	1.2	1.7	2.2	4.1		1
Ethyl cyanoacetate	CCl <sub>4</sub>	1.3	3.4	4.3				1
Ethylcyclohexane	CDCl <sub>3</sub>	0.9	1.9	1.4				1
Ethylene carbonate	CDCl <sub>3</sub>	4.5						1
Ethyl formate	CCl <sub>4</sub>	1.3	4.2	7.9				1
2-Ethyl-1,3-hexanediol	CDCl <sub>3</sub>	1.0	1.4	3.8				1
2-Ethyl-1-hexanol	CDCl <sub>3</sub>	0.9	1.3	1.8	3.5			1
Ethyl 3-methylbutanoate	CDCl <sub>3</sub>	1.0	1.3	1.9	4.1			1
3-Ethyl-2-methylpentane	CCl <sub>4</sub>	0.9	0.9	1.5				1
Fluorobenzene	CCl <sub>4</sub>	7.0						1
2-Fluorotoluene	CCl <sub>4</sub>	2.2	6.9					1
3-Fluorotoluene	CCl <sub>4</sub>	2.3	6.9					1
4-Fluorotoluene	CCl <sub>4</sub>	2.2	6.8	7.0				1
Furan	CDCl <sub>3</sub>	6.38	7.44					2
Furfural	CDCl <sub>3</sub>	6.6	7.3	7.7	9.7			1
Furfuryl alcohol	CDCl <sub>3</sub>	2.8	4.6	6.3	7.4			1
Glycerol	D <sub>2</sub> O	3.6						1
Glycerol triacetate (Triacetin)	CDCl <sub>3</sub>	2.1	4.2	4.3	5.2			1
Heptane	CDCl <sub>3</sub>	0.88	1.27	1.30				2
1-Heptanol	CCl <sub>4</sub>	0.9	1.4	3.4	3.5			1
3-Heptanol	CCl <sub>4</sub>	0.9	1.4	2.3	3.4			1
2-Heptanone (Methyl pentyl ketone)	CCl <sub>4</sub>	0.9	1.3	2.0	2.3			1
3-Heptanone (Ethyl butyl ketone)	CCl <sub>4</sub>	1.0	1.4	2.3				1
1-Heptene	CCl <sub>4</sub>	0.9	1.4	2.0	4.9	5.7		1
Hexane	CDCl <sub>3</sub>	0.89	1.27	1.29				2
Hexanedinitrile (Adiponitrile)	CDCl <sub>3</sub>	1.8	2.5					1
Hexanenitrile	CDCl <sub>3</sub>	0.9	1.5	2.3				1
Hexanoic acid (Caproic acid)	CDCl <sub>3</sub>	0.9	1.4	2.4	11.4			1
1-Hexanol	CDCl <sub>3</sub>	0.90	1.32	1.56	1.79	3.62		2
Hexyl acetate	CCl <sub>4</sub>	0.9	1.4	2.0	4.0			1
3-Hydroxypropanenitrile (Hydracrylonitrile)	CDCl <sub>3</sub>	2.6	3.4	3.9				1
Iodobenzene	CCl <sub>4</sub>	6.8	7.5	7.7				1
1-Iodobutane (Butyl iodide)	CDCl <sub>3</sub>	1.0	1.7	1.9	4.2			1
2-Iodobutane ( <i>sec</i> -Butyl iodide)	CDCl <sub>3</sub>	1.0	1.7	1.9	4.2			1
Iodoethane (Ethyl iodide)	CDCl <sub>3</sub>	1.2	2.6	3.7				1
Iodomethane (Methyl iodide)	CDCl <sub>3</sub>	2.2						1
1-Iodopropane (Propyl iodide)	CCl <sub>4</sub>	1.0	1.8	3.2				1
2-Iodopropane (Isopropyl iodide)	CDCl <sub>3</sub>	1.9	4.3					1
Isobutanal (2-Methyl-1-propanal)	CCl <sub>4</sub>	1.1	2.4	9.6				1
Isobutyl acetate	CCl <sub>4</sub>	0.9	1.9	2.0	3.8			1

Compound	Solvent	HNMR shifts (ppm relative to TMS)								Ref.
Isobutylbenzene	CCl <sub>4</sub>	0.9	1.9	2.4	7.1					1
Isobutyl formate	CDCl <sub>3</sub>	1.0	2.0	3.9	8.0					1
Isobutyl isobutanoate	CCl <sub>4</sub>	0.9	1.2	1.9	2.5	3.8				1
Isopentyl acetate	CDCl <sub>3</sub>	0.9	1.5	2.0	4.0					1
Isophorone	CDCl <sub>3</sub>	1.04	1.95	2.19	5.88					2
Isopropyl acetate	CDCl <sub>3</sub>	0.9	1.4	1.6	2.4					1
Isopropylbenzene (Cumene)	CDCl <sub>3</sub>	1.3	2.4	2.9	7.3					1
1-Isopropyl-4-methylbenzene ( <i>p</i> -Cymene)	CDCl <sub>3</sub>	1.2	2.3	2.9	7.1					1
Isoquinoline	CDCl <sub>3</sub>	8.5	9.3							1
<i>d</i> -Limonene (Citrene)	CCl <sub>4</sub>	1.4	1.7	1.9	4.6	5.3				1
Mesityl oxide	CDCl <sub>3</sub>	1.89	2.14	2.16	6.09					2
Methanol	CDCl <sub>3</sub>	3.43	3.66							2
2-Methoxyethanol (Ethylene glycol monomethyl ether)	CDCl <sub>3</sub>	2.5	3.4	3.5	3.7	3.5	3.7			1
2-Methoxyethyl acetate (Ethylene glycol monomethyl ether acetate)	CDCl <sub>3</sub>	2.09	3.39	3.59	4.22					2
Methyl acetate	CCl <sub>4</sub>	2.0	3.7							1
2-Methylacrylonitrile	CDCl <sub>3</sub>	2.0	5.7	5.8						1
2-Methylaniline ( <i>o</i> -Toluidine)	CCl <sub>4</sub>	2.0	3.2	6.7						1
3-Methylaniline ( <i>m</i> -Toluidine)	CCl <sub>4</sub>	2.2	3.3	6.4	6.9					1
<i>N</i> -Methylaniline	CCl <sub>4</sub>	2.7	3.3	6.4	6.6	7.1				1
Methyl benzoate	CCl <sub>4</sub>	3.8	7.4	8.0						1
3-Methylbutanoic acid (Isovaleric acid)	CCl <sub>4</sub>	1.0	2.2	11.0						1
3-Methyl-1-butanol (Isopentyl alcohol)	CCl <sub>4</sub>	0.9	1.5	3.5	4.1					1
Methyl cyanoacetate	CDCl <sub>3</sub>	3.5	3.8							1
Methylcyclohexane	CCl <sub>4</sub>	0.9	1.4							1
<i>cis</i> -4-Methylcyclohexanol	CDCl <sub>3</sub>	0.9	1.5	2.9	3.9					1
<i>N</i> -Methylformamide	CDCl <sub>3</sub>	2.82	7.4	8.16						2
Methyl formate	CDCl <sub>3</sub>	3.76	8.07							2
2-Methylheptane	CCl <sub>4</sub>	0.9	1.3							1
4-Methylheptane	CDCl <sub>3</sub>	0.8	0.9	1.4						1
2-Methylhexane	CDCl <sub>3</sub>	0.9	0.9	1.4						1
5-Methyl-2-hexanone (Methyl isopentyl ketone)	CCl <sub>4</sub>	0.9	1.4	2.0	2.3					1
Methyl methacrylate (Methyl 2-methyl-2-propenoate)	CDCl <sub>3</sub>	2.0	3.8	5.6	6.1					1
2-Methyloctane	CCl <sub>4</sub>	0.9	1.0	1.3						1
2-Methylpentane	CCl <sub>4</sub>	0.8	0.9	1.5						1
3-Methylpentane	CCl <sub>4</sub>	0.8	1.5							1
2-Methyl-2,4-pentanediol (Hexylene glycol)	CCl <sub>4</sub>	1.1	1.2	1.3	1.4	1.6	4.2	4.7	4.9	1
4-Methylpentanenitrile	CCl <sub>4</sub>	1.0	1.6	2.3						1
4-Methyl-2-pentanol	CCl <sub>4</sub>	0.9	1.1	1.3	1.8	3.5	3.7			1
3-Methyl-3-pentanol	CCl <sub>4</sub>	0.9	1.1	1.4	1.8					1
4-Methyl-2-pentanone (Methyl isobutyl ketone)	CDCl <sub>3</sub>	0.9	2.1	2.3						1
2-Methylpropanenitrile (Isobutyronitrile)	CDCl <sub>3</sub>	1.3	2.7							1
2-Methylpropanoic acid (Isobutyric acid)	CCl <sub>4</sub>	1.2	2.6							1
2-Methyl-1-propanol (Isobutyl alcohol)	CCl <sub>4</sub>	0.9	1.7	3.3	4.0					1
2-Methyl-2-propanol ( <i>tert</i> -Butyl alcohol)	CDCl <sub>3</sub>	1.3	1.4							1
2-Methylpyridine (2-Picoline)	CCl <sub>4</sub>	2.5	6.9	7.4	8.4					1
3-Methylpyridine (3-Picoline)	CCl <sub>4</sub>	2.3	7.0	7.4	8.4					1
<i>N</i> -Methyl-2-pyrrolidinone	CDCl <sub>3</sub>	2.1	2.4	2.8	3.4					1
Methyl salicylate	CCl <sub>4</sub>	3.9	6.7	6.9	7.3	7.7	10.6			1
2-Methylthiophene	CDCl <sub>3</sub>	2.5	6.7	6.9	7.0					1
Morpholine	CDCl <sub>3</sub>	2.59	2.86	3.67						2
Nitrobenzene	CCl <sub>4</sub>	7.52	7.65	8.19						2
Nitroethane	CDCl <sub>3</sub>	1.6	4.3							1



Compound	Solvent	HNMR shifts (ppm relative to TMS)						Ref.
Tetramethylurea	CCl <sub>4</sub>	2.8						1
Thiophene	CDCl <sub>3</sub>	7.1	7.3					1
Toluene	CDCl <sub>3</sub>	2.34	7.18					2
Tribromomethane (Bromoform)	CCl <sub>4</sub>	6.8						1
Tributylamine	CCl <sub>4</sub>	0.9	1.3	2.3				1
1,1,1-Trichloroethane	CCl <sub>4</sub>	2.7						1
1,1,2-Trichloroethane	CDCl <sub>3</sub>	4.0	5.8					1
Trichloroethene	CCl <sub>4</sub>	6.5						1
Trichloroethylsilane	CCl <sub>4</sub>	1.3						1
Trichloromethane (Chloroform)	CCl <sub>4</sub>	7.2						1
(Trichloromethyl)benzene (Benzotrichloride)	CCl <sub>4</sub>	7.3	7.8					1
Tridecane	CCl <sub>4</sub>	0.9	1.3					1
Triethanolamine	D <sub>2</sub> O	2.7	3.6					1
Triethylamine	CCl <sub>4</sub>	1.0	2.4					1
Triethylene glycol	CDCl <sub>3</sub>	3.5	3.7					1
Triethyl phosphate	CDCl <sub>3</sub>	1.4	4.1					1
2,2,2-Trifluoroethanol	CDCl <sub>3</sub>	3.4	3.9					1
(Trifluoromethyl)benzene (Benzotrifluoride)	CCl <sub>4</sub>	7.5						1
Trimethylamine	CCl <sub>4</sub>	2.12						2
1,2,3-Trimethylbenzene (Hemimellitene)	CDCl <sub>3</sub>	2.2	2.3	7.0				1
1,2,4-Trimethylbenzene (Pseudocumene)	CCl <sub>4</sub>	2.2	6.8					1
1,3,5-Trimethylbenzene (Mesitylene)	CDCl <sub>3</sub>	2.3	6.8					1
2,2,3-Trimethylbutane (Triptane)	CCl <sub>4</sub>	0.8	1.3					1
2,2,5-Trimethylhexane	CCl <sub>4</sub>	0.9	1.2					1
2,3,3-Trimethylpentane	CCl <sub>4</sub>	0.8	0.8	1.4				1
2,3,4-Trimethylpentane	CCl <sub>4</sub>	0.8	1.9					1
Trimethyl phosphate	CDCl <sub>3</sub>	3.78						2
2,4,6-Trimethylpyridine (2,4,6-Collidine)	CCl <sub>4</sub>	2.2	2.4	6.6				1
1-Undecene	CCl <sub>4</sub>	0.9	1.3	2.0	4.8	4.9	5.6	1
Vinyl acetate	CDCl <sub>3</sub>	2.1	4.6	4.9	7.3			1
<i>o</i> -Xylene	CDCl <sub>3</sub>	2.22	7.07					2
<i>m</i> -Xylene	CDCl <sub>3</sub>	2.28	6.95	7.11				2
<i>p</i> -Xylene	CDCl <sub>3</sub>	2.30	7.05					2

## BOND LENGTHS IN CRYSTALLINE ORGANIC COMPOUNDS

The following table gives average interatomic distances for bonds between the elements H, B, C, N, O, F, Si, P, S, Cl, As, Se, Br, Te, and I as determined from X-ray and neutron diffraction measurements on organic crystals. The table has been derived from an analysis of high-precision structure data on about 10,000 crystals contained in the 1985 version of the Cambridge Structural Database, which is maintained by the Cambridge Crystallographic Data Center. The explanation of the columns is:

Column 4:  $m$  is the median in Å units of all values.  
 Column 5:  $\sigma$  is the standard deviation in the sample.  
 Column 6:  $q_1$  is the lower quartile for the sample (i.e., 25% of values are less than  $q_1$  and 75% exceed it).  
 Column 7:  $q_u$  is the upper quartile for the sample.  
 Column 8:  $n$  is number of observations in the sample.  
 Column 9: Notes refer to the footnotes in Appendix 1.

Column 1: Specification of elements in the bond, with coordination number given in parentheses, and bond type (single, double, etc.). For carbon, the hybridization state is given.  
 Column 2: Substructure in which the bond is found. The target bond is set in boldface. Where X is not specified, it denotes any element type. C# indicates any sp<sup>3</sup> carbon atom, and C\* denotes an sp<sup>3</sup> carbon whose bonds, in addition to those specified in the linear formulation, are to C and H atoms only.  
 Column 3:  $d$  is the unweighted mean in Å units of all the values for that bond length found in the sample.

References to special cases are given in a shorthand form and listed in Appendix 2. Further information on the method of analysis of the data may be found in the reference cited below.

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### Reference

Frank H. Allen, Olga Kennard, David G. Watson, Lee Brammer, A. Guy Orpen, and Robin Taylor, *J. Chem. Soc. Perkin Trans. II*, S1–S19, 1987.

Bond	Substructure	$d$	$m$	$\sigma$	$q_1$	$q_u$	$n$	Note
As(3)–As(3)	$X_2$ – <b>As–As</b> – $X_2$	2.459	2.457	0.011	2.456	2.466	8	
As–B	see CUDLOC (2.065), CUDLUI (2.041)							
As–BR	see CODDEE, CODDII (2.346–3.203)							
As(4)–C	$X_3$ – <b>As–CH<sub>3</sub></b>	1.903	1.907	0.016	1.893	1.916	12	
	$(X)_2(C,O,S)=$ <b>As–Csp<sup>3</sup></b>	1.927	1.929	0.017	1.921	1.937	16	
	<b>As–Car</b> in Ph <sub>4</sub> As <sup>+</sup>	1.905	1.909	0.012	1.897	1.912	108	
	$(X)_2(C,O,S)=$ <b>As–Car</b>	1.922	1.927	0.016	1.908	1.934	36	
As(3)–C	$X_2$ – <b>As–Csp<sup>3</sup></b>	1.963	1.965	0.017	1.948	1.978	6	
	$X_2$ – <b>As–Car</b>	1.956	1.956	0.015	1.944	1.964	41	
As(3)–Cl	$X_2$ – <b>As–Cl</b>	2.268	2.256	0.039	2.247	2.281	10	
As(6)–F	in <b>AsF<sub>6</sub><sup>–</sup></b>	1.678	1.676	0.020	1.659	1.695	36	
As(3)–I	see OPIMAS (2.579, 2.590)							
As(3)–N(3)	$X_2$ – <b>As–N</b> – $X_2$	1.858	1.858	0.029	1.839	1.873	19	
As(4)–N(2)	see TPASSN (1.837)							
As(4)–O	$(X)_2(O=)$ <b>As–OH</b>	1.710	1.712	0.017	1.695	1.726	6	
As(3)–O	see ASAZOC, PHASOC01 (1.787–1.845)							
As(4)–O	$X_3$ – <b>As=O</b>	1.661	1.661	0.016	1.652	1.667	9	
As(3)=P(3)	see BELNIP (2.350, 2.362)							†
As(3)–P(3)	see BUTHAZ10 (2.124)							†
As(3)–S	$X_2$ – <b>As–S</b>	2.275	2.266	0.032	2.247	2.298	14	
As(4)–S	$X_3$ – <b>As=S</b>	2.083	2.082	0.004	2.080	2.086	9	
As(3)–Se(2)	see COSDIX, ESEARS (2.355–2.401)							†
As(3)–Si(4)	see BICGEZ, MESIAD (2.351–2.365)							†
As(3)–Te(2)	see ETEARS (2.571, 2.576)							†
B(n)–B(n)	$n = 5–7$ in boron cages	1.775	1.773	0.031	1.763	1.786	688	
B(4)–B(4)	see CETTAW (2.041)							
B(4)–B(3)	see COFVOI (1.698)							
B(3)–B(3)	$X_2$ – <b>B–B</b> – $X_2$	1.701	1.700	0.014	1.691	1.712	8	
B(6)–BR		1.967	1.971	0.014	1.954	1.979	7	†
B(4)–BR		2.017	2.008	0.031	1.990	2.044	15	†
B(n)–C	$n = 5–7$ : <b>B–C</b> in cages	1.716	1.717	0.020	1.707	1.728	96	
	$n = 3–4$ : <b>B–Csp<sup>3</sup></b> not cages	1.597	1.599	0.022	1.585	1.611	29	1
	$n = 4$ : <b>B–Car</b>	1.606	1.607	0.012	1.596	1.615	41	
	$n = 4$ : <b>B–Car</b> in Ph <sub>4</sub> B <sup>–</sup>	1.643	1.643	0.006	1.641	1.645	16	
B(n)–C	$n = 3$ : <b>B–Car</b>	1.556	1.552	0.015	1.546	1.566	24	
B(n)–Cl	<b>B(5)–Cl</b> and <b>B(3)–Cl</b>	1.751	1.751	0.011	1.743	1.761	14	



Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	<i>q</i> <sub>1</sub>	<i>q</i> <sub>n</sub>	<i>n</i>	Note
	<b>B(4)–Cl</b>	1.833	1.833	0.013	1.821	1.843	22	
B(4)–F	<b>B–F</b> (B neutral)	1.366	1.368	0.017	1.356	1.375	25	
	<b>B<sup>+</sup>–F</b> in BF <sub>4</sub> <sup>–</sup>	1.365	1.372	0.029	1.352	1.390	84	
B(4)–I	see TMPBTI (2.220, 2.253)							
B(4)–N(3)	X <sub>3</sub> – <b>B–N</b> (=C)(X)	1.611	1.617	0.013	1.601	1.625	8	
	in pyrazaboles	1.549	1.552	0.015	1.536	1.560	10	
B(3)–N(3)	X <sub>2</sub> – <b>B–N–C</b> <sub>2</sub> : all coplanar	1.404	1.404	0.014	1.389	1.408	40	2
	for $\tau(\text{BN}) > 30^\circ$ see BOGSUL, BUSHAY, CILRUK (1.434–1.530)							
	S <sub>2</sub> – <b>B–N–X</b> <sub>2</sub>	1.447	1.443	0.013	1.435	1.470	14	
B(4)–O	<b>B<sup>+</sup>–O</b> in BO <sub>4</sub> <sup>–</sup>	1.468	1.468	0.022	1.453	1.479	24	
	for neutral B–O see Note 3							3
B(3)–O(2)	X <sub>2</sub> – <b>B–O–X</b>	1.367	1.367	0.024	1.349	1.382	35	
B( <i>n</i> )–P	<i>n</i> = 4: <b>B–P</b>	1.922	1.927	0.027	1.900	1.954	10	
	<i>n</i> = 3: see BUPSI10 (1.892, 1.893)							
B(4)–S	<b>B(4)–S(3)</b>	1.930	1.927	0.009	1.925	1.934	10	
	<b>B(4)–S(2)</b>	1.896	1.896	0.004	1.893	1.899	6	
B(3)–S	N– <b>B–S</b> <sub>2</sub>	1.806	1.806	0.010	1.799	1.816	28	
	(=X–)(N–) <b>B–S</b>	1.851	1.854	0.013	1.842	1.859	10	
Br–Br	see BEPZEB, TPASTB	2.542	2.548	0.015	2.526	2.551	4	
Br–C	<b>Br–C<sup>*</sup></b>	1.966	1.967	0.029	1.951	1.983	100	4
	<b>Br–Csp<sup>3</sup></b> (cyclopropane)	1.910	1.910	0.010	1.900	1.914	8	
	<b>Br–Csp<sup>2</sup></b>	1.883	1.881	0.015	1.874	1.894	31	4
	<b>Br–Car</b> (mono-Br + <i>m,p</i> -Br <sub>2</sub> )	1.899	1.899	0.012	1.892	1.906	119	4
	<b>Br–Car</b> ( <i>o</i> -Br <sub>2</sub> )	1.875	1.872	0.011	1.864	1.884	8	4
–Br(2)–Cl	see TEACBR (2.362–2.402)							†
Br–I	see DTHIBR10 (2.646), TPHOSI (2.695)							
Br–N	see NBBZAM (1.843)							
Br–O	see CIYFOF	1.581	1.581	0.007	1.574	1.587	4	
Br–P	see CISTED (2.366)							
Br–S(2)	see BEMLIO (2.206)							†
Br–S(3)	see CIWYIQ (2.435, 2.453)							†
Br–S(3) <sup>+</sup>	see THINBR (2.321)							†
Br–SE	see CIFZUM (2.508, 2.619)							
Br–Si	see BIZJAV (2.284)							
Br–Te	In <b>Br<sub>6</sub>Te<sup>2–</sup></b> see CUGBAH (2.692–2.716)							
	<b>Br–Te(4)</b> see BETUTE10 (3.079, 3.015)							
	<b>Br–Te(3)</b> see BTUPTTE (2.835)							
Csp <sup>3</sup> –Csp <sup>3</sup>	<b>C#–CH<sub>2</sub>–CH<sub>3</sub></b>	1.513	1.514	0.014	1.507	1.523	192	
	(C#) <sub>2</sub> – <b>CH–CH<sub>3</sub></b>	1.524	1.526	0.015	1.518	1.534	226	
	(C#) <sub>3</sub> – <b>C–CH<sub>3</sub></b>	1.534	1.534	0.011	1.527	1.541	825	
	<b>C#–CH<sub>2</sub>–CH<sub>2</sub>–C#</b>	1.524	1.524	0.014	1.516	1.532	2459	
	(C#) <sub>2</sub> – <b>CH–CH<sub>2</sub>–C#</b>	1.531	1.531	0.012	1.524	1.538	1217	
	(C#) <sub>3</sub> – <b>C–CH<sub>2</sub>–C#</b>	1.538	1.539	0.010	1.533	1.544	330	
	(C#) <sub>2</sub> – <b>CH–CH–(C#)<sub>2</sub></b>	1.542	1.542	0.011	1.536	1.549	321	
	(C#) <sub>3</sub> – <b>C–CH–(C#)<sub>2</sub></b>	1.556	1.556	0.011	1.549	1.562	215	
	(C#) <sub>3</sub> – <b>C–C–(C#)<sub>3</sub></b>	1.588	1.580	0.025	1.566	1.610	21	
	<b>C*–C*</b> (overall)	1.530	1.530	0.015	1.521	1.539	5777	5,6
	in cyclopropane (any subst.)	1.510	1.509	0.026	1.497	1.523	888	7
	in cyclobutane (any subst.)	1.554	1.553	0.021	1.540	1.567	679	8
	in cyclopentane (C,H-subst.)	1.543	1.543	0.018	1.532	1.554	1641	
	in cyclohexane (C,H-subst.)	1.535	1.535	0.016	1.525	1.545	2814	
	cyclopropyl-C* (exocyclic)	1.518	1.518	0.019	1.505	1.531	366	7
	cyclobutyl-C* (exocyclic)	1.529	1.529	0.016	1.519	1.539	376	8
	cyclopentyl-C* (exocyclic)	1.540	1.541	0.017	1.527	1.549	956	
	cyclohexyl-C* (exocyclic)	1.539	1.538	0.016	1.529	1.549	2682	
	in cyclobutene (any subst.)	1.573	1.574	0.017	1.566	1.586	25	8
	in cyclopentene (C,H-subst.)	1.541	1.539	0.015	1.532	1.549	208	
	in cyclohexene (C,H-subst.)	1.541	1.541	0.020	1.528	1.554	586	
	in oxirane (epoxide)	1.466	1.466	0.015	1.458	1.474	249	9
	in aziridine	1.480	1.481	0.021	1.465	1.496	67	9

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	in oxetane	1.541	1.541	0.019	1.527	1.557	16	
	in azetidine	1.548	1.543	0.018	1.536	1.558	22	
	oxiranyl-C* (exocyclic)	1.509	1.507	0.018	1.497	1.519	333	9
	aziridinyl-C* (exocyclic)	1.512	1.512	0.018	1.496	1.526	13	9
<i>Csp<sup>3</sup>-Csp<sup>2</sup></i>	CH <sub>3</sub> -C=C	1.503	1.504	0.011	1.497	1.509	215	
	C#-CH <sub>2</sub> -C=C	1.502	1.502	0.013	1.494	1.510	483	
	(C#) <sub>2</sub> -CH-C=C	1.510	1.510	0.014	1.501	1.518	564	
	(C#) <sub>3</sub> -C-C=C	1.522	1.522	0.016	1.511	1.533	193	
<i>Csp<sup>3</sup>-Csp<sup>2</sup></i>	C*-C=C (overall)	1.507	1.507	0.015	1.499	1.517	1456	5
	C*-C=C (endocyclic)							
	in cyclopropene	1.509	1.508	0.016	1.500	1.516	20	10
	in cyclobutene	1.513	1.512	0.018	1.500	1.525	50	8
	in cyclopentene	1.512	1.512	0.014	1.502	1.521	208	
	in cyclohexene	1.506	1.505	0.016	1.495	1.516	391	
	in cyclopentadiene	1.502	1.503	0.019	1.490	1.515	18	
	in cyclohexa-1,3-diene	1.504	1.504	0.017	1.491	1.517	56	
	C*-C=C (exocyclic):							
	cyclopropenyl-C*	1.478	1.475	0.012	1.470	1.485	7	10
	cyclobutenyl-C*	1.489	1.483	0.015	1.479	1.496	11	8
	cyclopentenyl-C*	1.504	1.506	0.012	1.495	1.512	115	
	cyclohexenyl-C*	1.511	1.511	0.013	1.502	1.519	292	
	C*CH=O in aldehydes	1.510	1.510	0.008	1.501	1.518	7	
	(C*) <sub>2</sub> -C=O							
	in ketones	1.511	1.511	0.015	1.501	1.521	952	11
	in cyclobutanone	1.529	1.530	0.016	1.514	1.545	18	
	in cyclopentanone	1.514	1.514	0.016	1.505	1.523	312	
	acyclic and 6 + rings	1.509	1.509	0.016	1.499	1.519	626	
	C*-COOH in carboxylic acids	1.502	1.502	0.014	1.495	1.510	176	
	C*-COO <sup>-</sup> in carboxylate anions	1.520	1.521	0.011	1.516	1.528	57	
	C*-C(=O)(-OC*)							
	in acyclic esters	1.497	1.496	0.018	1.484	1.509	553	12
	in β-lactones	1.519	1.519	0.020	1.500	1.538	4	13
	in γ-lactones	1.512	1.512	0.015	1.501	1.521	110	12
	in δ-lactones	1.504	1.502	0.013	1.495	1.517	27	12
	cyclopropyl (C)-C=O in ketones, acids and esters	1.486	1.485	0.018	1.474	1.497	105	7
	C*-C(=O)(-NH <sub>2</sub> ) in acyclic amides	1.514	1.512	0.016	1.506	1.526	32	14
	C*-C(=O)(-NHC*) in acyclic amides	1.506	1.505	0.012	1.498	1.515	78	14
	C*-C(=O)[-N(C*) <sub>2</sub> ] in acyclic amides	1.505	1.505	0.011	1.496	1.517	15	14
<i>Csp<sup>3</sup>-Car</i>	CH <sub>3</sub> -Car	1.506	1.507	0.011	1.501	1.513	454	
	C#-CH <sub>2</sub> -Car	1.510	1.510	0.009	1.505	1.516	674	
	(C#) <sub>2</sub> -CH-Car	1.515	1.515	0.011	1.508	1.522	363	
	(C#) <sub>3</sub> -C-Car	1.527	1.530	0.016	1.517	1.539	308	
	C*-Car (overall)	1.513	1.513	0.014	1.505	1.521	1813	
	cyclopropyl (C)-Car	1.490	1.490	0.015	1.479	1.503	90	7
<i>Csp<sup>3</sup>-Csp<sup>1</sup></i>	C*-C≡C	1.466	1.465	0.010	1.460	1.469	21	15
	C#-C≡C	1.472	1.472	0.012	1.464	1.481	88	15
	C*-C≡N	1.470	1.469	0.013	1.463	1.479	106	7b
	cyclopropyl (C)-C≡N	1.444	1.447	0.010	1.436	1.451	38	7
<i>Csp<sup>2</sup>-Csp<sup>2</sup></i>	C=C-C=C							
	(conjugated)	1.455	1.455	0.011	1.447	1.463	30	16,18
	(unconjugated)	1.478	1.476	0.012	1.470	1.479	8	17,18
	(overall)	1.460	1.460	0.015	1.450	1.470	38	
	C=C-C=C-C=C	1.443	1.445	0.013	1.431	1.454	29	18
	C=C-C=C (endocyclic in TCNQ)	1.432	1.433	0.012	1.424	1.441	280	19
	C=C-C(=O)(-C*)							
	(conjugated)	1.464	1.462	0.018	1.453	1.476	211	16,18
	(unconjugated)	1.484	1.486	0.017	1.475	1.497	14	17,18
	(overall)	1.465	1.462	0.018	1.453	1.478	226	
	C=C-C(=O)-C=C							
	in benzoquinone (C,H-subst. only)	1.478	1.476	0.011	1.469	1.488	28	
	in benzoquinone (any subst.)	1.478	1.478	0.031	1.464	1.498	172	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	non-quinonoid	1.456	1.455	0.012	1.447	1.464	28	
	C=C-COOH	1.475	1.476	0.015	1.461	1.488	22	
	C=C-COOC*	1.488	1.489	0.014	1.478	1.497	113	
	C=C-COO <sup>-</sup>	1.502	1.499	0.017	1.488	1.510	11	
	HOOC-COOH	1.538	1.537	0.007	1.535	1.541	9	
	HOOC-COO <sup>-</sup>	1.549	1.552	0.009	1.546	1.553	13	
	<sup>-</sup> OOC-COO <sup>-</sup>	1.564	1.559	0.022	1.554	1.568	9	
	formal <i>Csp</i> <sup>2</sup> - <i>Csp</i> <sup>2</sup> single bond in selected non-fused heterocycles:							
	in 1 <i>H</i> -pyrrole (C3-C4)	1.412	1.410	0.016	1.401	1.427	29	
	in furan (C3-C4)	1.423	1.423	0.016	1.412	1.433	62	
	in thiophene (C3-C4)	1.424	1.425	0.015	1.415	1.433	40	
	in pyrazole (C3-C4)	1.410	1.412	0.016	1.400	1.418	20	
	in isoxazole (C3-C4)	1.425	1.425	0.016	1.413	1.438	9	
	in furazan (C3-C4)	1.428	1.427	0.007	1.422	1.435	6	
	in furoxan (C3-C4)	1.417	1.417	0.006	1.412	1.422	14	
<i>Csp</i> <sup>2</sup> - <i>Car</i>	C=C- <i>Car</i>							
	(conjugated)	1.470	1.470	0.015	1.463	1.480	37	16,18
<i>Csp</i> <sup>2</sup> - <i>Car</i>		1.488	1.490	0.012	1.480	1.496	87	17,18
	(overall)	1.483	1.483	0.015	1.472	1.494	124	
	cyclopropenyl (C=C)- <i>Car</i>	1.447	1.448	0.006	1.441	1.452	8	10
	<i>Car</i> -C(=O)-C*	1.488	1.489	0.016	1.478	1.500	84	
	<i>Car</i> -C(=O)- <i>Car</i>	1.480	1.481	0.017	1.468	1.494	58	
	<i>Car</i> -COOH	1.484	1.485	0.014	1.474	1.491	75	
	<i>Car</i> -C(=O)(-OC*)	1.487	1.487	0.012	1.480	1.494	218	
	<i>Car</i> -COO <sup>-</sup>	1.504	1.509	0.014	1.495	1.512	26	
	<i>Car</i> -C(-O)-NH <sub>2</sub>	1.500	1.503	0.020	1.498	1.510	19	
	<i>Car</i> -C=N-C#							
	(conjugated)	1.476	1.478	0.014	1.466	1.486	27	16
	(unconjugated)	1.491	1.490	0.008	1.485	1.496	48	17
	(overall)	1.485	1.487	0.013	1.481	1.493	75	
	in indole (C3-C3a)	1.434	1.434	0.011	1.428	1.439	40	
<i>Csp</i> <sup>2</sup> - <i>Csp</i> <sup>1</sup>	C=C-C≡C	1.431	1.427	0.014	1.425	1.441	11	7b
	C=C-C≡N in TCNQ	1.427	1.427	0.010	1.420	1.433	280	19
<i>Car</i> - <i>Car</i>	in biphenyls ( <i>ortho</i> subst. all <b>H</b> )	1.487	1.488	0.007	1.484	1.493	30	
	(≥1 non- <b>H</b> <i>ortho</i> -subst.)	1.490	1.491	0.010	1.486	1.495	212	
<i>Car</i> - <i>Csp</i> <sup>1</sup>	<i>Car</i> -C≡C	1.434	1.436	0.006	1.430	1.437	37	
	<i>Car</i> -C≡N	1.443	1.444	0.008	1.436	1.448	31	
<i>Csp</i> <sup>1</sup> - <i>Csp</i> <sup>1</sup>	C≡C-C=C	1.377	1.378	0.012	1.374	1.384	21	
<i>Csp</i> <sup>2</sup> = <i>Csp</i> <sup>2</sup>	C*-CH=CH <sub>2</sub>	1.299	1.300	0.027	1.280	1.311	42	
	(C*) <sub>2</sub> -C=CH <sub>2</sub>	1.321	1.321	0.013	1.313	1.328	77	
	C*-CH=CH-C*							
	( <i>cis</i> )	1.317	1.318	0.013	1.310	1.323	106	
	( <i>trans</i> )	1.312	1.311	0.011	1.304	1.320	19	
	(overall)	1.316	1.317	0.015	1.309	1.323	127	
	(C*) <sub>2</sub> -C=CH-C*	1.326	1.328	0.011	1.319	1.334	168	
	(C*) <sub>2</sub> -C=C-(C*) <sub>2</sub>	1.331	1.330	0.009	1.326	1.334	89	
	(C*,H) <sub>2</sub> -C=C-(C*,H) <sub>2</sub> (overall)	1.322	1.323	0.014	1.315	1.331	493	5
	in cyclopropene (any subst.)	1.294	1.288	0.017	1.284	1.302	10	10
	in cyclobutene (any subst.)	1.335	1.335	0.019	1.324	1.347	25	8
	in cyclopentene (C,H-subst.)	1.323	1.324	0.013	1.314	1.331	104	
	in cyclohexene (C,H-subst.)	1.326	1.325	0.012	1.318	1.334	196	
	C=C=C (allenes, any subst.)	1.307	1.307	0.005	1.303	1.310	18	
	C=C-C=C (C,H subst., conjugated)	1.330	1.330	0.014	1.322	1.338	76	16
	C=C-C=C-C=C (C,H subst., conjugated)	1.345	1.345	0.012	1.337	1.350	58	16
	C=C- <i>Car</i> (C,H subst., conjugated)	1.339	1.340	0.011	1.334	1.346	124	16
	C=C in cyclopenta-1,3-diene (any subst.)	1.341	1.341	0.017	1.328	1.356	18	
	C=C in cyclohexa-1,3-diene (any subst.)	1.332	1.332	0.013	1.323	1.341	56	
	in C=C-C=O							
	(C,H subst., conjugated)	1.340	1.340	0.013	1.332	1.348	211	16,18
	(C,H subst., unconjugated)	1.331	1.330	0.008	1.326	1.339	14	17,18

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	(C,H subst., overall)	1.340	1.339	0.013	1.332	1.348	226	
	in cyclohexa-2,5-dien-1-ones	1.329	1.327	0.011	1.321	1.335	28	
	in <i>p</i> -benzoquinones							
	(C*,H subst.)	1.333	1.337	0.011	1.325	1.338	14	
	(any subst.)	1.349	1.339	0.030	1.330	1.364	86	
	in TCNQ							
	(endocyclic)	1.352	1.353	0.010	1.345	1.358	142	19
	(exocyclic)	1.392	1.391	0.017	1.379	1.405	139	19
	C=C-OH in enol tautomers	1.362	1.360	0.020	1.349	1.370	54	
	in heterocycles (any subst.):							
	1 <i>H</i> -pyrrole (C2-C3, C4-C5)	1.375	1.377	0.018	1.361	1.388	58	
	furan (C2-C3, C4-C5)	1.341	1.342	0.021	1.329	1.351	125	
	thiophene (C2-C3, C4-C5)	1.362	1.359	0.025	1.346	1.377	60	
	pyrazole (C4-C5)	1.369	1.372	0.019	1.362	1.383	20	
	imidazole (C4-C5)	1.360	1.361	0.014	1.352	1.367	44	
	isoxazole (C4-C5)	1.341	1.336	0.012	1.331	1.355	9	
	indole (C2-C3)	1.364	1.363	0.012	1.355	1.371	40	
<i>Car</i> $\simeq$ <i>Car</i>	in phenyl rings with C*, H subst. only							
	H-C $\simeq$ C-H	1.380	1.381	0.013	1.372	1.388	2191	
	C*-C $\simeq$ C-H	1.387	1.388	0.010	1.382	1.393	891	
	C*-C $\simeq$ C-C*	1.397	1.397	0.009	1.392	1.403	182	
	C $\simeq$ C (overall)	1.384	1.384	0.013	1.375	1.391	3264	
	F-C $\simeq$ C-F	1.372	1.374	0.011	1.366	1.380	84	4
	Cl-C $\simeq$ C-Cl	1.388	1.389	0.014	1.380	1.398	152	4
	in naphthalene (D <sub>2h</sub> , any subst.)							
	C1-C2	1.364	1.364	0.014	1.356	1.373	440	
	C2-C3	1.406	1.406	0.014	1.397	1.415	218	
	C1-C8a	1.420	1.419	0.012	1.412	1.426	440	
	C4a-C8a	1.422	1.424	0.011	1.417	1.429	109	
<i>Car</i> $\simeq$ <i>Car</i>	in anthracene (D <sub>2h</sub> , any subst.)							
	C1-C2	1.356	1.356	0.009	1.350	1.360	56	
	C2-C3	1.410	1.410	0.010	1.401	1.416	34	
	C1-C9a	1.430	1.430	0.006	1.426	1.434	56	
	C4a-C9a	1.435	1.436	0.007	1.429	1.440	34	
	C9-C9a	1.400	1.402	0.009	1.395	1.406	68	
	in pyridine (C,H subst.)	1.379	1.381	0.012	1.371	1.387	276	20
	(any subst.)	1.380	1.380	0.015	1.371	1.389	537	20
	in pyridinium cation							
	(N <sup>+</sup> -H; C,H subst. on C)							
	C2-C3	1.373	1.375	0.012	1.368	1.380	30	
	C3-C4	1.379	1.380	0.011	1.371	1.388	30	
	(N <sup>+</sup> -X; C,H subst. on C)							
	C2-C3	1.373	1.372	0.019	1.362	1.382	151	
	C3-C4	1.383	1.385	0.019	1.372	1.394	151	
	in pyrazine (H subst. on C)	1.379	1.377	0.010	1.370	1.388	10	
	(any subst. on C)	1.405	1.405	0.024	1.388	1.420	60	
	in pyrimidine (C,H subst. on C)	1.387	1.389	0.018	1.379	1.400	28	
<i>Csp</i> <sup>1</sup> $\equiv$ <i>Csp</i> <sup>1</sup>	X-C $\equiv$ C-X	1.183	1.183	0.014	1.174	1.193	119	15
	C,H-C $\equiv$ C-C,H	1.181	1.181	0.014	1.173	1.192	104	15
	in C $\equiv$ C-C( <i>sp</i> <sup>2</sup> , <i>ar</i> )	1.189	1.193	0.010	1.181	1.195	38	15
	in C $\equiv$ C-C $\equiv$ C	1.192	1.192	0.010	1.187	1.197	42	15
	in CH $\equiv$ C-C#	1.174	1.174	0.011	1.167	1.180	42	15
<i>Csp</i> <sup>3</sup> -Cl	Omitting 1,2-dichlorides:							
	C-CH <sub>2</sub> -Cl	1.790	1.790	0.007	1.783	1.795	13	4
	C <sub>2</sub> -CH-Cl	1.803	1.802	0.003	1.800	1.807	8	4
	C <sub>3</sub> -C-Cl	1.849	1.856	0.011	1.837	1.858	5	4
	X-CH <sub>2</sub> -Cl (X = C,H,N,O)	1.790	1.791	0.011	1.783	1.797	37	4
	X <sub>2</sub> -CH-Cl (X = C,H,N,O)	1.805	1.803	0.014	1.800	1.812	26	4
	X <sub>3</sub> -C-Cl (X = C,H,N,O)	1.843	1.838	0.014	1.835	1.858	7	4
	X <sub>2</sub> -C-Cl <sub>2</sub> (X = C,H,N,O)	1.779	1.776	0.015	1.769	1.790	18	4
	X-C-Cl <sub>3</sub> (X = C,H,N,O)	1.768	1.765	0.011	1.761	1.776	33	4

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	Cl-CH(-C)-CH(-C)-Cl	1.793	1.793	0.013	1.786	1.800	66	4
	Cl-C(-C <sub>2</sub> )-C(-C <sub>2</sub> )-Cl	1.762	1.760	0.010	1.757	1.765	54	4
	cyclopropyl-Cl	1.755	1.756	0.011	1.749	1.763	64	
<i>Csp</i> <sup>2</sup> -Cl	C=C-Cl (C,H,N,O subst. on C)	1.734	1.729	0.019	1.719	1.748	63	4
	C=C-Cl <sub>2</sub> (C,H,N,O subst. on C)	1.720	1.716	0.013	1.708	1.729	20	4
	Cl-C=C-Cl	1.713	1.711	0.011	1.705	1.720	80	4
<i>Car</i> -Cl	<i>Car</i> -Cl (mono-Cl + m,p-Cl <sub>2</sub> )	1.739	1.741	0.010	1.734	1.745	340	4
	<i>Car</i> -Cl ( <i>o</i> -Cl <sub>2</sub> )	1.720	1.720	0.010	1.713	1.717	364	4
<i>Csp</i> <sup>1</sup> Cl	see HCLENE10 (1.634, 1.646)							
<i>Csp</i> <sup>3</sup> -F	Omitting 1,2-difluorides							
	C-CH <sub>2</sub> -F and C <sub>2</sub> -CH-F	1.399	1.399	0.017	1.389	1.408	25	4
	C <sub>3</sub> -C-F	1.428	1.431	0.009	1.421	1.435	11	4
	(C*,H) <sub>2</sub> -C-F <sub>2</sub>	1.349	1.347	0.012	1.342	1.356	58	4
	C*-C-F <sub>3</sub>	1.336	1.334	0.007	1.330	1.344	12	4
	F-C*-C*-F	1.371	1.374	0.007	1.362	1.375	26	4
	X <sub>3</sub> -C-F (X = C,H,N,O)	1.386	1.389	0.033	1.373	1.408	70	4
	X <sub>2</sub> -C-F <sub>2</sub> (X = C,H,N,O)	1.351	1.349	0.013	1.342	1.356	58	4
	X-C-F <sub>3</sub> (X = C,H,N,O)	1.322	1.323	0.015	1.314	1.332	309	4
	F-C(-X) <sub>2</sub> -C(-X) <sub>2</sub> -F (X = C,H,N,O)	1.373	1.374	0.009	1.362	1.377	30	4
	F-C(-X) <sub>2</sub> -NO <sub>2</sub> (X = any subst.)	1.320	1.319	0.009	1.312	1.327	18	
<i>Csp</i> <sup>2</sup> -F	C=C-F (C,H,N,O subst. on C)	1.340	1.340	0.013	1.334	1.346	34	4
<i>Car</i> -F	<i>Car</i> -F (mono-F + m,p-F <sub>2</sub> )	1.363	1.362	0.008	1.357	1.368	38	4
	<i>Car</i> -F ( <i>o</i> -F <sub>2</sub> )	1.340	1.340	0.009	1.336	1.344	167	4
<i>Csp</i> <sup>3</sup> -H	C-C-H <sub>3</sub> (methyl)	1.059	1.061	0.030	1.039	1.083	83	21
	C <sub>2</sub> -C-H <sub>2</sub> (primary)	1.092	1.095	0.013	1.088	1.099	100	21
	C <sub>3</sub> -C-H (secondary)	1.099	1.097	0.004	1.095	1.103	14	21
	C <sub>2,3</sub> -C-H (primary and secondary)	1.093	1.095	0.012	1.089	1.100	118	21
	X-C-H <sub>3</sub> (methyl)	1.066	1.074	0.028	1.049	1.087	160	21
	X <sub>2</sub> -C-H <sub>2</sub> (primary)	1.092	1.095	0.012	1.088	1.099	230	21
	X <sub>3</sub> -C-H (secondary)	1.099	1.099	0.007	1.095	1.103	117	21
	X <sub>2,3</sub> -C-H (primary and secondary)	1.094	1.096	0.011	1.091	1.100	348	21
<i>Csp</i> <sup>2</sup> -H	C=C=C-H	1.077	1.079	0.012	1.074	1.085	14	21
<i>Car</i> -H	<i>Car</i> -H	1.083	1.083	0.011	1.080	1.087	218	21
<i>Csp</i> <sup>3</sup> -I	C*-I	2.162	2.159	0.015	2.149	2.179	15	4
<i>Car</i> -I	<i>Car</i> -I	2.095	2.095	0.015	2.089	2.104	51	4
<i>Csp</i> <sup>3</sup> -N(4)	C*-NH <sub>3</sub> <sup>+</sup>	1.488	1.488	0.013	1.482	1.495	298	
	(C*) <sub>2</sub> -NH <sub>2</sub> <sup>+</sup>	1.494	1.493	0.016	1.484	1.503	249	
	(C*) <sub>3</sub> -NH <sup>+</sup>	1.502	1.502	0.015	1.491	1.512	509	
	(C*) <sub>4</sub> -N <sup>+</sup>	1.510	1.509	0.020	1.496	1.523	319	
	C*-N <sup>+</sup> (overall)	1.499	1.498	0.018	1.488	1.510	1370	
<i>Csp</i> <sup>3</sup> -N(3)	C*-N <sup>+</sup> in N-subst. pyridinium	1.485	1.484	0.009	1.477	1.490	32	
	C*-NH <sub>2</sub> ( <i>Nsp</i> <sup>3</sup> : pyramidal)	1.469	1.470	0.010	1.462	1.474	19	22
	(C*) <sub>2</sub> -NH ( <i>Nsp</i> <sup>3</sup> : pyramidal)	1.469	1.467	0.012	1.461	1.477	152	5,22
	(C*) <sub>3</sub> -N ( <i>Nsp</i> <sup>3</sup> : pyramidal)	1.469	1.468	0.014	1.460	1.476	1042	5,22
	C*- <i>Nsp</i> <sup>3</sup> (overall)	1.469	1.468	0.014	1.460	1.476	1201	
	<i>Csp</i> <sup>3</sup> - <i>Nsp</i> <sup>3</sup>							
	in aziridine	1.472	1.471	0.016	1.464	1.482	134	
	in azetidine	1.484	1.481	0.018	1.472	1.495	21	
	in tetrahydropyrrole	1.475	1.473	0.016	1.464	1.483	66	
	in piperidine	1.473	1.473	0.013	1.460	1.479	240	
	<i>Csp</i> <sup>3</sup> - <i>Nsp</i> <sup>2</sup> (N planar) in:							23
	acyclic amides C*-NH-C=O	1.454	1.451	0.011	1.446	1.461	78	14
	β-lactams C*-N(-X)-C=O (endo)	1.464	1.465	0.012	1.458	1.475	23	13
	γ-lactams							
	C*-NH-C=O (endo)	1.457	1.458	0.011	1.449	1.465	20	13
	C*-N(-C*)-C=O (endo)	1.462	1.461	0.010	1.453	1.466	15	13
	C*-N(-C*)-C=O (exo)	1.458	1.456	0.014	1.448	1.465	15	13
	δ-lactams							
	C*-NH-C=O (endo)	1.478	1.472	0.016	1.467	1.491	6	14
	C*-N(-C*)-C=O (endo)	1.479	1.476	0.007	1.475	1.482	15	14
	C*-N(-C*)-C=O (exo)	1.468	1.471	0.009	1.462	1.477	15	14

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	nitro compounds (1,2-dinitro omitted):							
	C-CH <sub>2</sub> -NO <sub>2</sub>	1.485	1.483	0.020	1.478	1.502	8	
	C <sub>2</sub> -CH-NO <sub>2</sub>	1.509	1.509	0.011	1.502	1.511	12	
	C <sub>3</sub> -C-NO <sub>2</sub>	1.533	1.533	0.013	1.530	1.539	17	
	C <sub>2</sub> -C-(NO <sub>2</sub> ) <sub>2</sub>	1.537	1.536	0.016	1.525	1.550	19	
	1,2-dinitro: NO <sub>2</sub> -C*-C*-NO <sub>2</sub>	1.552	1.550	0.023	1.536	1.572	32	
Csp <sup>3</sup> -N(2)	C#-N=N	1.493	1.493	0.020	1.477	1.506	54	
	C*-N=C-Car	1.465	1.468	0.011	1.461	1.472	75	
Csp <sup>2</sup> -N(3)	C=C-NH <sub>2</sub> Nsp <sup>2</sup> planar	1.336	1.344	0.017	1.317	1.348	10	23
	C=C-NH-C# Nsp <sup>2</sup> planar	1.339	1.340	0.016	1.327	1.351	17	23
	C=C-N-(C#) <sub>2</sub>							
	Nsp <sup>2</sup> planar	1.355	1.358	0.014	1.341	1.363	22	23
	Nsp <sup>3</sup> pyramidal	1.416	1.418	0.018	1.397	1.432	18	22
	Csp <sup>2</sup> -Nsp <sup>2</sup> (N planar) in:							23
	acyclic amides							
	NH <sub>2</sub> -C=O	1.325	1.323	0.009	1.318	1.331	32	14
	C*-NH-C=O	1.334	1.333	0.011	1.326	1.343	78	14
	(C*) <sub>2</sub> -N-C=O	1.346	1.342	0.011	1.339	1.356	5	14
	β-lactams C*-NH-C=O	1.385	1.388	0.019	1.374	1.396	23	13
	γ-lactams							
	C*-NH-C=O	1.331	1.331	0.011	1.326	1.337	20	13
	C*-N(-C*)-C=O	1.347	1.344	0.014	1.335	1.359	15	13
	δ-lactams							
	C*-NH-C=O	1.334	1.334	0.006	1.330	1.339	6	14
	(C*)-N(-C*)-C=O	1.352	1.353	0.010	1.344	1.356	15	14
	peptides C#-N(-X)-C(-C#)(=O)	1.333	1.334	0.013	1.326	1.340	380	24
	ureas							
	(NH <sub>2</sub> ) <sub>2</sub> -C=O	1.334	1.334	0.008	1.329	1.339	48	25,26
	(C#-NH) <sub>2</sub> -C=O	1.347	1.345	0.010	1.341	1.354	26	25
	[(C#) <sub>n</sub> -N] <sub>2</sub> -C=O	1.363	1.359	0.014	1.354	1.370	40	25,27
	thioureas	1.346	1.343	0.023	1.328	1.361	192	
	(X <sub>2</sub> N) <sub>2</sub> -C=S							
	imides							
	[C#-C(=O)] <sub>2</sub> -NH	1.376	1.377	0.012	1.369	1.383	64	
	[C#-C(=O)] <sub>2</sub> -N-C#	1.389	1.383	0.017	1.376	1.404	38	
	[Csp <sup>2</sup> -C(=O)] <sub>2</sub> -N-C#	1.396	1.396	0.010	1.389	1.403	46	
	[Csp <sup>2</sup> -C(=O)] <sub>2</sub> -N-Csp <sup>2</sup>	1.409	1.406	0.020	1.391	1.419	28	
	guanidinium [C-(NH <sub>2</sub> ) <sub>3</sub> ] <sup>+</sup> (unsubst.)	1.321	1.320	0.008	1.314	1.327	39	
	(any subst.)	1.328	1.325	0.015	1.317	1.333	140	
	in heterocyclic systems (any subst.)							
	1H-pyrrole (N1-C2, N1-C5)	1.372	1.374	0.016	1.363	1.384	58	
	indole (N1-C2)	1.370	1.370	0.012	1.364	1.377	40	
	pyrazole (N1-C5)	1.357	1.359	0.012	1.347	1.365	20	
	imidazole (N1-C2)	1.349	1.349	0.018	1.338	1.358	44	
	imidazole (N1-C5)	1.370	1.370	0.010	1.365	1.377	44	
Csp <sup>2</sup> -N(2)	in imidazole (N3-C4)	1.376	1.377	0.011	1.369	1.384	44	
Car-N(4)	Car-N <sup>+</sup> -(C,H) <sub>3</sub>	1.465	1.466	0.007	1.461	1.470	23	
Car-N(3)	Car-NH <sub>2</sub>							
	(Nsp <sup>2</sup> : planar)	1.355	1.360	0.020	1.340	1.372	33	23
	(Nsp <sup>3</sup> : pyramidal)	1.394	1.396	0.011	1.385	1.403	25	22
	(overall)	1.375	1.377	0.025	1.363	1.394	98	28
Car-N(3)	Car-NH-C#							
	(Nsp <sup>2</sup> : planar)	1.353	1.353	0.007	1.347	1.359	16	23
	(Nsp <sup>3</sup> : pyramidal)	1.419	1.423	0.017	1.412	1.432	8	22
	(overall)	1.380	1.364	0.032	1.353	1.412	31	28
	Car-N-(C#) <sub>2</sub>							
	(Nsp <sup>2</sup> : planar)	1.371	1.370	0.016	1.363	1.382	41	23
	(Nsp <sup>3</sup> : pyramidal)	1.426	1.425	0.011	1.421	1.431	22	22
	(overall)	1.390	1.385	0.030	1.366	1.420	69	28
	in indole (N1-C7a)	1.372	1.372	0.007	1.367	1.376	40	
	Car-NO <sub>2</sub>	1.468	1.469	0.014	1.460	1.476	556	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
<i>Car</i> -N(2)	<i>Car</i> -N=N	1.431	1.435	0.020	1.422	1.442	26	
<i>Csp</i> <sup>2</sup> =N(3)	in furoxan ( <sup>+</sup> N <sub>2</sub> =C <sub>3</sub> )	1.316	1.316	0.009	1.311	1.324	14	
<i>Csp</i> <sup>2</sup> =N(2)	<i>Car</i> -C=N-C#	1.279	1.279	0.008	1.275	1.285	75	
	(C,H) <sub>2</sub> -C=N-OH in oximes	1.281	1.280	0.013	1.273	1.288	67	
	S-C=N-X	1.302	1.302	0.021	1.285	1.319	36	
	in pyrazole (N <sub>2</sub> =C <sub>3</sub> )	1.329	1.331	0.014	1.315	1.339	20	
	in imidazole (C <sub>2</sub> =N <sub>3</sub> )	1.313	1.314	0.011	1.307	1.319	44	
	in isoxazole (N <sub>2</sub> =C <sub>3</sub> )	1.314	1.315	0.009	1.305	1.320	9	
	in furazan (N <sub>2</sub> =C <sub>3</sub> , C <sub>4</sub> =N <sub>5</sub> )	1.298	1.299	0.006	1.294	1.303	12	
	in furoxan (C <sub>4</sub> =N <sub>5</sub> )	1.304	1.306	0.008	1.300	1.308	14	
<i>Car</i> ≈ N(3)	C ≈ N <sup>+</sup> -H (pyrimidinium)	1.335	1.334	0.015	1.325	1.342	30	
	C ≈ N <sup>+</sup> -C* (pyrimidinium)	1.346	1.346	0.010	1.340	1.352	64	
	C ≈ N <sup>+</sup> -O <sup>-</sup> (pyrimidinium)	1.362	1.359	0.013	1.353	1.369	56	
<i>Car</i> ≈ N(2)	C ≈ N (pyridine)	1.337	1.338	0.012	1.330	1.344	269	
	C ≈ N (pyrazine)	1.336	1.335	0.022	1.319	1.347	120	
	C ≈ N ≈ C (pyrimidine)	1.339	1.338	0.015	1.333	1.342	28	
	N ≈ C ≈ N (pyrimidine)	1.333	1.335	0.013	1.326	1.337	28	
	C ≈ N (pyrimidine) (overall)	1.336	1.337	0.014	1.331	1.339	56	
	in any 6-membered N-containing aromatic ring:							
	H-C ≈ N ≈ C-H	1.334	1.334	0.014	1.327	1.341	146	
	H-C ≈ N ≈ C-C*	1.339	1.341	0.013	1.336	1.345	38	
	C*-C ≈ N ≈ C-C*	1.345	1.345	0.008	1.342	1.348	24	
	C ≈ N ≈ C (overall)	1.336	1.337	0.014	1.329	1.344	204	
<i>Csp</i> <sup>1</sup> ≡N(2)	X-S-N≡C <sup>-</sup> (isothiocyanide)	1.144	1.147	0.006	1.140	1.148	6	
<i>Csp</i> <sup>1</sup> ≡N(1)	C*-C≡N	1.136	1.137	0.010	1.131	1.142	140	
	C=C-C≡N in TCNQ	1.144	1.144	0.008	1.139	1.149	284	19
	<i>Car</i> -C≡N	1.138	1.138	0.007	1.133	1.143	31	
	X-C≡N	1.144	1.141	0.012	1.138	1.151	10	
	(S-C≡N) <sup>-</sup>	1.155	1.156	0.012	1.147	1.165	14	
<i>Csp</i> <sup>3</sup> -O(2)	in alcohols							
	CH <sub>3</sub> -OH	1.413	1.414	0.018	1.395	1.425	17	
	C-CH <sub>2</sub> -OH	1.426	1.426	0.011	1.420	1.431	75	
	C <sub>2</sub> -CH-OH	1.432	1.431	0.011	1.425	1.439	266	
	C <sub>3</sub> -C-OH	1.440	1.440	0.012	1.432	1.449	106	
	C*-OH (overall)	1.432	1.431	0.013	1.424	1.441	464	
	in dialkyl ethers							29
	CH <sub>3</sub> -O-C*	1.416	1.418	0.016	1.405	1.426	110	
	C-CH <sub>2</sub> -O-C*	1.426	1.424	0.011	1.418	1.435	34	
	C <sub>2</sub> -CH-O-C*	1.429	1.430	0.010	1.420	1.437	53	
	C <sub>3</sub> -C-O-C*	1.452	1.450	0.011	1.445	1.458	39	
	C*-O-C* (overall)	1.426	1.425	0.019	1.414	1.437	236	5
	in aryl alkyl ethers							29
	CH <sub>3</sub> -O- <i>Car</i>	1.424	1.424	0.012	1.417	1.431	616	
	C-CH <sub>2</sub> -O- <i>Car</i>	1.431	1.430	0.013	1.422	1.438	188	
	C <sub>2</sub> -CH-O- <i>Car</i>	1.447	1.446	0.020	1.435	1.466	58	
	C <sub>3</sub> -C-O- <i>Car</i>	1.470	1.469	0.018	1.456	1.483	55	
	C*-O- <i>Car</i> (overall)	1.429	1.427	0.018	1.419	1.436	917	
	in alkyl esters of carboxylic acids							12,29
	CH <sub>3</sub> -O-C(=O)-C*	1.448	1.449	0.010	1.442	1.455	200	
	C-CH <sub>2</sub> -O-C(=O)-C*	1.452	1.453	0.009	1.445	1.458	32	
	C <sub>2</sub> -CH-O-C(=O)-C*	1.460	1.460	0.010	1.454	1.465	78	
	C <sub>3</sub> -C-O-C(=O)-C*	1.477	1.475	0.008	1.472	1.484	6	
	C*-O-C(=O)-C* (overall)	1.450	1.451	0.014	1.442	1.459	314	
	in alkyl esters of α,β-unsaturated acids:							
	C*-O-C(=O)-C=C (overall)	1.453	1.452	0.013	1.444	1.459	112	
	in alkyl esters of benzoic acid							
	C*-O-C(=O)-C(phenyl) (overall)	1.454	1.454	0.012	1.446	1.463	219	
	in ring systems							
	oxirane (epoxides) (any subst.)	1.446	1.446	0.014	1.438	1.456	498	9
	oxetane (any subst.)	1.463	1.460	0.015	1.451	1.474	16	
	tetrahydrofuran (C,H subst.)	1.442	1.441	0.017	1.430	1.451	154	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	<i>q</i> <sub>1</sub>	<i>q</i> <sub>0</sub>	<i>n</i>	Note
<i>Csp</i> <sup>3</sup> -O(2)	tetrahydropyran (C,H subst.)	1.441	1.442	0.015	1.431	1.451	22	
	β-lactones: C*-O-C(=O)	1.492	1.494	0.010	1.481	1.501	4	16
	γ-lactones: C*-O-C(=O)	1.464	1.464	0.012	1.455	1.473	110	12
	δ-lactones: C*-O-C(=O)	1.461	1.464	0.017	1.452	1.473	27	12
	O-C-O system in <i>gem</i> -diols, and pyranose and furanose sugars:							30,31
	HO-C*-OH	1.397	1.401	0.012	1.388	1.405	18	
	C <sub>5</sub> -O <sub>5</sub> -C <sub>1</sub> -O <sub>1</sub> H in pyranoses							
	O <sub>1</sub> axial (α):							
	C <sub>5</sub> -O <sub>5</sub>	1.439	1.440	0.008	1.432	1.445	29	
	O <sub>5</sub> -C <sub>1</sub>	1.427	1.426	0.012	1.421	1.432	29	
	C <sub>1</sub> -O <sub>1</sub>	1.403	1.400	0.012	1.391	1.412	29	
	O <sub>1</sub> equatorial (β):							
	C <sub>5</sub> -O <sub>5</sub>	1.435	1.436	0.008	1.429	1.440	17	
	O <sub>5</sub> -C <sub>1</sub>	1.430	1.431	0.010	1.424	1.436	17	
	C <sub>1</sub> -O <sub>1</sub>	1.393	1.393	0.007	1.386	1.399	17	
α + β (overall):								
C <sub>5</sub> -O <sub>5</sub>	1.439	1.440	0.008	1.432	1.446	60		
O <sub>5</sub> -C <sub>1</sub>	1.430	1.429	0.012	1.421	1.436	60		
C <sub>1</sub> -O <sub>1</sub>	1.401	1.399	0.011	1.392	1.407	60		
C <sub>4</sub> -O <sub>4</sub> -C <sub>1</sub> -O <sub>1</sub> H in furanoses (overall values)								
C <sub>4</sub> -O <sub>4</sub>	1.442	1.446	0.012	1.436	1.449	18		
O <sub>4</sub> -C <sub>1</sub>	1.432	1.432	0.012	1.421	1.443	18		
C <sub>1</sub> -O <sub>1</sub>	1.404	1.405	0.013	1.397	1.409	18		
C <sub>5</sub> -O <sub>5</sub> -C <sub>1</sub> -O <sub>1</sub> -C* in pyranoses								
O <sub>1</sub> axial (α):								
C <sub>5</sub> -O <sub>5</sub>	1.439	1.438	0.010	1.433	1.446	67		
O <sub>5</sub> -C <sub>1</sub>	1.417	1.417	0.009	1.410	1.424	67		
C <sub>1</sub> -O <sub>1</sub>	1.409	1.409	0.014	1.401	1.417	67		
O <sub>1</sub> -C*	1.435	1.435	0.013	1.427	1.443	67		
O <sub>1</sub> equatorial (β):								
C <sub>5</sub> -O <sub>5</sub>	1.434	1.435	0.006	1.429	1.439	39		
O <sub>5</sub> -C <sub>1</sub>	1.424	1.424	0.008	1.418	1.431	39		
C <sub>1</sub> -O <sub>1</sub>	1.390	1.390	0.011	1.381	1.400	39		
O <sub>1</sub> -C*	1.437	1.438	0.013	1.428	1.445	39		
α + β (overall):								
C <sub>5</sub> -O <sub>5</sub>	1.436	1.436	0.009	1.431	1.442	126		
O <sub>5</sub> -C <sub>1</sub>	1.419	1.419	0.011	1.412	1.426	126		
C <sub>1</sub> -O <sub>1</sub>	1.402	1.403	0.016	1.391	1.413	126		
O <sub>1</sub> -C*	1.436	1.436	0.013	1.428	1.445	126		
C <sub>4</sub> -O <sub>4</sub> -C <sub>1</sub> -O <sub>1</sub> -C* in furanoses (overall values)								
C <sub>4</sub> -O <sub>4</sub>	1.443	1.445	0.013	1.429	1.453	23		
O <sub>4</sub> -C <sub>1</sub>	1.421	1.418	0.012	1.413	1.431	23		
C <sub>1</sub> -O <sub>1</sub>	1.410	1.409	0.014	1.401	1.420	23		
O <sub>1</sub> -C*	1.439	1.437	0.014	1.429	1.449	23		
Miscellaneous:								
C#-O-SiX <sub>3</sub>	1.416	1.416	0.017	1.405	1.428	29		
C*-O-SO <sub>2</sub> -C	1.465	1.461	0.014	1.454	1.475	33		
<i>Csp</i> <sup>2</sup> -O(2)	in enols: C=C-OH	1.333	1.331	0.017	1.324	1.342	53	
	in enol esters: C=C-O-C*	1.354	1.353	0.016	1.341	1.363	40	
	in acids:							
	C*-C(=O)-OH	1.308	1.311	0.019	1.298	1.320	174	
	C=C-C(=O)-OH	1.293	1.295	0.019	1.279	1.307	22	
	<i>Car</i> -C(=O)-OH	1.305	1.311	0.020	1.291	1.317	75	
	in esters:							
	C*-C(=O)-O-C*	1.336	1.337	0.014	1.328	1.346	551	12,29
	C=C-C(=O)-O-C*	1.332	1.331	0.011	1.324	1.339	112	
	<i>Car</i> -C(=O)-O-C*	1.337	1.335	0.013	1.329	1.344	219	12
	C*-C(=O)-O-C=C	1.362	1.359	0.018	1.351	1.374	26	
C*-C(=O)-O-C=C	1.407	1.405	0.017	1.394	1.420	26		



Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
	$C^*-C(=O)-O-Car$	1.360	1.359	0.011	1.355	1.367	40	12
	in anhydrides: $O=C-O-C=O$	1.386	1.386	0.011	1.379	1.393	70	
	in ring systems:							
	furan (O1-C2, O1-C5)	1.368	1.369	0.015	1.359	1.377	125	
	isoxazole (O1-C5)	1.354	1.354	0.010	1.345	1.360	9	
	$\beta$ -lactones: $C^*-C(=O)-O-C^*$	1.359	1.359	0.013	1.348	1.371	4	13
	$\gamma$ -lactones: $C^*-C(=O)-O-C^*$	1.350	1.349	0.012	1.342	1.359	110	12
	$\delta$ -lactones: $C^*-C(=O)-O-C^*$	1.339	1.339	0.016	1.332	1.347	27	12
<i>Car</i> -O(2)	in phenols: <i>Car</i> -OH	1.362	1.364	0.015	1.353	1.373	551	
	in aryl alkyl ethers: <i>Car</i> -O-C*	1.370	1.370	0.011	1.363	1.377	920	29,32
<i>Car</i> -O(2)	in diaryl ethers: <i>Car</i> -O- <i>Car</i>	1.384	1.381	0.014	1.375	1.391	132	
	in esters: <i>Car</i> -O-C(=O)-C*	1.401	1.401	0.010	1.394	1.408	40	12
<i>Csp</i> <sup>2</sup> =O(1)	in aldehydes and ketones:							
	$C^*-CH=O$	1.192	1.192	0.005	1.188	1.197	7	
	$(C^*)_2-C=O$	1.210	1.210	0.008	1.206	1.215	474	5
	$(C\#)_2-C=O$							
	in cyclobutanones	1.198	1.198	0.007	1.194	1.204	12	
	in cyclopentanones	1.208	1.208	0.007	1.203	1.212	155	
	in cyclohexanones	1.211	1.211	0.009	1.207	1.216	312	
	$C=C-C=O$	1.222	1.222	0.010	1.216	1.229	225	
	$(C=C)_2-C=O$	1.233	1.229	0.010	1.226	1.242	28	
	<i>Car</i> -C=O	1.221	1.218	0.014	1.212	1.229	85	
	$(Car)_2-C=O$	1.230	1.226	0.015	1.220	1.238	66	
	C=O in benzoquinones	1.222	1.220	0.013	1.211	1.231	86	
	delocalized double bonds in carboxylate anions:							
	H-C $\simeq$ O <sub>2</sub> <sup>-</sup> (formate)	1.242	1.243	0.012	1.234	1.252	24	
	$C^*-C \simeq O_2^-$	1.254	1.253	0.010	1.247	1.261	114	
	$C=C-C \simeq O_2^-$	1.250	1.248	0.017	1.238	1.261	52	
	<i>Car</i> -C $\simeq O_2^-$	1.255	1.253	0.010	1.249	1.262	22	
	HOOC-C $\simeq O_2^-$ (hydrogen oxalate)	1.243	1.247	0.015	1.232	1.256	26	
	$-O_2 \simeq C-C \simeq O_2^-$ (oxalate)	1.251	1.251	0.007	1.248	1.254	18	
	in carboxylic acids (X-COOH)							
	$C^*-C(=O)-OH$	1.214	1.214	0.019	1.203	1.224	175	
	$C=C-C(=O)-OH$	1.229	1.226	0.017	1.218	1.237	22	
	<i>Car</i> -C(=O)-OH	1.226	1.223	0.020	1.211	1.241	75	
	in esters:							
	$C^*-C(=O)-O-C^*$	1.196	1.196	0.010	1.190	1.202	551	12
	$C=C-C(=O)-O-C^*$	1.199	1.198	0.009	1.193	1.203	113	
	<i>Car</i> -C(=O)-O-C*	1.202	1.201	0.009	1.196	1.207	218	12
	$C^*-C(=O)-O-C=C$	1.190	1.190	0.014	1.184	1.198	26	
	$C^*-C(=O)-O-Car$	1.187	1.188	0.011	1.181	1.195	40	12
	in anhydrides: $O=C-O-C=O$	1.187	1.187	0.010	1.184	1.193	70	
	in $\beta$ -lactones: $C^*-C(=O)-O-C^*$	1.193	1.193	0.006	1.187	1.198	4	13
	$\gamma$ -lactones: $C^*-C(=O)-O-C^*$	1.201	1.202	0.009	1.196	1.206	109	12
	$\delta$ -lactones: $C^*-C(=O)-O-C^*$	1.205	1.207	0.008	1.201	1.209	27	12
	in amides:							
	NH <sub>2</sub> -C(-C*)=O	1.234	1.233	0.012	1.225	1.243	32	14
	$(C^*)(C^*,H-)N-C(-C^*)=O$	1.231	1.231	0.012	1.224	1.238	378	14
	$\beta$ -lactams: $C^*-NH-C=O$	1.198	1.200	0.012	1.193	1.204	23	13
	$\gamma$ -lactams:							
	$C^*-NH-C=O$	1.235	1.235	0.008	1.232	1.240	20	13
	$C^*-N(-C^*)-C=O$	1.225	1.226	0.011	1.217	1.233	15	13
	$\delta$ -lactams:							
	$C^*-NH-C=O$	1.240	1.241	0.003	1.237	1.243	6	14
	$C^*-N(-C^*)-C=O$	1.233	1.233	0.007	1.229	1.239	15	14
	in ureas:							
	$(NH)_2-C=O$	1.256	1.256	0.007	1.249	1.261	24	25,26
	$(C\#-NH)_2-C=O$	1.241	1.237	0.011	1.235	1.245	13	25
	$[(C\#)_n-N]_2-C=O$	1.230	1.230	0.007	1.224	1.234	20	25,27
<i>Csp</i> <sup>3</sup> -P(4)	$C_3-P^+-C^*$	1.800	1.802	0.015	1.790	1.812	35	33
	$C_2-P(=O)-CH_3$	1.791	1.790	0.006	1.786	1.795	10	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	<i>q</i> <sub>1</sub>	<i>q</i> <sub>n</sub>	<i>n</i>	Note
	C <sub>2</sub> -P(=O)-CH <sub>2</sub> -C	1.806	1.806	0.009	1.801	1.813	45	
	C <sub>2</sub> -P(=O)-CH-C <sub>2</sub>	1.821	1.821	0.009	1.815	1.828	15	
	C <sub>2</sub> -P(=O)-C-C <sub>3</sub>	1.841	1.842	0.008	1.835	1.847	14	
	C <sub>2</sub> -P(=O)-C* (overall)	1.813	1.811	0.017	1.800	1.822	84	
Csp <sup>3</sup> -P(3)	C <sub>2</sub> -P-C*	1.855	1.857	0.019	1.840	1.870	23	
Car-P(4)	C <sub>3</sub> -P <sup>+</sup> -Car	1.793	1.792	0.011	1.786	1.800	276	
	C <sub>2</sub> -P(=O)-Car	1.801	1.802	0.011	1.796	1.807	98	
	Ph <sub>3</sub> -P=N <sup>+</sup> =P-Ph <sub>3</sub>	1.795	1.795	0.008	1.789	1.800	197	
Car-P(3)	C <sub>2</sub> -P-Car	1.836	1.837	0.010	1.830	1.844	102	
	(N $\simeq$ ) <sub>2</sub> P-Car (P $\simeq$ N aromatic)	1.795	1.793	0.011	1.788	1.803	43	
Csp <sup>3</sup> -S(4)	C*-SO <sub>2</sub> -C (C* = CH <sub>3</sub> excluded)	1.786	1.782	0.018	1.774	1.797	75	
	C*-SO <sub>2</sub> -C (overall)	1.779	1.778	0.020	1.764	1.790	94	
	C*-SO <sub>2</sub> -O-X	1.745	1.744	0.009	1.738	1.754	7	34
	C*-SO <sub>2</sub> -N-X <sub>2</sub>	1.758	1.756	0.018	1.746	1.773	17	34
Csp <sup>3</sup> -S(3)	C*-S(=O)-C (C* = CH <sub>3</sub> excluded)	1.818	1.814	0.024	1.802	1.829	69	
	C*-S(=O)-C (overall)	1.809	1.806	0.025	1.793	1.820	88	
	CH <sub>3</sub> -S <sup>+</sup> -X <sub>2</sub>	1.786	1.787	0.007	1.779	1.792	21	
	C*-S <sup>+</sup> -X <sub>2</sub> (C* = CH <sub>3</sub> excluded)	1.823	1.820	0.016	1.812	1.834	18	
	C*-S <sup>+</sup> -X <sub>2</sub> (overall)	1.804	1.794	0.025	1.788	1.820	41	
Csp <sup>3</sup> -S(2)	C*-SH	1.808	1.805	0.010	1.800	1.819	6	
	CH <sub>3</sub> -S-C*	1.789	1.787	0.008	1.784	1.794	9	
Csp <sup>3</sup> -S(2)	C-CH <sub>2</sub> -S-C*	1.817	1.816	0.013	1.808	1.824	92	
	C <sub>2</sub> -CH-S-C*	1.819	1.819	0.011	1.811	1.825	32	
	C <sub>3</sub> -C-S-C*	1.856	1.860	0.011	1.854	1.863	26	
	C*-S-C* (overall)	1.819	1.817	0.019	1.809	1.827	242	
	in thiirane	1.834	1.835	0.025	1.810	1.858	4	9
	in thiirane: see ZCMXSP (1.817, 1.844)							
	in tetrahydrothiophene	1.827	1.826	0.018	1.811	1.837	20	
	in tetrahydrothiopyran	1.823	1.821	0.014	1.812	1.832	24	
	C-CH <sub>2</sub> -S-S-X	1.823	1.820	0.014	1.813	1.832	41	
	C <sub>3</sub> -C-S-S-X	1.863	1.865	0.015	1.848	1.878	11	
	C*-S-S-X (overall)	1.833	1.828	0.022	1.818	1.848	59	
Csp <sup>2</sup> -S(2)	C=C-S-C*	1.751	1.755	0.017	1.740	1.764	61	
	C=C-S-C=C (in tetrathiafulvalene)	1.741	1.741	0.011	1.733	1.750	88	
	C=C-S-C=C (in thiophene)	1.712	1.712	0.013	1.703	1.722	60	
	O=C-S-C#	1.762	1.759	0.018	1.747	1.778	20	
Car-S(4)	Car-SO <sub>2</sub> -C	1.763	1.764	0.009	1.756	1.769	96	
	Car-SO <sub>2</sub> -O-X	1.752	1.750	0.008	1.749	1.756	27	
	Car-SO <sub>2</sub> -N-X <sub>2</sub>	1.758	1.759	0.013	1.749	1.765	106	35
Car-S(3)	Car-S(=O)-C	1.790	1.790	0.010	1.783	1.798	41	
	Car-S <sup>+</sup> -X <sub>2</sub>	1.778	1.779	0.010	1.771	1.787	10	
Car-S(2)	Car-S-C*	1.773	1.774	0.009	1.765	1.779	44	
	Car-S-Car	1.768	1.767	0.010	1.762	1.774	158	
	Car-S-Car (in phenothiazine)	1.764	1.764	0.008	1.760	1.769	48	
	Car-S-S-X	1.777	1.777	0.012	1.767	1.785	47	
Csp <sup>1</sup> -S(2)	N $\equiv$ C-S-X	1.679	1.683	0.026	1.645	1.698	10	
Csp <sup>1</sup> -S(1)	(N $\equiv$ C-S) <sup>-</sup>	1.630	1.630	0.014	1.619	1.641	14	
Csp <sup>2</sup> =S(1)	(C*) <sub>2</sub> -C=S: see IPMUDS (1.599)							
	(Car) <sub>2</sub> -C=S: see CELDOM (1.611)							
	(X) <sub>2</sub> -C=S (X = C,N,O,S)	1.671	1.675	0.024	1.656	1.689	245	
	X <sub>2</sub> N-C(=S)-S-X	1.660	1.660	0.016	1.648	1.674	38	
	(X <sub>2</sub> N) <sub>2</sub> -C=S (thioureas)	1.681	1.684	0.020	1.669	1.693	96	
	N-C( $\simeq$ S) <sub>2</sub>	1.720	1.721	0.012	1.709	1.731	20	
Csp <sup>3</sup> -Se	C#-Se	1.970	1.967	0.032	1.948	1.998	21	
Csp <sup>2</sup> -Se(2)	C=C-Se-C=C (in tetraselenafulvalene)	1.893	1.895	0.013	1.882	1.902	32	
Car-Se(3)	Ph <sub>3</sub> -Se <sup>+</sup>	1.930	1.929	0.006	1.924	1.936	13	
Csp <sup>3</sup> -Si(5)	C#-Si-X <sub>4</sub>	1.874	1.876	0.015	1.859	1.884	9	
Csp <sup>3</sup> -Si(4)	CH <sub>3</sub> -Si-X <sub>3</sub>	1.857	1.857	0.018	1.848	1.869	552	
	C*-Si-X <sub>3</sub> (C* = CH <sub>3</sub> excluded)	1.888	1.887	0.023	1.872	1.905	124	
	C*-Si-X <sub>3</sub> (overall)	1.863	1.861	0.024	1.850	1.875	681	
Car-Si(4)	Car-Si-X <sub>3</sub>	1.868	1.868	0.014	1.857	1.878	178	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
Csp <sup>1</sup> -Si(4)	C≡C-Si-X <sub>3</sub>	1.837	1.840	0.012	1.824	1.849	8	
Csp <sup>3</sup> -Te	C#-Te	2.158	2.159	0.030	2.128	2.177	13	
Car-Te	Car-Te	2.116	2.115	0.020	2.104	2.130	72	
Csp <sup>2</sup> =Te	see CEDCUJ (2.044)							
Cl-Cl	see PHASCL (2.306, 2.227)							
Cl-I	see CMBIDZ (2.563), HXPASC (2.541, 2.513), METAMM (2.552), BQUINI (2.416, 2.718)							
Cl-N	see BECTAE (1.743-1.757), BOGPOC (1.705)							
Cl-O(1)	in ClO <sub>4</sub> <sup>-</sup>	1.414	1.419	0.026	1.403	1.431	252	
Cl-P	(N≈) <sub>2</sub> P-Cl (N ≈ P aromatic)	1.997	1.994	0.015	1.989	2.004	46	
	Cl-P (overall)	2.008	2.001	0.035	1.986	2.028	111	
Cl-S	Cl-S (overall)	2.072	2.079	0.023	2.047	2.091	6	
	see also longer bonds in CILSAR (2.283), BIHXIZ (2.357), CANLUY (2.749)							
Cl-Se	see BIRGUE10, BIRHAL10, CTCNSE (2.234-2.851)							
Cl-Si(4)	Cl-Si-X <sub>3</sub> (monochloro)	2.072	2.075	0.009	2.066	2.078	5	
	Cl <sub>2</sub> -Si-X <sub>2</sub> and Cl <sub>3</sub> -Si-X	2.020	2.012	0.015	2.007	2.036	5	
Cl-Te	Cl-Te in range 2.34-2.60	2.520	2.515	0.034	2.493	2.537	22	36
	see also longer bonds in BARRIV, BOJPUL, CETUTE, EPHTEA, OPNTEC10 (2.73-2.94)							
F-N(3)	F-N-C <sub>2</sub> and F <sub>2</sub> -N-C	1.406	1.404	0.016	1.395	1.416	9	
F-P(6)	in hexafluorophosphate, PF <sub>6</sub> <sup>-</sup>	1.579	1.587	0.025	1.563	1.598	72	
F-P(3)	(N≈) <sub>2</sub> P-F (N ≈ P aromatic)	1.495	1.497	0.016	1.481	1.510	10	
F-S	43 observations in range 1.409-1.770 in a wide variety of environments; F-S(6) in F <sub>2</sub> -SO <sub>2</sub> -C <sub>2</sub> (see FPSULF10, BETJOZ)	1.640	1.646	0.011	1.626	1.649	6	
	F-S(4) in F <sub>2</sub> -S(=O)-N (see BUDTEZ)	1.527	1.528	0.004	1.524	1.530	24	37
F-Si(6)	in SiF <sub>6</sub> <sup>2-</sup>	1.694	1.701	0.013	1.677	1.703	6	
F-Si(5)	F-Si-X <sub>4</sub>	1.636	1.639	0.035	1.602	1.657	10	
F-Si(4)	F-Si-X <sub>3</sub>	1.588	1.587	0.014	1.581	1.599	24	
F-Te	see CUCPLZ (F-Te(6) = 1.942, 1.937), FPHTEL(F- Te(4) = 2.006)							
H-N(4)	X <sub>3</sub> -N <sup>+</sup> -H	1.033	1.036	0.022	1.026	1.045	87	21
H-N(3)	X <sub>3</sub> -N-H	1.009	1.010	0.019	0.997	1.023	95	21
H-O(2)	in alcohols C <sup>*</sup> -O-H	0.967	0.969	0.010	0.959	0.974	63	21
	C#-O-H	0.967	0.970	0.010	0.959	0.974	73	21
	in acids O=C-O-H	1.015	1.017	0.017	1.001	1.031	16	21,38
I-I	in I <sub>3</sub> <sup>-</sup>	2.917	2.918	0.011	2.907	2.927	6	
I-N	see BZPRIB, CMBIDZ, HMTITI, HMTNTI, IFORAM, IODMAM (2.042-2.475)							
I-O	X-I-O (see BZPRIB, CAJMAB, IBZDAC11) for IO <sub>6</sub> <sup>-</sup> see BOVMEE (1.829-1.912)	2.144	2.144	0.028	2.127	2.164	6	
I-P(3)	see CEHKAB (2.490-2.493)							†
I-S	see DTHIBR10 (2.687), ISUREA10 (2.629), BZTPPI (3.251)							
I-Te(4)	I-Te-X <sub>3</sub>	2.926	2.928	0.026	2.902	2.944	8	
N(4)-N(3)	X <sub>3</sub> -N <sup>+</sup> -N <sup>0</sup> -X <sub>2</sub> (N <sup>0</sup> planar)	1.414	1.414	0.005	1.412	1.418	13	
N(3)-N(3)	(C)(C,H)-N <sub>a</sub> -N <sub>b</sub> (C)(C,H)							5,39
	N <sub>a</sub> , N <sub>b</sub> pyramidal	1.454	1.452	0.021	1.444	1.457	44	40
	N <sub>a</sub> pyramidal, N <sub>b</sub> planar	1.420	1.420	0.015	1.407	1.433	68	40
	N <sub>a</sub> , N <sub>b</sub> planar	1.401	1.401	0.018	1.384	1.418	40	40
	overall	1.425	1.425	0.027	1.407	1.443	139	
N(3)-N(2)	in pyrazole (N1-N2)	1.366	1.366	0.019	1.350	1.375	20	
	in pyridazinium (N1 <sup>+</sup> ≈N2)	1.350	1.349	0.010	1.345	1.361	7	
N(2) ≈ N(2)	N ≈ N (aromatic) in pyridazine							
	with C,H as <i>ortho</i> substituents	1.304	1.300	0.019	1.287	1.326	6	
	with N,Cl as <i>ortho</i> substituents	1.368	1.373	0.011	1.362	1.375	9	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note	
N(2)=N(2)	C#-N=N-C#								
	<i>cis</i>	1.245	1.244	0.009	1.239	1.252	21		
	<i>trans</i>	1.222	1.222	0.006	1.218	1.227	6		
	(overall)	1.240	1.241	0.012	1.230	1.251	27		
	<i>Car</i> -N=N- <i>Car</i>	1.255	1.253	0.016	1.247	1.262	13		
N(2)=N(1)	X-N=N=N (azides)	1.216	1.226	0.028	1.202	1.237	19		
	X-N=N=N (azides)	1.124	1.128	0.015	1.114	1.137	19		
N(3)-O(2)	(C,H) <sub>2</sub> -N-OH (N $sp^2$ : planar)	1.396	1.394	0.012	1.390	1.401	28		
	C <sub>2</sub> -N-O-C								
	(N $sp^3$ : pyramidal)	1.463	1.465	0.012	1.457	1.468	22		
	(N $sp^2$ : planar)	1.397	1.394	0.011	1.388	1.409	12		
N(3)-O(1)	in furoxan (N2-O1)	1.438	1.436	0.009	1.430	1.447	14		
	(C $\simeq$ ) <sub>2</sub> N <sup>+</sup> -O <sup>-</sup> in pyridine <i>N</i> -oxides	1.304	1.299	0.015	1.291	1.316	11		
N(2)-O(2)	in furoxan (*N2-O6 <sup>-</sup> )	1.234	1.234	0.008	1.228	1.240	14		
	in oximes								
	(C#) <sub>2</sub> -C=N-OH	1.416	1.418	0.006	1.416	1.420	7		
	(H)(C $sp^2$ )-C=N-OH	1.390	1.390	0.011	1.380	1.401	20		
	(C#)(C $sp^2$ )-C=N-OH	1.402	1.403	0.010	1.393	1.410	18		
	(C $sp^2$ ) <sub>2</sub> -C=N-OH	1.378	1.377	0.017	1.365	1.393	16		
	(C,H) <sub>2</sub> -C=N-OH (overall)	1.394	1.395	0.018	1.379	1.408	67		
	in furazan (O1-N2, O1-N5)	1.385	1.383	0.013	1.378	1.392	12		
	in furoxan (O1-N5)	1.380	1.380	0.011	1.370	1.388	14		
	in isoxazole (O1-N2)	1.425	1.425	0.010	1.417	1.434	9		
	in nitrate ions NO <sub>3</sub> <sup>-</sup>	1.239	1.240	0.020	1.227	1.251	105		
	N(3)=O(1)	in nitro groups							
C <sup>*</sup> -NO <sub>2</sub>		1.212	1.214	0.012	1.206	1.221	84		
C#-NO <sub>2</sub>		1.210	1.210	0.011	1.203	1.218	251		
<i>Car</i> -NO <sub>2</sub>		1.217	1.218	0.011	1.211	1.215	1116		
C-NO <sub>2</sub> (overall)		1.218	1.219	0.013	1.210	1.226	1733		
N(3)-P(4)		X <sub>2</sub> -P(=X)-NX <sub>2</sub>							
		N $sp^2$ : planar	1.652	1.651	0.024	1.634	1.670	205	
		N $sp^3$ : pyramidal	1.683	1.683	0.005	1.680	1.686	6	
		(overall)	1.662	1.662	0.029	1.639	1.682	358	
		subsets of this group are:							
	O <sub>2</sub> -P(=S)-NX <sub>2</sub>	1.628	1.624	0.015	1.615	1.634	9		
C-P(=S)-(NX <sub>2</sub> ) <sub>2</sub>	1.691	1.694	0.018	1.678	1.703	28			
O-P(=S)-(NX <sub>2</sub> ) <sub>2</sub>	1.652	1.654	0.014	1.642	1.664	28			
P(=O)-(NX <sub>2</sub> ) <sub>3</sub>	1.663	1.668	0.026	1.640	1.679	78			
N(3)-P(3)	-NX-P(-X)-NX-P(-X)-(P <sub>2</sub> N <sub>2</sub> ring)	1.730	1.721	0.017	1.716	1.748	20		
	-NX-P(=S)-NX-P(=S)-(P <sub>2</sub> N <sub>2</sub> ring)	1.697	1.697	0.015	1.690	1.703	44		
N(2)=P(4)	in P-substituted phosphazenes:								
	(N $\simeq$ ) <sub>2</sub> P-N (amino)	1.637	1.638	0.014	1.625	1.651	16		
N(2)=P(3)	(aziridinyl)	1.672	1.674	0.010	1.665	1.676	15		
	Ph <sub>3</sub> -P=N <sup>+</sup> =P-Ph <sub>3</sub>	1.571	1.573	0.013	1.563	1.580	66		
N(2) $\simeq$ P(3)	Ph <sub>3</sub> -P=N-C,S	1.599	1.597	0.018	1.580	1.615	7		
N(3)-S(4)	N $\simeq$ P aromatic								
	in phosphazenes	1.582	1.582	0.019	1.571	1.594	126		
	in P $\simeq$ N $\simeq$ S	1.604	1.606	0.009	1.594	1.612	36		
N(3)-S(2)	C-SO <sub>2</sub> -NH <sub>2</sub>	1.600	1.601	0.012	1.591	1.610	14	35	
	C-SO <sub>2</sub> -NH-C#	1.633	1.633	0.019	1.615	1.652	47	35	
	C-SO <sub>2</sub> -N-C(#) <sub>2</sub>	1.642	1.641	0.024	1.623	1.659	38	35	
N(2)-S(2)	C-S-NX <sub>2</sub> N $sp^2$ : planar	1.710	1.707	0.019	1.698	1.722	22	23	
	(for N $sp^3$ pyramidal see MODIAZ: 1.765)								
N(2) $\simeq$ S(2)	X-S-NX <sub>2</sub> N $sp^2$ : planar	1.707	1.705	0.012	1.699	1.715	30	23	
	C=N-S-X	1.656	1.663	0.027	1.632	1.677	36		
N(2) $\simeq$ S(2)	N $\simeq$ S aromatic in P $\simeq$ N $\simeq$ S	1.560	1.558	0.011	1.554	1.563	37		
N(2)=S(2)	N=S in N=S=N and N=S=S	1.541	1.546	0.022	1.521	1.558	37		
N(3)-SE	see COJCUZ (1.830), DSEMOR10 (1.846, 1.852), MORTS10 (1.841)								
N(2)-Se	see SEBZQI (1.805), NAPSEZ10 (1.809, 1.820)								
N(2)=Se	see CISMUM (1.790, 1.791)								

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
N(3)-Si(5)	see DMESIP01, BOJLER, CASSAQ, CASYOK, CECXEN, CINTEY, CIPBUY, FMESIB, MNPSIL, PNPOSI (1.973-2.344)							
N(3)-Si(4)	$X_3$ -Si-NX <sub>2</sub> (overall)	1.748	1.746	0.022	1.735	1.757	170	
	subsets of this group are:							
	$X_3$ -Si-NHX	1.714	1.719	0.014	1.702	1.727	16	
	$X_3$ -Si-NX-Si-X <sub>3</sub> acyclic	1.743	1.744	0.016	1.731	1.755	45	
	N-Si-N in 4-membered rings	1.742	1.742	0.009	1.735	1.748	53	
	N-Si-N in 5-membered rings	1.741	1.742	0.019	1.726	1.749	33	
N(2)-Si(4)	$X_3$ -Si-N'-Si-X <sub>3</sub>	1.711	1.712	0.019	1.693	1.729	15	
N-Te	see ACLTEP (2.402), BIBLAZ (1.980), CESSAU (2.023)							
O(2)-O(2)	C*-O-O-C*,H							
	$\tau(\text{OO}) = 70-85^\circ$	1.464	1.464	0.009	1.458	1.472	12	
	$\tau(\text{OO})$ ca. 180°	1.482	1.480	0.005	1.478	1.486	5	
	overall	1.469	1.471	0.012	1.461	1.478	17	
	O=C-O-O-C=O see ACBZPO01 (1.446), CEYLUN (1.452), CIMHIP (1.454)							
	Si-O-O-Si	1.496	1.499	0.005	1.490	1.499	10	
O(2)-P(5)	X-P-(OX) <sub>4</sub>							41
	trigonal bipyramidal:							
	axial	1.689	1.685	0.024	1.675	1.712	20	
	equatorial	1.619	1.622	0.024	1.604	1.628	20	
	square pyramidal	1.662	1.661	0.020	1.649	1.673	28	
O(2)-P(4)	C-O-P( $\approx$ O) <sub>3</sub> <sup>2-</sup>	1.621	1.622	0.007	1.615	1.628	12	
	(H-O) <sub>2</sub> -P( $\approx$ O) <sub>2</sub> <sup>-</sup>	1.560	1.561	0.009	1.555	1.566	16	
	(C-O) <sub>2</sub> -P( $\approx$ O) <sub>2</sub> <sup>-</sup>	1.608	1.607	0.013	1.599	1.615	16	
	(C#-O) <sub>3</sub> -P=O	1.558	1.554	0.011	1.550	1.564	30	
	(Car-O) <sub>3</sub> -P=O	1.587	1.588	0.014	1.572	1.599	19	
	X-O-P(=O)-(C,N) <sub>2</sub>	1.590	1.585	0.016	1.577	1.601	33	
	(X-O) <sub>2</sub> -P(=O)-(C,N)	1.571	1.572	0.013	1.563	1.579	70	
O(2)-P(3)	(N $\approx$ ) <sub>2</sub> P-O-C (N $\approx$ P aromatic)	1.573	1.573	0.011	1.563	1.584	16	
O(1)=P(4)	C-O-P( $\approx$ O) <sub>3</sub> <sup>2-</sup> (delocalized)	1.513	1.512	0.008	1.508	1.518	42	
	(H-O) <sub>2</sub> -P( $\approx$ O) <sub>2</sub> <sup>-</sup> (delocalized)	1.503	1.503	0.005	1.499	1.508	16	
	(C-O) <sub>2</sub> -P( $\approx$ O) <sub>2</sub> <sup>-</sup> (delocalized)	1.483	1.485	0.008	1.474	1.490	16	
	(C-O) <sub>3</sub> -P=O	1.449	1.448	0.007	1.446	1.452	18	
	C <sub>3</sub> -P=O	1.489	1.486	0.010	1.481	1.496	72	
	N <sub>3</sub> -P=O	1.461	1.462	0.014	1.449	1.470	26	
	(C) <sub>2</sub> (N)-P=O	1.487	1.489	0.007	1.479	1.493	5	
	(C,N) <sub>2</sub> (O)-P=O	1.467	1.462	0.007	1.462	1.472	33	
	(C,N)(O) <sub>2</sub> -P=O	1.457	1.458	0.009	1.454	1.462	35	
O(2)-S(4)	C-O-SO <sub>2</sub> -C	1.577	1.576	0.015	1.566	1.584	41	
	C-O-SO <sub>2</sub> -CH <sub>3</sub>	1.569	1.569	0.013	1.556	1.582	7	
	C-O-SO <sub>2</sub> -Car	1.580	1.578	0.015	1.571	1.588	27	
O(1)=S(4)	C-SO <sub>2</sub> -C	1.436	1.437	0.010	1.431	1.442	316	42
	X-SO <sub>2</sub> -NX <sub>2</sub>	1.428	1.428	0.010	1.422	1.434	326	
	C-SO <sub>2</sub> -N-(C,H) <sub>2</sub>	1.430	1.430	0.009	1.425	1.435	206	
	C-SO <sub>2</sub> -O-C	1.423	1.423	0.008	1.418	1.428	82	
	in SO <sub>4</sub> <sup>2-</sup>	1.472	1.473	0.013	1.463	1.481	104	
O(1)=S(3)	C-S(=O)-C	1.497	1.498	0.013	1.489	1.505	90	5
O-Se	see BAPPA, BIRGUE10, BIRHAL10, CXMSEO, DGLYSE, SPSEBU (1.597 for O=Se to 1.974 for O-Se)							
O(2)-Si(5)	(X-O) <sub>3</sub> -Si-(N)(C)	1.663	1.658	0.023	1.650	1.665	21	
O(2)-Si(4)	$X_3$ -Si-O-X (overall)	1.631	1.630	0.022	1.617	1.646	191	
O(2)-Si(4)	subsets of this group are:							
	$X_3$ -Si-O-C#	1.645	1.647	0.012	1.634	1.652	29	
	$X_3$ -Si-O-Si-X <sub>3</sub>	1.622	1.625	0.014	1.614	1.631	70	
	$X_3$ -Si-O-O-Si-X <sub>3</sub>	1.680	1.676	0.008	1.673	1.688	10	
O(2)-Te(6)	(X-O) <sub>6</sub> -Te	1.927	1.927	0.020	1.908	1.942	16	
O(2)-Te(4)	(X-O) <sub>2</sub> -Te-X <sub>2</sub>	2.133	2.136	0.054	2.078	2.177	12	
P(4)-P(4)	$X_3$ -P-P-X <sub>3</sub>	2.256	2.259	0.025	2.243	2.277	6	

Bond	Substructure	<i>d</i>	<i>m</i>	$\sigma$	$q_1$	$q_u$	<i>n</i>	Note
P(4)–P(3)	see CECHEX (2.197), COZPIQ (2.249)							
P(3)–P(3)	$X_2-P-P-X_2$	2.214	2.210	0.022	2.200	2.224	41	
P(4)=P(4)	see BUTSUE (2.054)							
P(3)=P(3)	see BALXOB (2.034)							
P(4)=S(1)	$C_3-P=S$	1.954	1.952	0.005	1.950	1.957	13	
	$(N,O)_2(C)-P=S$	1.922	1.924	0.014	1.913	1.927	26	
	$(N,O)_3-P=S$	1.913	1.914	0.014	1.906	1.921	50	
P(4)=Se(1)	$X_3-P=Se$	2.093	2.099	0.019	2.075	2.108	12	
P(3)–Si(4)	$X_2-P-Si-X_3$ ; 3- and 4-rings excluded (see BOPFER, BOPFIV, CASTOF10, COZVIW; 2.201–2.317)	2.264	2.260	0.019	2.249	2.283	22	
P(4)=Te(1)	see MOPHTE (2.356), TTEBPZ (2.327)							
S(2)–S(2)	$C-S-S-C$							
	$\tau(SS) = 75-105^\circ$	2.031	2.029	0.015	2.021	2.038	46	
	$\tau(SS) = 0-20^\circ$	2.070	2.068	0.022	2.057	2.077	28	
	(overall)	2.048	2.045	0.026	2.028	2.068	99	
	in polysulphide chain–S–S–S–	2.051	2.050	0.022	2.037	2.065	126	
S(2)–S(1)	$X-N-S-S$	1.897	1.896	0.012	1.887	1.908	5	
S–Se(4)	see BUWZUO (2.264, 2.269)							
S–Se(2)	$X-Se-S$ (any)	2.193	2.195	0.015	2.174	2.207	9	
S(2)–Si(4)	$X_3-Si-S-X$	2.145	2.138	0.020	2.130	2.158	19	
S(2)–Te	$X-S-Te$ (any)	2.405	2.406	0.022	2.383	2.424	10	
	$X-S-Te$ (any)	2.682	2.686	0.035	2.673	2.694	28	
Se(2)–Se(2)	$X-Se-Se-X$	2.340	2.340	0.024	2.315	2.361	15	
Se(2)–Te(2)	see BAWFUA, BAWGAH (2.524–2.561)							†
Si(4)–Si(4)	$X_3-Si-Si-X_3$ 3-membered rings excluded; see CIHRAM (2.511)	2.359	2.359	0.012	2.349	2.366	42	
Te–Te	see CAHJOK (2.751, 2.704)							

## Appendix 1. (Footnotes to Table)

- Sample dominated by B–CH<sub>3</sub>. For longer bonds in B–CH<sub>3</sub> see LITMEB10 [B(4)–CH<sub>3</sub> = 1.621–1.644 Å].
- p(π)–p(π) Bonding with Bsp<sup>2</sup> and Nsp<sup>2</sup> coplanar ( $\tau_{BN} = 0 \pm 15^\circ$ ) predominates. See G. Schmidt, R. Boese, and D. Bläser, *Z. Naturforsch.*, 1982, **37b**, 1230.
- 84 observations range from 1.38 to 1.61 Å and individual values depend on substituents on B and O. For a discussion of borinic acid adducts see S. J. Rettig and J. Trotter, *Can. J. Chem.*, 1982, **60**, 2957.
- See M. Kaftory in 'The Chemistry of Functional Groups. Supplement D: The Chemistry of Halides, Pseudohalides, and Azides', S. Patai and Z. Rappoport, Eds., Wiley: New York, 1983, Part 2, ch. 24.
- Bonds which are endocyclic or exocyclic to any 3- or 4-membered rings have been omitted from all averages in this section.
- The overall average given here is for Csp<sup>3</sup>–Csp<sup>3</sup> bonds which carry only C or H substituents. The value cited reflects the relative abundance of each 'substitution' group. The 'mean of means' for the 9 subgroups is 1.538 ( $\sigma = 0.022$ ) Å.
- See F. H. Allen, (a) *Acta Crystallogr.*, 1980, **B36**, 81; (b) 1981, **B37**, 890.
- See F. H. Allen, *Acta Crystallogr.*, 1984, **B40**, 64.
- See F. H. Allen, *Tetrahedron*, 1982, **38**, 2843.
- See F. H. Allen, *Tetrahedron*, 1982, **38**, 645.
- Cyclopropanones and cyclobutanones excluded.
- See W. B. Schweizer and J. D. Dunitz, *Helv. Chim. Acta*, 1982, **65**, 1547.
- See L. Norskov-Lauritsen, H.-B. Bürgi, P. Hoffmann, and H. R. Schmidt, *Helv. Chim. Acta*, 1985, **68**, 76.
- See P. Chakrabarti and J. D. Dunitz, *Helv. Chim. Acta*, 1982, **65**, 1555.
- See J. L. Hencher in 'The Chemistry of the C≡C Triple Bond', S. Patai, Ed., Wiley, New York, 1978, ch. 2.
- Conjugated: torsion angle about central C–C single bond is  $0 \pm 20^\circ$  (*cis*) or  $180 \pm 20^\circ$  (*trans*).
- Unconjugated: torsion angle about central C–C single bond is 20–160°.
- Other conjugative substituents excluded.
- TCNQ is tetracyanoquinodimethane.
- No difference detected between C2  $\simeq$  C3 and C3  $\simeq$  C4 bonds.
- Derived from neutron diffraction results only.
- Nsp<sup>3</sup>: pyramidal; mean valence angle at N is in range 108–114°.
- Nsp<sup>2</sup>: planar; mean valence angle at N is  $\geq 117.5^\circ$ .
- Cyclic and acyclic peptides.
- See R. H. Blessing, *J. Am. Chem. Soc.*, 1983, **105**, 2776.
- See L. Lebioda, *Acta Crystallogr.*, 1980, **B36**, 271.
- n* = 3 or 4, i.e. tri- or tetra-substituted ureas.
- Overall value also includes structures with mean valence angle at N in the range 115–118°.
- See F. H. Allen and A. J. Kirby, *J. Am. Chem. Soc.*, 1984, **106**, 6197.
- See A. J. Kirby, 'The Anomeric Effect and Related Stereoelectronic Effects at Oxygen', Springer, Berlin, 1983.
- See B. Fuchs, L. Schleifer, and E. Tartakovsky, *Nouv. J. Chim.*, 1984, **8**, 275.
- See S. C. Nyburg and C. H. Faerman, *J. Mol. Struct.*, 1986, **140**, 347.
- Sample dominated by P–CH<sub>3</sub> and P–CH<sub>2</sub>–C.
- Sample dominated by C\* = methyl.
- See A. Kalman, M. Czugler, and G. Argay, *Acta Crystallogr.*, 1981, **B37**, 868.
- Bimodal distribution resolved into 22 'short' bonds and 5 longer outliers.
- All 24 observations come from BUDTEZ.
- 'Long' O–H bonds in centrosymmetric O---H---O H-bonded dimers are excluded.
- N–N bond length also dependent on torsion angle about N–N bond and on nature of substituent C atoms; these effects are ignored here.
- N pyramidal has average angle at N in range 100–113.5°; N planar has average angle of  $\geq 117.5^\circ$ .
- See R. R. Holmes and J. A. Deiters, *J. Amer. Chem. Soc.*, 1977, **99**, 3318.
- No detectable variation in S=O bond length with type of C-substituent.

## Appendix 2

Short-form references to individual CSD entries cited by reference code in the Table. A full list of CSD bibliographic entries is given in SUP 56701.

ACBZPO01	<i>J. Am. Chem. Soc.</i> , 1975, <b>97</b> , 6729.	CIWYIQ	<i>Inorg. Chem.</i> , 1984, <b>23</b> , 1946.
ACLTEP	<i>J. Organomet. Chem.</i> , 1980, <b>184</b> , 417.	CIYFOF	<i>Inorg. Chem.</i> , 1984, <b>23</b> , 1790.
ASAZOC	<i>Dokl. Akad. Nauk SSSR</i> , 1979, <b>249</b> , 120.	CMBIDZ	<i>J. Org. Chem.</i> , 1979, <b>44</b> , 1447.
BALXOB	<i>J. Am. Chem. Soc.</i> , 1981, <b>103</b> , 4587.	CODDEE	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 1257.
BAPPAJ	<i>Inorg. Chem.</i> , 1981, <b>20</b> , 3071.	CODDII	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 1257.
BARRIV	<i>Acta Chem. Scand., Ser. A</i> , 1981, <b>35</b> , 443.	COFVOI	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 1027.
BAWFUA	<i>Cryst. Struct. Commun.</i> , 1981, <b>10</b> , 1345.	COJCUZ	<i>Chem. Ber.</i> , 1984, <b>117</b> , 2686.
BAWGAH	<i>Cryst. Struct. Commun.</i> , 1981, <b>10</b> , 1353.	COSDIX	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 1344.
BECTAE	<i>J. Org. Chem.</i> , 1981, <b>46</b> , 5048, 1981.	COZPIQ	<i>Chem. Ber.</i> , 1984, <b>117</b> , 2063.
BELNIP	<i>Z. Naturforsch., Teil B</i> , 1982, <b>37</b> , 299.	COZVIW	<i>Z. Anorg. Allg. Chem.</i> , 1984, <b>515</b> , 7.
BEMLIO	<i>Chem. Ber.</i> , 1982, <b>115</b> , 1126.	CTCNSE	<i>J. Am. Chem. Soc.</i> , 1980, <b>102</b> , 5430.
BEPZEB	<i>Cryst. Struct. Commun.</i> , 1982, <b>11</b> , 175.	CUCPIZ	<i>J. Am. Chem. Soc.</i> , 1984, <b>106</b> , 7529.
BETJOZ	<i>J. Am. Chem. Soc.</i> , 1982, <b>104</b> , 1683.	CUDLOC	<i>J. Cryst. Spectrosc.</i> , 1985, <b>15</b> , 53.
BETUTE10	<i>Acta Chem. Scand., Ser. A</i> , 1976, <b>30</b> , 719.	CUDLUI	<i>J. Cryst. Spectrosc.</i> , 1985, <b>15</b> , 53.
BIBLAZ	<i>Zh. Strukt. Khim.</i> , 1981, <b>22</b> , 118.	CUGBAH	<i>Acta Crystallogr., Sect. C</i> , 1985, <b>41</b> , 476.
BICGEZ	<i>Z. Anorg. Allg. Chem.</i> , 1982, <b>486</b> , 90.	CXMSEO	<i>Acta Crystallogr., Sect. B</i> , 1973, <b>29</b> , 595.
BIHXIZ	<i>J. Chem. Soc., Chem. Commun.</i> , 1982, 982.	DGLYSE	<i>Acta Crystallogr., Sect. B</i> , 1975, <b>31</b> , 1785.
BIRGUE10	<i>Z. Naturforsch., Teil B</i> , 1983, <b>38</b> , 20.	DMESIP01	<i>Acta Crystallogr., Sect. C</i> , 1984, <b>40</b> , 895.
BIRHAL10	<i>Z. Naturforsch., Teil B</i> , 1982, <b>37</b> , 1410.	DSEMOR10	<i>J. Chem. Soc., Dalton Trans.</i> , 1980, 628.
BIZJAV	<i>J. Organomet. Chem.</i> , 1982, <b>238</b> , C1.	DTHIBR10	<i>Inorg. Chem.</i> , 1971, <b>10</b> , 697.
BOGPOC	<i>Z. Naturforsch., Teil B</i> , 1982, <b>37</b> , 1402.	EPHTEA	<i>Inorg. Chem.</i> , 1980, <b>19</b> , 2487.
BOGSUL	<i>Z. Naturforsch., Teil B</i> , 1982, <b>37</b> , 1230.	ESEARS	<i>J. Chem. Soc. C</i> , 1971, 1511.
BOJLER	<i>Z. Anorg. Allg. Chem.</i> , 1982, <b>493</b> , 53.	ETEARS	<i>J. Chem. Soc. C</i> , 1971, 1511.
BOJPUL	<i>Acta Chem. Scand., Ser. A</i> , 1982, <b>36</b> , 829.	FMESIB	<i>J. Organomet. Chem.</i> , 1980, <b>197</b> , 275.
BOPFER	<i>Chem. Ber.</i> , 1983, <b>116</b> , 146.	FPHTEL	<i>J. Chem. Soc., Dalton Trans.</i> , 1980, 2306.
BOPFIV	<i>Chem. Ber.</i> , 1983, <b>116</b> , 146.	FPSULF10	<i>J. Am. Chem. Soc.</i> , 1982, <b>104</b> , 1683.
BOVMEE	<i>Acta Crystallogr., Sect. B</i> , 1982, <b>38</b> , 1048.	HCLENE10	<i>Acta Crystallogr., Sect. B</i> , 1982, <b>38</b> , 3139.
BQUINI	<i>Acta Crystallogr., Sect. B</i> , 1979, <b>35</b> , 1930.	HMTITI	<i>Acta Crystallogr., Sect. B</i> , 1975, <b>31</b> , 1505.
BTUPTE	<i>Acta Chem. Scand., Ser. A</i> , 1975, <b>29</b> , 738.	HMTNTI	<i>Z. Anorg. Allg. Chem.</i> , 1974, <b>409</b> , 237.
BUDTEZ	<i>Z. Naturforsch., Teil B</i> , 1983, <b>38</b> , 454.	HXPASC	<i>J. Chem. Soc., Dalton Trans.</i> , 1975, 1381.
BUPSIB10	<i>Z. Anorg. Allg. Chem.</i> , 1981, <b>474</b> , 31.	IBZDAC11	<i>J. Chem. Soc., Dalton Trans.</i> , 1979, 854.
BUSHAY	<i>Z. Naturforsch., Teil B</i> , 1983, <b>38</b> , 692.	IFORAM	<i>Monatsh. Chem.</i> , 1974, <b>105</b> , 621.
BUTHAZ10	<i>Inorg. Chem.</i> , 1984, <b>23</b> , 2582.	IODMAM	<i>Acta Crystallogr., Sect. B</i> , 1977, <b>33</b> , 3209.
BUTSUE	<i>J. Chem. Soc., Chem. Commun.</i> , 1983, 862.	IPMUDES	<i>Acta Crystallogr., Sect. B</i> , 1973, <b>29</b> , 2128.
BUWZUO	<i>Acta Chem. Scand., Ser. A</i> , 1983, <b>37</b> , 219.	ISUREA10	<i>Acta Crystallogr., Sect. B</i> , 1972, <b>28</b> , 643.
BZPRIB	<i>Z. Naturforsch., Teil B</i> , 1981, <b>36</b> , 922.	LITMEB10	<i>J. Am. Chem. Soc.</i> , 1975, <b>97</b> , 6401.
BZTPPI	<i>Inorg. Chem.</i> , 1978, <b>17</b> , 894.	MESIAD	<i>Z. Naturforsch., Teil B</i> , 1980, <b>35</b> , 789.
CAHJOK	<i>Inorg. Chem.</i> , 1983, <b>22</b> , 1809.	METAMM	<i>Acta Crystallogr.</i> , 1964, <b>17</b> , 1336.
CAJMAB	<i>Chem. Z.</i> , 1983, <b>107</b> , 169.	MNPSIL	<i>J. Am. Chem. Soc.</i> , 1969, <b>91</b> , 4134.
CANLUY	<i>Tetrahedron Lett.</i> , 1983, <b>24</b> , 4337.	MODIAZ	<i>J. Heterocycl. Chem.</i> , 1980, <b>17</b> , 1217.
CASSAQ	<i>J. Struct. Chem.</i> , 1983, <b>2</b> , 101.	MOPHTE	<i>Acta Chem. Scand., Ser. A</i> , 1980, <b>34</b> , 333.
CASTOF10	<i>Acta Crystallogr., Sect. C</i> , 1984, <b>40</b> , 1879.	MORTRS10	<i>J. Chem. Soc., Dalton Trans.</i> , 1980, 628.
CASYOK	<i>J. Struct. Chem.</i> , 1983, <b>2</b> , 107.	NAPSEZ10	<i>J. Am. Chem. Soc.</i> , 1980, <b>102</b> , 5070.
CECHEX	<i>Z. Anorg. Allg. Chem.</i> , 1984, <b>508</b> , 61.	NBBZAM	<i>Z. Naturforsch., Teil B</i> , 1977, <b>32</b> , 1416.
CECXEN	<i>J. Struct. Chem.</i> , 1983, <b>2</b> , 207.	OPIMAS	<i>Aust. J. Chem.</i> , 1977, <b>30</b> , 2417.
CEDCUJ	<i>J. Org. Chem.</i> , 1983, <b>48</b> , 5149.	OPNTEC10	<i>J. Chem. Soc., Dalton Trans.</i> , 1982, 251.
CEHKAB	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 139.	PHASCL	<i>Acta Crystallogr., Sect. B</i> , 1981, <b>37</b> , 1357.
CELDOM	<i>Acta Crystallogr., Sect. C</i> , 1984, <b>40</b> , 556.	PHASOC01	<i>Aust. J. Chem.</i> , 1975, <b>28</b> , 15.
CESSAU	<i>Acta Crystallogr., Sect. C</i> , 1984, <b>40</b> , 653.	PNPOSI	<i>J. Am. Chem. Soc.</i> , 1968, <b>90</b> , 5102.
CETTAW	<i>Chem. Ber.</i> , 1984, <b>117</b> , 1089.	SEBZQI	<i>J. Chem. Soc., Chem. Commun.</i> , 1977, 325.
CETUTE	<i>Acta Chem. Scand., Ser. A</i> , 1975, <b>29</b> , 763.	SPSEBU	<i>Acta Chem. Scand., Ser. A</i> , 1979, <b>33</b> , 403.
CEYLUN	<i>Izv. Akad. Nauk SSSR, Ser. Khim.</i> , 1983, 2744.	TEACBR	<i>Cryst. Struct. Commun.</i> , 1974, <b>3</b> , 753.
CIUZUM	<i>Acta Chem. Scand., Ser. A</i> , 1984, <b>38</b> , 289.	THINBR	<i>J. Am. Chem. Soc.</i> , 1970, <b>92</b> , 4002.
CIHRAM	<i>Angew. Chem., Int. Ed. Engl.</i> , 1984, <b>23</b> , 302.	TMPBTI	<i>Acta Crystallogr., Sect. B</i> , 1975, <b>31</b> , 1116.
CILRUK	<i>J. Chem. Soc., Chem. Commun.</i> , 1984, 1023.	TPASSN	<i>J. Chem. Soc., Dalton Trans.</i> , 1977, 514.
CILSAR	<i>J. Chem. Soc., Chem. Commun.</i> , 1984, 1021.	TPASTB	<i>Cryst. Struct. Commun.</i> , 1976, <b>5</b> , 39.
CIMHIP	<i>Acta Crystallogr., C</i> , 1984, <b>40</b> , 1458.	TPHOSI	<i>Z. Naturforsch., Teil B</i> , 1979, <b>34</b> , 1064.
CINTEY	<i>Dokl. Akad. Nauk SSSR</i> , 1984, <b>274</b> , 615.	TTEBPZ	<i>Z. Naturforsch., Teil B</i> , 1979, <b>34</b> , 256.
CIPBUY	<i>J. Struct. Chem.</i> , 1983, <b>2</b> , 281.	ZCMXSP	<i>Cryst. Struct. Commun.</i> , 1977, <b>6</b> , 93.
CISMUM	<i>Z. Naturforsch., Teil B</i> , 1984, <b>39</b> , 485.		
CISTED	<i>Z. Anorg. Allg. Chem.</i> , 1984, <b>511</b> , 95.		

## STRUCTURE OF FREE MOLECULES IN THE GAS PHASE

This table gives information on the geometric structure of selected molecules in the gas phase, including the overall geometry, interatomic distances, and bond angles. The molecules have been chosen to provide data on a wide variety of chemical bonds and to illustrate the influence of molecular environment on bond distances and angles. The table is restricted to molecules with conventional covalent or ionic bonds, but it should be pointed out that structure data on many loosely bonded complexes of the van der Waals type have recently become available. The references below contain data on many molecules that are not included here and give additional information such as uncertainties and isotopic variations.

The two techniques for gas phase structure determination are spectroscopy and electron diffraction. The following codes are used to indicate the method used for each set of data:

- ED – Gas phase electron diffraction
- MW – Microwave spectroscopy, including both measurements in bulk gases and molecular beams
- IR – Infrared spectroscopy
- R – Raman spectroscopy
- UV – Electronic spectroscopy in the ultraviolet and visible regions, including fluorescence measurements
- ESR – Electron spin resonance.

In some cases data from two sources have been combined to derive the structure; these are labeled by “ED, MW,” for example.

Because of the internal vibrations that are present in all molecules, even in their lowest energy state, the definition of interatomic distance is not a simple matter. The ideal measure is the equilibrium distance in the hypothetical non-vibrating state, designated by  $r_e$ . This is the value of the separation of the atoms at the minimum of the potential function that describes the forces between the two atoms. All other measures represent some form of average, generally complex, over the vibrational motions. Since the potential function is asymmetric and less steep at distances beyond the potential minimum, the average distance is normally greater than  $r_e$ . Distances determined by electron diffraction (ED) represent an average over all vibrational states that are populated at the temperature of the measurement; the most common measure is designated  $r_g$ . Distances determined by spectroscopy (MW, IR, R, or UV) through measurements on the ground vibrational state of the molecule, designated by  $r_0$ , describe some form of average, not easily defined, over the zero-point vibrations. Another measure that is frequently used in microwave spectroscopy is the “substitution” distance  $r_s$ , which is operationally defined through a series of measurements on different isotopic species. In simple cases,  $r_s$  often lies between  $r_0$  and  $r_e$  and is therefore a closer approximation to  $r_e$ . Several other types of averages have been used; good discussions can be found in Volumes II/25 and II/28 of the *Landolt-Börnstein* series (Reference 1) and in References 4 and 5.

Unless otherwise specified, distances and angles given in this table are  $r_0$  values if the method is spectroscopic and  $r_g$  values if the method is electron diffraction. When given, equilibrium and substitution distances are designated by  $r_e$  and  $r_s$ , respectively.

Many interatomic distances and angles calculated by *ab initio* techniques have been reported in the recent literature. However, it should be emphasized that all data in this table are obtained from direct experimental measurements. In a few cases, *ab initio* calculations of vibration-rotation interaction constants have been combined with the primary experimental measurements to derive  $r_e$  values in the table.

The number of significant figures in the values is an indication of the precision of the measurement; thus a distance quoted to three decimal places is probably reliable to about 0.005 Å or better. However, discrepancies between  $r_e$ ,  $r_0$ , and  $r_g$  values for the same bond are often the order of 0.01 Å because of vibrational averaging considerations, so care must be taken in comparing bond distances in different molecules. Some distances in simple molecules are given here to four or five decimal places, but little chemical significance can be attached to differences beyond the third decimal place.

The table is presented in two parts: Part A covers molecules that do not contain carbon while Part B lists carbon-containing molecules. Because many of the entries in Part A are free radicals or other transient species whose systematic chemical names are unfamiliar, the listing in Part A is in order of chemical formula. Part B is ordered by name. In both parts the second column gives information on the overall configuration of the molecule, often indicated by the point group of the equilibrium geometry. Columns 3 through 8 give the values of the bond distances and angles, and the last column indicates the experimental method. Distances are given in Å units, where 1 Å =  $10^{-10}$  m or 0.1 nm. Angles are given in degrees.

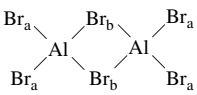
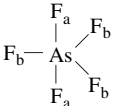
The efforts of Kozo Kuchitsu in preparing an earlier version of this table and in giving advice on the new version are gratefully acknowledged.

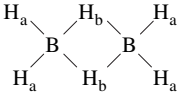
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II/25D, *Molecules Containing Five or More Carbon Atoms*, 2003  
II/28A, *Inorganic Molecules*, 2006  
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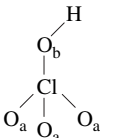


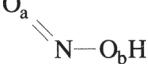
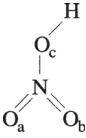
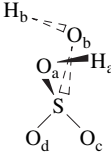
## Part 1 Molecules Not Containing Carbon


Formula	Structure	Bond distances in Å and angles in degrees					Method	
AgBr		Ag—Br ( $r_e$ )	2.3931				MW	
AgCl		Ag—Cl ( $r_e$ )	2.2808				MW	
AgF		Ag—F ( $r_e$ )	1.9832				MW	
AgH		Ag—H ( $r_e$ )	1.617				UV	
AgI		Ag—I ( $r_e$ )	2.5446				MW	
AgLi		Ag—Li	2.41				UV	
AgO		Ag—O ( $r_e$ )	2.0030				UV	
AgOH	bent	Ag—O	2.016	O—H	0.952	$\angle$ HOAg	108.3 (ass.)	MW
AlBr		Al—Br ( $r_e$ )	2.295				UV	
AlBr <sub>3</sub>	D <sub>3h</sub>	Al—Br	2.221				ED	
AlCa		Al—Ca	3.148				UV	
AlCl		Al—Cl ( $r_e$ )	2.1301				MW	
AlCl <sub>3</sub>	D <sub>3h</sub>	Al—Cl	2.063				ED	
AlCo		Al—Co	2.283				UV	
AlCu		Al—Cu	2.339				UV	
AlF		Al—F ( $r_e$ )	1.6544				MW	
AlF <sub>3</sub>	D <sub>3h</sub>	Al—F	1.633				ED	
AlH		Al—H ( $r_e$ )	1.6482				UV	
AlI		Al—I ( $r_e$ )	2.5371				MW	
AlI <sub>3</sub>	D <sub>3h</sub>	Al—I	2.461				ED	
AlK		Al—K	3.88				UV	
AlMn		Al—Mn	2.638				UV	
AlNi		Al—Ni	2.321				UV	
AlO		Al—O ( $r_e$ )	1.6176				UV	
AlS		Al—S ( $r_e$ )	2.029				UV	
AlV		Al—V	2.620				UV	
AlZn		Al—Zn	2.696				UV	
Al <sub>2</sub>		Al—Al ( $r_e$ )	2.701				UV	
Al <sub>2</sub> Br <sub>6</sub>		Al—Br <sub>a</sub>	2.234	Al—Br <sub>b</sub>	2.433	$\angle$ Br <sub>a</sub> AlBr <sub>b</sub>	122	ED
		$\angle$ Br <sub>b</sub> AlBr <sub>b</sub>	91.6					
	D <sub>2h</sub>							
Al <sub>2</sub> Cl <sub>6</sub>	See Al <sub>2</sub> Br <sub>6</sub>	Al—Cl <sub>a</sub>	2.061	Al—Cl <sub>b</sub>	2.250	$\angle$ Cl <sub>a</sub> AlCl <sub>a</sub>	122	ED
		$\angle$ Cl <sub>b</sub> AlCl <sub>b</sub>	90.0					
AsBr <sub>3</sub>	C <sub>3v</sub>	As—Br	2.324	$\angle$ BrAsBr	99.6			ED
AsCl <sub>3</sub>	C <sub>3v</sub>	As—Cl	2.165	$\angle$ ClAsCl	98.6			ED, MW
AsF <sub>3</sub>	C <sub>3v</sub>	As—F	1.710	$\angle$ FAsF	95.9			ED, MW
AsF <sub>5</sub>		As—F <sub>a</sub>	1.711	As—F <sub>b</sub>	1.656			ED
	D <sub>3h</sub>							
AsH		As—H ( $r_e$ )	1.5232					UV
AsH <sub>3</sub>	C <sub>3v</sub>	As—H ( $r_e$ )	1.511	$\angle$ HAsH ( $\theta_e$ )	92.1			MW, IR
AsI <sub>3</sub>	C <sub>3v</sub>	As—I	2.557	$\angle$ IAsI	100.2			ED
AsN		As—N ( $r_e$ )	1.6184					UV
AsO		As—O ( $r_e$ )	1.6236					UV
AsP		As—P ( $r_e$ )	1.99954					MW
As <sub>2</sub>		As—As ( $r_e$ )	2.1026					UV
AuH		Au—H ( $r_e$ )	1.5237					UV
Au <sub>2</sub>		Au—Au ( $r_e$ )	2.4719					UV
BBr		B—Br ( $r_e$ )	1.888					UV
BBr <sub>3</sub>	D <sub>3h</sub>	B—Br	1.893					ED
BCl		B—Cl ( $r_e$ )	1.7153					UV
BClF <sub>2</sub>	C <sub>2v</sub>	B—Cl ( $r_s$ )	1.728	B—F	1.315	$\angle$ FBF	118.1	MW

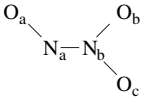
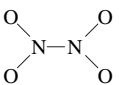
Formula	Structure	Bond distances in Å and angles in degrees						Method
BCl <sub>3</sub>	D <sub>3h</sub>	B—Cl	1.742					ED
BF		B—F ( <i>r<sub>e</sub></i> )	1.2626					UV
BF <sub>2</sub> H		B—H	1.189	B—F	1.311	∠FBF	118.3	MW
BF <sub>2</sub> OH	F <sub>a</sub> F <sub>b</sub> BOH planar	B—F <sub>a</sub> ( <i>r<sub>e</sub></i> )	1.3229	B—F <sub>b</sub> ( <i>r<sub>e</sub></i> )	1.3129	B—O ( <i>r<sub>e</sub></i> )	1.3448	MW
	F <sub>a</sub> <i>cis</i> to OH	∠FBF ( <i>θ<sub>e</sub></i> )	118.36	∠F <sub>a</sub> BO ( <i>θ<sub>e</sub></i> )	122.25	∠BOH ( <i>θ<sub>e</sub></i> )	113.14	
BF <sub>3</sub>	D <sub>3h</sub>	O—H ( <i>r<sub>e</sub></i> )	0.9574					
BH		B—F	1.313					ED, IR
BH <sub>2</sub> NH <sub>2</sub>	planar	B—H ( <i>r<sub>e</sub></i> )	1.2325					UV
		B—N	1.391	B—H	1.195	N—H	1.004	MW
		∠HBH	122.2	∠HNNH	114.2			
BH <sub>3</sub>	planar	B—H	1.1900					IR
BH <sub>3</sub> PH <sub>3</sub>	staggered form	B—P	1.937	B—H	1.212	P—H	1.399	MW
		∠PBH	103.6	∠BPH	116.9	∠HBH	114.6	
		∠HPH	101.3					
BI <sub>3</sub>	D <sub>3h</sub>	B—I	2.118					ED
BN		B—N ( <i>r<sub>e</sub></i> )	1.281					UV
BO		B—O ( <i>r<sub>e</sub></i> )	1.2045					EPR
BO <sub>2</sub>	linear	B—O	1.265					UV
BS		B—S	1.6091					UV
B <sub>2</sub>		B—B ( <i>r<sub>e</sub></i> )	1.590					UV
B <sub>2</sub> H <sub>6</sub>		B—H <sub>a</sub>	1.19	B—H <sub>b</sub>	1.33	B...B	1.77	IR, ED
		∠H <sub>a</sub> BH <sub>a</sub>	122	∠H <sub>b</sub> BH <sub>b</sub>	97			
B <sub>3</sub> H <sub>3</sub> O <sub>3</sub>		B—O	1.376	∠BOB	120	∠OBO	120	ED
B <sub>3</sub> H <sub>6</sub> N <sub>3</sub>	C <sub>2</sub>	B—N	1.435	B—H	1.26	N—H	1.05	ED
		∠BNB	121	∠NBN	118			
BaBr		Ba—Br ( <i>r<sub>e</sub></i> )	2.8445					UV
BaBr <sub>2</sub>		Ba—Br	2.912	∠BrBaBr	137.0			ED
BaCl		Ba—Cl ( <i>r<sub>e</sub></i> )	2.6828					UV
BaF		Ba—F ( <i>r<sub>e</sub></i> )	2.163					UV
BaH		Ba—H ( <i>r<sub>e</sub></i> )	2.2318					UV
BaI		Ba—I ( <i>r<sub>e</sub></i> )	3.0848					UV
BaI <sub>2</sub>		Ba—I	3.150	∠IBaI	137.6			ED
BaO		Ba—O ( <i>r<sub>e</sub></i> )	1.9397					MW
BaOH	linear	Ba—O	2.200	O—H	0.927			UV
BaS		Ba—S ( <i>r<sub>e</sub></i> )	2.5074					MBE
BeCl <sub>2</sub>	linear	Be—Cl ( <i>r<sub>e</sub></i> )	1.791					ED, IR
BeF		Be—F ( <i>r<sub>e</sub></i> )	1.3609					UV
BeF <sub>2</sub>	linear	Be—F ( <i>r<sub>e</sub></i> )	1.3730					IR
BeH		Be—H ( <i>r<sub>e</sub></i> )	1.3431					UV
BeH <sub>2</sub>	linear	Be—H ( <i>r<sub>e</sub></i> )	1.3264					IR
BeO		Be—O ( <i>r<sub>e</sub></i> )	1.3308					UV
BeS		Be—S ( <i>r<sub>e</sub></i> )	1.7415					UV
BiBr		Bi—Br ( <i>r<sub>e</sub></i> )	2.6095					MW
BiBr <sub>3</sub>	C <sub>3v</sub>	Bi—Br	2.577	∠BrBiBr	98.6			ED
BiCl		Bi—Cl ( <i>r<sub>e</sub></i> )	2.4716					MW
BiCl <sub>3</sub>	C <sub>3v</sub>	Bi—Cl	2.424	∠ClBiCl	97.5			ED
BiF		Bi—F ( <i>r<sub>e</sub></i> )	2.0516					MW
BiF <sub>3</sub>	C <sub>3v</sub>	Bi—F	1.987	∠FBiF	96.1			ED
BiH		Bi—H ( <i>r<sub>e</sub></i> )	1.805					UV
BiI		Bi—I ( <i>r<sub>e</sub></i> )	2.8005					MW
BiI <sub>3</sub>	C <sub>3v</sub>	Bi—I	2.807	∠IBiI	99.5			ED
BiO		Bi—O ( <i>r<sub>e</sub></i> )	1.934					UV
BiP		Bi—P ( <i>r<sub>e</sub></i> )	2.29345					IR
Bi <sub>2</sub>		Bi—Bi ( <i>r<sub>e</sub></i> )	2.6596					UV
BrCl		Br—Cl ( <i>r<sub>e</sub></i> )	2.1361					MW
BrF		Br—F ( <i>r<sub>e</sub></i> )	1.7590					MW
BrF <sub>3</sub>	F <sub>a</sub> —Br—F <sub>a</sub>   F <sub>b</sub>  C <sub>2v</sub>	Br—F <sub>a</sub>	1.810	∠F <sub>ax</sub> BrF <sub>eq</sub>	85.1	∠F <sub>a</sub> BrF <sub>b</sub>	86.2	MW
		Br—F <sub>b</sub>	1.721					

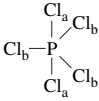
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BrF <sub>5</sub>	C <sub>4v</sub>	Br—F (av.)	1.753	(Br—F <sub>eq</sub> ) – (Br—F <sub>ax</sub> )	0.069	∠F <sub>ax</sub> BrF <sub>eq</sub>	85.1	ED, MW
BrN <sub>3</sub>	BrN <sub>a</sub> N <sub>b</sub> N <sub>c</sub> planar	N <sub>a</sub> —N <sub>b</sub>	1.113 (ass.)	N <sub>b</sub> —N <sub>c</sub>	1.247	N <sub>a</sub> —Br	1.899	ED
BrO		Br—O (r <sub>e</sub> )	1.7172					MW
BrO <sub>2</sub>	C <sub>2v</sub>	Br—O (r <sub>e</sub> )	1.644	∠OBrO (θ <sub>e</sub> )	114.3			MW
Br <sub>2</sub>		Br—Br (r <sub>e</sub> )	2.2811					R
CaBr <sub>2</sub>	linear	Ca—Br	2.62					ED
CaCl		Ca—Cl (r <sub>e</sub> )	2.43676					UV
CaCl <sub>2</sub>	linear	Ca—Cl	2.483					ED
CaF		Ca—F (r <sub>e</sub> )	1.967					UV
CaH		Ca—H (r <sub>e</sub> )	2.002					UV
CaI		Ca—I (r <sub>e</sub> )	2.8286					UV
CaI <sub>2</sub>	linear	Ca—I	2.840					ED
CaO		Ca—O (r <sub>e</sub> )	1.8221					UV
CaOH	linear	Ca—O	1.985	O—H	0.921			UV
CaS		Ca—S (r <sub>e</sub> )	2.3178					UV
CdH		Cd—H (r <sub>e</sub> )	1.781					EPR
CdH <sub>2</sub>	linear	Cd—H	1.6792					IR
CdBr <sub>2</sub>	linear	Cd—Br	2.394					ED
CdCl <sub>2</sub>	linear	Cd—Cl	2.284					ED
CdI <sub>2</sub>	linear	Cd—I	2.582					ED
CeF <sub>4</sub>	T <sub>d</sub>	Ce—F	2.036					ED
CeI <sub>3</sub>	quasiplanar	Ce—I	2.948					ED
ClBS	linear	B—Cl	1.681	B—S	1.606			MW
ClF		Cl—F (r <sub>e</sub> )	1.6283					MW
ClF <sub>3</sub>	F <sub>a</sub> —Cl—F <sub>a</sub>   F <sub>b</sub>	Cl—F <sub>a</sub>	1.698	Cl—F <sub>b</sub>	1.598	∠F <sub>a</sub> ClF <sub>b</sub>	87.5	MW
ClN <sub>3</sub>	ClN <sub>a</sub> N <sub>b</sub> N <sub>c</sub> planar	N <sub>a</sub> —N <sub>b</sub>	1.253	N <sub>b</sub> —N <sub>c</sub>	1.113	N <sub>a</sub> —Cl	1.746	MW
		∠NNN	171.0	∠CINN	108.7			
ClO		Cl—O (r <sub>e</sub> )	1.5696					MW, UV
ClO <sub>2</sub>	C <sub>2v</sub>	Cl—O	1.470	∠OClO	117.38			MW
Cl <sub>2</sub>		Cl—Cl (r <sub>e</sub> )	1.9878					UV
Cl <sub>2</sub> O	C <sub>2v</sub>	Cl—O	1.6959	∠ClOCl	110.89			MW
CoBr <sub>2</sub>	linear	Co—Br	2.241					ED
CoCl <sub>2</sub>	linear	Co—Cl	2.113					ED
CoF <sub>2</sub>	linear	Co—F	1.754	[Co—F (r <sub>e</sub> )]	1.738			ED
CoF <sub>3</sub>	D <sub>3h</sub>	Co—F	1.732					ED
CoH		Co—H (r <sub>e</sub> )	1.542					UV
CrF <sub>2</sub>	linear	Cr—F	1.795					ED
CrF <sub>3</sub>	D <sub>3h</sub>	Cr—F	1.732					ED
CrF <sub>4</sub>	T <sub>d</sub>	Cr—F	1.706					ED
CrH		Cr—H (r <sub>e</sub> )	1.656					UV
CrO		Cr—O (r <sub>e</sub> )	1.615					UV
CsBr		Cs—Br (r <sub>e</sub> )	3.0723					MW
CsCl		Cs—Cl (r <sub>e</sub> )	2.9063					MW
CsF		Cs—F (r <sub>e</sub> )	2.3454					MW
CsH		Cs—H (r <sub>e</sub> )	2.4938					UV
CsI		Cs—I (r <sub>e</sub> )	3.3152					MW
CsO		Cs—O (r <sub>e</sub> )	2.3007					MW
CsOH	linear; large amplitude bending mode	Cs—O (r <sub>e</sub> )	2.395	O—H (r <sub>e</sub> )	0.97			MW
Cs <sub>2</sub>		Cs—Cs (r <sub>e</sub> )	4.47					UV
CuBr		Cu—Br (r <sub>e</sub> )	2.1734					MW
CuCl		Cu—Cl (r <sub>e</sub> )	2.0512					MW
CuF		Cu—F (r <sub>e</sub> )	1.7449					MW
CuF <sub>2</sub>	linear	Cu—F	1.713					ED
CuH		Cu—H (r <sub>e</sub> )	1.4626					UV
CuI		Cu—I (r <sub>e</sub> )	2.3383					MW
CuLi		Cu—Li	2.26					UV
CuO		Cu—O (r <sub>e</sub> )	1.7244					UV

Formula	Structure	Bond distances in Å and angles in degrees						Method
CuOH	bent	Cu—O ( $r_s$ )	1.769	O—H	0.952	$\angle$ HOCu	110.24 ( $\theta$ )	MW
CuS		Cu—S	2.051					UV
Cu <sub>2</sub>		Cu—Cu ( $r_e$ )	2.2197					UV
DyBr <sub>3</sub>	quasiplanar	Dy—Br	2.609					ED
DyCl <sub>3</sub>	quasiplanar	Dy—Cl	2.461					ED
FN <sub>3</sub>	FN <sub>a</sub> N <sub>b</sub> N <sub>c</sub> planar	N <sub>a</sub> —N <sub>b</sub>	1.253	N <sub>b</sub> —N <sub>c</sub>	1.132	N <sub>a</sub> —F	1.439	MW
		$\angle$ NNN	170.3	$\angle$ FNN	103.8			
F <sub>2</sub>		F—F ( $r_e$ )	1.4119					R
FeBr <sub>2</sub>	linear	Fe—Br	2.294					ED
FeCl <sub>2</sub>	linear	Fe—Cl	2.132					UV,ED
FeF <sub>2</sub>	linear	Fe—F	1.769	[Fe—F ( $r_e$ )]	1.755			ED
FeF <sub>3</sub>	D <sub>3h</sub>	Fe—F	1.763					ED
FeH		Fe—H	1.620					IR
FeO		Fe—O	1.444					UV
FeS		Fe—S	2.017					MW
GaBr		Ga—Br ( $r_e$ )	2.3525					MW
GaBr <sub>3</sub>	D <sub>3h</sub>	Ga—Br	2.249					ED
GaCl		Ga—Cl ( $r_e$ )	2.2017					MW
GaCl <sub>3</sub>	D <sub>3h</sub>	Ga—Cl	2.110					ED
GaF		Ga—F ( $r_e$ )	1.7744					MW
GaF <sub>3</sub>	D <sub>3h</sub>	Ga—F	1.725					ED
GaH		Ga—H ( $r_e$ )	1.663					UV
GaI		Ga—I ( $r_e$ )	2.5747					MW
GaI <sub>3</sub>	D <sub>3h</sub>	Ga—I	2.458					ED
GaO		Ga—O	1.744					UV
Ga <sub>2</sub> Br <sub>6</sub>	See Al <sub>2</sub> Br <sub>6</sub>	Ga—Br <sub>a</sub>	2.250	Ga—Br <sub>b</sub>	2.453			ED
		$\angle$ Br <sub>a</sub> GaBr <sub>a</sub>	92.7	$\angle$ Br <sub>b</sub> GaBr <sub>b</sub>	123			
Ga <sub>2</sub> Cl <sub>6</sub>	See Al <sub>2</sub> Br <sub>6</sub>	Ga—Cl <sub>a</sub>	2.116	Ga—Cl <sub>b</sub>	2.305			ED
		$\angle$ Cl <sub>a</sub> GaCl <sub>a</sub>	90	$\angle$ Cl <sub>b</sub> GaCl <sub>b</sub>	124.5			
GdBr <sub>3</sub>	C <sub>3v</sub>	Gd—Br	2.641					ED
GdCl <sub>3</sub>	C <sub>3v</sub>	Gd—Cl	2.488					ED
GdF <sub>3</sub>	C <sub>3v</sub>	Gd—F	2.053					ED
GdI <sub>3</sub>	C <sub>3v</sub>	Gd—I	2.840	$\angle$ IGdI	108			ED
GeBrH <sub>3</sub>	C <sub>3v</sub>	Ge—H	1.526	Ge—Br	2.299	$\angle$ HGeH	106.2	MW, IR
GeBr <sub>2</sub>		Ge—Br ( $r_e$ )	2.359	$\angle$ BrGeBr	101.0			ED
GeBr <sub>4</sub>	T <sub>d</sub>	Ge—Br	2.272					ED
GeClH <sub>3</sub>	C <sub>3v</sub>	Ge—H	1.537	Ge—Cl	2.150	$\angle$ HGeH	111.0	IR, MW
GeCl <sub>2</sub>		Ge—Cl ( $r_e$ )	2.186	$\angle$ ClGeCl	100.3			ED
GeCl <sub>4</sub>	T <sub>d</sub>	Ge—Cl	2.113					ED
GeFH <sub>3</sub>	C <sub>3v</sub>	Ge—H	1.522	Ge—F	1.732	$\angle$ HGeH	113.0	MW, IR
GeF <sub>2</sub>		Ge—F ( $r_e$ )	1.7321	$\angle$ FGeF ( $\theta$ )	97.15			MW
GeH		Ge—H ( $r_e$ )	1.5880					UV
GeHI		Ge—I	2.525	Ge—H	1.593	$\angle$ HGeI	93.5	UV
GeH <sub>4</sub>	T <sub>d</sub>	Ge—H	1.5251					IR, R
GeI <sub>2</sub>		Ge—I	2.540	$\angle$ IGeI	102.1			ED
GeI <sub>4</sub>	T <sub>d</sub>	Ge—I	2.515					ED
GeO		Ge—O ( $r_e$ )	1.6246					MW
GeS		Ge—S ( $r_e$ )	2.0121					MW
GeSe		Ge—Se ( $r_e$ )	2.1346					MW
GeTe		Ge—Te ( $r_e$ )	2.3402					MW
Ge <sub>2</sub> H <sub>6</sub>		Ge—Ge	2.403	Ge—H	1.541			ED
		$\angle$ HGeH	106.4	$\angle$ GeGeH	112.5			
HBr		H—Br ( $r_e$ )	1.4145					MW
HCl		H—Cl ( $r_e$ )	1.2746					MW
HClO	ClOH (bent)	Cl—O	1.690	O—H	0.975	$\angle$ HOCl	102.5	MW, IR
HClO <sub>4</sub>		Cl—O <sub>a</sub>	1.407	Cl—O <sub>b</sub>	1.639			ED
		$\angle$ O <sub>a</sub> ClO <sub>a</sub>	114.3	$\angle$ O <sub>a</sub> ClO <sub>b</sub>	104.1			


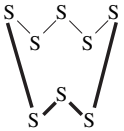
Formula	Structure	Bond distances in Å and angles in degrees						Method
HF		H—F ( $r_e$ )	0.9169					MW
HFO	FOH (bent)	F—O	1.442	O—H	0.96	$\angle$ HOF	97.2	MW
HI		H—I ( $r_e$ )	1.6090					MW
HIO	IOH (bent)	I—O	1.9941	O—H	0.967	$\angle$ HOI	103.9	MW
HNO	bent	N—O	1.212	N—H	1.063	$\angle$ HNO	108.6	UV
HNO <sub>2</sub>		<i>s-trans</i> conformer		<i>s-cis</i> conformer				MW
		O <sub>b</sub> —H	0.958	O <sub>b</sub> —H	0.98			
		N—O <sub>b</sub>	1.432	N—O <sub>b</sub>	1.39			
		N—O <sub>a</sub>	1.170	N—O <sub>a</sub>	1.19			
		$\angle$ O <sub>a</sub> NO <sub>b</sub>	110.7	$\angle$ O <sub>a</sub> NO <sub>b</sub>	114			
		$\angle$ NO <sub>b</sub> H	102.1	$\angle$ NO <sub>b</sub> H	104			
HNO <sub>3</sub>		N—O <sub>a</sub>	1.20	N—O <sub>b</sub>	1.21	N—O <sub>c</sub>	1.41	MW
		O <sub>c</sub> —H	0.96	$\angle$ O <sub>c</sub> NO <sub>b</sub>	115.9	$\angle$ HO <sub>c</sub> N	102.2	
		$\angle$ O <sub>c</sub> NO <sub>a</sub>	113.9					
HNSO	planar planar <i>cis</i>	N—S	1.512	S—O	1.451	N—H	1.029	MW
		$\angle$ NSO	120.4	$\angle$ HNS	115.8			
HN <sub>3</sub>	HN <sub>a</sub> N <sub>b</sub> N <sub>c</sub> planar	N <sub>a</sub> —N <sub>b</sub>	1.245	N <sub>b</sub> —N <sub>c</sub>	1.134	N <sub>a</sub> —H	1.015	MW
		$\angle$ NNN	171.8	$\angle$ HNN	109.2			
HPO		P—O	1.4843	P—H	1.473	$\angle$ HPO	104.57	MW
H <sub>2</sub>		H—H ( $r_e$ )	0.74144					UV
H <sub>2</sub> O	C <sub>2v</sub>	O—H ( $r_e$ )	0.9575	$\angle$ HOH ( $\theta_e$ )	104.51			MW, IR
H <sub>2</sub> O <sub>2</sub>	C <sub>2</sub>	O—O	1.475	$\angle$ OOH	94.8	dihedral angle	119.8	IR
H <sub>2</sub> S	C <sub>2v</sub>	H—S ( $r_e$ )	1.3356	$\angle$ HSH ( $\theta_e$ )	92.12			MW, IR
H <sub>2</sub> SO <sub>4</sub>		O—H	0.97	S—O <sub>a</sub>	1.574	S—O <sub>c</sub>	1.422	MW
		$\angle$ O <sub>a</sub> SO <sub>b</sub>	101.3	$\angle$ O <sub>c</sub> SO <sub>d</sub>	123.3	$\angle$ O <sub>a</sub> SO <sub>c</sub>	108.6	
		$\angle$ O <sub>a</sub> SO <sub>d</sub>	106.4	$\angle$ H <sub>a</sub> O <sub>a</sub> S	108.5	dihedral angle	20.8	
		dihedral angle between the H <sub>a</sub> O <sub>a</sub> S and O <sub>a</sub> SO <sub>b</sub> planes	90.9	dihedral angle between the H <sub>b</sub> SO <sub>b</sub> and O <sub>c</sub> SO <sub>d</sub> planes	88.4	dihedral angle between the H <sub>a</sub> O <sub>a</sub> S and O <sub>a</sub> SO <sub>c</sub> planes		
H <sub>2</sub> S <sub>2</sub>	C <sub>2</sub>	S—S	2.055	S—H	1.327	$\angle$ SSH	91.3	ED, MW
		dihedral angle	90.6					
HfBr <sub>4</sub>	T <sub>d</sub>	Hf—Br	2.450					ED
HfCl <sub>4</sub>	T <sub>d</sub>	Hf—Cl	2.316					ED
HfF		Hf—F	1.8596					UV
HfF <sub>4</sub>	T <sub>d</sub>	Hf—F	1.909					ED
HfI <sub>4</sub>	T <sub>d</sub>	Hf—I	2.662					ED
HgBr <sub>2</sub>	linear	Hg—Br	2.384					ED
HgCl <sub>2</sub>	linear	Hg—Cl	2.252					ED
HgH		Hg—H ( $r_e$ )	1.7404					UV
HgI <sub>2</sub>	linear	Hg—I	2.568					ED
HoCl <sub>3</sub>		Ho—Cl	2.462					ED
HoF <sub>3</sub>		Ho—F	2.007					ED
HoO		Ho—O	1.797					UV
IBr		I—Br ( $r_e$ )	2.4691					MW
ICl		I—Cl ( $r_e$ )	2.3210					MW
IF		I—F ( $r_e$ )	1.9098					UV
IF <sub>5</sub>	C <sub>4v</sub>	I—F (av.)	1.860	(I—F <sub>eq</sub> ) — (I—F <sub>ax</sub> )	0.03	$\angle$ F <sub>ax</sub> IF <sub>eq</sub>	82.1	ED, MW
IO		I—O ( $r_e$ )	1.8676					MW
I <sub>2</sub>		I—I ( $r_e$ )	2.6663					R
InBr		In—Br ( $r_e$ )	2.5432					MW
InCl		In—Cl ( $r_e$ )	2.4012					MW
InCl <sub>3</sub>		In—Cl	2.291					ED
InF		In—F ( $r_e$ )	1.9854					MW
InH		In—H ( $r_e$ )	1.8376					UV

Formula	Structure	Bond distances in Å and angles in degrees						Method
InI		In—I ( $r_e$ )	2.7537					MW
IrF <sub>6</sub>	O <sub>h</sub>	Ir—F	1.831					ED
KBH <sub>4</sub>	H <sub>a</sub> (BH <sub>3</sub> )K (C <sub>3v</sub> )	B—H (BH <sub>3</sub> )	1.272	B—H <sub>a</sub>	1.233	K—B	2.656	MW
KBr		K—Br ( $r_e$ )	2.8208					MW
KCl		K—Cl ( $r_e$ )	2.6667					MW
KF		K—F ( $r_e$ )	2.1716					MW
KH		K—H ( $r_e$ )	2.244					UV
KI		K—I ( $r_e$ )	3.0478					MW
KOH	linear; large amplitude bending mode	K—O	2.212	O—H	0.91			MW
K <sub>2</sub>		K—K ( $r_e$ )	3.9051					UV
KrF <sub>2</sub>	linear	Kr—F	1.89					ED
LaBr		La—Br ( $r_e$ )	2.65208					MW
LaBr <sub>3</sub>	C <sub>3v</sub>	La—Br	2.742					ED
LaCl		La—Cl ( $r_e$ )	2.49804					MW
LaCl <sub>3</sub>	C <sub>3v</sub>	La—Cl	2.589					ED
LaF		La—F ( $r_e$ )	2.02338					MW
LaI		La—I ( $r_e$ )	2.87885					MW
LaO		La—O ( $r_e$ )	1.82591					UV
LiBH <sub>4</sub>	H <sub>a</sub> (BH <sub>3</sub> )Li (C <sub>3v</sub> )	B—H (H <sub>3</sub> )	1.257	B—H <sub>a</sub>	1.218	Li—B	1.939	MW
LiBr		Li—Br ( $r_e$ )	2.1704					MW
LiCl		Li—Cl ( $r_e$ )	2.0207					MW
LiF		Li—F ( $r_e$ )	1.5639					MW
LiH		Li—H ( $r_e$ )	1.5949					MW
LiI		Li—I ( $r_e$ )	2.3919					MW
LiO		Li—O ( $r_e$ )	1.68822					UV
LiOH	linear	Li—O ( $r_e$ )	1.5776	O—H ( $r_e$ )	0.949			MW
Li <sub>2</sub>		Li—Li ( $r_e$ )	2.6729					UV
Li <sub>2</sub> Cl <sub>2</sub>		Li—Cl	2.23	Cl—Cl	3.61	∠ClLiCl	108	ED
Li <sub>2</sub> O	linear	Li—O	1.606					UV
LuBr <sub>3</sub>	C <sub>3v</sub>	Lu—Br	2.557					ED
LuCl <sub>3</sub>	C <sub>3v</sub>	Lu—Cl	2.417	∠ClLuCl	112			ED
LuI <sub>3</sub>	C <sub>3v</sub>	Lu—I	2.768					ED
MgBr		Mg—Br ( $r_e$ )	2.34742					MW
MgCl		Mg—Cl ( $r_e$ )	2.1964					UV
MgCl <sub>2</sub>	linear	Mg—Cl	2.179					ED
MgF		Mg—F ( $r_e$ )	1.7500					UV
MgF <sub>2</sub>	linear	Mg—F	1.771					ED
MgH		Mg—H ( $r_e$ )	1.7297					UV
MgO		Mg—O ( $r_e$ )	1.749					UV
MgOH	linear	Mg—O	1.770	O—H	0.912			UV
Mg <sub>2</sub>		Mg—Mg ( $r_e$ )	3.891					UV
MnBr <sub>2</sub>	linear	Mn—Br	2.344					ED
MnCl <sub>2</sub>	linear	Mn—Cl	2.202					ED
MnF <sub>2</sub>	linear	Mn—F	1.811	[Mn—F ( $r_e$ )]	1.797			ED
MnH		Mn—H ( $r_e$ )	1.7308					UV
MnI <sub>2</sub>	linear	Mn—I	2.538					ED
MoCl <sub>4</sub> O	C <sub>4v</sub>	Mo—Cl	2.279	Mo—O	1.658			ED
		∠ClMoCl	87.2					
MoF <sub>4</sub>		Mo—F	1.851					ED
MoF <sub>6</sub>	O <sub>h</sub>	Mo—F	1.821					ED
NBr		N—Br ( $r_e$ )	1.79					UV
NCl		N—Cl ( $r_e$ )	1.6107					UV
NClH <sub>2</sub>		N—H	1.017	N—Cl	1.748			MW, IR
		∠HNCI	103.7	∠HNI	107			
NCl <sub>3</sub>		N—Cl	1.759	∠ClNCl	107.1			ED

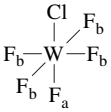
Formula	Structure	Bond distances in Å and angles in degrees						Method
NF		N—F ( $r_e$ )	1.3170					UV
NF <sub>2</sub>		N—F	1.3528	$\angle$ FNF	103.18			MW
NH <sub>2</sub>		N—H	1.024	$\angle$ HNH	103.3			UV
NH <sub>2</sub> NO <sub>2</sub>		N—N	1.427	N—H	1.005			MW
		dihedral angle between NH <sub>2</sub> and NNO <sub>2</sub> planes	128.2	$\angle$ HNH	115.2	$\angle$ ONO	130.1	
NH <sub>3</sub>	C <sub>3v</sub>	N—H ( $r_e$ )	1.012	$\angle$ HNH ( $\theta_e$ )	106.7			IR
NH <sub>4</sub> Cl	H <sub>3</sub> N...HCl (C <sub>3v</sub> )	N—Cl	3.136					MW
NH		N—H ( $r_e$ )	1.0362					LMR
NH <sub>2</sub> OH	bisector of HNH angle is <i>trans</i> to OH bond	N—O	1.453	N—H	1.02	O—H	0.962	MW
		$\angle$ HNO	103.3	$\angle$ HNH	107	$\angle$ NOH	101.4	
NO		N—O ( $r_e$ )	1.1506					IR
NOCl		N—O	1.14	N—Cl	1.975	$\angle$ ONCl	113	MW
NOF		N—O	1.136	N—F	1.512	$\angle$ FNO	110.1	MW
NO <sub>2</sub>		N—O	1.193	$\angle$ ONO	134.1			MW
NO <sub>2</sub> Cl	C <sub>2v</sub>	N—O	1.202	N—Cl	1.840	$\angle$ ONO	130.6	MW
NO <sub>2</sub> F	C <sub>2v</sub>	N—O	1.1798	N—F	1.467	$\angle$ ONO	136	MW
NS		N—S ( $r_e$ )	1.4940					IR
N <sub>2</sub>		N—N ( $r_e$ )	1.0977					UV
N <sub>2</sub> H <sub>4</sub>	H <sub>a</sub> atom is closer to the C <sub>2</sub> axis, H <sub>b</sub> is farther from the C <sub>2</sub> axis	N—N	1.449	N—H	1.021	$\angle$ NNH <sub>b</sub>	106	ED, MW
		$\angle$ HNH	106.6 (ass.)	$\angle$ NNH <sub>a</sub>	112			
		dihedral angle of internal rotation	91					
N <sub>2</sub> O		N—N ( $r_e$ )	1.1284	N—O ( $r_e$ )	1.1841			MW, IR
N <sub>2</sub> O <sub>3</sub>		N <sub>a</sub> —N <sub>b</sub>	1.864	N <sub>a</sub> —O <sub>a</sub>	1.142			MW
		N <sub>b</sub> —O <sub>b</sub>	1.202	N <sub>b</sub> —O <sub>c</sub>	1.217			
		$\angle$ O <sub>a</sub> N <sub>a</sub> N <sub>b</sub>	105.05	$\angle$ N <sub>a</sub> N <sub>b</sub> O <sub>b</sub>	112.72	$\angle$ N <sub>a</sub> N <sub>b</sub> O <sub>c</sub>	117.47	
N <sub>2</sub> O <sub>4</sub>		N—N	1.782	N—O	1.190	$\angle$ ONO	135.4	ED
NaBH <sub>4</sub>	D <sub>2h</sub> H <sub>a</sub> (BH <sub>3</sub> )Na (C <sub>3v</sub> )	B—H (BH <sub>3</sub> )	1.278	B—H <sub>a</sub>	1.238	Na—B	2.308	MW
NaBr		Na—Br ( $r_e$ )	2.5020					MW
NaCl		Na—Cl ( $r_e$ )	2.3609					MW
NaF		Na—F ( $r_e$ )	1.9260					MW
NaH		Na—H ( $r_e$ )	1.8873					UV
NaI		Na—I ( $r_e$ )	2.7115					MW
NaO		Na—O ( $r_e$ )	2.05155					UV
Na <sub>2</sub>		Na—Na ( $r_e$ )	3.0789					UV
NbCl <sub>4</sub>	T <sub>d</sub>	Nb—Cl	2.279					ED
NbCl <sub>5</sub>	D <sub>3h</sub>	Nb—Cl <sub>ax</sub>	2.307	Nb—Cl <sub>eq</sub>	2.276			ED
NbO		Nb—O ( $r_e$ )	1.691					UV
NdI <sub>3</sub>	C <sub>3v</sub>	Nd—I	2.879					ED
NiBr		Ni—Br	2.1963					UV
NiBr <sub>2</sub>	linear	Ni—Br	2.201					ED
NiCl <sub>2</sub>	linear	Ni—Cl	2.076					ED
NiF <sub>2</sub>	linear	Ni—F	1.729	[Ni—F ( $r_e$ )]	1.715			ED
NiH		Ni—H ( $r_e$ )	1.476					UV
NiI		Ni—I	2.348					UV
NpF <sub>6</sub>	O <sub>h</sub>	Np—F	1.982					ED
OF		O—F ( $r_e$ )	1.3579					LMR
OF <sub>2</sub>	C <sub>2v</sub>	O—F ( $r_e$ )	1.4053	$\angle$ FOF ( $\theta_e$ )	103.07			MW
OH		O—H ( $r_e$ )	0.96966					UV
O(SiH <sub>3</sub> ) <sub>2</sub>		Si—H	1.486	Si—O	1.634	$\angle$ SiOSi	144.1	ED
O <sub>2</sub>		O—O ( $r_e$ )	1.2074					MW

Formula	Structure	Bond distances in Å and angles in degrees						Method
O <sub>2</sub> F <sub>2</sub>	C <sub>2</sub>	O—O	1.217	F—O	1.575	∠OOF	109.5	MW
		dihedral angle of internal rotation	87.5					
O <sub>3</sub>	C <sub>2v</sub>	O—O ( <i>r<sub>e</sub></i> )	1.2716	∠OOO ( <i>θ</i> )	117.47			MW
OsF <sub>6</sub>	O <sub>h</sub>	Os—F	1.832					ED
OsO <sub>4</sub>	T <sub>d</sub>	Os—O	1.712					ED
PBr <sub>3</sub>	C <sub>3v</sub>	P—Br	2.220	∠BrPBr	101.0			ED
PCl		P—Cl ( <i>r<sub>e</sub></i> )	2.01461					UV
PCl <sub>3</sub>	C <sub>3v</sub>	P—Cl	2.039	∠ClPCl	100.27			ED
PCl <sub>5</sub>		P—Cl <sub>a</sub>	2.124	P—Cl <sub>b</sub>	2.020			ED
	D <sub>3h</sub>							
PF		P—F ( <i>r<sub>e</sub></i> )	1.5896					UV
PF <sub>3</sub>	C <sub>3v</sub>	P—F	1.570	∠FPF	97.8			ED, MW
PF <sub>5</sub>	D <sub>3h</sub>	P—F <sub>eq</sub>	1.534	P—F <sub>ax</sub>	1.577			ED
PH		P—H ( <i>r<sub>e</sub></i> )	1.4223					LMR
PH <sub>2</sub>		P—H	1.418	∠HPH	91.70			UV
PH <sub>3</sub>	C <sub>3v</sub>	P—H	1.4200	∠HPH	93.345			MW
PN		N—P ( <i>r<sub>e</sub></i> )	1.49087					MW
PO		O—P ( <i>r<sub>e</sub></i> )	1.4759					UV
POCl <sub>3</sub>	C <sub>3v</sub>	P—O	1.449	P—Cl	1.993	∠ClPCl	103.3	ED
POF <sub>3</sub>	C <sub>3v</sub>	P—O	1.436	P—F	1.524	∠FPF	101.3	ED, MW
P <sub>2</sub>		P—P ( <i>r<sub>e</sub></i> )	1.8931					UV
P <sub>2</sub> F <sub>4</sub>	<i>trans conformer</i>	P—F	1.587	P—P	2.281	∠FPF	99.1	P <sub>2</sub> F <sub>4</sub>
		∠PPF	95.4					
P <sub>4</sub>	T <sub>d</sub>	P—P	2.21					ED
P <sub>4</sub> O <sub>6</sub>	T <sub>d</sub>	P—O	1.638	∠POP	126.4			ED
PbBr <sub>2</sub>	bent	Pb—Br ( <i>r<sub>e</sub></i> )	2.598					ED
PbCl <sub>2</sub>	bent	Pb—Cl ( <i>r<sub>e</sub></i> )	2.444					ED
PbCl <sub>4</sub>	T <sub>d</sub>	Pb—Cl	2.369					ED
PbF		Pb—F ( <i>r<sub>e</sub></i> )	2.0575					UV
PbF <sub>2</sub>	bent	Pb—F ( <i>r<sub>e</sub></i> )	2.041					ED
PbH		Pb—H ( <i>r<sub>e</sub></i> )	1.839					UV
PbI <sub>2</sub>	bent	Pb—I ( <i>r<sub>e</sub></i> )	2.807					ED
PbO		Pb—O ( <i>r<sub>e</sub></i> )	1.9218					MW
PbS		Pb—S ( <i>r<sub>e</sub></i> )	2.2869					MW
PbSe		Pb—Se ( <i>r<sub>e</sub></i> )	2.4022					MW
PbTe		Pb—Te ( <i>r<sub>e</sub></i> )	2.5950					MW
PrCl <sub>3</sub>	C <sub>3v</sub>	Pr—Cl	2.554					ED
PrF <sub>3</sub>	C <sub>3v</sub>	Pr—F	2.091					ED
PrI <sub>3</sub>	C <sub>3v</sub>	Pr—I	2.901	∠IPrI	113			ED
PtC		Pt—C ( <i>r<sub>e</sub></i> )	1.6767					UV
PtH		Pt—H ( <i>r<sub>e</sub></i> )	1.52852					UV
PtN		Pt—N ( <i>r<sub>e</sub></i> )	1.682					MW
PtO		Pt—O ( <i>r<sub>e</sub></i> )	1.7273					UV
PtS		Pt—S ( <i>r<sub>e</sub></i> )	2.03983					MW
PtSi		Pt—Si ( <i>r<sub>e</sub></i> )	2.0612					MW
PuF <sub>6</sub>	O <sub>h</sub>	Pu—F	1.972					ED
RbBr		Rb—Br ( <i>r<sub>e</sub></i> )	2.9447					MW
RbCl		Rb—Cl ( <i>r<sub>e</sub></i> )	2.7869					MW
RbF		Rb—F ( <i>r<sub>e</sub></i> )	2.2703					MW
RbH		Rb—H ( <i>r<sub>e</sub></i> )	2.367					UV
RbI		Rb—I ( <i>r<sub>e</sub></i> )	3.1768					MW
RbO		Rb—O ( <i>r<sub>e</sub></i> )	2.25420					UV
RbOH	linear; large amplitude bending mode	Rb—O	2.301	O—H	0.957			MW
ReClO <sub>3</sub>	C <sub>3v</sub>	Re—O	1.702	Re—Cl	2.229	∠ClReO	109.4	MW



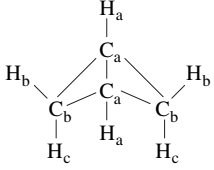
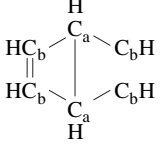
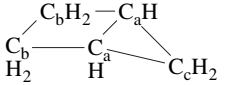
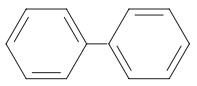
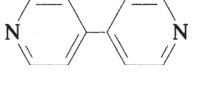
Formula	Structure	Bond distances in Å and angles in degrees						Method
ReClO <sub>4</sub>	C <sub>4v</sub>	Re—O	1.663	Re—Cl	2.270	∠ClReO	105.5	ED
ReCl <sub>5</sub>	D <sub>3h</sub>	Re—Cl <sub>eq</sub>	2.238	Re—Cl <sub>ax</sub>	2.263			ED
ReF <sub>6</sub>	O <sub>h</sub>	Re—F	1.832					ED
ReF <sub>7</sub>	pseudorotation	Re—F	1.835					ED
RhB		Rh—B	1.691					UV
RhC		Rh—C	1.614					UV
RhS		Rh—S	2.059					UV
RuO <sub>4</sub>	T <sub>d</sub>	Ru—O	1.706					ED
SCl <sub>2</sub>	C <sub>2v</sub>	S—Cl	2.006	∠ClSCl	103.0			ED
SF		S—F ( <i>r<sub>e</sub></i> )	1.6006					MW
SF <sub>2</sub>		S—F	1.5921	∠FSF	98.20			MW
SF <sub>6</sub>	O <sub>h</sub>	S—F	1.561					ED
SH		S—H ( <i>r<sub>e</sub></i> )	1.34066					UV
SO		S—O ( <i>r<sub>e</sub></i> )	1.4811					MW
SOCl <sub>2</sub>		S—O	1.44	S—Cl	2.072			MW
		∠ClSCl	97.2	∠OSCl	108.0			
SOF <sub>2</sub>		S—O	1.420	S—F	1.583			ED
		∠FSF	92.2	∠OSF	106.2			
SOF <sub>4</sub>		S—O	1.403	S—F <sub>a</sub>	1.575	S—F <sub>b</sub>	1.552	ED
		∠OSF <sub>a</sub>	90.7	∠OSF <sub>b</sub>	124.9			
		∠F <sub>a</sub> SF <sub>b</sub>	89.6	∠F <sub>b</sub> SF <sub>b</sub>	110.2			
	C <sub>2v</sub>							
SO <sub>2</sub>		S—O ( <i>r<sub>e</sub></i> )	1.4308	∠OSO ( <i>θ<sub>e</sub></i> )	119.329			MW
SO <sub>2</sub> Cl <sub>2</sub>	C <sub>2v</sub>	S—Cl	2.011	S—O	1.404			ED
		∠ClSCl	100.0	∠OSO	123.5			
SO <sub>2</sub> F <sub>2</sub>	C <sub>2v</sub>	S—F	1.530	S—O	1.397			ED
		∠FSF	97	∠OSO	123			
SO <sub>3</sub>	D <sub>3h</sub>	S—O	1.4198					IR
S(SiH <sub>3</sub> ) <sub>2</sub>		Si—S	2.136	Si—H	1.494	∠SiSSi	97.4	ED
S <sub>2</sub>		S—S ( <i>r<sub>e</sub></i> )	1.8892					R
S <sub>2</sub> Br <sub>2</sub>	C <sub>2</sub>	S—Br	2.24	S—S	1.98	∠SSBr	105	ED
		dihedral angle of internal rotation	83.5					
S <sub>2</sub> Cl <sub>2</sub>	C <sub>2</sub>	S—Cl	2.057	S—S	1.931	∠SSCl	108.2	ED
		dihedral angle of internal rotation	84.1					
S <sub>2</sub> O <sub>2</sub>	planar <i>cis</i> form	S—S	2.025	S—O	1.458	∠OSS	112.8	MW
S <sub>8</sub>		S—S	2.07	∠SSS	105	(D <sub>4d</sub> )		ED
SbBr <sub>3</sub>	C <sub>3v</sub>	Sb—Br	2.490	∠BrSbBr	98.2			ED
SbCl <sub>3</sub>	C <sub>3v</sub>	Sb—Cl	2.334	∠ClSbCl	97.1			ED
SbCl <sub>5</sub>	D <sub>3h</sub>	Sb—Cl <sub>eq</sub>	2.277	Sb—Cl <sub>ax</sub>	2.338			ED
SbF		Sb—F ( <i>r<sub>e</sub></i> )	1.918					UV
SbF <sub>3</sub>	C <sub>3v</sub>	Sb—F	1.880	∠FSbF	94.9			ED
SbH		Sb—H	1.723					UV
SbH <sub>3</sub>	C <sub>3v</sub>	Sb—H	1.704	∠HSbH	91.6			MW
SbI <sub>3</sub>	C <sub>3v</sub>	Sb—I	2.721	∠ISbI	99.0			ED
SbO		Sb—O ( <i>r<sub>e</sub></i> )	1.826					UV
SbP		Sb—P ( <i>r<sub>e</sub></i> )	2.20544					MW
ScCl <sub>3</sub>	D <sub>3h</sub>	Sc—Cl	2.291					ED
ScF		Sc—F ( <i>r<sub>e</sub></i> )	1.788					UV
ScF <sub>3</sub>	D <sub>3h</sub>	Sc—F	1.847					ED
SeF		Se—F	1.742					MW
SeF <sub>6</sub>	O <sub>h</sub>	Se—F	1.69					ED
SeH		Se—H ( <i>r<sub>e</sub></i> )	1.48					UV
SeO		Se—O ( <i>r<sub>e</sub></i> )	1.6393					MW

Formula	Structure	Bond distances in Å and angles in degrees					Method	
SeOF <sub>2</sub>		Se—O	1.576	Se—F	1.730		MW	
		∠OSeF	104.82	∠FSeF	92.22			
SeO <sub>2</sub>		Se—O ( <i>r<sub>e</sub></i> )	1.6076	∠OSeO ( <i>θ<sub>e</sub></i> )	113.83		MW	
SeO <sub>3</sub>	D <sub>3h</sub>	Se—O	1.69				ED	
Se <sub>2</sub>		Se—Se ( <i>r<sub>e</sub></i> )	2.1660				UV	
Se <sub>6</sub>	six-membered ring with chair conformation	Se—Se	2.34	∠SeSeSe	102		ED	
SiBrF <sub>3</sub>	C <sub>3v</sub>	Si—F	1.559	Si—Br	2.156	∠FSiBr	108.5	MW
SiBrH <sub>3</sub>	C <sub>3v</sub>	Si—Br	2.210	Si—H	1.486	∠HSiBr	107.8	MW
SiCl		Si—Cl ( <i>r<sub>e</sub></i> )	2.058				UV	
SiClH <sub>3</sub>	C <sub>3v</sub>	Si—Cl	2.049	Si—H	1.486	∠HSiCl	107.9	MW
SiCl <sub>4</sub>	T <sub>d</sub>	Si—Cl	2.019				ED	
SiF		Si—F	1.6008				UV	
SiFH <sub>3</sub>	C <sub>3v</sub>	Si—F	1.593	Si—H	1.486	∠HSiH	110.63	MW, IR
SiF <sub>2</sub>		Si—F ( <i>r<sub>e</sub></i> )	1.590	∠FSiF ( <i>θ<sub>e</sub></i> )	100.8		MW	
SiF <sub>3</sub> H	C <sub>3v</sub>	Si—H ( <i>r<sub>e</sub></i> )	1.4468	Si—F ( <i>r<sub>e</sub></i> )	1.5624	∠HSiF ( <i>θ<sub>e</sub></i> )	110.64	MW
SiF <sub>4</sub>	T <sub>d</sub>	Si—F	1.553				ED	
SiH		Si—H ( <i>r<sub>e</sub></i> )	1.5201				UV	
SiH <sub>3</sub> I	C <sub>3v</sub>	Si—I	2.437	Si—H	1.486	∠HSI	107.8	MW
SiH <sub>4</sub>	T <sub>d</sub>	Si—H	1.4798				IR	
SiN		Si—N ( <i>r<sub>e</sub></i> )	1.572				UV	
SiO		Si—O ( <i>r<sub>e</sub></i> )	1.5097				MW	
SiS		Si—S ( <i>r<sub>e</sub></i> )	1.9293				MW	
SiSe		Si—Se ( <i>r<sub>e</sub></i> )	2.0583				MW	
Si <sub>2</sub>		Si—Si ( <i>r<sub>e</sub></i> )	2.246				UV	
Si <sub>2</sub> Cl <sub>6</sub>		Si—Si	2.32	Si—Cl	2.009	∠ClSiCl	109.7	ED
Si <sub>2</sub> F <sub>6</sub>		Si—Si	2.317	Si—F	1.564	∠FSiF	108.6	ED
Si <sub>2</sub> H <sub>6</sub>		Si—Si	2.331	Si—H	1.492		ED	
		∠SiSiH	110.3	∠HSiH	108.6			
SnBr <sub>2</sub>		Sn—Br ( <i>r<sub>e</sub></i> )	2.501	∠BrSnBr	100.0		ED	
SnCl		Sn—Cl ( <i>r<sub>e</sub></i> )	2.361				UV	
SnCl <sub>2</sub>		Sn—Cl ( <i>r<sub>e</sub></i> )	2.335	∠ClSnCl	99.1		ED	
SnCl <sub>4</sub>	T <sub>d</sub>	Sn—Cl	2.281				ED	
SnF		Sn—F ( <i>r<sub>e</sub></i> )	1.944				UV	
SnH		Sn—H ( <i>r<sub>e</sub></i> )	1.7815				UV	
SnH <sub>4</sub>	T <sub>d</sub>	Sn—H	1.711				R, IR	
SnI <sub>2</sub>		Sn—I ( <i>r<sub>e</sub></i> )	2.688				ED	
SnO		Sn—O ( <i>r<sub>e</sub></i> )	1.8325				MW, UV	
SnS		Sn—S ( <i>r<sub>e</sub></i> )	2.2090				MW	
SnSe		Sn—Se ( <i>r<sub>e</sub></i> )	2.3256				MW	
SnTe		Sn—Te ( <i>r<sub>e</sub></i> )	2.5228				MW	
SrBr		Sr—Br ( <i>r<sub>e</sub></i> )	2.7352				UV	
SrBr <sub>2</sub>	quasilinear	Sr—Br	2.783				ED	
SrCl <sub>2</sub>		Sr—Cl	2.630	∠ClSrCl	155		ED	
SrF		Sr—F ( <i>r<sub>e</sub></i> )	2.0754				UV	
SrH		Sr—H ( <i>r<sub>e</sub></i> )	2.1456				UV	
SrI		Sr—I ( <i>r<sub>e</sub></i> )	2.9436				UV	
SrI <sub>2</sub>	linear	Sr—I	3.01				ED	
SrO		Sr—O ( <i>r<sub>e</sub></i> )	1.9198				MW	
SrOH		Sr—O	2.111	O—H	0.922		UV	
SrS		Sr—S ( <i>r<sub>e</sub></i> )	2.4405				UV	
TaBr <sub>5</sub>	D <sub>3h</sub>	Ta—Br <sub>eq</sub>	2.412	Ta—Br <sub>ax</sub>	2.473		ED	
TaCl <sub>5</sub>	D <sub>3h</sub>	Ta—Cl <sub>eq</sub>	2.268	Ta—Cl <sub>ax</sub>	2.315		ED	
TaO		Ta—O ( <i>r<sub>e</sub></i> )	1.6875				UV	
TbCl <sub>3</sub>	C <sub>3v</sub>	Tb—Cl	2.476				ED	
TeF <sub>6</sub>	O <sub>h</sub>	Te—F	1.815				ED	
TeH		Te—H	1.74				UV	
TeO		Te—O ( <i>r<sub>e</sub></i> )	1.825				UV	
Te <sub>2</sub>		Te—Te ( <i>r<sub>e</sub></i> )	2.5574				UV	
ThCl <sub>4</sub>	T <sub>d</sub>	Th—Cl	2.567				ED	

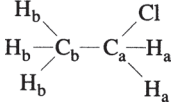
Formula	Structure	Bond distances in Å and angles in degrees						Method
ThF <sub>4</sub>	T <sub>d</sub>	Th—F	2.124					ED
ThO		Th—O ( <i>r<sub>e</sub></i> )	1.84032					UV
TiBr <sub>4</sub>	T <sub>d</sub>	Ti—Br	2.339					ED
TiCl <sub>3</sub>	D <sub>3h</sub>	Ti—Cl	2.208					ED
TiCl <sub>4</sub>	T <sub>d</sub>	Ti—Cl	2.170					ED
TiF		Ti—F	1.8342					MW
TiF <sub>4</sub>	T <sub>d</sub>	Ti—F	1.756					ED
TiI <sub>3</sub>	D <sub>3h</sub>	Ti—I	2.568					ED
TiI <sub>4</sub>	T <sub>d</sub>	Ti—I	2.546					ED
TiO		Ti—O ( <i>r<sub>e</sub></i> )	1.620					UV
TiS		Ti—S ( <i>r<sub>e</sub></i> )	2.0825					UV
TlBr		Tl—Br ( <i>r<sub>e</sub></i> )	2.6182					MW
TlCl		Tl—Cl ( <i>r<sub>e</sub></i> )	2.4848					MW
TlF		Tl—F ( <i>r<sub>e</sub></i> )	2.0844					MW
TlH		Tl—H ( <i>r<sub>e</sub></i> )	1.870					UV
TlI		Tl—I ( <i>r<sub>e</sub></i> )	2.8137					MW
UCl <sub>4</sub>	T <sub>d</sub>	U—Cl	2.506					ED
UCl <sub>6</sub>	O <sub>h</sub>	U—F	2.46					ED
UF <sub>4</sub>	T <sub>d</sub>	U—F	2.059					ED
UF <sub>6</sub>	O <sub>h</sub>	U—F	2.000					ED
UI <sub>3</sub>	C <sub>3v</sub>	U—I	2.88					ED
VCl <sub>3</sub> O	C <sub>3v</sub>	V—O	1.570	V—Cl	2.142	∠ClVCl	111.3	ED, MW
VBr <sub>4</sub>	T <sub>d</sub> (Jahn-Teller effect)	V—Br	2.276					ED
VCl <sub>4</sub>	T <sub>d</sub> (Jahn-Teller effect)	V—Cl	2.138					ED
VF <sub>3</sub>	D <sub>3h</sub>	V—F	1.751					ED
VF <sub>5</sub>		V—F <sub>eq</sub>	1.709	V—F <sub>ax</sub>	1.736			ED
VMo		V—Mo	1.876					UV
VO		V—O ( <i>r<sub>e</sub></i> )	1.5893					UV
WClF <sub>5</sub>		W—F (av.)	1.836	W—Cl	2.251	∠F <sub>a</sub> WF <sub>b</sub>	88.7	MW
WCl <sub>5</sub>	D <sub>3h</sub>	W—Cl <sub>eq</sub>	2.243	W—Cl <sub>ax</sub>	2.293			ED
WCl <sub>6</sub>	O <sub>h</sub>	W—Cl	2.290					ED
WF <sub>4</sub> O	C <sub>4v</sub>	W—O	1.666	W—F	1.847	∠FWF	86.2	ED
WF <sub>6</sub>	O <sub>h</sub>	W—F	1.833					ED
XeF <sub>2</sub>	linear	Xe—F	1.977					IR
XeF <sub>4</sub>	D <sub>4h</sub>	Xe—F	1.94					ED
XeF <sub>6</sub>	O <sub>h</sub>	Xe—F	1.890					ED
XeO <sub>4</sub>	T <sub>d</sub>	Xe—O	1.736					ED
YCl		Y—Cl	2.385					UV
YCl <sub>3</sub>		Y—Cl	2.437					ED
YF		Y—F ( <i>r<sub>e</sub></i> )	1.9257					UV
YI <sub>3</sub>		Y—I	2.817					ED
YO		Y—O ( <i>r<sub>e</sub></i> )	1.790					UV
YbBr		Yb—Br ( <i>r<sub>e</sub></i> )	2.6454					UV
YbH		Yb—H ( <i>r<sub>e</sub></i> )	2.0526					UV
ZnBr <sub>2</sub>	linear	Zn—Br	2.204					ED
ZnCl <sub>2</sub>	linear	Zn—Cl	2.072					ED
ZnF		Zn—F ( <i>r<sub>e</sub></i> )	1.7677					MW
ZnF <sub>2</sub>	linear	Zn—F	1.742	[Zn—F ( <i>r<sub>e</sub></i> )]	1.729			ED
ZnH		Zn—H ( <i>r<sub>e</sub></i> )	1.5949					UV
ZnI <sub>2</sub>	linear	Zn—I	2.401					ED
ZrBr <sub>4</sub>	T <sub>d</sub>	Zr—Br	2.465					ED
ZrCl <sub>4</sub>	T <sub>d</sub>	Zr—Cl	2.328					ED
ZrF <sub>4</sub>	T <sub>d</sub>	Zr—F	1.902					ED
ZrI <sub>4</sub>	T <sub>d</sub>	Zr—I	2.660					ED
ZrO		Zr—O ( <i>r<sub>e</sub></i> )	1.7116					UV

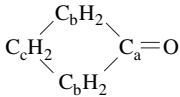
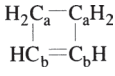
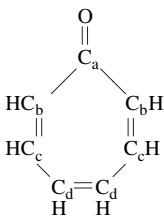
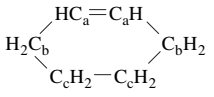
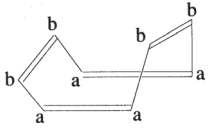
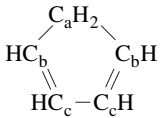
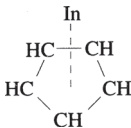
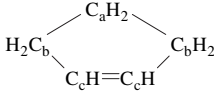
## Part 2. Molecules containing carbon

Compound	Structure	Bond distances in Å and angles in degrees						Method
Acetaldehyde		C <sub>a</sub> -O	1.210	C <sub>a</sub> -C <sub>b</sub>	1.515			ED, MW
		C <sub>a</sub> -H	1.128	C <sub>b</sub> -H	1.107			
		∠C <sub>b</sub> C <sub>a</sub> O	124.1	∠C <sub>b</sub> C <sub>a</sub> H	115.3	∠HC <sub>b</sub> H	109.8	
Acetamide	CH <sub>3</sub> CONH <sub>2</sub>	C-O	1.220	C-N	1.380			ED
		C-C	1.519	N-H	1.022	C-H	1.124	
		∠CCN	115.1	∠NCO	122.0			
Acetic acid		C-C	1.520	C-O <sub>a</sub>	1.214	C-O <sub>b</sub>	1.364	ED
		C-H	1.10	∠CCO <sub>a</sub>	126.6	∠CCO <sub>b</sub>	110.6	
Acetone	(CH <sub>3</sub> ) <sub>2</sub> CO Symmetry axis of each CH <sub>3</sub> is tilted 2° from the C-C bond	C-C	1.520	C-O	1.213	C-H	1.103	ED, MW
		∠CCC	116.0	∠HCH	108.5			
Acetonitrile	CH <sub>3</sub> CN (C <sub>3v</sub> )	C-N	1.159	C-C	1.468	C-H	1.107	ED, MW
		∠CCH	109.7					
Acetonitrile-N-oxide	CH <sub>3</sub> CNO (C <sub>3v</sub> )	C-C	1.442	C-N	1.169	N-O	1.217	MW
Acetyl chloride	CH <sub>3</sub> COCl	C-C	1.506	C-O	1.187	C-H	1.105	ED, MW
		C-Cl	1.798	∠HCH	108.6	∠OCCl	121.2	
		∠CCCl	111.6					
Acetylene	HC≡CH	C-C (r <sub>e</sub> )	1.203	C-H (r <sub>e</sub> )	1.060			IR
Acrolein		C <sub>a</sub> -C <sub>b</sub>	1.345	C <sub>b</sub> -C <sub>c</sub>	1.484	C <sub>c</sub> -O	1.217	ED, MW
		C <sub>a</sub> -H	1.10	C <sub>c</sub> -H	1.13	∠HC <sub>c</sub> C <sub>b</sub>	114	
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	120.3	∠C <sub>b</sub> C <sub>c</sub> O	123.3	Other CCH (av.)	122	
	(planar <i>s-trans</i> form)							
Acrylonitrile		C <sub>a</sub> -C <sub>b</sub>	1.343	C <sub>b</sub> -C <sub>c</sub>	1.438	C <sub>c</sub> -N	1.167	ED, MW
		C <sub>a</sub> -H	1.114	∠C <sub>b</sub> C <sub>c</sub> N	178	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	121.7	
		∠HCC	120					
Allene	CH <sub>2</sub> =C=CH <sub>2</sub>	C-C	1.3084	C-H	1.087	∠HCH	118.2	IR
Aniline	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	C-C	1.392	C-N	1.431	N-H	0.998	MW
		∠HNH	113.9	dihedral angle between NH <sub>2</sub> plane and N-C bond	140.6			
Azetidine		C-N	1.482	C-C	1.553			ED
		C-H	1.107	N-H	1.03			
		∠CCC	86.9	∠CCN	85.8	∠CNC	92.2	
		dihedral angle between CCC and CNC planes	147					
Benzamide	C <sub>6</sub> H <sub>5</sub> -C <sub>a</sub> ONH <sub>2</sub>	C-C (ring)	1.401	C (ring)-C <sub>a</sub>	1.511	C <sub>a</sub> -O	1.225	ED
		C-H	1.112	C-N	1.380			
		∠CCN	117.8	∠CCC (ring)	120(ass.)	∠CCO	121.2	
Benzene	C <sub>6</sub> H <sub>6</sub>	C-C	1.399	C-H	1.101			ED, IR
<i>p</i> -Benzoquinone		C <sub>a</sub> -O	1.225	C <sub>a</sub> -C <sub>b</sub>	1.481	C <sub>b</sub> -C <sub>b</sub>	1.344	ED
		∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	118.1					

Compound	Structure	Bond distances in Å and angles in degrees					Method	
Bicyclo[1.1.0]butane		C <sub>a</sub> —C <sub>a</sub> C <sub>b</sub> —H <sub>b</sub> ∠C <sub>b</sub> C <sub>a</sub> H <sub>a</sub> dihedral angle between the two C <sub>a</sub> C <sub>a</sub> C <sub>b</sub> planes	1.497 1.093 130.4 121.7	C <sub>a</sub> —C <sub>b</sub> C <sub>b</sub> —H <sub>c</sub> ∠C <sub>a</sub> C <sub>a</sub> H <sub>a</sub>	1.498 1.093 128.4	C <sub>a</sub> —H <sub>a</sub> ∠H <sub>b</sub> C <sub>b</sub> H <sub>c</sub> ∠C <sub>a</sub> C <sub>b</sub> C <sub>a</sub>	1.071 115.6 60.0	MW
Bicyclo[2.2.1]heptane	See preceding structure C <sub>7</sub> H <sub>12</sub>	C <sub>a</sub> —C <sub>b</sub> C—C (av.) dihedral angle between the two C <sub>a</sub> C <sub>b</sub> C <sub>b</sub> C <sub>a</sub> planes	1.54 1.549 113.1	C <sub>b</sub> —C <sub>b</sub> ∠C <sub>a</sub> C <sub>c</sub> C <sub>a</sub>	1.56 93.1	C <sub>a</sub> —C <sub>c</sub>	1.56	ED
Bicyclo[2.2.0]hexa-2,5-diene		C <sub>b</sub> —C <sub>b</sub> dihedral angle between the two C <sub>a</sub> C <sub>b</sub> C <sub>b</sub> C <sub>a</sub> planes	1.345 117.3	C <sub>a</sub> —C <sub>a</sub>	1.574	C <sub>a</sub> —C <sub>b</sub>	1.524	ED
Bicyclo[2.2.2]octane	HC <sub>a</sub> (C <sub>b</sub> H <sub>2</sub> C <sub>b</sub> H <sub>2</sub> ) <sub>2</sub> C <sub>a</sub> H large-amplitude torsional motion about D <sub>3h</sub> symmetry axis	C <sub>a</sub> —C <sub>b</sub> ∠C <sub>a</sub> C <sub>b</sub> C <sub>b</sub>	1.54 109.7	C <sub>b</sub> —C <sub>b</sub>	1.55	C—C (av.)	1.542	ED
Bicyclo[1.1.1]pentane	C <sub>5</sub> H <sub>8</sub>	C—C	1.557	∠CCC	74.2			ED
Bicyclo[2.1.0]pentane		C <sub>a</sub> —C <sub>a</sub> C <sub>a</sub> —C <sub>b</sub> dihedral angle between the C <sub>a</sub> C <sub>a</sub> C <sub>b</sub> C <sub>b</sub> and C <sub>a</sub> C <sub>a</sub> C <sub>c</sub> planes	1.536 1.528	C <sub>b</sub> —C <sub>b</sub>	1.565 112.7	C <sub>a</sub> —C <sub>c</sub>	1.507	MW
Biphenyl		C—C (intra-ring) torsional dihedral angle between the two rings	1.396 ≈40	C—C (inter-ring)	1.49			ED
4,4'-Bipyridyl		C—C (inter-ring) torsional dihedral angle between the two rings	1.465 ≈37	C—C (intra-ring)	1.375	C—N (intra-ring)	1.375	ED
Bis(cyclopentadienyl) beryllium	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Be (C <sub>5v</sub> )	Be—(cyclopentadienyl plane)	1.470, 1.92	C—C	1.423			ED
Bis(cyclopentadienyl) iron	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Fe (D <sub>5h</sub> )	Fe—C	2.064	C—C	1.440	C—H	1.104	ED
Bis(cyclopentadienyl) lead	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Pb (D <sub>5h</sub> )	Pb—C dihedral angle between the two C <sub>5</sub> H <sub>5</sub> planes (The two rings are not parallel)	2.79 40~50	C—C	1.430			ED
Bis(cyclopentadienyl) manganese	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Mn (D <sub>5h</sub> )	Mn—C	2.383	C—C	1.429			ED
Bis(cyclopentadienyl) nickel	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Ni (D <sub>5h</sub> )	Ni—C	2.196	C—C	1.430			ED
Bis(cyclopentadienyl) ruthenium	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Ru (D <sub>5h</sub> )	Ru—C	2.196	C—C	1.439			ED
Bis(cyclopentadienyl) tin	(C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> Sn (D <sub>5h</sub> )	Sn—C	2.71	C—C	1.431	C—H	1.14	ED
Borane carbonyl	BH <sub>3</sub> CO (C <sub>3v</sub> )	C—O ∠BCO	1.131 180	B—C ∠HBH	1.540 113.9	B—H	1.194	MW

Compound	Structure	Bond distances in Å and angles in degrees						Method
Bromobenzene		C <sub>a</sub> -C <sub>b</sub> C-Br	1.42 1.85	C <sub>b</sub> -C <sub>c</sub> C-H	1.375 1.072	C <sub>c</sub> -C <sub>d</sub> ∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	1.401 117.4	MW
Bromochloroacetylene	ClC≡CBr	C-Cl	1.636	C-Br	1.784	C-C	1.206	ED
Bromoiodoacetylene	IC≡CBr	C-I	1.972	C-Br	1.795	C-C	1.206	ED
Bromomethane	CH <sub>3</sub> Br	C-Br ( <i>r<sub>e</sub></i> )	1.933	C-H ( <i>r<sub>e</sub></i> )	1.086	∠HCH ( <i>θ<sub>e</sub></i> )	111.2	MW, IR
Bromomethyl	CH <sub>2</sub> Br (planar)	C-Br	1.848	C-H	1.084	∠HCH (ass.)	124.5	MW
Bromomethylene	CHBr (bent)	C-Br	1.857	C-H	1.110	∠HCH	101.0	UV
Bromomethylmercury	CH <sub>3</sub> HgBr (C <sub>3v</sub> )	C-Hg	2.07	Hg-Br	2.406	C-H (av.)	1.108	MW
1,3-Butadiene		C <sub>a</sub> -C <sub>b</sub> ∠CCC	1.349 124.4	C <sub>b</sub> -C <sub>c</sub> ∠C <sub>b</sub> C <sub>a</sub> H	1.467 120.9	C-H (av.)	1.108	ED
1,3-Butadiyne		C <sub>a</sub> -C <sub>b</sub>	1.218	C <sub>b</sub> -C <sub>c</sub>	1.384	C-H	1.09	ED
Butane	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	C-C ∠CCH	1.531 111.0	C-H dihedral angle for the <i>gauche</i> conformer	1.117 65	∠CCC	113.8	ED
2,3-Butanedione	CH <sub>3</sub> COCOCH <sub>3</sub> <i>trans</i> conformer	C-O ∠CCC	1.215 116.2	C-C (av.) ∠CCO	1.524 119.5	C-H	1.108	ED
2-Butanone		C-C (av.)	1.518	C <sub>c</sub> -O	1.219	C-H (av.)	1.102	ED
1,2,3-Butatriene	H <sub>2</sub> C <sub>a</sub> =C <sub>b</sub> =C <sub>c</sub> =C <sub>d</sub> H <sub>2</sub> (D <sub>2h</sub> )	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub> C <sub>a</sub> -C <sub>b</sub>	113.5 1.32	∠C <sub>b</sub> C <sub>c</sub> O C <sub>b</sub> -C <sub>c</sub>	121.9 1.28	∠C <sub>d</sub> C <sub>c</sub> O C-H	121.9 1.08	ED
<i>cis</i> -2-Butene	C <sub>a</sub> H <sub>3</sub> C <sub>b</sub> H=C <sub>b</sub> HC <sub>a</sub> H <sub>3</sub>	C <sub>a</sub> -C <sub>b</sub>	1.506	C <sub>b</sub> -C <sub>c</sub>	1.346	∠C <sub>a</sub> C <sub>b</sub> C <sub>b</sub>	125.4	ED
<i>trans</i> -2-Butene	C <sub>a</sub> H <sub>3</sub> C <sub>b</sub> H=C <sub>b</sub> HC <sub>a</sub> H <sub>3</sub>	C <sub>a</sub> -C <sub>b</sub>	1.508	C <sub>b</sub> -C <sub>c</sub>	1.347	∠C <sub>a</sub> C <sub>b</sub> C <sub>b</sub>	123.8	ED
1-Buten-3-yne		C <sub>a</sub> -C <sub>b</sub> C <sub>a</sub> -H <sub>a</sub> ∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub> ∠H <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	1.344 1.11 123.1 122	C <sub>b</sub> -C <sub>c</sub> C <sub>d</sub> -H <sub>d</sub> ∠C <sub>b</sub> C <sub>c</sub> C <sub>d</sub> ∠H <sub>c</sub> C <sub>b</sub> C <sub>a</sub>	1.434 1.09 178 122	C <sub>c</sub> -C <sub>d</sub> ∠H <sub>a</sub> C <sub>a</sub> C <sub>b</sub> ∠C <sub>c</sub> C <sub>d</sub> H <sub>d</sub>	1.215 119 182	ED, MW
<i>tert</i> -Butyl chloride	(CH <sub>3</sub> ) <sub>3</sub> CCl	C-C ∠CCCl	1.528 107.3	C-Cl ∠CCH	1.828 110.8	C-H ∠CCC	1.102 111.6	ED, MW
2-Butyne	C <sub>a</sub> H <sub>3</sub> -C <sub>b</sub> ≡C <sub>c</sub> -C <sub>d</sub> H <sub>3</sub>	C <sub>b</sub> -C <sub>c</sub> ∠C <sub>b</sub> C <sub>a</sub> H	1.214 110.7	C <sub>a</sub> -C <sub>b</sub>	1.468	C-H	1.116	ED
Carbon dimer	C <sub>2</sub>	C-C ( <i>r<sub>e</sub></i> )	1.2425					UV
Carbon trimer	C <sub>3</sub> (linear)	C-C	1.277					UV
Carbon dioxide	CO <sub>2</sub> (linear)	C-O ( <i>r<sub>e</sub></i> )	1.1600					IR
Carbon disulfide	CS <sub>2</sub> (linear)	C-S ( <i>r<sub>e</sub></i> )	1.5526					IR
Carbon monobromide	CBr	C-Br	1.8209					UV
Carbon monoselenide	CSe	C-Se ( <i>r<sub>e</sub></i> )	1.67609					UV
Carbon monosulfide	CS	C-S ( <i>r<sub>e</sub></i> )	1.5349					MW
Carbon monoxide	CO	C-O ( <i>r<sub>e</sub></i> )	1.1283					MW
Carbon oxyselenide	OCSe (linear)	C-O	1.159	C-Se	1.709			MW
Carbon oxysulfide	OCS (linear)	C-O ( <i>r<sub>e</sub></i> )	1.1578	C-S ( <i>r<sub>e</sub></i> )	1.5601			MW
Carbon phosphide	CP	C-P ( <i>r<sub>e</sub></i> )	1.562					UV
Carbon sulfide selenide	SCSe (linear)	C-S	1.553	C-Se	1.693			MW
Carbon sulfide telluride	SCTe (linear)	C-S	1.557	C-Te	1.904			MW
Carbon suboxide	OCCCO (linear)	C-C	1.289	C-O	1.163			ED

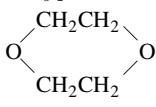
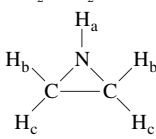
Compound	Structure	Bond distances in Å and angles in degrees						Method
Carbonyl bromide	COBr <sub>2</sub>	C—O	1.178	C—Br	1.923	∠BrCBr	112.3	ED, MW
Carbonyl chloride	COCl <sub>2</sub>	C—O	1.179	C—Cl	1.742	∠ClCCl	111.8	ED, MW
Carbonyl chloride fluoride	COClF	C—O	1.173	C—F	1.334	C—Cl	1.725	ED, MW
		∠ClCO	127.5	∠FCCl	108.8			
Carbonyl dicyanide	CO(CN) <sub>2</sub>	C—O	1.209	C—C	1.466	C—N	1.153	ED, MW
		∠CCC	115	∠CCN	180			
Carbonyl fluoride	COF <sub>2</sub>	C—O	1.172	C—F	1.3157	∠FCF	107.71	ED, MW
Chloroacetylene	HC≡CCl	C—Cl	1.6368	C—C	1.2033	C—H	1.0550	MW
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	C—C	1.400	C—Cl	1.737	C—H	1.083	ED
Chlorocyanoacetylene	ClC≡C—CN	C—Cl	1.624	C—N	1.160	C—C	1.205	ED
		C—CN	1.362					
Chloroethane		C—C	1.528	C—Cl	1.802	C—H	1.103	ED, MW
		∠CCCl	110.7	∠H <sub>b</sub> C <sub>b</sub> H <sub>b</sub>	109.8	∠H <sub>a</sub> C <sub>a</sub> H <sub>a</sub>	109.2	
		∠C <sub>b</sub> C <sub>a</sub> H <sub>a</sub>	110.6	C <sub>a</sub> —H <sub>a</sub> = C <sub>b</sub> —H <sub>b</sub> (ass.)				
2-Chloroethanol	ClCH <sub>2</sub> CH <sub>2</sub> OH ( <i>gauche</i> )	C—O	1.413	C—C	1.519	C—Cl	1.801	ED
		O—H	1.033	C—H	1.093			
		∠CCCl	110.7	∠CCO	113.8	dihedral angle of internal rotation	62.4	
Chloroiodoacetylene	ClC≡CI	C—Cl	1.63	C—I	1.99	C—C	1.209 (ass.)	MW
Chloromethane	CH <sub>3</sub> Cl	C—Cl	1.785	C—H	1.090	∠HCH	110.8	MW, IR
Chloromethylidyne	CCl	C—Cl	1.6512					UV
Chloromethylmercury	CH <sub>3</sub> HgCl (C <sub>3v</sub> )	C—Hg	2.06	Hg—Cl	2.282			MW
<i>trans</i> -1-Chloropropene	CH <sub>3</sub> CH=CHCl	C—Cl	1.728	∠CCCl	121.9			MW
3-Chloropropene	CH <sub>2</sub> ClCH=CH <sub>2</sub> <i>cis</i> conformer	C—Cl	1.811	∠CCCl	115.2			MW
	<i>skew</i> conformer	C—Cl	1.809	∠CCCl	109.6	dihedral angle of internal rotation	122.4	
Chlorotrifluoromethane	CClF <sub>3</sub> (C <sub>3v</sub> )	C—Cl	1.752	C—F	1.325	∠FCF	108.6	ED, MW
Chromium carbonyl	Cr(CO) <sub>6</sub>	Cr—C	1.92	C—O	1.16	∠CrCO	180	ED
Cobalt cyanide	CoC≡N	Co—C	1.883	C—N	1.131			MW
Copper cyanide	CuC≡N	Cu—C	1.832	C—N	1.158			MW
Cyanamide	H <sub>2</sub> N <sub>a</sub> CN <sub>b</sub>	N <sub>a</sub> —C	1.346	C—N <sub>b</sub>	1.160	N—H	1.00	MW
		∠HNH	114	dihedral angle between NH <sub>2</sub> plane and N—C bond	142			
Cyanide	CN	C—N ( <i>r<sub>e</sub></i> )	1.1718					MW
Cyanoacetylene	HC≡C <sub>b</sub> —C <sub>c</sub> N	C <sub>a</sub> —C <sub>b</sub>	1.205	C <sub>b</sub> —C <sub>c</sub>	1.378	C—H	1.058	MW
		C <sub>c</sub> —N	1.159					
Cyanocyclopropane	C <sub>3</sub> H <sub>5</sub> C <sub>a</sub> N	C—C (ring)	1.513	C—C <sub>a</sub>	1.472	C <sub>a</sub> —N	1.157	MW
		C—H	1.107	∠C <sub>a</sub> CH	119.6	∠HCH	114.6	
Cyanogen	N≡C—C≡N (linear)	C—N	1.163	C—C	1.393			ED
Cyanogen azide	N≡C—N=N≡N (planar)	C—N	1.312	N=N	1.252	N≡N	1.133	MW
		C≡N	1.164	∠CNN	120.2	∠NCN	176.0	
Cyanogen bromide	BrCN (linear)	C—N ( <i>r<sub>e</sub></i> )	1.157	C—Br ( <i>r<sub>e</sub></i> )	1.790			MW
Cyanogen chloride	ClCN (linear)	C—Cl ( <i>r<sub>e</sub></i> )	1.629	C—N ( <i>r<sub>e</sub></i> )	1.160			MW
Cyanogen fluoride	FCN (linear)	C—F	1.262	C—N	1.159			MW
Cyanogen iodide	ICN (linear)	C—I	1.995	C—N	1.159			MW
1-Cyano-2-propyne	HC≡C <sub>b</sub> C <sub>c</sub> H <sub>2</sub> C <sub>d</sub> ≡N	C <sub>a</sub> —C <sub>b</sub>	1.207 (ass.)	C <sub>b</sub> —C <sub>c</sub> (ass.)	1.465	C <sub>c</sub> —C <sub>d</sub>	1.454	MW
		C <sub>d</sub> —N	1.159 (ass.)	C <sub>a</sub> —H (ass.)	1.057	C <sub>c</sub> —H (ass.)	1.090	
		∠C <sub>b</sub> C <sub>c</sub> C <sub>d</sub>	113.4	∠HC <sub>c</sub> H	109.4 (ass.)	∠C <sub>b</sub> C <sub>c</sub> H	111.3 (ass.)	

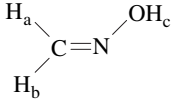
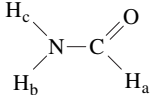
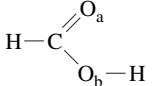
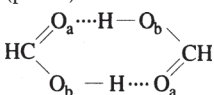
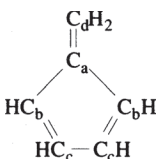
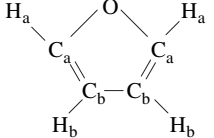
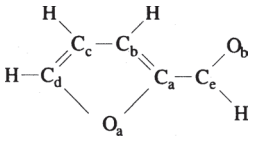
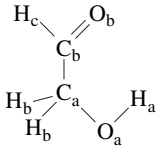
Compound	Structure	Bond distances in Å and angles in degrees					Method	
Cyclobutane	(CH <sub>2</sub> ) <sub>4</sub>	C—C	1.555	C—H	1.113		ED	
		dihedral angle between the two CCC planes	145					
Cyclobutanone		C <sub>a</sub> —C <sub>b</sub>	1.527	C <sub>b</sub> —C <sub>c</sub>	1.556		MW	
		∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	93.1	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	88.0			
Cyclobutene		C <sub>a</sub> —C <sub>a</sub>	1.566	C <sub>b</sub> —C <sub>b</sub>	1.342	C <sub>a</sub> —C <sub>b</sub>	1.517	MW
		C <sub>a</sub> —H	1.094	C <sub>b</sub> —H	1.083			
		∠C <sub>a</sub> C <sub>b</sub> C <sub>b</sub>	94.2	∠C <sub>b</sub> C <sub>b</sub> H	133.5	∠HC <sub>b</sub> H	109.2	
		∠C <sub>a</sub> C <sub>a</sub> H	114.5	∠C <sub>a</sub> C <sub>a</sub> C <sub>b</sub>	85.8	dihedral angle between CH <sub>2</sub> plane and C <sub>a</sub> —C <sub>a</sub> bond	135.8	
2,4,6-Cycloheptatrien-1-one		C <sub>a</sub> —C <sub>b</sub>	1.45	C <sub>b</sub> —C <sub>c</sub>	1.36	C <sub>c</sub> —C <sub>d</sub>	1.46	ED
		C <sub>d</sub> —C <sub>d</sub>	1.34	C <sub>a</sub> —O	1.23	∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	122	
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	133	∠C <sub>b</sub> C <sub>c</sub> C <sub>d</sub>	126	∠C <sub>c</sub> C <sub>d</sub> C <sub>d</sub>	130	
Cyclohexane	(C <sub>2v</sub> ) C <sub>6</sub> H <sub>12</sub> (chair form)	C—C	1.536	C—H	1.119	∠CCC	111.3	ED
Cyclohexene		C <sub>a</sub> —C <sub>a</sub>	1.334	C <sub>a</sub> —C <sub>b</sub>	1.50	C <sub>b</sub> —C <sub>c</sub>	1.52	ED
		C <sub>c</sub> —C <sub>c</sub>	1.54	∠C <sub>a</sub> C <sub>a</sub> C <sub>b</sub>	123.4	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	112.0	
		∠C <sub>b</sub> C <sub>c</sub> C <sub>c</sub>	110.9					
Cyclooctatetraene	half-chair form (C <sub>2</sub> )  tub form (D <sub>2d</sub> )	C <sub>a</sub> —C <sub>b</sub>	1.476	C <sub>a</sub> —C <sub>a</sub>	1.340	C <sub>b</sub> —C <sub>b</sub>	1.340	ED
		C—H	1.100	∠C <sub>b</sub> C <sub>a</sub> C <sub>a</sub>	126.1	∠C <sub>a</sub> C <sub>b</sub> C <sub>b</sub>	126.1	
		dihedral angle between C <sub>a</sub> C <sub>a</sub> C <sub>a</sub> C <sub>a</sub> and C <sub>a</sub> C <sub>b</sub> C <sub>b</sub> C <sub>a</sub> planes	136.9					
1,3-Cyclopentadiene		C <sub>a</sub> —C <sub>b</sub>	1.509	C <sub>b</sub> —C <sub>c</sub>	1.342	C <sub>c</sub> —C <sub>c</sub>	1.469	MW
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	109.3	∠C <sub>b</sub> C <sub>c</sub> C <sub>c</sub>	109.4	∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	102.8	
Cyclopentadienylindium		C—In	2.621	C—C	1.426	(C <sub>5v</sub> )	ED	
Cyclopentane	(CH <sub>2</sub> ) <sub>5</sub>	C—C	1.546	C—H	1.114	∠CCH	111.7	ED
Cyclopentene		C <sub>a</sub> —C <sub>b</sub>	1.546	C <sub>b</sub> —C <sub>c</sub>	1.519	C <sub>c</sub> —C <sub>c</sub>	1.342	ED
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	103.0	∠C <sub>b</sub> C <sub>c</sub> C <sub>c</sub>	110.0	∠C <sub>b</sub> C <sub>a</sub> C <sub>b</sub>	104.0	
		dihedral angle between C <sub>b</sub> C <sub>a</sub> C <sub>b</sub> and C <sub>b</sub> C <sub>c</sub> C <sub>c</sub> planes	151.2					
Cyclopropane	(CH <sub>2</sub> ) <sub>3</sub>	C—C	1.512	C—H	1.083	∠HCH	114.0	R

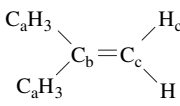
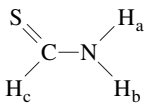
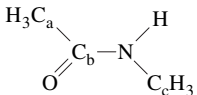


Compound	Structure	Bond distances in Å and angles in degrees					Method	
Cyclopropanone		$C_a-C_b$ $C-H$ dihedral angle between $CH_2$ plane and $C_b-C_b$ bond	1.475 1.086 151	$C_b-C_b$ $\angle C_a C_b C_b$	1.575 57.7	$C_a-O$ $\angle HC_b H$	1.191 114	MW
Cyclopropene		$C_a-C_b$ $C_b-H$	1.505 1.072	$C_b-C_b$ $\angle C_b C_b H$	1.293 150	$C_a-H$ $\angle HC_a H$	1.085 114.3	MW
Cyclopropenone		$C_a-C_b (r_s)$ $C-H (r_s)$	1.423 1.079	$C_b-C_c (r_s)$ $\angle HC_b C_c (\theta_s)$	1.349 144.3	$C_a-O (r_s)$ $C_b C_a C_c (\theta_s)$	1.212 56.6	MW
Decalin	$C_{2v}$ $C_{10}H_{18}$	$C-C$ (av.)	1.530	$C-H$ (av.)	1.113	$\angle CCC$ (av.)	111.4	ED
Diazirine		$C-N$ $\angle HCH$	1.482 117	$N-N$	1.228	$C-H$	1.09	MW
Diazoacetonitrile		$C_a-C_b$ $N_b-N_c$ $\angle C_a C_b H$	1.424 1.132 117	$C_a-N_a$ $C-H$ $\angle C_a C_b N_b$	1.165 1.082 119.5	$C_b-N_b$	1.280	MW
Diazomethane	$CH_2N_2$	$C-N$ $\angle HCH$	1.32 126.0	$N-N$	1.12	$C-H$	1.075	MW, IR
1,2-Dibromoethane	$CH_2BrCH_2Br$	$C-C$ $\angle CCB r$	1.506 109.5	$C-Br$ $\angle CCH$	1.950 110	$C-H$	1.108	ED
Dibromomethane	$CH_2Br_2$	$C-Br$ $\angle BrCB r$	1.924 113.2	$C-H$	1.08	$\angle HCB r$	109	ED
2,2'-Dichlorobiphenyl	$C_6H_4Cl-C_6H_4Cl$	$C-C$ (rings) $C-Cl$ dihedral angle between the two rings (defined as 0 for <i>cis</i> conformer)	1.398 1.732 74	$C-C$ (inter- ring) $\angle CCCL$	1.495 121.4	$C-H$ $\angle CCH$	1.10 126	ED
<i>trans</i> -1,4-Dichlorocyclohexane	$C_6H_{10}Cl_2$	$C-C$ $\angle CCC$	1.530 111.5	$C-Cl$ $\angle HCCl$	1.810 111.5	$C-H$	1.102	ED
	<i>equatorial:</i>	$\angle CCCL$	108.6	$\angle HCCl$	111.5			
	<i>axial:</i>	$\angle CCCL$	110.6	$\angle HCCl$	107.6			
1,1-Dichloroethane	$CHCl_2CH_3$	$C-C$ $\angle ClCCl$	1.540 112.0	$C-Cl$ $\angle CCCl$	1.766 111.0			MW
1,2-Dichloroethane	$CH_2ClCH_2Cl$	$C-C$ $\angle CCCL$	1.531 109.0	$C-Cl$ $\angle CCH$	1.790 113	$C-H$	1.11	ED
1,1-Dichloroethene	$CH_2=CCl_2 (C_{2v})$	$C-C$ $\angle ClCC$	1.32 (ass.) 123	$C-Cl$	1.73			MW
<i>cis</i> -1,2-Dichloroethene	$CHCl=CHCl$	$C-C$ $\angle ClCC$	1.354 123.8	$C-Cl$	1.718			ED
Dichloromethane	$CH_2Cl_2$	$C-Cl (r_s)$ $\angle ClCCl (\theta_s)$	1.765 112.0	$C-H (r_s)$ $\angle HCH (\theta_s)$	1.087 111.5			MW, IR

Compound	Structure	Bond distances in Å and angles in degrees						Method
1,2-Dicyanocyclobutene		$C_a-C_{a'}$	1.361	$C_a-C_b$	1.515	$C_b-C_{b'}$	1.567	MW
		$C_a-C_c$	1.420	$C_c-N$	1.157	$C_b-H$	1.088	
		$\angle C_a C_a C_b$	93.9	$\angle C_a C_b C_b$	86.1	$\angle C_a C_c N$	178.2	
		$\angle C_b C_a C_c$	133.3	$\angle C_a C_b H$	114.7	$\angle C_a C_a C_b H$	115.8	
Difluorocyanamide		$C-N_a$	1.158	$C-N_b$	1.386	$N_b-F$	1.399	MW
		$\angle N_a C N_b$	174	$\angle C N_b F$	105.4	$\angle F N_b F$	102.8	
Difluorocyclopropenone		$C_a-C_b$	1.453	$C_b-C_c$	1.324	$C_a-O$	1.192	MW
		$C-F$	1.314	$\angle F C_b C_c$	145.7			
Difluorodimethylsilane		$C-Si$	1.844	$Si-F$	1.585	$C-H$ (ass.)	1.093	MW
		$\angle C Si C$	115.2	$\angle F Si F$	106.1	$\angle Si C H$ (ass.)	110.8	
1,1-Difluoroethane		$C-C$	1.498	$C-F$	1.364	$C-H$ (av.)	1.081	ED
		$\angle CCF$	110.7	$\angle CCH$ (av.)	111.0	dihedral angle between CCF planes	118.9	
1,2-Difluoroethane		$C-C$	1.503	$C-F$	1.389	$C-H$	1.103	ED
		$\angle CCF$	110.3	$\angle CCH$	111	dihedral angle of internal rotation	109	
1,1-Difluoroethene		$C-C$	1.340	$C-F$	1.315	$C-H$	1.091	ED, MW
		$\angle CCF$	124.7	$\angle CCH$	119.0			
<i>cis</i> -1,2-Difluoroethene		$C-C$	1.33	$C-F$	1.342	$C-H$	1.099	ED, MW
		$\angle CCF$	122.0	$\angle CCH$	124.1			
Difluoromethane		$C-F$	1.357	$C-H$	1.093		MW	
		$\angle FCF$	108.3	$\angle HCH$	113.7			
Dimethoxymethane		$C_a-O$	1.432	$C_b-O$	1.382	$C-H$ (av.)	1.108	ED
		$\angle COC$	114.6	$\angle OCO$	114.3	$\angle OCH$	110.3	
Dimethylamine		$C-N$	1.455	$N-H$	1.00	$C-H$	1.106	ED
		$\angle CNC$	111.8	$\angle CNH$	107	$\angle NCH$	112	
		$\angle HCH$	107					
Dimethylberyllium		$C-Be$	1.698	$C-H$	1.127	$\angle BeCH$	113.9	ED
Dimethyl cadmium		$C-Cd$	2.112	$\angle HCH$	108.4			R
Dimethyl carbonate		$C_b-O_b$	1.209	$C_b-O_a$	1.34	$C_a-O_a$	1.42	ED
		$\angle O_a C_b O_a$	107	$\angle C_b O_a C_a$	114.5			
Dimethylcyanamide		$C_b-N_b$	1.161	$C_a-N_a$	1.463	$C_b-N_a$	1.338	ED
		$C-N$	1.482	$N-N$	1.247	$\angle CNN$	112.3	
<i>trans</i> -Dimethyldiazene		$\angle C_a N C_a$	115.5	$\angle C_a N C_b$	116.0			ED
		$B-B$	1.799	$B-C$	1.580			
		$B-H_b$ ( <i>cis</i> )	1.358	$B-H_b$ ( <i>trans</i> )	1.365	$B-H_t$	1.24	
1,2-Dimethyldiborane		$\angle BBC$ ( <i>cis</i> )	122.6	$\angle BBC$ ( <i>trans</i> )	121.8			ED
Dimethyl diselenide		$C-Se$	1.95	$Se-Se$	2.326	$C-H$	1.13	ED
		$\angle CSeSe$	98.9	$\angle HCSe$	108	$CSeSeC$ dihedral angle	88	
Dimethyl disulfide		$C-S$	1.816	$S-S$	2.029	$C-H$	1.105	ED
		$\angle SSC$	103.2	$\angle SCH$	111.3	$CSSC$ dihedral angle	85	

Compound	Structure	Bond distances in Å and angles in degrees						Method
<i>S,S'</i> -Dimethyl dithiocarbonate	$C_aH_3SC_bSC_aH_3$    O	$C_a-S$ $\angle OCS$	1.802 124.9	$C_b-S$ $\angle CSC$	1.777 99.3	$C_b-O$	1.206	ED
Dimethyl ether	<i>syn-syn</i> conformer ( $CH_3$ ) <sub>2</sub> O	$C-O$ $\angle COC$	1.416 112	$C-H$ $\angle HCH$	1.121 108			ED
<i>N,N'</i> -Dimethylhydrazine	$CH_3NH-NHCH_3$	$C-N$ $C-H$	1.46 1.12	$N-N$ $\angle NNC$	1.42 112	$N-H$ CNNC dihedral angle	1.03 90	ED
Dimethyl mercury	( $CH_3$ ) <sub>2</sub> Hg	$C-Hg$	2.083	$C-H$	1.160 (ass.)	Hg...H	2.71	ED
Dimethylphosphine	( $CH_3$ ) <sub>2</sub> PH	$C-P$ $\angle CPC$	1.848 99.7	$P-H$ $\angle CPH$	1.419 97.0			MW
2,2-Dimethylpropanenitrile	( $C_cH_3$ ) <sub>3</sub> $C_b-C_a\equiv N$	$C_a-C_b$ $\angle C_cC_bC_c$	1.495 110.5	$C_b-C_c$	1.536	$C_a-N$	1.159	MW
Dimethyl selenide	( $CH_3$ ) <sub>2</sub> Se	$C-Se$ $\angle CSeC$	1.943 96.2	$C-H$ $\angle SeCH$	1.093 108.7	$\angle HCH$	110.3	MW
Dimethyl silane	( $CH_3$ ) <sub>2</sub> SiH <sub>2</sub>	$C-Si$ $\angle CSiC$ $\angle HSiH$	1.868 110.9 107.8	$C-H$ $\angle CSiH$	1.089 109.5	$Si-H$ $\angle SiCH$	1.482 110.9	MW
Dimethyl sulfide	( $CH_3$ ) <sub>2</sub> S	$C-S$ $\angle CSC$	1.802 98.80	$C-H$ $\angle HCH$	1.090 109.3			ED, MW
Dimethyl sulfone	( $CH_3$ ) <sub>2</sub> SO <sub>2</sub>	$C-S$ $\angle CSC$	1.771 102	$S-O$ $\angle OSO$	1.435 121	$C-H$	1.114	ED
Dimethyl sulfoxide	( $CH_3$ ) <sub>2</sub> SO	$C-S$ $\angle CSC$ dihedral angle between SCC plane and S—O bond	1.799 96.6 115.5	$S-O$ $\angle CSO$	1.485 106.7	$C-H$ $\angle HCH$	1.081 110.3	MW
Dimethyl zinc	( $CH_3$ ) <sub>2</sub> Zn	$C-Zn$	1.929	$\angle HCH$	107.7			R
1,4-Dioxane	 chair form	$C-C$ $\angle CCO$	1.523 109.2	$C-O$ $\angle COC$	1.423 112.45	$C-H$	1.112	ED
Ethane	$C_2H_6$ staggered conformation	$C-C$ $C-C (r_c)$	1.5351 1.522	$C-H$	1.0940	$\angle CCH$	111.17	MW
1,2-Ethanediamine	$H_2NCH_2CH_2NH_2$ <i>gauche</i> conformer	$C-C$ $\angle CCN$	1.545 110.2	$C-N$ dihedral angle between NCC and CCN planes	1.469 64	$C-H$	1.11	ED
Ethanethiol	$C_bH_3-C_aH_2-SH$	$C_a-C_b$ $C_a-H$ $\angle C_bC_aS$	1.530 1.090 108.3	$C_a-S$ $C_b-H$ $\angle C_bC_aH$	1.829 1.093 109.6	$S-H$ $\angle C_aSH$ $\angle C_aC_bH$	1.350 96.4 109.7	MW
Ethanol	$C_bH_3C_aH_2OH$ staggered conformation	$C-C$ $C_a-H$ $\angle CCO$	1.512 1.10 107.8	$C-O$ $C_b-H$ $\angle C_bC_aH$	1.431 1.09 111	$O-H$ $\angle COH$ $\angle C_aC_bH$	0.971 105 110	MW
Ethylene	$CH_2=CH_2$	$C-C (r_s)$	1.329	$C-H (r_s)$	1.082	$\angle HCH (\theta_s)$	117.2	MW, IR
Ethyleneimine		$C-C$ $C-H$ $\angle CNC$ $\angle H_bCC$ $\angle H_cCN$	1.481 1.084 60.3 117.8 114.3	$N-C$ $N-H$ $\angle H_aNC$ $\angle H_bCN$	1.475 1.016 109.3 118.3	$\angle H_bCH_c$ $\angle H_cCC$	115.7 119.3	MW
Ethyl methyl ether	$C_2H_5OCH_3$	$C-C$ $\angle COC$	1.520 111.9	$C-O (av.)$ $\angle OCC$	1.418 109.4	$C-H (av.)$ $\angle HCH$	1.118 109.0	ED

Compound	Structure	Bond distances in Å and angles in degrees						Method
Ethyl methyl sulfide	$C_2H_5SCH_3$ <i>gauche conformer</i>	C—C	1.536	C—S (av.)	1.813	C—H	1.111	ED
		$\angle CSC$	97	$\angle SCC$	114.0	$\angle HCH$	110	
Fluoroketene	HFC=C=O	C—C	1.317	C—O	1.167	C—F	1.360	MW
		C—H	1.102	$\angle CCO$	178.0	$\angle CCF$	119.5	
		$\angle CCH$	122.3					
Fluoromethane	$CH_3F$	C—F ( $r_e$ )	1.382	C—H ( $r_e$ )	1.095	$\angle HCH$ ( $\theta_e$ )	110.45	MW, IR
Fluoromethylidyne	CF	C—F ( $r_e$ )	1.2718					UV
(Fluoromethylidyne) phosphine	$FC\equiv P$	C—F	1.285	C—P	1.541			MW
2-Fluoropropane	$CH_3CHFCH_3$	C—C	1.522	C—F	1.398			MW
		$\angle CCC$	113.4	$\angle CCF$	108.2			
Formaldehyde	$H_2CO$	C—O	1.208	C—H	1.116	$\angle HCH$	116.5	MW
Formaldehyde azine	$H_2C=N-N=CH_2$ <i>trans conformer</i>	C—N	1.277	N—N	1.418	C—H	1.094	ED
		$\angle CNN$	111.4	$\angle HCN$	120.7			
Formaldehyde oxime		C—N	1.276	N—O	1.408	O—H <sub>c</sub>	0.956	MW
		C—H <sub>a</sub>	1.085	C—H <sub>b</sub>	1.086	$\angle CNO$	110.2	
		$\angle H_aCN$	121.8	$\angle H_bCN$	115.6	$\angle NOH_c$	102.7	
Formamide		C—N	1.368	C—O	1.212	C—H <sub>a</sub>	1.125	ED, MW
		N—H	1.027	$\angle CNH$ (av.)	119.2	$\angle NCO$	125.0	
Formic acid		C—O <sub>a</sub>	1.202	C—O <sub>b</sub>	1.343	O <sub>b</sub> —H	0.972	MW
		C—H	1.097					
		$\angle O_aCO_b$	124.9	$\angle HCO_a$	124.1	$\angle CO_bH$	106.3	
Formic acid dimer	(planar) 	C—O <sub>a</sub>	1.220	C—O <sub>b</sub>	1.323	O <sub>a</sub> ...O <sub>b</sub>	2.703	ED
		$\angle O_aCO_b$	126.2	$\angle CO_aO_b$	108.5			
Formyl radical	$HC=O$	C—O	1.1712	C—H	1.110	$\angle HCO$	127.43	MW
Fulvene		C <sub>a</sub> —C <sub>d</sub>	1.349	C <sub>a</sub> —C <sub>b</sub>	1.470	C <sub>b</sub> —C <sub>c</sub>	1.355	MW
		C <sub>c</sub> —C <sub>c</sub>	1.476	C <sub>b</sub> —H	1.078	C <sub>c</sub> —H	1.080	
		C <sub>d</sub> —H	1.13	$\angle C_bC_aC_b$	106.6	$\angle C_bC_cC_c$	109	
		$\angle C_aC_bC_c$	107.7	$\angle C_aC_bH$	124.7	$\angle C_bC_cH$	126.4	
		$\angle HC_dH$	117					
Furan		C <sub>a</sub> —C <sub>b</sub>	1.361	C <sub>b</sub> —C <sub>b</sub>	1.431	C <sub>a</sub> —O	1.362	MW
		C <sub>a</sub> —H <sub>a</sub>	1.075	C <sub>b</sub> —H <sub>b</sub>	1.077			
		$\angle C_aC_bC_b$	106.1	$\angle C_bC_aO$	110.7	$\angle C_aOC_a$	106.6	
		$\angle C_bC_bH_b$	128.0	$\angle OC_aH_a$	115.9			
Furfural		C <sub>a</sub> —C <sub>c</sub>	1.458	C <sub>c</sub> —O <sub>b</sub>	1.250	C <sub>c</sub> —H	1.088	MW
		$\angle C_aC_cO$	121.6	$\angle C_cC_aC_b$	133.9	$\angle C_aC_cH$	116.9	
								<i>trans conformer</i> (with respect to O <sub>a</sub> and O <sub>b</sub> atoms)
Glycolaldehyde		C <sub>a</sub> —C <sub>b</sub>	1.499	C <sub>a</sub> —O <sub>a</sub>	1.437	C <sub>b</sub> —O <sub>b</sub>	1.209	MW
		C <sub>a</sub> —H <sub>b</sub>	1.093	C <sub>b</sub> —H <sub>c</sub>	1.102	O <sub>a</sub> —H <sub>a</sub>	1.051	
		$\angle C_aC_bO_b$	122.7	$\angle C_bC_aO_a$	111.5			
		$\angle C_aC_bH_c$	115.3	$\angle C_bC_aH_b$	109.2	$\angle H_bC_aH_b$	107.6	
		$\angle C_aO_aH_a$	101.6	$\angle H_bC_aO_a$	109.7			
Glyoxal	CHOCHO <i>trans conformer</i>	C—C	1.526	C—O	1.212	C—H	1.132	ED, UV
		$\angle CCO$	121.2	$\angle HCO$	112			
Hexachloroethane	$Cl_3CCl_3$	C—C	1.56	C—Cl	1.769	$\angle CClCl$	110.0	ED
2,4-Hexadiyne	$C_6H_2C\equiv C-C\equiv C-C_6H_5$	C <sub>a</sub> —C <sub>b</sub>	1.450	C <sub>b</sub> —C <sub>c</sub>	1.208	C <sub>c</sub> —C <sub>c</sub>	1.377	ED
		C <sub>a</sub> —H	1.09					
Hexafluoroethane	$F_3CCF_3$	C—C	1.545	CF	1.326	$\angle CCF$	109.8	ED

Compound	Structure	Bond distances in Å and angles in degrees						Method
Hexafluoropropene	$\text{CF}_2=\text{CFCF}_3$	C—C	1.513	C=C	1.329 (ass.)	C—F	1.329 (ass.)	ED
		$\angle\text{CCC}$	127.8	$\angle\text{FCC (CF)}$	120	$\angle\text{FCC(CF}_2\text{)}$	124	
		$\angle\text{FCC(CF}_3\text{)}$	110					
trans-1,3,5-Hexatriene	$\text{H}_2\text{C}_a=\text{C}_b\text{HC}_c\text{H}=\text{C}_c\text{HC}_b\text{H}=\text{C}_a\text{H}_2$	$\text{C}_a-\text{C}_b$	1.337	$\text{C}_b-\text{C}_c$	1.458	$\text{C}_c-\text{C}_c$	1.368	ED
		$\angle\text{C}_a\text{C}_b\text{C}_c$	121.7	$\angle\text{C}_b\text{C}_c\text{C}_c$	124.4			
Hydrogen cyanide	HCN (linear)	C—H ( $r_e$ )	1.0655	C—N ( $r_e$ )	1.1532			MW, IR
Iminocyanide radical	HNCN	N—H	1.034	N...N	2.470			UV
		$\angle\text{HNC}$	116.5	$\angle\text{NCN}$	~180			
Iodoacetylene	$\text{IC}\equiv\text{CH}$	C—C	1.218	C—I	1.980	C—H	1.059	IR
Iodocynoacetylene	$\text{IC}_a\equiv\text{C}_b\text{C}_c\equiv\text{N}$ (linear)	$\text{C}_a-\text{C}_b$	1.207	$\text{C}_b-\text{C}_c$	1.370	$\text{C}_c-\text{N}$	1.160	MW
		$\text{C}_a-\text{I}$	1.985					
Iodomethane	$\text{CH}_3\text{I}$	C—I ( $r_e$ )	2.132	C—H ( $r_e$ )	1.084	$\angle\text{HCH} (\theta_e)$	111.2	MW, IR
Iron pentacarbonyl	$\text{Fe(CO)}_5$ ( $\text{D}_{3h}$ )	Fe—C (av.)	1.821	(Fe—C) <sub>eq</sub> — (Fe—C) <sub>ax</sub>	0.020	C—O (av.)	1.153	ED
Isobutane	$(\text{C}_b\text{H}_3)_3\text{C}_a\text{H}$	$\text{C}_a-\text{C}_b$	1.535	$\text{C}_a-\text{H}$	1.122	$\text{C}_b-\text{H}$	1.113	ED, MW
		$\angle\text{C}_b\text{C}_a\text{C}_b$	110.8	$\angle\text{C}_a\text{C}_b\text{H}$	111.4			
Isobutene		$\text{C}_a-\text{C}_b$	1.508	$\text{C}_b-\text{C}_c$	1.342	$\text{C}_a-\text{H}$	1.119	ED, MW
		$\text{C}_c-\text{H}_c$	1.10					
		$\angle\text{C}_a\text{C}_b\text{C}_a$	115.6	$\angle\text{C}_a\text{C}_b\text{C}_c$	122.2	$\angle\text{C}_b\text{C}_c\text{H}$	121	
		$\angle\text{HC}_a\text{C}_b$ (av.)	111.4	$\angle\text{HC}_a\text{H}$	107.9	$\angle\text{H}_c\text{C}_c\text{H}_c$	118.5	
Isocyanic acid	HNCO (bent)	N—C	1.209	C—O	1.166	N—H	0.986	MW
		$\angle\text{NCO}$	180	$\angle\text{HNC}$	128.0			
Isocyanomethane	$\text{C}_a\text{H}_3-\text{N}\equiv\text{C}_b$	$\text{C}_a-\text{N}$	1.424	N—C <sub>b</sub>	1.166	$\text{C}_a-\text{H}$	1.102	MW
		$\angle\text{NC}_a\text{H}$	109.12					
		$\angle\text{HCH}$	123.0					
Isfulminic acid	HCNO (linear)	C—N	1.161	N—O	1.207	H—C	1.027	MW
Isothiocyanic acid	HNCS	N—C	1.216	C—S	1.561	N—H	0.989	MW
		$\angle\text{NCS}$	180	$\angle\text{HNC}$	135.0			
Ketene	$\text{H}_2\text{C}=\text{C}=\text{O}$	C—C	1.315	C—O	1.163			MW
		C—H	1.090	$\angle\text{HCH}$	123.5			
Malononitrile	$\text{CH}_2(\text{CN})_2$	C—C	1.480	C—N	1.147	C—H	1.091	MW
		$\angle\text{CCC}$	110.4	$\angle\text{CCN}$	176.6	$\angle\text{HCH}$	108.4	
Methane	$\text{CH}_4$	C—H ( $r_e$ )	1.0870					IR
Methanethioamide		C—S	1.626	C—N	1.358	C—H <sub>c</sub>	1.10	MW
		N—H <sub>a</sub>	1.002	N—H <sub>b</sub>	1.007			
		$\angle\text{NCS}$	125.3	$\angle\text{H}_a\text{NC}$	117.9	$\angle\text{H}_b\text{NC}$	120.4	
		$\angle\text{SCH}_c$	127	$\angle\text{H}_a\text{NH}_b$	121.7	$\angle\text{NCH}_c$	108	
Methanethiol	$\text{CH}_3\text{SH}$	C—S	1.819	S—H	1.34	C—H	1.09	MW
		$\angle\text{HSC}$	96.5	$\angle\text{HCH}$	109.8	angle between $\text{CH}_3$ symmetry axis and C— S bond	2.2	
Methanol	$\text{CH}_3\text{OH}$	C—O	1.4246	C—H	1.0936	O—H	0.9451	MW
		$\angle\text{COH}$	108.53	$\angle\text{HCH}$	108.63	angle between $\text{CH}_3$ symmetry axis and C— O bond	3.27	
Methyl	$\cdot\text{CH}_3$ planar ( $\text{D}_{3h}$ )	C—H	1.076					R
N-Methylacetamide		$\text{C}_a-\text{C}_b$	1.520	$\text{C}_b-\text{N}$	1.386	$\text{C}_c-\text{N}$	1.469	ED
		$\text{C}_b-\text{O}$	1.225	C—H	1.107			
		$\angle\text{C}_b\text{NC}_c$	119.7	$\angle\text{NC}_b\text{O}$	121.8	$\angle\text{C}_a\text{C}_b\text{N}$	114.1	

Compound	Structure	Bond distances in Å and angles in degrees						Method
Methylamine	CH <sub>3</sub> NH <sub>2</sub>	C—N	1.471	N—H	1.019	C—H	1.095	MW
		∠HNC	110.3	∠HNH	106.6	∠HCH	108.1	
		angle between CH <sub>3</sub> symmetry axis and C—N bond	4.3					
Methyl azide	CH <sub>3</sub> N <sub>a</sub> —N <sub>b</sub> —N <sub>c</sub>	C—N <sub>a</sub>	1.468	N <sub>a</sub> —N <sub>b</sub>	1.216	N <sub>b</sub> —N <sub>c</sub>	1.113	ED
		C—H	1.09	∠CN <sub>a</sub> N <sub>b</sub>	116.8			
	NNN linear							
3-Methyl-3H-diazirine	CH <sub>3</sub> CH N	C—C	1.501	C—N	1.481	N—N	1.235	MW
		∠NCN	49.3	dihedral angle between CNN plane and C—C bond	122.3			
Methylene	:CH <sub>2</sub>	C—H ( <i>r<sub>e</sub></i> )	1.0748	∠HCH ( <i>θ<sub>e</sub></i> )	133.84			IR,MW
Methylenecyclopropane	C <sub>c</sub> H <sub>2</sub> C <sub>b</sub> =C <sub>a</sub> H <sub>2</sub> C <sub>c</sub> H <sub>2</sub>	C <sub>a</sub> —C <sub>b</sub>	1.332	C <sub>b</sub> —C <sub>c</sub>	1.457	C <sub>c</sub> —C <sub>c</sub>	1.542	MW
		C <sub>c</sub> —H	1.09	∠C <sub>c</sub> C <sub>b</sub> C <sub>c</sub>	63.9	∠HC <sub>a</sub> H	114.3	
		∠HC <sub>c</sub> H	113.5	dihedral angle between C <sub>c</sub> H <sub>2</sub> plane and C <sub>c</sub> —C <sub>c</sub> bond	150.8			
3-Methyleneoxetane	O C <sub>c</sub> H <sub>2</sub> C <sub>b</sub> =C <sub>a</sub> H <sub>2</sub>	C <sub>a</sub> —C <sub>b</sub>	1.33	C <sub>b</sub> —C <sub>c</sub>	1.52	C <sub>c</sub> —O	1.45	MW
		C—H	1.09 (ass)	∠HC <sub>c</sub> H	114 (ass)	∠HC <sub>a</sub> H	120 (ass)	
		∠C <sub>c</sub> C <sub>b</sub> C <sub>c</sub>	87					
Methylenephosphine	CH <sub>c</sub> H <sub>t</sub> =PH planar	C—P	1.673	C—H <sub>c</sub>	1.09	C—H <sub>t</sub>	1.09	MW
		P—H	1.420	∠CPH	97.4			
		∠HCH	117.2	∠PCH <sub>c</sub>	124.4	∠PCH <sub>t</sub>	118.4	
Methyl formate	C <sub>a</sub> H <sub>3</sub> O <sub>a</sub> —C <sub>b</sub> O <sub>b</sub> H <sub>b</sub>	C <sub>b</sub> —O <sub>b</sub>	1.206	C—O (av.)	1.393	C <sub>a</sub> —H	1.08	ED
		C <sub>b</sub> —H	1.101 (ass.)					
		∠COC	114	∠O <sub>a</sub> C <sub>b</sub> O <sub>b</sub>	127	∠O <sub>a</sub> C <sub>a</sub> H	110	
Methylgermane	CH <sub>3</sub> GeH <sub>3</sub>	C—Ge	1.945	Ge—H	1.529	C—H	1.083	MW
		∠HGeH	109.3	∠HCH	108.4			
Methyl hypochlorite	CH <sub>3</sub> OCl	C—O	1.389	O—Cl	1.674	C—H	1.103	MW
		∠COCl	112.8	∠HCH	109.6			
Methyldiyne	:CH	C—H ( <i>r<sub>e</sub></i> )	1.1198					UV
Methyldynephosphine	HCP	C—P ( <i>r<sub>e</sub></i> )	1.5398	C—H ( <i>r<sub>e</sub></i> )	1.0692			MW
Methylketene	C <sub>c</sub> H <sub>3</sub> C <sub>b</sub> =C <sub>a</sub> =O H	C <sub>a</sub> —C <sub>b</sub>	1.306	C <sub>b</sub> —C <sub>c</sub>	1.518	C <sub>a</sub> —O	1.171	MW
		C <sub>b</sub> —H	1.083	C <sub>c</sub> —H	1.10			
		∠OC <sub>a</sub> C <sub>b</sub>	180.5	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	122.6	∠C <sub>a</sub> C <sub>b</sub> H	113.7	
		∠C <sub>c</sub> C <sub>b</sub> H	123.7	∠HCH	109.2			
Methyl nitrate	H <sub>a</sub> H <sub>a</sub> O <sub>a</sub> C H <sub>b</sub> O N O <sub>b</sub>	C—O	1.437	C—H <sub>a</sub>	1.10	C—H <sub>b</sub>	1.09	MW
		O—N	1.402	N—O <sub>a</sub>	1.205	N—O <sub>b</sub>	1.208	
		∠CON	112.7	∠ONO <sub>a</sub>	118.1	∠ONO <sub>b</sub>	112.4	
		∠OCH <sub>a</sub>	110	∠OCH <sub>b</sub>	103			
Methyloxirane	C <sub>a</sub> H <sub>3</sub> C <sub>b</sub> H—C <sub>c</sub> H <sub>2</sub> O	C <sub>a</sub> —C <sub>b</sub>	1.51	∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	121.0	dihedral angle between C <sub>b</sub> C <sub>c</sub> O plane and C <sub>a</sub> C <sub>b</sub> bond	123.8	MW
Methylphosphine	CH <sub>3</sub> PH <sub>2</sub>	C—P	1.858	C—H	1.094			ED
Methylphosphonic difluoride	CH <sub>3</sub> POF <sub>2</sub>	C—P	1.770	P—O	1.444	P—F	1.545	ED,MW
		∠OPC	117.8	∠FPC	103.7	∠FPF	99.2	
Methylsilane	CH <sub>3</sub> SiH <sub>3</sub>	C—Si	1.867	Si—H	1.485	C—H	1.093	MW
		∠HCH	107.7	∠HSiH	108.3			
Methylstannane	CH <sub>3</sub> SnH <sub>3</sub>	C—Sn	2.143	Sn—H	1.700			MW

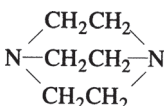
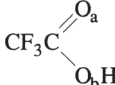
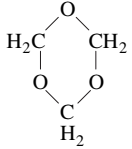
Compound	Structure	Bond distances in Å and angles in degrees						Method
Methyl thiocyanate		S—C <sub>a</sub>	1.824	S—C <sub>b</sub>	1.684	C <sub>b</sub> —N	1.170	MW
		C—H	1.081					
		∠C <sub>a</sub> SC <sub>b</sub>	99.0	∠HCH	110.6	∠HCS	108.3	
Methyltrioxorhenium	CH <sub>3</sub> ReO <sub>3</sub>	Re—C	2.074	Re—O	1.703	C—H	1.088	MW
		∠ReCH	108.9	∠CReO	106.4			
Molybdenum carbide	MoC	Mo—C	1.676					UV
Molybdenum carbonyl	Mo(CO) <sub>6</sub> (O <sub>h</sub> )	Mo—C	2.063	C—O	1.145			ED
Naphthalene		C <sub>a</sub> —C <sub>b</sub>	1.37	C <sub>b</sub> —C <sub>b</sub>	1.41	C <sub>a</sub> —C <sub>c</sub>	1.42	ED
		C <sub>c</sub> —C <sub>c</sub>	1.42	C—C (av.)	1.40	∠C <sub>a</sub> C <sub>c</sub> C <sub>c</sub>	119.4	
Neopentane	C(CH <sub>3</sub> ) <sub>4</sub>	C—C	1.537	C—H	1.114	∠CCH	112	ED
Nickel carbonyl	Ni(CO) <sub>4</sub> (T <sub>d</sub> )	Ni—C	1.839	C—O	1.121			IR
Nickel monocarbonyl	NiCO (linear)	Ni—C	1.64	C—O	1.19			IR
Nickel cyanide	NiC≡N (linear)	Ni—C	1.828	C—N	1.158			MW
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	C—N	1.489	N—O	1.224	C—H	1.088 (ass.)	MW
		∠ONO	125.3	∠NCH	107			
<i>N</i> -Nitrosodimethylamine	(CH <sub>3</sub> ) <sub>2</sub> NNO	C—N	1.461	N—O	1.235	N—N	1.344	ED
		∠CNC	123.2	∠CNN	116.4	∠ONN	113.6	
Nitrosomethane	CH <sub>3</sub> NO	C—N	1.49	N—O	1.22	C—H	1.084	MW
		∠CNO	112.6	∠NCH	109.0			
2,5-Norbornadiene		C <sub>a</sub> —C <sub>b</sub>	1.535	C <sub>b</sub> —C <sub>b</sub>	1.343	C <sub>a</sub> —C <sub>c</sub>	1.573	ED
		C—H	1.12	∠C <sub>a</sub> C <sub>c</sub> C <sub>a</sub>	94			
		dihedral angle between the two C <sub>a</sub> C <sub>b</sub> C <sub>b</sub> C <sub>a</sub> planes	115.6					
1,2,5-Oxadiazole		C—C	1.421	C—N	1.300	O—N	1.380	MW
		C—H	1.076	∠CCH	130.2	∠NCH	120.9	
		∠CCN	109.0	∠NON	110.4	∠ONC	105.8	
1,3,4-Oxadiazole		C—O	1.348	C—N	1.297	N—N	1.399	MW
		C—H	1.075	∠OCH	118.1	∠NCH	128.5	
		∠CNN	105.6	∠COC	102.0	∠OCN	113.4	
Oxalic acid		C—C	1.544	C—O <sub>a</sub>	1.205	C—O <sub>b</sub>	1.336	ED
		O <sub>b</sub> —H	1.05					
		∠CCO <sub>a</sub>	123.1	∠O <sub>a</sub> CO <sub>b</sub>	125.0	∠CO <sub>b</sub> H	104	
Oxalyl chloride		C—C	1.534	C—O	1.182	C—Cl	1.744	ED
		∠CCO	124.2	∠CCCl	111.7	68% trans, 32% gauche at 0 °C		
Oxetane		C—C	1.546	C—O	1.448	C—H (av.)	1.090	MW
		∠CCC	85	∠COC	92	∠OCC	92	
		∠HCH (av.)	109.9					

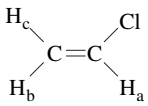
Compound	Structure	Bond distances in Å and angles in degrees						Method
Oxirane		C—C	1.466	C—O	1.431	C—H	1.085	MW
		∠HCH	116.6	dihedral angle between NH <sub>2</sub> plane and N—C bond	158.0			
Phenol		C—C (av.)	1.397	C <sub>a</sub> —O	1.364	O—H	0.956	MW
		C <sub>b</sub> —H	1.084	C <sub>c</sub> —H	1.076	C <sub>d</sub> —H	1.082	
		∠COH	109.0					
Phosphirane		C—C	1.502	C—P	1.867	P—H	1.43	MW
		C—H	1.09	∠CPC	47.4	∠HPC	95.2	
		∠HCH	114.4	∠CCH	118	dihedral angle between PCC plane and PH bond	95.7	
Piperazine		C—C	1.540	C—N	1.467	C—H	1.110	ED
		∠CNC	109.0	∠CCN	110.4			
	(C <sub>2h</sub> )							
Palladium carbide	PdC	Pd—C	1.712					UV
Platinum carbide	PtC	Pt—C ( <i>r<sub>p</sub></i> )	1.6767					UV
Potassium carbide	KC	K—C	2.528					MW
Propane	C <sub>3</sub> H <sub>8</sub>	C—C	1.532	C—H	1.107			ED
		∠CCC	112	∠HCH	107			
Propene		C <sub>a</sub> —C <sub>b</sub>	1.341	C <sub>b</sub> —C <sub>c</sub>	1.506			ED, MW
		C <sub>a</sub> —H <sub>a</sub>	1.104	C <sub>c</sub> —H <sub>d</sub>	1.117			
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	124.3	∠C <sub>b</sub> C <sub>a</sub> H <sub>a,b,c</sub>	121.3	∠C <sub>b</sub> C <sub>c</sub> H <sub>d</sub>	110.7	
2-Propenoyl chloride		C <sub>a</sub> —C <sub>b</sub>	1.35	C <sub>b</sub> —C <sub>c</sub>	1.48	C <sub>c</sub> —Cl	1.82	MW
		C <sub>c</sub> —O	1.19	C—H	1.086 (ass.)			
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	123	∠C <sub>b</sub> C <sub>c</sub> Cl	116	∠C <sub>b</sub> C <sub>c</sub> O	127	
		∠C <sub>a</sub> C <sub>b</sub> H	120 (ass.)	∠C <sub>b</sub> C <sub>a</sub> H	121.5 (ass.)			
2-Propynal	H <sub>a</sub> C <sub>a</sub> ≡C <sub>b</sub> —C <sub>c</sub> H <sub>c</sub> O (planar)	C <sub>a</sub> —C <sub>b</sub>	1.211	C <sub>b</sub> —C <sub>c</sub>	1.453	C <sub>c</sub> —O	1.214	ED, MW
		C <sub>a</sub> —H <sub>a</sub>	1.085	C <sub>c</sub> —H <sub>c</sub>	1.130			
		∠C <sub>a</sub> C <sub>b</sub> C <sub>c</sub>	178.6	∠C <sub>b</sub> C <sub>c</sub> O	124.2	∠C <sub>b</sub> C <sub>c</sub> H <sub>c</sub>	113.7	
Propyne	H <sub>3</sub> C <sub>c</sub> —C <sub>b</sub> ≡C <sub>a</sub> H	C <sub>c</sub> —C <sub>b</sub>	1.459	C <sub>b</sub> —C <sub>a</sub>	1.206			MW
		C <sub>a</sub> —H	1.056	C <sub>c</sub> —H	1.105	∠HC <sub>c</sub> C <sub>b</sub>	110.2	
Propynal isocyanide	H <sub>3</sub> C <sub>c</sub> —C <sub>b</sub> ≡C <sub>a</sub> —N≡C	C <sub>c</sub> —C <sub>b</sub> ( <i>r<sub>s</sub></i> )	1.456	C <sub>b</sub> —C <sub>a</sub> ( <i>r<sub>s</sub></i> )	1.206	C <sub>a</sub> —N ( <i>r<sub>s</sub></i> )	1.316	MW
		N—C ( <i>r<sub>s</sub></i> )	1.175	C <sub>c</sub> —H ( <i>r<sub>s</sub></i> )	1.090	∠HC <sub>c</sub> C <sub>b</sub> ( <i>θ<sub>s</sub></i> )	110.7	
Pyrazine		C—C	1.339	C—N	1.403	C—H	1.115	ED
		∠CCH	123.9	∠CCN	115.6			
Pyridazine		C <sub>a</sub> —C <sub>b</sub>	1.393	C <sub>b</sub> —C <sub>b</sub>	1.375	C <sub>a</sub> —N	1.341	ED, MW
		N—N	1.330	∠NCC	123.7	∠NNC	119.3	



Compound	Structure	Bond distances in Å and angles in degrees						Method
Pyridine		$C_a-C_b$	1.395	$C_b-C_c$	1.394	$C_a-N$	1.340	MW
		$C_a-H_a$	1.084	$C_b-H_b$	1.081	$C_c-H_c$	1.077	
		$\angle C_a C_b C_c$	118.5	$\angle C_b C_c C_a$	118.3	$\angle C_c C_b H_b$	121.3	
		$\angle C_a N C_a$	116.8	$\angle N C_a C_b$	123.9	$\angle N C_a H_a$	115.9	
Pyrimidine		$C-C$	1.393	$C-N$	1.340			ED
		$\angle N C N$	127.6	$\angle C N C$	115.5			
Pyrrrole	( $C_{2v}$ assumed) 	$C_a-C_b$	1.382	$C_b-C_b$	1.417	$C_a-N$	1.370	MW
		$C_a-H_a$	1.076	$C_b-H_b$	1.077	$N-H$	0.996	
		$\angle C_a C_b C_b$	107.4	$\angle C_a N C_a$	109.8	$\angle N C_a C_b$	107.7	
		$\angle C_b C_b H$	127.1	$\angle N C_a H_a$	121.5			
Pyruvonnitrile		$C_a-C_b$	1.518	$C_b-C_c$	1.477	$C-H$	1.12	ED, MW
		$C-N$	1.17	$C-O$	1.208	$\angle H C H$	109.2	
		$\angle C_a C_b C_c$	114.2	$\angle C_a C_b O$	124.5	$\angle C C N$	179	
Ruthenium carbide	$RuC$	$Ru-C$	1.607					UV
Silacyclobutane		$C-C$	1.571	$C-Si$	1.885	$C-H$	1.100	ED
		$Si-H$	1.47	$\angle CCC$	99.8	$\angle C S i C$	77.2	
		$\angle S i C C$	84.8	dihedral angle between CCC and CSiC planes	146			
Silaethene	$H_2Si=CH_2$	$Si-C (r_e)$	1.704	$Si-H (r_e)$	1.467	$C-H (r_e)$	1.082	MW
		$\angle H C S i$	122.0	$\angle H S i C$	122.4			
Silicon dicarbide	$CSiC$ (ring)	$C-C (r_s)$	1.269	$Si-C (r_s)$	1.832	$\angle C S i C (\theta_s)$	40.5	MW
Silylchloroacetylene	$SiH_3C\equiv CCl$	$C-C$	1.234	$Si-C$	1.812	$C-Cl$	1.620	ED
		$Si-H$	1.488	$\angle H S i C$	109.4			
Silyl cyanide	$SiH_3C\equiv N$	$Si-C$	1.850	$C-N$	1.156	$Si-H$	1.487	ED, MW
		$\angle H S i C$	107.25					
Sodium carbide	$NaC$	$Na-C$	2.232					MW
Spiro[2.2]pentane		$C_b-C_b$	1.52	$C_a-C_b$	1.47	$C-H$	1.09	ED
		$\angle C_b C_a C_b$	62	$\angle H C H$	118			
Strontium methyl	( $D_{2d}$ ) $SrCH_3$	$Sr-C$	2.487	$C-H$ (ass.)	1.104	$\angle H C H$	105.8	UV
Succinonitrile	$CH_2CN$   $CH_2CN$	$C-C$	1.561	$C-C(N)$	1.465	$C-N$	1.161	ED
		$C-H$	1.09	$\angle CCC$	110.4	dihedral angle of CCCC for <i>gauche</i> conformer	75	
Tetrabromomethane	$CBr_4$ ( $T_d$ )	$C-Br$	1.935					ED
Tetrachloroethene	$CCl_2=CCl_2$	$C-C$	1.354	$C-Cl$	1.718	$\angle Cl C Cl$	115.7	ED
Tetrachloromethane	$CCl_4$ ( $T_d$ )	$C-Cl$	1.767					ED
Tetracyanoethene	$(CN)_2C=C(CN)_2$	$C-C$	1.435	$C=C$	1.357	$C-N$	1.162	ED
		$\angle CC=C$	121.1					
2,2,4,4-Tetrafluoro-1,3-dithietane		$C-S$	1.785	$C-F$	1.314	$\angle C S C$	83.2	ED
		$\angle F C S$	113.7					
Tetrafluoroethene	( $D_{2h}$ assumed) $CF_2=CF_2$	$C-C$	1.31	$C-F$	1.319	$\angle C C F$	123.8	ED
Tetrafluoromethane	$CF_4$ ( $T_d$ )	$C-F$	1.323					ED

Compound	Structure	Bond distances in Å and angles in degrees						Method
Tetrahydrofuran		C—C	1.536	C—O	1.428	C—H	1.115	ED
Tetrahydropyran		C—C	1.531	C—O	1.420	C—H	1.116	ED
		$\angle\text{COC}$	111.5	$\angle\text{OCC}$	111.8	$\angle\text{CCC (C)}$	108	
		$\angle\text{CCC (O)}$	111					
Tetrahydrothiophene		C—C	1.536	C—S	1.839	C—H	1.120	ED
		$\angle\text{CCC}$	105.0	$\angle\text{CSC}$	93.4	$\angle\text{SCC}$	106.1	
Tetraiodomethane	$\text{CI}_4$ ( $T_d$ )	C—I	2.15					ED
Tetramethylgermane	$(\text{CH}_3)_4\text{Ge}$	C—Ge	1.945	C—H	1.12	$\angle\text{GeCH}$	108	ED
Tetramethyl lead	$(\text{CH}_3)_4\text{Pb}$	C—Pb	2.238					ED
Tetramethylsilane	$(\text{CH}_3)_4\text{Si}$	C—Si	1.875	C—H	1.115	$\angle\text{HCH}$	109.8	ED
Tetramethylstannane	$(\text{CH}_3)_4\text{Sn}$	C—Sn	2.144	C—H	1.12			ED
1,2,5-Thiadiazole		C—C	1.420	C—N	1.328	S—N	1.631	MW
		C—H	1.079					
		$\angle\text{CCN}$	113.8	$\angle\text{NSN}$	99.6	$\angle\text{CCH}$	126.2	
	(planar)							
1,3,4-Thiadiazole		C—S	1.721	C—N	1.302	N—N	1.371	MW
		C—H	1.08	$\angle\text{CSC}$	86.4	$\angle\text{SCN}$	114.6	
		$\angle\text{CCN}$	112.2	$\angle\text{NCH}$	123.5	$\angle\text{SCH}$	121.9	
	(planar)							
Thietane		C—C	1.549	C—S	1.847	C—H (av.)	1.100	ED, MW
		$\angle\text{CSC}$	76.8	$\angle\text{HCH (av.)}$	112	dihedral angle between CCC and CSC planes	154	
Thiirane		C—C	1.484	C—S	1.815	C—H	1.083	MW
		$\angle\text{CSC}$	48.3	$\angle\text{CCS}$	65.9	$\angle\text{HCH}$	116	
		dihedral angle between $\text{CH}_2$ plane and C—C bond	152					
Thioacetaldehyde		$\text{C}_a\text{—S} (r_s)$	1.610	$\text{C}_a\text{—C}_b (r_s)$	1.506			MW
		$\text{C}_a\text{—H} (r_s)$	1.089	$\text{C}_b\text{—H} (r_s)$	1.094			
				(av.)				
		$\angle\text{C}_b\text{C}_a\text{S} (\theta_s)$	125.3	$\angle\text{C}_b\text{C}_a\text{H} (\theta_s)$	119.4	$\angle\text{HC}_b\text{C}_a (\theta_s)$	110.6	
						(av.)		
Thiocarbonyl fluoride	$\text{F}_2\text{CS}$	C—S	1.589	C—F	1.315	$\angle\text{FCF}$	107.1	MW
Thioformaldehyde	$\text{CH}_2\text{S}$	C—S	1.611	C—H	1.093	$\angle\text{HCH}$	116.9	MW
Thioketene	$\text{H}_2\text{C}=\text{C}=\text{S}$	C—C ( $r_s$ )	1.314	C—S ( $r_s$ )	1.554	C—H ( $r_s$ )	1.080	IR
	$\text{C}_{2v}$	$\angle\text{HCH} (\theta_s)$	119.8					
Thiophene		$\text{C}_a\text{—C}_b$	1.370	$\text{C}_b\text{—C}_b$	1.423	$\text{C}_a\text{—S}$	1.714	MW
		$\text{C}_a\text{—H}_a$	1.078	$\text{C}_b\text{—H}_b$	1.081			
		$\angle\text{C}_a\text{C}_b\text{C}_b$	112.5	$\angle\text{C}_a\text{SC}_a$	92.2	$\angle\text{SC}_a\text{C}_b$	115.5	
		$\angle\text{SC}_a\text{H}_a$	119.9	$\angle\text{C}_b\text{C}_b\text{H}_b$	124.3			
Toluene	$\text{C}_6\text{H}_5\text{—CH}_3$	C—C (ring)	1.399	C— $\text{CH}_3$	1.524	C—H (av.)	1.11	ED
1,1,1-Tribromoethane	$\text{CH}_3\text{CBr}_3$	C—C	1.51 (ass.)	C—Br	1.93	C—H	1.095	MW
		$\angle\text{BrCBr}$	111	$\angle\text{CCBr}$	108	$\angle\text{CCH}$	109.0	
						(ass.)		

Compound	Structure	Bond distances in Å and angles in degrees						Method
Tribromomethane	$\text{CHBr}_3$ ( $C_{3v}$ )	C—Br	1.924	C—H	1.11	$\angle\text{BrCB}$	111.7	ED, MW
Tri- <i>tert</i> -butyl methane	$\text{HC}_a[\text{C}_b(\text{C}_c\text{H}_3)_3]_3$	C <sub>a</sub> —C <sub>b</sub>	1.611	C <sub>b</sub> —C <sub>c</sub>	1.548	C—H	1.111	ED
		$\angle\text{C}_a\text{C}_b\text{C}_c$	113.0					
Trichloroacetonitrile	$\text{CCl}_3\text{CN}$	C—C	1.460	C—N	1.165	C—Cl	1.763	ED
		$\angle\text{ClCCl}$	110.0					
1,1,1-Trichloroethane	$\text{CH}_3\text{CCl}_3$	C—C	1.541	C—Cl	1.771	C—H	1.090	MW
		$\angle\text{CCCl}$	109.6	$\angle\text{ClCCl}$	109.4	$\angle\text{HCH}$	110.0	
		$\angle\text{CCH}$	108.9					
Trichlorofluoromethane	$\text{CCl}_3\text{F}$	C—Cl	1.754	C—F	1.362	$\angle\text{ClCCl}$	111	MW
Trichloromethane	$\text{CHCl}_3$	C—Cl	1.758	C—H	1.100	$\angle\text{ClCCl}$	111.3	MW
Trichloromethylgermane	$\text{CH}_3\text{GeCl}_3$	C—Ge	1.89	Ge—Cl	2.132	C—H	1.103	ED, MW
		$\angle\text{ClGeCl}$	106.4	$\angle\text{GeCH}$	110.5	(ass.)		
Trichloromethylsilane	$\text{CH}_3\text{SiCl}_3$	C—Si	1.876	Si—Cl	2.021			MW
Trichloromethylstannane	$\text{CH}_3\text{SnCl}_3$	C—Sn	2.10	Sn—Cl	2.304	C—H	1.100	ED
1,1,1-Trichloro-2,2,2-trifluoroethane	$\text{CF}_3\text{CCl}_3$ (staggered configuration)	C—C	1.54	C—F	1.33	C—Cl	1.77	MW
		$\angle\text{CCF}$	110	$\angle\text{CCCl}$	109.6			
		$\angle\text{CSnCl}$	113.9	$\angle\text{ClSnCl}$	104.7	$\angle\text{SnCH}$	108	
Triethylenediamine		C—C	1.562	C—N	1.472	$\angle\text{CNC}$	108.7	ED
		$\angle\text{NCC}$	110.2					
	( $D_{3h}$ )							
Trifluoroacetic acid		C—C	1.546	C—O <sub>a</sub>	1.192	C—O <sub>b</sub>	1.35	ED
		C—F	1.325	O—H	0.96 (ass.)			
		$\angle\text{CCO}_a$	126.8	$\angle\text{CCO}_b$	111.1	$\angle\text{CCF}$	109.5	
1,1,1-Trifluoroethane	$\text{CH}_3\text{CF}_3$	C—C	1.494	C—F	1.340	C—H	1.081	ED
Trifluoroiodomethane	$\text{CF}_3\text{I}$ ( $C_{3v}$ )	C—F	1.330	C—I	2.138	$\angle\text{FCF}$	108.1	ED, MW
Trifluoromethane	$\text{CHF}_3$ ( $C_{3v}$ )	C—F	1.332	C—H	1.098	$\angle\text{FCF}$	108.8	MW
Trifluoromethanesulfonyl fluoride	$\text{CF}_3\text{SO}_2\text{F}_a$	C—S	1.835	C—F (av.)	1.325	S—O	1.410	ED
		S—F <sub>a</sub>	1.543	$\angle\text{CSF}_a$	95.4	$\angle\text{CSO}$	108.5	
		$\angle\text{OSO}$	124.1	$\angle\text{FCF}$	109.8			
Trifluoromethylimino-sulfur difluoride	$\text{CF}_3\text{N}=\text{SF}_2$	C—N	1.409	S—N	1.477	S—F	1.594	ED, MW
		C—F	1.331	$\angle\text{CNS}$	127.2	$\angle\text{NSF}$	112.7	
		$\angle\text{FSF}$	92.8	$\angle\text{FCF}$	108.1			
Trifluoromethyl peroxide	$\text{CF}_3\text{OOCF}_3$	O—O	1.42	C—O	1.399	C—F	1.320	ED
		$\angle\text{COO}$	107	$\angle\text{FCF}$	109.0	COOC dihedral angle of internal rotation	123	
		$\angle\text{CCF}$	119.2	$\angle\text{CCH}$	112			
Trimethyl aluminium	$(\text{CH}_3)_3\text{Al}$	C—Al	1.957	C—H	1.113			ED
		$\angle\text{CAIC}$	120	$\angle\text{AlCH}$	111.7			
Trimethylamine	$(\text{CH}_3)_3\text{N}$	C—N	1.458	C—H	1.100			ED
		$\angle\text{CNC}$	110.9	$\angle\text{HCH}$	110			
Trimethylarsine	$(\text{CH}_3)_3\text{As}$	C—As	1.979	$\angle\text{CAsC}$	98.8	$\angle\text{AsCH}$	111.4	ED
Trimethyl bismuth	$(\text{CH}_3)_3\text{Bi}$	C—Bi	2.263	C—H	1.07	$\angle\text{CBiC}$	97.1	ED
Trimethylborane	$(\text{CH}_3)_3\text{B}$	C—B	1.578	C—H	1.114			ED
		$\angle\text{CBC}$	120	$\angle\text{BCH}$	112.5			
Trimethylphosphine	$(\text{CH}_3)_3\text{P}$	C—P	1.847	C—H	1.091			ED
		$\angle\text{CPC}$	98.6	$\angle\text{PCH}$	110.7			
1,3,5-Trioxane		C—O	1.422	$\angle\text{OCO}$	112.2	$\angle\text{COC}$	110.3	MW

Compound	Structure	Bond distances in Å and angles in degrees					Method	
Triphenylamine	(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub> N (C <sub>3</sub> )	C—C	1.392	C—N	1.42	∠CNC	116	ED
		torsional dihedral angle of phenyl rings	47					
Tungsten carbide	WC	W—C	1.7135					UV
Tungsten carbonyl	W(CO) <sub>6</sub> (O <sub>h</sub> )	W—C	2.059	C—O	1.149			ED
Vanadium carbonyl	V(CO) <sub>6</sub> (O <sub>h</sub> , involving dynamic Jahn-Teller effect)	V—C	2.015	C—O	1.138			ED
Vinyl bromide	See Vinyl chloride	C—C	1.3256	C—Br	1.8835	C—H <sub>a</sub>	1.0780	MW
		C—H <sub>b</sub>	1.0804	C—H <sub>c</sub>	1.0794	∠CCBr	122.62	
		∠CCH <sub>a</sub>	124.34	∠CCH <sub>b</sub>	119.28	∠CCH <sub>c</sub>	122.03	
Vinyl chloride		C—C	1.3262	C—Cl	1.7263	C—H <sub>a</sub>	1.0783	MW
		C—H <sub>b</sub>	1.0796	C—H <sub>c</sub>	1.0796	∠CCCl	122.75	
		∠CCH <sub>a</sub>	123.91	∠CCH <sub>b</sub>	119.28	∠CCH <sub>c</sub>	121.77	
Vinyl fluoride	See Vinyl chloride	C—C	1.3210	C—F	1.3428	C—H <sub>a</sub>	1.0796	MW
		C—H <sub>b</sub>	1.0774	C—H <sub>c</sub>	1.0789	∠CCF	121.70	
		∠CCH <sub>a</sub>	125.95	∠CCH <sub>b</sub>	118.97	∠CCH <sub>c</sub>	121.34	
Vinyl iodide	See Vinyl chloride	C—C	1.3276	C—I	2.0830	C—H <sub>a</sub>	1.0787	MW
		C—H <sub>b</sub>	1.0823	C—H <sub>c</sub>	1.0799	∠CCI	122.97	
		∠CCH <sub>a</sub>	123.54	∠CCH <sub>b</sub>	119.36	∠CCH <sub>c</sub>	122.30	
Zinc cyanide	ZnC≡N (linear)	Zn—C	1.955	C—N	1.146			MW

## DIPOLE MOMENTS

This table gives selected values of the electric dipole moment for over 800 molecules. When available, values determined by microwave spectroscopy, molecular beam electric resonance, and other high-resolution spectroscopic techniques were selected. Otherwise, the values come from measurements of the dielectric constant in the gas phase or, if these do not exist, in the liquid phase. Entries are listed alphabetically; compounds not containing carbon are listed first, followed by compounds containing carbon.

The dipole moment is given in debye units (D). The conversion factor to SI units is  $1 \text{ D} = 3.33564 \times 10^{-30} \text{ C m}$ .

Dipole moments of individual conformers (rotational isomers) are given when they have been measured. The conformers are designated as *gauche*, *trans*, *axial*, etc. The meaning of these terms can be found in the references. In some cases an average value, obtained from measurements on the bulk gas, is also given. Other information on molecules that have been studied by spectroscopy, such as the components of the dipole moment in the molecular framework and the variation with vibrational state and isotopic species, is given in the references.

When the accuracy of a value is explicitly stated (i.e.,  $1.234 \pm 0.005$ ), the stated uncertainty generally indicates two or three standard deviations. When no uncertainty is given, the value may be assumed to be precise to a few units in the last decimal place. However, if more than three decimal places are given, the exact interpretation of the final digits may require analysis of the vibrational averaging.

Values measured in the gas phase that are questionable because of undetermined error sources are indicated as approximate ( $\approx$ ). Values obtained by liquid phase measurements, which sometimes have large errors because of association effects, are enclosed in brackets, e.g., [1.8].

### References

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Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
<i>Compounds not containing carbon</i>				Hydrazine	H <sub>4</sub> N <sub>2</sub>	1.75 ± 0.09	1
Aluminum monofluoride	AlF	1.53 ± 0.15	1	Hydrazoic acid	HN <sub>3</sub>	1.70 ± 0.09	3
Ammonia	H <sub>3</sub> N	1.4718 ± 0.0002	5	Hydrogen bromide	BrH	0.8272 ± 0.0003	3
Arsenic(III) chloride	AsCl <sub>3</sub>	1.59 ± 0.08	1	Hydrogen chloride	ClH	1.1086 ± 0.0003	3
Arsenic(III) fluoride	AsF <sub>3</sub>	2.59 ± 0.05	1	Hydrogen fluoride	FH	1.826178	2
Arsine	AsH <sub>3</sub>	0.217 ± 0.003	5	Hydrogen iodide	HI	0.448 ± 0.001	2
Barium oxide	BaO	7.954 ± 0.003	5	Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	1.573 ± 0.001	65
Barium sulfide	BaS	10.86 ± 0.02	3	Hydrogen sulfide	H <sub>2</sub> S	0.97833	5
Bromine chloride	BrCl	0.519 ± 0.004	3	Hydroxyl	HO	1.655 ± 0.001	5
Bromine dioxide	BrO <sub>2</sub>	2.8 ± 0.1	18	Hydroxylamine	H <sub>3</sub> NO	0.59 ± 0.05	2
Bromine fluoride	BrF	1.422 ± 0.016	3	Hypochlorous acid	ClHO	≈1.3	2
Bromine oxide	BrO	1.76 ± 0.04	2	Hypofluorous acid	FHO	2.23 ± 0.11	3
Bromine pentafluoride	BrF <sub>5</sub>	1.51 ± 0.15	1	Imidogen	HN	1.39 ± 0.07	3
Bromosilane	BrH <sub>3</sub> Si	1.319	3	Indium(I) chloride	ClIn	3.79 ± 0.19	2
Bromotrifluorosilane	BrF <sub>3</sub> Si	0.835 ± 0.007	64	Indium(I) fluoride	FIn	3.40 ± 0.07	2
Calcium monochloride	CaCl	≈3.6	4	Iodine bromide	BrI	0.726 ± 0.003	5
Cesium chloride	ClCs	10.387 ± 0.004	2	Iodine chloride	ClI	1.24 ± 0.02	2
Cesium fluoride	CsF	7.884 ± 0.001	2	Iodine fluoride	FI	1.948 ± 0.020	3
Cesium sodium	CsNa	4.75 ± 0.20	2	Iodine monoxide	IO	2.45 ± 0.05	2
Chlorine fluoride	ClF	0.888061	5	Iodine pentafluoride	F <sub>5</sub> I	2.18 ± 0.11	1
Chlorine oxide	ClO	1.297 ± 0.001	5	Lanthanum monoxide	LaO	3.207 ± 0.011	26
Chlorine trifluoride	ClF <sub>3</sub>	0.6 ± 0.1	1	Lead(II) oxide	OPb	4.64 ± 0.50	2
Chloroborane	BClH <sub>2</sub>	0.75 ± 0.05	14	Lead(II) sulfide	PbS	3.59 ± 0.18	2
Chlorogermane	ClGeH <sub>3</sub>	2.13 ± 0.02	1	Lithium bromide	BrLi	7.268 ± 0.001	2
Chlorosilane	ClH <sub>3</sub> Si	1.31 ± 0.01	1	Lithium chloride	CLi	7.12887	2
Chlorosyl fluoride	ClFO	1.93 ± 0.02	55	Lithium fluoride	FLi	6.3274 ± 0.0002	3
Chlorotrifluorosilane	ClF <sub>3</sub> Si	0.636 ± 0.004	5	Lithium fluoride–sodium fluoride complex	FLi•FNa	2.62 ± 0.02	51
Chromium monoxide	CrO	3.88 ± 0.13	5	Lithium hydride	HLi	5.884 ± 0.001	2
Copper(I) fluoride	CuF	5.77 ± 0.29	2	Lithium hydroxide	HLiO	4.754 ± 0.002	3
Copper(II) oxide	CuO	4.5 ± 0.5	5	Lithium iodide	ILi	7.428 ± 0.001	2
Dichlorosilane	Cl <sub>2</sub> H <sub>2</sub> Si	1.17 ± 0.02	1	Lithium monoxide	LiO	6.84 ± 0.03	2
Difluoramine	F <sub>2</sub> HN	1.92 ± 0.02	1	Lithium potassium	KLi	3.45 ± 0.20	2
Difluorine dioxide	F <sub>2</sub> O <sub>2</sub>	1.44 ± 0.07	1	Lithium rubidium	LiRb	4.0 ± 0.1	2
Difluoroborane	BF <sub>2</sub> H	0.971 ± 0.010	8	Lithium sodium	LiNa	0.463 ± 0.002	2
<i>cis</i> -Difluorodiazine	F <sub>2</sub> N <sub>2</sub>	0.16 ± 0.01	1	Magnesium oxide	MgO	6.2 ± 0.6	5
Difluorosilane	F <sub>2</sub> H <sub>2</sub> Si	1.55 ± 0.02	1	Mercapto	HS	0.7580 ± 0.0001	3
Difluorosilylene	F <sub>2</sub> Si	1.23 ± 0.02	2	Nitric acid	HNO <sub>3</sub>	2.17 ± 0.02	1
Disiloxane	H <sub>6</sub> OSi <sub>2</sub>	0.24 ± 0.02	1	Nitric oxide	NO	0.15872	2
Fluoramine	FH <sub>2</sub> N	2.27 ± 0.18	5	Nitrogen dioxide	NO <sub>2</sub>	0.316 ± 0.010	1
Fluorine azide	FN <sub>3</sub>	≈1.3	5	Nitrogen sulfide	NS	1.81 ± 0.02	2
Fluorine monoxide	F <sub>2</sub> O	0.308180	5	Nitrogen trichloride	Cl <sub>3</sub> N	0.39 ± 0.01	3
Fluorine oxide	FO	0.0043 ± 0.0004	5	Nitrogen trifluoride	F <sub>3</sub> N	0.235 ± 0.004	1
Fluoroborane	BF	≈0.5	2	Nitrogen trioxide	N <sub>2</sub> O <sub>3</sub>	2.122 ± 0.010	2
Fluorogermane	FGeH <sub>3</sub>	2.33 ± 0.12	2	Nitrosyl bromide	BrNO	≈1.8	1
Fluorosilane	FH <sub>3</sub> Si	1.2969 ± 0.0006	5	Nitrosyl fluoride	FNO	1.730 ± 0.003	3
Gallium monofluoride	FGa	2.45 ± 0.05	2	Nitrosyl hydride	HNO	1.62 ± 0.03	3
Germanium(II) fluoride	F <sub>2</sub> Ge	2.61 ± 0.02	2	Nitrous acid ( <i>cis</i> )	HNO <sub>2</sub>	1.423 ± 0.005	2
Germanium(II) oxide	GeO	3.2823 ± 0.0001	2	Nitrous acid ( <i>trans</i> )	HNO <sub>2</sub>	1.855 ± 0.016	2
Germanium(II) selenide	GeSe	1.65 ± 0.05	2	Nitrous oxide	N <sub>2</sub> O	0.16083	3
Germanium(II) sulfide	GeS	2.00 ± 0.06	2	Nitryl chloride	ClNO <sub>2</sub>	0.53	1
Germanium(II) telluride	GeTe	1.06 ± 0.07	2	Nitryl fluoride	FNO <sub>2</sub>	0.466 ± 0.005	2
Germylazide	GeH <sub>3</sub> N <sub>3</sub>	2.58 ± 0.02	25	Ozone	O <sub>3</sub>	0.53373	3
Hafnium monoxide	HfO	3.431 ± 0.005	26	Pentaborane(9)	B <sub>5</sub> H <sub>9</sub>	2.13 ± 0.04	1
Hafnium(IV) oxide	HfO <sub>2</sub>	7.92 ± 0.01	39	Perchloryl fluoride	ClFO <sub>3</sub>	0.023 ± 0.001	3
Hexaborane(10)	B <sub>6</sub> H <sub>10</sub>	2.50 ± 0.05	3	Peroxyntitrous acid	HNO <sub>3</sub>	1.07 ± 0.002	46

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
Peroxyntiric acid	HNO <sub>4</sub>	1.99 ± 0.02	67	Tin(II) oxide	OSn	4.32 ± 0.22	2
Phosphine	H <sub>3</sub> P	0.5740 ± 0.0003	3	Tin(II) sulfide	SSn	3.18 ± 0.16	2
Phosphorothioc trifluoride	F <sub>3</sub> PS	0.64 ± 0.02	1	Titanium(II) oxide	OTi	2.96 ± 0.05	5
Phosphorus(III) chloride	Cl <sub>3</sub> P	0.56 ± 0.02	2	Trichlorofluorosilane	Cl <sub>3</sub> FSi	0.49 ± 0.01	2
Phosphorus(III) fluoride	F <sub>3</sub> P	1.03 ± 0.01	1	Trichlorosilane	Cl <sub>3</sub> HSi	0.86 ± 0.01	2
Phosphorus monoxide	OP	1.88 ± 0.07	5	Trifluorammine oxide	F <sub>3</sub> NO	0.0390 ± 0.0004	9
Phosphorus nitride	NP	2.7470 ± 0.0001	2	1,1,1-Trifluorodisilane	F <sub>3</sub> H <sub>3</sub> Si <sub>2</sub>	2.03 ± 0.10	3
Phosphoryl chloride	Cl <sub>3</sub> OP	2.54 ± 0.05	2	Trifluoroiodosilane	F <sub>3</sub> ISi	1.11 ± 0.03	5
Phosphoryl fluoride	F <sub>3</sub> OP	1.8685 ± 0.0001	3	Trifluorosilane	F <sub>3</sub> HSi	1.27 ± 0.03	1
Potassium bromide	BrK	10.628 ± 0.001	2	Water	H <sub>2</sub> O	1.8546 ± 0.0040	3
Potassium chloride	ClK	10.269 ± 0.001	2	Water dimer–hydrogen bromide complex	H <sub>4</sub> O <sub>2</sub> •BrH	2.281 ± 0.003	48
Potassium fluoride	FK	8.585 ± 0.003	2	Water dimer–hydrogen chloride complex	H <sub>4</sub> O <sub>2</sub> •ClH	2.328 ± 0.003	48
Potassium hydroxide	HKO	7.415 ± 0.002	16	Ytterbium monofluoride	FYb	3.91 ± 0.04	45
Potassium iodide	IK	≈10.8	2	Yttrium monoxide	OY	4.524 ± 0.007	26
Potassium sodium	KNa	2.693 ± 0.014	3	Zirconium(II) oxide	OZr	2.55 ± 0.01	26
Rubidium bromide	BrRb	≈10.9	2	Zirconium(IV) oxide	O <sub>2</sub> Zr	7.80 ± 0.02	19
Rubidium chloride	ClRb	10.510 ± 0.005	2				
Rubidium fluoride	FRb	8.5465 ± 0.0005	2	<i>Compounds containing carbon</i>			
Rubidium iodide	IRb	≈11.5	2	Acenaphthene	C <sub>12</sub> H <sub>10</sub>	≈0.85	1
Rubidium sodium	NaRb	3.1 ± 0.3	2	Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	2.750 ± 0.006	3
Selenium dioxide	O <sub>2</sub> Se	2.62 ± 0.05	2	Acetamide	C <sub>2</sub> H <sub>5</sub> NO	3.68 ± 0.03	5
Selenium tetrafluoride	F <sub>4</sub> Se	1.78 ± 0.09	2	Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	1.70 ± 0.03	2
Silicon monosulfide	SSi	1.73 ± 0.09	2	Acetic anhydride	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	≈2.8	1
Silicon monoxide	OSi	3.0982	2	Acetone	C <sub>3</sub> H <sub>6</sub> O	2.88 ± 0.03	1
Silver(I) bromide	AgBr	5.62 ± 0.03	5	Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	3.92519	5
Silver(I) chloride	AgCl	6.08 ± 0.06	5	Acetophenone	C <sub>8</sub> H <sub>8</sub> O	3.02 ± 0.06	1
Silver(I) fluoride	AgF	6.22 ± 0.30	2	Acetyl chloride	C <sub>2</sub> H <sub>3</sub> ClO	2.72 ± 0.14	1
Silver(I) iodide	AgI	4.55 ± 0.05	5	Acetylene–carbon dioxide complex	C <sub>2</sub> H <sub>2</sub> •CO <sub>2</sub>	0.161 ± 0.001	22
Sodium bromide	BrNa	9.1183 ± 0.0006	2	Acetylene–carbon monoxide complex	C <sub>2</sub> H <sub>2</sub> •CO	0.311 ± 0.001	32
Sodium chloride	ClNa	9.00117	2	Acetylene–carbon oxysulfide trimer complex	C <sub>2</sub> H <sub>2</sub> •C <sub>3</sub> O <sub>3</sub> S <sub>3</sub>	1.23 ± 0.02	53
Sodium fluoride	FNa	8.156 ± 0.001	2	Acetylene–hydrogen cyanide complex	C <sub>2</sub> H <sub>2</sub> •CHN	3.29 ± 0.03	32
Sodium iodide	INa	9.236 ± 0.003	2	Acetyl fluoride	C <sub>2</sub> H <sub>3</sub> FO	2.96 ± 0.03	1
Stibine	H <sub>3</sub> Sb	0.12 ± 0.05	1	Acrolein ( <i>cis</i> )	C <sub>3</sub> H <sub>4</sub> O	2.552 ± 0.003	5
Strontium oxide	OSr	8.900 ± 0.003	2	Acrolein ( <i>trans</i> )	C <sub>3</sub> H <sub>4</sub> O	3.117 ± 0.004	5
Sulfur dichloride	Cl <sub>2</sub> S	0.36 ± 0.01	3	Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	3.92 ± 0.07	5
Sulfur difluoride	F <sub>2</sub> S	1.05 ± 0.05	2	Allyl alcohol ( <i>gauche</i> )	C <sub>3</sub> H <sub>6</sub> O	1.55 ± 0.08	3
Sulfur dioxide	O <sub>2</sub> S	1.63305	3	Allyl alcohol ( <i>average</i> )	C <sub>3</sub> H <sub>6</sub> O	1.60 ± 0.08	1
Sulfur monofluoride	FS	0.794 ± 0.02	3	Allylamine	C <sub>3</sub> H <sub>7</sub> N	≈1.2	1
Sulfur monoxide	OS	1.55 ± 0.02	1	Aniline	C <sub>6</sub> H <sub>7</sub> N	1.13 ± 0.02	3
Sulfur oxide (SSO)	OS <sub>2</sub>	1.47 ± 0.03	1	Anisole	C <sub>7</sub> H <sub>8</sub> O	1.38 ± 0.07	1
Sulfur tetrafluoride	F <sub>4</sub> S	0.632 ± 0.003	1	Azulene	C <sub>10</sub> H <sub>8</sub>	0.80 ± 0.02	1
Sulfuryl chloride	Cl <sub>2</sub> O <sub>2</sub> S	1.81 ± 0.04	1	Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	[3.0]	7
Sulfuryl fluoride	F <sub>2</sub> O <sub>2</sub> S	1.12 ± 0.02	1	Benzeneacetoneitrile	C <sub>8</sub> H <sub>7</sub> N	[3.5]	7
Tetraborane(10)	B <sub>4</sub> H <sub>10</sub>	0.486 ± 0.002	3	Benzene–hydrogen sulfide complex	C <sub>6</sub> H <sub>6</sub> •H <sub>2</sub> S	1.14 ± 0.02	40
Tetrafluorohydrazine ( <i>gauche</i> )	F <sub>4</sub> N <sub>2</sub>	0.257 ± 0.002	5	Benzene–krypton complex	C <sub>6</sub> H <sub>6</sub> •Kr	0.136 ± 0.002	58
Tetrafluorosilane–ammonia complex	F <sub>4</sub> Si•H <sub>3</sub> N	5.61 ± 0.02	31	Benzene–sulfur dioxide complex	C <sub>6</sub> H <sub>6</sub> •O <sub>2</sub> S	2.061 ± 0.002	33
Thallium(I) bromide	BrTl	4.49 ± 0.05	2	Benzenethiol	C <sub>6</sub> H <sub>6</sub> S	[1.23]	7
Thallium(I) chloride	ClTl	4.54299	2	Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	4.18 ± 0.08	1
Thallium(I) fluoride	FTl	4.2282 ± 0.0008	2	Benzyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	[1.22]	7
Thallium(I) iodide	ITl	4.61 ± 0.07	2	Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	1.71 ± 0.09	1
Thionitrosyl chloride (NSCl)	ClNS	1.87 ± 0.02	2				
Thionitrosyl fluoride (NSF)	FNS	1.902 ± 0.012	2				
Thionyl chloride	Cl <sub>2</sub> OS	1.45 ± 0.03	1				
Thionyl fluoride	F <sub>2</sub> OS	1.63 ± 0.01	1				

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
Benzyl benzoate	$C_{14}H_{12}O_2$	[2.06]	7	Butyl vinyl ether	$C_6H_{12}O$	[1.25]	7
Bis(2-aminoethyl)amine	$C_4H_{13}N_3$	[1.89]	7	1-Butyne	$C_4H_6$	$0.782 \pm 0.004$	5
Bis(2-chloroethyl) ether	$C_4H_8Cl_2O$	[2.58]	7	$\gamma$ -Butyrolactone	$C_4H_6O_2$	$4.27 \pm 0.03$	3
Bis(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	[2.84]	7	Calcium methoxide	$CH_3CaO$	$1.58 \pm 0.08$	43
Borane carbonyl	$CH_3BO$	$1.698 \pm 0.020$	3	Camphor, (+)	$C_{10}H_{16}O$	[3.1]	7
Bromoacetylene	$C_2HBr$	0.22962	5	Caprolactam	$C_6H_{11}NO$	[3.9]	7
Bromobenzene	$C_6H_5Br$	$1.70 \pm 0.03$	1	Carboimidic difluoride	$CHF_2N$	$1.393 \pm 0.001$	5
1-Bromobutane	$C_4H_9Br$	$2.08 \pm 0.10$	1	Carbon dioxide dimer–water complex	$C_2O_4 \cdot H_2O$	$1.989 \pm 0.002$	23
2-Bromobutane	$C_4H_9Br$	$2.23 \pm 0.11$	1	Carbon dioxide–mercury complex	$CO_2 \cdot Hg$	$0.107 \pm 0.003$	29
1-Bromo-2-chloroethane	$C_2H_4BrCl$	[1.2]	7	Carbon dioxide–water dimer complex	$CO_2 \cdot H_4O_2$	$1.746 \pm 0.010$	28
Bromochlorofluoromethane	$CHBrClF$	$1.5 \pm 0.3$	17	Carbon disulfide–sulfur dioxide complex	$CO_2 \cdot O_2S$	$1.096 \pm 0.001$	42
Bromochloromethane	$CH_2BrCl$	[1.66]	7	Carbon monoselenide	$CSe$	$1.99 \pm 0.04$	3
1-Bromodecane	$C_{10}H_{21}Br$	[1.93]	7	Carbon monosulfide	$CS$	$1.958 \pm 0.005$	2
Bromoethane	$C_2H_5Br$	$2.04 \pm 0.02$	5	Carbon monoxide	$CO$	0.10980	3
Bromoethene	$C_2H_3Br$	$1.42 \pm 0.03$	1	Carbon monoxide dimer–water complex	$C_2O_2 \cdot H_2O$	$1.57 \pm 0.05$	36
Bromofluoroacetylene	$C_2BrF$	$0.448 \pm 0.002$	5	Carbon oxyselenide	$COSe$	$0.73 \pm 0.02$	1
1-Bromoheptane	$C_7H_{15}Br$	$2.16 \pm 0.11$	1	Carbon oxysulfide	$COS$	0.715189	5
Bromomethane	$CH_3Br$	$1.8203 \pm 0.0004$	5	Carbon oxysulfide–carbon dioxide dimer complex	$COS \cdot C_2O_4$	$0.69 \pm 0.05$	44
2-Bromo-2-methylpropane	$C_4H_9Br$	[2.17]	7	Carbon oxysulfide–water complex	$COS \cdot H_2O$	$2.668 \pm 0.003$	37
1-Bromonaphthalene	$C_{10}H_7Br$	[1.55]	7	Carbonyl chloride	$CCl_2O$	$1.17 \pm 0.01$	1
1-Bromopentane	$C_5H_{11}Br$	$2.20 \pm 0.11$	1	Carbonyl fluoride	$CF_2O$	$0.95 \pm 0.01$	1
1-Bromopropane	$C_3H_7Br$	$2.18 \pm 0.11$	1	Chloroacetyl chloride	$C_2H_2Cl_2O$	$2.23 \pm 0.11$	1
2-Bromopropane	$C_3H_7Br$	$2.21 \pm 0.11$	1	Chloroacetylene	$C_2HCl$	0.44408	5
2-Bromopropene	$C_3H_5Br$	[1.51]	7	2-Chloroaniline	$C_6H_6ClN$	[1.77]	7
3-Bromopropene	$C_3H_5Br$	$\approx 1.9$	1	Chlorobenzene	$C_6H_5Cl$	$1.69 \pm 0.03$	1
Bromotrifluoromethane	$CBrF_3$	$0.65 \pm 0.05$	1	1-Chlorobutane	$C_4H_9Cl$	$2.05 \pm 0.04$	1
1,2-Butadiene	$C_4H_6$	$0.403 \pm 0.002$	1	2-Chlorobutane	$C_4H_9Cl$	$2.04 \pm 0.10$	1
Butanal	$C_4H_8O$	$2.72 \pm 0.05$	1	Chlorocyclohexane ( <i>axial</i> )	$C_6H_{11}Cl$	$1.91 \pm 0.02$	5
1,4-Butanediol	$C_4H_{10}O_2$	[2.58]	7	Chlorocyclohexane ( <i>equatorial</i> )	$C_6H_{11}Cl$	$2.44 \pm 0.07$	5
Butanenitrile ( <i>gauche</i> )	$C_4H_7N$	$3.91 \pm 0.04$	5	1-Chloro-1,1-difluoroethane	$C_2H_3ClF_2$	$2.14 \pm 0.04$	1
Butanenitrile ( <i>anti</i> )	$C_4H_7N$	$3.73 \pm 0.06$	5	Chlorodifluoromethane	$CHClF_2$	$1.42 \pm 0.03$	1
1-Butanethiol	$C_4H_{10}S$	[1.53]	7	Chloroethane	$C_2H_5Cl$	$2.05 \pm 0.02$	1
Butanoic acid	$C_4H_8O_2$	[1.65]	7	2-Chloroethanol	$C_2H_5ClO$	$1.78 \pm 0.09$	1
1-Butanol	$C_4H_{10}O$	$1.66 \pm 0.03$	1	Chloroethene	$C_2H_3Cl$	$1.45 \pm 0.03$	1
2-Butanone	$C_4H_8O$	$2.779 \pm 0.015$	2	1-Chloro-4-fluorobenzene	$C_6H_4ClF$	$0.12 \pm 0.01$	66
<i>trans</i> -2-Butenal	$C_4H_6O$	$3.67 \pm 0.07$	1	1-Chloro-1-fluoroethane	$C_2H_4ClF$	$2.068 \pm 0.014$	3
1-Butene ( <i>cis</i> )	$C_4H_8$	$0.438 \pm 0.007$	2	Chlorofluoromethane	$CH_2ClF$	$1.82 \pm 0.04$	1
1-Butene ( <i>skew</i> )	$C_4H_8$	$0.359 \pm 0.011$	2	Chloromethane	$CH_3Cl$	$1.8963 \pm 0.0002$	5
<i>cis</i> -2-Butene	$C_4H_8$	$0.253 \pm 0.005$	2	(Chloromethyl)benzene	$C_7H_7Cl$	[1.82]	7
<i>cis</i> -2-Butene-1,4-diol	$C_4H_8O_2$	[2.48]	7	1-Chloro-3-methylbutane	$C_5H_{11}Cl$	[1.92]	7
<i>trans</i> -2-Butene-1,4-diol	$C_4H_8O_2$	[2.45]	7	1-Chloro-2-methylpropane	$C_4H_9Cl$	$2.00 \pm 0.10$	1
<i>trans</i> -2-Butenoic acid	$C_4H_6O_2$	[2.13]	7	2-Chloro-2-methylpropane	$C_4H_9Cl$	$2.13 \pm 0.04$	1
<i>cis</i> -2-Buten-1-ol	$C_4H_8O$	$1.96 \pm 0.03$	5	1-Chloronaphthalene	$C_{10}H_7Cl$	[1.57]	7
<i>trans</i> -2-Buten-1-ol	$C_4H_8O$	$1.90 \pm 0.02$	5	1-Chloro-2-nitrobenzene	$C_6H_4ClNO_2$	$4.64 \pm 0.09$	1
1-Buten-3-yne	$C_4H_4$	$0.22 \pm 0.02$	3	1-Chloro-3-nitrobenzene	$C_6H_4ClNO_2$	$3.73 \pm 0.07$	1
2-Butoxyethanol	$C_6H_{14}O_2$	[2.08]	7	1-Chloro-4-nitrobenzene	$C_6H_4ClNO_2$	$2.83 \pm 0.06$	1
Butyl acetate	$C_6H_{12}O_2$	[1.87]	7	1-Chlorooctane	$C_8H_{17}Cl$	[2.00]	7
<i>sec</i> -Butyl acetate	$C_6H_{12}O_2$	[1.87]	7	Chloropentafluoroethane	$C_2ClF_5$	$0.52 \pm 0.05$	1
Butylamine	$C_4H_{11}N$	$\approx 1.0$	1	1-Chloropentane	$C_5H_{11}Cl$	$2.16 \pm 0.11$	1
<i>sec</i> -Butylamine	$C_4H_{11}N$	[1.28]	7	4-Chlorophenol	$C_6H_5ClO$	$2.11 \pm 0.11$	1
<i>tert</i> -Butylamine	$C_4H_{11}N$	[1.29]	7				
<i>tert</i> -Butylbenzene	$C_{10}H_{14}$	$\approx 0.83$	1				
Butyl ethyl ether	$C_6H_{14}O$	[1.24]	7				
Butyl formate	$C_5H_{10}O_2$	[2.03]	7				
Butyl stearate	$C_{22}H_{44}O_2$	[1.88]	7				



Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
1-Chloropropane ( <i>gauche</i> )	C <sub>3</sub> H <sub>7</sub> Cl	2.02 ± 0.03	5	Dibutyl sulfide	C <sub>8</sub> H <sub>18</sub> S	[1.61]	7
1-Chloropropane ( <i>trans</i> )	C <sub>3</sub> H <sub>7</sub> Cl	1.95 ± 0.02	5	<i>o</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	2.50 ± 0.05	1
1-Chloropropane ( <i>average</i> )	C <sub>3</sub> H <sub>7</sub> Cl	2.05 ± 0.04	1	<i>m</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	1.72 ± 0.09	1
2-Chloropropane	C <sub>3</sub> H <sub>7</sub> Cl	2.17 ± 0.11	1	1,4-Dichlorobutane	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	2.22 ± 0.11	1
<i>cis</i> -1-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	1.67 ± 0.08	1	1,1-Dichloro-2,2-difluoroethene	C <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	0.50	7
<i>trans</i> -1-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	1.97 ± 0.10	1	Dichlorodifluoromethane	CCl <sub>2</sub> F <sub>2</sub>	0.51 ± 0.05	1
2-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	1.647 ± 0.010	3	1,1-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	2.06 ± 0.04	1
3-Chloropropene	C <sub>3</sub> H <sub>5</sub> Cl	1.94 ± 0.10	1	1,2-Dichloroethane	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	[1.83]	7
4-Chloropyridine	C <sub>5</sub> H <sub>4</sub> CIN	0.756 ± 0.005	3	1,1-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1.34 ± 0.01	1
2-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	1.56 ± 0.08	1	<i>cis</i> -1,2-Dichloroethene	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1.90 ± 0.04	1
3-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	[1.82]	7	Dichlorofluoromethane	CHCl <sub>2</sub> F	1.29 ± 0.03	1
4-Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	2.21 ± 0.04	1	1,1-Dichloro-2-fluoropropene	C <sub>3</sub> H <sub>3</sub> Cl <sub>2</sub> F	2.43 ± 0.02	3
Chlorotrifluoroethene	C <sub>2</sub> ClF <sub>3</sub>	0.40 ± 0.10	1	Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>	1.60 ± 0.03	1
Chlorotrifluoromethane	CClF <sub>3</sub>	0.50 ± 0.01	1	(Dichloromethyl)benzene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	[2.07]	7
<i>o</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	[1.45]	7	Dichloromethylborane	CH <sub>3</sub> BCl <sub>2</sub>	1.419 ± 0.013	5
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	[1.48]	7	1,2-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	[1.85]	7
<i>p</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	[1.48]	7	1,3-Dichloropropane	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	2.08 ± 0.04	1
Cyanamide	CH <sub>2</sub> N <sub>2</sub>	4.28 ± 0.10	5	1,2-Dichloro-1,1,2,2-tetrafluoroethane	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	≈0.5	1
Cyanoacetylene	C <sub>3</sub> HN	3.73172	5	2,4-Dichlorotoluene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	[1.70]	7
Cyanofornamide	C <sub>2</sub> H <sub>2</sub> N <sub>2</sub> O	4.10 ± 0.12	47	3,4-Dichlorotoluene	C <sub>7</sub> H <sub>6</sub> Cl <sub>2</sub>	[2.95]	7
Cyanogen azide (NCN <sub>3</sub> )	CN <sub>4</sub>	2.96 ± 0.07	60	Diethanolamine	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	[2.8]	7
Cyanogen chloride	CClN	2.8331 ± 0.0002	3	1,1-Diethoxyethane	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	[1.38]	7
Cyanogen fluoride	CFN	2.120 ± 0.001	3	Diethylamine	C <sub>4</sub> H <sub>11</sub> N	0.92 ± 0.05	1
Cyanogen iodide	CIN	3.67 ± 0.02	5	Diethyl carbonate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	1.10 ± 0.06	1
Cyanomethylmercury	C <sub>2</sub> H <sub>5</sub> HgN	4.7 ± 0.1	12	Diethylene glycol	C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	[2.31]	7
Cyclobutanecarbonitrile	C <sub>5</sub> H <sub>7</sub> N	4.04 ± 0.04	5	Diethylene glycol dimethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	[1.97]	7
Cyclobutanone	C <sub>4</sub> H <sub>6</sub> O	2.89 ± 0.03	2	Diethylene glycol monoethyl ether	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	[1.6]	7
Cyclobutene	C <sub>4</sub> H <sub>6</sub>	0.132 ± 0.001	1	Diethylene glycol monoethyl ether acetate	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	[1.8]	7
1,3-Cycloheptadiene	C <sub>7</sub> H <sub>10</sub>	0.740	3	Diethylene glycol monomethyl ether	C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>	[1.6]	7
2,4,6-Cycloheptatrien-1-one	C <sub>7</sub> H <sub>6</sub> O	4.1 ± 0.3	3	Diethyl ether	C <sub>4</sub> H <sub>10</sub> O	1.098 ± 0.001	38
3,5-Cyclohexadiene-1,2-dione	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	4.23 ± 0.02	3	Diethyl malonate	C <sub>7</sub> H <sub>12</sub> O <sub>4</sub>	[2.54]	7
Cyclohexanone	C <sub>6</sub> H <sub>10</sub> O	3.246 ± 0.006	5	Diethyl oxalate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	[2.49]	7
Cyclohexene ( <i>half-chair</i> )	C <sub>6</sub> H <sub>10</sub>	0.332 ± 0.012	2	Diethyl sulfide ( <i>trans-trans</i> )	C <sub>4</sub> H <sub>10</sub> S	1.556 ± 0.004	54
Cyclohexylamine	C <sub>6</sub> H <sub>13</sub> N	[1.26]	7	Diethyl sulfide ( <i>trans-gauche</i> )	C <sub>4</sub> H <sub>10</sub> S	1.591 ± 0.009	54
1,3-Cyclopentadiene	C <sub>5</sub> H <sub>6</sub>	0.419 ± 0.004	1	Diethyl sulfide ( <i>gauche-gauche</i> )	C <sub>4</sub> H <sub>10</sub> S	1.645 ± 0.001	54
2,4-Cyclopentadien-1-one	C <sub>5</sub> H <sub>4</sub> O	3.132 ± 0.007	3	<i>o</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	2.46 ± 0.05	2
Cyclopentanone	C <sub>5</sub> H <sub>8</sub> O	≈3.3	1	<i>m</i> -Difluorobenzene	C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	1.51 ± 0.02	2
Cyclopentene	C <sub>5</sub> H <sub>8</sub>	0.20 ± 0.02	1	1,1-Difluorocyclohexane	C <sub>6</sub> H <sub>10</sub> F <sub>2</sub>	2.556 ± 0.010	3
3-Cyclopenten-1-one	C <sub>5</sub> H <sub>6</sub> O	2.79 ± 0.03	3	3,3-Difluorocyclopropene	C <sub>3</sub> H <sub>2</sub> F <sub>2</sub>	2.98 ± 0.02	3
Cyclopropane-sulfur dioxide complex	C <sub>3</sub> H <sub>6</sub> •O <sub>2</sub> S	1.681 ± 0.001	30	1,1-Difluoroethane	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	2.27 ± 0.05	1
Cyclopropanone	C <sub>3</sub> H <sub>4</sub> O	2.67 ± 0.13	2	1,2-Difluoroethane ( <i>gauche</i> )	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	2.67 ± 0.13	2
Cyclopropene	C <sub>3</sub> H <sub>4</sub>	0.454 ± 0.010	1	1,1-Difluoroethene	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1.3893 ± 0.0002	5
Cyclopropylamine	C <sub>3</sub> H <sub>7</sub> N	1.19 ± 0.01	2	<i>cis</i> -1,2-Difluoroethene	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	2.42 ± 0.02	1
Cyclopropyl methyl ketone	C <sub>5</sub> H <sub>8</sub> O	2.62 ± 0.25	2	Difluoromethane	CH <sub>2</sub> F <sub>2</sub>	1.9785 ± 0.02	3
Diacetone alcohol	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	[3.24]	7	Difluoromethylborane	CH <sub>3</sub> BF <sub>2</sub>	1.668 ± 0.003	3
Diazomethane	CH <sub>2</sub> N <sub>2</sub>	1.50 ± 0.01	1	Difluoromethylene	CF <sub>2</sub>	0.47 ± 0.02	3
Dibromodifluoromethane	CBr <sub>2</sub> F <sub>2</sub>	0.66 ± 0.05	1	1,1-Difluoro-1-propene	C <sub>3</sub> H <sub>4</sub> F <sub>2</sub>	0.889 ± 0.007	2
1,2-Dibromoethane	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	[1.19]	7	2,3-Dihydro-1,4-dioxin	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	0.939 ± 0.008	3
Dibromomethane	CH <sub>2</sub> Br <sub>2</sub>	1.43 ± 0.03	1	3,6-Dihydro-1,2-dioxin	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2.329 ± 0.001	3
1,2-Dibromopropane	C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	[1.2]	7				
Dibutylamine	C <sub>8</sub> H <sub>19</sub> N	[0.98]	7				
Dibutyl ether	C <sub>8</sub> H <sub>18</sub> O	1.17 ± 0.06	1				
Dibutyl phthalate	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	[2.82]	7				
Dibutyl sebacate	C <sub>18</sub> H <sub>34</sub> O <sub>4</sub>	[2.48]	7				

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
2,3-Dihydrofuran	C <sub>4</sub> H <sub>6</sub> O	1.32 ± 0.03	2	Ethoxybenzene	C <sub>8</sub> H <sub>10</sub> O	1.45 ± 0.15	1
2,5-Dihydrofuran	C <sub>4</sub> H <sub>6</sub> O	1.63 ± 0.01	5	2-Ethoxyethanol	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	[2.08]	7
Dihydro-3-methyl-2(3H)-furanone	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	4.56 ± 0.02	5	2-Ethoxyethyl acetate	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	[2.25]	7
Dihydro-5-methyl-2(3H)-furanone	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	4.71 ± 0.05	5	Ethyl acetate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1.78 ± 0.09	1
3,4-Dihydro-2H-pyran	C <sub>5</sub> H <sub>8</sub> O	1.400 ± 0.008	5	Ethyl acrylate	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	[1.96]	7
3,6-Dihydro-2H-pyran	C <sub>5</sub> H <sub>8</sub> O	1.283 ± 0.005	3	Ethylamine ( <i>gauche</i> )	C <sub>2</sub> H <sub>7</sub> N	1.210 ± 0.015	5
2,3-Dihydrothiophene	C <sub>4</sub> H <sub>6</sub> S	1.61 ± 0.20	5	Ethylamine ( <i>trans</i> )	C <sub>2</sub> H <sub>7</sub> N	1.304 ± 0.011	5
2,5-Dihydrothiophene	C <sub>4</sub> H <sub>6</sub> S	1.75 ± 0.01	3	Ethylamine ( <i>average</i> )	C <sub>2</sub> H <sub>7</sub> N	1.22 ± 0.10	1
Diiodomethane	CH <sub>2</sub> I <sub>2</sub>	[1.08]	7	Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	0.59 ± 0.05	1
Diisopentyl ether	C <sub>10</sub> H <sub>22</sub> O	[1.23]	7	Ethyl benzoate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	2.00 ± 0.10	1
Diisopropylamine	C <sub>6</sub> H <sub>15</sub> N	[1.15]	7	Ethyl butanoate	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	[1.74]	7
Diisopropyl ether	C <sub>6</sub> H <sub>14</sub> O	1.13 ± 0.10	1	Ethyl <i>trans</i> -cinnamate	C <sub>11</sub> H <sub>12</sub> O <sub>2</sub>	[1.84]	7
Diketene	C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	3.53 ± 0.07	1	Ethyl cyanate	C <sub>3</sub> H <sub>5</sub> NO	4.72 ± 0.09	5
1,2-Dimethoxybenzene	C <sub>8</sub> H <sub>10</sub> O <sub>2</sub>	[1.29]	7	Ethyl cyanoacetate	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	[2.17]	7
Dimethoxymethane	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	[0.74]	7	Ethylene carbonate	C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	[4.9]	7
<i>N,N</i> -Dimethylacetamide	C <sub>4</sub> H <sub>9</sub> NO	[3.7]	7	Ethylene glycol ( <i>average</i> )	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	2.36 ± 0.10	5
Dimethylamine	C <sub>2</sub> H <sub>7</sub> N	1.01 ± 0.02	2	Ethyleneimine	C <sub>2</sub> H <sub>5</sub> N	1.90 ± 0.01	1
<i>N,N</i> -Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	1.68 ± 0.17	1	Ethylene-sulfur dioxide complex	C <sub>2</sub> H <sub>4</sub> •O <sub>2</sub> S	1.650 ± 0.003	27
2,4-Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	[1.40]	7	Ethylene-water complex	C <sub>2</sub> H <sub>4</sub> •H <sub>2</sub> O	1.10 ± 0.01	56
2,6-Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	[1.63]	7	Ethyl formate ( <i>gauche</i> )	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1.81 ± 0.02	2
3,3-Dimethyl-1-butyne	C <sub>6</sub> H <sub>10</sub>	0.661 ± 0.004	1	Ethyl formate ( <i>trans</i> )	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1.98 ± 0.02	2
1,1-Dimethylcyclopropane	C <sub>5</sub> H <sub>10</sub>	0.142 ± 0.001	3	Ethyl formate ( <i>average</i> )	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1.93	1
3,3-Dimethylcyclopropene	C <sub>5</sub> H <sub>8</sub>	0.287 ± 0.003	3	2-Ethyl-1-hexanol	C <sub>8</sub> H <sub>18</sub> O	[1.74]	7
Dimethyl disulfide	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	[1.85]	7	2-Ethylhexyl acetate	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	[1.8]	7
Dimethyl ether	C <sub>2</sub> H <sub>6</sub> O	1.30 ± 0.01	1	Ethyl lactate	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	[2.4]	7
<i>N,N</i> -Dimethylformamide	C <sub>3</sub> H <sub>7</sub> NO	3.82 ± 0.08	1	Ethyl methyl ether ( <i>trans</i> )	C <sub>3</sub> H <sub>8</sub> O	1.17 ± 0.02	3
2,6-Dimethyl-4-heptanone	C <sub>9</sub> H <sub>18</sub> O	[2.66]	7	Ethyl methyl sulfide ( <i>gauche</i> )	C <sub>3</sub> H <sub>8</sub> S	1.593 ± 0.004	5
Dimethyl maleate	C <sub>6</sub> H <sub>8</sub> O <sub>4</sub>	[2.48]	7	Ethyl methyl sulfide ( <i>trans</i> )	C <sub>3</sub> H <sub>8</sub> S	1.56 ± 0.03	3
2,4-Dimethyl-3-pentanone	C <sub>7</sub> H <sub>14</sub> O	[2.74]	7	Ethyl propanoate	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	[1.74]	7
2,2-Dimethylpropanal	C <sub>5</sub> H <sub>10</sub> O	2.66 ± 0.05	2	Ethyl vinyl ether	C <sub>4</sub> H <sub>8</sub> O	[1.26]	7
2,2-Dimethylpropanenitrile	C <sub>5</sub> H <sub>9</sub> N	3.95 ± 0.04	1	Fluoroacetylene	C <sub>2</sub> HF	0.7207 ± 0.0003	3
2,4-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	[2.30]	7	Fluorobenzene	C <sub>6</sub> H <sub>5</sub> F	1.60 ± 0.08	1
2,6-Dimethylpyridine	C <sub>7</sub> H <sub>9</sub> N	[1.66]	7	Fluorocyclohexane	C <sub>6</sub> H <sub>11</sub> F	2.11 ± 0.04	2
Dimethyl sulfide	C <sub>2</sub> H <sub>6</sub> S	1.554 ± 0.004	3	Fluorocyclohexane ( <i>axial</i> )	C <sub>6</sub> H <sub>11</sub> F	1.81 ± 0.04	2
Dimethyl sulfoxide	C <sub>2</sub> H <sub>6</sub> OS	3.96 ± 0.04	1	1-Fluorocyclohexene	C <sub>6</sub> H <sub>9</sub> F	1.942 ± 0.010	5
1,3-Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2.06 ± 0.04	2	Fluoroethane	C <sub>2</sub> H <sub>5</sub> F	1.937 ± 0.007	5
1,3-Dioxolane	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1.19 ± 0.06	3	Fluoroethene	C <sub>2</sub> H <sub>3</sub> F	1.468 ± 0.003	5
Dipentyl ether	C <sub>10</sub> H <sub>22</sub> O	[1.20]	7	Fluoromethane	CH <sub>3</sub> F	1.858 ± 0.002	3
Diphenyl ether	C <sub>12</sub> H <sub>10</sub> O	≈1.3	1	Fluoromethylidyne	CF	0.645 ± 0.005	3
Dipropylamine	C <sub>6</sub> H <sub>15</sub> N	[1.03]	7	(Fluoromethylidyne) phosphine (FCP)	CFP	0.279 ± 0.001	62
Dipropyl ether	C <sub>6</sub> H <sub>14</sub> O	1.21 ± 0.06	1	Fluoromethylsilane	CH <sub>3</sub> FSi	1.700 ± 0.008	5
1,3-Dithiane	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	2.14 ± 0.04	5	1-Fluoro-4-nitrobenzene	C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	2.87 ± 0.06	1
Divinyl ether	C <sub>4</sub> H <sub>6</sub> O	0.78 ± 0.05	2	1-Fluoropropane ( <i>gauche</i> )	C <sub>3</sub> H <sub>7</sub> F	1.90 ± 0.10	1
Epichlorohydrin	C <sub>3</sub> H <sub>5</sub> ClO	[1.8]	7	1-Fluoropropane ( <i>trans</i> )	C <sub>3</sub> H <sub>7</sub> F	2.05 ± 0.04	1
1,2-Epoxybutane	C <sub>4</sub> H <sub>8</sub> O	1.891 ± 0.011	3	2-Fluoropropane	C <sub>3</sub> H <sub>7</sub> F	1.958 ± 0.001	5
1,2-Ethanediamine	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1.99 ± 0.10	1	<i>cis</i> -1-Fluoropropene	C <sub>3</sub> H <sub>5</sub> F	1.46 ± 0.03	1
1,2-Ethanediol, diacetate	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	[2.34]	7	<i>trans</i> -1-Fluoropropene	C <sub>3</sub> H <sub>5</sub> F	≈1.9	1
1,2-Ethanedithiol	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	2.03 ± 0.08	5	2-Fluoropropene	C <sub>3</sub> H <sub>5</sub> F	1.61 ± 0.03	1
Ethanedithiol ( <i>gauche</i> )	C <sub>2</sub> H <sub>6</sub> S	1.61 ± 0.08	3	3-Fluoropropene ( <i>gauche</i> )	C <sub>3</sub> H <sub>5</sub> F	1.939 ± 0.015	1
Ethanedithiol ( <i>trans</i> )	C <sub>2</sub> H <sub>6</sub> S	1.58 ± 0.08	3	3-Fluoropropene ( <i>cis</i> )	C <sub>3</sub> H <sub>5</sub> F	1.765 ± 0.014	1
Ethanol ( <i>gauche</i> )	C <sub>2</sub> H <sub>6</sub> O	1.68 ± 0.03	3	3-Fluoropropyne	C <sub>3</sub> H <sub>3</sub> F	1.73 ± 0.02	5
Ethanol ( <i>trans</i> )	C <sub>2</sub> H <sub>6</sub> O	1.44 ± 0.03	2	3-Fluoropyridine	C <sub>5</sub> H <sub>4</sub> FN	2.09 ± 0.26	3
Ethanol ( <i>average</i> )	C <sub>2</sub> H <sub>6</sub> O	1.69 ± 0.03	1	2-Fluorotoluene	C <sub>7</sub> H <sub>7</sub> F	1.37 ± 0.07	1
Ethanolamine	C <sub>2</sub> H <sub>7</sub> NO	[2.27]	7				

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
3-Fluorotoluene	$C_7H_7F$	$1.82 \pm 0.04$	2	2-Isocyanopropane	$C_4H_7N$	$4.055 \pm 0.001$	5
4-Fluorotoluene	$C_7H_7F$	$2.00 \pm 0.10$	1	Isopentane	$C_5H_{12}$	$0.13 \pm 0.05$	1
Formaldehyde	$CH_2O$	$2.332 \pm 0.002$	3	Isopentyl acetate	$C_7H_{14}O_2$	[1.86]	7
Formaldehyde dimer	$C_2H_4O_2$	$0.858 \pm 0.005$	57	Isopropylamine	$C_3H_9N$	$1.19 \pm 0.06$	3
Formamide	$CH_3NO$	$3.73 \pm 0.07$	1	Isopropylbenzene	$C_9H_{12}$	$\approx 0.79$	1
Formic acid	$CH_2O_2$	$1.425 \pm 0.002$	5	Isopropyl methyl ether	$C_4H_{10}O$	$1.247 \pm 0.003$	5
Formyl fluoride	$CHFO$	$2.081 \pm 0.001$	5	Isoquinoline	$C_9H_7N$	$2.73 \pm 0.14$	1
Fulminic acid	$CHNO$	3.09934	5	Isoxazole	$C_3H_3NO$	$2.95 \pm 0.04$	3
Fulvene	$C_6H_6$	$0.4236 \pm 0.013$	2	Isoxazole-carbon monoxide complex	$C_3H_3NO \cdot CO$	$2.873 \pm 0.004$	52
Furan	$C_4H_4O$	$0.66 \pm 0.01$	1	Ketene	$C_2H_2O$	1.42215	3
Furfural	$C_5H_4O_2$	[3.54]	7	Mesityl oxide	$C_6H_{10}O$	[2.79]	7
Furfuryl alcohol	$C_5H_6O_2$	[1.92]	7	Methacrylic acid	$C_4H_6O_2$	[1.65]	7
Glycerol	$C_3H_8O_3$	[2.56]	7	Methanethiol	$CH_4S$	$1.52 \pm 0.08$	1
Glycine (Conformer I)	$C_2H_5NO_2$	$1.147 \pm 0.005$	49	Methanol	$CH_4O$	$1.70 \pm 0.02$	1
Glycine (Conformer II)	$C_2H_5NO_2$	$5.45 \pm 0.05$	49	2-Methoxyethanol ( <i>gauche</i> )	$C_3H_8O_2$	$2.36 \pm 0.05$	2
Glycolaldehyde	$C_2H_4O_2$	$2.73 \pm 0.05$	2	2-Methoxyethyl acetate	$C_5H_{10}O_3$	[2.13]	7
Glyoxal ( <i>cis</i> )	$C_2H_2O_2$	$4.8 \pm 0.2$	2	1-Methoxy-1,2-propadiene	$C_4H_6O$	$0.963 \pm 0.020$	5
2-Heptanol	$C_7H_{16}O$	[1.71]	7	<i>N</i> -Methylacetamide	$C_3H_7NO$	[4.3]	7
3-Heptanol	$C_7H_{16}O$	[1.71]	7	Methyl acetate	$C_3H_6O_2$	$1.72 \pm 0.09$	1
2-Heptanone	$C_7H_{14}O$	[2.59]	7	Methyl acrylate	$C_4H_6O_2$	[1.77]	7
3-Heptanone	$C_7H_{14}O$	[2.78]	7	2-Methylacrylonitrile	$C_4H_5N$	$3.69 \pm 0.18$	1
Hexamethylphosphoric triamide	$C_6H_{18}N_3OP$	[5.5]	7	Methylamine	$CH_5N$	$1.31 \pm 0.03$	1
Hexanoic acid	$C_6H_{12}O_2$	[1.13]	7	2-Methylaniline	$C_7H_9N$	[1.60]	7
2-Hexanone	$C_6H_{12}O$	[2.66]	7	3-Methylaniline	$C_7H_9N$	[1.45]	7
<i>sec</i> -Hexyl acetate	$C_8H_{16}O_2$	[1.9]	7	4-Methylaniline	$C_7H_9N$	[1.52]	7
1-Hexyne	$C_6H_{10}$	$0.83 \pm 0.05$	1	Methyl azide	$CH_3N_3$	$2.17 \pm 0.04$	2
Hydrogen cyanide	$CHN$	2.985188	5	Methyl benzoate	$C_8H_8O_2$	[1.94]	7
Hydrogen cyanide trimer	$C_3H_3N_3$	10.6	21	2-Methyl-1,3-butadiene	$C_5H_8$	$0.25 \pm 0.01$	1
Hydrogen isocyanide	$CHN$	$3.05 \pm 0.15$	3	3-Methylbutanoic acid	$C_5H_{10}O_2$	[0.63]	7
<i>p</i> -Hydroquinone	$C_6H_6O_2$	$2.38 \pm 0.05$	15	2-Methyl-1-butanol	$C_5H_{12}O$	[1.88]	7
3-Hydroxypropanenitrile ( <i>gauche</i> )	$C_3H_5NO$	$3.17 \pm 0.02$	5	2-Methyl-2-butanol	$C_5H_{12}O$	[1.82]	7
Imidazole	$C_3H_4N_2$	$3.8 \pm 0.4$	2	3-Methyl-1-butene ( <i>gauche</i> )	$C_5H_{10}$	$0.398 \pm 0.004$	3
Iodoacetylene	$C_2HI$	0.02525	5	3-Methyl-1-butene ( <i>trans</i> )	$C_5H_{10}$	$0.320 \pm 0.010$	3
Iodobenzene	$C_6H_5I$	$1.70 \pm 0.09$	1	3-Methyl-2-butenenitrile	$C_5H_7N$	$4.61 \pm 0.13$	10
1-Iodobutane	$C_4H_9I$	[1.93]	7	2-Methyl-1-buten-3-yne	$C_5H_6$	$0.513 \pm 0.02$	2
2-Iodobutane	$C_4H_9I$	$2.12 \pm 0.11$	1	Methyl cyanate	$C_2H_3NO$	$4.26 \pm 0.18$	5
Iodoethane	$C_2H_5I$	$1.976 \pm 0.002$	5	<i>cis</i> -3-Methylcyclohexanol	$C_7H_{14}O$	[1.91]	7
Iodoethene	$C_2H_3I$	$1.311 \pm 0.005$	5	<i>trans</i> -3-Methylcyclohexanol	$C_7H_{14}O$	[1.75]	7
Iodomethane	$CH_3I$	$1.6406 \pm 0.0004$	5	3-Methylcyclopentanone	$C_6H_{10}O$	$3.14 \pm 0.03$	5
1-Iodo-2-methylpropane	$C_4H_9I$	[1.87]	7	3-Methyl-2-cyclopenten-1-one	$C_6H_8O$	$4.33 \pm 0.002$	5
Iodomethylsilane	$CH_3SiI$	$1.862 \pm 0.005$	5	Methylcyclopropane	$C_4H_8$	$0.139 \pm 0.004$	2
1-Iodopropane	$C_3H_7I$	$2.04 \pm 0.10$	1	Methyldiborane(6)	$CH_8B_2$	$0.566 \pm 0.006$	3
2-Iodopropane	$C_3H_7I$	[1.95]	7	Methyldifluorophosphine	$CH_3F_2P$	$2.056 \pm 0.006$	3
Isobutanal ( <i>gauche</i> )	$C_4H_8O$	$2.69 \pm 0.01$	5	Methylenecyclohexane	$C_7H_{12}$	$0.62 \pm 0.01$	5
Isobutanal ( <i>trans</i> )	$C_4H_8O$	$2.86 \pm 0.01$	5	Methylenecyclopropene	$C_4H_4$	$1.90 \pm 0.01$	5
Isobutane	$C_4H_{10}$	$0.132 \pm 0.002$	1	Methylenephosphine ( $CH_2 = PH$ )	$CH_3P$	$0.869 \pm 0.003$	61
Isobutene	$C_4H_8$	$0.503 \pm 0.010$	1	<i>N</i> -Methylformamide	$C_2H_5NO$	$3.83 \pm 0.08$	1
Isobutyl acetate	$C_6H_{12}O_2$	[1.86]	7	Methyl formate	$C_2H_4O_2$	$1.77 \pm 0.04$	1
Isobutylamine	$C_4H_{11}N$	[1.27]	7	2-Methylfuran	$C_5H_6O$	$0.65 \pm 0.05$	2
Isobutyl formate	$C_5H_{10}O_2$	[1.88]	7	3-Methylfuran	$C_5H_6O$	$1.03 \pm 0.02$	2
Isobutyl isobutanoate	$C_8H_{16}O_2$	[1.9]	7	5-Methyl-2(3 <i>H</i> )-furanone	$C_5H_6O_2$	$4.08 \pm 0.02$	5
Isocyanic acid (HNCO)	$CHNO$	$\approx 1.6$	2	Methyl hydroperoxide	$CH_4O_2$	$\approx 0.65$	13
Isocyanobenzene	$C_7H_5N$	$4.018 \pm 0.003$	5	Methyldiyne	$CH$	$\approx 1.46$	2
Isocyanocyclopropane	$C_4H_5N$	$4.03 \pm 0.10$	3				

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
Methyl isocyanate	$C_2H_3NO$	$\approx 2.8$	1	Pentachloroethane	$C_2HCl_5$	$0.92 \pm 0.05$	1
Methyl isothiocyanate	$C_2H_3NS$	$3.453 \pm 0.003$	5	<i>cis</i> -1,3-Pentadiene	$C_5H_8$	$0.500 \pm 0.015$	2
4-Methylisoxazole	$C_4H_5NO$	$3.583 \pm 0.005$	5	<i>trans</i> -1,3-Pentadiene	$C_5H_8$	$0.585 \pm 0.010$	2
Methyl methacrylate	$C_5H_8O_2$	[1.67]	7	1,3-Pentadiyne	$C_5H_4$	$1.207 \pm 0.001$	5
2-Methyloxazole	$C_4H_5NO$	$1.37 \pm 0.07$	5	1,5-Pentanediol	$C_5H_{12}O_2$	[2.5]	7
4-Methyloxazole	$C_4H_5NO$	$1.08 \pm 0.05$	5	2,4-Pentanedione	$C_5H_8O_2$	[2.78]	7
5-Methyloxazole	$C_4H_5NO$	$2.16 \pm 0.04$	5	Pentanenitrile	$C_5H_9N$	$4.12 \pm 0.08$	1
Methyloxirane	$C_3H_6O$	$2.01 \pm 0.02$	1	Pentanoic acid	$C_5H_{10}O_2$	[1.61]	7
2-Methyl-2,4-pentanediol	$C_6H_{14}O_2$	[2.9]	7	1-Pentanol	$C_5H_{12}O$	[1.7]	7
4-Methylpentanenitrile	$C_6H_{11}N$	[3.5]	7	2-Pentanol	$C_5H_{12}O$	[1.66]	7
Methylphosphonic difluoride	$CH_3F_2OP$	$3.69 \pm 0.26$	3	3-Pentanol	$C_5H_{12}O$	[1.64]	7
<i>N</i> -Methylpropanamide	$C_4H_9NO$	3.61	7	2-Pentanone	$C_5H_{10}O$	[2.70]	7
2-Methylpropanenitrile	$C_4H_7N$	$4.29 \pm 0.09$	3	3-Pentanone	$C_5H_{10}O$	[2.82]	7
2-Methyl-2-propanethiol	$C_4H_{10}S$	$1.66 \pm 0.03$	3	1,2,3-Pentatriene	$C_5H_6$	$0.51 \pm 0.05$	11
2-Methylpropanoic acid	$C_4H_8O_2$	[1.08]	7	1-Pentene	$C_5H_{10}$	$\approx 0.5$	1
2-Methyl-1-propanol	$C_4H_{10}O$	$1.64 \pm 0.08$	1	1-Penten-3-yne	$C_5H_6$	$0.66 \pm 0.02$	2
2-Methyl-2-propanol	$C_4H_{10}O$	[1.66]	7	<i>cis</i> -3-Penten-1-yne	$C_5H_6$	$0.78 \pm 0.02$	2
2-Methylpropenal	$C_4H_6O$	$2.68 \pm 0.13$	1	<i>trans</i> -3-Penten-1-yne	$C_5H_6$	$1.06 \pm 0.05$	2
2-Methyl-2-propenol ( <i>skew</i> )	$C_4H_8O$	$1.295 \pm 0.022$	5	Pentyl acetate	$C_7H_{14}O_2$	$1.75 \pm 0.10$	1
Methyl propyl ether ( <i>trans-trans</i> )	$C_4H_{10}O$	$1.107 \pm 0.013$	3	Pentyl formate	$C_6H_{12}O_2$	$1.90 \pm 0.10$	1
2-Methylpyridine	$C_6H_7N$	$1.85 \pm 0.04$	2	1-Pentyne ( <i>gauche</i> )	$C_5H_8$	$0.769 \pm 0.028$	2
3-Methylpyridine	$C_6H_7N$	[2.40]	7	1-Pentyne ( <i>trans</i> )	$C_5H_8$	$0.842 \pm 0.010$	2
4-Methylpyridine	$C_6H_7N$	$2.70 \pm 0.02$	2	Perfluoropyridine	$C_5F_5N$	$0.98 \pm 0.08$	3
2-Methylpyrimidine	$C_5H_6N_2$	$1.676 \pm 0.010$	3	Phenol	$C_6H_6O$	$1.224 \pm 0.008$	3
5-Methylpyrimidine	$C_5H_6N_2$	$2.881 \pm 0.006$	3	Phenylacetylene	$C_8H_6$	$0.656 \pm 0.005$	3
<i>N</i> -Methylpyrrolidine	$C_5H_{11}N$	$0.572 \pm 0.003$	5	Phenylsilane	$C_6H_5Si$	$0.845 \pm 0.012$	3
<i>N</i> -Methyl-2-pyrrolidinone	$C_5H_9NO$	[4.1]	7	1-Phosphapropyne ( $CH_3CP$ )	$C_2H_3P$	$1.499 \pm 0.001$	63
Methyl salicylate	$C_8H_8O_3$	[2.47]	7	Piperidine ( <i>equatorial</i> )	$C_5H_{11}N$	$0.82 \pm 0.02$	3
Methylsilane	$CH_3Si$	0.73456	5	Piperidine ( <i>axial</i> )	$C_5H_{11}N$	$1.19 \pm 0.02$	3
Methyl silyl ether	$CH_3OSi$	$1.15 \pm 0.02$	2	Piperidine ( <i>average</i> )	$C_5H_{11}N$	[1.19]	3
3-Methylthietane	$C_4H_8S$	$2.046 \pm 0.009$	5	Propanal ( <i>gauche</i> )	$C_3H_6O$	$2.86 \pm 0.01$	5
2-Methylthiophene	$C_5H_6S$	$0.674 \pm 0.005$	2	Propanal ( <i>cis</i> )	$C_3H_6O$	$2.52 \pm 0.05$	1
3-Methylthiophene	$C_5H_6S$	$0.914 \pm 0.015$	3	Propanal ( <i>average</i> )	$C_3H_6O$	2.72	1
Methyl vinyl ether	$C_3H_6O$	$0.965 \pm 0.002$	5	Propane	$C_3H_8$	$0.084 \pm 0.001$	1
Morpholine	$C_4H_9NO$	$1.55 \pm 0.03$	3	1,2-Propanediol	$C_3H_8O_2$	[2.25]	7
2-Nitroanisole	$C_7H_7NO_3$	[5.0]	7	1,3-Propanediol	$C_3H_8O_2$	[2.55]	7
Nitrobenzene	$C_6H_5NO_2$	$4.22 \pm 0.08$	1	Propanenitrile	$C_3H_5N$	$4.05 \pm 0.03$	3
Nitroethane	$C_2H_5NO_2$	$3.23 \pm 0.03$	2	1-Propanethiol ( <i>gauche</i> )	$C_3H_7S$	$1.683 \pm 0.010$	3
Nitromethane	$CH_3NO_2$	$3.46 \pm 0.02$	1	1-Propanethiol ( <i>trans</i> )	$C_3H_7S$	$1.60 \pm 0.08$	3
1-Nitropropane	$C_3H_7NO_2$	$3.66 \pm 0.07$	1	2-Propanethiol ( <i>gauche</i> )	$C_3H_7S$	$1.53 \pm 0.03$	3
2-Nitropropane	$C_3H_7NO_2$	$3.73 \pm 0.07$	1	2-Propanethiol ( <i>trans</i> )	$C_3H_7S$	$1.61 \pm 0.03$	3
Nonanoic acid	$C_9H_{18}O_2$	[0.79]	7	Propanoic acid ( <i>cis</i> )	$C_3H_6O_2$	$1.46 \pm 0.07$	2
2,5-Norbornadiene	$C_7H_8$	$0.0587 \pm 0.0001$	5	Propanoic acid ( <i>average</i> )	$C_3H_6O_2$	$1.75 \pm 0.09$	1
<i>cis</i> -9-Octadecenoic acid	$C_{18}H_{34}O_2$	[1.18]	7	1-Propanol ( <i>gauche</i> )	$C_3H_8O$	$1.58 \pm 0.03$	2
Octanoic acid	$C_8H_{16}O_2$	[1.15]	7	1-Propanol ( <i>trans</i> )	$C_3H_8O$	$1.55 \pm 0.03$	2
1-Octanol	$C_8H_{18}O$	[1.76]	7	2-Propanol ( <i>trans</i> )	$C_3H_8O$	$1.58 \pm 0.03$	2
2-Octanol	$C_8H_{18}O$	[1.71]	7	Propargyl alcohol	$C_3H_4O$	$1.13 \pm 0.06$	2
2-Octanone	$C_8H_{16}O$	[2.70]	7	Propene	$C_3H_6$	$0.366 \pm 0.001$	1
1,4-Oxathiane	$C_4H_8OS$	$0.295 \pm 0.003$	3	Propene-sulfur dioxide complex	$C_3H_6 \cdot O_2S$	$1.34 \pm 0.003$	35
Oxazole	$C_3H_3NO$	$1.503 \pm 0.030$	3	Propyl acetate	$C_5H_{10}O_2$	[1.78]	7
Oxetane	$C_3H_6O$	$1.94 \pm 0.01$	1	Propylamine	$C_3H_9N$	$1.17 \pm 0.06$	1
2-Oxetanone	$C_3H_4O_2$	$4.18 \pm 0.03$	1	Propylene carbonate	$C_4H_6O_3$	[4.9]	7
3-Oxetanone	$C_3H_4O_2$	$0.887 \pm 0.005$	2	Propyleneimine ( <i>cis</i> )	$C_3H_7N$	$1.77 \pm 0.09$	2
Oxirane	$C_2H_4O$	$1.89 \pm 0.01$	1	Propyleneimine ( <i>trans</i> )	$C_3H_7N$	$1.57 \pm 0.03$	2
Paraldehyde	$C_6H_{12}O_3$	$1.43 \pm 0.07$	1	Propyl formate	$C_4H_8O_2$	[1.89]	7

Name	Mol. Form.	$\mu/D$	Ref.	Name	Mol. Form.	$\mu/D$	Ref.
2-Propynal	$C_3H_2O$	$2.78 \pm 0.02$	5	Toluene	$C_7H_8$	$0.375 \pm 0.010$	3
Propyne	$C_3H_4$	$0.784 \pm 0.001$	3	Toluene-sulfur dioxide complex	$C_7H_8 \cdot O_2S$	$1.87 \pm 0.03$	34
Propyne-argon complex	$C_3H_4 \cdot Ar$	$0.730 \pm 0.005$	20	1 <i>H</i> -1,2,4-Triazole	$C_2H_3N_3$	$2.7 \pm 0.1$	3
4 <i>H</i> -Pyran-4-one	$C_5H_4O_2$	$3.79 \pm 0.02$	5	Tribromomethane	$CHBr_3$	$0.99 \pm 0.02$	1
4 <i>H</i> -Pyran-4-thione	$C_5H_4OS$	$3.95 \pm 0.05$	5	Tributylamine	$C_{12}H_{27}N$	[0.78]	7
1 <i>H</i> -Pyrazole	$C_3H_4N_2$	$2.20 \pm 0.01$	3	Tributyl borate	$C_{12}H_{27}BO_3$	[0.77]	7
Pyridazine	$C_4H_4N_2$	$4.22 \pm 0.02$	2	Tributyl phosphate	$C_{12}H_{27}O_4P$	[3.07]	7
Pyridine	$C_5H_5N$	$2.215 \pm 0.010$	3	Tricarbon monosulfide	$C_3S$	$3.704 \pm 0.009$	50
2-Pyridinecarbonitrile	$C_6H_4N_2$	$5.78 \pm 0.11$	3	1,1,1-Trichloroethane	$C_2H_3Cl_3$	$1.755 \pm 0.015$	2
3-Pyridinecarbonitrile	$C_6H_4N_2$	$3.66 \pm 0.11$	3	1,1,2-Trichloroethane	$C_2H_3Cl_3$	[1.4]	7
4-Pyridinecarbonitrile	$C_6H_4N_2$	$1.96 \pm 0.03$	3	Trichloroethene	$C_2HCl_3$	[0.8]	7
3-Pyridinecarboxaldehyde	$C_6H_5NO$	1.44	3	Trichloroethylsilane	$C_2H_5Cl_3Si$	[2.04]	7
4-Pyridinecarboxaldehyde	$C_6H_5NO$	1.66	3	Trichlorofluoromethane	$CCl_3F$	$0.46 \pm 0.02$	2
2-Pyridinecarboxaldehyde	$C_6H_5NO$	$3.56 \pm 0.07$	3	Trichloromethane	$CHCl_3$	$1.04 \pm 0.02$	2
Pyrimidine	$C_4H_4N_2$	$2.334 \pm 0.010$	2	(Trichloromethyl)benzene	$C_7H_5Cl_3$	[2.03]	7
Pyrrole	$C_4H_5N$	$1.767 \pm 0.001$	5	Trichloromethylsilane	$CH_3Cl_3Si$	$1.91 \pm 0.01$	2
Pyrrolidine	$C_4H_9N$	[1.57]	7	Tri- <i>o</i> -cresyl phosphate	$C_{21}H_{21}O_4P$	[2.87]	7
2-Pyrrolidone	$C_4H_7NO$	[3.5]	7	Tri- <i>m</i> -cresyl phosphate	$C_{21}H_{21}O_4P$	[3.05]	7
Quinoline	$C_9H_7N$	$2.29 \pm 0.11$	1	Tri- <i>p</i> -cresyl phosphate	$C_{21}H_{21}O_4P$	[3.18]	7
Salicylaldehyde	$C_7H_6O_2$	[2.86]	7	Triethanolamine	$C_6H_{15}NO_3$	[3.57]	7
Selenoformaldehyde	$CH_2Se$	$1.41 \pm 0.01$	5	Triethylamine	$C_6H_{15}N$	$0.66 \pm 0.05$	1
Silicon dicarbide	$C_2Si$	$2.393 \pm 0.006$	24	Triethyl phosphate	$C_6H_{15}O_4P$	[3.12]	7
Silicon methylidene	$CHSi$	$0.066 \pm 0.002$	41	Trifluoroacetic acid	$C_2HF_3O_2$	$2.28 \pm 0.25$	1
Styrene	$C_8H_8$	$0.123 \pm 0.003$	5	Trifluoroacetonitrile	$C_2F_3N$	$1.262 \pm 0.010$	3
Succinonitrile	$C_4H_4N_2$	[3.7]	7	1,2,4-Trifluorobenzene	$C_6H_3F_3$	$1.402 \pm 0.009$	5
Sulfolane	$C_4H_4O_2S$	[4.8]	7	1,1,1-Trifluoroethane	$C_2H_3F_3$	$2.347 \pm 0.005$	3
1,1,2,2-Tetrabromoethane	$C_2H_2Br_4$	[1.38]	7	Trifluoroethene	$C_2HF_3$	$1.32 \pm 0.03$	2
1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	$1.32 \pm 0.07$	1	Trifluoroiodomethane	$CF_3I$	$1.048 \pm 0.003$	3
1,2,3,4-Tetrafluorobenzene	$C_6H_2F_4$	$2.42 \pm 0.05$	3	Trifluoroisocyanomethane	$C_2F_3N$	$1.153 \pm 0.010$	5
1,2,3,5-Tetrafluorobenzene	$C_6H_2F_4$	$1.46 \pm 0.06$	3	Trifluoromethane	$CHF_3$	1.65150	3
1,1,1,2-Tetrafluoroethane	$C_2H_2F_4$	$1.80 \pm 0.22$	5	(Trifluoromethyl)benzene	$C_7H_5F_3$	$2.86 \pm 0.06$	1
Tetrahydrofuran	$C_4H_8O$	$1.75 \pm 0.04$	2	Trifluoromethylsilane	$CH_3F_3Si$	$2.3394 \pm 0.0002$	5
Tetrahydrofurfuryl alcohol	$C_5H_{10}O_2$	[2.1]	7	(Trifluoromethyl)silane	$CH_3F_3Si$	$2.32 \pm 0.02$	5
Tetrahydropyran ( <i>chair</i> )	$C_5H_{10}O$	$1.58 \pm 0.03$	3	3,3,3-Trifluoropropene	$C_3H_3F_3$	$2.45 \pm 0.05$	1
Tetrahydro-4 <i>H</i> -pyran-4-one	$C_5H_8O_2$	$1.720 \pm 0.003$	3	3,3,3-Trifluoro-1-propyne	$C_3HF_3$	$2.317 \pm 0.013$	5
1,2,5,6-Tetrahydropyridine	$C_5H_9N$	$1.007 \pm 0.003$	3	Trimethylamine	$C_3H_9N$	$0.612 \pm 0.003$	1
Tetrahydrothiophene	$C_4H_8S$	[1.90]	7	Trimethyl phosphate	$C_3H_9O_4P$	[3.18]	7
Tetramethylurea	$C_5H_{12}N_2O$	[3.5]	7	2,4,6-Trimethylpyridine	$C_8H_{11}N$	[2.05]	7
1 <i>H</i> -Tetrazole	$CH_2N_4$	$2.19 \pm 0.05$	3	1,3,5-Trioxane	$C_3H_6O_3$	$2.08 \pm 0.02$	1
Thiacyclohexane	$C_5H_{10}S$	$1.781 \pm 0.010$	3	Vinyl acetate	$C_4H_6O_2$	[1.79]	7
1,2,5-Thiadiazole	$C_2H_2N_2S$	$1.579 \pm 0.007$	3	Vinyl formate	$C_3H_4O_2$	$1.49 \pm 0.01$	1
Thietane	$C_3H_6S$	$1.85 \pm 0.09$	1	2-Vinylfuran	$C_6H_6O$	$0.69 \pm 0.07$	5
Thietane 1,1-dioxide	$C_3H_6O_2S$	$4.8 \pm 0.1$	5	Vinylsilane	$C_2H_6Si$	$0.657 \pm 0.002$	5
Thioacetaldehyde	$C_2H_4S$	$2.33 \pm 0.02$	68	<i>o</i> -Xylene	$C_8H_{10}$	$0.640 \pm 0.005$	2
Thiocarbonyl fluoride	$CF_2S$	0.080	59	2,4-Xylenol	$C_8H_{10}O$	[1.4]	7
Thioformaldehyde	$CH_2S$	$1.6491 \pm 0.0004$	3	2,5-Xylenol	$C_8H_{10}O$	[1.45]	7
Thiophene	$C_4H_4S$	$0.55 \pm 0.01$	2	2,6-Xylenol	$C_8H_{10}O$	[1.40]	7
2-Thiophenecarbonitrile	$C_5H_3NS$	$4.59 \pm 0.02$	3	3,4-Xylenol	$C_8H_{10}O$	[1.56]	7
3-Thiophenecarbonitrile	$C_5H_3NS$	$4.13 \pm 0.02$	3	3,5-Xylenol	$C_8H_{10}O$	[1.55]	7
4 <i>H</i> -Thiopyran-4-thione	$C_5H_4S_2$	$3.9 \pm 0.2$	5				

# BOND DISSOCIATION ENERGIES

Yu-Ran Luo

The bond dissociation energy (enthalpy) is also referred to as bond disruption energy, bond energy, bond strength, or binding energy (abbreviation: BDE, BE, or D). It is defined as the standard enthalpy change of the following fission:  $R-X \rightarrow R + X$ . The BDE, denoted by  $D^\circ(R-X)$ , is usually derived by the thermochemical equation,  $D^\circ(R-X) = \Delta_f H^\circ(R) + \Delta_f H^\circ(X) - \Delta_f H^\circ(RX)$ . The enthalpy of formation  $\Delta_f H^\circ$  of a large number of atoms, free radicals, ions, clusters and compounds is available from the websites of NIST, NASA, CODATA, and IUPAC. Most authors prefer to use the BDE values at 298.15 K.

The following seven tables provide essential information of experimental BDE values of R-X and R<sup>+</sup>-X bonds.

- (1) Table 1: Bond Dissociation Energies in Diatomic Molecules
- (2) Table 2: Enthalpy of Formation of Gaseous Atoms
- (3) Table 3: Bond Dissociation Energies in Polyatomic Molecules
- (4) Table 4: Enthalpies of Formation of Free Radicals and Other Transient Species
- (5) Table 5: Bond Dissociation Energies of Common Organic Molecules
- (6) Table 6: Bond Dissociation Energies in Diatomic Cations
- (7) Table 7: Bond Dissociation Energies in Polyatomic Cations

The data in these tables have been revised through September 2008.

**TABLE 1. Bond Dissociation Energies in Diatomic Molecules**

The BDEs in diatomic species have usually been measured by spectroscopy or mass spectrometry. In the absence of data on the enthalpy function, the values at 0 K,  $D^\circ(A-B)$ , are converted to  $D^\circ_{298}$  by the approximate equation:

$$D^\circ_{298}(A-B) \approx D^\circ(A-B) + (3/2)RT = D^\circ(A-B) + 3.7181 \text{ kJ mol}^{-1}$$

This table has been arranged in an alphabetical order of the atoms A in the diatomics A-B.

A-B	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	A-B	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	A-B	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	A-B	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.
Ac-O	794	1	Ag-Sn	136 ± 21	1	Al-Sb	216.3 ± 6	1	Ar-Si	5.86	1
Ag-Ag	162.9 ± 2.9	1	Ag-Te	195.8 ± 14.6	1	Al-Se	318 ± 13	1	Ar-Sn	<5.1	1
Ag-Al	183.7 ± 9.2	1	Al-Al	264.3 ± 0.5	1	Al-Si	246.9 ± 12.6	1	Ar-Tl	4.09	1
Ag-Au	202.5 ± 9.6	1	Al-Ar	5.69	1	Al-Te	268 ± 13	1	Ar-Xe	5.28	1
Ag-Bi	192 ± 42	1	Al-As	202.7 ± 7.1	1	Al-Ti	263.4	1	Ar-Zn	5.0	1
Ag-Br	280.3 ± 1.3	1	Al-Au	325.9 ± 6.3	1	Al-U	326 ± 29	1	As-As	385.8 ± 10.5	1
Ag-Cl	279.1 ± 8.4	1	Al-Br	429.2 ± 5.8	1	Al-V	147.4 ± 1.0	1	As-Cl	448	1
Ag-Cu	171.5 ± 9.6	1	Al-C	267.7	1	Al-Xe	7.39	1	As-D	270.3	1
Ag-D	226.8	1	Al-Ca	52.7	1	Am-O	553 ± 36	1	As-F	410	1
Ag-Dy	130 ± 19	1	Al-Cl	502	1	Ar-Ar	4.91	1	As-Ga	202.5 ± 4.8	1
Ag-Eu	127 ± 13	1	Al-Co	181.6 ± 0.2	1	Ar-B	4.62	1	As-H	274.0 ± 2.9	1
Ag-F	356.9 ± 5.8	1	Al-Cr	222.9 ± 0.9	1	Ar-Br	~5.0	1	As-I	296.6 ± 24	1
Ag-Ga	159 ± 17	1	Al-Cu	227.1 ± 1.2	1	Ar-C	5.158	1	As-In	201 ± 10	1
Ag-Ge	174.5 ± 21	1	Al-D	290.4	1	Ar-Ca	4.44 ± 0.60	1	As-N	489 ± 2.1	1
Ag-H	202.4 ± 9.1	1	Al-F	675	1	Ar-Cd	5.57 ± 0.05	1	As-O	484 ± 8	1
Ag-Ho	124 ± 19	1	Al-H	288 ± 13	1	Ar-Ga	3.96	1	As-P	433.5 ± 12.6	1
Ag-I	234 ± 29	1	Al-I	369.9 ± 2.1	1	Ar-Ge	<5.4	1	As-S	379.5 ± 6.3	1
Ag-In	166.5 ± 4.9	1	Al-Kr	6.05	1	Ar-He	3.96	1	As-Sb	330.5 ± 5.4	1
Ag-Li	186.1	1	Al-Li	76.1	1	Ar-Hg	5.32	1	As-Se	96	1
Ag-Mn	99.2 ± 21	1	Al-N	≤368 ± 15	1	Ar-I	~5.3	1	As-Tl	198.3 ± 14.6	1
Ag-Na	133.1 ± 12.6	1	Al-Ne	3.9	1	Ar-In	4.18	1	Au-Au	226.2 ± 0.5	1
Ag-Nd	<213	1	Al-Ni	224.7 ± 4.8	1	Ar-Kr	5.11	1	Au-B	367.8 ± 10.5	1
Ag-O	221 ± 21	1	Al-O	501.9 ± 10.6	1	Ar-Li	~7.82	1	Au-Ba	254.8 ± 10.0	1
Ag-S	216.7 ± 14.6	1	Al-P	216.7 ± 12.6	1	Ar-Mg	~3.7	1	Au-Be	237.7 ± 4.0	1
Ag-Se	210.0 ± 14.6	1	Al-Pd	254.4 ± 12.1	1	Ar-Na	~4.2	1	Au-Bi	293 ± 8.4	1
Ag-Si	185.1 ± 9.6	1	Al-S	332 ± 10	1	Ar-Ne	4.27	1	Au-Br	213 ± 21	1

A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Au-Ca	250.4 ± 4.0	1	B-H	345.2 ± 2.5	1	Bi-O	337.2 ± 12.6	1	Br-Sb	314 ± 59	1
Au-Ce	322 ± 18	1	B-I	361	1	Bi-P	281.7 ± 13	1	Br-Sc	444 ± 63	1
Au-Cl	280 ± 13	1	B-Ir	512.2 ± 17	1	Bi-Pb	142.4 ± 3.0	1	Br-Se	297 ± 84	1
Au-Co	218.0 ± 16.4	1	B-La	335 ± 63	1	Bi-S	315.5 ± 4.6	1	Br-Si	358.2 ± 8.4	1
Au-Cr	223.7 ± 28.9	1	B-N	377.9 ± 8.7	1	Bi-Sb	252.7 ± 3.9	1	Br-Sm	331.4	1
Au-Cs	253 ± 3.5	1	B-Ne	3.97	1	Bi-Se	280.3 ± 5.9	1	Br-Sn	337 ± 13	1
Au-Cu	227.1 ± 1.2	1	B-O	809	1	Bi-Sn	193 ± 13	1	Br-Sr	365	1
Au-D	322.2	1	B-P	347 ± 16.7	1	Bi-Te	232.2 ± 11.3	1	Br-T	372.77	1
Au-Dy	259 ± 24	1	B-Pd	351.5 ± 16.7	1	Bi-Tl	120.9 ± 12.6	1	Br-Tb	382.8	1
Au-Eu	245 ± 12	1	B-Pt	477.8 ± 16.7	1	Bk-O	598	1	Br-Th	364	1
Au-F	294.1	1	B-Rh	475.8 ± 21	1	Br-Br	193.859 ± 0.120	1	Br-Ti	373	1
Au-Fe	187.0 ± 19.3	1	B-Ru	446.9 ± 21	1	Br-C	318.0 ± 8.4	1	Br-Tl	331 ± 21	1
Au-Ga	290 ± 15	1	B-S	577 ± 9.2	1	Br-Ca	339	1	Br-Tm	299.1	1
Au-Ge	273.2 ± 14.6	1	B-Sc	272 ± 63	1	Br-Cd	159 ± 96	1	Br-U	377 ± 15	1
Au-H	300.5 ± 2.6	4	B-Se	462 ± 14.6	1	Br-Ce	373.2	1	Br-V	439 ± 42	1
Au-Ho	267 ± 35	1	B-Si	317 ± 12	1	Br-Cl	219.32 ± 0.05	1	Br-W	329.3	1
Au-I	276	1	B-Te	354 ± 20	1	Br-Co	326 ± 42	1	Br-Xe	5.94 ± 0.02	1
Au-In	286.0 ± 5.7	1	B-Th	297 ± 33	1	Br-Cr	328.0 ± 24.3	1	Br-Y	481 ± 84	1
Au-La	457 ± 28	1	B-Ti	272 ± 63	1	Br-Cs	389.1 ± 4.2	1	Br-Yb	295.4	1
Au-Li	284.5 ± 6.7	1	B-U	322 ± 33	1	Br-Cu	331 ± 25	1	Br-Zn	138 ± 29	1
Au-Lu	332 ± 19	1	B-Y	289 ± 63	1	Br-D	370.74	1	Br-Zr	420	1
Au-Mg	179.1 ± 2.7	1	Ba-Br	402	1	Br-Dy	339.3 ± 10.5	1	C-C	618.3 ± 15.4	1
Au-Mn	197.7 ± 21	1	Ba-Cl	443	1	Br-Er	361.3	1	C-Ce	443 ± 30	1
Au-Na	215.1 ± 12.6	1	Ba-D	≤193.7	1	Br-Eu	548	1	C-Cl	394.9 ± 13.4	1
Au-Nd	294 ± 29	1	Ba-F	580.6	1	Br-F	280 ± 12	1	C-D	341.4	1
Au-Ni	247 ± 16.4	1	Ba-H	192.0	1	Br-Fe	243 ± 84	1	C-F	513.8 ± 10.0	1
Au-O	223 ± 21	1	Ba-I	322.6 ± 6.3	1	Br-Ga	402 ± 13	1	C-Fe	376.3 ± 28.9	1
Au-Pb	133 ± 42	1	Ba-O	562 ± 13.4	1	Br-Gd	372.0	1	C-Ge	455.7 ± 11	1
Au-Pd	142.7 ± 21	1	Ba-Pd	221.8 ± 5.0	1	Br-Ge	347 ± 8	1	C-H	338.4 ± 1.2	1
Au-Pr	311 ± 25	1	Ba-Rh	259.4 ± 25	1	Br-H	366.16 ± 0.20	1	C-Hf	540 ± 25	1
Au-Rb	243 ± 3.5	1	Ba-S	418 ± 21	1	Br-Hg	74.9	1	C-I	253.1 ± 35.6	1
Au-Rh	232.6 ± 29	1	Be-Be	59	1	Br-Ho	321.8	1	C-Ir	631 ± 5	1
Au-S	253.6 ± 14.6	1	Be-Br	316	1	Br-I	179.1 ± 0.4	1	C-La	463 ± 20	1
Au-Sc	280 ± 40	1	Be-Cl	434	1	Br-In	409 ± 10	1	C-Mo	482 ± 16	1
Au-Se	251.0 ± 14.6	1	Be-D	203.1	1	Br-K	379.1 ± 4.2	1	C-N	750.0 ± 2.9	1
Au-Si	304.6 ± 6.0	1	Be-F	573	1	Br-La	446.2	1	C-Nb	523.8 ± 14.5	1
Au-Sn	256.5 ± 7.2	1	Be-H	221	1	Br-Li	418.8 ± 4.2	1	C-Ni	337.0	1
Au-Sr	264 ± 42	1	Be-I	261	1	Br-Lu	301.5	1	C-O	1076.38 ± 0.67	1
Au-Tb	285 ± 33	1	Be-O	437	1	Br-Mg	317.96	1	C-Os	608 ± 25	1
Au-Te	237.2 ± 14.6	1	Be-S	372 ± 59	1	Br-Mn	314.2 ± 9.6	1	C-P	507.5 ± 8.8	1
Au-U	318 ± 29	1	Be-T	204.4	1	Br-Mo	313.4	1	C-Pd	436 ± 20	1
Au-V	246.0 ± 8.7	1	Bi-Bi	204.4	1	Br-N	280.8 ± 21	1	C-Pt	577.8 ± 6.8	13
Au-Y	310 ± 12	1	Bi-Br	240.2	1	Br-Na	363.1 ± 4.2	1	C-Rh	580 ± 4	1
B-B	290	1	Bi-Cl	300.4 ± 4.2	1	Br-Nd	339.7	1	C-Ru	648 ± 13	1
B-Br	390.9 ± 0.5	1	Bi-D	283.7	1	Br-Ni	360 ± 13	1	C-S	713.3 ± 1.2	1
B-C	448 ± 29	1	Bi-F	366.5 ± 12.5	1	Br-O	237.6 ± 0.4	1	C-Sc	444 ± 21	1
B-Cd	301.0	1	Bi-Ga	158.6 ± 16.7	1	Br-P	≤329	1	C-Se	590.4 ± 5.9	1
B-Ce	305 ± 21	1	Bi-H	≤283.3	1	Br-Pb	248.5 ± 14.6	1	C-Si	447	1
B-Cl	427	1	Bi-I	186.1 ± 5.8	1	Br-Pr	344.5	1	C-Tc	564 ± 29	1
B-D	341.0 ± 6.3	1	Bi-In	153.6 ± 1.7	1	Br-Rb	380.7 ± 4.2	1	C-Th	453 ± 17	1
B-F	732	1	Bi-Li	149.4	1	Br-S	218 ± 17	1	C-Ti	423 ± 30	1

A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
C-U	455 ± 15	1	Cl-Cu	377.8 ± 7.5	1	Cl-Yb	374.5	1	Cu-In	187.4 ± 7.9	1
C-V	423 ± 24	1	Cl-D	436.303 ± 0.011	1	Cl-Zn	229 ± 8	1	Cu-Li	191.9	1
C-Y	418 ± 14	1	Cl-Dy	392.4	1	Cl-Zr	530	1	Cu-Na	176.1 ± 16.7	1
C-Zr	495.8 ± 38.6	1	Cl-Er	448.6	1	Cm-O	732	1	Cu-Ni	201.7 ± 9.6	1
Ca-Ca	16.52 ± 0.11	1	Cl-Eu	405.5	1	Co-Co	<127	1	Cu-O	287.4 ± 11.6	1
Ca-Cl	409 ± 8.7	1	Cl-F	260.83	1	Co-Cu	161.1 ± 16.4	1	Cu-S	274.5 ± 14.6	1
Ca-D	≤169.9	1	Cl-Fe	335.5	11	Co-D	270.2 ± 5.8	1	Cu-Se	255.2 ± 14.6	1
Ca-F	529	1	Cl-Ga	463 ± 13	1	Co-F	431 ± 63	1	Cu-Si	221.3 ± 6.3	1
Ca-H	223.8	1	Cl-Gd	451.0	1	Co-Ge	230 ± 21	1	Cu-Sn	170 ± 10	1
Ca-I	284.7 ± 8.4	1	Cl-Ge	390.8 ± 9.6	1	Co-H	244.9 ± 4.8	1	Cu-Tb	191 ± 18	1
Ca-Kr	5.15 ± 0.72	1	Cl-H	431.361 ± 0.013	1	Co-I	280 ± 21	1	Cu-Te	230.5 ± 14.6	1
Ca-Li	84.9 ± 8.4	1	Cl-Hg	92.0 ± 9.2	1	Co-Mn	50 ± 8	1	D-D	443.3197 ± 0.0003	1
Ca-O	383.3 ± 5.0	1	Cl-Ho	409.1	1	Co-Nb	267.02 ± 0.10	1	D-F	576.236 ± 0.011	1
Ca-Pd	347 - 360	1	Cl-I	211.3 ± 0.4	1	Co-O	397.4 ± 8.7	1	D-Ga	<276.5	1
Ca-S	335 ± 21	1	Cl-In	436 ± 8	1	Co-S	331	1	D-Ge	≤322	1
Ca-Xe	7.31 ± 0.96	1	Cl-K	433.0 ± 8.4	1	Co-Sc	240.1	7	D-H	439.2223 ± 0.0002	1
Cd-Cd	7.36	1	Cl-La	521.6	1	Co-Si	274.4 ± 17	1	D-Hg	42.05	1
Cd-Cl	208.4	1	Cl-Li	469 ± 13	1	Co-Ti	235.37 ± 0.10	1	D-I	302.33	1
Cd-F	305 ± 21	1	Cl-Lu	325.7 ± 2	1	Co-Y	253.71 ± 0.10	1	D-In	246	1
Cd-H	69.0 ± 0.4	1	Cl-Mg	312	1	Co-Zr	306.39 ± 0.10	1	D-K	182.4	1
Cd-I	97.2 ± 2.1	1	Cl-Mn	337.6	11	Cr-Cr	152.0 ± 6	1	D-Li	240.24	1
Cd-In	134	1	Cl-N	333.9 ± 9.6	1	Cr-Cu	154.4 ± 14.5	1	D-Lu	302	1
Cd-K	7.3	1	Cl-Na	412.1 ± 8.4	1	Cr-F	523 ± 19	1	D-Mg	161.33 ± 0.32	1
Cd-Kr	5.17	1	Cl-Nd	418.7	1	Cr-Fe	~75	1	D-Mn	312 ± 6	1
Cd-Na	10.2	1	Cl-Ni	372.3	11	Cr-Ge	154 ± 7	1	D-N	341.6	1
Cd-Ne	3.97	1	Cl-O	267.47 ± 0.08	1	Cr-H	189.9 ± 6.7	1	D-Ni	≤302.9	1
Cd-O	236 ± 84	1	Cl-P	≤376	1	Cr-I	287.0 ± 24.3	1	D-O	429.64	1
Cd-S	208.5 ± 20.9	1	Cl-Pb	301 ± 50	1	Cr-N	377.8 ± 18.8	1	D-P	299.0	1
Cd-Se	127.6 ± 25.1	1	Cl-Pr	423.5	1	Cr-Nb	295.72 ± 0.06	1	D-Pt	≤350.2	1
Cd-Te	100.0 ± 15.1	1	Cl-Ra	343 ± 75	1	Cr-O	461 ± 8.7	1	D-S	350.62 ± 1.20	1
Cd-Xe	6.54	1	Cl-Rb	427.6 ± 8.4	1	Cr-Pb	105 ± 2	1	D-Si	302.5	1
Ce-Ce	251.7	1	Cl-S	241.8	1	Cr-S	331	1	D-Sr	167.7	1
Ce-Cl	457.0	1	Cl-Sb	360 ± 50	1	Cr-Sn	141 ± 3	1	D-T	444.91	1
Ce-F	582 ± 42	1	Cl-Sc	331	1	Cs-Cs	43.919 ± 0.010	1	D-Tl	193.0	1
Ce-I	333.8	1	Cl-Se	322	1	Cs-F	517.1 ± 7.7	1	D-Zn	88.7	1
Ce-Ir	575 ± 9	1	Cl-Si	416.7 ± 6.3	1	Cs-H	175.364	1	Dy-Dy	70.3	1
Ce-N	519 ± 21	1	Cl-Sm	418.7	1	Cs-Hg	8	1	Dy-F	531	1
Ce-O	790	1	Cl-Sn	350 ± 8	1	Cs-I	338.5 ± 2.1	1	Dy-I	269.0 ± 8.4	1
Ce-Os	524 ± 20	1	Cl-Sr	409	1	Cs-Li	72.9 ± 1.2	5	Dy-O	615	1
Ce-Pd	319 ± 21	1	Cl-T	438.64	1	Cs-Na	63.2 ± 1.3	1	Dy-S	414 ± 42	1
Ce-Pt	550 ± 5	1	Cl-Ta	544	1	Cs-O	293 ± 25	1	Dy-Se	322 ± 20	1
Ce-Rh	545 ± 7	1	Cl-Tb	470.1	1	Cs-Rb	49.57 ± 0.01	1	Dy-Te	234 ± 20	1
Ce-Ru	494 ± 12	1	Cl-Th	489	1	Cu-Cu	201	1	Er-Er	75 ± 29	1
Ce-S	569	1	Cl-Ti	405.4 ± 10.5	1	Cu-D	270.3	1	Er-F	565 ± 17	1
Ce-Se	494.5 ± 14.6	1	Cl-Tl	372.8 ± 2.1	1	Cu-Dy	144 ± 18	1	Er-I	315.8	1
Ce-Te	189.4 ± 12.6	1	Cl-Tm	378.0	1	Cu-F	414	1	Er-O	606	1
Cf-O	498	1	Cl-U	439	1	Cu-Ga	215.9 ± 15	1	Er-S	418 ± 21	1
Cl-Cl	436.303 ± 0.011	8	Cl-V	477 ± 63	1	Cu-Ge	208.8 ± 21	1	Er-Se	326 ± 20	1
Cl-Co	343.9	11	Cl-W	419	1	Cu-H	254.8 ± 6	1	Er-Te	238 ± 20	1
Cl-Cr	380.3	11	Cl-Xe	7.08	1	Cu-Ho	144 ± 19	1	Es-O	460	1
Cl-Cs	445.7 ± 7.7	1	Cl-Y	523 ± 84	1	Cu-I	289 ± 63	1	Eu-Eu	45.2	1



A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Eu-F	544	1	F-Ti	569 ± 33	1	H-Hg	39.844	1	Hg-T	43.14	1
Eu-I	288.3	1	F-Tl	439 ± 21	1	H-I	298.26 ± 0.10	1	Hg-Te	<142	1
Eu-Li	268.1 ± 12.6	1	F-Tm	510	1	H-In	243.1	1	Hg-Tl	2.9	1
Eu-O	473	1	F-U	648	1	H-K	174.576	1	Hg-Xe	6.65	1
Eu-Rh	238 ± 34	1	F-V	590 ± 63	1	H-Li	238.039 ± 0.006	1	Hg-Zn	7.3	1
Eu-S	365.7 ± 13.4	1	F-W	≤544	1	H-Mg	127.18 ± 0.006	10	Ho-Ho	70.3	1
Eu-Se	302.9 ± 14.6	1	F-Xe	14.18	1	H-Mn	251 ± 5	1	Ho-I	275.1	1
Eu-Te	251.0 ± 14.6	1	F-Y	685.3 ± 13.4	1	H-Mo	202.5 ± 18.3	9	Ho-O	606	1
F-F	158.670 ± 0.096	1	F-Yb	≥517.6 ± 9.6	1	H-N	≤338.9	1	Ho-S	428.4 ± 14.6	1
F-Fe	447	1	F-Zn	364 ± 63	1	H-Na	185.69 ± 0.29	1	Ho-Se	333 ± 15	1
F-Ga	584 ± 13	1	F-Zr	627.2 ± 10.5	1	H-Nb	>221.9 ± 9.6	1	Ho-Te	≤259 ± 15	1
F-Gd	590 ± 17	1	Fe-Fe	118	1	H-Ni	240 ± 8	1	I-I	152.25 ± 0.57	1
F-Ge	523 ± 13	1	Fe-Ge	210.9 ± 29	1	H-O	429.91 ± 0.29	1	I-In	306.9 ± 1.1	1
F-H	569.680 ± 0.011	1	Fe-H	148 ± 3	1	H-P	297.0 ± 2.1	1	I-K	322.5 ± 2.1	1
F-Hf	650 ± 15	1	Fe-I	123	1	H-Pb	≤157	1	I-Kr	5.67	1
F-Hg	~180	1	Fe-O	407.0 ± 1.0	1	H-Pd	234 ± 25	1	I-La	411.7	1
F-Ho	540	1	Fe-S	328.9 ± 14.6	1	H-Pt	330	1	I-Li	345.2 ± 4.2	1
F-I	≤271.5	1	Fe-Si	297 ± 25	1	H-Rb	172.6	1	I-Lu	263.2	1
F-In	516 ± 13	1	Fm-O	443	1	H-Rh	241.0 ± 5.9	1	I-Mg	229	1
F-K	489.2	1	Ga-Ga	<106.4	1	H-Ru	223 ± 15	1	I-Mn	282.8 ± 9.6	1
F-Kr	6.6	1	Ga-H	265.9 ± 5.9	4	H-S	353.57 ± 0.30	1	I-Mo	266.9	1
F-La	659.0 ± 17.2	1	Ga-I	334 ± 13	1	H-Sb	239.7 ± 4.2	1	I-N	159 ± 17	1
F-Li	577 ± 21	1	Ga-In	94.0 ± 3	1	H-Sc	205 ± 17	1	I-Na	304.2 ± 2.1	1
F-Lu	405 ± 19	1	Ga-Kr	4.08	1	H-Se	312.5	1	I-Nd	301.5	1
F-Mg	463	1	Ga-Li	133.1 ± 14.6	1	H-Si	293.3 ± 1.9	1	I-Ni	293 ± 21	1
F-Mn	445.2 ± 7.5	1	Ga-O	374 ± 21	1	H-Sn	264 ± 17	1	I-O	233.4 ± 1.3	12
F-Mo	464	1	Ga-P	229.7 ± 12.6	1	H-Sr	164 ± 8	1	I-Pb	194 ± 38	1
F-N	≤349	1	Ga-Sb	192.0 ± 12.6	1	H-T	440.49	1	I-Pr	306.2	1
F-Na	477.3	1	Ga-Te	265 ± 21	1	H-Te	270.7 ± 1.7	1	I-Rb	318.8 ± 2.1	1
F-Nd	545.2 ± 12.6	1	Ga-Xe	5.27	1	H-Ti	204.6 ± 8.8	1	I-Si	243.1 ± 8.4	1
F-Ni	439.7 ± 5.9	2	Gd-Gd	206.3 ± 67.5	1	H-Tl	195.4 ± 4	1	I-Sm	293.1	1
F-Np	430 ± 50	1	Gd-I	333.8	1	H-V	209.3 ± 6.8	1	I-Sn	235 ± 3	1
F-O	220	1	Gd-O	715	1	H-Yb	183.1 ± 2.0	1	I-Sr	301	1
F-P	≤405	1	Gd-S	526.8 ± 10.5	1	H-Zn	85.8 ± 2	1	I-Tb	336.2	1
F-Pb	355 ± 13	1	Gd-Se	430 ± 15	1	He-He	3.809	1	I-Te	192 ± 42	1
F-Pr	582 ± 46	1	Gd-Te	341 ± 15	1	He-Hg	3.8	1	I-Th	361 ± 25	1
F-Pu	538 ± 29	1	Ge-Ge	264.4 ± 6.8	1	He-Xe	3.8	1	I-Ti	306	1
F-Rb	494 ± 21	1	Ge-H	263.2 ± 4.8	1	Hf-Hf	328 ± 58	1	I-Tl	285 ± 21	1
F-Ru	402	1	Ge-I	268 ± 25	1	Hf-N	535 ± 30	1	I-Tm	260.8	1
F-S	343.5 ± 6.7	1	Ge-Ni	290.3 ± 10.9	1	Hf-O	801 ± 13	1	I-U	299 ± 27	1
F-Sb	439 ± 96	1	Ge-O	657.5 ± 4.6	4	Hg-Hg	8.10 ± 0.18	1	I-Xe	~6.9	1
F-Sc	599.1 ± 13.4	1	Ge-Pb	145.3 ± 6.9	6	Hg-I	34.69 ± 0.96	1	I-Y	422.6 ± 12.5	1
F-Se	339 ± 42	1	Ge-Pd	254.7 ± 10.5	1	Hg-K	8.8	1	I-Yb	257.3	1
F-Si	576.4 ± 17	1	Ge-S	534 ± 3	1	Hg-Kr	5.75	1	I-Zn	153.1 ± 6.3	1
F-Sm	565	1	Ge-Sc	270 ± 11	1	Hg-Li	13.16 ± 0.38	1	I-Zr	127	1
F-Sn	476 ± 8	1	Ge-Se	484.7 ± 1.7	1	Hg-Na	10.8	1	In-In	82.0 ± 5.7	1
F-Sr	538	1	Ge-Si	297	1	Hg-Ne	4.14	1	In-Kr	4.85	1
F-T	579.009 ± 0.108	1	Ge-Sn	230.1 ± 13	1	Hg-O	269	1	In-Li	92.5 ± 14.6	1
F-Ta	573 ± 13	1	Ge-Te	396.7 ± 3.3	1	Hg-Rb	8.4	1	In-O	346 ± 30	1
F-Tb	561 ± 42	1	Ge-Y	279 ± 11	1	Hg-S	217.3 ± 22.2	1	In-P	197.9 ± 8.4	1
F-Th	652	1	H-H	435.7799 ± 0.0001	1	Hg-Se	144.3 ± 30.1	1	In-S	287.9 ± 14.6	1

A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
In-Sb	151.9 ± 10.5	1	Lr-O	665	1	Nd-Te	305 ± 15	1	O-Zr	766.1 ± 10.6	1
In-Se	245.2 ± 14.6	1	Lu-Lu	142 ± 33	1	Ne-Ne	4.070	1	Os-Os	415 ± 77	1
In-Te	215.5 ± 14.6	1	Lu-O	669	1	Ne-Xe	4.31	1	P-P	489.1	1
In-Xe	6.48	1	Lu-Pt	402 ± 34	1	Ne-Zn	3.92	1	P-Pt	≤416.7 ± 16.7	1
In-Zn	32.2	1	Lu-S	508.4 ± 14.4	1	Ni-Ni	204	1	P-Rh	353.1 ± 16.7	1
Ir-Ir	361 ± 68	1	Lu-Se	418 ± 15	1	Ni-O	366 ± 30	1	P-S	442 ± 10	1
Ir-La	577 ± 12	1	Lu-Te	325 ± 15	1	Ni-Pd	140.9	1	P-Sb	356.9 ± 4.2	1
Ir-Nb	465 ± 25	1	Md-O	418	1	Ni-Pt	273.7 ± 0.3	1	P-Se	363.7 ± 10.0	1
Ir-O	414 ± 42	1	Mg-Mg	11.3	1	Ni-S	356 ± 21	1	P-Si	363.6	1
Ir-Si	462.8 ± 21	1	Mg-Ne	~4.1	1	Ni-Si	318 ± 17	1	P-Te	297.9 ± 10.0	1
Ir-Th	574 ± 42	1	Mg-O	358.2 ± 7.2	1	Ni-V	206.3 ± 0.2	1	P-Th	372 ± 29	1
Ir-Ti	422 ± 13	1	Mg-S	234	1	Ni-Y	283.92 ± 0.10	1	P-Tl	209 ± 13	1
Ir-Y	457 ± 15	1	Mg-Xe	9.70 ± 1.79	1	Ni-Zr	279.8 ± 0.1	1	P-U	293 ± 21	1
K-K	56.96	1	Mn-Mn	61.6 ± 9.6	1	No-O	268	1	P-W	305 ± 4	1
K-Kr	4.6	1	Mn-O	362 ± 25	1	Np-O	731	1	Pb-Pb	86.6 ± 0.8	1
K-Li	82.0 ± 4.2	1	Mn-S	301 ± 17	1	O-O	498.36 ± 0.17	1	Pb-S	398	1
K-Na	65.994 ± 0.008	1	Mn-Se	239.3 ± 9.2	1	O-Os	575	1	Pb-Sb	161.5 ± 10.5	1
K-Zn	6.5	1	Mo-Mo	435.5 ± 1.0	1	O-P	589	1	Pb-Se	302.9 ± 4.2	1
K-O	271.5 ± 12.6	1	Mo-Nb	452 ± 25	1	O-Pa	792	1	Pb-Si	168.8 ± 7.3	6
K-Rb	53.723 ± 0.005	1	Mo-O	502	1	O-Pb	382.4 ± 3.3	4	Pb-Te	249.8 ± 10.5	1
K-Xe	5.0	1	N-N	944.84 ± 0.10	1	O-Pd	238.1 ± 12.6	1	Pd-Pd	>136	1
Kr-Kr	5.39	1	N-O	631.62 ± 0.18	1	O-Pr	740	1	Pd-Pt	191.0	1
Kr-Li	~12.1	1	N-P	617.1 ± 20.9	1	O-Pt	418.6 ± 11.6	13	Pd-Si	261 ± 12	1
Kr-Mg	6.71 ± 0.96	1	N-Pt	374.2 ± 9.6	1	O-Pu	656.1	1	Pd-Y	241 ± 15	1
Kr-Na	~4.53	1	N-Pu	469 ± 63	1	O-Rb	276 ± 12.6	1	Po-Po	187	1
Kr-Ne	4.31	1	N-S	467 ± 24	1	O-Re	627 ± 84	1	Pr-Pr	129.1	1
Kr-O	<8	1	N-Sb	460 ± 84	1	O-Rh	405 ± 42	1	Pr-S	492.5 ± 4.6	1
Kr-Tl	4.14	1	N-Sc	464 ± 84	1	O-Ru	528 ± 42	1	Pr-Se	446.4 ± 23.0	1
Kr-Xe	5.66	1	N-Si	437.1 ± 9.9	1	O-S	517.90 ± 0.05	1	Pr-Te	326 ± 20	1
Kr-Zn	5.0	1	N-Ta	607 ± 84	1	O-Sb	434 ± 42	1	Pt-Pt	306.7 ± 1.9	1
La-La	244.9	1	N-Th	577 ± 33	1	O-Sc	671.4 ± 1.0	1	Pt-Si	501 ± 18	1
La-N	519 ± 42	1	N-Ti	476 ± 33	1	O-Se	429.7 ± 6.3	1	Pt-Th	551 ± 42	1
La-O	798	1	N-U	531 ± 21	1	O-Si	799.6 ± 13.4	1	Pt-Ti	397.5 ± 10.6	1
La-Pt	505 ± 12	1	N-V	523 ± 38	1	O-Sm	573	1	Pt-Y	474 ± 12	1
La-Rh	550 ± 12	1	N-Xe	26.9	1	O-Sn	528	1	Rb-Rb	48.898 ± 0.005	1
La-S	573.4 ± 1.7	1	N-Y	477 ± 63	1	O-Sr	426.3 ± 6.3	1	Re-Re	432 ± 30	1
La-Se	485.7 ± 14.6	1	N-Zr	565 ± 25	1	O-Ta	839	1	Rh-Rh	235.85 ± 0.05	1
La-Te	385.6 ± 15	1	Na-Na	74.805 ± 0.586	1	O-Tb	694	1	Rh-Sc	444 ± 11	1
La-Y	197 ± 21	1	Na-Ne	~3.8	1	O-Tc	548	1	Rh-Si	395.0 ± 18.0	1
Li-Li	105.0	1	Na-O	270 ± 4	1	O-Te	377 ± 21	1	Rh-Th	513 ± 21	1
Li-Mg	67.4 ± 6.3	1	Na-Rb	63.887 ± 0.024	1	O-Th	877	1	Rh-Ti	390.8 ± 14.6	1
Li-Na	87.181 ± 0.001	1	Na-Xe	~5.12	1	O-Ti	666.5 ± 5.6	1	Rh-U	519 ± 17	1
Li-O	340.5 ± 6.3	1	Nb-Nb	513	1	O-Tl	213 ± 84	1	Rh-V	364 ± 29	1
Li-Pb	78.7 ± 8	1	Nb-Ni	271.9 ± 0.1	1	O-Tm	514	1	Rh-Y	446 ± 11	1
Li-S	312.5 ± 7.5	1	Nb-O	726.5 ± 10.6	1	O-U	755	1	Ru-Ru	193.0 ± 19.3	1
Li-Sb	169.0 ± 10.0	1	Nb-Ti	302.0 ± 0.1	1	O-V	637	1	Ru-Si	397.1 ± 21	1
Li-Si	149	1	Nb-V	369.3 ± 0.1	1	O-W	720 ± 71	1	Ru-Th	592 ± 42	1
Li-Sm	193.3 ± 18.8	1	Nd-Nd	82.8	1	O-Xe	36.4	1	Ru-V	414 ± 29	1
Li-Tm	276.1 ± 14.6	1	Nd-O	703	1	O-Y	714.1 ± 10.2	1	S-S	425.30	1
Li-Xe	~12.1	1	Nd-S	471.5 ± 14.6	1	O-Yb	387.7 ± 10	1	S-Sb	378.7	1
Li-Yb	143.5 ± 12.6	1	Nd-Se	393.9	1	O-Zn	≤250	1	S-Sc	478.2 ± 12.6	1

A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	A-B	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
S-Se	371.1 ± 6.7	1	Sb-Tl	126.7 ± 10.5	1	Si-Te	429.2	3	Ti-Ti	117.6	1
S-Si	617 ± 5	1	Sc-Sc	163 ± 21	1	Si-Y	258 ± 17	1	Ti-V	203.2 ± 0.1	1
S-Sm	389	1	Sc-Se	385 ± 17	1	Sm-Sm	54 ± 21	1	Ti-Zr	214.3 ± 0.1	1
S-Sn	467	1	Sc-Si	227.2 ± 14	1	Sm-Te	272.4 ± 14.6	1	Tl-Tl	59.4	1
S-Sr	338.5 ± 16.7	1	Sc-Te	289 ± 17	1	Sn-Sn	187.1 ± 0.3	1	Tl-Xe	4.18	1
S-Ta	669.5 ± 13.5	1	Se-Se	330.5	1	Sn-Te	338.1 ± 6.3	1	Tm-Tm	54 ± 17	1
S-Tb	515 ± 42	1	Se-Si	538 ± 13	1	Sr-Sr	16.64 ± 1.12	1	U-U	222 ± 21	1
S-Te	335 ± 42	1	Se-Sm	331.0 ± 14.6	1	T-T	446.67	1	V-V	269.3 ± 0.1	1
S-Ti	418 ± 3	1	Se-Sn	401.2 ± 5.9	1	Ta-Ta	390 ± 96	1	V-Zr	260.6 ± 0.3	1
S-Tm	368 ± 21	1	Se-Sr	251.0 ± 12.6	1	Tb-Tb	138.8	1	W-W	666	1
S-U	528.4 ± 10.5	1	Se-Tb	423 ± 20	1	Tb-Te	339 ± 42	1	Xe-Xe	6.023	1
S-V	449.4 ± 14.6	1	Se-Te	293.3	1	Tc-Tc	330	1	Y-Y	~270 ± 39	1
S-Y	528.4 ± 10.5	1	Se-Ti	381 ± 42	1	Te-Te	257.6 ± 4.1	1	Yb-Yb	16.3	1
S-Yb	167	1	Se-Tm	274 ± 40	1	Te-Ti	289 ± 17	1	Zn-Zn	22.2 ± 6.3	1
S-Zn	224.8 ± 12.6	1	Se-V	347 ± 21	1	Te-Tm	182 ± 40	1	Zr-Zr	298.2 ± 0.1	1
S-Zr	572.0 ± 11.6	1	Se-Y	435 ± 13	1	Te-Y	339 ± 13	1			
Sb-Sb	301.7 ± 6.3	1	Se-Zn	170.7 ± 25.9	1	Te-Zn	117.6 ± 18.0	1			
Sb-Te	277.4 ± 3.8	1	Si-Si	310	1	Th-Th	≤289 ± 33	1			

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TABLE 2. Enthalpy of Formation of Gaseous Atoms

Atom	$\Delta_f H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Ac	406	5	Cr	397.48 ± 4.2	3	La	431.0 ± 2.1	4	Pu	345	6
Ag	284.9 ± 0.8	2	Cs	76.5 ± 1.0	2	Li	159.3 ± 1.0	2	Ra	159	5
Al	330.9 ± 4.0	2	Cu	337.4 ± 1.2	2	Lu	427.6 ± 2.1	4	Rb	80.9 ± 0.8	2
Am	284	6	Dy	290.4 ± 2.1	4	Mg	147.1 ± 0.8	2	Re	774 ± 6.3	1
As	302.5 ± 13	1	Er	316.4 ± 2.1	4	Mn	283.3 ± 4.2	3	Rh	556 ± 4	1
Au	368.2 ± 2.1	1	Es	133	6	Mo	658.98 ± 3.8	3	Ru	650.6 ± 6.3	1
B	565 ± 5	2	Eu	177.4 ± 2.1	4	N	472.68 ± 0.40	2	S	277.17 ± 0.15	2
Ba	179.1 ± 5.0	3	F	79.38 ± 0.30	2	Na	107.5 ± 0.7	3	Sb	264.4 ± 2.5	1
Be	324 ± 5	2	Fe	415.5 ± 1.3	3	Nb	733.0 ± 8	3	Sc	377.8 ± 4	1
Bi	209.6 ± 2.1	1	Ga	271.96 ± 2.1	3	Nd	326.9 ± 2.1	4	Se	227.2 ± 4	1
Bk	310	6	Gd	397.5 ± 2.1	4	Ni	430.1 ± 8.4	3	Si	450.0 ± 8	2
Br	111.87 ± 0.12	3	Ge	372 ± 3	2	Np	464.8	6	Sm	206.7 ± 2.1	4
C	716.68 ± 0.45	2	H	217.998 ± 0.006	2	O	249.229 ± 0.002	7	Sn	301.2 ± 1.5	2
Ca	177.8 ± 0.8	2	Hf	618.4 ± 6.3	3	Os	787 ± 6.3	1	Sr	164.0 ± 1.7	3
Cd	111.80 ± 0.20	2	Hg	61.38 ± 0.04	2	P	316.5 ± 1.0	2	Ta	782.0 ± 2.5	1
Ce	420.1 ± 2.1	4	Ho	300.6 ± 2.1	4	Pa	563	5	Tb	388.7 ± 2.1	4
Cf	196	6	I	106.76 ± 0.04	2	Pb	195.2 ± 0.8	2	Tc	678	5
Cl	121.301 ± 0.008	2	In	243 ± 4	1	Pd	376.6 ± 2.1	1	Te	196.6 ± 2.1	1
Cm	386	6	Ir	669 ± 4	1	Pr	356.9 ± 2.1	4	Th	602 ± 6	2
Co	426.7	3	K	89.0 ± 0.8	2	Pt	565.7 ± 1.3	1	Ti	473 ± 3	2

Atom	$\Delta_f H^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	Atom	$\Delta_f H^\circ_{298}/\text{kJ mol}^{-1}$	Ref.
Tl	182.2 ± 0.4	1	U	533 ± 8	2	W	851.0 ± 6.3	3	Yb	155.6 ± 2.1	4
Tm	232.2 ± 2.1	4	V	515.5 ± 8	3	Y	424.7 ± 2.1	4	Zn	130.40 ± 0.40	2
									Zr	610.0 ± 8.4	3

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### TABLE 3. Bond Dissociation Energies in Polyatomic Molecules

The  $D^\circ_{298}$  values in polyatomic molecules are notoriously difficult to measure accurately since the mechanism of the kinetic systems involved in many of the measurements are seldom straightforward. Thus, much lively controversy has taken place in the literature and is likely to continue for some time to come. We will continue updating and presenting our assessment of the most reliable BDE data every year.

The references relating to each of the  $D^\circ_{298}$  values listed in Table 3 are contained in the *Comprehensive Handbook of Chemical Bond Energies*, by Yu-Ran Luo, CRC Press, 2007. Many  $D^\circ_{298}$  in Table 3 are derived from the equation

$$D^\circ_{298}(\text{R-X}) = \Delta_f H^\circ(\text{R}) + \Delta_f H^\circ(\text{X}) - \Delta_f H^\circ(\text{RX})$$

Here, the enthalpies of formation of the atoms and radicals are taken from Tables 2 and 4, respectively, and the enthalpies of formation of the molecules are from reference sources listed in the above *Comprehensive Handbook of Chemical Bond Energies*.

Table 3 presents H-C, C-C, C-halogen, O-, N-, S-, Si-, Ge-, Sn-, Pb-, P-, As-, Sb-, Bi-, Se-, Te-, and metal-X BDEs. The **boldface** in the species indicates the dissociated fragment. The **metal-X** BDEs are arranged on the basis of the Periodic Table with the new IUPAC notation for Groups 1 to 18, see inside front cover of this *Handbook*.

Bond	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	Bond	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.	Bond	$D^\circ_{298}/\text{kJ mol}^{-1}$	Ref.
<b>(1) C-H BDEs</b>			CH <sub>2</sub> =CHCCCH <sub>2</sub> -H	363.3	1	H-cyclo-C <sub>5</sub> H <sub>9</sub>	400.0 ± 4.2	1
CH <sub>3</sub> -H	439.3 ± 0.4	1	CH <sub>3</sub> CCCH <sub>2</sub> CH <sub>3</sub>	365.3 ± 9.6	1	H-cyclo-C <sub>6</sub> H <sub>11</sub>	416.3	1
CH <sub>3</sub> CH <sub>2</sub> -H	420.5 ± 1.3	1	HCCCH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	349.8 ± 8.4	1	H-C <sub>6</sub> H <sub>5</sub>	472.2 ± 2.2	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> -H	422.2 ± 2.1	1	HCCCH(CH <sub>3</sub> ) <sub>2</sub>	345.2 ± 8.4	1	H-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	375.5 ± 5.0	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>	410.5 ± 2.9	1	CH <sub>3</sub> CCCH(CH <sub>3</sub> ) <sub>2</sub>	344.3 ± 11.3	1	H-CH(CH <sub>3</sub> )C <sub>6</sub> H <sub>5</sub>	357.3 ± 6.3	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> -H	421.3	1	HCCCCC-H	~543 ± 13	1	H-CH(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	353.5 ± 2.1	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	411.1 ± 2.2	1	H <sub>2</sub> C=CH-H	464.2 ± 2.5	1	H-CH(C <sub>6</sub> H <sub>4</sub> -p-OH) <sub>2</sub>	375.8 ± 4.7	1
(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> -H	419.2 ± 4.2	1	CH <sub>2</sub> =C=CH-H	371.1 ± 12.6	1	H-C(CH <sub>3</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	348.1 ± 4.2	1
(CH <sub>3</sub> ) <sub>3</sub> C-H	400.4 ± 2.9	1	CH <sub>3</sub> CH=CH-H	464.8	1	H-C(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub>	338.9 ± 8.4	1
(CH <sub>3</sub> ) <sub>3</sub> CCH <sub>2</sub> -H	419.7 ± 4.2	1	CH <sub>2</sub> =CHCH <sub>2</sub> -H	369 ± 3	1	1-H-C <sub>10</sub> H <sub>7</sub>	469.4 ± 5.4	1
(CH <sub>3</sub> CH <sub>2</sub> )CH(CH <sub>3</sub> ) <sub>2</sub>	400.8	1	CH <sub>2</sub> =CH-CH <sub>2</sub> CH <sub>2</sub> -H	410.5	1	2-H-C <sub>10</sub> H <sub>7</sub>	468.2 ± 5.9	1
CH <sub>3</sub> CH <sub>2</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub>	415.1	1	CH <sub>2</sub> =CHCH <sub>2</sub> CH <sub>3</sub>	350.6	1	H-CF <sub>3</sub>	445.2 ± 2.9	1
(C <sub>6</sub> H <sub>5</sub> )CH(CH <sub>3</sub> ) <sub>2</sub>	396.2 ± 8.4	1	CH <sub>2</sub> =C(CH <sub>3</sub> )CH <sub>2</sub> -H	372.8	1	H-CHF <sub>2</sub>	431.8 ± 4.2	1
CH <sub>3</sub> CH(CH <sub>3</sub> )CH(CH <sub>3</sub> ) <sub>2</sub>	399.2 ± 13.0	1	CH <sub>2</sub> =CHCH=CHCH <sub>2</sub> -H	347.3 ± 12.6	1	H-CH <sub>2</sub> F	423.8 ± 4.2	1
CH <sub>3</sub> CH <sub>2</sub> (CH <sub>2</sub> ) <sub>3</sub> CH <sub>3</sub>	410	1	(CH <sub>2</sub> =CH) <sub>2</sub> CH-H	320.5 ± 4.2	1	H-CClF <sub>2</sub>	421.3 ± 8.4	1
CH <sub>3</sub> CH <sub>2</sub> (CH <sub>2</sub> ) <sub>4</sub> CH <sub>3</sub>	410	1	CH <sub>2</sub> =CHCH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	348.8	1	H-CCl <sub>2</sub> F	410.9 ± 8.4	1
HCC-H	557.81 ± 0.30	1	CH <sub>2</sub> =CHCH(CH <sub>3</sub> ) <sub>2</sub>	332.6 ± 7.1	1	H-CBrF <sub>2</sub>	415.5 ± 12.6	1
HCCCC-H	539 ± 12	1	CH <sub>2</sub> =C(CH <sub>3</sub> CH <sub>2</sub> )CH <sub>2</sub> -H	356.1 ± 8.4	1	H-CHClF	421.7 ± 10.0	1
HCCH <sub>2</sub> -H	384.1 ± 4.2	1	(CH <sub>2</sub> =CH) <sub>2</sub> C(CH <sub>3</sub> )-H	322.2	1	H-CCl <sub>3</sub>	392.5 ± 2.5	1
CH <sub>3</sub> CCCH <sub>2</sub> -H	379.5	1	H-cyclo-C <sub>3</sub> H <sub>5</sub>	444.8 ± 1.0	1	H-CHCl <sub>2</sub>	400.6 ± 2.0	1
HCCCH <sub>2</sub> CH <sub>3</sub>	373.0	1	H-CH <sub>2</sub> -cyclo-C <sub>3</sub> H <sub>5</sub>	407.5 ± 6.7	1	H-CH <sub>2</sub> Cl	419.0 ± 2.3	1
			H-cyclo-C <sub>4</sub> H <sub>7</sub>	409.2 ± 1.3	1	H-CFClBr	413 ± 21	1

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
H-CHClBr	406.0 ± 2.4	1	(CH <sub>2</sub> OH) <sub>2</sub>	385.3	1	Me <sub>2</sub> CHC(O)OEt	387.4	1
H-CCl <sub>2</sub> Br	387 ± 21	1	HOCH <sub>2</sub> (CH <sub>2</sub> ) <sub>2</sub> (OH)CH-H	399.2	1	PhCHMe(C(O)OEt)	358.2	1
H-CClBr <sub>2</sub>	371 ± 21	1	CH <sub>3</sub> OCH <sub>3</sub>	402.1	1	H-furaylmethyl	361.9 ± 8.4	1
H-CBr <sub>3</sub>	399.2 ± 8.4	1	CHF <sub>2</sub> OCF <sub>3</sub>	443.5 ± 4.2	1	CH <sub>3</sub> NH <sub>2</sub>	392.9 ± 8.4	1
H-CHBr <sub>2</sub>	412.6 ± 2.7	3	CHF <sub>2</sub> OCHF <sub>2</sub>	435.1 ± 4.2	1	CH <sub>3</sub> N=CH <sub>2</sub>	407.9 ± 14.6	1
H-CH <sub>2</sub> Br	427.2 ± 2.4	1	CH <sub>3</sub> OCF <sub>3</sub>	426.8 ± 4.2	1	CH <sub>3</sub> CH <sub>2</sub> NH <sub>2</sub>	377.0 ± 8.4	1
H-Cl <sub>3</sub>	423 ± 29	1	CH <sub>3</sub> OCH <sub>2</sub> CH <sub>3</sub>	389.1	1	C <sub>2</sub> H <sub>5</sub> CH <sub>2</sub> NH <sub>2</sub>	380.7 ± 8.4	1
H-CHI <sub>2</sub>	431.0 ± 8.4	1	(CH <sub>3</sub> ) <sub>3</sub> COC(CH <sub>3</sub> ) <sub>3</sub>	402.1	1	C <sub>3</sub> H <sub>7</sub> CH <sub>2</sub> NH <sub>2</sub>	393.3 ± 8.4	1
H-CHI	431.6 ± 2.8	1	CH <sub>3</sub> CH <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>	389.1	1	C <sub>4</sub> H <sub>9</sub> CH <sub>2</sub> NH <sub>2</sub>	387.7 ± 8.4	1
CF <sub>3</sub> CF <sub>2</sub> -H	429.7 ± 2.1	1	CH <sub>3</sub> CH <sub>2</sub> Ot-C(CH <sub>3</sub> ) <sub>3</sub>	405.4	1	HOCH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub>	379.5 ± 8.4	1
CHF <sub>2</sub> CF <sub>2</sub> -H	431.0 ± 18.8	1	CH <sub>3</sub> OPh	385.0	1	(CH <sub>3</sub> CH <sub>2</sub> ) <sub>2</sub> NH	370.7 ± 8.4	1
CH <sub>2</sub> FCF <sub>2</sub> -H	433.0 ± 14.6	1	H-2-oxiran-2-yl	420.5 ± 6.5	1	(C <sub>3</sub> H <sub>7</sub> CH <sub>2</sub> ) <sub>2</sub> NH	379.9 ± 8.4	1
CHF <sub>2</sub> CFH-H	426.8 ± 14.6	1	H-tetrahydrofuran-2-yl	385.3 ± 6.7	1	(C <sub>4</sub> H <sub>9</sub> CH <sub>2</sub> ) <sub>2</sub> NH	384.5 ± 8.4	1
CF <sub>3</sub> CH <sub>2</sub> -H	446.4 ± 4.5	1	HC(O)-H	368.40 ± 0.67	1	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NCH <sub>2</sub> CH <sub>3</sub>	379.5 ± 1.7	1
CH <sub>3</sub> CF <sub>2</sub> -H	416.3 ± 4.2	1	FC(O)-H	423.0	1	(C <sub>2</sub> H <sub>5</sub> CH <sub>2</sub> ) <sub>3</sub> N	376.6 ± 8.4	1
CH <sub>2</sub> FCHF-H	413.4 ± 12.6	1	CH <sub>3</sub> C(O)-H	374.0 ± 1.3	1	((CH <sub>3</sub> ) <sub>2</sub> CCH <sub>2</sub> ) <sub>3</sub> N	388.3 ± 8.4	1
CHF <sub>2</sub> CH <sub>2</sub> -H	433.0 ± 14.6	1	CF <sub>3</sub> C(O)-H	390.4	1	(Bu) <sub>2</sub> NCH <sub>2</sub> (nPr)	381 ± 10.0	1
CH <sub>2</sub> FCH <sub>2</sub> -H	433.5 ± 8.4	1	C <sub>2</sub> H <sub>5</sub> C(O)-H	374.5	1	((CH <sub>3</sub> ) <sub>2</sub> CH) <sub>3</sub> N	387.0 ± 8.4	1
CH <sub>3</sub> CHF-H	410.9 ± 8.4	1	CH <sub>2</sub> =CHC(O)-H	372.8	1	(CH <sub>3</sub> ) <sub>2</sub> CHNH <sub>2</sub>	372.0 ± 8.4	1
CF <sub>3</sub> CHCl-H	425.9 ± 6.3	1	C <sub>3</sub> H <sub>7</sub> C(O)-H	371.2	1	CH <sub>3</sub> NHCH <sub>3</sub>	364.0 ± 8.4	1
CF <sub>3</sub> CClBr-H	404.2 ± 6.3	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> C(O)-H	364.5	1	(CH <sub>3</sub> ) <sub>3</sub> N	380.7 ± 8.4	1
CClF <sub>2</sub> CHF-H	412.1 ± 2.1	1	C <sub>4</sub> H <sub>9</sub> C(O)-H	372.0	1	<i>tert</i> -BuN(CH <sub>3</sub> ) <sub>2</sub>	376.6 ± 8.4	1
CCl <sub>3</sub> CCl <sub>2</sub> -H	397.5 ± 8.4	1	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> C(O)-H	362.5	1	((HOCH <sub>2</sub> CH <sub>2</sub> ) <sub>2</sub> (CH <sub>3</sub> ))N	364.4 ± 8.4	1
CHCl <sub>2</sub> CCl <sub>2</sub> -H	393.3 ± 8.4	1	C <sub>2</sub> H <sub>5</sub> CH(CH <sub>3</sub> )C(O)-H	360.8	1	(HOCH <sub>2</sub> CH <sub>2</sub> ) <sub>3</sub> N	379.9 ± 8.4	1
CH <sub>3</sub> CCl <sub>2</sub> -H	397.9 ± 5.0	1	<i>tert</i> -BuC(O)-H	375.1	1	((HOCH <sub>2</sub> )CH(CH <sub>3</sub> )) <sub>3</sub> N	379.9 ± 8.4	1
CH <sub>3</sub> CHCl-H	406.6 ± 1.5	1	EtCHC(O)-H	367.2	1	PhCH <sub>2</sub> NH <sub>2</sub>	368.2	1
CH <sub>2</sub> ClCH <sub>2</sub> -H	423.1 ± 2.4	1	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>8</sub> C(O)-H	373.3	1	PhN(CH <sub>2</sub> CH <sub>3</sub> ) <sub>2</sub>	383.3 ± 4.2	1
CH <sub>3</sub> CBr <sub>2</sub> -H	397.1 ± 5.0	1	C <sub>6</sub> H <sub>5</sub> C(O)-H	371.1 ± 10.9	1	Ph <sub>2</sub> NCH <sub>3</sub>	379.5 ± 1.7	1
CH <sub>2</sub> BrCH <sub>2</sub> -H	415.1 ± 8.4	1	PhCH <sub>2</sub> C(O)-H	362.0	1	PhN(CH <sub>2</sub> Ph) <sub>2</sub>	357.3 ± 8.8	1
CH <sub>3</sub> CHBr-H	415.0 ± 2.7	3	PhC(CH <sub>3</sub> ) <sub>2</sub> C(O)-H	362.9	1	N(CH <sub>2</sub> Ph) <sub>3</sub>	372.8 ± 2.5	1
CF <sub>2</sub> =CF-H	464.4 ± 8.4	1	H-CH=C=O	448.1	1	PhN(CH <sub>2</sub> CH=CH <sub>2</sub> ) <sub>2</sub>	339.3 ± 2.9	1
CF <sub>3</sub> CF <sub>2</sub> CF <sub>2</sub> -H	432.2	1	CH <sub>3</sub> C(O)H	394.5 ± 9.2	1	N(CH <sub>2</sub> CH=CH <sub>2</sub> ) <sub>3</sub>	345.6 ± 3.3	1
CH <sub>3</sub> CH <sub>2</sub> CHCl-H	407.0 ± 3.5	1	CH <sub>3</sub> C(O)Cl	≤423.4	1	H <sub>2</sub> NNH(CH <sub>3</sub> )	410	1
CH <sub>2</sub> =CH-CHF-H	370.7 ± 4.6	1	CH <sub>3</sub> CH <sub>2</sub> C(O)H	383.7	1	HNN(CH <sub>3</sub> ) <sub>2</sub>	410	1
CH <sub>2</sub> =CHCHCl-H	370.7 ± 4.6	1	CH <sub>3</sub> COCH <sub>3</sub>	401.2 ± 2.9	1	(CH <sub>3</sub> ) <sub>2</sub> NC <sub>6</sub> H <sub>5</sub>	383.7 ± 5.4	1
CH <sub>2</sub> =CHCHBr-H	374.0 ± 4.6	1	CF <sub>3</sub> C(O)CH <sub>3</sub>	465.6	1	H-CN	528.5 ± 0.8	1
H-C <sub>6</sub> F <sub>5</sub>	487.4	1	CH <sub>3</sub> COCH <sub>2</sub> CH <sub>3</sub>	403.8	1	CH <sub>3</sub> CN	405.8 ± 4.2	1
H-CH <sub>2</sub> OH	401.92 ± 0.63	1	MeCOCH <sub>2</sub> Me	386.2 ± 7.1	1	CH <sub>3</sub> CH <sub>2</sub> CN	393.3 ± 12.6	1
CH <sub>2</sub> CHOH	467 ± 11	1	EtCOCH <sub>2</sub> Me	396.5 ± 2.8	1	PhCH <sub>2</sub> CN	344.3	1
CH <sub>3</sub> CH <sub>2</sub> OH	401.2 ± 4.2	1	CH <sub>3</sub> CH <sub>2</sub> COC <sub>6</sub> H <sub>5</sub>	402.8 ± 3.6	1	C <sub>6</sub> F <sub>5</sub> CH <sub>2</sub> CN	350.6	1
CH <sub>3</sub> CH <sub>2</sub> OH	421.7 ± 8	1	MeCH <sub>2</sub> COPh	388.7	1	CH <sub>2</sub> (CN) <sub>2</sub>	366.5	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH	392	1	H-C(O)OH	404.2	1	CH <sub>2</sub> (CN)(NH <sub>2</sub> )	355.2	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH	394.6 ± 8.4	1	CH <sub>3</sub> C(O)OH	398.7 ± 12.1	1	(CH <sub>3</sub> ) <sub>2</sub> CHCN	384.5	1
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH	406.3 ± 8.4	1	ClCH <sub>2</sub> C(O)OH	398.9	1	CH <sub>3</sub> NC	389.1 ± 12.6	1
(CH <sub>3</sub> ) <sub>2</sub> CHOH	383.7 ± 8.4	1	H-C(O)OCH <sub>3</sub>	399.2 ± 8.4	1	H-HCNN	405.8 ± 8.4	1
(CH <sub>3</sub> ) <sub>2</sub> CHOH	394.6 ± 8.4	1	CH <sub>3</sub> C(O)OCH <sub>3</sub>	406.3 ± 10.5	1	H-CNN	331 ± 17	1
CH <sub>2</sub> =CHCH <sub>2</sub> OH	341.4 ± 7.5	1	CH <sub>3</sub> C(O)OCH <sub>3</sub>	404.6	1	CH <sub>3</sub> NO <sub>2</sub>	415.4	1
(CH <sub>3</sub> ) <sub>3</sub> COH	418.4 ± 8.4	1	CH <sub>3</sub> C(O)OCH <sub>2</sub> CH <sub>3</sub>	401.7	1	CH <sub>3</sub> CH <sub>2</sub> NO <sub>2</sub>	410.5	1
(CH <sub>2</sub> =CH) <sub>2</sub> CHOH	288.7	1	CH <sub>3</sub> C(O)OPh	419.2 ± 5.4	1	C <sub>2</sub> H <sub>5</sub> CH <sub>2</sub> NO <sub>2</sub>	410.5	1
Ph <sub>2</sub> CHOH	326	1	CH <sub>3</sub> CH <sub>2</sub> C(O)OEt	400	1	Me <sub>2</sub> CHNO <sub>2</sub>	394.9	1
CH <sub>3</sub> CH(OH) <sub>2</sub>	~385	1	PhCH <sub>2</sub> C(O)OEt	370.7	1	C <sub>6</sub> H <sub>5</sub> C(NO <sub>2</sub> )CHCH <sub>3</sub>	357.3	1

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
H-C(S)H	399.6 ± 5.0	1	CH <sub>3</sub> -CHCH <sub>2</sub>	426.3 ± 6.3	1	CCl <sub>3</sub> -CH <sub>2</sub> Cl	323.8 ± 8.4	1
CH <sub>3</sub> SH	392.9 ± 8.4	1	CH <sub>3</sub> -CH=CCH <sub>2</sub>	359.8 ± 5.9	1	CCl <sub>3</sub> -CH <sub>3</sub>	362.3 ± 6.3	1
CH <sub>3</sub> SCH <sub>3</sub>	392.0 ± 5.9	1	CH <sub>3</sub> -cyclopro-en-1-yl	340.6 ± 20.9	1	CHCl <sub>2</sub> -CHCl <sub>2</sub>	326.9 ± 4.1	1
PhSCH <sub>3</sub>	389.1	1	CH <sub>3</sub> -CH <sub>2</sub> CH=CH <sub>2</sub>	317.6 ± 3.8	1	CHCl <sub>2</sub> -CH <sub>2</sub> Cl	352.2 ± 5.9	1
PhCH <sub>2</sub> SPh	352.3	1	CH <sub>3</sub> -CH <sub>2</sub> C(CH <sub>3</sub> )=CH <sub>2</sub>	310.0 ± 4.2	1	CHCl <sub>2</sub> -CH <sub>3</sub>	361.3 ± 2.5	1
(PhS) <sub>2</sub> CHPh	341.0	1	CH <sub>3</sub> -CH(CH <sub>3</sub> )CH=CH <sub>2</sub>	302.5 ± 6.3	1	CHBrCl-CH <sub>3</sub>	384.5	1
PhSCHPh <sub>2</sub>	344.8	1	CH <sub>3</sub> -C(CH <sub>3</sub> ) <sub>2</sub> CH=CH <sub>2</sub>	282.4 ± 6.3	1	CHClBr-CHClBr	317.1 ± 12.6	1
CH <sub>3</sub> SOCH <sub>3</sub>	393.3	1	CH <sub>3</sub> -cyclo-C <sub>5</sub> H <sub>7</sub>	299.2 ± 8.4	1	CH <sub>2</sub> Cl-CH <sub>2</sub> Cl	360.7 ± 8.4	1
CH <sub>3</sub> SO <sub>2</sub> CH <sub>3</sub>	414.2	1	CH <sub>3</sub> -C <sub>6</sub> H <sub>5</sub>	426.8 ± 4.2	1	CH <sub>2</sub> Cl-CH <sub>3</sub>	375.7 ± 9.2	1
CH <sub>3</sub> SO <sub>2</sub> CF <sub>3</sub>	431.0	1	HCC-C <sub>6</sub> H <sub>5</sub>	590.8 ± 5.9	1	Br <sub>3</sub> C-CH <sub>3</sub>	356.9 ± 12.6	1
CH <sub>3</sub> SO <sub>2</sub> Ph	414.2	1	C <sub>2</sub> H <sub>3</sub> -C <sub>6</sub> H <sub>5</sub>	482.0 ± 5.4	1	Br <sub>3</sub> C-CBr <sub>3</sub>	278.7 ± 16.7	1
PhCH <sub>2</sub> SO <sub>2</sub> Me	380.7	1	CH <sub>3</sub> -CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	325.1 ± 4.2	1	CHBr <sub>2</sub> -CH <sub>3</sub>	372.8	1
PhCH <sub>2</sub> SO <sub>2</sub> CF <sub>3</sub>	372.4	1	CH <sub>3</sub> -CH(CH <sub>3</sub> )C <sub>6</sub> H <sub>5</sub>	318.8 ± 8.4	1	CH <sub>2</sub> Br-CH <sub>2</sub> Cl	378.2	1
PhCH <sub>2</sub> SO <sub>2</sub> tBu	376.6	1	CH <sub>3</sub> -C(CH <sub>3</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	303.3 ± 8.4	1	CH <sub>2</sub> Br-CH <sub>2</sub> Br	379.9 ± 8.4	1
Ph <sub>2</sub> CHSO <sub>2</sub> Ph	365.3	1	CH <sub>3</sub> -CH <sub>2</sub> CHCHPh	295.4	1	CH <sub>2</sub> I-CH <sub>2</sub> I	387.0 ± 10.5	1
CH <sub>2</sub> (SPh) <sub>2</sub>	372.4	1	CH <sub>3</sub> -CH(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	315.9 ± 6.3	1	CH <sub>3</sub> -CH <sub>2</sub> Br	381.6 ± 8.4	1
H-CH <sub>2</sub> SiMe <sub>3</sub>	418 ± 6.3	1	CH <sub>3</sub> -C(CH <sub>3</sub> )(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	290.8 ± 8.4	1	CH <sub>3</sub> -CH <sub>2</sub> I	384.5 ± 8.4	1
H-CH <sub>2</sub> C(CH <sub>3</sub> ) <sub>2</sub> SiMe <sub>3</sub>	409 ± 5	1	C <sub>6</sub> H <sub>5</sub> -C <sub>6</sub> H <sub>5</sub>	478.6 ± 6.3	1	CF <sub>3</sub> -CF <sub>2</sub> CF <sub>3</sub>	424.3 ± 13.6	1
H-CH <sub>2</sub> SiMe <sub>2</sub> Ph	410.1	1	C <sub>6</sub> H <sub>5</sub> -CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	383.7 ± 8.4	1	CF <sub>3</sub> -CF=CF <sub>2</sub>	420.5	1
H-CH((CH <sub>3</sub> ) <sub>3</sub> Si) <sub>2</sub>	397 ± 13	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	272.8 ± 9.2	1	CH <sub>3</sub> -CH <sub>2</sub> CH <sub>2</sub> Cl	371.4 ± 2.8	1
H-CH <sub>2</sub> B(RO) <sub>2</sub>	412.5	1	C <sub>6</sub> H <sub>5</sub> -CH(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	361.1 ± 8.4	1	CH <sub>3</sub> -CHClCH <sub>3</sub>	367.5 ± 2.0	1
H-CH((CH <sub>3</sub> ) <sub>2</sub> P) <sub>2</sub>	385 ± 13	1	C <sub>6</sub> H <sub>5</sub> -C(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub>	324.3 ± 12.6	1	CH <sub>2</sub> Cl-CHClCH <sub>3</sub>	356.5 ± 8.4	1
<b>(2) C-C BDEs</b>			Ph <sub>2</sub> CH-CHPh <sub>2</sub>	247.3 ± 8.4	1	CH <sub>2</sub> Cl-CH <sub>2</sub> CClH <sub>2</sub>	369.0 ± 8.4	1
CH <sub>3</sub> -CH <sub>3</sub>	377.4 ± 0.8	1	PhCH <sub>2</sub> -CPh <sub>3</sub>	234.7 ± 14.6	1	CH <sub>3</sub> -CCl <sub>2</sub> CH <sub>3</sub>	362.8 ± 8.4	1
CH <sub>3</sub> -C <sub>2</sub> H <sub>5</sub>	370.3 ± 2.1	1	R-R, π-dimer, R = phenalenyl	42	1	CH <sub>2</sub> Br-CHBrCH <sub>3</sub>	369.4 ± 8.4	1
CH <sub>3</sub> -C <sub>3</sub> H <sub>7</sub>	372.0 ± 2.9	1	R-R, σ-dimer, R = phenalenyl	42.7	1	CH <sub>2</sub> ClCH <sub>2</sub> -CHClCH <sub>3</sub>	364.4 ± 8.4	1
CH <sub>3</sub> - <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	369.0 ± 3.8	1	R-R, R = 9-phenylfluorenyl	63.6	1	CH <sub>2</sub> ClCH <sub>2</sub> -CH <sub>2</sub> CClH <sub>2</sub>	369.0 ± 8.4	1
CH <sub>3</sub> -C <sub>4</sub> H <sub>9</sub>	371.5 ± 2.9	1	CF <sub>3</sub> -CF <sub>3</sub>	413.0 ± 5.0	1	CH <sub>3</sub> CHBr-CHBrCH <sub>3</sub>	355.6 ± 8.4	1
CH <sub>3</sub> - <i>iso</i> -C <sub>4</sub> H <sub>9</sub>	370.3 ± 4.6	1	CF <sub>3</sub> -CHF <sub>2</sub>	399.6 ± 8.4	1	CF <sub>3</sub> -C <sub>6</sub> H <sub>5</sub>	463.2 ± 12.6	1
CH <sub>3</sub> - <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	368.2 ± 2.9	1	CF <sub>3</sub> -CClF <sub>2</sub>	373.6 ± 12.5	1	CCl <sub>3</sub> -C <sub>6</sub> H <sub>5</sub>	388.7 ± 8.4	1
CH <sub>3</sub> - <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	363.6 ± 2.9	1	CF <sub>3</sub> -CH <sub>2</sub> F	397.5 ± 8.4	1	CH <sub>3</sub> -C <sub>6</sub> F <sub>5</sub>	439.3	1
CH <sub>3</sub> -C <sub>5</sub> H <sub>11</sub>	368.4 ± 6.3	1	CF <sub>3</sub> -CH <sub>2</sub> Cl	332.2 ± 5.4	1	CF <sub>3</sub> -C <sub>6</sub> F <sub>5</sub>	435.1	1
CH <sub>3</sub> -CH(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	365.7 ± 4.2	1	CF <sub>3</sub> -CHBrCl	377.0 ± 10.5	1	CF <sub>3</sub> -CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	365.7 ± 12.6	1
CH <sub>3</sub> -C(CH <sub>3</sub> ) <sub>2</sub> (CH <sub>2</sub> CH <sub>3</sub> )	360.9 ± 6.3	1	CF <sub>3</sub> -CH <sub>2</sub> Br	399.6 ± 8.4	1	C <sub>6</sub> F <sub>5</sub> -C <sub>6</sub> F <sub>5</sub>	488.3	1
CH <sub>3</sub> -C <sub>6</sub> H <sub>13</sub>	368.2 ± 6.3	1	CF <sub>3</sub> -CH <sub>2</sub> I	408.4 ± 10.5	1	CF <sub>3</sub> -CHPh <sub>2</sub>	352.3 ± 16.7	1
C <sub>2</sub> H <sub>5</sub> -C <sub>2</sub> H <sub>5</sub>	363.2 ± 2.5	1	CF <sub>3</sub> -CH <sub>3</sub>	429.3 ± 5.0	1	CF <sub>3</sub> -CPh <sub>3</sub>	290.8 ± 16.7	1
C <sub>3</sub> H <sub>7</sub> -C <sub>3</sub> H <sub>7</sub>	366.1 ± 3.3	1	CHF <sub>2</sub> -CHF <sub>2</sub>	382.4 ± 15.5	1	CF <sub>2</sub> CF-CF <sub>2</sub>	558.1 ± 12.6	1
<i>iso</i> -C <sub>3</sub> H <sub>7</sub> - <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	353.5 ± 4.6	1	CClF <sub>2</sub> -CClF <sub>2</sub>	378.7 ± 12.6	1	CH <sub>2</sub> FCH <sub>2</sub> -CPh <sub>3</sub>	274.9 ± 16.7	1
C <sub>4</sub> H <sub>9</sub> -C <sub>4</sub> H <sub>9</sub>	364.0 ± 3.8	1	CF <sub>2</sub> Cl-CFCl <sub>2</sub>	358.6 ± 12.6	1	CHF <sub>2</sub> CH <sub>2</sub> -CPh <sub>3</sub>	264.0 ± 16.7	1
<i>iso</i> -C <sub>4</sub> H <sub>9</sub> - <i>iso</i> -C <sub>4</sub> H <sub>9</sub>	362.3 ± 6.3	1	CHF <sub>2</sub> -CH <sub>2</sub> F	394.1 ± 16.7	1	CH <sub>3</sub> -CH <sub>2</sub> OH	364.8 ± 4.2	1
<i>sec</i> -C <sub>4</sub> H <sub>9</sub> - <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	348.5 ± 3.3	1	CH <sub>2</sub> F-CH <sub>2</sub> F	368.2 ± 8.4	1	CF <sub>3</sub> -CH <sub>2</sub> OH	405.4 ± 6.3	1
<i>tert</i> -C <sub>4</sub> H <sub>9</sub> - <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	322.6 ± 4.2	1	CHF <sub>2</sub> -CH <sub>3</sub>	405.0 ± 8.4	1	C <sub>2</sub> H <sub>5</sub> -CH <sub>2</sub> OH	356.9 ± 5.0	1
CH <sub>3</sub> -cyclo-C <sub>5</sub> H <sub>9</sub>	358.2 ± 5.0	1	CH <sub>2</sub> F-CH <sub>3</sub>	388.3 ± 8.4	1	C <sub>3</sub> H <sub>7</sub> -CH <sub>2</sub> OH	357.3 ± 3.3	1
CH <sub>3</sub> -cyclo-C <sub>6</sub> H <sub>11</sub>	377.0 ± 7.5	1	CHClF-CH <sub>3</sub>	399.6 ± 12.6	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -CH <sub>2</sub> OH	354.8 ± 4.2	1
cyclo-C <sub>6</sub> H <sub>11</sub> -cyclo-C <sub>6</sub> H <sub>11</sub>	369.0 ± 8.4	1	CF <sub>2</sub> Br-CHClF	369.4	1	C <sub>4</sub> H <sub>9</sub> -CH <sub>2</sub> OH	355.6 ± 4.2	1
CH <sub>3</sub> -CH <sub>2</sub> C≡CH	320.5 ± 5.0	1	CF <sub>2</sub> Br-CH <sub>3</sub>	396.6 ± 15.1	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> -CH <sub>2</sub> OH	352.7 ± 4.2	1
CH <sub>3</sub> -CH <sub>2</sub> C≡CCH <sub>3</sub>	308.4 ± 6.3	1	CCl <sub>3</sub> -CCl <sub>3</sub>	285.8 ± 6.3	1	<i>iso</i> -C <sub>4</sub> H <sub>9</sub> -CH <sub>2</sub> OH	354.0 ± 5.4	1
CH <sub>3</sub> -CH(CH <sub>3</sub> )C≡CH	305.4 ± 8.4	1	CCl <sub>3</sub> -CClF <sub>2</sub>	282.0 ± 12.6	1	C <sub>6</sub> H <sub>5</sub> -CH <sub>2</sub> OH	413.4 ± 5.4	1
CH <sub>3</sub> -CH(CH <sub>3</sub> ) <sub>2</sub> C≡CCH <sub>3</sub>	320.9 ± 6.3	1	CCl <sub>3</sub> -CHCl <sub>2</sub>	303.3 ± 6.3	1	HOH <sub>2</sub> C-CH <sub>2</sub> OH	358.2 ± 6.3	1
CH <sub>3</sub> -C(CH <sub>3</sub> ) <sub>2</sub> C≡CH	295.8 ± 6.3	1				NH <sub>2</sub> CH <sub>2</sub> -CH <sub>2</sub> OH	335.6 ± 10.5	1
CH <sub>3</sub> -C(CH <sub>3</sub> ) <sub>2</sub> C≡CCH <sub>3</sub>	303.3 ± 6.3	1				CH <sub>3</sub> -CH <sub>2</sub> OCH <sub>3</sub>	363.2 ± 5.0	1



Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	
$\text{CH}_3\text{OCH}_2\text{-CH}_2\text{OCH}_3$	$338.9 \pm 10.5$	1	$\text{C}_{58}\text{-C}_2$	$955.2 \pm 14.5$	1	$\text{Cl-CF}_2\text{CF}_2\text{Cl}$	$331.4 \pm 20.9$	1	
$\text{CH}_3\text{-C(O)H}$	$354.8 \pm 1.7$	1	<b>(3) C-halogen BDEs</b>			$\text{Cl-CCl}_2\text{CF}_3$	307.9	1	
$\text{CCl}_3\text{-C(O)H}$	$309.2 \pm 5.0$	1		$\text{F-CN}$	482.8	1	$\text{Cl-CCl}_2\text{CCl}_3$	303.8	1
$\text{CH}_3\text{-C(O)F}$	$417.6 \pm 6.3$	1		$\text{F-CF}_3$	$546.8 \pm 2.1$	1	$\text{Cl-CHClCCl}_3$	$330.5 \pm 4.2$	1
$\text{CH}_3\text{-C(O)Cl}$	$367.8 \pm 6.3$	1		$\text{F-CHF}_2$	$533.9 \pm 5.9$	1	$\text{Cl-CCl}_2\text{CHCl}_2$	311.7	1
$\text{CCl}_3\text{-C(O)Cl}$	$289.1 \pm 6.3$	1		$\text{F-CH}_2\text{F}$	$496.2 \pm 8.8$	1	$\text{Cl-CHClCH}_3$	$327.9 \pm 1.8$	1
$\text{CHCl}_2\text{-C(O)Cl}$	$312.5 \pm 8.4$	1		$\text{F-CF}_2\text{Cl}$	511.7	1	$\text{Cl-CH}_2\text{CH}_2\text{Cl}$	$345.1 \pm 5.0$	1
$\text{CClH}_2\text{-C(O)Cl}$	$340.2 \pm 8.4$	1		$\text{F-CFCl}_2$	$482.0 \pm 10.5$	1	$\text{Cl-CHBrCH}_3$	$331.8 \pm 8.4$	1
$\text{C}_6\text{H}_5\text{-C(O)H}$	$408.4 \pm 4.2$	1		$\text{F-CHFCl}$	$462.3 \pm 10.0$	1	$\text{Cl-CH}_2\text{CH}_3$	$352.3 \pm 3.3$	1
$\text{C}_6\text{H}_5\text{-C(O)Cl}$	$417.6 \pm 6.3$	1		$\text{F-CCl}_3$	$439.3 \pm 4$	1	$\text{Cl-CH}_2\text{CH=CH}_2$	$298.3 \pm 5.0$	1
$\text{CH}_3\text{-C(O)CH}_3$	$351.9 \pm 2.1$	1		$\text{F-CH}_2\text{Cl}$	$465.3 \pm 9.6$	1	$\text{Cl-C}_3\text{H}_7$	$352.7 \pm 4.2$	1
$\text{C}_2\text{H}_5\text{-C(O)CH}_3$	$347.3 \pm 2.9$	1		$\text{F-CH}_3$	$460.2 \pm 8.4$	1	$\text{Cl-CH}_2\text{CH}_2\text{CH}_2\text{Cl}$	348.9	1
$\text{C}_3\text{H}_7\text{-C(O)CH}_3$	$348.5 \pm 2.9$	1		$\text{F-C}\equiv\text{CH}$	521.3	1	$\text{Cl-iso-C}_3\text{H}_7$	$354.0 \pm 6.3$	1
<i>iso</i> - $\text{C}_3\text{H}_7\text{-C(O)CH}_3$	$340.2 \pm 3.8$	1		$\text{F-C}\equiv\text{CF}$	$519 \pm 21$	1	$\text{Cl-CH}_2\text{CHCH=CH}_2$	342.7	1
$\text{C}_4\text{H}_7\text{-C(O)CH}_3$	$346.9 \pm 5.4$	1		$\text{F-CF=CF}_2$	$546.4 \pm 12.6$	1	$\text{Cl-C}_4\text{H}_9$	$350.6 \pm 6.3$	1
<i>tert</i> - $\text{C}_4\text{H}_9\text{-C(O)CH}_3$	$329.3 \pm 4.2$	1		$\text{F-CF}_2\text{CF}_3$	$532.2 \pm 6.3$	1	$\text{Cl-sec-C}_4\text{H}_9$	$350.2 \pm 6.3$	1
$\text{C}_6\text{H}_5\text{-C(O)CH}_3$	$406.7 \pm 4.6$	1		$\text{F-CH}_2\text{CF}_3$	457.7	1	$\text{Cl-tert-C}_4\text{H}_9$	$351.9 \pm 6.3$	1
$\text{C}_6\text{H}_5\text{CH}_2\text{-C(O)CH}_3$	$299.7 \pm 8.4$	1		$\text{F-CF}_2\text{CH}_3$	$522.2 \pm 8.4$	1	$\text{CH}_2\text{CHCHCl(CH}_3\text{)}$	$300.0 \pm 6.3$	1
$\text{HC(O)-C(O)H}$	$295.8 \pm 6.3$	1		$\text{F-C}_2\text{H}_3$	$517.6 \pm 12.6$	1	$\text{Cl-C}_5\text{H}_{11}$	$350.6 \pm 6.3$	1
$\text{ClC(O)-C(O)Cl}$	$292.5 \pm 8.4$	1		$\text{F-C}_2\text{H}_5$	$467.4 \pm 8.4$	1	$\text{Cl-C(CH}_3\text{)}_2\text{(C}_2\text{H}_5\text{)}$	$352.7 \pm 6.3$	1
$\text{CH}_3\text{C(O)-C(O)H}$	$302.5 \pm 8.4$	1		$\text{F-C}_3\text{H}_7$	$474.9 \pm 8.4$	1	$\text{Cl-cyclo-C}_6\text{H}_{11}$	$360.2 \pm 6.5$	1
$\text{CH}_3\text{C(O)-C(O)CH}_3$	$307.1 \pm 4.2$	1		$\text{F-iso-C}_3\text{H}_7$	$483.8 \pm 8.4$	1	$\text{Cl-C}_6\text{H}_5$	$399.6 \pm 6.3$	1
$\text{C}_6\text{H}_5\text{C(O)-C(O)C}_6\text{H}_5$	$288.3 \pm 16.7$	1		$\text{F-tert-C}_4\text{H}_9$	$495.8 \pm 8.4$	1	$\text{Cl-C}_6\text{F}_5$	$383.3 \pm 8.4$	1
$\text{CH}_3\text{-C(O)OH}$	$384.9 \pm 8.4$	1		$\text{F-C}_6\text{H}_5$	$525.5 \pm 8.4$	1	$\text{Cl-CH}_2\text{C}_6\text{H}_5$	$299.9 \pm 4.3$	1
$\text{CF}_3\text{-C(O)OH}$	$370.7 \pm 8.4$	1	$\text{F-C}_6\text{F}_5$	$485 \pm 25$	1	$\text{Cl-C(O)Cl}$	$318.8 \pm 8.4$	1	
$\text{CCl}_3\text{-C(O)OH}$	$310.5 \pm 12.6$	1	$\text{F-CH}_2\text{C}_6\text{H}_5$	$412.8 \pm 4.2$	1	$\text{Cl-COF}$	376.6	1	
$\text{CClH}_2\text{-C(O)OH}$	$357.7 \pm 8.4$	1	$\text{F-COH}$	$497.9 \pm 10.5$	1	$\text{Cl-C(O)CH}_3$	$354.0 \pm 8.4$	1	
$\text{CH}_2\text{Br-C(O)OH}$	$358.2 \pm 8.4$	1	$\text{F-COF}$	510.3	1	$\text{Cl-C(O)CH}_2\text{CH}_3$	$353.3 \pm 6.3$	1	
$\text{NH}_2\text{CH}_2\text{-C(O)OH}$	$349.4 \pm 8.4$	1	$\text{F-COCl}$	484.5	1	$\text{Cl-C(O)C}_6\text{H}_5$	$341.0 \pm 8.4$	1	
$\text{CH}_3\text{NHCH}_2\text{-C(O)OH}$	$300.4 \pm 8.4$	1	$\text{F-C(O)CH}_3$	$511.7 \pm 12.6$	1	$\text{Cl-CH}_2\text{C(O)C}_6\text{H}_5$	309	1	
$\text{C}_6\text{H}_5\text{-C(O)OH}$	$429.7 \pm 8.4$	1	$\text{Cl-CN}$	$422.6 \pm 8.4$	1	$\text{Cl-CH}_2\text{C(O)OH}$	$310.9 \pm 2.2$	1	
$\text{C}_6\text{F}_5\text{-C(O)OH}$	$470.0 \pm 10.5$	1	$\text{Cl-CF}_3$	$365.3 \pm 3.8$	1	$\text{Cl-C(O)OC}_6\text{H}_5$	364	1	
$\text{HOCH}_2\text{-C(O)OH}$	$371.5 \pm 5.4$	1	$\text{Cl-CHF}_2$	$364 \pm 8$	1	$\text{Cl-C(NO}_2\text{)}_3$	302.1	1	
$\text{HOC(O)-C(O)OH}$	$334.7 \pm 6.3$	1	$\text{Cl-CH}_2\text{F}$	$354.4 \pm 11.7$	1	$\text{Br-CN}$	$364.8 \pm 4.2$	1	
$\text{CH}_3\text{NHCH}_2\text{-C(O)OH}$	$301.2 \pm 16.7$	1	$\text{Cl-CF}_2\text{Cl}$	$333.9 \pm 10.5$	1	$\text{Br-CF}_3$	$296.2 \pm 1.3$	1	
$\text{CH}_3\text{CH(NH}_2\text{)-C(O)OH}$	$331.4 \pm 16.7$	1	$\text{Cl-CFCl}_2$	$320.9 \pm 8.4$	1	$\text{Br-CHF}_2$	$288.7 \pm 8.4$	1	
$\text{NH}_2\text{CH}_2\text{-CH}_2\text{C(O)OH}$	$325.5 \pm 16.7$	1	$\text{Cl-CHFCl}$	$346.0 \pm 13.4$	1	$\text{Br-CF}_2\text{Cl}$	$269.9 \pm 6.3$	1	
$\text{CN-CN}$	$571.9 \pm 6.7$	1	$\text{Cl-CCl}_3$	296.6	1	$\text{Br-CCl}_3$	$231.4 \pm 4.2$	1	
$\text{HC(O)-CN}$	$455.2 \pm 8.4$	1	$\text{Cl-CHCl}_2$	$311.1 \pm 2.0$	1	$\text{Br-CH}_2\text{Cl}$	$277.3 \pm 3.6$	1	
$\text{HC(S)-CN}$	$530.1 \pm 8.4$	1	$\text{Cl-CH}_2\text{Cl}$	$338.0 \pm 3.3$	1	$\text{Br-CBr}_3$	$242.3 \pm 8.4$	1	
$\text{CF}_3\text{-CN}$	$469.0 \pm 4.2$	1	$\text{Cl-CBrCl}_2$	$287 \pm 10.5$	1	$\text{Br-CHBr}_2$	$274.9 \pm 13.0$	1	
$\text{CH}_3\text{-CN}$	$521.7 \pm 9.2$	1	$\text{Cl-CH}_2\text{Br}$	$332.8 \pm 4.6$	1	$\text{Br-CH}_2\text{Br}$	$276.1 \pm 5.3$	1	
$\text{NCC-CN}$	462.3	1	$\text{Cl-CH}_2\text{I}$	$328.2 \pm 6.9$	1	$\text{Br-CH}_2\text{I}$	$274.5 \pm 7.5$	1	
$\text{C}_2\text{H}_5\text{-CN}$	$506.7 \pm 7.5$	1	$\text{Cl-CH}_3$	$350.2 \pm 1.7$	1	$\text{Br-CH}_3$	$294.1 \pm 2.1$	1	
$\text{CH}_3\text{-CH}_2\text{CN}$	$348.1 \pm 12.6$	1	$\text{Cl-C}\equiv\text{CCl}$	$443 \pm 50$	1	$\text{Br-C}\equiv\text{CH}$	410.5	1	
$\text{C}_6\text{H}_5\text{-CH}_2\text{CN}$	$386.6 \pm 8.4$	1	$\text{Cl-C}\equiv\text{CH}$	$435.6 \pm 8.4$	1	$\text{Br-CH=CH}_2$	$338.3 \pm 3.1$	1	
$\text{CH}_3\text{-CH(CH}_3\text{)CN}$	$332.6 \pm 8.4$	1	$\text{Cl-CH}_2\text{CN}$	267.4	1	$\text{Br-CF}_2\text{CF}_3$	$283.3 \pm 6.3$	1	
$\text{CH}_3\text{-C(CH}_3\text{)}_2\text{CN}$	$340.6 \pm 16.7$	1	$\text{Cl-CCl=CCl}_2$	383.7	1	$\text{Br-CClBrCF}_3$	$251.0 \pm 6.3$	1	
$\text{CH}_3\text{-C(CH}_3\text{)(CN)C}_6\text{H}_5$	250.6	1	$\text{Cl-CH=CH}_2$	$394.1 \pm 3.1$	2	$\text{Br-CF}_2\text{CF}_2\text{Br}$	$282.8 \pm 6.7$	1	
$(\text{Ph})_2(\text{CN})\text{C-C(CN)(Ph)}_2$	109.6	1	$\text{Cl-CF=CF}_2$	$434.7 \pm 8.4$	1	$\text{Br-CHClCF}_3$	$274.9 \pm 6.3$	1	
$(\text{NO}_2)_3\text{C-C(NO}_2\text{)}_3$	308.8	1	$\text{Cl-CF}_2\text{CF}_3$	$346.0 \pm 7.1$	1	$\text{Br-CF}_2\text{CH}_3$	$287.0 \pm 5.4$	1	

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Br-CH <sub>2</sub> CH <sub>2</sub> Cl	292.5 ± 8.4	1	I-2-naphthyl	272.0 ± 10.5	1	C <sub>6</sub> H <sub>5</sub> OO-H	384	1
Br-CHClCH <sub>3</sub>	272.0 ± 8.4	1	I-CH <sub>2</sub> CN	187.0 ± 8.4	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> OO-H	363	1
Br-C <sub>2</sub> H <sub>5</sub>	292.9 ± 4.2	1	I-CH <sub>2</sub> OCH <sub>3</sub>	229.4 ± 8.4	1	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CHOO-H	370	1
Br-CH <sub>2</sub> CH=CH <sub>2</sub>	237.2 ± 5.0	1	I-CH <sub>2</sub> SCH <sub>3</sub>	216.8 ± 6.3	1	CH <sub>3</sub> C(O)OO-H	386	1
Br-C <sub>3</sub> H <sub>7</sub>	298.3 ± 4.2	1	I-C(O)CH <sub>3</sub>	223.0 ± 8.4	1	CCl <sub>2</sub> (CN)OO-H	384	1
Br- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	299.2 ± 6.3	1	I-C(O)C <sub>6</sub> H <sub>5</sub>	212.1 ± 8.4	1	OHCH <sub>2</sub> OO-H	368	1
Br-CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> Br	324.7	1	I-CH <sub>2</sub> C(O)OH	197.5 ± 2.7	1	H-ONO	330.7	1
Br-CF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>	278.2 ± 10.5	1	I-C(NO <sub>2</sub> ) <sub>3</sub>	144.8	1	H-OONO	299.2	1
CF <sub>3</sub> CFBrCF <sub>3</sub>	274.2 ± 4.6	1	(4) O-X BDEs			H-ONH <sub>2</sub>	318	1
Br-C <sub>4</sub> H <sub>9</sub>	296.6 ± 4.2	1	HO-H	497.10 ± 0.29	1	H-ONO <sub>2</sub>	426.8	1
Br- <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	300.0 ± 4.2	1	FO-H	425.1	1	H-ONNOH	189	1
Br- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	292.9 ± 6.3	1	ClO-H	393.7	1	H-OPO <sub>2</sub>	465.7 ± 12.6	1
Br-C <sub>6</sub> H <sub>5</sub>	336.4 ± 6.3	1	BrO-H	405	1	H-OSO <sub>2</sub> OH	441.4 ± 14.6	1
Br-C <sub>6</sub> F <sub>5</sub>	~328	1	IO-H	403.3	1	H-OSiMe <sub>3</sub>	495	1
Br-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	239.3 ± 6.3	1	CH <sub>3</sub> O-H	440.2 ± 3	1	(CH <sub>3</sub> )CHNO-H	354.4	1
Br-CH <sub>2</sub> C <sub>6</sub> F <sub>5</sub>	225.1 ± 6.3	1	CF <sub>3</sub> O-H	497.1	1	(CH <sub>3</sub> ) <sub>2</sub> CNO-H	354.0	1
Br-1-C <sub>10</sub> H <sub>7</sub>	339.7	1	HC≡CO-H	443.1	1	(C <sub>6</sub> H <sub>5</sub> )CHNO-H	368.6	1
Br-2-C <sub>10</sub> H <sub>7</sub>	341.8	1	C <sub>2</sub> H <sub>5</sub> O-H	441.0 ± 5.9	1	PhO-H	362.8 ± 2.9	1
Br-anthracenyl	322.6	1	CH <sub>2</sub> =CHO-H	355.6	1	α-tocopherol RO-H	323.4	1
Br-C(O)CH <sub>3</sub>	292.0 ± 8.4	1	CF <sub>3</sub> CH <sub>2</sub> O-H	447.7 ± 10.5	1	β-tocopherol RO-H	335.6	1
Br-C(O)C <sub>6</sub> H <sub>5</sub>	276.6 ± 8.4	1	C <sub>3</sub> H <sub>7</sub> O-H	≤433 ± 2	1	γ-tocopherol RO-H	335.1	1
Br-CH <sub>2</sub> C(O)CH <sub>3</sub>	257.9 ± 10.5	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> O-H	442.3 ± 2.8	1	δ-tocopherol RO-H	342.8	1
Br-CH <sub>2</sub> C(O)C <sub>6</sub> H <sub>5</sub>	271	1	C <sub>4</sub> H <sub>9</sub> O-H	432.3	1	p-C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -C <sub>6</sub> H <sub>4</sub> O-H	356.2	1
Br-CH <sub>2</sub> C(O)OH	257.4 ± 3.7	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> O-H	441.4 ± 4.2	1	O-O <sub>2</sub>	106.6	1
Br-C(NO <sub>2</sub> ) <sub>3</sub>	218.4	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> O-H	444.9 ± 2.8	1	HO-OH	210.66 ± 0.42	1
I-CN	320.1	1	<i>tert</i> -BuCH <sub>2</sub> O-H	436.1	1	HO-OF	199.7 ± 8.4	1
I-CF <sub>3</sub>	227.2 ± 1.3	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> O-H	442.7 ± 8.8	1	HO-OCl	~146	1
I-CCl <sub>3</sub>	168 ± 42	1	CH <sub>3</sub> C(OH)O-H	446.9 ± 6.3	1	HO-OBBr	138.5 ± 8.4	1
I-CH <sub>2</sub> Cl	221.8 ± 4.2	1	(CH <sub>3</sub> ) <sub>2</sub> C(OH)O-H	450.6 ± 6.3	1	FO-OF	199.6	1
I-CH <sub>2</sub> Br	219.2 ± 5.4	1	HC(O)O-H	468.6 ± 12.6	1	ClO-OCl	72.4 ± 2.8	1
I-CH <sub>2</sub> I	216.9 ± 7.9	1	CH <sub>3</sub> C(O)O-H	468.6 ± 12.6	1	IO-OI	74.9 ± 17	1
I-CH <sub>3</sub>	238.9 ± 2.1	1	C <sub>2</sub> H <sub>5</sub> C(O)O-H	472.8	1	<i>trans-perp</i> -HO-ONO	≤67.8 ± 0.4	1
I-CH <sub>2</sub> CN	187.0 ± 6.3	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> C(O)O-H	472.8	1	<i>cis-cis</i> -HO-ONO	83.3 ± 2.1	1
I-CF <sub>2</sub> CF <sub>3</sub>	219.2 ± 2.1	1	C <sub>6</sub> H <sub>5</sub> C(O)O-H	464.4 ± 16.7	1	HO-ONO <sub>2</sub>	163.2 ± 8.4	1
I-CF <sub>2</sub> CF <sub>2</sub> I	217.6 ± 6.7	1	HOO-H	366.06 ± 0.29	1	HO-OCH <sub>3</sub>	189.1 ± 4.2	1
I-CH <sub>2</sub> CF <sub>3</sub>	235.6 ± 4.2	1	CH <sub>3</sub> OO-H	370.3 ± 2.1	1	HO-OCF <sub>3</sub>	201.3 ± 20.9	1
I-CHFCClF <sub>2</sub>	202 ± 2	1	CF <sub>3</sub> OO-H	383	1	HO-OC <sub>2</sub> H <sub>5</sub>	178.7 ± 6.3	1
I-CF <sub>2</sub> CH <sub>3</sub>	217.6 ± 4.2	1	CH <sub>2</sub> FOO-H	379	1	HO-O- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	185.8 ± 6.3	1
I-CFICH <sub>3</sub>	218.0 ± 4.2	1	CCl <sub>3</sub> OO-H	386	1	HO-O- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	186.2 ± 4.2	1
CF <sub>3</sub> CFICF <sub>3</sub>	215.1	1	CHCl <sub>2</sub> OO-H	383	1	HO-OC(O)CH <sub>3</sub>	169.9 ± 2.1	1
I-CH=CH <sub>2</sub>	259.0 ± 4.2	1	CH <sub>2</sub> ClOO-H	379	1	HO-OC(O)C <sub>2</sub> H <sub>5</sub>	169.9 ± 2.1	1
I-C <sub>2</sub> H <sub>5</sub>	233.5 ± 6.3	1	CBr <sub>3</sub> OO-H	383	1	CH <sub>3</sub> O-OCH <sub>3</sub>	167.4 ± 6.3	1
I-CH <sub>2</sub> CH=CH <sub>2</sub>	185.8 ± 6.3	1	CH <sub>2</sub> BrOO-H	379	1	CF <sub>3</sub> O-OCF <sub>3</sub>	198.7 ± 2.1	1
I-C <sub>3</sub> H <sub>7</sub>	236.8 ± 4.2	1	C <sub>2</sub> H <sub>5</sub> OO-H	354.8 ± 9.2	1	C <sub>2</sub> H <sub>5</sub> O-OC <sub>2</sub> H <sub>5</sub>	166.1	1
I- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	234.7 ± 6.3	1	CH <sub>3</sub> CHClOO-H	377	1	C <sub>3</sub> H <sub>7</sub> O-OC <sub>3</sub> H <sub>7</sub>	155.2 ± 4.2	1
I-C <sub>4</sub> F <sub>9</sub>	205.8	1	CH <sub>3</sub> CCl <sub>2</sub> OO-H	383	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> O-O- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	157.7	1
I- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	227.2 ± 6.3	1	CF <sub>3</sub> CHClOO-H	384	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> O-O- <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	152.3 ± 4.2	1
I-C <sub>6</sub> H <sub>5</sub>	272.0 ± 4.2	1	C <sub>2</sub> Cl <sub>5</sub> OO-H	383	1	<i>tert</i> -BuO-O- <i>tert</i> -Bu	162.8 ± 2.1	1
I-C <sub>6</sub> F <sub>5</sub>	<301.7	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> OO-H	356	1	<i>tert</i> -BuCH <sub>2</sub> O-OCH <sub>2</sub> - <i>tert</i> -Bu	152.3	1
I-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	187.8 ± 4.8	1	CH <sub>2</sub> =CHCH <sub>2</sub> OO-H	372.4	1	EtC(Me) <sub>2</sub> O-OC(Me) <sub>2</sub> Et	164.4 ± 4.2	1
I-1-naphthyl	274.5 ± 10.5	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> OO-H	352.3 ± 8.8	1	(CF <sub>3</sub> ) <sub>3</sub> CO-OC(CF <sub>3</sub> ) <sub>3</sub>	148.5 ± 4.6	1



Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Ph <sub>3</sub> CO-OCPh <sub>3</sub>	131.4	1	CH <sub>3</sub> O-C <sub>4</sub> H <sub>9</sub>	346.0 ± 6.3	1	O <sub>2</sub> N-ONO <sub>2</sub>	95.4 ± 1.5	1
SF <sub>5</sub> O-OSF <sub>5</sub>	155.6	1	CH <sub>3</sub> O- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	353.1 ± 6.3	1	<i>cis</i> -HO-NO	207.0	1
SF <sub>5</sub> O-OOSF <sub>5</sub>	126.8	1	C <sub>6</sub> H <sub>5</sub> -OCH <sub>3</sub>	418.8 ± 5.9	1	<i>trans</i> -HO-NO	200.64 ± 0.19	1
(CH <sub>3</sub> ) <sub>3</sub> CO-OSi(CH <sub>3</sub> ) <sub>3</sub>	196.6	1	C <sub>6</sub> H <sub>5</sub> CH(CH <sub>3</sub> )-OCH <sub>3</sub>	313.4 ± 9.6	1	FO-NO	132.5 ± 17	1
<i>tert</i> -BuO-OGeEt <sub>3</sub>	192.5	1	C <sub>6</sub> H <sub>5</sub> -OC <sub>6</sub> H <sub>5</sub>	326.8 ± 4.2	1	<i>cis</i> -ClO-NO	127.6 ± 8.4	1
<i>tert</i> -BuO-OSnEt <sub>3</sub>	192.5	1	CH <sub>3</sub> -OC(O)H	383.7 ± 12.6	1	<i>trans</i> -ClO-NO	116.6 ± 8.4	1
CF <sub>3</sub> OO-OCF <sub>3</sub>	126.8 ± 8.4	1	HC(O)-OH	457.7 ± 2.1	1	<i>cis</i> -BrO-NO	138.1 ± 8.4	1
HC(O)O-OH	199.2 ± 8.4	1	CH <sub>3</sub> C(O)-OH	459.4 ± 4.2	1	<i>trans</i> -BrO-NO	121.6 ± 8.4	1
FC(O)O-OC(O)F	96.2	1	C <sub>6</sub> H <sub>5</sub> C(O)-OH	447.7 ± 10.5	1	<i>trans-perp</i> -HOO-NO	114.2 ± 4	1
CH <sub>3</sub> C(O)O-ONO <sub>2</sub>	131.4 ± 8.4	1	HO-CH <sub>2</sub> C(O)OH	368.2 ± 10.5	1	CH <sub>3</sub> O-NO	176.6 ± 3.3	1
CH <sub>3</sub> C(O)O-OC(O)CH <sub>3</sub>	140.2 ± 21	1	CH <sub>3</sub> -OC(O)CH <sub>3</sub>	380.3 ± 12.6	1	C <sub>2</sub> H <sub>5</sub> O-NO	185.4 ± 4.2	1
CF <sub>3</sub> C(O)O-OC(O)CF <sub>3</sub>	125.5	1	HC(O)-OCH <sub>3</sub>	423.8 ± 4.2	1	C <sub>3</sub> H <sub>7</sub> O-NO	179.1 ± 6.3	1
CF <sub>3</sub> OC(O)O-OC(O)F	121.3 ± 4.2	1	CH <sub>3</sub> C(O)-OCH <sub>3</sub>	424.3 ± 6.3	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> O-NO	175.3 ± 4.2	1
CF <sub>3</sub> OC(O)O-OCF <sub>3</sub>	142.3 ± 2.9	1	C <sub>6</sub> H <sub>5</sub> C(O)-OCH <sub>3</sub>	421.3 ± 12.6	1	C <sub>4</sub> H <sub>9</sub> O-NO	177.8 ± 6.5	1
CF <sub>3</sub> OC(O)O-OC(O)OCF <sub>3</sub>	119.2	1	C <sub>6</sub> H <sub>5</sub> C(O)-OC <sub>6</sub> H <sub>5</sub>	307.5 ± 8.4	1	<i>iso</i> -C <sub>4</sub> H <sub>9</sub> O-NO	175.7 ± 6.5	1
C <sub>2</sub> H <sub>5</sub> C(O)O-OC(O)C <sub>2</sub> H <sub>5</sub>	150.6	1	CH <sub>3</sub> OCH <sub>2</sub> -OCH <sub>3</sub>	367.5 ± 8.4	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> O-NO	173.6 ± 3.3	1
C <sub>3</sub> H <sub>7</sub> C(O)O-OC(O)C <sub>3</sub> H <sub>7</sub>	150.6	1	CH <sub>3</sub> C(O)-OC(O)CH <sub>3</sub>	382.4 ± 12.6	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> O-NO	176.1 ± 5.9	1
FS(O) <sub>2</sub> O-OS(O) <sub>2</sub> F	92-100	1	C <sub>6</sub> H <sub>5</sub> C(O)-OC(O)C <sub>6</sub> H <sub>5</sub>	384.9 ± 16.7	1	<i>tert</i> -AmO-NO	171.1 ± 0.4	1
HO-CF <sub>3</sub>	≤482.0 ± 1.3	1	CH <sub>3</sub> -OOH	300.4 ± 12.6	1	C <sub>6</sub> H <sub>5</sub> O-NO	87.0	1
FO-CF <sub>3</sub>	408 ± 17	1	C <sub>2</sub> H <sub>5</sub> -OOH	332.2 ± 20.9	1	HO-NO <sub>2</sub>	205.4	1
HO-CH <sub>3</sub>	384.93 ± 0.71	1	C <sub>3</sub> H <sub>7</sub> -OOH	364.4	1	FO-NO <sub>2</sub>	131.8 ± 12.6	1
HO-C <sub>2</sub> H <sub>5</sub>	391.2 ± 2.9	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -OOH	298.3	1	ClO-NO <sub>2</sub>	111.8 ± 2.1	1
HO-CH <sub>2</sub> CF <sub>3</sub>	408.4 ± 8.4	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -OOH	309.2 ± 4.2	1	BrO-NO <sub>2</sub>	118.0 ± 6.3	1
HO-CH <sub>2</sub> CH=CH <sub>2</sub>	332.6 ± 4.2	1	CH <sub>3</sub> -OOCH <sub>3</sub>	292.5 ± 8.4	1	IO-NO <sub>2</sub>	~100	1
HO-C <sub>3</sub> H <sub>7</sub>	392.0 ± 2.9	1	CF <sub>3</sub> -OOCF <sub>3</sub>	361.5 ± 8.4	1	CH <sub>3</sub> O-NO <sub>2</sub>	176.1 ± 4.2	1
HO- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	397.9 ± 4.2	1	CH <sub>3</sub> -OO	137.0 ± 3.8	1	C <sub>2</sub> H <sub>5</sub> O-NO <sub>2</sub>	174.5 ± 4.2	1
HO-C <sub>4</sub> H <sub>9</sub>	389.9 ± 4.2	1	CF <sub>3</sub> -OO	169.0	1	C <sub>3</sub> H <sub>7</sub> O-NO <sub>2</sub>	177.0 ± 4.2	1
HO- <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	396.1 ± 4.2	1	CClF <sub>2</sub> -OO	127.6	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> O-NO <sub>2</sub>	175.7 ± 4.2	1
HO- <i>iso</i> -C <sub>4</sub> H <sub>9</sub>	394.1 ± 4.2	1	CCl <sub>2</sub> F-OO	124.7	1	HOO-NO <sub>2</sub>	99.2 ± 4.6	1
HO- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	398.3 ± 4.2	1	CH <sub>2</sub> Cl-OO	122.4 ± 10.5	1	CH <sub>3</sub> OO-NO <sub>2</sub>	86.6 ± 8.4	1
HO-CH(CH <sub>3</sub> )(n-C <sub>3</sub> H <sub>7</sub> )	398.3 ± 4.2	1	CHCl <sub>2</sub> -OO	108.2 ± 8.2	1	CF <sub>3</sub> OO-NO <sub>2</sub>	105	1
HO-CH(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	399.2 ± 4.2	1	CCl <sub>3</sub> -OO	92.0 ± 6.4	1	CF <sub>2</sub> ClOO-NO <sub>2</sub>	106.7	1
HO-C(CH <sub>3</sub> ) <sub>2</sub> (C <sub>2</sub> H <sub>5</sub> )	395.8 ± 6.3	1	HC(O)-OOH	290.0	1	CFCl <sub>2</sub> OO-NO <sub>2</sub>	106.7	1
HO-C <sub>6</sub> H <sub>5</sub>	463.6 ± 4.2	1	CH <sub>3</sub> C(O)-OOC(O)CH <sub>3</sub>	315.1	1	CCl <sub>3</sub> OO-NO <sub>2</sub>	95.8	1
HO-C <sub>6</sub> F <sub>5</sub>	446.9 ± 9.2	1	ClO-CF <sub>3</sub>	≤369.9 ± 1.3	1	CH <sub>3</sub> N(O)-O	305.3 ± 4.4	1
HO-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	334.1 ± 2.6	1	CH <sub>3</sub> -ONO	245.2	1	C <sub>6</sub> H <sub>5</sub> N(O)-O	392 ± 8	1
HO-C(CH <sub>3</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	339.3 ± 6.3	1	C <sub>2</sub> H <sub>5</sub> -ONO	260.2	1	C <sub>5</sub> H <sub>5</sub> N-O	264.9 ± 2.0	1
<i>cyclo</i> -C <sub>5</sub> H <sub>9</sub> -OH	385.8 ± 6.3	1	C <sub>3</sub> H <sub>7</sub> -ONO	249.4 ± 6.3	1	C <sub>6</sub> H <sub>5</sub> N=N(O)(C <sub>6</sub> H <sub>5</sub> )-O	309.4 ± 3.5	1
1-C <sub>10</sub> H <sub>7</sub> -OH	468.6 ± 6.3	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -ONO	254.4 ± 6.3	1	C <sub>6</sub> H <sub>5</sub> (O)N=N(O)(C <sub>6</sub> H <sub>5</sub> )-O	309.4 ± 3.6	1
2-C <sub>10</sub> H <sub>7</sub> -OH	467.8 ± 6.3	1	C <sub>4</sub> H <sub>9</sub> -ONO	256.5 ± 6.3	1	O-SO	551.1	1
(CH <sub>3</sub> ) <sub>2</sub> (NH <sub>2</sub> )C-OH	310.4 ± 6.3	1	<i>iso</i> -C <sub>4</sub> H <sub>9</sub> -ONO	254.0 ± 6.3	1	O-SOF <sub>2</sub>	513.3	1
CH <sub>3</sub> C(O)-OH	459.4 ± 4.2	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> -ONO	253.6 ± 6.3	1	O-SOCl <sub>2</sub>	398.5	1
HOCH <sub>2</sub> -OH	411.3	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -ONO	252.7 ± 6.3	1	O-S(OH) <sub>2</sub>	493.7 ± 25	1
CH <sub>3</sub> -OCH <sub>3</sub>	351.9 ± 4.2	1	(C <sub>2</sub> H <sub>5</sub> )(CH <sub>3</sub> ) <sub>2</sub> C-ONO	254.0 ± 8.4	1	HO-SH	293.3 ± 16.7	1
ICH <sub>2</sub> -OCH <sub>3</sub>	373.2 ± 12.6	1	CH <sub>3</sub> -ONO <sub>2</sub>	340.2	1	HO-SOH	313.4 ± 12.6	1
CH <sub>3</sub> O-C <sub>2</sub> H <sub>5</sub>	355.2 ± 5.4	1	C <sub>2</sub> H <sub>5</sub> -ONO <sub>2</sub>	344.8	1	HO-S(OH)O <sub>2</sub>	384.9 ± 8.4	1
CH <sub>3</sub> O-CHClCH <sub>3</sub>	370.3 ± 8.4	1	CH <sub>3</sub> O-CH <sub>2</sub> CN	393.3	1	HO-SCH <sub>3</sub>	303.8 ± 12.6	1
CH <sub>3</sub> O-C <sub>3</sub> H <sub>7</sub>	358.6 ± 6.3	1	O-N <sub>2</sub>	167.4 ± 0.4	1	HO-SO <sub>2</sub> CH <sub>3</sub>	360.2 ± 12.6	1
CH <sub>3</sub> O- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	360.7 ± 4.2	1	O-NO	306.21 ± 0.13	1	F-OH	215.1	1
			O-NO <sub>2</sub>	206.3	1	F-OF	164.1	1
			NO-NO	40.6 ± 2.1	1			

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
F-OCF <sub>3</sub>	200.8 ± 4.2	1	ON-NO <sub>2</sub>	42.5	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -NH <sub>2</sub>	306.7 ± 6.3	1
F-OCH <sub>3</sub>	>196.6	1	O <sub>2</sub> N-NO <sub>2</sub>	57.3 ± 1	1	C <sub>6</sub> H <sub>5</sub> CH(CH <sub>3</sub> )-NH <sub>2</sub>	307.5 ± 9.6	1
F-ONO <sub>2</sub>	143.1	1	H <sub>2</sub> N-NH <sub>2</sub>	277.0 ± 1.3	1	HC(O)-NH <sub>2</sub>	421.7 ± 8.4	1
Cl-OH	233.5	1	F <sub>2</sub> N-NF <sub>2</sub>	92.9 ± 12.6	1	CH <sub>3</sub> C(O)-NH <sub>2</sub>	414.6 ± 8.4	1
Cl-OCl	142	1	H <sub>2</sub> N-NHCH <sub>3</sub>	275.8 ± 8.4	1	HS-NO	138.9	1
Cl-OCF <sub>3</sub>	≤220.9 ± 8.4	1	H <sub>2</sub> N-N(CH <sub>3</sub> ) <sub>2</sub>	259.8 ± 8.4	1	CH <sub>3</sub> S-NO	104.6 ± 4.2	1
Cl-OCH <sub>3</sub>	200.8	1	H <sub>2</sub> N-NHC <sub>6</sub> H <sub>5</sub>	227.6 ± 8.4	1	<i>tert</i> -BuS-NO	115.1	1
Cl-O- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	198.3	1	H <sub>2</sub> N-NO <sub>2</sub>	230	1	PhCH <sub>2</sub> S-NO	120.5	1
Cl-OOCl	91.2	1	H <sub>2</sub> NN(CH <sub>3</sub> )-NO	179.6	1	C <sub>6</sub> H <sub>5</sub> S-NO	81.2 ± 5.4	1
Cl-ONO <sub>2</sub>	172.0	1	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> N-NO	94.6	1	SCN-SCN	255.6	1
Br-OH	209.6 ± 4.2	1	N <sub>3</sub> -CH <sub>3</sub>	335.1 ± 20.5	1	FSO <sub>2</sub> -NF <sub>2</sub>	163	1
Br-OBBr	125	1	N <sub>3</sub> -C <sub>6</sub> H <sub>5</sub>	375.7 ± 20.9	1	F-NO	235.26	1
Br-O- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	183.3	1	N <sub>3</sub> -CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	211.3 ± 14.2	1	F-NO <sub>2</sub>	221.3	1
Br-ONO <sub>2</sub>	143.1 ± 6.3	1	CH <sub>3</sub> -NC	413.0 ± 3.3	1	F-NF <sub>2</sub>	254.0	1
I-OH	213.4	1	C <sub>2</sub> H <sub>5</sub> -NC	413.4 ± 8.4	1	F-NH <sub>2</sub>	286.6	1
I-OI	130.1	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -NC	423.0 ± 8.4	1	Cl-NO	158.8 ± 0.8	1
I-ONO <sub>2</sub>	>140.6	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -NC	399.6 ± 5.4	1	Cl-NO <sub>2</sub>	141.8 ± 1.3	1
(5) N-X BDEs			NC-NO	204.4	1	Cl-NF <sub>2</sub>	~134	1
H-NH <sub>2</sub>	450.08 ± 0.24	1	CH <sub>3</sub> -NO	172	1	Cl-NH <sub>2</sub>	253.1	1
H-NF <sub>2</sub>	316.7 ± 10.5	1	CF <sub>3</sub> -NO	167	1	Br-NO	120.1 ± 0.8	1
H-NNH	254.4	1	CCl <sub>3</sub> -NO	125	1	Br-NO <sub>2</sub>	82.0 ± 7.1	1
H-N <sub>3</sub>	≤389	1	C <sub>2</sub> H <sub>5</sub> -NO	171.5	1	Br-NF <sub>2</sub>	<227.2	1
H-N=CH <sub>2</sub>	364 ± 25	1	CH <sub>2</sub> CHCH <sub>2</sub> -NO	110	1	I-NO	75.6 ± 4	1
H-NO	199.5	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -NO	152.7 ± 12.6	1	I-NO <sub>2</sub>	79.6 ± 4	1
H-NHOH	341	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -NO	167	1	(6) S-X BDEs		
H-NCO	460.7 ± 2.1	1	C <sub>6</sub> H <sub>5</sub> -NO	226.8 ± 2.1	1	H-SH	381.18 ± 0.05	1
H-NCS	≤396.6 ± 4.6	1	C <sub>6</sub> F <sub>5</sub> -NO	211.3 ± 4.2	1	H-SCH <sub>3</sub>	365.7 ± 2.1	1
H-NCS	347.3 ± 8.4	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -NO	123	1	H-SCHCH <sub>2</sub>	351.5 ± 8.4	1
CH <sub>3</sub> NH <sub>2</sub>	425.1 ± 8.4	1	CH <sub>3</sub> -NO <sub>2</sub>	260.7 ± 2.1	1	H-SC <sub>2</sub> H <sub>5</sub>	365.3	1
<i>tert</i> -BuNH <sub>2</sub>	397.5 ± 8.4	1	C <sub>2</sub> H <sub>5</sub> -NO <sub>2</sub>	254.4	1	H-SC <sub>3</sub> H <sub>7</sub>	365.7	1
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> NH <sub>2</sub>	418.4	1	C <sub>3</sub> H <sub>7</sub> -NO <sub>2</sub>	256.5	1	H-S- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	369.9 ± 8.4	1
(CH <sub>3</sub> ) <sub>2</sub> NH	395.8 ± 8.4	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -NO <sub>2</sub>	259.8	1	H-S- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	362.3 ± 9.2	1
H-NHNH(CH <sub>3</sub> )	276 ± 21	1	C <sub>4</sub> H <sub>9</sub> -NO <sub>2</sub>	254.8	1	H-SOH	330.5 ± 14.6	1
H-NHN(CH <sub>3</sub> ) <sub>2</sub>	356 ± 21	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> -NO <sub>2</sub>	263.2	1	H-SCOCH <sub>3</sub>	370.7	1
NH <sub>2</sub> CN	414.2	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -NO <sub>2</sub>	258.6	1	H-SCOPh	364	1
(NH <sub>2</sub> ) <sub>2</sub> C=O	464.4	1	C <sub>6</sub> H <sub>5</sub> -NO <sub>2</sub>	295.8 ± 4.2	1	H-SO <sub>2</sub> CH <sub>3</sub>	≤397	1
(NH <sub>2</sub> ) <sub>2</sub> C=S	389.1	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -NO <sub>2</sub>	210.3 ± 6.3	1	H-SSCH <sub>3</sub>	330.5 ± 14.6	1
CH <sub>3</sub> CSNH <sub>2</sub>	380.7	1	(NO <sub>2</sub> )CH <sub>2</sub> -NO <sub>2</sub>	207.1	1	H-SPh	349.4 ± 4.5	1
PhCSNH <sub>2</sub>	380.7	1	(NO <sub>2</sub> ) <sub>3</sub> C-NO <sub>2</sub>	176.1	1	H-SSH	318.0 ± 14.6	1
(PhNH) <sub>2</sub> C=S	364.0	1	CF <sub>3</sub> -NF <sub>2</sub>	280.7	1	H-SSSH	292.9 ± 6.5	1
(NH <sub>2</sub> ) <sub>2</sub> C=NH	435.1	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> -NF <sub>2</sub>	237.2 ± 14.6	1	HS-SH	270.7 ± 8.4	1
Ph <sub>2</sub> C=NH	489.5	1	CH <sub>3</sub> -NH <sub>2</sub>	356.1 ± 2.1	1	FS-SF	362.3	1
H-N(SiMe <sub>3</sub> ) <sub>2</sub>	464	1	C <sub>2</sub> H <sub>5</sub> -NH <sub>2</sub>	352.3 ± 6.3	1	CIS-SCl	329.7	1
H-NHPh	375.3	1	C <sub>3</sub> H <sub>7</sub> -NH <sub>2</sub>	356.1 ± 2.9	1	HS-SCH <sub>3</sub>	272.0	1
C <sub>6</sub> H <sub>5</sub> NHOH	292	1	<i>iso</i> -C <sub>3</sub> H <sub>7</sub> -NH <sub>2</sub>	357.7 ± 3.8	1	HS-SPh	255.2 ± 6.3	1
C <sub>6</sub> H <sub>5</sub> NH(CONMe <sub>2</sub> )	387.9	1	C <sub>4</sub> H <sub>9</sub> -NH <sub>2</sub>	356.1 ± 2.9	1	CH <sub>3</sub> S-SCH <sub>3</sub>	272.8 ± 3.8	1
H-NPh <sub>2</sub>	364.8	1	<i>sec</i> -C <sub>4</sub> H <sub>9</sub> -NH <sub>2</sub>	359.0 ± 2.9	1	C <sub>2</sub> H <sub>5</sub> S-SC <sub>2</sub> H <sub>5</sub>	276.6	1
HN-N <sub>2</sub>	63	1	<i>iso</i> -C <sub>4</sub> H <sub>9</sub> -NH <sub>2</sub>	254.8 ± 5.0	1	MeS-SPh	272.0 ± 6.3	1
ON-N	480.7 ± 0.4	1	<i>tert</i> -C <sub>4</sub> H <sub>9</sub> -NH <sub>2</sub>	355.6 ± 6.3	1	C <sub>6</sub> H <sub>5</sub> S-SC <sub>6</sub> H <sub>5</sub>	214.2 ± 12.6	1
ON-NO	8.49 ± 0.12	1	pyridin-2-yl-NH <sub>2</sub>	431	1	F <sub>5</sub> S-SF <sub>5</sub>	305 ± 21	1
			C <sub>6</sub> H <sub>5</sub> -NH <sub>2</sub>	429.3 ± 4.2	1			

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
HS-CH <sub>3</sub>	312.5 ± 4.2	1	SiH <sub>3</sub> -Br	376 ± 9	1	MgO-H	441	1
HS-C <sub>2</sub> H <sub>5</sub>	307.9 ± 2.1	1	SiH <sub>3</sub> -I	299 ± 8	1	Mg(OH)-OH	349	1
HS-C <sub>3</sub> H <sub>7</sub>	310.5 ± 2.9	1	GeH <sub>3</sub> -H	348.9 ± 8.4	1	BrMg-CH <sub>3</sub>	253	1
HS- <i>iso</i> -C <sub>3</sub> H <sub>7</sub>	307.1 ± 3.8	1	Me <sub>3</sub> Ge-H	364.0	1	BrMg-CH <sub>2</sub> CH <sub>3</sub>	205	1
HS-C <sub>4</sub> H <sub>9</sub>	309.2 ± 2.9	1	Ph <sub>3</sub> Ge-H	359.8	1	BrMg- <i>i</i> -C <sub>3</sub> H <sub>7</sub>	184	1
HS- <i>sec</i> -C <sub>4</sub> H <sub>9</sub>	307.5 ± 2.9	1	(CH <sub>3</sub> ) <sub>3</sub> Ge-Ge(CH <sub>3</sub> ) <sub>3</sub>	280.3	1	BrMg- <i>t</i> -C <sub>4</sub> H <sub>9</sub>	174	1
HS- <i>iso</i> -C <sub>4</sub> H <sub>9</sub>	310.0 ± 4.6	1	(CH <sub>3</sub> ) <sub>3</sub> Ge-CH <sub>3</sub>	288.7	1	BrMg-C <sub>6</sub> H <sub>5</sub>	289	1
HS- <i>tert</i> -C <sub>4</sub> H <sub>9</sub>	301.2 ± 3.8	1	Me <sub>3</sub> Sn-H	326.4	1	BrMg-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	201	1
HS-C <sub>6</sub> H <sub>5</sub>	360.7 ± 6.3	1	Ph <sub>3</sub> Sn-H	294.6	1	BrMg-C(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub>	180	1
HS-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	258.2 ± 6.3	1	(CH <sub>3</sub> ) <sub>3</sub> Sn-Sn(CH <sub>3</sub> ) <sub>3</sub>	257.7	1	Ca(OH)-OH	409	1
HS-C(O)H	309.6 ± 8.4	1	(CH <sub>3</sub> ) <sub>3</sub> Sn-Cl	425 ± 17	1	Sr(OH)-OH	407	1
HS-C(O)CH <sub>3</sub>	307.9 ± 6.3	1	(CH <sub>3</sub> ) <sub>3</sub> Pb-Pb(CH <sub>3</sub> ) <sub>3</sub>	228.4	1	Ba(OH)-OH	443	1
CH <sub>3</sub> S-CH <sub>3</sub>	307.9 ± 3.3	1	Cl <sub>3</sub> Pb-Cl	271 ± 84	1			
HOS-CH <sub>3</sub>	284.9 ± 12.6	1	(CH <sub>3</sub> ) <sub>3</sub> Pb-CH <sub>3</sub>	238 ± 21	1			
CH <sub>3</sub> SO-CH <sub>3</sub>	221.8 ± 8.4	1						
HOSO <sub>2</sub> -CH <sub>3</sub>	324.3 ± 12.6	1	<b>(8) P-, As-, Sb-, Bi-X BDEs</b>					
CH <sub>3</sub> SO <sub>2</sub> -CH <sub>3</sub>	279.5	1	H <sub>2</sub> P-H	351.0 ± 2.1	1	Sc-CH <sub>3</sub>	116 ± 29	1
F <sub>3</sub> S-CF <sub>3</sub>	392 ± 43	1	CH <sub>3</sub> PH-H	322.2 ± 12.6	1	Sc-C <sub>6</sub> H <sub>6</sub>	60.8	1
F-SF <sub>5</sub>	391.6	1	H <sub>2</sub> P-PH <sub>2</sub>	256.1	1	La(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> - CH(SiMe <sub>3</sub> ) <sub>2</sub>	278.7 ± 10.5	1
F-SO <sub>2</sub> (F)	379	1	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> P-P(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	359.8	1	Nd(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> - CH(SiMe <sub>3</sub> ) <sub>2</sub>	236.8 ± 10.5	1
Cl-SF <sub>5</sub>	<272	1	F <sub>2</sub> P-F	549	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-H	226.8 ± 12.6	1
Cl-SO <sub>2</sub> CH <sub>3</sub>	293	1	Cl <sub>2</sub> P-Cl	356 ± 8	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-OCH <sub>3</sub>	343.1	1
Cl-SO <sub>2</sub> Ph	297	1	I <sub>2</sub> P-I	217	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-(η <sup>3</sup> - C <sub>3</sub> H <sub>5</sub> )	188.3 ± 6.3	1
Br-SBr	259 ± 17	1	H <sub>2</sub> P-I	217	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-S-nC <sub>3</sub> H <sub>7</sub>	295.4 ± 10.0	1
Br-SF <sub>5</sub>	<230	1	H <sub>2</sub> P-SiH <sub>3</sub>	331.4	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-N(CH <sub>3</sub> ) <sub>2</sub>	201.7 ± 7.5	1
I-SH	206.7 ± 8.4	1	H <sub>2</sub> As-H	319.2 ± 0.8	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-SiH (SiMe <sub>3</sub> ) <sub>2</sub>	179.9 ± 21	1
I-SCH <sub>3</sub>	206.3 ± 7.1	1	H <sub>2</sub> Sb-H	288.3 ± 2.1	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Sm-P(Et) <sub>2</sub>	136.4 ± 8.4	1
			F <sub>2</sub> Bi-F	435 ± 19	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Eu-I	238.9 ± 8.4	1
<b>(7) Si-, Ge-, Sn-, and Pb-X BDEs</b>			Br <sub>2</sub> Bi-Br	>297.1	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Yb-I	256.1 ± 6.3	1
SiH <sub>3</sub> -H	383.7 ± 2.1	1				Lu(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> - CH(SiMe <sub>3</sub> ) <sub>2</sub>	279.1 ± 10.5	1
Me <sub>3</sub> Si-H	396 ± 7	1	<b>(9) Se- and Te-X BDEs</b>			(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> Th-H	277 ± 6	1
H <sub>2</sub> Si <sub>2</sub> -H	373 ± 8	1	H-SeH	334.93 ± 0.75	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> Th-O	371 ± 24	1
(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> Si-H	396 ± 4	1	H-SeC <sub>6</sub> H <sub>5</sub>	326.4 ± 16.7	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>3</sub> ) <sub>3</sub> Th-CH <sub>3</sub>	375 ± 9	1
C <sub>6</sub> H <sub>5</sub> SiH <sub>2</sub> -H	382 ± 5	1	PhSe-SePh	280 ± 19	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>3</sub> ) <sub>3</sub> Th- CH <sub>2</sub> Si(CH <sub>3</sub> ) <sub>3</sub>	369 ± 12	1
(CH <sub>3</sub> S) <sub>3</sub> Si-H	364.0	1	H-TeH	277.0 ± 5.0	1	(C <sub>9</sub> H <sub>7</sub> ) <sub>3</sub> Th-CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>	342 ± 9	1
(iPrS) <sub>3</sub> Si-H	376.6	1	H-TeC <sub>6</sub> H <sub>5</sub>	≤264	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> tBu) <sub>3</sub> U-H	249.7 ± 5.7	1
PhMe <sub>2</sub> Si-H	377 ± 7	1	PhTe-TePh	138.1 ± 12.6	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> U-H	253.7 ± 5.1	1
Ph <sub>2</sub> SiH-H	379 ± 7	1				[HB(3,5-Me <sub>2</sub> Pz) <sub>3</sub> ] U(Cl) <sub>2</sub> -Cl	422.6	1
Ph <sub>2</sub> MeSi-H	361 ± 10	1	<b>(10) Metal-Centered BDEs</b>			(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> U-I	265.6 ± 4.3	1
SiF <sub>3</sub> -H	432 ± 5	1	Arranged by the Periodic Table			(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> tBu) <sub>3</sub> U-O	307 ± 9	1
SiCl <sub>3</sub> -H	395 ± 5	1	<b>(10.1) Group 1</b>			(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> U-CO	43.1 ± 0.8	1
SiBr <sub>3</sub> -H	334 ± 8	1	Li-OH	431.0	1	(C <sub>9</sub> H <sub>7</sub> ) <sub>3</sub> U-CH <sub>3</sub>	196.3 ± 6.6	1
SiH <sub>3</sub> -SiH <sub>3</sub>	321 ± 4	1	Li-C <sub>2</sub> H <sub>5</sub>	214.6 ± 8.4	1	(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> U(Cl)-C <sub>6</sub> H <sub>5</sub>	358 ± 11	1
SiH <sub>3</sub> -Si <sub>2</sub> H <sub>5</sub>	313 ± 8	1	Li-nC <sub>4</sub> H <sub>9</sub>	197.9 ± 16.3	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>4</sub> SiMe <sub>3</sub> ) <sub>3</sub> U-THF	41.0 ± 0.8	1
Ph <sub>3</sub> Si-SiPh <sub>3</sub>	368.2	1	Na-OH	342.3	1			
F <sub>3</sub> Si-SiF <sub>3</sub>	453.1 ± 25	1	Na-O <sub>2</sub>	<200	1	<b>(10.4) Group 4</b>		
SiH <sub>3</sub> -CH <sub>3</sub>	375 ± 5	1	K-OH	359	1	Ti(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> -Cl	471	1
SiF <sub>3</sub> -CH <sub>3</sub>	355.6	1	Rb-OH	356.2 ± 4.2	1	Ti(Cl)(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> -Cl	390	1
H <sub>3</sub> Si-NO	158.2 ± 5.7	1	Cs-OH	373	1	Ti(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> -I	219	1
H <sub>3</sub> Si-PH <sub>2</sub>	331.4	1						
SiH <sub>3</sub> -F	638 ± 5	1	<b>(10.2) Group 2</b>					
SiH <sub>3</sub> -Cl	458 ± 7	1	BeO-H	469	1			
			Be(OH)-OH	476	1			

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
Ti( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -CO	174	1	Cr(C <sub>6</sub> H <sub>6</sub> ) <sub>2</sub> -C <sub>6</sub> H <sub>6</sub>	268.2 ± 15.4	1	Fe-CH <sub>3</sub>	135 ± 29	1
Ti(CO)( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -CO	170	1	Cr(CO) <sub>5</sub> -C <sub>6</sub> H <sub>6</sub>	57.3 ± 3.3	1	Fe(C <sub>2</sub> H <sub>4</sub> )(CO) <sub>3</sub> -C <sub>2</sub> H <sub>4</sub>	89.1 ± 8	1
Ti-CH <sub>3</sub>	174 ± 29	1	(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> ) <sub>2</sub> (CO) <sub>3</sub> Cr-P(OMe) <sub>3</sub>	68.6 ± 2.5	1	Fe-C <sub>3</sub> H <sub>5</sub>	218	1
Ti(Cl)( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -CH <sub>3</sub>	276	1	( $\eta^5\text{-C}_5\text{H}_5$ )Mo(CO) <sub>3</sub> -H	290	1	Fe-C <sub>3</sub> H <sub>6</sub>	79	1
Ti(Cl)(( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -C <sub>6</sub> H <sub>5</sub> )	292	1	Mo( $\eta^5\text{-C}_5\text{H}_5$ )-H	246	1	Fe(CO) <sub>5</sub> -Ni(CO) <sub>4</sub>	37.7	1
Ti(C <sub>6</sub> H <sub>6</sub> ) <sub>2</sub> -C <sub>6</sub> H <sub>5</sub>	308.7	1	Mo(H)( $\eta^5\text{-C}_5\text{H}_5$ )-H	256.9 ± 8.4	1	Fe(CO) <sub>5</sub> -( $\eta^3\text{-C}_3\text{H}_5$ )	176	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -H	351.0 ± 7.5	1	Mo(CO) <sub>3</sub> ( $\eta^5\text{-C}_5\text{H}_5$ )-I	216.7 ± 4.2	1	Fe(C <sub>3</sub> H <sub>6</sub> )(CO) <sub>3</sub> -C <sub>3</sub> H <sub>6</sub>	~79.5	1
Zr(H)( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -H	326.4 ± 4	1	( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> Mo-O	272	1	(CO) <sub>2</sub> ( $\eta^5\text{-C}_5\text{H}_5$ )Ru-H	272	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -Cl	481.2	1	(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> ) <sub>2</sub> (CO) <sub>3</sub> Mo-H <sub>2</sub>	27.2 ± 0.8	1	(PMe <sub>3</sub> ) <sub>2</sub> ( $\eta^5\text{-C}_5\text{Me}_5$ )Ru-H	167.4	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -Br	410.0	1	(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> ) <sub>2</sub> (CO) <sub>3</sub> Mo-N <sub>2</sub>	37.7 ± 2.5	1	(CO) <sub>2</sub> ( $\eta^5\text{-C}_5\text{Me}_5$ )Ru-Cl	337.6	1
Zr(I)( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -I	336.4 ± 2.1	1	Mo(CO) <sub>5</sub> -CO	169.5 ± 8.4	1	( $\eta^5\text{-C}_5\text{Me}_5$ )(PMe <sub>3</sub> ) <sub>2</sub> Ru-Cl	<138	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> (Ph)-OH	482.4 ± 6.3	1	Mo(CO) <sub>3</sub> ( $\eta^5\text{-C}_5\text{H}_5$ )-CH <sub>3</sub>	203 ± 8	1	( $\eta^5\text{-C}_5\text{Me}_5$ )(PMe <sub>3</sub> ) <sub>2</sub> Ru-OH	204.6	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> (Ph)(OH)-OH	482.8 ± 10.5	1	W(CO) <sub>5</sub> -Xe	35.1 ± 0.8	1	(CO) <sub>4</sub> Ru-CO	115 ± 1.7	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> (NH <sub>2</sub> )H-NH <sub>2</sub>	421.3 ± 15.1	1	W(CO) <sub>3</sub> ( $\eta^5\text{-C}_5\text{H}_5$ )-H	303	1	( $\eta^5\text{-C}_5\text{Me}_5$ )(PMe <sub>3</sub> ) <sub>2</sub> Ru-CH <sub>3</sub>	142.3	1
Zr( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -CH <sub>3</sub>	276 ± 10	1	W(H)( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -H	310.9 ± 4.2	1	Os(H)(CO) <sub>4</sub> -H	326.4	1
Zr( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> )-C <sub>6</sub> H <sub>5</sub>	300 ± 10	1	W(I)( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> -H	273 ± 14	1	(CO) <sub>4</sub> Os-CO	133 ± 2.6	1
Zr( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> (Si(SiMe <sub>3</sub> ) <sub>3</sub> )-SiMe <sub>3</sub>	188 ± 30	1	(CO) <sub>5</sub> W-H <sub>2</sub>	≥67	1	Os(C <sub>2</sub> H <sub>2</sub> )(CO) <sub>4</sub> -CO	99.5 ± 0.8	1
Hf(H)( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -H	346.0 ± 7.9	1	(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> )(CO) <sub>3</sub> W-( $\eta^2\text{-H}_2$ )	28.5 ± 2.1	1	<b>(10.9) Group 9</b>		
Hf( $\eta^5\text{-C}_5\text{Me}_5$ )(C <sub>4</sub> H <sub>9</sub> )-C <sub>4</sub> H <sub>9</sub>	274 ± 10	1	W(CO) <sub>5</sub> -CO	192.5 ± 8.48.4	1	(CO) <sub>4</sub> Co-Co(CO) <sub>4</sub>	83 ± 29	1
<b>(10.5) Group 5</b>			W(CH <sub>3</sub> )( $\eta^5\text{-C}_5\text{H}_5$ )-CH <sub>3</sub>	220.9 ± 4	1	(CO) <sub>4</sub> Co-Mn(CO) <sub>5</sub>	96 ± 12	1
( $\eta^5\text{-C}_5\text{H}_5$ )(CO) <sub>3</sub> V- $\eta^2\text{H}_2$	90 ± 20	1	<b>(10.7) Group 7</b>			(CO) <sub>4</sub> Co-Re(CO) <sub>5</sub>	113 ± 15	1
( $\eta^5\text{-C}_5\text{H}_5$ )(CO) <sub>3</sub> V-CO	146 ± 21	1	F <sub>3</sub> Mn-MnF <sub>3</sub>	210.9 ± 2.5	1	Co(CO) <sub>4</sub> -H	278	1
V-CH <sub>3</sub>	169 ± 18	1	(CO) <sub>5</sub> Mn-Mn(CO) <sub>5</sub>	185 ± 8	1	Co(CO) <sub>3</sub> (PPh <sub>3</sub> )-H	272	1
V-C <sub>6</sub> H <sub>6</sub>	76.2	1	(CO) <sub>5</sub> Mn-H	284.5	1	(CO) <sub>3</sub> HCo-CO	~54	1
V(C <sub>6</sub> H <sub>6</sub> ) <sub>2</sub> -C <sub>6</sub> H <sub>6</sub>	307.8	1	(PPh <sub>3</sub> )Mn(CO) <sub>4</sub> -H	286.2	1	( $\eta^5\text{-C}_5\text{H}_5$ )Co(CO)-CO	184.3 ± 4.8	1
Nb( $\eta^5\text{-C}_5\text{H}_5$ ) <sub>2</sub> H <sub>3</sub> -TFE	18.8 ± 1.3	1	MnBr(CO) <sub>4</sub> -CO	184	1	Co-CH <sub>2</sub>	331 ± 38	1
Ta(CH <sub>3</sub> ) <sub>5</sub> -CH <sub>3</sub>	261 ± 5	1	( $\eta^5\text{-C}_5\text{H}_5$ )(CO) <sub>2</sub> Mn-CO	195.8 ± 9.2	1	Co-CH <sub>3</sub>	178 ± 8	1
(Me <sub>3</sub> SiCH <sub>2</sub> ) <sub>4</sub> Ta-(CH <sub>2</sub> SiMe <sub>3</sub> )	184.1 ± 8.4	1	Mn-CH <sub>3</sub>	>35 ± 12	1	cobalamin-CH <sub>3</sub>	150.6	1
<b>(10.6) Group 6</b>			Mn(CO) <sub>5</sub> -CH <sub>3</sub>	187.0 ± 3.8	1	cobinamide-iC <sub>4</sub> H <sub>9</sub>	104	1
[Cr(CO) <sub>3</sub> ( $\eta^5\text{-C}_5\text{Me}_5$ ) <sub>2</sub> -Hg]	61.5	1	Mn(CO) <sub>5</sub> -C <sub>6</sub> H <sub>5</sub>	207 ± 11	1	Co-C bonds in B <sub>12</sub>	123.8 ± 6.3	1
[Cr(CO) <sub>3</sub> ( $\eta^5\text{-C}_5\text{Me}_5$ )-Hg]	111.3	1	(CO) <sub>5</sub> Mn-Re(CO) <sub>5</sub>	149 ± 11	1	Cl(CO) <sub>2</sub> Rh-Rh(CO) <sub>2</sub> Cl	94.6	1
Cr(CO) <sub>5</sub> -Xe	37.7 ± 3.8	1	( $\eta^5\text{-C}_5\text{H}_5$ )Mn(CO) <sub>2</sub> -PhMe	59.4 ± 3.3	1	HRh(m-xylyl)Rh-H	255.6 ± 1.7	1
(CO) <sub>2</sub> (PPh <sub>3</sub> )( $\eta^5\text{-C}_5\text{H}_5$ )Cr-H	250.2 ± 4.2	1	(CO) <sub>5</sub> Tc-Tc(CO) <sub>5</sub>	177.5 ± 1.9	1	(PiPr <sub>3</sub> ) <sub>2</sub> (Cl)Rh-H <sub>2</sub>	136.0	1
( $\eta^5\text{-C}_5\text{H}_5$ )Cr(CO) <sub>3</sub> -H	257	1	(CO) <sub>5</sub> Re-Re(CO) <sub>5</sub>	187 ± 4.8	1	(PiPr <sub>3</sub> ) <sub>2</sub> (Cl)Rh-N <sub>2</sub>	69.0	1
Cr(CO) <sub>5</sub> -H <sub>2</sub>	78 ± 4	1	(CO) <sub>5</sub> Re-H	313	1	(PiPr <sub>3</sub> ) <sub>2</sub> (Cl)Rh-CO	201.7	1
(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> ) <sub>2</sub> (CO) <sub>3</sub> Cr-H <sub>2</sub>	30.5 ± 0.4	1	(CO) <sub>5</sub> Re-CH <sub>3</sub>	220 ± 8	1	HRh(m-xylyl)Rh-CH <sub>2</sub> OH	195.4 ± 7.5	1
( $\eta^6\text{-C}_6\text{H}_6$ )(CO) <sub>3</sub> Cr-H <sub>2</sub>	251 ± 17	1	<b>(10.8) Group 8</b>			Ir(Cl)(CO)(PMe <sub>3</sub> ) <sub>2</sub> -H	251	1
Cr(CO) <sub>5</sub> -N <sub>2</sub>	81 ± 4	1	(CO) <sub>4</sub> Fe-Fe(CO) <sub>5</sub>	171.5	1	Ir(H)( $\eta^5\text{-C}_5\text{Me}_5$ )(PMe <sub>3</sub> )-H	310.5 ± 21	1
(P(C <sub>6</sub> H <sub>11</sub> ) <sub>3</sub> ) <sub>2</sub> (CO) <sub>3</sub> Cr-N <sub>2</sub>	38.9 ± 0.8	1	(CO) <sub>4</sub> Fe(H) <sub>x</sub> -H	259.4 ± 8.4	1	Ir(Cl)(H)(CO)(PEt <sub>3</sub> ) <sub>2</sub> -H	243.1	1
( $\eta^5\text{-C}_5\text{Me}_5$ )(CO) <sub>3</sub> Cr-SH	193	1	( $\eta^5\text{-C}_5\text{H}_5$ )(CO) <sub>2</sub> Fe-H	239	1	Ir(Cl)(H)(CO)(PPh <sub>3</sub> ) <sub>2</sub> -H	246.9	1
Cr(CO) <sub>5</sub> -CO	154.0 ± 8.4	1	Fe(CO) <sub>3</sub> (N <sub>2</sub> )-N <sub>2</sub>	37.7 ± 19.2	1	(Cl)(CO)(PPh <sub>3</sub> ) <sub>2</sub> Ir-H <sub>2</sub>	62.8	1
Cr(CO) <sub>5</sub> -CH <sub>4</sub>	~33.5 ± 8	1	Fe(C <sub>2</sub> H <sub>2</sub> )(CO) <sub>4</sub> -CO	88 ± 2.3	1	(Cl)(CO)(PPh <sub>3</sub> ) <sub>2</sub> Ir-CO	45.2	1
Cr-C <sub>6</sub> H <sub>6</sub>	9.6 ± 5.8	1	Fe(CO) <sub>2</sub> (PMe <sub>3</sub> )-CO	>125	1	Ir(H)( $\eta^5\text{-C}_5\text{Me}_5$ )(PMe <sub>3</sub> )-C <sub>6</sub> H <sub>5</sub>	321	1
			Fe(CO) <sub>3</sub> (PPh <sub>3</sub> )-CO	<177.8 ± 5	1	<b>(10.10) Group 10</b>		
			Fe-NH <sub>3</sub>	31.4 ± 4.2	1	Ni-H <sub>2</sub> O	~29	1
			Fe-CH <sub>2</sub>	364 ± 29	1	Ni(CO) <sub>3</sub> -N <sub>2</sub>	~42	1

Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$D_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.		
Ni(CO) <sub>3</sub> -CO	104.6 ± 8.4	1	Cu(C <sub>6</sub> H <sub>6</sub> )-C <sub>6</sub> H <sub>6</sub>	27.0 ± 19.3	1	<b>(10.13) Group 13</b>				
Ni-CH <sub>3</sub>	208 ± 8	1	Ag-CH <sub>3</sub>	134.1 ± 6.8	1		H <sub>3</sub> B-BH <sub>3</sub>	172	1	
Ni-C <sub>2</sub> H <sub>2</sub>	193 ± 25	1	Ag-NH <sub>3</sub>	8 ± 13	1		H <sub>3</sub> B-NH <sub>3</sub>	130.1 ± 4.2	1	
Ni-C <sub>2</sub> H <sub>4</sub>	147.3 ± 17.6	1	Ag(NH <sub>3</sub> )-NH <sub>3</sub>	62.8 ± 4.2	1		(CH <sub>3</sub> ) <sub>3</sub> B-NH <sub>3</sub>	57.7 ± 1.3	1	
Ni-propyne	155 ± 21	1	Au-OH	>262	1		F <sub>3</sub> B-N(CH <sub>3</sub> ) <sub>3</sub>	130 ± 4.6	1	
Ni-2-butyne	121 ± 21	1	Au-NH <sub>3</sub>	76 ± 6	1		Cl <sub>3</sub> B-N(CH <sub>3</sub> ) <sub>3</sub>	127.6	1	
Pd-OH	213	1	Au-CH <sub>3</sub>	≥191.6	1		F <sub>2</sub> B-CH <sub>3</sub>	397 - 418	1	
<i>trans</i> -Pt(PPh <sub>3</sub> ) <sub>2</sub> (Cl)-H	307 ± 37	1	Au-C <sub>6</sub> H <sub>6</sub>	8.4	1		Al-OH	547 ± 13	1	
[Ph <sub>2</sub> PCH <sub>2</sub> ] <sub>2</sub> MePt-H	104.6	1	<b>(10.12) Group 12</b>				Al-C <sub>2</sub> H <sub>2</sub>	>54	1	
[Ph <sub>2</sub> PCH <sub>2</sub> ] <sub>2</sub> MePt-OH	167.4	1		Zn-CH <sub>3</sub>	70 ± 10		1	Cl <sub>3</sub> Al-N(CH <sub>3</sub> ) <sub>3</sub>	198.7 ± 8.4	1
[Ph <sub>2</sub> PCH <sub>2</sub> ] <sub>2</sub> MePt-SH	90.0	1		Zn(CH <sub>3</sub> )-CH <sub>3</sub>	266.5 ± 6.3		1	(CH <sub>3</sub> ) <sub>3</sub> Al-N(CH <sub>3</sub> ) <sub>3</sub>	130	1
Pt(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(CH <sub>3</sub> ) <sub>2</sub> -CH <sub>3</sub>	163 ± 21	1		Zn-C <sub>2</sub> H <sub>5</sub>	92.0 ± 17.6		1	(CH <sub>3</sub> ) <sub>3</sub> Al-O(CH <sub>3</sub> ) <sub>2</sub>	92	1
<i>cis</i> -Pt(PEt <sub>3</sub> ) <sub>2</sub> (CH <sub>3</sub> )-CH <sub>3</sub>	269 ± 13	1		Zn(C <sub>2</sub> H <sub>5</sub> )-C <sub>2</sub> H <sub>5</sub>	219.2 ± 8.4		1	(CH <sub>3</sub> ) <sub>3</sub> Ga-O(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	50.6 ± 0.8	1
<b>(10.11) Group 11</b>				Cd-CH <sub>3</sub>	63.6 ± 10.0	1	Cl <sub>3</sub> Ga-S(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	235.1	1	
	Cu-OH	>406		1	Cd(CH <sub>3</sub> )-CH <sub>3</sub>	234.3 ± 6.3	1	In-CH <sub>3</sub>	216.3	1
	Cu-CO	25 ± 5		1	Hg-CH <sub>3</sub>	22.6 ± 12.6	1	In(CH <sub>3</sub> ) <sub>1</sub> -CH <sub>3</sub>	318.8	1
Cu-CH <sub>3</sub>	223 ± 5	1		Hg(CH <sub>3</sub> )-CH <sub>3</sub>	239.3 ± 6.3	1	In(CH <sub>3</sub> ) <sub>2</sub> -CH <sub>3</sub>	587.4	1	
Cu-NH <sub>3</sub>	47 ± 15	1		ClHg-CH <sub>3</sub>	280.0 ± 12.6	1	(CH <sub>3</sub> ) <sub>3</sub> In-N(CH <sub>3</sub> ) <sub>3</sub>	83.3 ± 2.1	1	
Cu(NH <sub>3</sub> )-NH <sub>3</sub>	83.7 ± 4.2	1		BrHg-CH <sub>3</sub>	270 ± 38	1	TI-OH	330 ± 30	1	
Cu-C <sub>6</sub> H <sub>6</sub>	16.4 ± 12.5	1		IHg-CH <sub>3</sub>	258.6 ± 12.6	1				

## References

1. Luo, Y.R., *Comprehensive Handbook of Chemical Bond Energies*, CRC Press, 2007.
2. Shuman, N.S., et al., *J. Phys. Chem. A* 112, 5647-5652, 2008.
3. Seetula, J.A., et al., *Chem. Phys.* 351, 141-146, 2008.

TABLE 4. Enthalpies of Formation of Free Radicals and Other Transient Species

References: Yu-Ran Luo, *Comprehensive Handbook of Chemical Bond Energies*, CRC Press, 2007.

Radical	$\Delta H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Radical	$\Delta H_{298}^{\circ}/\text{kJ mol}^{-1}$	Ref.
<b>(1) Carbon-Centered Species</b>					
CH	595.8 ± 0.6	1	n-C <sub>3</sub> H <sub>7</sub> <sup>*</sup> , n-propyl, CH <sub>3</sub> CH <sub>2</sub> C <sup>*</sup> H <sub>2</sub>	100 ± 2	1
CH <sub>2</sub> (triplet)	391.2 ± 1.6	1	i-C <sub>3</sub> H <sub>7</sub> <sup>*</sup> , i-propyl, CH <sub>3</sub> C <sup>*</sup> HCH <sub>3</sub>	88 ± 3	1
CH <sub>2</sub> (singlet)	428.8 ± 1.6	1	<sup>*</sup> n-C <sub>4</sub> H <sub>9</sub> , CH≡CCH=C <sup>*</sup> H	547.3	1
<sup>*</sup> CH <sub>3</sub> , methyl	146.7 ± 0.3	1	<sup>*</sup> i-C <sub>4</sub> H <sub>9</sub> , CH <sub>2</sub> =C <sup>*</sup> C≡CH	499.2	1
<sup>*</sup> C <sub>2</sub> H, acetynyl, CH≡C <sup>*</sup>	567.4 ± 2.1	1	<sup>*</sup> C <sub>4</sub> H <sub>9</sub> , CH <sub>3</sub> C≡CC <sup>*</sup> H <sub>2</sub>	304.5	1
<sup>*</sup> C <sub>2</sub> H <sub>2</sub> , vinylidene CH <sub>2</sub> =C <sup>**</sup>	419.7 ± 16.7	1	<sup>*</sup> C <sub>4</sub> H <sub>9</sub> , CH≡CC <sup>*</sup> HCH <sub>3</sub>	316.5	1
<sup>*</sup> C <sub>2</sub> H <sub>3</sub> , vinyl, CH <sub>2</sub> =C <sup>*</sup> H	299.6 ± 3.3	1	<sup>*</sup> C <sub>4</sub> H <sub>9</sub> , <sup>*</sup> CH=CHCHCH <sub>2</sub>	364.4	1
<sup>*</sup> C <sub>2</sub> H <sub>5</sub> , ethyl, CH <sub>3</sub> C <sup>*</sup> H <sub>2</sub>	118.8 ± 1.3	1	<sup>*</sup> C <sub>4</sub> H <sub>9</sub> , CH <sub>2</sub> =CHC <sup>*</sup> HCH <sub>2</sub>	313.3	1
<sup>*</sup> C <sub>3</sub> H <sub>3</sub> , propargyl, CH≡CC <sup>*</sup> H <sub>2</sub>	351.9	2	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , CH <sub>3</sub> CH=CHC <sup>*</sup> H <sub>2</sub>	146 ± 8	1
<sup>*</sup> C <sub>3</sub> H <sub>3</sub> , CH <sub>3</sub> C≡C <sup>*</sup>	515 ± 13	1	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , CH <sub>2</sub> =CHCH <sub>2</sub> C <sup>*</sup> H <sub>2</sub>	192.5	1
<sup>*</sup> C <sub>3</sub> H <sub>3</sub> , CH <sub>2</sub> =C=CH <sup>*</sup> ↔ CH≡CC <sup>*</sup> H <sub>2</sub>	351.9	2	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , CH <sub>2</sub> =C(CH <sub>3</sub> )C <sup>*</sup> H <sub>2</sub>	137.9	1
<sup>*</sup> C <sub>3</sub> H <sub>3</sub> , cyclopro-2-en-1-yl	439.7 ± 17.2	1	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , CH <sub>2</sub> =CHC <sup>*</sup> HCH <sub>3</sub>	136.2	1
<sup>*</sup> C <sub>3</sub> H <sub>5</sub> , allyl, CH <sub>2</sub> =CHC <sup>*</sup> H <sub>2</sub>	171.0 ± 3.0	1	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , cyclopropylmethyl	213.8 ± 6.7	1
<sup>*</sup> C <sub>3</sub> H <sub>5</sub> , CH <sub>3</sub> CH=C <sup>*</sup> H	267 ± 6	1	<sup>*</sup> C <sub>4</sub> H <sub>7</sub> , cyclobutyl	219.2 ± 4.2	1
<sup>*</sup> C <sub>3</sub> H <sub>5</sub> , CH <sub>3</sub> C <sup>*</sup> =CH <sub>2</sub>	231.4	1	n-C <sub>4</sub> H <sub>9</sub> <sup>*</sup> , n-butyl, CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> C <sup>*</sup> H <sub>2</sub>	77.8 ± 2.1	1
<sup>*</sup> C <sub>3</sub> H <sub>5</sub> , cyclopropyl	279.9 ± 10.5	1	i-C <sub>4</sub> H <sub>9</sub> <sup>*</sup> , i-butyl, (CH <sub>3</sub> ) <sub>2</sub> CHC <sup>*</sup> H <sub>2</sub>	70 ± 4	1
			s-C <sub>4</sub> H <sub>9</sub> <sup>*</sup> , s-butyl, CH <sub>3</sub> C <sup>*</sup> HCH <sub>2</sub> CH <sub>3</sub>	67.8 ± 2.1	1
			t-C <sub>4</sub> H <sub>9</sub> <sup>*</sup> , t-butyl, (CH <sub>3</sub> ) <sub>3</sub> C <sup>*</sup>	48 ± 3	1



Radical	$\Delta_f H^\circ_{298} / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ_{298} / \text{kJ mol}^{-1}$	Ref.
$\cdot\text{C}_5\text{H}_3$ , $\text{CH}\equiv\text{C}-\text{C}\equiv\text{CC}\cdot\text{H}_2$	579.1	1	$\cdot\text{C}_7\text{H}_9$ , $(\text{CH}_2=\text{CH})_3\text{C}\cdot$	274.0	1
$\cdot\text{C}_5\text{H}_3$ , $(\text{CH}\equiv\text{C})_2\text{C}\cdot\text{H}$	573.2	1	$\cdot\text{C}_7\text{H}_{11}$ , norborn-1-yl	136.4 $\pm$ 10.5	1
$\cdot\text{C}_5\text{H}_5$ , $\text{CH}_2=\text{CHC}\equiv\text{CC}\cdot\text{H}_2$	351.5	1	$\cdot\text{C}_7\text{H}_{11}$ , cycloheptenyl	119.2	1
$\cdot\text{C}_5\text{H}_5$ , $\text{CH}_2=\text{CH}\cdot\text{C}\cdot\text{H}-\text{C}\equiv\text{CH}$	372.4	1	$\cdot\text{C}_7\text{H}_{13}$ , cycloheptyl	50.6 $\pm$ 4.2	1
$\cdot\text{C}_5\text{H}_5$ , cyclopenta-1,3-dien-5-yl	274.1 $\pm$ 7.3	1	$\cdot\text{C}_7\text{H}_{13}$ , cyclo-[ $\text{C}\cdot(\text{CH}_3)(\text{CH}_2)_5$ ]	22.6	1
$\cdot\text{C}_5\text{H}_7$ , $\text{CH}_3\text{C}\equiv\text{CC}\cdot\text{HCH}_3$	272.8 $\pm$ 9.2	1	$\cdot\text{C}_7\text{H}_{13}$ , cyclo-[ $\text{C}\cdot(\text{CH}_2\text{CH}_3)(\text{CH}_2)_4$ ]	47.0	1
$\cdot\text{C}_5\text{H}_7$ , $\text{CH}\equiv\text{CC}\cdot\text{HC}_2\text{H}_5$	277.0 $\pm$ 8.4	1	$\cdot\text{C}_7\text{H}_{15}$ , $(\text{nC}_5\text{H}_{11})(\text{CH}_3)\text{CH}\cdot$	8.4	1
$\cdot\text{C}_5\text{H}_7$ , $\text{CH}\equiv\text{CC}\cdot(\text{CH}_3)_2$	257.3 $\pm$ 9.2	1	$\cdot\text{C}_7\text{H}_{15}$ , $(\text{CH}_3)_2\text{CHCHC}\cdot(\text{CH}_3)_2$	-21.8 $\pm$ 5.2	1
$\cdot\text{C}_5\text{H}_7$ , $\text{CH}_2=\text{CHCH}=\text{CHC}\cdot\text{H}_2$	205.0 $\pm$ 12.6	1	$\cdot\text{C}_8\text{H}_7$ , cubyl	831.0 $\pm$ 16.7	1
$\cdot\text{C}_5\text{H}_7$ , $(\text{CH}_2=\text{CH})_2\text{C}\cdot\text{H}$	208.0 $\pm$ 4.2	1	$\cdot\text{C}_8\text{H}_7$ , $\text{C}_6\text{H}_5\text{C}\cdot=\text{CH}_2$	309.6	1
$\cdot\text{C}_5\text{H}_7$ , $\text{CH}_3\text{CH}=\text{C}=\text{CHC}\cdot\text{H}_2$	278.0	1	$\cdot\text{C}_8\text{H}_7$ , $\text{C}_6\text{H}_5\text{CH}=\text{CH}\cdot$	387.0	1
$\cdot\text{C}_5\text{H}_7$ , spiropentyl	380.7 $\pm$ 4.2	1	$\cdot\text{C}_8\text{H}_9$ , $\text{C}_6\text{H}_5\text{C}\cdot\text{H}(\text{CH}_3)$	175.7 $\pm$ 7.5	1
$\cdot\text{C}_5\text{H}_7$ , cyclopent-1-en-3-yl	160.7 $\pm$ 4.2	1	$\cdot\text{C}_8\text{H}_9$ , $\text{C}_6\text{H}_5\text{CH}_2\text{C}\cdot\text{H}_2$	236.0 $\pm$ 7.5	1
$\cdot\text{C}_5\text{H}_9$ , cyclopentyl	105.9 $\pm$ 4.2	1	$\cdot\text{C}_8\text{H}_9$ , p- $\text{CH}_3\text{C}_6\text{H}_4\text{C}\cdot\text{H}_2$	167.4	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_2=\text{CHC}\cdot\text{HCH}_2\text{CH}_3$	109.6 $\pm$ 8.4	1	$\cdot\text{C}_8\text{H}_9$ , m- $\text{CH}_3\text{C}_6\text{H}_4\text{C}\cdot\text{H}_2$	167.4	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_3\text{CH}=\text{CHC}\cdot\text{H}(\text{CH}_3)$	92	1	$\cdot\text{C}_8\text{H}_9$ , o- $\text{CH}_3\text{C}_6\text{H}_4\text{C}\cdot\text{H}_2$	167.4	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)\text{C}\cdot\text{H}_2$	92.0	1	$\cdot\text{C}_8\text{H}_9$ , 1-vinyl-cyclohexa-2,4-dienyl	247.7 $\pm$ 14.2	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_2=\text{CHC}\cdot(\text{CH}_3)_2$	87.0 $\pm$ 8.4	1	$\cdot\text{C}_8\text{H}_9$ , 2-vinyl-cyclohexa-2,4-dienyl	249.8 $\pm$ 14.2	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_2=\text{C}(\text{CH}_3)\text{C}\cdot\text{H}(\text{CH}_3)$	93.7	1	$\cdot\text{C}_8\text{H}_9$ , 3-vinyl-cyclohexa-2,4-dienyl	269.4 $\pm$ 14.2	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_2=\text{C}(\text{C}\cdot\text{H}_2)\text{CH}_2\text{CH}_3$	114.2	1	$\cdot\text{C}_8\text{H}_9$ , 6-vinyl-cyclohexa-2,4-dienyl	284.5 $\pm$ 14.2	1
$\cdot\text{C}_5\text{H}_9$ , $\text{CH}_2=\text{CH}(\text{CH}_2)_2\text{C}\cdot\text{H}_2$	179.5	1	$\cdot\text{C}_8\text{H}_{13}$ , $\text{CH}_2=\text{CHCH}=\text{CHC}\cdot\text{H}(\text{CH}_2)_2\text{CH}_3$	130.5	1
$\text{nC}_5\text{H}_{11}\cdot$ , $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{C}\cdot\text{H}_2$	54.4	1	$\cdot\text{C}_8\text{H}_{13}$ , $\text{CH}_2=\text{CHC}\cdot\text{H}(\text{CH}_2)_3\text{CH}=\text{CH}_2$	130.5	1
$\cdot\text{C}_5\text{H}_{11}$ , $(\text{C}_2\text{H}_5)_2\text{C}\cdot\text{H}$	47.0	1	$\cdot\text{C}_8\text{H}_{13}$ , bicyclooct-1-yl	92.0	1
$\cdot\text{C}_5\text{H}_{11}$ , $(\text{nC}_3\text{H}_7)(\text{CH}_3)\text{C}\cdot\text{H}$	50.2	1	$\cdot\text{C}_8\text{H}_{15}$ , $\text{CH}_2=\text{CHC}\cdot\text{H}(\text{CH}_2)_4\text{CH}_3$	49.8	1
$\cdot\text{C}_5\text{H}_{11}$ , $(\text{CH}_3)_3\text{C}\cdot\text{CH}_2$	36.4 $\pm$ 8.4	1	$\cdot\text{C}_8\text{H}_{15}$ , (E)- $\text{CH}_3\text{CH}=\text{C}\cdot(\text{CH}_2)_4\text{CH}_3$	29.7	1
$\cdot\text{C}_5\text{H}_{11}$ , $(\text{C}_2\text{H}_5)(\text{CH}_3)_2\text{C}\cdot$	29	1	$\cdot\text{C}_8\text{H}_{15}$ , (Z)- $(\text{CH}_3)_2\text{C}\cdot\text{CH}=\text{CHCH}(\text{CH}_3)_2$	9.2	1
$\cdot\text{C}_6\text{H}_5$ , phenyl	330.1 $\pm$ 3.3	1	$\cdot\text{C}_8\text{H}_{15}$ , cyclooctanyl	59.4	1
$\cdot\text{C}_6\text{H}_7$ , cyclohexa-1,3-dien-5-yl	199.2	1	$\cdot\text{C}_8\text{H}_{15}$ , cyclo-[ $\text{C}\cdot(\text{CH}_2\text{CH}_3)(\text{CH}_2)_5$ ]	10.0	1
$\cdot\text{C}_6\text{H}_7$ , cyclohexa-1,4-dien-3-yl	201.7 $\pm$ 5.0	1	$\cdot\text{C}_9\text{H}_7$ , indenyl	297.1	1
$\cdot\text{C}_6\text{H}_9$ , $\text{CH}_3\text{C}\equiv\text{CC}\cdot(\text{CH}_3)_2$	221.8 $\pm$ 9.2	1	$\cdot\text{C}_9\text{H}_9$ , indanyl-1	204.2 $\pm$ 8.4	1
$\cdot\text{C}_6\text{H}_9$ , $(\text{CH}_2=\text{CH})_2\text{C}\cdot(\text{CH}_3)$	193.7	1	$\cdot\text{C}_9\text{H}_{11}$ , 2,6-dimethylbenzyl	124.7	1
$\cdot\text{C}_6\text{H}_9$ , cyclohexa-1-en-3-yl	119.7	1	$\cdot\text{C}_9\text{H}_{11}$ , 3,6-dimethylbenzyl	124.7	1
$\cdot\text{C}_6\text{H}_{11}$ , $\text{CH}_2=\text{CH}(\text{CH}_2)_3\text{C}\cdot\text{H}_2$	158.6	1	$\cdot\text{C}_9\text{H}_{11}$ , 3,5-dimethylbenzyl	124.7	1
$\cdot\text{C}_6\text{H}_{11}$ , $\text{CH}_2=\text{CHC}\cdot\text{H}(\text{CH}_2)_2\text{CH}_3$	89.0	1	$\cdot\text{C}_9\text{H}_{11}$ , $\text{C}_6\text{H}_5\text{C}\cdot(\text{CH}_3)_2$	133.9 $\pm$ 4.2	1
$\cdot\text{C}_6\text{H}_{11}$ , $\text{CH}_2=\text{C}(\text{CH}_3)\text{C}\cdot(\text{CH}_3)_2$	37.7 $\pm$ 6.3	1	$\cdot\text{C}_9\text{H}_{11}$ , o- $\text{C}_6\text{H}_4\text{C}_2\text{H}_5$	279.5 $\pm$ 7.5	1
$\cdot\text{C}_6\text{H}_{11}$ , $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)\text{C}\cdot\text{H}_2$	39.7 $\pm$ 6.3	1	$\cdot\text{C}_9\text{H}_{17}$ , cyclononanyl	52.3	1
$\cdot\text{C}_6\text{H}_{11}$ , $(\text{CH}_3)_2\text{C}=\text{CHC}\cdot\text{H}(\text{CH}_3)$	47.3	1	$\cdot\text{C}_{10}\text{H}_7$ , naphth-1-yl	401.7 $\pm$ 5.4	1
$\cdot\text{C}_6\text{H}_{11}$ , (Z)- $\text{CH}_3\text{CH}=\text{CHC}\cdot(\text{CH}_3)_2$	54.4	1	$\cdot\text{C}_{10}\text{H}_7$ , naphth-2-yl	400.4 $\pm$ 5.9	1
$\cdot\text{C}_6\text{H}_{11}$ , cyclohexyl	75.3 $\pm$ 6.3	1	$\cdot\text{C}_{10}\text{H}_{11}$ , tetralin-1-yl	154.8 $\pm$ 5.0	1
$\text{nC}_6\text{H}_{13}\cdot$ , $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{C}\cdot\text{H}_2$	33.5	1	$\cdot\text{C}_{10}\text{H}_{13}$ , 1-phenyl-but-4-yl	192.0	1
$\cdot\text{C}_6\text{H}_{13}$ , $(\text{nC}_4\text{H}_9)(\text{CH}_3)\text{C}\cdot\text{H}$	29.3	1	$\cdot\text{C}_{10}\text{H}_{13}$ , $(\text{C}_6\text{H}_5\text{CH}_2)(\text{C}_2\text{H}_5)\text{C}\cdot\text{H}$	184.5	1
$\cdot\text{C}_6\text{H}_{13}$ , 2-methyl-2-pentyl	3.3 $\pm$ 8.4	1	$\cdot\text{C}_{10}\text{H}_{13}$ , $(\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2)(\text{CH}_3)\text{C}\cdot\text{H}$	184.5	1
$\cdot\text{C}_6\text{H}_{13}$ , 3-methyl-3-pentyl	14.2	1	$\cdot\text{C}_{10}\text{H}_{13}$ , $(\text{C}_6\text{H}_5\text{C}\cdot\text{HCH}_2\text{CH}_2\text{CH}_3)$	134.7	1
$\cdot\text{C}_6\text{H}_{13}$ , 2,3-dimethyl-2-butyl	3.1 $\pm$ 10	1	$\cdot\text{C}_{10}\text{H}_{15}$ , 1-adamantyl	51.5	1
$\cdot\text{C}_7\text{H}_3$ , $(\text{CH}\equiv\text{C})_3\text{C}\cdot$	784.5	1	$\cdot\text{C}_{10}\text{H}_{15}$ , 2-adamantyl	61.9	1
$\cdot\text{C}_7\text{H}_7$ , benzyl, $\text{C}_6\text{H}_5\text{C}\cdot\text{H}_2$	208.0 $\pm$ 1.7	1	$\cdot\text{C}_{10}\text{H}_{19}$ , cyclodecanyl	32.2	1
$\cdot\text{C}_7\text{H}_7$ , quadricyclolan-5-yl	578.6 $\pm$ 5.4	1	$\cdot\text{C}_{11}\text{H}_9$ , 1-naphthylmethyl	252.7	1
$\cdot\text{C}_7\text{H}_7$ , quadricyclolan-4-yl	587.4 $\pm$ 5.4	1	$\cdot\text{C}_{11}\text{H}_{21}$ , cycloundecanyl	7.5	1
$\cdot\text{C}_7\text{H}_7$ , norborna-2,5-dien-7-yl	511.7 $\pm$ 7.9	1	$\cdot\text{C}_{12}\text{H}_{23}$ , cyclododecanyl	-38.5	1
$\cdot\text{C}_7\text{H}_7$ , cyclohepta-1,3,5-trien-7-yl	285.3 $\pm$ 12.6	1	$\cdot\text{C}_{13}\text{H}_9$ , 9-fluorenyl	297.5	1
$\cdot\text{C}_7\text{H}_9$ , $\text{CH}_2=\text{CH}(\text{CH}=\text{CH})_2\text{CC}\cdot\text{H}_2$	251.0	1	$\cdot\text{C}_{13}\text{H}_{11}$ , $(\text{C}_6\text{H}_5)_2\text{C}\cdot\text{H}$	302.1 $\pm$ 4.2	1

Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.
$\cdot\text{C}_{13}\text{H}_{11}$ , 9-methyl-9-fluorenyl	268.2	1	$\cdot\text{C}_2\text{HF}_4$ , $\text{CHF}_2\text{C}\cdot\text{F}_2$	-664.8	1
$\cdot\text{C}_{14}\text{H}_{11}$ , 9,10-dihydroanthracen-9-yl	261.0	1	$\cdot\text{C}_2\text{H}_2\text{F}_3$ , $\text{CF}_3\text{C}\cdot\text{H}_2$	-517.1 $\pm$ 8.4	1
$\cdot\text{C}_{15}\text{H}_{11}$ , 9-anthracenylmethyl	337.6	1	$\cdot\text{C}_2\text{H}_2\text{F}_3$ , $\text{CHF}_2\text{C}\cdot\text{HF}$	-456.0	1
$\cdot\text{C}_{15}\text{H}_{11}$ , 9-phenanthrenylmethyl	311.3	1	$\cdot\text{C}_2\text{H}_2\text{F}_3$ , $\text{CH}_2\text{FC}\cdot\text{F}_2$	-449.8	1
$\cdot\text{C}_{16}\text{H}_{31}$ , $\text{CH}_2=\text{CHC}\cdot\text{H}(\text{CH}_2)_{12}\text{CH}_3$	-118.8	1	$\cdot\text{C}_2\text{H}_2\text{F}_2\text{Cl}$ , $\text{CF}_2\text{ClC}\cdot\text{H}_2$	-310.9 $\pm$ 7.0	1
$\cdot\text{C}_{19}\text{H}_{15}$ , trityl, $(\text{C}_6\text{H}_5)_3\text{C}\cdot$	392.0 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_3\text{F}_2$ , $\text{CH}_3\text{C}\cdot\text{F}_2$	-302.5 $\pm$ 8.4	1
$\cdot\text{C}_{35}\text{H}_{25}$ , pentamethylcyclopentadienyl	67.4	1	$\cdot\text{C}_2\text{H}_3\text{F}_2$ , $\text{CHF}_2\text{C}\cdot\text{H}_2$	-285.8	1
CF	255.2 $\pm$ 8	1	$\cdot\text{C}_2\text{H}_3\text{F}_2$ , $\text{CH}_2\text{FC}\cdot\text{HF}$	-238.5	1
$\text{CF}_2$	-182.0 $\pm$ 6.3	1	$\cdot\text{C}_2\text{H}_4\text{F}$ , $\text{CH}_3\text{C}\cdot\text{HF}$	-70.3 $\pm$ 8.4	1
$\text{FC}\cdot(\text{O})$	-161.2 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_4\text{F}$ , $\text{CH}_2\text{FC}\cdot\text{H}_2$	-59.4 $\pm$ 8.4	1
CHF	143.0 $\pm$ 12.6	1	$\cdot\text{C}_2\text{H}_2\text{F}_2\text{Cl}$ , $\text{CF}_2\text{ClC}\cdot\text{H}_2$	-315.2 $\pm$ 6	1
CCIF	31.0 $\pm$ 13.4	1	$\cdot\text{C}_2\text{F}_4\text{Cl}$ , $\text{CF}_2\text{ClC}\cdot\text{F}_2$	-686.0	1
CCl	443.1 $\pm$ 13.0	1	$\cdot\text{C}_2\text{HF}_3\text{Cl}$ , $\text{CClF}_2\text{C}\cdot\text{HF}$	-450.6 $\pm$ 12.6	1
$\text{CCl}_2$	226	1	$\cdot\text{C}_2\text{F}_4\text{Cl}$ , $\text{CF}_3\text{C}\cdot\text{FCl}$	-728.0	1
$\text{ClC}\cdot(\text{O})$	-21.8 $\pm$ 2.5	1	$\cdot\text{C}_2\text{F}_3\text{Cl}_2$ , $\text{CF}_3\text{C}\cdot\text{Cl}_2$	-564.0	1
CHCl	326.4 $\pm$ 8.4	1	$\cdot\text{C}_2\text{F}_3\text{ClBr}$ , $\text{CF}_3\text{C}\cdot\text{ClBr}$	-504.2 $\pm$ 8.4	1
CClBr	267	1	$\cdot\text{C}_2\text{Cl}$ , $\text{ClC}\equiv\text{C}\cdot$	534 $\pm$ 50	1
CBr	510 $\pm$ 63	1	$\cdot\text{C}_2\text{Cl}_3$ , $\text{CCl}_2=\text{C}\cdot\text{Cl}$	190 $\pm$ 50	1
CHBr	373 $\pm$ 18	1	$\cdot\text{C}_2\text{Cl}_5$ , $\text{CCl}_3\text{C}\cdot\text{Cl}_2$	35.1 $\pm$ 5.4	1
$\text{CBr}_2$	343.5	1	$\cdot\text{C}_2\text{HCl}_4$ , $\text{CHCl}_2\text{C}\cdot\text{Cl}_2$	23.4 $\pm$ 8.4	1
Cl	570 $\pm$ 35	1	$\cdot\text{C}_2\text{HCl}_4$ , $\text{CCl}_3\text{C}\cdot\text{HCl}$	51.0	1
$\text{Cl}_2$	468 $\pm$ 60	1	$\cdot\text{C}_2\text{H}_2\text{Cl}_3$ , $\text{CH}_2\text{ClC}\cdot\text{Cl}_2$	26.4	1
$\cdot\text{CF}_3$	-465.7 $\pm$ 2.1	1	$\cdot\text{C}_2\text{H}_2\text{Cl}_3$ , $\text{CHCl}_2\text{C}\cdot\text{HCl}$	46.4	1
$\cdot\text{CHF}_2$	-238.9 $\pm$ 4.2	1	$\cdot\text{C}_2\text{H}_2\text{Cl}_3$ , $\text{CCl}_3\text{C}\cdot\text{H}_2$	71.5 $\pm$ 8	1
$\cdot\text{CH}_2\text{F}$	-31.8 $\pm$ 4.2	1	$\cdot\text{C}_2\text{H}_3\text{Cl}_2$ , $\text{CH}_3\text{C}\cdot\text{Cl}_2$	42.5 $\pm$ 1.7	1
$\cdot\text{CClF}_2$	-279.0 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_3\text{Cl}_2$ , $\text{CH}_2\text{ClC}\cdot\text{ClH}$	65.3	1
$\cdot\text{CCl}_2\text{F}$	-89.0 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_3\text{Cl}_2$ , $\text{CHCl}_2\text{C}\cdot\text{H}_2$	90.1 $\pm$ 0.8	1
$\cdot\text{CBrClF}$	-35.5 $\pm$ 6.3	1	$\cdot\text{C}_2\text{H}_4\text{Cl}$ , $\text{CH}_3\text{C}\cdot\text{HCl}$	76.5 $\pm$ 1.6	1
$\cdot\text{CHClF}$	-60.7 $\pm$ 10.0	1	$\cdot\text{C}_2\text{H}_4\text{Cl}$ , $\text{CH}_2\text{ClC}\cdot\text{H}_2$	93.0 $\pm$ 2.4	1
$\cdot\text{CBrF}_2$	-224.7 $\pm$ 12.6	1	$\cdot\text{C}_2\text{H}_3\text{Br}_2$ , $\text{CH}_3\text{C}\cdot\text{Br}_2$	140.2 $\pm$ 5.4	1
$\cdot\text{CCl}_3$	71.1 $\pm$ 2.5	1	$\cdot\text{C}_2\text{H}_4\text{Br}$ , $\text{BrCH}_2\text{C}\cdot\text{H}_2$	135.1	1
$\cdot\text{CHCl}_2$	87.1 $\pm$ 1.6	1	$\cdot\text{C}_2\text{H}_4\text{Br}$ , $\text{CH}_3\text{C}\cdot\text{HBr}$	133.4 $\pm$ 3.4	3
$\cdot\text{CH}_2\text{Cl}$	117.2 $\pm$ 2.9	1	$\cdot\text{C}_2\text{Br}$ , $\text{CBrC}\cdot$	623.8	1
$\cdot\text{CHBrCl}$	140 $\pm$ 4	1	$\cdot\text{C}_2\text{Br}_3$ , $\text{CBr}_2\text{C}\cdot\text{Br}$	385.3	1
$\cdot\text{CHBr}_2$	199.1 $\pm$ 2.7	3	$\cdot\text{C}_2\text{Br}_5$ , $\text{CBr}_3\text{C}\cdot\text{Br}_2$	283.3	1
$\cdot\text{CBr}_2\text{Cl}$	163 $\pm$ 8	1	$\cdot\text{C}_3\text{H}_6\text{Cl}$ , $\text{CH}_3\text{CH}_2\text{C}\cdot\text{HCl}$	56.6	1
$\cdot\text{CBrCl}_2$	124 $\pm$ 8	1	$\cdot\text{C}_3\text{H}_6\text{Cl}$ , $\text{CH}_3\text{C}\cdot\text{ClCH}_3$	29.9 $\pm$ 0.6	1
$\cdot\text{CBr}_3$	214.8	1	$\cdot\text{C}_3\text{H}_6\text{Br}$ , $\text{C}\cdot\text{H}_2\text{CH}_2\text{CH}_2\text{Br}$	120.1 $\pm$ 1.3	1
$\cdot\text{CH}_2\text{Br}$	171.1 $\pm$ 2.7	1	$\cdot\text{C}_3\text{H}_6\text{Br}$ , $\text{CH}_3\text{C}\cdot\text{HCH}_2\text{Br}$	96.7 $\pm$ 5.9	1
$\cdot\text{Cl}_3$	424.9 $\pm$ 2.8	1	$\cdot\text{C}_3\text{H}_6\text{Br}$ , $\text{CH}_3\text{CH}_2\text{C}\cdot\text{HBr}$	107.5 $\pm$ 2.5	1
$\cdot\text{CHI}_2$	314.4 $\pm$ 3.3	1	$\cdot\text{C}_6\text{F}_5$	-547.7 $\pm$ 8.4	1
$\cdot\text{CH}_2\text{I}$	229.7 $\pm$ 8.4	1	$\cdot\text{CH}_3\text{O}$ , $\text{HOC}\cdot\text{H}_2$	-17.0 $\pm$ 0.7	1
$\cdot\text{C}_3\text{F}$ , $\text{FC}\equiv\text{C}\cdot$	460.0 $\pm$ 21.0	1	$\cdot\text{CH}_2\text{ClO}$ , $\text{HOC}\cdot\text{ClH}$	-60.7 $\pm$ 7.5	1
$\cdot\text{C}_2\text{Cl}$ , $\text{ClC}\equiv\text{C}\cdot$	568 $\pm$ 26	1	$\cdot\text{CHCl}_2\text{O}$ , $\text{HOC}\cdot\text{Cl}_2$	-94.1 $\pm$ 7.5	1
$\cdot\text{C}_2\text{F}_3$ , $\text{CF}_2=\text{C}\cdot\text{F}$	-192.0 $\pm$ 8.4	1	$\cdot\text{CH}_2\text{ClO}$ , $\text{ClOC}\cdot\text{H}_2$	135.6 $\pm$ 9.2	1
$\cdot\text{C}_2\text{F}_2\text{H}$ , $\text{CF}_2=\text{C}\cdot\text{H}$	-92.9 $\pm$ 8.4	1	$\cdot\text{CH}_2\text{BrO}$ , $\text{BrOC}\cdot\text{H}_2$	151 $\pm$ 16	1
$\cdot\text{C}_2\text{F}_2\text{H}$ , $\text{CHF}=\text{C}\cdot\text{F}$	-50.6 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_3\text{O}$ , $\text{C}\cdot\text{H}=\text{CHOH}$	121 $\pm$ 11	1
$\cdot\text{CCl}_2\text{H}$ , $\text{CHCl}=\text{C}\cdot\text{Cl}$	234.7 $\pm$ 8.4	1	$\cdot\text{C}_2\text{H}_3\text{O}$ , $\text{C}\cdot\text{H}_2\text{CHO}$	13.0 $\pm$ 2	1
$\cdot\text{CClH}_2$ , $\text{CH}_2=\text{C}\cdot\text{Cl}$	>251	1	$\cdot\text{C}_2\text{H}_5\text{O}$ , $\text{CH}_3\text{C}\cdot\text{HOH}$	-54.0	1
$\cdot\text{C}_2\text{F}_5$ , $\text{CF}_3\text{C}\cdot\text{F}_2$	-892.9 $\pm$ 4.2	1	$\cdot\text{C}_2\text{H}_4\text{ClO}$ , $\text{CH}_3\text{C}\cdot\text{ClOH}$	-108.4 $\pm$ 8.8	1
$\cdot\text{C}_2\text{HF}_4$ , $\text{CF}_3\text{C}\cdot\text{HF}$	-680.8 $\pm$ 9.6	1	$\cdot\text{C}_2\text{H}_4\text{ClO}$ , $\text{C}\cdot\text{H}_2\text{CHClOH}$	-73.2 $\pm$ 8.8	1

Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.
$\cdot\text{C}_2\text{H}_3\text{Cl}_2\text{O}$ , $\text{C}\cdot\text{H}_2\text{CCl}_2\text{OH}$	$-99.6 \pm 8.8$	1	$\text{iPrC}(\text{O})\text{C}\cdot(\text{CH}_3)_2$	$-173.6 \pm 20.9$	1
$\cdot\text{C}_2\text{H}_5\text{O}$ , $\text{C}\cdot\text{H}_2\text{CH}_2\text{OH}$	$-31 \pm 7$	1	$\text{tC}_4\text{H}_9\text{C}(\text{O})\text{C}\cdot\text{H}_2$	$-115.5 \pm 12.6$	1
$\cdot\text{C}_2\text{H}_3\text{O}$ , oxiran-2-yl	$149.8 \pm 6.3$	1	$\text{PhC}(\text{O})\text{C}\cdot\text{H}_2$	$84.5 \pm 12.6$	1
$\cdot\text{C}_3\text{H}_5\text{O}$ , $\text{CH}_2=\text{CHC}\cdot\text{HOH}$	$0 \pm 8.4$	1	$\text{PhC}(\text{O})\text{C}\cdot\text{HCH}_3$	$41.4 \pm 20.9$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\text{CH}_3\text{CH}_2\text{C}\cdot\text{HOH}$	$-81 \pm 4$	1	$\text{PhC}\cdot\text{HC}(\text{O})\text{CH}_2\text{Ph}$	$134.3 \pm 20.9$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $(\text{CH}_3)_2\text{C}\cdot\text{HCH}_2\text{OH}$	$-78.7 \pm 8.4$	1	$\text{PhC}(\text{O})\text{OC}\cdot\text{H}_2$	$-69.9$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\text{HOCH}_2\text{CH}_2\text{C}\cdot\text{H}_2$	$-66.9 \pm 8.4$	1	$\cdot\text{C}(\text{O})\text{OH-trans}$	$\geq -194.6 \pm 2.9$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $(\text{CH}_3)_2\text{C}\cdot\text{OH}$	$-96.4$	1	$\cdot\text{C}(\text{O})\text{OH-cis}$	$-219.7$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\cdot\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$	$-62.8 \pm 11.7$	1	$\cdot\text{C}(\text{O})\text{OCH}_3$	$-161.5$	1
$\cdot\text{C}_4\text{H}_9\text{O}$ , $\cdot\text{CH}_2\text{C}(\text{OH})(\text{CH}_3)_2$	$-147.3 \pm 8.4$	1	$\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{OH}$	$-248.9 \pm 12.0$	1
$\cdot\text{C}_2\text{H}_5\text{O}_2$ , $\text{C}\cdot\text{H}_2\text{OCH}_2\text{OOH}$	$109.6 \pm 4.2$	1	$\text{C}\cdot\text{H}(\text{CH}_3)\text{C}(\text{O})\text{OH}$	$-293 \pm 3$	1
$\text{PhCH}\cdot\text{OH}$	$29.3 \pm 8.4$	1	$\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{OCH}_3$	$-236.8 \pm 8.4$	1
$\text{Ph}_2\text{C}\cdot\text{OH}$	$152.3 \pm 6.3$	1	$\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{OCH}_2\text{CH}_3$	$-260.2 \pm 12.6$	1
$\cdot\text{C}_2\text{H}_5\text{O}$ , $\text{CH}_3\text{OC}\cdot\text{H}_2$	$0 \pm 4.2$	1	$\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{OPh}$	$-28.0$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\text{CH}_3\text{OC}\cdot\text{HCH}_3$	$-57.7 \pm 8.4$	1	$\cdot\text{C}_4\text{H}_7\text{O}$ , tetrahydrofuran-2-yl	$-18.0 \pm 6.3$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\text{CH}_3\text{CH}_2\text{OC}\cdot\text{H}_2$	$-45.2 \pm 8.4$	1	$\cdot\text{C}_4\text{H}_8\text{O}$ , cyclopentanone-2-yl	$-41.8 \pm 12.6$	1
$\cdot\text{C}_3\text{H}_7\text{O}$ , $\text{C}\cdot\text{H}_2\text{CH}_2\text{OCH}_3$	$-7.1 \pm 4.2$	1	$\cdot\text{C}_4\text{H}_7\text{O}_2$ , 1,4-dioxan-2-yl	$-131.8 \pm 12.6$	1
$\cdot\text{C}_4\text{H}_9\text{O}$ , $(\text{CH}_3)_2\text{CHOC}\cdot\text{H}_2$	$-70.3 \pm 7.1$	1	$\cdot\text{C}_2\text{H}_5\text{O}_2$ , 2-C(O)OH- $\cdot\text{C}_6\text{H}_4$	$-33.0$	1
$\cdot\text{C}_4\text{H}_9\text{O}$ , $\text{CH}_3\text{CH}_2\text{OC}\cdot\text{HCH}_3$	$-81.2 \pm 4.2$	1	$\cdot\text{C}_2\text{H}_5\text{O}_2$ , 3-C(O)OH- $\cdot\text{C}_6\text{H}_4$	$-35.0$	1
$\cdot\text{C}_4\text{H}_9\text{O}$ , $\text{C}\cdot\text{H}_2\text{CH}(\text{CH}_3)\text{OCH}_3$	$-42.3 \pm 3.8$	1	$\cdot\text{C}_2\text{H}_5\text{O}_2$ , 4-C(O)OH- $\cdot\text{C}_6\text{H}_4$	$-36.0$	1
$\cdot\text{C}_4\text{H}_9\text{O}$ , $(\text{CH}_3)_2\text{C}\cdot\text{OCH}_3$	$-72.4 \pm 10$	1	$\cdot\text{CH}_3\text{O}_2$ , $\text{C}\cdot\text{H}_2\text{OOH}$	$66.1$	1
$\cdot\text{C}_5\text{H}_{11}\text{O}$ , $(\text{CH}_3)_3\text{COC}\cdot\text{H}_2$	$-102.5 \pm 8.4$	1	$\cdot\text{C}_2\text{H}_5\text{O}_2$ , $\text{C}\cdot\text{H}_2\text{CH}_2\text{OOH}$	$46.0 \pm 4.6$	1
$\cdot\text{C}_2\text{H}_5\text{O}_2$ , $\text{HOCH}_2\text{C}\cdot\text{HOH}$	$-220.1 \pm 8.4$	1	$\cdot\text{C}_2\text{H}_5\text{O}_2$ , $\text{CH}_3\text{CH}\cdot\text{OOH}$	$26.9$	1
$\text{C}\cdot\text{H}=\text{C}=\text{O}$ , ketylenyl	$177.5 \pm 8.8$	1	$\cdot\text{C}_3\text{H}_7\text{O}_2$ , $\text{CH}_3\text{CH}\cdot\text{CH}_2\text{OOH}$	$10.9 \pm 5.4$	1
$\text{HC}\cdot(\text{O})$	$42.5 \pm 0.5$	1	$\cdot\text{C}_3\text{H}_7\text{O}_2$ , $\text{C}\cdot\text{H}_2\text{CH}(\text{OOH})\text{CH}_3$	$2.9 \pm 6.3$	1
$\text{C}\cdot\text{CO}$	$381.2 \pm 2.1$	1	$\cdot\text{C}_4\text{H}_9\text{O}_2$ , $(\text{CH}_3)_2\text{C}\cdot\text{CH}_2\text{OOH}$	$-30.1 \pm 5.4$	1
$\text{CH}_3\text{C}\cdot(\text{O})$	$-10.3 \pm 1.8$	1	$\cdot\text{C}_4\text{H}_9\text{O}_2$ , $\text{C}\cdot\text{H}_2\text{C}(\text{CH}_3)_2\text{OOH}$	$-26.8 \pm 5.4$	1
$\text{CF}_3\text{C}\cdot(\text{O})$	$-608.7$	1	$\cdot\text{C}_2\text{H}_3\text{O}_3$ , $\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{OOH}$	$-137.9$	1
$\text{CH}_2\text{ClC}\cdot(\text{O})$	$-21 \pm 12.6$	1	$\cdot\text{CHN}_2$	$494.5$	1
$\text{CHCl}_2\text{C}\cdot(\text{O})$	$-17.6 \pm 23$	1	$\cdot\text{CH}_2\text{N}=\text{CH}_2$	$263.6 \pm 12.6$	1
$\text{CCl}_3\text{C}\cdot(\text{O})$	$-19.7$	1	$\cdot\text{CH}_2\text{NH}_2$	$151.9 \pm 8.4$	1
$\text{CH}_3\text{CH}_2\text{C}\cdot(\text{O})$	$-31.7 \pm 3.4$	1	$\text{CH}_3\text{C}\cdot\text{HNH}_2$	$111.7 \pm 8.4$	1
$\text{CH}_2\text{CHC}\cdot(\text{O})$	$88.5$	1	$(\text{CH}_3)_2\text{C}\cdot\text{NH}_2$	$69.9 \pm 8.4$	1
$\text{CH}_2\text{C}(\text{CH}_3)\text{C}\cdot(\text{O})$	$58.6 \pm 16.7$	1	$\cdot\text{CH}_2\text{NHCH}_3$	$156.6$	1
$\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\cdot(\text{O})$	$54.4 \pm 4.2$	1	$\cdot\text{CH}_2\text{N}(\text{CH}_3)_2$	$148.0$	1
$(\text{CH}_3)_2\text{CHC}\cdot(\text{O})$	$-64.0 \pm 3.8$	1	$(\text{C}_2\text{H}_5)_2\text{NC}\cdot\text{HCH}_3$	$68.6 \pm 2.1$	1
$(\text{CH}_3)_3\text{CC}\cdot(\text{O})$	$-102.9 \pm 6.3$	1	$\cdot\text{CH}_2\text{N}(\text{CH}_3)\text{Ph}$	$266.0 \pm 12.6$	1
$\text{C}_6\text{H}_5\text{C}\cdot(\text{O})$	$116.3 \pm 10.9$	1	$\cdot\text{CN}$	$439.3 \pm 2.9$	1
$\text{HC}(\text{O})\text{CH}_2\cdot$	$10.5 \pm 9.2$	1	$\cdot\text{CH}_2\text{CN}$	$252.6 \pm 4$	1
$\text{ClC}(\text{O})\text{CH}_2\cdot$	$-52.7 \pm 13$	1	$\text{CH}_3\text{C}\cdot\text{HCN}$	$226.7 \pm 12.6$	1
$\text{E}\cdot\text{C}\cdot\text{HCIC}(\text{O})\text{H}$	$-27.2 \pm 10.5$	1	$\cdot\text{CH}_2\text{CH}_2\text{CN}$	$245.4 \pm 12.6$	1
$\text{Z}\cdot\text{C}\cdot\text{HCIC}(\text{O})\text{H}$	$-23.4 \pm 10.5$	1	$(\text{CH}_3)_2\text{C}\cdot\text{CN}$	$190.4 \pm 12.6$	1
$\text{C}\cdot\text{Cl}_2\text{C}(\text{O})\text{H}$	$-55.6 \pm 14.2$	1	$\text{Ph}(\text{CH}_3)\text{C}\cdot\text{CN}$	$248.5 \pm 8.4$	1
$\text{E}\cdot\text{C}\cdot\text{HCIC}(\text{O})\text{Cl}$	$-88.7 \pm 15.1$	1	$\text{NCC}\cdot\text{HCH}_2\text{CN}$	$381.8 \pm 12.6$	1
$\text{C}\cdot\text{H}_2\text{C}(\text{O})\text{F}$	$-273.0 \pm 5.8$	1	$\cdot\text{CH}_2\text{NC}$	$334.7 \pm 16.7$	1
$\text{Z}\cdot\text{C}\cdot\text{HCIC}(\text{O})\text{Cl}$	$-84.9 \pm 13.8$	1	$\cdot\text{C}(\text{O})\text{NC}$	$210.0 \pm 10$	1
$\text{C}\cdot\text{Cl}_2\text{C}(\text{O})\text{Cl}$	$-101.7 \pm 15.5$	1	$\cdot\text{C}(\text{O})\text{NH}_2$	$-15.1 \pm 4$	1
$\text{CH}_3\text{C}(\text{O})\text{CH}_2\cdot$	$-34 \pm 3$	1	$\text{C}\cdot\text{NN}$	$569 \pm 21$	1
$\text{CH}_3\text{C}(\text{O})\text{C}\cdot\text{HCH}_3$	$-70.3 \pm 7.1$	1	$\text{HC}\cdot\text{NN}$	$460 \pm 8$	1
$\text{CH}_3\text{C}(\text{O})\text{C}\cdot=\text{CH}_2$	$113.4$	1	$\text{H}_2\text{C}\cdot\text{NN}$	$292.5 \pm 2.1$	1
$\text{C}_2\text{H}_5\text{C}(\text{O})\text{C}\cdot\text{HCH}_3$	$-107.5 \pm 20.9$	1	$\cdot\text{CH}_2\text{NO}$	$157 \pm 4$	1



Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.
$\cdot\text{CH}_2\text{NO}_2$	115.1 $\pm$ 12.6	1	$\text{Ph}_2\text{C}\cdot\text{SO}_2\text{Ph}$	102 $\pm$ 12.6	1
$\text{CH}_3\text{C}\cdot\text{HNO}_2$	61.9 $\pm$ 12.6	1	$\text{Ph}_2\text{C}\cdot\text{SPh}$	435.6 $\pm$ 12.6	1
$(\text{CH}_3)_2\text{C}\cdot\text{NO}_2$	6.3 $\pm$ 12.6	1	$\text{NC}\cdot(\text{O})$	127.2	1
$\text{PhC}\cdot\text{HNO}_2$	169.0 $\pm$ 12.6	1	$\cdot\text{CNH}$	207.9 $\pm$ 12.1	1
$\cdot\text{C}_6\text{H}_6\text{N}$ , 3-NH <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	320.1	1	$\cdot\text{CNO}$	323 $\pm$ 30	1
$\cdot\text{C}_6\text{H}_6\text{N}$ , 4-NH <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	327.8	1	$\cdot\text{CH}_2\text{SiMe}_3$	-32 $\pm$ 6	1
$\cdot\text{C}_6\text{H}_4\text{NO}_2$ , 3-NO <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	340.6 $\pm$ 10.0	1	$\cdot\text{CH}_2\text{C}(\text{CH}_3)_2\text{SiMe}_3$	-125	1
$\cdot\text{C}_6\text{H}_4\text{NO}_2$ , 4-NO <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	302.7	1	$\cdot\text{CP}$	450 $\pm$ 9	1
$\cdot\text{C}_6\text{H}_4\text{CH}_3$ , 2-Me-C <sub>6</sub> H <sub>4</sub>	315.1 $\pm$ 10.5	1	<b>(2) Oxygen-Centered Species</b>		
$\cdot\text{C}_6\text{H}_4\text{CH}_3$ , 4-Me-C <sub>6</sub> H <sub>4</sub>	296.6 $\pm$ 9.6	1	$\text{HO}\cdot$	37.36 $\pm$ 0.13	1
$\cdot\text{C}_6\text{H}_3\text{N}_2\text{O}_4$ , 3,5-(NO <sub>2</sub> ) <sub>2</sub> -C <sub>6</sub> H <sub>3</sub>	305.4	1	$\text{FO}\cdot$	109 $\pm$ 10	1
$\cdot\text{C}_6\text{H}_6\text{NO}_2$ , 2-Me-4-NO <sub>2</sub> -C <sub>6</sub> H <sub>3</sub>	295.4 $\pm$ 8.4	1	$\text{ClO}\cdot$	101.63 $\pm$ 0.1	1
$\cdot\text{C}_4\text{H}_3\text{N}$ , pyrrol-2-yl	385.8	1	$\text{BrO}\cdot$	126.2 $\pm$ 1.7	1
$\cdot\text{C}_4\text{H}_3\text{N}$ , pyrrol-3-yl	385.8	1	$\text{IO}\cdot$	115.9 $\pm$ 5.0	1
$\cdot\text{C}_4\text{H}_8\text{N}$ , pyrrolidin-2-yl	142.7 $\pm$ 12.6	1	$\text{HOO}\cdot$	12.30 $\pm$ 0.25	1
$\cdot\text{C}_5\text{H}_4\text{N}$ , pyrid-2-yl	362.0	1	$\text{FOO}\cdot$	25.4 $\pm$ 2	1
$\cdot\text{C}_5\text{H}_4\text{N}$ , pyrid-3-yl	391.0	1	$\text{ClOO}\cdot$	98.0 $\pm$ 4	1
$\cdot\text{C}_5\text{H}_4\text{N}$ , pyrid-4-yl	391.0	1	$\text{BrOO}\cdot$	108 $\pm$ 40	1
$\cdot\text{C}_4\text{H}_7\text{N}_2$ , piperad-2-yl	119.7	1	$\text{IOO}\cdot$	96.6 $\pm$ 15	1
$\cdot\text{C}_4\text{H}_3\text{N}_2$ , pyrazin-2-yl	409.2 $\pm$ 12.6	1	$\text{OFO}\cdot$	378.6 $\pm$ 20	1
$\cdot\text{C}_4\text{H}_3\text{N}_2$ , pyrimid-2-yl	388.0 $\pm$ 12.6	1	$\text{OCIO}\cdot$	95.4	1
$\cdot\text{C}_4\text{H}_3\text{N}_2$ , pyrimid-4-yl	409.0 $\pm$ 12.6	1	$\text{ClOOCIO}\cdot$	142 $\pm$ 12	1
$\cdot\text{C}_4\text{H}_3\text{N}_2$ , pyrimid-5-yl	446.4 $\pm$ 12.6	1	$\text{ClClO}\cdot$	90 $\pm$ 30	1
$\cdot\text{CH}(\text{NO}_2)_2$	139.1	1	$\text{NCO}\cdot$	184.1	1
$\cdot\text{C}(\text{NO}_2)_3$	201.2	1	$\text{CNO}\cdot$	386.6	1
$\cdot\text{CH}_2\text{C}(\text{NO}_2)_3$	150.6	1	$\text{HONNO}\cdot$	172	1
$\cdot\text{CH}_2\text{CH}(\text{NO}_2)_2$	103.3	1	$\text{sym-ClO}_3$	217.2 $\pm$ 21	1
$\cdot\text{CH}_2\text{CH}_2\text{C}(\text{NO}_2)_3$	133.9	1	$\text{HSO}\cdot$	-21.8 $\pm$ 2.1	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_2\text{C}(\text{NO}_2)_3$	173.6	1	$\text{HSOO}\cdot$	112	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_2\text{CH}(\text{NO}_2)_2$	126.4	1	$\text{CH}_3\text{SOO}\cdot$	76	1
$\cdot\text{CH}_2\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_2\text{C}(\text{NO}_2)_3$	168.6	1	$\text{CF}_3\text{SO}_2\cdot$	-912	1
$\cdot\text{CH}_2\text{CH}_2\text{ONO}_2$	37.7	1	$\text{NCO}\cdot$	184.0	1
$\cdot\text{CH}_2(\text{ONO}_2)\text{CHCH}_2\text{ONO}_2$	-25.5	1	$\text{O}_2\text{NO}\cdot$	73.7 $\pm$ 1.4	1
$\cdot\text{CH}(\text{CH}_2\text{ONO}_2)_2$	-57.3	1	$\text{ONOO}\cdot$	82.8	1
$\cdot\text{CH}_2\text{C}(\text{CH}_2\text{ONO}_2)_3$	-158.2	1	$\text{HOS}(\text{O})_2\cdot$	-511.7	1
$\cdot\text{CH}_2\text{NHNO}_2$	164.8	1	$\text{CH}_3\text{O}\cdot$	21.0 $\pm$ 2.1	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_3$	149.4	1	$\text{CF}_3\text{O}\cdot$	-635.1 $\pm$ 7.1	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)_2$	210.5	1	$\text{CCl}_3\cdot$	-38.1 $\pm$ 9.2	1
$\cdot\text{CH}_2\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_3$	144.3	1	$\text{CH}_2\text{ClO}\cdot$	-21.3 $\pm$ 9.2	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_2\text{N}(\text{NO}_2)\text{CH}_3$	202.1	1	$\text{CHCl}_2\cdot$	-32.2 $\pm$ 9.2	1
$\cdot\text{CH}_2\text{N}(\text{NO}_2)(\text{CH}_2)\text{N}(\text{NO}_2)\text{CH}_3$	173.2	1	$\text{CH}_2=\text{CH}\cdot\text{O}\cdot$	18.4 $\pm$ 1.3	1
$\text{C}\cdot(\text{S})\text{H}$	300.4 $\pm$ 8.4	1	$\text{CF}_3\text{CHFO}\cdot$	-851.0	1
$\cdot\text{CH}_2\text{SH}$	151.9 $\pm$ 8.4	1	$\text{C}_2\text{H}_5\text{O}\cdot$	-13.6 $\pm$ 3.3	1
$\cdot\text{CH}_2\text{SCH}_3$	136.8 $\pm$ 5.9	1	$\text{CH}_3\text{CHClO}\cdot$	-61.9 $\pm$ 12.1	1
$\cdot\text{CH}_2\text{SPh}$	268.6 $\pm$ 12.6	1	$\text{CH}_3\text{CCl}_2\text{O}\cdot$	-91.6 $\pm$ 11.7	1
$\cdot\text{CH}_2\text{SOCH}_3$	23.8 $\pm$ 12.6	1	$\text{nC}_3\text{H}_7\text{O}\cdot$	-30.1 $\pm$ 8.4	1
$\text{HOC}\cdot(\text{S})\text{S}$	110.5	1	$\text{iC}_3\text{H}_7\text{O}\cdot$	-48.5 $\pm$ 3.3	1
$\cdot\text{CH}_2\text{SO}_2\text{CH}_3$	-177.0 $\pm$ 12.6	1	$(\text{CH}_3)_2\text{CClO}\cdot$	-108.4 $\pm$ 8.4	1
$\cdot\text{CH}_2\text{SO}_2\text{Ph}$	-57.3 $\pm$ 12.6	1	$\text{nC}_4\text{H}_9\text{O}\cdot$	-62.8	1
$\text{PhC}\cdot\text{HSO}_2\text{CH}_3$	-109.2 $\pm$ 12.6	1	$\text{sC}_4\text{H}_9\text{O}\cdot$	-69.5	1
$\text{PhC}\cdot\text{HSO}_2\text{Ph}$	7 $\pm$ 12.6	1	$\text{tC}_4\text{H}_9\text{O}\cdot$	-85.8 $\pm$ 3.8	1

Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ / \text{kJ mol}^{-1}$	Ref.
CH <sub>2</sub> =CHCH <sub>2</sub> O•	87.0	1	*NNH	249.5	1
C <sub>6</sub> H <sub>5</sub> O•	48.5 ± 2.9	1	*NCO	131.8	1
o-Cl-C <sub>6</sub> H <sub>4</sub> O•	30.6	1	*N <sub>3</sub>	414.2 ± 20.9	1
C <sub>6</sub> Cl <sub>5</sub> O•	~63	1	*N <sub>2</sub> H <sub>3</sub>	243.5	1
p-Cl-C <sub>6</sub> H <sub>4</sub> O•	~9	1	(Z)-N <sub>2</sub> H <sub>2</sub>	213.0 ± 10.9	1
o-OH-C <sub>6</sub> H <sub>4</sub> O•	-186.3	1	NF	209.2	1
p-OH-C <sub>6</sub> H <sub>4</sub> O•	-143.6	1	*NF <sub>2</sub>	42.3 ± 8	1
o-CH <sub>3</sub> O-C <sub>6</sub> H <sub>4</sub> O•	-125.5	1	*NHF	112 ± 15	1
p-CH <sub>3</sub> O-C <sub>6</sub> H <sub>4</sub> O•	-81.1	1	NBr	301 ± 21	1
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> O•	136.0 ± 12.6	1	HNO	107.1 ± 2.5	1
C <sub>10</sub> H <sub>7</sub> O•, naphthoxy-1	165.3	1	FNO	-65.7 ± 1.7	1
C <sub>10</sub> H <sub>7</sub> O•, naphthoxy-2	174.1	1	ClNO	51.71 ± 0.42	1
HC(O)O•	-129.7 ± 12.6	1	BrNO	82.13 ± 0.8	1
FC(O)O•	368.0	1	INO	112.1 ± 20.9	1
CH <sub>3</sub> C(O)O•	-179.9 ± 12.6	1	NCO	120.9	1
CF <sub>3</sub> C(O)O•	-797.0	1	NCN	464.8 ± 2.9	1
CF <sub>3</sub> OC(O)O•	-958.1 ± 16.7	1	NSi	372 ± 63	1
C <sub>6</sub> H <sub>5</sub> C(O)O•	-50.2 ± 16.7	1	NH <sub>2</sub> C(O)N•H	0.8 ± 12.6	1
CH <sub>3</sub> OO•	20.1 ± 5.1	1	CH <sub>3</sub> C(O)N•H	-6.7 ± 12.6	1
C <sub>2</sub> H <sub>3</sub> OO•, CH <sub>2</sub> =CHOO•	101.7 ± 1.7	1	NH <sub>2</sub> C(S)N•H	194 ± 12.6	1
C <sub>2</sub> H <sub>5</sub> OO•	-28.5 ± 9.6	1	CH <sub>3</sub> C(S)N•H	173 ± 12.6	1
C <sub>3</sub> H <sub>5</sub> OO•, CH <sub>2</sub> =CHCH <sub>2</sub> OO•	88.7	1	PhC(S)N•H	307 ± 12.6	1
iC <sub>3</sub> H <sub>7</sub> OO•	-65.4 ± 11.3	1	HCON•H	49.8 ± 12.6	1
C <sub>4</sub> H <sub>7</sub> OO•, CH <sub>3</sub> CH=CHCH <sub>2</sub> OO•	82.6 ± 5.3	1	NH <sub>2</sub> C(NH)N•H	250.6 ± 12.6	1
tC <sub>4</sub> H <sub>9</sub> OO•	-101.5 ± 9.2	1	*NHCN	319.2 ± 2.9	1
neo-C <sub>5</sub> H <sub>11</sub> OO•	-115.5	1	CH <sub>2</sub> N•H	104.6 ± 12.6	1
HOCH <sub>2</sub> OO•	-162.1	1	CH <sub>3</sub> N•H	184.1 ± 8.4	1
HOCH <sub>2</sub> CH <sub>2</sub> OO•	100	1	tBuN•H	95.4 ± 12.6	1
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> OO•	114.6 ± 4.2	1	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> N•H	288.3 ± 12.6	1
c-C <sub>6</sub> H <sub>11</sub> OO•	-25.0 ± 10.5	1	C <sub>6</sub> H <sub>5</sub> N•H	244.3 ± 4.2	1
(C <sub>2</sub> H <sub>5</sub> )N(CH <sub>3</sub> )CHOO•	-36.0 ± 12.6	1	(CH <sub>3</sub> ) <sub>2</sub> N•	158.2 ± 4.2	1
CF <sub>3</sub> OO•	-635.0	1	(C <sub>6</sub> H <sub>5</sub> )(CH <sub>3</sub> )N•	241.0 ± 6.3	1
CF <sub>2</sub> ClOO•	-406.7 ± 14.6	1	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> N•	366.0 ± 6.3	1
CFCl <sub>2</sub> OO•	-213.7	1	1-pyrrolyl	269.2 ± 12.6	1
CH <sub>2</sub> ClOO•	-5.1 ± 13.6	1	1-pyrazolyl	413.0 ± 2.1	1
CHCl <sub>2</sub> OO•	-19.2 ± 11.2	1	carbazol-9-yl	383.3 ± 8.4	1
CCl <sub>3</sub> OO•	-20.9 ± 8.9	1	CH <sub>3</sub> N <sub>2</sub> •	215.5 ± 7.5	1
CH <sub>3</sub> CHClOO•	-54.7 ± 3.4	1	C <sub>2</sub> H <sub>5</sub> N <sub>2</sub> •	187.4 ± 10.5	1
CH <sub>3</sub> CCl <sub>2</sub> OO•	-63.8 ± 9.8	1	iC <sub>3</sub> H <sub>7</sub> N <sub>2</sub> •	146.0 ± 8.4	1
CH <sub>3</sub> OCH <sub>2</sub> OO•	-142.2 ± 4.2	1	nC <sub>4</sub> H <sub>9</sub> N <sub>2</sub> •	140.6 ± 8.4	1
CH <sub>3</sub> C(O)CH <sub>2</sub> OO•	-142.1 ± 4	1	tC <sub>4</sub> H <sub>9</sub> N <sub>2</sub> •	97.5 ± 4.2	1
CH <sub>3</sub> C(O)OO•	-154.4 ± 5.8	1	(NO <sub>2</sub> )HN•	162.3	1
HOOO•	29.7 ± 8.4	1	(CH <sub>3</sub> )(NO <sub>2</sub> )N•	139.0	1
CH <sub>3</sub> OOO•	33.4 ± 12.6	1	(NO <sub>2</sub> ) <sub>2</sub> N•	200.0	1
C <sub>2</sub> H <sub>5</sub> OOO•	5.4 ± 12.6	1	CH <sub>3</sub> N•CH <sub>2</sub> N(NO <sub>2</sub> )CH <sub>3</sub>	185.4	1
<b>(3) Nitrogen-Centered Species</b>			<b>(4) Sulfur-Centered Species</b>		
ON	91.04 ± 0.08	1	HOS•	-6.7 ± 2.1	1
NO <sub>2</sub>	33.97 ± 0.08	1	HC(O)S•	56.5	1
N <sub>2</sub> O	82.05 ± 0.4	1	HS•O <sub>2</sub>	-221.8	1
NH	357 ± 1	1	HOS•O <sub>2</sub>	-384.9	1
*NH <sub>2</sub>	186.2 ± 1.0	1	NCS•	300 ± 8	1

Radical	$\Delta_f H^\circ_{298} / \text{kJ mol}^{-1}$	Ref.	Radical	$\Delta_f H^\circ_{298} / \text{kJ mol}^{-1}$	Ref.
HS•	143.0 ± 0.8	1	H <sub>3</sub> SiSi•H <sub>2</sub>	234 ± 6	1
CH <sub>3</sub> S•	124.7 ± 1.7	1	C <sub>6</sub> H <sub>5</sub> Si•H <sub>2</sub>	274	1
C <sub>2</sub> H <sub>5</sub> S•	101	1	H <sub>3</sub> SiSi•H	312 ± 8	1
nC <sub>3</sub> H <sub>7</sub> S•	80	1	MeSi•	302.2	1
iC <sub>3</sub> H <sub>7</sub> S•	74.9 ± 8.4	1	MeSi•H	202 ± 6	1
tC <sub>4</sub> H <sub>9</sub> S•	43.9 ± 8.4	1	Me <sub>2</sub> Si••	135 ± 8	1
C <sub>6</sub> H <sub>5</sub> S•	242.7 ± 4.6	1	SiN	313.8 ± 42	1
C <sub>6</sub> Cl <sub>5</sub> S•	~184	1	*GeH <sub>3</sub>	221.8 ± 8.4	1
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> S•	246	1	GeF	-71 ± 10	1
CH <sub>3</sub> S•O	-67 ± 10	1	GeF <sub>2</sub>	-574 ± 20	1
CH <sub>3</sub> S•O <sub>2</sub>	-239.3	1	*GeF <sub>3</sub>	-807 ± 50	1
HSS•	115.5 ± 14.6	1	GeCl	69 ± 18	1
CH <sub>3</sub> SS•	68.6 ± 8.4	1	GeCl <sub>2</sub>	-171 ± 5	1
C <sub>2</sub> H <sub>5</sub> SS•	43.5 ± 8.4	1	*GeCl <sub>3</sub>	-268 ± 50	1
iC <sub>3</sub> H <sub>7</sub> SS•	13.8 ± 8.4	1	GeBr	137 ± 5	1
tC <sub>4</sub> H <sub>9</sub> SS•	-19.2 ± 8.4	1	GeBr <sub>2</sub>	-61 ± 5	1
HOC(S)S•	110.5 ± 4.6	1	*GeBr <sub>3</sub>	-119 ± 50	1
HC(O)S•	56.5	1	GeI	211 ± 25	1
SF	13.0 ± 6.3	1	GeI <sub>2</sub>	50.2 ± 4	1
SF <sub>2</sub>	-296.7 ± 16.7	1	*GeI <sub>3</sub>	42 ± 50	1
SF <sub>3</sub>	-503.0 ± 33.5	1	SnF	-95 ± 7.2	1
SF <sub>4</sub>	-763.2 ± 20.9	1	SnF <sub>2</sub>	-511 ± 9.2	1
SF <sub>5</sub>	-879.9 ± 15.1	1	*SnF <sub>3</sub>	-647 ± 50	1
ClS•	156.5 ± 16.7	1	SnCl	35 ± 12	1
SN	263.6 ± 105	1	SnCl <sub>2</sub>	-202.6 ± 7.1	1
SCI	156.5 ± 16.7	1	*SnCl <sub>3</sub>	-292 ± 50	1
<b>(5) Si-, Ge-, Sn-, Pb-Centered Species</b>			SnBr	76 ± 12	1
SiF	-20.1 ± 12.6	1	SnBr <sub>2</sub>	-119 ± 2.8	1
SiF <sub>2</sub>	-638 ± 6	1	*SnBr <sub>3</sub>	-159 ± 50	1
*SiF <sub>3</sub>	-987 ± 20	1	SnI	173 ± 12	1
SiCl	198.3 ± 6.7	1	SnI <sub>2</sub>	-8.1 ± 4.2	1
SiCl <sub>2</sub>	-169 ± 3	1	*SnI <sub>3</sub>	-8 ± 50	1
*SiCl <sub>3</sub>	322 ± 8	1	*Sn(CH <sub>3</sub> ) <sub>3</sub>	132.2	1
SiBr	235 ± 46	1	*Sn(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub>	518.8 ± 21	1
SiBr <sub>2</sub>	46 ± 8	1	PbH	236.2 ± 19.2	1
*SiBr <sub>3</sub>	-201.7 ± 63	1	PbF	-80.3 ± 10.5	1
SiI	313.8 ± 42	1	PbF <sub>2</sub>	-435.1 ± 8.4	1
SiI <sub>2</sub>	92.5 ± 8.4	1	*PbF <sub>3</sub>	-490 ± 60	1
*SiI <sub>3</sub>	35.3 ± 63	1	PbCl	15.1 ± 50	1
SiH	376.6 ± 8.4	1	PbCl <sub>2</sub>	-174.1 ± 1.3	1
SiH <sub>2</sub> ( <sup>1</sup> A <sub>1</sub> )	273 ± 2	1	*PbCl <sub>3</sub>	-178 ± 80	1
SiH <sub>2</sub> ( <sup>3</sup> B <sub>1</sub> )	360.7	1	PbBr	70.9 ± 42	1
*SiH <sub>3</sub>	200.4 ± 2.5	1	PbBr <sub>2</sub>	-104.4 ± 6.3	1
MeSi•H <sub>2</sub>	141 ± 6	1	*PbBr <sub>3</sub>	-104 ± 80	1
Me <sub>2</sub> Si•H	78 ± 6	1	PbI	107.4 ± 37.7	1
Me <sub>3</sub> Si•	15 ± 7	1	PbI <sub>2</sub>	-3.2 ± 4.2	1
*Si <sub>2</sub> H <sub>3</sub>	~402	1	*PbI <sub>3</sub>	22 ± 80	1

## References

1. Luo, Y.R., *Comprehensive Handbook of Chemical Bond Energies*, CRC Press, 2007.
2. Wheeler, S.E., et al., *J. Phys. Chem. A* 111, 3819–3830, 2007.
3. Seetula, J.A., et al., *Chem. Phys.* 351, 141–146, 2008.

**TABLE 5. Bond Dissociation Energies of Some Organic Molecules**

$D_{298}^{\circ}(\text{R-X})/\text{kJ mol}^{-1}$  of some organic compounds are listed below. All data are from Tables 1 and 3.

	X=H	F	Cl	Br	I	OH	OCH <sub>3</sub>	NH <sub>2</sub>	NO	CH <sub>3</sub>	COCH <sub>3</sub>	CF <sub>3</sub>	CCl <sub>3</sub>
R=H	435.7799	569.658	431.361	366.16	298.26	497.10	440.2	450.08	199.5	439.3	374.0	445.2	392.5
CH <sub>3</sub>	439.3	460.2	350.2	294.1	238.9	384.93	351.9	356.1	172.0	377.4	351.9	429.3	362.3
C <sub>2</sub> H <sub>5</sub>	420.5	447.4	352.3	292.9	233.5	391.2	355.2	352.3	171.5	370.3	347.3	—	—
i-C <sub>3</sub> H <sub>7</sub>	410.5	483.8	354.0	299.2	234.7	397.9	360.7	357.7	152.7	369.0	340.2	—	—
t-C <sub>4</sub> H <sub>9</sub>	400.4	495.8	351.9	292.9	227.2	398.3	353.1	355.6	167	363.6	329.3	—	—
C <sub>6</sub> H <sub>5</sub>	472.2	525.5	399.6	336.4	272.0	463.6	418.8	429.3	226.8	426.8	406.7	463.2	388.7
C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	375.5	412.8	299.9	239.3	187.8	334.1	—	306.7	123	325.1	299.7	365.7	—
CCl <sub>3</sub>	392.5	439.3	296.6	231.4	168	—	—	—	125	362.3	—	332.2	285.8
CF <sub>3</sub>	445.2	546.8	365.3	296.2	227.2	≤482.0	—	—	167	429.3	—	413.0	332.2
C <sub>2</sub> F <sub>5</sub>	429.7	532.2	346.0	283.3	219.2	—	—	—	—	—	—	424.3	—
CH <sub>3</sub> CO	374.0	511.7	354.0	292.0	223.0	459.4	424.3	414.6	—	351.9	307.1	—	—
CN	528.5	482.8	422.6	364.8	320.1	—	—	—	204.4	521.7	—	469.0	—
C <sub>6</sub> F <sub>5</sub>	487.4	485	383.3	~328	<301.7	446.9	—	—	211.3	439.3	—	435.1	—

**TABLE 6. Bond Dissociation Energies in Diatomic Cations**

From thermochemistry, we have

$$D_{298}^{\circ}(\text{A}^+-\text{B}) \equiv \Delta_f H^{\circ}(\text{A}^+) + \Delta_f H^{\circ}(\text{B}) - \Delta_f H^{\circ}(\text{AB}^+) = D_{298}^{\circ}(\text{A}-\text{B}) + IP(\text{A}) - IP(\text{AB})$$

Thus,  $D_{298}^{\circ}(\text{A}^+-\text{B})$  may be derived using the Table 1 and the ionization potentials of species A and AB. The following Table has been arranged in an alphabetical order of the atoms. The **boldface** in the species indicates the dissociated fragment.

A <sup>+</sup> -B	$D_{298}^{\circ}$ kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	$D_{298}^{\circ}$ kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	$D_{298}^{\circ}$ kJ/mol <sup>-1</sup>	Ref.
<b>Ag</b> <sup>+</sup> -Ag	167.9 ± 8.7	1	<b>Au</b> <sup>+</sup> -B	329 ± 50	1	<b>Ba</b> <sup>+</sup> -I	335 ± 10	1
<b>Ag</b> <sup>+</sup> -Cl	32 ± 30	1	<b>Au</b> <sup>+</sup> -Be	401 ± 29	1	<b>Ba</b> <sup>+</sup> -O	441.4 ± 15	1
<b>Ag</b> <sup>+</sup> -F	24 ± 27	1	<b>Au</b> <sup>+</sup> -C	311.5 ± 7.7	4	<b>Be</b> <sup>+</sup> -Ar	49.0 ± 2.4	1
<b>Ag</b> <sup>+</sup> -H	43.5 ± 5.9	1	<b>Au</b> <sup>+</sup> -F	79	1	<b>Be</b> <sup>+</sup> -Au	410 ± 29	1
<b>Ag</b> <sup>+</sup> -O	123 ± 5	1	<b>Au</b> <sup>+</sup> -Ge	292 ± 24	1	<b>Be</b> <sup>+</sup> -Be	187.0	1
<b>Ag</b> <sup>+</sup> -S	123 ± 13	1	<b>Au</b> <sup>+</sup> -H	213.1 ± 7.7	4	<b>Be</b> <sup>+</sup> -Cl	417 ± 50	1
<b>Al</b> <sup>+</sup> -Al	121	1	<b>Au</b> <sup>+</sup> -I	230~280	1	<b>Be</b> <sup>+</sup> -F	575 ± 98	1
<b>Al</b> <sup>+</sup> -Ar	15.47	1	<b>Au</b> <sup>+</sup> -Xe	130 ± 13	1	<b>Be</b> <sup>+</sup> -H	307.3 ± 5.0	1
<b>Al</b> <sup>+</sup> -Ca	148.5	1	<b>B</b> <sup>+</sup> -Ar	32.7	1	<b>Be</b> <sup>+</sup> -O	362.0 ± 6.2	1
<b>Al</b> <sup>+</sup> -Cl	173 ± 42	1	<b>B</b> <sup>+</sup> -B	187	1	<b>Bi</b> <sup>+</sup> -Bi	199 ± 10	1
<b>Al</b> <sup>+</sup> -F	314 ± 21	1	<b>B</b> <sup>+</sup> -Br	164 ± 21	1	<b>Bi</b> <sup>+</sup> -O	174	1
<b>Al</b> <sup>+</sup> -Kr	5.54	1	<b>B</b> <sup>+</sup> -C	284 ± 58	1	<b>Bi</b> <sup>+</sup> -S	179 ± 50	1
<b>Al</b> <sup>+</sup> -O	166.7 ± 12.0	1	<b>B</b> <sup>+</sup> -Cl	308 ± 21	1	<b>Bi</b> <sup>+</sup> -Se	184 ± 29	1
<b>Al</b> <sup>+</sup> -Se	114 ± 49	1	<b>B</b> <sup>+</sup> -F	460 ± 10	1	<b>Bi</b> <sup>+</sup> -Te	125 ± 50	1
<b>Ar</b> <sup>+</sup> -Ar	130.323 ± 0.087	1	<b>B</b> <sup>+</sup> -H	198 ± 5	1	<b>Bi</b> <sup>+</sup> -Tl	100 ± 42	1
<b>Ar</b> <sup>+</sup> -He	2.9 ± 0.8	1	<b>B</b> <sup>+</sup> -O	326 ± 48	1	<b>Bk</b> <sup>+</sup> -O	610	1
<b>Ar</b> <sup>+</sup> -Ne	7.5 ± 0.8	1	<b>B</b> <sup>+</sup> -Pt	314 ± 98	1	<b>Br</b> <sup>+</sup> -Br	318.858 ± 0.024	1
<b>As</b> <sup>+</sup> -As	364 ± 22	1	<b>B</b> <sup>+</sup> -Se	298 ± 98	1	<b>Br</b> <sup>+</sup> -C	451.5 ± 8.6	1
<b>As</b> <sup>+</sup> -H	290.8 ± 3.0	1	<b>B</b> <sup>+</sup> -Si	365 ± 15	1	<b>Br</b> <sup>+</sup> -Cl	303.000 ± 0.048	1
<b>As</b> <sup>+</sup> -O	495	1	<b>Ba</b> <sup>+</sup> -Ar	11.85	1	<b>Br</b> <sup>+</sup> -F	251.5 ± 12.6	1
<b>As</b> <sup>+</sup> -P	367 ± 59	1	<b>Ba</b> <sup>+</sup> -Br	418 ± 10	1	<b>Br</b> <sup>+</sup> -H	379.26 ± 2.89	1
<b>As</b> <sup>+</sup> -S	433.2 ± 12.5	1	<b>Ba</b> <sup>+</sup> -Cl	468.2 ± 10	1	<b>Br</b> <sup>+</sup> -O	365.7 ± 3.1	1
<b>Au</b> <sup>+</sup> -Al	170 ± 30	1	<b>Ba</b> <sup>+</sup> -D	245.2 ± 9.6	1	<b>C</b> <sup>+</sup> -Ar	72.3	1
<b>Au</b> <sup>+</sup> -Au	234.5	1	<b>Ba</b> <sup>+</sup> -F	640 ± 29	1	<b>C</b> <sup>+</sup> -Br	398 ± 8.6	1

A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.
C <sup>+</sup> -C	601.9 ± 19.3	1	Co <sup>+</sup> -H	195 ± 6	1	Dy <sup>+</sup> -I	279.9	1
C <sup>+</sup> -Cl	614	1	Co <sup>+</sup> -He	16.4 ± 0.4	1	Dy <sup>+</sup> -O	597 ± 15	1
C <sup>+</sup> -F	721 ± 40	1	Co <sup>+</sup> -I	211.7 ± 8.4	1	Er <sup>+</sup> -Br	315.8	1
C <sup>+</sup> -H	397.848 ± 0.013	1	Co <sup>+</sup> -Kr	68.37 ± 0.18	1	Er <sup>+</sup> -Cl	406.7	1
C <sup>+</sup> -N	524.5 ± 4.2	1	Co <sup>+</sup> -Ne	12.8 ± 0.4	1	Er <sup>+</sup> -F	546 ± 34	1
C <sup>+</sup> -O	810.7 ± 0.8	1	Co <sup>+</sup> -O	317.3 ± 4.8	1	Er <sup>+</sup> -I	271.6	1
C <sup>+</sup> -P	587 ± 50	1	Co <sup>+</sup> -S	288.3 ± 8.7	1	Er <sup>+</sup> -O	583 ± 15	1
C <sup>+</sup> -S	706.6 ± 2.1	1	Co <sup>+</sup> -Si	317.1 ± 6.7	1	Es <sup>+</sup> -O	470 ± 60	1
C <sup>+</sup> -Se	587 ± 50	1	Co <sup>+</sup> -Xe	85.7 ± 6.8	1	Eu <sup>+</sup> -Ag	85 ± 50	1
Ca <sup>+</sup> -Al	144.7	1	Cr <sup>+</sup> -Ar	31.7 ± 3.9	1	Eu <sup>+</sup> -Au	252 ± 97	1
Ca <sup>+</sup> -Ar	12.99 ± 0.60	1	Cr <sup>+</sup> -C	277 ± 24	1	Eu <sup>+</sup> -Br	333.8	1
Ca <sup>+</sup> -Au	306 ± 29	1	Cr <sup>+</sup> -Cl	>211	1	Eu <sup>+</sup> -Cl	430.7	1
Ca <sup>+</sup> -Br	417.6 ± 10	1	Cr <sup>+</sup> -Cr	129	1	Eu <sup>+</sup> -F	543 ± 29	1
Ca <sup>+</sup> -Ca	104.1	1	Cr <sup>+</sup> -D	135 ± 9	1	Eu <sup>+</sup> -I	290.7	1
Ca <sup>+</sup> -Cl	433.4 ± 12	1	Cr <sup>+</sup> -F	279 ± 42	1	Eu <sup>+</sup> -O	393 ± 15	1
Ca <sup>+</sup> -F	556.5 ± 8.4	1	Cr <sup>+</sup> -H	136 ± 9	1	Eu <sup>+</sup> -S	257 ± 32	1
Ca <sup>+</sup> -H	284.2 ± 10	1	Cr <sup>+</sup> -He	7.8 ± 0.4	1	F <sup>+</sup> -Ar	161.1	1
Ca <sup>+</sup> -I	293.7 ± 10.8	1	Cr <sup>+</sup> -Ne	9.5 ± 0.4	1	F <sup>+</sup> -F	325.393 ± 0.096	1
Ca <sup>+</sup> -Kr	18.60 ± 0.72	1	Cr <sup>+</sup> -O	359	1	F <sup>+</sup> -He	181.62 ± 0.08	1
Ca <sup>+</sup> -Ne	4.95 ± 0.06	1	Cr <sup>+</sup> -S	258.6 ± 16.4	1	F <sup>+</sup> -Kr	152.4	1
Ca <sup>+</sup> -O	348 ± 5	1	Cr <sup>+</sup> -Si	203 ± 15	1	F <sup>+</sup> -Xe	188	1
Ca <sup>+</sup> -Xe	25.38 ± 0.96	1	Cr <sup>+</sup> -Xe	71.9 ± 10.0	1	Fe <sup>+</sup> -Ar	14.2 ± 7.7	1
Cd <sup>+</sup> -Cd	122.5 ± 10	1	Cs <sup>+</sup> -Ar	8.2	1	Fe <sup>+</sup> -Br	>293	1
Cd <sup>+</sup> -H	179.5	1	Cs <sup>+</sup> -Br	60.5 ± 10	1	Fe <sup>+</sup> -C	356.1 ± 17.2	1
Ce <sup>+</sup> -Au	278 ± 34	1	Cs <sup>+</sup> -Cl	107.4 ± 10	1	Fe <sup>+</sup> -Cl	>343	1
Ce <sup>+</sup> -Br	341.0	1	Cs <sup>+</sup> -Cs	62.6 ± 9.6	1	Fe <sup>+</sup> -Co	259 ± 21	1
Ce <sup>+</sup> -C	254 ± 96	1	Cs <sup>+</sup> -F	43.7 ± 10	1	Fe <sup>+</sup> -Cr	209 ± 29	1
Ce <sup>+</sup> -Ce	207 ± 42	1	Cs <sup>+</sup> -He	5.1	1	Fe <sup>+</sup> -Cu	222 ± 29	1
Ce <sup>+</sup> -Cl	429.5	1	Cs <sup>+</sup> -I	29.3 ± 10	1	Fe <sup>+</sup> -D	227	1
Ce <sup>+</sup> -F	586 ± 63	1	Cs <sup>+</sup> -Kr	15.1	1	Fe <sup>+</sup> -F	360 - 423	1
Ce <sup>+</sup> -I	295.5	1	Cs <sup>+</sup> -Na	48.1 ± 4.2	1	Fe <sup>+</sup> -Fe	272	1
Ce <sup>+</sup> -Ir	530 ± 96	1	Cs <sup>+</sup> -Ne	6.11	1	Fe <sup>+</sup> -H	211.2 ± 9.6	1
Ce <sup>+</sup> -N	494 ± 63	1	Cs <sup>+</sup> -O	59	1	Fe <sup>+</sup> -I	>239	1
Ce <sup>+</sup> -O	852 ± 15	1	Cs <sup>+</sup> -Rb	68.3 ± 10	1	Fe <sup>+</sup> -Kr	33.5 ± 6.7	1
Ce <sup>+</sup> -Pd	255 ± 53	1	Cs <sup>+</sup> -Xe	14.7	1	Fe <sup>+</sup> -N	485	1
Ce <sup>+</sup> -Pt	467 ± 96	1	Cu <sup>+</sup> -Ar	51.9 ± 6.8	1	Fe <sup>+</sup> -Nb	285 ± 21	1
Ce <sup>+</sup> -Rh	423 ± 96	1	Cu <sup>+</sup> -Cl	91 ± 10	1	Fe <sup>+</sup> -Ni	268 ± 21	1
Ce <sup>+</sup> -S	524 ± 59	1	Cu <sup>+</sup> -Cu	155.2 ± 7.7	1	Fe <sup>+</sup> -O	343.3 ± 1.9	1
Cl <sup>+</sup> -Ar	169	1	Cu <sup>+</sup> -F	117 ± 21	1	Fe <sup>+</sup> -S	295.2 ± 5.8	1
Cl <sup>+</sup> -Cl	385.746 ± 0.096	6	Cu <sup>+</sup> -Ge	231 ± 23	1	Fe <sup>+</sup> -Sc	200 ± 21	1
Cl <sup>+</sup> -D	457.284 ± 0.017	1	Cu <sup>+</sup> -H	93 ± 13	1	Fe <sup>+</sup> -Si	277 ± 9	1
Cl <sup>+</sup> -F	291 ± 10	1	Cu <sup>+</sup> -Kr	24.3 ± 0.8	1	Fe <sup>+</sup> -Ta	301 ± 21	1
Cl <sup>+</sup> -H	452.714 ± 0.018	1	Cu <sup>+</sup> -O	133.9 ± 11.6	1	Fe <sup>+</sup> -Ti	251 ± 25	1
Cl <sup>+</sup> -N	650 ± 10	1	Cu <sup>+</sup> -S	203.3 ± 14.5	1	Fe <sup>+</sup> -V	314 ± 21	1
Cl <sup>+</sup> -O	468.0 ± 2.1	1	Cu <sup>+</sup> -Si	260 ± 8	1	Fe <sup>+</sup> -Xe	46.0 ± 5.8	1
Co <sup>+</sup> -Ar	52.89 ± 0.06	1	Cu <sup>+</sup> -Xe	102.1 ± 5.8	1	Ga <sup>+</sup> -Bi	62 ± 98	1
Co <sup>+</sup> -Br	>289	1	D <sup>+</sup> -D	263.4405 ± 0.0003	1	Ga <sup>+</sup> -Br	56.5 ± 16	1
Co <sup>+</sup> -C	351 ± 29	1	Dy <sup>+</sup> -Br	324.2	1	Ga <sup>+</sup> -Cl	86 ± 21	1
Co <sup>+</sup> -Cl	285 ± 12	1	Dy <sup>+</sup> -Cl	407.9	1	Ga <sup>+</sup> -F	136 ± 15	1
Co <sup>+</sup> -Co	269	1	Dy <sup>+</sup> -Cu	196 ± 42	1	Ga <sup>+</sup> -Ga	126.3	1
Co <sup>+</sup> -D	199.6 ± 5.8	1	Dy <sup>+</sup> -F	535 ± 24	1	Ga <sup>+</sup> -I	41.6 ± 15	1

A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.
Ga <sup>+</sup> -O	46 ± 50	1	Ir <sup>+</sup> -C	635.8 ± 4.8	3	Lu <sup>+</sup> -H	204 ± 15	1
Ga <sup>+</sup> -Sb	38 ± 96	1	Ir <sup>+</sup> -D	302.8 ± 5.8	1	Lu <sup>+</sup> -I	40.7	1
Ga <sup>+</sup> -Te	19 ± 29	1	Ir <sup>+</sup> -H	305.7 ± 5.8	1	Lu <sup>+</sup> -O	524 ± 15	1
Gd <sup>+</sup> -Cd	122.5 ± 10	1	Ir <sup>+</sup> -O	247	1	Lu <sup>+</sup> -Si	107 ± 13	1
Gd <sup>+</sup> -H	179.5	1	K <sup>+</sup> -Ar	14 ± 7	1	Mg <sup>+</sup> -Ar	19.20	1
Ge <sup>+</sup> -Br	398 ± 42	1	K <sup>+</sup> -Br	35.7 ± 10.5	1	Mg <sup>+</sup> -Au	267 ± 29	1
Ge <sup>+</sup> -C	223 ± 31	1	K <sup>+</sup> -Cl	51 ± 19	1	Mg <sup>+</sup> -Cl	327 ± 6.5	1
Ge <sup>+</sup> -Cl	473 ± 50	1	K <sup>+</sup> -He	6.00	1	Mg <sup>+</sup> -D	203.6 ± 0.8	1
Ge <sup>+</sup> -F	565 ± 21	1	K <sup>+</sup> -I	18 ± 45	1	Mg <sup>+</sup> -F	477 ± 50	1
Ge <sup>+</sup> -Ge	274 ± 10	1	K <sup>+</sup> -K	83.86 ± 0.15	1	Mg <sup>+</sup> -H	190.8 ± 5.8	1
Ge <sup>+</sup> -H	377 ± 84	1	K <sup>+</sup> -Kr	15.8	1	Mg <sup>+</sup> -Kr	25.39	1
Ge <sup>+</sup> -O	344 ± 21	1	K <sup>+</sup> -Li	59.9 ± 5.9	1	Mg <sup>+</sup> -Mg	125	1
Ge <sup>+</sup> -S	283 ± 21	1	K <sup>+</sup> -Na	58.69 ± 0.08	1	Mg <sup>+</sup> -Ne	4.9 ± 0.6	1
Ge <sup>+</sup> -Se	234 ± 10	1	K <sup>+</sup> -Ne	7.79	1	Mg <sup>+</sup> -O	245.2 ± 10	1
Ge <sup>+</sup> -Si	268 ± 21	1	K <sup>+</sup> -O	13	1	Mg <sup>+</sup> -Xe	53.74	1
Ge <sup>+</sup> -Te	233 ± 19	1	K <sup>+</sup> -Xe	19.5	1	Mn <sup>+</sup> -Cl	>211	1
H <sup>+</sup> -D	261.1021 ± 0.0002	1	Kr <sup>+</sup> -Ar	55.31 ± 0.14	1	Mn <sup>+</sup> -F	321 ± 24	1
H <sup>+</sup> -H	259.4659 ± 0.0002	1	Kr <sup>+</sup> -H	464	1	Mn <sup>+</sup> -H	202.5 ± 5.9	1
He <sup>+</sup> -H	123.9	1	Kr <sup>+</sup> -He	2.1 ± 0.8	1	Mn <sup>+</sup> -I	>211	1
He <sup>+</sup> -He	229.687 ± 0.019	1	Kr <sup>+</sup> -Kr	110.967 ± 0.033	1	Mn <sup>+</sup> -Mn	129	1
Hf <sup>+</sup> -H	193.8 ± 10.6	2	Kr <sup>+</sup> -N	136.9 ± 13	1	Mn <sup>+</sup> -O	285 ± 13	1
Hf <sup>+</sup> -O	724 ± 21	1	Kr <sup>+</sup> -Ne	3.8 ± 0.8	1	Mn <sup>+</sup> -S	247 ± 23	1
Hg <sup>+</sup> -Ar	22.2 ± 1.2	1	La <sup>+</sup> -Au	436 ± 97	1	Mn <sup>+</sup> -Se	165 ± 50	1
Hg <sup>+</sup> -H	207	1	La <sup>+</sup> -Br	425.9	1	Mo <sup>+</sup> -C	442.7 ± 13.5	1
Hg <sup>+</sup> -Hg	134	1	La <sup>+</sup> -C	427 ± 33	1	Mo <sup>+</sup> -F	376 ± 29	1
Hg <sup>+</sup> -Kr	37.9 ± 1.3	1	La <sup>+</sup> -Cl	503.6	1	Mo <sup>+</sup> -H	170 ± 6	1
Hg <sup>+</sup> -Xe	72.2 ± 1.3	1	La <sup>+</sup> -F	589 ± 34	1	Mo <sup>+</sup> -Mo	449.4 ± 1.0	1
Ho <sup>+</sup> -Ag	155 ± 61	1	La <sup>+</sup> -H	243 ± 9	1	Mo <sup>+</sup> -O	488.2 ± 1.9	1
Ho <sup>+</sup> -Au	250 ± 60	1	La <sup>+</sup> -I	392.4	1	Mo <sup>+</sup> -S	355.1 ± 5.8	1
Ho <sup>+</sup> -Br	320.6	1	La <sup>+</sup> -Ir	356 ± 97	1	Mo <sup>+</sup> -Xe	>53.1 ± 6.8	1
Ho <sup>+</sup> -Cl	410.3	1	La <sup>+</sup> -O	875 ± 25	1	N <sup>+</sup> -Ar	208.4 ± 9.6	1
Ho <sup>+</sup> -Cu	214 ± 35	1	La <sup>+</sup> -Pt	522 ± 78	1	N <sup>+</sup> -F	584 ± 42	1
Ho <sup>+</sup> -F	542 ± 50	1	La <sup>+</sup> -Rh	345 ± 97	1	N <sup>+</sup> -H	≥435.67 ± 0.77	1
Ho <sup>+</sup> -Ho	88 ± 96	1	La <sup>+</sup> -S	629 ± 96	1	N <sup>+</sup> -N	843.85 ± 0.10	1
Ho <sup>+</sup> -I	270.4	1	La <sup>+</sup> -Si	277.0 ± 9.6	1	N <sup>+</sup> -O	115	1
Ho <sup>+</sup> -O	551 ± 25	1	Li <sup>+</sup> -Ar	33 ± 14	1	Na <sup>+</sup> -Ar	19 ± 8	1
I <sup>+</sup> -Br	184.90 ± 0.02	1	Li <sup>+</sup> -Bi	91 ± 50	1	Na <sup>+</sup> -Br	58.2 ± 10.6	1
I <sup>+</sup> -Cl	247.5 ± 0.4	1	Li <sup>+</sup> -Br	41.8 ± 10.6	1	Na <sup>+</sup> -Cl	20.3 ± 10	1
I <sup>+</sup> -F	262.9 ± 2.1	1	Li <sup>+</sup> -Cl	66 ± 15	1	Na <sup>+</sup> -He	7.55	1
I <sup>+</sup> -H	304.70 ± 0.10	1	Li <sup>+</sup> -F	7 ± 21	1	Na <sup>+</sup> -I	64.9 ± 3.0	1
I <sup>+</sup> -I	262.90 ± 0.04	1	Li <sup>+</sup> -He	10.66	1	Na <sup>+</sup> -Kr	~24.9	1
I <sup>+</sup> -O	316.3 ± 10.5	1	Li <sup>+</sup> -I	51.1 ± 6.3	1	Na <sup>+</sup> -Li	95.8 ± 3.9	1
In <sup>+</sup> -Br	65.2 ± 12.6	1	Li <sup>+</sup> -Kr	48.1	1	Na <sup>+</sup> -Na	98.64 ± 0.29	1
In <sup>+</sup> -Cl	193 ± 21	1	Li <sup>+</sup> -Li	137.3 ± 6.3	1	Na <sup>+</sup> -Na	6.4	1
In <sup>+</sup> -F	148 ± 50	1	Li <sup>+</sup> -Ne	15.32	1	Na <sup>+</sup> -Ne	~9.04	1
In <sup>+</sup> -I	51.5 ± 21	1	Li <sup>+</sup> -O	38.9 ± 9.6	1	Na <sup>+</sup> -O	37 ± 19	1
In <sup>+</sup> -In	81 ± 30	1	Li <sup>+</sup> -Sb	129.6 ± 13.9	1	Na <sup>+</sup> -Xe	~28.6	1
In <sup>+</sup> -S	171 ± 50	1	Li <sup>+</sup> -Xe	56.4	1	Nb <sup>+</sup> -Ar	40.87 ± 0.13	1
In <sup>+</sup> -Sb	73 ± 50	1	Lu <sup>+</sup> -Br	86.1	1	Nb <sup>+</sup> -C	509 ± 15	1
In <sup>+</sup> -Se	118 ± 50	1	Lu <sup>+</sup> -Cl	180.6	1	Nb <sup>+</sup> -Fe	>251	1
In <sup>+</sup> -Te	41 ± 50	1	Lu <sup>+</sup> -F	376.8	1	Nb <sup>+</sup> -H	220 ± 7	1

A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.
Nb <sup>+</sup> -Nb	576.8 ± 9.6	1	Pb <sup>+</sup> -S	293 ± 50	1	S <sup>+</sup> -N	516 ± 34	1
Nb <sup>+</sup> -O	688 ± 11	1	Pb <sup>+</sup> -Se	169.4 ± 6.3	1	S <sup>+</sup> -O	524.3 ± 0.4	1
Nb <sup>+</sup> -S	501.7 ± 20.3	1	Pb <sup>+</sup> -Te	163 ± 63	1	S <sup>+</sup> -P	573 ± 21	1
Nb <sup>+</sup> -V	404.7 ± 0.2	1	Pd <sup>+</sup> -C	528 ± 5	1	S <sup>+</sup> -S	522.4 ± 0.5	1
Nb <sup>+</sup> -Xe	73.28 ± 0.12	1	Pd <sup>+</sup> -H	208.4 ± 8.7	1	Sc <sup>+</sup> -C	326 ± 6	1
Nd <sup>+</sup> -Au	267 ± 84	1	Pd <sup>+</sup> -O	145 ± 11	1	Sc <sup>+</sup> -Cl	410 ± 42	1
Nd <sup>+</sup> -Br	352.9	1	Pd <sup>+</sup> -Pd	197 ± 29	1	Sc <sup>+</sup> -F	605 ± 32	1
Nd <sup>+</sup> -Cl	441.4	1	Pd <sup>+</sup> -S	197 ± 6	1	Sc <sup>+</sup> -Fe	201 ± 21	1
Nd <sup>+</sup> -F	309.6	1	Pd <sup>+</sup> -Si	289 ± 50	1	Sc <sup>+</sup> -H	235 ± 8	1
Nd <sup>+</sup> -I	596 ± 32	1	Pr <sup>+</sup> -Au	317 ± 81	1	Sc <sup>+</sup> -O	689 ± 5	1
Nd <sup>+</sup> -O	753 ± 15	1	Pr <sup>+</sup> -Br	357.7	1	Sc <sup>+</sup> -S	529.7 ± 17.4	1
Ne <sup>+</sup> -H	1239	1	Pr <sup>+</sup> -Cl	445.0	1	Sc <sup>+</sup> -Se	475.8 ± 8.4	1
Ne <sup>+</sup> -He	13.0 ± 0.8	1	Pr <sup>+</sup> -F	557 ± 63	1	Sc <sup>+</sup> -Si	242.3 ± 10.5	1
Ne <sup>+</sup> -Ne	125.29 ± 1.93	1	Pr <sup>+</sup> -I	317.0	1	Se <sup>+</sup> -F	364 ± 42	1
Ni <sup>+</sup> -Ar	53.9	1	Pr <sup>+</sup> -O	796 ± 15	1	Se <sup>+</sup> -H	304	1
Ni <sup>+</sup> -Br	>289	1	Pt <sup>+</sup> -Ar	36.4 ± 8.7	1	Se <sup>+</sup> -P	514 ± 25	1
Ni <sup>+</sup> -C	418	1	Pt <sup>+</sup> -B	398 ± 105	1	Se <sup>+</sup> -S	392 ± 19	1
Ni <sup>+</sup> -Cl	192 ± 4	1	Pt <sup>+</sup> -C	530.5 ± 4.8	1	Se <sup>+</sup> -Se	413 ± 19	1
Ni <sup>+</sup> -D	166.0 ± 7.7	1	Pt <sup>+</sup> -Cl	249.8 ± 14.5	1	Si <sup>+</sup> -Au	175 ± 50	1
Ni <sup>+</sup> -F	≥456	1	Pt <sup>+</sup> -H	275 ± 5	1	Si <sup>+</sup> -B	351 ± 15	1
Ni <sup>+</sup> -H	158.1 ± 7.7	1	Pt <sup>+</sup> -N	326.9 ± 9.6	1	Si <sup>+</sup> -Br	276 ± 96	1
Ni <sup>+</sup> -He	12.4 ± 0.4	1	Pt <sup>+</sup> -O	318.4 ± 6.7	1	Si <sup>+</sup> -C	365 ± 50	1
Ni <sup>+</sup> -I	>297	1	Pt <sup>+</sup> -Pt	318 ± 23	1	Si <sup>+</sup> -Cl	591.0 ± 0.6	1
Ni <sup>+</sup> -Ne	9.9 ± 0.4	1	Pt <sup>+</sup> -Si	515 ± 50	1	Si <sup>+</sup> -F	684.1 ± 5.4	1
Ni <sup>+</sup> -Ni	208	1	Pt <sup>+</sup> -Xe	86.6 ± 28.9	1	Si <sup>+</sup> -H	316.6 ± 2.1	1
Ni <sup>+</sup> -O	275.9 ± 7.7	1	Pu <sup>+</sup> -F	562 ± 50	1	Si <sup>+</sup> -O	478 ± 13.4	1
Ni <sup>+</sup> -S	241.0 ± 3.9	1	Pu <sup>+</sup> -O	655	1	Si <sup>+</sup> -P	272 ± 50	1
Ni <sup>+</sup> -Si	326 ± 6.7	1	Rb <sup>+</sup> -Ar	12.0	1	Si <sup>+</sup> -Pd	237 ± 50	1
Np <sup>+</sup> -F	730 ± 100	1	Rb <sup>+</sup> -Br	17.6v5.1	1	Si <sup>+</sup> -Pt	525 ± 50	1
Np <sup>+</sup> -O	≥752	1	Rb <sup>+</sup> -Cl	10.5 ± 10.5	1	Si <sup>+</sup> -S	387.5 ± 6.0	1
O <sup>+</sup> -Ar	33.8	1	Rb <sup>+</sup> -I	27 ± 42	1	Si <sup>+</sup> -Si	334 ± 19	1
O <sup>+</sup> -F	301.8 ± 8.4	1	Rb <sup>+</sup> -Kr	14.9	1	Si <sup>+</sup> -Te	347 ± 50	1
O <sup>+</sup> -H	487.9 ± 0.34	1	Rb <sup>+</sup> -Na	50.1 ± 3.9	1	Sm <sup>+</sup> -Br	343.3	1
O <sup>+</sup> -N	1050.64 ± 0.13	1	Rb <sup>+</sup> -Ne	6.95	1	Sm <sup>+</sup> -Cl	435.4	1
O <sup>+</sup> -O	647.75 ± 0.17	1	Rb <sup>+</sup> -O	29	1	Sm <sup>+</sup> -F	620.9	1
Os <sup>+</sup> -H	238.9	1	Rb <sup>+</sup> -Rb	75.6 ± 9.6	1	Sm <sup>+</sup> -I	299.1	1
Os <sup>+</sup> -O	418 ± 50	1	Rb <sup>+</sup> -Xe	21.5	1	Sm <sup>+</sup> -O	569 ± 15	1
P <sup>+</sup> -C	512 ± 42	1	Re <sup>+</sup> -C	497.7 ± 3.9	1	Sn <sup>+</sup> -Br	335 ± 50	1
P <sup>+</sup> -Cl	289	1	Re <sup>+</sup> -H	224.7 ± 6.7	1	Sn <sup>+</sup> -Cu	184 ± 96	1
P <sup>+</sup> -F	490.6 ± 8.4	1	Re <sup>+</sup> -O	435 ± 59	1	Sn <sup>+</sup> -F	364 ± 29	1
P <sup>+</sup> -H	329.6 ± 2.1	1	Rh <sup>+</sup> -C	414 ± 17	1	Sn <sup>+</sup> -O	281 ± 10	1
P <sup>+</sup> -N	483 ± 21	1	Rh <sup>+</sup> -H	164.8 ± 3.8	1	Sn <sup>+</sup> -S	240 ± 19	1
P <sup>+</sup> -O	791.3 ± 8.4	1	Rh <sup>+</sup> -O	295.0 ± 5.8	1	Sn <sup>+</sup> -Se	174 ± 6.3	1
P <sup>+</sup> -P	481 ± 50	1	Rh <sup>+</sup> -S	226 ± 13	1	Sn <sup>+</sup> -Sn	193	1
P <sup>+</sup> -S	606 ± 34	1	Ru <sup>+</sup> -C	453.5 ± 10.6	1	Sn <sup>+</sup> -Te	168.7 ± 8.4	1
Pa <sup>+</sup> -O	~800	1	Ru <sup>+</sup> -H	160.2 ± 5.0	1	Sr <sup>+</sup> -Ar	13.32 ± 2.92	1
Pb <sup>+</sup> -Br	260 ± 63	1	Ru <sup>+</sup> -O	372 ± 5	1	Sr <sup>+</sup> -Br	378.1 ± 8.4	1
Pb <sup>+</sup> -Cl	285 ± 63	1	Ru <sup>+</sup> -S	288 ± 6	1	Sr <sup>+</sup> -Cl	427 ± 8.4	1
Pb <sup>+</sup> -F	347 ± 32	1	S <sup>+</sup> -C	620.8 ± 1.3	1	Sr <sup>+</sup> -F	615 ± 50	1
Pb <sup>+</sup> -O	247 ± 8.4	1	S <sup>+</sup> -F	343.5 ± 4.8	1	Sr <sup>+</sup> -H	209 ± 5	1
Pb <sup>+</sup> -Pb	214 ± 29	1	S <sup>+</sup> -H	348.2 ± 1.7	1	Sr <sup>+</sup> -I	308.2	1

A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.	A <sup>+</sup> -B	D <sub>298</sub> <sup>o</sup> kJ/mol <sup>-1</sup>	Ref.
Sr <sup>+</sup> -Kr	18.13 ± 6.94	1	Tl <sup>+</sup> -I	133 ± 21	1	Xe <sup>+</sup> -H	355	1
Sr <sup>+</sup> -Ne	4.52 ± 9.6	1	Tl <sup>+</sup> -Tl	22 ± 50	1	Xe <sup>+</sup> -Kr	41.65 ± 0.08	1
Sr <sup>+</sup> -O	298.7	1	Tm <sup>+</sup> -Br	312.2	1	Xe <sup>+</sup> -N	66.4 ± 9.6	1
Sr <sup>+</sup> -Sr	108.5 ± 1.6	1	Tm <sup>+</sup> -Cl	407.9	1	Xe <sup>+</sup> -Ne	2.1 ± 0.8	1
Ta <sup>+</sup> -H	230 ± 6	1	Tm <sup>+</sup> -F	537 ± 16	1	Xe <sup>+</sup> -Xe	99.6	1
Ta <sup>+</sup> -O	787 ± 63	1	Tm <sup>+</sup> -I	266.8	1	Y <sup>+</sup> -C	281 ± 12	1
Ta <sup>+</sup> -Ta	666	1	Tm <sup>+</sup> -O	482 ± 15	1	Y <sup>+</sup> -F	677 ± 21	1
Tb <sup>+</sup> -Cu	245 ± 34	1	U <sup>+</sup> -Br	345 ± 29	1	Y <sup>+</sup> -H	260.5 ± 5.8	1
Tb <sup>+</sup> -O	722 ± 15	1	U <sup>+</sup> -C	300 ± 96	1	Y <sup>+</sup> -O	718 ± 25	1
Tc <sup>+</sup> -H	197.5	1	U <sup>+</sup> -Cl	431 ± 34	1	Y <sup>+</sup> -Pt	466 ± 192	1
Tc <sup>+</sup> -O	>167	1	U <sup>+</sup> -D	283.4 ± 9.6	1	Y <sup>+</sup> -S	533.9 ± 8	1
Te <sup>+</sup> -H	305 ± 12	1	U <sup>+</sup> -F	668 ± 29	1	Y <sup>+</sup> -Si	243 ± 13	1
Te <sup>+</sup> -O	339 ± 50	1	U <sup>+</sup> -H	284 ± 8	1	Y <sup>+</sup> -Te	360 ± 96	1
Te <sup>+</sup> -P	415 ± 97	1	U <sup>+</sup> -N	~485	1	Y <sup>+</sup> -Y	281 ± 21	1
Te <sup>+</sup> -Se	342 ± 19	1	U <sup>+</sup> -O	757 ± 42	1	Yb <sup>+</sup> -Br	307.4	1
Te <sup>+</sup> -Si	339.6	5	U <sup>+</sup> -P	186	1	Yb <sup>+</sup> -Cl	399.6	1
Te <sup>+</sup> -Te	278 ± 29	1	U <sup>+</sup> -S	518 ± 29	1	Yb <sup>+</sup> -F	557.5 ± 14.4	1
Th <sup>+</sup> -Cl	499 ± 29	1	V <sup>+</sup> -Ar	39.39 ± 0.12	1	Yb <sup>+</sup> -I	262.0	1
Th <sup>+</sup> -F	682 ± 29	1	V <sup>+</sup> -C	373 ± 13.5	1	Yb <sup>+</sup> -O	376 ± 15	1
Th <sup>+</sup> -O	875 ± 16	1	V <sup>+</sup> -D	202 ± 6	1	Yb <sup>+</sup> -Yb	238 ± 96	1
Th <sup>+</sup> -Pt	388 ± 193	1	V <sup>+</sup> -Fe	314 ± 21	1	Zn <sup>+</sup> -Ar	28.7 ± 1.2	1
Th <sup>+</sup> -Rh	504 ± 67	1	V <sup>+</sup> -H	202 ± 6	1	Zn <sup>+</sup> -H	216 ± 15	1
Ti <sup>+</sup> -C	395 ± 23	1	V <sup>+</sup> -Kr	49.46 ± 0.18	1	Zn <sup>+</sup> -O	161.1 ± 4.8	1
Ti <sup>+</sup> -Cl	426.8	1	V <sup>+</sup> -N	448.6 ± 5.8	1	Zn <sup>+</sup> -S	198 ± 12	1
Ti <sup>+</sup> -F	≥456	1	V <sup>+</sup> -Nb	403.5 ± 0.2	1	Zn <sup>+</sup> -Si	274.1 ± 9.6	1
Ti <sup>+</sup> -H	226.6 ± 10.6	1	V <sup>+</sup> -O	581.6 ± 9.6	1	Zn <sup>+</sup> -Zn	60 ± 19	1
Ti <sup>+</sup> -N	501 ± 13	1	V <sup>+</sup> -S	358.9 ± 8.7	1	Zr <sup>+</sup> -Ar	36.09 ± 0.24	1
Ti <sup>+</sup> -O	667 ± 7	1	V <sup>+</sup> -Si	229 ± 15	1	Zr <sup>+</sup> -C	445.8 ± 15.4	1
Ti <sup>+</sup> -Pt	82 ± 96	1	V <sup>+</sup> -V	302	1	Zr <sup>+</sup> -H	218.8 ± 9.6	1
Ti <sup>+</sup> -S	461.1 ± 6.8	1	V <sup>+</sup> -Xe	66.4 ± 0.6	1	Zr <sup>+</sup> -N	443 ± 46	1
Ti <sup>+</sup> -Si	249 ± 16	1	W <sup>+</sup> -C	483 ± 21	1	Zr <sup>+</sup> -O	753 ± 11	1
Ti <sup>+</sup> -Ti	229	1	W <sup>+</sup> -F	444 ± 96	1	Zr <sup>+</sup> -S	549.0 ± 9.6	1
Tl <sup>+</sup> -Br	52 ± 50	1	W <sup>+</sup> -H	222.5 ± 5	1	Zr <sup>+</sup> -Zr	407.0 ± 9.6	1
Tl <sup>+</sup> -Cl	26 ± 4	1	W <sup>+</sup> -O	695 ± 42	1			
Tl <sup>+</sup> -F	13 ± 21	1	Xe <sup>+</sup> -Ar	13.4	1			

## References

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TABLE 7. Bond Dissociation Energies in Polyatomic Cations

This Table has been arranged on the basis of the Periodic Table with the IUPAC notation for Groups 1 to 18, see inside front cover of this *Handbook*. The **boldface** in the species indicates the dissociated fragment.

Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.	Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.
<b>(1) Group 1</b>			<b>(2) Group 2</b>		
Li <sup>+</sup> -H <sub>2</sub>	27.2	1	K <sup>+</sup> -adenine	95.1 ± 3.2	1
Li <sup>+</sup> -CO	57 ± 13	1	K <sup>+</sup> -indole	104.6 ± 12.6	1
Li <sup>+</sup> -H <sub>2</sub> O	139 ± 8	1	K <sup>+</sup> -Phe (phenylalanine)	150.5 ± 5.8	1
Li <sup>+</sup> -NH <sub>3</sub>	156 ± 8	1	K <sup>+</sup> -Tyr (tyrosine)	165.0 ± 5.8	1
Li <sup>+</sup> -CH <sub>4</sub>	130	1	Rb <sup>+</sup> -H <sub>2</sub> O	66.9 ± 12.6	1
Li <sup>+</sup> -CH <sub>3</sub> OH	156 ± 8	1	Rb <sup>+</sup> -NH <sub>3</sub>	78.2	1
Li <sup>+</sup> -CH <sub>3</sub> OCH <sub>3</sub>	167 ± 10	1	Rb <sup>+</sup> -CH <sub>3</sub> CN	86.6 ± 1.3	1
Li <sup>+</sup> -pyridine	183.0 ± 14.5	1	Rb <sup>+</sup> -C <sub>6</sub> H <sub>5</sub> OH	70.2 ± 3.7	1
Li <sup>+</sup> -Gly (glycine)	220 ± 9	1	Cs <sup>+</sup> -H <sub>2</sub> O	57.3	1
Na <sup>+</sup> -H <sub>2</sub>	10.4 ± 0.8	1	Cs <sup>+</sup> -C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	70.8 ± 4.5	1
Na <sup>+</sup> -N <sub>2</sub>	33.5	1			
Na <sup>+</sup> -CO	31 ± 8	1	CH <sub>3</sub> Be <sup>+</sup> -CH <sub>3</sub>	192.9 ± 13.4	1
Na <sup>+</sup> -CO <sub>2</sub>	66.5	1	<i>tert</i> -C(CH <sub>3</sub> ) <sub>3</sub> Be <sup>+</sup> - <i>tert</i> -C(CH <sub>3</sub> ) <sub>3</sub>	121.8 ± 13.4	1
Na <sup>+</sup> -SO <sub>2</sub>	79.1	1	Mg <sup>+</sup> -OH	314 ± 33	1
Na <sup>+</sup> -O <sub>3</sub>	52.3	1	Mg <sup>+</sup> -CO	43.1 ± 5.8	1
Na <sup>+</sup> -H <sub>2</sub> O	91.2 ± 6.3	1	Mg <sup>+</sup> -CO <sub>2</sub>	58.4 ± 5.8	1
Na <sup>+</sup> (H <sub>2</sub> O)-H <sub>2</sub> O	82.0 ± 5.8	1	Mg <sup>+</sup> -H <sub>2</sub> O	122.5 ± 12.5	1
Na <sup>+</sup> (H <sub>2</sub> O) <sub>2</sub> -H <sub>2</sub> O	66.1	1	Mg <sup>+</sup> -NH <sub>3</sub>	158.9 ± 11.6	1
Na <sup>+</sup> (H <sub>2</sub> O) <sub>3</sub> -H <sub>2</sub> O	52.7 ± 0.8	1	Mg <sup>+</sup> -CH <sub>4</sub>	29.8 ± 6.8	1
Na <sup>+</sup> (glycine)-H <sub>2</sub> O	75.1 ± 5.3	1	Mg <sup>+</sup> -MeOH	147.6 ± 6.8	1
Na <sup>+</sup> (glutamine)-H <sub>2</sub> O	52 ± 1	1	Mg <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	155.2	1
Na <sup>+</sup> -NH <sub>3</sub>	106.2 ± 5.4	1	Mg <sup>+</sup> -pyridine	200.0 ± 6.4	1
Na <sup>+</sup> -HNO <sub>3</sub>	86.2	1	Mg <sup>+</sup> -imidazole	243.9 ± 10.4	1
Na <sup>+</sup> -CH <sub>4</sub>	30.1	1	Mg <sup>2+</sup> (H <sub>2</sub> O) <sub>5</sub> -H <sub>2</sub> O	101.3	1
Na <sup>+</sup> -CH <sub>3</sub> OH	98.8 ± 5.7	1	Mg <sup>2+</sup> (Me <sub>2</sub> CO) <sub>5</sub> -Me <sub>2</sub> CO	93.3	1
Na <sup>+</sup> -CH <sub>3</sub> CN	125.5 ± 9.6	1	Ca <sup>+</sup> -OH	435.1 ± 14.5	1
Na <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	44.6 ± 4.4	1	Ca <sup>+</sup> -H <sub>2</sub> O	117.2	1
Na <sup>+</sup> -CH <sub>3</sub> OCH <sub>3</sub>	101.4 ± 5.7	1	Ca <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	134	1
Na <sup>+</sup> -CH <sub>3</sub> C(O)H	114.4 ± 3.4	1	Ca <sup>+</sup> -imidazole	186.3 ± 3.9	1
Na <sup>+</sup> - MeCOMe	131.3 ± 4.1	1	Ca <sup>2+</sup> (H <sub>2</sub> O) <sub>4</sub> -H <sub>2</sub> O	110.0 ± 5.9	1
Na <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	97.0 ± 5.9	1	Ca <sup>2+</sup> (Me <sub>2</sub> CO) <sub>5</sub> -Me <sub>2</sub> CO	101.3	1
Na <sup>+</sup> -pyrrole	103.7 ± 4.8	1	Sr <sup>+</sup> -CO	20.3	1
Na <sup>+</sup> -Gly (glycine)	166.7 ± 5.1	1	Sr <sup>+</sup> -CO <sub>2</sub>	41.9	1
Na <sup>+</sup> -Ala (alanine)	167 ± 4	1	Sr <sup>+</sup> -H <sub>2</sub> O	144.3	1
Na <sup>+</sup> -GlyGly (glycylglycine)	203 ± 8	1	Sr <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	117	1
K <sup>+</sup> -H <sub>2</sub>	6.1 ± 0.8	1	Sr <sup>2+</sup> (H <sub>2</sub> O) <sub>5</sub> -H <sub>2</sub> O	87.4	1
K <sup>+</sup> -CO <sub>2</sub>	35.6	1	Ba <sup>+</sup> -OH	530.7 ± 19.3	1
K <sup>+</sup> -H <sub>2</sub> O	74.9	1	Ba <sup>2+</sup> (H <sub>2</sub> O) <sub>4</sub> -H <sub>2</sub> O	90.8	1
K <sup>+</sup> (H <sub>2</sub> O) <sub>2</sub> -H <sub>2</sub> O	67.4	1			
K <sup>+</sup> (H <sub>2</sub> O) <sub>3</sub> -H <sub>2</sub> O	55.2	1	<b>(3) Group 3</b>		
K <sup>+</sup> (H <sub>2</sub> O) <sub>4</sub> -H <sub>2</sub> O	11.8	1	Sc <sup>+</sup> -H <sub>2</sub>	23.0 ± 1.3	1
K <sup>+</sup> (H <sub>2</sub> O) <sub>5</sub> -H <sub>2</sub> O	44.8	1	Sc <sup>+</sup> -CH <sub>2</sub>	412 ± 22	1
K <sup>+</sup> (H <sub>2</sub> O) <sub>6</sub> -H <sub>2</sub> O	41.8	1	Sc <sup>+</sup> -CH <sub>3</sub>	233 ± 10	1
K <sup>+</sup> -NH <sub>3</sub>	79 ± 7	1	Sc <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	240 ± 20	1
K <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	80.3	1	Sc <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	≥131	1
			Sc <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	222 ± 21	1
			Sc <sup>+</sup> -H <sub>2</sub> O	131	1

Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.	Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.
Sc <sup>+</sup> -NH	483 ± 10	1	V <sup>+</sup> -CH	470 ± 5	1
Sc <sup>+</sup> -NH <sub>2</sub>	347 ± 5	1	V <sup>+</sup> -CH <sub>2</sub>	326 ± 6	1
Sc <sup>+</sup> -pyridine	231.5 ± 10.3	1	V <sup>+</sup> -CH <sub>3</sub>	193 ± 7	1
Y <sup>+</sup> -CH <sub>2</sub>	398 ± 13	1	V <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	172 ± 8	1
Y <sup>+</sup> -CH <sub>3</sub>	249 ± 5.0	1	V <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	124 ± 8	1
Y <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	218 ± 13	1	V <sup>+</sup> -(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )	530.7	1
Y <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	>138	1	V <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	234 ± 10	1
Y <sup>+</sup> -CO	29.9 ± 10.6	1	V <sup>+</sup> -CO	114.8 ± 2.9	1
Y <sup>+</sup> -CS	137.0 ± 7.7	1	V <sup>+</sup> -CO <sub>2</sub>	72.4 ± 3.8	1
Y <sup>+</sup> (O)-CO <sub>2</sub>	86 ± 5	1	V <sup>+</sup> -H <sub>2</sub> O	149.8 ± 5.0	1
La <sup>+</sup> -CH	523 ± 33	1	V <sup>+</sup> -NH	423 ± 29	1
La <sup>+</sup> -CH <sub>2</sub>	401 ± 7	1	V <sup>+</sup> -NH <sub>2</sub>	293 ± 6	1
La <sup>+</sup> -CH <sub>3</sub>	217 ± 15	1	V <sup>+</sup> -NH <sub>3</sub>	192 ± 11	1
La <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	262 ± 30	1	V <sup>+</sup> -pyridine	218.7 ± 13.5	1
La <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	192.5	1	V <sup>+</sup> -imidazole	≤243.4 ± 8.0	1
Lu <sup>+</sup> -CH <sub>2</sub>	>230 ± 6	1	Nb <sup>+</sup> -H <sub>2</sub>	61.9	1
Lu <sup>+</sup> -CH <sub>3</sub>	176 ± 20	1	Nb <sup>+</sup> -CH	581 ± 19	1
U <sup>+</sup> (F)-F	552 ± 44	1	Nb <sup>+</sup> -CH <sub>2</sub>	428.4 ± 8.7	1
U <sup>+</sup> (F) <sub>2</sub> -F	523 ± 38	1	Nb <sup>+</sup> -CH <sub>3</sub>	198.8 ± 10.6	1
U <sup>+</sup> (F) <sub>3</sub> -F	381 ± 19	1	Nb <sup>+</sup> -CH <sub>3</sub> NH <sub>2</sub>	134	1
U <sup>+</sup> (F) <sub>4</sub> -F	243 ± 17	1	Nb <sup>+</sup> -C <sub>3</sub> H <sub>6</sub>	117.7	1
U <sup>+</sup> (F) <sub>5</sub> -F	26 ± 11	1	(NbFe) <sup>+</sup> -C <sub>3</sub> H <sub>4</sub>	>163	1
			Nb <sup>+</sup> -CO	95.5 ± 4.8	1
<b>(4) Group 4</b>			Nb <sup>+</sup> -CS	242.2 ± 10.6	1
Ti <sup>+</sup> -CH	478 ± 5	1	Nb <sub>7</sub> <sup>+</sup> -N <sub>2</sub>	<215	1
Ti <sup>+</sup> -CH <sub>2</sub>	391 ± 15	1	Ta <sup>+</sup> -CH	561.5 ± 15.4	6
Ti <sup>+</sup> -CH <sub>3</sub>	213.8 ± 3	1	Ta <sup>+</sup> -CH <sub>2</sub>	464.1 ± 2.9	6
Ti <sup>+</sup> -CH <sub>4</sub>	70.3 ± 2.5	1	Ta <sup>+</sup> -CH <sub>3</sub>	259.5 ± 13.5	6
Ti <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	213 ± 13	1	Ta <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	251~301	1
Ti <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	146 ± 11	1	<b>(6) Group 6</b>		
Ti <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	259 ± 9	1	(CO) <sub>6</sub> Cr <sup>+</sup> -H	230 ± 10	1
Ti <sup>+</sup> -CO	117.7 ± 5.8	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(NO)(CO) <sub>2</sub> Cr <sup>+</sup> -H	207.1 ± 14	1
Ti <sup>+</sup> -H <sub>2</sub> O	157.7 ± 5.9	1	Cr <sup>+</sup> -H <sub>2</sub>	31.8 ± 2.1	1
Ti <sup>+</sup> -NH	466 ± 12	1	Cr <sup>+</sup> -CH	294 ± 29	1
Ti <sup>+</sup> -NH <sub>2</sub>	356 ± 13	1	Cr <sup>+</sup> -CH <sub>2</sub>	216 ± 4	1
Ti <sup>+</sup> -NH <sub>3</sub>	197 ± 7	1	Cr <sup>+</sup> -CH <sub>3</sub>	110 ± 4	1
Ti <sup>+</sup> -pyridine	217.2 ± 9.3	1	Cr <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	170 ± 10	1
Ti <sup>+</sup> -imidazole	≤232.4 ± 8.2	1	Cr <sup>+</sup> -indole	196.6 ± 16.7	1
Zr <sup>+</sup> -CH	568 ± 13	1	Cr <sup>+</sup> -CO	89.7 ± 5.8	1
Zr <sup>+</sup> -CH <sub>2</sub>	444.8 ± 5	1	Cr <sup>+</sup> -OH	298 ± 14	1
Zr <sup>+</sup> -CH <sub>3</sub>	227.7 ± 9.6	1	Cr <sup>+</sup> -H <sub>2</sub> O	132.6 ± 8.8	1
Zr <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	273 ± 14	1	Cr <sup>+</sup> -N <sub>2</sub>	59 ± 4	1
Zr <sup>+</sup> -CO	77 ± 10	1	Cr <sup>+</sup> -NH <sub>3</sub>	183 ± 10	1
Zr <sup>+</sup> -CS	257.6 ± 10.6	1	(CO) <sub>6</sub> Mo <sup>+</sup> -H	260 ± 9	1
Hf <sup>+</sup> -CH	492.1 ± 14.5	2	Mo <sup>+</sup> -CH	513.3 ± 13.5	1
Hf <sup>+</sup> -CH <sub>2</sub>	421.6 ± 6.8	2	Mo <sup>+</sup> -CH <sub>2</sub>	344.4 ± 10	1
Hf <sup>+</sup> -CH <sub>3</sub>	204.5 ± 25.1	2	Mo <sup>+</sup> -CH <sub>3</sub>	151.5 ± 8.7	1
Hf <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	150.6	1	Mo <sup>+</sup> -CO	193.9 ± 9.6	1
			Mo <sup>+</sup> -CO <sub>2</sub>	49.2 ± 7	1
<b>(5) Group 5</b>			Mo <sup>+</sup> -CS	162 ± 18	1
(CO) <sub>6</sub> V <sup>+</sup> -H	220 ± 14	1	Mo <sup>+</sup> -CS <sub>2</sub>	67.5 ± 12.5	1
V <sup>+</sup> -H <sub>2</sub>	42.7 ± 2.1	1			

Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.	Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.
Mo <sup>+</sup> -NH	<385	1	Fe <sup>+</sup> -N <sub>2</sub>	53 ± 4	1
Mo <sup>+</sup> -pyrrole	>289	1	Fe <sup>+</sup> -NH <sub>3</sub>	184 ± 12	1
(CO) <sub>6</sub> W <sup>+</sup> -H	257 ± 9	1	Fe <sup>+</sup> -CS <sub>2</sub>	166.1 ± 4.6	1
W <sup>+</sup> -CH	580 ± 27	1	Fe <sup>+</sup> -imidazole	246.1 ± 13.8	1
W <sup>+</sup> -CH <sub>2</sub>	456.4 ± 5.8	1	Fe <sup>+</sup> -SiH	254 ± 13	1
W <sup>+</sup> -CH <sub>3</sub>	~222.9 ± 9.6	1	Fe <sup>+</sup> -SiH <sub>2</sub>	181 ± 9	1
(PMe <sub>3</sub> ) <sub>3</sub> (CO) <sub>3</sub> W <sup>+</sup> -H	259.4	1	Fe <sup>+</sup> -SiH <sub>3</sub>	183 ± 9	1
W <sup>+</sup> -pyrrole	>209	1	Ru <sup>+</sup> (η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> ) <sub>2</sub> -H	292 ± 16	1
(7) Group 7			(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> ) <sub>2</sub> Ru <sup>+</sup> -H	284.5	1
(CO) <sub>5</sub> Mn <sup>+</sup> -H	172 ± 10	1	Ru <sup>+</sup> -CH	501.7 ± 11.6	1
Mn <sup>+</sup> -H <sub>2</sub>	7.9 ± 1.7	1	Ru <sup>+</sup> -CH <sub>2</sub>	344.4 ± 4.8	1
Mn <sup>+</sup> -CH <sub>2</sub>	295 ± 13	1	Ru <sup>+</sup> -CH <sub>3</sub>	160.2 ± 5.8	1
Mn <sup>+</sup> -CH <sub>3</sub>	215 ± 10	1	Ru <sup>+</sup> -CS	253 ± 20	1
Mn <sup>+</sup> (CO) <sub>5</sub> -CH <sub>3</sub>	132 ± 15	1	OsO <sub>4</sub> <sup>+</sup> -H	552 ± 13	1
Mn <sup>+</sup> (CO) <sub>5</sub> -CH <sub>4</sub>	>30	1	(9) Group 9		
Mn <sup>+</sup> -(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )	326.1 ± 9.6	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(CO) <sub>2</sub> Co <sup>+</sup> -H	245 ± 12	1
Mn <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	145 ± 10	1	(CH <sub>3</sub> OD)Co <sup>+</sup> -H	147.6 ± 7.7	1
Mn <sup>+</sup> -OH	332 ± 24	1	Co <sup>+</sup> -H <sub>2</sub>	76.1 ± 4.2	1
Mn <sup>+</sup> -CO	25 ± 10	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )Co <sup>+</sup> -H <sub>2</sub>	67.8	1
Mn <sup>+</sup> -H <sub>2</sub> O	121.8 ± 5.9	1	Co <sup>+</sup> -CH	420 ± 37	1
Mn <sup>+</sup> -CH <sub>3</sub> OH	134 ± 29	1	Co <sup>+</sup> -CH <sub>2</sub>	317 ± 5	1
Mn <sup>+</sup> -OC(CH <sub>3</sub> ) <sub>2</sub>	159 ± 14	1	Co <sup>+</sup> -CH <sub>3</sub>	203 ± 4	1
Mn <sup>+</sup> -CS	80.0 ± 21	1	Co <sup>+</sup> -CH <sub>4</sub>	96.7	1
Mn <sup>+</sup> -NH <sub>2</sub>	254 ± 20	1	Co <sup>+</sup> -C <sub>60</sub>	243 ± 67	1
Mn <sup>+</sup> -NH <sub>3</sub>	147 ± 8	1	Co <sup>+</sup> -CO	173.7 ± 6.7	1
Tc <sup>+</sup> -CH <sub>2</sub>	<464	1	Co <sup>+</sup> -H <sub>2</sub> O	164.4 ± 5.9	1
Tc <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	<320	1	Co <sup>+</sup> -CS	259 ± 33	1
Re <sup>+</sup> (CH <sub>3</sub> )(CO) <sub>5</sub> -H	294 ± 13	1	Co <sup>+</sup> -N <sub>2</sub>	96.2 ± 7.1	1
(PMe <sub>3</sub> )(CO) <sub>2</sub> Re <sup>+</sup> -H	300.4	1	Co <sup>+</sup> -NH <sub>2</sub>	247 ± 7	1
(8) Group 8			Co <sup>+</sup> -NH <sub>3</sub>	219 ± 16	1
Fe <sup>+</sup> (O)-H	444 ± 17	1	Co <sup>+</sup> -CH <sub>3</sub> CN	>255 ± 17	1
Fe <sup>+</sup> (CO)-H	120 ± 23	1	Co <sup>+</sup> -P(CH <sub>3</sub> ) <sub>3</sub>	278 ± 11	1
Fe <sup>+</sup> (H <sub>2</sub> O)-H	215 ± 14	1	Co <sup>+</sup> -P(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub>	339 ± 16	1
Fe <sup>+</sup> (η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )-H	193 ± 21	1	(CH)Rh <sup>+</sup> -H	372 ± 21	1
(CO) <sub>2</sub> Fe <sup>+</sup> -H	299 ± 15	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(CO) <sub>2</sub> Rh <sup>+</sup> -H	287 ± 12	1
Fe <sup>+</sup> -H <sub>2</sub>	45.2 ± 2.5	1	Rh <sup>+</sup> -CH	444 ± 12	1
Fe <sup>+</sup> -CH	423 ± 29	1	Rh <sup>+</sup> -CH <sub>2</sub>	356 ± 8	1
Fe <sup>+</sup> -CH <sub>2</sub>	≤342 ± 2	1	Rh <sup>+</sup> -CH <sub>3</sub>	142 ± 6	1
Fe <sup>+</sup> -CH <sub>3</sub>	229 ± 5	1	Rh <sup>+</sup> -NO	167 ± 21	1
Fe <sup>+</sup> -CH <sub>4</sub>	73.2	1	Rh <sup>+</sup> -CS	234 ± 19	1
Fe <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	159.0 ± 2.1	1	(CO)(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(PPh <sub>3</sub> )Ir <sup>+</sup> -H	313.4	1
Fe <sup>+</sup> -C <sub>2</sub> H <sub>3</sub>	238 ± 10	1	(CO) <sub>2</sub> (η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> )Ir <sup>+</sup> -H	298.3	1
Fe <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	145 ± 11	1	Ir <sup>+</sup> -CH	666.7 ± 22.2	3
Fe <sup>+</sup> -C <sub>2</sub> H <sub>5</sub>	233 ± 9	1	Ir <sup>+</sup> -CH <sub>2</sub>	474.7 ± 2.9	3
Fe <sup>+</sup> -C <sub>2</sub> H <sub>6</sub>	64 ± 6	1	Ir <sup>+</sup> -CH <sub>3</sub>	313.6 ± 17.4	3
Fe <sup>+</sup> -OH	366 ± 12	1	Ir <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	234.3	1
Fe <sup>+</sup> -CO	129.3 ± 3.9	1	(10) Group 10		
Fe <sup>+</sup> D-CO	53 ± 13	1	(CO) <sub>4</sub> Ni <sup>+</sup> -H	248 ± 9	1
Fe <sup>+</sup> -CO <sub>2</sub>	74.3 ± 7.7	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(NO)Ni <sup>+</sup> -H	315 ± 14	1
Fe <sup>+</sup> -H <sub>2</sub> O	128.9 ± 0.8	1	(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(η <sup>5</sup> -C <sub>5</sub> Me <sub>5</sub> )Ni <sup>+</sup> -H	215 ± 13	1

Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.	Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.
Ni <sup>+</sup> -H <sub>2</sub>	72.4 ± 1.3	1	Ag <sup>+</sup> -O <sub>2</sub>	29.7 ± 0.8	1
Ni <sup>+</sup> -CH	301.0 ± 11.6	1	Ag <sup>+</sup> -CO	89 ± 5	1
Ni <sup>+</sup> -CH <sub>2</sub>	306 ± 4	1	Ag <sup>+</sup> -H <sub>2</sub> O	134 ± 8	1
Ni <sup>+</sup> -CH <sub>3</sub>	169.8 ± 6.8	1	Ag <sup>+</sup> -CS	152 ± 20	1
Ni <sup>+</sup> -CH <sub>4</sub>	96.5 ± 4	1	Ag <sup>+</sup> -NH <sub>3</sub>	170 ± 13	1
Ni <sup>+</sup> -OH	235 ± 19	1	Au <sup>+</sup> -CH <sub>2</sub>	357.0 ± 6.8	5
Ni <sup>+</sup> -CO	175 ± 11	1	Au <sup>+</sup> -CH <sub>3</sub>	209.4 ± 23.2	5
Ni <sup>+</sup> -CO <sub>2</sub>	104 ± 1	1	Au <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	344.5	1
Ni <sup>+</sup> -H <sub>2</sub> O	183.7 ± 3.3	1	Au <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	289 ± 29	1
Ni <sup>+</sup> -CS	234.5 ± 9.6	1	Au <sup>+</sup> -CO	201 ± 8	1
Ni <sup>+</sup> -N <sub>2</sub>	110.9 ± 10.5	1	Au <sup>+</sup> -H <sub>2</sub> O	164.0 ± 9.6	1
Ni <sup>+</sup> -NO	227.6 ± 7.5	1	Au <sup>+</sup> -H <sub>2</sub> S	230 ± 25	1
Ni <sup>+</sup> -NH <sub>2</sub>	232.5 ± 7.7	1	Au <sup>+</sup> -NH <sub>3</sub>	297 ± 29	1
Ni <sup>+</sup> -NH <sub>3</sub>	238 ± 19	1	Au <sup>+</sup> -PH <sub>3</sub>	402 ± 33	1
Pd <sup>+</sup> -CH	536 ± 10	1	(12) Group 12		
Pd <sup>+</sup> -CH <sub>2</sub>	463 ± 3	1	Zn <sup>+</sup> -H <sub>2</sub>	15.7 ± 1.7	1
Pd <sup>+</sup> -CH <sub>3</sub>	258 ± 8	1	Zn <sup>+</sup> -CH <sub>3</sub>	280 ± 7	1
Pd <sup>+</sup> -CH <sub>4</sub>	170.8 ± 7.7	1	Zn <sup>+</sup> -OH	127.2	1
Pd <sup>+</sup> -CS	200 ± 14	1	Zn <sup>+</sup> -H <sub>2</sub> O	163	1
Pd <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	>28.9 ± 4.8	1	Zn <sup>+</sup> -NO	76.2 ± 9.6	1
Pt <sup>+</sup> -H <sub>2</sub>	146.7 ± 11.6	1	Zn <sup>+</sup> -pyrimidine	209.6 ± 7.7	1
Pt <sup>+</sup> -CH	536.4 ± 9.6	1	Zn <sup>+</sup> -CS	149 ± 23	1
Pt <sup>+</sup> -CH <sub>2</sub>	471	1	Cd <sup>+</sup> -CH <sub>3</sub>	228 ± 3	1
Pt <sup>+</sup> -CH <sub>3</sub>	257.6 ± 7.7	1	Cd <sup>+</sup> (CH <sub>3</sub> )-CH <sub>3</sub>	109 ± 3	1
Pt <sup>+</sup> -CH <sub>4</sub>	170.8 ± 7.7	1	Cd <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	136 ± 19	1
Pt <sup>+</sup> -O <sub>2</sub>	64.6 ± 4.8	1	Hg <sup>+</sup> -CH <sub>3</sub>	285 ± 3	1
Pt <sup>+</sup> -CO	218.1 ± 8.7	1	Hg <sup>+</sup> (CH <sub>3</sub> )-CH <sub>3</sub>	96 ± 3	1
Pt <sup>+</sup> -CO <sub>2</sub>	59.8 ± 4.8	1	(13) Group 13		
Pt <sup>+</sup> -NH <sub>3</sub>	274 ± 12	1	B <sup>+</sup> -H <sub>2</sub>	15.9 ± 0.8	1
Pt <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	229.7	1	HB <sup>+</sup> -H <sub>2</sub>	61.5 ± 2.1	1
(11) Group 11			(CH <sub>3</sub> ) <sub>2</sub> B <sup>+</sup> -CH <sub>3</sub>	32.6 ± 4.2	1
Cu <sup>+</sup> -H <sub>2</sub>	51.9 ± 0.4	1	Al <sup>+</sup> -H <sub>2</sub>	5.6 ± 0.6	1
Cu <sup>+</sup> -CH <sub>2</sub>	267.3 ± 6.8	1	Al <sup>+</sup> -N <sub>2</sub>	5.6	1
Cu <sup>+</sup> -CH <sub>3</sub>	111 ± 7	1	Al <sup>+</sup> -CO <sub>2</sub>	≥29.3	1
Cu <sup>+</sup> -C <sub>2</sub> H <sub>2</sub>	>21.2 ± 9.6	1	Al <sup>+</sup> -H <sub>2</sub> O	104 ± 15	1
Cu <sup>+</sup> -C <sub>2</sub> H <sub>4</sub>	176 ± 14	1	Al <sup>+</sup> -MeOH	139.7	1
Cu <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	218.0 ± 9.6	1	Al <sup>+</sup> -EtC(O)Et	191.2	1
Cu <sup>+</sup> -CO	149 ± 7	1	Al <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	147.3 ± 8.4	1
Cu <sup>+</sup> -N <sub>2</sub>	89 ± 30	1	Al <sup>+</sup> -pyridine	190.3 ± 10.3	1
Cu <sup>+</sup> -NO	109.0 ± 4.8	1	Al <sup>+</sup> -phenol	154.8 ± 16.7	1
Cu <sup>+</sup> -H <sub>2</sub> O	160.7 ± 7.5	1	Al <sup>+</sup> -imidazole	232.4 ± 8.2	1
Cu <sup>+</sup> -NH <sub>2</sub>	192 ± 13	1	Ga <sup>+</sup> -NH <sub>3</sub>	122.5	1
Cu <sup>+</sup> -NH <sub>3</sub>	237 ± 15	1	In <sup>+</sup> -NH <sub>3</sub>	111.0	1
Cu <sup>+</sup> -CS	238.3 ± 11.6	1	(14) Group 14		
Cu <sup>+</sup> -SiH	246 ± 27	1	C <sub>58</sub> <sup>+</sup> -C <sub>2</sub>	955 ± 15	1
Cu <sup>+</sup> -SiH <sub>2</sub>	≥231 ± 7	1	C <sub>60</sub> <sup>+</sup> -C <sub>2</sub>	822.0 ± 12.5	1
Cu <sup>+</sup> -SiH <sub>3</sub>	97 ± 25	1	C <sub>62</sub> <sup>+</sup> -C <sub>2</sub>	846.2 ± 10.6	1
Ag <sup>+</sup> -CH <sub>2</sub>	≥107 ± 4	1	C <sub>78</sub> <sup>+</sup> -C <sub>2</sub>	938.8 ± 10.6	1
Ag <sup>+</sup> -CH <sub>3</sub>	66.6 ± 4.8	1	HC <sub>2</sub> <sup>+</sup> -H	574.749	1
Ag <sup>+</sup> -C <sub>2</sub> H <sub>3</sub>	65.7 ± 7.5	1	C <sub>6</sub> H <sub>5</sub> <sup>+</sup> -H	376.3 ± 4.8	1
Ag <sup>+</sup> -C <sub>6</sub> H <sub>6</sub>	167 ± 19	1			

Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.	Bond	$Do_{98}^2/\text{kJ mol}^{-1}$	Ref.
$\text{C}_2\text{H}_3^+-\text{Cl}$	249 ± 1.0	7	$\text{C}_6\text{F}_6^+-\text{C}_6\text{F}_6$	30.1 ± 4	1
$\text{C}_2\text{H}_5^+-\text{Br}$	206.3 ± 1.0	7	$\text{C}_{60}^+-\text{C}_{60}$	35.89 ± 7.72	1
$\text{C}_6\text{H}_5^+-\text{Br}$	266.3	1	$\text{PhSiH}_2^+-\text{H}$	159	1
$\text{C}_2\text{H}_3^+-\text{I}$	196.2 ± 1.4	7	$\text{Si}^+(\text{CH}_3)_3-\text{Cl}$	178.5 ± 1.9	1
$\text{CH}_3^+-\text{H}_2$	186	1	$\text{SiH}_3^+-\text{CO}$	≥151	1
$\text{CH}_5^+-\text{H}_2$	7.9 ± 0.4	1	$\text{SiF}_3^+-\text{CO}$	174.1 ± 1.3	1
$\text{C}_2\text{H}_5^+-\text{H}_2$	17	1	$(\text{CH}_3)_3\text{Si}^+-\text{H}_2\text{O}$	125.9 ± 7.9	1
$\text{CH}_3^+-\text{O}_2$	80 ± 7	4	$(\text{CH}_3)_3\text{Si}^+-\text{NH}_3$	194.6	1
$\text{CO}^+-\text{N}_2$	67.5 ± 19.3	1	$\text{Si}^+(\text{CH}_3)(\text{Cl})_2-\text{CH}_3$	60.8 ± 2.9	1
$\text{H}_2\text{CH}^+-\text{N}_2$	31.8	1	$\text{Si}^+(\text{CH}_3)_2(\text{Cl})-\text{CH}_3$	41.5 ± 1.9	1
$\text{CO}^+-\text{CO}$	173.7 ± 14.6	1	$\text{Si}^+-\text{CH}_3$	413.9 ± 5.8	1
$\text{CO}^+(\text{CO})-\text{CO}$	52.3	1	$\text{Si}^+(\text{CH}_3)-\text{CH}_3$	123 ± 48	1
$\text{CO}^+(\text{CO})_2-\text{CO}$	30.2	1	$\text{Si}^+(\text{CH}_3)_2-\text{CH}_3$	513 ± 27	1
$\text{CO}^+(\text{CO})_3-\text{CO}$	18.4	1	$\text{Si}^+(\text{CH}_3)_3-\text{CH}_3$	66.6 ± 5.8	1
$(\text{CO}_2)^+-\text{CO}_2$	70.3	1	$(\text{CH}_3)_3\text{Si}^+-\text{CH}_3\text{OH}$	164.0	1
$(\text{CO}_2)^+(\text{CO}_2)_2-\text{CO}_2$	34.7	1	$(\text{CH}_3)_3\text{Si}^+-(\text{C}_2\text{H}_5)_2\text{O}$	184.9	1
$(\text{CO}_2)^+(\text{CO}_2)_2-\text{CO}_2$	21.3	1	$(\text{CH}_3)_3\text{Si}^+-\text{C}_6\text{H}_6$	100.0	1
$(\text{CO}_2)^+(\text{CO}_2)_3-\text{CO}_2$	20.1 ± 1.3	1	$(\text{CH}_3)_3\text{Si}^+-\text{CH}_3\text{NH}_2$	231.8	1
$\text{CH}_3^+-\text{N}_2\text{O}$	221.3	1	$(\text{CH}_3)_3\text{Ge}^+-\text{H}_2\text{O}$	119.7 ± 2.1	1
$\text{CH}_3^+-\text{SO}_2$	253.6	1	$(\text{C}_2\text{H}_5)_3\text{Ge}^+-\text{H}_2\text{O}$	104.2 ± 2.1	1
$\text{CH}_3^+-\text{OCS}$	239.3	1	$(\text{CH}_3)_3\text{Sn}^+-\text{NH}_3$	154	1
$\text{CH}_3^+-\text{CS}_2$	251.9	1	$(\text{CH}_3)_3\text{Sn}^+-\text{H}_2\text{O}$	108	1
$\text{CH}_3^+-\text{H}_2\text{O}$	279	1	$(\text{CH}_3)_3\text{Sn}^+-\text{C}_3\text{H}_7\text{CO}$	157	1
$\text{CH}_3^+(\text{H}_2\text{O})-\text{H}_2\text{O}$	106.3	1	$(\text{CH}_3)_3\text{Sn}^+-\text{C}_3\text{H}_7\text{SH}$	143	1
$\text{CH}_3^+(\text{H}_2\text{O})_2-\text{H}_2\text{O}$	87.9	1	$\text{Pb}^+-\text{H}_2\text{O}$	93.7	1
$\text{CH}_3^+(\text{H}_2\text{O})_3-\text{H}_2\text{O}$	61.9	1	$\text{Pb}^+-\text{NH}_3$	118.4 ± 0.8	1
$\text{CH}_3^+(\text{H}_2\text{O})_4-\text{H}_2\text{O}$	48.5	1	$\text{Pb}^+-\text{CH}_3\text{OH}$	97.5 ± 0.8	1
$\text{CH}_3^+-\text{H}_2\text{S}$	344.8	1	$\text{Pb}^+-\text{CH}_3\text{NH}_2$	148.1 ± 1.3	1
$\text{CH}_2^+-\text{CH}_2\text{O}$	303.0 ± 2.9	1	$\text{Pb}^+-\text{C}_6\text{H}_6$	110 ± 2	1
$\text{CH}_3^+-\text{NH}_3$	431.4	1			
$(\text{CH}_3)^+-\text{CH}_3$	209.2 ± 4.2	1	<b>(15) Group 15</b>		
$\text{CH}_3^+-\text{CH}_4$	166.5	1	$\text{H}_2\text{N}^+-\text{H}$	544.43 ± 0.10	1
$\text{CF}_3^+-\text{CH}_4$	19.0	1	$\text{H}_3\text{N}^+-\text{H}$	515.1	1
$(\text{CH}_3)^+-\text{CH}_4$	28.7 ± 1.3	1	$\text{Me}_3\text{N}^+-\text{H}$	376	1
$\text{C}_6\text{H}_6^+-\text{CH}_4$	12.0	1	$\text{Et}_3\text{N}^+-\text{H}$	362	1
$\text{CH}_3^+-\text{CH}_3\text{F}$	230	1	$(\text{imidazole})^+-\text{Zn}$	216.1 ± 3.9	1
$\text{CH}_3^+-\text{CF}_3\text{Cl}$	221	1	$\text{N}_2\text{H}^+-\text{H}_2$	24.7 ± 0.8	1
$\text{CH}_3^+-\text{CH}_3\text{Cl}$	259	1	$\text{ON}^+-\text{O}_2$	14.2	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{CH}_3\text{OH}$	63	1	$\text{N}^+-\text{N}_2$	303.8	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{CH}_3\text{CN}$	85	1	$\text{ON}^+-\text{N}_2$	21.3	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{SO}_2\text{F}_2$	43.5	1	$\text{N}_2^+-\text{N}_2$	102.3 ± 14.6	1
$\text{CH}_3^+-\text{C}_2\text{H}_3\text{O}$	338.7 ± 2.9	1	$\text{HN}_2^+-\text{N}_2$	60.7	1
$\text{CH}_3^+-\text{CF}_3\text{ClOCl}$	252	1	$\text{N}_3^+-\text{N}_2$	18.8 ± 1.3	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{C}_3\text{H}_7\text{S}$	185	1	$\text{O}_2\text{N}^+-\text{N}_2$	19.2 ± 1.3	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{C}_2\text{H}_5\text{OH}$	85	1	$\text{H}_4\text{N}^+-\text{N}_2$	54 ± 21	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{C}_3\text{H}_8$	27.6	1	$\text{ON}^+-\text{NO}$	59.4 ± 0.8	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{t-C}_4\text{H}_9\text{Cl}$	339	1	$\text{ON}^+-\text{CO}$	27.2 ± 1.3	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{C}_3\text{H}_7\text{Cl}$	30.1	1	$\text{ON}^+-\text{O}_3$	<58	1
<i>tert</i> - $\text{C}_4\text{H}_9^+-\text{C}_6\text{H}_6$	92	1	$\text{ON}^+-\text{CO}_2$	32.2	1
$(\text{C}_6\text{H}_6)^+-\text{C}_6\text{H}_6$	73.6	1	$\text{N}_2\text{O}^+-\text{ON}_2$	72.8 ± 6.3	1
$(\text{C}_6\text{H}_6)^+-\text{indole}$	54.8	1	$\text{NO}^+-\text{ON}_2$	36.4 ± 0.8	1
			$(\text{HON}_2)^+-\text{ON}_2$	69.9 ± 4	1

Bond	$Do_{98}^{\circ}/\text{kJ mol}^{-1}$	Ref.	Bond	$Do_{98}^{\circ}/\text{kJ mol}^{-1}$	Ref.
$\text{ON}^+-\text{H}_2\text{O}$	95	1	$(\text{H}_3\text{O})^+-\text{CO}_2$	64.0	1
$\text{ON}^+(\text{H}_2\text{O})-\text{H}_2\text{O}$	67.4	1	$(\text{H}_3\text{O})^+(\text{CO}_2)-\text{CO}_2$	51.9	1
$\text{ON}^+(\text{H}_2\text{O})_2-\text{H}_2\text{O}$	56.5	1	$(\text{H}_3\text{O})^+(\text{CO}_2)_2-\text{CO}_2$	43.9	1
$\text{H}_4\text{N}^+-\text{H}_2\text{O}$	$86.2 \pm 4.2$	1	$(\text{H}_3\text{O})^+(\text{CO}_2)_3-\text{CO}_2$	18.0	1
$\text{H}_4\text{N}^+(\text{H}_2\text{O})-\text{H}_2\text{O}$	$72.8 \pm 4.2$	1	$\text{O}_2^+-\text{ON}_2$	$56.1 \pm 4$	1
$\text{H}_4\text{N}^+(\text{H}_2\text{O})_2-\text{H}_2\text{O}$	$57.3 \pm 4.2$	1	$(\text{H}_3\text{O})^+-\text{ON}_2$	$70.7 \pm 6.5$	1
$\text{H}_4\text{N}^+(\text{H}_2\text{O})_3-\text{H}_2\text{O}$	51.0	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})-\text{ON}_2$	$50.6 \pm 2.1$	1
$\text{H}_4\text{N}^+(\text{H}_2\text{O})_4-\text{H}_2\text{O}$	44.4	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_2-\text{ON}_2$	$42.7 \pm 2.1$	1
(glycine) $\text{H}^+-\text{H}_2\text{O}$	$77.2 \pm 11.0$	1	$\text{O}_3^+-\text{O}_3$	$67.5 \pm 39$	1
(tryptophan) $\text{H}^+-\text{H}_2\text{O}$	$31.2 \pm 2.5$	1	$\text{OCIO}^+-\text{OCIO}$	$246 \pm 48$	1
(tryptophanylglycine) $\text{H}^+-\text{H}_2\text{O}$	$56.0 \pm 5.3$	1	$\text{O}_2^+-\text{H}_2\text{O}$	>67	1
$\text{H}_4\text{N}^+-\text{H}_2\text{S}$	47.7	1	$(\text{OH})^+(\text{H}_2\text{O})_2-\text{H}_2\text{O}$	87.4	1
$\text{H}^+(\text{NH}_3)-\text{NH}_3$	108.8	1	$(\text{OH})^+(\text{H}_2\text{SO}_4)(\text{H}_2\text{O})_4-\text{H}_2\text{O}$	56.9	1
$\text{H}^+(\text{NH}_3)_2-\text{NH}_3$	69.5	1	$(\text{OH})^+(\text{H}_2\text{SO}_4)(\text{H}_2\text{O})_5-\text{H}_2\text{O}$	49.8	1
$\text{H}^+(\text{NH}_3)_3-\text{NH}_3$	57.3	1	$(\text{OH})^+(\text{H}_2\text{SO}_4)(\text{H}_2\text{O})_6-\text{H}_2\text{O}$	44.8	1
$\text{H}^+(\text{NH}_3)_4-\text{NH}_3$	49.0	1	$(\text{H}_2\text{O})^+-\text{H}_2\text{O}$	164.0	1
$\text{H}^+(\text{NH}_3)_5-\text{NH}_3$	29.3	1	$(\text{H}_3\text{O})^+-\text{H}_2\text{O}$	140.2	1
$\text{H}^+(\text{NH}_3)_6-\text{NH}_3$	27.2	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})-\text{H}_2\text{O}$	93.3	1
$\text{NH}_4^+-\text{CH}_4$	15.0	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_2-\text{H}_2\text{O}$	71.1	1
$\text{ON}^+-\text{CH}_3\text{OH}$	97.6	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_3-\text{H}_2\text{O}$	64.0	1
$\text{O}_2\text{N}^+-\text{CH}_3\text{OH}$	$80.3 \pm 9.6$	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_4-\text{H}_2\text{O}$	54.4	1
( $\text{CH}_3\text{CNH}$ ) $^+-\text{CH}_3\text{CN}$	$130.1 \pm 9.6$	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_5-\text{H}_2\text{O}$	49.0	1
(pyridine $\text{H}$ ) $^+-\text{pyridine}$	$105.4 \pm 4$	1	$(\text{H}_3\text{O})^+(\text{H}_2\text{O})_6-\text{H}_2\text{O}$	43.1	1
(valine $\text{H}$ ) $^+-\text{valine}$	$86.6 \pm 8.4$	1	(HCOOH) $\text{H}^+-\text{H}_2\text{O}$	100.8	1
(betain $\text{H}$ ) $^+-\text{betaine}$	$139.9 \pm 4.8$	1	$\text{CH}_3\text{OH}_2^+-\text{H}_2\text{O}$	115.6	1
$\text{H}_4\text{P}^+-\text{H}_2\text{O}$	54.4	1	$\text{CH}_3\text{CHOH}^+-\text{H}_2\text{O}$	104.6	1
( $\text{H}_4\text{P}$ ) $^+-\text{PH}_3$	48.1	1	( $\text{CH}_3$ ) $_2\text{OH}^+-\text{H}_2\text{O}$	100.4	1
$\text{AsH}_2^+-\text{H}$	257	1	(tetrahydrofuran $\text{H}$ ) $^+-\text{H}_2\text{O}$	82.8	1
$\text{I}_2\text{As}^+-\text{acetone}$	$106 \pm 17$	1	(furan $\text{H}$ ) $^+-\text{H}_2\text{O}$	43.5	1
$\text{I}_2\text{As}^+-\text{benzene}$	$77 \pm 17$	1	furane $^+-\text{H}_2\text{O}$	41.0	1
$\text{Bi}^+-\text{H}_2\text{O}$	95.4	1	(phenol) $^+-\text{H}_2\text{O}$	78.0	1
$\text{Bi}^+-\text{NH}_3$	149	1	(1-naphthol) $^+-\text{H}_2\text{O}$	66.4	1
$\text{Bi}^+-\text{C}_6\text{H}_6$	$\leq 149$	1	$\text{H}_3\text{O}^+-\text{HC(O)H}$	137.7	1
<b>(16) Group 16</b>			$\text{H}_3\text{O}^+-\text{NH}_3$	229.3	1
$(\text{H}_3\text{O})^+-\text{H}_2$	$14.6 \pm 2.1$	1	$\text{H}_3\text{O}^+(\text{NH}_3)-\text{NH}_3$	77.0	1
$\text{O}^+-\text{O}_2$	179.5	1	$\text{H}_3\text{O}^+(\text{NH}_3)_2-\text{NH}_3$	71.5	1
$\text{O}^+(\text{O}_2)_1-\text{O}_2$	28.9	1	$\text{H}_3\text{O}^+(\text{NH}_3)_3-\text{NH}_3$	62.8	1
$\text{O}^+(\text{O}_2)_2-\text{O}_2$	3.9	1	$\text{H}_3\text{O}^+-\text{PH}_3$	144	1
$\text{O}_2^+-\text{O}_2$	$38.3 \pm 2.1$	1	$\text{H}_3\text{O}^+-\text{SO}_3$	74	1
$\text{O}_2^+(\text{O}_2)-\text{O}_2$	$24.6 \pm 1.3$	1	(HCOOH) $^+-\text{HCOOH}$	$96.5 \pm 9.6$	1
$\text{O}_2^+(\text{O}_2)_2-\text{O}_2$	$10.4 \pm 0.8$	1	$\text{H}_3\text{O}^+-\text{CH}_4$	33.5	1
$\text{O}_2^+(\text{O}_2)_3-\text{O}_2$	$9.0 \pm 0.8$	1	( $\text{CH}_3\text{OH}$ ) $^+-\text{CH}_3\text{OH}$	$115.8 \pm 19.3$	1
$\text{O}_2^+(\text{O}_2)_4-\text{O}_2$	$8.0 \pm 0.8$	1	$\text{CH}_3\text{OH}_2^+-\text{CH}_3\text{OH}$	136.4	1
$\text{O}_2^+(\text{O}_2)_5-\text{O}_2$	$7.9 \pm 1.3$	1	$\text{H}_3\text{O}^+-\text{CH}_3\text{CN}$	195.4	1
$\text{O}^+-\text{N}_2$	231.4	1	furan $^+-\text{furan}$	94.1	1
$\text{O}_2^+-\text{N}_2$	22.6	1	$\text{BH}^+-\text{B}$ , B = tetrahydrofuran	125.1	1
$(\text{H}_3\text{O})^+-\text{N}_2$	$22.2 \pm 2.1$	1	$\text{S}^+-\text{CS}_2$	166	1
$\text{O}_4^+-\text{N}_2$	12.3	1	$\text{CS}^+-\text{CS}_2$	150.6	1
$\text{O}_2^+-\text{CO}$	31.8	1	$\text{CS}_2^+-\text{CS}_2$	104.2	1
$\text{O}_2^+-\text{CO}_2$	$41.0 \pm 2.1$	1	$\text{HCS}_2^+-\text{CS}_2$	46.4	1
$\text{CO}_2^+-\text{CO}_2$	$65.3 \pm 4$	1	$\text{OS}^+-\text{SO}_2$	57.7	1

Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.	Bond	$Do^2_{98}/\text{kJ mol}^{-1}$	Ref.
$\text{O}_2\text{S}^+-\text{SO}_2$	63.6	1	$\text{He}^+(\text{He})_2-\text{He}$	$2.7 \pm 0.6$	1
$\text{OCS}^+-\text{OCS}$	100.0	1	$\text{Ne}^+(\text{Ne})-\text{Ne}$	$10.3 \pm 0.6$	1
$\text{OCS}^+-\text{CO}_2$	72.0	1	$\text{Ne}^+(\text{Ne})_2-\text{Ne}$	$3.3 \pm 0.6$	1
$\text{SO}_2^+-\text{CO}_2$	42.7	1	$\text{Ar}^+(\text{Ar})-\text{Ar}$	$20.4 \pm 0.6$	1
$\text{H}_3\text{S}^+-\text{H}_2\text{O}$	91.6	1	$\text{Ar}^+(\text{Ar})_2-\text{Ar}$	$7.0 \pm 0.6$	1
thiophene $\text{H}^+-\text{H}_2\text{O}$	42.7	1	$\text{Ar}^+(\text{N}_2)-\text{Ar}$	25.1	1
$\text{H}_3\text{S}^+-\text{H}_2\text{S}$	$53.6 \pm 6.3$	1	$\text{Ar}^+(\text{N}_2)(\text{Ar})-\text{Ar}$	7.1	1
$\text{H}_3\text{S}^+-\text{CH}_4$	16.3	1	$\text{Ar}^+(\text{N}_2)(\text{Ar})_2-\text{Ar}$	7.1	1
$(\text{CH}_3)_2\text{Se}^+-\text{Se}(\text{CH}_3)_2$	$\sim 95 \pm 3$	1	$\text{Kr}^+(\text{Kr})-\text{Kr}$	$23.3 \pm 0.6$	1
$(\text{CH}_3)_2\text{Te}^+-\text{Te}(\text{CH}_3)_2$	$97 \pm 2$	1	$\text{Kr}^+(\text{Kr})_2-\text{Kr}$	$9.0 \pm 0.6$	1
<b>(17) Group 17</b>			$\text{Xe}^+(\text{Xe})-\text{Xe}$	$25.2 \pm 0.6$	1
$\text{HF}^+-\text{HF}$	$\geq 138$	1	$\text{Xe}^+(\text{Xe})_2-\text{Xe}$	$11.0 \pm 0.6$	1
$(\text{H}_2\text{Cl})^+-\text{Cl}$	39.6	1	$\text{Ar}^+-\text{H}_2$	93.7	1
$\text{HCl}^+-\text{HCl}$	83.9	1	$\text{Ar}^+-\text{N}_2$	127.6	1
$\text{Cl}^+-\text{CCl}_3$	$446.7 \pm 9.6$	1	$\text{Ar}^+(\text{N}_2)-\text{N}_2$	31.0	1
$\text{Cl}^+-\text{C}_2\text{H}_3$	$685.0 \pm 4.8$	1	$\text{Ar}^+(\text{N}_2)_2-\text{N}_2$	10.9	1
$\text{HBr}^+-\text{HBr}$	96	1	$\text{Ar}^+-\text{CO}$	$75 \pm 17$	1
$\text{I}^+-\text{CH}_3$	330.0	1	$\text{Ar}^+(\text{CO})-\text{CO}$	13	1
$\text{I}^+(\text{CH}_3\text{I})-\text{CH}_3$	51.1	1	$\text{Kr}^+-\text{CO}$	$103.3 \pm 7.5$	1
$\text{I}^+(\text{CH}_3\text{I})_2-\text{CH}_3$	112.9	1	$\text{Kr}^+-\text{CO}_2$	$79.1 \pm 2.9$	1
<b>(18) Group 18</b>					
$\text{He}^+(\text{He})_1-\text{He}$	17.6	1			

## References

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2. Parke, L.G., et al., *Int. J. Mass Spectrom.* 254, 168–182, 2006.
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## ELECTRONEGATIVITY

Electronegativity is a parameter originally introduced by Pauling which describes, on a relative basis, the tendency of an atom in a molecule to attract bonding electrons. While electronegativity is not a precisely defined molecular property, the electronegativity difference between two atoms provides a useful measure of the polarity and ionic character of the bond between them. This table gives the electronegativity  $X$ , on the Pauling scale, for the most common oxidation state. Other scales are described in the references.

### References

1. Pauling, L., *The Nature of the Chemical Bond, Third Edition*, Cornell University Press, Ithaca, NY, 1960.
2. Allen, L. C., *J. Am. Chem. Soc.*, 111, 9003, 1989.
3. Allred, A. L., *J. Inorg. Nucl. Chem.*, 17, 215, 1961.

<i>Z</i>	Symbol	<i>X</i>	<i>Z</i>	Symbol	<i>X</i>	<i>Z</i>	Symbol	<i>X</i>
1	H	2.20	33	As	2.18	65	Tb	—
2	He	—	34	Se	2.55	66	Dy	1.22
3	Li	0.98	35	Br	2.96	67	Ho	1.23
4	Be	1.57	36	Kr	—	68	Er	1.24
5	B	2.04	37	Rb	0.82	69	Tm	1.25
6	C	2.55	38	Sr	0.95	70	Yb	—
7	N	3.04	39	Y	1.22	71	Lu	1.0
8	O	3.44	40	Zr	1.33	72	Hf	1.3
9	F	3.98	41	Nb	1.6	73	Ta	1.5
10	Ne	—	42	Mo	2.16	74	W	1.7
11	Na	0.93	43	Tc	2.10	75	Re	1.9
12	Mg	1.31	44	Ru	2.2	76	Os	2.2
13	Al	1.61	45	Rh	2.28	77	Ir	2.2
14	Si	1.90	46	Pd	2.20	78	Pt	2.2
15	P	2.19	47	Ag	1.93	79	Au	2.4
16	S	2.58	48	Cd	1.69	80	Hg	1.9
17	Cl	3.16	49	In	1.78	81	Tl	1.8
18	Ar	—	50	Sn	1.96	82	Pb	1.8
19	K	0.82	51	Sb	2.05	83	Bi	1.9
20	Ca	1.00	52	Te	2.1	84	Po	2.0
21	Sc	1.36	53	I	2.66	85	At	2.2
22	Ti	1.54	54	Xe	2.60	86	Rn	—
23	V	1.63	55	Cs	0.79	87	Fr	0.7
24	Cr	1.66	56	Ba	0.89	88	Ra	0.9
25	Mn	1.55	57	La	1.10	89	Ac	1.1
26	Fe	1.83	58	Ce	1.12	90	Th	1.3
27	Co	1.88	59	Pr	1.13	91	Pa	1.5
28	Ni	1.91	60	Nd	1.14	92	U	1.7
29	Cu	1.90	61	Pm	—	93	Np	1.3
30	Zn	1.65	62	Sm	1.17	94	Pu	1.3
31	Ga	1.81	63	Eu	—			
32	Ge	2.01	64	Gd	1.20			



## FORCE CONSTANTS FOR BOND STRETCHING

Representative force constants ( $f$ ) for stretching of chemical bonds are listed in this table. Except where noted, all force constants are derived from values of the harmonic vibrational frequencies  $\omega_e$ . Values derived from the observed vibrational fundamentals  $\nu$ , which are noted by a, are lower than the harmonic force constants, typically by 2 to 3% in the case of heavy atoms (often by 5 to 10% if one of the atoms is hydrogen). Values are given in the SI unit newton per centimeter (N/cm), which is identical to the commonly used cgs unit mdyn/Å.

## References

1. Huber, K. P., and Herzberg, G., *Molecular Spectra and Molecular Structure. IV. Constants of Diatomic Molecules*, Van Nostrand Reinhold, New York, 1979.
2. Shimanouchi, T., The Molecular Force Field, in Eyring, H., Henderson, D., and Yost, W., Eds., *Physical Chemistry: An Advanced Treatise*, Vol. IV, Academic Press, New York, 1970.
3. Tasumi, M., and Nakata, M., *Pure and Appl. Chem.*, 57, 121–147, 1985.

Bond	Molecule	$f$ (N/cm)	Note	Bond	Molecule	$f$ (N/cm)	Note
H-H	H <sub>2</sub>	5.75			OCS	7.44	
Be-H	BeH	2.27		C-N	CN	16.29	
B-H	BH	3.05			HCN	18.78	
C-H	CH	4.48			CH <sub>3</sub> CN	18.33	
	CH <sub>4</sub>	5.44	b		CH <sub>3</sub> NH <sub>2</sub>	5.12	a,c
	C <sub>2</sub> H <sub>6</sub>	4.83	a,b,c	C-P	CP	7.83	
	CH <sub>3</sub> CN	5.33	b	Si-Si	Si <sub>2</sub>	2.15	
	CH <sub>3</sub> Cl	5.02	a,b,c	Si-O	SiO	9.24	
	CCl <sub>2</sub> =CH <sub>2</sub>	5.57	b	Si-F	SiF	4.90	
	HCN	6.22		Si-Cl	SiCl	2.63	
N-H	NH	5.97		N-N	N <sub>2</sub>	22.95	
O-H	OH	7.80			N <sub>2</sub> O	18.72	
	H <sub>2</sub> O	8.45		N-O	NO	15.95	
P-H	PH	3.22			N <sub>2</sub> O	11.70	
S-H	SH	4.23		P-P	P <sub>2</sub>	5.56	
	H <sub>2</sub> S	4.28		P-O	PO	9.45	
F-H	HF	9.66		O-O	O <sub>2</sub>	11.77	
Cl-H	HCl	5.16			O <sub>3</sub>	5.74	a
Br-H	HBr	4.12		S-O	SO	8.30	
I-H	HI	3.14			SO <sub>2</sub>	10.33	a
Li-H	LiH	1.03		S-S	S <sub>2</sub>	4.96	
Na-H	NaH	0.78		F-F	F <sub>2</sub>	4.70	
K-H	KH	0.56		Cl-F	ClF	4.48	
Rb-H	RbH	0.52		Br-F	BrF	4.06	
Cs-H	CsH	0.47		Cl-Cl	Cl <sub>2</sub>	3.23	
C-C	C <sub>2</sub>	12.16		Br-Cl	BrCl	2.82	
	CCl <sub>2</sub> =CH <sub>2</sub>	8.43		Br-Br	Br <sub>2</sub>	2.46	
	C <sub>2</sub> H <sub>6</sub>	4.50	a,c	I-I	I <sub>2</sub>	1.72	
	CH <sub>3</sub> CN	5.16		Li-Li	Li <sub>2</sub>	0.26	
C-F	CF	7.42		Li-Na	LiNa	0.21	
	CH <sub>3</sub> F	5.71	a,c	Na-Na	Na <sub>2</sub>	0.17	
C-Cl	CCl	3.95		Li-F	LiF	2.50	
	CH <sub>3</sub> Cl	3.44	a,c	Li-Cl	LiCl	1.43	
	CCl <sub>2</sub> =CH <sub>2</sub>	4.02	b	Li-Br	LiBr	1.20	
C-Br	CH <sub>3</sub> Br	2.89	a,c	Li-I	LiI	0.97	
C-I	CH <sub>3</sub> I	2.34	a,c	Na-F	NaF	1.76	
C-O	CO	19.02		Na-Cl	NaCl	1.09	
	CO <sub>2</sub>	16.00		Na-Br	NaBr	0.94	
	OCS	16.14		Na-I	NaI	0.76	
	CH <sub>3</sub> OH	5.42	a,c	Be-O	BeO	7.51	
C-S	CS	8.49		Mg-O	MgO	3.48	
	CS <sub>2</sub>	7.88		Ca-O	CaO	3.61	

<sup>a</sup> Derived from fundamental frequency, without anharmonicity correction.

<sup>b</sup> Average of symmetric and antisymmetric (or degenerate) modes.

<sup>c</sup> Calculated from Local Symmetry Force Field (see Reference 2).

## FUNDAMENTAL VIBRATIONAL FREQUENCIES OF SMALL MOLECULES

This table lists the fundamental vibrational frequencies of selected three-, four-, and five-atom molecules. Both stable molecules and transient free radicals are included. The data have been taken from evaluated sources. In general, the selected values are based on gas-phase infrared, Raman, or ultraviolet spectra; when these were not available, liquid-phase or matrix-isolation spectra were used.

Molecules are grouped by structural type. Within each group, related molecules appear together for convenient comparison.

The vibrational modes are described by their approximate character in terms of stretching, bending, deformation, etc. However, it should be emphasized that most such descriptions are only approximate, and that the true normal mode usually involves a mixture of motions. Abbreviations are:

sym.	symmetric
antisym.	antisymmetric
str.	stretch
deform.	deformation
scis.	scissors
rock.	rocking
deg.	degenerate

In the case of free radicals, strong interactions may exist between the electronic and bending vibrational motions. Details can be found in References 3 and 4. The references should be consulted for information on the accuracy of the data and for data on other molecules not listed here.

All fundamental frequencies (more precisely, wavenumbers) are given in units of  $\text{cm}^{-1}$ .

### XY<sub>2</sub> Molecules

Molecule	Structure	Point groups D <sub>∞h</sub> (linear) and C <sub>2v</sub> (bent)		
		Sym. str.	Bend	Antisym. str.
CO <sub>2</sub>	Linear	1333	667	2349
CS <sub>2</sub>	Linear	658	397	1535
C <sub>3</sub>	Linear	1224	63	2040
CNC	Linear		321	1453
NCN	Linear	1197	423	1476
BO <sub>2</sub>	Linear	1056	447	1278
BS <sub>2</sub>	Linear	510	120	1015
KrF <sub>2</sub>	Linear	449	233	590
XeF <sub>2</sub>	Linear	515	213	555
XeCl <sub>2</sub>	Linear	316		481
H <sub>2</sub> O	Bent	3657	1595	3756
D <sub>2</sub> O	Bent	2671	1178	2788
F <sub>2</sub> O	Bent	928	461	831
Cl <sub>2</sub> O	Bent	639	296	686
O <sub>3</sub>	Bent	1103	701	1042
H <sub>2</sub> S	Bent	2615	1183	2626
D <sub>2</sub> S	Bent	1896	855	1999
SF <sub>2</sub>	Bent	838	357	813
SCL <sub>2</sub>	Bent	525	208	535
SO <sub>2</sub>	Bent	1151	518	1362
H <sub>2</sub> Se	Bent	2345	1034	2358
D <sub>2</sub> Se	Bent	1630	745	1696

### XY<sub>2</sub> Molecules

Molecule	Structure	Point groups D <sub>∞h</sub> (linear) and C <sub>2v</sub> (bent)		
		Sym. str.	Bend	Antisym. str.
NH <sub>2</sub>	Bent	3219	1497	3301
NO <sub>2</sub>	Bent	1318	750	1618
NF <sub>2</sub>	Bent	1075	573	942
ClO <sub>2</sub>	Bent	945	445	1111
CH <sub>2</sub>	Bent		963	
CD <sub>2</sub>	Bent		752	
CF <sub>2</sub>	Bent	1225	667	1114
CCl <sub>2</sub>	Bent	721	333	748
CBr <sub>2</sub>	Bent	595	196	641
SiH <sub>2</sub>	Bent	2032	990	2022
SiD <sub>2</sub>	Bent	1472	729	1468
SiF <sub>2</sub>	Bent	855	345	870
SiCl <sub>2</sub>	Bent	515		505
SiBr <sub>2</sub>	Bent	403		400
GeH <sub>2</sub>	Bent	1887	920	1864
GeCl <sub>2</sub>	Bent	399	159	374
SnF <sub>2</sub>	Bent	593	197	571
SnCl <sub>2</sub>	Bent	352	120	334
SnBr <sub>2</sub>	Bent	244	80	231
PbF <sub>2</sub>	Bent	531	165	507
PbCl <sub>2</sub>	Bent	314	99	299
ClF <sub>2</sub>	Bent	500		576

### XYZ Molecules

Molecule	Structure	Point Groups C <sub>∞v</sub> (linear) and C <sub>s</sub> (bent)		
		XY str.	Bend	YZ str.
HCN	Linear	3311	712	2097
DCN	Linear	2630	569	1925
FCN	Linear	1077	451	2323
CICN	Linear	744	378	2216
BrCN	Linear	575	342	2198
ICN	Linear	486	305	2188
CCN	Linear	1060	230	1917
CCO	Linear	1063	379	1967
HCO	Bent	2485	1081	1868
HCC	Linear	3612		1848
OCS	Linear	2062	520	859
NCO	Linear	1270	535	1921

### XYZ Molecules

Molecule	Structure	Point Groups C <sub>∞v</sub> (linear) and C <sub>s</sub> (bent)		
		XY str.	Bend	YZ str.
NNO	Linear	2224	589	1285
HNB	Linear	3675		2035
HNC	Linear	3653		2032
HNSi	Linear	3583	523	1198
HBO	Linear		754	1817
FBO	Linear		500	2075
CIBO	Linear	676	404	1958
BrBO	Linear	535	374	1937
FNO	Bent	766	520	1844
CINO	Bent	596	332	1800
BrNO	Bent	542	266	1799
HNF	Bent		1419	1000

## XYZ Molecules

Point Groups  $C_{\infty v}$  (linear) and  $C_s$  (bent)

Molecule	Structure	XY str.	Bend	YZ str.
HNO	Bent	2684	1501	1565
HPO	Bent	2095	983	1179
HOF	Bent	3537	886	1393
HOCl	Bent	3609	1242	725
HOO	Bent	3436	1392	1098
FOO	Bent	579	376	1490
CIOO	Bent	407	373	1443
BrOO	Bent			1487
HSO	Bent		1063	1009

## XYZ Molecules

Point Groups  $C_{\infty v}$  (linear) and  $C_s$  (bent)

Molecule	Structure	XY str.	Bend	YZ str.
NSF	Bent	1372	366	640
NSCl	Bent	1325	273	414
HCF	Bent		1407	1181
HCCl	Bent		1201	815
HSiF	Bent	1913	860	834
HSiCl	Bent		808	522
HSiBr	Bent	1548	774	408

Symmetric  $XY_3$  MoleculesPoint Groups  $D_{3h}$  (planar) and  $C_{3v}$  (pyramidal)

Molecule	Structure	Sym. str.	Sym. deform.	Deg. str.	Deg. deform.
NH <sub>3</sub>	Pyram.	3337	950	3444	1627
ND <sub>3</sub>	Pyram.	2420	748	2564	1191
PH <sub>3</sub>	Pyram.	2323	992	2328	1118
AsH <sub>3</sub>	Pyram.	2116	906	2123	1003
SbH <sub>3</sub>	Pyram.	1891	782	1894	831
NF <sub>3</sub>	Pyram.	1032	647	907	492
PF <sub>3</sub>	Pyram.	892	487	860	344
AsF <sub>3</sub>	Pyram.	741	337	702	262
PCl <sub>3</sub>	Pyram.	504	252	482	198
PI <sub>3</sub>	Pyram.	303	111	325	79
AsI <sub>3</sub>	Pyram.	219	94	224	71
AlCl <sub>3</sub>	Pyram.	375	183	595	150
SO <sub>3</sub>	Planar	1065	498	1391	530
BF <sub>3</sub>	Planar	888	691	1449	480
BH <sub>3</sub>	Planar		1125	2808	1640
CH <sub>3</sub>	Planar		606	3161	1396
CD <sub>3</sub>	Planar		453	2369	1029
CF <sub>3</sub>	Pyram.	1090	701	1260	510
SiF <sub>3</sub>	Pyram.	830	427	937	290

Linear  $XYX$  MoleculesPoint Group  $D_{\infty h}$ 

Molecule	Sym. XY str.	Antisym. XY str.	YY str.	Bend	Bend
C <sub>2</sub> H <sub>2</sub>	3374	3289	1974	612	730
C <sub>2</sub> D <sub>2</sub>	2701	2439	1762	505	537
C <sub>2</sub> N <sub>2</sub>	2330	2158	851	507	233

Planar  $X_2YZ$  MoleculesPoint Group  $C_{2v}$ 

Molecule	Sym. XY str.	YZ str.	YX <sub>2</sub> scis.	Antisym. XY str.	YX <sub>2</sub> rock	YX <sub>2</sub> wag
H <sub>2</sub> CO	2783	1746	1500	2843	1249	1167
D <sub>2</sub> CO	2056	1700	1106	2160	990	938
F <sub>2</sub> CO	965	1928	584	1249	626	774
Cl <sub>2</sub> CO	567	1827	285	849	440	580
O <sub>2</sub> NF	1310	822	568	1792	560	742
O <sub>2</sub> NCl	1286	793	370	1685	408	652

Tetrahedral XY<sub>4</sub> Molecules

Molecule	Sym. str.	Point Group T <sub>d</sub>		Deg. deform.(f)
		Deg. deform.(e)	Deg. str.(f)	
CH <sub>4</sub>	2917	1534	3019	1306
CD <sub>4</sub>	2109	1092	2259	996
CF <sub>4</sub>	909	435	1281	632
CCl <sub>4</sub>	459	217	776	314
CBr <sub>4</sub>	267	122	672	182
CI <sub>4</sub>	178	90	555	125
SiH <sub>4</sub>	2187	975	2191	914
SiD <sub>4</sub>	1558	700	1597	681
SiF <sub>4</sub>	800	268	1032	389
SiCl <sub>4</sub>	424	150	621	221
GeH <sub>4</sub>	2106	931	2114	819
GeD <sub>4</sub>	1504	665	1522	596
GeCl <sub>4</sub>	396	134	453	172
SnCl <sub>4</sub>	366	104	403	134
TiCl <sub>4</sub>	389	114	498	136
ZrCl <sub>4</sub>	377	98	418	113
HfCl <sub>4</sub>	382	102	390	112
RuO <sub>4</sub>	885	322	921	336
OsO <sub>4</sub>	965	333	960	329

## References

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3. G. Herzberg, *Electronic Spectra and Electronic Structure of Polyatomic Molecules*, D. Van Nostrand Co., Princeton, NJ, 1966.
4. M. E. Jacox, Ground state vibrational energy levels of polyatomic transient molecules, *J. Phys. Chem. Ref. Data*, 13, 945, 1984.

## SPECTROSCOPIC CONSTANTS OF DIATOMIC MOLECULES

This table lists the leading spectroscopic constants and equilibrium internuclear distance  $r_e$  in the ground electronic state for selected diatomic molecules. The constants are those describing the vibrational and rotational energy through the expressions:

$$E_{\text{vib}}/hc = \omega_e(v + 1/2) - \omega_e x_e(v + 1/2)^2 + \dots$$

$$E_{\text{rot}}/hc = B_v J(J + 1) - D_v [J(J + 1)]^2 + \dots$$

where

$$B_v = B_e - \alpha_e(v + 1/2) + \dots$$

$$D_v = D_e + \dots$$

Here  $v$  and  $J$  are the vibrational and rotational quantum numbers, respectively,  $h$  is Planck's constant, and  $c$  is the speed of light. In this customary formulation the constants  $\omega_e$ ,  $B_e$ , etc. have dimensions of inverse length; in this table they are given in units of  $\text{cm}^{-1}$ .

Users should note that higher order terms in the above energy expressions are required for very precise calculations; constants for many of these terms can be found in the references. Also, if the ground electronic state is not  $^1\Sigma$ , additional terms are needed to account for the interaction between electronic and pure rotational angular momentum. For some molecules in the table the data have been analyzed in terms of the Dunham series expansion:

$$E/hc = \sum_{lm} Y_{lm}(v + 1/2)^l J^m (J + 1)^m$$

In such cases it has been assumed that  $Y_{10} = \omega_e$ ,  $Y_{01} = B_e$ , etc., although in the highest approximations these identities are not precisely correct. Some of the values of  $r_e$  in the table have been corrected for breakdown of the Born-Oppenheimer approximation, which can affect the last decimal place. Because of differences in the method of data analysis and limitations in the model, care should be taken in comparing  $r_e$  values for different molecules to a precision beyond 0.001 Å.

Molecules are listed in alphabetical order by formula as written in the most common form. In most cases this form places the more electropositive element first, but there are exceptions such as OH, NH, CH, etc.

\* Indicates a value for the interval between  $v = 0$  and  $v = 1$  states instead of a value of  $\omega_e$ .

### References

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Molecule	State	$\omega_e$ $\text{cm}^{-1}$	$\omega_e x_e$ $\text{cm}^{-1}$	$B_e$ $\text{cm}^{-1}$	$\alpha_e$ $\text{cm}^{-1}$	$D_e$ $10^{-6}\text{cm}^{-1}$	$r_e$ Å
<sup>107</sup> Ag <sup>79</sup> Br	<sup>1</sup> Σ <sup>+</sup>	249.57	0.63	0.064833	0.0002361	0.0175	2.39311
<sup>107</sup> Ag <sup>35</sup> Cl	<sup>1</sup> Σ <sup>+</sup>	343.49	1.17	0.12298388	0.00059541	0.06305	2.28079
<sup>107</sup> Ag <sup>19</sup> F	<sup>1</sup> Σ <sup>+</sup>	513.45	2.59	0.2657020	0.0019206	0.284	1.98318
<sup>107</sup> Ag <sup>1</sup> H	<sup>1</sup> Σ <sup>+</sup>	1759.9	34.06	6.449	0.201	344	1.618
<sup>107</sup> Ag <sup>2</sup> H	<sup>1</sup> Σ <sup>+</sup>	1250.70	17.17	3.2572	0.0722	85.9	1.6180
<sup>107</sup> Ag <sup>127</sup> I	<sup>1</sup> Σ <sup>+</sup>	206.50	0.46	0.04486821	0.0001414	0.00847	2.54463
<sup>107</sup> Ag <sup>16</sup> O	<sup>2</sup> Π <sub>1/2</sub>	490.2	3.1	0.3020	0.0025	0.45	2.003
<sup>27</sup> Al <sub>2</sub>	<sup>3</sup> Π <sub>u</sub>	285.8	0.9	0.17127	0.0008		2.701
<sup>27</sup> Al <sup>79</sup> Br	<sup>1</sup> Σ <sup>+</sup>	378.0	1.28	0.15919713	0.00086045	0.11285	2.29481
<sup>27</sup> Al <sup>35</sup> Cl	<sup>1</sup> Σ <sup>+</sup>	481.30	1.95	0.24393012	0.00161113	0.2503	2.13011
<sup>27</sup> Al <sup>19</sup> F	<sup>1</sup> Σ <sup>+</sup>	802.3	4.77	0.5524798	0.0049841	1.0464	1.65437
<sup>27</sup> Al <sup>1</sup> H	<sup>1</sup> Σ <sup>+</sup>	1682.56	29.09	6.3907	0.1858	356.5	1.6478
<sup>27</sup> Al <sup>2</sup> H	<sup>1</sup> Σ <sup>+</sup>	1211.95	15.14	3.3186	0.0697	97	1.6463
<sup>27</sup> Al <sup>127</sup> I	<sup>1</sup> Σ <sup>+</sup>	316.1	1.0	0.11769985	0.00055859		2.53710
<sup>27</sup> Al <sup>16</sup> O	<sup>2</sup> Σ <sup>+</sup>	979.23	6.97	0.6414	0.0058	1.08	1.6179
<sup>27</sup> Al <sup>32</sup> S	<sup>2</sup> Σ <sup>+</sup>	617.1	3.33	0.2799	0.0018	0.22	2.029
<sup>75</sup> As <sub>2</sub>	<sup>1</sup> Σ <sub>g</sub> <sup>+</sup>	429.55	1.12	0.10179	0.000333		2.1026
<sup>75</sup> As <sup>1</sup> H	<sup>3</sup> Σ <sup>-</sup>	2130*		7.3067	0.2117	327	1.52315
<sup>75</sup> As <sup>2</sup> H	<sup>3</sup> Σ <sup>-</sup>	1484*		3.6688		90	1.5306
<sup>75</sup> As <sup>14</sup> N	<sup>1</sup> Σ <sup>+</sup>	1068.54	5.41	0.54551	0.003366	0.53	1.6184
<sup>75</sup> As <sup>16</sup> O	<sup>2</sup> Π <sub>1/2</sub>	967.08	4.85	0.48482	0.003299	0.49	1.6236
<sup>197</sup> Au <sub>2</sub>	<sup>1</sup> Σ <sub>g</sub> <sup>+</sup>	190.9	0.42	0.028013	0.0000723	0.00250	2.4719
<sup>197</sup> Au <sup>1</sup> H	<sup>1</sup> Σ <sup>+</sup>	2305.01	43.12	7.2401	0.2136	279	1.5239
<sup>197</sup> Au <sup>2</sup> H	<sup>1</sup> Σ <sup>+</sup>	1634.98	21.65	3.6415	0.07614	70.9	1.5238
<sup>11</sup> B <sub>2</sub>	<sup>3</sup> Σ <sub>g</sub> <sup>-</sup>	1051.3	9.35	1.212	0.014		1.590
<sup>11</sup> B <sup>79</sup> Br	<sup>1</sup> Σ <sup>+</sup>	684.31	3.52	0.4894	0.0035	1.00	1.888
<sup>11</sup> B <sup>35</sup> Cl	<sup>1</sup> Σ <sup>+</sup>	840.29	5.49	0.684282	0.006812	1.84	1.71528
<sup>11</sup> B <sup>19</sup> F	<sup>1</sup> Σ <sup>+</sup>	1402.1	11.8	1.516950	0.019056	7.105	1.26267
<sup>11</sup> B <sup>1</sup> H	<sup>1</sup> Σ <sup>+</sup>	2366.9	49.40	12.021	0.412	1242	1.2324
<sup>11</sup> B <sup>2</sup> H	<sup>1</sup> Σ <sup>+</sup>	1703.3	28	6.54	0.17	400	1.2324
<sup>11</sup> B <sup>14</sup> N	<sup>3</sup> Π	1514.6	12.3	1.666	0.025	8.1	1.281
<sup>11</sup> B <sup>16</sup> O	<sup>2</sup> Σ <sup>+</sup>	1885.69	11.81	1.7820	0.0166	6.32	1.2045

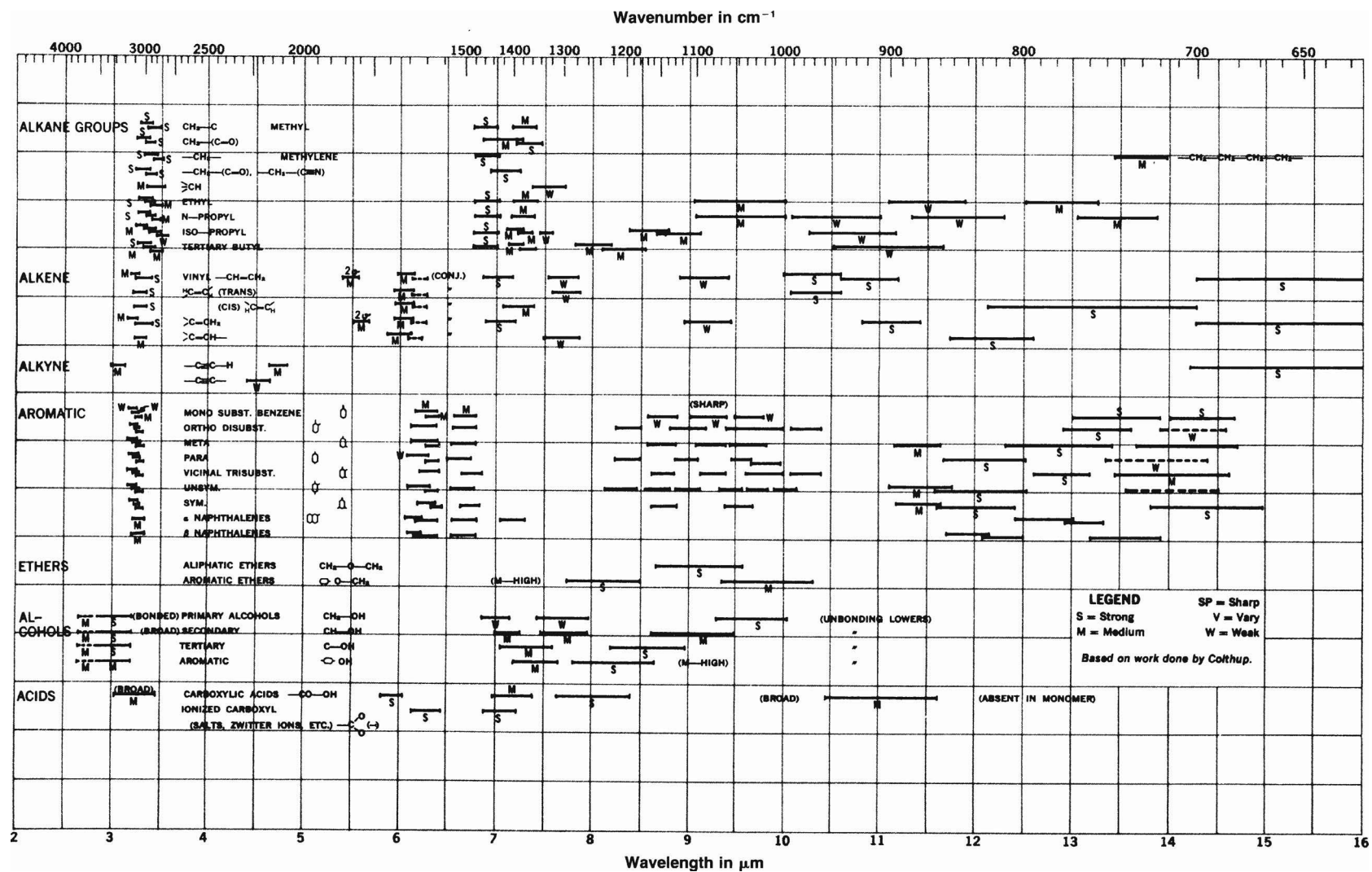
Molecule	State	$\omega_e$ cm <sup>-1</sup>	$\omega_e x_e$ cm <sup>-1</sup>	$B_e$ cm <sup>-1</sup>	$\alpha_e$ cm <sup>-1</sup>	$D_e$ 10 <sup>-6</sup> cm <sup>-1</sup>	$r_e$ Å
<sup>11</sup> B <sup>32</sup> S	2Σ <sup>+</sup>	1180.17	6.31	0.7949	0.0061	1.40	1.6092
<sup>138</sup> Ba <sup>79</sup> Br	2Σ <sup>+</sup>	193.77	0.41	0.0415082	0.0001219	0.00762	2.84449
<sup>138</sup> Ba <sup>35</sup> Cl	2Σ <sup>+</sup>	279.92	0.82	0.08396717	0.00033429	0.03022	2.68276
<sup>138</sup> Ba <sup>19</sup> F	2Σ <sup>+</sup>	468.9	1.79	0.2159	0.0012	0.175	2.163
<sup>138</sup> Ba <sup>1</sup> H	2Σ <sup>+</sup>	1168.31	14.50	3.38285	0.06599	112.67	2.23175
<sup>138</sup> Ba <sup>2</sup> H	2Σ <sup>+</sup>	829.77	7.32	1.7071	0.02363	28.77	2.2304
<sup>138</sup> Ba <sup>127</sup> I	2Σ <sup>+</sup>	152.14	0.27	0.02680587	0.00006634	0.00333	3.08476
<sup>138</sup> Ba <sup>16</sup> O	1Σ <sup>+</sup>	669.76	2.03	0.3126140	0.0013921	0.2724	1.93969
<sup>138</sup> Ba <sup>32</sup> S	1Σ <sup>+</sup>	379.42	0.88	0.10331	0.0003188	0.0306	2.5074
<sup>9</sup> Be <sup>19</sup> F	2Σ <sup>+</sup>	1247.36	9.12	1.4889	0.0176	8.28	1.3610
<sup>9</sup> Be <sup>1</sup> H	2Σ <sup>+</sup>	2060.78	36.31	10.3164	0.3030	1022.1	1.3426
<sup>9</sup> Be <sup>2</sup> H	2Σ <sup>+</sup>	1530.32	20.71	5.6872	0.1225	313.8	1.3419
<sup>9</sup> Be <sup>16</sup> O	1Σ <sup>+</sup>	1487.32	11.83	1.6510	0.0190	8.20	1.3309
<sup>9</sup> Be <sup>32</sup> S	1Σ <sup>+</sup>	997.94	6.14	0.79059	0.00664	2.00	1.7415
<sup>209</sup> Bi <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	172.71	0.34	0.022781	0.000055	0.00150	2.6596
<sup>209</sup> Bi <sup>1</sup> H	3Σ <sup>-</sup>	1635.73	31.6	5.137	0.148	183	1.805
<sup>209</sup> Bi <sup>2</sup> H	3Σ <sup>-</sup>	1173.32	16.1	2.592	0.054	50.6	1.804
<sup>79</sup> Br <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	325.32	1.08	0.082107	0.0003187	0.02092	2.2811
<sup>79</sup> Br <sup>35</sup> Cl	1Σ <sup>+</sup> <sub>g</sub>	444.28	1.84	0.152470	0.000770	0.07183	2.13607
<sup>79</sup> Br <sup>19</sup> F	1Σ <sup>+</sup>	670.75	4.05	0.35584	0.00261	0.401	1.75894
<sup>79</sup> Br <sup>16</sup> O	2Π <sub>3/2</sub>	779	6.8	0.429598	0.003639	0.523	1.717
<sup>12</sup> C <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	1854.71	13.34	1.8198	0.0177	6.92	1.2425
<sup>12</sup> C <sup>35</sup> Cl	2Π <sub>1/2</sub>	866.72*	6.2	0.6936	0.00672	1.9	1.6450
<sup>12</sup> C <sup>19</sup> F	2Π <sub>1/2</sub>	1308.1	11.10	1.4172	0.0184	6.5	1.2718
<sup>12</sup> C <sup>1</sup> H	2Π <sub>1/2</sub>	2858.5	63.0	14.457	0.534	1450	1.1199
<sup>12</sup> C <sup>2</sup> H	2Π <sub>1/2</sub>	2099.8	34.02	7.806	0.208	420	1.1190
<sup>12</sup> C <sup>14</sup> N	2Σ <sup>+</sup>	2068.59	13.09	1.8997830	0.0173717	6.4034	1.17181
<sup>12</sup> C <sup>16</sup> O	1Σ <sup>+</sup>	2169.81	13.29	1.93128075	0.01750390	6.1216	1.12823
<sup>12</sup> C <sup>31</sup> P	2Σ <sup>+</sup>	1239.67	6.86	0.7986	0.00597	1.33	1.562
<sup>12</sup> C <sup>32</sup> S	1Σ <sup>+</sup>	1285.15	6.50	0.8200434	0.0059182	1.336	1.53482
<sup>12</sup> C <sup>80</sup> Se	1Σ <sup>+</sup>	1035.36	4.86	0.5750	0.00379	0.71	1.67609
<sup>40</sup> Ca <sup>35</sup> Cl	2Σ <sup>+</sup>	367.53	1.31	0.1522302	0.0007990	0.1029	2.43676
<sup>40</sup> Ca <sup>19</sup> F	2Σ <sup>+</sup>	581.1	2.74	0.339	0.0026	0.45	1.967
<sup>40</sup> Ca <sup>1</sup> H	2Σ <sup>+</sup>	1298.34	19.10	4.2766	0.0970	183.7	2.0025
<sup>40</sup> Ca <sup>2</sup> H	2Σ <sup>+</sup>	910*		2.1769	0.035	47.9	2.002
<sup>40</sup> Ca <sup>127</sup> I	2Σ <sup>+</sup>	238.70	0.63	0.0693263	0.0002634	0.0234	2.82859
<sup>40</sup> Ca <sup>16</sup> O	1Σ <sup>+</sup>	732.03	4.83	0.444441	0.003282	0.6541	1.8221
<sup>40</sup> Ca <sup>32</sup> S	1Σ <sup>+</sup>	462.23	1.78	0.1766757	0.0008270	0.1032	2.31775
<sup>114</sup> Cd <sup>1</sup> H	2Σ <sup>+</sup>	1337.1*		5.323		314	1.781
<sup>114</sup> Cd <sup>2</sup> H	2Σ <sup>+</sup>			2.704		76	1.775
<sup>35</sup> Cl <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	559.7	2.68	0.2440	0.0015	0.186	1.988
<sup>35</sup> Cl <sup>19</sup> F	1Σ <sup>+</sup>	786.15	6.16	0.516479	0.004358	0.88	1.62831
<sup>35</sup> Cl <sup>16</sup> O	2Π <sub>3/2</sub>	853.8	5.5	0.62345	0.0058	1.33	1.56963
<sup>52</sup> Cr <sup>1</sup> H	6Σ <sup>+</sup>	1581*	32	6.220	0.179	347	1.656
<sup>52</sup> Cr <sup>2</sup> H	6Σ <sup>+</sup>	1182*		3.14		88.8	1.664
<sup>52</sup> Cr <sup>16</sup> O	5Π	898.4	6.8	0.5231	0.0070		1.615
<sup>133</sup> Cs <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	42.02	0.08	0.0127	0.0000264	0.00464	4.47
<sup>133</sup> Cs <sup>79</sup> Br	1Σ <sup>+</sup> <sub>g</sub>	149.66	0.37	0.03606925	0.00012401	0.00838	3.07225
<sup>133</sup> Cs <sup>35</sup> Cl	1Σ <sup>+</sup>	214.17	0.73	0.07209149	0.00033756	0.03268	2.90627
<sup>133</sup> Cs <sup>19</sup> F	1Σ <sup>+</sup>	352.56	1.62	0.18436969	0.0011756	0.20168	2.34535
<sup>133</sup> Cs <sup>1</sup> H	1Σ <sup>+</sup>	891.0	12.9	2.7099	0.0579	113	2.4938
<sup>133</sup> Cs <sup>2</sup> H	1Σ <sup>+</sup>	619.1*		1.354		20	2.505
<sup>133</sup> Cs <sup>127</sup> I	1Σ <sup>+</sup>	119.18	0.25	0.02362736	0.00006826	0.00371	3.31519
<sup>133</sup> Cs <sup>16</sup> O	2Σ <sup>+</sup>	357.5*		0.223073	0.001303	0.348	2.3007
<sup>63</sup> Cu <sub>2</sub>	1Σ <sup>+</sup> <sub>g</sub>	264.55	1.02	0.10874	0.000614	0.0716	2.2197
<sup>63</sup> Cu <sup>79</sup> Br	1Σ <sup>+</sup> <sub>g</sub>	314.8	0.96	0.10192625	0.00045214	0.04274	2.17344
<sup>63</sup> Cu <sup>35</sup> Cl	1Σ <sup>+</sup>	415.29	1.58	0.17628802	0.00099647	0.12706	2.05118
<sup>63</sup> Cu <sup>19</sup> F	1Σ <sup>+</sup>	622.7	3.95	0.3794029	0.0032298	0.563	1.74493
<sup>63</sup> Cu <sup>1</sup> H	1Σ <sup>+</sup>	1941.26	37.51	7.9441	0.2563	520	1.46263
<sup>63</sup> Cu <sup>2</sup> H	1Σ <sup>+</sup>	1384.14	18.97	4.0381	0.0917	136.2	1.4626

Molecule	State	$\omega_e$ cm <sup>-1</sup>	$\omega_e x_e$ cm <sup>-1</sup>	$B_e$ cm <sup>-1</sup>	$\alpha_e$ cm <sup>-1</sup>	$D_e$ 10 <sup>-6</sup> cm <sup>-1</sup>	$r_e$ Å
<sup>63</sup> Cu <sup>127</sup> I	1Σ <sup>+</sup>	264.5	0.60	0.07328742	0.00028390	0.02244	2.33832
<sup>63</sup> Cu <sup>16</sup> O	2Π <sub>3/2</sub>	640.17	4.43	0.44454	0.00456	0.85	1.7244
<sup>63</sup> Cu <sup>32</sup> S	2Π <sub>3/2</sub>	415.0	1.75	0.1891		0.18	2.051
<sup>19</sup> F <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	916.64	11.24	0.89019	0.013847	3.3	1.41193
<sup>56</sup> Fe <sup>16</sup> O	5Δ	965*		0.650		0.72	1.444
<sup>69</sup> Ga <sup>81</sup> Br	1Σ <sup>+</sup>	263.0	0.81	0.081839	0.0003207	0.032	2.35248
<sup>69</sup> Ga <sup>35</sup> Cl	1Σ <sup>+</sup>	365.67	1.25	0.1499046	0.0007936	0.1008	2.20169
<sup>69</sup> Ga <sup>19</sup> F	1Σ <sup>+</sup>	622.2	3.2	0.3595161	0.0028642	0.50	1.77437
<sup>69</sup> Ga <sup>1</sup> H	1Σ <sup>+</sup>	1604.52	28.77	6.137	0.181	342	1.663
<sup>69</sup> Ga <sup>2</sup> H	1Σ <sup>+</sup>			3.083	0.06	84	1.663
<sup>69</sup> Ga <sup>127</sup> I	1Σ <sup>+</sup>	216.38	0.47	0.0569359	0.0001897	0.015770	2.57464
<sup>69</sup> Ga <sup>16</sup> O	2Σ	767.5	6.24	0.4271		0.37	1.744
<sup>74</sup> Ge <sup>79</sup> Br	2Π <sub>1/2</sub>	295	0.7				
<sup>74</sup> Ge <sup>35</sup> Cl	2Π <sub>1/2</sub>	407.6	1.36				
<sup>72</sup> Ge <sup>1</sup> H	2Π <sub>1/2</sub>	1833.77	37	6.726	0.192	326	1.5880
<sup>72</sup> Ge <sup>2</sup> H	2Π <sub>1/2</sub>	1320.09	19	3.415	0.070	83.2	1.5874
<sup>74</sup> Ge <sup>16</sup> O	1Σ <sup>+</sup>	986.49	4.47	0.4856981	0.0030787	0.4709	1.62464
<sup>74</sup> Ge <sup>32</sup> S	1Σ <sup>+</sup>	575.8	1.80	0.18656576	0.00074910	0.07883	2.01209
<sup>74</sup> Ge <sup>80</sup> Se	1Σ <sup>+</sup>	408.7	1.36	0.09634051	0.00028904	0.02207	2.13463
<sup>74</sup> Ge <sup>130</sup> Te	1Σ <sup>+</sup>	323.9	0.75	0.06533821	0.00017246	0.012	2.34017
<sup>1</sup> H <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	4401.21	121.34	60.853	3.062	47100	0.74144
<sup>2</sup> H <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	3115.50	61.82	30.444	1.0786	11410	0.74152
<sup>3</sup> H <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	2546.5	41.23	20.335	0.5887		0.74142
<sup>1</sup> H <sup>81</sup> Br	1Σ <sup>+</sup>	2648.97	45.22	8.46488	0.23328	345.8	1.41444
<sup>2</sup> H <sup>81</sup> Br	1Σ <sup>+</sup>	1884.75	22.72	4.245596	0.084	88.32	1.4145
<sup>1</sup> H <sup>35</sup> Cl	1Σ <sup>+</sup>	2990.95	52.82	10.59342	0.30718	531.94	1.27455
<sup>2</sup> H <sup>35</sup> Cl	1Σ <sup>+</sup>	2145.16	27.18	5.448796	0.113292	140	1.27458
<sup>1</sup> H <sup>19</sup> F	1Σ <sup>+</sup>	4138.32	89.88	20.9557	0.798	2151	0.91681
<sup>2</sup> H <sup>19</sup> F	1Σ <sup>+</sup>	2998.19	45.76	11.0102	0.3017	594	0.91694
<sup>1</sup> H <sup>127</sup> I	1Σ <sup>+</sup>	2309.01	39.64	6.4263650	0.1689	206.9	1.60916
<sup>202</sup> Hg <sup>1</sup> H	2Σ <sup>+</sup>	1203.24*		5.3888		395.3	1.7662
<sup>202</sup> Hg <sup>2</sup> H	2Σ <sup>+</sup>	896.12*		2.739		91	1.757
<sup>127</sup> I <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	214.50	0.61	0.03737	0.000114	0.0043	2.666
<sup>127</sup> I <sup>79</sup> Br	1Σ <sup>+</sup>	268.64	0.81	0.0568325	0.0001969	0.0102	2.46899
<sup>127</sup> I <sup>35</sup> Cl	1Σ <sup>+</sup>	384.29	1.50	0.1141587	0.0005354	0.0403	2.32088
<sup>127</sup> I <sup>19</sup> F	1Σ <sup>+</sup>	610.24	3.12	0.2797111	0.0018738	0.2356	1.90976
<sup>127</sup> I <sup>16</sup> O	2Π <sub>3/2</sub>	681.5	4.3	0.34026	0.00270	0.36	1.8676
<sup>115</sup> In <sup>81</sup> Br	1Σ <sup>+</sup>	221.0	0.65	0.05489468	0.00018672	0.01350	2.54315
<sup>115</sup> In <sup>35</sup> Cl	1Σ <sup>+</sup>	317.39	1.03	0.1090583	0.0005177	0.0515	2.40117
<sup>115</sup> In <sup>19</sup> F	1Σ <sup>+</sup>	535.4	2.6	0.2623241	0.0018798	0.252	1.98540
<sup>115</sup> In <sup>1</sup> H	1Σ <sup>+</sup>	1476.0	25.61	4.995	0.143	223	1.8380
<sup>115</sup> In <sup>2</sup> H	1Σ <sup>+</sup>	1048.2	12.4	2.523	0.051	58	1.837
<sup>115</sup> In <sup>127</sup> I	1Σ <sup>+</sup>	177.08	0.34	0.03686702	0.00010411	0.00639	2.75364
<sup>39</sup> K <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	92.02	0.28	0.056743	0.000165	0.0863	3.9051
<sup>39</sup> K <sup>79</sup> Br	1Σ <sup>+</sup>	213	0.80	0.08122109	0.00040481	0.04462	2.82078
<sup>39</sup> K <sup>35</sup> Cl	1Σ <sup>+</sup>	281	1.30	0.1286348	0.0007899	0.1087	2.66665
<sup>39</sup> K <sup>19</sup> F	1Σ <sup>+</sup>	426.26	2.45	0.27993741	0.00233492	0.4829	2.17146
<sup>39</sup> K <sup>1</sup> H	1Σ <sup>+</sup>	983.6	14.3	3.416400	0.085313	163.55	2.243
<sup>39</sup> K <sup>2</sup> H	1Σ <sup>+</sup>	707	7.7	1.754	0.0318	50	2.240
<sup>39</sup> K <sup>127</sup> I	1Σ <sup>+</sup>	186.53	0.57	0.06087473	0.00026776	0.02593	3.04784
<sup>139</sup> La <sup>16</sup> O	2Σ <sup>+</sup>	812.8	2.22	0.35252001	0.00142365	0.2626	1.82591
<sup>7</sup> Li <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	351.43	2.61	0.67264	0.00704	9.87	2.6729
<sup>7</sup> Li <sup>79</sup> Br	1Σ <sup>+</sup>	563.2	3.5	0.555399	0.005644	2.159	2.17043
<sup>7</sup> Li <sup>35</sup> Cl	1Σ <sup>+</sup>	642.95	4.47	0.7065225	0.0080102	3.409	2.02067
<sup>7</sup> Li <sup>19</sup> F	1Σ <sup>+</sup>	910.57	8.21	1.3452583	0.0202887	11.745	1.56386
<sup>7</sup> Li <sup>1</sup> H	1Σ <sup>+</sup>	1405.65	23.20	7.51373	0.21665	862	1.59490
<sup>7</sup> Li <sup>2</sup> H	1Σ <sup>+</sup>	1054.80	12.94	4.23310	0.09155	276	1.5941
<sup>7</sup> Li <sup>127</sup> I	1Σ <sup>+</sup>	496.85	2.85	0.4431766	0.0040862	1.4104	2.39192
<sup>7</sup> Li <sup>16</sup> O	2Π	814.62	7.78	1.212830	0.017899	0.1079	1.68822
<sup>24</sup> Mg <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	51.12	1.64	0.09287	0.00378	1.22	3.891

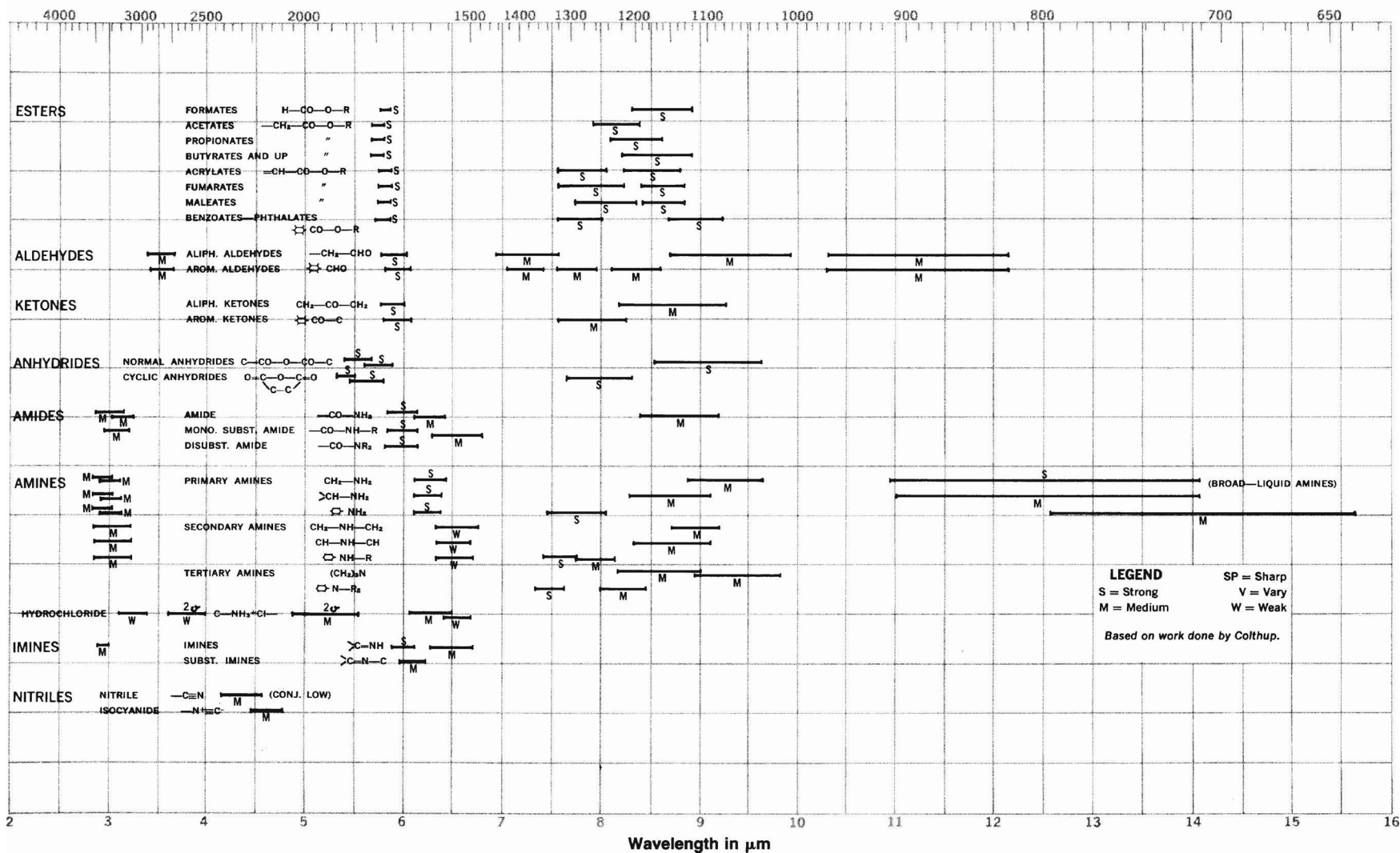
Molecule	State	$\omega_e$ cm <sup>-1</sup>	$\omega_e x_e$ cm <sup>-1</sup>	$B_e$ cm <sup>-1</sup>	$\alpha_e$ cm <sup>-1</sup>	$D_e$ 10 <sup>-6</sup> cm <sup>-1</sup>	$r_e$ Å
<sup>24</sup> Mg <sup>35</sup> Cl	2Σ <sup>+</sup>	462.12*	2.1	0.2456154	0.0016204	0.2723	2.19639
<sup>24</sup> Mg <sup>19</sup> F	2Σ <sup>+</sup>	711.69*	4.9	0.51922	0.00470	1.080	1.7500
<sup>24</sup> Mg <sup>1</sup> H	2Σ <sup>+</sup>	1495.20	31.89	5.8257	0.1859	344	1.7297
<sup>24</sup> Mg <sup>2</sup> H	2Σ <sup>+</sup>	1077.9	16.1	3.0306	0.06289	92	1.7302
<sup>24</sup> Mg <sup>16</sup> O	1Σ <sup>+</sup>	784.78	5.26	0.57470436	0.00532377	1.2328	1.74838
<sup>55</sup> Mn <sup>1</sup> H	7Σ	1548.0	28.8	5.6841	0.1570	303.9	1.7311
<sup>55</sup> Mn <sup>2</sup> H	7Σ	1103	13.9	2.8957	0.051	79.5	1.7310
<sup>14</sup> N <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	2358.57	14.32	1.99824	0.017318	5.76	1.09769
<sup>14</sup> N <sup>79</sup> Br	3Σ <sup>-</sup>	691.75	4.72	0.444	0.0040		1.79
<sup>14</sup> N <sup>35</sup> Cl	3Σ <sup>-</sup>	827.96	5.30	0.649770	0.006414	1.598	1.61071
<sup>14</sup> N <sup>19</sup> F	3Σ <sup>-</sup>	1141.37	8.99	1.2057	0.01492	5.39	1.3170
<sup>14</sup> N <sup>1</sup> H	3Σ <sup>-</sup>	3282.3	78.4	16.6993	0.6490	1709.7	1.0362
<sup>14</sup> N <sup>2</sup> H	3Σ <sup>-</sup>	2398	42	8.7913	0.2531	490.4	1.0361
<sup>14</sup> N <sup>16</sup> O	2Π <sub>1/2</sub>	1904.20	14.07	1.67195	0.0171	0.5	1.15077
<sup>14</sup> N <sup>32</sup> S	2Π <sub>1/2</sub>	1218.7	7.28	0.769602	0.0064	1.2	1.4940
<sup>23</sup> Na <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	159.13	0.72	0.154707	0.008736	0.581	3.0789
<sup>23</sup> Na <sup>79</sup> Br	1Σ <sup>+</sup>	302	1.5	0.1512533	0.0009410	0.1554	2.50204
<sup>23</sup> Na <sup>35</sup> Cl	1Σ <sup>+</sup>	366	2.05	0.2180631	0.0016248	0.3120	2.36080
<sup>23</sup> Na <sup>19</sup> F	1Σ <sup>+</sup>	535.66	3.57	0.4369011	0.0045580	1.163	1.92595
<sup>23</sup> Na <sup>1</sup> H	1Σ <sup>+</sup>	1172.2	19.72	4.9033634	0.1370919	343.40	1.88654
<sup>23</sup> Na <sup>2</sup> H	1Σ <sup>+</sup>	826.1*		2.557089	0.051600	93.46	1.88654
<sup>23</sup> Na <sup>127</sup> I	1Σ <sup>+</sup>	258	1.1	0.1178056	0.0006478	0.0973	2.71145
<sup>23</sup> Na <sup>16</sup> O	2Π	492.3		0.424630	0.004506	1.2638	2.05155
<sup>93</sup> Nb <sup>16</sup> O	4Σ <sup>-</sup>	989.0	3.8	0.4321	0.0021	0.22	1.691
<sup>58</sup> Ni <sup>1</sup> H	2Δ <sub>5/2</sub>	1926.6	38	7.700	0.23	481	1.476
<sup>58</sup> Ni <sup>2</sup> H	2Δ <sub>5/2</sub>	1390.1	19	3.992	0.092	130	1.465
<sup>16</sup> O <sub>2</sub>	3Σ <sub>g</sub> <sup>-</sup>	1580.19	11.98	1.44563	0.0159	4.839	1.20752
<sup>16</sup> O <sup>1</sup> H	2Π <sub>3/2</sub>	3737.76	84.88	18.911	0.7242	1938	0.96966
<sup>16</sup> O <sup>2</sup> H	2Π <sub>3/2</sub>	2720.24	44.05	10.021	0.276	537.4	0.9698
<sup>31</sup> P <sub>2</sub>	1Σ <sub>g</sub> <sup>+</sup>	780.77	2.84	0.30362	0.00149	0.188	1.8934
<sup>31</sup> P <sup>35</sup> Cl	3Σ <sup>-</sup>	551.38	2.23	0.2528748	0.0015119	0.2124	2.01461
<sup>31</sup> P <sup>19</sup> F	3Σ <sup>-</sup>	846.75	4.49	0.5665	0.00456		1.58938
<sup>31</sup> P <sup>1</sup> H	3Σ <sup>-</sup>	2365.2	44.5	8.5371	0.2514	436	1.42140
<sup>31</sup> P <sup>2</sup> H	3Σ <sup>-</sup>	1699.2	23.0	4.4081	0.0928	116	1.4220
<sup>31</sup> P <sup>14</sup> N	1Σ <sup>+</sup>	1337.24	6.98	0.7864854	0.0055364	1.091	1.49087
<sup>31</sup> P <sup>16</sup> O	2Π <sub>1/2</sub>	1233.34	6.56	0.7337	0.0055	1.3	1.4759
<sup>208</sup> Pb <sub>2</sub>		110.5	0.35				
<sup>208</sup> Pb <sup>79</sup> Br	2Π <sub>1/2</sub>	207.5	0.50				
<sup>208</sup> Pb <sup>35</sup> Cl	2Π <sub>1/2</sub>	303.9	0.88				
<sup>208</sup> Pb <sup>19</sup> F	2Π <sub>1/2</sub>	502.73	2.28	0.22875	0.001473	0.183	2.0575
<sup>208</sup> Pb <sup>1</sup> H	2Π <sub>1/2</sub>	1564.1	29.75	4.971	0.144	201	1.839
<sup>208</sup> Pb <sup>16</sup> O	1Σ <sup>+</sup>	720.96	3.52	0.30730373	0.00190977	0.2138	1.92181
<sup>208</sup> Pb <sup>32</sup> S	1Σ <sup>+</sup>	429.17	1.26	0.11632307	0.00043510	0.03418	2.28678
<sup>208</sup> Pb <sup>80</sup> Se	1Σ <sup>+</sup>	277.6	0.51	0.05059953	0.00012993	0.0070	2.40218
<sup>208</sup> Pb <sup>130</sup> Te	1Σ <sup>+</sup>	212.0	0.43	0.03130774	0.00006743	0.0027	2.59492
<sup>195</sup> Pt <sup>12</sup> C	1Σ <sup>+</sup>	1051.13	4.86	0.53044	0.003273	0.546	1.6767
<sup>195</sup> Pt <sup>1</sup> H	2Δ <sub>5/2</sub>	2294.68*	46	7.1963	0.1996	261	1.52852
<sup>195</sup> Pt <sup>2</sup> H	2Δ <sub>5/2</sub>	1644.3*	23	3.640	0.071	66	1.524
<sup>85</sup> Rb <sup>79</sup> Br	1Σ <sup>+</sup>	169.46	0.46	0.04752798	0.00018596	0.01496	2.94474
<sup>85</sup> Rb <sup>35</sup> Cl	1Σ <sup>+</sup>	228	0.92	0.0876404	0.0004537	0.04947	2.78673
<sup>85</sup> Rb <sup>19</sup> F	1Σ <sup>+</sup>	376	1.9	0.2106640	0.0015228	0.2684	2.27033
<sup>85</sup> Rb <sup>1</sup> H	1Σ <sup>+</sup>	936.9	14.21	3.020	0.072	123	2.367
<sup>85</sup> Rb <sup>127</sup> I	1Σ <sup>+</sup>	138.51	0.33	0.03283293	0.00010946	0.00738	3.17688
<sup>85</sup> Rb <sup>16</sup> O	2Σ <sup>+</sup>	388.4*		0.246481	0.002174	0.397	2.25420
<sup>32</sup> S <sub>2</sub>	3Σ <sub>g</sub> <sup>-</sup>	725.65	2.84	0.2955	0.001570	0.19	1.8892
<sup>32</sup> S <sup>19</sup> F	2Π <sub>3/2</sub>			0.552174			1.60058
<sup>32</sup> S <sup>1</sup> H	2Π <sub>3/2</sub>	2711.6	59.9	9.5995	0.2785	480.6	1.34066
<sup>32</sup> S <sup>2</sup> H	2Π <sub>3/2</sub>	1885	31	4.95130	0.10308	130	1.34049
<sup>32</sup> S <sup>16</sup> O	3Σ <sup>-</sup>	1149.2	5.6	0.7208171	0.005737	1.134	1.48109
<sup>121</sup> Sb <sup>35</sup> Cl	3Σ <sup>-</sup>	374.7	0.6				



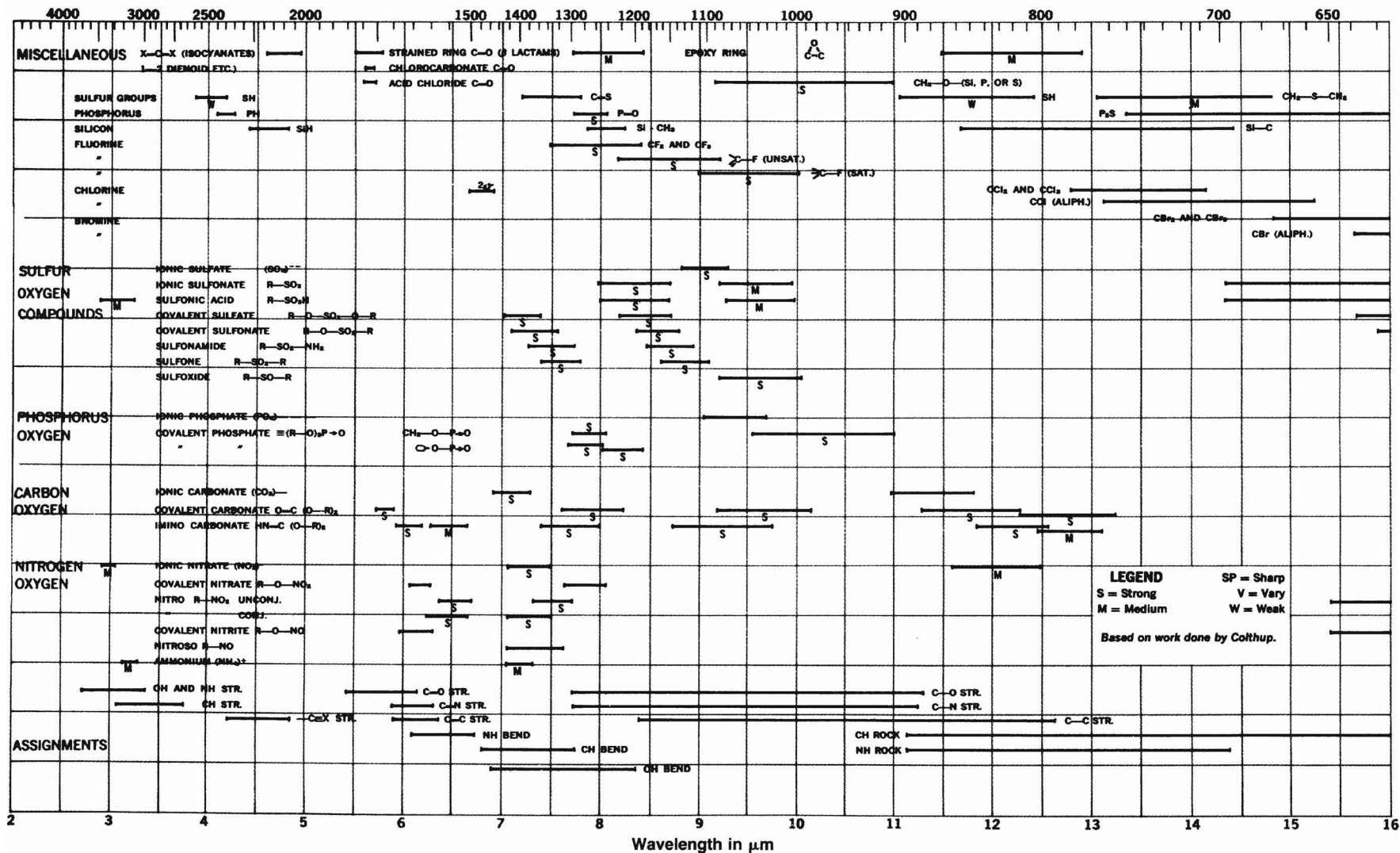
Molecule	State	$\omega_e$ cm <sup>-1</sup>	$\omega_e x_e$ cm <sup>-1</sup>	$B_e$ cm <sup>-1</sup>	$\alpha_e$ cm <sup>-1</sup>	$D_e$ 10 <sup>-6</sup> cm <sup>-1</sup>	$r_e$ Å
<sup>121</sup> Sb <sup>19</sup> F	3Σ <sup>-</sup>	605.0	2.6	0.2792	0.0020	0.23	1.918
<sup>121</sup> Sb <sup>1</sup> H	3Σ <sup>-</sup>			5.684		240	1.723
<sup>121</sup> Sb <sup>2</sup> H	3Σ <sup>-</sup>			2.8782		45	1.7194
<sup>121</sup> Sb <sup>14</sup> N	1Σ <sup>+</sup>	942.0	5.6				
<sup>121</sup> Sb <sup>16</sup> O	2Π <sub>1/2</sub>	816	4.2	0.3580	0.0022	0.270	1.826
<sup>45</sup> Sc <sup>19</sup> F	1Σ <sup>+</sup>	735.6	3.8	0.3950	0.00266		1.788
<sup>80</sup> Se <sub>2</sub>	3Σ <sub>g</sub> <sup>-</sup>	385.30	0.96	0.08992	0.000288	0.024	2.166
<sup>80</sup> Se <sup>1</sup> H	2Π <sub>3/2</sub>	2400*		8.02	0.23	330	1.48
<sup>80</sup> Se <sup>2</sup> H	2Π <sub>3/2</sub>	1708*		3.94			1.48
<sup>80</sup> Se <sup>16</sup> O	3Σ <sup>-</sup>	914.69	4.52	0.4655	0.00323	0.5	1.648
<sup>28</sup> Si <sub>2</sub>	3Σ <sub>g</sub> <sup>-</sup>	510.98	2.02	0.2390	0.0014	0.21	2.246
<sup>28</sup> Si <sup>35</sup> Cl	2Π <sub>1/2</sub>	535.60	2.17	0.2561	0.0016	0.25	2.058
<sup>28</sup> Si <sup>19</sup> F	2Π <sub>1/2</sub>	857.19	4.73	0.5812	0.00494	1.07	1.6011
<sup>28</sup> Si <sup>1</sup> H	2Π <sub>1/2</sub>	2041.80	35.51	7.4996	0.2190	397	1.5201
<sup>28</sup> Si <sup>2</sup> H	2Π <sub>1/2</sub>	1469.32	18.23	3.8840	0.0781	105.4	1.5199
<sup>28</sup> Si <sup>14</sup> N	2Σ <sup>+</sup>	1151.4	6.47	0.7311	0.00565	1.2	1.572
<sup>28</sup> Si <sup>16</sup> O	1Σ <sup>+</sup>	1241.54	5.97	0.7267521	0.0050379	0.9923	1.50975
<sup>28</sup> Si <sup>32</sup> S	1Σ <sup>+</sup>	749.64	2.58	0.30352788	0.00147308	0.201	1.92926
<sup>28</sup> Si <sup>80</sup> Se	1Σ <sup>+</sup>	580.0	1.78	0.1920117	0.0007767	0.0842	2.05832
<sup>120</sup> Sn <sup>79</sup> Br	2Π <sub>1/2</sub>	247.2	0.6				
<sup>120</sup> Sn <sup>35</sup> Cl	2Π <sub>1/2</sub>	351.1	1.06	0.1117	0.0004		2.361
<sup>118</sup> Sn <sup>19</sup> F	2Π <sub>1/2</sub>	577.6	2.69	0.2727	0.0014	0.26	1.944
<sup>120</sup> Sn <sup>1</sup> H	2Π <sub>1/2</sub>			5.31488		207.5	1.78146
<sup>120</sup> Sn <sup>2</sup> H	2Π <sub>1/2</sub>	1188.0*		2.6950	0.049	53.4	1.7770
<sup>120</sup> Sn <sup>127</sup> I	2Π <sub>1/2</sub>	199.0	0.6				
<sup>120</sup> Sn <sup>16</sup> O	1Σ <sup>+</sup>	822.13	3.72	0.35571998	0.00214432	0.26638	1.83251
<sup>120</sup> Sn <sup>32</sup> S	1Σ <sup>+</sup>	487.26	1.36	0.13686139	0.00050563	0.0424	2.20898
<sup>120</sup> Sn <sup>80</sup> Se	1Σ <sup>+</sup>	331.2	0.74	0.0649978	0.0001705	0.011	2.32557
<sup>120</sup> Sn <sup>130</sup> Te	1Σ <sup>+</sup>	259.5	0.50	0.04247917	0.00009543	0.0055	2.52280
<sup>88</sup> Sr <sup>79</sup> Br	2Σ <sup>+</sup>	216.60	0.52	0.0541847	0.0001827	0.01356	2.73522
<sup>88</sup> Sr <sup>35</sup> Cl	2Σ <sup>+</sup>	302.3	0.95				
<sup>88</sup> Sr <sup>19</sup> F	2Σ <sup>+</sup>	502.4	2.3	0.2505346	0.0015513	0.2498	2.07537
<sup>88</sup> Sr <sup>1</sup> H	2Σ <sup>+</sup>	1206.2	17.0	3.6751	0.0814	135	2.1456
<sup>88</sup> Sr <sup>2</sup> H	2Σ <sup>+</sup>	841	8.6	1.8609	0.0292	34.7	2.1449
<sup>88</sup> Sr <sup>127</sup> I	2Σ <sup>+</sup>	173.77	0.35	0.0367097	0.0001060	0.00655	2.94364
<sup>88</sup> Sr <sup>16</sup> O	1Σ <sup>+</sup>	653.5	3.96	0.33798	0.00219	0.36	1.91983
<sup>181</sup> Ta <sup>16</sup> O	2Δ <sub>3/2</sub>	1028.69	3.51	0.40284	0.00182	0.2450	1.68746
<sup>130</sup> Te <sub>2</sub>	3Σ <sub>g</sub> <sup>-</sup>	247.07	0.51	0.039681	0.000106	0.0044	2.5574
<sup>130</sup> Te <sup>1</sup> H	2Π <sub>3/2</sub>			5.56			1.74
<sup>130</sup> Te <sup>16</sup> O	0+	797.11	4.00	0.3554	0.00237	0.27	1.825
<sup>232</sup> Th <sup>16</sup> O	1Σ <sup>+</sup>	895.77	2.39	0.332644	0.001302	0.1833	1.84032
<sup>48</sup> Ti <sup>16</sup> O	3Δ <sub>1</sub>	1009.02	4.50	0.53541	0.00301	0.603	1.6202
<sup>205</sup> Tl <sup>81</sup> Br	1Σ <sup>+</sup>	192.10	0.39	0.0423899	0.0001276	0.0083	1.61817
<sup>205</sup> Tl <sup>35</sup> Cl	1Σ <sup>+</sup>	284.71	0.86	0.09139702	0.00039784	0.0377	2.48483
<sup>205</sup> Tl <sup>19</sup> F	1Σ <sup>+</sup>	476.86	2.24	0.22315014	0.00150380	0.1955	2.08439
<sup>205</sup> Tl <sup>1</sup> H	1Σ <sup>+</sup>	1390.7	22.7	4.806	0.154	254	1.870
<sup>205</sup> Tl <sup>2</sup> H	1Σ <sup>+</sup>	987.7	12.04	2.419	0.057	60	1.869
<sup>205</sup> Tl <sup>127</sup> I	1Σ <sup>+</sup>	150*		0.0271676	0.0000664	0.0036	2.81361
<sup>51</sup> V <sup>16</sup> O	4Σ <sup>-</sup>	1011.3	4.86	0.54825	0.00352	0.6	1.5893
<sup>89</sup> Y <sup>35</sup> Cl	1Σ	380.7	1.3	0.1160	0.0003	0.09	2.41
<sup>89</sup> Y <sup>19</sup> F	1Σ <sup>+</sup>	631.29	2.50	0.29042	0.00163	0.237	1.9257
<sup>89</sup> Y <sup>16</sup> O	2Σ <sup>+</sup>	861.0	2.9	0.3881	0.0018	0.32	1.790
<sup>174</sup> Yb <sup>1</sup> H	2Σ <sup>+</sup>	1249.54	21.06	3.9931	0.0957	161.8	2.0526
<sup>174</sup> Yb <sup>2</sup> H	2Σ <sup>+</sup>	886.6	10.57	2.01162	0.03425	41.60	2.0516
<sup>64</sup> Zn <sup>35</sup> Cl	2Σ	390.5	1.6				
<sup>64</sup> Zn <sup>19</sup> F	2Σ	628	3.5				
<sup>64</sup> Zn <sup>1</sup> H	2Σ <sup>+</sup>	1607.6	55.14	6.6794	0.2500	466	1.5949
<sup>64</sup> Zn <sup>2</sup> H	2Σ <sup>+</sup>	1072	28	3.350		124	1.6054
<sup>64</sup> Zn <sup>127</sup> I	2Σ	223.4	0.6				
<sup>90</sup> Zr <sup>16</sup> O	1Σ <sup>+</sup>	969.8	4.9	0.42263	0.0023	0.319	1.7116



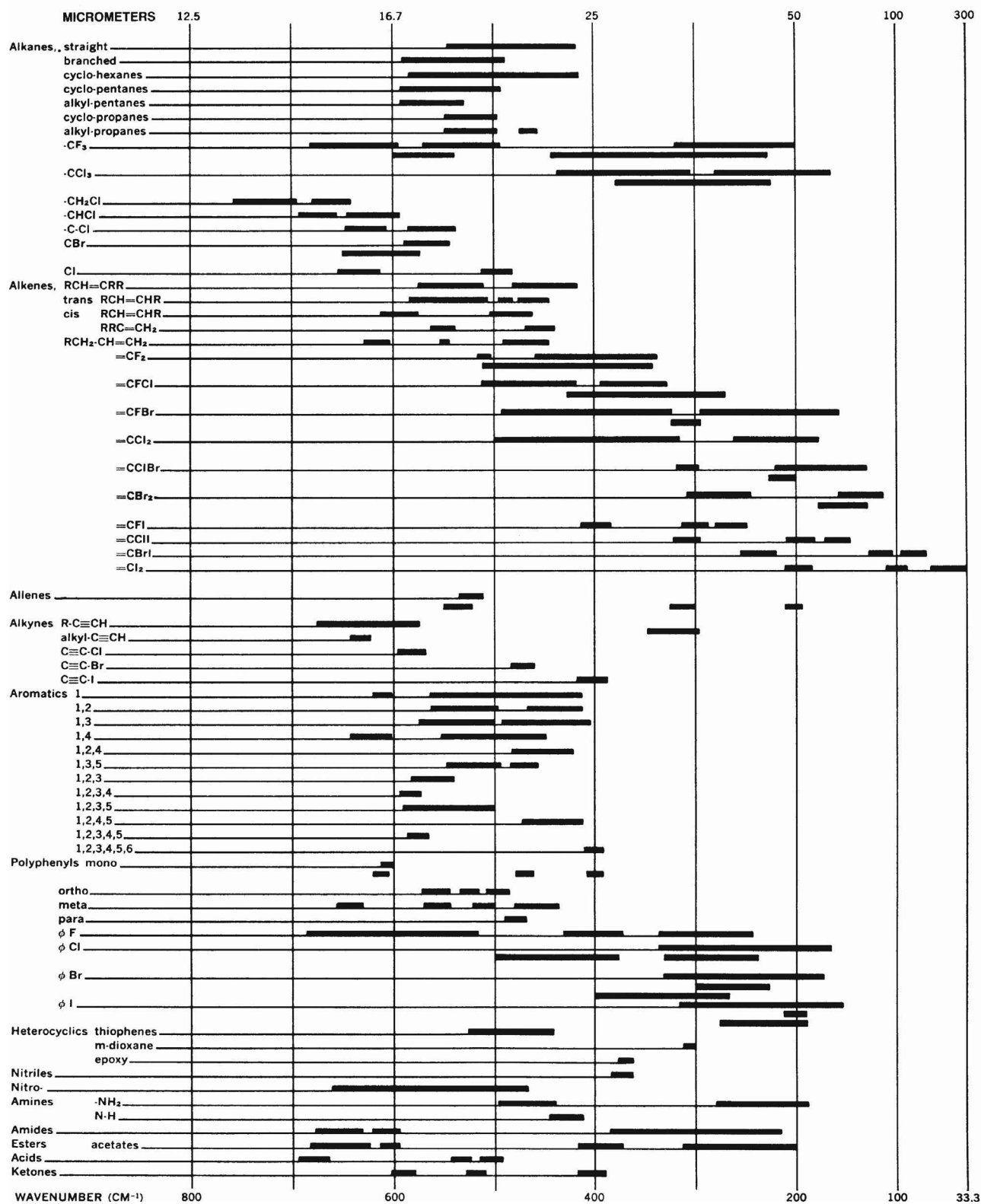
Wavenumber in  $\text{cm}^{-1}$

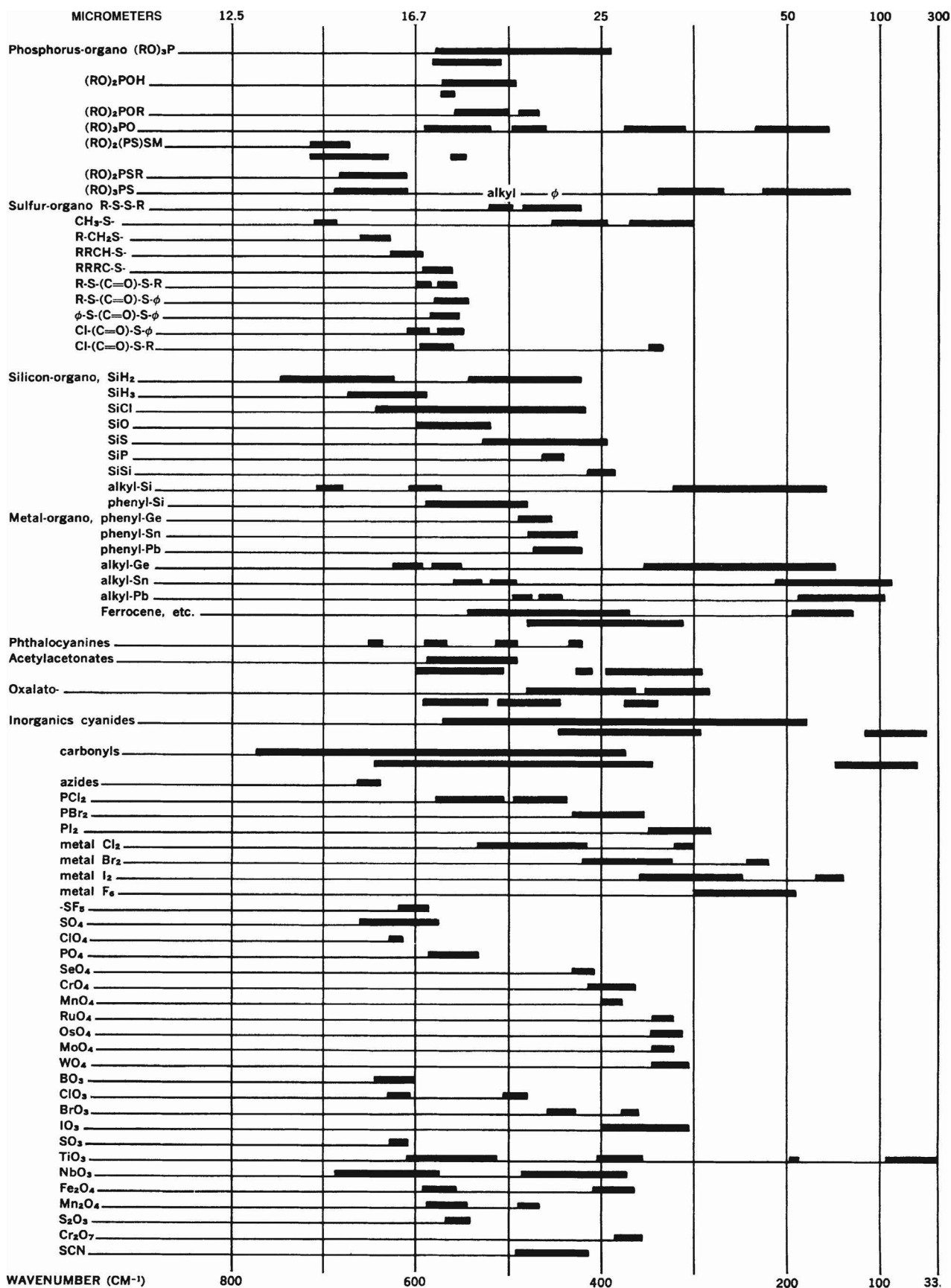


Wavenumber in  $\text{cm}^{-1}$



## Far Infrared Region





# NUCLEAR SPINS, MOMENTS, AND OTHER DATA RELATED TO NMR SPECTROSCOPY

This table presents the following data relevant to nuclear magnetic resonance spectroscopy:

**Z:** Atomic number

**Isotope:** Element symbol and mass number

**Abundance:** Natural abundance of the isotope in percent. An \* indicates a radioactive nuclide; if no value is given, the nuclide is not present in nature or its abundance is highly variable.

**I:** Nuclear spin

**$\nu$ :** Resonant frequency in megahertz for an applied field  $H_0$  of 1 tesla (in cgs units, 10 kilogauss). The resonant frequency scales with  $H_0$ .

**Relative sensitivity:** Sensitivity relative to  $^1\text{H}$  (=1) assuming an equal number of nuclei and constant temperature. Values were calculated from the expressions:

$$\text{For constant } H_0: 0.0076508(\mu/\mu_N)^3(I+1)/I^2$$

$$\text{For constant } \nu: 0.23871(\mu/\mu_N)(I+1)$$

**$\mu/\mu_N$ :** Nuclear magnetic moment in units of the nuclear magneton  $\mu_N$

**Q:** Nuclear quadrupole moment in units of femtometers squared ( $1 \text{ fm}^2 = 10^{-2} \text{ barn}$ ). Because the determination of quadrupole moments requires knowledge of the electron configuration

near the nucleus, values of Q in the literature tend to scatter considerably. The values quoted here come mainly from the review of Pyykkö (Ref. 3), otherwise from Ref. 1.

The table includes all stable nuclides of non-zero spin for which spin and magnetic moment values have been measured, as well as selected radioactive nuclides of current or potential interest. At least one isotope is included for each element through  $Z = 95$  for which data are available. See Reference 1 for a complete listing of spins and moments.

The assistance of P. Pyykkö in providing data on nuclear quadrupole moments is gratefully acknowledged.

## References

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2. Raghavan, P., *At. Data Nuc. Data Tables*, 42, 189, 1989.
3. Pyykkö, P., *Mol. Phys.* 106, 1965, 2008.
4. Stone, N. J., *At. Data Nucl. Data Tables*, 90, 75, 2005.
5. IUPAC Commission on Physicochemical Symbols, Terminology and Units, *Quantities, Units, and Symbols in Physical Chemistry, Third Edition*, Royal Society of Chemistry, Cambridge, 2007.

Z	Isotope	Abundance %	I	$\nu$ /MHz for $H_0 = 1 \text{ T}$	Relative Sensitivity		$\mu/\mu_N$	Q/fm <sup>2</sup>
					Const. $H_0$	Const. $\nu$		
1	<sup>1</sup> n		1/2	29.1647	0.32139	0.6850	-1.91304272	
1	<sup>1</sup> H	99.9885	1/2	42.5775	1.00000	1.0000	+2.792847337	
1	<sup>2</sup> H	0.0115	1	6.5359	0.00965	0.4094	+0.857438228	+0.2860
1	<sup>3</sup> H	*	1/2	45.4148	1.21354	1.0667	+2.9789625	
2	<sup>3</sup> He	0.000134	1/2	32.4380	0.44220	0.7619	-2.127750	
3	<sup>6</sup> Li	7.59	1	6.2661	0.00850	0.3925	+0.8220467	-0.0808
3	<sup>7</sup> Li	92.41	3/2	16.5483	0.29356	1.9434	+3.25644	-4.01
4	<sup>9</sup> Be	100	3/2	5.9842	0.01388	0.7028	-1.1776	+5.288
5	<sup>10</sup> B	19.9	3	4.5752	0.01985	1.7193	+1.800645	+8.459
5	<sup>11</sup> B	80.1	3/2	13.6630	0.16522	1.6045	+2.688649	+4.059
6	<sup>13</sup> C	1.07	1/2	10.7084	0.01591	0.2515	+0.7024118	
7	<sup>14</sup> N	99.636	1	3.0777	0.00101	0.1928	+0.4037610	+2.044
7	<sup>15</sup> N	0.364	1/2	4.3173	0.00104	0.1014	-0.2831888	
8	<sup>17</sup> O	0.038	5/2	5.7742	0.02910	1.5822	-1.89379	-2.558
9	<sup>19</sup> F	100	1/2	40.0776	0.83400	0.9413	+2.628868	
10	<sup>21</sup> Ne	0.27	3/2	3.3631	0.00246	0.3949	-0.661797	+10.155
11	<sup>23</sup> Na	100	3/2	11.2688	0.09270	1.3234	+2.217522	+10.4
12	<sup>25</sup> Mg	10.00	5/2	2.6083	0.00268	0.7147	-0.85545	+19.94
13	<sup>27</sup> Al	100	5/2	11.1031	0.20689	3.0424	+3.641507	+14.66
14	<sup>29</sup> Si	4.685	1/2	8.4655	0.00786	0.1988	-0.55529	
15	<sup>31</sup> P	100	1/2	17.2515	0.06652	0.4052	+1.13160	
16	<sup>33</sup> S	0.75	3/2	3.2717	0.00227	0.3842	+0.6438212	-6.78
17	<sup>35</sup> Cl	75.76	3/2	4.1765	0.00472	0.4905	+0.8218743	-8.165
17	<sup>37</sup> Cl	24.24	3/2	3.4765	0.00272	0.4083	+0.6841236	-6.435
18	<sup>37</sup> Ar	*	3/2	5.819	0.01276	0.6833	+1.145	+7.6
18	<sup>39</sup> Ar	*	7/2	3.46	0.01130	1.7080	-1.59	-12
19	<sup>39</sup> K	93.2581	3/2	1.9893	0.00051	0.2336	+0.3914662	+5.85
19	<sup>40</sup> K	0.0117	4	2.4737	0.00523	1.5493	-1.298100	-7.3
19	<sup>41</sup> K	6.7302	3/2	1.0919	0.00008	0.1282	+0.2148701	+7.11

Z	Isotope	Abundance		I	v/MHz for		Relative Sensitivity		Q/fm <sup>2</sup>
		%			H <sub>0</sub> = 1 T	Const. H <sub>0</sub>	Const. v	μ/μ <sub>N</sub>	
20	<sup>43</sup> Ca	0.135		7/2	2.8697	0.00643	1.4154	-1.317643	-4.08
21	<sup>45</sup> Sc	100		7/2	10.3591	0.30244	5.1094	+4.756487	-22.0
22	<sup>47</sup> Ti	7.44		5/2	2.4041	0.00210	0.6588	-0.78848	+30.2
22	<sup>49</sup> Ti	5.41		7/2	2.4048	0.00378	1.1861	-1.10417	+24.7
23	<sup>50</sup> V	0.250		6	4.2505	0.05571	5.5905	+3.345689	+21
23	<sup>51</sup> V	99.750		7/2	11.2133	0.38360	5.5307	+5.1487057	-5.2
24	<sup>53</sup> Cr	9.501		3/2	2.4115	0.00091	0.2832	-0.47454	-15
25	<sup>55</sup> Mn	100		5/2	10.5763	0.17881	2.8981	+3.46872	+33
26	<sup>57</sup> Fe	2.119		1/2	1.3816	0.00003	0.0324	+0.0906230	+16
27	<sup>59</sup> Co	100		7/2	10.077	0.27841	4.9703	+4.627	+42
28	<sup>61</sup> Ni	1.1399		3/2	3.8114	0.00359	0.4476	-0.75002	+16.2
29	<sup>63</sup> Cu	69.15		3/2	11.3188	0.09393	1.3292	+2.2273456	-22.0
29	<sup>65</sup> Cu	30.85		3/2	12.1027	0.11484	1.4213	+2.38161	-20.4
30	<sup>67</sup> Zn	4.102		5/2	2.6685	0.00287	0.7312	+0.875205	+15.0
31	<sup>69</sup> Ga	60.108		3/2	10.2478	0.06971	1.2035	+2.01659	+17.1
31	<sup>71</sup> Ga	39.892		3/2	13.0208	0.14300	1.5291	+2.56227	+10.7
32	<sup>73</sup> Ge	7.76		9/2	1.4897	0.00141	1.1547	-0.8794677	-19.6
33	<sup>75</sup> As	100		3/2	7.3150	0.02536	0.8590	+1.439475	+31.4
34	<sup>77</sup> Se	7.63		1/2	8.1568	0.00703	0.1916	+0.5350422	
35	<sup>79</sup> Br	50.69		3/2	10.7042	0.07945	1.2570	+2.106400	+31.3
35	<sup>81</sup> Br	49.31		3/2	11.5384	0.09951	1.3550	+2.270562	+26.2
36	<sup>83</sup> Kr	11.500		9/2	1.6442	0.00190	1.2744	-0.970669	+25.9
37	<sup>85</sup> Rb	72.17		5/2	4.1253	0.01061	1.1304	+1.35298	+27.6
37	<sup>87</sup> Rb	27.83		3/2	13.9814	0.17704	1.6419	+2.75131	+13.35
38	<sup>87</sup> Sr	7.00		9/2	1.8525	0.00272	1.4358	-1.093603	+30.5
39	<sup>89</sup> Y	100		1/2	2.0949	0.00012	0.0492	-0.1374154	
40	<sup>91</sup> Zr	11.22		5/2	3.9748	0.00949	1.0892	-1.30362	-17.6
41	<sup>93</sup> Nb	100		9/2	10.4523	0.48821	8.1013	+6.1705	-32
42	<sup>95</sup> Mo	15.90		5/2	2.7874	0.00327	0.7638	-0.9142	-2.2
42	<sup>97</sup> Mo	9.56		5/2	2.8463	0.00349	0.7799	-0.9335	+25.5
43	<sup>99</sup> Tc	*		9/2	9.6294	0.38174	7.4635	+5.6847	-12.9
44	<sup>99</sup> Ru	12.76		5/2	1.9553	0.00113	0.5358	-0.6413	+7.9
44	<sup>101</sup> Ru	17.06		5/2	2.1916	0.00159	0.6005	-0.7188	+45.7
45	<sup>103</sup> Rh	100		1/2	1.3477	0.00003	0.0317	-0.08840	
46	<sup>105</sup> Pd	22.33		5/2	1.957	0.00113	0.5364	-0.642	+66.0
47	<sup>107</sup> Ag	51.839		1/2	1.7331	0.00007	0.0407	-0.1136796	
47	<sup>109</sup> Ag	48.161		1/2	1.9924	0.00010	0.0468	-0.1306906	
48	<sup>111</sup> Cd	12.80		1/2	9.0692	0.00966	0.2130	-0.5948861	
48	<sup>113</sup> Cd	12.22		1/2	9.4871	0.01106	0.2228	-0.6223009	
49	<sup>113</sup> In	4.29		9/2	9.3655	0.35121	7.2589	+5.5289	+75.9
49	<sup>115</sup> In	95.71		9/2	9.3856	0.35348	7.2745	+5.5408	+77.0
50	<sup>115</sup> Sn	0.34		1/2	14.0077	0.03561	0.3290	-0.91883	
50	<sup>117</sup> Sn	7.68		1/2	15.2610	0.04605	0.3584	-1.00104	
50	<sup>119</sup> Sn	8.59		1/2	15.9660	0.05273	0.3750	-1.04728	
51	<sup>121</sup> Sb	57.21		5/2	10.2551	0.16302	2.8101	+3.3634	-54.3
51	<sup>123</sup> Sb	42.79		7/2	5.5532	0.04659	2.7390	+2.5498	-69.2
52	<sup>123</sup> Te	0.89		1/2	11.2349	0.01837	0.2639	-0.7369478	
52	<sup>125</sup> Te	7.07		1/2	13.5446	0.03219	0.3181	-0.8884509	
53	<sup>127</sup> I	100		5/2	8.5778	0.09540	2.3504	+2.813273	-69.6
54	<sup>129</sup> Xe	26.4006		1/2	11.8604	0.02162	0.2786	-0.7779763	
54	<sup>131</sup> Xe	21.2324		3/2	3.5159	0.00282	0.4129	+0.6918619	-11.4
55	<sup>133</sup> Cs	100		7/2	5.6234	0.04838	2.7736	+2.582025	-0.343
56	<sup>135</sup> Ba	6.592		3/2	4.2617	0.00501	0.5005	+0.838627	+16.0
56	<sup>137</sup> Ba	11.232		3/2	4.7634	0.00700	0.5594	+0.937365	+24.5
57	<sup>138</sup> La	0.090		5	5.6615	0.09404	5.3189	+3.713646	+45



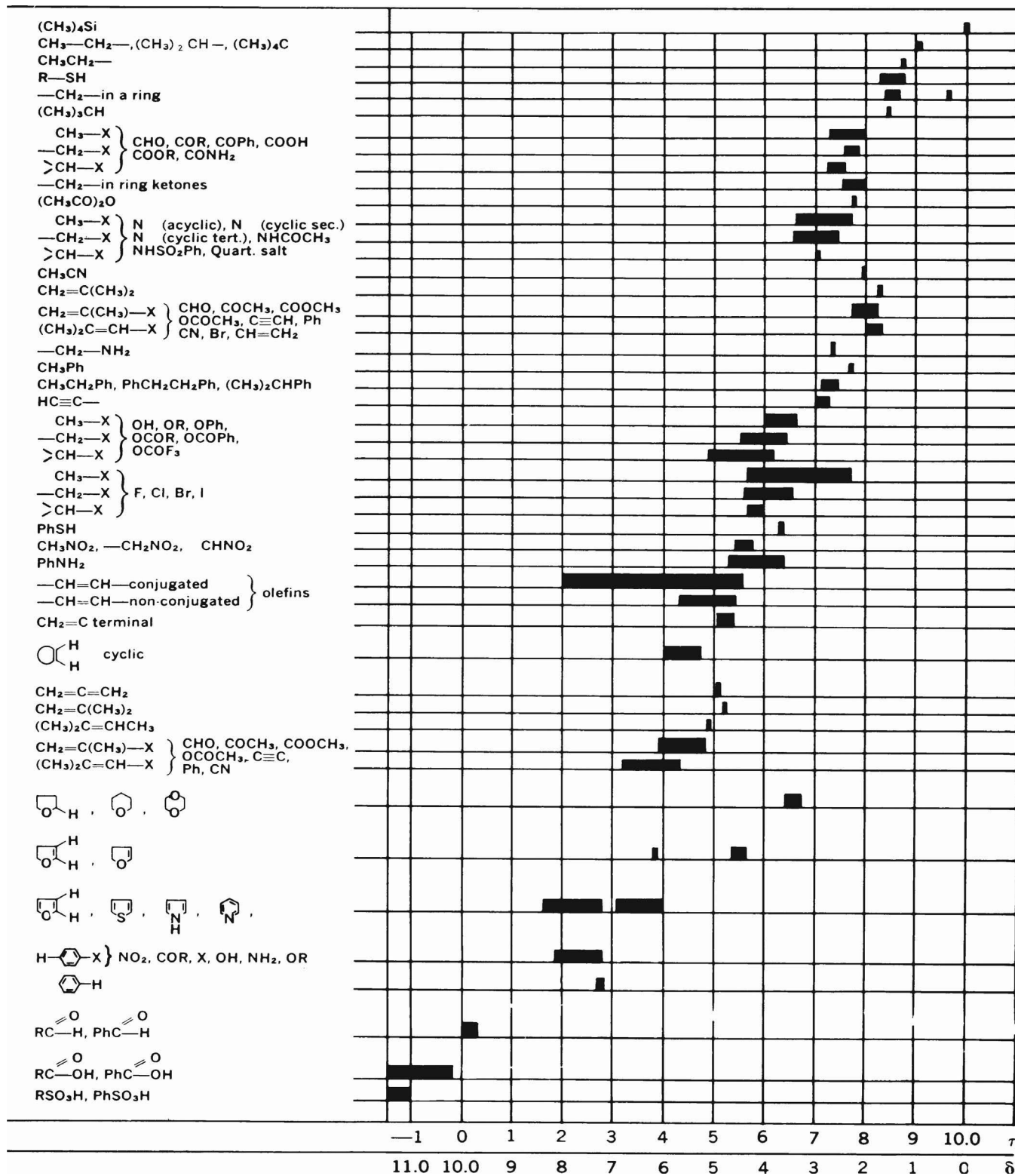
Z	Isotope	Abundance		I	v/MHz for $H_0 = 1 \text{ T}$	Relative Sensitivity		$\mu/\mu_N$	Q/fm <sup>2</sup>
		%				Const. $H_0$	Const. v		
57	<sup>139</sup> La	99.910		7/2	6.0612	0.06058	2.9895	+2.7830455	+20.0
58	<sup>137</sup> Ce	*		3/2	4.88	0.00752	0.5729	0.96	
58	<sup>139</sup> Ce	*		3/2	5.39	0.01012	0.6326	1.06	
58	<sup>141</sup> Ce	*		7/2	2.37	0.00364	1.1709	1.09	
59	<sup>141</sup> Pr	100		5/2	13.0359	0.33483	3.5720	+4.2754	-5.9
60	<sup>143</sup> Nd	12.2		7/2	2.319	0.00339	1.1440	-1.065	-63
60	<sup>145</sup> Nd	8.3		7/2	1.429	0.00079	0.7047	-0.656	-33
61	<sup>143</sup> Pm	*		5/2	11.59	0.23510	3.1748	+3.80	
61	<sup>147</sup> Pm	*		7/2	5.62	0.04827	2.7714	+2.58	+74
62	<sup>147</sup> Sm	14.99		7/2	1.7748	0.00152	0.8754	-0.8149	-26
62	<sup>149</sup> Sm	13.82		7/2	1.4631	0.00085	0.7216	-0.6718	+7.4
63	<sup>151</sup> Eu	47.81		5/2	10.5856	0.17929	2.9006	+3.4718	+90.3
63	<sup>153</sup> Eu	52.19		5/2	4.6745	0.01544	1.2809	+1.5331	+241
64	<sup>155</sup> Gd	14.80		3/2	1.312	0.00015	0.1541	-0.2582	+127
64	<sup>157</sup> Gd	15.65		3/2	1.720	0.00033	0.2020	-0.3385	+135
65	<sup>159</sup> Tb	100		3/2	10.23	0.06945	1.2019	+2.014	+143.2
66	<sup>161</sup> Dy	18.889		5/2	1.4654	0.00048	0.4015	-0.4806	+250.7
66	<sup>163</sup> Dy	24.896		5/2	2.0508	0.00130	0.5619	+0.6726	+265
67	<sup>165</sup> Ho	100		7/2	9.0883	0.20423	4.4826	+4.173	+358
68	<sup>167</sup> Er	22.869		7/2	1.2281	0.00050	0.6057	-0.5639	+356.5
69	<sup>169</sup> Tm	100		1/2	3.531	0.00057	0.0829	-0.2316	-120
70	<sup>171</sup> Yb	14.28		1/2	7.5261	0.00552	0.1768	+0.49367	
70	<sup>173</sup> Yb	16.13		5/2	2.0730	0.00135	0.5680	-0.67989	+280
71	<sup>175</sup> Lu	97.41		7/2	4.8626	0.03128	2.3984	+2.2327	+349
71	<sup>176</sup> Lu	2.59		7	3.451	0.03975	6.0518	+3.169	+497
72	<sup>177</sup> Hf	18.60		7/2	1.7282	0.00140	0.8524	+0.7935	+336.5
72	<sup>179</sup> Hf	13.62		9/2	1.0856	0.00055	0.8414	-0.6409	+379.3
73	<sup>181</sup> Ta	99.988		7/2	5.1627	0.03744	2.5464	+2.3705	+317
74	<sup>183</sup> W	14.31		1/2	1.7957	0.00008	0.0422	+0.1177848	
75	<sup>185</sup> Re	37.40		5/2	9.7176	0.13870	2.6628	+3.1871	+218
75	<sup>187</sup> Re	62.60		5/2	9.8170	0.14300	2.6900	+3.2197	+207
76	<sup>187</sup> Os	1.96		1/2	0.9856	0.00001	0.0231	+0.06465189	
76	<sup>189</sup> Os	16.15		3/2	3.3536	0.00244	0.3938	+0.659933	+85.6
77	<sup>191</sup> Ir	37.3		3/2	0.7658	0.00003	0.0899	+0.1507	+81.6
77	<sup>193</sup> Ir	62.7		3/2	0.8319	0.00004	0.0977	+0.1637	+75.1
78	<sup>195</sup> Pt	33.832		1/2	9.2922	0.01039	0.2182	+0.60952	
79	<sup>197</sup> Au	100		3/2	0.7406	0.00003	0.0870	+0.145746	+54.7
80	<sup>199</sup> Hg	16.87		1/2	7.7123	0.00594	0.1811	+0.5058855	
80	<sup>201</sup> Hg	13.18		3/2	2.8469	0.00149	0.3343	-0.5602257	+38.7
81	<sup>203</sup> Tl	29.52		1/2	24.7316	0.19598	0.5809	+1.6222579	
81	<sup>205</sup> Tl	70.48		1/2	24.9749	0.20182	0.5866	+1.6382146	
82	<sup>207</sup> Pb	22.1		1/2	9.0340	0.00955	0.2122	+0.59258	
83	<sup>209</sup> Bi	100		9/2	6.9630	0.14433	5.3968	+4.1106	-51.6
84	<sup>209</sup> Po	*		1/2	11.7	0.02096	0.2757	+0.77	
86	<sup>211</sup> Rn	*		1/2	9.16	0.00997	0.2152	+0.601	
87	<sup>223</sup> Fr	*		3/2	5.95	0.01362	0.6982	+1.17	+117
88	<sup>223</sup> Ra	*		3/2	1.3746	0.00017	0.1614	+0.2705	+121
88	<sup>225</sup> Ra	*		1/2	11.187	0.01814	0.2627	-0.7338	
89	<sup>227</sup> Ac	*		3/2	5.6	0.01131	0.6565	+1.1	+170
90	<sup>229</sup> Th	*		5/2	1.40	0.00042	0.3843	+0.46	+430
91	<sup>231</sup> Pa	100		3/2	10.2	0.06903	1.1995	2.01	-172
92	<sup>235</sup> U	0.7204		7/2	0.83	0.00015	0.4082	-0.38	+493.6
93	<sup>237</sup> Np	*		5/2	9.57	0.13264	2.6234	+3.14	+388.6
94	<sup>239</sup> Pu	*		1/2	3.09	0.00038	0.0727	+0.203	
95	<sup>243</sup> Am	*		5/2	4.6	0.01446	1.2532	+1.5	+421

# PROTON NMR CHEMICAL SHIFTS FOR CHARACTERISTIC ORGANIC STRUCTURES

The chart below summarizes the range of chemical shifts for protons in several classes of organic compounds and substituent groups. The chemical shifts  $\delta$  are given in parts per million relative to tetramethylsilane.

## Reference

Mohacsi, E., *J. Chem. Edu.*, 41, 38, 1964 (with permission)



## $^{13}\text{C}$ -NMR ABSORPTIONS OF MAJOR FUNCTIONAL GROUPS

The table below lists the range of  $^{13}\text{C}$  chemical shifts  $\delta$  in parts per million relative to tetramethylsilane, in descending order, for various functional groups. Examples of simple compounds for each family are given to illustrate the correlations. The shifts for the carbons of interest, which are italicized, are given in parentheses; when two or more values appear, they refer to the sequence of italicized carbon atoms from left to right in the formula.

$\delta$ (ppm)	Group	Family	Example ( $\delta$ of italicized carbon)		
220-165	$>\text{C}=\text{O}$	Ketones	$(\text{CH}_3)_2\text{CO}$	(206.0)	
			$(\text{CH}_3)_2\text{CHCOCH}_3$	(212.1)	
			$\text{CH}_3\text{CHO}$	(199.7)	
		Aldehydes	$\alpha,\beta$ -Unsaturated	$\text{CH}_3\text{CH}=\text{CHCHO}$	(192.4)
			carbonyls	$\text{CH}_2=\text{CHCOCH}_3$	(169.9)
		Carboxylic acids		$\text{HCO}_2\text{H}$	(166.0)
				$\text{CH}_3\text{CO}_2\text{H}$	(178.1)
			Amides	$\text{HCONH}_2$	(165.0)
		Esters		$\text{CH}_3\text{CONH}_2$	(172.7)
				$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$	(170.3)
				$\text{CH}_2=\text{CHCO}_2\text{CH}_3$	(165.5)
				$\text{C}_6\text{H}_6$	(128.5)
		140-120	$>\text{C}=\text{C}<$	Aromatic	
Alkenes	$\text{CH}_2=\text{CH}_2$				(123.2)
	$\text{CH}_2=\text{CHCH}_3$			(115.9, 136.2)	
	$\text{CH}_2=\text{CHCH}_2\text{Cl}$			(117.5, 133.7)	
	$\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$			(132.7)	
	$\text{CH}_3-\text{CN}$			(117.7)	
125-115	$-\text{CN}$	Nitriles			
		Alkynes	$\text{HCCH}$	(71.9)	
80-70	$-\text{CC}-$		$\text{CH}_3\text{CCH}_3$	(73.9)	
			$\text{CH}_3\text{OOCH}_2\text{CH}_3$	(57.6, 67.9)	
70-45	$-\text{C}-\text{O}$	Esters			
		Alcohols	$\text{HOCH}_3$	(49.0)	
			$\text{HOCH}_2\text{CH}_3$	(57.0)	
40-20	$-\text{C}-\text{NH}_2$	Amines	$\text{CH}_3\text{NH}_2$	(26.9)	
			$\text{CH}_3\text{CH}_2\text{NH}_2$	(35.9)	
			$\text{C}_6\text{H}_5-\text{S}-\text{CH}_3$	15.6	
30-15	$-\text{S}-\text{CH}_3$	Sulfides (thioethers)			
		Alkanes, cycloalkanes	$\text{CH}_4$	(-2.3)	
30-(-2.3)	$-\text{C}-\text{H}$		$\text{CH}_3\text{CH}_3$	(5.7)	
			$\text{CH}_3\text{CH}_2\text{CH}_3$	(15.8, 16.3)	
			$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	(13.4, 25.2)	
			$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$	(13.9, 22.8, 34.7)	
			Cyclohexane	(26.9)	

## References

1. Yoder, C. H. and Schaeffer, C. D., Jr., *Introduction to Multinuclear NMR: Theory and Application*, Benjamin/Cummings, Menlo Park, CA, 1987.
2. Silverstein, R. M., Bassler, G. C., and Morrill, T. C., *Spectrometric Identification of Organic Compounds*, John Wiley & Sons, New York, 1981.
3. Brown, D. W., A Short Set of  $^{13}\text{C}$  NMR Correlation Tables, *J. Chem. Educ.*, 62, 209, 1985.

## BOND LENGTHS IN ORGANOMETALLIC COMPOUNDS

This table summarizes the average values of interatomic distances of representative metal–ligand bonds. Sigma bonds between *d*- and *f*-block metals and the elements C, N, O, P, S, and As are included. The values are extracted from a much larger list in Reference 1. The tabulated values are the unweighted means of reported measurements on compounds in each category. If four or more measurements are available, the standard deviation is given in parentheses. All values are in Ångstrom units ( $10^{-10}$  m).

The first part of the table covers metal-carbon bonds in different ligand categories, while the second part covers metal bonds to

other elements. R stands for any alkyl group; Me for a  $\text{CH}_3$  group;  $\text{C}_6\text{R}_5$  indicates an aryl group; and  $\text{C}(=\text{O})\text{R}$  an acyl group. Metals are listed in atomic number order.

### Reference

- Orpen, A. G., Brammer, L., Allen, F.H., Kennard, O., Watson, D. G., and Taylor, R., *J. Chem. Soc. Dalton Trans.*, 1989, S1-S83.

M	M-CH <sub>3</sub>	M-CH <sub>2</sub> R	M-CR=CR <sub>2</sub>	M-C <sub>6</sub> R <sub>5</sub>	M-C(=O)R
Ti		2.167	2.215(0.042)	2.148	
V				2.114(0.012)	
Cr	2.168		2.035(0.009)	2.075(0.019)	
Mn	2.095(0.030)	2.176(0.024)	2.007	2.064(0.021)	2.044
Fe	2.074	2.091(0.030)	1.991(0.039)	2.031(0.062)	1.997(0.033)
Co	2.014(0.023)	2.039(0.032)	1.934(0.019)	1.974	1.990
Ni	2.029	1.964	1.892(0.017)	1.917(0.038)	1.850(0.059)
Cu				2.020	
Zn		1.964			
Zr	2.292(0.049)		2.257		
Nb	2.336	1.319			
Mo	2.254(0.065)	2.250(0.061)	2.204(0.049)	2.193(0.054)	2.109
Ru	2.179(0.045)	2.036(0.010)	2.063	2.092(0.057)	2.091
Rh	2.092(0.027)	2.100	2.040(0.054)	2.011(0.026)	1.995(0.031)
Pd		2.028	2.000(0.024)	1.981(0.032)	1.982(0.029)
Hf	2.275(0.049)		2.205		
Ta	2.217(0.035)	2.225(0.056)		2.199(0.073)	
W	2.189(0.039)	2.175	2.224		
Re	2.173(0.051)	2.290		2.027	2.190(0.027)
Os		2.221	2.052	2.090(0.032)	2.161
Ir	2.175		2.071(0.044)	2.070(0.038)	2.019
Pt	2.083(0.045)	2.062(0.031)	2.024(0.037)	2.049(0.046)	1.991(0.025)
Au	2.066(0.045)		2.042	2.059(0.024)	
Hg	2.072(0.026)	2.125		2.086(0.040)	
Th	2.567				

M	M-NH <sub>3</sub>	M-OH <sub>2</sub>	M-PMe <sub>3</sub>	M-SR	M-AsR <sub>3</sub>
Ti		2.066(0.052)		2.369	2.686
V		2.129(0.131)	2.510(0.010)	2.378(0.007)	
Cr	2.069(0.008)	1.997(0.070)	2.389(0.069)	2.362	2.460(0.040)
Mn		2.189(0.040)	2.455(0.164)	2.366(0.054)	2.400(0.013)
Fe		2.085(0.066)	2.246(0.042)	2.271(0.028)	2.352(0.043)
Co	1.965(0.021)	2.085(0.064)	2.217(0.043)	2.254(0.025)	2.323(0.021)
Ni	2.074(0.093)	2.079(0.038)	2.204(0.031)	2.187(0.007)	2.333(0.035)
Cu	1.987(0.017)	2.186(0.215)			2.367(0.016)
Zn	2.044	2.090(0.061)		2.295	
Y		2.398(0.068)			
Zr			2.692		
Nb		2.248(0.137)			2.741(0.008)
Mo	2.217	2.201(0.094)	2.462(0.046)	2.401(0.050)	2.582(0.036)
Ru	2.126(0.024)	2.074(0.051)	2.307(0.050)		2.446(0.031)
Rh	2.114(0.018)	2.190(0.096)	2.266(0.036)		2.416(0.039)
Pd	2.032	2.200	2.287(0.018)		2.386(0.052)
Ag		2.350			
Cd		2.318(0.065)		2.444	
La		2.556(0.062)			
Ce		2.565(0.063)			
Pr		2.518(0.038)			
Nd		2.533(0.058)			
Sm		2.459(0.050)			
Eu		2.441(0.055)			
Gd		2.443(0.074)			
Tb		2.455			
Dy		2.409(0.074)			
Ho		2.407(0.069)			
Er		2.404(0.083)			
Yb		2.353(0.066)			
Lu		2.404(0.116)			
Ta			2.589(0.044)		
W		2.115(0.065)	2.485(0.039)		
Re	2.253	2.199(0.091)	2.369(0.065)		2.575(0.006)
Os	2.136	2.166	2.328(0.029)		
Ir	2.050(0.021)		2.323(0.028)	2.461	
Pt			2.295(0.036)	2.320(0.015)	2.366(0.058)
Au		2.157		2.293	
Hg		2.690(0.083)		2.402(0.065)	
Th		2.483(0.032)			
U		2.455(0.047)			

## CHARACTERISTIC BOND LENGTHS IN FREE MOLECULES

This is a summary of typical bond lengths in gas-phase molecules. The value given for each bond is near the mid-range of values found in simple molecules. Bond lengths usually vary by 1 or 2%, and often by more, depending on the nature of the other bonds attached to the two atoms in question. References 1 and 2 give bond lengths in individual gas-phase molecules, as determined by spectroscopic and electron diffraction methods.

All bond distances are given in Å ( $1 \text{ \AA} = 10^{-10} \text{ m}$ ).

### References

1. "Bond Lengths and Angles in Gas-Phase Molecules", *CRC Handbook of Chemistry and Physics*, 86th Edition, 2005, p. 9-19.
2. Harmony, M. D., Laurie, V. W., Kuczowski, R. L., Schwendeman, R. H., Ramsay, D. A., Lovas, F. J., Lafferty, W. J., and Maki, A. G., Molecular structure of gas-phase polyatomic molecules determined by spectroscopic methods, *J. Phys. Chem. Ref. Data* 8, 619, 1979.
3. Lide, D. R., "A survey of carbon-carbon bond lengths", *Tetrahedron* 17, 125, 1962.

### A. Characteristic lengths of single bonds.

	As	Br	C	Cl	F	Ge	H	I	N	O	P	S	Sb	Se	Si
As	2.10														
Br	2.32	2.28													
C	1.96	1.94	1.53												
Cl	2.17	2.14	1.79	1.99											
F	1.71	1.76	1.39	1.63	1.41										
Ge		2.30	1.95	2.15	1.73	2.40									
H	1.51	1.41	1.09	1.28	0.92	1.53	0.74								
I		2.47	2.13	2.32	1.91	2.51	1.61	2.67							
N			1.46	1.90	1.37		1.02		1.45						
O			1.42	1.70	1.42		0.96		1.43	1.48					
P		2.22	1.85	2.04	1.57		1.42		1.65		2.25				
S		2.24	1.82	2.05	1.56		1.34					2.00			
Sb				2.33			1.70								
Se			1.95		1.71		1.47							2.33	
Si		2.21	1.87	2.05	1.58		1.48	2.44		1.63		2.14			2.33
Sn			2.14	2.28			1.71	2.67							
Te					1.82		1.66								

### B. Lengths of multiple bonds (non-ring molecules).

C=C	1.34
C≡C	1.20
C=N	1.21
C≡N	1.16
C=O	1.21
C=S	1.61
N=N	1.24
N≡N	1.13
N=O	1.18
O=O	1.21

### C. Effect of environment on carbon-carbon single bonds (other single bonds not shown). From Reference 3.

Configuration	C-C length	Examples of molecules
C-C	1.526	$\text{H}_3\text{C}-\text{CH}_3$
C-C=	1.501	$\text{H}_3\text{C}-\text{CH}=\text{CH}_2$
C-C≡	1.459	$\text{H}_3\text{C}-\text{C}\equiv\text{CH}$
=C-C=	1.467	$\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$
≡C-C=	1.445	$\text{HC}\equiv\text{C}-\text{CH}=\text{CH}_2$
≡C-C≡	1.378	$\text{HC}\equiv\text{C}-\text{C}\equiv\text{CH}$

### D. Some metal-carbon bond lengths in gas-phase molecules.

Al-C	1.96	Bi-C	2.26	Pb-C	2.24
B-C	1.58	Cd-C	2.11	Sn-C	2.14
Be-C	1.70	Hg-C	2.08	Zn-C	1.93

## ATOMIC RADII OF THE ELEMENTS

The simple model of an atom as a hard sphere that can approach only to a fixed distance from another atom to which it is not bonded has proved useful in interpreting crystal structures and other molecular properties. The term van der Waals radius,  $r_{\text{vdw}}$ , was originally introduced by Pauling as a measure of this atomic size. Thus in a closely packed structure two non-bonded atoms A and B will be separated by the sum of their van der Waals radii  $r_{\text{vdw}}$  (A) and  $r_{\text{vdw}}$  (B). The set of van der Waals radii proposed by Pauling was refined by Bondi (Reference 1) based on crystallographic data, gas kinetic collision cross sections, and liquid state properties. The non-bonded contact distances predicted from the recommended  $r_{\text{vdw}}$  of Bondi have been compared with actual data in the collection of the Cambridge Crystallographic Data Center by Rowland and Taylor (Reference 2) and modified slightly. Their recommended van der Waals radii are given in the third column of this table.

The Cambridge Crystallographic Data Center also makes use of a set of "covalent radii" to determine which atoms in a crystal are bonded to each other. Thus two atoms A and B are judged to be connected by a covalent bond if their separation falls within a tolerance of  $\pm 0.4 \text{ \AA}$  of the sum  $r_{\text{cov}}$  (A) +  $r_{\text{cov}}$  (B). The covalent radii are given in the fourth column of the table.

### References

1. Bondi, A., *J. Phys. Chem.* 68, 441, 1964.
2. Rowland, R. S. and Taylor, R., *J. Phys. Chem.* 100, 7384, 1996.
3. Cambridge Crystallographic Data Center, [www.ccdc.cam.ac.uk/products/csd/radii/](http://www.ccdc.cam.ac.uk/products/csd/radii/)

Element	Symbol	$r_{\text{vdw}}/\text{\AA}$	$r_{\text{cov}}/\text{\AA}$	Element	Symbol	$r_{\text{vdw}}/\text{\AA}$	$r_{\text{cov}}/\text{\AA}$	Element	Symbol	$r_{\text{vdw}}/\text{\AA}$	$r_{\text{cov}}/\text{\AA}$
Actinium	Ac		1.88	Hafnium	Hf		1.57	Promethium	Pm		1.80
Aluminum	Al		1.35	Helium	He	1.40		Protactinium	Pa		1.61
Americium	Am		1.51	Holmium	Ho		1.74	Radium	Ra		1.90
Antimony	Sb		1.46	Hydrogen	H	1.09	0.23	Rhenium	Re		1.35
Argon	Ar	1.88	1.51	Indium	In	1.93	1.63	Rhodium	Rh		1.45
Arsenic	As	1.85	1.21	Iodine	I	1.98	1.40	Rubidium	Rb		1.47
Astatine	At		1.21	Iridium	Ir		1.32	Ruthenium	Ru		1.40
Barium	Ba		1.34	Iron	Fe		1.34	Samarium	Sm		1.80
Berkelium	Bk		1.54	Krypton	Kr	2.02		Scandium	Sc		1.44
Beryllium	Be		0.35	Lanthanum	La		1.87	Selenium	Se	1.90	1.22
Bismuth	Bi		1.54	Lead	Pb	2.02	1.54	Silicon	Si	2.10	1.20
Boron	B		0.83	Lithium	Li	1.82	0.68	Silver	Ag	1.72	1.59
Bromine	Br	1.85	1.21	Lutetium	Lu		1.72	Sodium	Na	2.27	0.97
Cadmium	Cd	1.58	1.69	Magnesium	Mg	1.73	1.10	Strontium	Sr		1.12
Cesium	Cs		1.67	Manganese	Mn		1.35	Sulfur	S	1.80	1.02
Calcium	Ca		0.99	Mercury	Hg	1.55	1.70	Tantalum	Ta		1.43
Californium	Cf		1.83	Molybdenum	Mo		1.47	Technetium	Tc		1.35
Carbon	C	1.70	0.68	Neodymium	Nd		1.81	Tellurium	Te	2.06	1.47
Cerium	Ce		1.83	Neon	Ne	1.54		Terbium	Tb		1.76
Chlorine	Cl	1.75	0.99	Neptunium	Np		1.55	Thallium	Tl	1.96	1.55
Chromium	Cr		1.35	Nickel	Ni	1.63		Thorium	Th		1.79
Cobalt	Co		1.33	Niobium	Nb		1.48	Thulium	Tm		1.72
Copper	Cu	1.40	1.52	Nitrogen	N	1.55	0.68	Tin	Sn	2.17	1.46
Curium	Cm		0.99	Osmium	Os		1.37	Titanium	Ti		1.47
Dysprosium	Dy		1.75	Oxygen	O	1.52	0.68	Tungsten	W		1.37
Erbium	Er		1.73	Palladium	Pd	1.63		Uranium	U	1.86	1.58
Europium	Eu		1.99	Phosphorus	P	1.80	1.05	Vanadium	V		1.33
Fluorine	F	1.47	0.64	Platinum	Pt	1.72		Xenon	Xe	2.16	
Gadolinium	Gd		1.79	Plutonium	Pu		1.53	Ytterbium	Yb		1.94
Gallium	Ga	1.87	1.22	Polonium	Po		1.68	Yttrium	Y		1.78
Germanium	Ge		1.17	Potassium	K	2.75	1.33	Zinc	Zn	1.39	1.45
Gold	Au	1.66		Praseodymium	Pr		1.82	Zirconium	Zr		1.56

# HINDERED INTERNAL ROTATION

I. Ozier and N. Moazzen-Ahmadi

In asymmetric tops like methyl alcohol,  $\text{CH}_3\text{OH}$ , and symmetric rotors like  $\text{CH}_3\text{SiH}_3$ , the methyl group can undergo internal rotation relative to the rest of the molecule, traditionally called the frame (LS59, OM07). Although various different tops are considered here, all have three-fold symmetry. In such cases, the potential  $V$  hindering the internal rotation can be written:

$$V(\alpha) = V_3\left(\frac{1}{2}\right)(1 - \cos 3\alpha) + V_6\left(\frac{1}{2}\right)(1 - \cos 6\alpha) + V_9\left(\frac{1}{2}\right)(1 - \cos 9\alpha) + \dots,$$

where  $\alpha$  is the deviation from equilibrium of the angle between the top and frame that measures the torsional motion. If only the first two terms are retained, then  $V_3$  is the height of the hindering potential and  $V_6$  is the shape parameter. For symmetric tops like  $\text{CH}_3\text{CH}_3$  where the top and frame are identical,  $\alpha$  is replaced by  $2\gamma$  and the origin for  $\gamma$  is often taken as the eclipsed configuration. In the expansion,  $-\cos 6n\gamma$  is then replaced by  $(-1)^{n+1}\cos 6n\gamma$ , where  $n = 1, 2, \dots$ . In cases where different forms of the expansion have been used in the original works, the values of the parameters published there have been converted to the conventions defined here.

In Tables 1 and 2, values are given for  $V_3$  for a selection of asymmetric and symmetric tops, respectively. In cases where the higher order parameters have been determined, these are given in the Comments column. Where appropriate, this column also indicates the specific top, isomer, state, and/or isotopomer that has been studied. For ethane, three symmetric top isotopomer are listed to illustrate the isotopic dependence of  $V_3$  and  $V_6$ . In all other cases, only one isotopomer is listed, even if several have been studied. In all but one of these cases, the isotopomer reported is the one with the highest natural abundance. However,  $\text{CH}_3\text{OCDO}$  is listed because the results obtained are more precise than for  $\text{CH}_3\text{OCHO}$ . The molecules are listed alphabetically in Hill order according to the molecular formula.

The determinations listed for the potential parameters are effective values that incorporate to varying degrees effects from other molecular parameters. For example, the apparent value of  $V_3$  can be changed significantly if the reduced rotational constant  $F$  is calculated from the structure, rather than being determined independently (LS59). Other examples include such mechanisms as coupling to excited skeletal vibrations (OM07) and redundancies connecting some of the torsional parameters (LB68, MO87). The experimental uncertainties quoted are taken from the original works; no attempt has been made to standardize the definitions. All the potential parameters are given in  $\text{cm}^{-1}$ . Where the original work has reported these values in other units, the conversion to  $\text{cm}^{-1}$  has been carried out using standard factors (LB02):

$$1 \text{ calorie} = 4.1868 \text{ joules};$$

$$1 \text{ calorie/mole} = 0.34998915 \text{ cm}^{-1}.$$

A variety of different methods have been used to measure  $V_3$ ,  $V_6$ , and  $V_9$  (LS59, OM07); only a few of the more important will be discussed here. For *asymmetric rotors*, both the pure rotational spectrum and its torsion-rotation counterpart are electric dipole allowed and are affected in lowest order by the leading terms in the torsional Hamiltonian. Both types of spectra have been used extensively to determine  $V_3$  (LS59). For *symmetric tops* with a single torsional degree of freedom, either the permanent electric dipole moment vanishes, as in  $\text{CH}_3\text{CH}_3$ , or the normal rotational spectrum is independent of  $V_3$  in lowest order, as in  $\text{CH}_3\text{SiH}_3$ . In

the latter case, the molecular beam avoided crossing method can often be used (OM07). The torsion-rotation spectrum is forbidden in lowest order, but becomes weakly allowed through interactions with the infrared active skeletal vibrations (OM07). By employing long absorption path lengths, this spectrum has been used to determine  $V_3$  in a number of molecules. For both asymmetric and symmetric tops, the most precise determinations of the molecular parameters have been made in cases where both rotational and torsion-rotation spectra have been investigated.

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TABLE 1. Asymmetric Top Potential Parameters

Name	Molecular Formula	Line Formula	Ref.	$V_3/\text{cm}^{-1}$	Comments
1 Trifluoromethanethiol	CH <sub>3</sub> S	CF <sub>3</sub> SH	LB02	500.83 ± 0.03	
2 Methylphosphonic difluoride	CH <sub>3</sub> F <sub>2</sub> OP	CH <sub>3</sub> P(=O)F <sub>2</sub>	SL06	676 ± 25	
3 Methanol	CH <sub>4</sub> O	CH <sub>3</sub> OH	LB02	373.594 ± 0.007	$V_6 = -1.597 ± 0.051$ $V_9 = 1.04 ± 0.20$
4 Methanethiol	CH <sub>4</sub> S	CH <sub>3</sub> SH	SH86	443.029 ± 0.070	$V_6 = -1.6451 ± 0.0144$
5 Methylsulfane	CH <sub>4</sub> S <sub>2</sub>	CH <sub>3</sub> SSH	TH86	609.0 ± 14.0	
6 Trifluoromethyl isocyanate	C <sub>2</sub> F <sub>3</sub> NO	CF <sub>3</sub> N=C=O	LB02	47.8769 ± 0.0051	
7 Trifluoroacetaldehyde	C <sub>2</sub> HF <sub>3</sub> O	CF <sub>3</sub> C(H)=O	DG87	298 ± 10	
8 Pentafluoroethane	C <sub>2</sub> HF <sub>5</sub>	CF <sub>3</sub> CHF <sub>2</sub>	EG96	1190 ± 4	
9 Acetyl bromide	C <sub>2</sub> H <sub>3</sub> BrO	CH <sub>3</sub> C(Br)=O	K60	456.7 ± 10.5	
10 1-Chloro-1,1-difluoroethane	C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	CH <sub>3</sub> CClF <sub>2</sub>	ALB97	1311.8 ± 1.4	
11 Acetyl chloride	C <sub>2</sub> H <sub>3</sub> ClO	CH <sub>3</sub> C(Cl)=O	LB02	442.74 ± 1.05	<sup>35</sup> Cl
12 Acetyl fluoride	C <sub>2</sub> H <sub>3</sub> FO	CH <sub>3</sub> C(F)=O	PK59	364.3 ± 2.1	
13 Methyl fluoroformate	C <sub>2</sub> H <sub>3</sub> FO <sub>2</sub>	CH <sub>3</sub> OC(F)=O	LB02	374.1 ± 0.2	
14 Methyl trifluoromethyl ether	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	CH <sub>3</sub> OCF <sub>3</sub>	LB02	382 ± 10	CH <sub>3</sub>
15 Acetyl iodide	C <sub>2</sub> H <sub>3</sub> IO	CH <sub>3</sub> C(=O)I	MK66	455.3 ± 10.5	
16 Methyl cyanate	C <sub>2</sub> H <sub>3</sub> NO	CH <sub>3</sub> OC≡N	LB02	399.0 ± 17.5	
17 1-Chloro-1-fluoroethane	C <sub>2</sub> H <sub>4</sub> ClF	CH <sub>3</sub> CHClF	LB02	1334.9 ± 3.8	
18 1,1-Difluoroethane	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	CH <sub>3</sub> CHF <sub>2</sub>	LB02	1163.0 ± 2.5	
19 Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	CH <sub>3</sub> C(H)=O	KH96	407.716 ± 0.010	$V_6 = -12.068 ± 0.037$
20 Thioacetaldehyde S-oxide	C <sub>2</sub> H <sub>4</sub> OS	CH <sub>3</sub> C(H)=S=O	LB02	285.6 ± 0.3	Z isomer
21 Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	CH <sub>3</sub> COOH	IA03	170.1742 ± 0.0002	$V_6 = -6.4725 ± 0.0001$
22 Methyl formate	C <sub>2</sub> H <sub>3</sub> DO <sub>2</sub>	CH <sub>3</sub> OC(D)=O	LB02	400.60 ± 0.03	deuterated
23 Fluoroethane	C <sub>2</sub> H <sub>5</sub> F	CH <sub>3</sub> CH <sub>2</sub> F	FD83	1172.1 ± 1.4	
24 Nitrosoethane	C <sub>2</sub> H <sub>5</sub> NO	CH <sub>3</sub> CH <sub>2</sub> N=O	LB02	903 ± 25	<i>gauche</i> conformer
	C <sub>2</sub> H <sub>5</sub> NO	CH <sub>3</sub> CH <sub>2</sub> N=O	LB02	911 ± 25	<i>cis</i> conformer
25 Acetamide	C <sub>2</sub> H <sub>5</sub> NO	CH <sub>3</sub> C(NH <sub>2</sub> )=O	LB02	24.949 ± 0.008	
26 Difluorodimethylsilane	C <sub>2</sub> H <sub>6</sub> F <sub>2</sub> Si	(CH <sub>3</sub> ) <sub>2</sub> SiF <sub>2</sub>	SG05	439.4 ± 2.5	

Name	Molecular Formula	Line Formula	Ref.	$V_3/\text{cm}^{-1}$	Comments
27 <i>N</i> -Nitrosodimethylamine	$\text{C}_2\text{H}_6\text{N}_2\text{O}$	$(\text{CH}_3)_2\text{NN}=\text{O}$	LB02	$145.8 \pm 0.25$	<i>cis</i> $\text{CH}_3$
	$\text{C}_2\text{H}_6\text{N}_2\text{O}$	$(\text{CH}_3)_2\text{NN}=\text{O}$	LB02	$737.4 \pm 13.3$	<i>trans</i> $\text{CH}_3$
28 Ethanol	$\text{C}_2\text{H}_6\text{O}$	$\text{CH}_3\text{CH}_2\text{OH}$	LB02	$1173.76 \pm 2.20$	<i>trans</i> isomer
29 Dimethyl ether	$\text{C}_2\text{H}_6\text{O}$	$(\text{CH}_3)_2\text{O}$	NH04	$926.0 \pm 3.5$	
30 Dimethyl sulfide	$\text{C}_2\text{H}_6\text{S}$	$(\text{CH}_3)_2\text{S}$	NH04	$751.1 \pm 4.8$	
31 Vinylsilane	$\text{C}_2\text{H}_6\text{Si}$	$\text{SiH}_3\text{C}(\text{H})=\text{CH}_2$	SH82	$520.1 \pm 1.8$	
32 Dimethyl disulfide	$\text{C}_2\text{H}_6\text{S}_2$	$\text{CH}_3\text{SSCH}_3$	LB02	$535.1 \pm 1.8$	
33 Dimethyl diselenide	$\text{C}_2\text{H}_6\text{Se}_2$	$\text{CH}_3\text{SeSeCH}_3$	GG04	$395 \pm 2$	
34 Dimethylsilane	$\text{C}_2\text{H}_8\text{Si}$	$(\text{CH}_3)_2\text{SiH}_2$	NH04	$578.0 \pm 3.5$	
35 3,3,3-Trifluoropropene	$\text{C}_3\text{H}_3\text{F}_3$	$\text{CF}_3\text{C}(\text{H})=\text{CH}_2$	ALL97	$653.06 \pm 0.83$	
36 Methyl cyanofornate	$\text{C}_3\text{H}_3\text{NO}_2$	$\text{CH}_3\text{OC}(\text{C}\equiv\text{N})=\text{O}$	LB02	$406.6 \pm 1.1$	<i>s-trans</i> conformer
37 (Methylthio)acetylene	$\text{C}_3\text{H}_4\text{S}$	$\text{CH}_3\text{SC}\equiv\text{CH}$	DM87	$592.0 \pm 3.3$	
38 1,1,1-Trifluoropropane	$\text{C}_3\text{H}_5\text{F}_3$	$\text{CH}_3\text{CH}_2\text{CF}_3$	ALA97	$922.2 \pm 1.4$	
39 2-Iodopropene	$\text{C}_3\text{H}_5\text{I}$	$\text{CH}_3\text{C}(\text{I})=\text{CH}_2$	LB02	$905.8 \pm 4.2$	
40 Ethyl isocyanide	$\text{C}_3\text{H}_5\text{N}$	$\text{CH}_3\text{CH}_2\text{N}\equiv\text{C}$	LB02	$1167.6 \pm 18.2$	
41 Propene	$\text{C}_3\text{H}_6$	$\text{CH}_3\text{C}(\text{H})=\text{CH}_2$	LB02	$697.499 \pm 0.048$	$V_6 = -13.0$ (fixed)
42 Propanal	$\text{C}_3\text{H}_6\text{O}$	$\text{CH}_3\text{CH}_2\text{C}(\text{H})=\text{O}$	BW64	$798 \pm 39$	<i>cis</i> conformer
43 Acetone	$\text{C}_3\text{H}_6\text{O}$	$(\text{CH}_3)_2\text{C}=\text{O}$	G00	$251.4 \pm 2.6$	$V_6 = -6.92 \pm 0.65$
44 (Methylthio)ethene	$\text{C}_3\text{H}_6\text{S}$	$\text{CH}_3\text{SC}(\text{H})=\text{CH}_2$	MM01	$1138 \pm 13$	
45 Propanoic acid	$\text{C}_3\text{H}_6\text{O}_2$	$\text{CH}_3\text{CH}_2\text{COOH}$	S75	$819.0 \pm 10.5$	<i>cis</i> conformer
46 Methyl mercaptoacetate	$\text{C}_3\text{H}_6\text{O}_2\text{S}$	$\text{CH}_3\text{OC}(\text{H})\text{C}(\text{H}_2)\text{SH}$	LB02	$411 \pm 8$	state 0 <sup>+</sup>
	$\text{C}_3\text{H}_6\text{O}_2\text{S}$	$\text{CH}_3\text{OC}(\text{H})\text{C}(\text{H}_2)\text{SH}$	LB02	$412 \pm 9$	state 0 <sup>-</sup>
47 2-Bromopropane	$\text{C}_3\text{H}_7\text{Br}$	$(\text{CH}_3)_2\text{CHBr}$	LB02	$1437.0 \pm 2.5$	<sup>79</sup> Br
48 1-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{Cl}$	LE97	$1017.8 \pm 1.4$	<i>gauche</i> conformer
	$\text{C}_3\text{H}_7\text{Cl}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{Cl}$	LE97	$966.0 \pm 7.0$	<i>trans</i> conformer
49 2-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	$(\text{CH}_3)_2\text{CHCl}$	LB02	$1374.03 \pm 1.00$	<sup>35</sup> Cl
50 1-Fluoropropane	$\text{C}_3\text{H}_7\text{F}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{F}$	KD86	$965.3 \pm 12.2$	<i>gauche</i> conformer
	$\text{C}_3\text{H}_7\text{F}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{F}$	KD86	$948.5 \pm 2.8$	<i>trans</i> conformer
51 2-Fluoropropane	$\text{C}_3\text{H}_7\text{F}$	$(\text{CH}_3)_2\text{CHF}$	LB02	$1162.79 \pm 0.84$	
52 Butanenitrile	$\text{C}_4\text{H}_7\text{N}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}\equiv\text{N}$	VD88	$1087.4 \pm 8.4$	<i>gauche</i> conformer
	$\text{C}_4\text{H}_7\text{N}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}\equiv\text{N}$	VD88	$1088.5 \pm 13.3$	<i>trans</i> conformer
53 Propanamide	$\text{C}_3\text{H}_7\text{NO}$	$\text{CH}_3\text{CH}_2\text{C}(\text{H})\text{C}(\text{H})\text{NH}_2$	MM96	$761 \pm 42$	<i>syn</i> conformer
54 <i>N,N</i> -Dimethylformamide	$\text{C}_3\text{H}_7\text{NO}$	$(\text{CH}_3)_2\text{NC}(\text{H})=\text{O}$	LB02	$366.04 \pm 0.26$	<i>cis</i> $\text{CH}_3$
	$\text{C}_3\text{H}_7\text{NO}$	$(\text{CH}_3)_2\text{NC}(\text{H})=\text{O}$	LB02	$772.4 \pm 7.4$	<i>trans</i> $\text{CH}_3$
55 Propane	$\text{C}_3\text{H}_8$	$(\text{CH}_3)_2\text{CH}_2$	BL85	$1108.1 \pm 9.5$	
56 Cyclopropylgermane	$\text{C}_3\text{H}_8\text{Ge}$	$\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}(\text{H})(\text{GeH}_3)$	LB02	$466.6 \pm 16.7$	$\text{GeH}_3$
57 <i>N</i> -Nitrosoethylmethylamine	$\text{C}_3\text{H}_8\text{N}_2\text{O}$	$\text{CH}_3\text{CH}_2\text{N}(\text{CH}_3)\text{N}=\text{O}$	LB02	$310 \pm 30$	<i>N</i> -methyl top, OGM conformer
58 1-Propanol	$\text{C}_3\text{H}_8\text{O}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{OH}$	DS81	$956 \pm 21$	<i>trans</i> conformer
59 Cyclopropylsilane	$\text{C}_3\text{H}_8\text{Si}$	$\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}(\text{H})(\text{SiH}_3)$	TB86	$670.9 \pm 1.5$	
60 Dimethyl(methylene)silane	$\text{C}_3\text{H}_8\text{Si}$	$(\text{CH}_3)_2\text{Si}=\text{CH}_2$	LB02	$351.4 \pm 5.9$	
61 Dimethyl methylphosphonate	$\text{C}_3\text{H}_9\text{O}_3\text{P}$	$(\text{OCH}_3)_2\text{P}(\text{H})\text{CH}_3$	SL02	$662 \pm 6$	<i>P</i> -methyl top
	$\text{C}_3\text{H}_9\text{O}_3\text{P}$	$(\text{OCH}_3)_2\text{P}(\text{H})\text{CH}_3$	OH07	$278.82 \pm 0.06$	<i>O</i> -methyl top #1
	$\text{C}_3\text{H}_9\text{O}_3\text{P}$	$(\text{OCH}_3)_2\text{P}(\text{H})\text{CH}_3$	OH07	$181.82 \pm 0.01$	<i>O</i> -methyl top #2
62 But-2-ynoyl fluoride	$\text{C}_4\text{H}_3\text{FO}$	$\text{CH}_3\text{C}\equiv\text{CC}(\text{F})=\text{O}$	LB02	$2.20 \pm 0.12$	
63 <i>cis</i> -2-Butenenitrile	$\text{C}_4\text{H}_5\text{N}$	$\text{CH}_3\text{C}(\text{H})=\text{C}(\text{H})\text{C}\equiv\text{N}$	LB02	$485.50 \pm 0.25$	
64 2-Methylacrylonitrile	$\text{C}_4\text{H}_5\text{N}$	$\text{CH}_2=\text{C}(\text{CH}_3)\text{C}\equiv\text{N}$	LB02	$695.2 \pm 2.1$	
65 2-Methyloxazole	$\text{C}_4\text{H}_5\text{NO}$	$\text{N}=\text{C}(\text{CH}_3)\text{OC}(\text{H})=\text{C}(\text{H})$	LB02	$251.70 \pm 1.17$	
66 4-Methyloxazole	$\text{C}_4\text{H}_5\text{NO}$	$\text{N}=\text{C}(\text{H})\text{OC}(\text{H})=\text{C}(\text{CH}_3)$	LB02	$429.44 \pm 0.33$	

Name	Molecular Formula	Line Formula	Ref.	$V_3/\text{cm}^{-1}$	Comments
67 5-Methyloxazole	$\text{C}_4\text{H}_5\text{NO}$	$\text{N}=\text{C}(\text{H})\text{OC}(\text{CH}_3)=\text{C}(\text{H})$	LB02	$477.90 \pm 1.34$	
68 5-Methylisoxazole	$\text{C}_4\text{H}_5\text{NO}$	$\text{C}(\text{H})=\text{NOC}(\text{CH}_3)=\text{C}(\text{H})$	LB02	$272.05 \pm 1.00$	
69 2-Methylthiazole	$\text{C}_4\text{H}_5\text{NS}$	$\text{N}=\text{C}(\text{CH}_3)\text{SC}(\text{H})=\text{C}(\text{H})$	GH02	$34.938 \pm 0.020$	
70 4-Methylisothiazole	$\text{C}_4\text{H}_5\text{NS}$	$\text{N}=\text{C}(\text{H})\text{C}(\text{CH}_3)=\text{C}(\text{H})\text{S}$	LB02	$105.767 \pm 0.043$	
71 4-Methyl-2-oxetanone	$\text{C}_4\text{H}_6\text{O}_2$	$\text{OC}(=\text{O})\text{C}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)$	LB02	$1256.5 \pm 10.5$	
72 <i>trans</i> -1-Fluoro-2-butene	$\text{C}_4\text{H}_7\text{F}$	$\text{CH}_3\text{C}(\text{H})=\text{C}(\text{H})\text{CH}_2\text{F}$	LB02	$596 \pm 7$	anticlinal conformer
73 1-Isocyanopropane	$\text{C}_4\text{H}_7\text{N}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{N}=\text{C}$	LB02	$1012.3 \pm 8.4$	<i>gauche</i> conformer
	$\text{C}_4\text{H}_7\text{N}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{N}=\text{C}$	LB02	$1033.8 \pm 7.7$	<i>trans</i> conformer
74 Isobutene	$\text{C}_4\text{H}_8$	$(\text{CH}_3)_2\text{C}=\text{CH}_2$	LB02	$761.58 \pm 1.05$	
75 <i>cis</i> -2-Butene	$\text{C}_4\text{H}_8$	$\text{CH}_3\text{CH}=\text{CHCH}_3$	LB02	$259.89 \pm 0.42$	
76 3-Methoxy-1-propene	$\text{C}_4\text{H}_8\text{O}$	$\text{CH}_3\text{OC}(\text{H}_2)\text{C}(\text{H})=\text{CH}_2$	LB02	$728.0 \pm 10.5$	<i>skew-gauche</i> conformer
	$\text{C}_4\text{H}_8\text{O}$	$\text{CH}_3\text{OC}(\text{H}_2)\text{C}(\text{H})=\text{CH}_2$	LB02	$829.5 \pm 10.5$	<i>syn-trans</i> conformer
77 2,2-Dimethyloxirane	$\text{C}_4\text{H}_8\text{O}$	$\text{OC}(\text{CH}_3)(\text{CH}_3)\text{C}(\text{H}_2)$	LB02	$945.61 \pm 0.75$	
78 <i>cis</i> -2,3-Dimethyloxirane	$\text{C}_4\text{H}_8\text{O}$	$\text{OC}(\text{H})(\text{CH}_3)\text{C}(\text{H})(\text{CH}_3)$	LB02	$577.80 \pm 1.84$	<i>cis</i> conformer
	$\text{C}_4\text{H}_8\text{O}$	$\text{OC}(\text{H})(\text{CH}_3)\text{C}(\text{H})(\text{CH}_3)$	LB02	$862.52 \pm 1.84$	<i>trans</i> conformer
79 2-Methyloxetane	$\text{C}_4\text{H}_8\text{O}$	$\text{OC}(\text{H}_2)\text{C}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)$	LB02	$1166.5 \pm 4.9$	
80 3-Methyloxetane	$\text{C}_4\text{H}_8\text{O}$	$\text{OC}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)\text{C}(\text{H}_2)$	LB02	$1149.4 \pm 4.2$	
81 3-Methoxythietane	$\text{C}_4\text{H}_8\text{OS}$	$\text{SC}(\text{H}_2)\text{C}(\text{H})(\text{OCH}_3)\text{C}(\text{H}_2)$	LB02	$1071.0 \pm 10.5$	
82 3-(Methylthio)-1-propene	$\text{C}_4\text{H}_8\text{S}$	$\text{CH}_3\text{SC}(\text{H}_2)\text{C}(\text{H})=\text{CH}_2$	LB02	$619 \pm 28$	
83 2,2-Dimethylthiirane	$\text{C}_4\text{H}_8\text{S}$	$\text{SC}(\text{CH}_3)(\text{CH}_3)\text{C}(\text{H}_2)$	LB02	$1268.3 \pm 3.0$	
84 Butane	$\text{C}_4\text{H}_{10}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{CH}_3$	LB02	$948 \pm 24$	
85 <i>N</i> -Methyl- <i>N</i> -nitrosopropylamine	$\text{C}_4\text{H}_{10}\text{N}_2\text{O}$	$\text{CH}_3\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{N}(\text{CH}_3)\text{N}=\text{O}$	LB02	$320 \pm 30$	<i>N</i> -methyl top, conformer OMGA
86 Dihydro-3-methyl-2(3 <i>H</i> )-furanone	$\text{C}_5\text{H}_8\text{O}_2$	$\text{OC}(=\text{O})\text{C}(\text{H})(\text{CH}_3)\text{C}(\text{H}_2)\text{C}(\text{H}_2)$	LB02	$913.8 \pm 2.5$	
87 Dihydro-4-methyl-2(3 <i>H</i> )-furanone	$\text{C}_5\text{H}_8\text{O}_2$	$\text{OC}(=\text{O})\text{C}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)\text{C}(\text{H}_2)$	CA96	$1437.8 \pm 8.4$	
88 Dihydro-5-methyl-2(3 <i>H</i> )-furanone	$\text{C}_5\text{H}_8\text{O}_2$	$\text{OC}(=\text{O})\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)$	CA96	$1233.0 \pm 4.2$	
89 <i>tert</i> -Butyl isocyanate	$\text{C}_5\text{H}_9\text{NO}$	$(\text{CH}_3)_3\text{C}\equiv\text{N}=\text{C}=\text{O}$	LB02	$41.510 \pm 0.015$	$(\text{CH}_3)_3\text{C}$ group
90 Methyl <i>tert</i> -butyl ether	$\text{C}_5\text{H}_{12}\text{O}$	$(\text{CH}_3)_3\text{COCH}_3$	LB02	$498.6 \pm 1.5$	<i>O</i> -methyl top
91 2-Methylcyclopentanone	$\text{C}_6\text{H}_{10}\text{O}$	$\text{C}(=\text{O})\text{C}(\text{H})(\text{CH}_3)\text{C}(\text{H}_2)\text{C}(\text{H}_2)\text{C}(\text{H}_2)$	LB02	$844.2 \pm 2.4$	
92 3-Methylcyclopentanone	$\text{C}_6\text{H}_{10}\text{O}$	$\text{C}(=\text{O})\text{C}(\text{H}_2)\text{C}(\text{H})(\text{CH}_3)\text{C}(\text{H}_2)\text{C}(\text{H}_2)$	LB02	$1233.8 \pm 1.7$	
93 <i>tert</i> -Butyl ethyl ether	$\text{C}_6\text{H}_{14}\text{O}$	$(\text{CH}_3)_3\text{COC}(\text{H}_2)\text{CH}_3$	LB02	$1025 \pm 3$	ethyl $\text{CH}_3$
94 2,4-Difluorotoluene	$\text{C}_7\text{H}_6\text{F}_2$	$\text{C}(\text{H})=\text{C}(\text{CH}_3)\text{C}(\text{F})=\text{C}(\text{H})\text{C}(\text{F})=\text{C}(\text{H})$	LB02	$204.04 \pm 0.23$	
95 2-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	$\text{C}(\text{H})=\text{C}(\text{H})\text{C}(\text{Cl})=\text{C}(\text{CH}_3)\text{C}(\text{H})=\text{C}(\text{H})$	ND06	$513.8 \pm 2.7$	$^{35}\text{Cl}$
96 2,6-Dimethylpyridine	$\text{C}_7\text{H}_9\text{N}$	$\text{C}(\text{H})=\text{C}(\text{H})\text{C}(\text{CH}_3)=\text{NC}(\text{CH}_3)=\text{C}(\text{H})$	LB02	$98.24 \pm 0.27$	
97 1,2,2-Trimethylpropyl methylphosphonofluoridate	$\text{C}_7\text{H}_{16}\text{FO}_2\text{P}$	$(\text{CH}_3)_3\text{CC}(\text{H})(\text{CH}_3)\text{OP}(\text{O})(\text{F})\text{CH}_3$	SD04	$821 \pm 5$	<i>P</i> -methyl top, conformer GD-I
	$\text{C}_7\text{H}_{16}\text{FO}_2\text{P}$	$(\text{CH}_3)_3\text{CC}(\text{H})(\text{CH}_3)\text{OP}(\text{O})(\text{F})\text{CH}_3$	SD04	$738 \pm 5$	<i>P</i> -methyl top, conformer GD-II
98 Germyl azide	$\text{GeH}_3\text{N}_3$	$\text{GeH}_3-\text{N}=\text{N}=\text{N}$	GA89	$86.598 \pm 0.062$	
99 Silylphospine	$\text{H}_5\text{PSi}$	$\text{SiH}_3\text{PH}_2$	VR75	$537.2 \pm 14.0$	

TABLE 2. Symmetric Top Potential Parameters

Name	Molecular Formula	Line Formula	Ref.	$V_3/\text{cm}^{-1}$	Comments
1 Phosphine-trifluoroborane	$\text{BF}_3\text{H}_3\text{P}$	$\text{H}_3\text{PBF}_3$	OK75	$1169 \pm 123$	
2 Trihydro(phosphorus trifluoride)boron	$\text{BF}_3\text{H}_3\text{P}$	$\text{F}_3\text{PBH}_3$	KL67	$1134 \pm 53$	
3 Trihydro(phosphine)boron	$\text{BH}_6\text{P}$	$\text{H}_3\text{PBH}_3$	DL73	$864.5 \pm 17.5$	
4 Trifluoro(trifluoromethyl)silane	$\text{CF}_6\text{Si}$	$\text{CF}_3\text{SiF}_3$	LJ72	$489 \pm 50$	
5 Trifluoromethylgermane	$\text{CH}_3\text{F}_3\text{Ge}$	$\text{CF}_3\text{GeH}_3$	KW74	$448 \pm 53$	
6 Trifluoromethylsilane	$\text{CH}_3\text{F}_3\text{Si}$	$\text{CH}_3\text{SiF}_3$	ST06	$414.147 \pm 0.030$	
7 Methylgermane	$\text{CH}_6\text{Ge}$	$\text{CH}_3\text{GeH}_3$	L59	$433.6 \pm 8.8$	
8 Methylsilane	$\text{CH}_6\text{Si}$	$\text{CH}_3\text{SiH}_3$	OM07	$603.3878 \pm 0.0037$	
9 Methylstannane	$\text{CH}_6\text{Sn}$	$\text{CH}_3\text{SnH}_3$	CB61	$227 \pm 10$	
10 1,1,1-Trifluoroethane	$\text{C}_2\text{H}_3\text{F}_3$	$\text{CH}_3\text{CF}_3$	WA02	$1112.24 \pm 0.16$	
11 Ethane	$\text{C}_2\text{H}_6$	$\text{CH}_3\text{CH}_3$	OM07	$1013.28 \pm 0.10$	$V_6 = 8.798 \pm 0.041$
12 Ethane-1,1,1- $d_3$	$\text{C}_2\text{H}_3\text{D}_3$	$\text{CH}_3\text{CD}_3$	OM07	$1001.876 \pm 0.023$	$V_6 = 9.328 \pm 0.018$
13 Ethane- $d_6$	$\text{C}_2\text{D}_6$	$\text{CD}_3\text{CD}_3$	OM07	$989.946 \pm 0.090$	$V_6 = 9.51 \pm 0.10$
14 1-Silylpropyne	$\text{C}_3\text{H}_6\text{Si}$	$\text{CH}_3\text{C}\equiv\text{CSiH}_3$	NY85	$3.77 \pm 0.70$	
15 Trimethylchlorosilane	$\text{C}_3\text{H}_9\text{ClSi}$	$(\text{CH}_3)_3\text{SiCl}$	MS02	$576.9 \pm 0.9$	
16 2-Butyne	$\text{C}_4\text{H}_6$	$\text{CH}_3\text{C}\equiv\text{CCH}_3$	LB97	$6.067 \pm 0.040$	$V_6 = 0.1240 \pm 0.0144$ $V_9 = -0.0916 \pm 0.0180$
17 Ethynyltrimethylgermane	$\text{C}_5\text{H}_{10}\text{Ge}$	$(\text{CH}_3)_3\text{GeC}\equiv\text{CH}$	VG96	$376.2 \pm 16.7$	
18 Disilane	$\text{H}_6\text{Si}_2$	$\text{SiH}_3\text{SiH}_3$	BM07	$412.033 \pm 0.010$	

# LINE SPECTRA OF THE ELEMENTS

Joseph Reader and Charles H. Corliss

The original tables from which this table was derived were prepared under the auspices of the Committee on Line Spectra of the Elements of the National Academy of Sciences-National Research Council. The table contains the outstanding spectral lines of neutral (I) and singly ionized (II) atoms of the elements from hydrogen through plutonium ( $Z = 1-94$ ); selected strong lines from doubly ionized (III), triply ionized (IV), and quadruply ionized (V) atoms are also included. Listed are lines that appear in emission from the vacuum ultraviolet to the far infrared. These lines were selected from much larger lists in such a way as to include the stronger observed lines in each spectral region. A more extensive list may be found in Reference 1.

The data were compiled by the following contributors.

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All wavelengths are given in Ångstrom units ( $10^{-10}$  m). Below 2000 Å the wavelengths are in vacuum (except for the Cu II line at 1999.698 Å, which is in air); above 2000 Å the wavelengths are in air. Wavelengths given to three decimal places have an uncertainty of less than 0.001 Å and are therefore suitable for calibration purposes. In the air region, the elements used most commonly for calibration are Ne, Ar, Kr, Fe, Th, and Hg; in the vacuum region, the most common are C, N, O, Si, Cu.

All data refer to natural isotopic abundance of the elements except that Kr I and Kr II lines below 11,000 Å given to three decimal

places are for  $^{86}\text{Kr}$ . A separate table for  $^{198}\text{Hg}$  contains accurately known wavelengths that are frequently used for calibration.

A large number of the lines for neutral and singly ionized atoms were extracted from the National Bureau of Standards (NBS) *Tables of Spectral-Line Intensities* (Reference 2). The intensities of these lines represent quantitative estimates of relative line strengths that take account of varying detection sensitivity at different wavelengths. They are on a linear scale. For nearly all of the other lines the intensities represent qualitative estimates of the relative strengths of lines not greatly separated in wavelength. Because different observers frequently use different scales for their intensity estimates, these intensities are useful only as a rough indication of the appearance of a spectrum. In some cases the intensity scale is not intended to be linear. In the first and second spectra the intensities of the lines of the singly ionized atom (II) relative to those of the neutral atom (I) should be used with caution, inasmuch as the concentration of ions in a light source depends greatly on the excitation conditions.

Descriptive symbols that follow the wavelength have the following meanings:

c — complex  
d — line consists of two unresolved lines  
h — hazy  
l — shaded to longer wavelengths  
s — shaded to shorter wavelengths  
p — perturbed by a close line  
r — easily reversed  
w — wide

The table is arranged alphabetically by element name (not symbol); for each element the lines are listed by wavelength. References to the sources of data for each element are given at the end of the table, starting on page 10-89.

## General References

1. Reader, J., Corliss, C. H., Wiese, W. L., and Martin, G. A., *Tables of Line Spectra of the Elements, Part 1. Wavelengths and Intensities*, Nat. Stand. Ref. Data Sys.- Nat. Bur. Standards (U.S.), No. 68, 1980.
2. Meggers, W. F., Corliss, C. H., and Scribner, B. F., *Tables of Spectral Line Intensities, Part 1. Arranged by Elements*, Nat. Bur. Stand. (U.S.), Monograph 145, 1975.
3. Fuhr, J. R., Martin, W. C., Musgrove, A., Sugar, J., and Wiese, W. L., "NIST Atomic Spectroscopic Database" ver. 1.1, January 1996. *NIST Physical Reference Data*, National Institute of Standards and Technology, Gaithersburg, MD. Available at the WWW address: <http://physics.nist.gov/PhysRefData/contents.html>

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
<i>Actinium Ac Z = 89</i>			900	1582.04	IV	110	2368.11	I	290	6068.43	II
2000 h	2952.55	III	800	1584.46	IV	180	2369.30	I	110	6068.53	II
2000 h	3392.78	III	125	1596.059	II	140	2370.22	I	450	6073.23	II
3000	3487.59	III	700	1605.766	III	160	2372.07	I	110	6181.57	II
2000 s	3863.12	II	100	1611.814	III	850	2373.12	I	150	6181.68	II
3000 s	4088.44	II	800	1611.874	III	170	2373.35	I	290	6182.28	II
3000 s	4168.40	II	150	1625.627	II	110	2373.57	I	220	6182.45	II
100	4179.98	I	800	1639.06	IV	240	2567.98	I	450 h	6183.42	II
20	4183.12	I	100	1644.235	II	480	2575.10	I	450	6201.52	II
20	4194.40	I	100	1644.809	II	110	2637.70	II	360	6201.70	II
20 l	4384.53	I	1000	1670.787	II	150	2652.48	I	290	6226.18	II
20	4396.71	I	100	1686.250	II	200	2660.39	I	360	6231.78	II
2000 h	4413.09	III	800	1719.440	II	160	2669.17	II	450	6243.36	II
20	4462.73	I	500	1721.244	II	650	2816.19	II	450	6335.74	II
3000 h	4569.87	III	900	1721.271	II	150	3041.28	II	360	6696.02	I
1000	5910.85	II	500	1724.952	II	360	3050.07	I	230	6698.67	I
20	6359.86	I	900	1724.984	II	450	3057.14	I	110	7361.57	I
20 l	6691.27	I	350	1760.104	II	150	3074.64	II	140	7362.30	I
<i>Aluminum Al Z = 13</i>			300	1761.975	II	4500 r	3082.153	I	230	7835.31	I
900	125.53	V	290	1763.00	I	7200 r	3092.710	I	290	7836.13	I
800	126.07	V	500	1763.869	II	1800 r	3092.839	I	110	8075.35	I
800	130.41	V	700	1763.952	II	150	3428.92	II	290	8640.70	II
1000	130.85	V	450	1765.64	I	150	3443.64	I	360	8772.87	I
900	131.00	V	300	1765.815	II	900	3492.23	IV	450	8773.90	I
900	131.44	V	450	1766.38	I	800	3508.46	IV	110	8828.91	I
800	160.07	IV	400	1767.731	II	450	3586.56	II	180	8841.28	I
1000	278.69	V	450	1769.14	I	360	3587.07	II	140	8923.56	I
900	281.39	V	1000	1818.56	IV	290	3587.45	II	150	9290.65	II
70	486.884	III	600	1828.588	II	870	3601.63	III	110	9290.75	II
30	486.912	III	400	1832.837	II	220	3651.06	II	150	10076.29	II
250	511.138	III	250	1834.808	II	110	3651.10	II	110	10768.36	I
150	511.191	III	1000	1854.716	III	150	3654.98	II	140	10782.04	I
500	560.317	III	300	1855.929	II	290	3655.00	II	110	10872.98	I
200	560.433	III	700	1858.026	II	450	3900.68	II	230	10891.73	I
100	670.068	III	120	1859.980	II	4500 r	3944.006	I	450	11253.19	I
200	671.118	III	1000	1862.311	II	9000 r	3961.520	I	570	11254.88	I
500	695.829	III	600	1862.790	III	110	3995.86	II	570	13123.41	I
400	696.217	III	200	1929.978	II	290	4226.81	II	450	13150.76	I
200	725.683	III	150	1931.048	II	870	4529.19	III	230	16718.96	I
300	726.915	III	200	1932.377	II	150	4585.82	II	300	16750.56	I
400	855.034	III	400	1934.503	II	110	4588.19	II	140	16763.36	I
500	856.746	III	150	1934.713	II	550	4666.80	II	300	21093.04	I
400	892.024	III	300	1935.840	III	110	4898.76	II	360	21163.75	I
50	893.887	III	200	1935.949	III	110	4902.77	II	<i>Antimony Sb Z = 51</i>		
450	893.897	III	150	1936.907	II	150	5280.21	II	15	722.86	III
800	1042.17	IV	220	1939.261	II	290	5283.77	II	15	732.33	III
50	1191.812	II	700	1990.531	II	150	5285.85	II		861.5	IV
900	1237.19	IV	150	2016.052	II	110	5312.32	II	4	876.84	II
900	1257.62	IV	150	2016.234	II	220	5316.07	II	4	921.07	II
800	1264.18	IV	100	2016.368	II	150	5371.84	II	6	983.57	II
1000	1272.76	IV	200	2074.008	II	180	5557.06	I	15	999.62	III
150	1350.18	II	700	2094.264	II	110	5557.95	I	6	1001.13	II
800	1384.13	III	150	2094.744	II	450	5593.23	II	6	1009.43	II
800	1447.51	IV	300	2094.791	II	1200	5696.60	III	40	1011.94	III
800	1494.79	IV	100	2095.104	II	1000	5722.73	III	6	1052.21	II
1000	1526.14	V	200	2095.141	II	110	5853.62	II	8	1056.27	II
800	1537.54	IV	400	2269.10	I	220	5971.94	II	8	1057.32	II
800	1539.830	II	120	2269.22	I	290	6001.76	II	40	1065.90	III
1000	1557.25	IV	140	2321.56	I	220	6001.88	II	6	1073.81	II
100	1569.385	II	460	2367.05	I	450	6006.42	II	30	1075.82	III
			110	2367.61	I	150	6061.11	II		1087.6	IV

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
8	1104.32	V	100 r	2139.69	I	15	4514.50	II	4	447.53	V
30	1151.49	III	10	2141.80	II	30	4596.90	II	18	449.06	V
40	1157.74	III	50 r	2141.83	I	20	4599.09	II	4	449.49	V
	1199.1	IV	100 r	2144.86	I	15	4604.77	II	3	458.12	V
50	1205.20	III	1500 r	2175.81	I	30	4647.32	II	2	458.98	V
50	1210.64	III	250 r	2179.19	I	20	4675.74	II	6 p	461.23	V
12	1226.00	V	200 r	2201.32	I	40	4711.26	II	3	462.42	V
6	1230.30	II	300 r	2208.45	I	20	4757.81	II	7	463.94	V
8	1274.98	II	150 r	2220.73	I	20	4765.36	II	30	487.227	II
20	1306.69	III	100	2221.98	I	30	4784.03	II	50	490.650	II
8	1327.40	II	120 r	2224.93	I	20	4802.01	II	30	490.701	II
6	1358.04	II	300 r	2262.51	I	20	4832.82	II	30	519.327	II
8	1384.70	II	120	2288.98	I	20	4877.24	II	3	522.09	V
20	1404.18	III	150 r	2293.44	I	15	4947.40	II	5	524.19	V
6	1407.83	II	300 r	2306.46	I	15	5044.56	II	6	527.69	V
8	1436.49	II	2500 r	2311.47	I	20	5238.94	II	30	542.912	II
20 r	1486.57	I	150	2315.89	I	20	5354.24	II	200	543.203	II
40 h	1491.36	I	400 h	2373.67	I	40 h	5556.10	I	70	547.461	II
	1499.2	IV	300 h	2383.64	I	100 l	5632.02	I	2	554.50	V
12	1505.70	V	100	2395.22	I	30	5639.75	II	70	556.817	II
50 r	1512.57	I	150	2422.13	I	60 h	5830.34	I	5	558.48	V
12	1524.47	V	250	2426.35	I	100	6005.21	II	70	573.362	II
120 r	1532.74	I	400 r	2445.51	I	20	6053.41	II	30	576.736	II
80 r	1535.06	I	400	2478.32	I	30	6079.80	II	70	580.263	II
6	1565.51	II	150	2480.44	I	50	6130.04	II	30	583.437	II
8	1576.11	II	100	2510.54	I	20	6154.94	II	70	597.700	II
7	1581.36	II	2000 r	2528.52	I	20	6611.49	I	30	602.858	II
80 r	1599.96	I	15	2528.54	II	30	6647.44	II	30	612.372	II
10	1606.98	II	10	2567.75	II	30 h	7648.28	I	6	623.77	IV
200 w	1612.8	I	150	2574.06	I	80	7844.44	I	3	635.12	V
100 w	1623.3	I	15	2590.13	III	200	7924.65	I	500	661.867	II
20	1657.04	II	1500 r	2598.05	I	60	8411.69	I	30	664.562	II
100 w	1662.6	I	500 r	2598.09	I	150	8572.64	I	200	666.011	II
15	1673.89	III	300 r	2612.31	I	100	8619.55	I	1000	670.946	II
15	1711.84	III	12	2617.17	III	400	9518.68	I	3000	671.851	II
80 r	1716.93	I	200 r	2652.60	I	400	9949.14	I	70	676.242	II
150 r	1717.45	I	20	2669.39	III	200	10078.49	I	30	677.952	II
150 r	1723.43	I	300 r	2670.64	I	300	10261.01	I	30	679.218	II
15	1725.33	III	200 r	2682.76	I	200	10585.60	I	200	679.401	II
100 r	1736.19	I	120	2692.25	I	1000	10677.41	I	10	683.28	IV
100 h	1765.76	I	150 r	2718.90	I	800	10741.94	I	7	688.39	IV
100 r	1780.87	I	400 r	2769.95	I	80	10794.11	I	12 p	689.01	IV
100 r	1788.24	I	1000 r	2877.92	I	600	10839.73	I	6	699.41	IV
150	1800.18	I	15	2980.96	II	200	10868.58	I	8	700.28	IV
50 r	1810.50	I	500 r	3029.83	I	400	10879.55	I	3	705.35	V
80 r	1814.20	I	600 r	3232.52	I	300	11012.79	I	5	709.20	V
100	1829.50	I	20	3241.28	II	150	11266.23	I	4	715.60	V
50 r	1868.17	I	700 r	3267.51	I	5	12116.06	I	3	715.65	V
300 r	1871.15	I	15	3498.46	II				200	718.090	II
150 r	1882.56	I	25	3637.80	II	<i>Argon Ar Z = 18</i>			3000	723.361	II
100	1927.08	I	250	3637.83	I	3	336.56	V	2	725.11	V
200 r	1950.39	I	20	3722.78	II	3	337.56	V	500	725.548	II
60 r	2029.49	I	200 r	3722.79	I	6	338.00	V	70	730.930	II
70 r	2039.77	I	20	3850.22	II	2	338.43	V	200	740.269	II
150 r	2049.57	I	200	4033.55	I	2	339.01	V	200	744.925	II
1000 r	2068.33	I	20	4033.56	II	3	339.89	V	70	745.322	II
100	2079.56	I	20	4133.63	II	3	350.88	V	4	754.20	IV
50 r	2098.41	I	15	4140.54	II	4	396.87	IV	5	761.47	IV
80 r	2118.48	I	15	4195.17	II	4	398.55	IV	12	769.15	III
100 r	2127.39	I	20	4219.07	II	2	436.67	V	5	800.57	IV
50 r	2137.05	I	20	4314.32	II	5	446.00	V	10	801.09	IV
						8	446.95	V			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
10	801.41	IV	12	2293.03	III	12	2913.00	IV	35	3718.206	II
5	801.91	IV	4	2299.72	IV	11	2926.33	IV	70	3729.309	II
20	802.859	I	10	2300.85	III	200	2942.893	II	50	3737.889	II
100	806.471	I	15	2302.17	III	100	2979.050	II	150	3765.270	II
60	806.869	I	9	2317.00	III	10	3010.02	III	50	3766.119	II
30	807.218	I	15	2317.47	III	12	3024.05	III	20	3770.369	I
40	807.653	I	12	2318.04	III	50	3033.508	II	20	3770.520	II
50	809.927	I	10	2319.13	III	6	3037.98	IV	25	3780.840	II
120	816.232	I	10	2319.37	III	12	3054.82	III	20	3795.37	III
70	816.464	I	9	2345.17	III	10	3064.77	III	25	3803.172	II
80	820.124	I	7	2351.67	III	8	3077.40	IV	50	3809.456	II
4	822.16	V	9	2360.26	III	10	3078.15	III	7	3834.679	I
120	825.346	I	10	2395.63	III	50	3093.402	II	70	3850.581	II
120	826.365	I	12	2399.15	III	7	3110.41	III	10	3858.32	III
5	827.05	V	10	2413.20	III	7	3127.90	III	35	3868.528	II
3	827.35	V	7	2415.61	III	8	3200.37	I	7	3907.84	III
150	834.392	I	10	2418.82	III	20	3243.689	II	35	3925.719	II
4 p	834.88	V	5	2420.456	II	25	3285.85	III	50	3928.623	II
100	835.002	I	12	2423.52	III	25	3293.640	II	25	3932.547	II
2	836.13	V	12	2423.93	III	20	3301.88	III	70	3946.097	II
15	840.03	IV	7	2443.69	III	20	3307.228	II	7	3947.505	I
100	842.805	I	8	2447.71	IV	15	3311.25	III	35	3948.979	I
20	843.77	IV	8	2472.95	III	7	3319.34	I	8	3960.53	III
25	850.60	IV	7	2476.10	III	7	3323.59	III	20	3979.356	II
180	866.800	I	12	2488.86	III	25	3336.13	III	35	3994.792	II
150	869.754	I	12	2513.28	IV	20	3344.72	III	50	4013.857	II
10	871.10	III	10	2516.789	II	25	3350.924	II	6	4023.60	III
9	875.53	III	6	2518.40	IV	15	3358.49	III	50	4033.809	II
180 r	876.058	I	9	2525.69	IV	7	3361.28	III	20	4035.460	II
12	878.73	III	10	2534.709	II	7	3373.47	I	150	4042.894	II
8	879.62	III	15	2562.087	II	25	3376.436	II	50	4044.418	I
180 r	879.947	I	12	2562.17	IV	25	3388.531	II	100	4052.921	II
9	883.18	III	10	2568.07	IV	15	3391.85	III	200	4072.005	II
10	887.40	III	7	2569.53	IV	7	3393.73	I	70	4072.385	II
150	894.310	I	12	2599.47	IV	7	3417.49	III	25	4076.628	II
5	900.36	IV	10	2608.06	IV	9	3424.25	III	35	4079.574	II
9	901.17	IV	7	2608.44	IV	8	3438.04	III	25	4082.387	II
1000	919.781	II	12	2615.68	IV	7	3461.07	I	150	4103.912	II
1000	932.054	II	6	2619.98	IV	9	3471.32	III	300	4131.724	II
1000 r	1048.220	I	12	2621.36	IV	70	3476.747	II	5	4146.70	III
500 r	1066.660	I	12	2624.92	IV	20	3478.232	II	35	4156.086	II
7	1669.67	III	7	2631.90	III	20	3480.55	III	400	4158.590	I
7	1673.42	III	15	2640.34	IV	50	3491.244	II	50	4164.180	I
7	1675.48	III	10	2654.63	III	100	3491.536	II	35	4179.297	II
9	1914.40	III	8	2674.02	III	12	3499.67	III	50	4181.884	I
7	1915.56	III	9	2678.38	III	15	3503.58	III	100	4190.713	I
10	2125.16	III	9	2682.63	IV	70	3509.778	II	50	4191.029	I
15	2133.87	III	10	2724.84	III	8	3511.12	III	200	4198.317	I
10	2138.59	III	14	2757.92	IV	70	3514.388	II	400	4200.674	I
10	2148.73	III	7	2762.23	III	70	3545.596	II	25	4218.665	II
15	2166.19	III	10	2776.26	IV	70	3545.845	II	25	4222.637	II
10	2168.26	III	12	2784.47	IV	7	3554.306	I	25	4226.988	II
20	2170.23	III	14	2788.96	IV	100	3559.508	II	100	4228.158	II
25	2177.22	III	7	2797.11	IV	100	3561.030	II	100	4237.220	II
8	2184.06	III	16	2809.44	IV	70	3576.616	II	25	4251.185	I
10	2188.22	III	10	2830.25	IV	25	3581.608	II	200	4259.362	I
15	2192.06	III	7	2842.88	III	50	3582.355	II	100	4266.286	I
7	2248.73	III	8	2855.29	III	70	3588.441	II	70	4266.527	II
10	2279.10	III	6	2874.40	IV	7	3606.522	I	150	4272.169	I
7	2281.22	III	9	2884.12	III	25	3622.138	II	550	4277.528	II
7	2282.21	III	25	2891.612	II	20	3639.833	II	20	4282.898	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100	4300.101	I	25	5165.773	II	7	6951.478	I	200	10673.565	I
25	4300.650	II	20	5187.746	I	7	6960.250	I	11	10681.773	I
70	4309.239	II	20	5216.814	II	10000	6965.431	I	7	10683.034	II
200	4331.200	II	7	5221.271	I	150	7030.251	I	30	10733.87	I
50	4332.030	II	5	5421.352	I	10000	7067.218	I	30	10759.16	I
100	4333.561	I	10	5451.652	I	100	7068.736	I	7	10812.896	II
50	4335.338	I	25	5495.874	I	25	7107.478	I	11	11078.869	I
25	4345.168	I	5	5506.113	I	25	7125.820	I	30	11106.46	I
800	4348.064	II	25	5558.702	I	1000	7147.042	I	12	11441.832	I
50	4352.205	II	10	5572.541	I	15	7158.839	I	400	11488.109	I
25	4362.066	II	35	5606.733	I	70	7206.980	I	200	11668.710	I
50	4367.832	II	20	5650.704	I	15	7265.172	I	12	11719.488	I
200	4370.753	II	10	5739.520	I	7	7270.664	I	200	12112.326	I
70	4371.329	II	5	5834.263	I	2000	7272.936	I	50	12139.738	I
50	4375.954	II	10	5860.310	I	35	7311.716	I	50	12343.393	I
150	4379.667	II	15	5882.624	I	25	7316.005	I	200	12402.827	I
50	4385.057	II	25	5888.584	I	5	7350.814	I	200	12439.321	I
70	4400.097	II	50	5912.085	I	70	7353.293	I	100	12456.12	I
200	4400.986	II	15	5928.813	I	200	7372.118	I	200	12487.663	I
400	4426.001	II	5	5942.669	I	20	7380.426	II	150	12702.281	I
150	4430.189	II	7	5987.302	I	10000	7383.980	I	30	12733.418	I
50	4430.996	II	5	5998.999	I	20	7392.980	I	12	12746.232	I
50	4433.838	II	5	6025.150	I	15	7412.337	I	200	12802.739	I
20	4439.461	II	70	6032.127	I	10	7425.294	I	50	12933.195	I
35	4448.879	II	35	6043.223	I	25	7435.368	I	500	12956.659	I
100	4474.759	II	10	6052.723	I	10	7436.297	I	200	13008.264	I
200	4481.811	II	20	6059.372	I	20000	7503.869	I	200	13213.99	I
100	4510.733	I	7	6098.803	I	15000	7514.652	I	200	13228.107	I
20	4522.323	I	10	6105.635	I	25000	7635.106	I	100	13230.90	I
20	4530.552	II	100	6114.923	II	15000	7723.761	I	500	13272.64	I
400	4545.052	II	10	6145.441	I	10000	7724.207	I	1000	13313.210	I
20	4564.405	II	7	6170.174	I	10	7891.075	I	1000	13367.111	I
400	4579.350	II	150	6172.278	II	20000	7948.176	I	30	13499.41	I
400	4589.898	II	10	6173.096	I	20000	8006.157	I	1000	13504.191	I
15	4596.097	I	10	6212.503	I	25000	8014.786	I	11	13573.617	I
550	4609.567	II	5	6215.938	I	7	8053.308	I	30	13599.333	I
7	4628.441	I	25	6243.120	II	20000	8103.693	I	400	13622.659	I
35	4637.233	II	7	6296.872	I	35000	8115.311	I	200	13678.550	I
400	4657.901	II	15	6307.657	I	10000	8264.522	I	1000	13718.577	I
15	4702.316	I	7	6369.575	I	20	8392.27	I	10	13825.715	I
20	4721.591	II	20	6384.717	I	15000	8408.210	I	10	13907.478	I
550	4726.868	II	70	6416.307	I	20000	8424.648	I	200	14093.640	I
50	4732.053	II	25	6483.082	II	15000	8521.442	I	100	15046.50	I
300	4735.906	II	15	6538.112	I	7	8605.776	I	25	15172.69	I
800	4764.865	II	15	6604.853	I	4500	8667.944	I	10	15329.34	I
550	4806.020	II	25	6638.221	II	20	8771.860	II	30	15989.49	I
150	4847.810	II	20	6639.740	II	180	8849.91	I	30	16519.86	I
50	4865.910	II	50	6643.698	II	20	9075.394	I	500	16940.58	I
800	4879.864	II	5	6660.676	I	35000	9122.967	I	12	18427.76	I
70	4889.042	II	5	6664.051	I	550	9194.638	I	50	20616.23	I
20	4904.752	II	25	6666.359	II	15000	9224.499	I	30	20986.11	I
35	4933.209	II	100	6677.282	I	400	9291.531	I	20	23133.20	I
200	4965.080	II	35	6684.293	II	1600	9354.220	I	20	23966.52	I
50	5009.334	II	150	6752.834	I	25000	9657.786	I			
70	5017.163	II	5	6756.163	I	4500	9784.503	I	<i>Arsenic As Z = 33</i>		
70	5062.037	II	15	6766.612	I	180	10052.06	I	510	871.7	III
20	5090.495	II	20	6861.269	II	30	10332.72	I	325	889.0	III
100	5141.783	II	150	6871.289	I	100	10467.177	II	325	927.5	III
70	5145.308	II	5	6879.582	I	1600	10470.054	I	325	937.2	III
5	5151.391	I	10	6888.174	I	13	10478.034	I	325	953.6	III
15	5162.285	I	50	6937.664	I	180	10506.50	I	325	963.8	III
									250	987.7	V

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
340	1021.96	II	300	2831.164	II	14	587.57	III	10	3193.91	I
250	1029.5	V	100 r	2860.44	I	18	647.27	III	25 h	3203.70	I
340	1082.35	II	300	2884.406	II	300	719.86	V	30	3221.63	I
500	1139.40	II	80	2926.3	III	150	721.85	V	40	3222.19	I
615	1149.31	II	615	2959.572	II	1000	766.87	V	50	3261.96	I
555	1181.51	II	300	3003.819	II	40000	794.89	IV	60 r	3262.34	I
555	1189.87	II	300	3116.516	II	300	877.41	V	40	3281.50	I
615	1196.38	II	340	3842.60	II	50000	923.74	IV	15	3281.77	I
615	1196.56	II	325	3922.6	III	200	946.26	V	50	3322.80	I
340	1207.44	II	715	4190.082	II	200	1486.72	II	80 h	3356.80	I
800	1211.17	II	615	4197.40	II	400	1504.01	II	50	3368.18	III
800	1218.10	II	615	4242.982	II	300	1554.38	II	60 r	3377.08	I
340	1223.15	II	500	4315.657	II	200	1572.73	II	20	3377.39	I
760	1241.31	II	500	4323.867	II		1573.92	II	70 r	3420.32	I
965	1243.08	II	500	4336.64	II		1630.40	II	25	3421.01	I
870	1245.67	II	500	4352.145	II	100	1674.51	II	30 h	3421.48	I
800	1258.58	II	425	4352.864	II	400	1694.37	II	40	3463.74	I
965	1263.77	II	375	4371.17	II		1697.16	II	200 r	3501.11	I
800	1266.34	II	615	4427.106	II		1761.75	II	80 h	3524.97	I
800	1267.59	II	615	4431.562	II		1771.03	II	30 h	3531.35	I
715	1280.99	II	715	4458.469	II		1786.93	II	80 h	3544.66	I
715	1287.54	II	340	4461.075	II	100	1904.15	II	20 h	3547.68	I
715	1305.70	II	715	4466.348	II	500	1924.70	II	100	3552.45	II
340	1307.74	II	500	4474.46	II		1985.60	II	200	3567.73	II
760	1333.15	II	800	4494.230	II	300	1999.54	II	100	3576.28	II
965	1341.55	II	850	4507.659	II	10	2001.30	III	30	3577.62	I
760	1355.93	II	615	4539.74	II		2009.20	II	80 h	3579.67	I
965	1369.77	II	715	4543.483	II	400	2023.95	II	200	3596.57	II
800	1373.65	II	615	4602.427	II		2052.68	II	40	3630.64	I
1000	1375.07	II	340	4629.787	II		2054.57	II	40 h	3636.83	I
760	1375.78	II	340	4707.586	II	500	2214.7	II	20 h	3688.47	I
800	1394.64	II	340	4730.67	II	800	2245.61	II	400	3735.75	II
800	1400.31	II	340	4888.557	II	1000	2254.73	II	200	3816.69	II
500	1448.59	II	340	5105.58	II	1400	2304.24	II	200	3842.80	II
500	1558.88	II	500	5107.55	II	60	2331.10	III	100	3854.76	II
500	1570.99	II	425	5231.38	II	2000	2335.27	II	20	3889.33	I
100 r	1593.60	I	500	5331.23	II	190	2347.58	II	1400 l	3891.78	II
500	1660.55	II	340	5497.727	II	40	2512.28	III	20	3892.65	I
340	1860.34	II	425	5558.09	II	40	2523.83	III	40	3909.91	I
1000 r	1890.42	I	425	5651.32	II	60	2528.51	II	500	3914.73	II
500	1912.94	II	425	6110.07	II	50	2559.54	III	25	3926.85	III
800 r	1937.59	I	500	6170.27	II	8 h	2596.64	I	50	3935.72	I
585 r	1972.62	I	300	6511.74	II	100	2634.78	II	20	3937.87	I
170 r	1990.35	I	300	7092.27	II	40	2681.89	III	200	3939.67	II
100 r	1991.13	I	300	7102.72	II	8	2702.63	I	500	3949.51	II
100 r	1995.43	I	340	7990.53	II	18	2771.36	II	25	3993.06	III
230 r	2003.34	I	300	8174.51	II	15	2785.28	I	80	3993.40	I
100 r	2009.19	I	200	9300.61	I	100 r	3071.58	I	30	3995.66	I
200	2263.2	IV	230	9597.95	I	40	3079.14	III	300	4036.26	II
350 r	2288.12	I	290	9626.70	I	10 h	3108.21	I	200	4083.77	II
200	2301.0	IV	230	9833.76	I	8	3132.60	I	30 h	4084.86	I
350 r	2349.84	I	170	9915.71	I	8 h	3135.72	I	1500 h	4130.66	II
100 r	2370.77	I	290	9923.05	I	10	3137.70	I	20	4132.43	I
135 r	2381.18	I	290	10024.04	I	10	3155.34	I	200	4166.00	II
250	2417.5	IV	170	10614.07	I	10	3155.67	I	500	4216.04	II
250	2454.0	IV				12	3158.05	I	800	4267.95	II
170 r	2456.53	I	<i>Astatine At Z = 85</i>			12 h	3158.54	I	100	4283.10	I
200	2461.4	IV	8	2162.25	I	25	3165.60	I	300	4287.80	II
340	2602.00	II	10	2244.01	I	15 h	3173.69	I	200	4297.60	II
170 r	2780.22	I	<i>Barium Ba Z = 56</i>			30	3183.16	I	800	4309.32	II
300	2830.359	II	14	555.48	III	15	3183.96	I	20 h	4323.00	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
600	4325.73	II	300	6110.78	I	120 h	11697.45	I		107.38	I
200	4326.74	II	400	6135.83	II	120	13207.30	I	3	509.99	III
300	4329.62	II	20000	6141.72	II	120	13810.50	I	2	549.31	III
80	4350.33	I	150	6341.68	I	120	14077.90	I	6	582.08	III
60	4402.54	I	500	6378.91	II	120	15000.40	I	4	661.32	III
400	4405.23	II	10	6383.76	III	120	20712.00	I	8	675.59	III
40	4431.89	I	90	6450.85	I	150	25515.70	I		714.0	II
60 h	4488.98	I	150	6482.91	I	150	29223.90	I	4	725.59	III
50 h	4493.64	I	12000	6496.90	II				5	725.71	II
40	4505.92	I	300	6498.76	I				5	743.58	II
200	4509.63	II	150	6527.31	I				7	746.23	III
60 h	4523.17	I	3000	6595.33	I				2	767.75	III
130	4524.93	II	150	6654.10	I				8	775.37	II
65000	4554.03	II	1500	6675.27	I				20	842.06	II
40	4573.85	I	1800	6693.84	I					865.3	II
80	4579.64	I	1000	6769.62	II				2	925.25	II
30	4599.75	I	600	6865.69	I	1 h	76.10	III	10	943.56	II
20 h	4619.92	I	300 h	6867.85	I	2	76.48	III	10	973.27	II
25 h	4628.33	I	1000	6874.09	II	3	78.53	III		981.4	II
300	4644.10	II	6000	7059.94	I	4	78.66	III		1020.1	II
30	4673.62	I	2400 hs	7120.33	I	1 h	78.92	III	8	1026.93	II
35	4691.62	I	600	7195.24	I	5	81.89	III	5	1036.32	II
20	4700.43	I	600 hl	7228.84	I	10	82.38	III	15	1048.23	II
800	4708.94	II	3000	7280.30	I		82.58	II	1	1114.69	III
40	4726.44	I	1200	7392.41	I	20	83.20	III	20	1143.03	II
800	4843.46	II	300	7417.53	I		83.66	II		1155.9	II
300	4847.14	II	900 hl	7459.78	I	30	84.76	III	60	1197.19	II
200	4850.84	II	600	7488.08	I	50	88.31	III	2	1213.12	III
30 h	4877.65	I	450 hl	7636.90	I		89.16	I	1	1214.32	III
400	4899.97	II	600 hl	7642.91	I		89.80	II	2	1362.25	III
15	4902.90	I	1800	7672.09	I		90.04	II	1	1401.52	III
20000	4934.09	II	1200	7780.48	I		90.21	I	10	1421.26	III
8	4947.35	I	180 h	7839.57	I		90.67	I	5	1422.86	III
1000	4957.15	II	1500	7905.75	I		91.06	II		1426.12	I
300	4997.81	II	600	7911.34	I		91.36	II	1	1435.17	III
1000	5013.00	II	900 h	8210.24	I		91.74	II	2	1440.77	III
20 h	5159.94	I	8	8308.69	III		92.19	I		1491.76	I
20	5267.03	I	1800 h	8559.97	I		92.61	II	20	1512.30	II
800	5361.35	II	100	8710.74	II		93.14	II	60	1512.43	II
1000	5391.60	II	100	8737.71	II		93.42	II	100	1661.49	I
200	5421.05	II	300 h	8799.76	I		93.93	II	2 h	1754.69	III
100	5424.55	I	300	8860.98	I		94.78	II	15	1776.12	II
200	5428.79	II	450	8914.99	I		95.76	II	20	1776.34	II
300	5480.30	II	300	9219.69	I		96.29	I		1907.	I
200	5519.05	I	300	9308.08	I		97.24	I		1909.0	II
1000 r	5535.48	I	300 h	9324.58	I		97.44	I		1912.	I
20 h	5620.40	I	1500	9370.06	I		97.86	I	3	1917.03	III
10	5680.18	I	300	9455.92	I		97.97	I		1919.	I
400	5777.62	I	8	9521.76	III		98.12	I	5	1929.67	I
800	5784.18	II	450	9589.37	I		98.37	I	10	1943.68	I
100	5800.23	I	900	9608.88	I		98.66	I	60 h	1954.97	III
20	5805.69	I	300 h	9645.72	I		98.94	I		1956.	I
150	5826.28	I	1500 hl	9830.37	I		99.19	I	50	1964.59	I
2800	5853.68	II	900	10001.08	I	100	100.25	III	5	1985.13	I
15	5907.64	I	600	10032.10	I		100.86	I		1997.95	I
100	5971.70	I	1200 h	10233.23	I		101.20	I		1997.98	I
800	5981.25	II	300	10471.26	I		102.13	I	60	1998.01	I
100	5997.09	I	120 hl	10791.25	I		102.49	II		2033.25	I
300	5999.85	II	180 hl	11012.69	I		104.40	II		2033.28	I
100	6019.47	I	150 h	11114.42	I		104.67	I		2033.38	I
200	6063.12	I	240	11303.04	I		105.80	I	50	2055.90	I
							107.26	I			



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
40	1533.17	II	100	2924.	IV	60 h	5144.3	II	<i>Boron B Z = 5</i>		
30	1536.77	II	100	2933.	IV	20	5201.5	II		41.00	V
35	1538.06	II	100	2936.	IV	75 h	5209.2	II	30	48.59	V
20	1563.67	II	15	2936.7	II	40 h	5270.3	II	10	52.68	IV
40	1573.70	II	3200	2938.30	I	10	5397.8	II	30	60.31	IV
60	1591.79	II	20	2950.4	II	10 c	5552.35	I		194.37	V
25	1601.58	II	12	2963.4	II	3	5599.41	I		262.37	V
60 h	1606.40	III	2800	2989.03	I	20	5655.2	II	160	344.0	IV
40	1609.70	II	700	2993.34	I	40 h	5719.2	II	450	385.0	IV
40	1611.38	II	100	3012.	IV	6	5742.55	I	40	411.80	III
20	1652.81	II	2400	3024.64	I	12	5818.3	II	285	418.7	IV
20	1749.29	II	60	3034.87	I	20	5860.2	II	20	510.77	III
80	1777.11	II	100	3042.	IV	20	5973.0	II	40	510.85	III
60	1787.47	II	9000 c	3067.72	I	15	6059.1	II		512.53	V
70	1791.93	II	140	3076.66	I	15	6128.0	II	150	518.24	III
70	1823.80	II	35	3115.0	III	6	6134.82	I	75	518.27	III
100	1902.41	II	100	3239.	IV	3	6475.73	I	110	677.00	III
9000	1954.53	I	550 c	3397.21	I	3	6476.24	I	160	677.14	III
7000	1960.13	I	10	3430.83	II	15	6497.7	II	40	693.95	II
25	1989.35	II	12	3431.23	II	10	6577.2	II	40	731.36	II
7000	2021.21	I	40 h	3451.0	III	40 h	6600.2	II	40	731.44	II
9000	2061.70	I	40	3473.8	III	50 h	6808.6	II		749.74	V
45 h	2068.9	II	35	3485.5	III	4 h	6991.12	I	40	758.48	III
4600	2110.26	I	500 c	3510.85	I	12	7033.	II	70	758.67	III
2500	2133.63	I	380 c	3596.11	I	2	7036.15	I	110	882.54	II
15	2143.40	II	45	3613.4	III	10 h	7381.	II	110	882.68	II
15	2143.46	II	100	3643.	IV	2	7502.33	I	40	984.67	II
60	2186.9	II	12	3654.2	II	10 h	7637.	II	110	1081.88	II
40 h	2214.0	II	100	3682.	IV	10	7750.	II	110	1082.07	II
360	2228.25	I	50	3695.32	III	3	7838.70	I	70	1112.2	IV
1700	2230.61	I	50	3695.68	III	2	7840.33	I	450	1168.9	IV
340	2276.58	I	100	3734.	IV	20	7965.	II	70	1170.9	IV
100	2311.	IV	70 h	3792.5	II	40	8008.	III	110	1230.16	II
100	2326.	IV	12	3811.1	II	12 h	8050.	II	220	1362.46	II
16	2368.12	II	20	3815.8	II	50	8070.	III	70	1600.46	I
12	2368.25	II	10	3845.8	II	15	8328.	II	120	1600.73	I
100	2376.	IV	30	3863.9	II	15	8388.	II	160	1623.58	II
190	2400.88	I	100	3868.	IV	30	8532.	II	110	1623.77	II
75 h	2414.6	III	40 h	4079.1	II	2	8544.54	I	220	1624.02	II
10	2501.0	II	10	4097.2	II	1	8579.74	I	70	1624.16	II
25	2515.69	I	140	4121.53	I	25	8653.	II	160	1624.34	II
70	2524.49	I	140	4121.86	I	2	8754.88	I	100	1663.04	I
20 h	2544.5	II	75 h	4259.4	II	3	8761.54	I	150	1666.87	I
700	2627.91	I	25	4272.0	II	25	8863.	II	200	1667.29	I
100	2629.	IV	70 h	4301.7	II	2	8907.81	I	150	1817.86	I
100	2677.	IV	12 h	4339.8	II	2000 d	9657.04	I	200	1818.37	I
12	2693.0	II	25 h	4340.5	II	40	9827.78	I	300	1825.91	I
280 c	2696.76	I	12 h	4379.4	II	20	10104.5	I	300	1826.41	I
20	2713.3	II	25 h	4476.8	II	15	10138.8	I	110	1842.81	II
140 d	2730.50	I	60 h	4705.3	II	20	10300.6	I	20	1953.83	III
100	2767.	IV	600 c	4722.52	I	20	10536.19	I	550	2065.78	III
100	2772.	IV	30	4730.3	II	50	11072.44	I	250	2066.38	I
360	2780.52	I	20	4749.7	II	1500 d	11710.37	I	250	2066.65	I
100	2786.	IV	40 h	4797.4	III	40	11999.49	I	100	2066.93	I
15	2803.42	II	12	4908.2	II	200	12165.08	I	300	2067.19	I
11	2803.70	II	10	4916.6	II	200	12690.04	I	450	2067.23	III
12	2805.3	II	12	4969.7	II	100	12817.8	I	160	2077.09	III
140 c	2809.62	I	20	4993.6	II	200	14330.5	I	500	2088.91	I
100	2842.	IV	45 h	5079.3	III	50	16001.5	I	500	2089.57	I
80 h	2855.6	III	10	5091.6	II	60	22551.6	I	70	2220.30	II
4000	2897.98	I	50 h	5124.3	II				40	2234.09	III





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1000	23513.15	I	75	1793.40	III	30	2823.19	II	1000	5378.13	II
500	28346.50	I	40	1823.41	III	200	2836.900	I	200	5381.89	II
500	30380.85	I	100	1827.70	II	25	2856.46	II	40	5843.30	II
600	31630.13	I	50	1844.66	III	100	2868.180	I	50	5880.22	II
150	38345.75	I	40	1851.13	III	200 r	2880.767	I	300	6099.142	I
120	39964.36	I	40	1855.85	III	50 r	2881.224	I	100	6111.49	I
<i>Cadmium Cd Z = 48</i>											
50	427.01	IV	200	1856.67	III	200	2914.67	II	100	6325.166	I
50	447.85	IV	150	1874.08	III	50	2927.87	II	30	6330.013	I
60	480.90	IV	300	1922.23	II	200	2929.27	II	400	6354.72	II
70	493.00	IV	100	1943.54	II	1000 r	2980.620	I	500	6359.98	II
70	495.13	IV	40	1965.54	II	200 r	2981.362	I	2000	6438.470	I
70	498.14	IV	30	1986.89	II	50	2981.845	I	400	6464.94	II
70	498.53	IV	200	1995.43	II	50	3030.60	II	25	6567.65	II
80	504.09	IV	100	2007.49	II	150	3080.822	I	500	6725.78	II
70	504.20	IV	50	2032.45	II	25	3081.48	II	100	6759.19	II
70	504.50	IV	75	2036.23	II	30	3082.593	I	30	6778.116	I
80	506.31	IV	40	2039.83	III	100	3092.34	II	50	7237.01	II
60	508.01	IV	50	2045.61	III	200	3133.167	I	100	7284.38	II
50	508.95	IV	75	2087.91	III	50	3146.79	II	1000	7345.670	I
70	509.55	IV	150	2096.00	II	150	3250.33	II	50	8066.99	II
70	511.40	IV	50	2111.60	III	300	3252.524	I	5	8200.309	I
80	513.00	IV	1000 r	2144.41	II	300	3261.055	I	20	9289.	I
70	514.50	IV	50	2155.06	II	50	3343.21	II	15	11652.	I
60	519.42	IV	100	2187.79	II	50	3385.49	II	35	14487.	I
80	524.41	IV	1000	2194.56	II	30	3388.88	II	80	15708.	I
70	524.47	IV	1000	2265.02	II	800	3403.652	I	55 d	19120.	I
70	525.10	IV	1500 r	2288.022	I	50	3417.49	II	25	24371.	I
60	525.19	IV	1000	2312.77	II	50	3442.42	II	35	25448.	I
70	527.07	IV	200	2321.07	II	100	3464.43	II	<i>Calcium Ca Z = 20</i>		
80	531.09	IV	40	2376.82	II	1000	3466.200	I	250	190.46	V
80	531.51	IV	50	2418.69	II	800	3467.655	I	250	196.97	V
70	534.29	IV	50	2469.73	II	25	3483.08	II	300	199.55	V
70	536.77	IV	40	2487.93	II	150	3495.44	II	250	200.51	V
60	540.90	IV	40	2495.58	II	25	3499.952	I	265	257.98	V
70	541.74	IV	50	2509.11	II	100	3524.11	II	400	267.77	V
80	542.60	IV	30	2516.22	II	100	3535.69	II	300	270.31	V
60	553.06	IV	25 h	2525.196	I	1000	3610.508	I	400	280.99	V
80	554.05	IV	50	2544.613	I	800	3612.873	I	300	284.98	V
60	567.01	IV	50	2551.98	II	60	3614.453	I	450 c	286.96	V
150	1118.16	IV	25	2553.465	I	20	3649.558	I	500	322.17	V
100	1164.65	IV	3	2565.789	I	10	3981.926	I	300	323.22	V
100	1183.40	IV	500	2572.93	II	100	4029.12	II	300	330.94	V
100	1256.00	II	50	2580.106	I	200	4134.77	II	300	334.55	V
150	1296.43	II	30	2592.026	I	50	4141.49	II	250 c	342.45	IV
100	1326.50	II	25 h	2592.026	I	100	4285.08	II	250	343.93	IV
60	1370.48	IV	50	2602.048	I	8	4306.672	I	450	352.92	V
150	1370.91	II	50	2628.979	I	100	4412.41	II	250	377.18	V
60	1418.89	IV	40	2632.190	I	3	4412.989	I	200	387.08	V
200	1514.26	II	75	2639.420	I	1000	4415.63	II	750	425.00	V
50	1545.17	III	40	2659.23	II	30	4440.45	II	600	434.57	IV
200	1571.58	II	50 h	2660.325	I	8	4662.352	I	250	437.77	IV
100	1668.60	II	25	2668.20	II	200	4678.149	I	750	443.82	IV
50	1702.47	II	50	2672.62	II	30	4744.69	II	500	450.57	IV
40	1707.16	III	100	2677.540	I	300	4799.912	I	500	558.60	V
40	1722.95	III	25	2677.748	I	50	4881.72	II	400	637.93	V
50	1724.41	II	50	2707.00	II	50	5025.50	II	300	643.12	V
40	1747.67	III	75	2712.505	I	1000 h	5085.822	I	400	646.57	V
40	1773.06	III	50	2733.820	I	6	5154.660	I	750	656.00	IV
100	1785.84	II	1000	2748.54	II	100	5268.01	II	300	656.76	V
			100 h	2763.894	I	100	5271.60	II	500	669.70	IV
			50 h	2764.230	I	1000	5337.48	II	24	1341.89	II
			50	2774.958	I						

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
12	1342.54	II	20	4489.18	II	40	7820.78	II	250	371.75	III
20	1433.75	II	19	4499.88	III	60	7843.38	II	150	371.78	III
20	1545.29	III	23	4526.94	I	20	8017.50	II	650	384.03	IV
60	1649.86	II	22	4578.55	I	20	8020.50	II	700	384.18	IV
20	1807.34	II	23	4581.40	I	70	8133.05	II	500	386.203	III
40	1814.50	II	23	4581.47	I	100	8201.72	II	400	419.52	IV
40	1838.01	II	24	4585.87	I	110	8248.80	II	500	419.71	IV
60	1840.06	II	24	4585.96	I	70	8254.73	II	200	450.734	III
20	1843.09	II	20	4685.27	I	130	8498.02	II	400	459.46	III
40	1850.69	II	30	4716.74	II	170	8542.09	II	500	459.52	III
17	2123.03	III	40	4721.03	II	160	8662.14	II	570	459.63	III
16	2152.43	III	40	4799.97	II	100	8912.07	II	250	511.522	III
16	2687.76	III	25	4878.13	I	110	8927.36	II	250	535.288	III
19	2881.78	III	70	5001.48	II	110	9213.90	II	300	538.080	III
21	2899.79	III	80	5019.97	II	90	9312.00	II	350	538.149	III
19	2924.33	III	40	5021.14	II	100	9319.56	II	400	538.312	III
20	2988.63	III	23	5041.62	I	110	9320.65	II	350	574.281	III
10	3006.86	I	25	5188.85	I	25	9416.97	I	9	595.022	II
15	3028.59	III	22	5261.71	I	100	9567.97	II	30	687.053	II
3	3055.32	I	23	5262.24	I	110	9599.24	II	50	687.345	II
19	3119.67	III	22	5264.24	I	80	9601.82	II	10	858.092	II
170	3158.87	II	24	5265.56	I	80	9854.74	II	20	858.559	II
180	3179.33	II	25	5270.27	I	110	9890.63	II	30	903.624	II
150	3181.28	II	60	5285.27	II	90	9931.39	II	60	903.962	II
20	3316.51	II	70	5307.22	II	100	10223.04	II	150	904.142	II
12	3361.92	I	50	5339.19	II	20	10343.81	I	30	904.480	II
19	3372.67	III	27	5349.47	I	20	11838.99	II	800	977.03	III
20	3461.87	II	23	5512.98	I	25	12816.04	I	9	1009.86	II
13	3487.60	I	25	5581.97	I	24	12823.86	I	10	1010.08	II
18	3537.77	III	27	5588.76	I	25	12909.10	I	10	1010.37	II
20	3644.41	I	24	5590.12	I	30	13033.57	I	80	1036.337	II
30	3683.70	II	26	5594.47	I	21	13086.44	I	150	1037.018	II
40	3694.11	II	25	5598.49	I	24	13134.95	I	150	1157.910	I
170	3706.03	II	24	5601.29	I	20	16150.77	I	150	1158.019	I
180	3736.90	II	24	5602.85	I	22	16157.36	I	150	1158.035	I
20	3755.67	II	30	5857.45	I	21	16197.04	I	370	1174.93	III
30	3758.39	II	27	6102.72	I	20	18925.47	I	350	1175.26	III
230	3933.66	II	29	6122.22	I	24	18970.14	I	330	1175.59	III
220	3968.47	II	22	6161.29	I	30	19046.14	I	500	1175.71	III
50	4097.10	II	30	6162.17	I	48	19309.20	I	350	1175.99	III
60	4109.82	II	22	6163.76	I	49	19452.99	I	370	1176.37	III
30	4110.28	II	24	6166.44	I	47	19505.72	I	150	1188.992	I
40	4206.18	II	26	6169.06	I	50	19776.79	I	150	1189.447	I
50	4220.07	II	28	6169.56	I	35	19853.10	I	200	1189.631	I
50	4226.73	I	35	6439.07	I	34	19862.22	I	300	1193.009	I
24	4283.01	I	30	6449.81	I	23	19917.19	I	300	1193.031	I
22	4289.36	I	22	6455.60	I	24	19933.70	I	300	1193.240	I
22	4298.99	I	80	6456.87	II	25	22624.93	I	300	1193.264	I
25	4302.53	I	34	6462.57	I	30	22651.23	I	100	1193.393	I
20	4302.81	III	29	6471.66	I				150	1193.649	I
23	4307.74	I	32	6493.78	I				150	1193.679	I
22	4318.65	I	28	6499.65	I	110	34.973	V	100	1194.064	I
20	4355.08	I	23	6572.78	I	450	40.268	V	100	1194.488	I
19	4399.59	III	30	6717.69	I	110	227.19	V	100	1261.552	I
25	4425.44	I	33	7148.15	I	250	244.91	IV	100	1277.245	I
26	4434.96	I	31	7202.19	I	160	248.66	V	250	1277.282	I
25	4435.69	I	33	7326.15	I	160	248.74	V	250	1277.513	I
30	4454.78	I	30	7575.81	II	200	289.14	IV	300	1277.550	I
28	4455.89	I	60	7581.11	II	250	289.23	IV	300	1280.333	I
20	4456.61	I	80	7601.30	II	570	312.42	IV	100	1311.363	I
20	4472.04	II	20	7602.32	II	500	312.46	IV	9	1323.951	II
						250	371.69	III			

Carbon C Z = 6



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
120	1329.578	I	1000	4267.26	II	250	9620.80	I	40000	3085.10	III
120	1329.600	I	200	4325.56	III	300	9658.44	I	20000	3106.98	III
150	1334.532	II	600	4647.42	III	200	10683.08	I	30000	3110.53	III
300	1335.708	II	520	4650.25	III	300	10691.25	I	30000	3121.56	III
100	1354.288	I	375	4651.47	III	12	11619.29	I	20000	3141.29	III
150	1355.84	I	200 w	4658.30	IV	23	11628.83	I	20000	3143.96	III
120	1364.164	I	200	4665.86	III	13	11658.85	I	20000	3147.06	III
100	1459.032	I	200	4771.75	I	47	11659.68	I	710	3194.83	II
200	1463.336	I	200	4932.05	I	24	11669.63	I	990	3201.71	II
120	1467.402	I	5	4943.88	V	85	11748.22	I	710	3218.94	II
150	1481.764	I	5	4944.56	V	142	11753.32	I	880	3221.17	II
1000	1548.202	IV	200	5052.17	I	114	11754.76	I	710	3227.11	II
900	1550.774	IV	350	5132.94	II	11	11777.54	I	20000	3228.57	III
150	1560.310	I	350	5133.28	II	17	11892.91	I	710	3234.16	II
400	1560.683	I	350	5143.49	II	30	11895.75	I	990	3272.25	II
400	1560.708	I	570	5145.16	II	26	12614.10	I	20000	3353.29	III
100	1561.341	I	400	5151.09	II	20	13502.27	I	10000	3395.77	III
400	1561.438	I	300	5380.34	I	38	14399.65	I	30000	3427.36	III
150	1656.266	I	250	5648.07	II	16	14403.25	I	40000	3443.63	III
120	1656.928	I	350	5662.47	II	61	14420.12	I	30000	3454.39	III
300	1657.008	I	450	5695.92	III	12	14429.03	I	40000	3459.39	III
120	1657.380	I	250	5801.33	IV	13	14442.24	I	60000	3470.92	III
120	1657.907	I	200	5811.98	IV	12	16559.66	I	710	3485.05	II
150	1658.122	I	150	5826.42	III	50	16890.38	I	50000	3497.81	III
500	1751.823	I	570	5889.77	II	10	17338.56	I	60000	3504.64	III
1000	1930.905	I	350	5891.59	II	11	17448.60	I	770	3539.08	II
250	2162.94	III	200	6001.13	I	13	18139.80	I	50000	3544.07	III
40	2270.91	V	250	6006.03	I	23	19721.99	I	1200	3560.80	II
5	2277.25	V	110	6007.18	I				1000	3577.45	II
20	2277.92	V	150	6010.68	I				1800	3655.85	II
800	2296.87	III	300	6013.22	I	300	399.36	V	880	3660.64	II
800	2478.56	I	250	6014.84	I	200	482.96	V	880	3667.98	II
250	2509.12	II	800	6578.05	II	40	741.79	IV	1000	3709.29	II
350	2512.06	II	570	6582.88	II	30	754.60	IV	1000	3709.93	II
200 l	2524.41	IV	200	6587.61	I	75	1332.16	IV	1400	3716.37	II
300 s	2529.98	IV	150	6744.38	III	75	1372.72	IV	800	3728.42	II
250 h	2574.83	II	250	6783.90	II	100	2000.42	IV	860	3786.63	II
150	2697.75	III	150 h	7037.25	III	100	2009.94	IV	2500	3801.52	II
110 l	2724.85	III	250	7113.18	I	10000	2318.64	III	800	3803.09	II
150 l	2725.30	III	250	7115.19	I	10000	2372.34	III	1000	3808.11	II
150 l	2725.90	III	250	7115.63	II	10000	2380.12	III	1100	3838.54	II
350 l	2741.28	II	200	7116.99	I	10000	2431.45	III	860	3848.59	II
250	2746.49	II	350	7119.90	II	15000	2439.80	III	860	3853.15	II
1000	2836.71	II	800	7231.32	II	10000	2454.32	III	1200	3854.18	II
800	2837.60	II	1000	7236.42	II	10000	2469.95	III	1200	3854.31	II
200	2982.11	III	150	7612.65	III	10000	2483.82	III	1100	3878.36	II
800 h	2992.62	II	90 w	7726.2	IV	10000	2497.50	III	1500	3882.45	II
350	3876.19	II	200	7860.89	I	20000	2531.99	III	1000	3889.98	II
350	3876.41	II	200	8058.62	I	10000	2603.59	III	770	3907.29	II
350	3876.66	II	300 h	8196.48	III	340	2651.01	II	980	3912.44	II
570	3918.98	II	150	8332.99	III	270	2830.90	II	770	3918.28	II
800	3920.69	II	520	8335.15	I	250	2874.14	II	770	3931.09	II
150	4056.06	III	300	8500.32	III	10000	2923.81	III	770	3940.34	II
200	4067.94	III	250	9061.43	I	10000	2931.54	III	2000	3942.15	II
250	4068.91	III	200	9062.47	I	400	2976.91	II	2700	3942.75	II
250	4070.26	III	200	9078.28	I	10000	3022.75	III	770	3943.89	II
250	4074.52	II	250	9088.51	I	50000	3031.58	III	3100	3952.54	II
350 l	4075.85	II	450	9094.83	I	95000	3055.59	III	980	3956.28	II
150	4162.86	III	300	9111.80	I	20000	3056.56	III	770	3960.91	II
250 h	4186.90	III	800	9405.73	I	40000	3057.23	III	770	3967.05	II
800	4267.00	II	150	9603.03	I	20000	3057.58	III	770	3978.65	II
						680	3063.01	II			

*Cerium Ce Z = 58*

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
770	3984.68	II	280	5159.69	I	25	7329.91	I	630	2845.70	III
700	3992.39	II	280	5161.48	I	25	7397.77	I	3100	2859.32	III
910	3993.82	II	370	5187.46	II	25	7616.11	II	200	2893.85	III
2800	3999.24	II	260	5223.46	I	25	7689.17	II	180	2921.13	III
910	4003.77	II	260	5245.92	I	22	7844.94	II	3200	2976.86	III
2700	4012.39	II	340	5274.23	II	22	7857.54	II	210	3001.28	III
910	4014.90	II	450	5353.53	II	30	8025.56	II	1700	3066.59	III
840	4024.49	II	300	5393.40	II	25	8772.14	II	1100 c	3149.36	III
840	4028.41	II	280	5409.23	II	30	8891.20	II	1400	3152.36	III
840	4031.34	II	260	5512.08	II				8400	3268.32	III
2100	4040.76	II	300	5696.99	I	<i>Cesium Ce Z = 55</i>			1300	3315.51	III
910	4042.58	II	370	5699.23	I	10000	614.01	III	550	3340.60	III
700	4053.51	II	240	5719.03	I	2000	638.17	III	430	3344.02	III
1100	4071.81	II	230	5940.86	I	2500	666.25	III	1200	3349.46	III
1800	4073.48	II	55	6001.90	I	5000	691.60	III	400	3463.45	III
1500	4075.71	II	55	6005.86	I	3500	703.89	III	580	3476.83	III
1500	4075.85	II	55	6006.82	I	15000	718.14	II	480	3559.82	III
910	4083.23	II	75	6013.42	I	20000	721.79	III	7200	3597.45	III
770	4118.14	II	110	6024.20	I	20000	722.20	III	1300	3608.31	III
980	4123.87	II	10000	6032.54	III	5000	731.56	III	2300	3618.19	III
980	4127.37	II	110	6043.39	II	12000	740.29	III	300 c	3641.34	III
2700	4133.80	II	55	6047.40	I	15000	808.76	II	520	3651.08	III
2000	4137.65	II	10000	6060.91	III	15000	813.84	II	4800	3661.40	III
770	4142.40	II	45	6098.34	II	7500	830.39	III	640	3699.50	III
980	4149.94	II	45	6123.67	I	35000	901.27	II	430	3837.46	III
1400	4151.97	II	35	6143.36	II	15000	920.35	III	2100 c	3876.15	I
1300	4165.61	II	35	6186.17	I	40000	926.66	II	2900	3888.37	III
3500	4186.60	II	35	6208.98	I	25000 c	1054.79	III	600 c	3888.61	I
840	4198.72	II	35	6228.94	I	17 c	1673.99	III	2700	3925.60	III
910	4202.94	II	23	6232.45	II	12	1705.25	III	680 c	4001.70	III
1500	4222.60	II	28	6237.45	I	10	1801.83	III	3100	4006.55	III
770	4227.75	II	45	6272.05	II	20 c	1822.40	III	420	4006.78	III
980	4239.92	II	35	6295.58	I	11	1823.93	III	520	4043.42	III
1100	4248.68	II	28	6299.51	II	12	1824.70	III	14000	4264.70	II
2000	4289.94	II	23	6300.21	I	12	1841.80	III	18000 w	4277.13	II
1500	4296.67	II	35	6310.01	I	25	1915.50	III	370	4403.86	III
770	4300.33	II	35	6343.95	II	25 c	1923.29	III	1200	4410.22	III
770	4306.72	II	35	6371.11	II	12	1961.33	III	940	4425.68	III
980	4337.77	II	28	6386.84	I	17	1996.56	III	530	4471.48	III
700	4349.79	II	23	6393.02	II	710	2035.11	III	12000	4501.55	II
910	4364.66	II	35	6430.07	I	120	2056.43	III	1200	4506.72	III
910	4382.17	II	23	6436.40	I	330	2076.43	III	590	4522.86	III
700	4386.84	II	35	6458.03	I	540	2077.30	III	20000	4526.74	II
1700	4391.66	II	28	6467.39	I	410	2088.68	III	1000 c	4555.28	I
980	4418.78	II	35	6473.72	I	210	2101.63	III	460 c	4593.17	I
770	4449.34	II	23	6513.59	II	200	2141.47	III	99900	4603.79	II
2400	4460.21	II	45	6555.65	I	1000	2316.88	III	420 h	4620.61	III
1400	4471.24	II	23	6579.10	I	230	2325.95	III	210	4665.52	III
700	4479.36	II	22	6612.06	I	390	2340.49	III	25000	4830.19	II
700	4483.90	II	30	6628.93	I	1600	2455.81	III	140	4851.59	III
840	4486.91	II	22	6652.72	II	1600	2477.57	III	19000	4870.04	II
770	4523.08	II	26	6700.66	I	890	2485.45	III	37000	4952.85	II
840	4527.35	II	35	6704.27	I	410	2495.07	III	370	5035.72	III
840	4528.47	II	30	6774.28	II	1400	2525.67	III	27000	5043.80	II
840	4539.75	II	35	6775.59	I	430	2573.05	III	75000	5227.04	II
2100	4562.36	II	30	6924.81	I	16000	2596.86	III	29000	5249.38	II
1100	4572.28	II	30	6986.02	I	390	2610.12	III	11000	5274.05	II
840	4593.93	II	35	7061.75	II	6200	2630.51	III	10000 c	5349.13	II
1700	4628.16	II	35	7086.35	II	370	2700.32	III	22000	5370.99	II
310	4737.28	II	22	7238.36	II	710	2701.20	III	230	5380.79	III
470	5079.68	II	25	7252.75	I	390	2776.44	III	60 c	5465.94	I
						270	2810.87	III			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
37	5502.88	I	1500	17012.32	I	2500	728.951	II	12000	1396.527	I
39000	5563.02	II	760	20138.47	I	2000	777.562	II	500	1441.470	II
100	5635.21	I	880	22811.86	I	5000	787.580	II	500	1528.569	II
210 c	5664.02	I	1100	23037.98	I	5000	788.740	II	500	1542.942	II
27	5745.72	I	3900	23344.47	I	5000	793.342	II	500	1558.144	II
24000	5831.14	II	4400	24251.21	I	500	834.84	IV	500	1565.050	II
59 c	5838.83	I	850	24374.96	I	500	834.97	IV	600	1822.50	III
300	5845.14	I	890 d	25763.51	I	6000	839.297	II	500	1828.40	III
51000	5925.63	II	500	25764.73	I	8000	839.599	II	500	1857.488	II
140	5950.14	III	680 c	29310.06	I	600	840.93	IV	500	1901.61	III
110	5979.97	III	2800	30103.27	I	5000	851.691	II	500	1983.61	III
640 c	6010.49	I	610 c	30953.06	I	2000	888.026	II	450 h	1997.370	II
86	6034.09	I	1100	34900.13	I	2000	893.549	II	450	2032.116	II
150	6043.99	III	190	36131.00	I	2000	961.499	II	350 h	2088.583	II
870	6079.86	III	2 c	39177.28	I	500	973.21	IV	350 h	2091.458	II
9800	6128.61	II	2 d	39421.25	I	600	977.56	IV	700	2253.07	III
330	6150.42	III	1	39424.11	I	40	978.284	I	500	2268.95	III
1000	6213.10	I				700	984.95	IV	500	2278.34	III
170	6217.60	I	<i>Chlorine Cl Z = 17</i>			25	998.372	I	700	2283.93	III
450	6242.96	III	500	392.43	V	25	998.432	I	600	2323.50	III
320 c	6354.55	I	800	486.17	IV	75	1002.346	I	500	2336.45	III
510	6456.33	III	800	534.73	IV	500	1005.28	III	600	2340.64	III
8300	6495.53	II	700	535.67	IV	600	1008.78	III	600	2359.67	III
10000 w	6536.44	II	600	536.15	IV	150	1013.664	I	600	2370.37	III
490	6586.51	I	900	537.61	IV	700	1015.02	III	700	2416.42	III
97	6628.66	I	500	538.03	V	90	1025.553	I	600	2447.14	III
8800	6646.57	II	600	538.12	IV	6000	1063.831	II	600	2448.58	III
3300 c	6723.28	I	800	542.23	V	3000	1067.945	II	500	2486.91	III
9600	6724.47	II	600	542.30	V	9000	1071.036	II	500	2532.48	III
400	6753.12	III	1000	545.11	V	6000	1071.767	II	600	2580.67	III
200	6824.65	I	600	546.33	V	5000	1075.230	II	500	2603.59	III
300	6870.45	I	1000	547.63	V	5000	1079.080	II	500	2632.67	III
37000	6955.50	II	500	549.22	IV	200	1084.667	I	500	2633.18	III
4800	6973.30	I	700	552.02	IV	200	1085.171	I	600	2665.54	III
16000	6979.67	II	600	553.30	IV	250	1085.304	I	700	2710.37	III
980	6983.49	I	700	554.62	IV	400	1088.06	I	500	2724.03	IV
13000 w	7149.54	II	600	556.23	III	350	1090.271	I	500	2751.23	IV
1900 c	7219.60	III	700	556.61	III	250	1090.982	I	700	2782.47	IV
790	7228.53	I	700	557.12	III	250	1092.437	I	600	2965.56	III
130	7279.90	I	350	559.305	II	400	1094.769	I	500	3063.13	IV
1100	7279.96	I	700	561.53	III	350	1095.148	I	600	3076.68	IV
2600 c	7608.90	I	700	561.68	III	350	1095.662	I	600	3104.46	III
3300	7943.88	I	700	561.74	III	400	1095.797	I	800	3139.34	III
22000	7997.44	II	400	571.904	II	250	1096.810	I	900	3191.45	III
3500	8015.73	I	800	574.406	II	300	1097.369	I	700	3289.80	III
510	8078.94	I	500	601.50	IV	200	1098.068	I	700	3320.57	III
4500	8079.04	I	500	604.59	IV	200	1099.523	I	800	3329.06	III
59000 c	8521.13	I	500	606.35	III	500	1107.528	I	900	3340.42	III
15000 c	8761.41	I	700	618.057	II	800	1139.214	II	800	3392.89	III
61000 c	8943.47	I	600	619.982	II	800	1167.148	I	800	3393.45	III
18000	9172.32	I	800	620.298	II	3000	1179.293	I	900	3530.03	III
5200	9208.53	I	700	626.735	II	1200	1188.774	I	800	3560.68	III
19000	10024.36	I	800	635.881	II	900	1201.353	I	900	3602.10	III
4800	10123.41	I	1000	636.626	II	3000	1335.726	I	800	3612.85	III
26000	10123.60	I	1000	650.894	II	10000	1347.240	I	700	3622.69	III
2900	13424.31	I	1000	659.811	II	5000	1351.657	I	700	3656.95	III
38000 c	13588.29	I	1300	661.841	II	12000	1363.447	I	700	3670.28	III
8400	13602.56	I	2000	663.074	II	2500	1373.116	I	700	3682.05	III
5700	13758.81	I	1500	682.053	II	20000	1379.528	I	600	3705.45	III
55000 c	14694.91	I	1500	687.656	II	25000	1389.693	I	600	3707.34	III
820	16535.63	I	1500	693.594	II	20000	1389.957	I	800	3720.45	III
			2000	725.271	II						

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
800	3748.81	III	2300	7899.31	I	310	13296.0	I	130	2383.33	I
500	3779.35	III	1800	7915.08	I	550	13346.8	I	140	2408.62	I
10000	3850.99	II	3000	7924.645	I	525	13821.7	I	170	2496.31	I
25000	3860.83	II	2100	7933.89	I	294	14931.7	I	110	2502.53	I
500	3925.87	III	1700	7935.012	I	269	15108.0	I	190	2504.31	I
700	3991.50	III	650	7952.52	I	381	15465.1	I	110	2516.92	I
600	4018.50	III	1500	7974.72	I	1094	15520.3	I	390	2519.52	I
600	4059.07	III	1300	7976.97	I	1487	15730.1	I	190	2527.12	I
500	4104.23	III	600	7980.60	I	2780	15869.7	I	160	2549.54	I
500	4106.83	III	2900	7997.85	I	277	15883.3	I	130	2560.69	I
10000 h	4132.50	II	2200	8015.61	I	342	15928.9	I	150	2571.74	I
500	4608.21	III	1100	8023.33	I	735	15960.0	I	100	2577.65	I
40	4623.938	I	400	8051.07	I	283	15970.5	I	380	2591.85	I
50	4654.040	I	1700	8084.51	I	259	16198.5	I	250	2653.59	II
80	4661.208	I	2200	8085.56	I	717	19755.3	I	250	2658.59	II
45	4691.523	I	3000	8086.67	I	100	24470.0	I	320	2663.42	II
40	4721.255	I	1300	8087.73	I		39716.0	I	440	2666.02	II
45	4740.729	I	2500	8194.42	I		40085.5	I	280	2668.71	II
13000	4781.32	II	2200	8199.13	I		40089.5	I	350	2671.81	II
99000	4794.55	II	2200	8200.21	I		40532.2	I	280	2672.83	II
29000	4810.06	II	800	8203.78	I				1800	2677.16	II
16000	4819.47	II	18000	8212.04	I				320	2678.79	II
81000	4896.77	II	3000	8220.45	I	100	438.62	V	230	2687.09	II
47000	4904.78	II	20000	8221.74	I	100	464.02	V	280	2691.04	II
26000	4917.73	II	18000	8333.31	I	100	620.66	IV	180	2698.41	II
10000	4995.48	II	99900	8375.94	I	100	629.26	IV	180	2698.69	II
26000	5078.26	II	400	8406.199	I	80	630.30	IV	110	2701.99	I
30	5099.789	I	15000	8428.25	I	100	666.55	IV	140	2712.31	II
56000	5217.94	II	2200	8467.34	I	100	693.92	IV	170	2722.75	II
23000	5221.36	II	2200	8550.44	I	60	1030.47	III	420 h	2726.51	I
15000	5392.12	II	20000	8575.24	I	100	1033.69	III	280 h	2731.91	I
99000	5423.23	II	750	8578.02	I	100	1036.03	III	170 h	2736.47	I
10000	5423.51	II	75000	8585.97	I	80	1055.89	IV	250	2743.64	II
19000	5443.37	II	450	8628.54	I	80	1068.41	III	110 h	2748.29	I
10000	5444.21	II	300	8641.71	I	100	1116.48	V	330	2748.98	II
40	5532.162	I	3500	8686.26	I	150	1121.07	V	390	2750.73	II
50 d	5796.305	I	2200	8912.92	I	150	1127.63	V	280	2751.87	II
45	5799.914	I	3000	8948.06	I	100	1263.50	V	110 h	2752.88	I
30	5856.742	I	2000	9038.982	I	100	1417.42	IV	150	2757.10	I
50	6019.812	I	2500	9045.43	I	150	1465.86	V	350	2757.72	II
200	6140.245	I	1000	9069.656	I	150	1497.97	V	750	2762.59	II
160	6194.757	I	2000	9073.17	I	170	1519.03	V	750	2766.54	II
150	6434.833	I	7500	9121.15	I	220	1579.70	V	250 h	2769.92	I
300	6932.903	I	3000	9191.731	I	170	1591.72	V	610	2780.70	I
300	6981.886	I	500	9197.596	I	150	1603.19	V	180	2822.37	II
600	7086.814	I	4000	9288.86	I	120	1672.66	IV	180	2830.47	II
7500	7256.62	I	1500	9393.862	I	120	1758.51	IV	2500	2835.63	II
5000	7414.11	I	3500	9452.10	I	140	1802.72	IV	110	2840.02	II
550	7462.370	I	500	9486.964	I	130	1812.41	IV	1700	2843.25	II
550	7489.47	I	1000	9584.801	I	200	1837.44	V	1200	2849.84	II
700	7492.118	I	3500	9592.22	I	140	1873.89	IV	120	2851.36	II
11000	7547.072	I	250	9632.509	I	140	1967.18	IV	880	2855.68	II
2300	7672.42	I	1000	9702.439	I	120	1972.07	IV	610	2858.91	II
450	7702.828	I	250	9744.426	I	19000	2055.52	II	440	2860.93	II
7000	7717.581	I	200	9807.057	I	14000	2061.49	II	790	2862.57	II
10000	7744.97	I	400	9875.970	I	8900	2065.42	II	750	2865.11	II
2200	7769.16	I	331	10392.549	I	200	2226.72	III	610	2866.74	II
6500	7771.09	I	300	11123.05	I	200	2235.91	III	480	2867.65	II
2200	7821.36	I	269	11409.69	I	150	2237.59	III	210	2870.44	II
1700	7830.75	I	1000	11436.33	I	150	2244.10	III	110	2871.63	I
3000	7878.22	I	350	13243.8	I	150	2284.44	III	160	2873.48	II
						150	2324.88	III			

*Chromium Cr Z = 24*

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
320	2875.99	II	220	3197.08	II	110	3807.93	I	110	4374.16	I
230	2876.24	II	170	3209.18	II	180	3815.43	I	530	4384.98	I
180	2877.98	II	140	3217.40	II	180	3819.56	I	110	4458.54	I
120	2879.27	I	120	3245.54	I	130	3826.42	I	660	4496.86	I
170	2887.00	I	130	3251.84	I	130	3830.03	I	380	4526.47	I
700	2889.29	I	130	3257.82	I	380	3841.28	I	380	4530.74	I
370	2893.25	I	130	3339.80	II	190	3848.98	I	240	4535.72	I
190	2894.17	I	110	3342.59	II	140	3849.36	I	240	4540.50	I
210	2896.75	I	170	3358.50	II	290	3850.04	I	240	4540.72	I
180	2905.49	I	160	3360.30	II	140	3852.22	I	140	4544.62	I
260	2909.05	I	430	3368.05	II	190	3854.22	I	600	4545.96	I
260	2910.90	I	140	3382.68	II	110	3855.29	I	120	4565.51	I
250	2911.14	I	170	3403.32	II	140	3855.57	I	120	4571.68	I
480	2967.64	I	360	3408.76	II	260	3857.63	I	360	4580.06	I
480	2971.11	I	210	3421.21	II	660	3883.29	I	360	4591.39	I
210	2971.91	II	270	3422.74	II	570	3885.22	I	480	4600.75	I
480	2975.48	I	140	3433.31	II	380	3886.79	I	240	4613.37	I
190	2979.74	II	270	3433.60	I	260	3894.04	I	600	4616.14	I
350	2980.79	I	160	3436.19	I	360	3902.92	I	550	4626.19	I
110	2985.32	II	140	3441.44	I	960	3908.76	I	1600	4646.17	I
480	2985.85	I	170	3445.62	I	120 hd	3911.82	I	570	4651.28	I
1500	2986.00	I	170	3447.43	I	120	3915.84	I	840	4652.16	I
2100	2986.47	I	190	3453.33	I	190	3916.24	I	240 d	4698.46	I
660	2988.65	I	130	3455.60	I	1900	3919.16	I	190	4708.04	I
160	2989.19	II	100	3460.43	I	600	3921.02	I	240	4718.43	I
480	2991.89	I	120	3550.64	I	600	3928.64	I	120	4730.71	I
230	2994.07	I	130	3566.16	I	410	3941.49	I	140	4737.35	I
300	2995.10	I	130	3573.64	I	1900	3963.69	I	340	4756.11	I
700	2996.58	I	330 h	3574.80	I	120	3969.06	I	190	4789.32	I
210	2998.79	I	19000	3578.69	I	1600	3969.75	I	120	4801.03	I
1100	3000.89	I	160 h	3584.33	I	1600	3976.66	I	110	4829.38	I
750	3005.06	I	130	3585.30	II	960	3983.91	I	140	4870.80	I
140	3013.03	I	17000	3593.49	I	190	3984.34	I	130	4887.01	I
710	3013.71	I	350	3601.67	I	160	3989.99	I	260	4922.27	I
710	3014.76	I	13000	3605.33	I	960	3991.12	I	110	4936.33	I
1400	3014.92	I	130	3632.84	I	160	3991.67	I	70	4942.50	I
710	3015.19	I	350	3636.59	I	190	3992.84	I	110	4954.81	I
2800	3017.57	I	630	3639.80	I	160	4001.44	I	60	5013.32	I
430	3018.50	I	220	3641.83	I	120	4012.47	II	70	5166.23	I
240	3018.82	I	220	3649.00	I	120	4026.17	I	70	5184.59	I
430	3020.67	I	170	3653.91	I	190	4039.10	I	70	5192.00	I
2800	3021.56	I	220	3656.26	I	160	4048.78	I	85	5196.44	I
1100	3024.35	I	130	3663.21	I	120	4058.77	I	5300	5204.52	I
170	3029.16	I	120	3685.55	I	140	4126.52	I	8400	5206.04	I
710	3030.24	I	130	3686.80	I	120	4153.82	I	11000	5208.44	I
140	3031.35	I	130	3687.25	I	140	4163.62	I	85	5224.94	I
390	3034.19	I	130	3730.81	I	170	4174.80	I	290	5247.56	I
550	3037.04	I	150	3732.03	I	170	4179.26	I	530	5264.15	I
550	3040.85	I	480	3743.58	I	110	4209.37	I	180	5265.72	I
110	3050.14	II	570	3743.88	I	20000	4254.35	I	95 h	5275.17	I
710	3053.88	I	340	3749.00	I	110	4263.14	I	70 h	5276.03	I
240	3118.65	II	230	3757.66	I	16000	4274.80	I	340	5296.69	I
430	3120.37	II	260	3768.24	I	10000	4289.72	I	70 h	5297.36	I
470	3124.94	II	130	3791.38	I	780	4337.57	I	660	5298.27	I
120	3128.70	II	130	3792.14	I	1100	4339.45	I	85	5300.75	I
590	3132.06	II	120	3793.29	I	380	4339.72	I	340 h	5328.34	I
140	3136.68	II	130	3793.88	I	1900	4344.51	I	70 h	5329.17	I
140	3147.23	II	140	3797.13	I	380	4351.05	I	780	5345.81	I
100	3155.15	I	200	3797.72	I	2300	4351.77	I	380	5348.32	I
100	3163.76	I	530	3804.80	I	570	4359.63	I	40	5400.61	I
240	3180.70	II	110	3806.83	I	530	4371.28	I	1400	5409.79	I





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1000	3455.23	I	90	4549.66	I	200	974.759	II	250	1418.426	II
5100	3462.80	I	140	4565.59	I	250	977.567	II	250	1421.759	II
5100	3465.80	I	190	4581.60	I	100	987.657	II	200	1427.829	II
8000	3474.02	I	120	4629.38	I	250	992.953	II	400	1430.243	II
1900	3483.41	I	85	4663.41	I	300	1004.055	II	250	1434.904	II
4800	3489.40	I	110	4792.86	I	300	1008.569	II	150	1436.236	II
2400	3495.69	I	100	4840.27	I	300	1008.728	II	150	1442.139	II
50	3501.72	II	150	4867.88	I	300	1010.269	II	200	1445.984	II
9600	3502.28	I	80 h	4964.18	II	250	1012.597	II	200	1449.058	II
7000	3506.32	I	50	5212.71	I	500	1018.707	II	250	1450.304	II
50	3507.77	II	50	5230.22	I	500	1027.831	II	200	1452.294	II
2900	3509.84	I	50	5247.93	I	250	1028.328	II	300	1458.002	II
1400	3510.43	I	50	5342.71	I	200	1030.263	II	250	1459.412	II
4800	3512.64	I	50	5352.05	I	600	1036.470	II	200	1463.752	II
3800	3513.48	I	<i>Copper Cu Z = 29</i>			600	1039.348	II	400	1463.838	II
4800	3518.35	I	80	685.141	II	600	1039.582	II	200	1466.070	II
1300	3520.08	I	100	709.313	II	800	1044.519	II	400	1470.697	II
2700	3521.57	I	100	718.179	II	800	1044.744	II	200	1472.395	II
3800	3523.43	I	150	724.489	II	500	1049.755	II	250	1473.978	II
60	3523.51	II	200	735.520	II	600	1054.690	II	200	1474.935	II
6400	3526.85	I	250	736.032	II	400	1055.797	II	150	1476.059	II
2700	3529.03	I	80	779.295	II	600	1056.955	II	300 r	1481.23	III
7300	3529.81	I	100	797.455	II	400	1058.799	II	200	1481.544	II
1900	3533.36	I	150	810.998	II	600	1059.096	II	200	1485.328	II
50	3545.03	II	200	813.883	II	600	1060.634	II	750	1488.831	II
1100	3560.89	I	300	826.996	II	600	1063.005	II	300	1492.834	II
80	3561.07	II	150	848.808	II	200	1065.782	II	250	1493.366	II
8800	3569.38	I	250	851.303	II	200	1066.134	II	250	1495.430	II
50	3574.95	II	250	858.487	II	500	1069.195	II	350	1496.687	II
1600	3574.96	I	400	861.994	II	300	1073.745	II	150	1503.368	II
60	3575.32	II	400	865.390	II	200	1088.395	II	250	1504.757	II
2500	3575.36	I	250	869.336	II	300	1094.402	II	200	1505.388	II
60	3577.96	II	150	873.263	II	250	1097.053	II	300	1508.632	II
1000	3585.16	I	200	876.723	II	150	1119.947	II	350	1510.506	II
6700	3587.19	I	250	877.012	II	200	1142.640	II	200	1512.465	II
1900	3594.87	I	200	877.555	II	300	1144.856	II	200	1513.366	II
1600	3602.08	I	500	878.699	II	100	1250.048	II	500	1514.492	II
100	3621.21	II	100	884.133	II	150	1265.506	II	200	1517.631	II
1000	3627.81	I	250	885.847	II	300	1275.572	II	500	1519.492	II
80	3643.61	II	600	886.943	II	150	1282.455	II	600	1519.837	II
60	3681.35	II	600	890.567	II	150	1287.468	II	200	1520.540	II
1100	3745.50	I	500	892.414	II	150	1298.395	II	200	1524.860	II
1400	3842.05	I	800	893.678	II	300	1308.297	II	150	1525.764	II
6900	3845.47	I	400	894.227	II	300	1314.337	II	500	1531.856	II
5500	3873.12	I	600	896.759	II	100	1320.686	II	300	1532.131	II
2800	3873.96	I	400	896.976	II	100	1326.395	II	250	1533.986	II
7900	3894.08	I	600	901.073	II	150	1350.594	II	250	1535.002	II
1500	3935.97	I	400	906.113	II	250	1351.837	II	500	1537.559	II
80 h	3963.10	II	800	914.213	II	150	1355.305	II	200	1540.239	II
6000	3995.31	I	600	922.019	II	300	1358.773	II	300	1540.389	II
970	3997.91	I	500	924.239	II	200	1359.009	II	300	1540.588	II
350	4020.90	I	400	935.232	II	200	1362.600	II	750	1541.703	II
370	4045.39	I	600	935.898	II	250	1367.951	II	400	1544.677	II
350	4066.37	I	600	943.335	II	200	1371.840	II	100	1547.958	II
830	4092.39	I	600	945.525	II	300 r	1376.79	III	300	1550.653	II
550	4110.54	I	500	945.965	II	200 r	1377.49	III	300	1551.389	II
2800	4118.77	I	200	954.383	II	100	1393.128	II	500	1552.646	II
4400	4121.32	I	250	956.290	II	100	1398.642	II	250	1553.896	II
90	4190.71	I	400	958.154	II	150	1402.777	II	400	1555.134	II
90	4469.56	I	200	960.414	II	150	1407.169	II	500	1555.703	II
690	4530.96	I	250	968.042	II	100	1414.898	II	300	1558.345	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
400	1565.924	II	900	2135.981	II	800	2769.669	II	500	4043.751	II
400	1566.415	II	400	2148.984	II	200	2791.795	II	2000	4062.64	I
100	1569.416	II	150	2161.320	II	170	2799.528	II	120	4068.106	II
300	1579.492	II	1300 r	2165.09	I	100	2810.804	II	500	4131.363	II
300	1580.626	II	250	2174.982	II	1250 r	2824.37	I	200	4143.017	II
400	1581.995	II	1600 r	2178.94	I	350	2837.368	II	300	4153.623	II
500	1583.682	II	700	2179.410	II	100	2857.748	II	500	4161.140	II
400	1590.165	II	1700 r	2181.72	I	600	2877.100	II	370	4164.284	II
600	1593.556	II	700	2189.630	II	270	2884.196	II	400	4171.851	II
500 r	1593.75	III	900	2192.268	II	2500 r	2961.16	I	500	4179.512	II
400	1598.402	II	400	2195.683	II	100	2986.335	II	500	4211.866	II
400	1602.388	II	1700 r	2199.58	I	2000	2997.36	I	320	4230.449	II
200	1604.848	II	1300 r	2199.75	I	2000	3010.84	I	200	4255.635	II
300	1605.281	II	100	2200.509	II	2500	3036.10	I	950	4275.11	I
400	1606.834	II	200	2209.806	II	2500	3063.41	I	300	4279.962	II
250	1608.639	II	750	2210.268	II	1400	3073.80	I	500	4292.470	II
150	1610.296	II	1600 r	2214.58	I	1500	3093.99	I	400	4365.370	II
200	1617.915	II	250	2215.106	II	1250	3099.93	I	100	4444.831	II
600	1621.426	II	1000 r	2215.65	I	2000	3108.60	I	400	4506.002	II
400	1622.428	II	750	2218.108	II	1400 h	3126.11	I	150	4516.049	II
250	1630.268	II	2100 r	2225.70	I	1500	3194.10	I	150	4541.032	II
100	1636.605	II	150	2226.780	II	1400	3208.23	I	500	4555.920	II
1000 r	1642.21	III	1600 r	2227.78	I	1500 h	3243.16	I	100	4596.906	II
250	1649.458	II	350	2228.868	II	10000 r	3247.54	I	120	4649.271	II
30 r	1655.32	I	2500 r	2230.08	I	10000 r	3273.96	I	2000	4651.12	I
200	1656.322	II	1100 r	2238.45	I	1400 h	3282.72	I	120	4661.363	II
200	1660.001	II	900	2242.618	II	400	3290.418	II	320	4671.702	II
300	1663.002	II	2300 r	2244.26	I	1500 h	3290.54	I	300	4673.577	II
100	1672.776	II	1000	2247.002	II	110	3300.881	II	450	4681.994	II
30	1688.09	I	1300 r	2260.53	I	250	3301.229	II	100	4758.433	II
30	1691.08	I	2200 r	2263.08	I	2500 h	3307.95	I	400	4812.948	II
30 r	1703.84	I	150	2263.786	II	200	3316.276	II	120	4851.262	II
50 r	1713.36	I	200	2276.258	II	1500	3337.84	I	300	4854.988	II
150	1717.721	II	100	2286.645	II	150	3338.648	II	100	4873.304	II
50 r	1725.66	I	2500 r	2293.84	I	200	3365.648	II	150	4901.427	II
100	1736.551	II	170	2294.368	II	450	3370.454	II	1000	4909.734	II
50 r	1741.57	I	1000	2303.12	I	300	3374.952	II	500	4918.376	II
150	1753.281	II	150	2369.890	II	200	3380.712	II	200	4926.424	II
200 r	1774.82	I	2500 r	2392.63	I	100	3384.945	II	900	4931.698	II
100 r	1825.35	I	120	2403.337	II	1250 h	3483.76	I	120	4943.026	II
250	1929.751	II	1500	2406.66	I	1250	3524.23	I	700	4953.724	II
250	1944.597	II	1000 r	2441.64	I	2000	3530.38	I	500	4985.506	II
100	1946.493	II	100	2485.792	II	1400	3599.13	I	400	5006.801	II
200	1957.518	II	2000 r	2492.15	I	1400	3602.03	I	350	5009.851	II
150	1970.495	II	150	2506.273	II	1000	3686.555	II	400	5012.620	II
150	1977.027	II	120	2526.593	II	150	3786.270	II	350	5021.279	II
500	1979.956	II	300	2544.805	II	170	3797.849	II	200	5039.016	II
300	1989.855	II	100	2571.756	II	100	3818.879	II	300	5047.348	II
250	1999.698	II	150	2590.529	II	140	3826.921	II	900	5051.793	II
270	2035.854	II	200	2600.270	II	160	3864.137	II	400	5058.910	II
250	2037.127	II	2500 r	2618.37	I	280	3884.131	II	500	5065.459	II
350	2043.802	II	200	2666.291	II	150	3892.924	II	450	5067.094	II
300	2054.980	II	750	2689.300	II	170	3903.177	II	350	5072.302	II
100	2078.663	II	700	2700.962	II	140	3920.654	II	450	5088.277	II
110	2098.398	II	650	2703.184	II	120	3933.268	II	420	5093.816	II
320	2104.797	II	700	2713.508	II	120	3987.024	II	350	5100.067	II
300	2112.100	II	650	2718.778	II	150	3993.302	II	1500	5105.54	I
320	2117.310	II	300	2721.677	II	140	4003.476	II	250	5124.476	II
350	2122.980	II	120	2737.342	II	1250	4022.63	I	2000	5153.24	I
350	2126.044	II	270	2745.271	II	100	4032.647	II	100	5158.093	II
420	2134.341	II	2500 r	2766.37	I	600	4043.484	II	100	5183.367	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
2500	5218.20	I	270	6879.404	II	1200	3156.52	II	830	3577.98	II
100	5269.991	II	220	6937.553	II	670	3162.83	II	440	3580.04	II
100	5276.525	II	150	6952.871	II	1000	3169.99	II	3300	3585.06	II
1650	5292.52	I	150	6977.572	II	470	3215.19	II	1400	3585.78	II
100	5368.383	II	200	7022.860	II	830	3216.63	II	560	3586.11	II
1500	5700.24	I	300	7194.896	II	490	3235.89	II	1100	3591.41	II
1500	5782.13	I	400	7326.008	II	490	3245.12	II	560	3591.81	II
150	5805.989	II	300	7331.694	II	1200	3251.27	II	560	3592.11	II
100	5833.515	II	250	7382.277	II	890	3280.09	II	1800	3595.04	II
200	5897.971	II	1000	7404.354	II	490	3282.77	II	560	3600.38	II
120	5937.577	II	270	7434.156	II	1100	3308.88	II	1800	3606.12	II
400	5941.196	II	500	7562.015	II	780	3316.32	II	440	3618.51	II
100	5993.260	II	700	7652.333	II	1000	3319.88	II	560	3620.16	II
650	6000.120	II	1000	7664.648	II	780	3341.00	II	470	3624.27	II
100	6023.264	II	150	7681.788	II	510	3353.58	II	1100	3629.42	II
250	6072.218	II	450	7744.097	II	510	3368.11	II	4000	3630.24	II
150	6080.343	II	800	7778.738	II	5300	3385.02	II	440	3632.78	II
150	6099.990	II	750	7805.184	II	610	3388.85	II	1100	3640.25	II
160	6107.412	II	1500	7807.659	II	3800	3393.57	II	11000	3645.40	II
300	6114.493	II	1000	7825.654	II	1300	3396.16	II	1000	3648.78	II
600	6150.384	II	350	7860.577	II	5300	3407.80	II	700	3664.62	II
750	6154.222	II	300	7890.567	II	1300	3413.78	II	990	3672.30	II
500	6172.037	II	700	7902.553	II	530	3414.82	II	420	3672.70	II
550	6186.884	II	1500	7933.13	I	780	3419.63	II	1400	3674.08	II
400	6188.676	II	400	7944.438	II	530	3425.06	II	2200	3676.59	II
300	6198.092	II	400	7972.033	II	1900	3434.37	II	640	3678.51	I
470	6204.261	II	1200	7988.163	II	560	3440.93	II	820	3684.85	I
450	6208.457	II	2000	8092.63	I	1300	3441.45	II	1300	3685.78	I
750	6216.939	II	500	8277.560	II	3800	3445.57	II	4700	3694.81	II
700	6219.844	II	800	8283.160	II	830	3446.99	II	990	3698.21	II
500	6261.848	II	250	8503.396	II	2700	3454.32	II	540	3701.63	II
1000	6273.349	II	750	8511.061	II	1300	3456.56	II	440	3707.57	II
350	6288.696	II	200	8609.134	II	4400	3460.97	II	440	3708.22	II
900	6301.009	II	500	9813.213	II	720	3468.43	II	420	3710.07	II
550	6305.972	II	250	9827.978	II	560	3471.14	II	1600	3724.45	II
400	6312.492	II	200	9830.798	II	560 d	3471.53	II	930	3739.34	I
120	6326.466	II	600	9861.280	II	1300	3477.07	II	1200	3747.82	II
400	6373.268	II	600	9864.137	II	4400	3494.49	II	1400	3753.51	II
750	6377.840	II	200	9883.969	II	560	3496.34	II	1400	3753.75	II
400	6403.384	II	550	9916.419	II	830	3498.71	II	1200	3757.05	I
850	6423.884	II	500	9917.954	II	830	3504.53	II	4700	3757.37	II
200	6442.965	II	550	9925.594	II	830	3505.45	II	640	3767.63	I
750	6448.559	II	450	9938.998	II	1300	3506.81	II	640	3773.05	I
170	6466.246	II	500	9960.354	II	560	3517.26	II	420	3781.47	I
950	6470.168	II	450	10006.588	II	4400	3523.98	II	3300	3786.18	II
750	6481.437	II	550	10022.969	II	22000	3531.70	II	1600	3788.44	II
400	6484.421	II	550	10038.093	II	4400	3534.96	II	700	3791.87	II
220	6517.317	II	650	10054.938	II	5500	3536.02	II	510	3804.14	II
400	6530.083	II	450	10080.354	II	4400	3538.52	II	580	3806.27	II
120	6551.286	II				1700	3542.33	II	470	3812.27	I
200	6577.080	II	<i>Dysprosium Dy Z = 66</i>			1400	3546.83	II	470	3813.67	II
750	6624.292	II	260	2356.91	II	4400	3550.22	II	1400	3816.76	II
800	6641.396	II	240	2410.01	II	2200	3551.62	II	700	3825.68	II
450	6660.962	II	260	2439.84	II	440 h	3558.23	II	2300	3836.50	II
100	6770.362	II	220	2585.30	I	440	3559.30	II	1400	3841.31	II
300	6806.216	II	440	2634.80	II	2200	3563.15	II	420	3846.34	II
400	6809.647	II	220	2755.75	II	560	3563.69	II	420	3847.02	I
320	6823.202	II	300	2816.39	II	780	3573.83	II	1200	3853.03	II
250	6844.157	II	390	2913.95	II	1400	3574.15	II	420	3858.40	I
320	6868.791	II	610	3038.28	II	4400	3576.24	II	560	3868.45	II
270	6872.231	II	830	3135.38	II	1700	3576.87	II	1600	3868.81	I
			500	3141.14	II						







Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
<i>Gadolinium Gd Z = 64</i>			2000	3684.13	I	700	4694.33	I	50	6752.67	II
1200	1007.24	IV	3100	3687.74	II	410	4743.65	I	26	6786.33	II
1200	1063.84	IV	2000	3697.73	II	470	4767.24	I	100	6828.25	I
1600	1476.98	IV	1300	3699.73	II	300	4784.62	I	100	6916.57	I
1500	1705.03	IV	2700	3712.70	II	320	4821.69	I	50	6985.89	II
1600	1706.01	IV	2000	3713.57	I	280	4934.12	I	75	6991.92	I
2000	1736.24	IV	1400	3716.36	II	750	5015.04	I	60	6996.76	II
1500	1815.32	IV	2000	3717.48	I	75	5039.09	I	45	7006.16	II
2200	1975.24	III	1800 d	3719.45	II	5000	5091.70	III	35	7122.57	I
3400	2018.07	III	1500	3730.84	II	130	5098.38	II	170	7168.37	I
2800	2359.31	III	4500	3743.47	II	910	5103.45	I	28	7189.57	II
1400	2397.87	IV	1400	3758.31	II	180	5108.91	II	28	7262.66	I
2800	2697.39	III	8700	3768.39	II	120	5125.56	II	35	7441.85	I
2800	2703.28	III	1400	3770.69	II	860	5155.84	I	40	7464.36	I
2700	2727.89	III	2900	3783.05	I	190	5176.28	II	55	7562.97	I
9000	2904.73	III	5100	3796.37	II	410	5197.77	I	80	7733.50	I
9500	2955.53	III	3700	3813.97	II	280	5219.40	I	35	7846.35	II
1200	2999.04	II	3300	3850.69	II	130	5233.93	I	35	7856.93	I
2100	3010.13	II	5100	3850.97	II	320	5251.18	I	25	7930.25	II
1900	3027.60	II	4300	3852.45	II	120	5252.14	II	18	8146.15	I
2100	3032.84	II	1600	3866.99	I	140	5255.80	I	21	8668.63	I
1600	3034.05	II	1500	3894.70	II	280	5283.08	I	21 h	8832.06	II
2100	3081.99	II	2200	3916.51	II	280	5301.67	I	14 h	8849.14	I
3500	3100.50	II	1200	3934.79	I	220	5302.76	I	18 h	8867.31	I
930	3145.00	II	1400	3945.54	I	280	5307.30	I	5000	14332.88	III
980	3156.53	II	1200	3957.67	II	130	5321.50	I	<i>Gallium Ga Z = 31</i>		
980	3161.37	II	1100	4023.14	I	280	5321.78	I	14	294.53	IV
4000	3176.66	III	1100	4028.15	I	110	5327.32	I	61	295.67	IV
1400	3331.38	II	1400	4037.33	II	170	5333.30	I	30	298.44	V
1100	3336.18	II	1600	4045.01	I	300	5343.00	I	30	300.01	V
5400	3350.47	II	1300	4049.43	II	200	5348.67	I	30	302.86	V
4300	3358.62	II	2200	4049.86	II	300	5350.38	I	41	304.99	IV
5400	3362.23	II	2600	4053.64	I	240	5353.26	I	30	307.03	V
1100	3392.53	II	2600	4058.22	I	3000	5365.96	III	30	308.26	V
1100 d	3407.56	II	1900	4063.39	II	150	5370.63	I	30	311.79	V
6900	3422.47	II	1300	4078.44	II	4000	5553.30	III	30	313.68	V
1700	3439.21	II	2800	4078.70	I	3000	5587.88	III	30	319.41	V
2700	3439.99	II	1500	4085.56	II	190	5617.91	I	40	322.31	V
1400	3450.38	II	1100	4092.71	I	110	5632.25	I	40	322.99	V
1100	3451.23	II	2600	4098.61	II	260	5643.24	I	50	322.99	V
2700	3463.98	II	2200	4130.37	II	3000	5658.98	III	30	323.10	V
1700	3467.27	II	1100	4132.28	II	390	5696.22	I	40	324.25	V
1700	3468.99	II	2400	4175.54	I	120	5733.86	II	40	324.95	V
1400	3473.22	II	2400	4184.25	II	240	5791.38	I	40	326.14	V
2200	3481.28	II	2200	4190.78	I	220	5851.63	I	30	326.77	V
1700	3481.80	II	1300	4212.00	II	280	5856.22	I	30	328.65	V
1700	3494.40	II	4800	4225.85	I	110	5904.56	I	25	423.18	IV
1400	3505.51	II	1700	4251.73	II	170	5911.45	II	16	439.92	IV
1100	3512.50	II	1600	4262.09	I	85	5930.29	I	50	620.00	III
4300	3545.80	II	1100	4306.34	I	85	5936.84	I	40	622.01	III
3900	3549.36	II	1800	4313.84	I	65	5937.71	I	90	806.51	III
1400	3557.05	II	2600 d	4325.57	II	110 h	5988.02	I	90	817.30	III
5400	3584.96	II	1900	4327.12	I	430	6114.07	I	50	828.70	III
1100	3592.71	II	1000	4344.30	II	75	6305.15	II	20	878.17	V
1100	3604.87	I	2200	4346.46	I	40	6331.35	I	40	973.21	V
6100	3646.19	II	1400	4401.86	I	40	6380.95	II	40	989.75	V
3900	3654.62	II	1400	4422.41	I	40 h	6538.15	I	90	1014.47	V
3100	3656.15	II	1100	4430.63	I	55	6564.78	I	90	1019.71	V
1400	3662.26	II	1100	4519.66	I	50	6634.36	II	120	1050.48	V
2700	3664.60	II	910	4537.81	I	35	6681.23	II	80	1054.56	V
2000	3671.20	II	520	4614.50	I	85	6730.73	I	90	1058.12	V
									80	1066.69	V

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
60	1069.60	V	85	1338.09	IV	<i>Germanium Ge Z = 32</i>					
80	1073.77	V	77	1347.03	IV	700	294.51	V	100	1742.195	I
90	1078.83	V	76	1351.06	IV	1000	295.64	V	50	1746.065	I
110	1079.60	V	70	1353.92	III	200	304.98	V	200	1750.043	I
60	1080.99	V	74	1364.63	IV	20	621.52	V	100	1758.279	I
80	1085.00	III	60	1395.54	IV	50	724.21	V	100 h	1764.185	I
250	1085.01	V	77	1402.55	IV	60	746.88	V	100 h	1765.284	I
80	1087.37	V	70	1405.32	IV	60	760.05	V	50 h	1766.433	I
90	1091.71	V	73	1465.87	IV	10	862.234	II	200	1774.176	I
100	1094.36	V	90	1495.07	III	15	875.493	II	200	1785.046	I
80	1095.10	V	50	1534.46	III	15	905.977	II	100 h	1793.071	I
160	1102.83	V	10	1813.98	II	20	920.554	II	75 h	1801.432	I
140	1103.03	V	15	1845.30	II	300	971.35	V	200 h	1841.328	I
60	1105.61	III	20	2091.34	II	300	990.66	V	200 h	1842.410	I
75	1105.62	V	90	2417.70	III	50	999.101	II	100 h	1844.410	I
70	1106.17	V	90	2423.98	III	300	1004.38	V	100 h	1845.872	I
80	1118.34	V	15	2424.36	III	100	1016.638	II	100 h	1846.958	I
120	1126.40	V	10	2632.66	I	900	1045.71	V	200	1853.134	I
130	1128.10	V	10	2665.05	I	700	1072.66	V	500 r	1860.086	I
120	1128.53	V	20	2700.47	II	100	1075.072	II	100	1865.052	I
100	1129.94	V	15	2780.15	II	300	1085.51	II	300 r	1874.256	I
130	1136.07	V	50	3521.77	III	40	1088.45	III	100	1895.197	I
67	1137.06	IV	80	3581.19	III	800	1089.49	V	500 r	1904.702	I
130	1150.23	V	100	3589.34	III	200	1098.71	II	50 h	1908.434	I
90	1150.27	III	10	3731.10	III	500	1106.74	II	30	1912.409	I
70	1156.10	IV	10	3806.60	III	1000	1116.94	V	300 r	1917.592	I
120	1156.51	V	10	4032.99	I	500	1120.46	II	100 h	1923.467	I
35	1157.74	V	10	4172.04	I	700	1163.39	V	500 r	1929.826	I
70	1163.60	IV	15	4251.16	II	200	1164.27	V	10 h	1934.048	I
25	1169.40	V	10 h	4254.04	II	500	1181.19	II	100 r	1937.483	I
75	1170.58	IV	10	4255.77	II	500	1181.65	II	500	1938.008	II
48	1171.71	IV	40	4262.00	II	200	1188.73	II	100 r	1938.300	I
40	1178.95	V	100	4380.69	III	20	1188.99	IV	500	1938.891	II
68	1185.23	IV	150	4381.76	III	300	1191.26	II	30 s	1944.116	I
40	1186.06	IV	100	4863.00	III	700	1222.30	V	200	1944.731	I
73	1190.89	IV	150	4993.78	III	20	1229.81	IV	200	1955.115	I
73	1193.02	IV	10	5808.28	III	500	1237.059	II	500	1962.013	I
75	1195.02	IV	20	5848.25	III	500	1261.905	II	30 h	1963.373	I
69	1201.54	IV	15	5993.51	III	100	1264.710	II	30	1965.383	I
72	1206.89	IV	10	6334.2	II	200	1401.24	II	200	1970.880	I
80	1213.17	V	2000	6396.56	I	200	1538.091	II	200	1979.274	II
63	1216.15	IV	1000	6413.44	I	500	1576.855	II	300 h	1987.849	I
50	1228.03	IV	10 h	7251.4	I	75	1581.070	II	300	1988.267	I
60	1236.38	IV	20 h	7403.0	I	100	1602.486	II	500 r	1998.887	I
60	1238.59	IV	30 h	7464.0	I	3 r	1615.57	I	200	2011.29	I
75	1245.53	IV	10 h	7620.5	I	2 r	1624.130	I	1700	2019.068	I
83	1258.77	IV	50 h	7734.77	I	2 r	1630.173	I	2400 r	2041.712	I
81	1264.66	IV	100 h	7800.01	I	3 r	1636.31	I	1600 r	2043.770	I
82	1267.15	IV	15 h	8002.55	I	4 r	1639.730	I	420	2054.461	I
90	1267.16	III	20 h	8074.25	I	2	1647.531	I	220 h	2057.238	I
81	1279.24	IV	100 h	8311.86	I	200	1649.194	II	750 r	2065.215	I
15	1283.64	V	200 h	8386.49	I	2	1651.528	I	2600 r	2068.656	I
80	1285.33	IV	200 h	9492.92	I	4 r	1651.955	I	420	2086.021	I
80	1293.46	III	200 h	9493.12	I	3	1661.345	I	2000 r	2094.258	I
60	1295.36	III	300 h	9589.36	I	4 r	1663.539	I	25	2104.45	III
82	1295.86	IV	100 h	10905.95	I	10 h	1665.275	I	240	2105.824	I
83	1299.46	IV	400	11949.12	I	4	1667.802	I	95 h	2124.744	I
82	1303.53	IV	200	12109.78	I	3 r	1670.608	I	50 h	2186.451	I
80	1309.68	IV	60	14996.64	I	100 r	1691.090	I	340 r	2198.714	I
80	1314.82	IV	60	22016.81	I	200 r	1716.784	I	15	2220.375	I
60	1323.15	III	70	22568.71	I	100 h	1739.102	I	18	2256.001	I
									18	2314.201	I



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
24	2327.918	I	1000	5893.389	II	60	1368.62	I	100	1624.34	I
15	2359.233	I	500	6021.041	II	70	1374.82	I	300 d	1629.13	III
20	2379.144	I	75	6283.452	II	50	1375.76	I	250	1638.88	III
10	2389.472	I	100	6336.377	II	180	1377.73	III	50	1639.90	I
15	2397.885	I	100	6484.181	II	150	1378.69	III	100	1644.17	III
130	2417.367	I	6	6557.488	I	150	1379.98	III	150	1646.67	I
30	2436.412	I	50	7049.369	II	125	1380.53	III	250	1652.74	III
30	2488.25	IV	30	7145.390	II	200	1381.36	III	250	1664.77	III
90	2497.962	I	5	7353.334	I	80	1382.75	I	100	1665.76	I
500	2500.54	II	7	7384.208	I	50	1385.33	I	100	1668.11	III
70	2533.230	I	10	7833.575	I	300	1385.79	III	125	1673.93	III
20	2542.44	IV	10	8031.039	I	100	1389.41	III	1000	1693.94	III
3	2556.298	I	6	8044.165	I	180	1391.46	III	150	1697.09	III
28	2589.188	I	10	8256.013	I	60	1392.27	I	200	1698.98	III
500	2592.534	I	10	8482.21	I	180	1396.00	III	200	1699.34	I
8	2644.184	I	9	8700.60	I	50	1402.12	I	200	1700.00	III
1200	2651.172	I	5	9068.785	I	100	1402.91	III	200	1702.25	III
500	2651.568	I	5	9095.957	I	70	1407.38	I	100	1707.53	III
500	2691.341	I	6	9398.868	I	100	1408.45	I	250	1710.16	III
850	2709.624	I	20	9474.993	II	225	1409.50	III	200	1715.69	III
400	2729.78	II	20	9475.645	II	250	1413.80	III	100	1716.71	III
40	2740.426	I	4	9492.559	I	100	1414.27	III	300	1717.83	III
650	2754.588	I	7	9625.664	I	100	1417.09	III	500	1727.31	III
70	2793.925	I	5	10039.436	I	125	1417.39	III	100 d	1733.17	III
80	2829.008	I	4	10200.952	I	150	1427.42	III	300	1738.48	III
1000	2831.843	II	10	10382.427	I	300	1428.93	III	150	1744.39	III
1000	2845.527	II	10	10404.913	I	80	1429.19	I	500	1746.10	III
750	3039.067	I	8	10734.068	I	250	1430.06	III	500	1756.92	III
600	3067.021	I	8	10947.416	I	275	1433.37	III	500	1761.95	III
20	3124.816	I	10	11125.130	I	50	1435.79	I	300	1767.42	III
35	3211.86	III	230	11252.83	I	250	1435.81	III	100	1774.42	III
40	3255.05	III	600	11714.76	I	300	1439.12	III	800	1775.17	III
110	3269.489	I	1300	12069.20	I	200	1441.21	III	200	1776.40	III
40	3434.03	III	1050	12391.58	I	150	1446.37	III	100	1780.57	III
300	3499.21	II	235	13107.61	I	250	1448.42	III	60	1783.22	II
60	3554.19	IV	470	14822.38	I	250	1454.95	III	300	1786.11	III
50	3676.65	IV	150	16759.79	I	100	1464.72	III	150	1792.65	III
200	4178.96	III	135	17214.34	I	150	1471.28	III	500	1793.76	III
70	4226.562	I	70	18811.86	I	100	1474.73	III	200	1801.98	III
200	4260.85	III	62	19279.24	I	150	1481.10	III	400	1805.24	III
150	4291.71	III	28	20673.64	I	100	1481.76	I	100	1809.81	III
10	4685.829	I				300	1487.15	III	400	1821.17	III
1000	4741.806	II				250	1487.91	III	400	1844.89	III
1000	4814.608	II				200	1489.47	III	150	1848.83	III
50	4824.097	II				250	1500.37	III	500	1861.80	III
100	5131.752	II				200	1502.47	III	150	1871.92	III
200	5178.648	II				200	1503.74	III	100	1879.83	I
3	5194.583	I				100	1542.00	III	150	1918.28	III
6	5265.892	I				100	1548.50	III	100	1932.04	III
6	5513.263	I				100 h	1239.96	III	100	1935.42	III
8	5564.741	I				100	1278.51	III	100	1948.79	III
8	5607.010	I				100	1314.84	III	200	1958.47	III
6	5616.135	I				100 h	1328.37	I	100	1958.47	III
7	5621.426	I				200	1336.72	III	400	1989.63	III
6	5664.226	I				180	1341.68	III	150	1996.85	III
5	5664.842	I				100	1348.89	III	11000	2012.00	I
9	5691.954	I				150	1350.32	III	2600	2021.38	I
6	5701.776	I				150	1355.61	III	150	2082.09	II
5	5717.877	I				150	1356.13	III	300	2083.09	III
6	5801.029	I				50	1363.98	I	60	2110.68	II
9	5802.093	I				500	1365.40	III	100	2159.08	III
						200	1367.17	III	80	2167.33	III

*Gold Au Z = 79*

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
200	2172.20	III	100	3927.69	I	370	1437.27	V	200	2537.33	II
100	2184.11	III	400	4040.93	I	500	1437.73	V	320	2551.40	II
500	2188.97	III	700	4065.07	I	370	1445.40	V	400 h	2560.74	III
70	2248.56	II	100	4084.10	I	270	1457.91	V	250	2563.61	II
80	2263.62	II	100	4241.80	I	100	1717.21	IV	300 h	2567.46	III
300	2322.27	III	200	4315.11	I	270	1719.32	V	890	2571.67	II
180	2352.65	I	120 h	4437.27	I	550	1729.08	V	320	2573.90	II
100	2382.40	III	250	4488.25	I	750	1731.83	V	320	2576.82	II
120	2387.75	I	900 h	4607.51	I	750	1733.96	V	300	2578.14	II
150	2402.71	III	100 h	4620.56	I	440	1741.74	V	320	2582.54	II
150	2405.12	III	500	4792.58	I	1000	1749.11	V	390	2606.37	II
2600	2427.95	I	100	4811.60	I	1000	1750.19	V	450	2607.03	II
60	2533.52	II	100	5147.44	I	500	1760.89	V	230	2613.60	II
250	2641.48	I	300	5230.26	I	370	1765.62	V	450	2622.74	II
3400	2675.95	I	100 h	5261.76	I	270	1774.02	V	160	2637.00	I
1100	2748.25	I	100	5655.77	I	6200	2012.78	II	1100	2638.71	II
100	2780.82	I	100 h	5721.36	I	8500	2028.18	II	1100	2641.41	II
1000	2802.04	II	300	5837.37	I	300	2070.94	III	160	2642.75	I
300	2819.79	II	100 h	5862.93	I	1200	2096.18	II	670	2647.29	II
100	2822.55	II	300 h	5956.96	I	200 h	2099.30	III	160	2657.84	II
100 h	2825.44	II	600	6278.17	I	200 h	2110.31	III	210	2661.88	II
300	2837.85	II	100	6562.68	I	200	2155.66	III	290	2683.35	II
100	2846.92	II	600	7510.73	I	200	2183.50	III	200	2687.22	III
100	2856.74	II	10	8145.06	I	200	2195.44	III	670	2705.61	I
300	2883.45	I	10	9254.28	I	540	2210.82	II	210	2712.42	II
300	2891.96	I				200	2234.59	III	250	2718.59	I
100	2893.25	II	<i>Hafnium Hf Z = 72</i>			320	2254.01	II	710	2738.76	II
100	2907.04	II	220	545.41	V	160	2255.15	II	200	2743.64	I
300	2913.52	II	180	600.00	V	250	2266.83	II	360	2751.81	II
300	2918.24	II	200	618.27	IV	620	2277.16	II	500	2753.60	III
100	2954.22	II	200	644.54	IV	200 h	2313.44	III	450	2761.63	I
100 h	2990.27	II	400	647.39	IV	230	2321.14	II	160	2766.96	I
300	2994.80	II	600	665.65	IV	580	2322.47	II	170	2773.02	I
320	3029.20	I	200	673.49	IV	300	2323.25	II	980	2773.36	II
300	3065.42	I	270	867.25	V	300	2324.89	II	180	2774.02	II
100	3122.50	II	180	875.88	V	200	2332.97	II	390	2779.37	I
1600	3122.78	I	180	885.58	V	300	2336.47	III	230	2808.00	II
100	3194.72	I	180	896.14	V	200	2337.33	II	230	2813.86	II
100	3227.99	III	180	901.54	V	230	2343.32	II	170	2814.48	II
300	3230.63	I	180	919.10	V	320	2347.44	II	230	2817.68	I
300	3308.30	I	270	921.67	V	540	2351.22	II	200	2819.74	I
300	3309.64	I	245	951.62	V	250	2380.30	II	1200	2820.22	II
100	3309.86	III	180	960.12	V	250	2383.540	III	490	2822.68	II
100	3320.12	I	180	964.74	V	170	2393.18	II	180	2833.28	I
100	3355.15	I	160	971.51	V	450	2393.36	II	410	2845.83	I
100 h	3391.31	I	160	1092.76	V	670	2393.83	II	270	2849.21	II
100	3395.40	I	160	1201.76	V	540	2405.42	II	270	2850.96	I
100	3467.21	I	270	1232.03	V	370	2410.14	II	180	2851.21	II
300	3557.36	I	200	1233.59	V	320	2417.69	II	180	2860.56	I
300	3586.73	I	160	1237.42	V	390	2447.25	II	760	2861.01	II
100	3611.57	I	160	1239.53	V	450	2460.49	II	760	2861.70	II
100 h	3631.31	I	160	1244.46	V	400	2461.74	III	2100	2866.37	I
300	3637.90	I	440	1396.66	V	430	2464.19	II	210	2887.14	I
100 h	3645.02	I	270	1400.09	V	210	2469.18	II	800	2889.62	I
100	3650.74	I	160	1401.70	V	2000	2495.16	III	1800	2898.26	I
100	3709.62	I	370	1407.17	V	290	2496.99	II	1200	2904.41	I
100	3796.01	I	370	1408.38	V	580	2512.69	II	890	2904.75	I
100	3874.73	I	270	1412.28	V	580	2513.03	II	2000	2916.48	I
100 h	3892.26	I	270	1413.51	V	1000	2515.16	III	580	2918.58	I
400	3897.86	I	160	1421.96	V	890	2516.88	II	320	2919.59	II
300	3909.38	I	220	1422.53	V	340	2531.19	II	180	2924.62	I
			370	1433.43	V						



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
490	2929.63	II	670	3312.86	I	650	3793.37	II	160	5719.18	I
450	2929.90	I	180	3317.99	II	850 d	3800.38	I	95	6098.67	I
710	2937.80	II	890	3332.73	I	320	3811.78	I	95	6185.13	I
2000	2940.77	I	370	3352.06	II	1300	3820.73	I	85	6789.27	I
160	2944.71	I	230	3358.91	I	280	3830.02	I	160	6818.94	I
1200	2950.68	I	180	3360.06	I	800	3849.18	I	160	7063.83	I
1100	2954.20	I	180	3378.93	I	600	3858.31	I	570	7131.81	I
540	2958.02	I	230	3384.70	II	230	3860.91	I	650	7237.10	I
1400	2964.88	I	170	3386.21	I	200	3872.55	II	410	7240.87	I
620	2966.93	I	800	3389.83	II	160	3877.10	II	360	7624.40	I
710	2968.81	II	230	3392.81	I	380	3880.82	II	110	7740.17	I
890	2975.88	II	230	3394.59	II	200	3882.52	I	310	7845.35	I
1100	2980.81	I	230	3397.26	I	200	3889.23	I	130	7920.71	I
210	2982.72	I	230	3397.60	I	200	3889.33	I	250	7994.73	I
170	3000.10	II	2300	3399.80	II	620	3899.94	I	130	8204.58	I
800	3005.56	I	170	3400.21	I	620	3918.09	II	150	8546.48	I
1100	3012.90	II	180	3402.51	I	200	3923.90	II	160	8640.06	I
540	3016.78	I	230	3410.17	II	320	3931.38	I	40	8711.24	I
1100	3016.94	II	230	3417.34	I	410	3951.83	I	65	9004.73	I
980	3018.31	I	410	3419.18	I	160	3968.01	I	<i>Helium He Z = 2</i>		
1200	3020.53	I	200	3428.37	II	200	3973.48	I	15	231.454	II
410	3031.16	II	250	3438.24	II	180	4032.27	I	20	232.584	II
710	3050.76	I	710	3472.40	I	230	4062.84	I	30	234.347	II
1100	3057.02	I	200	3478.99	II	180	4083.35	I	50	237.331	II
850	3067.41	I	480	3479.28	II	540	4093.16	II	100	243.027	II
2100	3072.88	I	250	3495.75	II	1100	4174.34	I	300	256.317	II
170	3074.10	I	250	3497.16	I	160	4206.58	II	1000	303.780	II
250	3074.79	I	980	3497.49	I	190	4209.70	I	500	303.786	II
430	3080.84	I	1200	3505.23	II	170	4228.08	I	10	320.293	I
200	3096.76	I	980	3523.02	I	170	4232.44	II	2	505.500	I
340	3101.40	II	980	3535.54	II	170	4260.98	I	3	505.684	I
710	3109.12	II	760	3536.62	I	200	4263.39	I	4	505.912	I
710	3131.81	I	180	3548.81	I	170	4272.85	II	5	506.200	I
850	3134.72	II	540	3552.70	II	320	4294.79	I	7	506.570	I
170	3139.65	II	1300	3561.66	II	160	4330.27	I	10	507.058	I
220	3145.32	II	270	3567.36	I	180	4336.66	II	15	507.718	I
220	3148.41	I	1100	3569.04	II	250	4356.33	I	20	508.643	I
450	3156.63	I	210	3597.42	II	180	4370.97	II	25	509.998	I
270	3159.82	I	540	3599.87	I	160	4417.91	I	35	512.098	I
710	3162.61	II	800	3616.89	I	200	4438.04	I	50	515.616	I
450	3168.39	I	320	3630.87	II	250	4565.94	I	100	522.213	I
890	3172.94	I	800	3644.36	II	500 d	4598.80	I	400	537.030	I
450	3176.86	II	320	3649.10	I	230	4620.86	I	1000	584.334	I
220	3181.01	I	200	3651.84	I	210	4655.19	I	50	591.412	I
360	3193.53	II	220	3665.35	II	120	4699.01	I	5	958.70	II
670	3194.19	II	200	3672.27	I	160	4782.74	I	6	972.11	II
200	3196.93	I	480	3675.74	I	310	4800.50	I	8	992.36	II
310	3206.11	I	2200	3682.24	I	130	4859.24	I	15	1025.27	II
180	3210.98	I	280	3696.51	I	120	4975.25	I	30	1084.94	II
180	3217.30	II	240	3699.72	II	95	5018.20	I	35	1215.09	II
180	3220.61	II	340	3701.15	II	95	5047.45	I	50	1215.17	II
360	3247.66	I	1000	3717.80	I	75	5170.18	I	120	1640.34	II
220	3249.53	I	650	3719.28	II	230	5181.86	I	180	1640.47	II
890	3253.70	II	160	3729.10	I	110	5243.99	I	7	2385.40	II
270	3255.28	II	460	3733.79	I	120	5294.87	I	9	2511.20	II
180	3273.66	II	160	3737.88	II	110	5354.73	I	50	2577.6	I
200 h	3279.67	III	400	3746.80	I	110	5373.86	I	1	2723.19	I
270	3279.98	II	170	3766.92	II	75	5452.92	I	12	2733.30	II
160	3291.05	I	200	3768.25	I	230	5550.60	I	2	2763.80	I
210	3306.12	I	1400	3777.64	I	230	5552.12	I	10	2818.2	I
340	3310.27	I	1400	3785.46	I	95	5613.27	I	4	2829.08	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
10	2945.11	I	2000	10830.34	I	1600	3461.97	II	1300	4125.65	I
40	3013.7	I	9	10913.05	I	810 c	3473.91	II	4300	4127.16	I
20	3187.74	I	3	10917.10	I	5400 c	3474.26	II	1500	4136.22	I
3	3202.96	II	4	11626.4	II	6300	3484.84	II	980 cw	4152.61	II
15	3203.10	II	30	11969.12	I	2500 c	3494.76	II	8100	4163.03	I
1	3354.55	I	20	12527.52	I	810 c	3498.88	II	2500	4173.23	I
2	3447.59	I	50	12784.99	I	810	3510.73	I	540	4194.35	I
1	3587.27	I	20	12790.57	I	4100 c	3515.59	II	2000	4227.04	I
3	3613.64	I	7	12845.96	I	410 c	3519.94	II	1300 cw	4254.43	I
2	3634.23	I	10	12968.45	I	630	3540.76	II	490	4264.05	I
3	3705.00	I	2	12984.89	I	1600	3546.05	II	1300	4350.73	I
1	3732.86	I	12	15083.64	I	1100 c	3556.78	II	300	4477.64	II
10	3819.607	I	200	17002.47	I	410	3560.15	II	290	4629.10	II
1	3819.76	I	1	18555.55	I	410 c	3573.24	II	80	4701.69	II
500	3888.65	I	6	18636.8	II	630 c	3574.80	II	130	4709.84	II
20	3964.729	I	500	18685.34	I	810	3579.12	I	130 c	4717.52	I
1	4009.27	I	200	18697.23	I	410	3580.75	II	290	4742.04	II
50	4026.191	I	100	19089.38	I	410	3581.83	II	100 c	4757.01	I
5	4026.36	I	20	19543.08	I	630 c	3592.23	II	65	4782.92	I
12	4120.82	I	1000	20581.30	I	1100 cw	3598.77	II	290	4939.01	I
2	4120.99	I	80	21120.07	I	540 c	3600.95	II	250 c	4967.21	II
3	4143.76	I	10	21121.43	I	410	3618.43	I	220	4979.97	I
10	4387.929	I	20	21132.03	I	430 c	3626.69	II	90	4995.05	I
3	4437.55	I	3	30908.5	II	490	3627.25	II	130	5042.37	I
200	4471.479	I	4	40478.90	I	430 c	3631.76	II	80	5093.07	I
25	4471.68	I				430 c	3638.30	II	140	5127.81	I
6	4685.4	II	<i>Holmium Ho Z = 67</i>			1600 c	3662.29	I	130	5142.59	II
30	4685.7	II	170	2502.91	II	1400	3667.97	I	110	5143.22	II
30	4713.146	I	170	2533.80	I	720	3679.19	I	160	5149.59	II
4	4713.38	I	190	2605.86	II	670	3679.70	I	90 c	5167.88	I
20	4921.931	I	270	2750.35	II	720	3682.65	I	130 c	5182.11	I
100	5015.678	I	270	2769.89	II	580	3690.65	I	90	5190.11	II
10	5047.74	I	300	2824.20	II	410	3700.04	I	65	5251.82	I
5	5411.52	II	270 c	2831.69	II	490 c	3702.35	II	90	5301.25	I
500	5875.62	I	270	2849.10	II	430	3712.88	I	80	5330.11	I
100	5875.97	I	360	2880.26	II	450	3720.72	I	90	5359.99	I
8	6560.10	II	460	2880.98	II	1100	3731.40	I	100	5407.08	I
100	6678.15	I	570 c	2909.41	II	810	3736.35	I	70	5566.52	I
3	6867.48	I	410 c	2979.63	II	3200 cw	3748.17	II	65	5627.60	I
200	7065.19	I	410	2987.64	II	8900 c	3796.75	II	140	5659.58	I
30	7065.71	I	480 c	3049.38	II	8900 c	3810.73	II	140 c	5691.47	I
50	7281.35	I	410 c	3054.00	II	410 c	3835.35	II	140 c	5696.57	I
1	7816.15	I	500 c	3057.45	II	1300 cw	3837.51	II	140 c	5860.28	I
2	8361.69	I	500 c	3082.34	II	410 c	3842.05	II	70 c	5882.99	I
2	9063.27	I	910	3084.36	II	1100	3843.86	II	70	5921.76	I
2	9210.34	I	430 c	3086.54	II	490 c	3846.73	II	70 cw	5948.03	I
10	9463.61	I	760	3118.50	II	1800 c	3854.07	II	70	5972.76	I
4	9516.60	I	580 c	3166.62	II	2700 c	3861.68	II	90	5973.52	I
3	9526.17	I	810	3173.78	II	3000 c	3888.96	II	230 c	5982.90	I
1	9529.27	I	810 c	3181.50	II	13000 c	3891.02	II	120	6081.79	I
1	9603.42	I	980 c	3281.97	II	1300 cw	3905.68	II	70	6208.65	I
3	9702.60	I	630 c	3337.23	II	580	3955.73	I	70 c	6305.36	I
6	10027.73	I	980 c	3343.58	II	490	3959.68	I	70	6550.97	I
2	10031.16	I	8100 c	3398.98	II	2700	4040.81	I	260	6604.94	I
15	10123.6	II	810 c	3410.26	II	5400 c	4045.44	II	120	6628.99	I
1	10138.50	I	1400 c	3414.90	II	8100	4053.93	I	55 cw	6694.32	I
10	10311.23	I	5400	3416.46	II	1700	4065.09	II	55 c	6785.43	I
2	10311.54	I	1200	3421.63	II	720	4068.05	I	40 cw	6939.49	I
3	10667.65	I	2000 c	3425.34	II	8900	4103.84	I	45 cw	6950.39	I
300	10829.09	I	2000 c	3428.13	II	2900	4108.62	I	140	7555.09	I
1000	10830.25	I	3200	3453.14	II	1500	4120.20	I	40 c	7628.42	I
			16000 c	3456.00	II						

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
50 c	7693.15	I	82	1096.81	IV	80	2865.68	II	380 c	4638.16	II
60 cw	7815.48	I	84	1097.18	IV	120 d	2890.18	II	220 c	4644.58	II
60	7894.64	I	85	1116.10	IV	1100	2932.63	I	360 c	4655.62	II
50	8512.94	I	80	1124.06	IV	100	2941.05	II	320 w	4656.74	II
40	8670.19	I	90	1131.46	IV	100	2982.80	III	190 c	4681.11	II
90	8915.98	II	85	1144.43	IV	110 c	2999.40	II	450 w	4684.8	II
<i>Hydrogen H Z = 1</i>			80	1145.41	IV	100	3008.08	III	90 d	4907.06	II
15	926.226	I	89	1146.62	IV	8000	3039.36	I	150 c	4973.77	II
20	930.748	I	83	1154.11	IV	110 d	3099.80	II	80 h	5109.36	II
30	937.803	I	84	1154.60	IV	180 c	3101.8	II	100 w	5115.14	II
50	949.743	I	90	1157.71	IV	130 c	3138.60	II	140 c	5117.40	II
100	972.537	I	90	1157.82	IV	80 c	3142.75	II	270 c	5120.80	II
300	1025.722	I	85	1159.78	IV	130 d	3146.70	II	200 w	5121.75	II
1000	1215.668	I	88	1176.50	IV	150	3155.77	II	80 d	5129.85	II
500	1215.674	I	85	1191.58	IV	100 c	3158.40	II	240 c	5175.42	II
5	3835.384	I	83	1204.87	IV	90 c	3176.30	II	140 c	5184.44	II
6	3889.049	I	90	1206.55	IV	90 d	3198.11	II	200	5248.77	III
8	3970.072	I	88	1221.50	IV	13000	3256.09	I	150 c	5309.45	II
15	4101.74	I	85	1221.90	IV	3000	3258.56	I	80	5411.41	II
30	4340.47	I	85	1233.58	IV	90 c	3338.50	II	140 c	5418.45	II
80	4861.33	I	87	1235.84	IV	100 c	3404.28	II	220 w	5436.70	II
120	6562.72	I	90	1373.20	IV	110 d	3438.40	II	130 c	5497.50	II
180	6562.852	I	88	1398.77	IV	180 c	3693.91	II	140 c	5507.08	II
5	9545.97	I	81	1412.09	IV	95 c	3708.13	II	320 c	5513.00	II
7	10049.4	I	100	1625.42	III	380 w	3716.14	II	250 w	5523.28	II
12	10938.1	I	100	1748.83	III	120 c	3718.30	II	130 c	5536.50	II
20	12818.1	I	30	1842.41	III	160 c	3718.72	II	190 w	5555.45	II
40	18751.0	I	40	1850.30	III	160 c	3723.40	II	240 c	5576.90	II
5	21655.3	I	30	2154.08	III	170 w	3795.21	II	200 w	5636.70	II
8	26251.5	I	50	2205.28	II	230 c	3799.21	II	100	5645.15	III
15	40511.6	I	40	2281.64	II	250 c	3834.65	II	160 c	5708.50	II
4	46525.1	I	100 c	2306.05	II	200 c	3842.18	II	100 c	5721.80	II
6	74578.	I	90 d	2313.21	II	100	3852.82	III	100	5819.50	III
<i>Indium In Z = 49</i>			70 d	2327.95	II	100	3889.78	II	210 c	5853.15	II
17	378.61	V	80 h	2334.57	II	100 c	3902.07	II	490 w	5903.4	II
17	386.21	V	110 d	2382.63	II	250 w	3962.35	II	260 w	5915.4	II
14	388.91	V	70 h	2427.20	II	120 c	4004.66	II	120 c	5918.78	II
25	393.89	V	100	2447.90	II	140 d	4013.92	II	130 c	6062.9	II
25	400.57	V	110 d	2488.62	II	100	4023.77	III	250 c	6095.95	II
25	402.39	V	90	2488.95	II	150	4032.32	III	210 c	6108.66	II
622	472.71	IV	80	2498.59	II	410 w	4056.94	II	180 w	6115.9	II
689	479.39	IV	100	2499.60	II	100	4071.57	III	230 w	6128.7	II
709	498.62	IV	90 d	2500.99	II	100	4072.93	III	240 w	6129.4	II
10	882.24	III	110 d	2512.31	II	17000	4101.76	I	320 w	6132.1	II
10	890.84	III	100	2521.37	I	140 c	4205.14	II	150 c	6140.0	II
10	915.87	III	100	2527.41	III	100 d	4213.04	II	90	6143.23	II
85	954.67	IV	160 d	2554.44	II	110 d	4219.66	II	140 c	6148.10	II
87	973.50	IV	1100	2560.15	I	100	4252.68	III	190 w	6149.5	II
86	991.60	IV	200	2601.76	I	150 d	4372.87	II	80	6161.15	II
89	1024.68	IV	90 d	2654.70	II	150 c	4500.78	II	180 w	6162.45	II
85	1024.79	IV	100 d	2662.63	II	18000	4511.31	I	200	6197.72	III
88	1031.45	IV	140 d	2668.65	II	110 c	4549.01	II	100 c	6224.28	II
82	1031.98	IV	140 d	2674.56	II	140 c	4570.85	II	280 w	6228.3	II
80	1054.43	IV	80	2683.12	II	180 w	4578.02	II	140 w	6231.1	II
84	1063.03	IV	1600	2710.26	I	180 w	4578.40	II	270 w	6304.8	II
83	1068.25	IV	300	2713.94	I	140 c	4616.08	II	290 w	6362.3	II
82	1069.82	IV	80	2726.15	III	170 c	4617.17	II	300 w	6469.0	II
86	1077.64	IV	130 d	2749.75	II	250 c	4620.14	II	210 c	6541.20	II
90	1082.10	IV	700	2753.88	I	150 w	4620.70	II	190 c	6751.88	II
83	1086.33	IV	90 d	2818.97	II	170 c	4627.30	II	180 c	6765.9	II
			180 c	2836.92	I	140 c	4637.04	II	100 c	6783.72	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
10	34295.73	I	540	2333.30	I	230	2572.70	I	330	3039.26	I
9	34513.11	I	740	2333.84	I	740	2577.26	I	300	3047.16	I
3	40228.54	I	580	2334.50	I	740	2592.06	I	300	3049.44	I
2	41633.80	I	1600	2343.18	I	740	2599.04	I	300	3057.28	I
<i>Iridium Ir Z = 77</i>											
9900	2010.65	I	740	2343.61	I	700	2608.25	I	1600	3068.89	I
8700	2022.35	I	580	2355.00	I	1800	2611.30	I	320	3083.22	I
15000	2033.57	I	230	2357.53	II	210	2614.98	I	240	3086.44	I
6200	2052.22	I	410	2358.16	I	330	2617.78	I	390	3088.04	I
5000	2060.64	I	500	2360.73	I	210	2619.88	I	510	3100.29	I
3700	2083.22	I	2500	2363.04	I	250	2625.32	I	510	3100.45	I
3100	2085.74	I	370	2368.04	II	700	2634.17	I	340	3120.76	I
17000	2088.82	I	3500	2372.77	I	250	2639.42	I	200	3121.78	I
14000	2092.63	I	290	2375.09	II	3500	2639.71	I	3400	3133.32	I
2700	2112.68	I	250	2377.28	I	210	2644.19	I	490	3168.88	I
1800	2119.54	I	250	2377.98	I	1800	2661.98	I	370	3177.58	I
2000	2125.44	I	500	2379.38	I	350	2662.63	I	370	3198.92	I
4500	2126.81	II	540	2381.62	I	2700	2664.79	I	610	3212.12	I
2000	2127.52	I	210	2383.17	I	520	2669.91	I	370	3219.51	I
4500	2127.94	I	1300	2386.89	I	520	2671.84	I	5100	3220.78	I
3700	2148.22	I	2500	2390.62	I	330	2673.61	I	300	3229.28	I
2500	2150.54	I	2700	2391.18	I	270	2692.34	I	470	3241.52	I
3500	2152.68	II	230	2407.59	I	3000	2694.23	I	200	3262.01	I
2900	2155.81	I	290	2409.37	I	330	2772.46	I	390	3266.44	I
7900	2158.05	I	290	2410.17	I	250	2775.55	I	200	3322.60	I
2100	2162.88	I	290	2410.73	I	520	2781.29	I	560	3368.48	I
5800	2169.42	II	540	2413.31	I	330	2785.22	I	660	3437.02	I
4500	2175.24	I	370	2415.86	I	540	2797.35	I	410	3448.97	I
2700	2178.17	I	620	2418.11	I	1600	2797.70	I	3200	3513.64	I
1600	2187.43	II	210	2424.89	I	380	2798.18	I	220	3515.95	I
1100	2190.38	II	370	2424.99	I	410	2800.82	I	410	3522.03	I
740	2191.64	I	290	2425.66	I	680	2823.18	I	320	3558.99	I
910	2208.09	II	540	2427.61	I	1200	2824.45	I	1200	3573.72	I
1300	2220.37	I	540	2431.24	I	820	2836.40	I	320	3594.39	I
790	2221.07	II	1300	2431.94	I	1100	2839.16	I	220	3609.77	I
2500	2242.68	II	270	2435.14	I	820	2840.22	I	660	3628.67	I
620	2245.76	II	250	2445.34	I	3800	2849.72	I	220	3636.20	I
2100	2253.38	I	250	2447.76	I	380	2875.60	I	300	3661.71	I
2100	2255.10	I	910	2452.81	I	380	2875.98	I	300	3664.62	I
1400	2255.81	I	1300	2455.61	I	270	2877.68	I	320	3674.98	I
350	2258.51	I	230	2455.87	I	820	2882.64	I	200	3687.08	I
1400	2258.86	I	210	2457.03	I	650	2897.15	I	200	3731.36	II
830	2264.61	I	210	2457.23	I	260	2901.95	I	530	3747.20	I
1100	2266.33	I	870	2467.30	I	260	2904.80	I	3100	3800.12	I
1000	2268.90	I	3300	2475.12	I	200	2907.24	I	230	3817.24	I
660	2280.00	I	210	2478.11	I	440	2916.36	I	480	3902.51	I
950	2281.02	II	2100	2481.18	I	230	2918.57	I	480	3915.38	I
660	2281.91	I	620	2493.08	I	4400	2924.79	I	400	3934.84	I
330	2284.60	I	210	2496.27	I	1200	2934.64	I	590	3976.31	I
330	2295.08	I	250	2502.63	I	880	2936.68	I	460	3992.12	I
790	2298.05	I	4100	2502.98	I	250	2938.47	I	350	4033.76	I
460	2299.53	I	210	2513.71	I	2700	2943.15	I	370	4069.92	I
910	2300.50	I	990	2533.13	I	230	2946.97	I	150	4070.68	I
2700	2304.22	I	1100	2534.46	I	200	2949.76	I	100	4092.61	I
410	2305.47	I	580	2537.22	I	1200	2951.22	I	140	4115.78	I
210	2307.27	I	580	2542.02	I	200	2974.95	I	90	4172.56	I
910	2308.93	I	7900	2543.97	I	440	2980.65	I	260	4268.10	I
460	2315.38	I	790	2546.03	I	300	2996.08	I	220	4311.50	I
410	2321.45	I	210	2551.40	I	220	3002.25	I	160	4399.47	I
410	2321.58	I	210	2555.35	I	600	3003.63	I	65	4403.78	I
210	2327.98	I	910	2564.18	I	270	3017.31	I	110	4426.27	I
			210	2569.88	I	380	3029.36	I	55	4478.48	I





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
11	1952.65	III	60	2264.389	I	80	2406.97	II	500	2493.26	II
30	1953.005	I	80	2267.085	I	300	2410.52	II	60	2494.000	I
13	1953.32	III	10	2267.42	III	200	2411.07	II	50	2494.251	I
10	1953.49	III	80	2267.469	I	150	2413.31	II	100	2495.87	I
10 w	1954.22	III	50	2270.862	I	80	2417.87	II	600	2496.533	I
60	1957.823	I	150	2272.070	I	60	2420.396	I	150	2498.90	I
11	1958.58	III	150	2276.026	I	60	2423.089	I	1000	2501.132	I
60	1960.144	I	80	2279.937	I	150	2424.14	II	50	2501.693	I
13	1960.32	III	150	2284.086	I	120	2428.36	II	80	2506.09	II
30	1961.25	I	150	2287.250	I	120	2430.08	II	500	2507.900	I
50	1962.111	I	300	2292.524	I	80	2432.26	II	50	2508.753	I
12	1963.11	II	10	2293.06	III	60	2438.182	I	1000	2510.835	I
15	1987.50	III	15	2295.86	III	150	2439.30	II	120	2511.76	II
14	1991.61	III	200	2297.787	I	150	2439.74	I	80	2512.275	I
13	1994.07	III	600	2298.169	I	100	2442.57	I	400	2512.365	I
12	1995.56	III	80	2299.220	I	250	2443.872	I	80	2516.570	I
12	1996.42	III	300	2300.142	I	100	2444.51	II	300	2517.661	I
10	2061.55	III	50	2301.684	I	50	2445.212	I	800	2518.102	I
12	2068.24	III	100	2303.424	I	100	2445.57	II	150	2519.629	I
14	2078.99	III	150	2303.581	I	60	2447.709	I	50	2522.480	I
100	2084.122	I	120	2308.999	I	100	2453.476	I	4000	2522.849	I
10	2084.35	III	150	2313.104	I	1500	2457.598	I	200	2523.66	I
12	2090.14	III	10 p	2317.70	III	150	2458.78	II	500	2524.293	I
15	2097.48	III	10	2319.22	III	80	2461.28	II	100	2525.02	I
12	2097.69	III	200	2320.358	I	100	2461.86	II	200	2525.39	II
12	2103.80	III	10 p	2321.71	III	100	2462.181	I	300	2526.29	II
10	2107.32	III	10	2326.95	III	1500	2462.647	I	2000	2527.435	I
15	2151.78	III	100	2327.40	II	50	2463.730	I	800	2529.135	I
12	2157.71	III	100	2331.31	II	800	2465.149	I	250	2529.55	II
50	2157.794	I	300	2332.80	II	60	2467.732	I	150	2529.836	I
12	2158.47	III	10 p	2336.77	III	600	2468.879	I	200	2530.687	I
10	2161.27	III	200	2338.01	II	80	2470.67	II	120	2533.63	II
40	2166.773	I	10	2338.96	III	80	2470.965	I	100	2534.42	II
12	2166.95	III	600	2343.49	II	800	2472.336	I	120	2535.49	II
12	2171.04	III	80	2343.96	II	1000	2472.895	I	400	2535.607	I
15	2174.66	III	150	2344.28	II	200	2473.16	I	200	2536.792	I
300	2178.118	I	200	2348.11	II	600	2474.814	I	200	2536.80	II
12	2180.41	III	250	2348.30	II	60	2476.657	I	100	2538.80	II
250	2186.486	I	200	2359.12	II	120	2479.480	I	100	2538.91	II
60	2186.892	I	150	2360.00	II	1200	2479.776	I	150	2538.99	II
120	2187.195	I	120	2360.29	II	100	2480.16	II	50	2539.357	I
250	2191.839	I	200	2364.83	II	80	2482.12	II	200	2540.66	II
150	2196.043	I	80	2365.76	II	100	2482.66	II	600	2540.972	I
80	2200.390	I	80	2368.59	II	10000	2483.271	I	80	2541.10	II
80	2200.724	I	80	2369.456	I	300	2483.533	I	300	2542.10	I
15	2208.41	II	80	2369.95	II	1000	2484.185	I	250	2543.92	I
10 p	2208.85	III	120	2371.430	I	50	2485.990	I	150	2544.70	I
20	2213.65	II	300	2373.624	I	800	2486.373	I	800	2545.978	I
12	2218.26	II	150	2373.74	II	100	2486.691	I	80	2546.67	II
20	2220.38	II	120	2374.518	I	100	2487.066	I	100	2548.74	II
10	2221.83	III	120	2376.43	II	120	2487.370	I	80	2549.08	II
10	2229.27	III	80	2379.27	II	4000	2488.143	I	80	2549.39	II
10	2232.43	III	120	2380.76	II	100	2488.945	I	600	2549.613	I
10	2232.69	III	150	2381.835	I	80	2489.48	II	400	2562.53	II
10	2235.91	III	1000	2382.04	II	1000	2489.750	I	200	2563.48	II
10	2238.16	III	300	2388.63	II	50	2489.913	I	150	2574.36	II
12 p	2241.54	III	200	2389.973	I	3000	2490.644	I	300	2576.691	I
50	2250.790	I	1000	2395.62	II	100	2490.71	II	100	2582.58	II
60	2251.874	I	300	2399.24	II	2000	2491.155	I	1500	2584.54	I
300	2259.511	I	800	2404.88	II	100	2491.40	II	650	2585.88	II
12	2261.59	III	250	2406.66	II	100	2493.18	II	90	2591.54	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
90	2593.73	II	80	2744.527	I	500	2999.512	I	80	3246.005	I
650	2598.37	II	300	2746.48	II	120	3000.451	I	80	3265.046	I
2000	2599.40	II	100	2749.32	II	800	3000.948	I	50	3265.617	I
300	2599.57	I	500	2749.48	II	12	3001.62	III	13	3266.88	III
60	2605.657	I	1200	2750.140	I	60	3001.655	I	50	3271.000	I
300	2606.51	II	80	2753.29	II	12 h	3007.28	III	11	3276.08	III
800	2606.827	I	150	2754.032	I	200	3007.282	I	150	3286.75	I
650	2607.09	II	100	2754.426	I	500	3008.14	I	10	3288.81	III
600	2611.87	II	800	2755.73	II	120	3009.569	I	120	3305.97	I
320	2613.82	II	250	2756.328	I	15	3013.17	III	200	3306.343	I
320	2617.62	II	100	2757.316	I	60	3017.627	I	400	3355.227	I
250	2618.018	I	120	2761.780	I	60	3018.983	I	80	3355.517	I
90	2620.41	II	150	2761.81	II	500	3020.491	I	60	3369.546	I
400	2623.53	I	150	2762.026	I	1500	3020.639	I	120	3370.783	I
200	2625.67	II	120	2762.772	I	600	3021.073	I	50	3378.678	I
150	2628.29	II	120	2763.109	I	500	3024.032	I	50	3380.110	I
250	2631.05	II	80	2766.910	I	150	3025.638	I	60	3383.978	I
250	2631.32	II	250	2767.522	I	500	3025.842	I	50	3392.304	I
100	2632.237	I	300	2772.07	I	80	3030.148	I	150	3392.651	I
300	2635.809	I	600	2778.220	I	60	3031.214	I	150	3399.333	I
50	2641.646	I	3000	2788.10	I	60	3034.484	I	80	3404.353	I
200	2643.998	I	200	2797.78	I	800	3037.389	I	500	3407.458	I
300	2666.812	I	400	2804.521	I	80	3041.637	I	250	3413.131	I
60	2666.965	I	1500	2806.98	I	800	3047.604	I	60	3424.284	I
600	2679.062	I	10 p	2813.24	III	600	3057.446	I	500	3427.119	I
500	2684.75	II	2500	2813.287	I	1000	3059.086	I	60	3428.748	I
400	2689.212	I	300	2823.276	I	250	3067.244	I	6000	3440.606	I
10 h	2695.13	III	600	2825.56	I	120	3075.719	I	2500	3440.989	I
200	2699.106	I	50	2825.687	I	120	3091.577	I	1000	3443.876	I
80	2706.012	I	120	2828.808	I	80	3098.189	I	200	3445.149	I
400	2706.582	I	1500	2832.436	I	100	3099.895	I	1200	3465.860	I
60	2708.571	I	120	2835.950	I	100	3099.968	I	2000	3475.450	I
200	2711.655	I	200	2838.119	I	60	3100.303	I	500	3476.702	I
80	2714.41	II	200	2843.631	I	100	3100.665	I	2500	3490.574	I
50	2716.257	I	1000	2843.977	I	10 p	3136.43	III	500	3497.840	I
50	2717.786	I	100	2845.594	I	10	3174.09	III	10	3501.76	III
250	2718.436	I	800	2851.797	I	80	3175.445	I	250	3513.817	I
4000	2719.027	I	50	2869.307	I	10	3175.99	III	300	3521.261	I
100	2719.420	I	50	2872.334	I	10	3178.01	III	400	3526.040	I
50	2720.197	I	80	2874.172	I	150	3184.895	I	100	3526.166	I
1500	2720.903	I	50	2894.504	I	250	3191.659	I	60	3526.237	I
400	2723.578	I	12	2904.43	III	500	3193.226	I	60	3526.381	I
150	2724.953	I	10	2907.50	III	800	3193.299	I	60	3526.467	I
50	2726.235	I	12	2907.70	III	200	3196.928	I	100	3533.199	I
80	2727.54	II	120	2912.157	I	80	3199.500	I	200	3536.556	I
200	2728.020	I	120	2929.007	I	50	3205.398	I	300	3541.083	I
50	2728.820	I	1200	2936.903	I	100	3211.88	I	250	3542.075	I
80	2728.90	II	60	2941.343	I	200	3214.011	I	80	3553.739	I
1000	2733.581	I	1000	2947.876	I	200	3214.396	I	400	3554.925	I
60	2734.005	I	600	2953.940	I	60	3215.938	I	200	3556.878	I
50	2734.268	I	250	2957.364	I	50	3217.377	I	400	3558.515	I
500	2735.475	I	150	2965.254	I	80	3219.583	I	1000	3565.379	I
50	2735.612	I	1500	2966.898	I	60	3219.766	I	1200	3570.097	I
500	2737.310	I	120	2969.36	I	300	3222.045	I	800	3570.25	I
120	2737.83	I	800	2970.099	I	600	3225.78	I	120	3571.996	I
400	2739.55	II	1200	2973.132	I	80	3227.796	I	100	3573.393	I
250	2742.254	I	500	2973.235	I	50	3233.967	I	60	3573.829	I
800	2742.405	I	600	2981.445	I	120	3234.613	I	60	3573.888	I
200	2743.20	II	1000	2983.570	I	300	3236.222	I	4000	3581.19	I
150	2743.565	I	1000	2994.427	I	100	3239.433	I	150	3582.199	I
200	2744.068	I	250	2994.502	I	80	3244.187	I	150	3584.660	I



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
120	3584.929	I	6000	3737.131	I	1200	3927.920	I	40	4195.329	I
300	3585.319	I	100	3738.306	I	2000	3930.296	I	150	4198.304	I
150	3585.705	I	400	3743.362	I	60	3948.774	I	40	4199.095	I
10	3586.04	III	6000	3745.561	I	60	3949.953	I	300	4202.029	I
200	3586.103	I	1200	3745.899	I	50	3951.164	I	40	4203.984	I
400	3586.984	I	3000	3748.262	I	50	3952.601	I	80	4206.696	I
100	3594.633	I	80	3748.964	I	16	3954.33	III	80	4210.343	I
11	3600.94	III	3000	3749.485	I	60	3956.454	I	400	4216.183	I
150	3603.204	I	1500	3758.232	I	250	3956.68	I	100	4219.360	I
11	3603.88	III	400	3760.05	I	60	3966.614	I	50	4222.212	I
200	3605.454	I	1500	3763.788	I	11	3968.72	III	11	4222.27	III
500	3606.680	I	400	3765.54	I	100	3969.257	I	50	4225.956	I
1500	3608.859	I	600	3767.191	I	80	3977.741	I	200	4227.423	I
250	3610.16	I	60	3776.452	I	10 w	3979.42	III	100	4233.602	I
60	3612.068	I	250	3785.95	I	40	3981.771	I	13	4235.56	III
150	3617.788	I	100	3786.68	I	50	3983.956	I	250	4235.936	I
1500	3618.768	I	250	3787.880	I	60	3994.114	I	50	4238.809	I
200	3621.462	I	250	3790.092	I	200	3997.392	I	12	4243.75	III
150	3622.004	I	150	3794.34	I	40	3998.053	I	50	4247.425	I
150	3623.19	I	400	3795.002	I	400	4005.241	I	200	4250.118	I
100	3631.096	I	120	3797.518	I	60	4009.713	I	300	4250.787	I
1200	3631.463	I	250	3798.511	I	100	4021.867	I	40	4258.315	I
60	3632.041	I	400	3799.547	I	10	4035.42	III	800	4260.473	I
100	3638.298	I	200	3805.345	I	50	4040.638	I	250	4271.153	I
200	3640.389	I	80	3806.696	I	4000	4045.813	I	1200	4271.759	I
80	3643.717	I	600	3812.964	I	11	4053.11	III	12 h	4273.40	III
1500	3647.842	I	60	3813.059	I	1500	4063.594	I	12	4279.72	III
250	3649.506	I	1500	3815.840	I	50	4066.975	I	1200	4282.402	I
80	3650.279	I	2500	3820.425	I	50	4067.977	I	14 h	4286.16	III
200	3651.467	I	150	3821.179	I	1200	4071.737	I	80	4291.462	I
120	3670.024	I	80	3824.306	I	40	4076.629	I	16 h	4296.85	III
150	3670.089	I	2500	3824.444	I	12	4081.00	III	250	4299.234	I
100	3676.311	I	1500	3825.880	I	40	4100.737	I	18 h	4304.78	III
150	3677.629	I	1200	3827.823	I	40	4107.489	I	1200	4307.901	I
1500	3679.913	I	1000	3834.222	I	150	4118.544	I	20 h	4310.36	III
200	3682.242	I	120	3839.257	I	10	4120.90	III	150	4315.084	I
120	3683.054	I	500	3840.437	I	11	4122.02	III	1500	4325.761	I
150	3684.107	I	800	3841.047	I	11	4122.78	III	80	4352.734	I
120	3685.998	I	120	3843.256	I	40	4127.608	I	80	4369.771	I
500	3687.456	I	80	3846.800	I	400	4132.058	I	11 h	4372.31	III
120	3689.477	I	200	3849.96	I	80	4134.676	I	14 h	4372.53	III
150	3694.008	I	120	3850.817	I	40	4136.997	I	18 h	4372.81	III
120	3695.051	I	2500	3856.372	I	15	4137.76	III	800	4375.929	I
150	3701.086	I	150	3859.212	I	13	4139.35	III	3000	4383.544	I
80	3704.462	I	10000	3859.911	I	200	4143.415	I	1200	4404.750	I
1200	3705.566	I	150	3865.523	I	800	4143.869	I	300	4415.122	I
60	3707.041	I	60	3867.215	I	40	4153.898	I	12	4419.60	III
150	3707.821	I	250	3872.501	I	50	4154.500	I	600	4427.299	I
300	3707.919	I	150	3873.761	I	60	4156.799	I	400	4461.652	I
600	3709.246	I	250	3878.018	I	18	4164.73	III	120	4466.551	I
120	3716.442	I	2000	3878.573	I	13	4166.84	III	80	4476.017	I
8000	3719.935	I	4000	3886.282	I	50	4172.744	I	80	4482.169	I
1500	3722.563	I	200	3887.048	I	13	4174.26	III	200	4482.252	I
120	3724.377	I	300	3888.513	I	60	4174.912	I	50	4489.739	I
60	3725.491	I	800	3895.656	I	50	4175.635	I	50	4528.613	I
60	3727.093	I	1200	3899.707	I	50	4177.593	I	30	4647.433	I
500	3727.619	I	400	3902.945	I	120	4181.754	I	30	4736.771	I
150	3732.396	I	250	3906.479	I	50	4184.891	I	50	4859.741	I
1200	3733.317	I	80	3916.731	I	120	4187.038	I	120	4871.317	I
5000	3734.864	I	600	3920.258	I	120	4187.795	I	60	4872.136	I
120	3735.324	I	1200	3922.911	I	80	4191.430	I	30	4878.208	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100	4890.754	I	10	5368.06	III	80	7187.313	I	50	625.02	III
250	4891.492	I	400	5371.489	I	30	7207.381	I	30	625.76	III
30	4903.309	I	11 I	5375.47	III	30	7445.746	I	45	628.59	III
150	4918.992	I	40	5393.167	I	40	7495.059	I	50	630.04	III
500	4920.502	I	300	5397.127	I	60	7511.045	I	35	633.09	III
1500	4957.597	I	250	5405.774	I	80	7937.131	I	120	637.87	V
80	5001.862	I	250	5429.695	I	60	7945.984	I	50	639.98	III
30	5005.711	I	100	5434.523	I	80	7998.939	I	60	646.41	III
100	5006.117	I	200	5446.871	I	60	8046.047	I	50	651.20	III
60	5012.067	I	120	5455.609	I	50	8085.176	I	50	659.72	III
30	5014.941	I	25	5497.516	I	150	8220.41	I	30	664.86	III
150	5041.755	I	20	5501.464	I	120	8327.053	I	40	672.34	III
30	5049.819	I	30	5506.778	I	20	8331.908	I	35	672.85	III
30	5051.634	I	30	5569.618	I	120	8387.770	I	35	676.57	III
25	5074.748	I	60	5572.841	I	30	8468.404	I	35	680.13	III
150	5110.357	I	120	5586.755	I	15	8514.069	I	35	683.68	III
40	5139.251	I	200	5615.644	I	60	8661.898	I	45	686.25	III
100	5139.462	I	20	5624.541	I	150	8688.621	I	45	687.98	III
25	5151.910	I	50	5662.515	I	52	11422.32	I		690.86	V
12	5156.12	III	11	5719.88	III	87	11439.12	I		691.75	V
80	5166.281	I	10	5756.38	III	91	11593.59	I	45	691.93	III
2500	5167.487	I	20	5762.990	I	255	11607.57	I	50	695.61	III
80	5168.897	I	18	5833.93	III	160	11638.26	I	30	698.05	III
500	5171.595	I	10	5854.62	III	230	11689.98	I	50	708.36	III
50	5191.454	I	30	5862.353	I	160	11783.26	I	600	708.85	V
80	5192.343	I	15	5891.91	III	580	11882.84	I	50	714.00	III
200	5194.941	I	30	5914.114	I	225	11884.08	I	100 p	722.04	III
10	5199.08	III	10 p	5920.13	III	1030	11973.05	I	60	729.40	II
30	5204.582	I	18 p	5929.69	III	96	14400.56	I	30	746.70	III
25	5215.179	I	10	5952.31	III	72	14512.23	I	200	761.18	II
150	5216.274	I	14	5953.62	III	50	14555.06	I	100	763.98	II
60	5226.862	I	12	5979.32	III	40	14826.43	I	60	766.20	II
1000	5227.150	I	30	5986.956	I	94	15294.58	I	200	771.03	II
250	5232.939	I	12 h	5989.08	III	41	15769.42	I	60 p	773.69	II
10	5235.66	III	18	5999.54	III	105	18856.65	I	200	782.10	II
18	5243.31	III	16	6032.59	III				100	783.72	II
13 I	5260.34	III	13	6036.56	III	<i>Krypton Kr Z = 36</i>			60	785.97	III
100	5266.555	I	11	6048.72	III	30	467.35	III		793.44	IV
1200	5269.537	I	11	6054.18	III	150	472.16	V		794.11	IV
800	5270.357	I	40	6065.482	I	100	484.39	V	7	805.76	IV
14	5272.98	III	30	6102.159	I	250	496.25	V		810.70	V
15	5276.48	III	40	6136.614	I	120	500.77	V	18	816.82	IV
30	5281.789	I	40	6137.694	I	200	507.20	V	60	818.15	II
16	5282.30	III	40	6191.558	I	30	540.86	III	60	830.38	II
60	5283.621	I	30	6213.429	I	60	548.04	V	50	837.66	III
12	5284.83	III	30	6219.279	I	30	565.64	III	22	842.04	IV
11	5298.12	III	40	6230.726	I	30	569.16	III	100	844.06	II
12	5299.93	III	20	6246.317	I	30	571.98	III	50	854.73	III
25	5302.299	I	80	6247.56	II	30	579.83	III	60	862.58	III
14 w	5302.60	III	30	6252.554	I	30	585.14	III	60	864.82	II
10	5306.76	III	20	6393.602	I	30	585.96	III	60	868.87	II
10	5322.74	III	30	6399.999	I	30	593.70	III	40	870.84	III
150	5324.178	I	20	6411.647	I	30	594.10	III	50	876.08	III
800	5328.038	I	20	6421.349	I	30	596.41	III	200	884.14	II
300	5328.531	I	30	6430.844	I	40	600.17	III	1000	886.30	II
100	5332.899	I	200	6456.38	II	30	603.67	III	400	891.01	II
80	5339.928	I	60	6494.981	I	50	605.86	III	75	897.81	III
500	5341.023	I	20	6546.239	I	35	606.47	III	200	911.39	II
11	5346.88	III	20	6592.913	I	50	611.12	III	2000	917.43	II
12	5353.77	III	40	6677.989	I	35	616.72	III	50	945.44	I
12	5363.76	III	25	7164.443	I	40	621.45	III	50	946.54	I
						45	622.80	III			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
20	951.06	I	60	2992.22	III	300	4057.037	II	200	5468.17	II
50	953.40	I	50	3022.30	III	300	4065.128	II	10	5501.43	III
50	963.37	I	80	3024.45	III	50	4067.37	III	500	5562.224	I
2000	964.97	II	50	3046.93	III	500	4088.337	II	2000	5570.288	I
50	987.29	III	30	3056.72	III	250	4098.729	II	80	5580.386	I
100	1001.06	I	60	3063.13	III	100	4109.248	II	100	5649.561	I
100	1003.55	I	40	3097.16	III	40	4131.33	III	400	5681.89	II
100	1030.02	I	60	3112.25	III	250	4145.122	II	200 h	5690.35	II
30	1158.74	III	30	3120.61	III	40	4154.46	III	100	5832.855	I
200	1164.87	I	100	3124.39	III	150	4250.580	II	3000	5870.914	I
650	1235.84	I	60	3141.35	III	1000	4273.969	I	200	5992.22	II
6	1638.82	III	3	3142.01	IV	100	4282.967	I	60	5993.849	I
6	1914.09	III	100	3189.11	III	600	4292.923	II	10 h	6037.17	III
3	2237.34	IV	80	3191.21	III	200	4300.49	II	60	6056.125	I
6	2291.26	IV	6	3224.99	IV	500 h	4317.81	II	10 h	6078.38	III
3	2329.3	IV	40	3239.52	III	400	4318.551	I	10	6310.22	III
4	2336.75	IV	40	3240.44	III	1000	4319.579	I	300	6420.18	II
4	2348.27	IV	300	3245.69	III	150 h	4322.98	II	100	6421.026	I
3	2358.5	IV	3	3261.70	IV	100	4351.359	I	200	6456.288	I
3	2388.05	IV	150	3264.81	III	3000	4355.477	II	150	6570.07	II
40	2393.94	III	100	3268.48	III	500	4362.641	I	60	6699.228	I
4	2416.9	IV	30	3271.65	III	200	4369.69	II	100	6904.678	I
3	2428.04	IV	30	3285.89	III	800	4376.121	I	250	7213.13	II
5	2442.68	IV	30	3304.75	III	300 h	4386.54	II	100	7224.104	I
4	2451.7	IV	50	3311.47	III	200	4399.965	I	80	7287.258	I
6	2459.74	IV	200	3325.75	III	100	4425.189	I	400	7289.78	II
100 h	2464.77	II	60	3330.76	III	500	4431.685	II	400	7407.02	II
5	2474.06	IV	50	3342.48	III	600	4436.812	II	60	7425.541	I
60	2492.48	II	100	3351.93	III	600	4453.917	I	200	7435.78	II
40	2494.01	III	40	3374.96	III	800	4463.689	I	100	7486.862	I
4	2517.0	IV	100	3439.46	III	800	4475.014	II	300	7524.46	II
5	2518.02	IV	70	3474.65	III	400 h	4489.88	II	1000	7587.411	I
6	2519.38	IV	100	3488.59	III	600	4502.353	I	2000	7601.544	I
5	2524.5	IV	200	3507.42	III	400 h	4523.14	II	150	7641.16	II
5	2546.0	IV	100	3564.23	III	200 h	4556.61	II	1000	7685.244	I
6	2547.0	IV	100 h	3607.88	II	800	4577.209	II	1200	7694.538	I
4	2558.08	IV	200	3631.889	II	300	4582.978	II	250	7735.69	II
30	2563.25	III	30	3641.34	III	150 h	4592.80	II	150	7746.827	I
3	2586.9	IV	250	3653.928	II	500	4615.292	II	800	7854.821	I
5	2606.17	IV	80	3665.324	I	1000	4619.166	II	200	7913.423	I
10	2609.5	IV	150	3669.01	II	800	4633.885	II	180	7928.597	I
8	2615.3	IV	100	3679.559	I	2000	4658.876	II	200	7933.22	II
7	2621.11	IV	80	3686.182	II	500	4680.406	II	120	7973.62	II
60	2639.76	III	30	3690.65	III	100	4691.301	II	100	7982.401	I
30	2680.32	III	300 h	3718.02	II	200	4694.360	II	1500	8059.503	I
40	2681.19	III	200	3718.595	II	3000	4739.002	II	4000	8104.364	I
80 h	2712.40	II	150	3721.350	II	300	4762.435	II	6000	8112.899	I
3	2730.55	IV	200	3741.638	II	1000	4765.744	II	60	8132.967	I
8	2748.18	IV	150	3744.80	II	300	4811.76	II	3000	8190.054	I
6	2774.70	IV	80	3754.245	II	300	4825.18	II	200	8202.72	II
3	2829.60	IV	500	3778.089	II	800	4832.077	II	80	8218.365	I
100	2833.00	II	500	3783.095	II	700	4846.612	II	3000	8263.240	I
3	2836.08	IV	3	3809.30	IV	150	4857.20	II	100	8272.353	I
30	2841.00	III	5	3860.58	IV	300	4945.59	II	1500	8281.050	I
30	2851.16	III	40 h	3868.70	III	20 h	5016.45	III	5000	8298.107	I
5	2853.0	IV	150 h	3875.44	II	200	5022.40	II	100	8412.430	I
3	2859.3	IV	150	3906.177	II	250	5086.52	II	3000	8508.870	I
50	2870.61	III	200	3920.081	II	400 h	5125.73	II	150	8764.110	I
100	2892.18	III	5	3934.29	IV	500	5208.32	II	6000	8776.748	I
30	2909.17	III	100	3994.840	II	200	5308.66	II	2000	8928.692	I
50	2952.56	III	100 h	3997.793	II	500	5333.41	II	500	9238.48	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
500 hl	9293.82	II	2600	18167.315	I	10000	1523.79	III	410	4619.88	II
200 h	9320.99	II	100	18399.786	I	4000	1808.66	IV	540	4655.50	II
300	9361.95	II	150	18580.896	I	5000	1902.97	IV	360	4662.51	II
100	9362.082	I	300	18696.294	I	4000 c	2197.45	IV	230	4692.50	II
200 h	9402.82	II	170	18785.460	I	770	2256.76	II	230	4728.42	II
200 h	9470.93	II	200	18797.703	I	25000 w	2417.58	IV	500	4740.28	II
500	9577.52	II	140	20209.878	I	50000	2532.75	IV	390	4743.09	II
500 h	9605.80	II	300	20423.964	I	45000	2582.05	IV	320	4748.73	II
400 h	9619.61	II	140	20446.971	I	95000 w	2597.50	IV	320	4860.91	II
200	9663.34	II	600	21165.471	I	70000 w	2662.75	IV	850	4899.92	II
200 h	9711.60	II	1800	21902.513	I	420	2808.39	II	1000	4920.98	II
2000	9751.758	I	120	22485.775	I	50000 w	2848.30	IV	1000	4921.79	II
500	9803.14	II	180	23340.416	I	30000 c	2962.58	IV	370	4949.77	I
500	9856.314	I	120	24260.506	I	70000 w	3009.51	IV	340	4970.39	II
1000	10221.46	II	180	24292.221	I	90000 c	3056.68	IV	370	4986.83	II
100	11187.108	I	600	25233.820	I	1000	3171.63	III	720	4999.47	II
200	11257.711	I	180	28610.55	I	1500	3171.74	III	210	5050.57	I
150	11259.126	I	1000	28655.72	I	510	3245.13	II	470	5114.56	II
500	11457.481	I	150	28769.71	I	550	3265.67	II	470	5122.99	II
150	11792.425	I	140	28822.49	I	800	3303.11	II	450	5145.42	I
1500	11819.377	I	300	29236.69	I	1500	3337.49	II	290	5158.69	I
600	11997.105	I	300	30663.54	I	870	3344.56	II	580	5177.31	I
160	12077.224	I	300	30979.16	I	1500	3380.91	II	850	5183.42	II
100	12861.892	I	500	39300.6	I	320	3628.83	II	260	5188.22	II
1100	13177.412	I	1100	39486.52	I	1000	3645.42	II	720	5211.86	I
1000	13622.415	I	220	39557.25	I	550	3713.54	II	520	5234.27	I
2400	13634.220	I	100	39572.60	I	2400	3759.08	II	340	5253.46	I
800	13658.394	I	1400	39588.4	I	3700	3790.83	II	370	5271.19	I
200	13711.036	I	1100	39589.6	I	3900	3794.78	II	370	5301.98	II
600	13738.851	I	500	39954.8	I	600	3840.72	II	180	5303.55	II
150	13974.027	I	300	39966.6	I	1600	3849.02	II	500	5455.15	I
550	14045.657	I	1300	40306.1	I	3400	3871.64	II	470	5501.34	I
140	14104.298	I	250	40685.16	I	1700	3886.37	II	240	5648.25	I
180	14402.22	I	<i>Lanthanum La Z = 57</i>			1300	3916.05	II	180	5740.66	I
2000	14426.793	I	100	344.12	IV	1100	3921.54	II	370	5769.34	I
100	14517.84	I	400	390.72	V	2200	3929.22	II	320	5789.24	I
1600	14734.436	I	1000	432.11	V	9000	3949.10	II	450	5791.34	I
550	14762.672	I	2500	435.28	V	4400	3988.52	II	140	5821.99	I
450	14765.472	I	10000	463.14	IV	3600	3995.75	II	320	5930.62	I
400	14961.894	I	5000	482.16	V	2800	4031.69	II	720	6249.93	I
120	15005.307	I	7000	498.08	V	3000	4042.91	II	260 d	6262.30	II
140	15209.526	I	15000	499.54	IV	850	4067.39	II	450	6394.23	I
1700	15239.615	I	10000	503.58	V	2800	4077.35	II	250	6455.99	I
130	15326.480	I	12000	526.76	V	5500	4086.72	II	180	6709.50	I
1500	15334.958	I	10000	531.07	V	4400	4123.23	II	110	7045.96	I
700	15372.037	I	15000	533.23	V	550	4141.74	II	160	7066.23	II
200	15474.026	I	8000	547.44	V	1100	4151.97	II	50	7161.25	I
180	15681.02	I	40000	552.02	IV	1500	4196.55	II	110 w	7282.34	II
120	15820.09	I	5000	600.24	V	1600	4238.38	II	110 w	7334.18	I
200	16726.513	I	30000	631.26	IV	480	4269.50	II	75 cw	7483.50	II
2000	16785.128	I	400	796.99	III	600	4286.97	II	50	7498.83	I
1000	16853.488	I	2000	870.40	III	600	4296.05	II	85	7539.23	I
2400	16890.441	I	1000	882.34	III	440	4322.51	II	40	7964.83	I
1600	16896.753	I	400	942.86	III	4600	4333.74	II	75	8086.05	I
1800	16935.806	I	50000	1081.61	III	550	4354.40	II	85	8324.69	I
600	17098.771	I	95000	1099.73	III	2000	4429.90	II	95	8346.53	I
700	17367.606	I	2000	1255.63	III	850	4522.37	II	65	8545.44	I
120	17404.443	I	10000	1349.18	III	420	4526.12	II	300	8583.45	III
150	17616.854	I	25000	1368.04	IV	400	4558.46	II	40	8674.43	I
650	17842.737	I	20000	1463.47	IV	400	4574.88	II	35	8825.82	I
700	18002.229	I	15000	1507.87	IV	410	4613.39	II	120	9184.38	III

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100	9212.63	III	15	1056.53	IV	20	2259.01	V	100	5006.572	I
140	10284.79	III	10	1060.66	II	150	2332.418	I	50	5089.484	I
<i>Lead Pb Z = 82</i>			12	1072.09	IV	16	2359.53	IV	10	5107.242	I
10	496.38	IV	18	1080.81	IV	180	2388.797	I	2000	5201.437	I
12	499.94	IV	20	1084.17	IV	550 r	2393.792	I	10	5372.099	II
14	529.78	IV	10	1088.86	V	140	2399.597	I	40	5692.346	I
20	570.16	IV	10	1103.94	II	320 r	2401.940	I	200	5895.624	I
10	648.50	IV	10	1108.43	II	320 r	2411.734	I	2000	6001.862	I
20	703.73	V	10	1109.84	II	16	2417.61	IV	500	6011.667	I
12	749.46	V	20	1116.08	IV	15	2424.81	V	500	6059.356	I
10	752.52	V	10	1119.57	II	150 r	2443.829	I	40	6081.409	II
10	761.09	IV	10	1121.36	II	160 r	2446.181	I	50	6110.520	I
18	767.45	V	10	1133.14	II	130 r	2476.378	I	100	6235.266	I
18	769.49	V	18	1137.84	IV	80 r	2577.260	I	50 c	6660.20	II
14	771.42	V	14	1144.93	IV	500 r	2613.655	I	20000	7228.965	I
14	782.79	V	12	1157.88	V	900 r	2614.175	I	10	7346.676	I
15	797.02	V	14	1185.43	V	160	2628.262	I	20	7809.259	I
18	802.07	IV	20	1189.95	IV	4	2634.256	II	5	7896.737	I
12	802.82	IV	10	1203.63	II	10	2657.094	I	10	8168.001	I
18	809.63	V	10	1231.20	II	700	2663.154	I	6	8191.886	I
10	812.59	IV	11	1233.50	V	10	2697.541	I	5	8217.711	I
10	827.41	IV	10	1291.10	IV	25000 r	2801.995	I	40	8272.690	I
12	832.60	IV	20	1313.05	IV	100	2822.58	I	20	8409.384	I
12	845.94	IV	10	1331.65	II	14000 r	2823.189	I	10	8478.492	I
18	857.64	IV	10	1335.20	II	35000 r	2833.053	I	5	8722.810	I
16	862.33	IV	12	1343.06	IV	6	2840.557	II	10	8857.457	I
20	863.97	V	10	1348.37	II	14000 r	2873.311	I	8	9293.476	I
14	870.44	IV	16	1388.94	IV	3	2914.442	II	15	9438.05	I
6	873.71	II	18	1400.26	IV	15	2966.460	I	15	9604.297	I
12	879.96	IV	10	1404.34	IV	15	2972.991	I	15	9674.351	I
18	883.90	V	10	1433.96	II	15	2980.157	I	200	10290.458	I
14	884.96	IV	10	1512.42	II	4	2986.876	II	100	10498.965	I
14	884.99	IV	14	1535.71	IV	10	3043.85	III	50	10649.249	I
14	888.37	V	20	1553.1	III	150	3118.894	I	15	10886.688	I
8	889.68	II	10	1671.53	II	10	3137.81	III	40	10969.53	I
16	890.72	IV	10	1682.15	II	10	3176.50	III		13512.6	I
14	894.40	V	20	1726.75	II	600	3220.528	I		14743.0	I
12	896.08	V	10	1796.670	II	100	3229.613	I		15349.6	I
12	908.51	IV	10	1822.050	II	400	3240.186	I		39039.4	I
14	915.71	V	10	1904.77	I	200	3262.355	I	<i>Lithium Li Z = 3</i>		
12	917.90	IV	7	1921.471	II	35000	3572.729	I		102.9	III
12	918.09	V	12	1959.34	IV	50000 r	3639.568	I		103.4	III
12	920.28	V	16	1973.16	IV	20000	3671.491	I		104.1	III
12	920.66	V	10	1998.83	V	70000 r	3683.462	I		105.5	III
10	922.12	IV	5 r	2022.02	I	10	3713.982	II		108.0	III
12	922.49	IV	10	2042.58	IV	25000	3739.935	I		113.9	III
10	927.64	IV	12	2049.34	IV	12	3854.08	III		125.5	II
14	932.20	IV	8 r	2053.28	I	15000	4019.632	I		135.0	III
12	954.35	V	12	2079.22	IV	95000	4057.807	I		136.5	II
10	967.23	II	6	2111.758	I	14000	4062.136	I		140.5	II
10	986.71	II	10	2115.066	I	10	4157.814	I		167.21	II
10	995.89	II	15	2154.01	IV	10000	4168.033	I		168.74	II
10	1016.61	II	500 r	2170.00	I	8	4272.66	III		171.58	II
14	1028.61	IV	7	2175.580	I	200	4340.413	I		178.02	II
20	1032.05	IV	12	2177.46	IV	10	4496.15	IV		199.28	II
16	1041.24	IV	7	2187.888	I	6	4499.34	III		207.5	II
18	1044.14	IV	8	2189.603	I	16	4534.60	IV		456.	II
12	1048.9	III	10	2203.534	II	7	4571.21	III		483.	II
10	1049.82	II	20	2237.425	I	10	4579.051	II		540.	II
10	1050.77	II	20	2246.86	I	6	4761.12	III		540.0	III
10	1051.26	V	25	2246.89	I	1000	5005.416	I		729.	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
480 h	2728.95	I	250	4281.03	I	3000	323.31	IV	1	2613.36	I
3600	2754.17	II	330 d	4295.97	I	30	353.09	V	2	2614.73	I
750 h	2765.74	I	150	4309.57	I	150	857.29	IV	3	2617.51	I
2000	2772.55	III	190 c	4430.48	I	50	919.03	IV	3	2628.66	I
2700	2796.63	II	190	4450.81	I	250	1037.41	IV	6	2630.05	I
270 c	2834.35	II	3300	4518.57	I	300	1210.99	IV	8	2632.87	I
330 h	2845.13	I	100 h	4648.21	I	300	1342.19	IV	2	2644.80	I
3000	2847.51	II	1000	4658.02	I	800	1346.57	IV	3	2646.21	I
570 h	2885.14	I	85 h	4659.03	I	300	1346.68	IV	4	2649.06	I
6300	2894.84	II	150	4785.42	II	600	1352.05	IV	8	2660.76	II
4500	2900.30	II	85	4815.05	I	900	1384.46	IV	8	2660.82	II
300	2903.05	I	460	4904.88	I	500	1385.77	IV	6	2668.12	I
9000	2911.39	II	180	4942.34	I	800	1387.53	IV	8	2669.55	I
270 h	2949.73	I	800	4994.13	II	300	1404.68	IV	10	2672.46	I
1200	2951.69	II	800	5001.14	I	1000	1409.36	IV	3	2693.72	I
4200	2963.32	II	140	5134.05	I	500	1437.53	IV	5	2695.18	I
2400	2969.82	II	2700	5135.09	I	1000	1437.64	IV	6	2698.14	I
1800	2989.27	I	170	5196.61	I	300	1447.42	IV	8	2731.99	I
3000	3020.54	II	500	5402.57	I	300	1459.54	IV	10	2733.49	I
2100	3056.72	II	140 c	5421.90	I	400	1459.62	IV	12	2736.53	I
1000	3057.86	III	100	5437.88	I	400	1481.51	IV	5	2765.22	I
7500	3077.60	II	2100	5476.69	II	350	1490.45	IV	7	2768.34	I
390	3080.11	I	550	5736.55	I	300	1495.50	IV	38	2776.69	I
5100 h	3081.47	I	80	5800.59	I	300	1607.11	IV	32	2778.27	I
3000	3118.43	I	690 cw	5983.9	II	5	1668.43	I	90	2779.83	I
2400	3171.36	I	140	5997.13	I	500	1683.02	IV	8	2781.29	I
260	3191.80	II	1400	6004.52	I	10	1683.41	I	32	2781.42	I
1400	3198.12	II	440	6055.03	I	400	1698.81	IV	36	2782.97	I
4800	3254.31	II	150	6159.94	II	15	1707.06	I	1000	2795.53	II
3800	3278.97	I	600	6198.13	III	40	1734.84	II	600	2802.70	II
7600	3281.74	I	160	6199.66	II	50	1737.62	II	3	2809.76	I
6200	3312.11	I	2100	6221.87	II	20	1747.80	I	2	2811.11	I
7600	3359.56	I	80	6235.36	II	40	1750.65	II	1	2811.78	I
6200	3376.50	I	160	6242.34	II	50	1753.46	II	12	2846.72	I
950	3385.50	I	70 h	6345.35	I	30	1827.93	I	12	2846.75	I
160 h	3391.55	I	1100	6463.12	II	300	1844.17	IV	14	2848.34	I
1400	3396.82	I	29	6477.67	I	9	2025.82	I	14	2848.42	I
4100	3397.07	II	55 c	6523.18	I	25	2064.90	III	16	2851.65	I
4800	3472.48	II	35 cw	6611.28	II	20	2091.96	III	16	2851.66	I
8300 c	3507.39	II	23 c	6677.14	I	20	2177.70	III	6000	2852.13	I
1600	3508.42	I	30 c	6793.77	I	3	2329.58	II	2	2902.92	I
4800	3554.43	II	45	6917.31	I	20	2395.15	III	4	2906.36	I
4800	3567.84	I	23	7031.24	I	6	2449.57	II	3	2915.45	I
340	3596.34	I	45	7125.84	II	1	2557.23	I	10	2936.74	I
800	3623.99	II	14 ch	7237.98	I	1	2560.94	I	12	2938.47	I
680	3636.25	I	11 c	7441.52	I	1	2562.26	I	2	2942.00	I
2600	3647.77	I	9 c	8178.16	I	1	2564.94	I	13	2942.00	I
110	3756.70	I	17	8382.08	I	1	2570.91	I	20	3091.08	I
110	3756.79	I	35	8459.19	II	1	2572.25	I	22	3092.99	I
150	3800.67	I	10 d	8478.50	I	2	2574.94	I	14	3096.90	I
2700	3841.18	I	29 c	8508.08	I	1	2577.89	I	9	3104.71	II
530	3876.65	II	35 c	8610.98	I	1	2580.59	I	8	3104.81	II
50	3918.86	I				1	2584.22	I	6	3168.98	II
480	3968.46	I	<i>Magnesium Mg Z = 12</i>			1	2585.56	I	6	3172.71	II
670	4054.45	I	400	146.95	IV	2	2588.28	I	7	3175.78	II
310	4122.49	I	20	186.51	III	3	2591.89	I	2	3197.62	I
3100	4124.73	I	20	187.20	III	1	2593.23	I	17	3329.93	I
150 c	4131.79	I	10	188.53	III	1	2595.97	I	6	3332.15	I
460	4154.08	I	100	231.73	III	2	2602.50	I	9	3336.68	I
1600	4184.25	II	80	234.26	III	2	2603.85	I	7	3535.04	II
150	4277.50	I	35	276.58	V	4	2606.62	I	8	3538.86	II
			4000	320.99	IV	5					



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
7	3549.52	II	12	8712.69	I	90	1264.41	IV	500	2066.38	III
8	3553.37	II	13	8717.83	I	500	1283.58	III	1000	2069.02	III
140	3829.30	I	10	8734.99	II	400	1287.59	III	30	2076.21	II
300	3832.30	I	17	8736.02	I	300	1291.62	III	900	2077.38	III
500	3838.29	I	11	8745.66	II	1000	1360.72	III	800	2084.23	III
8	3848.24	II	14	8806.76	I	800	1365.20	III	600	2090.05	III
7	3850.40	II	10	8824.32	II	500 h	1609.17	III	1500	2092.16	I
3	3878.31	I	11	8835.08	II	1000	1614.14	III	500	2094.78	III
3	3895.57	I	20	8923.57	I	2000	1620.60	III	20	2097.46	II
4	3903.86	I	10	8997.16	I	500	1633.80	III	500	2097.93	III
6	3938.40	I	14	9218.25	II	80	1667.00	IV	500	2099.97	III
8	3986.75	I	13	9244.27	II	80	1698.30	IV	20	2102.50	II
10	4057.50	I	12	9246.50	I	20	1726.47	II	1700	2109.58	I
15	4167.27	I	30	9255.78	I	30	1732.70	II	30	2113.96	II
20	4351.91	I	10	9327.54	II	50	1733.55	II	1000	2169.78	III
9	4384.64	II	10	9340.54	II	40	1734.49	II	700	2174.15	III
10	4390.59	II	25	9414.96	I	30	1737.93	II	900	2176.87	III
8	4428.00	II	17	9429.81	I	20	1740.16	II	800	2181.86	III
9	4433.99	II	19	9432.76	I	20	1742.00	II	800	2184.87	III
14	4481.16	II	20	9438.78	I	85	1742.10	IV	290	2208.81	I
13	4481.33	II	12	9631.89	II	85	1766.27	IV	540	2213.85	I
28	4571.10	I	11	9632.43	II	80	1795.65	IV	900	2220.55	III
10	4730.03	I	15	9953.20	I	80	1795.79	IV	770	2221.84	I
7	4851.10	II	15	9983.20	I	30	1853.27	II	1000	2227.42	III
75	5167.33	I	17	9986.47	I	20	1857.92	II	20	2373.36	II
220	5172.68	I	18	9993.21	I	50	1902.95	II	20	2427.38	II
400	5183.61	I	14	10092.16	II	20	1907.84	II	50	2427.72	II
8	5264.21	II	35	10811.08	I	75	1910.25	IV	30	2427.94	II
7	5264.37	II	11	10914.23	II	30	1911.41	II	30	2437.37	II
9	5401.54	II	10	10951.78	II	20 d	1914.68	II	20	2437.84	II
6	5528.41	I	25	10953.32	I	100	1915.10	II	30	2452.49	II
30	5711.09	I	27	10957.30	I	20	1918.64	II	30	2499.00	II
10	6318.72	I	28	10965.45	I	30	1919.64	II	30	2507.60	II
9	6319.24	I	15	11032.10	I	80	1921.25	II	20	2516.60	II
7	6319.49	I	14	11033.66	I	20	1923.07	II	30	2516.74	II
10	6346.74	II	45	11828.18	I	20	1923.34	II	20	2521.66	II
9	6346.96	II	30	12083.66	I	30	1925.52	II	20	2530.72	II
11	6545.97	II	28	14877.62	I	50	1926.59	II	20	2531.80	II
7	6781.45	II	35	15024.99	I	30	1931.40	II	50	2532.78	II
8	6787.85	II	30	15040.24	I	500	1941.28	III	50	2533.33	II
7	6812.86	II	25	15047.70	I	800	1943.21	III	30	2534.10	II
8	6819.27	II	10	15765.84	I	20	1945.15	II	80	2534.22	II
10	7193.17	I	30	17108.66	I	20	1947.93	II	100	2535.66	II
10	7291.06	I	5	26392.90	I	20	1950.14	II	30	2535.98	II
12	7387.69	I				500	1952.36	III	100	2537.92	II
20	7657.60	I	<i>Manganese Mn Z = 25</i>			1000	1952.52	III	50	2541.11	II
19	7659.15	I	600	410.30	V	30	1953.23	II	80	2542.92	II
17	7659.90	I	600	410.60	V	20 d	1954.81	II	50	2543.45	II
15	7691.55	I	600	415.62	V	30	1959.25	II	100	2548.75	II
12	7877.05	II	650	415.98	V	20	1969.24	II	50	2551.85	II
13	7896.37	II	600	428.59	V	500	1978.95	III	30	2553.27	II
10	8098.72	I	600	435.67	V	30	1994.23	II	75	2556.57	II
9	8115.22	II	1000	441.72	V	9700	1996.06	I	30	2556.89	II
8	8120.43	II	850	442.49	V	14000	1999.51	I	95	2558.59	II
10	8209.84	I	60	579.79	IV	18000	2003.85	I	30	2559.41	II
20	8213.03	I	60	581.44	IV	1000 w	2027.83	III	150	2563.65	II
10	8213.99	II	60	581.65	IV	500 w	2028.14	III	30	2565.22	II
11	8234.64	II	60	585.21	IV	50	2037.31	II	580	2572.76	I
10	8310.26	I	90	1242.25	IV	40	2037.64	II	480	2575.51	I
15	8346.12	I	90	1244.50	IV	40	2039.97	II	12000	2576.10	II
10	8710.18	I	95	1251.93	IV	500	2049.68	III	550	2584.31	I
			95	1257.28	IV						



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
30	2588.97	II	70	2886.68	II	290	3619.28	I	800	4451.59	I
45	2589.71	II	160	2889.58	II	220	3623.79	I	160	4453.00	I
250	2592.94	I	55	2892.39	II	140	3629.74	I	130	4455.01	I
6200	2593.73	II	50	2898.70	II	100	3660.40	I	160	4455.32	I
250	2595.76	I	80	2900.16	II	280	3693.67	I	110	4455.82	I
95	2598.90	II	140 h	2914.60	I	180	3696.57	I	210	4457.55	I
30	2602.72	II	190 h	2925.57	I	210	3706.08	I	270	4458.26	I
45	2603.72	II	1100	2933.06	II	130	3718.93	I	150	4461.08	I
4300	2605.69	II	1500	2939.30	II	130	3731.93	I	510	4462.02	I
190	2610.20	II	250 h	2940.39	I	260	3790.22	I	290	4464.68	I
500	2618.14	II	1900	2949.20	II	110	3800.55	I	200	4470.14	I
140	2622.90	I	30	3019.92	II	3200	3806.72	I	130	4472.79	I
150	2624.04	I	55	3031.06	II	700	3809.59	I	170	4490.08	I
40	2624.80	II	30	3035.35	II	2100	3823.51	I	240	4498.90	I
200	2625.58	II	330	3044.57	I	390	3823.89	I	240	4502.22	I
190	2632.35	II	120	3045.59	I	200	3829.68	I	160	4709.72	I
130	2638.17	II	200	3047.04	I	480	3833.86	I	180	4727.48	I
80	2639.84	II	30	3050.65	II	1300	3834.36	I	130	4739.11	I
27	2650.99	II	250	3054.36	I	350	3839.78	I	1000	4754.04	I
60	2655.91	II	140	3062.12	I	670	3841.08	I	180	4761.53	I
30	2666.77	II	170	3066.02	I	350	3843.98	I	750	4762.38	I
30	2667.03	II	170	3070.27	I	120	3926.47	I	300	4765.86	I
110	2672.59	II	160	3073.13	I	130	3982.58	I	500	4766.43	I
55	2673.37	II	140 h	3178.50	I	150	3985.24	I	940	4783.42	I
55	2674.43	II	220	3212.88	I	190	3986.83	I	1000	4823.52	I
45	2680.34	II	1000	3228.09	I	150	3987.10	I	19	5004.91	I
30	2680.68	II	300	3230.72	I	1500	4018.10	I	30	5074.79	I
30	2681.25	II	850	3236.78	I	150	4026.44	I	200	5079.20	III
55	2684.55	II	330	3243.78	I	27000	4030.76	I	150	5100.03	III
55	2685.94	II	650	3248.52	I	19000	4033.07	I	60	5117.94	I
110	2688.25	II	100	3251.14	I	11000	4034.49	I	50	5150.89	I
27	2693.19	II	310	3252.95	I	1500	4035.73	I	50	5196.59	I
55	2695.36	II	310	3256.14	I	5600	4041.36	I	85	5255.32	I
27	2698.97	II	220	3258.41	I	210 d	4045.13	I	160	5341.06	I
85	2701.00	II	180	3260.23	I	1100	4048.76	I	19	5349.88	I
50	2701.17	II	180	3264.71	I	150	4055.21	I	95	5377.63	I
160	2701.70	II	200	3330.78	II	1900	4055.54	I	95	5394.67	I
100	2703.98	II	720	3441.99	II	210	4057.95	I	50	5399.49	I
130	2705.74	II	50	3460.03	II	1100	4058.93	I	95	5407.42	I
80	2707.53	II	360	3460.33	II	150	4059.39	I	35	5413.69	I
110	2708.45	II	360 h	3474.04	II	730	4061.74	I	85	5420.36	I
45	2709.96	II		3474.13	II	730	4063.53	I	35	5432.55	I
80	2710.33	II	290	3482.91	II	290	4070.28	I	150	5454.07	III
110	2711.58	II	180	3488.68	II	730	4079.24	I	12	5457.47	I
30	2716.80	II	140	3495.84	II	730	4079.42	I	60	5470.64	I
30	2717.53	II	50	3496.81	II	1100	4082.94	I	200	5474.68	III
30	2719.01	II	100	3497.54	II	1100	4083.63	I	40	5481.40	I
50	2719.74	II	360	3531.85	I	200	4110.90	I	30	5505.87	I
30	2722.10	II	1100	3532.12	I	150	4131.12	I	50	5516.77	I
30	2724.46	II	1300	3547.80	I	120	4135.04	I	40	5537.76	I
55	2728.61	II	1100	3548.03	I	150	4176.60	I	21	5551.98	I
6200	2794.82	I	390	3548.20	I	120	4189.99	I	200	5946.65	III
5100	2798.27	I	2200	3569.49	I	370	4235.14	I	140	6013.50	I
220	2799.84	I	720	3569.80	I	510	4235.29	I	200	6016.64	I
3700	2801.06	I	1400	3577.88	I	190	4239.72	I	290	6021.80	I
110	2809.11	I	720	3586.54	I	290	4257.66	I	200	6231.21	III
60	2815.02	II	290	3595.12	I	290	4265.92	I	17	6440.97	I
30	2816.33	II	150	3601.72	III	270	4281.10	I	24	6491.71	I
60	2870.08	II	420	3607.54	I	50	4323.63	II	14 h	6942.52	I
30	2872.94	II	420	3608.49	I	350	4414.88	I	12	6989.96	I
80	2879.49	II	360	3610.30	I	210	4436.35	I	14	7069.84	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
12	7184.25	I	30	3801.660	I	40	1783.70	II	50	2698.83	I
24 h	7283.82	I	20	3901.867	I	30	1796.22	II	50	2699.38	I
35 h	7302.89	I	60	3906.372	I	200	1796.90	II	80	2705.36	II
50	7326.51	I	200	3983.839	II	60	1798.74	II	70	2724.43	III
12	7680.20	I	1800	4046.572	I	30	1803.89	II	80	2752.78	I
12 h	8672.06	I	150	4077.838	I	40	1808.29	II	20	2759.71	I
12 h	8701.05	I	40	4108.057	I	400	1820.34	II	6	2769.22	III
17 h	8703.76	I	250	4339.224	I	5	1832.74	I	40	2803.46	I
30 h	8740.93	I	400	4347.496	I	1000	1849.50	I	30	2804.43	I
			4000	4358.337	I	160	1869.23	II	2	2805.34	I
<i>Mercury 198 Hg Z = 80</i>			80	4916.068	I	300	1870.55	II	2	2806.77	I
80	1250.564	I	1100	5460.753	I	200	1875.54	II	150	2814.93	II
8	1259.242	I	160	5675.922	I	1	1894.77	III	3	2844.76	III
100	1268.825	I	240	5769.598	I	20	1900.28	II	750	2847.68	II
5	1307.751	I	280	5790.663	I	30	1927.60	II	50	2856.94	I
20	1402.619	I	20	6072.713	I	300	1942.27	II	150	2893.60	I
10	1435.503	I	30	6234.402	I	100	1972.94	II	150	2916.27	II
1000	1849.492	I	160	6716.429	I	200	1973.89	II	60	2925.41	I
60	2262.210	II	250	6907.461	I	150	1987.98	II	150	2935.94	II
20	2302.065	I	240	11287.407	I	90	2026.97	II	400	2947.08	II
20	2345.440	I				90	2052.93	II	1200	2967.28	I
100	2378.325	I	<i>Mercury Hg Z = 80</i>			70	2148.00	II	300	3021.50	I
20	2380.004	I	3	621.44	III	5	2247.55	I	120	3023.47	I
40	2399.349	I	2	679.68	III	60	2262.23	II	30	3025.61	I
20	2399.729	I	2	878.59	III	20	2302.06	I	50	3027.49	I
20	2446.900	I	1	886.48	III	7	2314.15	III	15	3090.05	III
15	2464.064	I	400	893.08	II	15	2323.20	I	400	3125.67	I
40	2481.999	I	300	915.83	II	5	2340.57	I	320	3131.55	I
30	2482.713	I	150	923.39	II	20	2345.43	I	320	3131.84	I
40	2483.821	I	200	940.80	II	20	2352.48	I	400	3208.20	II
90	2534.769	I	100	962.74	II	100	2378.32	I	400	3264.06	II
15000	2536.506	I	50	969.13	II	20	2380.00	I	5	3283.02	III
25	2563.861	I	1	988.89	III	4	2380.55	III	12	3312.28	III
25	2576.290	I	2	1009.29	III	40	2399.38	I	80	3341.48	I
250	2652.043	I	5	1068.03	III	20	2399.73	I	100	3385.25	II
400	2653.683	I	800	1099.26	II	10	2400.49	I	8	3389.01	III
100	2655.130	I	2	1161.95	III	60	2407.35	II	5	3450.77	III
50	2698.831	I	80	1250.58	I	50	2414.13	II	400	3451.69	II
80	2752.783	I	8	1259.24	I	8	2431.65	III	3	3500.35	III
20	2759.710	I	100	1268.82	I	5	2441.06	I	4	3538.88	III
40	2803.471	I	5	1307.75	I	20	2446.90	I	200	3549.42	II
30	2804.438	I	300	1307.93	II	15	2464.06	I	5	3557.24	III
750	2847.675	II	400	1321.71	II	5	2480.56	III	2800	3650.15	I
50	2856.939	I	400	1331.74	II	40	2482.00	I	300	3654.84	I
150	2893.598	I	80	1350.07	II	30	2482.72	I	80	3662.88	I
150	2916.227	II	200	1361.27	II	40	2483.82	I	240	3663.28	I
60	2925.413	I	20	1402.62	I	7	2484.50	III	30	3701.44	I
1200	2967.283	I	200	1414.43	II	90	2534.77	I	35	3704.17	I
300	3021.500	I	10	1435.51	I	15000	2536.52	I	30	3801.66	I
120	3023.476	I	15	1619.46	II	25	2563.86	I	15	3803.51	III
30	3025.608	I	120	1623.95	II	25	2576.29	I	100	3806.38	II
50	3027.490	I	20	1628.25	II	5	2578.91	I	20	3901.87	I
400	3125.670	I	150	1649.94	II	2	2612.92	III	60	3906.37	I
320	3131.551	I	50	1653.64	II	4	2617.97	III	100	3918.92	II
320	3131.842	I	200	1672.41	II	15	2625.19	I	200	3983.96	II
80	3341.481	I	9	1681.40	III	5	2639.78	I	1800	4046.56	I
2800	3650.157	I	100	1702.73	II	250	2652.04	I	150	4077.83	I
300	3654.839	I	100	1707.40	II	400	2653.69	I	40	4108.05	I
80	3662.883	I	120	1727.18	II	100	2655.13	I	70	4122.07	III
240	3663.281	I	250	1732.14	II	3	2670.49	III	10	4140.34	III
30	3701.432	I	15	1759.75	III	5	2674.91	I	100	4216.74	III
35	3704.170	I	20	1775.68	I						

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
250	4339.22	I	120	13209.95	I	150	2269.71	III	80	2834.39	II
400	4347.49	I	140	13426.57	I	200	2294.97	III	80	2835.33	II
4000	4358.33	I	60	13468.38	I	160	2304.25	II	160	2842.15	II
100	4398.62	II	80	13505.58	I	160	2306.97	II	1700	2848.23	II
15	4470.58	III	500	13570.21	I	150	2330.93	III	370	2853.23	II
12	4552.84	III	450	13673.51	I	110	2332.12	II	370	2863.81	II
90	4660.28	II	200	13950.55	I	190	2341.59	II	220	2866.69	II
50	4797.01	III	500	15295.82	I	100	2359.76	III	1700	2871.51	II
80	4855.72	II	100	16881.48	I	110	2389.20	II	85	2872.88	II
10	4869.85	III	400	16920.16	I	140	2403.61	II	220	2879.05	II
5	4883.00	I	300	16942.00	I	120	2413.01	II	65	2888.15	II
5	4889.91	I	500	17072.79	I	85	2498.28	II	1300	2890.99	II
80	4916.07	I	400	17109.93	I	200	2506.19	III	95	2891.28	II
5	4970.37	I	20	17116.75	I	440	2538.46	II	190	2892.81	II
80	4973.57	III	20	17198.67	I	330	2542.67	II	950	2894.45	II
5	4980.64	I	20	17213.20	I	80	2558.88	II	140	2897.63	II
20	5102.70	I	70	17329.41	I	85	2564.34	II	70	2900.80	II
40	5120.64	I	30	17436.18	I	250	2593.70	II	290	2903.07	II
100	5128.45	II	50	18130.38	I	250	2602.80	II	80	2907.12	II
20	5137.94	I	40	19700.17	I	400	2616.78	I	600	2909.12	II
30	5210.82	III		22493.28	I	440	2629.85	I	1100	2911.92	II
20	5290.74	I	250	23253.07	I	330	2636.67	II	120	2918.83	II
5	5316.78	I		32148.06	I	720	2638.76	II	1300	2923.39	II
60	5354.05	I		36303.03	I	410	2640.99	I	140	2924.32	II
30	5384.63	I	<i>Molybdenum Mo Z = 42</i>			600	2644.35	II	1100	2930.50	II
1100	5460.74	I	50	867.92	IV	370	2646.49	II	800	2934.30	II
30	5549.63	I	100	884.19	IV	640	2649.46	I	95	2940.10	II
160	5675.86	I	60	886.05	IV	480	2653.35	II	110	2941.22	II
6	5695.71	III	50	891.74	IV	560 h	2655.03	I	150	2944.82	II
240	5769.60	I	100	1169.33	III	640	2660.58	II	140	2946.69	II
100	5789.66	I	100	1254.93	III	720	2672.84	II	95	2947.28	II
280	5790.66	I	100	1258.52	III	250	2673.27	II	125	2947.32	III
140	5803.78	I	100	1262.21	III	1000	2679.85	I	95	2955.84	II
60	5859.25	I	100	1263.74	III	95	2681.36	II	240	2956.06	II
60	5871.73	II	100	1274.37	III	640	2683.23	II	70	2956.90	II
20	5871.98	I	100	1276.40	III	880	2684.14	II	95	2960.24	II
20	6072.72	I	100	1277.40	III	560	2687.99	II	250	2963.79	II
1000	6149.50	II	200	1277.58	III	480	2701.42	II	210	2965.27	II
25	6220.35	III	200	1278.40	III	190	2713.51	II	70	2971.91	II
30	6234.40	I	150	1281.90	III	290	2717.35	II	250	2972.61	II
35	6418.98	III	150	1283.60	III	85	2726.97	II	80	2975.40	II
40	6501.38	III	100	1854.73	III	140	2729.68	II	95	2992.84	II
80	6521.13	II	80	1926.26	IV	80	2730.20	II	95	3027.77	II
10	6584.26	III	100	1929.24	IV	330	2732.88	II	100	3060.78	II
6	6610.12	III	80	1971.06	IV	160	2736.96	II	800	3064.28	I
30	6709.29	III	70	2010.92	IV	80 h	2737.88	II	250	3065.04	II
160	6716.43	I	19000	2015.11	II	290	2746.30	II	800	3074.37	I
250	6907.52	I	40000	2020.30	II	110	2756.07	II	85	3077.66	II
250	7081.90	I	21000	2038.44	II	220	2763.62	II	800	3085.62	I
200	7091.86	I	17000	2045.98	II	240	2769.76	II	270	3087.62	II
40	7346.37	II	50	2060.38	IV	160	2773.78	II	190	3092.07	II
100	7485.87	II	4800	2081.68	II	190	2774.39	II	560	3094.66	I
12	7517.46	III	2400	2089.52	II	1700	2775.40	II	560	3101.34	I
20	7728.82	I	2200	2092.50	II	65	2777.86	II	1400	3112.12	I
7	7808.10	III	4000	2093.11	II	880	2780.04	II	290	3122.00	II
100	7944.66	II	2700	2100.84	II	400	2784.99	II	14000	3132.59	I
25	7946.75	III	1500	2104.29	II	100	2807.74	III	110	3138.72	II
50	7984.51	III	1400	2108.02	II	400	2807.76	II	220	3152.82	II
5	8151.64	III	100	2184.37	III	1700	2816.15	II	55	3155.64	II
2000	10139.75	I	100	2211.02	III	220	2817.44	II	6000	3158.16	I
240	11287.40	I	400	2269.69	II	80	2827.74	II	8700	3170.35	I





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
140	234.32	IV	100	542.07	IV	300	2216.07	III	150	2963.24	II
120	234.70	IV	150	543.89	IV	10	2220.81	IV	150	2967.18	II
20	251.14	III	400	568.42	V	75	2227.42	V	100	2973.10	II
20	251.56	III	250	569.76	V	110	2232.41	V	15	2974.72	I
20	251.73	III	500	569.83	V	65	2245.48	V	100	2979.46	II
40	267.06	III	250	572.11	V	250	2258.02	IV	12	2982.67	I
40	267.52	III	800	572.34	V	65	2259.57	V	150	3001.67	II
20	267.71	III	35	587.213	I	175	2262.08	IV	120 p	3017.31	II
40	283.18	III	35	589.179	I	240	2263.21	III	300	3027.02	II
160	283.21	III	35	589.911	I	65	2263.39	V	300	3028.86	II
110	283.69	III	70	591.830	I	110	2264.54	IV	100	3030.79	II
40	283.89	III	100	595.920	I	200	2264.91	III	120	3034.46	II
220	301.12	III	75	598.706	I	250	2265.71	V	100	3035.92	II
220	313.05	III	35	598.891	I	550	2285.79	IV	100	3037.72	II
220	313.68	III	70	600.036	I	30	2293.14	IV	100	3039.59	II
40	313.95	III	170	602.726	I	250	2293.49	IV	100	3044.09	II
90	352.956	I	170	615.628	I	250	2350.84	IV	100	3045.56	II
60	354.962	I	170	618.672	I	450	2352.52	IV	120	3047.56	II
50	357.83	IV	120	619.102	I	700	2357.96	IV	100	3054.34	II
400	357.96	V	200	626.823	I	250	2362.68	IV	100	3054.68	II
500	358.47	V	200	629.739	I	250	2363.28	IV	100	3059.11	II
200	358.72	IV	1000	735.896	I	110	2365.49	IV	100	3062.49	II
500	359.38	V	400	743.720	I	350	2372.16	IV	100	3063.30	II
90	361.433	II	60	993.88	I	65	2384.20	IV	100	3070.89	II
60	362.455	II	70	1068.65	I	350	2384.95	IV	100	3071.53	II
1000	365.59	V	90	1131.72	I	300	2412.73	III	100	3075.73	II
220	379.31	III	100	1131.85	II	240	2412.94	III	120	3088.17	II
125	387.14	IV	90	1229.83	I	200	2413.78	III	100	3092.09	II
100	388.22	IV	20	1255.03	III	200	2473.40	III	120	3092.90	II
150	405.854	II	110	1255.68	III	80 p	2562.12	II	100	3094.01	II
120	407.138	II	160	1257.19	III	90 w	2567.12	II	100	3095.10	II
800	416.20	V	90	1418.38	I	800	2590.04	III	100	3097.13	II
150	421.61	IV	90	1428.58	I	600	2593.60	III	100	3117.98	II
200	445.040	II	90	1436.09	I	400	2595.68	III	120	3118.16	II
300	446.256	II	120	1681.68	II	300	2610.03	III	10	3126.199	I
250	446.590	II	180	1688.36	II	240	2613.41	III	300	3141.33	II
180	447.815	II	100	1888.11	II	200	2615.87	III	100	3143.72	II
150	454.654	II	100	1889.71	II	80	2623.11	II	100 p	3148.68	II
200	455.274	II	200	1907.49	II	80	2629.89	II	100	3164.43	II
10	456.275	II	500	1916.08	II	90 w	2636.07	II	100	3165.65	II
120	456.348	II	300	1930.03	II	80	2638.29	II	100	3188.74	II
90	456.896	II	200	1938.83	II	200	2638.70	III	120	3194.58	II
1000	460.728	II	100 c	1945.46	II	200	2641.07	III	500	3198.59	II
500	462.391	II	80	2007.01	II	80	2644.10	II	60	3208.96	II
140	469.77	IV	65	2018.44	IV	600	2677.90	III	120	3209.36	II
200	469.82	IV	110	2022.19	IV	500	2678.64	III	120	3213.74	II
180	469.87	IV	80	2025.56	II	80	2762.92	II	150	3214.33	II
140	469.92	IV	150	2085.47	II	90	2792.02	II	150	3218.19	II
250	480.41	V	200	2086.96	III	80	2794.22	II	120	3224.82	II
150	481.28	V	300	2089.43	III	100	2809.48	II	120	3229.57	II
250	481.36	V	240	2092.44	III	80	2906.59	II	200	3230.07	II
500	482.99	V	400	2095.54	III	80	2906.82	II	120	3230.42	II
285	488.10	III	180	2096.11	II	90	2910.06	II	120	3232.02	II
220	488.87	III	120	2096.25	II	90	2910.41	II	150	3232.37	II
450	489.50	III	200	2161.22	III	80	2911.14	II	100	3243.40	II
70	489.64	III	300	2163.77	III	80	2915.12	II	100	3244.10	II
220	490.31	III	200	2180.89	III	80	2925.62	II	100	3248.34	II
360	491.05	III	30	2203.88	IV	80 w	2932.10	II	100	3250.36	II
120	521.74	IV	200	2209.35	III	80	2940.65	II	150	3297.73	II
140	521.82	IV	200	2211.85	III	90	2946.04	II	150	3309.74	II
80	541.13	IV	240	2213.76	III	150	2955.72	II	300	3319.72	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1000	3323.74	II	250	3727.11	II	100	6074.338	I	1000	8571.352	I
150	3327.15	II	800	3766.26	II	80	6096.163	I	4000	8591.259	I
100	3329.16	II	1000	3777.13	II	60	6128.450	I	6000	8634.647	I
200	3334.84	II	100	3818.43	II	100	6143.063	I	3000	8647.041	I
150	3344.40	II	120	3829.75	II	120	6163.594	I	15000	8654.383	I
300	3345.45	II	150	4219.74	II	250	6182.146	I	4000	8655.522	I
150	3345.83	II	100	4233.85	II	150	6217.281	I	100	8668.26	II
200	3355.02	II	120	4250.65	II	150	6266.495	I	5000	8679.492	I
120	3357.82	II	120	4369.86	II	60	6304.789	I	5000	8681.921	I
200	3360.60	II	70	4379.40	II	100	6334.428	I	2000	8704.112	I
120	3362.16	II	150	4379.55	II	120	6382.992	I	4000	8771.656	I
100	3362.71	II	100	4385.06	II	200	6402.246	I	12000	8780.621	I
120	3367.22	II	200	4391.99	II	150	6506.528	I	10000	8783.753	I
12	3369.808	I	150	4397.99	II	60	6532.882	I	500	8830.907	I
40	3369.908	I	150	4409.30	II	150	6598.953	I	7000	8853.867	I
100	3371.80	II	100	4413.22	II	70	6652.093	I	1000	8865.306	I
500	3378.22	II	100	4421.39	II	90	6678.276	I	1000	8865.755	I
150	3388.42	II	100 p	4428.52	II	20	6717.043	I	3000	8919.501	I
120	3388.94	II	100 p	4428.63	II	100	6929.467	I	2000	8988.57	I
300	3392.80	II	150 p	4430.90	II	90	7024.050	I	100	9079.46	II
100	3404.82	II	150 p	4430.94	II	100	7032.413	I	6000	9148.67	I
120	3406.95	II	120	4457.05	II	50	7051.292	I	6000	9201.76	I
100	3413.15	II	100	4522.72	II	80	7059.107	I	4000	9220.06	I
120	3416.91	II	10	4537.754	I	100	7173.938	I	2000	9221.58	I
120	3417.69	II	10	4540.380	I	150	7213.20	II	2000	9226.69	I
50	3417.904	I	100	4569.06	II	150	7235.19	II	1000	9275.52	I
15	3418.006	I	15	4704.395	I	100	7245.167	I	200	9287.56	II
120	3428.69	II	12	4708.862	I	150	7343.94	II	6000	9300.85	I
60	3447.703	I	10	4710.067	I	40	7472.439	I	1500	9310.58	I
50	3454.195	I	10	4712.066	I	90	7488.871	I	3000	9313.97	I
100	3456.61	II	15	4715.347	I	100	7492.10	II	6000	9326.51	I
100	3459.32	II	10	4752.732	I	150	7522.82	II	2000	9373.31	I
25	3460.524	I	12	4788.927	I	80	7535.774	I	5000	9425.38	I
30	3464.339	I	10	4790.22	I	60	7544.044	I	3000	9459.21	I
30	3466.579	I	10	4827.344	I	100	7724.628	I	5000	9486.68	I
60	3472.571	I	10	4884.917	I	120	7740.74	II	5000	9534.16	I
150	3479.52	II	4	5005.159	I	300	7839.055	I	3000	9547.40	I
200	3480.72	II	10	5037.751	I	120	7926.20	II	120	9577.01	II
200	3481.93	II	10	5144.938	I	400	7927.118	I	1000	9665.42	I
25	3498.064	I	25	5330.778	I	700	7936.996	I	100	9808.86	II
30	3501.216	I	20	5341.094	I	2000	7943.181	I	800	10295.42	I
25	3515.191	I	8	5343.283	I	2000	8082.458	I	2000	10562.41	I
150	3520.472	I	60	5400.562	I	100	8084.34	II	1500	10798.07	I
120	3542.85	II	5	5562.766	I	1000	8118.549	I	2000	10844.48	I
120	3557.80	II	10	5656.659	I	600	8128.911	I	3000	11143.020	I
100	3561.20	II	5	5719.225	I	3000	8136.406	I	3500	11177.528	I
250	3568.50	II	12	5748.298	I	2500	8259.379	I	1600	11390.434	I
100	3574.18	II	80	5764.419	I	100	8264.81	II	1100	11409.134	I
200	3574.61	II	12	5804.450	I	2500	8266.077	I	3000	11522.746	I
50	3593.526	I	40	5820.156	I	800	8267.117	I	1500	11525.020	I
30	3593.640	I	500	5852.488	I	6000	8300.326	I	950	11536.344	I
15	3600.169	I	100	5872.828	I	100	8315.00	II	500	11601.537	I
20	3633.665	I	100	5881.895	I	1500	8365.749	I	1200	11614.081	I
150	3643.93	II	60	5902.462	I	100	8372.11	II	300	11688.002	I
200	3664.07	II	60	5906.429	I	8000	8377.606	I	2000	11766.792	I
20	3682.243	I	100	5944.834	I	1000	8417.159	I	1500	11789.044	I
12	3685.736	I	100	5965.471	I	4000	8418.427	I	500	11789.889	I
200	3694.21	II	100	5974.627	I	1500	8463.358	I	1000	11984.912	I
10	3701.225	I	120	5975.534	I	800	8484.444	I	3000	12066.334	I
150	3709.62	II	80	5987.907	I	5000	8495.360	I	800	12459.389	I
250	3713.08	II	100	6029.997	I	600	8544.696	I	1000	12689.201	I







Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1400	2313.66	I	530	3612.74	I	500 w	9900.92	II	100	2362.06	III
1400	2313.98	I	6600	3619.39	I				80	2362.50	III
1000	2316.04	II	200	3664.10	I	<i>Niobium Nb Z = 41</i>					
1400	2317.16	I	130	3669.24	I	80	464.55	V	80	2365.70	III
2600	2320.03	I	180	3670.43	I	80	468.32	V	100	2372.73	III
1900	2321.38	I	260	3674.15	I	80	763.77	V	170	2376.40	II
1400	2325.79	I	160	3688.42	I	80	774.02	V	110	2387.09	II
940	2329.96	I	80	3693.93	I	60	993.54	IV	100	2387.41	III
1200	2345.54	I	120	3722.48	I	400	1005.72	IV	140	2387.52	II
400	2347.52	I	150	3736.81	I	500	1007.05	IV	80	2388.23	III
1000	2375.42	II	60	3739.23	I	500	1010.19	IV	45	2388.27	II
240	2386.58	I	600	3775.57	I	100	1116.08	IV	160	2398.48	II
1000	2394.52	II	700	3783.53	I	150	1120.02	IV	80	2404.89	III
2000	2416.13	II	700	3807.14	I	100	1258.87	V	55	2405.34	II
240	2419.31	I	110	3831.69	I	100	1258.87	V	55	2405.85	II
160	2472.06	I	1200	3858.30	I	60	1314.56	III	140	2412.46	II
150	2798.65	I	110	3973.56	I	80	1445.43	III	100	2413.94	III
250	2821.29	I	110	4401.55	I	80	1445.98	III	160	2416.99	II
500	2943.91	I	85	4459.04	I	80	1447.09	III	140	2418.69	II
570	2981.65	I	55	4470.48	I	100	1456.68	III	100	2421.91	III
500	2992.60	I	65	4605.00	I	80	1484.73	III	75	2433.80	II
1000	2994.46	I	75	4648.66	I	100	1495.94	III	40	2435.95	II
4000	3002.49	I	110	4714.42	I	80	1498.02	III	45	2437.42	II
2200	3003.63	I	45	4786.54	I	80	1499.45	III	40	2442.14	II
3700	3012.00	I	45	4855.41	I	100	1501.99	III	28	2442.68	II
1700	3037.94	I	40	4904.41	I	60	1502.30	IV	65	2451.87	II
3500	3050.82	I	40	4904.41	I	80	1513.81	III	65	2453.95	II
1500	3054.32	I	45	4980.16	I	60	1524.36	IV	100	2456.99	III
1900	3057.64	I	45	4984.13	I	100	1524.91	III	55	2458.09	II
500	3064.62	I	50	5017.59	I	100	1590.21	III	65	2462.89	I
2600	3101.55	I	100	5035.37	I	80	1598.86	III	80	2468.72	III
1300	3101.88	I	100	5080.52	I	80	1604.72	III	80	2475.87	III
2900	3134.11	I	65	5081.11	I	80	1639.51	III	110	2477.38	II
1100	3232.96	I	40 h	5146.48	I	100	1682.77	III	65	2478.29	II
600	3243.06	I	40 h	5155.76	I	100	1705.44	III	65	2479.94	II
660	3315.66	I	180	5476.91	I	100	1707.14	III	35	2483.88	II
2000	3331.88	II	23	5709.56	I	100	1758.33	V	100	2499.73	III
2900	3369.57	I	16	5754.68	I	100	1877.34	V	110	2511.00	II
3300	3380.57	I	10	5857.76	I	100	1892.92	III	110	2521.40	II
1300	3391.05	I	10	5892.88	I	60	1922.41	IV	390	2544.80	II
3300	3392.99	I	10	6108.12	I	100	1938.84	III	100	2545.64	III
8200	3414.76	I	10	6176.81	I	60	1978.22	IV	110	2551.38	II
1600	3423.71	I	10	6191.18	I	3300	2029.32	II	130	2556.94	II
2600	3433.56	I	13	6256.36	I	65	2032.53	IV	80	2557.94	III
990	3437.28	I	16	6643.64	I	3000	2032.99	II	130	2562.41	II
4800	3446.26	I	22	6767.77	I	2000	2109.42	II	110	2571.33	II
1300	3452.89	I	10	6914.56	I	1700	2125.21	II	390	2583.99	II
5000	3458.47	I	26	7122.20	I	1100	2126.54	II	390	2590.94	II
5000	3461.65	I	16	7393.60	I	80 h	2130.24	III	80	2598.86	III
1600	3472.54	I	16	7409.35	I	1500	2131.18	II	80	2633.17	III
550	3483.77	I	23	7422.28	I	80	2273.92	III	200	2642.24	II
5500	3492.96	I	13	7522.76	I	100	2275.23	III	320	2646.26	II
660	3500.85	I	19	7555.60	I	80	2279.36	III	330	2647.50	I
2600	3510.34	I	23	7617.00	I	100	2281.51	III	330	2654.45	I
6600	3515.05	I	16	7714.32	I	80	2284.40	III	310	2656.08	II
660	3519.77	I	19	7727.61	I	100	2290.36	III	80	2657.99	III
8200	3524.54	I	19	7748.89	I	370	2295.68	II	110	2665.25	II
5000	3566.37	I	10	7788.94	I	280	2302.08	II	110	2666.59	II
990	3571.87	I	13	7797.59	I	100	2313.30	III	110	2667.30	II
1300	3597.70	I	1000	8096.75	II	100	2338.09	III	400	2671.93	II
1300	3610.46	I	700	8121.48	II	80	2344.12	III	200	2673.57	II
			9	8862.55	I	90	2349.21	III	200	2675.94	II
						80	2355.54	III			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
160	2691.77	II	80	3142.26	III	500	3584.97	I	350	4143.21	I
1000	2697.06	II	390	3145.40	II	750	3589.11	I	870	4150.12	I
320	2698.86	II	1200	3163.40	II	500	3589.36	I	4400	4152.58	I
320	2702.20	II	150	3175.78	II	500	3593.97	I	870	4163.47	I
150	2702.52	II	390	3180.29	II	500	3602.56	I	4400	4163.66	I
470	2716.62	II	300	3191.10	II	300	3619.51	II	4000	4164.66	I
470	2721.98	II	150	3191.43	II	420	3649.85	I	3500	4168.13	I
310	2733.26	II	1000	3194.98	II	400	3651.19	II	310	4184.44	I
110	2737.09	II	120	3203.35	II	200	3659.61	II	1200	4190.88	I
240	2768.13	II	300	3206.34	II	630	3660.37	I	870	4192.07	I
310	2773.20	I	390	3215.60	II	900	3664.70	I	870	4195.09	I
270	2780.24	II	800	3225.48	II	1500	3697.85	I	1300	4195.66	I
110	2793.05	II	140	3229.56	II	330	3711.34	I	310	4198.51	I
190	2827.08	II	400	3236.40	II	3300	3713.01	I	350	4201.52	I
250	2841.15	II	200	3247.47	II	480	3716.99	I	870	4205.31	I
280	2842.65	II	120	3248.94	II	2700	3726.24	I	350	4214.73	I
160	2846.28	II	320	3254.07	II	2700	3739.80	I	420	4217.94	I
240	2861.09	II	230	3260.56	II	670	3740.73	II	420	4229.15	I
100	2865.61	II	160	3263.37	II	1700	3742.39	I	770	4262.05	I
500	2868.52	II	200	3283.46	II	530	3763.49	I	420	4266.02	I
800	2875.39	II	160	3292.02	II	350	3765.08	I	400	4286.99	I
270	2876.95	II	320	3296.01	I	530	3771.85	I	580	4299.60	I
530	2877.03	II	400	3312.60	I	870	3781.01	I	580	4300.99	I
100	2880.72	II	120	3319.58	II	1700	3787.06	I	390	4311.27	I
570	2883.18	II	130	3341.60	II	1300	3790.15	I	350	4326.33	I
280	2888.83	II	1300	3341.97	I	3500	3791.21	I	390	4331.37	I
470	2897.81	II	1300	3343.71	I	2700	3798.12	I	330	4410.21	I
400	2899.24	II	1700	3349.06	I	2700	3802.92	I	150	4503.04	I
470	2908.24	II	420	3349.52	I	670	3803.88	I	530	4523.41	I
670	2910.59	II	340	3354.74	I	530	3804.74	I	480	4546.82	I
470	2911.74	II	1700	3358.42	I	670	3810.49	I	370	4564.53	I
1100	2927.81	II	130	3365.58	II	530	3811.03	I	720	4573.08	I
110	2931.47	II	340	3366.96	I	530	3815.51	I	480	4581.62	I
870	2941.54	II	130	3369.16	II	210	3818.86	II	1200	4606.77	I
110 h	2945.88	II	350	3374.92	I	670	3824.88	I	170	4616.17	I
110	2946.12	II	170	3386.24	II	350	3835.18	I	450	4630.11	I
110	2946.90	II	350	3392.34	I	350	3863.38	I	450	4648.95	I
1100	2950.88	II	230	3408.68	II	530	3877.56	I	450	4663.83	I
400	2972.57	II	180	3409.19	II	870	3878.82	I	340	4666.24	I
320	2974.10	II	230	3412.94	II	670	3883.14	I	240	4667.22	I
210	2977.68	II	230	3425.42	II	1100	3885.44	I	580	4672.09	I
200	2982.11	II	230	3426.57	II	670	3885.68	I	530	4675.37	I
330	2990.26	II	180	3432.70	II	580	3891.30	I	320	4685.14	I
470	2994.73	II	180	3440.59	II	670	3914.70	I	130 c	4706.14	I
80	3001.84	III	200	3479.56	II	530	3920.20	I	260	4708.29	I
140	3024.74	II	100	3484.05	II	670	3937.44	I	150	4713.50	I
350	3028.44	II	500	3498.63	I	520	3943.67	I	220 c	4749.70	I
300	3032.77	II	460	3507.96	I	910 d	3966.09	I	130 c	4967.78	I
100	3044.76	II	200	3510.26	II	1100	4032.52	I	190	4988.97	I
100	3055.52	II	200	3515.42	II	16000 c	4058.94	I	230	5017.75	I
220	3064.53	II	200	3517.67	II	350	4060.79	I	150	5026.36	I
110	3069.68	II	2000	3535.30	I	12000	4079.73	I	210	5039.04	I
100	3070.90	II	1300	3537.48	I	440	4100.40	I	170	5058.01	I
110	3071.56	II	250	3540.96	II	6700	4100.92	I	130	5065.25	I
100	3073.24	II	500	3544.02	I	310	4116.90	I	750	5078.96	I
400	3076.87	II	300	3550.45	I	5300	4123.81	I	420	5095.30	I
110	3080.35	II	1000	3554.66	I	670	4129.43	I	170	5100.16	I
1800	3094.18	II	630	3563.50	I	770	4129.93	I	170	5120.30	I
140	3099.19	II	630	3563.62	I	2300	4137.10	I	210	5134.75	I
270	3127.53	II	1500	3575.85	I	440	4139.44	I	250	5160.33	I
1500	3130.79	II	5000	3580.27	I	2700	4139.71	I	250	5164.38	I



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
150	1919.55	III	360	3919.00	II	185	5281.20	I	450	7762.24	II
150	1919.77	III	90	3938.52	III	140	5292.68	I	400	8184.87	I
300	1920.65	III	450	3955.85	II	90	5314.35	III	400	8188.02	I
150	1920.84	III	1000	3995.00	II	200	5320.82	III	250	8200.36	I
200	1921.30	III	150	3998.63	III	150	5327.18	III	300	8210.72	I
200	2064.01	III	200	4003.58	III	450	5495.67	II	570	8216.34	I
250	2064.42	III	360	4035.08	II	285	5535.36	II	400	8223.14	I
120	2068.68	III	550	4041.31	II	650	5666.63	II	400	8242.39	I
90	2071.09	III	360	4043.53	II	550	5676.02	II	550	8438.74	II
90	2080.34	IV	150	4057.76	IV	870	5679.56	II	500	8567.74	I
160	2095.53	II	250	4097.33	III	450	5686.21	II	570	8594.00	I
70	2096.20	II	140	4099.94	I	450	5710.77	II	650	8629.24	I
110	2096.86	II	200	4103.43	III	285	5747.30	II	500	8655.89	I
90	2117.59	III	185	4109.95	I	700	5752.50	I	220	8676.08	II
90	2121.50	III	285	4176.16	II	240	5764.75	I	700	8680.28	I
110	2130.18	II	120	4195.76	III	265	5829.54	I	650	8683.40	I
160	2142.78	II	150	4200.10	III	235	5854.04	I	500	8686.15	I
90	2147.31	III	285	4227.74	II	360	5927.81	II	110	8687.43	II
200	2188.20	III	285	4236.91	II	550	5931.78	II	110 h	8699.00	II
150	2188.38	III	220	4237.05	II	285	5940.24	II	500	8703.25	I
160	2206.09	II	450	4241.78	II	650	5941.65	II	160 h	8710.54	II
160	2286.69	II	90	4332.91	III	285	5952.39	II	570	8711.70	I
110	2288.44	II	120	4345.68	III	160	5999.43	I	500	8718.83	I
220	2316.49	II	300	4379.11	III	210	6008.47	I	250	8728.89	I
160	2316.69	II	285	4432.74	II	285	6167.76	II	200	8747.36	I
285	2317.05	II	650	4447.03	II	360	6379.62	II	500	9386.80	I
90 w	2318.09	IV	90	4510.91	III	150	6380.77	IV	570	9392.79	I
160	2461.27	II	120	4514.86	III	185	6411.65	I	250	9460.68	I
150	2477.69	IV	360	4530.41	II	210	6420.64	I	200	9863.33	I
110	2496.83	II	550	4601.48	II	210	6423.02	I	160 h	9865.41	II
70	2496.97	II	350	4603.73	V	210	6428.32	I	110 h	9868.21	II
110	2520.22	II	90	4606.33	IV	185	6437.68	I	160 h	9887.39	II
160	2520.79	II	450	4607.16	II	235	6440.94	I	220 h	9891.09	II
220	2522.23	II	360	4613.87	II	90	6454.11	III	160 h	9961.86	II
110	2590.94	II	250	4619.98	V	185	6457.90	I	220 h	9969.34	II
250	2645.65	IV	450	4621.39	II	120	6467.02	III	285 h	10023.27	II
300	2646.18	IV	870	4630.54	II	300	6468.44	I	220 h	10035.45	II
350	2646.96	IV	90	4634.14	III	265	6481.71	I	220 h	10065.15	II
250 w	2682.18	III	120	4640.64	III	750	6482.05	II	160 h	10070.12	II
90	2689.20	III	550	4643.08	II	360	6482.70	I	250	10105.13	I
160	2709.84	II	285	4788.13	II	300	6483.75	I	300	10108.89	I
110	2799.22	II	450	4803.29	II	325	6484.80	I	350	10112.48	I
110	2823.64	II	180	4847.38	I	160	6491.22	I	400	10114.64	I
60 l	2859.16	V	90	4858.82	III	210	6499.54	I	110 h	10126.27	II
160	2885.27	II	150	4867.15	III	185	6506.31	I	250	10539.57	I
90 l	2974.52	V	285	4895.11	II	750	6610.56	II	200	12074.51	I
150 w	2980.78	V	160	4914.94	I	185	6622.54	I	380	12186.82	I
250 w	2981.31	V	210	4935.12	I	185	6636.94	I	225	12288.97	I
60 w	2998.43	V	200 w	4944.56	V	235	6644.96	I	290	12328.76	I
220	3006.83	II	160	4950.23	I	185	6646.50	I	310	12381.65	I
90	3078.25	IV	350	4963.98	I	235	6653.46	I	180	12438.40	I
120	3367.34	III	285	4987.37	II	210	6656.51	I	510	12461.25	I
360	3437.15	II	450	4994.36	II	185	6722.62	I	920	12469.62	I
90	3463.37	IV	650	5001.48	II	210	7398.64	I	500	13429.61	I
570	3478.71	IV	360	5002.70	II	160	7406.12	I	840	13581.33	I
500	3482.99	IV	870	5005.15	II	265	7406.24	I	180	13587.73	I
400	3484.96	IV	550	5007.32	II	685	7423.64	I	180	13602.27	I
90	3747.54	IV	450	5010.62	II	785	7442.29	I	290	13624.18	I
90	3754.67	III	360	5016.39	II	900	7468.31	I	250	14757.07	I
120	3771.05	III	360	5025.66	II	185	7608.80	I	100	14868.87	I
285	3838.37	II	550	5045.10	II	60 w	7618.46	V	160	14966.60	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
180	15582.27	I	960	2770.71	I	35	5203.23	I	150	202.393	V
120 s	17516.58	I	2800	2806.91	I	45	5255.82	I	110	203.78	V
100 l	17584.86	I	5100	2838.63	I	55	5265.15	I	150	203.82	V
100	17878.26	I	2300	2844.40	I	40	5298.78	I	100	203.85	V
<i>Osmium Os Z = 76</i>			1500	2850.76	I	110	5376.79	I	200	203.89	V
9600	2001.45	I	1500	2860.96	I	120	5416.34	I	100	203.94	V
13000	2003.73	I	9600	2909.06	I	45	5416.69	I	110	207.18	IV
17000	2010.15	I	2100	2912.33	I	28	5417.51	I	150	207.24	IV
29000	2018.14	I	2100	2919.79	I	55	5443.31	I	300	207.794	V
14000	2022.76	I	1100 h	2948.23	I	22	5446.93	I	150	215.040	V
14000	2028.23	I	1400	2949.53	I	22	5457.30	I	200	215.103	V
18000	2034.44	I	4400	3018.04	I	28	5470.00	I	250	215.245	V
26000	2045.36	I	1100	3030.70	I	22	5509.33	I	250	216.018	V
8600	2058.69	I	2900	3040.90	I	270	5523.53	I	520	220.352	V
13000	2061.69	I	120	3042.74	II	22	5546.82	I	80	227.372	V
7800	2067.21	II	8600	3058.66	I	80	5584.44	I	80	227.469	V
4200	2070.67	II	1100	3077.72	I	35	5620.08	I	150	227.511	V
7200	2076.95	I	3100	3156.25	I	22	5642.56	I	80	227.549	V
14000	2079.97	I	180	3173.93	II	28	5645.25	I	80	227.634	V
2900	2082.54	I	150	3213.31	II	28	5680.88	I	80	227.689	V
2900	2089.03	I	1900	3232.06	I	170	5721.93	I	150	231.823	V
2900	2089.21	I	3100	3262.29	I	22	5765.05	I	140	233.46	IV
6000	2097.60	I	3100	3267.94	I	170	5780.82	I	150	233.50	IV
5300	2100.63	I	1200	3290.26	I	40	5800.60	I	110	233.52	IV
2100	2117.66	I	7600	3301.56	I	110	5857.76	I	200	233.56	IV
4800	2117.96	I	960	3336.15	I	28	5860.64	I	110	233.60	IV
5300	2137.11	I	960	3370.59	I	65	5996.00	I	90	238.36	IV
2600	2154.59	I	620	3387.84	I	35	6227.70	I	180	238.57	IV
1300	2157.84	I	620	3401.86	I	22	6269.41	I	110	248.459	V
1200	2158.53	I	620	3504.66	I	22	6403.15	I	110	252.56	IV
3100	2166.90	I	1200	3528.60	I	27	6729.56	I	110	252.95	IV
1100	2167.75	I	1200	3560.86	I	22	7145.54	I	150	253.08	IV
2100	2171.65	I	620	3598.11	I	26	7602.95	I	300	260.39	IV
1100	2234.61	I	95	3604.48	II	7	8041.29	I	250	260.56	IV
1300	2252.15	I	480	3670.89	I	<i>Oxygen O Z = 8</i>					
2000	2255.85	II	3700	3752.52	I	80	124.616	V	80 d	264.34	III
1400	2264.60	I	2100	3782.20	I	110	135.523	V	110	264.48	III
1400	2282.26	II	730	3876.77	I	80	138.109	V	110	266.97	III
500	2367.35	II	1000	3963.63	I	110	139.029	V	150	266.98	III
2600	2377.03	I	730	3977.23	I	80	151.447	V	150	267.03	III
1700	2387.29	I	960	4066.69	I	110	151.477	V	150	277.38	III
1100	2395.88	I	1200	4112.02	I	150	151.546	V	300	279.63	IV
200	2423.07	II	2500	4135.78	I	80	164.574	V	375	279.94	IV
1400	2424.97	I	1200	4173.23	I	110	164.657	V	110	285.71	IV
110	2454.91	II	1200	4211.86	I	80	164.709	V	150	285.84	IV
1800	2461.42	I	4900	4260.85	I	80	166.235	V	110	286.448	V
110	2468.90	II	560	4293.95	I	80	166.235	V	80	295.62	III
530	2486.24	II	560	4311.40	I	150	167.99	V	110	295.66	III
4500	2488.55	I	4900	4420.47	I	110	170.219	V	120	295.72	III
2600	2498.41	I	540	4550.41	I	450	172.169	V	150	303.41	III
2400	2513.25	I	670	4793.99	I	250	185.745	V	150	303.46	III
780	2538.00	II	55	5031.83	I	375	192.751	V	140	303.52	III
1000	2542.51	I	45	5039.12	I	450	192.799	V	160	303.62	III
1000	2590.76	I	35	5072.88	I	520	192.906	V	160	303.69	III
1800	2613.06	I	35	5074.77	I	80	193.003	V	250	303.80	III
3800	2637.13	I	35	5079.09	I	200	194.593	V	200	305.60	III
1900	2644.11	I	90	5103.50	I	150	195.86	IV	250	305.66	III
1900	2658.60	I	55	5110.81	I	200	196.01	IV	190	305.70	III
2100	2689.82	I	140	5149.74	I	80	202.161	V	300	305.77	III
3000	2714.64	I	40	5193.52	I	80	202.224	V	190	305.84	III
1300	2720.04	I	270	5202.63	I	80	202.283	V	200	306.62	IV
						80	202.334	V	150	306.88	IV

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
450	320.979	III	775	760.445	V	220	1763.22	III	775	2789.85	V
300	328.45	III	640	761.128	V	220	1764.48	III	160	2836.26	IV
250	328.74	III	700	762.003	V	750	1767.78	III	160	2921.45	IV
300	345.31	III	70	770.793	I	550	1768.24	III	200	2941.33	V
110	355.14	III	90	771.056	I	360	1771.67	III	210	2941.65	V
90	355.33	III	520	774.518	V	110	1773.00	III	80	2959.68	III
80	355.47	III	70	775.321	I	110	1773.85	III	265	2972.29	I
200	359.02	III	200	779.734	IV	220	1779.16	III	250	2983.78	III
190	359.22	III	315	779.821	IV	160	1781.03	III	80	3017.63	III
150	359.38	III	360	779.912	IV	160	1784.85	III	80	3023.45	III
210	373.80	III	200	779.997	IV	220	1789.66	III	80	3043.02	III
200	374.00	III	640	787.711	IV	110	1848.26	III	200	3047.13	III
300	374.08	III	520	790.109	IV	110	1856.62	III	110	3059.30	III
190	374.16	III	700	790.199	IV	285	1872.78	III	460	3063.42	IV
200	374.33	III	70	791.973	I	285	1872.87	III	410	3071.61	IV
210	374.44	III	300	796.66	II	285	1874.94	III	80	3121.71	III
450	395.558	III	200	802.200	IV	160	1920.04	III	160	3122.62	II
300	434.98	III	160	802.255	IV	110	1920.75	III	220	3129.44	II
800	507.391	III	90	804.267	I	110	1921.52	III	110	3132.86	III
900	507.683	III	70	804.848	I	220	1923.49	III	450	3134.82	II
1000	508.182	III	70	805.295	I	110	1923.82	III	285	3138.44	II
1000	525.795	III	80	805.810	I	110	1926.94	III	160	3144.66	V
250	537.83	II	240	832.762	II	360	2013.27	III	160	3209.66	IV
300	538.26	II	600	832.927	III	160	2026.96	III	80	3238.57	III
220	539.09	II	450	833.332	II	220	2045.67	III	200	3260.98	III
200	539.55	II	780	833.742	III	160	2052.74	III	300	3265.46	III
150	539.85	II	600	834.467	II	30 d	2283.42	II	80	3267.31	III
700	553.330	IV	600	835.096	III	30 d	2284.89	II	220	3270.98	II
775	554.075	IV	800	835.292	III	110	2293.32	II	220	3273.52	II
850	554.514	IV	40	877.879	I	200	2300.35	II	220	3277.69	II
700	555.261	IV	130	921.296	IV	30 d	2313.05	II	360	3287.59	II
700	597.818	III	160	921.366	IV	30 d	2316.12	II	160	3305.15	II
1000	599.598	III	80	922.008	I	30 d	2316.79	II	160	3306.60	II
580	608.398	IV	200	923.367	IV	50 d	2319.68	II	80	3312.30	III
110	609.70	III	130	923.433	IV	30 d	2322.15	II	110	3340.74	III
640	609.829	IV	90	935.193	I	30 d	2339.31	II	230	3348.08	IV
160	610.04	III	40	948.686	I	200 d	2390.44	III	270	3349.11	IV
200	610.75	III	90	971.738	I	80	2394.33	III	160	3354.27	IV
100	610.85	III	40	976.448	I	110	2411.60	II	200	3375.40	IV
270	616.952	IV	160	988.773	I	80	2422.84	III	220	3377.20	II
150	617.005	IV	40	990.204	I	80	2425.55	II	130	3378.06	IV
200	617.036	IV	250	1025.762	I	250	2433.56	II	360	3381.20	IV
520	624.617	IV	90	1027.431	I	80 d	2436.06	II	360	3385.52	IV
580	625.130	IV	160	1039.230	I	80 d	2438.83	III	285	3390.25	II
640	625.852	IV	60	1040.942	I	80	2444.26	II	270	3396.79	IV
1000	629.730	V	40	1152.152	I	300	2445.55	II	360	3403.52	IV
150	644.148	II	900	1302.168	I	200	2449.372	IV	220	3407.38	II
200	672.95	II	600	1304.858	I	200	2450.040	IV	230	3409.66	IV
150	673.77	II	300	1306.029	I	200	2454.99	III	160	3409.84	II
230	681.272	V	200	1338.612	IV	200	2493.44	IV	410	3411.69	IV
70	685.544	I	130	1342.992	IV	200	2493.77	IV	230	3413.64	IV
800	702.332	III	230	1343.512	IV	200	2507.73	IV	80	3444.10	III
800	702.822	III	640	1371.292	V	230	2509.19	IV	80	3455.12	III
900	702.899	III	160	1476.89	III	200	2517.2	IV	285	3470.81	II
1000	703.850	III	160 w	1506.72	V	200	2558.06	III	200	3489.83	IV
900	718.484	II	285	1590.01	III	80	2687.53	III	160	3492.24	IV
600	718.562	II	160	1591.33	III	110	2695.49	III	230	3560.39	IV
70	744.794	I	315 w	1643.68	V	300	2733.34	II	270	3563.33	IV
700	758.678	V	160	1707.996	V	110	2747.46	II	80	3698.70	III
640	759.441	V	220	1760.12	III	1000	2781.01	V	80	3702.75	III
580	760.228	V	110	1760.42	III	920	2786.99	V	80	3703.37	III



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
110	3707.24	III	50	4469.41	II	235	7947.55	I	540	11297.68	I
220	3712.75	II	360	4590.97	II	210	7950.80	I	590	11302.38	I
110	3715.08	III	285	4596.17	II	185	7952.16	I	265	11358.69	I
315 w	3725.93	IV	80 d	4609.39	II	110	7981.94	I	490	12464.02	I
285	3727.33	II	160	4638.85	II	135	7982.40	I	450	12570.04	I
360	3729.03	IV	360	4641.81	II	190	7986.98	I	120	12990.77	I
410	3736.85	IV	450	4649.14	II	135	7987.33	I	160	13076.91	I
160	3739.92	II	160	4650.84	II	250	7995.07	I	700	13163.89	I
110	3744.00	III	360	4661.64	II	400	8221.82	I	750	13164.85	I
230	3744.89	IV	285	4676.23	II	265	8227.65	I	640	13165.11	I
360	3749.49	II	220	4699.21	II	265	8230.02	I	160	16212.06	I
150	3754.67	III	285	4705.36	II	325	8233.00	I	120	17966.70	I
80	3757.21	III	160	4924.60	II	120	8235.35	I	590	18021.21	I
250	3759.87	III	230 w	4930.27	V	120	8426.16	I	120	18041.48	I
110	3791.26	III	220	4943.06	II	810	8446.25	I	120	18042.19	I
160	3803.14	II	135	5329.10	I	1000	8446.36	I	120	18046.23	I
120	3823.41	I	160	5329.68	I	935	8446.76	I	140	18229.23	I
450	3911.96	II	190	5330.74	I	325	8820.43	I	540	18243.63	I
160	3919.29	II	90	5435.18	I	160 d	9057.01	I	140	26173.56	I
185	3947.29	I	110	5435.78	I	120	9118.29	I	<i>Palladium Pd Z = 46</i>		
160	3947.48	I	135	5436.86	I	80	9134.71	I	200	705.49	III
140	3947.59	I	120	5577.34	I	80	9150.14	I	200	727.72	III
220	3954.37	II	110	5592.37	III	80	9151.48	I	500	763.06	III
100	3954.61	I	130	5597.91	V	235	9156.01	I	500	766.42	III
200	3961.59	III	160	5958.39	I	450	9260.81	I	2000	781.02	III
450	3973.26	II	190	5958.58	I	490	9260.84	I	500	794.08	III
220	3982.20	II	80	5995.28	I	450	9260.94	I	500	797.52	III
160	4069.90	II	160	6046.23	I	400	9262.58	I	500	800.03	III
285	4072.16	II	190	6046.44	I	540	9262.67	I	500	800.10	III
450	4075.87	II	110	6046.49	I	590	9262.77	I	500	803.67	III
80 d	4083.91	II	100	6106.27	I	490	9265.94	I	500	825.35	III
50 d	4087.14	II	400	6155.98	I	640	9266.01	I	500	840.58	III
150 d	4089.27	II	450	6156.77	I	185	9399.19	I	500	856.47	III
110	4097.24	II	490	6158.18	I	120	9481.16	I	500	864.04	III
220	4105.00	II	80	6256.83	I	120 d	9482.88	I	500	880.59	III
285	4119.22	II	100	6261.55	I	235	9487.43	I	500	888.84	III
100	4123.99	V	100	6366.34	I	140	9492.71	I	1000	889.29	III
160	4132.81	II	100	6374.32	I	265	9497.97	I	300	1596.89	III
50	4146.06	II	320	6453.60	I	160	9499.30	I	500	1741.62	III
220	4153.30	II	360	6454.44	I	235	9505.59	I	4000	1782.55	III
285	4185.46	II	400	6455.98	I	210	9521.96	I	400	1843.49	III
450	4189.79	II	130	6500.24	V	120	9523.36	I	1500	1851.59	III
80	4233.27	I	80	6604.91	I	120	9523.96	I	2000	1852.27	III
50 d	4253.74	II	100	6653.83	I	100	9528.28	I	1000	1859.21	III
50 d	4253.98	II	360	7001.92	I	100	9622.13	I	1500	1874.63	III
50 d	4275.47	II	450	7002.23	I	120	9625.29	I	2000	1885.83	III
50 d	4303.78	II	210	7156.70	I	160	9677.38	I	1000	1887.40	III
285	4317.14	II	400	7254.15	I	80	9694.66	I	1500	1891.34	III
160	4336.86	II	450	7254.45	I	65	9694.91	I	4000	1914.62	III
220	4345.56	II	320	7254.53	I	235	9741.50	I	1000	1930.33	III
285	4349.43	II	210	7476.44	I	235	9760.65	I	2000	1941.64	III
220	4366.90	II	100	7477.24	I	120	9909.05	I	800	2002.16	III
100	4368.25	I	120	7479.08	I	140	9936.98	I	1000	2004.47	III
220	4395.95	II	120	7480.67	I	120	9940.41	I	500	2055.11	III
450	4414.91	II	100	7706.75	I	160	9995.31	I	500	2149.82	III
285	4416.98	II	870	7771.94	I	120 d	10421.18	I	500	2177.55	III
160	4448.21	II	810	7774.17	I	590	11286.34	I	500	2177.63	III
160	4452.38	II	750	7775.39	I	640	11286.91	I	100 r	2231.59	II
50	4465.45	II	80	7886.27	I	490	11287.02	I	200 r	2296.53	II
50 d	4466.28	II	100	7943.15	I	490	11287.32	I	100	2426.87	II
50	4467.83	II	100	7947.17	I	490	11295.10	I	100	2430.94	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100	2433.11	II	45	7915.80	I	25	1379.429	I	700	3175.09	V
100	2435.32	II	55	8132.82	I	25	1381.469	I	520	3204.04	V
150	2446.17	II	45	8300.83	I	15	1381.637	I	300	3219.307	III
1100	2447.91	I	65	8761.35	I	500	1484.507	IV	400	3233.602	III
100	2457.29	II	<i>Phosphorus P Z = 15</i>			400	1487.788	IV	650	3347.736	IV
150	2469.29	II	250	328.78	V	350	1502.228	III	570	3364.467	IV
100	2471.18	II	150	359.899	IV	80	1532.51	II	400	3371.122	IV
1700	2476.42	I	500	388.318	IV	120	1535.90	II	300	3957.641	III
250	2486.52	II	250	389.50	V	450	1610.50	V	350	3978.307	III
300	2488.92	II	300	390.70	V	150	1618.632	III	400	4059.312	III
200	2498.81	II	300	445.158	IV	200	1618.907	III	300	4080.084	III
150	2505.73	II	375	475.60	V	140	1671.070	I	500	4222.195	III
150	2551.84	II	120	498.180	III	100	1671.510	I	350	4246.720	III
150	2565.51	II	520	542.57	V	180	1671.680	I	400	4420.71	II
100	2569.56	II	600	544.92	V	140	1672.035	I	250	4479.776	III
150	2658.75	II	200	569.853	III	140	1672.474	I	250	4540.288	IV
1900	2763.09	I	200	581.831	III	600	1674.591	I	250	4541.112	IV
150 h	2776.85	II	350	629.008	IV	600	1679.695	I	500	4588.04	II
100 h	2787.92	II	400	629.914	IV	140	1685.976	I	500	4589.86	II
200	2854.59	II	500	631.779	IV	100	1694.028	I	600	4602.08	II
100 h	2871.37	II	450	673.90	V	100	1694.486	I	300	4626.70	II
100 h	2878.01	II	10	810.24	II	100	1706.376	I	300	4658.31	II
520	2922.49	I	650	823.179	IV	100	1707.553	I	500	4943.53	II
650	3002.65	I	700	824.730	IV	600	1774.951	I	300	4954.39	II
1500	3027.91	I	800	827.932	IV	500	1782.838	I	300	4969.71	II
1100	3065.31	I	300	847.669	III	400	1787.656	I	100	5079.381	I
2600	3114.04	I	350	855.624	III	140	1834.801	I	100	5098.221	I
11000	3242.70	I	500	859.652	III	140	1847.165	I	100	5100.974	I
2700	3251.64	I	10	865.44	II	100	1849.820	I	140	5109.628	I
3500	3258.78	I	450	865.45	V	140	1851.194	I	140	5154.844	I
3600	3302.13	I	600	871.39	V	100	1852.069	I	180	5162.290	I
5000	3373.00	I	700	877.476	IV	500	1858.886	I	300	5253.52	II
24000	3404.58	I	300	913.971	III	400	1859.393	I	140	5293.539	I
13000	3421.24	I	300	917.120	III	140	1864.348	I	400	5296.13	II
5000	3433.45	I	350	918.665	III	650	1888.523	IV	250	5316.07	II
6400	3441.40	I	1000	950.655	IV	180	1905.481	I	300	5344.75	II
7700	3460.77	I	250	1003.598	III	140	1906.403	I	180	5345.851	I
10000	3481.15	I	570	1025.563	IV	280	1907.665	I	100	5364.631	I
2000	3489.77	I	500	1028.096	IV	280	2023.489	I	250	5378.20	II
12000	3516.94	I	570	1030.517	IV	180	2024.516	I	300	5386.88	II
12000	3553.08	I	500	1033.111	IV	400	2032.432	I	400	5425.91	II
4500	3571.16	I	500	1035.517	IV	400	2033.477	I	100	5428.094	I
20000	3609.55	I	900	1117.98	V	400	2135.465	I	400	5450.74	II
20000	3634.70	I	570	1118.551	IV	400	2136.182	I	140	5458.305	I
5500	3690.34	I	700	1128.01	V	400	2149.145	I	180	5477.672	I
1400	3718.91	I	20	1249.82	II	280	2152.940	I	140	5477.860	I
1500	3799.19	I	20	1301.87	II	500	2154.080	I	140	5478.267	I
1500	3832.29	I	20	1304.47	II	180	2235.732	I	100	5514.774	I
2200	3894.20	I	15	1304.68	II	450	2440.93	V	100	5516.997	I
1500	3958.64	I	35	1305.48	II	250	2478.256	IV	250	5588.34	II
290	4087.34	I	60	1310.70	II	750	2533.976	I	500	6024.18	II
2500	4212.95	I	500	1334.808	III	950	2535.603	I	400	6034.04	II
180	4473.59	I	650	1344.327	III	750	2553.262	I	500	6043.12	II
160	5163.84	I	300	1344.845	III	500	2554.915	I	250	6055.50	II
120	5295.63	I	500	1366.695	IV	250	2605.506	IV	150	6083.409	III
55	5542.80	I	15	1372.033	I	300	2632.713	III	350	6087.82	II
75	5670.07	I	400	1372.674	IV	400	2644.295	IV	180	6097.690	I
55 h	5695.09	I	15	1373.500	I	400	2728.770	IV	350	6165.59	II
65	6784.52	I	10	1374.732	I	500	2739.309	IV	500	6199.024	I
75	7368.12	I	15	1377.080	I	250	2739.872	IV	180	6210.499	I
120	7764.03	I	15	1377.937	I	450	2978.55	V	140	6375.681	I



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100	6388.579	I	228	15962.53	I	240	2308.04	I	70	2738.48	I
250	6435.32	II	296	16254.77	I	50	2310.96	II	70	2747.61	I
600	6459.99	II	203	16292.97	I	90	2315.50	I	80	2753.86	I
600	6503.46	II	1627	16482.92	I	220	2318.29	I	200	2754.92	I
600	6507.97	II	588	16590.07	I	100	2326.10	I	30	2769.84	I
100	6717.411	I	225	16613.05	I	170	2340.18	I	500	2771.67	I
150	6992.690	III	221	16738.68	I	280	2357.10	I	40	2773.24	I
100	7102.200	I	419	16803.39	I	180	2368.28	I	20	2774.00	I
100	7158.367	I	471	17112.48	I	50	2377.28	II	50	2774.77	II
180	7165.465	I	289	17286.91	I	130	2383.64	I	50	2793.27	I
180	7175.102	I	299	17423.67	I	40	2386.81	I	100	2794.21	II
180	7176.660	I	287	23844.97	I	120	2389.53	I	40 h	2799.98	II
200	7443.657	IV	311	29097.16	I	35	2396.17	I	140	2803.24	I
250	7845.63	II	<i>Platinum Pt Z = 78</i>			70	2401.87	I	10	2808.51	I
100	8046.801	I	30	1621.66	II	200	2403.09	I	50	2818.25	I
150	8113.528	III	30	1723.13	II	100	2418.06	I	30 h	2822.27	II
140	8278.058	I	30	1751.70	II	50	2424.87	II	1400	2830.30	I
100	8367.856	I	30	1777.09	II	80	2428.04	I	70	2834.71	I
140	8531.475	I	50 r	1777.09	II	50	2428.20	I	16	2853.11	I
140	8613.835	I	30	1781.86	II	25	2429.10	I	80 h	2860.68	II
180	8637.578	I	30	1879.09	II	180	2436.69	I	40 h	2865.05	II
400	8741.529	I	40	1883.05	II	650	2440.06	I	40 h	2875.85	II
100	8872.174	I	50	1889.52	II	60	2450.97	I	100 h	2877.52	II
180	9175.819	I	50	1911.70	II	440	2467.44	I	25	2888.20	I
950	9193.85	I	30	1929.25	II	35	2471.01	I	25	2893.22	I
600	9278.88	I	30	1929.68	II	1000	2487.17	I	600	2893.86	I
1250	9304.94	I	30	1939.80	II	25	2488.74	II	300	2897.87	I
500	9323.50	I	30	1949.90	II	200	2490.12	I	60	2905.90	I
950	9435.069	I	30	1983.74	II	160	2495.82	I	120	2912.26	I
950	9441.86	I	40	2014.93	II	240	2498.50	I	120	2913.54	I
600	9452.83	I	3200	2030.63	I	50	2505.93	I	70	2919.34	I
1250	9493.56	I	4400	2032.41	I	120	2508.50	I	30	2921.38	I
1700	9525.73	I	100	2036.46	II	50	2514.07	I	1700	2929.79	I
1500	9545.18	I	40	2041.57	II	60	2515.03	I	30	2942.76	I
280	9556.81	I	5500	2049.37	I	240	2515.58	I	30	2944.75	I
1700	9563.439	I	1500	2067.50	I	140	2524.30	I	25	2959.10	I
280	9593.50	I	3000	2084.59	I	40	2529.41	I	60	2960.75	I
750	9609.04	I	1000	2103.33	I	50	2536.49	I	1800	2997.97	I
400	9638.939	I	30	2115.57	II	160	2539.20	I	35	3001.17	II
500	9676.24	I	950	2128.61	I	18	2549.46	I	220	3002.27	I
180	9706.533	I	30	2130.69	II	50	2552.25	I	30	3017.88	I
1500	9734.750	I	1900	2144.23	I	50	2596.00	I	30 h	3031.22	II
280	9736.680	I	100	2144.24	II	70	2603.14	I	130	3036.45	I
1500	9750.77	I	600	2165.17	I	30	2616.76	II	800	3042.64	I
600	9790.21	I	1500	2174.67	I	50	2619.57	I	3200	3064.71	I
1700	9796.85	I	30	2190.32	II	30	2625.34	II	30	3071.94	I
280	9834.80	I	400	2202.22	I	1100	2628.03	I	130	3100.04	I
400	9903.68	I	50 h	2202.58	II	130	2639.35	I	320	3139.39	I
280	9976.67	I	320	2222.61	I	1000	2646.89	I	140	3156.56	I
229	10084.27	I	50 h	2233.11	II	500	2650.86	I	120	3200.71	I
458	10511.58	I	30 h	2240.99	II	20	2658.17	I	320	3204.04	I
962	10529.52	I	100	2245.52	II	2800	2659.45	I	30	3230.29	I
1235	10581.57	I	150	2249.30	I	40	2674.57	I	20	3233.42	I
415	10596.90	I	30	2251.52	II	440	2677.15	I	20	3250.36	I
435	10681.40	I	30 h	2251.92	II	200	2698.43	I	40	3251.98	I
265	10813.13	I	190	2268.84	I	2000	2702.40	I	160	3255.92	I
764	11183.23	I	30 h	2271.72	II	1600	2705.89	I	25	3268.42	I
402	11186.75	I	280	2274.38	I	60	2713.13	I	25	3281.97	I
479	14241.64	I	50 h	2287.50	II	1300	2719.04	I	120	3290.22	I
256	14307.83	I	30	2288.20	II	130	2729.92	I	500	3301.86	I
714	15711.52	I	150	2289.27	I	1800	2733.96	I	60	3315.05	I
			150	2292.40	I						



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
4	4740.91	I	8	10487.11	I	680	3880.47	II	620	4171.82	II
6	4744.35	I	17	11019.87	I	440 c	3885.19	II	730	4172.25	II
5	4753.93	I	16	11022.67	I	440 c	3889.34	II	5200	4179.39	II
7	4757.39	I	17	11690.21	I	770 c	3908.05	II	2500	4189.48	II
5	4786.49	I	16	11769.62	I	630	3912.90	II	560 c	4191.60	II
7	4791.05	I	17	11772.83	I	310	3913.55	II	2500 c	4206.72	II
6	4799.75	I		12522.11	I	1300 c	3918.85	II	500	4208.32	II
8	4804.35	I		13377.86	I	420	3919.63	II	320	4211.86	II
7	4849.86	I		13397.09	I	960	3925.47	II	320	4217.81	II
8	4856.09	I		15163.08	I	480	3927.46	II	3800	4222.93	II
8	4863.48	I		15168.40	I	370	3929.29	II	3800	4225.35	II
9	4869.76	I		40158.37	I	370	3935.82	II	320	4233.11	II
8	4942.02	I	<i>Praseodymium Pr Z = 59</i>			730 c	3947.63	II	320 c	4236.15	II
9	4950.82	I	7000	865.90	V	900 c	3949.43	II	960	4241.01	II
9	4956.15	I	5000	869.17	V	900 c	3953.51	II	340	4243.51	II
10	4965.03	I	2000	1228.59	IV	380	3956.75	II	840 c	4247.63	II
10	5084.23	I	5000	1229.22	IV	470	3962.45	II	500	4254.40	II
11	5097.17	I	5000	1293.22	IV	560	3964.26	II	320	4269.09	II
11	5099.20	I	5000	1295.28	IV	1600 c	3964.81	II	790 c	4272.27	II
12	5112.25	I	5000	1321.36	IV	560 c	3966.57	II	470 c	4280.07	II
12	5323.28	I	5000	1333.57	IV	500	3971.16	II	790 c	4282.42	II
13	5339.69	I	5000	1354.66	IV	320	3971.67	II	450 c	4298.98	II
12	5342.97	I	2000	1360.64	IV	620 c	3972.14	II	1500	4305.76	II
14	5359.57	I	2000	1365.77	IV	320	3974.85	II	1300	4333.97	II
16	5782.38	I	5000	1374.41	IV	1300 c	3989.68	II	360	4338.70	II
17	5801.75	I	5000	1435.56	IV	340	3992.16	II	620 cw	4344.30	II
15	5812.15	I	2000	1520.98	IV	1600	3994.79	II	470 c	4347.49	II
17	5831.89	I	5000	1574.55	IV	560 c	3997.04	II	340	4350.40	II
8	6120.27	II	5000	1575.10	IV	320	3999.12	II	450	4354.91	II
7	6307.29	II	3000	1578.38	IV	620 c	4000.17	II	410 c	4359.79	II
19	6911.08	I	2000	1622.30	IV	730	4004.70	II	1200	4368.33	II
12	6936.28	I	10000	1884.87	IV	1900	4008.69	II	320	4371.62	II
20	6938.77	I	2000	2083.23	IV	620	4010.60	II	430	4405.83	II
7	6964.18	I	3300	2246.20	V	730	4015.39	II	1700	4408.82	II
12	6964.67	I	2000 c	2378.98	IV	620	4020.96	II	410	4413.77	II
25	7664.90	I	40 h	2598.04	II	470	4022.71	II	1200 c	4429.13	II
24	7698.96	I	100 h	2707.37	II	360	4025.54	II	730	4449.83	II
5	7955.37	I	60	2760.35	II	360 c	4029.72	II	960	4468.66	II
4	7956.83	I	270	3168.24	II	730 c	4031.75	II	1100	4496.46	II
7	8078.11	I	200 d	3195.99	II	960	4033.83	II	790	4510.15	II
6	8079.62	I	190	3219.48	II	730	4038.45	II	340 c	4534.15	II
9	8250.18	I	200	3584.21	II	470	4039.34	II	340	4535.92	II
8	8251.74	I	250	3645.66	II	1300	4044.81	II	270 c	4628.74	II
3	8390.22	I	250	3646.30	II	340	4047.08	II	270 c	4672.09	II
11	8503.45	I	370	3668.83	II	450	4051.13	II	290	4695.77	I
10	8505.11	I	290	3714.05	II	2200	4054.88	II	250	4736.69	I
4	8763.96	I	410	3739.18	II	2200	4056.54	II	200	4924.60	I
3	8767.05	I	680	3761.87	II	450	4058.80	II	320	4939.74	I
13	8902.19	I	680	3800.30	II	3400	4062.81	II	380	4951.37	I
12	8904.02	I	390	3811.84	II	500 c	4079.77	II	270	5034.41	II
5	8923.31	I	1300 h	3816.02	II	500 c	4080.98	II	320	5045.52	I
4	8925.44	I	680	3818.28	II	790	4081.85	II	360	5110.38	II
7	9347.24	I	310	3821.80	II	500	4083.34	II	560	5110.76	II
3	9349.25	I	960	3830.72	II	560	4096.82	II	410	5129.52	II
6	9351.59	I	480	3840.99	II	380	4098.40	II	620	5173.90	II
15	9595.70	I	580	3846.59	II	2900 c	4100.72	II	360	5206.55	II
14	9597.83	I	1200	3850.79	II	1700 c	4118.46	II	360	5219.05	II
6	9949.67	I	720 c	3851.55	II	340	4130.77	II	560	5220.11	II
5	9954.14	I	960	3852.80	II	1500 c	4141.22	II	680	5259.73	II
9	10479.63	I	480 c	3865.45	II	2700	4143.11	II	340 c	5292.02	II
5	10482.15	I	480	3876.19	II	1700 c	4164.16	II	340	5292.62	II
			1700 c	3877.18	II						



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1000	2556.51	I	320	3069.94	I	240	3453.50	I	110 c	5752.93	I
250	2559.08	I	260	3071.16	I	55000 c	3460.46	I	110 cw	5776.83	I
340	2564.19	I	550	3082.43	I	40000 c	3464.73	I	550	5834.31	I
540	2568.64	II	340	3088.76	I	400	3467.96	I	200	6307.70	I
370	2571.81	II	700	3100.67	I	240	3476.44	I	200	6321.90	I
380	2586.79	I	700	3108.81	I	400	3480.38	I	100 cw	6605.19	I
290	2599.86	I	340	3110.86	I	320	3480.85	I	180 c	6813.41	I
290	2603.89	I	340 c	3118.19	I	240	3482.23	I	260	6829.90	I
660	2608.50	II	340	3121.36	I	560	3503.06	I	50 cw	7640.94	I
610 d	2611.54	I	420	3128.94	I	320	3516.65	I	65 cw	7912.94	I
310	2635.83	II	260	3134.02	I	320	3517.33	I	<i>Rhodium Rh Z = 45</i>		
550	2636.64	I	250	3141.38	I	320	3537.46	I	50	813.44	III
270	2642.75	I	440	3151.64	I	240	3549.89	I	80	882.51	III
270	2649.05	I	330	3153.79	I	240	3570.26	I	100	925.75	III
660	2651.90	I	360 c	3158.31	I	360	3579.12	I	150	937.28	III
400	2654.12	I	220	3164.52	I	810 c	3580.15	II	500	991.62	III
220	2663.63	I	700	3168.37	I	650	3580.97	I	400	992.48	III
940	2674.34	I	220	3174.61	I	810	3583.02	I	500 d	1009.60	III
220	2688.53	I	440	3177.71	I	320	3617.08	I	200	1012.22	III
1300	2715.47	I	260	3178.61	I	810	3637.84	I	200	1015.17	III
220	2732.21	I	600	3182.87	I	440	3651.97	I	200	1073.87	III
610	2733.04	II	1100	3184.76	I	320	3670.53	I	150	1784.24	III
220	2758.00	I	1100	3185.57	I	860 c	3689.50	I	200	1784.94	III
210	2763.79	I	260	3190.78	I	1500 c	3691.48	I	150	1796.50	III
310	2767.74	I	260	3192.36	I	520	3703.24	I	200	1816.03	III
220	2768.85	I	220	3198.58	I	240	3709.93	I	1000	1832.05	III
220	2769.32	I	1100 c	3204.25	I	360 c	3717.28	I	500	1859.85	III
350	2770.42	I	380	3235.94	I	4000	3725.76	I	800	1880.66	III
550	2783.57	I	600	3258.85	I	240 c	3735.01	I	500	1884.91	III
220	2791.29	I	600	3259.55	I	810	3735.31	I	500	1887.36	III
220	2814.68	I	300	3268.89	I	910	3740.10	I	700	1888.62	III
880	2819.95	I	280	3296.70	I	300 cw	3745.44	I	800	1901.32	III
310	2834.08	I	280	3296.99	I	700	3787.52	I	500	1910.16	III
220	2843.00	I	280	3301.60	I	240	3869.94	I	600	1919.37	III
270	2850.98	I	240	3302.23	I	240	3875.26	I	500	1927.07	III
240	2867.19	I	320	3303.21	II	240	3876.86	I	700	1931.79	III
2900	2887.68	I	280	3303.75	I	380 c	3917.27	I	500	1954.25	III
490	2896.01	I	240	3313.95	I	550	3929.85	I	500	1994.26	III
830 c	2902.48	I	600	3322.48	I	280	3961.04	I	800	2013.71	III
210	2905.58	I	2000	3338.18	I	350 c	3962.48	I	500	2017.47	III
550	2909.82	I	1600	3342.24	I	220	4033.31	I	500	2028.53	III
830 c	2927.42	I	810	3344.32	I	240	4081.43	I	800	2036.72	III
270	2930.61	I	320	3346.20	I	240 c	4110.89	I	600	2037.61	III
440	2943.14	I	240 d	3356.33	I	240 cw	4133.42	I	1000	2040.18	III
270	2962.27	I	240	3377.74	I	1800	4136.45	I	3000	2048.67	III
720	2965.11	I	320	3379.06	II	700	4144.36	I	2000	2064.11	III
1500	2965.76	I	320	3379.70	I	220	4182.90	I	800	2076.84	III
310	2976.29	I	240	3389.43	I	220	4183.06	I	1000	2118.53	III
210	2978.15	I	4000	3399.30	I	650	4221.08	I	1000	2118.63	III
220	2980.82	I	650	3404.72	I	3600 c	4227.46	I	1000	2139.44	III
220	2982.19	I	650	3405.89	I	260 c	4257.60	I	1000	2152.23	III
220	2988.47	I	240	3408.67	I	380	4358.69	I	3000	2158.17	III
1800	2992.36	I	320	3409.83	I	360 cw	4394.38	I	3000	2163.19	III
5500	2999.60	I	320	3417.77	I	2600	4513.31	I	3000	2167.33	III
350	3001.14	I	810	3419.41	I	260	4516.64	I	150	2276.21	II
220	3004.14	I	8000	3424.62	I	500	4522.73	I	140	2288.57	I
500	3016.02	I	400	3426.19	I	2200 cw	4889.14	I	110	2309.82	I
300	3016.49	I	300	3427.61	I	220	4923.90	I	350	2322.58	I
380	3030.45	I	320	3437.71	I	1300	5270.95	I	140	2326.47	I
240	3047.25	I	400	3449.37	I	1600 cw	5275.56	I	190	2334.77	II
1600	3067.40	I	16000 c	3451.88	I	100	5667.88	I	300	2361.92	I





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
10000	2075.95	II	40 l	8271.41	I	110	2517.32	II	650	3669.49	I
30000	2143.83	II	30	8271.71	I	150	2535.59	II	550	3726.10	I
10000	2217.08	II	40 l	8868.512	I	550	2549.58	I	8700	3726.93	I
5000	2291.71	II	30	8868.852	I	370	2609.06	I	11000	3728.03	I
50000	2472.20	II	30 l	9522.65	I	830	2612.07	I	7100	3730.43	I
1000	2631.75	III	20 l	9540.18	I	460	2642.96	I	3500	3742.28	I
2000	2956.07	III	2000 c	9689.05	II	330	2651.84	I	870	3742.78	I
500	3086.84	III	35 l	10075.282	I	400	2659.62	I	2800	3745.59	I
500	3111.36	III	30 l	10075.708	I	330	2661.61	II	760	3753.54	I
5000 c	3148.90	II	100	13235.17	I	690	2678.76	II	870	3755.93	I
25	3157.54	I	20	13442.81	I	330	2692.06	II	1200	3759.84	I
50	3227.98	I	30	13443.57	I	200	2712.41	II	600	3761.51	I
500	3286.41	III	75	13665.01	I	690	2719.52	I	600	3767.35	I
60	3348.72	I	1000	14752.41	I	140	2725.47	II	1500	3777.59	I
75	3350.82	I	800	15288.43	I	310	2734.35	II	600	3782.74	I
100	3587.05	I	150	15289.48	I	1800	2735.72	I	3900	3786.06	I
40	3591.57	I	20	22529.65	I	100	2778.38	II	6000	3790.51	I
5000	3600.60	II	4	27314.31	I	110	2787.83	II	760	3798.05	I
10000	3600.64	II				350	2810.03	I	7600	3798.90	I
25000	3940.51	II	<i>Ruthenium Ru Z = 44</i>			1700	2810.55	I	7600	3799.35	I
1000	4201.80	I	250	850.09	III	350	2818.36	I	600	3812.72	I
500	4215.53	I	200	850.30	III	400	2829.16	I	760	3817.27	I
90000	4244.40	II	250	919.74	III	640	2854.07	I	760	3819.03	I
15000	4273.14	II	500	940.09	III	420	2861.41	I	650	3822.09	I
20000	4571.77	II	500	966.54	III	550	2866.64	I	550	3824.93	I
10000	4648.57	II	750	974.14	III	1800	2874.98	I	760	3831.80	I
30000	4775.95	II	900	979.43	III	740	2886.54	I	930	3839.70	I
2	5087.987	I	500	981.35	III	370	2908.88	I	760	3850.43	I
2	5132.471	I	900	986.84	III	1100	2916.26	I	1300	3857.55	I
10	5150.134	I	900	994.56	III	180	2945.67	II	650	3862.69	I
10000	5152.08	II	300	1001.65	III	370	2949.50	I	1300	3867.84	I
1	5165.023	I	500	1009.13	III	550	2965.16	I	650	3892.21	I
2	5165.142	I	900	1009.87	III	170	2965.55	II	760	3909.08	I
15	5195.278	I	500	1014.68	III	140	2976.59	II	1500	3923.47	I
2	5233.968	I	800	1190.51	III	550	2976.92	I	3300	3925.92	I
20	5260.034	I	500	1200.07	III	1400	2988.95	I	600	3931.76	I
1	5260.228	I	500	1207.17	III	460	2994.96	I	760	3945.57	I
3	5322.380	I	500	1209.77	III	440	3006.59	I	600	3978.44	I
40	5362.601	I	300	1211.31	III	330	3017.24	I	600	3979.42	I
4	5390.568	I	500	1941.35	III	310	3020.88	I	870	3984.86	I
75	5431.532	I	500	2009.28	III	390	3064.84	I	1500	4022.16	I
3	5431.830	I	2400	2076.43	I	330	3096.57	I	600	4023.83	I
6	5578.788	I	2600	2083.77	I	830	3099.28	I	1400	4051.40	I
40	5647.774	I	2400	2090.89	I	740	3100.84	I	710	4054.05	I
20	5653.750	I	690	2255.52	I	490	3294.11	I	760	4068.37	I
60	5724.121	I	780	2272.09	I	370	3301.59	I	980	4076.73	I
3	5724.614	I	780	2279.57	I	930	3339.55	I	6000	4080.60	I
75	6070.755	I	480	2317.80	I	3100	3417.35	I	930	4097.79	I
30 c	6159.626	I	120	2334.96	II	4900	3428.31	I	1900	4112.74	I
75 c	6206.309	I	190 h	2342.85	II	6400	3436.74	I	2000	4144.16	I
120 c	6298.325	I	310	2351.33	I	8300	3498.94	I	650	4145.74	I
5	6299.224	I	170	2357.91	II	640	3514.49	I	870	4167.51	I
10000	6458.33	II	780	2402.72	II	790	3539.37	I	550	4197.58	I
5000	6560.81	II	150	2407.92	II	690	3570.59	I	550	4198.88	I
100 l	7279.997	I	180	2455.53	II	6400	3589.22	I	7600	4199.90	I
150	7408.173	I	150	2456.44	II	6900	3593.02	I	1500	4206.02	I
200 l	7618.933	I	370	2456.57	II	6400	3596.18	I	5400	4212.06	I
300	7757.651	I	280	2478.93	II	1300	3599.76	I	760	4214.44	I
60	7759.436	I	140	2498.42	II	3100	3634.93	I	930	4217.27	I
90000 c	7800.27	I	140	2498.57	II	6200	3661.35	I	550	4230.31	I
45000 c	7947.60	I	260	2507.01	II	830	3663.37	I	760	4241.05	I
			110	2513.32	II						

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
760	4243.06	I	26	6982.01	I	480	3854.56	I	730	4716.10	I
760	4284.33	I	26	7027.98	I	400	3858.74	I	770	4728.42	I
550	4295.93	I	35	7238.92	I	3700	3885.29	II	470	4745.68	II
3700	4297.71	I	16	7393.93	I	1600	3896.98	II	730	4760.27	I
930	4307.60	I	18	7468.91	I	1300	3903.42	II	580	4783.10	I
550	4319.87	I	26	7485.79	I	2500	3922.40	II	350	4785.86	I
550	4342.07	I	70	7499.75	I	1900	3928.28	II	970	4841.70	I
710	4354.13	I	26	7559.61	I	1300	3941.87	II	730	4883.97	I
870	4361.21	I	18	7621.50	I	470	3951.89	I	630	4910.40	I
2400	4372.21	I	18	7722.87	I	1500	3963.00	II	350	4913.25	II
870	4385.39	I	22	7791.86	I	1500	3971.40	II	430	4918.99	I
1300	4385.65	I	30	7847.80	I	620	3974.66	I	400	5044.28	I
1700	4390.44	I	80	7881.49	I	1000	3976.43	II	540	5071.20	I
1600	4410.03	I	18	8264.96	I	1500	3990.00	II	510	5117.16	I
1100	4460.04	I	22	8710.84	I	1400	4064.58	II	350	5122.14	I
5400	4554.51	I	<i>Samarium Sm Z = 62</i>			1000	4092.27	II	360	5155.03	II
1700	4584.44	I	150	2789.38	II	1900	4118.55	II	470	5175.42	I
720	4647.61	I	410	3152.52	II	1200	4152.21	II	250	5200.59	I
1400	4709.48	I	720	3183.92	II	1000	4188.13	II	260	5251.92	I
500	4757.84	I	600	3211.73	II	1100	4203.05	II	400	5271.40	I
550	4869.15	I	530	3216.85	II	1000	4225.33	II	250	5282.91	I
160	5011.23	I	600	3218.61	II	1200	4236.74	II	220	5453.00	I
450	5057.33	I	720	3230.56	II	2100	4256.39	II	230	5493.72	I
120	5076.32	I	720	3236.64	II	1300	4262.68	II	230	5516.09	I
200	5093.83	I	720	3239.66	II	1200	4279.68	II	140	5550.40	I
530	5136.55	I	720	3250.37	II	2200	4280.79	II	140	5659.86	I
170	5142.76	I	850	3254.38	II	710	4282.21	I	120	5696.73	I
250	5147.24	I	1700	3306.39	II	470	4282.83	I	85	5706.20	I
110	5151.07	I	1200	3321.18	II	1600	4296.74	I	70	5773.77	I
500	5155.14	I	1200	3365.86	II	1900	4318.94	II	60	5778.33	I
920	5171.03	I	1200	3382.40	II	470	4319.53	I	70 d	5786.98	II
180	5195.02	I	4200	3568.27	II	1800	4329.02	II	60	5788.38	I
130	5284.08	I	4200	3592.60	II	440	4330.02	I	60	5800.52	I
260	5309.27	I	1700	3604.28	II	1300	4334.15	II	65	5802.84	I
110	5335.93	I	3400	3609.49	II	880	4336.14	I	65	5867.79	I
130	5361.77	I	1700	3621.23	II	1100	4347.80	II	50	5874.21	I
110 h	5401.04	I	3400	3634.29	II	440	4362.91	I	50	5898.96	I
80	5484.32	I	2200	3661.36	II	530	4380.42	I	65	5965.71	II
130	5510.71	I	2200	3670.84	II	1600	4390.86	II	50	6045.00	I
90	5559.75	I	1100	3693.99	II	410	4401.17	I	50	6070.06	I
290	5636.24	I	1600	3728.47	II	470	4419.33	I	45	6084.12	I
180	5699.05	I	2100	3731.26	II	1500	4420.53	II	45 h	6159.56	I
65	5814.98	I	1600	3735.98	II	2900	4424.34	II	45	6256.54	I
55	5919.34	I	2900	3739.12	II	470	4429.66	I	100	6267.28	II
80	5921.45	I	1200	3743.87	II	1600	4433.88	II	140	6569.31	II
21 h	5973.38	I	930	3745.46	I	1800	4434.32	II	110	6589.72	II
16	5988.67	I	800	3756.41	I	530	4441.81	I	50	6671.51	I
35	5993.65	I	1200	3757.53	II	440	4442.28	I	120 d	6731.84	II
18	6116.77	I	1900	3760.69	II	710	4445.15	I	95	6794.20	II
26	6199.42	I	1100	3764.37	II	1300	4452.73	II	120	6860.93	I
26	6225.20	I	370 d	3773.33	I	1200	4454.63	II	120	6955.29	II
18	6295.22	I	1100	3778.14	II	1000	4458.52	II	90	7020.44	II
16	6390.23	I	1500	3788.12	II	2200	4467.34	II	90	7039.22	II
26 h	6444.84	I	1600	3793.97	II	810	4470.89	I	90	7042.24	II
21	6663.14	I	1600	3797.73	II	370	4499.11	I	90	7051.52	II
55	6690.00	I	1600	3826.20	II	440	4581.73	I	90	7082.37	II
21	6766.95	I	1100	3831.50	II	380	4649.49	I	26	7088.30	I
30	6775.02	I	560	3834.48	I	470 d	4670.75	I	30	7095.50	I
21	6824.17	I	1600	3843.50	II	1100	4674.60	II	30	7104.54	I
26	6911.48	I	530	3853.30	I	370	4688.73	I	26	7115.96	I
110	6923.23	I	2700	3854.21	II	530	4704.40	II	85 d	7149.60	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
23	7213.82	I	1200	2974.01	I	2700	4047.79	I	270	5089.89	I
60	7240.90	II	1400	2980.75	I	120	4049.95	I	390	5096.73	I
26	7347.30	I	340	2988.95	I	5500	4054.55	I	620	5099.23	I
30	7444.56	I	2200	3015.36	I	220	4056.59	I	370	5101.12	I
26	7445.41	I	2700	3019.34	I	100	4068.66	III	180	5109.06	I
13	7470.76	I	360	3030.76	I	160 h	4074.97	I	150	5112.86	I
45	7645.09	II	120 h	3056.31	I	160	4078.57	I	320	5116.69	I
12	7645.82	I	130	3065.11	II	6100	4082.40	I	390	5210.52	I
40 w	7835.08	II	990	3251.32	II	200	4086.67	I	280	5219.67	I
16	7895.96	I	1500	3255.69	I	400	4087.16	I	350	5239.82	II
90	7928.14	II	4400	3269.91	I	440 h	4133.00	I	280	5258.33	I
40	8048.70	II	5500	3273.63	I	530 h	4140.30	I	210	5285.76	I
16	8065.16	I	110 d	3343.28	II	720	4152.36	I	120	5341.05	I
45	8068.46	II	270	3352.05	II	1100 h	4165.19	I	350	5349.30	I
40 w	8305.79	II	9900	3353.73	II	110 h	4218.26	I	120	5349.71	I
19	8383.71	I	2000	3359.68	II	110 h	4219.73	I	210	5355.75	I
45 w	8485.99	II	1700	3361.27	II	180	4231.93	I	530	5356.10	I
45 w	8708.43	II	1700	3361.94	II	200	4233.61	I	270	5375.35	I
95	8913.66	II	4000	3368.95	II	400	4238.05	I	370	5392.08	I
<i>Scandium Sc Z = 21</i>			6600	3372.15	II	15000	4246.83	II	270	5446.20	I
350	180.14	V	130	3418.51	I	290	4294.77	II	120	5451.34	I
500	243.87	V	200	3429.21	I	350	4305.71	II	750	5481.99	I
500	252.85	V	200	3429.48	I	4200	4314.09	II	530	5484.62	I
500	253.73	V	270	3431.36	I	3300	4320.74	II	570	5514.22	I
900	283.91	V	530	3435.56	I	2400	4325.01	II	660	5520.50	I
800	284.45	V	270	3457.45	I	180	4354.61	II	660	5526.82	II
600	288.29	V	180	3462.19	I	110	4358.64	I	70	5564.86	I
900	289.59	V	130 d	3469.65	I	2000	4374.46	II	110	5591.33	I
15	289.85	IV	110	3471.13	I	130	4384.81	II	80	5640.98	II
1000 d	291.93	V	200	3498.91	I	1100	4400.37	II	250	5657.88	II
800	293.25	V	2700	3535.73	II	880	4415.56	II	1500	5671.81	I
15	296.31	IV	6600	3558.55	II	120 h	4557.24	I	1200	5686.84	I
15	299.04	IV	6100	3567.70	II	160 h	4573.99	I	1100	5700.21	I
700	300.00	V	13000	3572.53	II	350	4670.40	II	10	5706.82	IV
1000	573.36	V	9900	3576.35	II	120	4706.97	I	190	5708.61	I
600	587.94	V	7700	3580.94	II	120	4709.34	I	880	5711.75	I
10	785.12	IV	4000	3589.64	II	200	4728.77	I	230	5717.28	I
25	1168.61	III	4000	3590.48	II	490	4729.23	I	180	5724.08	I
15	1550.80	IV	28000	3613.84	II	590	4734.10	I	14	5771.63	IV
180	1603.06	III	110	3617.43	I	690	4737.65	I	620	6210.68	I
150	1610.19	III	20000	3630.75	II	790	4741.02	I	320	6239.78	I
160	2010.42	III	13000	3642.79	II	1200	4743.81	I	120	6245.63	II
12	2118.97	IV	6600	3645.31	II	200	4753.16	I	110	6249.96	I
11	2185.43	IV	110	3646.90	I	220	4779.35	I	80	6256.01	III
11	2205.46	IV	5300	3651.80	II	170	4839.44	I	250	6258.96	I
14	2222.22	IV	110	3664.25	II	90	4909.76	I	750	6305.67	I
11	2271.33	IV	290	3666.54	II	90	4922.84	I	60	6378.82	I
110	2438.62	I	75 h	3717.10	I	90	4934.25	I	90	6413.35	I
560	2545.22	II	270	3833.07	II	170	4954.06	I	60	6604.60	II
2900	2552.37	II	610	3843.03	II	120	4973.66	I	65	6737.87	I
560	2555.82	II	20000	3907.49	I	150	4980.37	I	50	6819.52	I
2300	2560.25	II	23000	3911.81	I	140	4991.92	I	50	6835.03	I
1100	2563.21	II	4400	3933.38	I	530	5031.02	II	90	7449.16	III
11	2586.93	IV	5500	3996.61	I	250	5064.32	I	55 h	7741.17	I
120	2692.78	I	530	4014.49	II	530	5070.23	I	30	7800.44	I
350	2699.07	III	20000	4020.40	I	250	5075.81	I	19 h	8761.40	I
360	2706.77	I	20000	4023.69	I	2100	5081.56	I	50	8829.78	III
210	2707.95	I	220	4030.67	I	1200	5083.72	I	30 h	8834.35	I
580	2711.35	I	140	4031.39	I	1100	5085.55	I	400	22051.86	I
230	2734.05	III	220	4043.80	I	750	5086.95	I	150	22065.05	I
340	2965.86	I	200	4046.48	I	390	5087.14	I			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
<i>Selenium Se Z = 34</i>			285	2057.5	III	150	8440.47	I	100	1190.42	II
360	613.0	V	500	2074.8	I	150	8450.38	I	200	1193.28	II
360	652.7	IV	285	2136.6	IV	150	8742.33	I	250	1194.50	II
450	670.1	IV	500	2164.2	I	300	8918.86	I	100	1197.39	II
360	724.3	III	600	2413.5	I	200	9001.97	I	30	1206.51	III
450	746.4	IV	300	2548.0	I	200	9038.61	I	30	1206.53	III
450	759.1	V	360	2665.5	IV	100	9432.50	I	9	1207.52	III
360	808.7	V	285	2724.3	IV	200	10217.25	I	10	1210.46	III
360	830.3	V	285	2767.2	III	377	10307.45	I	50	1226.81	II
360	832.7	II	220	2773.8	III	900	10327.26	I	100	1227.60	II
450	839.5	V	160	2951.6	IV	640	10386.36	I	150	1228.75	II
360	843.0	III	450	3387.2	III	275	11946.87	I	200	1229.39	II
360	845.8	V	450	3413.9	III	170	11952.64	I	100	1246.74	II
360	912.9	II	450	3457.8	III	205	11972.93	I	150	1248.43	II
360	959.6	IV	450	3637.6	III	315	14817.93	I	100	1250.09	II
360	974.8	III	450	3738.7	III	410	14917.47	I	150	1250.43	II
450	996.7	IV	450	3800.9	III	500	15151.44	I	200	1251.16	II
360	1013.4	II	450	4169.1	III	320	15471.00	I	40	1256.49	I
360	1014.0	II	360	4175.3	II	265	15520.97	I	50	1258.80	I
450	1033.6	II	450	4180.9	II	395	15618.40	I	1000	1260.42	II
450	1049.6	II	285	4382.9	II	360	16659.44	I	2000	1264.73	II
360	1057.4	II	285	4446.0	II	505	16813.78	I	200	1265.02	II
360	1094.7	V	220	4449.2	II	205	16866.54	I	17	1294.54	III
360	1099.1	III	285	4467.6	II	235	21374.24	I	14	1296.73	III
450	1119.2	III	500	4730.8	I	680	21442.56	I	15	1298.89	III
360	1141.9	II	400	4739.0	I	415	21473.48	I	18	1298.96	III
450	1192.3	II	300	4742.2	I	270	21716.36	I	14	1301.15	III
450	1227.6	V	285	4840.6	II	240	21730.60	I	16	1303.32	III
285	1291.0	II	360	4845.0	II	150	23388.85	I	100	1304.37	II
285	1308.9	II	450	5227.5	II	265	24148.18	I	50 h	1305.59	II
285	1314.4	IV	360	5305.4	II	375	24385.99	I	200	1309.27	II
120	1435.3	I	100	5365.5	I	255	25017.51	I	13	1312.59	III
120	1435.8	I	120	5369.9	I	510	25127.43	I	100	1346.87	II
150	1449.2	I	110	5374.1	I	<i>Silicon Si Z = 14</i>			100	1348.54	II
150	1500.9	I	285	5522.4	II	10	85.18	V	150	1350.06	II
250	1530.4	I	285	5566.9	II	15	96.44	V	100	1352.64	II
150	1531.3	I	285	5866.3	II	10	97.14	V	100	1353.72	II
200	1531.8	I	450	6056.0	II	20	117.86	V	15	1393.76	IV
150	1575.3	I	285	6303.8	III	20	118.97	V	12	1402.77	IV
150	1577.6	I	200	6325.6	I	20	118.97	V	13	1417.24	III
150	1577.9	I	360	6444.2	II	4	457.82	IV	90 h	1485.02	II
150	1579.5	I	285	6490.5	II	8	566.61	III	100 h	1485.51	II
200	1580.0	I	285	6535.0	II	8	653.33	III	12	1500.24	III
150	1587.5	I	150	6831.3	I	7	815.05	IV	10	1501.19	III
150	1593.2	I	120	6990.690	I	8	818.13	IV	9	1501.87	III
250	1606.5	I	100	6991.792	I	9	823.41	III	100 h	1509.10	II
200	1617.4	I	200	7010.809	I	40 h	845.77	II	50 h	1512.07	II
150	1621.2	I	150	7013.875	I	100	889.72	II	60 p	1516.91	II
150	1643.4	I	300	7062.065	I	200	892.00	II	500	1526.72	II
250	1671.2	I	200	7575.1	I	9	967.95	III	1000	1533.45	II
250	1675.3	I	250	7583.4	I	100	989.87	II	150	1594.55	I
250	1690.7	I	150	7592.2	I	200	992.68	II	100	1622.87	I
250	1793.3	I	300	8001.0	I	10	993.52	III	300	1629.43	I
300	1795.3	I	200	8036.4	I	13	994.79	III	200	1629.92	I
300	1855.2	I	150	8093.2	I	16	997.39	III	100	1667.62	I
250	1858.8	I	150	8094.7	I	50	1023.69	II	100	1668.52	I
400	1898.6	I	180	8149.3	I	8	1066.63	IV	100	1672.59	I
350	1913.8	I	150	8152.0	I	14	1108.37	III	200	1675.20	I
300	1919.2	I	200	8157.7	I	16	1109.97	III	200	1696.20	I
500	1960.9	I	180	8163.1	I	18	1113.23	III	200	1697.94	I
500	2039.8	I	150	8182.9	I	8	1122.49	IV	100 h	1770.92	I
						10	1128.34	IV			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100 h	1776.83	I	300	2904.28	II	16	4716.65	III	90	6131.850	I
100 h	1799.12	I	500	2905.69	II	50	4782.991	I	100	6142.487	I
150	1808.00	II	55	2970.355	I	35	4792.212	I	100	6145.015	I
500 h	1814.07	I	150	2987.645	I	80	4792.324	I	160	6155.134	I
200	1816.92	II	50	3006.739	I	15	4813.33	III	160	6237.320	I
200	1836.51	I	75	3020.004	I	16	4819.72	III	40	6238.287	I
200	1841.44	I	100 h	3030.00	II	18	4828.97	III	125	6243.813	I
9	1842.55	III	9	3040.93	III	30	4947.607	I	125	6244.468	I
200	1843.77	I	100 h	3043.69	II	40	5006.061	I	180	6254.188	I
300	1845.51	I	50 h	3048.30	II	1000	5041.03	II	45	6331.954	I
400	1847.47	I	150 h	3053.18	II	1000	5055.98	II	1000	6347.10	II
200	1848.14	I	25	3086.24	III	10 h	5091.42	III	1000	6371.36	II
500	1850.67	I	20	3093.42	III	100	5181.90	II	45	6526.609	I
200	1852.46	I	16	3096.83	III	100 h	5185.25	II	45	6527.199	I
500 h	1874.84	I	9	3165.71	IV	200 h	5192.86	II	45	6555.462	I
200	1881.85	I	16	3185.13	III	500 h	5202.41	II	50 h	6660.52	II
200	1887.70	I	13	3186.02	III	100 h	5405.34	II	100	6671.88	II
200 h	1893.25	I	150	3188.97	II	100 h	5438.62	II	7	6701.21	IV
1000 h	1901.33	I	150	3193.09	II	100 h	5456.45	II	50 h	6717.04	II
100 h	1902.46	II	100	3195.41	II	500 h	5466.43	II	100	6721.853	I
50 h	1910.62	II	14	3196.50	III	500 h	5466.87	II	50	6829.82	II
50	1941.67	II	200	3199.51	II	100 h	5469.21	II	30	6848.568	I
100	1949.56	II	100 h	3203.87	II	200 h	5496.45	II	80	6976.523	I
100	1954.97	I	200 h	3210.03	II	35	5517.535	I	180	7003.567	I
50	2058.65	II	15	3210.55	III	100 h	5540.74	II	180	7005.883	I
50	2059.01	II	75	3214.66	II	150 h	5576.66	II	90	7017.646	I
200	2072.02	II	12	3230.50	III	30	5622.221	I	250	7034.903	I
200	2072.70	II	14	3233.95	III	100 h	5632.97	II	6 h	7047.94	IV
100	2124.12	I	15	3241.62	III	200 h	5639.48	II	200	7165.545	I
50 h	2136.56	II	12	3258.66	III	90	5645.611	I	100	7226.206	I
110	2207.98	I	10	3276.26	III	150 h	5660.66	II	100	7235.326	I
115	2210.89	I	300	3333.14	II	80	5665.554	I	180	7250.625	I
110	2211.74	I	500	3339.82	II	1000 h	5669.56	II	160	7275.294	I
120	2216.67	I	15	3486.91	III	120	5684.484	I	400	7289.173	I
120	2218.06	I	9	3525.94	III	300 h	5688.81	II	375	7405.774	I
10	2296.87	III	20	3590.47	III	100	5690.425	I	200	7409.082	I
10	2308.19	III	8	3762.44	IV	90	5701.105	I	275	7415.946	I
100 h	2356.30	II	20 c	3791.41	III	200 h	5701.37	II	425	7423.497	I
30 h	2357.18	II	25	3796.11	III	100 h	5706.37	II	9 h	7466.32	III
50 h	2357.97	II	30	3806.54	III	160	5708.397	I	12 h	7612.36	III
300	2435.15	I	100 h	3853.66	II	20	5739.73	III	100	7680.267	I
11	2449.48	III	500 h	3856.02	II	45	5747.667	I	6 h	7723.82	IV
425	2506.90	I	200 h	3862.60	II	45	5753.625	I	30	7800.008	I
375	2514.32	I	300	3905.523	I	45	5754.220	I	400	7848.80	II
500	2516.113	I	20	3924.47	III	45	5762.977	I	500	7849.72	II
7	2517.51	IV	10	4088.85	IV	70	5772.145	I	30	7849.967	I
350	2519.202	I	70	4102.936	I	70	5780.384	I	90	7918.386	I
425	2524.108	I	9	4116.10	IV	90	5793.071	I	120	7932.349	I
450	2528.509	I	300 h	4128.07	II	100	5797.859	I	140	7944.001	I
110	2532.381	I	500 h	4130.89	II	150 h	5800.47	II	35	7970.306	I
25	2541.82	III	100 h	4190.72	II	200	5806.74	II	35	8035.619	I
10	2546.09	III	50	4198.13	II	50	5846.13	II	70	8093.241	I
14	2559.21	III	9	4338.50	III	300 h	5868.40	II	9 h	8102.86	III
30	2563.679	I	30	4552.62	III	40	5873.764	I	11 h	8103.45	III
85	2568.641	I	25	4567.82	III	10 h	5898.79	III	35	8230.642	I
45	2577.151	I	20	4574.76	III	150	5915.22	II	9 h	8262.57	III
190	2631.282	I	100	4621.42	II	200	5948.545	I	40	8443.982	I
11	2640.79	III	150	4621.72	II	500	5957.56	II	40	8501.547	I
14	2655.51	III	9 h	4631.24	IV	500	5978.93	II	60	8502.221	I
9	2817.11	III	10 h	4654.32	IV	90	6125.021	I	40	8536.165	I
1000	2881.579	I	9	4683.02	III	85	6131.574	I	120	8556.780	I





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
110	657.3	IV	355	1316.542	I	285	3902.0	I	160	9035.9	I
40	658.3	V	290	1316.618	I	160	3928.6	III	450	9212.9	I
70	659.8	V	375	1323.515	I	360	3933.3	II	450	9228.1	I
40	660.9	IV	355	1326.643	I	450	4120.8	I	450	9237.5	I
160	661.4	IV	775	1381.552	I	280	4142.3	II	285	9413.5	I
110	663.2	V	710	1385.510	I	360	4145.1	II	285	9421.9	I
40	663.7	IV	960	1388.435	I	450	4153.1	II	285	9437.1	I
40	664.8	IV	640	1389.154	I	450	4162.7	II	650	9649.9	I
70	666.1	IV	775	1392.588	I	360	4253.6	III	450	9672.3	I
20	678.1	V	1000	1396.112	I	450	4694.1	I	450	9680.8	I
40	680.3	V	300	1409.337	I	285	4695.4	I	450	9693.7	I
110	680.9	V	510	1425.030	I	160	4696.2	I	285	9697.3	I
40	681.6	V	425	1433.280	I	280	4716.2	II	285	9739.7	I
20	693.5	V	300	1436.968	I	450	4815.5	II	285	9932.3	I
70	729.5	III	300	1448.229	I	360	4924.1	II	285	9949.8	I
110	732.42	III	425	1472.972	I	450	4925.3	II	285	9958.9	I
70	735.2	III	550	1473.995	I	285	4993.5	I	285	10455.5	I
70	738.5	III	300	1474.380	I	360	5428.6	II	285	10459.5	I
110	744.9	IV	355	1481.665	I	650	5432.8	II			
110	748.4	IV	485	1483.039	I	1000	5453.8	II	<i>Tantalum Ta Z = 73</i>		
110	750.2	IV	300	1483.233	I	1000	5473.6	II	60	493.07	V
110	753.8	IV	330	1485.622	I	1000	5509.7	II	1000	890.87	V
285	786.5	V	390	1487.150	I	280	5564.9	II	500	947.30	V
70	789.0	III	20	1624.0	IV	1000	5606.1	II	67	999.34	IV
70	796.7	III	20	1629.2	IV	450	5640.0	II	79	1116.10	IV
70	800.5	IV	680	1666.688	I	450	5640.3	II	78	1136.17	IV
70	804.0	IV	640	1687.530	I	280	5647.0	II	85	1175.51	IV
70	809.7	IV	710	1807.311	I	650	5659.9	II	80	1189.28	IV
110	816.0	IV	680	1820.343	I	450	5664.7	II	80	1192.67	IV
70	824.9	III	640	1826.245	I	160	5706.1	I	85	1213.09	IV
70	836.3	III	710	1900.286	I	450	5819.2	II	500	1213.42	V
160	849.2	V	550	1914.698	I	450	6052.7	I	85	1215.53	IV
110	852.2	V	20	2387.0	IV	280	6286.4	II	90	1223.73	IV
220	854.8	V	40	2398.9	IV	450	6287.1	II	88	1238.12	IV
110	857.9	V	110	2460.5	III	450	6305.5	II	95	1240.06	IV
110	860.5	V	110	2489.6	III	450	6312.7	II	87	1258.34	IV
40	906.9	II	160	2496.2	III	280	6384.9	II	94	1264.91	IV
40	910.5	II	160	2499.1	III	280	6397.3	II	98	1272.42	IV
40	912.7	II	220	2508.2	III	280	6398.0	II	94	1275.48	IV
40	937.4	II	70	2636.9	III	360	6413.7	II	86	1275.94	IV
40	937.7	II	220	2665.4	III	160	6743.6	I	92	1308.51	IV
160	1062.7	IV	110	2691.8	III	285	6748.8	I	87	1315.58	IV
160	1073.0	IV	110	2702.8	III	450	6757.2	I	92	1332.38	IV
70	1073.5	IV	220	2718.9	III	450	7579.0	I	86	1343.30	IV
285	1077.1	III	110	2721.4	III	450	7629.8	I	92	1365.88	IV
40	1102.3	II	220	2726.8	III	285	7686.1	I	5000	1392.56	V
70	1194.0	III	220	2731.1	III	450	7696.7	I	91	1398.78	IV
70	1201.0	III	110	2741.0	III	1000	7924.0	I	93	1413.40	IV
40	1234.1	II	285	2756.9	III	160	7928.8	I	91	1454.32	IV
40	1250.5	II	110	2775.2	III	285	7930.3	I	92	1464.41	IV
110	1253.8	II	160	2785.5	III	450	7931.7	I	93	1469.82	IV
110	1259.5	II	110	2863.5	III	450	7967.4	I	90	1495.25	IV
275	1270.782	I	160	2904.3	III	450	7967.4	II	95	1514.19	IV
250	1277.216	I	160	2986.0	III	450	8314.7	I	85	1607.70	IV
280	1295.653	I	110	3097.5	IV	450	8314.7	II	7000	1709.10	V
275	1302.337	I	110	3497.3	III	450	8585.6	I	85	1712.16	IV
235	1302.863	I	160	3632.0	III	285	8680.5	I	85	1716.13	IV
235	1303.110	I	110	3709.4	III	450	8694.7	I	85	2055.75	IV
245	1303.430	I	160	3717.8	III	360	8874.5	I	1100	2140.13	II
260	1305.883	I	160	3838.3	III	110	8882.5	I	1500	2146.87	II
265	1310.194	I	285	3867.6	I	220	8884.2	I	1200	2182.71	II
									1100	2193.88	II

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1500	2196.03	II	770	2775.88	I	200	5037.37	I	75	7006.96	I
90	2199.58	IV	680	2796.34	I	100	5067.87	I	150	7148.63	I
1500	2199.67	II	680	2797.76	II	110	5115.84	I	110	7172.90	I
90	2207.64	IV	510	2806.58	I	100	5141.62	I	140	7301.74	I
1400 d	2210.03	II	640	2844.25	I	100	5143.69	I	160	7346.41	I
1400	2239.48	II	560	2848.52	I	330	5156.56	I	140 c	7352.86	I
1200	2250.76	II	1500	2850.49	I	110	5212.74	I	100	7356.96	I
840	2261.42	II	1900	2850.98	I	110 d	5218.45	I	90 cw	7369.09	I
990	2262.30	II	360	2861.98	I	140	5341.05	I	160	7407.89	I
990	2272.59	II	470	2871.42	I	200	5402.51	I	100	7882.37	I
790	2285.25	II	380	2880.02	I	130	5419.19	I	75	8026.50	I
600	2286.59	II	770	2891.84	I	90	5518.91	I	75	8281.62	I
990	2289.16	II	560	2902.05	I	150	5645.91	I			
440	2302.24	II	310	2915.49	I	130	5664.90	I	<i>Technetium Tc Z = 43</i>		
440	2302.93	II	410	2925.19	I	130	5776.77	I	10000 c	3636.07	I
440	2312.60	II	310	2932.70	I	90	5780.71	I	20000 c	4031.63	I
420	2315.46	II	1700	2933.55	I	130	5811.10	I	15000	4095.67	I
690	2331.98	II	470	2940.06	I	240	5877.36	I	20000	4262.27	I
550	2332.19	II	1200	2940.22	I	130	5882.30	I	30000	4297.06	I
250	2357.30	I	510	2951.92	I	90	5901.91	I	20000	4853.59	I
260	2361.09	I	340	2953.56	I	90	5918.95	I	<i>Tellurium Te Z = 52</i>		
600	2364.24	II	1500	2963.32	I	130	5939.76	I	8	802.28	II
320	2371.58	I	770	2965.13	II	240	5944.02	I	8	1059.51	II
1400	2387.06	II	770	2965.54	I	190 c	5997.23	I	8	1077.66	II
2400	2400.63	II	340	2969.47	I	100	6020.72	I	10	1161.42	II
320	2416.89	II	430	2975.56	I	250	6045.39	I	10	1174.34	II
360	2427.64	I	1800	3012.54	II	100	6047.25	I	12	1175.79	II
360	2429.71	II	290 d	3027.48	I	100	6101.58	I	9	1208.54	II
480	2432.70	II	530	3049.56	I	65	6144.56	I	9	1220.98	II
380	2470.90	II	530	3069.24	I	130	6154.50	I	9	1253.62	II
600	2474.62	I	360	3077.24	I	150	6256.68	I	9	1270.52	II
500	2484.95	I	560	3103.25	I	150	6268.70	I	10	1324.92	II
600	2488.70	II	380	3124.97	I	150	6309.58	I	9	1363.24	II
500	2490.46	I	380	3130.58	I	75	6325.08	I	8	1366.73	II
600	2504.45	I	270	3132.64	I	65	6341.17	I	10	1374.80	II
600	2507.45	I	320	3170.29	I	75	6356.16	I	10	1608.41	II
1200 d	2526.35	I	270	3173.59	I	65	6360.84	I	10	1613.15	II
600	2532.12	II	600	3180.95	I	90	6389.45	I	5	1655.4	I
1200	2559.43	I	300	3223.83	I	65	6428.60	I	5	1688.5	I
460	2562.10	I	1100	3311.16	I	250	6430.79	I	6	1700.0	I
600	2577.37	II	680	3318.84	I	200	6450.36	I	5	1708.0	I
600	2603.49	II	330 d	3330.99	II	380	6485.37	I	10	1822.4	I
1400	2608.63	I	640	3371.54	I	65	6505.52	I	26000	2002.02	I
1200	2635.58	II	360	3385.05	I	100	6514.39	I	6500	2081.16	I
860	2636.90	I	450	3406.94	I	100	6516.10	I	18000	2142.81	I
2400	2647.47	I	490	3480.52	I	100	6574.84	I	3200	2147.25	I
2600	2653.27	I	380	3497.85	I	110	6611.95	I	500	2259.02	I
1900	2656.61	I	490	3511.04	I	75	6621.30	I	1200	2383.26	I
1500	2661.34	I	750	3607.41	I	100	6673.73	I	1500	2385.78	I
770	2675.90	II	980	3626.62	I	180	6675.53	I	50	2438.69	II
1500	2685.17	II	500	3642.06	I	75 c	6740.73	I	120	2530.72	I
470	2694.52	II	210	3918.51	I	75	6771.74	I	100	2649.66	II
1000	2698.30	I	210	3970.10	I	160 c	6813.25	I	80	2661.10	II
1200	2710.13	I	210	3996.17	I	210	6866.23	I	110	2677.13	I
2600	2714.67	I	410	4061.40	I	180	6875.27	I	100	2858.29	II
470	2727.44	II	310	4067.91	I	150	6902.10	I	150	2895.41	II
1200	2748.78	I	300	4205.88	I	140	6927.38	I	70	2967.29	II
860	2749.83	I	360 c	4510.98	I	140	6928.54	I	70	3047.00	II
410	2752.49	II	340	4574.31	I	65	6951.26	I	100	3175.14	I
1000	2758.31	I	260	4619.51	I	180	6966.13	I	60	3256.80	II
430	2761.68	II	450	4681.88	I	110 d	6995.22	I	60	3329.22	II



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
150	3406.79	II	689	9956.30	I	810 d	3472.79	II	390	4196.74	I
50	3442.25	II	325	9977.13	I	810	3500.84	II	650	4203.74	I
50	3521.11	II	5950	10051.41	I	5700	3509.17	II	600	4206.49	I
50	3552.19	II	4097	10091.01	I	1300	3523.66	II	480	4215.09	I
100	3611.78	II	381	10118.08	I	1100	3540.24	II	480	4232.82	I
50	3617.57	II	397	10300.56	I	810	3543.89	II	650	4266.34	I
50	4006.52	II	745	10493.57	I	3200	3561.74	II	760 cw	4278.52	II
70	4127.32	II	1880	10918.34	I	810	3567.35	II	450	4310.42	I
100	4169.77	II	10200	11089.56	I	4200	3568.52	II	2200	4318.83	I
80	4225.73	II	508	11163.74	I	1600	3568.98	II	600	4322.23	I
100	4261.11	II	6620	11487.23	I	1100	3579.20	II	600	4325.83	II
60	4273.43	II	1580	13247.75	I	710	3585.03	II	3000	4326.43	I
80	4285.85	II	1050	14513.51	I	810	3596.38	II	600	4332.12	I
150	4364.00	II	1480	15452.45	I	1600	3600.44	II	870	4336.43	I
75	4385.10	II	2430	15546.23	I	810	3625.54	II	600	4337.64	I
170	4478.63	II	3760	16403.90	I	2300	3650.40	II	1700	4338.41	I
80	4537.07	II	1960	17303.54	I	810	3654.88	II	700	4340.62	I
100	4557.78	II	2780	18291.59	I	2000	3658.88	II	870	4356.81	I
70	4630.62	II	1020	21043.73	I	3800	3676.35	II	330	4382.45	I
100	4641.12	II	464	21602.50	I	810	3682.26	II	300	4388.23	I
180	4654.37	II	74	22555.29	I	450	3693.58	I	260	4390.91	I
200	4686.91	II	38	26539.17	I	450	3700.12	I	350	4423.10	I
100	4696.38	II				4700	3702.86	II	240	4436.12	I
100	4706.53	II	<i>Terbium Tb Z = 65</i>			2400	3703.92	II	240	4448.04	I
100	4766.05	II	1000	1259.40	IV	1000 d	3711.76	II	430	4493.07	I
100	4784.87	II	1000	1327.67	IV	650	3745.04	I	75	4514.31	II
100	4827.14	II	1000	1373.86	IV	870	3747.17	II	110	4549.07	I
150	4831.28	II	5000	1595.39	IV	870	3747.34	II	110	4550.45	I
150	4842.90	II	2000	1633.19	IV	1100	3755.24	II	110	4556.46	I
130	4865.12	II	2000	2027.79	IV	650	3759.35	I	110	4563.69	II
200	4866.24	II	1000	2089.98	IV	1700	3765.14	I	210	4578.69	II
8	5083.0	I	1000	2332.54	IV	2100	3776.49	II	65	4584.84	II
50	5449.84	II	110	2584.61	II	600	3783.53	I	65	4591.56	II
50	5487.95	II	110	2608.57	II	410	3789.92	I	75 d	4626.32	II
150	5576.35	II	130	2628.69	II	760 d	3806.85	II	95	4626.94	II
150	5649.26	II	140	2669.29	II	1500	3830.26	I	65	4632.07	I
100	5666.20	II	190	2704.07	II	540	3833.42	I	65 h	4636.59	I
200	5708.12	II	270	2769.53	II	920 d	3842.50	II	85	4641.00	II
150	5755.85	II	320	2897.44	II	3700	3848.73	II	210	4641.98	II
100	5974.68	II	250	2956.21	II	3500 w	3874.17	II	260 cw	4645.31	II
50	6367.13	II	230	3010.59	II	480	3888.22	I	80	4647.23	I
10 h	6790.0	I	230	3016.18	II	490	3894.64	I	80	4662.79	I
20 h	6837.6	I	460	3053.55	II	2400	3899.20	II	80	4676.90	I
20 h	6854.7	I	460	3070.05	II	1600	3901.33	I	70 c	4681.87	I
15 h	7191.1	I	670	3078.86	II	480	3908.06	I	80	4688.63	II
20 h	7263.5	I	480	3082.36	II	650	3915.43	I	80	4693.11	II
12	7460.98	II	480	3089.58	II	760	3925.45	II	200	4702.41	II
15	7468.75	II	480	3102.96	II	810 d	3939.52	II	110	4707.94	II
15	7921.69	II	440	3139.64	II	2200 d	3976.84	II	80	4739.93	I
15	7943.14	II	480	3187.26	II	1800	3981.87	II	70	4747.80	I
10	7950.34	II	480	3199.56	II	970	4002.59	II	410 cw	4752.53	II
30 h	8061.4	I	1100	3218.93	II	1900	4005.47	II	180	4786.78	I
10	8122.44	II	1200	3219.98	II	760	4012.75	II	100	4813.77	I
20	8186.44	II	480	3252.32	II	870	4032.28	I	80	4875.57	II
15	8273.53	II	760	3280.31	II	2100	4033.03	II	80	4881.15	II
15	8672.95	II	760	3281.40	II	430	4054.12	I	95	4915.90	I
10	8733.81	II	1000	3285.04	II	410	4060.37	I	65	4931.79	I
205	8758.18	I	1500	3293.07	II	1300	4061.58	I	85	4993.82	II
81	9004.37	I	3800	3324.40	II	650	4105.37	I	110	5078.25	I
5660	9722.74	I	760	3349.42	II	1100	4144.41	II	75	5089.12	II
532	9868.92	I	760	3364.93	II	350	4158.53	I	85	5186.13	I
			810	3454.06	II						



Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
120	5228.12	I	20	1034.73	IV	15	4981.35	II	910	3256.274	II
75	5248.71	I	20	1036.61	IV	25	5078.54	II	180	3257.366	I
75 w	5262.11	II	10 r	1049.73	II	25	5152.14	II	910	3262.668	II
75	5281.05	I	8 r	1050.30	II	18000	5350.46	I	620	3287.789	II
65	5304.72	I	5 r	1074.97	II	15 d	5384.85	II	910	3291.739	II
110	5319.23	I	30	1079.68	IV	10	5410.97	II	620	3292.520	II
65 w	5337.90	I	10 r	1130.17	II	25	5949.48	II	240	3301.650	I
160	5354.88	I	15 r	1162.55	II	10	6179.98	II	480	3304.238	I
75	5369.72	I	10 r	1167.43	II	10	6378.32	II	510	3321.450	II
75	5375.98	I	10 r	1183.41	II	16 h	6549.84	I	840	3325.120	II
50	5424.10	II	12 r	1194.84	II	10	6966.5	II	250	3330.476	I
55	5459.81	I	5 r	1246.00	II	10	7815.80	I	620	3334.604	II
55	5509.61	I	10	1266.33	III	20	8373.6	I	620	3337.870	II
50	5514.54	I	15 r	1307.50	II	10	8474.27	I	310	3348.768	I
65	5524.12	I	8 r	1310.20	II	10	8664.1	II	980	3351.228	II
85 c	5747.58	I	25 r	1321.71	II	20	9130.	II	620	3358.602	II
75	5795.64	I	8 r	1330.40	II	20	9130.5	I	250	3374.974	I
75	5803.13	II	10 r	1373.52	II	40	9509.4	I	1300	3392.035	II
65	5815.36	I	10	1477.14	III	20	9930.4	I	200	3396.727	I
65	5851.07	I	8 r	1489.65	I	30	10011.9	I	250	3398.544	I
65	5870.62	I	10 r	1499.30	II	40	10488.80	I	200	3405.558	I
65 c	5920.78	I	10 r	1507.82	II	1000	11512.82	I	250	3413.012	I
75	5967.34	II	15 r	1561.58	II	150	12736.4	I	390	3421.210	I
35	6331.68	II	10 r	1568.57	II	700	13013.2	I	270	3423.989	I
35 cw	6518.68	I	7 r	1593.26	II	<i>Thorium Th Z = 90</i>					
35	6581.82	I	5 h	1616.	I	150	1707.37	IV	770	3435.976	II
90	6677.94	II	5	1685.40	I	200	1959.02	IV	1300	3469.920	II
40 cw	6702.61	I	10 r	1792.76	II	200	2002.34	IV	170	3471.218	I
130	6794.58	II	12 r	1814.85	II	200	2413.50	III	200	3486.552	I
55	6896.37	II	25 r	1908.64	II	200	2427.94	III	670	3539.587	II
45 h	6899.95	I	100 r	2007.56	I	200	2431.68	III	180	3544.018	I
40	6901.98	I	100 r	2210.71	I	200	2441.24	III	170	3549.595	I
65	7204.28	I	30	2298.04	II	200	2441.24	III	200	3555.013	I
40	7257.73	I	140	2315.98	I	500	2565.593	II	530	3559.451	II
45	7348.88	II	900 h	2379.69	I	480	2692.415	II	200	3576.557	I
45	7496.12	I	20	2530.86	II	520	2747.156	II	270	3592.780	I
27 h	7582.03	II	700	2580.14	I	410	2752.166	II	270	3598.120	I
45	7590.24	I	420	2709.23	I	800	2832.315	II	980	3609.445	II
65	7596.44	I	4400 d	2767.87	I	1200	2837.295	II	200	3612.427	I
30	7627.81	I	10	2849.80	II	100	2848.084	I	480	3615.133	II
30	7737.63	I	2800	2918.32	I	550	2870.406	II	270	3635.943	I
30	7855.79	II	20	3091.56	II	100	2936.086	I	210	3642.248	I
27	7927.90	II	15	3185.51	II	100	2943.729	I	170	3649.735	I
30	8025.42	II	15	3186.56	II	420	3049.092	II	220	3663.202	I
30	8085.06	II	15	3187.74	II	450	3067.729	II	280	3669.968	I
65	8194.82	II	1200	3229.75	I	670	3078.828	II	700	3675.567	II
95	8212.57	I	15	3291.01	II	480	3080.217	II	150	3682.486	I
40	8450.06	II	15	3369.15	II	510	3108.296	II	170	3692.566	I
30 h	8511.80	I	9	3456.34	III	100	3116.263	I	180	3698.105	I
45	8583.45	II	20000	3519.24	I	510	3119.526	II	340	3706.767	I
30	8603.40	I	5000	3529.43	I	510	3122.963	II	590	3719.435	I
65	8765.74	II	8	3540.08	II	480	3125.507	II	770	3721.825	II
<i>Thallium Tl Z = 81</i>			9	3560.68	II	100	3136.216	I	1300	3741.183	II
10	570.49	IV	12000 w	3775.72	I	420	3139.306	II	310	3747.539	I
5 r	670.87	II	10	3832.30	II	420	3142.835	II	650	3752.569	II
15 r	696.30	II	10	3887.15	II	420	3175.726	II	180	3770.056	I
5 r	709.23	II	7	4109.85	III	1100	3180.193	II	590	3803.075	I
10 r	817.18	II	6	4269.81	III	770	3188.233	II	450	3828.384	I
5 r	836.34	II	20	4274.98	II	560	3221.292	II	840	3839.746	II
8 r	1018.85	II	40	4306.80	II	560	3229.009	II	450	3863.405	II
30	1028.69	IV	20	4737.05	II	480	3235.84	II	210	3875.374	I
						590	3238.116	II			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
340	3895.419	I	40	7191.132	II	1900	3151.04	II	6800	3883.13	I
590	3929.669	II	35	7208.006	I	1500	3157.34	II	1800	3883.44	II
200	3932.911	I	50	7525.508	II	450	3172.65	I	5400	3887.35	I
390	3967.392	I	30	7647.380	I	2300	3172.83	II	440	3896.62	I
200	3972.155	I	30	8330.451	I	1200	3236.81	II	3500	3916.48	I
150	3980.089	I	40	8967.641	I	1600	3240.23	II	1500	3949.27	I
530	3994.549	II	20	9833.42	I	2300	3241.54	II	1500	3958.10	II
220	4008.210	I	20	10726.93	I	320	3246.96	I	1800	3996.52	II
220	4009.056	I	20	10942.24	II	1900	3258.05	II	220	4024.23	I
280	4012.495	I	30	11230.259	I	1600	3266.64	II	380	4044.47	I
4200	4019.129	II	20	11984.67	II	1200	3267.40	II	10000	4094.19	I
250	4030.842	I	20	17208.22	II	1100	3276.81	II	9500	4105.84	I
250	4036.047	I	15	18811.88	I	1200	3283.40	II	1100	4138.33	I
250	4063.407	I	10	22264.35	II	1200	3285.61	II	8800	4187.62	I
700	4086.520	II	<i>Thulium Tm Z = 69</i>			2300	3291.00	II	6000	4203.73	I
700	4094.747	II	5000	2185.94	III	2000	3302.46	II	380	4222.67	I
150	4100.341	I	360	2284.79	II	1200	3309.80	II	3000	4242.15	II
840	4108.421	II	20000	2296.21	III	230	3349.99	I	270	4271.71	I
240	4112.754	I	5000	2305.03	III	4000	3362.61	II	150	4298.36	I
280	4115.758	I	20000	2311.16	III	1700	3397.50	II	2700	4359.93	I
1100	4116.713	II	5000	2312.72	III	850	3410.05	I	1400	4386.43	I
200	4127.411	I	5000	2326.19	III	340	3412.59	I	200	4394.42	I
200	4134.067	I	6000	2328.50	III	340	3416.59	I	140	4396.50	I
450	4149.986	II	6000	2329.29	III	6400	3425.08	II	120	4454.03	I
620	4178.060	II	3000	2331.80	III	340	3429.33	I	540	4481.26	II
620	4208.890	II	3000	2357.05	III	4900	3441.50	II	150	4519.60	I
110	4253.538	I	4000	2406.63	III	4900	3453.66	II	260	4522.57	II
110	4260.333	I	450	2409.02	II	8500	3462.20	II	110	4548.60	I
480	4277.313	II	450	2426.17	II	210	3467.51	I	270	4599.02	I
700	4282.042	II	770	2480.13	II	340	3476.69	I	300	4615.94	II
130	4337.277	I	30000	2489.44	III	340	3480.98	I	80	4626.33	II
1300	4381.860	II	2000	2504.71	III	420	3487.38	I	95	4626.56	II
1100	4391.110	II	1300	2509.08	II	340	3499.95	I	110	4634.26	II
110	4498.940	I	3000	2519.78	III	250	3517.60	I	120	4655.09	I
280	4510.527	II	130	2527.02	I	1700	3535.52	II	160	4681.92	I
90	4723.438	I	10000	2552.46	III	420	3537.91	I	120	4691.11	I
50	4840.843	I	360	2552.76	I	210	3555.82	I	110	4724.26	I
280	4863.163	II	540	2561.65	II	340	3560.92	I	680	4733.34	I
260	5017.255	II	430	2588.27	II	420	3563.88	I	70	4759.90	I
110	5067.974	I	170 h	2596.49	I	1300	3566.47	II	80	4831.20	II
120	5148.211	II	810	2607.06	II	420	3567.36	I	140	4957.18	I
95	5216.596	II	730	2624.33	II	280	3586.07	I	160	5009.77	II
110	5231.160	I	5000	2682.32	III	2100	3608.77	II	160	5034.22	II
95	5247.654	II	2000	2707.03	III	1000	3629.09	III	150	5060.90	I
60	5343.581	I	3000	2719.47	III	380	3638.41	I	95	5113.97	I
60	5587.026	I	540	2721.19	II	1100	3668.09	II	80	5213.38	I
95	5707.103	II	3000	2724.44	III	4800	3700.26	II	650	5307.12	I
70	5760.551	I	4000	2727.56	III	3800	3701.36	II	80	5346.49	II
85	5989.044	II	680	2794.60	II	7700	3717.91	I	270	5631.41	I
60	6169.822	I	730	2797.27	II	2400	3734.12	II	520	5675.84	I
50	6182.622	I	2000	2806.77	III	5000	3744.06	I	40	5684.76	II
50	6274.116	II	580	2827.92	II	1700	3751.81	I	35	5709.97	II
50	6274.117	II	200	2854.17	I	6000	3761.33	II	190	5764.29	I
50	6355.911	II	1600	2869.23	II	4800	3761.91	II	35	5838.76	II
60	6457.283	I	1000	2947.72	III	7100	3795.75	II	240	5895.63	I
50	6462.614	I	490	2973.22	I	770	3798.54	I	140	5971.26	I
50 h	6531.342	I	1000	2998.28	III	600	3807.72	I	200	6460.26	I
55	6989.656	I	1500	3015.30	II	290	3826.39	I	95	6604.96	I
30	7045.795	II	360	3081.12	I	1300	3838.20	II	110	6779.77	I
30	7084.171	I	7400	3131.26	II	290	3840.87	I	120	6844.26	I
30	7168.896	I	2300	3133.89	II	8900	3848.02	II	80	6845.76	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
10	6937.37	I	120 r	1823.00	I	110	3330.62	I	15	498.26	V
10	7017.90	I	9	1831.89	II	60	3351.97	II	14	502.08	V
12	7034.34	I	50 r	1848.75	I	10	3472.46	II	13	526.57	V
10	7106.14	I	200 r	1860.32	I	11	3575.45	II	18	779.07	IV
17	7272.62	I	80	1886.05	I	280 r	3801.02	I	20	1298.66	III
14	7310.51	I	100	1891.40	I	10	5332.36	II	20	1298.97	III
14	7432.18	I	12	1899.91	II	20	5561.95	II	23	1455.19	III
75	7481.08	I	50	1909.30	I	25	5588.92	II	20	1467.34	IV
75	7490.20	I	80	1925.31	I	500	5631.71	I	11	1717.40	V
140	7558.33	I	500	1941.86	III	15	5799.18	II	10	1841.49	V
80	7731.53	I	150	1952.15	I	50	5925.44	I	20	2067.56	IV
40	7856.08	I	50 h	1977.6	I	100	5970.30	I	18	2103.16	IV
55	7927.51	I	80	1984.20	I	150	6037.70	I	180	2273.28	I
110	7930.84	I	50	2040.66	I	250	6069.00	I	190	2279.96	I
95	8017.90	I	50	2054.03	I	100	6073.46	I	190	2305.67	I
27	8472.01	II	70	2058.31	I	400	6149.71	I	22	2413.99	III
			80	2068.58	I	200	6154.60	I	25	2516.05	III
			100	2072.89	I	150	6171.50	I	360	2525.60	II
			100	2073.08	I	100	6310.78	I	24	2527.84	III
			200	2096.39	I	70	6453.50	II	210	2529.85	I
			100	2100.93	I	25	6844.05	II	190	2531.25	II
			100 r	2113.93	I	20	7191.40	II	190	2534.62	II
			50	2121.26	I	10	7387.79	II	130	2535.87	II
			40 r	2148.73	I	13	7741.80	II	23	2540.06	III
			20 r	2151.43	I	100	7754.97	I	24	2563.44	III
			30	2151.54	II	100 h	8030.5	I	23	2565.42	III
			80	2171.32	I	200	8114.09	I	22	2567.56	III
			150 r	2194.49	I	80	8357.04	I	270	2599.92	I
			300 r	2199.34	I	300	8422.72	I	340	2605.15	I
			400 r	2209.65	I	400	8552.60	I	510	2611.28	I
			80 r	2231.72	I	50 h	8681.7	I	300	2619.94	I
			400 r	2246.05	I	50 h	9410.86	I	640	2641.10	I
			60	2251.17	I	80 h	9415.37	I	800	2644.26	I
			400 r	2268.91	I	150	9616.40	I	950	2646.64	I
			200 r	2286.68	I	50	9741.1	I	250	2742.32	I
			600 r	2317.23	I	100 h	9742.8	I	250	2802.50	I
			300 r	2334.80	I	300 h	9805.38	I	190	2841.94	II
			1000 r	2354.84	I	500	9850.52	I	180	2877.44	II
			22	2368.33	II	54	10894.00	I	280	2884.11	II
			100	2408.15	I	70	11191.85	I	450	2912.08	I
			800 r	2421.70	I	56	11277.66	I	340	2928.34	I
			1000 r	2429.49	I	200	11454.59	I	1100	2942.00	I
			15	2448.98	II	200	11616.26	I	1300	2948.26	I
			300	2483.39	I	258	11739.78	I	1600	2956.13	I
			13	2483.48	II	96	11825.18	I	22	2984.75	III
			10	2486.99	II	106	11835.82	I	1300 d	3066.22	II
			200	2495.70	I	254	11932.99	I	1100	3072.97	II
			400	2546.55	I	48	12009.50	I	1600	3075.22	II
			500 r	2571.58	I	111	12313.24	I	2300	3078.64	II
			200	2594.42	I	42	12530.87	I	3600	3088.02	II
			200 r	2661.24	I	42	12536.5	I	720	3119.72	I
			700 r	2706.51	I	89	12888.5	I	500	3161.20	II
			150	2779.81	I	187	12981.7	I	780	3161.77	II
			1400 r	2839.99	I	187	13018.5	I	1000	3162.57	II
			1000 r	2863.32	I	68	13081.5	I	1600	3168.52	II
			700 r	3009.14	I	378	13460.2	I	2400	3186.45	I
			850 r	3034.12	I	144	13608.2	I	1000	3190.87	II
			12	3047.50	II	40	20861.7	I	3100	3191.99	I
			550 r	3175.05	I	4	24738.2	I	3800	3199.92	I
			550 r	3262.34	I				780	3202.54	II
			50	3283.21	II				1100	3217.06	II
						<i>Titanium Ti Z = 22</i>					
						17	252.96	V			

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1300	3222.84	II	950	3962.85	I	840	5020.03	I	20	8466.87	III
6600	3234.52	II	950	3964.27	I	840	5022.87	I	90	8675.39	I
5200	3236.57	II	4800	3981.76	I	1200	5035.91	I	<i>Tungsten W Z = 74</i>		
4100	3239.04	II	570	3982.48	I	840	5036.47	I	5800	2001.71	II
2600	3241.99	II	5700	3989.76	I	740	5038.40	I	13000	2008.07	II
1200	3248.60	II	7800	3998.64	I	1200	5039.95	I	5100	2009.98	II
1200	3252.91	II	950	4008.93	I	1400	5064.66	I	4100	2010.23	II
1200	3254.25	II	1200	4024.57	I	1100	5173.75	I	4100	2014.23	II
1200	3261.60	II	840	4078.47	I	1300	5192.98	I	7300	2026.08	II
840	3314.42	I	890	4286.01	I	1400	5210.39	I	15000	2029.98	II
2900	3322.94	II	840	4287.40	I	17	5278.12	III	5300	2049.63	II
2100	3329.46	II	950	4289.07	I	20	5398.93	IV	9700	2079.11	II
1800	3335.20	II	840	4290.94	I	340	5512.53	I	6100	2094.75	II
1100	3340.34	II	840	4295.76	I	270	5514.35	I	2100	2118.87	II
5700	3341.88	I	2000	4298.66	I	320	5514.54	I	2400	2121.59	II
4300	3349.04	II	200	4300.05	II	250	5644.14	I	1500	2166.32	II
12000	3349.41	II	2900	4300.56	I	130	5675.44	I	1300	2204.48	II
4100	3354.64	I	4100	4301.09	I	95	5689.47	I	460	2249.80	I
7200	3361.21	II	6000	4305.92	I	95	5715.13	I	510	2277.58	I
1100	3370.44	I	1200	4314.80	I	85	5739.51	I	530 d	2294.49	I
4300	3371.45	I	330	4395.04	II	400	5866.46	I	340	2309.02	I
5700	3372.80	II	890	4427.10	I	230	5899.32	I	440	2313.17	I
2900 d	3377.48	I	230	4443.80	II	120	5918.55	I	460	2321.63	I
1400	3380.28	II	840	4449.15	I	150	5922.12	I	390 d	2326.56	I
5700	3383.76	II	550	4450.90	I	120	5941.76	I	320	2354.61	I
1400	3385.95	I	840	4453.32	I	300	5953.17	I	580	2360.44	I
1400	3387.84	II	950	4455.33	I	200	5965.84	I	850	2363.07	I
1100	3394.58	II	1100	4457.43	I	270	5978.56	I	510	2374.47	I
890	3444.31	II	240	4468.50	II	340	5999.04	I	670	2384.82	I
600	3461.50	II	530	4481.26	I	110	6064.63	I	730	2397.09	II
600	3477.18	II	780	4512.74	I	120	6085.23	I	560	2397.73	I
480	3491.05	II	1000	4518.03	I	120	6091.17	I	560	2397.98	I
890	3504.89	II	1000	4522.80	I	120	6126.22	I	1700 d	2405.58	I
600	3510.84	II	780	4527.31	I	17	6246.65	IV	610	2415.68	I
17	3576.44	IV	6000	4533.24	I	380	6258.10	I	870	2424.21	I
600	3610.16	I	240	4533.97	II	380	6258.70	I	1800	2435.96	I
4800	3635.46	I	3600	4534.78	I	300	6261.10	I	580	2444.06	I
6600	3642.68	I	2400	4535.58	I	55	6546.28	I	780	2451.48	II
7200	3653.50	I	1200	4535.92	I	65	6554.23	I	870	2452.00	I
600	3671.67	I	1200	4536.05	I	75	6556.07	I	630	2454.98	I
3100	3685.20	II	720	4544.69	I	18	6621.58	III	780	2455.51	I
600	3689.91	I	950	4548.77	I	18	6667.99	III	780	2456.53	I
2900	3729.82	I	240	4549.63	II	80	6743.12	I	1100	2459.30	I
3300	3741.06	I	15	4549.84	III	20	7072.64	III	1400	2466.85	I
330	3741.64	II	950	4552.46	I	18	7084.57	III	480	2472.51	I
5200	3752.86	I	720	4555.49	I	260	7209.44	I	1200	2474.15	I
3300	3759.30	II	240	4571.98	II	130	7244.86	I	870	2480.13	I
2900	3761.32	II	15 d	4572.20	III	130	7251.72	I	1500	2481.44	I
840	3786.04	I	950	4617.27	I	120	7344.72	I	480 d	2482.10	I
500	3882.89	I	480	4623.09	I	90	7357.74	I	580	2484.74	I
530	3900.54	II	720	4656.47	I	60	7364.11	I	390	2487.50	I
2600	3904.78	I	840	4667.59	I	60	7978.88	I	390	2489.23	II
500	3913.46	II	950	4681.92	I	55	8024.84	I	630	2495.26	I
500	3914.34	I	470	4840.87	I	75	8364.24	I	680	2504.70	I
15	3915.47	III	400	4885.08	I	100	8377.85	I	75	2510.47	II
1100	3924.53	I	380	4899.91	I	100	8382.54	I	310	2520.46	I
890	3929.88	I	5800	4981.73	I	75	8396.87	I	780	2521.32	I
1100	3947.78	I	4600	4991.07	I	120	8412.36	I	270	2522.04	II
4500	3948.67	I	4000	4999.51	I	170	8426.52	I	780	2523.41	I
4500	3956.34	I	3600	5007.21	I	490	8434.94	I	430	2527.76	I
5200	3958.21	I	3200 d	5014.19	I	240	8435.70	I	780	2533.64	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
1200	2547.14	I	440	3046.44	I	2200	4302.11	I	580	2931.41	II
780	2550.38	I	810	3049.69	I	200	4378.48	I	530 p	2940.37	II
2700	2551.35	I	180	3073.28	I	180	4384.85	I	1300	2941.92	II
730	2561.97	I	180 d	3084.83	I	200	4408.28	I	830	2943.90	II
870	2580.49	I	370	3093.50	I	640	4484.19	I	580	2956.06	II
390	2584.39	I	240	3107.23	I	170	4588.73	I	580	2967.94	II
390	2589.17	II	240	3108.02	I	640	4659.87	I	580	2971.06	II
370	2601.96	I	230	3117.57	I	640	4680.51	I	530	2984.61	II
680	2606.39	I	260	3120.18	I	790	4843.81	I	630	3022.21	II
370	2608.32	I	290	3163.42	I	380	4886.90	I	630	3031.99	II
970	2613.08	I	320	3176.60	I	220	4982.59	I	580	3050.20	II
480	2613.82	I	190	3181.82	I	820	5053.28	I	630	3057.91	II
400	2620.25	I	390	3191.57	I	770	5224.66	I	630	3062.54	II
400	2622.21	I	390	3198.84	I	220	5514.68	I	580	3072.78	II
400	2625.22	I	520	3207.25	I	65	5648.37	I	580	3093.01	II
400	2632.48	I	1000	3215.56	I	55	5735.09	I	580	3102.39	II
400	2632.70	I	190	3232.49	I	45	5804.85	I	970	3111.62	II
810	2633.13	I	210	3254.36	I	40	5902.64	I	530	3119.35	II
400 d	2638.62	I	210	3259.66	I	55	5947.57	I	680	3124.95	II
650	2646.18	I	210 d	3266.62	I	55	5965.86	I	530	3139.61	II
400	2646.73	I	730	3300.82	I	55	6012.78	I	680	3149.24	II
1600	2656.54	I	440	3311.38	I	40	6021.52	I	530	3153.11	II
810	2662.84	I	440	3326.20	I	45	6292.02	I	730	3229.50	II
810	2671.47	I	440	3331.69	I	35	6404.21	I	680	3232.16	II
650	2677.28	I	390	3373.75	I	40	6445.12	I	730	3291.33	II
2100	2681.42	I	230	3429.59	I	17	6611.62	I	1100	3305.89	II
650	2695.67	I	240	3443.00	I	13	6678.42	I	730	3390.38	I
650	2699.59	I	400	3495.24	I	15	6693.08	I	580	3424.56	II
400	2700.01	I	650	3545.22	I	13	6984.27	I	580	3435.49	I
400	2706.58	I	240	3570.65	I	15	7140.52	I	630	3466.30	I
400	2708.59	I	1900	3617.52	I	9	7162.64	I	680	3482.49	II
400 d	2708.80	I	650	3682.08	I	11	7200.16	I	1600	3489.37	I
400	2715.50	I	400	3683.30	I	10	7278.24	I	530	3496.41	II
2100	2718.91	I	570	3688.06	I	15	7285.81	I	630	3500.08	I
2600	2724.35	I	810	3707.92	I	15	7296.55	I	780	3507.34	I
400	2725.03	I	510	3757.92	I	10	7509.00	I	1600	3514.61	I
650	2748.84	I	680	3760.13	I	17	7569.92	I	630	3533.57	II
400	2762.34	I	1000	3768.45	I	17	7614.15	I	530	3540.47	II
400	2764.27	II	340	3773.71	I	13	7688.97	I	1200	3550.82	II
400	2769.74	I	1000	3780.77	I	11	7784.15	I	680	3555.32	I
810	2770.88	I	290	3809.22	I	22	8017.19	I	1200	3561.80	I
810	2774.00	I	190	3810.38	I	22	8055.64	I	2300	3566.59	I
810	2774.48	I	260	3810.79	I	13	8123.82	I	530	3569.08	I
810	2792.70	I	1400	3817.48	I	10	8338.08	I	630	3578.72	II
400	2799.93	I	1100	3835.06	I	27	8585.11	I	3200	3584.88	I
810	2818.06	I	730	3846.22	I	10	8594.42	I	840	3638.20	I
1600	2831.38	I	1800	3867.99	I	13	8865.53	I	2800	3670.07	II
810	2833.63	I	730	3881.41	I				1100	3701.52	II
810	2848.02	I	8600	4008.75	I	<i>Uranium U Z = 92</i>			600	3738.04	II
1500	2896.44	I	540	4015.22	I	440	2565.41	II	680	3746.42	II
690	2935.00	I	910	4045.59	I	610	2635.53	II	950	3748.68	II
2400	2944.40	I	730	4069.95	I	830	2793.94	II	600	3751.17	I
2400	2946.99	I	5000	4074.36	I	870	2802.56	II	1900	3782.84	II
730 d	2979.71	I	1000	4102.70	I	630	2807.05	II	570	3793.10	II
360	3013.79	I	540	4137.46	I	630	2817.96	II	1900	3811.99	I
520	3016.47	I	450	4171.17	I	870	2821.12	II	750	3826.51	II
770	3017.44	I	220	4207.05	I	680	2828.90	II	2000	3831.46	II
210	3024.93	I	250	4219.37	I	920	2832.06	II	1200	3839.63	I
310 d	3026.67	I	540	4244.36	I	970	2865.68	II	2400	3854.64	II
440 d	3041.73	I	1400	4269.38	I	1200	2889.62	II	4900	3859.57	II
270	3043.80	I	4100	4294.61	I	780	2906.80	II	1900	3865.92	II
						780	2908.28	II			







Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
100 I	5494.86	II	200	6528.65	II	300	8739.39	I	500	30794.18	I
40	5524.4	III	100	6533.16	I	100	8758.20	I	6000	31069.23	I
200	5525.53	II	1000	6595.01	II	5000	8819.41	I	125	31336.01	I
600	5531.07	II	100	6595.56	I	300	8862.32	I	550	31607.91	I
100	5566.62	I	400	6597.25	II	200	8908.73	I	100	32293.08	I
300	5616.67	II	100	6598.84	II	200	8930.83	I	1800	32739.26	I
300	5659.38	II	150	6668.92	I	1000	8952.25	I	3500	33666.69	I
600	5667.56	II	300	6694.32	II	100	8981.05	I	150	34014.67	I
150	5670.91	II	200	6728.01	I	200	8987.57	I	450	34335.27	I
100	5695.75	I	150	6788.71	II	400	9045.45	I	170	34744.00	I
200	5699.61	II	100	6790.37	II	500	9162.65	I	5000	35070.25	I
200	5716.10	II	1000	6805.74	II	100	9167.52	I	110	35246.92	I
500	5726.91	II	200	6827.32	I	100	9374.76	I	250	36209.21	I
500	5751.03	II	100	6872.11	I	200	9513.38	I	150	36231.74	I
300	5758.65	II	300	6882.16	I	50 h	9591.35	II	450	36508.36	I
300	5776.39	II	80	6910.22	II	150	9685.32	I	850	36788.83	I
100	5815.96	II	100	6925.53	I	50 I	9698.68	II	140	38685.98	I
300	5823.89	I	800 h	6942.11	II	100	9718.16	I	175	38737.82	I
150	5824.80	I	100	6976.18	I	2000	9799.70	I	270	38939.60	I
100	5875.02	I	2000	6990.88	II	3000	9923.19	I	120	39955.14	I
300	5893.29	II	150	7082.15	II	100	10838.37	I	<i>Ytterbium Yb Z = 70</i>		
100	5894.99	I	500	7119.60	I	90	11742.01	I	1000	1050.24	IV
200	5905.13	II	50 s	7147.50	II	375	12235.24	I	1000	1054.46	IV
100	5934.17	I	200	7149.03	II	100	12257.76	I	5000	1134.43	IV
500	5945.53	II	500	7164.83	II	300	12590.20	I	900	1316.04	IV
300	5971.13	II	100	7284.34	II	2500	12623.391	I	800	1326.36	IV
2000	5976.46	II	200	7301.80	II	250	13544.15	I	900	1350.26	IV
200	6008.92	II	200	7339.30	II	2000	13657.055	I	80	1561.42	III
1000	6036.20	II	100	7386.00	I	1250	14142.444	I	80 h	1765.21	III
2000	6051.15	II	150	7393.79	I	800	14240.96	I	800	1791.06	IV
600	6093.50	II	300	7548.45	II	375	14364.99	I	100	1863.32	III
1500	6097.59	II	200	7584.68	I	140	14660.81	I	800	1873.91	III
400	6101.43	II	80	7618.57	II	3000	14732.806	I	500	1898.25	III
100	6115.08	II	500	7642.02	I	100	15099.72	I	500	1998.82	III
100	6146.45	II	100	7643.91	I	2500	15418.394	I	900	2116.65	IV
150	6178.30	I	200	7670.66	II	150	15557.13	I	2500	2116.67	II
120	6179.66	I	60	7787.04	II	250	15979.54	I	800	2123.32	IV
300	6182.42	I	100	7802.65	I	100	16039.90	I	3000	2126.74	II
500	6194.07	II	100	7881.32	I	1000	16053.28	I	800	2139.99	IV
100	6198.26	I	300	7887.40	I	125	16554.49	I	20000	2144.77	IV
60	6205.97	III	500	7967.34	I	1500	16728.15	I	15000	2154.18	IV
100	6220.02	II	100	8029.67	I	1500	17325.77	I	370	2161.60	II
25	6221.7	III	200	8057.26	I	350	18788.13	I	850	2185.71	II
60	6238.2	III	150	8061.34	I	150	20187.19	I	640	2224.46	II
60	6259.05	III	100	8101.98	I	3000	20262.242	I	300	2240.11	III
500	6270.82	II	150 h	8151.80	II	250	21470.09	I	300	2305.32	III
400	6277.54	II	100	8171.02	I	1250	23193.33	I	140	2320.81	II
100	6284.41	II	700	8206.34	I	110	23279.54	I	170	2390.74	II
100	6286.01	I	10000	8231.635	I	1800	24824.71	I	460	2464.50	I
250	6300.86	II	500	8266.52	I	175	25145.84	I	140	2512.06	II
500	6318.06	I	7000	8280.116	I	2000	26269.08	I	270	2538.67	II
400	6343.96	II	2000	8346.82	I	2500	26510.86	I	2000	2567.61	III
600	6356.35	II	100	8347.24	II	250	28381.54	I	1000	2579.57	III
200	6375.28	II	2000	8409.19	I	750	28582.25	I	800	2599.14	III
100	6397.99	II	50 h	8515.19	II	300	29384.41	I	600	2621.11	III
300	6469.70	I	200	8576.01	I	150	29448.06	I	1000	2642.56	III
150	6472.84	I	50 h	8604.23	II	100	29649.58	I	1000	2651.74	III
120	6487.76	I	250	8648.54	I	100	29813.62	I	700	2652.25	III
100	6498.72	I	100	8692.20	I	600	30253.14	I	990	2653.75	II
200 h	6504.18	I	200	8696.86	I	1500	30475.46	I	200	2665.04	II
300	6512.83	II	50 h	8716.19	II	100	30504.12	I	2000	2666.13	III





Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
540	3552.69	I	300	4487.47	I	160	5706.73	I	100	1767.69	III
170	3558.76	I	500	4505.95	I	90	5743.85	I	100	1797.64	II
190	3571.43	I	890	4527.25	I	75	5765.64	I	100 d	1811.05	II
260	3576.05	I	440	4527.80	I	100	5781.69	II	100 d	1833.57	II
3300	3584.52	II	100	4544.32	I	120	6009.19	I	100	1864.12	II
300	3587.75	I	100	4559.37	I	120	6023.41	I	100	1866.08	II
100	3589.69	I	130	4596.55	I	120	6135.04	I	100	1872.13	II
2800	3592.92	I	95	4604.80	I	150	6138.43	I	100 d	1918.96	II
10000	3600.73	II	2000	4643.70	I	1200	6191.73	I	100 d	1929.67	II
6200	3601.92	II	200 h	4658.32	I	300	6222.59	I	100	1969.40	II
7800	3611.05	II	2000	4674.84	I	1000	6435.00	I	100	1982.11	II
4300	3620.94	I	180	4696.81	I	90	6538.60	I	100	1986.99	II
1900	3628.71	II	170	4728.53	I	70	6557.39	I	500	2025.48	II
7800	3633.12	II	160	4752.79	I	95	6613.75	II	500	2062.00	II
3000	3664.61	II	410	4760.98	I	40	6650.61	I	200	2064.23	II
170	3692.53	I	120	4781.04	I	150	6687.58	I	120	2079.08	I
13000	3710.30	II	170	4786.89	I	70	6700.71	I	300	2099.94	II
1200	3747.55	II	180	4799.30	I	190	6793.71	I	200	2102.18	II
10000	3774.33	II	140	4819.64	I	21	6815.16	I	800 r	2138.56	I
1400	3776.56	II	120	4822.13	I	45	6845.24	I	1000	2501.99	II
7400	3788.70	II	770	4839.87	I	29	6887.22	I	150	2515.81	I
1300	3818.35	II	550	4845.68	I	24 h	6950.31	I	1000	2557.95	II
4000	3832.88	II	410	4852.69	I	24	6979.88	I	300	2582.49	I
80	3876.82	I	120	4854.25	I	29	7052.94	I	200	2608.56	I
480	3878.28	II	890	4854.87	II	35	7191.66	I	300	2608.64	I
4400	3950.36	II	330	4859.84	I	35	7264.17	II	200	2670.53	I
3600	3982.60	II	1900	4883.69	II	50	7346.46	I	300	2684.16	I
940	4039.83	I	95	4893.44	I	29	7450.30	II	300	2712.49	I
2400	4047.64	I	1100	4900.12	II	9000	7558.71	III	200	2756.45	I
9400	4077.38	I	100	4906.11	I	35	7563.13	I	300	2770.86	I
2000	4083.71	I	150	4921.87	I	29	7855.52	I	300	2770.98	I
9900	4102.38	I	120	4974.30	I	110	7881.90	II	400	2800.87	I
8900	4128.31	I	100	5006.97	I	10000	7991.43	III	100	2801.06	I
7500	4142.85	I	75	5070.21	I	24	8344.43	I	200	3035.78	I
100 h	4157.63	I	75	5072.19	I	10000	8796.21	III	200	3072.06	I
2400	4167.52	I	1100	5087.42	II	95	8800.62	I	300	3196.31	II
2000	4174.14	I	180	5135.20	I	19 h	8835.85	II	500 r	3282.33	I
8000	4177.54	II	960	5200.41	II				800	3302.58	I
160	4217.80	I	1500	5205.72	II	<i>Zinc Zn Z = 30</i>			700 r	3302.94	I
280 h	4220.63	I	10000	5238.10	III	200	425.90	IV	800	3345.02	I
600	4235.73	II	180	5240.81	I	200	428.54	IV	800	3345.02	I
2200	4235.94	I	75	5380.62	I	200	430.59	IV	500	3345.57	I
300	4251.20	I	220	5402.78	II	1000	677.63	III	50	3883.34	I
360 h	4302.30	I	90	5424.37	I	750	677.96	III	300	4680.14	I
2800	4309.63	II	190	5438.24	I	200	713.90	III	400	4722.15	I
110	4330.78	I	710	5466.46	I	60	1193.23	II	400	4810.53	I
440 h	4348.79	I	100	5468.47	I	50	1239.12	IV	800	4911.62	II
120	4357.73	I	240	5497.41	II	50	1249.69	IV	500	4924.03	II
800	4358.73	II	300	5503.45	I	500	1265.74	IV	200	5181.98	I
120	4366.03	I	250	5509.90	II	500	1306.66	IV	500	5894.33	II
12000	4374.94	II	120	5521.63	I	200	1456.72	III	500	6021.18	II
150 h	4375.61	I	740	5527.54	I	200	1459.98	IV	500	6102.49	II
100	4387.74	I	120	5544.50	I	300	1499.42	III	500	6214.61	II
1800	4398.02	II	180	5577.42	I	300	1500.42	III	1000 h	6362.34	I
890	4422.59	II	620	5581.87	I	300	1505.92	III	300	7588.5	II
100	4443.66	I	120	5606.33	I	300	1515.85	III	300	7732.5	II
130	4446.63	I	560	5630.13	I	300	1552.30	III	100	11054.25	I
170	4475.72	I	120	5644.69	I	90	1572.99	II	100	13053.63	I
180	4476.96	I	120	5648.47	I	200	1629.19	III	100	13150.59	I
160	4477.45	I	740	5662.94	II	200	1639.33	III	100	14038.70	I
110	4487.28	I	90	5675.27	I	200	1673.05	III	20	16483.45	I
						80 d	1735.61	II	20	16491.98	I

Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å		Intensity	Wavelength/Å	
20	16505.23	I	620	2814.90	I	1000	3430.53	II	770	3998.97	II
10	24375.02	I	390	2818.74	II	4700	3438.23	II	400	4023.98	I
<i>Zirconium Zr Z = 40</i>											
500	304.01	V	530	2825.56	II	600	3447.36	I	770	4024.92	I
60	480.66	IV	710	2837.23	I	410	3457.56	II	990	4027.20	I
60	497.23	IV	660	2844.58	II	820	3463.02	II	400	4029.68	II
60	500.22	IV	350	2848.52	I	600	3471.19	I	490	4030.04	I
600	628.66	IV	350	2851.97	II	1200	3479.39	II	400	4035.89	I
500	633.56	IV	340	2869.81	II	1300	3481.15	II	610	4043.58	I
50	690.39	III	490	2875.98	I	4100	3496.21	II	490	4044.56	I
2000	740.61	V	300	2915.99	II	820	3505.67	II	400	4045.61	II
10000	800.00	V	270	2918.24	II	1000	3509.32	I	610	4048.67	II
10000	806.89	V	320	2926.99	II	2000	3519.60	I	770	4055.03	I
10000	812.05	V	320	2948.94	II	440	3525.81	II	600	4055.71	I
3000	841.40	V	320	2955.78	II	440	3533.22	I	1500	4064.16	I
300	863.65	IV	320	2960.87	I	630	3542.62	II	2000	4072.70	I
500	864.59	IV	320	2962.68	II	1800	3547.68	I	240	4078.31	I
9000	1183.97	IV	320	2968.96	II	630	3550.46	I	2000	4081.22	I
9000	1201.77	IV	320	2978.05	II	1800	3551.95	II	400	4121.46	I
10000	1219.86	IV	820	2985.39	I	2100	3556.60	II	1200	4149.20	II
500	1303.93	V	320	3003.74	II	1100	3566.10	I	400	4161.21	II
500 p	1323.81	V	820	3011.75	I	2100	3572.47	II	400	4166.36	I
1000	1469.47	IV	350	3020.47	II	1100	3575.79	I	660	4187.56	I
10000	1546.17	IV	500	3028.04	II	1300	3576.85	II	400	4194.76	I
10000	1598.95	IV	880	3029.52	I	880	3586.29	I	610	4199.09	I
5000	1607.95	IV	350 d	3036.39	II	3500	3601.19	I	610	4201.46	I
100	1612.38	III	690	3054.84	II	690	3611.89	II	610	4208.98	II
700	1725.02	V	690	3106.58	II	1100	3613.10	II	400	4213.86	I
200	1790.19	III	350	3120.74	I	1100	3614.77	II	2000	4227.76	I
150	1793.56	III	500	3129.18	II	1100	3623.86	I	2000	4239.31	I
125	1798.13	III	500	3129.76	II	1100	3663.65	I	770	4240.34	I
600	1860.86	V	350	3132.07	I	390	3671.27	II	770	4241.20	I
200	1940.25	III	690	3138.68	II	800	3674.72	II	1200	4241.69	I
600	2028.54	V	540	3164.31	II	390	3697.46	II	550	4282.20	I
125	2070.43	III	880	3165.97	II	960	3698.17	II	550	4294.79	I
200	2086.78	III	880	3182.86	II	720	3709.26	II	550	4341.13	I
10000	2091.49	IV	540	3191.21	I	560	3745.98	II	1000	4347.89	I
10000	2092.36	IV	540	3212.01	I	880	3751.60	II	290	4359.74	II
600	2132.42	V	760	3214.19	II	480	3764.39	I	310	4360.81	I
10000	2163.68	IV	630	3231.69	II	480	3766.72	I	350	4366.45	I
100	2175.80	III	630	3234.12	I	340	3766.82	II	550	4507.12	I
100	2191.15	III	760	3241.05	II	720	3780.54	I	610	4535.75	I
10000	2286.67	IV	1000	3273.05	II	560	3791.40	I	490	4542.22	I
100	2301.60	III	1300	3279.26	II	560	3822.41	I	490	4575.52	I
90	2539.65	I	880	3284.71	II	2200	3835.96	I	350	4602.57	I
570	2567.64	II	540	3305.15	II	1300	3836.76	II	700	4633.98	I
1600	2568.87	II	880	3306.28	II	550	3843.02	II	2300	4687.80	I
2100	2571.39	II	380	3322.99	II	550	3847.01	I	510	4688.45	I
250	2620.56	III	380	3326.80	II	550	3849.25	I	1900	4710.08	I
200	2643.79	III	380	3334.25	II	2900	3863.87	I	1400	4739.48	I
150	2664.26	III	760	3340.56	II	770	3864.34	I	870	4772.31	I
1800	2678.63	II	380	3344.79	II	990	3877.60	I	700	4815.63	I
90	2687.75	I	760	3356.09	II	1500	3885.42	I	250	5046.58	I
750	2700.13	II	540	3357.26	II	2900	3890.32	I	360	5064.91	I
1300	2722.61	II	380	3374.73	II	2000	3891.38	I	470	5078.25	I
800	2726.49	II	570	3387.87	II	610	3921.79	I	300	5155.45	I
1400	2734.86	II	760	3388.30	II	1200	3929.53	I	200	5158.00	I
1100	2742.56	II	5700	3391.98	II	940	3958.22	II	100	5191.60	II
660	2745.86	II	570	3393.12	II	490	3966.66	I	270	5385.14	I
660	2752.21	II	570	3404.83	II	990	3968.26	I	160	5664.51	I
530	2758.81	II	760	3410.25	II	660	3973.50	I	160	5797.74	I
			380	3414.66	I	770	3991.13	II	340	5879.80	I

Intensity	Wavelength/Å	Intensity	Wavelength/Å	Intensity	Wavelength/Å	Intensity	Wavelength/Å	
170	6045.85	I	300	6313.02	I	170	7103.72	I
170	6121.91	I	150	6953.84	I	590	7169.09	I
680	6127.44	I	150	6990.84	I	160	7944.61	I
340	6134.55	I	540	7097.70	I	160	8005.27	I
440	6143.20	I	280	7102.91	I	150	8063.09	I

### Sources of Data for Each Element

Numbers following the element name refer to the references on the following pages.

Actinium: 193

Aluminum: 6,8,81,89,127,144,146,227,228,282

Americium: 92

Antimony: 164,167,194,386,406

Argon: 190,203,204,219,367,368,372,373,374,375,414,421

Arsenic: 163,168,197,244,280

Astatine: 188

Barium: 1,78,111,252,259,277,279

Berkelium: 53,339

Beryllium: 15,44,73,102,115,134,135,171,175,198,335

Bismuth: 1,357,358,359,360,361

Boron: 66,69,74,94,104,171,221,222

Bromine: 42,122,124,139,142,240,243,246,248,249,250,316

Cadmium: 44,285,296,353,399

Calcium: 16,25,70,150,270

Californium: 52,331

Carbon: 22,66,211

Cerium: 1,136,166,261,305

Cesium: 78,82,154,155,200,201,259,263,325

Chlorine: 11,28,30,31,85,233,238,239

Chromium: 1,379,380,412

Cobalt: 1,100,125,159,236,276,291

Copper: 199,273,290,295,324

Curium: 51,332

Dysprosium: 1

Einsteinium: 333

Erbium: 1,301

Europium: 1,312

Fluorine: 68,169,224,225,226

Francium: 408

Gadolinium: 1,46,137,151,152

Gallium: 2,19,62,132,140,141,143,195,281

Germanium: 5,119,293,340,341,342

Gold: 38,72,234,393,395

Hafnium: 1,369,404,410,425

Helium: 16,94,173,183,317

Holmium: 1

Hydrogen: 214

Indium: 1,132,348,349,350,351,352,353,435,436

Iodine: 20,21,58,84,124,153,161,176,184

Iridium: 1

Iron: 56,63,71,101,105,138,174,278,381,382

Krypton: 61,121,123,147,208,232,366,390,409,417,421

Lanthanum: 1,78,79,220,309

Lead: 54,64,106,256,274,297,283,329,330

Lithium: 3,15,17,18,37,44,112,284,321,335

Lutetium: 1,148,310,401

Magnesium: 4,7,49,83,103,128,129,177,217,269,315,335

Manganese: 1,126,385,405,433

Mercury (198): 43,50,69,145,229,242

Mercury (Natural): 34,45,90,117,133,189,235,304,327,328,343

Molybdenum: 1,383,420

Neodymium: 1

Neon: 56,58,69,118,150,230,364,365,371,388,389,400,402,413,430

Neptunium: 93

Nickel: 1,294,415,416,422

Niobium: 1,392,407,431

Nitrogen: 66,107,108,212,213,318

Osmium: 1

Oxygen: 23,24,36,66,69,209,210,215

Palladium: 1,287,424

Phosphorus: 179,180,182,336

Platinum: 1,288

Plutonium: 91

Polonium: 47,48

Potassium: 32,59,60,75,76,86,150,160,172,268,314,322

Praseodymium: 1,149,306,308,337,338

Promethium: 196,260

Protactinium: 96

Radium: 253,254

Radon: 251

Rhenium: 1

Rhodium: 1,396

Rubidium: 12,109,130,241,257,258,262,264

Ruthenium: 1,423

Samarium: 1

Scandium: 1,88,150,298,323

Selenium: 9,80,181,216,245,247,275

Silicon: 87,170,237,292,319,320

Silver: 13,99,255,286,289,363,387,398

Sodium: 178,205,206,207,268,299,334

Strontium: 1,109,110,218,231,265,279,313

Sulfur: 29,144,202,209,210,266

Tantalum: 1,411,426

Technetium: 35

Tellurium: 1,344,345,346,347

Terbium: 1,302

Thallium: 1,195,348,354,355,356

Thorium: 1,97,98,156,157,165,434

Thulium: 1,307

Tin: 187,191,399,423

Titanium: 1,378,427,428

Tungsten: 1

Uranium: 1,303

Vanadium: 1,394,397,432

Xenon: 33,116,118,120,232,384,391,429

Ytterbium: 1,40,192,311

Yttrium: 1,77,265,419

Zinc: 39,55,113,131,185,186,370,376,377

Zirconium: 1,362,403,418

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# NIST ATOMIC TRANSITION PROBABILITIES

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For the 2005 edition of this *Handbook*, we include new, more accurate data for Fe I and Fe II,<sup>1</sup> and Ba I and Ba II.<sup>2</sup> The new tables contain critically evaluated atomic transition probabilities for over 10500 selected lines of all elements for which reliable data are available on an absolute scale. The material is largely for neutral and singly ionized spectra, but also includes a number of prominent lines of more highly charged ions of important elements.

Many of the data are obtained from comprehensive compilations of the Data Center on Atomic Transition Probabilities at the National Institute of Standards and Technology. Specifically, data have been taken from three recent comprehensive critical compilations on C, N and O,<sup>3</sup> on Sc through Mn<sup>4</sup> and Fe through Ni,<sup>5</sup> and special compilations on neutral and singly ionized iron and barium. Material from earlier compilations for the elements H through Ne<sup>6</sup> and Na through Ca<sup>7</sup> was supplemented by more recent material taken directly from the original literature. For the highly charged ions, some of the data were derived from studies of the systematic behavior of transition probabilities.<sup>8-10</sup> Most of the original literature is cited in the above tables and in recent bibliographies;<sup>11,12</sup> for lack of space, individual literature references are not cited here.

The wavelength range for the neutral species is normally the visible spectrum or shorter wavelengths; only the very prominent near infrared lines are included. For the higher ions, most of the strong lines are located in the far UV. The tabulation is limited to electric dipole — including intercombination — lines and comprises essentially the fairly strong transitions with estimated uncertainties in the 10% to 50% range. With the exception of hydrogen, helium, and the alkali metals, most transitions are between states with low principal quantum numbers.

The transition probability,  $A$ , is given in units of  $10^8 \text{ s}^{-1}$  and is listed to as many digits as is consistent with the indicated accuracy. The power of 10 is indicated by the E notation (i.e., E-02 means  $10^{-2}$ ). Generally, the estimated uncertainties of the  $A$ -values are  $\pm 25$  to 50% for two-digit numbers,  $\pm 10$  to 25% for three-digit numbers and  $\pm 1\%$  or better for four- and five-digit numbers.

Each transition is identified by the wavelength  $\lambda$  in ångströms ( $1 \text{ \AA} = 10^{-10} \text{ m}$ ); and the statistical weights,  $g_i$  and  $g_k$ , of the lower ( $i$ ) and upper ( $k$ ) states [the product  $g_k A$  (or  $g_i f$ ) is needed for many applications]. Whenever the wavelengths of individual lines within a multiplet are extremely close, only an average wavelength for the multiplet as well as the multiplet  $A$ -value are given, and this is indicated by an asterisk (\*) to the left of the wavelength. This also has been done when the transition probability for an entire multiplet has been taken from the literature and values for individual lines cannot be determined because of insufficient knowledge of the coupling of electrons. The wavelength data have been taken either from recent compilations or from the original literature cited in bibliographies published by the Atomic Energy Levels Data Center<sup>13,14</sup> at the National Institute of Standards and Technology. Wavelength values are consistent with those given in the table "Line Spectra of the Elements," which appears elsewhere in this *Handbook*.

In addition to the transition probability  $A$ , the atomic oscillator strength  $f$  and the line strength  $S$  are often used in the literature. The conversion factors between these quantities are (for electric-dipole transitions):

$$g_i f = 1.499 \cdot 10^{-8} \lambda^2 g_k A = 303.8 \lambda^{-1} S$$

where  $\lambda$  is in ångströms,  $A$  is in  $10^8 \text{ s}^{-1}$ , and  $S$  is in atomic units, which are

$$a_0^2 e^2 = 7.188 \cdot 10^{-59} \text{ m}^2 \text{ C}^2.$$

The table for hydrogen is presented first, followed by the tables for other elements in alphabetical sequence by element name (not symbol). Within each element, the tables are ordered by increasing ionization stage (e.g., Al I, Al II, etc.).

The transition probabilities for hydrogen and hydrogen-like ions are known precisely. Because of the hydrogen degeneracy, a "transition" is actually the sum of all fine-structure transitions between the principal quantum numbers; therefore, the hydrogen table gives weighted average  $A$ -values. For hydrogen-like ions of nuclear charge  $Z$ , the following scaling laws hold:

$$A_Z = Z^4 A_{\text{Hydrogen}}$$

$$f_Z = f_{\text{Hydrogen}}$$

$$S_Z = Z^{-2} S_{\text{Hydrogen}}$$

$$\lambda_Z = Z^{-2} \lambda_{\text{Hydrogen}}$$

For very highly charged hydrogen-like ions, starting at about  $Z > 25$ , relativistic corrections<sup>15</sup> must be applied.

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$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
<i>Hydrogen</i>											
<i>HI</i>											
912.768	2	1800	5.167E-06	3721.94	8	392	1.303E-04	75004	72	128	1.561E-03
912.839	2	1682	6.122E-06	3734.37	8	338	1.893E-04	123680	72	98	4.561E-03
912.918	2	1568	7.297E-06	3750.15	8	288	2.834E-04	<i>Aluminum</i>			
913.006	2	1458	8.753E-06	3770.63	8	242	4.397E-04	<i>AlI</i>			
913.104	2	1352	1.057E-05	3797.90	8	200	7.122E-04	2263.5	2	4	6.6E-01
913.215	2	1250	1.286E-05	3835.38	8	162	1.216E-03	2269.1	4	6	7.9E-01
913.339	2	1152	1.578E-05	3889.05	8	128	2.215E-03	2269.2	4	4	1.3E-01
913.480	2	1058	1.952E-05	3970.07	8	98	4.389E-03	2367.1	2	4	7.2E-01
913.641	2	968	2.438E-05	4101.73	8	72	9.732E-03	2373.1	4	6	8.6E-01
913.826	2	882	3.077E-05	4340.46	8	50	2.530E-02	2373.4	4	4	1.4E-01
914.039	2	800	3.928E-05	4861.32	8	32	8.419E-02	2568.0	2	4	2.3E-01
914.286	2	722	5.077E-05	6562.80	8	18	4.410E-01	2575.1	4	6	2.8E-01
914.576	2	648	6.654E-05	8392.40	18	800	1.517E-05	2575.4	4	4	4.4E-02
914.919	2	578	8.858E-05	8413.32	18	722	1.964E-05	2652.5	2	2	1.33E-01
915.329	2	512	1.200E-04	8437.96	18	648	2.580E-05	2660.4	4	2	2.64E-01
915.824	2	450	1.657E-04	8467.26	18	578	3.444E-05	3082.2	2	4	6.3E-01
916.429	2	392	2.341E-04	8502.49	18	512	4.680E-05	3092.7	4	6	7.4E-01
917.181	2	338	3.393E-04	8545.39	18	450	6.490E-05	3092.8	4	4	1.2E-01
918.129	2	288	5.066E-04	8598.40	18	392	9.211E-05	3944.0	2	2	4.93E-01
919.351	2	242	7.834E-04	8665.02	18	338	1.343E-04	3961.5	4	2	9.8E-01
920.963	2	200	1.263E-03	8750.48	18	288	2.021E-04	6696.0	2	4	1.69E-02
923.150	2	162	2.143E-03	8862.79	18	242	3.156E-04	6698.7	2	2	1.69E-02
926.226	2	128	3.869E-03	9014.91	18	200	5.156E-04	7835.3	4	6	5.7E-02
930.748	2	98	7.568E-03	9229.02	18	162	8.905E-04	7836.1	6	8	6.2E-02
937.803	2	72	1.644E-02	9545.97	18	128	1.651E-03	<i>AlII</i>			
949.743	2	50	4.125E-02	10049.4	18	98	3.358E-03	1047.9	1	3	3.6E-01
972.537	2	32	1.278E-01	10938.1	18	72	7.783E-03	1048.6	3	5	4.8E-01
1025.72	2	18	5.575E-01	12818.1	18	50	2.201E-02	1539.8	3	5	8.8E+00
1215.67	2	8	4.699E+00	16407.2	32	288	1.620E-04	1670.8	1	3	1.46E+01
3662.26	8	1800	2.847E-06	16806.5	32	242	2.556E-04	1719.4	1	3	6.79E+00
3663.40	8	1682	3.374E-06	17362.1	32	200	4.235E-04	1764.0	5	5	9.8E+00
3664.68	8	1568	4.022E-06	18174.1	32	162	7.459E-04	1772.8	1	3	9.5E+00
3666.10	8	1458	4.826E-06	18751.0	18	32	8.986E-02	1777.0	5	7	1.7E+01
3667.68	8	1352	5.830E-06	19445.6	32	128	1.424E-03	*1819.0	15	15	5.6E+00
3669.46	8	1250	7.096E-06	21655.3	32	98	3.041E-03	1855.9	1	3	8.32E-01
3671.48	8	1152	8.707E-06	26251.5	32	72	7.711E-03	1858.0	3	3	2.48E+00
3673.76	8	1058	1.078E-05	27575	50	288	1.402E-04	1862.3	5	3	4.12E+00
3676.36	8	968	1.347E-05	28722	50	242	2.246E-04	1931.0	3	1	1.08E+01
3679.35	8	882	1.700E-05	30384	50	200	3.800E-04	1990.5	3	5	1.47E+01
3682.81	8	800	2.172E-05	32961	50	162	6.908E-04	2816.2	3	1	3.83E+00
3686.83	8	722	2.809E-05	37395	50	128	1.388E-03	4663.1	5	3	5.3E-01
3691.55	8	648	3.685E-05	40511.5	32	50	2.699E-02	6226.2	1	3	6.2E-01
3697.15	8	578	4.910E-05	43753	72	288	1.288E-04	6231.8	3	5	8.4E-01
3703.85	8	512	6.658E-05	46525	50	98	3.253E-03	6243.4	5	7	1.1E+00
3711.97	8	450	9.210E-05	46712	72	242	2.110E-04	6335.7	5	3	1.4E-01
				51273	72	200	3.688E-04	6823.4	3	3	3.4E-01
				59066	72	162	7.065E-04	6837.1	5	3	5.7E-01
				74578	50	72	1.025E-02				

$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
6920.3	3	1	9.6E-01	*308.6	2	6	9.9E+01	4587.21	3	1	4.9E-03
7042.1	3	5	5.9E-01	*341.3	6	2	1.3E+02	4589.29	3	5	6.2E-05
7056.7	3	3	5.8E-01	550.05	2	4	8.55E+00	4596.10	3	3	9.47E-04
7471.4	5	7	9.4E-01	568.12	2	2	7.73E+00	4628.44	3	5	3.83E-04
<i>Al III</i>				1997	2	4	1.07E+00	4642.15	3	5	9.6E-04
*560.36	2	6	4.0E-01	2069	2	2	9.7E-01	4647.49	3	3	1.2E-03
695.83	2	4	7.4E-01	*4761	2	6	2.55E-01	4702.32	3	3	1.09E-03
696.22	2	2	7.2E-01	5172	2	4	3.95E-02	4746.82	3	1	3.6E-03
*1352.8	10	14	4.40E+00	5551	4	6	3.85E-02	4752.94	3	3	4.5E-03
1379.7	2	2	4.59E+00	5687	4	4	6.0E-03	4768.68	3	5	8.6E-03
1384.1	4	2	9.1E+00	<i>Argon</i>				4798.74	7	9	8.8E-04
1605.8	2	4	1.22E+01	<i>Ar I</i>				4835.97	7	9	9.3E-04
1611.8	4	4	2.42E+00	1048.22	1	3	5.36E+00	4836.70	3	5	1.02E-03
1611.9	4	6	1.45E+01	1066.66	1	3	1.29E+00	4876.26	3	5	7.8E-03
1854.7	2	4	5.40E+00	3406.18	3	1	3.9E-03	4886.29	7	9	1.2E-03
1862.8	2	2	5.33E+00	3461.08	3	5	6.7E-04	4887.95	3	3	1.3E-02
*1935.9	10	14	1.22E+01	3554.30	5	5	2.7E-03	4894.69	3	1	1.8E-02
3601.6	6	4	1.34E+00	3563.29	1	3	1.2E-03	4921.04	5	7	5.9E-04
3601.9	4	4	1.49E-01	3567.66	5	7	1.1E-03	4937.72	7	5	3.6E-04
3612.4	4	2	1.5E+00	3572.30	3	1	5.1E-03	4956.75	7	9	1.8E-03
<i>Al X</i>				3606.52	3	1	7.6E-03	4989.95	5	7	1.1E-03
39.925	1	3	2.22E+03	3632.68	3	5	6.6E-04	5032.03	7	5	8.2E-04
51.979	1	3	4.8E+03	3634.46	3	3	1.3E-03	5048.81	3	5	4.6E-03
55.227	1	3	5.2E+03	3643.12	3	5	2.4E-04	5054.18	3	3	4.5E-03
55.272	3	5	7.2E+03	3649.83	3	1	8.0E-03	5056.53	3	1	5.7E-03
55.376	5	7	9.5E+03	3659.53	3	3	4.4E-04	5060.08	7	9	3.7E-03
59.107	3	5	4.6E+03	3670.67	3	5	3.1E-04	5070.99	5	3	2.6E-03
332.78	1	3	5.6E+01	3675.23	3	3	4.9E-04	5073.08	3	5	5.9E-04
394.83	3	1	8.3E+01	3770.37	1	3	7.0E-04	5078.03	7	7	4.7E-04
395.36	3	5	1.2E+01	3834.68	3	1	7.5E-03	5087.09	5	7	1.6E-03
397.76	1	3	1.7E+01	3894.66	3	3	5.7E-04	5104.74	3	5	8.7E-04
400.43	3	3	1.3E+01	3947.50	5	5	5.6E-04	5118.21	5	7	2.7E-03
401.12	5	5	3.6E+01	3948.98	5	3	4.55E-03	5127.80	5	5	3.3E-04
403.55	3	1	4.9E+01	4044.42	3	5	3.33E-03	5151.39	3	1	2.39E-02
406.31	5	3	1.9E+01	4045.96	3	3	4.1E-04	5152.30	3	5	1.1E-03
670.06	3	5	9.8E+00	4054.53	3	3	2.7E-04	5162.29	3	3	1.90E-02
2535	1	3	3.8E-01	4158.59	5	5	1.40E-02	5177.54	7	5	2.4E-03
<i>Al XI</i>				4164.18	5	3	2.88E-03	5192.72	7	7	1.2E-04
*36.675	2	6	1.5E+03	4181.88	1	3	5.61E-03	5194.02	3	1	7.8E-03
39.091	2	4	2.6E+03	4190.71	5	5	2.80E-03	5210.49	7	7	1.1E-03
39.180	4	6	3.1E+03	4191.03	1	3	5.39E-03	5214.77	5	3	2.1E-03
39.530	2	2	1.8E+02	4198.32	3	1	2.57E-02	5216.28	5	3	1.3E-03
39.623	4	2	3.7E+02	4200.67	5	7	9.67E-03	5221.27	7	9	8.8E-03
48.298	2	4	3.09E+03	4251.18	5	3	1.11E-03	5241.09	5	5	1.3E-03
48.338	2	2	3.08E+03	4259.36	3	1	3.98E-02	5246.24	5	7	1.2E-03
52.299	2	4	8.1E+03	4266.29	3	5	3.12E-03	5249.20	5	5	7.9E-04
52.446	4	6	9.6E+03	4272.17	3	3	7.97E-03	5252.79	5	7	5.4E-03
52.458	4	4	1.6E+03	4300.10	3	5	3.77E-03	5254.47	3	5	3.6E-03
54.217	2	2	4.8E+02	4333.56	3	5	5.68E-03	5286.07	5	7	9.6E-04
54.388	4	2	9.6E+02	4335.34	3	3	3.87E-03	5290.00	5	3	9.0E-04
*99.083	2	6	2.2E+02	4345.17	3	3	2.97E-03	5309.52	5	5	1.2E-03
103.6	2	4	4.2E+02	4363.79	3	3	1.2E-04	5317.73	5	7	2.6E-03
103.8	4	6	5.0E+02	4424.00	1	3	7.3E-05	5373.50	3	5	2.7E-03
*141.6	2	6	4.07E+02	4510.73	3	1	1.18E-02	5393.27	5	5	9.6E-04
150.31	2	4	8.5E+02	4522.32	1	3	8.98E-04	5410.48	5	7	2.0E-03
150.61	4	6	9.9E+02	4544.75	3	3	8.3E-04	5421.35	7	5	6.0E-03
157.0	2	2	1.3E+02	4554.32	3	5	3.8E-04	5439.99	3	3	1.9E-03
157.4	4	2	2.6E+02	4584.96	3	5	1.6E-03	5442.24	7	7	9.3E-04
*205.0	2	6	6.3E+01	4586.61	3	3	2.3E-03	5451.65	3	5	4.7E-03
								5457.42	5	3	3.6E-03

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
5459.65	7	7	3.8E-04	6013.68	7	5	1.4E-03	6779.93	1	3	1.21E-03
5467.16	5	5	7.6E-04	6025.15	5	3	9.0E-03	6818.29	3	1	2.0E-03
5473.46	5	3	2.0E-03	6043.22	5	7	1.47E-02	6827.25	5	3	2.4E-03
5490.12	5	5	8.5E-04	6052.73	3	5	1.9E-03	6851.88	3	5	6.7E-04
5492.09	3	1	5.6E-03	6064.76	5	7	5.8E-04	6871.29	3	3	2.78E-02
5495.87	7	9	1.69E-02	6081.25	3	3	7.5E-04	6879.59	3	5	1.8E-03
5506.11	5	7	3.6E-03	6085.86	3	3	9.0E-05	6887.10	5	7	1.3E-03
5524.96	7	7	1.7E-03	6090.79	1	3	3.0E-03	6888.17	3	5	2.5E-03
5528.97	1	3	1.2E-03	6098.81	3	3	5.2E-03	6925.01	3	3	1.2E-03
5534.49	5	3	2.7E-03	6101.16	3	3	3.3E-03	6937.67	3	1	3.08E-02
5540.87	7	5	4.1E-04	6104.58	3	1	3.4E-03	6951.46	5	5	2.2E-03
5552.77	3	3	7.9E-04	6105.64	3	5	1.21E-02	6960.23	5	5	2.4E-03
5558.70	3	5	1.42E-02	6113.46	3	5	4.7E-04	6965.43	5	3	6.39E-02
5559.66	3	5	2.2E-03	6119.66	3	3	5.1E-04	6992.17	3	1	7.5E-03
5572.54	5	7	6.6E-03	6121.86	3	5	1.3E-04	7030.25	7	5	2.67E-02
5574.22	3	5	4.6E-04	6127.42	5	3	1.1E-03	7067.22	5	5	3.80E-02
5581.87	7	5	5.6E-04	6128.73	3	5	8.6E-04	7068.73	5	3	2.0E-02
5588.72	5	5	1.5E-03	6145.44	5	7	7.6E-03	7086.70	1	3	1.5E-03
5597.48	5	7	4.2E-03	6155.24	5	3	5.1E-03	7107.48	5	5	4.5E-03
5606.73	3	3	2.20E-02	6165.12	5	5	9.89E-04	7125.83	3	3	6.0E-03
5618.01	3	3	2.1E-03	6170.17	5	5	5.0E-03	7147.04	5	3	6.25E-03
5620.92	3	1	3.6E-03	6173.10	3	5	6.7E-03	7158.83	3	1	2.1E-02
5623.78	5	5	1.4E-03	6179.41	5	3	6.6E-04	7162.57	1	3	5.8E-04
5635.58	3	5	9.6E-04	6212.50	5	7	3.9E-03	7206.98	5	3	2.48E-02
5637.33	1	3	9.1E-04	6215.94	5	5	5.7E-03	7229.93	5	5	6.6E-04
5639.12	1	3	2.1E-03	6230.93	5	5	1.2E-04	7265.17	3	3	1.7E-03
5641.39	3	5	8.7E-04	6243.40	3	1	1.3E-03	7270.66	7	7	1.1E-03
5648.69	5	3	1.2E-03	6244.73	3	5	2.0E-04	7272.93	3	3	1.83E-02
5650.70	3	1	3.20E-02	6248.41	3	5	6.8E-04	7285.44	5	3	1.2E-03
5659.13	5	5	2.6E-03	6278.65	5	7	2.0E-04	7311.72	3	3	1.7E-02
5681.90	5	7	2.0E-03	6296.87	3	5	9.0E-03	7316.01	3	3	9.6E-03
5683.73	5	5	2.0E-03	6307.66	5	5	6.0E-03	7350.78	3	1	1.2E-02
5700.87	5	7	5.9E-03	6309.14	3	3	7.6E-04	7353.32	5	7	9.6E-03
5712.51	1	3	8.7E-04	6364.89	3	1	5.6E-03	7372.12	7	9	1.9E-02
5739.52	3	5	8.7E-03	6369.58	5	3	4.2E-03	7383.98	3	5	8.47E-02
5772.11	5	7	2.0E-03	6384.72	3	3	4.21E-03	7392.97	5	3	7.2E-03
5773.99	5	5	1.1E-03	6416.31	3	5	1.16E-02	7412.33	3	5	3.9E-03
5783.54	3	5	8.1E-04	6431.56	5	3	5.1E-04	7422.26	3	5	6.6E-04
5789.48	5	5	4.6E-04	6466.55	1	3	1.5E-03	7425.29	5	7	3.1E-03
5790.40	5	3	3.4E-04	6481.14	1	3	9.4E-04	7435.33	5	5	9.0E-03
5802.08	5	3	4.2E-03	6513.85	3	3	5.4E-04	7436.25	7	5	2.7E-03
5843.77	3	5	3.3E-04	6538.11	7	7	1.1E-03	7471.17	3	3	2.2E-04
5882.62	3	1	1.23E-02	6596.12	7	5	2.3E-04	7484.24	3	5	3.4E-03
5888.58	7	5	1.29E-02	6598.68	5	5	3.6E-04	7503.84	3	1	4.45E-01
5916.58	5	3	5.9E-04	6604.02	7	5	2.8E-03	7510.42	5	5	4.5E-03
5927.11	7	7	3.7E-04	6604.85	5	7	1.3E-04	7514.65	3	1	4.02E-01
5928.81	5	3	1.1E-02	6632.09	3	3	5.3E-04	7618.33	3	5	2.9E-03
5940.86	1	3	1.2E-03	6656.88	3	3	3.1E-04	7628.86	3	5	2.9E-03
5942.67	5	5	1.8E-03	6660.68	3	1	7.8E-03	7635.11	5	5	2.45E-01
5943.89	7	5	3.6E-04	6664.05	5	5	1.5E-03	7670.04	5	3	2.8E-03
5949.26	3	3	1.5E-03	6677.28	3	1	2.36E-03	7704.81	5	7	6.3E-04
5964.48	1	3	7.7E-04	6684.73	3	5	3.9E-04	7723.76	5	3	5.18E-02
5968.32	3	3	1.8E-03	6698.47	3	3	2.5E-04	7724.21	1	3	1.17E-01
5971.60	3	1	1.1E-02	6698.88	5	3	1.6E-03	7798.55	3	5	8.7E-04
5981.90	5	7	1.2E-04	6719.22	1	3	2.4E-03	7868.20	1	3	3.50E-03
5987.30	7	7	1.2E-03	6722.88	5	7	3.2E-04	7891.08	5	5	9.5E-03
5988.13	3	5	6.1E-04	6752.84	3	5	1.93E-02	7916.45	3	3	1.2E-03
5994.66	3	5	2.6E-04	6754.37	3	3	2.1E-03	7948.18	1	3	1.86E-01
5999.00	5	5	1.4E-03	6756.10	5	5	3.6E-03	8006.16	3	5	4.90E-02
6005.73	5	3	1.4E-03	6766.61	5	3	4.0E-03	8014.79	5	5	9.28E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
8037.23	1	3	3.59E-03	14093.6	1	3	4.3E-02	3582.4	4	6	2.53E+00
8046.13	3	1	1.12E-02	14739.1	5	7	8.8E-04	3588.4	8	10	3.03E+00
8053.31	5	3	8.6E-03	15046.4	1	3	5.2E-02	3605.9	4	6	4.4E-02
8066.60	5	5	1.4E-03	15172.3	1	3	1.3E-02	3656.0	6	6	7.6E-02
8103.69	3	3	2.5E-01	15329.6	5	5	1.2E-03	3682.5	4	2	1.7E-02
8115.31	5	7	3.31E-01	15555.5	5	7	9.8E-05	3709.9	4	4	4.7E-02
8264.52	3	3	1.53E-01	15734.9	5	3	2.9E-04	3717.2	6	8	5.2E-02
8384.73	5	7	2.4E-03	15816.8	5	3	8.7E-04	3729.3	6	4	4.80E-01
8408.21	3	5	2.23E-01	15989.3	1	3	1.9E-02	3746.9	4	6	2.1E-02
8424.65	3	5	2.15E-01	16122.7	5	3	3.9E-04	3763.5	8	6	1.78E-01
8490.30	3	5	9.6E-04	16180.0	5	5	1.2E-03	3766.1	4	4	7.4E-02
8521.44	3	3	1.39E-01	16264.1	3	3	3.0E-04	3777.5	2	2	1.1E-02
8605.78	5	5	1.04E-02	16520.1	3	5	2.6E-03	3780.8	8	8	7.7E-01
8620.46	1	3	9.2E-03	16739.8	3	5	3.1E-03	3786.4	8	6	1.5E-02
8667.94	1	3	2.43E-02	16940.4	5	5	2.5E-02	3799.4	6	4	1.7E-01
8761.69	3	5	9.5E-03	20317.0	1	3	1.6E-03	3808.6	6	6	1.0E-02
8784.61	3	1	2.4E-03	20616.5	5	5	3.9E-03	3826.8	6	6	2.81E-01
8799.08	5	3	4.6E-03	20812.0	5	7	7.6E-04	3841.5	4	2	2.69E-01
8962.19	3	3	1.6E-03	21332.2	3	3	3.2E-04	3844.7	6	8	4.8E-02
9075.42	3	1	1.2E-02	21534.9	3	5	1.1E-03	3845.4	6	4	1.6E-02
9122.97	5	3	1.89E-01	22039.2	3	1	1.2E-03	3850.6	4	4	3.87E-01
9194.64	3	3	1.76E-02	22077.4	5	3	1.4E-03	3868.5	4	6	1.4E+00
9224.50	3	5	5.03E-02	23133.4	3	3	1.7E-03	3872.1	4	4	1.5E-01
9291.53	3	1	3.26E-02	23844.8	9	7	1.1E-02	3875.3	4	2	8.2E-02
9354.22	3	3	1.06E-02	23967.5	3	1	3.6E-03	3880.3	2	2	2.32E-01
9657.78	3	3	5.43E-02	<i>Ar II</i>				3891.4	2	2	4.3E-02
9784.50	3	5	1.47E-02	2317.7	6	4	1.4E-01	3892.0	6	4	6.3E-02
10470.05	1	3	9.8E-03	2891.6	4	2	1.82E-01	3900.6	4	6	7.2E-02
10478.0	3	3	2.44E-02	2942.9	4	4	5.3E-01	3911.6	2	4	7.7E-02
10950.7	5	3	3.96E-03	2979.1	2	2	4.16E-01	3914.8	4	4	3.7E-02
11078.9	5	5	8.3E-03	3033.5	2	4	9.9E-02	3928.6	2	4	2.44E-01
11393.7	3	1	2.22E-02	3139.0	6	6	5.2E-01	3931.2	2	4	2.0E-02
11441.8	5	3	1.39E-02	3169.7	4	6	4.9E-01	3932.5	4	4	9.3E-01
11467.5	3	5	3.69E-03	3181.0	6	4	3.7E-01	3944.3	8	6	4.1E-02
11488.11	3	3	1.9E-03	3212.5	4	4	5.2E-02	3952.7	4	4	2.08E-01
11668.7	5	5	3.76E-02	3221.6	6	6	1.8E-02	3958.4	6	4	3.8E-02
11719.5	5	3	9.52E-03	3226.0	4	4	2.1E-02	3968.4	6	6	4.8E-02
12026.6	1	3	4.2E-03	3243.7	4	2	1.06E+00	3979.4	4	2	9.8E-01
12112.2	7	7	3.1E-02	3249.8	2	4	6.3E-01	3988.2	6	6	4.1E-02
12139.8	3	3	4.5E-02	3263.6	2	4	1.55E-01	3992.1	4	6	1.6E-02
12343.7	5	7	2.0E-02	3281.7	2	2	4.2E-01	4013.9	8	8	1.05E-01
12402.9	3	3	1.1E-01	3430.4	6	8	6.2E-02	4031.4	4	2	7.5E-02
12439.2	3	5	4.9E-02	3454.1	6	4	3.14E-01	4035.5	4	6	4.4E-02
12456.1	5	3	8.9E-02	3466.3	8	6	3.0E-02	4038.8	6	8	1.2E-02
12487.6	7	5	1.1E-01	3476.7	6	6	1.25E+00	4042.9	4	4	4.06E-01
12554.4	7	5	1.2E-03	3491.2	4	4	1.79E+00	4045.7	4	4	1.6E-02
12702.4	3	3	7.1E-02	3491.5	6	8	2.31E+00	4052.9	2	4	6.7E-01
12733.6	5	5	1.1E-02	3509.8	2	2	2.55E+00	4065.1	4	4	1.1E-02
12746.3	3	3	2.0E-02	3514.4	4	6	1.36E+00	4072.0	6	6	5.8E-01
12802.7	5	5	5.7E-02	3520.0	6	6	5.2E-01	4079.6	6	4	1.19E-01
12933.3	3	1	1.0E-01	3521.3	8	8	2.27E-01	4082.4	6	6	2.9E-02
12956.6	3	3	7.4E-02	3535.3	2	4	5.7E-01	4112.8	4	4	1.1E-02
13008.5	5	3	8.9E-02	3548.5	4	4	8.7E-01	4128.6	8	6	1.4E-02
13214.7	3	1	8.1E-02	3550.0	6	6	2.6E-02	4131.7	4	2	8.5E-01
13273.1	5	7	1.5E-01	3556.9	2	2	5.0E-02	4178.4	6	4	1.2E-02
13313.4	3	5	1.3E-01	3559.5	6	8	2.88E+00	4202.0	2	4	2.1E-02
13504.0	5	7	1.1E-01	3565.0	2	4	5.5E-01	4228.2	4	6	1.31E-01
13599.2	5	5	2.2E-02	3576.6	6	8	2.75E+00	4237.2	4	4	1.12E-01
13622.4	3	5	7.3E-02	3581.6	2	4	1.76E+00	4266.5	6	6	1.64E-01
13678.5	3	5	6.2E-02					4277.5	6	4	8.0E-01





$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2381.63	1	3	3.22E-04	4189.44	3	5	1.13E-03	9704.31	3	1	1.60E-01
2381.79	1	3	3.44E-04	4190.76	3	5	1.28E-03	9821.48	3	1	5.50E-02
2381.97	1	3	3.39E-04	4192.20	3	5	1.36E-03	10370.30	3	5	1.30E-02
2382.15	1	3	3.63E-04	4193.81	3	5	1.58E-03	10540.10	5	3	1.80E-02
2382.36	1	3	3.64E-04	4195.59	3	5	1.78E-03	10649.10	5	5	2.70E-02
2382.57	1	3	3.14E-04	4323.00	3	5	8.80E-02	11075.70	3	3	3.10E-05
2382.80	1	3	3.69E-04	4402.54	3	5	2.70E-01	11303.00	5	3	1.10E-03
2383.06	1	3	3.57E-04	4488.98	5	7	2.80E-01	11373.70	3	1	1.30E-01
2383.34	1	3	3.37E-04	4493.64	5	5	1.95E-01	12342.30	3	3	9.00E-04
2383.63	1	3	3.70E-04	4573.85	3	1	1.21E+00	14723.10	3	5	8.60E-03
2383.96	1	3	3.20E-04	4579.64	5	5	7.00E-01	14999.90	5	3	2.50E-03
2384.32	1	3	2.97E-04	4599.72	3	1	4.07E-01	17186.90	3	1	2.70E-02
2384.71	1	3	3.00E-04	4619.92	1	3	2.70E-02	18202.80	5	3	1.20E-02
2385.15	1	3	2.50E-04	4700.42	3	3	6.10E-02	21567.70	5	3	2.60E-03
2385.62	1	3	2.30E-04	4726.43	5	3	3.30E-01	30685.30	5	3	6.50E-03
2386.15	1	3	2.03E-04	4801.30	9	3	1.39E-01				
2386.74	1	3	1.87E-04	4902.85	5	3	5.40E-02	<i>Ba II</i>			
2387.40	1	3	1.37E-04	5169.53	5	3	9.00E-04	1622.43	2	4	2.46E-02
2388.13	1	3	9.66E-05	5519.04	3	5	5.70E-01	1630.36	2	2	2.42E-02
2388.96	1	3	8.37E-05	5535.48	1	3	1.19E+00	1761.74	4	4	1.00E-02
2399.39	1	3	1.10E-04	5777.62	5	7	8.00E-01	1771.10	4	2	1.00E-01
2402.07	1	3	4.60E-04	5784.04	3	5	2.10E-01	1786.95	6	4	9.00E-02
2405.30	1	3	4.90E-04	5800.23	5	5	2.39E-01	1892.49	2	4	1.30E-01
2409.23	1	3	8.60E-04	5826.27	5	3	4.50E-01	1954.28	4	6	1.40E-01
2414.08	1	3	1.50E-03	5971.70	5	5	1.62E-01	1955.05	4	4	2.40E-02
2420.11	1	3	2.30E-03	5997.09	3	3	2.80E-01	1985.75	2	4	2.00E-01
2427.41	1	3	5.60E-03	6019.47	3	1	8.10E-01	1999.55	2	4	7.12E-02
2438.81	1	3	1.40E-03	6063.11	5	3	5.60E-01	2009.28	2	2	6.51E-02
2452.33	1	3	8.10E-04	6083.39	3	1	1.10E-01	2024.06	2	2	6.86E-02
2472.74	1	3	4.60E-03	6129.23	3	1	6.00E-02	2052.75	4	6	2.20E-01
3071.58	1	3	4.20E-01	6309.36	3	3	2.00E-04	2054.09	4	4	3.70E-02
3501.11	1	3	3.50E-01	6341.68	5	7	1.16E-01	2079.98	4	2	1.17E-01
3889.33	1	3	1.10E-02	6450.85	3	5	1.10E-01	2153.93	2	4	3.43E-01
4132.43	1	3	1.50E-02	6498.76	7	7	5.40E-01	2200.89	2	2	1.13E-01
4175.69	3	5	1.97E-04	6527.31	5	5	3.30E-01	2214.76	4	4	1.60E-02
4175.91	3	5	1.98E-04	6527.40	15	15	6.15E-01	2232.79	4	6	3.69E-01
4176.12	3	5	2.08E-04	6595.33	3	3	3.80E-01	2235.38	4	4	6.13E-02
4176.36	3	5	2.19E-04	6675.27	5	3	1.89E-01	2245.69	4	2	1.60E-01
4176.60	3	5	2.26E-04	6693.84	7	5	1.46E-01	2254.78	6	4	1.40E-01
4176.86	3	5	2.48E-04	6986.80	5	3	5.20E-03	2285.99	4	2	2.03E-01
4177.15	3	5	2.77E-04	7059.94	7	9	5.00E-01	2528.41	2	4	6.91E-01
4177.44	3	5	3.03E-04	7120.33	3	5	1.10E-01	2634.78	4	6	7.33E-01
4177.74	3	5	3.14E-04	7195.23	1	3	5.60E-02	2641.37	4	4	1.21E-01
4178.07	3	5	3.07E-04	7213.60	5	5	6.50E-04	2647.26	2	2	2.26E-01
4178.43	3	5	3.64E-04	7280.30	5	7	3.20E-01	2771.35	4	2	3.95E-01
4178.80	3	5	4.01E-04	7392.41	3	3	1.81E-01	3390.18	4	6	4.54E-03
4179.20	3	5	4.31E-04	7417.54	7	5	7.70E-03	3412.44	6	8	4.77E-03
4179.64	3	5	4.46E-04	7488.08	7	7	7.30E-02	3413.95	6	6	3.18E-04
4180.09	3	5	4.53E-04	7528.18	5	5	2.70E-02	3552.45	4	6	3.87E-03
4180.57	3	5	4.55E-04	7610.48	5	5	1.10E-02	3576.28	6	8	4.07E-03
4181.09	3	5	4.99E-04	7644.90	9	3	5.03E-01	3578.57	6	6	2.71E-04
4181.66	3	5	5.42E-04	7672.09	3	5	1.52E-01	3891.78	2	4	2.17E+00
4182.27	3	5	6.11E-04	7780.48	5	5	7.60E-02	4130.65	4	6	2.18E+00
4182.94	3	5	6.65E-04	7877.80	3	5	1.60E-02	4166.00	4	4	3.54E-01
4183.64	3	5	6.70E-04	7905.75	5	3	2.65E-01	4216.07	2	4	5.09E-02
4184.40	3	5	7.93E-04	8147.70	5	5	6.30E-02	4267.92	6	8	3.10E-01
4185.25	3	5	8.43E-04	8560.00	5	5	2.00E-01	4309.26	8	10	3.10E-01
4186.16	3	5	9.24E-04	8654.08	5	7	3.10E-03	4325.75	4	6	5.65E-02
4187.15	3	5	9.90E-04	9370.12	5	5	7.60E-02	4329.56	4	4	9.39E-03
4188.25	3	5	1.03E-03	9645.60	7	5	1.10E-01	4524.93	2	2	6.63E-01





$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
8446.6	4	4	1.2E-01	4289.4	1	3	6.0E-01	2103.2	2	4	8.2E-01
8638.7	6	4	9.7E-02	4299.0	3	3	4.66E-01	2112.8	4	6	9.7E-01
Br II				4302.5	5	5	1.36E+00	2113.2	4	4	1.6E-01
4704.9	5	7	1.1E+00	4307.7	3	1	1.99E+00	2197.8	2	2	3.1E-01
4785.5	5	5	9.4E-01	4318.7	5	3	7.4E-01	2208.6	4	2	6.2E-01
4816.7	5	3	1.1E+00	4355.1	5	7	1.9E-01	3158.9	2	4	3.1E+00
<i>Cadmium</i>				4425.4	1	3	4.98E-01	3179.3	4	6	3.6E+00
<i>Cd I</i>				4435.0	3	5	6.7E-01	3181.3	4	4	5.8E-01
2288.0	1	3	5.3E+00	4435.7	3	3	3.42E-01	3706.0	2	2	8.8E-01
2836.9	1	3	2.8E-01	4454.8	5	7	8.7E-01	3736.9	4	2	1.7E+00
2880.8	3	5	4.2E-01	4455.9	5	5	2.0E-01	3933.7	2	4	1.47E+00
2881.2	3	3	2.4E-01	4526.9	5	3	4.1E-01	3968.5	2	2	1.4E+00
2980.6	5	7	5.9E-01	4578.6	3	5	1.76E-01	<i>Ca III</i>			
2981.4	5	5	1.5E-01	4581.4	5	7	2.09E-01	357.97	1	3	8.8E+02
3261.1	1	3	4.06E-03	4585.9	7	9	2.29E-01	439.69	1	3	1.9E-01
3403.7	1	3	7.7E-01	4685.3	3	5	8.0E-02	490.55	1	3	1.6E-02
3466.2	3	5	1.2E+00	4878.1	5	7	1.88E-01	<i>Ca V</i>			
3467.7	3	3	6.7E-01	5041.6	5	3	3.3E-01	558.60	5	3	2.2E+01
3610.5	5	7	1.3E+00	5188.9	3	5	4.0E-01	637.93	5	3	3.9E+00
3612.9	5	5	3.5E-01	5261.7	3	3	1.5E-01	643.12	3	1	9.1E+00
4140.5	3	5	4.7E-02	5262.2	3	1	6.0E-01	646.57	5	5	6.9E+00
4662.4	3	5	5.5E-02	5264.2	5	5	9.1E-02	647.88	3	3	2.3E+00
4678.1	1	3	1.3E-01	5265.6	5	3	4.4E-01	651.55	1	3	2.9E+00
4799.9	3	3	4.1E-01	5270.3	7	5	5.0E-01	656.76	3	5	2.1E+00
5085.8	5	3	5.6E-01	5582.0	5	7	6.0E-02	<i>Ca VII</i>			
6438.5	3	5	5.9E-01	5588.8	7	7	4.9E-01	550.20	5	5	1.8E+01
<i>Cd II</i>				5590.1	3	5	8.3E-02	624.39	1	3	3.3E+00
2144.4	2	4	2.8E+00	5594.5	5	5	3.8E-01	630.54	3	5	4.5E+00
2265.0	2	2	3.0E+00	5598.5	3	3	4.3E-01	630.79	3	3	2.2E+00
2572.9	2	2	1.7E+00	5601.3	7	5	8.6E-02	639.15	5	7	5.7E+00
2748.5	4	2	2.8E+00	5602.9	5	3	1.4E-01	640.41	5	5	1.3E+00
4415.6	4	6	1.4E-02	5857.5	3	5	6.6E-01	<i>Ca VIII</i>			
<i>Calcium</i>				6102.7	1	3	9.6E-02	182.71	2	2	1.6E+02
<i>Ca I</i>				6122.2	3	3	2.87E-01	184.16	4	2	3.2E+02
2275.5	1	3	3.01E-01	6161.3	5	5	3.3E-02	<i>Ca IX</i>			
2995.0	1	3	3.67E-01	6162.2	5	3	3.54E-01	163.23	5	3	3.76E+02
2997.3	3	5	2.41E-01	6163.8	3	3	5.6E-02	371.89	1	3	8.8E+01
2999.6	3	3	2.79E-01	6166.4	3	1	2.2E-01	373.81	3	5	1.16E+02
3000.9	3	1	1.58E+00	6169.1	5	3	1.7E-01	378.08	5	7	1.5E+02
3006.9	5	5	7.5E-01	6169.6	7	5	1.9E-01	395.03	3	5	2.2E+02
3009.2	5	3	4.30E-01	6439.1	7	9	5.3E-01	466.24	1	3	1.12E+02
3344.5	1	3	1.51E-01	6449.8	3	5	9.0E-02	498.01	3	5	2.49E+01
3350.2	3	5	1.78E-01	6462.6	5	7	4.7E-01	506.18	5	5	7.2E+01
3361.9	5	7	2.23E-01	6471.7	7	7	5.9E-02	515.57	5	3	3.75E+01
3624.1	1	3	2.12E-01	6493.8	3	5	4.4E-01	<i>Ca X</i>			
3630.8	3	5	2.97E-01	6499.7	5	5	8.1E-02	110.96	2	4	2.9E+02
3631.0	3	3	1.53E-01	<i>Ca II</i>				111.20	2	2	2.92E+02
3644.4	5	7	3.55E-01	1341.9	2	4	1.5E-02	151.84	2	2	2.3E+02
3644.8	5	5	9.4E-02	1342.5	2	2	1.5E-02	153.02	4	2	4.5E+02
3870.5	3	5	7.2E-02	1649.9	2	4	3.2E-03	206.57	4	4	2.9E+01
3957.1	3	3	9.8E-02	1652.0	2	2	3.1E-03	206.75	6	4	2.6E+02
3973.7	5	3	1.75E-01	1673.9	2	4	2.24E-01	207.39	4	2	2.8E+02
4092.6	3	5	1.1E-01	1680.1	4	6	2.65E-01	411.70	2	4	8.3E+01
4094.9	5	7	1.2E-01	1680.1	4	4	4.41E-02	419.75	4	6	9.5E+01
4098.5	7	9	1.3E-01	1807.3	2	4	3.54E-01	420.47	4	4	1.6E+01
4108.5	5	7	9.0E-01	1814.5	4	6	4.2E-01	557.76	2	4	3.50E+01
4226.7	1	3	2.18E+00	1814.7	4	4	7.0E-02	574.01	2	2	3.2E+01
4283.0	3	5	4.34E-01	1843.1	2	2	1.6E-01				
				1850.7	4	2	3.08E-01				

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
<i>Ca XI</i>				1431.60	5	7	2.11E+00	6655.52	3	3	5.03E-03
30.448	1	3	6.2E+03	1432.10	5	5	2.01E+00	6828.12	3	5	9.89E-03
30.867	1	3	4.9E+04	1432.53	5	3	2.11E+00	7111.47	3	5	2.17E-02
35.212	1	3	2.0E+03	1459.03	5	3	4.76E-01	7113.18	7	9	2.47E-02
<i>Ca XII</i>				1463.34	5	7	1.88E+00	7115.17	5	7	2.19E-02
140.05	4	2	3.7E+02	1467.40	5	3	5.49E-01	7115.18	3	1	4.43E-02
147.27	2	2	1.6E+02	1468.41	5	3	3.90E-02	7116.99	7	5	3.26E-02
<i>Ca XV</i>				1470.09	5	7	1.37E-02	7119.66	5	3	3.12E-02
141.69	5	3	4.08E+02	1472.23	5	3	8.01E-03	7860.88	5	5	1.53E-02
*142.23	9	3	6.3E+02	1481.76	5	5	3.92E-01	8058.62	5	5	1.09E-02
161.00	5	5	1.9E+02	1560.31	1	3	6.57E-01	8335.15	3	1	3.51E-01
<i>Ca XVII</i>				1561.34	5	5	2.94E-01	9061.44	3	5	7.31E-02
19.558	1	3	3.8E+04	1561.44	5	7	1.18E+00	9062.49	1	3	9.48E-02
21.198	3	5	4.9E+04	1656.27	3	5	8.58E-01	9078.29	3	3	7.07E-02
192.82	1	3	1.21E+02	1656.93	1	3	1.13E+00	9088.51	3	1	3.00E-01
218.82	3	5	2.76E+01	1657.01	5	5	2.52E+00	9094.83	5	5	2.28E-01
223.02	1	3	3.44E+01	1657.38	3	3	8.64E-01	9111.81	5	3	1.35E-01
228.72	3	3	2.37E+01	1657.91	3	1	3.43E+00	9405.73	3	5	2.91E-01
232.83	5	5	6.5E+01	1658.12	5	3	1.44E+00	9603.03	1	3	3.06E-02
244.06	5	3	3.28E+01	1751.83	1	3	9.07E-01	9620.78	3	3	8.62E-02
<i>Ca XVIII</i>				1763.91	1	3	3.59E-02	9658.43	5	3	1.25E-01
*18.71	2	6	2.31E+04	1765.37	1	3	1.04E-02	<i>C II</i>			
*19.74	6	10	7.0E+04	1930.90	5	3	3.51E+00	687.345	4	6	2.84E+01
302.19	2	4	2.0E+01	2478.56	1	3	3.40E-01	858.092	2	2	1.18E+00
344.76	2	2	1.3E+01	2902.23	1	3	4.32E-03	858.559	4	2	2.35E+00
<i>Carbon</i>				2903.27	3	3	1.29E-02	903.623	2	4	6.85E+00
<i>CI</i>				2905.00	5	3	2.15E-02	903.962	2	2	2.74E+01
945.191	1	3	3.79E+00	4371.37	3	3	1.27E-02	904.142	4	4	3.42E+01
945.338	3	3	1.14E+01	4762.31	1	3	3.37E-03	904.480	4	2	1.37E+01
945.579	5	3	1.89E+01	4762.53	3	5	2.72E-03	1009.86	2	4	5.71E+00
1193.24	5	7	1.22E+00	4766.67	3	3	2.36E-03	1010.08	4	4	1.14E+01
1260.74	1	3	5.32E-01	4770.03	3	1	1.07E-02	1010.37	6	4	1.71E+01
1260.93	3	1	1.70E+00	4771.74	5	5	7.97E-03	1036.34	2	2	7.61E+00
1261.00	3	3	4.42E-01	4775.90	5	3	4.84E-03	1037.02	4	2	1.52E+01
1261.12	3	5	3.71E-01	4812.92	1	3	4.03E-04	1323.91	4	4	4.33E+00
1261.43	5	3	7.06E-01	4817.37	3	3	8.76E-04	1323.95	6	6	4.49E+00
1261.55	5	5	1.27E+00	4826.80	5	3	6.28E-04	1334.53	2	4	2.37E+00
1274.11	5	7	1.03E-02	4932.05	3	1	6.02E-02	1335.71	4	6	2.84E+00
1277.25	1	3	1.27E+00	5023.84	7	9	1.81E-03	2091.14	2	4	1.00E-01
1277.28	3	5	1.73E+00	5039.06	7	9	4.73E-03	2091.19	4	6	1.69E-01
1277.51	3	3	9.12E-01	5041.48	3	5	5.25E-03	2091.65	6	8	2.41E-01
1277.55	5	7	2.31E+00	5041.79	5	7	3.28E-03	2093.16	6	6	7.20E-02
1277.72	5	5	6.35E-01	5052.17	3	5	2.60E-02	2173.85	2	4	2.31E-01
1277.95	5	3	5.56E-02	5380.34	3	3	1.86E-02	2174.17	2	2	2.31E-01
1279.23	5	7	1.10E-01	5545.05	3	3	3.04E-03	2509.13	2	4	4.53E-01
1279.89	3	5	3.08E-01	5668.94	3	3	2.35E-02	2511.74	4	4	9.04E-02
1280.14	1	3	3.11E-01	5793.12	7	5	3.44E-03	2512.06	4	6	5.42E-01
1280.33	5	5	5.77E-01	5794.47	5	5	6.44E-04	2727.31	2	4	6.63E-02
1280.40	3	3	1.73E-01	5800.23	3	3	1.04E-03	2728.72	4	4	3.31E-01
1280.60	3	1	8.22E-01	5800.60	5	3	3.04E-03	2729.21	2	2	2.65E-01
1280.85	5	3	3.33E-01	5805.20	3	1	4.12E-03	2730.63	4	2	1.32E-01
1328.83	1	3	7.95E-01	6001.12	5	5	3.22E-03	5132.95	2	4	3.89E-01
1329.09	3	1	2.41E+00	6006.02	7	5	1.79E-02	5133.28	4	6	2.80E-01
1329.58	5	5	1.79E+00	6007.18	3	3	5.34E-03	5137.26	2	2	1.55E-01
1329.60	5	3	1.00E+00	6010.68	3	1	2.13E-02	5139.17	4	4	1.24E-01
1355.84	5	7	1.04E+00	6013.17	7	5	1.79E-02	5143.49	4	2	7.73E-01
1364.16	5	5	1.57E-01	6013.21	7	9	4.35E-03	5145.16	6	6	6.49E-01
				6014.83	5	3	1.60E-02	5151.08	6	4	4.16E-01
				6016.45	5	7	3.86E-03	5640.55	2	4	9.89E-02
				6587.61	3	3	5.09E-02				

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
5648.07	4	4	1.97E-01	386.203	1	3	3.46E+01	9705.41	3	5	5.93E-02
5662.46	6	4	2.93E-01	459.466	1	3	5.91E+01	9706.44	3	3	3.29E-02
5818.31	2	2	3.38E-02	459.514	3	5	7.97E+01	9715.09	5	7	7.88E-02
5822.98	2	4	3.38E-03	459.627	5	7	1.06E+02	9717.75	5	5	1.97E-02
5823.18	4	2	3.38E-02	574.281	3	5	6.24E+01	9718.79	5	3	2.19E-03
5827.85	4	4	2.16E-02	977.020	1	3	1.767E+01				
5836.37	6	4	4.22E-02	1174.93	3	5	3.293E+00	<i>CIV</i>			
5843.62	6	6	1.20E-02	1175.26	1	3	4.385E+00	*312.43	2	6	4.63E+01
5856.06	8	6	5.31E-02	1175.59	3	3	3.287E+00	*384.13	6	10	1.76E+02
6095.29	2	4	4.20E-01	1175.71	5	5	9.856E+00	1548.19	2	4	2.65E+00
6098.51	4	6	5.03E-01	1175.99	3	1	1.313E+01	1550.77	2	2	2.64E+00
6102.56	4	4	8.37E-02	1176.37	5	3	5.468E+00	5801.31	2	4	3.17E-01
6578.05	2	4	3.63E-01	1247.38	3	1	2.082E+01	5811.97	2	2	3.16E-01
6582.88	2	2	3.62E-01	2296.87	3	5	1.376E+00				
6724.56	2	4	3.17E-02	2849.05	3	1	1.95E-01	<i>CV</i>			
6727.07	2	2	6.34E-02	3703.70	3	3	5.90E-01	34.9728	1	3	2.554E+03
6727.26	4	6	2.96E-02	4325.56	3	5	1.24E-01	40.2678	1	3	8.873E+03
6731.07	4	4	5.06E-02	4647.42	3	5	7.26E-01	*227.19	3	9	1.363E+02
6733.58	4	2	6.32E-02	4650.25	3	3	7.25E-01	247.315	1	3	1.278E+02
6734.00	6	8	1.80E-02	4651.02	3	5	2.28E-01	*248.71	9	15	4.247E+02
6738.61	6	6	7.23E-02	4651.47	3	1	7.24E-01	*260.19	9	3	6.680E+01
6742.43	6	4	4.41E-02	4652.05	1	3	3.04E-01	267.267	3	5	3.947E+02
6750.54	8	8	1.08E-01	4659.06	3	3	2.27E-01	*2273.9	3	9	5.646E-01
6755.16	8	6	2.38E-02	4663.64	3	1	9.05E-01	3526.66	1	3	1.663E-01
6779.94	4	6	2.56E-01	4665.86	5	5	6.78E-01	8420.72	3	5	6.898E-02
6780.59	2	4	1.52E-01	4673.95	5	3	3.75E-01	*8433.2	3	9	6.868E-02
6783.91	6	8	3.65E-01	5244.66	1	3	5.30E-02	8448.12	3	1	6.832E-02
6787.21	2	2	3.04E-01	5253.58	3	3	1.58E-01	8449.19	3	3	6.829E-02
6791.47	4	4	1.94E-01	5272.52	5	3	2.61E-01				
6798.10	4	2	6.04E-02	5695.92	3	5	4.27E-01	<i>Cesium</i>			
6800.69	6	6	1.09E-01	5858.34	3	1	1.34E-01	<i>Cs I</i>			
6812.28	6	4	1.80E-02	5863.25	3	3	3.35E-02	3203.5	2	4	7.6E-06
7046.25	4	2	3.20E-01	5871.68	5	3	1.00E-01	3205.3	2	4	7.9E-06
7053.09	4	4	3.19E-01	5880.56	5	5	1.99E-02	3207.5	2	4	8.5E-06
7063.68	4	6	3.17E-01	5894.07	7	5	1.11E-01	3210.0	2	4	9.4E-06
7112.48	2	4	2.94E-01	6727.48	1	3	1.12E-01	3212.8	2	4	1.19E-05
7113.04	4	6	3.15E-01	6731.04	3	5	1.50E-01	3216.2	2	4	1.49E-05
7115.63	6	8	3.60E-01	6742.15	3	3	8.32E-02	3220.1	2	4	1.7E-05
7119.76	4	4	1.17E-01	6744.39	5	7	1.99E-01	3220.2	2	2	1.07E-07
7119.91	8	10	4.19E-01	6762.17	5	5	4.95E-02	3224.8	2	4	2.0E-05
7125.72	6	6	1.02E-01	6773.39	5	3	5.47E-03	3225.0	2	2	1.43E-07
7132.47	6	4	8.33E-03	6851.18	3	5	7.60E-03	3230.5	2	4	2.5E-05
7134.10	8	8	5.93E-02	6853.68	5	7	5.64E-03	3230.7	2	2	1.97E-07
7231.33	2	4	3.52E-01	6857.24	3	3	3.79E-02	3237.4	2	4	2.8E-05
7236.42	4	6	4.22E-01	6862.69	5	5	3.51E-02	3237.6	2	2	2.63E-07
7237.17	4	4	7.03E-02	6868.78	5	3	1.26E-02	3245.9	2	4	3.45E-05
8028.85	2	2	1.71E-02	6872.04	7	7	4.46E-02	3246.2	2	2	3.7E-07
8037.73	2	4	4.26E-02	6881.10	7	5	7.80E-03	3256.7	2	4	4.25E-05
8039.40	4	2	8.51E-02	7353.88	5	3	3.09E-02	3257.1	2	2	7.0E-07
8048.31	4	4	1.36E-02	7707.43	3	5	1.30E-01	3270.5	2	4	5.6E-05
8062.10	4	6	3.04E-02	7771.76	3	1	1.77E-01	3271.0	2	2	9.8E-07
8062.80	6	4	4.56E-02	7780.41	3	3	1.76E-01	3288.6	2	4	1.0E-04
8076.64	6	6	7.05E-02	7796.00	3	5	1.75E-01	3289.3	2	2	2.7E-06
9238.30	4	6	3.34E-02	8500.32	1	3	1.01E-01	3313.1	2	4	1.6E-04
9251.01	2	4	2.77E-02	9593.32	3	3	5.32E-03	3314.0	2	2	5.2E-06
9863.06	2	4	5.56E-02	9651.47	5	5	1.57E-02	3347.5	2	4	2.2E-04
9870.78	4	6	9.31E-02	9696.48	5	7	7.53E-03	3348.8	2	2	1.1E-05
9882.68	6	8	1.33E-01	9696.54	3	5	7.12E-03	3397.9	2	4	4.0E-04
				9699.57	7	9	8.47E-03	3400.0	2	2	2.4E-05
<i>CI</i>				9701.10	1	3	4.40E-02	3476.8	2	4	6.6E-04
310.170	1	3	6.56E+00					3480.0	2	2	6.6E-05

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3611.4	2	4	1.5E-03	4917.7	3	5	7.5E-01	2769.90	7	5	1.1E+00
3617.3	2	2	2.5E-04	5078.3	7	7	7.7E-01	2780.70	9	7	1.4E+00
3876.1	2	4	3.8E-03	5219.1	3	9	8.6E-01	2879.27	5	7	2.1E-01
3888.6	2	2	9.7E-04	5392.1	5	7	1.0E+00	2887.00	3	5	2.7E-01
4555.3	2	4	1.88E-02					2889.22	9	9	6.6E-01
4593.2	2	2	8.0E-03	<i>Cl III</i>				2893.25	7	7	5.2E-01
8521.1	2	4	3.27E-01	2298.5	4	4	4.2E+00	2894.17	1	3	3.3E-01
8943.5	2	2	2.87E-01	2340.6	6	6	4.2E+00	2896.76	5	5	3.0E-01
<i>Chlorine</i>				2370.4	8	6	2.8E+00	2905.48	3	1	1.3E+00
<i>Cl I</i>				2531.8	2	4	4.4E+00	2909.05	5	3	6.8E-01
1188.8	4	6	2.33E+00	2532.5	4	6	5.3E+00	2910.89	7	5	3.4E-01
1188.8	4	4	2.71E-01	2577.1	4	6	4.3E+00	2911.15	9	7	2.6E-01
1201.4	2	4	2.39E+00	2580.7	6	8	4.7E+00	2967.64	7	9	3.9E-01
1335.7	4	2	1.74E+00	2601.2	2	4	4.6E+00	2971.10	5	7	7.1E-01
1347.2	4	4	4.19E+00	2603.6	4	6	5.0E+00	2975.48	3	5	8.9E-01
1351.7	2	2	3.23E+00	2609.5	6	8	5.7E+00	2980.78	1	3	5.10E-01
1363.4	2	4	7.5E-01	2617.0	8	10	6.6E+00	2988.64	5	7	5.2E-01
4323.3	4	4	1.1E-02	2661.6	4	6	3.4E+00	2991.88	3	1	3.0E+00
4363.3	4	6	6.8E-03	2665.5	6	8	4.8E+00	2994.06	5	5	2.5E-01
4379.9	4	4	1.4E-02	2691.5	4	4	3.5E+00	2995.09	5	5	4.3E-01
4389.8	6	8	1.4E-02	2710.4	4	6	3.5E+00	2996.57	5	3	2.0E+00
4526.2	4	4	5.1E-02	3340.4	6	6	1.5E+00	2998.78	5	3	4.07E-01
4601.0	2	2	4.2E-02	3392.9	4	4	1.9E+00	3000.88	7	5	1.6E+00
4661.2	2	4	1.2E-02	3393.5	6	6	1.9E+00	3005.06	9	7	9.2E-01
7256.6	6	4	1.5E-01	3530.0	6	8	1.8E+00	3013.72	3	5	8.3E-01
7414.1	6	4	4.7E-02	3560.7	4	6	1.7E+00	3015.20	1	3	1.63E+00
7547.1	4	4	1.2E-01	3602.1	6	8	1.7E+00	3015.20	1	3	1.63E+00
7717.6	4	4	3.0E-02	3602.1	6	8	1.7E+00	3020.67	3	3	1.5E+00
7745.0	2	4	6.3E-02	3612.9	4	6	1.2E+00	3021.58	9	11	2.91E+00
7769.2	6	6	6.0E-02	3720.5	4	6	1.7E+00	3024.36	5	5	1.27E+00
7821.4	6	8	9.8E-02	<i>Chromium</i>				3029.17	5	3	3.8E-01
7830.8	4	4	9.7E-02	<i>Cr I</i>				3030.25	7	7	1.1E+00
7878.2	6	6	1.8E-02	1999.95	9	9	1.4E+00	3031.35	5	3	3.1E-01
7899.3	4	6	5.1E-02	2383.30	9	11	4.1E-01	3034.19	7	7	3.5E-01
7924.6	2	4	2.1E-02	2389.21	3	5	2.3E-01	3037.05	9	9	5.4E-01
7935.0	6	8	3.9E-02	2408.60	9	7	6.7E-01	3040.84	7	5	7.4E-01
7997.9	4	4	2.1E-02	2408.72	7	5	2.9E-01	3053.87	9	7	7.97E-01
				2492.57	3	5	4.5E-01	3148.44	9	11	5.6E-01
				2495.08	3	3	2.7E-01	3155.16	11	13	5.7E-01
				2496.30	5	7	5.6E-01	3163.76	13	15	6.0E-01
				2502.55	7	9	2.2E-01	3237.73	9	9	1.3E+00
				2504.31	7	9	4.5E-01	3238.09	11	11	2.0E-01
				2508.11	5	5	2.1E-01	3578.68	7	9	1.48E+00
				2508.97	5	3	3.8E-01	3593.48	7	7	1.50E+00
				2527.11	9	9	5.3E-01	3605.32	7	5	1.62E+00
				2549.55	3	3	4.8E-01	3639.80	13	11	1.8E+00
				2560.70	5	5	4.3E-01	3743.89	13	13	7.61E-01
				2571.74	7	5	6.4E-01	3757.66	7	7	4.13E-01
				2577.66	7	7	2.6E-01	3768.24	5	5	5.10E-01
				2591.84	9	7	6.5E-01	3804.80	9	9	6.9E-01
				2620.48	5	3	1.9E-01	3963.69	13	15	1.3E+00
				2673.64	3	3	1.8E-01	3969.75	11	13	1.2E+00
				2701.99	9	11	2.1E-01	3983.90	7	9	1.05E+00
				2726.50	5	7	7.5E-01	3991.12	5	7	1.07E+00
				2731.90	5	5	7.8E-01	4001.44	9	11	6.8E-01
				2736.46	5	3	7.5E-01	4039.10	15	15	6.7E-01
				2752.85	3	3	8.7E-01	4048.78	13	13	6.4E-01
				2757.09	5	5	6.8E-01	4058.78	11	11	6.7E-01
				2761.74	5	3	6.8E-01	4065.71	9	11	3.5E-01
				2764.36	7	7	3.7E-01	4165.52	11	13	7.5E-01
								4204.48	13	11	3.1E-01







$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
13.76	1	3	1.51E+05	2424.93	10	10	3.2E+00	3523.42	4	2	9.8E-01
13.78	5	7	1.7E+05	2432.21	8	8	2.6E+00	3526.85	10	10	1.3E-01
13.84	5	7	2.59E+05	2436.66	6	6	2.6E+00	3529.03	6	8	8.8E-02
13.87	3	5	8.5E+04	2439.04	4	4	2.7E+00	3529.82	8	10	4.6E-01
13.92	3	5	8.5E+04	2460.80	4	6	1.2E-01	3533.36	4	6	9.1E-02
13.93	5	7	4.2E+04	2467.69	6	8	7.0E-02	3560.89	4	4	2.3E-01
13.95	5	5	3.8E+04	2470.27	10	12	1.5E-01	3564.95	6	8	7.0E-02
14.04	3	5	1.2E+05	2476.64	10	8	2.2E-01	3569.37	8	8	1.6E+00
14.24	1	3	1.41E+05	2504.52	10	8	1.8E-01	3574.97	6	6	1.5E-01
<i>Cr XXII</i>				2511.02	10	10	9.2E-01	3575.36	8	8	9.6E-02
2.190	4	2	1.7E+06	2521.36	10	8	3.0E+00	3585.15	8	8	7.1E-02
2.191	2	2	2.5E+06	2528.97	8	6	2.8E+00	3587.19	6	6	1.4E+00
2.198	4	4	4.5E+06	2530.13	6	6	7.1E-02	3594.87	6	6	9.2E-02
2.199	2	4	2.3E+06	2535.96	6	4	1.9E+00	3602.08	4	4	1.0E-01
2.202	4	6	1.6E+06	2536.50	8	8	3.0E-01	3704.06	6	8	1.2E-01
2.203	4	2	1.3E+06	2544.25	4	2	3.0E+00	3745.49	8	8	7.5E-02
13.149	2	4	1.29E+05	2562.12	4	4	3.9E-01	3842.05	8	6	1.3E-01
13.292	4	6	1.54E+05	2567.34	6	6	3.0E-01	3845.47	8	10	4.6E-01
<i>Cr XXIII</i>				2574.35	8	8	1.7E-01	3861.16	6	4	1.4E-01
1.7632	1	3	3.68E+05	2685.34	6	8	5.5E-02	3873.12	10	8	1.2E-01
1.8557	1	3	8.97E+05	3017.55	8	6	6.9E-02	3873.95	8	6	1.0E-01
2.095	3	1	3.5E+06	3044.00	10	10	1.9E-01	3881.87	6	4	8.2E-02
2.101	1	3	2.0E+06	3048.89	6	4	7.5E-02	3894.07	6	8	6.9E-01
2.101	5	5	7.9E+05	3061.82	8	8	1.6E-01	3894.98	4	2	8.8E-02
2.102	3	5	2.1E+06	3072.34	6	6	1.5E-01	3935.96	8	10	6.2E-02
2.103	3	5	1.2E+06	3086.78	4	4	1.9E-01	3995.31	8	10	2.5E-01
2.104	1	3	1.4E+06	3354.37	8	6	1.1E-01	3997.90	6	8	7.0E-02
2.105	3	3	9.6E+05	3367.11	10	8	6.0E-02	4092.39	8	8	5.7E-02
2.106	3	3	2.0E+06	3385.22	8	6	1.1E-01	4110.53	6	6	5.5E-02
2.107	5	5	2.3E+06	3388.16	6	4	2.4E-01	4118.77	6	8	1.6E-01
2.107	3	5	3.3E+06	3395.37	6	8	2.9E-01	4121.32	8	10	1.9E-01
2.109	5	3	1.7E+06	3405.12	10	10	1.0E+00	5146.75	8	8	1.5E-01
2.113	3	5	5.9E+05	3409.17	8	8	4.2E-01	5212.70	10	10	1.9E-01
2.119	3	1	2.7E+05	3412.34	8	10	6.1E-01	5265.79	6	8	5.0E-02
2.129	3	1	5.1E+05	3412.63	10	8	1.2E-01	5280.63	10	8	2.8E-01
2.1818	1	3	3.37E+06	3414.74	4	4	8.8E-02	5352.05	12	10	2.7E-01
2.1923	1	3	2.34E+05	3417.15	6	6	3.2E-01	5477.09	6	8	6.8E-02
<i>Cobalt</i>				3431.58	8	6	1.1E-01	5483.96	8	10	7.3E-02
<i>Co I</i>				3433.05	4	4	1.0E+00	6082.43	10	10	5.4E-02
2287.80	8	8	8.6E-01	3442.92	6	4	1.2E-01	6455.00	8	10	9.0E-02
2295.22	10	8	2.2E-01	3443.64	8	8	6.9E-01	7838.12	8	10	5.4E-02
2309.03	10	10	5.6E-01	3449.17	6	6	7.6E-01	8093.93	12	10	2.0E-01
2323.13	8	8	5.0E-01	3449.44	10	10	1.8E-01	8372.79	10	10	8.7E-02
2325.53	6	8	1.1E-01	3453.51	10	12	1.1E+00	<i>Co II</i>			
2335.98	6	6	5.1E-01	3455.24	4	2	1.9E-01	2286.15	11	13	3.3E+00
2338.66	4	4	7.7E-01	3462.80	4	6	7.9E-01	2307.85	9	11	2.6E+00
2353.36	8	10	1.5E-01	3465.79	10	12	9.2E-02	2311.61	7	9	2.8E+00
2355.48	6	8	1.3E-01	3474.02	6	8	5.6E-01	2314.05	5	7	2.8E+00
2358.18	4	6	1.4E-01	3483.41	8	10	5.5E-02	2314.97	3	5	2.7E+00
2365.06	10	10	1.3E-01	3489.40	8	6	1.3E+00	2330.36	5	3	1.32E+00
2371.85	6	8	7.3E-02	3491.32	4	4	5.0E-02	2344.28	3	3	1.5E+00
2384.86	10	8	2.4E-01	3495.68	4	6	4.9E-01	2353.41	7	7	1.9E+00
2392.03	6	6	4.0E-01	3502.28	10	8	8.0E-01	2363.80	9	9	2.1E+00
2402.06	8	6	5.1E-01	3502.63	6	6	5.2E-02	2378.62	11	9	1.9E+00
2407.25	10	12	3.6E+00	3506.32	8	6	8.2E-01	2383.45	9	7	1.8E+00
2412.76	4	6	6.5E-01	3509.84	6	8	3.2E-01	2388.92	11	11	2.8E+00
2414.46	6	8	3.4E+00	3512.64	6	4	1.0E+00	2389.54	5	3	1.5E+00
2415.29	4	6	3.6E+00	3513.48	8	10	7.8E-02	2404.17	3	3	1.5E+00
				3518.34	6	4	1.6E+00	2417.66	9	9	8.5E-01
				3521.58	10	8	1.8E-01				

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
<b>Copper</b>											
<b>Cu I</b>											
*2024.3	2	6	9.8E-02	4194.8	17	17	7.2E-01	3212.8	8	8	2.9E-01
2165.1	2	4	5.1E-01	4211.7	17	19	2.08E+00	3213.8	8	6	1.8E-01
2178.9	2	4	9.13E-01	4218.1	15	15	1.85E+00	3235.1	8	10	1.0E-02
2181.7	2	2	1.0E+00	4221.1	15	17	1.52E+00	3241.4	8	8	2.3E-02
2225.7	2	2	4.6E-01	4225.2	13	15	4.5E+00	3246.0	8	6	1.4E-02
2244.3	2	4	1.19E-02	4268.3	15	15	3.6E-02	3247.6	8	8	2.3E-02
2441.6	2	2	2.0E-02	4276.7	13	13	7.3E-01	3322.3	8	6	3.5E-02
2492.2	2	4	3.11E-02	4292.0	15	15	5.8E-02	3334.3	8	6	3.4E-01
2618.4	6	4	3.07E-01	4577.8	17	19	2.2E-02	3350.4	8	10	1.5E-02
2766.4	4	4	9.6E-02	4589.4	17	15	1.3E-01	3353.7	8	8	5.8E-03
2824.4	6	6	7.8E-02	4612.3	17	15	8.2E-02	3457.1	8	8	8.4E-03
2961.2	6	8	3.76E-02	5077.7	17	17	5.7E-03	3467.9	8	8	1.0E-02
3063.4	4	4	1.55E-02	5301.6	17	15	1.1E-02	3589.3	8	6	6.9E-03
3194.1	4	4	1.55E-02	5547.3	17	17	2.7E-03	4594.0	8	10	1.4E+00
3247.5	2	4	1.39E+00	5639.5	17	19	4.7E-03	4627.2	8	8	1.3E+00
3274.0	2	2	1.37E+00	5974.5	17	17	4.0E-03	4661.9	8	6	1.3E+00
3337.8	6	8	3.8E-03	5988.6	17	15	5.3E-03	5645.8	8	6	5.4E-03
4022.6	2	4	1.90E-01	6010.8	15	15	2.6E-02	5765.2	8	8	1.1E-02
4062.6	4	6	2.10E-01	6088.3	15	13	3.5E-02	6018.2	8	10	8.5E-03
4249.0	2	2	1.95E-01	6168.4	15	17	2.5E-02	6291.3	8	6	1.8E-03
4275.1	6	8	3.45E-01	6259.1	17	19	8.5E-03	6864.5	8	10	5.8E-03
4480.4	2	2	3.0E-02	6579.4	17	15	7.5E-03	7106.5	8	8	2.6E-03
4509.4	4	2	2.75E-01	<b>Erbium</b>				<b>Fluorine</b>			
4530.8	4	2	8.4E-02	<b>Er I</b>				<b>FI</b>			
4539.7	6	4	2.12E-01	3862.9	13	13	2.5E+00	806.96	4	6	3.3E+00
4587.0	8	6	3.20E-01	4008.0	13	15	2.6E+00	809.60	2	4	2.8E+00
4651.1	10	8	3.80E-01	4151.1	13	11	1.8E+00	951.87	4	2	2.6E+00
4704.6	8	8	5.5E-02	<b>Europium</b>				954.83	4	4	5.77E+00
5105.5	6	4	2.0E-02	<b>Eu I</b>				955.55	2	2	5.1E+00
5153.2	2	4	6.0E-01	2372.9	8	6	1.9E-01	958.52	2	4	1.3E+00
5218.2	4	6	7.5E-01	2375.3	8	8	2.0E-01	6239.7	6	4	2.5E-01
5220.1	4	4	1.50E-01	2379.7	8	10	2.0E-01	6348.5	4	4	1.8E-01
5292.5	8	8	1.09E-01	2619.3	8	10	7.0E-03	6413.7	2	4	1.1E-01
5700.2	4	4	2.4E-03	2643.8	8	8	6.6E-03	6708.3	6	4	1.4E-02
5782.1	4	2	1.65E-02	2659.4	8	10	1.2E-02	6774.0	6	6	1.0E-01
<b>Cu II</b>											
2489.7	5	5	1.5E-02	2682.6	8	6	1.2E-02	6795.5	4	2	5.2E-02
2544.8	9	7	1.1E+00	2710.0	8	10	1.4E-01	6834.3	4	4	2.1E-01
2689.3	7	7	4.1E-01	2724.0	8	8	1.2E-01	6856.0	6	8	4.94E-01
2701.0	5	5	6.7E-01	2731.4	8	8	3.1E-02	6870.2	2	2	3.8E-01
2703.2	3	3	1.2E+00	2732.6	8	6	3.7E-02	6902.5	4	6	3.2E-01
2713.5	5	5	6.8E-01	2735.3	8	10	4.7E-02	6909.8	2	4	2.2E-01
<b>Dysprosium</b>											
<b>Dy I</b>											
2862.7	17	15	6.5E-02	2738.6	8	10	1.3E-02	6966.4	4	2	1.1E-01
2964.6	17	17	6.5E-02	2743.3	8	6	1.1E-01	7037.5	4	4	3.0E-01
3147.7	15	17	1.1E-01	2745.6	8	6	5.0E-02	7127.9	2	2	3.8E-01
3263.2	15	13	1.4E-01	2747.8	8	8	5.2E-02	7309.0	6	8	4.7E-01
3511.0	15	13	3.1E-01	2772.9	8	6	1.0E-02	7311.0	4	2	3.9E-01
3571.4	15	13	2.0E-01	2878.9	8	10	2.8E-02	7314.3	4	6	4.8E-01
3757.1	17	19	3.0E+00	2892.5	8	8	1.0E-01	7332.0	6	4	3.1E-01
3868.8	17	17	3.1E+00	2893.0	8	6	1.0E-01	7398.7	6	6	2.85E-01
3967.5	17	19	8.7E-01	2909.0	8	10	6.9E-02	7425.7	4	2	3.4E-01
4046.0	17	15	1.5E+00	2958.9	8	6	1.6E-02	7482.7	4	4	5.6E-02
4103.9	13	11	1.7E+00	3059.0	8	8	3.8E-02	7489.2	2	2	1.1E-01
4186.8	17	17	1.32E+00	3067.0	8	10	9.1E-03	7514.9	2	2	5.2E-02
				3106.2	8	10	5.5E-02	7552.2	4	6	7.8E-02
				3111.4	8	10	3.0E-01	7573.4	2	4	1.0E-01
				3168.3	8	10	6.9E-02	7607.2	4	4	7.0E-02
				3185.5	8	10	5.8E-03	7754.7	4	6	3.82E-01
				3210.6	8	8	1.1E-01	7800.2	2	4	2.1E-01



$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>			
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$				
<b>Gallium</b>														
<b>Ga I</b>														
2195.4	2	2	1.9E-02	1075.1	4	2	1.3E+00	4024.0	3	1	1.128E-02			
2199.7	4	2	3.3E-02	1237.1	2	4	1.9E+01	*4026.2	9	15	1.160E-01			
2214.4	4	6	1.2E-02	1261.9	4	6	2.2E+01	*4120.8	9	3	4.453E-02			
2235.9	4	2	4.3E-02	1264.7	4	4	3.5E+00	4143.8	3	5	4.881E-02			
2255.0	2	2	3.1E-02	1602.5	2	2	3.4E+00	4169.0	3	1	1.830E-02			
2259.2	4	6	3.1E-02	1649.2	4	2	6.5E+00	4387.9	3	5	8.989E-02			
2294.2	2	4	7.0E-02	4741.8	2	4	4.6E-01	4437.6	3	1	3.269E-02			
2297.9	4	2	5.8E-02	4814.6	4	6	5.1E-01	*4471.5	9	15	2.458E-01			
2338.2	4	6	9.8E-02	4824.1	4	4	8.6E-02	*4713.2	9	3	9.521E-02			
2371.3	2	2	5.7E-02	5131.8	4	6	1.9E+00	4921.9	3	5	1.986E-01			
2418.7	4	2	1.0E-01	5178.5	6	6	1.3E-01	5015.7	1	3	1.337E-01			
2450.1	2	4	2.8E-01	5178.6	6	8	2.0E+00	5047.7	3	1	6.771E-02			
2500.2	4	6	3.4E-01	5893.4	2	4	9.2E-01	*5875.7	9	15	7.070E-01			
2659.9	2	2	1.2E-01	6021.0	2	2	8.4E-01	6678.2	3	5	6.371E-01			
2719.7	4	2	2.3E-01	6336.4	2	2	4.4E-01	*7065.2	9	3	2.785E-01			
2874.2	2	4	1.2E+00	6484.2	4	2	8.5E-01	7281.4	3	1	1.830E-01			
2943.6	4	6	1.4E+00	<b>Gold</b>							*8361.7	3	9	3.813E-03
2944.2	4	4	2.7E-01	<b>Au I</b>							*9463.6	3	9	5.687E-03
4033.0	2	2	4.9E-01	2427.95	2	4	1.99E+00	9603.4	1	3	5.829E-03			
4172.0	4	2	9.2E-01	2675.95	2	2	1.64E+00	*9702.6	9	3	8.651E-03			
<b>Ga II</b>														
829.60	1	3	2.2E-01	3122.78	6	4	1.90E-01	*10311	9	15	1.995E-02			
1414.4	1	3	1.88E+01	6278.30	4	2	3.4E-02	*10668	9	3	1.447E-02			
<b>Germanium</b>														
<b>Ge I</b>														
1944.7	3	1	7.0E-01	<b>Helium</b>							*10830	3	9	1.022E-01
1955.1	3	3	2.8E-01	<b>He I</b>							*10913	15	21	1.980E-02
1988.3	5	3	2.5E-01	510.00	1	3	4.622E-01	10917	5	7	1.608E-02			
1998.9	5	5	5.5E-01	512.10	1	3	7.317E-01	*10997	15	9	1.425E-03			
2041.7	1	3	1.1E+00	515.62	1	3	1.258E+00	11013	1	3	9.250E-03			
2065.2	3	3	8.5E-01	522.21	1	3	2.436E+00	11045	3	5	1.846E-02			
2068.7	3	5	1.2E+00	537.03	1	3	5.663E+00	11226	3	1	1.117E-02			
2086.0	3	5	4.0E-01	584.33	1	3	1.799E+01	*11969	9	15	3.478E-02			
2094.3	5	7	9.7E-01	*2677.1	3	9	4.417E-03	*12528	3	9	7.093E-03			
2105.8	5	5	1.7E-01	*2696.1	3	9	6.023E-03	12756	5	3	1.275E-03			
2256.0	5	5	3.2E-02	*2723.2	3	9	8.500E-03	*12785	15	21	4.134E-02			
2417.4	5	5	9.6E-01	*2763.8	3	9	1.251E-02	12791	5	7	3.248E-02			
2498.0	1	3	1.3E-01	*2829.1	3	9	1.939E-02	*12846	9	3	2.732E-02			
2533.2	3	3	1.0E-01	*2945.1	3	9	3.201E-02	12968	3	5	3.362E-02			
2589.2	5	3	5.1E-02	*3187.7	3	9	5.636E-02	*12985	15	9	2.729E-03			
2592.5	3	5	7.1E-01	3231.3	1	3	5.102E-03	<b>Indium</b>						
2651.2	5	5	2.0E+00	3258.3	1	3	6.963E-03	<b>In I</b>						
2651.6	1	3	8.5E-01	3296.8	1	3	9.843E-03	2560.2	2	4	4.0E-01			
2691.3	3	3	6.1E-01	3354.6	1	3	1.454E-02	2710.3	4	6	4.0E-01			
2709.6	3	1	2.8E+00	3447.6	1	3	2.269E-02	3039.4	2	4	1.3E+00			
2754.6	5	3	1.1E+00	*3554.4	9	15	7.597E-03	3256.1	4	6	1.3E+00			
3039.1	5	3	2.8E+00	*3563.0	9	3	4.836E-03	4101.8	2	2	5.6E-01			
3124.8	5	5	3.1E-02	*3587.3	9	15	1.811E-02	4511.3	4	2	1.02E+00			
3269.5	5	3	2.9E-01	3613.6	1	3	3.802E-02	<b>In II</b>						
4226.6	1	3	2.1E-01	*3634.2	9	15	2.606E-02	2941.1	3	1	1.4E+00			
4685.8	1	3	9.5E-02	*3652.0	9	3	9.744E-03	<b>Iodine</b>						
<b>Ge II</b>														
999.10	2	4	1.9E+00	*3705.0	9	15	3.953E-02	<b>II</b>						
1016.6	4	6	2.1E+00	*3819.6	9	15	6.435E-02	1782.8	4	4	2.71E+00			
1017.1	4	4	3.5E-01	3833.6	3	5	9.647E-03	1830.4	4	6	1.6E-01			
1055.0	2	2	6.9E-01	*3867.5	9	3	2.447E-02	<b>Iridium</b>						
<b>Ir I</b>														
				3871.8	3	5	1.339E-02	2475.12	10	10	2.1E-01			
				*3888.7	3	9	9.475E-02	2502.98	10	12	3.2E-01			
				3926.5	3	5	1.937E-02	2639.71	10	10	4.7E-01			
				3935.9	3	1	7.448E-03	2661.98	10	10	2.5E-01			
				3964.7	1	3	6.951E-02							
				4009.3	3	5	2.961E-02							

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
2664.79	10	8	4.0E-01	2443.87	11	11	5.89E-02	2606.83	9	11	2.43E-01
2694.23	10	12	4.8E-01	2453.48	9	7	1.89E-01	2609.22	7	7	4.60E-01
2849.72	10	10	2.2E-01	2453.57	11	13	1.23E-01	2618.02	7	7	1.50E-01
2853.31	10	10	2.0E-03	2457.60	11	11	4.81E-01	2623.53	7	9	2.13E-01
2882.64	10	8	7.2E-02	2462.18	7	5	1.10E-01	2632.24	5	5	1.21E-01
2924.79	10	12	1.42E-01	2462.65	9	9	5.85E-01	2635.72	11	9	4.29E-02
2934.64	8	10	2.0E-01	2463.73	7	5	1.64E-01	2635.81	5	7	2.11E-01
2951.22	10	8	2.8E-02	2465.15	9	9	4.35E-01	2641.03	9	7	7.71E-02
3003.63	8	10	5.9E-02	2468.88	11	11	2.40E-01	2641.64	9	7	6.47E-02
3168.88	8	10	5.47E-02	2470.97	9	11	2.36E-02	2644.00	3	5	2.34E-01
3220.78	10	8	2.4E-01	2472.34	11	13	7.21E-02	2656.15	13	15	1.63E-01
3558.99	6	8	1.5E-02	2472.87	5	3	2.10E-01	2662.06	7	5	4.64E-02
3573.72	8	10	5.4E-02	2472.89	7	7	1.30E+00	2666.81	11	9	8.91E-02
3617.21	6	8	2.0E-02	2473.16	9	9	2.75E-02	2666.97	9	11	5.16E-02
3628.67	8	8	2.8E-02	2474.81	7	7	6.13E-01	2669.49	11	13	1.34E-01
3661.71	8	10	4.0E-02	2476.66	5	3	3.05E-01	2679.02	9	11	1.10E-01
3734.77	8	8	2.7E-02	2479.48	5	5	2.10E-01	2679.06	11	11	1.50E-01
4033.76	8	10	2.7E-02	2479.78	5	5	1.74E+00	2689.21	9	7	1.68E-01
4069.92	6	8	3.6E-02	2483.27	9	11	4.80E+00	2689.83	7	9	3.04E-02
4913.35	12	12	3.3E-02	2483.53	5	5	2.09E-01	2697.02	7	9	3.51E-02
4939.24	10	12	2.5E-03	2484.19	3	3	2.26E+00	2699.11	9	9	5.59E-02
<i>Iron</i>				2485.99	9	9	2.94E-02	2701.91	9	7	1.05E-01
<i>Fe I</i>				2486.69	7	9	1.47E-01	2702.45	13	11	4.23E-02
1934.54	9	7	2.5E-01	2487.07	3	3	6.40E-01	2706.01	13	13	2.28E-01
1937.27	9	7	2.2E-01	2488.14	7	9	4.20E+00	2706.58	7	5	2.69E-01
1940.66	7	5	2.6E-01	2489.75	1	3	2.31E+00	2708.57	9	9	6.49E-01
2132.02	9	9	7.6E-02	2489.91	3	5	8.72E-02	2710.54	5	7	5.99E-02
2145.19	7	7	5.7E-02	2490.64	5	7	3.44E+00	2711.66	9	11	4.99E-02
2153.01	5	5	6.9E-02	2491.16	3	5	2.91E+00	2716.26	9	9	3.70E-02
2161.58	3	5	5.0E-02	2491.99	9	9	3.25E-01	2716.42	11	9	4.96E-02
2166.77	9	7	2.7E+00	2494.00	3	5	8.89E-02	2718.44	5	3	3.79E-01
2171.30	5	7	5.1E-02	2496.53	9	11	2.15E-01	2719.03	9	7	1.42E+00
2173.21	3	5	8.3E-02	2501.13	9	7	6.75E-01	2719.06	7	7	7.40E-01
2176.84	1	3	1.0E-01	2501.69	11	9	3.69E-02	2719.42	11	11	3.20E-01
2191.84	5	5	1.2E+00	2505.01	9	11	2.56E-01	2720.90	7	5	1.04E+00
2196.04	3	3	1.2E+00	2506.57	7	9	2.04E-01	2723.58	5	3	5.69E-01
2200.39	1	3	8.9E-01	2507.90	7	9	1.93E-01	2724.95	7	9	4.76E-02
2200.72	3	5	2.8E-01	2510.83	7	5	1.29E+00	2726.06	3	1	5.52E-01
2259.51	9	11	5.66E-02	2517.66	5	7	1.58E-01	2728.02	9	9	3.45E-02
2272.07	7	9	2.92E-02	2518.10	5	3	1.93E+00	2728.82	9	9	2.98E-01
2276.03	9	7	1.25E-01	2519.63	3	5	1.34E-01	2731.28	5	7	6.84E-02
2284.09	7	5	1.29E-01	2522.85	9	9	2.13E+00	2733.58	11	9	7.10E-01
2287.25	5	3	2.23E-01	2524.29	3	1	3.23E+00	2735.48	9	7	5.03E-01
2292.52	7	9	2.96E-02	2527.27	13	13	3.46E-01	2737.31	3	3	7.25E-01
2294.41	3	1	3.61E-01	2527.44	7	7	1.93E+00	2737.64	13	11	1.14E-01
2297.79	7	7	1.44E-01	2529.14	5	5	9.91E-01	2742.25	7	5	3.41E-01
2298.17	9	9	3.09E-01	2529.31	5	7	4.86E+00	2742.41	5	5	4.70E-01
2299.22	5	5	7.03E-02	2529.84	3	3	3.83E-01	2743.57	7	7	4.84E-02
2300.14	5	7	4.99E-02	2533.14	11	11	2.07E-01	2744.07	1	3	3.09E-01
2301.68	1	3	8.68E-02	2535.61	1	3	9.59E-01	2744.53	5	3	2.53E-01
2303.58	3	5	4.83E-02	2537.17	13	15	3.70E+00	2750.14	7	7	2.74E-01
2309.00	3	5	1.02E-01	2537.46	9	11	3.19E-02	2753.69	3	1	4.00E-01
2313.10	5	7	1.18E-01	2540.97	3	5	9.59E-01	2754.03	5	5	7.29E-02
2320.36	7	9	1.41E-01	2542.10	11	13	4.47E+00	2755.18	11	9	5.13E-02
2373.62	7	7	6.53E-02	2543.92	9	11	4.70E+00	2756.33	3	5	1.41E-01
2389.97	5	7	4.47E-02	2545.98	5	7	7.16E-01	2757.32	3	3	2.85E-01
2438.18	11	9	7.09E-02	2549.61	7	9	2.31E-01	2761.78	5	5	1.94E-01
2439.74	13	13	3.46E+00	2576.69	11	11	1.13E-01	2762.03	7	7	1.76E-01
2442.57	11	11	3.12E+00	2584.54	11	13	3.15E-01	2767.52	9	9	1.48E-01
				2599.57	9	9	1.47E-01	2769.30	13	13	1.80E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2772.07	11	11	2.34E-02	2973.13	5	7	1.35E-01	3099.89	3	3	1.93E-01
2772.11	5	7	4.12E-02	2973.24	7	9	1.83E-01	3099.97	9	9	8.23E-02
2778.22	11	11	9.08E-02	2976.13	5	7	9.70E-02	3100.30	5	5	1.87E-01
2780.70	9	9	9.01E-02	2980.53	7	7	1.66E-01	3100.67	7	7	1.35E-01
2784.34	11	11	2.30E-02	2981.45	7	5	6.53E-02	3100.84	13	11	2.73E-02
2787.93	9	11	2.27E-02	2981.85	7	9	1.86E-01	3101.00	9	9	5.53E-02
2788.10	11	13	5.92E-01	2982.23	9	7	3.47E-02	3112.08	11	11	5.24E-02
2789.80	11	9	2.36E-01	2983.57	9	7	2.79E-01	3119.49	11	9	8.28E-02
2797.78	9	9	4.52E-02	2987.29	9	7	5.25E-02	3120.44	9	7	7.26E-02
2803.61	9	9	1.04E-01	2990.39	9	11	3.5E-01	3125.68	13	11	8.46E-02
2804.52	9	9	1.05E-01	2994.43	7	5	4.39E-01	3132.52	9	7	3.39E-01
2804.86	9	7	2.40E-01	2996.39	3	5	1.70E-01	3142.45	7	7	3.93E-02
2806.98	9	11	1.15E-01	2999.51	11	11	1.70E-01	3142.89	5	5	5.65E-02
2812.04	9	9	5.00E-02	3000.45	9	11	5.41E-02	3143.99	9	9	6.10E-01
2813.29	9	11	3.42E-01	3000.95	5	3	6.42E-01	3145.06	9	9	4.65E-02
2823.28	7	7	1.51E-01	3003.03	7	5	7.50E-02	3147.79	7	7	7.59E-02
2825.56	7	9	1.32E-01	3004.11	11	11	2.79E-02	3153.20	7	9	7.91E-02
2832.44	7	9	2.38E-01	3005.30	13	15	2.94E-02	3154.50	5	7	4.64E-02
2834.75	9	11	5.41E-02	3007.15	9	7	7.34E-02	3156.27	7	7	6.36E-01
2838.12	5	5	1.28E-01	3008.14	3	1	1.07E+00	3157.04	9	11	1.26E-01
2843.63	9	7	6.96E-02	3009.09	13	11	7.77E-02	3157.89	5	7	1.61E-01
2843.98	5	7	3.17E-01	3009.57	9	9	1.43E-01	3160.66	9	9	1.93E-01
2845.59	7	5	7.86E-02	3011.48	7	9	3.79E-01	3161.95	11	13	4.65E-02
2851.80	3	5	3.37E-01	3015.92	11	9	6.3E-02	3165.86	7	9	5.35E-02
2853.77	7	9	5.91E-02	3016.18	5	3	8.85E-02	3166.44	9	7	1.14E-01
2863.43	9	9	4.13E-02	3018.98	7	7	1.03E-01	3171.35	9	7	1.85E-01
2868.45	5	3	1.45E-01	3019.29	9	11	2.33E-02	3175.44	11	11	1.44E-01
2877.30	9	9	4.61E-02	3020.49	5	5	1.94E-01	3178.01	11	9	1.28E-01
2883.75	11	11	2.91E-02	3020.64	9	9	7.59E-01	3180.22	7	9	4.42E-01
2887.81	11	13	7.98E-02	3021.07	7	7	4.55E-01	3181.52	7	5	1.84E-01
2892.48	9	9	8.78E-02	3024.03	3	5	4.87E-02	3182.06	9	9	3.23E-02
2894.50	5	5	4.83E-01	3025.64	13	13	5.86E-01	3182.97	5	7	1.42E-01
2895.03	7	7	4.24E-02	3025.84	1	3	3.48E-01	3188.57	11	11	5.00E-02
2899.41	5	3	4.68E-01	3026.46	5	5	1.10E-01	3188.82	3	5	2.53E-01
2901.91	11	11	1.78E-01	3030.15	11	11	5.04E-01	3190.65	9	11	5.75E-02
2907.52	9	11	1.61E-01	3031.64	3	3	1.38E-01	3190.82	9	9	5.55E-02
2908.86	7	9	8.98E-02	3037.39	3	5	2.91E-01	3192.80	3	5	5.01E-01
2918.02	13	13	1.18E+00	3040.43	9	11	2.45E-02	3193.30	5	7	3.07E-01
2919.84	9	11	7.44E-02	3041.64	7	9	4.24E-02	3194.42	5	3	1.08E-01
2920.69	5	5	6.38E-02	3041.74	7	9	5.20E-02	3196.12	11	9	1.40E-01
2923.29	11	11	1.39E+00	3042.02	3	5	4.70E-02	3196.93	9	11	5.97E-01
2923.85	11	11	2.97E-01	3042.66	5	7	5.20E-02	3199.53	9	9	2.23E-01
2925.36	7	9	1.69E-01	3047.60	5	7	2.84E-01	3202.56	9	7	6.18E-02
2929.01	7	5	5.10E-02	3053.07	3	5	1.53E-01	3205.40	3	3	9.77E-01
2929.12	9	9	1.53E+00	3055.26	7	5	9.48E-02	3210.23	9	11	1.15E-01
2936.90	9	9	1.40E-01	3057.45	11	9	3.13E-01	3210.83	5	3	9.24E-01
2947.36	5	5	9.30E-02	3059.09	7	9	1.63E-01	3211.61	9	9	3.07E-02
2947.88	7	7	1.83E-01	3060.54	9	7	6.75E-02	3211.99	11	9	4.64E-01
2948.43	9	9	3.32E-01	3066.48	9	7	9.11E-02	3214.01	7	7	8.38E-01
2953.49	7	7	3.64E-01	3067.00	11	13	1.71E-01	3214.06	7	5	1.18E+00
2953.94	5	5	1.89E-01	3067.12	5	7	3.89E-02	3215.94	5	5	6.19E-01
2954.65	5	7	1.06E-01	3067.24	9	7	3.12E-01	3217.38	11	9	1.50E-01
2957.36	3	3	1.77E-01	3068.17	5	3	1.11E-01	3219.58	7	9	4.64E-01
2957.48	5	3	1.31E-01	3073.98	11	9	3.83E-02	3219.80	9	7	3.61E-01
2959.99	11	13	5.02E-01	3075.72	7	5	3.14E-01	3221.92	3	3	1.22E-01
2960.66	11	9	8.48E-02	3078.43	1	3	1.52E-01	3222.07	11	11	8.65E-01
2965.25	1	3	1.16E-01	3079.99	9	11	8.35E-02	3225.79	11	13	1.18E+00
2966.90	9	11	2.72E-01	3083.74	5	3	3.08E-01	3227.80	9	7	4.96E-01
2968.48	3	3	8.26E-02	3091.58	3	1	5.53E-01	3228.25	5	3	3.72E-01
2970.10	3	5	1.08E-01	3098.19	11	11	7.52E-02	3229.99	9	11	1.06E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3230.21	5	5	2.06E-01	3406.80	3	3	2.08E-01	3534.53	11	11	2.20E-02
3230.96	7	5	3.7E-01	3407.46	7	9	6.09E-01	3536.56	5	7	9.95E-01
3233.05	13	15	4.19E-01	3410.17	3	5	5.07E-01	3537.73	5	3	1.33E-01
3233.97	9	9	2.08E-01	3411.35	9	9	6.0E-02	3537.89	11	11	8.0E-02
3239.43	9	9	2.95E-01	3413.13	5	7	3.23E-01	3540.12	7	9	9.48E-02
3244.19	9	11	3.06E-01	3415.53	3	5	4.64E-02	3541.08	9	11	8.65E-01
3246.96	5	3	1.09E-01	3417.84	3	3	4.01E-01	3542.08	7	9	9.51E-01
3248.20	7	7	1.92E-01	3418.51	3	1	9.88E-01	3543.67	3	5	1.6E-01
3250.76	11	11	2.85E-02	3422.66	3	5	1.38E-01	3545.64	9	9	2.05E-01
3252.91	9	11	2.20E-02	3424.28	7	7	1.61E-01	3547.19	9	9	7.13E-02
3253.60	7	9	1.62E-01	3425.01	9	7	2.57E-01	3552.11	3	5	4.8E-02
3254.36	11	13	4.24E-01	3426.63	5	3	1.94E-01	3552.83	5	5	1.74E-01
3257.23	9	9	4.76E-02	3426.67	11	11	1.07E-01	3553.74	11	9	1.09E+00
3257.59	7	5	8.94E-02	3427.12	7	9	5.04E-01	3554.50	3	5	9.87E-02
3259.99	7	9	2.99E-02	3428.19	5	5	1.71E-01	3554.92	11	13	1.40E+00
3264.51	5	3	1.01E-01	3431.81	5	7	5.53E-02	3556.88	9	11	4.1E-01
3265.62	7	5	3.06E-01	3440.61	9	7	1.71E-01	3558.52	5	7	1.77E-01
3271.00	5	3	6.4E-01	3440.99	7	5	1.24E-01	3559.50	3	3	2.2E-01
3271.48	7	7	8.47E-02	3443.88	5	3	7.92E-02	3560.70	7	9	7.4E-02
3280.26	9	11	4.21E-01	3445.15	5	7	2.34E-01	3565.38	7	9	4.29E-01
3282.89	3	5	3.42E-01	3447.28	5	5	1.07E-01	3567.03	5	7	8.34E-02
3284.59	5	5	5.64E-02	3450.33	3	3	2.34E-01	3568.82	7	9	6.72E-02
3286.75	7	7	5.99E-01	3451.91	3	5	1.13E-01	3568.97	11	9	4.64E-02
3290.99	3	5	7.58E-02	3458.30	3	1	2.92E-01	3570.10	9	11	6.76E-01
3292.02	7	9	5.77E-01	3459.91	5	3	2.17E-01	3572.00	11	11	2.89E-01
3292.59	3	3	3.0E-01	3465.86	3	3	1.19E-01	3572.59	9	9	3.31E-02
3298.13	3	5	9.01E-02	3468.84	9	11	2.61E-02	3573.39	5	7	1.05E-01
3305.97	5	7	4.05E-01	3469.01	9	9	8.58E-02	3573.83	13	13	2.41E-02
3306.34	9	9	5.74E-01	3475.45	5	5	9.75E-02	3573.89	9	7	5.73E-01
3306.35	3	5	4.84E-01	3475.65	7	5	8.61E-02	3575.11	3	3	1.60E-01
3307.23	13	13	1.97E-01	3476.34	7	7	2.70E-01	3575.25	11	9	7.43E-02
3310.34	11	11	3.78E-02	3476.85	7	9	3.21E-02	3575.37	5	5	3.06E-01
3310.49	7	9	6.17E-02	3485.34	5	3	1.30E-01	3576.76	11	9	8.8E-02
3314.74	5	7	7.25E-01	3489.67	11	13	7.47E-02	3578.38	1	3	7.82E-02
3319.25	9	9	3.73E-02	3490.57	7	7	6.14E-02	3581.19	11	13	1.02E+00
3322.47	9	11	8.21E-02	3495.29	9	7	9.46E-02	3581.65	11	9	3.21E-02
3323.74	5	5	2.8E-01	3497.10	7	7	9.02E-02	3581.81	3	5	8.68E-02
3328.87	11	11	2.21E-01	3500.56	7	5	5.28E-02	3582.20	13	11	2.35E-01
3335.77	3	5	7.48E-02	3505.06	5	3	1.77E-01	3584.66	11	11	3.29E-01
3336.26	9	9	4.91E-02	3506.50	5	5	7.35E-02	3584.79	7	5	1.56E-01
3337.67	11	9	6.06E-02	3508.47	9	11	6.46E-02	3584.96	11	9	6.74E-01
3340.56	5	5	4.95E-02	3513.82	11	11	3.40E-02	3585.19	11	9	3.19E-02
3341.91	11	11	3.02E-02	3516.41	7	9	3.6E-02	3585.32	7	7	1.17E-01
3342.29	3	3	9.42E-02	3516.56	7	5	6.82E-02	3585.71	9	9	3.75E-02
3347.93	5	5	4.91E-02	3521.26	9	9	6.14E-02	3586.11	13	11	7.02E-01
3354.06	1	3	1.34E-01	3522.27	11	11	5.03E-02	3586.74	13	13	3.62E-02
3355.23	9	9	2.59E-01	3522.90	5	7	3.51E-02	3586.98	5	5	1.66E-01
3369.55	9	9	2.15E-01	3523.31	5	3	1.06E-01	3587.24	7	9	7.73E-02
3370.78	11	11	2.89E-01	3524.07	7	5	9.9E-02	3588.53	9	7	7.21E-02
3380.11	7	7	1.66E-01	3524.24	5	7	5.04E-02	3588.61	11	11	1.19E-01
3383.69	5	3	8.33E-02	3526.17	7	7	4.14E-02	3588.92	5	3	2.15E-01
3383.98	7	7	6.52E-02	3526.24	7	9	1.70E-01	3589.45	9	7	1.05E-01
3392.30	5	5	9.93E-02	3526.38	7	7	4.13E-01	3594.63	9	9	3.14E-01
3392.65	7	7	1.88E-01	3526.47	5	5	1.29E-01	3595.30	5	5	8.21E-02
3394.58	5	3	8.70E-02	3526.67	5	5	5.26E-01	3597.02	5	3	1.8E-01
3399.33	5	5	2.76E-01	3527.79	9	9	2.17E-01	3599.63	11	9	2.33E-01
3402.26	13	13	2.19E-01	3529.82	3	3	7.75E-01	3602.46	7	7	1.02E-01
3403.29	5	7	3.98E-02	3530.39	13	13	4.65E-02	3602.53	7	5	2.12E-01
3404.35	5	7	1.09E-01	3533.01	1	3	8.52E-01	3603.20	11	11	2.59E-01
3406.44	3	5	2.7E-01	3533.20	3	5	8.25E-01	3603.82	3	3	1.70E-01

$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3605.45	9	9	4.66E-01	3689.46	9	9	3.70E-01	3781.94	5	7	3.8E-02
3605.50	13	11	2.12E-01	3690.45	1	3	1.22E-01	3785.95	11	13	4.14E-02
3606.68	11	13	8.29E-01	3690.73	11	11	2.99E-01	3786.19	5	5	1.3E-01
3608.14	9	11	6.22E-02	3694.01	5	7	8.35E-01	3787.16	5	5	9.9E-02
3608.86	3	5	8.13E-01	3695.05	7	9	2.01E-01	3787.88	3	5	1.29E-01
3610.16	13	13	5.90E-01	3697.43	7	7	1.94E-01	3789.18	9	11	2.16E-02
3610.69	5	3	1.05E-01	3698.60	5	7	3.6E-02	3789.82	9	7	4.1E-02
3612.07	11	13	1.11E-01	3699.14	5	7	4.9E-02	3793.48	7	7	7.92E-02
3613.44	7	7	7.0E-02	3701.09	7	9	6.35E-01	3794.34	9	11	4.15E-02
3617.79	5	7	7.09E-01	3702.03	3	1	3.7E-01	3795.00	5	7	1.15E-01
3618.30	11	9	4.89E-02	3703.55	7	7	3.84E-02	3797.51	13	13	4.57E-01
3618.39	9	9	8.88E-02	3703.69	9	11	6.31E-02	3798.51	9	11	3.23E-02
3618.77	5	7	7.22E-01	3703.82	1	3	1.02E-01	3799.55	7	9	7.31E-02
3621.46	9	11	4.45E-01	3704.46	11	9	1.42E-01	3801.68	5	7	6.26E-02
3621.72	11	9	1.07E-01	3707.92	7	5	3.32E-01	3801.98	11	13	3.7E-02
3622.00	7	7	5.14E-01	3709.25	9	7	1.56E-01	3802.28	5	5	5.63E-02
3623.19	13	13	6.68E-02	3711.22	7	9	3.62E-02	3804.01	11	9	4.6E-02
3625.14	11	9	8.15E-02	3711.41	3	5	1.28E-01	3805.34	9	11	8.60E-01
3630.35	9	7	1.04E-01	3716.44	9	7	3.49E-01	3806.22	3	3	2.5E-01
3631.10	11	11	2.15E-01	3718.41	7	7	5.17E-02	3806.70	11	11	4.35E-01
3631.46	7	9	5.17E-01	3719.93	9	11	1.62E-01	3807.54	3	5	9.37E-02
3632.04	3	5	6.74E-01	3721.50	5	5	1.94E-01	3808.73	9	9	3.54E-02
3632.56	11	9	5.69E-02	3722.56	5	5	4.97E-02	3810.76	5	3	1.94E-01
3633.07	9	11	3.54E-02	3724.38	5	7	1.04E-01	3812.96	7	5	7.91E-02
3634.33	9	7	1.05E-01	3726.93	5	5	4.57E-01	3813.06	7	7	5.52E-02
3636.22	5	7	2.20E-01	3727.09	9	7	1.71E-01	3813.88	13	11	6.62E-02
3637.87	9	9	5.9E-02	3727.62	7	5	2.24E-01	3815.84	9	7	1.12E+00
3638.30	7	9	2.36E-01	3727.81	7	5	1.91E-01	3816.34	5	7	4.16E-02
3640.39	9	11	3.57E-01	3730.39	9	11	9.73E-02	3817.64	11	11	7.7E-02
3644.80	7	5	8.3E-02	3730.46	7	9	3.09E-02	3819.49	7	5	4.9E-02
3645.07	9	9	2.91E-02	3730.95	5	7	3.50E-02	3820.43	11	9	6.67E-01
3645.82	1	3	4.87E-01	3732.40	5	5	2.69E-01	3821.18	11	13	5.54E-01
3647.42	3	3	3.38E-01	3734.86	11	11	9.01E-01	3821.83	5	5	7.30E-02
3647.84	9	11	2.91E-01	3735.32	9	9	2.70E-01	3825.88	9	7	5.97E-01
3649.51	11	9	3.94E-01	3737.13	7	9	1.41E-01	3827.82	7	5	1.05E+00
3650.03	7	7	2.26E-01	3738.31	11	13	3.44E-01	3829.45	3	3	1.32E-01
3650.28	11	11	6.15E-02	3740.24	7	9	1.3E-01	3833.31	9	9	4.68E-02
3651.47	7	9	5.83E-01	3742.62	9	9	6.75E-02	3834.22	7	5	4.52E-01
3655.46	5	5	1.18E-01	3743.36	5	3	2.60E-01	3836.33	5	5	3.29E-01
3659.52	9	9	6.31E-02	3743.47	11	11	6.05E-01	3839.26	9	9	2.35E-01
3664.54	7	9	4.68E-02	3744.10	5	3	3.17E-01	3840.44	5	3	4.70E-01
3666.24	11	9	3.87E-02	3745.56	5	7	1.15E-01	3841.05	5	3	1.36E+00
3667.25	9	7	1.3E-01	3746.93	7	7	2.33E-01	3843.26	9	7	3.70E-01
3668.21	7	9	3.2E-02	3748.26	3	5	9.15E-02	3845.70	5	7	5.89E-02
3669.15	9	7	8.03E-02	3748.96	9	11	1.48E-01	3845.99	9	7	4.5E-02
3669.52	9	7	2.34E-01	3749.49	9	9	7.63E-01	3846.41	11	9	1.68E-01
3670.02	3	5	8.60E-02	3753.61	7	5	1.22E-01	3846.80	7	7	6.20E-01
3670.09	11	13	7.20E-02	3756.94	11	11	2.2E-01	3849.97	3	1	6.05E-01
3674.76	5	3	7.91E-02	3757.45	5	3	8.26E-02	3852.57	7	9	3.26E-02
3676.31	9	11	4.63E-02	3758.23	7	7	6.34E-01	3854.37	9	7	5.07E-02
3677.31	5	7	2.28E-01	3759.15	13	11	4.55E-02	3856.37	7	5	4.64E-02
3677.63	7	5	6.08E-01	3760.05	13	15	4.47E-02	3859.21	13	11	7.25E-02
3682.17	7	5	1.04E-01	3760.53	3	5	5.50E-02	3859.91	9	9	9.69E-02
3682.24	5	5	1.5E+00	3762.20	9	11	2.4E-02	3865.52	3	3	1.55E-01
3684.11	9	7	2.97E-01	3763.79	5	5	5.44E-01	3867.22	5	5	3.16E-01
3684.14	9	7	9.29E-02	3765.54	13	15	9.51E-01	3871.75	11	11	5.83E-02
3686.00	9	11	3.34E-01	3765.70	11	11	2.36E-02	3872.50	5	5	1.05E-01
3687.46	11	9	8.00E-02	3767.19	3	3	6.39E-01	3873.76	11	9	6.57E-02
3687.66	9	9	7.38E-02	3778.51	7	5	1.17E-01	3878.02	7	7	7.72E-02
3688.46	7	9	7.3E-02	3779.45	3	3	1.05E-01	3878.67	9	7	7.02E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3878.73	3	3	5.34E-01	3997.39	9	11	1.26E-01	4175.64	3	5	1.14E-01
3883.28	7	7	1.28E-01	3998.05	11	9	5.70E-02	4181.75	5	7	2.32E-01
3884.36	11	9	3.99E-02	4005.24	7	5	2.04E-01	4182.38	5	5	5.04E-02
3885.51	3	5	7.26E-02	4006.31	11	9	5.1E-02	4184.89	5	5	1.03E-01
3886.28	7	7	5.29E-02	4009.71	3	5	4.64E-02	4187.04	7	5	2.15E-01
3887.05	9	9	3.52E-02	4014.53	9	7	1.53E-01	4187.80	9	7	1.52E-01
3888.51	5	5	2.50E-01	4017.15	9	11	3.25E-02	4191.43	5	3	2.73E-01
3888.82	5	3	1.95E-01	4018.27	5	7	3.44E-02	4195.33	11	11	1.11E-01
3891.93	3	3	2.71E-01	4021.87	7	9	8.55E-02	4196.21	7	7	1.09E-01
3893.39	11	11	1.00E-01	4024.73	7	9	8.09E-02	4198.25	9	9	1.47E-01
3894.01	5	5	1.03E-01	4030.49	9	11	1.04E-01	4198.30	11	9	8.03E-02
3897.89	11	13	6.20E-02	4030.89	9	7	5.02E-02	4198.63	5	5	1.25E-01
3900.52	7	7	7.9E-02	4031.96	3	5	7.6E-02	4199.10	9	11	4.92E-01
3902.95	7	7	2.14E-01	4040.64	5	7	4.8E-02	4200.92	7	9	6.25E-02
3903.90	9	9	7.61E-02	4043.90	7	7	8.69E-02	4202.03	9	9	8.22E-02
3906.75	5	7	7.05E-02	4044.61	5	3	8.17E-02	4203.94	13	13	2.97E-02
3907.93	7	5	6.67E-02	4045.59	9	7	7.39E-02	4203.98	3	5	7.37E-02
3909.66	3	5	5.7E-02	4045.81	9	9	8.62E-01	4210.34	3	3	1.48E-01
3911.00	9	9	2.68E-02	4054.87	5	3	9.61E-02	4217.55	3	5	2.46E-01
3916.73	13	11	9.83E-02	4058.22	9	7	4.47E-02	4219.36	11	13	2.88E-01
3918.42	3	1	4.22E-01	4062.44	3	3	1.85E-01	4222.21	7	7	5.76E-02
3918.64	7	7	1.17E-01	4063.59	7	7	6.65E-01	4224.17	9	11	1.06E-01
3919.07	9	9	3.72E-02	4067.98	9	9	1.51E-01	4224.51	3	5	6.81E-02
3925.64	5	5	8.04E-02	4070.77	7	5	1.1E-01	4225.45	5	7	1.65E-01
3925.94	1	3	1.67E-01	4071.74	5	5	7.64E-01	4227.43	11	13	5.29E-01
3926.01	7	7	7.26E-02	4073.76	5	3	1.68E-01	4233.60	3	5	1.85E-01
3928.08	9	9	5.64E-02	4074.79	9	9	3.43E-02	4235.94	9	9	1.88E-01
3931.12	5	7	4.8E-02	4076.63	9	9	1.32E-01	4238.81	7	9	2.41E-01
3932.63	9	11	2.70E-02	4076.80	5	7	3.81E-02	4245.26	1	3	9.0E-02
3933.60	3	5	5.92E-02	4079.17	5	5	5.4E-02	4246.09	7	5	5.85E-02
3935.81	5	5	1.14E-01	4080.21	3	1	2.3E-01	4247.43	9	11	1.94E-01
3941.28	5	5	9.1E-02	4084.49	11	9	8.66E-02	4250.12	5	7	2.07E-01
3942.44	3	5	9.62E-02	4085.00	3	5	4.7E-02	4250.79	7	7	1.02E-01
3946.99	9	11	3.91E-02	4085.30	7	7	8.92E-02	4260.47	11	11	3.99E-01
3947.53	5	5	5.12E-02	4085.98	7	5	5.1E-02	4267.83	1	3	8.17E-02
3948.10	7	9	1.31E-01	4098.18	7	7	7.49E-02	4271.15	7	9	1.82E-01
3948.77	11	9	2.08E-01	4107.49	5	3	1.74E-01	4271.76	9	11	2.28E-01
3949.95	7	5	4.79E-02	4109.80	3	3	1.51E-01	4276.68	9	9	2.6E-02
3951.16	3	5	4.29E-01	4112.96	11	13	1.1E-01	4282.40	7	5	1.21E-01
3952.60	11	11	2.97E-02	4118.55	11	13	4.96E-01	4294.12	9	9	3.12E-02
3953.15	7	9	2.97E-02	4125.62	9	11	9.9E-02	4299.23	9	11	1.29E-01
3955.34	3	3	1.5E-01	4126.18	11	11	4.2E-02	4307.90	7	9	3.38E-01
3956.46	13	11	1.76E-01	4127.61	1	3	1.43E-01	4309.03	13	13	1.96E-02
3956.68	11	13	1.22E-01	4132.06	5	7	1.18E-01	4315.08	5	5	7.76E-02
3957.02	5	7	1.67E-01	4132.90	3	5	7.70E-02	4325.76	5	7	5.16E-01
3960.28	5	7	4.10E-02	4134.68	5	7	1.25E-01	4327.10	5	5	1.12E-01
3963.10	3	5	1.5E-01	4137.00	3	5	2.75E-01	4369.77	9	9	6.09E-02
3967.42	9	7	1.52E-01	4142.59	3	5	7.5E-02	4383.55	9	11	5.00E-01
3967.96	7	9	6.09E-02	4143.41	9	9	2.70E-01	4388.41	7	7	1.03E-01
3969.26	9	7	2.26E-01	4143.87	7	9	1.33E-01	4401.29	7	7	6.4E-02
3970.39	3	1	3.9E-01	4149.37	11	13	4.23E-02	4404.75	7	9	2.75E-01
3971.32	11	9	4.97E-02	4153.90	7	9	2.05E-01	4415.12	5	7	1.19E-01
3973.65	5	7	5.81E-02	4154.50	5	3	2.64E-01	4422.57	3	3	8.72E-02
3976.61	3	5	1.20E-01	4154.81	9	11	1.40E-01	4433.22	5	3	2.1E-01
3977.74	5	5	6.41E-02	4156.80	5	5	1.20E-01	4443.19	1	3	1.02E-01
3981.77	9	9	3.57E-02	4157.78	5	7	2.18E-01	4455.03	9	7	4.1E-02
3983.96	9	7	5.72E-02	4158.79	3	5	1.6E-01	4466.55	5	7	1.20E-01
3985.39	5	5	8.53E-02	4170.90	5	5	6.29E-02	4469.38	5	7	1.59E-01
3989.86	5	7	5.3E-02	4172.12	7	5	9.80E-02	4476.02	3	5	1.01E-01
3996.96	9	9	7.95E-02	4172.64	11	11	2.24E-02	4484.22	7	9	5.04E-02



$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
4485.68	3	3	1.1E-01	5364.87	5	7	5.59E-01	22473.28	11	11	3.32E-02
4494.56	5	7	3.45E-02	5367.47	7	9	7.13E-01	23566.67	9	11	2.21E-02
4528.61	7	9	5.44E-02	5369.96	9	11	7.22E-01	24547.95	11	9	3.72E-02
4547.85	5	7	4.48E-02	5373.71	7	9	3.7E-02	24729.10	13	11	5.08E-02
4556.13	7	5	1.05E-01	5383.37	11	13	7.81E-01				
4619.29	7	5	5.2E-02	5393.17	7	9	4.91E-02	<i>Fe II</i>			
4638.01	7	7	3.37E-02	5398.28	5	5	9.0E-02	1055.26	10	8	4.6E-01
4654.61	7	7	3.68E-02	5404.15	9	11	6.92E-01	1063.97	10	8	3.5E-01
4667.45	7	9	6.03E-02	5410.91	7	9	6.33E-01	1068.35	8	8	1.59E+00
4673.16	5	7	3.81E-02	5415.20	11	13	7.67E-01	1071.58	6	8	1.14E+00
4678.85	7	9	4.97E-02	5463.28	9	9	2.9E-01	1096.88	10	8	2.26E+00
4736.77	9	11	4.78E-02	5473.90	7	7	5.2E-02	1112.05	10	12	2.0E-01
4789.65	5	7	4.57E-02	5476.29	7	9	2.87E-02	1121.97	10	8	1.92E+00
4800.65	7	9	3.01E-02	5476.56	9	9	8.70E-02	1122.84	8	6	1.81E+00
4859.74	5	3	1.62E-01	5563.60	5	7	3.4E-02	1125.45	10	8	1.03E+00
4871.32	7	5	2.44E-01	5569.62	5	3	2.34E-01	1127.10	10	10	5.9E-02
4872.14	3	3	2.54E-01	5572.84	7	5	2.28E-01	1128.05	2	4	1.40E+00
4878.21	1	3	1.21E-01	5576.09	3	1	2.5E-01	1130.44	6	8	3.1E-01
4890.76	5	5	2.25E-01	5586.76	9	7	2.19E-01	1133.40	8	10	2.6E-01
4891.49	9	7	3.08E-01	5594.66	9	9	5.20E-02	1133.67	10	8	3.1E-01
4903.31	3	5	6.58E-02	5602.95	3	3	1.00E-01	1138.63	8	8	5.5E-01
4918.99	7	7	1.79E-01	5615.64	11	9	2.64E-01	1142.37	10	8	2.6E-01
4920.50	11	9	3.58E-01	5624.54	5	5	7.41E-02	1143.23	10	10	9.8E-01
4957.30	9	9	1.18E-01	5633.95	11	13	7.7E-02	1144.94	10	12	3.52E+00
4957.60	13	11	4.22E-01	5638.26	9	7	4.4E-02	1147.41	8	8	1.24E+00
4966.09	11	11	3.31E-02	5649.99	3	5	5.1E-02	1148.28	8	10	3.35E+00
4973.10	3	3	1.1E-01	5655.18	7	9	4.7E-02	1151.15	6	8	2.23E+00
4978.60	5	3	1.19E-01	5658.82	7	7	4.34E-02	1267.42	8	6	9.3E-01
4985.25	5	5	1.48E-01	5662.52	11	9	6.18E-02	1272.61	6	4	3.3E-01
4988.95	7	7	5.2E-02	5679.02	5	7	3.7E-02	1272.65	6	4	2.2E-01
5001.86	9	7	3.7E-01	5686.53	9	11	6.71E-02	1371.02	14	12	1.74E+00
5006.12	11	11	5.87E-02	5705.99	7	9	6.1E-02	1563.79	8	8	1.33E+00
5014.94	7	5	2.64E-01	5753.12	3	5	8.26E-02	1580.63	8	10	5.8E-01
5021.59	7	9	6.18E-02	5762.99	5	7	9.6E-02	1588.69	10	8	4.9E-03
5022.24	5	3	2.4E-01	5816.37	9	11	4.49E-02	1608.45	10	8	1.91E+00
5048.44	3	5	4.88E-02	5905.67	5	3	1.1E-01	1608.54	10	8	2.1E-02
5068.77	9	7	3.37E-02	6301.50	5	5	6.43E-02	1610.92	10	10	1.94E-01
5074.75	9	11	1.4E-01	6400.00	7	9	9.27E-02	1611.20	10	8	4.40E-02
5090.77	7	5	1.9E-01	6411.65	5	7	4.43E-02	1618.47	8	8	5.53E-01
5121.64	5	5	7.9E-02	6419.95	7	7	1.2E-01	1621.25	8	8	1.3E-02
5137.38	11	9	1.0E-01	6469.19	3	3	8.3E-02	1621.69	8	6	1.32E+00
5139.25	7	5	9.16E-02	6496.47	5	5	7.8E-02	1623.09	8	8	1.99E-01
5139.46	9	9	8.69E-02	6569.22	7	9	6.0E-02	1625.52	8	10	4.04E-01
5184.27	5	7	3.8E-02	6633.75	7	7	3.44E-02	1625.91	6	8	1.02E-01
5191.46	5	3	2.32E-01	6841.34	5	7	3.4E-02	1629.16	6	6	8.66E-01
5192.34	7	7	1.34E-01	6855.16	7	9	2.86E-02	1631.13	6	4	6.93E-01
5208.59	7	5	6.23E-02	7187.32	9	11	8.36E-02	1633.91	6	8	3.85E-01
5215.18	5	3	1.10E-01	7511.02	11	11	1.35E-01	1634.35	4	6	3.21E-01
5226.86	5	5	1.36E-01	8220.38	13	11	1.69E-01	1635.40	8	6	2.28E+00
5232.94	9	11	1.94E-01	8699.45	7	9	4.08E-02	1636.33	4	4	9.63E-01
5235.39	9	7	3.75E-02	9012.07	11	9	4.46E-02	1637.40	10	8	3.57E-01
5242.49	13	11	2.38E-02	9401.11	9	11	2.64E-02	1639.40	2	4	6.85E-01
5263.31	5	5	6.36E-02	9414.04	7	9	3.98E-02	1641.76	6	4	1.76E+00
5266.56	7	9	1.10E-01	9443.80	5	7	6.39E-02	1647.16	6	6	4.98E-01
5273.16	1	3	8.12E-02	9569.91	11	11	2.50E-02	1661.32	10	8	1.2E-02
5281.79	5	7	5.00E-02	9626.50	9	9	4.51E-02	1663.70	6	8	9.9E-03
5283.62	7	7	1.02E-01	9738.57	11	13	7.64E-02	1670.75	10	8	1.06E+00
5302.30	3	5	9.04E-02	9763.38	3	5	5.42E-02	1676.86	8	8	6.75E-02
5324.18	9	9	2.06E-01	9861.74	7	9	5.49E-02	1688.40	6	8	2.53E-02
5339.93	5	7	6.36E-02	9889.04	9	11	2.22E-02	1702.04	10	12	1.02E+00

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
1761.37	8	8	1.42E+00	2352.31	2	4	4.38E+00	2412.01	6	8	1.66E-01
1785.27	6	8	1.2E+01	2353.47	12	14	4.98E+00	2413.31	2	4	1.02E+00
1786.75	6	6	1.2E+01	2353.68	8	8	1.30E+00	2414.10	14	12	1.05E-02
1788.08	6	4	4.6E+00	2354.48	10	8	8.13E-01	2414.51	10	8	4.2E-03
1796.98	6	8	3.0E-03	2354.89	6	4	2.67E-01	2416.45	8	10	2.38E+00
1818.52	8	8	5.70E-02	2356.21	6	8	7.1E-03	2417.87	12	12	9.5E-01
1833.08	6	8	2.2E-02	2359.11	4	6	5.0E-01	2418.17	6	8	2.0E-02
1863.11	6	8	2.4E-03	2359.60	10	10	2.25E-01	2418.44	6	8	2.28E+00
2020.75	6	8	1.83E-01	2360.00	10	10	3.59E-01	2419.89	10	10	2.2E-02
2057.33	6	8	2.80E-02	2360.29	8	6	6.23E-01	2422.69	6	8	1.46E+00
2074.19	10	8	2.30E-02	2360.53	6	8	2.22E-01	2422.93	10	8	2.94E-02
2078.16	10	10	2.84E-02	2361.73	8	8	2.40E-01	2423.21	4	6	1.40E+00
2097.02	8	8	1.07E-02	2362.02	8	8	1.41E-01	2424.15	10	12	2.21E+00
2122.45	10	8	4.8E-03	2363.86	8	10	5.3E+00	2424.39	6	8	1.61E-01
2146.37	8	8	7.1E-03	2364.83	8	8	5.90E-01	2424.50	8	8	2.9E-03
2162.02	10	10	2.54E-01	2365.76	6	6	2.16E+00	2424.59	6	6	1.24E+00
2182.36	10	8	8.6E-02	2366.59	6	6	1.01E-01	2424.65	8	8	6.55E-02
2187.68	8	8	2.87E-02	2366.88	8	10	3.51E-02	2428.08	12	10	7.0E-03
2189.03	10	10	1.97E-02	2368.60	6	4	6.06E-01	2428.36	8	10	2.68E+00
2191.98	8	8	7.54E-01	2369.95	10	12	5.9E+00	2428.80	4	4	1.38E+00
2201.59	6	8	7.77E-01	2370.50	4	4	1.73E-01	2429.04	2	4	1.23E+00
2208.41	10	10	1.59E+00	2372.36	10	8	6.6E-03	2429.39	4	4	6.9E-01
2209.03	10	8	1.27E+00	2373.74	10	10	4.25E-01	2429.86	8	8	1.51E+00
2213.66	14	14	3.26E-01	2375.19	4	2	9.81E-01	2430.08	8	10	1.91E+00
2218.26	8	10	1.57E+00	2376.43	12	14	6.4E+00	2432.26	6	8	1.57E+00
2220.38	12	12	4.19E-01	2378.55	8	8	1.70E-01	2432.87	14	14	2.86E+00
2228.73	6	8	1.59E+00	2378.70	8	8	1.49E-01	2433.50	10	12	1.30E-01
2249.18	10	8	3.00E-02	2379.28	8	8	2.73E-01	2434.06	8	6	7.2E-01
2250.18	4	4	1.67E-02	2379.42	10	10	3.68E-01	2434.24	8	10	2.01E+00
2250.94	6	6	3.19E-02	2380.76	6	8	3.10E-01	2434.73	12	12	2.79E+00
2251.56	8	6	9.8E-03	2382.04	10	12	3.13E+00	2434.95	4	6	1.39E+00
2253.13	8	8	4.41E-02	2382.36	4	6	3.19E-02	2435.00	8	8	2.02E+00
2254.41	4	2	5.5E-03	2382.90	12	14	1.62E-01	2436.62	6	8	2.70E+00
2255.77	6	4	4.75E-01	2383.06	8	6	1.0E-01	2439.30	12	14	2.25E+00
2260.08	10	10	3.18E-02	2383.24	6	6	3.59E-01	2440.42	6	8	1.18E+00
2260.24	2	2	3.4E-02	2384.39	4	4	3.22E-01	2441.13	10	10	8.95E-01
2260.86	4	6	2.16E-02	2385.01	6	8	3.60E-02	2442.38	10	12	2.75E+00
2262.69	4	4	1.98E-02	2388.39	10	12	2.02E-01	2443.71	8	10	1.44E+00
2266.00	6	6	1.0E-02	2388.63	8	8	1.05E+00	2444.52	6	8	2.78E+00
2267.59	6	8	3.69E-02	2390.10	14	16	5.5E+00	2445.11	12	12	2.03E+00
2268.56	2	4	6.0E-03	2390.76	6	6	1.17E+00	2445.57	4	6	2.07E+00
2268.82	8	8	3.97E-03	2391.48	8	10	3.77E-02	2445.80	4	6	1.23E+00
2279.92	8	10	4.49E-02	2394.00	12	10	9.4E-02	2446.11	8	8	1.06E+00
2292.42	12	10	8.42E-03	2395.42	6	4	2.67E-01	2446.47	12	14	2.99E-01
2296.88	6	8	1.82E-02	2395.63	8	10	2.59E+00	2447.21	6	6	1.15E+00
2312.22	10	8	9.3E-03	2396.72	10	12	2.15E-01	2447.33	4	2	2.56E+00
2327.40	6	4	6.55E-01	2399.24	6	6	1.39E+00	2447.76	12	10	1.97E+00
2327.88	10	12	1.08E+00	2400.05	12	14	4.57E+00	2449.96	4	4	1.24E+00
2331.31	10	8	3.17E-01	2401.29	6	8	1.89E+00	2450.21	2	4	1.26E+00
2332.80	8	6	1.31E+00	2402.45	10	10	5.8E-01	2453.98	8	10	1.31E+00
2338.01	4	4	1.13E+00	2402.60	6	8	2.17E-02	2454.58	14	12	1.16E+00
2338.54	10	12	5.6E-02	2402.63	8	8	8.19E-01	2455.71	8	8	1.01E+00
2343.50	10	8	1.73E+00	2404.43	4	2	6.44E-01	2455.90	4	6	1.73E+00
2343.96	8	6	3.13E-01	2404.89	6	8	1.96E+00	2457.10	6	4	4.71E-01
2344.28	2	4	9.27E-01	2406.09	6	8	2.05E-02	2458.78	10	12	2.31E+00
2345.34	14	12	7.3E-01	2406.66	4	4	1.61E+00	2458.97	6	4	2.51E+00
2348.12	10	8	6.50E-01	2410.27	8	8	7.65E-01	2460.44	10	12	5.39E+00
2348.30	6	6	1.15E+00	2410.52	4	6	1.55E+00	2461.28	6	8	2.34E+00
2351.20	12	10	7.19E-01	2411.07	2	2	2.37E+00	2461.86	8	10	2.43E+00
2351.67	6	6	1.80E+00	2411.81	10	12	4.33E+00	2463.28	12	10	7.1E-01



$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2464.01	10	8	1.32E+00	2525.92	8	8	7.4E-01	2559.93	6	8	2.47E-01
2464.91	6	4	2.22E+00	2526.08	10	8	3.52E-01	2560.28	4	4	1.77E+00
2465.91	8	6	1.62E+00	2526.29	6	6	2.47E+00	2561.59	10	10	1.1E-02
2466.50	2	4	2.40E+00	2527.10	12	10	3.67E-01	2562.09	4	2	1.62E+00
2466.67	4	2	2.64E+00	2527.71	10	8	9.1E-01	2562.54	8	6	1.79E+00
2466.82	6	4	1.77E+00	2528.68	10	8	2.3E-02	2563.48	6	4	1.51E+00
2468.30	10	10	9.8E-02	2529.08	4	6	1.80E+00	2566.22	8	10	2.61E+00
2469.37	10	8	2.23E-02	2529.23	12	10	3.27E-01	2566.40	8	6	2.29E+00
2469.52	8	6	2.58E+00	2529.55	10	10	2.20E+00	2566.62	10	12	7.1E-02
2470.41	6	6	6.0E-01	2530.10	4	6	6.6E-01	2566.91	4	2	1.15E+00
2470.67	8	6	1.54E+00	2533.63	12	12	1.92E+00	2568.41	2	4	4.77E-01
2470.85	8	8	5.4E-03	2534.42	8	8	1.83E+00	2568.89	8	8	2.8E-02
2471.28	10	8	4.15E-01	2535.36	6	4	2.46E+00	2569.78	2	4	1.11E+00
2472.61	8	10	3.22E+00	2535.49	10	8	7.47E-01	2570.55	6	8	1.1E-03
2473.32	2	2	2.74E+00	2536.67	12	12	5.7E-01	2570.85	8	6	1.84E+00
2475.12	4	6	3.72E+00	2536.81	10	10	1.69E+00	2571.55	10	10	2.89E-02
2475.54	6	8	3.18E+00	2536.84	12	14	6.8E-01	2572.97	6	8	7.89E-02
2476.27	8	10	9.7E-02	2537.14	10	10	1.44E+00	2573.21	8	10	1.42E-01
2477.35	8	8	1.70E-01	2538.21	14	12	1.26E+00	2573.76	8	8	2.3E-02
2478.57	6	6	9.1E-01	2538.40	6	8	3.7E-02	2574.37	6	4	2.43E+00
2480.16	10	8	1.55E+00	2538.50	8	6	5.9E-01	2576.86	10	12	1.32E+00
2481.05	12	12	1.46E-01	2538.68	6	8	7.4E-01	2577.43	6	8	7.8E-03
2482.12	14	14	6.5E-01	2538.91	10	8	1.28E+00	2577.92	2	2	1.24E+00
2482.33	4	4	2.23E+00	2538.99	14	12	1.93E+00	2580.72	8	6	2.2E-02
2482.66	12	10	1.25E+00	2539.81	8	8	5.6E-02	2581.11	6	6	7.61E-02
2482.87	6	4	1.69E+00	2540.52	2	2	1.26E+00	2582.41	6	8	2.22E-01
2483.72	8	10	5.4E-01	2540.66	6	8	1.70E+00	2582.58	4	4	8.80E-01
2484.24	4	6	8.3E-02	2541.10	8	6	9.6E-01	2583.05	8	10	2.16E-02
2484.44	8	8	2.16E+00	2541.84	8	6	8.2E-01	2583.35	8	10	9.0E-03
2489.11	4	4	2.6E-02	2542.32	4	2	3.9E-03	2585.62	10	10	3.09E-01
2489.48	12	12	5.1E-01	2542.74	2	2	1.61E+00	2585.88	10	8	8.94E-01
2489.83	12	12	1.94E+00	2543.38	10	12	6.7E-01	2586.06	6	4	5.8E-02
2490.71	10	12	1.44E+00	2543.43	6	4	8.3E-01	2587.95	8	10	1.69E+00
2490.86	8	8	8.8E-01	2544.97	4	6	3.93E-01	2588.19	2	2	1.5E-01
2491.40	10	8	1.01E+00	2545.22	8	10	5.3E-01	2588.80	8	8	8.4E-02
2492.34	10	12	2.30E-01	2545.44	8	10	1.52E-01	2590.55	4	6	7.9E-02
2493.26	14	16	3.04E+00	2545.53	8	10	1.2E-02	2591.54	6	6	5.72E-01
2493.88	6	6	1.74E+00	2546.67	8	8	7.98E-01	2592.79	14	16	2.74E+00
2494.12	12	10	2.97E-02	2547.34	8	8	2.28E-01	2593.73	2	4	1.63E-01
2497.68	10	12	8.4E-03	2548.16	6	8	8.0E-03	2594.96	8	8	1.0E-01
2497.82	6	6	1.68E+00	2548.32	4	6	2.69E-01	2595.28	12	10	1.67E-03
2500.92	6	8	2.41E+00	2548.59	10	10	2.67E-01	2595.30	10	8	1.2E-02
2501.35	2	2	1.48E+00	2548.74	4	2	2.43E+00	2598.37	8	6	1.43E+00
2502.39	8	8	1.43E+00	2548.92	12	10	6.0E-01	2599.40	10	10	2.35E+00
2503.33	12	12	7.3E-01	2549.08	10	8	1.89E+00	2604.05	8	8	1.49E-01
2503.54	8	8	3.32E-01	2549.40	4	4	1.65E+00	2604.67	8	10	1.2E-02
2503.57	10	10	2.53E-01	2549.46	6	6	1.12E+00	2605.04	6	8	2.34E+00
2503.88	10	10	2.23E+00	2549.77	8	6	2.35E-01	2605.31	4	4	1.99E+00
2506.09	10	10	9.9E-01	2550.03	10	10	1.74E+00	2605.43	6	6	3.40E-01
2506.80	8	10	1.98E+00	2550.15	8	10	3.91E-01	2605.90	4	2	1.27E+00
2508.34	8	10	3.79E-01	2550.57	12	12	1.6E-02	2606.52	6	6	2.31E+00
2510.57	8	8	1.54E-01	2550.68	12	12	1.07E+00	2607.09	6	4	1.73E+00
2511.76	8	10	2.30E+00	2551.20	10	8	2.48E-01	2608.85	10	8	5.0E-02
2513.15	10	8	2.49E-01	2554.94	8	8	2.6E-02	2609.13	8	10	2.77E-01
2514.38	8	8	2.11E+00	2555.07	6	8	1.96E-01	2609.44	6	8	6.0E-02
2517.14	2	4	9.2E-01	2555.45	4	6	2.49E-01	2609.87	8	8	1.34E-01
2519.05	8	6	2.10E+00	2557.08	8	10	2.8E-02	2611.07	4	6	7.28E-02
2521.09	6	4	2.05E+00	2557.51	10	8	1.53E-01	2611.34	8	6	1.4E-02
2521.82	8	8	2.36E+00	2559.24	8	8	6.4E-02	2611.87	8	8	1.20E+00
2525.39	14	14	1.91E+00	2559.77	6	8	2.42E-01	2613.57	10	12	2.0E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2613.82	4	2	2.12E+00	2699.20	4	4	6.2E-01	2770.50	12	10	4.08E-02
2614.19	8	10	3.3E-02	2703.99	8	8	1.38E+00	2771.19	10	12	4.3E-02
2614.59	10	8	3.37E-02	2704.58	8	8	1.66E-02	2771.56	6	4	1.9E-02
2614.87	8	6	3.5E-02	2707.13	4	6	8.3E-01	2772.73	6	8	1.1E-03
2617.62	6	6	4.88E-01	2709.06	4	6	3.88E-01	2774.69	2	4	2.73E-01
2619.08	10	10	2.48E-01	2709.38	6	4	2.78E-03	2775.34	6	6	1.5E-04
2620.17	6	6	1.1E-01	2709.99	6	8	8.7E-03	2776.18	6	8	2.66E-02
2620.41	4	4	4.30E-02	2711.84	12	14	4.36E-01	2776.91	8	8	4.08E-01
2620.70	8	8	3.43E-01	2712.39	10	12	1.29E-01	2779.30	10	8	1.00E+00
2621.67	2	2	5.60E-01	2714.41	8	6	5.70E-01	2779.91	2	4	2.56E-01
2623.13	14	14	8.8E-02	2716.22	6	6	1.15E+00	2780.05	2	2	3.3E-01
2623.72	6	6	1.92E-01	2716.44	6	6	2.8E-02	2783.69	12	10	1.06E+00
2625.49	12	14	2.55E+00	2716.57	14	12	1.35E+00	2784.28	2	4	3.4E-02
2625.67	8	10	3.52E-01	2716.70	8	8	1.02E-03	2785.19	12	10	1.53E+00
2626.50	4	6	3.48E-01	2717.88	16	14	1.51E+00	2787.24	8	6	1.83E-01
2626.70	8	8	1.94E-02	2718.64	10	8	1.18E+00	2790.56	8	10	2.1E-02
2628.29	2	4	8.74E-01	2719.30	6	8	4.44E-01	2793.89	10	12	1.26E-01
2628.58	6	6	3.4E-02	2721.81	12	10	5.1E-02	2796.63	10	10	2.0E-01
2629.59	6	8	7.2E-01	2722.06	8	8	1.42E-01	2797.92	10	10	3.2E-02
2630.07	4	6	5.1E-01	2722.74	6	8	8.2E-01	2799.29	10	8	1.55E-01
2631.05	4	6	8.16E-01	2724.88	6	6	9.58E-02	2799.72	10	10	5.0E-03
2631.32	6	8	6.29E-01	2726.52	6	8	5.0E-02	2804.02	6	6	1.6E-02
2631.61	10	12	6.6E-01	2727.38	12	10	3.12E-01	2805.32	4	6	2.5E-02
2633.20	6	4	1.21E+00	2727.54	6	4	9.38E-01	2805.79	8	8	3.22E-02
2636.70	4	4	8.8E-02	2728.91	8	10	1.25E-01	2809.78	8	8	3.10E-01
2637.50	6	6	6.2E-01	2730.73	4	4	2.79E-01	2811.27	12	10	1.2E-02
2637.64	2	4	6.6E-01	2732.01	10	8	7.05E-02	2812.49	4	4	2.9E-02
2639.57	2	2	8.0E-01	2732.45	10	10	9.8E-04	2813.61	8	10	3.40E-02
2641.12	4	4	3.7E-02	2732.94	8	6	9.5E-01	2817.09	6	4	3.37E-01
2642.01	6	6	2.29E-01	2736.49	2	4	1.5E-02	2819.34	12	12	9.7E-03
2646.21	12	10	1.44E-02	2736.97	4	2	1.22E+00	2826.03	8	6	4.5E-02
2649.47	6	8	1.98E+00	2739.55	8	8	2.21E+00	2827.43	12	14	2.4E-02
2650.48	6	8	1.60E+00	2741.39	6	6	2.03E-01	2828.63	12	10	6.9E-02
2651.30	12	12	4.0E-03	2743.20	2	4	1.97E+00	2831.56	4	6	7.6E-01
2652.57	10	8	4.45E-02	2744.90	6	8	3.62E-02	2833.09	6	6	4.55E-01
2654.63	4	4	8.1E-01	2746.48	4	6	2.05E+00	2835.71	4	6	5.1E-01
2657.92	10	10	3.2E-02	2746.98	6	6	1.69E+00	2836.19	4	4	5.4E-02
2658.25	8	8	2.12E-01	2749.18	4	4	1.21E+00	2836.51	2	4	9.8E-02
2659.06	10	10	2.5E-03	2749.32	6	8	2.16E+00	2837.30	10	12	1.9E-02
2662.56	2	2	1.33E+00	2749.49	2	2	1.16E+00	2838.22	4	2	8.6E-01
2664.66	8	10	1.91E+00	2750.01	10	10	1.8E-02	2839.51	10	8	1.47E+00
2666.64	6	8	1.87E+00	2751.13	4	4	2.92E-01	2839.80	8	10	5.8E-01
2667.22	4	6	1.02E+00	2752.15	4	4	7.7E-01	2840.34	12	12	7.7E-02
2669.93	2	4	5.2E-01	2753.29	10	12	1.89E+00	2840.65	2	4	7.6E-01
2670.38	6	8	6.0E-02	2754.89	8	6	1.21E+00	2840.76	10	12	1.49E-01
2671.39	2	4	6.5E-01	2755.74	8	10	2.15E+00	2841.36	10	10	4.3E-03
2680.23	6	8	1.10E-01	2756.51	6	8	7.3E-02	2842.08	8	8	1.5E-02
2682.51	8	10	9.2E-01	2757.03	10	8	8.07E-02	2843.32	10	10	1.40E-02
2683.00	4	6	7.3E-01	2759.33	8	8	2.7E-04	2843.48	4	6	9.6E-02
2684.75	8	10	1.57E+00	2761.81	2	4	1.38E-01	2844.96	2	2	5.5E-01
2684.96	12	12	6.4E-03	2762.33	6	6	6.0E-01	2845.60	8	6	1.57E+00
2686.11	6	6	9.4E-03	2762.45	6	4	3.3E-02	2847.21	8	6	1.7E-04
2686.39	6	4	1.6E-02	2763.66	14	12	1.34E+00	2847.77	4	4	5.1E-01
2691.74	10	8	5.04E-02	2763.91	8	6	2.9E-02	2848.11	6	6	9.9E-01
2692.60	10	12	1.40E+00	2764.79	12	12	1.1E-02	2848.32	6	4	1.59E+00
2692.83	8	6	1.64E-02	2765.13	10	8	1.47E+00	2848.91	12	10	5.3E-02
2693.86	8	6	4.2E-02	2767.50	12	14	1.58E+00	2849.61	10	12	4.6E-02
2697.33	4	4	2.48E-01	2768.93	4	6	4.75E-02	2852.87	2	4	1.65E-02
2697.46	4	2	1.65E+00	2769.15	8	10	6.6E-02	2853.21	6	6	2.3E-02
2697.73	10	8	2.6E-02	2769.35	12	14	2.07E-01	2855.67	8	10	9.2E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2856.15	10	10	5.0E-02	2975.94	2	2	9.1E-03	3210.44	2	4	3.63E-02
2856.38	6	8	4.42E-01	2978.85	10	10	7.2E-03	3211.08	6	8	2.1E-03
2856.91	8	8	1.32E+00	2979.35	2	4	1.61E-02	3213.31	4	6	6.12E-02
2857.17	6	8	1.22E-01	2980.96	6	8	1.1E-02	3227.74	6	8	8.9E-02
2857.42	6	6	2.0E-02	2982.06	4	6	2.41E-01	3231.71	6	8	1.4E-02
2858.34	10	12	4.85E-01	2984.82	6	6	4.29E-01	3232.78	8	6	5.0E-02
2861.17	4	4	1.7E-03	2985.54	2	4	2.39E-01	3237.40	4	4	1.8E-02
2864.97	8	8	4.3E-02	2997.30	6	8	8.6E-02	3237.82	2	4	6.8E-02
2868.87	6	6	7.3E-03	2998.85	6	8	4.2E-03	3241.69	8	8	1.9E-03
2869.16	8	10	1.4E-02	3000.06	8	6	3.0E-02	3243.72	10	8	5.1E-02
2869.31	4	6	4.04E-01	3002.32	6	8	2.0E-02	3247.17	4	6	7.1E-02
2869.70	8	6	1.1E-02	3002.65	4	6	1.79E-01	3247.39	8	8	6.0E-03
2870.61	8	10	7.5E-03	3004.26	8	8	8.6E-03	3255.89	8	8	2.78E-03
2871.06	10	12	2.2E-02	3020.01	12	10	6.4E-04	3257.36	8	6	1.5E-03
2871.13	12	10	3.0E-02	3021.42	8	6	3.8E-03	3258.77	6	8	9.39E-02
2872.38	10	8	1.70E-01	3036.96	6	6	2.22E-01	3259.05	8	10	6.7E-02
2873.40	8	10	4.56E-01	3044.84	8	10	1.2E-02	3266.94	10	10	4.5E-03
2875.35	8	10	1.35E-01	3048.99	4	4	3.84E-01	3267.04	8	10	2.0E-04
2876.80	8	8	9.56E-02	3056.80	14	12	1.7E-02	3268.51	8	6	6.8E-03
2879.25	10	8	3.6E-02	3062.24	12	10	1.36E-01	3269.77	10	8	5.2E-03
2880.76	8	8	2.21E-02	3065.32	6	6	2.9E-02	3273.49	8	8	8.5E-03
2883.71	12	14	1.48E-01	3070.69	10	8	1.28E-02	3276.60	6	8	1.0E-02
2884.76	6	8	2.46E-01	3071.12	2	4	2.59E-01	3277.35	8	10	3.31E-03
2885.93	14	12	3.8E-02	3076.44	4	6	3.75E-01	3279.64	10	10	5.8E-03
2886.24	12	10	6.9E-03	3077.17	14	12	1.35E-01	3281.29	6	6	2.31E-03
2887.31	6	4	1.9E-02	3078.68	6	8	5.5E-01	3285.41	4	2	4.5E-04
2888.10	4	6	6.1E-02	3089.38	6	8	2.2E-02	3289.35	8	8	2.1E-02
2892.83	4	6	1.8E-03	3096.29	8	8	1.9E-02	3295.23	6	8	3.6E-03
2894.78	10	12	5.7E-02	3101.89	6	8	9.1E-03	3295.82	4	4	2.04E-03
2895.22	8	10	1.09E-01	3105.17	4	2	7.5E-02	3297.88	6	4	1.0E-02
2897.27	6	4	1.8E-01	3105.55	2	2	7.0E-02	3302.86	6	8	2.78E-04
2902.32	6	8	8.81E-03	3106.57	8	8	1.88E-02	3303.46	2	2	6.5E-04
2902.46	10	10	3.2E-02	3114.30	4	4	6.4E-02	3304.43	6	8	2.0E-03
2906.12	2	4	4.4E-02	3114.69	2	4	2.5E-02	3313.99	2	4	1.4E-04
2907.86	8	6	1.3E-03	3116.58	6	4	5.5E-02	3323.06	8	10	1.4E-02
2910.76	8	8	1.5E-02	3129.01	8	10	2.3E-03	3325.01	8	8	3.35E-03
2916.15	8	8	4.8E-04	3131.72	12	10	6.6E-03	3360.11	12	12	2.1E-03
2917.08	6	8	2.7E-02	3133.05	4	6	1.5E-02	3366.97	8	6	2.2E-02
2917.47	6	8	1.4E-03	3135.36	6	6	8.8E-02	3381.01	6	4	3.0E-02
2922.02	8	10	3.8E-02	3144.75	8	6	2.7E-02	3388.14	8	10	3.8E-04
2926.59	8	10	5.1E-02	3146.75	10	10	4.9E-06	3395.33	8	8	3.66E-03
2934.49	8	10	5.6E-03	3154.20	10	10	2.06E-01	3398.36	14	14	2.5E-03
2939.51	6	4	4.0E-03	3155.95	10	8	4.17E-03	3416.02	4	2	2.6E-03
2944.40	4	2	3.5E-01	3162.80	8	8	5.5E-02	3425.57	6	8	2.1E-04
2945.26	6	6	5.6E-04	3163.09	6	6	1.92E-03	3436.11	8	6	5.7E-03
2947.65	6	4	2.01E-01	3166.67	6	4	1.4E-03	3442.22	8	6	3.2E-03
2949.18	10	8	2.45E-01	3167.86	8	8	1.59E-01	3453.62	8	10	8.5E-03
2953.77	6	8	5.2E-02	3170.34	4	2	8.2E-03	3456.92	8	6	7.1E-03
2954.05	8	8	1.2E-02	3177.53	8	8	1.74E-01	3463.96	6	6	7.6E-05
2959.60	8	6	9.7E-02	3179.50	6	8	1.11E-01	3464.50	10	8	2.2E-03
2959.84	8	6	1.36E-01	3180.15	4	6	7.7E-02	3468.68	8	8	2.0E-02
2961.28	4	2	8.9E-03	3183.11	4	6	9.80E-03	3475.74	6	8	1.7E-04
2964.13	8	6	4.6E-02	3185.32	2	4	3.00E-03	3487.99	4	6	1.7E-04
2964.62	2	2	6.5E-02	3186.74	4	4	3.85E-02	3493.47	10	10	3.2E-02
2965.03	4	4	9.43E-02	3187.30	10	10	5.0E-02	3494.67	4	6	7.1E-04
2965.41	6	4	1.1E-02	3192.07	8	10	5.2E-03	3495.62	10	8	2.62E-03
2968.74	8	10	2.4E-03	3192.91	6	6	1.27E-02	3499.88	8	8	4.29E-03
2969.94	8	6	2.28E-01	3193.80	2	2	5.4E-02	3503.47	2	2	2.6E-04
2970.52	4	6	2.70E-02	3193.86	8	8	3.86E-02	3507.40	2	4	4.1E-04
2970.69	10	8	4.15E-02	3196.07	6	8	1.61E-02	3508.20	2	4	1.2E-04

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3614.88	8	8	4.2E-03	4833.20	12	10	4.6E-06	5965.62	10	10	2.19E-01
3621.27	2	4	2.2E-02	4840.00	10	8	4.0E-06	5991.38	12	10	4.2E-05
3624.89	2	2	2.4E-02	4893.82	8	6	2.5E-05	6084.11	10	8	3.0E-05
3632.29	10	10	1.2E-03	4923.93	6	4	4.28E-02	6113.32	8	6	1.7E-05
3711.98	4	6	1.5E-03	4990.51	6	8	5.2E-01	6129.70	10	10	3.2E-06
3748.48	6	4	3.4E-02	4993.36	10	8	6.9E-05	6147.74	4	2	1.3E-03
3759.46	4	2	3.2E-02	5000.74	2	4	1.8E-05	6149.26	2	2	1.3E-03
3814.12	4	6	4.9E-03	5001.96	12	14	1.57E+00	6175.15	8	8	1.8E-03
3824.93	6	6	3.2E-05	5018.44	6	6	2.0E-02	6179.38	8	6	4.6E-04
3827.08	6	8	2.5E-03	5030.63	10	10	7.1E-01	6238.39	4	4	7.5E-04
3906.04	6	8	1.1E-02	5035.71	10	12	9.4E-01	6239.95	2	4	1.1E-04
3914.50	6	4	4.6E-05	5100.66	10	8	2.0E-05	6247.56	6	4	1.6E-03
3935.96	8	10	8.3E-03	5132.67	10	10	2.0E-05	6305.30	10	10	1.4E-03
3938.29	6	6	6.1E-05	5136.80	6	4	2.8E-05	6331.95	6	8	1.8E-03
3938.97	4	6	8.4E-03	5144.35	4	6	8.5E-01	6369.46	6	4	1.40E-04
3945.21	4	4	3.9E-05	5149.47	8	10	9.0E-01	6383.72	6	6	1.1E-03
3974.17	4	6	6.3E-05	5169.03	6	8	4.22E-02	6416.92	6	6	3.6E-04
4024.55	6	6	2.5E-03	5197.58	6	4	5.4E-03	6432.68	6	6	8.5E-05
4075.95	6	4	1.6E-05	5227.48	12	14	1.22E+00	6446.41	8	10	1.3E-03
4087.28	6	4	3.0E-05	5234.62	8	6	2.5E-03	6456.38	8	6	1.7E-03
4122.67	6	6	3.3E-04	5247.95	4	6	1.43E+00	6516.08	6	8	8.3E-05
4124.79	6	8	3.4E-05	5251.23	6	8	8.0E-01	7222.39	4	2	2.5E-04
4128.75	6	4	2.6E-04	5262.48	4	6	8.0E-07	7224.49	2	2	2.8E-04
4173.46	6	6	4.43E-03	5264.18	8	10	4.76E-01	7301.56	6	6	2.1E-05
4178.86	6	8	1.72E-03	5264.81	6	4	3.52E-04	7320.65	6	4	1.4E-04
4180.98	4	4	2.2E-04	5272.40	6	6	3.9E-03	7449.33	4	6	1.68E-04
4233.17	6	8	7.22E-03	5276.00	10	8	3.76E-03	7462.41	6	6	2.7E-04
4258.15	4	4	3.1E-04	5284.11	6	8	1.9E-04	7479.69	6	8	3.5E-05
4273.33	4	2	9.1E-04	5306.18	6	8	3.28E-01	7515.83	8	6	8.1E-05
4296.57	4	6	7.0E-04	5316.22	14	14	3.69E-01	7711.72	8	8	4.94E-04
4303.18	4	4	2.20E-03	5316.62	12	10	3.89E-03				
4351.77	4	6	4.86E-03	5316.78	8	6	6.5E-04	<i>Fe III</i>			
4369.41	2	4	2.3E-04	5325.55	8	8	8.0E-04	1843.4	9	7	4.8E+00
4384.32	12	10	7.2E-05	5387.06	12	14	5.2E-01	1844.3	7	5	4.9E+00
4385.39	2	2	4.5E-03	5395.86	6	8	5.5E-01	1846.9	5	3	5.5E+00
4413.60	10	10	2.2E-05	5402.06	10	12	5.6E-01	1854.38	3	1	5.7E+00
4416.83	2	4	2.1E-03	5414.07	8	8	9.4E-05	1865.20	7	7	6.1E+00
4472.93	6	4	2.5E-04	5425.26	10	10	9.2E-05	1893.98	11	9	5.5E+00
4489.18	8	6	5.9E-04	5427.83	12	10	5.9E-03	1896.80	13	11	5.0E+00
4491.41	4	4	1.89E-03	5429.99	8	10	6.0E-01	1904.3	5	5	5.7E+00
4508.29	4	2	7.3E-03	5465.93	6	8	6.2E-01	1907.58	15	13	5.3E+00
4515.34	6	6	2.37E-03	5482.31	10	12	4.78E-01	1915.08	13	15	6.0E+00
4520.22	10	8	9.8E-04	5493.83	8	10	4.01E-01	1922.79	11	13	5.5E+00
4522.63	6	4	8.4E-03	5506.19	12	14	1.14E+00	1930.39	9	11	5.1E+00
4534.17	4	6	2.3E-04	5510.78	10	12	2.28E-01	1931.51	9	11	5.3E+00
4541.52	4	4	8.6E-04	5525.12	10	8	3.17E-05	1937.35	7	9	5.1E+00
4549.19	4	6	9.2E-03	5529.05	6	6	2.01E-01	1943.48	5	7	5.0E+00
4549.47	8	6	1.00E-02	5534.85	12	10	3.0E-04	1950.33	13	15	5.5E+00
4555.89	8	8	2.26E-03	5544.76	12	12	2.49E-01	1951.01	11	11	5.3E+00
4576.34	6	6	6.4E-04	5607.14	6	8	4.63E-05	1952.65	9	9	4.9E+00
4582.84	6	8	3.44E-04	5627.50	8	6	2.93E-05	1953.32	7	7	5.1E+00
4583.84	10	8	7.22E-03	5725.96	6	6	5.1E-06	1987.50	13	13	4.9E+00
4620.52	8	8	2.53E-04	5783.63	8	10	4.62E-01				
4629.34	10	10	1.72E-03	5813.68	6	4	8.8E-04	<i>Fe VII</i>			
4635.32	6	8	1.0E-02	5823.15	8	10	2.0E-04	150.807	5	7	1.3E+03
4656.98	6	6	1.37E-04	5824.41	6	6	8.3E-07	150.852	7	9	1.3E+03
4666.76	8	10	1.3E-04	5885.01	4	6	6.4E-01	151.023	9	11	1.6E+03
4670.18	6	8	3.2E-05	5902.83	8	10	4.98E-01	151.046	7	7	2.2E+02
4720.15	4	6	7.5E-06	5955.70	6	8	4.19E-01	151.145	9	9	2.1E+02
4731.45	6	8	2.8E-04	5961.71	10	12	7.4E-01	151.432	5	7	2.2E+02
								151.512	5	5	5.3E+02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
151.675	7	7	3.9E+02	92.81	9	11	3.7E+03	217	6	8	4.0E+02
151.782	9	9	2.4E+02	92.87	11	13	3.9E+03	217	6	6	2.6E+02
154.307	3	1	8.9E+02	93.433	9	11	3.2E+03	219	2	4	4.8E+02
154.335	5	7	1.2E+03	179.762	5	7	1.67E+03	219	4	6	2.4E+02
154.363	3	3	4.2E+02	<i>Fe XII</i>				219.123	4	6	3.9E+02
154.565	5	3	3.5E+02	65.905	4	4	2.0E+03	220	4	4	3.2E+02
154.650	5	5	8.8E+02	66.526	6	8	1.7E+03	221	4	6	5.9E+02
154.848	1	3	7.7E+02	66.960	4	6	1.6E+03	226	2	4	3.9E+02
154.921	3	5	9.7E+02	67.164	4	2	1.1E+03	234	2	2	2.8E+02
154.941	3	3	2.4E+02	67.821	4	6	1.4E+03	264.787	4	4	3.38E+02
154.949	5	7	1.0E+03	68.382	2	4	1.7E+03	265	4	4	1.5E+02
155.994	9	11	1.8E+03	80.541	6	6	8.7E+02	266	6	4	1.7E+02
158.481	9	9	2.3E+02	81.943	6	4	1.4E+03	268	6	6	2.1E+02
165.087	1	3	6.9E+02	82.226	4	2	1.9E+03	268	4	2	3.3E+02
165.919	7	5	2.8E+03	84.48	4	6	4.5E+03	270.524	4	2	2.1E+02
166.365	9	7	2.9E+03	84.48	8	10	4.9E+03	274.203	2	2	1.8E+02
173.441	9	9	3.6E+03	84.52	10	12	5.2E+03	280	4	6	2.8E+02
176.744	9	9	2.7E+03	84.52	6	8	4.0E+03	283	6	8	2.7E+02
176.928	7	7	2.4E+03	84.85	6	8	2.3E+03	288.45	6	4	1.6E+02
177.172	5	5	1.5E+03	85.14	8	10	3.4E+03	<i>Fe XV</i>			
235.221	5	3	1.7E+02	85.477	10	12	4.6E+03	38.95	1	3	1.69E+03
240.053	3	1	1.3E+02	186.880	6	8	1.0E+03	52.911	1	3	2.94E+03
243.379	9	7	2.1E+02	192.394	4	2	9.0E+02	59.404	3	5	3.4E+03
<i>Fe VIII</i>				193.509	4	4	9.1E+02	63.959	5	7	1.6E+03
112.472	4	4	3.6E+02	195.119	4	6	8.6E+02	65.370	1	3	3.2E+02
112.486	6	6	4.3E+02	<i>Fe XIII</i>				65.612	3	3	9.8E+02
116.196	4	6	4.5E+02	62.353	1	3	2.0E+03	66.238	5	3	1.6E+03
117.197	6	8	3.8E+02	62.46	5	7	1.2E+03	68.860	9	11	9.2E+03
167.486	4	4	3.0E+03	62.699	3	5	2.3E+03	69.7	3	1	1.9E+03
168.172	6	6	3.1E+03	63.188	5	7	3.9E+03	69.942	3	5	7.4E+03
168.545	6	4	2.0E+03	64.139	1	3	2.1E+03	69.989	5	7	7.9E+03
168.929	4	2	2.1E+03	74.845	5	5	1.0E+03	70.052	7	9	8.8E+03
185.213	6	8	1.0E+03	75.892	5	3	7.7E+02	70.224	1	3	4.13E+03
186.601	4	6	9.4E+02	76.117	5	3	2.1E+03	70.53	7	5	2.6E+02
<i>Fe X</i>				78.452	9	11	6.3E+03	70.59	7	7	1.7E+03
76.822	2	2	1.8E+03	84.270	7	9	5.5E+03	73.199	7	9	8.8E+03
77.865	4	6	1.6E+03	107.384	7	5	1.8E+03	73.473	5	7	6.2E+03
100.026	8	10	2.6E+03	<i>Fe XIV</i>				233.857	5	7	2.2E+02
101.733	6	8	1.8E+03	58.963	2	4	2.7E+03	235	1	3	2.5E+02
101.846	4	6	1.7E+03	59.579	4	6	3.1E+03	243	1	3	2.4E+02
102.095	10	12	2.9E+03	69.176	4	6	5.6E+02	243	5	7	2.3E+02
102.192	10	12	2.9E+03	69.386	2	4	7.6E+02	243.790	3	5	4.2E+02
102.829	4	6	2.1E+03	69.66	2	2	8.9E+02	248	3	1	5.4E+02
103.319	6	8	2.6E+03	69.66	6	6	1.3E+03	284.160	1	3	2.28E+02
103.724	6	8	1.7E+03	70.251	6	4	8.1E+02	<i>Fe XVI</i>			
104.638	8	10	2.1E+03	70.613	4	2	1.7E+03	31.041	2	4	5.2E+02
174.534	4	6	1.8E+03	72.80	10	12	7.9E+03	31.242	4	6	6.1E+02
175.266	2	4	1.72E+03	76.022	4	6	6.6E+03	32.166	2	4	6.8E+02
<i>Fe XI</i>				76.152	6	8	7.0E+03	32.192	2	2	6.7E+02
72.166	5	7	2.9E+03	91.009	6	4	5.1E+02	32.433	2	4	7.7E+02
72.310	5	5	1.5E+03	91.273	4	2	5.6E+02	32.652	4	6	9.1E+02
72.635	5	7	1.6E+03	188	4	6	2.7E+02	34.857	2	4	1.23E+03
91.394	5	7	2.6E+03	190	6	8	2.8E+02	35.106	4	6	1.44E+03
91.472	7	9	2.5E+03	207	2	2	2.1E+02	35.333	4	6	6.4E+02
91.63	3	5	2.3E+03	211.316	2	4	3.6E+02	35.368	6	8	6.8E+02
91.63	7	9	3.4E+03	213	4	2	2.8E+02	36.01	4	2	5.0E+02
91.63	5	7	2.8E+03	214	2	2	4.0E+02	36.749	2	4	1.1E+03
91.733	9	11	4.1E+03	216	6	8	1.7E+02	36.803	2	2	1.2E+03
								37.096	4	6	1.0E+03

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
37.138	6	8	1.07E+03	13.68	3	1	8.0E+04	8.65	5	7	3.9E+04
39.827	2	4	2.1E+03	13.69	5	7	2.3E+04	8.66	5	5	4.4E+03
40.153	4	6	2.5E+03	13.700	1	3	2.7E+05	8.74	1	3	2.5E+04
40.161	4	4	4.1E+02	13.71	5	5	2.2E+04	9.42	3	1	4.3E+04
40.199	4	6	1.7E+03	13.738	5	7	1.0E+04	9.42	3	3	3.3E+04
40.245	6	8	1.8E+03	13.796	5	7	7.0E+04	9.44	3	5	1.7E+04
41.91	2	2	4.72E+02	13.83	5	5	1.4E+04	9.45	1	3	5.2E+04
42.30	4	2	9.2E+02	13.934	1	3	4.51E+04	9.46	5	3	1.5E+04
46.661	4	6	3.46E+03	13.961	3	3	2.0E+04	9.47	5	7	4.9E+04
46.718	6	8	3.7E+03	14.668	5	7	1.1E+04	9.47	5	5	6.1E+03
50.350	2	4	1.86E+03	14.671	5	3	1.1E+04	9.52	3	3	8.1E+03
50.555	2	2	1.98E+03	14.929	3	3	1.2E+04	9.58	5	5	5.2E+03
54.142	2	4	3.41E+03	14.966	5	3	2.5E+04	9.59	5	5	1.0E+04
54.728	4	6	4.16E+03	14.995	5	5	2.2E+04	9.67	1	3	5.7E+04
54.769	4	4	6.97E+02	15.015	1	3	1.4E+04	9.68	5	7	4.0E+03
62.879	2	2	1.05E+03	16.668	3	1	1.1E+04	9.74	5	3	5.3E+03
63.719	4	2	2.18E+03	<i>Fe XX</i>				12.02	1	3	1.3E+04
66.263	4	6	9.39E+03	12.67	6	6	1.0E+04	12.13	3	3	1.8E+04
66.368	6	8	1.00E+04	12.69	4	6	1.2E+04	12.18	5	7	2.2E+04
66.392	6	6	6.69E+02	12.73	4	2	4.0E+04	12.19	5	3	6.4E+03
76.502	6	4	6.7E+02	12.77	4	4	2.1E+05	12.21	3	1	1.5E+05
76.796	4	2	7.72E+02	12.78	4	2	6.9E+04	12.21	3	3	1.2E+05
80.192	4	6	5.2E+02	12.78	2	4	1.4E+05	12.25	1	3	2.1E+05
80.270	6	8	5.4E+02	12.79	6	4	1.7E+04	12.28	5	3	5.2E+04
85.587	2	4	4.0E+02	12.82	4	4	1.1E+05	12.30	5	7	2.1E+05
86.133	4	6	4.8E+02	12.88	6	4	2.7E+04	12.36	3	3	3.6E+04
96.256	4	6	8.7E+02	12.89	4	4	4.4E+04	12.37	5	7	3.1E+05
96.348	6	8	9.3E+02	12.90	4	2	6.2E+03	12.38	5	3	6.9E+03
117.2	2	4	3.93E+02	12.90	4	6	1.4E+05	12.47	5	7	5.8E+04
117.7	2	2	3.9E+02	12.92	2	4	1.7E+04	12.47	5	3	1.3E+04
123.4	2	4	5.9E+02	12.93	4	6	1.6E+05	12.49	5	7	1.3E+04
124.5	4	6	7.0E+02	12.93	2	2	1.2E+04	12.53	5	5	1.5E+04
144.06	4	6	1.6E+03	12.98	2	2	6.7E+04	12.57	1	3	7.2E+04
144.25	6	8	1.6E+03	12.99	6	6	5.1E+04	12.73	5	5	8.2E+03
148	4	2	6.5E+02	13.00	6	4	1.1E+04	12.95	3	5	6.2E+03
266.7	4	6	3.9E+02	13.01	2	4	3.0E+04	13.00	1	3	7.2E+03
267.0	6	8	4.3E+02	13.03	4	2	8.6E+04	13.03	5	5	1.3E+04
<i>Fe XVII</i>				13.07	6	4	8.2E+03	13.14	3	1	2.0E+04
11.023	1	3	2.1E+04	13.13	2	4	8.9E+04	13.41	1	3	7.3E+03
12.123	1	3	8.0E+04	13.24	4	4	1.2E+04	<i>Fe XXII</i>			
12.264	1	3	5.9E+04	13.28	4	4	6.1E+03	9.002	4	6	5.5E+04
12.526	1	3	3.0E+03	13.70	4	6	1.1E+04	9.006	6	8	5.7E+04
12.681	1	3	3.5E+03	13.71	2	2	9.9E+03	9.006	6	6	5.3E+04
13.823	1	3	3.3E+04	13.78	4	4	1.0E+04	9.163	4	6	6.9E+04
13.891	1	3	3.4E+03	13.79	6	6	1.2E+04	9.183	6	8	8.3E+04
15.015	1	3	2.28E+05	13.83	4	2	9.8E+03	9.241	4	6	5.1E+04
15.262	1	3	6.0E+04	13.90	4	2	1.2E+04	11.748	4	4	1.2E+05
16.777	1	3	8.29E+03	13.98	6	4	1.6E+04	11.748	4	6	1.6E+05
17.054	1	3	9.33E+03	13.99	4	2	2.2E+04	11.748	4	2	1.8E+05
41.37	9	11	4.8E+03	14.05	4	4	1.7E+04	11.763	2	4	1.6E+05
49.427	3	3	4.0E+03	14.23	2	2	6.3E+03	11.789	2	2	2.6E+05
50.26	7	9	6.0E+03	<i>Fe XXI</i>				11.789	6	8	1.2E+05
58.76	9	11	1.2E+04	8.53	3	1	1.8E+04	11.797	2	4	1.7E+05
<i>Fe XIX</i>				8.53	3	5	6.1E+03	11.823	6	4	7.9E+04
13.413	5	3	1.3E+04	8.53	3	3	1.5E+04	11.837	6	8	2.3E+05
13.426	5	7	4.8E+04	8.56	5	7	2.0E+04	11.837	6	6	1.7E+05
13.47	3	1	1.5E+05	8.56	1	3	2.1E+04	11.886	4	6	1.3E+05
13.520	5	7	2.0E+05	8.56	5	3	6.5E+03	11.898	2	4	8.2E+04
13.56	3	5	1.0E+04	8.64	5	7	1.5E+04	11.922	4	6	1.8E+05





$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2802.0	5	7	1.6E+00	*3104.8	10	14	8.1E-01	1639.8	3	5	2.1E+00
2823.2	5	5	2.6E-01	3848.2	6	4	2.8E-02	2814.2	1	3	3.35E-01
2833.1	1	3	5.8E-01	3848.3	4	4	3.0E-03				
2873.3	5	5	3.7E-01	3850.4	4	2	3.0E-02	<i>Mg X</i>			
3572.7	5	3	9.9E-01	*4481.2	10	14	2.23E+00	57.876	2	4	2.09E+03
3639.6	3	3	3.4E-01	9218.3	2	4	3.6E-01	57.920	2	2	2.09E+03
3671.5	5	3	4.4E-01	9244.3	2	2	3.6E-01	63.152	2	4	5.6E+03
3683.5	3	1	1.5E+00					63.295	4	6	6.7E+03
3739.9	5	5	7.3E-01	<i>Mg IV</i>				609.79	2	4	7.53E+00
4019.6	5	7	3.5E-02	320.99	4	2	1.2E+02	624.94	2	2	7.01E+00
4057.8	5	3	8.9E-01	323.31	2	2	5.9E+01	2212.5	2	4	9.64E-01
4062.1	5	3	9.2E-01	1219.0	6	6	5.9E+00	2278.7	2	2	8.82E-01
4168.0	5	5	1.2E-02	1375.5	4	4	4.5E+00	5918.7	2	4	3.20E-02
5005.4	1	3	2.7E-01	1459.6	6	4	4.6E+00	6229.6	4	6	3.30E-02
5201.4	1	3	1.9E-01	1495.5	4	6	6.4E+00				
7229.0	5	3	8.9E-03	1510.7	4	4	6.7E+00	<i>Mg XI</i>			
<i>Lithium</i>				1683.0	6	8	5.8E+00	7.310	1	3	1.15E+04
<i>Li I</i>				1698.8	4	6	3.9E+00	7.473	1	3	2.27E+04
*2741.2	2	6	1.3E-02	1893.9	6	6	2.8E+00	7.850	1	3	5.50E+04
*3232.7	2	6	1.17E-02	<i>Mg VI</i>				9.169	1	3	1.97E+05
*4602.9	6	10	2.23E-01	*269.92	10	6	3.1E+02				
*6103.6	6	10	6.860E-01	*292.53	6	6	9.0E+01	<i>Manganese</i>			
*6707.8	2	6	3.691E-01	*314.64	6	2	1.8E+02	<i>Mn I</i>			
<i>Lutetium</i>				*349.15	10	10	6.1E+01	2794.82	6	8	3.7E+00
<i>Lu I</i>				*387.94	6	10	1.3E+01	2798.27	6	6	3.6E+00
3376.5	4	4	2.23E+00	399.29	4	2	2.8E+01	2801.08	6	4	3.7E+00
3567.8	4	6	5.9E-01	400.68	4	4	2.8E+01	3007.65	6	8	1.8E-01
3620.3	6	4	1.1E-02	403.32	4	6	2.7E+01	3011.38	8	10	3.1E-01
3841.2	6	6	2.5E-01	<i>Mg VII</i>				3016.45	10	12	2.9E-01
4518.6	4	4	2.1E-01	277.01	3	3	9.5E+01	3043.36	8	8	5.9E-01
<i>Magnesium</i>				278.41	5	3	1.5E+02	3044.57	10	8	5.7E-01
<i>Mg I</i>				280.74	5	3	2.0E+02	3045.59	10	10	6.7E-01
2025.8	1	3	8.4E-01	319.02	5	5	8.9E+01	3045.80	8	10	1.7E-01
*2779.8	9	9	5.2E+00	*366.42	9	9	4.4E+01	3047.03	12	12	6.1E-01
*2850.0	9	15	2.3E-01	*433.04	9	15	1.6E+01	3054.36	8	6	4.6E-01
2852.1	1	3	4.95E+00	1334.3	5	5	5.3E+00	3070.27	6	6	1.9E-01
*3094.9	9	15	5.2E-01	1410.0	5	5	2.57E+00	3073.18	4	4	3.7E-01
3329.9	1	3	3.3E-02	1487.0	3	5	3.02E+00	3082.71	14	14	2.9E-01
3332.2	3	3	9.7E-02	1487.9	5	7	3.66E+00	3110.68	6	8	2.7E-01
3336.7	5	3	1.6E-01	<i>Mg VIII</i>				3113.80	12	10	2.6E-01
*3835.3	9	15	1.68E+00	*74.976	6	10	4.3E+03	3118.10	4	6	1.7E-01
4703.0	3	5	2.55E-01	315.02	4	4	1.2E+02	3122.88	10	10	1.9E-01
5167.3	1	3	1.16E-01	*342.29	10	6	6.3E+01	3126.85	8	6	2.3E-01
5172.7	3	3	3.46E-01	353.86	4	4	3.89E+01	3132.28	10	10	2.1E-01
5183.6	5	3	5.75E-01	356.00	6	4	5.7E+01	3132.79	8	8	2.7E-01
5528.4	3	5	1.99E-01	*428.52	10	10	3.24E+01	3175.58	8	10	1.8E-01
<i>Mg II</i>				*434.62	6	10	1.6E+01	3201.11	4	6	2.2E-01
1239.9	2	4	1.4E-02	*489.33	6	6	3.9E+01	3228.09	10	12	6.4E-01
1240.4	2	2	1.4E-02	*686.92	6	10	9.4E+00	3230.23	10	12	1.9E-01
*2660.8	10	14	3.8E-01	<i>Mg IX</i>				3230.72	8	8	3.5E-01
2790.8	2	4	4.0E+00	62.751	1	3	2.87E+03	3240.88	6	4	2.2E-01
2795.5	2	4	2.6E+00	*67.189	9	15	6.20E+03	3243.78	6	6	5.3E-01
2797.9	4	4	7.9E-01	*71.965	9	3	1.22E+03	3251.13	4	2	2.3E-01
2798.1	4	6	4.8E+00	72.312	3	5	4.43E+03	3252.95	4	4	1.8E-01
2802.7	2	2	2.6E+00	77.737	3	1	3.92E+02	3256.14	4	6	5.0E-01
2928.8	2	2	1.2E+00	368.07	1	3	5.27E+01	3258.41	2	2	9.7E-01
2936.5	4	2	2.3E+00	438.69	3	1	7.9E+01	3260.24	2	4	3.8E-01
				*443.74	9	9	4.19E+01	3267.79	14	14	3.5E-01
				749.55	3	5	8.2E+00	3268.72	6	8	3.3E-01
								3270.35	12	12	2.6E-01
								3273.02	10	10	2.7E-01



$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3298.23	6	4	2.8E-01	4070.28	2	2	2.3E-01	3482.90	5	5	2.0E-01
3303.28	4	4	1.9E-01	4079.42	2	4	3.8E-01	3488.68	3	3	2.5E-01
3463.66	8	8	3.2E-01	4082.95	4	6	2.95E-01	<i>Mn VI</i>			
3470.01	6	8	2.4E-01	4083.63	6	8	2.8E-01	307.999	9	9	3.7E+01
3511.83	12	12	2.7E-01	4089.94	8	10	1.7E-01	309.440	9	7	5.7E+01
3535.30	10	10	1.7E-01	4105.37	10	8	1.7E-01	309.579	7	5	4.4E+01
3559.81	6	6	2.1E-01	4135.03	12	12	3.0E-01	310.058	7	7	3.4E+01
3577.87	10	8	9.4E-01	4141.06	10	10	2.6E-01	310.182	5	5	2.8E+01
3595.11	6	4	1.8E-01	4148.80	8	8	2.3E-01	311.748	5	3	5.7E+01
3601.27	12	10	2.3E-01	4176.61	14	12	2.4E-01	320.598	3	5	1.5E+01
3607.53	8	8	2.3E-01	4189.99	12	10	2.0E-01	320.681	1	3	2.2E+01
3608.49	6	6	3.6E-01	4201.78	10	8	2.3E-01	320.874	3	1	7.8E+01
3610.30	4	4	4.2E-01	4235.30	8	6	9.17E-01	320.979	3	3	2.2E+01
3635.70	10	8	2.1E-01	4239.74	4	2	3.9E-01	321.176	5	5	6.0E+01
3660.40	12	14	9.1E-01	4257.67	2	2	3.7E-01	321.541	5	3	2.7E+01
3675.67	6	8	2.2E-01	4265.93	4	4	4.92E-01	325.146	9	7	1.3E+02
3676.96	10	12	7.3E-01	4281.10	6	6	2.3E-01	328.431	5	5	4.4E+01
3680.15	12	10	1.9E-01	4411.87	12	10	2.6E-01	328.558	3	5	1.2E+01
3682.09	8	10	7.6E-01	4414.89	8	6	2.93E-01	329.043	1	3	1.1E+01
3684.87	6	8	2.6E-01	4419.77	10	8	2.1E-01	1236.23	5	3	1.3E+01
3706.08	12	14	1.4E+00	4436.36	6	4	4.37E-01	1255.77	3	1	1.2E+01
3718.92	10	12	9.6E-01	4451.58	8	8	7.98E-01	1285.10	5	7	1.1E+01
3731.94	8	10	1.0E+00	4453.01	4	2	5.44E-01	1333.87	7	9	1.0E+01
3771.44	14	14	1.9E-01	4455.82	4	6	1.7E-01	<i>Mercury</i>			
3773.86	12	12	2.5E-01	4457.04	6	4	2.34E-01	<i>Hg I</i>			
3800.55	6	8	2.7E-01	4457.55	6	6	4.27E-01	2536.52	1	3	8.00E-02
3806.72	10	12	5.9E-01	4458.26	6	8	4.62E-01	2652.04	3	5	3.88E-01
3823.51	8	10	5.21E-01	4461.09	8	8	1.7E-01	2655.13	3	5	1.1E-01
3823.89	6	6	2.31E-01	4462.03	8	10	7.00E-01	2752.78	1	3	6.10E-02
3833.87	4	4	3.14E-01	4464.68	6	6	4.39E-01	2856.94	3	1	1.1E-02
3834.37	6	8	4.29E-01	4470.14	4	4	3.00E-01	2893.60	3	3	1.6E-01
3839.78	2	2	4.64E-01	4472.79	2	2	4.35E-01	2925.4	5	3	7.7E-02
3841.07	4	6	3.3E-01	4479.40	8	10	3.4E-01	2967.3	1	3	4.5E-01
3843.99	2	4	2.11E-01	4490.08	2	4	2.49E-01	3021.50	5	7	5.09E-01
3889.46	12	14	3.1E-01	4498.90	4	6	2.49E-01	3023.48	5	5	9.4E-02
3898.37	6	8	1.7E-01	4502.22	6	8	1.86E-01	3027.49	5	5	2.0E-02
3899.34	4	6	2.4E-01	4605.37	10	12	3.6E-01	3125.66	3	5	6.56E-01
3924.08	2	4	9.4E-01	4626.54	12	14	3.6E-01	3341.48	5	3	1.68E-01
3926.48	6	8	5.4E-01	4709.71	8	8	1.72E-01	3650.15	5	7	1.3E+00
3951.98	2	2	3.1E-01	4727.46	6	6	1.7E-01	3654.83	5	5	1.8E-01
3952.84	6	6	4.1E-01	4739.11	4	4	2.40E-01	4046.56	1	3	2.1E-01
3975.88	2	4	1.8E-01	4754.05	6	8	3.03E-01	4077.81	3	1	4.0E-02
3982.16	4	2	3.5E-01	4761.53	2	4	5.35E-01	4108.1	3	1	3.0E-02
3982.58	6	4	2.3E-01	4762.38	8	10	7.83E-01	4339.22	3	5	2.88E-02
3982.90	6	4	5.5E-01	4765.86	4	6	4.1E-01	4347.50	3	5	8.4E-02
3991.60	2	2	2.1E-01	4766.43	6	8	4.6E-01	4358.34	3	3	5.57E-01
4011.91	8	8	2.3E-01	4783.43	8	8	4.01E-01	4916.07	3	1	5.8E-02
4018.11	10	8	2.54E-01	4823.53	10	8	4.99E-01	5025.64	3	3	2.7E-04
4030.76	6	8	1.7E-01	6013.48	4	6	1.72E-01	5460.75	5	3	4.87E-01
4033.07	6	6	1.65E-01	6021.79	8	6	3.32E-01	5769.59	3	5	2.36E-01
4034.49	6	4	1.58E-01	<i>Mn II</i>				2593.72	7	7	2.6E+00
4041.36	10	10	7.87E-01	2593.72	7	7	2.6E+00	2605.68	7	5	2.7E+00
4048.75	6	4	7.5E-01	2605.68	7	5	2.7E+00	2933.05	5	3	2.0E+00
4052.48	6	8	3.8E-01	2933.05	5	3	2.0E+00	2939.31	5	5	1.9E+00
4055.55	8	8	4.31E-01	2939.31	5	5	1.9E+00	2949.20	5	7	1.9E+00
4058.94	4	2	7.25E-01	2949.20	5	7	1.9E+00	3441.99	9	7	4.3E-01
4061.74	8	6	1.9E-01	3441.99	9	7	4.3E-01	3460.32	7	5	3.2E-01
4063.53	6	6	1.69E-01	3460.32	7	5	3.2E-01	3474.13	5	3	1.5E-01
4065.08	12	14	2.5E-01	<i>Molybdenum</i>				<i>Mo I</i>			
4066.24	10	8	2.2E-01	<i>Molybdenum</i>				2616.79	3	5	7.34E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
2621.06	7	7	1.16E-01	3036.31	3	5	5.81E-01	3228.21	5	7	3.85E-01
2628.96	3	3	2.81E-01	3041.70	13	11	5.94E-01	3229.79	9	11	1.44E-01
2629.85	5	7	7.75E-01	3046.80	13	11	1.63E-01	3233.14	13	13	6.33E-01
2631.50	1	3	2.54E-01	3047.31	11	9	5.01E-01	3237.06	7	9	2.95E-01
2638.30	5	5	7.57E-01	3055.32	9	7	4.29E-01	3244.47	5	3	2.80E-01
2640.98	7	5	1.20E+00	3057.56	7	5	2.64E-01	3247.61	5	5	1.71E-01
2644.36	5	7	1.96E-01	3061.59	7	5	4.41E-01	3249.93	5	3	1.87E-01
2649.46	7	9	9.84E-01	3064.27	13	13	8.46E-01	3251.65	3	5	3.05E-01
2655.02	9	7	4.08E-01	3065.04	13	13	3.08E-01	3256.21	5	3	6.89E-01
2658.11	7	7	6.43E-01	3069.51	5	5	1.52E-01	3256.72	3	3	1.31E-01
2665.09	7	9	1.32E-01	3069.96	11	11	2.72E-01	3259.16	11	13	1.62E-01
2679.85	9	11	1.31E+00	3070.89	9	11	1.87E-01	3262.63	7	9	3.62E-01
2684.16	9	9	4.18E-01	3074.37	11	11	1.42E+00	3264.40	11	9	5.42E-01
2706.11	3	5	2.03E-01	3079.88	9	11	9.55E-01	3265.14	5	7	2.60E-01
2710.74	3	3	1.57E-01	3080.40	7	9	3.61E-01	3266.16	9	11	1.95E-01
2725.15	3	5	2.79E-01	3081.16	3	5	2.35E-01	3270.90	7	7	3.59E-01
2728.71	3	3	1.26E-01	3085.62	9	9	1.63E+00	3276.07	11	9	1.18E-01
2733.39	5	7	2.95E-01	3089.13	11	9	1.53E-01	3285.03	1	3	1.41E-01
2743.71	1	3	2.47E-01	3089.71	5	7	2.34E-01	3285.35	9	7	4.49E-01
2745.38	13	11	1.29E-01	3094.66	7	7	1.63E+00	3287.38	5	5	1.38E-01
2751.47	7	9	2.54E-01	3099.92	9	7	1.45E-01	3289.01	9	9	5.08E-01
2756.26	5	3	1.18E-01	3100.88	7	9	1.20E+00	3290.82	7	5	5.44E-01
2761.53	9	11	2.06E-01	3101.34	5	5	1.92E+00	3305.56	5	3	1.74E-01
2763.02	3	1	4.44E-01	3106.34	7	5	2.21E-01	3305.91	7	9	3.06E-01
2766.25	3	5	1.17E-01	3117.54	13	13	1.89E-01	3307.13	7	9	1.25E-01
2787.83	9	7	2.85E-01	3123.03	3	3	2.81E-01	3312.33	7	5	1.62E-01
2792.96	5	3	1.53E-01	3125.03	5	3	1.98E-01	3323.95	9	7	2.82E-01
2798.02	7	5	1.22E-01	3132.59	7	9	1.79E+00	3325.13	5	3	2.26E-01
2801.47	5	7	1.24E-01	3135.90	9	11	3.68E-01	3325.67	5	5	1.72E-01
2825.68	5	7	2.53E-01	3136.75	9	11	1.57E-01	3327.30	1	3	2.88E-01
2826.75	7	7	4.23E-01	3142.75	3	5	4.10E-01	3336.56	9	9	1.64E-01
2876.54	9	9	2.84E-01	3147.35	13	11	2.41E-01	3340.16	5	3	1.20E-01
2886.60	11	11	4.74E-01	3155.19	7	7	2.75E-01	3344.73	3	5	6.04E-01
2906.06	3	3	8.04E-01	3158.17	7	7	4.63E-01	3346.83	11	11	1.13E-01
2913.52	5	3	1.38E-01	3170.34	7	7	1.37E+00	3347.00	3	3	2.72E-01
2915.38	5	3	7.31E-01	3171.38	5	7	2.03E-01	3358.12	5	7	7.59E-01
2918.84	5	3	3.79E-01	3175.59	13	11	8.40E-01	3361.37	9	9	1.38E-01
2930.39	1	3	1.91E-01	3179.78	11	13	2.33E-01	3363.78	5	7	2.74E-01
2936.50	11	11	2.33E-01	3183.03	11	9	3.98E-01	3363.87	5	7	1.39E-01
2945.43	7	7	3.66E-01	3184.58	7	5	2.77E-01	3373.81	3	3	2.03E-01
2945.66	3	3	4.08E-01	3185.10	7	7	2.54E-01	3375.22	7	7	1.38E-01
2946.01	5	5	1.68E-01	3185.71	5	3	6.10E-01	3375.65	7	9	1.56E-01
2951.45	9	9	1.43E-01	3188.10	7	9	3.45E-01	3378.19	3	1	1.88E-01
2959.48	9	11	1.75E-01	3188.41	5	7	4.40E-01	3378.46	13	13	3.75E-01
2972.96	5	3	2.69E-01	3192.79	9	11	1.88E-01	3379.96	5	5	4.11E-01
2977.27	9	7	3.28E-01	3193.98	7	5	1.53E+00	3382.48	3	3	2.66E-01
2978.28	7	5	1.50E-01	3194.88	9	11	1.75E-01	3384.61	7	9	7.32E-01
2983.04	1	3	2.82E-01	3195.96	9	7	4.10E-01	3385.87	9	11	3.30E-01
2987.92	3	5	8.43E-01	3197.18	1	3	1.47E-01	3389.79	5	7	1.85E-01
2988.23	5	7	4.28E-01	3198.85	15	13	7.22E-01	3392.17	9	9	1.97E-01
2988.68	7	9	1.61E-01	3200.89	3	5	1.82E-01	3393.65	11	11	2.08E-01
2989.80	9	7	9.27E-01	3205.22	1	3	4.27E-01	3404.33	7	7	2.10E-01
3000.24	9	9	1.40E-01	3205.43	9	11	2.55E-01	3413.37	11	11	1.25E-01
3000.44	5	5	1.25E-01	3205.89	9	9	5.35E-01	3415.27	9	9	1.83E-01
3000.85	5	7	2.58E-01	3208.84	7	5	2.77E-01	3415.61	7	9	1.29E-01
3001.43	5	5	2.31E-01	3210.97	7	5	6.94E-01	3416.14	9	11	2.45E-01
3007.71	7	5	1.90E-01	3214.44	9	7	2.01E-01	3418.52	5	3	1.41E-01
3013.39	7	5	6.06E-01	3215.07	3	5	4.20E-01	3419.69	7	7	1.15E-01
3016.78	9	9	2.75E-01	3216.78	15	13	2.10E-01	3420.04	5	5	3.28E-01
3025.00	5	5	8.49E-01	3221.73	3	1	1.41E+00	3422.31	9	9	2.52E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3425.13	11	11	2.29E-01	3598.88	13	11	5.67E-01	3777.72	13	11	1.66E-01
3427.90	11	13	4.09E-01	3600.73	9	9	2.07E-01	3788.25	7	9	2.87E-01
3434.79	7	7	1.75E-01	3601.88	7	9	1.15E-01	3794.43	9	9	1.22E-01
3435.45	15	15	1.50E+00	3602.94	5	7	2.96E-01	3797.47	7	5	1.48E-01
3437.21	11	9	8.06E-01	3604.07	9	7	3.25E-01	3798.25	7	9	6.90E-01
3438.87	1	3	2.34E-01	3610.61	5	3	1.78E-01	3801.84	9	7	3.16E-01
3441.87	5	3	1.34E-01	3611.99	7	7	1.16E-01	3805.99	5	5	2.44E-01
3442.66	3	3	2.94E-01	3615.16	7	9	1.96E-01	3819.78	9	11	1.47E-01
3445.03	7	9	1.53E-01	3623.22	11	9	5.58E-01	3824.78	5	7	1.40E-01
3445.26	7	5	2.96E-01	3624.46	9	11	5.27E-01	3827.15	7	7	1.94E-01
3445.80	9	9	1.14E-01	3624.62	5	7	1.37E-01	3828.88	7	7	1.35E-01
3447.12	9	11	8.75E-01	3638.20	5	3	3.51E-01	3830.81	5	5	1.83E-01
3447.29	5	3	1.79E-01	3638.21	5	3	3.33E-01	3831.07	7	9	1.20E-01
3449.07	7	9	1.52E-01	3640.62	7	5	1.94E-01	3832.11	9	9	3.05E-01
3449.85	5	7	1.65E-01	3647.84	7	7	2.11E-01	3833.75	9	9	1.70E-01
3452.60	7	7	2.48E-01	3648.70	7	5	1.15E-01	3834.64	3	5	1.20E-01
3456.15	5	5	3.60E-01	3654.58	3	3	1.80E-01	3846.18	7	7	1.26E-01
3456.52	3	3	2.96E-01	3657.36	5	7	2.03E-01	3847.25	3	1	2.41E-01
3460.22	5	3	2.77E-01	3658.13	9	9	1.86E-01	3848.30	9	9	1.26E-01
3460.78	9	7	6.03E-01	3659.36	7	9	6.70E-01	3851.99	11	9	1.78E-01
3465.84	3	1	9.99E-01	3660.92	3	5	1.34E-01	3864.10	7	7	6.24E-01
3466.19	9	7	2.11E-01	3662.15	7	9	1.45E-01	3866.69	3	5	1.74E-01
3466.96	7	7	1.52E-01	3662.99	11	11	3.48E-01	3867.67	5	3	2.22E-01
3467.85	5	7	2.63E-01	3663.27	7	5	2.30E-01	3869.08	5	3	1.35E-01
3469.22	5	3	6.96E-01	3664.81	11	13	9.54E-01	3874.15	7	5	1.67E-01
3469.63	13	15	1.51E-01	3664.88	1	3	1.92E-01	3902.95	7	5	6.17E-01
3470.92	3	5	2.91E-01	3669.34	9	7	2.16E-01	3909.54	9	7	1.13E-01
3475.03	3	3	4.68E-01	3672.81	9	11	1.95E-01	3911.94	5	5	1.15E-01
3479.42	7	5	2.26E-01	3672.82	9	9	1.13E-01	3915.43	5	5	1.40E-01
3483.67	7	7	1.13E-01	3676.23	3	1	5.22E-01	3916.43	5	3	1.78E-01
3483.83	7	5	1.41E-01	3680.68	11	11	2.96E-01	3919.55	11	13	2.24E-01
3489.43	7	7	3.27E-01	3681.72	9	7	1.68E-01	3955.48	13	11	1.71E-01
3504.41	7	9	8.06E-01	3683.01	3	5	1.20E-01	3973.76	11	13	4.39E-01
3505.31	7	9	2.25E-01	3687.96	5	7	2.12E-01	3977.90	9	7	1.35E-01
3508.11	9	9	1.59E-01	3688.97	11	9	3.26E-01	3980.20	5	3	2.70E-01
3510.77	13	13	4.75E-01	3690.59	11	9	2.07E-01	3991.85	11	9	1.29E-01
3517.55	11	11	5.41E-01	3694.94	5	7	6.36E-01	4010.13	5	3	4.38E-01
3518.21	3	3	3.64E-01	3696.04	11	11	3.59E-01	4021.01	9	11	2.65E-01
3521.38	9	9	1.39E-01	3698.07	7	5	1.48E-01	4051.18	13	11	1.36E-01
3521.41	9	11	6.06E-01	3708.55	7	9	1.28E-01	4062.08	11	9	1.96E-01
3524.65	5	3	3.10E-01	3715.75	9	7	2.38E-01	4069.88	13	11	3.25E-01
3524.98	7	9	2.25E-01	3718.48	5	7	1.34E-01	4076.19	9	9	1.16E-01
3538.92	11	11	2.24E-01	3720.25	7	9	2.86E-01	4084.37	9	7	1.94E-01
3540.57	5	3	4.46E-01	3725.55	7	7	1.60E-01	4102.15	5	3	1.22E-01
3542.17	7	5	4.93E-01	3727.68	9	11	1.51E-01	4107.46	7	5	2.02E-01
3552.71	9	7	3.64E-01	3728.30	7	5	1.55E-01	4120.09	13	15	6.05E-01
3555.64	3	3	3.46E-01	3728.50	7	9	2.20E-01	4131.92	9	11	1.56E-01
3558.09	5	7	5.43E-01	3733.02	7	7	1.45E-01	4148.98	9	11	1.56E-01
3563.75	1	3	1.53E-01	3733.41	13	13	2.80E-01	4157.40	13	11	2.17E-01
3566.05	9	9	2.67E-01	3735.62	11	11	1.66E-01	4157.90	9	11	1.60E-01
3566.74	7	7	1.43E-01	3742.28	7	7	1.56E-01	4185.82	11	13	3.82E-01
3570.64	15	15	7.18E-01	3747.19	5	7	3.07E-01	4188.32	11	13	3.32E-01
3573.88	3	5	3.58E-01	3748.48	9	11	3.95E-01	4194.56	11	11	2.70E-01
3580.54	13	11	5.49E-01	3755.10	3	5	1.41E-01	4232.59	9	11	3.17E-01
3581.88	11	13	3.81E-01	3755.16	9	9	2.48E-01	4240.83	5	5	1.68E-01
3584.25	3	3	1.73E-01	3758.52	9	9	1.22E-01	4246.02	11	13	2.00E-01
3585.57	7	5	3.95E-01	3759.60	9	7	1.82E-01	4251.88	13	11	1.76E-01
3588.95	7	7	1.18E-01	3760.88	9	9	2.16E-01	4254.95	7	9	2.01E-01
3590.74	7	9	2.23E-01	3768.73	9	9	2.88E-01	4269.28	11	11	1.36E-01
3595.55	5	5	2.32E-01	3769.99	7	9	2.46E-01	4276.91	7	9	2.85E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
4277.24	9	11	1.35E-01	5926.37	7	7	1.63E-01	735.90	1	3	6.11E+00
4317.92	15	15	1.28E-01	5928.88	7	9	5.32E-01	743.72	1	3	4.86E-01
4325.80	3	3	1.84E-01	7154.11	9	9	3.45E-01	3369.8	5	5	1.0E-03
4326.14	5	7	2.56E-01	<i>Neodymium</i>			3369.9	5	3	7.6E-03	
4340.74	5	7	1.23E-01	<i>Nd II</i>			3375.6	5	3	2.2E-03	
4381.63	13	13	2.93E-01	3780.4	16	18	1.4E-01	3417.9	3	5	9.2E-03
4382.41	11	13	3.83E-01	3805.4	14	16	6.9E-01	3418.0	3	3	2.2E-03
4409.94	13	13	1.38E-01	3807.2	10	12	4.9E-02	3423.9	3	3	1.0E-03
4411.69	11	11	2.63E-01	3863.3	8	10	1.5E-01	3447.7	5	5	2.1E-02
4434.95	9	9	2.51E-01	3941.5	10	10	6.1E-01	3450.8	5	3	4.9E-03
4446.42	11	11	1.90E-01	3951.2	12	12	6.0E-01	3454.2	3	1	3.7E-02
4457.35	7	7	1.28E-01	3973.3	18	18	6.3E-01	3460.5	1	3	7.0E-03
4474.57	5	5	2.10E-01	3979.5	10	12	2.7E-01	3464.3	5	5	6.7E-03
4491.65	11	11	2.09E-01	3990.1	16	16	5.2E-01	3466.6	1	3	1.3E-02
4536.80	13	15	5.03E-01	4012.3	18	20	5.5E-01	3472.6	5	7	1.7E-02
4598.23	1	3	1.47E-01	4061.1	16	18	4.4E-01	3498.1	3	5	5.1E-03
4624.23	9	9	1.32E-01	4106.6	14	16	6.8E-02	3501.2	3	3	1.2E-02
4633.08	3	5	2.35E-01	4109.5	14	16	3.7E-01	3510.7	5	3	2.2E-03
4649.06	3	1	1.25E-01	4133.4	14	12	1.5E-01	3515.2	3	5	6.9E-03
4652.24	5	7	1.55E-01	4156.1	12	14	3.4E-01	3520.5	3	1	9.3E-02
4686.08	3	3	1.72E-01	4205.6	18	16	1.8E-01	3593.5	3	5	9.9E-03
4688.21	13	15	1.54E-01	4284.5	18	18	8.5E-02	3593.6	3	3	6.6E-03
4707.25	7	9	3.63E-01	4303.6	8	10	4.7E-01	3600.2	3	3	4.3E-03
4718.86	5	5	2.17E-01	4325.8	16	16	1.6E-01	3633.7	3	1	1.1E-02
4723.05	9	9	1.23E-01	4358.2	14	14	1.5E-01	3682.2	3	5	1.6E-03
4731.44	9	11	4.49E-01	4382.7	12	10	4.0E-02	3685.7	3	3	3.9E-03
4758.50	11	9	3.01E-01	4400.8	10	10	6.8E-02	3701.2	3	5	2.2E-03
4760.18	11	13	4.67E-01	4451.6	12	14	2.5E-01	4536.3	3	3	5.0E-03
4764.11	9	7	2.16E-01	4456.4	16	18	6.4E-02	4702.5	3	3	2.1E-03
4811.05	13	11	4.36E-01	4463.0	14	16	1.8E-01	4708.9	3	3	4.2E-02
4819.25	11	9	2.71E-01	4958.1	12	10	1.2E-02	4955.4	3	3	3.3E-03
4830.51	9	7	4.07E-01	5130.6	22	20	1.6E-01	5113.7	3	3	1.0E-02
4858.39	13	11	1.24E-01	5192.6	20	18	1.7E-01	5120.5	3	3	5.6E-03
4868.02	7	5	3.11E-01	5249.6	18	16	1.8E-01	5154.4	3	3	1.9E-02
5037.18	9	7	1.14E-01	5276.9	12	10	1.2E-01	5191.3	3	3	1.3E-02
5044.36	7	5	1.31E-01	5293.2	16	14	1.2E-01	5326.4	3	3	6.8E-03
5047.70	3	1	2.61E-01	5302.3	20	18	1.1E-01	5333.3	3	3	5.3E-03
5163.18	9	11	2.03E-01	5311.5	14	12	1.1E-01	5341.1	3	3	1.1E-01
5171.06	5	7	1.84E-01	5319.8	12	10	1.6E-01	5400.6	3	1	9.0E-03
5172.94	5	5	4.11E-01	5357.0	18	16	1.8E-01	5418.6	3	3	5.2E-03
5174.18	5	3	5.83E-01	5371.9	20	20	5.1E-02	5433.7	3	3	2.83E-03
5191.45	7	9	1.62E-01	5485.7	18	18	5.7E-02	5652.6	3	3	8.9E-03
5238.21	7	9	3.74E-01	5594.4	16	16	7.0E-02	5662.5	3	3	6.9E-03
5240.87	7	7	3.89E-01	5620.6	18	18	1.3E-01	5852.5	3	1	6.82E-01
5242.80	7	5	2.01E-01	5688.5	14	14	5.9E-02	5868.4	3	3	1.4E-02
5261.53	5	7	1.13E-01	5718.1	16	16	8.7E-02	5881.9	5	3	1.15E-01
5280.85	5	5	1.28E-01	5726.8	10	10	5.6E-02	5913.6	3	3	4.8E-02
5355.52	9	9	1.21E-01	5740.9	12	12	7.2E-02	5939.3	5	3	2.00E-03
5356.46	11	11	2.11E-01	5804.0	10	10	4.6E-02	5944.8	5	5	1.13E-01
5360.51	9	11	6.19E-01	5865.1	16	18	1.3E-02	5961.6	3	3	3.3E-02
5364.28	9	9	2.26E-01	6051.9	12	10	1.1E-02	5975.5	5	3	3.51E-02
5460.50	5	3	3.46E-01	<i>Neon</i>			6030.0	3	3	5.61E-02	
5493.76	7	5	2.13E-01	<i>Ne I</i>			6046.1	3	3	2.26E-03	
5506.49	5	7	3.61E-01	615.63	1	3	3.8E-01	6074.3	3	1	6.03E-01
5533.03	5	5	3.72E-01	618.67	1	3	9.3E-01	6096.2	3	5	1.81E-01
5570.44	5	3	3.30E-01	619.10	1	3	3.3E-01	6118.0	5	3	6.09E-03
5849.71	3	3	3.02E-01	626.82	1	3	7.4E-01	6128.5	3	3	6.7E-03
5851.50	3	5	1.55E-01	629.74	1	3	4.8E-01	6143.1	5	5	2.82E-01
5893.36	5	5	2.60E-01				6150.3	3	3	1.5E-02	
5895.93	5	7	3.12E-01				6163.6	1	3	1.46E-01	

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
6217.3	5	3	6.37E-02	462.39	2	2	2.3E+01	3243.4	6	6	2.3E-01
6266.5	1	3	2.49E-01	1907.5	4	2	2.8E-01	3244.1	6	8	1.5E+00
6273.0	3	3	9.7E-03	1916.1	4	4	6.9E-01	3248.1	4	4	2.4E-01
6293.7	3	3	6.39E-03	1930.0	2	2	5.7E-01	3255.4	6	4	3.8E-02
6304.8	3	5	4.16E-02	1938.8	2	4	1.3E-01	3263.4	2	4	3.9E-01
6328.2	5	3	3.39E-02	2858.0	6	6	7.9E-01	3269.9	4	6	5.1E-01
6330.9	3	3	2.3E-02	2870.0	6	6	1.7E-01	3270.8	6	4	5.7E-02
6334.4	5	5	1.61E-01	2873.0	6	4	3.8E-01	3297.7	6	6	4.3E-01
6351.9	1	3	3.45E-03	2876.3	4	6	7.8E-01	3309.7	4	2	3.1E-01
6383.0	3	3	3.21E-01	2876.5	6	4	3.3E-01	3310.5	4	4	6.9E-02
6401.1	3	3	1.39E-02	2878.1	2	2	6.9E-02	3311.3	4	2	2.6E-01
6402.2	5	7	5.14E-01	2888.4	4	6	7.0E-02	3314.7	6	6	4.4E-02
6506.5	3	5	3.00E-01	2891.5	4	4	6.1E-02	3319.7	4	2	1.6E+00
6532.9	1	3	1.08E-01	2897.0	6	8	5.2E-02	3320.2	8	6	2.1E-01
6599.0	3	3	2.32E-01	2906.8	2	4	5.5E-01	3323.7	4	4	1.6E+00
6602.9	3	3	5.9E-03	2910.1	4	2	1.7E+00	3327.2	4	4	9.1E-01
6652.1	3	1	2.9E-03	2910.4	2	4	5.9E-01	3329.2	8	8	8.8E-01
6678.3	3	5	2.33E-01	2916.2	6	4	9.6E-02	3330.7	6	6	3.9E-02
6717.0	3	3	2.17E-01	2925.6	2	2	5.6E-01	3334.8	6	8	1.8E+00
6721.1	3	3	4.9E-04	2933.7	6	6	6.9E-02	3336.1	4	6	1.1E+00
6929.5	3	5	1.74E-01	2955.7	6	4	1.2E+00	3344.4	2	2	1.5E+00
7024.1	3	3	1.89E-02	3001.7	4	4	8.7E-01	3345.5	6	4	1.4E+00
7032.4	5	3	2.53E-01	3017.3	6	4	3.5E-01	3345.8	4	4	2.2E-01
7051.3	3	3	3.0E-02	3027.0	6	6	1.4E+00	3353.6	4	2	1.2E-01
7059.1	3	5	6.8E-02	3028.7	4	2	8.5E-01	3355.0	4	6	1.3E+00
7173.9	3	5	2.87E-02	3028.9	2	4	4.7E-01	3356.3	6	6	2.0E-01
7245.2	3	3	9.35E-02	3034.5	6	8	3.1E+00	3357.8	6	6	5.0E-01
7304.8	1	3	2.55E-03	3037.7	4	4	2.1E+00	3360.3	2	4	8.6E-01
7438.9	1	3	2.31E-02	3045.6	2	2	2.5E+00	3360.6	2	4	8.2E-01
7472.4	3	3	4.0E-02	3047.6	4	6	1.8E+00	3362.9	4	2	3.5E-01
7535.8	3	3	4.3E-01	3054.7	2	4	9.4E-01	3371.8	4	6	2.2E-01
7937.0	5	5	7.8E-03	3092.9	6	6	1.3E+00	3374.1	4	4	3.0E-01
8082.5	3	3	1.2E-03	3097.1	8	8	1.3E+00	3378.2	2	2	1.7E+00
8118.5	3	3	4.9E-02	3118.0	8	6	4.2E-02	3379.3	2	2	3.0E-01
8128.9	3	5	7.2E-03	3134.1	6	4	2.6E-01	3386.2	4	6	5.5E-02
8259.4	5	5	2.03E-02	3140.4	8	6	2.4E-01	3388.4	4	6	2.2E+00
8571.4	3	3	5.5E-02	3151.1	6	6	4.8E-02	3390.6	2	4	7.7E-02
8582.9	3	5	1.00E-02	3154.8	8	6	1.8E-02	3392.8	2	4	4.4E-01
8647.0	5	5	3.91E-02	3164.4	8	8	1.6E-01	3404.8	4	6	1.9E+00
8681.9	3	3	2.1E-01	3165.7	6	6	1.2E-01	3407.0	6	8	2.3E+00
8767.5	3	3	1.1E-03	3173.6	6	4	4.5E-02	3411.4	4	2	6.1E-01
8771.7	3	3	1.6E-01	3176.1	4	6	6.0E-02	3413.2	4	4	1.8E+00
8783.8	3	5	3.13E-01	3187.6	4	6	1.4E-02	3414.9	4	6	1.8E-02
8865.3	3	3	9.4E-03	3188.7	6	6	3.9E-01	3416.9	6	6	6.4E-01
9201.8	3	3	9.1E-02	3190.9	4	6	1.5E-01	3417.7	6	8	1.6E+00
9433.0	3	3	1.1E-03	3194.6	4	4	5.2E-01	3438.9	2	2	1.4E+00
9486.7	3	3	2.5E-02	3198.6	6	8	1.7E+00	3440.7	2	4	3.5E-01
9534.2	3	3	6.3E-02	3198.9	4	4	2.3E-01	3453.1	4	4	4.6E-01
10621	3	3	2.4E-03	3209.0	8	8	1.6E-01	3454.8	4	4	1.6E+00
11409	3	3	4.2E-02	3209.4	2	4	6.0E-01	3456.6	2	4	9.6E-01
11525	3	3	8.4E-02	3213.7	2	4	1.7E+00	3457.1	4	6	9.9E-02
11767	3	3	6.9E-02	3214.3	4	6	2.2E+00	3459.3	6	6	1.6E+00
12459	3	3	1.5E-02	3218.2	8	10	3.6E+00	3475.2	4	4	1.2E-02
				3224.8	6	8	3.5E+00	3477.6	4	6	4.3E-01
<i>Ne II</i>				3229.5	8	8	1.3E-01	3481.9	4	2	1.4E+00
*357.03	6	10	3.8E+01	3229.6	8	10	3.6E+00	3503.6	2	2	2.0E+00
*361.77	6	2	1.6E+01	3230.1	6	6	1.8E+00	3522.7	4	2	2.3E-02
*406.28	6	10	1.8E+01	3230.4	4	6	1.4E-01	3538.0	4	2	7.6E-01
*446.37	6	6	4.07E+01	3232.0	6	4	2.7E-01	3539.9	4	4	3.6E-02
460.73	4	2	4.7E+01	3232.4	4	4	1.6E+00	3542.2	6	4	6.0E-01





$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
4732.47	7	9	9.3E-02	2270.21	8	10	1.56E+00	187	4	6	1.2E+02
4752.43	3	3	2.0E-01	2278.77	8	6	2.8E+00	187	4	2	3.3E+02
4756.52	9	9	1.5E-01	2287.09	6	4	2.8E+00	188	2	2	4.7E+02
4786.54	11	11	1.8E-01	2296.55	8	8	1.98E+00	190	6	8	2.0E+02
4812.00	3	1	9.5E-02	2297.14	6	4	2.70E+00	192	6	8	4.54E+02
4829.03	5	7	1.9E-01	2297.49	4	2	3.0E+00	192	6	6	3.1E+02
4831.18	9	7	1.6E-01	2298.27	6	6	2.8E+00	194	4	6	2.8E+02
4838.64	9	7	2.2E-01	2303.00	8	6	2.9E+00	194	2	4	5.5E+02
4855.41	5	5	5.7E-01	2316.04	10	8	2.88E+00	194	2	2	1.1E+02
4904.41	5	3	6.2E-01	2334.58	8	8	8.0E-01	194	4	4	3.5E+02
4912.03	3	3	1.5E-01	2375.42	6	8	6.6E-01	194.04	4	6	4.6E+02
4913.97	1	3	2.2E-01	2394.52	8	10	1.70E+00	195.27	4	4	9.5E+01
4918.36	9	7	2.3E-01	2416.13	6	8	2.1E+00	196	4	6	6.7E+02
4935.83	7	5	2.4E-01	2437.89	8	10	5.4E-01	197	4	6	1.5E+02
4937.34	9	9	1.2E-01	2510.87	8	10	5.8E-01	197	4	2	1.2E+02
4953.20	5	5	1.2E-01					199	2	4	4.9E+02
4980.17	9	11	1.9E-01	<i>Ni III</i>				206	2	2	3.7E+02
5000.34	7	7	1.4E-01	1692.51	11	13	7.9E+00	217	4	4	1.1E+02
5012.46	7	7	1.1E-01	1709.90	9	11	6.3E+00	218.391	2	4	9.5E+01
5017.58	11	11	2.0E-01	1719.46	5	7	6.0E+00	223.119	2	2	1.3E+02
5035.37	7	9	5.7E-01	1722.28	3	5	5.9E+00	231	4	4	1.6E+02
5042.20	3	5	1.4E-01	1724.52	3	1	6.7E+00	232.475	4	4	4.07E+02
5048.85	7	7	1.6E-01	1741.96	9	7	5.7E+00	233	6	4	2.4E+02
5080.53	9	11	3.2E-01	1752.43	7	5	5.5E+00	235	4	2	3.8E+02
5081.11	7	9	5.7E-01	1760.56	5	3	6.5E+00	235	6	6	2.5E+02
5082.35	3	3	2.5E-01	1769.64	11	11	6.2E+00	236	4	4	1.2E+02
5084.08	7	9	3.1E-01	1823.06	9	9	5.6E+00	237.875	4	2	2.6E+02
5099.95	7	7	2.9E-01	<i>Ni XIV</i>				238	6	4	1.3E+02
5115.40	11	9	2.2E-01	164.13	6	8	1.2E+03	239.550	2	2	2.6E+02
5129.37	7	5	1.2E-01	168	2	4	2.4E+02	245	4	4	1.4E+02
5155.14	5	5	1.1E-01	168.12	4	2	8.5E+02	245	4	6	3.2E+02
5155.76	5	7	2.9E-01	169.69	4	4	9.8E+02	249	6	8	3.3E+02
5176.57	5	5	1.8E-01	170.50	4	4	7.1E+02	249	6	4	1.2E+02
5371.33	7	7	1.6E-01	171.37	4	6	9.4E+02	250	4	2	1.6E+02
5476.91	1	3	9.5E-02	172.16	6	6	4.7E+02	254	6	4	1.8E+02
5637.12	3	3	1.1E-01	172.80	6	4	1.4E+02	<i>Ni XVII</i>			
5664.02	5	7	1.1E-01	172.80	4	4	5.6E+02	30.919	1	3	2.77E+03
5695.00	3	3	1.7E-01	177.28	4	4	8.9E+01	42.855	1	3	4.75E+03
6086.29	3	5	1.1E-01	181	4	6	7.4E+01	54.451	9	11	1.5E+04
6175.42	3	3	1.7E-01	182.14	4	2	1.5E+02	55.361	1	3	6.7E+03
7122.24	5	7	2.1E-01	196	4	2	3.8E+01	57.348	7	9	1.4E+04
7381.94	9	11	9.7E-02	288.894	4	4	4.6E+01	197.39	1	3	1.6E+02
7422.30	7	5	1.8E-01	292.399	6	6	3.6E+01	199.87	3	5	2.1E+02
7727.66	7	7	1.1E-01	<i>Ni XV</i>				204	3	3	1.8E+02
<i>Ni II</i>				50.249	5	7	6.8E+03	205	3	1	2.4E+02
2165.55	10	10	2.4E+00	60.890	9	11	1.0E+04	206	1	3	3.0E+02
2169.10	8	8	1.58E+00	64.635	7	9	9.6E+03	207.50	5	7	2.5E+02
2174.67	8	10	1.43E+00	163.64	5	7	5.6E+01	215.89	3	5	4.8E+02
2175.15	6	6	1.77E+00	173.73	5	7	7.6E+02	216	1	3	2.7E+02
2184.61	4	4	2.90E+00	175	3	1	5.7E+02	217	5	7	2.4E+02
2201.41	4	6	1.3E+00	179.28	5	7	7.5E+02	227	5	5	1.6E+02
2206.72	6	8	1.66E+00	181	1	3	6.8E+02	249.180	1	3	2.75E+02
2216.48	10	12	3.4E+00	269	3	1	5.3E+01	281.50	3	1	2.1E+02
2220.40	6	8	2.3E+00	278.386	5	5	4.3E+01	282	3	1	2.4E+02
2222.96	10	10	9.8E-01	<i>Ni XVI</i>				284	5	3	1.5E+02
2224.86	8	8	1.55E+00	166	4	6	3.1E+02	292	5	7	2.2E+02
2226.33	6	6	1.3E+00	168	6	8	3.2E+02	<i>Ni XVIII</i>			
2253.85	4	6	1.98E+00	182	2	2	2.5E+02	24.881	2	4	8.6E+02
2264.46	6	8	1.43E+00	185.23	2	4	4.2E+02	25.070	4	6	9.9E+02

$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
26.02	2	4	1.26E+03	11.48	3	1	1.1E+05	137.01	4	4	2.6E+02
26.020	2	4	1.1E+03	11.48	1	3	4.0E+05	138.80	4	6	7.2E+01
26.046	2	2	1.1E+03	11.517	5	7	1.4E+05	153.47	2	2	1.27E+02
26.218	4	6	1.5E+03	11.539	5	7	1.2E+05	159.69	2	4	8.9E+01
27.98	4	6	1.0E+03	11.67	1	3	8.0E+04				
27.982	2	4	2.0E+03	11.72	3	3	2.3E+04	<i>Ni XXV</i>			
28.018	6	8	1.1E+03	12.454	5	3	3.3E+04	9.30	3	1	9.3E+04
28.220	4	6	2.33E+03	12.472	3	3	1.8E+04	9.31	5	7	8.2E+04
29.383	4	6	1.58E+03	12.502	5	5	2.8E+04	9.32	3	5	7.8E+04
29.422	6	8	1.69E+03					9.34	1	3	1.1E+05
29.779	2	4	1.9E+03	<i>Ni XXII</i>				9.42	3	1	9.0E+04
29.829	2	2	1.9E+03	72.52	4	2	2.84E+02	9.49	3	5	8.9E+04
31.845	4	6	2.7E+03	84.06	6	4	1.2E+03	9.60	1	3	1.8E+05
31.890	6	8	3.0E+03	84.24	4	2	5.6E+02	9.63	3	5	2.4E+05
32.034	2	4	3.4E+03	85.86	4	2	4.9E+02	9.64	3	3	1.3E+05
32.340	4	6	4.0E+03	88.00	4	2	1.2E+03	9.71	3	1	2.3E+05
36.990	4	6	5.5E+03	95.95	2	2	4.4E+02	9.71	3	3	1.8E+05
37.049	6	8	5.9E+03	98.16	4	4	5.2E+02	9.74	5	7	3.0E+05
41.015	2	4	2.97E+03	98.58	4	4	2.45E+02	9.75	3	5	1.3E+05
41.218	2	2	3.2E+03	100.60	6	6	3.9E+02	9.76	1	3	3.03E+05
43.814	2	4	5.5E+03	101.31	6	4	4.83E+02	9.76	5	3	7.5E+04
44.365	4	6	6.8E+03	103.31	4	2	2.66E+02	9.78	5	7	2.9E+05
44.405	4	4	1.14E+03	106.04	4	4	2.36E+02	9.86	5	7	4.8E+05
52.615	4	6	1.5E+04	106.16	4	2	5.1E+02	9.87	3	5	2.03E+05
52.720	6	8	1.6E+04	124.31	2	2	3.7E+02	9.92	5	5	1.3E+05
52.745	6	6	1.06E+03	126.32	4	4	3.3E+02	9.94	5	7	1.29E+05
59.950	6	4	9.6E+02					9.97	3	5	2.5E+05
60.212	4	2	1.1E+03	<i>Ni XXIII</i>				10.08	1	3	2.80E+05
63.512	4	6	7.9E+02	87.66	3	3	2.8E+02				
63.589	6	8	8.5E+02	88.11	5	3	8.3E+02	<i>Ni XXVI</i>			
69.075	4	6	8.0E+02	90.49	3	3	1.77E+02	1.5930	4	2	3.4E+06
76.254	4	6	1.38E+03	90.96	5	3	2.5E+02	1.5935	2	2	4.0E+06
76.359	6	8	1.47E+03	91.83	5	3	7.5E+02	1.5973	4	4	8.1E+06
99.275	2	4	1.0E+03	92.32	3	1	4.39E+02	1.5977	2	4	4.4E+06
100.4	4	6	1.2E+03	100.42	1	3	2.1E+02	1.5982	2	2	7.3E+06
114.46	4	6	2.5E+03	102.08	5	5	5.3E+02	1.5996	2	2	2.7E+06
114.74	6	8	2.7E+03	103.23	3	3	2.4E+02	1.6005	4	6	2.7E+06
				103.67	5	5	1.78E+02	1.6036	4	2	2.1E+06
<i>Ni XIX</i>				104.70	3	1	2.94E+02	9.390	2	4	2.59E+05
9.140	1	3	3.1E+04	106.02	5	5	2.87E+02	9.535	4	6	2.96E+05
9.153	1	3	5.2E+03	108.27	7	5	3.32E+02				
9.977	1	3	1.1E+05	111.23	3	1	2.26E+02	<i>Ni XXVII</i>			
10.110	1	3	9.4E+04	111.78	5	3	2.19E+02	1.2534	1	3	3.35E+05
10.283	1	3	4.7E+03	111.86	1	3	1.7E+02	1.2824	1	3	6.38E+05
10.433	1	3	5.1E+03	112.55	3	1	1.0E+03	1.3500	1	3	1.63E+06
11.539	1	3	4.8E+04	128.87	5	5	4.02E+02	1.3516	1	3	2.4E+05
11.599	1	3	6.3E+03	133.54	3	3	1.86E+02	1.531	3	3	2.0E+05
12.435	1	3	3.66E+05	137.55	3	1	2.53E+02	1.534	3	1	6.9E+06
12.656	1	3	1.0E+05					1.537	5	5	2.3E+06
13.779	1	3	1.23E+04	<i>Ni XXIV</i>				1.537	1	3	3.7E+06
14.043	1	3	1.31E+04	101.13	6	4	1.63E+02	1.538	3	5	3.9E+06
40.7	3	3	6.4E+03	102.11	4	4	5.4E+02	1.539	1	3	2.6E+06
40.7	3	1	8.4E+03	103.43	2	4	1.3E+02	1.539	3	5	2.6E+06
41.132	7	9	9.4E+03	103.53	4	2	4.17E+02	1.540	3	3	1.7E+06
				104.64	2	2	4.7E+02	1.541	3	5	5.5E+06
<i>Ni XXI</i>				106.68	4	2	3.67E+02	1.542	3	3	3.6E+06
11.13	3	3	1.7E+04	113.14	4	4	1.65E+02	1.542	5	5	3.5E+06
11.23	5	3	1.7E+04	118.52	2	4	1.5E+02	1.544	5	3	3.2E+06
11.239	5	7	5.7E+04	122.72	6	4	2.17E+02	1.546	3	5	1.6E+06
11.28	3	1	2.2E+05	134.73	6	6	1.44E+02	1.547	3	3	2.1E+05
11.318	5	7	2.8E+05	135.47	4	4	8.0E+01	1.549	1	3	2.0E+05



$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
1.551	3	1	8.2E+05	6926.67	4	6	7.75E-03	9968.51	6	4	4.50E-03
1.558	3	1	6.5E+05	6945.18	6	6	1.83E-02	9980.42	4	6	8.10E-03
1.5883	1	3	6.02E+06	6951.60	2	4	1.03E-02	9997.73	8	8	9.20E-03
1.5963	1	3	7.70E+05	6960.50	4	4	4.67E-03				
<i>Nitrogen</i>											
<i>NI</i>											
1163.88	6	6	7.52E-01	6973.07	2	2	3.83E-03	<i>NII</i>			
1164.00	4	6	1.27E-02	6979.18	6	4	9.83E-03	474.891	5	5	9.66E+00
1164.21	6	4	5.17E-02	6982.03	4	2	2.04E-02	475.647	1	3	1.17E+01
1164.32	4	4	6.94E-01	7423.64	2	4	5.95E-02	475.698	3	5	1.58E+01
1167.45	6	8	1.29E+00	7442.30	4	4	1.24E-01	475.757	3	3	8.75E+00
1168.42	6	6	4.24E-02	7468.31	6	4	1.93E-01	475.803	5	7	2.10E+01
1168.54	4	6	1.24E+00	7898.98	6	4	2.82E-01	475.884	5	5	5.25E+00
1176.51	6	4	9.22E-01	7899.28	4	4	3.28E-02	508.697	5	5	1.91E+00
1176.63	4	4	1.02E-01	7915.42	4	2	3.13E-01	510.758	5	7	1.87E+01
1177.69	4	2	1.02E+00	8184.86	4	6	8.58E-02	513.849	5	5	1.24E+01
1199.55	4	6	4.01E+00	8188.01	2	4	1.27E-01	529.355	1	3	7.23E+00
1200.22	4	4	3.99E+00	8200.36	2	2	4.95E-02	529.413	3	1	2.43E+01
1200.71	4	2	3.98E+00	8210.72	4	4	4.84E-02	529.491	3	3	6.75E+00
1310.54	4	6	8.42E-01	8216.34	6	6	2.23E-01	529.637	3	5	4.92E+00
1316.29	4	6	1.42E-02	8223.13	4	2	2.64E-01	529.722	5	3	1.03E+01
1492.63	6	4	3.13E+00	8242.39	6	4	1.36E-01	529.867	5	5	1.94E+01
1492.82	4	4	3.51E-01	8567.74	2	4	4.92E-02	533.511	1	3	2.39E+01
1494.68	4	2	3.72E+00	8594.00	2	2	2.09E-01	533.581	3	5	3.20E+01
3822.03	2	2	3.70E-02	8629.24	4	4	2.66E-01	533.650	3	3	1.66E+01
3830.43	4	4	4.67E-02	8655.88	4	2	1.05E-01	533.729	5	7	4.13E+01
3834.22	4	2	1.89E-02	8680.28	6	8	2.46E-01	533.815	5	5	9.19E+00
4099.94	2	4	3.48E-02	8683.40	4	6	1.80E-01	547.818	5	3	2.16E+00
4109.95	4	6	3.90E-02	8686.15	2	4	1.09E-01	559.762	1	3	1.14E+01
4113.97	4	4	6.62E-03	8703.25	2	2	2.10E-01	574.650	5	7	3.60E+01
4137.64	2	4	2.80E-03	8711.70	4	4	1.28E-01	582.156	5	5	2.85E+01
4143.43	4	4	6.09E-03	8718.84	6	6	6.75E-02	635.197	1	3	2.33E+01
4151.48	6	4	1.01E-02	8728.90	4	2	3.76E-02	644.634	1	3	1.21E+01
4249.87	4	2	2.59E-02	8747.37	6	4	1.04E-02	644.837	3	3	3.64E+01
4264.00	6	4	2.26E-02	9028.92	2	2	3.02E-01	645.178	5	3	6.07E+01
4356.29	6	8	5.10E-02	9045.88	6	8	2.80E-01	660.286	5	3	3.69E+01
4385.54	2	2	8.84E-03	9049.49	6	6	1.88E-02	671.016	3	5	2.47E+00
4392.41	4	2	1.76E-02	9049.89	4	6	2.60E-01	671.386	5	5	7.40E+00
4435.43	2	4	7.51E-03	9060.48	2	4	2.95E-01	671.411	1	3	3.04E+00
4442.45	4	4	3.81E-02	9187.45	6	6	2.44E-01	671.630	3	3	2.27E+00
4669.89	4	4	7.49E-03	9187.86	4	6	1.76E-02	671.773	3	1	9.85E+00
4914.94	2	2	8.08E-03	9207.59	6	4	2.70E-02	672.001	5	3	3.87E+00
4935.12	4	2	1.76E-02	9208.00	4	4	2.33E-01	745.841	1	3	1.25E+01
5199.84	2	2	1.87E-02	9386.81	2	4	2.24E-01	746.984	5	3	3.85E+01
5201.61	2	4	1.87E-02	9392.79	4	6	2.63E-01	748.369	5	3	3.83E+00
5281.20	6	6	2.45E-03	9460.68	4	4	3.98E-02	775.965	5	5	3.08E+01
5344.05	6	6	6.10E-04	9776.90	2	4	1.18E-02	915.612	1	3	4.38E+00
5356.62	4	6	1.41E-03	9786.78	4	6	1.13E-02	915.962	3	1	1.32E+01
5367.01	4	4	1.07E-03	9788.29	2	2	2.99E-02	1083.99	1	3	2.18E+00
5372.61	2	4	8.34E-04	9798.56	4	4	2.75E-02	1085.55	5	5	9.47E-01
5378.27	2	2	1.66E-03	9810.01	4	2	5.30E-02	1085.70	5	7	3.87E+00
6606.18	4	6	8.87E-04	9814.02	6	8	6.56E-03	3408.13	3	1	2.19E-01
6622.54	6	6	7.93E-03	9822.75	6	6	4.95E-02	3437.14	3	1	2.07E+00
6626.99	2	4	2.20E-03	9834.61	6	4	4.50E-02	3593.60	3	5	1.21E-01
6636.94	4	4	1.40E-02	9863.33	8	8	9.62E-02	3609.10	3	3	1.41E-01
6644.96	8	6	3.49E-02	9872.15	8	6	2.97E-02	3615.86	3	1	1.53E-01
6646.50	2	2	2.18E-02	9883.38	2	2	2.93E-02	3829.80	3	5	2.42E-01
6653.46	6	4	2.74E-02	9905.52	4	2	3.11E-03	3838.37	5	5	6.98E-01
6656.51	4	2	2.17E-02	9909.22	2	4	7.58E-03	3842.19	1	3	3.06E-01
				9931.47	4	4	3.64E-02	3847.40	3	3	2.22E-01
				9947.07	6	8	1.08E-02	3855.10	3	1	8.82E-01
				9965.75	4	6	7.60E-03	3856.06	5	3	3.71E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3919.00	3	3	6.76E-01	5025.66	7	7	1.07E-01	5931.78	3	5	4.27E-01
3955.85	3	5	1.31E-01	5040.71	7	5	3.78E-03	5940.24	3	3	2.26E-01
3995.00	3	5	1.35E+00	5045.10	5	3	3.42E-01	5941.65	5	7	5.54E-01
4114.33	3	3	1.42E-03	5073.59	3	3	2.59E-02	5952.39	5	5	1.27E-01
4124.08	3	5	3.20E-01	5168.05	3	5	3.06E-01	5960.91	5	3	1.34E-02
4133.67	5	5	5.30E-01	5170.16	3	3	6.54E-01	6065.00	3	5	2.21E-03
4145.77	7	5	7.36E-01	5171.27	3	1	8.71E-01	6284.32	5	3	7.74E-02
4374.99	3	5	5.55E-03	5171.47	5	7	5.81E-01	6379.62	3	3	6.11E-02
4447.03	3	5	1.14E+00	5172.34	3	5	6.01E-01	6482.05	3	3	3.01E-01
4459.94	3	1	1.12E-01	5172.97	1	3	5.01E-01	6610.56	5	7	6.34E-01
4465.53	3	3	2.36E-02	5173.39	5	7	7.36E-01	6857.03	5	3	2.53E-01
4477.68	5	3	8.85E-02	5174.46	5	5	5.07E-01	6869.58	5	5	2.51E-01
4488.09	5	5	1.30E-02	5175.89	7	9	8.93E-01	6887.83	5	7	2.49E-01
4507.56	7	5	1.00E-01	5176.57	5	3	2.17E-01	7762.24	5	5	8.74E-02
4564.76	3	5	1.41E-02	5177.06	3	3	5.00E-01	8438.74	1	3	2.24E-01
4601.48	3	5	2.35E-01	5179.34	7	9	8.67E-01	8831.75	1	3	8.42E-03
4607.15	1	3	3.26E-01	5179.52	9	11	1.07E+00	8855.30	3	3	2.51E-02
4613.87	3	3	2.26E-01	5180.36	5	5	4.28E-01	8893.29	5	3	4.12E-02
4621.39	3	1	9.55E-01	5183.20	7	7	2.88E-01				
4630.54	5	5	7.72E-01	5184.96	7	7	3.20E-01	<i>N III</i>			
4643.09	5	3	4.51E-01	5185.09	5	3	7.11E-02	374.198	2	4	9.89E+01
4654.53	3	5	2.43E-02	5186.21	7	5	5.76E-02	451.871	2	2	1.03E+01
4667.21	3	3	2.99E-02	5190.38	9	9	1.77E-01	452.227	4	2	2.05E+01
4674.91	3	1	1.05E-01	5191.96	7	5	4.25E-02	684.998	2	4	9.63E+00
4694.27	1	3	1.23E-01	5199.50	9	7	1.51E-02	685.515	2	2	3.83E+01
4695.90	3	5	1.29E-01	5313.42	3	3	1.41E-01	685.817	4	4	4.54E+01
4697.64	3	3	3.06E-02	5320.20	5	3	4.20E-01	686.336	4	2	1.95E+01
4698.55	3	1	3.67E-01	5320.96	3	5	2.52E-01	763.334	2	2	9.58E+00
4700.03	5	7	1.05E-01	5327.76	5	5	4.65E-02	764.351	4	2	1.85E+01
4702.50	5	5	9.15E-02	5338.73	5	7	1.85E-01	771.545	2	4	8.19E+00
4704.25	5	3	2.13E-01	5340.21	7	5	2.59E-01	771.901	4	4	1.64E+01
4706.40	7	9	6.09E-02	5351.23	7	7	3.67E-01	772.384	6	4	2.45E+01
4709.58	7	7	1.82E-01	5383.72	3	5	3.31E-03	772.889	6	4	2.09E+01
4712.07	7	5	1.46E-01	5452.07	1	3	8.89E-02	772.955	4	2	2.34E+01
4718.38	9	9	3.02E-01	5454.22	3	1	3.34E-01	979.832	4	4	8.84E+00
4721.58	9	7	7.75E-02	5462.58	3	3	1.00E-01	979.905	6	6	9.21E+00
4774.24	3	5	3.24E-02	5478.09	3	5	4.75E-02	989.799	2	4	4.18E+00
4779.72	3	3	2.52E-01	5480.05	5	3	1.30E-01	991.511	4	4	8.17E-01
4781.19	5	7	2.05E-02	5495.65	5	5	2.40E-01	991.577	4	6	4.97E+00
4788.14	5	5	2.52E-01	5526.23	3	5	2.13E-01	1747.85	2	4	1.28E+00
4793.65	5	3	7.77E-02	5530.24	5	7	4.04E-01	1751.22	4	4	2.48E-01
4803.29	7	7	3.18E-01	5535.35	7	9	6.04E-01	1751.66	4	6	1.51E+00
4810.30	7	5	4.75E-02	5535.38	3	3	4.53E-01	2972.55	2	2	6.67E-01
4860.17	3	5	1.61E-02	5540.06	3	1	6.03E-01	2977.33	4	2	3.32E-01
4987.38	3	1	7.48E-01	5543.47	5	5	3.51E-01	2978.84	2	4	1.66E-01
4991.24	3	5	3.54E-01	5551.92	7	7	2.00E-01	2983.64	4	4	8.24E-01
4994.36	5	7	2.62E-01	5552.68	5	3	1.50E-01	3342.76	2	2	3.80E-01
4994.37	3	3	7.60E-01	5565.26	7	5	3.97E-02	3353.98	2	4	7.66E-01
4997.22	3	3	1.96E-01	5666.63	3	5	3.74E-01	3354.32	4	6	5.51E-01
5001.13	3	5	9.76E-01	5676.02	1	3	2.96E-01	3355.46	4	2	7.51E-01
5001.47	5	7	1.05E+00	5679.56	5	7	5.25E-01	3358.78	2	2	3.05E-01
5002.70	1	3	8.45E-02	5686.21	3	3	1.94E-01	3360.98	4	4	2.44E-01
5005.15	7	9	1.16E+00	5710.77	5	5	1.24E-01	3365.80	4	2	1.52E+00
5005.30	5	5	6.51E-02	5730.66	5	3	1.34E-02	3367.36	6	6	1.27E+00
5007.33	3	5	7.89E-01	5747.30	3	5	3.40E-02	3374.07	6	4	8.13E-01
5010.62	3	3	2.19E-01	5767.45	3	3	2.44E-02	3745.95	2	4	1.90E-01
5011.31	5	3	5.84E-01	5893.15	5	7	2.88E-01	3752.63	2	2	6.67E-02
5012.04	7	7	5.19E-01	5897.25	3	5	2.16E-01	3754.69	4	4	3.78E-01
5016.38	5	5	1.62E-01	5899.83	1	3	1.60E-01	3762.60	4	4	4.24E-02
5023.05	7	5	3.61E-01	5927.81	1	3	3.22E-01	3771.03	6	4	5.59E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3771.36	6	4	8.28E-02	7371.51	4	4	3.53E-02	7103.24	1	3	6.28E-02
3792.97	8	6	1.03E-01	7404.54	6	6	3.61E-02	7109.35	3	5	8.46E-02
3934.50	2	4	7.49E-01	8307.51	2	4	1.65E-02	7111.28	3	3	4.70E-02
3938.51	4	6	8.96E-01	8344.95	2	2	6.52E-02	*7116.8	9	15	1.12E-01
3942.88	4	4	1.49E-01	8386.39	4	4	8.03E-02	7122.98	5	7	1.12E-01
4097.36	2	4	8.70E-01	8424.56	4	2	3.17E-02	7127.25	5	5	2.80E-02
4103.39	2	2	8.67E-01					7127.25	5	3	3.11E-03
4195.74	2	4	9.37E-01	<i>NI V</i>				9165.07	3	5	4.23E-02
4200.07	4	6	1.12E+00	247.205	1	3	1.19E+02	9182.16	5	7	4.45E-02
4215.77	4	4	1.85E-01	*283.52	9	15	3.05E+02	9222.99	7	9	4.95E-02
4318.78	2	4	5.40E-02	*322.64	9	3	8.99E+01	9247.04	5	5	7.66E-03
4321.22	2	2	1.08E-01	335.047	3	5	1.845E+02	9311.55	7	7	5.36E-03
4321.39	4	6	5.03E-02	387.356	3	1	2.55E+01				
4325.43	4	4	8.60E-02	765.147	1	3	2.320E+01	<i>NI V</i>			
4327.69	6	8	3.06E-02	*923.16	9	9	1.759E+01	*209.29	2	6	1.21E+02
4327.88	4	2	1.07E-01	955.334	3	1	2.919E+01	*247.66	6	10	4.26E+02
4332.95	6	6	1.23E-01	1718.55	3	5	2.321E+00	1238.82	2	4	3.40E+00
4337.01	6	4	7.47E-02	2649.88	3	3	1.07E+00	1242.80	2	2	3.37E+00
4345.81	8	8	1.82E-01	3052.20	1	3	1.33E-01	4603.74	2	4	4.14E-01
4351.11	8	6	4.01E-02	3059.60	3	3	3.95E-01	4619.97	2	2	4.10E-01
4510.88	2	4	2.84E-01	3075.19	5	3	6.48E-01				
4510.96	4	6	4.77E-01	3443.61	3	5	3.46E-01	<i>NI VI</i>			
4514.85	6	8	6.80E-01	3445.22	1	3	4.60E-01	24.8980	1	3	5.158E+03
4518.14	2	2	5.65E-01	3454.65	3	3	3.42E-01	28.7870	1	3	1.809E+04
4523.56	4	4	3.61E-01	3461.36	3	1	1.36E+00	*161.220	3	9	2.859E+02
4530.86	4	2	1.12E-01	3463.36	5	5	1.02E+00	173.275	1	3	2.697E+02
4534.58	6	6	2.01E-01	3474.53	5	3	5.61E-01	*173.93	9	15	8.756E+02
4547.30	6	4	3.33E-02	3478.72	3	5	1.06E+00	185.192	3	5	8.205E+02
4634.13	2	4	6.36E-01	*3480.8	3	9	1.06E+00	*1901	3	9	6.780E-01
4640.64	4	6	7.60E-01	3483.00	3	3	1.06E+00	2896.4	1	3	2.079E-01
4641.85	4	4	1.26E-01	3484.93	3	1	1.06E+00	*6991.1	3	9	8.384E-02
4858.70	2	4	4.35E-01	3689.94	3	1	9.10E-02	9622.0	1	3	3.276E-02
4858.98	4	6	4.66E-01	3694.14	3	3	2.27E-02				
4861.27	6	8	5.32E-01	3707.39	5	3	6.73E-02	<i>Oxygen</i>			
4867.12	4	4	1.73E-01	3714.43	5	5	1.34E-02	<i>O I</i>			
4867.17	8	10	6.18E-01	3735.43	7	5	7.37E-02	791.973	5	5	4.94E+00
4873.60	6	6	1.50E-01	3747.54	3	5	9.92E-01	792.938	1	3	2.19E+00
4881.78	6	4	1.22E-02	4057.76	3	5	6.62E-01	792.967	3	5	1.64E+00
4884.14	8	8	8.71E-02	4740.26	3	5	1.53E-02	877.798	5	3	2.85E+00
4896.58	8	6	5.86E-03	4747.96	3	3	7.60E-02	877.879	5	5	5.12E+00
5260.86	2	2	2.80E-02	4752.49	5	7	1.13E-02	922.008	5	7	1.23E+00
5270.57	2	4	6.95E-02	4762.09	5	5	6.99E-02	935.193	5	5	1.33E+00
5272.68	4	2	1.39E-01	4769.86	5	3	2.50E-02	1028.16	1	3	4.22E-01
5282.43	4	4	2.21E-02	4786.92	7	7	8.79E-02	1152.15	5	5	5.28E+00
5297.75	4	6	4.93E-02	4796.66	7	5	1.53E-02	1217.65	1	3	2.06E+00
5298.95	6	4	7.38E-02	5200.41	3	5	2.67E-01	1302.17	5	3	3.41E+00
5314.36	6	6	1.14E-01	5204.28	5	7	3.55E-01	1304.86	3	3	2.03E+00
5320.87	6	8	5.68E-01	5205.15	1	3	1.97E-01	1306.03	1	3	6.76E-01
5327.19	4	6	5.29E-01	5226.70	3	3	1.46E-01	3823.41	7	7	6.63E-03
5352.46	6	6	3.72E-02	5245.60	5	5	8.66E-02	3823.87	5	3	1.87E-03
6365.84	2	2	2.18E-01	5272.35	5	3	9.48E-03	3824.35	5	5	5.19E-03
6394.75	2	4	2.15E-01	5288.25	5	3	3.22E-02	3825.02	3	3	5.59E-03
6445.34	2	4	8.89E-02	5736.93	3	5	1.84E-01	3825.19	5	7	8.31E-04
6450.79	2	2	1.77E-01	5776.31	1	3	1.85E-02	3855.01	5	5	1.63E-02
6454.08	4	6	1.49E-01	5784.76	3	1	5.51E-02	3947.29	5	7	4.91E-03
6463.09	4	4	1.13E-01	5795.09	3	3	1.37E-02	3947.48	5	5	4.88E-03
6467.02	6	8	2.11E-01	5812.31	3	5	1.36E-02	3947.59	5	3	4.87E-03
6468.57	4	2	3.52E-02	5826.43	5	3	2.25E-02	3951.93	3	1	3.10E-03
6478.76	6	6	6.31E-02	5843.84	5	5	4.01E-02	3952.98	5	3	1.29E-03
6487.84	6	4	1.05E-02	6380.75	1	3	1.42E-01	3953.00	1	3	1.03E-03
								3954.52	3	5	7.73E-04

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
3954.61	5	5	2.32E-03	9260.85	3	3	3.34E-01	3843.58	4	6	3.55E-02
3997.95	5	3	2.41E-02	9260.94	3	5	1.56E-01	3847.89	2	2	1.95E-01
4217.09	3	1	5.44E-03	9262.58	5	3	1.11E-01	3850.80	4	6	6.00E-03
4222.77	5	3	2.26E-03	9262.67	5	5	2.60E-01	3851.03	4	4	1.59E-01
4222.82	1	3	1.81E-03	9262.78	5	7	2.97E-01	3851.47	8	8	2.72E-02
4233.27	5	5	4.04E-03	9265.83	7	5	2.97E-02	3856.13	4	2	2.28E-01
4368.19	3	1	7.56E-03	9265.93	7	7	1.48E-01	3857.16	6	6	6.59E-02
4368.24	3	5	7.59E-03	9266.01	7	9	4.45E-01	3863.50	6	8	6.49E-02
4967.38	3	5	4.43E-03	9482.89	5	3	2.34E-01	3864.13	2	2	9.12E-02
4967.88	5	7	8.44E-03	9622.11	5	3	5.22E-04	3864.43	6	6	2.15E-01
4968.79	7	9	1.27E-02	9622.16	3	3	1.57E-03	3864.67	6	4	1.80E-01
5019.29	5	5	7.13E-03	9625.26	7	5	3.25E-04	3874.09	2	4	3.26E-02
5020.22	7	5	9.98E-03	9625.30	7	7	1.85E-03	3875.80	8	6	3.38E-02
5329.11	3	5	9.48E-03	9694.66	5	7	4.54E-04	3882.19	8	8	5.50E-01
5329.69	5	7	1.81E-02	9694.91	5	5	4.54E-04	3882.45	4	4	8.94E-02
5330.74	7	9	2.71E-02	9695.06	5	3	4.54E-04	3883.14	8	6	1.13E-01
5435.18	3	5	7.74E-03	<i>O II</i>				3893.52	4	6	1.89E-02
5435.77	5	5	1.29E-02	429.918	4	2	4.25E+01	3907.45	6	6	8.64E-02
5436.86	7	5	1.80E-02	430.041	4	4	4.13E+01	3911.96	6	4	1.09E+00
5512.60	3	5	2.69E-03	430.176	4	6	4.36E+01	3912.12	4	4	1.41E-01
5512.77	5	7	3.58E-03	483.760	4	2	2.05E+01	3919.27	4	2	1.22E+00
5554.83	3	3	5.83E-03	483.980	6	4	1.80E+01	3945.04	2	4	2.05E-01
5555.00	5	3	9.71E-03	484.027	4	4	3.22E+00	3954.36	2	2	8.57E-01
5958.39	3	5	6.80E-03	485.087	6	8	2.60E+01	3973.26	4	4	1.04E+00
5958.58	5	7	9.06E-03	485.470	6	6	1.20E+00	3982.71	4	2	4.27E-01
6046.23	3	3	1.05E-02	485.518	4	6	1.93E+01	4069.62	2	4	1.52E+00
6046.44	5	3	1.75E-02	2290.85	2	4	7.41E-02	4069.88	4	6	1.53E+00
6046.49	1	3	3.50E-03	2293.30	2	2	3.25E-01	4072.15	6	8	1.98E+00
6155.99	3	5	2.67E-02	2300.33	4	4	4.17E-01	4075.86	8	10	2.11E+00
6156.78	5	7	5.08E-02	2302.81	4	2	1.67E-01	4078.84	4	4	5.52E-01
6158.19	7	9	7.62E-02	2365.14	4	2	1.52E-01	4084.65	6	8	7.28E-02
6324.84	7	5	3.76E-05	2375.72	6	4	1.35E-01	4085.11	6	6	4.55E-01
6453.60	3	5	1.65E-02	2406.38	6	4	1.85E-01	4092.93	8	8	2.65E-01
6454.44	5	5	2.75E-02	2407.48	4	4	2.25E-01	4094.14	6	4	4.70E-02
6455.98	7	5	3.85E-02	2411.60	4	2	2.05E-01	4096.53	4	6	1.73E-01
6726.28	5	5	1.18E-05	2411.64	2	2	1.10E-01	4097.22	2	4	3.62E-01
6726.54	5	3	6.44E-06	2415.13	4	2	2.20E-01	4103.00	2	2	5.09E-01
7001.92	3	5	2.65E-02	2418.46	6	6	2.30E-01	4104.72	4	6	3.14E-01
7002.23	5	7	3.53E-02	2425.57	6	6	1.77E-01	4104.99	4	4	9.14E-01
7254.15	3	3	2.24E-02	2433.54	2	4	4.21E-01	4106.02	8	6	1.70E-02
7254.45	5	3	3.73E-02	2436.06	4	4	1.69E-01	4109.84	6	6	1.21E-02
7254.53	1	3	7.45E-03	2444.25	4	4	7.56E-02	4110.19	6	4	2.54E-01
7771.94	5	7	3.69E-01	2445.53	4	6	4.98E-01	4110.79	4	2	7.70E-01
7774.17	5	5	3.69E-01	2517.96	4	6	7.72E-02	4112.02	6	6	1.81E-01
7775.39	5	3	3.69E-01	2523.21	2	2	9.63E-02	4113.83	8	6	2.41E-01
7981.94	3	3	2.33E-04	2526.87	4	4	1.20E-01	4119.22	6	8	1.33E+00
7982.40	1	3	3.09E-04	2530.28	6	8	8.16E-02	4120.28	6	6	2.15E-01
7986.98	3	5	4.19E-04	2571.46	2	4	1.15E-01	4120.55	6	4	2.60E-01
7987.33	5	5	1.41E-04	2575.28	4	6	1.37E-01	4121.46	2	2	5.60E-01
7995.07	5	7	5.63E-04	3134.73	8	6	1.23E+00	4129.32	4	2	1.79E-01
8221.82	7	7	2.89E-01	3273.43	8	6	9.99E-01	4132.80	2	4	9.13E-01
8227.65	5	3	8.13E-02	3377.15	2	2	1.27E+00	4140.70	4	4	4.09E-02
8230.00	5	5	2.26E-01	3390.21	2	4	1.22E+00	4153.30	4	6	7.91E-01
8233.00	3	3	2.43E-01	3407.28	6	6	1.02E+00	4156.53	6	4	2.11E-01
8235.35	3	5	4.86E-02	3712.74	2	4	2.84E-01	4169.22	6	6	2.71E-01
8446.25	3	1	3.22E-01	3727.32	4	4	5.81E-01	4185.44	6	8	1.91E+00
8446.36	3	5	3.22E-01	3749.48	6	4	9.31E-01	4189.58	8	8	7.06E-02
8446.76	3	3	3.22E-01	3833.07	6	8	1.02E-02	4189.79	8	10	1.98E+00
8820.42	5	7	2.93E-01	3842.81	2	4	7.45E-02	4192.51	6	4	3.21E-01
9260.81	3	1	4.46E-01					4196.27	4	4	3.56E-02

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
4196.70	4	2	3.56E-01	4864.88	4	2	8.07E-02	597.814	1	3	1.49E+01
4317.14	2	4	3.70E-01	4871.52	4	6	5.60E-01	599.590	5	5	5.41E+01
4319.63	4	6	2.55E-01	4872.02	4	4	9.34E-02	702.337	1	3	6.06E+00
4319.87	2	2	5.62E-01	4890.86	4	2	4.80E-01	702.838	3	1	1.83E+01
4325.76	2	2	1.47E-01	4906.83	4	4	4.54E-01	832.929	1	3	3.41E+00
4327.46	6	6	6.76E-01	4924.53	4	6	5.43E-01	835.092	5	5	1.44E+00
4327.85	6	4	7.24E-02	4941.07	2	4	5.87E-01	835.289	5	7	5.99E+00
4328.59	4	2	1.12E+00	4943.01	4	6	7.78E-01	1679.03	3	5	6.57E-01
4331.47	4	6	4.82E-02	4955.71	4	4	1.82E-01	1686.73	3	3	6.48E-01
4331.86	4	4	6.50E-01	5159.94	2	2	3.29E-01	1760.41	3	5	8.38E-01
4336.86	4	4	1.57E-01	5175.90	4	2	1.49E-01	1764.46	5	5	2.50E+00
4345.56	4	2	8.31E-01	5190.50	2	4	1.26E-01	1766.63	1	3	1.11E+00
4347.22	6	4	1.19E-01	5206.65	4	4	3.58E-01	1772.28	3	1	3.29E+00
4347.41	4	4	9.32E-01	5583.22	2	4	2.17E-02	1772.97	5	3	1.37E+00
4349.43	6	6	6.91E-01	5611.07	2	2	2.14E-02	2390.43	3	3	1.62E+00
4351.26	6	6	9.89E-01	6627.37	4	2	1.73E-01	2454.97	3	1	3.43E+00
4351.46	4	6	5.82E-02	6641.03	2	2	9.88E-02	2665.68	3	5	6.75E-01
4359.40	4	6	1.44E-02	6666.66	4	2	6.78E-02	2674.58	5	5	1.11E+00
4366.89	6	4	3.98E-01	6677.87	2	4	3.37E-02	2683.66	3	1	1.85E+00
4369.27	4	4	3.57E-01	6717.75	2	2	1.33E-01	2686.15	7	5	1.54E+00
4395.93	6	6	3.91E-01	6721.39	4	2	1.81E-01	2687.55	3	3	1.84E+00
4405.98	6	4	4.30E-02	6810.48	6	8	1.64E-03	2695.48	3	5	1.82E+00
4414.90	4	6	8.34E-01	6844.10	4	6	2.97E-03	2794.14	3	1	1.82E-01
4416.97	2	4	7.13E-01	6846.80	8	8	3.17E-02	2798.93	3	3	4.52E-02
4443.01	6	6	5.05E-01	6869.48	6	6	5.35E-02	2809.66	5	3	1.34E-01
4443.52	6	8	1.89E-02	6884.88	4	4	6.12E-02	2818.70	5	5	2.66E-02
4447.68	8	6	2.52E-02	6895.10	10	8	2.72E-01	2836.31	7	5	1.46E-01
4448.19	8	8	5.10E-01	6906.44	8	6	2.48E-01	2959.69	3	5	1.83E+00
4452.38	4	4	1.37E-01	6907.87	4	2	3.03E-01	2983.78	3	5	2.15E+00
4466.24	2	4	9.00E-01	6910.56	6	4	2.43E-01	2992.08	3	5	9.32E-02
4467.46	2	2	9.00E-01					2996.48	3	3	4.64E-01
4563.18	4	4	7.18E-03	<i>O III</i>				2997.69	5	7	6.88E-02
4590.97	6	8	8.85E-01	263.694	1	3	3.32E+01	3004.34	5	5	4.27E-01
4595.96	6	6	4.87E-02	263.727	3	5	4.48E+01	3008.78	5	3	1.53E-01
4596.18	4	6	8.34E-01	263.773	3	3	2.49E+01	3017.62	7	7	5.38E-01
4638.86	2	4	3.71E-01	263.817	5	7	5.97E+01	3023.43	3	5	4.79E-01
4641.81	4	6	5.96E-01	263.861	5	5	1.49E+01	3024.36	7	5	9.39E-02
4649.13	6	8	7.81E-01	277.386	5	7	9.43E+01	3024.54	1	3	6.16E-01
4650.84	2	2	6.86E-01	279.788	5	5	4.25E+01	3035.41	3	3	4.59E-01
4661.63	4	4	4.10E-01	295.942	1	3	5.56E+01	3042.07	3	1	1.94E+00
4673.73	4	2	1.35E-01	303.413	1	3	4.29E+01	3047.10	5	5	1.49E+00
4676.23	6	6	2.05E-01	303.461	3	1	1.29E+02	3059.28	5	3	8.72E-01
4690.89	2	4	1.86E-01	303.517	3	3	3.21E+01	3064.98	1	3	2.17E-01
4691.42	2	2	7.43E-01	303.622	3	5	3.21E+01	3068.13	3	1	6.49E-01
4696.35	6	4	3.25E-02	303.695	5	3	5.34E+01	3068.26	3	3	5.41E-02
4698.44	6	6	6.59E-02	303.800	5	5	9.61E+01	3068.67	3	5	2.27E-01
4699.01	6	8	9.88E-01	305.596	1	3	1.20E+02	3074.14	5	7	1.84E-01
4699.22	4	6	9.36E-01	305.656	3	5	1.62E+02	3074.72	5	3	3.76E-01
4701.18	4	4	9.23E-01	305.702	3	3	9.01E+01	3075.13	5	5	1.61E-01
4701.71	4	2	3.69E-01	305.767	5	7	2.16E+02	3075.95	7	9	1.07E-01
4703.16	4	6	9.20E-01	305.836	5	5	5.40E+01	3083.65	7	7	3.20E-01
4705.35	6	8	1.10E+00	320.978	5	7	2.17E+02	3084.64	7	5	2.55E-01
4710.01	4	6	2.98E-01	328.448	5	5	1.04E+02	3088.04	9	9	5.30E-01
4741.70	6	6	4.71E-02	345.312	1	3	1.35E+02	3095.79	9	7	1.35E-01
4751.28	6	8	6.39E-02	374.073	5	5	2.85E+01	3115.67	3	1	1.39E+00
4752.69	6	6	1.45E-02	395.557	5	3	2.80E+01	3121.63	3	3	1.38E+00
4844.92	4	6	1.02E-02	507.388	1	3	1.61E+01	3132.79	3	5	1.37E+00
4856.39	4	6	5.58E-02	507.680	3	3	4.82E+01	3198.18	3	5	9.57E-02
4856.76	4	4	1.00E-01	508.178	5	3	8.04E+01	3201.14	3	3	4.77E-01
4860.97	2	4	4.70E-01	525.794	5	3	9.60E+01	3202.51	5	7	7.08E-02



$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3207.61	5	5	4.40E-01	3698.72	5	7	7.62E-01	625.127	4	4	2.13E+01
3210.58	5	3	1.58E-01	3703.36	7	9	1.14E+00	625.853	6	4	3.19E+01
3216.07	7	7	5.58E-01	3704.75	3	3	8.53E-01	779.736	6	4	1.46E+00
3221.21	7	5	9.75E-02	3707.27	3	5	7.34E-01	779.820	4	4	1.31E+01
3260.86	5	7	1.68E+00	3709.54	3	1	1.13E+00	779.912	6	6	1.36E+01
3265.33	7	9	1.88E+00	3712.49	5	5	6.59E-01	779.997	4	6	9.70E-01
3267.20	3	5	1.58E+00	3714.03	3	3	4.06E-01	787.710	2	4	5.95E+00
3281.83	5	5	2.89E-01	3715.09	5	7	9.73E-01	790.112	4	4	1.18E+00
3284.45	7	7	2.06E-01	3720.89	7	7	3.74E-01	790.199	4	6	7.08E+00
3299.39	1	3	1.64E-01	3721.95	5	3	2.80E-01	921.296	2	4	2.21E+00
3312.33	3	3	4.60E-01	3725.31	5	5	2.41E-01	921.365	2	2	8.83E+00
3326.06	3	3	2.65E-01	3728.51	5	7	1.29E+00	923.367	4	4	1.10E+01
3330.30	3	5	6.81E-01	3728.84	7	9	1.45E+00	923.436	4	2	4.39E+00
3330.32	3	5	4.76E-01	3729.80	3	5	1.22E+00	1338.61	2	4	2.17E+00
3332.41	5	3	7.92E-01	3732.13	5	3	2.67E-02	1342.99	4	4	4.29E-01
3332.93	5	7	5.04E-01	3734.83	7	5	7.40E-02	1343.51	4	6	2.57E+00
3336.67	3	3	3.76E-01	3742.63	5	5	2.24E-01	2120.58	2	2	1.05E+00
3336.69	5	5	8.77E-02	3746.90	7	7	1.59E-01	2132.64	4	4	1.29E+00
3340.76	5	3	6.57E-01	3754.70	3	5	7.53E-01	2493.39	2	4	1.18E+00
3344.20	5	5	1.25E-01	3757.23	1	3	5.56E-01	2493.75	4	6	8.48E-01
3344.51	5	7	3.48E-01	3759.88	5	7	9.79E-01	2493.99	2	2	6.09E-01
3347.98	7	5	4.86E-01	3774.03	3	3	3.91E-01	2499.27	2	2	4.68E-01
3350.62	5	3	1.12E+00	3791.28	5	5	2.24E-01	2501.81	4	4	3.73E-01
3350.92	7	7	9.91E-01	3810.98	5	3	2.37E-02	2507.73	4	2	2.32E+00
3355.86	7	7	6.89E-01	3816.75	5	3	9.63E-02	2509.22	6	6	1.94E+00
3362.31	7	5	6.87E-01	3961.57	5	7	1.25E+00	2510.58	4	2	1.19E+00
3376.61	3	1	1.49E+00	4072.64	1	3	3.37E-01	2517.37	6	4	1.24E+00
3376.76	3	3	1.12E+00	4073.98	3	5	4.54E-01	2781.22	2	2	1.03E-01
3377.26	3	5	5.20E-01	4081.02	5	7	6.02E-01	2803.57	6	4	1.26E-01
3382.61	5	7	9.86E-01	4089.30	3	3	2.49E-01	2805.87	2	4	2.90E-01
3383.31	5	3	3.70E-01	4103.07	5	5	1.48E-01	2812.50	6	6	3.58E-02
3383.81	5	5	8.62E-01	4118.60	5	3	1.63E-02	2816.53	4	4	5.74E-01
3384.90	7	9	1.48E+00	4440.09	5	3	4.42E-01	2829.17	8	6	1.56E-01
3394.22	7	7	4.88E-01	4447.69	5	5	4.40E-01	2836.27	6	4	8.43E-01
3395.43	7	5	9.75E-02	4461.61	5	7	4.36E-01	2916.31	2	4	1.06E+00
3406.88	1	3	1.93E-01	4524.22	3	1	3.38E-01	2921.46	4	6	1.27E+00
3408.13	3	1	5.79E-01	4532.78	5	3	1.40E-01	2926.18	4	4	2.11E-01
3415.26	3	3	1.44E-01	4535.29	3	3	8.40E-02	3063.43	2	4	1.30E+00
3428.63	3	5	1.42E-01	4555.39	5	5	2.49E-01	3071.60	2	2	1.29E+00
3430.57	5	3	2.37E-01	4557.91	3	5	8.27E-02	3177.89	2	4	7.59E-02
3444.05	5	5	4.21E-01	5268.30	1	3	3.50E-01	3180.77	2	2	1.51E-01
3446.68	3	5	9.71E-01	5508.24	5	5	1.06E-01	3180.99	4	6	7.06E-02
3447.15	1	3	8.09E-01	5592.25	3	3	3.27E-01	3185.74	4	4	1.21E-01
3447.97	5	7	1.19E+00					3188.22	6	8	4.28E-02
3450.91	7	9	1.44E+00	<i>OIV</i>				3188.64	4	2	1.50E-01
3451.30	3	3	8.06E-01	238.360	2	4	2.96E+02	3194.78	6	6	1.71E-01
3454.84	5	5	6.89E-01	238.570	4	6	3.54E+02	3199.58	6	4	1.04E-01
3454.99	9	11	1.72E+00	238.579	4	4	5.90E+01	3209.65	8	8	2.53E-01
3459.48	5	3	1.14E-01	279.631	2	2	2.68E+01	3216.31	8	6	5.56E-02
3459.94	7	7	5.14E-01	279.933	4	2	5.34E+01	3348.06	2	4	8.51E-01
3466.13	9	9	2.84E-01	553.329	2	4	1.22E+01	3349.11	4	6	1.02E+00
3466.85	7	5	6.82E-02	554.076	2	2	4.86E+01	3354.27	4	2	7.71E-01
3475.24	9	7	2.42E-02	554.513	4	4	6.06E+01	3362.55	4	4	7.65E-01
3520.94	1	3	1.50E-01	555.263	4	2	2.41E+01	3375.40	4	6	7.56E-01
3531.22	3	1	4.45E-01	608.397	2	2	1.21E+01	3378.02	4	4	1.66E-01
3533.38	3	3	1.11E-01	609.829	4	2	2.40E+01	3381.21	4	6	7.19E-01
3534.90	3	5	1.11E-01	616.952	6	4	2.60E+01	3381.30	2	4	4.28E-01
3555.24	5	3	1.82E-01	617.005	4	4	2.89E+00	3385.52	6	8	1.02E+00
3556.78	5	5	3.26E-01	617.036	4	2	2.89E+01	3390.19	2	2	8.49E-01
3695.38	3	5	4.01E-01	624.619	2	4	1.07E+01	3396.80	4	4	5.40E-01

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
3405.77	4	2	1.67E-01	2781.01	3	5	1.40E+00	*173.03	6	10	8.78E+02
3409.70	6	6	3.00E-01	*2784.0	3	9	1.40E+00	1031.91	2	4	4.16E+00
3411.30	4	4	1.69E-01	2786.99	3	3	1.39E+00	1037.61	2	2	4.09E+00
3411.69	4	6	1.02E+00	2789.85	3	1	1.38E+00	3811.35	2	4	5.14E-01
3425.55	6	4	4.94E-02	3058.68	3	5	1.39E+00	3834.24	2	2	5.05E-01
3489.89	4	6	7.29E-01	3144.66	3	5	8.86E-01				
3492.21	2	4	6.06E-01	3219.24	3	1	1.54E-01	<i>O VII</i>			
3493.43	4	4	1.21E-01	3222.29	1	3	1.16E-01	18.6270	1	3	9.365E+03
3560.39	4	6	1.03E+00	3227.54	3	3	3.38E-02	21.6020	1	3	3.309E+04
3563.33	6	8	1.10E+00	3239.21	3	3	3.28E-01	*120.33	3	9	5.334E+02
3593.08	6	6	7.15E-02	3248.28	5	3	1.18E-01	128.411	1	3	8.982E+02
3725.89	2	4	5.61E-01	3263.54	5	5	1.86E-02	*128.46	9	15	1.615E+03
3725.94	4	6	6.01E-01	3275.64	5	3	4.76E-01	135.820	3	5	1.523E+03
3729.03	6	8	6.86E-01	3297.62	7	5	1.30E-01	*1630.3	3	9	7.935E-01
3736.68	4	4	2.23E-01	3690.17	3	5	1.97E-02	2448.98	1	3	2.514E-01
3736.85	8	10	7.95E-01	3698.36	3	3	1.03E-01	*5933.1	3	9	1.002E-01
3744.89	6	6	1.92E-01	3702.72	5	7	1.41E-02	8241.76	1	3	3.864E-02
3758.39	8	8	1.11E-01	3717.31	5	5	9.63E-02				
3930.68	2	2	3.80E-02	3725.63	5	3	2.91E-02	<i>Phosphorus</i>			
3942.06	2	4	9.42E-02	3746.64	7	7	1.18E-01	<i>P I</i>			
3945.31	4	2	1.88E-01	3761.58	7	5	1.61E-02	1671.7	4	2	3.9E-01
3956.77	4	4	2.98E-02	4119.37	3	5	3.66E-01	1674.6	4	4	4.0E-01
3974.58	4	6	6.62E-02	4120.49	3	1	3.33E-01	1679.7	4	6	3.9E-01
3977.09	6	4	9.91E-02	4123.96	5	7	4.81E-01	1775.0	4	6	2.17E+00
3995.08	6	6	1.52E-01	4125.49	1	3	2.70E-01	1782.9	4	4	2.14E+00
4687.03	2	4	2.79E-01	4134.11	3	3	3.34E-01	1787.7	4	2	2.13E+00
4772.60	2	4	1.23E-01	4153.27	3	3	1.92E-01	2135.5	4	4	2.11E-01
4779.10	2	2	2.45E-01	4158.86	3	5	3.39E-01	2136.2	6	4	2.83E+00
4783.42	4	6	2.06E-01	4178.46	5	5	1.12E-01	2149.1	4	2	3.18E+00
4794.18	4	4	1.56E-01	4213.35	5	3	1.19E-02	2152.9	2	4	4.85E-01
4798.27	6	8	2.91E-01	4522.66	5	3	1.02E-02	2154.1	4	4	1.73E-01
4813.15	6	6	8.65E-02	4554.53	3	5	2.41E-01	2154.1	4	6	5.8E-01
5305.51	4	4	6.10E-02	5114.06	1	3	1.80E-01	2534.0	2	4	2.00E-01
5362.51	6	6	6.12E-02	5339.94	1	3	1.85E-02	2535.6	4	4	9.5E-01
6876.49	2	4	1.88E-02	5349.74	3	1	7.04E-02	2553.3	2	2	7.1E-01
6931.60	2	2	7.35E-02	5372.71	3	3	1.42E-02	2554.9	4	2	3.00E-01
7004.11	4	4	8.90E-02	5414.59	3	5	9.29E-03				
7061.30	4	2	3.48E-02	5428.38	5	3	2.68E-02	<i>P II</i>			
				5471.12	5	5	4.86E-02	1301.9	1	3	5.0E-01
<i>O V</i>				5571.81	1	3	8.33E-02	1304.5	3	1	1.5E+00
172.169	1	3	2.94E+02	5580.12	3	5	1.11E-01	1304.7	3	3	3.7E-01
*192.85	9	15	6.90E+02	5583.23	3	3	6.20E-02	1305.5	3	5	3.8E-01
*215.17	9	3	1.83E+02	*5589.9	9	15	1.49E-01	1309.9	5	3	6.2E-01
220.353	3	5	4.292E+02	5597.89	5	7	1.48E-01	1310.7	5	5	1.1E+00
248.460	3	1	5.59E+01	5604.27	5	5	3.68E-02	4475.3	5	7	1.3E+00
629.732	1	3	2.872E+01	5607.41	5	3	4.08E-03	4499.2	5	7	1.4E+00
758.677	3	5	5.547E+00	6330.05	5	7	1.21E-01	4530.8	3	5	1.0E+00
759.442	1	3	7.373E+00	6460.12	3	5	9.37E-02	4554.8	3	5	9.6E-01
760.227	3	3	5.514E+00	6466.14	5	7	1.01E-01	4588.0	5	7	1.7E+00
760.446	5	5	1.652E+01	6500.24	7	9	1.11E-01	4589.9	3	5	1.6E+00
761.128	3	1	2.197E+01	6543.77	5	5	1.64E-02	4602.1	7	9	1.9E+00
762.004	5	3	9.125E+00	6601.28	7	7	1.14E-02	4943.5	7	5	6.3E-01
774.518	3	1	3.804E+01	6764.72	1	3	4.37E-02	5253.5	3	5	1.0E+00
1371.30	3	5	3.336E+00	6789.62	3	5	5.79E-02	5425.9	5	5	6.9E-01
2729.31	3	5	4.52E-01	6817.40	3	3	3.00E-02	6024.2	3	5	5.1E-01
2731.45	1	3	5.90E-01	6828.95	5	7	7.35E-02	6043.1	5	7	6.8E-01
2743.61	3	3	4.38E-01	6878.76	5	5	1.65E-02				
2752.23	3	1	1.82E+00					<i>P III</i>			
2755.13	5	5	1.37E+00	<i>O VI</i>				1334.8	2	4	5.5E-01
2769.69	5	3	7.88E-01	*150.10	2	6	2.62E+02	1344.3	4	6	6.4E-01
								1344.8	4	4	1.1E-01

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$				
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$					
4057.4	4	4	1.0E-01	4734.2	15	13	2.5E-02	3692.36	10	8	9.1E-01				
4059.3	6	4	9.0E-01	4879.1	15	15	1.8E-02	3700.91	8	10	3.9E-01				
4080.1	4	2	9.9E-01	4886.0	15	15	1.3E-02	3713.02	4	4	8.3E-02				
<i>Potassium</i>															
<i>K I</i>															
4044.1	2	4	1.24E-02	4912.6	17	15	5.7E-02	3788.47	4	6	1.4E-01				
4047.2	2	2	1.24E-02	5034.4	19	19	1.1E-01	3793.22	8	6	4.2E-01				
5084.2	2	2	3.50E-03	5110.8	21	19	2.78E-01	3799.31	8	8	5.5E-01				
5099.2	4	2	7.0E-03	5135.1	17	17	1.25E-01	3806.76	6	6	6.2E-02				
5323.3	2	2	6.3E-03	5173.9	19	17	3.18E-01	3818.19	6	4	5.8E-01				
5339.7	4	2	1.26E-02	5219.1	15	15	9.5E-02	3822.26	6	6	8.5E-01				
5343.0	2	4	4.0E-03	5220.1	17	15	2.35E-01	3828.48	6	6	6.2E-01				
5359.6	4	6	4.6E-03	5251.7	15	13	1.1E-02	3828.89	6	4	5.8E-01				
5782.4	2	2	1.23E-02	5259.7	15	13	2.24E-01	3856.52	8	10	5.9E-01				
5801.8	4	2	2.46E-02	5292.6	13	13	9.3E-02	3872.39	4	6	6.7E-03				
5812.2	2	4	2.8E-03	5810.6	17	19	2.3E-02	3877.34	8	6	3.7E-02				
5831.9	4	6	3.2E-03	5879.3	15	15	7.6E-02	3913.51	8	8	2.5E-03				
6911.1	2	2	2.72E-02	6200.8	15	17	1.8E-02	3922.19	4	2	6.25E-02				
6938.8	4	2	5.4E-02	6278.7	13	15	2.6E-02	3934.23	8	8	1.58E-01				
7664.9	2	4	3.87E-01	6398.0	11	13	1.9E-02	3942.72	4	2	7.15E-01				
7699.0	2	2	3.82E-01	<i>Rhodium</i>											
<i>Rh I</i>															
607.93	1	3	1.3E-02	3083.96	8	6	4.8E-02	3958.86	6	8	5.5E-01				
2550.0	6	4	2.0E+00	3114.91	6	4	4.45E-02	3984.40	4	4	1.1E-01				
2635.1	4	4	1.2E+00	3121.76	6	6	1.1E-01	3995.61	4	6	4.7E-02				
2992.4	6	8	2.5E+00	3123.70	10	8	4.6E-02	4053.44	2	2	2.8E-02				
3052.1	4	6	1.7E+00	3137.71	4	6	3.3E-02	4056.34	6	4	9.5E-03				
3202.0	4	4	1.8E+00	3189.05	6	6	3.03E-01	4082.78	6	4	1.4E-01				
3289.1	4	6	2.0E+00	3197.13	6	4	4.35E-02	4097.52	2	4	7.0E-02				
3322.4	6	6	1.3E+00	3263.14	6	6	1.3E-01	4121.68	6	6	9.8E-02				
3421.8	2	4	1.5E+00	3271.61	6	4	2.0E-01	4128.87	6	8	1.73E-01				
<i>K XVI</i>															
206.27	1	3	9.4E+01	3280.55	8	8	2.36E-01	4135.27	8	8	1.0E-01				
<i>K XVII</i>															
22.020	2	4	4.7E+04	3283.57	6	8	4.4E-01	4196.50	6	8	3.9E-02				
22.163	4	6	5.6E+04	3289.14	4	4	1.0E-01	4211.14	8	10	1.62E-01				
22.18	4	4	9.3E+03	3323.09	8	10	6.3E-01	4244.44	4	4	6.5E-03				
22.60	2	2	2.5E+03	3331.09	4	2	5.40E-02	4278.60	4	6	9.2E-03				
22.76	4	2	4.7E+03	3338.54	8	6	3.5E-02	4288.71	6	8	6.1E-02				
<i>Praseodymium</i>															
<i>Pr II</i>															
3997.0	15	15	1.87E-01	3360.80	4	4	1.2E-01	4373.04	2	4	1.8E-02				
4062.8	13	15	1.00E+00	3368.38	6	4	1.1E-01	4374.80	8	10	1.64E-01				
4100.7	17	19	8.4E-01	3396.82	10	10	6.5E-01	4379.92	6	6	2.48E-02				
4143.1	15	17	5.8E-01	3399.70	6	8	1.2E-01	4492.47	6	6	4.5E-03				
4179.4	13	15	5.2E-01	3462.04	6	6	6.2E-01	4528.72	6	8	1.35E-02				
4222.9	11	13	3.91E-01	3470.66	4	4	8.5E-01	4548.73	4	6	5.5E-03				
4241.0	17	15	2.30E-01	3478.91	6	6	3.32E-01	4551.64	4	4	4.00E-02				
4359.8	15	15	1.1E-01	3484.04	6	8	9.3E-03	4565.19	4	4	1.1E-02				
4405.8	17	17	9.0E-02	3498.73	4	6	2.12E-01	4569.00	6	8	1.0E-02				
4429.3	15	15	2.28E-01	3502.52	10	10	4.3E-01	4608.12	2	2	2.1E-02				
4449.8	13	13	1.24E-01	3507.32	6	8	3.4E-01	4675.03	8	8	6.4E-03				
4468.7	11	13	1.54E-01	3528.02	8	8	8.5E-01	4721.00	6	4	3.43E-03				
4510.2	13	15	1.16E-01	3543.95	4	4	4.65E-01	4745.11	6	6	5.2E-03				
4534.2	15	17	4.9E-02	3549.54	6	6	2.22E-01	4755.58	4	4	6.0E-03				
				3570.18	4	6	1.82E-01	4842.43	6	8	1.6E-03				
				3583.10	8	10	2.6E-01	4963.71	2	2	3.0E-02				
				3596.19	6	4	5.5E-01	4977.75	4	4	9.8E-03				
				3597.15	6	8	5.9E-01	4979.18	4	6	1.0E-02				
				3612.47	4	2	8.90E-01	5090.63	6	6	5.0E-03				
				3620.46	6	4	8.5E-02	5120.69	6	8	3.1E-03				
				3654.87	8	8	6.0E-02	5130.76	4	4	4.35E-03				
				3657.99	8	6	8.8E-01	5155.54	2	4	9.8E-03				
				3666.22	6	8	8.4E-02	5184.19	6	8	1.6E-03				
				3690.70	6	4	3.23E-01	5212.73	4	2	5.95E-03				
								5292.14	10	10	3.7E-03				
								5390.44	4	6	9.5E-03				
								5424.72	4	4	5.0E-03				



$\lambda$	Weights		$A$	$\lambda$	Weights		$A$	$\lambda$	Weights		$A$
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
5599.42	6	8	1.3E-02	3911.81	6	8	1.79E+00	4983.43	4	4	2.58E-01
5983.60	10	10	2.1E-02	3933.38	6	6	1.62E-01	4991.91	6	6	3.8E-01
<i>Rubidium</i>											
<i>Rb I</i>											
3022.5	2	4	4.13E-05	3996.60	4	6	1.65E-01	4995.00	4	6	5.9E-02
3032.0	2	4	4.93E-05	4020.39	4	4	1.63E+00	5018.41	6	4	2.09E-01
3044.2	2	4	8.2E-05	4023.22	4	4	3.0E-01	5021.52	4	4	2.30E-01
3060.2	2	4	1.05E-04	4023.68	6	6	1.65E+00	5064.31	8	10	7.3E-02
3082.0	2	4	1.49E-04	4031.38	6	6	2.9E-01	5066.38	6	6	3.6E-02
3112.6	2	4	2.5E-04	4036.86	6	4	7.9E-02	5070.17	6	8	1.16E-01
3113.1	2	2	1.3E-04	4043.80	8	8	3.11E-01	5072.71	2	4	2.0E-02
3157.5	2	4	3.38E-04	4047.80	6	4	1.54E-01	5075.82	4	6	1.15E-01
3158.3	2	2	2.0E-04	4051.83	8	6	7.7E-02	5080.22	4	4	4.1E-02
3228.0	2	4	6.4E-04	4054.54	4	2	1.67E-01	5081.56	10	10	7.6E-01
3229.2	2	2	3.8E-04	4067.00	6	8	1.91E-01	5083.72	8	8	6.2E-01
3348.7	2	4	1.37E-03	4067.63	10	8	4.1E-02	5085.55	6	6	5.7E-01
3350.8	2	2	8.9E-04	4074.96	4	6	3.7E-01	5086.94	4	4	6.6E-01
3587.1	2	4	3.97E-03	4078.56	2	4	4.3E-01	5096.72	6	4	1.69E-01
3591.6	2	2	2.9E-03	4080.57	4	4	6.6E-02	5099.27	4	6	1.50E-01
4201.8	2	4	1.8E-02	4082.39	6	4	2.73E-01	5101.12	10	8	8.8E-02
4215.5	2	2	1.5E-02	4086.66	6	8	3.7E-01	5331.79	4	4	1.11E-01
7800.3	2	4	3.70E-01	4087.47	4	6	1.12E-01	5339.43	6	6	1.06E-01
7947.6	2	2	3.40E-01	4093.12	4	4	1.23E-01	5341.07	4	2	3.8E-01
<i>Scandium</i>											
<i>Sc I</i>											
2116.7	4	4	2.0E-01	4094.86	6	6	1.44E-01	5349.34	6	4	5.9E-01
2120.4	6	6	2.0E-01	4098.36	8	8	8.7E-02	5350.28	8	8	6.8E-02
2262.3	4	4	5.8E-02	4132.98	4	6	1.19E+00	5355.79	6	4	3.0E-01
2266.6	4	2	4.8E-01	4140.27	6	8	1.17E+00	5356.10	8	6	5.7E-01
2270.9	6	4	4.6E-01	4147.38	6	6	1.74E-01	5375.37	8	6	3.4E-01
2280.8	4	6	2.8E-01	4161.85	8	8	1.77E-01	5392.06	10	8	4.2E-01
2289.6	6	6	4.1E-02	4171.53	6	4	1.36E-01	5416.16	4	6	4.4E-02
2311.29	4	6	4.1E-02	4186.42	6	8	8.4E-02	5416.41	6	6	2.0E-02
2315.69	4	4	2.5E-01	4187.61	8	6	1.28E-01	5425.55	6	8	4.5E-02
2320.32	6	6	2.4E-01	4193.53	4	6	6.1E-02	5429.42	2	4	9.0E-02
2324.75	6	4	4.1E-02	4204.52	6	8	3.5E-02	5432.98	4	4	5.4E-02
2328.19	4	6	4.6E-02	4205.20	10	8	1.12E-01	5433.25	6	4	9.7E-02
2334.67	4	2	1.7E-01	4212.32	4	6	1.58E-01	5438.28	4	6	3.4E-02
2346.03	6	4	1.3E-01	4212.48	6	6	8.6E-02	5439.04	2	2	1.74E-01
2429.19	4	4	2.8E-01	4216.08	2	4	2.36E-01	5442.62	4	2	2.15E-01
2438.63	6	6	2.1E-01	4218.23	4	4	2.26E-01	5446.20	8	8	2.8E-01
2468.40	4	2	4.9E-02	4225.54	6	8	9.5E-02	5451.37	6	6	1.50E-01
2692.78	4	2	1.61E-01	4225.69	4	6	7.6E-02	5455.24	4	4	6.6E-02
2699.02	4	6	2.4E-02	4231.64	4	4	1.31E-01	5464.95	4	2	3.2E-02
2706.74	4	4	3.1E-01	4233.59	6	6	4.0E-01	5468.40	6	4	9.7E-02
2707.93	6	4	1.49E-01	4238.05	8	8	7.1E-01	5472.19	8	6	9.7E-02
2711.34	6	6	3.2E-01	4239.55	6	4	2.27E-01	5482.01	8	8	5.2E-01
2965.88	4	6	7.5E-02	4246.14	8	6	1.15E-01	5484.63	6	6	5.2E-01
2974.01	4	4	5.5E-01	4542.55	6	4	1.28E-01	5514.23	6	8	4.1E-01
2980.76	6	6	5.4E-01	4544.67	8	6	1.33E-01	5520.52	8	10	4.3E-01
2988.97	6	4	6.9E-02	4706.94	4	6	2.81E-01	5526.10	4	4	7.1E-02
3015.37	4	6	7.8E-01	4709.31	6	8	4.0E-01	5541.07	6	6	5.5E-02
3019.35	6	8	8.7E-01	4711.72	2	4	1.81E-01	5631.04	2	4	3.0E-02
3030.76	6	6	1.00E-01	4714.30	4	4	2.14E-01	5671.83	10	12	5.4E-01
3255.68	4	4	3.2E-01	4719.31	6	6	1.04E-01	5686.86	8	10	4.9E-01
3269.90	4	2	3.13E+00	4728.77	8	8	1.16E-01	5700.19	6	8	4.6E-01
3273.63	6	4	2.81E+00	4729.20	4	4	2.20E-01	5708.64	10	10	4.7E-02
3907.48	4	6	1.66E+00	4729.24	6	6	1.93E-01	5711.79	4	6	4.5E-01
				4734.11	4	2	1.10E+00	5717.31	8	8	7.5E-02
				4737.65	6	4	8.8E-01	5724.13	6	6	7.4E-02
				4741.02	8	6	9.1E-01	5988.43	6	6	6.6E-02
				4743.82	10	8	9.8E-01	6026.16	4	4	7.2E-02
				4973.67	4	2	8.4E-01	6146.20	6	8	4.2E-02
				4980.36	6	4	5.6E-01	6198.43	4	6	3.5E-02

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
6249.96	6	8	3.2E-02	3590.47	7	5	2.9E-01	7680.3	3	5	4.6E-02
6262.22	4	6	8.4E-02	3613.83	7	9	1.48E+00	7918.4	3	5	5.2E-02
6280.16	2	4	4.0E-02	3630.74	5	7	1.20E+00	7932.3	5	7	5.1E-02
6284.16	6	6	3.9E-02	3642.78	3	5	1.13E+00	7944.0	7	9	5.8E-02
6284.73	4	4	7.1E-02	3645.31	7	7	2.74E-01	7970.3	5	5	7.1E-03
6293.02	2	2	1.04E-01	3651.80	5	5	3.0E-01				
7741.16	10	10	3.8E-02	3859.59	7	5	1.1E+00	<i>Si II</i>			
7800.42	8	8	5.1E-02	4246.82	5	5	1.29E+00	989.87	2	4	6.7E+00
				4314.08	9	7	4.1E-01	992.68	4	6	8.0E+00
<i>Sc II</i>				4320.75	7	5	4.0E-01	1020.7	2	2	1.3E+00
1880.6	5	3	5.0E+00	4325.00	5	3	4.3E-01	1190.4	2	4	6.9E+00
2064.3	7	5	2.2E+00	4374.46	9	9	1.48E-01	1193.3	2	2	2.8E+01
2068.0	5	3	2.0E+00	4400.39	7	7	1.43E-01	1194.5	4	4	3.6E+01
2273.1	1	3	7.7E+00	4415.54	5	5	1.47E-01	1197.4	4	2	1.4E+01
2545.20	5	5	4.0E-01	4670.41	5	7	1.16E-01	1248.4	4	4	1.3E+01
2552.35	7	5	2.21E+00	5031.01	5	3	3.5E-01	1251.2	6	4	1.9E+01
2555.79	3	3	6.9E-01	5239.81	1	3	1.39E-01	1260.4	2	4	2.0E+01
2560.23	5	3	2.01E+00	5526.79	9	7	3.3E-01	1264.7	4	6	2.3E+01
2563.19	3	1	2.70E+00	5657.91	5	5	1.04E-01	1304.4	2	2	3.6E+00
2611.19	5	5	2.2E+00	5669.06	3	1	1.31E-01	1309.3	4	2	7.0E+00
2667.70	3	5	1.5E+00					1526.7	2	2	3.73E+00
2746.36	3	1	3.9E+00	<i>Silicon</i>				1533.5	4	2	7.4E+00
2782.31	5	5	1.3E+00	<i>Si I</i>				1808.0	2	4	3.7E-02
2789.15	7	7	1.3E+00	1977.6	1	3	1.8E-01	2904.3	4	6	6.7E-01
2801.31	9	9	1.3E+00	1979.2	3	1	5.1E-01	2905.7	6	8	7.1E-01
2819.49	3	5	2.3E+00	1980.6	3	3	1.3E-01	3210.0	4	6	4.6E-01
2822.12	5	7	2.5E+00	1983.2	3	5	1.4E-01	4128.1	4	6	1.32E+00
2826.64	7	9	2.8E+00	1986.4	5	3	2.1E-01	4130.9	6	8	1.42E+00
2870.85	5	3	1.1E+00	1989.0	5	5	4.1E-01	5041.0	2	4	9.8E-01
2912.98	5	3	1.1E+00	2208.0	1	3	3.11E-01	5056.0	4	6	1.2E+00
2979.68	3	5	1.2E+00	2210.9	3	5	4.16E-01	5957.6	2	2	4.2E-01
2988.92	5	7	2.9E+00	2211.7	3	3	2.32E-01	5978.9	4	2	8.1E-01
3039.92	7	9	3.5E+00	2216.7	5	7	5.5E-01	6347.1	2	4	7.0E-01
3045.73	5	7	3.68E+00	2218.1	5	5	1.38E-01	6371.4	2	2	6.9E-01
3052.92	7	9	3.92E+00	2506.9	3	5	4.66E-01	7848.8	4	6	3.9E-01
3060.54	7	7	3.0E-01	2514.3	1	3	6.1E-01	7849.7	6	8	4.2E-01
3065.12	9	11	4.00E+00	2516.1	5	5	1.21E+00				
3075.36	9	9	2.5E-01	2519.2	3	3	4.56E-01	<i>Si III</i>			
3128.27	3	3	1.9E+00	2524.1	3	1	1.81E+00	883.40	5	7	6.3E+01
3133.07	5	5	1.8E+00	2528.5	5	3	7.7E-01	994.79	3	3	7.89E+00
3139.72	7	7	2.1E+00	2532.4	1	3	2.6E-01	997.39	5	3	1.31E+01
3190.98	3	3	1.1E+00	2631.3	1	3	9.7E-01	1141.6	3	5	3.0E+01
3199.33	5	3	1.9E+00	2881.6	5	3	1.89E+00	1144.3	5	7	3.9E+01
3312.72	5	7	1.2E+00	3905.5	1	3	1.18E-01	1161.6	5	5	1.6E+01
3320.40	5	3	1.2E+00	4738.8	3	3	1.0E-02	1206.5	1	3	2.59E+01
3343.23	9	7	1.1E+00	4783.0	5	3	1.7E-02	1206.5	3	5	4.89E+01
3353.72	5	7	1.51E+00	4792.3	5	5	1.7E-02	1207.5	5	5	1.9E+01
3359.67	5	5	2.16E-01	4818.1	5	7	1.1E-02	1294.5	3	5	5.42E+00
3361.26	3	3	3.4E-01	4821.2	3	5	8.0E-03	1296.7	1	3	7.19E+00
3361.93	3	1	1.17E+00	4947.6	3	1	4.2E-02	1298.9	3	3	5.36E+00
3368.94	5	3	8.3E-01	5006.1	3	5	2.8E-02	1299.0	5	5	1.61E+01
3372.15	7	5	9.9E-01	5622.2	3	3	1.6E-02	1301.2	3	1	2.13E+01
3379.16	3	3	2.5E+00	5690.4	3	3	1.2E-02	1303.3	5	3	8.85E+00
3535.71	5	3	6.1E-01	5708.4	5	5	1.4E-02	1328.8	1	3	2.7E+01
3558.53	5	7	3.0E-01	5754.2	5	3	1.5E-02	1417.2	3	1	2.60E+01
3567.70	3	5	3.5E-01	5772.1	3	1	3.6E-02	1435.8	5	7	2.1E+01
3572.53	7	7	1.38E+00	5948.5	3	5	2.2E-02	1589.0	5	3	1.1E+01
3576.34	5	5	1.06E+00	7226.2	3	5	7.9E-03	1778.7	7	9	4.4E+00
3580.93	3	3	1.23E+00	7405.8	3	5	3.7E-02	1783.1	5	7	3.8E+00
3589.63	5	3	4.6E-01	7409.1	5	7	2.3E-02	3241.6	5	3	2.3E+00
								*3486.9	15	21	1.8E+00

$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3590.5	3	5	3.9E+00	225.03	3	3	1.2E+02	4393.3	4	4	1.6E-03
4552.6	3	5	1.26E+00	227.01	5	3	2.0E+02	4393.3	4	6	9.2E-03
4554.0	5	3	7.6E-01	227.30	5	3	2.3E+02	4494.2	2	4	1.2E-02
4567.8	3	3	1.25E+00	258.10	5	5	1.04E+02	4497.7	4	6	1.4E-02
4683.0	5	5	9.5E-01	*294.37	9	9	5.9E+01	4497.7	4	4	2.4E-03
4716.7	5	7	2.8E+00	*347.36	9	15	2.2E+01	4664.8	2	4	2.33E-02
5451.5	3	5	6.0E-01	<i>Si X</i>				4668.6	4	4	4.1E-03
5473.1	5	7	7.9E-01	253.77	2	4	2.9E+01	4668.6	4	6	2.5E-02
5716.3	9	7	1.9E-01	256.57	2	2	1.1E+02	4747.9	2	2	6.3E-03
5739.7	1	3	4.7E-01	258.35	4	4	1.4E+02	4751.8	4	2	1.27E-02
7462.6	5	3	4.9E-01	261.05	4	2	5.4E+01	4978.5	2	4	4.1E-02
7466.3	7	5	5.4E-01	272.00	2	2	3.0E+01	4982.8	4	4	8.2E-03
7612.4	3	5	1.1E+00	277.26	4	2	5.7E+01	4982.8	4	6	4.89E-02
<i>Si IV</i>				287.08	2	4	2.6E+01	5148.8	2	2	1.17E-02
457.82	2	4	3.6E+00	289.19	4	4	5.0E+01	5153.4	4	2	2.33E-02
458.16	2	2	3.6E+00	292.22	6	4	7.3E+01	5682.6	2	4	1.03E-01
515.12	2	2	4.1E+00	*347.73	10	10	4.3E+01	5688.2	4	6	1.2E-01
516.35	4	2	8.2E+00	*353.09	6	10	2.1E+01	5688.2	4	4	2.1E-02
*560.50	6	10	1.0E+00	<i>Si XI</i>				5890.0	2	4	6.11E-01
*749.94	10	14	1.45E+01	43.763	1	3	6.11E+03	5895.9	2	2	6.10E-01
815.05	2	2	1.23E+01	*49.116	9	3	2.45E+03	6154.2	2	2	2.6E-02
818.13	4	2	2.44E+01	49.222	3	5	8.9E+03	6160.8	4	2	5.2E-02
*860.74	10	6	1.8E+00	52.296	3	1	7.6E+02	8183.3	2	4	4.53E-01
*1066.6	10	14	3.91E+01	303.30	1	3	6.42E+01	8194.8	4	6	5.4E-01
1122.5	2	4	2.05E+01	358.29	3	1	1.03E+02	8194.8	4	4	9.0E-02
1128.3	4	4	4.03E+00	358.63	3	5	1.38E+01	11381	2	2	8.9E-02
1128.3	4	6	2.42E+01	361.41	1	3	1.80E+01	11404	4	2	1.76E-01
1393.8	2	4	7.73E+00	364.50	3	3	1.32E+01	<i>Na II</i>			
1402.8	2	2	7.58E+00	365.42	5	5	3.90E+01	300.15	1	3	3.0E+01
*1724.1	10	6	5.5E+00	368.28	3	1	5.1E+01	301.44	1	3	4.9E+01
<i>Si V</i>				371.48	5	3	2.07E+01	372.08	1	3	3.4E+01
96.439	1	3	4.8E+02	604.14	3	5	1.12E+01	<i>Na III</i>			
97.143	1	3	2.0E+03	2300.8	1	3	4.34E-01	378.14	4	2	7.7E+01
117.86	1	3	3.0E+02	<i>Si XII</i>				380.10	2	2	3.7E+01
<i>Si VI</i>				*40.924	2	6	4.42E+03	1991.0	4	6	8.3E+00
246.00	4	2	1.7E+02	*44.118	6	10	1.4E+04	2004.2	2	4	4.6E+00
249.12	2	2	8.5E+01	499.43	2	4	9.56E+00	2011.9	6	8	8.4E+00
<i>Si VII</i>				520.72	2	2	8.47E+00	2151.5	2	4	4.4E+00
217.83	5	3	4.3E+02	1862	2	4	1.15E+00	2174.5	4	6	5.3E+00
272.64	5	3	5.1E+01	1949	2	2	1.0E+00	2230.3	6	8	3.7E+00
274.18	3	1	1.2E+02	4620	2	4	4.6E-02	2232.2	4	4	3.3E+00
275.35	5	5	8.9E+01	4942	4	6	4.5E-02	2246.7	4	6	2.4E+00
275.67	3	3	3.0E+01	<i>Silver</i>				2459.3	4	6	3.0E+00
276.84	1	3	3.9E+01	<i>Ag I</i>				2468.9	2	4	2.4E+00
278.45	3	5	2.9E+01	2061.2	2	4	3.1E-02	2497.0	6	6	1.7E+00
<i>Si VIII</i>				2069.9	2	2	1.5E-02	<i>Na V</i>			
214.76	4	2	4.1E+02	3280.7	2	4	1.4E+00	*307.89	10	6	2.0E+02
216.92	6	4	3.6E+02	3382.9	2	2	1.3E+00	*333.46	6	6	5.6E+01
232.86	2	2	8.0E+01	5209.1	2	4	7.5E-01	*369.01	10	6	1.2E+02
235.56	4	4	9.7E+01	5465.5	4	6	8.6E-01	*400.72	10	10	5.0E+01
250.45	2	2	7.7E+01	5471.6	4	4	1.4E-01	*445.14	6	10	7.1E+00
250.79	4	2	1.6E+02	<i>Sodium</i>				459.90	4	2	2.3E+01
314.31	4	2	5.2E+01	<i>Na I</i>				461.05	4	4	2.3E+01
316.20	4	4	5.0E+01	3302.4	2	4	2.81E-02	463.26	4	6	2.2E+01
319.83	4	6	4.9E+01	3303.0	2	2	2.81E-02	510.10	2	2	5.6E+01
<i>Si IX</i>				4390.0	2	4	7.7E-03	511.19	4	4	6.8E+01
223.73	1	3	4.2E+01	<i>Na VI</i>				313.75	5	3	1.3E+02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
361.25	5	5	7.7E+01	2428.1	1	3	1.7E-01	1820.3	3	3	2.2E+00
*416.53	9	9	3.7E+01	2569.5	1	3	5.3E-02	1826.2	1	3	7.2E-01
*492.80	9	15	1.3E+01	2931.8	1	3	1.9E-02	4694.1	5	7	6.7E-03
1550.6	5	5	4.35E+00	4607.3	1	3	2.01E+00	4695.4	5	5	6.7E-03
1567.8	5	3	2.68E+00	<i>Sr II</i>				4696.2	5	3	6.5E-03
1608.5	3	1	2.6E+00	2018.7	2	2	1.2E-01	6403.6	3	5	5.7E-03
1649.4	5	5	2.05E+00	2051.9	4	2	2.4E-01	6408.1	5	5	9.5E-03
1741.5	3	5	2.59E+00	2282.0	2	4	8.3E-01	6415.5	7	5	1.3E-02
1747.5	5	7	3.1E+00	2322.4	4	6	9.1E-01	*6751.2	15	25	7.9E-02
<i>Na VII</i>				2324.5	4	4	1.5E-01	7679.6	3	5	1.2E-02
*94.409	6	10	2.7E+03	2423.5	2	2	2.4E-01	7686.1	5	5	2.0E-02
*105.27	6	2	4.5E+02	2471.6	4	2	4.8E-01	7696.7	7	5	2.8E-02
353.29	4	4	1.0E+02	3464.5	4	6	3.1E+00	<i>S II</i>			
381.30	4	2	4.0E+01	3474.9	4	4	5.1E-01	1124.4	2	4	1.0E+00
397.49	4	4	3.5E+01	4077.7	2	4	1.42E+00	1125.0	4	4	4.6E+00
399.18	6	4	5.2E+01	4161.8	2	2	6.5E-01	1131.0	2	2	3.5E+00
*483.28	10	10	2.9E+01	4215.5	2	2	1.27E+00	1131.6	4	2	1.4E+00
486.74	2	4	1.1E+01	4305.5	4	2	1.4E+00	1250.5	4	2	4.6E-01
491.95	4	6	1.3E+01	4414.8	4	6	1.1E-01	1253.8	4	4	4.2E-01
555.80	4	4	2.3E+01	4417.5	4	4	1.8E-02	1259.5	4	6	3.4E-01
777.83	4	6	6.8E+00	4585.9	4	2	7.0E-02	4463.6	8	6	5.3E-01
<i>Na VIII</i>				5303.1	2	4	1.9E-01	4483.4	6	4	3.1E-01
*83.34	9	15	3.94E+03	5379.1	4	6	2.2E-01	4486.7	4	2	6.6E-01
*89.88	9	3	8.09E+02	5385.5	4	4	3.7E-02	4524.7	4	4	9.3E-02
90.536	3	5	2.86E+03	5723.7	2	2	7.1E-02	4525.0	6	4	1.2E+00
411.15	1	3	4.42E+01	5819.0	4	2	1.4E-01	4552.4	4	2	1.2E+00
1239.4	3	3	3.02E+00	8688.9	4	6	5.5E-01	4656.7	2	4	9.0E-02
1802.7	3	1	2.70E+00	8719.6	4	4	9.7E-02	4716.2	4	4	2.9E-01
1867.7	3	5	2.01E+00	<i>Sulfur</i>				4815.5	6	4	8.8E-01
2059.1	3	5	1.80E+00	<i>SI</i>				4885.6	2	4	1.7E-01
2558.2	5	3	2.26E-02	1295.7	5	5	4.9E+00	4917.2	2	2	6.6E-01
2772.0	3	5	4.19E-01	1296.2	5	3	2.7E+00	4924.1	4	6	2.2E-01
3021.0	5	7	4.90E-01	1302.3	3	5	1.8E+00	4925.3	2	4	2.4E-01
3108.9	1	3	2.58E-01	1302.9	3	3	1.6E+00	4942.5	2	2	1.5E-01
3182.3	1	3	2.92E-01	1302.9	3	3	1.6E+00	4991.9	4	4	1.5E-01
<i>Na IX</i>				1303.1	3	1	6.6E+00	5009.5	4	2	7.0E-01
70.615	2	4	1.35E+03	1303.4	5	3	1.9E+00	5014.0	4	4	8.4E-01
70.653	2	2	1.35E+03	1305.9	1	3	2.4E+00	5027.2	4	2	2.6E-01
77.764	2	4	3.6E+03	1401.5	5	3	9.1E-01	5032.4	6	6	8.1E-01
77.911	4	6	4.3E+03	1409.3	3	3	5.0E-01	5047.3	4	2	3.6E-01
681.72	2	4	6.63E+00	1412.9	1	3	1.6E-01	5103.3	6	4	5.0E-01
694.17	2	2	6.30E+00	1425.0	5	7	4.5E+00	5142.3	2	2	1.9E-01
2487.7	2	4	8.32E-01	1425.2	5	5	1.2E+00	5201.0	4	4	7.5E-01
2535.8	2	2	7.89E-01	1433.3	3	5	3.3E+00	5201.3	6	4	6.5E-02
6841.8	2	4	2.59E-02	1433.3	3	3	1.9E+00	5212.6	4	6	9.8E-02
7103.4	4	6	2.78E-02	1437.0	1	3	2.4E+00	5212.6	6	6	8.5E-01
<i>Strontium</i>				1448.2	5	3	7.3E+00	5320.7	6	8	9.2E-01
<i>Sr I</i>				1473.0	5	7	4.2E-01	5345.7	4	6	8.8E-01
2206.2	1	3	6.6E-03	1474.0	5	7	1.6E+00	5345.7	6	6	1.1E-01
2211.3	1	3	8.5E-03	1474.4	5	5	5.0E-01	5428.6	2	4	4.2E-01
2217.8	1	3	1.2E-02	1474.6	5	3	6.2E-02	5432.8	4	6	6.8E-01
2226.3	1	3	1.6E-02	1481.7	3	5	1.7E-01	5453.8	6	8	8.5E-01
2237.7	1	3	2.3E-02	1483.0	3	5	1.2E+00	5473.6	2	2	7.3E-01
2253.3	1	3	3.7E-02	1483.2	3	3	7.5E-01	5509.7	4	4	4.0E-01
2275.3	1	3	6.7E-02	1487.2	1	3	8.7E-01	5526.2	8	8	8.1E-02
2307.3	1	3	1.2E-01	1666.7	5	5	6.3E+00	5536.8	4	6	6.6E-02
2354.3	1	3	1.8E-01	1687.5	1	3	9.4E-01	5556.0	4	2	1.1E-01
				1782.3	1	3	1.9E+00	5564.9	6	6	1.7E-01
				1807.3	5	3	3.8E+00	5578.8	6	6	1.1E-01

$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
5606.1	10	8	5.4E-01	706.48	2	4	4.17E+01	3260.2	4	4	5.8E-03
5616.6	4	4	1.2E-01	712.68	4	6	4.85E+01	3337.8	6	6	1.3E-02
5640.0	4	6	6.6E-01	712.84	4	4	8.1E+00	3383.9	6	4	5.3E-03
5645.6	6	4	1.8E-02	933.38	2	4	1.7E+01	3406.9	4	6	6.8E-02
5647.0	2	4	5.7E-01	944.52	2	2	1.6E+01	3419.7	8	8	1.91E-02
5659.9	6	4	4.6E-01	<i>S VII</i>				3463.8	4	6	2.62E-02
5664.7	4	2	5.8E-01	60.161	1	3	9.46E+03	3484.6	4	4	8.5E-03
5819.2	4	4	8.5E-02	60.804	1	3	5.1E+02	3488.8	6	4	7.3E-03
6305.5	8	6	1.8E-01	72.029	1	3	8.61E+02	3497.9	6	8	4.9E-02
6312.7	6	4	3.0E-01	<i>S VIII</i>				3505.0	8	6	2.72E-02
<i>S III</i>				198.55	4	2	2.5E+02	3553.4	4	6	3.3E-03
2496.2	7	5	2.5E+00	202.61	2	2	1.2E+02	3607.4	6	8	4.6E-02
2508.2	5	3	2.3E+00	<i>S XI</i>				3625.2	10	8	1.0E-02
2636.9	3	5	4.5E-01	*189.90	9	3	4.3E+02	3626.6	8	10	7.1E-02
2665.4	5	5	1.4E+00	190.37	5	3	2.8E+02	3642.1	10	12	5.5E-02
2680.5	1	3	6.2E-01	215.95	5	5	1.4E+02	3657.5	6	6	4.3E-03
2691.8	3	3	4.6E-01	217.63	1	3	7.2E+01	3731.0	4	6	5.3E-03
2702.8	3	1	1.9E+00	239.81	1	3	2.6E+01	3754.5	8	8	6.5E-03
2718.9	3	3	1.2E+00	242.57	3	5	1.9E+01	3784.3	4	6	4.3E-02
2721.4	5	3	7.7E-01	242.82	3	3	1.9E+01	3792.1	4	4	9.0E-03
2726.8	3	5	6.0E-01	246.90	5	5	5.4E+01	3826.9	6	6	5.2E-03
2731.1	5	5	1.1E+00	247.12	5	3	3.0E+01	3836.6	8	10	4.0E-03
2756.9	7	7	1.4E+00	*288.49	9	15	2.9E+01	3848.1	10	8	1.30E-02
2785.5	3	3	6.1E-01	<i>S XII</i>				3858.6	10	10	2.5E-03
2856.0	5	7	5.1E+00	212.14	2	4	3.7E+01	3918.5	4	2	2.5E-02
2863.5	7	9	5.7E+00	215.18	2	2	1.4E+02	3922.8	4	4	3.98E-02
2872.0	3	5	4.7E+00	218.20	4	4	1.7E+02	3996.2	2	4	3.35E-02
2950.2	3	5	3.0E+00	221.44	4	2	6.4E+01	3999.3	4	4	1.8E-02
2964.8	5	7	4.0E+00	227.50	2	2	3.7E+01	4003.7	10	8	3.1E-03
3662.0	3	3	6.4E-01	234.48	4	2	6.8E+01	4006.8	6	8	7.6E-03
3717.8	5	3	1.0E+00	<i>S XIII</i>				4026.9	4	4	3.60E-02
3778.9	3	5	4.4E-01	32.236	1	3	1.09E+04	4029.9	10	10	2.8E-02
3831.8	1	3	5.6E-01	37.600	3	1	1.3E+03	4030.7	8	10	2.3E-03
3837.8	3	3	4.2E-01	256.66	1	3	8.7E+01	4040.9	10	12	7.3E-03
3838.3	5	5	1.3E+00	299.89	3	5	1.78E+01	4061.4	2	4	6.5E-02
3860.6	3	1	1.6E+00	303.37	1	3	2.28E+01	4064.6	4	4	3.83E-02
3899.1	5	3	6.7E-01	307.36	3	3	1.64E+01	4067.2	6	4	6.8E-03
4253.6	5	7	1.2E+00	308.91	5	5	4.82E+01	4067.9	6	8	8.4E-03
4285.0	3	5	9.0E-01	312.68	3	1	6.3E+01	4097.2	10	10	2.1E-03
<i>S IV</i>				316.84	5	3	2.50E+01	4105.0	6	4	1.1E-02
551.17	2	2	2.06E+01	500.42	3	5	1.43E+01	4136.2	8	6	1.82E-02
554.07	4	2	4.08E+01	<i>S XIV</i>				4147.9	10	8	1.79E-02
3097.5	2	4	2.6E+00	*30.434	2	6	8.28E+03	4175.2	6	8	2.8E-02
3117.7	2	2	2.5E+00	*32.517	6	10	2.6E+04	4205.9	8	10	8.9E-03
<i>S V</i>				417.67	2	4	1.2E+01	4303.0	6	6	2.08E-02
437.37	1	3	1.12E+01	445.71	2	2	1.0E+01	4378.8	8	6	4.8E-03
438.19	3	3	3.33E+01	1550	2	4	1.4E+00	4386.1	4	6	1.0E-02
439.65	5	3	5.5E+01	1663	2	2	1.2E+00	4402.5	6	6	2.28E-02
*661.52	9	15	6.44E+01	3967	2	4	5.4E-02	4415.7	2	4	2.53E-02
*679.01	9	15	8.6E+01	4153	4	6	5.7E-02	4441.0	4	6	7.5E-03
*690.75	9	9	5.0E+01	<i>Tantalum</i>				4441.7	10	8	9.0E-03
786.48	1	3	5.25E+01	<i>Ta I</i>				4473.5	6	8	1.36E-02
*854.85	9	9	4.18E+01	3127.9	4	6	5.7E-03	4511.0	10	12	1.56E-02
<i>S VI</i>				3168.3	4	4	6.0E-03	4511.5	10	8	3.6E-03
248.99	2	4	3.1E+01	3170.3	8	10	8.5E-02	4514.2	10	10	3.1E-03
249.27	2	2	3.1E+01	3205.5	6	8	5.6E-03	4521.1	10	10	2.3E-03
388.94	2	2	4.5E+01					4530.9	4	6	2.42E-02
390.86	4	2	8.8E+01					4547.2	4	6	5.3E-03
								4553.7	6	8	9.5E-03
								4565.9	8	8	2.5E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
4574.3	4	4	1.2E-02	5944.0	4	6	2.13E-02	2601.1	8	6	1.7E-01
4580.7	8	10	2.1E-03	5997.2	10	10	2.4E-02	2622.5	8	10	6.1E-02
4619.5	6	4	5.3E-02	6020.7	2	4	1.0E-02	2841.1	6	6	2.0E-01
4633.1	4	4	1.2E-02	6045.4	6	8	2.6E-02	2854.2	8	6	2.7E-01
4669.1	6	4	2.85E-02	6047.3	8	10	9.0E-03	2914.8	8	8	7.7E-02
4681.9	6	6	1.5E-02	6249.8	6	6	3.5E-03	2933.0	8	6	1.0E-01
4684.9	10	8	2.8E-03	6258.7	6	8	3.3E-03	2973.2	8	8	2.3E-01
4685.3	6	8	3.4E-03	6309.6	4	6	1.83E-02	3046.9	8	8	1.8E-01
4691.9	2	4	4.08E-02	6360.8	6	8	4.6E-03	3081.1	8	8	1.9E-01
4706.1	6	6	1.4E-02	6428.6	6	6	6.0E-03	3122.5	6	6	5.2E-01
4740.2	4	4	5.0E-02	6430.8	8	8	2.9E-02	3142.4	6	6	8.8E-02
4758.0	4	6	7.5E-03	6450.4	8	10	2.2E-02	3172.7	8	8	1.8E-01
4769.0	8	8	2.8E-02	6485.4	10	10	5.8E-02	3233.7	8	10	5.1E-02
4780.9	10	8	2.16E-02	6514.4	6	4	2.2E-02	3247.0	6	8	3.0E-01
4812.8	4	4	1.2E-02	6516.1	6	8	1.25E-02	3251.8	6	4	5.2E-01
4825.4	6	6	2.63E-02	6612.0	6	4	1.9E-02	3380.7	6	8	2.0E-01
4832.2	4	4	1.7E-02	6673.7	2	4	9.0E-03	3406.0	6	8	1.5E-01
4852.2	4	4	1.7E-02	6771.7	4	4	5.8E-03	3410.1	8	10	1.0E-01
4884.0	6	8	1.1E-02	6866.2	8	6	2.58E-02	3416.6	8	8	5.7E-02
4904.6	12	10	1.95E-02	6927.4	10	12	1.01E-02	3418.6	6	6	1.1E-01
4920.9	8	10	2.1E-03	6928.5	10	8	1.69E-02	3563.9	8	6	9.8E-02
4921.3	2	4	1.2E-02	6951.3	10	10	3.7E-03	3567.4	8	10	4.2E-02
4926.0	4	4	1.5E-02	6953.9	6	8	8.3E-03	3744.1	8	8	9.5E-01
4936.4	8	6	4.5E-02	6966.1	8	8	1.2E-02	3751.8	8	10	1.9E-01
4969.7	4	4	1.0E-02	6969.5	10	10	2.9E-03	3798.5	6	4	1.2E+00
5012.5	4	4	1.9E-02	7407.9	6	4	2.0E-02	3807.7	6	6	3.9E-01
5037.4	10	8	4.4E-02					3883.1	8	6	1.0E+00
5043.3	6	4	2.73E-02	<i>Thallium</i>				3887.4	8	8	3.8E-01
5067.9	8	6	2.92E-02	<i>TLI</i>				3916.5	6	8	1.5E+00
5069.9	10	12	1.7E-03	2104.6	2	4	4.0E-02	3949.3	6	6	1.0E+00
5082.3	10	12	1.9E-03	2118.9	2	2	2.0E-02	4022.6	6	8	4.0E-02
5087.4	6	4	1.5E-02	2129.3	2	4	5.8E-02	4044.5	6	4	2.9E-01
5090.7	8	6	9.5E-03	2151.9	2	2	3.1E-02	4094.2	8	6	9.0E-01
5095.3	6	6	5.0E-03	2168.6	2	4	9.8E-02	4105.8	8	10	6.0E-01
5136.5	2	2	4.5E-02	2237.8	2	4	1.9E-01	4138.3	6	4	7.0E-01
5141.6	4	2	1.2E-02	2316.0	2	2	7.8E-02	4158.6	6	8	5.5E-02
5143.7	6	4	1.7E-02	2379.7	2	4	4.4E-01	4187.6	8	8	6.1E-01
5147.6	6	4	9.0E-03	2507.9	4	2	1.1E-02	4203.7	8	10	2.5E-01
5161.8	4	6	6.3E-03	2538.2	4	2	1.6E-02	4222.7	6	8	1.5E-01
5218.7	8	6	8.2E-03	2580.1	2	2	1.8E-01	4271.7	6	6	1.1E-01
5235.4	6	6	4.7E-03	2609.0	4	6	1.0E-01	4359.9	8	6	1.3E-01
5295.0	6	6	7.5E-03	2609.8	4	4	1.9E-02	4386.4	8	8	4.2E-02
5336.1	6	8	5.5E-03	2665.6	4	2	5.7E-02	4394.4	6	4	1.1E-01
5349.6	6	4	2.2E-02	2709.2	4	6	1.7E-01	4643.1	6	6	3.4E-02
5354.7	4	4	6.5E-03	2710.7	4	4	3.7E-02	4681.9	6	8	3.9E-02
5396.0	6	8	2.5E-03	2767.9	2	4	1.26E+00	4691.1	6	6	3.9E-02
5402.5	4	2	1.4E-02	2826.2	4	2	8.0E-02	5307.1	8	10	2.3E-02
5435.3	4	6	1.1E-02	2918.3	4	6	4.2E-01	5658.3	6	8	1.0E-02
5499.4	10	10	6.1E-03	2921.5	4	4	7.6E-02	5675.8	8	10	1.3E-02
5518.9	8	10	3.8E-02	3229.8	4	2	1.73E-01	5760.2	6	6	1.3E-02
5620.7	8	10	6.0E-03	3519.2	4	6	1.24E+00				
5640.2	6	8	4.9E-03	3529.4	4	4	2.20E-01	<i>Tin</i>			
5645.9	6	8	1.43E-02	3775.7	2	2	6.25E-01	<i>Su I</i>			
5699.2	6	6	4.2E-03	5350.5	4	2	7.05E-01	2073.1	1	3	3.6E-02
5767.9	6	8	2.6E-03					2199.3	3	5	2.9E-01
5780.7	4	6	3.3E-03	<i>Thulium</i>				2209.7	5	5	5.6E-01
5811.1	8	6	5.7E-03	<i>Tm I</i>				2246.1	1	3	1.6E+00
5849.7	10	8	2.8E-03	2513.8	8	10	6.9E-02	2268.9	5	7	1.2E+00
5877.4	10	12	2.3E-02	2527.0	8	8	1.7E-01	2286.7	5	5	3.1E-01
5939.8	2	4	1.6E-02	2596.5	8	10	1.6E-01	2317.2	5	7	2.0E+00



$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$			
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$				
2334.8	3	3	6.6E-01	5596.2	4	4	1.5E-01	4055.01	1	3	2.8E-01			
2354.8	3	5	1.7E+00	5797.2	6	6	2.8E-01	4060.26	3	5	2.4E-01			
2380.7	3	5	3.1E-02	5799.2	6	8	8.1E-01	4064.20	3	3	2.4E-01			
2408.2	5	3	1.8E-01	6453.5	2	4	1.2E+00	4065.09	3	1	7.0E-01			
2421.7	5	7	2.5E+00	6761.5	2	2	3.2E-01	4186.12	9	9	2.10E-01			
2429.5	5	7	1.5E+00	6844.1	2	2	6.6E-01	4266.23	5	5	3.1E-01			
2433.5	5	3	8.0E-03	<i>Titanium</i>							4284.99	5	5	3.2E-01
2455.2	5	5	1.1E-02	<i>Ti I</i>							4289.07	5	5	3.0E-01
2476.4	5	3	1.1E-02	2276.75	7	5	1.3E+00	4290.93	3	3	4.5E-01			
2483.4	5	5	2.1E-01	2280.00	9	7	9.4E-01	4295.75	3	1	1.3E+00			
2491.8	1	3	1.7E-01	2299.86	5	5	6.9E-01	4393.93	9	11	3.3E-01			
2495.7	5	5	6.2E-01	2302.75	7	7	5.7E-01	4417.27	11	9	3.6E-01			
2523.9	5	3	7.4E-02	2305.69	9	9	5.2E-01	4449.14	11	11	9.7E-01			
2546.6	1	3	2.1E-01	2424.26	9	9	1.7E-01	4450.90	9	9	9.6E-01			
2558.0	1	3	3.4E-01	2520.54	5	3	3.8E-01	4453.31	5	5	5.98E-01			
2571.6	5	7	4.5E-01	2529.87	7	5	3.8E-01	4453.71	7	7	4.7E-01			
2594.4	5	5	3.0E-01	2541.92	9	7	4.3E-01	4455.32	7	7	4.8E-01			
2636.9	1	3	1.1E-01	2599.91	5	5	6.7E-01	4457.43	9	9	5.6E-01			
2661.2	3	3	1.1E-01	2605.16	7	7	6.4E-01	4465.81	5	7	3.28E-01			
2706.5	3	5	6.6E-01	2611.29	9	9	6.4E-01	4481.26	7	7	5.7E-01			
2761.8	5	5	3.7E-03	2611.47	7	5	3.3E-01	4496.15	7	5	4.4E-01			
2779.8	5	7	1.8E-01	2619.94	9	7	2.1E-01	4518.02	7	9	1.72E-01			
2785.0	5	3	1.4E-01	2631.55	7	7	1.7E-01	4522.80	5	7	1.9E-01			
2788.0	1	3	1.4E-01	2632.42	5	5	2.7E-01	4527.31	3	5	2.2E-01			
2812.6	1	3	2.3E-01	2641.12	5	3	1.8E+00	4533.24	11	11	8.83E-01			
2813.6	5	5	1.2E-01	2644.28	7	5	1.4E+00	4534.78	9	9	6.87E-01			
2840.0	5	5	1.7E+00	2646.65	9	7	1.5E+00	4544.69	5	3	3.3E-01			
2850.6	5	5	3.3E-01	2733.27	5	5	1.9E+00	4548.76	7	5	2.85E-01			
2863.3	1	3	5.4E-01	2735.30	3	1	4.1E+00	4552.45	9	7	2.1E-01			
2913.5	1	3	8.3E-01	2912.07	5	7	1.3E+00	4563.43	9	11	2.1E-01			
3009.1	3	3	3.8E-01	2942.00	5	5	1.0E+00	4617.27	7	9	8.51E-01			
3032.8	1	3	6.2E-01	2948.26	7	7	9.3E-01	4623.10	5	7	5.74E-01			
3034.1	3	1	2.0E+00	2956.13	9	9	9.7E-01	4639.94	3	3	6.64E-01			
3141.8	1	3	1.9E-01	2956.80	7	5	1.8E-01	4640.43	3	1	5.0E-01			
3175.1	5	3	1.0E+00	3186.45	5	7	8.0E-01	4645.19	3	1	8.57E-01			
3218.7	1	3	4.7E-02	3191.99	7	9	8.5E-01	4650.02	5	3	2.6E-01			
3223.6	5	5	1.2E-03	3199.92	9	11	9.4E-01	4742.79	9	9	5.3E-01			
3262.3	5	3	2.7E+00	3341.88	5	7	6.5E-01	4758.12	11	11	7.13E-01			
3330.6	5	5	2.0E-01	3354.63	7	9	6.9E-01	4759.27	13	13	7.40E-01			
3655.8	1	3	4.1E-02	3370.44	5	3	7.6E-01	4778.26	9	9	2.0E-01			
3801.0	5	3	2.8E-01	3371.45	9	11	7.2E-01	4805.42	5	7	5.8E-01			
4524.7	1	3	2.6E-01	3377.58	7	5	6.9E-01	4840.87	5	5	1.76E-01			
5631.7	1	3	2.4E-02	3385.94	9	7	5.0E-01	4856.01	13	15	5.2E-01			
5970.3	5	3	9.6E-02	3635.46	5	7	8.04E-01	4885.08	11	13	4.90E-01			
6037.7	5	5	5.0E-02	3642.68	7	9	7.74E-01	4913.62	7	9	4.44E-01			
6069.0	1	3	4.6E-02	3653.50	9	11	7.54E-01	4928.34	3	5	6.2E-01			
6073.5	3	1	6.3E-02	3724.57	9	9	9.1E-01	4981.73	11	13	6.60E-01			
6171.5	3	3	4.9E-02	3725.16	5	3	7.3E-01	4989.14	7	5	3.25E-01			
<i>Sn II</i>				3729.81	5	5	4.27E-01	4991.07	9	11	5.84E-01			
2368.3	4	2	4.4E-03	3741.06	7	7	4.17E-01	4999.50	7	9	5.27E-01			
2449.0	4	6	3.7E-01	3752.86	9	9	5.04E-01	5000.99	9	7	3.52E-01			
2487.0	6	8	5.5E-01	3786.04	5	3	1.4E+00	5007.21	5	7	4.92E-01			
3283.2	4	6	1.0E+00	3948.67	5	3	4.85E-01	5014.28	3	5	6.8E-01			
3352.0	6	8	1.0E+00	3956.34	7	5	3.00E-01	5036.47	7	9	3.94E-01			
3472.5	2	4	1.6E-01	3958.21	9	7	4.05E-01	5038.40	5	7	3.87E-01			
3575.5	4	6	1.3E-01	3981.76	5	5	3.76E-01	5062.11	5	3	2.98E-01			
5332.4	2	4	8.6E-01	3989.76	7	7	3.79E-01	5210.39	9	9	3.57E-02			
5562.0	4	6	1.2E+00	3998.64	9	9	4.08E-01	5222.69	3	3	1.95E-01			
5588.9	4	6	8.5E-01	4013.24	7	5	2.0E-01	5224.30	11	11	3.6E-01			
								5259.98	5	7	2.3E-01			

$\lambda$	Weights		A	$\lambda$	Weights		A	$\lambda$	Weights		A
	$\text{\AA}$	$g_i$			$g_k$	$10^8 \text{ s}^{-1}$			$\text{\AA}$	$g_i$	
5351.07	7	7	3.4E-01	3023.67	8	8	1.0E+00	3510.86	8	8	9.3E-01
5503.90	11	9	2.6E-01	3029.76	10	10	3.5E-01	3520.27	2	4	4.8E-01
5774.04	9	11	5.5E-01	3056.75	2	4	3.2E-01	3535.41	4	6	5.5E-01
5785.98	11	13	6.1E-01	3058.08	6	6	5.0E-01	3641.33	4	2	4.9E-01
5804.27	13	15	6.8E-01	3066.34	4	4	3.3E-01	3706.23	4	4	3.1E-01
6098.66	9	7	2.5E-01	3071.25	6	4	3.6E-01	3741.64	6	6	6.2E-01
6220.46	9	7	1.8E-01	3072.99	4	2	1.6E+00	3757.70	4	4	4.1E-01
<i>Ti II</i>				3075.23	6	4	1.13E+00	3759.30	8	8	9.4E-01
2440.91	4	4	5.1E-01	3078.65	8	6	1.09E+00	3761.33	6	6	9.9E-01
2451.18	6	6	4.5E-01	3081.52	10	8	1.1E+00	4911.18	6	4	3.2E-01
2525.59	10	8	5.6E-01	3088.04	10	8	1.25E+00	<i>Ti III</i>			
2531.28	8	6	4.9E-01	3089.44	8	6	1.3E+00	865.79	5	3	6.6E+01
2534.63	6	4	5.4E-01	3097.20	4	6	4.4E-01	1002.37	5	5	7.6E+00
2535.89	4	2	6.8E-01	3103.81	10	8	1.1E+00	1004.67	7	5	4.3E+01
2555.99	6	8	3.2E-01	3105.10	2	4	6.3E-01	1005.80	3	3	1.3E+01
2635.44	4	4	1.9E+00	3106.26	6	6	7.8E-01	1007.16	5	3	3.8E+01
2638.56	6	6	1.7E+00	3117.67	4	2	1.1E+00	1008.12	3	1	5.1E+01
2642.02	8	8	1.9E+00	3119.83	6	4	5.9E-01	1286.37	9	9	2.0E+00
2645.86	10	10	2.7E+00	3127.86	6	6	1.6E+00	1289.30	7	7	2.2E+00
2746.54	6	8	2.6E+00	3128.50	8	8	1.1E+00	1291.62	5	5	2.4E+00
2751.59	8	10	3.7E+00	3161.23	4	2	5.9E-01	1293.23	9	7	1.0E+00
2752.68	8	10	1.1E+00	3161.80	6	4	4.6E-01	1298.97	7	5	4.9E+00
2757.62	6	8	7.2E-01	3162.59	8	6	3.9E-01	1327.59	5	3	3.2E+00
2758.35	4	6	9.9E-01	3168.55	10	8	4.1E-01	1420.44	1	3	1.2E+00
2758.79	2	4	4.4E-01	3181.73	6	8	4.6E-01	1421.63	3	1	4.0E+00
2764.28	4	4	7.4E-01	3182.54	4	6	4.3E-01	1422.41	5	5	3.0E+00
2804.82	6	8	4.6E+00	3189.49	4	4	9.2E-01	1424.14	5	3	1.6E+00
2810.30	8	10	5.1E+00	3190.91	6	8	1.3E+00	1455.19	9	7	6.4E+00
2817.83	10	12	3.8E+00	3202.56	4	6	1.1E+00	1498.70	5	5	2.8E+00
2819.87	8	8	6.5E-01	3224.25	12	10	7.0E-01	2007.36	3	3	3.4E+00
2821.26	6	8	7.9E-01	3228.62	4	2	2.0E+00	2007.60	1	3	1.2E+00
2827.12	8	10	1.0E+00	3232.29	8	6	6.0E-01	2010.80	5	3	5.4E+00
2828.06	12	14	4.4E+00	3234.51	10	10	1.38E+00	2097.30	5	7	3.3E+00
2828.64	6	6	1.2E+00	3236.13	4	4	7.0E-01	2099.86	3	5	2.5E+00
2828.83	10	10	9.1E-01	3236.58	8	8	1.11E+00	2104.86	3	3	1.1E+00
2834.02	10	12	7.9E-01	3239.04	6	6	9.87E-01	2105.09	1	3	1.7E+00
2836.47	8	8	1.2E+00	3239.66	6	4	9.4E-01	2199.22	3	3	5.7E+00
2839.64	12	12	8.3E-01	3241.99	4	4	1.16E+00	2237.77	7	7	2.4E+00
2845.93	10	10	1.2E+00	3251.91	6	4	3.38E-01	2331.35	3	1	4.3E+00
2851.11	2	4	4.1E-01	3252.92	8	6	3.9E-01	2331.66	3	3	1.2E+00
2856.10	12	12	1.5E+00	3272.07	2	4	3.2E-01	2339.00	5	3	3.0E+00
2862.33	4	6	4.0E-01	3278.28	4	4	9.6E-01	2346.79	7	5	3.3E+00
2877.47	8	8	5.7E-01	3278.91	6	4	1.0E+00	2374.99	5	3	4.0E+00
2884.13	10	10	5.2E-01	3282.32	2	2	1.6E+00	2413.99	5	7	3.8E+00
2910.65	8	8	4.6E-01	3287.66	8	10	1.4E+00	2516.05	7	9	3.4E+00
2926.64	10	8	8.9E-01	3315.32	2	4	3.8E-01	2567.56	3	3	2.3E+00
2931.10	6	6	3.2E+00	3321.70	4	4	7.2E-01	2984.75	5	5	1.9E+00
2936.02	4	6	2.7E+00	3322.94	10	10	3.96E-01	3066.51	3	3	2.5E+00
2938.57	6	8	2.4E+00	3329.46	8	8	3.25E-01	3228.89	3	3	1.5E+00
2941.90	8	10	1.8E+00	3332.11	6	4	1.1E+00	3278.31	7	9	3.4E+00
2942.97	8	8	1.1E+00	3340.34	4	4	3.6E-01	3320.94	3	5	2.8E+00
2945.30	10	12	2.7E+00	3361.23	8	10	1.1E+00	3340.20	7	9	3.7E+00
2952.00	8	8	3.0E-01	3372.80	6	8	1.11E+00	3346.18	9	11	3.7E+00
2954.59	10	12	4.0E+00	3383.77	4	6	1.09E+00	3354.71	11	13	4.4E+00
2958.80	8	10	4.0E+00	3452.49	2	2	7.7E-01	3397.24	3	1	1.8E+00
2979.06	4	6	1.2E+00	3456.40	4	4	8.2E-01	3404.46	3	3	1.8E+00
2990.06	6	8	5.6E-01	3465.56	4	2	4.1E-01	3417.62	3	5	1.9E+00
3017.17	12	12	3.6E-01	3483.63	10	8	9.7E-01	3915.47	9	11	2.1E+00
3022.64	10	10	1.2E+00	3492.37	8	6	9.8E-01	4119.14	5	5	9.9E-01
				3504.90	10	10	8.2E-01				



$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
4213.26	9	11	2.2E+00	439.513	3	3	7.5E+00	60.762	2	2	3.5E+02
4215.53	9	11	2.2E+00	439.745	3	1	2.1E+01	61.286	4	2	1.8E+02
4247.62	11	13	1.1E+00	447.484	5	5	1.6E+01	62.433	4	6	2.08E+02
4248.54	5	7	2.3E+00	447.701	5	3	6.5E+00	62.470	6	8	2.22E+02
4250.09	3	5	9.5E-01	507.174	3	5	6.5E+00	65.540	4	6	3.2E+02
4259.01	11	13	9.4E-01	516.215	5	7	6.9E+00	65.577	6	8	3.5E+02
4269.84	9	11	1.7E+00	<i>Ti X</i>				67.171	2	4	6.2E+02
4285.61	13	15	3.0E+00	253	4	6	2.1E+02	67.555	4	6	7.2E+02
4288.66	11	13	1.1E+00	254	6	8	2.3E+02	70.986	4	6	5.7E+02
4296.70	11	13	1.6E+00	281	2	2	1.1E+02	71.031	6	8	6.1E+02
4319.56	9	11	1.1E+00	289.579	2	4	2.5E+02	71.545	2	2	1.8E+02
4343.25	3	1	1.0E+00	290.294	4	6	1.1E+02	71.987	4	2	3.48E+02
4378.94	3	5	1.6E+00	291	4	2	1.8E+02	82.121	2	4	5.9E+02
4433.91	11	13	1.8E+00	291	2	2	2.3E+02	82.307	4	6	1.13E+03
4440.66	1	3	1.2E+00	292	6	8	1.1E+02	82.344	2	2	5.8E+02
4533.26	3	5	1.5E+00	293.684	6	8	2.97E+02	82.368	6	8	1.2E+03
4576.53	9	7	1.3E+00	293.798	6	6	1.7E+02	89.844	2	4	9.9E+02
4628.07	3	1	1.5E+00	295.584	4	6	2.9E+02	90.512	4	6	1.16E+03
4652.86	7	9	2.6E+00	296	4	6	1.4E+02	90.547	4	4	1.9E+02
4874.00	5	7	1.5E+00	297	4	6	9.9E+01	116.497	4	6	3.0E+03
4914.32	3	3	1.1E+00	298	4	6	4.3E+02	116.597	6	8	3.2E+03
4971.19	9	11	2.1E+00	302	2	2	1.6E+02	116.62	6	6	2.1E+02
5083.80	5	3	9.7E-01	305	2	4	2.5E+02	139.884	6	4	2.6E+02
5278.33	3	3	9.4E-01	317	2	2	1.5E+02	140.361	4	2	2.9E+02
7506.87	11	13	1.1E+00	355.815	2	2	1.3E+02	141.6	4	6	1.7E+02
<i>Ti IV</i>				360.133	4	4	2.19E+02	141.7	6	8	1.7E+02
423.49	4	6	4.9E+01	363	4	2	2.1E+02	169.7	4	6	2.8E+02
424.16	6	8	5.3E+01	363	6	6	1.3E+02	169.8	6	8	2.9E+02
433.63	4	2	5.5E+00	365.628	4	2	1.2E+02	207.2	2	4	1.5E+02
433.76	6	4	5.0E+00	382	4	6	1.8E+02	208.5	4	6	1.8E+02
729.36	4	2	5.7E+00	385	6	8	1.8E+02	252.8	4	6	4.8E+02
1183.64	2	2	6.9E+00	389.99	6	4	1.1E+02	253.1	6	8	5.2E+02
1195.21	4	2	1.4E+01	<i>Ti XI</i>				257.5	4	2	2.4E+02
1451.74	2	4	1.8E+01	65.403	1	3	5.1E+02	<i>Ti XIII</i>			
1467.34	4	6	2.1E+01	87.725	1	3	8.5E+02	23.356	1	3	1.02E+05
2067.56	2	4	5.1E+00	266	5	7	1.8E+02	23.698	1	3	1.2E+04
2103.16	2	2	5.0E+00	308.250	3	5	1.3E+02	23.991	1	3	3.4E+02
2541.79	4	6	6.9E+00	313.229	5	7	1.6E+02	26.641	1	3	4.06E+03
2546.88	6	8	7.4E+00	318	3	1	1.4E+02	26.960	1	3	3.06E+03
2862.60	4	2	4.1E+00	322.75	5	7	1.99E+02	117.1	3	3	1.3E+02
3576.44	4	6	4.6E+00	323	1	3	1.8E+02	117.3	3	1	2.8E+02
<i>Ti VIII</i>				327.192	3	5	2.9E+02	120.2	5	3	5.4E+02
249	6	4	1.0E+01	332	3	1	3.25E+02	120.2	7	5	4.4E+02
258.610	6	8	7.5E+02	386.140	1	3	1.48E+02	128.7	3	3	1.2E+02
269.533	4	6	6.0E+02	408	7	9	1.37E+02	<i>Ti XIV</i>			
272.037	4	4	4.3E+02	425.74	3	1	1.2E+02	21.341	4	6	9.8E+03
272.843	6	4	6.2E+01	446.69	3	1	1.2E+02	21.522	2	4	4.5E+04
276.701	2	4	9.3E+01	453	5	7	1.3E+02	21.657	4	4	1.3E+04
277.813	4	4	3.8E+02	<i>Ti XII</i>				21.733	4	4	8.8E+04
289.375	2	4	3.6E+01	52.896	2	4	1.61E+02	21.82	4	2	6.4E+04
478.971	4	4	1.7E+01	53.140	4	6	1.9E+02	21.883	2	4	7.0E+04
480.376	6	6	1.5E+01	53.433	2	4	2.1E+02	21.958	2	4	1.2E+04
<i>Ti IX</i>				53.457	2	2	2.1E+02	22.05	2	2	1.4E+04
267.941	5	7	5.1E+02	55.181	2	4	2.4E+02	24.592	4	2	6.1E+03
278.713	5	7	4.7E+02	55.443	4	6	2.81E+02	24.891	2	2	7.5E+03
281.446	3	1	3.2E+02	59.133	2	4	3.72E+02	<i>Ti XV</i>			
285.128	1	3	4.1E+02	59.435	4	6	4.41E+02	20.19	5	7	6.9E+03
433.567	1	3	6.9E+00	60.701	2	4	3.4E+02	20.234	5	7	1.9E+04



$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>	$\lambda$ Å	Weights		A 10 <sup>8</sup> s <sup>-1</sup>
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3198.8	7	9	4.6E-02	4294.6	7	5	1.2E-01	6285.9	7	5	6.6E-03
3207.3	7	9	3.0E-02	4302.1	7	7	3.6E-02	6292.0	3	5	2.26E-03
3208.3	5	5	4.4E-02	4355.2	9	9	5.1E-03	6303.2	9	9	1.84E-03
3215.6	9	11	2.1E-01	4361.8	9	7	1.64E-03	6404.2	5	7	1.50E-03
3221.9	5	7	1.61E-02	4378.5	7	5	3.48E-03	6439.7	9	9	1.29E-03
3223.1	5	3	3.53E-03	4458.1	3	5	4.2E-03	6445.1	7	5	6.4E-03
3232.5	9	9	2.4E-02	4466.3	7	5	1.5E-02	6532.4	3	5	4.6E-03
3235.1	7	5	2.68E-03	4472.5	13	11	1.55E-03	6538.1	11	9	2.7E-03
3259.7	7	7	1.3E-02	4484.2	3	5	5.6E-03	6563.2	5	5	2.04E-03
3300.8	7	9	8.1E-02	4492.3	9	11	3.6E-03	6814.9	9	9	1.46E-03
3311.4	7	5	5.6E-02	4495.3	11	11	3.3E-03	7285.8	13	11	1.47E-03
3363.3	9	7	6.6E-03	4504.8	9	7	7.0E-03	7569.9	5	3	3.73E-03
3371.0	7	5	1.0E-02	4552.5	9	9	1.42E-03	7664.9	5	3	3.80E-03
3371.4	3	3	6.7E-03	4586.8	1	3	4.20E-03	8017.2	5	7	1.6E-03
3386.1	7	7	2.64E-03	4592.6	7	9	3.4E-03	8358.7	5	7	1.89E-03
3413.0	7	9	9.7E-03	4609.9	7	9	1.42E-02	9381.4	9	7	1.53E-03
3459.5	9	9	2.04E-03	4613.3	9	9	2.9E-03				
3510.0	7	9	5.2E-03	4634.8	9	9	8.8E-03	<i>Uranium</i>			
3545.2	1	3	3.2E-02	4659.9	1	3	1.0E-02	<i>UI</i>			
3570.6	5	3	6.7E-03	4680.5	7	7	1.4E-02	3553.0	13	13	2.0E-02
3606.1	3	5	9.6E-03	4720.4	3	5	3.22E-03	3553.0	9	7	1.4E-02
3617.5	7	7	1.1E-01	4729.6	7	5	7.8E-03	3553.4	15	13	2.2E-02
3631.9	3	5	1.3E-02	4752.6	3	3	5.20E-03	3554.5	11	9	8.4E-03
3675.6	9	11	1.20E-02	4757.5	7	5	2.72E-03	3554.9	15	17	7.9E-03
3682.1	9	11	2.0E-02	4757.8	11	9	4.1E-03	3555.3	13	15	2.7E-02
3707.9	7	7	2.9E-02	4788.4	9	11	2.6E-03	3555.8	13	11	4.1E-03
3757.9	7	9	1.38E-02	4843.8	5	5	1.9E-02	3556.9	13	11	7.5E-03
3760.1	5	7	1.99E-02	4886.9	9	11	8.1E-03	3557.8	13	13	2.9E-02
3768.5	3	3	3.47E-02	4924.6	13	11	1.75E-03	3558.0	11	13	1.6E-02
3780.8	7	5	4.2E-02	4931.6	7	5	1.0E-02	3558.6	9	7	3.9E-02
3809.2	7	5	9.0E-03	4948.6	9	11	1.36E-03	3559.4	7	9	1.5E-02
3817.5	7	7	3.1E-02	4972.6	9	11	3.9E-03	3560.3	9	7	6.4E-02
3829.1	3	3	3.83E-03	4982.6	1	3	4.17E-03	3561.4	15	13	5.5E-02
3835.1	5	5	5.2E-02	4986.9	11	9	6.3E-03	3561.5	9	9	2.5E-02
3846.3	3	5	2.14E-02	5006.2	9	7	1.2E-02	3561.8	13	11	5.7E-02
3847.5	1	3	8.3E-03	5015.3	7	9	5.4E-03	3563.7	13	13	2.9E-02
3864.3	5	5	5.6E-03	5040.4	3	5	5.2E-03	3563.8	7	7	1.1E-02
3868.0	7	9	4.6E-02	5053.3	3	3	1.9E-02	3565.0	13	11	2.9E-02
3881.4	7	7	3.6E-02	5071.5	13	11	3.4E-03	3566.0	13	15	1.7E-02
3968.5	1	3	5.07E-03	5117.6	11	11	1.61E-03	3566.6	11	11	2.4E-01
3975.5	9	11	4.1E-03	5124.2	5	5	4.0E-03	3568.8	13	13	3.8E-02
4001.4	9	9	5.6E-03	5141.2	7	9	1.12E-03	3569.1	17	15	1.1E-01
4008.8	7	9	1.63E-01	5224.7	7	5	1.2E-02	3569.4	9	9	1.5E-02
4019.3	5	3	6.7E-03	5243.0	9	7	1.1E-02	3570.1	13	11	1.3E-02
4028.8	1	3	2.0E-02	5254.5	7	5	3.86E-03	3570.2	11	9	5.3E-03
4045.6	7	5	2.88E-02	5268.6	9	9	1.4E-03	3570.6	13	15	2.7E-02
4055.2	7	9	1.79E-03	5500.5	11	9	6.9E-03	3570.7	15	15	1.2E-02
4070.0	7	5	3.60E-02	5514.7	5	3	7.3E-03	3571.2	11	11	6.3E-03
4070.6	3	5	5.6E-03	5537.7	9	11	2.2E-03	3571.6	17	15	1.3E-01
4074.4	7	7	1.0E-01	5617.1	7	7	1.47E-03	3572.9	13	15	1.5E-02
4088.3	5	3	4.13E-03	5631.9	9	7	1.43E-03	3573.9	13	11	4.0E-02
4102.7	9	7	4.9E-02	5660.7	13	11	6.8E-03	3574.1	13	15	3.5E-02
4115.6	11	11	4.8E-03	5675.4	5	5	2.20E-03	3574.8	13	15	1.9E-02
4137.5	5	7	8.4E-03	5796.5	9	7	2.21E-03	3577.1	17	15	4.3E-02
4171.2	7	9	8.6E-03	5891.6	7	7	1.47E-03	3577.5	15	13	7.8E-03
4203.8	9	7	4.9E-03	5947.6	5	7	2.40E-03	3577.8	11	11	8.3E-03
4219.4	9	7	6.1E-03	5965.9	7	5	1.0E-02	3577.9	13	13	2.3E-02
4244.4	9	11	1.38E-02	6021.5	5	3	8.7E-03	3578.3	13	11	2.0E-02
4269.4	7	5	3.04E-02	6081.4	5	3	4.7E-03	3580.0	9	9	1.2E-02
4283.8	9	7	1.69E-03	6203.5	7	7	3.0E-03	3580.2	11	9	2.9E-02

$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		A $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3580.4	11	13	7.5E-03	3543.49	2	2	6.7E-01	4232.95	8	8	7.7E-01
3580.9	13	13	2.1E-02	3545.33	4	4	3.7E-01	4268.64	14	14	1.2E+00
3582.6	13	13	2.9E-02	3553.27	6	6	2.2E-01	4271.55	12	12	9.6E-01
3584.6	7	5	2.4E-02	3555.14	4	2	2.6E-01	4276.95	10	10	9.4E-01
3584.9	13	15	1.8E-01	3663.60	4	6	3.1E+00	4284.05	8	8	1.2E+00
3585.4	11	11	1.9E-02	3667.74	6	8	2.7E+00	4291.82	12	14	8.8E-01
3585.8	11	9	2.8E-02	3672.41	12	12	9.2E-01	4296.10	10	12	7.7E-01
3587.8	9	11	1.3E-02	3673.41	8	10	2.7E+00	4297.67	8	10	7.0E-01
3588.3	7	9	1.8E-02	3676.70	14	14	1.3E+00	4298.03	6	8	7.8E-01
3589.7	11	13	2.1E-02	3680.12	10	12	2.2E+00	4379.23	10	12	1.1E+00
3589.8	15	13	5.9E-02	3686.26	10	12	2.3E-01	4384.71	8	10	1.1E+00
3590.7	9	7	2.2E-02	3687.50	12	14	2.9E+00	4389.98	6	8	6.9E-01
3591.7	11	9	5.3E-02	3688.07	8	8	3.5E-01	4395.22	4	6	5.5E-01
3593.0	11	11	1.4E-02	3690.28	2	4	4.5E-01	4400.57	2	4	3.4E-01
3593.2	13	15	4.2E-02	3692.22	6	6	5.4E-01	4406.64	10	10	2.2E-01
3593.7	11	11	7.2E-02	3695.34	14	16	2.8E+00	4407.63	8	8	4.4E-01
<i>Vanadium</i>											
<i>VI</i>											
3043.12	6	8	2.3E-01	3695.86	4	4	6.6E-01	4408.20	6	6	6.0E-01
3050.39	10	8	5.3E-01	3703.57	10	8	9.2E-01	4416.47	4	2	2.6E-01
3053.65	4	4	1.3E+00	3704.70	8	6	6.6E-01	4452.01	14	16	9.2E-01
3056.33	6	6	1.3E+00	3705.04	6	4	3.6E-01	4457.75	10	12	2.7E-01
3060.46	8	8	1.4E+00	3706.03	10	10	5.2E-01	4460.33	10	8	3.0E-01
3066.37	10	10	2.1E+00	3708.71	12	12	4.4E-01	4462.36	12	14	7.6E-01
3066.53	6	4	3.2E-01	3790.46	10	8	2.3E-01	4468.00	8	10	2.3E-01
3075.93	4	6	2.8E-01	3794.96	10	10	2.3E-01	4469.71	10	12	6.2E-01
3080.33	2	4	2.7E-01	3806.79	10	10	2.5E-01	4474.04	10	8	4.7E-01
3083.54	6	8	2.5E-01	3818.24	4	2	6.73E-01	4496.06	8	6	4.0E-01
3087.06	2	2	9.2E-01	3828.56	6	4	5.33E-01	4514.18	6	4	3.3E-01
3088.11	4	6	4.9E-01	3840.75	8	6	5.48E-01	4524.21	12	10	3.0E-01
3089.13	4	4	5.3E-01	3855.36	4	4	3.30E-01	4525.17	4	2	4.1E-01
3093.79	6	6	4.1E-01	3855.85	10	8	5.78E-01	4529.58	10	8	2.4E-01
3094.69	2	4	4.3E-01	3863.86	8	6	3.1E-01	4545.40	10	12	7.6E-01
3112.92	4	2	5.0E-01	3864.86	6	6	2.70E-01	4560.72	8	10	7.0E-01
3183.41	6	8	2.4E+00	3871.07	10	8	2.8E-01	4571.79	6	8	6.0E-01
3183.96	8	10	2.5E+00	3875.07	8	8	2.36E-01	4578.73	4	6	6.8E-01
3183.98	4	6	2.4E+00	3902.26	10	10	2.68E-01	4706.16	6	4	2.4E-01
3185.38	10	12	2.7E+00	3921.86	4	2	2.7E-01	4757.47	4	2	7.6E-01
3198.01	6	6	3.9E-01	3922.43	6	6	2.6E-01	4766.62	6	4	5.6E-01
3202.39	8	8	4.0E-01	3930.02	10	10	3.3E-01	4776.36	8	6	5.1E-01
3205.58	8	10	1.3E+00	3934.01	8	8	6.2E-01	4786.50	10	8	4.7E-01
3207.41	10	10	2.6E-01	3992.80	12	10	1.2E+00	4796.92	12	10	4.8E-01
3212.43	10	12	1.4E+00	3998.73	14	12	1.0E+00	4807.52	14	12	5.8E-01
3218.87	8	6	3.5E-01	4050.96	10	10	1.4E+00	5193.00	12	12	4.0E-01
3233.19	10	8	3.2E-01	4051.35	12	12	1.3E+00	5195.39	8	8	2.3E-01
3273.03	8	8	2.7E-01	4090.57	8	10	8.5E-01	5234.08	10	10	4.9E-01
3284.36	10	10	2.8E-01	4092.68	8	10	2.30E-01	5240.87	12	12	4.3E-01
3309.18	4	4	3.2E-01	4095.48	6	8	7.2E-01	5415.25	12	14	3.1E-01
3329.85	6	4	7.7E-01	4099.78	6	8	4.10E-01	5487.91	12	10	2.9E-01
3356.35	4	6	3.1E-01	4102.15	4	6	7.1E-01	5507.75	10	8	3.5E-01
3365.55	2	4	4.8E-01	4104.77	10	8	2.1E+00	6090.21	8	6	2.60E-01
3376.05	4	4	3.2E-01	4105.16	4	6	4.9E-01	<i>VII</i>			
3377.39	4	2	9.0E-01	4109.78	2	4	5.00E-01	2527.90	13	13	6.1E-01
3377.62	6	6	6.0E-01	4111.78	10	10	1.01E+00	2528.47	9	9	5.2E-01
3397.58	6	4	2.3E-01	4115.18	8	8	5.80E-01	2528.83	11	11	5.3E-01
3400.39	8	8	2.5E-01	4116.47	6	6	3.2E-01	2554.04	9	9	5.4E-01
3529.73	4	6	4.1E-01	4116.59	2	2	2.90E-01	2589.10	9	9	7.7E-01
3533.68	6	8	5.2E-01	4123.50	4	2	1.00E+00	2640.86	5	7	1.2E+00
3533.76	2	4	3.7E-01	4128.06	6	4	7.70E-01	2677.80	3	5	3.4E-01
				4131.99	8	6	5.5E-01	2679.33	7	7	3.4E-01
				4134.49	10	8	2.90E-01	2683.09	1	3	3.4E-01
				4232.46	10	10	9.8E-01				







$\lambda$ Å	Weights		$A$ $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		$A$ $10^8 \text{ s}^{-1}$	$\lambda$ Å	Weights		$A$ $10^8 \text{ s}^{-1}$
	$g_i$	$g_k$			$g_i$	$g_k$			$g_i$	$g_k$	
3496.08	1	3	3.49E-01	4374.95	5	5	9.97E-01	<i>Zinc</i>			
3549.01	5	7	3.97E-01	4398.01	5	3	1.16E-01	<i>Zn I</i>			
3584.51	3	5	4.02E-01	4422.59	3	1	1.83E-01	748.29	1	3	6.0E-02
3600.74	7	7	1.4E+00	4682.33	5	5	1.9E-02	765.60	1	3	7.6E-02
3601.91	3	3	1.13E+00	4786.58	7	7	2.1E-02	792.05	1	3	5.7E-02
3611.04	5	5	1.04E+00	4823.31	5	5	4.3E-02	793.85	1	3	1.8E-01
3628.70	5	3	3.3E-01	4854.87	5	3	3.9E-01	809.92	1	3	2.6E-01
3664.62	7	5	3.7E-01	4881.44	5	3	1.5E-03	1109.1	1	3	3.05E-01
3710.29	7	9	1.5E+00	4883.69	9	7	4.7E-01	2138.6	1	3	7.09E+00
3747.55	3	3	1.9E-01	4900.11	7	5	4.51E-01	3075.9	1	3	3.29E-04
3774.34	5	7	1.1E+00	4982.13	7	9	1.5E-02	3282.3	1	3	9.0E-01
3776.56	5	3	2.42E-01	5087.42	9	9	2.0E-01	3302.6	3	5	1.2E+00
3788.70	3	5	8.1E-01	5119.11	5	7	1.6E-02	3302.9	3	3	6.7E-01
3818.34	5	5	9.70E-02	5200.41	5	5	1.3E-01	3345.0	5	7	1.7E+00
3832.90	7	7	3.0E-01	5205.73	7	7	1.6E-01	3345.6	5	5	4.0E-01
3878.29	7	5	2.9E-02	5289.82	7	5	6.7E-03	3345.9	5	3	4.5E-02
3930.66	5	5	2.1E-02	5320.78	9	7	3.9E-03	6362.3	3	5	4.74E-01
3950.36	3	5	2.80E-01	5473.39	3	5	4.3E-02	11054	3	1	2.43E-01
3951.59	5	3	1.5E-02	5480.73	1	3	7.62E-02	<i>Zn II</i>			
3982.60	5	5	2.7E-01	5497.41	5	5	1.2E-01	2025.5	2	4	3.3E+00
4124.91	5	7	1.8E-02	5509.90	5	5	4.24E-02	2064.2	2	4	4.6E+00
4177.54	5	5	5.27E-01	5544.61	3	1	1.8E-01	2099.9	4	6	5.6E+00
4199.27	3	5	5.36E-03	5546.01	5	3	5.8E-02	2102.2	4	4	9.3E-01
4204.69	1	3	2.20E-02	5728.89	5	5	3.0E-02	4911.6	4	6	1.6E+00
4235.73	5	5	2.3E-02	6613.74	5	7	1.7E-02				
4309.62	7	5	1.29E-01	6832.48	5	5	3.3E-03				
4358.73	3	3	5.55E-02	7264.16	5	3	1.3E-02				

# ELECTRON AFFINITIES

Thomas M. Miller

Electron affinity is defined as the energy difference between the lowest (ground) state of the neutral and the lowest state of the corresponding negative ion. The accuracy of electron affinity measurements has been greatly improved since the advent of laser photodetachment experiments with negative ions. Electron affinities can be determined with optical precision, though a detailed understanding of atomic and molecular states and splittings is required to specify the photodetachment threshold corresponding to the electron affinity.

Atomic and molecular electron affinities are discussed in two excellent articles reviewing photodetachment studies which appear in *Gas Phase Ion Chemistry*, Vol. 3, Bowers, M. T., Ed., Academic Press, Orlando, 1984: Chapter 21 by Drzaic, P. S., Marks, J., and Brauman, J. I., "Electron Photodetachment from Gas Phase Negative Ions," p. 167, and Chapter 22 by Mead, R. D., Stevens, A. E., and Lineberger, W. C., "Photodetachment in Negative Ion Beams," p. 213. Persons interested in photodetachment details should consult these articles and the critical reviews of Andersen, T., Haugen, H. K., and Hotop, H., *J. Phys. Chem. Ref. Data*, 28, 1511, 1999; Hotop, H. and Lineberger, W. C., *J. Phys. Chem. Ref. Data*, 14, 731, 1985; and Andersen, T., Haugen, H. K., and Hotop, H., *J. Phys. Chem. Ref. Data* 28, 1511, 1999. For simplicity in the tables below, any electron affinity that was discussed in the articles by Drzaic et al. or Hotop and Lineberger is referenced to these sources, where original references are given. The development of cluster-ion pho-

todetachment apparatuses has brought an explosion of electron affinity estimates for atomic and molecular clusters. The policy in this tabulation is to list the electron affinities for the atoms, diatoms, and triatoms, if adiabatic electron affinities have been determined, but to refer the reader to original sources for higher-order clusters. Additional data on molecular electron affinities may be found in Lias, S. G., Bartmess, J. E., Liebman, J. F., Holmes, J. L., Levin, R. D., and Mallard, W. G., *Gas Phase Ion and Neutral Thermochemistry*, *J. Phys. Chem. Ref. Data*, 17, (Supplement No. 1), 1988 and on the NIST WebBook at the Internet address <http://webbook.nist.gov/>.

For the present tabulation the 2002 CODATA value  $e/hc = 8065.54445 \pm 0.00069 \text{ cm}^{-1} \text{ eV}^{-1}$  (<http://physics.nist.gov>) has been used to convert electron affinities from the units used in spectroscopic work,  $\text{cm}^{-1}$ , into eV for these tables. The 86 ppb uncertainty in  $e/hc$  is insignificant compared to uncertainties in the electron affinity measurements.

Abbreviations used in the tables: calc = calculated value; PT = photodetachment threshold using a lamp as a light source; LPT = laser photodetachment threshold; LPES = laser photoelectron spectroscopy; DA = dissociative attachment; attach = electron attachment/detachment equilibrium; e-scat = electron scattering; kinetic = dissociation kinetics; Knud=Knudsen cell; CT = charge transfer; CD = collisional detachment; and ZEKE = zero electron kinetic energy spectroscopy.

TABLE 1. Atomic Electron Affinities

Atomic number	Atom	Electron affinity in eV	Uncertainty in eV	Method	Ref.
1	H	0.754195	0.000019	LPT	89
		0.75420812	—	calc	205
	D	0.754593	0.000074	LPT	89 deuterium
	D	0.75465624	—	calc	205 deuterium
	T	0.75480540	—	calc	205 tritium
2	He	not stable	—	calc	1
3	Li	0.618049	0.000020	LPT	185
4	Be	not stable	—	calc	1
5	B	0.279723	0.000025	LPES	191
6	C	1.262119	0.000020	LPT	28
7	N	not stable	—	DA	1
8	O	1.4611096	0.0000007	LPT	4
9	F	3.4011895	0.0000025	LPT	227
10	Ne	not stable	—	calc	1
11	Na	0.547926	0.000025	LPT	1
12	Mg	not stable	—	e-scat	1
13	Al	0.43283	0.00005	LPES	208
14	Si	1.3895220	0.0000024	LPES	227
15	P	0.7465	0.0003	LPT	1
16	S	2.077103	0.000001	LPT	1
17	Cl	3.612724	0.000027	LPT	52
18	Ar	not stable	—	calc	1
19	K	0.50147	0.00010	LPT	1
20	Ca	0.02455	0.00010	LPT	44
21	Sc	0.188	0.020	LPES	1
22	Ti	0.079	0.014	LPES	1
23	V	0.525	0.012	LPES	1
24	Cr	0.666	0.012	LPES	1
25	Mn	not stable	—	calc	1



Atomic number	Atom	Electron affinity in eV	Uncertainty in eV	Method	Ref.
26	Fe	0.151	0.003	LPES	27
27	Co	0.662	0.003	LPES	27
28	Ni	1.156	0.010	LPES	1
29	Cu	1.235	0.005	LPES	37
30	Zn	not stable	—	e-scat	1
31	Ga	0.43	0.03	LPES	183
32	Ge	1.232712	0.000015	LPES	28
33	As	0.814	0.008	LPES	200
34	Se	2.020670	0.000025	LPT	1
35	Br	3.363588	0.000002	LPT	74
36	Kr	not stable	—	calc	1
37	Rb	0.48592	0.00002	LPT	1
38	Sr	0.048	0.006	LPT	122
39	Y	0.307	0.012	LPES	1
40	Zr	0.426	0.014	LPES	1
41	Nb	0.893	0.025	LPES	1
42	Mo	0.748	0.002	LPES	127
43	Tc	0.55	0.20	calc	1
44	Ru	1.05	0.15	calc	1
45	Rh	1.137	0.008	LPES	1
46	Pd	0.562	0.005	LPES	116
47	Ag	1.302	0.007	LPES	1
48	Cd	not stable	—	e-scat	1
49	In	0.3	0.2	PT	1
50	Sn	1.112067	0.000015	LPES	28
51	Sb	1.046	0.005	LPES	108
52	Te	1.970876	0.000007	LPT	261
53	I	3.059037	0.000010	LPT	92
54	Xe	not stable	—	calc	1
55	Cs	0.471626	0.000025	LPT	1
56	Ba	0.14462	0.00006	LPT	195
57	La	0.47	0.02	LPT	184
58	Ce	0.955	0.026	LPES	269
59	Pr	0.962	0.024	LPES	225
63	Eu	0.864	0.024	LPES	268
69	Tm	1.029	0.022	LPES	264
70	Yb	-0.020	—	calc	196
71	Lu	0.34	0.01	LPT	223
72	Hf	»0	—	calc	1
73	Ta	0.322	0.012	LPES	1
74	W	0.815	0.002	LPES	37
75	Re	0.15	0.15	calc	1
76	Os	1.1	0.2	calc	1
77	Ir	1.5638	0.0005	LPT	141
78	Pt	2.128	0.002	LPT	1
79	Au	2.30863	0.00003	LPT	1
80	Hg	not stable	—	e-scat	1
81	Tl	0.2	0.2	PT	1
82	Pb	0.364	0.008	LPES	1
83	Bi	0.942362	0.000013	LPT	262
84	Po	1.9	0.3	calc	1
85	At	2.8	0.2	calc	1
86	Rn	not stable	—	calc	1
87	Fr	0.46	—	calc	82
88	Ra	0.10	—	calc	273
89	Ac	0.35	—	calc	207
118	ekaradon	0.056	0.01	calc	140
121	ekaactinium	0.57	—	calc	207

TABLE 2. Electron Affinities for Diatomic Molecules

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.	Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
Ag <sub>2</sub>	1.023	0.007	LPES	37	MnH	0.869	0.010	LPES	9
AgO	1.654	0.002	LPES	233	MnO	1.375	0.010	LPES	158
Al <sub>2</sub>	1.10	0.15	LPES	68	MoO	1.290	0.006	LPES	127
AlO	2.60	0.02	LPES	143	NH	0.370	0.004	LPT	32
AlP	2.043	0.020	LPES	218	NO	0.026	0.005	LPES	73
AlS	2.60	0.03	LPES	129	NRh	1.51	0.02	LPES	206
As <sub>2</sub>	0.739	0.008	LPES	200	NS	1.194	0.011	LPES	2
AsH	1.0	0.1	PT	2	Na <sub>2</sub>	0.430	0.015	LPES	104
AsO	1.286	0.008	LPES	198	NaBr	0.788	0.010	LPES	30
Au <sub>2</sub>	1.938	0.007	LPES	37	NaCl	0.727	0.010	LPES	30
AuO	2.374	0.007	LPES	282	NaF	0.520	0.010	LPES	30
AuPd	1.88	—	LPES	220	NaI	0.865	0.010	LPES	30
AuS	2.469	0.006	LPES	282	NaK	0.465	0.030	LPES	104
BN	3.160	0.005	LPES	189	NbO	1.29	0.02	LPES	174
BO	2.508	0.008	LPES	6	Ni <sub>2</sub>	0.926	0.010	LPES	112
BeH	0.7	0.1	PT	2	NiCu	0.889	0.010	LPES	128
Bi <sub>2</sub>	1.271	0.008	LPES	119	NiAg	0.979	0.010	LPES	128
Br <sub>2</sub>	2.55	0.10	CT	2	NiD	0.477	0.007	LPES	29
BrO	2.353	0.006	LPES	88	NiH	0.481	0.007	LPES	29
C <sub>2</sub>	3.269	0.006	LPES	87	NiO	1.470	0.003	LPES	146
CH	1.238	0.008	LPES	2	O <sub>2</sub>	0.450	0.002	LPES	222
CN	3.862	0.004	LPES	111	OD	1.825533	0.000037	LPT	142
CRh	1.46	0.02	LPES	206	OH	1.8276487	0.000011	LPT	226
CS	0.205	0.021	LPES	2	ORh	1.58	0.02	LPES	206
CaH	0.93	0.05	PT	2	P <sub>2</sub>	0.589	0.025	LPES	42
Cl <sub>2</sub>	2.38	0.10	CT	2	PH	1.027	0.006	LPES	281
ClO	2.275	0.006	LPES	88	PO	1.092	0.010	LPES	2
Co <sub>2</sub>	1.110	0.008	LPES	27	Pb <sub>2</sub>	1.366	0.010	LPES	117
CoD	0.680	0.010	LPES	29	PbO	0.722	0.006	LPES	105
CoH	0.671	0.010	LPES	29	PbS	1.049	0.010	LPES	228
Cr <sub>2</sub>	0.505	0.005	LPES	114	Pd <sub>2</sub>	1.685	0.008	LPES	112
CrD	0.568	0.010	LPES	29	PdCO	0.604	0.010	LPES	160
CrH	0.563	0.010	LPES	29	PdO	1.570	0.006	LPES	290
CrO	1.221	0.006	LPES	5	Pt <sub>2</sub>	1.898	0.008	LPES	112
Cs <sub>2</sub>	0.469	0.015	LPES	104	PtN	1.240	0.010	LPES	46
CsCl	0.455	0.010	LPES	30	Rb <sub>2</sub>	0.498	0.015	LPES	104
CsO	0.273	0.012	LPES	133	RbCl	0.544	0.010	LPES	30
Cu <sub>2</sub>	0.836	0.006	LPES	37	RbCs	0.478	0.020	LPES	104
CuO	1.777	0.006	LPES	118	Re <sub>2</sub>	1.571	0.008	LPES	33
F <sub>2</sub>	3.08	0.10	CT	2	S <sub>2</sub>	1.670	0.015	LPES	53
FO	2.272	0.006	LPES	88	SD	2.315	0.002	LPES	10
Fe <sub>2</sub>	0.902	0.008	LPES	27	SF	2.285	0.006	LPES	93
FeD	0.932	0.015	LPES	9	SH	2.314343	0.000004	LPT	47
FeH	0.934	0.011	LPES	9	SO	1.125	0.005	LPES	84
FeO	1.493	0.005	LPES	45	Sb <sub>2</sub>	1.282	0.008	LPES	108
GaAs	1.949	0.020	LPES	218	ScO	1.35	0.02	LPES	171
GaO	2.612	0.008	LPES	279	Se <sub>2</sub>	1.94	0.07	LPES	38
GaP	1.988	0.020	LPES	218	SeH	2.212519	0.000025	LPT	48
Ge <sub>2</sub>	2.035	0.001	LPES	123	SeO	1.456	0.020	LPES	41
I <sub>2</sub>	2.524	0.015	LPES	305	Si <sub>2</sub>	2.201	0.010	LPES	100
IBr	2.55	0.10	CT	2	SiF	0.81	0.02	LPES	278
IO	2.378	0.006	LPES	88	SiH	1.277	0.009	LPES	2
InP	1.845	0.020	LPES	218	SiN	2.949	0.008	LPES	274
K <sub>2</sub>	0.497	0.012	LPES	104	Sn <sub>2</sub>	1.962	0.010	LPES	117
KBr	0.642	0.010	LPES	30	SnO	0.598	0.006	LPES	168
KCl	0.582	0.010	LPES	30	SnPb	1.569	0.008	LPES	117
KCs	0.471	0.020	LPES	104	Te <sub>2</sub>	1.92	0.07	LPES	38
KI	0.728	0.010	LPES	30	TeH	2.102	0.015	LPES	39
KRb	0.486	0.020	LPES	104	TeO	1.697	0.022	LPES	40
LiCl	0.593	0.010	LPES	30	TiO	1.30	0.03	LPES	172
LiD	0.337	0.012	LPES	102	VO	1.229	0.008	LPES	170
LiH	0.342	0.012	LPES	102	YO	1.35	0.02	LPES	171
MgCl	1.589	0.011	LPES	31	ZnF	1.974	0.008	LPES	179
MgH	1.05	0.06	PT	2	ZnH	<0.95	—	PT	2
MgI	1.899	0.018	LPES	31	ZnO	2.087	0.008	LPES	179
MgO	1.630	0.025	LPES	178	ZrO	1.3	0.3	LPES	173
MnD	0.866	0.010	LPES	9					

TABLE 3. Electron Affinities for Triatomic Molecules

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.	Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
Ag <sub>3</sub>	2.32	0.05	LPES	37	Ga <sub>2</sub> P	2.481	0.015	LPES	192
AgCN	1.588	0.010	LPES	163	Ge <sub>3</sub>	2.23	0.01	LPES	123
Al <sub>3</sub>	1.4	0.15	LPES	68	GeH <sub>2</sub>	1.097	0.015	LPES	28
AlO <sub>2</sub>	4.23	0.02	LPES	143	HCO	0.313	0.005	LPES	35
AlP <sub>2</sub>	1.933	0.007	LPES	217	HCl <sub>2</sub>	4.896	0.005	LPES	69
Al <sub>2</sub> N	2.571	0.008	LPES	297	HNO	0.338	0.015	LPES	14
Al <sub>2</sub> P	2.513	0.020	LPES	217	HO <sub>2</sub>	1.078	0.006	LPES	15
Al <sub>2</sub> S	0.80	0.12	LPES	129	HS <sub>2</sub>	1.907	0.015	LPES	53
As <sub>3</sub>	1.45	0.03	LPES	200	I <sub>3</sub>	4.226	0.013	LPES	162
AsH <sub>2</sub>	1.27	0.03	PT	2	InP <sub>2</sub>	1.61	0.05	LPES	137
Au <sub>3</sub>	3.7	0.3	LPES	37	In <sub>2</sub> P	2.36	0.05	LPES	137
AuBr <sub>2</sub>	4.46	0.07	LPES	294	K <sub>3</sub>	0.956	0.050	LPES	18
AuCl <sub>2</sub>	4.60	0.07	LPES	294	MnD <sub>2</sub>	0.465	0.014	LPES	34
Au <sub>2</sub>	4.18	0.07	LPES	294	MnH <sub>2</sub>	0.444	0.016	LPES	34
Au <sub>2</sub> H	3.55	0.03	LPES	276	MnO <sub>2</sub>	2.06	0.03	LPES	158
Au <sub>2</sub> Pd	3.80	—	LPES	220	N <sub>3</sub>	2.70	0.12	PT	2
BO <sub>2</sub>	4.3	0.2	CT	98	N <sub>3</sub>	2.68	0.01	LPT	255
B <sub>2</sub> N	3.098	0.005	LPES	193	NCN	2.484	0.006	LPES	154
B <sub>3</sub>	2.82	0.02	LPES	221	NCO	3.609	0.005	LPES	111
Bi <sub>3</sub>	1.60	0.03	LPES	119	NCS	3.537	0.005	LPES	111
C <sub>3</sub>	1.981	0.020	LPES	11	NH <sub>2</sub>	0.771	0.005	LPES	58
CBr <sub>2</sub>	1.88	0.07	LPES	235	N <sub>2</sub> O	-0.03	0.10	calc	59
CCl <sub>2</sub>	1.59	0.07	LPES	235	NO <sub>2</sub>	2.273	0.005	LPES	63
CD <sub>2</sub>	0.645	0.006	LPES	12	(NO)R	R=Ar,Kr,Xe	—	LPES	90
CDF	0.535	0.005	LPES	95	Na <sub>3</sub>	1.019	0.060	LPES	18
CF <sub>2</sub>	0.180	0.020	LPES	235	NaCS <sub>2</sub>	0.80	0.05	LPES	278
CH <sub>2</sub>	0.652	0.006	LPES	12	Na <sub>2</sub> CS <sub>2</sub>	0.25	0.05	LPES	278
CHBr	1.454	0.005	LPES	95	Nb <sub>3</sub>	1.032	0.010	LPES	175
CHCl	1.210	0.005	LPES	95	Ni <sub>3</sub>	1.41	0.05	LPES	55
CHF	0.542	0.005	LPES	95	NiCN	1.771	0.010	LPES	287
CHI	1.42	0.17	LPES	95	NiCO	0.804	0.012	LPES	2
Cl <sub>2</sub>	2.09	0.07	LPES	235	NiD <sub>2</sub>	1.926	0.007	LPES	34
C <sub>2</sub> Cr	2.30	1.617	0.015	271	NiH <sub>2</sub>	1.934	0.008	LPES	34
C <sub>2</sub> H	2.969	0.006	LPES	87	NiO <sub>2</sub>	3.05	0.01	LPES	214 ONiO
C <sub>2</sub> Nb	1.380	0.025	LPES	243	NiO <sub>2</sub>	0.82	0.03	LPES	214 Ni(O <sub>2</sub> )
C <sub>2</sub> O	2.289	0.018	LPES	180	O <sub>3</sub>	2.1028	0.0025	LPT	2
COS	-0.04	—	LPES	272	O <sub>2</sub> Ar	0.52	0.02	LPES	75
CS <sub>2</sub>	0.58	0.05	LPES	278	OCIO	2.140	0.008	LPES	88
C <sub>2</sub> Ti	1.542	0.020	LPES	147	OIO	2.577	0.008	LPES	88
CoD <sub>2</sub>	1.465	0.013	LPES	34	PH <sub>2</sub>	1.263	0.006	LPES	281
CoH <sub>2</sub>	1.450	0.014	LPES	34	P <sub>2</sub> H	1.514	0.010	LPES	281
CrH <sub>2</sub>	>2.5	—	LPES	34	PO <sub>2</sub>	3.42	0.01	LPES	124
Cr <sub>2</sub> D	1.464	0.005	LPES	107	Pd <sub>3</sub>	<1.5	0.1	LPES	55
Cr <sub>2</sub> H	1.474	0.005	LPES	107	PdCN	2.543	0.007	LPES	287
Cr <sub>2</sub> O	0.9	0.1	LPES	306	PdCO	0.606	0.010	LPES	293
CrO <sub>2</sub>	2.413	0.008	LPES	144	Pt <sub>3</sub>	1.87	0.02	LPES	55
CrO <sub>2</sub>	1.5	0.06	LPES	241	PtCN	3.191	0.003	LPES	287
Cs <sub>3</sub>	0.864	0.030	LPES	18	PtCO	1.212	0.010	LPES	293
Cu <sub>3</sub>	2.11	0.05	LPES	37	Rb <sub>3</sub>	0.920	0.030	LPES	18
CuCN	1.466	0.010	LPES	163	ReO <sub>2</sub>	2.5	0.1	LPES	216
CuCl <sub>2</sub>	4.35	0.05	LPES	177	S <sub>3</sub>	2.093	0.025	LPES	16
CuBr <sub>2</sub>	4.35	0.05	LPES	177	SO <sub>2</sub>	1.107	0.008	LPES	16
DCO	0.301	0.005	LPES	35	S <sub>2</sub> O	1.877	0.008	LPES	16
DNO	0.330	0.015	LPES	14	Sb <sub>3</sub>	1.85	0.03	LPES	108
DO <sub>2</sub>	1.077	0.005	LPES	15	SeO <sub>2</sub>	1.823	0.050	LPES	38
DS <sub>2</sub>	1.912	0.015	LPES	53	SiF <sub>2</sub>	0.10	0.10	LPES	278
Fe <sub>3</sub>	1.43	0.06	LPES	149	Si <sub>2</sub> F	1.99	0.28	LPES	17
FeC <sub>2</sub>	1.9782	0.0006	LPES	254	SiH <sub>2</sub>	1.124	0.020	LPES	2
FeCO	1.157	0.005	LPES	103	Si <sub>2</sub> H	2.31	0.01	LPES	182
FeD <sub>2</sub>	1.038	0.013	LPES	34	Si <sub>3</sub>	2.29	0.02	LPES	110
FeH <sub>2</sub>	1.049	0.014	LPES	34	Sn <sub>3</sub>	2.24	0.01	LPES	289
FeO <sub>2</sub>	2.358	0.030	LPES	130	SnCN	1.922	0.006	LPES	292
Fe <sub>2</sub> H	0.564	0.019	LPES	254	Ta <sub>3</sub>	1.36	0.03	LPES	169
Fe <sub>2</sub> O	1.60	0.02	LPES	152	TiO <sub>2</sub>	1.59	0.03	LPES	172
GaAs <sub>2</sub>	1.894	0.033	LPES	192	V <sub>3</sub>	1.107	0.010	LPES	176
GaP <sub>2</sub>	1.666	0.041	LPES	192	VO <sub>2</sub>	2.3	0.2	CT	101
Ga <sub>2</sub> As	2.428	0.020	LPES	192	WO <sub>2</sub>	1.958	0.050	LPES	233
Ga <sub>2</sub> N	2.506	0.008	LPES	302					

TABLE 4. Electron Affinities for Larger Polyatomic Molecules

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
Ag <sub>n</sub>	<i>n</i> =1-60	—	LPES	37
Al <sub>n</sub>	<i>n</i> =3-32	—	LPES	68
Al <sub>5</sub>	2.23	0.05	LPES	238
Al <sub>2</sub> C <sub>2</sub>	0.64	0.05	LPES	239 acetylide
Al <sub>3</sub> C	2.56	0.06	LPES	161
Al <sub>3</sub> C <sub>2</sub>	2.19	0.03	LPES	244
Al <sub>3</sub> Ge <sub>2</sub>	2.43	0.03	LPES	244
Al <sub>3</sub> Si <sub>2</sub>	2.36	0.03	LPES	244
Al <sub>3</sub> O	1.00	0.15	LPES	68
Al <sub>5</sub> H <sub>2</sub> O <sub>5</sub>	3.10	0.10	LPES	283
Al <sub>5</sub> O <sub>4</sub>	3.50	0.05	LPES	283
Al <sub>n</sub> O <sub>m</sub>	<i>n</i> =1,2	<i>m</i> =1-5	LPES	143
Al <sub>n</sub> O <sub>m</sub>	<i>n</i> =3-7	<i>m</i> =2-5	LPES	267
Al <sub>n</sub> P <sub>m</sub>	<i>n</i> =1-4	<i>m</i> =1-4	LPES	217
Al <sub>n</sub> S <sub>m</sub>	<i>n</i> =1-5	<i>m</i> =1-3	LPES	129
Ar(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =2,6,7	—	LPES	77
Ar <sub>n</sub> Br	<i>n</i> =2-9	—	ZEKE	212
Ar <sub>n</sub> I	<i>n</i> =2-19	—	ZEKE	212
As <sub>4</sub>	<0.8	—	LPES	200
As <sub>5</sub>	≈1.7	—	LPES	200
As <sub>5</sub>	≈3.5	—	LPES	253
Au <sub>n</sub>	<i>n</i> =1-233	—	LPES	37
AuF <sub>6</sub>	7.5	estimate	CT	98
Au <sub>3</sub> Pd	2.51	—	LPES	220
Au <sub>4</sub> Pd	2.69	—	LPES	220
Au <sub>6</sub>	2.06	0.02	LPES	288
Au <sub>6</sub> (CO)	2.04	0.05	LPES	288
Au <sub>6</sub> (CO) <sub>2</sub>	2.03	0.05	LPES	288
Au <sub>6</sub> (CO) <sub>3</sub>	1.95	0.05	LPES	288
Au <sub>12</sub> Nb	3.70	0.03	LPES	275
Au <sub>12</sub> Ta	3.77	0.03	LPES	275
Au <sub>12</sub> V	3.76	0.03	LPES	275
B <sub>5</sub>	2.33	0.02	LPES	245
BD <sub>3</sub>	0.027	0.014	LPES	62
BH <sub>3</sub>	0.038	0.015	LPES	62
B <sub>6</sub> Li	2.3	0.1	LPES	298
B <sub>3</sub> N	2.098	0.035	LPES	193
Bi <sub>n</sub>	<i>n</i> =2-9	—	LPES	213
Bi <sub>4</sub>	1.05	0.010	LPES	119
Bi <sub>5</sub>	2.87	0.02	LPES	253
Br(CO <sub>2</sub> )	3.582	0.017	LPES	131
Br(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1-4	—	LPES	250
Br <sub>7</sub> Au <sub>2</sub>	3.52	0.02	LPES	301
C <sub>n</sub>	<i>n</i> =2-84	—	LPES	70
C <sub>n</sub> Cr	<i>n</i> =2-8	—	LPES	271
C <sub>n</sub> Nb	<i>n</i> =2-7	—	LPES	243
(CO <sub>2</sub> ) <sub>n</sub>	<i>n</i> =1,2	—	LPES	75
(CS) <sub>n</sub>	<i>n</i> =2	—	LPES	75
(CS <sub>2</sub> ) <sub>n</sub>	<i>n</i> =1,2	—	LPES	75
CAI <sub>3</sub> Ge	2.70	0.06	LPES	224
CAI <sub>3</sub> Si	2.77	0.06	LPES	224
CCl <sub>4</sub>	≤1.14	—	CT	266
CCoNO <sub>3</sub>	1.73	0.03	LPES	199 Co(CO <sub>2</sub> )NO
CDO <sub>2</sub>	3.510	0.015	LPES	109
CF <sub>3</sub>	1.82	0.05	LPES	187
CF <sub>3</sub> Br	0.91	0.2	CD	2
CF <sub>3</sub> I	1.57	0.2	CD	2
CFO <sub>2</sub>	4.277	0.030	LPES	131
CHCl <sub>3</sub>	≤0.78	—	CT	266

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
CHO <sub>2</sub>	3.498	0.015	LPES	109
CH <sub>2</sub> O <sub>4</sub>	2.1	0.2	PT	2 CO <sub>3</sub> (H <sub>2</sub> O)
CH <sub>2</sub> S	0.465	0.023	LPES	53
CD <sub>3</sub> NO <sub>2</sub>	0.24	0.08	LPES	211
CD <sub>3</sub> O	1.559	0.004	LPES	194
CD <sub>3</sub> O <sub>2</sub>	1.154	0.004	LPES	188 <i>d</i> <sub>3</sub> -methyl peroxy radical
CD <sub>3</sub> S	1.856	0.006	LPT	2
CD <sub>3</sub> S <sub>2</sub>	1.748	0.022	LPES	53
CH <sub>3</sub>	0.08	0.03	LPES	2
CH <sub>3</sub> I	0.11	0.02	LPES	277
CH <sub>3</sub> NO <sub>2</sub>	0.26	0.08	LPES	211
CH <sub>3</sub> O	1.572	0.004	LPES	194
CH <sub>3</sub> O <sub>2</sub>	1.161	0.005	LPES	188 methyl peroxy radical
CH <sub>3</sub> S	1.867	0.004	LPES	166
CH <sub>3</sub> S <sub>2</sub>	1.757	0.022	LPES	53
CH <sub>3</sub> Si	0.852	0.010	LPES	97 CH <sub>3</sub> -Si
CH <sub>3</sub> Si	2.010	0.010	LPES	97 CH <sub>2</sub> =SiH
CH <sub>4</sub> N	0.432	0.015	LPES	215
CH <sub>3</sub> Si	1.19	0.04	LPT	65 CH <sub>3</sub> SiH <sub>2</sub>
CO <sub>3</sub>	2.69	0.14	LPES	2
C <sub>2</sub> F <sub>2</sub>	2.255	0.006	LPES	106 difluorovinylidene
C <sub>2</sub> DN	2.009	0.020	LPES	219 DCCN
C <sub>2</sub> DN	1.877	0.010	LPES	219 DCNC
C <sub>2</sub> DO	2.350	0.020	LPES	13
C <sub>2</sub> HF	1.718	0.006	LPES	106 monofluorovinylidene
C <sub>2</sub> HN	2.003	0.014	LPES	219 HCCN
C <sub>2</sub> HN	1.883	0.013	LPES	219 HCNC
C <sub>2</sub> HO	2.338	0.008	LPES	190
C <sub>2</sub> HNPd	2.17	0.03	LPES	291
C <sub>2</sub> HPd	1.98	0.03	LPES	287
C <sub>2</sub> HPt	2.650	0.010	LPES	287
C <sub>2</sub> D <sub>2</sub>	0.492	0.006	LPES	83 vinylidene- <i>d</i> <sub>2</sub>
C <sub>2</sub> HD	0.489	0.006	LPES	83 vinylidene- <i>d</i> <sub>1</sub>
C <sub>2</sub> HFe	1.4512	0.0025	LPES	254
C <sub>2</sub> HNi	1.063	0.019	LPES	254
C <sub>2</sub> H <sub>2</sub>	0.490	0.006	LPES	83 vinylidene
C <sub>2</sub> H <sub>2</sub> FO	2.22	0.09	PT	2 acetyl fluoride enolate
C <sub>2</sub> D <sub>2</sub> N	1.538	0.012	LPES	21 cyanomethyl- <i>d</i> <sub>2</sub> radical
C <sub>2</sub> D <sub>2</sub> N	1.070	0.024	LPES	21 isocyanomethyl- <i>d</i> <sub>2</sub> radical
C <sub>2</sub> H <sub>2</sub> Fe	1.328	0.019	LPES	254
C <sub>2</sub> H <sub>2</sub> N	1.543	0.014	LPES	21 cyanomethyl radical
C <sub>2</sub> H <sub>2</sub> N	1.059	0.024	LPES	21 isocyanomethyl radical
C <sub>2</sub> H <sub>2</sub> Ni	2.531	0.005	LPES	287 HNiC <sub>2</sub> H
C <sub>2</sub> H <sub>3</sub>	0.667	0.024	LPES	90 vinyl
C <sub>2</sub> H <sub>3</sub> Fe	1.587	0.019	LPES	254
C <sub>2</sub> H <sub>3</sub> Ni	1.103	0.019	LPES	254
C <sub>2</sub> D <sub>3</sub> O	1.81897	0.00012	LPT	22 acetaldehyde- <i>d</i> <sub>3</sub> enolate
C <sub>2</sub> H <sub>3</sub> O	1.82476	0.00012	LPT	22 acetaldehyde enolate
C <sub>2</sub> D <sub>3</sub> O	1.699	0.004	LPES	194 ethoxide- <i>d</i> <sub>3</sub>
C <sub>2</sub> H <sub>3</sub> N	0.56	0.01	PT	2 ethyl nitrine
C <sub>2</sub> H <sub>3</sub> O	1.712	0.004	LPES	194 ethoxide
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	1.186	0.004	LPES	188 ethyl peroxy radical
C <sub>2</sub> H <sub>3</sub> S	1.953	0.006	LPT	2 ethyl sulfide
C <sub>2</sub> H <sub>3</sub> S	0.868	0.051	LPES	53 CH <sub>3</sub> SCH <sub>2</sub>
C <sub>2</sub> H <sub>7</sub> O <sub>2</sub>	2.26	0.08	PT	50 MeOHOMe
C <sub>3</sub> Fe	1.69	0.08	LPES	132
C <sub>3</sub> H	1.858	0.023	LPES	11
C <sub>3</sub> HFe	1.58	0.06	LPES	132
C <sub>3</sub> H <sub>2</sub>	1.794	0.008	LPES	153
C <sub>3</sub> H <sub>2</sub> F <sub>3</sub> O	2.625	0.010	LPT	113 1,1,1-trifluoroacetone enolate

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
C <sub>3</sub> H <sub>3</sub>	0.893	0.025	LPES	24 propargyl radical
C <sub>3</sub> H <sub>2</sub> D	0.88	0.15	LPES	24 propargyl- <i>d</i> <sub>1</sub> radical
C <sub>3</sub> D <sub>2</sub> H	0.907	0.023	LPES	24 propargyl- <i>d</i> <sub>2</sub> radical
C <sub>3</sub> H <sub>3</sub> N	1.247	0.012	LPES	21 CH <sub>3</sub> CH-CN
C <sub>3</sub> D <sub>5</sub>	0.464	0.006	LPES	138 allyl- <i>d</i> <sub>5</sub>
C <sub>3</sub> H <sub>5</sub>	0.481	0.008	LPES	138 allyl
C <sub>3</sub> H <sub>5</sub>	0.397	0.069	kinetic	155 cyclopropyl
C <sub>3</sub> H <sub>4</sub> D	0.373	0.019	LPES	25 allyl- <i>d</i> <sub>1</sub>
C <sub>3</sub> H <sub>5</sub> O	1.758	0.019	LPT	113 acetone enolate
C <sub>3</sub> H <sub>5</sub> O	1.621	0.006	LPT	113 propionaldehyde enolate
C <sub>3</sub> H <sub>5</sub> O <sub>2</sub>	1.80	0.06	PT	2 methyl acetate enolate
C <sub>3</sub> H <sub>7</sub> O	1.789	0.033	LPES	23 propyl oxide
C <sub>3</sub> H <sub>7</sub> O	1.847	0.004	LPES	194 isopropyl oxide
C <sub>3</sub> H <sub>7</sub> S	2.00	0.02	PT	2 propyl sulfide
C <sub>3</sub> H <sub>7</sub> S	2.02	0.02	PT	2 isopropyl sulfide
C <sub>3</sub> O	1.34	0.15	LPES	11
C <sub>3</sub> O <sub>2</sub>	0.85	0.15	LPES	11
C <sub>3</sub> Ti	1.561	0.015	LPES	147
C <sub>4</sub> F <sub>4</sub> Cl <sub>2</sub>	0.87	0.08	attach	258 1,2-dichlorotetrafluoro-cyclobutene
C <sub>4</sub> F <sub>4</sub> O <sub>3</sub>	0.5	0.2	CD	2 tetrafluorosuccinic anhydride
C <sub>4</sub> F <sub>8</sub>	0.63	0.05	attach	256 octafluorocyclobutane
C <sub>4</sub> Fe	<2.2	0.2	LPES	132
C <sub>4</sub> HFe	1.67	0.06	LPES	132
C <sub>4</sub> H <sub>2</sub> Fe	1.633	0.019	LPES	254
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	1.44	0.10	CT	61 maleic anhydride
C <sub>4</sub> H <sub>3</sub> Fe	1.182	0.019	LPES	254
C <sub>4</sub> H <sub>3</sub> Ni	0.824	0.019	LPES	254
C <sub>4</sub> D <sub>4</sub>	0.909	0.015	LPES	125 vinylvinylidene- <i>d</i> <sub>4</sub>
C <sub>4</sub> H <sub>4</sub>	0.914	0.015	LPES	125 vinylvinylidene
C <sub>4</sub> H <sub>4</sub> N	2.145	0.010	LPES	265 pyrrolyl
C <sub>4</sub> H <sub>4</sub> N <sub>3</sub> O	0.75	—	LPES	285 NO (pyrimidine)
C <sub>4</sub> H <sub>5</sub> O	1.801	0.008	LPT	113 cyclobutanone enolate
C <sub>4</sub> H <sub>6</sub>	0.431	0.006	LPES	135 trimethylenemethane
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	0.69	0.10	CT	61 2,3-butanedione
C <sub>4</sub> H <sub>6</sub> D	0.493	0.008	LPES	138 2-methylallyl- <i>d</i> <sub>7</sub>
C <sub>4</sub> H <sub>7</sub>	0.505	0.006	LPES	138 2-methylallyl
C <sub>4</sub> H <sub>7</sub> O	1.67	0.05	PT	2 butyraldehyde enolate
C <sub>4</sub> H <sub>5</sub> DO	1.67	0.05	PT	2 2-butanone-3- <i>d</i> <sub>1</sub> enolate
C <sub>4</sub> H <sub>4</sub> D <sub>2</sub> O	1.75	0.06	PT	2 2-butanone-3,3- <i>d</i> <sub>2</sub> enolate
C <sub>4</sub> H <sub>9</sub> O	1.909	0.004	LPES	194 <i>t</i> -butoxyl
C <sub>4</sub> H <sub>9</sub> S	2.03	0.02	PT	2 <i>n</i> -butyl sulfide
C <sub>4</sub> H <sub>9</sub> S	2.07	0.02	PT	2 <i>t</i> -butyl sulfide
C <sub>4</sub> O	2.05	0.15	LPES	11
C <sub>4</sub> O <sub>2</sub>	2.0	0.2	LPES	11
C <sub>4</sub> Ti	1.494	0.020	LPES	147
C <sub>5</sub>	2.853	0.001	LPT	99
C <sub>5</sub> F <sub>5</sub> N	0.70	0.05	attach	259 pentafluoropyridine
C <sub>5</sub> F <sub>6</sub> O <sub>3</sub>	1.5	0.2	CD	2 hexafluoroglutaric anhydride
C <sub>5</sub> HF <sub>4</sub> N	0.40	0.08	attach	259 tetrafluoropyridine
C <sub>5</sub> D <sub>5</sub>	1.790	0.008	LPES	11 cyclopentadienyl- <i>d</i> <sub>5</sub>
C <sub>5</sub> H <sub>5</sub>	1.804	0.007	LPES	11 cyclopentadienyl
C <sub>5</sub> H <sub>5</sub> NO <sub>2</sub>	1.39	—	LPES	285 O <sub>2</sub> (pyridine)
C <sub>5</sub> H <sub>5</sub> N <sub>2</sub> O	0.62	—	LPES	285 NO (pyridine)
C <sub>5</sub> H <sub>7</sub>	0.91	0.03	PT	2 pentadienyl
C <sub>5</sub> H <sub>7</sub> NO <sub>3</sub>	1.87	—	LPES	285 O <sub>2</sub> (pyridine · H <sub>2</sub> O)
C <sub>5</sub> H <sub>7</sub> O	1.598	0.007	LPT	113 cyclopentanone enolate
C <sub>5</sub> H <sub>9</sub> O	1.69	0.05	PT	2 3-pentanone enolate
C <sub>5</sub> H <sub>11</sub> O	1.93	0.05	LPT	2 neopentoxyl
C <sub>5</sub> H <sub>11</sub> S	2.09	0.02	PT	2 pentyl sulfide
C <sub>5</sub> O <sub>2</sub>	1.2	0.2	LPES	11

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
C <sub>5</sub> Ti	1.748	0.050	LPES	147
C <sub>6</sub>	4.180	0.001	LPT	8
C <sub>6</sub> Br <sub>4</sub> O <sub>2</sub>	2.44	0.20	CT	2 tetrabromo-BQ
C <sub>6</sub> Cl <sub>4</sub> O <sub>2</sub>	2.78	0.10	CT	61 tetrachloro-BQ
C <sub>6</sub> F <sub>4</sub> O <sub>2</sub>	2.70	0.10	CT	61 tetrafluoro-BQ
C <sub>6</sub> F <sub>5</sub> Br	1.15	0.11	CT	67 pentafluorobromobenzene
C <sub>6</sub> F <sub>5</sub> Cl	0.75	0.05	attach	260 pentafluorochlorobenzene
C <sub>6</sub> F <sub>5</sub> I	1.41	0.11	CT	67 pentafluoroiodobenzene
C <sub>6</sub> F <sub>5</sub> NO <sub>2</sub>	1.52	0.11	CT	67 pentafluoro-NB
C <sub>6</sub> F <sub>6</sub>	0.53	0.05	attach	257 hexafluorobenzene
C <sub>6</sub> F <sub>10</sub>	>1.4	0.3	CT	2 perfluorocyclohexane
C <sub>6</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	2.48	0.10	CT	61 2,6-dichloro-BQ
C <sub>6</sub> H <sub>3</sub> F <sub>2</sub> NO <sub>2</sub>	1.17	0.10	CT	61 2,4-difluoro-NB
C <sub>6</sub> D <sub>4</sub>	0.551	0.010	LPES	36 <i>o</i> -benzynes-d <sub>4</sub>
C <sub>6</sub> H <sub>4</sub>	0.560	0.010	LPES	36 <i>o</i> -benzynes
C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	1.16	0.10	CT	61 <i>o</i> -bromo-NB
C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	1.32	0.10	CT	61 <i>m</i> -bromo-NB
C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	1.29	0.10	CT	61 <i>p</i> -bromo-NB
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1.14	0.10	CT	61 <i>o</i> -chloro-NB
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1.28	0.10	CT	61 <i>m</i> -chloro-NB
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1.26	0.10	CT	61 <i>p</i> -chloro-NB
C <sub>6</sub> H <sub>4</sub> ClO	≤2.58	0.08	PT	2 <i>o</i> -chlorophenoxide
C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	1.07	0.10	CT	61 <i>o</i> -fluoro-NB
C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	1.23	0.10	CT	61 <i>m</i> -fluoro-NB
C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	1.12	0.10	CT	61 <i>p</i> -fluoro-NB
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1.65	0.10	CT	61 <i>o</i> -diNB
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	1.65	0.10	CT	61 <i>m</i> -diNB
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	2.00	0.10	CT	61 <i>p</i> -diNB
C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	1.860	0.005	LPES	284 1,4-benzoquinone (BQ)
C <sub>6</sub> D <sub>5</sub>	1.092	0.020	LPES	26 phenyl- <i>d</i> <sub>5</sub>
C <sub>6</sub> D <sub>5</sub> N	1.44	0.02	LPES	96 phenylnitrene- <i>d</i> <sub>5</sub>
C <sub>6</sub> H <sub>2</sub> O <sub>2</sub>	1.859	0.005	LPES	232 dehydrobenzoquinone
C <sub>6</sub> H <sub>3</sub> O <sub>2</sub>	<2.18	—	LPES	232 benzoquinonide
C <sub>6</sub> H <sub>5</sub>	1.096	0.006	LPES	26 phenyl
C <sub>6</sub> H <sub>5</sub> N	1.429	0.011	LPT	115 phenylnitrene
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	1.00	0.01	LPES	164 nitrobenzene (NB)
C <sub>6</sub> H <sub>5</sub> O	2.253	0.006	LPES	26 phenoxyl
C <sub>6</sub> H <sub>5</sub> S	<2.47	0.06	PT	2 thiophenoxide
C <sub>6</sub> H <sub>5</sub> NH	1.70	0.03	PT	2 anilide
C <sub>6</sub> H <sub>6</sub> NO	0.44	—	LPES	285 NO (benzene)
C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	1.06	—	LPES	285 O <sub>2</sub> (benzene)
C <sub>6</sub> H <sub>7</sub>	<1.67	0.04	PT	2 methylchlopentadienyl
C <sub>6</sub> H <sub>8</sub>	0.855	0.010	LPES	203 (CH <sub>2</sub> ) <sub>2</sub> C-C(CH <sub>2</sub> ) <sub>2</sub>
C <sub>6</sub> H <sub>8</sub> Si	1.435	0.004	LPT	65 C <sub>6</sub> H <sub>5</sub> SiH <sub>3</sub>
C <sub>6</sub> H <sub>9</sub>	0.654	0.010	LPES	203 CH <sub>2</sub> =C(CH <sub>3</sub> )-C(CH <sub>2</sub> ) <sub>2</sub>
C <sub>6</sub> H <sub>9</sub> O	1.526	0.010	LPT	113 cyclohexanone enolate
C <sub>6</sub> H <sub>10</sub>	0.645	0.015	LPES	126 <i>t</i> -butyl vinylidene
C <sub>6</sub> H <sub>11</sub> O	1.755	+0.05/-0.005	LPT	113 pinacolone enolate
C <sub>6</sub> H <sub>11</sub> O	1.82	0.06	PT	2 3,3-dimethylbutanone enolate
C <sub>6</sub> N <sub>4</sub>	2.3	0.3	PT	2 TCNE
C <sub>6</sub> F <sub>5</sub> N	1.11	0.11	CT	67 pentafluorobenzonitrile
C <sub>7</sub> F <sub>8</sub>	0.86	0.11	CT	67 octafluorotoluene
C <sub>7</sub> F <sub>14</sub>	1.08	0.10	CT	61 perfluoromethylcyclohexane
C <sub>7</sub> HF <sub>5</sub> O	1.10	0.11	CT	67 pentafluorobenzaldehyde
C <sub>7</sub> H <sub>3</sub> N <sub>2</sub> O <sub>4</sub>	2.16	0.10	CT	61 3,5-(NO <sub>2</sub> ) <sub>2</sub> -benzonitrile
C <sub>7</sub> H <sub>4</sub> F <sub>3</sub> NO <sub>2</sub>	1.41	0.10	CT	61 <i>m</i> -trifluoromethyl-NB
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	1.61	0.10	CT	61 <i>o</i> -cyano-NB
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	1.56	0.10	CT	61 <i>m</i> -cyano-NB
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	1.72	0.10	CT	61 <i>p</i> -cyano-NB
C <sub>7</sub> H <sub>6</sub> Br	1.308	0.008	LPES	167 <i>o</i> -bromobenzyl



Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
C <sub>7</sub> H <sub>6</sub> Br	1.307	0.008	LPES	167 <i>m</i> -bromobenzyl
C <sub>7</sub> H <sub>6</sub> Br	1.229	0.008	LPES	167 <i>p</i> -bromobenzyl
C <sub>7</sub> H <sub>6</sub> Cl	1.257	0.008	LPES	167 <i>o</i> -chlorobenzyl
C <sub>7</sub> H <sub>6</sub> Cl	1.272	0.008	LPES	167 <i>m</i> -chlorobenzyl
C <sub>7</sub> H <sub>6</sub> Cl	1.174	0.008	LPES	167 <i>p</i> -chlorobenzyl
C <sub>7</sub> H <sub>6</sub> F	1.091	0.008	LPES	167 <i>o</i> -fluorobenzyl
C <sub>7</sub> H <sub>6</sub> F	1.173	0.008	LPES	167 <i>m</i> -fluorobenzyl
C <sub>7</sub> H <sub>6</sub> F	0.937	0.008	LPES	167 <i>p</i> -fluorobenzyl
C <sub>7</sub> H <sub>6</sub> FO	2.218	0.010	LPT	2 <i>m</i> -fluoroacetophenone enolate
C <sub>7</sub> H <sub>6</sub> FO	2.176	0.010	LPT	2 <i>p</i> -fluoroacetophenone enolate
C <sub>7</sub> H <sub>6</sub> FeO <sub>3</sub>	0.990	0.10	CT	120 η <sub>4</sub> -1,3-butadiene-Fe(CO) <sub>3</sub>
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1.77	0.05	PT	60 3,4-dinitrotoluene
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1.77	0.05	PT	60 2,3-dinitrotoluene
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1.60	0.05	PT	60 2,4-dinitrotoluene
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	1.55	0.05	PT	60 2,6-dinitrotoluene
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	1.85	0.10	CT	61 <i>o</i> -CH <sub>3</sub> -BQ
C <sub>7</sub> H <sub>7</sub>	0.912	0.006	LPES	26 benzyl
C <sub>7</sub> H <sub>7</sub>	0.868	0.006	LPES	136 1-quadricyclanide
C <sub>7</sub> H <sub>7</sub>	0.962	0.006	LPES	136 2-quadricyclanide
C <sub>7</sub> H <sub>7</sub>	1.286	0.006	LPES	136 norbornadienide
C <sub>7</sub> H <sub>7</sub>	0.39	0.04	LPES	136 cycloheptatrienide
C <sub>7</sub> H <sub>7</sub>	3.046	0.006	LPES	136 1-(1,6-heptadiynide)
C <sub>7</sub> H <sub>7</sub>	>1.140	0.006	LPES	136 3-(1,6-heptadiynide)
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	0.92	0.10	CT	61 <i>o</i> -methyl-NB
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	0.99	0.10	CT	61 <i>m</i> -methyl-NB
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	0.95	0.10	CT	61 <i>p</i> -methyl-NB
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	1.04	0.10	CT	61 <i>m</i> -OCH <sub>3</sub> -NB
C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	0.91	0.10	CT	61 <i>p</i> -OCH <sub>3</sub> -NB
C <sub>7</sub> H <sub>7</sub> O	<2.36	0.06	PT	2 <i>o</i> -methyl phenoxide
C <sub>7</sub> H <sub>7</sub> O	2.14	0.02	PT	50 benzyloxy
C <sub>7</sub> H <sub>8</sub> FO	<3.05	0.06	PT	50 PhCH <sub>2</sub> OH
C <sub>7</sub> H <sub>9</sub>	1.27	0.03	PT	2 heptatrienyl
C <sub>7</sub> H <sub>9</sub> O	1.61	0.05	PT	2 2-norbornanone enolate
C <sub>7</sub> H <sub>9</sub> Si	1.33	0.04	LPT	65 C <sub>6</sub> H <sub>5</sub> (CH <sub>3</sub> )SiH
C <sub>7</sub> H <sub>11</sub> O	1.598	0.007	LPT	113 cycloheptanone enolate
C <sub>7</sub> H <sub>11</sub> O	1.49	0.04	PT	2 2,5-dimethyl- cyclopentanone enolate
C <sub>7</sub> H <sub>13</sub> O	1.72	0.06	PT	2 4-heptanone enolate
C <sub>7</sub> H <sub>13</sub> O	1.46	0.04	PT	2 diisopropyl ketone enolate
C <sub>8</sub> F <sub>14</sub> N <sub>2</sub>	1.89	0.10	CT	51 1,4-(CN) <sub>2</sub> C <sub>6</sub> F <sub>4</sub>
C <sub>8</sub> H <sub>3</sub> F <sub>5</sub> O	0.88	0.11	CT	67 pentafluoroacetophenone
C <sub>8</sub> H <sub>3</sub> F <sub>6</sub> NO <sub>2</sub>	1.79	0.10	CT	61 3,5-(CF <sub>3</sub> ) <sub>2</sub> -NB
C <sub>8</sub> H <sub>4</sub> F <sub>3</sub> N	0.70	0.05	attach	263 <i>o</i> -trifluoromethylbenzotrile
C <sub>8</sub> H <sub>4</sub> F <sub>3</sub> N	0.67	0.05	attach	263 <i>m</i> -trifluoromethylbenzotrile
C <sub>8</sub> H <sub>4</sub> F <sub>3</sub> N	0.83	0.05	attach	263 <i>p</i> -trifluoromethylbenzotrile
C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	1.21	0.10	CT	61 phthalic anhydride
C <sub>8</sub> H <sub>6</sub>	1.044	0.008	LPES	148
C <sub>8</sub> H <sub>7</sub>	1.091	0.008	LPES	134
C <sub>8</sub> H <sub>7</sub> O	2.057	0.010	PT	2 acetophenone enolate
C <sub>8</sub> H <sub>7</sub> O	2.10	0.08	LPT	2 phenylacetaldehyde enolate
C <sub>8</sub> H <sub>8</sub>	0.55	0.02	CT	134 cyclooctatetraene
C <sub>8</sub> H <sub>8</sub>	0.919	0.008	LPES	139 <i>m</i> -xylene
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	1.21	0.05	PT	60 3,5-dimethyl-NB
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	2.61	0.05	PT	60 2,6-dimethyl-NB
C <sub>8</sub> H <sub>9</sub> NO <sub>2</sub>	0.86	0.10	CT	61 2,3-dimethyl-NB
C <sub>8</sub> H <sub>13</sub> O	1.63	0.06	PT	2 cyclooctanone enolate
C <sub>8</sub> N <sub>4</sub> NiS <sub>4</sub>	4.56	0.04	LPES	307 Ni-bis(dithiolene)
C <sub>8</sub> N <sub>4</sub> PdS <sub>4</sub>	4.55	0.04	LPES	307 Pd-bis(dithiolene)
C <sub>8</sub> N <sub>4</sub> PtS <sub>4</sub>	4.45	0.04	LPES	307 Pt-bis(dithiolene)
C <sub>8</sub> S <sub>2</sub>	0.049	0.005	LPES	230 bithiophene



Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
$C_9H_8FeO_3$	0.76	0.10	CT	120 $\eta_4$ -1,3-cyclohexadiene-Fe(CO) <sub>3</sub>
$C_9H_9O$	2.030	0.010	LPT	2 <i>m</i> -methylacetophenone enolate
$C_9H_9SiN$	1.43	0.10	PT	2 trimethylsilylnitrene
$C_9H_{11}NO_2$	0.70	0.10	CT	61 2,4,6-trimethyl-NB
$C_9H_{15}O$	1.69	0.06	PT	2 cyclononanone enolate
$C_{10}H_4C_{12}O_2$	2.19	0.10	CT	61 2,3-dichloro-1,4-naphthoquinone
$C_{10}H_6N_2O_4$	1.78	0.10	CT	61 1,3-dinitronaphthalene
$C_{10}H_6N_2O_4$	1.77	0.10	CT	61 1,5-dinitronaphthalene
$C_{10}H_6O_2$	1.81	0.10	CT	61 1,4-naphthoquinone
$C_{10}H_7$	1.403	0.015	LPES	197 1-naphthyl radical
$C_{10}H_7NO_2$	1.23	0.10	CT	61 1-nitronaphthalene
$C_{10}H_7NO_2$	1.18	0.10	CT	61 2-nitronaphthalene
$C_{10}H_8$	0.790	0.008	LPES	230 azulene
$C_{10}H_8CrO_3$	0.93	0.10	CT	120 $\eta_4$ -1,3,5-cycloheptatriene Cr(CO) <sub>3</sub>
$C_{10}H_8FeO_3$	0.98	0.10	CT	120 $\eta_4$ -1,3,5-cycloheptatriene-Fe(CO) <sub>3</sub>
$C_{10}H_8NO$	0.66	—	LPES	285 NO (naphthlene)
$C_{10}H_8O_2$	1.41	—	LPES	285 O <sub>2</sub> (naphthlene)
$C_{10}H_{10}O_3$	2.09	—	LPES	285 O <sub>2</sub> (naphthlene · H <sub>2</sub> O)
$C_{10}H_{12}O_4$	2.72	—	LPES	285 O <sub>2</sub> (naphthlene · (H <sub>2</sub> O) <sub>2</sub> )
$C_{10}H_{17}O$	1.83	0.06	PT	2 cyclodecanone enolate
$C_{11}H_8FeO_3$	1.29	0.10	CT	120 $\eta_4$ -1,3-butadiene-Fe(CO) <sub>3</sub>
$C_{12}F_{10}$	0.82	0.11	CT	67 decafluorobiphenyl
$C_{12}H_4N_4$	2.8	0.3	CD	2 TCNQ
$C_{12}H_5$	1.07	0.10	PT	2 perinaphthenyl
$C_{12}H_{12}NO$	0.79	—	LPES	285 NO (benzene) <sub>2</sub>
$C_{12}H_{15}O$	2.032	0.010	LPT	2 <i>t</i> -butylacetophenone enolate
$C_{12}H_{21}O$	1.90	0.07	PT	2 cyclododecanone enolate
$C_{13}F_{10}O$	1.52	0.11	CT	67 decafluorobenzophenone
$C_{13}H_9FO$	0.64	0.10	CT	61 4-fluorobenzophenone
$C_{13}H_{10}O$	0.62	0.10	CT	61 benzophenone
$C_{14}H_9NO_2$	1.43	0.10	CT	61 9-nitroanthracene
$C_{14}H_{10}$	0.530	0.005	LPES	286 anthracene
$C_{14}H_{12}O$	0.770	0.005	LPES	286 anthracene · H <sub>2</sub> O
$(C_{14}H_{10})_n$	$n=1-16$	—	LPES	231 anthracene clusters
$C_{16}H_{10}$	0.406	0.010	LPES	270 pyrene
$C_{18}H_{12}$	1.04	0.10	CT	66 tetracene
$C_{18}H_{12}$	0.32	0.01	LPES	303 chrysene
$C_{20}H_{12}$	0.79	0.10	CT	66 benz[a]pyrene
$C_{20}H_{12}$	0.973	0.005	LPES	236 perylene
$C_{20}H_{16}NO$	1.06	—	LPES	285 NO (naphthalene) <sub>2</sub>
$C_{22}H_{14}$	1.35	0.10	CT	66 pentacene
$C_{44}Cl_{28}FeN_4$	2.59	0.11	CT	186 FeTPPCl <sub>28</sub>
$C_{44}Cl_8F_{20}FeN_4$	3.21	0.03	CT	186 FeTPPβCl <sub>8</sub>
$C_{44}Cl_9F_{20}FeN_4$	3.35	0.03	CT	186 FeTPPF <sub>20</sub> βCl <sub>8</sub> Cl
$C_{44}H_8F_{20}FeN_4$	2.15	0.15	CT	186 FeTPPF <sub>20</sub>
$C_{44}H_8ClF_{20}FeN_4$	3.14	0.03	CT	186 FeTPPF <sub>20</sub> Cl
$C_{44}H_8Cl_{21}FeN_4$	2.93	0.23	CT	186 FeTPPoCl <sub>20</sub> Cl
$C_{44}H_{12}Cl_{17}FeN_4$	3.14	0.03	CT	186 FeTPPoCl <sub>8</sub> βCl <sub>8</sub> Cl
$C_{44}H_{20}Cl_8FeN_4$	1.86	0.03	CT	186 FeTPPoCl <sub>8</sub>
$C_{44}H_{20}Cl_9FeN_4$	2.10	0.19	CT	186 FeTPPoCl <sub>8</sub> Cl
$C_{44}H_{28}FeN_4$	1.87	0.03	CT	186 iron tetraphenylporphyrin (FeTPP)
$C_{44}H_{28}NiN_4$	1.51	0.01	CT	186 nickel tetraphenylporphyrin (NiTPP)
$C_{44}H_{28}ClFeN_4$	2.15	0.15	CT	186 FeTPPCL
$C_{44}H_{30}N_4$	1.69	0.01	CT	186 H <sub>2</sub> tetraphenylporphyrin
$C_{45}H_{29}NiN_4O$	1.74	0.01	CT	186 NiTPPCHO
$C_{52}H_{39}FeN_7O$	1.97	0.03	CT	186 FeTPP-val
$C_{60}$	2.683	0.008	LPES	201
$C_{60}F_2$	2.74	0.07	Knud	202
$C_{64}H_{64}FeN_8O_4$	2.07	0.03	CT	186 FeTPP-piv
$C_{70}F_2$	2.80	0.07	Knud	202

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
(benzene) <sub>n</sub>	<i>n</i> =53-124	—	LPES	248
(toluene) <sub>n</sub>	<i>n</i> =33-139	—	LPES	248
CeF <sub>4</sub>	3.8	0.4	CT	98
Cl(CO <sub>2</sub> )	3.907	0.010	LPES	131
Cl(H <sub>2</sub> O)	<i>n</i> =1-4	—	LPES	250
Co <sub>n</sub>	<i>n</i> =1-108	—	LPES	251
CoBr <sub>3</sub>	4.6	0.1	LPES	249
CoCl <sub>3</sub>	4.7	0.1	LPES	249
CoF <sub>4</sub>	6.4	0.3	CT	98
Cr(CO) <sub>3</sub>	1.349	0.006	LPES	94
CrO <sub>3</sub>	3.66	0.02	LPES	241
CrO <sub>4</sub>	4.98	0.09	LPES	241
CrO <sub>5</sub>	4.4	0.1	LPES	241
Cr <sub>2</sub> O <sub>n</sub>	<i>n</i> =1-7	—	LPES	306
CsO <sub>4</sub>	2.5	0.2	LPES	252
Cu <sub>n</sub>	<i>n</i> =1-411	—	LPES	37
CuBr <sub>2</sub>	4.35	0.05	LPES	237
Cu <sub>n</sub> (CN) <sub>m</sub>	<i>n</i> =1-6	<i>m</i> =1-6	LPES	159
CuCl <sub>2</sub>	4.35	0.05	LPES	237
F(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1-4	—	LPES	242
F(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1-4	—	LPES	250
Fe <sub>n</sub>	<i>n</i> =3-34	—	LPES	149
Fe(CO) <sub>2</sub>	1.22	0.02	LPES	2
Fe(CO) <sub>3</sub>	1.8	0.2	LPES	2
Fe(CO) <sub>4</sub>	2.4	0.3	LPES	2
FeBr <sub>3</sub>	4.26	0.06	LPES	249
FeBr <sub>4</sub>	5.50	0.08	LPES	249
FeCl <sub>3</sub>	4.22	0.06	LPES	249
FeCl <sub>4</sub>	6.00	0.08	LPES	249
FeF <sub>3</sub>	3.6	0.1	CT	98
FeF <sub>4</sub>	6.0	estimate	CT	98
Fe <sub>2</sub> H <sub>2</sub>	0.942	0.019	LPES	254
Fe <sub>n</sub> O <sub>m</sub>	<i>n</i> =1-4	<i>m</i> =1-6	LPES	152
Ga <sub>2</sub> As <sub>3</sub>	2.783	0.024	LPES	192
Ga <sub>x</sub> As <sub>y</sub>	<i>n</i> =2-50	<i>n</i> = <i>x</i> + <i>y</i>	LPES	229
Ga <sub>2</sub> P <sub>3</sub>	2.991	0.026	LPES	192
Ge <sub>n</sub>	<i>n</i> =3-15	—	LPES	71
Ge <sub>x</sub> As <sub>y</sub>	<i>n</i> =5-30	<i>n</i> = <i>x</i> + <i>y</i>	LPES	72
GeH <sub>3</sub>	<1.74	0.04	PT	2
H(NH <sub>3</sub> ) <sub>n</sub>	<i>n</i> =1,2	—	LPES	76
HNO <sub>3</sub>	0.57	0.15	CD	2
(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =2-19	—	LPES	77
I(CO <sub>2</sub> )	3.225	0.001	LPES	131
I(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1-4	—	LPES	250
In <sub>x</sub> P <sub>y</sub>	<i>n</i> =2-8	<i>n</i> = <i>x</i> + <i>y</i>	LPES	137
IrF <sub>4</sub>	4.7	0.3	CT	98
IrF <sub>6</sub>	6.5	0.4	CT	98
K <sub>n</sub>	<i>n</i> =2-7	—	LPES	18
KO <sub>4</sub>	2.8	0.2	LPES	252
LiO <sub>4</sub>	3.3	0.2	LPES	252
MnBr <sub>3</sub>	5.03	0.06	LPES	249
MnCl <sub>3</sub>	5.07	0.06	LPES	249
MnF <sub>4</sub>	5.5	0.2	CT	98
MnO <sub>3</sub>	3.335	0.010	LPES	158
Mo(CO) <sub>3</sub>	1.337	0.006	LPES	94
MoF <sub>5</sub>	3.5	0.2	CT	98
MoF <sub>6</sub>	3.8	0.2	CT	98
MoO <sub>3</sub>	3.17	0.02	LPES	280
MoO <sub>4</sub>	5.20	0.07	LPES	86
MoO <sub>5</sub>	5.10	0.07	LPES	86

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
Mo <sub>2</sub> O <sub>2</sub>	2.24	0.02	LPES	280
Mo <sub>2</sub> O <sub>3</sub>	2.33	0.07	LPES	280
Mo <sub>2</sub> O <sub>4</sub>	2.13	0.04	LPES	280
N <sub>2</sub> CD	2.622	0.005	LPES	154 NCND
N <sub>2</sub> CH	2.622	0.005	LPES	154 NCNH
(NH <sub>3</sub> ) <sub>n</sub>	<i>n</i> =41-1100	—	LPES	77
NH <sub>2</sub> (NH <sub>3</sub> ) <sub>n</sub>	<i>n</i> =1,2	—	LPES	78
NO(H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1,2	—	LPES	75
NO <sub>3</sub>	3.937	0.014	LPES	85
NO <sub>3</sub> (H <sub>2</sub> O) <sub>n</sub>	<i>n</i> =0-6	—	LPES	240
NO(N <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1,2	—	LPES	79
(NO) <sub>2</sub>	>2.1	—	LPES	75
(N <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1,2	—	LPES	81
Na <sub>n</sub>	<i>n</i> =2-5	—	LPES	18
(NaF) <sub>n</sub>	<i>n</i> =1-7,12	—	LPES	64
Na(NaF) <sub>n</sub>	<i>n</i> =5,7-12	—	LPES	64
NaO <sub>4</sub>	3.1	0.2	LPES	252
NaO <sub>5</sub>	3.2	0.2	LPES	252
NaSO <sub>3</sub>	2.3	0.2	LPES	252
Nb <sub>n</sub>	<i>n</i> =6-17	—	LPES	181
Nb <sub>8</sub>	1.513	0.008	LPES	157
Nb <sub>3</sub> O	1.393	0.006	LPES	169
Ni <sub>n</sub>	<i>n</i> =1-100	—	LPES	247
Ni <sub>n</sub> (benzene) <sub>m</sub>	<i>n</i> =1-3	<i>m</i> =1,2	LPES	295
NiBr <sub>3</sub>	4.94	0.08	LPES	249
NiCl <sub>3</sub>	5.20	0.08	LPES	249
Ni(CO) <sub>2</sub>	0.643	0.014	LPES	2
Ni(CO) <sub>3</sub>	1.077	0.013	LPES	2
Ni(CO)H	1.126	0.010	LPES	293 HNiCO
OH(H <sub>2</sub> O)	<2.95	0.15	PT	2
OH(NH <sub>3</sub> )	2.35	0.07	LPES	234
OH(N <sub>2</sub> O)	2.14	0.02	LPES	209
OH(N <sub>2</sub> O) <sub>n</sub>	<i>n</i> =1-5	—	LPES	209
OsF <sub>4</sub>	3.9	0.3	CT	98
OsF <sub>6</sub>	6.0	0.3	CT	98
P <sub>5</sub>	3.88	0.03	LPES	253
PBr <sub>3</sub>	1.59	0.15	CD	2
PBr <sub>2</sub> Cl	1.63	0.20	CD	2
PCl <sub>2</sub> Br	1.52	0.20	CD	2
PCl <sub>3</sub>	0.82	0.10	CD	2
PF <sub>5</sub>	0.75	0.15	CT	121
PO <sub>3</sub>	4.95	0.06	LPES	156
POCl <sub>2</sub>	3.83	0.25	CD	2
POCl <sub>3</sub>	1.41	0.20	CD	2
P <sub>2</sub> H <sub>2</sub>	1.00	0.01	LPES	281 <i>trans</i> -P <sub>2</sub> H <sub>2</sub>
P <sub>2</sub> H <sub>2</sub>	1.03	0.01	LPES	281 <i>cis</i> -P <sub>2</sub> H <sub>2</sub>
PtF <sub>4</sub>	5.5	0.3	CT	98
PtF <sub>6</sub>	7.0	0.4	CT	98
ReF <sub>6</sub>	4.7	estimate	CT	98
ReO <sub>3</sub>	3.6	0.1	LPES	216
RhF <sub>4</sub>	5.4	0.3	CT	98
RuF <sub>4</sub>	4.8	0.3	CT	98
RuF <sub>5</sub>	5.2	0.4	CT	98
RuF <sub>6</sub>	7.5	0.3	CT	98
SF <sub>4</sub>	1.5	0.2	CT	91
SF <sub>5</sub>	4.23	0.12	e-scat	204
SF <sub>6</sub>	1.05	0.10	CT	56
SO <sub>3</sub>	1.97	0.10	LPES	165
(SO <sub>2</sub> ) <sub>2</sub>	0.6	0.2	LPES	80

Molecule	Electron affinity in eV	Uncertainty in eV	Method	Ref.
Sb <sub>n</sub>	<i>n</i> =2-9	—	LPES	213
Sb <sub>5</sub>	3.46	0.03	LPES	253
ScBr <sub>4</sub>	6.13	0.08	LPES	249
ScCl <sub>4</sub>	6.89	0.08	LPES	249
SeF <sub>6</sub>	2.9	0.2	CD	2
Si <sub>4</sub>	2.13	0.01	LPES	110
Si <sub>5</sub>	2.59	0.02	LPES	110
Si <sub>7</sub>	1.85	0.02	LPES	110
Si <sub>n</sub>	<i>n</i> =3-20	—	LPES	71
Si <sub>2</sub> C <sub>3</sub>	1.766	0.012	LPES	296 linear Si-C <sub>3</sub> -Si
SiD <sub>3</sub>	1.386	0.022	LPES	43
SiF <sub>3</sub>	2.41	0.22	LPES	17
SiF <sub>4</sub>	≤0	—	LPES	17
SiF <sub>5</sub>	≥4.66	—	LPES	17
Si <sub>n</sub> F	<i>n</i> =2-11	—	LPES	17
SiH <sub>3</sub>	1.406	0.014	LPES	43
Si <sub>3</sub> H	2.53	0.01	LPES	182
Si <sub>4</sub> H	2.68	0.01	LPES	182
Si <sub>n</sub> Na <sub>m</sub>	<i>n</i> =4-11	<i>m</i> =1-3	LPES	210
Sn <sub>n</sub>	<i>n</i> =1-12	—	LPES	289
SnCH <sub>2</sub> CN	1.57	0.02	LPES	292
Sn(CN) <sub>2</sub>	2.622	0.004	LPES	292
Sn(CN)(CH <sub>2</sub> CN)	2.29	0.05	LPES	292
Ta <sub>3</sub> O	1.583	0.010	LPES	169
TeF <sub>6</sub>	3.34	0.17	CD	2
Ti <sub>n</sub>	<i>n</i> =1-130	—	LPES	151
TiO <sub>3</sub>	4.2	—	LPES	172
UF <sub>5</sub>	3.7	0.2	CT	98
UF <sub>6</sub>	5.1	0.2	CT	98
UO <sub>3</sub>	<2.1	—	CT	98
V <sub>n</sub>	<i>n</i> =3-65	—	LPES	150
VF <sub>4</sub>	3.5	0.2	CT	98
V <sub>2</sub> O <sub>n</sub>	<i>n</i> =3-7	—	LPES	246
V <sub>3</sub> O	1.218	0.008	LPES	169
V <sub>4</sub> O <sub>10</sub>	4.2	0.6	CT	101
W(CO) <sub>3</sub>	1.859	0.006	LPES	94
WF <sub>5</sub>	1.25	0.3	CD	18
WF <sub>6</sub>	3.5	0.1	CT	19
WO <sub>2</sub>	1.998	0.010	LPES	299
WO <sub>3</sub>	3.62	0.05	LPES	86
(WO <sub>3</sub> ) <sub>n</sub>	<i>n</i> =7-10	—	LPES	300
WO <sub>4</sub>	5.30	0.05	LPES	86
WO <sub>5</sub>	5.1	0.1	LPES	86

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# ATOMIC AND MOLECULAR POLARIZABILITIES

Thomas M. Miller

The *polarizability* of an atom or molecule describes the response of the electron cloud to an external field. The atomic or molecular energy shift  $\Delta W$  due to an external electric field  $E$  is proportional to  $E^2$  for external fields that are weak compared to the internal electric fields between the nucleus and electron cloud. The *electric dipole polarizability*  $\alpha$  is the constant of proportionality defined by  $\Delta W = -\alpha E^2/2$ . The induced electric dipole moment is  $\alpha E$ . *Hyperpolarizabilities*, coefficients of higher powers of  $E$ , are less often required. Technically, the polarizability is a tensor quantity but for spherically symmetric charge distributions reduces to a single number. In any case, an *average polarizability* is usually adequate in calculations. Frequency-dependent or *dynamic polarizabilities* are needed for electric fields that vary in time, except for frequencies that are much lower than electron orbital frequencies, where *static polarizabilities* suffice.

Polarizabilities for atoms and molecules in excited states are found to be larger than for ground states and may be positive or negative. Molecular polarizabilities are very slightly temperature dependent since the size of the molecule depends on its rovibrational state. Only in the case of dihydrogen has this effect been studied enough to warrant consideration in Table 3.

Polarizabilities are normally expressed in c.g.s. units of  $\text{cm}^3$ . Ground state polarizabilities are in the range of  $10^{-24} \text{ cm}^3 = 1 \text{ \AA}^3$  and hence are often given in  $\text{\AA}^3$  units. Theorists tend to use atomic units of  $a_0^3$  where  $a_0$  is the Bohr radius. The conversion is  $\alpha(\text{cm}^3) = 0.148184 \times 10^{-24} \times \alpha(a_0^3)$ . Polarizabilities are only recently encountered in SI units,  $\text{C m}^2/\text{V} = \text{J}/(\text{V/m})^2$ . The conversion from c.g.s. units to SI units is  $\alpha(\text{C m}^2/\text{V}) = 4\pi\epsilon_0 \times 10^{-6} \alpha(\text{cm}^3)$ , where  $\epsilon_0$  is

the permittivity of free space in SI units and the factor  $10^{-6}$  simply converts  $\text{cm}^3$  into  $\text{m}^3$ . Thus,  $\alpha(\text{C m}^2/\text{V}) = 1.11265 \times 10^{-16} \times \alpha(\text{cm}^3)$ . Persons measuring excited state polarizabilities by optical methods tend to use units of  $\text{MHz}/(\text{V/cm})^2$ , where the energy shift,  $\Delta W$ , is expressed in frequency units with a factor of  $h$  understood. The polarizability is  $-2 \Delta W/E^2$ . The conversion into c.g.s. units is  $\alpha(\text{cm}^3) = 5.95531 \times 10^{-16} \times \alpha[\text{MHz}/(\text{V/cm})^2]$ .

The polarizability appears in many formulas for low-energy processes involving the valence electrons of atoms or molecules. These formulas are given below in c.g.s. units: the polarizability  $\alpha$  is in  $\text{cm}^3$ ; masses  $m$  or  $\mu$  are in grams; energies are in ergs; and electric charges are in esu, where  $e = 4.8032 \times 10^{-10}$  esu. The symbol  $\alpha(\nu)$  denotes a frequency ( $\nu$ ) dependent polarizability, where  $\alpha(\nu)$  reduces to the static polarizability  $\alpha$  for  $\nu = 0$ . For further information, see Bonin, K. D., and Kresin, V. V., *Electric Dipole Polarizabilities of Atoms, Molecules, and Clusters*, World Scientific, Singapore, 1997; Bonin, K. D., and Kadar-Kallen, *Int. J. Mod. Phys. B*, 24, 3313, 1994; and Miller, T. M., and Bederson, B., *Advances in Atomic and Molecular Physics*, 13, 1, 1977, and Gould, H., and Miller, T. M., *Advances in Atomic, Molecular, and Optical Physics*, 51, 243, 2005. Details on polarizability-related interactions, especially in regard to hyperpolarizabilities and nonlinear optical phenomena, are given by Bogaard, M. P., and Orr, B. J., in *Physical Chemistry, Series Two, Vol. 2, Molecular Structure and Properties*, Buckingham, A. D., Ed., Butterworths, London, 1975, pp. 149–194. A tabulation of tensor and hyperpolarizabilities is included. The gas number density,  $n$ , in Table 1 is usually taken to be that of 1 atm at 0 °C in reporting experimental data.

TABLE 1. Formulas Involving Polarizability

Description	Formula	Remarks
Lorentz-Lorenz relation	$\alpha(\nu) = \frac{3}{4\pi n} \left[ \frac{\eta^2(\nu) - 1}{\eta^2(\nu) + 2} \right]$	For a gas of atoms or nonpolar molecules; the index of refraction is $\eta(\nu)$
Refraction by polar molecules	$\alpha(\nu) + \frac{d^2}{3kT} = \frac{3}{4\pi n} \left[ \frac{\eta^2(\nu) - 1}{\eta^2(\nu) + 2} \right]$	The dipole moment is $d$ , in esu cm ( $= 10^{-18}$ D)
Dielectric constant (dimensionless)	$\kappa(\nu) = 1 + 4\pi n \alpha(\nu)$	From the Lorentz-Lorenz relation for the usual case of $\kappa(\nu) \approx 1$
Index of refraction (dimensionless)	$\eta(\nu) = 1 + 2\pi n \alpha(\nu)$	From $\eta^2(\nu) = \kappa(\nu)$
Diamagnetic susceptibility	$\chi_m = e^2 (a_0 N \alpha)^{1/2} / 4m_e c^2$	From the approximation that the static polarizability is given by the variational formula $\alpha = (4/9a_0) \Sigma(N r_i^2)^2$ ; $N$ is the number of electrons, $m_e$ is the electron mass; a crude approximation is $\chi_m = (E_i/4m_e c^2) \alpha$ , where $E_i$ is the ionization energy
Long-range electron- or ion-molecule interaction energy	$V(r) = -e^2 \alpha / 2r^4$	The target molecule polarizability is $\alpha$
Ion mobility in a gas	$\kappa = -13.87 / (\alpha \mu)^{1/2} \text{ cm}^2 / \text{V} \cdot \text{s}$	This one formula is not in c.g.s. units. Enter $\alpha$ in $\text{\AA}^3$ or $10^{-24} \text{ cm}^3$ units and the reduced mass $\mu$ of the ion-molecule pair in amu. Classical limit; pure polarization potential
Langevin capture cross section	$\sigma(v_o) = (2\pi e / v_o) (\alpha / \mu)^{1/2}$	The relative velocity of approach for an ion-molecule pair is $v_o$ ; the target molecular polarizability is $\alpha$ and the reduced mass of the ion-molecule pair is $\mu$
Langevin reaction rate coefficient	$k = 2\pi e (\alpha / \mu)^{1/2}$	Collisional rate coefficient for an ion-molecule reaction
Rate coefficient for polar molecules	$k_d = 2\pi e \left[ (\alpha / \mu)^{1/2} + cd(2 / \mu \pi kT)^{1/2} \right]$	The dipole moment of the neutral is $d$ in esu cm; the number $c$ is a "locking factor" that depends on $\alpha$ and $d$ , and is between 0 and 1

Description	Formula	Remarks
Modified effective range cross section for electron-neutral scattering	$\sigma(k) = 4\pi A^2 + 32\pi^4 \mu e^2 \alpha A k / 3h^2 + \dots$	Here, $k$ is the electron momentum divided by $h/2\pi$ , where $h$ is Planck's constant; $A$ is called the "scattering length"; the reduced mass is $\mu$
van der Waals constant between two systems A, B	$C_6 = \frac{3}{2} \left[ \frac{\alpha^A \alpha^B E^A E^B}{E^A + E^B} \right]$	For the interaction potential term $V_6(r) = -C_6 r^{-6}$ ; $E^{A,B}$ represents average dipole transition energies and $\alpha^{A,B}$ the respective polarizabilities of A, B
Dipole-quadrupole constant between two systems A, B	$C_8 = \frac{15}{4} \left[ \frac{\alpha^A \alpha_q^B E^A E_q^B}{E^A + E_q^B} \right] + \frac{15}{4} \left[ \frac{\alpha_q^A \alpha^B E_q^A E^B}{E_q^A + E^B} \right]$	For the interaction potential term $V_8(r) = -C_8 r^{-8}$ ; $E_q^{A,B}$ represents average quadrupole transition energies and $\alpha_q^{A,B}$ are the respective quadrupole polarizabilities of A, B
van der Waals constant between an atom and a surface	$C_3 = \frac{\alpha g E^A E^S}{8(E^A + E^S)}$	For an interaction potential $V_3(r) = -C_3 r^{-3}$ ; $E^{A,S}$ are characteristic energies of the atom and surface; $g = 1$ for a free-electron metal and $g = (\epsilon_\infty - 1)/(\epsilon_\infty + 1)$ for an ionic crystal
Relationship between $\alpha(\nu)$ and oscillator strengths	$\alpha(\nu) = \frac{e^2 h^2}{4\pi^2 m_e} \sum \frac{f_k}{E_k^2 - (h\nu)^2}$	Here, $f_k$ is the oscillator strength from the ground state to an excited state $k$ , with excitation energy $E_k$ . This formula is often used to estimate static polarizabilities ( $\nu = 0$ )
Dynamic polarizability	$\alpha(\nu) = \frac{\alpha E_r^2}{E_r^2 - (h\nu)^2}$	Approximate variation of the frequency-dependent polarizability $\alpha(\nu)$ from $\nu = 0$ up to the first dipole-allowed electronic transition, of energy $E_r$ ; the static dipole polarizability is $\alpha(0)$ ; infrared contributions ignored
Rayleigh scattering cross section	$\alpha(\nu) = \frac{8\pi}{9c^4} (2\pi\nu)^4 \times [3\alpha^2(\nu) + 2\gamma^2(\nu) / 3]$	The photon frequency is $\nu$ ; the polarizability anisotropy (the difference between polarizabilities parallel and perpendicular to the molecular axis) is $\gamma(\nu)$
Verdet constant	$V(\nu) = \frac{\nu n}{2m_e c^2} \left[ \frac{d\alpha(\nu)}{d\nu} \right]$	Defined from $\theta = V(\nu)B$ , where $\theta$ is the angle of rotation of linearly polarized light through a medium of number density $n$ , per unit length, for a longitudinal magnetic field strength $B$ (Faraday effect)

TABLE 2. Static Average Electric Dipole Polarizabilities for Ground State Atoms (in Units of  $10^{-24} \text{ cm}^3$ )

Atomic number	Atom	Polarizability	Estimated accuracy (%)	Method	Ref.	Atomic number	Atom	Polarizability	Estimated accuracy (%)	Method	Ref.
1	H	0.666793	"exact"	calc	MB77	18	Ar	1.6411	0.05	index/diel	NB65/OC67
2	He	0.2050522	"exact"	calc	LJS04	19	K	43.4	2	beam	MB77
		0.2050	0.1	index/diel	NB65/OC67	20	Ca	22.8	2	calc	MB77
3	Li	24.33	0.7	beam	MJBTV06			29.4	6	calc	BM02
4	Be	5.60	2	calc	MB77			25.0	8	beam	MB77
5	B	3.03	2	calc	MB77	21	Sc	17.8	25	calc	D84
6	C	1.76	2	calc	MB77	22	Ti	14.6	25	calc	D84
7	N	1.10	2	calc/index	MB77	23	V	12.4	25	calc	D84
8	O	0.802	2	calc/index	MB77	24	Cr	11.6	25	calc	D84
9	F	0.557	2	calc	MB77	25	Mn	9.4	25	calc	D84
10	Ne	0.3956	0.1	diel	OC67	26	Fe	8.4	25	calc	D84
11	Na	24.11	0.12	interferom	ESCHP94	27	Co	7.5	25	calc	D84
12	Mg	10.6	2	calc	MB77	28	Ni	6.8	25	calc	D84
		11.1	5	calc	S71	29	Cu	6.2	6	calc	BM02
		10.6	5	calc	BM02			6.1	25	calc	D84
13	Al	6.8	4.4	beam	MMD90	30	Zn	5.75	2	index	GHM96
14	Si	5.38	2	calc	MB77			6.1	6	calc	BM02
15	P	3.63	2	calc	MB77			5.6	25	calc	D84
16	S	2.90	2	calc	MB77	31	Ga	8.12	2	calc	MB77
17	Cl	2.18	2	calc	MB77	32	Ge	6.07	2	calc	MB77
						33	As	4.31	2	calc	MB77
						34	Se	3.77	2	calc	MB77
						35	Br	3.05	2	calc	MB77

Atomic number	Atom	Polarizability	Estimated accuracy			Atomic number	Atom	Polarizability	Estimated accuracy		
			(%)	Method	Ref.				(%)	Method	Ref.
36	Kr	2.4844	0.05	diel	OC67	69	Tm	21.8	25	calc	D84
37	Rb	47.3	2	beam	MB77	70	Yb	21.0	25	calc	D84
38	Sr	27.6	8	beam	MB77	71	Lu	21.9	25	calc	D84
		23.5	6	calc	BM02	72	Hf	16.2	25	calc	D84
39	Y	22.7	25	calc	D84	73	Ta	13.1	25	calc	D84
40	Zr	17.9	25	calc	D84	74	W	11.1	25	calc	D84
41	Nb	15.7	25	calc	D84	75	Re	9.7	25	calc	D84
42	Mo	12.8	25	calc	D84	76	Os	8.5	25	calc	D84
43	Tc	11.4	25	calc	D84	77	Ir	7.6	25	calc	D84
44	Ru	9.6	25	calc	D84	78	Pt	6.5	25	calc	D84
45	Rh	8.6	25	calc	D84	79	Au	5.8	25	calc	D84
46	Pd	4.8	25	calc	D84	80	Hg	5.02	1	index	GH96
47	Ag	7.2	25	calc	D84			5.7	25	calc	D84
		7.36	3	index	GH95	81	Tl	7.6	15	beam	NYU84
		7.4	6	calc	BM02			7.5	25	calc	D84
48	Cd	7.2	25	calc	D84	82	Pb	6.8	25	calc	D84
		10.2	12	beam	GMBJSJ84	83	Bi	7.4	25	calc	D84
		9.1	25	calc	D84	84	Po	6.8	25	calc	D84
49	In	7.7	25	calc	D84	85	At	6.0	25	calc	D84
50	Sn	6.6	25	calc	D84	86	Rn	5.3	25	calc	D84
51	Sb	5.5	25	calc	D84	87	Fr	48.60	2	calc	LSMS05
52	Te	5.35	25	index	A56			47.1	5	calc	DJSB99
		4.7	25	calc	D84	88	Ra	38.3	25	calc	D84
53	I	4.044	0.5	diel	MB77	89	Ac	32.1	25	calc	D84
54	Xe	59.42	0.13	beam	AG03	90	Th	32.1	25	calc	D84
55	Cs	39.7	8	beam	MB77	91	Pa	25.4	25	calc	D84
56	Ba	31.1	25	calc	D84	92	U	24.9	6	beam	KB94
57	La	29.6	25	calc	D84	93	Np	24.8	25	calc	D84
58	Ce	28.2	25	calc	D84	94	Pu	24.5	25	calc	D84
59	Pr	31.4	25	calc	D84	95	Am	23.3	25	calc	D84
60	Nd	30.1	25	calc	D84	96	Cm	23.0	25	calc	D84
61	Pm	28.8	25	calc	D84	97	Bk	22.7	25	calc	D84
62	Sm	27.7	25	calc	D84	98	Cf	20.5	25	calc	D84
63	Eu	23.5	25	calc	D84	99	Es	19.7	25	calc	D84
64	Gd	25.5	25	calc	D84	100	Fm	23.8	25	calc	D84
65	Tb	24.5	25	calc	D84	101	Md	18.2	25	calc	D84
66	Dy	23.6	25	calc	D84	102	No	17.5	25	calc	D84
67	Ho	22.7	25	calc	D84	119	ekafrancium	24.26	2	cal	LSMS05
68	Er										

<sup>a</sup> Methods: calc = calculated value; beam = atomic beam deflection technique; interferom = atomic beam interference; index = determination based on the measured index of refraction; diel = determination based on the measured dielectric constant.

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**TABLE 3. Average Electric Dipole Polarizabilities for Ground State Diatomic Molecules (in Units of  $10^{-24}$  cm<sup>3</sup>)**

Molecule	Polarizability	Ref.	Molecule	Polarizability	Ref.
Al <sub>2</sub>	19	23		5.35	2
BH	3.32*	1	HgCl	7.4*	9
Br <sub>2</sub>	7.02	2	ICl	12.3	2
CO	1.95	3	K <sub>2</sub>	77	22
Cl <sub>2</sub>	4.61	3		72	21
Cs <sub>2</sub>	104	22	Li <sub>2</sub>	32.8	29
CsK	89	22		34	22
D <sub>2</sub> ( $\nu=0, J=0$ )	0.7921*	5	LiCl	3.46*	10
D <sub>2</sub> (293 K)	0.7954	6	LiF	10.8*	11
DCl	2.84	2	LiH	3.84*	12
F <sub>2</sub>	1.38*	7		3.68*	13
H <sub>2</sub> ( $\nu=0, J=0$ )	0.8023*	5		3.88*	14
H <sub>2</sub> (293 K)	0.8045*	5	N <sub>2</sub>	1.7403	6,8
H <sub>2</sub> (293 K)	0.8042	6	NO	1.70	2
H <sub>2</sub> (322 K)	0.8059	8	Na <sub>2</sub>	40	22
HBr	3.61	3		38	21
HCl	2.63	3	NaK	51	22
	2.77	2	NaLi	40	4
HD ( $\nu=0, J=0$ )	0.7976*	5	O <sub>2</sub>	1.5812	6
HF	0.80	27	Rb <sub>2</sub>	79	22
HI	5.44	3			

**TABLE 4. Average Electric Dipole Polarizabilities for Ground State Triatomic Molecules (in Units of  $10^{-24}$  cm<sup>3</sup>)**

Molecule	Polarizability	Ref.	Molecule	Polarizability	Ref.
BeH <sub>2</sub>	4.34*	14	HgI <sub>2</sub>	19.1	2
CO <sub>2</sub>	2.911	8	Li <sub>3</sub>	34.5	29
CS <sub>2</sub>	8.74	3	LiNa <sub>2</sub>	61.2	30
	8.86	2	Li <sub>2</sub> Na	35.4	30
D <sub>2</sub> O	1.26	2	N <sub>2</sub> O	3.03	8
H <sub>2</sub> O	1.45	2	NO <sub>2</sub>	3.02	2+
H <sub>2</sub> S	3.782	3	Na <sub>3</sub>	70	21
	3.95	2	O <sub>3</sub>	3.21	2
HCN	2.59	3	OCS	5.71	2
	2.46	2		5.2	15
HgBr <sub>2</sub>	14.5	2	SO <sub>2</sub>	3.72	3
HgCl <sub>2</sub>	11.6	2		4.28	2

**TABLE 5. Average Electric Dipole Polarizabilities for Ground State Inorganic Polyatomic Molecules (Larger than Triatomic) (in Units of  $10^{-24}$  cm<sup>3</sup>)**

Molecule	Polarizability	Ref.	Molecule	Polarizability	Ref.
AsCl <sub>3</sub>	14.9	2	(HgCl) <sub>2</sub>	14.7	9
AsN <sub>3</sub>	5.75	2	K <sub>n</sub>	$n=2,5,7-9,11,20$	21
BCl <sub>3</sub>	9.38	20	(KBr) <sub>2</sub>	42.0	16
BF <sub>3</sub>	3.31	2	(KCl) <sub>2</sub>	32.1	16
(BN <sub>3</sub> ) <sub>2</sub>	5.73	2	(KF) <sub>2</sub>	21.0	16
(BH <sub>2</sub> N) <sub>3</sub>	8.0	2+	(KI) <sub>2</sub>	36.3	16
ClF <sub>3</sub>	6.32	2	Li <sub>n</sub>	$n=2-22$	29
(CsBr) <sub>2</sub>	54.5	16	(LiBr) <sub>2</sub>	18.9	16
(CsCl) <sub>2</sub>	42.4	16	(LiCl) <sub>2</sub>	13.1	16
(CsF) <sub>2</sub>	28.4	16	(LiF) <sub>2</sub>	6.9	16
(CsI) <sub>2</sub>	51.8	16	(LiI) <sub>2</sub>	23.4	16
Ga <sub>n</sub> As <sub>m</sub>	$n+m=4-30$	28	LiNa <sub>3</sub>	75.6	30
GeCl <sub>4</sub>	15.1	2	Li <sub>2</sub> Na <sub>2</sub>	60.0	30
GeH <sub>3</sub> Cl	6.7	2+	Li <sub>3</sub> Na	54.8	30

Molecule	Polarizability	Ref.	Molecule	Polarizability	Ref.
ND <sub>3</sub>	1.70	2	(RbI) <sub>2</sub>	46.3	16
NF <sub>3</sub>	3.62	2	SF <sub>6</sub>	6.54	8
NH <sub>3</sub>	2.81	20	(SF <sub>5</sub> ) <sub>2</sub>	13.2	2
	2.10	2	SO <sub>3</sub>	4.84	2
	2.26	3	SO <sub>2</sub> Cl <sub>2</sub>	10.5	2
	2.22*	33	SeF <sub>6</sub>	7.33	2
(NO <sub>2</sub> ) <sub>2</sub>	6.69	2	SiF <sub>4</sub>	5.45	2
Na <sub>n</sub>	<i>n</i> =1-40	21	SiH <sub>4</sub>	5.44	2
(NaBr) <sub>2</sub>	26.8	16	(SiH <sub>3</sub> ) <sub>2</sub>	11.1	2
(NaCl) <sub>2</sub>	23.4	16	SiHCl <sub>3</sub>	10.7	2
(NaF) <sub>2</sub>	20.7	16	SiH <sub>2</sub> Cl <sub>2</sub>	8.92	2
(NaI) <sub>2</sub>	26.9	16	SiH <sub>3</sub> Cl	7.02	2
OsO <sub>4</sub>	8.17	2	SnBr <sub>4</sub>	22.0	2
PCl <sub>3</sub>	12.8	2	SnCl <sub>4</sub>	18.0	2
PF <sub>5</sub>	6.10	2		13.8	15
PH <sub>3</sub>	4.84	2	SnI <sub>4</sub>	32.3	2
(RbBr) <sub>2</sub>	48.2	16	TeF <sub>6</sub>	9.00	2
(RbCl) <sub>2</sub>	43.2	16	TiCl <sub>4</sub>	16.4	2
(RbF) <sub>2</sub>	40.7	16	UF <sub>6</sub>	12.5	2

TABLE 6. Average Electric Dipole Polarizabilities for Ground State Hydrocarbon Molecules (in Units of 10<sup>-24</sup> cm<sup>3</sup>)

Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
CH <sub>4</sub>	methane	2.593	8			10.87	15
C <sub>2</sub> H <sub>2</sub>	acetylene	3.33	3		1-hexene	11.65	27
		3.93	2	C <sub>6</sub> H <sub>14</sub>	hexane	11.9	2
C <sub>2</sub> H <sub>4</sub>	ethylene	4.252	8	C <sub>7</sub> H <sub>8</sub>	toluene	11.8	25
C <sub>2</sub> H <sub>6</sub>	ethane	4.47	3			12.26	15
		4.43	2			12.3	2
C <sub>3</sub> H <sub>4</sub>	propyne	6.18	2	C <sub>7</sub> H <sub>12</sub>	1-heptyne	12.8	2†
C <sub>3</sub> H <sub>6</sub>	propene	6.26	2	C <sub>7</sub> H <sub>14</sub>	methylcyclohexane	13.1	2
	cyclopropane	5.66	2		1-heptene	13.51	27
C <sub>3</sub> H <sub>8</sub>	propane	6.29	3	C <sub>7</sub> H <sub>16</sub>	heptane	13.61	2
		6.37	2	C <sub>8</sub> H <sub>8</sub>	styrene	15.0	2
C <sub>4</sub> H <sub>6</sub>	1-butyne	7.41	2†			14.41	27
	1,3-butadiene	8.64	2	C <sub>8</sub> H <sub>10</sub>	ethylbenzene	14.2	2
C <sub>4</sub> H <sub>8</sub>	1-butene	7.97	2		<i>o</i> -xylene	14.9	2
		8.52	2			14.1	15
	<i>trans</i> -2-butene	8.49	2		<i>p</i> -xylene	13.7	25
	2-methylpropene	8.29	2			14.2	15
C <sub>4</sub> H <sub>10</sub>	butane	8.20	2			14.9	2
	isobutane	8.14	27		<i>m</i> -xylene	14.2	15
C <sub>5</sub> H <sub>6</sub>	1,3-cyclopentadiene	8.64	2	C <sub>8</sub> H <sub>16</sub>	ethylcyclohexane	15.9	2
C <sub>5</sub> H <sub>8</sub>	1-pentyne	9.12	2	C <sub>8</sub> H <sub>18</sub>	<i>n</i> -octane	15.9	2
	<i>trans</i> -1,3-pentadiene	10.0	2		3-methylheptane	15.44	27
	isoprene	9.99	2		2,2,4-trimethylpentane	15.44	27
C <sub>5</sub> H <sub>10</sub>	cyclopentane	9.15	18	C <sub>9</sub> H <sub>10</sub>	$\alpha$ -methylstyrene	16.05	27
	1-pentene	9.65	27	C <sub>9</sub> H <sub>12</sub>	isopropylbenzene	16.0	2†
	2-pentene	9.84	27		1,3,5-trimethylbenzene	15.5	25
C <sub>5</sub> H <sub>12</sub>	pentane	9.99	2			16.14	27
	neopentane	10.20	18	C <sub>9</sub> H <sub>18</sub>	isopropylcyclohexane	17.2	2
C <sub>6</sub> H <sub>6</sub>	benzene	10.0	25	C <sub>9</sub> H <sub>20</sub>	nonane	17.36	27
		10.32	3	C <sub>10</sub> H <sub>8</sub>	naphthalene	16.5	17
		10.74	2			17.48	27
C <sub>6</sub> H <sub>10</sub>	1-hexyne	10.9	2†	C <sub>10</sub> H <sub>14</sub>	durene	17.3	25
	2-ethyl-1,3-butadiene	11.8	2†		<i>tert</i> -butylbenzene	17.2	25
	3-methyl-1,3-pentadiene	11.8	2†			17.8	2†
	2-methyl-1,3-pentadiene	12.1	2†	C <sub>10</sub> H <sub>20</sub>	<i>tert</i> -butylcyclohexane	19.8	2
	2,3-dimethyl-1,3-butadiene	11.8	2†	C <sub>10</sub> H <sub>22</sub>	decane	19.10	27
	cyclohexene	10.7	2†	C <sub>11</sub> H <sub>10</sub>	$\alpha$ -methylnaphthalene	19.35	27
C <sub>6</sub> H <sub>12</sub>	cyclohexane	11.0	18		$\beta$ -methylnaphthalene	19.52	27



Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
C <sub>11</sub> H <sub>14</sub>	$\alpha,\beta$ -trimethylstyrene	19.64	27		phenanthrene	36.8*	17
C <sub>11</sub> H <sub>16</sub>	pentamethylbenzene	19.1	25			24.70	27
C <sub>11</sub> H <sub>24</sub>	undecane	21.03	27	C <sub>14</sub> H <sub>22</sub>	<i>p</i> -di- <i>tert</i> -butylbenzene	24.5	25
C <sub>12</sub> H <sub>10</sub>	acenaphthene	20.61	27	C <sub>16</sub> H <sub>10</sub>	pyrene	28.22	27
C <sub>12</sub> H <sub>12</sub>	$\alpha$ -ethylnaphthalene	21.19	27	C <sub>17</sub> H <sub>12</sub>	2,3-benzfluorene	30.21	27
	$\beta$ -ethylnaphthalene	21.36	27	C <sub>18</sub> H <sub>12</sub>	naphthacene	32.27	27
C <sub>12</sub> H <sub>18</sub>	hexamethylbenzene	20.9	25		1,2-benzanthracene	32.86	27
C <sub>12</sub> H <sub>26</sub>	dodecane	22.75	27		chrysene	33.06	27
C <sub>13</sub> H <sub>10</sub>	fluorene	21.68	27		triphenylene	31.07	27
C <sub>14</sub> H <sub>10</sub>	anthracene	25.4	17	C <sub>18</sub> H <sub>30</sub>	1,3,5-tri- <i>tert</i> -butylbenzene	31.8	25
		25.93	27	C <sub>24</sub> H <sub>12</sub>	coronene	42.50	27

TABLE 7. Average Electric Dipole Polarizabilities for Ground State Organic Halides (in Units of 10<sup>-24</sup> cm<sup>3</sup>)

Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
CBr <sub>2</sub> F <sub>2</sub>	dibromodifluoromethane	9.0	2 <sup>†</sup>		<i>trans</i> -dichloroethylene	8.15	27
CClF <sub>3</sub>	chlorotrifluoromethane	5.72	20		<i>cis</i> -dichloroethylene	8.03	27
		5.59	2	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> F <sub>2</sub>	1,1-dichloro-2,2-difluoroethane	8.4	2 <sup>†</sup>
CCl <sub>2</sub> F <sub>2</sub>	dichlorodifluoromethane	7.93	20				
		7.81	2	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	chloroacetyl chloride	8.92	2
CCl <sub>2</sub> O	phosgene	7.29	2	C <sub>2</sub> H <sub>2</sub> Cl <sub>3</sub> F	1,2,2-trichloro-1-fluoroethane	10.2	2 <sup>†</sup>
CCl <sub>2</sub> S	thiophosgene	10.2	2	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-tetrachloroethane	12.1	2 <sup>†</sup>
CCl <sub>3</sub> F	trichlorofluoromethane	9.47	2	C <sub>2</sub> H <sub>2</sub> ClN	chloroacetoneitrile	6.10	18
CCl <sub>3</sub> NO <sub>2</sub>	trichloronitromethane	10.8	2 <sup>†</sup>	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1,1-difluoroethylene	5.01	20
CCl <sub>4</sub>	carbon tetrachloride	11.2	2	C <sub>2</sub> H <sub>3</sub> Br	bromoethylene	7.59	2
		10.5	3	C <sub>2</sub> H <sub>3</sub> Cl	chloroethylene	6.41	2
CF <sub>4</sub>	carbon tetrafluoride	3.838	8	C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	1-chloro-1,1-difluoroethane	8.05	2
CF <sub>2</sub> O	carbonylfluoride	1.88*	17	C <sub>2</sub> H <sub>3</sub> ClO	acetyl chloride	6.62	2
CHBr <sub>3</sub>	bromoform	11.8	27	C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	methyl chloroformate	7.1	2 <sup>†</sup>
CHBrF <sub>2</sub>	bromodifluoromethane	5.7	2 <sup>†</sup>	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-trichloroethane	10.7	2
CHClF <sub>2</sub>	chlorodifluoromethane	6.38	20	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,1-trifluoroethane	4.4	2 <sup>†</sup>
		5.91	2	C <sub>2</sub> H <sub>3</sub> I	iodoethylene	9.3	2 <sup>†</sup>
CHCl <sub>2</sub> F	dichlorofluoromethane	6.82	2	C <sub>2</sub> H <sub>4</sub> BrCl	1-bromo-2-chloroethane	9.5	2 <sup>†</sup>
CHCl <sub>3</sub>	chloroform	9.5	8	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-dibromoethane	10.7	2 <sup>†</sup>
		8.23	27	C <sub>2</sub> H <sub>4</sub> ClF	1-chloro-2-fluoroethane	6.5	2 <sup>†</sup>
CHF <sub>3</sub>	fluoroform	3.52	20	C <sub>2</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-chloro-1-nitroethane	10.9	2
		3.57	8	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-dichloroethane	8.64	2
CHFO	fluoroformaldehyde	1.76*	17		1,2-dichloroethane	8.0	2 <sup>†</sup>
CHI <sub>3</sub>	iodoform	18.0	27	C <sub>2</sub> H <sub>5</sub> Br	bromoethane	8.05	2
CH <sub>2</sub> Br <sub>2</sub>	dibromomethane	9.32	2			7.28	27
		8.68	27	C <sub>2</sub> H <sub>5</sub> Cl	chloroethane	7.27	20
CH <sub>2</sub> ClNO <sub>2</sub>	chloronitromethane	6.9	2 <sup>†</sup>			8.29	2
CH <sub>2</sub> Cl <sub>2</sub>	dichloromethane	6.48	3			6.4	15
		7.93	2	C <sub>2</sub> H <sub>5</sub> ClO	2-chloroethanol	7.1	2 <sup>†</sup>
CH <sub>2</sub> I <sub>2</sub>	diiodomethane	12.90	27			6.88	27
CH <sub>3</sub> Br	bromomethane	5.87	20		chloromethyl methyl ether	7.1	2 <sup>†</sup>
		6.03	2	C <sub>2</sub> H <sub>5</sub> F	fluoroethane	4.96	2
		5.55	15	C <sub>2</sub> H <sub>5</sub> I	iodoethane	10.0	2
CH <sub>3</sub> Cl	chloromethane	5.35	20	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	dichloropropene	10.1	2 <sup>†</sup>
		4.72	8	C <sub>3</sub> H <sub>5</sub> Cl	chloropropene	8.3	2
CH <sub>3</sub> F	fluoromethane	2.97	8	C <sub>3</sub> H <sub>5</sub> ClO	chloroacetone	8.4	2 <sup>†</sup>
CH <sub>3</sub> I	iodomethane	7.97	2	C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	ethyl chloroformate	9.0	2 <sup>†</sup>
C <sub>2</sub> ClF <sub>5</sub>	chloropentafluoroethane	6.3	2 <sup>†</sup>	C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	1-chloro-1-nitropropane	10.4	2 <sup>†</sup>
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-dichlorotetrafluoroethane	8.5	2 <sup>†</sup>	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	dichloropropane	10.9	2 <sup>†</sup>
C <sub>2</sub> Cl <sub>3</sub> N	trichloroacetoneitrile	10.42	18	C <sub>3</sub> H <sub>7</sub> Br	1-bromopropane	9.4	2 <sup>†</sup>
C <sub>2</sub> F <sub>6</sub>	hexafluoroethane	6.82	2			9.07	27
C <sub>2</sub> HBr	bromoacetylene	7.39	2		2-bromopropane	9.6	2 <sup>†</sup>
C <sub>2</sub> HCl	chloroacetylene	6.07	2	C <sub>3</sub> H <sub>7</sub> Cl	chloropropane	10.0	2
C <sub>2</sub> HCl <sub>3</sub>	trichloroethylene	10.03	27	C <sub>3</sub> H <sub>7</sub> ClO	$\beta$ -chloroethyl methyl ether	8.71	27
C <sub>2</sub> HCl <sub>5</sub>	pentachloroethane	14.0	2		2-chloro-1-propanol	8.89	27
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-dichloroethylene	7.83	27		3-chloro-1-propanol	8.84	27

Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
C <sub>3</sub> H <sub>7</sub> I	1-iodopropane	11.5	2 <sup>†</sup>	C <sub>6</sub> H <sub>5</sub> Br	bromobenzene	14.7	2
C <sub>4</sub> H <sub>5</sub> Cl	4-chloro-1,2-butadiene	10.0	2 <sup>†</sup>			13.62	27
C <sub>4</sub> H <sub>7</sub> Cl	1-chloro-2-methylpropene	10.8	2	C <sub>6</sub> H <sub>5</sub> Cl	chlorobenzene	14.1	2
C <sub>4</sub> H <sub>7</sub> ClO <sub>2</sub>	2-chlorobutyric acid	10.87	27			12.3	15
	3-chlorobutyric acid	10.80	27	C <sub>6</sub> H <sub>5</sub> ClO	chlorophenol	13.0	2 <sup>†</sup>
	4-chlorobutyric acid	10.69	27	C <sub>6</sub> H <sub>5</sub> F	fluorobenzene	10.3	2
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub>	1,4-dichlorobutane	12.0	2 <sup>†</sup>	C <sub>6</sub> H <sub>5</sub> I	iodobenzene	15.5	2 <sup>†</sup>
C <sub>4</sub> H <sub>9</sub> Br	bromobutane	13.9	2	C <sub>6</sub> H <sub>11</sub> ClO <sub>2</sub>	ethyl 2-chlorobutanoate	14.16	27
		10.86	27		ethyl 3-chlorobutanoate	14.13	27
C <sub>4</sub> H <sub>9</sub> Cl	1-chlorobutane	11.3	2		ethyl 4-chlorobutanoate	14.11	27
	1-chloro-2-methylpropane	11.1	2	C <sub>6</sub> H <sub>13</sub> Br	bromohexane	14.44	27
	2-chloro-2-methylpropane	12.5	2 <sup>†</sup>	C <sub>6</sub> H <sub>13</sub> F	fluorohexane	11.80	27
	2-chlorobutane	12.4	2	C <sub>7</sub> H <sub>7</sub> Br	<i>p</i> -bromotoluene	14.80	27
C <sub>4</sub> H <sub>9</sub> ClO	β-chloroethyl ethyl ether	10.56	27	C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -chlorotoluene	13.70	27
	2-chloro-1-butanol	10.70	27	C <sub>7</sub> H <sub>7</sub> F	<i>p</i> -fluorotoluene	11.70	27
	3-chloro-1-butanol	10.38	27	C <sub>7</sub> H <sub>7</sub> I	<i>p</i> -iodotoluene	17.10	27
C <sub>4</sub> H <sub>9</sub> I	1-iodobutane	13.3	2 <sup>†</sup>	C <sub>7</sub> H <sub>15</sub> Br	1-bromoheptane	16.8	2 <sup>†</sup>
		12.65	27			16.23	27
C <sub>5</sub> H <sub>9</sub> ClO <sub>2</sub>	methyl 2-chlorobutanoate	12.33	27	C <sub>7</sub> H <sub>15</sub> F	fluoroheptane	13.66	27
	methyl 3-chlorobutanoate	12.31	27	C <sub>8</sub> H <sub>17</sub> Br	bromooctane	18.02	27
	methyl 4-chlorobutanoate	12.27	27	C <sub>8</sub> H <sub>17</sub> F	fluorooctane	15.46	27
	2-chloropentanoic acid	12.69	27	C <sub>9</sub> H <sub>19</sub> Br	bromononane	19.81	27
	3-chloropentanoic acid	12.57	27	C <sub>9</sub> H <sub>19</sub> F	fluorononane	17.34	27
	4-chloropentanoic acid	12.53	27	C <sub>10</sub> F <sub>8</sub>	octafluoronaphthalene	17.64	27
C <sub>5</sub> H <sub>11</sub> Br	1-bromopentane	13.1	2 <sup>†</sup>	C <sub>10</sub> H <sub>8</sub> Br	α-bromonaphthalene	20.34	27
C <sub>5</sub> H <sub>11</sub> Cl	1-chloropentane	12.0	2 <sup>†</sup>	C <sub>10</sub> H <sub>7</sub> Cl	α-chloronaphthalene	19.30	27
C <sub>5</sub> H <sub>11</sub> F	fluoropentane	9.95	27		β-chloronaphthalene	19.58	27
C <sub>6</sub> F <sub>6</sub>	hexafluorobenzene	9.58	27	C <sub>10</sub> H <sub>7</sub> I	α-iodonaphthalene	22.41	27
C <sub>6</sub> HF <sub>5</sub>	pentafluorobenzene	9.63	27		β-iodonaphthalene	22.95	27
C <sub>6</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	2,5-dichloro-1,4-benzoquinone	18.4	2	C <sub>10</sub> H <sub>21</sub> Br	bromodecane	21.60	27
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,4-tetrafluorobenzene	9.69	27	C <sub>10</sub> H <sub>21</sub> F	fluorodecane	19.18	27
	1,2,4,5-tetrafluorobenzene	9.69	27	C <sub>11</sub> H <sub>23</sub> F	fluoroundecane	21.00	27
C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	1,3,5-trifluorobenzene	9.74	27	C <sub>12</sub> H <sub>25</sub> Br	bromododecane	25.18	27
C <sub>6</sub> H <sub>4</sub> BrF	<i>p</i> -bromofluorobenzene	13.4	2 <sup>†</sup>	C <sub>12</sub> H <sub>25</sub> F	fluorododecane	22.83	27
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	chloronitrobenzene	14.6	2 <sup>†</sup>	C <sub>12</sub> H <sub>8</sub> Br <sub>2</sub> O	4,4'-dibromodiphenyl ether	27.8	2 <sup>†</sup>
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -dichlorobenzene	14.17	27	C <sub>13</sub> H <sub>9</sub> BrO	4-bromodiphenyl ether	24.2	2 <sup>†</sup>
	<i>m</i> -dichlorobenzene	14.23	27	C <sub>13</sub> H <sub>11</sub> BrO	<i>p</i> -bromophenyl- <i>p</i> -tolyl ether	26.6	2 <sup>†</sup>
	<i>p</i> -dichlorobenzene	14.20	27	C <sub>14</sub> H <sub>9</sub> Br	9-bromoanthracene	28.32	27
C <sub>6</sub> H <sub>4</sub> FI	<i>p</i> -fluoroiodobenzene	15.5	2 <sup>†</sup>	C <sub>14</sub> H <sub>9</sub> Cl	9-chloroanthracene	27.35	27
C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	<i>p</i> -fluoronitrobenzene	12.8	2 <sup>†</sup>	C <sub>14</sub> H <sub>9</sub> F	fluoranthracene	28.34	27
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>o</i> -difluorobenzene	9.80	27	C <sub>14</sub> H <sub>25</sub> F	fluorotetradecane	26.57	27
	<i>m</i> -difluorobenzene	10.3	2 <sup>†</sup>	C <sub>16</sub> H <sub>33</sub> Br	bromohexadecane	32.34	27
	<i>p</i> -difluorobenzene	9.80	27	C <sub>18</sub> H <sub>37</sub> Br	bromooctadecane	35.92	27

TABLE 8. Static Average Electric Dipole Polarizabilities for Other Ground State Organic Molecules (in Units of 10<sup>-24</sup> cm<sup>3</sup>)

Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
CN <sub>4</sub> O <sub>8</sub>	tetranitromethane	15.3	2	C <sub>2</sub> H <sub>3</sub> N	acetonitrile	4.40	2 <sup>†</sup>
CH <sub>2</sub> O	formaldehyde	2.8	2 <sup>†</sup>			4.48	18
		2.45	18	C <sub>2</sub> H <sub>4</sub> O	acetaldehyde	4.6	2 <sup>†</sup>
CH <sub>2</sub> O <sub>2</sub>	formic acid	3.4	2 <sup>†</sup>			4.59	18
CH <sub>3</sub> NO	formamide	4.2	2 <sup>†</sup>		ethylene oxide	4.43	18
		4.08	18	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	acetic acid	5.1	2 <sup>†</sup>
CH <sub>3</sub> NO <sub>2</sub>	nitromethane	7.37	2		methyl formate	5.05	27
CH <sub>4</sub> O	methanol	3.29	2	C <sub>2</sub> H <sub>4</sub> O <sub>4</sub>	formic acid dimer	12.7	2
		3.23	15	C <sub>2</sub> H <sub>5</sub> NO	acetamide	5.67	18
		3.32	18		<i>N</i> -methyl formamide	5.91	18
CH <sub>5</sub> N	methyl amine	4.7	2	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	nitroethane	9.63	2
		4.01	19		ethyl nitrite	7.0	15
		4.01*	33	C <sub>2</sub> H <sub>6</sub> O	ethanol	5.41	2
C <sub>2</sub> N <sub>2</sub>	cyanogen	7.99	2			5.11	18
C <sub>2</sub> H <sub>2</sub> O	ketene	4.4	2 <sup>†</sup>		methyl ether	5.29	20



Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
		5.84	2		1,4-dioxane	10.0	2
		5.16	15		<i>p</i> -dioxane	8.60	18
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	ethylene glycol	5.7	2 <sup>†</sup>		2-methyl-1,3-dioxolane	9.44	15
		5.61	27		butyric acid	8.58	27
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	dimethyl sulfone	7.3	2 <sup>†</sup>		methyl propionate	8.97	27
C <sub>2</sub> H <sub>6</sub> S	ethanethiol	7.41	2	C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	1-nitrobutane	10.4	2 <sup>†</sup>
C <sub>2</sub> H <sub>7</sub> N	ethyl amine	7.10	2		2-methyl-2-nitropropane	10.3	2 <sup>†</sup>
	dimethyl amine	6.37	2	C <sub>4</sub> H <sub>10</sub> O	ethyl ether	10.2	2
		5.90*	33			8.73	15
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	ethylene diamine	7.2	2 <sup>†</sup>		1-butanol	8.88	2
C <sub>3</sub> H <sub>2</sub> N <sub>2</sub>	malononitrile	5.79	18		2-methylpropanol	8.92	2
C <sub>3</sub> H <sub>3</sub> N	acrylonitrile	8.05	2		methyl propyl ether	8.86	27
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	pyrazole	7.23	27		ethylene glycol monoethyl ether	9.28	27
C <sub>3</sub> H <sub>4</sub> O	propenal	6.38	2 <sup>†</sup>	C <sub>4</sub> H <sub>10</sub> S	ethyl sulfide	10.8	2
C <sub>3</sub> H <sub>5</sub> N	propionitrile	6.70	2	C <sub>4</sub> H <sub>11</sub> N	butylamine	13.5	2
		6.24	18		diethylamine	10.2	2
		6.27*	32			9.61	27
C <sub>3</sub> H <sub>6</sub> O	acetone	6.33	15	C <sub>5</sub> H <sub>5</sub> N	pyridine	9.5	15
		6.4	2 <sup>†</sup>			9.18	27
		6.39	18		4-cyano-1,3-butadiene	10.5	2 <sup>†</sup>
	allyl alcohol	7.65	2	C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,5-dimethylpyrazole	10.72	27
	propionaldehyde	6.50	2	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	acetyl acetone	10.5	2 <sup>†</sup>
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	propionic acid	6.9	2 <sup>†</sup>	C <sub>5</sub> H <sub>9</sub> N	valeronitrile	10.4	2
	ethyl formate	8.01	2		22-DMPN	9.59	18
		6.88	27	C <sub>5</sub> H <sub>10</sub> O	diethyl ketone	9.93	15
	methyl acetate	6.94	2		methyl propyl ketone	9.93	15
		6.81	27	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	ethyl propionate	10.41	27
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	dimethyl carbonate	7.7	2 <sup>†</sup>		methyl butanoate	10.41	27
C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -methyl acetamide	7.82	18	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	diethyl carbonate	11.3	2
	<i>N,N</i> -dimethyl formamide	7.81	18	C <sub>5</sub> H <sub>12</sub> O	ethyl propyl ether	10.68	27
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	nitropropane	8.5	2 <sup>†</sup>	C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	tetramethyl orthocarbonate	13.0	2 <sup>†</sup>
C <sub>3</sub> H <sub>8</sub> O	2-propanol	7.61	2	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	<i>p</i> -dinitrobenzene	18.4	2
		6.97	18	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	<i>p</i> -benzoquinone	14.5	2
	1-propanol	6.74	2	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	nitrobenzene	14.7	2
	ethyl methyl ether	7.93	2			12.92	15
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	dimethoxymethane	7.7	2 <sup>†</sup>	C <sub>6</sub> H <sub>6</sub> O	phenol	11.1	2 <sup>†</sup>
	ethylene glycol monomethyl ether	7.44	27			9.94*	17
C <sub>3</sub> H <sub>9</sub> N	propylamine	7.70	27	C <sub>6</sub> H <sub>7</sub> N	aniline	12.1	2 <sup>†</sup>
		9.20	2	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	phenylenediamine	13.8	2 <sup>†</sup>
	isopropylamine	7.77	27		phenylhydrazine	12.91	27
	trimethylamine	8.15	2	C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	1-ethyl-5-methylpyrazole	12.50	27
		7.78*	33	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	ethyl acetoacetate	12.9	2 <sup>†</sup>
C <sub>4</sub> H <sub>2</sub> N <sub>2</sub>	fumaronitrile	11.8	2	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	dimethylketazine	15.6	2
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	succinonitrile	8.1	2 <sup>†</sup>	C <sub>6</sub> H <sub>12</sub> O	cyclohexanol	11.56	18
	pyrimidine	8.53*	17	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	amyl formate	14.2	2
	pyridazine	9.27*	17	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	paraldehyde	17.9	2
C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	diketene	8.0	2 <sup>†</sup>	C <sub>6</sub> H <sub>14</sub> O	propyl ether	12.8	2
C <sub>4</sub> H <sub>4</sub> S	thiophene	9.67	2			12.5	15
C <sub>4</sub> H <sub>5</sub> N	methacrylonitrile	8.0	2 <sup>†</sup>	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-diethoxyethane	13.2	2 <sup>†</sup>
	<i>trans</i> -crotononitrile	8.2	2 <sup>†</sup>		1,2-diethoxyethane	11.3	2 <sup>†</sup>
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	<i>N</i> -methylpyrazole	8.99	27	C <sub>6</sub> H <sub>15</sub> N	triethylamine	13.1	2
C <sub>4</sub> H <sub>6</sub> O	crotonaldehyde	8.5	2 <sup>†</sup>			13.38	27
	methacrylaldehyde	8.3	2 <sup>†</sup>		dipropylamine	13.29	27
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	biacetyl	8.2	2 <sup>†</sup>	C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	<i>p</i> -cyanonitrobenzene	19.0	2
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	acetic anhydride	8.9	2 <sup>†</sup>	C <sub>7</sub> H <sub>5</sub> N	benzonitrile	12.5	2 <sup>†</sup>
C <sub>4</sub> H <sub>6</sub> S	divinyl sulfide	10.9	2 <sup>†</sup>	C <sub>7</sub> H <sub>7</sub> NO <sub>3</sub>	nitroanisole	15.7	2 <sup>†</sup>
C <sub>4</sub> H <sub>7</sub> N	butyronitrile	8.4	2 <sup>†</sup>	C <sub>7</sub> H <sub>8</sub> O	anisole	13.1	2 <sup>†</sup>
	isobutyronitrile	8.05	18	C <sub>7</sub> H <sub>9</sub> NO	<i>o</i> -anisidine	14.2	2 <sup>†</sup>
		8.05*	32	C <sub>7</sub> H <sub>10</sub> N <sub>2</sub>	1,1-methylphenylhydrazine	14.81	27
C <sub>4</sub> H <sub>8</sub> O	butanal	8.2	2 <sup>†</sup>	C <sub>7</sub> H <sub>14</sub> O	cyclohexyl methyl ether	13.4	2 <sup>†</sup>
	methyl ethyl ketone	8.13	15		2,4-dimethyl-3-pentanone	13.5	15
	<i>trans</i> -2,3-epoxy butane	8.22*	17	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	pentyl acetate	14.9	2
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	ethyl acetate	9.7	2	C <sub>8</sub> H <sub>4</sub> N <sub>2</sub>	<i>p</i> -dicyanobenzene	19.2	2
		8.62	27				

Molecule	Name	Polarizability	Ref.	Molecule	Name	Polarizability	Ref.
C <sub>8</sub> H <sub>6</sub> N <sub>2</sub>	quinoxaline	15.13	27		2-methylquinoline	18.65	27
C <sub>8</sub> H <sub>8</sub> O	acetophenone	15.0	2		1-methylisoquinoline	18.28	27
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	2,5-dimethyl-1,4-benzoquinone	18.8	2	C <sub>10</sub> H <sub>10</sub> Fe	ferrocene	17.1	26
C <sub>8</sub> H <sub>10</sub> O	phenetole	14.9	2	C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	2,3-dimethylquinoxaline	18.70	27
C <sub>8</sub> H <sub>11</sub> N	N-dimethylaniline	16.2	2†	C <sub>10</sub> H <sub>14</sub> BeO <sub>4</sub>	beryllium acetylacetonate	34.1	2
C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	1,1-ethylphenylhydrazine	16.62	27	C <sub>11</sub> H <sub>8</sub> O	1-naphthaldehyde	19.75	27
C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	ethyl sorbate	17.2	2†		2-naphthaldehyde	20.06	27
	tetramethylcyclobutane-1,3-dione	18.6	2	C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	phenazine	23.43	27
C <sub>8</sub> H <sub>14</sub> O <sub>4</sub>	diethyl succinate	16.8	2†	C <sub>12</sub> H <sub>9</sub> NO <sub>3</sub>	4-nitrodiphenyl ether	24.7	2†
C <sub>8</sub> H <sub>18</sub> O	butyl ether	17.2	2	C <sub>14</sub> H <sub>8</sub> O <sub>2</sub>	anthraquinone	24.46	27
C <sub>9</sub> H <sub>7</sub> N	quinoline	15.70	27	C <sub>14</sub> H <sub>14</sub> O	di-p-tolyl ether	24.9	2†
	isoquinoline	16.43	27	C <sub>15</sub> H <sub>21</sub> AlO <sub>6</sub>	aluminum acetylacetonate	51.9	2
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	ethyl benzoate	16.9	2†	C <sub>15</sub> H <sub>21</sub> CrO <sub>6</sub>	chromium acetylacetonate	53.7	2
C <sub>9</sub> H <sub>21</sub> N	tripropylamine	18.87	27	C <sub>15</sub> H <sub>21</sub> FeO <sub>6</sub>	ferric acetylacetonate	58.1	2
C <sub>10</sub> H <sub>9</sub> N	α-naphthylamine	19.50	27	C <sub>20</sub> H <sub>26</sub> O <sub>8</sub> Th	thorium acetylacetonate	79.0	2
	β-naphthylamine	19.73	27	C <sub>60</sub>	buckminsterfullerene	76.5	24
						79	31

Note: All polarizabilities in the tables are experimental values except those values marked by an asterisk (\*), which indicates a calculated result. The experimental polarizabilities are mostly determined by measurements of a dielectric constant or refractive index that are quite accurate (0.5% or better). However, one should treat many of the results with several percent of caution because of the age of the data and because some of the results refer to optical frequencies rather than static. Comments given with the references are intended to allow one to judge the degree of caution required. Interested persons should consult these references. In many cases, the reference given is to a theoretical paper in which the experimental results are quoted. These papers, noted in the References, contain valuable information on polarizability calculations and experimental data which often includes the tensor components of the polarizability.

An empirical additive formula for molecular polarizabilities at 589 nm frequency has been given in Bosque, R., and Sales, J., *J. Chem. Inf. Comput. Sci.* 42, 1154, 2002:  $\alpha = 0.32 + 1.51\#C + 0.17\#H + 0.57\#O + 1.05\#N + 2.99\#S + 2.48\#P + 2.16\#Cl + 3.29\#Br + 5.45\#I$ , where "#C" denotes the number of carbon atoms in the molecule, etc.

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# IONIZATION ENERGIES OF ATOMS AND ATOMIC IONS

The ionization energies (often called ionization potentials) of neutral and partially ionized atoms are listed in this table. Data were obtained from the compilations cited below, supplemented by results from the recent research literature. Values for the first and second ionization energies come from Reference 6. All values are given in electron volts (eV).

Following the traditional spectroscopic notation, columns are headed I, II, III, etc. up to VIII, where I indicates the neutral atom, II the singly ionized atom, III the doubly ionized atom, etc. The first section of the table includes spectra I to VIII of all the elements through rutherfordium; subsequent sections cover higher spectra (ionization stages) for those elements for which data are available.

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### Neutral Atoms to +7 Ions

Z	Element	I	II	III	IV	V	VI	VII	VIII
1	H	13.598443							
2	He	24.587387	54.417760						
3	Li	5.391719	75.6400	122.45429					
4	Be	9.32270	18.21114	153.89661	217.71865				
5	B	8.29802	25.1548	37.93064	259.37521	340.22580			
6	C	11.26030	24.3833	47.8878	64.4939	392.087	489.99334		
7	N	14.5341	29.6013	47.44924	77.4735	97.8902	552.0718	667.046	
8	O	13.61805	35.1211	54.9355	77.41353	113.8990	138.1197	739.29	871.4101
9	F	17.4228	34.9708	62.7084	87.1398	114.2428	157.1651	185.186	953.9112
10	Ne	21.56454	40.96296	63.45	97.12	126.21	157.93	207.2759	239.0989
11	Na	5.139076	47.2864	71.6200	98.91	138.40	172.18	208.50	264.25
12	Mg	7.646235	15.03527	80.1437	109.2655	141.27	186.76	225.02	265.96
13	Al	5.985768	18.82855	28.44765	119.992	153.825	190.49	241.76	284.66
14	Si	8.15168	16.34584	33.49302	45.14181	166.767	205.27	246.5	303.54
15	P	10.48669	19.7695	30.2027	51.4439	65.0251	220.421	263.57	309.60
16	S	10.36001	23.33788	34.79	47.222	72.5945	88.0530	280.948	328.75
17	Cl	12.96763	23.8136	39.61	53.4652	67.8	97.03	114.1958	348.28
18	Ar	15.759610	27.62966	40.74	59.81	75.02	91.009	124.323	143.460
19	K	4.3406633	31.63	45.806	60.91	82.66	99.4	117.56	154.88
20	Ca	6.11316	11.87172	50.9131	67.27	84.50	108.78	127.2	147.24
21	Sc	6.56149	12.79977	24.75666	73.4894	91.65	110.68	138.0	158.1
22	Ti	6.82812	13.5755	27.4917	43.2672	99.30	119.53	140.8	170.4
23	V	6.74619	14.618	29.311	46.709	65.2817	128.13	150.6	173.4
24	Cr	6.76651	16.4857	30.96	49.16	69.46	90.6349	160.18	184.7
25	Mn	7.43402	15.6400	33.668	51.2	72.4	95.6	119.203	194.5
26	Fe	7.9024	16.1877	30.652	54.8	75.0	99.1	124.98	151.06
27	Co	7.88101	17.084	33.50	51.3	79.5	102.0	128.9	157.8
28	Ni	7.6398	18.16884	35.19	54.9	76.06	108	133	162
29	Cu	7.72638	20.2924	36.841	57.38	79.8	103	139	166
30	Zn	9.394199	17.96439	39.723	59.4	82.6	108	134	174
31	Ga	5.999301	20.51515	30.7258	63.241	86.01	112.7	140.9	169.9
32	Ge	7.89943	15.93461	34.2241	45.7131	93.5			
33	As	9.7886	18.5892	28.351	50.13	62.63	127.6		
34	Se	9.75239	21.19	30.8204	42.9450	68.3	81.7	155.4	
35	Br	11.8138	21.591	36	47.3	59.7	88.6	103.0	192.8
36	Kr	13.99961	24.35984	36.950	52.5	64.7	78.5	111.0	125.802
37	Rb	4.177128	27.2895	40	52.6	71.0	84.4	99.2	136
38	Sr	5.69485	11.0301	42.89	57	71.6	90.8	106	122.3
39	Y	6.2173	12.224	20.52	60.597	77.0	93.0	116	129
40	Zr	6.63390	13.1	22.99	34.34	80.348			
41	Nb	6.75885	14.0	25.04	38.3	50.55	102.057	125	

Z	Element	Neutral Atoms to +7 Ions							
		I	II	III	IV	V	VI	VII	VIII
42	Mo	7.09243	16.16	27.13	46.4	54.49	68.8276	125.664	143.6
43	Tc	7.28	15.26	29.54					
44	Ru	7.36050	16.76	28.47					
45	Rh	7.45890	18.08	31.06					
46	Pd	8.3369	19.43	32.93					
47	Ag	7.57623	21.47746	34.83					
48	Cd	8.99382	16.90831	37.48					
49	In	5.78636	18.8703	28.03	54				
50	Sn	7.34392	14.6322	30.50260	40.73502	72.28			
51	Sb	8.60839	16.63	25.3	44.2	56	108		
52	Te	9.0096	18.6	27.96	37.41	58.75	70.7	137	
53	I	10.45126	19.1313	33					
54	Xe	12.12984	20.9750	32.1230					
55	Cs	3.893905	23.15744						
56	Ba	5.211664	10.00383						
57	La	5.5769	11.059	19.1773	49.95	61.6			
58	Ce	5.5387	10.85	20.198	36.758	65.55	77.6		
59	Pr	5.473	10.55	21.624	38.98	57.53			
60	Nd	5.5250	10.72	22.1	40.4				
61	Pm	5.582	10.90	22.3	41.1				
62	Sm	5.6437	11.07	23.4	41.4				
63	Eu	5.67038	11.25	24.92	42.7				
64	Gd	6.14980	12.09	20.63	44.0				
65	Tb	5.8638	11.52	21.91	39.79				
66	Dy	5.9389	11.67	22.8	41.47				
67	Ho	6.0215	11.80	22.84	42.5				
68	Er	6.1077	11.93	22.74	42.7				
69	Tm	6.18431	12.05	23.68	42.7				
70	Yb	6.25416	12.176	25.05	43.56				
71	Lu	5.42586	13.9	20.9594	45.25	66.8			
72	Hf	6.82507	15	23.3	33.33				
73	Ta	7.54957							
74	W	7.86403	16.1						
75	Re	7.83352							
76	Os	8.43823							
77	Ir	8.96702							
78	Pt	8.9588	18.563						
79	Au	9.22553	20.20						
80	Hg	10.4375	18.7568	34.2					
81	Tl	6.108194	20.4283	29.83					
82	Pb	7.41663	15.03248	31.9373	42.32	68.8			
83	Bi	7.2855	16.703	25.56	45.3	56.0	88.3		
84	Po	8.414							
85	At								
86	Rn	10.7485							
87	Fr	4.072741							
88	Ra	5.278423	10.14715						
89	Ac	5.17	11.75						
90	Th	6.3067	11.9	20.0	28.8				
91	Pa	5.89							
92	U	6.1941	10.6						
93	Np	6.2657							
94	Pu	6.0260	11.2						
95	Am	5.9738							
96	Cm	5.9914							
97	Bk	6.1979							
98	Cf	6.2817	11.8						
99	Es	6.42	12.0						
100	Fm	6.50							
101	Md	6.58							
102	No	6.65							
103	Lr	4.9							
104	Rf	6.0							

<b>+8 Ions to +15 Ions</b>									
Z	Element	IX	X	XI	XII	XIII	XIV	XV	XVI
9	F	1103.1176							
10	Ne	1195.8286	1362.1995						
11	Na	299.864	1465.121	1648.702					
12	Mg	328.06	367.50	1761.805	1962.6650				
13	Al	330.13	398.75	442.00	2085.98	2304.1410			
14	Si	351.12	401.37	476.36	523.42	2437.63	2673.182		
15	P	372.13	424.4	479.46	560.8	611.74	2816.91	3069.842	
16	S	379.55	447.5	504.8	564.44	652.2	707.01	3223.78	3494.1892
17	Cl	400.06	455.63	529.28	591.99	656.71	749.76	809.40	3658.521
18	Ar	422.45	478.69	538.96	618.26	686.10	755.74	854.77	918.03
19	K	175.8174	503.8	564.7	629.4	714.6	786.6	861.1	968
20	Ca	188.54	211.275	591.9	657.2	726.6	817.6	894.5	974
21	Sc	180.03	225.18	249.798	687.36	756.7	830.8	927.5	1009
22	Ti	192.1	215.92	265.07	291.500	787.84	863.1	941.9	1044
23	V	205.8	230.5	255.7	308.1	336.277	896.0	976	1060
24	Cr	209.3	244.4	270.8	298.0	354.8	384.168	1010.6	1097
25	Mn	221.8	248.3	286.0	314.4	343.6	403.0	435.163	1134.7
26	Fe	233.6	262.1	290.2	330.8	361.0	392.2	457	489.256
27	Co	186.13	275.4	305	336	379	411	444	511.96
28	Ni	193	224.6	321.0	352	384	430	464	499
29	Cu	199	232	265.3	369	401	435	484	520
30	Zn	203	238	274	310.8	419.7	454	490	542
31	Ga	210.8	244.0	280.7	319.2	357.2	471.2	508.8	548.3
36	Kr	230.85	268.2	308	350	391	447	492	541
37	Rb	150	277.1						
38	Sr	162	177	324.1					
39	Y	146.2	191	206	374.0				
42	Mo	164.12	186.4	209.3	230.28	279.1	302.60	544.0	570

<b>+16 Ions to +23 Ions</b>									
Z	Element	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
17	Cl	3946.2960							
18	Ar	4120.8857	4426.2296						
19	K	1033.4	4610.8	4934.046					
20	Ca	1087	1157.8	5128.8	5469.864				
21	Sc	1094	1213	1287.97	5674.8	6033.712			
22	Ti	1131	1221	1346	1425.4	6249.0	6625.82		
23	V	1168	1260	1355	1486	1569.6	6851.3	7246.12	
24	Cr	1185	1299	1396	1496	1634	1721.4	7481.7	7894.81
25	Mn	1224	1317	1437	1539	1644	1788	1879.9	8140.6
26	Fe	1266	1358	1456	1582	1689	1799	1950	2023
27	Co	546.58	1397.2	1504.6	1603	1735	1846	1962	2119
28	Ni	571.08	607.06	1541	1648	1756	1894	2011	2131
29	Cu	557	633	670.588	1697	1804	1916	2060	2182
30	Zn	579	619	698	738	1856			
36	Kr	592	641	786	833	884	937	998	1051
42	Mo	636	702	767	833	902	968	1020	1082

<b>+24 Ions to +29 Ions</b>							
Z	Element	XXV	XXVI	XXVII	XXVIII	XXIX	XXX
25	Mn	8571.94					
26	Fe	8828	9277.69				
27	Co	2219.0	9544.1	10012.12			
28	Ni	2295	2399.2	10288.8	10775.40		
29	Cu	2308	2478	2587.5	11062.38	11567.617	
36	Kr	1151	1205.3	2928	3070	3227	3381
42	Mo	1263	1323	1387	1449	1535	1601

# IONIZATION ENERGIES OF GAS-PHASE MOLECULES

Sharon G. Lias

This table presents values for the first ionization energies (IP) of approximately 1000 molecules and atoms. Substances are listed by molecular formula in the modified Hill order (see Preface). Values enclosed in parentheses are considered not to be well established. Data appearing in the 1988 reference were updated in 1996 for inclusion in the database of ionization energies available at the Internet site of the Standard Reference Data program of the National Institute of Standards and Technology (<http://webbook.nist.gov>). The list appearing here includes these updates.

The list also includes values for enthalpies of formation of the ions at 298 K,  $\Delta_f H_{\text{ion}}$ , given according to the ion convention used by

mass spectrometrists; to convert these values to the electron convention used by thermodynamicists, add 6 kJ/mol. Details on the calculation of  $\Delta_f H_{\text{ion}}$ , as well as data for a much larger number of molecules, may be found in the reference and on the Internet site.

## Reference

Lias, S. G., Bartmess, J. E., Liebman, J. F., Holmes, J. L., Levin, R. D., and Mallard, W.G., *Gas-Phase Ion and Neutral Thermochemistry*, *J. Phys. Chem. Ref. Data*, Vol. 17, Suppl. No. 1, 1988.

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
<i>Substances not containing carbon</i>			
Ac	Actinium	5.17	905
Ag	Silver	7.57624	1016
AgCl	Silver(I) chloride	( $\leq 10.08$ )	$\leq 1065$
AgF	Silver(I) fluoride	( $11.0 \pm 0.3$ )	1071
Al	Aluminum	5.98577	905
AlBr	Aluminum monobromide	(9.3)	913
AlBr <sub>3</sub>	Aluminum tribromide	(10.4)	593
AlCl	Aluminum monochloride	9.4	855
AlCl <sub>3</sub>	Aluminum trichloride	(12.01)	573
AlF	Aluminum monofluoride	$9.73 \pm 0.01$	673
AlF <sub>3</sub>	Aluminum trifluoride	$\leq 15.45$	$\leq 282$
AlI	Aluminum monoiodide	$9.3 \pm 0.3$	965
AlI <sub>3</sub>	Aluminum triiodide	(9.1)	673
Am	Americium	$5.9738 \pm 0.0002$	860
Ar	Argon	15.75962	1521
As	Arsenic	9.8152	1250
AsCl <sub>3</sub>	Arsenic(III) chloride	( $10.55 \pm 0.025$ )	754
AsF <sub>3</sub>	Arsenic(III) fluoride	( $12.84 \pm 0.05$ )	452
AsH <sub>3</sub>	Arsine	(9.89)	1021
Au	Gold	9.22567	1254
B	Boron	8.29803	1363
BBr <sub>3</sub>	Boron tribromide	(10.51)	809
BCl <sub>3</sub>	Boron trichloride	$11.60 \pm 0.02$	718
BF	Fluoroborane	$11.12 \pm 0.01$	957
	Difluoroborane	(9.4)	317
BF <sub>3</sub>	Boron trifluoride	$15.7 \pm 0.3$	365
BH	Boron monohydride	(9.77)	1385
BH <sub>3</sub>	Borane	$12.026 \pm 0.024$	1261
BI <sub>3</sub>	Boron triiodide	( $9.25 \pm 0.03$ )	964
BO <sub>2</sub>	Boron dioxide	( $13.5 \pm 0.3$ )	1001
B <sub>2</sub> H <sub>6</sub>	Diborane	$11.38 \pm 0.05$	1134
B <sub>2</sub> O <sub>3</sub>	Boron oxide	$13.5 \pm 0.15$	460
B <sub>4</sub> H <sub>10</sub>	Tetraborane	$10.76 \pm 0.04$	1105
B <sub>5</sub> H <sub>9</sub>	Pentaborane(9)	$9.90 \pm 0.04$	1028
B <sub>6</sub> H <sub>10</sub>	Hexaborane	(9.0)	965
Ba	Barium	5.21170	683
BaO	Barium oxide	$6.91 \pm 0.06$	543
Be	Beryllium	9.32263	1224
BeO	Beryllium oxide	( $10.1 \pm 0.4$ )	1111
Bi	Bismuth	7.2855	908
BiCl <sub>3</sub>	Bismuth trichloride	(10.4)	736

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
Bk	Berkelium	6.23	911
Br	Bromine (atomic)	11.81381	1252
BrCl	Bromine chloride	11.01	1079
BrF	Bromine fluoride	11.86	1086
BrF <sub>5</sub>	Bromine pentafluoride	13.172 ± 0.002	840
BrH	Hydrogen bromide	11.66 ± 0.03	1087
BrH <sub>3</sub> Si	Bromosilane	10.6	943
BrI	Iodine bromide	9.790 ± 0.004	986
BrK	Potassium bromide	7.85 ± 0.1	578
BrLi	Lithium bromide	(8.7)	685
BrNO	Nitrosyl bromide	10.17 ± 0.03	1065
BrNa	Sodium bromide	8.31 ± 0.1	660
BrO	Bromine monoxide	10.46 ± 0.02	1135
BrRb	Rubidium bromide	7.94 ± 0.03	583
BrTl	Thallium(I) bromide	9.14 ± 0.02	844
Br <sub>2</sub>	Bromine	10.516 ± 0.005	1046
Br <sub>2</sub> Hg	Mercury(II) bromide	10.560 ± 0.003	935
Br <sub>2</sub> Sn	Tin(II) bromide	9.0	839
Br <sub>3</sub> Ga	Gallium(III) bromide	10.40	711
Br <sub>3</sub> P	Phosphorus(III) bromide	9.7	798
Br <sub>4</sub> Hf	Hafnium(IV) bromide	(10.9)	366
Br <sub>4</sub> Sn	Tin(IV) bromide	10.6	709
Br <sub>4</sub> Ti	Titanium(IV) bromide	10.3	375
Br <sub>4</sub> Zr	Zirconium(IV) bromide	(10.7)	388
Ca	Calcium	6.11316	768
CaCl	Calcium monochloride	5.86 ± 0.07	462
CaO	Calcium oxide	6.66 ± 0.18	668
Cd	Cadmium	8.99367	980
Ce	Cerium	5.5387	957
Cf	Californium	6.30	805
Cl	Chlorine (atomic)	12.96764	1373
ClCs	Cesium chloride	(7.84 ± 0.05)	510
ClF	Chlorine fluoride	12.66 ± 0.01	1171
ClFO <sub>3</sub>	Perchloryl fluoride	(12.945 ± 0.005)	1224
ClF <sub>2</sub>	Chlorine difluoride	(12.77 ± 0.05)	1128
ClF <sub>3</sub>	Chlorine trifluoride	(12.65 ± 0.05)	1057
ClF <sub>5</sub> S	Sulfur chloride pentafluoride	(12.335 ± 0.005)	144
ClH	Hydrogen chloride	12.749 ± 0.009	1137
ClHO	Hypochlorous acid	(11.12 ± 0.01)	993
ClH <sub>3</sub> Si	Chlorosilane	11.4	899
ClI	Iodine chloride	10.088 ± 0.01	991
ClIn	Indium(I) chloride	(9.51)	842
ClK	Potassium chloride	(8.0 ± 0.4)	557
CLi	Lithium chloride	9.57	727
ClNO	Nitrosyl chloride	10.87 ± 0.01	1099
ClNO <sub>2</sub>	Nitryl chloride	(11.84)	1155
ClNa	Sodium chloride	8.92 ± 0.06	681
ClO	Chlorine monoxide	10.95	1159
ClO <sub>2</sub>	Chlorine dioxide	10.33 ± 0.02	1093
ClRb	Rubidium chloride	(8.50 ± 0.03)	590
ClTl	Thallium(I) chloride	9.70 ± 0.03	869
Cl <sub>2</sub>	Chlorine	11.480 ± 0.005	1108
Cl <sub>2</sub> CrO <sub>2</sub>	Chromyl chloride	11.6	580
Cl <sub>2</sub> Ge	Germanium(II) chloride	(10.20 ± 0.05)	813
Cl <sub>2</sub> H <sub>2</sub> Si	Dichlorosilane	11.4	765
Cl <sub>2</sub> Hg	Mercury(II) chloride	11.380 ± 0.003	952
Cl <sub>2</sub> O	Chlorine oxide	10.94	1135
Cl <sub>2</sub> OS	Thionyl chloride	10.96	844
Cl <sub>2</sub> O <sub>2</sub> S	Sulfuryl chloride	12.05	807
Cl <sub>2</sub> Pb	Lead(II) chloride	(10.2)	791



Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
Cl <sub>2</sub> S	Sulfur dichloride	9.45 ± 0.03	895
Cl <sub>2</sub> Si	Dichlorosilylene	(10.93 ± 0.10)	887
Cl <sub>2</sub> Sn	Tin(II) chloride	(10.0)	760
Cl <sub>3</sub> Ga	Gallium(III) chloride	11.52	664
Cl <sub>3</sub> HSi	Trichlorosilane	(11.7)	648
Cl <sub>3</sub> N	Nitrogen trichloride	(10.12 ± 0.1)	1244
Cl <sub>3</sub> OP	Phosphorus(V) oxychloride	11.36 ± 0.02	540
Cl <sub>3</sub> OV	Vanadyl trichloride	(11.6)	425
Cl <sub>3</sub> P	Phosphorus(III) chloride	9.91	668
Cl <sub>3</sub> PS	Phosphorus(V) sulfide trichloride	9.71 ± 0.03	573
Cl <sub>3</sub> Sb	Antimony(III) chloride	(≤ 10.7)	s719
Cl <sub>4</sub> Ge	Germanium(IV) chloride	11.68 ± 0.05	629
Cl <sub>4</sub> Hf	Hafnium(IV) chloride	(11.7)	246
Cl <sub>4</sub> Si	Tetrachlorosilane	11.79 ± 0.01	527
Cl <sub>4</sub> Sn	Tin(IV) chloride	11.7 ± 0.2	656
Cl <sub>4</sub> Ti	Titanium(IV) chloride	(11.5)	349
Cl <sub>4</sub> V	Vanadium(IV) chloride	(9.2)	361
Cl <sub>4</sub> Zr	Zirconium(IV) chloride	(11.2)	210
Cl <sub>5</sub> Mo	Molybdenum(V) chloride	(8.7)	392
Cl <sub>5</sub> Nb	Niobium(V) chloride	(10.97)	356
Cl <sub>5</sub> P	Phosphorus(V) chloride	(10.2)	608
Cl <sub>5</sub> Ta	Tantalum(V) chloride	(11.08)	303
Cl <sub>6</sub> W	Tungsten(VI) chloride	(9.5)	348
Cm	Curium	6.02	966
Co	Cobalt	7.8810	1187
Cr	Chromium	6.76664	1050
Cs	Cesium	3.89390	452
CsF	Cesium fluoride	(8.80 ± 0.10)	489
CsNa	Cesium sodium	(4.05 ± 0.04)	535
Cu	Copper	7.72638	1084
CuF	Copper(I) fluoride	10.15 ± 0.02	984
Dy	Dysprosium	5.9389	862
Er	Erbium	6.1078	907
Es	Einsteinium	6.42	753
Eu	Europium	5.6704	723
F	Fluorine (atomic)	17.42282	1761
FGa	Gallium monofluoride	(9.6 ± 0.5)	700
FH	Hydrogen fluoride	16.044 ± 0.003	1276
FHO	Hypofluorous acid	12.71 ± 0.01	1130
FH <sub>3</sub> Si	Fluorosilane	11.7	752
FI	Iodine fluoride	10.54 ± 0.01	922
FIn	Indium monofluoride	(9.6 ± 0.5)	740
FNO	Nitrosyl fluoride	12.63 ± 0.03	1152
FNO <sub>2</sub>	Nitryl fluoride	(13.09)	1154
FNS	Thionitrosyl fluoride (NSF)	11.51 ± 0.04	1090
FO	Fluorine monoxide	12.78 ± 0.03	1342
FO <sub>2</sub>	Fluorine superoxide (FOO)	(12.6 ± 0.2)	1228
FS	Sulfur fluoride	10.09	986
FTl	Thallium(I) fluoride	10.52	835
F <sub>2</sub>	Fluorine	15.697 ± 0.003	1515
F <sub>2</sub> Ge	Germanium(II) fluoride	(≤ 11.65)	551
F <sub>2</sub> HN	Difluoramine	(11.53 ± 0.08)	1046
F <sub>2</sub> H <sub>2</sub> Si	Difluorosilane	(12.2)	386
F <sub>2</sub> Mg	Magnesium fluoride	(13.6 ± 0.3)	588
F <sub>2</sub> N	Difluoroamidogen	11.628 ± 0.01	1155
F <sub>2</sub> N <sub>2</sub>	<i>trans</i> -Difluorodiazine	(12.8)	1315
F <sub>2</sub> O	Fluorine monoxide	13.11 ± 0.01	1290
F <sub>2</sub> OS	Thionyl fluoride	12.25	688
F <sub>2</sub> O <sub>2</sub> S	Sulfuryl fluoride	13.04 ± 0.01	501
F <sub>2</sub> Pb	Lead(II) fluoride	(11.5)	679

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
F <sub>2</sub> S	Sulfur difluoride	(10.08)	676
F <sub>2</sub> Si	Difluorosilylene	10.78 ± 0.05	450
F <sub>2</sub> Sn	Tin(II) fluoride	(11.1)	586
F <sub>2</sub> Xe	Xenon difluoride	12.35 ± 0.01	1083
F <sub>3</sub> HSi	Trifluorosilane	(14.0)	150
F <sub>3</sub> N	Nitrogen trifluoride	13.00 ± 0.02	1125
F <sub>3</sub> NO	Trifluoramine oxide	13.31 ± 0.06	1121
F <sub>3</sub> OP	Phosphorus(V) oxyfluoride	12.76 ± 0.01	-24
F <sub>3</sub> P	Phosphorus(III) fluoride	11.60 ± 0.05	161
F <sub>3</sub> PS	Phosphorus(V) sulfide trifluoride	≤ 11.05 ± 0.035	≤ 58
F <sub>3</sub> Si	Trifluorosilyl	(9.99)	-32
F <sub>4</sub> Ge	Germanium(IV) fluoride	(15.5)	307
F <sub>4</sub> N <sub>2</sub>	Tetrafluorohydrazine	11.94 ± 0.03	1119
F <sub>4</sub> S	Sulfur tetrafluoride	12.0 ± 0.3	399
F <sub>4</sub> Si	Tetrafluorosilane	15.24 ± 0.14	-144
F <sub>4</sub> Xe	Xenon tetrafluoride	12.65 ± 0.1	1016
F <sub>5</sub> I	Iodine pentafluoride	12.943 ± 0.005	408
F <sub>5</sub> P	Phosphorus(V) fluoride	(15.1)	-137
F <sub>5</sub> S	Sulfur pentafluoride	9.60 ± 0.05	10
F <sub>6</sub> Mo	Molybdenum(VI) fluoride	(14.5 ± 0.1)	-159
F <sub>6</sub> S	Sulfur hexafluoride	15.32 ± 0.02	258
F <sub>6</sub> U	Uranium(VI) fluoride	14.00 ± 0.10	-796
Fe	Iron	7.9024	1177
Fm	Fermium	6.50	627
Ga	Gallium	5.99930	851
GaI <sub>3</sub>	Gallium(III) iodide	9.40	765
Gd	Gadolinium	6.1500	991
Ge	Germanium	7.900	1139
GeH <sub>4</sub>	Germane	≤ 10.53	≤ 1108
GeI <sub>4</sub>	Germanium(IV) iodide	(9.42)	850
GeO	Germanium(II) oxide	11.25 ± 0.01	1044
GeS	Germanium(II) sulfide	(9.98)	1055
H	Hydrogen (atomic)	13.59844	1530
HI	Hydrogen iodide	10.386 ± 0.001	1028
HLi	Lithium hydride	7.7	882
HN	Imidogen	≤ 13.49 ± 0.01	1678
HNO	Nitrosyl hydride	(10.1)	1075
HNO <sub>2</sub>	Nitrous acid	≤ 11.3	≤ 1011
HNO <sub>3</sub>	Nitric acid	11.95 ± 0.01	1019
HN <sub>3</sub>	Hydrazoic acid	10.72 ± 0.025	1328
HO	Hydroxyl	13.0170 ± 0.0002	1294
HO <sub>2</sub>	Hydroperoxy	11.35 ± 0.01	1106
HS	Mercapto	10.4219 ± 0.0004	1145
H <sub>2</sub>	Hydrogen	15.42593 ± 0.00005	1488
H <sub>2</sub> N	Amidogen	11.14 ± 0.01	1264
H <sub>2</sub> O	Water	12.6206 ± 0.0020	976
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide	10.58 ± 0.04	885
H <sub>2</sub> S	Hydrogen sulfide	10.457 ± 0.012	989
H <sub>2</sub> Se	Hydrogen selenide	9.892 ± 0.005	984
H <sub>2</sub> Si	Silylene	8.244 ± 0.025	1084
H <sub>3</sub> N	Ammonia	10.070 ± 0.020	925
H <sub>3</sub> NO	Hydroxylamine	(10.00)	923
H <sub>3</sub> P	Phosphine	9.869 ± 0.002	958
H <sub>3</sub> Sb	Stibine	9.54 ± 0.03	1067
H <sub>4</sub> N <sub>2</sub>	Hydrazine	8.1 ± 0.15	877
H <sub>4</sub> Si	Silane	11.00 ± 0.02	1095
H <sub>4</sub> Sn	Stannane	(10.75)	1200
H <sub>6</sub> Si <sub>2</sub>	Disilane	9.74 ± 0.02	1019
H <sub>8</sub> Si <sub>3</sub>	Trisilane	(9.2)	1009
He	Helium	24.58741	2372

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
Hf	Hafnium	6.82507 ± 0.00004	1278
Hg	Mercury	10.43750	1069
HgI <sub>2</sub>	Mercury(II) iodide	9.5088 ± 0.0022	900
Ho	Holmium	6.0216	882
I	Iodine (atomic)	10.45126	1115
IK	Potassium iodide	(7.21 ± 0.3)	570
ILi	Lithium iodide	(7.5)	633
INa	Sodium iodide	7.64 ± 0.02	659
ITl	Thallium(I) iodide	8.47 ± 0.02	826
I <sub>2</sub>	Iodine	9.3074 ± 0.0002	960
I <sub>4</sub> Ti	Titanium(IV) iodide	(9.1)	602
I <sub>4</sub> Zr	Zirconium(IV) iodide	(9.3)	500
In	Indium	5.78636	802
Ir	Iridium	9.1	1543
K	Potassium	4.34066	508
KLi	Lithium potassium	4.57 ± 0.04	512
KNa	Potassium sodium	4.41636 ± 0.00017	561
K <sub>2</sub>	Dipotassium	4.0637 ± 0.0002	519
Kr	Krypton	13.99961	1351
La	Lanthanum	5.5770	969
Li	Lithium	5.39172	680
LiNa	Lithium sodium	5.05 ± 0.04	571
LiO	Lithium monoxide	(8.44)	894
LiRb	Lithium rubidium	4.3 ± 0.1	486
Li <sub>2</sub>	Dilithium	5.1127 ± 0.0003	709
Lu	Lutetium	5.42585	950
Md	Mendelevium	6.58	635
Mg	Magnesium	7.64624	885
MgO	Magnesium oxide	(8.76 ± 0.22)	901
Mn	Manganese	7.43402	998
Mo	Molybdenum	7.09243	1343
N	Nitrogen (atomic)	14.53414	1875
NO	Nitric oxide	9.26438 ± 0.00005	985
NO <sub>2</sub>	Nitrogen dioxide	9.586 ± 0.002	958
NP	Phosphorus nitride	11.84 ± 0.04	1247
NS	Nitrogen sulfide	8.87 ± 0.01	1119
N <sub>2</sub>	Nitrogen	15.5808	1503
N <sub>2</sub> O	Nitrous oxide	12.886	1325
N <sub>2</sub> O <sub>4</sub>	Nitrogen tetroxide	(10.8)	1050
N <sub>2</sub> O <sub>5</sub>	Nitrogen pentoxide	(11.9)	1161
Na	Sodium	5.13908	603
NaRb	Rubidium sodium	4.32 ± 0.04	480
Na <sub>2</sub>	Disodium	4.894 ± 0.003	614
Nb	Niobium	6.75885	1384
Nd	Neodymium	5.5250	859
Ne	Neon	21.56454	2081
Ni	Nickel	7.6398	1167
No	Nobelium	6.65	642
Np	Neptunium	6.2657 ± 0.0003	1069
O	Oxygen (atomic)	13.61806	1563
OPb	Lead(II) oxide	9.08 ± 0.10	939
OS	Sulfur monoxide	10.294 ± 0.004	998
OS <sub>2</sub>	Sulfur oxide (SSO)	10.584 ± 0.005	971
OSi	Silicon monoxide	11.49 ± 0.20	1008
OSn	Tin(II) oxide	9.60 ± 0.02	944
OSr	Strontium oxide	6.6 ± 0.2	623
O <sub>2</sub>	Oxygen	12.0697 ± 0.0002	1165
O <sub>2</sub> S	Sulfur dioxide	12.349 ± 0.001	894
O <sub>2</sub> Th	Thorium(IV) oxide	(8.7 ± 0.15)	342
O <sub>2</sub> Ti	Titanium(IV) oxide	(9.54 ± 0.1)	623

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
O <sub>2</sub> U	Uranium(IV) oxide	(5.4 ± 0.1)	57
O <sub>3</sub>	Ozone	12.43	1342
O <sub>3</sub> S	Sulfur trioxide	12.82 ± 0.03	841
O <sub>3</sub> U	Uranium(VI) oxide	(10.5 ± 0.5)	214
O <sub>4</sub> Os	Osmium(VIII) oxide	(12.32)	850
O <sub>4</sub> Ru	Ruthenium(VIII) oxide	12.15 ± 0.03	988
O <sub>7</sub> Re <sub>2</sub>	Rhenium(VII) oxide	(12.7 ± 0.2)	125
Os	Osmium	8.7	1630
P	Phosphorus	10.48669	1328
P <sub>2</sub>	Diphosphorus	10.53	1160
Pa	Protactinium	5.89	1133
Pb	Lead	7.41666	911
PbS	Lead(II) sulfide	(8.5 ± 0.5)	954
Pd	Palladium	8.3367	1181
Pm	Promethium	5.55	536
Pr	Praseodymium	5.464	883
Pt	Platinum	9.0	1433
Pu	Plutonium	6.025	926
Ra	Radium	5.27892	668
Rb	Rubidium	4.17713	484
Re	Rhenium	7.88	1530
Rh	Rhodium	7.45890	1276
Rn	Radon	10.74850	1037
Ru	Ruthenium	7.36050	1355
S	Sulfur	10.36001	1277
SSn	Tin(II) sulfide	(8.8)	966
S <sub>2</sub>	Disulfur	9.356 ± 0.002	1031
Sb	Antimony	8.64	1096
Sc	Scandium	6.56144	1010
Se	Selenium	9.75238	1168
Si	Silicon	8.15169	1238
Sm	Samarium	5.6437	751
Sn	Tin	7.34381	1011
Sr	Strontium	5.69484	713
Ta	Tantalum	7.89	1544
Tb	Terbium	5.8639	955
Tc	Technetium	7.28	1380
Te	Tellurium	9.0096	1066
Th	Thorium	6.308 ± 0.003	1207
Ti	Titanium	6.8282	1127
Tl	Thallium	6.10829	771
Tm	Thulium	6.18431	827
U	Uranium	6.19405	1129
V	Vanadium	6.746 ± 0.002	1166
W	Tungsten	7.98	1621
Xe	Xenon	12.12987	1170
Y	Yttrium	6.217	1022
Yb	Ytterbium	6.25416	754
Zn	Zinc	9.39405	1037
Zr	Zirconium	6.63390	1251
<i>Substances containing carbon</i>			
C	Carbon	11.26030	1803
CBrClF <sub>2</sub>	Bromochlorodifluoromethane	(11.21)	642
CBrCl <sub>3</sub>	Bromotrichloromethane	(10.6)	980
CBrF <sub>3</sub>	Bromotrifluoromethane	(11.40)	451
CBr <sub>2</sub> F <sub>2</sub>	Dibromodifluoromethane	11.03 ± 0.04	683
CBr <sub>4</sub>	Tetrabromomethane	(10.31 ± 0.02)	1079
CCL	Chloromethylidyne	(8.9 ± 0.2)	1244
CClF <sub>3</sub>	Chlorotrifluoromethane	12.6 ± 0.2	505

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
CClN	Cyanogen chloride	12.34 ± 0.01	1329
CCl <sub>2</sub>	Dichloromethylene	(9.27)	1058
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	12.05 ± 0.24	685
CCl <sub>2</sub> O	Carbonyl chloride	(11.5)	888
CCl <sub>3</sub> F	Trichlorofluoromethane	11.77 ± 0.02	868
CCl <sub>4</sub>	Tetrachloromethane	11.47 ± 0.01	1010
CF	Fluoromethylidyne	9.11 ± 0.01	1134
CFN	Cyanogen fluoride	13.34 ± 0.02	1325
CF <sub>2</sub>	Difluoromethylene	11.44 ± 0.03	899
CF <sub>2</sub> O	Carbonyl fluoride	13.035 ± 0.030	617
CF <sub>3</sub>	Trifluoromethyl	8.7 ± 0.2	379
CF <sub>3</sub> I	Trifluoroiodomethane	10.23	397
CH	Methylidyne	10.64 ± 0.01	1622
CHBrCl <sub>2</sub>	Bromodichloromethane	10.6	973
CHBr <sub>2</sub> Cl	Chlorodibromomethane	10.59 ± 0.01	1030
CHBr <sub>3</sub>	Tribromomethane	10.48 ± 0.02	1035
CHCl	Chloromethylene	9.84	1247
CHClF <sub>2</sub>	Chlorodifluoromethane	(12.2)	693
CHCl <sub>2</sub> F	Dichlorofluoromethane	(11.5)	829
CHCl <sub>3</sub>	Trichloromethane	11.37 ± 0.02	992
CHF	Fluoromethylene	10.06 ± 0.05	1121
CHF <sub>3</sub>	Trifluoromethane	(13.86)	643
CHI <sub>3</sub>	Triiodomethane	9.25 ± 0.02	1010
CHN	Hydrogen cyanide	13.60 ± 0.01	1447
CHN	Hydrogen isocyanide	(12.5 ± 0.1)	1407
CHNO	Isocyanic acid	11.595 ± 0.005	1016
CHNO	Fulminic acid	(10.83)	1263
CHO	Oxomethyl (HCO)	(8.55)	826
CH <sub>2</sub>	Methylene	10.396 ± 0.003	1392
CH <sub>2</sub> BrCl	Bromochloromethane	10.77 ± 0.01	1085
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	(10.50 ± 0.02)	1013
CH <sub>2</sub> ClF	Chlorofluoromethane	11.71 ± 0.01	870
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	11.32 ± .01	996
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane	12.71	774
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane	9.46 ± 0.02	1030
CH <sub>2</sub> N <sub>2</sub>	Diazomethane	8.999 ± 0.001	1098
CH <sub>2</sub> N <sub>2</sub>	Cyanamide	(10.4)	1137
CH <sub>2</sub> O	Formaldehyde	10.88 ± 0.01	941
CH <sub>2</sub> O <sub>2</sub>	Formic acid	11.33 ± 0.01	715
CH <sub>3</sub>	Methyl	9.843 ± 0.002	1095
CH <sub>3</sub> BO	Borane carbonyl	11.14 ± 0.02	962
CH <sub>3</sub> Br	Bromomethane	10.541 ± 0.003	979
CH <sub>3</sub> Cl	Chloromethane	11.22 ± 0.01	1001
CH <sub>3</sub> Cl <sub>3</sub> Si	Methyltrichlorosilane	(11.36 ± 0.03)	548
CH <sub>3</sub> F	Fluoromethane	12.47 ± 0.02	956
CH <sub>3</sub> I	Iodomethane	9.538	936
CH <sub>3</sub> NO	Formamide	10.16 ± 0.06	796
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	11.08 ± 0.07	994
CH <sub>3</sub> N <sub>3</sub>	Methyl azide	9.81 ± 0.02	1227
CH <sub>3</sub> O	Methoxy	(10.72)	1050
CH <sub>4</sub>	Methane	12.61 ± 0.01	1143
CH <sub>4</sub> N <sub>2</sub> O	Urea	9.7	690
CH <sub>4</sub> O	Methanol	10.85 ± 0.01	845
CH <sub>4</sub> S	Methanethiol	9.44 ± 0.005	888
CH <sub>5</sub> N	Methylamine	(8.80)	826
CH <sub>6</sub> N <sub>2</sub>	Methylhydrazine	7.7 ± 0.15	835
CH <sub>6</sub> Si	Methylsilane	(10.7)	1003
CN	Cyanide	13.5984	1748
CNO	Cyanate	11.76 ± 0.01	1290
CO	Carbon monoxide	14.014 ± 0.0003	1242

Mol. form.	Name	IP/eV	$\Delta_i H_{\text{ion}}$ kJ/mol
COS	Carbon oxysulfide	11.18 ± 0.01	936
COSe	Carbon oxyselenide	10.36 ± 0.01	929
CO <sub>2</sub>	Carbon dioxide	13.773 ± 0.002	935
CS	Carbon sulfide	11.33 ± 0.01	1361
CS <sub>2</sub>	Carbon disulfide	10.0685 ± 0.0020	1089
C <sub>2</sub>	Dicarbon	(11.4 ± 0.3)	2000
C <sub>2</sub> Br <sub>2</sub> F <sub>4</sub>	1,2-Dibromotetrafluoroethane	(11.1)	280
C <sub>2</sub> ClF <sub>3</sub>	Chlorotrifluoroethylene	9.81 ± 0.03	373
C <sub>2</sub> ClF <sub>5</sub>	Chloropentafluoroethane	(12.6)	99
C <sub>2</sub> Cl <sub>2</sub>	Dichloroacetylene	9.9	1165
C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	1,2-Dichlorotetrafluoroethane	12.2	252
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,1-Trichlorotrifluoroethane	11.5	386
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichlorotrifluoroethane	11.99 ± 0.02	429
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene	9.326 ± 0.001	887
C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	1,1,2,2-Tetrachloro-1,2-difluoroethane	(11.3)	563
C <sub>2</sub> Cl <sub>4</sub> O	Trichloroacetyl chloride	(11.0)	827
C <sub>2</sub> Cl <sub>6</sub>	Hexachloroethane	(11.1)	920
C <sub>2</sub> F <sub>3</sub> N	Trifluoroacetonitrile	13.93 ± 0.07	845
C <sub>2</sub> F <sub>4</sub>	Tetrafluoroethylene	10.12 ± 0.02	315
C <sub>2</sub> F <sub>6</sub>	Hexafluoroethane	(13.6)	-30
C <sub>2</sub> H	Ethynyl	(11.61 ± 0.07)	1685
C <sub>2</sub> HBr	Bromoacetylene	10.31 ± 0.02	1242
C <sub>2</sub> HBrClF <sub>3</sub>	2-Bromo-2-chloro-1,1,1-trifluoroethane	(11.0)	363
C <sub>2</sub> HCl	Chloroacetylene	10.58 ± 0.02	1276
C <sub>2</sub> HClF <sub>2</sub>	1-Chloro-2,2-difluoroethylene	9.80 ± 0.04	628
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	9.46 ± 0.02	894
C <sub>2</sub> HCl <sub>3</sub> O	Dichloroacetyl chloride	(10.9)	809
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane	(11.0)	919
C <sub>2</sub> HF	Fluoroacetylene	11.26	1195
C <sub>2</sub> HF <sub>3</sub>	Trifluoroethylene	10.14	489
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid	11.46	75
C <sub>2</sub> H <sub>2</sub>	Acetylene	11.400 ± 0.002	1328
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethylene	9.81 ± 0.04	949
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene	9.66 ± 0.01	936
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	9.64 ± 0.02	934
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	Chloroacetyl chloride	(≤ 10.3)	815
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,1,2-Tetrachloroethane	(11.1)	920
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane	(≤ 11.62)	≤ 971
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1,1-Difluoroethylene	10.29 ± 0.01	650
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	<i>cis</i> -1,2-Difluoroethylene	10.23 ± 0.02	690
C <sub>2</sub> H <sub>2</sub> O	Ketene	9.617 ± 0.003	880
C <sub>2</sub> H <sub>2</sub> O <sub>2</sub>	Glyoxal	10.2	773
C <sub>2</sub> H <sub>2</sub> S <sub>2</sub>	Thiirene	8.61	892
C <sub>2</sub> H <sub>3</sub> Br	Bromoethylene	9.83 ± 0.02	1028
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	9.99 ± 0.02	985
C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	1-Chloro-1,1-difluoroethane	(11.98)	626
C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride	10.82 ± 0.04	801
C <sub>2</sub> H <sub>3</sub> ClO	Chloroacetaldehyde	(10.48)	815
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid	(10.7)	597
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane	(11.0)	917
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane	(11.0)	911
C <sub>2</sub> H <sub>3</sub> F	Fluoroethylene	10.36 ± 0.01	861
C <sub>2</sub> H <sub>3</sub> FO	Acetyl fluoride	(11.5)	667
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,1-Trifluoroethane	13.3 ± 0.5	536
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	12.20 ± 0.01	1253
C <sub>2</sub> H <sub>3</sub> NO	Methylisocyanate	(10.67)	900
C <sub>2</sub> H <sub>4</sub>	Ethylene	10.5138 ± 0.0006	1067
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1,2-Dibromoethane	10.35 ± 0.04	961
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	11.04 ± 0.02	935
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	11.04 ± 0.02	931

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	1,1-Difluoroethane	(11.87)	643
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	10.229 ± 0.0007	821
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	10.56 ± 0.01	966
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	10.65 ± 0.02	595
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	10.835 ± 0.005	690
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	10.29 ± 0.01	931
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	10.98 ± 0.02	947
C <sub>2</sub> H <sub>5</sub> ClO	2-Chloroethanol	(10.5)	756
C <sub>2</sub> H <sub>5</sub> F	Fluoroethane	(11.78)	873
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	9.3492 ± 0.0006	893
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine	(9.5 ± 0.3)	1044
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	9.65 ± 0.03	693
C <sub>2</sub> H <sub>5</sub> NO	<i>N</i> -Methylformamide	9.83 ± 0.04	760
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	10.88 ± 0.05	948
C <sub>2</sub> H <sub>6</sub>	Ethane	11.56 ± 0.02	1031
C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	Dichlorodimethylsilane	(10.7)	576
C <sub>2</sub> H <sub>6</sub> O	Ethanol	10.43 ± 0.05	772
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	10.025 ± 0.025	783
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide	9.10 ± 0.03	727
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	10.16	593
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol	9.31 ± 0.03	851
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	8.69 ± 0.02	801
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide	(7.4 ± 0.3)	690
C <sub>2</sub> H <sub>7</sub> N	Ethylamine	8.86 ± 0.02	808
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	8.24 ± 0.08	777
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine	8.96	664
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	(8.6)	812
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,1-Dimethylhydrazine	7.29 ± 0.05	787
C <sub>2</sub> N <sub>2</sub>	Cyanogen	13.37 ± 0.01	1597
C <sub>3</sub> F <sub>6</sub>	Perfluoropropene	10.60 ± 0.03	-103
C <sub>3</sub> F <sub>6</sub> O	Perfluoroacetone	(11.57 ± 0.13)	-282
C <sub>3</sub> F <sub>8</sub>	Perfluoropropane	(13.38)	-491
C <sub>3</sub> HN	Cyanoacetylene	11.64 ± 0.01	1475
C <sub>3</sub> H <sub>2</sub> O	2-Propynal	(10.7 ± 0.1)	1145
C <sub>3</sub> H <sub>3</sub> F <sub>3</sub>	3,3,3-Trifluoropropene	(10.9)	437
C <sub>3</sub> H <sub>3</sub> N	2-Propenenitrile	10.91 ± 0.01	1237
C <sub>3</sub> H <sub>3</sub> NO	Oxazole	(9.9)	940
C <sub>3</sub> H <sub>3</sub> NO	Isoxazole	(9.93)	1038
C <sub>3</sub> H <sub>4</sub>	Allene	9.692 ± 0.004	1126
C <sub>3</sub> H <sub>4</sub>	Propyne	10.37 ± 0.01	1187
C <sub>3</sub> H <sub>4</sub>	Cyclopropene	9.67 ± 0.01	1209
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	Imidazole	(8.81)	997
C <sub>3</sub> H <sub>4</sub> O	Propargyl alcohol	10.49 ± 0.02	1060
C <sub>3</sub> H <sub>4</sub> O	Acrolein	10.103 ± 0.006	900
C <sub>3</sub> H <sub>4</sub> O	Cyclopropanone	(9.1 ± 0.1)	895
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Propenoic acid	10.60	701
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	2-Oxetanone	(9.70 ± 0.01)	653
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	(9.96)	1008
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene	10.04 ± 0.01	965
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	(10.64)	919
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Methyl chloroacetate	(10.3)	575
C <sub>3</sub> H <sub>5</sub> F	3-Fluoropropene	(10.11)	821
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	11.84 ± 0.02	1194
C <sub>3</sub> H <sub>5</sub> NO	Acrylamide	(9.5)	720
C <sub>3</sub> H <sub>6</sub>	Propene	9.73 ± 0.02	959
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	9.86	1005
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,2-Dibromopropane	(10.1)	903
C <sub>3</sub> H <sub>6</sub> Br <sub>2</sub>	1,3-Dibromopropane	(≤ 10.2)	≤ 919
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropane	10.8 ± 0.1	886
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,3-Dichloropropane	10.89 ± 0.04	892

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	9.67 ± 0.05	808
C <sub>3</sub> H <sub>6</sub> O	Methyl vinyl ether	8.95 ± 0.01	763
C <sub>3</sub> H <sub>6</sub> O	Propanal	9.96 ± 0.01	772
C <sub>3</sub> H <sub>6</sub> O	Acetone	9.703 ± 0.006	719
C <sub>3</sub> H <sub>6</sub> O	Methyloxirane	(10.22)	892
C <sub>3</sub> H <sub>6</sub> O	Oxetane	9.65 ± 0.01	851
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	10.525 ± 0.003	568
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	10.61 ± 0.01	639
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	10.25 ± 0.02	579
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1,3-Dioxolane	(9.9)	658
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	1,3,5-Trioxane	(10.3)	528
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	10.18 ± 0.01	898
C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	10.10 ± 0.03	877
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	10.81 ± 0.01	911
C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane	10.79 ± 0.02	896
C <sub>3</sub> H <sub>7</sub> F	1-Fluoropropane	(11.3)	806
C <sub>3</sub> H <sub>7</sub> F	2-Fluoropropane	(11.08)	776
C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	9.25 ± 0.01	860
C <sub>3</sub> H <sub>7</sub> I	2-Iodopropane	9.19 ± 0.02	845
C <sub>3</sub> H <sub>7</sub> N	Allylamine	(8.76)	891
C <sub>3</sub> H <sub>7</sub> N	Cyclopropylamine	(8.8)	926
C <sub>3</sub> H <sub>7</sub> N	Propyleneimine	(9.0)	960
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	(9.12)	688
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	(10.81)	919
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane	(10.71)	894
C <sub>3</sub> H <sub>8</sub>	Propane	10.95 ± 0.05	952
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	10.18 ± 0.06	727
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	10.17 ± 0.02	709
C <sub>3</sub> H <sub>8</sub> O	Ethyl methyl ether	9.72 ± 0.07	722
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Dimethoxymethane	9.7	588
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol	9.20 ± 0.01	819
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol	9.145 ± 0.005	806
C <sub>3</sub> H <sub>8</sub> S	Ethyl methyl sulfide	(8.55)	765
C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	Trimethyl borate	(10.0)	65
C <sub>3</sub> H <sub>9</sub> ClSi	Trimethylchlorosilane	(10.15)	624
C <sub>3</sub> H <sub>9</sub> N	Propylamine	(8.78)	777
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine	(8.72)	758
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	7.82 ± 0.06	731
C <sub>3</sub> H <sub>9</sub> NO	3-Amino-1-propanol	(9.0)	651
C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride	(10.8)	645
C <sub>4</sub> H <sub>4</sub>	1-Buten-3-yne	9.58 ± 0.02	1230
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Succinonitrile	(12.1 ± 0.25)	1377
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine	9.23	1087
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyridazine	8.67 ± 0.03	1112
C <sub>4</sub> H <sub>4</sub> O	Furan	8.883 ± 0.003	822
C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	Diketene	(9.6 ± 0.02)	736
C <sub>4</sub> H <sub>4</sub> O <sub>3</sub>	Succinic anhydride	(10.6)	500
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Fumaric acid	(10.7)	355
C <sub>4</sub> H <sub>4</sub> S	Thiophene	8.86 ± 0.02	970
C <sub>4</sub> H <sub>5</sub> N	Methylacrylonitrile	10.34	1127
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole	8.207 ± 0.005	900
C <sub>4</sub> H <sub>5</sub> N	Cyclopropanecarbonitrile	(10.25)	1173
C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene	(9.03)	1034
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	9.082 ± 0.004	986
C <sub>4</sub> H <sub>6</sub>	1-Butyne	10.19 ± 0.02	1148
C <sub>4</sub> H <sub>6</sub>	2-Butyne	9.59 ± 0.03	1071
C <sub>4</sub> H <sub>6</sub>	Cyclobutene	9.43 ± 0.02	1067
C <sub>4</sub> H <sub>6</sub> O	Divinyl ether	(8.7)	827
C <sub>4</sub> H <sub>6</sub> O	<i>trans</i> -2-Butenal	9.73 ± 0.01	835
C <sub>4</sub> H <sub>6</sub> O	2-Methylpropenal	(9.92)	834



Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>4</sub> H <sub>6</sub> O	Cyclobutanone	(9.35)	815
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>cis</i> -Crotonic acid	(10.08)	625
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>trans</i> -Crotonic acid	(9.9)	604
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid	(10.15)	611
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	9.19 ± 0.05	572
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate	(9.9)	641
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	(10.0)	398
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Dimethyl oxalate	(10.0)	287
C <sub>4</sub> H <sub>6</sub> S	2,5-Dihydrothiophene	(8.4)	898
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	(11.2)	1110
C <sub>4</sub> H <sub>7</sub> N	2-Methylpropanenitrile	(11.3)	1115
C <sub>4</sub> H <sub>7</sub> NO	2-Pyrrolidone	(9.2)	674
C <sub>4</sub> H <sub>8</sub>	1-Butene	9.55 ± 0.06	921
C <sub>4</sub> H <sub>8</sub>	<i>cis</i> -2-Butene	9.11 ± 0.01	871
C <sub>4</sub> H <sub>8</sub>	<i>trans</i> -2-Butene	9.10 ± 0.01	866
C <sub>4</sub> H <sub>8</sub>	Isobutene	9.239 ± 0.003	875
C <sub>4</sub> H <sub>8</sub>	Cyclobutane	(9.82 ± 0.05)	976
C <sub>4</sub> H <sub>8</sub>	Methylcyclopropane	(9.46)	936
C <sub>4</sub> H <sub>8</sub> Br <sub>2</sub>	1,4-Dibromobutane	(10.15)	879
C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether	(8.98)	709
C <sub>4</sub> H <sub>8</sub> O	1,2-Epoxybutane	(≤ 10.15)	862
C <sub>4</sub> H <sub>8</sub> O	Butanal	9.84 ± 0.02	742
C <sub>4</sub> H <sub>8</sub> O	Isobutanal	9.71 ± 0.01	721
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	9.52 ± 0.04	678
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	9.38 ± 0.05	721
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid	10.17 ± 0.05	509
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	2-Methylpropanoic acid	10.33 ± 0.03	516
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	10.52 ± 0.02	555
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	10.01 ± 0.05	522
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	10.15 ± 0.03	548
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Dioxane	9.8	607
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	9.19 ± 0.01	571
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	Sulfolane	(9.8)	577
C <sub>4</sub> H <sub>8</sub> S	Tetrahydrothiophene	8.38	774
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	(10.12)	869
C <sub>4</sub> H <sub>9</sub> Br	2-Bromobutane	10.01 ± 0.02	845
C <sub>4</sub> H <sub>9</sub> Br	1-Bromo-2-methylpropane	10.09 ± 0.02	861
C <sub>4</sub> H <sub>9</sub> Br	2-Bromo-2-methylpropane	9.92 ± 0.03	823
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	10.67 ± 0.03	875
C <sub>4</sub> H <sub>9</sub> Cl	2-Chlorobutane	10.53	857
C <sub>4</sub> H <sub>9</sub> Cl	1-Chloro-2-methylpropane	10.73 ± 0.07	877
C <sub>4</sub> H <sub>9</sub> Cl	2-Chloro-2-methylpropane	(10.61)	842
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	9.23 ± 0.01	840
C <sub>4</sub> H <sub>9</sub> I	2-Iodobutane	9.10 ± 0.02	815
C <sub>4</sub> H <sub>9</sub> I	1-Iodo-2-methylpropane	9.19 ± 0.01	824
C <sub>4</sub> H <sub>9</sub> I	2-Iodo-2-methylpropane	(9.02)	798
C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine	(8.0)	769
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide	8.81 ± 0.03	616
C <sub>4</sub> H <sub>9</sub> NO	Morpholine	(8.2)	841
C <sub>4</sub> H <sub>10</sub>	Butane	10.53 ± 0.10	890
C <sub>4</sub> H <sub>10</sub>	Isobutane	(10.57)	886
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	9.99 ± 0.05	689
C <sub>4</sub> H <sub>10</sub> O	2-Butanol	9.88 ± 0.03	658
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	10.02 ± 0.04	683
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	9.90 ± 0.02	642
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	9.51 ± 0.03	666
C <sub>4</sub> H <sub>10</sub> O	Methyl propyl ether	9.41 ± 0.07	670
C <sub>4</sub> H <sub>10</sub> O	Isopropyl methyl ether	9.45 ± 0.04	661
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol monoethyl ether	(9.6)	529
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	Ethylene glycol dimethyl ether	(9.3)	558

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	9.14 ± 0.01	794
C <sub>4</sub> H <sub>10</sub> S	2-Butanethiol	(9.10)	781
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-1-propanethiol	(9.12)	783
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-2-propanethiol	(9.03)	762
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	(8.43)	730
C <sub>4</sub> H <sub>10</sub> S	Methyl propyl sulfide	(8.8)	767
C <sub>4</sub> H <sub>10</sub> S	Isopropyl methyl sulfide	(8.7)	749
C <sub>4</sub> H <sub>10</sub> S <sub>2</sub>	Diethyl disulfide	(8.27)	724
C <sub>4</sub> H <sub>11</sub> N	Butylamine	8.7 ± 0.1	748
C <sub>4</sub> H <sub>11</sub> N	sec-Butylamine	8.46 ± 0.1	711
C <sub>4</sub> H <sub>11</sub> N	tert-Butylamine	8.46 ± 0.1	695
C <sub>4</sub> H <sub>11</sub> N	Isobutylamine	8.50 ± 0.1	721
C <sub>4</sub> H <sub>11</sub> N	Diethylamine	7.85 ± 0.1	684
C <sub>4</sub> H <sub>12</sub> Si	Tetramethylsilane	9.80 ± 0.04	713
C <sub>4</sub> H <sub>12</sub> Sn	Tetramethylstannane	8.89 ± 0.05	837
C <sub>4</sub> NiO <sub>4</sub>	Nickel carbonyl	8.27 ± 0.04	200
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural	9.22 ± 0.01	739
C <sub>5</sub> H <sub>5</sub> N	Pyridine	9.25	1031
C <sub>5</sub> H <sub>6</sub>	1-Penten-3-yne	9.00 ± 0.01	1119
C <sub>5</sub> H <sub>6</sub>	cis-3-Penten-1-yne	9.14 ± 0.04	1137
C <sub>5</sub> H <sub>6</sub>	trans-3-Penten-1-yne	9.05 ± 0.01	1128
C <sub>5</sub> H <sub>6</sub>	2-Methyl-1-buten-3-yne	9.25 ± 0.02	1152
C <sub>5</sub> H <sub>6</sub>	1,3-Cyclopentadiene	8.55 ± 0.02	955
C <sub>5</sub> H <sub>6</sub> O	2-Methylfuran	8.38 ± 0.02	729
C <sub>5</sub> H <sub>6</sub> O	3-Methylfuran	(8.64)	763
C <sub>5</sub> H <sub>6</sub> S	2-Methylthiophene	(8.14)	867
C <sub>5</sub> H <sub>6</sub> S	3-Methylthiophene	(8.40)	893
C <sub>5</sub> H <sub>8</sub>	cis-1,3-Pentadiene	8.63 ± 0.03	914
C <sub>5</sub> H <sub>8</sub>	trans-1,3-Pentadiene	8.59 ± 0.02	905
C <sub>5</sub> H <sub>8</sub>	1,4-Pentadiene	9.60 ± 0.02	1032
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	8.84 ± 0.01	928
C <sub>5</sub> H <sub>8</sub>	1-Pentyne	10.10 ± 0.01	1119
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	9.01 ± 0.01	905
C <sub>5</sub> H <sub>8</sub>	Spiropentane	(9.26)	1078
C <sub>5</sub> H <sub>8</sub> O	Cyclopropyl methyl ketone	(≤ 9.46)	796
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone	9.26 ± 0.01	701
C <sub>5</sub> H <sub>8</sub> O	3,4-Dihydro-2H-pyran	8.35 ± 0.01	681
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acrylate	(≤ 10.3)	617
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	(9.7)	589
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione	8.85 ± 0.01	469
C <sub>5</sub> H <sub>9</sub> NO	N-Methyl-2-pyrrolidone	(≤ 9.17)	≤ 676
C <sub>5</sub> H <sub>10</sub>	1-Pentene	9.51 ± 0.01	896
C <sub>5</sub> H <sub>10</sub>	cis-2-Pentene	9.01 ± 0.03	843
C <sub>5</sub> H <sub>10</sub>	trans-2-Pentene	9.04 ± 0.01	841
C <sub>5</sub> H <sub>10</sub>	2-Methyl-1-butene	9.12 ± 0.01	844
C <sub>5</sub> H <sub>10</sub>	3-Methyl-1-butene	9.52 ± 0.01	891
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	8.69 ± 0.01	796
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	(10.33 ± 0.15)	918
C <sub>5</sub> H <sub>10</sub> O	2,2-Dimethylpropanal	9.51 ± 0.01	675
C <sub>5</sub> H <sub>10</sub> O	Cyclopentanol	(9.72)	695
C <sub>5</sub> H <sub>10</sub> O	Pentanal	9.74 ± 0.04	709
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	9.38 ± 0.01	646
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	9.31 ± 0.01	640
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone	9.30 ± 0.01	635
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran	9.25 ± 0.01	670
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid	(≤ 10.53)	≤ 527
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	3-Methylbutanoic acid	(≤ 10.51)	≤ 499
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	10.52 ± 0.02	584
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	(≤ 9.92)	501
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate	9.99 ± 0.03	482

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	(10.00)	500
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate	(10.07)	520
C <sub>5</sub> H <sub>10</sub> S	Thiacyclohexane	(8.2)	728
C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane	10.10 ± 0.01	846
C <sub>5</sub> H <sub>11</sub> I	1-Iodopentane	9.20 ± 0.01	817
C <sub>5</sub> H <sub>11</sub> N	Piperidine	8.03 ± 0.11	726
C <sub>5</sub> H <sub>11</sub> N	<i>N</i> -Methylpyrrolidine	≤ 8.41 ± 0.02	≤ 809
C <sub>5</sub> H <sub>12</sub>	Pentane	10.28 ± 0.10	845
C <sub>5</sub> H <sub>12</sub>	Isopentane	10.32 ± 0.05	843
C <sub>5</sub> H <sub>12</sub>	Neopentane	(≤ 10.2)	≤ 818
C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	(10.00)	668
C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	(9.78)	630
C <sub>5</sub> H <sub>12</sub> O	3-Pentanol	9.78	628
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-1-butanol	(9.86)	649
C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol	(9.8)	615
C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol	(9.88 ± 0.13)	637
C <sub>5</sub> H <sub>12</sub> O	Butyl methyl ether	(9.4 ± 0.1)	648
C <sub>5</sub> H <sub>12</sub> O	Methyl <i>tert</i> -butyl ether	(9.24)	608
C <sub>5</sub> H <sub>12</sub> O	Ethyl propyl ether	(9.45)	640
C <sub>5</sub> H <sub>12</sub> S	<i>tert</i> -Butyl methyl sulfide	(8.38)	687
C <sub>5</sub> H <sub>12</sub> S	Ethyl propyl sulfide	(8.50)	716
C <sub>5</sub> H <sub>12</sub> S	Ethyl isopropyl sulfide	(8.35)	689
C <sub>6</sub> BrF <sub>5</sub>	Bromopentafluorobenzene	(9.67)	222
C <sub>6</sub> ClF <sub>5</sub>	Chloropentafluorobenzene	(9.72)	126
C <sub>6</sub> Cl <sub>6</sub>	Hexachlorobenzene	(8.98)	822
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene	9.89 ± 0.04	8
C <sub>6</sub> F <sub>12</sub>	Perfluorocyclohexane	(13.2)	-1095
C <sub>6</sub> HF <sub>5</sub>	Pentafluorobenzene	(9.63)	122
C <sub>6</sub> HF <sub>5</sub> O	Pentafluorophenol	(9.20)	-71
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,4-Tetrafluorobenzene	(9.53)	284
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,5-Tetrafluorobenzene	(9.53)	263
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,4,5-Tetrafluorobenzene	(9.35)	254
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,4-Trichlorobenzene	(9.04)	880
C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,3,5-Trichlorobenzene	9.32 ± 0.02	899
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-3-nitrobenzene	(9.92 ± 0.1)	995
C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-4-nitrobenzene	(9.96 ± 0.1)	999
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene	9.06 ± 0.02	907
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene	9.10 ± 0.02	906
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene	8.92 ± 0.02	885
C <sub>6</sub> H <sub>4</sub> FNO <sub>2</sub>	1-Fluoro-4-nitrobenzene	(9.90)	826
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>o</i> -Difluorobenzene	9.29 ± 0.01	602
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>m</i> -Difluorobenzene	9.33 ± 0.01	591
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>p</i> -Difluorobenzene	9.1589 ± 0.0003	577
C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	<i>p</i> -Benzoquinone	10.01 ± 0.06	844
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	9.00 ± 0.02	971
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	9.07 ± 0.02	930
C <sub>6</sub> H <sub>5</sub> ClO	<i>m</i> -Chlorophenol	8.655 ± 0.001	680
C <sub>6</sub> H <sub>5</sub> ClO	<i>p</i> -Chlorophenol	(≤ 8.69)	≤ 692
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	9.20 ± 0.01	772
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	8.685	1003
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene	9.86 ± 0.02	1019
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>o</i> -Nitrophenol	(9.1)	782
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>m</i> -Nitrophenol	(9.0)	755
C <sub>6</sub> H <sub>5</sub> NO <sub>3</sub>	<i>p</i> -Nitrophenol	(9.1)	761
C <sub>6</sub> H <sub>6</sub>	Benzene	9.24378 ± 0.00007	975
C <sub>6</sub> H <sub>6</sub>	Fulvene	(8.36)	1031
C <sub>6</sub> H <sub>6</sub> ClN	<i>o</i> -Chloroaniline	(8.50)	883
C <sub>6</sub> H <sub>6</sub> ClN	<i>m</i> -Chloroaniline	(8.09)	835
C <sub>6</sub> H <sub>6</sub> ClN	<i>p</i> -Chloroaniline	(≤ 8.18)	≤ 844
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>o</i> -Nitroaniline	(8.27)	861

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>m</i> -Nitroaniline	(8.31)	865
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>p</i> -Nitroaniline	(8.34)	859
C <sub>6</sub> H <sub>6</sub> O	Phenol	8.49 ± 0.02	723
C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	<i>p</i> -Hydroquinone	7.94 ± 0.01	503
C <sub>6</sub> H <sub>6</sub> S	Benzenethiol	(8.32)	915
C <sub>6</sub> H <sub>7</sub> N	Aniline	7.720 ± 0.002	832
C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	(9.02)	970
C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine	(9.04)	979
C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	(9.04)	976
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>o</i> -Phenylenediamine	(7.2)	787
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>m</i> -Phenylenediamine	(7.14)	777
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	<i>p</i> -Phenylenediamine	(6.87 ± 0.05)	759
C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene	9.27 ± 0.05	978
C <sub>6</sub> H <sub>10</sub>	1-Hexyne	10.03 ± 0.05	1089
C <sub>6</sub> H <sub>10</sub>	3,3-Dimethyl-1-butyne	9.90 ± 0.04	1060
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	8.945 ± 0.01	859
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	9.14 ± 0.01	656
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide	9.10 ± 0.01	694
C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	Diethyl oxalate	(9.8)	205
C <sub>6</sub> H <sub>11</sub> NO	Caprolactam	(9.07 ± 0.02)	629
C <sub>6</sub> H <sub>12</sub>	1-Hexene	9.44 ± 0.04	869
C <sub>6</sub> H <sub>12</sub>	<i>cis</i> -2-Hexene	(8.97 ± 0.01)	818
C <sub>6</sub> H <sub>12</sub>	<i>trans</i> -2-Hexene	(8.97 ± 0.01)	814
C <sub>6</sub> H <sub>12</sub>	2-Methyl-1-pentene	(9.08 ± 0.01)	817
C <sub>6</sub> H <sub>12</sub>	4-Methyl-1-pentene	9.45 ± 0.01	862
C <sub>6</sub> H <sub>12</sub>	2-Methyl-2-pentene	(8.58)	761
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>cis</i> -2-pentene	8.98 ± 0.01	809
C <sub>6</sub> H <sub>12</sub>	4-Methyl- <i>trans</i> -2-pentene	(8.97 ± 0.01)	804
C <sub>6</sub> H <sub>12</sub>	2-Ethyl-1-butene	(9.06 ± 0.02)	818
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-1-butene	(9.07 ± 0.01)	812
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-2-butene	8.27 ± 0.01	729
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	9.86 ± 0.03	828
C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	(9.85)	845
C <sub>6</sub> H <sub>12</sub> O	Hexanal	9.72 ± 0.05	691
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	9.3 ± 0.1	626
C <sub>6</sub> H <sub>12</sub> O	3-Hexanone	9.12 ± 0.02	600
C <sub>6</sub> H <sub>12</sub> O	3-Methyl-2-pentanone	9.21 ± 0.01	600
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone	9.30 ± 0.01	609
C <sub>6</sub> H <sub>12</sub> O	2-Methyl-3-pentanone	9.10 ± 0.01	592
C <sub>6</sub> H <sub>12</sub> O	3,3-Dimethyl-2-butanone	9.12 ± 0.02	589
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol	(9.75)	651
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid	≤ 10.12	≤ 463
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	(9.92 ± .05)	471
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>sec</i> -Butyl acetate	9.90	453
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 2,2-dimethylpropanoate	(9.90 ± 0.04)	466
C <sub>6</sub> H <sub>13</sub> I	1-Iodohexane	9.179	794
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	(8.86)	750
C <sub>6</sub> H <sub>14</sub>	Hexane	10.13	810
C <sub>6</sub> H <sub>14</sub>	2-Methylpentane	(10.12)	802
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	(10.08)	801
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane	(10.06)	787
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	(10.02)	791
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	(9.89)	639
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol	(9.80 ± 0.03)	611
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol	(9.63 ± 0.03)	599
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	(9.27)	602
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether	9.20 ± 0.05	569
C <sub>6</sub> H <sub>14</sub> O	Butyl ethyl ether	(9.36)	610
C <sub>6</sub> H <sub>14</sub> O	Methyl pentyl ether	(≤ 9.67)	≤ 657
C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1,1-Diethoxyethane	(9.2)	434

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol dimethyl ether	≤ 9.8	≤ 448
C <sub>6</sub> H <sub>14</sub> S	Dipropyl sulfide	8.30 ± 0.02	676
C <sub>6</sub> H <sub>14</sub> S	Diisopropyl sulfide	(8.2 ± 0.2)	649
C <sub>6</sub> H <sub>15</sub> N	Hexylamine	(8.63 ± 0.05)	699
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine	(7.84 ± 0.02)	641
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine	(7.73 ± 0.03)	602
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	(7.50 ± 0.02)	631
C <sub>6</sub> H <sub>15</sub> NO <sub>3</sub>	Triethanolamine	(7.9)	206
C <sub>7</sub> H <sub>3</sub> F <sub>5</sub>	2,3,4,5,6-Pentafluorotoluene	(9.4)	64
C <sub>7</sub> H <sub>5</sub> ClO	Benzoyl chloride	(9.53)	815
C <sub>7</sub> H <sub>5</sub> Cl <sub>3</sub>	(Trichloromethyl)benzene	(≤ 9.60)	≤ 914
C <sub>7</sub> H <sub>5</sub> F <sub>3</sub>	(Trifluoromethyl)benzene	9.685 ± 0.005	335
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile	9.70 ± 0.01	1154
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	9.49 ± 0.02	878
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Benzoic acid	(9.3)	604
C <sub>7</sub> H <sub>7</sub> Br	<i>p</i> -Bromotoluene	8.67 ± 0.02	908
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene	(8.7 ± 0.1)	856
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene	(8.83)	869
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene	(8.69)	855
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene	9.10 ± 0.02	897
C <sub>7</sub> H <sub>7</sub> F	<i>o</i> -Fluorotoluene	8.91 ± 0.01	709
C <sub>7</sub> H <sub>7</sub> F	<i>m</i> -Fluorotoluene	8.91 ± 0.01	709
C <sub>7</sub> H <sub>7</sub> F	<i>p</i> -Fluorotoluene	8.79 ± 0.01	701
C <sub>7</sub> H <sub>7</sub> NO	Benzamide	(9.25)	792
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>o</i> -Nitrotoluene	9.24	946
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>m</i> -Nitrotoluene	9.45 ± 0.1	941
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>p</i> -Nitrotoluene	9.46 ± 0.05	942
C <sub>7</sub> H <sub>8</sub>	Toluene	8.8276 ± 0.0006	901
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	(8.24)	670
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	8.29 ± 0.07	668
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	(8.3)	675
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	(8.3)	701
C <sub>7</sub> H <sub>8</sub> O	Anisole	8.22 ± 0.03	725
C <sub>7</sub> H <sub>9</sub> N	Benzylamine	(8.64)	917
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methylaniline	(7.44 ± 0.02)	772
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methylaniline	(7.50 ± 0.02)	778
C <sub>7</sub> H <sub>9</sub> N	<i>p</i> -Methylaniline	(7.24 ± 0.02)	753
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline	7.34 ± 0.04	792
C <sub>7</sub> H <sub>9</sub> N	2,3-Dimethylpyridine	(8.85 ± 0.02)	922
C <sub>7</sub> H <sub>9</sub> N	2,4-Dimethylpyridine	(8.85 ± 0.03)	918
C <sub>7</sub> H <sub>9</sub> N	2,5-Dimethylpyridine	(≤ 8.80 ± 0.05)	≤ 916
C <sub>7</sub> H <sub>9</sub> N	2,6-Dimethylpyridine	8.86 ± 0.03	913
C <sub>7</sub> H <sub>9</sub> N	3,4-Dimethylpyridine	(≤ 9.15)	≤ 953
C <sub>7</sub> H <sub>9</sub> N	3,5-Dimethylpyridine	(≤ 9.25)	≤ 965
C <sub>7</sub> H <sub>10</sub> O	Dicyclopropyl ketone	(9.1)	1041
C <sub>7</sub> H <sub>14</sub>	1-Heptene	9.34 ± 0.10	839
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -3-Heptene	(8.92)	790
C <sub>7</sub> H <sub>14</sub>	Cycloheptane	9.97	844
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	9.64	775
C <sub>7</sub> H <sub>14</sub>	<i>cis</i> -1,2-Dimethylcyclopentane	(9.92 ± 0.05)	828
C <sub>7</sub> H <sub>14</sub>	<i>trans</i> -1,2-Dimethylcyclopentane	9.7 ± 0.2	799
C <sub>7</sub> H <sub>14</sub> O	1-Heptanal	(9.65)	668
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone	9.28 ± 0.10	594
C <sub>7</sub> H <sub>14</sub> O	3-Heptanone	9.18 ± 0.08	589
C <sub>7</sub> H <sub>14</sub> O	4-Heptanone	9.10 ± 0.06	577
C <sub>7</sub> H <sub>14</sub> O	5-Methyl-2-hexanone	(9.28)	586
C <sub>7</sub> H <sub>14</sub> O	2,4-Dimethyl-3-pentanone	8.95 ± 0.01	552
C <sub>7</sub> H <sub>14</sub> O	1-Methylcyclohexanol	(9.8 ± 0.2)	586
C <sub>7</sub> H <sub>16</sub>	Heptane	9.93 ± 0.10	771
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	(9.84)	614

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>7</sub> H <sub>16</sub> O	2-Heptanol	(9.70)	580
C <sub>7</sub> H <sub>16</sub> O	3-Heptanol	(9.68)	578
C <sub>7</sub> H <sub>16</sub> O	4-Heptanol	(9.61)	572
C <sub>7</sub> H <sub>16</sub> O	Ethyl pentyl ether	( $\leq 9.49$ )	$\leq 602$
C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	Phthalic anhydride	(10.1)	603
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Isophthalic acid	(9.98)	268
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	Terephthalic acid	(9.86)	232
C <sub>8</sub> H <sub>7</sub> N	2-Methylbenzonitrile	( $\leq 9.38$ )	1085
C <sub>8</sub> H <sub>7</sub> N	3-Methylbenzonitrile	( $\leq 9.34$ )	1085
C <sub>8</sub> H <sub>7</sub> N	4-Methylbenzonitrile	9.32 $\pm$ 0.02	1083
C <sub>8</sub> H <sub>7</sub> N	Indole	7.7602 $\pm$ 0.0006	908
C <sub>8</sub> H <sub>8</sub>	Styrene	8.464 $\pm$ 0.001	964
C <sub>8</sub> H <sub>8</sub> O	<i>p</i> -Tolualdehyde	(9.33)	825
C <sub>8</sub> H <sub>8</sub> O	Acetophenone	9.29 $\pm$ 0.03	810
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>o</i> -Toluic acid	(9.1)	558
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>m</i> -Toluic acid	(9.43)	579
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>p</i> -Toluic acid	(9.23)	560
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzeneacetic acid	(8.26)	479
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate	9.32 $\pm$ 0.03	611
C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	8.77 $\pm$ 0.01	876
C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	8.56 $\pm$ 0.01	844
C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	8.56 $\pm$ 0.01	843
C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	8.44 $\pm$ 0.01	832
C <sub>8</sub> H <sub>10</sub> O	<i>p</i> -Ethylphenol	(7.84)	613
C <sub>8</sub> H <sub>10</sub> O	2,3-Xylenol	(8.26)	640
C <sub>8</sub> H <sub>10</sub> O	2,4-Xylenol	(8.0)	609
C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	(8.05)	615
C <sub>8</sub> H <sub>10</sub> O	3,4-Xylenol	(8.09)	624
C <sub>8</sub> H <sub>10</sub> O	Phenetole	(8.13)	683
C <sub>8</sub> H <sub>11</sub> N	2,4,6-Trimethylpyridine	( $\leq 8.9$ )	$\leq 880$
C <sub>8</sub> H <sub>11</sub> N	<i>N</i> -Ethylaniline	( $\leq 7.67$ )	$\leq 794$
C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline	7.12 $\pm$ 0.02	787
C <sub>8</sub> H <sub>14</sub>	1-Octyne	(9.95 $\pm$ 0.02)	1040
C <sub>8</sub> H <sub>14</sub>	2-Octyne	9.31 $\pm$ 0.01	961
C <sub>8</sub> H <sub>14</sub>	3-Octyne	9.22 $\pm$ 0.01	952
C <sub>8</sub> H <sub>14</sub>	4-Octyne	9.20 $\pm$ 0.01	946
C <sub>8</sub> H <sub>16</sub>	1-Octene	9.43 $\pm$ 0.01	829
C <sub>8</sub> H <sub>16</sub>	Cyclooctane	9.75 $\pm$ 0.05	816
C <sub>8</sub> H <sub>16</sub>	Ethylcyclohexane	(9.54)	748
C <sub>8</sub> H <sub>16</sub>	1,1-Dimethylcyclohexane	(9.42)	728
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,2-Dimethylcyclohexane	(<9.78)	772
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,2-Dimethylcyclohexane	9.41	728
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,3-Dimethylcyclohexane	(<9.98)	778
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,3-Dimethylcyclohexane	9.53	743
C <sub>8</sub> H <sub>16</sub>	<i>cis</i> -1,4-Dimethylcyclohexane	(<9.93)	782
C <sub>8</sub> H <sub>16</sub>	<i>trans</i> -1,4-Dimethylcyclohexane	(9.56)	738
C <sub>8</sub> H <sub>16</sub>	Propylcyclopentane	(9.34)	753
C <sub>8</sub> H <sub>16</sub> O	2,2,4-Trimethyl-3-pentanone	(8.80)	511
C <sub>8</sub> H <sub>18</sub>	Octane	9.80 $\pm$ 0.10	737
C <sub>8</sub> H <sub>18</sub>	2-Methylheptane	(9.84)	734
C <sub>8</sub> H <sub>18</sub>	2,2,4-Trimethylpentane	(9.86)	713
C <sub>8</sub> H <sub>18</sub>	2,2,3,3-Tetramethylbutane	9.8	720
C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether	(9.28)	s 560
C <sub>8</sub> H <sub>18</sub> O	Di- <i>sec</i> -butyl ether	(9.11)	511
C <sub>8</sub> H <sub>18</sub> O	Di- <i>tert</i> -butyl ether	8.88 $\pm$ 0.07	493
C <sub>8</sub> H <sub>18</sub> S	Dibutyl sulfide	(8.2)	624
C <sub>8</sub> H <sub>18</sub> S	Di- <i>tert</i> -butyl sulfide	(8.0)	583
C <sub>8</sub> H <sub>18</sub> S	Diisobutyl sulfide	(8.34)	625
C <sub>8</sub> H <sub>19</sub> N	Dibutylamine	(7.69)	586
C <sub>8</sub> H <sub>19</sub> N	Diisobutylamine	(7.8)	574

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>8</sub> H <sub>20</sub> Si	Tetraethylsilane	(8.9)	595
C <sub>9</sub> H <sub>7</sub> N	Quinoline	8.62 ± 0.01	1041
C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	8.53 ± 0.03	1032
C <sub>9</sub> H <sub>8</sub>	Indene	8.14 ± 0.01	949
C <sub>9</sub> H <sub>10</sub>	<i>o</i> -Methylstyrene	(8.20)	908
C <sub>9</sub> H <sub>10</sub>	<i>m</i> -Methylstyrene	(8.15)	899
C <sub>9</sub> H <sub>10</sub>	<i>p</i> -Methylstyrene	(8.1)	895
C <sub>9</sub> H <sub>10</sub>	Cyclopropylbenzene	(8.35)	956
C <sub>9</sub> H <sub>10</sub>	Indan	(8.3)	864
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate	(8.9)	537
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	8.713 ± 0.010	848
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	8.73 ± 0.01	847
C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene	8.42 ± 0.02	803
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene	8.27 ± 0.01	784
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	8.41 ± 0.01	796
C <sub>9</sub> H <sub>13</sub> N	<i>N,N</i> -Dimethyl- <i>o</i> -toluidine	7.40 ± 0.02	814
C <sub>9</sub> H <sub>14</sub> O	Isophorone	(≤ 9.07)	≤ 670
C <sub>9</sub> H <sub>18</sub>	Butylcyclopentane	(9.95)	793
C <sub>9</sub> H <sub>18</sub>	Propylcyclohexane	(9.46)	720
C <sub>9</sub> H <sub>18</sub>	Isopropylcyclohexane	(9.33)	704
C <sub>9</sub> H <sub>18</sub> O	2-Nonanone	(9.16)	545
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone	(9.07)	530
C <sub>9</sub> H <sub>18</sub> O	2,6-Dimethyl-4-heptanone	9.01 ± 0.06	512
C <sub>9</sub> H <sub>20</sub>	Nonane	9.71 ± 0.10	709
C <sub>10</sub> F <sub>8</sub>	Perfluoronaphthalene	8.85	-368
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene	8.08 ± 0.03	955
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene	(8.13)	906
C <sub>10</sub> H <sub>8</sub>	Naphthalene	8.1442 ± 0.0009	936
C <sub>10</sub> H <sub>8</sub>	Azulene	7.38 ± 0.05	1001
C <sub>10</sub> H <sub>8</sub> O	1-Naphthol	7.76 ± 0.03	719
C <sub>10</sub> H <sub>8</sub> O	2-Naphthol	7.87 ± 0.06	729
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl phthalate	(9.64 ± 0.07)	277
C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	8.46 ± 0.02	841
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	8.69 ± 0.02	826
C <sub>10</sub> H <sub>14</sub>	<i>sec</i> -Butylbenzene	8.68 ± 0.02	820
C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	8.68 ± 0.05	816
C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	8.69 ± 0.02	817
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Cymene	(8.29)	771
C <sub>10</sub> H <sub>14</sub>	<i>o</i> -Diethylbenzene	(≤ 8.51)	≤ 804
C <sub>10</sub> H <sub>14</sub>	<i>m</i> -Diethylbenzene	(8.49)	798
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Diethylbenzene	(8.40)	790
C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	8.04 ± 0.02	730
C <sub>10</sub> H <sub>14</sub> O	<i>p</i> - <i>tert</i> -Butylphenol	(7.8)	552
C <sub>10</sub> H <sub>16</sub>	$\alpha$ -Pinene	(8.07)	808
C <sub>10</sub> H <sub>16</sub> O	Camphor	(8.76)	577
C <sub>10</sub> H <sub>18</sub>	<i>cis</i> -Decahydronaphthalene	9.36 ± 0.04	734
C <sub>10</sub> H <sub>18</sub>	<i>trans</i> -Decahydronaphthalene	9.34 ± 0.04	720
C <sub>10</sub> H <sub>20</sub>	1-Decene	9.42 ± 0.05	786
C <sub>10</sub> H <sub>20</sub>	Butylcyclohexane	(9.41)	695
C <sub>10</sub> H <sub>22</sub>	Decane	(9.65)	682
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	7.97 ± 0.03	882
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	7.91 ± 0.08	877
C <sub>11</sub> H <sub>16</sub>	<i>p</i> - <i>tert</i> -Butyltoluene	(8.12)	730
C <sub>11</sub> H <sub>24</sub>	Undecane	(9.56)	650
C <sub>11</sub> H <sub>24</sub>	2-Methyldecane	(9.7)	658
C <sub>12</sub> H <sub>8</sub>	Acenaphthylene	(8.22)	1053
C <sub>12</sub> H <sub>9</sub> N	Carbazole	(7.57)	961
C <sub>12</sub> H <sub>10</sub>	Acenaphthene	7.75 ± 0.07	903
C <sub>12</sub> H <sub>10</sub>	Biphenyl	8.23 ± 0.10	977
C <sub>12</sub> H <sub>10</sub> N <sub>2</sub> O	<i>trans</i> -Azoxybenzene	(8.1)	1123

Mol. form.	Name	IP/eV	$\Delta_f H_{\text{ion}}$ kJ/mol
C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether	(8.09)	766
C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	7.16 ± 0.04	908
C <sub>12</sub> H <sub>18</sub>	5,7-Dodecadiyne	(8.67)	1079
C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	7.85 ± 0.01	670
C <sub>12</sub> H <sub>22</sub>	Cyclohexylcyclohexane	(9.41)	690
C <sub>12</sub> H <sub>27</sub> N	Tributylamine	(7.4)	492
C <sub>13</sub> H <sub>10</sub>	9 <i>H</i> -Fluorene	7.91 ± 0.02	952
C <sub>13</sub> H <sub>10</sub> O	Benzophenone	9.08 ± 0.05	926
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	(8.55)	963
C <sub>14</sub> H <sub>10</sub>	Anthracene	7.439 ± 0.006	948
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	7.8914 ± 0.0006	966
C <sub>14</sub> H <sub>10</sub>	Diphenylacetylene	7.94 ± 0.03	1168
C <sub>14</sub> H <sub>12</sub>	<i>cis</i> -Stilbene	(7.80)	1005
C <sub>14</sub> H <sub>12</sub>	<i>trans</i> -Stilbene	7.656 ± 0.001	973
C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	8.9 ± 0.1	1002
C <sub>16</sub> H <sub>10</sub>	Fluoranthene	7.9 ± 0.1	1052
C <sub>16</sub> H <sub>10</sub>	Pyrene	7.4256 ± 0.0006	935
C <sub>18</sub> H <sub>12</sub>	Chrysene	7.60 ± 0.01	1017
C <sub>18</sub> H <sub>14</sub>	<i>o</i> -Terphenyl	(7.99)	1056
C <sub>18</sub> H <sub>14</sub>	<i>m</i> -Terphenyl	(8.01)	1057
C <sub>18</sub> H <sub>14</sub>	<i>p</i> -Terphenyl	7.80 ± 0.03	1037
C <sub>20</sub> H <sub>12</sub>	Perylene	6.960 ± 0.001	981
C <sub>24</sub> H <sub>12</sub>	Coronene	7.29 ± 0.01	1026



## X-RAY ATOMIC ENERGY LEVELS

The energy levels in this tables are the values recommended by Bearden and Burr on the basis of a thorough review of the literature on x-ray wavelengths and related data. All values are in electron volts (eV). Values in parentheses are interpolated, and an asterisk \* indicates a level which is not resolved from the level above it. See Reference 1 for uncertainties in the levels and a complete description of how the recommended values were obtained.

### References

1. Bearden, J. A., and Burr, A. F., *Rev. Mod. Phys.*, 39, 125, 1967; also published as *X-Ray Wavelengths and X-Ray Atomic Energy Levels*, Natl. Stand. Ref. Data Sys. — Natl. Bur. Standards (U.S.), No. 14, 1967.
2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, pp. 7-158 to 7-167, McGraw-Hill, New York, 1972.

<b>Level</b>	<b><sup>1</sup>H</b>	<b><sup>2</sup>He</b>	<b><sup>3</sup>Li</b>	<b><sup>4</sup>Be</b>	<b><sup>5</sup>B</b>	<b><sup>6</sup>C</b>	<b><sup>7</sup>N</b>	<b><sup>8</sup>O</b>
K	13.59811	24.58678	54.75	111.0	188.0	283.8	401.6	532.0
L <sub>I</sub>								23.7
L <sub>II,III</sub>					4.7	6.4	9.2	7.1
<b>Level</b>	<b><sup>9</sup>F</b>	<b><sup>10</sup>Ne</b>	<b><sup>11</sup>Na</b>	<b><sup>12</sup>Mg</b>	<b><sup>13</sup>Al</b>	<b><sup>14</sup>Si</b>	<b><sup>15</sup>P</b>	<b><sup>16</sup>S</b>
K	685.4	866.9	1072.1	1305.0	1559.6	1838.9	2145.5	2472.0
L <sub>I</sub>	(31)	(45)	63.3	89.4	117.7	148.7	189.3	229.2
L <sub>II,III</sub>	8.6	18.3	31.1	51.4	73.1	99.2	132.2	164.8
<b>Level</b>	<b><sup>17</sup>Cl</b>	<b><sup>18</sup>Ar</b>	<b><sup>19</sup>K</b>	<b><sup>20</sup>Ca</b>	<b><sup>21</sup>Sc</b>	<b><sup>22</sup>Ti</b>	<b><sup>23</sup>V</b>	<b><sup>24</sup>Cr</b>
K	2822.4	3202.9	3607.4	4038.1	4492.8	4966.4	5465.1	5989.2
L <sub>I</sub>	270.2	320	377.1	437.8	500.4	563.7	628.2	694.6
L <sub>II</sub>	201.6	247.3	296.3	350.0	406.7	461.5	520.5	583.7
L <sub>III</sub>	200.0	245.2	293.6	346.4	402.2	455.5	512.9	574.5
M <sub>I</sub>	17.5	25.3	33.9	43.7	53.8	60.3	66.5	74.1
M <sub>II,III</sub>	6.8	12.4	17.8	25.4	32.3	34.6	37.8	42.5
M <sub>IV</sub>					6.6	3.7	2.2	2.3
<b>Level</b>	<b><sup>25</sup>Mn</b>	<b><sup>26</sup>Fe</b>	<b><sup>27</sup>Co</b>	<b><sup>28</sup>Ni</b>	<b><sup>29</sup>Cu</b>	<b><sup>30</sup>Zn</b>	<b><sup>31</sup>Ga</b>	<b><sup>32</sup>Ge</b>
K	6539.0	7112.0	7708.9	8332.8	8978.9	9658.6	10367.1	11103.1
L <sub>I</sub>	769.0	846.1	925.6	1008.1	1096.1	1193.6	1297.7	1414.3
L <sub>II</sub>	651.4	721.1	793.6	871.9	951.0	1042.8	1142.3	1247.8
L <sub>III</sub>	640.3	708.1	778.6	854.7	931.1	1019.7	1115.4	1216.7
M <sub>I</sub>	83.9	92.9	100.7	111.8	119.8	135.9	158.1	180.0
M <sub>II</sub>	48.6	54.0	59.5	68.1	73.6	86.6	106.8	127.9
M <sub>III</sub>	48.6*	54.0*	59.5*	68.1*	73.6*	86.6*	102.9	120.8
M <sub>IV</sub>	3.3	3.6	2.9	3.6	1.6	8.1	17.4	28.7
<b>Level</b>	<b><sup>33</sup>As</b>	<b><sup>34</sup>Se</b>	<b><sup>35</sup>Br</b>	<b><sup>36</sup>Kr</b>	<b><sup>37</sup>Rb</b>	<b><sup>38</sup>Sr</b>	<b><sup>39</sup>Y</b>	<b><sup>40</sup>Zr</b>
K	11866.7	12657.8	13473.7	14325.6	15199.7	16104.6	17038.4	17997.6
L <sub>I</sub>	1526.5	1653.9	1782.0	1921.0	2065.1	2216.3	2372.5	2531.6
L <sub>II</sub>	1358.6	1476.2	1596.0	1727.2	1863.9	2006.8	2155.5	2306.7
L <sub>III</sub>	1323.1	1435.8	1549.9	1674.9	1804.4	1939.6	2080.0	2222.3
M <sub>I</sub>	203.5	231.5	256.5		322.1	357.5	393.6	430.3
M <sub>II</sub>	146.4	168.2	189.3	222.7	247.4	279.8	312.4	344.2
M <sub>III</sub>	140.5	161.9	181.5	213.8	238.5	269.1	300.3	330.5
M <sub>IV</sub>	41.2	56.7	70.1	88.9	111.8	135.0	159.6	182.4
M <sub>V</sub>	41.2*	56.7*	69.0	88.9*	110.3	133.1	157.4	180.0
N <sub>I</sub>			27.3	24.0	29.3	37.7	45.4	51.3
N <sub>II</sub>	2.5	5.6	5.2	10.6	14.8	19.9	25.6	28.7
N <sub>III</sub>	2.5*	5.6*	4.6	10.6*	14.0	19.9*	25.6*	28.7*
<b>Level</b>	<b><sup>41</sup>Nb</b>	<b><sup>42</sup>Mo</b>	<b><sup>43</sup>Tc</b>	<b><sup>44</sup>Ru</b>	<b><sup>45</sup>Rh</b>	<b><sup>46</sup>Pd</b>	<b><sup>47</sup>Ag</b>	<b><sup>48</sup>Cd</b>
K	18985.6	19999.5	21044.0	22117.2	23219.9	24350.3	25514.0	26711.2
L <sub>I</sub>	2697.7	2865.5	3042.5	3224.0	3411.9	3604.3	3805.8	4018.0
L <sub>II</sub>	2464.7	2625.1	2793.2	2966.9	3146.1	3330.3	3523.7	3727.0
L <sub>III</sub>	2370.5	2520.2	2676.9	2837.9	3003.8	3173.3	3351.1	3537.5
M <sub>I</sub>	468.4	504.6		585.0	627.1	669.9	717.5	770.2
M <sub>II</sub>	378.4	409.7	444.9	482.8	521.0	559.1	602.4	650.7
M <sub>III</sub>	363.0	392.3	425.0	460.6	496.2	531.5	571.4	616.5
M <sub>IV</sub>	207.4	230.3	256.4	283.6	311.7	340.0	372.8	410.5

<b>Level</b>	<b><sup>41</sup>Nb</b>	<b><sup>42</sup>Mo</b>	<b><sup>43</sup>Tc</b>	<b><sup>44</sup>Ru</b>	<b><sup>45</sup>Rh</b>	<b><sup>46</sup>Pd</b>	<b><sup>47</sup>Ag</b>	<b><sup>48</sup>Cd</b>
M <sub>V</sub>	204.6	227.0	252.9	279.4	307.0	334.7	366.7	403.7
N <sub>I</sub>	58.1	61.8		74.9	81.0	86.4	95.2	107.6
N <sub>II</sub>	33.9	34.8	38.9	43.1	47.9	51.1	62.6	66.9
N <sub>III</sub>	33.9*	34.8*	38.9*	43.1*	47.9*	51.1*	55.9	66.9*
N <sub>IV</sub>	3.2	1.8		2.0	2.5	1.5	3.3	9.3
<b>Level</b>	<b><sup>49</sup>In</b>	<b><sup>50</sup>Sn</b>	<b><sup>51</sup>Sb</b>	<b><sup>52</sup>Te</b>	<b><sup>53</sup>I</b>	<b><sup>54</sup>Xe</b>	<b><sup>55</sup>Cs</b>	<b><sup>56</sup>Ba</b>
K	27939.9	29200.1	30491.2	31813.8	33169.4	34561.4	35984.6	37440.6
L <sub>I</sub>	4237.5	4464.7	4698.3	4939.2	5188.1	5452.8	5714.3	5988.8
L <sub>II</sub>	3938.0	4156.1	4380.4	4612.0	4852.1	5103.7	5359.4	5623.6
L <sub>III</sub>	3730.1	3928.8	4132.2	4341.4	4557.1	4782.2	5011.9	5247.0
M <sub>I</sub>	825.6	883.8	943.7	1006.0	1072.1		1217.1	1292.8
M <sub>II</sub>	702.2	756.4	811.9	869.7	930.5	999.0	1065.0	1136.7
M <sub>III</sub>	664.3	714.4	765.6	818.7	874.6	937.0	997.6	1062.2
M <sub>IV</sub>	450.8	493.3	536.9	582.5	631.3		739.5	796.1
M <sub>V</sub>	443.1	484.8	527.5	572.1	619.4	672.3	725.5	780.7
N <sub>I</sub>	121.9	136.5	152.0	168.3	186.4		230.8	253.0
N <sub>II</sub>	77.4	88.6	98.4	110.2	122.7	146.7	172.3	191.8
N <sub>III</sub>	77.4*	88.6*	98.4*	110.2*	122.7*	146.7*	161.6	179.7
N <sub>IV</sub>	16.2	23.9	31.4	39.8	49.6		78.8	92.5
N <sub>V</sub>	16.2*	23.9*	31.4*	39.8*	49.6*		76.5	89.9
O <sub>I</sub>	0.1	0.9	6.7	11.6	13.6		22.7	39.1
O <sub>II</sub>	0.8	1.1	2.1	2.3	3.3		13.1	16.6
O <sub>III</sub>	0.8*	1.1*	2.1*	2.3*	3.3*		11.4	14.6
<b>Level</b>	<b><sup>57</sup>La</b>	<b><sup>58</sup>Ce</b>	<b><sup>59</sup>Pr</b>	<b><sup>60</sup>Nd</b>	<b><sup>61</sup>Pm</b>	<b><sup>62</sup>Sm</b>	<b><sup>63</sup>Eu</b>	<b><sup>64</sup>Gd</b>
K	38924.6	40443.0	41990.6	43568.9	45184.0	46834.2	48519.0	50239.1
L <sub>I</sub>	6266.3	6548.8	6834.8	7126.0	7427.9	7736.8	8052.0	8375.6
L <sub>II</sub>	5890.6	6164.2	6440.4	6721.5	7012.8	7311.8	7617.1	7930.3
L <sub>III</sub>	5482.7	5723.4	5964.3	6207.9	6459.3	6716.2	6976.9	7242.8
M <sub>I</sub>	1361.3	1434.6	1511.0	1575.3		1722.8	1800.0	1880.8
M <sub>II</sub>	1204.4	1272.8	1337.4	1402.8	1471.4	1540.7	1613.9	1688.3
M <sub>III</sub>	1123.4	1185.4	1242.2	1297.4	1356.9	1419.8	1480.6	1544.0
M <sub>IV</sub>	848.5	901.3	951.1	999.9	1051.5	1106.0	1160.6	1217.2
M <sub>V</sub>	831.7	883.3	931.0	977.7	1026.9	1080.2	1130.9	1185.2
N <sub>I</sub>	270.4	289.6	304.5	315.2		345.7	360.2	375.8
N <sub>II</sub>	205.8	223.3	236.3	243.3	242	265.6	283.9	288.5
N <sub>III</sub>	191.4	207.2	217.6	224.6	242*	247.4	256.6	270.9
N <sub>IV</sub>	98.9	110.0	113.2	117.5	120.4	129.0	133.2	140.5
N <sub>VI,VII</sub>		0.1	2.0	1.5		5.5	0.0	0.1
O <sub>I</sub>	32.3	37.8	37.4	37.5		37.4	31.8	36.1
O <sub>II,III</sub>	14.4	19.8	22.3	21.1		21.3	22.0	20.3
<b>Level</b>	<b><sup>65</sup>Tb</b>	<b><sup>66</sup>Dy</b>	<b><sup>67</sup>Ho</b>	<b><sup>68</sup>Er</b>	<b><sup>69</sup>Tm</b>	<b><sup>70</sup>Yb</b>	<b><sup>71</sup>Lu</b>	<b><sup>72</sup>Hf</b>
K	51995.7	53788.5	55617.7	57485.5	59389.6	61332.3	63313.8	65350.8
L <sub>I</sub>	8708.0	9045.8	9394.2	9751.3	10115.7	10486.4	10870.4	11270.7
L <sub>II</sub>	8251.6	8580.6	8917.8	9264.3	9616.9	9978.2	10348.6	10739.4
L <sub>III</sub>	7514.0	7790.1	8071.1	8357.9	8648.0	8943.6	9244.1	9560.7
M <sub>I</sub>	1967.5	2046.8	2128.3	2206.5	2306.8	2398.1	2491.2	2600.9
M <sub>II</sub>	1767.7	1841.8	1922.8	2005.8	2089.8	2173.0	2263.5	2365.4
M <sub>III</sub>	1611.3	1675.6	1741.2	1811.8	1884.5	1949.8	2023.6	2107.6
M <sub>IV</sub>	1275.0	1332.5	1391.5	1453.3	1514.6	1576.3	1639.4	1716.4
M <sub>V</sub>	1241.2	1294.9	1351.4	1409.3	1467.7	1527.8	1588.5	1661.7
N <sub>I</sub>	397.9	416.3	435.7	449.1	471.7	487.2	506.2	538.1
N <sub>II</sub>	310.2	331.8	343.5	366.2	385.9	396.7	410.1	437.0
N <sub>III</sub>	385.0	292.9	306.6	320.0	336.6	343.5	359.3	380.4
N <sub>IV</sub>	147.0	154.2	161.0	176.7	179.6	198.1	204.8	223.8
N <sub>V</sub>	147.0*	154.2*	161.0*	167.6	179.6*	184.9	195.0	213.7
N <sub>VI,VII</sub>	2.6	4.2	3.7	4.3	5.3	6.3	6.9	17.1
O <sub>I</sub>	39.0	62.9	51.2	59.8	53.2	54.1	56.8	64.9
O <sub>II</sub>	25.4	26.3	20.3	29.4	32.3	23.4	28.0	38.1
O <sub>III</sub>	25.4*	26.3*	20.3*	29.4*	32.3*	23.4*	28.0*	30.6

Level	<sup>73</sup> Ta	<sup>74</sup> W	<sup>75</sup> Re	<sup>76</sup> Os	<sup>77</sup> Ir	<sup>78</sup> Pt	<sup>79</sup> Au	<sup>80</sup> Hg
K	67416.4	69525.0	71676.4	73870.8	76111.0	78394.8	80724.9	83102.3
L <sub>I</sub>	11681.5	12099.8	12526.7	12968.0	13418.5	13879.9	14352.8	14839.3
L <sub>II</sub>	11136.1	11544.0	11958.7	12385.0	12824.1	13272.6	13733.6	14208.7
L <sub>III</sub>	9881.1	10206.8	10535.3	10870.9	11215.2	11563.7	11918.7	12283.9
M <sub>I</sub>	2708.0	2819.6	2931.7	3048.5	3173.7	3296.0	3424.9	3561.6
M <sub>II</sub>	2468.7	2574.9	2681.6	2792.2	2908.7	3026.5	3147.8	3278.5
M <sub>III</sub>	2194.0	2281.0	2367.3	2457.2	2550.7	2645.4	2743.0	2847.1
M <sub>IV</sub>	1793.2	1871.6	1948.9	2030.8	2116.1	2201.9	2291.1	2384.9
M <sub>V</sub>	1735.1	1809.2	1882.9	1960.1	2040.4	2121.6	2205.7	2294.9
N <sub>I</sub>	565.5	595.0	625.0	654.3	690.1	722.0	758.8	800.3
N <sub>II</sub>	464.8	491.6	517.9	546.5	577.1	609.2	643.7	676.9
N <sub>III</sub>	404.5	425.3	444.4	468.2	494.3	519.0	545.4	571.0
N <sub>IV</sub>	241.3	258.8	273.7	289.4	311.4	330.8	352.0	378.3
N <sub>V</sub>	229.3	245.4	260.2	272.8	294.9	313.3	333.9	359.8
N <sub>VI</sub>	25.0	36.5	40.6	46.3	63.4	74.3	86.4	102.2
N <sub>VII</sub>	25.0*	33.6	40.6*	46.3*	60.5	71.1	82.8	98.5
O <sub>I</sub>	71.1	77.1	82.8	83.7	95.2	101.7	107.8	120.3
O <sub>II</sub>	44.9	46.8	45.6	58.0	63.0	65.3	71.7	80.5
O <sub>III</sub>	36.4	35.6	34.6	45.4	50.5	51.7	53.7	57.6
O <sub>IV</sub>	5.7	6.1	3.5		3.8	2.2	2.5	6.4
Level	<sup>81</sup> Tl	<sup>82</sup> Pb	<sup>83</sup> Bi	<sup>84</sup> Po	<sup>85</sup> At	<sup>86</sup> Rn	<sup>87</sup> Fr	<sup>88</sup> Ra
K	85530.4	88004.5	90525.9	93105.0	95729.9	98404	101137	103921.9
L <sub>I</sub>	15346.7	15860.8	16387.5	16939.3	17493	18049	18639	19236.7
L <sub>II</sub>	14697.9	15200.0	15711.1	16244.3	16784.7	17337.1	17906.5	18484.3
L <sub>III</sub>	12657.5	13035.2	13418.6	13813.8	14213.5	14619.4	15031.2	15444.4
M <sub>I</sub>	3704.1	3850.7	3999.1	4149.4	(4317)	(4482)	(4652)	4822.0
M <sub>II</sub>	3415.7	3554.2	3696.3	3854.1	4008	4159	4327	4489.5
M <sub>III</sub>	2956.6	3066.4	3176.9	3301.9	3426	3538	3663	3791.8
M <sub>IV</sub>	2485.1	2585.6	2687.6	2798.0	2908.7	3021.5	3136.2	3248.4
M <sub>V</sub>	2389.3	2484.0	2579.6	2683.0	2786.7	2892.4	2999.9	3104.9
N <sub>I</sub>	845.5	893.6	938.2	995.3	(1042)	(1097)	(1153)	1208.4
N <sub>II</sub>	721.3	763.9	805.3	851	886	929	980	1057.6
N <sub>III</sub>	609.0	644.5	678.9	705	740	768	810	879.1
N <sub>IV</sub>	406.6	435.2	463.6	500.2	533.2	566.6	603.3	635.9
N <sub>V</sub>	386.2	412.9	440.0	473.4			577	602.7
N <sub>VI</sub>	122.8	142.9	161.9					298.9
N <sub>VII</sub>	118.5	138.1	157.4					298.9*
O <sub>I</sub>	136.3	147.3	159.3					254.4
O <sub>II</sub>	99.6	104.8	116.8					200.4
O <sub>III</sub>	75.4	86.0	92.8					152.8
O <sub>IV</sub>	15.3	21.8	26.5	31.4				67.2
O <sub>V</sub>	13.1	19.2	24.4	31.4*				67.2*
P <sub>I</sub>		3.1						43.5
P <sub>II,III</sub>		0.7	2.7					18.8
Level	<sup>89</sup> Ac	<sup>90</sup> Th	<sup>91</sup> Pa	<sup>92</sup> U	<sup>93</sup> Np	<sup>94</sup> Pu	<sup>95</sup> Am	<sup>96</sup> Cm
K	106755.3	109650.9	112601.4	115606.1	118678	121818	125027	128220
L <sub>I</sub>	19840	20472.1	21104.6	21757.4	22426.8	23097.2	23772.9	24460
L <sub>II</sub>	19083.2	19693.2	20313.7	20947.6	21600.5	22266.2	22944.0	23779
L <sub>III</sub>	15871.0	16300.3	16733.1	17166.3	17610.0	18056.8	18504.1	18930
M <sub>I</sub>	(5002)	5182.3	5366.9	5548.0	5723.2	5932.9	6120.5	6288
M <sub>II</sub>	4656	4830.4	5000.9	5182.2	5366.2	5541.2	5710.2	5895
M <sub>III</sub>	3909	4046.1	4173.8	4303.4	4434.7	4556.6	4667.0	4797
M <sub>IV</sub>	3370.2	3490.8	3611.2	3727.6	3850.3	3972.6	4092.1	4227
M <sub>V</sub>	3219.0	3332.0	3441.8	3551.7	3665.8	3778.1	3886.9	3971
N <sub>I</sub>	(1269)	1329.5	1387.1	1440.8	1500.7	1558.6	1617.1	1643
N <sub>II</sub>	1080	1168.2	1224.3	1272.6	1327.7	1372.1	1411.8	1440
N <sub>III</sub>	890	967.3	1006.7	1044.9	1086.8	1114.8	(1135.7)	1154
N <sub>IV</sub>	674.9	714.1	743.4	780.4	815.9	848.9	878.7	

Level	<sup>89</sup> Ac	<sup>90</sup> Th	<sup>91</sup> Pa	<sup>92</sup> U	<sup>93</sup> Np	<sup>94</sup> Pu	<sup>95</sup> Am	<sup>96</sup> Cm
N <sub>V</sub>		676.4	708.2	737.7	770.3	801.4	827.6	
N <sub>VI</sub>		344.4	371.2	391.3	415.0	445.8		
N <sub>VII</sub>		335.2	359.5	380.9	404.4	432.4		
O <sub>I</sub>		290.2	309.6	323.7		351.9		385
O <sub>II</sub>		229.4	222.9	259.3	283.4	274.1		
O <sub>III</sub>		181.8	222.9*	195.1	206.1	206.5		
O <sub>IV</sub>		94.3	94.1	105.0	109.3	116.0	115.8	
O <sub>V</sub>		87.9	94.1*	96.3	101.3	105.4	103.3	
P <sub>I</sub>		59.5		70.7				
P <sub>II</sub>		49.0		42.3				
P <sub>III</sub>		43.0		32.3				
Level	<sup>97</sup> Bk	<sup>98</sup> Cf	<sup>99</sup> Es	<sup>100</sup> Fm	<sup>101</sup> Md	<sup>102</sup> No	<sup>103</sup> Lr	
K	131590	135960	139490	143090	146780	150540	154380	
L <sub>I</sub>	25275	26110	26900	27700	28530	29380	30240	
L <sub>II</sub>	24385	25250	26020	26810	27610	28440	29280	
L <sub>III</sub>	19452	19930	20410	20900	21390	21880	22360	
M <sub>I</sub>	6556	6754	6977	7205	7441	7675	7900	
M <sub>II</sub>	6147	6359	6574	6793	7019	7245	7460	
M <sub>III</sub>	4977	5109	5252	5397	5546	5688	5710	
M <sub>IV</sub>	4366	4497	4630	4766	4903	5037	5150	
M <sub>V</sub>	4132	4253	4374	4498	4622	4741	4860	
N <sub>I</sub>	1755	1799	1868	1937	2010	2078	2140	
N <sub>II</sub>	1554	1616	1680	1747	1814	1876	1930	
N <sub>III</sub>	1235	1279	1321	1366	1410	1448	1480	
O <sub>I</sub>	398	419	435	454	472	484	490	

# ELECTRON BINDING ENERGIES OF THE ELEMENTS

Gwyn P. Williams

This table gives the binding energies in electron volts (eV) for selected electronic levels of the elements. For metallic elements the binding energy is referred to the Fermi level; for semiconductors, to the valence band maximum; and for gases and insulators, to the vacuum level. The atomic number is listed after the element name.

## References

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2. Cardona, M. and Ley, L., *Photoemission from Solids*, Springer-Verlag, Heidelberg, 1978.
3. Bearden, J. A. and Burr, A. F., *Rev. Mod. Phys.*, 39, 125, 1967.

<b>Actinium (89)</b>					
K	1s	106755	L II	2p <sub>1/2</sub>	250.6 <sup>a</sup>
L I	2s	19840	L III	2p <sub>3/2</sub>	248.4 <sup>a</sup>
L II	2p <sub>1/2</sub>	19083	M I	3s	29.3 <sup>a</sup>
L III	2p <sub>3/2</sub>	15871	M II	3p <sub>1/2</sub>	15.9 <sup>a</sup>
M I	3s	5002	M III	3p <sub>3/2</sub>	15.7 <sup>a</sup>
M II	3p <sub>1/2</sub>	4656	<b>Arsenic (33)</b>		
M III	3p <sub>3/2</sub>	3909	K	1s	11867
M IV	3d <sub>3/2</sub>	3370	L I	2s	1527.0 <sup>a,d</sup>
M V	3d <sub>5/2</sub>	3219	L II	2p <sub>1/2</sub>	1359.1 <sup>a,d</sup>
N I	4s	1269 <sup>a</sup>	L III	2p <sub>3/2</sub>	1323.6 <sup>a,d</sup>
N II	4p <sub>1/2</sub>	1080 <sup>a</sup>	M I	3s	204.7 <sup>a</sup>
N III	4p <sub>3/2</sub>	890 <sup>a</sup>	M II	3p <sub>1/2</sub>	146.2 <sup>a</sup>
N IV	4d <sub>3/2</sub>	675 <sup>a</sup>	M III	3p <sub>3/2</sub>	141.2 <sup>a</sup>
N V	4d <sub>5/2</sub>	639 <sup>a</sup>	M IV	3d <sub>3/2</sub>	41.7 <sup>a</sup>
N VI	4f <sub>5/2</sub>	319 <sup>a</sup>	M V	3d <sub>5/2</sub>	41.7 <sup>a</sup>
N VII	4f <sub>7/2</sub>	319 <sup>a</sup>	<b>Astatine (85)</b>		
O I	5s	272 <sup>a</sup>	K	1s	95730
O II	5p <sub>1/2</sub>	215 <sup>a</sup>	L I	2s	17493
O III	5p <sub>3/2</sub>	167 <sup>a</sup>	L II	2p <sub>1/2</sub>	16785
O IV	5d <sub>3/2</sub>	80 <sup>a</sup>	L III	2p <sub>3/2</sub>	14214
O V	5d <sub>5/2</sub>	80 <sup>a</sup>	M I	3s	4317
P I	6s	—	M II	3p <sub>1/2</sub>	4008
P II	6p <sub>1/2</sub>	—	M III	3p <sub>3/2</sub>	3426
P III	6p <sub>3/2</sub>	—	M IV	3d <sub>3/2</sub>	2909
<b>Aluminum (13)</b>			M V	3d <sub>5/2</sub>	2787
K	1s	1559.0	N I	4s	1042 <sup>a</sup>
L I	2s	117.8 <sup>a</sup>	N II	4p <sub>1/2</sub>	886 <sup>a</sup>
L II	2p <sub>1/2</sub>	72.9 <sup>a</sup>	N III	4p <sub>3/2</sub>	740 <sup>a</sup>
L III	2p <sub>3/2</sub>	72.5 <sup>a</sup>	N IV	4d <sub>3/2</sub>	533 <sup>a</sup>
<b>Antimony (51)</b>			N V	4d <sub>5/2</sub>	507 <sup>a</sup>
K	1s	30419	N VI	4f <sub>5/2</sub>	210 <sup>a</sup>
L I	2s	4698	N VII	4f <sub>7/2</sub>	210 <sup>a</sup>
L II	2p <sub>1/2</sub>	4380	O I	5s	195 <sup>a</sup>
L III	2p <sub>3/2</sub>	4132	O II	5p <sub>1/2</sub>	148 <sup>a</sup>
M I	3s	946 <sup>b</sup>	O III	5p <sub>3/2</sub>	115 <sup>a</sup>
M II	3p <sub>1/2</sub>	812.7 <sup>b</sup>	O IV	5d <sub>3/2</sub>	40 <sup>a</sup>
M III	3p <sub>3/2</sub>	766.4 <sup>b</sup>	O V	5d <sub>5/2</sub>	40 <sup>a</sup>
M IV	3d <sub>3/2</sub>	537.5 <sup>b</sup>	<b>Boron (5)</b>		
M V	3d <sub>5/2</sub>	528.2 <sup>b</sup>	K	1s	188 <sup>a</sup>
N I	4s	153.2 <sup>b</sup>	<b>Bromine (35)</b>		
N II	4p <sub>1/2</sub>	95.6 <sup>b,c</sup>	K	1s	13474
N III	4p <sub>3/2</sub>	95.6 <sup>b</sup>	L I	2s	1782 <sup>a</sup>
N IV	4d <sub>3/2</sub>	33.3 <sup>b</sup>	L II	2p <sub>1/2</sub>	1596 <sup>a</sup>
N V	4d <sub>5/2</sub>	32.1 <sup>b</sup>	L III	2p <sub>3/2</sub>	1550 <sup>a</sup>
<b>Argon (18)</b>			M I	3s	257 <sup>a</sup>
K	1s	3205.9 <sup>a</sup>	M II	3p <sub>1/2</sub>	189 <sup>a</sup>
L I	2s	326.3 <sup>a</sup>	M III	3p <sub>3/2</sub>	182 <sup>a</sup>
			M IV	3d <sub>3/2</sub>	70 <sup>a</sup>
			M V	3d <sub>5/2</sub>	69 <sup>a</sup>
			<b>Cadmium (48)</b>		
			K	1s	26711
			L I	2s	4018
			L II	2p <sub>1/2</sub>	3727
			L III	2p <sub>3/2</sub>	3538
			M I	3s	772.0 <sup>b</sup>
			M II	3p <sub>1/2</sub>	652.6 <sup>b</sup>
			M III	3p <sub>3/2</sub>	618.4 <sup>b</sup>
			M IV	3d <sub>3/2</sub>	411.9 <sup>b</sup>
			M V	3d <sub>5/2</sub>	405.2 <sup>b</sup>
			N I	4s	109.8 <sup>b</sup>
			N II	4p <sub>1/2</sub>	63.9 <sup>b,c</sup>
			N III	4p <sub>3/2</sub>	63.9 <sup>b,c</sup>
			N IV	4d <sub>3/2</sub>	11.7 <sup>b</sup>
			N V	4d <sub>5/2</sub>	10.7 <sup>b</sup>
			<b>Calcium (20)</b>		
			K	1s	4038.5 <sup>a</sup>
			L I	2s	438.4 <sup>b</sup>
			L II	2p <sub>1/2</sub>	349.7 <sup>b</sup>
			L III	2p <sub>3/2</sub>	346.2 <sup>b</sup>
			M I	3s	44.3 <sup>b</sup>
			M II	3p <sub>1/2</sub>	25.4 <sup>b</sup>
			M III	3p <sub>3/2</sub>	25.4 <sup>b</sup>
			<b>Carbon (6)</b>		
			K	1s	284.2 <sup>a</sup>
			<b>Cerium (58)</b>		
			K	1s	40443
			L I	2s	6548
			L II	2p <sub>1/2</sub>	6164
			L III	2p <sub>3/2</sub>	5723
			M I	3s	1436 <sup>a,d</sup>
			M II	3p <sub>1/2</sub>	1274 <sup>a,d</sup>
			M III	3p <sub>3/2</sub>	1187 <sup>a,d</sup>
			M IV	3d <sub>3/2</sub>	902.4 <sup>a</sup>
			M V	3d <sub>5/2</sub>	883.8 <sup>a</sup>
			N I	4s	291.0 <sup>a</sup>
			N II	4p <sub>1/2</sub>	223.3
			N III	4p <sub>3/2</sub>	206.5 <sup>a</sup>
			N IV	4d <sub>3/2</sub>	109 <sup>a</sup>
			N V	4d <sub>5/2</sub>	—
			N VI	4f <sub>5/2</sub>	0.1
			N VII	4f <sub>7/2</sub>	0.1
			O I	5s	37.8
			O II	5p <sub>1/2</sub>	19.8 <sup>a</sup>
			O III	5p <sub>3/2</sub>	17.0 <sup>a</sup>
			<b>Cesium (55)</b>		
			K	1s	35985
			L I	2s	5714
			L II	2p <sub>1/2</sub>	5359
			L III	2p <sub>3/2</sub>	5012
			M I	3s	1211 <sup>a,d</sup>
			M II	3p <sub>1/2</sub>	1071 <sup>a</sup>

M III	3p <sub>3/2</sub>	1003 <sup>a</sup>	O II	5p <sub>1/2</sub>	26.3	O I	5s	234 <sup>a</sup>	N IV	4d <sub>3/2</sub>	353.2 <sup>b</sup>
M IV	3d <sub>3/2</sub>	740.5 <sup>a</sup>	O III	5p <sub>3/2</sub>	26.3	O II	5p <sub>1/2</sub>	182 <sup>a</sup>	N V	4d <sub>5/2</sub>	335.1 <sup>b</sup>
M V	3d <sub>5/2</sub>	726.6 <sup>a</sup>	<b>Erbium (68)</b>			O III	5p <sub>3/2</sub>	140 <sup>a</sup>	N VI	4f <sub>5/2</sub>	87.6 <sup>b</sup>
N I	4s	232.3 <sup>a</sup>	K	1s	57486	O IV	5d <sub>3/2</sub>	58 <sup>a</sup>	N VII	4f <sub>7/2</sub>	83.9 <sup>b</sup>
N II	4p <sub>1/2</sub>	172.4 <sup>a</sup>	L I	2s	9751	O V	5d <sub>5/2</sub>	58 <sup>a</sup>	O I	5s	107.2 <sup>a,d</sup>
N III	4p <sub>3/2</sub>	161.3 <sup>a</sup>	L II	2p <sub>1/2</sub>	9264	P I	6s	34	O II	5p <sub>1/2</sub>	74.2 <sup>b</sup>
N IV	4d <sub>3/2</sub>	79.8 <sup>a</sup>	L III	2p <sub>3/2</sub>	8358	P II	6p <sub>1/2</sub>	15	O III	5p <sub>3/2</sub>	57.2 <sup>b</sup>
N V	4d <sub>5/2</sub>	77.5 <sup>a</sup>	M I	3s	2206	P III	6p <sub>3/2</sub>	15	<b>Hafnium (72)</b>		
N VI	4f <sub>5/2</sub>	—	M II	3p <sub>1/2</sub>	2006	<b>Gadolinium (64)</b>			K	1s	65351
N VII	4f <sub>7/2</sub>	—	M III	3p <sub>3/2</sub>	1812	K	1s	50239	L I	2s	11271
O I	5s	22.7	M IV	3d <sub>3/2</sub>	1453	L I	2s	8376	L II	2p <sub>1/2</sub>	10739
O II	5p <sub>1/2</sub>	14.2 <sup>a</sup>	M V	3d <sub>5/2</sub>	1409	L II	2p <sub>1/2</sub>	7930	L III	2p <sub>3/2</sub>	9561
O III	5p <sub>3/2</sub>	12.1 <sup>a</sup>	N I	4s	449.8 <sup>a</sup>	L III	2p <sub>3/2</sub>	7243	M I	3s	2601
<b>Chlorine (17)</b>			N II	4p <sub>1/2</sub>	366.2	M I	3s	1881	M II	3p <sub>1/2</sub>	2365
K	1s	2822.0	N III	4p <sub>3/2</sub>	320.2 <sup>a</sup>	M II	3p <sub>1/2</sub>	1688	M III	3p <sub>3/2</sub>	2107
L I	2s	270 <sup>a</sup>	N IV	4d <sub>3/2</sub>	167.6 <sup>a</sup>	M III	3p <sub>3/2</sub>	1544	M IV	3d <sub>3/2</sub>	1176
L II	2p <sub>1/2</sub>	202 <sup>a</sup>	N V	4d <sub>5/2</sub>	167.6 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1221.9 <sup>a</sup>	M V	3d <sub>5/2</sub>	1662
L III	2p <sub>3/2</sub>	200 <sup>a</sup>	N VI	4f <sub>5/2</sub>	—	M V	3d <sub>5/2</sub>	1189.6 <sup>a</sup>	N I	4s	538 <sup>a</sup>
<b>Chromium(24)</b>			N VII	4f <sub>7/2</sub>	4.7 <sup>a</sup>	N I	4s	378.6 <sup>a</sup>	N II	4p <sub>1/2</sub>	438.2 <sup>b</sup>
K	1s	5989	O I	5s	50.6 <sup>a</sup>	N II	4p <sub>1/2</sub>	286	N III	4p <sub>3/2</sub>	380.7 <sup>b</sup>
L I	2s	696.0 <sup>b</sup>	O II	5p <sub>1/2</sub>	31.4 <sup>a</sup>	N III	4p <sub>3/2</sub>	271	N IV	4d <sub>3/2</sub>	220.0 <sup>b</sup>
L II	2p <sub>1/2</sub>	583.8 <sup>b</sup>	O III	5p <sub>3/2</sub>	24.7 <sup>a</sup>	N IV	4d <sub>3/2</sub>	—	N V	4d <sub>5/2</sub>	211.5 <sup>b</sup>
L III	2p <sub>3/2</sub>	574.1 <sup>b</sup>	<b>Europium (63)</b>			N V	4d <sub>5/2</sub>	142.6 <sup>a</sup>	N VI	4f <sub>5/2</sub>	15.9 <sup>b</sup>
M I	3s	74.1 <sup>b</sup>	K	1s	48519	N VI	4f <sub>5/2</sub>	8.6 <sup>a</sup>	N VII	4f <sub>7/2</sub>	14.2 <sup>b</sup>
M II	3p <sub>1/2</sub>	42.2 <sup>b</sup>	L I	2s	8052	N VII	4f <sub>7/2</sub>	8.6 <sup>a</sup>	O I	5s	64.2 <sup>b</sup>
M III	3p <sub>3/2</sub>	42.2 <sup>b</sup>	L II	2p <sub>1/2</sub>	7617	O I	5s	36	O II	5p <sub>1/2</sub>	38 <sup>a</sup>
<b>Cobalt (27)</b>			L III	2p <sub>3/2</sub>	6977	O II	5p <sub>1/2</sub>	20	O III	5p <sub>3/2</sub>	29.9 <sup>b</sup>
K	1s	7709	M I	3s	1800	O III	5p <sub>3/2</sub>	20	<b>Helium (2)</b>		
L I	2s	925.1 <sup>b</sup>	M II	3p <sub>1/2</sub>	1614	<b>Gallium (31)</b>			K	1s	24.6 <sup>a</sup>
L II	2p <sub>1/2</sub>	793.2 <sup>b</sup>	M III	3p <sub>3/2</sub>	1481	K	1s	10367	<b>Holmium (67)</b>		
L III	2p <sub>3/2</sub>	778.1 <sup>b</sup>	M IV	3d <sub>3/2</sub>	1158.6 <sup>a</sup>	L I	2s	1299.0 <sup>a,d</sup>	K	1s	55618
M I	3s	101.0 <sup>b</sup>	M V	3d <sub>5/2</sub>	1127.5 <sup>a</sup>	L II	2p <sub>1/2</sub>	1143.2 <sup>b</sup>	L I	2s	9394
M II	3p <sub>1/2</sub>	58.9 <sup>b</sup>	N I	4s	360	L III	2p <sub>3/2</sub>	1116.4 <sup>b</sup>	L II	2p <sub>1/2</sub>	8918
M III	3p <sub>3/2</sub>	58.9 <sup>b</sup>	N II	4p <sub>1/2</sub>	284	M I	3s	159.5 <sup>b</sup>	L III	2p <sub>3/2</sub>	8071
<b>Copper (29)</b>			N III	4p <sub>3/2</sub>	257	M II	3p <sub>1/2</sub>	103.5 <sup>b</sup>	M I	3s	2128
K	1s	8979	N IV	4d <sub>3/2</sub>	133	M III	3p <sub>3/2</sub>	100.0 <sup>b</sup>	M II	3p <sub>1/2</sub>	1923
L I	2s	1096.7 <sup>b</sup>	N V	4d <sub>5/2</sub>	1227 <sup>a</sup>	M IV	3d <sub>3/2</sub>	18.7 <sup>b</sup>	M III	3p <sub>3/2</sub>	1741
L II	2p <sub>1/2</sub>	952.3 <sup>b</sup>	N VI	4f <sub>5/2</sub>	0	M V	3d <sub>5/2</sub>	18.7 <sup>b</sup>	M IV	3d <sub>3/2</sub>	1392
L III	2p <sub>3/2</sub>	932.5 <sup>b</sup>	N VII	4f <sub>7/2</sub>	0	<b>Germanium (32)</b>			M V	3d <sub>5/2</sub>	1351
M I	3s	122.5 <sup>b</sup>	O I	5s	32	K	1s	11103	N I	4s	432.4 <sup>a</sup>
M II	3p <sub>1/2</sub>	77.3 <sup>b</sup>	O II	5p <sub>1/2</sub>	22	L I	2s	1414.6 <sup>a,d</sup>	N II	4p <sub>1/2</sub>	343.5
M III	3p <sub>3/2</sub>	75.1 <sup>b</sup>	O III	5p <sub>3/2</sub>	22	L II	2p <sub>1/2</sub>	1248.1 <sup>a,d</sup>	N III	4p <sub>3/2</sub>	308.2 <sup>a</sup>
<b>Dysprosium (66)</b>			<b>Fluorine (9)</b>			L III	2p <sub>3/2</sub>	1217.0 <sup>a,d</sup>	N IV	4d <sub>3/2</sub>	160 <sup>a</sup>
K	1s	53789	K	1s	696.7 <sup>a</sup>	M I	3s	180.1 <sup>a</sup>	N V	4d <sub>5/2</sub>	160 <sup>a</sup>
L I	2s	9046	<b>Francium (87)</b>			M II	3p <sub>1/2</sub>	124.9 <sup>a</sup>	N VI	4f <sub>5/2</sub>	8.6 <sup>a</sup>
L II	2p <sub>1/2</sub>	8581	K	1s	101137	M III	3p <sub>3/2</sub>	120.8 <sup>a</sup>	N VII	4f <sub>7/2</sub>	5.2 <sup>a</sup>
L III	2p <sub>3/2</sub>	7790	L I	2s	18639	M IV	3d <sub>3/2</sub>	29.8 <sup>a</sup>	O I	5s	49.3 <sup>a</sup>
M I	3s	2047	L II	2p <sub>1/2</sub>	17907	M V	3d <sub>5/2</sub>	29.2 <sup>a</sup>	O II	5p <sub>1/2</sub>	30.8 <sup>a</sup>
M II	3p <sub>1/2</sub>	1842	L III	2p <sub>3/2</sub>	15031	<b>Gold (79)</b>			O III	5p <sub>3/2</sub>	24.1 <sup>a</sup>
M III	3p <sub>3/2</sub>	1676	M I	3s	4652	K	1s	80725	<b>Hydrogen (1)</b>		
M IV	3d <sub>3/2</sub>	1333	M II	3p <sub>1/2</sub>	4327	L I	2s	14353	K	1s	13.6
M V	3d <sub>5/2</sub>	1292 <sup>a</sup>	M III	3p <sub>3/2</sub>	3663	L II	2p <sub>1/2</sub>	13734	<b>Indium (49)</b>		
N I	4s	414.2 <sup>a</sup>	M IV	3d <sub>3/2</sub>	3136	L III	2p <sub>3/2</sub>	11919	K	1s	27940
N II	4p <sub>1/2</sub>	333.5 <sup>a</sup>	M V	3d <sub>5/2</sub>	3000	M I	3s	3425	L I	2s	4238
N III	4p <sub>3/2</sub>	293.2 <sup>a</sup>	N I	4s	1153 <sup>a</sup>	M II	3p <sub>1/2</sub>	3148	L II	2p <sub>1/2</sub>	3938
N IV	4d <sub>3/2</sub>	153.6 <sup>a</sup>	N II	4p <sub>1/2</sub>	980 <sup>a</sup>	M III	3p <sub>3/2</sub>	2743	L III	2p <sub>3/2</sub>	3730
N V	4d <sub>5/2</sub>	153.6 <sup>a</sup>	N III	4p <sub>3/2</sub>	810 <sup>a</sup>	M IV	3d <sub>3/2</sub>	2291	M I	3s	827.2 <sup>b</sup>
N VI	4f <sub>5/2</sub>	8.0 <sup>a</sup>	N IV	4d <sub>3/2</sub>	603 <sup>a</sup>	M V	3d <sub>5/2</sub>	2206	M II	3p <sub>1/2</sub>	703.2 <sup>b</sup>
N VII	4f <sub>7/2</sub>	4.3 <sup>a</sup>	N V	4d <sub>5/2</sub>	577 <sup>a</sup>	N I	4s	762.1 <sup>b</sup>	M III	3p <sub>3/2</sub>	665.3 <sup>b</sup>
O I	5s	49.9 <sup>a</sup>	N VI	4f <sub>5/2</sub>	268 <sup>a</sup>	N II	4p <sub>1/2</sub>	642.7 <sup>b</sup>	M IV	3d <sub>3/2</sub>	451.4 <sup>b</sup>
			N VII	4f <sub>7/2</sub>	268 <sup>a</sup>	N III	4p <sub>3/2</sub>	546.3 <sup>b</sup>			

M V	3d <sub>5/2</sub>	443.9 <sup>b</sup>	N III	4p <sub>3/2</sub>	14.1 <sup>a</sup>	N VII	4f <sub>7/2</sub>	7.5 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1003.3 <sup>a</sup>
N I	4s	122.9 <sup>b</sup>	<i>Lanthanum (57)</i>			O I	5s	57.3 <sup>a</sup>	M V	3d <sub>5/2</sub>	980.4 <sup>a</sup>
N II	4p <sub>1/2</sub>	73.5 <sup>b,c</sup>	K	1s	38925	O II	5p <sub>1/2</sub>	33.6 <sup>a</sup>	N I	4s	319.2 <sup>a</sup>
N III	4p <sub>3/2</sub>	73.5 <sup>b,c</sup>	L I	2s	6266	O III	5p <sub>3/2</sub>	26.7 <sup>a</sup>	N II	4p <sub>1/2</sub>	243.3
N IV	4d <sub>3/2</sub>	17.7 <sup>b</sup>	L II	2p <sub>1/2</sub>	5891	<i>Magnesium (12)</i>			N III	4p <sub>3/2</sub>	224.6
N V	4d <sub>5/2</sub>	16.9 <sup>b</sup>	L III	2p <sub>3/2</sub>	5483	K	1s	1303.0 <sup>b</sup>	N IV	4d <sub>3/2</sub>	120.5 <sup>a</sup>
<i>Iodine (53)</i>			M I	3s	1362 <sup>a,d</sup>	L I	2s	88.6 <sup>a</sup>	N V	4d <sub>5/2</sub>	120.5 <sup>a</sup>
K	1s	33169	M II	3p <sub>1/2</sub>	1209 <sup>a,d</sup>	L II	2p <sub>1/2</sub>	49.6 <sup>b</sup>	N VI	4f <sub>5/2</sub>	1.5
L I	2s	5188	M III	3p <sub>3/2</sub>	1128 <sup>a,d</sup>	L III	2p <sub>3/2</sub>	49.2 <sup>a</sup>	N VII	4f <sub>7/2</sub>	1.5
L II	2p <sub>1/2</sub>	4852	M IV	3d <sub>3/2</sub>	853 <sup>a</sup>	<i>Manganese (25)</i>			O I	5s	37.5
L III	2p <sub>3/2</sub>	4557	M V	3d <sub>5/2</sub>	836 <sup>a</sup>	K	1s	6539	O II	5p <sub>1/2</sub>	21.1
M I	3s	1072 <sup>a</sup>	N I	4s	247.7 <sup>a</sup>	L I	2s	769.1 <sup>b</sup>	O III	5p <sub>3/2</sub>	21.1
M II	3p <sub>1/2</sub>	931 <sup>a</sup>	N II	4p <sub>1/2</sub>	205.8	L II	2p <sub>1/2</sub>	649.9 <sup>b</sup>	<i>Neon (10)</i>		
M III	3p <sub>3/2</sub>	875 <sup>a</sup>	N III	4p <sub>3/2</sub>	196.0 <sup>a</sup>	L III	2p <sub>3/2</sub>	638.7 <sup>b</sup>	K	1s	870.2 <sup>a</sup>
M IV	3d <sub>3/2</sub>	631 <sup>a</sup>	N IV	4d <sub>3/2</sub>	105.3 <sup>a</sup>	M I	3s	82.3 <sup>b</sup>	L I	2s	48.5 <sup>a</sup>
M V	3d <sub>5/2</sub>	620 <sup>a</sup>	N V	4d <sub>5/2</sub>	102.5 <sup>a</sup>	M II	3p <sub>1/2</sub>	47.2 <sup>b</sup>	L II	2p <sub>1/2</sub>	21.7 <sup>a</sup>
N I	4s	186 <sup>a</sup>	N VI	4f <sub>5/2</sub>	—	M III	3p <sub>3/2</sub>	47.2 <sup>b</sup>	L III	2p <sub>3/2</sub>	21.6 <sup>a</sup>
N II	4p <sub>1/2</sub>	123 <sup>a</sup>	N VII	4f <sub>7/2</sub>	—	<i>Mercury (80)</i>			<i>Nickel (28)</i>		
N III	4p <sub>3/2</sub>	123 <sup>a</sup>	O I	5s	34.3 <sup>a</sup>	K	1s	83102	K	1s	8333
N IV	4d <sub>3/2</sub>	50 <sup>a</sup>	O II	5p <sub>1/2</sub>	19.3 <sup>a</sup>	L I	2s	14839	L I	2s	1008.6 <sup>b</sup>
N V	4d <sub>5/2</sub>	50 <sup>a</sup>	O III	5p <sub>3/2</sub>	16.8 <sup>a</sup>	L II	2p <sub>1/2</sub>	14209	L II	2p <sub>1/2</sub>	870.0 <sup>b</sup>
<i>Iridium (77)</i>			<i>Lead (82)</i>			L III	2p <sub>3/2</sub>	12284	L III	2p <sub>3/2</sub>	852.7 <sup>b</sup>
K	1s	76111	K	1s	88005	M I	3s	3562	M I	3s	110.8 <sup>b</sup>
L I	2s	13419	L I	2s	15861	M II	3p <sub>1/2</sub>	3279	M II	3p <sub>1/2</sub>	68.0 <sup>b</sup>
L II	2p <sub>1/2</sub>	12824	L II	2p <sub>1/2</sub>	15200	M III	3p <sub>3/2</sub>	2847	M III	3p <sub>3/2</sub>	66.2 <sup>b</sup>
L III	2p <sub>3/2</sub>	11215	L III	2p <sub>3/2</sub>	13055	M IV	3d <sub>3/2</sub>	2385	<i>Niobium (41)</i>		
M I	3s	3174	M I	3s	3851	M V	3d <sub>5/2</sub>	2295	K	1s	18986
M II	3p <sub>1/2</sub>	2909	M II	3p <sub>1/2</sub>	3554	N I	4s	802.2 <sup>b</sup>	L I	2s	2698
M III	3p <sub>3/2</sub>	2551	M III	3p <sub>3/2</sub>	3066	N II	4p <sub>1/2</sub>	680.2 <sup>b</sup>	L II	2p <sub>1/2</sub>	2465
M IV	3d <sub>3/2</sub>	2116	M IV	3d <sub>3/2</sub>	2586	N III	4p <sub>3/2</sub>	576.6 <sup>b</sup>	L III	2p <sub>3/2</sub>	2371
M V	3d <sub>5/2</sub>	2040	M V	3d <sub>5/2</sub>	2484	N IV	4d <sub>3/2</sub>	378.2 <sup>b</sup>	M I	3s	466.6 <sup>b</sup>
N I	4s	691.1 <sup>b</sup>	N I	4s	891.8 <sup>b</sup>	N V	4d <sub>5/2</sub>	358.8 <sup>b</sup>	M II	3p <sub>1/2</sub>	376.1 <sup>b</sup>
N II	4p <sub>1/2</sub>	577.8 <sup>b</sup>	N II	4p <sub>1/2</sub>	761.9 <sup>b</sup>	N VI	4f <sub>5/2</sub>	104.0 <sup>b</sup>	M III	3p <sub>3/2</sub>	360.6 <sup>b</sup>
N III	4p <sub>3/2</sub>	495.8 <sup>b</sup>	N III	4p <sub>3/2</sub>	643.5 <sup>b</sup>	N VII	4f <sub>7/2</sub>	99.9 <sup>b</sup>	M IV	3d <sub>3/2</sub>	205.0 <sup>b</sup>
N IV	4d <sub>3/2</sub>	311.9 <sup>b</sup>	N IV	4d <sub>3/2</sub>	434.3 <sup>b</sup>	O I	5s	127 <sup>b</sup>	M V	3d <sub>5/2</sub>	202.3 <sup>b</sup>
N V	4d <sub>5/2</sub>	296.3 <sup>b</sup>	N V	4d <sub>5/2</sub>	412.2 <sup>b</sup>	O II	5p <sub>3/2</sub>	83.1 <sup>b</sup>	N I	4s	56.4 <sup>b</sup>
N VI	4f <sub>5/2</sub>	63.8 <sup>b</sup>	N VI	4f <sub>5/2</sub>	141.7 <sup>b</sup>	O III	5p <sub>3/2</sub>	64.5 <sup>b</sup>	N II	4p <sub>1/2</sub>	32.6 <sup>b</sup>
N VII	4f <sub>7/2</sub>	60.8 <sup>b</sup>	N VII	4f <sub>7/2</sub>	136.9 <sup>b</sup>	O IV	5d <sub>3/2</sub>	9.6 <sup>b</sup>	N III	4p <sub>3/2</sub>	30.8 <sup>b</sup>
O I	5s	95.2 <sup>a,d</sup>	O I	5s	147 <sup>a,d</sup>	O V	5d <sub>5/2</sub>	7.8 <sup>b</sup>	<i>Nitrogen (7)</i>		
O II	5p <sub>1/2</sub>	63.0 <sup>a,d</sup>	O II	5p <sub>1/2</sub>	106.4 <sup>b</sup>	<i>Molybdenum (42)</i>			K	1s	409.9 <sup>a</sup>
O III	5p <sub>3/2</sub>	48.0 <sup>b</sup>	O III	5p <sub>3/2</sub>	83.3 <sup>b</sup>	K	1s	20000	L I	2s	37.3 <sup>a</sup>
<i>Iron (26)</i>			O IV	5d <sub>3/2</sub>	20.7 <sup>b</sup>	L I	2s	2866	<i>Osmium (76)</i>		
K	1s	7112	O V	5d <sub>5/2</sub>	18.1 <sup>b</sup>	L II	2p <sub>1/2</sub>	2625	K	1s	73871
L I	2s	844.6 <sup>b</sup>	<i>Lithium (3)</i>			L III	2p <sub>3/2</sub>	2520	L I	2s	12968
L II	2p <sub>1/2</sub>	719.9 <sup>b</sup>	K	1s	54.7 <sup>a</sup>	M I	3s	506.3 <sup>b</sup>	L II	2p <sub>1/2</sub>	12385
L III	2p <sub>3/2</sub>	706.8 <sup>b</sup>	<i>Lutetium</i>			M II	3p <sub>1/2</sub>	411.6 <sup>b</sup>	L III	2p <sub>3/2</sub>	10871
M I	3s	91.3 <sup>b</sup>	K	1s	63314	M III	3p <sub>3/2</sub>	394.0 <sup>b</sup>	M I	3s	3049
M II	3p <sub>1/2</sub>	52.7 <sup>b</sup>	L I	2s	10870	M IV	3d <sub>3/2</sub>	231.1 <sup>b</sup>	M II	3p <sub>1/2</sub>	2792
M III	3p <sub>3/2</sub>	52.7 <sup>b</sup>	L II	2p <sub>1/2</sub>	10349	M V	3d <sub>5/2</sub>	227.9 <sup>b</sup>	M III	3p <sub>3/2</sub>	2457
<i>Krypton (36)</i>			L III	2p <sub>3/2</sub>	9244	N I	4s	63.2 <sup>b</sup>	M IV	3d <sub>3/2</sub>	2031
K	1s	14326	M I	3s	2491	N II	4p <sub>1/2</sub>	37.6 <sup>b</sup>	M V	3d <sub>5/2</sub>	1960
L I	2s	1921	M II	3p <sub>1/2</sub>	2264	N III	4p <sub>3/2</sub>	35.5 <sup>b</sup>	N I	4s	658.2 <sup>b</sup>
L II	2p <sub>1/2</sub>	1730.9 <sup>a</sup>	M III	3p <sub>3/2</sub>	2024	<i>Neodymium (60)</i>			N II	4p <sub>1/2</sub>	549.1 <sup>b</sup>
L III	2p <sub>3/2</sub>	1678.4 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1639	K	1s	43569	N III	4p <sub>3/2</sub>	470.7 <sup>b</sup>
M I	3s	292.8 <sup>a</sup>	M V	3d <sub>5/2</sub>	1589	L I	2s	7126	N IV	4d <sub>3/2</sub>	293.1 <sup>b</sup>
M II	3p <sub>1/2</sub>	222.2 <sup>a</sup>	N I	4s	506.8 <sup>a</sup>	L II	2p <sub>1/2</sub>	6722	N V	4d <sub>5/2</sub>	278.5 <sup>b</sup>
M III	3p <sub>3/2</sub>	214.4 <sup>a</sup>	N II	4p <sub>1/2</sub>	412.4 <sup>a</sup>	L III	2p <sub>3/2</sub>	6208	N VI	4f <sub>5/2</sub>	53.4 <sup>b</sup>
M IV	3d <sub>3/2</sub>	95.0 <sup>a</sup>	N III	4p <sub>3/2</sub>	359.2 <sup>a</sup>	M I	3s	1575	N VII	4f <sub>7/2</sub>	50.7 <sup>b</sup>
M V	3d <sub>5/2</sub>	93.8 <sup>a</sup>	N IV	4d <sub>3/2</sub>	206.1 <sup>a</sup>	M II	3p <sub>1/2</sub>	1403	O I	5s	84 <sup>a</sup>
N I	4s	27.5 <sup>a</sup>	N V	4d <sub>5/2</sub>	196.3 <sup>a</sup>	M III	3p <sub>3/2</sub>	1297	O II	5p <sub>1/2</sub>	58 <sup>a</sup>
N II	4p <sub>1/2</sub>	14.1 <sup>a</sup>	N VI	4f <sub>5/2</sub>	8.9 <sup>a</sup>						



O III	5p <sub>3/2</sub>	44.5 <sup>b</sup>	O II	5p <sub>1/2</sub>	132 <sup>a</sup>	N V	4d <sub>5/2</sub>	708 <sup>a</sup>	L I	2s	12527
<b>Oxygen (8)</b>			O III	5p <sub>3/2</sub>	104 <sup>a</sup>	N VI	4f <sub>5/2</sub>	371 <sup>a</sup>	L II	2p <sub>1/2</sub>	11959
K	1s	543.1 <sup>a</sup>	O IV	5d <sub>3/2</sub>	31 <sup>a</sup>	N VII	4f <sub>7/2</sub>	360 <sup>a</sup>	L III	2p <sub>3/2</sub>	10535
L I	2s	41.6 <sup>a</sup>	O V	5d <sub>5/2</sub>	31 <sup>a</sup>	O I	5s	310 <sup>a</sup>	M I	3s	2932
<b>Palladium (46)</b>			<b>Potassium (19)</b>			O II	5p <sub>1/2</sub>	232 <sup>a</sup>	M II	3p <sub>1/2</sub>	2682
K	1s	24350	K	1s	3608.4 <sup>a</sup>	O III	5p <sub>3/2</sub>	232 <sup>a</sup>	M III	3p <sub>3/2</sub>	2367
L I	2s	3604	L I	2s	378.6 <sup>a</sup>	O IV	5d <sub>3/2</sub>	94 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1949
L II	2p <sub>1/2</sub>	3330	L II	2p <sub>1/2</sub>	297.3 <sup>a</sup>	O V	5d <sub>5/2</sub>	94 <sup>a</sup>	M V	3d <sub>5/2</sub>	1883
L III	2p <sub>3/2</sub>	3173	L III	2p <sub>3/2</sub>	294.6 <sup>a</sup>	P I	6s	—	N I	4s	625.4 <sup>b</sup>
M I	3s	671.6 <sup>b</sup>	M I	3s	34.8 <sup>a</sup>	P II	6p <sub>1/2</sub>	—	N II	4p <sub>1/2</sub>	518.7 <sup>b</sup>
M II	3p <sub>1/2</sub>	559.9 <sup>b</sup>	M II	3p <sub>1/2</sub>	18.3 <sup>a</sup>	P III	6p <sub>3/2</sub>	—	N III	4p <sub>3/2</sub>	446.8 <sup>b</sup>
M III	3p <sub>3/2</sub>	532.3 <sup>b</sup>	M III	3p <sub>3/2</sub>	18.3 <sup>a</sup>	<b>Radium (88)</b>			N IV	4d <sub>3/2</sub>	273.9 <sup>b</sup>
M IV	3d <sub>3/2</sub>	340.5 <sup>b</sup>	<b>Praseodymium (59)</b>			K	1s	103922	N V	4d <sub>5/2</sub>	260.5 <sup>b</sup>
M V	3d <sub>5/2</sub>	335.2 <sup>b</sup>	K	1s	41991	L I	2s	19237	N VI	4f <sub>5/2</sub>	42.9 <sup>a</sup>
N I	4s	87.1 <sup>a,d</sup>	L I	2s	6835	L II	2p <sub>1/2</sub>	18484	N VII	4f <sub>7/2</sub>	40.5 <sup>a</sup>
N II	4p <sub>1/2</sub>	55.7 <sup>b,c</sup>	L II	2p <sub>1/2</sub>	6440	L III	2p <sub>3/2</sub>	15444	O I	5s	83 <sup>b</sup>
N III	4p <sub>3/2</sub>	50.9 <sup>b,c</sup>	L III	2p <sub>3/2</sub>	5964	M I	3s	4822	O II	5p <sub>1/2</sub>	45.6 <sup>b</sup>
<b>Phosphorus (15)</b>			M I	3s	1511	M II	3p <sub>1/2</sub>	4490	O III	5p <sub>3/2</sub>	34.6 <sup>a,d</sup>
K	1s	2145.5	M II	3p <sub>1/2</sub>	1337	M III	3p <sub>3/2</sub>	3792	<b>Rhodium (45)</b>		
L I	2s	189 <sup>a</sup>	M III	3p <sub>3/2</sub>	1242	M IV	3d <sub>3/2</sub>	3248	K	1s	23220
L II	2p <sub>1/2</sub>	136 <sup>a</sup>	M IV	3d <sub>3/2</sub>	948.3 <sup>a</sup>	M V	3d <sub>5/2</sub>	3105	L I	2s	3412
L III	2p <sub>3/2</sub>	135 <sup>a</sup>	M V	3d <sub>5/2</sub>	928.8 <sup>a</sup>	N I	4s	1208 <sup>a</sup>	L II	2p <sub>1/2</sub>	3146
<b>Platinum (78)</b>			N I	4s	304.5	N II	4p <sub>1/2</sub>	1058	L III	2p <sub>3/2</sub>	3004
K	1s	78395	N II	4p <sub>1/2</sub>	236.3	N III	4p <sub>3/2</sub>	879 <sup>a</sup>	M I	3s	628.1 <sup>b</sup>
L I	2s	13880	N III	4p <sub>3/2</sub>	217.6	N IV	4d <sub>3/2</sub>	636 <sup>a</sup>	M II	3p <sub>1/2</sub>	521.3 <sup>b</sup>
L II	2p <sub>1/2</sub>	13273	N IV	4d <sub>3/2</sub>	115.1 <sup>a</sup>	N V	4d <sub>5/2</sub>	603 <sup>a</sup>	M III	3p <sub>3/2</sub>	496.5 <sup>b</sup>
L III	2p <sub>3/2</sub>	11564	N V	4d <sub>5/2</sub>	115.1 <sup>a</sup>	N VI	4f <sub>5/2</sub>	299 <sup>a</sup>	M IV	3d <sub>3/2</sub>	311.9 <sup>b</sup>
M I	3s	3296	N VI	4f <sub>5/2</sub>	2.0	N VII	4f <sub>7/2</sub>	299 <sup>a</sup>	M V	3d <sub>5/2</sub>	307.2 <sup>b</sup>
M II	3p <sub>1/2</sub>	3027	N VII	4f <sub>7/2</sub>	2.0	O I	5s	254 <sup>a</sup>	N I	4s	81.4 <sup>a,d</sup>
M III	3p <sub>3/2</sub>	2645	O I	5s	37.4	O II	5p <sub>1/2</sub>	200 <sup>a</sup>	N II	4p <sub>1/2</sub>	50.5 <sup>b</sup>
M IV	3d <sub>3/2</sub>	2202	O II	5p <sub>1/2</sub>	22.3	O III	5p <sub>3/2</sub>	153 <sup>a</sup>	N III	4p <sub>3/2</sub>	47.3 <sup>b</sup>
M V	3d <sub>5/2</sub>	2122	O III	5p <sub>3/2</sub>	22.3	O IV	5d <sub>3/2</sub>	68 <sup>a</sup>	<b>Rubidium (37)</b>		
N I	4s	725.4 <sup>b</sup>	<b>Promethium (61)</b>			O V	5d <sub>5/2</sub>	68 <sup>a</sup>	K	1s	15200
N II	4p <sub>1/2</sub>	609.1 <sup>b</sup>	K	1s	45184	P I	6s	44	L I	2s	2065
N III	4p <sub>3/2</sub>	519.4 <sup>b</sup>	L I	2s	7428	P II	6p <sub>1/2</sub>	19	L II	2p <sub>1/2</sub>	1864
N IV	4d <sub>3/2</sub>	331.6 <sup>b</sup>	L II	2p <sub>1/2</sub>	7013	P III	6p <sub>3/2</sub>	19	L III	2p <sub>3/2</sub>	1804
N V	4d <sub>5/2</sub>	314.6 <sup>b</sup>	L III	2p <sub>3/2</sub>	6459	<b>Radon (86)</b>			M I	3s	326.7 <sup>a</sup>
N VI	4f <sub>5/2</sub>	74.5 <sup>b</sup>	M I	3s	—	K	1s	98404	M II	3p <sub>1/2</sub>	248.7 <sup>a</sup>
N VII	4f <sub>7/2</sub>	71.2 <sup>b</sup>	M II	3p <sub>1/2</sub>	1471.4	L I	2s	18049	M III	3p <sub>3/2</sub>	239.1 <sup>a</sup>
O I	5s	101.7 <sup>a,d</sup>	M III	3p <sub>3/2</sub>	1357	L II	2p <sub>1/2</sub>	17337	M IV	3d <sub>3/2</sub>	113.0 <sup>a</sup>
O II	5p <sub>1/2</sub>	65.3 <sup>a,b</sup>	M IV	3d <sub>3/2</sub>	1052	L III	2p <sub>3/2</sub>	14619	M V	3d <sub>5/2</sub>	112 <sup>a</sup>
O III	5p <sub>3/2</sub>	51.7 <sup>b</sup>	M V	3d <sub>5/2</sub>	1027	M I	3s	4482	N I	4s	30.5 <sup>a</sup>
<b>Polonium (84)</b>			N I	4s	—	M II	3p <sub>1/2</sub>	4159	N II	4p <sub>1/2</sub>	16.3 <sup>a</sup>
K	1s	93105	N II	4p <sub>1/2</sub>	242	M III	3p <sub>3/2</sub>	3538	N III	4p <sub>3/2</sub>	15.3 <sup>a</sup>
L I	2s	16939	N III	4p <sub>3/2</sub>	242	M IV	3d <sub>3/2</sub>	3022	<b>Ruthenium (44)</b>		
L II	2p <sub>1/2</sub>	16244	N IV	4d <sub>3/2</sub>	120	M V	3d <sub>5/2</sub>	2892	K	1s	22117
L III	2p <sub>3/2</sub>	13814	N V	4d <sub>5/2</sub>	120	N I	4s	1097 <sup>a</sup>	L I	2s	3224
M I	3s	4149	<b>Protactinium (91)</b>			N II	4p <sub>1/2</sub>	929 <sup>a</sup>	L II	2p <sub>1/2</sub>	2967
M II	3p <sub>1/2</sub>	3854	K	1s	112601	N III	4p <sub>3/2</sub>	768 <sup>a</sup>	L III	2p <sub>3/2</sub>	2838
M III	3p <sub>3/2</sub>	3302	L I	2s	21105	N IV	4d <sub>3/2</sub>	567 <sup>a</sup>	M I	3s	586.2 <sup>b</sup>
M IV	3d <sub>3/2</sub>	2798	L II	2p <sub>1/2</sub>	20314	N V	4d <sub>5/2</sub>	541 <sup>a</sup>	M II	3p <sub>1/2</sub>	483.3 <sup>b</sup>
M V	3d <sub>5/2</sub>	2683	L III	2p <sub>3/2</sub>	16733	N VI	4f <sub>5/2</sub>	238 <sup>a</sup>	M III	3p <sub>3/2</sub>	461.5 <sup>b</sup>
N I	4s	995 <sup>a</sup>	M I	3s	5367	N VII	4f <sub>7/2</sub>	238 <sup>a</sup>	M IV	3d <sub>3/2</sub>	284.2 <sup>b</sup>
N II	4p <sub>1/2</sub>	851 <sup>a</sup>	M II	3p <sub>1/2</sub>	5001	O I	5s	214 <sup>a</sup>	M V	3d <sub>5/2</sub>	280.0 <sup>b</sup>
N III	4p <sub>3/2</sub>	705 <sup>a</sup>	M III	3p <sub>3/2</sub>	4174	O II	5p <sub>1/2</sub>	164 <sup>a</sup>	N I	4s	75.0 <sup>b</sup>
N IV	4d <sub>3/2</sub>	500 <sup>a</sup>	M IV	3d <sub>3/2</sub>	3611	O III	5p <sub>3/2</sub>	127 <sup>a</sup>	N II	4p <sub>1/2</sub>	46.5 <sup>b</sup>
N V	4d <sub>5/2</sub>	473 <sup>a</sup>	M V	3d <sub>5/2</sub>	3442	O IV	5d <sub>3/2</sub>	48 <sup>a</sup>	N III	4p <sub>3/2</sub>	43.2 <sup>b</sup>
N VI	4f <sub>5/2</sub>	184 <sup>a</sup>	N I	4s	1387 <sup>a</sup>	O V	5d <sub>5/2</sub>	48 <sup>a</sup>	<b>Samarium (62)</b>		
N VII	4f <sub>7/2</sub>	184 <sup>a</sup>	N II	4p <sub>1/2</sub>	1224 <sup>a</sup>	P I	6s	26	K	1s	46834
O I	5s	177 <sup>a</sup>	N III	4p <sub>3/2</sub>	1007 <sup>a</sup>	<b>Rhenium (75)</b>			L I	2s	7737
			N IV	4d <sub>3/2</sub>	743 <sup>a</sup>	K	1s	71676	L II	2p <sub>1/2</sub>	7312



L III	2p <sub>3/2</sub>	6716	L II	2p <sub>1/2</sub>	2007	N IV	4d <sub>3/2</sub>	41.9 <sup>b</sup>	O I	5s	290 <sup>a,c</sup>		
M I	3s	1723	L III	2p <sub>3/2</sub>	1940	N V	4d <sub>5/2</sub>	40.4 <sup>b</sup>	O II	5p <sub>1/2</sub>	229 <sup>a,c</sup>		
M II	3p <sub>1/2</sub>	1541	M I	3s	358.7 <sup>b</sup>	<i>Terbium (65)</i>					O III	5p <sub>3/2</sub>	182 <sup>a,c</sup>
M III	3p <sub>3/2</sub>	1419.8	M II	3p <sub>1/2</sub>	280.3 <sup>b</sup>	K	1s	51996	O IV	5d <sub>3/2</sub>	92.5 <sup>b</sup>		
M IV	3d <sub>3/2</sub>	1110.9 <sup>a</sup>	M III	3p <sub>3/2</sub>	270.0 <sup>b</sup>	L I	2s	8708	O V	5d <sub>5/2</sub>	85.4 <sup>b</sup>		
M V	3d <sub>5/2</sub>	1083.4 <sup>a</sup>	M IV	3d <sub>3/2</sub>	136.0 <sup>b</sup>	L II	2p <sub>1/2</sub>	8252	P I	6s	41.4 <sup>b</sup>		
N I	4s	347.2 <sup>a</sup>	M V	3d <sub>5/2</sub>	134.2 <sup>b</sup>	L III	2p <sub>3/2</sub>	7514	P II	6p <sub>1/2</sub>	24.5 <sup>b</sup>		
N II	4p <sub>1/2</sub>	265.6	N I	4s	38.9 <sup>b</sup>	M I	3s	1968	P III	6p <sub>3/2</sub>	16.6 <sup>b</sup>		
N III	4p <sub>3/2</sub>	247.4	N II	4p <sub>1/2</sub>	21.6 <sup>b</sup>	M II	3p <sub>1/2</sub>	1768	<i>Thulium (69)</i>				
N IV	4d <sub>3/2</sub>	129.0	N III	4p <sub>3/2</sub>	20.1 <sup>b</sup>	M III	3p <sub>3/2</sub>	1611	K	1s	59390		
N V	4d <sub>5/2</sub>	129.0	<i>Sulfur (16)</i>					M IV	3d <sub>3/2</sub>	1267.9 <sup>a</sup>	L I	2s	10116
N VI	4f <sub>5/2</sub>	5.2	K	1s	2472	M V	3d <sub>5/2</sub>	1241.1 <sup>a</sup>	L II	2p <sub>1/2</sub>	9617		
N VII	4f <sub>7/2</sub>	5.2	L I	2s	230.9 <sup>a,d</sup>	N I	4s	396.0 <sup>a</sup>	L III	2p <sub>3/2</sub>	8648		
O I	5s	37.4	L II	2p <sub>1/2</sub>	163.6 <sup>a</sup>	N II	4p <sub>1/2</sub>	322.4 <sup>a</sup>	M I	3s	2307		
O II	5p <sub>1/2</sub>	21.3	L III	2p <sub>3/2</sub>	162.5 <sup>a</sup>	N III	4p <sub>3/2</sub>	284.1 <sup>a</sup>	M II	3p <sub>1/2</sub>	2090		
O III	5p <sub>3/2</sub>	21.3	<i>Tantalum (73)</i>					N IV	4d <sub>3/2</sub>	150.5 <sup>a</sup>	M III	3p <sub>3/2</sub>	1885
<i>Scandium (21)</i>			K	1s	67416	N V	4d <sub>5/2</sub>	150.5 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1515		
K	1s	4492	L I	2s	11682	N VI	4f <sub>5/2</sub>	7.7 <sup>a</sup>	M V	3d <sub>5/2</sub>	1468		
L I	2s	498.0 <sup>a</sup>	L II	2p <sub>1/2</sub>	11136	N VII	4f <sub>7/2</sub>	2.4 <sup>a</sup>	N I	4s	470.9 <sup>a</sup>		
L II	2p <sub>1/2</sub>	403.6 <sup>a</sup>	L III	2p <sub>3/2</sub>	9881	O I	5s	45.6 <sup>a</sup>	N II	4p <sub>1/2</sub>	385.9 <sup>a</sup>		
L III	2p <sub>3/2</sub>	389.7 <sup>a</sup>	M I	3s	2708	O II	5p <sub>1/2</sub>	28.7 <sup>a</sup>	N III	4p <sub>3/2</sub>	332.6 <sup>a</sup>		
M I	3s	51.1 <sup>a</sup>	M II	3p <sub>1/2</sub>	2469	O III	5p <sub>3/2</sub>	22.6 <sup>a</sup>	N IV	4d <sub>3/2</sub>	175.5 <sup>a</sup>		
M II	3p <sub>1/2</sub>	28.3 <sup>a</sup>	M III	3p <sub>3/2</sub>	2194	<i>Thallium (81)</i>					N V	4d <sub>5/2</sub>	175.5 <sup>a</sup>
M III	3p <sub>3/2</sub>	28.3 <sup>a</sup>	M IV	3d <sub>3/2</sub>	1793	K	1s	85530	N VI	4f <sub>5/2</sub>	—		
<i>Selenium (34)</i>			M V	3d <sub>5/2</sub>	1735	L I	2s	15347	N VII	4f <sub>7/2</sub>	4.6		
K	1s	12658	N I	4s	563.4 <sup>b</sup>	L II	2p <sub>1/2</sub>	14698	O I	5s	54.7 <sup>a</sup>		
L I	2s	1652.0 <sup>a,d</sup>	N II	4p <sub>1/2</sub>	463.4 <sup>b</sup>	L III	2p <sub>3/2</sub>	12658	O II	5p <sub>1/2</sub>	31.8 <sup>a</sup>		
L II	2p <sub>1/2</sub>	1474.3 <sup>a,d</sup>	N III	4p <sub>3/2</sub>	400.9 <sup>b</sup>	M I	3s	3704	O III	5p <sub>3/2</sub>	25.0 <sup>a</sup>		
L III	2p <sub>3/2</sub>	1433.9 <sup>a,d</sup>	N IV	4d <sub>3/2</sub>	237.9 <sup>b</sup>	M II	3p <sub>1/2</sub>	3416	<i>Tin (50)</i>				
M I	3s	229.6 <sup>a</sup>	N V	4d <sub>5/2</sub>	226.4 <sup>b</sup>	M III	3p <sub>3/2</sub>	2957	K	1s	29200		
M II	3p <sub>1/2</sub>	166.5 <sup>a</sup>	N VI	4f <sub>5/2</sub>	23.5 <sup>b</sup>	M IV	3d <sub>3/2</sub>	2485	L I	2s	4465		
M III	3p <sub>3/2</sub>	160.7 <sup>a</sup>	N VII	4f <sub>7/2</sub>	21.6 <sup>b</sup>	M V	3d <sub>5/2</sub>	2389	L II	2p <sub>1/2</sub>	4156		
M IV	3d <sub>3/2</sub>	55.5 <sup>a</sup>	O I	5s	69.7 <sup>b</sup>	N I	4s	846.2 <sup>b</sup>	L III	2p <sub>3/2</sub>	3929		
M V	3d <sub>5/2</sub>	54.6 <sup>a</sup>	O II	5p <sub>1/2</sub>	42.2 <sup>a</sup>	N II	4p <sub>1/2</sub>	720.5 <sup>b</sup>	M I	3s	884.7 <sup>b</sup>		
<i>Silicon (14)</i>			O III	5p <sub>3/2</sub>	32.7 <sup>b</sup>	N III	4p <sub>3/2</sub>	609.5 <sup>b</sup>	M II	3p <sub>1/2</sub>	756.5 <sup>b</sup>		
K	1s	1839	<i>Technetium (43)</i>					N IV	4d <sub>3/2</sub>	405.7 <sup>b</sup>	M III	3p <sub>3/2</sub>	714.6 <sup>b</sup>
L I	2s	149.7 <sup>a,d</sup>	K	1s	21044	N V	4d <sub>5/2</sub>	385.0 <sup>b</sup>	M IV	3d <sub>3/2</sub>	493.2 <sup>b</sup>		
L II	2p <sub>1/2</sub>	99.8 <sup>a</sup>	L I	2s	3043	N VI	4f <sub>5/2</sub>	122.2 <sup>b</sup>	M V	3d <sub>5/2</sub>	484.9 <sup>b</sup>		
L III	2p <sub>3/2</sub>	99.2 <sup>a</sup>	L II	2p <sub>1/2</sub>	2793	N VII	4f <sub>7/2</sub>	117.8 <sup>b</sup>	N I	4s	137.1 <sup>b</sup>		
<i>Silver (47)</i>			L III	2p <sub>3/2</sub>	2677	O I	5s	136 <sup>a,d</sup>	N II	4p <sub>1/2</sub>	83.6 <sup>b,c</sup>		
K	1s	25514	M I	3s	586.1 <sup>a</sup>	O II	5p <sub>1/2</sub>	94.6 <sup>b</sup>	N III	4p <sub>3/2</sub>	83.6 <sup>b,c</sup>		
L I	2s	3806	M II	3p <sub>1/2</sub>	447.6 <sup>a</sup>	O III	5p <sub>3/2</sub>	73.5 <sup>b</sup>	N IV	4d <sub>3/2</sub>	24.9 <sup>b</sup>		
L II	2p <sub>1/2</sub>	3524	M III	3p <sub>3/2</sub>	417.7 <sup>a</sup>	O IV	5d <sub>3/2</sub>	14.7 <sup>b</sup>	N V	4d <sub>5/2</sub>	23.9 <sup>b</sup>		
L III	2p <sub>3/2</sub>	3351	M IV	3d <sub>3/2</sub>	257.6 <sup>a</sup>	O V	5d <sub>5/2</sub>	12.5 <sup>b</sup>	<i>Titanium (22)</i>				
M I	3s	719.0 <sup>b</sup>	M V	3d <sub>5/2</sub>	253.9 <sup>a</sup>	<i>Thorium (90)</i>					K	1s	4966
M II	3p <sub>1/2</sub>	603.8 <sup>b</sup>	N I	4s	69.5 <sup>a</sup>	K	1s	109651	L I	2s	560.9 <sup>b</sup>		
M III	3p <sub>3/2</sub>	573.0 <sup>b</sup>	N II	4p <sub>1/2</sub>	42.3 <sup>a</sup>	L I	2s	20472	L II	2p <sub>1/2</sub>	460.2 <sup>b</sup>		
M IV	3d <sub>3/2</sub>	374.0 <sup>b</sup>	N III	4p <sub>3/2</sub>	39.9 <sup>a</sup>	L II	2p <sub>1/2</sub>	19693	L III	2p <sub>3/2</sub>	453.8 <sup>b</sup>		
M V	3d <sub>5/2</sub>	368.0 <sup>b</sup>	<i>Tellurium (52)</i>					L III	2p <sub>3/2</sub>	16300	M I	3s	58.7 <sup>b</sup>
N I	4s	97.0 <sup>b</sup>	K	1s	31814	M I	3s	5182	M II	3p <sub>1/2</sub>	32.6 <sup>b</sup>		
N II	4p <sub>1/2</sub>	63.7 <sup>b</sup>	L I	2s	4939	M II	3p <sub>1/2</sub>	4830	M III	3p <sub>3/2</sub>	32.6 <sup>b</sup>		
N III	4p <sub>3/2</sub>	58.3 <sup>b</sup>	L II	2p <sub>1/2</sub>	4612	M III	3p <sub>3/2</sub>	4046	<i>Tungsten (74)</i>				
<i>Sodium (11)</i>			L III	2p <sub>3/2</sub>	4341	M IV	3d <sub>3/2</sub>	3491	K	1s	69525		
K	1s	1070.8 <sup>b</sup>	M I	3s	1006 <sup>b</sup>	M V	3d <sub>5/2</sub>	3332	L I	2s	12100		
L I	2s	63.5 <sup>b</sup>	M II	3p <sub>1/2</sub>	870.8 <sup>b</sup>	N I	4s	1330 <sup>a</sup>	L II	2p <sub>1/2</sub>	11544		
L II	2p <sub>1/2</sub>	30.4 <sup>b</sup>	M III	3p <sub>3/2</sub>	820.0 <sup>b</sup>	N II	4p <sub>1/2</sub>	1168 <sup>a</sup>	L III	2p <sub>3/2</sub>	10207		
L III	2p <sub>3/2</sub>	30.5 <sup>a</sup>	M IV	3d <sub>3/2</sub>	583.4 <sup>b</sup>	N III	4p <sub>3/2</sub>	966.4 <sup>b</sup>	M I	3s	2820		
<i>Strontium (38)</i>			M V	3d <sub>5/2</sub>	573.0 <sup>b</sup>	N IV	4d <sub>3/2</sub>	712.1 <sup>b</sup>	M II	3p <sub>1/2</sub>	2575		
K	1s	16105	N I	4s	169.4 <sup>b</sup>	N V	4d <sub>5/2</sub>	675.2 <sup>b</sup>	M III	3p <sub>3/2</sub>	2281		
L I	2s	2216	N II	4p <sub>1/2</sub>	103.3 <sup>b,c</sup>	N VI	4f <sub>5/2</sub>	342.4 <sup>b</sup>	M IV	3d <sub>3/2</sub>	1949		
			N III	4p <sub>3/2</sub>	103.3 <sup>b,c</sup>	N VII	4f <sub>7/2</sub>	333.1 <sup>b</sup>					

M V	3d <sub>5/2</sub>	1809	O II	5p <sub>1/2</sub>	257 <sup>a,c,d</sup>	N VII	4f <sub>7/2</sub>	—	M III	3p <sub>3/2</sub>	298.8 <sup>a</sup>		
N I	4s	594.1 <sup>b</sup>	O III	5p <sub>3/2</sub>	192 <sup>a,c,d</sup>	O I	5s	23.3 <sup>a</sup>	M IV	3d <sub>3/2</sub>	157.7 <sup>b</sup>		
N II	4p <sub>1/2</sub>	490.4 <sup>b</sup>	O IV	5d <sub>3/2</sub>	102.8 <sup>b</sup>	O II	5p <sub>1/2</sub>	13.4 <sup>a</sup>	M V	3d <sub>5/2</sub>	155.8 <sup>b</sup>		
N III	4p <sub>3/2</sub>	423.6 <sup>b</sup>	O V	5d <sub>5/2</sub>	94.2 <sup>b</sup>	O III	5p <sub>3/2</sub>	12.1 <sup>a</sup>	N I	4s	43.8 <sup>a</sup>		
N IV	4d <sub>3/2</sub>	255.9 <sup>b</sup>	P I	6s	43.9 <sup>b</sup>	<i>Ytterbium (70)</i>					N II	4p <sub>1/2</sub>	24.4 <sup>a</sup>
N V	4d <sub>5/2</sub>	243.5 <sup>b</sup>	P II	6p <sub>1/2</sub>	26.8 <sup>b</sup>	K	1s	61332	N III	4p <sub>3/2</sub>	23.1 <sup>a</sup>		
N VI	4f <sub>5/2</sub>	33.6 <sup>a</sup>	P III	6p <sub>3/2</sub>	16.8 <sup>b</sup>	L I	2s	10486	<i>Zinc (30)</i>				
N VII	4f <sub>7/2</sub>	31.4 <sup>b</sup>	<i>Vanadium (23)</i>			L II	2p <sub>1/2</sub>	9978	K	1s	9659		
O I	5s	75.6 <sup>b</sup>	K	1s	5465	L III	2p <sub>3/2</sub>	8944	L I	2s	1196.2 <sup>a</sup>		
O II	5p <sub>1/2</sub>	453 <sup>a,d</sup>	L I	2s	626.7 <sup>b</sup>	M I	3s	2398	L II	2p <sub>1/2</sub>	1044.9 <sup>a</sup>		
O III	5p <sub>3/2</sub>	36.8 <sup>b</sup>	L II	2p <sub>1/2</sub>	519.8 <sup>b</sup>	M II	3p <sub>1/2</sub>	2173	L III	2p <sub>3/2</sub>	1021.8 <sup>a</sup>		
<i>Uranium (92)</i>			L III	2p <sub>3/2</sub>	521.1 <sup>b</sup>	M III	3p <sub>3/2</sub>	1950	M I	3s	139.8 <sup>a</sup>		
K	1s	115606	M I	3s	66.3 <sup>b</sup>	M IV	3d <sub>3/2</sub>	1576	M II	3p <sub>1/2</sub>	91.4 <sup>a</sup>		
L I	2s	21757	M II	3p <sub>1/2</sub>	37.2 <sup>b</sup>	M V	3d <sub>5/2</sub>	1528	M III	3p <sub>3/2</sub>	88.6 <sup>a</sup>		
L II	2p <sub>1/2</sub>	20948	M III	3p <sub>3/2</sub>	37.2 <sup>b</sup>	N I	4s	480.5 <sup>a</sup>	M IV	3d <sub>3/2</sub>	10.2 <sup>a</sup>		
L III	2p <sub>3/2</sub>	17166	<i>Xenon (54)</i>			N II	4p <sub>1/2</sub>	388.7 <sup>a</sup>	M V	3d <sub>5/2</sub>	10.1 <sup>a</sup>		
M I	3s	5548	K	1s	34561	N III	4p <sub>3/2</sub>	339.7 <sup>a</sup>	<i>Zirconium (40)</i>				
M II	3p <sub>1/2</sub>	5182	L I	2s	5453	N IV	4d <sub>3/2</sub>	191.2 <sup>a</sup>	K	1s	17998		
M III	3p <sub>3/2</sub>	4303	L II	2p <sub>1/2</sub>	5107	N V	4d <sub>5/2</sub>	182.4 <sup>a</sup>	L I	2s	2532		
M IV	3d <sub>3/2</sub>	3728	L III	2p <sub>3/2</sub>	4786	N VI	4f <sub>5/2</sub>	2.5 <sup>a</sup>	L II	2p <sub>1/2</sub>	2307		
M V	3d <sub>5/2</sub>	3552	M I	3s	1148.7 <sup>a</sup>	N VII	4f <sub>7/2</sub>	1.3 <sup>a</sup>	L III	2p <sub>3/2</sub>	2223		
N I	4s	1439 <sup>a,d</sup>	M II	3p <sub>1/2</sub>	1002.1 <sup>a</sup>	O I	5s	52.0 <sup>a</sup>	M I	3s	430.3 <sup>b</sup>		
N II	4p <sub>1/2</sub>	1271 <sup>a,d</sup>	M III	3p <sub>3/2</sub>	940.6 <sup>a</sup>	O II	5p <sub>1/2</sub>	30.3 <sup>a</sup>	M II	3p <sub>1/2</sub>	343.5 <sup>b</sup>		
N III	4p <sub>3/2</sub>	1043 <sup>b</sup>	M IV	3d <sub>3/2</sub>	689.0 <sup>a</sup>	O III	5p <sub>3/2</sub>	24.1 <sup>a</sup>	M III	3p <sub>3/2</sub>	329.8 <sup>b</sup>		
N IV	4d <sub>3/2</sub>	778.3 <sup>b</sup>	M V	3d <sub>5/2</sub>	676.4 <sup>a</sup>	<i>Yttrium (39)</i>					M IV	3d <sub>3/2</sub>	181.1 <sup>b</sup>
N V	4d <sub>5/2</sub>	736.2 <sup>b</sup>	N I	4s	213.2 <sup>a</sup>	K	1s	17038	M V	3d <sub>5/2</sub>	178.8 <sup>b</sup>		
N VI	4f <sub>5/2</sub>	388.2 <sup>a</sup>	N II	4p <sub>1/2</sub>	146.7	L I	2s	2373	N I	4s	50.6 <sup>b</sup>		
N VII	4f <sub>7/2</sub>	377.4 <sup>b</sup>	N III	4p <sub>3/2</sub>	145.5 <sup>a</sup>	L II	2p <sub>1/2</sub>	2156	N II	4p <sub>1/2</sub>	28.5 <sup>b</sup>		
O I	5s	321 <sup>a,c,d</sup>	N IV	4d <sub>3/2</sub>	69.5 <sup>a</sup>	L III	2p <sub>3/2</sub>	2080	N III	4p <sub>3/2</sub>	27.1 <sup>b</sup>		
			N V	4d <sub>5/2</sub>	67.5 <sup>a</sup>	M I	3s	392.0 <sup>a,d</sup>					
			N VI	4f <sub>5/2</sub>	—	M II	3p <sub>1/2</sub>	310.6 <sup>a</sup>					

<sup>a</sup> Reference 1.<sup>b</sup> Reference 2 (remaining values from Reference 3).<sup>c</sup> One-particle approximation not valid.<sup>d</sup> Derived using energy differences from Reference 3.

## NATURAL WIDTH OF X-RAY LINES

Natural widths of K X-ray lines in eV:

Element	$K\alpha_1$	$K\alpha_2$	$K\beta_1$	$K\beta_3$	Element	$K\alpha_1$	$K\alpha_2$	$K\beta_1$	$K\beta_3$
Ca	1.00	0.98			Ce	18.60	19.50	20.60	18.60
Ti	1.45	2.13			Nd	21.50	21.50	23.25	21.33
Cr	2.05	2.64			Sm	26.00	24.70	25.65	24.65
Fe	2.45	3.20			Gd	29.50	28.00	29.37	28.00
Ni	3.00	3.70			Dy	33.90	32.20	32.73	32.00
Zn	3.40	3.96			Er	35.00	35.50	36.20	35.70
Ge	3.75	4.18			Yb	38.80	40.60	41.43	41.15
Se	4.10	4.43			Hf	42.70	44.30	46.00	46.10
Kr	4.23	4.62			W	46.80	48.00	51.83	51.50
Sr	5.17	4.97			Os	49.00	49.40	55.90	55.95
Zr	5.70	5.25			Pt	54.10	54.30	59.98	62.13
Mo	6.82	6.80			Hg	64.75	68.20	65.75	68.95
Ru	7.41	7.96			Pb	67.10	72.30	72.20	73.80
Pd	8.80	9.20			Po	73.20	75.10	78.60	80.10
Cd	9.80	10.40			Rn	80.00	81.50	85.50	86.50
Sn	11.20	12.40	11.80	11.00	Ra	87.00	88.20	94.20	95.50
Te	12.80	14.20	13.30	13.10	Th	94.70	95.00	99.70	101.00
Xe	14.20	15.10	15.30	14.50	U	103.00	104.30	105.00	107.30
Ba	16.10	16.80	18.15	16.70					

From Salem, S. I. and Lee, P. L., *At. Data Nucl. Data Tables*, 18, 233, 1976.

Natural widths of L X-ray lines in eV:

Element	$L\alpha_1$	$L\alpha_2$	$L\beta_1$	$L\beta_2$	$L\beta_3$	$L\beta_4$	$Ly_1$
Zr	1.68	1.52	1.87	5.13	5.50	5.60	3.34
Mo	1.86	1.80	2.03	5.30	5.90	5.78	3.76
Ru	2.03	1.98	2.18	5.45	6.35	5.96	4.15
Pd	2.21	2.16	2.36	5.63	6.80	6.18	4.50
Gd	2.43	2.40	2.54	5.82	7.23	6.28	4.83
Sn	2.62	2.62	2.75	6.10	7.70	6.60	5.23
Tc	2.88	2.88	2.96	6.25	8.22	6.82	5.60
Xe	3.15	3.15	3.20	6.43	8.70	7.15	5.95
Ba	3.39	3.45	3.45	6.70	9.20	7.42	6.35
Ce	3.70	3.78	3.73	6.86	9.70	7.82	6.75
Nd	3.93	4.08	4.00	7.18	10.30	8.15	7.16
Sm	4.13	4.50	4.33	7.42	10.80	8.60	7.50
Cd	4.46	4.90	4.63	7.70	11.20	9.08	7.83
Dy	4.81	5.35	5.03	7.90	11.50	9.60	8.30
Er	5.17	5.73	5.45	8.28	11.85	10.03	8.75
Yb	5.40	6.22	5.90	8.58	12.20	11.00	9.20
Hf	5.83	6.70	6.36	8.92	12.40	12.80	9.63
W	6.50	7.20	6.90	9.06	13.10	14.60	10.20
Os	7.04	7.70	7.42	9.60	14.60	16.50	10.65
Pt	7.60	8.28	8.00	9.95	16.10	18.00	11.20
Hg	8.10	8.80	8.70	10.40	17.40	19.70	11.80
Pb	8.82	9.35	9.35	10.75	18.65	21.30	12.30
Po	9.50	9.95	10.10	11.25	19.90	22.70	13.05
Rn	10.03	10.50	10.65	11.65	21.00	24.00	13.55
Ra	11.00	11.20	11.60	12.20	22.00	25.20	14.30
Th	11.90	11.80	12.40	12.80	22.85	26.35	15.00
U	12.40	12.40	13.50	13.30	23.70	27.50	15.70
Pu	13.20	13.00	14.10	13.90	24.10	28.30	16.40
Cm	14.80	13.60	15.70	14.60	25.00	29.40	17.10

# PHOTON ATTENUATION COEFFICIENTS

Martin J. Berger and John H. Hubbell

This table gives mass attenuation coefficients for photons for all elements at energies between 1 keV (soft x-rays) and 1 GeV (hard gamma rays). The mass attenuation coefficient  $\mu$  describes the attenuation of radiation as it passes through matter by the relation

$$I(x)/I_0 = e^{-\mu\rho x}$$

where  $I_0$  is the initial intensity,  $I(x)$  the intensity after path length  $x$ , and  $\rho$  is the mass density of the element in question. To a high approximation the mass attenuation coefficient is additive for the elements present, independent of the way in which they are bound in chemical compounds.

The power of ten is indicated beside each number in the table; i.e., 7.41 + 03 means  $7.41 \times 10^3$ . A vertical line between two columns indicates that an absorption edge lies between those energy values. The various edges are labeled at the bottom of the table.

The attenuation coefficients were calculated with the computer program XCOM (Reference 1), which uses a cross-section database compiled at the Photon and Charged Particle Data Center at the National Institute of Standards and Technology. Their accuracy has been confirmed at all energies by extensive comparisons with experimental attenuation coefficients. Such comparisons for X-ray energies up to 100 keV can be found in Reference 2.

## References

1. Berger, M. J. and Hubbell, J. H., *National Bureau of Standards Report NBSIR-87-3597*, 1987.
2. Saloman, E. B., Hubbell, J. H., and Scofield, J. H., *Atomic Data and Nuclear Data Tables*, 38, 1, 1988.

		Mass attenuation coefficient, cm <sup>2</sup> /g								
		Photon energy, MeV								
Atomic no.		0.001	0.002	0.005	0.01	0.02	0.05	0.1	0.2	0.5
H	1	7.21 + 00	1.06 + 00	4.19-01	3.85-01	3.69-01	3.36-01	2.94-01	2.43-01	1.73-01
He	2	6.08 + 01	6.86 + 00	5.77-01	2.48-01	1.96-01	1.70-01	1.49-01	1.22-01	8.71-02
Li	3	2.34 + 02	2.71 + 01	1.62 + 00	3.40-01	1.86-01	1.49-01	1.29-01	1.06-01	7.53-02
Be	4	6.04 + 02	7.47 + 01	4.37 + 00	6.47-01	2.25-01	1.55-01	1.33-01	1.09-01	7.74-02
B	5	1.23 + 03	1.60 + 02	9.68 + 00	1.25 + 00	3.01-01	1.66-01	1.39-01	1.14-01	8.07-02
C	6	2.21 + 03	3.03 + 02	1.91 + 01	2.37 + 00	4.42-01	1.87-01	1.51-01	1.23-01	8.72-02
N	7	3.31 + 03	4.77 + 02	3.14 + 01	3.88 + 00	6.18-01	1.98-01	1.53-01	1.23-01	8.72-02
O	8	4.59 + 03	6.95 + 02	4.79 + 01	5.95 + 00	8.65-01	2.13-01	1.55-01	1.24-01	8.73-02
F	9	5.65 + 03	9.05 + 02	6.51 + 01	8.21 + 00	1.13 + 00	2.21-01	1.50-01	1.18-01	8.27-02
Ne	10	7.41 + 03	1.24 + 03	9.34 + 01	1.20 + 01	1.61 + 00	2.58-01	1.60-01	1.24-01	8.66-02
Na	11	6.54 + 02	1.52 + 03	1.19 + 02	1.56 + 01	2.06 + 00	2.80-01	1.59-01	1.20-01	8.37-02
Mg	12	9.22 + 02	1.93 + 03	1.58 + 02	2.11 + 01	2.76 + 00	3.29-01	1.69-01	1.24-01	8.65-02
Al	13	1.19 + 03	2.26 + 03	1.93 + 02	2.62 + 01	3.44 + 00	3.68-01	1.70-01	1.22-01	8.44-02
Si	14	1.57 + 03	2.78 + 03	2.45 + 02	3.39 + 01	4.46 + 00	4.38-01	1.84-01	1.28-01	8.75-02
P	15	1.91 + 03	3.02 + 02	2.86 + 02	4.04 + 01	5.35 + 00	4.92-01	1.87-01	1.25-01	8.51-02
S	16	2.43 + 03	3.85 + 02	3.49 + 02	5.01 + 01	6.71 + 00	5.85-01	2.02-01	1.30-01	8.78-02
Cl	17	2.83 + 03	4.52 + 02	3.90 + 02	5.73 + 01	7.74 + 00	6.48-01	2.05-01	1.27-01	8.45-02
Ar	18	3.18 + 03	5.12 + 02	4.23 + 02	6.32 + 01	8.63 + 00	7.01-01	2.04-01	1.20-01	7.96-02
K	19	4.06 + 03	6.59 + 02	5.19 + 02	7.91 + 01	1.09 + 01	8.68-01	2.34-01	1.32-01	8.60-02
Ca	20	4.87 + 03	8.00 + 02	6.03 + 02	9.34 + 01	1.31 + 01	1.02 + 00	2.57-01	1.38-01	8.85-02
Sc	21	5.24 + 03	8.70 + 02	6.31 + 02	9.95 + 01	1.41 + 01	1.09 + 00	2.58-01	1.31-01	8.31-02
Ti	22	5.87 + 03	9.86 + 02	6.84 + 02	1.11 + 02	1.59 + 01	1.21 + 00	2.72-01	1.31-01	8.19-02
V	23	6.50 + 03	1.11 + 03	9.29 + 01	1.22 + 02	1.77 + 01	1.35 + 00	2.88-01	1.32-01	8.07-02
Cr	24	7.40 + 03	1.28 + 03	1.08 + 02	1.39 + 02	2.04 + 01	1.55 + 00	3.17-01	1.38-01	8.28-02
Mn	25	8.09 + 03	1.42 + 03	1.21 + 02	1.51 + 02	2.25 + 01	1.71 + 00	3.37-01	1.39-01	8.19-02
Fe	26	9.09 + 03	1.63 + 03	1.40 + 02	1.71 + 02	2.57 + 01	1.96 + 00	3.72-01	1.46-01	8.41-02
Co	27	9.80 + 03	1.78 + 03	1.54 + 02	1.84 + 02	2.80 + 01	2.14 + 00	3.95-01	1.48-01	8.32-02
Ni	28	9.86 + 03	2.05 + 03	1.79 + 02	2.09 + 02	3.22 + 01	2.47 + 00	4.44-01	1.58-01	8.70-02
Cu	29	1.06 + 04	2.15 + 03	1.90 + 02	2.16 + 02	3.38 + 01	2.61 + 00	4.58-01	1.56-01	8.36-02
Zn	30	1.55 + 03	2.37 + 03	2.12 + 02	2.33 + 02	3.72 + 01	2.89 + 00	4.97-01	1.62-01	8.45-02
Ga	31	1.70 + 03	2.52 + 03	2.27 + 02	3.42 + 01	3.93 + 01	3.08 + 00	5.20-01	1.62-01	8.24-02
Ge	32	1.89 + 03	2.71 + 03	2.47 + 02	3.74 + 01	4.22 + 01	3.34 + 00	5.55-01	1.66-01	8.21-02
As	33	2.12 + 03	2.93 + 03	2.71 + 02	4.12 + 01	4.56 + 01	3.63 + 00	5.97-01	1.72-01	8.26-02
Se	34	2.32 + 03	3.10 + 03	2.90 + 02	4.41 + 01	4.82 + 01	3.86 + 00	6.28-01	1.74-01	8.13-02
Br	35	2.62 + 03	3.41 + 03	3.21 + 02	4.91 + 01	5.27 + 01	4.26 + 00	6.86-01	1.84-01	8.33-02
Kr	36	2.85 + 03	3.60 + 03	3.43 + 02	5.26 + 01	5.55 + 01	4.52 + 00	7.22-01	1.87-01	8.23-02
Rb	37	3.17 + 03	3.41 + 03	3.74 + 02	5.77 + 01	5.98 + 01	4.92 + 00	7.80-01	1.96-01	8.36-02
Sr	38	3.49 + 03	2.59 + 03	4.06 + 02	6.27 + 01	6.39 + 01	5.31 + 00	8.37-01	2.04-01	8.44-02
Y	39	3.86 + 03	7.42 + 02	4.42 + 02	6.87 + 01	6.86 + 01	5.76 + 00	9.05-01	2.15-01	8.61-02
Zr	40	4.21 + 03	8.12 + 02	4.76 + 02	7.42 + 01	7.24 + 01	6.17 + 00	9.66-01	2.24-01	8.69-02
Nb	41	4.60 + 03	8.89 + 02	5.13 + 02	8.04 + 01	7.71 + 01	6.64 + 00	1.04 + 00	2.34-01	8.83-02
Mo	42	4.94 + 03	9.60 + 02	5.45 + 02	8.58 + 01	1.31 + 01	7.04 + 00	1.10 + 00	2.42-01	8.85-02
Tc	43	5.36 + 03	1.04 + 03	5.84 + 02	9.23 + 01	1.41 + 01	7.52 + 00	1.17 + 00	2.53-01	8.97-02
Ru	44	5.72 + 03	1.12 + 03	6.17 + 02	9.80 + 01	1.50 + 01	7.92 + 00	1.23 + 00	2.62-01	8.99-02
Rh	45	6.17 + 03	1.21 + 03	6.59 + 02	1.05 + 02	1.61 + 01	8.45 + 00	1.31 + 00	2.74-01	9.13-02
Pd	46	6.54 + 03	1.29 + 03	6.91 + 02	1.11 + 02	1.70 + 01	8.85 + 00	1.38 + 00	2.83-01	9.13-02
Ag	47	7.04 + 03	1.40 + 03	7.39 + 02	1.19 + 02	1.84 + 01	9.45 + 00	1.47 + 00	2.97-01	9.32-02
Cd	48	7.35 + 03	1.47 + 03	7.69 + 02	1.24 + 02	1.92 + 01	9.78 + 00	1.52 + 00	3.04-01	9.25-02
In	49	7.81 + 03	1.58 + 03	8.13 + 02	1.32 + 02	2.04 + 01	1.03 + 01	1.61 + 00	3.17-01	9.37-02
Sn	50	8.16 + 03	1.66 + 03	8.47 + 02	1.38 + 02	2.15 + 01	1.07 + 01	1.68 + 00	3.26-01	9.37-02

L<sub>3</sub> L<sub>1</sub>  
L<sub>2</sub>

K EDGE

		Mass attenuation coefficient, cm <sup>2</sup> /g								
		Photon energy, MeV								
Atomic	no.	1.0	2.0	5.0	10.0	20.0	50.0	100.0	500.0	1000.0
H	1	1.26-01	8.77-02	5.05-02	3.25-02	2.15-02	1.42-02	1.19-02	1.14-02	1.16-02
He	2	6.36-02	4.42-02	2.58-02	1.70-02	1.18-02	8.61-03	7.78-03	7.79-03	7.95-03
Li	3	5.50-02	3.83-02	2.26-02	1.53-02	1.11-02	8.68-03	8.21-03	8.61-03	8.87-03
Be	4	5.65-02	3.94-02	2.35-02	1.63-02	1.23-02	1.02-02	9.94-03	1.08-02	1.12-02
B	5	5.89-02	4.11-02	2.48-02	1.76-02	1.37-02	1.19-02	1.19-02	1.32-02	1.37-02
C	6	6.36-02	4.44-02	2.71-02	1.96-02	1.58-02	1.43-02	1.46-02	1.64-02	1.70-02
N	7	6.36-02	4.45-02	2.74-02	2.02-02	1.67-02	1.57-02	1.63-02	1.85-02	1.92-02
O	8	6.37-02	4.46-02	2.78-02	2.09-02	1.77-02	1.71-02	1.79-02	2.06-02	2.13-02
F	9	6.04-02	4.23-02	2.66-02	2.04-02	1.77-02	1.75-02	1.86-02	2.14-02	2.21-02
Ne	10	6.32-02	4.43-02	2.82-02	2.20-02	1.95-02	1.96-02	2.11-02	2.43-02	2.51-02
Na	11	6.10-02	4.28-02	2.75-02	2.18-02	1.97-02	2.03-02	2.19-02	2.53-02	2.62-02
Mg	12	6.30-02	4.43-02	2.87-02	2.31-02	2.13-02	2.23-02	2.42-02	2.81-02	2.90-02
Al	13	6.15-02	4.32-02	2.84-02	2.32-02	2.17-02	2.31-02	2.52-02	2.93-02	3.03-02
Si	14	6.36-02	4.48-02	2.97-02	2.46-02	2.34-02	2.52-02	2.76-02	3.23-02	3.34-02
P	15	6.18-02	4.36-02	2.91-02	2.45-02	2.36-02	2.58-02	2.84-02	3.33-02	3.45-02
S	16	6.37-02	4.50-02	3.04-02	2.59-02	2.53-02	2.79-02	3.08-02	3.62-02	3.75-02
Cl	17	6.13-02	4.33-02	2.95-02	2.55-02	2.52-02	2.81-02	3.11-02	3.67-02	3.80-02
Ar	18	5.76-02	4.07-02	2.80-02	2.45-02	2.45-02	2.76-02	3.07-02	3.62-02	3.75-02
K	19	6.22-02	4.40-02	3.05-02	2.70-02	2.74-02	3.11-02	3.46-02	4.09-02	4.24-02
Ca	20	6.39-02	4.52-02	3.17-02	2.84-02	2.90-02	3.32-02	3.71-02	4.40-02	4.56-02
Sc	21	5.98-02	4.24-02	3.00-02	2.72-02	2.80-02	3.23-02	3.62-02	4.30-02	4.45-02
Ti	22	5.89-02	4.18-02	2.98-02	2.73-02	2.84-02	3.30-02	3.71-02	4.40-02	4.56-02
V	23	5.79-02	4.11-02	2.96-02	2.74-02	2.88-02	3.36-02	3.78-02	4.49-02	4.65-02
Cr	24	5.93-02	4.21-02	3.06-02	2.86-02	3.03-02	3.56-02	4.01-02	4.76-02	4.93-02
Mn	25	5.85-02	4.16-02	3.04-02	2.87-02	3.07-02	3.63-02	4.09-02	4.86-02	5.04-02
Fe	26	5.99-02	4.26-02	3.15-02	2.99-02	3.22-02	3.83-02	4.33-02	5.15-02	5.33-02
Co	27	5.91-02	4.20-02	3.13-02	3.00-02	3.26-02	3.88-02	4.40-02	5.23-02	5.41-02
Ni	28	6.16-02	4.39-02	3.29-02	3.18-02	3.48-02	4.17-02	4.73-02	5.61-02	5.81-02
Cu	29	5.90-02	4.20-02	3.18-02	3.10-02	3.41-02	4.10-02	4.66-02	5.53-02	5.72-02
Zn	30	5.94-02	4.24-02	3.22-02	3.18-02	3.51-02	4.24-02	4.82-02	5.72-02	5.91-02
Ga	31	5.77-02	4.11-02	3.16-02	3.13-02	3.48-02	4.22-02	4.80-02	5.70-02	5.89-02
Ge	32	5.73-02	4.09-02	3.16-02	3.16-02	3.53-02	4.30-02	4.89-02	5.80-02	6.00-02
As	33	5.73-02	4.09-02	3.19-02	3.21-02	3.60-02	4.40-02	5.01-02	5.95-02	6.15-02
Se	34	5.62-02	4.01-02	3.14-02	3.19-02	3.60-02	4.41-02	5.03-02	5.97-02	6.17-02
Br	35	5.73-02	4.09-02	3.23-02	3.29-02	3.74-02	4.60-02	5.24-02	6.22-02	6.43-02
Kr	36	5.63-02	4.02-02	3.20-02	3.28-02	3.74-02	4.61-02	5.26-02	6.25-02	6.46-02
Rb	37	5.69-02	4.06-02	3.25-02	3.36-02	3.85-02	4.75-02	5.43-02	6.45-02	6.67-02
Sr	38	5.71-02	4.08-02	3.29-02	3.41-02	3.93-02	4.87-02	5.56-02	6.61-02	6.83-02
Y	39	5.80-02	4.14-02	3.35-02	3.50-02	4.05-02	5.03-02	5.75-02	6.83-02	7.06-02
Zr	40	5.81-02	4.15-02	3.38-02	3.55-02	4.12-02	5.13-02	5.87-02	6.98-02	7.22-02
Nb	41	5.87-02	4.18-02	3.44-02	3.63-02	4.22-02	5.27-02	6.03-02	7.17-02	7.42-02
Mo	42	5.84-02	4.16-02	3.44-02	3.65-02	4.26-02	5.33-02	6.10-02	7.26-02	7.51-02
Tc	43	5.88-02	4.19-02	3.48-02	3.71-02	4.35-02	5.45-02	6.24-02	7.43-02	7.68-02
Ru	44	5.85-02	4.16-02	3.48-02	3.73-02	4.39-02	5.50-02	6.30-02	7.51-02	7.77-02
Rh	45	5.89-02	4.20-02	3.53-02	3.80-02	4.48-02	5.63-02	6.45-02	7.69-02	7.94-02
Pd	46	5.85-02	4.16-02	3.52-02	3.80-02	4.50-02	5.66-02	6.49-02	7.73-02	8.00-02
Ag	47	5.92-02	4.21-02	3.58-02	3.88-02	4.61-02	5.81-02	6.67-02	7.93-02	8.20-02
Cd	48	5.83-02	4.14-02	3.54-02	3.85-02	4.59-02	5.79-02	6.64-02	7.91-02	8.18-02
In	49	5.85-02	4.15-02	3.56-02	3.90-02	4.65-02	5.88-02	6.75-02	8.04-02	8.32-02
Sn	50	5.80-02	4.11-02	3.55-02	3.90-02	4.66-02	5.90-02	6.78-02	8.07-02	8.35-02

		Mass attenuation coefficient, cm <sup>2</sup> /g								
		Photon energy, MeV								
Atomic	no.	0.001	0.002	0.005	0.01	0.02	0.05	0.1	0.2	0.5
Sb	51	8.58 + 03	1.77 + 03	8.85 + 02	1.46 + 02	2.27 + 01	1.12 + 01	1.76 + 00	3.38-01	9.45-02
Te	52	8.43 + 03	1.83 + 03	9.01 + 02	1.50 + 02	2.34 + 01	1.14 + 01	1.80 + 00	3.43-01	9.33-02
I	53	9.10 + 03	2.00 + 03	8.43 + 02	1.63 + 02	2.54 + 01	1.23 + 01	1.94 + 00	3.66-01	9.70-02
Xe	54	9.41 + 03	2.09 + 03	6.39 + 02	1.69 + 02	2.65 + 01	1.27 + 01	2.01 + 00	3.76-01	9.70-02
Cs	55	9.37 + 03	2.23 + 03	2.30 + 02	1.79 + 02	2.82 + 01	1.34 + 01	2.12 + 00	3.94-01	9.91-02
ZB	56	8.54 + 03	2.32 + 03	2.41 + 02	1.86 + 02	2.94 + 01	1.38 + 01	2.20 + 00	4.05-01	9.92-02
La	57	9.09 + 03	2.46 + 03	2.58 + 02	1.97 + 02	3.12 + 01	1.45 + 01	2.32 + 00	4.24-01	1.01-01
Ce	58	9.71 + 03	2.61 + 03	2.74 + 02	2.08 + 02	3.31 + 01	1.52 + 01	2.45 + 00	4.45-01	1.04-01
Pr	59	1.06 + 04	2.77 + 03	2.92 + 02	2.21 + 02	3.53 + 01	1.60 + 01	2.59 + 00	4.69-01	1.07-01
Nd	60	6.63 + 03	2.88 + 03	3.06 + 02	2.30 + 02	3.68 + 01	1.65 + 01	2.69 + 00	4.84-01	1.08-01
Pm	61	2.06 + 03	3.05 + 03	3.26 + 02	2.44 + 02	3.92 + 01	1.73 + 01	2.84 + 00	5.10-01	1.12-01
Sm	62	2.11 + 03	3.12 + 03	3.36 + 02	2.50 + 02	4.03 + 01	1.77 + 01	2.90 + 00	5.19-01	1.11-01
Eu	63	2.22 + 03	3.28 + 03	3.54 + 02	2.63 + 02	4.24 + 01	1.85 + 01	3.04 + 00	5.43-01	1.14-01
Gd	64	2.29 + 03	3.36 + 03	3.65 + 02	2.69 + 02	4.36 + 01	3.86 + 00	3.11 + 00	5.54-01	1.14-01
Tb	65	2.40 + 03	3.51 + 03	3.84 + 02	2.82 + 02	4.59 + 01	4.06 + 00	3.25 + 00	5.77-01	1.17-01
Dy	66	2.49 + 03	3.47 + 03	3.99 + 02	2.90 + 02	4.76 + 01	4.23 + 00	3.36 + 00	5.95-01	1.18-01
Ho	67	2.62 + 03	3.59 + 03	4.17 + 02	3.01 + 02	4.98 + 01	4.43 + 00	3.49 + 00	6.18-01	1.20-01
Er	68	2.75 + 03	3.52 + 03	4.36 + 02	3.13 + 02	5.20 + 01	4.63 + 00	3.63 + 00	6.41-01	1.23-01
Tm	69	2.90 + 03	3.69 + 03	4.57 + 02	2.83 + 02	5.45 + 01	4.87 + 00	3.78 + 00	6.68-01	1.26-01
Yb	70	3.02 + 03	3.80 + 03	4.72 + 02	2.94 + 02	5.63 + 01	5.04 + 00	3.88 + 00	6.86-01	1.27-01
Lu	71	3.19 + 03	3.45 + 03	4.94 + 02	2.21 + 02	5.88 + 01	5.28 + 00	4.03 + 00	7.13-01	1.30-01
Hf	72	3.34 + 03	3.60 + 03	5.11 + 02	2.30 + 02	6.09 + 01	5.48 + 00	4.15 + 00	7.34-01	1.32-01
Ta	73	3.51 + 03	3.77 + 03	5.33 + 02	2.38 + 02	6.33 + 01	5.72 + 00	4.30 + 00	7.60-01	1.35-01
W	74	3.68 + 03	3.92 + 03	5.53 + 02	9.69 + 01	6.57 + 01	5.95 + 00	4.44 + 00	7.84-01	1.38-01
Re	75	3.87 + 03	3.77 + 03	5.76 + 02	1.01 + 02	6.84 + 01	6.21 + 00	4.59 + 00	8.12-01	1.41-01
Os	76	4.03 + 03	2.22 + 03	5.93 + 02	1.04 + 02	7.04 + 01	6.41 + 00	4.70 + 00	8.33-01	1.43-01
Ir	77	4.24 + 03	1.03 + 03	6.18 + 02	1.09 + 02	7.32 + 01	6.69 + 00	4.86 + 00	8.63-01	1.46-01
Pt	78	4.43 + 03	1.08 + 03	6.40 + 02	1.13 + 02	7.57 + 01	6.95 + 00	4.99 + 00	8.90-01	1.49-01
Au	79	4.65 + 03	1.14 + 03	6.66 + 02	1.18 + 02	7.88 + 01	7.26 + 00	5.16 + 00	9.22-01	1.53-01
Hg	80	4.83 + 03	1.18 + 03	6.87 + 02	1.22 + 02	8.12 + 01	7.50 + 00	5.28 + 00	9.46-01	1.56-01
Tl	81	5.01 + 03	1.23 + 03	7.07 + 02	1.26 + 02	8.36 + 01	7.75 + 00	5.40 + 00	9.69-01	1.58-01
Pb	82	5.21 + 03	1.29 + 03	7.30 + 02	1.31 + 02	8.64 + 01	8.04 + 00	5.55 + 00	9.99-01	1.61-01
Bi	83	5.44 + 03	1.35 + 03	7.58 + 02	1.36 + 02	8.95 + 01	8.38 + 00	5.74 + 00	1.03 + 00	1.66-01
Po	84	5.72 + 03	1.42 + 03	7.93 + 02	1.43 + 02	9.35 + 01	8.80 + 00	5.99 + 00	1.08 + 00	1.71-01
At	85	5.87 + 03	1.49 + 03	8.25 + 02	1.49 + 02	9.70 + 01	9.19 + 00	6.17 + 00	1.12 + 00	1.77-01
Rn	86	5.83 + 03	1.49 + 03	8.16 + 02	1.48 + 02	9.56 + 01	9.12 + 00	6.09 + 00	1.10 + 00	1.73-01
Fr	87	6.08 + 03	1.56 + 03	8.49 + 02	1.54 + 02	9.93 + 01	9.52 + 00	1.66 + 00	1.14 + 00	1.78-01
Ra	88	6.20 + 03	1.62 + 03	8.74 + 02	1.59 + 02	1.02 + 02	9.85 + 00	1.71 + 00	1.17 + 00	1.82-01
Ac	89	6.47 + 03	1.70 + 03	8.69 + 02	1.65 + 02	1.06 + 02	1.03 + 01	1.79 + 00	1.21 + 00	1.87-01
Th	90	6.61 + 03	1.74 + 03	8.88 + 02	1.69 + 02	9.37 + 01	1.05 + 01	1.83 + 00	1.23 + 00	1.90-01
Pa	91	6.53 + 03	1.83 + 03	8.76 + 02	1.77 + 02	7.03 + 01	1.10 + 01	1.92 + 00	1.29 + 00	1.97-01
U	92	6.63 + 03	1.86 + 03	8.89 + 02	1.79 + 02	7.11 + 01	1.12 + 01	1.95 + 00	1.30 + 00	1.98-01
Np	93	6.95 + 03	1.96 + 03	9.32 + 02	1.87 + 02	7.45 + 01	1.18 + 01	2.05 + 00	1.35 + 00	2.05-01
Pu	94	7.19 + 03	2.04 + 03	9.65 + 02	1.94 + 02	7.71 + 01	1.22 + 01	2.13 + 00	1.39 + 00	2.10-01
Am	95	7.37 + 03	2.10 + 03	9.90 + 02	1.98 + 02	7.93 + 01	1.25 + 01	2.19 + 00	1.42 + 00	2.14-01
Cm	96	7.54 + 03	2.15 + 03	1.02 + 03	2.03 + 02	8.14 + 01	1.28 + 01	2.25 + 00	1.44 + 00	2.18-01
Bk	97	7.84 + 03	2.25 + 03	1.06 + 03	2.10 + 02	8.39 + 01	1.34 + 01	2.35 + 00	1.50 + 00	2.25-01
Cf	98	7.89 + 03	2.31 + 03	9.27 + 02	2.15 + 02	8.58 + 01	1.37 + 01	2.41 + 00	1.52 + 00	2.29-01
Es	99	7.79 + 03	2.40 + 03	9.59 + 02	2.22 + 02	4.01 + 01	1.42 + 01	2.51 + 00	1.57 + 00	2.36-01
Fm	100	7.13 + 03	2.46 + 03	9.77 + 02	2.26 + 02	4.09 + 01	1.45 + 01	2.57 + 00	1.59 + 00	2.39-01



		Mass attenuation coefficient, cm <sup>2</sup> /g								
		Photon energy, MeV								
Atomic	no.	1.0	2.0	5.0	10.0	20.0	50.0	100.0	500.0	1000.0
Sb	51	5.80-02	4.10-02	3.56-02	3.92-02	4.70-02	5.96-02	6.85-02	8.16-02	8.44-02
Te	52	5.67-02	4.01-02	3.49-02	3.86-02	4.64-02	5.89-02	6.77-02	8.07-02	8.35-02
I	53	5.84-02	4.12-02	3.61-02	4.00-02	4.82-02	6.13-02	7.04-02	8.40-02	8.69-02
Xe	54	5.78-02	4.08-02	3.58-02	3.99-02	4.82-02	6.12-02	7.04-02	8.40-02	8.69-02
Cs	55	5.85-02	4.12-02	3.64-02	4.06-02	4.91-02	6.25-02	7.19-02	8.58-02	8.88-02
ZB	56	5.80-02	4.08-02	3.61-02	4.04-02	4.90-02	6.25-02	7.19-02	8.58-02	8.88-02
La	57	5.88-02	4.12-02	3.66-02	4.11-02	5.00-02	6.37-02	7.34-02	8.76-02	9.06-02
Ce	58	5.96-02	4.18-02	3.73-02	4.19-02	5.10-02	6.52-02	7.50-02	8.96-02	9.27-02
Pr	59	6.07-02	4.24-02	3.80-02	4.29-02	5.23-02	6.68-02	7.69-02	9.19-02	9.50-02
Nd	60	6.07-02	4.24-02	3.81-02	4.30-02	5.26-02	6.72-02	7.74-02	9.25-02	9.56-02
Pm	61	6.19-02	4.31-02	3.88-02	4.40-02	5.38-02	6.89-02	7.94-02	9.48-02	9.81-02
Sm	62	6.11-02	4.24-02	3.83-02	4.35-02	5.34-02	6.84-02	7.88-02	9.41-02	9.73-02
Eu	63	6.19-02	4.28-02	3.88-02	4.42-02	5.42-02	6.96-02	8.02-02	9.57-02	9.90-02
Gd	64	6.12-02	4.23-02	3.84-02	4.38-02	5.38-02	6.91-02	7.97-02	9.51-02	9.83-02
Tb	65	6.20-02	4.27-02	3.89-02	4.45-02	5.47-02	7.03-02	8.11-02	9.67-02	1.00-01
Dy	66	6.20-02	4.26-02	3.90-02	4.46-02	5.49-02	7.06-02	8.15-02	9.72-02	1.00-01
Ho	67	6.26-02	4.29-02	3.93-02	4.50-02	5.55-02	7.14-02	8.24-02	9.83-02	1.02-01
Er	68	6.32-02	4.32-02	3.96-02	4.55-02	5.61-02	7.23-02	8.34-02	9.95-02	1.03-01
Tm	69	6.40-02	4.36-02	4.01-02	4.61-02	5.70-02	7.35-02	8.48-02	1.01-01	1.04-01
Yb	70	6.40-02	4.35-02	4.00-02	4.61-02	5.70-02	7.35-02	8.49-02	1.01-01	1.04-01
Lu	71	6.48-02	4.39-02	4.05-02	4.66-02	5.77-02	7.45-02	8.60-02	1.02-01	1.06-01
Hf	72	6.50-02	4.39-02	4.05-02	4.68-02	5.80-02	7.48-02	8.64-02	1.03-01	1.06-01
Ta	73	6.57-02	4.41-02	4.08-02	4.72-02	5.85-02	7.56-02	8.73-02	1.04-01	1.07-01
W	74	6.62-02	4.43-02	4.10-02	4.75-02	5.89-02	7.62-02	8.80-02	1.05-01	1.08-01
Re	75	6.69-02	4.46-02	4.14-02	4.79-02	5.95-02	7.70-02	8.89-02	1.06-01	1.09-01
Os	76	6.71-02	4.46-02	4.13-02	4.79-02	5.96-02	7.71-02	8.90-02	1.06-01	1.10-01
Ir	77	6.79-02	4.50-02	4.17-02	4.84-02	6.02-02	7.80-02	9.01-02	1.07-01	1.11-01
Pt	78	6.86-02	4.52-02	4.20-02	4.87-02	6.06-02	7.86-02	9.08-02	1.08-01	1.12-01
Au	79	6.95-02	4.57-02	4.24-02	4.93-02	6.14-02	7.95-02	9.19-02	1.09-01	1.13-01
Hg	80	6.99-02	4.57-02	4.25-02	4.94-02	6.15-02	7.98-02	9.22-02	1.10-01	1.13-01
Tl	81	7.03-02	4.58-02	4.25-02	4.94-02	6.16-02	8.00-02	9.24-02	1.10-01	1.14-01
Pb	82	7.10-02	4.61-02	4.27-02	4.97-02	6.21-02	8.06-02	9.31-02	1.11-01	1.15-01
Bi	83	7.21-02	4.66-02	4.32-02	5.03-02	6.28-02	8.15-02	9.42-02	1.12-01	1.16-01
Po	84	7.39-02	4.75-02	4.40-02	5.12-02	6.40-02	8.32-02	9.61-02	1.15-01	1.18-01
At	85	7.54-02	4.82-02	4.46-02	5.20-02	6.49-02	8.44-02	9.76-02	1.16-01	1.20-01
Rn	86	7.30-02	4.65-02	4.30-02	5.01-02	6.26-02	8.14-02	9.42-02	1.12-01	1.16-01
Fr	87	7.45-02	4.72-02	4.36-02	5.08-02	6.35-02	8.26-02	9.56-02	1.14-01	1.18-01
Ra	88	7.53-02	4.75-02	4.38-02	5.10-02	6.38-02	8.31-02	9.61-02	1.15-01	1.19-01
Ac	89	7.69-02	4.82-02	4.44-02	5.17-02	6.47-02	8.43-02	9.75-02	1.16-01	1.20-01
Th	90	7.71-02	4.81-02	4.42-02	5.15-02	6.45-02	8.40-02	9.72-02	1.16-01	1.20-01
Pa	91	7.94-02	4.93-02	4.52-02	5.26-02	6.59-02	8.60-02	9.95-02	1.19-01	1.23-01
U	92	7.90-02	4.88-02	4.46-02	5.19-02	6.51-02	8.49-02	9.83-02	1.17-01	1.21-01
Np	93	8.13-02	4.99-02	4.56-02	5.30-02	6.65-02	8.68-02	1.01-01	1.20-01	1.24-01
Pu	94	8.26-02	5.05-02	4.60-02	5.34-02	6.71-02	8.76-02	1.01-01	1.21-01	1.25-01
Am	95	8.33-02	5.06-02	4.60-02	5.34-02	6.70-02	8.77-02	1.02-01	1.21-01	1.25-01
Cm	96	8.41-02	5.08-02	4.60-02	5.34-02	6.70-02	8.77-02	1.02-01	1.21-01	1.26-01
Bk	97	8.62-02	5.18-02	4.68-02	5.42-02	6.81-02	8.92-02	1.03-01	1.24-01	1.28-01
Cf	98	8.70-02	5.20-02	4.68-02	5.42-02	6.81-02	8.92-02	1.04-01	1.24-01	1.28-01
Es	99	8.89-02	5.28-02	4.74-02	5.48-02	6.89-02	9.04-02	1.05-01	1.25-01	1.29-01
Fm	100	8.94-02	5.28-02	4.72-02	5.45-02	6.86-02	9.00-02	1.05-01	1.25-01	1.29-01



# CLASSIFICATION OF ELECTROMAGNETIC RADIATION

Hans Dolezalek

Basic Conversions:

$$c = \lambda\nu = v/k$$

$$\nu = c/\lambda = ck$$

$$\lambda = c/\nu = 1/k$$

$$k = \nu/c = 1/\lambda$$

$$c = \text{speed of light} = 2.99792458 \times 10^8 \text{ m/s}$$

Frequency ( $\nu$ )	Wavelength ( $\lambda$ )	Wave number ( $k$ )	Names of bands	Approximate photon energies
$3 \times 10^0 - 3 \times 10^1$ Hz 3 – 30 Hz	$10^8 - 10^7$ m 100 – 10 Mm	$10^8 - 10^7$ m <sup>-1</sup> 10 – 100 Gm <sup>-1</sup>	ELF-(ELF 1), ITU band no. 1	
$3 \times 10^1 - 3 \times 10^2$ Hz 30 – 300 Hz	$10^7 - 10^6$ m 10 – 1 Mm	$10^7 - 10^6$ m <sup>-1</sup> 100 Gm <sup>-1</sup> – 1Mm <sup>-1</sup>	SLF-(ELF 2), ITU band no. 2, megameter waves	
$3 \times 10^2 - 3 \times 10^3$ Hz 300 Hz – 3 kHz	$10^6 - 10^5$ m 1 Mm – 100 km	$10^6 - 10^5$ m <sup>-1</sup> 1 – 10 Mm <sup>-1</sup>	ULF-(ELF 3), ITU band no. 3	
$3 \times 10^3 - 3 \times 10^4$ Hz 3 – 30 kHz	$10^5 - 10^4$ m 100 – 10 km	$10^5 - 10^4$ m <sup>-1</sup> 100 Mm <sup>-1</sup>	VLF, ITU band no. 4, myriameter waves	
$3 \times 10^4 - 3 \times 10^5$ Hz 30 – 300 kHz	$10^4 - 10^3$ m 10 – 1 km	$10^4 - 10^3$ m <sup>-1</sup> 100 Mm <sup>-1</sup> – 1 km <sup>-1</sup>	LF, ITU band no. 5, kilometer waves	
$3 \times 10^5 - 3 \times 10^6$ Hz 300 kHz – 3 MHz	$10^3 - 10^2$ m 1 km – 100 m	$10^3 - 10^2$ m <sup>-1</sup> 1 – 10 km <sup>-1</sup>	MF, ITU band no. 6, hectometer waves	
$3 \times 10^6 - 3 \times 10^7$ Hz 3 – 30 MHz	$10^2 - 10^1$ m 100 – 10 m	$10^2 - 10^1$ m <sup>-1</sup> 10 – 100 km <sup>-1</sup>	HF, ITU band no. 7, decameter waves	
$3 \times 10^7 - 3 \times 10^8$ Hz 30 – 300 MHz	$10^1 - 10^0$ m 10 – 1 m	$10^1 - 10^0$ m <sup>-1</sup> 100 km <sup>-1</sup> – 1 mm <sup>-1</sup>	VHF, ITU band no. 8, meter waves	
$3 \times 10^8 - 3 \times 10^9$ Hz 300 MHz – 3 GHz	$10^0 - 10^{-1}$ m 1 m – 100 mm	$10^0 - 10^1$ m <sup>-1</sup> 1 – 10 m <sup>-1</sup>	UHF, ITU band no. 9, decimeter waves <sup>a</sup>	
$3 \times 10^9 - 3 \times 10^{10}$ Hz 3 – 30 GHz	$10^{-1} - 10^{-2}$ m 100 – 10 mm	$10^1 - 10^2$ m <sup>-1</sup> 10 – 100 m <sup>-1</sup>	SHF, ITU band no. 10, centimeter waves <sup>a</sup>	
$3 \times 10^{10} - 3 \times 10^{11}$ Hz 30 – 300 GHz	$10^{-2} - 10^{-3}$ m 10 – 1 mm	$10^2 - 10^3$ m <sup>-1</sup> 100 m <sup>-1</sup> – 1 mm <sup>-1</sup> (1 – 10 cm <sup>-1</sup> )	EHF, ITU band no. 11, millimeter waves	
$3 \times 10^{11} - 3 \times 10^{12}$ Hz 300 GHz – 3 THz	$10^{-3} - 10^{-4}$ m 1 mm – 100 $\mu$ m	$10^3 - 10^4$ m <sup>-1</sup> (1 – 10 mm <sup>-1</sup> ) (10 – 100 cm <sup>-1</sup> )	Part of micrometer waves, includes part of far or thermal infrared; ITU band no. 12	
$3 \times 10^{12} - 3 \times 10^{13}$ Hz 3 – 30 THz	$10^{-4} - 10^{-5}$ m 100 – 10 $\mu$ m	$10^4 - 10^5$ m <sup>-1</sup> 10 – 100 mm <sup>-1</sup> (100 – 1000 cm <sup>-1</sup> )	Part of micrometer waves includes part of far (thermal) infrared	
$3 \times 10^{13} - 3 \times 10^{14}$ Hz 30 – 300 THz	$10^{-5} - 10^{-6}$ m 10 – 1 $\mu$ m (100,000 – 10,000 Å)	$10^5 - 10^6$ m <sup>-1</sup> 100 mm <sup>-1</sup> – 1 $\mu$ m <sup>-1</sup>	Part of $\mu$ m waves, part of infrared	$(1.6 - 16) \times 10^{-20}$ joule {0.1 – 1 eV}
$3 \times 10^{14} - 3 \times 10^{15}$ Hz 300 THz – 3 PHz	$10^{-6} - 10^{-7}$ m 1 $\mu$ m – 100 m (10,000 – 1000 Å)	$10^6 - 10^7$ m <sup>-1</sup> 1 – 10 $\mu$ m <sup>-1</sup>	Near infrared, visible, near ultraviolet	$(1.6 - 16) \times 10^{-19}$ joule {1 – 10 eV}
$3 \times 10^{15} - 3 \times 10^{16}$ Hz 3 – 30 PHz	$10^{-7} - 10^{-8}$ m 100 – 10 nm (1000 – 100 Å)	$10^7 - 10^8$ m <sup>-1</sup> 10 – 100 $\mu$ m <sup>-1</sup>	Part of vacuum ultraviolet	$(1.6 - 16) \times 10^{-18}$ joule {10 – 100 eV}
$3 \times 10^{16} - 3 \times 10^{17}$ Hz 30 – 300 PHz	$10^{-8} - 10^{-9}$ m 10 – 1 nm (100 – 10 Å)	$10^8 - 10^9$ m <sup>-1</sup> 100 $\mu$ m <sup>-1</sup> – 1 nm <sup>-1</sup>	Part of soft X-rays	$(1.6 - 16) \times 10^{-17}$ joule {100 – 1000 eV}
$3 \times 10^{17} - 3 \times 10^{18}$ Hz 300 PHz – 3 EHz	$10^{-9} - 10^{-10}$ m 1 nm – 100 pm (10 – 1 Å)	$10^9 - 10^{10}$ m <sup>-1</sup> 1 – 10 nm <sup>-1</sup>	Part of soft X-rays	$(1.6 - 16) \times 10^{-16}$ joule {1 – 10 keV}
$3 \times 10^{18} - 3 \times 10^{19}$ Hz 3 – 30 EHz	$10^{-10} - 10^{-11}$ m 100 – 10 pm (1 – 0.1 Å)	$10^{10} - 10^{11}$ m <sup>-1</sup> 10 – 100 nm <sup>-1</sup>	Hard X-rays and part of soft $\gamma$ -rays	$(1.6 - 16) \times 10^{-15}$ joule {10 – 100 keV}
$3 \times 10^{19} - 3 \times 10^{20}$ Hz 30 – 300 EHz	$10^{-11} - 10^{-12}$ m 10 – 1 pm (0.1 – 0.01 Å)	$10^{11} - 10^{12}$ m <sup>-1</sup> 100 nm <sup>-1</sup> – 1 pm <sup>-1</sup>	Part of soft and part of hard $\gamma$ -rays (limit at 510 keV)	$(1.6 - 16) \times 10^{-14}$ joule {100 keV – 1 MeV}
$3 \times 10^{20} - 3 \times 10^{21}$ Hz 300 – 3000 EHz	$10^{-12} - 10^{-13}$ m 1 pm – 100 fm (0.01 – 0.001 Å)	$10^{12} - 10^{13}$ m <sup>-1</sup> 1 – 10 pm <sup>-1</sup>	Part of hard $\gamma$ -rays and part of “cosmic” $\gamma$ -rays	$(1.6 - 16) \times 10^{-13}$ joule {1 – 10 MeV}
$3 \times 10^{21} - 3 \times 10^{22}$ Hz 3000 – 30,000 EHz	$10^{-13} - 10^{-14}$ m 100 – 10 fm (0.001 – 0.0001 Å)	$10^{13} - 10^{14}$ m <sup>-1</sup> 10 – 100 pm <sup>-1</sup>	$\gamma$ -rays produced by cosmic rays	$(1.6 - 16) \times 10^{-12}$ joule {10 – 100 MeV}

*Note:* Abbreviations used in this table: Å—ångstrom ( $1 \text{ Å} = 10^{-10} \text{ m}$ ); EHz—exahertz ( $10^{18}$  hertz); EHF—extremely high frequency; ELF—extremely low frequency; eV—electron volt ( $1 \text{ eV} = 1.60218 \times 10^{-19} \text{ joule}$ ); fm—femtometer ( $10^{-15} \text{ m}$ ); GHz—gigahertz ( $10^9$  hertz); Gm—gigameter ( $10^9 \text{ m}$ ); HF—high frequency; Hz—hertz ( $\text{s}^{-1}$ ); ITU—International Telecommunications Union; keV—kiloelectron volt ( $10^3 \text{ eV}$ ); km—kilometer ( $10^3 \text{ m}$ ); LF—low frequency; m—meter; MeV—megaelectron volt ( $10^6 \text{ eV}$ ); MF—medium frequency; MHz—megahertz ( $10^6$  hertz); Mm—megameter ( $10^6 \text{ meter}$ ); mm—millimeter ( $10^{-3} \text{ meter}$ );  $\mu\text{m}$ —micrometer ( $10^{-6} \text{ meter}$ ); nm—nanometer ( $10^{-9} \text{ meter}$ ); PHz—petahertz ( $10^{15}$  hertz); pm—picometer ( $10^{-12} \text{ meter}$ ); SHF—super high frequency; SLF—super low frequency; THz—terahertz; UHF—ultra high frequency; ULF—ultra low frequency; VHF—very high frequency; VLF—very low frequency.

<sup>a</sup> Also called “microwaves”; not to be confused with “micrometer waves”.

**Letter Designations of Microwave Bands**

Frequency (GHz)	Wavelength (cm)	Wavenumber ( $\text{cm}^{-1}$ )	Band
1—2	30—15	0.033—0.067	L-Band
2—4	15—7.5	0.067—0.133	S-Band
4—8	7.5—3.7	0.133—0.267	C-Band
8—12	3.7—2.5	0.267—0.4	X-Band
12—18	2.5—1.7	0.4—0.6	Ku-Band
18—27	1.7—1.1	0.6—0.9	K-Band
27—40	1.1—0.75	0.9—1.33	Ka-Band

## BLACK BODY RADIATION

The total power radiated from an ideal black body and the wavelength corresponding to maximum power are given here as a function of absolute temperature. Constants used in the calculation are taken from the table "Fundamental Physical Constants" in

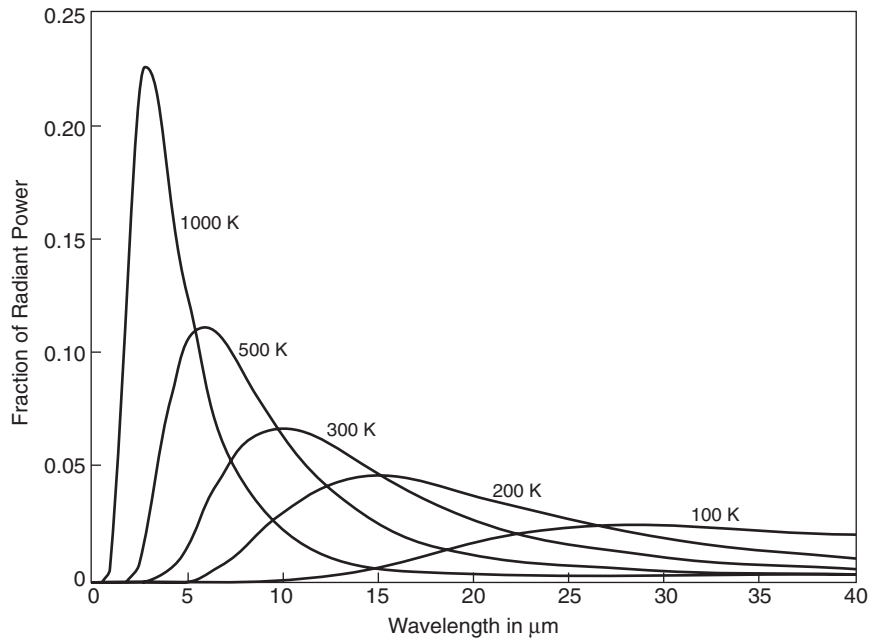
Section 1. The radiated power in a band  $\Delta\lambda$  at  $\lambda_{\max}$  may be calculated from:

$$P_{\max} = 0.657548 (\Delta\lambda/\lambda_{\max}) P_{\text{tot}}$$

$T/K$	$P_{\text{tot}}$	$\lambda_{\max}/\mu\text{m}$	$T/K$	$P_{\text{tot}}$	$\lambda_{\max}/\mu\text{m}$	$T/K$	$P_{\text{tot}}$	$\lambda_{\max}/\mu\text{m}$
50	0.354 W/m <sup>2</sup>	57.955	740	17.004	3.916	1520	302.689	1.906
100	5.671	28.978	750	17.942	3.864	1540	318.937	1.882
150	28.707	19.318	760	18.918	3.813	1560	335.831	1.858
200	90.728	14.489	770	19.934	3.763	1580	353.387	1.834
250	221.504	11.591	780	20.989	3.715	1600	371.623	1.811
273	314.973	10.614	790	22.087	3.668	1620	390.555	1.789
280	348.541	10.349	800	23.226	3.622	1640	410.202	1.767
290	401.064	9.992	810	24.410	3.577	1660	430.581	1.746
300	459.311	9.659	820	25.638	3.534	1680	451.710	1.725
310	523.684	9.348	830	26.911	3.491	1700	473.607	1.705
320	594.596	9.055	840	28.232	3.450	1720	496.290	1.685
330	672.478	8.781	850	29.600	3.409	1740	519.779	1.665
340	757.771	8.523	860	31.018	3.369	1760	544.093	1.646
350	850.931	8.279	870	32.486	3.331	1780	569.249	1.628
360	952.428	8.049	880	34.006	3.293	1800	595.267	1.610
370	1.063 kW/m <sup>2</sup>	7.832	890	35.578	3.256	1820	622.168	1.592
380	1.182	7.626	900	37.204	3.220	1840	649.970	1.575
390	1.312	7.430	910	38.886	3.184	1860	678.694	1.558
400	1.452	7.244	920	40.623	3.150	1880	708.359	1.541
410	1.602	7.068	930	42.418	3.116	1900	738.987	1.525
420	1.764	6.899	940	44.272	3.083	1920	770.597	1.509
430	1.939	6.739	950	46.187	3.050	1940	803.210	1.494
440	2.125	6.586	960	48.162	3.018	1960	836.848	1.478
450	2.325	6.439	970	50.201	2.987	1980	871.531	1.464
460	2.539	6.299	980	52.303	2.957	2000	907.282	1.449
470	2.767	6.165	990	54.471	2.927	2020	944.121	1.435
480	3.010	6.037	1000	56.705	2.898	2040	982.071	1.420
490	3.269	5.914	1020	61.379	2.841	2060	1.021 MW/m <sup>2</sup>	1.407
500	3.544	5.796	1040	66.337	2.786	2080	1.061	1.393
510	3.836	5.682	1060	71.589	2.734	2100	1.103	1.380
520	4.146	5.573	1080	77.147	2.683	2120	1.145	1.367
530	4.474	5.467	1100	83.022	2.634	2140	1.189	1.354
540	4.822	5.366	1120	89.227	2.587	2160	1.234	1.342
550	5.189	5.269	1140	95.773	2.542	2180	1.281	1.329
560	5.577	5.175	1160	102.672	2.498	2200	1.328	1.317
570	5.986	5.084	1180	109.939	2.456	2220	1.377	1.305
580	6.417	4.996	1200	117.584	2.415	2240	1.428	1.294
590	6.871	4.911	1220	125.621	2.375	2260	1.479	1.282
600	7.349	4.830	1240	134.063	2.337	2280	1.532	1.271
610	7.851	4.750	1260	142.924	2.300	2300	1.587	1.260
620	8.379	4.674	1280	152.217	2.264	2320	1.643	1.249
630	8.933	4.600	1300	161.955	2.229	2340	1.700	1.238
640	9.514	4.528	1320	172.154	2.195	2360	1.759	1.228
650	10.122	4.458	1340	182.827	2.163	2380	1.819	1.218
660	10.760	4.391	1360	193.989	2.131	2400	1.881	1.207
670	11.427	4.325	1380	205.655	2.100	2420	1.945	1.197
680	12.124	4.261	1400	217.838	2.070	2440	2.010	1.188
690	12.853	4.200	1420	230.556	2.041	2460	2.077	1.178
700	13.615	4.140	1440	243.822	2.012	2480	2.145	1.168
710	14.410	4.081	1460	257.652	1.985	2500	2.215	1.159
720	15.239	4.025	1480	272.063	1.958	2550	2.398	1.136
730	16.103	3.970	1500	287.070	1.932	2600	2.591	1.115

$T/K$	$P_{tot}$	$\lambda_{max}/\mu\text{m}$	$T/K$	$P_{tot}$	$\lambda_{max}/\mu\text{m}$	$T/K$	$P_{tot}$	$\lambda_{max}/\mu\text{m}$
2650	2.796	1.093	3600	9.524	0.805	5100	38.362	0.568
2700	3.014	1.073	3650	10.065	0.794	5200	41.461	0.557
2750	3.243	1.054	3700	10.627	0.783	5300	44.743	0.547
2800	3.485	1.035	3750	11.214	0.773	5400	48.217	0.537
2850	3.741	1.017	3800	11.824	0.763	5500	51.889	0.527
2900	4.011	0.999	3850	12.458	0.753	5600	55.767	0.517
2950	4.294	0.982	3900	13.118	0.743	5700	59.858	0.508
3000	4.593	0.966	3950	13.804	0.734	5800	64.170	0.500
3050	4.907	0.950	4000	14.517	0.724	5900	68.712	0.491
3100	5.237	0.935	4100	16.024	0.707	6000	73.490	0.483
3150	5.583	0.920	4200	17.645	0.690	6500	101.222	0.446
3200	5.946	0.906	4300	19.386	0.674	7000	136.149	0.414
3250	6.326	0.892	4400	21.254	0.659	7500	179.418	0.386
3300	6.725	0.878	4500	23.253	0.644	8000	232.264	0.362
3350	7.142	0.865	4600	25.389	0.630	8500	296.004	0.341
3400	7.578	0.852	4700	27.670	0.617	9000	372.042	0.322
3450	8.033	0.840	4800	30.101	0.604	9500	461.867	0.305
3500	8.509	0.828	4900	32.689	0.591	10000	567.051	0.290
3550	9.006	0.816	5000	35.441	0.580			

The curves below show, for various temperatures, the fraction of radiant power as a function of wavelength. The function plotted is  $P_\lambda/\Delta\lambda P_{tot}$ , where  $P_\lambda$  is the power at wavelength  $\lambda$  in a small interval  $\Delta\lambda$  (in  $\mu\text{m}$ ), and  $P_{tot}$  is the total power.



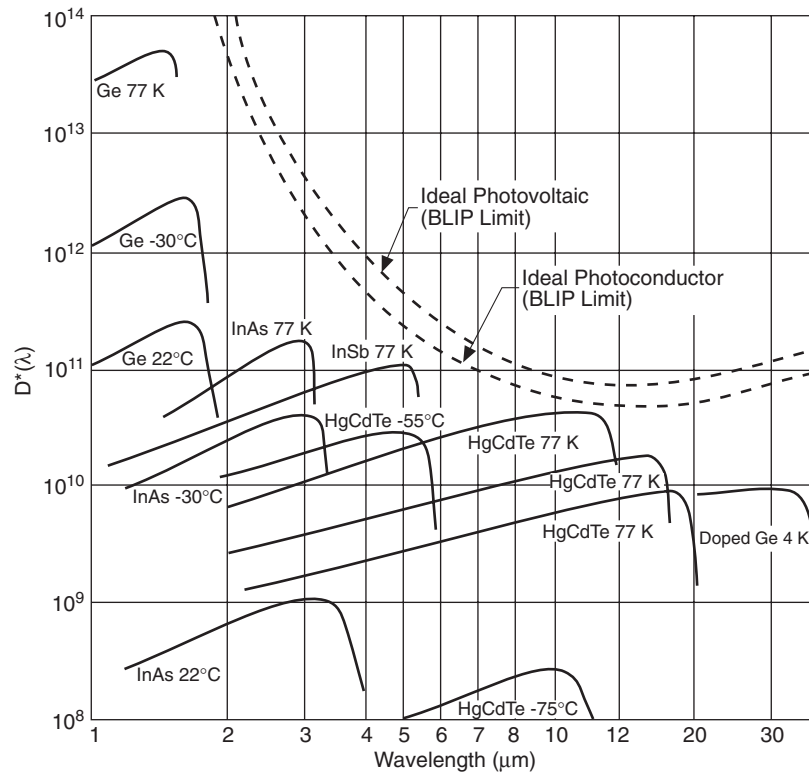
## CHARACTERISTICS OF INFRARED DETECTORS

This graph summarizes the wavelength response of some semiconductors used as detectors for infrared radiation. The quantity  $D^*(\lambda)$  is the signal to noise ratio for an incident radiant power density of  $1 \text{ W/cm}^2$  and a bandwidth of  $1 \text{ Hz}$  ( $60^\circ$  field of view). The Ge, InAs, and InSb detectors are photovoltaics, while the HgCdTe series are photoconductive devices. The cutoff wavelength of the latter can be varied by adjusting the relative amounts of Hg, Cd,

and Te (three examples are shown at  $77 \text{ K}$ ). The graph also shows the theoretical background limited sensitivity for ideal detectors which introduce no intrinsic noise.

### Reference

*Infrared Detectors 1995*, EG&G Judson, Montgomeryville, PA.



# REFRACTIVE INDEX AND TRANSMITTANCE OF REPRESENTATIVE GLASSES

Typical values of the index of refraction and internal transmittance (fraction of light transmitted through a one centimeter thickness) are tabulated here for selected types of glasses, as well as for synthetic fused (vitreous) silica. Nominal compositions are given in the first part of the table. The second part gives the index of refraction, relative to air, and the internal transmittance for representative samples of each glass at wavelengths in the infrared, visible, and near-ultraviolet regions. It should be emphasized that wide variation of these parameters may be found among subtypes of each glass. More detailed data may be found in Reference 3.

Assuming that the Lambert-Beer Law is followed, the transmittance of a glass plate of thickness  $d$  (in centimeters) can be obtained by raising the transmittance value in the table to the power  $d$ .

## References

1. Weber, M. J., *CRC Handbook of Laser Science and Technology*, Vol. IV, Part 2, CRC Press, Boca Raton, FL, 1988.
2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972.
3. *Schott Optical Glass*, Schott Glass Technologies, Inc., 400 York Ave., Duryea, PA 18642.
4. Kaye, G. W. C., and Laby, T. H., *Tables of Physical and Chemical Constants, 15th Edition*, Longman, London, 1986.

		Composition in percent by mass									
Type	Name	SiO <sub>2</sub>	B <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	CaO	BaO	ZnO	PbO	P <sub>2</sub> O <sub>5</sub>
PK	Phosphate crown		3	10		12	5				70
PSK	Dense phosphate crown		3	5			4	28			60
BK	Borosilicate crown	70	10		8	8	1	3			
K	Crown	74			9	11	6				
ZK	Zinc crown	71			17				12		
BaK	Barium crown	60	3		3	10		19	5		
SK	Dense crown	39	15	5				41			
KF	Crown flint	67		2	16				3	12	
BaLF	Barium light flint	51			6	5		20	14	4	
SSK	Extra dense crown	35	10	5				42	8		
LLF	Extra light flint	63			5	8				24	
BaF	Barium flint	46				8		16	8	22	
LF	Light flint	53			5	8				34	
F	Flint	47			2	7				44	
BaSF	Dense barium flint	43			1	7		11	5	33	
SF	Dense flint	33				5				62	
KzFS	Short flint										
SiO <sub>2</sub>	Fused silica	100									

Type	Index of refraction				Transmittance of 1 cm plate			
	1.060 μm	546.1 nm	365.0 nm	312.6 nm	1.060 μm	546.1 nm	365.0 nm	310 nm
PK	1.51519	1.52736	1.54503	1.5574	0.997	0.998	0.987	0.46
PSK	1.54154	1.55440	1.57342	1.5868	0.996	0.998	0.984	0.46
BK	1.50669	1.51872	1.53627	1.5486	0.999	0.998	0.987	0.35
K	1.50091	1.51314	1.53189	1.5454	0.998	0.998	0.988	0.40
ZK	1.52220	1.53534	1.55588	1.5708	0.996	0.998	0.976	0.27
BaK	1.55695	1.57124	1.59407	1.6108	0.998	0.997	0.986	0.28
SK	1.59490	1.60994	1.63398		0.998	0.998	0.959	0.28
KF	1.50586	1.51978	1.54251	1.5600	0.998	0.996	0.989	0.49
BaLF	1.57579	1.59166	1.61804		0.996	0.998	0.933	0.010
SSK	1.60402	1.61993	1.64595		0.999	0.998	0.915	0.010
LaK	1.69710	1.71616	1.74573		0.999	0.998	0.882	0.17
LLF	1.52775	1.54344	1.57038		0.998	0.997	0.990	0.32
BaF	1.56873	1.58565	1.61524		0.999	0.997	0.992	0.004
LF	1.56594	1.58482	1.61926		0.999	0.998	0.981	0.008
F	1.58636	1.60718	1.64606		0.997	0.998	0.959	
BaSF	1.60889	1.62987	1.66926		0.999	0.998	0.857	
SF	1.71350	1.74620	1.8145		0.998	0.997	0.650	
KzFS	1.59680	1.61639	1.64849	1.6739		0.998	0.672	0.012
SiO <sub>2</sub>	1.44968	1.46008	1.47435 <sup>a</sup>	1.53430 <sup>b</sup>				

<sup>a</sup> At 366.3 nm.

<sup>b</sup> At 213.9 nm.

## INDEX OF REFRACTION OF WATER

This table gives the index of refraction of liquid water at atmospheric pressure, relative to a vacuum, at several temperatures and wavelengths. It is generated from the formulation in Reference 1, which covers a wide range of temperature, pressure, and wavelength. The wavelengths listed here correspond to prominent lines of cadmium (226.50 and 361.05 nm), potassium (404.41 nm), sodium (589.00 nm), Ne (632.80 nm, from a helium - neon laser), and mercury (1.01398  $\mu\text{m}$ ).

### References

1. Schiebener, P., Straub, J., Levelt Sengers, J. M. H., and Gallagher, J. S., *J. Phys. Chem. Ref. Data*, 19, 677, 1990; 19, 1617, 1990.
2. Marsh, K. N., Editor, *Recommended Reference Materials for the Realization of Physicochemical Properties*, Blackwell Scientific Publications, Oxford, 1987.

$t/^{\circ}\text{C}$	226.50 nm	361.05 nm	404.41 nm	589.00 nm	632.80 nm	1.01398 $\mu\text{m}$
0	1.39450	1.34896	1.34415	1.33432	1.33306	1.32612
10	1.39422	1.34870	1.34389	1.33408	1.33282	1.32591
20	1.39336	1.34795	1.34315	1.33336	1.33211	1.32524
30	1.39208	1.34682	1.34205	1.33230	1.33105	1.32424
40	1.39046	1.34540	1.34065	1.33095	1.32972	1.32296
50	1.38854	1.34373	1.33901	1.32937	1.32814	1.32145
60	1.38636	1.34184	1.33714	1.32757	1.32636	1.31974
70	1.38395	1.33974	1.33508	1.32559	1.32438	1.31784
80	1.38132	1.33746	1.33284	1.32342	1.32223	1.31576
90	1.37849	1.33501	1.33042	1.32109	1.31991	1.31353
100	1.37547	1.33239	1.32784	1.31861	1.31744	1.31114

# INDEX OF REFRACTION OF LIQUIDS FOR CALIBRATION PURPOSES

This table gives the index of refraction of six liquids which are available in highly pure form and whose index of refraction has been accurately measured as a function of wavelength and temperature. They are therefore useful for calibration of refractometers. The estimated uncertainty in the values is:

2,2,4-Trimethylpentane	±0.00003
Hexadecane	±0.00008
<i>trans</i> -Bicyclo[4.0.0]decane	±0.00008
1-Methylnaphthalene	±0.00008
Toluene	±0.00003
Methylcyclohexane	±0.00003

Full details are given in the references. This table is reprinted from Reference 1 by permission of the International Union of Pure and Applied Chemistry.

## References

1. Marsh, K. N., Editor, *Recommended Reference Materials for the Realization of Physicochemical Properties*, Blackwell Scientific Publications, Oxford, 1987.
2. Tilton, L. W., *J. Opt. Soc. Am.*, 32, 71, 1941.

$\lambda$ nm	2,2,4-Trimethylpentane			Hexadecane		
	20°C	25°C	30°C	20°C	25°C	30°C
667.81	1.38916	1.38670	1.38424	1.43204	1.43001	1.42798
656.28	1.38945	1.38698	1.38452	1.43235	1.43032	1.42829
589.26	1.39145	1.38898	1.38650	1.43453	1.43250	1.43047
546.07	1.39316	1.39068	1.38820	1.43640	1.43436	1.43232
501.57	1.39544	1.39294	1.39044	1.43888	1.43684	1.43480
486.13	1.39639	1.39389	1.39138	1.43993	1.43788	1.43583
435.83	1.40029	1.39776	1.39523	1.44419	1.44213	1.44007

$\lambda$ nm	<i>trans</i> -Bicyclo[4.4.0]decane			1-Methylnaphthalene		
	20°C	25°C	30°C	20°C	25°C	30°C
667.81	1.46654	1.46438	1.46222	1.60828	1.60592	1.60360
656.28	1.46688	1.46472	1.46256	1.60940	1.60703	1.60471
589.26	1.46932	1.46715	1.46498	1.61755	1.61512	1.61278
546.07	1.47141	1.46923	1.46705	1.62488	1.62240	1.62005
501.57	1.47420	1.47200	1.46980	1.63513	1.63259	1.63022
486.13	1.47535	1.47315	1.47095	1.63958	1.63701	1.63463
435.83	1.48011	1.47789	1.47567		1.65627	1.65386

$\lambda$ nm	Toluene			Methylcyclohexane		
	20°C	25°C	30°C	20°C	25°C	30°C
667.81	1.49180	1.48903	1.48619	1.42064	1.41812	1.41560
656.28	1.49243	1.48966	1.48682	1.42094	1.41842	1.41591
589.26	1.49693	1.49413	1.49126	1.42312	1.42058	1.41806
546.07	1.50086	1.49803	1.49514	1.42497	1.42243	1.41989
501.57	1.50620	1.50334	1.50041	1.42744	1.42488	1.42233
486.13	1.50847	1.50559	1.50265	1.42847	1.42590	1.42334
435.83	1.51800	1.51506	1.51206	1.43269	1.43010	1.42752



## INDEX OF REFRACTION OF AIR

This is a table of the index of refraction  $n$  of dry air at 15°C and a pressure of 101.325 kPa and containing 0.045% by volume of carbon dioxide (“standard air”). The index of refraction is defined by  $n = \lambda_{\text{vac}} / \lambda_{\text{air}}$  where  $\lambda$  is the wavelength of the radiation. The index is calculated from the expression

$$(n-1) \times 10^8 = 8342.54 + 2406147(130 - \sigma^2)^{-1} + 15998(38.9 - \sigma^2)^{-1}$$

where  $\sigma = 1/\lambda_{\text{vac}}$  and  $\lambda_{\text{vac}}$  has units of  $\mu\text{m}$ . The equation is valid for  $\lambda_{\text{vac}}$  from 200 nm to 2  $\mu\text{m}$ . The table also gives the correction  $(n-1)\lambda_{\text{air}}$  which must be added to the wavelength in air to obtain  $\lambda_{\text{vac}}$ .

If the air is at a temperature  $t$  in °C (ITS-90) and a pressure  $p$  in pascals, a value of  $(n - 1)$  from this table should be multiplied by

$$p[1 + p(60.1 - 0.972t) \times 10^{-10}]/96095.43(1 + 0.003661t)$$

### References

1. Birch, K. P., and Downs, M. J., *Metrologia*, 31, 315, 1994.
2. Edlen, B., *Metrologia* 2, 71, 1966.

$\lambda_{\text{vac}}$	$(n-1) \times 10^8$	$\lambda_{\text{vac}} - \lambda_{\text{air}}$	$\lambda_{\text{vac}}$	$(n-1) \times 10^8$	$\lambda_{\text{vac}} - \lambda_{\text{air}}$	$\lambda_{\text{vac}}$	$(n-1) \times 10^8$	$\lambda_{\text{vac}} - \lambda_{\text{air}}$
200 nm	32409	0.06480 nm	540	27804	0.15010	880	27462	0.24160
210	31748	0.06665	550	27784	0.15277	890	27458	0.24431
220	31226	0.06868	560	27765	0.15544	900	27454	0.24701
230	30801	0.07082	570	27747	0.15811	910	27449	0.24972
240	30447	0.07305	580	27730	0.16079	920	27445	0.25243
250	30148	0.07535	590	27714	0.16347	930	27441	0.25513
260	29892	0.07769	600	27698	0.16614	940	27437	0.25784
270	29670	0.08009	610	27684	0.16882	950	27434	0.26055
280	29477	0.08251	620	27670	0.17151	960	27430	0.26326
290	29307	0.08497	630	27657	0.17419	970	27427	0.26597
300	29157	0.08745	640	27644	0.17688	980	27423	0.26868
310	29023	0.08995	650	27632	0.17956	990	27420	0.27138
320	28904	0.09247	660	27621	0.18225			
330	28796	0.09500	670	27610	0.18494	1.00 $\mu\text{m}$	27417	0.0002741
340	28700	0.09755	680	27600	0.18763	1.05	27402	0.0002876
350	28612	0.10011	690	27590	0.19032	1.10	27390	0.0003012
360	28532	0.10269	700	27581	0.19301	1.15	27379	0.0003148
370	28460	0.10527	710	27572	0.19570	1.20	27370	0.0003283
380	28393	0.10786	720	27563	0.19840	1.25	27361	0.0003419
390	28332	0.11046	730	27555	0.20109	1.30	27354	0.0003555
400	28276	0.11307	740	27547	0.20379	1.35	27347	0.0003691
410	28224	0.11569	750	27539	0.20649	1.40	27341	0.0003827
420	28177	0.11831	760	27532	0.20918	1.45	27336	0.0003963
430	28132	0.12094	770	27525	0.21188	1.50	27331	0.0004099
440	28091	0.12357	780	27518	0.21458	1.55	27327	0.0004234
450	28053	0.12620	790	27511	0.21728	1.60	27323	0.0004370
460	28018	0.12885	800	27505	0.21998	1.65	27319	0.0004506
470	27985	0.13149	810	27499	0.22268	1.70	27316	0.0004642
480	27954	0.13414	820	27493	0.22538	1.75	27313	0.0004778
490	27925	0.13679	830	27488	0.22808	1.80	27310	0.0004914
500	27897	0.13945	840	27482	0.23079	1.85	27307	0.0005050
510	27872	0.14211	850	27477	0.23349	1.90	27305	0.0005187
520	27848	0.14477	860	27472	0.23619	1.95	27303	0.0005323
530	27825	0.14743	870	27467	0.23890	2.00	27301	0.0005459

# CHARACTERISTICS OF LASER SOURCES

William F. Krupke

Light amplification by stimulated emission of radiation was first demonstrated by Maiman in 1960, the result of a population inversion produced between energy levels of chromium ions in a ruby crystal when irradiated with a xenon flashlamp. Since then population inversions and coherent emission have been generated in literally thousands of substances (neutral and ionized gases, liquids, and solids) using a variety of incoherent excitation techniques (optical pumping, electrical discharges, gas-dynamic flow, electron-beams, chemical reactions, nuclear decay).

The extrema of laser output parameters that have been demonstrated to date and the laser media used are summarized in Table 1. Note that the extreme power and energy parameters listed in this table were attained with laser systems rather than with simple laser oscillators.

Laser sources are commonly classified in terms of the state-of-matter of the active medium: gas, liquid, and solid. Each of these classes is further subdivided into one or more types as shown in Table 2. A well-known representative example of each type of laser is also given in Table 2 together with its nominal operation wavelength and the methods by which it is pumped.

The various lasers together cover a wide spectral range from the far ultraviolet to the far infrared. The particular wavelength of emission (usually a narrow line) is presented for some six dozen lasers in Figures 1A and 1B.

By suitably designing the excitation source and/or by controlling the laser resonator structure, laser systems can provide continuous or pulsed radiation as shown in Table 3.

Besides the method of excitation and the temporal behavior of a laser, there are many other parameters that characterize its operation and efficiency, as shown in Tables 4 and 5.

Although many lasers only emit in one or more narrow spectral "lines," an increasing number of lasers can be tuned by changing the composition or the pressure of the medium, or by varying the wavelength of the pump bands. The spectral regions in which these tunable lasers operate are presented in Figure 2.

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TABLE 1. Extrema of Output Parameters of Laser Devices or Systems

Parameter	Value	Laser medium
Peak power	$1 \times 10^{14}$ W(collimated)	Nd:glass
Peak power density	$10^{18}$ W/cm <sup>2</sup> (focused)	Nd:glass
Pulse energy	$>10^5$ J	CO <sub>2</sub> , Nd:glass
Average power	$10^5$ W	CO <sub>2</sub>
Pulse duration	$3 \times 10^{-15}$ s continuous wave (cw)	Rh6G dye; various gases, liquids, solids
Wavelength	60 nm $\leftrightarrow$ 385 $\mu$ m	Many required
Efficiency (nonlaser pumped)	70%	CO
Beam quality	Diffraction limited	Various gases, liquids, solids
Spectral linewidth	20 Hz (for $10^{-1}$ s)	Neon-helium
Spatial coherence	10 m	Ruby

TABLE 2. Classes, Types, and Representative Examples of Laser Sources

Class	Type (characteristic)	Representative example	Nominal operating wavelength (nm)	Method(s) of excitation
Gas	Atom, neutral (electronic transition)	Neon-Helium (Ne-He)	633	Glow discharge
	Atom, ionic (electronic transition)	Argon (Ar <sup>+</sup> )	488	Arc discharge
	Molecule, neutral (electronic transition)	Krypton fluoride (KrF)	248	Glow discharge; e-beam
	Molecule, neutral (vibrational transition)	Carbon dioxide (CO <sub>2</sub> )	10600	Glow discharge; gasdynamic flow
	Molecule, neutral (rotational transition)	Methyl fluoride (CH <sub>3</sub> F)	496000	Laser pumping
	Molecule, ionic (electronic transition)	Nitrogen ion (N <sub>2</sub> <sup>+</sup> )	420	E-beam
Liquid	Organic solvent (dye-chromophore)	Rhodamine dye (Rh6G)	580-610	Flashlamp; laser pumping
	Organic solvent (rare earth chelate)	Europium:TTF	612	Flashlamp
	Inorganic solvent (trivalent rare earth ion)	Neodymium:POCl <sub>4</sub>	1060	Flashlamp
Solid	Insulator, crystal (impurity)	Neodymium:YAG	1064	Flashlamp, arc lamp
	Insulator, crystal (stoichiometric)	Neodymium:UP(NdP <sub>5</sub> O <sub>14</sub> )	1052	Flashlamp
	Insulator, crystal (color center)	F <sub>2</sub> <sup>-</sup> :LiF	1120	Laser pumping
	Insulator, amorphous (impurity)	Neodymium:glass	1061	Flashlamp
	Semiconductor (p-n junction)	GaAs	820	Injection current
	Semiconductor (electron-hole plasma)	GaAs	890	E- beam, laser pumping

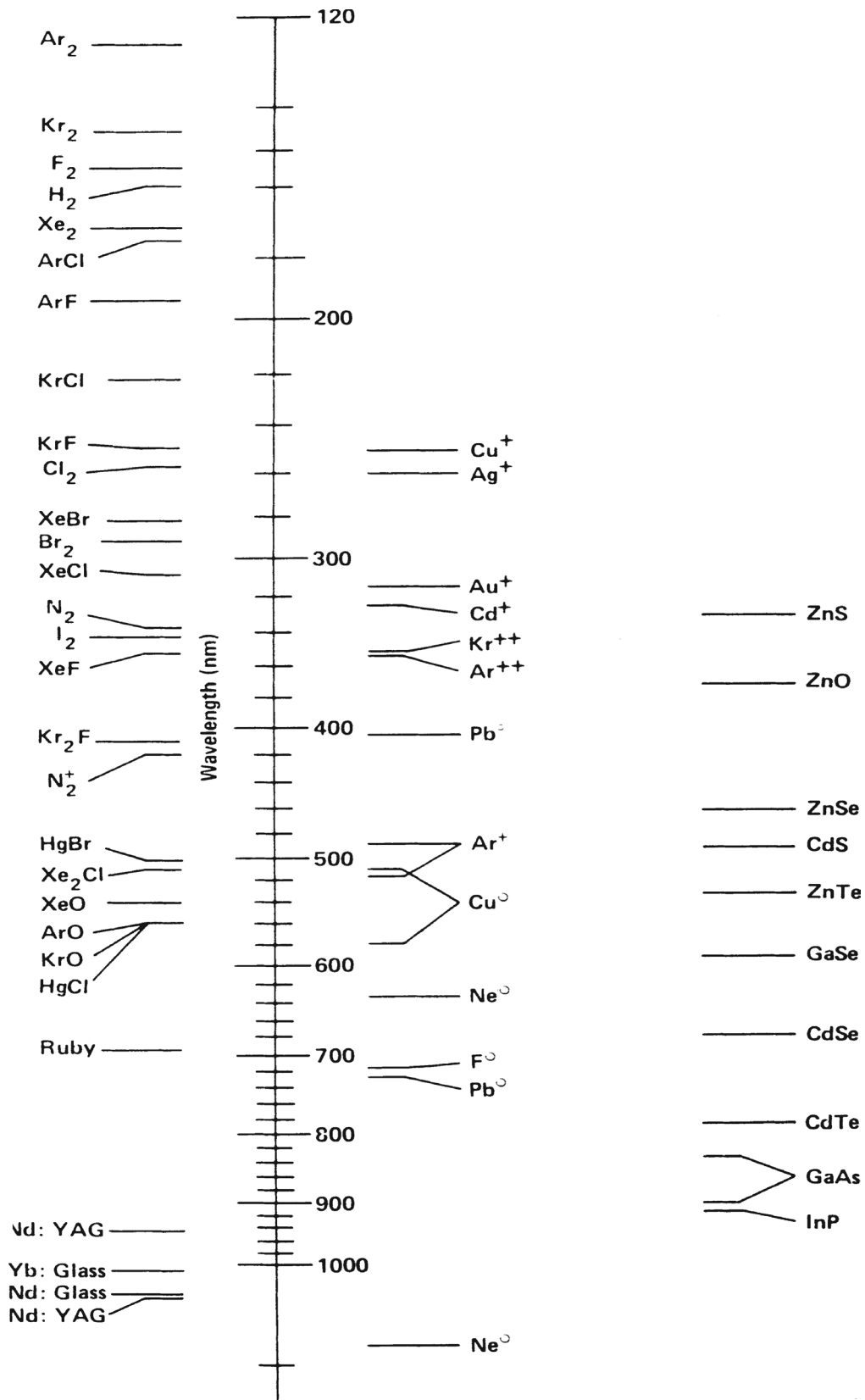


FIGURE 1A. Wavelengths of lasers operating in the 120 to 1200 nm spectral region.

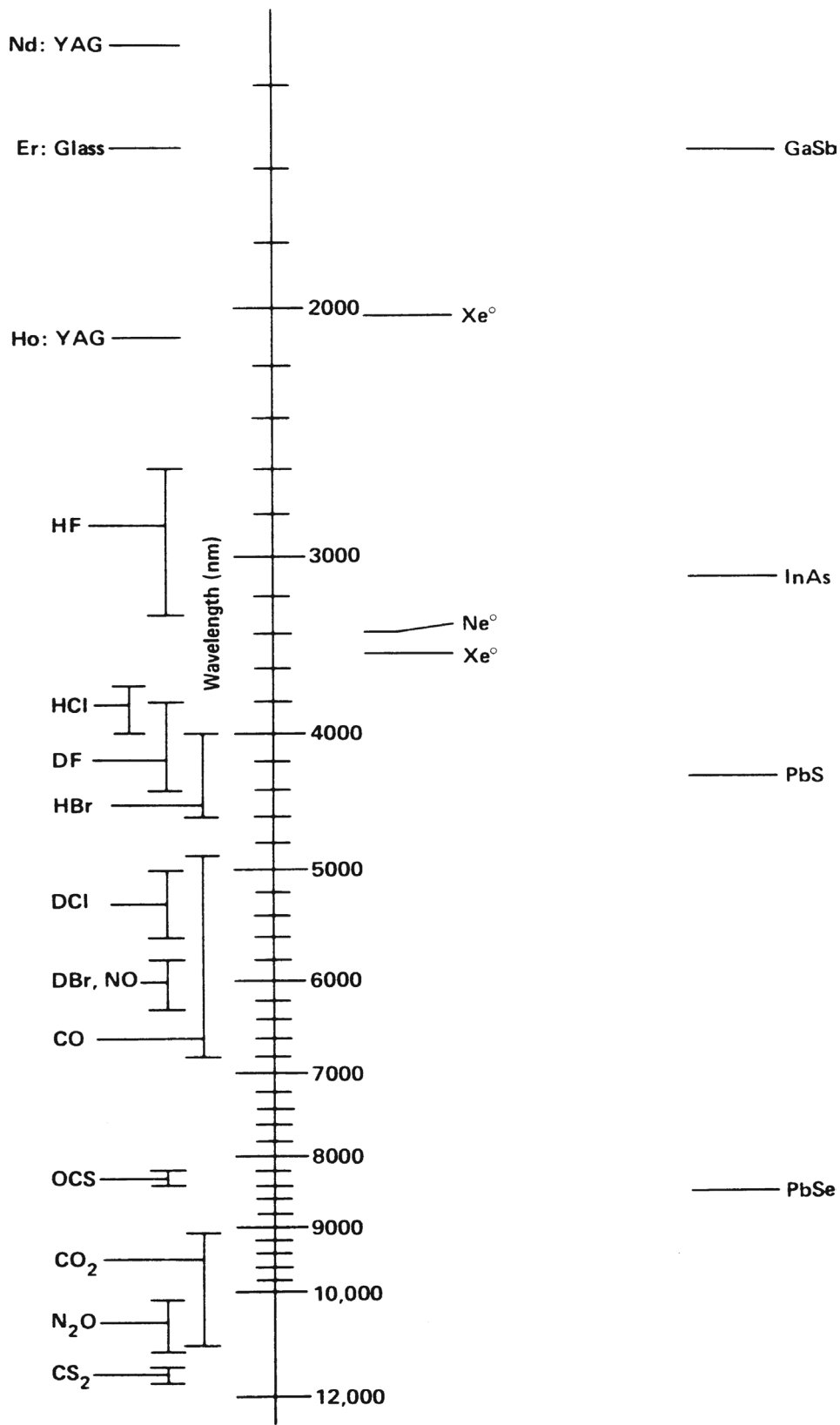


FIGURE 1B. Wavelength of lasers operating in the 1300 to 12,000 nm spectral region.

TABLE 3. Temporal Characteristics of Lasers and Laser Systems

Form	Technique	Pulse width range (s)
Continuous wave	Excitation is continuous; resonator Q is held constant at some moderate value	$\infty$
Pulsed	Excitation is pulsed; resonator Q is held constant at some moderate value	$10^{-8} - 10^{-3}$
Q-Switched	Excitation is continuous or pulsed; resonator Q is switched from a very low value to a moderate value	$10^{-8} - 10^{-6}$
Cavity dumped	Excitation is continuous or pulsed; resonator Q is switched from a very high value to a low value	$10^{-7} - 10^{-5}$
Mode locked	Excitation is continuous or pulsed; phase or loss of the resonator modes is modulated at a rate related to the resonator transit time	$10^{-12} - 10^{-9}$

TABLE 4. Properties and Performance of Some Continuous Wave (CW) Lasers

Parameter	Unit	Gas			Liquid	Solid	
		Neon helium	Argon ion	Carbon dioxide	Rhodamine 6G dye	Nd:YAG	GaAs
Excitation method		DC discharge	DC discharge	DC discharge	Ar <sup>+</sup> laser pump	Krypton arc lamp	DC injection
Gain medium composition		Neon:helium	Argon	CO <sub>2</sub> :N <sub>2</sub> :He	Rh 6G:H <sub>2</sub> O	Nd:YAG	p:n:GaAs
Gain medium density	Torr ions/cm <sup>3</sup>	0.1:1.0	0.4	0.4:0.8:5.0	2(18):2(22)	1.5(20):2(22)	2(19):3(18):3(22)
Wavelength	nm	633	488	10600	590	1064	810
Laser cross-section	cm <sup>2</sup>	3(-13)	1.6(-12)	1.5(-16)	1.8(-16)	7(-19)	~6(-15)
Radiative lifetime (upper level)	s	~1(-7)	7.5(-9)	4(-3)	6.5(-9)	2.6(-4)	~1(-9)
Decay lifetime (upper level)	s	~1(-7)	~5.0(-9)	~4(-3)	6.0(-9)	2.3(-4)	~1(-9)
Gain bandwidth	nm	2(-3)	5(-3)	1.6(-2)	80	0.5	10
Type, gain saturation		Inhomogeneous	Inhomogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Homogeneous saturation flux	W cm <sup>-2</sup>			~20	3(5)	2.3(3)	~2(4)
Decay lifetime (lower level)	s	~1(-8)	~4(-10)	~5(-6)	<1(-12)	<1(-7)	<1(-12)
Inversion density	cm <sup>-3</sup>	~1(9)	2(10)	2(15)	2(16)	6(16)	1(16)
Small signal gain coefficient	cm <sup>-1</sup>	~1(-3)	~3(-2)	1(-2)	4	5(-2)	40
Pump power density	W cm <sup>-3</sup>	3	900	0.15	1(6)	150	7(7)
Output power density	W cm <sup>-3</sup>	2.6(-3)	~1	2(-2)	3(5)	95	5(6)
Laser size (diameter: length)	cm:cm	0.5:100	0.3:100	5.0:600	1(-3):0.3	0.6:10	5(-4):7(-3);2(-2) <sup>a</sup>
Excitation current/voltage	A/V	3(-2):2(3)	30:300	0.1:1.5(4)		90:125	1.0/1.7
Excitation current density	A cm <sup>-2</sup>	0.15	600	6(-3)		140	4.5(3)
Excitation power	W	60	9(3)	1.5(3)	4	1.1(4)	1.7
Output power	W	0.06	10	240	0.3	300	0.12
Efficiency <sup>b</sup>	%	0.1	0.1	13	7	2.6	7

<sup>a</sup> Junction thickness:width:length.<sup>b</sup> Pressure dependent.

TABLE 5. Properties and Performance of Some Pulsed Lasers

Parameter	Unit	Gas				Liquid	Solid	
		Carbon dioxide		Krypton fluoride		Rhodamine 6G	Nd:YAG	Nd:glass
Excitation method		TEA-discharge	E- beam/sust.	Glow discharge	E-beam	Xenon flashlamp	Xenon flashlamp	Xenon flashlamp
Gain medium composition		CO <sub>2</sub> :N <sub>2</sub> :He	CO <sub>2</sub> :N <sub>2</sub> :He	He:Kr:F <sub>2</sub>	Ar:Kr:F <sub>2</sub>	Rh6G:alcohol	Nd:YAG	Nd:Glass
Gain medium density	torr	100:50:600	240:240:320	1070:70:3	1235:52:3			–
	ions/cm <sup>3</sup>					1(18):1.5(22)	1.5(20):1(22)	3(20):2(22)
Wavelength	nm	10600	10600	249	249	590	1064	1061
Laser cross-section	cm <sup>-2</sup>	2(-18)	2(-18)	2(-16)	2(-16)	1.8(-16)	7(-19)	2.8(-20)
Radiative lifetime (upper level)	s	4(-3)	4(-3)	7(-9)	7(-9)	6.5(-9)	2.6(-4)	4.1(-4)
Decay lifetime (upper level)	s	~1(-4)	5(-5)	2(-9)	3(-9)	6.0(-9)	2.3(-4)	3.7(-4)
Gain bandwidth	nm	1	1	2	2	80	0.5	26
Homogeneous saturation fluence	J/cm <sup>2</sup>	0.2	0.2	4(-3)	4(-3)	2(-3)	0.6	~5
Decay lifetime (lower level)	s	5(-8) <sup>a</sup>	1(-8) <sup>a</sup>	<1(-12)	<1(-12)	<1(-12)	<1(-7)	<1(-8)
Inversion density	cm <sup>-3</sup>	3(17)	6(17)	4(14)	2(14)	2(16)	4(17)	3(18)
Small signal gain coefficient	cm <sup>-1</sup>	2(-2)	4(-2)	8–92)	4(-2)	4	0.3	8(-2)
Medium excitation energy density	J/cm <sup>3</sup>	0.1	0.36	0.15	0.13	2.8	0.15	0.6
Output energy density	J/cm <sup>3</sup>	2(-2)	1.8(-2)	1.5(-3)	1.2(-2)	0.85	5(-2)	2(-2)
Laser dimensions	cm: cm: cm	4.5:4.5:87	10:10:100	1.5:4.5:100	8.5:10:100	1.2:25	0.6:7.5	0.6:8.3
Excitation current/voltage	A/V	6(4)/3.3(3)	2.4(4)/4(4)	2.5(4)/1.5(5)	1.2(4)/2.5(5)	2(5)/2.5(4)		
Excitation current density	A cm <sup>-2</sup>	8.5	22	170	11.5	2.6(3)		
Excitation peak power	W	2(8)	9(8)	4(9)	3(9)	5.4(9)	4(4)	9(4)
Output pulse energy	J	35	180	1	102	32	0.1	1.0
Output pulse length	s	1(-6)	4(-6)	2.5(-8)	6(-7)	3.2(-6)	2(-8)	1(-4)
Output pulse power	W	3.5(7)	4(7)	4(7)	2(8)	1(7)	5(6)	1(4)
Efficiency	%	17	5	1	10 <sup>b</sup>	0.2	1.5	3.7

<sup>a</sup> Pressure dependent.

<sup>b</sup> Intrinsic efficiency ≡ energy output/energy deposited in gas.

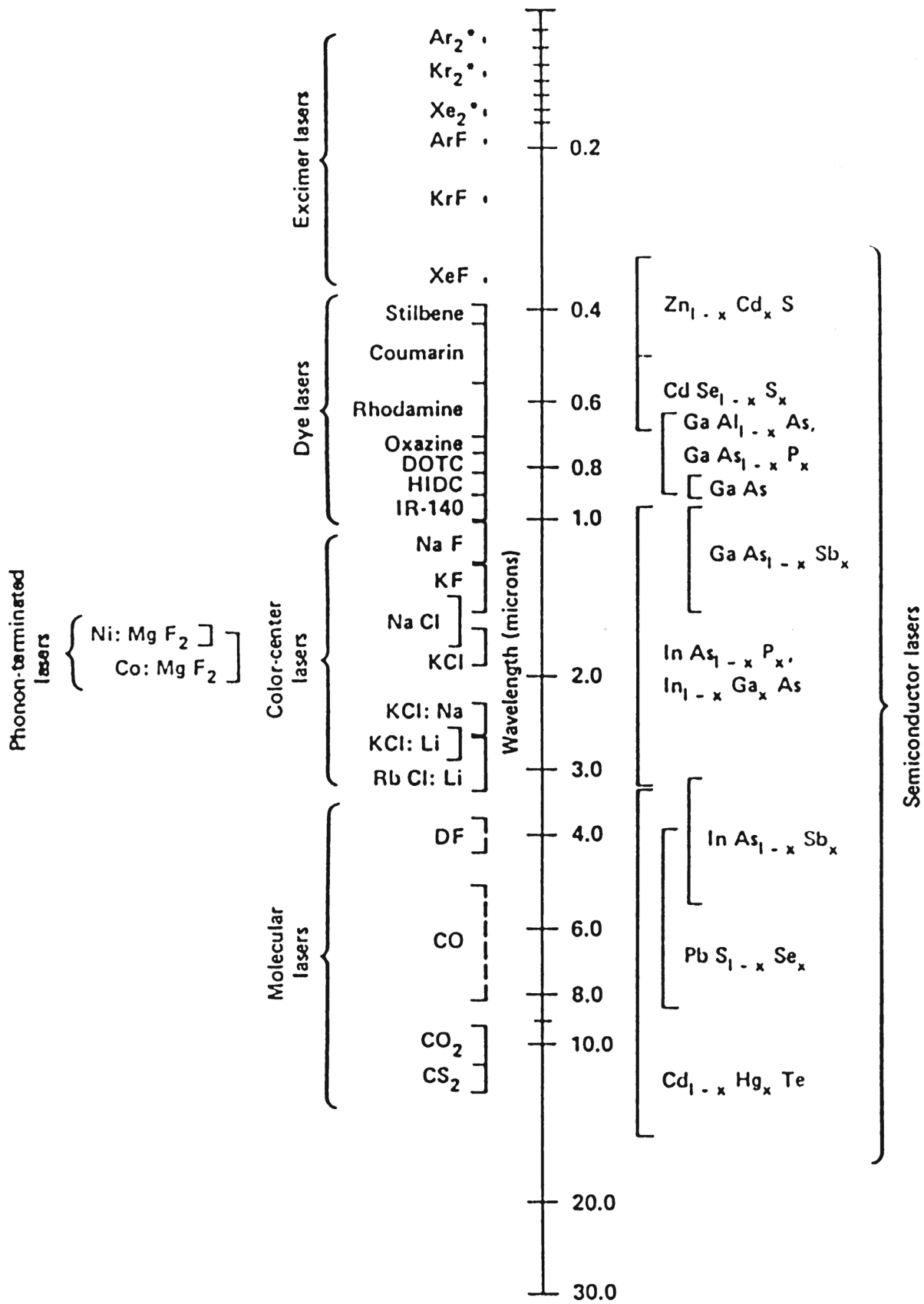


FIGURE 2. Spectral tuning ranges of various types of tunable lasers.

# INFRARED LASER FREQUENCIES

Arthur Maki

The CO<sub>2</sub> laser has been the subject of a number of very accurate frequency measurements. Most of the earlier measurements are given by Bradley et al.<sup>1</sup> That analysis was based on a single absolute frequency measurement and many laser frequency differences. New measurements of the methane frequency<sup>2-4</sup> have made it necessary to slightly revise that single absolute frequency measurement. In addition, there have been several other absolute frequency measurements<sup>5-7</sup> that have been used here to improve the accuracy of the present tables. New frequency difference measurements have also been added to the database used for the present tables.<sup>8</sup>

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## Frequencies for the 00°1-(10°0,02°0)<sub>I</sub> and 00°1-(10°0,02°0)<sub>II</sub> Bands of <sup>12</sup>C<sup>16</sup>O<sub>2</sub> with the Estimated 2σ Uncertainties

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
P(70)	26721305.4647	0.1680	P(70)	29789856.3783	0.0308
P(68)	26794232.6712	0.1217	P(68)	29861850.7690	0.0192
P(66)	26866318.8073	0.0867	P(66)	29933216.1760	0.0122
P(64)	26937571.7234	0.0606	P(64)	30003944.2861	0.0086
P(62)	27007998.9216	0.0415	P(62)	30074026.9127	0.0072
P(60)	27077607.5643	0.0279	P(60)	30143456.0039	0.0066
P(58)	27146404.4834	0.0185	P(58)	30212223.6504	0.0061
P(56)	27214396.1873	0.0121	P(56)	30280322.0930	0.0055
P(54)	27281588.8696	0.0081	P(54)	30347743.7306	0.0049
P(52)	27347988.4161	0.0057	P(52)	30414481.1273	0.0044
P(50)	27413600.4119	0.0043	P(50)	30480527.0196	0.0041
P(48)	27478430.1487	0.0036	P(48)	30545874.3239	0.0039
P(46)	27542482.6310	0.0032	P(46)	30610516.1429	0.0039
P(44)	27605762.5826	0.0030	P(44)	30674445.7724	0.0039
P(42)	27668274.4525	0.0028	P(42)	30737656.7080	0.0039
P(40)	27730022.4206	0.0027	P(40)	30800142.6511	0.0039
P(38)	27791010.4036	0.0026	P(38)	30861897.5150	0.0038
P(36)	27851242.0594	0.0025	P(36)	30922915.4310	0.0037
P(34)	27910720.7927	0.0024	P(34)	30983190.7534	0.0037
P(32)	27969449.7593	0.0023	P(32)	31042718.0652	0.0037
P(30)	28027431.8708	0.0022	P(30)	31101492.1833	0.0036
P(28)	28084669.7981	0.0021	P(28)	31159508.1631	0.0037
P(26)	28141165.9762	0.0020	P(26)	31216761.3029	0.0037
P(24)	28196922.6067	0.0019	P(24)	31273247.1487	0.0037
P(22)	28251941.6622	0.0017	P(22)	31328961.4978	0.0037
P(20)	28306224.8888	0.0016	P(20)	31383900.4028	0.0037
P(18)	28359773.8090	0.0014	P(18)	31438060.1749	0.0037
P(16)	28412589.7245	0.0012	P(16)	31491437.3872	0.0036
P(14)	28464673.7184	0.0011	P(14)	31544028.8776	0.0036
P(12)	28516026.6574	0.0009	P(12)	31595831.7516	0.0036
P(10)	28566649.1935	0.0008	P(10)	31646843.3843	0.0035
P(8)	28616541.7661	0.0008	P(8)	31697061.4225	0.0035
P(6)	28665704.6027	0.0008	P(6)	31746483.7868	0.0035
P(4)	28714137.7205	0.0008	P(4)	31795108.6724	0.0035
P(2)	28761840.9272	0.0008	P(2)	31842934.5511	0.0035
R(0)	28832026.2198	0.0008	R(0)	31913172.5691	0.0035
R(2)	28877902.4382	0.0007	R(2)	31958996.0621	0.0034
R(4)	28923046.4303	0.0006	R(4)	32004017.3822	0.0034



Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
R(6)	28967457.0657	0.0005	R(6)	32048236.2498	0.0034
R(8)	29011133.0054	0.0003	R(8)	32091652.6619	0.0034
R(10)	29054072.7010	0.0001	R(10)	32134266.8917	0.0034
R(12)	29096274.3935	0.0003	R(12)	32176079.4878	0.0034
R(14)	29137736.1129	0.0005	R(14)	32217091.2721	0.0035
R(16)	29178455.6759	0.0007	R(16)	32257303.3386	0.0036
R(18)	29218430.6852	0.0009	R(18)	32296717.0510	0.0037
R(20)	29257658.5269	0.0010	R(20)	32335334.0408	0.0038
R(22)	29296136.3689	0.0011	R(22)	32373156.2044	0.0039
R(24)	29333861.1583	0.0012	R(24)	32410185.7003	0.0041
R(26)	29370829.6191	0.0011	R(26)	32446424.9459	0.0042
R(28)	29407038.2491	0.0011	R(28)	32481876.6140	0.0042
R(30)	29442483.3168	0.0011	R(30)	32516543.6293	0.0042
R(32)	29477160.8582	0.0012	R(32)	32550429.1641	0.0042
R(34)	29511066.6733	0.0013	R(34)	32583536.6340	0.0042
R(36)	29544196.3221	0.0015	R(36)	32615869.6937	0.0041
R(38)	29576545.1205	0.0017	R(38)	32647432.2320	0.0040
R(40)	29608108.1360	0.0019	R(40)	32678228.3665	0.0039
R(42)	29638880.1831	0.0022	R(42)	32708262.4386	0.0038
R(44)	29668855.8183	0.0024	R(44)	32737539.0081	0.0039
R(46)	29698029.3350	0.0027	R(46)	32766062.8469	0.0041
R(48)	29726394.7582	0.0032	R(48)	32793838.9334	0.0045
R(50)	29753945.8385	0.0037	R(50)	32820872.4463	0.0055
R(52)	29780676.0464	0.0042	R(52)	32847168.7576	0.0071
R(54)	29806578.5659	0.0047	R(54)	32872733.4269	0.0099
R(56)	29831646.2878	0.0052	R(56)	32897572.1935	0.0141
R(58)	29855871.8032	0.0058	R(58)	32921690.9701	0.0202
R(60)	29879247.3960	0.0074	R(60)	32945095.8355	0.0288
R(62)	29901765.0357	0.0113	R(62)	32967793.0268	0.0407
R(64)	29923416.3695	0.0186	R(64)	32989788.9322	0.0567
R(66)	29944192.7145	0.0302	R(66)	33011090.0831	0.0780
R(68)	29964085.0488	0.0475	R(68)	33031703.1467	0.1060
R(70)	29983084.0036	0.0720	R(70)	33051634.9172	0.1423

**Frequencies for the  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_I$  and  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_{II}$  Bands of  $^{13}C^{16}O_2$  with the Estimated  $2\sigma$  Uncertainties**

P(66)	25523832.1808	0.7836	P(66)	28512082.5283	1.2894
P(64)	25590013.4703	0.5415	P(64)	28585121.9396	0.9194
P(62)	25655543.6502	0.3629	P(62)	28657449.4180	0.6420
P(60)	25720428.2487	0.2339	P(60)	28729056.6374	0.4375
P(58)	25784672.4840	0.1430	P(58)	28799935.4147	0.2897
P(56)	25848281.2771	0.0810	P(56)	28870077.7187	0.1853
P(54)	25911259.2627	0.0405	P(54)	28939475.6771	0.1135
P(52)	25973610.8005	0.0157	P(52)	29008121.5846	0.0659
P(50)	26035339.9857	0.0045	P(50)	29076007.9109	0.0357
P(48)	26096450.6582	0.0079	P(48)	29143127.3077	0.0180
P(46)	26156946.4123	0.0101	P(46)	29209472.6164	0.0090
P(44)	26216830.6053	0.0101	P(44)	29275036.8754	0.0058
P(42)	26276106.3655	0.0090	P(42)	29339813.3270	0.0050
P(40)	26334776.6003	0.0077	P(40)	29403795.4243	0.0044
P(38)	26392844.0030	0.0068	P(38)	29466976.8383	0.0037
P(36)	26450311.0599	0.0063	P(36)	29529351.4635	0.0032
P(34)	26507180.0565	0.0061	P(34)	29590913.4252	0.0029
P(32)	26563453.0836	0.0060	P(32)	29651657.0844	0.0028
P(30)	26619132.0428	0.0058	P(30)	29711577.0447	0.0028
P(28)	26674218.6515	0.0055	P(28)	29770668.1566	0.0031
P(26)	26728714.4479	0.0054	P(26)	29828925.5239	0.0035
P(24)	26782620.7952	0.0054	P(24)	29886344.5074	0.0041
P(22)	26835938.8858	0.0054	P(22)	29942920.7308	0.0046
P(20)	26888669.7451	0.0055	P(20)	29998650.0838	0.0051
P(18)	26940814.2347	0.0055	P(18)	30053528.7271	0.0054

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
P(16)	26992373.0555	0.0055	P(16)	30107553.0955	0.0055
P(14)	27043346.7508	0.0054	P(14)	30160719.9016	0.0055
P(12)	27093735.7083	0.0052	P(12)	30213026.1388	0.0054
P(10)	27143540.1624	0.0051	P(10)	30264469.0839	0.0054
P(8)	27192760.1962	0.0049	P(8)	30315046.2994	0.0054
P(6)	27241395.7431	0.0048	P(6)	30364755.6359	0.0055
P(4)	27289446.5880	0.0047	P(4)	30413595.2335	0.0056
P(2)	27336912.3682	0.0046	P(2)	30461563.5231	0.0057
R(0)	27407012.8882	0.0045	P(0)	30531879.5415	0.0057
R(2)	27453013.4589	0.0043	P(2)	30577664.6138	0.0056
R(4)	27498426.5430	0.0040	P(4)	30622575.1885	0.0054
R(6)	27543251.1200	0.0037	P(6)	30666611.0128	0.0051
R(8)	27587486.0225	0.0034	P(8)	30709772.1257	0.0047
R(10)	27631129.9356	0.0031	P(10)	30752058.8571	0.0045
R(12)	27674181.3963	0.0029	P(12)	30793471.8269	0.0044
R(14)	27716638.7917	0.0029	P(14)	30834011.9425	0.0043
R(16)	27758500.3577	0.0029	P(16)	30873680.3976	0.0044
R(18)	27799764.1770	0.0029	P(18)	30912478.6694	0.0044
R(20)	27840428.1773	0.0030	P(20)	30950408.5159	0.0044
R(22)	27880490.1283	0.0029	P(22)	30987471.9732	0.0043
R(24)	27919947.6395	0.0029	P(24)	31023671.3517	0.0042
R(26)	27958798.1567	0.0028	P(26)	31059009.2327	0.0042
R(28)	27997038.9591	0.0028	P(28)	31093488.4642	0.0042
R(30)	28034667.1551	0.0027	P(30)	31127112.1569	0.0043
R(32)	28071679.6785	0.0027	P(32)	31159883.6793	0.0045
R(34)	28108073.2842	0.0026	P(34)	31191806.6529	0.0046
R(36)	28143844.5432	0.0026	P(36)	31222884.9469	0.0048
R(38)	28178989.8377	0.0026	P(38)	31253122.6730	0.0053
R(40)	28213505.3554	0.0028	P(40)	31282524.1795	0.0061
R(42)	28247387.0838	0.0033	P(42)	31311094.0452	0.0077
R(44)	28280630.8035	0.0046	P(44)	31338837.0736	0.0108
R(46)	28313232.0818	0.0083	P(46)	31365758.2858	0.0173
R(48)	28345186.2652	0.0161	P(48)	31391862.9147	0.0295
R(50)	28376488.4720	0.0301	P(50)	31417156.3972	0.0505
R(52)	28407133.5839	0.0531	P(52)	31441644.3679	0.0845
R(54)	28437116.2372	0.0887	P(54)	31465332.6516	0.1366
R(56)	28466430.8141	0.1419	P(56)	31488227.2557	0.2138
R(58)	28495071.4324	0.2188	P(58)	31510334.3631	0.3247
R(60)	28523031.9357	0.3271	P(60)	31531660.3243	0.4800
R(62)	28550305.8819	0.4763	P(62)	31552211.6497	0.6932
R(64)	28576886.5323	0.6781	P(64)	31571995.0017	0.9805
R(66)	28602766.8393	0.9467	P(66)	31591017.1868	1.3619

**Frequencies for the  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_I$  and  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_{II}$  Bands of  $^{12}C^{18}O_2$  with the Estimated  $2\sigma$  Uncertainties**

P(70)	27045326.3119	0.4540	P(70)	30695237.5856	0.0858
P(68)	27114914.0922	0.3324	P(68)	30755520.2231	0.0570
P(66)	27183635.7945	0.2392	P(66)	30815311.4928	0.0364
P(64)	27251496.4118	0.1688	P(64)	30874607.2084	0.0223
P(62)	27318500.7361	0.1165	P(62)	30933403.2309	0.0131
P(60)	27384653.3618	0.0783	P(60)	30991695.4724	0.0075
P(58)	27449958.6881	0.0510	P(58)	31049479.9009	0.0049
P(56)	27514420.9224	0.0319	P(56)	31106752.5446	0.0041
P(54)	27578044.0828	0.0191	P(54)	31163509.4964	0.0040
P(52)	27640832.0010	0.0108	P(52)	31219746.9183	0.0040
P(50)	27702788.3248	0.0059	P(50)	31275461.0455	0.0039
P(48)	27763916.5206	0.0035	P(48)	31330648.1908	0.0039
P(46)	27824219.8762	0.0028	P(46)	31385304.7490	0.0039
P(44)	27883701.5029	0.0026	P(44)	31439427.2006	0.0039
P(42)	27942364.3379	0.0025	P(42)	31493012.1163	0.0038
P(40)	28000211.1464	0.0024	P(40)	31546056.1605	0.0038

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
P(38)	28057244.5242	0.0022	P(38)	31598556.0954	0.0037
P(36)	28113466.8992	0.0021	P(36)	31650508.7847	0.0037
P(34)	28168880.5335	0.0020	P(34)	31701911.1970	0.0037
P(32)	28223487.5256	0.0019	P(32)	31752760.4093	0.0037
P(30)	28277289.8118	0.0017	P(30)	31803053.6105	0.0037
P(28)	28330289.1679	0.0016	P(28)	31852788.1043	0.0038
P(26)	28382487.2111	0.0015	P(26)	31901961.3125	0.0038
P(24)	28433885.4012	0.0013	P(24)	31950570.7773	0.0038
P(22)	28484485.0420	0.0012	P(22)	31998614.1649	0.0038
P(20)	28534287.2828	0.0011	P(20)	32046089.2669	0.0037
P(18)	28583293.1193	0.0010	P(18)	32092994.0036	0.0037
P(16)	28631503.3952	0.0010	P(16)	32139326.4254	0.0036
P(14)	28678918.8025	0.0009	P(14)	32185084.7154	0.0036
P(12)	28725539.8830	0.0010	P(12)	32230267.1907	0.0036
P(10)	28771367.0288	0.0010	P(10)	32274872.3041	0.0037
P(8)	28816400.4829	0.0010	P(8)	32318898.6455	0.0038
P(6)	28860640.3403	0.0011	P(6)	32362344.9434	0.0039
P(4)	28904086.5477	0.0011	P(4)	32405210.0652	0.0041
P(2)	28946738.9048	0.0011	P(2)	32447493.0185	0.0041
R(0)	29009228.1702	0.0010	P(0)	32509824.0580	0.0042
R(2)	29049894.0586	0.0010	P(2)	32550648.1723	0.0042
R(4)	29089764.2368	0.0009	P(4)	32590887.7542	0.0042
R(6)	29128837.8426	0.0008	P(6)	32630542.4457	0.0041
R(8)	29167113.8668	0.0008	P(8)	32669612.0295	0.0041
R(10)	29204591.1529	0.0009	P(10)	32708096.4282	0.0040
R(12)	29241268.3964	0.0010	P(12)	32745995.7040	0.0040
R(14)	29277144.1444	0.0011	P(14)	32783310.0573	0.0040
R(16)	29312216.7955	0.0012	P(16)	32820039.8258	0.0040
R(18)	29346484.5984	0.0012	P(18)	32856185.4827	0.0040
R(20)	29379945.6517	0.0013	P(20)	32891747.6358	0.0040
R(22)	29412597.9024	0.0013	P(22)	32926727.0254	0.0040
R(24)	29444439.1458	0.0013	P(24)	32961124.5220	0.0040
R(26)	29475467.0236	0.0014	P(26)	32994941.1249	0.0040
R(28)	29505679.0230	0.0015	P(28)	33028177.9594	0.0040
R(30)	29535072.4755	0.0016	P(30)	33060836.2743	0.0040
R(32)	29563644.5557	0.0018	P(32)	33092917.4394	0.0041
R(34)	29591392.2794	0.0020	P(34)	33124422.9429	0.0043
R(36)	29618312.5023	0.0023	P(36)	33155354.3878	0.0046
R(38)	29644401.9182	0.0028	P(38)	33185713.4894	0.0049
R(40)	29669657.0575	0.0036	P(40)	33215502.0716	0.0056
R(42)	29694074.2853	0.0053	P(42)	33244722.0637	0.0068
R(44)	29717649.7992	0.0082	P(44)	33273375.4969	0.0092
R(46)	29740379.6276	0.0128	P(46)	33301464.5003	0.0134
R(48)	29762259.6274	0.0200	P(48)	33328991.2976	0.0199
R(50)	29783285.4820	0.0307	P(50)	33355958.2027	0.0294
R(52)	29803452.6988	0.0461	P(52)	33382367.6161	0.0427
R(54)	29822756.6072	0.0681	P(54)	33408222.0209	0.0607
R(56)	29841192.3558	0.0985	P(56)	33433523.9780	0.0848
R(58)	29858754.9100	0.1401	P(58)	33458276.1228	0.1165
R(60)	29875439.0495	0.1960	P(60)	33482481.1601	0.1576
R(62)	29891239.3658	0.2702	P(62)	33506141.8605	0.2104
R(64)	29906150.2589	0.3673	P(64)	33529261.0556	0.2775
R(66)	29920165.9352	0.4930	P(66)	33551841.6335	0.3621
R(68)	29933280.4042	0.6540	P(68)	33573886.5352	0.4679
R(70)	29945487.4756	0.8581	P(70)	33595398.7493	0.5992

**Frequencies for the  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_I$  and  $00^{\circ}1-(10^{\circ}0,02^{\circ}0)_{II}$  Bands of  $^{13}\text{C}^{18}\text{O}_2$  with the Estimated  $2\sigma$  Uncertainties**

P(70)	25967863.7652	1.1146	P(70)	28960476.2278	0.4069
P(68)	26033448.2798	0.8152	P(68)	29022326.9578	0.2861
P(66)	26098273.9159	0.5860	P(66)	29083661.3546	0.1961

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
P(64)	26162346.4813	0.4129	P(64)	29144473.5795	0.1303
P(62)	26225671.5466	0.2844	P(62)	29204757.8761	0.0833
P(60)	26288254.4494	0.1906	P(60)	29264508.5768	0.0507
P(58)	26350100.2984	0.1237	P(58)	29323720.1086	0.0290
P(56)	26411213.9778	0.0772	P(56)	29382386.9988	0.0152
P(54)	26471600.1504	0.0459	P(54)	29440503.8809	0.0073
P(52)	26531263.2618	0.0258	P(52)	29498065.4997	0.0038
P(50)	26590207.5442	0.0138	P(50)	29555066.7172	0.0032
P(48)	26648437.0195	0.0077	P(48)	29611502.5178	0.0031
P(46)	26705955.5026	0.0057	P(46)	29667368.0132	0.0031
P(44)	26762766.6051	0.0055	P(44)	29722658.4475	0.0034
P(42)	26818873.7378	0.0055	P(42)	29777369.2022	0.0039
P(40)	26874280.1143	0.0056	P(40)	29831495.8006	0.0044
P(38)	26928988.7531	0.0056	P(38)	29885033.9125	0.0049
P(36)	26983002.4809	0.0056	P(36)	29937979.3584	0.0053
P(34)	27036323.9351	0.0055	P(34)	29990328.1139	0.0054
P(32)	27088955.5657	0.0054	P(32)	30042076.3132	0.0055
P(30)	27140899.6384	0.0051	P(30)	30093220.2534	0.0055
P(28)	27192158.2363	0.0049	P(28)	30143756.3978	0.0054
P(26)	27242733.2620	0.0047	P(26)	30193681.3793	0.0053
P(24)	27292626.4396	0.0044	P(24)	30242992.0038	0.0052
P(22)	27341839.3165	0.0042	P(22)	30291685.2529	0.0051
P(20)	27390373.2651	0.0040	P(20)	30339758.2870	0.0049
P(18)	27438229.4843	0.0037	P(18)	30387208.4477	0.0048
P(16)	27485409.0008	0.0035	P(16)	30434033.2603	0.0046
P(14)	27531912.6704	0.0033	P(14)	30480230.4356	0.0045
P(12)	27577741.1795	0.0031	P(12)	30525797.8725	0.0044
P(10)	27622895.0455	0.0031	P(10)	30570733.6593	0.0043
P(8)	27667374.6182	0.0031	P(8)	30615036.0750	0.0043
P(6)	27711180.0803	0.0033	P(6)	30658703.5912	0.0044
P(4)	27754311.4480	0.0034	P(4)	30701734.8727	0.0045
P(2)	27796768.5718	0.0036	P(2)	30744128.7785	0.0045
R(0)	27859189.3155	0.0036	P(0)	30806522.5414	0.0045
R(2)	27899959.0889	0.0035	P(2)	30847319.2956	0.0044
R(4)	27940052.7921	0.0033	P(4)	30887476.2168	0.0043
R(6)	27979469.5315	0.0031	P(6)	30926993.0424	0.0042
R(8)	28018208.2478	0.0028	P(8)	30965869.7046	0.0041
R(10)	28056267.7161	0.0026	P(10)	31004106.3298	0.0040
R(12)	28093646.5448	0.0025	P(12)	31041703.2379	0.0040
R(14)	28130343.1757	0.0025	P(14)	31078660.9408	0.0040
R(16)	28166355.8825	0.0025	P(16)	31114980.1420	0.0040
R(18)	28201682.7706	0.0025	P(18)	31150661.7340	0.0041
R(20)	28236321.7757	0.0025	P(20)	31185706.7976	0.0042
R(22)	28270270.6628	0.0024	P(22)	31220116.5992	0.0043
R(24)	28303527.0249	0.0024	P(24)	31253892.5891	0.0043
R(26)	28336088.2817	0.0023	P(26)	31287036.3991	0.0044
R(28)	28367951.6781	0.0024	P(28)	31319549.8396	0.0043
R(30)	28399114.2823	0.0025	P(30)	31351434.8973	0.0043
R(32)	28429572.9843	0.0026	P(32)	31382693.7318	0.0042
R(34)	28459324.4940	0.0028	P(34)	31413328.6728	0.0042
R(36)	28488365.3390	0.0029	P(36)	31443342.2165	0.0041
R(38)	28516691.8625	0.0029	P(38)	31472737.0219	0.0040
R(40)	28544300.2211	0.0031	P(40)	31501515.9074	0.0039
R(42)	28571186.3823	0.0032	P(42)	31529681.8467	0.0040
R(44)	28597346.1222	0.0032	P(44)	31557237.9646	0.0042
R(46)	28622775.0223	0.0038	P(46)	31584187.5329	0.0046
R(48)	28647468.4672	0.0071	P(48)	31610533.9656	0.0057
R(50)	28671421.6417	0.0148	P(50)	31636280.8146	0.0088
R(52)	28694629.5272	0.0286	P(52)	31661431.7650	0.0151
R(54)	28717086.8993	0.0510	P(54)	31685990.6298	0.0261
R(56)	28738788.3239	0.0852	P(56)	31709961.3449	0.0434

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
R(58)	28759728.1540	0.1355	P(58)	31733347.9642	0.0693
R(60)	28779900.5263	0.2075	P(60)	31756154.6537	0.1068
R(62)	28799299.3572	0.3078	P(62)	31778385.6867	0.1594
R(64)	28817918.3393	0.4447	P(64)	31800045.4375	0.2317
R(66)	28835750.9374	0.6283	P(66)	31821138.3761	0.3291
R(68)	28852790.3843	0.8707	P(68)	31841669.0622	0.4581
R(70)	28869029.6768	1.1863	P(70)	31861642.1394	0.6268

**Frequencies for the  $01^{1c}1-(11^{1c}0,03^{1c}0)_I$  and  $01^{1c}1-(11^{1c}0,03^{1c}0)_{II}$  Bands of  $^{12}C^{16}O_2$  with the Estimated  $2\sigma$  Uncertainties**

P(59)	26125213.2723	1.6633	P(59)	30427055.2899	0.1962
P(57)	26191576.6703	1.0880	P(57)	30494640.3229	0.1332
P(55)	26257240.7898	0.6844	P(55)	30561557.5929	0.0865
P(53)	26322208.2302	0.4094	P(53)	30627802.0344	0.0530
P(51)	26386481.4313	0.2286	P(51)	30693368.7014	0.0306
P(49)	26450062.6783	0.1155	P(49)	30758252.7710	0.0175
P(47)	26512954.1076	0.0498	P(47)	30822449.5469	0.0123
P(45)	26575157.7109	0.0191	P(45)	30885954.4624	0.0114
P(43)	26636675.3402	0.0160	P(43)	30948763.0834	0.0109
P(41)	26697508.7115	0.0182	P(41)	31010871.1119	0.0100
P(39)	26757659.4084	0.0177	P(39)	31072274.3882	0.0091
P(37)	26817128.8857	0.0160	P(37)	31132968.8940	0.0091
P(35)	26875918.4726	0.0144	P(35)	31192950.7549	0.0102
P(33)	26934029.3751	0.0131	P(33)	31252216.2430	0.0118
P(31)	26991462.6787	0.0119	P(31)	31310761.7788	0.0134
P(29)	27048219.3509	0.0106	P(29)	31368583.9339	0.0147
P(27)	27104300.2431	0.0096	P(27)	31425679.4328	0.0155
P(25)	27159706.0925	0.0093	P(25)	31482045.1550	0.0157
P(23)	27214437.5237	0.0097	P(23)	31537678.1367	0.0154
P(21)	27268495.0505	0.0104	P(21)	31592575.5725	0.0147
P(19)	27321879.0769	0.0108	P(19)	31646734.8172	0.0137
P(17)	27374589.8987	0.0108	P(17)	31700153.3868	0.0127
P(15)	27426627.7040	0.0104	P(15)	31752828.9602	0.0119
P(13)	27477992.5747	0.0098	P(13)	31804759.3803	0.0113
P(11)	27528684.4867	0.0096	P(11)	31855942.6551	0.0113
P(9)	27578703.3113	0.0101	P(9)	31906376.9582	0.0116
P(7)	27628048.8151	0.0113	P(7)	31956060.6304	0.0122
P(5)	27676720.6609	0.0127	P(5)	32004992.1796	0.0129
P(3)	27724718.4080	0.0141	P(3)	32053170.2819	0.0136
R(1)	27841759.7696	0.0152	P(1)	32170312.0391	0.0149
R(3)	27887393.2105	0.0146	P(3)	32215845.0845	0.0151
R(5)	27932349.2934	0.0135	P(5)	32260620.8121	0.0152
R(7)	27976627.0108	0.0124	P(7)	32304638.8261	0.0152
R(9)	28020225.2521	0.0115	P(9)	32347898.8990	0.0150
R(11)	28063142.8031	0.0110	P(11)	32390400.9714	0.0148
R(13)	28105378.3457	0.0109	P(13)	32432145.1513	0.0145
R(15)	28146930.4576	0.0109	P(15)	32473131.7137	0.0142
R(17)	28187797.6116	0.0107	P(17)	32513361.0997	0.0140
R(19)	28227978.1750	0.0103	P(19)	32552833.9153	0.0140
R(21)	28267470.4088	0.0099	P(21)	32591550.9309	0.0141
R(23)	28306272.4666	0.0099	P(23)	32629513.0796	0.0143
R(25)	28344382.3939	0.0107	P(25)	32666721.4564	0.0144
R(27)	28381798.1267	0.0122	P(27)	32703177.3164	0.0142
R(29)	28418517.4902	0.0141	P(29)	32738882.0732	0.0136
R(31)	28454538.1976	0.0165	P(31)	32773837.2976	0.0136
R(33)	28489857.8477	0.0213	P(33)	32808044.7156	0.0174
R(35)	28524473.9240	0.0312	P(35)	32841506.2063	0.0279
R(37)	28558383.7917	0.0486	P(37)	32874223.8000	0.0462
R(39)	28591584.6963	0.0754	P(39)	32906199.6761	0.0735
R(41)	28624073.7602	0.1131	P(41)	32937436.1606	0.1114
R(43)	28655847.9806	0.1644	P(43)	32967935.7238	0.1624
R(45)	28686904.2261	0.2328	P(45)	32997700.9775	0.2292

Line	Band I frequency (MHz)	Uncertainty (MHz)	Line	Band II frequency (MHz)	Uncertainty (MHz)
R(47)	28717239.2334	0.3239	P(47)	33026734.6728	0.3151
R(49)	28746849.6038	0.4465	P(49)	33055039.6965	0.4238
R(51)	28775731.7988	0.6142	P(51)	33082619.0689	0.5595
R(53)	28803882.1361	0.8465	P(53)	33109475.9403	0.7272

**Frequencies for the  $01^{1^1}-(11^{1^0},03^{1^0})_I$  and  $01^{1^1}-(11^{1^0},03^{1^0})_{II}$  Bands of  $^{12}C^{16}O_2$  with the Estimated  $2\sigma$  Uncertainties**

P(60)	26051570.0104	4.4521	P(60)	30355115.0204	0.2752
P(58)	26120964.4932	3.0629	P(58)	30425283.5969	0.1926
P(56)	26189552.8496	2.0516	P(56)	30494732.8293	0.1301
P(54)	26257339.6006	1.3305	P(54)	30563455.6325	0.0840
P(52)	26324329.0344	0.8289	P(52)	30631445.1076	0.0512
P(50)	26390525.2136	0.4901	P(50)	30698694.5456	0.0292
P(48)	26455931.9824	0.2698	P(48)	30765197.4310	0.0163
P(46)	26520552.9722	0.1334	P(46)	30830947.4444	0.0111
P(44)	26584391.6075	0.0551	P(44)	30895938.4662	0.0104
P(42)	26647451.1105	0.0181	P(42)	30960164.5794	0.0105
P(40)	26709734.5057	0.0151	P(40)	31023620.0723	0.0105
P(38)	26771244.6242	0.0174	P(38)	31086299.4415	0.0107
P(36)	26831984.1067	0.0157	P(36)	31148197.3941	0.0114
P(34)	26891955.4069	0.0126	P(34)	31209308.8510	0.0126
P(32)	26951160.7945	0.0105	P(32)	31269628.9481	0.0138
P(30)	27009602.3576	0.0096	P(30)	31329153.0395	0.0147
P(28)	27067282.0045	0.0092	P(28)	31387876.6994	0.0151
P(26)	27124201.4662	0.0090	P(26)	31445795.7236	0.0149
P(24)	27180362.2977	0.0089	P(24)	31502906.1318	0.0141
P(22)	27235765.8792	0.0090	P(22)	31559204.1695	0.0128
P(20)	27290413.4182	0.0093	P(20)	31614686.3091	0.0113
P(18)	27344305.9494	0.0096	P(18)	31669349.2515	0.0098
P(16)	27397444.3368	0.0097	P(16)	31723189.9280	0.0086
P(14)	27449829.2733	0.0096	P(14)	31776205.5007	0.0081
P(12)	27501461.2824	0.0096	P(12)	31828393.3642	0.0085
P(10)	27552340.7179	0.0101	P(10)	31879751.1463	0.0095
P(8)	27602467.7649	0.0111	P(8)	31930276.7092	0.0107
P(6)	27651842.4399	0.0125	P(6)	31979968.1497	0.0120
P(4)	27700464.5912	0.0139	P(4)	32028823.8002	0.0131
P(2)	27748333.8988	0.0148	P(2)	32076842.2290	0.0139
R(2)	27864709.8633	0.0146	P(2)	32193218.1935	0.0150
R(4)	27909939.2762	0.0135	P(4)	32238298.4853	0.0151
R(6)	27954412.3294	0.0122	P(6)	32282538.0393	0.0153
R(8)	27998127.7801	0.0112	P(8)	32325936.7244	0.0153
R(10)	28041084.2173	0.0107	P(10)	32368494.6458	0.0154
R(12)	28083280.0620	0.0108	P(12)	32410212.1438	0.0155
R(14)	28124713.5668	0.0110	P(14)	32451089.7941	0.0155
R(16)	28165382.8151	0.0112	P(16)	32491128.4063	0.0154
R(18)	28205285.7213	0.0111	P(18)	32530329.0234	0.0152
R(20)	28244420.0302	0.0110	P(20)	32568692.9211	0.0149
R(22)	28282783.3158	0.0114	P(22)	32606221.6061	0.0147
R(24)	28320372.9812	0.0129	P(24)	32642916.8154	0.0144
R(26)	28357186.2574	0.0149	P(26)	32678780.5147	0.0140
R(28)	28393220.2023	0.0168	P(28)	32713814.8971	0.0133
R(30)	28428471.6994	0.0175	P(30)	32748022.3813	0.0120
R(32)	28462937.4565	0.0165	P(32)	32781405.6101	0.0106
R(34)	28496614.0042	0.0142	P(34)	32813967.4482	0.0122
R(36)	28529497.6934	0.0163	P(36)	32845710.9809	0.0212
R(38)	28561584.6939	0.0309	P(38)	32876639.5111	0.0385
R(40)	28592870.9914	0.0593	P(40)	32906756.5580	0.0646
R(42)	28623352.3850	0.1054	P(42)	32936065.8540	0.1015
R(44)	28653024.4839	0.1779	P(44)	32964571.3426	0.1518
R(46)	28681882.7038	0.2907	P(46)	32992277.1760	0.2184
R(48)	28709922.2632	0.4635	P(48)	33019187.7118	0.3048
R(50)	28737138.1785	0.7231	P(50)	33045307.5105	0.4152



# INFRARED AND FAR-INFRARED ABSORPTION FREQUENCY STANDARDS

Arthur Maki

Aside from the CO<sub>2</sub> laser transitions, the absorption spectrum of CO has been more accurately and thoroughly measured than any other spectrum. A bibliography of earlier measurements on CO is given by Maki and Wells,<sup>1</sup> and the present tables were calculated from the measurements referred to in that work. In addition, some new and very accurate frequency measurements<sup>2,3</sup> have been made and were incorporated in the present tables. The frequencies of the rotational transitions of HF and HCl were calculated from constants obtained from fitting the measurements of Evenson et al.<sup>4,5</sup> and Jennings and Wells.<sup>6</sup>

A new report on infrared wavenumber standards from the International Union of Pure and Applied Chemistry, Commission on Molecular Structure and Spectroscopy, may be found in Reference 7.

## References

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## Wavenumbers for the $\nu = 1 - 0$ Band of CO

Wavenumber (unc) <sup>a</sup> /cm <sup>-1</sup>	Transition	Wavenumber (unc)/cm <sup>-1</sup>	Transition
2139.426071(01)	P(1)	2147.081132(01)	R(0)
2135.546178(01)	P(2)	2150.856006(01)	R(1)
2131.631574(01)	P(3)	2154.595581(01)	R(2)
2127.682404(01)	P(4)	2158.299710(01)	R(3)
2123.698816(01)	P(5)	2161.968245(01)	R(4)
2119.680957(01)	P(6)	2165.601041(01)	R(5)
2115.628973(01)	P(7)	2169.197949(01)	R(6)
2111.543012(01)	P(8)	2172.758824(01)	R(7)
2107.423221(01)	P(9)	2176.283519(01)	R(8)
2103.269746(01)	P(10)	2179.771887(01)	R(9)
2099.082734(01)	P(11)	2183.223782(01)	R(10)
2094.862333(01)	P(12)	2186.639057(01)	R(11)
2090.608688(01)	P(13)	2190.017565(01)	R(12)
2086.321947(01)	P(14)	2193.359161(01)	R(13)
2082.002256(01)	P(15)	2196.663698(01)	R(14)
2077.649762(01)	P(16)	2199.931030(01)	R(15)
2073.264612(01)	P(17)	2203.161010(01)	R(16)
2068.846952(01)	P(18)	2206.353492(01)	R(17)
2064.396929(01)	P(19)	2209.508331(02)	R(18)
2059.914688(02)	P(20)	2212.625379(02)	R(19)
2055.400377(02)	P(21)	2215.704492(02)	R(20)
2050.854140(02)	P(22)	2218.745522(02)	R(21)
2046.276126(03)	P(23)	2221.748326(03)	R(22)
2041.666479(03)	P(24)	2224.712755(03)	R(23)
2037.025345(03)	P(25)	2227.638666(03)	R(24)
2032.352870(04)	P(26)	2230.525912(04)	R(25)
2027.649200(04)	P(27)	2233.374349(04)	R(26)
2022.914480(04)	P(28)	2236.183829(04)	R(27)
2018.148857(05)	P(29)	2238.954210(05)	R(28)
2013.352474(05)	P(30)	2241.685344(05)	R(29)
2008.525477(06)	P(31)	2244.377088(06)	R(30)
2003.668012(06)	P(32)	2247.029296(07)	R(31)
1998.780224(07)	P(33)	2249.641824(08)	R(32)
1993.862257(09)	P(34)	2252.214527(10)	R(33)
1988.914257(11)	P(35)	2254.747262(14)	R(34)
1983.936367(14)	P(36)	2257.239883(18)	R(35)
1978.928733(18)	P(37)	2259.692248(24)	R(36)
1973.891500(25)	P(38)	2262.104213(33)	R(37)
		2264.475634(45)	R(38)

**Wavenumbers for the  $\nu = 1 - 0$  Band of CO**

Wavenumber (unc) <sup>*</sup> /cm <sup>-1</sup>	Transition	Wavenumber (unc)/cm <sup>-1</sup>	Transition
1968.824811(34)	P(39)	2266.806368(61)	R(39)
1963.728813(46)	P(40)	2269.096273(81)	R(40)
1958.603648(61)	P(41)	2271.345206(106)	R(41)
1953.449462(82)	P(42)	2273.553027(139)	R(42)

\* The uncertainty in the last digits (twice the standard error) is given in parentheses.

**Wavenumbers for the  $\nu = 2 - 0$  Band of CO**

Wavenumber (unc) <sup>*</sup> /cm <sup>-1</sup>	Transition	Wavenumber (unc)/cm <sup>-1</sup>	Transition
4256.217140(02)	P(1)	4263.837198(02)	R(0)
4252.302244(02)	P(2)	4267.542066(02)	R(1)
4248.317633(02)	P(3)	4271.176630(02)	R(2)
4244.263453(02)	P(4)	4274.740746(02)	R(3)
4240.139852(02)	P(5)	4278.234264(02)	R(4)
4235.946975(02)	P(6)	4281.657039(02)	R(5)
4231.684972(02)	P(7)	4285.008924(02)	R(6)
4227.353987(02)	P(8)	4288.289772(02)	R(7)
4222.954169(02)	P(9)	4291.499437(02)	R(8)
4218.485665(02)	P(10)	4294.637773(02)	R(9)
4213.948620(02)	P(11)	4297.704631(02)	R(10)
4209.343182(02)	P(12)	4300.699868(02)	R(11)
4204.669499(02)	P(13)	4303.623334(02)	R(12)
4199.927716(02)	P(14)	4306.474886(02)	R(13)
4195.117980(02)	P(15)	4309.254375(02)	R(14)
4190.240439(02)	P(16)	4311.961657(02)	R(15)
4185.295239(02)	P(17)	4314.596584(02)	R(16)
4180.282526(02)	P(18)	4317.159011(02)	R(17)
4175.202447(02)	P(19)	4319.648791(02)	R(18)
4170.055149(03)	P(20)	4322.065779(03)	R(19)
4164.840777(03)	P(21)	4324.409829(03)	R(20)
4159.559478(03)	P(22)	4326.680794(03)	R(21)
4154.211398(03)	P(23)	4328.878530(03)	R(22)
4148.796683(04)	P(24)	4331.002889(04)	R(23)
4143.315479(04)	P(25)	4333.053728(04)	R(24)
4137.767932(04)	P(26)	4335.030899(05)	R(25)
4132.154187(05)	P(27)	4336.934259(06)	R(26)
4126.474391(06)	P(28)	4338.763661(07)	R(27)
4120.728689(07)	P(29)	4340.518961(09)	R(28)
4114.917226(09)	P(30)	4342.200014(11)	R(29)
4109.040148(12)	P(31)	4343.806675(16)	R(30)
4103.097600(16)	P(32)	4345.338799(21)	R(31)
4097.089728(21)	P(33)	4346.796243(29)	R(32)
4091.016676(29)	P(34)	4348.178862(40)	R(33)
4084.878591(40)	P(35)	4349.486513(54)	R(34)
4078.675618(54)	P(36)	4350.719052(73)	R(35)
4072.407901(73)	P(37)	4351.876336(96)	R(36)
4066.075588(97)	P(38)	4352.958224(127)	R(37)
4059.678822(127)	P(39)	4353.964572(166)	R(38)
		4354.895240(214)	R(39)

\* The uncertainty in the last digits (twice the standard error) is given in parentheses.

**Wavenumbers for the  $\nu = 3 - 0$  Band of CO**

Wavenumber (unc) <sup>*</sup> /cm <sup>-1</sup>	Transition	Wavenumber (unc)/cm <sup>-1</sup>	Transition
6346.594000(13)	P(1)	6354.179057(13)	R(0)
6342.644103(13)	P(2)	6357.813923(13)	R(1)
6338.589491(13)	P(3)	6361.343487(13)	R(2)
6334.430309(13)	P(4)	6364.767599(13)	R(3)
		6368.086115(13)	R(4)



Wavenumbers for the  $\nu = 3 - 0$  Band of CO

Wavenumber (unc) <sup>*</sup> /cm <sup>-1</sup>	Transition	Wavenumber (unc)/cm <sup>-1</sup>	Transition
6330.166705(13)	P(5)	6371.298887(13)	R(5)
6325.798826(13)	P(6)	6374.405768(12)	R(6)
6321.326819(13)	P(7)	6377.406611(12)	R(7)
6316.750831(12)	P(8)	6380.301271(12)	R(8)
6312.071008(12)	P(9)	6383.089600(12)	R(9)
6307.287498(12)	P(10)	6385.771452(12)	R(10)
6302.400447(12)	P(11)	6388.346680(13)	R(11)
6297.410003(12)	P(12)	6390.815139(13)	R(12)
6292.316311(13)	P(13)	6393.176681(13)	R(13)
6287.119520(13)	P(14)	6395.431160(13)	R(14)
6281.819775(13)	P(15)	6397.578430(13)	R(15)
6276.417224(13)	P(16)	6399.618344(13)	R(16)
6270.912012(13)	P(17)	6401.550757(13)	R(17)
6265.304287(13)	P(18)	6403.375523(13)	R(18)
6259.594194(13)	P(19)	6405.092495(14)	R(19)
6253.781880(13)	P(20)	6406.701527(14)	R(20)
6247.867492(14)	P(21)	6408.202474(14)	R(21)
6241.851176(14)	P(22)	6409.595189(15)	R(22)
6235.733077(14)	P(23)	6410.879527(15)	R(23)
6229.513342(15)	P(24)	6412.055343(16)	R(24)
6223.192117(15)	P(25)	6413.122491(17)	R(25)
6216.769547(16)	P(26)	6414.080825(19)	R(26)
6210.245778(17)	P(27)	6414.930201(23)	R(27)
6203.620957(19)	P(28)	6415.670474(28)	R(28)
6196.895229(23)	P(29)	6416.301500(37)	R(29)
6190.068739(28)	P(30)	6416.823133(50)	R(30)
6183.141633(37)	P(31)	6417.235231(67)	R(31)
6176.114058(50)	P(32)	6417.537649(90)	R(32)
6168.986159(67)	P(33)		
6161.758082(90)	P(34)		

\* The uncertainty in the last digits (twice the standard error) is given in parentheses.

## Frequencies and Wavenumbers for the Rotational Lines of CO

Frequency/MHz	Uncertainty <sup>*</sup> /MHz	$J'$	$J''$	Wavenumber/cm <sup>-1</sup>	Uncertainty <sup>*</sup> /cm <sup>-1</sup>
115271.2029	0.0004	1	0	3.84503345	0.00000001
230538.0016	0.0008	2	1	7.68991999	0.00000003
345795.9923	0.0012	3	2	11.53451273	0.00000004
461040.7712	0.0016	4	3	15.37866477	0.00000005
576267.9350	0.0019	5	4	19.22222923	0.00000006
691473.0809	0.0021	6	5	23.06505926	0.00000007
806651.8065	0.0023	7	6	26.90700800	0.00000008
921799.7104	0.0025	8	7	30.74792863	0.00000008
1036912.3919	0.0027	9	8	34.58767438	0.00000009
1151985.4515	0.0029	10	9	38.42609848	0.00000010
1267014.4906	0.0031	11	10	42.26305422	0.00000010
1381995.1119	0.0034	12	11	46.09839491	0.00000011
1496922.9195	0.0038	13	12	49.93197392	0.00000013
1611793.5189	0.0042	14	13	53.76364468	0.00000014
1726602.5173	0.0047	15	14	57.59326065	0.00000016
1841345.5237	0.0052	16	15	61.42067535	0.00000017
1956018.1486	0.0057	17	16	65.24574239	0.00000019
2070616.0050	0.0061	18	17	69.06831542	0.00000020
2185134.7075	0.0065	19	18	72.88824816	0.00000022
2299569.8733	0.0069	20	19	76.70539441	0.00000023
2413917.1217	0.0071	21	20	80.51960806	0.00000024
2528172.0747	0.0073	22	21	84.33074306	0.00000024
2642330.3567	0.0074	23	22	88.13865346	0.00000025
2756387.5949	0.0075	24	23	91.94319341	0.00000025

## Frequencies and Wavenumbers for the Rotational Lines of CO

Frequency/MHz	Uncertainty*/MHz	$J'$	$J''$	Wavenumber/cm <sup>-1</sup>	Uncertainty*/cm <sup>-1</sup>
2870339.4194	0.0077	25	24	95.74421713	0.00000026
2984181.4631	0.0080	26	25	99.54157896	0.00000027
3097909.3621	0.0085	27	26	103.33513334	0.00000028
3211518.7558	0.0090	28	27	107.12473480	0.00000030
3325005.2869	0.0096	29	28	110.91023800	0.00000032
3438364.6013	0.0102	30	29	114.69149772	0.00000034
3551592.3489	0.0107	31	30	118.46836884	0.00000036
3664684.1829	0.0111	32	31	122.24070637	0.00000037
3777635.7608	0.0118	33	32	126.00836545	0.00000039
3890442.7435	0.0137	34	33	129.77120137	0.00000046
4003100.7965	0.0179	35	34	133.52906952	0.00000060
4115605.5892	0.0254	36	35	137.28182546	0.00000085
4227952.7954	0.0370	37	36	141.02932487	0.00000123
4340138.0932	0.0531	38	37	144.77142361	0.00000177
4452157.1657	0.0746	39	38	148.50797766	0.00000249
4564005.7001	0.1025	40	39	152.23884318	0.00000342

\* The uncertainty given is twice the standard error.

## Frequencies and Wavenumbers for the Rotational Lines of HF

Frequency/MHz	Uncertainty*/MHz	$J'$	$J''$	Wavenumber/cm <sup>-1</sup>	Uncertainty*/cm <sup>-1</sup>
1232476.21	0.12	1	0	41.110981	0.000004
2463428.09	0.19	2	1	82.171116	0.000006
3691334.81	0.25	3	2	123.129676	0.000008
4914682.58	0.51	4	3	163.936165	0.000017
6131968.11	1.10	5	4	204.540439	0.000037
7341702.00	2.00	6	5	244.892818	0.000067
8542412.1	3.21	7	6	284.944197	0.000107
9732646.8	4.72	8	7	324.646153	0.000157
10910978.2	6.51	9	8	363.951056	0.000217
12076004.8	8.55	10	9	402.81216	0.000285
13226355.2	10.81	11	10	441.18372	0.000361
14360689.8	13.25	12	11	479.02105	0.00044
15477704.4	15.86	13	12	516.28065	0.00053
16576131.8	18.61	14	13	552.92024	0.00062
17654744.4	21.48	15	14	588.89888	0.00072
18712356.5	24.44	16	15	624.17703	0.00082
19747825.6	27.43	17	16	658.71656	0.00092
20760054.3	30.32	18	17	692.4809	0.00101
21747991.7	32.91	19	18	725.4349	0.00110
22710634.7	34.94	20	19	757.5452	0.00117
23647028.7	36.08	21	20	788.7800	0.00120
24556268.8	35.93	22	21	819.1090	0.00120
25437499.9	34.12	23	22	848.5037	0.00114
26289917.4	30.32	24	23	876.9373	0.00101
27112767.2	24.41	25	24	904.38457	0.00081
27905345.6	16.88	26	25	930.82214	0.00056
28666999.3	10.80	27	26	956.22817	0.00036
29397124.8	14.65	28	27	980.58253	0.00049
30095168.2	24.62	29	28	1003.86676	0.00082
30760624.2	33.36	30	29	1026.0640	0.00111
31393035.7	36.17	31	30	1047.1590	0.00121

\* The uncertainty given is twice the standard error.

Frequencies and Wavenumbers for the Rotational Lines of H<sup>35</sup>Cl

Frequency/MHz	Uncertainty*/MHz	<i>J'</i>	<i>J''</i>	Wavenumber/cm <sup>-1</sup>	Uncertainty*/cm <sup>-1</sup>
1876226.517	0.065	3	2	62.584180	0.000002
2499864.439	0.066	4	3	83.386502	0.000002
3121986.563	0.064	5	4	104.138262	0.000002
3742216.601	0.076	6	5	124.826909	0.000003
4360180.042	0.098	7	6	145.439951	0.000003
4975504.51	0.11	8	7	165.964966	0.000004
5587820.10	0.12	9	8	186.389615	0.000004
6196759.76	0.22	10	9	206.701656	0.000007
6801959.63	0.50	11	10	226.888951	0.000017
7403059.41	1.02	12	11	246.939481	0.000034
7999702.7	1.8	13	12	266.841359	0.000062
8591537.3	3.1	14	13	286.582837	0.000103
9178215.8	4.8	15	14	306.152324	0.000161

\* The uncertainty given is twice the standard error.

Frequencies and Wavenumbers for the Rotational Lines of H<sup>37</sup>Cl

Frequency/MHz	Uncertainty*/MHz	<i>J'</i>	<i>J''</i>	Wavenumber/cm <sup>-1</sup>	Uncertainty*/cm <sup>-1</sup>
1873410.72	0.05	3	2	62.490255	0.000002
2496115.33	0.05	4	3	83.261445	0.000002
3117308.69	0.05	5	4	103.982225	0.000002
3736615.64	0.06	6	5	124.640082	0.000002
4353662.84	0.08	7	6	145.222561	0.000003
4968079.04	0.09	8	7	165.717279	0.000003
5579495.53	0.10	9	8	186.111938	0.000003
6187546.42	0.19	10	9	206.394332	0.000006
6791869.04	0.45	11	10	226.552365	0.000015
7392104.3	0.9	12	11	246.574057	0.000030
7987896.9	1.6	13	12	266.447561	0.000054
8578896.1	2.7	14	13	286.161170	0.000089

\* The uncertainty given is twice the standard error.

## SENSITIVITY OF THE HUMAN EYE TO LIGHT OF DIFFERENT WAVELENGTHS

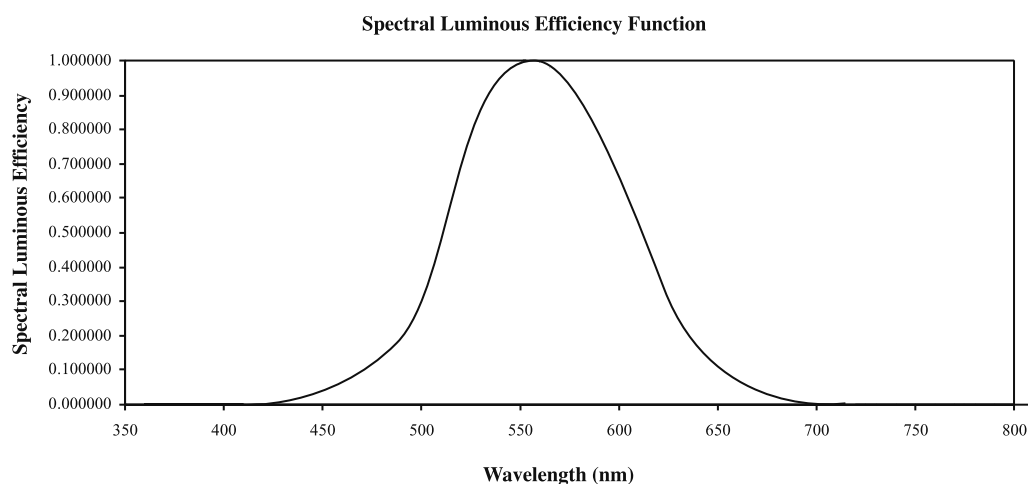
The human eye responds to electromagnetic radiation in the wavelength range from about 360 nm (violet) to 820 nm (red), with a peak sensitivity near 555 nm (green). While the detailed shape of this response curve depends on the individual person, studies on representative samples of human subjects have led to adoption of a standard function relating the perceived brightness (luminous flux) to the actual power of the spectral radiation. This function is referred to as  $V(\lambda)$ , the photopic spectral luminous efficiency function, and it plays an important role in photometry.

The function  $V(\lambda)$ , as adopted by the International Commission on Illumination (CIE), is tabulated and plotted below.

### References

1. *The Basis for Physical Photometry*, CIE Publication #18.2, 1983.
2. *CIE Standard Colorimetric Observers*, ISO/CIE #10527, 1991.
3. *Kaye and Laby Tables of Physical and Chemical Constants, Sixteenth Edition*, Longman Group Ltd., Harlow, Essex, 1995.

$\lambda/\text{nm}$	$V(\lambda)$	$\lambda/\text{nm}$	$V(\lambda)$	$\lambda/\text{nm}$	$V(\lambda)$
360	0.000004	520	0.710000	670	0.032000
370	0.000012	530	0.862000	680	0.017000
380	0.000039	540	0.954000	690	0.008210
390	0.000120	550	0.994950	700	0.004102
400	0.000396	555	1.000000	710	0.002091
410	0.001210	560	0.995000	720	0.001047
420	0.004000	570	0.952000	730	0.000520
430	0.011600	580	0.870000	740	0.000249
440	0.023000	590	0.757000	750	0.000120
450	0.038000	600	0.631000	760	0.000060
460	0.060000	610	0.503000	770	0.000030
470	0.090980	620	0.381000	780	0.000015
480	0.139020	630	0.265000	790	0.000007
490	0.208020	640	0.175000	800	0.000004
500	0.323000	650	0.107000	810	0.000002
510	0.503000	660	0.061000	820	0.000001



# INDEX OF REFRACTION OF INORGANIC CRYSTALS

This table lists the index of refraction of selected crystalline inorganic compounds. When, available, values are given as a function of wavelength in the range from the ultraviolet to the far infrared region. For each compound a value at 589 nm, the wavelength of the principal sodium line, is given. The data have been taken from the references indicated; in many cases, data from a reference have been refitted to generate the index of refraction at the wavelengths used in this table. All values refer to ambient temperature. Entries marked by \* are based on extrapolation beyond the range of available experimental data.

Compounds belonging to the cubic crystal system have only a single refractive index value, but other systems are anisotropic, so that the crystal is characterized by two or three unique indexes. Hexagonal, rhombohedral, and tetragonal crystals have two unique indexes which are traditionally labeled  $n_o$  and  $n_e$  for "ordinary ray" and "extraordinary ray". Orthorhombic, monoclinic, and triclinic crystals are characterized by three indexes which are here called  $n_x$ ,  $n_y$ , and  $n_z$ . The table indicates the crystal system for each entry in order to identify the material uniquely.

The refractive index and other optical properties for metals, semiconductors, and certain other compounds can be found in the tables "Optical Properties of Selected Elements" and "Optical Properties of Selected Inorganic and Organic Solids" in Section 12 of this *Handbook*.

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- Weber, M. J., *CRC Handbook of Laser Science and Technology*, Vol. IV. Optical Materials. Part 2: Properties, CRC Press, Boca Raton, FL, 1986.

Compound	Crystal system	Ray	Index of Refraction at the Indicated Wavelength								Ref.
			300 nm	589 nm	750 nm	1 $\mu\text{m}$	2 $\mu\text{m}$	5 $\mu\text{m}$	10 $\mu\text{m}$	20 $\mu\text{m}$	
AgCl	cub	$n$		2.0668	2.0401	2.0224	2.0062	1.9975	1.9803	1.9069	5
AlPO <sub>4</sub>	rhomb	$n_o$		1.5247	1.5203	1.5161	1.5034				6
	rhomb	$n_e$		1.5338	1.5290	1.5245	1.5116				6
Al <sub>2</sub> O <sub>3</sub>	hex	$n_o$		1.7673							4
	hex	$n_e$		1.7598							4
As <sub>2</sub> O <sub>3</sub> <sup>a</sup>	cub	$n$		1.7537							4
BaF <sub>2</sub>	cub	$n$	1.5010	1.4744	1.4712	1.4686	1.4647	1.4511	1.4014		2
BaO	cub	$n$		1.9841							4
BaSO <sub>4</sub>	orth	$n_x$		1.6362							4
	orth	$n_y$		1.6374							4
	orth	$n_z$		1.6480							4
BaTiO <sub>3</sub>	tetr	$n_o$		2.4405							4
	tetr	$n_e$		2.3831							4
BaWO <sub>4</sub>	tetr	$n_o$		1.8426							4
	tetr	$n_e$		1.8405							4
BeO	hex	$n_o$		1.7184							4
	hex	$n_e$		1.7342							4
BeSO <sub>4</sub> ·4H <sub>2</sub> O	tetr	$n_o$		1.4713							4
	tetr	$n_e$		1.4328							4
CaCO <sub>3</sub> <sup>b</sup>	hex	$n_o$	1.7216	1.6584	1.6503	1.6436	1.6249				5
	hex	$n_e$	1.5145	1.4864	1.4828	1.4801	1.4753				5
CaF <sub>2</sub>	cub	$n$	1.4540	1.4338	1.4311	1.4289	1.4239	1.3990	1.299		2
CaO	cub	$n$		1.8396							4
CaSO <sub>4</sub>	orth	$n_x$		1.5698							4
	orth	$n_y$		1.5755							4
	orth	$n_z$		1.6137							4
CaSO <sub>4</sub> ·2H <sub>2</sub> O	monocl	$n_x$		1.5207							4
	monocl	$n_y$		1.5227							4
	monocl	$n_z$		1.5304							4
CaWO <sub>4</sub>	tetr	$n_o$		1.9195							4
	tetr	$n_e$		1.9355							4
CdS	hex	$n_o$		2.507	2.390	2.334					5

Compound	Crystal system	Ray	Index of Refraction at the Indicated Wavelength								Ref.
			300 nm	589 nm	750 nm	1 $\mu\text{m}$	2 $\mu\text{m}$	5 $\mu\text{m}$	10 $\mu\text{m}$	20 $\mu\text{m}$	
CdSe	hex	$n_e$		2.525	2.409	2.352					5
	hex	$n_o$			2.68*	2.5502	2.4682	2.4483	2.4331		7
	hex	$n_c$			2.69*	2.5696	2.4873	2.4676	2.4514		7
CdTe	cub	$n$							2.6724	2.6302	7
CeF <sub>3</sub>	hex	$n_o$		1.6183							4
	hex	$n_e$		1.6113							4
CsBr	cub	$n$	1.8047	1.6974	1.6861	1.6784	1.6711	1.6678	1.6630	1.6439	1
CsCl	cub	$n$	1.712	1.640	1.631	1.626	1.620	1.616	1.606	1.563	1
CsClO <sub>4</sub>	orth	$n_x$		1.4752							4
	orth	$n_y$		1.4788							4
	orth	$n_z$		1.4804							4
CsF	cub	$n$	1.506	1.477	1.474	1.472	1.469*	1.461*	1.436*	1.32*	1
CsI	cub	$n$	1.9790	1.7873	1.7694	1.7576	1.7465	1.7428	1.7396	1.7280	1
Cs <sub>2</sub> SO <sub>4</sub>	orth	$n_x$		1.5598							4
	orth	$n_y$		1.5644							4
	orth	$n_z$		1.5662							4
CuBr	cub	$n$		2.117							7
CuCl	cub	$n$		1.9727	1.9391				1.9245		7
CuSO <sub>4</sub> ·5H <sub>2</sub> O	tricl	$n_x$		1.5140							4
	tricl	$n_y$		1.5367							4
	tricl	$n_z$		1.5436							4
Dy <sub>2</sub> O <sub>3</sub>	cub	$n$		1.9757							4
FeF <sub>2</sub>	tetr	$n_o$		1.514							4
	tetr	$n_e$		1.524							4
Gd <sub>2</sub> O <sub>3</sub>	cub	$n$		1.96							4
HgS	rhomb	$n_o$		2.9413	2.7770	2.7120	2.6305		2.6018		6
	rhomb	$n_e$		3.3072	3.0896	3.0050	2.8776		2.8522		6
KBr	cub	$n$	1.6482	1.5598	1.5498	1.5444	1.5383	1.5345	1.5264	1.4924	1
KCl	cub	$n$	1.5455	1.4902	1.4840	1.4798	1.4753	1.4704	1.4564	1.3946	1
KClO <sub>4</sub>	orth	$n_x$		1.4730							4
	orth	$n_y$		1.4736							4
	orth	$n_z$		1.4768							4
KF	cub	$n$	1.380	1.362	1.360	1.358	1.355	1.344	1.304*	1.09*	1
KH <sub>2</sub> AsO <sub>4</sub>	tetr	$n_o$		1.5674							7
	tetr	$n_e$		1.5179							7
KH <sub>2</sub> PO <sub>4</sub>	tetr	$n_o$	1.5450	1.5093	1.5030	1.4957					5
	tetr	$n_e$	1.4977	1.4682	1.4641	1.4606					5
KI	cub	$n$	1.834*	1.665	1.650	1.640	1.631	1.627	1.620	1.593	1
KIO <sub>3</sub>	tricl	$n_x$		1.6959							7
	tricl	$n_y$		1.8317							7
	tricl	$n_z$		1.8343							7
KIO <sub>4</sub>	tetr	$n_o$		1.6205							4
	tetr	$n_e$		1.6476							4
KNbO <sub>3</sub>	orth	$n_x$		2.2480	2.3395	2.2612					7
	orth	$n_y$		2.3464	2.2959	2.2622					7
	orth	$n_z$		2.1803	2.1457	2.1288					7
K <sub>2</sub> SO <sub>4</sub>	orth	$n_x$		1.4934							4
	orth	$n_y$		1.4947							4
	orth	$n_z$		1.4973							4
LaF <sub>3</sub>	hex	$n_o$		1.605							4
	hex	$n_e$		1.599							4
LiBr	cub	$n$	1.810	1.783	1.781	1.778	1.774*	1.756*	1.68*	1.33*	1
LiCl	cub	$n$	1.677	1.662	1.660	1.658	1.654*	1.62*	1.53*		1
LiClO <sub>4</sub> ·3H <sub>2</sub> O	hex	$n_o$		1.4832							4
	hex	$n_e$		1.4384							4
LiF	cub	$n$	1.4087	1.3921	1.3895	1.3871	1.3786	1.3266	1.1005		1
LiI	cub	$n$	1.979	1.955	1.952	1.950	1.948*	1.940*	1.91*	1.77*	1
LiIO <sub>3</sub>	hex	$n_o$		1.8875	1.8713	1.8589	1.8410				6
	hex	$n_e$		1.7400	1.7268	1.7179	1.7062				6
LiNbO <sub>3</sub>	rhomb	$n_o$		2.3007	2.2632	2.2370					7

Compound	Crystal system	Ray	Index of Refraction at the Indicated Wavelength							Ref.	
			300 nm	589 nm	750 nm	1 $\mu\text{m}$	2 $\mu\text{m}$	5 $\mu\text{m}$	10 $\mu\text{m}$		20 $\mu\text{m}$
LiTaO <sub>3</sub>	rhomb	$n_e$		2.2116	2.1804	2.1567					7
	rhomb	$n_o$		2.1864	2.1590	2.1391	2.1066				7
	rhomb	$n_e$		2.1908	2.1634	2.1432	2.1115				7
Li <sub>2</sub> SO <sub>4</sub> ·H <sub>2</sub> O	monocl	$n_x$		1.4615							4
	monocl	$n_y$		1.4765							4
	monocl	$n_z$		1.4863							4
Lu <sub>2</sub> O <sub>3</sub>	cub	$n$		1.9349							4
MgF <sub>2</sub>	tetr	$n_o$	1.3930	1.3776	1.375	1.373	1.368	1.34	1.21		2
	tetr	$n_e$	1.4055	1.3894	1.387	1.385	1.379	1.34	1.21		2
MgO	cub	$n$		1.7355	1.7283	1.7228	1.7084	1.6361			5
MgSO <sub>4</sub> ·7H <sub>2</sub> O	orth	$n_x$		1.4326							4
	orth	$n_y$		1.4555							4
	orth	$n_z$		1.4607							4
MnF <sub>2</sub>	tetr	$n_o$		1.472							4
	tetr	$n_e$		1.501							4
NH <sub>4</sub> H <sub>2</sub> AsO <sub>4</sub>	tetr	$n_o$	1.6401	1.5777	1.5704	1.5583					7
	tetr	$n_e$	1.5754	1.5232	1.5179	1.5101					7
NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>	tetr	$n_o$	1.5668	1.5247	1.5187	1.5084					7
	tetr	$n_e$	1.5137	1.4797	1.4754	1.4694					7
NaBr	cub	$n$	1.748	1.642	1.631	1.623	1.616	1.609	1.593*	1.520*	1
NaBrO <sub>3</sub>	cub	$n$		1.6168							4
NaCl	cub	$n$	1.6066	1.5441	1.5369	1.5320	1.5265	1.5188	1.4947	1.382*	1
NaClO <sub>3</sub>	cub	$n$		1.5151							7
NaF	cub	$n$	1.3424	1.3252	1.3231	1.3214	1.3179	1.3017	1.2400		1
NaH <sub>2</sub> PO <sub>4</sub> ·2H <sub>2</sub> O	orth	$n_x$		1.4400							7
	orth	$n_y$		1.4628							7
	orth	$n_z$		1.4814							7
NaI	cub	$n$	1.93*	1.774	1.758	1.74	1.73*	1.73*	1.71*	1.66*	1
NaNO <sub>2</sub>	orth	$n_x$		1.6547							7
	orth	$n_y$		1.3455							7
	orth	$n_z$		1.4125							7
NaNO <sub>3</sub>	rhomb	$n_o$		1.5840							5
	rhomb	$n_e$		1.3340							5
Na <sub>2</sub> HPO <sub>4</sub> ·7H <sub>2</sub> O	monocl	$n_x$		1.4411							4
	monocl	$n_y$		1.4423							4
	monocl	$n_z$		1.4525							4
Na <sub>2</sub> SO <sub>4</sub>	orth	$n_x$		1.4669							4
	orth	$n_y$		1.4730							4
	orth	$n_z$		1.4809							4
NdF <sub>3</sub>	hex	$n_o$		1.6191							4
	hex	$n_e$		1.6132							4
Nd <sub>2</sub> O <sub>3</sub>	cub	$n$		1.92							4
NiF <sub>2</sub>	tetr	$n_o$		1.526							4
	tetr	$n_e$		1.561							4
NiSO <sub>4</sub> ·6H <sub>2</sub> O	tetr	$n_o$		1.5107							4
	tetr	$n_e$		1.4870							4
PbF <sub>2</sub>	cub	$n$	1.94*	1.767	1.754	1.745	1.73	1.70	1.66	1.32	5
PbSO <sub>4</sub>	orth	$n_x$		1.8780							4
	orth	$n_y$		1.8834							4
	orth	$n_z$		1.8945							4
PrF <sub>3</sub>	hex	$n_o$		1.6207							4
	hex	$n_e$		1.6146							4
RbBr	cub	$n$	1.639	1.553	1.544	1.538	1.532	1.530	1.525	1.505*	1
RbCl	cub	$n$	1.549	1.493	1.487	1.483	1.479	1.475	1.465	1.424*	1
RbClO <sub>4</sub>	orth	$n_x$		1.4691							4
	orth	$n_y$		1.4701							4
	orth	$n_z$		1.4732							4
RbF	cub	$n$	1.428*	1.397	1.394	1.391	1.388	1.379	1.346	1.19*	1
RbH <sub>2</sub> AsO <sub>4</sub>	tetr	$n_o$	1.6183	1.5603	1.5538	1.5432					7
	tetr	$n_e$	1.5718	1.5232	1.5184	1.5121					7

Compound	Crystal system	Ray	Index of Refraction at the Indicated Wavelength								Ref.
			300 nm	589 nm	750 nm	1 $\mu\text{m}$	2 $\mu\text{m}$	5 $\mu\text{m}$	10 $\mu\text{m}$	20 $\mu\text{m}$	
RbH <sub>2</sub> PO <sub>4</sub>	tetr	$n_o$	1.5434	1.5078	1.5021	1.4941					7
	tetr	$n_e$	1.5106	1.4791	1.4754	1.4704					7
RbI	cub	$n$	1.808	1.647	1.633	1.623	1.615	1.612	1.608	1.595	1
Rb <sub>2</sub> SO <sub>4</sub>	orth	$n_x$		1.5131							4
	orth	$n_y$		1.5133							4
	orth	$n_z$		1.5144							4
Sb <sub>2</sub> O <sub>5</sub> <sup>e</sup>	cub	$n$		2.8017							4
Sc <sub>2</sub> O <sub>3</sub>	cub	$n$		1.9943							4
SiO <sub>2</sub> <sup>d</sup>	hex	$n_o$	1.5733	1.5442	1.5394	1.5350	1.5209				5
	hex	$n_e$	1.5882	1.5534	1.5484	1.5438	1.5291				5
SnO <sub>2</sub>	tetr	$n_o$		1.993							4
	tetr	$n_e$		2.088							4
SrF <sub>2</sub>	cub	$n$	1.459	1.4380	1.435	1.433	1.429	1.412	1.35		2
SrO	cub	$n$		1.8710							4
SrSO <sub>4</sub>	orth	$n_x$		1.6214							4
	orth	$n_y$		1.6231							4
	orth	$n_z$		1.6303							4
SrTiO <sub>3</sub>	cub	$n$		2.4082	2.3525	2.3160	2.2676	2.1205			5
SrWO <sub>4</sub>	tetr	$n_o$		1.8618							4
	tetr	$n_e$		1.8719							4
TbF <sub>3</sub>	hex	$n_o$		1.6034							4
	hex	$n_e$		1.5603							4
TeO <sub>2</sub>	tetr	$n_o$		2.2738		2.2080					7
	tetr	$n_e$		2.4295		2.3520					7
ThO <sub>2</sub>	cub	$n$		2.1113							4
TiO <sub>2</sub> <sup>e</sup>	tetr	$n_o$		2.612	2.533	2.485	2.399	2.220			5
	tetr	$n_e$		2.910	2.805	2.748					5
	tetr	$n_o$		2.562							4
	tetr	$n_e$		2.489							4
TlBr	cub	$n$		2.418	2.350	2.289	2.103	1.984	2.339	2.322	5
TlCl	cub	$n$		2.247	2.198	2.145	1.986	1.891	2.193		5
TlClO <sub>4</sub>	orth	$n_x$		1.6427							4
	orth	$n_y$		1.6446							4
	orth	$n_z$		1.6542							4
Tl <sub>2</sub> SO <sub>4</sub>	orth	$n_x$		1.8604							4
	orth	$n_y$		1.8676							4
	orth	$n_z$		1.8857							4
Y <sub>2</sub> O <sub>3</sub>	cub	$n$		1.930							4
Yb <sub>2</sub> O <sub>3</sub>	cub	$n$		1.9468							4
ZnF <sub>2</sub>	tetr	$n_o$		1.495							4
	tetr	$n_e$		1.525							4
ZnO	hex	$n_o$		2.0036	1.9662	1.9435	1.9197				7
	hex	$n_e$		2.0199	1.9821	1.9589	1.9330				7
ZnS <sup>f</sup>	cub	$n$		2.3691	2.3232	2.2932	2.2633				7
ZnS <sup>g</sup>	hex	$n_o$		2.372	2.331	2.303	2.26	2.25	2.20		3,5
	hex	$n_e$		2.368	2.327	2.301					5
ZnSe	cub	$n$		2.6222	2.5384	2.4888	2.4462	2.4296	2.4065		3
ZnTe	cub	$n$		3.060	2.880	2.789	2.719	2.698	2.684		3
ZrSiO <sub>4</sub> <sup>h</sup>	tetr	$n_o$		1.9255							4
	tetr	$n_e$		1.9843							4

\* Provisional value based on extrapolation beyond the range of experimental data.

<sup>a</sup> Arsenolite

<sup>b</sup> Calcite

<sup>c</sup> Senarmontite

<sup>d</sup>  $\alpha$ -Quartz

<sup>e</sup> Rutile

<sup>f</sup> Sphalerite

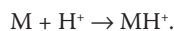
<sup>g</sup> Wurtzite

<sup>h</sup> Zircon



## PROTON AFFINITIES

Proton affinity is a useful parameter for describing gas phase ion-molecule reactions in fields such as atmospheric chemistry, plasma chemistry, mass spectrometry, and astrophysics. The proton affinity  $E_{\text{pa}}$  (often designated in the literature as PA) of a molecular species M is defined as the negative of the enthalpy change for the gas phase reaction



A closely related quantity is the gas phase basicity  $\Delta_{\text{base}} G^\circ$  (often designated as GB), which is the negative of the Gibbs energy change for the same reaction. Thus the two are related by

$$\Delta_{\text{base}} G^\circ = E_{\text{pa}} + T\Delta S,$$

where  $T$  is the temperature and  $\Delta S$  is the entropy change in the reaction (which can be calculated if the molecular structure of M and  $\text{M}^+$  is known).

Direct measurement of the proton affinity is possible for only a few molecules, mainly olefins and carbonyl compounds. However, these measurements have been used to establish a scale of  $E_{\text{pa}}$  values that permits proton affinities to be determined for many other molecules, including unstable species and reaction intermediates. The basis for this scale is described by Hunter and Lias in Reference 1.

The  $E_{\text{pa}}$  and  $\Delta_{\text{base}} G^\circ$  values at a temperature of 298 K are tabulated below for selected molecules. Many values are given to one decimal place, but the majority are not accurate to better than one or two kilojoules per mole. The methods of measurement are de-

scribed in Reference 1, which contains a much more extensive and detailed tabulation.

Compounds are listed by molecular formula in the Hill order, but with all compounds that do not contain carbon appearing before those that do contain carbon.

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Molecular formula	Name	$E_{\text{pa}}$ kJ/mol	$\Delta_{\text{base}} G^\circ$ kJ/mol	Notes
Ar	Argon	369.2	346.3	
AsF <sub>3</sub>	Arsenic(III) fluoride	636.7	604.2	
AsH <sub>3</sub>	Arsine	747.9	712.0	
BHO <sub>2</sub>	Metaboric acid	763.0	730.5	
BH <sub>3</sub> O <sub>3</sub>	Boric acid	728.1	698.4	
B <sub>2</sub> H <sub>6</sub>	Diborane	615	586.0	
B <sub>3</sub> H <sub>6</sub> N <sub>3</sub>	Borazine	802.5	772.8	
B <sub>4</sub> H <sub>10</sub>	Tetraborane(10)	605	572.5	
B <sub>5</sub> H <sub>9</sub>	Pentaborane(9)	699.4	666.9	
BaO	Barium oxide	1215.4	1187.6	
Br	Bromine (atomic)	554.4	531.2	
BrH	Hydrogen bromide	584.2	557.7	
BrLi	Lithium bromide	819	792.5	
CaO	Calcium oxide	1190.6	1162.3	
Cl	Chlorine (atomic)	513.6	490.1	
ClH	Hydrogen chloride	556.9	530.1	
CLi	Lithium chloride	827	800.5	
Co	Cobalt	742.7	719.8	
Cr	Chromium	791.3	768.4	
CsHO	Cesium hydroxide	1117.9	1092.2	
Cs <sub>2</sub> O	Cesium oxide	1442.9	1412.2	
Cu	Copper	655.3	632.4	
F	Fluorine (atomic)	340.1	315.1	
FH	Hydrogen fluoride	484	456.7	
FO	Fluorine oxide	508.7	482.2	
F <sub>2</sub>	Fluorine	332	305.5	
F <sub>2</sub> O <sub>2</sub> S	Sulfuryl fluoride	605.5	580.5	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
F <sub>3</sub> N	Nitrogen trifluoride	568.4	538.6	
F <sub>3</sub> OP	Phosphoryl fluoride	694.0	664.2	
F <sub>3</sub> P	Phosphorus(III) fluoride	695.3	662.8	
F <sub>4</sub> Si	Tetrafluorosilane	502.9	476.6	
F <sub>6</sub> S	Sulfur hexafluoride	575.3	550.7	
Fe	Iron	754	731.1	
FeO	Iron(II) oxide	907	880.5	
GeH <sub>4</sub>	Germane	713.4	687.1	
HI	Hydrogen iodide	627.5	601.3	
HKO	Potassium hydroxide	1101.8	1075.4	
HLi	Lithium hydride	1021.7	996.4	
HLiO	Lithium hydroxide	1000.1	972.1	
HNO <sub>3</sub>	Nitric acid	751.4	731.5	
HN <sub>3</sub>	Hydrazoic acid	756.0	723.5	
HNa	Sodium hydride	1095	1070.6	
HNaO	Sodium hydroxide	1071.8	1044.8	
HO	Hydroxyl	593.2	564.0	
HO <sub>2</sub>	Hydroperoxy	660	627.5	
HP	Phosphorus monohydride	670.3	639.6	
H <sub>2</sub>	Hydrogen	422.3	394.7	
H <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	Nitramide	757.4	725.0	
H <sub>2</sub> O	Water	691	660.0	
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide	674.5	643.8	
H <sub>2</sub> O <sub>4</sub> S	Sulfuric acid	717	681	Ref. 3
H <sub>2</sub> P	Phosphino	709.2	675.7	
H <sub>2</sub> S	Hydrogen sulfide	705	673.8	
H <sub>2</sub> Se	Hydrogen selenide	707.8	676.4	
H <sub>2</sub> Si	Silylene	839.2	804.1	
H <sub>2</sub> Te	Hydrogen telluride	735.9	704.5	
H <sub>3</sub> N	Ammonia	853.6	819.0	
H <sub>3</sub> P	Phosphine	785	750.9	
H <sub>4</sub> N <sub>2</sub>	Hydrazine	853.2	822.4	
H <sub>4</sub> Si	Silane	639.7	613.4	
H <sub>6</sub> OSi <sub>2</sub>	Disiloxane	749	718.3	
He	Helium	177.8	148.5	
I	Iodine (atomic)	608.2	583.5	
K <sub>2</sub> O	Potassium oxide	1342.5	1311.8	
Kr	Krypton	424.6	402.4	
La	Lanthanum	1013	991.9	
Li <sub>2</sub>	Dilithium	1162	1133.1	
Li <sub>2</sub> O	Lithium oxide	1206	1175.3	
Lu	Lutetium	992	970.6	
Mg	Magnesium	819.6	797.3	
MgO	Magnesium oxide	988	959.4	
Mg <sub>2</sub>	Dimagnesium	919	886.5	
Mn	Manganese	797.3	774.4	
N	Nitrogen (atomic)	342.2	318.7	
NO	Nitric oxide	531.8	505.3	
NO <sub>2</sub>	Nitrogen dioxide	591.0	560.3	
NP	Phosphorus nitride	789.4	757.0	
N <sub>2</sub>	Nitrogen	493.8	464.5	
N <sub>2</sub> O	Nitrous oxide	549.8	523.3	Protonation at N
N <sub>2</sub> O	Nitrous oxide	575.2	548.7	Protonation at O
Na <sub>2</sub>	Disodium	1146.8	1118.2	
Na <sub>2</sub> O	Sodium oxide	1375.9	1345.2	
Ne	Neon	198.8	174.4	
Ni	Nickel	737	714.1	
O	Oxygen (atomic)	485.2	459.6	
OP	Phosphorus monoxide	682	649.5	
OSi	Silicon monoxide	777.8	750.4	Protonation at O

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
OSi	Silicon monoxide	533	500.5	Protonation at Si
OSr	Strontium oxide	1209	1180.7	
O <sub>2</sub>	Oxygen	421	396.3	
O <sub>2</sub> S	Sulfur dioxide	672.3	643.3	
O <sub>3</sub>	Ozone	625.5	595.9	
O <sub>3</sub> S	Sulfur trioxide	588.3	560.3	
O <sub>4</sub> Os	Osmium(VIII) oxide	676.9	650.6	
P	Phosphorus	626.8	604.8	
Pd	Palladium	696	673.4	
Rh	Rhodium	768	745.4	
Ru	Ruthenium	774	751.4	
S	Sulfur	664.3	640.2	
SSi	Silicon monosulfide	627	596.6	Protonation at Si
SSi	Silicon monosulfide	683	660.2	Protonation at S
Sc	Scandium	914	892.0	
Si	Silicon	837	814.1	
Ti	Titanium	876	853.7	
U	Uranium	995.2	973.2	
V	Vanadium	859.4	836.8	
Xe	Xenon	499.6	478.1	
Y	Yttrium	967	945.9	
Zn	Zinc	608.6	586.0	
CBrF <sub>3</sub>	Bromotrifluoromethane	580.0	550.3	
CBrN	Cyanogen bromide	749.8	719.2	
CClF <sub>3</sub>	Chlorotrifluoromethane	571.3	541.5	
CClN	Cyanogen chloride	722.1	691.5	
CCl <sub>2</sub>	Dichloromethylene	861	828.5	
CCl <sub>2</sub> S	Carbonothioic dichloride	752.5	721.8	
CFN	Cyanogen fluoride	632	601.3	
CF <sub>2</sub>	Difluoromethylene	765	732.5	
CF <sub>2</sub> O	Carbonyl fluoride	666.7	637.0	
CF <sub>3</sub> I	Trifluoroiodomethane	628.0	598.2	
CF <sub>3</sub> NO	Trifluoronitrosomethane	703.3	670.8	
CF <sub>4</sub>	Tetrafluoromethane	529.3	503.7	
CHCl	Chloromethylene	874.1	839.9	
CHF	Fluoromethylene	797.9	763.8	
CHF <sub>3</sub>	Trifluoromethane	619.5	589.7	
CHF <sub>3</sub> O <sub>3</sub> S	Trifluoromethanesulfonic acid	699.4	666.9	
CHN	Hydrogen cyanide	712.9	681.6	
CHN	Hydrogen isocyanide	772.3	739.8	
CHNO	Isocyanic acid (HNCO)	753	718.8	
CHNO	Fulminic acid	758	725.5	
CHO	Oxomethyl (HCO)	636	601.8	
CHO <sub>2</sub>	Formyloxyl	623.4	590.9	
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane	620.5	589.7	
CH <sub>2</sub> N <sub>2</sub>	Diazomethane	858.9	826.7	
CH <sub>2</sub> N <sub>2</sub>	Cyanamide	805.6	774.9	
CH <sub>2</sub> O	Formaldehyde	712.9	683.3	
CH <sub>2</sub> O <sub>2</sub>	Formic acid	742.0	710.3	
CH <sub>2</sub> S	Thioformaldehyde	759.7	730.5	
CH <sub>2</sub> Se	Selenoformaldehyde	764.0	734.9	
CH <sub>3</sub> Br	Bromomethane	664.2	638.0	
CH <sub>3</sub> Cl	Chloromethane	647.3	621.1	
CH <sub>3</sub> F	Fluoromethane	598.9	571.5	
CH <sub>3</sub> I	Iodomethane	691.7	665.5	
CH <sub>3</sub> NO	Formamide	822.2	791.2	
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	754.6	721.6	
CH <sub>3</sub> NO <sub>2</sub>	Methyl nitrite	798.9	766.4	
CH <sub>3</sub> NO <sub>3</sub>	Methyl nitrate	733.6	714.8	
CH <sub>3</sub> N <sub>3</sub>	Methyl azide	833	800.5	

Molecular formula	Name	$E_{\text{pa}}$ kJ/mol	$\Delta_{\text{base}}G^\circ$ kJ/mol	Notes
CH <sub>4</sub>	Methane	543.5	520.6	
CH <sub>4</sub> N	Methylamidogen	832.8	801.6	
CH <sub>4</sub> N <sub>2</sub> O	Urea	873.5	841.6	Protonation at O; Ref. 8
CH <sub>4</sub> N <sub>2</sub> S	Thiourea	893.7	863.9	
CH <sub>4</sub> O	Methanol	754.3	724.5	
CH <sub>4</sub> O <sub>3</sub> S	Methanesulfonic acid	761.3	728.9	
CH <sub>4</sub> S	Methanethiol	773.4	742	
CH <sub>5</sub> N	Methylamine	899.0	864.5	
CH <sub>5</sub> NO	O-Methylhydroxylamine	844.8	812.3	
CH <sub>5</sub> N <sub>3</sub>	Guanidine	986.3	949.4	
CH <sub>5</sub> P	Methylphosphine	851.5	817.6	
CH <sub>6</sub> N <sub>2</sub>	Methylhydrazine	898.8	866.4	
CN	Cyanide	>595	>564	Protonation at N
CNS	Thiocyanate	751	718.5	
CO	Carbon monoxide	594	562.8	Protonation at C
CO	Carbon monoxide	426.3	402.2	Protonation at O
COS	Carbon oxysulfide	628.5	602.6	Protonation at S
COSe	Carbon oxyselenide	670	644.1	Protonation at Se
CO <sub>2</sub>	Carbon dioxide	540.5	515.8	
CS	Carbon monosulfide	791.5	760	
CS <sub>2</sub>	Carbon disulfide	681.9	657.7	
CSe	Carbon monoselenide	831.8	800.2	Protonation at C
CSe <sub>2</sub>	Carbon diselenide	725	700.9	
C <sub>2</sub> ClF <sub>3</sub> O	Trifluoroacetyl chloride	681.6	649.8	
C <sub>2</sub> Cl <sub>3</sub> N	Trichloroacetonitrile	723.2	692.6	
C <sub>2</sub> F <sub>3</sub> N	Trifluoroacetonitrile	688.4	657.7	
C <sub>2</sub> H	Ethynyl	753	720.8	
C <sub>2</sub> HCl <sub>3</sub> O	Trichloroacetaldehyde	722.3	690.5	
C <sub>2</sub> HCl <sub>3</sub> O <sub>2</sub>	Trichloroacetic acid	770.0	739.1	
C <sub>2</sub> HF	Fluoroacetylene	686	661.3	
C <sub>2</sub> HF <sub>3</sub>	Trifluoroethene	699.4	666.9	
C <sub>2</sub> HF <sub>3</sub> O <sub>2</sub>	Trifluoroacetic acid	711.7	680.7	
C <sub>2</sub> H <sub>2</sub>	Acetylene	641.4	616.7	
C <sub>2</sub> H <sub>2</sub> ClN	Chloroacetonitrile	745.7	715.1	
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1,1-Difluoroethene	734	705.1	
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	<i>trans</i> -1,2-Difluoroethene	688.6	657.9	
C <sub>2</sub> H <sub>2</sub> O	Ketene	825.3	793.6	
C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	Chloroacetic acid	765.4	734.5	
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> O	2,2,2-Trichloroethanol	729.3	698.9	
C <sub>2</sub> H <sub>3</sub> F	Fluoroethene	729	700.1	
C <sub>2</sub> H <sub>3</sub> FO <sub>3</sub>	Fluoroacetic acid	765.4	734.5	
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	2,2,2-Trifluoroethanol	700.2	669.9	
C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> O	Methyl trifluoromethyl ether	719.2	690.0	
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	779.2	748	
C <sub>2</sub> H <sub>3</sub> N	Isocyanomethane	839.1	806.6	
C <sub>2</sub> H <sub>3</sub> NO	Methyl isocyanate	764.4	732.0	
C <sub>2</sub> H <sub>3</sub> NS	Methyl thiocyanate	796.7	766.1	
C <sub>2</sub> H <sub>3</sub> NS	Methyl isothiocyanate	799.2	766.7	
C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	1 <i>H</i> -1,2,3-Triazole	879.3	847.4	
C <sub>2</sub> H <sub>3</sub> N <sub>3</sub>	1 <i>H</i> -1,2,4-Triazole	886.0	855.9	
C <sub>2</sub> H <sub>4</sub>	Ethylene	680.5	651.5	
C <sub>2</sub> H <sub>4</sub> F <sub>2</sub> O	2,2-Difluoroethanol	727.4	697.0	
C <sub>2</sub> H <sub>4</sub> F <sub>3</sub> N	2,2,2-Trifluoroethylamine	846.8	812.9	
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub>	Aminoacetonitrile	824.9	791.0	
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	768.5	736.5	
C <sub>2</sub> H <sub>4</sub> O	Oxirane	774.2	745.3	
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	783.7	752.8	
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	782.5	751.5	
C <sub>2</sub> H <sub>4</sub> S	Thiirane	807.4	777.6	
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	696.2	669.7	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>2</sub> H <sub>5</sub> BrO	2-Bromoethanol	766.1	735.7	
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	693.4	666.9	
C <sub>2</sub> H <sub>5</sub> ClO	2-Chloroethanol	766.1	735.7	
C <sub>2</sub> H <sub>5</sub> F	Fluoroethane	683.4	655.8	
C <sub>2</sub> H <sub>5</sub> FO	2-Fluoroethanol	715.6	685.2	
C <sub>2</sub> H <sub>5</sub> I	Iodoethane	724.8	698.3	
C <sub>2</sub> H <sub>5</sub> N	Ethenamine	898.9	866.5	
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine	905.5	872.5	
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	863.6	832.6	
C <sub>2</sub> H <sub>5</sub> NO	<i>N</i> -Methylformamide	851.3	820.3	
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	765.7	733.2	
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Ethyl nitrite	818.9	786.4	
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Glycine	886.5	852.2	
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Acetohydroxamic acid	854.0	823.0	
C <sub>2</sub> H <sub>5</sub> NS	Thioacetamide	884.6	852.8	
C <sub>2</sub> H <sub>6</sub>	Ethane	596.3	569.9	
C <sub>2</sub> H <sub>6</sub> Hg	Dimethyl mercury	771.6	740.8	
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	Ethanimidamide	970.7	938.2	
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	trans-Dimethyldiazene	865.1	834.4	
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	2-Aminoacetamide		882.3	
C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	<i>N</i> -Methyl- <i>N</i> -nitromethanamine	828.3	795.8	
C <sub>2</sub> H <sub>6</sub> O	Ethanol	776.4	746	
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	792	764.5	
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide	884.4	853.7	
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	1,2-Ethanediol	815.9	773.6	
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol	789.6	758.4	
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	830.9	801.2	
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide	815.3	782.8	
C <sub>2</sub> H <sub>7</sub> N	Ethylamine	912.0	878	
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	929.5	896.5	
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine	930.3	896.8	
C <sub>2</sub> H <sub>7</sub> O <sub>3</sub> P	Dimethyl hydrogen phosphite	894.8	862.4	
C <sub>2</sub> H <sub>7</sub> P	Dimethylphosphine	912.0	877.9	
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	951.6	912.5	
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,1-Dimethylhydrazine	927.1	894.7	
C <sub>2</sub> N <sub>2</sub>	Cyanogen	674.7	645.8	
C <sub>2</sub> O	Dicarbon monoxide	774.7	747.0	
C <sub>3</sub>	Carbon trimer	767.0	736.3	
C <sub>3</sub> F <sub>6</sub> O	Perfluoroacetone	670.4	639.7	
C <sub>3</sub> HN	Cyanoacetylene	751.2	720.5	
C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> O	1,1,1,3,3,3-Hexafluoro-2-propanol	686.6	656.2	
C <sub>3</sub> H <sub>2</sub> N <sub>2</sub>	Malononitrile	723.0	694.1	
C <sub>3</sub> H <sub>3</sub>	2-Propynyl	741	708.5	
C <sub>3</sub> H <sub>3</sub> Cl <sub>3</sub> O	1,1,1-Trichloro-2-propanone	768.3	736.3	
C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> O	1,1,1-Trifluoroacetone	723.9	692.0	
C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> O <sub>2</sub>	Methyl trifluoroacetate	740.5	709.6	
C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile	784.7	753.7	
C <sub>3</sub> H <sub>3</sub> NO	Oxazole	876.4	844.5	
C <sub>3</sub> H <sub>3</sub> NO	Isoxazole	848.6	816.8	
C <sub>3</sub> H <sub>3</sub> NO	2-Oxopropanenitrile	746.9	716.2	
C <sub>3</sub> H <sub>3</sub> NS	Thiazole	904	872.1	
C <sub>3</sub> H <sub>3</sub> N <sub>3</sub>	1,3,5-Triazine	848.8	819.6	
C <sub>3</sub> H <sub>4</sub>	Allene	775.3	745.8	
C <sub>3</sub> H <sub>4</sub>	Propyne	748.2	723.0	
C <sub>3</sub> H <sub>4</sub>	Cyclopropene	818.5	787.8	
C <sub>3</sub> H <sub>4</sub> ClN	3-Chloropropanenitrile	773.1	742.4	
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	1 <i>H</i> -Pyrazole	894.1	860.5	
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub>	Imidazole	942.8	909.2	
C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> S	2-Thiazolamine	930.6	898.7	
C <sub>3</sub> H <sub>4</sub> O	Acrolein	797.0	765.1	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>3</sub> H <sub>4</sub> O	1-Propen-1-one	834.1	803.4	
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Ethylene carbonate	814.2	784.4	
C <sub>3</sub> H <sub>5</sub>	Allyl	736	707.4	
C <sub>3</sub> H <sub>5</sub>	Cyclopropyl	738.9	702.0	
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Ethyl chloroformate	764.8	733.8	
C <sub>3</sub> H <sub>5</sub> FO	1-Fluoro-2-propanone	795.4	763.5	
C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> O	2,2,2-Trifluoroethyl methyl ether	747.6	718.4	
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	794.1	763.0	
C <sub>3</sub> H <sub>5</sub> N	2-Propyn-1-amine	887.4	853.5	
C <sub>3</sub> H <sub>5</sub> N	Ethyl isocyanide	851.3	818.9	
C <sub>3</sub> H <sub>5</sub> NO	Acrylamide	870.7	839.8	
C <sub>3</sub> H <sub>5</sub> NO	Methoxyacetone nitrile	758.1	727.4	
C <sub>3</sub> H <sub>5</sub> NO	2-Azetidinone	852.6	821.7	
C <sub>3</sub> H <sub>5</sub> NS	(Methylthio)acetone nitrile	784.8	754.1	
C <sub>3</sub> H <sub>5</sub> N <sub>3</sub>	1 <i>H</i> -Pyrazol-3-amine	921.5	889.6	
C <sub>3</sub> H <sub>5</sub> N <sub>3</sub>	1 <i>H</i> -Pyrazol-4-amine	907.6	874.0	
C <sub>3</sub> H <sub>6</sub>	Propene	741.6		Ref. 5
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	750.3	722.2	
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	3-Aminopropanenitrile	866.4	832.5	
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	Dimethylcyanamide	852.1	821.4	
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> S	2-Imidazolidinethione	921.9	891.2	
C <sub>3</sub> H <sub>6</sub> O	Methyl vinyl ether	859.2	830.3	
C <sub>3</sub> H <sub>6</sub> O	Propanal	786.0	754.0	
C <sub>3</sub> H <sub>6</sub> O	Acetone	812	782.1	
C <sub>3</sub> H <sub>6</sub> O	Oxetane	801.3	773.9	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	797.2	766.2	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	799.4	768.4	
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	821.6	790.7	
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	Dimethyl carbonate	830.2	799.2	
C <sub>3</sub> H <sub>6</sub> S	(Methylthio)ethene	858.2	829.3	
C <sub>3</sub> H <sub>6</sub> S	Thietane	834.8	805.0	
C <sub>3</sub> H <sub>6</sub> S	Methylthiirane	833.3	801.5	
C <sub>3</sub> H <sub>7</sub> N	Allylamine	909.5	875.5	
C <sub>3</sub> H <sub>7</sub> N	Cyclopropylamine	904.7	869.9	
C <sub>3</sub> H <sub>7</sub> N	Azetidine	943.4	908.6	
C <sub>3</sub> H <sub>7</sub> N	1-Methylaziridine	934.8	904.1	
C <sub>3</sub> H <sub>7</sub> N	Propyleneimine	925.1	892.1	
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	887.5	856.6	
C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -Methylacetamide	888.5	857.6	
C <sub>3</sub> H <sub>7</sub> NO	Propanamide	876.2	845.3	
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Isopropyl nitrite	845.5	813.0	
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	<i>L</i> -Alanine	901.6	867.7	
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	Sarcosine	921.2	888.7	
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub> S	<i>L</i> -Cysteine	903.2	869.3	
C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	<i>L</i> -Serine	914.6	880.7	
C <sub>3</sub> H <sub>8</sub>	Propane	625.7	607.8	
C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O	<i>N,N'</i> -Dimethylurea	903.3	873.5	
C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> S	<i>N,N'</i> -Dimethylthiourea	926.0	895.1	
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	786.5	756.1	
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	793.0	762.6	
C <sub>3</sub> H <sub>8</sub> O	Ethyl methyl ether	808.6	781.2	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Propanediol	876.2	825.9	
C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	2-Methoxyethanol	768.8	729.8	
C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	Glycerol	874.8	820	
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol	794.9	763.6	
C <sub>3</sub> H <sub>8</sub> S	2-Propanethiol	803.6	772.3	
C <sub>3</sub> H <sub>8</sub> S	Ethyl methyl sulfide	846.5	815.3	
C <sub>3</sub> H <sub>9</sub> As	Trimethylarsine	897.3	864.9	
C <sub>3</sub> H <sub>9</sub> BO <sub>3</sub>	Trimethyl borate	815.8	783.4	
C <sub>3</sub> H <sub>9</sub> N	Propylamine	917.8	883.9	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine	923.8	889.0	
C <sub>3</sub> H <sub>9</sub> N	Ethylmethylamine	942.2	909.2	
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	948.9	918.1	
C <sub>3</sub> H <sub>9</sub> NO	2-Methoxyethylamine	928.6	894.6	
C <sub>3</sub> H <sub>9</sub> NO	Trimethylamine oxide	983.2	953.5	
C <sub>3</sub> H <sub>9</sub> NO	3-Amino-1-propanol	962.5	917.3	
C <sub>3</sub> H <sub>9</sub> O <sub>3</sub> P	Trimethyl phosphite	929.7	899.9	
C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P	Trimethyl phosphate	890.6	860.8	
C <sub>3</sub> H <sub>9</sub> P	Trimethylphosphine	958.8	926.3	
C <sub>3</sub> H <sub>10</sub> N <sub>2</sub>	1,3-Propanediamine	987.0	940.0	
C <sub>3</sub> H <sub>10</sub> OSi	Trimethylsilanol	814.0	781.5	
C <sub>4</sub> F <sub>8</sub>	Perfluorocyclobutane	>544		Ref. 6
C <sub>4</sub> H <sub>2</sub>	1,3-Butadiyne	737.2	712.8	
C <sub>4</sub> H <sub>4</sub> F <sub>6</sub> O	Bis(2,2,2-trifluoroethyl) ether	702.3	674.9	
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrazine	877.1	847.0	
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyrimidine	885.8	855.7	
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub>	Pyridazine	907.2	877.1	
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	Uracil	872.7	841.7	
C <sub>4</sub> H <sub>4</sub> N <sub>2</sub> S <sub>2</sub>	2,4(1 <i>H</i> ,3 <i>H</i> )-Pyrimidinedithione	911.4	880.5	
C <sub>4</sub> H <sub>4</sub> O	Furan	812	781	Ref. 10
C <sub>4</sub> H <sub>4</sub> O <sub>3</sub>	Succinic anhydride	797		Ref. 9
C <sub>4</sub> H <sub>4</sub> S	Thiophene	815.0	784.3	
C <sub>4</sub> H <sub>5</sub> Cl <sub>3</sub> O <sub>2</sub>	Ethyl trichloroacetate	790.4	759.4	
C <sub>4</sub> H <sub>5</sub> F <sub>3</sub> O <sub>2</sub>	Ethyl trifluoroacetate	758.8	727.9	
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole	875.4	843.8	
C <sub>4</sub> H <sub>5</sub> N	Cyclopropanecarbonitrile	808.2	777.5	
C <sub>4</sub> H <sub>5</sub> NO <sub>2</sub>	Ethyl cyanofornate	745.7	714.7	
C <sub>4</sub> H <sub>5</sub> NS	2-Methylthiazole	930.6	898.7	
C <sub>4</sub> H <sub>5</sub> N <sub>3</sub> O	Cytosine	949.9	918	
C <sub>4</sub> H <sub>6</sub>	1,2-Butadiene	778.9	749.8	
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	783.4	757.6	
C <sub>4</sub> H <sub>6</sub>	2-Butyne	775.8	745.1	
C <sub>4</sub> H <sub>6</sub>	Cyclobutene	784.4	753.6	
C <sub>4</sub> H <sub>6</sub> F <sub>3</sub> NO	2,2,2-Trifluoro- <i>N,N</i> -dimethylacetamide	849.0	818.0	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	1-Methylimidazol	959.6	927.7	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	2-Methyl-1 <i>H</i> -imidazole	963.4	929.6	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	4-Methyl-1 <i>H</i> -imidazole	952.8	920.9	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	1-Methyl-1 <i>H</i> -pyrazole	912.0	880.1	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	3-Methyl-1 <i>H</i> -pyrazole	906.0	874.2	
C <sub>4</sub> H <sub>6</sub> N <sub>2</sub>	4-Methyl-1 <i>H</i> -pyrazole	906.8	873.4	
C <sub>4</sub> H <sub>6</sub> O	2-Methylpropenal	808.7	776.8	
C <sub>4</sub> H <sub>6</sub> O	3-Buten-2-one	834.7	802.8	
C <sub>4</sub> H <sub>6</sub> O	Cyclobutanone	802.5	772.7	
C <sub>4</sub> H <sub>6</sub> O	2,3-Dihydrofuran	866.9	834.4	
C <sub>4</sub> H <sub>6</sub> O	2,5-Dihydrofuran	823.4	796	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>trans</i> -2-Butenoic acid	824.0	793	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid	816.7	785.7	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Cyclopropanecarboxylic acid	821.4	790.4	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	813.9	782.9	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate	825.8	794.8	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Butanedione	801.9	770.1	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	$\gamma$ -Butyrolactone	840.0	808.1	
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	2,3-Dihydro-1,4-dioxin	823.5	792.8	
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride	844		Ref. 9
C <sub>4</sub> H <sub>7</sub>	2-Methylallyl	778	747.3	
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	798.4	767.7	
C <sub>4</sub> H <sub>7</sub> N	2-Methylpropanenitrile	803.6	772.8	
C <sub>4</sub> H <sub>7</sub> N	1-Isocyanopropane	856.8	824.3	
C <sub>4</sub> H <sub>7</sub> NO	2-Butenamide	887.1	856.1	



Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>4</sub> H <sub>7</sub> NO	2-Methyl-2-propenamide	880.4	849.4	
C <sub>4</sub> H <sub>7</sub> NO <sub>4</sub>	L-Aspartic acid	908.9	875	
C <sub>4</sub> H <sub>8</sub>	<i>trans</i> -2-Butene	747	719.9	
C <sub>4</sub> H <sub>8</sub>	Isobutene	802.1	775.6	
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub>	(Dimethylamino)acetonitrile	884.5	853.7	
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	L-Asparagine	929	891.5	
C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>3</sub>	N-Glycylglycine		882	
C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether	870.1	840.4	
C <sub>4</sub> H <sub>8</sub> O	2-Methoxy-1-propene	894.9	866.1	
C <sub>4</sub> H <sub>8</sub> O	Butanal	792.7	760.8	
C <sub>4</sub> H <sub>8</sub> O	Isobutanal	797.3	765.5	
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	827.3	795.5	
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	822.1	794.7	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	804.9	773.9	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Isopropyl formate	811.3	780.3	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	835.7	804.7	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Methyl propanoate	830.2	799.2	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Dioxane	825.4	796.2	
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Dioxane	797.4	770.0	
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	Ethyl methyl carbonate	842.7	810.8	
C <sub>4</sub> H <sub>8</sub> S	Tetrahydrothiophene	849.1	819.3	
C <sub>4</sub> H <sub>9</sub> N	Pyrrolidine	948.3	915.3	
C <sub>4</sub> H <sub>9</sub> NO	N-Methylpropanamide	920.4	889.4	
C <sub>4</sub> H <sub>9</sub> NO	2-Methylpropanamide	878.6	846.7	
C <sub>4</sub> H <sub>9</sub> NO	N-Ethylacetamide	898.0	867.0	
C <sub>4</sub> H <sub>9</sub> NO	N,N-Dimethylacetamide	908.0	877.0	
C <sub>4</sub> H <sub>9</sub> NO	Morpholine	924.3	891.2	
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	<i>tert</i> -Butyl nitrite	863.9	831.4	
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	Ethyl N-methylcarbamate	888.8	857.8	
C <sub>4</sub> H <sub>9</sub> NO <sub>3</sub>	L-Threonine	922.5	888.5	
C <sub>4</sub> H <sub>9</sub> NS	N,N-Dimethylthioacetamide	925.3	894.4	
C <sub>4</sub> H <sub>10</sub>	Isobutane	677.8	671.3	
C <sub>4</sub> H <sub>10</sub> N <sub>2</sub>	Piperazine	943.7	914.7	
C <sub>4</sub> H <sub>10</sub> N <sub>2</sub>	3-Ethyl-3-methyldiaziridine	903.8	871.3	
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	789.2	758.9	
C <sub>4</sub> H <sub>10</sub> O	2-Butanol	815.7	784.6	
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	793.7	762.2	
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	802.6	772.2	
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	828.4	801	
C <sub>4</sub> H <sub>10</sub> O	Methyl propyl ether	814.9	785.7	
C <sub>4</sub> H <sub>10</sub> O	Isopropyl methyl ether	826.3	797.1	
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Butanediol	915.6	854.9	
C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1,2-Dimethoxyethane	858.0	820.2	
C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>	1,2,4-Butanetriol	905.9	841	
C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	801.7	770.5	
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-1-propanethiol	802.6	771.4	
C <sub>4</sub> H <sub>10</sub> S	2-Methyl-2-propanethiol	816.4	785.1	
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	856.7	827.0	
C <sub>4</sub> H <sub>11</sub> N	Butylamine	921.5	886.6	
C <sub>4</sub> H <sub>11</sub> N	<i>tert</i> -Butylamine	934.1	899.9	
C <sub>4</sub> H <sub>11</sub> N	Isobutylamine	924.8	890.8	
C <sub>4</sub> H <sub>11</sub> N	Diethylamine	952.4	919.4	
C <sub>4</sub> H <sub>11</sub> N	Isopropylmethylamine	952.4	919.4	
C <sub>4</sub> H <sub>11</sub> N	Ethyldimethylamine	960.1	929.1	
C <sub>4</sub> H <sub>11</sub> NO	N-Ethyl-N-hydroxyethanamine	914.7	882.2	
C <sub>4</sub> H <sub>11</sub> NO	4-Amino-1-butanol	984.5	932.1	
C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	Diethanolamine	953	920	
C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	1,4-Butanediamine	1005.6	954.3	
C <sub>4</sub> H <sub>12</sub> N <sub>2</sub>	N,N'-Dimethyl-1,2-ethanediamine	989.2	946.9	
C <sub>4</sub> H <sub>12</sub> Sn	Tetramethylstannane	823.7	797.4	



Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>4</sub> H <sub>14</sub> OSi <sub>2</sub>	1,1,3,3-Tetramethyldisiloxane	845.3	814.6	
C <sub>4</sub> NiO <sub>4</sub>	Nickel carbonyl	742.3	716.0	
C <sub>5</sub> F <sub>5</sub> N	Perfluoropyridine	764.9	733.0	
C <sub>5</sub> FeO <sub>5</sub>	Iron pentacarbonyl	833.0	798.5	
C <sub>5</sub> H <sub>3</sub> ClN <sub>4</sub>	6-Chloro-1 <i>H</i> -purine	873.6	841.7	
C <sub>5</sub> H <sub>4</sub> BrN	2-Bromopyridine	904.8	873.0	
C <sub>5</sub> H <sub>4</sub> BrN	3-Bromopyridine	910.0	878.2	
C <sub>5</sub> H <sub>4</sub> BrN	4-Bromopyridine	917.8	886.0	
C <sub>5</sub> H <sub>4</sub> ClN	2-Chloropyridine	900.9	869	
C <sub>5</sub> H <sub>4</sub> ClN	3-Chloropyridine	903.4	871.5	
C <sub>5</sub> H <sub>4</sub> ClN	4-Chloropyridine	916.1	884.2	
C <sub>5</sub> H <sub>4</sub> FN	3-Fluoropyridine	902.0	870.1	
C <sub>5</sub> H <sub>4</sub> FN	2-Fluoropyridine	884.6	852.7	
C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	4-Nitropyridine	874.3	842.5	
C <sub>5</sub> H <sub>4</sub> N <sub>2</sub> O <sub>3</sub>	4-Nitropyridine 1-oxide	868.0	837.3	
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub>	1 <i>H</i> -Purine	920.1	888.2	
C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O	Hypoxanthine	912.3	880.5	
C <sub>5</sub> H <sub>5</sub>	Cyclopentadienyl	831.5	799.1	
C <sub>5</sub> H <sub>5</sub> N	Pyridine	930	898.1	
C <sub>5</sub> H <sub>5</sub> NO	3-Pyridinol	929.5	897.7	
C <sub>5</sub> H <sub>5</sub> NO	Pyridine-1-oxide	923.6	892.9	
C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	Adenine	942.8	912.5	
C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O	Guanine	959.5	927.6	
C <sub>5</sub> H <sub>6</sub>	1,3-Cyclopentadiene	821.6	798.4	
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	2-Pyridinamine	947.2	915.3	
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	3-Pyridinamine	954.4	922.6	
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	4-Pyridinamine	979.7	947.8	
C <sub>5</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	Thymine	880.9	850.0	
C <sub>5</sub> H <sub>6</sub> O	2-Methylfuran	865.9	833.5	
C <sub>5</sub> H <sub>6</sub> O	3-Methylfuran	854.0	821.5	
C <sub>5</sub> H <sub>6</sub> O <sub>3</sub>	Glutaric anhydride	816		Ref. 9
C <sub>5</sub> H <sub>6</sub> O <sub>3</sub>	3-Methylsuccinic anhydride	807		Ref. 9
C <sub>5</sub> H <sub>6</sub> S	2-Methylthiophene	859.0	826.5	
C <sub>5</sub> H <sub>7</sub> F <sub>3</sub> O <sub>2</sub>	Propyl trifluoroacetate	763.9	732.9	
C <sub>5</sub> H <sub>8</sub>	<i>trans</i> -1,3-Pentadiene	834.1	804.4	
C <sub>5</sub> H <sub>8</sub>	2-Methyl-1,3-butadiene	826.4	797.6	
C <sub>5</sub> H <sub>8</sub>	2-Pentyne	810.2	778.0	
C <sub>5</sub> H <sub>8</sub>	3-Methyl-1-butyne	814.9	787.8	
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	766.3	733.8	
C <sub>5</sub> H <sub>8</sub>	1-Methylcyclobutene	841.5	807.3	
C <sub>5</sub> H <sub>8</sub>	Vinylcyclopropane	816.3	787.5	
C <sub>5</sub> H <sub>8</sub>	3,3-Dimethylcyclopropene	847.8	817.1	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,3-Dimethyl-1 <i>H</i> -pyrazole	933.9	902.3	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,4-Dimethyl-1 <i>H</i> -imidazole	976.7	944.9	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,5-Dimethyl-1 <i>H</i> -pyrazole	934.3	902.8	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	3,4-Dimethyl-1 <i>H</i> -pyrazole	927.3	895.4	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	3,5-Dimethyl-1 <i>H</i> -pyrazole	933.5	900.1	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Dimethyl-1 <i>H</i> -imidazole	984.7	952.6	
C <sub>5</sub> H <sub>8</sub> N <sub>2</sub>	1,5-Dimethyl-1 <i>H</i> -imidazole	977.6	945.8	
C <sub>5</sub> H <sub>8</sub> O	<i>trans</i> -2-Pentalen	839.0	807.2	
C <sub>5</sub> H <sub>8</sub> O	3-Methyl-2-butenal	856.9	825.0	
C <sub>5</sub> H <sub>8</sub> O	3-Methyl-3-buten-2-one	843.1	811.3	
C <sub>5</sub> H <sub>8</sub> O	Cyclopropyl methyl ketone	854.9	823	
C <sub>5</sub> H <sub>8</sub> O	Cyclopentanone	823.7	794.0	
C <sub>5</sub> H <sub>8</sub> O	3,4-Dihydro-2 <i>H</i> -pyran	865.8	833.4	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	3-Methyl-2-butenic acid	822.9	791.9	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	<i>cis</i> -2-Methyl-2-butenic acid	822.5	791.5	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Cyclobutanecarboxylic acid	817.4	786.4	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl <i>trans</i> -2-butenate	851.3	820.4	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	831.4	800.5	

Molecular formula	Name	$E_{\text{pa}}$ kJ/mol	$\Delta_{\text{base}}G^\circ$ kJ/mol	Notes
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl cyclopropanecarboxylate	842.1	811.2	
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2,4-Pentanedione	873.5	836.8	
C <sub>5</sub> H <sub>9</sub> N	2-Isocyano-2-methylpropane	870.7	838.3	
C <sub>5</sub> H <sub>9</sub> N	3-(Dimethylamino)-1-propyne	940.3	909.5	
C <sub>5</sub> H <sub>9</sub> N	Pentanenitrile	802.4	771.7	
C <sub>5</sub> H <sub>9</sub> N	2,2-Dimethylpropanenitrile	810.9	780.2	
C <sub>5</sub> H <sub>9</sub> NO	3-Ethoxypropanenitrile	807.2	776.5	
C <sub>5</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethyl-2-propenamide	904.3	873.4	
C <sub>5</sub> H <sub>9</sub> NO	<i>N</i> -Methyl-2-pyrrolidone	923.5	891.6	
C <sub>5</sub> H <sub>9</sub> NO <sub>2</sub>	<i>L</i> -Proline	920.5	886.0	
C <sub>5</sub> H <sub>9</sub> NO <sub>4</sub>	<i>L</i> -Glutamic acid	913.0	879.1	
C <sub>5</sub> H <sub>9</sub> N <sub>3</sub>	Histamine	999.8	961.9	
C <sub>5</sub> H <sub>10</sub>	2-Methyl-2-butene	808.8	779.9	
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O	1,3-Dimethyl-2-imidazolidinone	918.4	886.0	
C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>3</sub>	<i>L</i> -Glutamine	937.8	900	
C <sub>5</sub> H <sub>10</sub> O	Allyl ethyl ether	833.7	804.5	
C <sub>5</sub> H <sub>10</sub> O	Pentanal	796.6	764.8	
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	832.7	800.9	
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	836.8	807	
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone	836.3	804.4	
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran	822.8	795.4	
C <sub>5</sub> H <sub>10</sub> O	2-Methyltetrahydrofuran	840.8	811.6	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Butyl formate	806.0	775	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	836.6	805.6	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Isopropyl acetate	836.6	805.6	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl butanoate	836.4	805.4	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Methyl isobutanoate	836.6	805.7	
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	<i>cis</i> -1,2-Cyclopentanediol	885.6	853.1	
C <sub>5</sub> H <sub>10</sub> S	Thiacyclohexane	855.8	826.0	
C <sub>5</sub> H <sub>11</sub> N	Allyldimethylamine	957.8	926.8	
C <sub>5</sub> H <sub>11</sub> N	Piperidine	954.0	921	
C <sub>5</sub> H <sub>11</sub> N	<i>N</i> -Methylpyrrolidine	965.6	934.8	
C <sub>5</sub> H <sub>11</sub> NO	2,2-Dimethylpropanamide	889.0	857.2	
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Valine	910.6	876.7	
C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub> S	<i>L</i> -Methionine	935.4	901.5	
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> O	Tetramethylurea	930.6	899.6	
C <sub>5</sub> H <sub>12</sub> N <sub>2</sub> S	Tetramethylthiourea	947.6	916.6	
C <sub>5</sub> H <sub>12</sub> O	2,2-Dimethyl-1-propanol	795.5	765.2	
C <sub>5</sub> H <sub>12</sub> O	Butyl methyl ether	820.3	791.2	
C <sub>5</sub> H <sub>12</sub> O	Methyl tert-butyl ether	841.6	812.4	
C <sub>5</sub> H <sub>12</sub> O	Ethyl isopropyl ether	842.7	813.5	
C <sub>5</sub> H <sub>12</sub> S	2,2-Dimethyl-1-propanethiol	809.5	778.2	
C <sub>5</sub> H <sub>12</sub> Si	Vinyltrimethylsilane	833	804.1	
C <sub>5</sub> H <sub>13</sub> N	Pentylamine	923.5	889.5	
C <sub>5</sub> H <sub>13</sub> N	2-Methyl-2-butanamine	937.8	903.6	
C <sub>5</sub> H <sub>13</sub> N	2,2-Dimethylpropylamine	928.3	894.0	
C <sub>5</sub> H <sub>13</sub> N	Ethylisopropylamine	960.0	926.7	
C <sub>5</sub> H <sub>13</sub> N	<i>N,N</i> -Dimethyl-1-propanamine	962.8	931.9	
C <sub>5</sub> H <sub>13</sub> N	Diethylmethylamine	971.0	940.0	
C <sub>5</sub> H <sub>13</sub> N <sub>3</sub>	1,1,3,3-Tetramethylguanidine	1031.6	997.4	
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	<i>N,N,N,N</i> '-Tetramethylmethanediamine	952.2	919.8	
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	<i>N,N</i> -Dimethyl-1,3-propanediamine	1025.0	975.3	
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	1,5-Pentanediamine	999.6	946.2	
C <sub>6</sub> CrO <sub>6</sub>	Chromium carbonyl	739.2	714.6	
C <sub>6</sub> F <sub>6</sub>	Hexafluorobenzene	648.0	624.4	
C <sub>6</sub> HF <sub>5</sub>	Pentafluorobenzene	690.4	662.7	
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,4-Tetrafluorobenzene	700.4	672.7	
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,3,5-Tetrafluorobenzene	747.3	719.6	
C <sub>6</sub> H <sub>2</sub> F <sub>4</sub>	1,2,4,5-Tetrafluorobenzene	746.5	718.8	
C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	1,2,3-Trifluorobenzene	724.3	696.6	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	1,2,4-Trifluorobenzene	729.5	699.4	
C <sub>6</sub> H <sub>3</sub> F <sub>3</sub>	1,3,5-Trifluorobenzene	741.9	715.4	
C <sub>6</sub> H <sub>4</sub>	Benzene	841	808.5	
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>o</i> -Difluorobenzene	731.2	703.5	
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>m</i> -Difluorobenzene	749.7	722	
C <sub>6</sub> H <sub>4</sub> F <sub>2</sub>	<i>p</i> -Difluorobenzene	718.7	692.8	
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	2-Pyridinecarbonitrile	872.9	841	
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	3-Pyridinecarbonitrile	877.0	845.1	
C <sub>6</sub> H <sub>4</sub> N <sub>2</sub>	4-Pyridinecarbonitrile	880.6	848.8	
C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	<i>p</i> -Benzoquinone	799.1	769.3	
C <sub>6</sub> H <sub>5</sub>	Phenyl	884	851.5	
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	754.1	725.8	
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	753.1	724.6	
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	755.9	726.6	
C <sub>6</sub> H <sub>5</sub> NO	Nitrosobenzene	854.3	823.6	
C <sub>6</sub> H <sub>5</sub> NO	4-Pyridinecarboxaldehyde	904.6	872.8	
C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene	800.3	769.5	
C <sub>6</sub> H <sub>5</sub> N <sub>3</sub>	Azidobenzene	820	787.5	
C <sub>6</sub> H <sub>5</sub> O	Phenoxy	873.2		Ref. 4
C <sub>6</sub> H <sub>6</sub>	Benzene	750.4	725.4	
C <sub>6</sub> H <sub>6</sub> BrN	3-Bromoaniline	873.2	841.4	
C <sub>6</sub> H <sub>6</sub> ClN	3-Chloroaniline	868.1	836.3	
C <sub>6</sub> H <sub>6</sub> ClN	4-Chloroaniline	873.8	842.0	
C <sub>6</sub> H <sub>6</sub> ClN	2-Chloro-4-methylpyridine	921.2	889.4	
C <sub>6</sub> H <sub>6</sub> ClN	2-Chloro-6-methylpyridine	908.0	876.2	
C <sub>6</sub> H <sub>6</sub> ClNO	2-Chloro-6-methoxypyridine	909.9	878.0	
C <sub>6</sub> H <sub>6</sub> FN	3-Fluoroaniline	867.3	835.5	
C <sub>6</sub> H <sub>6</sub> FN	4-Fluoroaniline	871.5	839.7	
C <sub>6</sub> H <sub>6</sub> IN	3-Iodoaniline	878.7	846.8	
C <sub>6</sub> H <sub>6</sub> N	Anilino	949.8	917.4	
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O	3-Pyridinecarboxamide	918.3	886.4	
C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	4-Nitroaniline	866.0	834.2	
C <sub>6</sub> H <sub>6</sub> N <sub>4</sub>	6-Methyl-1 <i>H</i> -purine	939.2	907.3	
C <sub>6</sub> H <sub>6</sub> O	Bis(2-propynyl) ether	783.9	756.5	
C <sub>6</sub> H <sub>6</sub> O	Phenol	817.3	786.3	
C <sub>6</sub> H <sub>7</sub> N	Bis(2-propynyl)amine	910.0	876.9	
C <sub>6</sub> H <sub>7</sub> N	Aniline	882.5	850.6	
C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	949.1	917.3	
C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine	943.4	911.6	
C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	947.2	915.3	
C <sub>6</sub> H <sub>7</sub> NO	1-Methyl-2(1 <i>H</i> )-pyridinone	925.8	894.8	
C <sub>6</sub> H <sub>7</sub> NO	2-Aminophenol	898.8	866.9	
C <sub>6</sub> H <sub>7</sub> NO	3-Aminophenol	898.8	866.9	
C <sub>6</sub> H <sub>7</sub> NO	2-Methoxypyridine	934.7	902.8	
C <sub>6</sub> H <sub>7</sub> NO	3-Methoxypyridine	942.7	910.9	
C <sub>6</sub> H <sub>7</sub> NO	4-Methoxypyridine	961.7	929.8	
C <sub>6</sub> H <sub>7</sub> NO	3-Methylpyridine-1-oxide	935.2	902.8	
C <sub>6</sub> H <sub>8</sub>	1,3-Cyclohexadiene	837	804.5	
C <sub>6</sub> H <sub>8</sub>	1,4-Cyclohexadiene	837	808.0	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Benzenediamine	896.5	865.8	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1,3-Benzenediamine	929.9	899.2	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	1,4-Benzenediamine	905.9	874.0	
C <sub>6</sub> H <sub>8</sub> N <sub>2</sub> O	Bis(2-cyanoethyl) ether	813.8	786.4	
C <sub>6</sub> H <sub>8</sub> O	2,4-Dimethylfuran	894.7	862.3	
C <sub>6</sub> H <sub>8</sub> O	2,5-Dimethylfuran	865.9	835.2	
C <sub>6</sub> H <sub>8</sub> O	3,4-Dimethylfuran	869.0	838.3	
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1,3-Cyclohexanedione	881.2	849.4	
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1,4-Cyclohexanedione	812.5	782.7	
C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>	1,2-Cyclohexanedione	849.6	818.9	
C <sub>6</sub> H <sub>8</sub> O <sub>3</sub>	4-Methylglutaric anhydride	820		Ref. 9

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>6</sub> H <sub>9</sub> F <sub>3</sub> O <sub>2</sub>	Butyl trifluoroacetate	764.8	733.8	
C <sub>6</sub> H <sub>9</sub> N	2,5-Dimethylpyrrole	918.7	887.1	
C <sub>6</sub> H <sub>9</sub> N <sub>3</sub> O <sub>2</sub>	L-Histidine	988	950.2	
C <sub>6</sub> H <sub>10</sub>	Methylenecyclopentane	832.4	803.5	
C <sub>6</sub> H <sub>10</sub>	(1-Methylvinyl)cyclopropane	871.6	842.7	
C <sub>6</sub> H <sub>10</sub>	2-Methyl-1,3-pentadiene	864.9	836	
C <sub>6</sub> H <sub>10</sub>	3-Methyl-1,3-pentadiene	852.3	823.4	
C <sub>6</sub> H <sub>10</sub>	2,3-Dimethyl-1,3-butadiene	835.0	807.8	
C <sub>6</sub> H <sub>10</sub>	1-Hexyne	799.8	774.8	
C <sub>6</sub> H <sub>10</sub>	2-Hexyne	806.1	781.1	
C <sub>6</sub> H <sub>10</sub>	Cyclohexene	784.5	752.0	
C <sub>6</sub> H <sub>10</sub>	1-Methylcyclopentene	816.5	787.1	
C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	1,3,5-Trimethyl-1H-pyrazole	949.3	917.4	
C <sub>6</sub> H <sub>10</sub> N <sub>2</sub>	3,4,5-Trimethyl-1H-pyrazole	949.3	916.0	
C <sub>6</sub> H <sub>10</sub> O	7-Oxabicyclo[2.2.1]heptane	844.2	816.8	
C <sub>6</sub> H <sub>10</sub> O	7-Oxabicyclo[4.1.0]heptane	848.1	815.6	
C <sub>6</sub> H <sub>10</sub> O	<i>trans</i> -3-Hexen-2-one	865.6	833.8	
C <sub>6</sub> H <sub>10</sub> O	Diallyl ether	827.4	800.0	
C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	841.0	811.2	
C <sub>6</sub> H <sub>10</sub> O	Mesityl oxide	878.7	846.9	
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Cyclopentanecarboxylic acid	817.4	786.4	
C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	2,5-Hexanedione	892.0	851.8	
C <sub>6</sub> H <sub>11</sub> N	<i>N</i> -Allyl-2-propen-1-amine	949.3	916.3	
C <sub>6</sub> H <sub>11</sub> NO	1-Methyl-2-piperidinone	924.4	892.6	
C <sub>6</sub> H <sub>11</sub> N <sub>3</sub> O <sub>4</sub>	<i>N</i> -( <i>N</i> -Glycylglycyl)glycine	966.8	916.8	
C <sub>6</sub> H <sub>12</sub>	1-Hexene	805.2	776.3	
C <sub>6</sub> H <sub>12</sub>	2-Methyl-2-pentene	812	783.1	
C <sub>6</sub> H <sub>12</sub>	2,3-Dimethyl-2-butene	813.9	785.9	
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	686.9	666.9	
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub>	Triethylenediamine	963.4	934.6	
C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>3</sub>	<i>N</i> -L-Alanyl-L-alanine		905.6	
C <sub>6</sub> H <sub>12</sub> O	Oxepane	834.2	806.8	
C <sub>6</sub> H <sub>12</sub> O	3-Hexanone	843.2	811.3	
C <sub>6</sub> H <sub>12</sub> O	3,3-Dimethyl-2-butanone	840.1	808.2	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>cis</i> -1,3-Cyclohexanediol	882.2	849.7	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	<i>trans</i> -1,3-Cyclohexanediol	828.6	797.9	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 2,2-dimethylpropanoate	845.2	814.2	
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Diacetone alcohol	822.9	791.1	
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	$\alpha$ -D-Glucose		778.9	
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	$\beta$ -D-Glucose		778.9	
C <sub>6</sub> H <sub>13</sub> N	<i>N,N</i> ,2-Trimethylpropenylamine	967.0	934.5	
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	934.4	899.6	
C <sub>6</sub> H <sub>13</sub> N	1-Methylpiperidine	971.1	940.1	
C <sub>6</sub> H <sub>13</sub> N	Hexahydro-1H-azepine	956.7	923.5	
C <sub>6</sub> H <sub>13</sub> NO	<i>N,N</i> -Dimethylbutanamide	921.7	890.8	
C <sub>6</sub> H <sub>13</sub> NO	<i>N,N</i> -Diethylacetamide	925.4	894.4	
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	L-Leucine	914.6	880.6	
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub>	L-Isoleucine	917.4	883.5	
C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>	L-Lysine	996	951.0	
C <sub>6</sub> H <sub>14</sub> N <sub>4</sub> O <sub>2</sub>	L-Arginine	1051.0	1006.6	
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	837.9	810.5	
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether	855.5	828.1	
C <sub>6</sub> H <sub>14</sub> O	<i>tert</i> -Butyl ethyl ether	856.0	826.9	
C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	Diethylene glycol dimethyl ether	918.8	870.9	
C <sub>6</sub> H <sub>14</sub> S	Dipropyl sulfide	864.7	834.9	
C <sub>6</sub> H <sub>14</sub> S	Diisopropyl sulfide	876.4	846.6	
C <sub>6</sub> H <sub>15</sub> N	Butyldimethylamine	969.2	938.2	
C <sub>6</sub> H <sub>15</sub> N	Isobutyldimethylamine	968.7	937.8	
C <sub>6</sub> H <sub>15</sub> N	Hexylamine	927.5	893.5	
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine	962.3	929.3	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>6</sub> H <sub>15</sub> N	Diisopropylamine	971.9	938.6	
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	981.8	951	
C <sub>6</sub> H <sub>15</sub> NO	6-Amino-1-hexanol	969.0	915.7	
C <sub>6</sub> H <sub>15</sub> OP	Triethylphosphine oxide	936.6	906.8	
C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> P	Triethyl phosphate	909.3	879.6	
C <sub>6</sub> H <sub>15</sub> P	Triethylphosphine	984.5	952.0	
C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	1,6-Hexanediamine	999.5	946.2	
C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	<i>N,N,N',N'</i> -Tetramethyl-1,2-ethanediamine	1012.8	970.6	
C <sub>6</sub> H <sub>16</sub> OSi	Triethylsilanol	822.1	794.8	
C <sub>6</sub> H <sub>18</sub> N <sub>3</sub> OP	Hexamethylphosphoric triamide	958.6	928.7	
C <sub>6</sub> H <sub>18</sub> N <sub>3</sub> P	Hexamethylphosphorous triamide	930.1	897.7	
C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	Hexamethyldisiloxane	846.4	816.2	
C <sub>6</sub> MoO <sub>6</sub>	Molybdenum hexacarbonyl	762.6	738.1	
C <sub>6</sub> O <sub>6</sub> W	Tungsten carbonyl	758.0	733.4	
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	3-Nitrobenzonitrile	781.4	750.7	
C <sub>7</sub> H <sub>4</sub> N <sub>2</sub> O <sub>2</sub>	4-Nitrobenzonitrile	775.7	745.1	
C <sub>7</sub> H <sub>5</sub> ClO	3-Chlorobenzaldehyde	813.0	781.1	
C <sub>7</sub> H <sub>5</sub> ClO	4-Chlorobenzaldehyde	831.3	799.4	
C <sub>7</sub> H <sub>5</sub> FO	3-Fluorobenzaldehyde	814.3	782.5	
C <sub>7</sub> H <sub>5</sub> FO	4-Fluorobenzaldehyde	827.1	795.3	
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile	811.5	780.9	
C <sub>7</sub> H <sub>5</sub> N	Isocyanobenzene	868.4	836.0	
C <sub>7</sub> H <sub>5</sub> NO	Benzoxazole	891.6	859.8	
C <sub>7</sub> H <sub>5</sub> NO <sub>3</sub>	4-Nitrobenzaldehyde	795.1	763.2	
C <sub>7</sub> H <sub>6</sub> ClNO	3-Chlorobenzamide	877.2	846.3	
C <sub>7</sub> H <sub>6</sub> ClNO	4-Chlorobenzamide	877.2	846.3	
C <sub>7</sub> H <sub>6</sub> F	<i>m</i> -Fluorobenzyl	836.5	804	
C <sub>7</sub> H <sub>6</sub> FNO	3-Fluorobenzamide	877.2	846.3	
C <sub>7</sub> H <sub>6</sub> FNO	4-Fluorobenzamide	877.2	846.3	
C <sub>7</sub> H <sub>6</sub> F <sub>3</sub> N	3-(Trifluoromethyl)aniline	856.9	825.1	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Benzimidazole	953.8	920.5	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Indazole	900.8	868.9	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	3-Aminobenzonitrile	842.3	810.4	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub>	1 <i>H</i> -Pyrrolo[2,3- <i>b</i> ]pyridine	940.2	908.3	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	4-Nitrobenzamide	845.3	814.4	
C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>3</sub>	3-Nitrobenzamide	854.2	823.2	
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	834.0	802.1	
C <sub>7</sub> H <sub>6</sub> O	2,4,6-Cycloheptatrien-1-one	920.8	891.0	
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Benzoic acid	821.1	790.1	
C <sub>7</sub> H <sub>7</sub>	Benzyl	831.4	800.7	
C <sub>7</sub> H <sub>7</sub> Br	2-Bromotoluene	775.3	745.8	
C <sub>7</sub> H <sub>7</sub> Br	3-Bromotoluene	782.0	752.5	
C <sub>7</sub> H <sub>7</sub> Br	4-Bromotoluene	775.3	745.8	
C <sub>7</sub> H <sub>7</sub> Cl	2-Chlorotoluene	790.5	761.1	
C <sub>7</sub> H <sub>7</sub> Cl	3-Chlorotoluene	783.9	754.5	
C <sub>7</sub> H <sub>7</sub> Cl	4-Chlorotoluene	762.9	735.2	
C <sub>7</sub> H <sub>7</sub> F	2-Fluorotoluene	773.3	743.8	
C <sub>7</sub> H <sub>7</sub> F	3-Fluorotoluene	785.4	756.0	
C <sub>7</sub> H <sub>7</sub> F	4-Fluorotoluene	763.8	736.1	
C <sub>7</sub> H <sub>7</sub> I	1-Iodo-2-methylbenzene	780.3	750.8	
C <sub>7</sub> H <sub>7</sub> N	4-Vinylpyridine	944.1	912.3	
C <sub>7</sub> H <sub>7</sub> NO	1-(3-Pyridinyl)ethanone	916.2	884.3	
C <sub>7</sub> H <sub>7</sub> NO	1-(4-Pyridinyl)ethanone	914.7	882.9	
C <sub>7</sub> H <sub>7</sub> NO	4-Aminobenzaldehyde	910.4	878.6	
C <sub>7</sub> H <sub>7</sub> NO	Benzamide	892.1	861.2	
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Methyl 3-pyridinecarboxylate	925.6	893.8	
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Methyl 4-pyridinecarboxylate	926.6	894.7	
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-2-carboxylic acid	901.5	869.0	
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	Aniline-3-carboxylic acid	864.7	832.3	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
$C_7H_7NO_2$	Aniline-4-carboxylic acid	864.7	832.3	
$C_7H_7NO_2$	4-Nitrotoluene	815.2	782.7	
$C_7H_7NO_3$	4-Nitrobenzenemethanol	810.5	778.0	
$C_7H_7N_3$	1-Methyl-1 <i>H</i> -benzotriazole	931.2	898.7	
$C_7H_7O$	2-Methylphenoxy	874.5	842	
$C_7H_8$	Toluene	784.0	756.3	
$C_7H_8$	2,5-Norbornadiene	849.3	820.3	
$C_7H_8N_2O$	4-Aminobenzamide	927.9	896.9	
$C_7H_8N_2O$	3-Aminobenzamide	900.9	869.9	
$C_7H_8N_2O_2$	<i>N</i> -Methyl-4-nitroaniline	891.6	865.1	
$C_7H_8O$	<i>o</i> -Cresol	832	800	Ref. 10
$C_7H_8O$	<i>m</i> -Cresol	841	809	Ref. 10
$C_7H_8O$	<i>p</i> -Cresol	814	782	Ref. 10
$C_7H_8O$	Benzyl alcohol	778.3	748.0	
$C_7H_8O$	Anisole	839.6	807.2	
$C_7H_8O_2$	2,6-Dimethyl-4 <i>H</i> -pyran-4-one	941.5	907.3	
$C_7H_8O_2S$	Methyl phenyl sulfone	812.7	780.3	
$C_7H_8S$	(Methylthio)benzene	872.6	843.7	
$C_7H_9N$	Benzylamine	913.3	879.4	
$C_7H_9N$	2-Methylaniline	890.9	859.1	
$C_7H_9N$	3-Methylaniline	895.8	864.0	
$C_7H_9N$	4-Methylaniline	896.7	864.8	
$C_7H_9N$	<i>N</i> -Methylaniline	916.6	890.1	
$C_7H_9N$	2-Ethylpyridine	952.4	920.6	
$C_7H_9N$	3-Ethylpyridine	947.4	915.5	
$C_7H_9N$	4-Ethylpyridine	951.1	919.2	
$C_7H_9N$	2,3-Dimethylpyridine	958.9	927.0	
$C_7H_9N$	2,4-Dimethylpyridine	962.9	930.8	
$C_7H_9N$	2,5-Dimethylpyridine	958.8	926.9	
$C_7H_9N$	2,6-Dimethylpyridine	963.0	931.1	
$C_7H_9N$	3,4-Dimethylpyridine	957.3	925.5	
$C_7H_9N$	3,5-Dimethylpyridine	955.4	923.5	
$C_7H_9NO$	2-Methoxyaniline	905.2	873.3	
$C_7H_9NO$	3-Methoxyaniline	913.0	881.1	
$C_7H_9NO$	4-Methoxyaniline	900.3	868.5	
$C_7H_{10}$	Bicyclo[2.2.1]hept-2-ene	836.5	804.0	
$C_7H_{10}N_2$	<i>N,N</i> -Dimethyl-2-pyridinamine	968.2	941.6	
$C_7H_{10}N_2$	<i>N,N</i> -Dimethyl-4-pyridinamine	997.6	971.1	
$C_7H_{10}O$	Dicyclopropyl ketone	880.4	850.6	
$C_7H_{10}O$	Bicyclo[2.2.1]heptan-2-one	847.4	815.5	
$C_7H_{11}N$	Cyclohexanecarbonitrile	815.0	784.4	
$C_7H_{12}$	2,4-Dimethyl-1,3-pentadiene	886.5	857.6	
$C_7H_{12}$	1-Methylcyclohexene	825.1	792.6	
$C_7H_{12}$	1,2-Dimethylcyclopentene	822.6	791.9	
$C_7H_{12}N_2$	2,3,4,6,7,8-Hexahydropyrrolo[1,2- <i>a</i> ]pyrimidine	1038.3	1005.9	
$C_7H_{12}O$	Cycloheptanone	845.6	815.9	
$C_7H_{12}O$	4-Methylcyclohexanone	844.9	813.0	
$C_7H_{12}O_2$	Cyclohexanecarboxylic acid	823.8	792.8	
$C_7H_{13}N$	1-Azabicyclo[2.2.2]octane	983.3	952.5	
$C_7H_{14}$	2,4-Dimethyl-2-pentene	812	783.1	
$C_7H_{14}O$	Methoxycyclohexane	840.5	811.3	
$C_7H_{14}O$	4-Heptanone	845.0	815.3	
$C_7H_{14}O$	2,4-Dimethyl-3-pentanone	850.3	820.5	
$C_7H_{14}O$	Cyclohexanemethanol	802.1	771.7	
$C_7H_{15}N$	Cyclohexanemethanamine	926.6	895.8	
$C_7H_{16}O$	<i>tert</i> -Butyl isopropyl ether	870.7	841.5	
$C_7H_{17}N$	Heptylamine	923.2	889.3	
$C_7H_{17}N$	Methyldipropylamine	983.5	950.9	
$C_7H_{17}N$	Diethylpropylamine	978.8	947.9	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
$C_7H_{18}N_2$	1,7-Heptanediamine	998.5	944.9	
$C_7H_{18}N_2$	<i>N,N,N',N'</i> -Tetramethyl-1,3-propanediamine	1035.2	985.4	
$C_8H_4F_3N$	3-(Trifluoromethyl)benzotrile	791.4	760.8	
$C_8H_4F_3N$	4-(Trifluoromethyl)benzotrile	787.2	758.3	
$C_8H_4N_2$	<i>m</i> -Dicyanobenzene	779.3	750.4	
$C_8H_4N_2$	<i>p</i> -Dicyanobenzene	779.0	751.8	
$C_8H_5Cl$	1-Chloro-4-ethynylbenzene	832.4	801.7	
$C_8H_5Cl_3O$	2,2,2-Trichloro-1-phenylethanone	818.9	787.0	
$C_8H_5F_3O$	2,2,2-Trifluoro-1-phenylethanone	799.2	767.4	
$C_8H_5F_3O$	4-(Trifluoromethyl)benzaldehyde	805.6	773.8	
$C_8H_5NO$	4-Formylbenzotrile	796.9	766.3	
$C_8H_6$	Phenylacetylene	832.0	801.3	
$C_8H_6ClN$	4-(Chloromethyl)benzotrile	812.8	782.1	
$C_8H_6ClN$	3-(Chloromethyl)benzotrile	811.2	780.6	
$C_8H_6N_2$	Quinoxaline	903.8	873.7	
$C_8H_6N_2$	Cinnoline	936.3	904.4	
$C_8H_7Br$	1-Bromo-4-vinylbenzene	838.7	809.8	
$C_8H_7Br$	1-Bromo-3-vinylbenzene	822.4	793.5	
$C_8H_7ClO$	1-(3-Chlorophenyl)ethanone	846.9	815.1	
$C_8H_7ClO$	1-(4-Chlorophenyl)ethanone	856.6	824.8	
$C_8H_7ClO_2$	Methyl 4-chlorobenzoate	842.1	811.1	
$C_8H_7ClO_2$	Methyl 3-chlorobenzoate	835.4	804.4	
$C_8H_7FO$	1-(4-Fluorophenyl)ethanone	858.6	826.8	
$C_8H_7N$	Benzeneacetotrile	805.5	774.8	
$C_8H_7N$	1 <i>H</i> -Indole	933.4	901.9	
$C_8H_7NO_3$	1-(4-Nitrophenyl)ethanone	824.3	792.5	
$C_8H_7NO_3$	1-(3-Nitrophenyl)ethanone	826.0	794.1	
$C_8H_7NO_4$	Methyl 3-nitrobenzoate	815.7	784.7	
$C_8H_7NO_4$	Methyl 4-nitrobenzoate	813.2	782.3	
$C_8H_8$	Styrene	839.5	809.2	
$C_8H_8N_2$	1-Methyl-1 <i>H</i> -benzimidazole	967.0	935.2	
$C_8H_8N_2$	2-Methyl-2 <i>H</i> -indazole	941.4	909.6	
$C_8H_8N_2$	1-Methyl-1 <i>H</i> -indazole	922.4	890.5	
$C_8H_8O$	3-Methylbenzaldehyde	840.0	808.1	
$C_8H_8O$	4-Methylbenzaldehyde	851.8	820.0	
$C_8H_8O$	Acetophenone	861.1	829.3	
$C_8H_8O_2$	<i>o</i> -Toluic acid	838.8	807.8	
$C_8H_8O_2$	<i>m</i> -Toluic acid	829.8	798.8	
$C_8H_8O_2$	<i>p</i> -Toluic acid	836.7	805.7	
$C_8H_8O_2$	Methyl benzoate	850.5	819.5	
$C_8H_8O_2$	3-Methoxybenzaldehyde	844.1	812.2	
$C_8H_8O_2$	4-Methoxybenzaldehyde	881.1	849.3	
$C_8H_8O_2$	1-(3-Hydroxyphenyl)ethanone	863.6	831.8	
$C_8H_8O_2$	1-(4-Hydroxyphenyl)ethanone	883.7	851.9	
$C_8H_8O_3$	Methyl 4-hydroxybenzoate	863.4	832.5	
$C_8H_8O_3$	Methyl 3-hydroxybenzoate	850.0	819.1	
$C_8H_9N$	2,3-Dihydro-1 <i>H</i> -indole	957.1	926.3	
$C_8H_9NO$	3-Methylbenzamide	900.9	869.9	
$C_8H_9NO$	4-Methylbenzamide	900.9	869.9	
$C_8H_9NO$	1-(4-Aminophenyl)ethanone	908.8	877.0	
$C_8H_9NO_2$	3-Methoxybenzamide	900.9	869.9	
$C_8H_9NO_2$	2,4-Dimethyl-1-nitrobenzene	831.0	798.5	
$C_8H_9NO_2$	Methyl 4-aminobenzoate	883.9	853.0	
$C_8H_9NO_2$	4-Methoxybenzamide	900.3	869.4	
$C_8H_{10}$	Ethylbenzene	788.0	760.3	
$C_8H_{10}$	<i>o</i> -Xylene	796.0	768.3	
$C_8H_{10}$	<i>m</i> -Xylene	812.1	786.2	
$C_8H_{10}$	<i>p</i> -Xylene	794.4	766.8	
$C_8H_{10}ClN$	4-Chloro- <i>N,N</i> -dimethylaniline	922.9	896.4	



Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
$C_8H_{10}N_2O_2$	<i>N,N</i> -Dimethyl-4-nitroaniline	896.7	870.2	
$C_8H_{10}N_2O_2$	<i>N,N</i> -Dimethyl-3-nitroaniline	894.1	867.6	
$C_8H_{10}O$	Benzyl methyl ether	816.7	787.5	
$C_8H_{10}O$	2-Methylanisole	850	818	Ref. 10
$C_8H_{10}O$	3-Methylanisole	860	828	Ref. 10
$C_8H_{10}O$	4-Methylanisole	841	809	Ref. 10
$C_8H_{11}N$	4-Isopropylpyridine	955.7	923.8	
$C_8H_{11}N$	3-Ethylaniline	897.9	866.1	
$C_8H_{11}N$	<i>N</i> -Ethylaniline	924.8	892.9	
$C_8H_{11}N$	<i>N,N</i> -Dimethylaniline	941.1	909.2	
$C_8H_{11}N$	2,6-Dimethylaniline	901.7	869.8	
$C_8H_{11}N$	Benzeneethanamine	936.2	902.3	
$C_8H_{11}N$	2-Propylpyridine	955.7	923.8	
$C_8H_{12}$	2-Methyl-2-norbornene	845	812.5	
$C_8H_{12}N_2$	<i>N,N</i> -Dimethyl-1,4-benzenediamine	955.0	928.4	
$C_8H_{12}N_2O_2$	Ethyl 1,5-dimethyl-1 <i>H</i> -pyrazole-3-carboxylate	933.4	901.5	
$C_8H_{14}O$	Cyclooctanone	849.4	819.6	
$C_8H_{14}O$	1-Cyclohexylethanone	841.4	809.5	
$C_8H_{14}O_2$	Methyl cyclohexanecarboxylate	846.2	815.3	
$C_8H_{16}O$	2,2,4-Trimethyl-3-pentanone	856.9	825.0	
$C_8H_{17}N$	Cyclohexyldimethylamine	983.6	952.6	
$C_8H_{18}O$	Dibutyl ether	845.7	818.3	
$C_8H_{18}O$	Di- <i>sec</i> -butyl ether	865.9	838.5	
$C_8H_{18}O$	Di- <i>tert</i> -butyl ether	887.4	860.0	
$C_8H_{18}O_4$	Triethylene glycol dimethyl ether	946.6	892.4	
$C_8H_{18}O_5$	Tetraethylene glycol		>910	
$C_8H_{18}S$	Dibutyl sulfide	871.8	842.1	
$C_8H_{18}S$	Di- <i>tert</i> -butyl sulfide	893.8	864.0	
$C_8H_{19}N$	<i>N</i> -Ethyl- <i>N</i> -isopropyl-2-propanamine	994.3	963.5	
$C_8H_{19}N$	Octylamine	928.9	895.0	
$C_8H_{19}N$	Dibutylamine	968.5	935.3	
$C_8H_{19}N$	Di- <i>sec</i> -butylamine	980.7	947.5	
$C_8H_{19}N$	Diisobutylamine	958.1	925.1	
$C_8H_{20}N_2$	<i>N,N,N',N'</i> -Tetramethyl-1,4-butanediamine	1046.3	992.7	
$C_8H_{20}N_2$	Tetraethylhydrazine	964.3	935.3	
$C_9H_7MnO_3$	Manganese 2-methylcyclopentadienyl tricarbonyl	833.8	801.3	
$C_9H_7N$	Quinoline	953.2	921.4	
$C_9H_7N$	Isoquinoline	951.7	919.9	
$C_9H_7NO$	4-Acetylbenzotrile	826.8	795.0	
$C_9H_8$	Indene	848.8	819.6	
$C_9H_8O$	2-Methylbenzofuran	859.6	827.2	
$C_9H_8O_3$	Methyl 4-formylbenzoate	832.9	801.9	
$C_9H_9Cl$	1-Chloro-4-isopropenylbenzene	854.3	825.4	
$C_9H_9ClO_2$	3-Chloro-4-methoxyacetophenone	883.7	851.9	
$C_9H_{10}$	2-Methylstyrene	855.2	826.3	
$C_9H_{10}$	3-Methylstyrene	849.4	820.5	
$C_9H_{10}$	4-Methylstyrene	861.7	832.8	
$C_9H_{10}$	<i>cis</i> -1-Propenylbenzene	836.4	807.5	
$C_9H_{10}$	<i>trans</i> -1-Propenylbenzene	834.2	805.3	
$C_9H_{10}$	Isopropenylbenzene	864.2	835.3	
$C_9H_{10}$	Cyclopropylbenzene	834.9	802.4	
$C_9H_{10}N_2$	4-(Dimethylamino)benzotrile	889.1	862.6	
$C_9H_{10}O$	1-(3-Methylphenyl)ethanone	868.2	836.4	
$C_9H_{10}O$	1-Phenyl-1-propanone	867.4	835.6	
$C_9H_{10}O$	1-Phenyl-2-propanone	842.6	810.8	
$C_9H_{10}O$	4-Methylacetophenone	875.5	843.6	
$C_9H_{10}OS$	4-Acetylthioanisole	888.2	856.3	
$C_9H_{10}O_2$	Methyl 2-methylbenzoate	858.3	827.3	



Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Methyl 3-methylbenzoate	857.7	826.8	
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	1-(3-Methoxyphenyl)ethanone	871.2	839.3	
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Methyl 4-methylbenzoate	861.5	830.6	
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	4-Acetylanisole	895.6	863.7	
C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	Methyl 4-methoxybenzoate	870.6	839.6	
C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	Methyl 3-methoxybenzoate	856.7	825.8	
C <sub>9</sub> H <sub>11</sub> N	5,6,7,8-Tetrahydroquinoline	966.0	934.1	
C <sub>9</sub> H <sub>11</sub> N	5,6,7,8-Tetrahydroisoquinoline	966.6	934.7	
C <sub>9</sub> H <sub>11</sub> NO	4-(Dimethylamino)benzaldehyde	924.8	898.3	
C <sub>9</sub> H <sub>11</sub> NO	<i>N,N</i> -Dimethylbenzamide	932.7	901.8	
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	1,3,5-Trimethyl-2-nitrobenzene	823.8	793.1	
C <sub>9</sub> H <sub>11</sub> NO <sub>2</sub>	<i>L</i> -Phenylalanine	922.9	888.9	
C <sub>9</sub> H <sub>11</sub> NO <sub>3</sub>	<i>L</i> -Tyrosine	926	892.1	
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	790.1	762.4	
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	791.6	763.9	
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	836.2	808.6	
C <sub>9</sub> H <sub>12</sub> N <sub>2</sub>	3-(2-Pyrrolidinyl)pyridine, (S)-	964.0	931.0	
C <sub>9</sub> H <sub>12</sub> N <sub>2</sub> O <sub>6</sub>	Uridine	947.6	916.6	
C <sub>9</sub> H <sub>12</sub> O <sub>3</sub>	1,3,5-Trimethoxybenzene	926.7	898.2	
C <sub>9</sub> H <sub>13</sub> N	<i>N</i> -Ethyl- <i>N</i> -methylaniline	939.0	912.4	
C <sub>9</sub> H <sub>13</sub> N	2,6-Diethylpyridine	972.3	940.4	
C <sub>9</sub> H <sub>13</sub> N	4- <i>tert</i> -Butylpyridine	957.7	925.8	
C <sub>9</sub> H <sub>13</sub> N	2- <i>tert</i> -Butylpyridine	961.7	929.8	
C <sub>9</sub> H <sub>13</sub> N	2-Methyl- <i>N,N</i> -dimethylaniline	951.8	925.3	
C <sub>9</sub> H <sub>13</sub> N	3-Methyl- <i>N,N</i> -dimethylaniline	942.1	915.7	
C <sub>9</sub> H <sub>13</sub> N	4-Methyl- <i>N,N</i> -dimethylaniline	950.0	918.1	
C <sub>9</sub> H <sub>13</sub> N	<i>N,N</i> -Dimethylbenzylamine	968.4	937.4	
C <sub>9</sub> H <sub>13</sub> NO	4-Methoxy- <i>N,N</i> -dimethylaniline	949.1	922.4	
C <sub>9</sub> H <sub>13</sub> N <sub>3</sub> O <sub>5</sub>	Cytidine	982.5	950.0	
C <sub>9</sub> H <sub>14</sub> O	Isophorone	893.5	861.6	
C <sub>9</sub> H <sub>15</sub> N	<i>N,N</i> -Diallyl-2-propen-1-amine	972.3	941.3	
C <sub>9</sub> H <sub>15</sub> N	<i>N</i> -(1-Cyclopenten-1-yl)pyrrolidine	1019.2	988.4	
C <sub>9</sub> H <sub>16</sub> O	Cyclononane	852.6	822.8	
C <sub>9</sub> H <sub>17</sub> N <sub>3</sub> O <sub>4</sub>	<i>N</i> -( <i>N</i> - <i>L</i> -Alanyl- <i>L</i> -alanyl)- <i>L</i> -alanine		924.1	
C <sub>9</sub> H <sub>18</sub> O	5-Nonanone	853.7	821.9	
C <sub>9</sub> H <sub>18</sub> O	Di- <i>tert</i> -butyl ketone	861.3	831.5	
C <sub>9</sub> H <sub>19</sub> N	1-Isobutylpiperidine	974.5	943.5	
C <sub>9</sub> H <sub>19</sub> N	2,2,6,6-Tetramethylpiperidine	987.0	953.9	
C <sub>9</sub> H <sub>21</sub> N	Tripropylamine	991.0	960.1	
C <sub>10</sub> H <sub>8</sub>	Naphthalene	802.9	779.4	
C <sub>10</sub> H <sub>8</sub>	Azulene	925.2	896	
C <sub>10</sub> H <sub>8</sub> N <sub>2</sub>	2,2'-Bipyridine	965		Ref. 7
C <sub>10</sub> H <sub>9</sub> N	1-Naphthylamine	907.0	875.1	
C <sub>10</sub> H <sub>10</sub> Fe	Ferrocene	863.6	841.3	
C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	1,8-Naphthalenediamine	944.5	912.1	
C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	1-Methyl-3-phenyl-1 <i>H</i> -pyrazole	932.6	900.8	
C <sub>10</sub> H <sub>10</sub> N <sub>2</sub>	1-Methyl-5-phenyl-1 <i>H</i> -pyrazole	932.4	900.5	
C <sub>10</sub> H <sub>10</sub> Ni	Nickelocene	935.7	907.3	
C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	1,4-Diacetylbenzene	850.8	821.0	
C <sub>10</sub> H <sub>10</sub> O <sub>2</sub>	1,3-Diacetylbenzene	852.0	822.3	
C <sub>10</sub> H <sub>10</sub> O <sub>3</sub>	4-Acetylphenyl acetate	853.2	821.3	
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl isophthalate	843.5	814.3	
C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	Dimethyl terephthalate	843.2	812.3	
C <sub>10</sub> H <sub>10</sub> Ru	Ruthenocene	899.1	876.8	
C <sub>10</sub> H <sub>12</sub>	1-Methyl-3-(1-methylvinyl)benzene	867.6	838.7	
C <sub>10</sub> H <sub>12</sub>	1-Methyl-4-(1-methylvinyl)benzene	881.8	852.9	
C <sub>10</sub> H <sub>12</sub>	1-Methyl-2-(1-methylvinyl)benzene	857.8	828.9	
C <sub>10</sub> H <sub>12</sub>	1,2,3,4-Tetrahydronaphthalene	809.7	782.1	
C <sub>10</sub> H <sub>12</sub> O	1-(2,4-Dimethylphenyl)ethanone	882.6	850.8	
C <sub>10</sub> H <sub>12</sub> O	1-(2,5-Dimethylphenyl)ethanone	873.5	841.6	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>10</sub> H <sub>12</sub> O	1-(3,4-Dimethylphenyl)ethanone	882.8	851.0	
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 2,5-dimethylbenzoate	864.7	833.7	
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 2,4-dimethylbenzoate	868.2	837.2	
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Methyl 3,5-dimethylbenzoate	864.3	833.4	
C <sub>10</sub> H <sub>13</sub> N	1-Phenylpyrrolidine	941.6	915.1	
C <sub>10</sub> H <sub>13</sub> NO	4'-(Dimethylamino)acetophenone	932.8	906.3	
C <sub>10</sub> H <sub>13</sub> NO	<i>N,N</i> ,3-Trimethylbenzamide	927.0	896.0	
C <sub>10</sub> H <sub>13</sub> NO	<i>N,N</i> ,4-Trimethylbenzamide	927.0	896.0	
C <sub>10</sub> H <sub>13</sub> NO	1-[3-(Dimethylamino)phenyl]ethanone	928.0	901.5	
C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>3</sub>	2'-Deoxyadenosine	991.5	959.1	
C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>4</sub>	Adenosine	989.3	956.8	
C <sub>10</sub> H <sub>13</sub> N <sub>5</sub> O <sub>5</sub>	Guanosine	993.4	960.9	
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	791.9	764.2	
C <sub>10</sub> H <sub>14</sub>	1,2,3,5-Tetramethylbenzene	845.6	816.5	
C <sub>10</sub> H <sub>14</sub> ClN	4-Chloro- <i>N,N</i> -diethylaniline	931.0	899.2	
C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	<i>L</i> -Nicotine	963.4	932.6	
C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O	<i>N,N</i> -Diethyl-3-pyridinecarboxamide	940.9	909.0	
C <sub>10</sub> H <sub>14</sub> N <sub>2</sub> O <sub>5</sub>	Thymidine	948.3	915.9	
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> ,2,6-Tetramethylaniline	954.1	923.2	
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> ,3,5-Tetramethylaniline	956.1	924.3	
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> -Diethylaniline	959.8	927.9	
C <sub>10</sub> H <sub>16</sub> N <sub>2</sub>	<i>N,N,N',N'</i> -Tetramethyl-1,2-benzenediamine	982.6	950.2	
C <sub>10</sub> H <sub>17</sub> N	Tricyclo[3.3.1.1 <sup>3,7</sup> ]decan-1-amine	948.8	916.3	
C <sub>10</sub> H <sub>22</sub> O	Dipentyl ether	852.7	825.3	
C <sub>10</sub> H <sub>22</sub> O <sub>5</sub>	Tetraethylene glycol dimethyl ether	953.8	897.8	
C <sub>10</sub> H <sub>23</sub> N	Decylamine	930.4	896.5	
C <sub>10</sub> H <sub>24</sub> N <sub>2</sub>	<i>N,N,N',N'</i> -Tetramethyl-1,6-hexanediamine	1035.8	982.2	
C <sub>11</sub> H <sub>9</sub> N	4-Phenylpyridine	939.7	907.8	
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	834.8	805.3	
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	831.9	802.4	
C <sub>11</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	<i>L</i> -Tryptophan	948.9	915	
C <sub>11</sub> H <sub>14</sub> O <sub>2</sub>	Methyl 2,4,6-trimethylbenzoate	866.3	835.3	
C <sub>11</sub> H <sub>15</sub> N	1-Phenylpiperidine	952.9	926.4	
C <sub>11</sub> H <sub>15</sub> N	Tricyclo[3.3.1.1 <sup>3,7</sup> ]decane-1-carbonitrile	834.4	803.8	
C <sub>11</sub> H <sub>16</sub>	Pentamethylbenzene	850.7	823.5	
C <sub>11</sub> H <sub>17</sub> N	<i>N,N</i> -Diethyl-4-methylaniline	962.8	931.0	
C <sub>11</sub> H <sub>17</sub> N	2-Hexylpyridine	963.6	931.7	
C <sub>11</sub> H <sub>18</sub> O	1,4,7,7-Tetramethylbicyclo[2.2.1]heptan-2-one	863.3	831.4	
C <sub>11</sub> H <sub>24</sub> O <sub>4</sub>	2,6,10,14-Tetraoxapentadecane		895.1	
C <sub>12</sub> H <sub>8</sub> N <sub>2</sub>	Phenazine	938.4	908.3	
C <sub>12</sub> H <sub>9</sub> NO	Phenyl-3-pyridinylmethanone	934.1	902.3	
C <sub>12</sub> H <sub>10</sub>	Acenaphthene	851.7	821.0	
C <sub>12</sub> H <sub>10</sub>	Biphenyl	813.6	782.9	
C <sub>12</sub> H <sub>16</sub> O	1-(4- <i>tert</i> -Butylphenyl)ethanone	882.5	850.6	
C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	860.6	836.0	
C <sub>12</sub> H <sub>18</sub> O	1-Tricyclo[3.3.1.1 <sup>3,7</sup> ]dec-1-ylethanone	864.9	833.1	
C <sub>12</sub> H <sub>19</sub> N	<i>N,N</i> -Dipropylaniline	963.0	931.1	
C <sub>12</sub> H <sub>20</sub> O	2,5-Di- <i>tert</i> -butylfuran	894.7	863.9	
C <sub>12</sub> H <sub>27</sub> N	Tributylamine	998.5	967.6	
C <sub>13</sub> H <sub>9</sub> N	Acridine	972.6	940.7	
C <sub>13</sub> H <sub>10</sub>	9 <i>H</i> -Fluorene	831.5	803.8	
C <sub>13</sub> H <sub>10</sub> O	Benzophenone	882.3	852.5	
C <sub>13</sub> H <sub>12</sub>	2-Methylbiphenyl	815.9	783.4	
C <sub>13</sub> H <sub>12</sub>	3-Methylbiphenyl	828.0	795.5	
C <sub>13</sub> H <sub>12</sub>	4-Methylbiphenyl	817.9	785.4	
C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	802.0	769.5	
C <sub>13</sub> H <sub>13</sub> P	Methyldiphenylphosphine	972.1	939.7	

Molecular formula	Name	$E_{pa}$ kJ/mol	$\Delta_{base}G^\circ$ kJ/mol	Notes
C <sub>13</sub> H <sub>21</sub> N	2,4-Di- <i>tert</i> -butylpyridine	983.8	952.0	
C <sub>13</sub> H <sub>21</sub> N	2,6-Di- <i>tert</i> -butylpyridine	982.9	951	
C <sub>13</sub> H <sub>21</sub> NO	<i>N,N</i> -Dimethyltricyclo[3.3.1.1 <sup>3,7</sup> ]decane-1-carboxamide	949.4	917.6	
C <sub>14</sub> H <sub>10</sub>	Anthracene	877.3	846.6	
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	825.7	795.0	
C <sub>14</sub> H <sub>12</sub>	1,1-Diphenylethene	885.7	856.9	
C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	801.8	774.1	
C <sub>14</sub> H <sub>18</sub>	1,2,3,4,5,6,7,8-Octahydroanthracene	845.4	814.7	
C <sub>14</sub> H <sub>18</sub>	1,2,3,4,5,6,7,8-Octahydrophenanthrene	846.2	815.5	
C <sub>14</sub> H <sub>23</sub> N	4-Octylaniline	894.5	862	
C <sub>15</sub> H <sub>12</sub>	2-Methylanthracene	887.5	855.1	
C <sub>15</sub> H <sub>12</sub>	9-Methylanthracene	896.5	865.8	
C <sub>15</sub> H <sub>12</sub> N <sub>2</sub>	3,5-Diphenyl-1 <i>H</i> -pyrazole	946.3	912.7	
C <sub>15</sub> H <sub>16</sub>	1,3-Diphenylpropane	820.1	787.6	
C <sub>15</sub> H <sub>18</sub>	1,4-Dimethyl-7-isopropylazulene	983.1	950.6	
C <sub>15</sub> H <sub>24</sub>	1,3-Di- <i>tert</i> -butyl-5-methylbenzene	853.7	826.0	
C <sub>16</sub> H <sub>10</sub>	Fluoranthene	828.6	800.9	
C <sub>16</sub> H <sub>10</sub>	Pyrene	869.2	840.1	
C <sub>16</sub> H <sub>18</sub>	1,4-Diphenylbutane	822.0	779.8	
C <sub>17</sub> H <sub>20</sub>	1,5-Diphenylpentane	824.7	782.4	
C <sub>18</sub> H <sub>12</sub>	Chrysene	840.9	810.1	
C <sub>18</sub> H <sub>12</sub>	Naphthacene	905.5	876.5	
C <sub>18</sub> H <sub>12</sub>	Triphenylene	819.2	791.2	
C <sub>18</sub> H <sub>15</sub> As	Triphenylarsine	908.9	876.4	
C <sub>18</sub> H <sub>15</sub> AsO	Triphenylarsine oxide	906.2	876.4	
C <sub>18</sub> H <sub>15</sub> N	Triphenylamine	908.9	876.4	
C <sub>18</sub> H <sub>15</sub> OP	Triphenylphosphine oxide	906.2	876.4	
C <sub>18</sub> H <sub>15</sub> P	Triphenylphosphine	972.8	940.4	
C <sub>18</sub> H <sub>15</sub> PS	Triphenylphosphine sulfide	906.2	876.4	
C <sub>18</sub> H <sub>15</sub> Sb	Triphenylstibine	845.5	813.1	
C <sub>18</sub> H <sub>22</sub>	1,6-Diphenylhexane	826.1	783.8	
C <sub>18</sub> H <sub>30</sub>	1,3,5-Tri- <i>tert</i> -butylbenzene	848.8	822.3	
C <sub>20</sub> H <sub>12</sub>	Perylene	888.6	859.6	
C <sub>22</sub> H <sub>12</sub>	Benzo[ghi]perylene	876.0	845.2	
C <sub>22</sub> H <sub>14</sub>	Picene	851.3	820.6	
C <sub>24</sub> H <sub>12</sub>	Coronene	861.3	835.0	
C <sub>60</sub>	Carbon (fullerene-C <sub>60</sub> )		827.5	
C <sub>70</sub>	Carbon (fullerene-C <sub>70</sub> )		827.5	

## INDEX OF REFRACTION OF GASES

This table gives the index of refraction of several gases at selected wavelengths ranging from the blue to the red region of the spectrum. The entries at 0.5893  $\mu\text{m}$  correspond to the prominent sodium D line in the yellow region. All values refer to gas at a pressure of one atmosphere (101.325 kPa) and at a temperature of 0°C.

### References

1. Gray, D. E., ed., *American Institute of Physics Handbook, 3rd Edition*, p. 6-110, McGraw-Hill, New York, 1972.
2. Forsythe, W. E., *Smithsonian Physical Tables, Ninth Edition*, p. 533, Smithsonian Institution, Washington, 1954.
3. *Kaye and Laby Tables of Physical and Chemical Constants, Sixteenth Edition*, p. 131, Longman Group Ltd., Harlow, Essex, 1995.

Gas	Wavelength						
	0.4360 $\mu\text{m}$	0.4861 $\mu\text{m}$	0.5461 $\mu\text{m}$	0.5790 $\mu\text{m}$	0.5893 $\mu\text{m}$	0.6563 $\mu\text{m}$	0.6709 $\mu\text{m}$
Air	1.0002966	1.0002947	1.0002932	1.0002926	1.0002924	1.0002915	1.0002913
Ar					1.000281		
CH <sub>4</sub>					1.000444		
Cl <sub>2</sub>					1.000773		
CO <sub>2</sub>	1.0004563		1.0004506		1.0004493		1.0004471
H <sub>2</sub>	1.0001418	1.0001406	1.0001397	1.0001393	1.0001392	1.0001387	1.0001385
He					1.000036		
N <sub>2</sub>		1.0003012	1.0002998		1.0002990	1.0002982	
N <sub>2</sub> O					1.000516		
NO					1.000297		
O <sub>2</sub>	1.0002743	1.0002734	1.0002717	1.0002710	1.0002709	1.0002698	1.0002683
SO <sub>2</sub>					1.000686		

## SUMMARY TABLES OF PARTICLE PROPERTIES

Extracted from the Particle Listings of the  
*Review of Particle Physics*  
W.-M. Yao et al., *J. Phys. G* **33**, 1 (2006)  
Available at <http://pdg.lbl.gov>

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(Approximate closing date for data: January 1, 2006)

## GAUGE AND HIGGS BOSONS

$\gamma$   $I(J^{PC}) = 0, 1(1^{--})$

Mass  $m < 6 \times 10^{-17}$  eV  
Charge  $q < 5 \times 10^{-30}$  e  
Mean life  $\tau =$  Stable

$g$   
or gluon  $I(J^P) = 0(1^-)$

Mass  $m = 0^{[a]}$   
SU(3) color octet

$W$   $J = 1$

Charge =  $\pm 1e$   
Mass  $m = 80.403 \pm 0.029$  GeV  
 $m_Z - m_W = 10.785 \pm 0.029$  GeV  
 $m_{W^+} - m_{W^-} = -0.2 \pm 0.6$  GeV  
Full width  $\Gamma = 2.141 \pm 0.041$  GeV  
 $\langle N_{\pi^\pm} \rangle = 15.70 \pm 0.35$   
 $\langle N_{K^\pm} \rangle = 2.20 \pm 0.19$   
 $\langle N_p \rangle = 0.92 \pm 0.14$   
 $\langle N_{\text{charged}} \rangle = 19.41 \pm 0.15$   
 $W^-$  modes are charge conjugates of the modes below.

$W^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\ell^+ \nu$	[b] (10.80 $\pm$ 0.09) %		–
$e^+ \nu$	(10.75 $\pm$ 0.13) %		40201
$\mu^+ \nu$	(10.57 $\pm$ 0.15) %		40201
$\tau^+ \nu$	(11.25 $\pm$ 0.20) %		40182
hadrons	(67.60 $\pm$ 0.27) %		–
$\pi^+ \gamma$	$< 8 \times 10^{-5}$	95%	40201
$D_s^+ \gamma$	$< 1.3 \times 10^{-3}$	95%	40177
$c\bar{X}$	(33.4 $\pm$ 2.6) %		–
$c\bar{s}$	(31 $^\pm$ ) %		–
invisible	[c] (1.4 $\pm$ 2.8) %		–

$Z$   $J = 1$

Charge = 0  
Mass  $m = 91.1876 \pm 0.0021$  GeV<sup>[d]</sup>  
Full width  $\Gamma = 2.4952 \pm 0.0023$  GeV  
 $\Gamma(\ell^+ \ell^-) = 83.984 \pm 0.086$  MeV<sup>[b]</sup>  
 $\Gamma(\text{invisible}) = 499.0 \pm 1.5$  MeV<sup>[e]</sup>  
 $\Gamma(\text{hadrons}) = 1744.4 \pm 2.0$  MeV  
 $\Gamma(\mu^+ \mu^-)/\Gamma(e^+ e^-) = 1.0009 \pm 0.0028$   
 $\Gamma(\tau^+ \tau^-)/\Gamma(e^+ e^-) = 1.0019 \pm 0.0032$ <sup>[f]</sup>

#### Average charged multiplicity

$\langle N_{\text{charged}} \rangle = 20.76 \pm 0.16$  ( $S = 2.1$ )

#### Couplings to leptons

$g_V^\ell = -0.03783 \pm 0.00041$   
 $g_A^\ell = -0.50123 \pm 0.00026$   
 $g^{V_e} = 0.53 \pm 0.09$   
 $g^{V_\mu} = 0.502 \pm 0.017$

#### Asymmetry parameters<sup>[g]</sup>

$A_e = 0.1515 \pm 0.0019$   
 $A_\mu = 0.142 \pm 0.015$   
 $A_\tau = 0.143 \pm 0.004$   
 $A_s = 0.90 \pm 0.09$   
 $A_c = 0.670 \pm 0.027$   
 $A_b = 0.923 \pm 0.020$

#### Charge asymmetry (%) at Z pole

$A_{FB}^{(0\ell)} = 1.71 \pm 0.10$   
 $A_{FB}^{(0u)} = 4 \pm 7$   
 $A_{FB}^{(0s)} = 9.8 \pm 1.1$   
 $A_{FB}^{(0c)} = 7.07 \pm 0.35$   
 $A_{FB}^{(0b)} = 9.92 \pm 0.16$

Z DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$e^+ e^-$	(3.363 $\pm$ 0.004) %		45594
$\mu^+ \mu^-$	(3.366 $\pm$ 0.007) %		45594
$\tau^+ \tau^-$	(3.370 $\pm$ 0.008) %		45559
$\ell^+ \ell^-$	[b] (3.3658 $\pm$ 0.0023) %		–
invisible	(20.00 $\pm$ 0.06) %		–
hadrons	(69.91 $\pm$ 0.06) %		–
$(u\bar{u} + c\bar{c})/2$	(11.6 $\pm$ 0.6) %		–
$(d\bar{d} + s\bar{s} + b\bar{b})/3$	(15.6 $\pm$ 0.4) %		–
$c\bar{c}$	(12.03 $\pm$ 0.21) %		–
$b\bar{b}$	(15.12 $\pm$ 0.05) %		–
$b\bar{b}b\bar{b}$	(3.6 $\pm$ 1.3) $\times 10^{-4}$		–

$ggg$	< 1.1	%	CL = 95%	–
$\pi^0\gamma$	< 5.2	$\times 10^{-5}$	CL = 95%	45594
$\eta\gamma$	< 5.1	$\times 10^{-5}$	CL = 95%	45592
$\omega\gamma$	< 6.5	$\times 10^{-4}$	CL = 95%	45590
$\eta'(958)\gamma$	< 4.2	$\times 10^{-5}$	CL = 95%	45589
$\gamma\gamma$	< 5.2	$\times 10^{-5}$	CL = 95%	45594
$\gamma\gamma\gamma$	< 1.0	$\times 10^{-5}$	CL = 95%	45594
$\pi^\pm W^\mp$	[ $b$ ] < 7	$\times 10^{-5}$	CL = 95%	10146
$\rho^\pm W^\mp$	[ $b$ ] < 8.3	$\times 10^{-5}$	CL = 95%	10120
$J/\psi(1S)X$	$(3.51^{+0.23}_{-0.25}) \times 10^{-3}$		S = 1.1	–
$\psi(2S)X$	$(1.60 \pm 0.29) \times 10^{-3}$			–
$\chi_{c1}(1P)X$	$(2.9 \pm 0.7) \times 10^{-3}$			–
$\chi_{c2}(1P)X$	< 3.2	$\times 10^{-3}$	CL = 90%	–
$\Upsilon(1S)X + \Upsilon(2S)X + \Upsilon(3S)X$	$(1.0 \pm 0.5) \times 10^{-4}$			–
$\Upsilon(1S)X$	< 4.4	$\times 10^{-5}$	CL = 95%	–
$\Upsilon(2S)X$	< 1.39	$\times 10^{-4}$	CL = 95%	–
$\Upsilon(3S)X$	< 9.4	$\times 10^{-5}$	CL = 95%	–
$(D^0/\bar{D}^0)X$	$(20.7 \pm 2.0) \%$			–
$D^\pm X$	$(12.2 \pm 1.7) \%$			–
$D^*(2010)^\pm X$	[ $b$ ] $(11.4 \pm 1.3) \%$			–
$D_{s1}(2536)^\pm X$	$(3.6 \pm 0.8) \times 10^{-3}$			–
$D_{sJ}(2573)^\pm X$	$(5.8 \pm 2.2) \times 10^{-3}$			–
$D^*(2629)^\pm X$	searched for			–
$B^+ X$	$(6.03 \pm 0.15) \%$			–
$B_s^0 X$	$(1.55 \pm 0.13) \%$			–
$B_c^\pm X$	searched for			–
$\Lambda_c^+ X$	$(1.54 \pm 0.33) \%$			–
$b$ -baryon X	$(1.51 \pm 0.26) \%$			–
anomalous $\gamma$ + hadrons	[ $i$ ] < 3.2	$\times 10^{-3}$	CL = 95%	–
$e^+e^-\gamma$	[ $i$ ] < 5.2	$\times 10^{-4}$	CL = 95%	45594
$\mu^+\mu^-\gamma$	[ $i$ ] < 5.6	$\times 10^{-4}$	CL = 95%	45594
$\tau^+\tau^-\gamma$	[ $i$ ] < 7.3	$\times 10^{-4}$	CL = 95%	45559
$\ell^+\ell^-\gamma\gamma$	[ $j$ ] < 6.8	$\times 10^{-6}$	CL = 95%	–
$q\bar{q}\gamma\gamma$	[ $j$ ] < 5.5	$\times 10^{-6}$	CL = 95%	–
$\nu\bar{\nu}\gamma\gamma$	[ $j$ ] < 3.1	$\times 10^{-6}$	CL = 95%	45594
$e^\pm\mu^\mp$	LF [ $b$ ] < 1.7	$\times 10^{-6}$	CL = 95%	45594
$e^\pm\tau^\mp$	LF [ $b$ ] < 9.8	$\times 10^{-6}$	CL = 95%	45576
$\mu^\pm\tau^\mp$	LF [ $b$ ] < 1.2	$\times 10^{-5}$	CL = 95%	45576
$pe$	L, B < 1.8	$\times 10^{-6}$	CL = 95%	45589
$p\mu$	L, B < 1.8	$\times 10^{-6}$	CL = 95%	45589

### Higgs Bosons — $H^0$ and $H^\pm$ , Searches for

$H^0$  Mass  $m > 114.4$  GeV, CL = 95%

$H^0$  in Supersymmetric Models ( $m_{H_1^0} < m_{H_2^0}$ )

Mass  $m > 89.8$  GeV, CL = 95%

$A^0$  Pseudoscalar Higgs Boson in Supersymmetric Models [k]

Mass  $m > 90.4$  GeV, CL = 95%  $\tan\beta > 0.4$

$H^\pm$  Mass  $m > 79.3$  GeV, CL = 95%

(See the Particle Listings for a Note giving details of Higgs Bosons.)

### Heavy Bosons Other than Higgs Bosons, Searches for

#### Additional W Bosons

$W'$  with standard couplings decaying to  $e\nu, \mu\nu$

Mass  $m > 800$  GeV, CL = 95%

$W_R$  — right-handed W

Mass  $m > 715$  GeV, CL = 90% (electroweak fit)

#### Additional Z Bosons

$Z_{SM}$  with standard couplings

Mass  $m > 825$  GeV, CL = 95% ( $p\bar{p}$  direct search)

Mass  $m > 1500$  GeV, CL = 95% (electroweak fit)

$Z_{LR}$  of  $SU(2)_L \times SU(2)_R \times U(1)$

(with  $g_L = g_R$ )

Mass  $m > 630$  GeV, CL = 95% ( $p\bar{p}$  direct search)

Mass  $m > 860$  GeV, CL = 95% (electroweak fit)

$Z_X$  of  $SO(10) \times SU(5) \times U(1)_X$  (with  $g_X = e \cos\theta_W$ )

Mass  $m > 690$  GeV, CL = 95% ( $p\bar{p}$  direct search)

Mass  $m > 781$  GeV, CL = 95% (electroweak fit)

$Z_\psi$  of  $E_6 \rightarrow SO(10) \times U(1)_\psi$  (with  $g_\psi = e \cos\theta_W$ )

Mass  $m > 675$  GeV, CL = 95% ( $p\bar{p}$  direct search)

Mass  $m > 366$  GeV, CL = 95% (electroweak fit)

$Z_\eta$  of  $E_6 \rightarrow SU(3) \times SU(2) \times U(1) \times U(1)_\eta$  (with  $g_\eta = e \cos\theta_W$ )

Mass  $m > 720$  GeV, CL = 95% ( $p\bar{p}$  direct search)

Mass  $m > 619$  GeV, CL = 95% (electroweak fit)

### Scalar Leptoquarks

Mass  $m > 256$  GeV, CL = 95% (1st generation, pair prod.)

Mass  $m > 298$  GeV, CL = 95% (1st gener., single prod.)

Mass  $m > 202$  GeV, CL = 95% (2nd gener., pair prod.)

Mass  $m > 73$  GeV, CL = 95% (2nd gener., single prod.)

Mass  $m > 148$  GeV, CL = 95% (3rd gener., pair prod.)

(See the Particle Listings for assumptions on leptoquark quantum numbers and branching fractions.)

### Axions ( $A^0$ ) and Other Very Light Bosons, Searches for

The standard Peccei–Quinn axion is ruled out. Variants with reduced couplings or much smaller masses are constrained by various data. The Particle Listings in the full *Review* contain a Note discussing axion searches.

The best limit for the half-life of neutrinoless double beta decay with Majoron emission is  $> 7.2 \times 10^{24}$  years (CL = 90%).

### NOTES

In this Summary Table:

When a quantity has “(S = . . .)” to its right, the error on the quantity has been enlarged by the “scale factor” S, defined as  $S = \sqrt{\chi^2/(N-1)}$ , where  $N$  is the number of measurements used in calculating the quantity. We do this when  $S > 1$ , which often indicates that the measurements are inconsistent. When  $S > 1.25$ , we also show in the Particle Listings an ideogram of the measurements. For more about S, see the Introduction.

A decay momentum  $p$  is given for each decay mode. For a 2-body decay,  $p$  is the momentum of each decay product in the rest frame of the decaying particle. For a 3-or-more-body decay,  $p$  is the largest momentum any of the products can have in this frame.

- [a] Theoretical value. A mass as large as a few MeV may not be precluded.
- [b]  $\ell$  indicates each type of lepton ( $e, \mu$ , and  $\tau$ ), not sum over them.
- [c] This represents the width for the decay of the W boson into a charged particle with momentum below detectability,  $p < 200$  MeV.
- [d] The Z-boson mass listed here corresponds to a Breit–Wigner resonance parameter. It lies approximately 34 MeV above the real part of the position of the pole (in the energy-squared plane) in the Z-boson propagator.
- [e] This partial width takes into account Z decays into  $\nu\bar{\nu}$  and any other possible undetected modes.
- [f] This ratio has not been corrected for the  $\tau$  mass.
- [g] Here  $A \equiv 2g_V g_A / (g_V^2 + g_A^2)$ .
- [h] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [i] See the Z Particle Listings for the  $\gamma$  energy range used in this measurement.
- [j] For  $m_{\gamma\gamma} = (60 \pm 5)$  GeV.
- [k] The limits assume no invisible decays.

# LEPTON SUMMARY TABLE

## LEPTONS

**e**

$$J = \frac{1}{2}$$

Mass  $m = (548.57990945 \pm 0.00000024) \times 10^{-6}$  u  
 Mass  $m = 0.51099892 \pm 0.00000004$  MeV  
 $|m_{e^+} - m_{e^-}|/m < 8 \times 10^{-9}$ , CL = 90%  
 $|q_{e^+} + q_{e^-}|/e < 4 \times 10^{-8}$   
 Magnetic moment  $\mu = 1.0011596521859 \pm 0.00000000000038 \mu_B$   
 $(g_{e^+} - g_{e^-})/g_{\text{average}} = (-0.5 \pm 2.1) \times 10^{-12}$   
 Electric dipole moment  $d = (0.07 \pm 0.07) \times 10^{-26}$  e cm  
 Mean life  $\tau > 4.6 \times 10^{26}$  yr, CL = 90%<sup>[a]</sup>

**$\mu$**

$$J = \frac{1}{2}$$

Mass  $m = 0.1134289264 \pm 0.0000000030$  u  
 Mass  $m = 105.658369 \pm 0.000009$  MeV  
 Mean life  $\tau = (2.19703 \pm 0.00004) \times 10^{-6}$  s  
 $\tau_{\mu^+}/\tau_{\mu^-} = 1.00002 \pm 0.00008$   
 $c\tau = 658.654$  m  
 Magnetic moment  $\mu = 1.0011659208 \pm 0.0000000006 e\hbar/2m_{\mu}$   
 $(g_{\mu^+} - g_{\mu^-})/g_{\text{average}} = (-2.6 \pm 1.6) \times 10^{-8}$   
 Electric dipole moment  $d = (3.7 \pm 3.4) \times 10^{-19}$  e cm

### Decay parameters<sup>[b]</sup>

$\rho = 0.7509 \pm 0.0010$   
 $\eta = 0.001 \pm 0.024$  (S = 2.0)  
 $\delta = 0.7495 \pm 0.0012$   
 $\xi P_{\mu} = 1.003 \pm 0.008$ <sup>[c]</sup>  
 $\xi P_{\mu} \delta/\rho > 0.99682$ , CL = 90%<sup>[c]</sup>  
 $\xi' = 1.00 \pm 0.04$   
 $\xi'' = 0.7 \pm 0.4$   
 $\alpha/A = (0 \pm 4) \times 10^{-3}$   
 $\alpha'/A = (0 \pm 4) \times 10^{-3}$   
 $\beta/A = (4 \pm 6) \times 10^{-3}$   
 $\beta'/A = (1 \pm 5) \times 10^{-3}$   
 $\bar{\eta} = 0.02 \pm 0.08$

$\mu^+$  modes are charge conjugates of the modes below.

$\mu^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$e^- \bar{\nu}_e \nu_{\mu}$	$\approx 100\%$		53
$e^- \bar{\nu}_e \nu_{\mu} \gamma$	[d] (1.4 $\pm$ 0.4) %		53
$e^- \bar{\nu}_e \nu_{\mu} e^+ e^-$	[e] (3.4 $\pm$ 0.4) $\times 10^{-5}$		53
<b>Lepton Family number (LF) violating modes</b>			
$e^- \nu_e \bar{\nu}_{\mu}$	LF [f] < 1.2 %	90%	53
$e^- \gamma$	LF < 1.2 $\times 10^{-11}$	90%	53
$e^- e^+ e^-$	LF < 1.0 $\times 10^{-12}$	90%	53
$e^- 2\gamma$	LF < 7.2 $\times 10^{-11}$	90%	53

**$\tau$**

$$J = \frac{1}{2}$$

Mass  $m = 1776.99^{+0.29}_{-0.26}$  MeV  
 $(m_{\tau^+} - m_{\tau^-})/m_{\text{average}} < 3.0 \times 10^{-3}$ , CL = 90%  
 Mean life  $\tau = (290.6 \pm 1.0) \times 10^{-15}$  s  
 $c\tau = 87.11 \mu\text{m}$   
 Magnetic moment anomaly  $> -0.052$  and  $< 0.013$ , CL = 95%  
 $\text{Re}(d_{\tau}) = -0.22$  to  $0.45 \times 10^{-16}$  e cm, CL = 95%  
 $\text{Im}(d_{\tau}) = -0.25$  to  $0.008 \times 10^{-16}$  e cm, CL = 95%

### Weak dipole moment

$\text{Re}(d_{\tau}^W) < 0.50 \times 10^{-17}$  e cm, CL = 95%  
 $\text{Im}(d_{\tau}^W) < 1.1 \times 10^{-17}$  e cm, CL = 95%

### Weak anomalous magnetic dipole moment

$\text{Re}(\alpha_{\tau}^W) < 1.1 \times 10^{-3}$ , CL = 95%  
 $\text{Im}(\alpha_{\tau}^W) < 2.7 \times 10^{-3}$ , CL = 95%

### Decay parameters

See the  $\tau$  Particle Listings for a note concerning  $\tau$ -decay parameters.

$\rho^{\tau}(e \text{ or } \mu) = 0.745 \pm 0.008$   
 $\rho^{\tau}(e) = 0.747 \pm 0.010$   
 $\rho^{\tau}(\mu) = 0.763 \pm 0.020$   
 $\xi^{\tau}(e \text{ or } \mu) = 0.985 \pm 0.030$   
 $\xi^{\tau}(e) = 0.994 \pm 0.040$   
 $\xi^{\tau}(\mu) = 1.030 \pm 0.059$   
 $\eta^{\tau}(e \text{ or } \mu) = 0.013 \pm 0.020$   
 $\eta^{\tau}(\mu) = 0.094 \pm 0.073$   
 $(\delta\xi)^{\tau}(e \text{ or } \mu) = 0.746 \pm 0.021$   
 $(\delta\xi)^{\tau}(e) = 0.734 \pm 0.028$   
 $(\delta\xi)^{\tau}(\mu) = 0.778 \pm 0.037$   
 $\xi^{\tau}(\pi) = 0.993 \pm 0.022$   
 $\xi^{\tau}(\rho) = 0.994 \pm 0.008$   
 $\xi^{\tau}(a_1) = 1.001 \pm 0.027$   
 $\xi^{\tau}(\text{all hadronic modes}) = 0.995 \pm 0.007$

$\tau^+$  modes are charge conjugates of the modes below. “ $h^{\pm}$ ” stands for  $\pi^{\pm}$  or  $K^{\pm}$ . “ $l$ ” stands for  $e$  or  $\mu$ . “Neutrals” stands for  $\gamma$ 's and/or  $\pi^0$ 's.

$\tau^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Modes with one charged particle</b>			
particle <sup>-</sup> $\geq 0$ neutrals $\geq 0K^0 \nu_{\tau}$ (“1-prong”)	(85.33 $\pm$ 0.08) %	S = 1.4	–
particle <sup>-</sup> $\geq 0$ neutrals $\geq 0K_L^0 \nu_{\tau}$	(84.69 $\pm$ 0.09) %	S = 1.4	–
$\mu^- \bar{\nu}_{\mu} \nu_{\tau}$	[g] (17.36 $\pm$ 0.05) %		885
$\mu^- \bar{\nu}_{\mu} \nu_{\tau} \gamma$	[e] (3.6 $\pm$ 0.4) $\times 10^{-3}$		885
$e^- \bar{\nu}_e \nu_{\tau}$	[g] (17.84 $\pm$ 0.05) %		888
$e^- \bar{\nu}_e \nu_{\tau} \gamma$	[e] (1.75 $\pm$ 0.18) %		888
$h^- \geq 0K_L^0 \nu_{\tau}$	(12.14 $\pm$ 0.07) %	S = 1.1	883
$h^- \nu_{\tau}$	(11.59 $\pm$ 0.06) %	S = 1.1	883
$\pi^- \nu_{\tau}$	[g] (10.90 $\pm$ 0.07) %	S = 1.1	883
$K^- \nu_{\tau}$	[g] (6.91 $\pm$ 0.23) $\times 10^{-3}$		820
$h^- \geq 1$ neutrals $\nu_{\tau}$	(37.05 $\pm$ 0.12) %	S = 1.3	–
$h^- \geq 1\pi^0 \nu_{\tau}$ (ex. $K^0$ )	(36.51 $\pm$ 0.12) %	S = 1.3	–
$h^- \pi^0 \nu_{\tau}$	(25.95 $\pm$ 0.10) %	S = 1.1	878
$\pi^- \pi^0 \nu_{\tau}$	[g] (25.50 $\pm$ 0.10) %	S = 1.1	878
$\pi^- \pi^0$ non- $\rho(770) \nu_{\tau}$	(3.0 $\pm$ 3.2) $\times 10^{-3}$		878
$K^- \pi^0 \nu_{\tau}$	[g] (4.52 $\pm$ 0.27) $\times 10^{-3}$		814
$h^- \geq 2\pi^0 \nu_{\tau}$	(10.81 $\pm$ 0.14) %	S = 1.5	–
$h^- 2\pi^0 \nu_{\tau}$	(9.47 $\pm$ 0.12) %	S = 1.3	862
$h^- 2\pi^0 \nu_{\tau}$ (ex. $K^0$ )	(9.31 $\pm$ 0.12) %	S = 1.3	862
$\pi^- 2\pi^0 \nu_{\tau}$ (ex. $K^0$ )	[g] (9.25 $\pm$ 0.12) %	S = 1.3	862
$\pi^- 2\pi^0 \nu_{\tau}$ (ex. $K^0$ ), scalar	< 9 $\times 10^{-3}$	CL = 95%	862
$\pi^- 2\pi^0 \nu_{\tau}$ (ex. $K^0$ ), vector	< 7 $\times 10^{-3}$	CL = 95%	862
$K^- 2\pi^0 \nu_{\tau}$ (ex. $K^0$ )	[g] (5.8 $\pm$ 2.3) $\times 10^{-4}$		796
$h^- \geq 3\pi^0 \nu_{\tau}$	(1.33 $\pm$ 0.07) %	S = 1.1	–
$h^- \geq 3\pi^0 \nu_{\tau}$ (ex. $K^0$ )	(1.25 $\pm$ 0.07) %	S = 1.1	–
$h^- 3\pi^0 \nu_{\tau}$	(1.17 $\pm$ 0.08) %	S = 1.1	836
$\pi^- 3\pi^0 \nu_{\tau}$ (ex. $K^0$ )	[g] (1.04 $\pm$ 0.08) %	S = 1.1	836
$K^- 3\pi^0 \nu_{\tau}$ (ex. $K^0, \eta$ )	[g] (4.2 $\pm$ 2.1) $\times 10^{-4}$		766
$h^- 4\pi^0 \nu_{\tau}$ (ex. $K^0$ )	(1.6 $\pm$ 0.4) $\times 10^{-3}$		800
$h^- 4\pi^0 \nu_{\tau}$ (ex. $K^0, \eta$ )	[g] (1.0 $\pm$ 0.4) $\times 10^{-3}$		800
$K^- \geq 0\pi^0 \geq 0K^0 \geq 0\gamma \nu_{\tau}$	(1.57 $\pm$ 0.04) %	S = 1.1	820
$K^- \geq 1(\pi^0 \text{ or } K^0 \text{ or } \gamma) \nu_{\tau}$	(8.78 $\pm$ 0.33) $\times 10^{-3}$		–
<b>Modes with <math>K^0</math>'s</b>			
$K_S^0$ (particles) <sup>-</sup> $\nu_{\tau}$	(9.27 $\pm$ 0.34) $\times 10^{-3}$	S = 1.1	–
$h^- \bar{K}^0 \nu_{\tau}$	(1.05 $\pm$ 0.04) %	S = 1.1	812
$\pi^- \bar{K}^0 \nu_{\tau}$	[g] (9.0 $\pm$ 0.4) $\times 10^{-3}$	S = 1.1	812
$\pi^- \bar{K}^0$	< 1.7 $\times 10^{-3}$	CL = 95%	812
(non- $K^*(892)^-$ ) $\nu_{\tau}$			
$K^- K^0 \nu_{\tau}$	[g] (1.53 $\pm$ 0.16) $\times 10^{-3}$		737
$K^- K^0 \geq 0\pi^0 \nu_{\tau}$	(3.07 $\pm$ 0.24) $\times 10^{-3}$		737

$b^- \bar{K}^0 \pi^0 \nu_\tau$	$(5.3 \pm 0.4) \times 10^{-3}$		794
$\pi^- \bar{K}^0 \pi^0 \nu_\tau$	[g] $(3.8 \pm 0.4) \times 10^{-3}$		794
$\bar{K}^0 \rho^- \nu_\tau$	$(2.2 \pm 0.5) \times 10^{-3}$		612
$K^- K^0 \pi^0 \nu_\tau$	[g] $(1.54 \pm 0.20) \times 10^{-3}$		685
$\pi^- \bar{K}^0 \geq 1\pi^0 \nu_\tau$	$(3.2 \pm 1.0) \times 10^{-3}$		-
$\pi^- \bar{K}^0 \pi^0 \pi^0 \nu_\tau$	$(2.6 \pm 2.4) \times 10^{-4}$		763
$K^- K^0 \pi^0 \pi^0 \nu_\tau$	$< 1.6 \times 10^{-4}$	CL = 95%	619
$\pi^- K^0 \bar{K}^0 \nu_\tau$	$(1.60 \pm 0.31) \times 10^{-3}$	S = 1.2	682
$\pi^- K_S^0 K_S^0 \nu_\tau$	[g] $(2.4 \pm 0.5) \times 10^{-4}$		682
$\pi^- K_S^0 K_L^0 \nu_\tau$	[g] $(1.12 \pm 0.30) \times 10^{-3}$	S = 1.2	682
$\pi^- K^0 \bar{K}^0 \pi^0 \nu_\tau$	$(3.1 \pm 2.3) \times 10^{-4}$		614
$\pi^- K_S^0 K_S^0 \pi^0 \nu_\tau$	$< 2.0 \times 10^{-4}$	CL = 95%	614
$\pi^- K_S^0 K_L^0 \pi^0 \nu_\tau$	$(3.1 \pm 1.2) \times 10^{-4}$		614
$K^0 b^+ b^- \geq 0$ neutrals $\nu_\tau$	$< 1.7 \times 10^{-3}$	CL = 95%	760
$K^0 b^+ b^- \nu_\tau$	$(2.3 \pm 2.0) \times 10^{-4}$		760

## Modes with three charged particles

$b^- b^- b^+ \geq 0$ neutrals $\geq 0 K_L^0 \nu_\tau$	$(15.22 \pm 0.09)$ %	S = 1.4	861
$b^- b^- b^+ \geq 0$ neutrals $\nu_\tau$	$(14.59 \pm 0.08)$ %	S = 1.4	861
(ex. $K_S^0 \rightarrow \pi^+ \pi^-$ ) ("3-prong")			
$b^- b^- b^+ \nu_\tau$	$(9.87 \pm 0.08)$ %	S = 1.3	861
$b^- b^- b^+ \nu_\tau$ (ex. $K^0$ )	$(9.51 \pm 0.08)$ %	S = 1.3	861
$b^- b^- b^+ \nu_\tau$ (ex. $K^0, \omega$ )	$(9.47 \pm 0.08)$ %	S = 1.3	861
$\pi^- \pi^+ \pi^- \nu_\tau$	$(9.33 \pm 0.08)$ %	S = 1.3	861
$\pi^- \pi^+ \pi^- \nu_\tau$ (ex. $K^0$ )	$(9.02 \pm 0.08)$ %	S = 1.3	861
$\pi^- \pi^+ \pi^- \nu_\tau$ (ex. $K^0$ ), non-axial vector	$< 2.4$ %	CL = 95%	861
$\pi^- \pi^+ \pi^- \nu_\tau$ (ex. $K^0, \omega$ )	[g] $(8.99 \pm 0.08)$ %	S = 1.3	861
$b^- b^- b^+ \geq 1$ neutrals $\nu_\tau$	$(5.34 \pm 0.06)$ %	S = 1.1	-
$b^- b^- b^+ \geq 1\pi^0 \nu_\tau$ (ex. $K^0$ )	$(5.06 \pm 0.06)$ %	S = 1.1	-
$b^- b^- b^+ \pi^0 \nu_\tau$	$(4.73 \pm 0.07)$ %	S = 1.2	834
$b^- b^- b^+ \pi^0 \nu_\tau$ (ex. $K^0$ )	$(4.55 \pm 0.06)$ %	S = 1.2	834
$b^- b^- b^+ \pi^0 \nu_\tau$ (ex. $K^0, \omega$ )	$(2.78 \pm 0.08)$ %	S = 1.2	834
$\pi^- \pi^+ \pi^- \pi^0 \nu_\tau$	$(4.59 \pm 0.07)$ %	S = 1.2	834
$\pi^- \pi^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0$ )	$(4.46 \pm 0.06)$ %	S = 1.2	834
$\pi^- \pi^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0, \omega$ )	[g] $(2.69 \pm 0.08)$ %	S = 1.2	834
$b^- b^- b^+ \geq 2\pi^0 \nu_\tau$ (ex. $K^0$ )	$(5.14 \pm 0.34) \times 10^{-3}$	S = 1.1	-
$b^- b^- b^+ 2\pi^0 \nu_\tau$	$(5.02 \pm 0.34) \times 10^{-3}$	S = 1.1	797
$b^- b^- b^+ 2\pi^0 \nu_\tau$ (ex. $K^0$ )	$(4.92 \pm 0.34) \times 10^{-3}$	S = 1.1	797
$b^- b^- b^+ 2\pi^0 \nu_\tau$ (ex. $K^0, \omega, \eta$ )	[g] $(9 \pm 4) \times 10^{-4}$		797
$b^- b^- b^+ 3\pi^0 \nu_\tau$	[g] $(2.2 \pm 0.5) \times 10^{-4}$		749
$K^- h^+ b^- \geq 0$ neutrals $\nu_\tau$	$(6.79 \pm 0.35) \times 10^{-3}$	S = 1.3	794
$K^- h^+ \pi^- \nu_\tau$ (ex. $K^0$ )	$(4.86 \pm 0.32) \times 10^{-3}$	S = 1.4	794
$K^- h^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0$ )	$(8.5 \pm 1.2) \times 10^{-4}$		763
$K^- \pi^+ \pi^- \geq 0$ neutrals $\nu_\tau$	$(5.2 \pm 0.4) \times 10^{-3}$	S = 1.5	794
$K^- \pi^+ \pi^- \geq 0\pi^0 \nu_\tau$ (ex. $K^0$ )	$(4.1 \pm 0.4) \times 10^{-3}$	S = 1.5	794
$K^- \pi^+ \pi^- \nu_\tau$	$(3.9 \pm 0.4) \times 10^{-3}$	S = 1.6	794
$K^- \pi^+ \pi^- \nu_\tau$ (ex. $K^0$ )	[g] $(3.33 \pm 0.35) \times 10^{-3}$	S = 1.6	794
$K^- \rho^0 \nu_\tau \rightarrow K^- \pi^+ \pi^- \nu_\tau$	$(1.6 \pm 0.6) \times 10^{-3}$		-
$K^- \pi^+ \pi^- \pi^0 \nu_\tau$	$(1.32 \pm 0.14) \times 10^{-3}$		763
$K^- \pi^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0$ )	$(7.9 \pm 1.2) \times 10^{-4}$		763
$K^- \pi^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0, \eta$ )	[g] $(7.3 \pm 1.2) \times 10^{-4}$		763
$K^- \pi^+ \pi^- \pi^0 \nu_\tau$ (ex. $K^0, \omega$ )	$(3.7 \pm 0.9) \times 10^{-4}$		763
$K^- \pi^+ K^- \geq 0$ neut. $\nu_\tau$	$< 9 \times 10^{-4}$	CL = 95%	685
$K^- K^+ \pi^- \geq 0$ neut. $\nu_\tau$	$(1.59 \pm 0.10) \times 10^{-3}$	S = 1.4	685
$K^- K^+ \pi^- \nu_\tau$	[g] $(1.53 \pm 0.10) \times 10^{-3}$	S = 1.4	685
$K^- K^+ \pi^- \pi^0 \nu_\tau$	[g] $(6.1 \pm 2.0) \times 10^{-5}$	S = 1.1	618
$K^- K^+ K^- \geq 0$ neut. $\nu_\tau$	$< 2.1 \times 10^{-3}$	CL = 95%	472
$K^- K^+ K^- \nu_\tau$	$< 3.7 \times 10^{-5}$	CL = 90%	472
$K^- K^+ K^- \pi^0 \nu_\tau$	$< 4.8 \times 10^{-6}$	CL = 90%	346
$\pi^- K^+ \pi^- \geq 0$ neut. $\nu_\tau$	$< 2.5 \times 10^{-3}$	CL = 95%	794
$e^- e^- e^+ \bar{\nu}_\mu \nu_\tau$	$(2.8 \pm 1.5) \times 10^{-5}$		888
$\mu^- e^- e^+ \bar{\nu}_\mu \nu_\tau$	$< 3.6 \times 10^{-5}$	CL = 90%	885

## Modes with five charged particles

$3b^- 2b^+ \geq 0$ neutrals $\nu_\tau$	$(1.02 \pm 0.04) \times 10^{-3}$	S = 1.1	794
(ex. $K_S^0 \rightarrow \pi^- \pi^+$ ) ("5-prong")			
$3b^- 2b^+ \nu_\tau$ (ex. $K^0$ )	[g] $(8.38 \pm 0.35) \times 10^{-4}$	S = 1.1	794
$3b^- 2b^+ \pi^0 \nu_\tau$ (ex. $K^0$ )	[g] $(1.78 \pm 0.27) \times 10^{-4}$		746
$3b^- 2b^+ 2\pi^0 \nu_\tau$	$< 1.1 \times 10^{-4}$	CL = 90%	687

## Miscellaneous other allowed modes

$(5\pi)^- \nu_\tau$	$(7.6 \pm 0.5) \times 10^{-3}$	S = 1.1	800
$4b^- 3b^+ \geq 0$ neutrals $\nu_\tau$	$< 3.0 \times 10^{-7}$	CL = 90%	683
("7-prong")			
$4b^- 3b^+ \nu_\tau$	$< 4.3 \times 10^{-7}$	CL = 90%	683
$4b^- 3b^+ \pi^0 \nu_\tau$	$< 2.5 \times 10^{-7}$	CL = 90%	612
$X^-(S=-1) \nu_\tau$	$(2.95 \pm 0.07)$ %	S = 1.1	-

$K^*(892)^- \geq 0$ neutrals $\geq$	$(1.42 \pm 0.18)$ %	S = 1.4	665
$0K_L^0 \nu_\tau$			
$K^*(892)^- \nu_\tau$	$(1.29 \pm 0.05)$ %		665
$K^*(892)^0 K^- \geq 0$ neutrals $\nu_\tau$	$(3.2 \pm 1.4) \times 10^{-3}$		542
$K^*(892)^0 K^- \nu_\tau$	$(2.1 \pm 0.4) \times 10^{-3}$		542
$\bar{K}^*(892)^0 \pi^- \geq 0$ neutrals $\nu_\tau$	$(3.8 \pm 1.7) \times 10^{-3}$		656
$\bar{K}^*(892)^0 \pi^- \nu_\tau$	$(2.2 \pm 0.5) \times 10^{-3}$		656
$(\bar{K}^*(892)\pi)^- \nu_\tau \rightarrow$ $\pi^- \bar{K}^0 \pi^0 \nu_\tau$	$(1.0 \pm 0.4) \times 10^{-3}$		-
$K_1(1270)^- \nu_\tau$	$(4.7 \pm 1.1) \times 10^{-3}$		433
$K_1(1400)^- \nu_\tau$	$(1.7 \pm 2.6) \times 10^{-3}$	S = 1.7	335
$K^*(1410)^- \nu_\tau$	$(1.5^{+1.4}_{-1.0}) \times 10^{-3}$		326
$K_0^*(1430)^- \nu_\tau$	$< 5 \times 10^{-4}$	CL = 95%	326
$K_2^*(1430)^- \nu_\tau$	$< 3 \times 10^{-3}$	CL = 95%	317
$\eta \pi^- \nu_\tau$	$< 1.4 \times 10^{-4}$	CL = 95%	798
$\eta \pi^- \pi^0 \nu_\tau$	[g] $(1.77 \pm 0.24) \times 10^{-3}$		778
$\eta \pi^- \pi^0 \pi^0 \nu_\tau$	$(1.5 \pm 0.5) \times 10^{-4}$		746
$\eta K^- \nu_\tau$	[g] $(2.7 \pm 0.6) \times 10^{-4}$		720
$\eta K^*(892)^- \nu_\tau$	$(2.9 \pm 0.9) \times 10^{-4}$		511
$\eta K^- \pi^0 \nu_\tau$	$(1.8 \pm 0.9) \times 10^{-4}$		665
$\eta \bar{K}^0 \pi^- \nu_\tau$	$(2.2 \pm 0.7) \times 10^{-4}$		661
$\eta \pi^+ \pi^- \pi^- \geq 0$ neutrals $\nu_\tau$	$< 3 \times 10^{-3}$	CL = 90%	744
$\eta \pi^- \pi^+ \pi^- \nu_\tau$	$(2.3 \pm 0.5) \times 10^{-4}$		744
$\eta a_1(1260)^- \nu_\tau \rightarrow \eta \pi^- \rho^0 \nu_\tau$	$< 3.9 \times 10^{-4}$	CL = 90%	-
$\eta \eta \pi^- \nu_\tau$	$< 1.1 \times 10^{-4}$	CL = 95%	637
$\eta \eta \pi^- \pi^0 \nu_\tau$	$< 2.0 \times 10^{-4}$	CL = 95%	559
$\eta'(958)\pi^- \nu_\tau$	$< 7.4 \times 10^{-5}$	CL = 90%	620
$\eta'(958)\pi^- \pi^0 \nu_\tau$	$< 8.0 \times 10^{-5}$	CL = 90%	591
$\phi \pi^- \nu_\tau$	$< 2.0 \times 10^{-4}$	CL = 90%	585
$\phi K^- \nu_\tau$	$< 6.7 \times 10^{-5}$	CL = 90%	445
$f_1(1285)\pi^- \nu_\tau$	$(4.1 \pm 0.8) \times 10^{-4}$		408
$f_1(1285)\pi^- \nu_\tau \rightarrow$ $\eta \pi^- \pi^+ \pi^- \nu_\tau$	$(1.3 \pm 0.4) \times 10^{-4}$		-
$\pi(1300)^- \nu_\tau \rightarrow (\rho\pi)^- \nu_\tau \rightarrow$ $(3\pi)^- \nu_\tau$	$< 1.0 \times 10^{-4}$	CL = 90%	-
$\pi(1300)^- \nu_\tau \rightarrow ((\pi\pi)_{S\text{-wave}}\pi)^-$ $\nu_\tau \rightarrow (3\pi)^- \nu_\tau$	$< 1.9 \times 10^{-4}$	CL = 90%	-
$b^- \omega \geq 0$ neutrals $\nu_\tau$	$(2.39 \pm 0.09)$ %	S = 1.2	708
$b^- \omega \nu_\tau$	[g] $(1.99 \pm 0.08)$ %	S = 1.2	708
$K^- \omega \nu_\tau$	$(4.1 \pm 0.9) \times 10^{-4}$		610
$b^- \omega \pi^0 \nu_\tau$	[g] $(4.1 \pm 0.4) \times 10^{-3}$		684
$b^- \omega 2\pi^0 \nu_\tau$	$(1.4 \pm 0.5) \times 10^{-4}$		644
$2b^- b^+ \omega \nu_\tau$	$(1.20 \pm 0.22) \times 10^{-4}$		641

Lepton Family number (LF), Lepton number (L),  
or Baryon number (B) violating modes

L means lepton number violation (e.g.  $\tau^- \rightarrow e^+ \pi^- \pi^-$ ). Following common usage, LF means lepton family violation and not lepton number violation (e.g.,  $\tau^- \rightarrow e^- \pi^+ \pi^-$ ). B means baryon number violation.

$e^- \gamma$	LF	$< 1.1 \times 10^{-7}$	CL = 90%	888
$\mu^- \gamma$	LF	$< 6.8 \times 10^{-8}$	CL = 90%	885
$e^- \pi^0$	LF	$< 1.9 \times 10^{-7}$	CL = 90%	883
$\mu^- \pi^0$	LF	$< 4.1 \times 10^{-7}$	CL = 90%	880
$e^- K_S^0$	LF	$< 9.1 \times 10^{-7}$	CL = 90%	819
$\mu^- K_S^0$	LF	$< 9.5 \times 10^{-7}$	CL = 90%	815
$e^- \eta$	LF	$< 2.4 \times 10^{-7}$	CL = 90%	804
$\mu^- \eta$	LF	$< 1.5 \times 10^{-7}$	CL = 90%	800
$e^- \rho^0$	LF	$< 2.0 \times 10^{-6}$	CL = 90%	719
$\mu^- \rho^0$	LF	$< 6.3 \times 10^{-6}$	CL = 90%	715
$e^- K^*(892)^0$	LF	$< 5.1 \times 10^{-6}$	CL = 90%	665
$\mu^- K^*(892)^0$	LF	$< 7.5 \times 10^{-6}$	CL = 90%	660
$e^- \bar{K}^*(892)^0$	LF	$< 7.4 \times 10^{-6}$	CL = 90%	665
$\mu^- \bar{K}^*(892)^0$	LF	$< 7.5 \times 10^{-6}$	CL = 90%	660
$e^- \eta'(958)$	LF	$< 1.0 \times 10^{-6}$	CL = 90%	630
$\mu^- \eta'(958)$	LF	$< 4.7 \times 10^{-7}$	CL = 90%	625
$e^- \phi$	LF	$< 6.9 \times 10^{-6}$	CL = 90%	596
$\mu^- \phi$	LF	$< 7.0 \times 10^{-6}$	CL = 90%	590
$e^- e^+ e^-$	LF	$< 2.0 \times 10^{-7}$	CL = 90%	888
$e^- \mu^+ \mu^-$	LF	$< 2.0 \times 10^{-7}$	CL = 90%	882
$e^+ \mu^- \mu^-$	LF	$< 1.3 \times 10^{-7}$	CL = 90%	882
$\mu^- e^+ e^-$	LF	$< 1.9 \times 10^{-7}$	CL = 90%	885
$\mu^+ e^- e^-$	LF	$< 1.1 \times 10^{-7}$	CL = 90%	885
$\mu^- \mu^+ \mu^-$	LF	$< 1.9 \times 10^{-7}$	CL = 90%	873
$e^- \pi^+ \pi^-$	LF	$< 1.2 \times 10^{-7}$	CL = 90%	877
$e^+ \pi^- \pi^-$	L	$< 2.7 \times 10^{-7}$	CL = 90%	877
$\mu^- \pi^+ \pi^-$	LF	$< 2.9 \times 10^{-7}$	CL = 90%	866
$\mu^+ \pi^- \pi^-$	L	$< 7 \times 10^{-8}$	CL = 90%	866



$e^- \pi^+ K^-$	LF	< 3.2	$\times 10^{-7}$	CL = 90%	813
$e^- \pi^- K^+$	LF	< 1.7	$\times 10^{-7}$	CL = 90%	813
$e^+ \pi^- K^-$	L	< 1.8	$\times 10^{-7}$	CL = 90%	813
$e^- K_S^0 K_S^0$	LF	< 2.2	$\times 10^{-6}$	CL = 90%	736
$e^- K^+ K^-$	LF	< 1.4	$\times 10^{-7}$	CL = 90%	739
$e^+ K^+ K^-$	L	< 1.5	$\times 10^{-7}$	CL = 90%	739
$\mu^- \pi^+ K^-$	LF	< 2.6	$\times 10^{-7}$	CL = 90%	800
$\mu^- \pi^- K^+$	LF	< 3.2	$\times 10^{-7}$	CL = 90%	800
$\mu^+ \pi^- K^-$	L	< 2.2	$\times 10^{-7}$	CL = 90%	800
$\mu^- K_S^0 K_S^0$	LF	< 3.4	$\times 10^{-6}$	CL = 90%	696
$\mu^- K^+ K^-$	LF	< 2.5	$\times 10^{-7}$	CL = 90%	699
$\mu^+ K^- K^-$	L	< 4.8	$\times 10^{-7}$	CL = 90%	699
$e^- \pi^0 \pi^0$	LF	< 6.5	$\times 10^{-6}$	CL = 90%	878
$\mu^- \pi^0 \pi^0$	LF	< 1.4	$\times 10^{-5}$	CL = 90%	867
$e^- \eta \eta$	LF	< 3.5	$\times 10^{-5}$	CL = 90%	700
$\mu^- \eta \eta$	LF	< 6.0	$\times 10^{-5}$	CL = 90%	654
$e^- \pi^0 \eta$	LF	< 2.4	$\times 10^{-5}$	CL = 90%	798
$\mu^- \pi^0 \eta$	LF	< 2.2	$\times 10^{-5}$	CL = 90%	784
$\bar{p} \gamma$	L,B	< 3.5	$\times 10^{-6}$	CL = 90%	641
$\bar{p} \pi^0$	L,B	< 1.5	$\times 10^{-5}$	CL = 90%	632
$\bar{p} 2\pi^0$	L,B	< 3.3	$\times 10^{-5}$	CL = 90%	604
$\bar{p} \eta$	L,B	< 8.9	$\times 10^{-6}$	CL = 90%	475
$\bar{p} \pi^0 \eta$	L,B	< 2.7	$\times 10^{-5}$	CL = 90%	360
$\Delta \pi^-$	L,B	< 7.2	$\times 10^{-8}$	CL = 90%	526
$\bar{\Delta} \pi^-$	L,B	< 1.4	$\times 10^{-7}$	CL = 90%	526
$e^-$ light boson	LF	< 2.7	$\times 10^{-3}$	CL = 95%	-
$\mu^-$ light boson	LF	< 5	$\times 10^{-3}$	CL = 95%	-

### Heavy Charged Lepton Searches

#### $L^\pm$ – charged lepton

Mass  $m > 100.8$  GeV, CL = 95% <sup>[h]</sup> Decay to  $\nu W$ .

#### $L^\pm$ – stable charged heavy lepton

Mass  $m > 102.6$  GeV, CL = 95%

### Neutrino Properties

See the note on “Neutrino properties listings” in the Particle Listings.

Mass  $m < 2$  eV (tritium decay)

Mean life/mass,  $\tau/m > 300$  s/eV, CL = 90% (reactor)

Mean life/mass,  $\tau/m > 7 \times 10^9$  s/eV (solar)

Mean life/mass,  $\tau/m > 15.4$  s/eV, CL = 90% (accelerator)

Magnetic moment  $\mu < 0.9 \times 10^{-10} \mu_B$ , CL = 90% (reactor)

### Number of Neutrino Types

Number  $N = 2.994 \pm 0.012$  (Standard Model fits to LEP data)

Number  $N = 2.92 \pm 0.06$  (Direct measurement of invisible  $Z$  width)

### Neutrino Mixing

The following values are obtained through data analyses based on the 3-neutrino mixing scheme described in the review “Neutrino mass, mixing, and flavor change” by B. Kayser in this *Review*.

$$\sin^2(2\theta_{12}) = 0.86_{-0.04}^{+0.03}$$

$$\Delta m_{21}^2 = (8.0_{-0.3}^{+0.4}) \times 10^{-5} \text{eV}^2$$

The ranges below for  $\sin^2(2\theta_{23})$  and  $\Delta m_{32}^2$  correspond to the projections onto the appropriate axes of the 90% CL contours

in the  $\sin^2(2\theta_{23})$ - $\Delta m_{32}^2$  plane.

$$\begin{aligned} \sin^2(2\theta_{23}) &> 0.92 \\ \Delta m_{32}^2 &= 1.9 \text{ to } 3.0 \times 10^{-3} \text{eV}^{2[i]} \\ \sin^2(2\theta_{13}) &< 0.19, \text{ CL} = 90\% \end{aligned}$$

### Heavy Neutral Leptons, Searches for

For excited leptons, see Compositeness Limits below (see page A-54).

#### Stable Neutral Heavy Lepton Mass Limits

Mass  $m > 45.0$  GeV, CL = 95% (Dirac)

Mass  $m > 39.5$  GeV, CL = 95% (Majorana)

#### Neutral Heavy Lepton Mass Limits

Mass  $m > 90.3$  GeV, CL = 95%

(Dirac  $\nu_L$  coupling to  $e, \mu, \tau$ ; conservative case( $\tau$ ))

Mass  $m > 80.5$  GeV, CL = 95%

(Majorana  $\nu_L$  coupling to  $e, \mu, \tau$ ; conservative case( $\tau$ ))

### NOTES

In this Summary Table:

When a quantity has “(S = ...)” to its right, the error on the quantity has been enlarged by the “scale factor” S, defined as  $S = \sqrt{\chi^2/(N-1)}$ , where  $N$  is the number of measurements used in calculating the quantity. We do this when  $S > 1$ , which often indicates that the measurements are inconsistent. When  $S > 1.25$ , we also show in the Particle Listings an ideogram of the measurements. For more about S, see the Introduction.

A decay momentum  $p$  is given for each decay mode. For a 2-body decay,  $p$  is the momentum of each decay product in the rest frame of the decaying particle. For a 3-or-more-body decay,  $p$  is the largest momentum any of the products can have in this frame.

- [a] This is the best limit for the mode  $e^- \rightarrow \nu \gamma$ . The best limit for “electron disappearance” is  $6.4 \times 10^{24}$  yr.
- [b] See the “Note on Muon Decay Parameters” in the  $\mu$  Particle Listings for definitions and details.
- [c]  $P_\mu$  is the longitudinal polarization of the muon from pion decay. In standard  $V-A$  theory,  $P_\mu = 1$  and  $\rho = \delta = 3/4$ .
- [d] This only includes events with the  $\gamma$  energy  $> 10$  MeV. Since the  $e^- \bar{\nu}_e \nu_\mu$  and  $e^- \bar{\nu}_e \nu_\mu \gamma$  modes cannot be clearly separated, we regard the latter mode as a subset of the former.
- [e] See the relevant Particle Listings for the energy limits used in this measurement.
- [f] A test of additive vs. multiplicative lepton family number conservation.
- [g] Basis mode for the  $\tau$ .
- [h]  $L^\pm$  mass limit depends on decay assumptions; see the Full Listings.
- [i] The sign of  $\Delta m_{32}^2$  is not known at this time. The range quoted is for the absolute value.

## QUARK SUMMARY TABLE

### QUARKS

The  $u$ -,  $d$ -, and  $s$ -quark masses are estimates of so-called “current-quark masses,” in a mass-independent subtraction scheme such as  $\overline{\text{MS}}$  at a scale  $\mu \approx 2$  GeV. The  $c$ - and  $b$ -quark masses are the “running” masses in the  $\overline{\text{MS}}$  scheme. For the  $b$ -quark we also quote the 1S mass. These can be different from the heavy quark masses obtained in potential models.

<b>u</b>	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$	Mass $m = 1.5$ to $3.0$ MeV <sup>[a]</sup> Charge = $\frac{2}{3}e$ $I_z = +\frac{1}{2}$ $m_u/m_d = 0.3$ to $0.6$
<b>d</b>	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$	Mass $m = 3$ to $7$ MeV <sup>[a]</sup> Charge = $-\frac{1}{3}e$ $I_z = -\frac{1}{2}$ $m_s/m_d = 17$ to $22$ $\bar{m} = (m_u + m_d)/2 = 2.5$ to $5.5$ MeV
<b>s</b>	$I(J^P) = 0(\frac{1}{2}^+)$	Mass $m = 95 \pm 25$ MeV <sup>[a]</sup> Charge = $-\frac{1}{3}e$ Strangeness = $-1$ $(m_s(m_u + m_d)/2)/(m_d - m_u) = 30$ to $50$
<b>c</b>	$I(J^P) = 0(\frac{1}{2}^+)$	Mass $m = 1.25 \pm 0.09$ GeV    Charge = $\frac{2}{3}e$ Charm = $+1$
<b>b</b>	$I(J^P) = 0(\frac{1}{2}^+)$	Charge = $\frac{1}{3}e$ Bottom = $-1$  Mass $m = 4.20 \pm 0.07$ GeV    ( $\overline{\text{MS}}$ mass) Mass $m = 4.70 \pm 0.07$ GeV    (1S mass)
<b>t</b>	$I(J^P) = 0(\frac{1}{2}^+)$	Charge = $\frac{2}{3}e$ Top = $+1$  Mass $m = 174.2 \pm 3.3$ GeV <sup>[b]</sup> (direct observation of top events) Mass $m = 172.3_{-7.6}^{+10.2}$ GeV (Standard Model electroweak fit)

t DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$Wq(q = b, s, d)$			-
$Wb$			-
$\ell\nu_\ell$ anything	[c,d] (9.4 ± 2.4)	%	-
$\tau\nu_\tau b$			-
$\gamma q(q = u, c)$	[e] < 5.9 × 10 <sup>-3</sup>	95%	-
<b><math>\Delta T = 1</math> weak neutral current (T1) modes</b>			
$Zq(q = u, c)$ T1	[f] < 13.7%	95%	-

### b'(4<sup>th</sup> Generation) Quark, Searches for

Mass  $m > 190$  GeV, CL = 95%    ( $p\bar{p}$ , quasi-stable  $b'$ )  
 Mass  $m > 199$  GeV, CL = 95%    ( $p\bar{p}$ , neutral-current decays)  
 Mass  $m > 128$  GeV, CL = 95%    ( $p\bar{p}$ , charged-current decays)  
 Mass  $m > 46.0$  GeV, CL = 95%    ( $e^+e^-$ , all decays)

### Free Quark Searches

All searches since 1977 have had negative results.

### NOTES

- [a] The ratios  $m_u/m_d$  and  $m_s/m_d$  are extracted from pion and kaon masses using chiral symmetry. The estimates of  $u$  and  $d$  masses are not without controversy and remain under active investigation. Within the literature there are even suggestions that the  $u$  quark could be essentially massless. The  $s$ -quark mass is estimated from SU(3) splittings in hadron masses.
- [b] Based on published top mass measurements using data from Tevatron Run-I and Run-II. Including also the most recent unpublished results from Run-II, the Tevatron Electroweak Working Group reports a top mass of  $172.5 \pm 1.3 \pm 1.9$  GeV. See the note “The Top Quark” in the Quark Particle Listings of this Review.
- [c]  $\ell$  means  $e$  or  $\mu$  decay mode, not the sum over them.
- [d] Assumes lepton universality and  $W$ -decay acceptance.
- [e] This limit is for  $\Gamma(t \rightarrow \gamma q)/\Gamma(t \rightarrow Wb)$ .
- [f] This limit is for  $\Gamma(t \rightarrow Zq)/\Gamma(t \rightarrow Wb)$ .

## MESON SUMMARY TABLE

### LIGHT UNFLAVORED MESONS

$$(S = C = B = 0)$$

For  $I = 1(\pi, b, \rho, a)$ :  $u\bar{d}, (u\bar{u} - d\bar{d})/\sqrt{2}, d\bar{u}$ ;  
for  $I = 0(\eta, \eta', b, b', \omega, \phi, f, f')$ :  $c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s})$

$\pi^\pm$

$$I^G(J^{PC}) = 1^-(0^-)$$

Mass  $m = 139.57018 \pm 0.00035$  MeV ( $S = 1.2$ )

Mean life  $\tau = (2.6033 \pm 0.0005) \times 10^{-8}$  s ( $S = 1.2$ )

$c\tau = 7.8045$  m

$\pi^\pm \rightarrow \ell^\pm \nu \gamma$  form factors <sup>[a]</sup>

$F_V = 0.017 \pm 0.008$

$F_A = 0.0115 \pm 0.0005$  ( $S = 1.2$ )

$R = 0.059_{-0.008}^{+0.009}$

$\pi^-$  modes are charge conjugates of the modes below.

For decay limits to particles which are not established, see the appropriate Search sections (Massive Neutrino Peak Search Test,  $A^0$  (axion), and Other Light Boson ( $X^0$ ) Searches, etc.).

$\pi^\pm$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$\rho$ (MeV/c)
$\mu^+ \nu_\mu$	[b] (99.98770 $\pm$ 0.00004)	%	30
$\mu^+ \nu_\mu \gamma$	[c] (2.00 $\pm$ 0.25)	$\times 10^{-4}$	30
$e^+ \nu_e$	[b] (1.230 $\pm$ 0.004)	$\times 10^{-4}$	70
$e^+ \nu_e \gamma$	[c] (1.61 $\pm$ 0.23)	$\times 10^{-7}$	70
$e^+ \nu_e \pi^0$	(1.036 $\pm$ 0.006)	$\times 10^{-8}$	4
$e^+ \nu_e e^+ e^-$	(3.2 $\pm$ 0.5)	$\times 10^{-9}$	70
$e^+ \nu_e \nu \bar{\nu}$	< 5	$\times 10^{-6}$ 90%	70
Lepton Family number (LF) or Lepton number (L) violating modes			
$\mu^+ \bar{\nu}_e$	L [d] < 1.5	$\times 10^{-3}$ 90%	30
$\mu^+ \nu_e$	LF [d] < 8.0	$\times 10^{-3}$ 90%	30
$\mu^- e^+ e^+ \nu$	LF < 1.6	$\times 10^{-6}$ 90%	30

$\pi^0$

$$I^G(J^{PC}) = 1^-(0^{++})$$

Mass  $m = 134.9766 \pm 0.0006$  MeV ( $S = 1.1$ )

$m_{\pi^\pm} - m_{\pi^0} = 4.5936 \pm 0.0005$  MeV

Mean life  $\tau = (8.4 \pm 0.6) \times 10^{-17}$  s ( $S = 3.0$ )

$c\tau = 25.1$  nm

For decay limits to particles which are not established, see the appropriate Search sections ( $A^0$  (axion) and Other Light Boson ( $X^0$ ) Searches, etc.).

$\pi^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$2\gamma$	(98.798 $\pm$ 0.032)%	S = 1.1	67
$e^+ e^- \gamma$	(1.198 $\pm$ 0.032) %	S = 1.1	67
$\gamma$ positronium	(1.82 $\pm$ 0.29) $\times 10^{-9}$		67
$e^+ e^+ e^- e^-$	(3.14 $\pm$ 0.30) $\times 10^{-5}$		67
$e^+ e^-$	(6.2 $\pm$ 0.5) $\times 10^{-8}$		67
$4\gamma$	< 2 $\times 10^{-8}$	CL = 90%	67
$\nu \bar{\nu}$	[e] < 2.7 $\times 10^{-7}$	CL = 90%	67
$\nu_e \bar{\nu}_e$	< 1.7 $\times 10^{-6}$	CL = 90%	67
$\nu_\mu \bar{\nu}_\mu$	< 1.6 $\times 10^{-6}$	CL = 90%	67
$\nu_\tau \bar{\nu}_\tau$	< 2.1 $\times 10^{-6}$	CL = 90%	67
$\gamma \nu \bar{\nu}$	< 6 $\times 10^{-4}$	CL = 90%	67

Charge conjugation (C) or Lepton Family number (LF) violating modes

$3\gamma$	C < $3.1 \times 10^{-8}$	CL = 90%	67
$\mu^+ e^-$	LF < 3.8	$\times 10^{-10}$	CL = 90%
$\mu^- e^+$	LF < 3.4	$\times 10^{-9}$	CL = 90%
$\mu^+ e^- + \mu^- e^+$	LF < 1.72	$\times 10^{-8}$	CL = 90%

$\eta$

$$I^G(J^{PC}) = 0^+(0^{-+})$$

Mass  $m = 547.51 \pm 0.18$  MeV <sup>[f]</sup> ( $S = 5.8$ )

Full width  $\Gamma = 1.30 \pm 0.07$  keV <sup>[g]</sup>

C-nonconserving decay parameters

$\pi^+ \pi^- \pi^0$  Left-right asymmetry =  $(0.09 \pm 0.17) \times 10^{-2}$

$\pi^+ \pi^- \pi^0$  Sextant asymmetry =  $(0.18 \pm 0.16) \times 10^{-2}$

$\pi^+ \pi^- \pi^0$  Quadrant asymmetry =  $(-0.17 \pm 0.17) \times 10^{-2}$

$\pi^+ \pi^- \gamma$  Left-right asymmetry =  $(0.9 \pm 0.4) \times 10^{-2}$

$\pi^+ \pi^- \gamma$   $\beta$  (D-wave) =  $-0.02 \pm 0.07$  ( $S = 1.3$ )

Dalitz plot parameter

$\pi^0 \pi^0 \pi^0$   $\alpha = -0.031 \pm 0.004$  ( $S = 1.1$ )

$\eta$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
Neutral modes			
neutral modes	(71.9 $\pm$ 0.5) %	S = 1.3	-
$2\gamma$	[g] (39.38 $\pm$ 0.26) %	S = 1.2	274
$3\pi^0$	(32.51 $\pm$ 0.28) %	S = 1.2	179
$\pi^0 2\gamma$	(4.4 $\pm$ 1.6) $\times 10^{-4}$	S = 2.0	257
$\pi^0 \pi^0 \gamma \gamma$	< 1.2 $\times 10^{-3}$	CL = 90%	238
other neutral modes	< 2.8 %	CL = 90%	-
Charged modes			
charged modes	(28.0 $\pm$ 0.5) %	S = 1.3	-
$\pi^+ \pi^- \pi^0$	(22.7 $\pm$ 0.4) %	S = 1.3	174
$\pi^+ \pi^- \gamma$	(4.69 $\pm$ 0.11) %	S = 1.2	236
$e^+ e^- \gamma$	(6.0 $\pm$ 0.8) $\times 10^{-3}$	S = 1.4	274
$\mu^+ \mu^- \gamma$	(3.1 $\pm$ 0.4) $\times 10^{-4}$		253
$e^+ e^-$	< 7.7 $\times 10^{-5}$	CL = 90%	274
$\mu^+ \mu^-$	(5.8 $\pm$ 0.8) $\times 10^{-6}$		253
$e^+ e^- e^+ e^-$	< 6.9 $\times 10^{-5}$	CL = 90%	274
$\pi^+ \pi^- e^+ e^-$	(4.0 <sup>+5.3</sup> <sub>-2.5</sub> ) $\times 10^{-4}$	S = 2.1	235
$\pi^+ \pi^- 2\gamma$	< 2.0 $\times 10^{-3}$		236
$\pi^+ \pi^- \pi^0 \gamma$	< 5 $\times 10^{-4}$	CL = 90%	174
$\pi^0 \mu^+ \mu^- \gamma$	< 3 $\times 10^{-6}$	CL = 90%	210
Charge conjugation (C), Parity (P), Charge conjugation $\times$ Parity (CP), or Lepton Family number (LF) violating modes			
$\pi^0 \gamma$	C < 9 $\times 10^{-5}$	CL = 90%	257
$\pi^+ \pi^-$	P, CP < 1.3 $\times 10^{-5}$	CL = 90%	236
$\pi^0 \pi^0$	P, CP < 4.3 $\times 10^{-4}$	CL = 90%	238
$\pi^0 \pi^0 \gamma$	C < 5 $\times 10^{-4}$	CL = 90%	238
$\pi^0 \pi^0 \pi^0 \gamma$	C < 6 $\times 10^{-5}$	CL = 90%	179
$3\gamma$	C < 4 $\times 10^{-5}$	CL = 90%	274
$4\pi^0$	P, CP < 6.9 $\times 10^{-7}$	CL = 90%	40
$\pi^0 e^+ e^-$	C [b] < 4 $\times 10^{-5}$	CL = 90%	257
$\pi^0 \mu^+ \mu^-$	C [b] < 5 $\times 10^{-6}$	CL = 90%	210
$\mu^+ e^- + \mu^- e^+$	LF < 6 $\times 10^{-6}$	CL = 90%	264

$f_0(600)$ <sup>[i]</sup>  
or  $\sigma$

$$I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = (400-1200)$  MeV

Full width  $\Gamma = (600-1000)$  MeV

$f_0(600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	dominant	-
$\gamma\gamma$	seen	-

$\rho(770)^{[i]}$ 

$$I^G(J^{PC}) = 1^+(1^-)$$

Mass  $m = 775.5 \pm 0.4$  MeVFull width  $\Gamma = 149.4 \pm 1.0$  MeV $\Gamma_{ee} = 7.02 \pm 0.11$  keV

$\rho(770)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\pi\pi$	$\sim 100$ %		363
$\rho(770)^\pm$ decays			
$\pi^\pm\gamma$	$(4.5 \pm 0.5) \times 10^{-4}$	S = 2.2	375
$\pi^\pm\eta$	$< 6 \times 10^{-3}$	CL = 84%	153
$\pi^\pm\pi^+\pi^-\pi^0$	$< 2.0 \times 10^{-3}$	CL = 84%	254
$\rho(770)^0$ decays			
$\pi^+\pi^-\gamma$	$(9.9 \pm 1.6) \times 10^{-3}$		362
$\pi^0\gamma$	$(6.0 \pm 0.8) \times 10^{-4}$		376
$\eta\gamma$	$(2.95 \pm 0.30) \times 10^{-4}$	S = 1.2	194
$\pi^0\pi^0\gamma$	$(4.5 \pm 0.8) \times 10^{-5}$		363
$\mu^+\mu^-$	[k] $(4.55 \pm 0.28) \times 10^{-5}$		373
$e^+e^-$	[k] $(4.70 \pm 0.08) \times 10^{-5}$		388
$\pi^+\pi^-\pi^0$	$(1.01^{+0.34}_{-0.36} \pm 0.34) \times 10^{-4}$		323
$\pi^+\pi^-\pi^+\pi^-$	$(1.8 \pm 0.9) \times 10^{-5}$		251
$\pi^+\pi^-\pi^0\pi^0$	$< 4 \times 10^{-5}$	CL = 90%	257

 $\omega(782)$ 

$$I^G(J^{PC}) = 0^-(1^-)$$

Mass  $m = 782.65 \pm 0.12$  MeV (S = 1.9)Full width  $\Gamma = 8.49 \pm 0.08$  MeV $\Gamma_{ee} = 0.60 \pm 0.02$  keV

$\omega(782)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\pi^+\pi^-\pi^0$	$(89.1 \pm 0.7)$ %	S = 1.1	327
$\pi^0\gamma$	$(8.90^{+0.27}_{-0.23})$ %	S = 1.1	380
$\pi^+\pi^-$	$(1.70 \pm 0.27)$ %	S = 1.4	366
neutrals (excluding $\pi^0\gamma$ )	$(1.6^{+7.4}_{-1.1}) \times 10^{-3}$		-
$\eta\gamma$	$(4.9 \pm 0.5) \times 10^{-4}$		200
$\pi^0 e^+ e^-$	$(7.7 \pm 0.9) \times 10^{-4}$	S = 1.1	380
$\pi^0 \mu^+ \mu^-$	$(9.6 \pm 2.3) \times 10^{-5}$		349
$e^+ e^-$	$(7.18 \pm 0.12) \times 10^{-5}$	S = 1.1	391
$\pi^+\pi^-\pi^0\pi^0$	$< 2$ %	CL = 90%	262
$\pi^+\pi^-\gamma$	$< 3.6 \times 10^{-3}$	CL = 95%	366
$\pi^+\pi^-\pi^+\pi^-$	$< 1 \times 10^{-3}$	CL = 90%	256
$\pi^0\pi^0\gamma$	$(6.7 \pm 1.1) \times 10^{-5}$		367
$\eta\pi^0\gamma$	$< 3.3 \times 10^{-5}$	CL = 90%	163
$\mu^+\mu^-$	$(9.0 \pm 3.1) \times 10^{-5}$		377
$3\gamma$	$< 1.9 \times 10^{-4}$	CL = 95%	391
Charge conjugation (C) violating modes			
$\eta\pi^0$	C < 1 $\times 10^{-3}$	CL = 90%	163
$3\pi^0$	C < 3 $\times 10^{-4}$	CL = 90%	330

 $\eta'(958)$ 

$$I^G(J^{PC}) = 0^+(0^{+-})$$

Mass  $m = 957.78 \pm 0.14$  MeVFull width  $\Gamma = 0.203 \pm 0.016$  MeV (S = 1.3) $\eta'(958)$  DECAY MODESFraction ( $\Gamma_i/\Gamma$ )Scale factor/  
Confidence level $p$   
(MeV/c)

$\pi^+\pi^-\eta$	$(44.5 \pm 1.4)$ %	S = 1.1	232
$\rho^0\gamma$ (including non-resonant $\pi^+\pi^-\gamma$ )	$(29.4 \pm 0.9)$ %	S = 1.1	165
$\pi^0\pi^0\eta$	$(20.8 \pm 1.2)$ %	S = 1.2	239
$\omega\gamma$	$(3.03 \pm 0.31)$ %		159
$\gamma\gamma$	$(2.12 \pm 0.14)$ %	S = 1.3	479
$3\pi^0$	$(1.55 \pm 0.26) \times 10^{-3}$		430
$\mu^+\mu^-\gamma$	$(1.04 \pm 0.26) \times 10^{-4}$		467
$\pi^+\pi^-\pi^0$	$< 5$ %	CL = 90%	428
$\pi^0\rho^0$	$< 4$ %	CL = 90%	111
$\pi^+\pi^+\pi^-\pi^-$	$< 1$ %	CL = 90%	372
$\pi^+\pi^+\pi^-\pi^-$ neutrals	$< 1$ %	CL = 95%	-
$\pi^+\pi^+\pi^-\pi^-\pi^0$	$< 1$ %	CL = 90%	298
$6\pi$	$< 1$ %	CL = 90%	211
$\pi^+\pi^-e^+e^-$	$< 6 \times 10^{-3}$	CL = 90%	458
$\gamma e^+ e^-$	$< 9 \times 10^{-4}$	CL = 90%	479
$\pi^0\gamma\gamma$	$< 8 \times 10^{-4}$	CL = 90%	469
$4\pi^0$	$< 5 \times 10^{-4}$	CL = 90%	380
$e^+e^-$	$< 2.1 \times 10^{-7}$	CL = 90%	479

Charge conjugation (C), Parity (P),  
Lepton family number (LF) violating modes

$\pi^+\pi^-$	$P, CP < 2$ %	CL = 90%	458
$\pi^0\pi^0$	$P, CP < 9 \times 10^{-4}$	CL = 90%	459
$\pi^0 e^+ e^-$	C [b] < 1.4 $\times 10^{-3}$	CL = 90%	469
$\eta e^+ e^-$	C [b] < 2.4 $\times 10^{-3}$	CL = 90%	322
$3\gamma$	C < 1.0 $\times 10^{-4}$	CL = 90%	479
$\mu^+\mu^-\pi^0$	C [b] < 6.0 $\times 10^{-5}$	CL = 90%	445
$\mu^+\mu^-\eta$	C [b] < 1.5 $\times 10^{-5}$	CL = 90%	274
$e\mu$	LF < 4.7 $\times 10^{-4}$	CL = 90%	473

 $f_0(980)^{[I]}$ 

$$I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = 980 \pm 10$  MeVFull width  $\Gamma = 40$  to 100 MeV $f_0(980)$  DECAY MODESFraction ( $\Gamma_i/\Gamma$ ) $p$  (MeV/c)

$\pi\pi$	dominant	471
$K\bar{K}$	seen	†
$\gamma\gamma$	seen	490

 $a_0(980)^{[I]}$ 

$$I^G(J^{PC}) = 1^-(0^{++})$$

Mass  $m = 984.7 \pm 1.2$  MeV (S = 1.5)Full width  $\Gamma = 50$  to 100 MeV $a_0(980)$  DECAY MODESFraction ( $\Gamma_i/\Gamma$ ) $p$  (MeV/c)

$\eta\pi$	dominant	322
$K\bar{K}$	seen	†
$\gamma\gamma$	seen	492

 $\phi(1020)$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 1019.460 \pm 0.019$  MeVFull width  $\Gamma = 4.26 \pm 0.05$  MeV (S = 1.7)

$\phi(1020)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$K^+K^-$	$(49.2 \pm 0.6)$ %	$S = 1.2$	127
$K_L^0 K_S^0$	$(34.0 \pm 0.5)$ %	$S = 1.1$	110
$\rho\pi^+ \pi^+ \pi^- \pi^0$	$(15.3 \pm 0.4)$ %	$S = 1.2$	-
$\eta\gamma$	$(1.301 \pm 0.024)$ %	$S = 1.1$	363
$\pi^0\gamma$	$(1.25 \pm 0.07) \times 10^{-3}$		501
$e^+e^-$	$(2.97 \pm 0.04) \times 10^{-4}$	$S = 1.1$	510
$\mu^+\mu^-$	$(2.86 \pm 0.19) \times 10^{-4}$		499
$\eta e^+e^-$	$(1.15 \pm 0.10) \times 10^{-4}$		363
$\pi^+\pi^-$	$(7.3 \pm 1.3) \times 10^{-5}$		490
$\omega\pi^0$	$(5.2^{+1.3}_{-1.1}) \times 10^{-5}$		171
$\omega\gamma$	< 5 %	CL = 84%	209
$\rho\gamma$	< 1.2 $\times 10^{-5}$	CL = 90%	215
$\pi^+\pi^-\gamma$	$(4.1 \pm 1.3) \times 10^{-5}$		490
$f_0(980)\gamma$	$(4.40 \pm 0.21) \times 10^{-4}$		39
$\pi^0\pi^0\gamma$	$(1.09 \pm 0.06) \times 10^{-4}$		492
$\pi^+\pi^-\pi^+\pi^-$	$(3.9^{+2.8}_{-2.2}) \times 10^{-6}$		410
$\pi^+\pi^+\pi^-\pi^-\pi^0$	< 4.6 $\times 10^{-6}$	CL = 90%	342
$\pi^0 e^+ e^-$	$(1.12 \pm 0.28) \times 10^{-5}$		501
$\pi^0\eta\gamma$	$(8.3 \pm 0.5) \times 10^{-5}$		346
$a_0(980)\gamma$	$(7.6 \pm 0.6) \times 10^{-5}$		34
$\eta'(958)\gamma$	$(6.2 \pm 0.7) \times 10^{-5}$	$S = 1.1$	60
$\eta\pi^0\pi^0\gamma$	< 2 $\times 10^{-5}$	CL = 90%	293
$\mu^+\mu^-\gamma$	$(1.4 \pm 0.5) \times 10^{-5}$		499
$\rho\gamma\gamma$	< 5 $\times 10^{-4}$	CL = 90%	215
$\eta\pi^+\pi^-$	< 1.8 $\times 10^{-5}$	CL = 90%	288
$\eta\mu^+\mu^-$	< 9.4 $\times 10^{-6}$	CL = 90%	321

$$b_1(1170) \quad I^G(J^{PC}) = 0^-(1^{+-})$$

Mass  $m = 1170 \pm 20$  MeV  
Full width  $\Gamma = 360 \pm 40$  MeV

$b_1(1170)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	307

$$b_1(1235) \quad I^G(J^{PC}) = 1^+(1^{+-})$$

Mass  $m = 1229.5 \pm 3.2$  MeV ( $S = 1.6$ )  
Full width  $\Gamma = 142 \pm 9$  MeV ( $S = 1.2$ )

$b_1(1235)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\omega\pi$	dominant		348
[D/S amplitude ratio = $0.277 \pm 0.027$ ]			
$\pi^\pm\gamma$	$(1.6 \pm 0.4) \times 10^{-3}$		607
$\eta\rho$	seen		†
$\pi^+\pi^+\pi^-\pi^0$	< 50 %	84%	535
$(K\bar{K})^\pm\pi^0$	< 8 %	90%	248
$K_S^0 K_L^0 \pi^\pm$	< 6 %	90%	235
$K_S^0 K_S^0 \pi^\pm$	< 2 %	90%	235
$\phi\pi$	< 1.5 %	84%	147

$$a_1(1260)^{[m]} \quad I^G(J^{PC}) = 1^-(1^{++})$$

Mass  $m = 1230 \pm 40$  MeV<sup>[m]</sup>  
Full width  $\Gamma = 250$  to 600 MeV

$a_1(1260)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$(\rho\pi)_{S\text{-wave}}$	seen	353
$(\rho\pi)_{D\text{-wave}}$	seen	353
$(\rho(1450)\pi)_{S\text{-wave}}$	seen	†
$(\rho(1450)\pi)_{D\text{-wave}}$	seen	†
$\sigma\pi$	seen	-
$f_0(980)\pi$	not seen	189
$f_0(1370)\pi$	seen	†
$f_2(1270)\pi$	seen	†
$K\bar{K}^*(892) + \text{c.c.}$	seen	†
$\pi\gamma$	seen	608

$$f_2(1270) \quad I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 1275.4 \pm 1.1$  MeV  
Full width  $\Gamma = 185.2^{+3.1}_{-2.5}$  MeV ( $S = 1.5$ )

$f_2(1270)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\pi\pi$	$(84.7^{+2.5}_{-1.2})$ %	$S = 1.2$	623
$\pi^+\pi^-2\pi^0$	$(7.1^{+1.4}_{-2.7})$ %	$S = 1.3$	563
$K\bar{K}$	$(4.6 \pm 0.4)$ %	$S = 2.7$	404
$2\pi^+2\pi^-$	$(2.8 \pm 0.4)$ %	$S = 1.2$	559
$\eta\eta$	$(4.0 \pm 0.8) \times 10^{-3}$	$S = 2.1$	327
$4\pi^0$	$(3.0 \pm 1.0) \times 10^{-3}$		565
$\gamma\gamma$	$(1.41 \pm 0.13) \times 10^{-5}$		638
$\eta\pi\pi$	< 8 $\times 10^{-3}$	CL = 95%	478
$K^0 K^- \pi^+ + \text{c.c.}$	< 3.4 $\times 10^{-3}$	CL = 95%	293
$e^+e^-$	< 6 $\times 10^{-10}$	CL = 90%	638

$$f_1(1285) \quad I^G(J^{PC}) = 0^+(1^{++})$$

Mass  $m = 1281.8 \pm 0.6$  MeV ( $S = 1.6$ )  
Full width  $\Gamma = 24.2 \pm 1.1$  MeV ( $S = 1.3$ )

$f_1(1285)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level (MeV/c)	$p$ (MeV/c)
$4\pi$	$(33.1^{+2.1}_{-1.8})$ %	$S = 1.3$	568
$\pi^0\pi^0\pi^+\pi^-$	$(22.0^{+1.4}_{-1.2})$ %	$S = 1.3$	566
$2\pi^+2\pi^-$	$(11.0^{+0.7}_{-0.6})$ %	$S = 1.3$	563
$\rho^0\pi^+\pi^-$	$(11.0^{+0.7}_{-0.6})$ %	$S = 1.3$	336
$\rho^0\rho^0$	seen		†
$4\pi^0$	< 7 $\times 10^{-4}$	CL = 90%	568
$\eta\pi\pi$	$(52 \pm 16)$ %		482
$a_0(980)\pi$ [ignoring $a_0(980) \rightarrow K\bar{K}$ ]	$(36 \pm 7)$ %		234
$\eta\pi\pi$ [excluding $a_0(980)\pi$ ]	$(16 \pm 7)$ %		482
$K\bar{K}\pi$	$(9.0 \pm 0.4)$ %	$S = 1.1$	308
$K\bar{K}^*(892)$	not seen		†
$\gamma\rho^0$	$(5.5 \pm 1.3)$ %	$S = 2.8$	406
$\phi\gamma$	$(7.4 \pm 2.6) \times 10^{-4}$		236

$$\eta(1295) \quad I^G(J^{PC}) = 0^+(0^{-+})$$

Mass  $m = 1294 \pm 4$  MeV ( $S = 1.6$ )  
Full width  $\Gamma = 55 \pm 5$  MeV

$\eta(1295)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\eta\pi^+\pi^-$	seen	487
$a_0(980)\pi$	seen	244
$\eta\pi^0\pi^0$	seen	490
$\eta(\pi\pi)_{S\text{-wave}}$	seen	-

$$\pi(1300) \quad I^G(J^{PC}) = 1^-(0^{-+})$$

Mass  $m = 1300 \pm 100$  MeV<sup>[n]</sup>  
Full width  $\Gamma = 200$  to 600 MeV

$\pi(1300)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	404
$\pi(\pi\pi)_{S\text{-wave}}$	seen	-

$$\pi_2(1320) \quad I^G(J^{PC}) = 1^-(2^{++})$$

Mass  $m = 1318.3 \pm 0.6$  MeV ( $S = 1.2$ )  
Full width  $\Gamma = 107 \pm 5$  MeV<sup>[n]</sup>

$a_2(1320)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\rho\pi$	$(70.1 \pm 2.7) \%$	$S = 1.2$	417
$\eta\pi$	$(14.5 \pm 1.2) \%$		536
$\omega\pi\pi$	$(10.6 \pm 3.2) \%$	$S = 1.3$	366
$K\bar{K}$	$(4.9 \pm 0.8) \%$		437
$\eta'(958)\pi$	$(5.3 \pm 0.9) \times 10^{-3}$		288
$\pi^\pm\gamma$	$(2.68 \pm 0.31) \times 10^{-3}$		652
$\gamma\gamma$	$(9.4 \pm 0.7) \times 10^{-6}$		659
$\pi^+\pi^-\pi^-$	$< 8 \%$	CL = 90%	621
$e^+e^-$	$< 6 \times 10^{-9}$	CL = 90%	659

$$f_0(1370)^{[ll]} \quad I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = 1200$  to  $1500$  MeV  
Full width  $\Gamma = 200$  to  $500$  MeV

$f_0(1370)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	seen	672
$4\pi$	seen	617
$4\pi^0$	seen	617
$2\pi^+2\pi^-$	seen	612
$\pi^+\pi^-2\pi^0$	seen	615
$\rho\rho$	dominant	†
$2(\pi\pi)_{S\text{-wave}}$	seen	-
$\pi(1300)\pi$	seen	†
$a_1(1260)\pi$	seen	35
$\eta\eta$	seen	412
$K\bar{K}$	seen	475
$\gamma\gamma$	seen	685
$e^+e^-$	not seen	685

$$\pi_1(1400)^{[ol]} \quad I^G(J^{PC}) = 1^-(1^{-+})$$

Mass  $m = 1376 \pm 17$  MeV  
Full width  $\Gamma = 300 \pm 40$  MeV

$\pi_1(1400)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\eta\pi^0$	seen	570
$\eta\pi^-$	seen	569

$$\eta(1405)^{[pl]} \quad I^G(J^{PC}) = 0^+(0^{-+})$$

Mass  $m = 1409.8 \pm 2.5$  MeV<sup>[nl]</sup> ( $S = 2.2$ )  
Full width  $\Gamma = 51.1 \pm 3.4$  MeV<sup>[nl]</sup> ( $S = 2.0$ )

$\eta(1405)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$K\bar{K}\pi$	seen		425
$\eta\pi\pi$	seen		563
$a_0(980)\pi$	seen		342
$\eta(\pi\pi)_{S\text{-wave}}$	seen		-
$f_0(980)\eta$	seen		†
$4\pi$	seen		639
$\rho\rho$	$< 58 \%$	99.85%	†
$K^*(892)K$	seen		125

$$f_1(1420)^{[ql]} \quad I^G(J^{PC}) = 0^+(1^{++})$$

Mass  $m = 1426.3 \pm 0.9$  MeV ( $S = 1.1$ )  
Full width  $\Gamma = 54.9 \pm 2.6$  MeV

$f_1(1420)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}\pi$	dominant	438
$K\bar{K}^*(892)+c.c.$	dominant	163
$\eta\pi\pi$	possibly seen	573
$\phi\gamma$	seen	349

$$\omega(1420)^{[rl]} \quad I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m$  (1400–1450) MeV  
Full width  $\Gamma$  (180–250) MeV

$\omega(1420)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	dominant	486
$\omega\pi\pi$	seen	444
$b_1(1235)\pi$	seen	125
$e^+e^-$	seen	710

$$a_0(1450)^{[ll]} \quad I^G(J^{PC}) = 1^-(0^{++})$$

Mass  $m = 1474 \pm 19$  MeV  
Full width  $\Gamma = 265 \pm 13$  MeV

$a_0(1450)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\eta$	seen	627
$\pi\eta'(958)$	seen	410
$K\bar{K}$	seen	547
$\omega\pi\pi$	seen	484

$$\rho(1450)^{[sl]} \quad I^G(J^{PC}) = 1^+(0^{--})$$

Mass  $m = 1459 \pm 11$  MeV<sup>[nl]</sup> ( $S = 3.4$ )  
Full width  $\Gamma = 147 \pm 40$  MeV<sup>[nl]</sup> ( $S = 4.9$ )

$\rho(1450)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\pi\pi$	seen		717
$4\pi$	seen		666
$\omega\pi$	$< 2.0 \%$	95%	508
$e^+e^-$	seen		730
$\eta\rho$	$< 4 \%$		304
$a_2(1320)\pi$	not seen		39
$\phi\pi$	$< 1 \%$		355
$K\bar{K}$	$< 1.6 \times 10^{-3}$	95%	537
$\eta\gamma$	possibly seen		627

$$\eta(1475)^{[pl]} \quad I^G(J^{PC}) = 0^+(0^{-+})$$

Mass  $m = 1476 \pm 4$  MeV ( $S = 1.4$ )  
Full width  $\Gamma = 87 \pm 9$  MeV ( $S = 1.6$ )

$\eta(1475)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}\pi$	dominant	477
$K\bar{K}^*(892)+c.c.$	seen	245
$a_0(980)\pi$	seen	393
$\gamma\gamma$	seen	738

$$f_0(1500)^{[ol]} \quad I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = 1507 \pm 5$  MeV ( $S = 1.2$ )  
Full width  $\Gamma = 109 \pm 7$  MeV

$f_0(1500)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$\eta\eta'(958)$	$(1.9 \pm 0.8) \%$	1.7	37
$\eta\eta$	$(5.1 \pm 0.9) \%$	1.4	518
$4\pi$	$(49.5 \pm 3.3) \%$	1.2	692
$4\pi^0$	seen		692
$2\pi^+2\pi^-$	seen		688
$\pi\pi$	$(34.9 \pm 2.3) \%$	1.2	741
$\pi^+\pi^-$	seen		741
$2\pi^0$	seen		741
$K\bar{K}$	$(8.6 \pm 1.0) \%$	1.1	569
$\gamma\gamma$	not seen		754

$$f_2'(1525) \quad I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 1525 \pm 5$  MeV<sup>[nl]</sup>  
Full width  $\Gamma = 73_{-5}^{+6}$  MeV<sup>[nl]</sup>

$f_2^{\prime}(1525)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	$(88.8 \pm 3.1) \%$	581
$\eta\eta$	$(10.3 \pm 3.1) \%$	531
$\pi\pi$	$(8.2 \pm 1.5) \times 10^{-3}$	750
$\gamma\gamma$	$(1.11 \pm 0.14) \times 10^{-6}$	763

 $\pi_1(1600)^{[ol]}$ 

$$I^G(J^{PC}) = 1^-(1^{-+})$$

$$\text{Mass } m = 1653_{-15}^{+18} \text{ MeV } (S = 1.6)$$

$$\text{Full width } \Gamma = 225_{-28}^{+45} \text{ MeV } (S = 1.5)$$

$\pi_1(1600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi\pi$	seen	799
$\rho^0\pi^-$	seen	635
$f_2(1270)\pi^-$	not seen	310
$b_1(1235)\pi$	seen	350
$\eta'(958)\pi^-$	seen	537
$f_1(1285)\pi$	seen	307

 $\eta_2(1645)$ 

$$I^G(J^{PC}) = 0^+(2^{-+})$$

$$\text{Mass } m = 1617 \pm 5 \text{ MeV}$$

$$\text{Full width } \Gamma = 181 \pm 11 \text{ MeV}$$

$\eta_2(1645)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$a_2(1320)\pi$	seen	242
$K\bar{K}\pi$	seen	580
$K^*\bar{K}$	seen	404
$\eta\pi^+\pi^-$	seen	685
$a_0(980)\pi$	seen	496
$f_2(1270)\eta$	not seen	†

 $\omega(1650)^{[ll]}$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

$$\text{Mass } m = 1670 \pm 30 \text{ MeV}$$

$$\text{Full width } \Gamma = 315 \pm 35 \text{ MeV}$$

$\omega(1650)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	646
$\omega\pi\pi$	seen	617
$\omega\eta$	seen	500
$e^+e^-$	seen	835

 $\omega_3(1670)$ 

$$I^G(J^{PC}) = 0^-(3^{--})$$

$$\text{Mass } m = 1667 \pm 4 \text{ MeV}$$

$$\text{Full width } \Gamma = 168 \pm 10 \text{ MeV}^{[ml]}$$

$\omega_3(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	645
$\omega\pi\pi$	seen	615
$b_1(1235)\pi$	possibly seen	361

 $\pi_2(1670)$ 

$$I^G(J^{PC}) = 1^-(2^{-+})$$

$$\text{Mass } m = 1672.4 \pm 3.2 \text{ MeV}^{[ml]} (S = 1.4)$$

$$\text{Full width } \Gamma = 259 \pm 9 \text{ MeV}^{[ml]} (S = 1.3)$$

$\omega_2(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$3\pi$	$(95.8 \pm 1.4) \%$		809
$f_2(1270)\pi$	$(56.2 \pm 3.2) \%$		329
$\rho\pi$	$(31 \pm 4) \%$		648
$\sigma\pi$	$(10.9 \pm 3.4) \%$		-
$(\pi\pi)_{S\text{-wave}}$	$(8.7 \pm 3.4) \%$		-
$K\bar{K}^*(892)+\text{c.c.}$	$(4.2 \pm 1.4) \%$		455
$\omega\rho$	$(2.7 \pm 1.1) \%$		304
$\rho(1450)\pi$	$< 3.6$	$\times 10^{-3}$	97.7% 154
$b_1(1235)\pi$	$< 1.9$	$\times 10^{-3}$	97.7% 366
$f_1(1285)\pi$	possibly seen		323
$a_2(1320)\pi$	not seen		292

 $\phi(1680)$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

$$\text{Mass } m = 1680 \pm 20 \text{ MeV}^{[ml]}$$

$$\text{Full width } \Gamma = 150 \pm 50 \text{ MeV}^{[ml]}$$

$\phi(1680)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}^*(892)+\text{c.c.}$	dominant	462
$K_S^0 K\pi$	seen	621
$K\bar{K}$	seen	680
$e^+e^-$	seen	840
$\omega\pi\pi$	not seen	623

 $\rho_3(1690)$ 

$$I^G(J^{PC}) = 1^+(3^{--})$$

$$\text{Mass } m = 1688 \pm 2.1 \text{ MeV}^{[ml]}$$

$$\text{Full width } \Gamma = 161 \pm 10 \text{ MeV}^{[ml]} (S = 1.5)$$

$\rho_3(1690)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$4\pi$	$(71.1 \pm 1.9)$	%	790
$\pi^\pm\pi^+\pi^-\pi^0$	$(67 \pm 22)$	%	787
$\omega\pi$	$(16 \pm 6)$	%	655
$\pi\pi$	$(23.6 \pm 1.3)$	%	834
$K\bar{K}\pi$	$(3.8 \pm 1.2)$	%	629
$K\bar{K}$	$(1.58 \pm 0.26)$	%	1.2 685
$\eta\pi^+\pi^-$	seen		727
$\rho(770)\eta$	seen		520
$\pi\pi\rho$	seen		633
Excluding $2\rho$ and $a_2(1320)\pi$ .			
$a_2(1320)\pi$	seen		307
$\rho\rho$	seen		334

 $\rho(1700)^{[sl]}$ 

$$I^G(J^{PC}) = 1^+(1^{--})$$

$$\text{Mass } m = 1720 \pm 20 \text{ MeV}^{[ml]} (\eta\rho^0 \text{ and } \pi^+\pi^- \text{ modes})$$

$$\text{Full width } \Gamma = 250 \pm 100 \text{ MeV}^{[ml]} (\eta\rho^0 \text{ and } \pi^+\pi^- \text{ modes})$$

$\rho(1700)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$2(\pi^+\pi^-)$	large	803
$\rho\pi\pi$	dominant	653
$\rho^0\pi^+\pi^-$	large	650
$\rho^\pm\pi^+\pi^0$	large	652
$a_1(1260)\pi$	seen	404
$h_1(1170)\pi$	seen	447
$\pi(1300)\pi$	seen	349
$\rho\rho$	seen	372
$\pi^+\pi^-$	seen	849
$\pi\pi$	seen	849
$K\bar{K}^*(892)+\text{c.c.}$	seen	496
$\eta\rho$	seen	545
$a_2(1320)\pi$	not seen	334
$K\bar{K}$	seen	704
$e^+e^-$	seen	860
$\pi^0\omega$	seen	674

**$f_0(1710)^{[u]}$** 

$$I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = 1718 \pm 6$  MeV ( $S = 1.2$ )Full width  $\Gamma = 137 \pm 8$  MeV ( $S = 1.1$ )

$f_0(1710)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	703
$\eta\eta$	seen	662
$\pi\pi$	seen	849

 **$\pi(1800)$** 

$$I^G(J^{PC}) = 1^-(0^{-+})$$

Mass  $m = 1812 \pm 14$  MeV ( $S = 2.3$ )Full width  $\Gamma = 207 \pm 13$  MeV

$\pi(1800)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi^+\pi^-\pi^-$	seen	879
$f_0(600)\pi^-$	seen	-
$f_0(980)\pi^-$	seen	631
$f_0(1370)\pi^-$	seen	368
$f_0(1500)\pi^-$	not seen	248
$\rho\pi^-$	not seen	732
$\eta\eta\pi^-$	seen	661
$a_0(980)\eta$	seen	470
$f_0(1500)\pi^-$	seen	248
$\eta\eta'(958)\pi^-$	seen	376
$K_0^*(1430)K^-$	seen	†
$K^*(892)K^-$	not seen	570

 **$\phi_3(1850)$** 

$$I^G(J^{PC}) = 0^+(3^{--})$$

Mass  $m = 1812 \pm 7$  MeVFull width  $\Gamma = 87_{-23}^{+28}$  MeV ( $S = 1.2$ )

$\phi_3(1850)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	785
$K\bar{K}^*(892) + c.c.$	seen	602

 **$f_2(1950)$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 1944 \pm 12$  MeV ( $S = 1.5$ )Full width  $\Gamma = 472 \pm 18$  MeV

$f_2(1950)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K^*(892)\bar{K}^*(892)$	seen	387
$\pi^+\pi^-$	seen	962
$4\pi$	seen	925
$\eta\eta$	seen	803
$K\bar{K}$	seen	837
$\gamma\gamma$	seen	972

 **$f_2(2010)$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 2011_{-80}^{+60}$  MeVFull width  $\Gamma = 202 \pm 60$  MeV

$f_2(2010)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\phi\phi$	seen	†

 **$a_4(2040)$** 

$$I^G(J^{PC}) = 1^-(4^{++})$$

Mass  $m = 2001 \pm 10$  MeVFull width  $\Gamma = 313 \pm 31$  MeV **$a_4(2040)$  DECAY MODES**

DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	870
$\pi^+\pi^-\pi^0$	seen	977
$\rho\pi$	seen	844
$f_2(1270)\pi$	seen	583
$\omega\pi^-\pi^0$	seen	822
$\omega\rho$	seen	628
$\eta\pi^0$	seen	920
$\eta'(958)\pi$	seen	764

 **$f_4(2050)$** 

$$I^G(J^{PC}) = 0^+(4^{++})$$

Mass  $m = 2025 \pm 10$  MeV ( $S = 1.8$ )Full width  $\Gamma = 225 \pm 18$  MeV ( $S = 1.7$ )

$f_4(2050)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\omega\omega$	not seen	642
$\pi\pi$	(17.0 ± 1.5)%	1003
$K\bar{K}$	(6.8 $_{-1.8}^{+3.4}$ ) × 10 <sup>-3</sup>	884
$\eta\eta$	(2.1 ± 0.8) × 10 <sup>-3</sup>	852
$4\pi^0$	< 1.2%	967
$a_2(1320)\pi$	seen	572

 **$f_2(2300)$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 2297 \pm 28$  MeVFull width  $\Gamma = 149 \pm 40$  MeV

$f_2(2300)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\phi\phi$	seen	529
$K\bar{K}$	seen	1037
$\gamma\gamma$	seen	1149

 **$f_2(2340)$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 2339 \pm 60$  MeVFull width  $\Gamma = 319_{-70}^{+80}$  MeV

$f_2(2340)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\phi\phi$	seen	573

**STRANGE MESONS**

$$(S = \pm 1, C = B = 0)$$

 $K^+ = u\bar{s}, K^0 = d\bar{s}, \bar{K}^0 = \bar{d}s, K^- = \bar{u}s$ , similarly for  $K^{*}$ 's **$K^\pm$** 

$$I^{(J^P)} = \frac{1}{2}(0^-)$$

Mass  $m = 493.677 \pm 0.016$  MeV<sup>[u]</sup> ( $S = 2.8$ )Mean life  $\tau = (1.2385 \pm 0.0024) \times 10^{-8}$  s ( $S = 2.0$ ) $c\tau = 3.713$  m**Slope parameter  $g$** <sup>[u]</sup>(See Particle Listings for quadratic coefficients an alternative parameterization related to  $\pi\pi$  scattering)

$$K^+ \rightarrow \pi^+\pi^+\pi^- = -0.2154 \pm 0.0035 \quad (S = 1.4)$$

$$K^- \rightarrow \pi^-\pi^-\pi^+ = -0.217 \pm 0.007 \quad (S = 2.5)$$

$$K^\pm \rightarrow \pi^\pm\pi^+\pi^- (g_+ - g_-) / (g_+ + g_-) = (1.5 \pm 2.9) \times 10^{-4}$$

$$K^\pm \rightarrow \pi^\pm\pi^0\pi^0 = 0.626 \pm 0.007$$

$$K^\pm \rightarrow \pi^\pm\pi^0\pi^0 (g_+ - g_-) / (g_+ + g_-) = (0.02 \pm 0.19)\%$$

 **$K^\pm$  decay form factors**<sup>[a,x]</sup>Assuming  $\mu$ - $e$  universality

$$\lambda_+(K_{\mu 3}^+) = \lambda_+(K_{e 3}^+) = (2.96 \pm 0.05) \times 10^{-2}$$

$$\lambda_0(K_{\mu 3}^+) = (1.96 \pm 0.12) \times 10^{-2}$$



Not assuming  $\mu$ - $e$  universality

$$\lambda_+(K_{e3}^+) = (2.96 \pm 0.06) \times 10^{-2}$$

$$\lambda_+(K_{\mu 3}^+) = (2.96 \pm 0.17) \times 10^{-2}$$

$$\lambda_0(K_{\mu 3}^+) = (1.96 \pm 0.13) \times 10^{-2}$$

$K_{e3}$  form factor quadratic fit

$$\lambda'_+(K_{e3}^+) \text{ linear coeff.} = (2.48 \pm 0.17) \times 10^{-2}$$

$$\lambda''_+(K_{e3}^+) \text{ quadratic coeff.} = (0.19 \pm 0.09) \times 10^{-2}$$

$$K_{e3}^+ |f_S/f_+| = (-0.3^{+0.8}_{-0.7}) \times 10^{-2}$$

$$K_{e3}^+ |f_T/f_+| = (-1.2 \pm 2.3) \times 10^{-2}$$

$$K_{\mu 3}^+ |f_S/f_+| = (0.2 \pm 0.6) \times 10^{-2}$$

$$K_{\mu 3}^+ |f_T/f_+| = (-0.1 \pm 0.7) \times 10^{-2}$$

$$K^+ \rightarrow e^+ v_e \gamma \quad |F_A + F_V| = 0.148 \pm 0.010$$

$$K^+ \rightarrow \mu^+ v_\mu \gamma \quad |F_A + F_V| = 0.165 \pm 0.013$$

$$K^+ \rightarrow e^+ v_e \gamma \quad |F_A - F_V| < 0.49$$

$$K^+ \rightarrow \mu^+ v_\mu \gamma \quad |F_A - F_V| = -0.24 \text{ to } 0.04, \text{ CL} = 90\%$$

**Charge radius**

$$\langle r \rangle = 0.560 \pm 0.031 \text{ fm}$$

**CP violation parameters**

$$\Delta(K_{\pi\mu\mu}^\pm) = -0.02 \pm 0.12$$

**T violation parameters**

$$K^+ \rightarrow \pi^0 \mu^+ v_\mu \quad P_T = (-1.7 \pm 2.5) \times 10^{-3}$$

$$K^+ \rightarrow \mu^+ v_\mu \gamma \quad P_T = (-0.6 \pm 1.9) \times 10^{-2}$$

$$K^+ \rightarrow \pi^0 \mu^+ v_\mu \quad \text{Im}(\xi) = -0.006 \pm 0.008$$

$K^-$  modes are charge conjugates of the modes below.

$K^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Leptonic and semileptonic modes</b>			
$e^+ v_e$	$(1.55 \pm 0.07) \times 10^{-5}$		247
$\mu^+ v_\mu$	$(63.44 \pm 0.14) \%$	S = 1.2	236
$\pi^0 e^+ v_e$	$(4.98 \pm 0.07) \%$	S = 1.3	228
Called $K_{e3}^+$ .			
$\pi^0 \mu^+ v_\mu$	$(3.32 \pm 0.06) \%$	S = 1.2	215
Called $K_{\mu 3}^+$ .			
$\pi^0 \pi^0 e^+ v_e$	$(2.2 \pm 0.4) \times 10^{-5}$		206
$\pi^+ \pi^- e^+ v_e$	$(4.09 \pm 0.09) \times 10^{-5}$		203
$\pi^+ \pi^- \mu^+ v_\mu$	$(1.4 \pm 0.9) \times 10^{-5}$		151
$\pi^0 \pi^0 \pi^0 e^+ v_e$	$< 3.5 \times 10^{-6}$	CL = 90%	135
<b>Hadronic modes</b>			
$\pi^+ \pi^0$	$(20.92 \pm 0.12) \%$	S = 1.1	205
$\pi^+ \pi^0 \pi^0$	$(1.757 \pm 0.024) \%$	S = 1.1	133
$\pi^+ \pi^+ \pi^-$	$(5.590 \pm 0.031) \%$	S = 1.1	125
<b>Leptonic and semileptonic modes with photons</b>			
$\mu^+ v_\mu \gamma$	$[y,z] (6.2 \pm 0.8) \times 10^{-3}$		236
$\mu^+ v_\mu \gamma$ (SD <sup>+</sup> )	$[aa] < 3.0 \times 10^{-5}$	CL = 90%	-
$\mu^+ v_\mu \gamma$ (SD+INT)	$[aa] < 2.7 \times 10^{-5}$	CL = 90%	-
$\mu^+ v_\mu \gamma$ (SD <sup>-</sup> + SD-INT)	$[aa] < 2.6 \times 10^{-4}$	CL = 90%	-
$e^+ v_e \gamma$ (SD <sup>+</sup> )	$[aa] (1.52 \pm 0.23) \times 10^{-5}$		-
$e^+ v_e \gamma$ (SD <sup>-</sup> )	$[aa] < 1.6 \times 10^{-4}$	CL = 90%	-
$\pi^0 e^+ v_e \gamma$	$[y,z] (2.69 \pm 0.20) \times 10^{-4}$		228
$\pi^0 e^+ v_e \gamma$ (SD)	$[aa] < 5.3 \times 10^{-5}$	CL = 90%	228
$\pi^0 \mu^+ v_\mu \gamma$	$[y,z] (2.4 \pm 0.8) \times 10^{-5}$		215
$\pi^0 \pi^0 e^+ v_e \gamma$	$< 5 \times 10^{-6}$	CL = 90%	206
<b>Hadronic modes with photons</b>			
$\pi^+ \pi^0 \gamma$	$[y,z] (2.75 \pm 0.15) \times 10^{-4}$		205
$\pi^+ \pi^0 \gamma$ (DE)	$[z,bb] (4.4 \pm 0.7) \times 10^{-6}$		205
$\pi^+ \pi^0 \pi^0 \gamma$	$[y,z] (7.6^{+5.6}_{-3.0}) \times 10^{-6}$		133
$\pi^+ \pi^+ \pi^- \gamma$	$[y,z] (1.04 \pm 0.31) \times 10^{-4}$		125
$\pi^+ \gamma \gamma$	$[z] (1.10 \pm 0.32) \times 10^{-6}$		227
$\pi^+ 3\gamma$	$[z] < 1.0 \times 10^{-4}$	CL = 90%	227

Leptonic modes with  $\ell\bar{\ell}$  pairs

$e^+ v_e v\bar{v}$	$< 6 \times 10^{-5}$	CL = 90%	247
$\mu^+ v_\mu v\bar{v}$	$< 6.0 \times 10^{-6}$	CL = 90%	236
$e^+ v_e e^+ e^-$	$(2.48 \pm 0.20) \times 10^{-8}$		247
$\mu^+ v_\mu e^+ e^-$	$(7.06 \pm 0.31) \times 10^{-8}$		236
$e^+ v_e \mu^+ \mu^-$	$(1.7 \pm 0.5) \times 10^{-8}$		223
$\mu^+ v_\mu \mu^+ \mu^-$	$< 4.1 \times 10^{-7}$	CL = 90%	185

Lepton Family number (LF), Lepton number (L),  $\Delta S = \Delta Q$  (SQ) violating modes, or  $\Delta S = 1$  weak neutral current (S1) modes

$\pi^+ \pi^+ e^- \bar{v}_e$	SQ	$< 1.2 \times 10^{-8}$	CL = 90%	203
$\pi^+ \pi^+ \mu^- \bar{v}_\mu$	SQ	$< 3.0 \times 10^{-6}$	CL = 95%	151
$\pi^+ e^+ e^-$	S1	$(2.88 \pm 0.13) \times 10^{-7}$		227
$\pi^+ \mu^+ e^-$	S1	$(8.1 \pm 1.4) \times 10^{-8}$	S = 2.7	172
$\pi^+ v\bar{v}$	S1	$(1.5^{+1.3}_{-0.9}) \times 10^{-10}$		227
$\pi^+ \pi^0 v\bar{v}$	S1	$< 4.3 \times 10^{-5}$	CL = 90%	205
$\mu^- v e^+ e^+$	LF	$< 2.0 \times 10^{-8}$	CL = 90%	236
$\mu^+ v_e$	LF	$[d] < 4 \times 10^{-3}$	CL = 90%	236
$\pi^+ \mu^+ e^-$	LF	$< 1.3 \times 10^{-11}$	CL = 90%	214
$\pi^+ \mu^- e^+$	LF	$< 5.2 \times 10^{-10}$	CL = 90%	214
$\pi^- \mu^+ e^+$	L	$< 5.0 \times 10^{-10}$	CL = 90%	214
$\pi^- e^+ e^+$	L	$< 6.4 \times 10^{-10}$	CL = 90%	227
$\pi^- \mu^+ \mu^+$	L	$[d] < 3.0 \times 10^{-9}$	CL = 90%	172
$\mu^+ \bar{v}_e$	L	$[d] < 3.3 \times 10^{-3}$	CL = 90%	236
$\pi^0 e^+ \bar{v}_e$	L	$< 3 \times 10^{-3}$	CL = 90%	228
$\pi^+ \gamma$	[cc]	$< 2.3 \times 10^{-9}$	CL = 90%	227

$K^0$

$$I(J^P) = \frac{1}{2}(0^-)$$

50%  $K_S$ , 50%  $K_L$

$$\text{Mass } m = 497.648 \pm 0.022 \text{ MeV}$$

$$m_{K^0} - m_{K^\pm} = 3.972 \pm 0.027 \text{ MeV} \quad (S = 1.2)$$

**Mean square charge radius**

$$\langle r^2 \rangle = -0.077 \pm 0.010 \text{ fm}^2$$

**T-violation parameters in  $K^0 \bar{K}^0$  mixing**<sup>[x]</sup>

$$\text{Asymmetry } A_T \text{ in } K^0 \bar{K}^0 \text{ mixing} = (6.6 \pm 1.6) \times 10^{-3}$$

**CPT-violation parameters**<sup>[x]</sup>

$$\text{Re } \delta = (2.9 \pm 2.7) \times 10^{-4}$$

$$\text{Im } \delta = (-0.2 \pm 2.0) \times 10^{-5}$$

$$\text{Re}(y), K_{e3} \text{ parameter} = (0.4 \pm 2.5) \times 10^{-3}$$

$$\text{Re}(x_-), K_{e3} \text{ parameter} = (-0.8 \pm 2.5) \times 10^{-3}$$

$$|m_{K^0} - m_{\bar{K}^0}| / m_{\text{average}} < 10^{-18}, \text{ CL} = 90\%^{[dd]}$$

$$(\Gamma_{K^0} - \Gamma_{\bar{K}^0}) / m_{\text{average}} = (8 \pm 8) \times 10^{-18}$$

**Tests of  $\Delta S = \Delta Q$**

$$\text{Re}(x_+), K_{e3} \text{ parameter} = (-0.8 \pm 3.1) \times 10^{-3}$$

$K_S^0$

$$I(J^P) = \frac{1}{2}(0^-)$$

Mean life  $\tau = (0.8953 \pm 0.0005) \times 10^{-10} \text{ s}$  (S = 1.1) Assuming CPT

Mean life  $\tau = (0.8958 \pm 0.0006) \times 10^{-10} \text{ s}$  (S = 1.2) Not assuming CPT

$$c\tau = 2.6842 \text{ cm} \quad \text{Assuming CPT}$$

**CP-violation parameters**<sup>[ee]</sup>

$$\text{Im}(\eta_{+-0}) = -0.002 \pm 0.009$$

$$\text{Im}(\eta_{000}) = (-0.1 \pm 1.6) \times 10^{-2}$$

$$|\eta_{000}| = |A(K_S^0 \rightarrow 3\pi^0)/A(K_L^0 \rightarrow 3\pi^0)| < 0.018, \text{ CL} = 90\%$$

$$\text{CP asymmetry } A \text{ in } \pi^+ \pi^- e^+ e^- = (-1 \pm 4) \%$$

$K_S^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
<b>Hadronic modes</b>			
$\pi^0\pi^0$	$(30.69 \pm 0.05) \%$		209
$\pi^+\pi^-$	$(69.20 \pm 0.05) \%$		206
$\pi^+\pi^-\pi^0$	$(3.5^{+1.5}_{-0.5}) \times 10^{-7}$		133
<b>Modes with photons or <math>\ell\bar{\ell}</math> pairs</b>			
$\pi^+\pi^-\gamma$	$[y,ff] (1.79 \pm 0.05) \times 10^{-3}$		206
$\pi^+\pi^-e^+e^-$	$(4.69 \pm 0.30) \times 10^{-5}$		206
$\pi^0\gamma\gamma$	$[ff] (4.9 \pm 1.8) \times 10^{-8}$		231
$\gamma\gamma$	$(2.84 \pm 0.07) \times 10^{-6}$		249
<b>Semileptonic modes</b>			
$\pi^\pm e^\mp \nu_e$	$[gg] (7.04 \pm 0.09) \times 10^{-4}$		229
<b>CP violating (CP) and <math>\Delta S = 1</math> weak neutral current (S1) modes</b>			
$3\pi^0$	CP < 1.2	$\times 10^{-7}$	90% 139
$\mu^+\mu^-$	S1 < 3.2	$\times 10^{-7}$	90% 225
$e^+e^-$	S1 < 1.4	$\times 10^{-7}$	90% 249
$\pi^0 e^+ e^-$	S1 [ff] $(3.0^{+1.5}_{-1.2}) \times 10^{-9}$		231
$\pi^0 \mu^+ \mu^-$	S1 $(2.9^{+1.3}_{-1.2}) \times 10^{-9}$		177

 $K_L^0$ 

$$I(J^P) = \frac{1}{2}(0^-)$$

 $m_{K_L} - m_{K_S}$ 

$$= (0.5292 \pm 0.0009) \times 10^{10} \hbar s^{-1} \quad (S = 1.2) \quad \text{Assuming } CPT$$

$$= (3.483 \pm 0.006) \times 10^{-12} \text{ MeV} \quad \text{Assuming } CPT$$

$$= (0.5290 \pm 0.0016) \times 10^{10} \hbar s^{-1} \quad (S = 1.2) \quad \text{Not assuming } CPT$$

$$\text{Mean life } \tau = (5.114 \pm 0.021) \times 10^{-8} \text{ s}$$

$$c\tau = 15.33 \text{ m}$$

Slope parameter  $g^{[w]}$ 

$$\text{(See Particle Listings for quadratic coefficients)}$$

$$K_L^0 \rightarrow \pi^+\pi^-\pi^0 = 0.678 \pm 0.008 \quad (S = 1.5)$$

 $K_L$  decay form factors<sup>[x]</sup>Linear parametrization assuming  $\mu$ - $e$  universality

$$\lambda_+(K_{\mu 3}^0) = \lambda_+(K_{e 3}^0) = (2.84 \pm 0.04) \times 10^{-2}$$

$$\lambda_0(K_{\mu 3}^0) = (1.64 \pm 0.11) \times 10^{-2}$$

Quadratic parametrization assuming  $\mu$ - $e$  universality

$$\lambda'_+(K_{\mu 3}^0) = \lambda'_+(K_{e 3}^0) = (2.42 \pm 0.14) \times 10^{-2} \quad (S = 1.3)$$

$$\lambda''_+(K_{\mu 3}^0) = \lambda''_+(K_{e 3}^0) = (0.18 \pm 0.05) \times 10^{-2} \quad (S = 1.1)$$

$$\lambda_0(K_{\mu 3}^0) = (1.46 \pm 0.13) \times 10^{-2}$$

Pole parametrization assuming  $\mu$ - $e$  universality

$$M_V^\mu(K_{\mu 3}^0) = M_V^e(K_{e 3}^0) = 877 \pm 5 \text{ MeV} \quad (S = 1.1)$$

$$M_S^\mu(K_{\mu 3}^0) = 1187 \pm 50$$

$$K_{e 3}^0 |f_S/f_+| = (1.5^{+1.4}_{-1.6}) \times 10^{-2}$$

$$K_{e 3}^0 |f_T/f_+| = (5^{+4}_{-5}) \times 10^{-2}$$

$$K_{\mu 3}^0 |f_T/f_+| = (12 \pm 12) \times 10^{-2}$$

$$K_L \rightarrow e^+e^-\gamma: \alpha_{K^*} = -0.33 \pm 0.05$$

$$K_L \rightarrow \mu^+\mu^-\gamma: \alpha_{K^*} = -0.158 \pm 0.027$$

$$K_L \rightarrow e^+e^-e^+e^-: \alpha_{K^*}^{\text{eff}} = -0.14 \pm 0.22$$

$$K_L \rightarrow \pi^+\pi^-e^+e^-: a_1/a_2 = -0.734 \pm 0.022 \text{ GeV}^2$$

$$K_L \rightarrow \pi^0 2\gamma: a_V = -0.54 \pm 0.12 \quad (S = 2.8)$$

CP-violation parameters<sup>[ee]</sup>

$$A_L = (0.332 \pm 0.006) \%$$

$$|\eta_{00}| = (2.225 \pm 0.007) \times 10^{-3}$$

$$|\eta_{+-}| = (2.236 \pm 0.007) \times 10^{-3}$$

$$|\epsilon| = (2.232 \pm 0.007) \times 10^{-3}$$

$$|\eta_{00}/\eta_{+-}| = 0.9950 \pm 0.0008^{[hb]} \quad (S = 1.6)$$

$$\text{Re}(\epsilon'/\epsilon) = (1.66 \pm 0.26) \times 10^{-3}^{[hb]} \quad (S = 1.6)$$

Assuming  $CPT$ 

$$\phi_{+-} = (43.52 \pm 0.05)^\circ \quad (S = 1.2)$$

$$\phi_{00} = (43.50 \pm 0.06)^\circ \quad (S = 1.2)$$

$$\phi_\epsilon = \phi_{\text{SW}} = (43.51 \pm 0.05)^\circ \quad (S = 1.1)$$

Not assuming  $CPT$ 

$$\phi_{+-} = (43.4 \pm 0.7)^\circ \quad (S = 1.3)$$

$$\phi_{00} = (43.7 \pm 0.8)^\circ \quad (S = 1.2)$$

$$\phi_\epsilon = (43.5 \pm 0.7)^\circ \quad (S = 1.3)$$

$$CP \text{ asymmetry } A \text{ in } K_L^0 \rightarrow \pi^+\pi^-e^+e^- = (13.7 \pm 1.5) \%$$

$$\beta_{CP} \text{ from } K_L^0 \rightarrow e^+e^-e^+e^- = -0.19 \pm 0.07$$

$$\gamma_{CP} \text{ from } K_L^0 \rightarrow e^+e^-e^+e^- = 0.01 \pm 0.11 \quad (S = 1.6)$$

$$j \text{ for } K_L^0 \rightarrow \pi^+\pi^-\pi^0 = 0.0012 \pm 0.0008$$

$$f \text{ for } K_L^0 \rightarrow \pi^+\pi^-\pi^0 = 0.004 \pm 0.006$$

$$|\eta_{+-\gamma}| = (2.35 \pm 0.07) \times 10^{-3}$$

$$\phi_{+-\gamma} = (44 \pm 4)^\circ$$

$$|\epsilon_{+-\gamma}|/\epsilon < 0.3, \text{ CL} = 90\%$$

 $T$ -violation parameters

$$\text{Im}(\xi) \text{ in } K_{\mu 3}^0 = -0.007 \pm 0.026$$

 $CPT$  invariance tests

$$\phi_{00} - \phi_{+-} = (0.2 \pm 0.4)^\circ$$

$$\text{Re}(\frac{2}{3}\eta_{+-} + \frac{1}{3}\eta_{00}) - \frac{\delta_L}{2} = (-3 \pm 35) \times 10^{-6}$$

 $\Delta S = -\Delta Q$  in  $K_{\ell 3}^0$  decay

$$\text{Re } x = -0.002 \pm 0.006$$

$$\text{Im } x = 0.0012 \pm 0.0021$$

$K_L^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Semileptonic modes</b>			
$\pi^\pm e^\mp \nu_e$	[gg] $(40.53 \pm 0.15) \%$	S = 2.1	229
Called $K_{e 3}^0$ .			
$\pi^\pm \mu^\mp \nu_\mu$	[gg] $(27.02 \pm 0.07) \%$		216
Called $K_{\mu 3}^0$ .			
$(\pi\mu \text{ atom})\nu$	$(1.05 \pm 0.11) \times 10^{-7}$		188
$\pi^0 \pi^\pm e^\mp \nu$	[gg] $(5.20 \pm 0.11) \times 10^{-5}$		207
<b>Hadronic modes, including Charge conjugation <math>\times</math> Parity violating (CPV) modes</b>			
$3\pi^0$	$(19.56 \pm 0.14) \%$	S = 1.9	139
$\pi^+\pi^-\pi^0$	$(12.56 \pm 0.05) \%$		133
$\pi^+\pi^-$	CPV $(1.976 \pm 0.008) \times 10^{-3}$		206
$\pi^0\pi^0$	CPV $(8.69 \pm 0.04) \times 10^{-4}$	S = 1.1	209
<b>Semileptonic modes with photons</b>			
$\pi^\pm e^\mp \nu_e \gamma$	[y,gg,ii] $(3.79 \pm 0.08) \times 10^{-3}$		229
$\pi^\pm \mu^\mp \nu_\mu \gamma$	$(5.64 \pm 0.23) \times 10^{-4}$		216
<b>Hadronic modes with photons or <math>\ell\bar{\ell}</math> pairs</b>			
$\pi^0\pi^0\gamma$	< 5.6	$\times 10^{-6}$	209
$\pi^+\pi^-\gamma$	[y,ii] $(4.17 \pm 0.15) \times 10^{-5}$		206
$\pi^0 2\gamma$	[ii] $(1.49 \pm 0.08) \times 10^{-6}$	S = 2.0	231
$\pi^0\gamma e^+e^-$	$(2.3 \pm 0.4) \times 10^{-8}$		231
<b>Other modes with photons or <math>\ell\bar{\ell}</math> pairs</b>			
$2\gamma$	$(5.48 \pm 0.05) \times 10^{-4}$	S = 1.2	249
$3\gamma$	< 2.4	$\times 10^{-7}$	CL = 90% 249
$e^+e^-\gamma$	$(10.0 \pm 0.5) \times 10^{-6}$	S = 1.5	249
$\mu^+\mu^-\gamma$	$(3.59 \pm 0.11) \times 10^{-7}$	S = 1.3	225
$e^+e^-\gamma\gamma$	[ii] $(5.95 \pm 0.33) \times 10^{-7}$		249
$\mu^+\mu^-\gamma\gamma$	[ii] $(1.0^{+0.8}_{-0.6}) \times 10^{-8}$		225
<b>Charge conjugation <math>\times</math> Parity (CP) or Lepton Family number (LF) violating modes, or <math>\Delta S = 1</math> weak neutral current (S1) modes</b>			
$\mu^+\mu^-$	S1 $(6.87 \pm 0.11) \times 10^{-9}$		225
$e^+e^-$	S1 $(9^{+6}_{-4}) \times 10^{-12}$		249
$\pi^+\pi^-e^+e^-$	S1 [ii] $(3.11 \pm 0.19) \times 10^{-7}$		206
$\pi^0\pi^0e^+e^-$	S1 < 6.6	$\times 10^{-9}$	CL = 90% 209
$\mu^+\mu^-e^+e^-$	S1 $(2.69 \pm 0.27) \times 10^{-9}$		225
$e^+e^-e^+e^-$	S1 $(3.56 \pm 0.21) \times 10^{-8}$		249

$\pi^0 \mu^+ \mu^-$	CP,SI [jj]	$< 3.8 \times 10^{-10}$	CL = 90%	177
$\pi^0 e^+ e^-$	CP,SI [jj]	$< 2.8 \times 10^{-10}$	CL = 90%	231
$\pi^0 \nu \bar{\nu}$	CP,SI [kk]	$< .9 \times 10^{-7}$	CL = 90%	231
$e^\pm \mu^\mp$	LF [gg]	$< 4.7 \times 10^{-12}$	CL = 90%	238
$e^\pm e^\pm \mu^\mp \mu^\mp$	LF [gg]	$< 4.12 \times 10^{-11}$	CL = 90%	225
$\pi^0 \mu^\pm e^\mp$	LF [gg]	$< 6.2 \times 10^{-9}$	CL = 90%	217

$$K^*(892) \quad I(J^P) = \frac{1}{2}(1^-)$$

$K^*(892)^\pm$  mass  $m = 891.66 \pm 0.26$  MeV  
 $K^*(892)^0$  mass  $m = 896.00 \pm 0.25$  MeV (S = 1.4)  
 $K^*(892)^\pm$  full width  $\Gamma = 50.8 \pm 0.9$  MeV  
 $K^*(892)^0$  full width  $\Gamma = 50.3 \pm 0.6$  MeV (S = 1.1)

$K^*(892)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$K\pi$	$\sim 100$ %		289
$K^0\gamma$	$(2.31 \pm 0.20) \times 10^{-3}$		307
$K^\pm\gamma$	$(9.9 \pm 0.9) \times 10^{-4}$		309
$K\pi\pi$	$< 7 \times 10^{-4}$	95%	223

$$K_1(1270) \quad I(J^P) = \frac{1}{2}(1^+)$$

Mass  $m = 1272 \pm 7$  MeV<sup>[nl]</sup>  
Full width  $\Gamma = 90 \pm 20$  MeV<sup>[nl]</sup>

$K_1(1270)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\rho$	$(42 \pm 6)$ %	45
$K_0^*(1430)\pi$	$(28 \pm 4)$ %	†
$K^*(892)\pi$	$(16 \pm 5)$ %	302
$K\omega$	$(11.0 \pm 2.0)$ %	†
$Kf_0(1370)$	$(3.0 \pm 2.0)$ %	†
$\gamma K^0$	seen	539

$$K_1(1400) \quad I(J^P) = \frac{1}{2}(1^+)$$

Mass  $m = 1402 \pm 7$  MeV  
Full width  $\Gamma = 174 \pm 13$  MeV (S = 1.6)

$K_1(1400)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K^*(892)\pi$	$(94 \pm 6)$ %	402
$K\rho$	$(3.0 \pm 3.0)$ %	292
$Kf_0(1370)$	$(2.0 \pm 2.0)$ %	†
$K\omega$	$(1.0 \pm 1.0)$ %	284
$K_0^*(1430)\pi$	not seen	†
$\gamma K^0$	seen	613

$$K^*(1410) \quad I(J^P) = \frac{1}{2}(1^-)$$

Mass  $m = 1414 \pm 15$  MeV (S = 1.3)  
Full width  $\Gamma = 232 \pm 21$  MeV (S = 1.1)

$K^*(1410)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$K^*(892)\pi$	$> 40$ %	95%	410
$K\pi$	$(6.6 \pm 1.3)$ %		612
$K\rho$	$< 7$ %	95%	305
$\gamma K^0$	seen		619

$$K_0^*(1430)^{[11]} \quad I(J^P) = \frac{1}{2}(1^+)$$

Mass  $m = 1414 \pm 6$  MeV  
Full width  $\Gamma = 290 \pm 21$  MeV

$K_0^*(1430)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\pi$	$(93 \pm 10)$ %	613

$$K_2^*(1430)^{[11]} \quad I(J^P) = \frac{1}{2}(2^+)$$

$K_2^*(1430)^\pm$  mass  $m = 1425.6 \pm 1.5$  MeV (S = 1.1)  
 $K_2^*(1430)^0$  mass  $m = 1432.4 \pm 1.3$  MeV  
 $K_2^*(1430)^\pm$  full width  $\Gamma = 98.5 \pm 2.7$  MeV (S = 1.1)  
 $K_2^*(1430)^0$  full width  $\Gamma = 109 \pm 5$  MeV (S = 1.9)

$K_2^*(1430)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$K\pi$	$(49.9 \pm 1.2)$ %	619	
$K^*(892)\pi$	$(24.7 \pm 1.5)$ %		419
$K^*(892)\pi\pi$	$(13.4 \pm 2.2)$ %	372	
$K\rho$	$(8.7 \pm 0.8)$ %	S = 1.2	318
$K\omega$	$(2.9 \pm 0.8)$ %	311	
$K^+\gamma$	$(2.4 \pm 0.5) \times 10^{-3}$	S = 1.1	627
$K\eta$	$(1.5^{+3.4}_{-1.0}) \times 10^{-3}$	S = 1.3	487
$K\omega\pi$	$< 7.2 \times 10^{-4}$	CL = 95%	100
$K^0\gamma$	$< 9 \times 10^{-4}$	CL = 90%	626

$$K^*(1680) \quad I(J^P) = \frac{1}{2}(1^-)$$

Mass  $m = 1717 \pm 27$  MeV (S = 1.4)  
Full width  $\Gamma = 322 \pm 110$  MeV (S = 4.2)

$K^*(1680)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\pi$	$(38.7 \pm 2.5)$ %	781
$K\rho$	$(31.4^{+4.7}_{-2.1})$ %	570
$K^*(892)\pi$	$(29.9^{+2.2}_{-4.7})$ %	618

$$K_2(1770)^{[mm]} \quad I(J^P) = \frac{1}{2}(2^-)$$

Mass  $m = 1773 \pm 8$  MeV  
Full width  $\Gamma = 186 \pm 14$  MeV

$K_2(1770)^{[mm]}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\pi\pi$		794
$K_2^*(1430)\pi$	dominant	288
$K^*(892)\pi$	seen	654
$Kf_2(1270)$	seen	53
$K\phi$	seen	441
$K\omega$	seen	607

$$K_3^*(1780) \quad I(J^P) = \frac{1}{2}(3^-)$$

Mass  $m = 1776 \pm 7$  MeV (S = 1.1)  
Full width  $\Gamma = 159 \pm 21$  MeV (S = 1.3)

$K_3^*(1780)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$K\rho$	$(31 \pm 9)$ %		613
$K^*(892)\pi$	$(20 \pm 5)$ %		656
$K\pi$	$(18.8 \pm 1.0)$ %		813
$K\eta$	$(30 \pm 13)$ %		719
$K_2^*(1430)\pi$	$< 16$ %	95%	291

$$K_2(1820)^{[mm]} \quad I(J^P) = \frac{1}{2}(2^-)$$

Mass  $m = 1816 \pm 13$  MeV  
Full width  $\Gamma = 276 \pm 35$  MeV

$K_2(1820)^{[mm]}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K_2^*(1430)\pi$	seen	327
$K^*(892)\pi$	seen	681
$Kf_2(1270)$	seen	185
$K\omega$	seen	638

**$K_4^*(2045)$** 

$$I(J^P) = \frac{1}{2}(4^+)$$

Mass  $m = 2045 \pm 9$  MeV ( $S = 1.1$ )Full width  $\Gamma = 198 \pm 30$  MeV

$K_4^*(2045)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\pi$	(9.9 ± 1.2) %	958
$K^*(892)\pi\pi$	(9 ± 5) %	802
$K^*(892)\pi\pi\pi$	(7 ± 5) %	768
$\rho K\pi$	(5.7 ± 3.2) %	741
$\omega K\pi$	(5.0 ± 3.0) %	738
$\phi K\pi$	(2.8 ± 1.4) %	594
$\phi K^*(892)$	(1.4 ± 0.7) %	363

**CHARMED MESONS** $(C = \pm 1)$  $D^+ = c\bar{d}, D^0 = c\bar{u}, \bar{D}^0 = \bar{c}u, D^- = \bar{c}d$ , similarly for  $D^{*}$ 's **$D^{\pm}$** 

$$I(J^P) = \frac{1}{2}(0^-)$$

Mass  $m = 1869.3 \pm 0.4$  MeV ( $S = 1.1$ )Mean life  $\tau = (1040 \pm 7) \times 10^{-15}$  s $c\tau = 311.8$   $\mu\text{m}$ **c-quark decays**

$$\Gamma(c \rightarrow \ell^+ \text{anything})/\Gamma(c \rightarrow \text{anything}) = 0.096 \pm 0.004^{[\text{exp}]}$$

$$\Gamma(c \rightarrow D^*(2010)^+ \text{anything})/\Gamma(c \rightarrow \text{anything}) = 0.255 \pm 0.017$$

**CP-violation decay-rate asymmetries**

$$A_{CP}(K_S^0 \pi^\pm) = -0.016 \pm 0.017$$

$$A_{CP}(K_S^0 K^\pm) = 0.07 \pm 0.06$$

$$A_{CP}(K^\pm K^\mp \pi^\pm) = 0.007 \pm 0.008$$

$$A_{CP}(K^\pm K^*0) = 0.005 \pm 0.017$$

$$A_{CP}(\phi \pi^\pm) = -0.001 \pm 0.015$$

$$A_{CP}(\pi^+ \pi^- \pi^\pm) = -0.02 \pm 0.04$$

$$A_{CP}(K_S^0 K^\pm \pi^\mp \pi^\pm) = -0.04 \pm 0.07$$

**T-violation decay-rate asymmetry**

$$A_T(K_S^0 K^\pm \pi^\mp \pi^\pm) = 0.02 \pm 0.07$$

 **$D^* \rightarrow \bar{K}^*(892)^0 \ell^+ \nu_\ell$  form factors**

$$r_\nu = 1.62 \pm 0.08 \quad (S = 1.5)$$

$$r_2 = 0.83 \pm 0.05$$

$$r_3 = 0.0 \pm 0.4$$

$$\Gamma_L/\Gamma_T = 1.13 \pm 0.08$$

$$\Gamma_+/ \Gamma_- = 0.22 \pm 0.06 \quad (S = 1.6)$$

Most decay modes (other than the semileptonic modes) that involve a neutral K meson are now given as  $K_S^0$  modes, not as  $\bar{K}^0$  modes. Nearly always it is a  $K_S^0$  that is measured, and interference between Cabibbo-allowed and doubly Cabibbo-suppressed modes can invalidate the assumption that  $2\Gamma(K_S^0) = \Gamma(\bar{K}^0)$ .

$D^*$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Inclusive modes</b>			
$e^+$ anything	(17.2 ± 1.9) %		-
$K^-$ anything	(27.5 ± 2.4) %		-
$\bar{K}^0$ anything + $K^0$ anything	(61 ± 8) %		-
$K^+$ anything	(5.5 ± 1.6) %		-
$\bar{K}^*(892)^0$ anything	(23 ± 5) %		-
$K^*(892)^0$ anything	< 6.6	% CL = 90%	-
$\eta$ anything	[pp] < 13	% CL = 90%	-
$\phi$ anything	< 1.8	% CL = 90%	-
$\phi e^+$ anything	< 1.6	% CL = 90%	-

**Leptonic and semileptonic modes**

$e^+ \nu_e$	< 2.4	$\times 10^{-5}$	CL = 90%	935
$\mu^+ \nu_\mu$	(4.4 ± 0.7)	$\times 10^{-4}$		932
$\bar{K}^0 e^+ \nu_e$	(8.6 ± 0.5) %			868
$\bar{K}^0 \mu^+ \nu_\mu$	(9.5 ± 0.8) %			865
$K^- \pi^+ e^+ \nu_e$	(4.5 $^{+1.0}_{-0.8}$ ) %		S = 1.1	863
$\bar{K}^*(892)^0 e^+ \nu_e$	(3.74 ± 0.21) %			722
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$				
$K^- \pi^+ e^+ \nu_e$ nonresonant	< 7	$\times 10^{-3}$	CL = 90%	863
$K^- \pi^+ \mu^+ \nu_\mu$	(4.0 ± 0.5) %			851
$\bar{K}^*(892)^0 \mu^+ \nu_\mu$	(3.7 ± 0.3) %			717
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$				
$K^- \pi^+ \mu^+ \nu_\mu$ nonresonant	(2.1 ± 0.6)	$\times 10^{-3}$		851
$(\bar{K}^*(892)\pi)^0 e^+ \nu_e$	< 1.2	%	CL = 90%	712
$(\bar{K}^*(892)\pi)^0 \mu^+ \nu_\mu$	< 9	$\times 10^{-3}$	CL = 90%	846
$\bar{K}^*(892)$				
$K^- \pi^+ \pi^0 \mu^+ \nu_\mu$	< 1.7	$\times 10^{-3}$	CL = 90%	825
$\pi^0 e^+ \nu_e$	(4.4 ± 0.7)	$\times 10^{-3}$		930

Fractions of some of the following modes with resonances have already appeared above as submodes of particular charged-particle modes.

$\bar{K}^*(892)^0 e^+ \nu_e$	(5.61 ± 0.31) %	S = 1.1	722	
$\bar{K}^*(892)^0 \mu^+ \nu_\mu$	(5.5 ± 0.5) %	S = 1.1	717	
$\bar{K}_1(1270)^0 \mu^+ \nu_\mu$	< 4	%	CL = 95%	493
$\bar{K}_0^*(1430)^0 \mu^+ \nu_\mu$	< 2.5	$\times 10^{-4}$		388
$\bar{K}_S^*(1430)^0 \mu^+ \nu_\mu$	< 1.1	%	CL = 95%	380
$\bar{K}^*(1680)^0 \mu^+ \nu_\mu$	< 1.6	$\times 10^{-3}$		105
$\rho^0 e^+ \nu_e$	(2.2 ± 0.4)	$\times 10^{-3}$		774
$\rho^0 \mu^+ \nu_\mu$	(3.4 ± 0.8)	$\times 10^{-3}$		770
$\omega e^+ \nu_e$	(1.6 $^{+0.7}_{-0.6}$ )	$\times 10^{-3}$		771
$\phi e^+ \nu_e$	< 2.09	%	CL = 90%	657
$\phi \mu^+ \nu_\mu$	< 3.72	%	CL = 90%	651
$\eta \ell^+ \nu_\ell$	< 7	$\times 10^{-3}$	CL = 90%	854
$\eta'(958) \mu^+ \nu_\mu$	< 1.1	%	CL = 90%	684

**Hadronic modes with a  $\bar{K}$  or  $\bar{K}K\bar{K}$** 

$K_S^0 \pi^+$	(1.47 ± 0.06) %	S = 1.1	862
$K^- \pi^+ \pi^+$	[qq] (9.51 ± 0.34) %	S = 1.1	845
$\bar{K}^*(892)^0 \pi^+$	[rr] (1.33 ± 0.11) %		714
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$			
$\bar{K}_0^*(1430)^0 \pi^+$	[rr] (2.41 ± 0.24) %		382
$\bar{K}_0^*(1430)^0 \rightarrow K^- \pi^+$			
$\bar{K}^*(1680)^0 \pi^+$	[rr] (4.0 ± 0.8)	$\times 10^{-3}$	58
$\bar{K}^*(1680)^0 \rightarrow K^- \pi^+$			
$K^- \pi^+ \pi^+$ nonresonant	[rr] (9.0 ± 0.7) %		845
$K_S^0 \pi^+ \pi^0$	[qq] (7.0 ± 0.5) %	S = 1.2	845
$K_S^0 \rho^+$	(4.8 ± 1.1) %		677
$\bar{K}^*(892)^0 \pi^+$	(1.3 ± 0.6) %		714
$\bar{K}^*(892)^0 \rightarrow K_S^0 \pi^0$			
$K_S^0 \pi^+ \pi^0$ nonresonant	(9 ± 7)	$\times 10^{-3}$	845
$K^- \pi^+ \pi^+ \pi^0$	[qq] (6.00 ± 0.28) %	S = 1.1	816
$\bar{K}^*(892)^0 \rho^+$ total,	(1.3 ± 0.8) %		422
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$			
$\bar{K}_1(1400)^0 \pi^+$	(1.8 ± 0.7) %		390
$\bar{K}_1(1400)^0 \rightarrow K^- \pi^+ \pi^0$			
$K^- \rho^+ \pi^+$ total	(2.6 ± 1.6) %		613
$K^- \rho^+ \pi^+$ 3-body	(9 ± 6)	$\times 10^{-3}$	613
$\bar{K}^*(892)^0 \pi^+ \pi^0$ total,	(4.2 ± 0.6) %		690
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$			
$\bar{K}^*(892)^0 \pi^+ \pi^0$ 3-body,	(2.7 ± 0.8) %		690
$\bar{K}^*(892)^0 \rightarrow K^- \pi^+$			
$K^*(892)^- \pi^+ \pi^+$ 3-body,	(6 ± 3)	$\times 10^{-3}$	688
$K^*(892)^- \rightarrow K^- \pi^0$			
$K^- \pi^+ \pi^+ \pi^0$ nonresonant	[ss] (1.0 ± 0.7) %		816
$K_S^0 \pi^+ \pi^+ \pi^-$	[qq] (3.11 ± 0.21) %	S = 1.1	814
$K_S^0 a_1(1260)^+$ ,	(1.8 ± 0.3) %		328
$a_1(1260)^+ \rightarrow \pi^+ \pi^+ \pi^-$			
$\bar{K}_1(1400)^0 \pi^+$	(1.8 ± 0.7) %		390
$\bar{K}_1(1400)^0 \rightarrow K_S^0 \pi^+ \pi^-$			
$K^*(892)^- \pi^+ \pi^+$ 3-body,	(1.3 ± 0.6) %		688
$K^*(892)^- \rightarrow K_S^0 \pi^-$			
$K_S^0 \rho^0 \pi^+$ total	(1.86 ± 0.34) %	CL = 90%	610
$K_S^0 \rho^0 \pi^+$ 3-body	(2.2 ± 2.2)	$\times 10^{-3}$	610
$K_S^0 \pi^+ \pi^+ \pi^-$ nonresonant	(3.7 ± 1.9)	$\times 10^{-3}$	814

$K^- 3\pi^+\pi^-$	[ $qq$ ]	$(5.8 \pm 0.6) \times 10^{-3}$	$S = 1.1$	772
$\overline{K}^*(892)^0\pi^+\pi^+\pi^-$		$(1.2 \pm 0.4) \times 10^{-3}$		645
$\overline{K}^*(892)^0 \rightarrow K^-\pi^+$				
$\overline{K}^*(892)^0\rho^0\pi^+$		$(2.3 \pm 0.4) \times 10^{-3}$		239
$\overline{K}^*(892)^0 \rightarrow K^-\pi^+$				
$K^-\rho^0\pi^+\pi^+$		$(1.75 \pm 0.29) \times 10^{-3}$		524
$K^- 3\pi^+\pi^-$ nonresonant		$(4.1 \pm 3.0) \times 10^{-4}$		772
$K^+ 2K_S^0$		$(4.7 \pm 2.1) \times 10^{-3}$		545
$K^+K^-K_S^0\pi^+$		$(2.4 \pm 0.6) \times 10^{-4}$		435

Fractions of some of the following modes with resonances have already appeared above as submodes of particular charged-particle modes.

$K_S^0 a_1(1260)^+$		$(3.6 \pm 0.6) \%$		328
$K_S^0 a_2(1320)^+$		$< 1.5$	$\times 10^{-3}$ CL = 90%	199
$\overline{K}^*(892)^0\rho^0$ total	[ $ss$ ]	$(1.8 \pm 1.4) \%$		422
$\overline{K}^*(892)^0\rho^+$ S-wave	[ $ss$ ]	$(1.4 \pm 1.5) \%$		422
$\overline{K}^*(892)^0\rho^+$ P-wave		$< 1$	$\times 10^{-3}$ CL = 90%	422
$\overline{K}^*(892)^0\rho^+$ D-wave		$(8 \pm 7)$	$\times 10^{-3}$	422
$\overline{K}^*(892)^0\rho^+$ D-wave longitudinal		$< 7$	$\times 10^{-3}$ CL = 90%	422
$\overline{K}_1(1270)^0\pi^+$		$< 7$	$\times 10^{-3}$ CL = 90%	487
$\overline{K}_1(1400)^0\pi^+$		$(4.3 \pm 1.5) \%$	$S = 1.2$	390
$\overline{K}^*(892)^0\pi^+\pi^0$ total		$(5.8 \pm 2.9) \%$		690
$\overline{K}^*(892)^0\pi^+\pi^0$ 3-body	[ $ss$ ]	$(3.6 \pm 2.1) \%$		690
$K^*(892)^-\pi^+\pi^+$ total		—		688
$K^*(892)^-\pi^+\pi^+$ 3-body		$(1.8^{+1.1}_{-0.9}) \%$	$S = 1.2$	688
$\overline{K}^*(892)^0 a_1(1260)^+$		$(9.4 \pm 1.9) \times 10^{-3}$		†

#### Pionic modes

$\pi^+\pi^0$		$(1.28 \pm 0.09) \times 10^{-3}$		925
$\pi^+\pi^+\pi^-$		$(3.31 \pm 0.21) \times 10^{-3}$		908
$\rho^0\pi^+$		$(1.07 \pm 0.11) \times 10^{-3}$		766
$\pi^+(\pi^+\pi^-)_{S\text{-wave}}$		$(1.86 \pm 0.18) \times 10^{-3}$		908
$\sigma\pi^+, \sigma \rightarrow \pi^+\pi^-$		$(1.53 \pm 0.32) \times 10^{-3}$		—
$f_0(980)\pi^+, f_0(980) \rightarrow \pi^+\pi^-$		$(2.1 \pm 0.5) \times 10^{-4}$		669
$f_0(1370)\pi^+, f_0(1370) \rightarrow \pi^+\pi^-$		$(8 \pm 6) \times 10^{-5}$		—
$f_2(1270)\pi^+, f_2(1270) \rightarrow \pi^+\pi^-$		$(4.8 \pm 1.3) \times 10^{-4}$		485
$\pi^+ 2\pi^0$		$(4.8 \pm 0.4) \times 10^{-3}$		910
$\pi^+\pi^+\pi^-\pi^0$		$(1.18 \pm 0.09) \%$		883
$\eta\pi^+, \eta \rightarrow \pi^+\pi^-\pi^0$		$(7.9 \pm 0.7) \times 10^{-4}$		848
$\omega\pi^+, \omega \rightarrow \pi^+\pi^-\pi^0$		$< 3$	$\times 10^{-4}$ CL = 90%	763
$3\pi^+ 2\pi^-$		$(1.68 \pm 0.17) \times 10^{-3}$	$S = 1.1$	845

Fractions of some of the following modes with resonances have already appeared above as submodes of particular charged-particle modes.

$\eta\pi^+$		$(3.50 \pm 0.32) \times 10^{-3}$		848
$\omega\pi^+$		$< 3.4$	$\times 10^{-4}$ CL = 90%	763
$\eta\rho^+$		$< 7$	$\times 10^{-3}$ CL = 90%	655
$\eta'(958)\pi^+$		$(5.3 \pm 1.1) \times 10^{-3}$		680
$\eta'(958)\rho^+$		$< 6$	$\times 10^{-3}$ CL = 90%	348

#### Hadronic modes with a $K\overline{K}$ pair

$K^+K_S^0$		$(2.96 \pm 0.19) \times 10^{-3}$		792
$K^+K^-\pi^+$	[ $qq$ ]	$(1.00 \pm 0.04) \%$	$S = 1.2$	744
$\phi\pi^+, \phi \rightarrow K^+K^-$		$(3.2 \pm 0.4) \times 10^{-3}$		647
$K^+\overline{K}^*(892)^0$		$(3.02 \pm 0.35) \times 10^{-3}$		613
$\overline{K}^*(892)^0 \rightarrow K^-\pi^+$				
$K^+\overline{K}_S^0(1430)^0$		$(3.7 \pm 0.4) \times 10^{-3}$		—
$\overline{K}_S^0(1430)^0 \rightarrow K^-\pi^+$				
$K_S^0 K_S^0\pi^+$		—		741
$K^*(892)^+K_S^0$		$(5.3 \pm 2.3) \times 10^{-3}$		611
$K^*(892)^+ \rightarrow K_S^0\pi^+$				
$K^+K^-\pi^+\pi^0$		—		682
$\phi\pi^+\pi^0, \phi \rightarrow K^+K^-$		$(1.1 \pm 0.5) \%$		619
$\phi\rho^+, \phi \rightarrow K^+K^-$		$< 7$	$\times 10^{-3}$ CL = 90%	258
$K^+K^-\pi^+\pi^0$ non- $\phi$		$(1.5^{+0.7}_{-0.6}) \%$		682
$K^+K_S^0\pi^+\pi^-$		$(1.75 \pm 0.21) \times 10^{-3}$		678
$K_S^0 K^-\pi^+\pi^+$		$(2.39 \pm 0.23) \times 10^{-3}$		678
$K^*(892)^+\overline{K}^*(892)^0$		$(5.8 \pm 2.4) \times 10^{-3}$		280
$K^{*+} \rightarrow K_S^0\pi^+, \overline{K}^{*0} \rightarrow K^-\pi^+$				
$K_S^0 K^-\pi^+\pi^+$ (non- $K^*\overline{K}^{*0}$ )		$< 4$	$\times 10^{-3}$ CL = 90%	678
$K^+K^-\pi^+\pi^+\pi^-$		$(2.3 \pm 1.2) \times 10^{-4}$		600

Fractions of the following modes with resonances have already appeared above as submodes of particular charged-particle modes.

$\phi\pi^+$		$(6.5 \pm 0.7) \times 10^{-3}$		647
$\phi\pi^+\pi^0$		$(2.3 \pm 1.0) \%$		619
$\phi\rho^+$		$< 1.5$	$\%$ CL = 90%	259
$K^*(892)^+K_S^0$		$(1.6 \pm 0.7) \%$		611
$K^*(892)^+\overline{K}^*(892)^0$		$(2.6 \pm 1.1) \%$		280

#### Doubly Cabibbo-suppressed modes

$K^+\pi^0$		$< 4.2$	$\times 10^{-4}$ CL = 90%	864
$K^+\pi^+\pi^-$		$(6.4 \pm 0.8) \times 10^{-4}$		845
$K^+\rho^0$		$(2.5 \pm 0.7) \times 10^{-4}$		678
$K^*(892)^0\pi^+, K^*(892)^0 \rightarrow K^+\pi^-$		$(3.0 \pm 0.6) \times 10^{-4}$		714
$K^+ f_0(980), f_0(980) \rightarrow \pi^+\pi^-$		$(5.7 \pm 3.5) \times 10^{-5}$		—
$K_S^0(1430)^0\pi^+, K_S^0(1430)^0 \rightarrow K^+\pi^-$		$(5.2 \pm 3.5) \times 10^{-5}$		—
$K^+K^+K^-$		$(9.0 \pm 2.1) \times 10^{-5}$		550

#### $\Delta C = 1$ weak neutral current ( $CI$ ) modes, or

#### Lepton Family number ( $LF$ ) or Lepton number ( $L$ ) violating modes

$\pi^+e^+e^-$	$CI$	$< 7.4$	$\times 10^{-6}$ CL = 90%	929
$\pi^+\phi, \phi \rightarrow e^+e^-$	[ $tt$ ]	$(2.7^{+3.6}_{-1.8}) \times 10^{-6}$		—
$\pi^+\mu^+\mu^-$	$CI$	$< 8.8$	$\times 10^{-6}$ CL = 90%	917
$\rho^+\mu^+\mu^-$	$CI$	$< 5.6$	$\times 10^{-4}$ CL = 90%	757
$K^+e^+e^-$	[ $uu$ ]	$< 6.2$	$\times 10^{-6}$ CL = 90%	869
$K^+\mu^+\mu^-$	[ $uu$ ]	$< 9.2$	$\times 10^{-6}$ CL = 90%	856
$\pi^+e^+\mu^-$	$LF$ [ $gg$ ]	$< 3.4$	$\times 10^{-5}$ CL = 90%	926
$K^+e^+\mu^-$	$LF$ [ $gg$ ]	$< 6.8$	$\times 10^{-5}$ CL = 90%	866
$\pi^-e^+e^+$	$L$	$< 3.6$	$\times 10^{-6}$ CL = 90%	929
$\pi^-\mu^+\mu^+$	$L$	$< 4.8$	$\times 10^{-6}$ CL = 90%	917
$\pi^-e^+\mu^+$	$L$	$< 5.0$	$\times 10^{-5}$ CL = 90%	926
$\rho^-\mu^+\mu^+$	$L$	$< 5.6$	$\times 10^{-4}$ CL = 90%	757
$K^-e^+e^+$	$L$	$< 4.5$	$\times 10^{-6}$ CL = 90%	869
$K^-\mu^+\mu^+$	$L$	$< 1.3$	$\times 10^{-5}$ CL = 90%	856
$K^-e^+\mu^+$	$L$	$< 1.3$	$\times 10^{-4}$ CL = 90%	866
$K^*(892)^-\mu^+\mu^+$	$L$	$< 8.5$	$\times 10^{-4}$ CL = 90%	703

$D^0$

$$I(J^P) = \frac{1}{2}(0^-)$$

$$\text{Mass } m = 1864.5 \pm 0.4 \text{ MeV} \quad (S = 1.1)$$

$$m_{D^{\pm}} - m_{D^0} = 4.78 \pm 0.10 \text{ MeV} \quad (S = 1.1)$$

$$\text{Mean life } \tau = (410.1 \pm 1.5) \times 10^{-13} \text{ s}$$

$$c\tau = 122.9 \mu\text{m}$$

$$|m_{D_1^0} - m_{D_2^0}| < 7 \times 10^{10} \text{ h s}^{-1}, \text{ CL} = 95\%^{[lvv]}$$

$$(\Gamma_{D_1^0} - \Gamma_{D_2^0})/\Gamma = 2\gamma = (1.4 \pm 1.0) \times 10^{-2}$$

$$\Gamma(K^+\ell^-\bar{\nu}_\ell \text{ (via } \overline{D}^0)) / \Gamma(K^-\ell^+\nu_\ell) < 0.005, \text{ CL} = 90\%$$

$$\Gamma(K^+\pi^- \text{ (via } \overline{D}^0)) / \Gamma(K^-\pi^+) < 4.0 \times 10^{-4}, \text{ CL} = 95\%$$

$$\Gamma(K_S^0\pi^+\pi^- \text{ (in } D^0 \rightarrow \overline{D}^0)) / \Gamma(K_S^0\pi^+\pi^-) \Gamma_0 / \Gamma_0$$

$$< 0.0063, \text{ CL} = 95\%$$

#### CP-violation decay-rate asymmetries

$$A_{CP}(K^+K^-) = 0.014 \pm 0.010$$

$$A_{CP}(K_S^0 K_S^0) = -0.23 \pm 0.19$$

$$A_{CP}(\pi^+\pi^-) = 0.013 \pm 0.012$$

$$A_{CP}(\pi^0\pi^0) = 0.00 \pm 0.05$$

$$A_{CP}(\pi^+\pi^-\pi^0) = 0.01^{+0.10}_{-0.09}$$

$$A_{CP}(K_S^0\phi) = -0.03 \pm 0.09$$

$$A_{CP}(K_S^0\pi^0) = 0.001 \pm 0.013$$

$$A_{CP}(K^{\mp}\pi^{\mp}) = 0.05 \pm 0.04$$

$$A_{CP}(K^{\mp}\pi^{\pm}\pi^0) = -0.03 \pm 0.09$$

$$A_{CP}(K^{\pm}\pi^{\mp}\pi^0) = 0.00 \pm 0.05$$

$$A_{CP}(K_S^0\pi^+\pi^-) = -0.009^{+0.026}_{-0.061}$$

$$A_{CP}(K^{\pm}\pi^{\mp}\pi^+\pi^-) = -0.02 \pm 0.04$$

$$A_{CP}(K^+K^-\pi^+\pi^-) = -0.08 \pm 0.07$$

#### T-violation decay-rate asymmetry

$$A_T(K^+K^-\pi^+\pi^-) = 0.01 \pm 0.07$$

#### CPT-violation decay-rate asymmetry

$$A_{CPT}(K^{\mp}\pi^{\pm}) = 0.008 \pm 0.008$$

Most decay modes (other than the semileptonic modes) that involve a neutral  $K$  meson are now given as  $K_S^0$  modes, not as  $\bar{K}^0$  modes. Nearly always it is a  $K_S^0$  that is measured, and interference between Cabibbo-allowed and doubly Cabibbo-suppressed modes can invalidate the assumption that  $2\Gamma(K_S^0) = \Gamma(\bar{K}^0)$ .

$D^*$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Topological modes</b>			
0-prongs	[ $ww$ ] (19 ± 6) %	—	—
2-prongs	(67 ± 6) %	—	—
4-prongs	[ $xx$ ] (13.8 ± 0.5) %	—	—
6-prongs	(1.2 <sup>+1.3</sup> <sub>-0.7</sub> ) × 10 <sup>-3</sup>	—	—
<b>Inclusive modes</b>			
$e^+$ anything	[ $yy$ ] (6.71 ± 0.29) %	—	—
$\mu^+$ anything	(6.5 ± 0.7) %	—	—
$K^-$ anything	(53 ± 4) %	S = 1.3	—
$\bar{K}^0$ anything + $K^0$ anything	(42 ± 5) %	—	—
$K^+$ anything	(3.4 <sup>+0.6</sup> <sub>-0.4</sub> ) %	—	—
$\bar{K}^*(892)^0$ anything	(9 ± 4) %	—	—
$K^*(892)^0$ anything	(2.8 ± 1.3) %	—	—
$\eta$ anything	[ $pp$ ] < 13 %	CL = 90%	—
$\phi$ anything	(1.7 ± 0.8) %	—	—
<b>Semileptonic modes</b>			
$K^- e^+ \nu_e$	(3.51 ± 0.11) %	—	867
$K^- \mu^+ \nu_\mu$	(3.19 ± 0.16) %	—	863
$K^*(892)^- e^+ \nu_e$	(2.17 ± 0.16) %	—	719
$K^*(892)^- \mu^+ \nu_\mu$	(1.95 ± 0.25) %	—	714
$K^- \pi^+ \pi^- \mu^+ \nu_\mu$	< 1.2 × 10 <sup>-3</sup> CL = 90%	—	821
( $\bar{K}^*(892)\pi^-$ ) $^- \mu^+ \nu_\mu$	< 1.4 × 10 <sup>-3</sup> CL = 90%	—	692
$\pi^- e^+ \nu_e$	(2.81 ± 0.19) × 10 <sup>-3</sup>	—	927
$\pi^- \mu^+ \nu_\mu$	(2.4 ± 0.4) × 10 <sup>-3</sup>	—	924
$\rho^- e^+ \nu_e$	(1.9 ± 0.4) × 10 <sup>-3</sup>	—	771
<b>Hadronic modes with one <math>\bar{K}</math></b>			
$K^- \pi^+$	(3.80 ± 0.07) %	S = 1.1	861
$K_S^0 \pi^0$	(1.14 ± 0.12) %	—	860
$K_S^0 \pi^+ \pi^-$	[ $qq$ ] (2.90 ± 0.19) %	—	842
$K_S^0 \rho^0$	(7.5 <sup>+0.6</sup> <sub>-0.8</sub> ) × 10 <sup>-3</sup>	—	674
$K_S^0 \omega, \omega \rightarrow \pi^+ \pi^-$	(2.1 ± 0.6) × 10 <sup>-4</sup>	—	670
$K_S^0 f_0(980), f_0(980) \rightarrow \pi^+ \pi^-$	(1.36 <sup>+0.30</sup> <sub>-0.22</sub> ) × 10 <sup>-3</sup>	—	549
$K_S^0 f_2(1270), f_2(1270) \rightarrow \pi^+ \pi^-$	(1.3 <sup>+1.1</sup> <sub>-0.7</sub> ) × 10 <sup>-4</sup>	—	262
$K_S^0 f_0(1370), f_0(1370) \rightarrow \pi^+ \pi^-$	(2.5 ± 0.6) × 10 <sup>-3</sup>	†	—
$K^*(892)^- \pi^+, K^*(892)^- \rightarrow K_S^0 \pi^-$	(1.91 ± 0.14) %	—	711
$K^*(892)^+ \pi^-, K^*(892)^+ \rightarrow K_S^0 \pi^+$	[ $zz$ ] (10 <sup>+12</sup> <sub>-4</sub> ) × 10 <sup>-5</sup>	—	711
$K_0^*(1430)^- \pi^+, K_0^*(1430)^- \rightarrow K_S^0 \pi^-$	(2.8 <sup>+0.6</sup> <sub>-0.4</sub> ) × 10 <sup>-3</sup>	—	378
$K_2^*(1430)^- \pi^+, K_2^*(1430)^- \rightarrow K_S^0 \pi^-$	(3.2 <sup>+2.1</sup> <sub>-1.1</sub> ) × 10 <sup>-4</sup>	—	367
$K^*(1680)^- \pi^+, K^*(1680)^- \rightarrow K_S^0 \pi^-$	(6 ± 5) × 10 <sup>-4</sup>	—	46
$K_S^0 \pi^+ \pi^-$ nonresonant	(2.6 <sup>+5.9</sup> <sub>-1.6</sub> ) × 10 <sup>-4</sup>	—	842
$K^- \pi^+ \pi^0$	[ $qq$ ] (14.1 ± 0.5) %	S = 1.2	844
$K^- \rho^+$	(11.0 ± 0.7) %	—	675
$K^- \rho(1700)^+, \rho(1700)^+ \rightarrow \pi^+ \pi^0$	(8.0 ± 1.7) × 10 <sup>-3</sup>	†	—
$K^*(892)^- \pi^+, K^*(892)^- \rightarrow K^- \pi^0$	(2.25 <sup>+0.36</sup> <sub>-0.20</sub> ) %	—	711
$\bar{K}^*(892)^0 \pi^0, \bar{K}^*(892)^0 \rightarrow K^- \pi^+$	(1.91 ± 0.24) %	—	711
$K_0^*(1430)^- \pi^+, K_0^*(1430)^- \rightarrow K^- \pi^0$	(4.6 ± 2.2) × 10 <sup>-3</sup>	—	378
$\bar{K}_0^*(1430)^0 \pi^0, \bar{K}_0^*(1430)^0 \rightarrow K^- \pi^+$	(5.8 <sup>+4.6</sup> <sub>-1.5</sub> ) × 10 <sup>-3</sup>	—	379
$K^*(1680)^- \pi^+, K^*(1680)^- \rightarrow K^- \pi^0$	(1.8 ± 0.7) × 10 <sup>-3</sup>	—	46

$K^- \pi^+ \pi^0$ nonresonant	(1.13 <sup>+0.54</sup> <sub>-0.20</sub> ) %	—	844
$K_S^0 \pi^0 \pi^0$	—	—	843
$\bar{K}^*(892)^0 \pi^0, \bar{K}^*(892)^0 \rightarrow K_S^0 \pi^0$	(6.3 <sup>+1.8</sup> <sub>-1.5</sub> ) × 10 <sup>-3</sup>	—	711
$K_S^0 \pi^0 \pi^0$ nonresonant	(4.2 ± 1.1) × 10 <sup>-3</sup>	—	843
$K^- \pi^+ \pi^+ \pi^-$	[ $qq$ ] (7.72 ± 0.28) %	S = 1.3	812
$K^- \pi^+ \rho^0$ total	(6.4 ± 0.4) %	—	609
$K^- \pi^+ \rho^0$ 3-body	(4.9 ± 2.2) × 10 <sup>-3</sup>	—	609
$\bar{K}^*(892)^0 \rho^0, \bar{K}^*(892)^0 \rightarrow K^- \pi^+$	(1.00 ± 0.22) %	—	416
$K^- a_1(1260)^+, a_1(1260)^+ \rightarrow \pi^+ \pi^+ \pi^-$	(3.6 ± 0.6) %	—	327
$\bar{K}^*(892)^0 \pi^+ \pi^-$ total, $\bar{K}^*(892)^0 \rightarrow K^- \pi^+$	(1.5 ± 0.4) %	—	685
$\bar{K}^*(892)^0 \pi^+ \pi^-$ 3-body, $\bar{K}^*(892)^0 \rightarrow K^- \pi^+$	(9.7 ± 2.1) × 10 <sup>-3</sup>	—	685
$K_1(1270)^- \pi^+, K_1(1270)^- \rightarrow K^- \pi^+ \pi^-$	[ $ss$ ] (2.9 ± 0.3) × 10 <sup>-3</sup>	—	484
$K^- \pi^+ \pi^+ \pi^-$ nonresonant	(1.80 ± 0.25) %	—	812
$K_S^0 \pi^+ \pi^- \pi^0$	[ $qq$ ] (5.3 ± 0.6) %	—	812
$K_S^0 \eta, \eta \rightarrow \pi^+ \pi^- \pi^0$	(8.6 ± 1.4) × 10 <sup>-4</sup>	—	772
$K_S^0 \omega, \omega \rightarrow \pi^+ \pi^- \pi^0$	(9.8 ± 1.8) × 10 <sup>-3</sup>	—	670
$K^*(892)^- \rho^+, K^*(892)^- \rightarrow K_S^0 \pi^-$	(2.1 ± 0.8) %	—	416
$K_1(1270)^- \pi^+, K_1(1270)^- \rightarrow K_S^0 \pi^- \pi^0$	[ $ss$ ] (2.2 ± 0.6) × 10 <sup>-3</sup>	—	484
$\bar{K}^*(892)^0 \pi^+ \pi^-$ 3-body, $\bar{K}^*(892)^0 \rightarrow K_S^0 \pi^0$	(2.4 ± 0.5) × 10 <sup>-3</sup>	—	685
$K_S^0 \pi^+ \pi^- \pi^0$ nonresonant	(1.1 ± 1.1) %	—	812
$K^- \pi^+ \pi^+ \pi^- \pi^0$	(4.1 ± 0.4) %	—	771
$\bar{K}^*(892)^0 \pi^+ \pi^- \pi^0, \bar{K}^*(892)^0 \rightarrow K^- \pi^+$	(1.2 ± 0.6) %	—	643
$K^- \pi^+ \omega, \omega \rightarrow \pi^+ \pi^- \pi^0$	(2.7 ± 0.5) %	—	605
$\bar{K}^*(892)^0 \omega, \bar{K}^*(892)^0 \rightarrow K^- \pi^+, \omega \rightarrow \pi^+ \pi^- \pi^0$	(6.5 ± 2.4) × 10 <sup>-3</sup>	—	410
$K_S^0 \eta \pi^0$	(5.2 ± 1.2) × 10 <sup>-3</sup>	—	721
$K_S^0 a_0(980), a_0(980) \rightarrow \eta \pi^0$	(6.2 ± 2.0) × 10 <sup>-3</sup>	—	—
$\bar{K}^*(892)^0 \eta, \bar{K}^*(892)^0 \rightarrow K_S^0 \pi^0$	(1.5 ± 0.5) × 10 <sup>-3</sup>	—	—
$K_S^0 2\pi^+ 2\pi^-$	(2.75 ± 0.31) × 10 <sup>-3</sup>	—	768
$K_S^0 \rho^0 \pi^+ \pi^-, \text{no } K^*(892)^-$	(1.1 ± 0.7) × 10 <sup>-3</sup>	—	—
$K^*(892)^- \pi^+ \pi^+ \pi^-, K^*(892)^- \rightarrow K_S^0 \pi^-, \text{no } \rho^0$	(5 ± 8) × 10 <sup>-4</sup>	—	642
$K^*(892)^- \rho^0 \pi^+, K^*(892)^- \rightarrow K_S^0 \pi^-$	(1.7 ± 0.7) × 10 <sup>-3</sup>	—	230
$K_S^0 2\pi^+ 2\pi^-$ nonresonant	< 1.3 × 10 <sup>-3</sup> CL = 90%	—	768
$K^- 3\pi^+ 2\pi^-$	(2.1 ± 0.5) × 10 <sup>-4</sup>	—	713
Fractions of many of the following modes with resonances have already appeared above as submodes of particular charged-particle modes. (Modes for which there are only upper limits and $\bar{K}^*(892)\rho$ submodes only appear below.)			
$K_S^0 \eta$	(3.8 ± 0.6) × 10 <sup>-3</sup>	—	772
$K_S^0 \omega$	(1.10 ± 0.20) %	—	670
$K_S^0 \eta'(958)$	(9.1 ± 1.4) × 10 <sup>-3</sup>	—	565
$K^- a_1(1260)^+$	(7.5 ± 1.1) %	—	327
$\bar{K}_0^0 a_1(1260)^0$	< 1.9 %	CL = 90%	322
$K^- a_2(1320)^+$	< 2 × 10 <sup>-3</sup> CL = 90%	—	197
$\bar{K}^*(892)^0 \pi^+ \pi^-$ total	(2.3 ± 0.5) %	—	685
$\bar{K}^*(892)^0 \pi^+ \pi^-$ 3-body	(1.46 ± 0.32) %	—	685
$\bar{K}^*(892)^0 \rho^0$	(1.50 ± 0.33) %	—	417
$\bar{K}^*(892)^0 \rho^0$ transverse	(1.6 ± 0.5) %	—	417
$\bar{K}^*(892)^0 \rho^0$ S-wave	(2.9 ± 0.6) %	—	417
$\bar{K}^*(892)^0 \rho^0$ S-wave long.	< 3 × 10 <sup>-3</sup> CL = 90%	—	417
$\bar{K}^*(892)^0 \rho^0$ P-wave	< 3 × 10 <sup>-3</sup> CL = 90%	—	417
$\bar{K}^*(892)^0 \rho^0$ D-wave	(2.0 ± 0.6) %	—	417
$K^*(892)^- \rho^+$	(6.4 ± 2.5) %	—	417
$K^*(892)^- \rho^+$ longitudinal	(3.1 ± 1.2) %	—	417
$K^*(892)^- \rho^+$ transverse	(3.4 ± 2.0) %	—	417
$K^*(892)^- \rho^+$ P-wave	< 1.5 %	CL = 90%	417
$K_1(1270)^- \pi^+$	[ $ss$ ] (1.12 ± 0.31) %	—	484
$K_1(1400)^- \pi^+$	< 1.2 %	CL = 90%	386

$\bar{K}_1(1400)^0\pi^0$	< 3.7	%	CL = 90%	387
$\bar{K}^*(892)^0\pi^+\pi^-\pi^0$	(1.8 ± 0.9)	%		643
$K^-\pi^+\omega$	(3.0 ± 0.6)	%		605
$\bar{K}^*(892)^0\omega$	(1.1 ± 0.4)	%		410
$K^-\pi^+\eta'(958)$	(7.2 ± 1.8)	$\times 10^{-3}$		479
$\bar{K}^*(892)^0\eta'(958)$	< 1.1	$\times 10^{-3}$	CL = 90%	118

## Hadronic modes with three K's

$K_S^0 K^+ K^-$	(4.58 ± 0.34)	$\times 10^{-3}$		544
$K_S^0 a_0(980)^0, a_0^0 \rightarrow K^+ K^-$	(3.0 ± 0.4)	$\times 10^{-3}$		-
$K^- a_0(980)^+, a_0^+ \rightarrow K^+ K_S^0$	(6.1 ± 1.8)	$\times 10^{-4}$		-
$K^+ a_0(980)^-, a_0^- \rightarrow K^- K_S^0$	< 1.1	$\times 10^{-4}$	CL = 95%	-
$K_S^0 f_0(980), f_0 \rightarrow K^+ K^-$	< 1.0	$\times 10^{-4}$	CL = 95%	-
$K_S^0 \phi, \phi \rightarrow K^+ K^-$	(2.10 ± 0.16)	$\times 10^{-3}$		520
$K_S^0 f_0(1400), f_0 \rightarrow K^+ K^-$	(1.7 ± 1.1)	$\times 10^{-4}$		-
$3K_S^0$	(9.3 ± 1.3)	$\times 10^{-4}$		538
$K^+ K^- K^-\pi^+$	(2.11 ± 0.31)	$\times 10^{-4}$		434
$K^+ K^- \bar{K}^*(892)^0,$ $\bar{K}^*(892)^0 \rightarrow K^-\pi^+$	(4.2 ± 1.7)	$\times 10^{-5}$		†
$K^-\pi^+\phi, \phi \rightarrow K^+ K^-$	(3.8 ± 1.6)	$\times 10^{-5}$		422
$\phi \bar{K}^*(892)^0, \phi \rightarrow K^+ K^-,$ $\bar{K}^*(892)^0 \rightarrow K^-\pi^+$	(1.01 ± 0.20)	$\times 10^{-4}$		†
$K^+ K^- K^-\pi^+$ nonresonant	(3.2 ± 1.4)	$\times 10^{-5}$		434
$K_S^0 K_S^0 K^\pm \pi^\mp$	(6.1 ± 1.3)	$\times 10^{-4}$		427

## Pionic modes

$\pi^+\pi^-$	(1.364 ± 0.032)	$\times 10^{-3}$		922
$\pi^0\pi^0$	(7.9 ± 0.8)	$\times 10^{-4}$		922
$\pi^+\pi^-\pi^0$	(1.31 ± 0.06)	%		907
$\rho^+\pi^-$	(10.0 ± 0.6)	$\times 10^{-3}$		764
$\rho^0\pi^0$	(3.2 ± 0.4)	$\times 10^{-3}$		764
$\rho^-\pi^+$	(4.5 ± 0.4)	$\times 10^{-3}$		764
$f_0(980)\pi^0, f_0(980) \rightarrow$ $\pi^+\pi^-$	< 3.4	$\times 10^{-6}$	CL = 95%	-
$f_0(600)\pi^0, f_0(600) \rightarrow$ $\pi^+\pi^-$	< 2.7	$\times 10^{-5}$	CL = 95%	-
$(\pi^+\pi^-)_{S\text{-wave}}\pi^0$	< 2.5	$\times 10^{-4}$	CL = 95%	907
$3\pi^0$	< 3.5	$\times 10^{-4}$	CL = 90%	908
$2\pi^+ 2\pi^-$	(7.31 ± 0.27)	$\times 10^{-3}$		879
$\pi^+\pi^- 2\pi^0$	(9.8 ± 0.9)	$\times 10^{-3}$		882
$\eta\pi^0$	[aaa] (5.6 ± 1.4)	$\times 10^{-4}$		846
$\omega\pi^0$	[aaa] < 2.6	$\times 10^{-4}$	CL = 90%	761
$2\pi^+ 2\pi^-\pi^0$	(4.1 ± 0.5)	$\times 10^{-3}$		844
$\eta\pi^+\pi^-$	[aaa] < 1.9	$\times 10^{-3}$	CL = 90%	827
$\omega\pi^+\pi^-$	[aaa] (1.6 ± 0.5)	$\times 10^{-3}$		738
$3\pi^+ 3\pi^-$	(4.0 ± 1.1)	$\times 10^{-4}$		795

Hadronic modes with a  $K\bar{K}$  pair

$K^+ K^-$	(3.84 ± 0.10)	$\times 10^{-3}$		791
$2K_S^0$	(3.7 ± 0.7)	$\times 10^{-4}$		788
$K_S^0 K^-\pi^+$	(3.4 ± 0.5)	$\times 10^{-3}$	S = 1.1	739
$\bar{K}^*(892)^0 K_S^0, \bar{K}^*(892)^0 \rightarrow$ $K^-\pi^+$	< 6	$\times 10^{-4}$	CL = 90%	608
$K^*(892)^+ K^-,$ $K^*(892)^+ \rightarrow K_S^0 \pi^+$	(1.2 ± 0.3)	$\times 10^{-3}$		610
$K_S^0 K^-\pi^+$ nonresonant	(1.1 ± 1.1)	$\times 10^{-3}$		739
$K_S^0 K^+\pi^-$	(2.6 ± 0.5)	$\times 10^{-3}$		739
$K^*(892)^0 K_S^0, K^*(892)^0 \rightarrow$ $K^+\pi^-$	< 3	$\times 10^{-4}$	CL = 90%	608
$K^*(892)^- K^+,$ $K^*(892)^- \rightarrow K_S^0 \pi^-$	(7 ± 4)	$\times 10^{-4}$		610
$K_S^0 K^+\pi^-$ nonresonant	(1.9 <sup>+1.1</sup> <sub>-0.8</sub> )	$\times 10^{-3}$		739
$K^+ K^-\pi^0$	(1.3 ± 0.4)	$\times 10^{-3}$		743
$K_S^0 K_S^0 \pi^0$	< 5.9	$\times 10^{-4}$		740
$K^+ K^-\pi^+\pi^-$	[bbb] (2.32 ± 0.13)	$\times 10^{-3}$		676
$\phi\pi^+\pi^-$ 3-body, $\phi \rightarrow$ $K^+ K^-$	(2.3 ± 2.3)	$\times 10^{-5}$		614
$\phi\rho^0, \phi \rightarrow K^+ K^-$	(6.7 ± 0.6)	$\times 10^{-4}$		250
$K^+ K^-\rho^0$ 3-body	(5 ± 7)	$\times 10^{-5}$		302
$f_0(980)\pi^+\pi^-, f_0 \rightarrow$ $K^+ K^-$	(3.5 ± 0.9)	$\times 10^{-4}$		-
$K^*(892)^0 K^\mp \pi^\pm$ 3-body, $K^{*0} \rightarrow K^\pm \pi^\mp$	[ccc] (2.5 ± 0.5)	$\times 10^{-4}$		531
$K^*(892)^0 \bar{K}^*(892)^0, K^{*0} \rightarrow$ $K^\pm \pi^\mp$	(7 ± 5)	$\times 10^{-5}$		272
$K_1(1270)^\pm K^\mp,$ $K_1(1270)^\pm \rightarrow K^\pm \pi^\mp \pi^-$	(7.6 ± 1.7)	$\times 10^{-4}$		-

$K_1(1400)^\pm K^\mp,$ $K_1(1400)^\pm \rightarrow$ $K^\pm \pi^\mp \pi^-$	(5.1 ± 1.2)	$\times 10^{-4}$		-
$K_S^0 K_S^0 \pi^+\pi^-$	(1.26 ± 0.24)	$\times 10^{-3}$		673
$K_S^0 K^-\pi^+\pi^-$	< 1.5	$\times 10^{-4}$	CL = 90%	595
$K^+ K^-\pi^+\pi^-$	(3.1 ± 2.0)	$\times 10^{-3}$		600

Fractions of most of the following modes with resonances have already appeared above as submodes of particular charged-particle modes.

$\bar{K}^*(892)^0 K_S^0$	< 8	$\times 10^{-4}$	CL = 90%	608
$K^*(892)^+ K^-$	(3.7 ± 0.8)	$\times 10^{-3}$		610
$K^*(892)^0 K_S^0$	< 4	$\times 10^{-4}$	CL = 90%	608
$K^*(892)^- K^+$	(2.0 ± 1.1)	$\times 10^{-3}$		610
$\phi\pi^0$	(7.4 ± 0.5)	$\times 10^{-4}$		644
$\phi\eta$	(1.4 ± 0.4)	$\times 10^{-4}$		489
$\phi\omega$	< 2.1	$\times 10^{-3}$	CL = 90%	237

## Radiative modes

$\rho^0\gamma$	< 2.4	$\times 10^{-4}$	CL = 90%	771
$\omega\gamma$	< 2.4	$\times 10^{-4}$	CL = 90%	768
$\phi\gamma$	(2.4 <sup>+0.7</sup> <sub>-0.6</sub> )	$\times 10^{-5}$		654
$\bar{K}^*(892)^0\gamma$	< 7.6	$\times 10^{-4}$	CL = 90%	719

Doubly Cabibbo suppressed (DC) modes or  $\Delta C = 2$  forbidden via mixing (C2M) modes

$K^+ \ell^- \bar{\nu}_\ell$ (via $\bar{D}^0$ )	C2M	< 1.8	$\times 10^{-4}$	CL = 90%	-
$K^+$ or $K^*(892)^+ e^- \bar{\nu}_e$ (via $\bar{D}^0$ )	C2M	< 6	$\times 10^{-5}$	CL = 90%	-
$K^+\pi^-$	DC	(1.43 ± 0.04)	$\times 10^{-4}$		861
$K^+\pi^-$ (via $\bar{D}^0$ )	C2M	< 1.5	$\times 10^{-5}$	CL = 95%	861
$K_S^0 \pi^+\pi^-$ (in $D^0 \rightarrow \bar{D}^0$ )	C2M	< 1.8	$\times 10^{-4}$	CL = 95%	-
$K^*(892)^+\pi^-,$ $K^*(892)^+ \rightarrow K_S^0 \pi^+$	DC	(10 <sup>+12</sup> <sub>-4</sub> )	$\times 10^{-5}$		711
$K^+\pi^-\pi^0$	DC	(3.29 <sup>+0.30</sup> <sub>-0.27</sub> )	$\times 10^{-4}$		844
$K^+\pi^-\pi^+\pi^-$	DC	(2.49 <sup>+0.21</sup> <sub>-0.15</sub> )	$\times 10^{-4}$		812
$K^+\pi^-\pi^+\pi^-$ (via $\bar{D}^0$ )	C2M	< 4	$\times 10^{-4}$	CL = 90%	812
$\mu^-$ anything (via $\bar{D}^0$ )	C2M	< 4	$\times 10^{-4}$	CL = 90%	-

 $\Delta C = 1$  weak neutral current (C1) modes, Lepton Family number (LF) violating modes, or Lepton number (L) violating modes

$\gamma\gamma$	C1	< 2.6	$\times 10^{-5}$	CL = 90%	932
$e^+e^-$	C1	< 1.2	$\times 10^{-6}$	CL = 90%	932
$\mu^+\mu^-$	C1	< 1.3	$\times 10^{-6}$	CL = 90%	926
$\pi^0 e^+e^-$	C1	< 4.5	$\times 10^{-5}$	CL = 90%	927
$\pi^0 \mu^+\mu^-$	C1	< 1.8	$\times 10^{-4}$	CL = 90%	915
$\eta e^+e^-$	C1	< 1.1	$\times 10^{-4}$	CL = 90%	852
$\eta\mu^+\mu^-$	C1	< 5.3	$\times 10^{-4}$	CL = 90%	838
$\pi^+\pi^- e^+e^-$	C1	< 3.73	$\times 10^{-4}$	CL = 90%	922
$\rho^0 e^+e^-$	C1	< 1.0	$\times 10^{-4}$	CL = 90%	771
$\pi^+\pi^-\mu^+\mu^-$	C1	< 3.0	$\times 10^{-5}$	CL = 90%	894
$\rho^0 \mu^+\mu^-$	C1	< 2.2	$\times 10^{-5}$	CL = 90%	754
$\omega e^+e^-$	C1	< 1.8	$\times 10^{-4}$	CL = 90%	768
$\omega\mu^+\mu^-$	C1	< 8.3	$\times 10^{-4}$	CL = 90%	751
$K^- K^+ e^+e^-$	C1	< 3.15	$\times 10^{-4}$	CL = 90%	791
$\phi e^+e^-$	C1	< 5.2	$\times 10^{-5}$	CL = 90%	654
$K^- K^+ \mu^+\mu^-$	C1	< 3.3	$\times 10^{-5}$	CL = 90%	709
$\phi\mu^+\mu^-$	C1	< 3.1	$\times 10^{-5}$	CL = 90%	631
$\bar{K}^0 e^+e^-$	[uu]	< 1.1	$\times 10^{-4}$	CL = 90%	866
$\bar{K}^0 \mu^+\mu^-$	[uu]	< 2.6	$\times 10^{-4}$	CL = 90%	852
$K^-\pi^+ e^+e^-$	C1	< 3.85	$\times 10^{-4}$	CL = 90%	861
$\bar{K}^*(892)^0 e^+e^-$	[uu]	< 4.7	$\times 10^{-5}$	CL = 90%	719
$K^-\pi^+\mu^+\mu^-$	C1	< 3.59	$\times 10^{-4}$	CL = 90%	829
$\bar{K}^*(892)^0 \mu^+\mu^-$	[uu]	< 2.4	$\times 10^{-5}$	CL = 90%	700
$\pi^+\pi^-\pi^0 \mu^+\mu^-$	C1	< 8.1	$\times 10^{-4}$	CL = 90%	863
$\mu^\pm e^\mp$	LF	[gg] < 8.1	$\times 10^{-7}$	CL = 90%	929
$\pi^0 e^\pm \mu^\mp$	LF	[gg] < 8.6	$\times 10^{-5}$	CL = 90%	924
$\eta e^\pm \mu^\mp$	LF	[gg] < 1.0	$\times 10^{-4}$	CL = 90%	848
$\pi^+\pi^- e^\pm \mu^\mp$	LF	[gg] < 1.5	$\times 10^{-5}$	CL = 90%	911
$\rho^0 e^\pm \mu^\mp$	LF	[gg] < 4.9	$\times 10^{-5}$	CL = 90%	767
$\omega e^\pm \mu^\mp$	LF	[gg] < 1.2	$\times 10^{-4}$	CL = 90%	764
$K^- K^+ e^\pm \mu^\mp$	LF	[gg] < 1.8	$\times 10^{-4}$	CL = 90%	754
$\phi e^\pm \mu^\mp$	LF	[gg] < 3.4	$\times 10^{-5}$	CL = 90%	648
$\bar{K}^0 e^\pm \mu^\mp$	LF	[gg] < 1.0	$\times 10^{-4}$	CL = 90%	862
$K^-\pi^+ e^\pm \mu^\mp$	LF	[gg] < 5.53	$\times 10^{-4}$	CL = 90%	848
$\bar{K}^*(892)^0 e^\pm \mu^\mp$	LF	[gg] < 8.3	$\times 10^{-5}$	CL = 90%	714
$\pi^-\pi^- e^+e^+ + \text{c.c.}$	L	< 1.12	$\times 10^{-4}$	CL = 90%	922

$\pi^- \pi^- \mu^+ \mu^+ + c.c.$	$L$	$< 2.9 \times 10^{-5}$	CL = 90%	894
$K^- \pi^- e^+ e^+ + c.c.$	$L$	$< 2.06 \times 10^{-4}$	CL = 90%	861
$K^- \pi^- \mu^+ \mu^+ + c.c.$	$L$	$< 3.9 \times 10^{-4}$	CL = 90%	829
$K^- K^- e^+ e^+ + c.c.$	$L$	$< 1.52 \times 10^{-4}$	CL = 90%	791
$K^- K^- \mu^+ \mu^+ + c.c.$	$L$	$< 9.4 \times 10^{-5}$	CL = 90%	709
$\pi^- \pi^- e^+ \mu^+ + c.c.$	$L$	$< 7.9 \times 10^{-5}$	CL = 90%	911
$K^- \pi^- e^+ \mu^+ + c.c.$	$L$	$< 2.18 \times 10^{-4}$	CL = 90%	848
$K^- K^- e^+ \mu^+ + c.c.$	$L$	$< 5.7 \times 10^{-5}$	CL = 90%	754

 **$D^*(2007)^0$** 

$$I(J^P) = \frac{1}{2}(1^-)$$

 $I, J, P$  need confirmation.Mass  $m = 2006.7 \pm 0.4$  MeV ( $S = 1.1$ ) $m_{D^{*0}} - m_{D^0} = 142.12 \pm 0.07$  MeVFull width  $\Gamma < 2.1$  MeV, CL = 90% $\bar{D}^*(2007)^0$  modes are charge conjugates of modes below.

$D^*(2007)^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^0 \pi^0$	(61.9 ± 2.9) %	43
$D^0 \gamma$	(38.1 ± 2.9) %	137

 **$D^*(2010)^\pm$** 

$$I(J^P) = \frac{1}{2}(1^-)$$

 $I, J, P$  need confirmation.Mass  $m = 2010.0 \pm 0.4$  MeV ( $S = 1.1$ ) $m_{D^{*(2010)+}} - m_{D^+} = 140.64 \pm 0.10$  MeV ( $S = 1.1$ ) $m_{D^{*(2010)+}} - m_{D^0} = 145.421 \pm 0.010$  MeV ( $S = 1.1$ )Full width  $\Gamma = 96 \pm 22$  keV $D^*(2010)^-$  modes are charge conjugates of the modes below.

$D^*(2010)^\pm$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^0 \pi^+$	(67.7 ± 0.5) %	39
$D^+ \pi^0$	(30.7 ± 0.5) %	38
$D^+ \gamma$	(1.6 ± 0.4) %	136

 **$D_1(2420)^0$** 

$$I(J^P) = \frac{1}{2}(1^+)$$

 $I, J, P$  need confirmation.Mass  $m = 2422.3 \pm 1.3$  MeV ( $S = 1.2$ ) $m_{D_1^0} - m_{D^{*+}} = 411.7 \pm 0.8$ Full width  $\Gamma = 20.4 \pm 1.7$  MeV $\bar{D}_1(2420)^0$  modes are charge conjugates of modes below.

$D_1(2420)^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^*(2010)^+ \pi^-$	seen	355
$D^0 \pi^+ \pi^-$	seen	426
$D^+ \pi^-$	not seen	474
$D^{*0} \pi^+ \pi^-$	not seen	281

 **$D_2^*(2460)^0$** 

$$I(J^P) = \frac{1}{2}(2^+)$$

 $J^P = 2^+$  assignment strongly favored.Mass  $m = 2461.1 \pm 1.6$  MeV ( $S = 1.3$ ) $m_{D_2^{*0}} - m_{D^+} = 593.9 \pm 0.8$ Full width  $\Gamma = 43 \pm 4$  MeV ( $S = 1.8$ ) $\bar{D}_2^*(2460)^0$  modes are charge conjugates of modes below.

$D_2^*(2460)^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^+ \pi^-$	seen	506
$D^*(2010)^+ \pi^-$	seen	389
$D^0 \pi^+ \pi^-$	not seen	462
$D^{*0} \pi^+ \pi^-$	not seen	325

 **$D_2^*(2460)^\pm$** 

$$I(J^P) = \frac{1}{2}(2^+)$$

 $J^P = 2^+$  assignment strongly favored.Mass  $m = 2459 \pm 4$  MeV ( $S = 1.7$ ) $m_{D_2^*(2460)^\pm} - m_{D_2^*(2460)^0} = 2.4 \pm 1.7$  MeVFull width  $\Gamma = 29 \pm 5$  MeV $D_2^*(2460)^-$  modes are charge conjugates of modes below.

$D_2^*(2460)^\pm$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^0 \pi^+$	seen	507
$D^{*0} \pi^+$	seen	390
$D^+ \pi^+ \pi^-$	not seen	456
$D^{*+} \pi^+ \pi^-$	not seen	319

**CHARMED, STRANGE MESONS** $(C = S = \pm 1)$  $D_s^+ = c\bar{s}, D_s^- = \bar{c}s$ , similarly for  $D_s^{* \pm}$  **$D_s^\pm$  was  $F^\mp$** 

$$I(J^P) = 0(0^-)$$

Mass  $m = 1968.2 \pm 0.5$  MeV ( $S = 1.1$ ) $m_{D_s^\pm} - m_{D^\pm} = 98.85 \pm 0.30$  MeV ( $S = 1.4$ )Mean life  $\tau = (500 \pm 7) \times 10^{-15}$  s ( $S = 1.3$ ) $c\tau = 149.9$   $\mu$ m **$T$ -violation decay-rate asymmetry** $A_T(K_S^0 K^\pm \pi^+ \pi^-) = -0.04 \pm 0.07$  **$D_s^*$  form factors** $r_2 = 1.32 \pm 0.24$  ( $S = 1.2$ ) $r_\nu = 1.72 \pm 0.21$  $\Gamma_L/\Gamma_T = 0.72 \pm 0.18$ Unless otherwise noted, the branching fractions for modes with a resonance in the final state include all the decay modes of the resonance.  $D_s^-$  modes are charge conjugates of the modes below.

$D_s^*$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Inclusive modes</b>			
$K^-$ anything	(13 <sup>+14</sup> <sub>-12</sub> ) %		—
$\bar{K}^0$ anything + $K^0$	(39 ± 28) %		—
anything			
$K^+$ anything	(20 <sup>+18</sup> <sub>-14</sub> ) %		—
(non- $K \bar{K}$ ) anything	(64 ± 17) %		—
$e^+$ anything	(8 <sup>+6</sup> <sub>-5</sub> ) %		—
$\phi$ anything	(18 <sup>+15</sup> <sub>-10</sub> ) %		—
<b>Leptonic and semileptonic modes</b>			
$\mu^+ \nu_\mu$	(6.1 ± 1.9) %	$\times 10^{-3} S = 1.4$	981
$\tau^+ \nu_\tau$	(6.4 ± 1.5) %		182
$\phi \ell^+ \nu_\ell$	[ddd]	$S = 1.1$	720
$\eta \ell^+ \nu_\ell + \eta'(958) \ell^+ \nu_\ell$	[ddd]		—
$\eta \ell^+ \nu_\ell$	[ddd]		908
$\eta'(958) \ell^+ \nu_\ell$	[ddd]		751
<b>Hadronic modes with a <math>K\bar{K}</math> pair</b>			
$K^+ \bar{K}^0$	(4.4 ± 0.9) %		850
$K^+ K^- \pi^+$	[qq]	$S = 1.1$	805
$\phi \pi^+$	[eee]	$S = 1.1$	711
$\phi \pi^+, \phi \rightarrow K^+ K^-$	(2.16 ± 0.28) %	$S = 1.1$	712
$K^+ \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K^- \pi^+$	(2.5 ± 0.5) %		416
$f_0(980) \pi^+, f_0 \rightarrow K^+ K^-$	(5.7 ± 2.5) %	$\times 10^{-3}$	732
$K^+ \bar{K}_0^*(1430)^0, \bar{K}_0^* \rightarrow K^- \pi^+$	(4.8 ± 2.5) %	$\times 10^{-3}$	218
$K^0 \bar{K}^0 \pi^+$	—		802
$K^*(892)^+ \bar{K}^0$	[eee]	(5.3 ± 1.3) %	683
$K^+ K^- \pi^+ \pi^0$	—		748
$\phi \pi^+ \pi^0$	[eee]	(11 ± 5) %	686



$\phi \rho^+$	[eee]	$(8.2^{+2.0}_{-2.4})$	%		401
$\phi \pi^+ \pi^0$ 3-body	[eee]	< 3.1	%	CL = 90%	686
$K^+ K^- \pi^+ \pi^0$ non- $\phi$		< 11	%	CL = 90%	748
$K^+ \bar{K}^0 \pi^+ \pi^-$		$(3.1 \pm 0.9)$	%		744
$K^0 K^- \pi^+ \pi^+$		$(5.3 \pm 1.4)$	%		744
$K^*(892)^+ \bar{K}^{*0}(892)^0$	[eee]	$(7.0 \pm 2.7)$	%		416
$K^0 K^- \pi^+ \pi^+$ (non- $K^{*+} \bar{K}^{*0}$ )		< 3.5	%	CL = 90%	744
$K^+ K^- \pi^+ \pi^+ \pi^-$		$(8.3 \pm 2.0)$	$\times 10^{-3}$		673
$\phi \pi^+ \pi^+ \pi^-$	[eee]	$(1.18 \pm 0.20)$	%		640
$K^+ K^- \rho^0 \pi^+$ non- $\phi$		< 2.5	$\times 10^{-4}$	CL = 90%	248
$\phi \rho^0 \pi^+$	[eee]	$(1.24 \pm 0.33)$	%		181
$\phi a_1(1260)^+$	[eee]	$(2.9 \pm 0.7)$	%		†
$K^+ K^- \pi^+ \pi^+ \pi^-$ nonresonant		$(8 \pm 7)$	$\times 10^{-4}$		673
$K_S^0 K_S^0 \pi^+ \pi^+ \pi^-$		$(2.7 \pm 1.3)$	$\times 10^{-3}$		669

Hadronic modes without  $K$ 's

$\pi^+ \pi^+ \pi^-$		$(1.22 \pm 0.23)$	%	S = 1.2	959
$\pi^+ (\pi^+ \pi^-)_{S\text{-wave}}$	[fff]	$(1.06 \pm 0.22)$	%		959
$f_2(1270) \pi^+, f_2 \rightarrow \pi^+ \pi^-$		$(1.2 \pm 0.7)$	$\times 10^{-3}$		559
$\rho(1450)^0 \pi^+, \rho^0 \rightarrow \pi^+ \pi^-$		$(8 \pm 7)$	$\times 10^{-4}$		421
$\pi^+ \pi^+ \pi^- \pi^0$		< 15	%	CL = 90%	935
$\eta \pi^+$	[eee]	$(2.11 \pm 0.35)$	%		902
$\omega \pi^+$	[eee]	$(3.4 \pm 1.2)$	$\times 10^{-3}$		822
$3\pi^+ 2\pi^-$		$(7.6 \pm 1.6)$	$\times 10^{-3}$		899
$\pi^+ \pi^+ \pi^- \pi^0 \pi^0$		—			902
$\eta \rho^+$	[eee]	$(13.1 \pm 2.6)$	%		724
$\eta \pi^+ \pi^0$ 3-body	[eee]	< 5	%	CL = 90%	885
$3\pi^+ 2\pi^- \pi^0$		$(4.9 \pm 3.2)$	%		856
$\eta'(958) \pi^+$	[eee]	$(4.7 \pm 0.7)$	%		743
$3\pi^+ 2\pi^- 2\pi^0$		—			803
$\eta'(958) \rho^+$	[eee]	$(12.2 \pm 2.4)$	%		464
$\eta'(958) \pi^+ \pi^0$ 3-body	[eee]	< 1.8	%	CL = 90%	720

Modes with one or three  $K$ 's

$K^0 \pi^+$		< 1.9	$\times 10^{-3}$	CL = 90%	916
$K^+ \pi^+ \pi^-$		$(6.6 \pm 1.4)$	$\times 10^{-3}$		900
$K^+ \rho^0$		$(2.6 \pm 0.7)$	$\times 10^{-3}$		744
$K^+ \rho(1450)^0, \rho^0 \rightarrow \pi^+ \pi^-$		$(7.0 \pm 2.9)$	$\times 10^{-4}$		—
$K^*(892)^0 \pi^+, K^{*0} \rightarrow K^+ \pi^-$		$(1.4 \pm 0.4)$	$\times 10^{-3}$		775
$K^*(1410)^0 \pi^+, K^{*0} \rightarrow K^+ \pi^-$		$(1.2 \pm 0.4)$	$\times 10^{-3}$		—
$K^*(1430)^0 \pi^+, K^{*0} \rightarrow K^+ \pi^-$		$(5 \pm 4)$	$\times 10^{-4}$		—
$K^+ \pi^+ \pi^-$ nonresonant		$(1.0 \pm 0.4)$	$\times 10^{-3}$		900
$K^+ K^+ K^-$		$(4.6 \pm 1.8)$	$\times 10^{-4}$		627
$\phi K^+$	[eee]	< 6	$\times 10^{-4}$	CL = 90%	606

## Doubly Cabibbo-suppressed modes

$K^+ K^+ \pi^-$		$(2.7 \pm 1.2)$	$\times 10^{-4}$		805
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 $\Delta C = 1$  weak neutral current (C1) modes,  
Lepton family number (LF), or  
Lepton number (L) violating modes

$\pi^+ e^+ e^-$	[uu]	< 2.7	$\times 10^{-4}$	CL = 90%	979
$\pi^+ \mu^+ \mu^-$	[uu]	< 2.6	$\times 10^{-5}$	CL = 90%	968
$K^+ e^+ e^-$	CI	< 1.6	$\times 10^{-3}$	CL = 90%	922
$K^+ \mu^+ \mu^-$	CI	< 3.6	$\times 10^{-5}$	CL = 90%	909
$K^*(892)^+ \mu^+ \mu^-$	CI	< 1.4	$\times 10^{-3}$	CL = 90%	765
$\pi^+ e^\pm \mu^\mp$	LF [gg]	< 6.1	$\times 10^{-4}$	CL = 90%	976
$K^+ e^\pm \mu^\mp$	LF [gg]	< 6.3	$\times 10^{-4}$	CL = 90%	919
$\pi^- e^+ e^+$	L	< 6.9	$\times 10^{-4}$	CL = 90%	979
$\pi^- \mu^+ \mu^+$	L	< 2.9	$\times 10^{-5}$	CL = 90%	968
$\pi^- e^+ \mu^+$	L	< 7.3	$\times 10^{-4}$	CL = 90%	976
$K^- e^+ e^+$	L	< 6.3	$\times 10^{-4}$	CL = 90%	922
$K^- \mu^+ \mu^+$	L	< 1.3	$\times 10^{-5}$	CL = 90%	909
$K^- e^+ \mu^+$	L	< 6.8	$\times 10^{-4}$	CL = 90%	919
$K^*(892)^- \mu^+ \mu^+$	L	< 1.4	$\times 10^{-3}$	CL = 90%	765

 $D_s^{*\pm}$ 

$$I(J^P) = 0(?^2)$$

 $J^P$  is natural, width and decay modes consistent with  $1^-$ .

Mass  $m = 2112.0 \pm 0.6$  MeV (S = 1.1)

$m_{D_s^{*\pm}} - m_{D_s^\pm} = 143.8 \pm 0.4$  MeV

Full width  $\Gamma < 1.9$  MeV, CL = 90%

 $D_s^{*-}$  modes are charge conjugates of the modes below.

$D_s^{*+}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D_s^+ \gamma$	$(94.2 \pm 0.7)\%$	139
$D_s^+ \pi^0$	$(5.8 \pm 0.7)\%$	48

 $D_{s0}^{*+}(2317)^\pm$ 

$$I(J^P) = 0(0^+)$$

 $J, P$  need confirmation. $J^P$  is natural, low mass consistent with  $0^+$ .

Mass  $m = 2317.3 \pm 0.6$  MeV

$m_{D_{s0}^{*+}(2317)^\pm} - m_{D_s^\pm} = 349.1 \pm 0.6$  MeV

Full width  $\Gamma < 4.6$  MeV, CL = 90%

 $D_{s1}^{*+}(2460)^\pm$ 

$$I(J^P) = 0(1^+)$$

Mass  $m = 2458.9 \pm 0.9$  MeV (S = 1.1)

$m_{D_{s1}^{*+}(2460)^\pm} - m_{D_s^{*\pm}} = 346.9 \pm 1.0$  MeV (S = 1.2)

$m_{D_{s1}^{*+}(2460)^\pm} - m_{D_s^\pm} = 490.7 \pm 0.9$  MeV (S = 1.2)

Full width  $\Gamma < 5.5$  MeV, CL = 90%

 $D_{s1}^{*+}(2536)^\pm$ 

$$I(J^P) = 0(1^+)$$

 $J, P$  need confirmation.

Mass  $m = 2535.35 \pm 0.34 \pm 0.5$  MeV

Full width  $\Gamma < 2.3$  MeV, CL = 90%

 $D_{s1}(2536)^-$  modes are charge conjugates of the modes below.

$D_{s1}(2536)^\pm$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^*(2010)^+ K^0$	seen	150
$D^*(2007)^0 K^+$	seen	168
$D^+ K^0$	not seen	382
$D^0 K^+$	not seen	392
$D_s^\pm \gamma$	possibly seen	388

 $D_{s2}(2573)^\pm$ 

$$I(J^P) = 0(?^2)$$

 $J^P$  is natural, width and decay modes consistent with  $2^+$ .

Mass  $m = 2573.5 \pm 1.7$  MeV

Full width  $\Gamma = 15^{+5}_{-4}$  MeV

 $D_{s2}(2573)^-$  modes are charge conjugates of the modes below.

$D_{s2}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$D^0 K^+$	seen	436
$D^*(2007)^0 K^+$	not seen	246

**BOTTOM MESONS**

$$(B = \pm 1)$$

$$B^+ = u\bar{b}, B^0 = d\bar{b}, \bar{B}^0 = \bar{d}b, B^- = \bar{u}b, \quad \text{similarly for } B^{*s}$$

**B-particle organization**

Many measurements of  $B$  decays involve admixtures of  $B$  hadrons. Previously we arbitrarily included such admixtures in the  $B^\pm$  section, but because of their importance we have created two new sections: “ $B^\pm/B^0$  Admixture” for  $\Upsilon(4S)$  results and “ $B^\pm/B^0/B_s^0/b$ -baryon Admixture” for results at higher energies. Most inclusive decay branching fractions and  $\chi_b$  at high energy are found in the Admixture sections.  $B^0\text{-}\bar{B}^0$  mixing data are found in the  $B^0$  section, while  $B_s^0\text{-}\bar{B}_s^0$  mixing data and  $B\text{-}\bar{B}$  mixing data for a  $B^0/B_s^0$  admixture are found in the  $B_s^0$  section.  $CP$ -violation data are found in the  $B^\pm, B^0,$  and  $B^\pm B^0$  Admixture sections.  $b$ -baryons are found near the end of the Baryon section.

The organization of the  $B$  sections is now as follows, where bullets indicate particle sections and brackets indicate reviews.

- $B^\pm$   
mass, mean life, branching fractions  $CP$  violation
- $B^0$   
mass, mean life, branching fractions  
polarization in  $B^0$  decay,  $B^0\text{-}\bar{B}^0$  mixing,  $CP$  violation
- $B^\pm B^0$  Admixtures  
branching fractions,  $CP$  violation
- $B^\pm/B^0/B_s^0/b$ -baryon Admixtures  
mean life, production fractions, branching fractions  
 $\chi_b$  at high energy,  $V_{cb}$  measurements
- $B^*$   
mass
- $B_s^0$   
mass, mean life, branching fractions  
polarization in  $B_s^0$  decay,  $B_s^0\text{-}\bar{B}_s^0$  mixing
- $B_c^\pm$   
mass, mean life, branching fractions

At end of Baryon Listings:

- $\Lambda_b$   
mass, mean life, branching fractions
- $b$ -baryon Admixture  
mean life, branching fractions

**$B^\pm$**

$$I(J^P) = \frac{1}{2}(0^-)$$

$I, J, P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^\pm} = 5279.0 \pm 0.5 \text{ MeV}$$

$$\text{Mean life } \tau_{B^\pm} = (1.638 \pm 0.011) \times 10^{-12} \text{ s}$$

$$c\tau = 491.1 \mu\text{m}$$

**$CP$  violation**

$$A_{CP}(B^+ \rightarrow J/\psi(1S)K^+) = -0.024 \pm 0.014$$

$$A_{CP}(B^+ \rightarrow J/\psi(1S)\pi^+) = 0.09 \pm 0.08$$

$$A_{CP}(B^+ \rightarrow J/\psi K^*(892)^+) = 0.048 \pm 0.033$$

$$A_{CP}(B^+ \rightarrow \psi(2S)K^+) = -0.025 \pm 0.024$$

$$A_{CP}(B^+ \rightarrow \psi(2S)K^*(892)^+) = -0.08 \pm 0.21$$

$$A_{CP}(B^+ \rightarrow \chi_{c1}K^+) = 0.00 \pm 0.08$$

$$A_{CP}(B^+ \rightarrow \chi_{c1}K^*(892)^+) = -0.5 \pm 0.5$$

$$A_{CP}(B^+ \rightarrow \bar{D}^0\pi^+) = -0.008 \pm 0.008$$

$$A_{CP}(B^+ \rightarrow D_{CP(+1)}\pi^+) = 0.035 \pm 0.024$$

$$A_{CP}(B^+ \rightarrow D_{CP(-1)}\pi^+) = 0.017 \pm 0.026$$

$$A_{CP}(B^+ \rightarrow \bar{D}^0K^+) = 0.07 \pm 0.04$$

$$r_B(B^+ \rightarrow D^0K^+) = 0.12 \pm 0.09$$

$$\delta_B(B^+ \rightarrow D^0K^+) = 104 \pm 50 \text{ degrees}$$

$$A_{CP}(B^+ \rightarrow [K^-\pi^+]_D K^+) = 0.9^{+0.8}_{-0.6}$$

$$A_{CP}(B^+ \rightarrow [K^-\pi^+]_{\bar{D}} K^*(892)^+) = -0.2 \pm 0.6$$

$$A_{CP}(B^+ \rightarrow [K^-\pi^+]_D \pi^+) = 0.30^{+0.30}_{-0.26}$$

$$A_{CP}(B^+ \rightarrow [\pi^+\pi^-\pi^0]_D K^+) = -0.02 \pm 0.16$$

$$A_{CP}(B^+ \rightarrow D_{CP(+1)}K^+) = 0.22 \pm 0.14(S = 1.4)$$

$$A_{CP}(B^+ \rightarrow D_{CP(-1)}K^+) = -0.09 \pm 0.10$$

$$A_{CP}(B^+ \rightarrow D^{*0}\pi^+) = -0.014 \pm 0.015$$

$$A_{CP}(B^+ \rightarrow (D_{CP(+1)}^*)^0\pi^+) = -0.02 \pm 0.05$$

$$A_{CP}(B^+ \rightarrow (D_{CP(-1)}^*)^0\pi^+) = -0.09 \pm 0.05$$

$$A_{CP}(B^+ \rightarrow D^{*0}K^+) = -0.09 \pm 0.09$$

$$r_B^*(B^+ \rightarrow D^{*0}K^+) = 0.17 \pm 0.11$$

$$\delta_B^*(B^+ \rightarrow D^{*0}K^+) = -64 \pm 50 \text{ degrees}$$

$$A_{CP}(B^+ \rightarrow D_{CP(+1)}^{*0}K^+) = -0.15 \pm 0.16$$

$$A_{CP}(B^+ \rightarrow D_{CP(-1)}^{*0}K^+) = 0.13 \pm 0.31$$

$$A_{CP}(B^+ \rightarrow D_{CP(+1)}K^*(892)^+) = -0.08 \pm 0.21$$

$$A_{CP}(B^+ \rightarrow D_{CP(-1)}K^*(892)^+) = -0.3 \pm 0.4$$

$$A_{CP}(B^+ \rightarrow K_S^0\pi^+) = -0.02 \pm 0.07(S = 1.9)$$

$$A_{CP}(B^+ \rightarrow K^+\pi^0) = 0.04 \pm 0.04$$

$$A_{CP}(B^+ \rightarrow K^+\eta') = 0.020 \pm 0.025$$

$$A_{CP}(B^+ \rightarrow \eta K^+) = -0.25 \pm 0.14$$

$$A_{CP}(B^+ \rightarrow \eta K^*(892)^+) = 0.13 \pm 0.14$$

$$A_{CP}(B^+ \rightarrow \omega K^+) = -0.02 \pm 0.13$$

$$A_{CP}(B^+ \rightarrow K^{*0}\pi^+) = 0.07 \pm 0.10$$

$$A_{CP}(B^+ \rightarrow K^+\pi^-\pi^+) = -0.01 \pm 0.04$$

$$A_{CP}(B^+ \rightarrow f_0(980)K^+) = 0.09^{+0.14}_{-0.11}$$

$$A_{CP}(B^+ \rightarrow \rho^0 K^+) = 0.32 \pm 0.16$$

$$A_{CP}(B^+ \rightarrow K_0^*(1430)^0\pi^+) = -0.06 \pm 0.04$$

$$A_{CP}(B^+ \rightarrow K^*(892)^+\pi^0) = 0.04 \pm 0.29$$

$$A_{CP}(B^+ \rightarrow \rho^0 K^*(892)^+) = 0.20 \pm 0.31$$

$$A_{CP}(B^+ \rightarrow K^0 K^+) = 0.15 \pm 0.33$$

$$A_{CP}(B^+ \rightarrow K^+ K_S^0 K_S^0) = -0.04 \pm 0.11$$

$$A_{CP}(B^+ \rightarrow K^+ K^- K^+) = 0.02 \pm 0.08$$

$$A_{CP}(B^+ \rightarrow \phi K^+) = 0.01 \pm 0.07$$

$$A_{CP}(B^+ \rightarrow \phi K^*(892)^+) = 0.05 \pm 0.11$$

$$A_{CP}(B^+ \rightarrow \eta K^+\gamma) = -0.16 \pm 0.11$$

$$A_{CP}(B^+ \rightarrow \pi^+\pi^0) = -0.02 \pm 0.07$$

$$A_{CP}(B^+ \rightarrow \pi^+\pi^-\pi^+) = -0.01 \pm 0.08$$

$$A_{CP}(B^+ \rightarrow \rho^0\pi^+) = -0.07 \pm 0.13$$

$$A_{CP}(B^+ \rightarrow f_2(1270)\pi^+) = 0.00 \pm 0.25$$

$$A_{CP}(B^+ \rightarrow \rho^+\pi^0) = 0.15 \pm 0.12$$

$$A_{CP}(B^+ \rightarrow \rho^+\rho^0) = -0.09 \pm 0.16$$

$$A_{CP}(B^+ \rightarrow \omega\pi^+) = 0.10 \pm 0.22(S = 1.9)$$

$$A_{CP}(B^+ \rightarrow \omega\rho^+) = 0.05 \pm 0.26$$

$$A_{CP}(B^+ \rightarrow \eta\pi^+) = -0.05 \pm 0.10$$

$$A_{CP}(B^+ \rightarrow \eta'\pi^+) = 0.14 \pm 0.16$$

$$A_{CP}(B^+ \rightarrow \eta\rho^+) = 0.02 \pm 0.18$$

$$A_{CP}(B^+ \rightarrow p\bar{p}\pi^+) = -0.16 \pm 0.22$$

$$A_{CP}(B^+ \rightarrow p\bar{p}K^+) = -0.05 \pm 0.11$$

$$\gamma(B^+ \rightarrow D^{(*)}K^+) = (75 \pm 20)^\circ$$

$B^-$  modes are charge conjugates of the modes below. Modes which do not identify the charge state of the  $B$  are listed in the  $B^\pm/B^0$  ADMIXTURE section.

The branching fractions listed below assume 50%  $B^0\bar{B}^0$  and 50%  $B^+B^-$  production at the  $\Upsilon(4S)$ . We have attempted to bring older measurements up to date by rescaling their assumed  $\Upsilon(4S)$  production ratio to 50:50 and their assumed  $D, D_s, D^*$ , and  $\psi$  branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

$B^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$\rho$ (MeV/c)
<b>Semileptonic and leptonic modes</b>			
$\ell^+ \nu_\ell$ anything	[ggg] (10.9 ± 0.4) %		–
$\bar{D}^0 \ell^+ \nu_\ell$	[ggg] (2.15 ± 0.22) %		2310
$\bar{D}^*(2007)^0 \ell^+ \nu_\ell$	[ggg] (6.5 ± 0.5) %		2258
$\bar{D}_1(2420)^0 \ell^+ \nu_\ell$	(5.6 ± 1.6) × 10 <sup>-3</sup>		2084
$\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell$	< 8 × 10 <sup>-3</sup>	CL = 90%	2066
$D^- \pi^+ \ell^+ \nu_\ell$	(5.3 ± 1.0) × 10 <sup>-3</sup>		2306
$D^{*-} \pi^+ \ell^+ \nu_\ell$	(6.4 ± 1.5) × 10 <sup>-3</sup>		2254
$\pi^0 \ell^+ \nu_\ell$	(7.4 ± 1.1) × 10 <sup>-5</sup>		2638
$\eta \ell^+ \nu_\ell$	(8 ± 4) × 10 <sup>-5</sup>		2611
$\omega \ell^+ \nu_\ell$	[ggg] (1.3 ± 0.6) × 10 <sup>-4</sup>		2582
$\rho^0 \ell^+ \nu_\ell$	[ggg] (1.24 ± 0.23) × 10 <sup>-4</sup>		2583
$p \bar{p} e^+ \nu_e$	< 5.2 × 10 <sup>-3</sup>	CL = 90%	2467
$e^+ \nu_e$	< 1.5 × 10 <sup>-5</sup>	CL = 90%	2640
$\mu^+ \nu_\mu$	< 6.6 × 10 <sup>-6</sup>	CL = 90%	2638
$\tau^+ \nu_\tau$	< 2.6 × 10 <sup>-4</sup>	CL = 90%	2340
$e^+ \nu_e \gamma$	< 2.0 × 10 <sup>-4</sup>	CL = 90%	2640
$\mu^+ \nu_\mu \gamma$	< 5.2 × 10 <sup>-5</sup>	CL = 90%	2638
<b>Inclusive modes</b>			
$D^0 X$	(9.8 ± 1.1) %		–
$\bar{D}^0 X$	(79 ± 5) %		–
$D^+ X$	(3.8 ± 1.0) %		–
$D^- X$	(9.8 ± 1.8) %		–
$D_s^+ X$	(14 <sup>+5</sup> <sub>-4</sub> ) %		–
$D_s^- X$	< 2.2 %	CL = 90%	–
$\Lambda_c^+ X$	(2.9 <sup>+1.4</sup> <sub>-1.1</sub> ) %		–
$\bar{\Lambda}_c^- X$	(3.5 <sup>+1.3</sup> <sub>-1.2</sub> ) %		–
$\bar{c} X$	(98 ± 6) %		–
$c X$	(33 <sup>+6</sup> <sub>-4</sub> ) %		–
$\bar{c} c X$	(131 <sup>+10</sup> <sub>-8</sub> ) %		–
<b><math>D, D^*</math>, or <math>D_s</math> modes</b>			
$\bar{D}^0 \pi^+$	(4.92 ± 0.20) × 10 <sup>-3</sup>		2308
$D_{CP(+1)} \pi^+$	[bbb] (4.0 ± 0.8) × 10 <sup>-3</sup>		–
$D_{CP(-1)} \pi^+$	[bbb] (3.6 ± 0.8) × 10 <sup>-3</sup>		–
$\bar{D}^0 \rho^+$	(1.34 ± 0.18) %		2237
$\bar{D}^0 K^+$	(4.08 ± 0.24) × 10 <sup>-4</sup>		2281
$D_{CP(+1)} K^+$	[bbb] (3.7 ± 0.6) × 10 <sup>-4</sup>		–
$D_{CP(-1)} K^+$	[bbb] (3.5 ± 0.5) × 10 <sup>-4</sup>		–
[ $K^- \pi^+$ ] $_{\rho} \pi^+$	[iii] (1.7 ± 0.5) × 10 <sup>-5</sup>		–
[ $\pi^+ \pi^- \pi^0$ ] $_{D} K^-$	(5.5 ± 1.2) × 10 <sup>-6</sup>		–
$\bar{D}^0 K^*(892)^+$	(6.3 ± 0.8) × 10 <sup>-4</sup>		2213
$D_{CP(-1)} K^*(892)^+$	[bbb] (2.0 ± 0.9) × 10 <sup>-4</sup>		–
$D_{CP(+1)} K^*(892)^+$	[bbb] (6.2 ± 1.5) × 10 <sup>-4</sup>		–
$\bar{D}^0 K^+ \bar{K}^0$	(5.5 ± 1.6) × 10 <sup>-4</sup>		2189
$\bar{D}^0 K^+ \bar{K}^*(892)^0$	(7.5 ± 1.7) × 10 <sup>-4</sup>		2071
$\bar{D}^0 \pi^+ \pi^+ \pi^-$	(1.1 ± 0.4) %		2289
$\bar{D}^0 \pi^+ \pi^- \pi^-$	(5 ± 4) × 10 <sup>-3</sup>		2289
<b>nonresonant</b>			
$\bar{D}^0 \pi^+ \rho^0$	(4.2 ± 3.0) × 10 <sup>-3</sup>		2207
$\bar{D}^0 a_1(1260)^+$	(4 ± 4) × 10 <sup>-3</sup>		2123
$\bar{D}^0 \omega \pi^+$	(4.1 ± 0.9) × 10 <sup>-3</sup>		2206
$D^*(2010)^- \pi^+ \pi^+$	(1.35 ± 0.22) × 10 <sup>-3</sup>		2247
$D^- \pi^+ \pi^+$	(1.02 ± 0.16) × 10 <sup>-3</sup>		2299
$D^+ K^0$	< 5.0 × 10 <sup>-6</sup>	CL = 90%	2278
$\bar{D}^*(2007)^0 \pi^+$	(4.6 ± 0.4) × 10 <sup>-3</sup>		2256

$\bar{D}^*(2007)^0 \omega \pi^+$	(4.5 ± 1.2) × 10 <sup>-3</sup>		2149
$\bar{D}^*(2007)^0 \rho^+$	(9.8 ± 1.7) × 10 <sup>-3</sup>		2181
$\bar{D}^*(2007)^0 K^+$	(3.7 ± 0.4) × 10 <sup>-4</sup>		2227
$\bar{D}^*(2007)^0 K^*(892)^+$	(8.1 ± 1.4) × 10 <sup>-4</sup>		2156
$\bar{D}^*(2007)^0 K^+ \bar{K}^0$	< 1.06 × 10 <sup>-3</sup>	CL = 90%	2132
$\bar{D}^*(2007)^0 K^+ K^*(892)^0$	(1.5 ± 0.4) × 10 <sup>-3</sup>		2008
$\bar{D}^*(2007)^0 \pi^+ \pi^+ \pi^-$	(1.03 ± 0.12) %		2236
$\bar{D}^*(2007)^0 a_1(1260)^+$	(1.9 ± 0.5) %		2063
$\bar{D}^*(2007)^0 \pi^- \pi^+ \pi^+ \pi^0$	(1.8 ± 0.4) %		2219
$\bar{D}^{*0} 3\pi^+ 2\pi^-$	(5.7 ± 1.2) × 10 <sup>-3</sup>		2196
$D^*(2010)^+ \pi^0$	< 1.7 × 10 <sup>-4</sup>	CL = 90 %	2255
$D^*(2010)^+ K^0$	< 9.0 × 10 <sup>-6</sup>	CL = 90 %	2225
$D^*(2010)^- \pi^+ \pi^+ \pi^0$	(1.5 ± 0.7) %		2235
$D^*(2010)^- \pi^+ \pi^+ \pi^+ \pi^-$	(2.6 ± 0.4) × 10 <sup>-3</sup>		2217
$\bar{D}_1^*(2420)^0 \pi^+$	(1.5 ± 0.6) × 10 <sup>-3</sup>	S = 1.3	2081
$\bar{D}_1(2420)^0 \pi^+ \times B(\bar{D}_1^0 \rightarrow \bar{D}^0 \pi^+ \pi^-)$	(1.9 <sup>+0.5</sup> <sub>-0.6</sub> ) × 10 <sup>-4</sup>		2081
$\bar{D}_2^*(2462)^0 \pi^+$	(3.4 ± 0.8) × 10 <sup>-4</sup>		–
$\times B(\bar{D}_2^*(2462)^0 \rightarrow D^- \pi^+)$			
$\bar{D}_0^*(2308)^0 \pi^+$	(6.1 ± 1.9) × 10 <sup>-4</sup>		–
$\times B(\bar{D}_0^*(2308)^0 \rightarrow D^- \pi^+)$			
$\bar{D}_1(2421)^0 \pi^+$	(6.8 ± 1.5) × 10 <sup>-4</sup>		–
$\times B(\bar{D}_1(2421)^0 \rightarrow D^{*-} \pi^+)$			
$\bar{D}_2^*(2462)^0 \pi^+$	(1.8 ± 0.5) × 10 <sup>-4</sup>		–
$\times B(\bar{D}_2^*(2462)^0 \rightarrow D^{*-} \pi^+)$			
$\bar{D}_1(2427)^0 \pi^+$	(5.0 ± 1.2) × 10 <sup>-4</sup>		–
$\times B(\bar{D}_1(2427)^0 \rightarrow D^{*-} \pi^+)$			
$\bar{D}_1(2420)^0 \pi^+ \times B(\bar{D}_1^0 \rightarrow D^{*0} \pi^+ \pi^-)$	< 6 × 10 <sup>-6</sup>	CL = 90 %	2081
$\bar{D}_1^*(2420)^0 \rho^+$	< 1.4 × 10 <sup>-3</sup>	CL = 90 %	1995
$\bar{D}_2^*(2460)^0 \pi^+$	< 1.3 × 10 <sup>-3</sup>	CL = 90 %	2063
$\bar{D}_2^*(2460)^0 \pi^+ \times B(\bar{D}_2^{*0} \rightarrow D^{*0} \pi^+ \pi^-)$	< 2.2 × 10 <sup>-5</sup>	CL = 90 %	2063
$\bar{D}_2^*(2460)^0 \rho^+$	< 4.7 × 10 <sup>-3</sup>	CL = 90 %	1976
$\bar{D}^0 D_s^+$	(1.09 ± 0.27) %		1815
$D_{s0}(2317)^+ \bar{D}^0 \times B(D_{s0}(2317)^+ \rightarrow D_s^+ \pi^0)$	(7.4 <sup>+2.3</sup> <sub>-1.9</sub> ) × 10 <sup>-4</sup>		1605
$D_{s0}(2317)^+ \bar{D}^0 \times B(D_{s0}(2317)^+ \rightarrow D_s^{*+} \gamma)$	< 7.6 × 10 <sup>-4</sup>	CL = 90 %	1605
$D_{s0}(2317)^+ \bar{D}^*(2010)^0 \times B(D_{s0}(2317)^+ \rightarrow D_s^+ \pi^0)$	(9 ± 7) × 10 <sup>-4</sup>		–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^{*+} \pi^0)$	(1.4 <sup>+0.6</sup> <sub>-0.5</sub> ) × 10 <sup>-3</sup>	S = 1.3	–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^{*+} \pi^0)$	(4.7 <sup>+1.4</sup> <sub>-1.2</sub> ) × 10 <sup>-4</sup>		–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^+ \gamma)$	< 2.2 × 10 <sup>-4</sup>	CL = 90 %	–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^+ \pi^+ \pi^-)$	< 2.7 × 10 <sup>-4</sup>	CL = 90 %	–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^+ \pi^0)$	< 9.8 × 10 <sup>-4</sup>	CL = 90 %	–
$D_{sJ}(2457)^+ \bar{D}^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^{*+} \gamma)$	(7.6 <sup>+3.6</sup> <sub>-2.9</sub> ) × 10 <sup>-3</sup>		–
$D_{sJ}(2457)^+ \bar{D}^*(2010)^0 \times B(D_{sJ}(2457)^+ \rightarrow D_s^{*+} \pi^0)$	(1.4 <sup>+0.7</sup> <sub>-0.6</sub> ) × 10 <sup>-3</sup>		–
$\bar{D}^0 D_{sJ}(2536)^+ \times B(D_{sJ}(2536)^+ \rightarrow D^*(2007)^0 K^+)$	< 2 × 10 <sup>-4</sup>	CL = 90 %	1447
$\bar{D}^*(2007)^0 D_{sJ}(2536)^+ \times B(D_{sJ}(2536)^+ \rightarrow D^*(2007)^0 K^+)$	< 7 × 10 <sup>-4</sup>	CL = 90 %	1338
$\bar{D}^0 D_{sJ}(2573)^+ \times B(D_{sJ}(2573)^+ \rightarrow D^0 K^+)$	< 2 × 10 <sup>-4</sup>	CL = 90 %	1416
$\bar{D}^*(2007)^0 D_{sJ}(2573)^+ \times B(D_{sJ}(2573)^+ \rightarrow D^0 K^+)$	< 5 × 10 <sup>-4</sup>	CL = 90 %	1305
$\bar{D}^0 D_s^{*+}$	(7.2 ± 2.6) × 10 <sup>-3</sup>		1734
$\bar{D}^*(2007)^0 D_s^+$	(10 ± 4) × 10 <sup>-3</sup>		1737
$\bar{D}^*(2007)^0 D_s^{*+}$	(2.2 ± 0.7) %		1651
$D_s^{(*)+} \bar{D}^{*0}$	(2.7 ± 1.2) %		–
$\bar{D}^*(2007)^0 D^*(2010)^+$	< 1.1 %	CL = 90 %	1713

$\bar{D}^0 D^*(2010)^+ + \bar{D}^*(2007)^0 D^+$	< 1.3	%	CL = 90%	1792				
$\bar{D}^0 D^*(2010)^+$	$(4.6 \pm 0.9)$	$\times 10^{-4}$		1792	$\psi(3770)K^+$	$(4.9 \pm 1.3)$	$\times 10^{-4}$	1220
$\bar{D}^0 D^+$	$(4.8 \pm 1.0)$	$\times 10^{-4}$		1866	$\psi(3770)K^+ \times$ $B(\psi(3770) \rightarrow D^0 \bar{D}^0)$	$(3.4 \pm 0.9)$	$\times 10^{-4}$	1220
$\bar{D}^0 D^+ K^0$	< 2.8	$\times 10^{-3}$	CL = 90%	1571	$\psi(3770)K^+ \times$ $B(\psi(3770) \rightarrow D^+ D^- K^+)$	$(1.4 \pm 0.8)$	$\times 10^{-4}$	1220
$\bar{D}^*(2007)^0 D^+ K^0$	< 6.1	$\times 10^{-3}$	CL = 90%	1475				
$\bar{D}^0 \bar{D}^*(2010)^+ K^0$	$(5.2 \pm 1.2)$	$\times 10^{-3}$		1476				
$\bar{D}^*(2007)^0 D^*(2010)^+ K^0$	$(7.8 \pm 2.6)$	$\times 10^{-3}$		1362	$\chi_{c0} \pi^+ \times B(\chi_{c0} \rightarrow \pi^+ \pi^-)$	< 3	$\times 10^{-7}$	CL = 90%
$\bar{D}^0 D^0 K^+$	$(1.37 \pm 0.32)$	$\times 10^{-3}$	S = 1.5	1577	$\chi_{c0}(1P)K^+$	$(1.6_{-0.4}^{+0.5})$	$\times 10^{-4}$	1478
$\bar{D}^*(2010)^0 D^0 K^+$	< 3.8	$\times 10^{-3}$	CL = 90%	-	$\chi_{c0} K^*(892)^+$	< 2.86	$\times 10^{-3}$	CL = 90%
$\bar{D}^0 D^*(2007)^0 K^+$	$(4.7 \pm 1.0)$	$\times 10^{-3}$		1481	$\chi_{c2} K^+$	< 2.9	$\times 10^{-5}$	CL = 90%
$\bar{D}^*(2007)^0 D^*(2007)^0 K^+$	$(5.3 \pm 1.6)$	$\times 10^{-3}$		1368	$\chi_{c2} K^*(892)^+$	< 1.2	$\times 10^{-5}$	CL = 90%
$D^- D^+ K^+$	< 4	$\times 10^{-4}$	CL = 90%	1571	$\chi_{c1}(1P)K^+$	$(5.3 \pm 0.7)$	$\times 10^{-4}$	S = 1.7
$D^- D^*(2010)^+ K^+$	< 7	$\times 10^{-4}$	CL = 90%	1475	$\chi_{c1}(1P)K^*(892)^+$	$(3.6 \pm 0.9)$	$\times 10^{-4}$	1411
$D^*(2010)^- D^+ K^+$	$(1.5 \pm 0.4)$	$\times 10^{-3}$		1475				1265
$D^*(2010)^- D^*(2010)^+ K^+$	< 1.8	$\times 10^{-3}$	CL = 90%	1363				
$(\bar{D}^+ + \bar{D}^*) (D + D^*) K$	$(3.5 \pm 0.6)$	%		-	<b>K or K* modes</b>			
$D_s^+ \pi^0$	< 1.7	$\times 10^{-4}$	CL = 90%	2270	$K^0 \pi^+$	$(2.41 \pm 0.17)$	$\times 10^{-5}$	S = 1.4
$D_s^{*+} \pi^0$	< 2.7	$\times 10^{-4}$	CL = 90%	2215	$K^+ \pi^0$	$(1.21 \pm 0.08)$	$\times 10^{-5}$	2615
$D_s^+ \eta$	< 4	$\times 10^{-4}$	CL = 90%	2235	$\eta' K^+$	$(7.05 \pm 0.35)$	$\times 10^{-5}$	2528
$D_s^{*+} \eta$	< 6	$\times 10^{-4}$	CL = 90%	2178	$\eta' K^*(892)^+$	< 1.4	$\times 10^{-5}$	CL = 90%
$D_s^+ \rho^0$	< 3.1	$\times 10^{-4}$	CL = 90%	2197	$\eta K^+$	$(2.6 \pm 0.6)$	$\times 10^{-6}$	S = 1.3
$D_s^{*+} \rho^0$	< 4	$\times 10^{-4}$	CL = 90%	2138	$\eta K^*(892)^+$	$(2.6 \pm 0.4)$	$\times 10^{-5}$	2534
$D_s^+ \omega$	< 4	$\times 10^{-4}$	CL = 90%	2195	$\omega K^+$	$(5.1 \pm 0.7)$	$\times 10^{-6}$	2557
$D_s^{*+} \omega$	< 6	$\times 10^{-4}$	CL = 90%	2136	$\omega K^*(892)^+$	< 7.4	$\times 10^{-6}$	CL = 90%
$D_s^+ a_1(1260)^0$	< 1.8	$\times 10^{-3}$	CL = 90%	2079	$a_1^+ K^0$	< 3.9	$\times 10^{-6}$	CL = 90%
$D_s^{*+} a_1(1260)^0$	< 1.3	$\times 10^{-3}$	CL = 90%	2015	$a_1^0 K^+$	< 2.5	$\times 10^{-6}$	CL = 90%
$D_s^+ \phi$	< 1.9	$\times 10^{-6}$	CL = 90%	2141	$K^*(892)^0 \pi^+$	$(1.16 \pm 0.19)$	$\times 10^{-5}$	S = 1.8
$D_s^{*+} \phi$	< 1.2	$\times 10^{-5}$	CL = 90%	2079	$K^*(892)^+ \pi^0$	$(6.9 \pm 2.4)$	$\times 10^{-6}$	2562
$D_s^+ \bar{K}^0$	< 9	$\times 10^{-4}$	CL = 90%	2242	$K^+ \pi^- \pi^+$	$(5.6 \pm 0.9)$	$\times 10^{-5}$	S = 2.6
$D_s^{*+} \bar{K}^0$	< 9	$\times 10^{-4}$	CL = 90%	2185	$K^+ \pi^- \pi^+$ nonresonant	$(3.1_{-0.8}^{+1.0})$	$\times 10^{-6}$	2609
$D_s^+ \bar{K}^*(892)^0$	< 4	$\times 10^{-4}$	CL = 90%	2172	$K^+ f_0(980) \times B(f_0 \rightarrow \pi^+ \pi^-)$	$(8.9 \pm 1.0)$	$\times 10^{-6}$	2524
$D_s^{*+} \bar{K}^*(892)^0$	< 4	$\times 10^{-4}$	CL = 90%	2112	$f_2(1270)^0 K^+$	< 2.3	$\times 10^{-6}$	CL = 90%
$D_s^+ \pi^+ K^+$	< 7	$\times 10^{-4}$	CL = 90%	2222	$f_0^*(1370)^0 K^+ \times$ $B(f_0^*(1370)^0 \rightarrow \pi^+ \pi^-)$	< 1.07	$\times 10^{-5}$	CL = 90%
$D_s^{*+} \pi^+ K^+$	< 9.8	$\times 10^{-4}$	CL = 90%	2164	$\rho^0(1450) K^+ \times$ $B(\rho^0(1450) \rightarrow \pi^+ \pi^-)$	< 1.17	$\times 10^{-5}$	CL = 90%
$D_s^+ \pi^+ K^*(892)^+$	< 5	$\times 10^{-3}$	CL = 90%	2138	$f_0(1500) K^+ \times$ $B(f_0(1500) \rightarrow \pi^+ \pi^-)$	< 4.4	$\times 10^{-6}$	CL = 90%
$D_s^{*+} \pi^+ K^*(892)^+$	< 7	$\times 10^{-3}$	CL = 90%	2076	$f_2'(1525) K^+ \times$ $B(f_2'(1525) \rightarrow \pi^+ \pi^-)$	< 3.4	$\times 10^{-6}$	CL = 90%
<b>Charmonium modes</b>								
$\eta_c K^+$	$(9.1 \pm 1.3)$	$\times 10^{-4}$		1753	$K^+ \rho^0$	$(5.0_{-0.8}^{+0.7})$	$\times 10^{-6}$	2558
$\eta_c' K^+$	$(3.4 \pm 1.8)$	$\times 10^{-4}$		-	$K^*(1430)^0 \pi^+$	$(3.8 \pm 0.5)$	$\times 10^{-5}$	2448
$J/\psi(1S) K^+$	$(1.008 \pm 0.035)$	$\times 10^{-3}$		1683	$K_2^*(1430)^0 \pi^+$	< 6.9	$\times 10^{-6}$	CL = 90%
$J/\psi(1S) K^+ \pi^+ \pi^-$	$(1.07 \pm 0.19)$	$\times 10^{-3}$	S = 1.9	1612	$K^*(1410)^0 \pi^+$	< 4.5	$\times 10^{-5}$	CL = 90%
$h_c(1P) K^+ \times B(h_c(1P) \rightarrow J/\psi \pi^+ \pi^-)$	< 3.4	$\times 10^{-6}$	CL = 90%	1401	$K^*(1680)^0 \pi^+$	< 1.2	$\times 10^{-5}$	CL = 90%
$X(3872) K^+$	< 3.2	$\times 10^{-4}$	CL = 90%	1141	$K^- \pi^- \pi^+$	< 1.8	$\times 10^{-6}$	CL = 90%
$X(3872) K^+ \times B(X \rightarrow J/\psi \pi^+ \pi^-)$	$(1.14 \pm 0.20)$	$\times 10^{-5}$		1141	$K^- \pi^+ \pi^+$ nonresonant	< 5.6	$\times 10^{-5}$	CL = 90%
$X(3872) K^+ \times B(X(3872) \rightarrow D^0 \bar{D}^0)$	< 6.0	$\times 10^{-5}$	CL = 90%	1141	$K_1(1400)^0 \pi^+$	< 2.6	$\times 10^{-3}$	CL = 90%
$X(3872) K^+ \times B(X(3872) \rightarrow D^+ D^-)$	< 4.0	$\times 10^{-5}$	CL = 90%	1141	$K^0 \pi^+ \pi^0$	< 6.6	$\times 10^{-5}$	CL = 90%
$X(3872) K^+ \times B(X(3872) \rightarrow D^0 \bar{D}^0 \pi^0)$	< 6.0	$\times 10^{-5}$	CL = 90%	1141	$K^0 \rho^+$	< 4.8	$\times 10^{-5}$	CL = 90%
$X(3872) K^+ \times B(X(3872) \rightarrow J/\psi(1S) \eta)$	< 7.7	$\times 10^{-6}$	CL = 90%	1141	$K^*(892)^+ \pi^+ \pi^-$	< 1.1	$\times 10^{-3}$	CL = 90%
$X(3872)^+ K^0 \times [jjj]$	< 2.2	$\times 10^{-5}$	CL = 90%	-	$K^*(892)^+ \rho^0$	$(1.1 \pm 0.4)$	$\times 10^{-5}$	2504
$Y(4260)^0 K^+ \times B(Y^0 \rightarrow J/\psi \pi^+ \pi^-)$	< 2.9	$\times 10^{-5}$	CL = 95%	-	$K^*(892)^0 \rho^+$	$(8.9 \pm 2.1)$	$\times 10^{-6}$	2504
$J/\psi(1S) K^*(892)^+$	$(1.41 \pm 0.08)$	$\times 10^{-3}$		1571	$K^*(892)^+ K^*(892)^0$	< 7.1	$\times 10^{-5}$	CL = 90%
$J/\psi(1S) K(1270)^+$	$(1.8 \pm 0.5)$	$\times 10^{-3}$		1390	$K_1(1400)^+ \rho^0$	< 7.8	$\times 10^{-4}$	CL = 90%
$J/\psi(1S) K(1400)^+$	< 5	$\times 10^{-4}$	CL = 90%	1308	$K_2^*(1430)^+ \rho^0$	< 1.5	$\times 10^{-3}$	CL = 90%
$J/\psi(1S) \eta K^+$	$(1.08 \pm 0.33)$	$\times 10^{-4}$		1510	$K^+ \bar{K}^0$	$(1.20 \pm 0.32)$	$\times 10^{-6}$	2593
$J/\psi(1S) \phi K^+$	$(5.2 \pm 1.7)$	$\times 10^{-5}$	S = 1.2	1227	$\bar{K}^0 K^+ \pi^0$	< 2.4	$\times 10^{-5}$	CL = 90%
$J/\psi(1S) \pi^+$	$(4.9 \pm 0.6)$	$\times 10^{-5}$	S = 1.5	1727	$K^+ K_S^0 K_S^0$	$(1.15 \pm 0.13)$	$\times 10^{-5}$	2521
$J/\psi(1S) \rho^+$	< 7.7	$\times 10^{-4}$	CL = 90%	1611	$K_S^0 K_S^0 \pi^+$	< 3.2	$\times 10^{-6}$	CL = 90%
$J/\psi(1S) a_1(1260)^+$	< 1.2	$\times 10^{-3}$	CL = 90%	1414	$K^+ K^- \pi^+$	< 6.3	$\times 10^{-6}$	CL = 90%
$J/\psi(1S) p \bar{\Lambda}$	$(1.18 \pm 0.31)$	$\times 10^{-5}$		567	$K^+ K^- \pi^+$ nonresonant	< 7.5	$\times 10^{-5}$	CL = 90%
$J/\psi(1S) \bar{D}^0 p$	< 1.1	$\times 10^{-5}$	CL = 90%	-	$K^+ K^+ \pi^-$	< 1.3	$\times 10^{-6}$	CL = 90%
$J/\psi(1S) D^+$	< 1.2	$\times 10^{-4}$	CL = 90%	871	$K^+ K^+ \pi^-$ nonresonant	< 8.79	$\times 10^{-5}$	CL = 90%
$J/\psi(1S) \bar{D}^0 \pi^+$	< 2.5	$\times 10^{-5}$	CL = 90%	665	$K^+ K^*(892)^0$	< 5.3	$\times 10^{-6}$	CL = 90%
$\psi(2S) K^+$	$(6.48 \pm 0.35)$	$\times 10^{-4}$		1284	$K^+ K^- K^+$	$(3.01 \pm 0.19)$	$\times 10^{-5}$	2522
$\psi(2S) K^*(892)^+$	$(6.7 \pm 1.4)$	$\times 10^{-4}$	S = 1.3	1115	$K^+ \phi$	$(9.0 \pm 0.8)$	$\times 10^{-6}$	S = 1.3
$\psi(2S) K^+ \pi^+ \pi^-$	$(1.9 \pm 1.2)$	$\times 10^{-3}$		1178	$f_0(980) K^+ \times$ $B(f_0(980) \rightarrow K^+ K^-)$	< 2.9	$\times 10^{-6}$	CL = 90%
					$a_2(1320) K^+ \times$ $B(a_2(1320) \rightarrow K^+ K^-)$	< 1.1	$\times 10^{-6}$	CL = 90%
					$f_2'(1525) K^+ \times$ $B(f_2'(1525) \rightarrow K^+ K^-)$	< 4.9	$\times 10^{-6}$	CL = 90%
					$\phi(1680) K^+ \times$ $B(\phi(1680) \rightarrow K^+ K^-)$	< 8	$\times 10^{-7}$	CL = 90%

$K^+K^-K^+$ nonresonant	$(2.40^{+0.30}_{-0.62}) \times 10^{-5}$		2522
$K^*(892)^+K^+K^-$	$< 1.6 \times 10^{-3}$	CL = 90%	2466
$K^*(892)^+\phi$	$(9.6 \pm 3.0) \times 10^{-6}$	S = 1.9	2460
$K_1(1400)^+\phi$	$< 1.1 \times 10^{-3}$	CL = 90%	2339
$K_2^*(1430)^+\phi$	$< 3.4 \times 10^{-3}$	CL = 90%	2332
$K^+\phi\phi$	$(2.6^{+1.1}_{-0.9}) \times 10^{-6}$		2306
$K^*(892)^+\gamma$	$(4.03 \pm 0.26) \times 10^{-5}$		2564
$K_1(1270)^+\gamma$	$(4.3 \pm 1.3) \times 10^{-5}$		2486
$\eta K^+\gamma$	$(8.4 \pm 1.8) \times 10^{-6}$		2588
$\phi K^+\gamma$	$(3.4 \pm 1.0) \times 10^{-6}$		2516
$K^+\pi^-\pi^+\gamma$	$(2.50 \pm 0.28) \times 10^{-5}$		2609
$K^*(892)^0\pi^+\gamma$	$(2.0^{+0.7}_{-0.6}) \times 10^{-5}$		2562
$K^+\rho^0\gamma$	$< 2.0 \times 10^{-5}$	CL = 90%	2558
$K^+\pi^-\pi^+\gamma$ nonresonant	$< 9.2 \times 10^{-6}$	CL = 90%	2609
$K_1(1400)^+\gamma$	$< 1.5 \times 10^{-5}$		2453
$K_2^*(1430)^+\gamma$	$(1.4 \pm 0.4) \times 10^{-5}$		2447
$K^*(1680)^+\gamma$	$< 1.9 \times 10^{-3}$	CL = 90%	2360
$K_3^*(1780)^+\gamma$	$< 3.9 \times 10^{-5}$	CL = 90%	2341
$K_4^*(2045)^+\gamma$	$< 9.9 \times 10^{-3}$	CL = 90%	2243

## Light unflavored meson modes

$\rho^+\gamma$	$< 1.8 \times 10^{-6}$	CL = 90%	2583
$\pi^+\pi^0$	$(5.5 \pm 0.6) \times 10^{-6}$		2636
$\pi^+\pi^+\pi^-$	$(1.62 \pm 0.15) \times 10^{-5}$		2630
$\rho^0\pi^+$	$(8.7 \pm 1.1) \times 10^{-6}$		2581
$\pi^+f_0(980) \times$ $B(f_0(980) \rightarrow \pi^+\pi^-)$	$< 3.0 \times 10^{-6}$	CL = 90%	2547
$\pi^+f_2(1270)$	$(8.2 \pm 2.5) \times 10^{-6}$		2483
$\rho(1450)^0\pi^+$	$< 2.3 \times 10^{-6}$	CL = 90%	2436
$f_0(1370)\pi^+ \times B(f_0(1370) \rightarrow$ $\pi^+\pi^-)$	$< 3.0 \times 10^{-6}$	CL = 90%	2460
$f_0(600)\pi^+ \times B(f_0(600) \rightarrow$ $\pi^+\pi^-)$	$< 4.1 \times 10^{-6}$	CL = 90%	-
$\pi^+\pi^-\pi^+$ nonresonant	$< 4.6 \times 10^{-6}$	CL = 90%	2630
$\pi^+\pi^0\pi^0$	$< 8.9 \times 10^{-4}$	CL = 90%	2631
$\rho^+\pi^0$	$(1.20 \pm 0.19) \times 10^{-5}$		2581
$\pi^+\pi^-\pi^+\pi^0$	$< 4.0 \times 10^{-3}$	CL = 90%	2621
$\rho^+\rho^0$	$(2.6 \pm 0.6) \times 10^{-5}$		2523
$a_1(1260)^+\pi^0$	$< 1.7 \times 10^{-3}$	CL = 90%	2494
$a_1(1260)^0\pi^+$	$< 9.0 \times 10^{-4}$	CL = 90%	2494
$\omega\pi^+$	$(5.9 \pm 1.0) \times 10^{-6}$	S = 1.2	2580
$\omega\rho^+$	$(1.3 \pm 0.4) \times 10^{-5}$		2522
$\eta\pi^+$	$(4.9 \pm 0.5) \times 10^{-6}$		2609
$\eta'\pi^+$	$(4.0 \pm 0.9) \times 10^{-6}$		2551
$\eta'\rho^+$	$< 2.2 \times 10^{-5}$	CL = 90%	2492
$\eta\rho^+$	$(8.4 \pm 2.2) \times 10^{-6}$		2553
$\phi\pi^+$	$< 4.1 \times 10^{-7}$	CL = 90%	2539
$\phi\rho^+$	$< 1.6 \times 10^{-5}$		2480
$a_0^0\pi^+$	$< 5.8 \times 10^{-6}$	CL = 90%	-
$\pi^+\pi^+\pi^+\pi^-\pi^-$	$< 8.6 \times 10^{-4}$	CL = 90%	2608
$\rho^0a_1(1260)^+$	$< 6.2 \times 10^{-4}$	CL = 90%	2433
$\rho^0a_2(1320)^+$	$< 7.2 \times 10^{-4}$	CL = 90%	2410
$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$	$< 6.3 \times 10^{-3}$	CL = 90%	2592
$a_1(1260)^+a_1(1260)^0$	$< 1.3 \%$	CL = 90%	2335

Charged particle ( $h^\pm$ ) modes

$h^\pm-k^\pm$ or $\pi^\pm$			
$h^+\pi^0$	$(1.6^{+0.7}_{-0.6}) \times 10^{-5}$		2636
$\omega h^+$	$(1.38^{+0.27}_{-0.24}) \times 10^{-5}$		2580
$h^+X^0$ (Familon)	$< 4.9 \times 10^{-5}$	CL = 90%	-

## Baryon modes

$p\bar{p}\pi^+$	$(3.1^{+0.8}_{-0.7}) \times 10^{-6}$		2439
$p\bar{p}\pi^+$ nonresonant	$< 5.3 \times 10^{-5}$	CL = 90%	2439
$p\bar{p}\pi^+\pi^+\pi^-$	$< 5.2 \times 10^{-4}$	CL = 90%	2369
$p\bar{p}K^+$	$(5.6 \pm 1.0) \times 10^{-6}$	S = 2.4	2348
$\Theta(1710)^{++}\bar{p} \times$ $B(\Theta(1710)^{++} \rightarrow$ $pK^+)$	[kkk] $< 9.1 \times 10^{-8}$	CL = 90%	-
$f_1(2220)K^+ \times$ $B(f_1(2220) \rightarrow p\bar{p})$	[kkk] $< 4.1 \times 10^{-7}$	CL = 90%	2135
$p\bar{\Lambda}(1520)$	$< 1.5 \times 10^{-6}$	CL = 90%	2322
$p\bar{p}K^+$ nonresonant	$< 8.9 \times 10^{-5}$	CL = 90%	2348
$p\bar{p}K^*(892)^+$	$(1.03^{+0.38}_{-0.33}) \times 10^{-5}$		2215
$p\bar{\Lambda}$	$< 4.9 \times 10^{-7}$	CL = 90%	2430

$p\bar{\Delta}\gamma$	$(2.2 \pm 0.6) \times 10^{-6}$		2430
$p\bar{\Sigma}\gamma$	$< 4.6 \times 10^{-6}$	CL = 90%	2413
$p\bar{\Delta}\pi^+\pi^-$	$< 2.0 \times 10^{-4}$	CL = 90%	2367
$\Lambda\bar{\Lambda}\pi^+$	$< 2.8 \times 10^{-6}$	CL = 90%	2358
$\Lambda\bar{\Lambda}K^+$	$(2.9^{+1.0}_{-0.8}) \times 10^{-6}$		2251
$\bar{\Delta}^0 p$	$< 3.8 \times 10^{-4}$	CL = 90%	2402
$\Delta^{++}\bar{p}$	$< 1.5 \times 10^{-4}$	CL = 90%	2402
$D^+ p\bar{p}$	$< 1.5 \times 10^{-5}$	CL = 90%	1860
$D^+(2010)^+ p\bar{p}$	$< 1.5 \times 10^{-5}$	CL = 90%	1786
$\bar{\Lambda}_c^- p\pi^+$	$(2.1 \pm 0.7) \times 10^{-4}$		1980
$\bar{\Lambda}_c^- p\pi^+\pi^0$	$(1.8 \pm 0.6) \times 10^{-3}$		1935
$\bar{\Lambda}_c^- p\pi^+\pi^+\pi^-$	$(2.3 \pm 0.7) \times 10^{-3}$		1880
$\bar{\Lambda}_c^- p\pi^+\pi^+\pi^-\pi^0$	$< 1.34 \%$	CL = 90%	1822
$\bar{\Sigma}_c^-(2455)^0 p$	$< 8 \times 10^{-5}$	CL = 90%	1938
$\bar{\Sigma}_c^-(2520)^0 p$	$< 4.6 \times 10^{-5}$	CL = 90%	1904
$\bar{\Sigma}_c^-(2455)^0 p\pi^0$	$(4.4 \pm 1.8) \times 10^{-4}$		1896
$\bar{\Sigma}_c^-(2455)^0 p\pi^-\pi^+$	$(4.4 \pm 1.7) \times 10^{-4}$		1845
$\bar{\Sigma}_c^-(2455)^{-} p\pi^+\pi^+$	$(2.8 \pm 1.2) \times 10^{-4}$		1845
$\bar{\Lambda}_c^-(2593)^- / \bar{\Lambda}_c^-(2625)^- p\pi^+$	$< 1.9 \times 10^{-4}$	CL = 90%	-

Lepton Family number (LF) or Lepton number (L) violating modes, or  $\Delta B = 1$  weak neutral current (B1) modes

$\pi^+e^+e^-$	B1 $< 3.9 \times 10^{-3}$	CL = 90%	2638
$\pi^+\mu^+\mu^-$	B1 $< 9.1 \times 10^{-3}$	CL = 90%	2633
$\pi^+\nu\bar{\nu}$	B1 $< 1.0 \times 10^{-4}$	CL = 90%	2638
$K^+e^+e^-$	B1 $(8.0^{+2.2}_{-1.9}) \times 10^{-7}$	S = 1.4	2616
$K^+\mu^+\mu^-$	B1 $(3.4^{+1.9}_{-1.4}) \times 10^{-7}$	S = 1.7	2612
$K^+\ell^+\ell^-$	B1 [ggg] $(5.3 \pm 1.1) \times 10^{-7}$		2616
$K^+\bar{\nu}\nu$	B1 $< 5.2 \times 10^{-5}$	CL = 90%	2616
$K^*(892)^+e^+e^-$	B1 $< 4.6 \times 10^{-6}$	CL = 90%	2564
$K^*(892)^+\mu^+\mu^-$	B1 $< 2.2 \times 10^{-6}$	CL = 90%	2560
$K^*(892)^+\ell^+\ell^-$	B1 [ggg] $< 2.2 \times 10^{-6}$	CL = 90%	2564
$\pi^+e^+\mu^-$	LF $< 6.4 \times 10^{-3}$	CL = 90%	2637
$\pi^+e^-\mu^+$	LF $< 6.4 \times 10^{-3}$	CL = 90%	2637
$K^+e^+\mu^-$	LF $< 8 \times 10^{-7}$	CL = 90%	2615
$K^+e^-\mu^+$	LF $< 6.4 \times 10^{-3}$	CL = 90%	2615
$K^*(892)^+e^\pm\mu^\mp$	LF $< 7.9 \times 10^{-6}$	CL = 90%	2563
$\pi^-e^+e^+$	L $< 1.6 \times 10^{-6}$	CL = 90%	2638
$\pi^-\mu^+\mu^+$	L $< 1.4 \times 10^{-6}$	CL = 90%	2633
$\pi^-e^+\mu^+$	L $< 1.3 \times 10^{-6}$	CL = 90%	2637
$\rho^-e^+e^+$	L $< 2.6 \times 10^{-6}$	CL = 90%	2583
$\rho^-\mu^+\mu^+$	L $< 5.0 \times 10^{-6}$	CL = 90%	2578
$\rho^-e^+\mu^+$	L $< 3.3 \times 10^{-6}$	CL = 90%	2581
$K^-e^+e^+$	L $< 1.0 \times 10^{-6}$	CL = 90%	2616
$K^-\mu^+\mu^+$	L $< 1.8 \times 10^{-6}$	CL = 90%	2612
$K^-e^+\mu^+$	L $< 2.0 \times 10^{-6}$	CL = 90%	2615
$K^*(892)^-e^+e^+$	L $< 2.8 \times 10^{-6}$	CL = 90%	2564
$K^*(892)^-\mu^+\mu^+$	L $< 8.3 \times 10^{-6}$	CL = 90%	2560
$K^*(892)^-e^+\mu^+$	L $< 4.4 \times 10^{-6}$	CL = 90%	2563

 $B^0$ 

$$I(J^P) = \frac{1}{2}(0^-)$$

$I, J, P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^0} = 5279.4 \pm 0.5 \text{ MeV}$$

$$m_{B^0} - m_{B^\pm} = 0.33 \pm 0.28 \text{ MeV} \quad (S = 1.1)$$

$$\text{Mean life } \tau_{B^0} = (1.530 \pm 0.009) \times 10^{-12} \text{ s}$$

$$c\tau = 458.7 \mu\text{m}$$

$$\tau_{B^+}/\tau_{B^0} = 1.071 \pm 0.009 \quad (\text{direct measurements})$$

 $B^0-\bar{B}^0$  mixing parameters

$$\chi_d = 0.188 \pm 0.003$$

$$\Delta m_{B^0} = m_{B_H^0} - m_{B_L^0} = (0.507 \pm 0.005) \times 10^{12} \hbar s^{-1}$$

$$= (3.337 \pm 0.033) \times 10^{-10} \text{ MeV}$$

$$x_d = \Delta m_{B^0} / \Gamma_{B^0} = 0.776 \pm 0.008$$

$$\text{Re}(\lambda_{CP} / |\lambda_{CP}|) \text{Re}(z) = 0.01 \pm 0.05$$

$$\text{Re}(z) = 0.00 \pm 0.12$$

$$\text{Im}(z) = -0.002 \pm 0.033 \quad (S = 1.4)$$

## CP violation parameters

$$\begin{aligned} \text{Re}(\epsilon_{B^0})/(1+|\epsilon_{B^0}|^2) &= (-1.3 \pm 2.9) \times 10^{-3} \\ A_{T/CP} &= 0.005 \pm 0.018 \\ A_{CP}(B^0 \rightarrow D^*(2010)^+ D^-) &= 0.03 \pm 0.07 \\ A_{CP}(B^0 \rightarrow K^*(892)^0 \phi) &= 0.01 \pm 0.07 \\ A_{CP}(B^0 \rightarrow K^+ \pi^-) &= -0.113 \pm 0.020 \\ A_{CP}(B^0 \rightarrow K_S^0 \pi^0) &= 0.16 \pm 0.29 \\ A_{CP}(B^0 \rightarrow \eta K^*(892)^0) &= 0.02 \pm 0.11 \\ A_{CP}(B^0 \rightarrow \rho^+ K^-) &= 0.26 \pm 0.15 \\ A_{CP}(B^0 \rightarrow K^+ \pi^- \pi^0) &= 0.07 \pm 0.11 \\ A_{CP}(B^0 \rightarrow K^*(892)^+ \pi^-) &= -0.05 \pm 0.14 \\ A_{CP}(B^0 \rightarrow \rho^+ \pi^-) &= -0.15 \pm 0.08 \\ A_{CP}(B^0 \rightarrow \rho^- \pi^+) &= -0.53 \pm 0.30 \\ A_{CP}(B^0 \rightarrow K^*(1430) \gamma) &= -0.08 \pm 0.15 \\ C_{D^*(2010)^- D^+}(B^0 \rightarrow D^*(2010)^- D^+) &= 0.20 \pm 0.18 \\ S_{D^*(2010)^- D^+}(B^0 \rightarrow D^*(2010)^- D^+) &= -0.53 \\ &\pm 0.32 \quad (S = 1.2) \\ C_{D^*(2010)^+ D^-}(B^0 \rightarrow D^*(2010)^+ D^-) &= -0.17 \\ &\pm 0.23 \quad (S = 1.3) \\ S_{D^*(2010)^+ D^-}(B^0 \rightarrow D^*(2010)^+ D^-) &= -0.54 \pm 0.27 \\ C_{D^*+ D^*-}(B^0 \rightarrow D^*+ D^*-) &= 0.27 \pm 0.17 \\ S_{D^*+ D^*-}(B^0 \rightarrow D^*+ D^*-) &= -0.2 \pm 0.4 \quad (S = 1.2) \\ C_+(B^0 \rightarrow D^{*+} D^{*-}) &= 0.06 \pm 0.17 \\ S_+(B^0 \rightarrow D^{*+} D^{*-}) &= -0.75 \pm 0.25 \\ C_-(B^0 \rightarrow D^{*+} D^{*-}) &= -0.2 \pm 0.10 \\ S_-(B^0 \rightarrow D^{*+} D^{*-}) &= -1.8 \pm 1.8 \\ C_{D^+ D^-}(B^0 \rightarrow D^+ D^-) &= 0.1 \pm 0.4 \\ S_{D^+ D^-}(B^0 \rightarrow D^+ D^-) &= -0.3 \pm 0.6 \\ C_{J/\psi(1S)\pi^0}(B^0 \rightarrow J/\psi(1S)\pi^0) &= 0.13 \pm 0.24 \\ S_{J/\psi(1S)\pi^0}(B^0 \rightarrow J/\psi(1S)\pi^0) &= -0.4 \pm 0.4 \quad (S = 1.1) \\ C_{\omega K_S^0}(B^0 \rightarrow \omega K_S^0) &= -0.3 \pm 0.5 \\ S_{\omega K_S^0}(B^0 \rightarrow \omega K_S^0) &= 0.8 \pm 0.7 \\ C_{\eta'(958)K}(B^0 \rightarrow \eta'(958)K_S^0) &= -0.04 \pm 0.20 \quad (S = 2.5) \\ S_{\eta'(958)K}(B^0 \rightarrow \eta'(958)K_S^0) &= 0.43 \pm 0.17 \quad (S = 1.5) \\ C_{f_0(980)K_S^0}(B^0 \rightarrow f_0(980)K_S^0) &= 0.39 \pm 0.28 \\ S_{f_0(980)K_S^0}(B^0 \rightarrow f_0(980)K_S^0) &= 0.5 \pm 0.4 \\ C_{K_S K_S K_S}(B^0 \rightarrow K_S K_S K_S) &= -0.41 \pm 0.21 \\ S_{K_S K_S K_S}(B^0 \rightarrow K_S K_S K_S) &= -0.3_{-0.7}^{+0.8} \quad (S = 2.4) \\ C_{K^+ K^- K_S^0}(B^0 \rightarrow K^+ K^- K_S^0) &= 0.09 \pm 0.10 \\ S_{K^+ K^- K_S^0}(B^0 \rightarrow K^+ K^- K_S^0) &= -0.45 \pm 0.13 \\ C_{\phi K_S^0}(B^0 \rightarrow \phi K_S^0) &= -0.04 \pm 0.17 \\ S_{\phi K_S^0}(B^0 \rightarrow \phi K_S^0) &= 0.35 \pm 0.21 \\ C_{K_S^0 \pi^0}(B^0 \rightarrow K_S^0 \pi^0) &= 0.08 \pm 0.14 \\ S_{K_S^0 \pi^0}(B^0 \rightarrow K_S^0 \pi^0) &= 0.34 \pm 0.28 \\ C_{K_S^0 \pi^0 \gamma}(B^0 \rightarrow K_S^0 \pi^0 \gamma) &= -0.3 \pm 0.4 \quad (S = 1.5) \\ S_{K_S^0 \pi^0 \gamma}(B^0 \rightarrow K_S^0 \pi^0 \gamma) &= -0.3_{-0.5}^{+0.6} \quad (S = 1.3) \\ C_{K^*(892)^0 \gamma}(B^0 \rightarrow K^*(892)^0 \gamma) &= -0.40 \pm 0.23 \\ S_{K^*(892)^0 \gamma}(B^0 \rightarrow K^*(892)^0 \gamma) &= -0.39 \pm 0.33 \\ C_{\pi\pi}(B^0 \rightarrow \pi^+ \pi^-) &= -0.36 \pm 0.23 \quad (S = 2.3) \\ S_{\pi\pi}(B^0 \rightarrow \pi^+ \pi^-) &= -0.49 \pm 0.18 \quad (S = 1.5) \\ C_{\pi^0 \pi^0}(B^0 \rightarrow \pi^0 \pi^0) &= -0.3 \pm 0.4 \\ C_{\rho\pi}(B^0 \rightarrow \rho^+ \pi^-) &= 0.30 \pm 0.13 \\ S_{\rho\pi}(B^0 \rightarrow \rho^+ \pi^-) &= -0.04 \pm 0.23 \quad (S = 1.3) \\ \Delta C_{\rho\pi}(B^0 \rightarrow \rho^+ \pi^-) &= 0.33 \pm 0.13 \\ \Delta S_{\rho\pi}(B^0 \rightarrow \rho^+ \pi^-) &= -0.07 \pm 0.22 \quad (S = 1.3) \\ C_{\rho\rho}(B^0 \rightarrow \rho^+ \rho^-) &= -0.02 \pm 0.17 \\ S_{\rho\rho}(B^0 \rightarrow \rho^+ \rho^-) &= -0.22 \pm 0.22 \\ |\lambda|(B^0 \rightarrow c\bar{c}K^0) &= 0.969 \pm 0.028 \\ |\lambda|(B^0 \rightarrow J/\psi K^*(892)^0) &< 0.25, CL=95\% \\ \cos 2\beta(B^0 \rightarrow J/\psi K^*(892)^0) &= 1.7_{-0.9}^{+0.7} \quad (S = 1.6) \\ (S_+ + S_-)/2(B^0 \rightarrow D^* \pi^+) &= -0.028 \pm 0.017 \quad (S = 1.3) \\ (S_- - S_+)/2(B^0 \rightarrow D^* \pi^+) &= -0.001 \pm 0.018 \\ (S_+ + S_-)/2(B^0 \rightarrow D^- \pi^+) &= -0.043 \pm 0.030 \\ (S_- - S_+)/2(B^0 \rightarrow D^- \pi^+) &= -0.01 \pm 0.04 \\ \sin(2\beta) &= 0.725 \pm 0.037 \\ \sin(2\beta_{\text{eff}})(B^0 \rightarrow \phi K^0) &= 0.50 \pm 0.26 \\ \sin(2\beta_{\text{eff}})(B^0 \rightarrow K^+ K^- K_S^0) &= 0.55 \pm 0.25 \\ |\sin(2\beta + \gamma)| &> 0.35, CL = 90\% \\ \alpha &= (96 \pm 10)^\circ \end{aligned}$$

$\bar{B}^0$  modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing. Modes which do not identify the charge state of the  $B$  are listed in the  $B^\pm/B^0$  ADMIXTURE section.

The branching fractions listed below assume 50%  $B^0\bar{B}^0$  and 50%  $B^+B^-$  production at the  $\Upsilon(4S)$ . We have attempted to bring older measurements up to date by rescaling their assumed  $\Upsilon(4S)$  production ratio to 50:50 and their assumed  $D, D_s, D^*$ , and  $\psi$  branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

$B^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\ell^+ \nu_\ell$ anything	[ggg] (10.4 ± 0.4) %		–
$D^- \ell^+ \nu_\ell$	[ggg] (2.12 ± 0.20) %		2309
$D^*(2010)^- \ell^+ \nu_\ell$	[ggg] (5.35 ± 0.20) %		2257
$\bar{D}^0 \pi^+ \ell^+ \nu_\ell$	(3.2 ± 1.0) × 10 <sup>-3</sup>		2308
$\bar{D}^{*0} \pi^+ \ell^+ \nu_\ell$	(6.5 ± 1.5) × 10 <sup>-3</sup>		2256
$\rho^- \ell^+ \nu_\ell$	[ggg] (2.3 ± 0.4) × 10 <sup>-4</sup>		2583
$\pi^- \ell^+ \nu_\ell$	[ggg] (1.36 ± 0.15) × 10 <sup>-4</sup>		2638
<b>Inclusive modes</b>			
$K^\pm$ anything	(78 ± 8) %		–
$D^0 X$	(6.3 ± 2.0) %		–
$\bar{D}^0 X$	(51 ± 4) %		–
$D^+ X$	< 5.1 %	CL = 90%	–
$D^- X$	(40 ± 5) %		–
$D^+ X$	(10.9 <sup>+4.4</sup> <sub>-3.2</sub> ) %		–
$D_S^+ X$	< 8.7 %	CL = 90%	–
$\Lambda_c^+ X$	< 3.8 %	CL = 90%	–
$\bar{\Lambda}_c^- X$	(4.9 <sup>+2.3</sup> <sub>-2.0</sub> ) %		–
$\bar{c} X$	(104 ± 8) %		–
$c X$	(24 ± 5) %		–
$\bar{c} c X$	(128 <sup>+11</sup> <sub>-10</sub> ) %		–
<b><math>D, D^*</math>, or <math>D_s</math> modes</b>			
$D^- \pi^+$	(2.83 ± 0.17) × 10 <sup>-3</sup>		2306
$D^- \rho^+$	(7.5 ± 1.2) × 10 <sup>-3</sup>		2235
$D^- K^0 \pi^+$	(4.9 ± 0.9) × 10 <sup>-4</sup>		2259
$D^- K^*(892)^+$	(4.5 ± 0.7) × 10 <sup>-4</sup>		2211
$D^- \omega \pi^+$	(2.8 ± 0.6) × 10 <sup>-3</sup>		2204
$D^- K^+$	(2.0 ± 0.6) × 10 <sup>-4</sup>		2279
$D^- K^+ \bar{K}^0$	< 3.1 × 10 <sup>-4</sup>	CL = 90%	2188
$D^- K^+ \bar{K}^*(892)^0$	(8.8 ± 1.9) × 10 <sup>-4</sup>		2070
$\bar{D}^0 \pi^+ \pi^-$	(8.0 ± 1.6) × 10 <sup>-4</sup>		2301
$D^*(2010)^- \pi^+$	(2.76 ± 0.21) × 10 <sup>-3</sup>		2255
$D^- \pi^+ \pi^+ \pi^-$	(8.0 ± 2.5) × 10 <sup>-3</sup>		2287
$(D^- \pi^+ \pi^+ \pi^-)$ nonresonant	(3.9 ± 1.9) × 10 <sup>-3</sup>		2287
$D^- \pi^+ \rho^0$	(1.1 ± 1.0) × 10 <sup>-3</sup>		2206
$D^- a_1(1260)^+$	(6.0 ± 3.3) × 10 <sup>-3</sup>		2121
$D^*(2010)^- \pi^+ \pi^0$	(1.5 ± 0.5) %		2248
$D^*(2010)^- \rho^+$	(6.8 ± 0.9) × 10 <sup>-3</sup>		2180
$D^*(2010)^- K^+$	(2.14 ± 0.20) × 10 <sup>-4</sup>		2226
$D^*(2010)^- K^0 \pi^+$	(3.0 ± 0.8) × 10 <sup>-4</sup>		2205
$D^*(2010)^- K^*(892)^+$	(3.3 ± 0.6) × 10 <sup>-4</sup>		2155
$D^*(2010)^- K^+ \bar{K}^0$	< 4.7 × 10 <sup>-4</sup>	CL = 90%	2131
$D^*(2010)^- K^+ \bar{K}^*(892)^0$	(1.29 ± 0.33) × 10 <sup>-3</sup>		2007
$D^*(2010)^- \pi^+ \pi^+ \pi^-$	(7.0 ± 0.8) × 10 <sup>-3</sup>	S = 1.3	2235
$(D^*(2010)^- \pi^+ \pi^+ \pi^-)$ nonresonant	(0.0 ± 2.5) × 10 <sup>-3</sup>		2235
$D^*(2010)^- \pi^+ \rho^0$	(5.7 ± 3.2) × 10 <sup>-3</sup>		2150
$D^*(2010)^- a_1(1260)^+$	(1.30 ± 0.27) %		2061
$D^*(2010)^- \pi^+ \pi^+ \pi^- \pi^0$	(1.76 ± 0.27) %		2218
$D^* 3\pi^+ 2\pi^-$	(4.7 ± 0.9) × 10 <sup>-3</sup>		2195
$D^*(2010)^- p\bar{p}\pi^+$	(6.5 ± 1.6) × 10 <sup>-4</sup>		1708
$D^*(2010)^- p\bar{n}$	(1.5 ± 0.4) × 10 <sup>-3</sup>		1785
$\bar{D}^*(2010)^- \omega \pi^+$	(2.9 ± 0.5) × 10 <sup>-3</sup>		2148
$D_1(2420)^- \pi^+ \times B(D_1^- \rightarrow D^- \pi^+ \pi^-)$	(8.9 <sup>+2.3</sup> <sub>-3.5</sub> ) × 10 <sup>-5</sup>		–
$D_1(2420)^- \pi^+ \times B(D_1^- \rightarrow D^- \pi^+ \pi^-)$	< 3.3 × 10 <sup>-5</sup>	CL = 90%	–

$\bar{D}_s^0(2460)^-\pi^+$	< 2.2	$\times 10^{-3}$	CL = 90%	2064	$\bar{D}^0 K^+\pi^-$ non-resonant	< 3.7	$\times 10^{-5}$	CL = 90%	-
$D_s^*(2460)^-\pi^+\times B((D_s^2)^-\rightarrow D^{*-}\pi^+\pi^-)$	< 2.4	$\times 10^{-5}$	CL = 90%	-	$\bar{D}^0\pi^0$	$(2.91 \pm 0.28) \times 10^{-4}$			2308
$\bar{D}_s^0(2460)^-\rho^+$	< 4.9	$\times 10^{-3}$	CL = 90%	1977	$\bar{D}^0\rho^0$	$(2.9 \pm 1.1) \times 10^{-4}$			2237
$D^-D^+$	$(1.9 \pm 0.6)$	$\times 10^{-4}$		1864	$\bar{D}^0\eta$	$(2.2 \pm 0.5) \times 10^{-4}$	S = 1.6		2274
$D^-D_s^+$	$(6.5 \pm 2.1)$	$\times 10^{-3}$		1813	$\bar{D}^0\eta'$	$(1.25 \pm 0.23) \times 10^{-4}$	S = 1.1		2198
$D^*(2010)^-D_s^+$	$(8.8 \pm 1.6)$	$\times 10^{-3}$		1735	$\bar{D}^0\omega$	$(2.5 \pm 0.6) \times 10^{-4}$	S = 1.5		2235
$D^-D_s^{*+}$	$(8.6 \pm 3.4)$	$\times 10^{-3}$		1732	$D^0K^+\pi^-$	< 1.9	$\times 10^{-5}$	CL = 90%	2261
$D^*(2010)^-D_s^{*+}$	$(1.79 \pm 0.16)$	%		1649	$D^0K^*(892)^0$	< 1.8	$\times 10^{-5}$	CL = 90%	2213
$D_{s0}(2317)^+K^-\times B(D_{s0}(2317)^+\rightarrow D_s^+\pi^0)$	$(4.3 \pm 1.5)$	$\times 10^{-5}$		2097	$\bar{D}^{*0}\gamma$	< 2.5	$\times 10^{-5}$	CL = 90%	2258
$D_{s0}(2317)^+\pi^-\times B(D_{s0}(2317)^+\rightarrow D_s^+\pi^0)$	< 2.5	$\times 10^{-5}$	CL = 90%	2128	$\bar{D}^*(2007)^0\pi^0$	$(2.7 \pm 0.5) \times 10^{-4}$			2256
$D_{sJ}(2457)^+K^-\times B(D_{sJ}(2457)^+\rightarrow D_s^+\pi^0)$	< 9.4	$\times 10^{-6}$	CL = 90%	-	$\bar{D}^*(2007)^0\rho^0$	< 5.1	$\times 10^{-4}$	CL = 90%	2182
$D_{sJ}(2457)^+\pi^-\times B(D_{sJ}(2457)^+\rightarrow D_s^+\pi^0)$	< 4.0	$\times 10^{-6}$	CL = 90%	-	$\bar{D}^*(2007)^0\eta$	$(2.6 \pm 0.6) \times 10^{-4}$			2220
$D_s^-D_s^+$	< 1.0	$\times 10^{-4}$	CL = 90%	1759	$\bar{D}^*(2007)^0\eta'$	$(1.23 \pm 0.35) \times 10^{-4}$			2141
$D_s^+D_s^+$	< 1.3	$\times 10^{-4}$	CL = 90%	1674	$\bar{D}^*(2007)^0\pi^+\pi^-$	$(6.2 \pm 2.2) \times 10^{-4}$			2248
$D_s^-D_s^{*+}$	< 2.4	$\times 10^{-4}$	CL = 90%	1584	$\bar{D}^*(2007)^0K^0$	< 6.6	$\times 10^{-5}$	CL = 90%	2227
$D_{s0}(2317)^+D^-\times B(D_{s0}(2317)^+\rightarrow D_s^+\pi^0)$	$(9.7_{-3.4}^{+4.1})$	$\times 10^{-4}$	S = 1.4	1602	$\bar{D}^*(2007)^0K^*(892)^0$	< 6.9	$\times 10^{-5}$	CL = 90%	2157
$D_{s0}(2317)^+D^-\times B(D_{s0}(2317)^+\rightarrow D_s^{*+}\gamma)$	< 9.5	$\times 10^{-4}$	CL = 90%	-	$D^*(2007)^0K^*(892)^0$	< 4.0	$\times 10^{-5}$	CL = 90%	2157
$D_{s0}(2317)^+D^*(2010)^-\times B(D_{s0}(2317)^+\rightarrow D_s^+\pi^0)$	$(1.5 \pm 0.6)$	$\times 10^{-3}$		1510	$D^*(2007)^0\pi^+\pi^+\pi^-\pi^-$	$(2.7 \pm 0.5) \times 10^{-3}$			2219
$D_{sJ}(2457)^+D^-\times B(D_{sJ}(2457)^+\rightarrow D_s^{*+}\pi^0)$	$(2.0_{-0.5}^{+0.6})$	$\times 10^{-3}$		-	$D^*(2010)^-D^*(2010)^-$	$(8.3 \pm 1.1) \times 10^{-4}$			1711
$D_{sJ}(2457)^+D^-\times B(D_{sJ}(2457)^+\rightarrow D_s^{*+}\pi^0)$	$(6.6_{-1.5}^{+1.8})$	$\times 10^{-4}$		-	$\bar{D}^*(2007)^0\omega$	$(4.2 \pm 1.1) \times 10^{-4}$			2180
$D_{sJ}(2457)^+D^-\times B(D_{sJ}(2457)^+\rightarrow D_s^+\gamma)$	< 6.0	$\times 10^{-4}$	CL = 90%	-	$D^*(2010)^+D^-$	< 6.3	$\times 10^{-4}$	CL = 90%	1790
$D_{sJ}(2457)^+D^-\times B(D_{sJ}(2457)^+\rightarrow D_s^+\gamma)$	< 2.0	$\times 10^{-4}$	CL = 90%	-	$D^*(2010)^-D^+ + D^*(2010)^+D^-$	$(9.3 \pm 1.5) \times 10^{-4}$			1790
$D_{sJ}(2457)^+D^-\times B(D_{sJ}(2457)^+\rightarrow D_s^+\pi^0)$	< 3.6	$\times 10^{-4}$	CL = 90%	-	$D^*(2007)^0\bar{D}^*(2007)^0$	< 2.7	%	CL = 90%	1715
$D_{sJ}(2457)^+D^*(2010)^+\times B(D_{sJ}(2457)^+\rightarrow D_s^+\pi^0)$	$(5.5_{-2.0}^{+2.5})$	$\times 10^{-3}$		-	$D^-D^0K^+$	$(1.7 \pm 0.4) \times 10^{-3}$			1574
$D_{sJ}(2457)^+D^*(2010)^+\times B(D_{sJ}(2457)^+\rightarrow D_s^+\gamma)$	$(2.3_{-0.7}^{+0.9})$	$\times 10^{-3}$		-	$D^-D^*(2007)^0K^+$	$(4.6 \pm 1.0) \times 10^{-3}$			1478
$D^-D_{sJ}(2536)^+\times B(D_{sJ}(2536)^+\rightarrow D^*(2007)^0K^+)$	< 5	$\times 10^{-4}$	CL = 90%	1444	$D^*(2010)^-D^0K^+$	$(3.1_{-0.5}^{+0.6}) \times 10^{-3}$			1479
$D^*(2010)^-D_{sJ}(2536)^+\times B(D_{sJ}(2536)^+\rightarrow D^*(2007)^0K^+)$	< 7	$\times 10^{-4}$	CL = 90%	1336	$D^*(2010)^-D^*(2007)^0K^+$	$(1.18 \pm 0.20)$	%		1366
$D^-D_{sJ}(2573)^+\times B(D_{sJ}(2573)^+\rightarrow D^0K^+)$	< 1	$\times 10^{-4}$	CL = 90%	1413	$D^-D^+K^0$	< 1.7	$\times 10^{-3}$	CL = 90%	1568
$D^*(2010)^-D_{sJ}(2573)^+\times B(D_{sJ}(2573)^+\rightarrow D^0K^+)$	< 2	$\times 10^{-4}$	CL = 90%	1302	$D^*(2010)^-D^+K^0 + D^-D^*(2010)^+K^0$	$(6.5 \pm 1.6) \times 10^{-3}$			1473
$D_s^+\pi^-$	$(2.2 \pm 0.7)$	$\times 10^{-5}$		2270	$D^*(2010)^-D^*(2010)^+K^0$	$(8.8 \pm 1.9) \times 10^{-3}$			1360
$D_s^+\pi^0$	< 4.1	$\times 10^{-5}$	CL = 90%	2215	$\bar{D}^0D^0K^0$	< 1.4	$\times 10^{-3}$	CL = 90%	1575
$D_s^+\rho^-$	< 6	$\times 10^{-4}$	CL = 90%	2197	$\bar{D}^0D^*(2007)^0K^0 + \bar{D}^*(2007)^0D^0K^0$	< 3.7	$\times 10^{-3}$	CL = 90%	1478
$D_s^+\rho^0$	< 6	$\times 10^{-4}$	CL = 90%	2138	$\bar{D}^*(2007)^0D^*(2007)^0K^0$	< 6.6	$\times 10^{-3}$	CL = 90%	1365
$D_s^+a_1(1260)^-$	< 2.1	$\times 10^{-3}$	CL = 90%	2080	$(\bar{D} + \bar{D}^*)(D + D^*)K$	$(4.3 \pm 0.7)$	%		-
$D_s^+a_1(1260)^-$	< 1.8	$\times 10^{-3}$	CL = 90%	2015	$\eta_c K^0$	$(9.9 \pm 1.9) \times 10^{-4}$			1753
$D_s^-K^+$	$(3.1 \pm 0.8)$	$\times 10^{-5}$		2242	$\eta_c K^*(892)^0$	$(1.6 \pm 0.7) \times 10^{-3}$			1648
$D_s^-K^+$	< 2.5	$\times 10^{-5}$	CL = 90%	2185	$J/\psi(1S)K^0$	$(8.72 \pm 0.33) \times 10^{-4}$			1683
$D_s^-K^*(892)^+$	< 8	$\times 10^{-4}$	CL = 90%	2172	$J/\psi(1S)K^+\pi^-$	$(1.2 \pm 0.6) \times 10^{-3}$			1652
$D_s^-K^*(892)^+$	< 9	$\times 10^{-4}$	CL = 90%	2112	$J/\psi(1S)K^*(892)^0$	$(1.33 \pm 0.06) \times 10^{-3}$			1571
$D_s^-\pi^+K^0$	< 4	$\times 10^{-3}$	CL = 90%	2222	$J/\psi(1S)\eta K_s^0$	$(8 \pm 4) \times 10^{-5}$			1508
$D_s^-\pi^+K^0$	< 2.6	$\times 10^{-3}$	CL = 90%	2164	$J/\psi(1S)\phi K^0$	$(9.4 \pm 2.6) \times 10^{-5}$			1224
$D_s^-\pi^+K^*(892)^0$	< 3.1	$\times 10^{-3}$	CL = 90%	2138	$J/\psi(1S)K(1270)^0$	$(1.3 \pm 0.5) \times 10^{-3}$			1390
$D_s^-\pi^+K^*(892)^0$	< 1.7	$\times 10^{-3}$	CL = 90%	2076	$J/\psi(1S)\pi^0$	$(2.2 \pm 0.4) \times 10^{-5}$			1728
$\bar{D}^0K^0$	$(5.0 \pm 1.4)$	$\times 10^{-5}$		2280	$J/\psi(1S)\eta$	< 2.7	$\times 10^{-5}$	CL = 90%	1672
$\bar{D}^0K^+\pi^-$	$(8.8 \pm 1.7)$	$\times 10^{-5}$		2261	$J/\psi(1S)\pi^+\pi^-$	$(4.6 \pm 0.9) \times 10^{-5}$			1716
$\bar{D}^0K^*(892)^0$	$(5.3 \pm 0.8)$	$\times 10^{-5}$		2213	$J/\psi(1S)\rho^0$	$(1.6 \pm 0.7) \times 10^{-5}$			1611
$D_s^0(2460)^-K^+\times B(D_s^0(2460)^-\rightarrow \bar{D}^0\pi^-)$	$(1.8 \pm 0.5)$	$\times 10^{-5}$		2031	$J/\psi(1S)\omega$	< 2.7	$\times 10^{-4}$	CL = 90%	1609
					$J/\psi(1S)\phi$	< 9.2	$\times 10^{-6}$	CL = 90%	1519
					$J/\psi(1S)\eta'(958)$	< 6.3	$\times 10^{-5}$	CL = 90%	1546
					$J/\psi(1S)K^0\pi^+\pi^-$	$(1.0 \pm 0.4) \times 10^{-3}$			1611
					$J/\psi(1S)K^0\rho^0$	$(5.4 \pm 3.0) \times 10^{-4}$			1390
					$J/\psi(1S)K^*(892)^+\pi^-$	$(8 \pm 4) \times 10^{-4}$			1514
					$J/\psi(1S)K^*(892)^0\pi^+\pi^-$	$(6.6 \pm 2.2) \times 10^{-4}$			1447
					$X(3872)^-K^+$	< 5	$\times 10^{-4}$	CL = 90%	-
					$X(3872)^-K^+\times [jij]$	< 5.4	$\times 10^{-6}$	CL = 90%	-
					$B(X(3872)^-\rightarrow J/\psi(1S)\pi^-\pi^0)$				
					$X(3872)K^0 \times B(X \rightarrow J/\psi\pi^+\pi^-)$	< 1.03	$\times 10^{-5}$	CL = 90%	1140
					$J/\psi(1S)p\bar{p}$	< 8.3	$\times 10^{-7}$	CL = 90%	862
					$J/\psi(1S)\gamma$	< 1.6	$\times 10^{-6}$	CL = 90%	1731
					$J/\psi(1S)\bar{D}^0$	< 1.3	$\times 10^{-5}$	CL = 90%	877
					$\psi(2S)K^0$	$(6.2 \pm 0.6) \times 10^{-4}$			1283
					$\psi(2S)K^+\pi^-$	< 1	$\times 10^{-3}$	CL = 90%	1238
					$\psi(2S)K^*(892)^0$	$(7.2 \pm 0.8) \times 10^{-4}$			1116
					$\chi_{c0}(1P)K^0$	< 5.0	$\times 10^{-4}$	CL = 90%	1477
					$\chi_{c0}K^*(892)^0$	< 7.7	$\times 10^{-4}$	CL = 90%	-
					$\chi_{c2}K^0$	< 2.6	$\times 10^{-5}$	CL = 90%	-
					$\chi_{c2}K^*(892)^0$	< 3.6	$\times 10^{-5}$	CL = 90%	-
					$\chi_{c1}(1P)K^0$	$(3.9 \pm 0.4) \times 10^{-4}$			1411
					$\chi_{c1}(1P)K^*(892)^0$	$(3.2 \pm 0.6) \times 10^{-4}$			1265

<b>K or K* modes</b>				$\omega\eta'$	< 2.8	$\times 10^{-6}$	CL = 90%	2491	
$K^+\pi^-$		$(1.82 \pm 0.08) \times 10^{-5}$	2615	$\omega\rho^0$	< 3.3	$\times 10^{-6}$	CL = 90%	2522	
$K^0\pi^0$		$(1.15 \pm 0.10) \times 10^{-5}$	2614	$\omega\omega$	< 1.9	$\times 10^{-5}$	CL = 90%	2521	
$\eta'K^0$		$(6.8 \pm 0.4) \times 10^{-5}$	2528	$\phi\pi^0$	< 1.0	$\times 10^{-6}$	CL = 90%	2539	
$\eta'K^*(892)^0$		< 7.6	$\times 10^{-6}$	$\phi\eta$	< 1.0	$\times 10^{-6}$	CL = 90%	2511	
$\eta K^*(892)^0$		$(1.77 \pm 0.23) \times 10^{-5}$	2534	$\phi\eta'$	< 4.5	$\times 10^{-6}$	CL = 90%	2447	
$\eta K^0$		< 2.0	$\times 10^{-6}$	$\phi\rho^0$	< 1.3	$\times 10^{-5}$	CL = 90%	2480	
$\omega K^0$		$(5.5^{+1.2}_{-1.0}) \times 10^{-6}$	2557	$\phi\omega$	< 2.1	$\times 10^{-5}$	CL = 90%	2479	
$a_0^0 K^0$		< 7.8	$\times 10^{-6}$	$\phi\phi$	< 1.5	$\times 10^{-6}$	CL = 90%	2435	
$a_0^- K^+$		< 2.1	$\times 10^{-6}$	$a_0^{\mp} \pi^{\pm}$	< 5.1	$\times 10^{-6}$	CL = 90%	-	
$K_S^0 X^0$ (Familon)		< 5.3	$\times 10^{-5}$	$\pi^+ \pi^- \pi^0$	< 7.2	$\times 10^{-4}$	CL = 90%	2631	
$\omega K^*(892)^0$		< 6.0	$\times 10^{-6}$	$\rho^0 \pi^0$	$(1.8 \pm 0.8)$	$\times 10^{-6}$	S = 1.3	2581	
$K^+ K^-$		< 3.7	$\times 10^{-7}$	$\rho^{\mp} \pi^{\pm}$	[gg] $(2.28 \pm 0.25)$	$\times 10^{-5}$		2581	
$K^0 \bar{K}^0$		$(1.13^{+0.38}_{-0.35}) \times 10^{-6}$	2592	$\pi^+ \pi^- \pi^+ \pi^-$	< 2.3	$\times 10^{-4}$	CL = 90%	2621	
$K_S^0 K_S^0 K_S^0$		$(6.2^{+1.2}_{-1.1}) \times 10^{-6}$	S = 1.3	$\rho^0 \rho^0$	< 1.1	$\times 10^{-6}$	CL = 90%	2523	
$K^+ \pi^- \pi^0$		$(3.7 \pm 0.5) \times 10^{-5}$	2609	$a_1(1260)^{\mp} \pi^{\pm}$	[gg] < 4.9	$\times 10^{-4}$	CL = 90%	2494	
$K^+ \rho^-$		$(8.5 \pm 2.8) \times 10^{-6}$	S = 1.7	$a_2(1320)^{\mp} \pi^{\pm}$	[gg] < 3.0	$\times 10^{-4}$	CL = 90%	2473	
$(K^+ \pi^- \pi^0)$ non-resonant		< 9.4	$\times 10^{-6}$	$\pi^+ \pi^- \pi^0 \pi^0$	< 3.1	$\times 10^{-3}$	CL = 90%	2622	
$K_x^0 \pi^0$	[III]	$(6.1 \pm 1.6) \times 10^{-6}$	-	$\rho^+ \rho^-$	$(2.5 \pm 0.4)$	$\times 10^{-5}$		2523	
$K^0 \pi^+ \pi^-$		$(4.38 \pm 0.29) \times 10^{-5}$	2609	$a_1(1260)^0 \pi^0$	< 1.1	$\times 10^{-3}$	CL = 90%	2494	
$K^0 \rho^0$		< 3.9	$\times 10^{-5}$	$\omega\pi^0$	< 1.2	$\times 10^{-6}$	CL = 90%	2580	
$K^0 f_0(980)$		$(5.5 \pm 0.9) \times 10^{-6}$	2524	$\pi^+ \pi^+ \pi^- \pi^- \pi^0$	< 9.0	$\times 10^{-3}$	CL = 90%	2609	
$K^*(892)^+ \pi^-$		$(1.18 \pm 0.15) \times 10^{-5}$	2562	$a_1(1260)^+ \rho^-$	< 3.4	$\times 10^{-3}$	CL = 90%	2433	
$K_x^+ \pi^-$	[III]	$(5.1 \pm 1.6) \times 10^{-6}$	-	$a_1(1260)^0 \rho^0$	< 2.4	$\times 10^{-3}$	CL = 90%	2433	
$K^*(892)^0 \pi^0$		< 3.5	$\times 10^{-6}$	$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^-$	< 3.0	$\times 10^{-3}$	CL = 90%	2592	
$K_2^+(1430)^+ \pi^-$		< 1.8	$\times 10^{-5}$	$a_1(1260)^+ a_1(1260)^-$	< 2.8	$\times 10^{-3}$	CL = 90%	2336	
$K^0 K^- \pi^+$		< 2.1	$\times 10^{-5}$	$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^0$	< 1.1	%	CL = 90%	2572	
$K^+ K^- \pi^0$		< 1.9	$\times 10^{-5}$	CL = 90%					
$K^0 K^+ K^-$		$(2.47 \pm 0.23) \times 10^{-5}$	2522	<b>Baryon modes</b>					
$K^0 \phi$		$(8.6^{+1.3}_{-1.1}) \times 10^{-6}$	2516	$p\bar{p}$	< 2.7	$\times 10^{-7}$	CL = 90%	2467	
$K^- \pi^+ \pi^+ \pi^-$	[nnmm]	< 2.3	$\times 10^{-4}$	$p\bar{p}\pi^+ \pi^-$	< 2.5	$\times 10^{-4}$	CL = 90%	2406	
$K^*(892)^0 \pi^+ \pi^-$		< 1.4	$\times 10^{-3}$	$p\bar{p}K^0$	$(2.1^{+0.6}_{-0.4})$	$\times 10^{-6}$		2347	
$K^*(892)^0 \rho^0$		< 3.4	$\times 10^{-5}$	$\Theta(1540)^+ \bar{p} \times$	[mnn] < 2.3	$\times 10^{-7}$	CL = 90%	2318	
$K^*(892)^0 f_0(980)$		< 1.7	$\times 10^{-4}$	$B(\Theta(1540)^+ \rightarrow$					
$K_1(1400)^+ \pi^-$		< 1.1	$\times 10^{-3}$	$pK_S^0$					
$K^- a_1(1260)^+$	[nnmm]	< 2.3	$\times 10^{-4}$	$p\bar{p}K^*(892)^0$	< 7.6	$\times 10^{-6}$	CL = 90%	2215	
$K^*(892)^0 K^+ K^-$		< 6.1	$\times 10^{-4}$	$p\bar{p}\pi^-$	$(2.6 \pm 0.5)$	$\times 10^{-6}$		2401	
$K^*(892)^0 \phi$		$(9.5 \pm 0.9) \times 10^{-6}$	2460	$p\bar{p}K^-$	< 8.2	$\times 10^{-7}$	CL = 90%	2308	
$\bar{K}^*(892)^0 K^*(892)^0$		< 2.2	$\times 10^{-5}$	$\bar{p}\Sigma^0 \pi^-$	< 3.8	$\times 10^{-6}$	CL = 90%	2383	
$K^*(892)^0 K^*(892)^0$		< 3.7	$\times 10^{-5}$	$\Delta\Delta$	< 6.9	$\times 10^{-7}$	CL = 90%	2392	
$K^*(892)^+ K^*(892)^-$		< 1.41	$\times 10^{-4}$	$\Delta^0 \bar{\Delta}^0$	< 1.5	$\times 10^{-3}$	CL = 90%	2335	
$K_1(1400)^0 \rho^0$		< 3.0	$\times 10^{-3}$	$\bar{\Delta}^+ \bar{\Delta}^-$	< 1.1	$\times 10^{-4}$	CL = 90%	2335	
$K_1(1400)^0 \phi$		< 5.0	$\times 10^{-3}$	$\bar{D}^0 p\bar{p}$	$(1.18 \pm 0.22)$	$\times 10^{-4}$		1863	
$K_0^0(1430)^0 \phi$	seen		2336	$\bar{D}^*(2007)^0 p\bar{p}$	$(1.2 \pm 0.4)$	$\times 10^{-4}$		1788	
$K_2^+(1430)^0 \rho^0$		< 1.1	$\times 10^{-3}$	$\bar{\Sigma}_c^- \Delta^{++}$	< 1.0	$\times 10^{-3}$	CL = 90%	1839	
$K_2^+(1430)^0 \phi$	seen		2333	$\bar{\Lambda}_c^- p\pi^+ \pi^-$	$(1.3 \pm 0.4)$	$\times 10^{-3}$		1934	
$K^*(892)^0 \gamma$		$(4.01 \pm 0.20) \times 10^{-5}$	2564	$\bar{\Lambda}_c^- p$	$(2.2 \pm 0.8)$	$\times 10^{-5}$		2021	
$\eta K^0 \gamma$		$(8.7^{+3.6}_{-3.1}) \times 10^{-6}$	2587	$\bar{\Lambda}_c^- p\pi^0$	< 5.9	$\times 10^{-4}$	CL = 90%	1982	
$\eta K^0 \gamma$		< 8.3	$\times 10^{-6}$	$\bar{\Lambda}_c^- p\pi^+ \pi^- \pi^0$	< 5.07	$\times 10^{-3}$	CL = 90%	1882	
$K^+ \pi^- \gamma$		$(4.6 \pm 1.4) \times 10^{-6}$	2615	$\bar{\Lambda}_c^- p\pi^+ \pi^- \pi^+ \pi^-$	< 2.74	$\times 10^{-3}$	CL = 90%	1821	
$K^*(1410)\gamma$		< 1.3	$\times 10^{-4}$	$\bar{\Sigma}_c(2520)^- \rho\pi^+$	$(1.6 \pm 0.7)$	$\times 10^{-4}$		1860	
$K^+ \pi^- \gamma$ nonresonant		< 2.6	$\times 10^{-6}$	$\bar{\Sigma}_c(2520)^0 \rho\pi^-$	< 1.21	$\times 10^{-4}$	CL = 90%	1860	
$K^0 \pi^+ \pi^- \gamma$		$(2.4 \pm 0.5) \times 10^{-5}$	2609	$\bar{\Sigma}_c(2455)^0 \rho\pi^-$	$(10 \pm 8)$	$\times 10^{-5}$	S = 1.7	1895	
$K_1(1270)^0 \gamma$		< 5.8	$\times 10^{-5}$	$\bar{\Sigma}_c(2455)^- \rho\pi^+$	$(2.8 \pm 0.9)$	$\times 10^{-4}$		1895	
$K_1(1400)^0 \gamma$		< 1.5	$\times 10^{-5}$	$\Lambda_c(2593)^-$	< 1.1	$\times 10^{-4}$	CL = 90%	-	
$K_2^+(1430)^0 \gamma$		$(1.24 \pm 0.24) \times 10^{-5}$	2447	$l \Lambda_c(2625)^- p$					
$K^*(1680)^0 \gamma$		< 2.0	$\times 10^{-3}$	CL = 90%					
$K_4^*(1780)^0 \gamma$		< 8.3	$\times 10^{-5}$	CL = 90%					
$K_4^*(2045)^0 \gamma$		< 4.3	$\times 10^{-3}$	CL = 90%					
<b>Light unflavored meson modes</b>				<b>Lepton Family number (LF) violating modes, or <math>\Delta B = 1</math> weak neutral current (B1) modes</b>					
$\rho^0 \gamma$		< 4	$\times 10^{-7}$	$\gamma\gamma$	B1	< 6.2	$\times 10^{-7}$	CL = 90%	2640
$\omega\gamma$		< 8	$\times 10^{-7}$	$e^+ e^-$	B1	< 6.1	$\times 10^{-8}$	CL = 90%	2640
$\phi\gamma$		< 8.5	$\times 10^{-7}$	$\mu^+ \mu^-$	B1	< 3.9	$\times 10^{-8}$	CL = 90%	2638
$\pi^+ \pi^-$		$(4.6 \pm 0.4) \times 10^{-6}$	2636	$K^0 e^+ e^-$	B1	< 5.4	$\times 10^{-7}$	CL = 90%	2616
$\pi^0 \pi^0$		$(1.5 \pm 0.5) \times 10^{-6}$	S = 1.7	$K^0 \mu^+ \mu^-$	B1	$(2.0^{+1.3}_{-1.0})$	$\times 10^{-7}$	S = 1.6	2612
$\eta\pi^0$		< 2.5	$\times 10^{-6}$	$K^0 \ell^+ \ell^-$	B1	[ggg] < 6.8	$\times 10^{-7}$	CL = 90%	2616
$\eta\eta$		< 2.0	$\times 10^{-6}$	$K^*(892)^0 e^+ e^-$	B1	< 2.4	$\times 10^{-6}$	CL = 90%	2564
$\eta\pi^0$		< 3.7	$\times 10^{-6}$	$K^*(892)^0 \mu^+ \mu^-$	B1	$(1.22^{+0.38}_{-0.32})$	$\times 10^{-6}$		2560
$\eta\eta'$		< 1.0	$\times 10^{-5}$	$K^*(892)^0 \nu\bar{\nu}$	B1	< 1.0	$\times 10^{-3}$	CL = 90%	2564
$\eta'\eta$		< 4.6	$\times 10^{-6}$	$K^*(892)^0 \ell^+ \ell^-$	B1	[ggg] $(1.17 \pm 0.30)$	$\times 10^{-6}$		2564
$\eta'\rho^0$		< 4.3	$\times 10^{-6}$	$e^{\pm} \mu^{\mp}$	LF	[gg] < 1.7	$\times 10^{-7}$	CL = 90%	2639
$\eta\rho^0$		< 1.5	$\times 10^{-6}$	$K^0 e^{\pm} \mu^{\mp}$	LF	< 4.0	$\times 10^{-6}$	CL = 90%	2615
$\omega\eta$		< 1.9	$\times 10^{-6}$	$K^*(892)^0 e^{\pm} \mu^{\mp}$	LF	< 3.4	$\times 10^{-6}$	CL = 90%	2563
				$e^{\pm} \tau^{\mp}$	LF	[gg] < 1.1	$\times 10^{-4}$	CL = 90%	2341
				$\mu^{\pm} \tau^{\mp}$	LF	[gg] < 3.8	$\times 10^{-5}$	CL = 90%	2339
				invisible	B1	< 2.2	$\times 10^{-4}$	CL = 90%	-
				$\nu\bar{\nu}\gamma$	B1	< 4.7	$\times 10^{-5}$	CL = 90%	2640



**$B^\pm/B^0$  ADMIXTURE****CP violation**

$$A_{CP}(B \rightarrow K^*(892)\gamma) = -0.010 \pm 0.028$$

$$A_{CP}(B \rightarrow s\gamma) = 0.00 \pm 0.04$$

$$A_{CP}(b \rightarrow X_s \ell^+ \ell^-) = -0.22 \pm 0.26$$

The branching fraction measurements are for an admixture of  $B$  mesons at the  $\Upsilon(4S)$ . The values quoted assume that  $B(\Upsilon(4S) \rightarrow B\bar{B}) = 100\%$ .

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

$\bar{B}$  modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing.

<b>B DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)				
<b>Semileptonic and leptonic modes</b>							
$B \rightarrow e^+ \nu_e$ anything	[ <i>ooo</i> ] (10.78 ± 0.18) %		–				
$B \rightarrow \bar{\nu}_e e^+$ anything	< 5.9 × 10 <sup>-4</sup>	CL = 90%	–				
$B \rightarrow \mu^+ \nu_\mu$ anything	[ <i>ooo</i> ] (10.78 ± 0.18) %		–				
$B \rightarrow \ell^+ \nu_\ell$ anything	[ <i>ggg,ooo</i> ] (10.78 ± 0.18) %		–				
$B \rightarrow D^- \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] (2.8 ± 0.9) %		–				
$B \rightarrow \bar{D}^0 \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] (7.2 ± 1.5) %		–				
$B \rightarrow D^{*-} \ell^+ \nu_\ell$ anything	[ <i>ppp</i> ] (6.7 ± 1.3) × 10 <sup>-3</sup>		–				
$B \rightarrow \bar{D}^{*0} \ell^+ \nu_\ell$ anything	[ <i>ggg,qqq</i> ] (2.7 ± 0.7) %		–				
$B \rightarrow \bar{D}_1(2420) \ell^+ \nu_\ell$ anything	(3.8 ± 1.3) × 10 <sup>-3</sup>	S = 2.4	–				
$B \rightarrow D\pi \ell^+ \nu_\ell$ anything + $D^* \pi \ell^+ \nu_\ell$ anything	(2.6 ± 0.5) %	S = 1.5	–				
$B \rightarrow D\pi \ell^+ \nu_\ell$ anything	(1.5 ± 0.6) %		–				
$B \rightarrow D^* \pi \ell^+ \nu_\ell$ anything	(1.9 ± 0.4) %		–				
$B \rightarrow \bar{D}_s^*(2460) \ell^+ \nu_\ell$ anything	(4.4 ± 1.6) × 10 <sup>-3</sup>		–				
$B \rightarrow D^{*0} \pi^+ \ell^+ \nu_\ell$ anything	(1.00 ± 0.34) %		–				
$B \rightarrow D_s^- \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] < 7 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow D_s^- \ell^+ \nu_\ell K^+$ anything	[ <i>ggg</i> ] < 5 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow D_s^- \ell^+ \nu_\ell K^0$ anything	[ <i>ggg</i> ] < 7 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow \ell^+ \nu_\ell$ charm	(10.61 ± 0.17) %		–				
$B \rightarrow X_u \ell^+ \nu_\ell$ anything	(2.33 ± 0.22) × 10 <sup>-3</sup>		–				
$B \rightarrow K^+ \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] (6.2 ± 0.6) %		–				
$B \rightarrow K^- \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] (10 ± 4) × 10 <sup>-3</sup>		–				
$B \rightarrow K^0 / \bar{K}^0 \ell^+ \nu_\ell$ anything	[ <i>ggg</i> ] (4.6 ± 0.5) %		–				
<b>D, D*, or D<sub>s</sub> modes</b>							
$B \rightarrow D^\pm$ anything	(22.8 ± 1.4) %		–				
$B \rightarrow D^0 / \bar{D}^0$ anything	(64.0 ± 3.0) %	S = 1.2	–				
$B \rightarrow D^*(2010)^\pm$ anything	(22.5 ± 1.5) %		–				
$B \rightarrow D^*(2007)^0$ anything	(26.0 ± 2.7) %		–				
$B \rightarrow D_s^\pm$ anything	[ <i>gg</i> ] (8.6 ± 1.2) %		–				
$B \rightarrow D_s^{*\pm}$ anything	(6.5 ± 1.2) %		–				
$B \rightarrow D_s^{*0} / \bar{D}_s^{*0}$ anything	(3.4 ± 0.7) %		–				
$B \rightarrow D^{(*)} \bar{D}^{(*)} K^0 + D^{(*)} \bar{D}^{(*)} K^\pm$	[ <i>gg,rrr</i> ] (7.1 <sup>+2.7</sup> <sub>-1.7</sub> ) %		–				
$b \rightarrow c\bar{c}s$	(22 ± 4) %		–				
$B \rightarrow D_s^{(*)} \bar{D}^{(*)}$	[ <i>gg,rrr</i> ] (4.0 ± 0.6) %		–				
$B \rightarrow D^* D^*(2010)^\pm$	[ <i>gg</i> ] < 5.9 × 10 <sup>-3</sup>	CL = 90%	1711				
$B \rightarrow DD^*(2010)^\pm + D^* D^\pm$	[ <i>gg</i> ] < 5.5 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow DD^\pm$	[ <i>gg</i> ] < 3.1 × 10 <sup>-3</sup>	CL = 90%	1866				
$B \rightarrow D_s^{(*)} \bar{D}^{(*)} X$ ( $n\pi^\pm$ )	[ <i>gg,rrr</i> ] (9 <sup>+5</sup> <sub>-4</sub> ) %		–				
$B \rightarrow D^*(2010)\gamma$	< 1.1 × 10 <sup>-3</sup>	CL = 90%	2257				
$B \rightarrow D_s^+ \pi^-, D_s^{*+} \pi^-, D_s^+ \rho^-, D_s^{*+} \rho^-, D_s^+ \pi^0, D_s^{*+} \pi^0, D_s^+ \eta, D_s^{*+} \eta, D_s^+ \rho^0, D_s^{*+} \rho^0, D_s^+ \omega, D_s^{*+} \omega$	[ <i>gg</i> ] < 4 × 10 <sup>-4</sup>	CL = 90%	–				
$B \rightarrow D_{s1}(2536)^+$ anything	< 9.5 × 10 <sup>-3</sup>	CL = 90%	–				
<b>Charmonium modes</b>							
$B \rightarrow J/\psi(1S)$ anything	(1.094 ± 0.032) %	S = 1.1	–				
$B \rightarrow J/\psi(1S)$ (direct) anything	(7.8 ± 0.4) × 10 <sup>-3</sup>	S = 1.1	–				
$B \rightarrow \psi(2S)$ anything	(3.07 ± 0.21) × 10 <sup>-3</sup>		–				
$B \rightarrow \chi_{c1}(1P)$ anything	(3.86 ± 0.27) × 10 <sup>-3</sup>		–				
$B \rightarrow \chi_{c1}(1P)$ (direct) anything	(3.18 ± 0.25) × 10 <sup>-3</sup>		–				
$B \rightarrow \chi_{c2}(1P)$ anything	(1.3 ± 0.4) × 10 <sup>-3</sup>	S = 1.9	–				
$B \rightarrow \chi_{c2}(1P)$ (direct) anything	(1.65 ± 0.31) × 10 <sup>-3</sup>		–				
$B \rightarrow \eta_c(1S)$ anything	< 9 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow KY(3940) \times B(Y(3940)) \rightarrow \omega J/\psi$	[ <i>sss</i> ] (7.1 ± 3.4) × 10 <sup>-5</sup>		1083				
<b>K or K* modes</b>							
$B \rightarrow K^\pm$ anything	[ <i>gg</i> ] (78.9 ± 2.5) %		–				
$B \rightarrow K^+$ anything	(66 ± 5) %		–				
$B \rightarrow K^-$ anything	(13 ± 4) %		–				
$B \rightarrow K^0 / \bar{K}^0$ anything	[ <i>gg</i> ] (64 ± 4) %		–				
$B \rightarrow K^*(892)^\pm$ anything	(18 ± 6) %		–				
$B \rightarrow K^*(892)^0 / K^*(892)^0$ anything	[ <i>gg</i> ] (14.6 ± 2.6) %		–				
$B \rightarrow K^*(892)\gamma$	(4.2 ± 0.6) × 10 <sup>-5</sup>		2564				
$B \rightarrow \eta K\gamma$	(8.5 <sup>+1.8</sup> <sub>-1.6</sub> ) × 10 <sup>-6</sup>		2588				
$B \rightarrow K_1(1400)\gamma$	< 1.27 × 10 <sup>-4</sup>	CL = 90%	2453				
$B \rightarrow K_2^*(1430)\gamma$	(1.7 <sup>+0.6</sup> <sub>-0.5</sub> ) × 10 <sup>-5</sup>		2447				
$B \rightarrow K_2^*(1770)\gamma$	< 1.2 × 10 <sup>-3</sup>	CL = 90%	2342				
$B \rightarrow K_2^*(1780)\gamma$	< 3.7 × 10 <sup>-5</sup>	CL = 90%	2341				
$B \rightarrow K_4^*(2045)\gamma$	< 1.0 × 10 <sup>-3</sup>	CL = 90%	2244				
$B \rightarrow K\eta(958)$	(8.3 ± 1.1) × 10 <sup>-5</sup>		2528				
$B \rightarrow K^*(892)\eta(958)$	< 2.2 × 10 <sup>-5</sup>	CL = 90%	2472				
$B \rightarrow K\eta$	< 5.2 × 10 <sup>-6</sup>	CL = 90%	2588				
$B \rightarrow K^*(892)\eta$	(1.8 ± 0.5) × 10 <sup>-5</sup>		2534				
$B \rightarrow K\phi\phi$	(2.3 ± 0.9) × 10 <sup>-6</sup>		2306				
$B \rightarrow \bar{b} \rightarrow \bar{s}\gamma$	(3.43 ± 0.29) × 10 <sup>-4</sup>		–				
$B \rightarrow \bar{b} \rightarrow \bar{s}$ gluon	< 6.8 %	CL = 90%	–				
$B \rightarrow \eta$ anything	< 4.4 × 10 <sup>-4</sup>	CL = 90%	–				
$B \rightarrow \eta'$ anything	(4.2 ± 0.9) × 10 <sup>-4</sup>		–				
<b>Light unflavored meson modes</b>							
$B \rightarrow \rho\gamma$	< 1.9 × 10 <sup>-6</sup>	CL = 90%	2583				
$B \rightarrow \rho / \omega\gamma$	< 1.2 × 10 <sup>-6</sup>	CL = 90%	–				
$B \rightarrow \pi^\pm$ anything	[ <i>gg,ttt</i> ] (358 ± 7) %		–				
$B \rightarrow \pi^0$ anything	(235 ± 11) %		–				
$B \rightarrow \eta$ anything	(17.6 ± 1.6) %		–				
$B \rightarrow \rho^0$ anything	(21 ± 5) %		–				
$B \rightarrow \omega$ anything	< 81 %	CL = 90%	–				
$B \rightarrow \phi$ anything	(3.42 ± 0.13) %		–				
$B \rightarrow \phi K^*(892)$	< 2.2 × 10 <sup>-5</sup>	CL = 90%	2460				
<b>Baryon modes</b>							
$B \rightarrow \Lambda_c^+ / \bar{\Lambda}_c^-$ anything	(6.4 ± 1.1) %		–				
$B \rightarrow \bar{\Lambda}_c^- e^+$ anything	< 3.2 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow \bar{\Lambda}_c^- p$ anything	(3.6 ± 0.7) %		–				
$B \rightarrow \bar{\Lambda}_c^- p e^+ \nu_e$	< 1.5 × 10 <sup>-3</sup>	CL = 90%	2021				
$B \rightarrow \bar{\Sigma}_c^{*-}$ anything	(4.2 ± 2.4) × 10 <sup>-3</sup>		–				
$B \rightarrow \bar{\Sigma}_c^-$ anything	< 9.6 × 10 <sup>-3</sup>	CL = 90%	–				
$B \rightarrow \bar{\Sigma}_c^0$ anything	(4.6 ± 2.4) × 10 <sup>-3</sup>		–				
$B \rightarrow \bar{\Sigma}_c^0 N$ ( $N = p$ or $n$ )	< 1.5 × 10 <sup>-3</sup>	CL = 90%	1938				
$B \rightarrow \Xi_c^0$ anything	(1.93 ± 0.30) × 10 <sup>-4</sup>	S = 1.1	–				
$\times B(\Xi_c^0 \rightarrow \Xi^- \pi^+)$			–				
$B \rightarrow \Xi_c^+$ anything	(4.5 <sup>+1.3</sup> <sub>-1.2</sub> ) × 10 <sup>-4</sup>		–				
$\times B(\Xi_c^+ \rightarrow \Xi^0 \pi^+)$			–				
$B \rightarrow p / \bar{p}$ anything	[ <i>gg</i> ] (8.0 ± 0.4) %		–				
$B \rightarrow p / \bar{p}$ (direct) anything	[ <i>gg</i> ] (5.5 ± 0.5) %		–				
$B \rightarrow \Lambda / \bar{\Lambda}$ anything	[ <i>gg</i> ] (4.0 ± 0.5) %		–				
$B \rightarrow \Xi^- / \bar{\Xi}^+$ anything	[ <i>gg</i> ] (2.7 ± 0.6) × 10 <sup>-3</sup>		–				
$B \rightarrow$ baryons anything	(6.8 ± 0.6) %		–				
$B \rightarrow p\bar{p}$ anything	(2.47 ± 0.23) %		–				
$B \rightarrow \Lambda\bar{p} / \bar{\Lambda} p$ anything	[ <i>gg</i> ] (2.5 ± 0.4) %		–				
$B \rightarrow \Lambda\bar{\Lambda}$ anything	< 5 × 10 <sup>-3</sup>	CL = 90%	–				

Lepton Family number ( $LF$ ) violating modes or $\Delta B = 1$ weak neutral current ( $B1$ ) modes			
$B \rightarrow se^+e^-$	$B1$	$(4.7 \pm 1.3) \times 10^{-6}$	–
$B \rightarrow s\mu^+\mu^-$	$B1$	$(4.3 \pm 1.2) \times 10^{-6}$	–
$B \rightarrow s\ell^+\ell^-$	$B1$ [ggg]	$(4.5 \pm 1.0) \times 10^{-6}$	–
$B \rightarrow Ke^+e^-$	$B1$	$(6.0^{+1.4}_{-1.2}) \times 10^{-7}$	$S = 1.1$ 2617
$B \rightarrow K^*(892)e^+e^-$	$B1$	$(1.24^{+0.37}_{-0.32}) \times 10^{-6}$	2564
$B \rightarrow K\mu^+\mu^-$	$B1$	$(4.7^{+1.0}_{-1.0}) \times 10^{-7}$	2612
$B \rightarrow K^*(892)\mu^+\mu^-$	$B1$	$(1.19^{+0.34}_{-0.29}) \times 10^{-6}$	2560
$B \rightarrow K\ell^+\ell^-$	$B1$	$(5.4 \pm 0.8) \times 10^{-7}$	2617
$B \rightarrow K^*(892)\ell^+\ell^-$	$B1$	$(1.05 \pm 0.20) \times 10^{-6}$	2564
$B \rightarrow e^\pm\mu^\mp s$	$LF$ [gg]	$< 2.2 \times 10^{-5}$	$CL = 90\%$ –
$B \rightarrow \pi e^\pm\mu^\mp$	$LF$	$< 1.6 \times 10^{-6}$	$CL = 90\%$ 2637
$B \rightarrow \rho e^\pm\mu^\mp$	$LF$	$< 3.2 \times 10^{-6}$	$CL = 90\%$ 2582
$B \rightarrow Ke^\pm\mu^\mp$	$LF$	$< 1.6 \times 10^{-6}$	$CL = 90\%$ 2616
$B \rightarrow K^*(892)e^\pm\mu^\mp$	$LF$	$< 6.2 \times 10^{-6}$	$CL = 90\%$ 2563

### $B^\pm/B^0/B_s^0/b$ -baryon ADMIXTURE

These measurements are for an admixture of bottom particles at high energy (LEP, Tevatron,  $Spp\bar{S}$ ).

$$\text{Mean life } \tau = (1.568 \pm 0.009) \times 10^{-12} \text{ s}$$

$$\text{Mean life } \tau = (1.72 \pm 0.10) \times 10^{-12} \text{ s} \quad \text{Charged } b\text{-hadron admixture}$$

$$\text{Mean life } \tau = (1.58 \pm 0.14) \times 10^{-12} \text{ s} \quad \text{Neutral } b\text{-hadron admixture}$$

$$\tau_{\text{charged } b\text{-hadron}}/\tau_{\text{neutral } b\text{-hadron}} = 1.09 \pm 0.13$$

$$|\Delta\tau_b|/\tau_{b,\bar{b}} = -0.001 \pm 0.014$$

The branching fraction measurements are for an admixture of  $B$  mesons and baryons at energies above the  $\Upsilon(4S)$ . Only the highest energy results (LEP, Tevatron,  $Spp\bar{S}$ ) are used in the branching fraction averages. In the following, we assume that the production fractions are the same at the LEP and at the Tevatron.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

The modes below are listed for a  $\bar{b}$  initial state.  $b$  modes are their charge conjugates. Reactions indicate the weak decay vertex and do not include mixing.

$\bar{b}$ DECAY MODES	Scale factor/ Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
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### PRODUCTION FRACTIONS

The production fractions for weakly decaying  $b$ -hadrons at high energy have been calculated from the best values of mean lives, mixing parameters, and branching fractions in this edition by the Heavy Flavor Averaging Group (HFAG) as described in the note “ $B^0$ - $\bar{B}^0$  Mixing” in the  $B^0$  Particle Listings. Values assume

$$B(\bar{b} \rightarrow B^+) = B(\bar{b} \rightarrow B^0)$$

$$B(\bar{b} \rightarrow B^+) + B(\bar{b} \rightarrow B^0) + B(\bar{b} \rightarrow B_s^0) + B(b \rightarrow b\text{-baryon}) = 100\%.$$

The notation for production fractions varies in the literature ( $f_d, d_{B^0}, f(b \rightarrow \bar{B}^0)$ ,  $Br(b \rightarrow \bar{B}^0)$ ). We use our own branching fraction notation here,  $B(\bar{b} \rightarrow B^0)$ .

$B^+$	$(39.8 \pm 1.2) \%$	–
$B^0$	$(39.8 \pm 1.2) \%$	–
$B_s^0$	$(10.3 \pm 1.4) \%$	–
$b$ -baryon	$(10.0 \pm 2.0) \%$	–
$B_c$	–	–

### DECAY MODES

#### Semileptonic and leptonic modes

$\nu$ anything	$(23.1 \pm 1.5) \%$	–
$\ell^+ \nu_\ell$ anything	[ggg] $(10.69 \pm 0.22) \%$	–
$e^+ \nu_e$ anything	$(10.86 \pm 0.35) \%$	–
$\mu^+ \nu_\mu$ anything	$(10.95^{+0.29}_{-0.25}) \%$	–
$D^-\ell^+ \nu_\ell$ anything	[ggg] $(2.2 \pm 0.4) \%$	$S = 1.9$ –
$D^-\pi^+\ell^+ \nu_\ell$ anything	$(4.9 \pm 1.9) \times 10^{-3}$	–
$D^-\pi^-\ell^+ \nu_\ell$ anything	$(2.6 \pm 1.6) \times 10^{-3}$	–
$\bar{D}^0\ell^+ \nu_\ell$ anything	[ggg] $(6.90 \pm 0.35) \%$	–
$\bar{D}^0\pi^-\ell^+ \nu_\ell$ anything	$(1.07 \pm 0.27) \%$	–
$\bar{D}^0\pi^+\ell^+ \nu_\ell$ anything	$(2.3 \pm 1.6) \times 10^{-3}$	–
$D^{*-}\ell^+ \nu_\ell$ anything	[ggg] $(2.75 \pm 0.19) \%$	–

$D^{*-}\pi^+\ell^+ \nu_\ell$ anything	$(4.8 \pm 1.0) \times 10^{-3}$	–
$D^{*-}\pi^-\ell^+ \nu_\ell$ anything	$(6 \pm 7) \times 10^{-4}$	–
$\bar{D}_j^0\ell^+ \nu_\ell$ anything $\times$ $[ggg,uuu]$	$(2.6 \pm 0.9) \times 10^{-3}$	–
$B(\bar{D}_j^0 \rightarrow D^{*+}\pi^-)$	–	–
$D_j^-\ell^+ \nu_\ell$ anything $\times$ $[ggg,uuu]$	$(7.0 \pm 1.9) \times 10^{-3}$	–
$B(D_j^- \rightarrow D^0\pi^-)$	–	–
$\bar{D}_2^*(2460)^0\ell^+ \nu_\ell$ anything $\times$ $B(\bar{D}_2^*(2460)^0 \rightarrow D^{*-}\pi^+)$	$< 1.4 \times 10^{-3}$	$CL = 90\%$ –
$D_2^*(2460)^-\ell^+ \nu_\ell$ anything $\times$ $B(D_2^*(2460)^- \rightarrow D^0\pi^-)$	$(4.2^{+1.5}_{-1.8}) \times 10^{-3}$	–
$\bar{D}_2^*(2460)^0\ell^+ \nu_\ell$ anything $\times$ $B(\bar{D}_2^*(2460)^0 \rightarrow D^-\pi^+)$	$(160 \pm 80) \%$	–
charmless $\ell \bar{\nu}_\ell$ [ggg]	$(1.7 \pm 0.5) \times 10^{-3}$	–
$\tau^+ \nu_\tau$ anything	$(2.48 \pm 0.26) \%$	–
$D^{*-}\tau \nu_\tau$ anything	$(9 \pm 4) \times 10^{-3}$	–
$\bar{c} \rightarrow \ell \bar{\nu}_\ell$ anything [ggg]	$(8.02 \pm 0.19) \%$	–
$c \rightarrow \ell^+ \nu$ anything	$(1.6^{+0.4}_{-0.5}) \%$	–

### Charmed meson and baryon modes

$\bar{D}^0$ anything	$(61.0 \pm 3.1) \%$	–
$D^0 D_s^\pm$ anything [gg]	$(9.1^{+3.9}_{-2.8}) \%$	–
$D^\mp D_s^\pm$ anything [gg]	$(4.0^{+2.3}_{-1.8}) \%$	–
$\bar{D}^0 D^0$ anything [gg]	$(5.1^{+2.0}_{-1.8}) \%$	–
$D^0 D^\pm$ anything [gg]	$(2.7^{+1.8}_{-1.6}) \%$	–
$D^\pm D^\mp$ anything [gg]	$< 9 \times 10^{-3}$	$CL = 90\%$ –
$D^-$ anything	$(22.4 \pm 1.8) \%$	–
$D^*(2010)^+$ anything	$(17.3 \pm 2.0) \%$	–
$D_1(2420)^0$ anything	$(5.0 \pm 1.5) \%$	–
$D^*(2010)^\mp D_s^\pm$ anything [gg]	$(3.3^{+1.6}_{-1.3}) \%$	–
$D^0 D^*(2010)^\pm$ anything [gg]	$(3.0^{+1.1}_{-0.9}) \%$	–
$D^*(2010)^\pm D^\mp$ anything [gg]	$(2.5^{+1.2}_{-1.0}) \%$	–
$D^*(2010)^\pm D^*(2010)^\mp$ anything [gg]	$(1.2 \pm 0.4) \%$	–
$\bar{D}D$ anything	$(10^{+11}_{-10}) \%$	–
$D_2^*(2460)^0$ anything	$(4.7 \pm 2.7) \%$	–
$D_s^-$ anything	$(15.0 \pm 2.6) \%$	–
$D_s^+$ anything	$(10.1 \pm 3.1) \%$	–
$\Lambda_c^+$ anything	$(9.7 \pm 2.9) \%$	–
$\bar{c}/c$ anything [ttt]	$(116.2 \pm 3.2) \%$	–

### Charmonium modes

$J/\psi(1S)$ anything	$(1.16 \pm 0.10) \%$	–
$\psi(2S)$ anything	$(4.8 \pm 2.4) \times 10^{-3}$	–
$\chi_{c1}(1P)$ anything	$(1.4 \pm 0.4) \%$	–

### $K$ or $K^*$ modes

$\bar{s}\gamma$	$(3.1 \pm 1.1) \times 10^{-4}$	–
$\bar{s}\bar{\nu}_\nu$	$< 6.4 \times 10^{-4}$	$CL = 90\%$ –
$K^\pm$ anything	$(74 \pm 6) \%$	–
$K_S^0$ anything	$(29.0 \pm 2.9) \%$	–

### Pion modes

$\pi^\pm$ anything	$(397 \pm 21) \%$	–
$\pi^0$ anything [ttt]	$(278 \pm 60) \%$	–
$\phi$ anything	$(2.82 \pm 0.23) \%$	–

### Baryon modes

$p/\bar{p}$ anything	$(13.1 \pm 1.1) \%$	–
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### Other modes

[ttt]	$(497 \pm 7) \%$	–
charged anything	$(1.7^{+1.0}_{-0.7}) \times 10^{-5}$	–
hadron <sup>+</sup> hadron <sup>-</sup>	$(7 \pm 21) \times 10^{-3}$	–
charmless	–	–

### Baryon modes

$\Lambda/\bar{\Lambda}$ anything	$(5.9 \pm 0.6) \%$	–
$b$ -baryon anything	$(10.2 \pm 2.8) \%$	–

$\mu^+ \mu^-$  anything  $\Delta B = 1$  weak neutral current (BI) modes  
BI  $< 3.2 \times 10^{-4}$  CL = 90% -

$$B^* \quad I(J^P) = \frac{1}{2}(1^-)$$

$I, J, P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^*} = 5325.0 \pm 0.6 \text{ MeV}$$

$$m_{B^*} - m_B = 45.78 \pm 0.35 \text{ MeV}$$

$B^*$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$B\gamma$	dominant	45

### BOTTOM, STRANGE MESONS

$$(B = \pm 1, S = \mp 1)$$

$$B_s^0 = s\bar{b}, \bar{B}_s^0 = \bar{s}b, \text{ similarly for } B_s^{*\pm}$$

$$B_s^0 \quad I(J^P) = 0(0^-)$$

$I, J, P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B_s^0} = 5367.5 \pm 1.8 \text{ MeV} \quad (S = 1.1)$$

$$\text{Mean life } \tau = (1.466 \pm 0.059) \times 10^{-12} \text{ s}$$

$$c\tau = 439 \mu\text{m}$$

#### $B_s^0 \bar{B}_s^0$ mixing parameters

$$\Delta m_{B_s^0} = m_{B_s^0 H} - m_{B_s^0 L} > 14.4 \times 10^{12} \hbar \text{ s}^{-1}, \text{ CL} = 95\%$$

$$> 94.8 \times 10^{-10} \text{ MeV}, \text{ CL} = 95\%$$

$$x_s = \Delta m_{B_s^0} / \Gamma_{B_s^0} > 19.9, \text{ CL} = 95\%$$

$$\chi_s > 0.49878, \text{ CL} = 95\%$$

These branching fractions all scale with  $B(\bar{b} \rightarrow B_s^0)$ , the LEP  $B_s^0$  production fraction. The first four were evaluated using  $B(\bar{b} \rightarrow B_s^0) = (10.7 \pm 1.4)\%$  and the rest assume  $B(\bar{b} \rightarrow B_s^0) = 12\%$ .

The branching fraction  $B(B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell \text{ anything})$  is not a pure measurement since the measured product branching fraction  $B(\bar{b} \rightarrow B_s^0) \times B(B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell \text{ anything})$  was used to determine  $B(\bar{b} \rightarrow B_s^0)$ , as described in the note on " $B^0 - \bar{B}^0$  Mixing"

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm \text{ anything}$ , the values usually are multiplicities, not branching fractions. They can be greater than one.

$B_s^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$D_s^- \text{ anything}$	(94 ± 30) %		-
$D_s^- \ell^+ \nu_\ell \text{ anything}$	(7.9 ± 2.4) %		-
$D_s^- \pi^+$	< 13 %		2321
$D_s^{(*)+} D_s^{(*)-}$	(23 <sup>+21</sup> <sub>-13</sub> ) %		-
$J/\psi(1S)\phi$	(9.3 ± 3.3) × 10 <sup>-4</sup>		1588
$J/\psi(1S)\pi^0$	< 1.2 × 10 <sup>-3</sup>	90%	1787
$J/\psi(1S)\eta$	< 3.8 × 10 <sup>-3</sup>	90%	1734
$\psi(2S)\phi$	seen		1121
$\pi^+ \pi^-$	< 1.7 × 10 <sup>-4</sup>	90%	2680
$\pi^0 \pi^0$	< 2.1 × 10 <sup>-4</sup>	90%	2680
$\eta \pi^0$	< 1.0 × 10 <sup>-3</sup>	90%	2654
$\eta \eta$	< 1.5 × 10 <sup>-3</sup>	90%	2627
$\rho^0 \rho^0$	< 3.20 × 10 <sup>-4</sup>	90%	2569
$\phi \rho^0$	< 6.17 × 10 <sup>-4</sup>	90%	2527
$\phi \phi$	(1.4 ± 0.8) × 10 <sup>-5</sup>		2483
$\pi^+ K^-$	< 2.1 × 10 <sup>-4</sup>	90%	2659
$K^+ K^-$	< 5.9 × 10 <sup>-5</sup>	90%	2638
$\bar{K}^*(892)^0 \rho^0$	< 7.67 × 10 <sup>-4</sup>	90%	2550
$\bar{K}^*(892)^0 K^*(892)^0$	< 1.681 × 10 <sup>-3</sup>	90%	2531
$\phi K^*(892)^0$	< 1.013 × 10 <sup>-3</sup>	90%	2507
$p\bar{p}$	< 5.9 × 10 <sup>-5</sup>	90%	2514
$\gamma \gamma$	< .48 × 10 <sup>-4</sup>	90%	2684
$\phi \gamma$	< 1.2 × 10 <sup>-4</sup>	90%	2587

#### Lepton Family number (LF) violating modes or

	$\Delta B = 1$ weak neutral current (BI) modes		
$\mu^+ \mu^-$	BI	< 1.5 × 10 <sup>-7</sup>	90% 2682
$e^+ e^-$	BI	< 5.4 × 10 <sup>-5</sup>	90% 2684
$e^\pm \mu^\mp$	LF	[gg] < 6.1 × 10 <sup>-6</sup>	90% 2683
$\phi(1020)\mu^+ \mu^-$	BI	< 4.7 × 10 <sup>-5</sup>	90% 2582
$\phi \nu \bar{\nu}$	BI	< 5.4 × 10 <sup>-3</sup>	90% 2587

### BOTTOM, CHARMED MESONS

$$(B = C = \pm 1)$$

$$B_c^+ = c\bar{b}, B_c^- = \bar{c}b, \text{ similarly for } B_c^{*\pm}$$

$$B_c^\pm \quad I(J^P) = 0(0^-)$$

$I, J, P$  need confirmation.

Quantum numbers shown are quark model predictions.

$$\text{Mass } m = 6.286 \pm 0.005 \text{ GeV}$$

$$\text{Mean life } \tau = (0.46_{-0.16}^{+0.18}) \times 10^{-12} \text{ s}$$

$B_c^-$  modes are charge conjugates of the modes below.

$B_c^\pm$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
The following quantities are not pure branching ratios; rather the fraction $\Gamma_i/\Gamma \times B(\bar{b} \rightarrow B_c)$ .			
$J/\psi(1S)\ell^+ \nu_\ell \text{ anything}$	(5.2 <sup>+2.4</sup> <sub>-2.1</sub> ) × 10 <sup>-5</sup>		-
$J/\psi(1S)\pi^+$	< 8.2 × 10 <sup>-5</sup>	90%	2377
$J/\psi(1S)\pi^+ \pi^+ \pi^-$	< 5.7 × 10 <sup>-4</sup>	90%	2357
$J/\psi(1S)a_1(1260)$	< 1.2 × 10 <sup>-3</sup>	90%	2177
$D^*(2010)^+ \bar{D}^0$	< 6.2 × 10 <sup>-3</sup>	90%	2474

### $c\bar{c}$ MESONS

$$\eta_c(1S) \quad I^G(J^{PC}) = 0^+(0^{-+})$$

$$\text{Mass } m = 2980.4 \pm 1.2 \text{ MeV} \quad (S = 1.5)$$

$$\text{Full width } \Gamma = 2.5.5 \pm 3.4 \text{ MeV} \quad (S = 2.0)$$

$\eta_c(1S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
Decays involving hadronic resonances			
$\eta'(958)\pi\pi$	(4.1 ± 1.7) %		1321
$\rho\rho$	(2.0 ± 0.7) %		1273
$K^*(892)^0 K^- \pi^+ + \text{c.c.}$	(2.0 ± 0.7) %		1276
$K^*(892)\bar{K}^*(892)$	(9.2 ± 3.4) × 10 <sup>-3</sup>		1194
$K^{*0}\bar{K}^{*0}\pi^+\pi^-$	(1.5 ± 0.8) %		1071
$\phi K^+ K^-$	(2.9 ± 1.4) × 10 <sup>-3</sup>		1102
$\phi\phi$	(2.7 ± 0.9) × 10 <sup>-3</sup>		1087
$\phi 2(\pi^+ \pi^-)$	< 4.7 × 10 <sup>-3</sup>	90%	1249
$a_0(980)\pi$	< 2 %	90%	1324
$a_2(1320)\pi$	< 2 %	90%	1194
$K^*(892)\bar{K} + \text{c.c.}$	< 1.28 %	90%	1308
$f_2(1270)\eta$	< 1.1 %	90%	1143
$\omega\omega$	< 3.1 × 10 <sup>-3</sup>	90%	1268
$\omega\phi$	< 1.7 × 10 <sup>-3</sup>	90%	1183
$f_2(1270) f_2(1270)$	(1.0 <sup>+0.4</sup> <sub>-0.5</sub> ) %		771
Decays into stable hadrons			
$K\bar{K}\pi$	(7.0 ± 1.2) %		1379
$\eta\pi\pi$	(4.9 ± 1.8) %		1427
$\pi^+ \pi^- K^+ K^-$	(1.5 ± 0.6) %		1343
$K^+ K^- 2(\pi^+ \pi^-)$	(10 ± 4) × 10 <sup>-3</sup>		1252
$2(K^+ K^-)$	(1.5 ± 0.7) × 10 <sup>-3</sup>		1053
$2(\pi^+ \pi^-)$	(1.20 ± 0.30) %		1457
$3(\pi^+ \pi^-)$	(2.0 ± 0.7) %		1405
$p\bar{p}$	(1.3 ± 0.4) × 10 <sup>-3</sup>		1158
$K\bar{K}\eta$	< 3.1 %	90%	1263
$\pi^+ \pi^- p\bar{p}$	< 1.2 %	90%	1025
$\Lambda\bar{\Lambda}$	< 2 × 10 <sup>-3</sup>	90%	988
Radiative decays			
$\gamma\gamma$	(2.8 ± 0.9) × 10 <sup>-4</sup>		1490

	Charge conjugation (C), Parity (P), Lepton family number (LF) violating modes		
$\pi^+\pi^-$	$P, CP$	$< 8.7 \times 10^{-4}$	90%
$\pi^0\pi^0$	$P, CP$	$< 5.6 \times 10^{-4}$	90%
$K^+K^-$	$P, CP$	$< 7.6 \times 10^{-4}$	90%
$K_S^0 K_S^0$	$P, CP$	$< 4.2 \times 10^{-4}$	90%

 $J/\psi(1S)$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 3096.916 \pm 0.011$  MeVFull width  $\Gamma = 93.4 \pm 2.1$  keV $\Gamma_{ee} = 5.55 \pm 0.14 \pm 0.02$  keV

$J/\psi(1S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
hadrons	(87.7 ± 0.5) %		–
virtual $\gamma \rightarrow$ hadrons	(13.50 ± 0.30) %		–
$e^+e^-$	(5.94 ± 0.06) %		1548
$\mu^+\mu^-$	(5.93 ± 0.06) %		1545
Decays involving hadronic resonances			
$\rho\pi$	(1.69 ± 0.15) %	$S = 2.4$	1448
$\rho^0\pi^0$	(5.6 ± 0.7) × 10 <sup>-3</sup>		1448
$a_2(1320)\rho$	(1.09 ± 0.22) %		1123
$\omega\pi^+\pi^+\pi^-\pi^-$	(8.5 ± 3.4) × 10 <sup>-3</sup>		1392
$\omega\pi^+\pi^+\pi^0$	(4.0 ± 0.7) × 10 <sup>-3</sup>		1418
$\omega\pi^+\pi^-$	(7.2 ± 1.0) × 10 <sup>-3</sup>		1435
$\omega f_2(1270)$	(4.3 ± 0.6) × 10 <sup>-3</sup>		1142
$K^*(892)^0 \bar{K}_2^*(1430)^0 + c.c.$	(6.7 ± 2.6) × 10 <sup>-3</sup>		1012
$\omega K^*(892) \bar{K} + c.c.$	(5.3 ± 2.0) × 10 <sup>-3</sup>		1097
$K^+ \bar{K}^*(892)^- + c.c.$	(5.0 ± 0.4) × 10 <sup>-3</sup>		1373
$K^0 \bar{K}^*(892)^0 + c.c.$	(4.2 ± 0.4) × 10 <sup>-3</sup>		1373
$K_1(1400)^\pm K^\mp$	(3.8 ± 1.4) × 10 <sup>-3</sup>		1171
$\omega\pi^0\pi^0$	(3.4 ± 0.8) × 10 <sup>-3</sup>		1436
$b_1(1235)^\pm \pi^\mp$	[gg] (3.0 ± 0.5) × 10 <sup>-3</sup>		1300
$\omega K^\pm K_S^0 \pi^\mp$	[gg] (2.9 ± 0.7) × 10 <sup>-3</sup>		1210
$b_1(1235)^0 \pi^0$	[gg] (2.3 ± 0.6) × 10 <sup>-3</sup>		1300
$\phi K^*(892) \bar{K} + c.c.$	(2.04 ± 0.28) × 10 <sup>-3</sup>		969
$\omega K \bar{K}$	(1.9 ± 0.4) × 10 <sup>-3</sup>		1268
$\omega f_0(1710) \rightarrow \omega K \bar{K}$	(4.8 ± 1.1) × 10 <sup>-4</sup>		878
$\phi 2(\pi^+\pi^-)$	(1.66 ± 0.23) × 10 <sup>-3</sup>		1318
$\Delta(1232)^{++} \bar{p}\pi^-$	(1.6 ± 0.5) × 10 <sup>-3</sup>		1030
$\omega\eta$	(1.74 ± 0.20) × 10 <sup>-3</sup>	$S = 1.6$	1394
$\phi K \bar{K}$	(1.83 ± 0.24) × 10 <sup>-3</sup>	$S = 1.5$	1179
$\phi f_0(1710) \rightarrow \phi K \bar{K}$	(3.6 ± 0.6) × 10 <sup>-4</sup>		875
$p\bar{p}\omega$	(1.30 ± 0.25) × 10 <sup>-3</sup>	$S = 1.3$	768
$\Delta(1232)^{++} \bar{\Delta}(1232)^{--}$	(1.10 ± 0.29) × 10 <sup>-3</sup>		938
$\Sigma(1385)^- \bar{\Sigma}(1385)^+ (or\ c.c.)$	[gg] (1.03 ± 0.13) × 10 <sup>-3</sup>		697
$p\bar{p}\eta(958)$	(9 ± 4) × 10 <sup>-4</sup>	$S = 1.7$	596
$\phi f_2'(1525)$	(8 ± 4) × 10 <sup>-4</sup>	$S = 2.7$	871
$\phi\pi^+\pi^-$	(9.4 ± 1.5) × 10 <sup>-4</sup>	$S = 1.7$	1365
$\phi K^\pm K_S^0 \pi^\mp$	[gg] (7.2 ± 0.9) × 10 <sup>-4</sup>		1114
$\omega f_1(1420)$	(6.8 ± 2.4) × 10 <sup>-4</sup>		1062
$\phi\eta$	(7.4 ± 0.8) × 10 <sup>-4</sup>	$S = 1.5$	1320
$\Xi(1530)^- \bar{\Xi}^+$	(5.9 ± 1.5) × 10 <sup>-4</sup>		601
$\rho K^- \bar{\Sigma}(1385)^0$	(5.1 ± 3.2) × 10 <sup>-4</sup>		646
$\omega\pi^0$	(4.5 ± 0.5) × 10 <sup>-4</sup>	$S = 1.4$	1446
$\phi\eta'(958)$	(4.0 ± 0.7) × 10 <sup>-4</sup>	$S = 2.1$	1192
$\phi f_0(980)$	(3.2 ± 0.9) × 10 <sup>-4</sup>	$S = 1.9$	1182
$\Xi(1530)^0 \bar{\Xi}^0$	(3.2 ± 1.4) × 10 <sup>-5</sup>		608
$\Sigma(1385)^- \bar{\Sigma}^+ (or\ c.c.)$	[gg] (3.1 ± 0.5) × 10 <sup>-4</sup>		855
$\phi f_1(1285)$	(2.6 ± 0.5) × 10 <sup>-4</sup>	$S = 1.1$	1032
$\rho\eta$	(1.93 ± 0.23) × 10 <sup>-4</sup>		1396
$\omega\eta'(958)$	(1.82 ± 0.21) × 10 <sup>-4</sup>		1279
$\omega f_0(980)$	(1.4 ± 0.5) × 10 <sup>-4</sup>		1271
$\rho\eta'(958)$	(1.05 ± 0.18) × 10 <sup>-4</sup>		1281
$p\bar{p}\phi$	(4.5 ± 1.5) × 10 <sup>-5</sup>		527
$a_2(1320)^\pm \pi^\mp$	[gg] $< 4.3$ × 10 <sup>-3</sup>	CL = 90%	1263
$K \bar{K}_2^*(1430) + c.c.$	$< 4.0$ × 10 <sup>-3</sup>	CL = 90%	1159
$K_1(1270)^\pm K^\mp$	$< 3.0$ × 10 <sup>-3</sup>	CL = 90%	1231
$K_S^*(1430)^0 \bar{K}_2^*(1430)^0$	$< 2.9$ × 10 <sup>-3</sup>	CL = 90%	604
$K^*(892)^0 \bar{K}^*(892)^0$	$< 5$ × 10 <sup>-4</sup>	CL = 90%	1266
$\phi f_2(1270)$	$< 3.7$ × 10 <sup>-4</sup>	CL = 90%	1036
$p\bar{p}\rho$	$< 3.1$ × 10 <sup>-4</sup>	CL = 90%	774
$\phi\eta(1405) \rightarrow \phi\eta\pi\pi$	$< 2.5$ × 10 <sup>-4</sup>	CL = 90%	946
$\omega f_2'(1525)$	$< 2.2$ × 10 <sup>-4</sup>	CL = 90%	1003
$\Sigma(1385)^0 \bar{\Lambda}$	$< 2$ × 10 <sup>-4</sup>	CL = 90%	912

$\Delta(1232)^+ \bar{p}$	$< 1$	× 10 <sup>-4</sup>	CL = 90%	1100
$\Theta(1540) \bar{\Theta}(1540) \rightarrow$ $K_S^0 p K^- \bar{n} + c.c.$	$< 1.1$	× 10 <sup>-5</sup>	CL = 90%	–
$\Theta(1540) K^- \bar{n} \rightarrow K_S^0 p K^- \bar{n}$	$< 2.1$	× 10 <sup>-5</sup>	CL = 90%	–
$\Theta(1540) K_S^0 \bar{p} \rightarrow K_S^0 \bar{p} K^+ n$	$< 1.6$	× 10 <sup>-5</sup>	CL = 90%	–
$\Theta(1540) K^+ n \rightarrow K_S^0 \bar{p} K^+ n$	$< 5.6$	× 10 <sup>-5</sup>	CL = 90%	–
$\bar{\Theta}(1540) K_S^0 p \rightarrow K_S^0 p K^- \bar{n}$	$< 1.1$	× 10 <sup>-5</sup>	CL = 90%	–
$\Sigma^0 \bar{\Lambda}$	$< 9$	× 10 <sup>-5</sup>	CL = 90%	1032
$\phi\pi^0$	$< 6.4$	× 10 <sup>-6</sup>	CL = 90%	1377

## Decays into stable hadrons

$2(\pi^+\pi^-)\pi^0$	(3.37 ± 0.26) %		1496
$3(\pi^+\pi^-)\pi^0$	(2.9 ± 0.6) %		1433
$\pi^+\pi^-\pi^0$	(2.02 ± 0.14) %	$S = 1.7$	1533
$\pi^+\pi^-\pi^0 K^+ K^-$	(1.20 ± 0.30) %		1368
$4(\pi^+\pi^-)\pi^0$	(9.0 ± 3.0) × 10 <sup>-3</sup>		1345
$\pi^+\pi^- K^+ K^-$	(6.2 ± 0.7) × 10 <sup>-3</sup>		1407
$K \bar{K}\pi$	(6.1 ± 1.0) × 10 <sup>-3</sup>		1442
$p\bar{p}\pi^+\pi^-$	(6.0 ± 0.5) × 10 <sup>-3</sup>	$S = 1.3$	1107
$2(\pi^+\pi^-)$	(3.55 ± 0.23) × 10 <sup>-3</sup>		1517
$3(\pi^+\pi^-)$	(4.3 ± 0.4) × 10 <sup>-3</sup>		1466
$2(\pi^+\pi^-\pi^0)$	(1.62 ± 0.21) %		1468
$2(\pi^+\pi^-)\eta$	(2.26 ± 0.28) × 10 <sup>-3</sup>		1446
$3(\pi^+\pi^-)\eta$	(7.2 ± 1.5) × 10 <sup>-4</sup>		1379
$n\bar{n}\pi^+\pi^-$	(4 ± 4) × 10 <sup>-3</sup>		1106
$\Sigma^0 \bar{\Sigma}^0$	(1.31 ± 0.10) × 10 <sup>-3</sup>		988
$2(\pi^+\pi^-) K^+ K^-$	(4.7 ± 0.7) × 10 <sup>-3</sup>	$S = 1.3$	1320
$p\bar{p}\pi^+\pi^-$	(2.3 ± 0.9) × 10 <sup>-3</sup>	$S = 1.9$	1033
$p\bar{p}$	(2.17 ± 0.08) × 10 <sup>-3</sup>		1232
$p\bar{p}\eta$	(2.09 ± 0.18) × 10 <sup>-3</sup>		949
$p\bar{n}\pi^-$	(2.00 ± 0.10) × 10 <sup>-3</sup>		1174
$n\bar{n}$	(2.2 ± 0.4) × 10 <sup>-3</sup>		1231
$\Xi\bar{\Xi}$	(1.8 ± 0.4) × 10 <sup>-3</sup>	$S = 1.8$	818
$\Lambda\bar{\Lambda}$	(1.54 ± 0.19) × 10 <sup>-3</sup>	$S = 2.2$	1074
$p\bar{p}\pi^0$	(1.09 ± 0.09) × 10 <sup>-3</sup>		1176
$\Lambda\bar{\Sigma}^+ \pi^- (or\ c.c.)$	[gg] (1.06 ± 0.12) × 10 <sup>-3</sup>		950
$pK^- \bar{\Lambda}$	(8.9 ± 1.6) × 10 <sup>-4</sup>		876
$2(K^+ K^-)$	(7.8 ± 1.4) × 10 <sup>-4</sup>		1131
$pK^- \bar{\Sigma}^0$	(2.9 ± 0.8) × 10 <sup>-4</sup>		819
$K^+ K^-$	(2.37 ± 0.31) × 10 <sup>-4</sup>		1468
$K_S^0 K_L^0$	(1.46 ± 0.26) × 10 <sup>-4</sup>	$S = 2.7$	1466
$\Lambda\bar{\Lambda} \pi^0$	(2.2 ± 0.6) × 10 <sup>-4</sup>		998
$\pi^+\pi^-$	(1.47 ± 0.23) × 10 <sup>-4</sup>		1542
$\Lambda\bar{\Sigma}^+ c.c.$	$< 1.5$	× 10 <sup>-4</sup>	CL = 90%
$K_S^0 K_L^0$	$< 1$	× 10 <sup>-6</sup>	CL = 95%

## Radiative decays

$\gamma\eta_c(1S)$	(1.3 ± 0.4) %		114
$\gamma\pi^+\pi^- 2\pi^0$	(8.3 ± 3.1) × 10 <sup>-3</sup>		1518
$\gamma\eta\pi\pi$	(6.1 ± 1.0) × 10 <sup>-3</sup>		1488
$\gamma\eta(1405/1475) \rightarrow \gamma K \bar{K}\pi$	[p] (2.8 ± 0.6) × 10 <sup>-3</sup>	$S = 1.6$	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\rho^0$	(7.8 ± 2.0) × 10 <sup>-6</sup>	$S = 1.8$	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\eta\pi^+\pi^-$	(3.0 ± 0.5) × 10 <sup>-4</sup>		–
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\phi$	$< 8.2$	× 10 <sup>-5</sup>	CL = 95%
$\gamma\rho\rho$	(4.5 ± 0.8) × 10 <sup>-3</sup>		1340
$\gamma\eta_2(1870) \rightarrow \gamma\pi^+\pi^-$	(6.2 ± 2.4) × 10 <sup>-4</sup>		–
$\gamma\eta'(958)$	(4.71 ± 0.27) × 10 <sup>-3</sup>	$S = 1.1$	1400
$\gamma 2\pi^+ 2\pi^-$	(2.8 ± 0.5) × 10 <sup>-3</sup>	$S = 1.9$	1517
$\gamma f_2(1270) f_2(1270)$	(9.5 ± 1.7) × 10 <sup>-4</sup>		878
$\gamma f_2'(1270) f_2'(1270)$ (non resonant)	(8.2 ± 1.9) × 10 <sup>-4</sup>		–
$\gamma K^+ K^- \pi^+ \pi^-$	(2.1 ± 0.6) × 10 <sup>-3</sup>		1407
$\gamma f_4(2050)$	(2.7 ± 0.7) × 10 <sup>-3</sup>		886
$\gamma\omega\omega$	(1.59 ± 0.33) × 10 <sup>-3</sup>		1336
$\gamma\eta(1405/1475) \rightarrow \gamma\rho^0\rho^0$	(1.7 ± 0.4) × 10 <sup>-3</sup>	$S = 1.3$	1223
$\gamma f_2(1270)$	(1.38 ± 0.14) × 10 <sup>-3</sup>		1286
$\gamma f_0(1710) \rightarrow \gamma K \bar{K}$	(8.5 <sup>+1.3</sup> <sub>-0.9</sub> ) × 10 <sup>-4</sup>	$S = 1.2$	1075
$\gamma\eta$	(9.8 ± 1.0) × 10 <sup>-4</sup>	$S = 1.7$	1500
$\gamma f_1(1420) \rightarrow \gamma K \bar{K} \pi$	(7.9 ± 1.3) × 10 <sup>-4</sup>		1220
$\gamma f_1(1285)$	(6.1 ± 0.8) × 10 <sup>-4</sup>		1283
$\gamma f_1(1510) \rightarrow \gamma\eta\pi^+\pi^-$	(4.5 ± 1.2) × 10 <sup>-4</sup>		–
$\gamma f_2'(1525)$	(4.5 <sup>+0.7</sup> <sub>-0.4</sub> ) × 10 <sup>-4</sup>		1173
$\gamma f_2'(1950) \rightarrow \gamma K^*(892) \bar{K}^*(892)$	(7.0 ± 2.2) × 10 <sup>-4</sup>		–
$\gamma K^*(892) \bar{K}^*(892)$	(4.0 ± 1.3) × 10 <sup>-3</sup>		1266
$\gamma\phi\phi$	(4.0 ± 1.2) × 10 <sup>-4</sup>	$S = 2.1$	1166

$\gamma p\bar{p}$	$(3.8 \pm 1.0) \times 10^{-4}$		1232
$\gamma\eta(2225)$	$(2.9 \pm 0.6) \times 10^{-4}$		752
$\gamma\eta(1760) \rightarrow \gamma\rho^0\rho^0$	$(1.3 \pm 0.9) \times 10^{-4}$		1048
$\gamma X(1835)$	$(2.2 \pm 0.6) \times 10^{-4}$		1006
$\gamma(K\bar{K}\pi)_{J^{PC}=0^{-+}}$	$(7 \pm 4) \times 10^{-4}$	S = 2.1	1442
$\gamma\pi^0$	$(3.3^{+0.6}_{-0.4}) \times 10^{-5}$		1546
$\gamma p\bar{p}\pi^+\pi^-$	$< 7.9 \times 10^{-4}$	CL = 90%	1107
$\gamma\gamma$	$< 5 \times 10^{-4}$	CL = 90%	1548
$\gamma\Delta\bar{\Delta}$	$< 1.3 \times 10^{-4}$	CL = 90%	1074
$3\gamma$	$< 5.5 \times 10^{-5}$	CL = 90%	1548
$\gamma f_J(2220)$	$> 2.50 \times 10^{-3}$	CL = 99.9%	745
$\gamma f_J(2220) \rightarrow \gamma\pi\pi$	$(8 \pm 4) \times 10^{-5}$		-
$\gamma f_J(2220) \rightarrow \gamma K\bar{K}$	$(8.1 \pm 3.0) \times 10^{-5}$		-
$\gamma f_J(2220) \rightarrow \gamma p\bar{p}$	$(1.5 \pm 0.8) \times 10^{-5}$		-
$\gamma f_0(1500)$	$> (5.7 \pm 0.8) \times 10^{-4}$		1182
$\gamma e^+e^-$	$(8.8 \pm 1.4) \times 10^{-3}$		1548
<b>Lepton Family number (LF) violating modes</b>			
$e^\pm\mu^\mp$	LF < 1.1	$\times 10^{-6}$ CL = 90%	1547
$e^\pm\tau^\mp$	LF < 8.3	$\times 10^{-6}$ CL = 90%	1039
$\mu^\pm\tau^\mp$	LF < 2.0	$\times 10^{-6}$ CL = 90%	1035

$$\chi_{c0}(1P) \quad I^G(J^{PC}) = 0^+(0^{++})$$

Mass  $m = 3414.76 \pm 0.35$  MeV (S = 1.2)  
Full width  $\Gamma = 10.4 \pm 0.7$  MeV

$\chi_{c1}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Hadronic decays</b>			
$2(\pi^+\pi^-)$	$(2.41 \pm 0.23)\%$		1679
$f_0(980)f_0(980) \rightarrow 2\pi^+2\pi^-$	$(7.1 \pm 2.3) \times 10^{-4}$		-
$\pi^+\pi^-K^+K^-$	$(2.0 \pm 0.4)\%$	S = 1.6	1580
$f_0(980)f_0(980) \rightarrow \pi^+\pi^-K^+K^-$	$(1.7^{+1.1}_{-1.0}) \times 10^{-4}$		-
$f_0(980)f_0(2200) \rightarrow \pi^+\pi^-K^+K^-$	$(8.4^{+2.2}_{-2.7}) \times 10^{-4}$		-
$f_0(1370)f_0(1370) \rightarrow \pi^+\pi^-K^+K^-$	$< 2.9 \times 10^{-4}$	CL = 90%	-
$f_0(1370)f_0(1500) \rightarrow \pi^+\pi^-K^+K^-$	$< 1.8 \times 10^{-4}$	CL = 90%	-
$f_0(1370)f_0(1710) \rightarrow \pi^+\pi^-K^+K^-$	$(7.1^{+3.8}_{-2.5}) \times 10^{-4}$		-
$f_0(1500)f_0(1370) \rightarrow \pi^+\pi^-K^+K^-$	$< 1.4 \times 10^{-4}$	CL = 90%	-
$f_0(1500)f_0(1500) \rightarrow \pi^+\pi^-K^+K^-$	$< 6 \times 10^{-5}$	CL = 90%	-
$f_0(1500)f_0(1710) \rightarrow \pi^+\pi^-K^+K^-$	$< 7 \times 10^{-5}$	CL = 90%	-
$\rho^0\pi^+\pi^-$	$(1.6 \pm 0.5)\%$		1607
$3(\pi^+\pi^-)$	$(1.19 \pm 0.18)\%$		1633
$K^+\bar{K}^*(892)^0\pi^- + c.c.$	$(1.2 \pm 0.4)\%$		1523
$K_1(1270)^+K^- + c.c. \rightarrow \pi^+\pi^-K^+K^-$	$(6.7 \pm 2.0) \times 10^{-3}$		-
$K_1(1400)^+K^- + c.c. \rightarrow \pi^+\pi^-K^+K^-$	$< 2.9 \times 10^{-3}$	CL = 90%	-
$K^*(892)^0\bar{K}^*(892)^0$	$(1.8 \pm 0.6) \times 10^{-3}$		1456
$K_0^*(1430)^0\bar{K}_0^*(1430)^0 \rightarrow \pi^+\pi^-K^+K^-$	$(1.05^{+0.39}_{-0.30}) \times 10^{-3}$		-
$K_0^*(1430)^0\bar{K}_2^*(1430)^0 + c.c. \rightarrow \pi^+\pi^-K^+K^-$	$(8.5^{+2.1}_{-2.6}) \times 10^{-4}$		-
$K^+K^-$	$(5.4 \pm 0.6) \times 10^{-3}$		1634
$\pi\pi$	$(7.2 \pm 0.6) \times 10^{-3}$		1702
$\eta\eta$	$(1.9 \pm 0.5) \times 10^{-3}$		1617
$\omega\omega$	$(2.3 \pm 0.7) \times 10^{-3}$		1517
$K^+K^-K_S^0K_S^0$	$(1.5 \pm 0.5) \times 10^{-3}$		1331
$K^+K^-K^+K^-$	$(2.1 \pm 0.4) \times 10^{-3}$		1333
$K_S^0K_S^0$	$(2.8 \pm 0.7) \times 10^{-3}$	S = 1.9	1633
$K_S^0K_S^0\pi^+\pi^-$	$(6.1 \pm 1.1) \times 10^{-3}$		1579
$K_S^0K_S^0p\bar{p}$	$< 8.8 \times 10^{-4}$	CL = 90%	884
$\pi^+\pi^-p\bar{p}$	$(2.1 \pm 0.7) \times 10^{-3}$	S = 1.4	1320
$\phi\phi$	$(9 \pm 5) \times 10^{-4}$		1370
$p\bar{p}$	$(2.24 \pm 0.27) \times 10^{-4}$		1426
$\Delta\bar{\Delta}$	$(4.4 \pm 1.5) \times 10^{-4}$		1292
$\Delta\bar{\Delta}\pi^+\pi^-$	$< 4.0 \times 10^{-3}$	CL = 90%	1153
$\Xi^-\Xi^+$	$< 1.03 \times 10^{-3}$	CL = 90%	1081
$K_S^0K^+\pi^- + c.c.$	$< 7 \times 10^{-4}$	CL = 90%	1610

## Radiative decays

$\gamma J/\psi(1S)$	$(1.30 \pm 0.11)\%$	303
$\gamma\gamma$	$(2.76 \pm 0.33) \times 10^{-4}$	1707

$$\chi_{c1}(1P) \quad I^G(J^{PC}) = 0^+(1^{++})$$

Mass  $m = 3510.66 \pm 0.07$  MeV (S = 1.5)  
Full width  $\Gamma = 0.89 \pm 0.05$  MeV

$\chi_{c1}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Hadronic decays</b>			
$3(\pi^+\pi^-)$	$(5.8 \pm 1.4) \times 10^{-3}$	S = 1.2	1683
$2(\pi^+\pi^-)$	$(7.6 \pm 2.6) \times 10^{-3}$		1728
$\pi^+\pi^-K^+K^-$	$(4.5 \pm 1.0) \times 10^{-3}$		1632
$\rho^0\pi^+\pi^-$	$(3.9 \pm 3.5) \times 10^{-3}$		1657
$K^+\bar{K}^*(892)^0\pi^- + c.c.$	$(3.2 \pm 2.1) \times 10^{-3}$		1577
$K^*(892)^0\bar{K}^*(892)^0$	$(1.6 \pm 0.4) \times 10^{-3}$		1512
$K_S^0K^+\pi^- + c.c.$	$(2.3 \pm 0.7) \times 10^{-3}$		1661
$\pi^+\pi^-K_S^0K_S^0$	$(7.7 \pm 3.3) \times 10^{-4}$		1630
$\pi^+\pi^-p\bar{p}$	$(4.9 \pm 1.9) \times 10^{-4}$		1381
$K^+K^-K^+K^-$	$(3.9 \pm 1.7) \times 10^{-4}$		1393
$p\bar{p}$	$(6.7 \pm 0.5) \times 10^{-5}$		1484
$\Delta\bar{\Delta}$	$(2.4 \pm 1.0) \times 10^{-4}$		1355
$\Delta\bar{\Delta}\pi^+\pi^-$	$< 1.5 \times 10^{-3}$	CL = 90%	1223
$K_S^0K_S^0p\bar{p}$	$< 4.5 \times 10^{-4}$	CL = 90%	968
$\Xi^-\Xi^+$	$< 3.4 \times 10^{-4}$	CL = 90%	1156
$\pi^+\pi^- + K^+K^-$	$< 2.1 \times 10^{-3}$		-
$K_S^0K_S^0$	$< 7 \times 10^{-5}$	CL = 90%	1683
<b>Radiative decays</b>			
$\gamma J/\psi(1S)$	$(35.6 \pm 1.9)\%$		389

$$\chi_{c2}(1P) \quad I^G(J^{PC}) = 0^+(2^{++})$$

Mass  $m = 3556.20 \pm 0.09$  MeV  
Full width  $\Gamma = 2.06 \pm 0.12$  MeV

$\chi_{c2}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Hadronic decays</b>			
$2(\pi^+\pi^-)$	$(1.23 \pm 0.15)\%$		1751
$\pi^+\pi^-K^+K^-$	$(9.9 \pm 2.5) \times 10^{-3}$	S = 1.6	1656
$3(\pi^+\pi^-)$	$(8.6 \pm 1.8) \times 10^{-3}$		1707
$\rho^0\pi^+\pi^-$	$(7 \pm 4) \times 10^{-3}$		1681
$K^+\bar{K}^*(892)^0\pi^- + c.c.$	$(4.8 \pm 2.8) \times 10^{-3}$		1602
$K^*(892)^0\bar{K}^*(892)^0$	$(3.8 \pm 0.8) \times 10^{-3}$		1538
$\phi\phi$	$(1.9 \pm 0.7) \times 10^{-3}$		1457
$\omega\omega$	$(2.0 \pm 0.7) \times 10^{-3}$		1597
$\pi\pi$	$(2.14 \pm 0.25) \times 10^{-3}$		1773
$\eta\eta$	$< 1.2 \times 10^{-3}$	CL = 90%	1692
$\pi^+\pi^-K_S^0K_S^0$	$(2.6 \pm 0.6) \times 10^{-3}$		1655
$K^+K^-K^+K^-$	$(1.41 \pm 0.35) \times 10^{-3}$		1421
$\pi^+\pi^-p\bar{p}$	$(1.32 \pm 0.34) \times 10^{-3}$		1410
$K^+K^-$	$(7.7 \pm 1.4) \times 10^{-4}$		1708
$K_S^0K_S^0$	$(6.7 \pm 1.1) \times 10^{-4}$		1707
$K_S^0K_S^0p\bar{p}$	$< 7.9 \times 10^{-4}$	CL = 90%	1007
$p\bar{p}$	$(6.6 \pm 0.5) \times 10^{-5}$		1510
$\Delta\bar{\Delta}$	$(2.7 \pm 1.3) \times 10^{-4}$		1385
$\Delta\bar{\Delta}\pi^+\pi^-$	$< 3.5 \times 10^{-3}$	CL = 90%	1255
$J/\psi(1S)\pi^+\pi^-p^0$	$< 1.5\%$	CL = 90%	185
$K_S^0K^+\pi^- + c.c.$	$< 1.0 \times 10^{-3}$	CL = 90%	1685
$\Xi^-\Xi^+$	$< 3.7 \times 10^{-4}$	CL = 90%	1190
<b>Radiative decays</b>			
$\gamma J/\psi(1S)$	$(20.2 \pm 1.0)\%$		430
$\gamma\gamma$	$(2.59 \pm 0.19) \times 10^{-4}$		1778

$\eta_c(2S)$ 

$$I^G(J^{PC}) = 0^+(0^{-+})$$

Quantum numbers are quark model predictions.  
 Mass  $m = 3638 \pm 4$  MeV ( $S = 1.8$ )  
 Full width  $\Gamma = 14 \pm 7$  MeV

$\eta_c(2S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}\pi$	seen	1729
$\gamma\gamma$	seen	1819

 $\psi(2S)$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 3686.093 \pm 0.034$  MeV ( $S = 1.4$ )  
 Full width  $\Gamma = 337 \pm 13$  keV  
 $\Gamma_{ee} = 2.48 \pm 0.06$  keV

$\psi(2S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
hadrons	$(97.85 \pm 0.13)\%$		-
virtual $\gamma \rightarrow$ hadrons	$(1.73 \pm 0.14)\%$	$S = 1.5$	-
$e^+e^-$	$(7.35 \pm 0.18) \times 10^{-3}$		1843
$\mu^+\mu^-$	$(7.3 \pm 0.8) \times 10^{-3}$		1840
$\tau^+\tau^-$	$(2.8 \pm 0.7) \times 10^{-3}$		489
<b>Decays into <math>J/\psi(1S)</math> and anything</b>			
$J/\psi(1S)$ anything	$(56.1 \pm 0.9)\%$		-
$J/\psi(1S)$ neutrals	$(23.0 \pm 0.4)\%$		-
$J/\psi(1S)\pi^+\pi^-$	$(31.8 \pm 0.6)\%$		477
$J/\psi(1S)\pi^0\pi^0$	$(16.46 \pm 0.35)\%$		481
$J/\psi(1S)\eta$	$(3.09 \pm 0.08)\%$		200
$J/\psi(1S)\pi^0$	$(1.26 \pm 0.13) \times 10^{-3}$	$S = 1.3$	528
<b>Hadronic decays</b>			
$3(\pi^+\pi^-)\pi^0$	$(3.5 \pm 1.6) \times 10^{-3}$		1746
$2(\pi^+\pi^-)\pi^0$	$(2.66 \pm 0.29) \times 10^{-3}$		1799
$\rho_0(1320)$	$(2.6 \pm 0.9) \times 10^{-4}$		1500
$p\bar{p}$	$(2.65 \pm 0.22) \times 10^{-4}$	$S = 1.4$	1586
$\Delta^{++}\Delta^{--}$	$(1.28 \pm 0.35) \times 10^{-4}$		1371
$\Lambda\bar{\Lambda}$	$(2.5 \pm 0.7) \times 10^{-4}$	$S = 3.1$	1467
$\Sigma^+\bar{\Sigma}^-$	$(2.6 \pm 0.8) \times 10^{-4}$		1408
$\Sigma^0\bar{\Sigma}^0$	$(2.1 \pm 0.7) \times 10^{-4}$	$S = 2.0$	1405
$\Sigma(1385)^+\bar{\Sigma}(1385)^-$	$(1.1 \pm 0.4) \times 10^{-4}$		1218
$\Xi^-\bar{\Xi}^+$	$(1.5 \pm 0.7) \times 10^{-4}$	$S = 3.0$	1285
$\Xi^0\bar{\Xi}^0$	$(2.8 \pm 0.9) \times 10^{-4}$		1292
$\Xi(1530)^0\bar{\Xi}(1530)^0$	$< 8.1 \times 10^{-5}$	$CL = 90\%$	1025
$\Omega^-\bar{\Omega}^+$	$< 7.3 \times 10^{-5}$	$CL = 90\%$	774
$\pi^0 p\bar{p}$	$(1.33 \pm 0.17) \times 10^{-4}$		1543
$\eta p\bar{p}$	$(6.0 \pm 1.2) \times 10^{-5}$		1373
$\omega p\bar{p}$	$(6.9 \pm 2.1) \times 10^{-5}$		1247
$\phi p\bar{p}$	$< 2.4 \times 10^{-5}$	$CL = 90\%$	1109
$\pi^+\pi^-\pi^0 p\bar{p}$	$(6.0 \pm 0.4) \times 10^{-4}$		1491
$2(\pi^+\pi^-\pi^0)$	$(4.5 \pm 1.4) \times 10^{-3}$		1776
$\eta\pi^+\pi^-$	$< 1.6 \times 10^{-4}$	$CL = 90\%$	1791
$\eta\pi^+\pi^-\pi^0$	$(9.5 \pm 1.7) \times 10^{-4}$		1778
$\eta'\pi^+\pi^-\pi^0$	$(4.5 \pm 2.1) \times 10^{-4}$		-
$\omega\pi^+\pi^-$	$(6.6 \pm 1.7) \times 10^{-4}$	$S = 2.7$	1748
$b_1^+\pi^-$	$(3.6 \pm 0.6) \times 10^{-4}$		1635
$b_1^0\pi^0$	$(2.4 \pm 0.6) \times 10^{-4}$		-
$\omega f_2(1270)$	$(2.0 \pm 0.6) \times 10^{-4}$		1515
$\pi^+\pi^-K^+K^-$	$(7.2 \pm 0.5) \times 10^{-4}$		1726
$\rho^0 K^+K^-$	$(2.2 \pm 0.4) \times 10^{-4}$		1616
$K^*(892)^0\bar{K}_2^*(1430)^0$	$(1.9 \pm 0.5) \times 10^{-4}$		1418
$K^+K^-2(\pi^+\pi^-)$	$(1.8 \pm 0.9) \times 10^{-3}$		1654
$K_1(1270)^\pm K^\mp$	$(1.00 \pm 0.28) \times 10^{-3}$		1581
$K_S^0 K_S^0 \pi^+\pi^-$	$(2.2 \pm 0.4) \times 10^{-4}$		1724
$\rho^0 p\bar{p}$	$(5.0 \pm 2.2) \times 10^{-5}$		1251
$K^+\bar{K}^*(892)^0\pi^- + c.c.$	$(6.7 \pm 2.5) \times 10^{-4}$		1674
$2(\pi^+\pi^-)$	$(2.4 \pm 0.6) \times 10^{-4}$	$S = 2.2$	1817
$\rho^0\pi^+\pi^-$	$(2.2 \pm 0.6) \times 10^{-4}$	$S = 1.4$	1750
$K^+K^-\pi^+\pi^-\pi^0$	$(1.24 \pm 0.10) \times 10^{-3}$		1694
$\omega f_0(1710) \rightarrow \omega K^+K^-$	$(5.9 \pm 2.2) \times 10^{-5}$		-
$K^*(892)^0 K^-\pi^+\pi^0 + c.c.$	$(8.6 \pm 2.2) \times 10^{-4}$		-
$K^*(892)^+ K^-\pi^+\pi^- + c.c.$	$(9.6 \pm 2.8) \times 10^{-4}$		-
$K^*(892)^+ K^-\rho^0 + c.c.$	$(7.3 \pm 2.6) \times 10^{-4}$		-
$K^*(892)^0 K^-\rho^+ + c.c.$	$(6.1 \pm 1.8) \times 10^{-4}$		-
$\eta K^+K^-$	$< 1.3 \times 10^{-4}$	$CL = 90\%$	1664

$\omega K^+K^-$	$(1.85 \pm 0.25) \times 10^{-4}$	$S = 1.1$	1614
$3(\pi^+\pi^-)$	$(3.5 \pm 2.0) \times 10^{-4}$	$S = 2.8$	1774
$p\bar{p}\pi^+\pi^-\pi^0$	$(7.3 \pm 0.7) \times 10^{-4}$		1435
$K^+K^-$	$(1.0 \pm 0.7) \times 10^{-4}$		1776
$K_S^0 K_L^0$	$(5.2 \pm 0.7) \times 10^{-5}$		1775
$\pi^+\pi^-\pi^0$	$(1.68 \pm 0.26) \times 10^{-4}$	$S = 1.4$	1830
$\rho(2150)\pi \rightarrow \pi^+\pi^-\pi^0$	$(1.9_{-0.4}^{+1.2}) \times 10^{-4}$		-
$\rho(770)\pi \rightarrow \pi^+\pi^-\pi^0$	$(3.2 \pm 1.2) \times 10^{-5}$	$S = 1.8$	-
$\pi^+\pi^-$	$(8 \pm 5) \times 10^{-5}$		1838
$K_1(1400)^\pm K^\mp$	$< 3.1 \times 10^{-4}$	$CL = 90\%$	1532
$K^+K^-\pi^0$	$< 2.96 \times 10^{-5}$	$CL = 90\%$	1754
$K^+\bar{K}^*(892)^- + c.c.$	$(1.7_{-0.7}^{+0.8}) \times 10^{-5}$		1698
$K^*(892)^0\bar{K}^0 + c.c.$	$(1.09 \pm 0.20) \times 10^{-4}$		1697
$\phi\pi^+\pi^-$	$(1.13 \pm 0.29) \times 10^{-4}$	$S = 1.7$	1690
$\phi f_0(980) \rightarrow \pi^+\pi^-$	$(6.0 \pm 2.2) \times 10^{-5}$		-
$2(K^+K^-)$	$(6.0 \pm 1.4) \times 10^{-5}$		1499
$\phi K^+K^-$	$(7.0 \pm 1.6) \times 10^{-5}$		1546
$2(K^+K^-)\pi^0$	$(1.10 \pm 0.28) \times 10^{-4}$		1440
$\phi\eta$	$(2.8_{-0.8}^{+1.0}) \times 10^{-5}$		1654
$\phi\eta'$	$(3.1 \pm 1.6) \times 10^{-5}$		1555
$\omega\eta'$	$(3.2_{-2.1}^{+2.5}) \times 10^{-5}$		1623
$\omega\pi^0$	$(2.1 \pm 0.6) \times 10^{-5}$		1757
$\rho\eta'$	$(1.9_{-1.2}^{+1.7}) \times 10^{-5}$		1625
$\rho\eta$	$(2.2 \pm 0.6) \times 10^{-5}$	$S = 1.1$	1717
$\omega\eta$	$< 1.1 \times 10^{-5}$	$CL = 90\%$	1715
$\phi\pi^0$	$< 4 \times 10^{-6}$	$CL = 90\%$	1699
$p\bar{p}K^+K^-$	$(2.7 \pm 0.7) \times 10^{-5}$		1118
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$(2.8 \pm 0.6) \times 10^{-4}$		1346
$\Lambda\bar{p}K^+$	$(1.00 \pm 0.14) \times 10^{-4}$		1327
$\Lambda\bar{p}K^+\pi^+\pi^-$	$(1.8 \pm 0.4) \times 10^{-4}$		1167
$\phi f_2'(1525)$	$(4.4 \pm 1.6) \times 10^{-5}$		1321
$\Theta(1540)\bar{\Theta}(1540) \rightarrow$	$< 8.8 \times 10^{-6}$	$CL = 90\%$	-
$K_S^0 pK^-\bar{n} + c.c.$			
$\Theta(1540)K^-\bar{n} \rightarrow K_S^0 pK^-\bar{n}$	$< 1.0 \times 10^{-5}$	$CL = 90\%$	-
$\bar{\Theta}(1540)K_S^0\bar{p} \rightarrow K_S^0\bar{p}K^+n$	$< 7.0 \times 10^{-6}$	$CL = 90\%$	-
$\bar{\Theta}(1540)K^+n \rightarrow K_S^0\bar{p}K^+n$	$< 2.6 \times 10^{-5}$	$CL = 90\%$	-
$\bar{\Theta}(1540)K_S^0\bar{p} \rightarrow K_S^0\bar{p}K^-\bar{n}$	$< 6.0 \times 10^{-6}$	$CL = 90\%$	-
$K_S^0 K_S^0$	$< 4.6 \times 10^{-6}$		1775

**Radiative decays**

$\gamma\chi_{c0}(1P)$	$(9.2 \pm 0.4)\%$		261
$\gamma\chi_{c1}(1P)$	$(8.7 \pm 0.4)\%$		171
$\gamma\chi_{c2}(1P)$	$(8.1 \pm 0.4)\%$		128
$\gamma\eta_c(1S)$	$(2.6 \pm 0.4) \times 10^{-3}$		638
$\gamma\eta_c(2S)$	$< 2.0 \times 10^{-3}$	$CL = 90\%$	47
$\gamma\eta'(958)$	$(1.5 \pm 0.4) \times 10^{-4}$		1719
$\gamma f_2(1270)$	$(2.1 \pm 0.4) \times 10^{-4}$		1622
$\gamma f_0(1710) \rightarrow \gamma\pi\pi$	$(3.0 \pm 1.3) \times 10^{-5}$		-
$\gamma f_0(1710) \rightarrow \gamma K\bar{K}$	$(6.0 \pm 1.6) \times 10^{-5}$		-
$\gamma\gamma$	$< 1.3 \times 10^{-4}$	$CL = 90\%$	1843
$\gamma\eta$	$< 9 \times 10^{-5}$	$CL = 90\%$	1802
$\gamma\eta(1405) \rightarrow \gamma K\bar{K}\pi$	$< 1.2 \times 10^{-4}$	$CL = 90\%$	1569

 $\psi(3770)$ 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 3771.1 \pm 2.4$  MeV  
 Full width  $\Gamma = 23.0 \pm 2.7$  MeV ( $S = 1.1$ )  
 $\Gamma_{ee} = 0.242_{-0.024}^{+0.027}$  keV ( $S = 1.1$ )

In addition to the dominant decay mode to  $D\bar{D}$ ,  $\psi(3770)$  was found to decay into the final states containing the  $J/\psi$  (BAI 05, ADAM 06). ADAMS 06 and HUANG 06A searched for various decay modes with light hadrons and found a statistically significant signal for the decay to  $\phi\eta$  only (ADAMS 06).

$\psi(3770)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$D\bar{D}$	dominant		281
$D^0\bar{D}^0$	seen		281
$D^+D^-$	seen		247
$J/\psi\pi^+\pi^-$	$(1.93 \pm 0.28) \times 10^{-3}$		558
$J/\psi\pi^0\pi^0$	$(8.0 \pm 3.0) \times 10^{-4}$		562
$J/\psi\eta$	$(9 \pm 4) \times 10^{-4}$		357
$J/\psi\pi^0$	$< 2.8 \times 10^{-4}$	CL = 90%	601
$e^+e^-$	$(1.05 \pm 0.14) \times 10^{-5}$	S = 1.1	1886
$K_S^0 K_L^0$	$< 2.1 \times 10^{-4}$	CL = 90%	1819
$2(\pi^+\pi^-)$	$< 1.12 \times 10^{-3}$	CL = 90%	1860
$2(\pi^+\pi^-)\pi^0$	$< 1.06 \times 10^{-3}$	CL = 90%	1842
$\eta\pi^+\pi^-$	$< 1.24 \times 10^{-3}$	CL = 90%	1835
$\omega\pi^+\pi^-$	$< 6.0 \times 10^{-4}$	CL = 90%	1793
$\eta 3\pi$	$< 1.34 \times 10^{-3}$	CL = 90%	1823
$\eta' 3\pi$	$< 2.44 \times 10^{-3}$	CL = 90%	1739
$K^+K^-\pi^+\pi^-$	$< 9.0 \times 10^{-4}$	CL = 90%	1771
$\phi\pi^+\pi^-$	$< 4.1 \times 10^{-4}$	CL = 90%	1736
$\phi f_0(980)$	$< 4.5 \times 10^{-4}$	CL = 90%	1599
$K^+K^-\pi^+\pi^-\pi^0$	$< 2.36 \times 10^{-3}$	CL = 90%	1740
$\eta K^+K^-$	$< 4.1 \times 10^{-4}$	CL = 90%	1711
$\omega K^+K^-$	$< 3.4 \times 10^{-4}$	CL = 90%	1663
$2(K^+K^-)$	$< 6.0 \times 10^{-4}$	CL = 90%	1550
$\phi K^+K^-$	$< 7.5 \times 10^{-4}$	CL = 90%	1596
$2(K^+K^-)\pi^0$	$< 2.9 \times 10^{-4}$	CL = 90%	1492
$p\bar{p}\pi^+\pi^-$	$< 5.8 \times 10^{-4}$	CL = 90%	1543
$p\bar{p}\pi^+\pi^-\pi^0$	$< 1.85 \times 10^{-3}$	CL = 90%	1489
$\eta p\bar{p}$	$< 5.4 \times 10^{-4}$	CL = 90%	1429
$\omega p\bar{p}$	$< 2.9 \times 10^{-4}$	CL = 90%	1308
$p\bar{p}K^+K^-$	$< 3.2 \times 10^{-4}$	CL = 90%	1184
$\phi p\bar{p}$	$< 1.3 \times 10^{-4}$	CL = 90%	1176
$\Lambda\bar{\Lambda}$	$< 1.2 \times 10^{-4}$	CL = 90%	1520
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$< 2.5 \times 10^{-4}$	CL = 90%	1403
$\Lambda\bar{p}K^+$	$< 2.8 \times 10^{-4}$	CL = 90%	1385
$\Lambda\bar{p}K^+\pi^+\pi^-$	$< 6.3 \times 10^{-4}$	CL = 90%	1232
$\phi\eta$	$(3.1 \pm 0.7) \times 10^{-4}$		1702
$\pi^+\pi^-\pi^0$	not seen		1873
$\rho\pi$	not seen		1803
$\omega\pi^0$	not seen		1802
$\phi\pi^0$	not seen		1745
$\rho\eta$	not seen		1762
$\omega\eta$	not seen		1761
$\rho\eta'$	not seen		1673
$\omega\eta'$	not seen		1671
$\phi\eta'$	not seen		1605
$K^{*0}\bar{K}^0$	not seen		1743
$K^{*+}K^-$	not seen		1744
$b_1\pi$	not seen		1682

**X(3872)**

$$I^G(J^{PC}) = 0^2(\chi^2+)$$

Quantum numbers not established.

Mass  $m = 3871.2 \pm 0.5$  MeV (S = 1.4) $m_{X(3872)^\pm} - m_{J/\psi} = 775 \pm 4$  MeV $m_{X(3872)^\pm} - m_{\psi(2S)}$ Full width  $\Gamma < 2.3$  MeV, CL = 90%

X(3872) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi^+\pi^- J/\psi(1S)$	seen	649
$D^0\bar{D}^0$	not seen	520
$D^+D^-$	not seen	502
$D^0\bar{D}^0\pi^0$	not seen	117

 **$\chi_{c2}(2P)$** 

$$I^G(J^{PC}) = 0^+(2^{2++})$$

Mass  $m = 3929 \pm 5$  MeVFull width  $\Gamma = 29 \pm 10$  MeV **$\psi(4040)^{[xxxx]}$** 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 4039 \pm 1$  MeVFull width  $\Gamma = 80 \pm 10$  MeV $\Gamma_{ee} = 0.86 \pm 0.07$  keV

$\psi(4040)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$e^+e^-$	$(1.07 \pm 0.16) \times 10^{-5}$		2019
$D^0\bar{D}^0$	seen		776
$D^*(2007)^0\bar{D}^0 + c.c.$	seen		576
$D^*(2007)^0\bar{D}^*(2007)^0$	seen		227
$J/\psi\pi^+\pi^-$	$< 4 \times 10^{-3}$	90%	794
$J/\psi\pi^0\pi^0$	$< 2 \times 10^{-3}$	90%	797
$J/\psi\eta$	$< 7 \times 10^{-3}$	90%	675
$J/\psi\pi^0$	$< 2 \times 10^{-3}$	90%	823
$J/\psi\pi^+\pi^-\pi^0$	$< 2 \times 10^{-3}$	90%	746
$\chi_{c1}\gamma$	$< 1.1$ %	90%	494
$\chi_{c2}\gamma$	$< 1.7$ %	90%	454
$\chi_{c1}\pi^+\pi^-\pi^0$	$< 1.1$ %	90%	306
$\chi_{c2}\pi^+\pi^-\pi^0$	$< 3.2$ %	90%	233
$\phi\pi^+\pi^-$	$< 3 \times 10^{-3}$	90%	1880

 **$\psi(4160)^{[xxxx]}$** 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 4153 \pm 3$  MeVFull width  $\Gamma = 103 \pm 8$  MeV $\Gamma_{ee} = 0.83 \pm 0.07$  keV

$\psi(4160)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$e^+e^-$	$(8.1 \pm 0.9) \times 10^{-6}$		2076
$J/\psi\pi^+\pi^-$	$< 3 \times 10^{-3}$	90%	888
$J/\psi\pi^0\pi^0$	$< 3 \times 10^{-3}$	90%	891
$J/\psi K^+K^-$	$< 2 \times 10^{-3}$	90%	324
$J/\psi\eta$	$< 8 \times 10^{-3}$	90%	786
$J/\psi\pi^0$	$< 1 \times 10^{-3}$	90%	914
$J/\psi\eta'$	$< 5 \times 10^{-3}$	90%	385
$J/\psi\pi^+\pi^-\pi^0$	$< 1 \times 10^{-3}$	90%	847
$\psi(2S)\pi^+\pi^-$	$< 4 \times 10^{-3}$	90%	353
$\chi_{c1}\gamma$	$< 7 \times 10^{-3}$	90%	593
$\chi_{c2}\gamma$	$< 1.3$ %	90%	554
$\chi_{c1}\pi^+\pi^-\pi^0$	$< 2 \times 10^{-3}$	90%	452
$\chi_{c2}\pi^+\pi^-\pi^0$	$< 8 \times 10^{-3}$	90%	398
$\phi\pi^+\pi^-$	$< 2 \times 10^{-3}$	90%	1941

 **$\psi(4415)^{[xxxx]}$** 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 4421 \pm 4$  MeVFull width  $\Gamma = 62 \pm 20$  MeV $\Gamma_{ee} = 0.58 \pm 0.07$  keV

$\psi(4415)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
hadrons	dominant	-
$e^+e^-$	$(9.4 \pm 3.2) \times 10^{-6}$	2210

**$b\bar{b}$  MESONS** **$\Upsilon(1S)$** 

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass  $m = 9460.30 \pm 0.26$  MeV ( $S = 3.3$ )  
 Full width  $\Gamma = 54.02 \pm 1.25$  keV  
 $\Gamma_{ee} = 1.340 \pm 0.018$  keV

$\Upsilon(1S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\tau^+\tau^-$	$(2.67^{+0.14}_{-0.16})\%$		4384
$e^+e^-$	$(2.38 \pm 0.11)\%$		4730
$\mu^+\mu^-$	$(2.48 \pm 0.05)\%$		4729
<b>Hadronic decays</b>			
$\eta'(958)$ anything	$(2.8 \pm 0.4)\%$		-
$J/\psi(1S)$ anything	$(6.5 \pm 0.7) \times 10^{-4}$		4223
$\chi_{c0}$ anything	$< 5 \times 10^{-3}$	90%	-
$\chi_{c1}$ anything	$(2.3 \pm 0.7) \times 10^{-4}$		-
$\chi_{c2}$ anything	$(3.4 \pm 1.0) \times 10^{-4}$		-
$\psi(2S)$ anything	$(2.7 \pm 0.9) \times 10^{-4}$		-
$\rho\pi$	$< 2 \times 10^{-4}$	90%	4697
$\pi^+\pi^-$	$< 5 \times 10^{-4}$	90%	4728
$K^+K^-$	$< 5 \times 10^{-4}$	90%	4704
$p\bar{p}$	$< 5 \times 10^{-4}$	90%	4636
$\pi^0\pi^+\pi^-$	$< 1.84 \times 10^{-5}$	90%	4725
<b>Radiative decays</b>			
$\gamma\pi^+\pi^-$	$(6.3 \pm 1.8) \times 10^{-5}$		4728
$\gamma\pi^0\pi^0$	$(1.7 \pm 0.7) \times 10^{-5}$		4728
$K^+K^-$ with $2 < m_{K^+K^-} < 3$ GeV	$(1.14 \pm 0.13) \times 10^{-5}$		-
$\gamma p\bar{p}$ with $2 < m_{p\bar{p}} < 3$ GeV	$< 6 \times 10^{-6}$	90%	-
$\gamma 2h^+2h^-$	$(7.0 \pm 1.5) \times 10^{-4}$		4720
$\gamma 3h^+3h^-$	$(5.4 \pm 2.0) \times 10^{-4}$		4703
$\gamma 4h^+4h^-$	$(7.4 \pm 3.5) \times 10^{-4}$		4679
$\gamma\pi^+\pi^-K^+K^-$	$(2.9 \pm 0.9) \times 10^{-4}$		4686
$\gamma 2\pi^+2\pi^-$	$(2.5 \pm 0.9) \times 10^{-4}$		4720
$\gamma 3\pi^+3\pi^-$	$(2.5 \pm 1.2) \times 10^{-4}$		4703
$\gamma 2\pi^+2\pi^-K^+K^-$	$(2.4 \pm 1.2) \times 10^{-4}$		4658
$\gamma\pi^+\pi^-p\bar{p}$	$(1.5 \pm 0.6) \times 10^{-4}$		4604
$\gamma 2\pi^+2\pi^-p\bar{p}$	$(4 \pm 6) \times 10^{-5}$		4563
$\gamma 2K^+2K^-$	$(2.0 \pm 2.0) \times 10^{-5}$		4601
$\gamma\eta'(958)$	$< 1.6 \times 10^{-5}$	90%	4682
$\gamma\eta$	$< 2.1 \times 10^{-5}$	90%	4714
$\gamma f_0(980)$	$< 3 \times 10^{-5}$	90%	4679
$\gamma f'_2(1525)$	$(3.7^{+1.2}_{-1.1}) \times 10^{-5}$		4607
$\gamma f_2(1270)$	$(1.00 \pm 0.10) \times 10^{-4}$		4644
$\gamma\eta(1405)$	$< 8.2 \times 10^{-5}$	90%	4625
$\gamma f_0(1710)$	$< 1.8 \times 10^{-4}$	90%	4574
$\gamma f_4(2050)$	$< 5.3 \times 10^{-5}$	90%	4513
$\gamma f_0(2200) \rightarrow \gamma K^+K^-$	$< 2 \times 10^{-4}$	90%	4475
$\gamma f_J(2220) \rightarrow \gamma K^+K^-$	$< 8 \times 10^{-7}$	90%	4469
$\gamma f_J(2220) \rightarrow \gamma\pi^+\pi^-$	$< 6 \times 10^{-7}$	90%	-
$\gamma f_J(2220) \rightarrow \gamma p\bar{p}$	$< 1.1 \times 10^{-6}$	90%	-
$\gamma\eta(2225) \rightarrow \gamma\phi\phi$	$< 3 \times 10^{-3}$	90%	4469
$\gamma X$	$< 3 \times 10^{-5}$	90%	-
( $X$ = pseudoscalar with $m < 7.2$ GeV)			
$\gamma X\bar{X}$	$< 1 \times 10^{-3}$	90%	-
( $X\bar{X}$ = vectors with $m < 3.1$ GeV)			

 **$\chi_{b0}(1P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(0^{++})$$

$J$  needs confirmation.

Mass  $m = 9859.44 \pm 0.42 \pm 0.31$  MeV

$\chi_{b1}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\gamma\Upsilon(1S)$	$< 6\%$	90%	391

 **$\chi_{b1}(1P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(1^{++})$$

$J$  needs confirmation.

Mass  $m = 9892.78 \pm 0.26 \pm 0.31$  MeV

$\chi_{b1}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\gamma\Upsilon(1S)$	$(35 \pm 8)\%$	423

 **$\chi_{b2}(1P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

$J$  needs confirmation.

Mass  $m = 9912.21 \pm 0.26 \pm 0.31$  MeV

$\chi_{b2}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\gamma\Upsilon(1S)$	$(22 \pm 4)\%$	442

 **$\Upsilon_{2S}$** 

$$I^G(J^{PC}) = 0^+(1^{--})$$

Mass  $m = 10.02326 \pm 0.00031$  GeVFull width  $\Gamma = 31.98 \pm 2.63$  keV $\Gamma_{ee} = 0.612 \pm 0.011$  keV

$\Upsilon(2S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\Upsilon(1S)\pi^+\pi^-$	$(18.8 \pm 0.6)\%$		475
$\Upsilon(1S)\pi^0\pi^0$	$(9.0 \pm 0.8)\%$		480
$\tau^+\tau^-$	$(1.7 \pm 1.6)\%$		4686
$\mu^+\mu^-$	$(1.93 \pm 0.17)\%$	$S = 2.2$	5011
$e^+e^-$	$(1.91 \pm 0.16)\%$		5012
$\Upsilon(1S)\pi^0$	$< 1.1 \times 10^{-3}$	CL = 90%	531
$\Upsilon(1S)\eta$	$< 2 \times 10^{-3}$	CL = 90%	127
$J/\psi(1S)$ anything	$< 6 \times 10^{-3}$	CL = 90%	4533
<b>Radiative decays</b>			
$\gamma\chi_{b1}(1P)$	$(6.9 \pm 0.4)\%$		130
$\gamma\chi_{b2}(1P)$	$(7.15 \pm 0.35)\%$		110
$\gamma\chi_{b0}(1P)$	$(3.8 \pm 0.4)\%$		162
$\gamma f_0(1710)$	$< 5.9 \times 10^{-4}$	CL = 90%	4864
$\gamma f'_2(1525)$	$< 5.3 \times 10^{-4}$	CL = 90%	4896
$\gamma f_2(1270)$	$< 2.41 \times 10^{-4}$	CL = 90%	4930
$\gamma\eta_b(1S)$	$< 5.1 \times 10^{-4}$	CL = 90%	697

 **$\chi_{b0}(2P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(0^{++})$$

$J$  needs confirmation.

Mass  $m = 10.2325 \pm 0.0004 \pm 0.0005$  GeV

$\chi_{b0}(2P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\gamma\Upsilon(2S)$	$(4.6 \pm 2.1)\%$	207
$\gamma\Upsilon(1S)$	$(9 \pm 6) \times 10^{-3}$	743

 **$\chi_{b1}(2P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(1^{++})$$

$J$  needs confirmation.

Mass  $m = 10.25546 \pm 0.00022 \pm 0.00050$  GeV $m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)} = 23.5 \pm 1.0$  MeV

$\chi_{b1}(2P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$\omega\Upsilon(1S)$	$(1.63^{+0.38}_{-0.34})\%$		135
$\gamma\Upsilon(2S)$	$(21 \pm 4)\%$	1.5	230
$\gamma\Upsilon(1S)$	$(8.5 \pm 1.3)\%$	1.3	764
$\pi\pi\chi_{b1}(1P)$	$(8.6 \pm 3.1) \times 10^{-3}$		238

 **$\chi_{b2}(2P)^{[\gamma\gamma]}$** 

$$I^G(J^{PC}) = 0^+(2^{++})$$

$J$  needs confirmation.

Mass  $m = 10.26865 \pm 0.00022 \pm 0.00050$  GeV $m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)} = 13.5 \pm 0.6$  MeV



$\chi_{b2}(2P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\omega\Upsilon(1S)$	$(1.10^{+0.34}_{-0.30})$ %	194
$\gamma\Upsilon(2S)$	$(16.2 \pm 2.4)$ %	242
$\gamma\Upsilon(1S)$	$(7.1 \pm 1.0)$ %	777
$\pi\pi\chi_{b2}(1P)$	$(6.0 \pm 2.1) \times 10^{-3}$	229

$$\Upsilon(3S) \quad I^G(J^{PC}) = 0^-(1^{- -})$$

$$\text{Mass } m = 10.3552 \pm 0.0005 \text{ GeV}$$

$$\text{Full width } \Gamma = 20.32 \pm 1.85 \text{ keV}$$

$$\Gamma_{ee} = 0.443 \pm 0.008 \text{ keV}$$

$\Upsilon(3S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\Upsilon(2S)$ anything	$(10.6 \pm 0.8)$ %		296
$\Upsilon(2S)\pi^+\pi^-$	$(2.8 \pm 0.6)$ %	$S = 2.2$	177
$\Upsilon(2S)\pi^0\pi^0$	$(2.00 \pm 0.32)$ %		190
$\Upsilon(2S)\gamma\gamma$	$(5.0 \pm 0.7)$ %		327
$\Upsilon(1S)\pi^+\pi^-$	$(4.48 \pm 0.21)$ %		813
$\Upsilon(1S)\pi^0\pi^0$	$(2.06 \pm 0.28)$ %		816
$\Upsilon(1S)\pi$	$< 2.2$	$\text{CL} = 90\%$	677
$\mu^+\mu^-$	$(2.18 \pm 0.21)$ %	$S = 2.1$	5177
$e^+e^-$	seen		5178
Radiative decays			
$\gamma\chi_{b2}(2P)$	$(13.1 \pm 1.6)$ %	$S = 3.4$	86
$\gamma\chi_{b1}(2P)$	$(12.6 \pm 1.2)$ %	$S = 2.4$	99
$\gamma\chi_{b0}(2P)$	$(5.9 \pm 0.6)$ %	$S = 1.4$	122
$\gamma\chi_{b0}(1P)$	$(3.0 \pm 1.1) \times 10^{-3}$		484
$\gamma\eta_b(2S)$	$< 6.2$	$\text{CL} = 90\%$	-
$\gamma\eta_b(1S)$	$< 4.3$	$\text{CL} = 90\%$	1001

$$\Upsilon(4S) \text{ or } \Upsilon(10580) \quad I^G(J^{PC}) = 0^-(1^{- -})$$

$$\text{Mass } m = 10.5794 \pm 0.0012 \text{ GeV}$$

$$\text{Full width } \Gamma = 20.5 \pm 2.5 \text{ MeV}$$

$$\Gamma_{ee} = 0.272 \pm 0.029 \text{ keV } (S = 1.5)$$

$\Upsilon(4S)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$B\bar{B}$	$> 96$ %	95%	330
$B^+B^-$	$(50.6 \pm 0.8)$ %		335
$D_s^+$ anything + c.c.	$(18.2 \pm 3.2)$ %		-
$B^0\bar{B}^0$	$(49.4 \pm 0.8)$ %		330
non- $B\bar{B}$	$< 4$ %	95%	-
$e^+e^-$	$(1.57 \pm 0.08) \times 10^{-5}$		5290
$J/\psi(1S)$ anything	$< 1.9$	$\times 10^{-4}$ 95%	-
$D^{*+}$ anything + c.c.	$< 7.4$ %	90%	5099
$\phi$ anything	$< 2.3$	$\times 10^{-3}$ 90%	5240
$\Upsilon(1S)$ anything	$< 4$	$\times 10^{-3}$ 90%	1053
$\Upsilon(1S)\pi^+\pi^-$	$< 1.2$	$\times 10^{-4}$ 90%	1026
$\Upsilon(2S)\pi^+\pi^-$	$< 3.9$	$\times 10^{-4}$ 90%	468

$$\Upsilon(10860) \quad I^G(J^{PC}) = 0^-(1^{- -})$$

$$\text{Mass } m = 10.865 \pm 0.008 \text{ GeV } (S = 1.1)$$

$$\text{Full width } \Gamma = 110 \pm 13 \text{ MeV}$$

$$\Gamma_{ee} = 0.31 \pm 0.07 \text{ keV } (S = 1.3)$$

$\Upsilon(10860)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$e^+e^-$	$(2.8 \pm 0.7) \times 10^{-6}$	5432
$D_s$ anything + c.c.	$(45 \pm 11)$ %	-

$$\Upsilon(11020) \quad I^G(J^{PC}) = 0^-(1^{- -})$$

$$\text{Mass } m = 11.019 \pm 0.008 \text{ GeV}$$

$$\text{Full width } \Gamma = 79 \pm 16 \text{ MeV}$$

$$\Gamma_{ee} = 0.130 \pm 0.030 \text{ keV}$$

$\Upsilon(11020)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$e^+e^-$	$(1.6 \pm 0.5) \times 10^{-6}$	5510

## NOTES

In this Summary Table:

When a quantity has “( $S = \dots$ )” to its right, the error on the quantity has been enlarged by the “scale factor”  $S$ , defined as  $S = \sqrt{\chi^2/(N-1)}$ , where  $N$  is the number of measurements used in calculating the quantity. We do this when  $S > 1$ , which often indicates that the measurements are inconsistent. When  $S > 1.25$ , we also show in the Particle Listings an ideogram of the measurements. For more about  $S$ , see the Introduction.

A decay momentum  $p$  is given for each decay mode. For a 2-body decay,  $p$  is the momentum of each decay product in the rest frame of the decaying particle. For a 3-or-more-body decay,  $p$  is the largest momentum any of the products can have in this frame.

- [a] See the “Note on  $\pi^\pm \rightarrow \ell^\pm \nu \gamma$  and  $K^\pm \rightarrow \ell^\pm \nu \gamma$  Form Factors” in the  $\pi^\pm$  Particle Listings for definitions and details.
- [b] Measurements of  $\Gamma(e^+ \nu_e)/\Gamma(\mu^+ \nu_\mu)$  always include decays with  $\gamma$ 's, and measurements of  $\Gamma(e^+ \nu_e \gamma)$  and  $\Gamma(\mu^+ \nu_\mu \gamma)$  never include low-energy  $\gamma$ 's. Therefore, since no clean separation is possible, we consider the modes with  $\gamma$ 's to be subreactions of the modes without them, and let  $[\Gamma(e^+ \nu_e) + \Gamma(\mu^+ \nu_\mu)]/\Gamma_{\text{total}} = 100\%$ .
- [c] See the  $\pi^\pm$  Particle Listings for the energy limits used in this measurement; low-energy  $\gamma$ 's are not included.
- [d] Derived from an analysis of neutrino-oscillation experiments.
- [e] Astrophysical and cosmological arguments give limits of order  $10^{-13}$ ; see the  $\pi^0$  Particle Listings.
- [f] Due to a new measurement in the average, this is 0.45 MeV larger than the mass we gave in our 2002 edition,  $547.30 \pm 0.12$  MeV.
- [g] Due to removing an old measurement from the average, this is 0.11 keV larger than the width we gave in our 2002 edition,  $1.18 \pm 0.11$  keV. See the  $\Gamma(2\gamma)$  data block in the Data Listings.
- [h] C parity forbids this to occur as a single-photon process.
- [i] See the “Note on scalar mesons” in the  $f_0(1370)$  Particle Listings. The interpretation of this entry as a particle is controversial.
- [j] See the “Note on  $\rho(770)$ ” in the  $\rho(770)$  Particle Listings.
- [k] The  $\omega\rho$  interference is then due to  $\omega\rho$  mixing only, and is expected to be small. If  $e\mu$  universality holds,  $\Gamma(\rho^0 \rightarrow \mu^+ \mu^-) = \Gamma(\rho^0 \rightarrow e^+ e^-) \times 0.99785$ .
- [l] See the “Note on scalar mesons” in the  $f_0(1370)$  Particle Listings.
- [m] See the “Note on  $a_1(1260)$ ” in the  $a_1(1260)$  Particle Listings.
- [n] This is only an educated guess; the error given is larger than the error on the average of the published values. See the Particle Listings for details.
- [o] See the “Note on non- $q\bar{q}$  mesons” in the Particle Listings (see the index for the page number).
- [p] See the “Note on the  $\eta(1405)$ ” in the  $\eta(1405)$  Particle Listings.
- [q] See the “Note on the  $f_1(1420)$ ” in the  $\eta(1405)$  Particle Listings.
- [r] See also the  $\omega(1650)$  Particle Listings.
- [s] See the “Note on the  $\rho(1450)$  and the  $\rho(1700)$ ” in the  $\rho(1700)$  Particle Listings.
- [t] See also the  $\omega(1420)$  Particle Listings.
- [u] See the “Note on  $f_0(1710)$ ” in the  $f_0(1710)$  Particle Listings.
- [v] See the note in the  $K^\pm$  Particle Listings.
- [w] The definition of the slope parameter  $g$  of the  $K \rightarrow 3\pi$  Dalitz plot is as follows (see also “Note on Dalitz Plot Parameters for  $K \rightarrow 3\pi$  Decays” in the  $K^\pm$  Particle Listings):

$$|M|^2 = 1 + g(s_3 - s_0)/m_{\pi^+}^2 + \dots$$

- [x] For more details and definitions of parameters see the Particle Listings.
- [y] Most of this radiative mode, the low-momentum  $\gamma$  part, is also included in the parent mode listed without  $\gamma$ 's.
- [z] See the  $K^\pm$  Particle Listings for the energy limits used in this measurement.
- [aa] Structure-dependent part.
- [bb] Direct-emission branching fraction.
- [cc] Violates angular-momentum conservation.
- [dd] Derived from measured values of  $\phi_{+-}$ ,  $\phi_{00}$ ,  $|\eta|$ ,  $|m_{K_L^0} - m_{K_S^0}|$ , and  $\tau_{K_S^0}$ , as described in the introduction to “Tests of Conservation Laws.”

[ee] The  $CP$ -violation parameters are defined as follows (see also “Note on  $CP$  Violation in  $K_S \rightarrow 3\pi$ ” and “Note on  $CP$  Violation in  $K_L^0$  Decay” in the Particle Listings):

$$\begin{aligned}\eta_{+-} &= |\eta_{+-}|e^{i\phi_{+-}} = \frac{A(K_L^0 \rightarrow \pi^+\pi^-)}{A(K_S^0 \rightarrow \pi^+\pi^-)} = \epsilon + \epsilon' \\ \eta_{00} &= |\eta_{00}|e^{i\phi_{00}} = \frac{A(K_L^0 \rightarrow \pi^0\pi^0)}{A(K_S^0 \rightarrow \pi^0\pi^0)} = \epsilon - 2\epsilon' \\ \delta &= \frac{\Gamma(K_L^0 \rightarrow \pi^-\ell^+\nu) - \Gamma(K_L^0 \rightarrow \pi^+\ell^-\nu)}{\Gamma(K_L^0 \rightarrow \pi^-\ell^+\nu) + \Gamma(K_L^0 \rightarrow \pi^+\ell^-\nu)}, \\ \text{Im}(\eta_{+-0})^2 &= \frac{\Gamma(K_S^0 \rightarrow \pi^+\pi^-\pi^0)^{CP \text{ viol.}}}{\Gamma(K_L^0 \rightarrow \pi^+\pi^-\pi^0)}, \\ \text{Im}(\eta_{000})^2 &= \frac{\Gamma(K_S^0 \rightarrow \pi^0\pi^0\pi^0)}{\Gamma(K_L^0 \rightarrow \pi^0\pi^0\pi^0)}\end{aligned}$$

where for the last two relations  $CPT$  is assumed valid, i.e.,  $\text{Re}(\eta_{+-0}) \simeq 0$  and  $\text{Re}(\eta_{000}) \simeq 0$ .

- [ff] See the  $K_S^0$  Particle Listings for the energy limits used in this measurement.
- [gg] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [hh]  $\text{Re}(\epsilon'/\epsilon) = \epsilon'/\epsilon$  to a very good approximation provided the phases satisfy  $CPT$  invariance.
- [ii] See the  $K_L^0$  Particle Listings for the energy limits used in this measurement.
- [jj] Allowed by higher-order electroweak interactions.
- [kk] Violates  $CP$  in leading order. Test of direct  $CP$  violation since the indirect  $CP$ -violating and  $CP$ -conserving contributions are expected to be suppressed.
- [ll] See the “Note on  $f_0(1370)$ ” in the  $f_0(1370)$  Particle Listings and in the 1994 edition.
- [mm] See the note in the  $L(1770)$  Particle Listings in Reviews of Modern Physics 56 No. 2 Pt. II (1984), p. S200. See also the “Note on  $K_2(1770)$  and the  $K_2(1820)$ ” in the  $K_2(1770)$  Particle Listings.
- [nn] See the “Note on  $K_2(1770)$  and the  $K_2(1820)$ ” in the  $K_2(1770)$  Particle Listings.
- [oo] This result applies to  $Z^0 \rightarrow c\bar{c}$  decays only. Here  $\ell^+$  is an average (not a sum) of  $e^+$  and  $\mu^+$  decays.
- [pp] This is a weighted average of  $D^\pm$  (44%) and  $D^0$  (56%) branching fractions. See “ $D^+$  and  $D^0 \rightarrow (\eta \text{ anything})/(\text{total } D^+ \text{ and } D^0)$ ” under “ $D^+$  Branching Ratios” in the Particle Listings.
- [qq] The branching fraction for this mode may differ from the sum of the submodes that contribute to it, due to interference effects. See the relevant papers in the Particle Listings.
- [rr] These subfractions of the  $K^-\pi^+\pi^+$  mode are uncertain: see the Particle Listings.
- [ss] The two experiments measuring this fraction are in serious disagreement. See the Particle Listings.
- [tt] This is *not* a test for the  $\Delta C = 1$  weak neutral current, but leads to the  $\pi^+e^+e^-$  final state.
- [uu] This mode is not a useful test for a  $\Delta C = 1$  weak neutral current because both quarks must change flavor in this decay.
- [vv] This  $D_1^0 - D_2^0$  limit is inferred from the  $D^0 - \bar{D}^0$  mixing ratio  $\Gamma(K^+\pi^- \text{ (via } \bar{D}^0)) / \Gamma(K^-\pi^+ \text{ (via } D^0))$  near the end of the  $D^0$  Listings.
- [www] This value is obtained by subtracting the branching fractions for 2-, 4- and 6-prongs from unity.
- [xx] This is the sum of our  $K^-\pi^+\pi^+\pi^-$ ,  $K^-\pi^+\pi^+\pi^-\pi^0$ ,  $\bar{K}^0 2\pi^+2\pi^-$ ,  $2\pi^+2\pi^-$ ,  $2\pi^+2\pi^-\pi^0$ ,  $K^+K^-\pi^+\pi^-$ , and  $K^+K^-\pi^+\pi^-\pi^0$ , branching fractions.
- [yy] The branching fractions for the  $K^-e^+\nu_e$ ,  $K^*(892)^-e^+\nu_e$ ,  $\pi^-e^+\nu_e$ , and  $\rho^-e^+\nu_e$  modes add up to  $6.14 \pm 0.20\%$ .
- [zz] This is a doubly Cabibbo-suppressed mode.
- [aaa] This branching fraction includes all the decay modes of the resonance in the final state.
- [bbb] The experiments on the division of this charge mode among its submodes disagree, and the submode branching fractions here add up to considerably more than the charged-mode fraction.
- [ccc] However, these upper limits are in serious disagreement with values obtained in another experiment.
- [ddd] For now, we average together measurements of the  $Xe^+\nu_e$  and  $X\mu^+\nu_\mu$  branching fractions. This is the *average*, not the *sum*.
- [eee] This branching fraction includes all the decay modes of the final-state resonance.
- [fff] This comes from a  $K$ -matrix parametrization of the  $\pi^+\pi^- S$ -wave and is a sum over the  $f_0(980)$ ,  $f_0(1300)$ ,  $f_0(1200-1600)$ ,  $f_0(1500)$ , and  $f_0(1750)$ . Not all of these correspond to particles in our Tables.
- [ggg] An  $\ell$  indicates an  $e$  or a  $\mu$  mode, not a sum over these modes.
- [hhh] An  $CP(\pm 1)$  indicates the  $CP = +1$  and  $CP = -1$  eigenstates of the  $D^0 - \bar{D}^0$  system.
- [iii]  $D$  denotes  $D^0$  or  $\bar{D}^0$ .
- [jjj]  $X(3872)^+$  is a hypothetical charged partner of the  $X(3872)$ .
- [kkk]  $\Theta(1710)^{++}$  is a possible narrow pentaquark state and  $G(2220)$  is a possible glueball resonance.
- [lll] Stands for the possible candidates of  $K^*(1410)$ ,  $K_0^*(1430)$  and  $K_2^*(1430)$ .
- [mmm]  $B^0$  and  $B_s^0$  contributions not separated. Limit is on weighted average of the two decay rates.
- [nmm]  $\Theta(1540)^+$  denotes a possible narrow pentaquark state.
- [ooo] These values are model dependent.
- [ppp] Here “anything” means at least one particle observed.
- [qqq]  $D^{**}$  stands for the sum of the  $D(1^1P_1)$ ,  $D(1^3P_0)$ ,  $D(1^3P_1)$ ,  $D(1^3P_2)$ ,  $D(2^1S_0)$ , and  $D(2^1S_1)$  resonances.
- [rrr]  $D^{(*)}\bar{D}^{(*)}$  stands for the sum of  $D^*\bar{D}^*$ ,  $D^*\bar{D}$ ,  $D\bar{D}^*$ , and  $D\bar{D}$ .
- [sss]  $Y(3940)$  denotes a near-threshold enhancement in the  $\omega J/\psi$  mass spectrum.
- [ttt] Inclusive branching fractions have a multiplicity definition and can be greater than 100%.
- [uuu]  $D_j$  represents an unresolved mixture of pseudoscalar and tensor  $D^{**}$  ( $P$ -wave) states.
- [vvv] Not a pure measurement. See note at head of  $B_s^0$  Decay Modes.
- [www] Includes  $p\bar{p}\pi^+\pi^-\gamma$  and excludes  $p\bar{p}\eta$ ,  $p\bar{p}\omega$ ,  $p\bar{p}\eta'$ .
- [xxx]  $J^{PC}$  known by production in  $e^+e^-$  via single photon annihilation.  $I^G$  is not known; interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.
- [yyy] Spectroscopic labeling for these states is theoretical, pending experimental information.

See also the table of suggested  $q\bar{q}$  quark-model assignments in the Quark Model section.

• Indicates particles that appear in the preceding Meson Summary Table. We do not regard the other entries as being established.

† Indicates that the value of  $J$  given is preferred, but needs confirmation.

LIGHT UNFLAVORED ( $S = C = B = 0$ )		STRANGE ( $S = \pm 1, C = B = 0$ )		BOTTOM ( $B = \pm 1$ )	
$I^G(J^{PC})$	$I^G(J^{PC})$	$I(J^P)$	$I(J^P)$	$I^G(J^{PC})$	$I^G(J^{PC})$
<ul style="list-style-type: none"> <li>• <math>\pi^\pm</math> <math>1^-(0^-)</math></li> <li>• <math>\pi^0</math> <math>1^-(0^{++})</math></li> <li>• <math>\eta</math> <math>0^+(0^{++})</math></li> <li>• <math>f_0(600)</math> <math>0^+(0^{++})</math></li> <li>• <math>\rho(770)</math> <math>1^+(1^{--})</math></li> <li>• <math>\omega(782)</math> <math>0^-(1^{--})</math></li> <li>• <math>\eta'(958)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_0(980)</math> <math>0^+(0^{++})</math></li> <li>• <math>a_0(980)</math> <math>1^-(0^{++})</math></li> <li>• <math>\phi(1020)</math> <math>0^-(1^{--})</math></li> <li>• <math>b_1(1170)</math> <math>0^-(1^{--})</math></li> <li>• <math>b_1(1235)</math> <math>1^+(1^{+-})</math></li> <li>• <math>a_1(1260)</math> <math>1^-(1^{++})</math></li> <li>• <math>f_2(1270)</math> <math>0^+(2^{++})</math></li> <li>• <math>f_1(1285)</math> <math>0^+(1^{++})</math></li> <li>• <math>\eta(1295)</math> <math>0^+(0^{++})</math></li> <li>• <math>\pi(1300)</math> <math>1^-(0^{++})</math></li> <li>• <math>a_2(1320)</math> <math>1^-(2^{++})</math></li> <li>• <math>f_0(1370)</math> <math>0^+(0^{++})</math></li> <li>• <math>b_1(1380)</math> <math>?^-(1^{+-})</math></li> <li>• <math>\pi_1(1400)</math> <math>1^-(1^{--})</math></li> <li>• <math>\eta(1405)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_1(1420)</math> <math>0^+(1^{++})</math></li> <li>• <math>\omega(1420)</math> <math>0^-(1^{--})</math></li> <li>• <math>f_2(1430)</math> <math>0^+(2^{++})</math></li> <li>• <math>a_0(1450)</math> <math>1^-(0^{++})</math></li> <li>• <math>\rho(1450)</math> <math>1^+(1^{--})</math></li> <li>• <math>\eta(1475)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_0(1500)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_1(1510)</math> <math>0^+(1^{++})</math></li> <li>• <math>f_2'(1525)</math> <math>0^+(2^{++})</math></li> <li>• <math>f_2(1565)</math> <math>0^+(2^{++})</math></li> <li>• <math>b_1(1595)</math> <math>0^-(1^{+-})</math></li> <li>• <math>\pi_1(1600)</math> <math>1^-(1^{--})</math></li> <li>• <math>a_1(1640)</math> <math>1^-(1^{++})</math></li> <li>• <math>f_2(1640)</math> <math>0^+(2^{++})</math></li> <li>• <math>\eta_2(1645)</math> <math>0^+(2^{--})</math></li> <li>• <math>\omega(1650)</math> <math>0^-(1^{--})</math></li> <li>• <math>\omega_3(1670)</math> <math>0^-(3^{--})</math></li> </ul>	<ul style="list-style-type: none"> <li>• <math>\pi_2(1670)</math> <math>1^-(2^{--})</math></li> <li>• <math>\phi(1680)</math> <math>0^-(1^{--})</math></li> <li>• <math>\rho_3(1690)</math> <math>1^+(3^{--})</math></li> <li>• <math>\rho(1700)</math> <math>1^+(1^{--})</math></li> <li>• <math>a_2(1700)</math> <math>1^-(2^{++})</math></li> <li>• <math>f_0(1710)</math> <math>0^+(0^{++})</math></li> <li>• <math>\eta(1760)</math> <math>0^+(0^{++})</math></li> <li>• <math>\pi(1800)</math> <math>1^-(0^{++})</math></li> <li>• <math>f_2(1810)</math> <math>0^+(2^{++})</math></li> <li>• <math>X(1835)</math> <math>?^?(?^{--})</math></li> <li>• <math>\phi_3(1850)</math> <math>0^-(3^{--})</math></li> <li>• <math>\eta_2(1870)</math> <math>0^+(2^{--})</math></li> <li>• <math>\rho(1900)</math> <math>1^+(1^{--})</math></li> <li>• <math>f_2(1910)</math> <math>0^+(2^{++})</math></li> <li>• <math>f_2(1950)</math> <math>0^+(2^{++})</math></li> <li>• <math>\rho_3(1990)</math> <math>1^+(3^{--})</math></li> <li>• <math>f_2(2010)</math> <math>0^+(2^{++})</math></li> <li>• <math>f_0(2020)</math> <math>0^+(0^{++})</math></li> <li>• <math>a_4(2040)</math> <math>1^-(4^{++})</math></li> <li>• <math>f_4(2050)</math> <math>0^+(4^{++})</math></li> <li>• <math>\pi_2(2100)</math> <math>1^-(2^{--})</math></li> <li>• <math>f_0(2100)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_2(2150)</math> <math>0^+(2^{++})</math></li> <li>• <math>\rho(2150)</math> <math>1^+(1^{--})</math></li> <li>• <math>f_0(2200)</math> <math>0^+(0^{++})</math></li> <li>• <math>f_J(2220)</math> <math>0^+(2 \text{ or } 4^{++})</math></li> <li>• <math>\eta(2225)</math> <math>0^+(0^{++})</math></li> <li>• <math>\rho_3(2250)</math> <math>1^+(3^{--})</math></li> <li>• <math>f_2(2300)</math> <math>0^+(2^{++})</math></li> <li>• <math>f_4(2300)</math> <math>0^+(4^{++})</math></li> <li>• <math>f_2(2340)</math> <math>0^+(2^{++})</math></li> <li>• <math>\rho_5(2350)</math> <math>1^+(5^{--})</math></li> <li>• <math>a_6(2450)</math> <math>1^-(6^{++})</math></li> <li>• <math>f_6(2510)</math> <math>0^+(6^{++})</math></li> </ul>	<ul style="list-style-type: none"> <li>• <math>K^\pm</math> <math>1/2(0^-)</math></li> <li>• <math>K^0</math> <math>1/2(0^-)</math></li> <li>• <math>K_S^0</math> <math>1/2(0^-)</math></li> <li>• <math>K_L^0</math> <math>1/2(0^-)</math></li> <li>• <math>K_0^*(800)</math> <math>1/2(0^+)</math></li> <li>• <math>K^*(892)</math> <math>1/2(1^-)</math></li> <li>• <math>K_1(1270)</math> <math>1/2(1^+)</math></li> <li>• <math>K_1(1400)</math> <math>1/2(1^+)</math></li> <li>• <math>K^*(1410)</math> <math>1/2(1^-)</math></li> <li>• <math>K_0^*(1430)</math> <math>1/2(0^+)</math></li> <li>• <math>K_2^*(1430)</math> <math>1/2(2^+)</math></li> <li>• <math>K(1460)</math> <math>1/2(0^-)</math></li> <li>• <math>K_2(1580)</math> <math>1/2(2^-)</math></li> <li>• <math>K(1630)</math> <math>1/2(?^?)</math></li> <li>• <math>K_1(1650)</math> <math>1/2(1^+)</math></li> <li>• <math>K^*(1680)</math> <math>1/2(1^-)</math></li> <li>• <math>K_2(1770)</math> <math>1/2(2^-)</math></li> <li>• <math>K_3^*(1780)</math> <math>1/2(3^-)</math></li> <li>• <math>K_2(1820)</math> <math>1/2(2^-)</math></li> <li>• <math>K(1830)</math> <math>1/2(0^-)</math></li> <li>• <math>K_0^*(1950)</math> <math>1/2(0^+)</math></li> <li>• <math>K_2^*(1980)</math> <math>1/2(2^+)</math></li> <li>• <math>K_4^*(2045)</math> <math>1/2(4^+)</math></li> <li>• <math>K_2(2250)</math> <math>1/2(2^-)</math></li> <li>• <math>K_3(2320)</math> <math>1/2(3^+)</math></li> <li>• <math>K_5^*(2380)</math> <math>1/2(5^-)</math></li> <li>• <math>K_4(2500)</math> <math>1/2(4^-)</math></li> <li>• <math>K(3100)</math> <math>?^?(?^{??})</math></li> </ul>	<ul style="list-style-type: none"> <li>• <math>B^\pm</math> <math>1/2(0^-)</math></li> <li>• <math>B^0</math> <math>1/2(0^-)</math></li> <li>• <math>B^\pm/B^0</math> ADMIXTURE</li> <li>• <math>B^\pm/B^0/B_s^0/b</math>-baryon ADMIXTURE</li> <li>• <math>V_{cb}</math> and <math>V_{ub}</math> CKM Matrix Elements</li> <li>• <math>B^*</math> <math>1/2(1^-)</math></li> <li>• <math>B_J^*(5732)</math> <math>?(2^?)</math></li> </ul>		
				BOTTOM, STRANGE ( $B = \pm 1, S = \mp 1$ )	
				<ul style="list-style-type: none"> <li>• <math>B_s^0</math> <math>0(0^-)</math></li> <li>• <math>B_s^*</math> <math>0(1^-)</math></li> <li>• <math>B_{sJ}^*(5850)</math> <math>?(2^?)</math></li> </ul>	
				BOTTOM, CHARMED ( $B = C = \pm 1$ )	
				<ul style="list-style-type: none"> <li>• <math>B_c^\pm</math> <math>0(0^-)</math></li> </ul>	
				$c\bar{c}$	
				<ul style="list-style-type: none"> <li>• <math>\eta_c(1S)</math> <math>0^+(0^{++})</math></li> <li>• <math>J/\psi(1S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\chi_{c0}(1P)</math> <math>0^+(0^{++})</math></li> <li>• <math>\chi_{c1}(1P)</math> <math>0^+(1^{++})</math></li> <li>• <math>h_c(1P)</math> <math>?^?(?^{??})</math></li> <li>• <math>\chi_{c2}(1P)</math> <math>0^+(2^{++})</math></li> <li>• <math>\eta_c(2S)</math> <math>0^+(0^{++})</math></li> <li>• <math>\psi(2S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\psi(3770)</math> <math>0^-(1^{--})</math></li> <li>• <math>X(3872)</math> <math>0^?(2^?+)</math></li> <li>• <math>\chi_{c2}(2P)</math> <math>0^+(2^{++})</math></li> <li>• <math>Y(3940)</math> <math>?^?(?^{??})</math></li> <li>• <math>\psi(4040)</math> <math>0^-(1^{--})</math></li> <li>• <math>\psi(4160)</math> <math>0^-(1^{--})</math></li> <li>• <math>Y(4260)</math> <math>?^?(1^{--})</math></li> <li>• <math>\psi(4415)</math> <math>0^-(1^{--})</math></li> </ul>	
				$b\bar{b}$	
				<ul style="list-style-type: none"> <li>• <math>\eta_b(1S)</math> <math>0^+(0^{++})</math></li> <li>• <math>\Upsilon(1S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\chi_{b0}(1P)</math> <math>0^+(0^{++})</math></li> <li>• <math>\chi_{b1}(1P)</math> <math>0^+(1^{++})</math></li> <li>• <math>\chi_{b2}(1P)</math> <math>0^+(2^{++})</math></li> <li>• <math>\Upsilon(2S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\Upsilon(1D)</math> <math>0^-(2^{--})</math></li> <li>• <math>\chi_{b0}(2P)</math> <math>0^+(0^{++})</math></li> <li>• <math>\chi_{b1}(2P)</math> <math>0^+(1^{++})</math></li> <li>• <math>\chi_{b2}(2P)</math> <math>0^+(2^{++})</math></li> <li>• <math>\Upsilon(3S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\Upsilon(4S)</math> <math>0^-(1^{--})</math></li> <li>• <math>\Upsilon(10860)</math> <math>0^-(1^{--})</math></li> <li>• <math>\Upsilon(11020)</math> <math>0^-(1^{--})</math></li> </ul>	
				NON- $q\bar{q}$ CANDIDATES	
		OTHER LIGHT			
		Further States			
				CHARMED ( $C = \pm 1$ )	
				<ul style="list-style-type: none"> <li>• <math>D^\pm</math> <math>1/2(0^-)</math></li> <li>• <math>D^0</math> <math>1/2(0^-)</math></li> <li>• <math>D^*(2007)^0</math> <math>1/2(1^-)</math></li> <li>• <math>D^*(2010)^\pm</math> <math>1/2(1^-)</math></li> <li>• <math>D_0^*(2400)^0</math> <math>1/2(0^+)</math></li> <li>• <math>D_0^*(2400)^\pm</math> <math>1/2(0^+)</math></li> <li>• <math>D_1(2420)^0</math> <math>1/2(1^+)</math></li> <li>• <math>D_1(2420)^\pm</math> <math>1/2(?^?)</math></li> <li>• <math>D_1(2430)^0</math> <math>1/2(1^+)</math></li> <li>• <math>D_2^*(2460)^0</math> <math>1/2(2^+)</math></li> <li>• <math>D_2^*(2460)^\pm</math> <math>1/2(2^+)</math></li> <li>• <math>D^*(2640)^\pm</math> <math>1/2(?^?)</math></li> </ul>	
				CHARMED, STRANGE ( $C = S = \pm 1$ )	
				<ul style="list-style-type: none"> <li>• <math>D_s^\pm</math> <math>0(0^-)</math></li> <li>• <math>D_s^{*\pm}</math> <math>0(?^?)</math></li> <li>• <math>D_{s0}^*(2317)^\pm</math> <math>0(0^+)</math></li> <li>• <math>D_{s1}(2460)^\pm</math> <math>0(1^+)</math></li> <li>• <math>D_{s1}(2536)^\pm</math> <math>0(1^+)</math></li> <li>• <math>D_{s2}(2573)^\pm</math> <math>0(?^?)</math></li> </ul>	

## BARYON SUMMARY TABLE

This short table gives the name, the quantum numbers (where known), and the status of baryons in the *Review*. Only the baryons with 3- or 4-star status are included in the main Baryon Summary Table. Due to insufficient data or uncertain interpretation, the other entries in the short table are not established as baryons. The names with masses are of baryons that decay strongly. For  $N$ ,  $\Delta$ , and  $\Xi$  resonances, the partial wave is indicated by the symbol  $L_{2i,2j}$ , where  $L$  is the orbital angular momentum ( $S, P, D, \dots$ ),  $I$  is the isospin, and  $J$  is the total angular momentum. For  $\Lambda$  and  $\Sigma$  resonances, the symbol is  $L_{i,2j}$ .

$p$	$P_{11}$	****	$\Delta(1232)$	$P_{33}$	****	$\Lambda$	$P_{01}$	****	$\Sigma^+$	$P_{11}$	****	$\Xi^0$	$P_{11}$	****
$n$	$P_{11}$	****	$\Delta(1600)$	$P_{33}$	**	$\Lambda(1405)$	$S_{01}$	****	$\Sigma^0$	$P_{11}$	****	$\Xi^-$	$P_{11}$	****
$N(1440)$	$P_{11}$	****	$\Delta(1620)$	$S_{31}$	****	$\Lambda(1520)$	$D_{03}$	****	$\Sigma^-$	$P_{11}$	****	$\Xi(1530)$	$P_{13}$	****
$N(1520)$	$D_{13}$	****	$\Delta(1700)$	$D_{33}$	****	$\Lambda(1600)$	$P_{01}$	**	$\Sigma(1385)$	$P_{13}$	****	$\Xi(1620)$		*
$N(1535)$	$S_{11}$	****	$\Delta(1750)$	$P_{31}$	*	$\Lambda(1670)$	$S_{01}$	****	$\Sigma(1480)$		*	$\Xi(1690)$		**
$N(1650)$	$S_{11}$	****	$\Delta(1900)$	$S_{31}$	**	$\Lambda(1690)$	$D_{03}$	****	$\Sigma(1560)$		**	$\Xi(1820)$	$D_{13}$	***
$N(1675)$	$D_{15}$	****	$\Delta(1905)$	$F_{35}$	****	$\Lambda(1800)$	$S_{01}$	**	$\Sigma(1580)$	$D_{13}$	*	$\Xi(1950)$		***
$N(1680)$	$F_{15}$	****	$\Delta(1910)$	$P_{31}$	****	$\Lambda(1810)$	$P_{01}$	**	$\Sigma(1620)$	$S_{11}$	**	$\Xi(2030)$		**
$N(1700)$	$D_{13}$	**	$\Delta(1920)$	$P_{33}$	****	$\Lambda(1820)$	$F_{05}$	****	$\Sigma(1660)$	$P_{11}$	**	$\Xi(2120)$		*
$N(1710)$	$P_{11}$	**	$\Delta(1930)$	$D_{35}$	**	$\Lambda(1830)$	$D_{05}$	****	$\Sigma(1670)$	$D_{13}$	****	$\Xi(2250)$		**
$N(1720)$	$P_{13}$	****	$\Delta(1940)$	$D_{33}$	*	$\Lambda(1890)$	$P_{03}$	****	$\Sigma(1690)$		**	$\Xi(2370)$		**
$N(1900)$	$P_{13}$	**	$\Delta(1950)$	$F_{37}$	****	$\Lambda(2000)$		*	$\Sigma(1750)$	$S_{11}$	**	$\Xi(2500)$		*
$N(1990)$	$F_{17}$	**	$\Delta(2000)$	$F_{35}$	**	$\Lambda(2020)$	$F_{07}$	*	$\Sigma(1770)$	$P_{11}$	*			
$N(2000)$	$F_{15}$	**	$\Delta(2150)$	$S_{31}$	*	$\Lambda(2100)$	$G_{07}$	****	$\Sigma(1775)$	$D_{15}$	****	$\Omega^-$		****
$N(2080)$	$D_{13}$	**	$\Delta(2200)$	$G_{37}$	*	$\Lambda(2110)$	$F_{05}$	**	$\Sigma(1840)$	$P_{13}$	*	$\Omega(2250)^-$		***
$N(2090)$	$S_{11}$	*	$\Delta(2300)$	$H_{39}$	**	$\Lambda(2325)$	$D_{03}$	*	$\Sigma(1880)$	$P_{11}$	**	$\Omega(2380)^-$		**
$N(2100)$	$P_{11}$	*	$\Delta(2350)$	$D_{35}$	*	$\Lambda(2350)$	$H_{09}$	**	$\Sigma(1915)$	$F_{15}$	****	$\Omega(2470)^-$		**
$N(2190)$	$G_{17}$	****	$\Delta(2390)$	$F_{37}$	*	$\Lambda(2585)$		**	$\Sigma(1940)$	$D_{13}$	**			
$N(2200)$	$D_{15}$	**	$\Delta(2400)$	$G_{39}$	**				$\Sigma(2000)$	$S_{11}$	*	$\Lambda_c^+$		****
$N(2220)$	$H_{19}$	****	$\Delta(2420)$	$H_{3,11}$	****				$\Sigma(2030)$	$F_{17}$	****	$\Lambda_c(2593)^+$		**
$N(2250)$	$G_{19}$	****	$\Delta(2750)$	$I_{3,13}$	**				$\Sigma(2070)$	$F_{15}$	*	$\Lambda_c(2625)^+$		**
$N(2600)$	$I_{1,11}$	****	$\Delta(2950)$	$K_{3,15}$	**				$\Sigma(2080)$	$P_{13}$	**	$\Lambda_c(2765)^+$		*
$N(2700)$	$K_{1,13}$	**							$\Sigma(2100)$	$G_{17}$	*	$\Lambda_c(2880)^+$		**
			$\Theta(1540)^+$	*					$\Sigma(2250)$		**	$\Lambda_c(2880)^+$		****
									$\Sigma(2455)$		**	$\Sigma_c(2455)$		****
									$\Sigma(2620)$		**	$\Sigma_c(2520)$		**
									$\Sigma(3000)$		*	$\Sigma_c(2800)$		**
									$\Sigma(3170)$		*	$\Xi_c^+$		**
												$\Xi_c^0$		**
												$\Xi_c^{'+}$		**
												$\Xi_c^0$		**
												$\Xi_c^-$		**
												$\Xi_c 2645$		**
												$\Xi_c 2790$		**
												$\Xi_c 2815$		**
												$\Omega_c^0$		**
												$\Xi_{cc}^+$		*
												$\Lambda_b^0$		**
												$\Xi_b^0, \Xi_b^-$		*

\*\*\*\* Existence is certain, and properties are at least fairly well explored.

\*\*\* Existence ranges from very likely to certain, but further confirmation is desirable and/or quantum numbers, branching fractions, etc. are not well determined.

\*\* Evidence of existence is only fair.

\* Evidence of existence is poor.

<p><b>N BARYONS</b>  <math>(S = 0, I = 1/2)</math>  <math>p, N^+ = uud; \quad n, N^0 = udd</math></p>
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**p**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$$

Mass  $m = 1.00727646688 \pm 0.00000000013$  u  
 Mass  $m = 938.27203 \pm 0.00008$  MeV<sup>[a]</sup>  
 $|m_p - m_{\bar{p}}|/m_p < 1.0 \times 10^{-8}$ , CL = 90%<sup>[b]</sup>  
 $|\frac{q_p}{m_p}|/(\frac{q_e}{m_p}) = 0.99999999991 \pm 0.00000000009$   
 $|q_p + q_{\bar{p}}|/e < 1.0 \times 10^{-8}$ , CL = 90%<sup>[b]</sup>  
 $|q_p + q_e|/e < 1.0 \times 10^{-21}$ <sup>[c]</sup>  
 Magnetic moment  $\mu = 2.792847351 \pm 0.000000028\mu_N$   
 $(\mu_p + \mu_{\bar{p}})/\mu_p = (-2.6 \pm 2.9) \times 10^{-3}$   
 Electric dipole moment  $d < 0.54 \times 10^{-23}$  e cm  
 Electric polarizability  $\alpha = (12.0 \pm 0.6) \times 10^{-4}$  fm<sup>3</sup>  
 Magnetic polarizability  $\beta = (1.9 \pm 0.5) \times 10^{-4}$  fm<sup>3</sup>  
 Charge radius = 0.875  $\pm$  0.007 fm  
 Mean life  $\tau > 1.9 \times 10^{29}$  years, CL = 90% ( $p \rightarrow$  invisible mode)  
 Mean life  $\tau > 10^{31}$  to  $10^{33}$  years<sup>[d]</sup> (mode dependent)

See the “Note on Nucleon Decay” in our 1994 edition (*Phys. Rev. D50*, 1673) for a short review.

The “partial mean life” limits tabulated here are the limits on  $\tau/B_i$ , where  $\tau$  is the total mean life and  $B_i$  is the branching fraction for the mode in question. For  $N$  decays,  $p$  and  $n$  indicate proton and neutron partial lifetimes.

$p$ DECAY MODES	Partial mean life (10 <sup>30</sup> years)	Confidence level	$p$ (MeV/c)
<b>Antilepton + meson</b>			
$N \rightarrow e^+\pi$	>158 ( $n$ ), >1600 ( $p$ )	90%	459
$N \rightarrow \mu^+\pi$	>100 ( $n$ ), >473 ( $p$ )	90%	453
$N \rightarrow \nu\pi$	>112 ( $n$ ), >25 ( $p$ )	90%	459
$p \rightarrow e^+\eta$	>313	90%	309
$p \rightarrow \mu^+\eta$	>126	90%	297
$n \rightarrow \nu\eta$	>158	90%	310
$N \rightarrow e^+\rho$	>217 ( $n$ ), > 75 ( $p$ )	90%	149
$N \rightarrow \mu^+\rho$	>228 ( $n$ ), > 110 ( $p$ )	90%	113
$N \rightarrow \nu\rho$	>19 ( $n$ ), > 162 ( $p$ )	90%	149
$p \rightarrow e^+\omega$	>107	90%	143
$p \rightarrow \mu^+\omega$	>117	90%	105
$n \rightarrow \nu\omega$	>108	90%	144
$N \rightarrow e^+K$	>17 ( $n$ ), > 150 ( $p$ )	90%	339
$p \rightarrow e^+K_S^0$	> 120	90%	337
$p \rightarrow e^+K_L^0$	>51	90%	337
$N \rightarrow \mu^+K$	>26 ( $n$ ), > 120 ( $p$ )	90%	329
$p \rightarrow \mu^+K_S^0$	>150	90%	326
$p \rightarrow \mu^+K_L^0$	>83	90%	326
$N \rightarrow \nu K$	>86 ( $n$ ), > 670 ( $p$ )	90%	339
$n \rightarrow \nu K_S^0$	> 51	90%	338
$p \rightarrow e^+K^*(892)^0$	> 84	90%	45
$N \rightarrow \nu K^*(892)$	>78 ( $n$ ), > 51 ( $p$ )	90%	45
<b>Antilepton + mesons</b>			
$p \rightarrow e^+\pi^+\pi^-$	>82	90%	448
$p \rightarrow e^+\pi^0\pi^0$	>147	90%	449
$n \rightarrow e^+\pi^-\pi^0$	>52	90%	449
$p \rightarrow \mu^+\pi^+\pi^-$	>133	90%	425
$p \rightarrow \mu^+\pi^0\pi^0$	>101	90%	427
$n \rightarrow \mu^+\pi^-\pi^0$	>74	90%	427
$n \rightarrow e^+K^0\pi^-$	>18	90%	319
<b>Lepton + meson</b>			
$n \rightarrow e^-\pi^+$	>65	90%	459
$n \rightarrow \mu^-\pi^+$	>49	90%	453
$n \rightarrow e^-\rho^+$	>62	90%	150
$n \rightarrow \mu^-\rho^+$	>7	90%	114
$n \rightarrow e^-K^+$	>32	90%	340
$n \rightarrow \mu^-K^+$	>57	90%	330

<b>Lepton + mesons</b>			
$p \rightarrow e^-\pi^+\pi^+$	>30	90%	448
$n \rightarrow e^-\pi^+\pi^0$	>29	90%	449
$p \rightarrow \mu^-\pi^+\pi^+$	>17	90%	425
$n \rightarrow \mu^-\pi^+\pi^0$	>34	90%	427
$p \rightarrow e^-\pi^+K^+$	>75	90%	320
$p \rightarrow \mu^-\pi^+K^+$	>245	90%	279

<b>Antilepton + photon(s)</b>			
$p \rightarrow e^+\gamma$	>670	90%	469
$p \rightarrow \mu^+\gamma$	>478	90%	463
$n \rightarrow \nu\gamma$	>28	90%	470
$p \rightarrow e^+\gamma\gamma$	>100	90%	469
$n \rightarrow \nu\gamma\gamma$	>219	90%	470

<b>Three (or more) leptons</b>			
$p \rightarrow e^+e^+e^-$	>793	90%	469
$p \rightarrow e^+\mu^+\mu^-$	>359	90%	457
$p \rightarrow e^+\nu\nu$	>17	90%	469
$n \rightarrow e^+e^-\nu$	>257	90%	470
$n \rightarrow \mu^+e^-\nu$	>83	90%	464
$n \rightarrow \mu^+\mu^-\nu$	>79	90%	458
$p \rightarrow \mu^+e^+e^-$	>529	90%	463
$p \rightarrow \mu^+\mu^+\mu^-$	>675	90%	439
$p \rightarrow \mu^+\nu\nu$	>21	90%	463
$p \rightarrow e^-\mu^+\mu^+$	>6	90%	457
$n \rightarrow 3\nu$	> 0.0005	90%	470

<b>Inclusive modes</b>			
$N \rightarrow e^+$ anything	>0.6 ( $n, p$ )	90%	–
$N \rightarrow \mu^+$ anything	>12 ( $n, p$ )	90%	–
$N \rightarrow e^+\pi^0$ anything	>0.6 ( $n, p$ )	90%	–

<b><math>\Delta B = 2</math> dinucleon modes</b>			
The following are lifetime limits per iron nucleus.			
$pp \rightarrow \pi^+\pi^+$	>0.7	90%	–
$pn \rightarrow \pi^+\pi^0$	>2	90%	–
$nn \rightarrow \pi^+\pi^-$	>0.7	90%	–
$nn \rightarrow \pi^0\pi^0$	>3.4	90%	–
$pp \rightarrow e^+e^+$	>5.8	90%	–
$pp \rightarrow e^+\mu^+$	>3.6	90%	–
$pp \rightarrow \mu^+\mu^+$	>1.7	90%	–
$pn \rightarrow e^+\bar{\nu}$	>2.8	90%	–
$pn \rightarrow \mu^+\bar{\nu}$	>1.6	90%	–
$nn \rightarrow \nu_e\bar{\nu}_e$	>0.000049	90%	–
$pn \rightarrow$ invisible	>2.1 $\times 10^{-5}$	90%	–
$pp \rightarrow$ invisible	>0.00005	90%	–

<b><math>\bar{p}</math> DECAY MODES</b>			
$\bar{p}$ DECAY MODES	Partial mean life (years)	Confidence level	$\bar{p}$ (MeV/c)
$\bar{p} \rightarrow e^-\gamma$	>7 $\times 10^5$	90%	469
$\bar{p} \rightarrow \mu^-\gamma$	>5 $\times 10^4$	90%	463
$\bar{p} \rightarrow e^-\pi^0$	>4 $\times 10^5$	90%	459
$\bar{p} \rightarrow \mu^-\pi^0$	>5 $\times 10^4$	90%	453
$\bar{p} \rightarrow e^-\eta$	>2 $\times 10^4$	90%	309
$\bar{p} \rightarrow \mu^-\eta$	>8 $\times 10^3$	90%	297
$\bar{p} \rightarrow e^-K_S^0$	>900	90%	337
$\bar{p} \rightarrow \mu^-K_S^0$	>4 $\times 10^3$	90%	326
$\bar{p} \rightarrow e^-K_L^0$	>9 $\times 10^3$	90%	337
$\bar{p} \rightarrow \mu^-K_L^0$	>7 $\times 10^3$	90%	326
$\bar{p} \rightarrow e^-\gamma\gamma$	>2 $\times 10^4$	90%	469
$\bar{p} \rightarrow \mu^-\gamma\gamma$	>2 $\times 10^4$	90%	463
$\bar{p} \rightarrow e^-\omega$	>200	90%	143

**n**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$$

Mass  $m = 1.0086649156 \pm 0.0000000006$  uMass  $m = 939.56536 \pm 0.00008$  MeV<sup>[a]</sup>
 $m_n - m_p = 1.2933317 \pm 0.0000005$  MeV  
 $= 0.0013884487 \pm 0.0000000006$  u
Mean life  $\tau = 885.7 \pm 0.8$  s $c\tau = 2.655 \times 10^8$  kmMagnetic moment  $\mu = -1.9130427 \pm 0.0000005\mu_N$ Electric dipole moment  $d < 0.63 \times 10^{-25}e$  cm, CL = 90%Mean-square charge radius  $\langle r_n^2 \rangle = -0.1161 \pm 0.0022$  fm<sup>2</sup> (S = 1.3)Electric polarizability  $\alpha = (11.6 \pm 1.5) \times 10^{-4}$  fm<sup>3</sup>Magnetic polarizability  $\beta = (3.7 \pm 2.0) \times 10^{-4}$  fm<sup>3</sup>Charge  $q = (-0.4 \pm 1.1) \times 10^{-21}e$ Mean  $n\bar{n}$ -oscillation time  $> 8.6 \times 10^7$  s, CL = 90% (free n)Mean  $n\bar{n}$ -oscillation time  $> 1.3 \times 10^8$  s, CL = 90%<sup>[el]</sup> (bound n)Decay parameters<sup>[f]</sup>

$pe_e^- \bar{\nu}_e$	$\lambda \equiv g_A/g_V = -1.2695 \pm 0.0029(S = 2.0)$
"	$A = -0.1173 \pm 0.0013(S = 2.3)$
"	$B = 0.981 \pm 0.004(S = 1.1)$
"	$a = -0.103 \pm 0.004$
"	$\phi_{AV} = (180.06 \pm 0.07)^{\circ[\text{gl}]}$
"	$D = (-4 \pm 6) \times 10^{-4}$

n DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$pe_e^- \bar{\nu}_e$	100 %		1
$pe_e^- \bar{\nu}_e \gamma$	$ b  6.9 \times 10^{-3}$	90%	1
Charge conservation (Q) violating mode			
$pv_e \bar{\nu}_e$	Q < 8	$\times 10^{-27}$ 68%	1

**N(1440)P<sub>11</sub>**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$$

Breit-Wigner mass = 1420 to 1470 ( $\approx 1440$ ) MeVBreit-Wigner full width = 200 to 450 ( $\approx 300$ ) MeV $p_{\text{beam}} = 0.61$  GeV/c  $4\pi\bar{\lambda}^2 = 31.0$  mbRe(pole position) = 1350 to 1380 ( $\approx 1365$ ) MeV-2Im(pole position) = 160 to 220 ( $\approx 190$ ) MeV

N(1440) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.55 to 0.75	398
$N\pi\pi$	30-40%	347
$\Delta\pi$	20-30%	147
$N\rho$	<8%	†
$N(\pi\pi)_{S\text{-wave}}^{J=0}$	5-10%	-
$p\gamma$	0.035-0.048%	414
$p\gamma$ , helicity = 1/2	0.035-0.048%	414
$n\gamma$	0.009-0.032%	413
$n\gamma$ , helicity = 1/2	0.009-0.032%	413

**N(1520)D<sub>13</sub>**

$$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$$

Breit-Wigner mass = 1515 to 1525 ( $\approx 1520$ ) MeVBreit-Wigner full width = 100 to 125 ( $\approx 115$ ) MeV $p_{\text{beam}} = 0.74$  GeV/c $4\pi\bar{\lambda}^2 = 23.5$  mbRe(pole position) = 1505 to 1515 ( $\approx 1510$ ) MeV-2Im(pole position) = 105 to 120 ( $\approx 110$ ) MeV

N(1520) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	(0.55 to 0.65)	457
$N\eta$	$(2.3 \pm 0.4) \times 10^{-3}$	155
$N\pi\pi$	40-50%	414
$\Delta\pi$	15-25%	230
$N\rho$	15-25%	†
$N(\pi\pi)_{S\text{-wave}}^{J=0}$	<8%	-
$p\gamma$	0.46-0.56%	470
$p\gamma$ , helicity = 1/2	0.001-0.034%	470
$p\gamma$ , helicity = 3/2	0.44-0.53%	470
$n\gamma$	0.30-0.53%	470
$n\gamma$ , helicity = 1/2	0.04-0.10%	470
$n\gamma$ , helicity = 3/2	0.25-0.45%	470

**N(1535)S<sub>11</sub>**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$$

Breit-Wigner mass = 1525 to 1545 ( $\approx 1535$ ) MeVBreit-Wigner full width = 125 to 175 ( $\approx 150$ ) MeV $p_{\text{beam}} = 0.76$  GeV/c  $4\pi\bar{\lambda}^2 = 22.5$  mbRe(pole position) = 1490 to 1530 ( $\approx 1510$ ) MeV-2Im(pole position) = 90 to 250 ( $\approx 170$ ) MeV

N(1535) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	35-55%	468
$N\eta$	45-60%	186
$N\pi\pi$	1-10%	426
$\Delta\pi$	<1%	244
$N\rho$	<4%	†
$N(\pi\pi)_{S\text{-wave}}^{J=0}$	<3%	-
$N(1440)\pi$	<7%	†
$p\gamma$	0.15-0.35%	481
$p\gamma$ , helicity = 1/2	0.15-0.35%	481
$n\gamma$	0.004-0.29%	480
$n\gamma$ , helicity = 1/2	0.004-0.29%	480

**N(1650)S<sub>11</sub>**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$$

Breit-Wigner mass = 1645 to 1670 ( $\approx 1655$ ) MeVBreit-Wigner full width = 145 to 185 ( $\approx 165$ ) MeV $p_{\text{beam}} = 0.97$  GeV/c  $4\pi\bar{\lambda}^2 = 16.2$  mbRe(pole position) = 1640 to 1670 ( $\approx 1655$ ) MeV-2Im(pole position) = 150 to 180 ( $\approx 165$ ) MeV

N(1650) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.60 to 0.95	551
$N\eta$	3-10%	354
$\Lambda K$	3-11%	179
$N\pi\pi$	10-20%	517
$\Delta\pi$	1-7%	349
$N\rho$	4-12%	†
$N(\pi\pi)_{S\text{-wave}}^{J=0}$	<4%	-
$N(1440)\pi$	<5%	156
$p\gamma$	0.04-0.18%	562
$p\gamma$ , helicity = 1/2	0.04-0.18%	562
$n\gamma$	0.003-0.17%	561
$n\gamma$ , helicity = 1/2	0.003-0.17%	561

**N(1675)D<sub>15</sub>**

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^-)$$

Breit-Wigner mass = 1670 to 1680 ( $\approx 1675$ ) MeVBreit-Wigner full width = 130 to 165 ( $\approx 150$ ) MeV $p_{\text{beam}} = 1.01$  GeV/c  $4\pi\bar{\lambda}^2 = 15.4$  mbRe(pole position) = 1655 to 1665 ( $\approx 1660$ ) MeV-2Im(pole position) = 125 to 150 ( $\approx 135$ ) MeV

N(1675) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.35 to 0.45	564
$N\eta$	(0.0 $\pm$ 1.0)%	376
$\Lambda K$	<1%	216
$N\pi\pi$	50–60%	532
$\Delta\pi$	50–60%	366
$N\rho$	<1–3%	†
$p\gamma$	0.004–0.023%	575
$p\gamma$ , helicity = 1/2	0.0–0.015%	575
$p\gamma$ , helicity = 3/2	0.0–0.011%	575
$n\gamma$	0.02–0.12%	574
$n\gamma$ , helicity = 1/2	0.006–0.046%	574
$n\gamma$ , helicity = 3/2	0.01–0.08%	574

**N(1680)F<sub>15</sub>**

$$I(J^P) = \frac{1}{2}(\frac{5}{2}^+)$$

Breit–Wigner mass = 1680 to 1690 ( $\approx$ 1685) MeV  
 Breit–Wigner full width = 120 to 140 ( $\approx$ 130) MeV  
 $p_{\text{beam}} = 1.02\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 15.0$  mb  
 Re(pole position) = 1665 to 1680 ( $\approx$ 1675) MeV  
 $-2\text{Im}(\text{pole position}) = 110$  to 135 ( $\approx$ 120) MeV

N(1680) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.65 to 0.70%	571
$N\eta$	(0.0 $\pm$ 1.0)%	387
$N\pi\pi$	30–40%	539
$\Delta\pi$	5–15%	374
$N\rho$	3–15%	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	5–20%	–
$p\gamma$	0.21–0.32%	581
$p\gamma$ , helicity = 1/2	0.001–0.011%	581
$p\gamma$ , helicity = 3/2	0.20–0.32%	581
$n\gamma$	0.021–0.046%	581
$n\gamma$ , helicity = 1/2	0.004–0.029%	581
$n\gamma$ , helicity = 3/2	0.01–0.024%	581

**N(1700)D<sub>13</sub>**

$$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$$

Breit–Wigner mass = 1650 to 1750 ( $\approx$ 1700) MeV  
 Breit–Wigner full width = 50 to 150 ( $\approx$ 100) MeV  
 $p_{\text{beam}} = 1.05\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 14.5$  mb  
 Re(pole position) = 1630 to 1730 ( $\approx$ 1680) MeV  
 $-2\text{Im}(\text{pole position}) = 50$  to 150 ( $\approx$ 100) MeV

N (1700) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–15%	581
$N\eta$	(0.0 $\pm$ 1.0)%	402
$\Lambda K$	<3%	255
$N\pi\pi$	85–95%	550
$N\rho$	<35%	†
$p\gamma$	0.01–0.05%	591
$p\gamma$ , helicity = 1/2	0.0–0.024%	591
$p\gamma$ , helicity = 3/2	0.002–0.026%	591
$n\gamma$	0.01–0.13%	590
$n\gamma$ , helicity = 1/2	0.0–0.09%	590
$n\gamma$ , helicity = 3/2	0.01–0.05%	590

**N(1710)P<sub>11</sub>**

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$$

Breit–Wigner mass = 1680 to 1740 ( $\approx$ 1710) MeV  
 Breit–Wigner full width = 50 to 250 ( $\approx$ 100) MeV  
 $p_{\text{beam}} = 1.07\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 14.2$  mb  
 Re(pole position) = 1670 to 1770 ( $\approx$ 1720) MeV  
 $-2\text{Im}(\text{pole position}) = 80$  to 380 ( $\approx$ 230) MeV

N (1710) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20%	588
$N\eta$	(6.2 $\pm$ 1.0)%	412
$N\omega$	(13.0 $\pm$ 2.0)%	†
$\Lambda K$	5–25%	269
$N\pi\pi$	40–90%	557
$\Delta\pi$	15–40%	394
$N\rho$	5–25%	†
$N(\pi\pi)_{S\text{-wave}}^{I=0}$	10–40%	–
$p\gamma$	0.002–0.05%	598
$p\gamma$ , helicity = 1/2	0.002–0.05%	598
$n\gamma$	0.0–0.02%	597
$n\gamma$ , helicity = 1/2	0.0–0.02%	597

**N(1720)P<sub>13</sub>**

$$I(J^P) = \frac{1}{2}(\frac{3}{2}^+)$$

Breit–Wigner mass = 1700 to 1750 ( $\approx$ 1720) MeV  
 Breit–Wigner full width = 150 to 300 ( $\approx$ 200) MeV  
 $p_{\text{beam}} = 1.09\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 13.9$  mb  
 Re(pole position) = 1660 to 1690 ( $\approx$ 1675) MeV  
 $-2\text{Im}(\text{pole position}) = 115$  to 275 MeV

N (1720) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20%	594
$N\eta$	(4.0 $\pm$ 1.0)%	422
$\Lambda K$	1–15%	283
$N\pi\pi$	>70%	564
$N\rho$	70–85%	73
$p\gamma$	0.003–0.10%	604
$p\gamma$ , helicity = 1/2	0.003–0.08%	604
$p\gamma$ , helicity = 3/2	0.001–0.03%	604
$n\gamma$	0.002–0.39%	603
$n\gamma$ , helicity = 1/2	0.0–0.002%	603
$n\gamma$ , helicity = 3/2	0.001–0.39%	603

**N(2190)G<sub>17</sub>**

$$I(J^P) = \frac{1}{2}(\frac{7}{2}^-)$$

Breit–Wigner mass = 2100 to 2200 ( $\approx$ 2190) MeV  
 Breit–Wigner full width = 300 to 700 ( $\approx$ 500) MeV  
 $p_{\text{beam}} = 2.07\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 6.21$  mb  
 Re(pole position) = 2050 to 2100 ( $\approx$ 2075) MeV  
 $-2\text{Im}(\text{pole position}) = 400$  to 520 ( $\approx$ 450) MeV

N (2190) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20%	888
$N\eta$	(0.0 $\pm$ 1.0)%	792

**N(2220)H<sub>19</sub>**

$$I(J^P) = \frac{1}{2}(\frac{9}{2}^+)$$

Breit–Wigner mass = 2200 to 2300 ( $\approx$ 2250) MeV  
 Breit–Wigner full width = 350 to 500 ( $\approx$ 400) MeV  
 $p_{\text{beam}} = 2.21\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 5.74$  mb  
 Re(pole position) = 2130 to 2200 ( $\approx$ 2170) MeV  
 $-2\text{Im}(\text{pole position}) = 400$  to 560 ( $\approx$ 480) MeV

N (2220) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20%	924

**N(2250)G<sub>19</sub>**

$$I(J^P) = \frac{1}{2}(\frac{9}{2}^-)$$

Breit–Wigner mass = 2200 to 2350 ( $\approx$ 2275) MeV  
 Breit–Wigner full width = 230 to 800 ( $\approx$ 500) MeV  
 $p_{\text{beam}} = 2.27\text{GeV}/c$      $4\pi\tilde{\lambda}^2 = 5.56$  mb  
 Re(pole position) = 2150 to 2250 ( $\approx$ 2200) MeV  
 $-2\text{Im}(\text{pole position}) = 350$  to 550 ( $\approx$ 450) MeV

$N(2250)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–15%	938

 **$N(2600)I_{1,11}$** 

$$I(J^P) = \frac{1}{2}(\frac{11}{2}^-)$$

Breit–Wigner mass = 2550 to 2750 ( $\approx 2600$ ) MeV  
 Breit–Wigner full width = 500 to 800 ( $\approx 650$ ) MeV  
 $p_{\text{beam}} = 3.12\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 3.86$  mb

$N(2600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–10%	1126

 **$\Delta$  BARYONS****( $S = 0, I = 3/2$ )**

$$\Delta^{++} = uuu, \quad \Delta^+ = uud, \quad \Delta^0 = udd, \quad \Delta^- = ddd$$

 **$\Delta(1232)P_{33}$** 

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit–Wigner mass (mixed charges) = 1231 to 1233 ( $\approx 1232$ ) MeV  
 Breit–Wigner full width (mixed charges) = 116 to 120 ( $\approx 118$ ) MeV  
 $p_{\text{beam}} = 0.30\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 94.8$  mb  
 Re(pole position) = 1209 to 1211 ( $\approx 1210$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 98$  to  $102$  ( $\approx 100$ ) MeV

$\Delta(1232)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	100%	229
$N\gamma$	0.52–0.60%	259
$N\gamma$ , helicity = 1/2	0.11–0.13%	259
$N\gamma$ , helicity = 3/2	0.41–0.47%	259

 **$\Delta(1600)P_{33}$** 

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit–Wigner mass = 1550 to 1700 ( $\approx 1600$ ) MeV  
 Breit–Wigner full width = 250 to 450 ( $\approx 350$ ) MeV  
 $p_{\text{beam}} = 0.87\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 18.6$  mb  
 Re(pole position) = 1500 to 1700 ( $\approx 1600$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 200$  to  $400$  ( $\approx 300$ ) MeV

$\Delta(1600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–25%	513
$N\pi\pi$	75–90%	477
$\Delta\pi$	40–70%	303
$N\rho$	<25%	†
$N(1440)\pi$	10–35%	82
$N\gamma$	0.001–0.02%	525
$N\gamma$ , helicity = 1/2	0.0–0.02%	525
$N\gamma$ , helicity = 3/2	0.001–0.005%	525

 **$\Delta(1620)S_{31}$** 

$$I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$$

Breit–Wigner mass = 1600 to 1660 ( $\approx 1630$ ) MeV  
 Breit–Wigner full width = 135 to 150 ( $\approx 145$ ) MeV  
 $p_{\text{beam}} = 0.93\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 17.2$  mb  
 Re(pole position) = 1590 to 1610 ( $\approx 1600$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 115$  to  $120$  ( $\approx 118$ ) MeV

$\Delta(1620)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	20–30%	534
$N\pi\pi$	70–80%	499
$\Delta\pi$	30–60%	328
$N\rho$	7–25%	†
$N\gamma$	0.004–0.044%	545
$N\gamma$ , helicity = 1/2	0.004–0.044%	545

 **$\Delta(1700)D_{33}$** 

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^-)$$

Breit–Wigner mass = 1670 to 1750 ( $\approx 1700$ ) MeV  
 Breit–Wigner full width = 200 to 400 ( $\approx 300$ ) MeV  
 $p_{\text{beam}} = 1.05\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 14.5$  mb  
 Re(pole position) = 1620 to 1680 ( $\approx 1650$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 160$  to  $240$  ( $\approx 200$ ) MeV

$\Delta(1700)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20%	581
$N\pi\pi$	80–90%	550
$\Delta\pi$	30–60%	386
$N\rho$	30–55%	†
$N\gamma$	0.12–0.26%	591
$N\gamma$ , helicity = 1/2	0.08–0.16%	591
$N\gamma$ , helicity = 3/2	0.025–0.12%	591

 **$\Delta(1905)F_{35}$** 

$$I(J^P) = \frac{3}{2}(s^+)$$

Breit–Wigner mass = 1865 to 1915 ( $\approx 1890$ ) MeV  
 Breit–Wigner full width = 270 to 400 ( $\approx 330$ ) MeV  
 $p_{\text{beam}} = 1.42\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 9.89$  mb  
 Re(pole position) = 1825 to 1835 ( $\approx 1830$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 265$  to  $300$  ( $\approx 280$ ) MeV

$\Delta(1905)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.09 to 0.15	704
$N\pi\pi$	85–95%	680
$\Delta\pi$	<25%	531
$N\rho$	>60%	397
$N\gamma$	0.01–0.03%	712
$N\gamma$ , helicity = 1/2	0.0–0.1%	712
$N\gamma$ , helicity = 3/2	0.004–0.03%	712

 **$\Delta(1910)P_{31}$** 

$$I(J^P) = \frac{3}{2}(1^+)$$

Breit–Wigner mass = 1870 to 1920 ( $\approx 1910$ ) MeV  
 Breit–Wigner full width = 190 to 270 ( $\approx 250$ ) MeV  
 $p_{\text{beam}} = 1.46\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 9.54$  mb  
 Re(pole position) = 1830 to 1880 ( $\approx 1855$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 200$  to  $500$  ( $\approx 350$ ) MeV

$\Delta(1910)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	15–30%	717
$N\gamma$	0.0–0.2%	725
$N\gamma$ , helicity = 1/2	0.0–0.2%	725

 **$\Delta(1920)P_{33}$** 

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit–Wigner mass = 1900 to 1970 ( $\approx 1920$ ) MeV  
 Breit–Wigner full width = 150 to 300 ( $\approx 200$ ) MeV

$$p_{\text{beam}} = 1.48\text{GeV}/c \quad 4\pi\bar{\lambda}^2 = 9.37 \text{ mb}$$

Re(pole position) = 1850 to 1950 ( $\approx 1900$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 200$  to  $400$  ( $\approx 300$ ) MeV

$\Delta(1920)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–20%	723
$\Sigma K$	( $2.10 \pm 0.30$ )%	431



$\Delta(1930)D_{35}$	$I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$
Breit–Wigner mass = 1900 to 2020 ( $\approx 1960$ ) MeV	
Breit–Wigner full width = 220 to 500 ( $\approx 360$ ) MeV	
$p_{\text{beam}} = 1.56\text{GeV}/c$ $4\pi\lambda^2 = 8.76$ mb	
Re(pole position) = 1840 to 1960 ( $\approx 1900$ ) MeV	
$-2\text{Im}(\text{pole position}) = 175$ to $360$ ( $\approx 270$ ) MeV	

$\Delta(1930)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.05 to 0.15	748
$N\gamma$	0.0–0.02%	755
$N\gamma$ , helicity = 1/2	0.0–0.01%	755
$N\gamma$ , helicity = 3/2	0.0–0.01%	755

$\Delta(1950)F_{37}$	$I(J^P) = \frac{3}{2}(\frac{7}{2}^+)$
Breit–Wigner mass = 1915 to 1950 ( $\approx 1930$ ) MeV	
Breit–Wigner full width = 235 to 335 ( $\approx 285$ ) MeV	
$p_{\text{beam}} = 1.50\text{GeV}/c$ $4\pi\lambda^2 = 9.21$ mb	
Re(pole position) = 1870 to 1890 ( $\approx 1880$ ) MeV	
$-2\text{Im}(\text{pole position}) = 220$ to $260$ ( $\approx 240$ ) MeV	

$\Delta(1950)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	0.35 to 0.45	729
$N\pi\pi$		706
$\Delta\pi$	20–30%	560
$N\rho$	<10%	442
$N\gamma$	0.08–0.13%	737
$N\gamma$ , helicity = 1/2	0.03–0.055%	737
$N\gamma$ , helicity = 3/2	0.05–0.075%	737

$\Delta(2420)H_{3,11}$	$I(J^P) = \frac{3}{2}(\frac{11}{2}^+)$
Breit–Wigner mass = 2300 to 2500 ( $\approx 2420$ ) MeV	
Breit–Wigner full width = 300 to 500 ( $\approx 400$ ) MeV	
$p_{\text{beam}} = 2.64\text{GeV}/c$ $4\pi\lambda^2 = 4.68$ mb	
Re(pole position) = 2260 to 2400 ( $\approx 2330$ ) MeV	
$-2\text{Im}(\text{pole position}) = 350$ to $750$ ( $\approx 550$ ) MeV	

$\Delta(2420)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–15%	1023

<b><math>\Lambda</math> BARYONS</b>
$(S = -1, I = 0)$
$\Lambda^0 = uds$

$\Lambda$	$I(J^P) = 0(\frac{1}{2}^+)$
Mass $m = 1115.683 \pm 0.006$ MeV	
$(m_\Lambda - m_{\bar{\Lambda}})/m_\Lambda = (-0.1 \pm 1.1) \times 10^{-5}$ ( $S = 1.6$ )	
Mean life $\tau = (2.631 \pm 0.020) \times 10^{-10}$ ( $S = 1.6$ )	
$(\tau_\Lambda - \tau_{\bar{\Lambda}})/\tau_\Lambda = -0.001 \pm 0.009$	
$c\tau = 7.89$ cm	
Magnetic moment $\mu = -0.613 \pm 0.004\mu_N$	
Electric dipole moment $d < 1.5 \times 10^{-16}e$ cm, CL = 95%	

<b>Decay parameters</b>	
$p\pi^-$	$\alpha_- = 0.642 \pm 0.013$
"	$\phi_- = (-6.5 \pm 3.5)^\circ$
"	$\gamma_- = 0.76^{[i]}$
"	$\Delta_- = (8 \pm 4)^\circ^{[i]}$
$n\pi^0$	$\alpha_0 = 0.65 \pm 0.04$
$pe^- \bar{\nu}_e$	$g_A/g_V = -0.718 \pm 0.015^{[f]}$

$\Lambda$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$p\pi^-$	$(63.9 \pm 0.5)\%$	101
$n\pi^0$	$(35.8 \pm 0.5)\%$	104
$n\gamma$	$(1.75 \pm 0.15) \times 10^{-3}$	162
$p\pi^- \gamma$	$[j] \quad (8.4 \pm 1.4) \times 10^{-4}$	101
$pe^- \bar{\nu}_e$	$(8.32 \pm 0.14) \times 10^{-4}$	163
$p\mu^- \bar{\nu}_\mu$	$(1.57 \pm 0.35) \times 10^{-4}$	131

$\Lambda(1405)S_{01}$	$I(J^P) = 0(\frac{1}{2}^-)$
Mass $m = 1406 \pm 4$ MeV	
Full width $\Gamma = 50 \pm 2$ MeV	
Below $\bar{K}N$ threshold	

$\Lambda(1405)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Sigma\pi$	100%	157

$\Lambda(1520)D_{03}$	$I(J^P) = 0(\frac{3}{2}^-)$
Mass $m = 1519.5 \pm 1.0$ MeV <sup>[k]</sup>	
Full width $\Gamma = 15.6 \pm 1.0$ MeV <sup>[k]</sup>	
$p_{\text{beam}} = 0.39\text{GeV}/c$ $4\pi\lambda^2 = 82.8$ mb	

$\Lambda(1520)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	45 $\pm$ 1%	243
$\Sigma\pi$	42 $\pm$ 1%	268
$\Delta\pi\pi$	10 $\pm$ 1%	259
$\Sigma\pi\pi$	0.9 $\pm$ 0.1%	169
$\Delta\gamma$	0.85 $\pm$ 0.15%	350

$\Lambda(1600)P_{01}$	$I(J^P) = 0(\frac{1}{2}^+)$
Mass $m = 1560$ to $1700$ ( $\approx 1600$ ) MeV	
Full width $\Gamma = 50$ to $250$ ( $\approx 150$ ) MeV	
$p_{\text{beam}} = 0.58\text{GeV}/c$ $4\pi\lambda^2 = 41.6$ mb	

$\Lambda(1600)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	15–30%	343
$\Sigma\pi$	10–60%	338

$\Lambda(1670)S_{01}$	$I(J^P) = 0(\frac{1}{2}^-)$
Mass $m = 1660$ to $1680$ ( $\approx 1670$ ) MeV	
Full width $\Gamma = 25$ to $50$ ( $\approx 35$ ) MeV	
$p_{\text{beam}} = 0.74\text{GeV}/c$ $4\pi\lambda^2 = 28.5$ mb	

$\Lambda(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–30%	414
$\Sigma\pi$	25–55%	394
$\Delta\eta$	10–25%	71

$\Lambda(1690)D_{03}$	$I(J^P) = 0(\frac{3}{2}^-)$
Mass $m = 1685$ to $1695$ ( $\approx 1690$ ) MeV	
Full width $\Gamma = 50$ to $70$ ( $\approx 60$ ) MeV	
$p_{\text{beam}} = 0.78\text{GeV}/c$ $4\pi\lambda^2 = 26.1$ mb	

$\Lambda(1690)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–30%	433
$\Sigma\pi$	20–40%	410
$\Delta\pi\pi$	$\sim 25\%$	419
$\Sigma\pi\pi$	$\sim 20\%$	358

**$\Lambda(1800)S_{01}$** 

$$I(J^P) = 0(\frac{1}{2}^-)$$

Mass  $m = 1720$  to  $1850$  ( $\approx 1800$ ) MeV  
 Full width  $\Gamma = 200$  to  $400$  ( $\approx 300$ ) MeV  
 $p_{\text{beam}} = 1.01\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 17.5$  mb

$\Lambda(1800)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	25–40%	528
$\Sigma\pi$	seen	494
$\Sigma(1385)\pi$	seen	349
$N\bar{K}^*$ (892)	seen	†

 **$\Lambda(1810)P_{01}$** 

$$I(J^P) = 0(\frac{1}{2}^+)$$

Mass  $m = 1750$  to  $1850$  ( $\approx 1810$ ) MeV  
 Full width  $\Gamma = 50$  to  $250$  ( $\approx 150$ ) MeV  
 $p_{\text{beam}} = 1.04\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 17.0$  mb

$\Lambda(1810)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–50%	537
$\Sigma\pi$	10–40%	501
$\Sigma(1385)\pi$	seen	357
$N\bar{K}^*$ (892)	30–60%	†

 **$\Lambda(1820)F_{05}$** 

$$I(J^P) = 0(\frac{5}{2}^+)$$

Mass  $m = 1815$  to  $1825$  ( $\approx 1820$ ) MeV  
 Full width  $\Gamma = 70$  to  $90$  ( $\approx 80$ ) MeV  
 $p_{\text{beam}} = 1.06\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 16.5$  mb

$\Lambda(1820)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	55–65%	545
$\Sigma\pi$	8–14%	509
$\Sigma(1385)\pi$	5–10%	366

 **$\Lambda(1830)D_{05}$** 

$$I(J^P) = 0(\frac{5}{2}^-)$$

Mass  $m = 1810$  to  $1830$  ( $\approx 1830$ ) MeV  
 Full width  $\Gamma = 60$  to  $110$  ( $\approx 95$ ) MeV  
 $p_{\text{beam}} = 1.08\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 16.0$  mb

$\Lambda(1830)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	3–10%	553
$\Sigma\pi$	35–75%	516
$\Sigma(1385)\pi$	>15%	374

 **$\Lambda(1890)P_{03}$** 

$$I(J^P) = 0(\frac{3}{2}^+)$$

Mass  $m = 1850$  to  $1910$  ( $\approx 1890$ ) MeV  
 Full width  $\Gamma = 60$  to  $200$  ( $\approx 100$ ) MeV  
 $p_{\text{beam}} = 1.21\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 13.6$  mb

$\Lambda(1890)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	20–35%	599
$\Sigma\pi$	3–10%	560
$\Sigma(1385)\pi$	seen	423
$N\bar{K}^*$ (892)	seen	236

 **$\Lambda(2100)G_{07}$** 

$$I(J^P) = 0(\frac{7}{2}^-)$$

Mass  $m = 2090$  to  $2110$  ( $\approx 2100$ ) MeV  
 Full width  $\Gamma = 100$  to  $250$  ( $\approx 200$ ) MeV  
 $p_{\text{beam}} = 1.68\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 8.68$  mb

$\Lambda(2100)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	25–35%	751
$\Sigma\pi$	$\sim 5\%$	705
$\Delta\eta$	<3%	617
$\Xi K$	<3%	491
$\Delta\omega$	<8%	443
$N\bar{K}^*$ (892)	10–20%	515

 **$\Lambda(2110)F_{05}$** 

$$I(J^P) = 0(\frac{5}{2}^+)$$

Mass  $m = 2090$  to  $2140$  ( $\approx 2110$ ) MeV  
 Full width  $\Gamma = 150$  to  $250$  ( $\approx 200$ ) MeV  
 $p_{\text{beam}} = 1.70\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 8.53$  mb

$\Lambda(2110)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	5–25%	757
$\Sigma\pi$	10–40%	711
$\Delta\omega$	seen	455
$\Sigma(1385)\pi$	seen	591
$N\bar{K}^*$ (892)	10–60%	525

 **$\Lambda(2350)H_{09}$** 

$$I(J^P) = 0(\frac{9}{2}^+)$$

Mass  $m = 2340$  to  $2370$  ( $\approx 2350$ ) MeV  
 Full width  $\Gamma = 100$  to  $250$  ( $\approx 150$ ) MeV  
 $p_{\text{beam}} = 2.29\text{GeV}/c$   $4\pi\bar{\lambda}^2 = 5.85$  mb

$\Lambda(2350)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	$\sim 12\%$	915
$\Sigma\pi$	$\sim 10\%$	867

 **$\Sigma$  BARYONS**

$$(S = -1, I = 1)$$

$$\Sigma^+ = uus, \quad \Sigma^0 = uds, \quad \Sigma^- = dds$$

 **$\Sigma^+$** 

$$I(J^P) = 1(\frac{1}{2}^+)$$

Mass  $m = 1189.37 \pm 0.07$  MeV ( $S = 2.2$ )  
 Mean life  $\tau = (0.8018 \pm 0.0026) \times 10^{-10}$  s  
 $c\tau = 2.404$  cm  
 $(\tau_{\Sigma^+} - \tau_{\Sigma^-})/\tau_{\Sigma^+} = (-0.6 \pm 1.2) \times 10^{-3}$   
 Magnetic moment  $\mu = 2.458 \pm 0.010\mu_N$  ( $S = 2.1$ )  
 $\Gamma(\Sigma^+ \rightarrow n\ell^+\nu)/\Gamma(\Sigma^- \rightarrow n\ell^-\bar{\nu}) < 0.043$

**Decay parameters**

$p\pi^0$	$\alpha_0 = -0.980^{+0.017}_{-0.015}$
"	$\phi_0 = (36 \pm 34)^\circ$
"	$\gamma_0 = 0.16^{[i]}$
"	$\Delta_0 = (187 \pm 6)^{\circ[i]}$
$n\pi^+$	$\alpha_+ = 0.068 \pm 0.013$
"	$\phi_+ = (167 \pm 20)^\circ$ ( $S = 1.1$ )
"	$\gamma_+ = -0.97^{[i]}$
"	$\Delta_+ = (-73^{+133}_{-10})^{\circ[i]}$
$p\gamma$	$\alpha_\gamma = -0.76 \pm 0.08$

$\Sigma^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$p\pi^0$	$(51.57 \pm 0.30) \%$		189
$n\pi^+$	$(48.31 \pm 0.30) \%$		185
$p\gamma$	$(1.23 \pm 0.05) \times 10^{-3}$		225
$n\pi^+\gamma$	[j] $(4.5 \pm 0.5) \times 10^{-4}$		185
$\Lambda e^+ \bar{\nu}_e$	$(2.0 \pm 0.5) \times 10^{-5}$		71
$\Delta S = \Delta Q(SQ)$ violating modes or $\Delta S = 1$ weak neutral current (SI) modes			
$ne^+ \bar{\nu}_e$	$SQ < 5$	$\times 10^{-6}$ 90%	224
$n\mu^+ \bar{\nu}_\mu$	$SQ < 3.0$	$\times 10^{-5}$ 90%	202
$pe^+ e^-$	SI $< 7$	$\times 10^{-6}$	225
$p\mu^+ \mu^-$	SI $(9_{-8}^+)$	$\times 10^{-8}$	121

$$\boxed{\Sigma^0} \quad I(J^P) = 1\left(\frac{1}{2}^+\right)$$

Mass  $m = 1192.642 \pm 0.024$  MeV

$m_{\Sigma^-} - m_{\Sigma^0} = 4.807 \pm 0.035$  MeV ( $S = 1.1$ )

$m_{\Sigma^0} - m_\Lambda = 76.959 \pm 0.023$  MeV

Mean life  $\tau = (7.4 \pm 0.7) \times 10^{-20}$  s

$c\tau = 2.22 \times 10^{-11}$  m

Transition magnetic moment  $|\mu_{\Sigma\Lambda}| = 1.61 \pm 0.08 \mu_N$

$\Sigma^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Lambda\gamma$	100%		74
$\Lambda\gamma\gamma$	$< 3\%$	90%	74
$\Lambda e^+ e^-$	[j] $5 \times 10^{-3}$		74

$$\boxed{\Sigma^-} \quad I(J^P) = 1\left(\frac{1}{2}^+\right)$$

Mass  $m = 1197.449 \pm 0.030$  MeV ( $S = 1.2$ )

$m_{\Sigma^-} - m_{\Sigma^+} = 8.08 \pm 0.08$  MeV ( $S = 1.9$ )

$m_{\Sigma^-} - m_\Lambda = 81.766 \pm 0.030$  MeV ( $S = 1.2$ )

Mean life  $\tau = (1.479 \pm 0.011) \times 10^{-10}$  s ( $S = 1.3$ )

$c\tau = 4.434$  cm

Magnetic moment  $\mu = -1.160 \pm 0.025 \mu_N$  ( $S = 1.7$ )

$\Sigma^-$  charge radius =  $0.78 \pm 0.10$  fm

#### Decay parameters

$n\pi^-$	$\alpha_- = -0.068 \pm 0.008$
"	$\phi_- = (10 \pm 15)^\circ$
"	$\gamma_- = 0.98^{[i]}$
"	$\Delta_- = (249_{-120}^{+12})^{e[i]}$
$ne^- \bar{\nu}_e$	$g_A/g_V = 0.340 \pm 0.017^{[f]}$
"	$f_2(0)/f_1(0) = 0.97 \pm 0.14$
"	$D = 0.11 \pm 0.10$
$\Lambda e^- \bar{\nu}_e$	$g_V/g_A = 0.01 \pm 0.10^{[f]}$ ( $S = 1.5$ )
"	$g_{WM}/g_A = 2.4 \pm 1.7^{[f]}$

$\Sigma^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$n\pi^-$	$(99.848 \pm 0.005)\%$	193
$n\pi^-\gamma$	[j] $4.6 \pm 0.6 \times 10^{-4}$	193
$ne^- \bar{\nu}_e$	$(1.017 \pm 0.034) \times 10^{-3}$	230
$n\mu^- \bar{\nu}_\mu$	$(4.5 \pm 0.4) \times 10^{-4}$	210
$\Lambda e^- \bar{\nu}_e$	$(5.73 \pm 0.27) \times 10^{-5}$	79

$$\boxed{\Sigma(1385)P_{13}} \quad I(J^P) = 1\left(\frac{3}{2}^+\right)$$

$\Sigma(1385)^+$  mass  $m = 1382.8 \pm 0.4$  MeV ( $S = 2.0$ )

$\Sigma(1385)^0$  mass  $m = 1383.7 \pm 1.0$  MeV ( $S = 1.4$ )

$\Sigma(1385)^-$  mass  $m = 1387.2 \pm 0.5$  MeV ( $S = 2.2$ )

$\Sigma(1385)^+$  full width  $\Gamma = 35.8 \pm 0.8$  MeV

$\Sigma(1385)^0$  full width  $\Gamma = 36 \pm 5$  MeV

$\Sigma(1385)^-$  full width  $\Gamma = 39.4 \pm 2.1$  MeV ( $S = 1.7$ )

Below  $\bar{K}$  N threshold

$\Sigma(1385)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Lambda\pi$	$(87.0 \pm 1.5) \%$		208
$\Sigma\pi$	$(11.7 \pm 1.5) \%$		129
$\Lambda\gamma$	$(1.3 \pm 0.4) \%$		241
$\Sigma^-\gamma$	$< 2.4$	$\times 10^{-4}$ 90%	173

$$\boxed{\Sigma(1660)P_{11}} \quad I(J^P) = 1\left(\frac{1}{2}^+\right)$$

Mass  $m = 1630$  to  $1690$  ( $\approx 1660$ ) MeV

Full width  $\Gamma = 40$  to  $200$  ( $\approx 100$ ) MeV

$p_{\text{beam}} = 0.72 \text{ GeV}/c$   $4\pi\lambda^2 = 29.9$  mb

$\Sigma(1660)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	10–30%	405
$\Lambda\pi$	seen	440
$\Sigma\pi$	seen	387

$$\boxed{\Sigma(1670)D_{13}} \quad I(J^P) = 1\left(\frac{3}{2}^-\right)$$

Mass  $m = 1665$  to  $1685$  ( $\approx 1670$ ) MeV

Full width  $\Gamma = 40$  to  $80$  ( $\approx 60$ ) MeV

$p_{\text{beam}} = 0.74 \text{ GeV}/c$   $4\pi\lambda^2 = 28.5$  mb

$\Sigma(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	7–13%	414
$\Lambda\pi$	5–15%	448
$\Sigma\pi$	30–60%	394

$$\boxed{\Sigma(1750)S_{11}} \quad I(J^P) = 1\left(\frac{1}{2}^-\right)$$

Mass  $m = 1730$  to  $1800$  ( $\approx 1750$ ) MeV

Full width  $\Gamma = 60$  to  $160$  ( $\approx 90$ ) MeV

$p_{\text{beam}} = 0.91 \text{ GeV}/c$   $4\pi\lambda^2 = 20.7$  mb

$\Sigma(1750)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	10–40%	486
$\Lambda\pi$	seen	507
$\Sigma\pi$	$< 8\%$	456
$\Sigma\eta$	15–55%	99

$$\boxed{\Sigma(1775)D_{15}} \quad I(J^P) = 1\left(\frac{5}{2}^-\right)$$

Mass  $m = 1770$  to  $1780$  ( $\approx 1775$ ) MeV

Full width  $\Gamma$  105 to 135 ( $\approx 120$ ) MeV

$p_{\text{beam}} = 0.96 \text{ GeV}/c$   $4\pi\lambda^2 = 19.0$  mb

$\Sigma(1775)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	37–43%	508
$\Lambda\pi$	14–20%	525
$\Sigma\pi$	2–5%	475
$\Sigma(1385)\pi$	8–12%	327
$\Lambda(1520)\pi$	17–23%	201

$$\boxed{\Sigma(1915)F_{15}} \quad I(J^P) = 1\left(\frac{5}{2}^+\right)$$

Mass  $m = 1900$  to  $1935$  ( $\approx 1915$ ) MeV

Full width  $\Gamma = 80$  to  $160$  ( $\approx 120$ ) MeV

$p_{\text{beam}} = 1.26 \text{ GeV}/c$   $4\pi\lambda^2 = 12.8$  mb

$\Sigma(1915)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	5–15%	618
$\Lambda\pi$	seen	623
$\Sigma\pi$	seen	577
$\Sigma(1385)\pi$	$< 5\%$	443

**$\Sigma(1940)D_{13}$** 

$$I(J^P) = 1\left(\frac{3}{2}^-\right)$$

Mass  $m = 1900$  to  $1950$  ( $\approx 1940$ ) MeVFull width  $\Gamma = 150$  to  $300$  ( $\approx 220$ ) MeV

$$p_{\text{beam}} = 1.32\text{GeV}/c \quad 4\pi\bar{\lambda}^2 = 12.1 \text{ mb}$$

$\Sigma(1940)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	<20%	637
$\Lambda\pi$	seen	640
$\Sigma\pi$	seen	595
$\Sigma(1385)\pi$	seen	463
$\Lambda(1520)\pi$	seen	355
$\Delta(1232)\bar{K}$	seen	410
$N\bar{K}^*$ (892)	seen	322

 **$\Sigma(2030)F_{17}$** 

$$I(J^P) = 1\left(\frac{7}{2}^+\right)$$

Mass  $m = 2025$  to  $2040$  ( $\approx 2030$ ) MeVFull width  $\Gamma = 150$  to  $200$  ( $\approx 180$ ) MeV

$$p_{\text{beam}} = 1.52\text{GeV}/c \quad 4\pi\bar{\lambda}^2 = 9.93 \text{ mb}$$

$\Sigma(2030)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	17-23%	702
$\Lambda\pi$	17-23%	700
$\Sigma\pi$	5-10%	657
$\Xi K$	<2%	422
$\Sigma(1385)\pi$	5-15%	532
$\Lambda(1520)\pi$	10-20%	430
$\Delta(1232)\bar{K}$	10-20%	498
$N\bar{K}^*$ (892)	<5%	439

 **$\Sigma(2250)$** 

$$I(J^P) = 1(\frac{3}{2}^?)$$

Mass  $m = 2210$  to  $2280$  ( $\approx 2250$ ) MeVFull width  $\Gamma = 60$  to  $150$  ( $\approx 100$ ) MeV

$$p_{\text{beam}} = 2.04\text{GeV}/c \quad 4\pi\bar{\lambda}^2 = 6.76 \text{ mb}$$

$\Sigma(2250)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\bar{K}$	<10%	851
$\Lambda\pi$	seen	842
$\Sigma\pi$	seen	803

 **$\Xi$  BARYONS**

$$(S = -2, I = 1)2$$

$$\Xi^0 = uss, \Xi^- = dss$$

 **$\Xi^0$** 

$$I(J^P) = \frac{1}{2}\left(\frac{1}{2}^+\right)$$

 $P$  is not yet measured; + is the quark model prediction.Mass  $m = 1314.83 \pm 0.20$  MeV

$$m_{\Xi^-} - m_{\Xi^0} = 6.48 \pm 0.24 \text{ MeV}$$

Mean life  $\tau = (2.90 \pm 0.09) \times 10^{-10}$  s

$$c\tau = 8.71 \text{ cm}$$

Magnetic moment  $\mu = -1.250 \pm 0.014\mu_N$ **Decay parameters**

$$\Lambda\pi^0 \quad \alpha = -0.411 \pm 0.022 (S = 2.1)$$

$$" \quad \phi = (21 \pm 12)^\circ$$

$$" \quad \gamma = 0.85^{[i]}$$

$$" \quad \Delta = (218_{-19}^{+12})^{[i]}$$

$$\Lambda\gamma \quad \alpha = -0.73 \pm 0.17$$

$$\Sigma^0\gamma \quad \alpha = -0.63 \pm 0.09$$

$$\Sigma^+ e^- \bar{\nu}_e \quad g_1(0)/f_1(0) = 1.32_{-0.18}^{+0.22}$$

$$\Sigma^+ e^- \bar{\nu}_e \quad f_2(0)/f_1(0) = 2.0 \pm 1.3$$

$\Xi^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Lambda\pi^0$	$(99.523 \pm 0.013)\%$		135
$\Lambda\gamma$	$(1.17 \pm 0.07) \times 10^{-3}$		184
$\Sigma^0\gamma$	$(3.33 \pm 0.10) \times 10^{-3}$		117
$\Sigma^+ e^- \bar{\nu}_e$	$(2.7 \pm 0.4) \times 10^{-4}$		119
$\Sigma^+ \mu^- \bar{\nu}_\mu$	$(4.9_{-1.6}^{+2.1}) \times 10^{-6}$		64

 $\Delta S = \Delta Q(SQ)$  violating modes or $\Delta S = 2$  forbidden (S2) modes

$\Sigma^- e^+ \nu_e$	SQ	< 9	$\times 10^{-4}$	90%	112
$\Sigma^- \mu^+ \nu_\mu$	SQ	< 9	$\times 10^{-4}$	90%	49
$p\pi^-$	S2	< 8	$\times 10^{-6}$	90%	299
$p e^- \bar{\nu}_e$	S2	< 1.3	$\times 10^{-3}$		323
$p \mu^- \bar{\nu}_\mu$	S2	< 1.3	$\times 10^{-3}$		309

 **$\Xi^-$** 

$$I(J^P) = \frac{1}{2}\left(\frac{1}{2}^+\right)$$

 $P$  is not yet measured; + is the quark model prediction.Mass  $m = 1321.31 \pm 0.13$  MeVMean life  $\tau = (1.639 \pm 0.015) \times 10^{-10}$  s

$$c\tau = 4.91 \text{ cm}$$

Magnetic moment  $\mu = -0.6507 \pm 0.0025\mu_N$ **Decay parameters**

$$\Lambda\pi^- \quad \alpha = -0.458 \pm 0.012 (S = 1.8)$$

$$[\alpha(\Xi^-) \alpha_-(\Lambda) - \alpha(\Xi^+) \alpha_+(\bar{\Lambda})]/[\text{sum}] = (0 \pm 7) \times 10^{-4}$$

$$" \quad \phi = (-2.1 \pm 0.8)^\circ$$

$$" \quad \gamma = 0.89^{[i]}$$

$$" \quad \Delta = (175.9 \pm 1.5)^{[i]}$$

$$\Lambda e^- \bar{\nu}_e \quad g_A/g_V = -0.25 \pm 0.05^{[i]}$$

$\Xi^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Lambda\pi^-$	$(99.887 \pm 0.035)\%$		139
$\Sigma^- \gamma$	$(1.27 \pm 0.23) \times 10^{-4}$		118
$\Lambda e^- \bar{\nu}_e$	$(5.63 \pm 0.31) \times 10^{-4}$		190
$\Lambda \mu^- \bar{\nu}_\mu$	$(3.5_{-2.2}^{+3.5}) \times 10^{-4}$		163
$\Sigma^0 e^- \bar{\nu}_e$	$(8.7 \pm 1.7) \times 10^{-5}$		122
$\Sigma^0 \mu^- \bar{\nu}_\mu$	< 8	$\times 10^{-4}$	90% 70
$\Xi^0 e^- \bar{\nu}_e$	< 2.3	$\times 10^{-3}$	90% 6
$\Delta S = 2$ forbidden (S2) modes			
$n\pi^-$	S2 < 1.9	$\times 10^{-5}$	90% 303
$ne^- \bar{\nu}_e$	S2 < 3.2	$\times 10^{-3}$	90% 327
$n\mu^- \bar{\nu}_\mu$	S2 < 1.5	%	90% 313
$p\pi^- \pi^-$	S2 < 4	$\times 10^{-4}$	90% 223
$p\pi^- e^- \bar{\nu}_e$	S2 < 4	$\times 10^{-4}$	90% 304
$p\pi^- \mu^- \bar{\nu}_\mu$	S2 < 4	$\times 10^{-4}$	90% 250
$p\mu^- \mu^-$	L < 4	$\times 10^{-8}$	90% 272

 **$\Xi(1530)P_{13}$** 

$$I(J^P) = \frac{1}{2}\left(\frac{3}{2}^+\right)$$

 $\Xi(1530)^0$  mass  $m = 1531.80 \pm 0.32$  MeV ( $S = 1.3$ ) $\Xi(1530)^-$  mass  $m = 1535.0 \pm 0.6$  MeV $\Xi(1530)^0$  full width  $\Gamma = 9.1 \pm 0.5$  MeV $\Xi(1530)^-$  full width  $\Gamma = 9.9_{-1.9}^{+1.7}$  MeV

$\Xi(1530)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Xi\pi$	100%		158
$\Xi\gamma$	< 4%	90%	202

$\Xi(1690)$	$I(J^P) = \frac{1}{2}(\frac{3}{2}^?)$	
Mass $m = 1690 \pm 10 \text{ MeV}^{[k]}$		
Full width $\Gamma < 30 \text{ MeV}$		
$\Xi(1690)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda \bar{K}$	seen	240
$\Sigma \bar{K}$	seen	70
$\Xi \pi$	seen	311
$\Xi^- \pi^+ \pi^-$	possibly seen	214

$\Xi(1820)D_{13}$	$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$	
Mass $m = 1823 \pm 5 \text{ MeV}^{[k]}$		
Full width $\Gamma = 24_{-10}^{+15} \text{ MeV}^{[k]}$		
$\Xi(1820)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda \bar{K}$	large	402
$\Sigma \bar{K}$	small	324
$\Xi \pi$	small	421
$\Xi(1530)\pi$	small	237

$\Xi(1950)$	$I(J^P) = \frac{1}{2}(\frac{3}{2}^?)$	
Mass $m = 1950 \pm 15 \text{ MeV}^{[k]}$		
Full width $\Gamma = 60 \pm 20 \text{ MeV}^{[k]}$		
$\Xi(1950)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda \bar{K}$	seen	522
$\Sigma \bar{K}$	possibly seen	460
$\Xi \pi$	seen	519

$\Xi(2030)$	$I(J^P) = \frac{1}{2}(\geq \frac{5}{2}^?)$	
Mass $m = 2025 \pm 5 \text{ MeV}^{[k]}$		
Full width $\Gamma = 20_{-5}^{+15} \text{ MeV}^{[k]}$		
$\Xi(2030)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda \bar{K}$	$\sim 20\%$	585
$\Sigma \bar{K}$	$\sim 80\%$	529
$\Xi \pi$	small	574
$\Xi(1530)\pi$	small	416
$\Lambda \bar{K}\pi$	small	499
$\Sigma \bar{K}\pi$	small	428

<b><math>\Omega</math> BARYONS</b>	
$(S = -3, I = 0)$	
$\Omega^- = sss$	

$\Omega^-$	$I(J^P) = 0(\frac{3}{2}^+)$	
$J^P$ is not yet measured; $\frac{3}{2}^+$ is the quark model prediction.		
Mass $m = 1672.45 \pm 0.29 \text{ MeV}$		
$(m_{\Omega^-} - m_{\Omega^+})/m_{\Omega^-} = (-1 \pm 8) \times 10^{-5}$		
Mean life $\tau = (0.821 \pm 0.011) \times 10^{-10} \text{ s}$		
$c\tau = 2.461 \text{ cm}$		
$(\tau_{\Omega^-} - \tau_{\Omega^+})/\tau_{\Omega^-} = -0.002 \pm 0.040$		
Magnetic moment $\mu = -2.02 \pm 0.05 \mu_N$		

<b>Decay parameters</b>	
$\Lambda K^-$	$\alpha = 0.0175 \pm 0.0024$
$\frac{1}{2}[\alpha(\Lambda K^-) + \alpha(\bar{\Lambda} K^+)]$	$= 0.00 \pm 0.04$
$\Xi^0 \pi^-$	$\alpha = 0.09 \pm 0.14$
$\Xi^- \pi^0$	$\alpha = 0.05 \pm 0.21$

$\Omega^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	(MeV/c)
$\Lambda K^-$	$(67.8 \pm 0.7) \%$		211
$\Xi^0 \pi^-$	$(23.6 \pm 0.7) \%$		294
$\Xi^- \pi^0$	$(8.6 \pm 0.4) \%$		290
$\Xi^- \pi^+ \pi^-$	$(4.3_{-1.4}^{+3.4}) \times 10^{-4}$		190
$\Xi(1530)^0 \pi^-$	$(6.4_{-2.0}^{+5.1}) \times 10^{-4}$		17
$\Xi^0 e^- \bar{\nu}_e$	$(5.6 \pm 2.8) \times 10^{-3}$		319
$\Xi^- \gamma$	$< 4.6 \times 10^{-4}$	90%	314
$\Delta S = 2$ forbidden ( $S_2$ ) modes			
$\Lambda \pi^-$	$S_2 < 2.9 \times 10^{-6}$	90%	449

$\Omega(2250)^-$	$I(J^P) = 0(\frac{3}{2}^?)$	
Mass $m = 2252 \pm 9 \text{ MeV}$		
Full width $\Gamma = 55 \pm 18 \text{ MeV}$		
$\Omega(2250)^-$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi^- \pi^+ K^-$	seen	532
$\Xi(1530)^0 K^-$	seen	437

<b>CHARMED BARYONS (<math>C = +1</math>)</b>	
$\Lambda_c^+ = udc, \quad \Sigma_c^{++} = uuc, \quad \Sigma_c^+ = udc, \quad \Sigma_c^0 = ddc,$	
$\Xi_c^+ = usc, \quad \Xi_c^0 = dsc, \quad \Omega_c^0 = ssc$	

$\Lambda_c^+$	$I(J^P) = 0(\frac{1}{2}^+)$	
$J$ is not well measured; $\frac{1}{2}$ is the quark-model prediction.		
Mass $m = 2286.46 \pm 0.14 \text{ MeV}$		
Mean life $\tau = (200 \pm 6) \times 10^{-15} \text{ s}$ ( $S = 1.6$ )		
$c\tau = 59.9 \mu\text{m}$		

<b>Decay asymmetry parameters</b>	
$\Lambda \pi^+$	$\alpha = -0.91 \pm 0.15$
$\Sigma^+ \pi^0$	$\alpha = -0.45 \pm 0.32$
$\Lambda \ell^+ \nu_\ell$	$\alpha = -0.86 \pm 0.04$
$[\alpha(\Lambda_c^+) + \alpha(\bar{\Lambda}_c^-)]/[\alpha(\Lambda_c^+) - \alpha(\bar{\Lambda}_c^-)]$ in $\Lambda_c^+ \rightarrow \Lambda \pi^+, \bar{\Lambda}_c^- \rightarrow \bar{\Lambda} \pi^- = -0.07 \pm 0.31$	
$[\alpha(\Lambda_c^+) + \alpha(\bar{\Lambda}_c^-)]/[\alpha(\Lambda_c^+) - \alpha(\bar{\Lambda}_c^-)]$ in $\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e, \bar{\Lambda}_c^- \rightarrow \bar{\Lambda} e^- \bar{\nu}_e = 0.00 \pm 0.04$	

Nearly all branching fractions of the  $\Lambda_c^+$  are measured relative to the  $pK^- \pi^+$  mode, but there are no model-independent measurements of this branching fraction. We explain how we arrive at our value of  $B(\Lambda_c^+ \rightarrow pK^- \pi^+)$  in a Note at the beginning of the branching-ratio measurements in the Listings. When this branching fraction is eventually well determined, all the other branching fractions will slide up or down proportionally as the true value differs from the value we use here.

$\Lambda_c^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Hadronic modes with a <math>p</math>: <math>S = -1</math> final states</b>			
$p \bar{K}^0$	$(2.3 \pm 0.6) \%$		873
$p K^- \pi^+$	$[m] (5.0 \pm 1.3) \%$		823
$p \bar{K}^* (892)^0$	$[n] (1.6 \pm 0.5) \%$		685
$\Delta(1232)^{++} K^-$	$(8.6 \pm 3.0) \times 10^{-3}$		710
$\Lambda(1520) \pi^+$	$[n] (1.8 \pm 0.6) \%$		627
$p K^- \pi^+$ nonresonant	$(2.8 \pm 0.8) \%$		823
$p \bar{K}^0 \pi^0$	$(3.3 \pm 1.0) \%$		823
$p \bar{K}^0 \eta$	$(1.2 \pm 0.4) \%$		568
$p \bar{K}^0 \pi^+ \pi^-$	$(2.6 \pm 0.7) \%$		754
$p K^- \pi^+ \pi^0$	$(3.4 \pm 1.0) \%$		759
$p K^* (892)^- \pi^+$	$[n] (1.1 \pm 0.5) \%$		580
$p(K^- \pi^+)^{\text{nonresonant}} \pi^0$	$(3.6 \pm 1.2) \%$		759
$\Delta(1232) \bar{K}^* (892)$	seen		419
$p K^- \pi^+ \pi^+ \pi^-$	$(1.1 \pm 0.8) \times 10^{-3}$		671
$p K^- \pi^+ \pi^0 \pi^0$	$(8 \pm 4) \times 10^{-3}$		678

Hadronic modes with a $p$ : $S = 0$ final states			
$p\pi^+\pi^-$	$(3.5 \pm 2.0) \times 10^{-3}$		927
$p f_0(980)$	$[n] (2.8 \pm 1.9) \times 10^{-3}$		622
$p\pi^+\pi^+\pi^-\pi^-$	$(1.8 \pm 1.2) \times 10^{-3}$		852
$pK^+K^-$	$(7.7 \pm 3.5) \times 10^{-4}$		616
$p\phi$	$[n] (8.2 \pm 2.7) \times 10^{-4}$		590
$pK^+K^-$ non- $\phi$	$(3.5 \pm 1.7) \times 10^{-4}$		616
Hadronic modes with a hyperon: $S = -1$ final states			
$\Lambda\pi^+$	$(1.01 \pm 0.28)\%$		864
$\Lambda\pi^+\pi^0$	$(3.6 \pm 1.3)\%$		844
$\Lambda\rho^+$	$< 5\%$	CL = 95%	635
$\Lambda\pi^+\pi^+\pi^-$	$(2.6 \pm 0.7)\%$		807
$\Sigma(1385)^+\pi^+\pi^-, \Sigma^*+ \rightarrow \Lambda\pi^+$	$(7 \pm 4) \times 10^{-3}$		688
$\Sigma(1385)^-\pi^+\pi^+, \Sigma^*- \rightarrow \Lambda\pi^-$	$(5.5 \pm 1.7) \times 10^{-3}$		688
$\Lambda\pi^+\rho^0$	$(1.1 \pm 0.5)\%$		523
$\Sigma(1385)^+\rho^0, \Sigma^*+ \rightarrow \Lambda\pi^+$	$(3.7 \pm 3.1) \times 10^{-3}$		363
$\Lambda\pi^+\pi^+\pi^-$ nonresonant	$< 8 \times 10^{-3}$	CL = 90%	807
$\Lambda\pi^+\pi^+\pi^-\pi^0$ total	$(1.8 \pm 0.8)\%$		757
$\Lambda\pi^+\eta$	$[n] (1.8 \pm 0.6)\%$		691
$\Sigma(1385)^+\eta$	$[n] (8.5 \pm 3.3) \times 10^{-3}$		570
$\Lambda\pi^+\omega$	$[n] (1.2 \pm 0.5)\%$		517
$\Lambda\pi^+\pi^+\pi^-\pi^0$ , no $\eta$ or $\omega$	$< 7 \times 10^{-3}$	CL = 90%	757
$\Lambda K + \bar{K}^0$	$(6.5 \pm 2.0) \times 10^{-3}$		443
$\Xi(1690)^0 K^+, \Xi^*0 \rightarrow \Lambda \bar{K}^0$	$(1.9 \pm 0.7) \times 10^{-3}$		286
$\Sigma^0\pi^+$	$(1.04 \pm 0.31)\%$		825
$\Sigma^+\pi^0$	$(1.00 \pm 0.34)\%$		827
$\Sigma^+\eta$	$(5.5 \pm 2.3) \times 10^{-3}$		714
$\Sigma^+\pi^+\pi^-$	$(3.6 \pm 1.0)\%$		804
$\Sigma^+\rho^0$	$< 1.4\%$	CL = 95%	575
$\Sigma^-\pi^+\pi^+$	$(1.9 \pm 0.8)\%$		799
$\Sigma^0\pi^+\pi^0$	$(1.8 \pm 0.8)\%$		803
$\Sigma^0\pi^+\pi^+\pi^-$	$(8.3 \pm 3.1) \times 10^{-3}$		763
$\Sigma^+\pi^+\pi^-\pi^0$	—		767
$\Sigma^+\omega$	$[n] (2.7 \pm 1.0)\%$		569
$\Sigma^+K^+K^-$	$(2.8 \pm 0.8) \times 10^{-3}$		349
$\Sigma^+\phi$	$[n] (3.2 \pm 1.0) \times 10^{-3}$		295
$\Xi(1690)^0 K^+, \Xi^*0 \rightarrow \Sigma^+ K^-$	$(8.2 \pm 3.1) \times 10^{-4}$		286
$\Sigma^+K^+K^-$ nonresonant	$< 7 \times 10^{-4}$	CL = 90%	349
$\Xi^0 K^+$	$(3.9 \pm 1.4) \times 10^{-3}$		653
$\Xi^- K^+\pi^+$	$(4.9 \pm 1.7) \times 10^{-3}$		566
$\Xi(1530)^0 K^+$	$[n] (2.6 \pm 1.0) \times 10^{-3}$		473
Hadronic modes with a hyperon: $S = 0$ final states			
$\Lambda K^+$	$(7.5 \pm 2.6) \times 10^{-4}$		781
$\Sigma^0 K^+$	$(5.8 \pm 2.4) \times 10^{-4}$		735
$\Sigma^+ K^+\pi^-$	$(1.7 \pm 0.7) \times 10^{-3}$		670
$\Sigma^+ K^*(892)^0$	$[n] (2.8 \pm 1.1) \times 10^{-3}$		470
$\Sigma^- K^+\pi^+$	$< 1.0 \times 10^{-3}$	CL = 90%	664
Doubly Cabibbo-suppressed modes			
$pK^+\pi^-$	$< 2.3 \times 10^{-4}$	CL = 90%	823
Semileptonic modes			
$\Lambda\ell^+\nu_\ell$	$[o] (2.0 \pm 0.6)\%$		871
$\Lambda e^+\nu_e$	$(2.1 \pm 0.6)\%$		871
$\Lambda\mu^+\nu_\mu$	$(2.0 \pm 0.7)\%$		867
Inclusive modes			
$e^+$ anything	$(4.5 \pm 1.7)\%$		—
$pe^+$ anything	$(1.8 \pm 0.9)\%$		—
$p$ anything	$(50 \pm 16)\%$		—
$p$ anything (no $\Lambda$ )	$(12 \pm 19)\%$		—
$n$ anything	$(50 \pm 16)\%$		—
$n$ anything (no $\Lambda$ )	$(29 \pm 17)\%$		—
$\Lambda$ anything	$(35 \pm 11)\%$	$S = 1.4$	—
$\Sigma^\pm$ anything	$[p] (10 \pm 5)\%$		—
3prongs	$(24 \pm 8)\%$		—
$\Delta C = 1$ weak neutral current (C1) modes, or Lepton number (L) violating modes			
$p\mu^+\mu^-$	C1 $< 3.4 \times 10^{-4}$	CL = 90%	937
$\Sigma^-\mu^+\mu^+$	L $< (7.0) \times 10^{-4}$	CL = 90%	812

$$\Lambda_c(2593)^+ \quad I(J^P) = 0(\frac{1}{2}^-)$$

The spin-parity follows from the fact that  $\Sigma_c(2455)\pi$  decays, with little available phase space, are dominant. This assumes that  $J^P = 1/2^+$  for the  $\Sigma_c(2455)$ .

$$\text{Mass } m = 2595.4 \pm 0.6 \text{ MeV } (S = 1.1)$$

$$m - m_{\Lambda_c^+} = 308.9 \pm 0.6 \text{ MeV } (S = 1.1)$$

$$\text{Full width } \Gamma = 3.6_{-1.3}^{+2.0} \text{ MeV}$$

$\Lambda_c^+\pi\pi$  and its submode  $\Sigma_c(2455)\pi$  — the latter just barely — are the only strong decays allowed to an excited  $\Lambda_c^+$  having this mass; and the submode seems to dominate.

$\Lambda_c(2593)^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda_c^+\pi^+\pi^-$	$[q] \approx 67\%$	124
$\Sigma_c(2455)^{++}\pi^-$	$24 \pm 7\%$	28
$\Sigma_c(2455)^0\pi^+$	$24 \pm 7\%$	28
$\Lambda_c^+\pi^+\pi^-$ 3-body	$18 \pm 10\%$	124
$\Lambda_c^+\pi^0$	$[r]$ not seen	261
$\Lambda_c^+\gamma$	not seen	291

$$\Lambda_c(2625)^+ \quad I(J^P) = 0(\frac{3}{2}^-)$$

$J^P$  has not been measured;  $\frac{3}{2}^-$  is the quark-model prediction.

$$\text{Mass } m = 2628.1 \pm 0.6 \text{ MeV } (S = 1.5)$$

$$m - m_{\Lambda_c^+} = 341.7 \pm 0.6 \text{ MeV } (S = 1.6)$$

$$\text{Full width } \Gamma < 1.9 \text{ MeV, CL} = 90\%$$

$\Lambda_c^+\pi\pi$  and its submode  $\Sigma(2455)\pi$  are the only strong decays allowed to an excited  $\Lambda_c^+$  having this mass.

$\Lambda_c(2625)^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\Lambda_c^+\pi^+\pi^-$	$[q] \approx 67\%$		184
$\Sigma_c(2455)^{++}\pi^-$	$< 5$	90%	102
$\Sigma_c(2455)^0\pi^+$	$< 5$	90%	102
$\Lambda_c^+\pi^+\pi^-$ 3-body	large		184
$\Lambda_c^+\pi^0$	$[r]$ not seen		293
$\Lambda_c^+\gamma$	not seen		319

$$\Sigma_c(2455) \quad I(J^P) = 1(\frac{1}{2}^+)$$

$J^P$  has not been measured;  $\frac{1}{2}^+$  is the quark-model prediction.

$$\Sigma_c(2455)^{++} \text{ mass } m = 2454.02 \pm 0.18 \text{ MeV}$$

$$\Sigma_c(2455)^+ \text{ mass } m = 2452.9 \pm 0.4 \text{ MeV}$$

$$\Sigma_c(2455)^0 \text{ mass } m = 2453.76 \pm 0.18 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Lambda_c^+} = 167.56 \pm 0.11 \text{ MeV}$$

$$m_{\Sigma_c^+} - m_{\Lambda_c^+} = 166.4 \pm 0.4 \text{ MeV}$$

$$m_{\Sigma_c^0} - m_{\Lambda_c^+} = 167.30 \pm 0.11 \text{ MeV}$$

$$m_{\Sigma_c^{++}} - m_{\Sigma_c^0} = 0.27 \pm 0.11 \text{ MeV } (S = 1.1)$$

$$m_{\Sigma_c^+} - m_{\Sigma_c^0} = -0.9 \pm 0.4 \text{ MeV}$$

$$\Sigma_c(2455)^{++} \text{ full width } \Gamma = 2.23 \pm 0.30 \text{ MeV}$$

$$\Sigma_c(2455)^+ \text{ full width } \Gamma < 4.6 \text{ MeV, CL} = 90\%$$

$$\Sigma_c(2455)^0 \text{ full width } \Gamma = 2.2 \pm 0.4 \text{ MeV } (S = 1.4)$$

$\Lambda_c^+\pi$  is the only strong decay allowed to a  $\Sigma_c$  having this mass.

$\Sigma_c(2455)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Lambda_c^+\pi$	$\approx 100\%$	94

$\Sigma_c(2520)$	$I(J^P) = 1(\frac{3}{2}^+)$
$J^P$ has not been measured; $\frac{3}{2}^+$ is the quark model prediction.	
$\Sigma_c(2520)^{++}$ mass $m = 2518.4 \pm 0.6$ MeV ( $S = 1.4$ )	
$\Sigma_c(2520)^+$ mass $m = 2517.5 \pm 2.3$ MeV	
$\Sigma_c(2520)^0$ mass $m = 2518.0 \pm 0.5$ MeV	
$m_{\Sigma_c(2520)^{++}} - m_{\Lambda_c^+} = 231.9 \pm 0.6$ MeV ( $S = 1.5$ )	
$m_{\Sigma_c(2520)^+} - m_{\Lambda_c^+} = 231.0 \pm 2.3$ MeV	
$m_{\Sigma_c(2520)^0} - m_{\Lambda_c^+} = 231.6 \pm 0.5$ MeV ( $S = 1.1$ )	
$m_{\Sigma_c(2520)^{++}} - m_{\Sigma_c(2520)^0} = 0.3 \pm 0.6$ MeV ( $S = 1.2$ )	
$\Sigma_c(2520)^{++}$ full width $\Gamma = 14.9 \pm 1.9$ MeV	
$\Sigma_c(2520)^+$ full width $\Gamma < 17$ MeV, CL = 90%	
$\Sigma_c(2520)^0$ full width $\Gamma = 16.1 \pm 2.1$ MeV	
$\Lambda_c^+\pi$ is the only strong decay allowed to a $\Sigma_c$ having this mass.	
$m_{\Sigma_c(2520)}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ ) $p$ (MeV/c)
$\Lambda_c^+\pi$	$\approx 100\%$ 180

$\Sigma_c(2800)$	$I(J^P) = 1(?^2)$
$\Sigma_c(2800)^{++}$ mass $m = 2801_{-6}^{+4}$	
$\Sigma_c(2800)^+$ mass $m = 2792_{-5}^{+14}$	
$\Sigma_c(2800)^0$ mass $m = 2802_{-7}^{+4}$	
$m_{\Sigma_c(2800)^{++}} - m_{\Lambda_c^+} = 514_{-6}^{+4}$	
$m_{\Sigma_c(2800)^+} - m_{\Lambda_c^+} = 505_{-5}^{+14}$	
$m_{\Sigma_c(2800)^0} - m_{\Lambda_c^+} = 515_{-7}^{+4}$	
$\Sigma_c(2800)^{++}$ full width $\Gamma = 75_{-17}^{+22}$	
$\Sigma_c(2800)^+$ full width $\Gamma = 62_{-40}^{+60}$	
$\Sigma_c(2800)^0$ full width $\Gamma = 61_{-18}^{+28}$	
$\Sigma_c(2800)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ ) $p$ (MeV/c)
$\Lambda_c^+\pi$	seen 443

$\Xi_c^+$	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$
$J^P$ has not been measured; $\frac{1}{2}^+$ is the quark model prediction.	
Mass $m = 2467.9 \pm 0.4$ MeV	
Mean life $\tau = (442 \pm 26) \times 10^{-15}$ s ( $S = 1.3$ )	
$c\tau = 132\mu$ m	

$\Xi_c^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
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No absolute branching fractions have been measured.  
The following are branching *ratios* relative to  $\Xi^- \pi^+ \pi^+$ .

	Cabibbo-favored ( $S = -2$ ) decays	
$pK_S^0 K_S^0$	[s] 0.087 $\pm$ 0.022	767
$\Lambda \bar{K}^0 \pi^+$	—	852
$\Sigma(1385)^+ \bar{K}^0$	[n,s] 1.0 $\pm$ 0.5	746
$\Lambda K^- \pi^+ \pi^+$	[s] 0.323 $\pm$ 0.033	787
$\Lambda \bar{K}^*(892)^0 \pi^+$	[n,s] < 0.2	90% 608
$\Sigma(1385)^+ K^- \pi^+$	[n,s] < 0.3	90% 678
$\Sigma^+ K^- \pi^+$	[s] 0.94 $\pm$ 0.11	811
$\Sigma^+ \bar{K}^*(892)^0$	[n,s] 0.81 $\pm$ 0.15	658
$\Sigma^0 K^- \pi^+ \pi^+$	[s] 0.29 $\pm$ 0.16	735
$\Xi^0 \pi^+$	[s] 0.55 $\pm$ 0.16	877
$\Xi^- \pi^+ \pi^+$	[s] DEFINED AS 1	851
$\Xi(1530)^0 \pi^+$	[n,s] < 0.1	90% 750
$\Xi^0 \pi^+ \pi^0$	[s] 2.34 $\pm$ 0.68	856
$\Xi^0 \pi^+ \pi^+ \pi^-$	[s] 1.74 $\pm$ 0.50	818
$\Xi^0 e^+ \nu_e$	[s] 2.3 $_{-0.9}^{+0.7}$	884
$\omega^- K^+ \pi^+$	[s] 0.07 $\pm$ 0.04	399

	Cabibbo-suppressed decays	
$pK^- \pi^+$	[s] 0.21 $\pm$ 0.03	944
$p\bar{K}^*(892)^0$	[n,s] 0.12 $\pm$ 0.02	828
$\Sigma^+ K^+ K^-$	[s] 0.15 $\pm$ 0.07	580
$\Sigma^+ \phi$	[n,s] < 0.11	90% 549
$\Xi(1690)^0 K^+, \Xi(1690)^0 \rightarrow \Sigma^+ K^-$	[s] < 0.05	90% 501

$\Xi_c^0$	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$
$J^P$ has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.	
Mass $m = 2471.0 \pm 0.4$ MeV	
$m_{\Xi_c^0} - m_{\Xi_c^+} = 3.1 \pm 0.5$ MeV	
Mean life $\tau = (112_{-10}^{+13}) \times 10^{-15}$ s	
$c\tau = 33.6\mu$ m	
<b>Decay asymmetry parameters</b>	
$\Xi^- \pi^+$	$\alpha = -0.6 \pm 0.4$
No absolute branching fractions have been measured. Several measurements of ratios of fractions may be found in the Listings that follow.	

$\Xi_c^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$pK^- K^- \pi^+$	seen	676
$pK^- \bar{K}^*(892)^0$	seen	413
$pK^- K^- \pi^+$ no $\bar{K}^*(892)^0$	seen	676
$\Lambda K_S^0$	seen	906
$\Lambda \bar{K}^0 \pi^+ \pi^-$	seen	787
$\Lambda K^- \pi^+ \pi^+ \pi^-$	seen	703
$\Xi^- \pi^+$	seen	875
$\Xi^- \pi^+ \pi^+ \pi^-$	seen	817
$\Omega^- K^+$	seen	523
$\Xi^- e^+ \nu_e$	seen	882
$\Xi^- \ell^+$ anything	seen	—

$\Xi_c^{*+}$	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$
$J^P$ has not been measured; $\frac{1}{2}^+$ is the quark-model prediction.	
Mass $m = 2575.7 \pm 3.1$ MeV	
$m_{\Xi_c^{*+}} - m_{\Xi_c^+} = 107.8 \pm 3.0$ MeV	
The $\Xi_c^{*+} - \Xi_c^+$ mass difference is too small for any strong decay to occur.	

$\Xi_c^{*+}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi_c^+ \gamma$	seen	106

$\Xi_c^{*0}$	$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$	
$J^P$ has not been measured; $\frac{1}{2}^+$ is the quark model prediction.		
Mass $m = 2578.0 \pm 2.9$ MeV		
$m_{\Xi_c^{*0}} - m_{\Xi_c^0} = 107.0 \pm 2.9$ MeV		
The $\Xi_c^{*0} - \Xi_c^0$ mass difference is too small for any strong decay to occur.		
$\Xi_c^{*0}$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi_c^0 \gamma$	seen	105

**$\Xi_c(2645)$** 

$$I(J^P) = \frac{1}{2}(\frac{3}{2}^+)$$

$J^P$  has not been measured;  $\frac{3}{2}^+$  is the quark-model prediction.  
 $\Xi_c(2645)^+$  mass  $m = 2646.6 \pm 1.4$  MeV (S = 1.6)  
 $\Xi_c(2645)^0$  mass  $m = 2646.1 \pm 1.2$  MeV  
 $m_{\Xi_c(2645)^+} - m_{\Xi_c^0} = 175.6 \pm 1.4$  MeV (S = 1.7)  
 $m_{\Xi_c(2645)^0} - m_{\Xi_c^+} = 178.2 \pm 1.1$  MeV  
 $\Xi_c(2645)^+$  full width  $\Gamma < 3.1$  MeV, CL = 90%  
 $\Xi_c(2645)^0$  full width  $\Gamma < 5.5$  MeV, CL = 90%  
 $\Xi_c\pi$  is the only strong decay allowed to a  $\Xi_c$  resonance having this mass.

$\Xi_c(2645)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi_c^0\pi^+$	seen	102
$\Xi_c^+\pi^-$	seen	107

 **$\Xi_c(2790)$** 

$$I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$$

$J^P$  has not been measured;  $\frac{1}{2}^-$  is the quark-model prediction.  
 $\Xi_c(2790)^+$  mass =  $2789.2 \pm 3.2$  MeV  
 $\Xi_c(2790)^0$  mass =  $2791.9 \pm 3.3$  MeV  
 $m_{\Xi_c(2790)^+} - m_{\Xi_c^0} = 318.2 \pm 3.2$  MeV  
 $m_{\Xi_c(2790)^0} - m_{\Xi_c^+} = 324.0 \pm 3.3$  MeV  
 $\Xi_c(2790)^+$  width  $< 15$  MeV, CL = 90%  
 $\Xi_c(2790)^0$  width  $< 12$  MeV, CL = 90%

$\Xi_c(2790)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi_c^+\pi^-$	seen	159

 **$\Xi_c(2815)$** 

$$I(J^P) = \frac{1}{2}(\frac{3}{2}^-)$$

$J^P$  has not been measured;  $\frac{3}{2}^-$  is the quark-model prediction.  
 $\Xi_c(2815)^+$  mass  $m = 2816.5 \pm 1.2$  MeV  
 $\Xi_c(2815)^0$  mass  $m = 2818.2 \pm 2.1$  MeV  
 $m_{\Xi_c(2815)^+} - m_{\Xi_c^+} = 348.6 \pm 1.2$  MeV  
 $m_{\Xi_c(2815)^0} - m_{\Xi_c^0} = 347.2 \pm 2.1$  MeV  
 $\Xi_c(2815)^+$  full width  $\Gamma < 3.5$  MeV, CL = 90%  
 $\Xi_c(2815)^0$  full width  $\Gamma < 6.5$  MeV, CL = 90%  
The  $\Xi_c\pi\pi$  modes are consistent with being entirely via  $\Xi_c(2645)\pi$ .

$\Xi_c(2815)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Xi_c^+\pi^+\pi^-$	seen	196
$\Xi_c^0\pi^+\pi^-$	seen	191

 **$\Omega_c^0$** 

$$I(J^P) = 0(\frac{1}{2}^+)$$

$J^P$  has not been measured;  $\frac{1}{2}^+$  is the quark-model prediction.  
Mass  $m = 2697.5 \pm 2.6$  MeV (S = 1.2)  
Mean life  $\tau = (69 \pm 12) \times 10^{-15}$  s  
 $c\tau = 21\mu\text{m}$   
No absolute branching fractions have been measured.

$\Omega_c^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\Sigma^+K^-K^-\pi^+$	seen	691
$\Xi^0K^-\pi^+$	seen	903
$\Xi^-K^-\pi^+\pi^+$	seen	832
$\Omega^-e^+v_e$	seen	830
$\Omega^-\pi^+$	seen	822
$\Omega^-\pi^+\pi^0$	seen	798
$\Omega^-\pi^-\pi^+\pi^+$	seen	754

**BOTTOM BARYONS**

$$(B = -1)$$

$$\Lambda_b^0 = udb, \Xi_b^0 = usb, \Xi_b^- = dsb$$

 **$\Lambda_b^0$** 

$$I(J^P) = 0(\frac{1}{2}^+)$$

$I(J^P)$  not yet measured;  $0(\frac{1}{2}^+)$  is the quark model prediction.  
Mass  $m = 5624 \pm 9$  MeV (S = 1.8)  
Mean life  $\tau = (1.230 \pm 0.074) \times 10^{-12}$  s  
 $c\tau = 369\mu\text{m}$

These branching fractions are actually an average over weakly decaying  $b$ -baryons weighted by their production rates in  $Z$  decay (or high-energy  $p\bar{p}$ ), branching ratios, and detection efficiencies. They scale with the LEP  $b$ -baryon production fraction  $B(b \rightarrow b\text{-baryon})$  and are evaluated for our value  $B(b \rightarrow b\text{-baryon}) = (10.0 \pm 2.0)\%$ .

The branching fractions  $B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell \text{ anything})$  and  $B(\Lambda_b^0 \rightarrow \Lambda_c^+\ell^-\bar{\nu}_\ell \text{ anything})$  are not pure measurements because the underlying measured products of these with  $B(b \rightarrow b\text{-baryon})$  were used to determine  $B(b \rightarrow b\text{-baryon})$ , as described in the note "Production and Decay of  $b$ -Flavored Hadrons."

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm \text{ anything}$ , the values usually are multiplicities, not branching fractions. They can be greater than one.

$\Lambda_b^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$J/\psi(1S)\Lambda$	$(4.7 \pm 2.8) \times 10^{-4}$		1744
$\Lambda_c^+\pi^-$	seen		2345
$\Lambda_c^+a_1(1260)^-$	seen		2155
$\Lambda_c^+\ell^-\bar{\nu}_\ell \text{ anything}$	[t] $(9.1 \pm 2.3) \%$		-
$\Lambda_c^+\ell^-\bar{\nu}_\ell$	$(5.0^{+1.9}_{-1.4}) \%$		2347
$\Lambda_c^+\pi^+\pi^-\ell^-\bar{\nu}_\ell$	$(5.6 \pm 3.1) \%$		2337
$p\bar{b}^-$	[u] $< 2.3 \times 10^{-5}$	90%	2732
$p\pi^-$	$< 5.0 \times 10^{-5}$	90%	2732
$pK^-$	$< 5.0 \times 10^{-5}$	90%	2711
$\Lambda\gamma$	$< 1.3 \times 10^{-3}$	90%	2701

 **$b$ -baryon ADMIXTURE ( $\Lambda_b^c, \Xi_b^c, \Sigma_b^c, \Omega_b^c$ )**

$$\text{Mean life } \tau = (1.209 \pm 0.049) \times 10^{-12} \text{ s}$$

These branching fractions are actually an average over weakly decaying  $b$ -baryons weighted by their production rates in  $Z$  decay (or high-energy  $p\bar{p}$ ), branching ratios, and detection efficiencies. They scale with the LEP  $b$ -baryon production fraction  $B(b \rightarrow b\text{-baryon})$  and are evaluated for our value  $B(b \rightarrow b\text{-baryon}) = (10.0 \pm 2.0)\%$ .

The branching fractions  $B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell \text{ anything})$  and  $B(\Lambda_b^0 \rightarrow \Lambda_c^+\ell^-\bar{\nu}_\ell \text{ anything})$  are not pure measurements because the underlying measured products of these with  $B(b \rightarrow b\text{-baryon})$  were used to determine  $B(b \rightarrow b\text{-baryon})$ , as described in the note "Production and Decay of  $b$ -Flavored Hadrons."

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm \text{ anything}$ , the values usually are multiplicities, not branching fractions. They can be greater than one.

$b$ -baryon ADMIXTURE DECAY MODES ( $\Lambda_b^c, \Xi_b^c, \Sigma_b^c, \Omega_b^c$ )	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$p\mu^-\bar{\nu}$ anything	$(4.9^{+2.1}_{-1.3})\%$	-
$p\ell\bar{\nu}_\ell$ anything	$(4.7 \pm 1.2)\%$	-
$p$ anything	$(59 \pm 21)\%$	-
$\Lambda\ell^-\bar{\nu}_\ell$ anything	$(3.2 \pm 0.7)\%$	-
$\Lambda/\bar{\Lambda}$ anything	$(33 \pm 8)\%$	-
$\Xi^-\ell^-\bar{\nu}_\ell$ anything	$(5.5 \pm 1.6) \times 10^{-3}$	-



## NOTES

This Summary Table only includes established baryons. The Particle Listings include evidence for other baryons. The masses, widths, and branching fractions for the resonances in this Table are Breit–Wigner parameters, but pole positions are also given for most of the  $N$  and  $\Delta$  resonances.

For most of the resonances, the parameters come from various partial-wave analyses of more or less the same sets of data, and it is not appropriate to treat the results of the analyses as independent or to average them together. Furthermore, the systematic errors on the results are not well understood. Thus, we usually only give ranges for the parameters. We then also give a best guess for the mass (as part of the name of the resonance) and for the width. The *Note on  $N$  and  $\Delta$  Resonances* and the *Note on  $\Lambda$  and  $\Sigma$  Resonances* in the Particle Listings review the partial-wave analyses.

When a quantity has “(S = . . .)” to its right, the error on the quantity has been enlarged by the “scale factor” S, defined as  $S = \sqrt{\chi^2/(N-1)}$ , where  $N$  is the number of measurements used in calculating the quantity. We do this when  $S > 1$ , which often indicates that the measurements are inconsistent. When  $S > 1.25$ , we also show in the Particle Listings an ideogram of the measurements. For more about S, see the Introduction.

A decay momentum  $p$  is given for each decay mode. For a 2-body decay,  $p$  is the momentum of each decay product in the rest frame of the decaying particle. For a 3-or-more-body decay,  $p$  is the largest momentum any of the products can have in this frame. For any resonance, the *nominal* mass is used in calculating  $p$ . A dagger (“†”) in this column indicates that the mode is forbidden when the nominal masses of resonances are used, but is in fact allowed due to the nonzero widths of the resonances.

- [a] The masses of the  $p$  and  $n$  are most precisely known in u (unified atomic mass units). The conversion factor to MeV,  $1 \text{ u} = 931.494043 \pm 0.000080 \text{ MeV}$ , is less well known than are the masses in u.
- [b] These two results are not independent, and both use the more precise measurement of  $|q_p/m_p|/(q_p/m_p)$ .
- [c] The limit is from neutrality-of-matter experiments; it assumes  $q_n = q_p + q_e$ . See also the charge of the neutron.
- [d] The first limit is for  $p \rightarrow$  anything or “disappearance” modes of a bound proton. The second entry, a rough range of limits, assumes the dominant decay modes are among those investigated. For antiprotons the best limit, inferred from the observation of cosmic ray  $\bar{p}$ 's is  $\tau_{\bar{p}} > 10^7 \text{ yr}$ , the cosmic-ray storage time, but this limit depends on a number of assumptions. The best direct observation of stored antiprotons gives  $\tau_{\bar{p}}/B(\bar{p} \rightarrow e^- \gamma) > 7 \times 10^5 \text{ yr}$ .

- [e] There is some controversy about whether nuclear physics and model dependence complicate the analysis for bound neutrons (from which the best limit comes). The first limit here is from reactor experiments with free neutrons.
- [f] The parameters  $g_A, g_V,$  and  $g_{WM}$  for semileptonic modes are defined by  $\bar{B}_f[\gamma_\lambda(g_V + g_A \gamma_5) + i(g_{WM}/m_{B_f}) \sigma_{\lambda\nu} q^\nu] B_i$ , and  $\phi_{AV}$  is defined by  $g_A/g_V = |g_A/g_V| e^{i\phi_{AV}}$ . See the “Note on Baryon Decay Parameters” in the neutron Particle Listings.
- [g] Time-reversal invariance requires this to be  $0^\circ$  or  $180^\circ$ .
- [h] This limit is for  $\gamma$  energies between 35 and 100 keV.
- [i] The decay parameters  $\gamma$  and  $\Delta$  are calculated from  $\alpha$  and  $\phi$  using

$$\gamma = \sqrt{1-\alpha^2} \cos \phi, \quad \tan \Delta = -\frac{1}{\alpha} \sqrt{1-\alpha^2} \sin \phi.$$

See the “Note on Baryon Decay Parameters” in the neutron Particle Listings.

- [j] See the Listings for the pion momentum range used in this measurement.
- [k] The error given here is only an educated guess. It is larger than the error on the weighted average of the published values.
- [l] A theoretical value using QED.
- [m] See the note on “ $\Lambda_c^+$  Branching Fractions” in the  $\Lambda_c^+$  Particle Listings.
- [n] This branching fraction includes all the decay modes of the final-state resonance.
- [o] An  $\ell$  indicates an  $e$  or a  $\mu$  mode, not a sum over these modes.
- [p] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [q] Assuming isospin conservation, so that the other third is  $\Lambda_c^+ \pi^0 \pi^0$ .
- [r] A test that the isospin is indeed 0, so that the particle is indeed a  $\Lambda_c^+$ .
- [s] No absolute branching fractions have been measured. The value here is the branching *ratio* relative to  $\Xi^- \pi^+ \pi^+$ .
- [t] Not a pure measurement. See note at head of  $\Lambda_b^0$  Decay Modes.
- [u] Here  $h^-$  means  $\pi^-$  or  $K^-$ .

## SEARCHES SUMMARY TABLE

**SEARCHES FOR  
MONOPOLES,  
SUPERSYMMETRY,  
TECHNICOLOR,  
COMPOSITENESS,  
EXTRA DIMENSIONS, etc.**

**Magnetic Monopole Searches**

Isolated supermassive monopole candidate events have not been confirmed. The most sensitive experiments obtain negative results.

Best cosmic-ray supermassive monopole flux limit:  
 $< 1.0 \times 10^{-15} \text{ cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$  for  $1.1 \times 10^{-4} < \beta < 0.1$

**Supersymmetric Particle Searches**

Limits are based on the Minimal Supersymmetric Standard Model. Assumptions include: 1)  $\tilde{\chi}_1^0$  (or  $\tilde{\gamma}$ ) is lightest supersymmetric particle; 2) R-parity is conserved; 3) with the exception of  $\tilde{t}$  and  $\tilde{b}$ , all scalar quarks are assumed to be degenerate in mass and  $m_{\tilde{q}_R} = m_{\tilde{q}_L}$ . 4) Limits for sleptons refer to the  $\tilde{\ell}_R$  states.

See the Particle Listings for a Note giving details of supersymmetry.

$\tilde{\chi}_i^0$  — neutralinos (mixtures of  $\tilde{\gamma}$ ,  $\tilde{Z}^0$ , and  $\tilde{H}^0$ )  
 Mass  $m_{\tilde{\chi}_1^0} > 46 \text{ GeV}$ , CL = 95% [all  $\tan\beta$ , all  $\Delta m_0$ , all  $m_0$ ]

Mass  $m_{\tilde{\chi}_2^0} > 62.4 \text{ GeV}$ , CL = 95%  
 [ $1 < \tan\beta < 40$ , all  $m_0$ , all  $m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0}$ ]

Mass  $m_{\tilde{\chi}_3^0} > 99.9 \text{ GeV}$ , CL = 95%  
 [ $1 < \tan\beta < 40$ , all  $m_0$ , all  $m_{\tilde{\chi}_3^0} - m_{\tilde{\chi}_1^0}$ ]

$\tilde{\chi}_i^\pm$  — charginos (mixtures of  $\tilde{W}^\pm$  and  $\tilde{H}_i^\pm$ )

Mass  $m_{\tilde{\chi}_1^\pm} > 94 \text{ GeV}$ , CL = 95%  
 [ $\tan\beta < 40$ ,  $m_{\tilde{\chi}_1^\pm} - m_{\tilde{\chi}_1^0} > 3 \text{ GeV}$ , all  $m_0$ ]

$\tilde{e}$  — scalar electron (selectron)

Mass  $m > 73 \text{ GeV}$ , CL = 95% [all  $m_{\tilde{e}_R} - m_{\tilde{\chi}_1^0}$ ]

$\tilde{\mu}$  — scalar muon (smuon)

Mass  $m > 94 \text{ GeV}$ , CL = 95%  
 [ $1 \leq \tan\beta \leq 40$ ,  $m_{\tilde{\mu}_R} - m_{\tilde{\chi}_1^0} > 10 \text{ GeV}$ ]

$\tilde{\tau}$  — scalar tau (stau)

Mass  $m > 81.9 \text{ GeV}$ , CL = 95%

[ $m_{\tilde{\tau}_R} - m_{\tilde{\chi}_1^0} > 15 \text{ GeV}$ , all  $\theta_\tau$ ]

$\tilde{q}$  — scalar quark (squark)

These limits include the effects of cascade decays, evaluated assuming a fixed value of the parameters  $\mu$  and  $\tan\beta$ . The limits are weakly sensitive to these parameters over much of parameter space. Limits assume GUT relations between gaugino masses and the gauge coupling.

Mass  $m > 250 \text{ GeV}$ , CL = 95% [ $\tan\beta = 2$ ,  $\mu < 0$ ,  $A = 0$ ]

$\tilde{b}$  — scalar bottom (sbottom)

Mass  $m > 89 \text{ GeV}$ , CL = 95% [ $m_{\tilde{b}_1} - m_{\tilde{\chi}_1^0} > 8 \text{ GeV}$ , all  $\theta_b$ ]

$\tilde{t}$  — scalar top (stop)

Mass  $m > 95.7 \text{ GeV}$ , CL = 95%

[ $\tilde{t} \rightarrow c\tilde{\chi}_1^0$ , all  $\theta_t$ ,  $m_{\tilde{t}} - m_{\tilde{\chi}_1^0} > 10 \text{ GeV}$ ]

$\tilde{g}$  — gluino

The limits summarized here refer to the high-mass region ( $m_{\tilde{g}} \sim 5 \text{ GeV}$ ), and include the effects of cascade decays, evaluated assuming a fixed value of the parameters  $\mu$  and  $\tan\beta$ . The limits are weakly sensitive to these parameters over much of parameter space. Limits assume GUT relations between gaugino masses and the gauge coupling,

Mass  $m > 195 \text{ GeV}$ , CL = 95% [any  $m_{\tilde{q}}$ ]

Mass  $m > 300 \text{ GeV}$ , CL = 95% [ $m_{\tilde{q}} = m_{\tilde{g}}$ ]

**Technicolor**

Searches for a color-octet techni- $\rho$  constrain its mass to be greater than 260 to 480 GeV, depending on allowed decay channels. Similar bounds exist on the color-octet techni- $\omega$ .

**Quark and Lepton Compositeness, Searches for**

**Scale Limits  $\Lambda$  for Contact Interactions**  
 (the lowest dimensional interactions with four fermions)  
 If the Lagrangian has the form

$$\pm \frac{g^2}{2\Lambda^2} \bar{\psi}_L \gamma_\mu \psi_L \bar{\psi}_L \gamma^\mu \psi_L$$

(with  $g^2/4\pi$  set equal to 1), then we define  $\Lambda \equiv \Lambda_{LL}^\pm$ . For the full definitions and for other forms, see the Note in the Listings on Searches for Quark and Lepton Compositeness in the full *Review* and the original literature.

$\Lambda_{LL}^+(eeee)$	$>$	8.3 TeV, CL = 95%
$\Lambda_{LL}^-(eeee)$	$>$	10.3 TeV, CL = 95%
$\Lambda_{LL}^+(ee\mu\mu)$	$>$	8.5 TeV, CL = 95%
$\Lambda_{LL}^-(ee\mu\mu)$	$>$	6.3 TeV, CL = 95%
$\Lambda_{LL}^+(ee\tau\tau)$	$>$	5.4 TeV, CL = 95%
$\Lambda_{LL}^-(ee\tau\tau)$	$>$	6.5 TeV, CL = 95%
$\Lambda_{LL}^+(llll)$	$>$	9.0 TeV, CL = 95%
$\Lambda_{LL}^-(llll)$	$>$	7.8 TeV, CL = 95%
$\Lambda_{LL}^+(eeuu)$	$>$	23.3 TeV, CL = 95%
$\Lambda_{LL}^-(eeuu)$	$>$	12.5 TeV, CL = 95%
$\Lambda_{LL}^+(eedd)$	$>$	11.1 TeV, CL = 95%
$\Lambda_{LL}^-(eedd)$	$>$	26.4 TeV, CL = 95%
$\Lambda_{LL}^+(eccc)$	$>$	1.0 TeV, CL = 95%
$\Lambda_{LL}^-(eccc)$	$>$	2.1 TeV, CL = 95%
$\Lambda_{LL}^+(eebb)$	$>$	5.6 TeV, CL = 95%
$\Lambda_{LL}^-(eebb)$	$>$	4.9 TeV, CL = 95%
$\Lambda_{LL}^+(\mu\mu qq)$	$>$	2.9 TeV, CL = 95%
$\Lambda_{LL}^-(\mu\mu qq)$	$>$	4.2 TeV, CL = 95%
$\Lambda(\ell\nu\ell\nu)$	$>$	3.10 TeV, CL = 90%
$\Lambda(e\nu qq)$	$>$	2.81 TeV, CL = 95%
$\Lambda_{LL}^+(qqqq)$	$>$	2.7 TeV, CL = 95%
$\Lambda_{LL}^-(qqqq)$	$>$	2.4 TeV, CL = 95%
$\Lambda_{LL}^+(\nu\nu qq)$	$>$	5.0 TeV, CL = 95%
$\Lambda_{LL}^-(\nu\nu qq)$	$>$	5.4 TeV, CL = 95%

**Excited Leptons**

The limits from  $\ell^* \ell^{*-}$  do not depend on  $\lambda$  (where  $\lambda$  is the  $\ell \ell^*$  transition coupling). The  $\lambda$ -dependent limits assume chiral coupling.

$e^{*\pm}$  — excited electron

Mass  $m > 103.2$  GeV, CL = 95% (from  $e^* e^*$ )

Mass  $m > 255$  GeV, CL = 95% (from  $e e^*$ )

Mass  $m > 310$  GeV, CL = 95% (if  $\lambda_\gamma = 1$ )

$\mu^{*\pm}$  — excited muon

Mass  $m > 103.2$  GeV, CL = 95% (from  $\mu^* \mu^*$ )

Mass  $m > 190$  GeV, CL = 95% (from  $\mu \mu^*$ )

$\tau^{*\pm}$  — excited tau

Mass  $m > 103.2$  GeV, CL = 95% (from  $\tau^* \tau^*$ )

Mass  $m > 185$  GeV, CL = 95% (from  $\tau \tau^*$ )

$\nu^*$  — excited neutrino

Mass  $m > 102.6$  GeV, CL = 95% (from  $\nu^* \nu^*$ )

Mass  $m > 190$  GeV, CL = 95% (from  $\nu \nu^*$ )

$q^*$  — excited quark

Mass  $m > 45.6$  GeV, CL = 95% (from  $q^* q^*$ )

Mass  $m$  (from  $q^* X$ )

**Color Sextet and Octet Particles**

Color Sextet Quarks ( $q_6$ )

Mass  $m > 84$  GeV, CL = 95% (Stable  $q_6$ )

Color Octet Charged Leptons ( $\ell_8$ )

Mass  $m > 86$  GeV, CL = 95% (Stable  $\ell_8$ )

Color Octet Neutrinos ( $\nu_8$ )

Mass  $m > 110$  GeV, CL = 90% ( $\nu_8 \rightarrow \nu g$ )

**Extra Dimensions**

Please refer to the Extra Dimensions section of the full *Review* for a discussion of the model-dependence of these bounds, and further constraints.

**Constraints on the fundamental gravity scale**

$M_H > 1.1$  TeV, CL = 95% (dim-8 operators;  $p \bar{p} \rightarrow e^+ e^-, \gamma \gamma$ )

$M_D > 1.1$  TeV, CL = 95% ( $e^+ e^- \rightarrow G \gamma$ ; 2-flat dimensions)

$M_D > 3\text{--}1000$  TeV (astrophys. and cosmology; 2-flat dimensions; limits depend on technique and assumptions)

**Constraints on the radius of the extra dimensions, for the case of two-flat dimensions of equal radii**

$r < 90\text{--}660$  nm (astrophysics; limits depend on technique and assumptions)

$r < 0.22$  mm, CL = 95% (direct tests of Newton's law; cited in Extra Dimensions review)

# TABLE OF THE ISOTOPES

Norman E. Holden

This table presents an evaluated set of values for the experimental quantities that characterize the decay of radioactive nuclides. A list of the major references used in this evaluation is given below. When uncertainties are not listed, they are assumed to be five or less in the last digit quoted. If they exceed five in the last digit, the value is prefaced by an approximate sign. For quasi-stable nu-

clides, the measured width,  $\Gamma$ , of the resonance is given. To estimate the approximate half-life, the Heisenberg relationship may be used, the half-life =  $4.56 \times 10^{22}$  seconds /  $\Gamma(\text{MeV})$ . The effective literature cutoff date for data in this edition of the Table is December, 2005.

## Table Layout

Column No.	Column title	Description
1	Isotope or Element	For elements, the atomic number and chemical symbol are listed. For nuclides, the mass number and chemical symbol are listed. Isomers are indicated by the addition of m, m1, or m2.
2	Isotopic Abundance	In atom percent.
3	Atomic Mass or Atomic Weight	Atomic mass relative to $^{12}\text{C} = 12$ . Atomic weight of elements is given on the same scale.
4	Half-life/Resonance Width	Half-life in decimal notation. $\mu\text{s}$ = microseconds; ms = milliseconds; s = seconds; m = minutes; h = hours; d = days; and y = years. For quasi-stable nuclides, the measured width at half maximum of the energy resonance is given
5	Decay Mode/Energy	Decay modes are $\alpha$ = alpha particle emission; $\beta^-$ = negative beta emission; $\beta^+$ = positron emission; EC = orbital electron capture; IT = isomeric transition from upper to lower isomeric state; n = neutron emission; sf = spontaneous fission; $\beta\beta$ = double beta decay. Total disintegration energy in MeV units.
6	Particle Energy/Intensity	End point energies of beta transitions and discrete energies of alpha particles in MeV and their intensities in percent.
7	Spin and Parity	Nuclear spin or angular momentum of the nuclides in units of $h/2\pi$ ; parity is positive or negative.
8	Magnetic Dipole Moment	Magnetic dipole moments in nuclear magneton units.
9	Electric Quadrupole Moment	Electric quadrupole moments in barn units ( $10^{-24} \text{ cm}^2$ ).
10	Gamma Ray Energy/Intensity	Gamma ray energies in MeV and intensities in percent. Ann. rad. refers to the 511.006 keV photons emitted in the annihilation of positrons in matter.

## General Nuclear Data References

The following references represent the major sources of the nuclear data presented, along with subsequent published journal articles and reports:

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5. N.E. Holden, *Total and Spontaneous Fission Half-lives for Uranium, Plutonium, Americium and Curium Nuclides*, Pure & Applied Chemistry 61, 1483 (1989).
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Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>0</sup> n		1.008664916	614. s	$\beta^-$ /0.78235 $\beta^-$ , $\gamma$	0.782/100. / < 0.069	1/2+	-1.913043		
<b><sub>1</sub>H</b>		<b>1.00794(7)</b>							
<sup>1</sup> H	99.9885(70)	1.007825032	> 2.8 × 10 <sup>23</sup> y			1/2+	+2.79285		
<sup>2</sup> H	0.0115(70)	2.014101778				1+	+0.85744	+2.86 mb	
<sup>3</sup> H		3.016049278	12.33 y	$\beta^-$ /0.01859	0.01860/100.	1/2+	+2.97896		
<sup>4</sup> H		4.0278	$\Gamma \sim 3$	n/	/100	2-			
<sup>5</sup> H		5.0353	$\Gamma < 0.5$	n/	/100	(1/2+)			
<sup>6</sup> H		6.0449	$\Gamma = 1.6(4)$	n/		(2-)			
<sup>7</sup> H		7.053	$\Gamma \sim 20.$						
<b><sub>2</sub>He</b>		<b>4.002602(2)</b>							
<sup>3</sup> He	0.000134(3)	3.016029319				1/2+	-2.12762		
<sup>4</sup> He	99.999866(3)	4.002603254				0+			
<sup>5</sup> He		5.01222	$\Gamma = 0.60(2)$	n, $\alpha$		3/2-			
<sup>6</sup> He		6.018889	0.807 s	$\beta^-$ /3.508 $\beta^-$ , d	3.510/100. /0.00076	0+			
<sup>7</sup> He		7.02802	$\Gamma = 0.15(2)$	n		(3/2)-			
<sup>8</sup> He		8.03392	0.119 s	$\beta^-$ /10.65 n/ $\beta^-$ , t	/84. /16. /0.82	0+		0.9807/84. 0.4776/5.	
<sup>9</sup> He		9.04395	$\Gamma = 0.10(6)$	n	/100	(1/2-)			
<sup>10</sup> He		10.0524	$\Gamma = 0.3(2)$	2n	/100	0+			
<b><sub>3</sub>Li</b>		<b>6.941(2)</b>							
<sup>4</sup> Li		4.0272	$\Gamma = 6.0$	p/	/100	2-			
<sup>5</sup> Li		5.01254	$\Gamma = 1.2$	p/ $\alpha$		3/2-			
<sup>6</sup> Li	7.59(4)	6.01512280				1+	+0.82205	-0.8 mb	
<sup>7</sup> Li	92.41(4)	7.0160046				3/2-	+3.25644	-0.0400	
<sup>8</sup> Li		8.0224874	0.840 s	$\beta^-$ /16.004 $\alpha$ / $\alpha(1.6)$	12.5/100.  13.5/75. 11/25.	2+	+1.6536	+0.0314	
<sup>9</sup> Li		9.026790	0.178 s	$\beta^-$ /13.606 $\beta^-$ /	13.5/75. 11/25.	3/2-	3.4368	-0.0306	
<sup>10</sup> Li		10.03548	$\Gamma = 0.11(5)$	n	/7.	1+			
<sup>11</sup> Li		11.04380	8.8 ms	$\beta^-$ /20.6 $\beta^-$ , n $\beta^-$ , 2n $\beta^-$ , 3n $\beta^-$ , d $\beta^-$ , t	/8.3 /85.7 /4.1 /1.9 />0.01 /0.02	3/2(-)	3.668	-0.031	3.368/33. 0.320/7. 2.590/8. 5.958/3. 2.895/1.5 2.811/1.1
<sup>12</sup> Li		12.054	< 0.01 $\mu$ s						
<b><sub>4</sub>Be</b>		<b>9.012182(3)</b>							
<sup>5</sup> Be		5.041		p, <sup>3</sup> He		(1/2+)			
<sup>6</sup> Be		6.01973	$\Gamma = 0.092(6)$	2p, $\alpha$		0+			
<sup>7</sup> Be		7.0169298	53.28 d	EC/0.8618		3/2-	-1.4		0.4776/10.4
<sup>8</sup> Be		8.00530510	$\Gamma = 6.8(17)$ eV	2 $\alpha$ /0.046		0+			
<sup>9</sup> Be	100.	9.0121822				3/2-	-1.1776	+0.0529	
<sup>10</sup> Be		10.0135338	1.52 × 10 <sup>6</sup> y	$\beta^-$ /0.5559	0.555/100.	0+			
<sup>11</sup> Be		11.02166	13.8 s	$\beta^-$ , $\beta^-$ - $\alpha$ /11.51	11.48/61.	1/2+			2.125/35.5
<sup>12</sup> Be		12.02692	22.0 ms	$\beta^-$ , (n) /11.71	n /0.5	0+			(0.95 - 4.4)
<sup>13</sup> Be		13.0357	$\Gamma \sim 1.$						
<sup>14</sup> Be		14.0429	4.6 ms	$\beta^-$ /16.2 $\beta^-$ , n $\beta^-$ , 2n $\beta^-$ , $\alpha$ $\beta^-$ , t	 0.288/94. /6. / < 0.012 / < 0.04	0+		3.5346/0.9 3.6845/7.	
<sup>15</sup> Be		15.053	< 0.2 $\mu$ s	$\beta^-$					

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>16</sup> Be		16.062	< 0.2 $\mu$ s	$\beta^-$		0+			
<b><sub>5</sub>B</b>		<b>10.811(7)</b>							
<sup>7</sup> B		7.0299	$\Gamma = 1.4(2)$	p, $\alpha$		(3/2-)			
<sup>8</sup> B		8.024607	0.770 s	$\beta^+$ , 2 $\alpha$ /17.979	13.7( $\beta^+$ )/93.	2+	1.0355	0.068	ann.rad.
<sup>9</sup> B		9.013329	$\Gamma = 0.5(2)$ keV	p, 2 $\alpha$ /		3/2-			
<sup>10</sup> B	19.9(7)	10.0129370				3+	+1.8006	+0.085	
<sup>11</sup> B	80.1(7)	11.0093054				3/2-	+2.6886	+0.0406	
<sup>12</sup> B		12.014352	0.0202 s	$\beta^-$ /13.369		1+	+1.0027	0.0132	4.438/1.3
				$\beta^-$ $\alpha$ /1.6/					3.215/0.00065
<sup>13</sup> B		13.017780	0.0174 s	$\beta^-$ /13.437	13.4	3/2-	+3.1778	0.037	3.68/7.6
				$\beta^-$ n/0.25/	2.43(n)/0.09				
					3.55(n)/0.16				
<sup>14</sup> B		14.02540	14. ms	$\beta^-$ /20.64		2-	1.185	0.0298	6.094/90.
<sup>15</sup> B		15.03110	9.9 ms	$\beta^-$ , (n)/19.09	n//99.7	(3/2-)	2.66	0.038	
<sup>16</sup> B		16.0398	$\Gamma < 0.1$	n					
<sup>17</sup> B		17.0470	5.1 ms	$\beta^-$ , (n)/22.7			2.54	0.039	
<sup>18</sup> B		18.056	< 0.026 $\mu$ s			0-			
<sup>19</sup> B		19.0637	2.9 ms	$\beta^-$ , (n)/26.5	1n//72.	(3/2-)			
					2n//16.				
					3n// < 9.				
<b><sub>6</sub>C</b>		<b>12.0107(8)</b>							
<sup>8</sup> C		8.03768	$\Gamma = 0.25(4)$	p		0+			
<sup>9</sup> C		9.031037	127. ms	$\beta^+$ , p, 2 $\alpha$ /16.498		(3/2-)	-1.391		ann.rad.
<sup>10</sup> C		10.0168532	19.3 s	$\beta^+$ /3.648	1.865	0+			ann.rad.
									0.71829/100.
<sup>11</sup> C		11.011434	20.3 m	$\beta^+$ , EC/1.982	0.9608/99.	3/2-	-0.964	0.0333	ann.rad.
<sup>12</sup> C	98.93(8)	12.000000000				0+			
<sup>13</sup> C	1.07(8)	13.003354838				$\frac{1}{2}$ -	+0.70241		
<sup>14</sup> C		14.003241989	5715. y	$\beta^-$ /0.15648	0.1565/100.	0+			
<sup>15</sup> C		15.010599	2.45 s	$\beta^-$ /9.772	4.51/68.	$\frac{1}{2}$ +	1.32		5.298/68.
					9.82/32.				(7.30-9.05)
<sup>16</sup> C		16.014701	$\sim 0.750$ s	$\beta^-$ /8.012	$\beta$ /3.3, 4.3/84, 16	0+			
				$\beta$ , n	n/0.8, 1.7/84, 16				
<sup>17</sup> C		17.02259	0.19 s	$\beta^-$ /13.17		3/2+			1.375
				$\beta^-$ , n	n/1.6-3.7/11.				1.849
									1.906
<sup>18</sup> C		18.02676	0.092 s	$\beta^-$ /11.81		0+			
				$\beta^-$ , n	n/0.88-4.59/21.				
<sup>19</sup> C		19.0348	0.05 s	n		$\frac{1}{2}$ +			
<sup>20</sup> C		20.0403	0.02 s	$\beta$ ,n	1n// $\sim 65$ .	0+			
					2n// < 19.				
<sup>21</sup> C		21.049	< 0.03 $\mu$ s						
<sup>22</sup> C		22.057	6 ms	$\beta^-$ , n	1n// $\sim 61$ .	0+			
					2n// < 37.				
<b><sub>7</sub>N</b>		<b>14.0067(2)</b>							
<sup>10</sup> N		10.0417	$\Gamma = 2.3(16)$						
<sup>11</sup> N		11.02609	$\Gamma \sim 1$ .			$\frac{1}{2}$ +			
<sup>12</sup> N		12.018613	11.00 ms	$\beta^+$ , $\beta^+$ $\alpha$ /17.338	16.38/95.	1+	+0.457	+10. mb	ann.rad.
									4.438/2.
<sup>13</sup> N		13.0057386	9.97 m	$\beta^+$ /2.2204	1.190/100.	$\frac{1}{2}$ -	0.3222		
<sup>14</sup> N	99.636(20)	14.003074005				1+	+0.40376	+0.0200	
<sup>15</sup> N	0.364(20)	15.00010898				$\frac{1}{2}$ -	-0.28319		
<sup>16</sup> N		16.006102	7.13 s	$\beta^-$ /10.419	4.27/68.	2-			6.129/68.8
					10.44/26.		1.986	18 mb	7.115/4.7
				$\beta^-$ , $\alpha$	1.85/.0012				(0.99-8.87)
<sup>17</sup> N		17.00845	4.17 s	$\beta^-$ , $\beta^-$ n/8.68	3.7/100.	$\frac{1}{2}$ -	0.352		0.871/3.

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
				0.4–1.7n/95.					2.1842/0.3
<sup>18</sup> N		18.01408	0.62 s	$\beta^-$ $\alpha$ / $\beta^-$ /13.90	8.0, 8.2 9.4/100.	1-	0.328	0.012	0.822/48. 1.65/47. 1.982/77. (0.535–7.13)
<sup>19</sup> N		19.01703	0.32 s	$\beta^-$ /12.53			< 0.32		(0.096–3.14)
<sup>20</sup> N		20.0234	0.14 s	$\beta^-$ /17.97					
<sup>21</sup> N		21.0271	0.08 s						
<sup>22</sup> N		22.0344	0.02 s	$\beta^-$ ,n	1n// ~ 41. 2n// < 13.				
<sup>23</sup> N		23.0412	15. ms	$\beta^-$ , n	n// ~ 42. 2n// ~ 8. 3n// < 3.4				
<sup>24</sup> N		24.0510	< 0.052 $\mu$ s						
<sup>25</sup> N		25.061	< 0.26 $\mu$ s						
<b><sub>8</sub>O</b>		<b>15.9994(3)</b>							
<sup>12</sup> O		12.03441	$\Gamma = 0.51(16)$	2p		0+			
<sup>13</sup> O		13.02481	8.9 ms	$\beta^+$ , p/17.77	1.560 (p) p/(1.00 - 13.5)	(3/2-)	1.389	0.011	ann.rad. 4.438/0.56
<sup>14</sup> O		14.0085963	70.63 s	$\beta^+$ /5.1430	1.81/99.	0+			ann.rad. 2.312/99.4
<sup>15</sup> O		15.0030656	122.2 s	$\beta^+$ /2.754	1.723/100.	1/2-	0.7195		ann.rad.
<sup>16</sup> O	99.757(16)	15.9949146196				0+			
<sup>17</sup> O	0.038(1)	16.9991317				5/2+	-1.8938	-0.026	
<sup>18</sup> O	0.205(14)	17.999161				0+			
<sup>19</sup> O		19.003580	26.9 s	$\beta^-$ /4.820	3.25/60. 4.60/40.	5/2+	1.5320	3.7 mb	0.197/95.9 1.3569/50.4 (0.11–4.18)
<sup>20</sup> O		20.004077	13.5 s	$\beta^-$ /3.814		0+			1.057/100.
<sup>21</sup> O		21.00866	3.4 s	$\beta^-$ /8.11					(0.28–4.6)
<sup>22</sup> O		22.0100	2.2 s	$\beta^-$ /6.5		0+			0.072/100 0.638/98 1.862/63 (0.918-2.499)
<sup>23</sup> O		23.0157	0.08 s						
<sup>24</sup> O		24.0205	~ 65. ms	$\beta^-$ , n	n//18.	0+			1.83/28. 0.52/14. 1.31/12.
<sup>25</sup> O		25.0295	< 0.05 $\mu$ s						
<sup>26</sup> O		26.0383	< 0.04 $\mu$ s			0+			
<sup>27</sup> O		27.048	< 0.026 $\mu$ s						
<sup>28</sup> O		28.058	< 0.10 $\mu$ s			0+			
<b><sub>9</sub>F</b>		<b>18.9984032(5)</b>							
<sup>14</sup> F		14.0351							
<sup>15</sup> F		15.0180	$\Gamma = 0.8(3)$	p		(1/2+)			
<sup>16</sup> F		16.01147	$\Gamma = 0.037(14)$	p		0-			
<sup>17</sup> F		17.0020952	64.5 s	$\beta^+$ /2.761	1.75/	5/2+	+4.721	0.058	ann.rad.
<sup>18</sup> F		18.000938	1.829 h	$\beta^+$ , EC/1.656	0.635/97.	1+			ann.rad.
<sup>19</sup> F	100.	18.9984032				½+	+2.62887	0.072	
<sup>20</sup> F		19.9999813	11.00 s	$\beta^-$ /7.0245	5.398/100.	2+	+2.0934	0.042	1.634/100. 3.33/0.009
<sup>21</sup> F		20.999949	4.16 s	$\beta^-$ /5.684	3.7/8. 5.0/63. 5.4/29.	5/2+	3.9		0.3507/90. 1.395/15. (1.746–4.684)
<sup>22</sup> F		22.00300	4.23 s	$\beta^-$ /10.82	3.48/15. 4.67/7.	4+			1.2746/100. 2.0826/82.

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<sup>23</sup> F		23.0036	2.2 s	$\beta^-$ /8.5	5.50/62.	5/2+			(0.82–4.37) 1.701/48. 2.129/34. (0.493–3.83)
<sup>24</sup> F		24.0081	0.3 s	$\beta^-$ /13.5					1.9816/
<sup>25</sup> F		25.0121	~ 50. ms	$\beta^-$ , (n)	n//14.				1.70/39. (0.57–2.19)
<sup>26</sup> F		26.0196	10. ms	$\beta^-$ , (n)	n//11.				2.02/67. 1.67/19.
<sup>27</sup> F		27.0268	5.0 ms	$\beta^-$ , (n)	n//90.				2.02/18.
<sup>28</sup> F		28.036	< 0.04 $\mu$ s						
<sup>29</sup> F		29.043	2.5 ms	$\beta^-$ , (n)	n//100.				
<sup>30</sup> F		30.053	< 0.26 $\mu$ s						
<sup>31</sup> F		31.060	> 0.26 $\mu$ s						
<b><sup>10</sup>Ne</b>		<b>20.1797(6)</b>							
<sup>16</sup> Ne		16.02576	$\Gamma = 0.12(4)$	2p		0+			
<sup>17</sup> Ne		17.01767	109. ms	$\beta^+$ , p/14.53 $\beta^+$ , $\alpha$	1.4–10.6/6.9 /0.014	1/2-	0.787		ann.rad./ 0.495
<sup>18</sup> Ne		18.0057082	1.668 s	$\beta^+$ /4.446	3.416/92.	0+			ann.rad./ 1.0413/7.8 (0.658–1.70)
<sup>19</sup> Ne		19.0018802	17.22 s	$\beta^+$ /3.238	2.24/99.	1/2+	-1.885		ann.rad./ (0.11–1.55)
<sup>20</sup> Ne	90.48(3)	19.992440175				0+			
<sup>21</sup> Ne	0.27(1)	20.99384668				3/2+	-0.66180	+0.103	
<sup>22</sup> Ne	9.25(3)	21.99138511				0+		-0.19	
<sup>23</sup> Ne		22.9944669	37.2 s	$\beta^-$ /4.376	3.95/32. 4.39/67.	5/2+	-1.08	+0.15	0.440/33. (1.64–2.98)
<sup>24</sup> Ne		23.9936108	3.38 m	$\beta^-$ /2.47	1.10/8. 1.98/92.	0+			0.4723/100. 0.874/7.9
<sup>25</sup> Ne		24.99774	0.61 s	$\beta^-$ /7.30	6.3/ 7.3/	1/2+	-1.006		0.0895/96. (0.98–3.69)
<sup>26</sup> Ne		26.00046	197 ms	$\beta^-$ , n/7.3	n//0.13	0+			0.082/100 1.278/6 0.233/5 0.151/3 1.211/1 2.489/1
<sup>27</sup> Ne		27.0076	31. ms	$\beta^-$ , n/12.7	n//2.	(3/2+)			
<sup>28</sup> Ne		28.0121	19. ms	$\beta^-$ , n/12.3	n//12. 2n//3.	0+			2.06/19. 0.86/3.
<sup>29</sup> Ne		29.0194	15. ms	$\beta^-$ , (n)/15.4 $\beta^-$ , 2n	n//29. 2n//4.	(3/2+)			2.92/55. (0.22–1.18)
<sup>30</sup> Ne		30.025	7. ms	$\beta^-$ , (n)	n//9.	0+			0.151/9.
<sup>31</sup> Ne		31.033	3. ms						
<sup>32</sup> Ne		32.040	~ 3.5 ms			0+			
<sup>33</sup> Ne		33.049	< 0.26 $\mu$ s						
<sup>34</sup> Ne		34.057	> 1.5 $\mu$ s			0+			
<b><sup>11</sup>Na</b>		<b>22.98976928(2)</b>							
<sup>18</sup> Na		18.02597	$\Gamma = 0.34(9)$						
<sup>19</sup> Na		19.01388	0.03 s	$\beta^+$ , p/11.18					
<sup>20</sup> Na		20.00735	0.446 s	$\beta^+$ /13.89 $\alpha$	2.15/	2+	+0.3694	~ + 0.04	ann.rad./ 1.634/79.
<sup>21</sup> Na		20.997655	22.48 s	$\beta^+$ /3.547	2.50/95.	3/2+	+2.3863	~ +0.05	ann.rad./ 0.351/5.
<sup>22</sup> Na		21.9944364	2.605 y	$\beta^+$ /90/2.842 EC/10/	0.545/90.	3+	+1.746	+0.19	ann.rad./ 1.2745/99.9



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<sup>23</sup> Na	100.	22.989769281				3/2+	+2.21752	+0.106	
<sup>24m</sup> Na			20.2 ms	I.T., $\beta^-$		1+			0.4723/100.
<sup>24</sup> Na		23.9909628	14.96 h	$\beta^-$ /5.5158	1.389/>99.	4+	+1.690		1.3686/100. 2.754/100. (0.997-4.238)
<sup>25</sup> Na		24.989954	59.3 s	$\beta^-$ /3.835	2.6/7. 3.15/25. 4.0/65.	5/2+	+3.683	$\sim$ -0.06	0.3897/12.7 0.5850/13. 0.9747/14.9 (0.836-2.80)
<sup>26</sup> Na		25.99263	1.071 s	$\beta^-$ /9.31		3+	+2.851	-5.3 mb	1.809/98.9 (0.24-7.37)
<sup>27</sup> Na		26.994077	0.290 s	$\beta^-$ /9.01	7.95/	5/2+	+3.90	-7.2 mb	0.9847/87.4 1.698/11.9
<sup>28</sup> Na		27.99894	31. ms	$\beta^-$ , n/ $\beta^-$ /14.0	12.3/	1+	+2.42	+0.04	1.473/37. 2.389/18.6
<sup>29</sup> Na		29.00286	44. ms	$\beta^-$ , n/13.3	11.5/	3/2+	+2.46	+86. mb	2.560/36. (1.04-3.99)
<sup>30</sup> Na		30.00898	50. ms	$\beta^-$ , n/17.5	n//30.	2+	+2.07		1.483/46.
<sup>31</sup> Na		31.0136	17.2 ms	$\beta^-$ , n/15.9	n//37.	3/2-	+2.30		1.483/14. (0.05-3.54)
<sup>32</sup> Na		32.0205	13.5 ms	$\beta^-$ /19.1					0.240-3.935
<sup>33</sup> Na		33.027	8.0 ms	$\beta^-$ /20.	/ $\sim$ 38 0.8,1.02/47(6) /13(3)				0.886/16 0.546/6.4 0.050-2.55
<sup>34</sup> Na		34.035	5. ms	$\beta^-$ /24.					
<sup>35</sup> Na		35.042	1.5 ms	$\beta^-$ /24					
<sup>36</sup> Na		36.051	< 0.26 $\mu$ s						
<sup>37</sup> Na		37.059	> 1.5 $\mu$ s						
<b><sup>12</sup>Mg</b>		<b>24.3050(6)</b>							
<sup>19</sup> Mg		19.0355	< 0.02 $\mu$ s						
<sup>20</sup> Mg		20.01886	96. ms	$\beta^+$ /10.73	/70 /30	0+			
<sup>21</sup> Mg		21.01171	122. ms	$\beta^+$ , p/13.10		5/2+			0.332/51.
<sup>22</sup> Mg		21.999574	3.876 s	$\beta^+$ /4.786	3.05/	0+			0.0729/60. 0.5820/100. (1.28-1.93)
<sup>23</sup> Mg		22.994124	11.32 s	$\beta^+$ /4.057	3.09/92.	3/2+	0.536	1.25	0.440/8.2
<sup>24</sup> Mg	78.99(4)	23.98504170				0+			
<sup>25</sup> Mg	10.00(1)	24.98583692				5/2+	-0.85545	+0.200	
<sup>26</sup> Mg	11.01(3)	25.98259293				0+			
<sup>27</sup> Mg		26.98434059	9.45 m	$\beta^-$ /2.6103	1.59/41. 1.75/58. 2.65/0.3	1/2+			0.17068/0.9 0.84376/72. 1.01443/28.
<sup>28</sup> Mg		27.983877	20.9 h	$\beta^-$ /1.832	0.459/95.	0+			0.0306/95. 0.4006/36. 0.9418/36. 1.342/54.
<sup>29</sup> Mg		28.98860	1.3 s	$\beta^-$ /7.55	5.4/	3/2+			0.960/15. 1.398/16. 2.224/36.
<sup>30</sup> Mg		29.99043	0.32 s	$\beta^-$ /7.0		0+			0.224/85.
<sup>31</sup> Mg		30.99655	0.24 s	$\beta^-$ /11.7	8.4/29.9	(3/2+)	-0.8836		1.613/47. 0.947/37. (0.666-4.640)
<sup>32</sup> Mg		31.99898	0.12 s	$\beta^-$ , n	/1.7				
<sup>33</sup> Mg		33.00525	91. ms	$\beta^-$ /10.3		0+			2.765/25. 1.848/
				$\beta^-$ , n	/17.				

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<sup>34</sup> Mg		34.0095	0.02 s	$\beta^-$ /11.3		0+			
<sup>35</sup> Mg		35.0173	0.07 s			(7/2-)			
<sup>36</sup> Mg		36.023	4. ms			0+			
<sup>37</sup> Mg		37.031	> 0.26 $\mu$ s			(7/2-)			
<sup>38</sup> Mg		38.038	> 0.26 $\mu$ s			0+			
<sup>39</sup> Mg		39.047	< 0.26 $\mu$ s						
<sup>40</sup> Mg		40.054				0+			
<b><sub>13</sub>Al</b>		<b>26.9815386(8)</b>							
<sup>21</sup> Al		21.0280	< 0.035 $\mu$ s						
<sup>22</sup> Al		22.0195	59. ms	$\beta^+$ /18.6	p/1.3/18.	4+			ann.rad./
				$\beta^+$ , p, 2p, $\alpha$ /	$\alpha$ /3.3/0.3				
<sup>23m</sup> Al			~ 0.35 s	$\beta^+$ , p/0.17					0.554
									0.839
<sup>23</sup> Al		23.00727	0.47 s	$\beta^+$ /12.24					ann.rad./
				$\beta^+$ , p/					
<sup>24m</sup> Al			0.129 s	I.T./0.4259					
				$\beta^+$	13.3	1+			1.3686/5.3
<sup>24</sup> Al		23.999939	2.07 s	$\beta^+$ /13.878,p	3.40/48.	4+			1.078(2)/16.
					4.42/41.				1.368(2)/96.
					6.80/3.				2.753(2)/43.
					8.74/8.				4.315(3)/15.
									5.392(3)/20.
									7.0662(2)/41.
<sup>25</sup> Al		24.9904281	7.17 s	$\beta^+$ /4.277	3.27/	5/2+	3.646		ann.rad./
									1.6115(2)/100.
									0.975(2)/5.
<sup>26m</sup> Al			6.345 s	$\beta^+$ /	3.2/	0+			ann.rad./
<sup>26</sup> Al		25.9868917	7.1 $\times 10^5$ y	$\beta^+$ /82/4.0042	1.16/	5+	+2.804	+0.17	ann.rad./
				EC/18					1.8087/99.8
<sup>27</sup> Al	100.	26.9815386				5/2+	+3.64151	+0.140	
<sup>28</sup> Al		27.9819103	2.25 m	$\beta^-$ /4.6422	2.865/100.	3+	3.24	0.18	1.7778(6)/100.
<sup>29</sup> Al		28.980445	6.5 m	$\beta^-$ /3.680	1.4/30.	5/2+			1.2732(8)/89.
					2.5/70.				2.0282(8)/4.
									2.4262(8)/7.
<sup>30</sup> Al		29.98296	3.68 s	$\beta^-$ /8.56	5.05/	3+	3.01		1.26313(3)/35.
									2.23525(5)/65.
<sup>31</sup> Al		30.98395	0.64 s	$\beta^-$ /8.00	6.25/	5/2+			0.75223(3)/18.
									1.69473(3)/59.
									2.31664(4)/73.
<sup>32</sup> Al		31.9881	33. ms	$\beta^-$ /13.0		1+	1.96		
<sup>33</sup> Al		32.9908	41.7 ms	$\beta^-$ /12.0	/91.5				1.940/2.5
				$\beta^-$ , n	/8.5				(1.01-4.34)
<sup>34</sup> Al		33.9969	56. ms	$\beta^-$ /17.1	4.255/44	4			0.929/57
				$\beta^-$ , n	/26.				(0.12-4.26)
<sup>35</sup> Al		34.9999	38. ms	$\beta^-$ /14.3	0.974/48	5/2+			0.064/45.
				$\beta^-$ , n	/ 38.				(0.12-5.63)
<sup>36</sup> Al		36.0062	0.09 s	$\beta^-$ /18.3					
				$\beta^-$ , n	/ $<$ 31.				
<sup>37</sup> Al		37.0107	11. ms	$\beta^-$ /16.					
<sup>38</sup> Al		38.017	> 7.6 ms						
<sup>39</sup> Al		39.023	> 8. ms						
<sup>40</sup> Al		40.031	> 0.26 $\mu$ s						
<sup>41</sup> Al		41.038	> 0.26 $\mu$ s						
<b><sub>14</sub>Si</b>		<b>28.0855(3)</b>							
<sup>22</sup> Si		22.0345	29. ms	$\beta^+$ , p	1.99/20	0+			
<sup>23</sup> Si		23.0255	40.7 ms	$\beta^+$ , p/5.9	1.32,(0.6-11.6)				
<sup>24</sup> Si		24.01155	0.14 s	$\beta^+$ , p/10.81	1.44,3.92,1.09	0+			ann.rad./

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<sup>25</sup> Si		25.00411	221 ms	$\beta+$ , p/12.74	(1.66-4.47) p/4.25/9.5 p/0.40/4.75 p/0.56-6.80	5/2+			ann.rad./
<sup>26</sup> Si		25.992330	2.23 s	$\beta+$ /5.066	3.282/	0+			ann.rad./ 0.8294(8)/22.
<sup>27</sup> Si		26.9867049	4.14 s	$\beta+$ /4.8118	3.85/100.	5/2+	-0.8554		ann.rad./ 2.211(5)/0.2
<sup>28</sup> Si	92.223(19)	27.976926533				0+			
<sup>29</sup> Si	4.685(8)	28.97649470				1/2+	-0.5553		
<sup>30</sup> Si	3.092(11)	29.97377017				0+			
<sup>31</sup> Si		30.97536323	2.62 h	$\beta-$ /1.4920	1.471/99.9	3/2+			1.2662(5)/0.05
<sup>32</sup> Si		31.97414808	$1.6 \times 10^2$ y	$\beta-$ /0.224	0.213/100.	0+			
<sup>33</sup> Si		32.97800	6.1 s	$\beta-$ /5.85	3.92	(3/2+)	1.21		1.4313(5)/13. 1.8477/100. 2.538(2)/10.
<sup>34</sup> Si		33.97858	2.8 s	$\beta-$ /4.60	3.09/	0+			0.42907(5)/60. 1.17852(2)/64. 1.60756(5)/36.
<sup>35</sup> Si		34.98458	0.9 s	$\beta-$ /10.50					
<sup>36</sup> Si		35.9866	0.5 s	$\beta-$ /7.9		0*			
<sup>37</sup> Si		36.9929	$\sim 0.09$ s	$\beta-$ , n	$\sim 12.$				
<sup>38</sup> Si		37.9956	$> 1$ $\mu$ s	$\beta-$ , n	$\sim 17.$				
<sup>39</sup> Si		39.0021	48. ms	$\beta-$ /14.8					
<sup>40</sup> Si		40.006	33. ms			0*			
<sup>41</sup> Si		41.015	20. ms						
<sup>42</sup> Si		42.020	13. ms			0*			
<sup>43</sup> Si		43.029	$> 0.26$ $\mu$ s						
<b><sub>15</sub>P</b>		<b>30.973762(2)</b>							
<sup>24</sup> P		24.034							
<sup>25</sup> P		25.0203	$< 0.03$ $\mu$ s						
<sup>26</sup> P		26.0118	44. ms	$\beta+$ , p/18.1	p/0.41/18.0 p/1.98/2.4 p/0.78-7.49	3+			
<sup>27</sup> P		26.99923	0.3 s	$\beta+$ , p/11.63	p/0.73, 0.61/0.07	1/2+			
<sup>28</sup> P		27.992315	270. ms	$\beta+$ /14.332	3.94/13. 5.25/13. 6.96/16. 8.8/7. 11.49/52.	3+			ann.rad./ 1.779(2)/98. 2.839(2)/2.8 3.040(2)/3.2 4.498(2)/12. 7.537(2)/9.
<sup>29</sup> P		28.981801	4.14 s	$\beta+$ /4.9431	3.945/98.	1/2+	1.2349		ann.rad./ 1.273/1.32 2.426/0.39
<sup>30</sup> P		29.9783138	2.50 m	$\beta+$ /4.2323	3.245/99.9	1+			ann.rad./ 2.230(3)/0.07
<sup>31</sup> P	100.	30.9737616				1/2+	+1.13160		
<sup>32</sup> P		31.9739073	14.28 d	$\beta-$ /1.7106	1.710/100.	1+	-0.2524		
<sup>33</sup> P		32.971726	25.3 d	$\beta-$ /0.249	0.249/100.	1/2+			
<sup>34</sup> P		33.973636	12.4 s	$\beta-$ /5.374	3.2/15. 5.1/85.	1+			1.78-4.1/ 2.127(5)/15.
<sup>35</sup> P		34.973314	47. s	$\beta-$ /3.989	2.34/100.	1/2+			1.572(1)/100.
<sup>36</sup> P		35.97826	5.7 s	$\beta-$ /10.41					0.902/77. 3.291/100.
<sup>37</sup> P		36.97961	2.3 s	$\beta-$ /7.90					0.6462/

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<sup>38</sup> P		37.9842	0.6 s	$\beta^-$ /12.4					1.5829/ 1.2923/ 2.224/
<sup>39</sup> P		38.9862	0.3 s	$\beta^-$ /10.5	$\sim 12.$				
<sup>40</sup> P		39.9913	0.15 s	$\beta^-$ /14.5	/26				
<sup>41</sup> P		40.9943	0.10 s	$\beta^-$ / $\sim 13.8$	$\sim 30.$				
<sup>42</sup> P		42.0010	49. ms	$\beta^-$ /17.	$\sim 50.$				
<sup>43</sup> P		43.006	36. ms	$\beta^-$ /16.	/100.				
<sup>44</sup> P		44.013	19. ms						
<sup>45</sup> P		45.019	> 0.2 $\mu$ s						
<sup>46</sup> P		46.027	> 0.2 $\mu$ s						
<b><sup>16</sup>S</b>		<b>32.065(5)</b>							
<sup>26</sup> S		26.0279	$\sim 10$ ms			0+			
<sup>27</sup> S		27.0188	16. ms	$\beta^+$ , 2p/18.3	p/2.26, 7.80				
<sup>28</sup> S		28.0044	0.13 s			0+			
<sup>29</sup> S		28.99661	0.188 s	$\beta^+$ /13.79		5/2+			ann.rad./
<sup>30</sup> S		29.984903	1.18 s	$\beta^+$ /6.138	4.42/78. 5.08/20.	0+			ann.rad./ 0.678/79.
<sup>31</sup> S		30.979555	2.56 s	$\beta^+$ /5.396	4.39/99.	1/2+	0.48793		ann.rad./ 1.2662(5)/1.2
<sup>32</sup> S	94.99(26)	31.9720710				0+			
<sup>33</sup> S	0.75(2)	32.9714588				3/2+	+0.64382	-0.068	
<sup>34</sup> S	4.25(24)	33.9678669				0+			
<sup>35</sup> S		34.9690322	87.2 d	$\beta^-$ /0.1672	0.1674/100.	3/2+	+1.00	+0.047	
<sup>36</sup> S	0.01(1)	35.9670808				0+			
<sup>37</sup> S		36.9711256	5.05 m	$\beta^-$ /4.8653	1.64/94. 4.75/5.6	7/2-			0.9083(4)/0.06 3.1033(2)/94.2
<sup>38</sup> S		37.97116	2.84 h	$\beta^-$ /2.94	1.00/	0+			0.1962(4)/0.2 1.9421(3)/84.
<sup>39</sup> S		38.97513	11.5 s	$\beta^-$ /6.64					1.301/52. 1.697/44.
<sup>40</sup> S		39.9755	9. s	$\beta^-$ /4.7		0+			
<sup>41</sup> S		40.9796	$\sim 2.6$ s	$\beta^-$ /8.7					
<sup>42</sup> S		41.9810	$\sim 0.56$ s	$\beta^-$ /7.8		0+			
<sup>43</sup> S		42.9872	0.26 s	$\beta^-$ /12.	$< 4.$				
<sup>44</sup> S		43.9902	0.10 s	$\beta^-$ /9.	$\sim 40$				
<sup>45</sup> S		44.997	68. ms	$\beta^-$ /14.	/18.				
<sup>46</sup> S		46.001	0.05 s	$\beta^-$ , n	/54.				
<sup>47</sup> S		47.009	> 0.2 $\mu$ s						
<sup>48</sup> S		48.014	> 0.2 $\mu$ s			0+			
<sup>49</sup> S		49.024	< 0.2 $\mu$ s						
<b><sup>17</sup>Cl</b>		<b>35.453(2)</b>							
<sup>28</sup> Cl		28.029							
<sup>29</sup> Cl		29.0141	< 0.02 $\mu$ s						
<sup>30</sup> Cl		30.0048	< 0.03 $\mu$ s						
<sup>31</sup> Cl		30.99241	0.15 s	$\beta^+$ , p/11.98	0.986, 1.52/0.7	3/2+			ann.rad./



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<sup>36</sup> Ar	0.3365(30)	35.96754511				0+			2.964(1)/0.2
<sup>37</sup> Ar		36.9667763	35.0 d	EC/.813		3/2+	+1.15	+0.076	
<sup>38</sup> Ar	0.0632(5)	37.9627324				0+			
<sup>39</sup> Ar		38.964313	268. y	$\beta^-$ /0.565	0.565/100.	7/2-	-1.59	-0.12	
<sup>40</sup> Ar	99.6003(30)	39.962383123				0+			
<sup>41</sup> Ar		40.9645006	1.82 h	$\beta^-$ /2.492	1.198/	7/2-			1.29364(5)/99. 1.6770(3)/0.05
<sup>42</sup> Ar		41.96305	33. y	$\beta^-$ /0.60	0.60/100.	0+			
<sup>43</sup> Ar		42.96564	5.4 m	$\beta^-$ /4.6					0.4791(2)/10. 0.7380(1)/43. 0.9752(1)/100. 1.4400(3)/39.
<sup>44</sup> Ar		43.964924	11.87 m	$\beta^-$ /3.55		0+			0.182-1.866
<sup>45</sup> Ar		44.968040	21.5 s	$\beta^-$ /6.9		7/2-			0.0610/25. 1.020/35. 3.707/34.
<sup>46</sup> Ar		45.96809	8.4 s	$\beta^-$ /5.70		0+			1.944/
<sup>47</sup> Ar		46.9722	1.23 s	$\beta^-$					0.36/100 1.66/53 1.74/41 (2.02 - 4.01)
<sup>48</sup> Ar		47.9745	0.48 s			0+			
<sup>49</sup> Ar		48.981	0.17 s	$\beta^-$ , n	n// ~ 65.				
<sup>50</sup> Ar		49.984	~ 0.085 s	$\beta^-$ , n	n// ~ 35.	0+			
<sup>51</sup> Ar		50.992	> 0.2 $\mu$ s	$\beta^-$					
<sup>52</sup> Ar		51.997	10 ms	$\beta^-$		0+			
<sup>53</sup> Ar		53.005		$\beta^-$					
<b><sup>19</sup>K</b>		<b>39.0983(1)</b>							
<sup>32</sup> K		32.022							
<sup>33</sup> K		33.0073	< 0.025 $\mu$ s						
<sup>34</sup> K		33.9984	< 0.04 $\mu$ s						
<sup>35</sup> K		34.98801	0.19 s	$\beta^+$ /11.88		3/2+			ann.rad./ 1.751/14. 2.5698/26. 2.9827/51.
				$\beta^+$ , p/	/0.37				
<sup>36</sup> K		35.98129	0.342 s	$\beta^+$ /12.81	5.3/42. 9.9/44.	2+	+0.548		ann.rad./ 1.97044(5)/82. 2.20783(5)/30. 2.43343(2)/32.
				$\beta^+$ , p	/0.048				
<sup>37</sup> K		36.9733759	1.23 s	$\beta^+$ /6.149	5.13/	3/2+	+0.2032		ann.rad./ 2.7944(8)/2. 3.602(2)/0.05
<sup>38m</sup> K			0.924 s	$\beta^+$ /6.742	5.02/100.	0+			ann.rad./
<sup>38</sup> K		37.9690812	7.63 m	$\beta^+$ /5.913	2.60/99.8	3+	+1.37		ann.rad./ 2.1675(3)/99.8 3.9356(5)/0.2
<sup>39</sup> K	93.2581(44)	38.9637067				3/2+	+0.39146	+0.049	
<sup>40</sup> K	0.0117(1)	39.9639985	1.248 $\times 10^9$ y	$\beta^-$ /1.3111 $\beta^+$ , EC/1.505	1.312/89. 1.50/10.7	4-	-1.29810	-0.061	ann.rad./ 1.4608/10.5
<sup>41</sup> K	6.7302(44)	40.9618258				3/2+	+0.21487	+0.060	
<sup>42</sup> K		41.9624028	12.36 h	$\beta^-$ /3.525	1.97/19. 3.523/81.	2-	-1.1425		0.31260(2)/0.3 1.5246(3)/18.1
<sup>43</sup> K		42.96072	22.3 h	$\beta^-$ /1.82	0.465/8. 0.825/87. 1.24/3.5 1.814/1.3	3/2+	+0.163		0.2211(2)/4. 0.3729(2)/88. 0.3971(2)/11. 0.6178(2)/81.
<sup>44</sup> K		43.96156	22.1 m	$\beta^-$ /5.66	5.66/34.	2-	-0.856		0.36821/2.2

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									1.15700(1)/58.
									2.15079(2)/22.
<sup>45</sup> K		44.96070	17.8 m	$\beta^-$ /4.20	1.1/23. 2.1/69. 4.0/8.	3/2+	+0.173		0.1743(5)/80. 1.2607(8)/7. 1.7056(6)/69. 2.3542(5)/14.
<sup>46</sup> K		45.96198	1.8 m	$\beta^-$ /7.72	6.3/	2-	-1.05		1.347(1)/91. 3.700(5)/28.
<sup>47</sup> K		46.96168	17.5 s	$\beta^-$ /6.64	4.1/99. 6.0/1.	½+	+1.93		0.56474(3)/15. 0.58575(3)/85. 2.0131/100
<sup>48</sup> K		47.96551	6.8 s	$\beta^-$ /12.09	5.0/	(2-)			0.67122(1)/4. 0.6723(5)/20. 0.78016(1)/32. 3.83153(7)/80.
<sup>49</sup> K		48.9675	1.26 s	$\beta^-$ /11.0					2.025/ 2.252/
<sup>50</sup> K		49.9728	0.472 s	$\beta^-$ /14.2					
<sup>51</sup> K		50.976	0.365 s	$\beta^-$ /					
<sup>52</sup> K		51.983	0.105 s	$\beta^-$					
<sup>53</sup> K		52.987	30. ms	$\beta^-$		3/2+			
<sup>54</sup> K		53.994	10. ms	$\beta^-$					
<b><sup>20</sup>Ca</b>		<b>40.078(4)</b>							
<sup>34</sup> Ca		34.0141	< 0.035 $\mu$ s			0+			
<sup>35</sup> Ca		35.0049	25.7 ms	$\beta^+$ , p/15.6	p/1.43/49 1.9–8.8				
<sup>36</sup> Ca		35.99309	0.10 s	$\beta^+$ , (p)/10.99	2.52	0+			ann.rad./
				$\beta^+$ , n/					
<sup>37</sup> Ca		36.98587	0.18 s	$\beta^+$ /11.64	3.103	3/2+			ann.rad./ 1.369
				$\beta^+$ , n/					
<sup>38</sup> Ca		37.976318	0.44 s	$\beta^+$ /6.74		0+			ann.rad./ 1.5677(5)/25. 3.210(2)/1.
<sup>39</sup> Ca		38.970720	0.861 s	$\beta^+$ /6.531	5.49/100.	3/2+	1.02168		ann.rad./
<sup>40</sup> Ca	96.941(156)	39.9625910				0+			
<sup>41</sup> Ca		40.9622781	1.02 $\times 10^5$ y	EC/0.4214		7/2-	-1.5948	-0.090	
<sup>42</sup> Ca	0.647(23)	41.9586180				0+			
<sup>43</sup> Ca	0.135(10)	42.9587666				7/2-	-1.3173	-0.055	
<sup>44</sup> Ca	2.086(110)	43.9554818				0+			
<sup>45</sup> Ca		44.9561866	162.7 d	$\beta^-$ /0.257	0.257/100.	7/2-	-1.327	+0.05	
<sup>46</sup> Ca	0.004(3)	45.953693	> 0.4 $\times 10^{16}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>47</sup> Ca		46.954546	4.536 d	$\beta^-$ /1.992	0.684/84. 1.98/16.	7/2-	-1.38	+0.02	1.297/75 (0.041–1.88)
<sup>48</sup> Ca	0.187(21)	47.952534	4.3 $\times 10^{19}$ y > 7.1 $\times 10^{19}$ y	$\beta^-$ - $\beta^-$ $\beta^-$		0+			
<sup>49</sup> Ca		48.955674	8.72 m	$\beta^-$ /5.262	0.89/7. 1.95/92.	3/2-			3.0844(1)/90.7 4.0719(1)/8.12 (0.143 - 4.738)
<sup>50</sup> Ca		49.95752	14. s	$\beta^-$ /4.97	3.12/	0+			0.2569/98. (0.0715–1.59)
<sup>51</sup> Ca		50.9615	10. s	$\beta^-$ /7.3		(3/2-)			
<sup>52</sup> Ca		51.965	4.6 s	$\beta^-$ /8.0		0+			
<sup>53</sup> Ca		52.9701	0.09 s	$\beta^-$ /10.9					
<sup>54</sup> Ca		53.974	> 0.3 $\mu$ s			0+			
<sup>55</sup> Ca		54.981	> 0.3 $\mu$ s						
<sup>56</sup> Ca		55.986	> 0.3 $\mu$ s			0+			
<b><sup>21</sup>Sc</b>		<b>44.955912(6)</b>							

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<sup>36</sup> Sc		36.0149	0.102 s						
<sup>37</sup> Sc		37.0031	0.181 s						
<sup>38</sup> Sc		37.9947	< 0.3 $\mu$ s						
<sup>39</sup> Sc		38.98479	< 0.3 $\mu$ s	p					
<sup>40</sup> Sc		39.977967	0.182 s	$\beta^+$ /14.320	5.73/50. 7.53/15. 8.76/15. 9.58/20.	4-			ann.rad./ 0.752/41. 3.732/99.5 (1.12–3.92)
<sup>41</sup> Sc		40.9692511	0.596 s	$\beta^+$ /6.4953	5.61/100.	7/2-	+5.431	-0.156	ann.rad./
<sup>42m</sup> Sc			61.6 s	$\beta^+$ /	2.82/	7+			ann.rad./ 0.4375(5)/100. 1.2270(5)/100. 1.5245(5)/100.
<sup>42</sup> Sc		41.9655164	0.682 s	$\beta^+$ /6.4259	5.32/100.	0+			ann.rad./
<sup>43</sup> Sc		42.961151	3.89 h	$\beta^+$ , EC/2.221	0.82/22. 1.22/78.	7/2-	+4.62	-0.26	ann.rad./ 0.3729(1)/22.
<sup>44m</sup> Sc			58.2 h	I.T./0.27 EC/3.926		6+	+3.88		0.27124(1)/87. (1.00–1.16)
<sup>44</sup> Sc		43.959403	3.93 h	$\beta^+$ , EC/3.653	1.47/	2+	+2.56	+0.10	ann.rad./ 1.157/100
<sup>45</sup> Sc	100.	44.955912				7/2-	+4.75649	-0.220	
<sup>46m</sup> Sc			18.7 s	I.T./0.14253		1-			0.14253(2)/62.
<sup>46</sup> Sc		45.955172	83.81 d	$\beta^-$ /2.367	0.357/100.	4+	+3.03	+0.12	0.8893/100 1.121/100
<sup>47</sup> Sc		46.952408	3.349 d	$\beta^-$ /0.600	0.439/69. 0.601/31.	7/2-	+5.34	-0.22	0.15938(1)/68.
<sup>48</sup> Sc		47.95223	43.7 h	$\beta^-$ /3.99	0.655/	6+			0.9835/100 1.03750(1)/97. 1.3121/100
<sup>49</sup> Sc		48.950024	57.3 m	$\beta^-$ /2.006	2.00/99.9.	7/2-			1.7619(3)/0.05
<sup>50</sup> Sc		49.95219	1.71 m	$\beta^-$ /6.89	3.05/76. 3.60/24.	(5+)			0.5235(1)/88. 1.1210(1)/100. 1.5537(2)/100.
<sup>51</sup> Sc		50.95360	12.4 s	$\beta^-$ /6.51	4.4/ 5.0/	7/2-			1.4373(4)/52. 0.718–2.144
<sup>52</sup> Sc		51.9567	8.2 s	$\beta^-$ /9.0		(3+)			
<sup>53</sup> Sc		52.9596	> 3. ms	$\beta^-$ /8.1					
<sup>54m</sup> Sc			$\sim$ 7 $\mu$ s	I.T.		(5+)			0.110/IT
<sup>54</sup> Sc		53.9633	0.27 s	$\beta^-$ /11.6					0.100/50 1.70/40 0.50/40
<sup>55</sup> Sc		54.968	0.103 s	$\beta^-$ /13					0.593(1)/40
<sup>56m</sup> Sc			0.06 s						1.161/21 0.690/19
<sup>56</sup> Sc		55.973	35. ms	$\beta^-$		(1+)			1.129/48
<sup>57</sup> Sc		56.978	13. ms	$\beta^-$					
<sup>58</sup> Sc		57.984	12. ms	$\beta^-$					
<b><sup>22</sup>Ti</b>		<b>47.867(1)</b>							
<sup>38</sup> Ti		38.0098	< 0.12 $\mu$ s			0+			
<sup>39</sup> Ti		39.0016	30. ms	$\beta^+$ /15.4					
<sup>40</sup> Ti		39.9905	54. ms	$\beta^+$ /11.7	p/2.16/29 3.73/23 1.70/22 0.242–5.74	0+			
<sup>41</sup> Ti		40.9832	80. ms	$\beta^+$ , p/12.93	p/4.73/107 3.10/67 3.75/39 0.744–6.73	3/2+			ann.rad./





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<sup>56</sup> V		55.9505	0.22 s	$\beta^-$ /9.1					1.01/30. 0.688/26. (0.82 – 1.32)
<sup>57</sup> V		56.9526	0.35 s	$\beta^-$ /8.1					0.268/52. 0.692/20. (0.25 – 1.31)
<sup>58</sup> V		57.9567	0.19 s	$\beta^-$ /11.6					0.880/62 1.056/28 2.217/13 (1.04 – 1.57)
<sup>59</sup> V		58.9602	97. ms	$\beta^-$ /9.9					0.90/80.
<sup>60m</sup> V			0.12 s						
<sup>60</sup> V		59.9650	0.07 s	$\beta^-$ /14.					0.102–0.208
<sup>61</sup> V		60.9685	47. ms						(0.071-1.144)
<sup>62</sup> V		61.9738	34. ms						
<sup>63</sup> V		62.978	17. ms						
<sup>64</sup> V		63.983	> 0.3 $\mu$ s						
<b><sup>24</sup>Cr</b>		<b>51.9961(6)</b>							
<sup>42</sup> Cr		42.0064	13. ms	$\beta^+$ , p	p/1.90/29 p/1.50–3.7	0+			
<sup>43</sup> Cr		42.9977	21. ms	$\beta^+$ , p	p/3.83/18 p/4.29/15 p/1.01–4.59				
<sup>44</sup> Cr		43.98555	53. ms	$\beta^+$ , (p)/10.3	p/0.95–3.1	0+			
<sup>45</sup> Cr		44.9796	0.05 s	$\beta^+$ , p/12.5		7/2-			ann.rad./
<sup>46</sup> Cr		45.96836	0.3 s	$\beta^+$ /7.60		0+			ann.rad./
<sup>47</sup> Cr		46.96290	0.51 s	$\beta^+$ /7.45		3/2-			ann.rad./
<sup>48</sup> Cr		47.95403	21.6 h	EC/1.66		0+			ann.rad./ 0.116(2)/95. 0.305(10)/100.
<sup>49</sup> Cr		48.951336	42.3 m	$\beta^+$ , EC/2.631	1.39/ 1.45/ 1.54/	5/2-	0.476		ann.rad./ 0.09064(1)/51. 0.15293(1)/27. (0.062-1.6)
<sup>50</sup> Cr	4.345(13)	49.946044	> 1.3 $\times 10^{18}$ y	$\beta^+$ EC		0+			
<sup>51</sup> Cr		50.944767	27.70 d	EC/0.7527		7/2-	-0.934		0.3201/10.2
<sup>52</sup> Cr	83.789(18)	51.940508				0+			
<sup>53</sup> Cr	9.501(17)	52.940649				3/2-	-0.47454	-0.15	
<sup>54</sup> Cr	2.365(7)	53.938880				0+			
<sup>55</sup> Cr		54.940840	3.497 m	$\beta^-$ /2.603	2.5/	3/2-			1.5282(2)/0.04 (0.13–2.37)
<sup>56</sup> Cr		55.940653	5.9 m	$\beta^-$ /1.62	1.50/100.	0+			0.026(2)/100. 0.083(3)/100.
<sup>57</sup> Cr		56.943613	21. s	$\beta^-$ /5.1	3.3/ 3.5/	3/2-	0.0834		0.850/8. (0.083-2.62)
<sup>58</sup> Cr		57.9444	7.0 s	$\beta^-$ /4.0		0+			(0.131–0.683)
<sup>59m</sup> Cr			0.10 ms	I.T.		(9/2+)			0.208/IT 0.193 0.102
<sup>59</sup> Cr		58.9486	1.0 s	$\beta^-$ /7.7					1.236
<sup>60</sup> Cr		59.9500	0.6 s	$\beta^-$ /6.0		0+			
<sup>61</sup> Cr		60.9547	0.26 s	$\beta^-$ /8.8					0.354–1.860
<sup>62</sup> Cr		61.9566	0.19 s	$\beta^-$ /7.3		0+			(0.156-1.215)
<sup>63</sup> Cr		62.9619	0.129 s	$\beta^-$					(0.250-3.454)
<sup>64</sup> Cr		63.9644	0.043 s	$\beta^-$		0+			0.188
<sup>65</sup> Cr		64.9702	0.027 s	$\beta^-$					0.272, 1.368
<sup>66</sup> Cr		65.973	0.01 s	$\beta^-$		0+			
<sup>67</sup> Cr		66.980	> 0.3 $\mu$ s						

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<b><sup>25</sup>Mn</b>		<b>54.938045(5)</b>							
<sup>44</sup> Mn		44.0069	< 0.105 $\mu$ s						
<sup>45</sup> Mn		44.9945	< 0.07 $\mu$ s						
<sup>46</sup> Mn		45.9867	34. ms	$\beta^+$ /17.1					
				$\beta^+$ , p	// ~ 58				
<sup>47</sup> Mn		46.9761	~ 0.1 s	$\beta^+$ /12.3					
<sup>48</sup> Mn		47.9685	0.15 s	$\beta^+$ /13.5	5.79/58.	4+			
					4.43/10.				
<sup>49</sup> Mn		48.95962	0.38 s	$\beta^+$ /7.72	6.69/	5/2-			ann.rad./
<sup>50m</sup> Mn			1.74 m	$\beta^+$ /7.887	3.54/	5+			ann.rad./
									1.0980/94.
									0.783/91.
									(0.66-3.11)
<sup>50</sup> Mn		49.954238	0.283 s	$\beta^+$ /7.6330	6.61/	0+			ann.rad./
<sup>51</sup> Mn		50.948211	46.2 m	$\beta^+$ , EC/3.208	2.2/	5/2-	3.568	0.4	ann.rad./
									0.7491(1)/0.26
									(1.148-1.164)
<sup>52m</sup> Mn			21.1 m	$\beta^+$ /98/5.09	2.631/	2+	0.0076		ann.rad./
				I.T./2/0.378					0.3778 (I.T.)
									1.43406(1)/98.
									(0.7-4.8)
<sup>52</sup> Mn		51.945566	5.591 d	$\beta^+$ /4.712	0.575/	6+	+3.063	+0.5	ann.rad./
				EC/					0.74421(1)/90.
									1.4341/100
<sup>53</sup> Mn		52.941290	$3.7 \times 10^6$ y	EC/0.5970		7/2-	5.024		
<sup>54</sup> Mn		53.940359	312.1 d	EC/1.377		3+	+3.282	+0.33	0.8340/100
			$6.7 \times 10^8$ y	$\beta^+$	// $1.3 \times 10^{-7}$				
<sup>55</sup> Mn	100.	54.938045				5/2-	+3.4687	+0.32	
<sup>56</sup> Mn		55.938905	2.579 h	$\beta^-$ /3.6954	0.718/18.	3+	+3.2266		0.84675/98.9
					1.028/34.				1.81072(4)/26.3
									2.113/13.8
									(1.04 - 3.37)
<sup>57</sup> Mn		56.938285	1.45 m	$\beta^-$ /2.691		5/2-			
<sup>58</sup> Mn		57.93998	65 s	$\beta^-$ /6.25	3.8/	3+			0.45916(2)/20.
					5.1/				0.81076(1)/82.
									1.32309(5)/53.
<sup>59</sup> Mn		58.94044	4.6 s	$\beta^-$ /5.19	4.5/	5/2-			0.726/
									0.473/
									0.287-2.35
<sup>60m</sup> Mn			1.77 s	$\beta^-$ /IT	5.7/	3+			0.824/
<sup>60</sup> Mn		59.9429	50. s	$\beta^-$ /8.6		0+			1.969/
<sup>61</sup> Mn		60.9447	0.67 s	$\beta^-$ /7.4		(5/2)-			
<sup>62</sup> Mn		61.9484	0.67 s	$\beta^-$ /10.4		(3+)			0.877/
									0.942-1.299
<sup>63</sup> Mn		62.9502	0.28 s	$\beta^-$ /8.8					0.356,0.450
<sup>64m</sup> Mn			> 0.1 ms						0.135/IT
<sup>64</sup> Mn		63.9543	87 ms	$\beta^-$ /11.8					0.746
<sup>65</sup> Mn		64.9563	0.092 s	$\beta^-$ /10.					0.366
<sup>66</sup> Mn		65.9611	64 ms						0.471
<sup>67</sup> Mn		66.9641	45 ms						
<sup>68</sup> Mn		67.969	~ 28 ms						
<sup>69</sup> Mn		68.973	14 ms						
<b><sup>26</sup>Fe</b>		<b>55.845(2)</b>							
<sup>45</sup> Fe		45.0146	1.8 ms	2p /1.14	p// ~ 59.				
<sup>46</sup> Fe		46.0008	11. ms	$\beta^+$ /13.1	p// ~ 36.	0+			
<sup>47</sup> Fe		46.9929	21.7 ms	$\beta^+$ /15.6	p//87.				

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<sup>48</sup> Fe		47.9805	~ 44. ms	$\beta+$ /11.2		0+			
<sup>49</sup> Fe		48.9736	70. ms	$\beta+$ /13.0		(7/2-)			ann.rad./
<sup>50</sup> Fe		49.9630	0.15 s	$\beta+$ /8.2		0+			0.651
<sup>51</sup> Fe		50.95682	0.31 s	$\beta+$ /8.02		(5/2-)			ann.rad./
<sup>52m</sup> Fe			46. s	$\beta+$ /4.4		(12+)			ann.rad./ (0.622–2.286)/
<sup>52</sup> Fe		51.94811	8.28 h	$\beta+$ /57/2.37 EC/43/ I.T./	0.804/	0+			ann.rad./ 0.16868(1)/99. 0.377 (I.T.)/
<sup>53m</sup> Fe			2.6 m	I.T./3.0407		19/2-			0.7011(1)/99. 1.0115(1)/87. 1.3281(1)/87. 2.3396(1)/13.
<sup>53</sup> Fe		52.945308	8.51 m	$\beta+$ /3.743	2.40/42. 2.80/57.	7/2-			ann.rad./ 0.3779(1)/42. (1.2–3.2)
<sup>54</sup> Fe	5.845(35)	53.939611	> 3.1 × 10 <sup>22</sup> y	EC-EC		0+			
<sup>55</sup> Fe		54.938293	2.73 y	EC/0.2314		3/2-			Mn x-ray
<sup>56</sup> Fe	91.754(36)	55.934938				0+			
<sup>57</sup> Fe	2.119(10)	56.935394				½-	+0.0906	0.16	
<sup>58</sup> Fe	0.282(4)	57.933276				0+			
<sup>59</sup> Fe		58.934876	44.51 d	$\beta$ -/1.565	0.273/48. 0.475/51.	3/2-	-0.336		1.099/57 1.292/43. (0.14–1.48)
<sup>60</sup> Fe		59.934072	1.5 × 10 <sup>6</sup> y	$\beta$ - /0.237	0.184/100.	0+			0.0586/100
<sup>61m</sup> Fe			0.25 $\mu$ s	I.T.		(9/2+)			0.654/IT 0.207
<sup>61</sup> Fe		60.93675	6.0 m	$\beta$ - /3.98	2.5/13. 2.63/54. 2.80/31.				1.205/44. 1.028/43. (0.12–3.37)
<sup>62</sup> Fe		61.93677	68. s	$\beta$ - /2.53	2.5/100.	0+			0.5061(1)/100.
<sup>63</sup> Fe		62.9404	6. s	$\beta$ - /6.3		5/2-			0.995/ (1.365–1.427)
<sup>64</sup> Fe		63.9412	2.0 s	$\beta$ - /4.9		0+			
<sup>65m</sup> Fe			0.4 $\mu$ s	I.T.		(5/2-)			0.364/IT
<sup>65</sup> Fe		64.9454	1.3 s	$\beta$ - /7.9					
<sup>66</sup> Fe		65.9468	0.44 s	$\beta$ - /5.7		0+			0.471–1.425
<sup>67m</sup> Fe			~ 0.04 ms	I.T.		(5/2-)			0.367/IT
<sup>67</sup> Fe		66.9510	0.48 s	$\beta$ - /8.8					0.189
<sup>68</sup> Fe		67.954	0.19 s	$\beta$ - / ~ 7.6		0+			
<sup>69</sup> Fe		68.959	0.11 s						
<sup>70</sup> Fe		69.961	0.10 s			0+			
<sup>71</sup> Fe		70.967	> 0.3 $\mu$ s						
<sup>72</sup> Fe		71.970	> 0.3 $\mu$ s			0+			
<b><sub>27</sub>Co</b>		<b>58.933195(5)</b>							
<sup>47</sup> Co		47.0115							
<sup>48</sup> Co		48.0018							
<sup>49</sup> Co		48.9897	< 0.035 $\mu$ s						
<sup>50</sup> Co		49.9815	44. ms	$\beta+$ /17.0	2.03–2.79				
<sup>51</sup> Co		50.9707	> 0.2 $\mu$ s	$\beta+$ /12.8					
<sup>52</sup> Co		51.9636	0.12 s	$\beta+$ /14.0					0.849–1.942
<sup>53m</sup> Co			0.25 s	$\beta+$ , p/		19/2-			ann.rad./
<sup>53</sup> Co		52.95422	0.24 s	$\beta+$ /8.30		7/2-			ann.rad./
<sup>54m</sup> Co			1.46 m	$\beta+$ /8.44	4.25/100.	7+			ann.rad./ 0.411(1)/99. 1.130(1)/100. 1.408(1)/100.
<sup>54</sup> Co		53.948460	0.1932 s	$\beta+$ /8.2430	7.34/100.	0+			ann.rad./

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<sup>55</sup> Co		54.941999	17.53 h	$\beta^+$ /3.4513 EC/	0.53/ 1.03/ 1.50/	7/2-	+4.822		ann.rad./ 0.9312/75. 0.4772/20. (0.092-3.11)
<sup>56</sup> Co		55.939839	77.3 d	$\beta^+$ /4.566 EC/	1.459/18.	4+	3.85	+0.25	ann.rad./ 0.8468/99.9 1.2383/68. (0.26-3.61)
<sup>57</sup> Co		56.936291	271.8 d	EC/0.8361		7/2-	+4.72	+0.5	0.12206/86 (0.014-0.706)
<sup>58m</sup> Co			9.1 h	I.T./		5+			0.02489/0.035
<sup>58</sup> Co		57.935753	70.88 d	$\beta^+$ /2.307 EC/		2+	+4.04	+0.22	ann.rad./ 0.81076/99
<sup>59</sup> Co	100.	58.933195				7/2-	+4.63	+0.41	
<sup>60m</sup> Co			10.47 m	I.T./99.8/0.059 $\beta^-$ /0.2/1.56		2+	+4.40	+0.3	0.0586/2.0
<sup>60</sup> Co		59.933817	5.271 y	$\beta^-$ /2.824	0.315/99.7	5+	+3.799	+0.44	1.1732/100 1.3325/100
<sup>61</sup> Co		60.932476	1.650 h	$\beta^-$ /1.322	1.22/95.	7/2-			0.0674/86. 0.842-0.909
<sup>62m</sup> Co			13.9 m	$\beta^-$ /	0.88/25. 2.88/75.	5+			1.1635(3)/70. 1.1730(3)/98. 2.0039(3)/19.
<sup>62</sup> Co		61.93405	1.50 m	$\beta^-$ /5.32	1.03/10. 1.76/5. 2.9/20. 4.05/60.	2+			1.1292(3)/13. 1.1730(3)/83. 1.9851(1)/3. 2.3020(1)/19.
<sup>63</sup> Co		62.93361	27.5 s	$\beta^-$ /3.67	3.6/	7/2-			0.08713(1)/49. 0.9817(3)/2.6 0.156-2.17
<sup>64</sup> Co		63.93581	0.30 s	$\beta^-$ /7.31	7.0/	1+			
<sup>65</sup> Co		64.93648	1.14 s	$\beta^-$ /5.96		(7/2)-			
<sup>66m2</sup> Co			> 0.1 ms	I.T.		(8-)			0.252/IT 0.214 0.175
<sup>66m1</sup> Co			1.2 $\mu$ s	I.T.		(5+)			0.175/IT
<sup>66</sup> Co		65.9398	0.25 s	$\beta^-$ /10.0					(1.245-1.425)
<sup>67</sup> Co		66.9409	0.43 s	$\beta^-$ /8.4					0.694
<sup>68</sup> Co		67.9449	0.19 s	$\beta^-$ /11.7					
<sup>69</sup> Co		68.9463	0.20 s	$\beta^-$ /9.3					
<sup>70</sup> Co		69.951	0.12 s	$\beta^-$ 13.					1.26/102 0.97/100 (0.45 - 0.92)
<sup>71</sup> Co		70.953	97. ms	$\beta^-$ $\beta^-$ ,n	// > 3				0.566/100 (0.25 - 0.77)
<sup>72</sup> Co		71.958	60. ms	$\beta^-$ $\beta^-$ ,n	// > 6				1.096/100 0.845 (0.455 - 1.197)
<sup>73</sup> Co		72.960	41. ms	$\beta^-$ $\beta^-$ ,n	// > 9				0.524/100 (0.24 - 0.76)
<sup>74</sup> Co		73.965	30. ms	$\beta^-$ $\beta^-$ ,n	// > 26				0.739 1.024
<sup>75</sup> Co		74.968	> 0.3 $\mu$ s						
<b><sup>28</sup>Ni</b>		<b>58.6934(2)</b>							
<sup>48</sup> Ni		48.020	~ 2.1 ms	2p	p// ~ 25	0+			
<sup>49</sup> Ni		49.0097	12. ms						
<sup>50</sup> Ni		49.9959	12. ms	$\beta^+$ , p	p//70.	0+			
<sup>51</sup> Ni		50.9877	> 0.2 $\mu$ s	$\beta^+$ /16.0					

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<sup>52</sup> Ni		51.9757	38. ms	$\beta^+$ /11.7		0+			
<sup>53</sup> Ni		52.9685	0.05 s	$\beta^+$ , p/13.3		7/2-			ann.rad./
<sup>54</sup> Ni		53.95791	0.10 s	$\beta^+$ /8.80		0+			0.937
<sup>55</sup> Ni		54.95133	0.20 s	$\beta^+$ /8.70	7.66/	7/2-			ann.rad./
<sup>56</sup> Ni		55.94213	6.08 d	EC/2.14		0+			0.15838/99
				$\beta^+$ /<10 <sup>-6</sup>					0.81185(3)/87. 0.2695–0.7500
<sup>57</sup> Ni		56.939794	35.6 h	$\beta^+$ /3.264	0.712/10.	3/2-	-0.798		ann.rad./
				EC/	0.849/76.				1.3776/78. (0.127–3.177)
<sup>58</sup> Ni	68.0769(89)	57.935343	>4 × 10 <sup>19</sup> y	EC-EC		0+			
<sup>59</sup> Ni		58.934347	~ 7.6 × 10 <sup>4</sup> y	EC/		3/2-			
<sup>60</sup> Ni	26.2231(77)	59.930786				0+			
<sup>61</sup> Ni	1.1399(6)	60.931056				3/2-	-0.75002	+0.16	
<sup>62</sup> Ni	3.6345(17)	61.928345				0+			
<sup>63</sup> Ni		62.929669	100. y	$\beta^-$ /0.066945	0.065/	½-			
<sup>64</sup> Ni	0.9256(9)	63.927966				0+			
<sup>65</sup> Ni		64.930084	2.517 h	$\beta^-$ /2.137	0.65/30. 1.020/11. 2.140/58.	5/2-	0.69		0.36627(3)/5. 1.11553(4)/16. 1.48184(5)/23.
<sup>66</sup> Ni		65.929139	54.6 h	$\beta^-$ /0.23		0+			
<sup>67m</sup> Ni			13.3 $\mu$ s	I.T.		9/2+			0.313/IT 0.694
<sup>67</sup> Ni		66.931569	21. s	$\beta^-$ /3.56	3.8/	½-	+0.601		1.0722/100. 1.6539/100. (0.10–1.98)
<sup>68m2</sup> Ni			0.34 $\mu$ s						0.511
<sup>68m1</sup> Ni			0.86 ms	I.T.		(5-)			0.814/IT 2.033
<sup>68</sup> Ni		67.931869	29. s	$\beta^-$ /2.06		0+			
<sup>69m2</sup> Ni			0.44 $\mu$ s	I.T.		(17/2)			0.148/IT 0.593 1.959
<sup>69m1</sup> Ni			3.5 s						
<sup>69</sup> Ni		68.935610	11. s	$\beta^-$ /5.4					0.6807(3)/100. (0.207–1.213)
<sup>70m</sup> Ni			0.21 $\mu$ s	I.T.		(8+)			0.183/IT 0.448 0.970 1.259
<sup>70</sup> Ni		69.9365	6.0 s	$\beta^-$ /3.5		0+			
<sup>71</sup> Ni		70.9407	2.56 s	$\beta^-$ /6.9					
<sup>72</sup> Ni		71.9421	1.6 s	$\beta^-$ /5.2		0+			
<sup>73</sup> Ni		72.9465	0.84 s	$\beta^-$ /9.					
<sup>74</sup> Ni		73.9481	0.9 s	$\beta^-$ /7.		0+			
<sup>75</sup> Ni		74.9529	0.34 s						
<sup>76</sup> Ni		75.955	0.24 s			0+			
<sup>77</sup> Ni		76.961	0.13 s						
<sup>78</sup> Ni		77.963	~ 0.11 s			0+			
<b><sup>29</sup>Cu</b>		<b>63.546(3)</b>							
<sup>52</sup> Cu		51.9972							
<sup>53</sup> Cu		52.9856	< 0.3 $\mu$ s						
<sup>54</sup> Cu		53.9767	< 0.075 $\mu$ s						
<sup>55</sup> Cu		54.9661	> 0.2 $\mu$ s	$\beta^+$ /13.2					
<sup>56</sup> Cu		55.9586	93. ms	$\beta^+$ /15.3					0.511/233 2.700/100 0.9507–3.287
<sup>57</sup> Cu		56.94921	196. ms	$\beta^+$ /8.77		3/2-			0.77–3.01

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>58</sup> Cu		57.944539	3.21 s	$\beta^+$ /8.563 EC/	4.5/15. 7.439/83.	1+			ann.rad./ 0.0403(4)/5. 1.4483(2)/11. 1.4546(2)/16.
<sup>59</sup> Cu		58.939498	1.36 m	$\beta^+$ /4.800	1.9/ 3.75/	3/2-	+ 1.89		ann.rad./ 0.3393(1)/8. 0.8780(1)/12. 1.3015(1)/15. (0.4-2.6)
<sup>60</sup> Cu		59.937365	23.7 m	$\beta^+$ /6.127 EC/	2.00/69. 3.00/18. 3.92/6.	2+	+1.219		ann.rad./ 1.3325/88. 1.7915/45. (0.12-5.048)
<sup>61</sup> Cu		60.933458	3.35 h	$\beta^+$ /2.237	0.56/3. 0.94/5. 1.15/2. 1.220/51.	3/2-	+2.14		ann.rad./ 0.2830/13. 0.6560/11. (0.067-2.123)
<sup>62</sup> Cu		61.932584	9.67 m	$\beta^+$ /98/3.948 EC/	2.93/98.	1+	-0.380		ann.rad./ 1.17302(1)/0.6 (0.87-3.37)
<sup>63</sup> Cu	69.15(15)	62.929598				3/2-	+2.2233	-0.211	
<sup>64</sup> Cu		63.929764	12.701 h	$\beta^-$ /38/0.579 $\beta^+$ /19/1.6751 EC/41/	0.578/ 0.65/	1+	-0.217		ann.rad./ 1.3459(3)/0.6
<sup>65</sup> Cu	30.85(15)	64.927790				3/2-	+2.3817	-0.195	
<sup>66</sup> Cu		65.928869	5.09 m	$\beta^-$ /2.642	1.65/6. 2.7/94.	1+	-0.282		0.8330(1)/0.22 1.0392(2)/9.2
<sup>67</sup> Cu		66.927730	2.580 d	$\beta^-$ /0.58	0.395/56. 0.484/23. 0.577/20.	3/2-	+ 2.54		0.09125(1)/7. 0.09325(1)/17. 0.18453(1)/47.
<sup>68m</sup> Cu			3.79 m	I.T./86/ $\beta^-$ /14/1.8		6-	+1.24		0.0843(5)/70. 0.1112(5)/18. 0.5259(5)/74. (0.64-1.34)
<sup>68</sup> Cu		67.929611	31. s	$\beta^-$ /4.46	3.5/40. 4.6/31.	1+	+2.48		1.0774(5)/58. 1.2613(5)/17. (0.15-2.34)
<sup>69m</sup> Cu			0.36 $\mu$ s	I.T.		(13/2+)			0.075/IT 0.190/IT 0.680 1.871
<sup>69</sup> Cu		68.929429	2.8 m	$\beta^-$ /2.68	2.48/80.	3/2-	+2.84		0.5307(3)/3. 0.8340(5)/6. 1.0065(8)/10. 0.8849/100 1.072/19
<sup>70m2</sup> Cu			6.6 s	$\beta$ /93 IT/7					0.141/ IT
<sup>70m1</sup> Cu			33. s	$\beta^-$ /52 IT/48	2.52/10.	5-	+1.9		0.8848(2)/100. 0.9017(2)/90. 1.2517(5)/60. (0.39-3.06)
<sup>70</sup> Cu		69.932392	44.5 s	$\beta^-$ /6.60	5.42/54. 6.09/46.	1+	+1.5		0.8848(2)/100. 0.9017/99.7 (0.438 - 3.062)
<sup>71m</sup> Cu			0.28 $\mu$ s	I.T.		(19/2)			0.133/IT 0.494 0.939 1.189
<sup>71</sup> Cu		70.932677	20. s	$\beta^-$ /4.56		3/2-			0.490/
<sup>72m</sup> Cu			1.76 $\mu$ s	I.T.		(4-)			0.051/IT

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									0.082
									0.138
<sup>72</sup> Cu		71.935820	6.6 s	$\beta^-$ /8.2		(1+)			0.652/
<sup>73</sup> Cu		72.936675	4.2 s	$\beta^-$ /6.3	5.8/43				0.450/100
					6.25/42				0.307–1.559
<sup>74</sup> Cu		73.93988	1.59 s	$\beta^-$ /9.9					
<sup>75</sup> Cu		74.942	1.2 s	$\beta^-$ /7.9					
<sup>76m</sup> Cu			1.2 s						
<sup>76</sup> Cu		75.94528	0.64 s	$\beta^-$ /11.					
<sup>77</sup> Cu		76.9479	0.46 s	$\beta^-$ / ~ 10.					
<sup>78</sup> Cu		77.9520	0.33 s	$\beta^-$ /12.					
<sup>79</sup> Cu		78.9546	0.19 s	$\beta^-$ /11.					
<sup>80</sup> Cu		79.961	> 0.3 $\mu$ s						
<b><sub>30</sub>Zn</b>		<b>69.409(4)</b>							
<sup>54</sup> Zn		53.9930	~ 3.2 ms	2p	p/87	0+			
<sup>55</sup> Zn		54.9840	> 1.6 $\mu$ s						
<sup>56</sup> Zn		55.9724	0.04 s			0+			
<sup>57</sup> Zn		56.9648	0.04 s	$\beta^+$ , p/14.6		(7/2-)			ann.rad./
<sup>58</sup> Zn		57.95459	0.09 s	$\beta^+$		0+			
<sup>59</sup> Zn		58.94926	183. ms	$\beta^+$ , p/9.09	8.1/	3/2-			ann.rad./
									(0.491–0.914)
<sup>60</sup> Zn		59.94183	2.40 m	$\beta^+$ /97/4.16		0+			ann.rad./
				EC/3/					0.669/47.
									(0.062–0.947)
<sup>61</sup> Zn		60.93951	1.485 m	$\beta^+$ /5.64	4.38/68.	3/2-			ann.rad./
									0.4748/17.
									(0.15–3.52)
<sup>62</sup> Zn		61.93433	9.22 h	$\beta^+$ /3/1.63	0.66/7.	0+			ann.rad./
				EC/93/					0.0408/25
									0.5967/26.
									(0.20–1.526)/
<sup>63</sup> Zn		62.933212	38.5 m	$\beta^+$ /93/3.367	1.02/	3/2-	-0.28164	+0.29	ann.rad./
				EC/7/	1.40/				0.66962(5)/8.4
					1.71/				0.96206(5)/6.6
					2.36/84.				(0.24–3.1)
<sup>64</sup> Zn	48.268(321)	63.929142	> 4.3 $\times 10^{18}$ y	EC- $\beta^+$		0+			
<sup>65</sup> Zn		64.929241	244.0 d	$\beta^+$ /98/1.3514	0.325/	5/2-	+0.7690	-0.023	ann.rad./
				EC/1.5/					1.1155/49.8
<sup>66</sup> Zn	27.975(77)	65.926033				0+			
<sup>67</sup> Zn	4.102(21)	66.927127				5/2-	+0.8755	+0.15	
<sup>68</sup> Zn	19.024(123)	67.924844				0+			
<sup>69m</sup> Zn			13.76 h	I.T./99+/0.439		9/2+			0.4390(2)/95.
<sup>69</sup> Zn		68.926550	56. m	$\beta^-$ /0.906	0.905/99.9	½-			0.318/
<sup>70</sup> Zn	0.631(9)	69.925319	> 1.3 $\times 10^{16}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>71m</sup> Zn			3.97 h	$\beta^-$ /	1.45/	9/2+			0.3864/93.
									0.4874/62.
									0.6203/57.
									(0.099–2.489)
<sup>71</sup> Zn		70.92772	2.4 m	$\beta^-$ /2.81		½-			0.5116(1)/30.
									0.9103(1)/7.5
									(0.12–2.29)
<sup>72</sup> Zn		71.92686	46.5 h	$\beta^-$ /0.46	0.25/14.	0+			0.0164(3)/8.
					0.30/86.				0.1447(1)/83.
									0.1915(2)/9.4
<sup>73m</sup> Zn			6. s		I.T./0.196	(7/2+)			0.042
<sup>73</sup> Zn		72.92978	24. s	$\beta^-$ /4.29	4.7/	(1/2-)			0.216(1)/100.
									0.496–0.911
<sup>74</sup> Zn		73.92946	1.60 m	$\beta^-$ /2.3	2.1/	0+			0.0565/



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									0.1401/ (0.05-0.35)
<sup>75</sup> Zn		74.9329	10.2 s	$\beta^-$ /6.0					0.229/
<sup>76</sup> Zn		75.9333	5.7 s	$\beta^-$ /4.2	3.6/	0+			0.119/
<sup>77m</sup> Zn			1.0 s	$\beta^-$ /		(1/2-)			0.772
<sup>77</sup> Zn		76.9370	2.1 s	$\beta^-$ /7.3	4.8/				0.189/
<sup>78m</sup> Zn			> 0.03 ms						1.070
<sup>78</sup> Zn		77.9384	1.5 s	$\beta^-$ /6.4		0+			0.225/
<sup>79</sup> Zn		78.9427	1.0 s	$\beta^-$ /8.6					0.702/
<sup>80</sup> Zn		79.9443	0.54 s	$\beta^-$ /7.3		0+			0.713/ 0.2248/
<sup>81</sup> Zn		80.9505	0.29 s	$\beta^-$ /11.9					
<sup>82</sup> Zn		81.9544	> 0.15 $\mu$ s			0+			
<sup>83</sup> Zn		82.9610	> 0.15 $\mu$ s						
<b><sub>31</sub>Ga</b>		<b>69.723(1)</b>							
<sup>56</sup> Ga		55.9949							
<sup>57</sup> Ga		56.9829							
<sup>58</sup> Ga		57.9743							
<sup>59</sup> Ga		58.9634	< 0.043 $\mu$ s						
<sup>60</sup> Ga		59.9571	0.07 s	$\beta^+$					1.004
				$\beta^+$ , p	// ~ 1.6				3.848
				$\beta^+$ , $\alpha$	// ~ 0.02				1.555-2.559
<sup>61</sup> Ga		60.9495	0.17 s	$\beta^+$ /9.0		3/2			0.088-1.362
<sup>62</sup> Ga		61.94418	116.0 ms	$\beta^+$ /9.17	8.3/	0+			ann.rad./
				EC/					0.954/0.0012
<sup>63</sup> Ga		62.939294	32. s	$\beta^+$ /5.5	4.5/				ann.rad./
				EC/					0.6271(2)/10.
									0.6370(2)/11.
									1.0652(4)/45.
<sup>64m</sup> Ga			0.022 ms						0.0429
<sup>64</sup> Ga		63.936839	2.63 m	$\beta^+$ /7.165	2.79/	0+			ann.rad./
					6.05/				0.80785(1)/14.
									0.99152(1)/43.
									1.38727(1)/12.
									3.3659(1)/13.
<sup>65</sup> Ga		64.932735	15.2 m	$\beta^+$ /86/3.255	0.82/10.	3/2-			ann.rad./
				EC/	1.39/19.				0.1151(2)/55.
					2.113/56.				0.1530(2)/96.
					2.237/15.				0.2069(2)/39.
									(0.06-2.4)
<sup>66</sup> Ga		65.931589	9.5 h	$\beta^+$ /56/5.175	0.74/1.	0+			ann.rad./
				EC/43/	1.84/54.				1.03935(8)/38.
					4.153/51.				2.7523(1)/23.
									(0.28-5.01)
<sup>67</sup> Ga		66.928202	3.261 d	EC/1.001		3/2-	+1.8507	0.20	0.09332/37.
									0.18459/20.
									0.30024/17.
									(0.091-0.89)
<sup>68</sup> Ga		67.927980	1.130 h	$\beta^+$ /90/2.921	1.83/	1+	0.01175	0.028	ann.rad./
				EC/10/					1.0774(1)/3.
									(0.57-2.33)/
<sup>69</sup> Ga	60.108(9)	68.925574				3/2-	+2.01659	+0.17	
<sup>70</sup> Ga		69.926022	21.1 m	EC/0.2/0.655		1+			0.1755(5)/0.15
				$\beta^-$ /99.8/1.656	1.65/99.				1.042(5)/0.48
<sup>71</sup> Ga	39.892(9)	70.924701	> 2.4 $\times 10^{26}$ y	$\beta^-$		3/2-	+2.56227	+0.11	
<sup>72</sup> Ga		71.926366	14.10 h	$\beta^-$ /4.001	0.64/40.	3-	-0.13224	+0.5	0.8340/95.53
					1.51/9.				2.202/26.9
					2.52/8.				0.630/26.2

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<sup>73</sup> Ga		72.925175	74.87 h	$\beta^-$ /1.59	3.15/11.	3/2-			(0.113–3.678) 0.05344(5)/10. 0.29732(5)/47. (0.01–1.00)/
<sup>74m</sup> Ga			10. s	I.T./		1+			0.0565(1)/75.
<sup>74</sup> Ga		73.926946	8.1 m	$\beta^-$ /5.4	2.6/	3-			0.5959/92. 2.354/45. (0.23–3.99)
<sup>75</sup> Ga		74.926500	2.10 m	$\beta^-$ /3.39	3.3/	3/2-			0.2529/ 0.5746/ (0.12–2.10)
<sup>76</sup> Ga		75.928828	29. s	$\beta^-$ /7.0		3-			0.5629/66. 0.5455/26. (0.34–4.25)
<sup>77</sup> Ga		76.929154	13.0 s	$\beta^-$ /5.3	5.2/				0.469/ 0.459/
<sup>78</sup> Ga		77.931608	5.09 s	$\beta^-$ /8.2		3+			0.619/77. 1.187/20.
<sup>79</sup> Ga		78.9329	2.85 s	$\beta^-$ /7.0	4.6/				0.465/
<sup>80</sup> Ga		79.9365	1.68 s	$\beta^-$ /10.4	10./				0.659/
<sup>81</sup> Ga		80.9378	1.22 s	$\beta^-$ /8.3	5.1/				0.217/
<sup>82</sup> Ga		81.9430	0.599 s	$\beta^-$ /12.6					1.348/
<sup>83</sup> Ga		82.9470	0.308 s	$\beta^-$ /~ 11.5					
<sup>84</sup> Ga		83.9527	~ 0.085 s	$\beta^-$ /14					
<sup>85</sup> Ga		84.9570	> 0.3 $\mu$ s						
<sup>86</sup> Ga		85.963	> 0.3 $\mu$ s						
<b><sub>32</sub>Ge</b>		<b>72.64(1)</b>							
<sup>58</sup> Ge		57.9910				0+			
<sup>59</sup> Ge		58.9818							
<sup>60</sup> Ge		59.9702	> 0.11 $\mu$ s			0+			
<sup>61</sup> Ge		60.9638	0.04 s	$\beta^+$ /13.6					
<sup>62</sup> Ge		61.9547	0.13 s			0+			
<sup>63</sup> Ge		62.9496	0.15 s	$\beta^-$ /9.8					
<sup>64</sup> Ge		63.94165	1.06 m	$\beta^+$ /4.4	3.0/	0+			ann.rad./ 0.1282(2)/11. 0.4270(3)/37. 0.6671(3)/17.
				EC/					
				$\beta^+$ , p					
<sup>65</sup> Ge		64.9394	31. s	$\beta^+$ /6.2	0.82/10. 1.39/19.				ann.rad./ 0.0620/27. 0.6497/33. 0.8091/21. (0.19–3.28)
				EC, p	2.113/56. 2.237/15.				
				$\beta^+$ , p	//0.011				
<sup>66</sup> Ge		65.93384	2.26 h	$\beta^+$ /27/2.10		0+			ann.rad./ 0.0438/29. 0.3819/28. (0.022–1.77)
				EC/73/					
<sup>67</sup> Ge		66.932734	19.0 m	$\beta^+$ /96/4.225	1.6/ 2.3/ 3.15/	½-			ann.rad./ 0.1670/84. (0.25–3.73)
				EC/4/					
<sup>68</sup> Ge		67.92809	270.8 d	EC/0.11		0+			Ga k x-ray/39.
<sup>69</sup> Ge		68.927965	1.63 d	$\beta^+$ /36/2.2273	0.70/ 1.2/	5/2-	0.735	0.02	ann.rad./ 0.574/13. 1.1068/36. (0.2–2.04)
				EC/64/					
<sup>70</sup> Ge	20.38(18)	69.924247				0+			
<sup>71m</sup> Ge			20.4 ms		I.T./0.0234	9/2+			0.1749
<sup>71</sup> Ge		70.924951	11.2 d	EC/0.229		½-	+0.547		
<sup>72</sup> Ge	27.31(26)	71.922076				0+			

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<sup>73</sup> Ge	7.76(8)	72.923459	> 1.8 × 10 <sup>23</sup> y	$\beta^-$		9/2+	-0.879467	-0.17	
<sup>74</sup> Ge	36.72(15)	73.921178				0+			
<sup>75m</sup> Ge			48. s	I.T./		7/2+			0.13968(3)/39.
<sup>75</sup> Ge		74.922859	1.380 h	$\beta^-$ /1.177	1.19/	½-	+0.510		0.26461(5)/11. 0.41931(5)/0.2
<sup>76</sup> Ge	7.83(7)	75.921403	1.6 × 10 <sup>21</sup> y	$\beta-\beta^-$		0+			
<sup>77m</sup> Ge			53. s	I.T./20/ $\beta^-$ /80/2.861	2.9/	½-			1.605/0.22 1.676/0.16 0.195-1.482
<sup>77</sup> Ge		76.923549	11.25 h	$\beta^-$ /2.702	0.71/23. 1.38/35. 2.19/42.	7/2+			0.2110/29. 0.2155/27. 0.2644/51. (0.15-2.35)
<sup>78</sup> Ge		77.922853	1.45 h	$\beta^-$ /0.95	0.70/	0+			0.2773(5)/96. 0.2939(5)/4.
<sup>79m</sup> Ge			39. s	$\beta^-$ /IT		7/2+			
<sup>79</sup> Ge		78.9254	19.1 s	$\beta^-$ /4.2	4.0/20. 4.3/80.	½-			0.1096/21. (0.10-2.59) 0.5427(4)/15.
<sup>80</sup> Ge		79.92537	29.5 s	$\beta^-$ /2.67	2.4/	0+			0.1104(4)/6. 0.2656(4)/25.
<sup>81m</sup> Ge			~ 7.6 s	$\beta^-$ /	3.75/	½+			0.3362(4)/ 0.7935(4)/
<sup>81</sup> Ge		80.9288	~ 7.6 s	$\beta^-$ /6.2	3.44/	9/2+			0.1976(4)/21. 0.3362(4)/100.
<sup>82</sup> Ge		81.9296	4.6 s	$\beta^-$ /4.7	1.093/80	0+			1.093/
<sup>83</sup> Ge		82.9346	1.9 s	$\beta^-$ /8.9					
<sup>84</sup> Ge		83.9375	0.98 s	$\beta^-$ /7.7		0+			
<sup>85</sup> Ge		84.9430	0.54 s	$\beta^-$ /10.					
<sup>86</sup> Ge		85.9465	> 0.3 $\mu$ s			0+			
<sup>87</sup> Ge		86.9525	> 0.3 $\mu$ s						
<sup>88</sup> Ge		87.957	> 0.3 $\mu$ s			0+			
<sup>89</sup> Ge		88.964	> 0.3 $\mu$ s						
<b><sup>33</sup>As</b>		<b>74.92160(2)</b>							
<sup>60</sup> As		59.993							
<sup>61</sup> As		60.981							
<sup>62</sup> As		61.9732							
<sup>63</sup> As		62.9637	< 0.043 $\mu$ s						
<sup>64</sup> As		63.9576	0.02 s						
<sup>65</sup> As		64.9496	0.13 s	$\beta^+$ /9.4					
<sup>66m2</sup> As			8. $\mu$ s						
<sup>66m1</sup> As			1.1 $\mu$ s						
<sup>66</sup> As		65.945	95.8 ms	$\beta^+$ /9.55					
<sup>67</sup> As		66.9392	42. s	$\beta^+$ /6.0 EC/	5.0/	5/2-			0.121/ 0.123/ 0.244/
<sup>68</sup> As		67.93677	2.53 m	$\beta^+$ /8.1		3+			ann.rad./ 0.652/32. 0.762/33. 1.016/77. (0.61-3.55)
<sup>69</sup> As		68.93227	15.2 m	$\beta^+$ /98/4.01 EC/2/	2.95/	5/2-	+ 1.623		ann.rad./ 0.0868(5)/1.5 0.1458(3)/2.4
<sup>70</sup> As		69.93092	52.6 m	$\beta^+$ /84/6.22 EC/16/2.14 /2.89	1.44/	4+	+2.1061	+0.09	ann.rad./ 1.0395(7)/82. (0.17-4.4)/
<sup>71</sup> As		70.927112	2.72 d	$\beta^+$ /32/2.013		5/2-	+1.6735	-0.02	ann.rad./

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				EC/68/					0.1749(2)/84. 1.0957(2)/4.2
<sup>72</sup> As		71.926752	26.0 h	$\beta^+$ /77/4.356	0.669/5. 1.884/12. 2.498/62. 3.339/19.	2-	-2.1566	-0.08	ann.rad./ 0.83395(5)/80. 1.0507(1)/9.6 (0.1–4.0)
<sup>73</sup> As		72.923825	80.3 d	EC/0.341		3/2-			0.0133/0.1 0.0534/10.5 Se k x-ray/90.
<sup>74</sup> As		73.923829	17.78 d	$\beta^+$ /31/2.562 EC/37/ $\beta^-$ /1.353	0.94/26. 1.53/3. 0.71/16. 1.35/16.	2-	-1.597		ann.rad./ 0.59588(1)/60. 0.6084(1)/0.6 0.6348(1)/15.
<sup>75m</sup> As			0.017 s						
<sup>75</sup> As	100.	74.921597				3/2-	+1.43947	+0.31	
<sup>76</sup> As		75.922394	26.3 h	$\beta^-$ /2.962	0.54/3. 1.785/8. 2.410/36. 2.97/51.	2-	-0.903		0.5591(1)/45. 0.65703(5)/6.2 1.21602(1)/3.4 (0.3–2.67)
<sup>77</sup> As		76.920647	38.8 h	$\beta^-$ /0.683	0.70/98.	3/2-	+1.295		0.2391(2)/1.6 0.2500(3)/0.4 0.5208/0.43
<sup>78</sup> As		77.92183	1.512 h	$\beta^-$ /4.21	3.00/12. 3.70/17. 4.42/37.	2-			0.6136(3)/54. 0.6954(3)/18. 1.3088(3)/10.
<sup>79m</sup> As			1.21 $\mu$ s	I.T.		9/2+			0.542/IT 0.231
<sup>79</sup> As		78.92095	9.0 m	$\beta^-$ /2.28	1.80/95.	3/2-			0.0955(5)/16. 0.3645(5)/1.9
<sup>80</sup> As		79.92253	16. s	$\beta^-$ /5.64	3.38/	1+			0.6662(2)/42. (2.5–3.0)
<sup>81</sup> As		80.92213	33. s	$\beta^-$ /3.856		3/2-			0.4676(2)/20. 0.4911(2)/8.
<sup>82m</sup> As			13.7 s	$\beta^-$ /	3.6/	5-			0.6544(1)/77. 0.344/65. (0.561 – 1.894)
<sup>82</sup> As		81.9245	19. s	$\beta^-$ /7.4	7.2/80.	(2-)			0.6544(1)/54. (0.755 – 3.667)
<sup>83</sup> As		82.9250	13.4 s	$\beta^-$ /5.5					0.7345/100. 1.1131/34. 2.0767/28.
<sup>84m</sup> As			0.6 s	$\beta^-$					
<sup>84</sup> As		83.9291	4. s	$\beta^-$ , n/7.2		1-			0.6671(2)/21. 1.4439(5)/49. (0.325–5.150)
<sup>85</sup> As		84.9320	2.03 s	$\beta^-$ , n/8.9		3/2-			0.667(1)/42. 1.4551(2)/100.
<sup>86</sup> As		85.9365	0.95 s	$\beta^-$ , n/11.4					0.704/
<sup>87</sup> As		86.9399	0.49 s	$\beta^-$ , n/10.					0.704/
<sup>88</sup> As		87.9449	> 0.3 $\mu$ s						
<sup>89</sup> As		88.9494	> 0.3 $\mu$ s						
<sup>90</sup> As		89.956	> 0.3 $\mu$ s						
<sup>91</sup> As		90.960	> 0.3 $\mu$ s						
<sup>92</sup> As		91.967	> 0.3 $\mu$ s						
<sup>34</sup> Se		78.96(3)							
<sup>64</sup> Se			> 0.18 $\mu$ s			0+			
<sup>65</sup> Se		64.965	0.011 s	$\beta^+$ /60/14.					

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<sup>66</sup> Se		65.9552	0.03 s	$\beta^+$ , p	3.55/	0+			
<sup>67</sup> Se		66.9501	0.13 s	$\beta^+$ /10.2					ann.rad./ 0.352
<sup>68</sup> Se		67.94180	36. s	$\beta^+$ , (p)/ $\beta^+$ /4.7		0+			ann.rad./ (0.050–0.426)
<sup>69</sup> Se		68.93956	27.4 s	$\beta^+$ /6.78 EC/	5.006/				ann.rad./ 0.0664(4)/27. 0.0982(4)/63.
<sup>70</sup> Se		69.9334	41.1 m	$\beta^+$ , p $\beta^+$ /2.4	// ~ 0.045	0+			ann.rad 0.04951(5)/35. 0.4262(2)/29.
<sup>71</sup> Se		70.93224	4.7 m	$\beta^+$ /4.4 EC/	3.4/36.	5/2-			ann.rad 0.1472(3)/47. 0.8309(3)/13. 1.0960(3)/10.
<sup>72</sup> Se		71.92711	8.5 d	EC/0.34		0+			0.0460(2)/57.
<sup>73m</sup> Se			40. m	I.T./73/0.0257 $\beta^+$ /27/2.77	0.85 1.45/ 1.70/	3/2-			ann.rad. 0.0257(2)/27. 0.2538(1)/2.5
<sup>73</sup> Se		72.92677	7.1 h	$\beta^+$ /65/2.74 EC/35/	0.80/ 1.32/95. 1.68/1.	9/2+	0.86		ann.rad 0.0670(1)/72. 0.3609(1)/97. (0.6–1.5)
<sup>74</sup> Se	0.89(4)	73.922476				0+			
<sup>75</sup> Se		74.922523	119.78 d	EC/0.864		5/2+	0.67	1.0	0.13600/55 0.26465/58 (0.024–0.821)
<sup>76</sup> Se	9.37(29)	75.919214				0+			
<sup>77m</sup> Se			17.4 s	I.T./		7/2+			0.1619(2)/52.
<sup>77</sup> Se	7.63(16)	76.919914				½-	+0.53506		
<sup>78</sup> Se	23.77(28)	77.917309				0+			
<sup>79m</sup> Se			3.92 m	I.T./					0.09573(3)/9.5
<sup>79</sup> Se		78.918499	2.9 × 10 <sup>5</sup> y	$\beta^-$ /0.151		7/2+	-1.018	+0.8	
<sup>80</sup> Se	49.61(41)	79.916521				0+			
<sup>81m</sup> Se			57.3 m	I.T./99/0.1031		7/2+			0.1031(3)/9.7 0.2602(2)/0.06 0.2760/0.06
<sup>81</sup> Se		80.917993	18.5 m	$\beta^-$ /1.585	1.6/98.	½-			0.2759/0.85 0.2901/0.75 0.8283/0.32
<sup>82</sup> Se	8.73(22)	81.916699	~ 1 × 10 <sup>20</sup> y	$\beta^-$ - $\beta^-$		0+			
<sup>83m</sup> Se			1.17 m	$\beta^-$ /3.96	2.88/ 3.92/	½-			0.35666(6)/17. 0.9879(1)/15. 1.0305(1)/21. 2.0514(2)/11. (0.19–3.1)
<sup>83</sup> Se		82.919118	22.3 m	$\beta^-$ /3.668	0.93/ 1.51/	9/2+			0.22516(6)/33. 0.35666(6)/69. 0.51004(8)/45. (0.21–2.42)
<sup>84</sup> Se		83.91846	3.3 m	$\beta^-$ /1.83	1.41/100.	0+			0.4088(5)/100.
<sup>85</sup> Se		84.92225	32. s	$\beta^-$ /6.18	5.9/	5/2+			0.3450(1)/22. 0.6094(1)/41.
<sup>86</sup> Se		85.92427	15. s	$\beta^-$ /5.10		0+			2.0124(1)/24. 2.4433(8)/100. 2.6619(1)/49.
<sup>87</sup> Se		86.92852	5.4 s	$\beta^-$ /7.28 n/		5/2+			0.468(1)/100. 1.4979(1)/23.
<sup>88</sup> Se		87.93142	1.5 s	$\beta^-$ , n/6.85		0+			0.5346/

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<sup>89</sup> Se		88.9365	0.41 s	$\beta^-$ , n/9.0					
<sup>90</sup> Se		89.9400	> 0.3 $\mu$ s			0+			
<sup>91</sup> Se		90.9460	0.27 s	$\beta^-$ , n/8.					
<sup>92</sup> Se		91.950	> 0.3 $\mu$ s			0+			
<sup>93</sup> Se		92.956	> 0.3 $\mu$ s						
<sup>94</sup> Se		93.960	> 0.3 $\mu$ s			0+			
<b><sub>35</sub>Br</b>		<b>79.904(1)</b>							
<sup>67</sup> Br		66.9648							
<sup>68</sup> Br		67.9585	< 1.5 $\mu$ s						
<sup>69</sup> Br		68.9501	< 0.024 $\mu$ s	$\beta^+$ /9.6					
<sup>70m</sup> Br			2.2 s			9+			
<sup>70</sup> Br		69.9446	$\sim$ 0.08 s	$\beta^+$ /10.0	/0.75				
<sup>71</sup> Br		70.939	21. s	$\beta^+$ /6.9					
<sup>72</sup> Br		71.9366	1.31 m	$\beta^+$ /8.7		3	$\sim$ 0.55		0.4547–1.3167
<sup>73</sup> Br		72.93169	3.4 m	$\beta^+$ /4.7	3.7/	3/2-			ann.rad 0.065–0.700
<sup>74m</sup> Br			46. m	$\beta^+$ /	4.5/	4-	1.82		ann.rad 0.6348 0.7285 (0.2–4.38)
<sup>74</sup> Br		73.92989	25.4 m	$\beta^+$ /6.91					ann.rad 0.6341 0.6348 (0.2–4.7)
<sup>75</sup> Br		74.92578	1.62 h	$\beta^+$ /76/3.03		3/2-	+0.75		ann.rad 0.28650 (0.1–1.56)
<sup>76m</sup> Br			1.4 s	I.T./5.05		4+			0.104548 0.05711
<sup>76</sup> Br		75.92454	16.0 h	$\beta^+$ /57/4.96	1.9/ 3.68/	1-	0.54821	0.270	ann.rad 0.55911 1.85368 (0.4–4.6)
<sup>77m</sup> Br			4.3 m	I.T./0.1059		9/2+			0.1059
<sup>77</sup> Br		76.921379	2.376 d	EC/99/1.365		3/2-	0.973	+0.53	ann.rad. 0.23898 0.52069 (0.08–1.2)
<sup>78</sup> Br		77.921146	6.45 m	$\beta^+$ /92/3.574	1.2/ 2.5/	1+	0.13		ann.rad. 0.61363 (0.7–3.0)
<sup>79m</sup> Br			4.86 s	I.T./0.207		9/2+			0.2072
<sup>79</sup> Br	50.69(7)	78.918337				3/2-	+2.106400	+0.331	
<sup>80m</sup> Br			4.42 h	I.T./0.04885		5-	+1.3177	+0.75	Br k x-ray 0.03705/39.1 0.04885/0.3
<sup>80</sup> Br		79.918529	17.66 m	$\beta^-$ /92/2.004	1.38 $\beta^-$ /-7.6	1+	0.5140	0.196	ann.rad. 0.6169/6.7 (0.64–1.45)
				EC/5.7/1.8706	1.99 $\beta^-$ /-82				
				$\beta^+$ /2.6/	0.85 $\beta^+$ /2.8				
<sup>81</sup> Br	49.31(7)	80.916291				3/2-	+2.270562	+0.276	
<sup>82m</sup> Br			6.1 m	I.T./98/0.046		2-			0.046/0.24 (0.62–2.66)
				$\beta^-$ /2 /3.139					
<sup>82</sup> Br		81.916804	1.471 d	$\beta^-$ /3.093	0.444/	5-	+1.6270	0.751	0.5544/71 0.61905/43 0.77649/84 (0.013–1.96)
<sup>83</sup> Br		82.915180	2.40 h	$\beta^-$ /0.972	0.395/1 0.925/99	3/2-			0.52964 (0.12–0.68)

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<sup>84m</sup> Br			6.0 m	$\beta^-$ /4.97	2.2/100	(6-)			0.4240/100 0.8817/98 1.4637/101
<sup>84</sup> Br	83.91648		31.8 m	$\beta^-$ /4.65	2.70/11 3.81/20 4.63/34	2-	2.		0.8816/41 1.8976/13 (0.23-4.12)
<sup>85</sup> Br	84.91561		2.87 m	$\beta^-$ /2.87	2.57	3/2-			0.80241/2.56 0.92463/1.6 (0.09-2.4)
<sup>86</sup> Br	85.91880		55.5 s	$\beta^-$ /7.63	3.3 7.4	(2-)			1.56460/64 2.75106/21 (0.5-6.8)
<sup>87</sup> Br	86.92071		55.6 s	$\beta^-$ /6.85 n/	6.1/	3/2-			1.41983 1.4762 (0.2-6.1)
<sup>88m</sup> Br			5.1 $\mu$ s						
<sup>88</sup> Br	87.92407		16.3 s	$\beta^-$ /8.96 n/		1-			0.7649 0.7753 0.8021 (0.1-6.99)
<sup>89</sup> Br	88.92640		4.35 s	$\beta^-$ /8.16 n/		3/2-			0.7753 1.0978
<sup>90</sup> Br	89.9306		1.91 s	$\beta^-$ /10.4 n/	8.3/ 9.8/	2-			0.6555 0.7071 1.3626
<sup>91</sup> Br	90.9340		0.54 s	$\beta^-$ /90 /9.80 $\beta^-$ n/10 /					0.263 0.803
<sup>92</sup> Br	91.93926		0.31 s	$\beta^-$ /12.20 $\beta^-$ n/					0.740
<sup>93</sup> Br	92.9431		0.10 s	$\beta^-$ /11 $\beta^-$ n	//11				0.117 (0.237-3.606)
<sup>94</sup> Br	93.9487		0.07 s	$\beta^-$ n/					
<sup>95</sup> Br	94.9529		> 0.3 $\mu$ s						
<sup>96</sup> Br	95.959		> 0.3 $\mu$ s						
<sup>97</sup> Br	96.963		> 0.3 $\mu$ s						
<b><sup>36</sup>Kr</b>	<b>83.798(2)</b>								
<sup>69</sup> Kr	68.9652		0.03 s	$\beta^+$ , (p)	4.07/				
<sup>70</sup> Kr	69.9553		0.06 s			0+			
<sup>71</sup> Kr	70.950		100. ms	$\beta^+$ , EC/10.1					(0.198-0.207)
<sup>72</sup> Kr	71.94209		17.1 s	$\beta^+$ /5.0 EC/		0+			ann.rad 0.3099/15.3 0.4150/12.8 (0.305 - 3.305)
<sup>73</sup> Kr	72.93929		28. s	$\beta^+$ /6.7 EC/		5/2-			ann.rad. 0.1781/66 (0.06-0.86)
<sup>74</sup> Kr	73.933084		11.5 m	$\beta^+$ /3.1 EC/	/0.25	0+			ann.rad. 0.08970/31 0.2030/20 (0.010-1.06)
<sup>75</sup> Kr	74.93095		4.3 m	$\beta^+$ /4.90 EC/	3.2/	5/2+	-0.531	+1.1	ann.rad. 0.1325/68 0.1547/21 (0.02-1.7)
<sup>76</sup> Kr	75.925910		14.8 h	EC/1.31		0+			Br k x-ray 0.270/21 0.3158/39 (0.03-1.07)

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<sup>77</sup> Kr		76.924670	1.24 h	$\beta^+$ /80/3.06 EC/20/	1.55/ 1.70/ 1.87/	5/2+	-0.583	+0.9	ann.rad. 0.1297/80 0.1465/38 (0.02–2.3)
<sup>78</sup> Kr	0.355(3)	77.920365	$> 2.3 \times 10^{20}$ y	EC-EC		0+			
<sup>79m</sup> Kr			53. s	I.T./0.1299		7/2+	-0.786	+0.40	Kr x-ray
<sup>79</sup> Kr		78.920082	1.455 d	$\beta^+$ /7 /1.626 EC/93 /		½-	+0.536		ann.rad. 0.2613/13 0.39756/19 0.6061/8 (0.04–1.3)
<sup>80</sup> Kr	2.286(10)	79.916379				0+			
<sup>81m</sup> Kr			13.1 s	I.T./0.1904		½-	+0.586		0.1904
<sup>81</sup> Kr		80.916592	$2.1 \times 10^5$ y	EC/0.2807		7/2+	-0.908	+0.63	Br k x-ray 0.2760
<sup>82</sup> Kr	11.593(31)	81.913484				0+			
<sup>83m</sup> Kr			1.86 h	I.T./0.0416		½-	+0.591		Kr k x-ray 0.00940 0.03216
<sup>83</sup> Kr	11.500(19)	82.914136				9/2+	-0.970699	+0.259	
<sup>84</sup> Kr	56.987(15)	83.911507				0+			
<sup>85m</sup> Kr			4.48 h	$\beta^-$ /79 / I.T./21 /0.305	0.83/79	½-	+ 0.633		0.30487 0.15118
<sup>85</sup> Kr		84.912527	10.73 y	$\beta^-$ /0.687	0.15/0.4	9/2+	1.005	+0.43	0.51399
<sup>86</sup> Kr	17.279(41)	85.9106107				0+			
<sup>87</sup> Kr		86.9133549	1.27 h	$\beta^-$ /3.887	1.33/8 3.49/43 3.89/30	5/2+	-1.023	-0.30	0.40258/49.6 2.5548/9.2 (0.13–3.31)
<sup>88</sup> Kr		87.91445	2.84 h	$\beta^-$ /2.91		0+			0.19632/26. 2.392/34.6 (0.03–2.8)
<sup>89</sup> Kr		88.9176	3.15 m	$\beta^-$ /4.99	3.8/ 4.6/ 4.9/	5/2+	-0.330	+0.16	0.19746 0.2209/19.9 0.5858/16.4 1.4728/6.8 (0.2–4.7)
<sup>90</sup> Kr		89.91952	32.3 s	$\beta^-$ /4.39	2.6/77 2.8/6	0+			0.12182/32.9 0.5395/28.6 1.1187/36.2 (0.1–4.2)
<sup>91</sup> Kr		90.9235	8.6 s	$\beta^-$ /6.4	4.33/ 4.59/	5/2+	-0.583	+0.30	0.10878/43.5 0.50658/19. (0.2–4.4)
<sup>92</sup> Kr		91.92616	1.84 s	$\beta^-$ /5.99 n/		0+			0.1424/66. (0.14–3.7)
<sup>93</sup> Kr		92.9313	1.29 s	$\beta^-$ /8.6 n/	7.1/	½+	-0.413		0.1820 0.2534/42. 0.32309/24.6 (0.057–4.03)
<sup>94</sup> Kr		93.9344	0.21 s	$\beta^-$ /7.3 n	n//1.0	0+			0.2196/67 0.6293/100. (0.098–0.985)
<sup>95</sup> Kr		94.9398	0.10 s	$\beta^-$ /9.7	n//2.9		- 0.410		
<sup>96</sup> Kr		95.9431	~ 80 ms	$\beta^-$ ,n	n//3.7	0+			
<sup>97</sup> Kr		96.9486	0.06 s	$\beta^-$ ,n	n//7.				
<sup>98</sup> Kr		97.952	0.05 s	$\beta^-$ ,n	n//7.	0+			
<sup>99</sup> Kr		98.958	0.04 s	$\beta^-$ ,n	n// ~ 11.				
<sup>100</sup> Kr		99.9611	$> 0.34 \mu\text{s}$			0+			



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<sup>37</sup> Rb		85.4678(3)							
<sup>71</sup> Rb		70.9653							
<sup>72</sup> Rb		71.9591	< 1.5 $\mu$ s						
<sup>73</sup> Rb		72.9506	< 0.03 $\mu$ s						
<sup>74</sup> Rb		73.944265	64.8 ms	$\beta^+$ /10.4					0.456/0.0025 (0.053 – 4.244)
<sup>75</sup> Rb		74.93857	19. s	$\beta^+$ /7.02	2.31/				ann.rad 0.179
<sup>76</sup> Rb		75.935072	39. s	$\beta^+$ /8.50	4.7/	1-	-0.372623	+0.4	ann.rad 0.4240/92. (0.064–1.68)
<sup>77</sup> Rb		76.93041	3.8 m	$\beta^+$ /5.34	3.86/	3/2-	+0.654468	+0.70	ann.rad 0.0665/59 (0.04–2.82)
<sup>78m</sup> Rb			5.7 m	I.T./0.1034 $\beta^+$ / EC/	3.4	4-	+2.549	+0.81	ann.rad 0.4553/81. (0.103–4.01)
<sup>78</sup> Rb		77.92814	17.7 m	$\beta^+$ /7.22 EC/		0+			ann.rad 0.4553/63. (0.42–5.57)
<sup>79</sup> Rb		78.92399	23. m	$\beta^+$ /84/3.65 EC/16 /		5/2+	+0.3358	-0.10	ann.rad. 0.68812/23. (0.017–3.02)
<sup>80</sup> Rb		79.92252	34. s	$\beta^+$ /5.72	4.1/22 4.7/74	1+	-0.0836	+0.35	ann.rad. 0.6167/25.
<sup>81m</sup> Rb			30.5 m	I.T./0.85 $\beta^+$ , EC/	1.4	9/2+	+5.598	-0.74	ann.rad. (0.085–1.9)
<sup>81</sup> Rb		80.91900	4.57 h	$\beta^+$ /27/2.24 EC/73	1.05/	3/2-	+2.060	+0.40	ann.rad./ 0.19030/64. (0.05–1.9)
<sup>82m</sup> Rb			6.47 h	$\beta^+$ /26/ EC/74/	0.80/	5-	+1.5100	+1.0	ann.rad./ 0.5544/63. 0.7765/85. (0.092–2.3)
<sup>82</sup> Rb		81.918209	1.258 m	$\beta^+$ /96/4.40 EC/4/	3.3/	1+	+0.554508	+0.19	ann.rad./ 0.7665/13. (0.47–3.96)
<sup>83</sup> Rb		82.91511	86.2 d	EC/0.91		5/2-	+1.425	+0.20	Kr x-ray 0.5205/46. (0.03–0.80)
<sup>84m</sup> Rb			20.3 m	I.T./0.216		6-	+0.2129	+0.6	0.2163/34. 0.2482/63. 0.4645/32.
<sup>84</sup> Rb		83.914385	32.9 d	$\beta^+$ /22/2.681 EC/75 / $\beta^-$ /3/0.894	0.780/11 1.658/11 0.893/	2-	-1.32412	-0.015	ann.rad./ 0.8817/68. (1.02–1.9)
<sup>85</sup> Rb	72.17(2)	84.91178974				5/2-	+1.353	+0.23	
<sup>86m</sup> Rb			1.018 m	I.T./0.5560		6-	+1.815	+0.37	0.556/98.
<sup>86</sup> Rb		85.9111674	18.65 d	$\beta^-$ /1.775	1.774/8.8	2-	-1.6920	+0.19	1.0768/8.8
<sup>87</sup> Rb	27.83(2)	86.90918053	4.88 $\times 10^{10}$ y	$\beta^-$ /0.283	0.273/100	3/2-	+2.7512	+0.13	
<sup>88</sup> Rb		87.9113156	17.7 m	$\beta^-$ /5.316	5.31	2-	0.508		0.8980/14.4 1.8360/22.8 (0.34–4.85)
<sup>89</sup> Rb		88.91228	15.4 m	$\beta^-$ /4.50	1.26/38 1.9/5 2.2/34 4.49/18	3/2-	+2.304	+0.14	1.032/58. 1.248/42. 2.1960/13 (0.12–4.09)

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<sup>90m</sup> Rb			4.3 m	$\beta^-$ /4.50	1.7/ 6.5/	4-	+1.616	+0.20	0.1069(IT) 0.8317/94 (0.20–5.00)
<sup>90</sup> Rb	89.91480		2.6 m	$\beta^-$ /6.59	6.6	1-			0.8317/28. (0.31–5.60)
<sup>91</sup> Rb	90.91654		58.0 s	$\beta^-$ /5.861	5.9	3/2-	+2.182	+0.15	0.0936/34. (0.35–4.70)
<sup>92</sup> Rb	91.91073		4.48 s	$\beta^-$ /8.11	8.1/94	1-			0.8148/8. (0.1–6.1)
<sup>93</sup> Rb	92.92204		5.85 s	$\beta^-$ /7.46 n/1	7.4/	5/2-	+1.410	+0.18	0.2134/4.8 0.4326/12.5 0.9861/4.9 (0.16–5.41)
<sup>94</sup> Rb	93.92641		2.71 s	$\beta^-$ /10.31 n/10	9.5/	3	+1.498	+0.16	0.8369/87. 1.5775/32. (0.12–6.35)
<sup>95</sup> Rb	94.92930		0.377 s	$\beta^-$ /9.30 n/8	8.6/	5/2-	+1.334	+0.21	0.352/65. 0.680/22. (0.20–2.27)
<sup>96m</sup> Rb			1.7 $\mu$ s						0.2999 0.4612 0.2400 0.093–0.369
<sup>96</sup> Rb	95.93427		0.199 s	$\beta^-$ /11.76 n/13/	10.8/	2+	+1.466	+0.25	0.815/76. (0.20–5.42)
<sup>97</sup> Rb	96.93735		0.169 s	$\beta^-$ /10.42 n/27/	10.0	3/2+	+1.841	+0.58	0.167/100. 0.585/79. 0.599/56. 1.258/52. (0.14–2.08)
<sup>98</sup> Rb	97.94179		0.107 s	$\beta^-$ /12.34 n/13	0.144/				(0.07–3.68)
<sup>99</sup> Rb	98.9454		59. ms	$\beta^-$ /11.3					
<sup>100</sup> Rb	99.9499		53. ms	$\beta^-$ /13.5					0.129 (0.058–4.483)
<sup>101</sup> Rb	100.9532		0.03 s	$\beta^-$ /11.8					
<sup>102</sup> Rb	101.9589		0.09 s	$\beta^-$					
<b><sup>38</sup>Sr</b>	<b>87.62(1)</b>								
<sup>73</sup> Sr	72.966		> 25 ms						
<sup>74</sup> Sr	73.9563		> 1.5 $\mu$ s			0+			
<sup>75</sup> Sr	74.9499		88. ms	$\beta^+$ ,p	p//5.				0.144/4.5
<sup>76</sup> Sr	75.94177		7.9 s	$\beta^+$ /6.1		0+			
<sup>77</sup> Sr	76.93795		9.0 s	$\beta^+$ /6.9 $\beta^+$ , p	5.6 //0.08		-0.35	+1.4	0.147
<sup>78</sup> Sr	77.93218		2.7 m	$\beta^+$ /3.76		0+			(0.047–0.793)
<sup>79</sup> Sr	78.92971		2.1 m	$\beta^+$ /5.32	4.1	3/2-	-0.474	+0.74	ann.rad./ 0.039/28. 0.105/22. (0.135–0.612)
<sup>80</sup> Sr	79.92452		1.77 h	$\beta^+$ /1.87		0+			ann.rad./ 0.174/10. 0.589/39. (0.24–0.55)
<sup>81</sup> Sr	80.92321		22.3 m	$\beta^+$ /87/3.93 EC/13/	2.43/ 2.68/	1/2-	+0.544		ann.rad./ 0.148/31. 0.1534/35 (0.06–1.7)
<sup>82</sup> Sr	81.91840		25.36 d	EC/0.18		0+			Rb x-ray

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<sup>83m</sup> Sr			5.0 s	I.T./0.2591		½-	+0.582		0.2591/87.5
<sup>83</sup> Sr		82.91756	1.350 d	$\beta^+$ /24/2.28	0.465/	7/2+	-0.898	+0.79	ann.rad./
				EC/76/	0.803/				0.3816/12.
					1.227/				0.3816
									0.7627/30.
									(0.094-2.15)
<sup>84</sup> Sr	0.56(1)	83.913425				0+			
<sup>85m</sup> Sr			1.127 h	I.T./87/0.2387		½-	+0.601		0.2318/84.
				EC/13					(0.15-0.24)
<sup>85</sup> Sr		84.912933	64.85 d	EC/1.065		9/2+	-1.001	+0.30	0.51399/99.3
<sup>86</sup> Sr	9.86(1)	85.909260				0+			
<sup>87m</sup> Sr			2.81 h	I.T./0.3884		½-	+0.63		0.3884(IT)
<sup>87</sup> Sr	7.00(1)	86.908877				9/2+	-1.093	+0.34	
<sup>88</sup> Sr	82.58(1)	87.905612				0+			
<sup>89</sup> Sr		88.907451	50.52 d	$\beta^-$ /1.497	1.492/100	5/2+	-1.149	-0.3	0.9092
<sup>90</sup> Sr		89.907738	29.1 y	$\beta^-$ /0.546	0.546/100	0+			
<sup>91</sup> Sr		90.910203	9.5 h	$\beta^-$ /2.70	0.61/7	5/2+	-0.887	+0.044	0.5556/61.
					1.09/33				0.7498/24.
					1.36/29				1.0243/33.
					2.66/26				(0.12-2.4)
<sup>92</sup> Sr		91.911038	2.71 h	$\beta^-$ /1.91	0.55/96	0+			1.3831/90.
					1.5/3				(0.24-1.1)
<sup>93</sup> Sr		92.91403	7.4 m	$\beta^-$ /4.08	2.2/10	5/2+	-0.794	+0.26	0.5903/
					2.6/25				0.7104
					3.2/65				0.87573
									0.8883/
									(0.17-3.97)
<sup>94</sup> Sr		93.91536	1.25 m	$\beta^-$ /3.511	2.1/	0+			0.6219
					3.3/				0.7043
									0.7241
									0.8064
									1.4283
<sup>95</sup> Sr		94.91936	25.1 s	$\beta^-$ /6.08		½+	-0.5379		0.6859
					6.1/50				0.8269
									2.7173
									2.9332
<sup>96</sup> Sr		95.92170	1.06 s	$\beta^-$ /5.37	4.2/	0+			0.1222
									0.5305
									0.8094
									0.9318
<sup>97</sup> Sr		96.92615	0.42 s	$\beta^-$ /7.47	5.3	(1/2+)	-0.500		0.2164
									0.3071
									0.6522
									0.9538
									1.2580
									1.9050
<sup>98</sup> Sr		97.92845	0.65 s	$\beta^-$ /5.83	5.1	0+			0.0365
									0.1190
									0.4286
									0.4447
									0.5636
<sup>99</sup> Sr		98.9332	0.27 s	$\beta^-$ /8.0			-0.26	0.8	
<sup>100</sup> Sr		99.9354	0.201 s	$\beta^-$ /7.1		0+			
<sup>101</sup> Sr		100.9405	0.115 s	$\beta^-$ /9.5					
<sup>102</sup> Sr		101.9430	68. ms	$\beta^-$ /8.8		0+			
<sup>103</sup> Sr		102.9490	> 0.3 $\mu$ s						
<sup>104</sup> Sr		103.952	> 0.3 $\mu$ s			0+			
<sup>105</sup> Sr		104.959	> 0.3 $\mu$ s						

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<sup>39</sup> Y		88.90585(2)							
<sup>76</sup> Y		75.9585	> 0.2 $\mu$ s						
<sup>77</sup> Y		76.9497	~ 57. ms						
<sup>78m</sup> Y			5.8 s			(5+)			
<sup>78</sup> Y		77.9436	53 ms	$\beta$ +/10.5					0.279/100 0.504/90 0.713/40
<sup>79</sup> Y		78.9374	15. s	$\beta$ +/7.1					(0.152–1.106)
<sup>80m</sup> Y			4.8 s						0.2285
<sup>80</sup> Y		79.9343	30. s	$\beta$ +/7.0	5.5 5.0/	(4-)			ann.rad./ 0.3858/100 0.5951/42 0.756–1.396
<sup>81</sup> Y		80.9291	1.21 m	$\beta$ +/5.5	3.7/ 4.2/				ann.rad./ 0.428 0.469
<sup>82</sup> Y		81.9268	9.5 s	$\beta$ +/7.8	6.3/	1+			ann.rad./ 0.5736 0.6017 0.7375
<sup>83m</sup> Y			2.85 m	$\beta$ +/95/4.6 EC/5 /	2.9	1/2-			ann.rad./ 0.2591 0.4218 0.4945
<sup>83</sup> Y		82.92235	7.1 m	$\beta$ +/4.47 EC/	3.3	9/2+			ann.rad./ 0.0355 0.4899 0.8821 (0.03–3.4)
<sup>84m</sup> Y			4.6 s	$\beta$ +/ EC/		1+			ann.rad./ 0.7930
<sup>84</sup> Y		83.9204	40. m	$\beta$ +/6.4 EC/	1.64/47 2.24/25 2.64/21 3.15/7	5-			ann.rad./ 0.4628 0.6606 0.7931 0.9744 1.0398 (0.2–3.3)
<sup>85m</sup> Y			4.9 h	$\beta$ +/70/ EC/30/		9/2+	6.2		ann.rad./ 0.2317 0.5356 2.1238 (0.1–3.1) 0.7673
<sup>85</sup> Y		84.91643	2.6 h	$\beta$ +/55/3.26 EC/45/	1.54/	1/2-			ann.rad./ 0.2317 0.5045 0.9140 (0.07–1.4)
<sup>86m</sup> Y			48. m	IT./99/ $\beta$ +/ EC/		8+	4.8		ann.rad./ 0.0102(IT) 0.2080 (0.09–1.1)
<sup>86</sup> Y		85.91489	14.74 h	$\beta$ +/5.24 EC/		4-	<0.6		ann.rad./ 0.3070 0.6277 1.0766 1.1531

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									1.9207
									(0.1-3.8)
<sup>87m</sup> Y			13. h	I.T./98/ $\beta^+ / 0.7 /$ EC/	1.15/0.7	9/2+	6.1		0.3807
<sup>87</sup> Y		86.910876	3.35 d	EC/99+/1.862	0.78/	1/2-			0.3880
									0.4870
<sup>88</sup> Y		87.909501	106.6 d	EC/99+/3.623 $\beta^+ / 0.2 /$	0.76/	4-			ann.rad./
									0.89802
									1.83601
									2.73404
									3.2190
<sup>89m</sup> Y			15.7 s	I.T./0.909		9/2+			0.9092(IT)
<sup>89</sup> Y	100.	88.905848				1/2-	-0.13742		
<sup>90m</sup> Y			3.24 h	I.T./99+/ $\beta^- / 0.002 /$	0.68204	7+	5.1		0.2025
									0.4794
									0.6820
<sup>90</sup> Y		89.907152	2.67 d	$\beta^- / 2.282$	2.28/	2-	-1.630	-0.155	
<sup>91m</sup> Y			49.7 m	I.T./0.555		9/2+	5.96		0.5556(IT)
<sup>91</sup> Y		90.907305	58.5 d	$\beta^- / 1.544$	1.545/	1/2-	0.1641		1.208
<sup>92</sup> Y		91.90895	3.54 h	$\beta^- / 3.63$	3.64/	2-			0.4485
									0.5611
									0.9345
									1.4054
									(0.4-3.3)
<sup>93m</sup> Y			0.82 s	I.T./0.759		9/2+			0.1686(IT)
									0.5902
<sup>93</sup> Y		92.90958	10.2 h	$\beta^- / 2.87$	2.88/90	1/2-			0.2669
									0.9471
									1.9178
<sup>94m</sup> Y			1.4 $\mu$ s						0.4322
									0.7699
									1.2024
<sup>94</sup> Y		93.91160	18.7 m	$\beta^- / 4.919$	4.92/	2-			0.3816
									0.9188
									1.1389
									(0.3-4.1)
<sup>95</sup> Y		94.91282	10.3 m	$\beta^- / 4.42$		1/2-			0.4324
									0.9542
									2.1760
									3.5770
<sup>96m</sup> Y			9.6 s	$\beta^- /$		(3+)			0.1467
									0.6174
									0.9150
									1.1071
									1.7507
<sup>96</sup> Y		95.91589	6.2 s	$\beta^- / 7.09$	7.12/	0-			1.594
<sup>97m</sup> Y			1.21 s	$\beta^- / 7.4$	4.8/ 6.0/	9/2+			0.1614
									0.9700
									1.1030
<sup>97</sup> Y		96.91813	3.76 s	$\beta^- / 6.69$	6.7	1/2-			0.2969
									1.9960
									3.2876
									3.4013
<sup>98m</sup> Y			2.1 s	$\beta^- / 9.8$	5.5/	(4-)			0.2415
									0.6205
									0.6473
									1.2228
									1.8016
<sup>98</sup> Y		97.92220	0.59 s	$\beta^- / 8.83$	8.7/	1+			0.2131

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									1.2228
									1.5907
									2.9413
									4.4501
<sup>99m</sup> Y			0.011 ms						
<sup>99</sup> Y	98.92464		1.47 s	$\beta^-$ /7.57		1/2-			0.1218/43.8
				n	/2.5/				0.5362
									0.7242
									1.0130
<sup>100m</sup> Y			0.94 s	$\beta^-$ , n /		3+			
<sup>100</sup> Y	99.9278		0.73 s	$\beta^-$ , n/9.3	n/1.8/	1+			
<sup>101</sup> Y	100.9303		0.43 s	$\beta^-$ , n/8.6	n/1.5/	(5/2+)			
<sup>102</sup> Y	101.9336		0.36 s	$\beta^-$ , n/9.9	n/4.0/				
<sup>103</sup> Y	102.9367		0.23 s	$\beta^-$ , n	n/8.3/				
<sup>104</sup> Y	103.9411		0.18 s						
<sup>105</sup> Y	104.9449		> 0.15 $\mu$ s						
<sup>106</sup> Y	105.950		> 0.15 $\mu$ s						
<sup>107</sup> Y	106.9414		> 0.15 $\mu$ s						
<sup>108</sup> Y	107.959		> 0.15 $\mu$ s						
<sup>40</sup> Zr	91.224(2)								
<sup>78</sup> Zr	77.9552		> 0.2 $\mu$ s			0+			
<sup>79</sup> Zr	78.9492		0.06 s						
<sup>80</sup> Zr	79.940		~ 4.5 s	$\beta^+$ /8.0		0+			0.290
									0.538
<sup>81</sup> Zr	80.9372		5.3 s	$\beta^+$ /7.2	6.1	(3/2-)			
<sup>82</sup> Zr	81.9311		32. s	$\beta^+$ /4.0	3.	0+			ann.rad./
<sup>83m</sup> Zr			7. s	$\beta^+$ /7.0		(7/2+)			ann.rad./
<sup>83</sup> Zr	82.9287		44. s	$\beta^+$ /5.9	4.8	(1/2-)			ann.rad./
				EC					0.0556
									0.1050
									0.2560
									0.474
									1.525
<sup>84</sup> Zr	83.9233		26. m	$\beta^+$ /2.7		0+			ann.rad./
				EC/					0.0449
									0.1125
									0.3729
									0.667
<sup>85m</sup> Zr			10.9 s	I.T./0.2922		1/2-			ann.rad./
				$\beta^+$ , EC/					0.2922(IT)
									0.4165
<sup>85</sup> Zr	84.9215		7.9 m	$\beta^+$ /4.7	3.1	7/2+			ann.rad./
				EC/					0.2663
									0.4163
									0.4543
<sup>86</sup> Zr	85.91647		16.5 h	EC/1.47		0+			0.0280
									0.243
									0.612
<sup>87m</sup> Zr			14.0 s	I.T./0.3362		1/2-	+ 0.64		0.1352(IT)
									0.2010
<sup>87</sup> Zr	86.91482		1.73 h	$\beta^+$ /3.67	2.26	9/2+	- 0.895	+ 0.42	ann.rad./
				EC/					0.3811
									1.228
<sup>88m</sup> Zr			1.4 $\mu$ s			(8+)			0.077
<sup>88</sup> Zr	87.91023		83.4 d	EC/0.67		0+			0.3929
<sup>89m</sup> Zr			4.18 m	I.T./94/0.5877		1/2-	+ 0.80		ann.rad./
				$\beta^+$ /1.5/					0.5877(IT)
				EC/4.7/					1.507



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>88</sup> Nb		87.9183	14.3 m	$\beta^+$ /7.6 EC/	3.2/	8+			1.0825 ann.rad./ 1.0570 1.0828 (0.07–2.5)
<sup>89m</sup> Nb			2.0 h	$\beta^+$ / EC/	3.3/	9/2+			0.5880/10(D) (0.17–4.0)
<sup>89</sup> Nb		88.91342	1.10 h	$\beta^+$ /74/4.29 EC/26 /	2.8/	1/2-	+6.216		ann.rad./ 0.5074 0.5880 0.7696 1.2775
<sup>90m</sup> Nb			18.8 s	I.T./0.1246		4-			0.002 0.1225
<sup>90</sup> Nb		89.911265	14.6 h	$\beta$ /53 /6.111 EC/47 /	0.86/5 1.5/92	8+	4.961		ann.rad./ 0.1412 1.1292 2.1862 2.3189 (0.1–3.3)
<sup>91m</sup> Nb			62. d	I.T./97 / EC/3 /		1/2-			0.1045(IT) 1.2050
<sup>91</sup> Nb		90.906996	$7 \times 10^2$ y	EC/1.253		9/2+			Mo k x-ray
<sup>92m</sup> Nb			10.13 d	EC/99+/		2+	6.114		0.9126 0.9345 1.8475
<sup>92</sup> Nb		91.907194	$3.7 \times 10^7$ y	EC/2.006		7+			0.5611 0.9345
<sup>93m</sup> Nb			16.1 y	I.T./0.0304		1/2-			Nb x-ray 0.0304
<sup>93</sup> Nb	100.	92.906378				9/2+	+6.1705	-0.32	
<sup>94m</sup> Nb			6.26 m	I.T./99+ $\beta^-$ /0.5/	/2.086	3+			Nb k x-ray 0.0409 0.87109
<sup>94</sup> Nb		93.907284	$2.4 \times 10^4$ y	$\beta^-$ /2.045	0.47/	6+			0.70263 0.87109
<sup>95m</sup> Nb			3.61 d	I.T./97.5/ $\beta^-$ /2.5 /	0.2357	1/2-			0.2040 0.2356
<sup>95</sup> Nb		94.906836	34.97 d	$\beta^-$ /0.926	0.160/	9/2+	6.141		0.76578
<sup>96</sup> Nb		95.908101	23.4 h	$\beta^-$ /3.187	0.5/10 0.75/90	6+	4.976		0.7782 0.2191–1.498
<sup>97m</sup> Nb			58.1 s	I.T./0.7434	0.734/98	1/2-			0.7434
<sup>97</sup> Nb		96.908099	1.23 h	$\beta^-$ /1.934	1.27/98	9/2+	6.15		0.4809 0.6579
<sup>98m</sup> Nb			51. m	$\beta^-$ /4.67		5+			0.7874 0.1726–1.89
<sup>98</sup> Nb		97.91033	2.9 s	$\beta^-$ /4.59	4.6/	1+			0.6451 0.7874 1.0243
<sup>99m</sup> Nb			2.6 m	$\beta^-$ /	3.2/	1/2-			0.0978/100 (0.138–3.010)
<sup>99</sup> Nb		98.91162	15.0 s	$\beta^-$ /3.64	3.5/100	9/2+			0.0977 0.1378/3.1
<sup>100m2</sup> Nb			0.013 ms						
<sup>100m1</sup> Nb			3.0 s	$\beta^-$ /6.74	5.8				Nb k x-ray 0.159 0.6364 1.0637
<sup>100</sup> Nb		99.91418	1.5 s	$\beta^-$ /6.25	6.2/ 5.3/				0.5354 0.6001–1.566



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>101</sup> Nb		100.91525	7.1 s	$\beta^-$ /4.57	4.3/				0.1105–0.810
<sup>102m</sup> Nb			4.3 s	$\beta^-$ /					
<sup>102</sup> Nb		101.91804	1.3 s	$\beta^-$ /7.21	7.2/				0.2960–2.184
<sup>103</sup> Nb		102.9191	1.5 s	$\beta^-$ /5.53	5.3/	5/2+			
<sup>104m</sup> Nb			0.9 s	$\beta^-$ , n/	n/0.06				
<sup>104</sup> Nb		103.9225	4.8 s	$\beta^-$ , n/8.1	n/0.05				
<sup>105</sup> Nb		104.9239	3.0 s	$\beta^-$ , n/6.5	n/1.7				
<sup>106</sup> Nb		105.9280	1.0 s	$\beta^-$ , n/9.3	n/4.5				
<sup>107</sup> Nb		106.9303	0.30 s	$\beta^-$ , n/7.9	n/6.0				
<sup>108</sup> Nb		107.9348	0.19 s	$\beta^-$ , n/	n/6.2				(0.193–0.590)
<sup>109</sup> Nb		108.9376	0.19 s	$\beta^-$ , n/	n/31				
<sup>110</sup> Nb		109.9424	0.17 s	$\beta^-$ , n/	n/40				
<sup>111</sup> Nb		110.9457	> 0.15 $\mu$ s						
<sup>112</sup> Nb		111.951	> 0.15 $\mu$ s						
<sup>113</sup> Nb		112.955	> 0.15 $\mu$ s						
<b><sup>42</sup>Mo</b>		<b>95.94(2)</b>							
<sup>83</sup> Mo		82.9487	~ 6. ms						
<sup>84</sup> Mo		83.9401	~ 3.7 s	$\beta^+$ /6.		0+			
<sup>85</sup> Mo		84.9366	3.2 s	$\beta^+$ /8.1		½+			
<sup>86</sup> Mo		85.9307	19. s	$\beta^+$ /4.8		0+			
<sup>87</sup> Mo		86.9273	14. s	EC, $\beta^+$ /6.5					(0.752–1.004)
<sup>88</sup> Mo		87.92195	8.0 m	$\beta^+$ /3.4		0+	+0.5		ann.rad./
				EC					0.0800
									0.1399
									0.1707
<sup>89m</sup> Mo			0.19 s	I.T./0.118		½-			0.118(IT)
									0.268
<sup>89</sup> Mo		88.91948	2.2 m	$\beta^+$ /5.58		9/2+			ann.rad./
				EC/					0.659
									0.803
									1.155
									1.272
<sup>90m</sup> Mo			1.2 $\mu$ s						0.063
<sup>90</sup> Mo		89.91394	5.7 h	$\beta^+$ /25/2.489	1.085/	0+			ann.rad./
				EC/75 /					0.04274
									0.12237
									0.25734
<sup>91m</sup> Mo			1.08 m	I.T./50/0.653		½-			ann.rad./
				$\beta^+$ , EC/50 /	2.5/				0.6529
					2.8/				1.2081
					4.0/				1.5080
									2.2407
<sup>91</sup> Mo		90.91175	15.5 m	$\beta^+$ /94/4.43	3.44/94	9/2-			ann.rad./
				EC/6/					1.6373
									2.6321
									3.0286
									(0.1–4.2)
<sup>92</sup> Mo	14.77(31)	91.906811	> 3 $\times$ 10 <sup>17</sup> y	$\beta^+$ -EC		0+			
<sup>93m</sup> Mo			6.9 h	I.T./99+ /2.425		21/2+	+9.21		0.26306(IT)
									0.68461
									1.47711
<sup>93</sup> Mo		92.906813	3.5 $\times$ 10 <sup>3</sup> y	EC/0.405		5/2+			0.0304
<sup>94</sup> Mo	9.23(10)	93.905088				0+			
<sup>95</sup> Mo	15.90(9)	94.905842				5/2+	-0.9142	-0.02	
<sup>96</sup> Mo	16.68(1)	95.904680				0+			
<sup>97</sup> Mo	9.56(5)	96.906022				5/2+	-0.9335	+0.26	
<sup>98</sup> Mo	24.19(26)	97.905408				0+			
<sup>99</sup> Mo		98.907712	2.7476 d	$\beta^-$ /1.357	0.45/14	½+	0.375		0.144048



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
									0.7731
									1.5096
<sup>93m</sup> Tc			43. m	I.T./13		½-			0.3924(IT)
				EC/20					0.9437
									2.6445
<sup>93</sup> Tc	92.910249		2.73 h	β+ /13/3.201	0.81	9/2+	6.26		ann.rad./
				EC/87/					1.3629
									1.4771
									1.5203
									(0.1-3.0)
<sup>94m</sup> Tc			52. m	β+ /72/4.33		2+			ann.rad./
				EC/28/					0.8710
									1.8686
<sup>94</sup> Tc	93.909657		4.88 h	β+ /11/4.256		7+	5.08		ann.rad./
				EC/89/					0.4491
									0.7026
									0.8496
									0.8710
<sup>95m</sup> Tc			61. d	I.T./4/		1/2-			ann.rad./
				β+ /0.3	0.5/				0.0389(IT)
				EC/96	0.7/				0.2041
									0.5821
									0.5821
									0.8351
<sup>95</sup> Tc	94.90766		20.0 h	EC/100/1.691		9/2+	5.89		0.7657
									1.0738
<sup>96m</sup> Tc			52. m	I.T./90/		4+			0.0342(IT)
				β+, EC/2/					0.7782
									1.2002
<sup>96</sup> Tc	95.90787		4.3 d	EC/2.973		7+	+5.04		Mo k x-ray
									0.7782
									0.8125
									0.8498
									1.12168
<sup>97m</sup> Tc			91. d	I.T./0.0965		1/2-			Tc k x-ray
				EC	/3.9				0.0965
<sup>97</sup> Tc	96.906365		4.2 × 10 <sup>6</sup> y	EC/100/0.320		9/2+			Mo k x-ray
<sup>98</sup> Tc	97.907216		~ 6.6 × 10 <sup>6</sup> y	β- /1.80	0.40/100	6+			0.65241
									0.74535
<sup>99m</sup> Tc			6.01 h	I.T./100/0.142		1/2-			Tc k x-ray
									0.14049
									0.14261
<sup>99</sup> Tc	98.906255		2.13 × 10 <sup>5</sup> y	β- /0.294	0.293/100	9/2+	+5.6847	-0.129	
<sup>100</sup> Tc	99.907658		15.8 s	β- /3.202	2.2/	1+			0.5396
				EC /1.8(10) <sup>-3</sup> /	2.9/				0.5908
					3.3				(0.3 79-2.30)
<sup>101</sup> Tc	100.90732		14.2 m	β- /1.61	1.32/	9/2+			0.1272
									0.1841
									0.3068
									0.5451
									(0.073-0.969)
<sup>102m</sup> Tc			4.4 m	I.T./2/4.8	1.8/				0.4184
				β- /98/					0.4752
									0.6281
									0.6302
									1.0464
									1.1033
									1.6163
									2.2447
<sup>102</sup> Tc	101.90922		5.3 s	β- /4.53	3.4/	1+			0.4686



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<sup>93m</sup> Ru			10.8 s	I.T./21/ $\beta^+$ , EC/79/	5.3/	1/2-			ann.rad./ 0.7344 1.1112 1.3962 2.0931
<sup>93</sup> Ru		92.9171	1.0 m	$\beta^+$ /6.3 EC/		9/2+			ann.rad./ 0.6807 1.4349 (0.5-4.2)weak
<sup>94</sup> Ru		93.91136	52. m	EC/100/1.59		0+			0.3672 0.5247 0.8922
<sup>95</sup> Ru		94.91041	1.64 h	EC/85/2.57 $\beta^+$ /15/	1.20/ 0.91/	5/2+	0.86		ann.rad./ 0.3364 0.6268 0.036-2.424
<sup>96</sup> Ru	5.54(14)	95.90760	> 3.1 × 10 <sup>16</sup> y	$\beta^+\beta^+$		0+			
<sup>97</sup> Ru		96.90756	2.89 d	EC/1.12		5/2+	-0.78		Tc k x-ray 0.2157 0.3245 0.4606
<sup>98</sup> Ru	1.87(3)	97.90529				0+			
<sup>99</sup> Ru	12.76(14)	98.905939				5/2+	-0.6413	+0.079	
<sup>100</sup> Ru	12.60(7)	99.904220				0+			
<sup>101</sup> Ru	17.06(2)	100.905582				5/2+	-0.7188	+0.46	
<sup>102</sup> Ru	31.55(14)	101.904349				0+			
<sup>103</sup> Ru		102.906324	39.27 d	$\beta^-$ /0.763	0.223	3/2+	0.206	+0.62	0.05329 0.29498 0.4438 0.49708 0.55704 0.61033 (0.04-1.6)
<sup>104</sup> Ru	18.62(27)	103.905433				0+			
<sup>105</sup> Ru		104.907753	4.44 h	$\beta^-$ /1.917	1.11/22 1.134/13 1.187/49	3/2+	-0.3		0.12968 0.1491 0.2629 0.31664 0.46943 0.67634 0.72420 (0.1-1.8)
<sup>106</sup> Ru		105.90733	1.020 y	$\beta^-$ /0.0394	0.0394/100	0+			
<sup>107</sup> Ru		106.9099	3.8 m	$\beta^-$ /2.9	2.1/ 3.2/				0.1939 0.3741 0.4625 0.8488
<sup>108</sup> Ru		107.9102	4.5 m	$\beta^-$ /1.4	1.2/	0+			0.0923 0.1651 0.4339 0.4975 0.6189
<sup>109</sup> Ru		108.9132	34.5 s	$\beta^-$ /4.2					0.1164 0.3584
<sup>110</sup> Ru		109.9141	15. s	$\beta^-$ /2.81		0+			0.1121 0.3737 0.4397 0.7967
<sup>111</sup> Ru		110.9177	1.5 s	$\beta^-$ /5.5					
<sup>112</sup> Ru		111.9190	4.5 s	$\beta^-$ /4.5		0+			

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<sup>113m</sup> Ru			0.6 s						
<sup>113</sup> Ru		112.9225	0.80 s	$\beta^-$ /7.					0.2632 0.048–2.418
<sup>114</sup> Ru		113.9243	0.57 s	$\beta^-$ /6.1		0+			0.127/24 (0.053–0.180)
<sup>115</sup> Ru		114.9287	$\sim 0.74$ s	$\beta^-$ /8.					
<sup>116</sup> Ru		115.931	$> 0.15$ $\mu$ s			0+			
<sup>117</sup> Ru		116.936	$> 0.15$ $\mu$ s						
<sup>118</sup> Ru		117.938	$> 0.15$ $\mu$ s			0+			
<sup>119</sup> Ru		118.943	$> 0.15$ $\mu$ s						
<sup>120</sup> Ru		119.945	$> 0.15$ $\mu$ s			0+			
<b><sup>45</sup>Rh</b>		<b>102.90550(2)</b>							
<sup>89</sup> Rh		88.9488	$> 0.15$ $\mu$ s						
<sup>90m</sup> Rh			$\sim 12$ . ms						
<sup>90</sup> Rh		89.9429	1.0 s						
<sup>91m</sup> Rh			1.5 s	IT					0.387 (0.438-0.973)
<sup>91</sup> Rh		90.9366	1.5 s						
<sup>92m</sup> Rh			0.5 s						0.866 (0.163-0.991)
<sup>92</sup> Rh		91.9320	4.7 s	$\beta^+$ /11.1					
<sup>93</sup> Rh		92.9257	12. s	$\beta^+$ /8.1					(0.138–1.493)
<sup>94m</sup> Rh			25.8 s	$\beta^+$ /		8+			ann.rad./ 0.1264 0.3117 0.7562 1.0752 1.4307
<sup>94</sup> Rh		93.9217	1.18 m	$\beta^+$ /9.6	6.4/	3+			ann.rad./ 0.1461 0.3117 0.7562 1.4307
<sup>95m</sup> Rh			1.96 m	I.T./88/ $\beta^+$ , EC/12/		$\frac{1}{2}^+$			ann.rad./ 0.5433(IT) 0.7837
<sup>95</sup> Rh		94.9159	5.0 m	$\beta^+$ /5.1	3.2	9/2+			ann.rad./ 0.2293 0.4103 0.6610 0.9416 1.3520 (0.2–3.8)
<sup>96m</sup> Rh			1.51 m	I.T./60/0.052 $\beta^+$ , EC/40/	4.70/	2+			ann.rad./ Tc,Ru x-rays 0.8326 1.0985 1.6921 (0.4–3.3)
<sup>96</sup> Rh		95.91446	9.6 m	$\beta^+$ /6.45 EC/	3.3/	5+			ann.rad./ 0.4299 0.6315 0.6853 0.7418 0.8326 (0.2–3.4)
<sup>97m</sup> Rh			46. m	I.T./5 / $\beta^+$ , EC/95/	2.6/	1/2-			ann.rad./ 0.1886 0.4215 2.2452

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<sup>97</sup> Rh		96.91134	31.0 m	$\beta+$ /3.52	2.1/	9/2+			ann.rad./ 0.1886 0.3892 0.4515 0.8398 0.8788 (0.2-3.5)
<sup>98m</sup> Rh			3.5 m	$\beta+$ /		5+			ann.rad./ 0.6154 0.6524 0.7452
<sup>98</sup> Rh	97.91071		8.7 m	$\beta+$ /90/5.06	3.4/	2+			ann.rad./ 0.6524 0.7623
<sup>99m</sup> Rh			4.7 h	$\beta+$ /8/ EC/92/	.74/	9/2+	5.67		ann.rad./ 0.2766/ 0.3408 0.6178 1.2612
<sup>99</sup> Rh	98.90813		16. d	$\beta+$ /4/2.10 EC/97/	0.54/ 0.68/	1/2-			ann.rad./ 0.0894/ 0.3530 0.5277 (0.1-2.0)
<sup>100m</sup> Rh			4.7 m	I.T./99/ $\beta+$ /0.4/		5+			ann.rad./ 0.0748/ 0.2647(IT)
<sup>100</sup> Rh	99.90812		20.8 h	$\beta+$ /3.63 EC/	2.62/ 2.07/	1-			0.4462 0.5396 0.5882 0.8225 1.5534 2.3761
<sup>101m</sup> Rh			4.35 d	EC/92/ I.T./8/0.1573		9/2+	+5.51		Rh k x-ray 0.1272/ 0.3069 0.5451
<sup>101</sup> Rh	100.90616		3.3 y	EC/0.54		1/2-			Ru k x-ray 0.1272 0.1980 0.3252
<sup>102m</sup> Rh			3.74 y	EC/2.323 IT/0.0419		6*	4.04		0.4751 0.6313 0.6975 0.7668 1.0466 1.1032
			> 1.2 × 10 <sup>6</sup> y	$\beta^+$	<0.00025				
<sup>102</sup> Rh	101.906843		207. d	EC/62 $\beta^-$ /19/ $\beta^+$ /14/			0.5		ann.rad./ 0.4686 0.4751 0.5566 0.6280 1.1032 (0.4-1.6)
<sup>103m</sup> Rh			56.12 m	IT		7/2+	4.54		
<sup>103</sup> Rh	100.	102.905504				1/2-	-0.0884		
<sup>104m</sup> Rh			4.36 m	I.T./99+ / $\beta^-$	1.3/	5+			Rh k x-ray 0.0514 0.0971 0.5558

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<sup>104</sup> Rh		103.906656	42.3 s	$\beta^-$ /99+/2.441	1.88/2	1+			0.3581
									0.5558
									1.2370
<sup>105m</sup> Rh			43. s	I.T./1.296		1/2-			(0.35–1.8)
									Rh k x-ray
<sup>105</sup> Rh		104.905694	35.4 h	$\beta^-$ /0.567	0.247/30	7/2+	+4.45		0.1296
									0.2801
									0.3061
<sup>106m</sup> Rh			2.18 h	$\beta^-$ /	0.92/	6+			0.3189
									0.2217
									0.4510
<sup>106</sup> Rh		105.90729	29.9 s	$\beta^-$ /3.54	2.4/2	1+	+2.58		0.5119
									0.6162
									0.62187
<sup>107</sup> Rh		106.90675	21.7 m	$\beta^-$ /1.51	1.20/65	7/2+			(0.05–3.04)
									0.2776
									0.3028
<sup>108m</sup> Rh			6.0 m	$\beta^-$ /	1.5/17				0.3925
									0.4339
									0.4973
<sup>108</sup> Rh		107.9087	17. s	$\beta^-$ /4.5		1+			0.6189
									0.4046
									0.4339
<sup>109</sup> Rh		108.90874	1.34 m	$\beta^-$ /2.59	2.25/	7/2+			0.4973
									0.5811
									0.6146
<sup>109m</sup> Rh			29. s	$\beta^-$ /	6/				0.9014
									0.9471
									0.1134
<sup>110</sup> Rh		109.91114	3.1 s	$\beta^-$ /5.4	5.5/	1+			0.1780
									0.4400
									0.5463
<sup>110m</sup> Rh			29. s	$\beta^-$ /	6/				0.2914
									0.3254
									0.3268
<sup>111</sup> Rh		110.91159	11. s	$\beta^-$ /3.7					0.4261
									0.9045
									(0.1–1.6)
<sup>112</sup> Rh		111.9144	6.8 s	$\beta^-$ /					0.3737
									0.4397
									0.7967
<sup>112m</sup> Rh		111.9144	3.5 s	$\beta^-$ /6.2		1+			0.3737
									0.4400
									0.5463
<sup>113</sup> Rh		112.91553	0.9 s	$\beta^-$ /4.9					0.6877
									0.8381
									0.9045
<sup>113m</sup> Rh			1.9 s	$\beta^-$ /					0.275
									0.3489
									0.1285
<sup>114</sup> Rh		113.9188	1.8 s	$\beta^-$ /6.5		1+			(0.103-1.923)
									0.3405
									(0.276-0.783)
<sup>115</sup> Rh		114.9203	0.99 s	$\beta^-$ /6.0					0.3405
									0.340
									0.398–1.665
<sup>116m</sup> Rh			0.9 s	$\beta^-$ /					0.340
									0.340
									0.398–1.665
<sup>116</sup> Rh		115.9241	0.7 s	$\beta^-$ /8.0		1+			0.340
									0.340
									0.398–1.665



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>117</sup> Rh		116.9260	0.44 s	$\beta^-$ /7.					0.0346 0.1317
<sup>118</sup> Rh		117.9301	~ 0.30 ms						0.379 0.575 0.370–1.037
<sup>119</sup> Rh		118.932	0.17 s						
<sup>120</sup> Rh		119.936	0.12 s						
<sup>121</sup> Rh		120.939	> 0.15 $\mu$ s						
<sup>122</sup> Rh		121.943							
<b><sup>46</sup>Pd</b>		<b>106.42(1)</b>							
<sup>91</sup> Pd		90.949	> 1.5 $\mu$ s						
<sup>92</sup> Pd		91.9404	1.0 s			0+			
<sup>93</sup> Pd		92.9359	1.2 s	$\beta^+$ , p		9/2+			0.240/81 0.382–0.864
<sup>94</sup> Pd		93.9288	9. s	EC, $\beta^+$ /~ 6.6		0+			0.5582 (0.0546–0.798)
<sup>95m</sup> Pd		94.92684	13.4 s	EC, $\beta^+$ /10.2		21/2+			
<sup>95</sup> Pd		94.9247							
<sup>96</sup> Pd		95.9182	2.03 m	EC, $\beta^+$ /3.5	1.15/	0+			0.1248 0.4995
<sup>97</sup> Pd		96.9165	3.1 m	$\beta^+$ , EC/4.8	3.5/	5/2+			ann.rad./ 0.2653 0.4752 0.7927 (0.2–3.4)
<sup>98</sup> Pd		97.91272	17.7 m	$\beta^+$ /1.87 EC/		0+			ann.rad./ 0.0677 0.1125 0.6630 0.8379
<sup>99</sup> Pd		98.91177	21.4 m	$\beta^+$ /49/3.37 EC/51/	2.18/	5/2+			ann.rad./ 0.1360 0.2636 0.6734 (0.2–2.85)
<sup>100</sup> Pd		99.90851	3.7 d	EC/0.36		0+			0.03271 0.0748 0.0840
<sup>101</sup> Pd		100.90829	8.4 h	$\beta^+$ /5/1.980 EC/95/	0.776/	5/2+	-0.66		ann.rad./ 0.0244 0.2963 0.5904
<sup>102</sup> Pd	1.02(1)	101.905609				0+			
<sup>103</sup> Pd		102.906087	16.99 d	EC/0.543		5/2+			Rh k x-ray 0.03975 0.3575 0.4971
<sup>104</sup> Pd	11.14(8)	103.904036				0+			
<sup>105</sup> Pd	22.33(8)	104.905085				5/2+	-0.642	+0.66	
<sup>106</sup> Pd	27.33(3)	105.903486				0+			
<sup>107m</sup> Pd			20.9 s	I.T./0.2149		11/2-			Pd k x-ray 0.2149(IT)
<sup>107</sup> Pd		106.905133	6.5 $\times 10^6$ y	$\beta^-$ /0.033	0.03/	5/2+			
<sup>108</sup> Pd	26.46(9)	107.903893				0+			
<sup>109m</sup> Pd			4.75 m	I.T./0.1889		11/2-			Pd x-ray 0.1889(IT)
<sup>109</sup> Pd		108.905950	13.5 h	$\beta^-$ /1.116	1.028	5/2+			0.0880 (0.08–1.0)



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<sup>98</sup> Ag	97.9216		47.6 s	$\beta+$ /8.4 EC/ $\beta+$ , p	/36. /0.11	5+			ann.rad./ 0.5711 0.6786 0.8631 (0.153–1.185)
<sup>99m</sup> Ag			11. s	I.T./100/		$\frac{1}{2}-$			Ag k x-ray 0.1636(IT) 0.3426
<sup>99</sup> Ag	98.9176		2.07 m	$\beta+$ /87 5.4 EC/13/		9/2+			ann.rad./ 0.2199 0.2645 0.8056 0.8323 (0.2–3.5)
<sup>100m</sup> Ag			2.3 m	$\beta+$ / EC/		2+			ann.rad./ 0.6657 1.6941
<sup>100</sup> Ag	99.9161		2.0 m	$\beta+$ /7.1 EC/	4.7/	5+			ann.rad./ 0.2807 0.4503 0.6657 0.7508 0.7732
<sup>101m</sup> Ag			3.1 s	I.T./0.23		$\frac{1}{2}-$			Ag k x-ray 0.0981 0.176(IT)
<sup>101</sup> Ag	100.9128		11.1 m	$\beta+$ /69/4.2 EC/31/	2.7/ 2.18/ 2.73/ 3.38/	9/2+	5.7		ann.rad./ 0.2610 0.2747 0.3269 0.4392 0.6673 1.1739 (0.2–3.1)
<sup>102m</sup> Ag			7.8 m	$\beta+$ /38/ EC/13/ I.T./49/	3.4	2+	+4.14		ann.rad./ 0.5567 0.9777 1.8347 2.0545 2.1594 3.2386
<sup>102</sup> Ag	101.91169		13.0 m	$\beta+$ /78/5.92 EC/22/	2.26/	5+	4.6		ann.rad./ 0.5564 0.7193 0.163–2.242
<sup>103m</sup> Ag			5.7 s	I.T./0.134		1/2-			Ag k x-ray 0.1344
<sup>103</sup> Ag	102.90897		1.10 h	$\beta+$ /28/2.69 EC/72/	1.7 1.3	7/2+	+4.47		ann.rad./ 0.1187 0.1482
<sup>104m</sup> Ag			33. m	$\beta+$ /64/ EC/36/ I.T./0.07/	2.71/	2+	+3.7		ann.rad./ 0.5558 0.7657 (0.5–3.4)
<sup>104</sup> Ag	103.90863		69. m	$\beta+$ /16/4.28 EC/84/	0.99/	5+	3.92		ann.rad./ 0.5558 0.9259 0.9416 (0.18–2.27)
<sup>105m</sup> Ag			7.2 m	I.T./98/0.0255		7/2+	+4.41		Ag x-ray



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<sup>115</sup> Ag		114.90876	20. m	$\beta^-$ /3.10		1/2-			0.1316 0.2128 0.2291 0.4727 (0.13–2.49)
<sup>116m2</sup> Ag			20. s	$\beta^-$ ,IT/7	IT/0.0479				
<sup>116m</sup> Ag			9.8 s	$\beta^-$ /92 /	3.2/ 2.9	5+			0.5134 0.7055 0.255–2.838
<sup>116</sup> Ag		115.91136	2.68 m	I.T./8 $\beta^-$ /6.16	IT/.0809 5.3	2-			0.5134 0.6993 2.4779
<sup>117m</sup> Ag			5.3 s	$\beta^-$ /	3.2/	7/2+			0.1354 0.2981 0.3868 0.1571
<sup>117</sup> Ag		116.91168	1.22 m	$\beta^-$ /4.18	2.3	1/2-			0.1354 0.3377
<sup>118m</sup> Ag			2.8 s	$\beta^-$ /59/ I.T./41 /0.1277					0.1277 0.4878 0.6771 0.7709 (0.190-2.778)
<sup>118</sup> Ag		117.9146	4.0 s	$\beta^-$ /7.1					0.4878 0.6771 3.2259
<sup>119</sup> Ag		118.9157	2.1 s	$\beta^-$ /5.35		7/2+			0.0674 0.3662 0.3991 0.6264
<sup>120m</sup> Ag			0.40 s	$\beta^-$ /63. I.T./37.					0.2030 0.5059 0.6978 0.8300 (0.115-1.644)
<sup>120</sup> Ag		119.9188	1.23 s	$\beta^-$ /8.2 $\beta^-$ ,n	n//<0.0030%				0.5059 0.6978 0.8171 (0.442-3.044)
<sup>121</sup> Ag		120.9199	0.78 s	$\beta^-$ /6.4					0.1150 0.3148 0.3537 0.3696 0.5007 1.5105 (0.11–2.5)
<sup>122m</sup> Ag			1. s	$\beta^-$ /					
<sup>122</sup> Ag		121.9235	0.44 s	$\beta^-$ /9.2					
<sup>123</sup> Ag		122.9249	0.31 s	$\beta^-$ /7.4					
<sup>124</sup> Ag		123.9286	0.22 s	$\beta^-$ /10.1					
<sup>125</sup> Ag		124.9304	0.17 s	$\beta^-$					
<sup>126</sup> Ag		125.9345	0.11 s	$\beta^-$					
<sup>127</sup> Ag		126.9368	0.11 s	$\beta^-$					
<sup>128</sup> Ag		127.9412	58 ms	$\beta^-$					
<sup>129m</sup> Ag			0.16 s						
<sup>129</sup> Ag		128.9437	~ 46. ms	$\beta^-$ , n					
<sup>130</sup> Ag		129.9505	~ 35 ms						
<sup>48</sup> Cd		<b>112.411(8)</b>							

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<sup>95</sup> Cd		94.950							
<sup>96</sup> Cd		95.9398				0+			
<sup>97</sup> Cd		96.9349	3. s	$\beta^+$ , (p)					
<sup>98</sup> Cd		97.9274	9.2 s	$\beta^+$ /5.4 (p)	/0.025	0+			
<sup>99</sup> Cd		98.9250	16. s	$\beta^+$ , EC/6.9					ann.rad./
<sup>100</sup> Cd		99.9203	1.1 m	$\beta^+$ , EC/3.9		0+			ann.rad./ (0.090–1.043)
<sup>101</sup> Cd		100.9187	1.2 m	$\beta^+$ /83/5.5 EC/17/	4.5	5/2+			In k x-ray 0.0985 1.7225 0.31–2.84)
<sup>102</sup> Cd		101.91446	5.8 m	$\beta^+$ /27/2.59 EC/73		0+			ann.rad./ 0.0974 0.4810 1.0366 1.3598
<sup>103</sup> Cd		102.91342	7.5 m	$\beta^+$ /33/4.14 EC/67/		5/2+	-0.81	-0.8	ann.rad./ Ag k x-ray 1.0799 1.4487 1.4618 (0.1–2.8)
<sup>104</sup> Cd		103.90985	58. m	EC/1.14		0+			Ag k x-ray 0.0835 0.7093
<sup>105</sup> Cd		104.90947	55.5 m	$\beta^+$ /26/2.739 EC/74/	1.69/	5/2+	-0.7393	+0.43	Ag k x-ray 0.3469 0.6072 0.9618 1.3025 (0.25–2.4)
<sup>106</sup> Cd	1.25(6)	105.90646	$> 5.8 \times 10^{17}$ y	EC, EC		0+			
<sup>107</sup> Cd		106.90662	6.52 h	EC/99+/1.417 $\beta^+$ /		5/2+	-0.615055	+0.68	Ag k x-ray 0.0931 0.8289
<sup>108</sup> Cd	0.89(3)	107.90418	$>4.1 \times 10^{17}$ y	EC EC		0+			
<sup>109</sup> Cd		108.904982	462.0 d	EC/0.214		5/2+	-0.827846	+0.69	Ag k x-ray 0.08804
<sup>110</sup> Cd	12.49(18)	109.903002				0+			
<sup>111m</sup> Cd			48.5 m	I.T./		11/2-			Cd k x-ray 0.1508(IT) 0.2454
<sup>111</sup> Cd	12.80(12)	110.904178				1/2+	-0.594886		
<sup>112</sup> Cd	24.13(21)	111.902758				0+			
<sup>113m</sup> Cd			14.1 y	$\beta^-$ /99.9/0.59	0.59/99.9	11/2-	-1.087	-0.71	0.2637
<sup>113</sup> Cd	12.22(12)	112.904402	$8.2 \times 10^{15}$ y	$\beta^-$		1/2+	-0.622301		
<sup>114</sup> Cd	28.73(42)	113.903359	$>6.0 \times 10^{17}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>115m</sup> Cd			44.6 d	$\beta^-$ /1.629	0.68/1.6 1.62/97	11/2-	-1.042	-0.54	0.48450 0.93381 1.29064
<sup>115</sup> Cd		114.905431	2.228 d	$\beta^-$ /1.446	0.593/42 1.11/58	1/2+	-0.648426		0.23141 0.26085 0.33624 0.49227 0.52780
<sup>116</sup> Cd	7.49(18)	115.904756	$3.8 \times 10^{19}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>117m</sup> Cd			3.4 h	$\beta^-$ /2.66	0.72/	11/2-			0.1586 0.5529 0.37–2.42

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<sup>117</sup> Cd		116.907219	2.49 h	$\beta^-$ /2.52	0.67/51 2.2/10	1/2+			0.2209 0.2733 0.3445 1.3033
<sup>118</sup> Cd		117.90692	50.3 m	$\beta^-$ /0.52		0+			
<sup>119m</sup> Cd			2.20 m	$\beta^-$ /		11/2-			0.1056 0.7208 1.0250 2.0213
<sup>119</sup> Cd		118.9099	2.69 m	$\beta^-$ /3.8	$\sim$ 3.5/	1/2+			0.1340 0.2929 0.3429
<sup>120</sup> Cd		119.90985	50.8 s	$\beta^-$ /1.76	1.5/	0+			
<sup>121m</sup> Cd			8. s	$\beta^-$ /		11/2-			0.1008 0.9878 1.0209 1.1815 2.0594
<sup>121</sup> Cd		120.9130	13.5 s	$\beta^-$ /4.9		(3/2+)			0.2102 0.3242 0.3492 1.0403
<sup>122</sup> Cd		121.91333	5.3 s	$\beta^-$ /3.0		0+			
<sup>123m</sup> Cd			1.9 s	$\beta^-$ /					
<sup>123</sup> Cd		122.91700	2.09 s	$\beta^-$ /6.12		3+			
<sup>124</sup> Cd		123.9177	1.24 s	$\beta^-$ /4.17		0+			0.0365 0.0628 0.1799
<sup>125m</sup> Cd			0.66 s	$\beta^-$ /					
<sup>125</sup> Cd		124.9213	0.68 s	$\beta^-$ /7.16		3/2+			
<sup>126</sup> Cd		125.9224	0.52 s	$\beta^-$ /5.49		0+			0.2601
<sup>127</sup> Cd		126.9264	0.4 s	$\beta^-$ /8.5		3/2+			
<sup>128</sup> Cd		127.9278	0.28 s	$\beta^-$ /7.1		0+			0.247
<sup>129</sup> Cd		128.9322	0.24 s	$\beta^-$ /5.9					0.281
<sup>130</sup> Cd		129.9339	0.162 s	$\beta^-$ /		0+			
				$\beta^-$ , n	$\sim$ 3.5				
<sup>131</sup> Cd		130.9407	68 ms						
<sup>132</sup> Cd		131.9456	0.10 s	$\beta^-$ , n/	/60	0+			
<sup>133</sup> Cd			0.06 s						
<b><sup>49</sup>In</b>		<b>114.818(3)</b>							
<sup>97</sup> In		96.950							
<sup>98m</sup> In			$\sim$ 0.03 s						
<sup>98</sup> In		97.9421	1. s						
<sup>99</sup> In		98.9342	$\sim$ 3.8 s	$\beta^+$ /8.9					
<sup>100</sup> In		99.9311	5.9 s	$\beta^+$ , (p)/10.5					(0.297-1.365)
<sup>101</sup> In		100.9263	15. s	$\beta^+$ /7.3					
<sup>102</sup> In		101.9241	23. s	EC/8.9		(5)			0.1566 0.7767 (0.397-0.923)
<sup>103m</sup> In			34. s						
<sup>103</sup> In		102.91991	1.1 m	$\beta^+$ , EC/6.05 EC	4.2 /45	9/2+			ann.rad./ 0.1879 (0.157-3.98)
<sup>104m</sup> In			16. s	IT/0.0935					
<sup>104</sup> In		103.9183	1.84 m	$\beta^+$ , EC/7.9	4.8	5+	+4.44	+0.7	ann.rad./ 0.6580 0.8341 0.8781

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<sup>105m</sup> In			43. s	I.T.		½-			In k x-ray 0.6740
<sup>105</sup> In	104.91467		5.1 m	β+, EC/4.85	3.7	9/2+	+5.675	+0.83	0.1310 0.2600 0.6038
<sup>106m</sup> In			5.3 m	β+ /85/ EC/15/	4.90	3+			ann.rad./ 0.6326 0.8611 1.7164
<sup>106</sup> In	105.91347		6.2 m	β+ /65/6.52 EC/35/	2.6	7+	+4.92	+0.97	ann.rad./ 0.2259 0.6327 0.8611 0.9978 1.0091
<sup>107m</sup> In			51. s	I.T./0.6786		½-			In k x-ray 0.6785
<sup>107</sup> In	106.91030		32.4 m	β+ /35/3.43 E.C/65/	2.20/	9/2+	+5.59	+0.81	ann.rad./ Cd k x-ray 0.2050 0.3209 0.5055 (0.2-2.99)
<sup>108m</sup> In			57. m	β+ /53/ EC/47/	1.3	6+	+4.94	+0.47	ann.rad./ Cd k x-ray 0.6329 1.9863 3.4522
<sup>108</sup> In	107.90970		40. m	β+ /33/5.15 EC/67/	3.49/	3+	+4.56	+1.01	ann.rad./ Cd k x-ray 0.2429 0.6331 0.8756
<sup>109m</sup> In			1.3 m	I.T./0.650		½-			In k x-ray 0.6498
<sup>109</sup> In	108.90715		4.17 h	β+ /8/2.02 EC/92/	0.79/	9/2+	+5.54	+0.84	ann.rad./ Cd k x-ray 0.2035 0.6235
<sup>110m</sup> In			4.9 h	EC/		7+	+4.72	+1.00	Cd k x-ray 0.6577 0.8847 0.9375 (0.1-1.98)
<sup>110</sup> In	109.90717		1.15 h	β+ /62/3.88 EC/38/	2.22/	2+	+4.37	+0.35	ann.rad./ Cd k x-ray 0.6577 (0.6-3.6)
<sup>111m</sup> In			7.7 m	I.T./0.537		½-	+5.53		In k x-ray 0.537
<sup>111</sup> In	110.905103		2.8049 d	EC/0.866		9/2+	+5.50	+0.80	Cd k x-ray 0.1712 0.2453
<sup>112m</sup> In			20.8 m	I.T./0.155		4+			In k x-ray 0.1555
<sup>112</sup> In	111.90553		14.4 m	β+ /22/2.586 EC/34/ β- /0.663		1+	+2.82	+0.09	ann.rad./ Cd k x-ray 0.6171
<sup>113m</sup> In			1.658 h	I.T./0.3917		½-	-0.210		In k x-ray 0.3917



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<sup>113</sup> In	4.29(5)	112.904058				9/2+	+5.529	+0.80	
<sup>114m</sup> In			49.51 d	I.T./97/0.190		5+	+4.65	+0.74	In k x-ray 0.19027
<sup>114</sup> In		113.904914	1.198 m	$\beta^-$ /97/1.989 EC/3/1.453	1.984/	1+	+2.82		Cd k x-ray 0.5584 0.5727 1.2998
<sup>115m</sup> In			4.486 h	I.T./95/0.336 $\beta^-$ /5 /0.83		½-	-0.255		In k x-ray 0.3362 0.4974
<sup>115</sup> In	95.71(5)	114.903878	$4.4 \times 10^{14}$ y	$\beta^-$ /0.495		9/2+	+5.541	+0.81	
<sup>116m2</sup> In			2.16 s	I.T./0.162		8-	+3.22	+0.31	In k x-ray 0.1624
<sup>116m1</sup> In			54.1 m	$\beta^-$ /	/0.023 1.0	5+	+4.43	+0.80	0.13792 0.41688/27 1.09723/58.5 1.29349/85
<sup>116</sup> In		115.905260	14.1 s	$\beta^-$ /3.274	3.3/99	1+	2.788	0.11	0.46313 1.2526 1.29349
<sup>117m</sup> In			1.94 h	$\beta^-$ /53/1.769 I.T./47 /	1.77/	½-	-0.2517		In k x-ray 0.15855 0.31531 0.55294
<sup>117</sup> In		116.90451	44. m	$\beta^-$ /1.455	0.74/	9/2+	+5.52	+0.83	0.15855 0.3966 0.55294
<sup>118m2</sup> In			8.5 s	I.T./98/ $\beta^-$ /2/		(8-)	+3.32	+0.44	In k x-ray 0.1382
<sup>118m1</sup> In			4.40 m	$\beta^-$ /	1.3 2.0	5+	+4.23	+0.80	0.2086 0.6833 1.2295
<sup>118</sup> In		117.90635	5.0 s	$\beta^-$ /4.42	4.2/	1+			0.5282 1.1734 1.2295 2.0432
<sup>119m</sup> In			17.9 m	$\beta^-$ /97/ I.T./3/0.311	2.7/	½-	-0.32		0.3114 0.7631
<sup>119</sup> In		118.90585	2.3 m	$\beta^-$ /2.36	1.6/	9/2+	+5.52	+0.85	0.0239 0.6495 0.7631 1.2149
<sup>120m2</sup> In			47 s	$\beta^-$ /6.1		8-	+3.692	+0.53	1.171 1.023
<sup>120m1</sup> In			46. s	$\beta^-$ /5.8	2.2/	5+	+4.30	+0.81	1.171 1.023
<sup>120</sup> In		119.90796	3.1 s	$\beta^-$ /5.37	5.6/ 3.1/	(1+)			0.4146 0.5924 0.8637 1.0232 1.1714 (0.4-2.7)
<sup>121m</sup> In			3.8 m	$\beta^-$ /99/ I.T./1/0.313	3.7/	1/2-	-0.36		0.0601 0.3136 0.9256 1.0412 1.1022 1.1204
<sup>121</sup> In		120.90785	23. s	$\beta^-$ /3.36	2.5	9/2+	+5.50	+0.81	0.2620 0.6573

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>122m</sup> In			10. s	$\beta^-$ /	4.4/	8-	+3.78	+0.59	0.9256 1.0014
									1.1403
<sup>122</sup> In		121.91028	1.5 s	$\beta^-$ /6.37	5.3/	(1+)			0.2391 1.0014 1.1403 1.164 1.1903
<sup>123m</sup> In			47. s	$\beta^-$ /	4.6/	(1/2-)	-0.40		0.1258 1.170 3.234
<sup>123</sup> In		122.91044	6.0 s	$\beta^-$ /4.39	3.3/	(9/2+)	+5.49	+0.76	0.6188 1.0197 1.1305
<sup>124m</sup> In			3.4 s	$\beta^-$		8-	+3.89	+0.66	0.1029 0.9699 1.0729 1.1316
<sup>124</sup> In		123.91318	3.18 s	$\beta^-$ /7.36	5/	3+	+4.04	+0.61	0.7070 0.9978 1.1316 3.2142 (0.3-4.6)
<sup>125m</sup> In			12.2 s	$\beta^-$ /	5.5/	1/2-	-0.43		0.1876
<sup>125</sup> In		124.91360	2.33 s	$\beta^-$ /5.42	4.1/	9/2+	+5.50	+0.71	0.4260 1.0318 1.3350
<sup>126m</sup> In			1.53 s		4.9/	3+	+4.03	+0.49	0.9086 0.9696 1.1411
<sup>126</sup> In		125.91646	1.63 s	$\beta^-$ /8.21	4.2/	8-	+4.06		0.1118 0.9086 1.1411
<sup>127m</sup> In			3.73 s	$\beta^-$ /	6.4/	(1/2-)			0.2523 3.074
<sup>127</sup> In		126.91735	1.14 s	$\beta^-$ /6.51	4.9/	(9/2+)	+5.52	+0.59	0.4680 0.6461 0.8051 1.5977
<sup>128m</sup> In			0.7 s	$\beta^-$ /	5.4/	(8-)			1.8670 1.9739 (0.1205-2.12)
<sup>128</sup> In		127.92017	0.80 s	$\beta^-$ /8.98	5.0/	3+			0.9352 1.1688 3.5198 4.2970
<sup>129m</sup> In			1.23 s	$\beta^-$ /98/ n/2/	$\sim$ 7.5/	1/2-			0.3153 0.9067 1.2220
<sup>129</sup> In		128.9217	0.63 s	$\beta^-$ /7.66	5.5/	9/2+			0.2853 0.7693 1.8650 2.1180
<sup>130m2</sup> In			0.53 s	$\beta^-$ /	8.8/	5+			0.0892 0.7744 1.2212
<sup>130m1</sup> In			0.51 s	$\beta^-$ /	6.1/	10-			0.0892 0.1298 0.7744 1.2212

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<sup>130</sup> In		129.92497	0.29 s	$\beta^-$ /10.25	10.0/	1-			1.9052
<sup>131m2</sup> In			0.3 s	$\beta^-$ /		(21/2+)			
<sup>131m1</sup> In			0.35 s	$\beta^-$ /		(1/2-)			
<sup>131</sup> In		130.92685	0.28 s	$\beta^-$ /9.18	6.4/	(9/2+)			0.3328 2.433
<sup>132</sup> In		131.9330	$\sim$ 0.206 s	$\beta^-$ /13.6	6.0/ 8.8/	(7-)			0.1320 0.2992 0.3747 4.0406
<sup>133</sup> In		132.9378	0.165 s	$\beta^-$ , (n)					
<sup>134</sup> In		133.9442	0.14 s						(0.354–2.005)
<sup>135</sup> In		134.9493	0.09 s						
<b><sub>50</sub>Sn</b>		<b>118.710(7)</b>							
<sup>99</sup> Sn		98.949							
<sup>100</sup> Sn		99.939	1.0 s	$\beta^+$ /7.3	3.4/	0+			
<sup>101</sup> Sn		100.9361	3. s	$\beta^+$ /9.					
<sup>102</sup> Sn		101.9303	3.8 s	$\beta^+$ /5.8		0+			
<sup>103</sup> Sn		102.9281	7. s	$\beta^+$ /7.7					1.3558 (0.351-2.813)
				$\beta^+$ ,p EC	p//1.2 / 20.				
<sup>104</sup> Sn		103.9231	21. s	$\beta^+$ , EC/4.5		0+			
<sup>105</sup> Sn		104.9214	28. s	$\beta^+$ /6.3					In-x-ray (0.2879–3.819)
<sup>106</sup> Sn		105.91688	2.0 m	$\beta^+$ /20/3.18 EC/80/		0+			ann.rad./ In k x-ray 0.3865 0.4772
<sup>107</sup> Sn		106.9156	2.92 m	EC/5.0 $\beta^+$ /	1.2/				0.4218 0.6105 0.6785 1.0013 1.1290 1.542
<sup>108</sup> Sn		107.91193	10.3 m	$\beta^+$ /1/2.09 EC/99/	0.36/	0+			In k x-ray 0.2724 0.3965 (0.105–1.68)
<sup>109</sup> Sn		108.91128	18.0 m	$\beta^+$ /9/3.85 EC/91/	1.52/	7/2+	-1.08	+0.3	ann.rad./ In k x-ray 0.6498 1.0992
<sup>110</sup> Sn		109.90784	4.17 h	EC/0.64		0+			In k x-ray 0.283
<sup>111</sup> Sn		110.90773	35. m	$\beta^+$ /31/2.45 EC/69/	1.5/	7/2+	+0.61	+0.2	In k x-ray 0.7620 1.1530 1.9147
<sup>112</sup> Sn	0.97(1)	111.904818				0+			
<sup>113m</sup> Sn			21.4 m	IT./92/0.077 EC/8/		7/2+			Sn k x-ray In x-ray 0.0774
<sup>113</sup> Sn		112.905171	115.1 d	EC/1.036		$\frac{1}{2}^+$	-0.879		In k x-ray 0.25511 0.39169
<sup>114</sup> Sn	0.66(1)	113.902779				0+			
<sup>115</sup> Sn	0.34(1)	114.903342				$\frac{1}{2}^+$	-0.9188		
<sup>116</sup> Sn	14.54(9)	115.901741				0+			

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<sup>117m</sup> Sn			14.0 d	I.T./0.3146		11/2-	-1.396	-0.4	Sn k x-ray 0.15856
<sup>117</sup> Sn	7.68(7)	116.902952				½+	-1.0010		
<sup>118</sup> Sn	24.22(9)	117.901603				0+			
<sup>119m</sup> Sn			293. d	I.T./0.0896		11/2-	-1.4	0.21	Sn k x-ray 0.02387
<sup>119</sup> Sn	8.59(4)	118.903308				½+	-1.0473		
<sup>120</sup> Sn	32.58(9)	119.902195				0+			
<sup>121m</sup> Sn			44. y	I.T./78/0.006		11/2-	-1.388	-0.14	Sn k x-ray 0.03715
<sup>121</sup> Sn		120.904236	1.128 d	$\beta^-$ /22/	0.354/	3/2+	0.698	-0.02	
<sup>122</sup> Sn	4.63(3)	121.903439		$\beta^-$ /0.388	0.383/100	0+			
<sup>123m</sup> Sn			40.1 m	$\beta^-$ /1.428	1.26/99	3/2+			0.1603 0.3814
<sup>123</sup> Sn		122.905721	129.2 d	$\beta^-$ /1.404	1.42/99.4	11/2-	-1.370	+0.03	0.1603 1.0302 1.0886
<sup>124</sup> Sn	5.79(5)	123.905274	> 2.2 × 10 <sup>18</sup> y	$\beta\beta^-$		0+			
<sup>125m</sup> Sn			9.51 m	$\beta^-$ /2.387	2.03/98	3/2+	+0.764	+0.8	0.3321 1.4040
<sup>125</sup> Sn		124.907784	9.63 d	$\beta^-$ /2.364	2.35/82	11/2-	-1.35	+0.1	1.0671 (0.2–2.3)
<sup>126</sup> Sn		125.90765	2.34 × 10 <sup>5</sup> y	$\beta^-$ /0.38	0.25/100	0+			0.0643 0.0876 0.4148 0.6663 0.6950
<sup>127m</sup> Sn			4.15 m	$\beta^-$ /3.21	2.72/	3/2+	+0.757	+0.60	0.4909 1.3480 1.5640
<sup>127</sup> Sn		126.91036	2.12 h	$\beta^-$ /3.20	2.42/ 3.2/	11/2-	-1.33	+0.3	0.8231 1.0956 (0.120–2.84)
<sup>128m</sup> Sn			6.5 s	IT/0.091		(7-)			
<sup>128</sup> Sn		127.91054	59.1 m	$\beta^-$ /1.27	0.48/ 0.63/	0+			0.4823 0.5573 0.6805
<sup>129m</sup> Sn			6.9 m	$\beta^-$ /		11/2-	-1.30	-0.2	1.1611
<sup>129</sup> Sn		128.91348	2.4 m	$\beta^-$ /4.0		3/2+	+0.754	+0.05	0.6456
<sup>130m</sup> Sn			1.7 m	$\beta^-$ /		(7-)	-0.381	-0.4	0.1449 0.8992
<sup>130</sup> Sn		129.91397	3.7 m	$\beta^-$ /2.15	1.10/	0+			0.0700 0.1925 0.7798
<sup>131m</sup> Sn			1.02 m	$\beta^-$ /	3.4/	11/2-	-1.28	+0.02	0.3043 0.4500 0.7985 1.2260 (0.08–3.21)
<sup>131</sup> Sn		130.91700	39. s	$\beta^-$ /4.69	3.8/	3/2+	+0.747	-0.04	see <sup>131m</sup> Sn
<sup>132</sup> Sn		131.91782	40. s	$\beta^-$ /3.12	1.8/	0+			0.0855 0.2467 0.3402 0.8985
<sup>133</sup> Sn		132.92383	1.44 s	$\beta^-$ /7.8	7.5/	7/2-			
<sup>134</sup> Sn		133.9283	1.04 s	$\beta^-$ /6.8		0+			(0.053–2.417)
<sup>135</sup> Sn		134.9347	0.53 s	$\beta^-$					(0.053–0.830)
<sup>136</sup> Sn		135.9393	0.25 s	$\beta^-$ , n	/21.				0.733–1.855
<sup>137</sup> Sn		136.946	0.19 s	$\beta^-$ , n	/30. /~ 58	0+			



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<sup>118</sup> Sb		117.905529	3.6 m	$\beta^+$ /74/3.657 EC/26/	2.65/	1+	2.5		ann.rad./ Sn k x-ray 1.22964
<sup>119</sup> Sb		118.90394	38.1 h	EC/0.59		5/2+	+3.45	-0.4	Sn k x-ray 0.0239
<sup>120m</sup> Sb			5.76 d	EC/		8-	2.34		Sn k x-ray 0.0898 0.19730 1.02301 1.17121
<sup>120</sup> Sb		119.90507	15.89 m	$\beta^+$ /41/2.68 EC/59/	1.72/	1+	+2.3		ann.rad./ Sn k x-ray 0.7038 1.17121
<sup>121</sup> Sb	57.21(5)	120.903816				5/2+	+3.363	-0.4	
<sup>122m</sup> Sb			4.19 m	I.T./0.162		8-			Sb x-ray 0.0614 0.0761
<sup>122</sup> Sb		121.905174	2.72 d	$\beta^-$ /98/1.979 $\beta^+$ /2/1.620	1.414/65 1.980/26	2-	-1.90	+0.9	0.56409 0.69277 1.14050 1.2569
<sup>123</sup> Sb	42.79(5)	122.904214				7/2+	+2.550	-0.5	
<sup>124m2</sup> Sb			20.3 m	I.T./0.035		8-			
<sup>124m1</sup> Sb			1.6 m	I.T./80/ $\beta^-$ /20/	1.2/ 1.7/	5+			0.4984 0.6027 0.6458 1.1010
<sup>124</sup> Sb		123.905936	60.20 d	$\beta^-$ /2.905	0.61/52 2.301/23	3-	1.2	+1.9	0.60271/97.8 0.64583/7.4 0.72277/10.5 1.69094/48.2 (0.0274-2.808)
<sup>125</sup> Sb		124.905254	2.758 y	$\beta^-$ /0.767	0.13/30 0.302/45 0.62/13	7/2+	+2.63		0.0355 0.17632 0.38044 0.42786 0.46336 0.60060 0.63595
<sup>126m2</sup> Sb			11. s	I.T./		3-			L x-ray 0.0227
<sup>126m1</sup> Sb			19.0 m	$\beta^-$ /86 / I.T./14 /	1.9	5+			0.4148 0.6663 0.6950
<sup>126</sup> Sb		125.90725	12.4 d	$\beta^-$ /3.67	1.9	8-	1.3		0.2786 0.4148/83.3 0.6663/99.7 0.6950/99 0.7205
<sup>127</sup> Sb		126.90692	3.84 d	$\beta^-$ /1.581	0.89/ 1.10/ 1.50/	7/2+	2.70		0.2524 0.2908 0.4121 0.4370 0.6857 0.7837
<sup>128m</sup> Sb			10.1 m	$\beta^-$ /96/ I.T./4/	2.6/	5+			0.3140 0.5941 0.7432 0.7539

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<sup>128</sup> Sb		127.90917	9.1 h	$\beta^-$ /4.38	2.3/	8-	1.3		0.2148 0.3141 0.5265 0.7433 0.7540
<sup>129m</sup> Sb			17.7 m	$\beta^-$ /					0.4338 0.6578 0.7598
<sup>129</sup> Sb		128.90915	4.40 h	$\beta^-$ /2.38	0.65/	7/2-	2.82		0.0278 0.1808 0.3594 0.4596 0.5447 0.8128 0.9146 1.0301
<sup>130m</sup> Sb			6.5 m	$\beta^-$ /2.6	2.12/				0.1023 0.7934 0.8394
<sup>130</sup> Sb		129.91166	38.4 m	$\beta^-$ /4.96	2.9/	8-			0.1823 0.3309 0.4680 0.7394 0.8394
<sup>131</sup> Sb		130.91198	23.0 m	$\beta^-$ /3.20	1.31/ 3.0/	7/2+			0.6423 0.6579 0.9331 0.9434
<sup>132m</sup> Sb			2.8 m	$\beta^-$ /	3.9/	4+			0.1034 0.3538 0.6968 0.9739 0.9896
<sup>132</sup> Sb		131.91447	4.2 m	$\beta^-$ /5.49		8-			0.1034 0.1506 0.6968 0.9739
<sup>133</sup> Sb		132.91525	2.5 m	$\beta^-$ /4.00	1.20/	7/2+	3.00		0.4235 0.6318 0.8165 1.0764
<sup>134m</sup> Sb			10.4 s	$\beta^-$ /	6.1	7-			
<sup>134</sup> Sb		133.92038	0.8 s	$\beta^-$ /8.4	8.4	0-			0.1152 0.2970 0.7063 1.2791
<sup>135</sup> Sb		134.9252	1.71 s	$\beta^-$ /8.12		7/2+			1.127 1.279
<sup>136</sup> Sb		135.9304	0.82 s	$\beta^-$ /9.3					
<sup>137</sup> Sb		136.9353	> 0.15 $\mu$ s						
<sup>138</sup> Sb		137.9408	> 0.15 $\mu$ s						
<sup>139</sup> Sb		138.9460	> 0.15 $\mu$ s						
<b><sup>52</sup>Te</b>		<b>127.60(3)</b>							
<sup>105</sup> Te		104.9436							
<sup>106</sup> Te		105.9375	0.07 ms	$\alpha$ /4.3	/100	0+			
<sup>107</sup> Te		106.9350	3.1 ms	$\alpha$ / 70/ $\beta^+$ , EC/10.1	3.86(1)/				(0.090-0.721)
<sup>108</sup> Te		107.9294	2.1 s	$\alpha$ /68 /	3.314(4)/	0+			

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<sup>109</sup> Te		108.9274	4.6 s	$\beta^+$ , EC/32 /6.8 $\beta^+$ EC/96 /8.7					0.7523 0.287–2.045
<sup>110</sup> Te		109.9224	19. s	$\beta^+$ , EC/4.5	3.107(4)/	0+			ann.rad./ 0.2191 0.6059
<sup>111</sup> Te		110.9211	19.3 s	$\beta^+$ , EC/8.0		(7/2+)			ann.rad./ 0.267 0.322 0.341
<sup>112</sup> Te		111.9170	2.0 m	$\beta^+$ , EC/4.3		0+			ann.rad./ 0.2962 0.3727 0.4187
<sup>113</sup> Te		112.9159	1.7 s	$\beta^+$ /85/5.7 EC/15/	4.5/	(7/2+)			ann.rad./ Sb k x-ray 0.8144 1.0181 1.1812
<sup>114</sup> Te		113.91209	15. m	$\beta^+$ /40/3.2 EC/60/		0+			ann.rad./ Sb k x-ray 0.0838 0.0903
<sup>115m</sup> Te			6.7 m	$\beta^+$ /45/ EC/55/		(1/2+)			ann.rad./ Sb k x-ray 0.7236 0.7704
<sup>115</sup> Te		114.91190	5.8 m	$\beta^+$ /45/4.6 EC/55/	2.7/	7/2+			ann.rad./ Sb k x-ray 0.7236 1.3268 1.3806 (0.22–2.7)
<sup>116</sup> Te		115.90846	2.49 h	EC/1.5		0+			Sb k x-ray 0.0937
<sup>117</sup> Te		116.90865	1.03 h	EC/75/3.54 $\beta^+$ /25/	1.78/	$\frac{1}{2}+$			ann.rad./ Sb k x-ray 0.9197 1.7164 2.3000
<sup>118</sup> Te		117.90583	6.00 d	EC/0.28		0+			Sb k x-ray
<sup>119m</sup> Te			4.69 d	EC/		11/2-	0.89		Sb k x-ray 0.15360 0.2705 1.21271
<sup>119</sup> Te		118.90640	16.0 h	$\beta^+$ /2/2.293 EC/98/	0.627/	$\frac{1}{2}+$	0.25		ann.rad. Sb k x-ray 0.6440 0.6998
<sup>120</sup> Te	0.09(1)	119.90402				0+			
<sup>121m</sup> Te			~ 154. d	I.T. (89%) EC (11%)		11/2-	0.90		Te k x-ray 0.2122
<sup>121</sup> Te		120.90494	16.8 d	EC/1.04		$\frac{1}{2}+$			Sb k x-ray 0.5076 0.5731
<sup>122</sup> Te	2.55(12)	121.903044				0+			
<sup>123m</sup> Te			119.7 d	I.T./0.247		11/2-	-0.93		Te k x-ray 0.1590/84.1
<sup>123</sup> Te	0.89(3)	122.904270	> 9.2 × 10 <sup>16</sup> y	EC/0.051		$\frac{1}{2}+$	-0.73695		
<sup>124</sup> Te	4.74(14)	123.902818				0+			



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<sup>125m</sup> Te			58. d	I.T./0.145		11/2-	-0.99	-0.06	Te k x-ray 0.0355
<sup>125</sup> Te	7.07(15)	124.904431				½+	-0.8885		
<sup>126</sup> Te	18.84(25)	125.903312				0+			
<sup>127m</sup> Te			109. d	I.T./98/0.088		11/2-	-1.04		Te k x-ray 0.0883
				$\beta^-$ /2/0.77					
<sup>127</sup> Te		126.905226	9.4 h	$\beta^-$ /0.698	0.696/	3/2+	0.64		0.3603
<sup>128</sup> Te	31.74(8)	127.904463	$2.2 \times 10^{24}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>129m</sup> Te			33.6 d	I.T./63/0.105		11/2-	-1.09		Te k x-ray 0.45984 0.6959
				$\beta^-$ /37/	1.60/				
<sup>129</sup> Te		128.906598	1.16 h	$\beta^-$ /1.498	0.99/9 1.45/89	3/2+	0.70	0.06	0.0278 0.45984 0.48728
<sup>130</sup> Te	34.08(62)	129.906224	$8 \times 10^{20}$ y	$\beta^-$ - $\beta^-$		0+			
<sup>131m</sup> Te			1.35 d	$\beta^-$ /78/2.4	0.42/	11/2-	-1.04		0.0811 0.1021 0.14973 0.77369 0.79375 0.85225
				I.T./22/0.18					
<sup>131</sup> Te		130.908524	25.0 m	$\beta^-$ /2.233	1.35/12 1.69/22 2.14/60	3/2+	0.70		0.14973 0.45327 0.49269
<sup>132</sup> Te		131.90855	3.26 d	$\beta^-$ /0.51	0.215	0+			0.049725 0.11198 0.22830
<sup>133m</sup> Te			55.4 m	$\beta^-$ /82/	2.4/30	11/2-			Te k x-ray 0.0949 0.1689 0.3121 0.3341
				I.T./18/0.334					
<sup>133</sup> Te		132.91096	12.4 m	$\beta^-$ /2.94	2.25/25 2.65	3/2+			0.3121 0.4079 1.3334
<sup>134</sup> Te		133.91137	42. m	$\beta^-$ /1.51	0.6/	0+			0.7672/29 0.0794-0.9255
					0.7/				
<sup>135</sup> Te		134.9165	19.0 s	$\beta^-$ /6.0	5.4/				0.267 0.603 0.870
					6.0				
<sup>136</sup> Te		135.92010	17.5 s	$\beta^-$ /5.1	2.5/	0+			2.0779/25 0.0873-3.235
<sup>137</sup> Te		136.9253	2.5 s	$\beta^-$ /98 /6.9	6.8	7/2-			0.2436
				n/2 /					
<sup>138</sup> Te		137.9292	1.4 s	$\beta^-$ /6.4		0+			
<sup>139</sup> Te		138.9347	> 0.15 $\mu$ s						
<sup>140</sup> Te		139.9389	> 0.15 $\mu$ s			0+			
<sup>141</sup> Te		140.9447	> 0.15 $\mu$ s						
<sup>142</sup> Te		141.949	> 0.15 $\mu$ s			0+			
<b><sup>53</sup>I</b>		<b>126.90447(3)</b>							
<sup>108</sup> I		107.9435	0.04 s	$\alpha$ /91/4.	3.95				
<sup>109</sup> I		108.9382	0.11 ms	p					0.593/100 0.717/63 0.496-1.057
<sup>110</sup> I		109.9352	0.65 s	$\beta^+$ , EC/83/11.4					ann.rad./
				$\alpha$ /17/~ 3.6	3.457(10)/				
				p/11/					
<sup>111</sup> I		110.9303	2.5 s	$\beta^+$ , E.C./8.5					ann.rad./



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									0.7228/10.3
									1.6910/11.2
									(0.31-1.73)
<sup>125</sup> I		124.904630	59.4 d	EC/0.1861		5/2+	2.82	-0.89	Te k x-ray
									0.0355
<sup>126</sup> I		125.905624	13.0 d	EC/		2-	1.44		ann.rad./
				$\beta^+$ /2.155	1.13/				Te k x-ray
				$\beta^-$ /1.258/47	0.87/				0.3887
					1.25/				0.6622
<sup>127</sup> I	100.	126.904473				5/2+	+2.8133	-0.79	
<sup>128</sup> I		127.905809	25.00 m	$\beta^-$ /2.118	2.13/	1+			Te k x-ray
				EC/1.251					0.44287
									0.52658
<sup>129</sup> I		128.904988	$1.7 \times 10^7$ y	$\beta^-$ /0.194	0.15/	7/2+	+2.621	-0.55	Xe k x-ray
									0.0396
<sup>130m</sup> I			9.0 m	I.T./83/0.048		2+			I k x-ray
				$\beta^-$ /17/					0.5361
<sup>130</sup> I		129.906674	12.36 h	$\beta^-$ /2.949	1.04/	5+	3.35		0.4180
					0.62				0.5361
									0.6685
									0.7395
<sup>131</sup> I		130.906125	8.021 d	$\beta^-$ /0.971	0.606/	7/2+	+2.742	-0.40	0.08017
									0.28431
									0.36446
									0.63699
<sup>132m</sup> I			1.39 h	IT		8-			
<sup>132</sup> I		131.90800	2.28 h	$\beta^-$ /14/3.58	0.80/	4+	3.09	0.09	I k x-ray
				I.T./86/	1.03/				0.0980
					1.2/				0.5059
					1.6/				0.52264
					2.16/				0.63019
									0.6506
									0.66768
									0.77260
									0.95457
<sup>133m</sup> I			9. s	I.T./1.63		19/2-			I Kx-ray
									0.0730
									0.6474
									0.9126
<sup>133</sup> I		132.907797	20.8 h	$\beta^-$ /1.77	1.24/85	7/2+	+2.86	-0.27	0.51056
									0.52989
									0.87537
<sup>134m</sup> I			3.7 m	I.T./98/0.316		8-			I k x-ray
				$\beta^-$ /2/					0.0444
									0.2719
<sup>134</sup> I		133.90974	52.6 m	$\beta^-$ /4.05	1.2/	4+			0.1354
									0.84702
									0.88409
<sup>135</sup> I		134.91005	6.57 h	$\beta^-$ /2.63	0.9/	7/2+	2.94		0.2884
					1.3/				0.41768
									0.52658
									1.13156
									1.26046
<sup>136m</sup> I			47. s	$\beta^-$ /	4.7/	6-			0.1973
					5.2/				0.3468
									0.3701
									0.3814
									1.3130
									(0.16-2.36)
<sup>136</sup> I		135.91465	1.39 m	$\beta^-$ /6.93	4.3/	2-			0.3447



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<sup>119</sup> Xe		118.91541	5.8 m	$\beta^+$ , EC/5.0	3.5/	7/2+	-0.654	+1.31	0.1199 0.0873
									0.1000 0.2318 0.4615
<sup>120</sup> Xe		119.91178	40. m	$\beta^+$ , EC/97/1.96 $\beta^+$ /3/		0+			1 k x-ray 0.0251 0.0726 0.1781 (0.1-1.03)
<sup>121</sup> Xe		120.91146	39. m	$\beta^+$ /44/3.73 EC/56/	2.8/	5/2+	-0.701	+1.33	ann.rad./ 1 k x-ray 0.1328 0.2527 0.4452 (0.1-3.1)
<sup>122</sup> Xe		121.90837	20.1 h	EC/0.9		0+			1 k x-ray 0.3501
<sup>123</sup> Xe		122.90848	2.00 h	$\beta^+$ /23/2.68 EC/77/	1.51/	$\frac{1}{2}+$	-0.150		ann.rad./ 1 k x-ray 0.1489 0.1781 (0.1-2.1)
<sup>124</sup> Xe	0.0952(3)	123.905893	> 10 <sup>17</sup> y	$\beta$ - $\beta$ -		0+			
<sup>125m</sup> Xe			57. s	I.T./0.252		(9/2-)	-0.745	+0.42	Xe k x-ray 0.1111 0.141
<sup>125</sup> Xe		124.906395	17.1 h	EC/1.653	0.47/	$\frac{1}{2}+$	-0.269		1 k x-ray 0.1884 0.2434
<sup>126</sup> Xe	0.0890(2)	125.90427				0+			
<sup>127m</sup> Xe			1.15 m	I.T./0.297		(9/2-)	-0.884	+0.69	Xe k x-ray 0.1246 0.1725
<sup>127</sup> Xe		126.905184	36.34 d	EC/0.662		$\frac{1}{2}+$	-0.504		1 k x-ray 0.1721 0.2029 0.3750
<sup>128</sup> Xe	1.9102(8)	127.903531				0+			
<sup>129m</sup> Xe			8.89 d	I.T./0.236		11/2-	-0.891	+0.64	Xe k x-ray 0.0396 0.1966
<sup>129</sup> Xe	26.4006(82)	128.904779				$\frac{1}{2}+$	-0.7780		
<sup>130</sup> Xe	4.0710(13)	129.903508				0+			
<sup>131m</sup> Xe			11.9 d	I.T./0.164		11/2-	-0.9940	+0.73	Xe k x-ray 0.16398
<sup>131</sup> Xe	21.2324(30)	130.905082				3/2+	+0.69186	-0.12	
<sup>132</sup> Xe	26.9086(33)	131.904153				0+			
<sup>133m</sup> Xe			2.19 d	I.T./0.233		11/2-	-1.082	+0.77	Xe k x-ray 0.23325
<sup>133</sup> Xe		132.905911	5.243 d	$\beta^-$ /0.427	0.346/99	3/2+	+0.813	+0.14	Cs k x-ray 0.080998 0.1606
<sup>134</sup> Xe	10.4357(21)	133.905394	> 1.1 $\times$ 10 <sup>16</sup> y	$\beta$ - $\beta$ -		0+			
<sup>135m</sup> Xe			15.3 m	I.T./		11/2-	1.103	+0.62	Xe k x-ray 0.52658
<sup>135</sup> Xe		134.907227	9.10 h	$\beta^-$ /1.15	0.91/	3/2+	0.903	+0.21	0.24975 0.60807
<sup>136</sup> Xe	8.8573(44)	135.90722	> 2.4 $\times$ 10 <sup>21</sup> y	$\beta$ - $\beta$ -		0+			
<sup>137</sup> Xe		136.91156	3.82 m	$\beta^-$ /4.17	4.1/	7/2-	-0.970	-0.49	0.45549



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									0.5865
									0.5906
<sup>119m</sup> Cs			29. s			3/2	+0.84	+0.9	
<sup>119</sup> Cs		118.92238	43. s	$\beta^+$ , EC/6.3		9/2+	+5.5	+2.8	ann.rad./
									0.169
									0.176
									0.224
									0.257
<sup>120m</sup> Cs			60. s	$\beta^+$ , EC/					
<sup>120</sup> Cs		119.92068	64. s	$\beta^+$ , EC/7.92		2+	+3.87	+1.45	ann.rad./
									0.3224
									0.4735
									0.5534
									(0.3-3.28)
<sup>121m</sup> Cs			2.0 m	I.T./60/ $\beta^+$ /40/	4.4	(9/2+)	+5.41	+2.7	ann.rad./
									0.1794
									0.1961
<sup>121</sup> Cs		120.91723	2.3 m	$\beta^+$ , EC/5.40	4.38/	3/2+	+0.77	+0.84	ann.rad./
									0.1537
									(0.08-0.56)
<sup>122m2</sup> Cs			4.4 m	$\beta^+$ , EC		8-	+4.77	+3.3	ann.rad./
<sup>122m1</sup> Cs			0.36 s	IT					0.3311
									0.4971
									0.6385
									(0.27-2.22)
<sup>122</sup> Cs		121.91611	21. s	$\beta^+$ , EC/7.1	5.8/	(1+)	-0.133	-0.19	ann.rad./
									0.3311
									0.5120
									0.8179
<sup>123m</sup> Cs			1.6 s	I.T./		11/2-			Cs k x-ray
									0.0946
<sup>123</sup> Cs		122.91300	5.87 m	$\beta^+$ /75/4.20 EC/25/	3.0/	1/2+	+1.38		ann.rad./
									Xe k x-ray
									0.0974
									0.5964
<sup>124m</sup> Cs			6.3 s	IT		7+			
<sup>124</sup> Cs		123.91226	30. s	$\beta^+$ /9 /5.92 EC/8 /	~ 5.	1+	+0.673	-0.74	ann.rad./
									Xe k x-ray
									0.3539
									0.4925
									0.9418
<sup>125</sup> Cs		124.90973	45. m	$\beta^+$ /40/3.09 EC/60/	2.06/	1/2+	+1.41		ann.rad./
									Xe k x-ray
									0.112
									0.526
<sup>126</sup> Cs		125.90945	1.64 m.	$\beta^+$ /81/4.83 EC/19/	3.4 3.7/	1+	+0.78	-0.68	ann.rad./
									Xe k x-ray
									0.3886
									0.4912
									0.9252
<sup>127</sup> Cs		126.90742	6.2 h	$\beta^+$ /96/2.08 EC/4/	0.65/ 1.06	1/2+	+1.46		Xe k x-ray
									0.1247
									0.4119
<sup>128</sup> Cs		127.90775	3.62 m	$\beta^+$ /68/3.930 EC/32 /	2.44/ 2.88/	1+	+0.97	-0.57	ann.rad./
									Xe k x-ray
									0.4429
<sup>129</sup> Cs		128.90606	1.336 d	EC/1.195		1/2+	+1.49		Xe k x-ray
									0.3719
									0.4115
<sup>130m</sup> Cs			3.5 m	IT, $\beta^+$ , EC		5-	+0.629	+1.45	

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<sup>130</sup> Cs		129.90671	29.21 m	$\beta^+$ /55/2.98 EC/43/	1.98/ 0.44/1.6	1+	+1.46	-0.06	ann.rad./ Xe k x-ray 0.5361
<sup>131</sup> Cs		130.90546	9.69 d	EC/0.352		5/2+	+3.54	-0.58	Xe k x-ray
<sup>132</sup> Cs		131.906434	6.48 d	EC/98/ $\beta^+$ /0.3/2.120 $\beta^-$ / /1.280		2-	+2.22	+0.51	Xe k x-ray 0.4646 0.6302 0.66769
<sup>133</sup> Cs	100.	132.90545193				7/2+	+2.582	-0.00355	
<sup>134m</sup> Cs			2.91 h	I.T./0.139		8-	+1.098	+1.0	Cs k x-ray 0.12749
<sup>134</sup> Cs		133.90671848	2.065 y	$\beta^-$ /2.059 EC/1.22	0.089/27 0.658/70	4+	+2.994	+0.39	0.56327 0.56935 0.60473 0.79584
<sup>135m</sup> Cs			53. m	I.T./1.627		19/2-	+2.18	+0.9	0.7869 0.8402
<sup>135</sup> Cs		134.905977	$2.3 \times 10^6$ y	$\beta^-$ /0.269	0.205/100	7/2+	+2.732	+0.05	
<sup>136m</sup> Cs			19. s	I.T./		8-	+1.32	+0.7	
<sup>136</sup> Cs		135.907312	13.16 d	$\beta^-$ /2.548	0.341/	5+	+3.71	+0.2	0.06691 0.34057 0.81850 1.04807
<sup>137</sup> Cs		136.907089	30.2 y	$\beta^-$ /1.176	0.514/95	7/2+	+2.84	+0.05	Ba k x-ray 0.66164
<sup>138m</sup> Cs			2.9 m	I.T./75 $\beta^-$ /25 /	/0.080 3.3	6-	+1.71	-0.40	Cs k x-ray 0.0799 0.1917 0.4628 1.43579
<sup>138</sup> Cs		137.91102	32.2 m	$\beta^-$ /5.37	2.9/	3-	+0.700	+0.12	0.1381 0.46269 1.00969 1.43579 2.21788
<sup>139</sup> Cs		138.913364	9.3 m	$\beta^-$ /4.213	4.21	7/2+	+2.70	-0.07	0.6272 1.2832 (0.4–3.66)
<sup>140</sup> Cs		139.91728	1.06 m	$\beta^-$ /6.22	5.7/ 6.21/	1-	+0.13390	-0.11	0.5283 0.6023 0.9084 (0.41–3.94)
<sup>141</sup> Cs		140.92005	24.9 s	$\beta^-$ /5.26	5.20/	7/2+	+2.44	-0.4	Ba k x-ray 0.0485 0.5616 0.5887 1.1940 (0.05–3.33)
<sup>142</sup> Cs		141.92430	1.8 s	$\beta^-$ /7.31	6.9/ 7.28				0.3596 0.9668 1.1759 1.3265
<sup>143</sup> Cs		142.92735	1.78 s	$\beta^-$ /6.24	6.1	(3/2+)	+0.87	+0.47	0.1955 0.2324 0.3064 (0.17–1.98)
<sup>144</sup> Cs		143.93208	1.01 s	$\beta^-$ /8.47	8.46/ 7.9/	1	-0.546	+0.30	0.1993 0.5598 0.6392 0.7587



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<sup>145</sup> Cs		144.93553	0.59 s	$\beta^-$ /7.89	7.4/ 7.9/	3/2+	+0.784	+0.6	0.1126 0.1755 0.1990
<sup>146</sup> Cs		145.9403	0.322 s	$\beta^-$ , (n)/9.38	~ 9.0	2-	-0.515	+0.22	
<sup>147</sup> Cs		146.9442	0.227 s	$\beta^-$ , (n)/9.3					(0.024-2.2798)
<sup>148</sup> Cs		147.9492	0.15 s	$\beta^-$ , (n)/10.5					
<sup>149</sup> Cs		148.9529	> 50 ms						
<sup>150</sup> Cs		149.9582	> 50 ms						
<sup>151</sup> Cs		150.9622	> 50 ms						
<b><sup>56</sup>Ba</b>		<b>137.327(7)</b>							
<sup>114</sup> Ba		113.9507	0.43 s	$\beta^+$ , (p) $\alpha$	p/20 /0.9	0+			
<sup>115</sup> Ba		114.947	0.45 s	$\beta^+$ , (p)	p/<15				
<sup>116</sup> Ba		115.9414	1.3 s	$\beta^+$ , (p)	p/3	0+			
<sup>117</sup> Ba		116.9385	1.8 s	$\beta^+$ , (p), EC/8.4	p/16	(3/2-)			(0.0457-0.364)
<sup>118</sup> Ba		117.9330	5.2 s	$\beta^+$ ,		0+			(0.040-0.156)
<sup>119</sup> Ba		118.9307	5.4 s	$\beta^+$ , EC/8.					
<sup>120</sup> Ba		119.9260	24. s	$\beta^+$ , EC/5.0		0+			ann.rad./ 0.140 (0.075-0.146)
<sup>121</sup> Ba		120.9241	30. s	$\beta^+$ , EC/6.8		5/2+	+0.660	+1.8	ann.rad./
<sup>122</sup> Ba		121.91990	2.0 m	$\beta^+$ , EC/3.8		0+			ann.rad./
<sup>123</sup> Ba		122.91878	2.7 m	$\beta^+$ , EC/5.5			-0.68	+1.5	ann.rad./ 0.0306 0.0927 0.1161 0.1235
<sup>124</sup> Ba		123.91509	12. m	$\beta^+$ , EC/2.65		0+			ann.rad./ 0.1695 0.1888 1.2160
<sup>125m</sup> Ba			8. m	$\beta^+$ , EC/	4.5		0.174		
<sup>125</sup> Ba		124.9145	3.5 m	$\beta^+$ , EC/4.6	3.4	1/2+	+0.18		ann.rad./ 0.0550 0.0776 0.0854 0.1409
<sup>126</sup> Ba		125.91125	1.65 h	$\beta^+$ /2/1.67 EC/98 /		0+			Cs k x-ray 0.2179 0.2336 0.2576
<sup>127m</sup> Ba			1.9 s	IT		7/2-	-0.723	1.6	
<sup>127</sup> Ba		126.91109	12.9 m	$\beta^+$ /54/3.5 EC/46/		1/2+	+0.083		ann.rad./ Cs k x-ray 0.1148 0.1808 (0.07-2.5)
<sup>128</sup> Ba		127.90832	2.43 d	EC/0.52		0+			Cs k x-ray 0.27344
<sup>129m</sup> Ba			2.17 h	EC/98/ $\beta^+$ /2/		7/2+	+0.93	+1.6	Cs k x-ray 0.1769 0.1823 0.2023 1.4593
<sup>129</sup> Ba		128.90868	2.2 h	$\beta^+$ /20/2.43 EC/80/	1.42/	1/2+	-0.40		ann.rad./ Cs k x-ray 0.1291 0.2143

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<sup>130m</sup> Ba			9.5 ms	I.T./2.475	/100.	8-	-0.04	+2.8	0.2208 0.080-0.802
<sup>130</sup> Ba	0.106(1)	129.906321	$2.2 \times 10^{21}$ y	$\beta+\beta+$		0+			
<sup>131m</sup> Ba			14.6 m	I.T./0.187		9/2-	-0.87	+1.5	Ba k x-ray 0.1085
<sup>131</sup> Ba		130.906941	11.7 d	EC/1.37		1/2+	0.7081		Cs k x-ray 0.12381/28.4 0.21608/21.3 0.49636/42.9 (0.0549-1.171)
<sup>132</sup> Ba	0.101(1)	131.905061	$1.3 \times 10^{21}$ y	EC EC		0+			
<sup>133m</sup> Ba			1.621 d	I.T./0.288		11/2-	-0.91	+0.9	Ba k x-ray 0.2761
<sup>133</sup> Ba		132.906008	10.53 y	EC/0.517		1/2+	0.7717		Cs k x-ray 0.08099 0.35600
<sup>134</sup> Ba	2.417(18)	133.904508				0+			
<sup>135m</sup> Ba			1.20 d	I.T./0.2682		11/2-	-1.00	+1.0	Ba k x-ray 0.2682
<sup>135</sup> Ba	6.592(12)	134.9056886				3/2+	+0.838	+0.16	
<sup>136m</sup> Ba			0.308 s	I.T./2.0305		7-			Ba k x-ray 0.8185 1.0481
<sup>136</sup> Ba	7.854(24)	135.9045759				0+			
<sup>137m</sup> Ba			2.552 m	I.T./0.6617		11/2-	-0.99	+0.8	Ba k x-ray 0.66164
<sup>137</sup> Ba	11.232(24)	136.9058274				3/2+	+0.9374	+0.245	
<sup>138</sup> Ba	71.698(42)	137.9052472				0+			
<sup>139</sup> Ba		138.9088412	1.396 h	$\beta^-$ /2.317	2.14/27 2.27/72	7/2-	-0.97	-0.57	0.16585 1.2544 1.42033
<sup>140</sup> Ba		139.91060	12.75 d	$\beta^-$ /1.05	0.48 1.0/ 1.02/	0+			0.16268 0.30485 0.53727
<sup>141</sup> Ba		140.91441	18.3 m	$\beta^-$ /3.22	2.59/ 2.73/	3/2-	-0.34	+0.45	0.1903 0.2770 0.3042 (0.1-2.5)
<sup>142</sup> Ba		141.91645	10.7 m	$\beta^-$ /2.212	1.0/ 1.10/	0+			0.23152 0.25512 0.3090 1.2040
<sup>143</sup> Ba		142.92063	14.3 s	$\beta^-$ /4.24	4.2/	5/2+	+0.44	-0.88	0.1786 0.21148 0.7988 (0.17-2.4)
<sup>144</sup> Ba		143.92295	11.4 s	$\beta^-$ /3.1	2.4/ 2.9/	0+			La k x-ray 0.10386 0.1566 0.1728 0.3882 0.43048
<sup>145</sup> Ba		144.9276	4.0 s	$\beta^-$ /4.9	4.9/	(5/2-)	-0.28	+1.22	La k x-ray 0.0918 0.09709
<sup>146</sup> Ba		145.9302	2.20 s	$\beta^-$ /4.12	3.9/	0+			0.0644 0.2513 0.3270 0.3329 0.3622

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<sup>147</sup> Ba		146.9349	0.892 s	$\beta^-$ /5.75	5.5/				
<sup>148</sup> Ba		147.9377	0.64 s	$\beta^-$ , n/5.11		0+			
<sup>149</sup> Ba		148.9426	0.36 s	$\beta^-$ , (n)/7.3					
<sup>150</sup> Ba		149.9457	0.3 s			0+			
<sup>151</sup> Ba		150.9508	> 0.15 $\mu$ s						
<sup>152</sup> Ba		151.9543				0+			
<sup>153</sup> Ba		151.960							
<b><sub>57</sub>La</b>		<b>138.90547(7)</b>							
<sup>117</sup> La		116.9501	23 ms	p	0.806/	3/2+			
<sup>118</sup> La		117.9467							
<sup>119</sup> La		118.9410							
<sup>120</sup> La		119.9381	2.8 s	EC, $\beta^+$ /11.					
<sup>121</sup> La		120.9330	5.3 s						
<sup>122</sup> La		121.9307	9. s	EC, $\beta^+$ /~ 9.7					
<sup>123</sup> La		122.9262	17. s	EC/7.					
<sup>124</sup> La		123.9246	30. s	EC/ ~ 8.8		(7+)			
<sup>125m</sup> La			0.39 s						
<sup>125</sup> La		124.92082	1.2 m	$\beta^+$ , EC/5.6		11/2-			ann.rad./ 0.0436 0.0676
<sup>126m</sup> La			< 50. s						
<sup>126</sup> La		125.9195	54. s	$\beta^+$ , EC/7.6					ann.rad./ 0.256 0.455 0.117-3.853
<sup>127</sup> La		126.91638	3.8 m	$\beta^+$ , EC/4.7		3/2+			ann.rad./ 0.025 0.0562
<sup>128</sup> La		127.9156	5.0 m	$\beta^+$ /80/6.7 EC/20/		(5-)			ann.rad./ Ba k x-ray 0.2841/87 0.4793/54 (0.315-2.212)
<sup>129m</sup> La			0.56 s	IT		(11/2-)			
<sup>129</sup> La		128.91269	11.6 m	$\beta^+$ /58/3.72 EC/42/	2.42/	3/2+			ann.rad./ Ba k x-ray 0.1105 0.2786 (0.1-1.8)
<sup>130</sup> La		129.91237	8.7 m	$\beta^+$ /78/5.6 EC/22/		3+			ann.rad./ Ba k x-ray 0.3573/81 0.5506/27 (0.1965-1.989)
<sup>131</sup> La		130.91007	59. m	$\beta^+$ /76/3.0 EC/24/	1.42/ 1.94/	3/2+			ann.rad./ Ba k x-ray 0.1085 0.3658 0.5263
<sup>132m</sup> La			24. m	IT./76/ $\beta^+$ , EC/24/		6-			La k x-ray 0.1352 0.4645
<sup>132</sup> La		131.91010	4.8 h	$\beta^+$ /40/4.71 EC/60/	2.6/ 3.2 3.7/	2-			ann.rad./ Ba k x-ray 0.4645 0.5671
<sup>133</sup> La		132.90822	3.91 h	$\beta^+$ /4/2.2 EC/96/	1.2/	5/2+			Ba k x-ray 0.2788

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									0.2901
									0.3024
<sup>134</sup> La		133.90851	6.5 m	$\beta^+$ /63/3.71 EC/37/	2.67/	1+			ann.rad./ Ba k x-ray
									0.6047 (0.5–1.9)
<sup>135</sup> La		134.90698	19.5 h	EC/1.20		5/2+			Ba k x-ray 0.4805
<sup>136</sup> La		135.9076	9.87 m	$\beta^+$ /36/2.9 EC/64/	1.8/	1+			ann.rad./ Ba k x-ray
									0.8185
<sup>137</sup> La		136.90649	$6 \times 10^4$ y	EC/0.60		7/2+	+2.70	+0.2	0.2836
<sup>138</sup> La	0.0888(6)	137.907112	$1.06 \times 10^{11}$ y			5+	+3.7136	+0.4	1.4358/65 0.7887/35
<sup>139</sup> La	99.9112(6)	138.906353				7/2+	+2.7830	+0.20	
<sup>140</sup> La		139.909478	1.678 d	$\beta^-$ /3.762	1.35	3-	+0.73	+0.09	
					1.24/ 1.67/				
<sup>141</sup> La		140.910962	3.90 h	$\beta^-$ /2.502	2.43/	7/2+			
<sup>142</sup> La		141.91408	1.54 h	$\beta^-$ /4.505	2.11/	2-			
					2.98/ 4.52/				
<sup>143</sup> La		142.91606	14.1 m	$\beta^-$ /3.43	3.3/	7/2-			
<sup>144</sup> La		143.91960	40.7 s	$\beta^-$ /5.5	4.1/				
<sup>145</sup> La		144.9216	24. s	$\beta^-$ /4.1	4.1/	3/2+			
<sup>146m</sup> La			10.0 s	$\beta^-$ /6.7	5.5/	(6)			
<sup>146</sup> La		145.9258	6.3 s	$\beta^-$ /6.6	6.2/	(2-)			
<sup>147</sup> La		146.9282	4.02 s	$\beta^-$ /5.0	4.6/				
<sup>148</sup> La		147.9322	1.1 s	$\beta^-$ /7.26		2-			
<sup>149</sup> La		148.9347	1.10 s	$\beta^-$ /5.5					0.1335 0.009–1.709 x-ray (0.097–0.209)
<sup>150</sup> La		149.9388	0.51 s						
<sup>151</sup> La		150.9417	> 0.15 $\mu$ s						
<sup>152</sup> La		151.9462	> 0.15 $\mu$ s						
<sup>153</sup> La		152.950	> 0.15 $\mu$ s						
<sup>154</sup> La		153.955							
<sup>155</sup> La		154.958							
<b><sub>58</sub>Ce</b>		<b>140.116(1)</b>							
<sup>119</sup> Ce		118.953							
<sup>120</sup> Ce		119.947				0+			
<sup>121</sup> Ce		120.943	1.1 s	$\beta^+$ , p					
<sup>122</sup> Ce		121.9379				0+			
<sup>123</sup> Ce		122.9354	3.8 s	$\beta^+$ , EC/~ 8.6					ann.rad./
<sup>124</sup> Ce		123.9304	6. s	EC/~ 5.6		0+			
<sup>125</sup> Ce		124.9284	9.6 s	$\beta^+$ , EC/7.		7/2-			ann.rad./ 0.1346 0.1666 0.056–1.329
<sup>126</sup> Ce		125.92397	50. s	EC/4.		0+			
<sup>127</sup> Ce		126.9227	29. s	$\beta^+$ , EC/6.1					ann.rad./ (0.058–1.961)
<sup>128</sup> Ce		127.91891	4.1 m	$\beta^+$ , EC/3.2		0+			ann.rad./ (0.023–0.880)
<sup>129</sup> Ce		128.91810	3.5 m	$\beta^+$ , EC/5.6					ann.rad./ (0.0675–1.015)
<sup>130</sup> Ce		129.91474	26. m	$\beta^+$ , EC/2.2		0+			ann.rad./ La k x-ray

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<sup>131m</sup> Ce			5. m	$\beta^+$ EC					0.047–1.431 ann.rad./
									0.2304
									0.3955
									0.4213
<sup>131</sup> Ce		130.91442	10. m	$\beta^+$ , EC/4.0	2.8/				ann.rad.
									0.119
									0.169
									0.414
<sup>132m</sup> Ce			9.4 ms	IT/2.340					0.3255
									0.10–0.955
<sup>132</sup> Ce		131.91146	3.5 h	EC/1.3		0+			La k x-ray
									0.1554
									0.1821
<sup>133m</sup> Ce			1.6 h	$\beta^+$ , EC/		$\frac{1}{2}^+$			ann.rad.
									0.0769
									0.0973
									0.5577
<sup>133</sup> Ce		132.91152	5.4 h	$\beta^+$ /8/2.9 EC/92/	1.3/	9/2-			ann.rad.
									0.0584
									0.1308
									0.4722
									0.5104
<sup>134</sup> Ce		133.90892	3.16 d	EC/0.5		0+			La k x-ray
									0.1304
									0.1623
									0.6047
<sup>135m</sup> Ce			20. s	IT./0.446		11/2-			Ce k x-ray
									0.0826
									0.1497
									0.2134
<sup>135</sup> Ce		134.90915	17.7 h	$\beta^+$ /1 /2.026 EC/99 /	0.8/	1/2+			La k x-ray
									0.0345
									0.2656
									0.3001
									0.6068
<sup>136</sup> Ce	0.185(2)	135.90717	$> 0.7 \times 10^{14}$ y	EC EC		0+			
<sup>137m</sup> Ce			1.43 d	IT./99 /0.254 EC/0.8 /		11/2-	1.0		Ce k x-ray
									0.1693
									0.2543
<sup>137</sup> Ce		136.90781	9.0 h	$\beta^+$ /1.222		3/2+	0.96		La k x-ray
									0.4472
<sup>138</sup> Ce	0.251(2)	137.90599	$> 0.9 \times 10^{14}$ y	EC EC		0+			
<sup>139m</sup> Ce			56.4 s	IT./0.7542		11/2-			Ce k x-ray
									0.7542
<sup>139</sup> Ce		138.90665	137.6 d	EC/0.28		3/2+	1.06		La k x-ray
<sup>140</sup> Ce	88.450(51)	139.905439				0+			0.16585
<sup>141</sup> Ce		140.908276	32.50 d	$\beta^-$ /0.581	0.436/69 0.581/31	7/2-	1.1		Pr k x-ray
									0.14544/48.0
<sup>142</sup> Ce	11.114(51)	141.909244	$> 1.6 \times 10^{17}$ y	$\beta^-$ $\beta^-$		0+			
<sup>143</sup> Ce		142.912386	1.38 d	$\beta^-$ /1.462	1.404/ 1.110/47	3/2-	0.43		Pr k x-ray
									0.0574
									0.2933
<sup>144</sup> Ce		143.913647	284.6 d	$\beta^-$ /0.319	0.185/20 0.318/	0+			Pr k x-ray
									0.0801
									0.1335
<sup>145</sup> Ce		144.91723	3.00 m	$\beta^-$ /2.54	1.7/24 1.3	3/2-			Pr k x-ray
									0.0627
									0.7245
<sup>146</sup> Ce		145.9188	13.5 m	$\beta^-$ /1.04	0.7/90	0+			Pr k x-ray



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									0.495
									0.632
<sup>134</sup> Pr		133.91571	17. m	$\beta^+$ , EC/6.2		2+			ann.rad./
									0.294
									0.495
<sup>135</sup> Pr		134.91311	24. m	$\beta^+$ , EC/3.7	2.5/	3/2+			ann.rad./
									0.0826
									0.2135
									0.2961
									0.5832
<sup>136</sup> Pr		135.91269	13.1 m	$\beta^+$ /57 /5.13 EC/43	2.98/	2+			ann.rad./
									Ce k x-ray
									0.5398
									0.5522
<sup>137</sup> Pr		136.91071	1.28 h	$\beta^+$ /26 /2.70 EC/74 /	1.68/	5/2+			ann.rad./
									Ce k x-ray
									0.4339
									0.5140
									0.8367
									(0.16–1.8)
<sup>138m</sup> Pr			2.1 h	$\beta^+$ /24 / EC/76 /	1.65/	7-			ann.rad./
									Ce k x-ray
									0.3027
									0.7887
									1.0378
									(0.07–2.0)
<sup>138</sup> Pr		137.91075	1.45 m	$\beta^+$ /75 /4.44 EC/25 /	3.42/	1+			ann.rad./
									Ce k x-ray
									0.7887
<sup>139</sup> Pr		138.90894	4.41 h	$\beta^+$ /8 /2.129 EC/92 /	1.09/	5/2+			ann.rad./
									Ce k x-ray
									0.2551
									1.3473
									1.6307
<sup>140</sup> Pr		139.90908	3.39 m	$\beta^+$ /51 /3.39 EC/49 /	2.37/	1+			ann.rad./
									Ce k x-ray
									0.3069
									1.5965
<sup>141</sup> Pr	100.	140.907653				5/2+	+4.275	-0.08	
<sup>142m</sup> Pr			14.6 m	I.T./0.004	c.e.	5-	2.2		
<sup>142</sup> Pr		141.910045	19.12 h	$\beta^-$ /2.162 EC/0.744	0.58/4 2.16/96	2-	+0.234	+0.030	0.5088
									1.57580
<sup>143</sup> Pr		142.910817	13.57 d	$\beta^-$ /0.934	0.933/	7/2+	+2.70	+0.8	0.7420
<sup>144m</sup> Pr			7.2 m	IT/99+/0.059 $\beta^-$ /		3-			Pr k x-ray
									0.0590
									0.6965
									0.8142
<sup>144</sup> Pr		143.913305	17.28 m	$\beta^-$ /2.998	0.807/1 2.30/	0-			0.69649
									1.48912
									2.18562
<sup>145</sup> Pr		144.91451	5.98 h	$\beta^-$ /1.81	1.80/97	7/2+			0.0725
									0.6758
									0.7483
<sup>146</sup> Pr		145.9176	24.2 m	$\beta^-$ /4.2	2.2/30 3.7/10 4.2/40	2-			0.4539/48
									1.5247
<sup>147</sup> Pr		146.91900	13.4 m	$\beta^-$ /2.69	1.5/	3/2+			0.3146/24.
					2.1/				0.5779/16
									0.6413/19.
<sup>148m</sup> Pr			2.0 m	$\beta^-$ /	4.0/	(4)			0.3016





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<sup>138</sup> Nd		137.91195	5.1 h	EC/1.1		0+			Pr k x-ray 0.1995 0.3258
<sup>139m</sup> Nd			5.5 h	I.T./12 /0.231 $\beta^+$ /88 /	1.17/	11/2-			Nd k x-ray Pr k x-ray 0.1139/34. 0.7382/30.
<sup>139</sup> Nd		138.91198	30. m	$\beta^+$ /25 /2.79 EC/75 /	1.77/	3/2+	0.91	+0.3	ann.rad./ Pr k x-ray 0.4050
<sup>140</sup> Nd		139.90955	3.37 d	EC /0.22		0+			Pr k x-ray
<sup>141m</sup> Nd			1.04 m	IT/99+/0.756		11/2-			Nd k x-ray 0.7565
<sup>141</sup> Nd		140.909610	2.49 h	EC/98 /1.823 $\beta^+$ /2 /	0.802/	3/2+	1.01	+0.3	Pr k x-ray (0.15–1.7)
<sup>142</sup> Nd	27.153(39)	141.907723				0+			
<sup>143</sup> Nd	12.173(27)	142.909814				7/2-	-1.07	-0.60	
<sup>144</sup> Nd	23.798(18)	143.910087	$2.1 \times 10^{15}$ y	$\alpha$	1.83	0+			
<sup>145</sup> Nd	8.293(12)	144.912574				7/2-	-0.66	-0.31	
<sup>146</sup> Nd	17.189(33)	145.913117				0+			
<sup>147</sup> Nd		146.916100	10.98 d	$\beta^-$ /0.896	0.805/	5/2-	0.58	0.9	Pr k x-ray 0.53102 0.09111–0.686
<sup>148</sup> Nd	5.756(21)	147.916893				0+			
<sup>149</sup> Nd		148.920149	1.73 h	$\beta^-$ /1.691	1.03/25 1.13/26 1.42/	5/2-	0.35	1.3	Pr k x-ray 0.1143/19. 0.2113/27. (0.026–1.6)
<sup>150</sup> Nd	5.638(29)	149.920891	$1.4 \times 10^{20}$ y	$\beta\text{-}\beta\text{-}$		0+			
<sup>151</sup> Nd		150.923829	12.4 m	$\beta^-$ /2.442	1.2/	(3/2+)			Pm k x-ray 0.1168 0.2557 1.1806 (0.10–1.9)m
<sup>152</sup> Nd		151.92468	11.4 m	$\beta^-$ /1.1		0+			0.2785/29. 0.2501/18. (0.016–0.66)
<sup>153</sup> Nd		152.92770	28.9 s	$\beta^-$ /3.6					0.418
<sup>154</sup> Nd		153.9295	25.9 s	$\beta^-$ /2.8		0+			0.1519 0.7998
<sup>155</sup> Nd		154.9329	8.9 s	$\beta^-$ /5.0					0.1807
<sup>156</sup> Nd		155.9350	5.5 s	$\beta^-$ /4.1		0+			0.0848
<sup>157</sup> Nd		156.9390	> 0.3 $\mu$ s						
<sup>158</sup> Nd		157.9416	> 0.3 $\mu$ s			0+			
<sup>159</sup> Nd		158.946							
<sup>160</sup> Nd		159.949				0+			
<sup>161</sup> Nd		160.954							
<b><sup>61</sup>Pm</b>									
<sup>128</sup> Pm		127.9484	1.0 s	$\beta^+$ , p					ann.rad.
<sup>129</sup> Pm		128.9432	~ 2.4 s						
<sup>130</sup> Pm		129.9405	2.5 s	$\beta^+$ , EC/11.					0.1589 0.326–1.062
<sup>131</sup> Pm		130.9359	~ 6.3 s	$\beta^+$					0.185 0.220 0.146
<sup>132</sup> Pm		131.9338	6. s	$\beta^+$ , EC/10.					ann.rad./
<sup>133</sup> Pm		132.92978	12. s	$\beta^+$ , EC/~ 7.0					ann.rad./
<sup>134</sup> Pm		133.9284	24. s	$\beta^+$ , EC/~ 8.9		(5+)			ann.rad./



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<sup>150</sup> Pm		149.92098	2.68 h	$\beta^-$ /3.45	1.6/ 2.3/ 1.8/	(1-)			0.3339/69. 1.1658/16. 1.3245/17. (0.25-2.9)
<sup>151</sup> Pm		150.92121	1.183 d	$\beta^-$ /1.187	0.84/	5/2+	+1.8	1.9	0.1677/8 0.2751/7 0.3401/22
<sup>152m2</sup> Pm			15. m	$\beta^-$ , I.T./		(>6)			(0.14-1.4)
<sup>152m1</sup> Pm			7.5 m	$\beta^-$ /		(4-)			0.1218 0.2447 0.3404 1.0971 1.4375
<sup>152</sup> Pm		151.92350	4.1 m	$\beta^-$ /3.5	3.5/20 3.50/60	1+			0.1218 (0.12-2.1)
<sup>153</sup> Pm		152.92412	5.4 m	$\beta^-$ /1.90	1.7/	(5/2-)			0.0910 0.1198 0.1273
<sup>154m</sup> Pm			2.7 m	$\beta^-$ /	2.0/				0.0820 0.1848 1.4403
<sup>154</sup> Pm		153.92646	1.7 m	$\beta^-$ /4.1	1.9/				0.0820 0.8396 1.3940 2.0589 (0.08-2.8)
<sup>155</sup> Pm		154.92810	48. s	$\beta^-$ /3.2		(5/2-)			(0.05-0.78)
<sup>156</sup> Pm		155.93106	26.7 s	$\beta^-$ /5.16					
<sup>157</sup> Pm		156.9330	10.9 s	$\beta^-$ /4.6					
<sup>158</sup> Pm		157.9366	5. s	$\beta^-$ /6.3					
<sup>159</sup> Pm		158.9390	1.5 s						(0.072-0.261)
<sup>160</sup> Pm		159.9430							
<sup>161</sup> Pm		160.9459							
<sup>162</sup> Pm		161.950							
<sup>163</sup> Pm		162.954							
<b><sup>62</sup>Sm</b>		<b>150.36(2)</b>							
<sup>129</sup> Sm		128.954	~ 0.55 s	$\beta^+$ , p					
<sup>130</sup> Sm		129.9489				0+			
<sup>131</sup> Sm		130.9461	1.2 s	$\beta^+$ , EC/					ann.rad./
<sup>132</sup> Sm		131.9407	4.0 s	$\beta^+$		0+			
<sup>133</sup> Sm		132.9387	2.9 s	$\beta^+$ , EC/~ 8.4		5/2+			ann.rad./ 0.3696 0.0845
<sup>134</sup> Sm		133.9340	11. s	$\beta^+$ , EC/5.		0+			ann.rad./
<sup>135</sup> Sm		134.9325	10. s	$\beta^+$ , EC/7.		7/2+			ann.rad./
<sup>136</sup> Sm		135.92828	42. s	$\beta^+$ , EC/4.5		0+			ann.rad./
<sup>137</sup> Sm		136.92697	45. s	$\beta^+$ , EC/6.1					ann.rad./
<sup>138</sup> Sm		137.92324	3.0 m	$\beta^+$ , EC/3.9		0+			ann.rad./ 0.0536 0.0747
<sup>139m</sup> Sm			10. s	I.T./94 /0.457 $\beta^+$ /6 /	4.7	(11/2-)	1.1		Sm k x-ray 0.1118 0.1553 0.1901 0.2673
<sup>139</sup> Sm		138.92230	2.6 m	$\beta^+$ /75 /5.5 EC/25 /	4.1/	½+	-0.53		Pm k x-ray 0.3678 0.4028

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<sup>140</sup> Sm		139.91900	14.8 m	$\beta^+$ , EC/3.4	1.9/	0+			(0.27–2.4) ann.rad./ Pm k x-ray 0.1396 0.2255 (0.07–1.7)
<sup>141m</sup> Sm			22.6 m	$\beta^+$ /32 / EC/68 / I.T./0.3 /0.1758	1.6/ 2.19/	11/2-	-0.83	+1.6	ann.rad./ Pm k x-ray 0.1966 0.4318 0.7774
<sup>141</sup> Sm		140.91848	10.2 m	$\beta^+$ /52 /4.54 EC/48 /	3.2/	½+	-0.74		ann.rad./ Pm k x-ray 0.4382
<sup>142</sup> Sm		141.91520	1.208 h	$\beta^+$ /6 /2.10 EC/94 /	1.0/	0+			ann.rad./ Pm k x-ray
<sup>143m</sup> Sm			1.10 m	IT/99/0.7540		11/2-			Sm k x-ray 0.7540
<sup>143</sup> Sm		142.914628	8.83 m	$\beta^+$ /46 /3.443 EC/54 /	2.47/	3/2+	+1.01	+0.4	ann.rad./ Pm k x-ray 1.0565
<sup>144</sup> Sm	3.083(20)	143.911999				0+			
<sup>145</sup> Sm		144.913410	340. d	EC/0.617		7/2-	-1.12	-0.60	Pm k x-ray 0.0613 0.4924
<sup>146</sup> Sm		145.913041	$1.03 \times 10^8$ y	$\alpha$ /	2.50/	0+			
<sup>147</sup> Sm	15.017(75)	146.914898	$1.06 \times 10^{11}$ y	$\alpha$ /	2.23/	7/2-	-0.815	-0.26	
<sup>148</sup> Sm	11.254(51)	147.914823	$7 \times 10^{15}$ y	$\alpha$ /	1.96/	0+			
<sup>149</sup> Sm	13.830(56)	148.917185	$10^{16}$ y	$\alpha$ /		7/2-	-0.672	+0.075	
<sup>150</sup> Sm	7.351(36)	149.917276				0+			
<sup>151</sup> Sm		150.919932	90. y	$\beta^-$ /0.0768	0.076/	5/2-	-0.363	+0.7	0.02154
<sup>152</sup> Sm	26.735(48)	151.919732				0+			
<sup>153</sup> Sm		152.922097	1.929 d	$\beta^-$ /0.808	0.64/ 0.69/	3/2+	-0.0216	+1.3	Eu k x-ray 0.0697/4.7 0.10318/29 0.075–0.714
<sup>154</sup> Sm	22.730(78)	153.922209				0+			
<sup>155</sup> Sm		154.924640	22.2 m	$\beta^-$ /1.627	1.52	3/2-		1.1	Eu k x-ray 0.1043/75.
<sup>156</sup> Sm		155.92553	9.4 h	$\beta^-$ /0.72	0.43/ 0.71/	0+			0.0872 0.1657 0.2038
<sup>157</sup> Sm		156.92836	8.0 m	$\beta^-$ /2.7	2.4/	3/2-			Eu k x-ray 0.1964 0.1978 0.3942
<sup>158</sup> Sm		157.9300	5.5 m	$\beta^-$ /2.0		0+			0.1894/100. 0.3636/82.
<sup>159</sup> Sm		158.9332	11.3 s	$\beta^-$ /3.8					0.1898
<sup>160</sup> Sm		159.9351	9.6 s	$\beta^-$ /3.6		0+			0.110
<sup>161</sup> Sm		160.9388	~ 4.8 s						0.264
<sup>162</sup> Sm		161.941	2.4 s			0+			(0.036-0.741)
<sup>163</sup> Sm		162.945							
<sup>164</sup> Sm		163.948				0+			
<sup>165</sup> Sm		164.953							
<b><sup>63</sup>Eu</b>		<b>151.964(1)</b>							
<sup>130</sup> Eu		129.964	0.9 ms	p	1.027/				
<sup>131</sup> Eu		130.9578	~ 26. ms	$\beta^+$ , p	p/0.95				

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<sup>132</sup> Eu		131.9544							
<sup>133</sup> Eu		132.9492							
<sup>134</sup> Eu		133.9465	0.5 s	EC, $\beta^+$					ann.rad./
<sup>135</sup> Eu		134.9418	1.5 s	EC, $\beta^+$ /~ 8.7					ann.rad./
<sup>136m</sup> Eu			~ 3.2 s			7+			0.255
<sup>136</sup> Eu		135.9396	~ 3.9 s	EC, $\beta^+$ /10.		1+			ann.rad./
<sup>137</sup> Eu		136.9356	11. s	EC/~ 7.5		11/2-			ann.rad./
<sup>138</sup> Eu		137.93371	12. s	EC, $\beta^+$ /~ 9.2		7+	5		ann.rad./
<sup>139</sup> Eu		138.92979	18. s	EC, $\beta^+$ /6.7			6		ann.rad./
<sup>140m</sup> Eu			0.125 s	EC, $\beta^+$					ann.rad./
<sup>140</sup> Eu		139.9281	1.51 s	EC, $\beta^+$ /8.4		1-			ann.rad./
<sup>141m</sup> Eu			3.0 s	$\beta^+$ /58 / EC/9 / I.T./33 /0.0964		11/2-			ann.rad./ Eu k x-ray (0.09-1.6)
<sup>141</sup> Eu		140.92493	40. s	$\beta^+$ /81 /5.6 EC/15 /		5/2+	+3.49	+0.85	ann.rad./ Sm k x-ray 0.3845 0.3940
<sup>142m</sup> Eu			1.22 m	$\beta^+$ /83 / EC/17 /	4.8/	8-	+2.98	+1.4	ann.rad./ Sm k x-ray 0.5566 0.7680 1.0233
<sup>142</sup> Eu		141.92343	2.4 s	$\beta^-$ /94/7.4 EC/6 /	7.0/	1+	+1.54	+0.12	ann.rad./ 0.7680
<sup>143</sup> Eu		142.92030	2.62 m	$\beta^+$ /72/5.17 EC/28/	4.1/ 5.1/	5/2+	+3.67	+0.51	ann.rad./ Sm k x-ray 0.1107/7 1.5368/3. 1.9127/2.
<sup>144</sup> Eu		143.91882	10.2 s	$\beta^+$ /86 /6.33 EC/13 /	5.31/	1+	+1.89	+0.10	ann.rad./ Sm k x-ray 1.6601
<sup>145</sup> Eu		144.916265	5.93 d	$\beta^+$ /2 /2.660 EC/98 /1.71	0.79/	5/2+	+4.00	+0.29	ann.rad./ Sm k x-ray 0.6535 0.8937 1.6587
<sup>146</sup> Eu		145.91721	4.57 d	$\beta^+$ /5 /3.88 EC/95 /	1.47/	4-	+1.42	-0.18	ann.rad./ Sm k x-ray 0.6336 0.6341 0.7470 (0.27-2.64)
<sup>147</sup> Eu		146.916746	24.4 d	EC/99. /1.722 $\beta^+$ /0.4 /		5/2+	+3.72	+0.53	Sm k x-ray 0.12113/20.6 0.19725/24.0 (0.601-1.077)
<sup>148</sup> Eu		147.91809	54.5 d	EC/3.11	0.92	5-	+2.34	+0.35	Sm k x-ray 0.5503/99. 0.6299/71. (0.067-2.17)
<sup>149</sup> Eu		148.917931	93.1 d	EC/0.692		5/2+	+3.57	+0.75	Sm k x-ray 0.2770/4.1 0.3275/4.8
<sup>150</sup> Eu		149.91970	36. y	EC/2.26		5-	+2.71	+1.13	Sm k x-ray 0.3340 0.4394 0.5843 (0.25-1.8)

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<sup>150m</sup> Eu			12.8 h	$\beta^-$ /92 /	1.013/	0-			Sm k x-ray
				$\beta^+$ /0.4 /	1.24/				0.3339
				EC/8 /					0.4065
<sup>151</sup> Eu	47.81(6)	150.919850				5/2+	+3.472	+0.90	
<sup>152m2</sup> Eu			1.60 h	I.T./0.1478		8-			Eu k x-ray
									0.0898
<sup>152m1</sup> Eu			9.30 h	$\beta^-$ /72 /	1.85/	0-			Sm k x-ray
				EC/28 /	0.89/				0.12178
									0.84153
									0.96334
<sup>152</sup> Eu		151.921745	13.5 y	EC/72 /1.874	0.69/	3-	-1.941	+2.71	Sm k x-ray
				$\beta^-$ /28 /1.818	1.47/				Gd k x-ray
									0.12178
									0.34427
									1.40802
									(0.252–1.528)
<sup>153</sup> Eu	52.19(6)	152.921230				5/2+	+1.533	+2.41	
<sup>154m</sup> Eu			46.1 m	I.T./~ 0.16		8-			Eu k x-ray
									0.0682
									0.1009
<sup>154</sup> Eu		153.922979	8.59 y	$\beta^-$ /99.9/1.969	0.27/29	3-	-2.01	+2.8	Gd k x-ray
				EC/0.02/0.717	0.58/38				0.12299/40.
					0.84/17				0.72331/20.
					0.98/4				1.2745/36
					1.87/11				(0.059-1.90)
<sup>155</sup> Eu		154.922893	4.76 y	$\beta^-$ /0.252	0.15/	5/2+	+1.52	+2.4	Gd k x-ray
									0.0865/30
									0.1053/20
<sup>156</sup> Eu		155.92475	15.2 d	$\beta^-$ /2.451	0.30/11	1+	$\approx$ 1.1		0.08899/9.
					0.49/30				0.64623/7.
					1.2/12				0.723441/6.
					2.45/31				0.8118/10.
<sup>157</sup> Eu		156.92542	15.13 h	$\beta^-$ /1.36	0.98/	(5/2+)	+1.50	+2.6	Gd k x-ray
					1.30/41				0.0639/100.
									0.3705/48.
									0.4107/76.
<sup>158</sup> Eu		157.9279	45.9 m	$\beta^-$ /3.5	2.5/	(1-)	+1.44	+0.7	0.0795
									0.8976
									0.9442
									0.9771
<sup>159</sup> Eu		158.92909	18.1 m	$\beta^-$ /2.51	2.4/	(5/2+)	+1.38	+2.7	0.0678
					2.57/				0.0786
									0.0957
<sup>160</sup> Eu		159.9320	38. s	$\beta^-$ /4.1	2.7/	(0-)			0.0753
					4.1/				0.1735
									0.4131
									0.5155
									0.8217
									0.9110
									0.9246
<sup>161</sup> Eu		160.9337	27. s	$\beta^-$ /3.7					0.0719
<sup>162</sup> Eu		161.9370	11. s	$\beta^-$ /5.6					
<sup>163</sup> Eu		162.9392							
<sup>164</sup> Eu		163.943							
<sup>165</sup> Eu		164.946							
<sup>166</sup> Eu		165.950							
<sup>167</sup> Eu		166.953							
<sup>64</sup> Gd		157.25(3)							

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<sup>135</sup> Gd		134.953	1.1 s	$\beta^+$					(0.163–0.360)
<sup>136</sup> Gd		135.9473				0+			
<sup>137</sup> Gd		136.9450	7. s	EC, $\beta^+$ /~ 8.8					ann.rad./
<sup>138</sup> Gd		137.9401	~ 4.7 s	EC, $\beta^+$		0+			0.0647
<sup>139m</sup> Gd			~ 4.8 s						0.1216
<sup>139</sup> Gd		138.9382	5. s	EC, $\beta^+$ /~ 7.7					0.104–0.323
<sup>140</sup> Gd		139.93367	16. s	EC/4.8		0+			0.1748
<sup>141m</sup> Gd			25. s	EC, $\beta^+$ /		11/2-			ann.rad./
<sup>141</sup> Gd		140.93213	21. s	$\beta^+$ /7.3		1/2+			ann.rad./
<sup>142</sup> Gd		141.92812	1.17 m	EC, $\beta^+$ /4.2		0+			ann.rad./
<sup>143m</sup> Gd			1.84 m	$\beta^+$ /67 /		11/2-			ann.rad./
				EC/33 /					Eu k x-ray
				I.T./					0.1176
									0.2719
									0.5880
									0.6681
									0.7999
<sup>143</sup> Gd		142.9268	39. s	$\beta^+$ /82 /6.0		1/2+			ann.rad./
				EC/18 /					Eu k x-ray
									0.2048
									0.2588
<sup>144</sup> Gd		143.92296	4.5 m	$\beta^+$ /45 /4.3	3.3/	0+			ann.rad./
				EC/55 /					Eu k x-ray
									0.3332
<sup>145m</sup> Gd			1.44 m	I.T./95 /0.749		11/2-	-1.0		0.0273
				$\beta^+$ /4 /5.7					0.3295
									0.3866
									0.7214
<sup>145</sup> Gd		144.92171	23.4 m	$\beta^+$ /33 /5.05	2.5/	1/2+	-0.74		ann.rad./
				EC/67 /					Eu k x-ray
									1.7579
									1.8806
									(0.32–3.69)
<sup>146</sup> Gd		145.918311	48.3 d	EC/99.9 /1.03	0.35/	0+			Eu k x-ray
				$\beta^+$ /0.2					0.1147
									0.1155
									0.1546
<sup>147</sup> Gd		146.919094	1.588 d	EC/99.8 /2.188	0.93/	7/2-	1.0		Eu k x-ray
				EC/0.2 /					0.2293
									0.3699
									0.3960
									0.9289
									(0.1–1.8)
<sup>148</sup> Gd		147.918115	71. y	$\alpha$ /3.27	3.1828/	0+			
<sup>149</sup> Gd		148.919341	9.3 d	EC/1.32		7/2-	0.9		Eu k x-ray
									0.1496
									0.2985
									0.3465
<sup>150</sup> Gd		149.91866	1.8 × 10 <sup>6</sup> y	$\alpha$ /2.80	2.73/	0+			
<sup>151</sup> Gd		150.920348	124. d	EC/0.464		7/2-	0.8		Eu k x-ray
									0.1536
									0.2432
<sup>152</sup> Gd	0.20(1)	151.919791				0+			
<sup>153</sup> Gd		152.921750	240. d	EC/0.485		3/2-	0.4		Eu k x-ray
									0.09743
									0.10318
<sup>154</sup> Gd	2.18(3)	153.920867				0+			
<sup>155</sup> Gd	14.80(12)	154.922622				3/2-	-0.259	+1.30	
<sup>156</sup> Gd	20.47(9)	155.922123				0+			
<sup>157</sup> Gd	15.65(2)	156.923960				3/2-	-0.340	+1.36	





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<sup>148</sup> Tb		147.92427	1.00 h	$\beta^+$ , EC/5.69		2-	-1.75	-0.3	0.8824 ann.rad./ Gd k x-ray
									0.4888 0.7845 (0.14-3.8)
<sup>149m</sup> Tb			4.16 m	EC/88 / $\beta^+$ /12 /		11/2-			ann.rad./ Gd k x-ray
									0.1650 0.7960
<sup>149</sup> Tb		148.923246	4.13 h	$\beta^+$ /4 /3.636 $\alpha$ /16/	1.8/ 3.97/	$\frac{1}{2}+$	+1.35		Gd k x-ray
									0.1650 0.3522 0.3886 (0.1-3.2)
<sup>150m</sup> Tb			6.0 m	$\beta^+$ /17 / EC/83 /					ann.rad./ Gd k x-ray
									0.4384 0.6380 0.6504 0.8275
<sup>150</sup> Tb		149.92366	3.3 h	$\beta^+$ , EC/4.66		2-	-0.90		ann.rad./
									0.4963 0.6380 (0.3-4.29)
<sup>151m</sup> Tb			25. s	I.T./95 / $\beta^+$ , EC/7 /		11/2-			0.0229
									0.0495 0.3797 0.8305
<sup>151</sup> Tb		150.923103	17.61 h	$\beta^+$ /1 /2.565 EC/99 /	0.70/	1/2+	+0.92		Gd k x-ray
									0.1083 0.2517 0.2870 (0.1-1.8)
<sup>152m</sup> Tb			4.3 m	I.T./79 /0.5018 EC/21 /4.35		(8+)			Tb k x-ray
									Gd k x-ray
									0.2833 0.3443 0.4111
<sup>152</sup> Tb		151.92407	17.5 h	$\beta^+$ /20 /3.99 EC/80 /	2.5/ 2.8/	2-	-0.58	+0.3	ann.rad./
									Gd k x-ray
									0.3443 (0.2-2.88)
<sup>153</sup> Tb		152.923435	2.34 d	EC/1.570		5/2+	+3.44	+1.1	Gd k x-ray
									0.2119 (0.05-1.1)
<sup>154m2</sup> Tb			23.1 h	EC/98 / I.T./2 /		(7-)	0.9		Gd k x-ray
									0.1231 0.2479 0.3467 1.4199
<sup>154m1</sup> Tb			9. h	$\beta^+$ /78 / I.T./22 /		(3-)	1.7	+3.	Gd k x-ray
									0.1231 0.2479 0.5401 (0.12-2.57)
<sup>154</sup> Tb		153.92468	21.5 h	EC/99 /3.56 $\beta^+$ /1 /	1.86/ 2.45	0-			Gd k x-ray
									0.1231 1.2744 2.1872

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>155</sup> Tb		154.92351	5.3 d	EC/0.82		3/2+	+2.01	+1.41	(0.12–3.14) Gd k x-ray 0.08654 0.10530
<sup>156m2</sup> Tb			1.02 d	I.T./		(7-)			Tb k x-ray 0.0496
<sup>156m1</sup> Tb			5.3 h	I.T./0.0884		(0+)			Tb k x-ray 0.0884
<sup>156</sup> Tb		155.924747	5.3 d	EC/2.444		3-	~ 1.7	+2.	Gd k x-ray 0.08896 0.19921 0.53435 1.22245
<sup>157</sup> Tb		156.924025	$1.1 \times 10^2$ y	EC/0.0601		3/2+	+2.01	+1.4	Gd k x-ray 0.0545
<sup>158m</sup> Tb			10.5 s	I.T./0.11		0-			Gd k x-ray 0.0110
<sup>158</sup> Tb		157.925413	$1.8 \times 10^2$ y	EC/80 /1.220 $\beta^-$ /20 /0.937		3-	+1.76	+2.7	Gd k x-ray 0.0795 0.9442 0.9621
<sup>159</sup> Tb	100.	158.925347				3/2+	+2.014	+1.43	
<sup>160</sup> Tb		159.927168	72.3 d	$\beta^-$ /1.835	0.57/47 0.86/27	3-	+1.79	3.8	Dy k x-ray 0.08678 0.29857 0.87936 0.96615
<sup>161</sup> Tb		160.927570	6.91 d	$\beta^-$ /0.593	0.46/23 0.52/66 0.6/10	3/2+	2.2	+1.2	Dy k x-ray 0.02565 0.04892 0.07458
<sup>162</sup> Tb		161.92949	7.6 m	$\beta^-$ /2.51	1.4	(1/2-)			Dy k x-ray 0.2600 0.8075 0.8882
<sup>163</sup> Tb		162.930648	19.5 m	$\beta^-$ /1.785	0.80/	3/2+			Dy k x-ray 0.3511 0.3897 0.4945
<sup>164</sup> Tb		163.9334	3.0 m	$\beta^-$ /3.9	1.7/	(5+)			Dy k x-ray 0.1689 0.2157 0.6110 0.6885 0.7548
<sup>165</sup> Tb		164.9349	2.1 m	$\beta^-$ /3.0		3/2+			0.5389 1.1785 1.2920 1.6648
<sup>166</sup> Tb		165.9380	26 s	$\beta^-$ /					
<sup>167</sup> Tb		166.9401	19 s						0.057 0.070
<sup>168</sup> Tb		167.944	8 s						0.075–0.227
<sup>169</sup> Tb		168.946							
<sup>170</sup> Tb		169.950							
<sup>171</sup> Tb		170.953							
<b><sup>66</sup>Dy</b>		<b>162.500(1)</b>							
<sup>139</sup> Dy		138.960	0.6 s	$\beta^+$ , p					

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>140</sup> Dy		139.954				0+			
<sup>141</sup> Dy		140.9514	0.9 s	EC, $\beta^+$ /9.					
<sup>142</sup> Dy		141.9464	2.3 s	EC, $\beta^+$ /7.1		0+			
<sup>143</sup> Dy		142.9438	3.9 s	EC, $\beta^+$ /~ 8.8					
<sup>144</sup> Dy		143.93925	9.1 s	EC, $\beta^+$ /~ 6.2		0+			
<sup>145m</sup> Dy		144.9365	14. s	EC, $\beta^+$		11/2-			
<sup>146m</sup> Dy			0.15 s	I.T.		10+			
<sup>146</sup> Dy		145.93285	30. s	EC, $\beta^+$ /5.2		0+			
<sup>147m</sup> Dy			56. s	I.T./40 / $\beta^+$ , EC/60 /		(11/2-)	-0.66	+0.7	Dy k x-ray 0.072 0.6787
<sup>147</sup> Dy		146.93109	75. s	EC, $\beta^+$ /6.37		½+	-0.92		ann.rad./ 0.1007 0.2534 0.3653
<sup>148</sup> Dy		147.92715	3.1 m	$\beta^+$ /4 /2.68 EC/96 /	1.2/	0+			ann.rad./ Tb k x-ray 0.6202
<sup>149</sup> Dy		148.92731	4.2 m	$\beta^+$ , EC/3.81		(7/2-)	-0.12	-0.62	ann.rad./ 0.1008 0.1063 0.2534 0.6536 0.7894 1.7765 1.8062
<sup>150</sup> Dy		149.925585	7.18 m	$\beta^+$ , EC/67 /1.79 $\alpha$ /33 /	4.233/	0+			Tb k x-ray 0.3967
<sup>151</sup> Dy		150.926185	17. m	$\beta^+$ /5 /2.871 EC/89 / $\alpha$ /6 /	4.067/	7/2-	-0.95	-0.30	Tb k x-ray 0.1764 0.3030 0.3861 0.5463 (0.16-2.09)
<sup>152</sup> Dy		151.92472	2.37 h	EC/0.60 $\alpha$ /	3.63/	0+			Tb k x-ray 0.2569
<sup>153</sup> Dy		152.925765	6.3 h	$\beta^+$ /1 /2.171 EC/99 / $\alpha$ /0.01 /	0.89/ 3.46/	(7/2-)	-0.78	~-0.15	Tb k x-ray 0.0807 0.0997 0.2137 (0.08-1.66)
<sup>154</sup> Dy		153.92442	3. × 10 <sup>6</sup> y	$\alpha$ /2.95	2.87/	0+			
<sup>155</sup> Dy		154.92575	9.9 h	$\beta^+$ /2 /2.095 EC/98 /	0.845/	3/2-	-0.385	+1.04	Tb k x-ray 0.0655 0.2269
<sup>156</sup> Dy	0.056(3)	155.92428				0+			
<sup>157</sup> Dy		156.92547	8.1 h	EC/1.34		3/2-	-0.301	+1.30	Tb k x-ray (0.0609-1.319)
<sup>158</sup> Dy	0.095(3)	157.924409				0+			
<sup>159</sup> Dy		158.925739	144. d	EC/0.366		3/2-	-0.354	+1.37	Tb k x-ray 0.3262
<sup>160</sup> Dy	2.329(18)	159.925198				0+			
<sup>161</sup> Dy	18.889(42)	160.926933				5/2+	-0.480	+2.51	
<sup>162</sup> Dy	25.475(36)	161.926798				0+			
<sup>163</sup> Dy	24.896(42)	162.928731				5/2-	+0.673	+2.65	
<sup>164</sup> Dy	28.260(54)	163.929175				0+			
<sup>165m</sup> Dy			1.26 m	I.T./98 /0.108 $\beta^-$ /2 /		1/2-			Dy k x-ray 0.1082 0.5155
<sup>165</sup> Dy		164.931703	2.33 h	$\beta^-$ /1.286	1.29/	7/2+	-0.52	+3.5	Ho k x-ray

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<sup>166</sup> Dy		165.932807	3.400 d	$\beta^-$ /0.486	0.40/	0+			0.09468/3.8 Ho k x-ray 0.0282 0.0825
<sup>167</sup> Dy		166.9357	6.2 m	$\beta^-$ /~ 2.35	1.78	(1/2-)			Ho k x-ray 0.2593 0.3103 0.5697 (0.06-1.4)
<sup>168</sup> Dy		167.9371	8.5 m	$\beta^-$ /1.6		0+			Ho k x-ray 0.1925 0.4867
<sup>169</sup> Dy		168.9403	~ 39. s	$\beta^-$ /3.2					
<sup>170</sup> Dy		169.9424				0+			
<sup>171</sup> Dy		170.9462							
<sup>172</sup> Dy		171.9488				0+			
<sup>173</sup> Dy		172.953							
<b><sup>67</sup>Ho</b>		<b>164.93032(2)</b>							
<sup>140</sup> Ho		139.969	6 ms	p/	p/1.09				
<sup>141m</sup> Ho			8 $\mu$ s	p/	p/1.23				
<sup>141</sup> Ho		140.963	4.2 ms	$\beta^+$ , p	p/1.71				
<sup>142</sup> Ho		141.960	0.4 s	EC/ $\beta^+$ , p					0.307
<sup>143</sup> Ho		142.9546	> 0.2 $\mu$ s						
<sup>144</sup> Ho		143.9515	0.7 s	$\beta^+$ , EC/12					
<sup>145</sup> Ho		144.9472	2.4 s	$\beta^+$					
<sup>146</sup> Ho		145.9446	3.3 s	$\beta^+$ , EC/10.7		(10+)			ann.rad./
<sup>147</sup> Ho		146.94006	5.8 s	$\beta^+$ , EC/8.2		11/2-			ann.rad./
<sup>148m</sup> Ho			9. s	$\beta^+$ , EC/		4-			ann.rad./
<sup>148</sup> Ho		147.9377	2. s	$\beta^+$ , EC/9.4		1+			ann.rad./ 0.6615 1.6883
<sup>149m</sup> Ho			21. s	$\beta^+$ , EC/		11/2-			ann.rad./ 1.0733 1.0911
<sup>149</sup> Ho		148.93378	> 30. s	$\beta^+$ , EC/6.01		1/2+			
<sup>150m</sup> Ho			25. s	$\beta^+$ , EC/		(9+)			ann.rad./ 0.3939 0.5511 0.6534 0.8034
<sup>150</sup> Ho		149.93350	1.3 m	$\beta^+$ , EC/6.6					ann.rad./ 0.5913 0.6534 0.8034
<sup>151m</sup> Ho			47. s	$\beta^+$ , EC/87 / $\alpha$ /13	4.605/				ann.rad./ 0.2102 0.4889 0.6948 0.7762
<sup>151</sup> Ho		150.93169	35.2 s	$\beta^+$ , EC/80/5.13 $\alpha$ /20 /	4.519/				ann.rad./ 0.3522 0.5274 0.9676 1.0471
<sup>152m</sup> Ho			50. s	$\beta^+$ , EC/90/ $\alpha$ /10/	4.453/	(9+)	+5.9	-1.	ann.rad./ 0.4929 0.6138 0.6474



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									0.2182
									0.9488
<sup>159m</sup> Ho			8.3 s	IT/0.206		1/2+			Ho k x-ray
									0.1660
									0.2059
<sup>159</sup> Ho		158.927712	33.0 m	EC/1.838		7/2-	+4.28	+3.2	Dy k x-ray
									0.1210
									0.1320
									0.2529
									0.3096
									(0.06–1.2)
<sup>160m2</sup> Ho			3. s			1+			
<sup>160m</sup> Ho			5.0 h	IT/67/0.060		2-	+2.52	+1.8	0.0868
				EC/33/3.35					0.1970
									0.6464
									0.7281
									0.8791
									0.9619
									0.9658
<sup>160</sup> Ho		159.92873	25.6 m	$\beta^+$ , EC/3.29	0.57/	5+	+3.71	+4.0	See Ho[166m]
									0.7282
									0.8794
<sup>161m</sup> Ho			6.8 s	IT/0.211					Ho k x-ray
									0.2112
<sup>161</sup> Ho		160.927855	2.48 h	EC/0.859		7/2-	+4.25	+3.2	Dy k x-ray
									0.0256
									0.0592
									0.0774
									0.1031
<sup>162m</sup> Ho			1.12 h	IT/61/		6-	+3.60	+4.	Dy k x-ray
				EC/39/					Ho k x-ray
									0.0807
									0.1850
									0.2828
									0.9372
									1.2200
<sup>162</sup> Ho		161.929096	15. m	EC/96 /0.295		1+			Dy k x-ray
				$\beta^+$ /4 /					0.0807
									1.3196
									1.3728
<sup>163m</sup> Ho			1.09 s	I.T./0.298		(1/2+)			Ho k x-ray
									0.2798
<sup>163</sup> Ho		162.928734	$4.57 \times 10^3$ y	EC/0.00258		7/2-	+4.23	+3.6	Dy M x-rays
<sup>164m</sup> Ho			38. m	I.T./0.140		(6-)			Ho k x-ray
									0.0373
									0.0566
									0.0940
<sup>164</sup> Ho		163.930234	29. m	EC/58 /0.987		1+			Dy k x-ray
				$\beta^-$ /42 /0.963					0.0734
									0.0914
<sup>165</sup> Ho	100.	164.930322				7/2-	+4.17	+3.49	
<sup>166m</sup> Ho			$1.2 \times 10^3$ y	$\beta^-$ /		7-	3.6	-3.	Er k x-ray
									0.18407
									0.71169
									0.81031
<sup>166</sup> Ho		165.932284	1.117 d	$\beta^-$ /1.855	1.776/48	0-			Er k x-ray
					1.855/51				0.08057
									1.37943
<sup>167</sup> Ho		166.93313	3.1 h	$\beta^-$ /1.007	0.31/43	(7/2-)			Er k x-ray
					0.61/21				0.0793



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<sup>157</sup> Er		156.93192	25. m	$\beta^+$ , EC/3.5		3/2-	-0.412	+0.92	ann.rad./ 0.117 0.385 1.320 1.660 1.820 2.000
<sup>158</sup> Er		157.92989	2.2 h	EC/99.5 /1.78 $\beta^+$ /0.5 /	0.74/	0+			Ho k x-ray 0.0719 0.2486 0.3868
<sup>159</sup> Er		158.930684	36. m	$\beta^+$ /7 /2.769 EC/93 /		3/2-	-0.304	+1.17	ann.rad./ Ho k x-ray 0.6245 0.6493 (0.07–2.5)
<sup>160</sup> Er		159.92908	1.191 d	EC/0.33		0+			Ho k x-ray (0.05–0.96)
<sup>161</sup> Er		160.93000	3.21 h	EC/2.00		3/2-	-0.37	+1.36	Ho k x-ray 0.8265 (0.07–1.74)
<sup>162</sup> Er	0.139(5)	161.928778				0+			
<sup>163</sup> Er		162.93003	1.25 h	EC/1.210		5/2-	+0.557	+2.55	Ho k x-ray 0.4361 0.4399 1.1135
<sup>164</sup> Er	1.601(3)	163.929200				0+			
<sup>165</sup> Er		164.930726	10.36 h	EC/0.376		5/2-	+0.643	+2.71	Ho k x-ray
<sup>166</sup> Er	33.503(36)	165.930293				0+			
<sup>167m</sup> Er			2.27 s	I.T./0.208		½-			Er k x-ray 0.2078
<sup>167</sup> Er	22.869(9)	166.932048				7/2+	-0.5639	+3.57	
<sup>168</sup> Er	26.978(18)	167.932370				0+			
<sup>169</sup> Er		168.934590	9.40 d	$\beta^-$ /0.351	0.35/~ 100	½-	+0.485		Tm k x-ray 0.1098 0.1182
<sup>170</sup> Er	14.910(36)	169.935464				0+			
<sup>171</sup> Er		170.938030	7.52 h	$\beta^-$ /1.491		5/2-	0.66	2.9	Tm k x-ray 0.11160 0.29591 0.30832 (0.08–1.4)
<sup>172</sup> Er		171.939356	2.05 d	$\beta^-$ /0.891	0.28/48 0.36/46	0+			Tm k x-ray 0.0597 0.4073 0.6101
<sup>173</sup> Er		172.9424	1.4 m	$\beta^-$ /2.6		(7/2-)			Tm k x-ray 0.1928 0.1992 0.8952
<sup>174</sup> Er		173.9442	3.1 m	$\beta^-$ /1.8		0+			Tm k x-ray (0.100–0.152)
<sup>175</sup> Er		174.9478	1.2 m	$\beta^-$					(0.0765–1.168)
<sup>176</sup> Er		175.9501				0+			
<sup>177</sup> Er		176.954							
<b><sup>69</sup>Tm</b>		<b>168.93421(2)</b>							
<sup>144</sup> Tm			~ 1.9 $\mu$ s	p	1.70, 1.43				
<sup>145</sup> Tm		144.9701	3.1 $\mu$ s	p// ~ 10	1.73/91				



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<sup>146m</sup> Tm			0.198 s	$\beta+$ , p	1.4/9 p/1.118/100				
					1.01/ 0.89/8				
<sup>146</sup> Tm	145.9664		0.08 s	$\beta+$ /14. p	p/1.19/100 1.01/28 0.94/22				
<sup>147m</sup> Tm			0.4 ms	$\beta+$ , p	p/1.115				
<sup>147</sup> Tm	146.9610		0.56 s	EC, $\beta+$ /85 p/15/	~ 10.7 1.052/				
<sup>148m</sup> Tm	147.9578		0.7 s	$\beta+$ , EC/12.					ann.rad./
<sup>148</sup> Tm									
<sup>149</sup> Tm	148.9527		0.9 s	$\beta+$ , EC/~ 9.2		11/2-			
<sup>150</sup> Tm	149.9500		2.3 s	$\beta+$ , EC/~ 11.5		6-			(0.1007-2.177)
<sup>151</sup> Tm	150.94548		4. s	$\beta+$ , EC/7.5					ann.rad./
<sup>152m</sup> Tm			8. s	$\beta+$ , EC/		9+			
<sup>152</sup> Tm	151.9444		5. s	$\beta+$ , EC/8.8					ann.rad./
<sup>153</sup> Tm	152.94201		1.6 s	$\beta+$ , EC/10 /6.46 $\alpha$ /90 /	5.109/				ann.rad./
<sup>154m</sup> Tm			3.3 s	$\beta+$ , EC/15 / $\alpha$ /	$\alpha$ /5.031/100 4.84/0.24				ann.rad./ 0.4605-0.7960
<sup>154</sup> Tm	153.94157		8.1 s	$\beta+$ , EC/56 /7.4 $\alpha$ /44 /	$\alpha$ /4.956/100 4.83/0.45				ann.rad./
<sup>155</sup> Tm	154.93920		30. s	$\beta+$ , EC/5.58 $\alpha$ /	4.46/				0.0315 0.0638 0.0881 0.2268 0.5320 0.6067
<sup>156m</sup> Tm			19. s	$\alpha$ /	4.46/				
<sup>156</sup> Tm	155.93898		1.40 m	$\beta+$ , EC/7.6 $\alpha$ /	4.23/	2-	+0.40	-0.5	ann.rad./ 0.3446 0.4529 0.5860
<sup>157</sup> Tm	156.93697		3.6 m	$\beta+$ , EC/4.5 $\alpha$ /	2.6 3.97/	½	+0.48		ann.rad./ 0.1104 0.3484 0.3855 0.4550 (0.1-1.58)
<sup>158</sup> Tm	157.93698		4.0 m	$\beta+$ , EC/74 /6.5 EC/26 /		(2-)	+0.04	+0.7	ann.rad./ Er k x-ray 0.1921 0.3351 0.6280 1.1498 (0.18-2.81)
<sup>159</sup> Tm	158.93498		9.1 m	$\beta+$ /23 /3.9 EC/77 /		5/2+	+3.42	+1.9	ann.rad./ Er k x-ray 0.0591 0.0848 0.2713 (0.05-1.27)
<sup>160m</sup> Tm			1.24 m	IT		(5)			
<sup>160</sup> Tm	159.93526		9.4 m	$\beta+$ /15 /5.9 EC/85 /		1-	+0.16	+0.58	ann.rad./ Er k x-ray 0.1264 0.2642 0.7285 0.8544

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									0.8614
									1.3685
<sup>161</sup> Tm		160.93355	31. m	$\beta^+$ , EC/3.2		7/2+	+2.40	+2.9	ann.rad./ Er k x-ray
									0.0595
									0.0844
									1.6481
									(0.04–2.15)
<sup>162m</sup> Tm			24. s	I.T./90 / $\beta^+$ , EC/10 /		5+			Tm k x-ray
									Er k x-ray
									0.0669
									0.8115
									0.9003
<sup>162</sup> Tm		161.93400	21.7 m	$\beta^+$ /8 /4.81 EC/92 /		1-	+0.07	+0.69	ann.rad./ Er k x-ray
									0.1020
									0.7987
									(0.1–3.75)
<sup>163</sup> Tm		162.93265	1.81 h	EC/98 /2.439 $\beta^+$ /1 /		½+	-0.082		Er k x-ray
									0.0692
									0.1043
									0.2414
<sup>164m</sup> Tm			5.1 m	I.T./80 / $\beta^+$ , EC/20 /		6-			0.0914
									0.1394
									0.2081
									0.2405
									0.3149
<sup>164</sup> Tm		163.93356	2.0 m	$\beta^+$ /36 /3.96 EC/64 /	2.94/	1+	+2.38	+0.71	ann.rad./ Er k x-ray
									0.0914
<sup>165</sup> Tm		164.932435	1.253 d	EC/1.593		½+	-0.139		Er k x-ray
									0.0472
									0.0544
									0.29728
									0.80636
<sup>166</sup> Tm		165.93355	7.70 h	EC/98 /3.04 $\beta^+$ /2 /		2+	+0.092	+2.14	Er k x-ray
									0.0806
									0.1844
									0.7789
									1.2734
									2.0524
<sup>167</sup> Tm		166.932852	9.24 d	EC/0.748		½+	-0.197		Er k x-ray
									0.0571
									0.20778
<sup>168</sup> Tm		167.934173	93.1 d	EC/1.679		3+	+0.23	+3.2	Er k x-ray
									0.19825
									0.4475
									0.81595
<sup>169</sup> Tm	100	168.934213				½+	-0.232	-1.2	
<sup>170</sup> Tm		169.935801	128.6 d	$\beta^-$ /99.8/0.968 EC/0.2 /0.314	0.883/24 0.968/76	1-	+0.247	+0.74	Yb k x-ray
									0.08425
<sup>171</sup> Tm		170.936429	1.92 y	$\beta^-$ /0.096	0.03/2 0.096/98	½+	-0.230		0.06674
<sup>172</sup> Tm		171.93840	2.65 d	$\beta^-$ /1.88	1.79/36 1.88/29	2-			Yb k x-ray
									0.07879
									1.38722
									1.46601
									1.52982
									1.60861
<sup>173</sup> Tm		172.939604	8.2 h	$\beta^-$ /1.298	0.80/21	½+			Yb k x-ray



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<sup>163</sup> Yb		162.93633	11.1 m	$\beta^+$ /26 /3.4	1.4/	3/2-	-0.37	+1.24	0.1635 ann.rad./ Tm k x-ray
									0.0636 0.8603 (0.06 -1.9)
<sup>164</sup> Yb		163.93449	1.26 h	EC/1.0		0+			Tm k x-ray 0.0914 0.6752
<sup>165</sup> Yb		164.93528	9.9 m	$\beta^+$ /10 /2.76 EC/90 /	1.58/	(5/2-)	+0.48	+2.48	ann.rad./ Tm k x-ray 0.0801 1.0903
<sup>166</sup> Yb		165.93388	2.363 d	EC/0.30		0+			Tm k x-ray 0.0828 0.1844 0.7789 1.2734 2.0524
<sup>167</sup> Yb		166.934950	17.5 m	$\beta^+$ /0.5 /1.954 EC/99.5 /	0.639/	5/2-	+0.62	+2.70	Tm k x-ray 0.06296 0.10616 0.11337 0.17633
<sup>168</sup> Yb	0.13(1)	167.933897				0+			
<sup>169m</sup> Yb			46. s	I.T./0.0242		1/2-			Yb L x-ray 0.0242
<sup>169</sup> Yb		168.935190	32.02 d	EC/0.909		7/2+	-0.63	+3.5	0.1979/35.9 0.3078/10.05 0.0207-0.2611
<sup>170</sup> Yb	3.04(15)	169.934762				0+			
<sup>171</sup> Yb	14.28(57)	170.936326				1/2-	+0.49367		
<sup>172</sup> Yb	21.83(67)	171.936382				0+			
<sup>173</sup> Yb	16.13(27)	172.938211				5/2-	-0.67989	+2.80	
<sup>174</sup> Yb	31.83(92)	173.938862				0+			
<sup>175</sup> Yb		174.941277	4.19 d	$\beta^-$ /0.470	0.466/73 0.071/21 0.353/6.2	7/2-	0.77		Lu k x-ray 0.3963/13 (0.114-0.28)
<sup>176m</sup> Yb			11.4 s	I.T./1.051		(8-)			Yb k x-ray 0.0961 0.1901 0.2929 0.3897
<sup>176</sup> Yb	12.76(41)	175.942572	10 <sup>26</sup> y	$\beta^-\beta^-$		0+			
<sup>177m</sup> Yb			6.41 s	I.T./0.3315		1/2-			Yb k x-ray 0.1131 0.2084
<sup>177</sup> Yb		176.945261	1.9 h	$\beta^-$ /1.399	1.40	9/2+			Lu k x-ray 0.1504
<sup>178</sup> Yb		177.94665	1.23 h	$\beta^-$ /0.65	0.25/	0+			0.1415 0.3246 0.3516 0.3815 0.6125
<sup>179</sup> Yb		178.9502	8. m	$\beta^-$ /2.4					
<sup>180</sup> Yb		179.9523	2. m	$\beta^-$		0+			0.1028-0.4423
<sup>181</sup> Yb		180.9562							
<sup>71</sup> Lu		<b>174.967(1)</b>							



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<sup>166m1</sup> Lu			1.4 m	$\beta^+$ , EC/58 / IT/42 /0.0344		(3-)			ann.rad./ 0.1024 0.2281 0.2861 0.8119 0.8301
<sup>166</sup> Lu	165.93986		2.8 m	$\beta^+$ /25 /5.5 EC/75 /		(6-)			ann.rad./ Yb k x-ray 0.1024 0.2281 0.3375 0.3679
<sup>167</sup> Lu	166.93827		52. m	$\beta^+$ /2 /3.1 EC/98 /	2.1/	7/2+			Yb k x-ray 0.0297 0.2392 (0.03–2.0)
<sup>168m1</sup> Lu			6.7 m	$\beta^+$ /12 / EC/88 / IT/<0.8		3+			ann.rad./ Yb k x-ray 0.1988/190 0.8960/100 0.9792/128 0.018–2.65
<sup>168</sup> Lu	167.93874		5.5 m	$\beta^+$ /6 /4.5 EC/94 /	1.2/	(6-)			ann.rad./ Yb k x-ray 0.1114 0.1124 0.2286 0.3483 1.4836
<sup>169m1</sup> Lu			2.7 m	IT./0.0290		1/2-			Lu L x-ray 0.0290
<sup>169</sup> Lu	168.93765		1.419 d	EC/2.293	1.271/	7/2+	2.30	3.5	Yb k x-ray 0.19121 0.9606 (0.08–2.1)
<sup>170m1</sup> Lu			0.7 s	IT./0.0929		4-			Lu L x-ray 0.04449 0.0484
<sup>170</sup> Lu	169.93848		2.01 d	EC/3.46	2.44/	0+			Yb k x-ray 0.58711 0.5908 1.28029 (0.1–3.38)
<sup>171m1</sup> Lu			1.31 m	IT./0.0711		1/2-			Lu k x-ray 0.07119
<sup>171</sup> Lu	170.937913		8.24 d	EC/1.479	0.362/	7/2+	2.30	3.42	Yb k x-ray 0.01939 0.66744 (0.02–1.3)
<sup>172m1</sup> Lu			3.7 m	IT./0.0419		1-			Lu L x-rays 0.04186
<sup>172</sup> Lu	171.939086		6.64 d	EC/2.519		4-	2.90	3.80	Yb k x-ray 0.18156 1.09367 (0.07–2.2)
<sup>173</sup> Lu	172.938931		1.37 y	EC/0.671		7/2+	2.28	3.63	Yb k x-ray 0.07860 0.27198
<sup>174m1</sup> Lu			142. d	IT/99.3/ EC/0.7 /	0.17086	6-	1.50		Lu k x-ray 0.067055

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<sup>174</sup> Lu		173.940338	3.3 y	EC/1.374		1-	1.9		Yb k x-ray 0.07664 1.2419
<sup>175</sup> Lu	97.41(2)	174.940772				7/2+	+2.2327	+3.49	
<sup>176m</sup> Lu			3.66 h	$\beta^-$ /1.315	1.229/ 1.317/	1-	+0.318	-1.47	Hf k x-ray 0.088372
<sup>176</sup> Lu	2.59(2)	175.942686	$3.73 \times 10^{10}$ y	$\beta^-$ /1.192 $\beta^+$ / < 0.9		7-	+3.169	+4.92	Hf k x-ray 0.20187 0.30691
<sup>177m2</sup> Lu			6. m	$\beta^-$		39/2-			0.089
<sup>177m</sup> Lu			160.7 d	IT/22/0.9702 $\beta^-$ /78		23/2-	2.33	5.4	Lu k x-ray Hf k x-ray 0.11295 0.20836 0.37850 0.41853
<sup>177</sup> Lu		176.943758	6.65 d	$\beta^-$ /0.498	0.497/	7/2+	+2.239	+3.39	0.11295 0.20836
<sup>178m</sup> Lu			23.1 m	$\beta^-$ /		(9-)			0.2166 0.3317
<sup>178</sup> Lu		177.945955	28.5 m	$\beta^-$ /2.099	2.03/	1+			Hf k x-ray 0.0932 1.3099 1.3408 (0.09-1.7)
<sup>179</sup> Lu		178.94733	4.6 h	$\beta^-$ /1.405	1.35/	7/2+			0.2143 0.3377
<sup>180</sup> Lu		179.9499	5.7 m	$\beta^-$ /3.1	1.49/				0.40795/50. (0.07-1.9)
<sup>181</sup> Lu		180.9520	3.5 m	$\beta^-$ /2.5		(7/2+)			0.0458 0.2059 0.5749
<sup>182</sup> Lu		181.9550	2.0 m	$\beta^-$ /~ 4.1					0.0978 0.7208 0.8182
<sup>183</sup> Lu		182.9576	58. s	$\beta^-$ /		7/2+			
<sup>184</sup> Lu		183.9609	20 s	$\beta^-$					
<b><sup>72</sup>Hf</b>	<b>178.49(2)</b>								
<sup>153</sup> Hf		152.971	> 0.2 $\mu$ s						
<sup>154</sup> Hf		153.965	2. s	EC, $\beta^+$ /~ 6.7		0+			
<sup>155</sup> Hf		154.9634	0.9 s	EC, $\beta^+$ /8.					
<sup>156</sup> Hf		155.9594	25. ms	$\alpha$ /		0+			
<sup>157</sup> Hf		156.9584	0.11 s	$\alpha$ /					
<sup>158</sup> Hf		157.95480	2.9 s	EC/54 /5.1 $\alpha$ /46 /	5.27/	0+			
<sup>159</sup> Hf		158.95400	5.6 s	$\beta^+$ , EC/88 /6.9 $\alpha$ /12 /	5.09/				ann.rad./
<sup>160</sup> Hf		159.95068	~ 12. s	$\beta^+$ , EC/97 /4.9 $\alpha$ /4.78		0+			ann.rad./
<sup>161</sup> Hf		160.95028	17. s	$\alpha$ /	4.60/				
<sup>162</sup> Hf		161.94721	38. s	$\beta^+$ , EC/3.7		0+			ann.rad./ 0.1739 0.1963 0.4101
<sup>163</sup> Hf		162.94709	40. s	$\beta^+$ , EC/5.5					ann.rad./ 0.0454 0.0621 0.0710

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<sup>164</sup> Hf		163.94438	2.8 m	EC, $\beta^+$ /3.0		0+			0.6882
<sup>165</sup> Hf		164.94457	1.32 m	EC/4.6		11/2-			
<sup>166</sup> Hf		165.94218	6.8 m	EC/93 /2.3 $\beta^+$ /7 /		0+			ann.rad./ Lu k x-ray 0.0788
<sup>167</sup> Hf		166.94260	2.0 m	$\beta^+$ /40 /4.0 EC/60 /		(5/2-)			ann.rad./ Lu k x-ray 0.1754 0.3152
<sup>168</sup> Hf		167.94057	25.9 m	$\beta^+$ , EC/1.8		0+			ann.rad./ (0.0144–1.311)
<sup>169</sup> Hf		168.94126	3.25 m	EC/85 /3.3 $\beta^+$ /15 /		(5/2-)			ann.rad./ Lu k x-ray 0.3695 0.4929
<sup>170</sup> Hf		169.93961	16.0 h	EC/1.1		0+			Lu k x-ray 0.0985 0.1202 0.1647 0.5729 0.6207
<sup>171m</sup> Hf			30. s			(1/2-)	+0.53		
<sup>171</sup> Hf		170.94049	12.2 h	EC, $\beta^+$ /2.4		7/2+	-0.67	+3.46	ann.rad./ Lu k x-ray 0.1221 0.6620 1.0714
<sup>172</sup> Hf		171.93945	1.87 y	EC/0.35		0+			Lu k x-ray 0.02399 0.12582 (0.0818–0.123)
<sup>173</sup> Hf		172.94051	23.6 h	EC/1.6		½-			Lu k x-ray 0.12367 0.13963 0.29697 0.31124 (0.1–2.1)
<sup>174</sup> Hf	0.16(1)	173.940046	$2.0 \times 10^{15}$ y			0+			
<sup>175</sup> Hf		174.941509	71. d	EC/0.686		5/2-	-0.60	+2.7	Lu k x-ray 0.08936 0.34340
<sup>176</sup> Hf	5.26(7)	175.941409				0+			
<sup>177m2</sup> Hf			51.4 m	I.T./2.740		37/2-			Hf k x-ray 0.2140 0.2951 0.3115 0.3267
<sup>177m1</sup> Hf			1.1 s	I.T./		23/2+			Hf k x-ray 0.20836 0.22847 0.37851
<sup>177</sup> Hf	18.60(9)	176.943221				7/2-	+0.7935	+0.337	
<sup>178m2</sup> Hf			31. y	I.T./		16+	+8.16	+6.00	Hf k x-ray 0.32555 0.42635 0.089–0.574
<sup>178m1</sup> Hf			4.0 s	I.T./		8-			Hf k x-ray 0.21342 0.32555



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<sup>178</sup> Hf	27.28(7)	177.943699				0+			0.42635
<sup>179m2</sup> Hf			25.1 d	IT./1.1057		25/2-	7.4		Hf k x-ray
									0.1227
									0.1461
									0.3626
									0.4537
<sup>179m1</sup> Hf			18.7 s	IT./0.375		1/2-			Hf k x-ray
									0.1607
									0.2141
<sup>179</sup> Hf	13.62(2)	178.945816				9/2+	-0.641	+3.79	
<sup>180m</sup> Hf			5.52 h	IT./1.1416		8-	+9.	+4.6	Hf k x-ray
									0.2152
									0.3323
									0.4432
<sup>180</sup> Hf	35.08(16)	179.946550				0+			
<sup>181m</sup> Hf			1.5 ms	/1.738		25/2-			
<sup>181</sup> Hf		180.949101	42.4 d	$\beta^-$ /1.027	0.408/	1/2-			Ta k x-ray
									0.13294/54
									0.48200/100
									0.3459/20
<sup>182m</sup> Hf			62. m	$\beta^-$ /54 /1.60	0.49/43	8-			Hf k x-ray
				IT/46 /1.173	0.95/10				0.0509
									0.2244
									0.3441
									0.4558
									0.5066
									0.9428
<sup>182</sup> Hf		181.95055	$8.9 \times 10^6$ y	$\beta^-$ /0.37		0+			Ta k x-ray
									0.2704/79
									(0.098-0.270)
<sup>183</sup> Hf		182.95353	1.07 h	$\beta^-$ /2.01	1.18/68	3/2-			Ta k x-ray
					1.54/25				0.0732
									0.4591
									0.7837
<sup>184</sup> Hf		183.95545	4.1 h	$\beta^-$ /1.34	0.74/38	0+			Ta k x-ray
					0.85/16				0.0414
					1.10/46				0.1391
									0.3449
<sup>185</sup> Hf		184.9588	$\sim 3.5$ m	$\beta^-$ /					0.165
<sup>186</sup> Hf		185.9609	$\sim 2.6$ m			0+			0.738
<sup>187</sup> Hf		186.9646	$> 0.3 \mu\text{s}$						
<sup>188</sup> Hf		187.967	$> 0.3 \mu\text{s}$			0+			
<b><sup>73</sup>Ta</b>		<b>180.94788(2)</b>							
<sup>155</sup> Ta		154.975	12 $\mu\text{s}$	p/1.77					
<sup>156</sup> Ta		155.9723	0.11 s	$\beta^+$ / $\sim 11.6$					
				p/	1.02/ $\sim 100$				
<sup>157</sup> Ta		156.9682	10 ms	$\alpha$ /	6.117				
				p/	0.927/3.4				
<sup>158</sup> Ta		157.9667	37. ms	$\alpha$ /	6.05/100				
					5.97/100				
<sup>159</sup> Ta		158.96302	0.6 s	$\beta^+$ , EC/20 /8.5	$\alpha$ /5.52/34				ann.rad./
				$\alpha$ /80 /	5.60/55				
<sup>160</sup> Ta		159.9615	1.4 s	$\beta^+$ , EC/10.1					ann.rad./
				$\alpha$	5.41/				
<sup>161</sup> Ta		160.9584	3.16 s	$\beta^+$ , EC/7.5					ann.rad./
				$\alpha$ /	5.15				
<sup>162</sup> Ta		161.9573	4. s	EC/8.6					

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<sup>163</sup> Ta		162.95433	10.6 s	EC/6.8					
<sup>164</sup> Ta		163.95353	14.2 s	$\beta+$ /8.5		3+			ann.rad./
				$\alpha$ /	4.62/				0.2110
									0.3768
<sup>165</sup> Ta		164.95077	31. s	EC $\beta$ + /5.9					
<sup>166</sup> Ta		165.95051	34. s	$\beta+$ /82 /7.7					ann.rad./
				EC/18 /					Hf k x-ray
									0.1587
									0.3117
									0.8101
<sup>167</sup> Ta		166.94809	1.4 m	$\beta+$ , EC/5.6					ann.rad./
<sup>168</sup> Ta		167.94805	2.4 m	$\beta+$ /77 /6.7		3+			ann.rad./
				EC/23 /					Hf k x-ray
									0.1239
									0.2615
									0.7502
<sup>169</sup> Ta		168.94601	4.9 m	$\beta+$ , EC/4.4					ann.rad./
									0.0288
									0.1535
									0.1924
<sup>170</sup> Ta		169.94618	6.8 m	$\beta$ + /70 /6.0		(3+)			ann.rad./
				EC/35 /					Hf k x-ray
									0.1008
									0.2212
<sup>171</sup> Ta		170.94448	23.3 m	$\beta+$ , EC/3.7		(5/2-)			0.0496
									0.5018
									0.5064
									(0.05–1.02)
<sup>172</sup> Ta		171.94490	36.8 m	$\beta+$ /25 /4.9		(3-)			ann.rad./
				EC/75 /					Hf k x-ray
									0.21396
									1.10923
									(0.09 –3.8)
<sup>173</sup> Ta		172.94375	3.6 h	$\beta+$ /24 /3.7		(5/2-)	1.70	-1.9	ann.rad./
				EC/76 /					Hf k x-ray
									0.06972
									0.17219
									(0.06 –2.7)
<sup>174</sup> Ta		173.94445	1.12 h	$\beta+$ /27 /3.8		(3+)			ann.rad./
				EC/73 /					Hf k x-ray
									0.09089
									0.20638
									(0.09–3.64)
<sup>175</sup> Ta		174.94374	10.5 h	EC/2.0		7/2+	2.27	+3.7	Hf k x-ray
									0.2077
									0.2671
									0.3487
<sup>176</sup> Ta		175.94486	8.1 h	EC/3.1		1-			Hf k x-ray
									0.08837
									1.15735
<sup>177</sup> Ta		176.944472	2.356 d	EC/1.166		7/2+	2.25		Hf k x-ray
									0.11295
									(0.07–1.06)
<sup>178m</sup> Ta			2.4 h	EC/		(7-)			Hf k x-ray
									0.08886
									0.21342
									0.32555
									0.42635
<sup>178</sup> Ta		177.94578	9.29 m	EC/99 /1.9		1+	+2.74	+0.65	ann.rad./
				$\beta+$ /1 /					Hf k x-ray



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>169</sup> W		168.95178	1.3 m	EC/5.4					(0.037–0.573) ann.rad./ Ta k x-ray 0.123 (0.097–0.699)
<sup>170</sup> W		169.94923	2.4 m	EC/2.2		0+			ann.rad./ Ta k x-ray 0.3162 (0.060–0.144)
<sup>171</sup> W		170.94945	2.4 m	EC/4.6					ann.rad./ Ta k x-ray 0.1842 (0.052–0.479)
<sup>172</sup> W		171.94729	6.6 m	$\beta^+$ , EC/2.5		0+			ann.rad./ Ta k x-ray 0.0389 (0.034–0.674)
<sup>173</sup> W		172.94769	6.3 m	EC/4.0					ann.rad./ Ta k x-ray 0.4576 (0.035–0.623)
<sup>174</sup> W		173.94608	35. m	EC/1.9		0+			ann.rad./ Ta k x-ray 0.3287 0.4288 (0.056–0.429)
<sup>175</sup> W		174.94672	35. m	EC/2.9		$\frac{1}{2}^-$			(0.015–0.27)
<sup>176</sup> W		175.94563	2.5 h	$\beta^+$ , EC/0.8		0+			0.03358 0.06129 0.09487 0.10020
<sup>177</sup> W		176.94664	2.21 h	EC/2.0		(1/2-)			Ta k x-ray 0.15505 0.18569 0.42694
<sup>178</sup> W		177.94588	21.6 d	EC/0.091		0+			Ta k x-ray
<sup>179m</sup> W			6.4 m	IT/99.7/0.222 EC/0.3/		(1/2-)			W k x-ray 0.2220
<sup>179</sup> W		178.94707	38. m	EC/1.06		(7/2-)			Ta k x-ray 0.0307
<sup>180</sup> W	0.12(1)	179.946704	$1.8 \times 10^{18}$ y	$\alpha$ /		0+			
<sup>181</sup> W		180.948197	121.1 d	EC/0.188		9/2+			Ta k x-ray 0.13617 0.15221
<sup>182</sup> W	26.50(16)	181.948204	$> 7.7 \times 10^{21}$ y	$\alpha$ /		0+			
<sup>183m</sup> W			5.15 s	I.T./		(11/2+)			W k x-ray 0.0465 0.0526 0.0991 0.1605
<sup>183</sup> W	14.31(4)	182.950223	$> 4.1 \times 10^{21}$ y	$\alpha$ /		$\frac{1}{2}^-$	+0.1177848		
<sup>184</sup> W	30.64(2)	183.950931	$> 8.9 \times 10^{21}$ y	$\alpha$ /		0+			
<sup>185m</sup> W			1.6 m	I.T./0.1974		11/2+			W k x-ray 0.0659 0.1315 0.1737
<sup>185</sup> W		184.953419	74.8 d	$\beta^-$ /0.433	0.433/99.9	3/2-			0.12536
<sup>186</sup> W	28.43(19)	185.954364	$> 8.2 \times 10^{21}$ y	$\alpha$ /		0+			
<sup>187m</sup> W			1.6 $\mu$ s	IT	0.411	11/2+			(0.014–0.287)
<sup>187</sup> W		186.957161	23.9 h	$\beta^-$ /1.311	0.624/66	3/2-	0.62		Re k x-ray



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									0.0797
									0.0843
									0.1968
<sup>178</sup> Re		177.95099	13.2 m	$\beta^+$ /11 /4.7 EC/89 /	3.3/	(3+)			ann.rad./ W k x-ray
									0.1059
									0.2373
									0.9391
<sup>179m</sup> Re			0.47 ms						
<sup>179</sup> Re		178.94999	19.7 m	EC/99 /2.71 $\beta^+$ /1 /	0.95/	(5/2+)	2.8		W k x-ray
									0.1199
									0.2900
									0.4154
									0.4302
									1.6803
<sup>180</sup> Re		179.95079	2.45 m	EC/92 /3.80 $\beta^+$ /8 /	1.76/	1-	1.6		ann.rad./ W k x-ray
									0.1036
									0.9028
									(0.07–2.2)
<sup>181</sup> Re		180.95007	20. h	EC /1.74		5/2+	3.19		W k x-ray
									0.3607
									0.3655
									0.6390
<sup>182m</sup> Re			12.7 h	EC/	0.55/ 1.74/	2+	3.3	+1.8	W k x-ray
									0.0677
									1.1214
									1.2215
									(0.06–2.2)
<sup>182</sup> Re		181.9512	2.67 d	EC/2.8		(7+)	2.8	+4.1	W k x-ray
									0.0678
									0.2293
									1.1213
									1.2214
<sup>183</sup> Re		182.95082	70. d	EC/0.56		(5/2+)	+3.17	+2.3	W k x-ray
									0.16232
<sup>184m</sup> Re			165. d	I.T./75 /0.188 EC/25 /		8+	+2.9		Re k x-ray
									0.1047
									0.2165
									0.92093
									(0.10–1.1)
<sup>184</sup> Re		183.952521	38. d	EC/1.48		3-	+2.53	+2.8	W k x-ray
									0.79207
									0.90328
									(0.1–1.4)
<sup>185</sup> Re	37.40(2)	184.952955				5/2+	+3.1871	+2.18	
<sup>186m</sup> Re			$2.0 \times 10^5$ y	I.T./0.150		8+			Re k x-ray
									0.0590
<sup>186</sup> Re		185.954986	3.718 d	$\beta^-$ /92 /1.070 EC/8 /0.582	0.973/21 1.07/71	1-	+1.739	+0.62	W k x-ray
									0.1227/0.6
									0.1372/9.5
									(0.63–0.77)
<sup>187</sup> Re	62.60(2)	186.955753	$4.2 \times 10^{10}$ y	$\beta^-$ /0.00266	0.0025/	5/2+	+3.2197	+2.07	
<sup>188m</sup> Re			18.6 m	I.T./0.172		(6-)			Re k x-ray
									0.0925
									0.1059
<sup>188</sup> Re		187.958114	17.00 h	$\beta^-$ /2.120	1.962/20 2.118/79	1-	+1.788	+0.57	Os k x-ray
									0.15502
									0.309–2.022
<sup>189</sup> Re		188.95923	24. h	$\beta^-$ /1.01	1.01/	(5/2+)			0.1471

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									0.2167
									0.2194
									0.2451
<sup>190m</sup> Re			3.0 h	$\beta^-$ /51 / I.T./49 /		(6-)			Re k x-ray
									0.1191
									0.2238
									0.6731
									(0.1-1.79)
<sup>190</sup> Re		189.9618	3.0 m	$\beta^-$ /3.2	1.8/	(2-)			Os k x-ray
									0.1867
									0.5580
									0.6051
<sup>191</sup> Re		190.96313	9.7 m	$\beta^-$ /2.05	1.8/				
<sup>192m</sup> Re			~ 0.12 ms						(0.0606-0.146)
<sup>192</sup> Re		191.9660	16. s	$\beta^-$ /4.2	~ 2.5/				(0.2-0.75)
<sup>193m</sup> Re			~ 0.08 ms						(0.061-0.146)
<sup>193</sup> Re		192.9675	> 0.3 $\mu$ s						
<sup>194</sup> Re		193.9704	> 0.3 $\mu$ s						
<b><sub>76</sub>Os</b>		<b>190.23(3)</b>							
<sup>162</sup> Os		161.984	1.8 ms	$\alpha$ /	6.60	0+			
<sup>163</sup> Os		162.9827	5.5 ms	$\alpha$ /	6.51				
<sup>164</sup> Os		163.9780	0.04 s	$\alpha$		0+			
<sup>165</sup> Os		164.9768	0.07 s	$\alpha$					
<sup>166</sup> Os		165.97269	0.18 s	$\beta^+$ , EC/28 /6.3 $\alpha$ /72 /	6.27/ 5.98/	0+			ann. rad./
<sup>167</sup> Os		166.9716	0.7 s	$\beta^+$ , EC/76 /8.2 $\alpha$ /24 /					ann.rad./
<sup>168</sup> Os		167.96780	2.2 s	$\beta^+$ , EC/51 /5.7 $\alpha$ /49 /		0+			ann. rad./
<sup>169</sup> Os		168.96702	3.3 s	$\beta^+$ , EC/89 /7.7 $\alpha$ /13 /	5.57/80 5.51/12				ann.rad./
<sup>170</sup> Os		169.96358	7.1 s	$\beta^+$ , EC/5.0 $\alpha$ /		0+			ann.rad./ (0.162-0.216)
<sup>171</sup> Os		170.96319	8.4 s	$\beta^+$ , EC/98 /7.1 $\alpha$ /19 /	$\alpha$ /5.24/93.5 5.17/6.5				ann.rad./ 0.190-0.705
<sup>172</sup> Os		171.96002	19. s	$\beta^+$ , EC/99 /4.5 $\alpha$ /1.1/		0+			ann.rad./ (0.063-1.120)
<sup>173</sup> Os		172.95981	16. s	$\beta^+$ , EC/6.3 $\alpha$ /0.4 /					ann.rad./ 0.142-0.299
<sup>174</sup> Os		173.95706	44. s	$\beta^+$ , EC/3.9 $\alpha$ /0.02 /	4.94/ 4.76/	0+			0.118 0.138 / 0.001 0.158 0.325
<sup>175</sup> Os		174.95695	1.4 m	$\beta^+$ , EC/5.3					0.125 0.181 0.248
<sup>176</sup> Os		175.95481	3.6 m	$\beta^+$ , EC/3.2		0+			0.8155 0.7758 0.8573 1.2093 1.2909
<sup>177</sup> Os		176.95497	2.8 m	$\beta^+$ , EC/4.5		(1/2-)			0.0848 0.1958 0.3002 1.2686
<sup>178</sup> Os		177.95325	5.0 m	$\beta^+$ , EC/2.3		0+			ann.rad./ 0.5946





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<sup>197</sup> Os			2.8 m	$\beta^-$					0.2239 (0.0412-0.406)
<b><sub>77</sub>Ir</b>		<b>192.217(3)</b>							
<sup>164</sup> Ir		163.9922	0.06 ms	p	1.78				
<sup>165</sup> Ir		164.9875	0.3 ms	p/87 $\alpha$ /13	1.71 6.72				
<sup>166m</sup> Ir			14.3 ms	$\alpha$ /98.2 p/1.8	6.545 1.32				
<sup>166</sup> Ir		165.9858	0.010 s	$\alpha$ /93 p/6.9	6.56 1.15				
<sup>167m</sup> Ir			26. ms	$\alpha$ /48, $\beta^+$ p/32	6.39/90 1.25/0.42				
<sup>167</sup> Ir		166.98167	32. ms	$\alpha$ /80, $\beta^+$ p/0.4	6.35/48 1.06/39.3				
<sup>168</sup> Ir		167.9799	0.16 s	$\alpha$ /82					
<sup>169m</sup> Ir			280. ms	$\alpha$ /	6.12/59				
<sup>169</sup> Ir		168.97630	353. ms	$\alpha$ /	5.99/42				
<sup>170</sup> Ir		169.9750	0.43 s	$\alpha$ /	6.03/				
<sup>171</sup> Ir		170.97163	1.3 s	$\alpha$ /	5.91/				
<sup>172</sup> Ir		171.9705	2.1 s	$\alpha$ /	5.811/				0.228 (0.379-0.475)
<sup>173</sup> Ir		172.96750	3.0 s	$\alpha$ /	5.665/				0.0493 (0.092-0.296)
<sup>174</sup> Ir		173.96686	4. s	$\alpha$ /	5.478/				0.1587 (0.276-1.33)
<sup>175</sup> Ir		174.96411	~ 4.5 s	$\alpha$ /	5.393/				0.1056
<sup>176</sup> Ir		175.96365	8. s	EC, $\beta^+$ /80 $\alpha$ /3.2/	5.118/				0.260 (0.135-0.415)
<sup>177</sup> Ir		176.96130	30. s	EC, $\beta^+$ /5.7 $\alpha$ /0.06/	5.011/				0.184 (0.062-0.194)
<sup>178</sup> Ir		177.96108	12. s	$\beta^+$ , EC/6.3					0.1320 0.2667 0.3633
<sup>179</sup> Ir		178.95912	4. m	EC/4.9					0.0975 (0.045-0.220)
<sup>180</sup> Ir		179.95923	1.5 m	EC/6.4					0.2765 (0.132-1.106)
<sup>181</sup> Ir		180.95763	4.9 m	$\beta^+$ , EC/4.1		(7/2+)			ann.rad./ 0.1076 (0.0196-1.715)
<sup>182</sup> Ir		181.95808	15. m	$\beta^+$ /44 /5.6 EC/56 /					ann.rad./ Os k x-ray 0.1273 0.2370
<sup>183</sup> Ir		182.95685	57. m	$\beta^+$ , EC/3.5					ann.rad./ 0.0877 0.2285 0.2824
<sup>184</sup> Ir		183.95748	3.0 h	$\beta^+$ /12 /4.6 EC/88 /	2.3/ 2.9/	5-	0.70	+2.41	ann.rad./ Os k x-ray 0.11968 0.2640 0.3904
<sup>185</sup> Ir		184.95670	14. h	$\beta^+$ /3 /2.4 EC/97 /		(5/2-)	2.60	-2.1	ann.rad./ Os k x-ray 0.2543 1.8288

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$^{186m}\text{Ir}$			1.7 h	EC /		(2-)	0.64	+1.46	Os k x-ray 0.1371 0.7675
$^{186}\text{Ir}$		185.95795	15.7 h	EC/98 /3.83 $\beta^+$ /2 /		(5+)	3.9	-2.55	Os k x-ray 0.1372 0.2968 0.4348 (0.13-3.0)
$^{187}\text{Ir}$		186.95736	10.5 h	EC/1.50		3/2+		+0.94	Os k x-ray 0.0743 0.4009 0.4271 0.6109 0.9128
$^{188}\text{Ir}$		187.95885	1.72 d	$\beta^+$ /2.81 EC/99+ /	1.13/ 1.64/	(2-)	0.30	+0.48	Os k x-ray 0.1550 0.4780 0.6330 2.2146
$^{189}\text{Ir}$		188.95872	13.2 d	EC/0.53		3/2+	0.13	+0.88	Os k x-ray 0.2449 0.376
$^{190m2}\text{Ir}$			3.09 h	$\beta^+$ , EC/95 / I.T./5 /		(11-)			
$^{190m1}\text{Ir}$			1.12 h	I.T. /0.0263		7+			Ir L x-ray
$^{190}\text{Ir}$		189.960546	11.8 d	EC/2.0		(4+)	0.04	+2.8	Os k x-ray 0.1867 0.4072 0.5186 0.5580 0.6051 (0.2-1.4)
$^{191m}\text{Ir}$			4.93 s	I.T./0.1714		11/2-	+0.603		Ir k x-ray 0.1294
$^{191}\text{Ir}$	37.3(2)	190.960594				3/2+	+0.151	+0.82	
$^{192m2}\text{Ir}$			241. y	I.T./0.161		(9+)			Ir k x-ray
$^{192m1}\text{Ir}$			1.44 m	I.T./0.0580		(1+)			Ir L x-ray 0.0580 0.3165
$^{192}\text{Ir}$		191.962605	73.83 d	$\beta^-$ /1.460		(4-)	+1.92	+2.15	Pt k x-ray 0.31649/83. 0.46806/48.
$^{193m}\text{Ir}$			10.53 d	I.T./0.0802		11/2-			Ir L x-ray 0.0803
$^{193}\text{Ir}$	62.7(2)	192.962926				3/2+	+0.164	+0.75	
$^{194m}\text{Ir}$			170. d	$\beta^-$ /		11			Pt k x-ray 0.3284 0.4829 0.5624
$^{194}\text{Ir}$		193.965078	19.3 h	$\beta^-$ /2.247	1.92/9 2.25/86	1-	+0.39	+0.34	0.2935 0.3284 0.6451 (0.1-2.2)
$^{195m}\text{Ir}$			3.9 h	$\beta^-$ /	0.41/ 0.97/	(11/2-)			Pt k x-ray 0.3199/9.6 0.3649/9.5 0.4329/9.6 0.6849/9.6
$^{195}\text{Ir}$		194.965980	2.8 h	$\beta^-$ /1.120	1.0/80 1.11/13	(3/2+)			Pt k x-ray 0.0989/9.7
$^{196m}\text{Ir}$			1.40 h	$\beta^-$ /	1.16/				Pt k x-ray

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									0.3557
									0.3935
									0.4471
									0.5214
									0.6473
<sup>196</sup> Ir		195.96840	52. s	$\beta^-$ /3.21	2.1/15 3.2/80	0-			0.3329 0.3557 0.7796
<sup>197m</sup> Ir			8.9 m	$\beta^-$ / I.T./		(11/2-)			0.3465 see Ir[197]
<sup>197</sup> Ir		196.96965	5.8 m	$\beta^-$ /2.16	1.5/ 2.0/	(3/2+)			0.0531 0.1351 0.4306
									0.4697
<sup>198</sup> Ir		197.9723	8. s	$\beta^-$ /4.1					0.4074 0.5070
<sup>199</sup> Ir		198.97380							
<b><sub>78</sub>Pt</b>		<b>195.084(9)</b>							
<sup>166</sup> Pt		165.995	0.3 ms	$\alpha$ /	7.11/	0+			
<sup>167</sup> Pt		166.930	0.9 ms	$\alpha$ /	6.98/				
<sup>168</sup> Pt		167.9882	2.1 ms	$\alpha$	6.82	0+			0.582/69 0.594/69 0.725/62
<sup>169</sup> Pt		168.9867	7.0 ms	$\alpha$	6.69				
<sup>170</sup> Pt		169.98250	14.0 ms	$\alpha$	6.55	0+			0.509/100 0.662/86 0.214-0.726
<sup>171</sup> Pt		170.9812	0.05 s	$\alpha$	6.45				0.4450 (0.1564-1.208)
<sup>172</sup> Pt		171.97735	0.10 s	$\alpha$ /	6.31/94	0+			
<sup>173</sup> Pt		172.9764	0.36 s	$\beta^+$ , EC/8.2 $\alpha$ /	6.23 6.20/				
<sup>174</sup> Pt		173.97282	0.89 s	$\beta^+$ , EC/17 /5.6 $\alpha$ /83 /	6.040/	0+			
<sup>175</sup> Pt		174.97242	2.5 s	$\beta^+$ , EC/65 /7.6 $\alpha$ /35 /	5.831/5 5.96/54 6.038/				0.0774 0.1354 0.2128
<sup>176</sup> Pt		175.96895	6.3 s	$\beta^+$ , EC/60 /5.1 $\alpha$ /40 /	5.528/0.6 5.750/41	0+			ann.rad./ 0.2277
<sup>177</sup> Pt		176.96847	11. s	EC/91 /6.8 $\alpha$ /9 /	5.53/ 5.485/3 5.525/6				0.0908
<sup>178</sup> Pt		177.96565	21. s	EC/93 /4.5 $\alpha$ /7 /	5.286/0.2 5.442/7	0+			
<sup>179</sup> Pt		178.96536	33. s	$\beta^+$ , EC/5.7 $\alpha$ /	5.16/		+0.43		
<sup>180</sup> Pt		179.96303	52. s	$\beta^+$ , EC/99.7 /3.7 $\alpha$ /0.3 /	0+ 5.140/				
<sup>181</sup> Pt		180.96310	51. s	$\beta^+$ , EC/5.2			+0.48		
<sup>182</sup> Pt		181.96117	2.7 m	$\beta^+$ , EC/2.9		0+			ann.rad./ 0.1360 0.1460 0.2100
<sup>183m</sup> Pt			43. s	$\beta^+$ , EC/ I.T./		(7/2-)	+0.78	+3.4	ann.rad./ 0.3132/26

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									0.3164/59
									0.6296/100
									0.058-1.75
<sup>183</sup> Pt		182.96160	7. m	$\beta^+$ , EC/4.6			+0.50		ann.rad./
									0.119/100
									0.307/93
									0.260/90
									0.058-1.377
<sup>184</sup> Pt		183.95992	17.3 m	$\beta^+$ , EC/2.3		0+			ann.rad./
									0.1549
									0.1919
									0.5484
<sup>185m</sup> Pt			33. m	$\beta^+$ , EC/		$\frac{1}{2}^-$	+0.5		
<sup>185</sup> Pt		184.96062	1.18 h	$\beta^+$ , EC/3.8		(9/2+)	-0.75	+3.7	ann.rad./
									0.1353
									0.1974
									0.2296
									0.2551
<sup>186</sup> Pt		185.95935	2.0 h	$\beta^+$ , EC/1.38		0+			ann.rad./
									0.6115
									0.6892
<sup>187</sup> Pt		186.96059	2.35 h	$\beta^+$ , EC/3.1		3/2-	-0.41	-1.1	ann.rad./
									Ir k x-ray
									0.1064
									0.1100
									0.2015
									0.2849
									0.7092
<sup>188</sup> Pt		187.95940	10.2 d	EC/0.51		0+			Ir k x-ray
									0.1876
									0.1951
<sup>189</sup> Pt		188.96083	10.9 h	$\beta^+$ , EC/1.97		3/2-	-0.43	-1.2	Ir k x-ray
									0.0943
									0.6076
									0.7214
									(0.09-1.47)
<sup>190</sup> Pt	0.014(1)	189.95993	$4.5 \times 10^{11}$ y			0+			
<sup>191</sup> Pt		190.961677	2.86 d	EC/1.02		(3/2-)	-0.50	-0.9	Ir k x-ray
									0.3599
									0.4094
									0.5389
<sup>192</sup> Pt	0.782(7)	191.961038				0+			
<sup>193m</sup> Pt			4.33 d	I.T./0.1498		13/2+	-0.75		Pt k x-ray
									0.1355
<sup>193</sup> Pt		192.962988	60. y	EC/0.0566		(1/2-)	+0.60		Ir k x-rays
<sup>194</sup> Pt	32.967(99)	193.962680				0+			
<sup>195m</sup> Pt			4.01 d	I.T./0.2952		13/2+	-0.61	+1.4	Pt k x-ray
									0.0989
<sup>195</sup> Pt	33.832(10)	194.964791				1/2-	+0.6095		
<sup>196</sup> Pt	25.242(41)	195.964952				0+			
<sup>197m</sup> Pt			1.590 h	I.T./97 / $\beta^-$ /3 /		13/2+			Pt k x-ray
									0.0530
									0.3465
<sup>197</sup> Pt		196.967340	19.9 h	$\beta^-$ /0.719		1/2-	0.51		Au k x-ray
									0.1914
									0.2688
<sup>198</sup> Pt	7.163(55)	197.967893				0+			
<sup>199m</sup> Pt			13.6 s	I.T./0.424		13/2+			Pt k x-ray
									0.3919
<sup>199</sup> Pt		198.970593	30.8 m	$\beta^-$ /1.70	0.90/18	(5/2-)			0.3170/3.88

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					1.14/14				0.49375/4.47
									0.5430/11.7
									(0.055-1.293)
<sup>200</sup> Pt		199.971441	12.5 h	$\beta^-$ /~ 0.66		0+			Au k x-ray
									0.13590
									0.22747
									0.24371
<sup>201</sup> Pt		200.97451	2.5 m	$\beta^-$ /2.66		(5/2-)			0.070
									0.152
									0.222
									1.760
<sup>202m</sup> Pt			0.3 ms						(0.535-0.719)
<sup>202</sup> Pt		201.9757	1.8 d			0+			0.440
<b><sup>79</sup>Au</b>		<b>196.966569(4)</b>							
<sup>170m</sup> Au			0.62 ms	p/58	1.74/				
				$\alpha$ /42	7.11/				
<sup>170</sup> Au		169.9961	0.30 ms	p/89	1.46/				
				$\alpha$ /11	7.00/				
<sup>171m</sup> Au			1.09 ms	$\alpha$ /66	6.995				
				p/34	1.694				
<sup>171</sup> Au		170.99188	0.022 ms	p/100	1.437				
<sup>172</sup> Au		171.9900	4 ms	$\alpha$ /7.02	6.86				
<sup>173m</sup> Au			15 ms	$\alpha$ /92	6.732				
<sup>173</sup> Au		172.98624	0.02 s	$\alpha$ /94	6.672				
<sup>174</sup> Au		173.9848	0.14 s	$\alpha$	6.54				
<sup>175</sup> Au		174.98127	0.15 s	$\alpha$					
<sup>176</sup> Au		175.9801	0.9 s	$\beta^+$ , EC/10.5					
				$\alpha$ /	6.260/80				
					6.290/20				
<sup>177</sup> Au		176.97687	1.2 s	$\alpha$ /	6.115/				
					6.150/				
<sup>178</sup> Au		177.9760	2.6 s	$\alpha$ /	5.920/				
<sup>179</sup> Au		178.97321	7.5 s	$\alpha$ /	5.85/				
<sup>180</sup> Au		179.97252	8.1 s	EC/8.6	5.65				0.1522
				$\alpha$ /	5.61				0.2564
					5.50				0.5242
									0.6765
									0.8084
									0.8597
<sup>181</sup> Au		180.97008	11.4 s	EC/97.5/6.3	5.482/				
				$\alpha$ /2.7/					
<sup>182</sup> Au		181.96962	21. s	$\beta^+$ , EC/6.9					ann.rad./
				$\alpha$ /0.13/					0.1549
									0.2649
									(0.13-1.4)
<sup>183</sup> Au		182.96759	42. s	EC/5.5			+1.97		0.1630
				$\alpha$ /0.8/					0.2730
									0.3625
<sup>184m</sup> Au			48 s	I.T.		(2+)	+1.44	+1.9	0.069(IT)
<sup>184</sup> Au		183.96745	21. s	EC, $\beta^+$ /7.1		(5+)	+2.07	+4.7	
				$\alpha$ /0.013/					
<sup>185m</sup> Au			6.8 m	$\beta^+$ , EC/					
				I.T./0.145					
<sup>185</sup> Au		184.96579	4.3 m	$\beta^+$ , EC/4.71		(5/2-)	+2.17	-1.1	ann.rad./
				$\alpha$ /0.26/					
<sup>186m</sup> Au			< 2. m	$\beta^+$ , EC/					0.1915
<sup>186</sup> Au		185.96595	10.7 m	$\beta^+$ , EC/6.0		3-	-1.26	+3.1	ann.rad./

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				$\alpha/8(10)^{-4}$					0.1915
									0.2988
<sup>187m</sup> Au			2.3 s	IT		9/2-			
<sup>187</sup> Au		186.96457	8.3 m	$\beta+$ , EC/3.60		1/2+	+0.54		ann.rad./
									0.9152
									1.2668
									1.3321
									1.4081
<sup>188</sup> Au		187.96532	8.8 m	$\beta+$ , EC/5.3		(1-)	-0.07		ann.rad./
									0.2660
									0.3404
									0.6061
<sup>189m</sup> Au			4.6 m	$\beta+$ , EC/		11/2-	+6.19		0.1667
<sup>189</sup> Au		188.96395	28.7 m	EC/96 /3.2		1/2+	+0.49		ann.rad./
				$\beta+$ /4 /					Pt k x-ray
									0.4478
									0.7133
									0.8128
<sup>190</sup> Au		189.96470	43. m	$\beta+$ /2 /4.44		1-	-0.07		ann.rad./
				EC/98 /					Pt k x-ray
									0.2958
									0.3018
									0.5977
<sup>191m</sup> Au			0.9 s	IT./0.2663		(11/2-)	6.6		Au k x-ray
									0.2414
									0.2526
<sup>191</sup> Au		190.96370	3.2 h	EC/1.83		3/2+	+0.137	+0.72	Pt k x-ray
									0.5864/16
									(0.088-1.30)
<sup>192</sup> Au		191.96481	4.9 h	$\beta+$ /5 /3.52	2.19/	1-	-0.011	-0.23	ann.rad./
				EC/95 /	2.49/				Pt k x-ray
									0.2959
									0.3165
<sup>193m</sup> Au			3.9 s	IT./0.2901		11/2-	6.2	+1.98	Au k x-ray
									0.2580
<sup>193</sup> Au		192.96415	17.6 h	EC/1.07		3/2+	+0.140	+0.66	Pt k x-ray
									0.1862
									0.2556
<sup>194</sup> Au		193.96537	1.64 d	$\beta+$ /3 /2.49	1.49/	1-	+0.076	-0.24	ann.rad./
				EC/97 /					Pt k x-ray
									0.2935
									0.3284/61
<sup>195m</sup> Au			30.5 s	IT./0.3186		11/2-	6.2	+1.9	Au k x-ray
									0.2617
<sup>195</sup> Au		194.965035	186.10 d	EC/0.227		3/2+	+0.149	+0.61	Pt k x-ray
<sup>196m2</sup> Au			9.7 h	IT./0.5954		12-	5.7		Au k x-ray
									0.1478
									0.1883
<sup>196m1</sup> Au			8.1 s	IT./0.0846		8+			0.0847
<sup>196</sup> Au		195.966570	6.17 d	EC/92 /1.506		2-	+0.591	0.81	Pt k x-ray
<sup>197m</sup> Au			7.8 s	IT./0.4094		11/2-	+6.0	+1.7	Au k x-ray
				$\beta-$ /8 /0.686					0.1302
									0.2790
<sup>197</sup> Au	100.	196.966569				3/2+	+0.14575	+0.55	
<sup>198m</sup> Au			2.30 d	IT./0.812		(12-)			Au k x-ray
									0.0972
									0.1803
									0.2419
<sup>198</sup> Au		197.968242	2.695 d	$\beta-$ /1.372	0.290/1	2-	+0.5934	+0.64	Hg k x-ray
					0.961/99				0.411794

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<sup>199</sup> Au		198.968765	3.14 d	$\beta^-$ /0.453	0.25/22 0.292/72 0.462/6	3/2+	+0.2715	+0.51	Hg k x-ray 0.15837 0.20820
<sup>200m</sup> Au			18.7 h	$\beta^-$ /84 /1.0 I.T./16 /	0.56/	12-	5.9		Au k x-ray 0.2559/71 0.3680/77 0.4978/73 0.5793/72 0.084-0.904)
<sup>200</sup> Au		199.97073	48.4 m	$\beta^-$ /2.24	0.7/15 2.2/77	1-			0.3679/19 1.2254/10.6 (0.077-1.570)
<sup>201</sup> Au		200.971657	26. m	$\beta^-$ /1.28	1.27/82	3/2+			(0.027-0.732)
<sup>202</sup> Au		201.9738	29. s	$\beta^-$ /3.0		(1-)			0.4396
<sup>203</sup> Au		202.975155	1.0 m	$\beta^-$ /2.14	~ 1.9/	3/2+			(0.04-0.37)
<sup>204</sup> Au		203.9777	40. s	$\beta^-$ /4.5		(2-)			0.4366 1.5113
<sup>205</sup> Au		204.9799	31. s	$\beta^-$ /					(0.38-1.33)
<b><sub>80</sub>Hg</b>		<b>200.59(2)</b>							
<sup>171</sup> Hg		171.0038	0.06 ms	$\alpha$	7.49				
<sup>172</sup> Hg		171.9988	0.3 ms	$\alpha$	7.36	0+			
<sup>173</sup> Hg		172.9972	0.8 ms	$\alpha$	7.20				
<sup>174</sup> Hg		173.99286	1.9 ms	$\alpha$	7.07	0+			
<sup>175</sup> Hg		174.9914	0.02 s	$\alpha$					
<sup>176</sup> Hg		175.98736	21 ms	$\alpha$	6.74/94	0+			
<sup>177m</sup> Hg			1.5 $\mu$ s	IT					0.246
<sup>177</sup> Hg		176.9863	0.13 s	$\alpha$	6.58				
<sup>178</sup> Hg		177.98248	0.26 s	EC/50 /6.1 $\alpha$ /50 /	6.43/	0+			
<sup>179</sup> Hg		178.98183	1.05 s	EC/8.0 $\alpha$ /	6.29/				
<sup>180</sup> Hg		179.97827	2.6 s	EC/5.5 $\alpha$ /	6.12/33 5.69/.03	0+			0.1250 0.3005 0.3812
<sup>181</sup> Hg		180.97782	3.6 s	$\beta^+$ EC/76 /~ 7.3 $\alpha$ /24 /		(1/2-)	+0.507		0.0663 0.0811 0.0924 0.1474 0.1587 0.2142 0.2398
<sup>182</sup> Hg		181.97469	10.8 s	$\beta^+$ , EC/85/5.0 $\alpha$ /15/	5.87/8.6 5.45/0.03	0+			0.129/122 0.2176/66 0.0256-0.543
<sup>183</sup> Hg		182.97445	9. s	$\beta^+$ , EC/77/6.3 $\alpha$ /	5.83/	1/2-	+0.524		0.0714 0.0874 0.1538
<sup>184</sup> Hg		183.97171	30.9 s	$\beta^+$ , EC/99/4.1 $\alpha$ /1/	5.91/	0+			0.1565/102 0.2367/100 0.2384/18 (0.018-0.4227)
<sup>185m</sup> Hg			21. s	$\beta^+$ , EC, IT, $\alpha$ /	5.37/	13/2+	-1.02	+0.2	0.211 0.292
<sup>185</sup> Hg		184.97190	51. s	$\beta^+$ , EC/95/5.8		1/2-	+0.509		0.02-0.55
<sup>186</sup> Hg		185.96936	1.4 m	$\beta^+$ , EC/3.3 $\alpha$	5.09/0.02	0+			0.1119 0.2518
<sup>187m</sup> Hg			1.7 m	$\beta^+$ , EC/		13/2+	-1.04	+0.5	see Hg187
<sup>187</sup> Hg		186.96981	2.4 m	$\beta^+$ , EC/4.9		3/2-	-0.594	-0.8	0.1034/32

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									0.2334/100
									0.2403/33
									0.27151/31
									0.3763/38
									0.5254/30
									0.10–2.18
<sup>188</sup> Hg		187.96758	3.2 m	$\beta^+$ , EC/2.3		0+			0.0988
				$\alpha$	4.61				0.1148
									0.1424
									0.1900
<sup>189m</sup> Hg			8.6 m	EC/		13/2+	-1.06	+0.7	0.0780
									0.3210
									0.4345
									0.5655
									(0.08–2.170)
<sup>189</sup> Hg		188.96819	7.6 m	EC/4.2		3/2-	-0.6086	-0.8	0.2005
									0.2038
									0.2386
									0.2485
<sup>190</sup> Hg		189.96632	20.0 m	EC/1.5		0+			0.1296
									0.1426
<sup>191m</sup> Hg			51. m	$\beta^+$ /6 / EC/94 /		13/2+	-1.07	+0.6	ann.rad./ Au k x-ray
									0.2741
									0.4203
									0.5787
									(0.07–1.9)
<sup>191</sup> Hg		190.96716	50. m	$\beta^+$ , EC/3.2		(3/2-)	-0.62	-0.8	0.1963
									0.2247
									0.2524
<sup>192</sup> Hg		191.96563	5.0 h	EC/~ 0.5		0+			Au k x-ray
									0.1572
									0.2748
									0.3065
<sup>193m</sup> Hg			11.8 h	$\beta^+$ , EC/91 / I.T./9 /0.2901		13/2+	-1.05843	+0.92	Hg k x-ray
									0.1866
									0.2580
									0.4076
									0.5733
									0.9324
									(0.1–1.96)
<sup>193</sup> Hg		192.96667	3.8 h	EC, B+/2.34		3/2-	-0.6276	-0.7	0.1866
									0.2580
									0.8611
<sup>194</sup> Hg		193.96544	520. y	EC/0.04		0+			Au L x-rays
<sup>195m</sup> Hg			1.67 d	I.T./((54)/0.3186 EC/(46)/		13/2+	-1.04465	+1.1	Hg k x-ray Au k x-ray
									0.2617
									0.5603
									0.7798
<sup>195</sup> Hg		194.96672	10.5 h	EC/1.51		1/2-	+0.541475		Au k x-ray
									0.0614
									0.7798
<sup>196</sup> Hg	0.15(1)	195.965833	>2.5 × 10 <sup>18</sup> y			0+			
<sup>197m</sup> Hg			23.8 h	I.T./((93)/0.2989		13/2+	-1.02768	+1.2	Hg k x-ray Au k x-ray
									0.13398
<sup>197</sup> Hg		196.967213	2.69 d	EC/0.600		1/2-	+0.527374		Au k x-ray
									0.07735
<sup>198</sup> Hg	9.97(20)	197.9667690				0+			



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<sup>199m</sup> Hg			42.7 m	I.T./0.532		13/2+	-1.014703	+1.2	Hg k x-ray 0.15841
<sup>199</sup> Hg	16.87(22)	198.9682799				1/2-	+0.505885		
<sup>200</sup> Hg	23.10(19)	199.9683260				0+			
<sup>201</sup> Hg	13.18(9)	200.970302				3/2-	-0.560226	+0.39	
<sup>202</sup> Hg	29.86(26)	201.970643				0+			
<sup>203</sup> Hg		202.972873	46.61 d	$\beta^-$ /0.492	0.213/100	5/2-	+0.8489	+0.34	Tl k x-ray 0.279188
<sup>204</sup> Hg	6.87(15)	203.9734939				0+			
<sup>205</sup> Hg		204.976073	5.2 m	$\beta^-$ /1.531	1.33/4	1/2-	+0.6010		0.20378 (0.2-1.4)
<sup>206</sup> Hg		205.97751	8.2 m	$\beta^-$ /1.31	0.935/34 1.3/63	0+			Tl k x-ray 0.3052 0.6502
<sup>207</sup> Hg		206.9826	2.9 m	$\beta^-$ /4.8		(9/2+)			
<sup>208</sup> Hg		207.9859	41. m	$\beta^-$		0+			0.474
<sup>209</sup> Hg		208.9910	36 s	$\beta^-$					0.324
<sup>210</sup> Hg		209.9945	> 0.3 $\mu$ s	$\beta^-$		0+			
<b><sub>81</sub>Tl</b>		<b>204.3833(2)</b>							
<sup>176</sup> Tl		176.0006	5 ms	p	1.26/~ 100				
<sup>177m</sup> Tl			0.23 ms	p/51 $\alpha$ /49	1.95 7.48				
<sup>177</sup> Tl		176.99643	0.017 s	$\alpha$ /73 p/27					
<sup>178</sup> Tl		177.9949	0.25 s	$\alpha$ /	6.704 6.785 6.62 6.859				
<sup>179m</sup> Tl			1.7 ms	$\alpha$	/7.21/80 /7.10/20				
<sup>179</sup> Tl		178.99109	0.3 s	$\alpha$	6.57/				
<sup>180</sup> Tl		179.9899	1.5 s	$\alpha$ /8	6.28/30 6.36/30 6.21/18 6.56/15 6.47/7				
<sup>181m</sup> Tl			1.4 ms	$\alpha$	6.58/100				
<sup>181</sup> Tl		180.98626	3.2 ms	$\alpha$ / < 10	6.19/100				
<sup>182</sup> Tl		181.9857	3. s	$\beta^+$ , EC/10.9					0.351 (0.26-0.41)
<sup>183m</sup> Tl			53. ms	$\alpha$	6.33/80 6.38/16 6.46/4	9/2-			0.0618 (0.046-0.0894)
<sup>183</sup> Tl		182.98219	5. s	$\beta^+$ , EC/7.7		$\frac{1}{2}+$			0.208
<sup>184</sup> Tl		183.98187	11. s	$\beta^+$ , EC/(98)/9.2 $\alpha$ /(2)/	6.16/				0.2868 0.3399 0.3667
<sup>185m</sup> Tl			1.8 s	I.T./0.453 $\alpha$ /5.97	6.01	(9/2-)			0.1688 0.2840
<sup>185</sup> Tl		184.9788	20. s	EC/ $\beta^+$ /6.6					
<sup>186m</sup> Tl			4. s	I.T./0.374					0.3738
<sup>186</sup> Tl		185.9783	28. s	$\beta^+$ , EC/7.5					0.3567 0.4026 0.4053
<sup>187m</sup> Tl			15.6 s	I.T./~ 0.33		(9/2+)	+3.8	-2.4	0.2995
<sup>187</sup> Tl		186.97591	50. s	$\beta^+$ , EC/6.0		$\frac{1}{2}+$	1.6		
<sup>188m</sup> Tl			1.18 m	$\beta^+$ , EC/		(7+)			Hg k x-ray 0.4129



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									0.6954 (0.08-1.0)
<sup>196</sup> Tl		195.97048	1.84 h	$\beta^+$ / (15)/4.4 EC/(85)/		2-	+0.072	-0.18	ann.rad./ Hg k x-ray 0.4257 0.6105 (0.03-2.4)
<sup>197m1</sup> Tl			0.54 s	IT/53/0.608 $\beta^+$ , EC/47/		9/2-			Tl k x-ray 0.2262 0.4118 0.5872 0.6367
<sup>197</sup> Tl		196.96958	2.83 h	$\beta^+$ / (1)/2.18 EC/(99)/		1/2+	+1.58		Hg k x-ray 0.1522/8.2 0.4258
<sup>198m1</sup> Tl			1.87 h	$\beta^+$ , EC/(53)/ IT/47/0.5347		7+	+0.64		Hg k x-ray Tl k x-ray 0.4118 0.5872 0.6367
<sup>198</sup> Tl		197.9405	5.3 h	EC, $\beta^+$ / (1)/3.5	1.4/ 2.1/ 2.4/	2-			Hg k x-ray 0.4118 0.6367 0.6759 (0.23-2.8)
<sup>199</sup> Tl		198.96988	7.4 h	EC/1.4		1/2-	+1.60		Hg k x-ray 0.2082 0.2473 0.4555
<sup>200</sup> Tl		199.97096	1.087 d	EC/2.46	1.07/ 1.44/	2-	0.04		Hg k x-ray 0.36799 1.2057 (0.11-2.3)
<sup>201</sup> Tl		200.97082	3.038 d	EC/0.48		1/2+	+1.605		Hg k x-ray 0.13528 0.16740/10.0
<sup>202</sup> Tl		201.97211	12.47 d	EC/1.36		2-	0.06		Hg k x-ray 0.43957
<sup>203</sup> Tl	29.524(14)	202.972344				1/2+	+1.622258		
<sup>204</sup> Tl		203.973864	3.78 y	$\beta^-$ /97/0.7637 EC/(3)/0.347	0.763/97	2-	0.09		Hg k x-ray
<sup>205</sup> Tl	70.476(14)	204.974428				1/2+	+1.638215		
<sup>206m1</sup> Tl			3.76 m	I.T./2.644		12-			Tl k x-ray 0.2166 0.2661 0.4534 0.6866 1.0219
<sup>206</sup> Tl		205.976110	4.20 m	$\beta^-$ /1.533	1.53/99.9	0-			Pb k x-ray 0.80313
<sup>207m1</sup> Tl			1.3 s	I.T./1.350		11/2-			Tl k x-ray 0.3501 1.0000
<sup>207</sup> Tl		206.97742	4.77 m	$\beta^-$ /1.423	1.43/99.8	1/2+	+1.88		0.89723
<sup>208</sup> Tl		207.982019	3.053 m	$\beta^-$ /5.001	1.28/23 1.52/22 1.796/51	(5+)	+0.29		Pb k x-ray 0.27728 0.51061 0.58302 2.61448
<sup>209</sup> Tl		208.98536	2.16 m	$\beta^-$ /3.98	1.8 /100	(1/2+)			Pb k x-ray



Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>193m</sup> Pb			5.8 m	$\beta+$ , EC/		13/2+	-1.15	+0.19	ann.rad./ 0.3650 0.3922
<sup>193</sup> Pb	192.97617		~ 2. m	EC/5.2		3/2 (-)			
<sup>194</sup> Pb	193.97401		10. m	$\beta+$ , EC/2.7 $\alpha$	4.64	0+			ann.rad./ 0.2036
<sup>195m</sup> Pb			15. m	$\beta+$ /(8)/ EC/(92)/		13/2+	-1.132	+0.30	ann.rad./ Tl k x-ray 0.3836 0.3942 0.8784
<sup>195</sup> Pb	194.97454		~ 15. m	$\beta+$ , EC/5.8					ann.rad./ 0.3836 0.3937 0.7776
<sup>196</sup> Pb	195.97277		37. m	$\beta+$ , EC/2.1		0+			Tl k x-ray 0.2531 0.5021
<sup>197m</sup> Pb			43. m	EC/79/ $\beta+$ /2/ IT/19/0.3193		13/2+	-1.104	+0.38	Tl k x-ray 0.3079 0.3877 0.7743 (0.2-2.2)
<sup>197</sup> Pb	196.97343		~ 8. m	EC/97/3.6 $\beta+$ /3/		(3/2-)	-1.075	-0.08	Tl k x-ray 0.3755 0.3858 0.7611
<sup>198</sup> Pb	197.97203		2.4 h	EC/1.4		0+			Tl k x-ray 0.1734 0.2903 0.3654
<sup>199m</sup> Pb			12.2 m	IT/93/0.4248 $\beta+$ , EC/(7)/		13/2+			Pb k x-ray 0.4255
<sup>199</sup> Pb	198.97292		1.5 h	EC/(99)/2.9 $\beta+$ /(1)/		5/2-	-1.074	+0.08	Tl k x-ray 0.3534 0.7202 1.1350 (0.22-2.4)
<sup>200</sup> Pb	199.97183		21.5 h	EC/0.81		0+			Tl k x-ray 0.14763
<sup>201m</sup> Pb			1.02 m	I.T./0.6291		13/2+			Pb k x-ray 0.6288
<sup>201</sup> Pb	200.97289		9.33 h	EC/1.90		5/2-	+0.675	-0.009	Tl k x-ray 0.33120 0.36131 (0.11-1.8)
<sup>202m</sup> Pb			3.53 h	IT/90/2.170 $\beta+$ /10/		9-	-0.228	+0.58	Pb k x-ray Tl k x-ray 0.42219 0.78700 0.96271
<sup>202</sup> Pb	201.97216		$5.3 \times 10^4$ y	EC/0.05		0+			Tl L x-ray
<sup>203m</sup> Pb			6.2 s	I.T./0.8252		13/2+			Pb k x-ray 0.8203 0.8252
<sup>203</sup> Pb	202.97339		2.163 d	EC/0.98		5/2-	+0.686	+0.10	Tl k x-ray 0.279188
<sup>204m</sup> Pb			1.13 h	I.T./2.185		9-			Pb k x-ray 0.37481 0.89922





Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
									0.80313
									0.88100
<sup>207</sup> Bi		206.978471	31.55 y	EC/2.399		9/2-	4.08	-0.6	Pb k x-ray 0.56915
									1.06310
<sup>208</sup> Bi		207.979742	$3.68 \times 10^5$ y	EC/2.880		5+	4.63	-0.64	Pb k x-ray 2.61435
<sup>209</sup> Bi	100.	208.980399	$1.9 \times 10^{19}$ y	$\alpha$	3.13	9/2-	+4.111	-0.37	
<sup>210m</sup> Bi			$3.0 \times 10^6$ y	$\alpha$ /	4.420(3)/0.29	9-	+2.73	-0.47	Tl k x-ray 0.2661
					4.569(3)/3.9				0.3052
					4.584(3)/1.4				0.6502
					4.908(4)/39				4.946(3)/55
<sup>210</sup> Bi		209.984120	5.01 d	$\beta^-$ /1.163	1.16/99	1-	-0.0445	+0.136	0.2661 0.352
<sup>211</sup> Bi		210.98727	2.14 m	$\alpha$ /(99.7)/ $\beta^-$ /(0.3)/0.58	6.279/16 6.623/84	9/2-			Tl k x-ray 0.3501
<sup>212m2</sup> Bi			7. m	$\beta^-$ /		(15-)			
<sup>212m1</sup> Bi			25.0 m	$\alpha$ /(93)/ $\beta^-$ /(7)/	6.300/40 6.340/53	(9-)			0.120 0.233 0.275 0.404 0.727
<sup>212</sup> Bi		211.991286	1.009 h	$\beta^-$ /(64)/2.254 $\alpha$ /(36)/	6.051/25 6.090/9.6	(1-)	+0.32	+0.1	Tl k x-ray Po k x-ray 0.2881 0.72725 0.78551 1.62066
<sup>213</sup> Bi		212.994385	45.6 m	$\beta^-$ /(98)/1.43 $\alpha$ /(2)/	1.02/31 1.42/66 5.549/0.16 5.869/2.0	9/2-	+3.72	-0.60	Po k x-ray 0.4404 (0.15-1.328)
<sup>214</sup> Bi		213.99871	19.7 m	$\beta^-$ /3.27					1.10006 0.60931 1.12027 1.76449 (0.19-3.2)
<sup>215m</sup> Bi			37. s	$\beta$					(0.158-0.498)
<sup>215</sup> Bi		215.00177	7.7 m	$\beta^-$ /2.3					0.2937/35.2 (0.271-1.399)
<sup>216</sup> Bi		216.00631	2.3 m	$\beta^-$ /4.0					0.5498 0.4192
<sup>217</sup> Bi		217.0095	98 s	$\beta$ /					0.2646/100 (0.254-1.017)
<sup>218</sup> Bi		218.0143	33. s	$\beta^-$					0.5097/134 0.3857/100 (0.174-0.703)
<b><sup>84</sup>Po</b>									
<sup>188</sup> Po		187.99942	0.27 ms	$\alpha$	7.91/80 7.320	0+			
<sup>189</sup> Po		188.99848	5 ms	$\alpha$	7.532/8 7.259/80 7.309/12				
<sup>190</sup> Po		189.99510	2.4 ms	$\alpha$ /	7.53/96.4 7.01/3.3	0+			
<sup>191m</sup> Po			93. ms	$\alpha$	7.376/50 6.888/46				



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<sup>191</sup> Po		190.99457	22 ms	$\alpha$ /	7.334/77 6.97/8				
<sup>192</sup> Po		191.99134	32. ms	$\alpha$ /8.5	7.17/98.6 6.59/1.4	0+			
<sup>193m</sup> Po			$\sim 0.07$ s	$\alpha$ /	7.00				
<sup>193</sup> Po		192.99103	0.45 s	$\alpha$ /	6.95				
<sup>194</sup> Po		193.98819	0.2 s	$\alpha$ /	6.84/93 6.19/0.22	0+			
<sup>195m</sup> Po			$\sim 2.8$ s	$\alpha$ /	6.70/				
<sup>195</sup> Po		194.98811	$\sim 3.9$ s	$\alpha$ /	6.62/				
<sup>196</sup> Po		195.98554	5. s	$\alpha$ /(95)/ $\beta$ +, EC/(5)/ $\sim 4.6$	6.53/94 5.77/0.02	0+			
<sup>197m</sup> Po			25.8 s	$\alpha$ /(84)/ $\beta$ +, EC/(16)/	6.385(3)/55	13/2+			
<sup>197</sup> Po		196.98566	53. s	$\alpha$ /(44)/ $\beta$ +, EC/(56)/6.2	6.282(4)/76	(3/2-)			
<sup>198</sup> Po		197.98339	1.76 m	$\alpha$ /(70)/ $\beta$ +, EC/(30)/4.0	6.18/57 5.27/7.6 $\times 10^{-4}$	0+			
<sup>199m</sup> Po			4.2 m	$\beta$ +, EC/(51)/ $\alpha$ /(39)/		13/2+	0.99		ann.rad./ 0.2745 0.4998 1.0020
<sup>199</sup> Po		198.98367	5.2 m	$\beta$ +, EC/(88)/7. $\alpha$ /(12)/		(3/2-)			Bi k x-ray 0.1877 0.3616 1.0214 1.0344
<sup>200</sup> Po		199.981780	11.5 m	$\beta$ +, EC/85/3.4 $\alpha$ /(15)/		0+			0.14748 0.32792 0.6176 0.6709
<sup>201m</sup> Po			8.9 m	$\beta$ +, EC/(57)/ IT/40/0.418 $\alpha$ /(3)/		13/2+	1.00		Bi k x-ray Po k x-ray 0.2726 0.4123 0.4179 0.9670
<sup>201</sup> Po		200.98226	15.3 m	$\beta$ +, EC/98/4.9 $\alpha$ /(2)/		3/2-	0.94		Bi k x-ray 0.2056 0.2250 0.8483 0.9048
<sup>202</sup> Po		201.98076	45. m	$\beta$ +, EC/98/2.8 $\alpha$ /(2)/		0+			0.0410 0.1656 0.3158 0.6884
<sup>203m</sup> Po			1.2 m	IT/96/0.6414 $\beta$ -EC/(4)/		13/2+			Bi k x-ray Po k x-ray 0.6414
<sup>203</sup> Po		202.98142	35. m	$\beta$ +, EC/4.2		5/2-	+0.74		0.17516 0.21477 0.89350 0.90863 1.09095
<sup>204</sup> Po		203.98032	3.53 h	EC/2.34 $\alpha$		0+			Bi k x-ray 0.2702 0.8844 1.0162 (0.11-1.9)
<sup>205</sup> Po		204.98120	1.7 h	$\beta$ +, EC/3.53		5/2-	+0.76	+0.17	Bi k x-ray

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									0.83681
									0.84983
									0.87241
									1.00124
									(0.12–2.7)
<sup>206</sup> Po		205.98048	8.8 d	EC/(95)/1.85 $\alpha$ /(5)/	5.223/5.5	0+			Bi k x-ray
									0.28644
									0.31156
									0.51134
									0.80737
									1.03228
									(0.11–1.5)
<sup>207m</sup> Po			2.8 s	IT/1.383		19/2-			Po k x-ray
									0.2682
									0.30074
									0.81448
<sup>207</sup> Po		206.98159	5.80 h	EC, $\beta$ +/2.91		5/2-	+0.79	+0.28	Bi k x-ray
									0.74263
									0.91176
									0.99225
<sup>208</sup> Po		207.981246	2.898 y	$\alpha$ /5.213	4.233/0.0002 5.1158/100	0+			
<sup>209</sup> Po		208.982430	102. y	$\alpha$ /4.976	4.624/0.56 4.879/99.2	1/2-	$\sim +0.77$		0.26049
									0.8964
<sup>210</sup> Po		209.982874	138.4 d	$\alpha$ /5.407	4.516/0.001 5.304/100	0+			0.80313
<sup>211m</sup> Po			25.2 s	$\alpha$ /	7.273/91 7.994/1.7 8.316/0.25 8.875/7.0	25/2+			Pb k x-ray
									0.32808
									0.56915
									0.89723
									1.06310
<sup>211</sup> Po		210.986653	0.516 s	$\alpha$ /7.594	6.570/0.54 6.892/0.55 7.450/98.9	9/2+			0.56915
									0.89723
<sup>212m</sup> Po			45. s	$\alpha$ /	8.514/2.0 9.086/1.0 11.650/97	16+			
<sup>212</sup> Po		211.988868	0.298 $\mu$ s	$\alpha$ /8.953	8.784/100	0+			
<sup>213</sup> Po		212.992857	3.7 $\mu$ s	$\alpha$ /8.537	7.614/0.003 8.375/100	9/2+			
<sup>214</sup> Po		213.995201	163.7 $\mu$ s	$\alpha$ /7.833	6.904/0.01 7.686/99.99	0+			0.7995
									0.298
<sup>215</sup> Po		214.999420	1.780 ms	$\alpha$ /7.526	6.950/0.02 6.957/0.03 7.386/100	(9/2+)			
<sup>216</sup> Po		216.001915	0.145 s	$\alpha$ /6.906	5.895/0.002 6.778/99.99	0+			
<sup>217</sup> Po		217.00634	1.53 s	$\alpha$ /6.662	6.539/				
<sup>218</sup> Po		218.008973	3.04 m	$\alpha$ /6.114	6.003/99.999 5.181/0.11	0+			
<sup>219</sup> Po		219.0137	$\sim 2$ m						
<sup>220</sup> Po		220.0166	$> 0.3$ $\mu$ s			0+			
<sup>85</sup> At									
<sup>191m</sup> At			2.1 ms	$\alpha$	7.65/98 7.72/2				
<sup>191</sup> At			$\sim 1.7$ ms	$\alpha$	7.55/100				
<sup>193m</sup> At			21 ms	$\alpha$	7.33/98 7.42/2				



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									0.78189
									0.79020
									(0.1–2.6)
<sup>210</sup> At		209.98715	8.1 h	EC/99.8/3.98		5+			Po k x-ray
				$\alpha$ /(0.2)/5.632	5.361/0.05				0.24535
					5.442/0.05				0.52758
									1.18143
									1.43678
									1.48335
									(0.04–2.4)
<sup>211</sup> At		210.987496	7.21 h	EC/(58)/0.787		9/2-			Po k x-ray
				$\alpha$ /(42)/5.980	5.211/0.004				0.66956
					5.868/42				0.6870
									0.74263
<sup>212m</sup> At			0.119 s	$\alpha$ /	7.837/65	(9-)			
					7.897/33				
<sup>212</sup> At		211.99075	0.314 s	$\alpha$ /7.828	7.058/0.4	(1-)			
					7.088/0.6				
					7.618/15				
					7.681/84				
<sup>213</sup> At		212.992937	0.11 $\mu$ s	$\alpha$ /9.254	9.080/	9/2-			
<sup>214m</sup> At			0.76 $\mu$ s	$\alpha$ /8.762		(9-)			
<sup>214</sup> At		213.996372	0.56 $\mu$ s	$\alpha$ /8.987	8.819/100	(1-)			
<sup>215</sup> At		214.99865	0.10 ms	$\alpha$ /8.178	7.626/0.045	(9/2-)			0.40486
					8.023/99.9				
<sup>216</sup> At		216.002423	0.30 ms	$\alpha$ /7.947	7.595/0.2	(1-)			
					7.697/2.1				
					7.800/97				
<sup>217</sup> At		217.004719	32. ms	$\alpha$ /7.202	6.812/0.06	(9/2-)			0.2595
					7.067/99.9				0.3345
									0.5940
<sup>218</sup> At		218.00869	1.6 s	$\alpha$ /6.883	6.654/6				
					6.695/90				
					6.748/4				
<sup>219</sup> At		219.011162	50. s	$\alpha$ /6.390	6.275/				
<sup>220</sup> At		220.0154	3.71 m	$\beta^-$ /3.7					(0.24–0.70)
<sup>221</sup> At		221.0181	2.3 m	$\beta$					
<sup>222</sup> At		222.0223	0.9 m	$\beta$					
<sup>223</sup> At		223.0252	50. s	$\beta$					
<b><sup>86</sup>Rn</b>									
<sup>195m</sup> Rn			5 ms	$\alpha$	7.56				
<sup>195</sup> Rn		195.00544	6 ms	$\alpha$	7.54				
<sup>196</sup> Rn		196.00212	4. ms	$\alpha$ /	7.46	0+			
<sup>197m</sup> Rn			0.02 s	$\alpha$	7.36				
<sup>197</sup> Rn		197.0016	0.07 s	$\alpha$ /	7.26				
<sup>198</sup> Rn		197.99868	64. ms	$\alpha$	7.205	0+			
<sup>199m</sup> Rn			0.32 s	$\alpha$	7.060	(13/2+)			
<sup>199</sup> Rn		198.9984	0.62 s	$\alpha$ /	6.989	3/2-			
<sup>200</sup> Rn		199.99570	1.06 s	$\alpha$ /(98)/	6.901/	0+			0.4329
				EC/(2)/5.					0.5043
<sup>201m</sup> Rn			3.8 s	EC/(10)/		13/2+			
				$\alpha$ /(90)/	6.773/				
<sup>201</sup> Rn		200.9956	7.0 s	$\alpha$ /(80)/	6.725/	(3/2-)			
				EC/(20)/	$\alpha$ /6.778				
<sup>202</sup> Rn		201.99326	9.9 s	$\alpha$ /(12)/	6.641/	0+			0.5695
				EC/(88)/					0.2876–0.6255
<sup>203m</sup> Rn			28. s	$\alpha$ /	6.551	13/2+	-0.96	+1.3	

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<sup>203</sup> Rn		202.99339	45. s	$\alpha/(66)/6.629$ EC/(34)/~ 7.4	6.499/	3/2-			
<sup>204</sup> Rn		203.99143	1.24 m	$\alpha/(68)/$ EC/(32)/3.8	6.420/	0+			
<sup>205</sup> Rn		204.99172	2.8 m	$\alpha/(23)/6.390$ EC/(77)/5.2	6.123(3)/0.02 6.262(3)/23	(5/2-)	+0.80	+0.06	0.2652 0.3553 0.4648 0.6205 0.6753 0.7300
<sup>206</sup> Rn		205.99021	5.7 m	$\alpha/(68)/6.384$ EC/(32)/3.3	6.258(3)/	0+			0.06170 0.0968 0.3245 0.3862 0.4822 0.4973 0.7728
<sup>207</sup> Rn		206.99073	9.3 m	$\beta_+$ , EC/77/4.6 $\alpha/(23)/6.252$	5.995(4)/0.02 6.068(3)/0.15 6.126(3)/22.8	5/2-	+0.82	+0.22	At k x-ray 0.32947 0.34455 0.36767 0.40267 0.74723 (0.18-1.4)
<sup>208</sup> Rn		207.98964	24.3 m	$\alpha/(60)/6.260$ EC/(40)/2.85	5.469(2)/0.003 6.140(2)/60	0+			
<sup>209</sup> Rn		208.99042	29. m	$\beta_+$ /(83)/3.93 $\alpha/(17)/$	2.16/2.3 5.887(3)/0.04 5.898(3)/0.02 6.039(2)/16.9	5/2-	+0.8388	+0.31	At k x-ray 0.27933 0.33753 0.40841 0.68942 0.74594 (0.18-3.2)
<sup>210</sup> Rn		209.98970	2.4 h	$\alpha/(96)/6.157$ EC/(4)/2.37	5.351(2)/0.005 6.039(2)/96	0+			At k x-ray 0.19625 0.45824 0.57104 0.64868 (0.14-1.7)
<sup>211</sup> Rn		210.99060	14.6 h	$\beta_+$ , EC/74/2.89 $\alpha/(26)/5.964$	5.619(1)/0.7 5.784(1)/16.4 5.851(1)/8.8	1/2-	+0.60		At k x-ray 0.16877 0.25022 0.37049 0.67412 0.67839 1.36298 (0.11-2.7)
<sup>212</sup> Rn		211.990704	24. m	$\alpha/6.385$	5.587(4)/0.05 6.260(4)/99.95	0+			
<sup>213</sup> Rn		212.99388	19. ms	$\alpha/8.243$	7.552(8)/1.0 8.087(8)/98.2 7.254/0.8	9/2+			0.540
<sup>214</sup> Rn		213.99536	0.27 $\mu$ s	$\alpha/9.209$	9.037(9)/	0+			
<sup>215</sup> Rn		214.99875	2.3 $\mu$ s	$\alpha/8.840$	8.674(8)/	(9/2+)			
<sup>216</sup> Rn		216.00027	45. $\mu$ s	$\alpha$		0+			
<sup>217</sup> Rn		217.003928	0.6 ms	$\alpha/7.885$	7.500/0.1 7.742(4)/100	9/2+			
<sup>218</sup> Rn		218.005601	35. ms	$\alpha/7.267$	6.534(1)/0.16 7.133(1)/99.8	0+			0.6093 0.6653
<sup>219</sup> Rn		219.009480	3.96 s	$\alpha/6.946(1)$	6.3130(5)/0.05	(5/2+)	-0.44	+0.93	Po k x-ray

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					6.425(3)/7.5				0.13057
					6.5309(4)/0.12				0.27113
					6.5531(3)/12.2				0.40170
					6.8193(3)/81				(0.1–1.05)
<sup>220</sup> Rn		220.011394	55.6 s	$\alpha/6.404$	5.7486(5)/0.07	0+			
					6.2883(1)/99.9				
<sup>221</sup> Rn		221.01554	25. m	$\alpha/(22)/6.148$ $\beta^-/(78)/1.2$	5.778(3)/1.8 5.788(3)/2.2	7/2+	-0.020	-0.38	Fr L x-ray 0.07384
					6.037(3)/18				0.08323
									0.0610
									0.18639
<sup>222</sup> Rn		222.017578	3.823 d	$\alpha/5.590$	4.987(1)/0.08	0+			0.510
					5.4897(3)/99.9				
<sup>223</sup> Rn		223.0218	23. m	$\beta^- /$			-0.78	+0.80	
<sup>224</sup> Rn		224.0241	1.8 h	$\beta^- /$		0+			0.1085
									0.2601
									0.2655
<sup>225</sup> Rn		225.0284	4.5 m	$\beta^- /$		7/2-	-0.70	+0.84	
<sup>226</sup> Rn		226.0309	7.4 m	$\beta^- /$		0+			
<sup>227</sup> Rn		227.0354	2. s	$\beta^- /$					
<sup>228</sup> Rn		228.0380	65. s	$\beta^- /$		0+			
<b><sup>87</sup>Fr</b>									
<sup>199</sup> Fr		199.00726	12 s	$\alpha$	7.66				
<sup>200</sup> Fr		200.0066	49 ms	$\alpha$	7.47				
<sup>201m</sup> Fr			~ 0.02 s	$\alpha/$	7.454				
<sup>201</sup> Fr		201.0039	~ 60 ms	$\alpha/$	7.36/	(9/2-)			
<sup>202m</sup> Fr			0.29 s	$\alpha$	7.236/				
<sup>202</sup> Fr		202.00337	0.30 s	$\alpha/7.590$	7.24/100				
<sup>203</sup> Fr		203.00093	0.54 s	$\alpha/7.280$	7.132(5)/	(9/2-)			
<sup>204m2</sup> Fr			0.8 s	$\alpha$	7.01				
<sup>204m1</sup> Fr			2. s	$\alpha$	6.97				
<sup>204</sup> Fr		204.00065	1.8 s	$\alpha/$	7.03/96				
					6.97/90				
					7.01/74				
<sup>205</sup> Fr		204.99859	3.9 s	$\alpha/7.050$	6.914(5)/	(9/2-)			
<sup>206m</sup> Fr			0.7 s	$\alpha/$	6.93				0.531(IT)
<sup>206</sup> Fr		205.99867	16.0 s	$\alpha/7.416$	6.792(5)/84				
<sup>207</sup> Fr		206.99695	14.8 s	$\alpha/6.900$	6.766(5)/	9/2-	+3.9	-0.16	
<sup>208</sup> Fr		207.99714	59.1 s	$\alpha/(77)/6.770$ EC/(23)/6.99	6.636(5)/	7+	-4.8	+0.004	
<sup>209</sup> Fr		208.99595	50.0 s	$\alpha/(89)/5.1$ EC/(11)/5.16	6.646(3)/	9/2-	+3.9	-0.24	0.7978 (0.1103–1.384)
<sup>210</sup> Fr		209.99641	3.2 m	$\alpha/6.670/71$ EC/6.26	6.543(5)/99.87 (5.90-6.42)	6+	+4.4	+0.19	0.2030 0.6438 0.8175 0.9008
<sup>211</sup> Fr		210.99554	3.10 m	$\alpha/6.660/87$ EC/4.61	6.534(5)/99.94 (5.87-6.20)	9/2-	+4.0	-0.19	0.220 0.2799 0.5389 0.9169
<sup>212</sup> Fr		211.99620	20. m	EC/(57)/5.12 $\alpha/(43)/6.529$	6.261(1)/16 6.335(1)/4 6.335(1)/4 6.343(1)/1.3 6.383(1)/10 6.406(1)/9.5	(5+)	+4.6	-0.10	Rn x-ray 0.08107 0.08378 0.2277 1.1856 1.2748
					6.08–6.18				0.014–1.178
<sup>213</sup> Fr		212.99619	34.6 s	$\alpha/6.905$	8.476(4)/51	9/2-	+4.0	-0.14	(0.408-0.577)

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<sup>214m</sup> Fr			3.4 ms	$\alpha$ /	8.547(4)/46 6.775-8.046	9-			
<sup>214</sup> Fr	213.99897		5.0 ms	$\alpha$ /8.587	7.409(3)/0.3 7.605(8)/1.0 7.940(3)/1.0 8.355(3)/4.7 8.427(3)/93	(1-)			(0.073-0.966)
<sup>215</sup> Fr	215.00034		0.12 $\mu$ s	$\alpha$ /9.537	9.360(8)/	(9/2-)			
<sup>216</sup> Fr	216.00320		0.70 $\mu$ s	$\alpha$ /9.175	9.005(10)/95				(0.045-0.160)
<sup>217</sup> Fr	217.00463		0.016 ms	$\alpha$ /8.471	8.315(8)/	(9/2-)			
<sup>218m</sup> Fr			22. ms	$\alpha$					
<sup>218</sup> Fr	218.007578		1. ms	$\alpha$ /8.014	7.384(10)/0.5 7.542(15)/1.0 7.572(10)/5 7.732(10)/0.5 7.867(2)/93	(1-)			
<sup>219</sup> Fr	219.00925		21. ms	$\alpha$ /8.132	6.802(2)/0.25 6.967(2)/0.6 7.146(2)/0.25 7.313(2)/99	(9/2-)			
<sup>220</sup> Fr	220.012327		27.4 s	$\alpha$ /6.800	6.582(1)/10 6.630(2)/6 6.641(1)/12 6.686(1)/61 6.39-6.58	1+	-0.67	+0.47	0.0450 0.061 0.1060 0.1539 0.1617
<sup>221</sup> Fr	221.014255		4.8 m	$\alpha$ /6.457	5.9393(7)/0.17 5.9797(7)/0.49 6.0751(7)/0.15 6.1270(7)/ 6.2433(3)/1.3 6.3410(7)/83.4	(5/2-)	+1.58	-1.0	At k x-ray 0.0995 0.21798 0.4091
<sup>222</sup> Fr	222.01755		14.3 m	$\beta^-$ /2.03 $\alpha$ /5.850	1.78/	2-	+0.63	+0.51	
<sup>223</sup> Fr	223.019736		22.0 m	$\beta^-$ /1.149 $\alpha$ /0.006	$\alpha$ /5.291 5.314 5.403	(3/2+)	+1.17	+1.17	0.1509 0.0589 0.1453
<sup>224</sup> Fr	224.02325		3.0 m	$\beta^-$ /2.82		1-	+0.40	+0.517	0.13150 0.21575 0.8367 (0.1-2.21)
<sup>225</sup> Fr	225.02557		3.9 m	$\beta^-$ /1.87		3/2	+1.07	+1.3	
<sup>226</sup> Fr	226.0294		49. s	$\beta^-$ /3.6		1	+0.071	-1.35	0.18606 0.25373
<sup>227</sup> Fr	227.0318		2.48 m	$\beta^-$ /2.5		1/2	+1.50		
<sup>228</sup> Fr	228.0357		39. s	$\beta^-$ /~ 3.5		2-	-0.76	+2.4	
<sup>229</sup> Fr	229.03845		50. s	$\beta^-$ /					
<sup>230</sup> Fr	230.0425		19. s	$\beta^-$ /		(3)			
<sup>231</sup> Fr	231.0454		17. s	$\beta^-$ /					
<sup>232</sup> Fr	232.050		5. s	$\beta^-$ /					(0.0545-0.721)
<b><sup>88</sup>Ra</b>									
<sup>201</sup> Ra			~ 1.6 ms	$\alpha$	7.91/				
<sup>202</sup> Ra	202.0099		~ 0.02 ms	$\alpha$	7.74	0+			
<sup>203m</sup> Ra			24 ms	$\alpha$	7.61				
<sup>203</sup> Ra	203.0093		~ 31 ms	$\alpha$	7.59				
<sup>204</sup> Ra	204.0065		0.06 s	$\alpha$	7.48	0+			
<sup>205m</sup> Ra			~ 0.17 s						
<sup>205</sup> Ra	205.0063		0.22 s	$\alpha$	7.34				
<sup>206</sup> Ra	206.00383		0.4 s	$\alpha$ /7.416	7.272(5)/	0+			

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<sup>207</sup> Ra		207.0038	1.3 s	$\alpha/7.270$	7.133(5)/				
<sup>208</sup> Ra		208.00184	1.4 s	$\alpha/7.273$	7.133(5)/	0+			
<sup>209</sup> Ra		209.00199	4.6 s	$\alpha/7.150$	(6.50-7.14)	5/2-	+0.87	+0.40	(0.387-0.634)
<sup>210m</sup> Ra			2.4 $\mu$ s						(0.0967-0.775)
<sup>210</sup> Ra		210.00050	3.7 s	$\alpha/7.610$	7.020(5)/	0+			574.9
<sup>211m</sup> Ra			3.9 $\mu$ s						(0.396-0.802)
<sup>211</sup> Ra		211.00090	13. s	$\alpha/7.046$ EC/5.0	6.907/99. (6.26-6.79)	(5/2-)	+0.878	+0.48	(0.120-0.665)
<sup>212m</sup> Ra			8.3 $\mu$ s						(0.440-0.824)
<sup>212</sup> Ra		211.99979	13.0 s	$\alpha/7.033$	6.901(2)/	0+			
<sup>213m</sup> Ra			2.1 ms	IT					(0.160-1.061)
<sup>213</sup> Ra		213.00038	2.7 m	EC/(20)/3.88 $\alpha/(80)/6.860$		(1/2-)	+0.613		0.1024 0.11010 0.2125
					6.521(3)/4.8 6.622(3)/39 6.730(3)/36				
<sup>214m</sup> Ra			> 0.015 ms						(0.181-1.382)
<sup>214</sup> Ra		214.00011	2.46 s	$\alpha/7.272$	7.14/99.8/ 6.51/0.2	0+			0.642
<sup>215m</sup> Ra			7.6 $\mu$ s						(0.196-1.048)
<sup>215</sup> Ra		215.00272	1.64 ms	$\alpha/8.864$	7.883(6)/2.8 8.171(3)/1.4 8.700(3)/95.9	(9/2+)			0.773/100 0.852/74 0.055-1.048
<sup>216</sup> Ra		216.00353	0.18 $\mu$ s	$\alpha/9.526$	9.349(8)/	0+			
<sup>217</sup> Ra		217.00632	1.6 $\mu$ s	$\alpha/9.161$	8.992(8)/	9/2-			
<sup>218</sup> Ra		218.00714	26. $\mu$ s	$\alpha/8.547$	8.390(8)/	0+			
<sup>219</sup> Ra		219.01009	0.010 s	$\alpha/8.132$	7.680(10)/65 7.982(9)/35				
<sup>220</sup> Ra		220.01103	18. ms	$\alpha/7.593$	7.39/5 7.45/95	0+			0.465
<sup>221</sup> Ra		221.013917	29. s	$\alpha/6.879$	6.254(10)/0.7 6.578(5)/3 6.585(3)/8 6.608(3)/35 6.669(3)/21 6.758(3)/31	5/2+	-0.180	+1.9	
<sup>222</sup> Ra		222.015375	36.2 s	$\alpha/5.590$	6.237(2)/3.0 6.556(2)/97	0+			0.324 0.1448-0.8402
<sup>223</sup> Ra		223.018502	11.43 d	$\alpha/5.979$	5.287(1)/0.15 5.338(1)/0.13 5.365(1)/0.13 5.433(5)/2.3 5.502(1)/1.0 5.540(1)/9.2 5.607(3)/24 5.716(3)/52 5.747(1)/9 5.857(1)/0.32 5.872(1)/0.85	(3/2+)	+0.271	+1.25	Rn k x-ray 0.12231 0.14418 0.15418 0.15859 0.26939 0.32388 0.33328 0.44494 (0.10-0.7)
<sup>224</sup> Ra		224.020212	3.66 d	$\alpha/5.789$	5.034(10)/0.003 5.047(1)/0.007 5.164(5)/0.007 5.449(2)/4.9 5.685(2)/95	0+			Rn k x-ray 0.2407 0.4093 0.6501
<sup>225</sup> Ra		225.023612	14.9 d	$\beta^-$ /0.36 $\alpha$	0.32/100 $5.01 \times 10^{-5}$ $4.98 \times 10^{-6}$	(3/2+)	-0.734		Ac k x-ray 0.0434
<sup>226</sup> Ra		226.025410	1599. y > $4 \times 10^{18}$ y	$\alpha/4.870$ sf/ $4 \times 10^{-14}$	4.194(1)/0.001 4.343(1)/0.006 4.601(1)/6.16	0+			Rn k x-ray 0.1861/3.64 0.2624



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<sup>227</sup> Ra		227.029178	42. m	$\beta^-$ /1.325	4.784(1)/93.8 1.03/ 1.30/	(3/2+)	-0.404	+1.5	0.053–2.448 Ac L x-ray Ac k x-ray 0.02739
<sup>228</sup> Ra		228.031070	5.76 y	$\beta^-$ /0.046	0.039/50 0.014/30 0.026/20	0+			0.0135 (0.006–0.0306)
<sup>229</sup> Ra		229.03496	4.0 m	$\beta^-$ /1.76	1.76/	(3/2+)	+0.503	+3.1	0.0145–0.1715
<sup>230</sup> Ra		230.03706	1.5 h	$\beta^-$ /1.0	0.7/	0+			0.0631 0.0720 0.2028 0.4698 0.4787
<sup>231</sup> Ra		231.0412	1.7 m	$\beta^-$					
<sup>232</sup> Ra		232.0436	4. m	$\beta^-$		0+			
<sup>233</sup> Ra		233.0481	30. s	$\beta^-$					
<sup>234</sup> Ra		234.051	~ 30. s	$\beta^-$ /		0+			
<b><sup>89</sup>Ac</b>									
<sup>206m</sup> Ac			0.04 s	$\alpha$	7.79				
<sup>206</sup> Ac		206.0145	~ 26 ms	$\alpha$	7.75				
<sup>207</sup> Ac		207.0120	27 ms	$\alpha$ /	7.69				
<sup>208m</sup> Ac			~ 25. ms	$\alpha$ /	7.72				
<sup>208</sup> Ac		208.0116	~ 0.1 s	$\alpha$ /	7.62				
<sup>209</sup> Ac		209.00949	~ 0.10 s	$\alpha$ /	7.58				
<sup>210</sup> Ac		210.0094	0.34 s	$\alpha$ /7.610	7.462(8) /				
<sup>211</sup> Ac		211.0077	0.20 s	$\alpha$ /7.620	7.480(8) /				
<sup>212</sup> Ac		212.0078	0.9 s	$\alpha$ /7.520	7.379(8) /				
<sup>213</sup> Ac		213.0066	0.73 s	$\alpha$ /7.500	7.364(8) /	(9/2-)			
<sup>214</sup> Ac		214.00690	8.2 s	$\alpha$ / (86) / 7.350 EC / (14) / 6.34	7.215/54 7.081/42 (6.48–7.15)	(5+)			(0.0626–0.754)
<sup>215</sup> Ac		215.00645	0.17 s	$\alpha$ / 7.750	7.60/99.57 7.21/0.46 7.03/0.20 6.96/0.14	(9/2-)			0.399 0.582 0.654
<sup>216m</sup> Ac			0.44 ms	$\alpha$ /	8.198(8) / 1.7 8.283(8) / 2.5 9.028(5) / 49 9.106(5) / 46	(9-)			(0.0826–1.375)
<sup>216</sup> Ac		216.00872	44. ms	$\alpha$ / 9.241	8.990(2) / 10 9.070(8) / 90	(1-)			
<sup>217m</sup> Ac			0.7 $\mu$ s	$\alpha$ /	10.540/100				
<sup>217</sup> Ac		217.00935	0.07 $\mu$ s	$\alpha$ / 9.832	9.650(10) / 100	9/2-			
<sup>218</sup> Ac		218.01164	1.1 $\mu$ s	$\alpha$ / 9.380	9.205(15) /				
<sup>219</sup> Ac		219.01242	0.012 ms	$\alpha$ / 8.830	8.664(10) /	(9/2-)			
<sup>220</sup> Ac		220.01476	26. ms	$\alpha$ / 8.350	7.610(20) / 23 4.680(20) / 21 7.790(10) / 13 7.850(10) / 24 7.985(10) / 4 8.005(10) / 5 8.060(10) / 6 8.195(10) / 3				
<sup>221</sup> Ac		221.01559	52. ms	$\alpha$ / 7.790	7.170(10) / 2 7.375(10) / 10 7.440(15) / 20 7.645(10) / 70				
<sup>222m</sup> Ac			63. s	$\alpha$ / (>89) /	6.710(20) / 7				



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<sup>229</sup> Ac		229.03302	1.04 h	$\beta^-$ /1.10	1.1/	(3/2+)			0.09335/2.43 0.16451/2.61 0.56916/2.24 0.0111-0.898
<sup>230</sup> Ac		230.0363	2.03 m	$\beta^-$ /2.7 $\beta^-$ , sf	1.4/ /0.000119	1+			Th k x-ray 0.45497 0.50820 (0.12-2.5)
<sup>231</sup> Ac		231.0386	7.5 m	$\beta^-$ /2.1	2.1/100	(1/2+)			0.14379 0.18574 0.22140 0.28250 0.3070
<sup>232</sup> Ac		232.0420	2.0 m	$\beta^-$ /3.7		(2-)			
<sup>233</sup> Ac		233.0446	2.4 m	$\beta^-$ /		(1/2+)			
<sup>234</sup> Ac		234.0484	40. s	$\beta^-$ /		(1+)			
<b><sup>90</sup>Th</b>		<b>232.03806(2)</b>							
<sup>209</sup> Th		209.0177	~ 0.01 s	$\alpha$	8.08				
<sup>210</sup> Th		210.0158	~ 9 ms	$\alpha$	7.90	0+			
<sup>211</sup> Th		211.0149	0.04 s	$\alpha$	7.79				
<sup>212</sup> Th		212.01298	~ 30. ms	$\alpha$ /	7.80/	0+			
<sup>213</sup> Th		213.0130	0.14 s	$\alpha$ /7.840	7.692(10)/				
<sup>214</sup> Th		214.01150	0.10 s	$\alpha$ /7.825	7.677(10)/	0+			
<sup>215</sup> Th		215.01173	1.2 s	$\alpha$ /7.660	7.33(10)/8	(1/2-)			0.134 0.192 (0.069-0.295)
<sup>216m</sup> Th			0.14 ms	$\alpha$	9.93/74				(0.0905-1.478)
<sup>216</sup> Th		216.01106	27. ms	$\alpha$ /8.071	8.00, 9.31 7.92/99.46	0+			0.628
<sup>217</sup> Th		217.01311	0.25 ms	$\alpha$ /9.424	7.30/0.54 9.27/94.6				(0.546-0.822)
<sup>218</sup> Th		218.01328	0.11 $\mu$ s	$\alpha$ /9.847	8.46/3.8 8.73/1.6	0+			
<sup>219</sup> Th		219.01554	1.05 $\mu$ s	$\alpha$ /9.510	9.665(10)/ 9.340(20)/	0+			
<sup>220</sup> Th		220.01575	10. $\mu$ s	$\alpha$ /8.953	8.790(20)/	0+			
<sup>221</sup> Th		221.01818	2. ms	$\alpha$ /8.628	7.732/7 8.142/72 8.469/21				
<sup>222</sup> Th		222.01847	2.24 ms	$\alpha$ /8.129	7.980/97.7	0+			
<sup>223</sup> Th		223.02081	0.60 s	$\alpha$ /7.454	7.599/2.3 7.29(1)/41(5) 7.32(1)/29(5) 7.350(15)/20(5) 7.390(15)/10(4)				
<sup>224</sup> Th		224.02147	1.05 s	$\alpha$ /7.305	6.768(5)/1.2 6.997(5)/19 7.170(5)/7	0+			
<sup>225</sup> Th		225.023951	8.72 m	EC/(10)/0.68 $\alpha$ /(90)/6.920	6.441(2)/15 6.479(2)/43 6.501(3)/14 6.627(3)/3 6.650(5)/3 6.700(5)/2 6.743(3)/7 6.796(2)/9	(3/2+)			
<sup>226</sup> Th		226.024903	30.83 m	$\alpha$ /6.454	6.026(1)/0.2	0+			Ra k x-ray

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
					6.041(1)/0.19				0.1112
					6.098(1)/1.3				0.2421
					6.2283(4)/23				0.1310
					6.3375(4)/75				0.1733–0.9295
<sup>227</sup> Th		227.027704	18.72 d	$\alpha$ /6.146		(3/2+)			Ra L x-ray
									Ra k x-ray
									0.05014
									0.23597
									0.25624
									(0.02–1.0)
<sup>228</sup> Th		228.028741	1.913 y	$\alpha$ /5.520	5.1770(2)/0.18	0+			
					5.2114(1)/0.4				
					5.3405(1)/26.7				
					5.4233(1)/73				
<sup>229m</sup> Th			13.9 h	$\alpha$	4.83–5.08				
<sup>229</sup> Th		229.031762	$7.9 \times 10^3$ y	$\alpha$ /5.168	4.814/9.3	5/2+	+0.46	+4.	0.1935/4.3
					4.845(5)/56				0.21089/277
					4.9008(5)/10.2				0.13697/1.21
					4.689–5.077				0.0111–0.6036
<sup>230</sup> Th		230.033134	$7.54 \times 10^4$ y	$\alpha$ /4.771	4.4383(6)/0.03	0+			0.0677/0.46
					4.4798(6)/0.12				0.1439/0.078
			$> 2 \times 10^{18}$ y	sf/ $< 4 \times 10^{-12}$	4.6211(6)/23.4				
					4.6876(6)/76.3				
<sup>231</sup> Th		231.036304	1.063 d	$\beta^-$ /0.390	0.138/22	5/2+			Pa L x-ray
					0.218/20				Pa k x-ray
					0.305/52				0.02564
									0.084203/
									(0.02–0.3)
<sup>232</sup> Th	100.	232.038055	$1.40 \times 10^{10}$ y	$\alpha$ /4.081	3.830(10)/0.2	0+			0.0590
			$1.2 \times 10^{21}$ y	sf/ $1.1 \times 10^{-9}$	3.952(5)/23				0.124
					4.010(5)/77				
<sup>233</sup> Th		233.041582	22.3 m	$\beta^-$ /1.245	1.245/	$\frac{1}{2}+$			Pa L x-ray
									Pa k x-ray
									0.02938
									0.08653
									0.45930
									(0.02–1.2)
<sup>234</sup> Th		234.043601	24.10 d	$\beta^-$ /0.273	0.102/20	0+			Pa L x-ray
					0.198/72				0.06329/4.1
									0.09235/2.4
									0.09278/2.4
<sup>235</sup> Th		235.04751	7.2 m	$\beta^-$ /1.9					0.4162
									0.6594
									0.7272
									0.747
									0.9318
<sup>236</sup> Th		236.0499	37.5 m	$\beta^-$ /~ 1.0		0+			Pa k x-ray
									0.1107
<sup>237</sup> Th		237.0539	5.0 m	$\beta^-$					
<sup>238</sup> Th		238.0565	9.4 m			0+			0.0890
<b><sub>91</sub>Pa</b>		<b>231.03588(2)</b>							
<sup>212</sup> Pa		212.0232	~ 5 ms	$\alpha$	8.27				
<sup>213</sup> Pa		213.0211	7 ms	$\alpha$	8.24				
<sup>214</sup> Pa		214.0209	17 ms	$\alpha$	8.12				
<sup>215</sup> Pa		215.0192	15. ms	$\alpha$	8.08/100				
<sup>216</sup> Pa		216.0191	0.19 s	$\alpha$ /	7.95/51				0.134
					7.82/45				
					7.79/4				

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<sup>217m</sup> Pa			1.08 ms	$\alpha$ /	10.16/72				0.4504–0.8208
					8.306/11				
					9.55/6				
					9.69/2				
<sup>217</sup> Pa	217.0183		3.8 ms	$\alpha$ /8.490	8.337/99				0.0466–0.634
					7.873/0.4				
					7.728/0.3				
					7.710/0.3				
<sup>218</sup> Pa	218.02004		0.12 ms	$\alpha$ /	9.54/31				0.092
					9.61/69				
<sup>219</sup> Pa	219.0199		0.05 $\mu$ s	$\alpha$					
<sup>220</sup> Pa	220.0219		0.8 $\mu$ s	$\alpha$					
<sup>221</sup> Pa	221.0219		6. $\mu$ s	$\alpha$	9.08(3)				
<sup>222</sup> Pa	222.0237		~ 4.3 ms	$\alpha$ /8.700	8.180/50				
					8.330/20				
					8.540/30				
<sup>223</sup> Pa	223.0240		~ 6.5 ms	$\alpha$ /8.340	8.006(10)/55				
					8.196(10)/45				
<sup>224</sup> Pa	224.02563		0.84 s	$\alpha$ /7.630	7.555(10)/75(3)				0.1945
					7.46(1)/25(3)				(0.028–0.412)
<sup>225</sup> Pa	225.0261		1.8 s	$\alpha$ /7.380	7.195(10)/30				
					7.245(10)/70				
<sup>226</sup> Pa	226.02795		1.8 m	$\alpha$ /(74)/6.987	6.728(10)/0.7				
				EC/(26)/2.83	6.823(10)/35				
					6.863(10)/39				
<sup>227</sup> Pa	227.02881		38.3 m	$\alpha$ /(85)/6.582	6.357(4)/7	(5/2-)			0.0649
				EC/(15)/1.02	6.376(10)/2.2				0.0669
					6.401(4)/8				0.1100
					6.416(4)/13				
					6.423(10)/10				
					6.465(4)/43				
<sup>228</sup> Pa	228.031051		22. h	EC/(98)/2.111		(3+)	+3.5		Th k x-ray
				$\alpha$ /(2)	5.779/0.23				0.409/100
					5.805/0.15				0.4631/222
					6.078/0.4				0.91116/242
					6.105/0.25				0.96464/120
					6.118/0.22				0.96897/149
									0.058–1.96
<sup>229</sup> Pa	229.032097		1.5 d	EC/(99.8)/0.32		(5/2+)			0.04244
				$\alpha$ /(0.2)/5.836	5.536(2)/0.02				(0.024–0.18)
					5.579(2)/0.09				
					5.668(2)/0.05				
<sup>230</sup> Pa	230.034541		17.4 d	EC/(90)/1.310	0.51/	(2-)	2.0		Th L x-ray
				$\beta^-$ /(10)/0.563					Th k x-ray
									0.4437
									0.45477
									0.89876
									0.91856
									0.95199
									(0.053–1.07)
<sup>231</sup> Pa	231.035884		$3.25 \times 10^4$ y	$\alpha$ /5.148	4.6781(5)/1.5	3/2-	2.01	-1.7	Ac L x-ray
					4.7102(5)/1.0				Ac k x-ray
			$> 2 \times 10^{17}$ y	$sf/< 1.6 \times 10^{-15}$	4.7343(5)/8.4				0.01899
					4.8513(5)/1.4				0.027396
					4.9339(5)/3				0.03823
					4.9505(5)/22.8				0.04639
					4.9858(5)/1.4				0.25586
					5.0131(5)/25.4				0.26029
					5.0292(5)/20				0.28367
					5.0318(5)/2.5				0.30007

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					5.0587(5)/11				0.30264
									0.33007
									(0.02-0.61)
<sup>232</sup> Pa		232.03859	1.31 d	$\beta^-$ /1.34		(2-)			U k x-ray
									0.10900
									0.15009
									0.89439
									0.96934
									(0.10-1.17)
<sup>233</sup> Pa		233.040247	27.0 d	$\beta^-$ /0.571	0.15/40	3/2-	+4.0	-3.0	U L x-ray
					0.256/60				U k x-ray
									0.30017
									0.31201/38.4
									(0.0286-0.456)
<sup>234m</sup> Pa			1.17 m	$\beta^-$ /99.9/2.29		(0-)			U k x-ray
				IT/0.13/					0.25818/0.07
									0.76641/0.32
									1.0009/0.86
									(0.06-1.96)
<sup>234</sup> Pa		234.043308	6.69 h	$\beta^-$ /2.197	0.51/	(4+)			U L x-ray
									U k x-ray
									0.1312/0.03
									0.5695/0.02
									0.9256/0.02
									(0.02-1.99)
<sup>235</sup> Pa		235.04544	24.4 m	$\beta^-$ /1.41	1.4/97	(3/2-)			0.0308-0.65893
<sup>236</sup> Pa		236.0487	9.1 m	$\beta^-$ /2.9	1.1/40	(1-)			U k x-ray
					2.0/50				0.64235
					3.1/10				0.68759
									1.7630
									(0.04-2.18)
<sup>237</sup> Pa		237.0512	8.7 m	$\beta^-$ /2.3	1.1/60	(1/2+)			0.4986
					1.6/30				0.5293
					2.3/10				0.5407
									0.8536
									0.8650
									(0.04-1.4)
<sup>238</sup> Pa		238.0545	2.3 m	$\beta^-$ /3.5	1.2/	(3-)			0.10350
					1.7/				0.1785
									0.4484
									0.6350
									0.6800
									1.01446
									(0.04-2.5)
<sup>239</sup> Pa		239.0573	1.8 h						
<sup>92</sup> U		<b>238.02891(3)</b>							
<sup>217</sup> U		217.0244	~ 0.2 ms	$\alpha$	8.02				
<sup>218m</sup> U			~ 0.56 ms	$\alpha$	10.68				
<sup>218</sup> U		218.02354	0.5 ms	$\alpha$	8.61	0+			
<sup>219</sup> U		219.0249	~ 0.08 ms	$\alpha$	9.68(4)/				
<sup>222</sup> U		222.0261	~ 1. $\mu$ s	$\alpha$		0+			
<sup>223</sup> U		223.0277	0.02 s	$\alpha$ /	8.78(4)/				
<sup>224</sup> U		224.02761	~ 1. ms	$\alpha$ /	8.46/100	0+			
<sup>225</sup> U		225.02939	84. ms	$\alpha$ /	7.87/83				
					7.82/15				
					7.63/2				
<sup>226</sup> U		226.02934	0.26 s	$\alpha$ /7.560	7.56/86	0+			
					7.38/14				

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<sup>227</sup> U		227.03116	1.1 m	$\alpha/7.200$	6.870/				
<sup>228</sup> U		228.03137	9.1 m	$\alpha/6.803$	6.404(6)/0.6	0+			0.095
					6.440(5)/0.7				0.152
					6.589(5)/29				0.187
					6.681(6)/70				0.246
<sup>229</sup> U		229.03351	58. m	EC/(80)/1.31 $\alpha/(20)/6.473$	6.223/3 6.297(3)/11 6.332(3)/20 6.360(3)/64	(3/2+)			
<sup>230</sup> U		230.033940	20.8 d $> 4 \times 10^{10}$ y	$\alpha/5.992$ sf/ $< 10^{-10}$	5.5866(3)/0.01 5.6624(3)/0.26 5.6663(3)/0.38 5.8178(3)/32 5.8887(3)/67	0+			Th L x-ray 0.07218 0.15421 0.23034 (0.081–0.8565)
<sup>231</sup> U		231.036294	4.2 d	EC/0.36 $\alpha/(10^{-3})$	$5.46/1.6 \times 10^{-3}$ $5.47/1.4 \times 10^{-3}$ $5.40/1. \times 10^{-3}$	(5/2-)			Pa L x-ray Pa k x-ray 0.02564 0.08420
<sup>232</sup> U		232.037156	70. y $2.6 \times 10^{15}$ y	$\alpha/5.414$ sf/ $2.7 \times 10^{-12}$	4.9979(1)/0.003 5.1367(1)/0.3 5.2635(1)/31 5.3203(1)/69	0+			
<sup>233</sup> U		233.039635	$1.592 \times 10^5$ y $> 2.7 \times 10^{17}$ y	$\alpha/4.909$ sf/ $6 \times 10^{-11}$	4.7830(8)/13.2 4.8247(8)/84.4 4.510–4.804	5/2+	+0.59	3.66	Th L x-ray 0.04244 0.09714 (0.0252–1.119)
<sup>234</sup> U	0.0054(5)	234.040952	$2.455 \times 10^5$ y $1.5 \times 10^{16}$ y	$\alpha/4.856$ sf/ $1.6 \times 10^{-9}$	4.604(1)/0.24 4.7231(1)/27.5 4.776(1)/72.5	0+			0.05323/0.156 0.12091
<sup>235m</sup> U			26. m	IT/0.0007		1/2+			
<sup>235</sup> U	0.7204(6)	235.043930	$7.04 \times 10^8$ y $1.0 \times 10^{19}$ y	$\alpha/4.6793$ sf/ $7 \times 10^{-9}$	4.1525(9)/0.9 4.2157(9)/6. 4.3237(9)/4.6 4.3641(9)/19. 4.370(4)/6 4.3952(9)/57. 4.4144(9)/2.1 4.5025(9)/1.7 4.5558(9)/4.2 4.5970(9)/4.8	7/2-	-0.38	4.9	Th L x-ray Th k x-ray 0.10917 0.14378 0.16338 0.18574 0.20213 0.20533 0.22140 (0.03–0.79)
<sup>236</sup> U		236.045568	$2.342 \times 10^7$ y $2.5 \times 10^{16}$ y	$\alpha/4.569$ sf/ $9 \times 10^{-8}$	4.332(8)/0.26 4.445(5)/26 4.494(3)/74	0+			Th L x-ray 0.04946/100 0.11279/24.1 0.17115/0.080
<sup>237</sup> U		237.048730	6.75 d	$\beta^- /0.519$	0.24/ 0.25/	1/2+			Np L x-ray Np k x-ray 0.05953 0.20801
<sup>238</sup> U	99.2742(10)	238.050788	$4.47 \times 10^9$ y $8.2 \times 10^{15}$ y	$\alpha$ sf/ $5 \times 10^{-5}$	4.0395/0.23 4.147(5)/23 4.196(5)/77	0+			Th L x-ray 0.04955/.06 0.1135/.01
<sup>239</sup> U		239.054293	23.5 m	$\beta^- /1.265$	1.2/ 1.3/	5/2+			(0.522–0.681)
<sup>240</sup> U		240.05659	14.1 h	$\beta^- /0.39$	0.36/	0+			Np L x-ray 0.04410 0.05558 0.06760
<sup>242</sup> U		242.0629	16.8 m	$\beta^- /\sim 1.2$		0+			

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<sup>93</sup> Np									
<sup>225</sup> Np		225.0339	> 2 $\mu$ s						
<sup>226</sup> Np		226.0352	0.03 s	$\alpha$ /	8.04(2)/				
<sup>227</sup> Np		227.0350	0.51 s	$\alpha$ /	7.65(2)/				
					7.68(1)/				
<sup>228</sup> Np		228.0362	61. s	EC/60(7)/ $\alpha$ /40(7)/, sf					
<sup>229</sup> Np		229.0363	4.0 m	$\alpha$ /7.010	6.890(20)				
<sup>230</sup> Np		230.0378	4.6 m	EC/97 /3.6 $\alpha$ /3	6.660(20)				
<sup>231</sup> Np		231.03825	48.8 m	EC/98 /1.8 $\alpha$ /2 /6.368	6.280/2	5/2			0.2629 0.3475 0.3703
<sup>232</sup> Np		232.0401	14.7 m	EC/99 /2.7		(4-)			U L x-ray U k x-ray 0.3268 0.81925 0.86683
<sup>233</sup> Np		233.04074	36.2 m	EC/1.2		(5/2+)			U L x-ray U k x-ray 0.29887 0.31201
<sup>234</sup> Np		234.04290	4.4 d	$\beta$ +, EC/1.81	0.79/	(0+)			U L x-ray U k x-ray 1.5272 1.5587 1.6022
<sup>235</sup> Np		235.044063	1.085 y	EC/99.9 /0.124 $\alpha$ /0.001/5.191		5/2+			U k x-ray
<sup>236m</sup> Np			22.5 h	EC/52 / $\beta$ - /48 /		(1-)			U L x-ray Pu L x-ray U k x-ray 0.64235 0.68759
<sup>236</sup> Np		236.04657	$1.55 \times 10^5$ y	EC/91 /0.94 $\beta$ - /9 /0.49		(6-)			U L x-ray U k x-ray 0.10423 0.16031
<sup>237</sup> Np		237.048173	$2.14 \times 10^6$ y $1 \times 10^{18}$ y	$\alpha$ /4.957 sf/2.1 $\times 10^{-10}$	4.6395(5)/6.5 4.766(5)/9.7 4.7715(5)/22.7 4.7884(5)/47.8 4.558-4.873	5/2+	+3.14	+3.89	Pa L x-ray Pa k x-ray 0.029378/15 0.08653/12 (0.03-0.28)
<sup>238</sup> Np		238.050946	2.117 d	$\beta$ - /1.292	1.2/	2+			Pu L x-ray Pu k x-ray 0.98447/25.2 1.02855/18.3 (.044-1.026)
<sup>239</sup> Np		239.052939	2.355 d	$\beta$ - /0.722	0.341/30 0.438/48	5/2+			Pu L x-ray Pu k x-ray 0.10613 0.228186/11 0.27760/15 (0.04-0.50)
<sup>240m</sup> Np			7.22 m	$\beta$ - /99.9 / IT/0.1 /	2.18/	(1+)			0.25143 0.26333 0.55454 0.59735



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<sup>240</sup> Np		240.05616	1.032 h	$\beta^-$ /2.20	0.89/	5+			0.1471/ 0.5664 0.6008
<sup>241</sup> Np		241.0583	13.9 m	$\beta^-$ /1.3	1.3/	5/2+			0.1330/ 0.1740 0.280
<sup>242m</sup> Np			2.2 m	$\beta^-$ /		(1+)			0.15910 0.2651/ 0.78570 0.9448/
<sup>242</sup> Np		242.0616	5.5 m	$\beta^-$ /2.7	2.7/	6+			0.6209 0.73620 0.78074 1.47340 (0.04–2.37)
<sup>243</sup> Np		243.06428	1.9 m						
<sup>244</sup> Np		244.0679	2.3 m						
<b><sup>94</sup>Pu</b>									
<sup>228</sup> Pu		228.03874	~ 1.1 s	$\alpha$ /	7.81(2)/	0+			
<sup>229</sup> Pu		229.0402	~ 1.5 m	$\alpha$ /	7.46/				
<sup>230</sup> Pu		230.03965	1.7 m	$\alpha$ /	7.06/81 7.00/19	0+			
<sup>231</sup> Pu		231.04110	8.6 m	EC/90 $\alpha$ /10	6.72				
<sup>232</sup> Pu		232.04119	34. m	EC/>80/1.1 $\alpha$ / $<20$ /6.716	6.542(10)/38 6.600(10)/62	0+			
<sup>233</sup> Pu		233.04300	20.9 m	EC(99.9)/1.9 $\alpha$ /0.1 /6.416	6.300(20)/0.1				0.1503 0.1804 0.2353 0.5002 0.5346/ 1.0352/
<sup>234</sup> Pu		234.04332	8.8 h	EC/94 /0.39 $\alpha$ /6 /6.310	6.035(3)/0.024 6.149(3)/1.9 6.200(3)/4.	0+			
<sup>235</sup> Pu		235.04529	25.3 m	EC/99+ /1.2 $\alpha$ /0.003/5.957	5.850(20)/0.003	(5/2+)			
<sup>236m</sup> Pu			1.2 $\mu$ s						
<sup>236</sup> Pu		236.046058	2.87 y 1.5 $\times 10^9$ y	$\alpha$ /5.867 sf/1.9 $\times 10^{-7}$	5.611/0.21 5.7210/30.5 5.7677(1)/69.3	0+			0.0476/0.07 0.109/0.02 (0.17–0.97)
<sup>237</sup> Pu		237.048410	45.7 d	EC/99.9 /0.220 $\alpha$ /0.003 /5.747	5.334(4)/0.0015 5.356(4)/0.0006 5.650(4)/0.0007	7/2-			Np L x-ray Np k x-ray 0.026344 0.03319 0.05954 (0.03–0.5)
<sup>238</sup> Pu		238.049560	87.7 y 4.75 $\times 10^{10}$ y	$\alpha$ /5.593 sf/1.8 $\times 10^{-7}$	5.3583(1)/0.10 5.465(1)/28.3 5.4992(1)/71.6	0+			U k x-ray 0.04347 (0.04–1.1)
<sup>239</sup> Pu		239.052163	2.410 $\times 10^4$ y 8. $\times 10^{15}$ y	$\alpha$ /5.244 sf/3 $\times 10^{-10}$	5.055/0.047 5.076/0.078 5.106/11.9 5.144/17.1 5.157/70.8 (4.74 –5.03)	1/2+ +0.203			U k x-ray 0.05162 0.05682 0.12928 0.37502 0.41369

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)	
<sup>240</sup> Pu		240.053814	6.56 × 10 <sup>3</sup> y	$\alpha$ /5.255	5.0212(1)/0.07	0+			U L x-ray	
			1.14 × 10 <sup>11</sup> y	sf/5.7 × 10 <sup>-6</sup>	5.1237(1)/26.4				0.04524	
					5.1681(1)/73.5				0.10423	
								(0.04–0.97)		
<sup>241</sup> Pu		241.056852	14.3 y	$\beta^-$ /99+/0.0208	4.853/3 × 10 <sup>-4</sup>	5/2+	-0.683	+6.	0.14854	
				$\alpha$ /0.002 /5.139	4.897/0.002				0.1600	
				< 6 × 10 <sup>16</sup> y	sf/> 2.4 × 10 <sup>-14</sup>					
<sup>242</sup> Pu		242.058743	3.75 × 10 <sup>5</sup> y	$\alpha$ /4.983	4.7546(7)/0.098	0+			U L x-ray	
			6.77 × 10 <sup>10</sup> y	sf/5.5 × 10 <sup>-4</sup>	4.8564(7)/22.4				0.04491	
					4.9006(7)/78				0.10350	
<sup>243</sup> Pu		243.062003	4.956 h	$\beta^-$ /0.582	0.49/21	7/2+			Am L x-ray	
									0.58/60	0.0417
										0.0839
<sup>244</sup> Pu		244.064204	8.00 × 10 <sup>7</sup> y	$\alpha$ /99.9/4.665	4.546(1)/19.4	0+			U L x-ray	
			6.6 × 10 <sup>10</sup> y	sf/0.12	4.589(1)/80.5				0.0439	
<sup>245</sup> Pu		245.06775	10.5 h	$\beta^-$ /1.21	0.93/57	(9/2-)			Am L x-ray	
									1.21/11	Am k x-ray
										0.2804 /
										0.30832
										0.32752
										0.56014
			(0.03–1.2)							
<sup>246</sup> Pu		246.07021	10.85 d	$\beta^-$ /0.40	0.150/85	0+			Am L x-ray	
									0.35/10	Am k x-ray
										0.04379
								0.22371		
<sup>247</sup> Pu		247.0741	2.3 d							
<b><sup>95</sup>Am</b>										
<sup>232</sup> Am		232.0466	0.9 m	EC/~ 5.0						
<sup>233</sup> Am		233.0464	~ 3.2 m	$\alpha$	6.78					
<sup>234</sup> Am		234.0478	2.3 m	EC/4.2						
<sup>235</sup> Am		235.0480	10.3 m	EC					Pu K x-ray	
					$\alpha$	6.46/0.4	0.291/100			
							(0.170-0.828)			
<sup>236m</sup> Am			2.9 m			(1-)		(0.583-0.713)		
<sup>236</sup> Am		236.0496	3.6 m	EC		(5-)		(0.158-1.038)		
<sup>237</sup> Am		237.0500	1.22 h	EC/99.98 /1.7					Pu k x-ray	
					$\alpha$ /0.02 /6.20	6.042(5)/0.02	0.14559			
							0.28026			
							0.43845			
<sup>238</sup> Am		238.05198	1.63 h	EC/2.26		1+			Pu L x-ray	
					$\alpha$ /0.0001 /6.04				5.940/0.0001	Pu k x-ray
										0.91870
								0.96278		
<sup>239</sup> Am		239.053025	11.9 h	EC/99.99/0.803		5/2-			Pu L x-ray	
					$\alpha$ /0.01/5.924				5.734(2)/0.001	Pu k x-ray
									5.776(2)/0.008	0.18172
										0.22818
								0.27760		
<sup>240</sup> Am		240.05530	2.12 d	EC/1.38		(3-)			Pu L x-ray	
					$\alpha$ /5.592				5.378(1)/16 × 10 <sup>-4</sup>	Pu k x-ray
										0.88878
								0.98764		
								(0.1–1.3)		
<sup>241</sup> Am		241.056829	432.7 y	$\alpha$ /5.637	5.2443(1)/0.002	5/2-	+1.58	+3.1	Np L x-ray	
			1.2 × 10 <sup>14</sup> y	sf/3.6 × 10 <sup>-10</sup>	5.3221(1)/0.015				0.02634 /0.024	
					5.3884(1)/1.4				0.03319/0.0126	
					5.4431(1)/12.8				0.05954/0.359	

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $h/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
					5.4857(1)/85.2				(0.03–1.128)
					5.5116(1)/0.20				
					5.5442(1)/0.34				
<sup>242m</sup> Am			141. y	IT/99.5/0.048		5-	+1.0	+6.5	Am L x-ray
				$\alpha$ /0.5/5.62	5.141(4)/0.026				0.04863
			$> 3 \times 10^{12}$ y	sf/ $< 4.7 \times 10^{-9}$	5.2070(2)/0.4				0.08648
									0.10944
									0.16304
<sup>242</sup> Am	242.059549		16.02 h	$\beta^-$ /83 /0.665	0.63/46	1-	+0.388	-2.4	Pu L x-ray
				EC/17 /0.750	0.67/37				Cm L x-ray
									Pu k x-ray
									0.0422
									0.04453
<sup>243</sup> Am	243.061381		$7.37 \times 10^3$ y	$\alpha$ /5.438	5.1798(5)/1.1	5/2-	+1.5	+2.9	0.04354
			$2. \times 10^{14}$ y	sf/ $3.7 \times 10^{-9}$	5.2343(5)/11				0.07467
					5.2766(5)/88				0.08657
					5.394(5)/0.12				0.11770
					5.3500(5)/0.16				0.14197
<sup>244m</sup> Am			$\sim 26$ . m	$\beta^-$ /1.498		(1-)			0.0429
<sup>244</sup> Am	244.064285		10.1 h	$\beta^-$ /1.428					Am L x-ray
									Cm k x-ray
									0.7460
									0.9000
<sup>245</sup> Am	245.066452		2.05 h	$\beta^-$ /0.894	0.65/19	(5/2+)			Cm L x-ray
					0.90/77				Cm k x-ray
									0.25299
<sup>246m</sup> Am			25.0 m	$\beta^-$ /	1.3/79.	2-			Cm L x-ray
					1.60/14				Cm k x-ray
					2.1/7				0.27002
									0.79881
									1.06201
									1.07885
									(0.04–2.29)
<sup>246</sup> Am	246.06978		39. m	$\beta^-$ /2.38	1.2/	(7-)			Cm L x-ray
									Cm k x-ray
									0.1529
									0.2046
									0.6786
<sup>247</sup> Am	247.0721		22. m	$\beta^-$ /1.7					Cm L x-ray
									Cm k x-ray
									0.2267 /
									0.2853 /
<b><sup>96</sup>Cm</b>									
<sup>233</sup> Cm	233.0508			$\alpha$ /	7.34/				
<sup>234</sup> Cm	234.05016		$\sim 51$ . s	$\alpha$	7.24/	0+			
<sup>235</sup> Cm	235.0514								
<sup>236</sup> Cm	236.0514			EC/1.7		0+			
<sup>237</sup> Cm	237.0529			EC/2.5					
<sup>238</sup> Cm	238.05303		2.4 h	EC/ $>90$ /0.97		0+			
				$\alpha$ / $<10$ /6.632	6.520(50)/ $<10$				
<sup>239</sup> Cm	239.0550		$\sim 3$ . h	EC/1.7					0.0407
									0.1466
									0.1874
<sup>240</sup> Cm	240.055530		27. d	$\alpha$ /6.397	5.989/0.014	0+			
					6.147/0.05				
			$1.9 \times 10^6$ y	sf/ $3.9 \times 10^{-6}$	6.2478(6) /28.8				
					6.2906(6) /70.6				

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<sup>241</sup> Cm		241.057653	32.8 d	EC/99 /0.768 $\alpha$ /1 /6.184	5.8842(4)/0.12 5.9291(4)/0.18 5.9389(4)/0.69	1/2+			Am k x-ray
									0.13241
									0.16505
									0.18028
									0.43063
<sup>242</sup> Cm		242.058836	162.8 d	$\alpha$ /6.216 $7.0 \times 10^6$ y sf/ $6.4 \times 10^{-6}$	5.9694(1)/0.035 6.069(1)/25 6.1129(1)/74	0+			Pu L x-ray
									0.04408
									0.10189
									(0.04-1.2)
<sup>243</sup> Cm		243.061389	29.1 y	$\alpha$ /6.167 $5.5 \times 10^{11}$ y sf/ $5.3 \times 10^{-9}$	5.6815(5) /0.2 5.6856(5)/1.6 5.7420(5)/10.6 5.7859(5)/73.3 5.9922(5)/6.5 6.0103(5)/1.0 6.0589(5)/5 6.0666(5)/1.5	5/2+	0.41		Pu L x-ray
									Pu k x-ray
									0.10612
									0.20975
									0.22819
									0.27760
									0.28546
									0.33431
(0.04-0.7)									
<sup>244</sup> Cm		244.062753	18.1 y	$\alpha$ /5.902 $1.32 \times 10^7$ y sf/ $1.4 \times 10^{-4}$	5.6656/0.02 5.7528/23 5.8050/77 5.515/0.004	0+			Pu L x-ray
									0.04282
									0.09885
									0.15262
<sup>245</sup> Cm		245.065491	$8.48 \times 10^3$ y	$\alpha$ /5.623 $1.4 \times 10^{12}$ y sf/ $6.1 \times 10^{-7}$	5.235(10)/0.3 5.3038(10)/5.0 5.3620(7)/93 5.4927(11)/0.8 5.5331(11)/0.6	7/2+	0.5		Pu L x-ray
									Pu k x-ray
									0.04195
									0.13299
									0.13606
<sup>246</sup> Cm		246.067224	$4.76 \times 10^3$ y	$\alpha$ /5.476 $1.8 \times 10^7$ y sf/0.026	5.343(3)/21 5.386(3)/79	0+			Pu L x-ray
									0.04453
<sup>247</sup> Cm		247.070354	$1.56 \times 10^7$ y	$\alpha$ /5.352	4.818(4)/4.7 4.8690(20)/71 4.941(4)/1.6 4.9820(20)/2.0 5.1436(20)/1.2 5.2104(20)/5.7 5.2659(20)/13.8	9/2-	0.37		Pu k x-ray
									0.2792
									0.2886
									0.3471
									0.4035
<sup>248</sup> Cm		248.072349	$3.48 \times 10^5$ y	$\alpha$ /99.92 /5.162 $4.15 \times 10^6$ y sf/8.38	4.931(5)/0.07 5.0349(2)/16.5 5.0784(2)/(75)/1	0+			
<sup>249</sup> Cm		249.075953	64.15 m	$\beta^-$ /0.900	0.9/	1/2+			Bk k x-ray
									0.56039/0.84
									0.63431/1.5 (0.085-0.653)
<sup>250</sup> Cm		250.07836	$\sim 9.7 \times 10^3$ y	sf/85.8 $\alpha$ /5.27		0+			
<sup>251</sup> Cm		251.08229	16.8 m	$\beta^-$ /1.42	0.90/16	(1/2+)			0.3896 /
									0.5299
									0.5425
<sup>252</sup> Cm		252.0849	< 2 d			0+			
<b><sub>97</sub>Bk</b>									
<sup>238</sup> Bk		238.0583	2.4 m	EC/5.0					
<sup>239</sup> Bk		239.0583							
<sup>240</sup> Bk		240.0598	$\sim 4.8$ m						
<sup>241</sup> Bk		241.0602	4.6 m	EC					(0.152-0.262)
<sup>242</sup> Bk		242.0620	7.0 m	EC/3.0					
<sup>243</sup> Bk		243.063008	4.5 h	EC/99.8 /1.508	6.542(4)/0.03	(3/2-)			0.1466

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				$\alpha/0.15 /6.871$	6.5738(2)/0.04				0.1874
					6.7180(22)/0.02				0.755
					6.7581(20)/0.02				0.840
									0.946
<sup>244</sup> Bk	244.06518	4.4 h	EC/99.99 /2.26			(4-)			0.1445
			$\alpha/0.01 /6.778$		6.625(4)/0.003				0.1876
					6.667(4)/0.003				0.2176
									0.9815
									0.9215/
<sup>245</sup> Bk	245.066362	4.94 d	EC/99.9 /0.810			3/2-			Cm L x-ray
			$\alpha/0.1 /6.453$		5.8851(5)/0.03				Cm k x-ray
					6.1176(9)/0.01				0.25299
					6.1467(5)/0.02				0.3809
					6.3087(5)/0.014				0.3851
					6.3492(5)/0.018				
<sup>246</sup> Bk	246.0687	1.80 d	EC/1.35			(2-)			Cm L x-ray
									Cm k x-ray
									0.79881
									1.08142
<sup>247</sup> Bk	247.07031	$1.4 \times 10^3$ y	$\alpha/5.889$		5.465(5)/1.5	(3/2-)			0.04175
					5.501(5)/7				0.0839
					5.532(5)/45				0.268
					5.6535(20)/5.5				
					5.678(2)/13				
					5.712(2)/17				
					5.753(2)/4.3				
					5.794(2)/5.5				
<sup>248</sup> Bk	248.07310	23.7 h	$\beta^- /70 /0.87$		0.86/	(1-)			Cm L x-ray
			EC/30 /0.72						Cf L x-ray
									Cm k x-ray
									Cf k x-ray
									0.5507
<sup>249</sup> Bk	249.074987	320. d	$\beta^- /0.125$		0.125/100	7/2+	2.0		$0.327/10^{-5}$
			$\alpha/0.001 /5.525$		5.390(1)/0.0002				$0.308/10^{-6}$
		$1.8 \times 10^9$ y	$sf/4.9 \times 10^{-8}$		5.4174(6)/0.001				
<sup>250</sup> Bk	250.078317	3.217 h	$\beta^- /1.780$		0.74/	2-			Cf L x-ray
									Cf k x-ray
									0.98912
									1.03184
									(0.04–1.6)
<sup>251</sup> Bk	251.08076	56. m	$\beta^- /1.09$			(3/2-)			0.02481
									0.1528
									0.1776
<sup>252</sup> Bk	252.0843	1.8 m							
<sup>98</sup> Cf									
<sup>237</sup> Cf	237.062	2.1 s	$\alpha, sf/10$						
<sup>238</sup> Cf	238.0614	21 ms	$sf/\sim 100$			0+			
			$\alpha/\sim 0.2$						
<sup>239</sup> Cf	239.0624	$\sim 0.7$ m	$\alpha$						
<sup>240</sup> Cf	240.0623	1.1 m	$\alpha/7.719$		7.590(10)/	0+			
			$sf/\sim 2.1$						
<sup>241</sup> Cf	241.0637	4. m	EC/3.3						
			$\alpha/7.60$		7.335(5)/				
<sup>242</sup> Cf	242.06370	3.5 m	$\alpha/7.509$		7.351(6)/20	0+			
			$sf/<0.014$		7.385(4)/80				
<sup>243</sup> Cf	243.0654	11. m	EC/86 /2.2		7.060(6)/20	(1/2+)			
			$\alpha/14 /7.40$		7.170/4				
<sup>244</sup> Cf	244.066001	20. m	$\alpha/7.328$		7.168(5)/25	0+			

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<sup>245</sup> Cf		245.068049	44. m	$\alpha/36 /7.255$ EC/64 /1.569	7.210(5)/75				Cm K x-ray
					7.14/91.7				0.5709
					6.983/0.31				0.6014
					7.09/7				0.6163
<sup>246</sup> Cf		246.068805	1.49 d	$\alpha/6.869$	6.6156(10)/0.18	0+			Cm L x-ray
					6.7086(7)/21.8				0.04221
			1.8 × 10 <sup>3</sup> y	sf/2.3 × 10 <sup>-4</sup>	6.7501(7)/78.0	0.0945			
<sup>247</sup> Cf		247.07100	3.11 h	EC/99.96 /0.65 $\alpha/0.04 /6.55$	6.301(5)/	7/2+			Bk k x-ray
									0.2941
									0.4778
<sup>248</sup> Cf		248.07219	334. d	$\alpha/6.369$	6.220(5)/17	0+			
			3.2 × 10 <sup>4</sup> y	sf/0.0029	6.262(5)/83				
<sup>249</sup> Cf		249.074854	351. y	$\alpha/6.295$	5.758/3.7	9/2-			Cm L x-ray
					5.812/85.7				Cm k x-ray
			8. × 10 <sup>10</sup> y	sf/4.4 × 10 <sup>-7</sup>	5.8488(2)/1.0	0.25299/2.5			
					5.9029(2)/2.8	0.33351/13.6			
					5.9451(2)/4.0	0.38832/63.6			
<sup>250</sup> Cf		250.076406	13.1 y	$\alpha/6.129$ sf/0.077	6.1401(2)/1.1	0+			(0.0376–1.103)
					6.1940(2)/2.2				
					5.8913(4)/0.3				0.04285
<sup>251m</sup> Cf			26.3 $\mu$ s		5.9889(4)/15				
					6.0310(4)/84.5				
<sup>251</sup> Cf		251.079587	9.0 × 10 <sup>2</sup> y	$\alpha/6.172$	5.56448(7)/1.5	1/2+			0.109/19.8
					5.632(1)/4.5				0.1775/17.3
					5.648(1)/3.5				(0.0385–0.354)
					5.6773(6)/35				
					5.762(3)/3.8				
					5.7937(7)/2.0				
					5.8124(8)/4.2				
					5.8514(6)/27				
					6.0140(7)/11.6				
					6.0744(7)/2.7				
<sup>252</sup> Cf		252.081626	2.65 y	$\alpha/96.9 /6.217$	5.7977(1)/0.23	0+			Cm L x-ray
			86. y	sf/3.1/	6.0756(4)/15.2				0.04339
					6.1184(4)/81.6				0.1002
<sup>253</sup> Cf		253.08513	17.8 d	$\beta^- /99.7 /0.29$	0.27/100	(7/2+)			
				$\alpha/0.3 /6.126$	5.921(5)/0.02				
<sup>254</sup> Cf		254.08732	60.5 d	sf/99.7/		0+			
				$\alpha/0.3/5.930$	5.792(5)/0.05				
<sup>255</sup> Cf		255.0911	1.4 h	$\beta^- /0.7$	5.834(5)/0.26				
<sup>256</sup> Cf		256.0934	12. m	sf		0+			
<b><sub>99</sub>Es</b>									
<sup>241</sup> Es		241.0685	~ 8 s	$\alpha$	8.11				
<sup>242</sup> Es		242.0698	16 s	$\alpha$	7.92				
<sup>243</sup> Es		243.0696	21. s	$\alpha/>30 /$	7.89/>30				
				EC/<70 /4.0					
<sup>244</sup> Es		244.0709	37. s	EC/76 /4.6					
				$\alpha/4 /$	7.57/4				
<sup>245</sup> Es		245.0713	1.3 m	$\alpha/40 /7.858$	7.74				
				EC/60 /3.1					
<sup>246</sup> Es		246.0729	7.7 m	EC/90 /3.9					
				$\alpha/10 /$	7.35				
<sup>247</sup> Es		247.07366	4.8 m	EC/93 /2.48					
				$\alpha/7 /$	7.32				

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<sup>248</sup> Es		248.0755	26. m	EC/99.7 /3.1					
				$\alpha/0.3$ /	6.87				
<sup>249</sup> Es		249.07641	1.70 h	EC/99.4 /1.45		(7/2+)			0.3795
				$\alpha/0.6$ /	6.77				0.8132
<sup>250m</sup> Es			2.2 h	EC/		(1-)			Cf L x-ray
				$\beta+$					Cf k x-ray
									0.9891
									1.0319
<sup>250</sup> Es		250.0786	8.6 h	EC/2.1		(6+)			Cf L x-ray
									Cf k x-ray
									0.30339
									0.34948
									0.82883
<sup>251</sup> Es		251.07999	1.38 d	EC/99.5 /0.38		(3/2-)			
				$\alpha/0.5$ /	6.462/0.05				
					6.492/0.4				
<sup>252</sup> Es		252.08298	1.29 y	$\alpha/76$ /	6.632/61.0	(5-)			
				EC/24 /1.26	6.562/10.3				
<sup>253</sup> Es		253.084825	20.47 d	$\alpha/$	6.633/89.8	7/2+	+4.10	7.	0.04180/5.6
			$6.3 \times 10^5$ y	sf/ $8.9 \times 10^{-6}$	6.5916/6.6				0.3892/2.7
									(0.0309-1.106)
<sup>254m</sup> Es			1.64 d	$\beta-$ /99.6 /	0.475	2+	2.9	3.7	Fm L x-ray
				$\alpha/0.3$ /6.67	6.382	2+			Fm k x-ray
			> 10. y	sf/0.045					0.6488
									0.6938
<sup>254</sup> Es		254.088022	276. d	$\alpha/$	6.429	(7+)			0.064
			> $2.5 \times 10^7$ y	sf/ $< 3 \times 10^{-6}$					
<sup>255</sup> Es		255.09027	40. d	$\beta-$ /92 /0.29		(7/2+)			
				$\alpha/8$ /	6.26				
			$2.6 \times 10^3$ y	sf/0.0042	6.300				
<sup>256m</sup> Es			7.6 h	$\beta-$ /		(8+)			0.218
									0.232
									0.862
<sup>256</sup> Es		256.0936	25. m	$\beta-$ /1.7		(1+)			
<sup>257</sup> Es		257.0960	7.7 d	$\beta-$					
<b><sup>100</sup>Fm</b>									
<sup>242</sup> Fm		242.0734	0.8 ms	sf/> 96		0+			
<sup>243</sup> Fm		243.0744	0.2 s	$\alpha/$	8.55				
				sf/< 0.4					
<sup>244</sup> Fm		244.0741	3.3 ms	sf/> 97		0+			
<sup>245</sup> Fm		245.0754	4. s	$\alpha/$	8.15/				
				sf/<0.1					
<sup>246</sup> Fm		246.07530	1.2 s	$\alpha/85/$	8.24/	0+			
				sf/15/					
<sup>247m</sup> Fm			4.3 s	$\alpha/$	8.17/				
<sup>247</sup> Fm		247.0769	29. s	$\alpha/8.20$	7.87/70				
				EC/2.9	7.93/30				
<sup>248</sup> Fm		248.07720	33. s	$\alpha/99.9$ /8.001	7.83/20	0+			
				sf/0.1/	7.87/80				
<sup>249</sup> Fm		249.0790	1.6 m	EC/2.4		(7/2+)			
				$\alpha/$	7.57				
<sup>250m</sup> Fm			1.8 s	IT/					
				sf/ $< 8 \times 10^{-5}$					
<sup>250</sup> Fm		250.07952	30. m	$\alpha/$	7.43/	0+			
				EC/0.8					
				sf/0.007					
<sup>251</sup> Fm		251.08158	5.3 h	EC/98 /1.47		(9/2-)			
				$\alpha/2$ /	6.833				

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<sup>252</sup> Fm		252.08247	1.058 d	$\alpha/7.154$ sf/0.0023	6.998/15 7.039/85	0+			
<sup>253</sup> Fm		253.085185	3.0 d	EC/88/0.333 $\alpha/12$ /	6.676/ 6.943/	$1/2+$			Es k x-ray 0.2719
<sup>254</sup> Fm		254.086854	3.240 h	$\alpha/$ sf/0.059	7.150 7.192	0+			
<sup>255</sup> Fm		255.089962	20.1 h $1.0 \times 10^4$ y	$\alpha/$ sf/ $2.3 \times 10^{-5}$	6.9635(5)/5.0 7.0225(5)/93.4	7/2+			0.08148/1. (0.041-0.900)
<sup>256</sup> Fm		256.09177	2.63 h	sf/91 $\alpha/19$	6.92/	0+			
<sup>257</sup> Fm		257.09511	100.5 d	$\alpha/99.79$ sf/0.21	6.519	(9/2+)			0.1794 0.2410
<sup>258</sup> Fm		258.0971	0.37 ms	sf/		0+			
<sup>259</sup> Fm		259.1006	1.5 s	sf/					
<sup>260</sup> Fm		260.103	$\sim 4$ ms	sf/		0+			
<b>101 Md</b>									
<sup>245m</sup> Md			$\sim 0.4$ s	$\alpha$	8.64, 8.68				
<sup>245</sup> Md		245.0808	0.9 ms	sf					
<sup>246</sup> Md		246.0819	1.0 s	$\alpha$	8.74 8.50–8.56				
<sup>247m</sup> Md			$\sim 0.2$ s	sf/					
<sup>247</sup> Md		247.0816	3. s	$\alpha$	8.43				
<sup>248</sup> Md		248.0828	7. s	EC/80 /5.3 $\alpha/20$ /	8.32/15 8.36/5				
				sf/<0.05					
<sup>249</sup> Md		249.0830	24. s	EC>/<80 /3.7 $\alpha/$ >20 /8.46	8.030(20)/ 7.75/4				
<sup>250</sup> Md		250.0844	50. s	EC/94 /4.6 $\alpha/6$ /8.25	7.83/2				
<sup>251</sup> Md		251.0848	4.0 m	EC/>>94 /3.1 $\alpha/$ <6 /	7.55/				
<sup>252</sup> Md		252.0866	2. m	EC/>>50 /3.9 $\alpha/$ <50 /	7.73/				
<sup>253</sup> Md		253.0873	$\sim 6$ m	EC/2.0					
<sup>254m</sup> Md			30. m	EC/					
<sup>254</sup> Md		254.0897	10. m	EC/2.7					
<sup>255</sup> Md		255.09108	27. m	EC/92 /1.04 $\alpha/8$ / sf/< 0.15	$\alpha/7.33/93$ 7.27/5 7.75/1	(7/2-)		0.121/100 0.115/65 0.136/35	
					7.71/1			0.141–0.453	
<sup>256</sup> Md		256.0941	1.30 h	EC/89 /2.13 $\alpha/11$ / sf/< 2.6	7.21/71 7.14/22 7.68/2.5 7.25/2.5 7.64/2.1			Fm k x-ray 0.121/409 0.115/266 0.136/143 0.634/119 0.141–1.37	
<sup>257</sup> Md		257.095541	5.5 h	EC/85 /0.41 $\alpha/15$ , sf/< 1	7.074 7.014	(7/2-)		Fm k x-ray (0.181–0.389)	
<sup>258m</sup> Md			57. m	EC/ sf/< 30		(1-)		Fm k x-ray	
<sup>258</sup> Md		258.098431	51.5 d	$\alpha/7.40$ sf/< 0.003	6.718(2)/ 6.763(4)/	(8-)		0.3678 0.057–0.448	
<sup>259</sup> Md		259.1005	1.64 h	sf/>>98.7 $\alpha/$ <1.3		7/2+			
<sup>260</sup> Md		260.1037	$\sim 27.8$ d	sf/ 73–100					
<b>102 No</b>									
<sup>248</sup> No		248.0866	< 1.0 $\mu$ s	sf		0+			



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<sup>249</sup> No		249.0878	0.05 ms	sf					
				$\alpha/ < 20$					
<sup>250</sup> No		250.0875	6. $\mu$ s	sf/		0+			
				$\alpha/ < 10$					
<sup>251m</sup> No			0.9 s	$\alpha$	8.67				
<sup>251</sup> No		251.0890	0.78 s	$\alpha/91$	8.62/96				
				sf/0.26	8.58/4				
<sup>252</sup> No		252.08898	2.44 s	$\alpha/75/8.551$	8.42	0+			
				sf/24/	8.37				
				EC, $\beta+ / < 1.6$					
<sup>253</sup> No		253.0907	1.7 m	$\alpha/$	8.00	(9/2-)			0.222/100
				EC/3.2					(0.151-0.280)
<sup>254m</sup> No			0.28 s	IT./					
				sf/ < .2					
<sup>254</sup> No		254.09096	49. s	$\alpha/$	8.09	0+			0.102
				EC/1.1					0.152
				sf/0.17					
<sup>255</sup> No		255.09324	3.1 m	$\alpha/62 /$	8.12/	$\frac{1}{2}+$			0.187
				EC/38/2.01	7.93				
					8.08				
<sup>256</sup> No		256.09428	2.9 s	$\alpha/$	8.43	0+			
				sf/0.5					
<sup>257</sup> No		257.09688	24.5 s	$\alpha/$	8.222/83	(7/2+)			0.0770
				sf/ < 1.5	8.27				0.1018
					8.323/17				0.1241
<sup>258</sup> No		258.0982	~ 1.2 ms	sf/		0+			
<sup>259</sup> No		259.1010	58. m	$\alpha/78 /7.794$	7.52	(9/2+)			
				EC/22/0.5	7.55				
				sf/ < 9.7					
<sup>260</sup> No		260.1026	0.11 s	sf/		0+			
<sup>262</sup> No		262.1073	~ 8. ms	sf/		0+			
<b><sup>103</sup>Lr</b>									
<sup>251</sup> Lr		251.0944	39 m	sf					
<sup>252</sup> Lr		252.0954	~ 0.36 s	$\alpha$	9.02/73				
				sf/ < 1	8.97/27				
<sup>253m</sup> Lr			~ 0.57 s	$\alpha$	8.79				
				sf/1.3					
<sup>253</sup> Lr		253.0952	1.5 s	$\alpha/$	8.72				
				sf/8					
<sup>254</sup> Lr		254.0965	13. s	$\alpha/$	8.45				
				EC/5.2					
				sf/ < 0.1					
<sup>255</sup> Lr		255.09669	22. s	$\alpha/$	8.37/60				
				EC/3.2	8.43/40				
				sf/ < 0.1					
<sup>256</sup> Lr		256.0986	27. s	$\alpha/99.7 /8.554$	8.43/				
				EC/4.2	8.39				
				sf/ < 0.03					
<sup>257</sup> Lr		257.0996	0.65 s	$\alpha/$	8.80	7/2+			
				EC/2.5					
				sf/ < 0.03					
<sup>258</sup> Lr		258.1018	3.9 s	$\alpha/$	8.60/46				
				EC/3.4	8.62/25				
				sf/ < 5	8.56/20				
					8.65/9				
<sup>259</sup> Lr		259.1029	6.1 s	$\alpha/80$	8.44(1)				
				sf/20					
<sup>260</sup> Lr		260.1055	3. m	$\alpha/$	8.03				

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<sup>261</sup> Lr		261.1069	40. m	sf					
<sup>262</sup> Lr		262.1096	3.6 h	EC/2.					
				sf/<10					
<b><sup>104</sup>Rf</b>									
<sup>253</sup> Rf		253.1007	~ 48. $\mu$ s	sf					
				$\alpha$ / $<10$					
<sup>254</sup> Rf		254.1002	23. $\mu$ s	sf/>98.5		0+			
				$\alpha$ / $<1.5$					
<sup>255</sup> Rf		255.1013	1.6 s	$\alpha$	8.72/<0.05				0.203
				sf/52	8.77/94				0.142
					8.67/<0.05				
					8.58/<0.05				
					8.92/<0.05				
<sup>256</sup> Rf		256.10117	6.2 ms	sf/99.68		0+			
				$\alpha$ /0.32	8.81				
<sup>257</sup> Rf		257.1030	4.7 s	$\alpha$ /9.22	8.77				0.117
				EC/11	9.01				
				sf/<1.4	8.95				
					8.62				
<sup>258</sup> Rf		258.1035	12. ms	sf/87		0+			
				$\alpha$ /13					
<sup>259</sup> Rf		259.1056	3.4 s	$\alpha$ /9.09/93	8.77(2)/				
				sf/7	8.86/				
<sup>260</sup> Rf		260.1064	20. ms	sf/		0+			
<sup>261m</sup> Rf			1.3 m	$\alpha$	8.28				
<sup>261</sup> Rf		261.10877	5. s	$\alpha$ /60, sf/40	8.52/				
<sup>262</sup> Rf		262.1099	2.1 s	sf/>99.2		0+			
<sup>263</sup> Rf		263.1126	10. m	sf, $\alpha$					
<sup>265</sup> Rf		265.1167	~ 13 h	$\alpha$					
<sup>267</sup> Rf		267.122	~ 0.1 d	sf					
<b><sup>105</sup>Db</b>									
<sup>255</sup> Db		255.1074	~ 1.5 s	$\alpha$ ,					
				sf/~ 20					
<sup>256</sup> Db		256.1081	1.6 s	$\alpha$ /64	9.02/67				
				EC/35	8.89/11				
				sf/0.05	9.08/11				
					9.12/11				
<sup>257m</sup> Db			0.8 s	$\alpha$	9.16				
				sf/<13					
<sup>257</sup> Db		257.1077	1.5 s	$\alpha$ /	8.97/33				
				sf/<6	9.07/38				
					9.12/5.5				
					8.94/9				
					9.02/9				
					8.89/5.5				
<sup>258</sup> Db		258.1092	4.2 s	$\alpha$ /	9.30/				
				EC/5.3	9.17/				
				sf/<33	9.08/				
<sup>259</sup> Db		259.1096	~ 0.51 s	sf/					
				$\alpha$ /	9.47/				
<sup>260m</sup> Db			0.3 m						
<sup>260</sup> Db		260.1113	1.5 s	$\alpha$ /	9.05/				
				sf/<9.6	9.08/				
					9.13/				
<sup>261</sup> Db		261.1121	1.8 s	$\alpha$ /	8.93/				
				sf/<18					
<sup>262</sup> Db		262.1141	0.5 m	sf/<33					

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				$\alpha$ /	8.45/ 8.53/ 8.67/ 8.36/ 8.41/ EC/3				
<sup>263</sup> Db		263.1150	~ 0.45 m	sf/57					
				$\alpha$ /41					
<sup>267</sup> Db		267.1224	1.2 h	sf					
<sup>268</sup> Db		268.125	1.2 d	sf, EC					
<b><sup>106</sup>Sg</b>									
<sup>258</sup> Sg		258.1132	~ 2.9 ms	sf		0+			
				$\alpha$ / $<20$					
<sup>259</sup> Sg		259.1145	0.5 s	$\alpha$ / sf/ $<20$	9.62 9.35 9.03				
<sup>260</sup> Sg		260.11442	4. ms	$\alpha$ /50 sf/50	9.76 9.72 9.81	0+			
<sup>261</sup> Sg		261.1161	0.3 s	$\alpha$ , sf/ $<10$	9.56				
<sup>262</sup> Sg		262.1164	0.007 s	sf		0+			
				$\alpha$ / $<22$					
<sup>263m</sup> Sg			0.3 s	$\alpha$	9.2				
<sup>263</sup> Sg		263.1183	0.8 s	$\alpha$	9.06				
				sf/ $<30$	9.25				
<sup>265</sup> Sg		265.1211	8. s	$\alpha$ / $>65$ sf/ $<35$	8.84/46 8.76/23 8.94/23 8.69/8				
<sup>266</sup> Sg		266.1221	~ 21. s	$\alpha$ / sf/ $<82$	8.77/66 8.52/33	0+			
<sup>271</sup> Sg		271.133	~ 0.04 h	$\alpha$ /50 sf/50	8.53				
<b><sup>107</sup>Bh</b>									
<sup>260</sup> Bh		260.122		$\alpha$					
<sup>261</sup> Bh		261.1217	12. ms	$\alpha$ , sf $<10$	10.40 10.10 10.03				
<sup>262m</sup> Bh			8. ms	$\alpha$ / sf/ $<12$	10.37 10.24				
<sup>262</sup> Bh		262.1229	0.10 s	$\alpha$ / sf/ $<12$	10.06 9.91 9.74				
<sup>264</sup> Bh		264.1246	1.0 s	$\alpha$ / sf/	9.3 – 9.8				
<sup>265</sup> Bh		265.1252	0.9 s	$\alpha$	9.24				
<sup>266</sup> Bh		266.1269	~ 2 s	$\alpha$	9.08				
<sup>267</sup> Bh		267.1277	~ 17 s	$\alpha$	8.83				
<b><sup>108</sup>Hs</b>									
<sup>263</sup> Hs		263.1286		$\alpha$ / $\alpha$ , sf/ $\sim 50$					
<sup>264</sup> Hs		264.12839	~ 0.08 ms		11.0	0+			
<sup>265m</sup> Hs			~ 0.75 ms	$\alpha$	10.57/63 10.73 10.52 10.34				
<sup>265</sup> Hs		265.1301	2.0 ms	$\alpha$ / sf/ $<1$	10.30/90 10.43 10.37				

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<sup>266</sup> Hs		266.1301	~ 2.3 ms	$\alpha$	10.25 10.2	0+			
<sup>267m</sup> Hs			~ 0.8 s						
<sup>267</sup> Hs		267.1318	0.05 s	$\alpha$ / $>88$	9.88 9.83 9.75				
<sup>269</sup> Hs		269.1341	~ 14 s	$\alpha$	9.23 9.18				
<sup>270</sup> Hs		270.1347	~ 3.6 s	$\alpha$	9.16	0+			
<sup>275</sup> Hs		275.146	~ 0.15 s	$\alpha$	9.3				
<sup>277</sup> Hs		277.150	~ 11 m	sf					
<b><sup>109</sup>Mt</b>									
<sup>266m</sup> Mt			~ 1.2 ms	$\alpha$	10.46–10.81				
<sup>266</sup> Mt		266.1373	~ 0.7 ms	$\alpha$	10.48–11.31				
<sup>267</sup> Mt		267.137	19 ms	$\alpha$					
<sup>268</sup> Mt		268.1387	~ 0.03 s	$\alpha$ / $>68$	10.3 - 10.8				
<sup>270</sup> Mt		270.141	5 ms	$\alpha$	10.0				
<sup>275</sup> Mt		275.149	0.01 s	$\alpha$	10.3				
<sup>276</sup> Mt		276.151	~ 0.7 s	$\alpha$	9.7				
<b><sup>110</sup>Ds</b>									
<sup>267</sup> Ds		267.1443	~ 3 $\mu$ s	$\alpha$ / $>32$	11.6				
<sup>269</sup> Ds		269.1451	0.17 ms	$\alpha$ / $>75$	11.11				
<sup>270m</sup> Ds			~ 6 ms	$\alpha$	10.95 11.15 12.15				
<sup>270</sup> Ds		270.1447	0.1 ms	$\alpha$	11.03	0+			
<sup>271m</sup> Ds			0.07 s	$\alpha$	9.9				
<sup>271</sup> Ds		271.1461	1.6 ms	$\alpha$	10.8				
<sup>273m</sup> Ds			0.076 ms	$\alpha$	11.8				
<sup>273</sup> Ds		273.1489	118 ms	$\alpha$ /	9.73				
<sup>279</sup> Ds		279.159	0.18 s	sf/90 $\alpha$ /10	9.7				
<sup>280</sup> Ds		280.160	~ 7.6 s	sf/		0+			
<sup>281</sup> Ds		281.162	10. s	sf					
<sup>282</sup> Ds			0.5 ms	sf					
<b><sup>111</sup>Rg</b>									
<sup>272</sup> Rg		272.1536	~ 2 ms	$\alpha$ / $>68$	10.82				
<sup>274</sup> Rg		274.156	~ 65 ms	$\alpha$	11.2				
<sup>279</sup> Rg		279.162	~ 0.17 s	$\alpha$	10.4				
<sup>280</sup> Rg		280.164	~ 3.6 s	$\alpha$	~ 9.75				
<b><sup>112</sup>112</b>									
<sup>277</sup> 112		277.1639	~ 0.24 ms	$\alpha$	11.45 11.65				
<sup>283</sup> 112		283.172	~ 4. s	sf/ $< 10$ $\alpha$ / $\sim 100$	9.5				
<sup>284</sup> 112		284.172	0.10 s	sf					
<sup>285</sup> 112		285.174	~ 34. s	$\alpha$	9.16				
<b><sup>113</sup>113</b>									
<sup>278</sup> 113			0.24 ms	$\alpha$	11.7				
<sup>283</sup> 113		283.176	~ 0.1 s	$\alpha$	10.1				
<sup>284</sup> 113		284.178	~ 0.5 s	$\alpha$	10.0				

Elem. or Isot.	Natural Abundance (Atom %)	Atomic Mass or Weight	Half-life/ Resonance Width (MeV)	Decay Mode/ Energy (/MeV)	Particle Energy/ Intensity (MeV/%)	Spin ( $\hbar/2\pi$ )	Nuclear Magnetic Mom. (nm)	Elect. Quadr. Mom. (b)	$\gamma$ -Energy / Intensity (MeV/%)
<b><sup>114</sup></b>									
<sup>286</sup> 114		286.184	0.16 s	$\alpha/40$	10.2				
				sf/60					
<sup>287</sup> 114		287.186	0.5 s	$\alpha$	10.0				
<sup>288</sup> 114		288.186	0.8 s	$\alpha$	9.95				
<sup>289</sup> 114		289.187	~ 2.7 s	$\alpha$	9.82				
<b><sup>115</sup></b>									
<sup>287</sup> 115		287.191	~ 0.03 s	$\alpha$	10.6				
<sup>288</sup> 115		288.192	~ 0.09 s	$\alpha$	10.5				
<b><sup>116</sup></b>									
<sup>290</sup> 116		290.199	~ 15 ms	$\alpha$	10.9				
<sup>291</sup> 116		291.200	~ 6. ms	$\alpha$	~ 10.74				
<sup>292</sup> 116		292.200	~ 18. ms	$\alpha$	~ 10.66				
<sup>293</sup> 116			~ 0.05 s	$\alpha$	10.5				
<b><sup>118</sup></b>									
<sup>294</sup> 118			~ 2.0 ms	$\alpha$	11.7				

# NEUTRON SCATTERING AND ABSORPTION PROPERTIES

Norman E. Holden

This table presents an evaluated set of values for experimental quantities that characterize the properties for scattering and absorption of neutrons. The neutron cross section is given for room temperature neutrons, 20.43°C, corresponding to a thermal neutron energy of 0.0253 electron volts (eV) or a neutron velocity of 2200 meters/second. The neutron resonance integral is defined over the energy range from 0.5 eV to  $0.1 \times 10^6$  eV, or 0.1 MeV.

Bound neutron scattering lengths and neutron cross sections averaged over a Maxwellian spectrum at 30 keV for astrophysical applications are also presented. A list of the major references used is given below. The literature cutoff date is January 2003. Uncertainties are given in parentheses. Parentheses with two or more numbers indicate values to the excited state(s) and to the ground state of the product nucleus.

## Table Layout

Column Number	Column Title	Description
1	Isotope/Element	For elements, atomic number and chemical symbol are listed. For nuclides, mass number and chemical symbol are listed. Isomers are indicated by the addition of m, m1, or m2.
2	Isotopic Abundance	in atom percent
3	Half-life	Half-life in decimal notation. $\mu$ s = microsecond; ms = millisecond; s = second; m = minute; h = hour; d = day; y = year.
4	Thermal Neutron Cross Sections	Cross sections for neutron capture reactions in units of barns ( $10^{-24}$ cm <sup>2</sup> ) or millibarns (mb). Proton, alpha production and fission reactions are designated by $\sigma_p$ , $\sigma_\alpha$ , $\sigma_f$ , respectively. Separate values are listed for isomeric production.
5	Neutron Resonance Integrals	Resonance integrals for neutron capture reactions in barns ( $10^{-24}$ cm <sup>2</sup> ) or millibarns (mb). Proton, alpha production and fission reactions are designated by R.I. <sub>p</sub> , R.I. <sub>α</sub> , R.I. <sub>f</sub> , respectively. Separate values are listed for isomeric production.
6	Neutron Scattering Lengths	Bound coherent scattering lengths for neutron scattering reactions in units of femtometers (fm), which is equal to fermis ( $10^{-13}$ cm).
7	Maxwellian Averaged Cross Section	Astrophysical Cross Sections, averaged over a stellar neutron maxwellian spectrum characterized by a thermal energy of 30 keV, expressed in barns ( $10^{-24}$ cm <sup>2</sup> ), millibarns (mb) or microbarns ( $\mu$ b).

## General Nuclear Data References

The following references represent the major sources of the nuclear data presented:

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Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>1</sup> H			0.332(2)	0.149(1)	-3.739(1)	
<sup>1</sup> H	99.9885(70)	>2.8×10 <sup>23</sup> y	0.332(2)	0.149(1)	- 3.741(1)	0.25(2) mb*
<sup>2</sup> H	0.0115(70)		0.51(1)mb	0.23(2) mb	6.671(4)	2.1(4) $\mu$ b
<sup>3</sup> H		12.33 y	< 6. $\mu$ b		4.79(3)	
<sup>2</sup> He			< 0.05		3.26(3)	
<sup>3</sup> He	0.000134(3)		$\sigma_p = 5.33(1) \times 10^3$ 0.05(1) mb	RI <sub>p</sub> = 2.39(1)×10 <sup>3</sup>	5.74(7)	8.(1) $\mu$ b*
<sup>4</sup> He	99.999867(3)				3.26(3)	
<sup>3</sup> Li			71.(2)	32.(1)	- 1.90(2)	
<sup>6</sup> Li	7.59(4)		$\sigma_t = 9.4(1) \times 10^2$	RI <sub>t</sub> = 422.(4)	2.0(1)	$\sigma_t \approx 1$ .

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>7</sup> Li	92.41(4)		39.(5) mb 45.(5) mb	17.(2) mb 20.(2) mb		0.06(1) mb* 42.(3) $\mu$ b
<sup>8</sup> Li		0.84 s			- 2.22(2)	< $\approx$ 5.5 $\mu$ b
<sup>4</sup> Be			8.8(4) mb	3.9(2) mb	7.79(1)	
<sup>7</sup> Be		53.28 d	$\sigma_p = 3.9(1) \times 10^4$ $\sigma_\alpha \approx 0.1$	$RI_p = 1.75(5) \times 10^4$		$\sigma_p = 16(4)^*$
<sup>9</sup> Be	100.		8.8(4) mb	3.9(2) mb	7.79(1)	
<sup>10</sup> Be		1.52 $\times 10^6$ y	< 1. mb			
<sup>5</sup> B			7.6(1) $\times 10^2$	3.4(1) $\times 10^2$	5.30(4)	
<sup>10</sup> B	19.9(7)		$\sigma_\alpha = 38.4(1) \times 10^2$ 0.3(1) $\sigma_p = 7.(1)$ mb $\sigma_i = 8.(2)$ mb	$RI_\alpha = 17.3(1) \times 10^2$ 0.13(4)	- 0.1(3)	
<sup>11</sup> B	80.1(7)		5.(3) mb	2.(1) mb	6.65(4)	
<sup>6</sup> C			3.5(1) mb	1.6(1) mb	6.646(1)	
<sup>12</sup> C	98.93(8)		3.5(1) mb	1.6(1) mb	6.651(2)	16.(1) $\mu$ b*
<sup>13</sup> C	1.07(8)		1.4(1) mb	1.7(2) mb	6.19(9)	0.021(4) mb
<sup>14</sup> C		5715. y	< 1.4 $\mu$ b			3.(1) $\mu$ b*
<sup>7</sup> N			2.00(6)	0.90(3)	9.36(2)	
<sup>14</sup> N	99.636(20)		$\sigma_p = 1.93(5)$ 0.080(1)	$RI_p = 0.87(3)$ 0.034(1)	9.37(2)	$\sigma_p = 1.8(2)$ mb* 0.04(1) mb
<sup>15</sup> N	0.364(20)		0.04(1) mb	0.11(3) mb	6.44(3)	6.(1) $\mu$ b*
<sup>8</sup> O			0.29(1) mb	0.40(4) mb	5.805(4)	
<sup>16</sup> O	99.757(16)		0.19(1) mb	0.36(4) mb	5.805(5)	34.(4) $\mu$ b
<sup>17</sup> O	0.038(1)		$\sigma_\alpha = 0.257(10)$ 0.54(7) mb	0.11(1) 0.39(5) mb	5.8(2)	$\sigma_\alpha = 3.9(5)$ mb*
<sup>18</sup> O	0.205(14)		0.16(1) mb	0.81(4) mb	5.84(7)	9.(1) $\mu$ b*
<sup>9</sup> F			9.5(1) mb	21.(3) mb	5.65(1)	6.(1) mb
<sup>19</sup> F	100.		9.5(1) mb	21.(3) mb	5.65(1)	6.(1) mb
<sup>10</sup> Ne			42.(5) mb	19.(3) mb	4.566(6)	
<sup>20</sup> Ne	90.48(3)		39.(5) mb	18.(3) mb	4.631(6)	0.12(1) mb
<sup>21</sup> Ne	0.27(1)		0.7(1) $\sigma_\alpha = 0.18(9)$ mb	0.31(5)	6.7(2)	$\approx$ 1.5 mb
<sup>22</sup> Ne	9.25(3)		51.(5) mb	23.(3) mb	3.87(1)	58.(4) $\mu$ b*
<sup>11</sup> Na			0.53(2)	0.32(2)	3.63(2)	2.1(2) mb
<sup>22</sup> Na		2.605 y	$\sigma_p = 2.8(3) \times 10^4$ $\sigma_\alpha = 2.6(4) \times 10^2$	$RI_p < 2. \times 10^5$ $RI_\alpha = 1.2(2) \times 10^2$		
<sup>23</sup> Na	100.		$\sigma_m = 0.43(3)$	$RI_m = 0.30(6)$	3.63(2)	2.1(2) mb
<sup>12</sup> Mg			66.(6) mb	38.(5) mb	5.375(4)	
<sup>24</sup> Mg	78.99(4)		0.053(6)	32.(4) mb	5.7(2)	3.3(4) mb
<sup>25</sup> Mg	10.00(1)		0.20(1)	98.(15) mb	3.6(2)	6.4(4) mb
<sup>26</sup> Mg	11.01(3)		0.038(1)	25.(2) mb	4.9(2)	0.13(1) mb*
<sup>27</sup> Mg		9.45 m	0.07(2)	0.03(1)		
<sup>13</sup> Al			0.230(2)	0.17(1)	3.45(1)	
<sup>26</sup> Al		7.1 $\times 10^5$ y	$\sigma_p = 1.97(10)$ $\sigma_\alpha = 0.34(1)$			0.14(2)
<sup>27</sup> Al	100.		0.230(2)	0.17(1)	3.45(1)	2.9(3) mb
<sup>14</sup> Si			0.166(9)	0.12(2)	4.15(1)	
<sup>28</sup> Si	92.223(19)		0.17(1)	0.11(2)	4.11(1)	2.9(3) mb
<sup>29</sup> Si	4.685(8)		0.12(1)	0.08(2)	4.7(1)	7.9(9) mb
<sup>30</sup> Si	3.092(11)		0.107(3)	0.62(6)	4.61(1)	3.2(3) mb*
<sup>31</sup> Si		2.62 h	73.(6) mb	33.(3) mb		
<sup>32</sup> Si		1.6 $\times 10^2$ y	< 0.5			
<sup>15</sup> P			0.17(1)	0.08(1)	5.13(1)	
<sup>31</sup> P	100.		0.17(1)	0.08(1)	5.13(1)	1.7(1) mb
<sup>16</sup> S			0.54(2)	0.24(2)	2.847(1)	
<sup>32</sup> S	94.93(31)		0.55(5) $\sigma_\alpha < 0.5$ mb	0.25(2)	2.804(2)	4.1(2) mb

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>33</sup> S	0.76(2)		0.46(3) $\sigma_{\alpha} = 0.12(1)$ $\sigma_p = 2. \text{ mb}$	0.21(2) $RI_{\alpha} = 0.05(1)$	4.7(2)	7.4(15) mb $\sigma_{\alpha} = 0.18(1)$
<sup>34</sup> S	4.29(28)		0.25(1)	0.13	3.48(3)	0.23(1) mb
<sup>36</sup> S	0.02(1)		0.24(2)	0.26(3)		0.17(1) mb*
<sup>17</sup> Cl			33.6(3)	15.(2)	9.58(1)	
<sup>35</sup> Cl	75.78(4)		43.7(4) $\sigma_p = 0.44(1)$ $\sigma_{\alpha} \approx 0.08 \text{ mb}$	20.(2) $RI_p = 0.2$	11.7(1)	9.4(3) mb $\sigma_p = 1.7(2) \text{ mb}^*$
<sup>36</sup> Cl		$3.01 \times 10^5 \text{ y}$	$\sigma_p = 46.(2) \text{ mb}$ <10. $\sigma_{\alpha} = 0.59(7) \text{ mb}$	$RI_p = 0.02$		$\sigma_p = 91.(8) \text{ mb}$ $\sigma_{\alpha} = 0.9(2) \text{ mb}$
<sup>37</sup> Cl	24.22(4)		(0.05 + 0.38)	(0.04+0.26)	3.1(1)	2.0(2) mb
<sup>18</sup> Ar			0.66(3)	0.42(5)	1.91(1)	
<sup>36</sup> Ar	0.3365(30)		5.(1) $\sigma_{\alpha} = 5.4(3) \text{ mb}$ $\sigma_p < 1.5 \text{ mb}$	2.(1)	24.9(1)	
<sup>37</sup> Ar		35.0 d	$\sigma_{\alpha} = 1.08(8) \times 10^3$ $\sigma_p = 37.(4)$	$RI_{\alpha} = 900.$ $RI_p = 31.$		$\sigma_{\alpha} \approx 1.3$ $\sigma_p \approx 0.04$
<sup>38</sup> Ar	0.0632(5)		0.8(2)	0.4(1)	3.5(35)	
<sup>39</sup> Ar		268. y	$6.(2) \times 10^2$ $\sigma_{\alpha} < 0.29$			
<sup>40</sup> Ar	99.6003(30)		0.64(3)	0.41(5)	1.83(1)	2.5(3) mb
<sup>41</sup> Ar		1.82 h	0.5(1)	0.2(1)		
<sup>19</sup> K			2.1(1)	1.0(1)	3.67(2)	
<sup>39</sup> K	93.2581(44)		2.1(2) $\sigma_{\alpha} = 4.3(5) \text{ mb}$ $\sigma_p < 0.05 \text{ mb}$	0.9(1)	3.74(2)	11.8(4) mb
<sup>40</sup> K	0.0117(1)	$1.26 \times 10^9 \text{ y}$	30.(8) $\sigma_p = 4.4(4)$ $\sigma_{\alpha} = 0.42(8)$	13.(4) 2.0(2)		$\sigma_p = 7.(1) \text{ mb}$ $\sigma_{\alpha} = 40.(6) \text{ mb}$
<sup>41</sup> K	6.7302(44)		1.46(3)	1.4(2)	2.69(8)	22.(1) mb
<sup>20</sup> Ca			0.43(2)	0.23(2)	4.70(2)	
<sup>40</sup> Ca	96.941(156)		0.41(3) $\sigma_{\alpha} = 0.13(4) \text{ mb}$ $\approx 4.$	0.22(4)	4.80(2)	6.7(7) mb
<sup>41</sup> Ca		$1.02 \times 10^5 \text{ y}$	$\sigma_{\alpha} = 0.18(3)$ $\sigma_p = 7.(2) \text{ mb}$			
<sup>42</sup> Ca	0.647(23)		0.65(10)	0.39(4)	3.4(1)	16.(2) mb
<sup>43</sup> Ca	0.135(10)		6.(1)	3.9(2)	- 1.56(9)	51.(6) mb
<sup>44</sup> Ca	2.086(110)		0.8(2)	0.56(1)	1.42(6)	9.(1) mb
<sup>45</sup> Ca		162.7 d	$\approx 15.$			
<sup>46</sup> Ca	0.004(3)	$>4 \times 10^{15} \text{ y}$	0.70(3)	0.9(1)	3.6(2)	5.3(5) mb*
<sup>48</sup> Ca	0.187(21)	$4.3 \times 10^{19} \text{ y}$	1.0(1)	0.5(1)	0.39(9)	0.8(1) mb*
<sup>21</sup> Sc			27.2(2)	12.(1)	12.3(1)	
<sup>45</sup> Sc	100.		(10.+17.)	(5.6+6.4)	12.3(1)	69.(5) mb
<sup>46</sup> Sc		83.81 d	8.(1)	3.6(5)		
<sup>22</sup> Ti			6.1(1)	2.8(2)	- 3.438(2)	
<sup>44</sup> Ti		60 y	1.1(2) $\sigma_p < 0.2$			
<sup>46</sup> Ti	8.25(3)		0.6(2)	0.4(1)	4.93(6)	27.(3) mb
<sup>47</sup> Ti	7.44(2)		1.6(2)	1.6(2)	3.63(1)	64.(8) mb
<sup>48</sup> Ti	73.72(3)		7.9(9)	3.6(2)	- 6.09(2)	32.(5) mb
<sup>49</sup> Ti	5.41(2)		1.9(5)	1.2(2)	1.04(5)	22.(2) mb
<sup>50</sup> Ti	5.18(2)		0.179(3)	0.12(2)	6.18(8)	3.6(4) mb
<sup>23</sup> V			5.0(2)	2.8(1)	- 0.382(1)	
<sup>50</sup> V	0.250(4)	$1.4 \times 10^{17} \text{ y}$	21.(4) $\sigma_p = 0.7(4) \text{ mb}$	50.(20)	7.6(6)	

\*Extrapolated value.



Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>51</sup> V	99.750(4)		4.9(1)	2.7(2)	- 0.402(2)	38.(4) mb
<sup>24</sup> Cr			3.0(2)	1.7(1)	3.635(7)	
<sup>50</sup> Cr	4.345(13)	>1.8×10 <sup>17</sup> y	15.(1)	8.(1)	- 4.5(1)	0.05(1)
<sup>51</sup> Cr		27.70 d	< 10.			
<sup>52</sup> Cr	83.789(18)		0.8(1)	0.6(2)	4.91(2)	8.8(4) mb
<sup>53</sup> Cr	9.501(17)		18.(2)	9.(1)	- 4.2(1)	0.06(1)
<sup>54</sup> Cr	2.365(7)		0.36(4)	0.25(5)	4.6(1)	7.(2) mb
<sup>25</sup> Mn			13.3(1)	14.0(3)	- 3.75(2)	
<sup>53</sup> Mn		3.7×10 <sup>6</sup> y	70.(10)	32.(5)		
<sup>54</sup> Mn		312.1 d	< 10.			
<sup>55</sup> Mn	100.		13.3(1)	14.0(3)	- 3.75(2)	40.(3) mb
<sup>26</sup> Fe			2.7(1)	1.4(2)	9.45(2)	
<sup>54</sup> Fe	5.845(35)		2.3(2)	1.3(2)	4.2(1)	29.(2) mb
<sup>55</sup> Fe		2.73 y	$\sigma_{\alpha} = 10. \mu\text{b}$ 13.(2)	RI $_{\alpha} = 1.1(1)$ mb 6.(1)		
<sup>56</sup> Fe	91.754(36)		$\sigma_{\alpha} = 0.01$ 2.8(3)	1.4(2)	9.93(3)	11.7(5) mb
<sup>57</sup> Fe	2.119(10)		1.4(2)	0.8(4)	2.3(1)	40.(4) mb
<sup>58</sup> Fe	0.282(4)		1.3(1)	1.3(2)	15.(7)	12.(1) mb
<sup>59</sup> Fe		44.51 d	13.(3)	6.(1)		
<sup>27</sup> Co			37.19(8)	74.(2)	2.49(2)	
<sup>58m</sup> Co		9.1 h	1.4(1)×10 <sup>5</sup>	2.5(10)×10 <sup>5</sup>		
<sup>58</sup> Co		70.88 d	1.9(2)×10 <sup>3</sup>	7.(1)×10 <sup>3</sup>		
<sup>59</sup> Co	100.		(20.7+16.5)	(39.+35.)	2.49(2)	38.(4) mb
<sup>60m</sup> Co		10.47 m	58.(3)	230.(50)		
<sup>60</sup> Co		5.271 y	2.0(2)	4.3(10)		
<sup>28</sup> Ni			4.5(2)	2.3(2)	10.3(1)	
<sup>58</sup> Ni	68.0769(89)	>4×10 <sup>19</sup> y	4.6(4)	2.3(2)	14.4(1)	41.(2) mb
<sup>59</sup> Ni		≈ 7.6×10 <sup>4</sup> y	$\sigma_{\alpha} < 0.03$ mb $\sigma_{\text{abs}} = 92.(4)$ $\sigma_{\alpha} = 14.(2)$ $\sigma_{\text{p}} = 2.(1)$	RI $_{\text{abs}} = 1.4(1)$ ×10 <sup>2</sup>		
<sup>60</sup> Ni	26.2231(77)		2.9(3)	1.5(2)	2.8(1)	25.(1) mb
<sup>61</sup> Ni	1.1399(6)		2.5(5)	1.5(4)	7.60(6)	82.(8) mb
<sup>62</sup> Ni	3.6345(17)		$\sigma_{\alpha} = 0.03$ mb 15.(1)	6.8(3)	- 8.7(2)	13.(4) mb
<sup>63</sup> Ni		100. y	20.(5)	9.(2)		
<sup>64</sup> Ni	0.9256(9)		1.6(1)	1.2(2)	- 0.37(7)	9.(1) mb
<sup>65</sup> Ni		2.517 h	22.(2)	10.(1)		
<sup>29</sup> Cu			3.8(1)	4.1(4)	7.718(4)	
<sup>63</sup> Cu	69.15(15)		4.5(2)	5.(1)	6.43(15)	0.09(1)
<sup>64</sup> Cu		12.701 h	≈ 270.			
<sup>65</sup> Cu	30.85(15)		2.17(3)	2.2(1)	10.61(19)	41.(5) mb
<sup>66</sup> Cu		5.09 m	1.4(1)×10 <sup>2</sup>	60.(20)		
<sup>30</sup> Zn			1.1(2)	2.8(4)	5.680(5)	
<sup>64</sup> Zn	48.27(32)	>2.3×10 <sup>18</sup> y	0.74(5)	1.4(3)	5.23(4)	59.(5) mb
<sup>65</sup> Zn		243.8 d	$\sigma_{\text{p}} < 12. \mu\text{b}$ $\sigma_{\alpha} = 11.(3) \mu\text{b}$ 66.(8)	30.(4)		
<sup>66</sup> Zn	27.977(77)		$\sigma_{\alpha} = 2.0(2)$ 0.9(3)	1.8(2)	5.98(5)	35.(3) mb
<sup>67</sup> Zn	4.102(21)		$\sigma_{\alpha} < 0.02$ mb 6.9(1.4)	25.(5)	7.58(8)	0.15(2)
<sup>68</sup> Zn	19.02(12)		$\sigma_{\alpha} = 0.4$ mb (0.072 + 0.8)	(0.2 + 2.9)	6.04(3)	19.(2) mb $\sigma_{\text{m}} = 3.(1)$ mb
<sup>70</sup> Zn	0.631(9)		$\sigma_{\alpha} < 0.02$ mb (8.1+83.) mb	0.9(2)		0.02(1)
<sup>31</sup> Ga			2.9(1)	22.(3)	7.288(2)	

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>69</sup> Ga	60.108(9)		1.68(7)	16.(2)	7.88(4)	0.14(1)
<sup>71</sup> Ga	39.892(9)	>2.4×10 <sup>26</sup> y	4.7(2)	31.(3)	6.40(3)	0.12(1)
			$\sigma_m = 0.15(5)$			
<sup>32</sup> Ge			2.2(1)	6.(2)	8.19(2)	
<sup>68</sup> Ge		270.8 d	1.0(5)			
<sup>70</sup> Ge	20.370(89)		(0.3 + 2.7)	2.3(1)	10.0(1)	88.(5) mb
<sup>72</sup> Ge	27.380(60)		0.9(2)	0.8(3)	8.5(1)	0.07(2)
<sup>73</sup> Ge	7.759(78)	>1.8×10 <sup>23</sup> y	15.(1)	66.(20)	5.02(4)	0.3(1)
<sup>74</sup> Ge	36.656(80)		(0.14 + 0.28)	(0.4+0.5)	7.6(1)	53.(7) mb
<sup>76</sup> Ge	7.835(81)	1.6×10 <sup>21</sup> y	(0.09 + 0.06)	(1.3+0.6)	8.2(15)	0.03(2)
<sup>33</sup> As			4.0(4)	61.(5)	6.58(1)	
<sup>75</sup> As	100.		4.0(4)	61.(5)	6.58(1)	0.57(4)
<sup>34</sup> Se			12.(1)	14.(3)	7.970(9)	
<sup>74</sup> Se	0.89(4)		50.(2)	520(50)	0.8(3)	0.2(1)
<sup>75</sup> Se		119.78 d	3.3(10)×10 <sup>2</sup>			
<sup>76</sup> Se	9.37(29)		(22. + 63.)	(9.+31.)	12.2(1)	0.16(1)
<sup>77</sup> Se	7.63(16)		42.(4)	30.(5)	8.25(8)	0.3(1)
			$\sigma_\alpha = 0.97(3)$ $\mu$ b			
<sup>78</sup> Se	23.77(28)		$\sigma_m = 0.38(2)$	RI <sub>m</sub> = 4.3(4)	8.24(9)	0.1
<sup>80</sup> Se	49.61(41)		(0.05+0.54)	(0.15+0.85)	7.48(3)	42.(3) mb
<sup>82</sup> Se	8.73(22)	≈ 1×10 <sup>20</sup> y	(39.+ 5.2) mb	39.(4) mb	6.34(8)	0.04(2)
<sup>35</sup> Br			6.8(2)	92.(8)	6.79(2)	
<sup>76</sup> Br		16.0 h	224.(42)			
<sup>79</sup> Br	50.69(7)		(2.5+8.3)	(36.+96.)	6.79(7)	0.63(4)
						$\sigma_m = 0.08(1)$
<sup>81</sup> Br	49.31(7)		(2.4+0.24)	51.(5)	6.78(7)	0.31(2)
<sup>36</sup> Kr			24.(1)	39.(6)	7.81(2)	
<sup>78</sup> Kr	0.353(3)	>2.3×10 <sup>20</sup> y	(0.17+6.)	20.(1)		(0.11+0.19)
<sup>80</sup> Kr	2.286(10)		(4.6+7.)	57.(6)		(0.09+0.18)
<sup>82</sup> Kr	11.593(3)		(14.+7.)	130.(13)		90.(6) mb
<sup>83</sup> Kr	11.500(19)		183.(30)	183.(20)		0.24(2)
<sup>84</sup> Kr	56.987(15)		( $\sigma_m + \sigma_g$ ) = 0.11	2.4(3)		(16.+33.) mb
			$\sigma_m = 0.09$			
<sup>85</sup> Kr		10.73 y	1.7(2)	1.8(10)		0.07(2)
<sup>86</sup> Kr	17.279(41)		3.(2) mb	≈ 1. mb	8.1(3)	3.2(4) mb
<sup>37</sup> Rb			0.39(4)	6.(3)	7.08(2)	
<sup>84</sup> Rb		32.9 d	$\sigma_p = 12.(2)$			
<sup>85</sup> Rb	72.17(2)		(0.06+0.38)	(0.7+7.)	7.0(1)	0.24(1)
<sup>86</sup> Rb		18.65 d	<20.			
<sup>87</sup> Rb	27.83(2)	4.88×10 <sup>10</sup> y	0.10(1)	2.3(4)	7.3(1)	16.(1) mb
<sup>88</sup> Rb		17.7 m	1.2(3)	0.5(1)		
<sup>38</sup> Sr			1.2(1)	10.(1)	7.02(2)	
<sup>84</sup> Sr	0.56(1)		(0.6+0.2)	(9.+1.)		0.4(1)
<sup>86</sup> Sr	9.86(1)		$\sigma_m = 0.81(4)$	RI <sub>m</sub> = 4.(1)	5.68(5)	(48.+22.) mb
<sup>87</sup> Sr	7.00(1)		16.(3)	118.(30)	7.41(7)	97.(5) mb
<sup>88</sup> Sr	82.58(1)		5.8(4) mb	0.07(3)	7.16(6)	6.0(2) mb
<sup>89</sup> Sr		50.52 d	0.42(4)	0.2		
<sup>90</sup> Sr		29.1 y	10.(1) mb	0.10(2)		
<sup>39</sup> Y			1.25(5)	1.0(1)	7.75(2)	
<sup>89</sup> Y	100.		(0.001+1.25)	(0.006+1.0)	7.75(2)	19.(1) mb
<sup>90</sup> Y		2.67 d	<6.5			
<sup>91</sup> Y		58.5 d	1.4(3)	0.6(1)		
<sup>40</sup> Zr			0.19(1)	0.95(9)	7.16(3)	
			$\sigma_\alpha < 0.1$ mb			
<sup>90</sup> Zr	51.45(40)		≈ 0.014	0.2(1)	6.4(1)	21.(2) mb
<sup>91</sup> Zr	11.22(5)		1.2(3)	5.(2)	8.8(1)	60.(8) mb
<sup>92</sup> Zr	17.15(8)		0.2(1)	0.6(2)	7.5(2)	33.(4) mb
<sup>93</sup> Zr		1.5×10 <sup>6</sup> y	<4.	16.(5)		0.10(1)

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>94</sup> Zr	17.38(28)	>10 <sup>17</sup> y	0.049(6)	0.25(3)	8.3(2)	26.(1) mb
<sup>96</sup> Zr	2.80(9)	>1.7×10 <sup>18</sup> y	0.020(3)	5.0(5)	5.5(1)	11.(1) mb
<sup>41</sup> Nb			1.11(1)	8.5(6)	7.14(3)	
<sup>93</sup> Nb	100.		$\sigma_{\alpha} < 0.1$ mb 1.1	(6.3+2.2)	7.14(3)	266.(5) mb
<sup>94</sup> Nb		2.4×10 <sup>4</sup> y	$\sigma_m = 0.86$ ( $\sigma_m + \sigma_g$ ) = 15.(1)	126.(13)		
<sup>95</sup> Nb		34.97 d	$\sigma_m = 0.6(1)$ <7.	<200.		
<sup>42</sup> Mo			2.5(1)	26.(5)	6.72(2)	
<sup>92</sup> Mo	14.77(31)	>3×10 <sup>17</sup> y	$\sigma_{\alpha} < 0.1$ mb 0.06	≈ 0.8	6.93(8)	0.07(1)
<sup>94</sup> Mo	9.226(99)		$\sigma_m = 0.2$ $\mu$ b 0.02	≈ 0.8	6.82(7)	0.10(2)
<sup>95</sup> Mo	15.900(85)		13.4(3)	109.(5)	6.93(6)	0.29(1)
<sup>96</sup> Mo	16.674(12)		$\sigma_{\alpha} = 30.(4)$ $\mu$ b 0.5	17.(3)	6.22(6)	0.11(1)
<sup>97</sup> Mo	9.560(50)		2.5(2)	14.(3)	7.26(8)	0.34(1)
<sup>98</sup> Mo	24.20(25)		$\sigma_{\alpha} = 0.4(2)$ $\mu$ b 0.14(1)	7.2(7)	6.60(7)	0.10(1)
<sup>100</sup> Mo	9.67(20)	≈ 1×10 <sup>19</sup> y	0.19(1)	3.6(3)	6.75(7)	0.11(1)
<sup>43</sup> Tc						
<sup>98</sup> Tc		≈ 6.6×10 <sup>6</sup> y	$\sigma_m = 0.9(2)$			
<sup>99</sup> Tc		2.13×10 <sup>5</sup> y	23.(2)	4.0(4)×10 <sup>2</sup>	6.8(3)	0.93(5)
<sup>44</sup> Ru			2.6 (1)	48.(5)	7.03(3)	
<sup>96</sup> Ru	5.54(14)	>3.1×10 <sup>16</sup> y	0.23(4)	7.(2)		0.21(1)
<sup>98</sup> Ru	1.87(3)		< 8.			0.3(1)
<sup>99</sup> Ru	12.76(14)		4.(1)	195.(20)		1.2(3)
<sup>100</sup> Ru	12.60(7)		5.8(6)	11.(2)		0.21(1)
<sup>101</sup> Ru	17.06(2)		5.(1)	1.1(3)×10 <sup>2</sup>		1.00(4)
<sup>102</sup> Ru	31.55(14)		$\sigma_{\alpha} < 0.15$ $\mu$ b 1.2(1)	4.3(5)		0.15(1)
<sup>103</sup> Ru		39.27 d	<20.	≈ 30.		
<sup>104</sup> Ru	18.62(27)		0.49(2)	6.(2)		0.15(1)
<sup>105</sup> Ru		4.44 h	0.29(3)	0.13(1)		
<sup>106</sup> Ru		1.020 y	0.15(4)	2.0(6)		
<sup>45</sup> Rh			145.(2)	1.2(1)×10 <sup>3</sup>	5.88(4)	
<sup>103</sup> Rh	100.		(11.+ 134.)	(0.08+1.1)×10 <sup>3</sup>	5.88(4)	0.81(1)
<sup>104m</sup> Rh		4.36 m	800.(100)			
<sup>104</sup> Rh		42.3 s	40.(30)			
<sup>105</sup> Rh		35.4 h	1.1(3)×10 <sup>4</sup>	1.7(4)×10 <sup>4</sup>		
<sup>46</sup> Pd			7.(1)	82.(8)	5.91(6)	
<sup>102</sup> Pd	1.02(1)		3.2(10)	10.(2)		0.3(1)
<sup>104</sup> Pd	11.14(8)			16.(2)		0.29(3)
<sup>105</sup> Pd	22.33(8)		22.(2)	60.(20)	5.5(3)	1.20(6)
<sup>106</sup> Pd	27.33(3)		$\sigma_{\alpha} = 0.5(2)$ $\mu$ b (0.013+0.28)	(0.2+5.5)	6.4(4)	0.25(3)
<sup>107</sup> Pd		6.5×10 <sup>6</sup> y	1.8(2)	108.(4)		1.34(6)
<sup>108</sup> Pd	26.46(9)		(0.19+8.5)	(2.+240.)	4.1(3)	0.20(2)
<sup>110</sup> Pd	11.72(9)		(0.033+0.7)	(0.7+8.)		0.15(2)
<sup>47</sup> Ag			62.(1)	767.(60)	5.922(7)	
<sup>107</sup> Ag	51.839(8)		(1.+35.)	(3.+105.)	7.56(1)	0.80(3)
<sup>109</sup> Ag	48.161(8)		(4.1 + 87.)	(0.7+14.1)×10 <sup>2</sup>	4.17(1)	0.79(3)
<sup>110m</sup> Ag		249.8 d	82.(11)	20.(4)		
<sup>111</sup> Ag		7.47 d	3.(2)	105.(20)		
<sup>48</sup> Cd			2.52(5)×10 <sup>3</sup>	73.(8)	4.87(5)	
<sup>106</sup> Cd	1.25(6)	>2.6×10 <sup>17</sup> y	0.20(3)	4.(1)		0.30(2)
<sup>108</sup> Cd	0.89(3)	>4.1×10 <sup>17</sup> y	1.	14.(3)	5.4(1)	0.20(1)

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>109</sup> Cd		462.0 d	$\approx 180.$ $\sigma_{\alpha} < 0.05$	$6.7(12) \times 10^3$		
<sup>110</sup> Cd	12.49(18)		(0.06+11.)	(6.+34.)	5.9(1)	(0.01+0.22)
<sup>111</sup> Cd	12.80(12)		3.5(20)	51.(6)	6.5(1)	0.75(1)
<sup>112</sup> Cd	24.13(21)		(0.012+2.2)	15.	6.4(1)	0.19(1)
<sup>113</sup> Cd	12.22(12)	$7.7 \times 10^{15}$ y	$2.06(4) \times 10^4$ $\sigma_{\alpha} < 1. \mu\text{b}$	390.(40)	- 8.0(2)	0.67(1)
<sup>114</sup> Cd	28.73(42)		(0.04+0.29)	16.(7)	7.5(1)	(0.01+0.12)
<sup>116</sup> Cd	7.49(18)	$3.8 \times 10^{19}$ y	(26.+52.) mb	1.2	6.3(1)	(12.+47.) mb
<sup>49</sup> In			197.(4)	$3.3(2) \times 10^3$	4.07(2)	
<sup>113</sup> In	4.29(5)		(3.1+5.0+3.9)	(220.+90.)	5.39(6)	(0.48+0.31)
<sup>115</sup> In	95.71(5)	$4.4 \times 10^{14}$ y	(88.+73.+44.)	$(1.5+1.2+0.7) \times 10^3$	4.01(2)	(0.69+0.02)
<sup>50</sup> Sn			0.61(3)	8.(2)	6.225(2)	
<sup>112</sup> Sn	0.97(1)		(0.15+0.40)	(8.+19.)		0.21(1)
<sup>113</sup> Sn		115.1 d	$\approx 9.$	210.(50)		
<sup>114</sup> Sn	0.66(1)		$\approx 0.12$	5.(1)	6.2(3)	134.(3) mb
<sup>115</sup> Sn	0.34(1)		$\sigma_{\alpha} = 0.06$ mb	29.(6)		0.34(1)
<sup>116</sup> Sn	14.54(9)		(0.006+0.14)	(0.5+11.)	5.93(5)	91.(2) mb
<sup>117</sup> Sn	7.68(7)		1.1(1)	16.(5)	6.48(5)	319.(7) mb
<sup>118</sup> Sn	24.22(9)		$\sigma_m = 4.$ mb	4.7(5)	6.07(5)	62.(1) mb
<sup>119</sup> Sn	8.59(4)		2.(1)	2.9(5)	6.12(5)	0.18(1)
<sup>120</sup> Sn	32.58(9)		(0.001+0.13)	1.2(3)	6.49(5)	(0.5+36.) mb
<sup>122</sup> Sn	4.63(3)		(0.15+0.001)	0.81(4)	5.74(5)	(18.+4.) mb
<sup>124</sup> Sn	5.79(5)	$> 2.2 \times 10^{18}$ y	(0.13+0.004)	(8.0+0.08)	5.97(5)	12.(2) mb
<sup>51</sup> Sb			5.2(2)	169.(20)	5.57(3)	
<sup>121</sup> Sb	57.21(5)		(0.4+5.8)	(13.+192.)	5.71(6)	0.53(2)
<sup>123</sup> Sb	42.79(5)		(0.02+0.04+4.0)	(1.+119.)	5.38(7)	0.30(1)
<sup>124</sup> Sb		60.20 d	17.(3)	$\approx 8.$		
<sup>52</sup> Te			4.2(1)	47.(3)	5.80(3)	
<sup>120</sup> Te	0.09(1)		(1.+5.)	$\approx 1.$	5.3(5)	0.4(1)
<sup>122</sup> Te	2.55(12)		(0.4+3.)	(5.+75.)	3.8(2)	295.(3) mb
<sup>123</sup> Te	0.89(3)	$> 5.3 \times 10^{16}$ y	370.(40)	$4.5(3) \times 10^3$	- 0.05	0.83(1)
<sup>124</sup> Te	4.74(14)		(1.+6.)	(1.4+4.)	8.0(1)	155.(2) mb
<sup>125</sup> Te	7.07(15)		1.1(2)	21.(4)	5.02(8)	431.(4) mb
<sup>126</sup> Te	18.84(25)		(0.12+0.8)	(0.6+7.4)	5.56(7)	(28.+53.) mb
<sup>128</sup> Te	31.74(8)	$2.2 \times 10^{24}$ y	(0.03+0.2)	(0.2+1.6)	5.89(7)	(3.+41.) mb
<sup>130</sup> Te	34.08(62)	$8. \times 10^{20}$ y	(0.01+0.19)	(0.03+0.3)	6.02(7)	(4.+11.) mb
<sup>53</sup> I			6.2(1)	$1.5(1) \times 10^2$	5.28(2)	
<sup>125</sup> I		59.4 d	900.(100)	$1.4(2) \times 10^4$		
<sup>127</sup> I	100.		6.2(1)	$1.5(1) \times 10^2$	5.28(2)	0.64(3)
<sup>128</sup> I		25.00 m	22.(4)	$\approx 10.$		
<sup>129</sup> I		$1.7 \times 10^7$ y	(20.7+10.3)	36.(4)		0.44(2)
<sup>130</sup> I		12.36 h	18.(3)	$\approx 8.$		
<sup>131</sup> I		8.021 d	$\approx 0.7$	8.(4)		
<sup>54</sup> Xe			25.(1)	263.(50)	4.92(3)	
<sup>124</sup> Xe	0.0953(27)	$> 10^{17}$ y	(28.+137.)	$(0.6+3.0) \times 10^3$		(0.13+0.51)
<sup>125</sup> Xe		17.1 h	$\sigma_{\alpha} < 0.03$			
<sup>126</sup> Xe	0.0890(14)		(0.45+3.)	(8.+52.)		(0.04+0.32)
<sup>127</sup> Xe		36.34 d	$\sigma_{\alpha} \leq 0.01$			
<sup>128</sup> Xe	1.910(22)		$\sigma_m = 0.48$	$RI_m = 38.(10)$		0.26(1)
<sup>129</sup> Xe	26.40(18)		22.(5)	250.(50)		0.62(2)
<sup>130</sup> Xe	4.071(53)		$\sigma_m = 0.45$	$RI_m = 16.(4)$		0.132(3)
<sup>131</sup> Xe	21.233(62)		90.(10)	$9.(1) \times 10^2$		0.45(8)
<sup>132</sup> Xe	26.9087(680)		(0.05+0.4)	(0.9+3.7)		(5.+60.) mb
<sup>133</sup> Xe		5.243 d	190.(90)			
<sup>134</sup> Xe	10.436(29)	$> 1.1 \times 10^{16}$ y	(0.003 + 0.26)	0.40(4)		20.(2) mb
<sup>135</sup> Xe		9.10 h	$2.65(11) \times 10^6$	$7.6(5) \times 10^3$		

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>136</sup> Xe	8.858(33)	>8×10 <sup>20</sup> y	0.26(2)	0.7(2)		0.9(1) mb
<sup>55</sup> Cs			30.4(8)	422.(50)	5.42(2)	
<sup>132</sup> Cs		6.48 d	$\sigma_{\alpha} < 0.15$			
<sup>133</sup> Cs	100.		(2.7+27.3)	(32.+360.)	5.42(2)	(0.04+0.47)
<sup>134</sup> Cs		2.065 y	140.(10)	54.(9)		
<sup>135</sup> Cs		2.3×10 <sup>6</sup> y	8.3(3)	38.(3)		
<sup>137</sup> Cs		30.2 y	(0.20+0.07)	0.36(7)		
<sup>56</sup> Ba			1.3(2)	10.(2)	5.07(3)	
<sup>130</sup> Ba	0.106(1)	2.2×10 <sup>21</sup> y	(1.+8.)	(25.+200.)	- 3.6(6)	0.76(11)
<sup>132</sup> Ba	0.101(1)	1.3×10 <sup>21</sup> y	(0.84+9.7)	(4.7+24.)	7.8(3)	0.6(1)
<sup>133</sup> Ba		10.53 y	4.(1)	85.(30)		
<sup>134</sup> Ba	2.417(18)		(0.1+1.3)	(5.6+18.)	5.7(1)	0.18(1)
<sup>135</sup> Ba	6.592(12)		(0.014+5.8)	(0.47+131.)	4.7(1)	0.46(2)
<sup>136</sup> Ba	7.854(24)		(0.010+0.44)	(0.1+1.5)	4.91(8)	61.(2) mb
<sup>137</sup> Ba	11.232(24)		5.(1)	4.(1)	6.8(1)	76.(3) mb
<sup>138</sup> Ba	71.698(42)		0.41(2)	0.4(1)	4.84(8)	4.0(2) mb
<sup>139</sup> Ba		1.396 h	5.(1)	2.2(5)		
<sup>140</sup> Ba		12.75 d	1.6(3)	14.(1)		
<sup>57</sup> La			9.2(2)	12.(1)	8.24(4)	
<sup>138</sup> La	0.090(1)	1.06×10 <sup>11</sup> y	57.(6)	4.1(9)×10 <sup>2</sup>		
<sup>139</sup> La	99.910(1)		9.2(2)	12.(1)	8.24(4)	38.(3) mb
<sup>140</sup> La		1.678 d	2.7(3)	69.(4)		
<sup>58</sup> Ce			0.64(4)	0.71(6)	4.84(2)	
<sup>136</sup> Ce	0.185(2)		(1.0+6.5)	58.(12)	5.80(9)	(0.028+0.3)
<sup>138</sup> Ce	0.251(2)		(0.025+1.0)	(1.5+5.2)	6.70(9)	179.(5) mb
<sup>140</sup> Ce	88.450(51)		0.58(4)	0.50(5)	4.84(9)	11.0(4) mb
<sup>141</sup> Ce		32.50 d	29.(3)	13.(2)		
<sup>142</sup> Ce	11.114(51)	>1.6×10 <sup>17</sup> y	0.97(3)	1.3(3)	4.75(9)	28.(1) mb
<sup>143</sup> Ce		1.38 d	6.1(7)	2.7(3)		
<sup>144</sup> Ce		284.6 d	1.0(1)	2.6(3)		
<sup>59</sup> Pr			11.5(4)	14.(3)	4.58(5)	
<sup>141</sup> Pr	100.		(4.+7.5)	14.(3)	4.58(5)	111.(2) mb
<sup>142</sup> Pr		19.12 h	20.(3)	9.(1)		
<sup>143</sup> Pr		13.57 d	90.(10)	190.(25)		
<sup>60</sup> Nd			51.(2)	49.(5)	7.69(5)	
<sup>142</sup> Nd	27.2(5)		19.(1)	34.(11)	7.7(3)	35.(1) mb
<sup>143</sup> Nd	12.2(2)		330.(10)	128.(30)		0.24(1)
			$\sigma_{\alpha} = 17. \text{ mb}$			
<sup>144</sup> Nd	23.8(3)	2.1×10 <sup>15</sup> y	3.6(3)	3.9(5)	2.8(3)	81.(2) mb
<sup>145</sup> Nd	8.3(1)		47.(6)	260.(40)		0.42(1)
			$\sigma_{\alpha} = 12. \mu\text{b}$			
<sup>146</sup> Nd	17.2(3)		1.5(2)	3.0(4)	8.7(2)	91.(1) mb
<sup>147</sup> Nd		10.98 d	440.(150)	200.		
<sup>148</sup> Nd	5.7(1)		2.4(1)	13.(2)	5.7(3)	147.(2) mb
<sup>150</sup> Nd	5.6(2)	≈ 1×10 <sup>19</sup> y	1.0(1)	14.(2)	5.3(2)	0.16(1)
<sup>61</sup> Pm						
<sup>146</sup> Pm		5.53 y	8.4(1.7)×10 <sup>3</sup>			
<sup>147</sup> Pm		2.623 y	(84.+96.)	(1000.+1280.)	12.6(4)	2.(1)
<sup>148m</sup> Pm		41.3 d	10600.(800)			
<sup>148</sup> Pm		5.37 d	≈ 10 <sup>3</sup>	2.6(2.4)×10 <sup>3</sup>		
<sup>149</sup> Pm		2.212 d	1400.(200)			
<sup>151</sup> Pm		1.183 d	≈ 150.			
<sup>62</sup> Sm			5.6(1)×10 <sup>3</sup>	1.4(2)×10 <sup>3</sup>		
<sup>144</sup> Sm	3.07(7)		1.6(1)	2.4(3)		92.(6) mb
<sup>145</sup> Sm		340. d	280.(20)	600.(90)		
<sup>147</sup> Sm	14.99(18)	1.06×10 <sup>11</sup> y	56.(4), $\sigma_{\alpha} = 0.6 \text{ mb}$	710.(50)	14.(3)	0.97(1)
<sup>148</sup> Sm	11.24(10)	7×10 <sup>15</sup> y	2.4(6)	27.(14)		241.(2) mb
<sup>149</sup> Sm	13.82(7)	10 <sup>16</sup> y	4.01(6)×10 <sup>4</sup> , $\sigma_{\alpha} = 31. \text{ mb}$	3.1(5)×10 <sup>3</sup>		1.82(2)

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>150</sup> Sm	7.38(1)		102.(5)	290.(30)	14.(3)	422.(4) mb
<sup>151</sup> Sm		90. y	1.52(3)×10 <sup>4</sup>	3520.(60)		2.(1)
<sup>152</sup> Sm	26.75(16)		206.(15)	3.0(3)×10 <sup>3</sup>	- 5.0(6)	473.(4) mb
<sup>153</sup> Sm		1.929 d	420.(180)			
<sup>154</sup> Sm	22.75(29)		7.5(3)	32.(6)	9.(1)	0.21(1)
<sup>63</sup> Eu			4570.(100)	3.8(5)×10 <sup>3</sup>	5.3(3)	
<sup>151</sup> Eu	47.81(6)		(4.+3150.+6000.) $\sigma_{\alpha} = 8.7(3) \mu\text{b}$	(2.+4.)×10 <sup>3</sup>		(1.6+2.2)
<sup>152m1</sup> Eu		9.30 h	6.8(15)×10 <sup>4</sup>	< 10 <sup>5</sup>		
<sup>152</sup> Eu		13.5 y	1.1(2)×10 <sup>4</sup>	1.6(2)×10 <sup>3</sup>		5.(2)
<sup>153</sup> Eu	52.19(6)		300.(20), $\sigma_{\alpha} < 1. \mu\text{b}$	1.8(4)×10 <sup>3</sup>	8.2(1)	2.8(1)
<sup>154</sup> Eu		8.59 y	1.5(3)×10 <sup>3</sup>	1.6(2)×10 <sup>3</sup>		4.4(7)
<sup>155</sup> Eu		4.76 y	3.9(2)×10 <sup>3</sup>	1.6(2)×10 <sup>4</sup>		1.3(1)
<sup>64</sup> Gd			48.8(6)×10 <sup>3</sup>	400.(10)	9.5(2)	
<sup>148</sup> Gd		75. y	1.40(14)×10 <sup>4</sup>			
<sup>152</sup> Gd	0.20(1)	1.1×10 <sup>14</sup> y	700.(200), $\sigma_{\alpha} < 7. \text{mb}$	700.(200)		1.05(2)
<sup>153</sup> Gd		240. d	2.(1)×10 <sup>4</sup> , $\sigma_{\alpha} = 0.03$			
<sup>154</sup> Gd	2.18(3)		(0.035+60.)	230.(50)		1.03(1)
<sup>155</sup> Gd	14.80(12)		61.(1)×10 <sup>3</sup> , $\sigma_{\alpha} = .08 \text{mb}$	1540.(100)		2.65(3)
<sup>156</sup> Gd	20.47(9)		≈ 2.0	104.(15)	6.3(4)	615.(5) mb
<sup>157</sup> Gd	15.65(2)		2.54(3)×10 <sup>5</sup> , $\sigma_{\alpha} < 0.05$	800.(100)		1.37(2)
<sup>158</sup> Gd	24.84(7)		2.3(3)	73.(7)	9.(2)	324.(3) mb
<sup>160</sup> Gd	21.86(19)	>1.9×10 <sup>19</sup> y	1.5(7)	6.(1)	9.15(5)	0.15(2)
<sup>161</sup> Gd		3.66 m	2.0(6)×10 <sup>4</sup>			
<sup>65</sup> Tb			23.2(5)	420.(50)	7.34(2)	
<sup>159</sup> Tb	100.		23.2(5)	420.(50)	7.34(2)	1.6(2)
<sup>160</sup> Tb		72.3 d	570.(110)			
<sup>66</sup> Dy			9.5(2)×10 <sup>2</sup>	1.5(2)×10 <sup>3</sup>	16.9(3)	
<sup>156</sup> Dy	0.056(3)		33.(3), $\sigma_{\alpha} < 9. \text{mb}$	1000.(100)		1.6(2)
<sup>158</sup> Dy	0.095(3)		43.(6), $\sigma_{\alpha} < 6. \text{mb}$	120.(10)	6.1(5)	0.8(2)
<sup>159</sup> Dy		144. d	8.(2)×10 <sup>3</sup>			
<sup>160</sup> Dy	2.39(18)		60.(10), $\sigma_{\alpha} < 0.3 \text{mb}$	1100.(200)	6.7(4)	0.89(1)
<sup>161</sup> Dy	18.889(42)		600.(50), $\sigma_{\alpha} < 1. \mu\text{b}$	1100.(100)	10.3(4)	1.96(2)
<sup>162</sup> Dy	25.475(36)		170.(20)	2755.(300)	- 1.4(5)	446.(4) mb
<sup>163</sup> Dy	24.896(42)		120.(10), $\sigma_{\alpha} < 20. \mu\text{b}$	1600.(400)	5.0(4)	1.11(1)
<sup>164</sup> Dy	28.260(54)		(1.7+1.0)×10 <sup>3</sup>	(4.+2.)×10 <sup>2</sup>	49.4(2)	212.(3) mb
<sup>165m</sup> Dy		1.26 m	2.0(6)×10 <sup>3</sup>			
<sup>165</sup> Dy		2.33 h	3.5(3)×10 <sup>3</sup>	2.2(3)×10 <sup>4</sup>		
<sup>67</sup> Ho			61.(2)	670.(40)	8.01(8)	
<sup>163</sup> Ho		4.57×10 <sup>3</sup> y				(0.4+1.7)
<sup>165</sup> Ho	100.		(3.1+58.), $\sigma_{\alpha} < 20. \mu\text{b}$	(?+670.)	8.01(8)	(0.8+0.5)
<sup>166m</sup> Ho		1.2×10 <sup>3</sup> y	3.1(8)×10 <sup>3</sup>	10.(3)×10 <sup>3</sup>		
<sup>68</sup> Er			1.5(2)×10 <sup>2</sup>	730.(10)	7.79(2)	
<sup>162</sup> Er	0.139(5)		19.(3), $\sigma_{\alpha} < 11. \text{mb}$	480.(50)	8.8(2)	1.6(1)
<sup>164</sup> Er	1.601(3)		13.(3), $\sigma_{\alpha} < 1.2 \text{mb}$	105.(10)	8.2(2)	1.08(5)
<sup>166</sup> Er	33.503(36)		(3.+14.), $\sigma_{\alpha} < 70. \mu\text{b}$	96.(12)	10.6(2)	0.56(6)
<sup>167</sup> Er	22.869(9)		6.5(8)×10 <sup>2</sup> , $\sigma_{\alpha} = 3. \mu\text{b}$	2970.(70)	3.0(3)	1.4(2)
<sup>168</sup> Er	26.978(18)		2.3(3), $\sigma_{\alpha} = 0.09 \text{mb}$	37.(5)	7.4(4)	0.34(4)
<sup>170</sup> Er	14.910(36)		8.(2)	26.(4)	9.6(5)	0.17(1)
<sup>171</sup> Er		7.52 h	370.(40)	170.(20)		
<sup>69</sup> Tm			108.(4)	1.5(2)×10 <sup>3</sup>	7.07(3)	
<sup>169</sup> Tm	100		(8.+100.)	1.5(2)×10 <sup>3</sup>	7.07(3)	1.13(6)
<sup>170</sup> Tm		128.6 d	100.(20)	460.(50)		
<sup>171</sup> Tm		1.92 y	≈ 160.	118.(6)		
<sup>70</sup> Yb			52.(10)	1.7(2)×10 <sup>2</sup>	12.43(3)	
<sup>168</sup> Yb	0.13(1)		2.4(2)×10 <sup>3</sup> , $\sigma_{\alpha} < 0.1 \text{mb}$	2.0(5)×10 <sup>4</sup>	-4.07(2)	0.7(4)
<sup>169</sup> Yb		32.02 d	3.6(3)×10 <sup>3</sup>	5200.(500)		
<sup>170</sup> Yb	3.04(15)		12.(2), $\sigma_{\alpha} < 10. \mu\text{b}$	320.(30)	6.8(1)	0.77(1)

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>171</sup> Yb	14.28(57)		53.(5), $\sigma_\alpha < 1.5 \mu\text{b}$	315.(30)	9.7(1)	1.21(1)
<sup>172</sup> Yb	21.83(67)		$\approx 1.3$ , $\sigma_\alpha < 1. \mu\text{b}$	25.(3)	9.4(1)	0.34(1)
<sup>173</sup> Yb	16.13(27)		16.(2), $\sigma_\alpha < 1. \mu\text{b}$	380.(30)	9.56(7)	0.75(1)
<sup>174</sup> Yb	31.83(92)		(46.+17.), $\sigma_\alpha < 0.02 \text{ mb}$	(13.+16.)	19.3(1)	151.(2) mb
<sup>176</sup> Yb	12.76(41)		3.1(2), $\sigma_\alpha < 1. \mu\text{b}$	8.(2)	8.7(1)	116.(2) mb
<sup>71</sup> Lu			78.(7)	8.3(7) $\times 10^2$	7.21(3)	
<sup>175</sup> Lu	97.41(2)		(16.+8.)	(550.+270.)	7.24(3)	(1.04+0.11)
<sup>176</sup> Lu	2.59(2)	3.73 $\times 10^{10}$ y	(2.+2100.)	(3.+930.)	6.1(2)	1.53(7)
<sup>177m</sup> Lu		160.7 d	3.2(3)	1.4(2)		
<sup>177</sup> Lu		6.65 d	1000.(300)			
<sup>72</sup> Hf			106.(3)	19.7(5) $\times 10^2$	7.8(1)	
<sup>174</sup> Hf	0.16(1)	2.0 $\times 10^{15}$ y	600.(50)	400.(50)	11.(1)	0.8(2)
<sup>176</sup> Hf	5.26(7)		23.(4)	700.(100)	6.6(2)	0.46(2)
<sup>177</sup> Hf	18.60(9)		(1.+375.), $\sigma_\alpha < 20. \mu\text{b}$	7170.(200)		1.5(1)
<sup>178m2</sup> Hf		31. y	$\sigma_{m2} = 45.(5)$	RI <sub>m2</sub> = 8(1) $\times 10^2$		
<sup>178</sup> Hf	27.28(7)		(54.+32.)	(0.9+1.0) $\times 10^3$	5.9(2)	0.31(1)
<sup>179</sup> Hf	13.62(2)		(0.43+46.)	(6.8+620.)	7.5(2)	(0.01+0.95)
<sup>180</sup> Hf	35.08(16)		13.0(5), $\sigma_\alpha < 13. \mu\text{b}$	32.(1)	13.2(3)	179.(5) mb
<sup>181</sup> Hf		42.4 d	30.(25)			
<sup>73</sup> Ta			20.(1)	650(20.)	6.91(7)	
<sup>179</sup> Ta		1.8 y	9.3(6) $\times 10^2$	1.22(7) $\times 10^3$		
<sup>180m</sup> Ta	0.012(2)	> 1.2 $\times 10^{15}$ y	$\approx 560.$	1350.(100)		
<sup>181</sup> Ta	99.988(2)		(0.012 + 20.), $\sigma_\alpha < 1. \mu\text{b}$	(0.4+650.)	6.91(7)	0.77(2)
<sup>182</sup> Ta		114.43 d	8200.(600)	900.(90)		
<sup>74</sup> W			18.(1)	3.6(3) $\times 10^2$	4.86(2)	
<sup>180</sup> W	0.12(1)	7.4 $\times 10^{16}$ y	$\approx 4.$	210.(30)		0.54(6)
<sup>182</sup> W	26.50(16)	8.3 $\times 10^{18}$ y	20.(1)	600.(90)	6.97(4)	274.(8) mb
<sup>183</sup> W	14.31(4)	1.9 $\times 10^{18}$ y	10.5(3)	340.(50)	6.53(4)	0.52(2)
<sup>184</sup> W	30.64(2)	4.0 $\times 10^{18}$ y	(0.002 + 2.0)	15.(2)	7.48(6)	0.22(1)
<sup>185</sup> W		74.8 d	$\approx 3.3$	300.(50)		
<sup>186</sup> W	28.43(19)	6.5 $\times 10^{18}$ y	37.(2)	510.(50)	- 0.72(4)	176.(5) mb
<sup>187</sup> W		23.9 h	70.(10)	2760.(550)		
<sup>188</sup> W		69.78 h	12.(1)			
<sup>75</sup> Re			90.(4)	8.4(2) $\times 10^2$	9.2(3)	
<sup>185</sup> Re	37.40(2)		(0.33+110.)	1700.(50)	9.0(3)	1.54(6)
<sup>187</sup> Re	62.60(2)	4.2 $\times 10^{10}$ y	(2.+72.)	(9.+310.)	9.3(3)	1.16(6)
<sup>76</sup> Os			17.(1)	1.5(1) $\times 10^2$	10.7(2)	
<sup>184</sup> Os	0.02(1)	>5.6 $\times 10^{13}$ y	3.3(3) $\times 10^3$ , $\sigma_\alpha < 10. \text{mb}$	1.4(1) $\times 10^3$		0.4(2)
<sup>186</sup> Os	1.59(3)	2. $\times 10^{15}$ y	$\approx 80.$ , $\sigma_\alpha < 0.1 \text{ mb}$	3.8(9) $\times 10^2$	12(2)	0.42(2)
<sup>187</sup> Os	1.96(2)		2.(1) $\times 10^2$ , $\sigma_\alpha < 0.1 \text{ mb}$	5.0(7) $\times 10^2$		0.90(3)
<sup>188</sup> Os	13.24(8)		$\approx 5.$ , $\sigma_\alpha < 30. \mu\text{b}$	1.5(2) $\times 10^2$	7.6(3)	0.40(2)
<sup>189</sup> Os	16.15(5)		(0.00026+40.), $\sigma_\alpha < 10. \mu\text{b}$	(0.013+670.)	10.7(3)	1.17(5)
<sup>190</sup> Os	26.26(2)		(9.+4.), $\sigma_\alpha < 20. \mu\text{b}$	(22.+8.)	11.0(3)	0.30(5)
<sup>191</sup> Os		15.4 d	3.8(6) $\times 10^2$	1.7(3) $\times 10^2$		
<sup>192</sup> Os	40.78(19)		3.(1), $\sigma_\alpha < 10. \mu\text{b}$	7.(1)	11.5(4)	0.31(5)
<sup>193</sup> Os		30.5 h	2.5(5) $\times 10^2$	1.1(2) $\times 10^2$		
<sup>77</sup> Ir			4.2(1) $\times 10^2$	2.8(4) $\times 10^3$	10.6(3)	
<sup>191</sup> Ir	37.3(2)		(0.14+660.+260.)	(1.0+4.2) $\times 10^3$		1.35(4)
<sup>192</sup> Ir		73.83 d	1.4(3) $\times 10^3$	4.8(7) $\times 10^3$		
<sup>193</sup> Ir	62.7(2)		(0.04+6.+109.)	1.4(2) $\times 10^3$		0.99(7)
<sup>194</sup> Ir		19.3 h	1.6(3) $\times 10^3$	7.(2) $\times 10^2$		
<sup>78</sup> Pt			10.(1)	1.3(1) $\times 10^2$	9.60(1)	
<sup>190</sup> Pt	0.014(1)	4.5 $\times 10^{11}$ y	1.5(1) $\times 10^2$ , $\sigma_\alpha < 8. \text{mb}$	70.(10)	9.(1)	0.7(2)
<sup>192</sup> Pt	0.782(7)		(2.0+6.), $\sigma_\alpha < 0.2 \text{ mb}$	115.(20)	9.9(5)	0.6(1)
<sup>194</sup> Pt	32.967(99)		(0.1+1.1), $\sigma_\alpha < 5. \mu\text{b}$	(4.+?)	10.55(8)	(0.03+0.34)
<sup>195</sup> Pt	33.832(10)		28.(1), $\sigma_\alpha < 5. \mu\text{b}$	365.(50)	8.8(1)	0.9(2)
<sup>196</sup> Pt	25.242(41)		(0.045+0.55)	7.(2)	9.89(8)	(0.01+0.19)
<sup>198</sup> Pt	7.163(55)		(0.3+3.1)	(5.+53.)	7.8(1)	(3.+79.) mb

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>199</sup> Pt		30.8 m	$\approx 15$ .	$\approx 7$ .		
<sup>79</sup> Au			98.7(1)	$1.55(3)\times 10^3$	7.63(6)	
<sup>197</sup> Au	100.		$\sigma_{m+g} = 98.7(1)$ $\sigma_m = 8.2(2)$ mb	$RI_{m+g} = 1.55(3)\times 10^3$ $RI_m = 0.06(2)$	7.63(6)	582.9) mb
<sup>198</sup> Au		2.695 d	$26.5(15)\times 10^3$	$\approx 4\times 10^4$		
<sup>199</sup> Au		3.14 d	$\approx 30$ .			
<sup>80</sup> Hg			$3.7(1)\times 10^2$	87.(5)	12.69(2)	
<sup>196</sup> Hg	0.15(1)	$>2.5\times 10^{18}$ y	(105.+3000.)	(53.+410.)	30.(1)	0.4(2)
<sup>198</sup> Hg	9.97(8)		(0.017+2.)	(1.7+70.)		0.17(2)
<sup>199</sup> Hg	16.87(10)		$2.1(2)\times 10^3$	435(20)	16.9(4)	0.37(2)
<sup>200</sup> Hg	23.10(16)		$\approx 1$ .	2.1(5)		0.12(1)
<sup>201</sup> Hg	13.18(8)		$\approx 8$ .	30.(3)		0.26(1)
<sup>202</sup> Hg	29.86(20)		4.9(5)	4.5(2)	11.(1)	74.(6) mb
<sup>204</sup> Hg	6.87(4)		0.4(1)	0.8(2)		42.(4) mb
<sup>81</sup> Tl			3.3(1)	12.5(8)	8.776(5)	
<sup>203</sup> Tl	29.524(14)		11.(1), $\sigma_\alpha < 0.3$ mb	41.(2)	7.0(2)	124.(8) mb
<sup>204</sup> Tl		3.78 y	22.(2)	90.(20)		0.14(5)
<sup>205</sup> Tl	70.476(14)		0.11(2)	0.6(2)	9.52(7)	54.(4) mb
<sup>82</sup> Pb			0.172(2)	0.14(4)	9.402(2)	
<sup>204</sup> Pb	1.4(1)		0.68(7)	2.0(2)	10.9(1)	90.(6) mb
<sup>205</sup> Pb		$1.51\times 10^7$ y	$\approx 5$ .	$\approx 2$ .		0.06(1)
<sup>206</sup> Pb	24.1(1)		0.027(1)	0.10(1)	9.23(5)	16.(1) mb
<sup>207</sup> Pb	22.1(1)		0.61(3)	0.38(1)	9.28(2)	10.(1) mb
<sup>208</sup> Pb	52.4(1)	$>2\times 10^{19}$ y	0.23(1) mb, $\sigma_\alpha < 8$ . $\mu$ b	2.0(2) mb	9.50(3)	0.36(4) mb
<sup>210</sup> Pb		22.6 y	$< 0.5$			
<sup>83</sup> Bi			0.034(1)	0.19(2)	8.532(2)	
<sup>209</sup> Bi	100.		(11.+23.) mb, $\sigma_\alpha < 0.3$ $\mu$ b	0.19(2)	8.532(2)	2.7(5) mb
<sup>210m</sup> Bi		$3.0\times 10^6$ y	54.(4) mb	0.20(3)		
<sup>84</sup> Po			$\sigma_m < 0.5$ mb, $\sigma_\alpha < 2$ . mb			
<sup>210</sup> Po		138.4 d	$\sigma_g < 30$ . mb, $\sigma_f < 0.1$			
<sup>85</sup> At						
<sup>86</sup> Rn						
<sup>220</sup> Rn		55.6 s	$< 0.2$			
<sup>222</sup> Rn		3.823 d	0.74(5)			
<sup>88</sup> Ra						
<sup>223</sup> Ra		11.43 d	$1.3(2)\times 10^2$ , $\sigma_f < 0.7$			
<sup>224</sup> Ra		3.66 d	12.0(5)			
<sup>226</sup> Ra		1599. y	$\approx 13$ ., $\sigma_f < 7$ . $\mu$ b	280.(50)	10.(1)	
<sup>228</sup> Ra		5.76 y	36.(5), $\sigma_f < 2$ .			
<sup>89</sup> Ac						
<sup>227</sup> Ac		21.77 y	$8.8(7)\times 10^2$ , $\sigma_f < 0.35$ mb	$1.5(4)\times 10^3$		
<sup>90</sup> Th			7.4	85.(3)	10.31(3)	
<sup>227</sup> Th		18.72 d	$\sigma_f = 2.0(2)\times 10^2$			
<sup>228</sup> Th		1.913 y	$1.2(2)\times 10^2$ , $\sigma_f < 0.3$	1014.(400)		
<sup>229</sup> Th		$7.9\times 10^3$ y	$\approx 60$ .	$1.0(2)\times 10^3$		
			$\sigma_f = 30$ .(3)	$RI_f = 466$ .(75)		
<sup>230</sup> Th		$7.54\times 10^4$ y	23.4(5)	$1.0(1)\times 10^3$		
			$\sigma_f < 0.5$ mb			
<sup>232</sup> Th	100.	$1.40\times 10^{10}$ y	7.37(4)	85.(3)	10.31(3)	
			$\sigma_f = 3$ .(1) $\mu$ b			
			$\sigma_\alpha < 1$ . $\mu$ b			
<sup>233</sup> Th		22.3 m	$1.5(1)\times 10^3$	$4$ .(1) $\times 10^2$		
			$\sigma_f = 15$ .(2)			
<sup>234</sup> Th		24.10 d	1.8(5)			
			$\sigma_f < 0.01$			

\*Extrapolated value.



Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>91</sup> Pa						
<sup>230</sup> Pa		17.4 d	1.5(3)×10 <sup>3</sup>			
<sup>231</sup> Pa		3.25×10 <sup>4</sup> y	2.0(1)×10 <sup>2</sup>	750.(80)	9.1(3)	
			$\sigma_f = 20.(1)$ mb	RI <sub>f</sub> = 0.05(1)		
<sup>232</sup> Pa		1.31 d	4.6(10)×10 <sup>2</sup>	300.(70)		
			$\sigma_f = 1.5(5)$ ×10 <sup>3</sup>	RI <sub>f</sub> = 1.0(1)×10 <sup>3</sup>		
<sup>233</sup> Pa		27.0 d	39.(2)	(460.+440.)		
			$\sigma_m = 20.(4)$			
			$\sigma_g = 19.(3)$			
			$\sigma_f < 0.1$			
<sup>92</sup> U			3.4(3); $\sigma_f = 4.2(1)$	280.(20), RI <sub>f</sub> = 2.0	8.417(5)	
<sup>230</sup> U		20.8 d	$\sigma_f \approx 25.$			
<sup>231</sup> U		4.2 d	$\sigma_f \approx 250.$			
<sup>232</sup> U		70. y	73.(2)	280.(15)		
			$\sigma_f = 74.(8)$	RI <sub>f</sub> = 350.(30)		
<sup>233</sup> U		1.592×10 <sup>5</sup> y	47.(2)	137.(6)	10.1(2)	
			$\sigma_f = 5.3(1)$ ×10 <sup>2</sup>	RI <sub>f</sub> = 760.(17)		
			$\sigma_\alpha < 0.2$ mb			
<sup>234</sup> U	0.0054(5)	2.455×10 <sup>5</sup> y	96.(2)	660.(70)	12.(4)	
			$\sigma_f = 0.07(2)$	RI <sub>f</sub> = 6.5		
<sup>235</sup> U	0.7204(6)	7.04×10 <sup>8</sup> y	95.(5)	144.(6)	10.47(4)	
			$\sigma_f = 586.(2)$	RI <sub>f</sub> = 275(5)		
			$\sigma_\alpha < 0.1$ mb			
<sup>236</sup> U		2.342×10 <sup>7</sup> y	5.1(3)	360.(15)		
			$\sigma_f < 1.3$ mb	RI <sub>f</sub> = 4.38(50)		
<sup>237</sup> U		6.75 d	$\approx 10^2$	1200.(200)		
			$\sigma_f < 0.35$			
<sup>238</sup> U	99.2742(10)	4.47×10 <sup>9</sup> y	2.7(1)	277.(3)	8.402(5)	
			$\sigma_f \approx 3.$ $\mu$ b	1.54(15) mb		
			$\sigma_\alpha = 1.4(5)$ $\mu$ b			
<sup>239</sup> U		23.5 m	22.(2)			
			$\sigma_f = 15.(3)$			
<sup>93</sup> Np						
<sup>234</sup> Np		4.4 d	$\sigma_f = 9.(3)$ ×10 <sup>2</sup>			
<sup>235</sup> Np		1.085 y	1.6(1)×10 <sup>2</sup>			
<sup>236m</sup> Np		22.5 h	$\sigma_f = 2.7(2)$ ×10 <sup>3</sup>	7.(4)×10 <sup>2</sup>		
<sup>236</sup> Np		1.55×10 <sup>5</sup> y	$\sigma_f = 3.0(2)$ ×10 <sup>3</sup>	1.35(30)×10 <sup>3</sup>		
<sup>237</sup> Np		2.14×10 <sup>6</sup> y	1.7(1)×10 <sup>2</sup>	6.5(3)×10 <sup>2</sup>	10.6(1)	
			$\sigma_f = 20.(1)$ mb	RI <sub>f</sub> = 4.7		
<sup>238</sup> Np		2.117 d	$\sigma_f = 2.6(3)$ ×10 <sup>3</sup>	1.4(3)×10 <sup>3</sup>		
<sup>239</sup> Np		2.355 d	(32.+19.)			
			$\sigma_f < 1.$			
<sup>94</sup> Pu						
<sup>236</sup> Pu		2.87 y	$\sigma_f = 1.6(3)$ ×10 <sup>2</sup>	1000.(60)		
<sup>237</sup> Pu		45.7 d	$\sigma_f = 2.3(3)$ ×10 <sup>3</sup>			
<sup>238</sup> Pu		87.7 y	5.1(2)×10 <sup>2</sup>	1.6(2)×10 <sup>2</sup>	14.1(5)	
			$\sigma_f = 17.(1)$	RI <sub>f</sub> = 26.(2)		
<sup>239</sup> Pu		2.410 x 10 <sup>4</sup> y	2.7(1)×10 <sup>2</sup>	2.0(2)×10 <sup>2</sup>	7.7(1)	
			$\sigma_f = 752.(3)$	3.0(1)×10 <sup>2</sup>		
			$\sigma_\alpha \leq 0.3$ mb			
<sup>240</sup> Pu		6.56×10 <sup>3</sup> y	2.9(1)×10 <sup>2</sup>	8.4(3)×10 <sup>3</sup>	3.5(1)	
			$\sigma_f \approx 59.$ mb	RI <sub>f</sub> = 3.2		
<sup>241</sup> Pu		14.4 y	3.7(1)×10 <sup>2</sup> , $\sigma_\alpha < 0.2$ mb	1.6(1)×10 <sup>2</sup>		
			$\sigma_f = 1.01(1)$ ×10 <sup>3</sup>	5.7(4)×10 <sup>2</sup>		
<sup>242</sup> Pu		3.75 x 10 <sup>5</sup> y	19.(1)	1.1(1)×10 <sup>3</sup>	8.1(1)	
			$\sigma_f < 0.2$	RI <sub>f</sub> = 0.23		
<sup>243</sup> Pu		4.956 h	<100.			
			$\sigma_f = 2.0(2)$ ×10 <sup>2</sup>			

\*Extrapolated value.

Elem. or Isot.	Natural Abundance (%)	Half-Life	Thermal Neut. Cross-Section (barns)	Resonance Integral (barns)	Coh. Scat. Length (fm)	$\sigma$ (30 keV) Maxw. Avg. (barns)
<sup>244</sup> Pu		8.00×10 <sup>7</sup> y	1.7(1)	41.(3)		
<sup>245</sup> Pu		10.5 h	1.5(3)×10 <sup>2</sup>	220.(40)		
<sup>95</sup> Am						
<sup>241</sup> Am		432.7 y	(0.6+6.4)×10 <sup>2</sup> $\sigma_f = 3.15(10)$	(1.+14.)×10 <sup>2</sup> 14.(1)		
<sup>242m</sup> Am		141. y	1.7(4)×10 <sup>3</sup> $\sigma_f = 5.9(3)×10^3$	≈ 200. RI <sub>f</sub> = 1.8(1)×10 <sup>3</sup>		
<sup>242</sup> Am		16.02 h	$\sigma_f = 2.1(2)×10^3$ 3.3(5)×10 <sup>2</sup>	RI <sub>f</sub> = < 300. ≈ 1.5×10 <sup>2</sup>		
<sup>243</sup> Am		7.37×10 <sup>3</sup> y	(75.+5.) $\sigma_f = 79.(2)$ mb	(17.1+1.0)×10 <sup>2</sup> RI <sub>f</sub> = 0.056	8.3(2)	
<sup>244m</sup> Am		≈ 26. m	$\sigma_f = 1.6(3)×10^3$			
<sup>244</sup> Am		10.1 h	$\sigma_f = 2.2(3)×10^3$			
<sup>96</sup> Cm						
<sup>242</sup> Cm		162.8 d	≈ 20. $\sigma_f ≈ 5.$	120.(50)		
<sup>243</sup> Cm		29.1 y	1.3(1)×10 <sup>2</sup> $\sigma_f = 6.2(2)×10^2$	214.(20) RI <sub>f</sub> = 1.6(1)×10 <sup>3</sup>		
<sup>244</sup> Cm		18.1 y	15.(1) $\sigma_f = 1.1(2)$	640.(50) RI <sub>f</sub> = 10.8(8)	9.5(3)	
<sup>245</sup> Cm		8.48×10 <sup>3</sup> y	3.5(2)×10 <sup>2</sup> $\sigma_f = 2.1(1)×10^3$	110.(10) RI <sub>f</sub> = 8.(1)×10 <sup>2</sup>		
<sup>246</sup> Cm		4.76×10 <sup>3</sup> y	1.2(2) $\sigma_f = 0.16(7)$	120.(10) 13.(2)	9.3(2)	
<sup>247</sup> Cm		1.56×10 <sup>7</sup> y	60.(30) $\sigma_f = 82.(5)$	5.(1)×10 <sup>2</sup> 7.3(7)×10 <sup>2</sup>		
<sup>248</sup> Cm		3.48×10 <sup>5</sup> y	2.6(3) $\sigma_f = 0.36(7)$	270.(30) 13.(2)	7.7(2)	
<sup>249</sup> Cm		64.15 m	≈ 1.6			
<sup>250</sup> Cm		≈ 9.7×10 <sup>3</sup> y	≈ 80.			
<sup>97</sup> Bk						
<sup>249</sup> Bk		320. d	7.(1)×10 <sup>2</sup> $\sigma_f ≈ 0.1$	9.(1)×10 <sup>2</sup>		
<sup>250</sup> Bk		3.217 h	$\sigma_f = 1.0(2)×10^3$			
<sup>98</sup> Cf						
<sup>249</sup> Cf		351. y	5.0(3)×10 <sup>2</sup> $\sigma_f = 1.7(1)×10^3$	7.7(4)×10 <sup>2</sup> RI <sub>f</sub> = 2.1(3)×10 <sup>3</sup>		
<sup>250</sup> Cf		13.1 y	2.0(2)×10 <sup>3</sup> $\sigma_f = 110.(90)$	12.(2)×10 <sup>3</sup> RI <sub>f</sub> = 160.(40)		
<sup>251</sup> Cf		9.0×10 <sup>2</sup> y	2.9(2)×10 <sup>3</sup> $\sigma_f = 4.5(5)×10^3$	1.6(1)×10 <sup>3</sup> RI <sub>f</sub> = 5.5(3)×10 <sup>3</sup>		
<sup>252</sup> Cf		2.65 y	20.(2) $\sigma_f = 32.(4)$	43.(3) RI <sub>f</sub> = 1.1(3)×10 <sup>2</sup>		
<sup>253</sup> Cf		17.8 d	18.(2) $\sigma_f = 1.3(2)×10^3$	8.(1)		
<sup>254</sup> Cf		60.5 d	4.5(10)	2.		
<sup>99</sup> Es						
<sup>253</sup> Es		20.47 d	(180.+5.8)	(37.5+1.1)×10 <sup>2</sup>		
<sup>254m</sup> Es		1.64 d	$\sigma_f = 1.8(1)×10^3$			
<sup>254</sup> Es		276. d	28.(3) $\sigma_f = 1.8(2)×10^3$	18.(2) RI <sub>f</sub> = 1.2(3)×10 <sup>3</sup>		
<sup>255</sup> Es		40. d	≈ 55.			
<sup>100</sup> Fm						
<sup>255</sup> Fm		20.1 h	26.(3) $\sigma_f = 3.3(2)×10^3$	14.(2)		
<sup>257</sup> Fm		100.5 d	$\sigma_f = 3.0(2)×10^3$			

\*Extrapolated value.

# COSMIC RADIATION

A.G. Gregory and R.W. Clay

## The Nature of Cosmic Rays

Primary cosmic radiation, in the form of high energy nuclear particles, electrons and photons from outside the solar system and from the Sun, continually bombards our atmosphere. Secondary radiation, resulting from the interaction of the primary cosmic rays with atmospheric gas, is present at sea-level and throughout the atmosphere.

The secondary radiation is collimated by absorption and scattering in the atmosphere and consists of a number of components associated with different particle species. High energy primary particles can produce large numbers of secondary particles forming an extensive air shower. Thus, a number of particles may then be detected simultaneously at sea-level.

Primary particle energies accessible in the vicinity of the earth range from  $\sim 10^8$  eV to  $\sim 10^{20}$  eV. At the lower energies, the limit is determined by the inability of charged particles to traverse the heliosphere to us through the outward-moving solar wind. The upper energy limit is set by the practicality of building detectors to record particles with the extremely low fluxes found at those energies (J.G. Wilson, 1976; O.C. Allkofer, 1975a).

## Primary Cosmic Rays

### Primary Particle Energy Spectrum

Figure 1 shows the spectrum of primary particle energies. This includes all particle species. In differential form it is roughly a power law of intensity versus energy with an index of  $\sim -3$ . There appears to be a knee (a steepening) at a little above  $10^{15}$  eV and an ankle (a flattening) above  $\sim 10^{18}$  eV. Figure 2 emphasizes the features in the spectrum at the highest energies through multiplying the flux with a strongly rising power law of energy. This figure should be used with caution as errors for the two axes are not now independent.

Data on the high energy cosmic ray spectrum are uncertain largely because of limited event statistics due to the very low flux which might best be measured in particles per square kilometer per century. The highest energy event recorded to 1995 had an energy of  $3 \times 10^{20}$  eV (D.J. Bird et al., 1993).

It is expected that the highest energy cosmic rays will interact with the 2.7 K cosmic microwave background through photoproduction or photodisintegration. These interactions will appreciably reduce the observed flux of cosmic rays with energies above  $5 \times 10^{19}$  eV if they travel further than  $\sim 150$  million light years. This process is known as the Greisen-Zatsepin-Kuz'min (GZK) cut off (P. Sokolsky, 1989).

At energies below  $\sim 10^{13}$  eV, solar system magnetic fields and plasma can modulate the primary component and Figure 3 shows the extent of this modulation between solar maximum and minimum (E. Juliusson, 1975; J. Linsley, 1981).

### Primary Particle Energy Density

If the above spectrum is corrected for solar effects, the energy density above a particle energy of  $10^9$  eV outside the solar system is found to be  $\sim 5 \times 10^5$  eV  $m^{-3}$ . As the threshold energy is increased, the energy density decreases rapidly, being  $2 \times 10^4$  eV  $m^{-3}$  above  $10^{12}$  eV and  $10^2$  eV  $m^{-3}$  above  $10^{15}$  eV. The energy density at lower energies outside the heliosphere is unknown but may be substan-

tially greater if the particle rest mass energy is included together with the kinetic energy (A. W. Wolfendale, 1979).

### Primary Particle Isotropy

This is measured as an anisotropy  $(I_{\max} - I_{\min})/(I_{\max} + I_{\min}) \times 100\%$ , where  $I$ , the intensity ( $m^{-2}s^{-1}sr^{-1}$ ), is usually measured with an angular resolution of a few degrees.

The measured anisotropy is small and energy dependent. It is roughly constant in amplitude at between 0.05 and 0.1% (with a phase of 0 to 6 hours in right ascension) for energies between  $10^{11}$  eV and  $10^{14}$  eV and appears to increase at higher energies roughly as  $0.4 \times (\text{Energy(eV)}/10^{16})^{0.5}$  up to  $\sim 10^{18}$  eV. The latter rise may well be an artifact of the progressively more limited statistics as the flux drops rapidly with energy. It appears possible that a real anisotropy has been observed at the highest energies (above a few times  $10^{19}$  eV) with a directional preference for the supergalactic plane (this plane reflects the directions of galaxies within about 100 million light years) (A.W. Wolfendale, 1979; R.W. Clay, 1987; T. Stanev et al., 1995).

### Primary Particle Composition

The composition of low energy cosmic rays is close to universal nuclear abundances except where propagation effects are present. For example, Li, Be, and B which are spallation products, are over-abundant by about six orders of magnitude.

Composition at  $10^{11}$  eV per nucleus

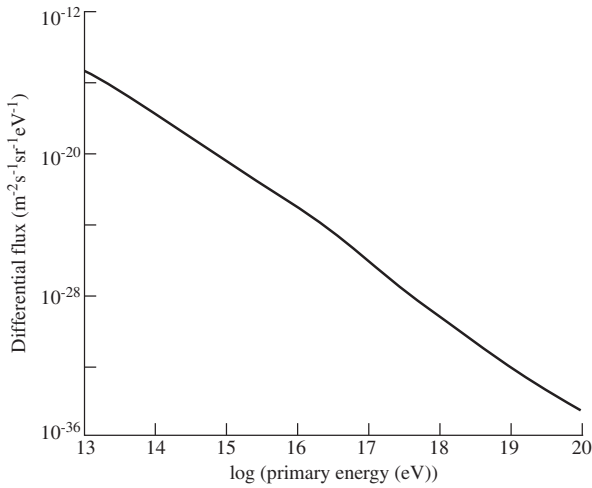
Charge	1	2	(3-5)	(6-8)	(10-14)	(16-24)	(26-28)	$\geq 30$
% Composition	50	25	1	12	7	4	4	0.1
(10% uncertainty)								

Measurements at higher energies indicate that there is an increase in the relative abundances of nuclei with charge greater than 6 at energies above 50 TeV/nucleus (K. Asakimori et al., 1993) ( $1 \text{ TeV} = 10^{12}$  eV).

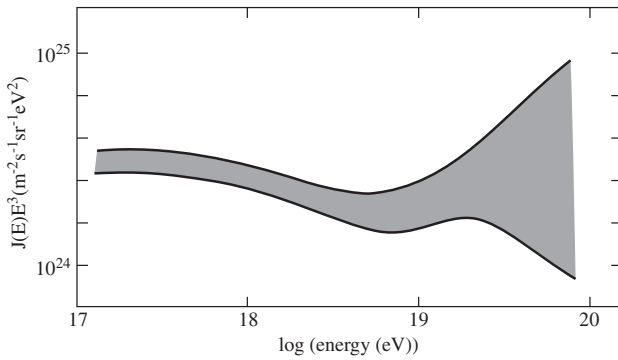
Cosmic ray composition at low energies is often quoted at a fixed energy per nucleon. When presented in this way, protons constitute roughly 90% of the flux, helium nuclei about 10% and the remainder sum to a total of about 1%.

Certain radioactive isotopic ratios show lifetime effects. The ratio of  $Be^{10}/B^9$  abundances is used to measure an "age" of cosmic rays since  $Be^{10}$  is unstable with a half life of about  $1.6 \times 10^6$  years. A ratio of 0.6 is expected in the absence of  $Be^{10}$  decay and a ratio of about 0.2 is found experimentally (E. Juliusson, 1975; P. Meyer, 1981).

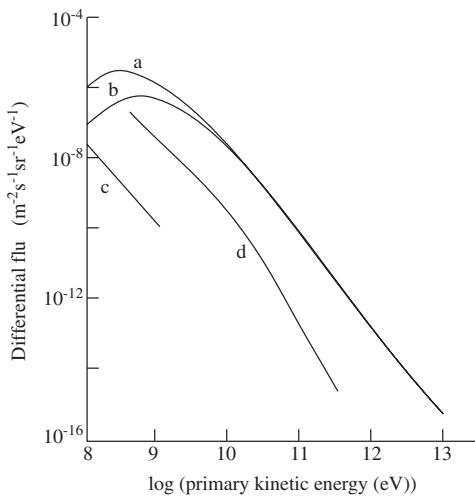
At higher energies, composition determinations are indirect and are rather contradictory and controversial. Experiments aim to differentiate between broad composition models. The measurement technique is based on studies of cosmic ray shower development. A rather direct technique for such studies is to use fluorescence observations of the shower development to determine the atmospheric depth of maximum development of the shower. Such observations suggest a heavy composition (large atomic number) at energies  $\sim 10^{17}$  eV which changes with increasing energy to a light composition (perhaps protonic) above  $\sim 10^{19}$  eV (T. K. Gaisser et al., 1993).



**FIGURE 1.** The energy spectrum of cosmic ray particles. This spectrum is of a differential form and can be converted to an integral spectrum by integration over all energies above a required threshold ( $E$ ). Insofar as the spectrum approximates a power law of index  $-3$ , a simple conversion to the integral at an energy  $E/1.8$  is obtained by multiplying the differential flux by the energy and dividing by  $0.62$ .



**FIGURE 2.** Energy spectrum at the highest energies. This spectrum (after Yoshida et al., 1995) has the differential spectrum multiplied by energy cubed. It is from a compilation of a number of measurements and indicates the good general agreement at the lower energies and a spread due to inadequate statistics at the highest energies.



**FIGURE 3.** Energy spectrum of particles at lower energies. (a) Solar minimum proton energy spectrum. (b) Solar maximum proton energy spectrum. (c) Gamma-ray energy spectrum. (d) Local interstellar electron spectrum.

### Primary Electrons

Primary electrons constitute about 1% of the cosmic ray beam. The positron to negative electron ratio is about 10% (J. M. Clem et al., 1995).

### Antimatter in the Primary Beam

The ratio of antiprotons to protons in the primary cosmic ray beam (at about 400 MeV) is about  $10^{-5}$ . At about 10 GeV the ratio is about  $10^{-3}$ . At the highest measured energies (10 TeV), the upper limit to the ratio is about 20% (S. Orito et al., 1995; M. Amenomori et al., 1995).

### Primary Gamma-Rays

The flux of primary gamma-rays is low at high energies. At 1 GeV the ratio of gamma-rays to protons is about  $10^{-6}$ . The arrival directions of these gamma-rays are strongly concentrated in the plane of the Milky Way although there is a diffuse, near isotropic background flux and some point sources have been detected.

Since the absorption cross section for gamma-rays above 100 MeV is approximately 20 mbarn/electron, less than 10% of gamma-rays reach mountain altitudes (A. W. Wolfendale, 1979; P. F. Michelson, 1994).

### Sea Level Cosmic Radiation

The sea level cosmic ray dose is 300 millirad-yr<sup>-1</sup> and the sea level ionization is  $2.2 \times 10^6$  ion pairs m<sup>-3</sup>s<sup>-1</sup>. The sea level flux has a soft component, which can be absorbed in about 100 mm of lead (about 100 g·cm<sup>-2</sup> of absorber) and a more penetrating (largely muon) hard component. The sea level radiation is largely produced in the atmosphere and is a secondary component from interactions of the primary particles. The steep primary energy spectrum means that most secondaries at sea level are from rather low energy primaries. Thus the secondary flux is dependent on the solar cycle and the geomagnetic latitude of the observer.

### Absolute Flux of the Hard Component

Vertical Integral Intensity  $I(0) \sim 100 \text{ m}^{-2}\text{s}^{-1}\text{sr}^{-1}$   
 Angular dependence  $I(\theta) \sim I(0) \cos^2(\theta)$   
 Integrated Intensity  $\sim 200 \text{ m}^{-2}\text{s}^{-1}$   
 (O.C. Allkofer, 1975b).

### Flux of the Soft Component

In free air, the soft component comprises about one third of the total cosmic ray flux.

### Latitude Effect

The geomagnetic field influences the trajectories of lower energy cosmic rays approaching the Earth. As a result, the background flux is reduced by about 7% at the geomagnetic equator. The effect decreases towards the poles and is negligible at latitudes above about 40°.

### Flux of Protons

The proton component is strongly attenuated by the atmosphere with an attenuation length (reduction by a factor of e) of about 120 g·cm<sup>-2</sup>. It constitutes about 1% of the total vertical sea level flux.

### Absorption

The soft component is absorbed in about 100 g·cm<sup>-2</sup> of matter. The hard component is absorbed much more slowly:

Absorption in lead, 6% per 100 g·cm<sup>-2</sup>  
 Absorption in rock, 8.5% per 100 g·cm<sup>-2</sup>

Absorption in water, 10% per 100 g·cm<sup>-2</sup>  
 (Absorption for depths less than 100 g·pd cm<sup>-2</sup> is given by K. Greisen, 1943.)

### Altitude Dependence

The cosmic ray background in the atmosphere has a maximum intensity of about 15 times that at sea level at a depth of about 150 g·cm<sup>-2</sup> (15 km altitude). At maximum intensity, the soft and hard components contribute roughly equally but the hard component is then attenuated more slowly (S. Hayakawa, 1969).

### Cosmic Ray Showers

High energy cosmic rays produce particle cascades in the atmosphere which can be detected at sea level provided that their energy exceeds about 100 GeV (such low energy cascades may be detected by using the most sensitive atmospheric Cerenkov detectors). The primary particle progressively loses energy which is transferred through the production of successive generations of secondary particles to a cascade of hadrons, an electromagnetic shower component (both positively and negatively charged electrons and gamma-rays) and muons. The secondary particles are relativistic and all travel effectively at the speed of light. As a result, they reach sea level at approximately the same time but, due to Coulomb scattering (for the electrons) and production angles (for the pions producing the muons), are spread laterally into a disk-like shower front with a characteristic lateral width of several tens of meters and thickness (near the central shower core) of 2 to 3 m. The number of particles at sea level is roughly proportional to the primary particle energy:

Number of particles at sea level  $\sim 10^{-10} \times \text{energy (eV)}$ .

At altitudes below a few kilometers, the number of particles in a shower attenuates with an *attenuation length* of about 200 g·cm<sup>-2</sup>.

i.e., particle number = original number  $\times \exp(-(\text{depth increase})/200)$

The above applies to an individual shower. The rate of observation of showers of a given size (particle number at the detector) at different depths of absorber attenuates with an *absorption length* of about 100 g·cm<sup>-2</sup> (J.G. Wilson, 1976).

### Atmospheric Background Light from Cosmic Rays

Cosmic ray particles produce Cerenkov light in the atmosphere and produce fluorescent light through the excitation of atmospheric molecules.

### Cerenkov Light

High energy charged particles will cause the emission of Cerenkov light in air if their energies are above about 30 MeV (electrons). This threshold is pressure (and hence altitude) dependent. A typical Cerenkov light pulse (at sea level, 100 m from the central shower core) has a time spread of a few nanoseconds. Over this time, the photon flux between 430 and 530 nm would be  $\sim 10^{14} \text{ m}^{-2}\text{s}^{-1}$  for a primary particle energy of  $10^{16} \text{ eV}$ . For comparison, the night sky background flux is  $\sim 6 \times 10^{11} \text{ photons m}^{-2}\text{s}^{-1}\text{sr}^{-1}$  in the same wavelength band (J.V. Jelley, 1967).

### Fluorescence Light

Cosmic ray particles in the atmosphere excite atmospheric molecules which then emit fluorescence light. This is weak compared to the highly collimated Cerenkov component when viewed in the direction of the incident cosmic ray particle but is emitted

isotropically. Typical pulse widths are longer than 50 ns and may be up to several microseconds for the total pulse from distant large showers (R.M. Baltrusaitis et al., 1985).

## Effects of Cosmic Rays

### Cerenkov Effects in Transparent Media

Background cosmic ray particles will produce Cerenkov light in transparent material with a photon yield between wavelengths  $\lambda_1$  and  $\lambda_2$

$$\sim (2\pi/137)\sin^2(\theta_c) \int_{\lambda_1}^{\lambda_2} d\lambda / \lambda^2 \text{ photons}(\text{unit length})^{-1}$$

where  $\theta_c$  (the Cerenkov angle) =  $\cos^{-1}(1/\text{refractive index})$ .

This background light is known to affect light detectors, e.g., photomultipliers, and can be a major source of background noise (R.W. Clay and A.G. Gregory, 1977).

### Effects on Electronic Components

If background cosmic ray particles pass through electronic components, they may deposit sufficient energy to affect the state of, e.g., a transistor flip-flop. This effect may be significant where reliability is of great importance or the background flux is high. For instance, it has been estimated that, in communication satellite operation, an error rate of about  $2 \times 10^{-3}$  per transistor per year may be found. Permanent damage may also result. A significant error rate may be found even at sea level in large electronic memories. This error rate is dependent on the sensitivity of the component devices to the deposition of electrons in their sensitive volumes (J.F. Ziegler, 1981).

### Biophysical Significance

When cosmic rays interact with living tissue, they produce radiation damage. The amount of the damage depends on the total dose of radiation. At sea level, this dose is small compared with doses from other sources but both the quantity and quality of the radiation change rapidly with altitude. Approximate dose rates under various conditions are:

- Dose rates (mrem·yr<sup>-1</sup>)
- Sea level cosmic rays, 30
- Cosmic rays at 10 km (subsonic jets), 2000
- Cosmic rays at 18 km (supersonic transports), 10,000
- (c.f., mean total sea level dose, 300)

Astronauts would be subject to radiation from galactic (0.05 rads per day) and solar (a few hundred rads per solar flare) cosmic rays as well as large fluxes of low energy radiation when passing through the Van Allen belts (about 0.3 rads per traverse).

Both astronauts and SST travellers would be subject to a small flux of low energy heavy nuclei stopping in the body. Such particles are capable of destroying cell nuclei and could be particularly harmful in the early stages of the development of an embryo. The rates of heavy nuclei stopping in tissue in supersonic transports and spacecraft are approximately as follows:

- Stopping nuclei ((cm<sup>3</sup> tissue)<sup>-1</sup> hr<sup>-1</sup>)
- Supersonic transport (16 km), 0.0005
- Supersonic transport (20 km), 0.005
- Spacecraft, 0.15
- (O. C. Allkofer, 1975a; O. C. Allkofer et al., 1974).

### Carbon Dating

Radiocarbon is produced in the atmosphere due to the action of cosmic ray slow neutrons. Solar cycle modulation of the very low energy cosmic rays causes an anticorrelation of the atmospheric <sup>14</sup>C activity with sunspot number with a mean amplitude of about 0.5%. In the long term, modulation of cosmic rays by a varying magnetic field may be important (A.A. Burchuladze et al., 1979).

### Practical Uses of Cosmic Rays

There are few direct practical uses of cosmic rays. Their attenuation in water and snow have, however, enabled automatic monitors of water and snow depth to be constructed. A search for hidden cavities in pyramids has been carried out using a muon "telescope".

### Other Effects

Stellar X-rays have been observed to affect the transmission times of radio signals between distant stations by altering the depth of the ionospheric reflecting layer. It has also been suggested that variations in ionization of the atmosphere due to solar modulation may have observable effects on climatic conditions.

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# TECHNIQUES FOR MATERIALS CHARACTERIZATION

## Experimental Techniques Used to Determine the Composition, Structure, and Energy States of Solids and Liquids

H.P.R. Frederikse

The many experimental methods, originally designed to study the chemical and physical behavior of solids and liquids, have grown into a new field known as Materials Characterization (or Materials Analysis). During the past 30 years a host of techniques aimed at the study of surfaces and thin films has been added to the many tools for the analysis of bulk samples. The field has benefited particularly from the development of computers and micro-processors, which have vastly increased the speed and accuracy of the measuring devices and the recording of their output. Materials characterization was and is a very important tool in the search for new physical and chemical phenomena. It plays an essential role in new applications of solids and liquids in industry, communications, and medicine. Many of its techniques are used in quality control, in safety regulations, and in the fight against pollution.

In most Materials Characterization experiments the sample is subjected to some kind of radiation: electromagnetic, acoustic, thermal, or particles (electrons, ions, neutrons, etc.). The surface

analysis techniques usually require a high vacuum. As a result of interactions between the solid (or liquid) and the incoming radiation a beam of a similar (or a different) nature will emerge from the sample. Measurement of the physical and/or chemical attributes of this emerging radiation will yield qualitative, and often quantitative, information about the composition and the properties of the material being probed.

The modern tendency of describing practically everything in this world by a combination of a few letters (acronyms) has also penetrated the field of Materials Characterization. The table below gives the meaning of the acronym for every technique listed, the form and size of the required sample (bulk, surface, film, liquid, powder, etc.), the nature of the incoming and of the emerging radiation, the depth and the lateral spatial resolution that can be probed, and the information obtained from the experiment. The last column lists one or two major references to the technique described.

	Technique	Sample	In	Out	Depth	Lateral resolution	Information obtained	Ref.
<b>Optical and Mass Spectroscopies for Chemical Analysis</b>								
1.	AAS Atomic Absorption Spectroscopy	Atomize (flame, electro, thermal, etc.)	Light e.g., glow discharge	Absorption spectrum	—	—	Concentration of atomic species (quantitative, using standards)	1,2
2.	ICP-AES Induct. Coupled Plasma – Atomic Emission Spectroscopy	Atomize (flame, electro, thermal, ICP, etc.)	—	Emission spectrum	—	—	Concentration of atomic species (quantitative, using standards)	3
3.	Dynamic SIMS Dynamic Secondary Ion Mass Spectroscopy	Surface	Ion beam (1–20 keV)	Secondary ions; analysis with mass spectrometer	2 nm–1 $\mu$ m (or deeper: ion milling)	0.50 nm	Elemental and isotopic analysis; depth profile (all elements); detection limits: ppb–ppm	4
4.	Static SIMS Static Secondary Ion Mass Spectroscopy	Surface	Ion beam (0.5–20 keV)	Secondary ions, analysis with mass spectrometer	0.1–0.5 nm	10 $\mu$ m	Elemental analysis of surface layers; molecular analysis; detection limits: ppb–ppm	4
5.	SNMS Sputtered Neutral Mass Spectroscopy	Surface, bulk	Plasma discharge; noble gases: 0.5–20 keV	Sputtered atoms ionized by atoms or electrons; then mass analyzed	0.1–0.5 nm (or deeper: ion milling)	1 cm	Elemental analysis $Z \geq 3$ ; depth profile; detection limit: ppm	4,6
6.	SALI Surface Analysis by Laser Ionization	Surface	e-beam, ion-beam, or laser for sputtering	Sputtered atoms ionized by laser; then mass analyzed	0.1–0.5 nm up to 3 $\mu$ m in milling mode	60 nm	Surface analysis; depth profiling	7
7.	LIMS Laser Ionization Mass Spectroscopy	Surface, bulk	u.v. laser (ns pulses)	Ionized species; analyzed with mass spectrometer	50–150 nm	5 $\mu$ m–1 mm	Elemental (micro)analysis; detection limits: 1–100 ppm	8
8.	SSMS Spark Source Mass Spectroscopy	Sample in the form of two electrodes	High voltage R.F. spark produces ions	Ions – analyzed in mass spectrometer	1–5 $\mu$ m	—	Survey of trace elements; detection limit: 0.01–0.05 ppm	9
9.	GDMS Glow Discharge Mass Spectroscopy	Sample forms the cathode for a D.C. glow discharge	Sputtered atoms ionized in plasma	Ions – analyzed in mass spectrometer	0.1–100 $\mu$ m	3–4 mm	(Bulk) trace element analysis; detection limit: sub-ppb	9,10
10.	ICPMS Induct. Coupled Plasma Mass Spectroscopy	Liquid-dissolved sample carried by gas stream into R.F. induction coil	Ions produced in argon plasma	Ions – analyzed in quadrupole mass spectrometer	—	—	High sensitivity analysis of trace elements	11
<b>Photons — Absorption, Reflection and Electron Emission</b>								
11.	IRS Infrared Spectroscopy	Thin crystal, glass, liquid	I.R. light (W-filament, globar, Hg-arc)	I.R. spectrum	—	—	Electronic transitions (mainly in semiconductors and superconductors); vibrational modes (in crystals and molecules)	12,13,14
12.	FTIR Fourier Transform I.R. Spectroscopy	Solid, liquid; transmission or reflection	White light (all frequencies)	Fourier Transform of spectrum (interferometer)	—	—	Spectra obtained at higher speed and resolution	15
13.	ATR Attenuated Total Reflection	Surface or thin crystal	—	—	$\mu$ m's	—	Atomic or molecular spectra of surfaces and films	16
14.	( $\mu$ )-RS (Micro-) Raman Spectroscopy	Solid, liquid (1 $\mu$ m–1 cm)	Laser beam, e.g., Ar-line, YAG-line	Raman spectra	0.5 $\mu$ m	0.5 $\mu$ m	Molecular and crystal vibrations	12,14,17

	Technique	Sample	In	Out	Depth	Lateral resolution	Information obtained	Ref.
15.	CARS Coherent Anti-Stokes Raman Spectroscopy	Solid, liquid (50 $\mu\text{m}$ –3 cm)	Pump beam ( $\omega_p$ )+ probe beam ( $\omega_s$ )	Anti-Stokes spectrum	–	–	High resolution Raman spectra	14
16.	Ellipsometry	Transparent films, crystals, adsorbed layers	Polarized light	Change in polarization	0.05 nm–5 $\mu\text{m}$	25 $\mu\text{m}$ (or sample thickness)	Refractive index and absorption	18,19
17.	UPS Ultraviolet Photo-electron Spectroscopy	Surfaces, adsorbed layers	u.v. light, 10–100 eV; 200 eV (synchrotron)	Electrons	0.2–10 nm	0.1–10 nm	Energies of electronic states of surfaces and free molecules	20,21
18.	PSD Photon Stimulated Desorption	Surfaces with adsorbed species	Far u.v. light $E > 10$ eV	Ions – analyzed with mass spectrometer	0.1–2 nm	–	Structure and desorption kinetics of adsorbed atoms and molecules	22
<b>X-Rays</b>								
19.	XRD X-Ray Diffraction	Single crystals, powders, films	X-rays: $\lambda = 0.05$ –0.2 nm (6–17 keV)	Diffacted X-ray beam	1–1000 $\mu\text{m}$	0.1–10 nm	Identification of crystallographic structures; all elements (low Z difficult)	23,24
20.	XRF/EDS X-Ray Fluorescence/Energy Dispersive Spectroscopy	Thin films, single layer	Prim. X-ray beam $\lambda = 0.02$ –0.1 nm 12–80 keV	Fluorescent X-rays	1–100 $\mu\text{m}$	10 nm	Elemental analysis; all elements except H, He, Li – (EDS also used in XRD, SEM, TEM and EPMA)	25,26
21.	EXAFS Extended X-Ray Absorption Fine Structure	Films, foils	High intensity X-rays (synchrotron)	Spectrum near absorption edge	nm– $\mu\text{m}$	–	Local atomic structure: order/disorder in vicinity of absorbing atom	27
22.	XPS/ESCA X-Ray Photo-electron Spectroscopy/ Electron Spect. for Chemical Analysis	Surfaces, thin films ( $\approx 20$ atomic layers)	Soft X-rays (1–20 keV)	Core electrons; valence electrons	0.5–10 nm	5 nm–50 $\mu\text{m}$	(Quantitative) identification of all elements in surface layer or film	28,29
<b>Electrons</b>								
23.	CL Cathode Luminescence	Insulators, semiconductors	Electrons 5–50 keV	Photons 0.1–5 eV	1 nm–2 $\mu\text{m}$	1 or 2 $\mu\text{m}$	Energy levels of impurities and point defects	30
24.	APS Appearance Potential Spectroscopy	Surface ( $\approx 20$ atomic layers)	Electrons (energy scan) 50–2000 eV	X-rays to pinpoint electron energy threshold	–	–	Identification of surface species	21, see also C
25.	AES Auger Electron Spectroscopy	Thin films, surfaces	Electrons 3–10 keV	Auger electrons 20–2000 eV	0.3–3 nm	$\approx 30$ nm	Elemental composition of surface (except H, He); detection limit 0.1–1%	28,29
26.	EELS Electron Energy Loss Spectroscopy	Very thin samples (<200 nm)	Electrons (100–400 keV)	(Retarded) electrons; minus 1–1000 eV	<200 nm	1–100 nm	Local elemental concentration; electronic structure, chem. bonding; interatomic distances	31
27.	EXELFS Extended Electron Energy Loss Fine Structure	Thin films	Electrons (100–400 keV)	Electrons energies 0–30 eV above edge	<200 nm	1–100 nm	Density of states of valence electrons (above Fermi level)	27,32
28.	ESD Electron Stimulated Desorption	Adsorbed species	Electrons $E > 10$ eV	Ions – analyzed with mass spectrometer	–	–	Structure and desorption properties of adsorbed atoms and molecules	22
29.	ESDIAD ESD-Ion Angular Distribution	(See ESD)	(See ESD)	Directional dependence of emitted ions	–	–	Geometries of adsorbed species (atoms or molecules)	22
30.	EPMA Electron Probe (X-Ray) Micro Analysis	Solid conductors and insulators <1 cm thick	Electrons 5–30 keV	Characteristic X-ray 0.1–15 keV	100 nm–5 $\mu\text{m}$	1 $\mu\text{m}$	Elemental analysis, $Z \leq 4$ , major, minor and trace amounts	33,34
31.	LEED Low Energy Electron Diffraction	Surface	Mono-energetic electron beam 10–1000 eV	Diffacted electrons	0.4–2 nm	<5 $\mu\text{m}$	Crystallographic structure of surface; resolution: 0.01 nm	35
32.	RHEED Reflection High Energy Electron Diffraction	Surface	Electron beam at grazing angle 5–50 keV	Reflected electrons	0.2–10 nm	<5 $\mu\text{m}$	Surface symmetry	36,37
33.	SEM Scanning Electron Microscopy	Bulk, films (conducting)	High energy electrons usually $\approx 30$ keV	Secondary and backscattered electrons	1 nm–5 $\mu\text{m}$	1–20 nm	Surface image, defect structure; resolution 5–15 nm; magnification 300,000 $\times$	33,34
34.	(S)TEM (Scanning) Transmission Electron Microscopy	Thin specimen – <200 nm	High energy electrons typically 300 keV	Transmitted and diffracted electrons	(Sample thickness)	2–20 nm	(Defect) structure of cryst. solids; microchemistry; high resol.: 0.2 nm	33
35.	FEM Field Emission Microscopy	Metals, alloys (sharp point)	–	Electron emission (with appl. electric field – 50 kV)	$\approx 0.5$ nm	10–100 nm	Surface image, crystallographic structure	34
36.	STM Scanning Tunneling Microscopy	Polished or cleaved surface (conducting)	Tunneling current controls distance between sample and very sharp tip	–	1–5 nm	2–10 nm	Atomic-scale relief map of surface; resolution: vert. 0.002 nm, hor. 0.2 nm	39
37.	SPM Scanned Probe Microscopy	Very flat surface	Any field: e.g. mechan. vibration recorded with laser probe; same with magnetic, electric or thermal field	–	1–100 nm	1–100 nm	Surface-magnetic field, surface-thermal conductivity, etc.	39a
38.	AFM Atomic Force Microscopy	Very flat surface	Similar to STM; force measured with cantilever spring	–	0.5–5 nm	0.2–130 nm	Surface topography with atomic resolution; interatomic force	40



	Technique	Sample	In	Out	Depth	Lateral resolution	Information obtained	Ref.
<b>Ions and Neutrons</b>								
39.	ISS (or LEIS) Ion Scattering Spectroscopy (Low Energy Ion Scattering)	Surface	Ion beam He <sup>+</sup> or Ne <sup>+</sup> <3 keV	Sputtered ions (energy analysis)	0.1–0.5 nm	1–100 μm	Elemental analysis (better for low Z) detection limits: 0.01–1%	41
40.	FIM Field Ion Microscopy	Surface: metals, alloys; very sharp tip	(He gas above sample)	He ions + high electric field produce image	≈0.1 nm	0.1–2 nm	Atomic structure of surface	34,42
41.	RBS Rutherford Back Scattering	Solids, thin films	Mono-energetic ions (H <sup>+</sup> or He <sup>+</sup> ) 0.5–3 MeV	Backscattered ions	10 nm–1 μm	1 mm	Element identification (Li to U) detection limit: 0.01–1%	46
42.	NRA Nuclear Reaction Analysis	Solids, thin films	Mono-energetic ions (Li, Be, B, etc.) 200 keV–6 MeV	Protons, deuterons <sup>3</sup> He, α-particles, γ-rays	0.1–5 μm	10 μm–10 mm	Element identification (all) detection limit: 10 <sup>-12</sup> –10 <sup>-2</sup>	47
43.	PIXE Particle Induced X-ray Emission	Thin films, surface layers	High energy ions (H <sup>+</sup> or He <sup>+</sup> )	Characteristic X-rays	<10 μm	1 μm–2 mm	Trace impurities: Z>3 detection limit: 0.1–100 ppm (depending on sample thickness)	48
44.	INS Ion Neutralization Spectroscopy	Surface	He-ions (≈5 eV)	Electrons	–	–	Energies of valence electrons	49
45.	NAA Neutron Activation Analysis	Bulk, >0.5 g	Thermal neutrons	Characteristic γ-rays, (≈1 MeV)	Bulk	–	Trace concentrations (of isotopes) of elements: trans. metals, Pt-group; detection limit: 10 <sup>9</sup> –10 <sup>14</sup> atoms/cm <sup>3</sup>	43
46.	N(P)D Neutron (Powder) Diffraction	Crystalline solids	Thermal neutrons E ≈0.0025 eV	Diffacted neutrons	Bulk	–	Crystallographic structure; porosity, particle size	44
47.	SANS Small Angle Neutron Scattering	Inhomogeneous solids; powders; porous samples	Thermal neutrons 2 θ = 10 <sup>-2</sup> –10 <sup>-4</sup>	Scattered neutrons	1–25 mm	–	Average size of inhomogeneities; range: 1 nm–1 mm	45
<b>Acoustic</b>								
48.	SLAM Scanning Laser Acoustic Microscopy	Bulk, film	Acoustic wave produced by laser 1 MHz–1 GHz	Reflected acoustic wave	μm–cm	0.1–20 mm	Defect structure; thickness measurement	50
<b>Thermal</b>								
49.	DTA Differential Thermal Analysis	Specimen and reference sample	Uniform heating	Temperature difference	Bulk	–	Phase transitions, crystallization	51
50.	DSC Differential Scanning Calorimetry	Specimen and ref. sample	Controlled heating	Measure heat required for equal temperature	Bulk	–	Phase transitions, crystallization; activation energies	51
51.	TGA Thermo Gravimetric Analysis	Bulk, 1–100 g	Controlled heating	Weight as function of temperature (and time)	Bulk	–	Decomposition, non-stoichiometry, kinetics of reaction	52
<b>Resonance</b>								
52.	EPR (ESR) Electron Paramagnetic (Spin) Resonance	Paramagnetic solids or liquids	Microwave radiation in magnetic field 3–300 GHz; 1–100 kG	Microwave absorption (at resonance)	Bulk	–	Local environment of paramagnetic ion; concentration of paramagnetic, species; detection limit: 10 <sup>11</sup> spins/cm <sup>3</sup>	53,54
53.	ECR Electron Cyclotron Resonance	Semiconductors, metals; free electrons (low temperature)	Microwave radiation in magnetic field 10–30 GHz; 5–10 kG	Microwave absorption (at resonance)	Bulk	–	Electronic energy bands, effective masses	55
54.	Mössbauer Effect	Source and absorber	Mono-energetic γ-rays: 5–100 keV	Mössbauer spectrum (Doppler shifted (lines))	50 m	1 cm	Interaction between nucleus and its environment (local electric, magnetic fields; bonds; valency; diffusion, etc.)	56
55.	NMR (MRI) Nuclear Magnetic Resonance (Magnetic Resonance Imaging)	Solids, liquids	R.F. radiation + magnetic field; e.g. for protons: 60 MHz, 14 kG	R.F. absorption	<1 cm	1 cm	Quant. analysis; local magnetic environment; diffusion; imaging	58
56.	ENDOR Electron Nuclear Double Resonance	Solids, liquids	R.F. + microwave radiation in magn. field.	Microwave absorption	–	–	Hyperfine interaction → local atomic structure	54
57.	NQR Nuclear Quadrupole Resonance	Solids	R.F. radiation 0.5–1000 MHz	R.F. absorption	–	–	Asymmetry of the charge distribution at the nucleus	55,59
<b>Other</b>								
58.	BET Brunauer-Emmett-Teller	(Large) surface area 1–20 m <sup>2</sup> /g	Adsorbed gas (e.g., N <sub>2</sub> at low temp.) as function of pressure (monolayer coverage)	–	–	–	Surface area measurement	60

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# SYMMETRY OF CRYSTALS

L. I. Berger

The ability of a body to coincide with itself in its different positions regarding a coordinate system is called its symmetry. This property reveals itself in iteration of the parts of the body in space. The iteration may be done by reflection in mirror planes, rotation about certain axes, inversions and translations. These actions are called the symmetry operations. The planes, axes, points, etc., are known as symmetry elements. Essentially, mirror reflection is the only truly primitive symmetry operation. All other operations may be done by a sequence of reflections in certain mirror planes. Hence, the mirror plane is the only true basic symmetry element. But for clarity, it is convenient to use the other symmetry operations, and accordingly, the other aforementioned symmetry elements. The symmetry elements and operations are presented in Table 1.

The entire set of symmetry elements of a body is called its symmetry class. There are thirty-two symmetry classes that describe all crystals that have ever been noted in mineralogy or been synthesized (more than 150,000). The denominations and symbols of the symmetry classes are presented in Table 2.

There are several known approaches to classification of individual crystals in accordance with their symmetry and crystallochemistry. The particles that form a crystal are distributed in certain points in space. These points are separated by certain distances (translations) equal to each other in any chosen direction in the crystal. Crystal lattice is a diagram that describes the location of particles (individual or groups) in a crystal. The lattice parameters

are three non-coplanar translations that form the crystal lattice. Three basic translations form the unit cell of a crystal. August Bravais (1848) has shown that all possible crystal lattice structures belong to one or another of fourteen lattice types (Bravais lattices). The Bravais lattices, both primitive and non-primitive, are the contents of Table 3.

Among the three-dimensional figures, there is a group of polyhedrons that are called regular, which have all faces of the same shape and all edges of the same size (regular polygons). It has been shown that there are only five regular polyhedrons. Because of their importance in crystallography and solid state physics, a brief description of these polyhedrons is included in Table 4.

The systematic description of crystal structures is presented primarily in the well-known *Strukturbericht*. The classification of crystals by the *Strukturbericht* does not reflect their crystal class, the Bravais lattice, but is based on the crystallochemical type. This makes it inconvenient to use the *Strukturbericht* categories for comparison of some individual crystals. Thus, there have been several attempts to provide a more convenient classification of crystals. Table 5 presents a compilation of different classifications which allows the reader to correlate the *Strukturbericht* type with the international and Schoenflies point and space groups and with Pearson's symbols, based on the Bravais lattice and chemical composition of the class prototype. The information included in Table 5 has been chosen as an introduction to a more detailed crystallophysical and crystallochemical description of solids.

TABLE 1. Symmetry Operations and Elements  
Symmetry element

Symmetry operation	Name	Symbol		Presentation on the stereographic projection	
		International (Hermann-Mauguin)	Schoenflies	Parallel	Perpendicular
Reflection in a plane	Plane	m	$C_s$		
Rotation by angle $\alpha = 360^\circ/n$ about an axis	Axis	n = 1, 2, 3, 4 or 6	$C_n$		
		n = 2	$C_2$		
		n = 3	$C_3$		
		n = 4	$C_4$		
		n = 6	$C_6$		
Rotation about an axis and inversion in a symmetry center lying on the axis	Inversion (improper) axis	$\bar{n} = \bar{3}, \bar{4}, \bar{6}$	$C_{ni}$		
		$\bar{n} = \bar{3}$	$C_{3i}$		
		$\bar{n} = \bar{4}$	$C_{4i}$		

**TABLE 1. Symmetry Operations and Elements**  
Symmetry element

Symmetry operation	Name	Symbol		Presentation on the stereographic projection	
		International (Hermann-Mauguin)	Schoenflies	Parallel	Perpendicular
		$\bar{n} = \bar{6}$	$C_{6i}$		
Inversion in a point	Center	$\bar{1}$	$C_i$		
Parallel translation	Translation vector $\vec{a}$ , $\vec{b}$ , $\vec{c}$				
Reflection in a plane and translation parallel to the plane	Glide-plane	a, b, c, n, d			
Rotation about an axis and translation parallel to the axis	Screw axis	$n_m$ ( $m = 1, 2, \dots, n - 1$ )			
Rotation about an axis and reflection in a plane perpendicular to the axis	Rotatory-reflection axis	$\bar{n}$ $\bar{n} = \bar{1}, \bar{2}, \bar{3}, \bar{4}, \bar{6}$	$S_n$		

**TABLE 2. The Thirty-Two Symmetry Classes**

Class name<sup>a</sup> and its symbol – International (Int) and Schoenflies (Sch)

Crystal symbol	Primitive		Central		Planal		Axial		Plane-axial		Inversion primitive		Inversion-planal	
	Int	Sch	Int	Sch	Int	Sch	Int	Sch	Int	Sch	Int	Sch	Int	Sch
Triclinic	1	$C_1$	1	$C_1$										
Monoclinic			—		m	$C_s$	2	$C_2$	2/m	$C_{2h}$				
Orthorhombic					mm2	$C_{2v}$	222	$D_2$	mmm	$D_{2h}$				
Trigonal	3	$C_3$	3	$C_{3i}$	3m	$C_{3v}$	32	$D_3$	$\bar{3}m$	$C_{3d}$				
Tetragonal	4	$C_4$	4/m	$C_{4h}$	4mm	$C_{4v}$	422	$D_4$	4/mmm	$D_{4h}$	$\bar{4}$	$S_4$	$\bar{4}2m$	$D_{2d}$
Hexagonal	6	$C_6$	6/m	$C_{6h}$	6mm	$C_{6v}$	622	$D_6$	6/mmm	$D_{6h}$	$\bar{6}$	$C_{3h}$	$\bar{6}m2$	$D_{3h}$
Cubic	23	T	m3	$T_h$	$\bar{4}3m$	$T_d$	432	O	m3m	$O_h$				

<sup>a</sup> Per Fedorov Institute of Crystallography, Russian Academy of Sciences, nomenclature.

**TABLE 3. The Fourteen Possible Space Lattices (Bravais Lattices)**

Crystal system	Metric category of the system	No. of different lattices in the system	Lattice type <sup>a</sup> (marked by +)					No. of identipoints per unit cell	Characteristic parameters (marked by +)						Description of characteristic parameters $a < X, b < Y, c < Z$		Symmetry of the lattice	
			P	C	I	F	R		a	b	c	$\alpha$	$\beta$	$\gamma$	$\alpha = (b, c), \beta = (a, c), \gamma = (a, b)$	Int	Sch	
Triclinic	Trimetric	1	+					1	+	+	+	+	+	+	$a \neq b \neq c, \alpha \neq \beta \neq \gamma$	1	C	
Monoclinic	Trimetric	2	+	+				1 or 2	+	+	+	+			$a \neq b \neq c, \alpha = \gamma = 90^\circ \neq \beta$	2/m	$C_{2h}$	
Orthorhombic	Trimetric	4	+	+	+	+		1, 2 or 4	+	+	+			$a \neq b \neq c, \alpha = \beta = \gamma = 90^\circ$	mmm	$D_{2h}$		
Trigonal (rhombohedral)	Dimetric	1					+	1	+		+			$a = b = c, 120^\circ > \alpha = \beta = \gamma \neq 90^\circ$	3m	$D_{3d}$		
Tetragonal	Dimetric	2	+	+				1 or 2	+	+				$a = b \neq c, \alpha = \beta = \gamma = 90^\circ$	4/mmm	$D_{4h}$		
Hexagonal	Dimetric	1	+					1	+	+				$a = b \neq c, \alpha = \beta = 90^\circ, \gamma = 120^\circ$	6/mmm	$D_{6h}$		
Isometric (cubic)	Monometric	3	+	+	+			1, 2 or 4	+					$a = b = c, \alpha = \beta = \gamma = 90^\circ$	m3m	$O_h$		

<sup>a</sup> Designations of the space-lattice types: P – primitive, C – side-centered (base-centered), I – body-centered, F – face-centered, R – rhombohedral.

**TABLE 4. The Five Possible Regular Polyhedrons**

Polyhedron	Symmetry (Schoenflies)			Number of <sup>b</sup>		
	Class	Elements	Form of faces	Faces (F)	Edges (E)	Vertices (V)
Tetrahedron	T	$4C_3, 3C_2$	Equilateral triangle	4	6	4

Cube (hexahedron)	O	$3C_4 4C_3 6C_2$	Square	6	12	8
Octahedron	O	$3C_4 4C_3 6C_2$	Equilateral triangle	8	12	6
Pentagonal dodecahedron	J	$6C_5 10C_3 15C_2$	Regular pentagon	12	30	20
Icosahedron	J	$6C_5 10C_3 15C_2$	Equilateral triangle	20	30	12

<sup>a</sup> Per formula by Leonhard Euler:  $F + V - E = 2$

TABLE 5. Classification of Crystals

Strukturbericht symbol	Structure name	Symmetry group		Pearson symbol <sup>a</sup>	Standard ASTM
		International	Schoenflies		E157-82a
		3	4		symbol <sup>b</sup>
1	2	3	4	5	6
A1	Cu	Fm3m	$O_h^4$	cF4	F
A2	W	Im3m	$O_h^9$	cI2	B
A3	Mg	$P6_3/mmc$	$D_{6h}^4$	hP2	H
A4	C	Fd3m	$O_h^7$	cF8	F
A5	Sn	$I4_1/amd$	$D_{4h}^{19}$	tI4	U
A6	In	$I4/mmm$	$D_{4h}^{17}$	tI2	U
A7	As	$R\bar{3}m$	$D_{3d}^5$	hR2	R
A8	Se	$P3_1 21$ or $P3_2 21$	$D_3^4 (D_3^6)$	hP3	H
A10	Hg	$R\bar{3}m$	$D_{3d}^5$	hR1	R
A11	Ga	Cmca	$D_{2h}^{18}$	oC8	Q
A12	$\alpha$ -Mn	$I4\bar{3}m$	$T_d^3$	cI58	B
A13	$\beta$ -Mn	$P4_1 32$	$O^7$	cP20	C
A15	$OW_3$	Pm3n	$O_h^3$	cP8	C
A20	$\alpha$ -U	Cmcm	$D_{2h}^{17}$	oC4	Q
B1	ClNa	Fm3m	$O_h^5$	cF8	F
B2	ClCs	Pm3m	$O_h^1$	cP2	C
B3	SZn	$F\bar{4}3m$	$T_d^2$	cF8	F
B4	SZn	$P6_3 mc$	$C_{6v}^4$	hP4	H
B8 <sub>1</sub>	AsNi	$P6_3/mmc$	$D_{6h}^4$	hP4	H
B8 <sub>2</sub>	InNi <sub>2</sub>	$P6_3/mmc$	$D_{6h}^4$	hP6	H
B9	HgS	$P3_1 21$ or $P3_2 21$	$D_3^4$ or $D_3^6$	hP6	H
B10	OPb	$P4/nmm$	$D_{4h}^7$	tP4	T
B11	$\gamma$ -CuTi	$P4/nmm$	$D_{4h}^7$	tP4	T
B13	NiS	$R\bar{3}m$	$D_{3d}^5$	hR6	R
B16	GeS	Pnma	$D_{2h}^{16}$	oP8	O
B17	PtS	$P4_2/mmc$	$D_{4h}^9$	tP4	T
B18	CuS	$P6_3/mmc$	$D_{6h}^4$	hP12	H
B19	AuCd	Pmma	$D_{2h}^5$	oP4	O
B20	FeSi	$P2_1 3$	$T^4$	cP8	C
B27	BFe	Pnma	$D_{2h}^{16}$	oP8	O
B31	MnP	Pnma	$D_{2h}^{16}$	oP8	O
B32	NaTl	Fd3m	$O_h^7$	cF16	F
B34	Pds	$P4_2/m$	$C_{4h}^2$	tP16	T
B35	CoSn	$P6/mmm$	$D_{6h}^1$	hP6	H
B37	SeTl	$I4/mcm$	$D_{4h}^{18}$	tI16	U
B <sub>e</sub>	CdSb	Pbca	$D_{2h}^{15}$	oP16	O
B <sub>f</sub> (B33)	$\xi$ -BCr	Cmcm	$D_{2h}^{17}$	oC8	Q
B <sub>g</sub>	BMo	$I4_1/amd$	$D_{4h}^{19}$	tI4	U
B <sub>h</sub>	CW	$P6m2$	$D_{3h}^1$	hP2	H
B <sub>i</sub>	$\gamma'$ CMo (AsTi)	$P6_3/mmc$	$D_{6h}^4$	hP8	H
C1	CaF <sub>2</sub>	$Fm\bar{3}m$	$O_h^5$	cF12	F
C1 <sub>b</sub>	AgAsMg	$F\bar{4}3m$	$T_d^2$	cF12	F
C2	FeS <sub>2</sub>	Pa3	$T_h^6$	cP12	C
C3	Cu <sub>2</sub> O	Pn3m	$O_h^4$	cP6	C
C4	O <sub>2</sub> Ti	$P4_2/mnm$	$D_{4h}^{14}$	tP6	T
C6	CdI <sub>2</sub>	P3m1	$D_{3d}^3$	hP3	H
C7	MoS <sub>2</sub>	$P6_3/mmc$	$D_{6h}^4$	hP6	H
C11 <sub>a</sub>	C <sub>2</sub> Ca	$I4/mmm$	$D_{4h}^{17}$	tI6	U
C11 <sub>b</sub>	MoSi <sub>2</sub>	$I4/mmm$	$D_{4h}^{17}$	tI6	U

TABLE 5. Classification of Crystals

Strukturbericht symbol	Structure name	Symmetry group		Pearson symbol <sup>a</sup>	Standard ASTM E157-82a symbol <sup>b</sup>
		International	Schoenflies		
		3	4		
1	2			5	6
C12	CaSi <sub>2</sub>	R $\bar{3}m$	D <sup>5</sup> <sub>3d</sub>	hR6	R
C14	MgZn <sub>2</sub>	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP12	H
C15	Cu <sub>2</sub> Mg	Fd3m	O <sup>7</sup> <sub>h</sub>	cF24	F
C15 <sub>b</sub>	AuBe <sub>5</sub>	F $\bar{4}3m$ or F23	T <sup>2</sup> <sub>d</sub> or T <sup>2</sup>	cF24	F
C16	Al <sub>2</sub> Cu	I4/mcm	D <sup>18</sup> <sub>4h</sub>	tI12	U
C18	FeS <sub>2</sub>	Pnmm	D <sup>12</sup> <sub>2h</sub>	oP6	O
C19	CdCl <sub>2</sub>	R $\bar{3}m$	D <sup>5</sup> <sub>3d</sub>	hR3	R
C22	Fe <sub>2</sub> P	P2 $\bar{6}m$	D <sup>1</sup> <sub>3h</sub>	hP9	H
C23	Cl <sub>2</sub> Pb	Pnma	D <sup>16</sup> <sub>2h</sub>	oP12	O
C32	AlB <sub>2</sub>	P6/mmm	D <sup>1</sup> <sub>6h</sub>	hP3	H
C33	Bi <sub>2</sub> STe <sub>2</sub>	R $\bar{3}m$	D <sup>5</sup> <sub>3d</sub>	hR5	R
C34	AuTe <sub>2</sub>	C2/m (P2/m)	C <sup>3</sup> <sub>2h</sub> (C <sup>1</sup> <sub>2h</sub> )	mC6	N
C36	MgNi <sub>2</sub>	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP24	H
C38	Cu <sub>2</sub> Sb	P4/nmm	D <sup>7</sup> <sub>4h</sub>	tP6	T
C40	CrSi <sub>2</sub>	P6 <sub>2</sub> 22	D <sup>4</sup> <sub>6</sub>	hP9	H
C42	SiS <sub>2</sub>	Ibam	D <sup>26</sup> <sub>2h</sub>	oI12	P
C44	GeS <sub>2</sub>	Fdd2	C <sup>19</sup> <sub>2v</sub>	oF72	S
C46	AuTe <sub>2</sub>	Pma2	C <sup>4</sup> <sub>2v</sub>	oP24	O
C49	Si <sub>2</sub> Zr	Cmcm	D <sup>17</sup> <sub>2h</sub>	oC12	Q
C54	Si <sub>2</sub> Ti	Fddd	D <sup>24</sup> <sub>2h</sub>	oF24	S
C <sub>c</sub>	Si <sub>2</sub> Th	I4 <sub>1</sub> /amd	D <sup>19</sup> <sub>4h</sub>	tI12	U
C <sub>e</sub>	CoGe <sub>2</sub>	Aba2	C <sup>17</sup> <sub>2v</sub>	oC23	Q
DO <sub>2</sub>	As <sub>3</sub> Co	Im3	T <sup>5</sup> <sub>h</sub>	oI32	B
DO <sub>3</sub>	BiF <sub>3</sub>	Fm3m	O <sup>5</sup> <sub>h</sub>	cF16	F
DO <sub>9</sub>	O <sub>3</sub> Re	Pm3m	O <sup>1</sup> <sub>h</sub>	cP4	C
DO <sub>11</sub>	CFe <sub>3</sub>	Pnma	D <sup>16</sup> <sub>2h</sub>	oP16	O
DO <sub>18</sub>	AsNa <sub>3</sub>	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP8	H
DO <sub>19</sub>	Ni <sub>3</sub> Sn	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP8	H
DO <sub>20</sub>	Al <sub>3</sub> Ni	Pnma	D <sup>16</sup> <sub>2h</sub>	oP16	O
DO <sub>21</sub>	Cu <sub>3</sub> P	P $\bar{3}c1$	D <sup>4</sup> <sub>3d</sub>	hP24	H
DO <sub>22</sub>	Cu <sub>3</sub> P	I4/mmm	D <sup>17</sup> <sub>4h</sub>	tI8	U
DO <sub>23</sub>	Al <sub>3</sub> Zr	I4/mmm	D <sup>17</sup> <sub>4h</sub>	tI16	U
DO <sub>24</sub>	Ni <sub>3</sub> Ti	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP16	H
DO <sub>c</sub>	SiU <sub>3</sub>	I4/mcm	D <sup>18</sup> <sub>4h</sub>	tI16	U
DO <sub>e</sub>	Ni <sub>3</sub> P	I $\bar{4}$	S <sup>2</sup> <sub>4</sub>	tI32	U
D1 <sub>3</sub>	Al <sub>4</sub> Ba	I4/mmm	D <sup>17</sup> <sub>4h</sub>	tI10	U
D1 <sub>a</sub>	MoNi <sub>4</sub>	I4/m	C <sup>5</sup> <sub>4h</sub>	tI10	U
D1 <sub>b</sub>	Al <sub>4</sub> U	Imma	D <sup>28</sup> <sub>2h</sub>	oI20	P
D1 <sub>c</sub>	PtSn <sub>4</sub>	Aba2	C <sup>17</sup> <sub>2v</sub>	oC20	Q
D1 <sub>e</sub>	B <sub>4</sub> Th	P4/mbm	D <sup>5</sup> <sub>4h</sub>	tP20	T
D1 <sub>f</sub>	BMn <sub>4</sub>	Fddd	D <sup>24</sup> <sub>2h</sub>	oF40	S
D2 <sub>1</sub>	B <sub>6</sub> Ca	Pm3m	O <sup>1</sup> <sub>h</sub>	cP7	C
D2 <sub>3</sub>	NaZn <sub>13</sub>	Fm3m	O <sup>5</sup> <sub>h</sub>	cF112	F
D2 <sub>b</sub>	Mn <sub>12</sub> Th	I4/mmm	D <sup>17</sup> <sub>4h</sub>	tI26	U
D2 <sub>c</sub>	MnU <sub>6</sub>	I4/mcm	D <sup>18</sup> <sub>4h</sub>	tI28	U
D2 <sub>d</sub>	CaCu <sub>3</sub>	P6/mmm	D <sup>1</sup> <sub>6h</sub>	hP6	H
D2 <sub>f</sub>	B <sub>12</sub> U	Fm3m	O <sup>5</sup> <sub>h</sub>	cF52	F
D2 <sub>h</sub>	Al <sub>6</sub> Mn	Cmcm	D <sup>17</sup> <sub>2h</sub>	oC28	Q
D5 <sub>1</sub>	$\alpha$ -Al <sub>2</sub> O <sub>3</sub>	R3c	D <sup>6</sup> <sub>3d</sub>	hR10	R
D5 <sub>2</sub>	La <sub>2</sub> O <sub>3</sub>	P $\bar{3}m1$	D <sup>3</sup> <sub>3d</sub>	hP5	H
D5 <sub>3</sub>	Mn <sub>2</sub> O <sub>3</sub>	Ia3	T <sup>7</sup> <sub>h</sub>	oI80	B
D5 <sub>8</sub>	S <sub>3</sub> Sb <sub>2</sub>	Pnma	D <sup>16</sup> <sub>2h</sub>	oP20	O
D5 <sub>9</sub>	P <sub>2</sub> Zn <sub>3</sub>	P4 <sub>2</sub> /mmc	D <sup>9</sup> <sub>4h</sub>	tP40	T
D5 <sub>10</sub>	C <sub>2</sub> C <sub>3</sub>	Pnma	D <sup>16</sup> <sub>2h</sub>	oP20	O
D5 <sub>13</sub>	Al <sub>3</sub> Ni <sub>2</sub>	P $\bar{3}m1$	D <sup>3</sup> <sub>3d</sub>	hP5	H
D5 <sub>a</sub>	Si <sub>2</sub> U <sub>3</sub>	P4/mbm	D <sup>5</sup> <sub>4h</sub>	tP10	T
D5 <sub>c</sub>	C <sub>3</sub> Pu <sub>2</sub>	I $\bar{4}3d$	T <sup>6</sup> <sub>d</sub>	oI40	B

TABLE 5. Classification of Crystals

Strukturbericht symbol	Structure name	Symmetry group		Pearson symbol <sup>a</sup>	Standard ASTM E157-82a symbol <sup>b</sup>
		International	Schoenflies		
		3	4		
1	2			5	6
D7 <sub>1</sub>	Al <sub>2</sub> C <sub>3</sub>	R $\bar{3}$ m	D <sup>5</sup> <sub>3d</sub>	hR7	R
D7 <sub>3</sub>	P <sub>4</sub> Th <sub>3</sub>	I $\bar{4}$ 3d	T <sup>6</sup> <sub>d</sub>	cI28	B
D7 <sub>b</sub>	B <sub>4</sub> Ta <sub>3</sub>	Immm	D <sup>25</sup> <sub>2h</sub>	oI14	P
D8 <sub>1</sub>	Fe <sub>3</sub> Zn <sub>10</sub>	Im3m	O <sup>9</sup> <sub>h</sub>	cI52	B
D8 <sub>2</sub>	Cu <sub>3</sub> Zn <sub>8</sub>	I $\bar{4}$ 3m	T <sup>3</sup> <sub>d</sub>	cI52	B
D8 <sub>3</sub>	Al <sub>4</sub> Cu <sub>3</sub>	P43m	T <sup>1</sup> <sub>d</sub>	cP52	C
D8 <sub>4</sub>	C <sub>6</sub> Cr <sub>23</sub>	Fm3m	O <sup>5</sup> <sub>h</sub>	cF116	F
D8 <sub>5</sub>	Fe <sub>7</sub> W <sub>6</sub>	R $\bar{3}$ m	D <sup>5</sup> <sub>3d</sub>	hR13	R
D8 <sub>6</sub>	Cu <sub>15</sub> Si <sub>4</sub>	I $\bar{4}$ 3m	T <sup>3</sup> <sub>d</sub>	cI76	B
D8 <sub>8</sub>	Mn <sub>5</sub> Si <sub>3</sub>	P6 <sub>3</sub> /mcm	D <sup>3</sup> <sub>6h</sub>	hP16	H
D8 <sub>9</sub>	Co <sub>9</sub> S <sub>8</sub>	Fm3m	O <sup>5</sup> <sub>h</sub>	cF68	F
D8 <sub>10</sub>	Al <sub>3</sub> Cr <sub>5</sub>	R3m	C <sup>5</sup> <sub>3v</sub>	hR26	R
D8 <sub>11</sub>	Al <sub>5</sub> Co <sub>2</sub>	P6 <sub>3</sub> /mcm	D <sup>3</sup> <sub>6h</sub>	hP28	H
D8 <sub>a</sub>	Mn <sub>23</sub> Th <sub>6</sub>	Fm3m	O <sup>5</sup> <sub>h</sub>	cF116	F
D8 <sub>b</sub>	$\sigma$ -phase of Cr-Fe	p $\bar{4}$ <sub>2</sub> /mnm	D <sup>14</sup> <sub>4h</sub>	tP30	T
D8 <sub>e</sub>	(Al,Zn) <sub>49</sub> Mg <sub>32</sub>	Im3	T <sup>5</sup> <sub>h</sub>	cI162	B
D8 <sub>f</sub>	Ge <sub>7</sub> Ir <sub>3</sub>	Im3m	O <sup>9</sup> <sub>h</sub>	cI40	B
D8 <sub>h</sub>	B <sub>5</sub> W <sub>2</sub>	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP14	H
D8 <sub>i</sub>	B <sub>5</sub> Mo <sub>2</sub>	R $\bar{3}$ m	D <sup>5</sup> <sub>3d</sub>	hR7	R
D8 <sub>j</sub>	B <sub>3</sub> Cr <sub>5</sub>	I4/mcm	D <sup>18</sup> <sub>4h</sub>	tI32	U
D8 <sub>m</sub>	Si <sub>3</sub> W <sub>5</sub>	I4/mcm	D <sup>18</sup> <sub>4h</sub>	tI32	U
D10 <sub>1</sub>	C <sub>3</sub> Cr <sub>7</sub>	P31c	C <sup>4</sup> <sub>3v</sub>	hP80	H
D10 <sub>2</sub>	Fe <sub>3</sub> Th <sub>7</sub>	P6 <sub>3</sub> mc	C <sup>4</sup> <sub>6v</sub>	hP20	H
E0 <sub>1</sub>	ClFPb	P4/nmm	D <sup>7</sup> <sub>4h</sub>	tP6	T
E1 <sub>1</sub>	CuFeS <sub>2</sub>	I $\bar{4}$ 2d	D <sup>12</sup> <sub>2d</sub>	tI16	U
E2 <sub>1</sub>	CaO <sub>3</sub> Ti	Pm3m	O <sup>1</sup> <sub>h</sub>	cP5	C
E2 <sub>4</sub>	S <sub>3</sub> Sn <sub>2</sub>	Pnma	D <sup>16</sup> <sub>2h</sub>	oP20	O
E3	Al <sub>2</sub> CdS <sub>4</sub>	I $\bar{4}$	S <sup>2</sup> <sub>4</sub>	tI14	U
E9 <sub>3</sub>	SiFe <sub>3</sub> W <sub>3</sub>	Fd3m	O <sup>7</sup> <sub>h</sub>	cF112	F
E9 <sub>a</sub>	Al <sub>7</sub> Cu <sub>2</sub> Fe	P4/mnc	D <sup>6</sup> <sub>4h</sub>	tP40	T
E9 <sub>b</sub>	AlLi <sub>3</sub> N <sub>2</sub>	Ia3	T <sup>7</sup> <sub>h</sub>	cI96	B
F0 <sub>1</sub>	NiSSb	P2 <sub>1</sub> 3	T <sup>4</sup>	cP12	C
F5 <sub>1</sub>	CrNaS <sub>2</sub>	R3m or R32	D <sup>5</sup> <sub>3d</sub> or D <sup>7</sup> <sub>3</sub>	hR4	R
F5 <sub>6</sub>	Cu <sub>2</sub> Sb	Pnma	D <sup>16</sup> <sub>2h</sub>	oP16	O
H1 <sub>1</sub>	Al <sub>2</sub> MgO <sub>4</sub>	Fd3m	O <sup>7</sup> <sub>h</sub>	cF56	F
H2 <sub>4</sub>	Cu <sub>3</sub> S <sub>4</sub> V	P43m	T <sup>1</sup> <sub>d</sub>	cP8	C
H2 <sub>5</sub>	AsCu <sub>3</sub> S <sub>4</sub>	Pmn2 <sub>1</sub>	C <sup>7</sup> <sub>2v</sub>	oP16	O
L1 <sub>0</sub>	AuCu	P4/mmm	D <sup>1</sup> <sub>4h</sub>	tP4	T
L1 <sub>2</sub>	AlCu <sub>3</sub>	Pm3m	O <sup>1</sup> <sub>h</sub>	cP4	C
L2 <sub>1</sub>	AlCu <sub>2</sub> Mn	Fm3m	O <sup>5</sup> <sub>h</sub>	cF16	F
L2 <sub>2</sub>	Sb <sub>2</sub> Tl <sub>7</sub>	Im3m	O <sup>9</sup> <sub>h</sub>	cI54	B
L/2 <sub>b</sub>	H <sub>2</sub> Th	I4/mmm	D <sup>17</sup> <sub>4h</sub>	tI6	U
L/3	Fe <sub>2</sub> N	P6 <sub>3</sub> /mmc	D <sup>4</sup> <sub>6h</sub>	hP3	H
L6 <sub>0</sub>	CuTi <sub>3</sub>	P4/mmm	D <sup>1</sup> <sub>4h</sub>	tP4	T

<sup>a</sup> The first letter denotes the crystal system: triclinic (a), monoclinic (m), orthorhombic (o), tetragonal (t), hexagonal (h) and cubic (c). Trigonal (rhombohedral) system is denoted by combination hR. The second letter of Pearson's symbol denotes lattice type: primitive (P), edge-(base-) centered (C), body-centered (I) or face-centered (F). The following number denotes number of atoms in the crystal unit cell.

<sup>b</sup> Standard ASTM E157-82a has the Bravais lattices designations as following: C – primitive cubic; B – body-centered cubic; F – face-centered cubic; T – primitive tetragonal; U – body-centered tetragonal; R – rhombohedral; H – hexagonal; O – primitive orthorhombic; P – body-centered orthorhombic; Q – base-centered orthorhombic; S – face-centered orthorhombic; M – primitive monoclinic; N – centered monoclinic; A – triclinic.

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## IONIC RADII IN CRYSTALS

Ionic radii are a useful tool for predicting and visualizing crystal structures. This table lists a set of ionic radii  $R_i$  in Å units for the most common coordination numbers  $CN$  of positive and negative ions. The values are based on experimental crystal structure determinations, supplemented by empirical relationships, and theoretical calculations. The notation sq after the coordination number indicates a square configuration, while py indicates pyramidal.

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Ion	CN	$R_i/\text{Å}$	Ion	CN	$R_i/\text{Å}$	Ion	CN	$R_i/\text{Å}$
<b>Anions</b>								
F <sup>-1</sup>	6	1.33		8	1.12	Eu <sup>+3</sup>	6	0.95
Cl <sup>-1</sup>	6	1.81		10	1.23		8	1.07
Br <sup>-1</sup>	6	1.96		12	1.34	F <sup>+7</sup>	6	0.08
I <sup>-1</sup>	6	2.20	Cd <sup>+2</sup>	4	0.78	Fe <sup>+2</sup>	4	0.63
OH <sup>-1</sup>	4	1.35		6	0.95		6	0.61
	6	1.37		8	1.10		8	0.92
O <sup>-2</sup>	2	1.21		12	1.31	Fe <sup>+3</sup>	4	0.49
	6	1.40	Ce <sup>+3</sup>	6	1.01		6	0.55
	8	1.42		8	1.14		8	0.78
S <sup>-2</sup>	6	1.84		10	1.25	Fr <sup>+1</sup>	6	1.80
Se <sup>-2</sup>	6	1.98	Ce <sup>+4</sup>	6	0.87	Ga <sup>+3</sup>	4	0.47
Te <sup>-2</sup>	6	2.21		8	0.97		6	0.62
<b>Cations</b>				10	1.07	Gd <sup>+3</sup>	6	0.94
Ac <sup>+3</sup>	6	1.12		12	1.14		8	1.05
Ag <sup>+1</sup>	4	1.00	Cf <sup>+3</sup>	6	0.95	Ge <sup>+2</sup>	6	0.73
	6	1.15	Cf <sup>+4</sup>	6	0.82	Ge <sup>+4</sup>	4	0.39
	8	1.28		8	0.92		6	0.53
Ag <sup>+2</sup>	4sq	0.79	Cl <sup>+5</sup>	3py	0.12	Hf <sup>+4</sup>	4	0.58
	6	0.94		8	0.92		6	0.71
Al <sup>+3</sup>	4	0.39	Cl <sup>+7</sup>	4	0.08		8	0.83
	5	0.48	Cm <sup>+3</sup>	6	0.97	Hg <sup>+1</sup>	6	1.19
	6	0.54	Cm <sup>+4</sup>	6	0.85	Hg <sup>+2</sup>	2	0.69
Am <sup>+3</sup>	6	0.98		8	0.95		4	0.96
	8	1.09	Co <sup>+2</sup>	4	0.56		6	1.02
Am <sup>+4</sup>	6	0.85		6	0.65		8	1.14
	8	0.95		8	0.90	I <sup>+5</sup>	3py	0.44
As <sup>+3</sup>	6	0.58	Co <sup>+3</sup>	6	0.55		6	0.95
As <sup>+5</sup>	4	0.34	Cr <sup>+2</sup>	6	0.73	I <sup>+7</sup>	4	0.42
	6	0.46	Cr <sup>+3</sup>	6	0.62		6	0.53
Au <sup>+1</sup>	6	1.37	Cr <sup>+4</sup>	4	0.41	In <sup>+3</sup>	4	0.62
Au <sup>+3</sup>	4sq	0.64		6	0.55		6	0.80
	6	0.85	Cr <sup>+6</sup>	4	0.26	Ir <sup>+3</sup>	6	0.68
Ba <sup>+2</sup>	6	1.35		6	0.44	Ir <sup>+4</sup>	6	0.63
	8	1.42	Cs <sup>+1</sup>	6	1.67	Ir <sup>+5</sup>	6	0.57
	12	1.61		8	1.74	K <sup>+1</sup>	4	1.37
Be <sup>+2</sup>	4	0.27		10	1.81		6	1.38
	6	0.45		12	1.88		8	1.51
Bi <sup>+3</sup>	5	0.96	Cu <sup>+1</sup>	2	0.46		12	1.64
	6	1.03		4	0.60	La <sup>+3</sup>	6	1.03
	8	1.17		6	0.77		8	1.16
Bi <sup>+5</sup>	6	0.76	Cu <sup>+2</sup>	4sq	0.57		10	1.27
Bk <sup>+3</sup>	6	0.96		6	0.73		12	1.36
Bk <sup>+4</sup>	6	0.83	Dy <sup>+2</sup>	6	1.07	Li <sup>+1</sup>	4	0.59
	8	0.93		8	1.19		6	0.76
Br <sup>+5</sup>	3py	0.31	Dy <sup>+3</sup>	6	0.91		8	0.92
Br <sup>+7</sup>	4	0.25		8	1.03	Lu <sup>+3</sup>	6	0.86
	6	0.39	Er <sup>+3</sup>	6	0.89		8	0.97
C <sup>+4</sup>	4	0.15		8	1.00	Mg <sup>+2</sup>	4	0.57
	6	0.16	Eu <sup>+2</sup>	6	1.17		6	0.72
Ca <sup>+2</sup>	6	1.00		8	1.25		8	0.89
				10	1.35	Mn <sup>+2</sup>	4	0.66

Ion	CN	$R_i/\text{\AA}$	Ion	CN	$R_i/\text{\AA}$	Ion	CN	$R_i/\text{\AA}$
	6	0.83	Pr <sup>+3</sup>	6	0.99	Tc <sup>+4</sup>	6	0.65
	8	0.96		8	1.13	Te <sup>+4</sup>	4	0.66
Mn <sup>+3</sup>	6	0.58	Pr <sup>+4</sup>	6	0.85		6	0.97
Mn <sup>+4</sup>	4	0.39		8	0.96	Te <sup>+6</sup>	4	0.43
	6	0.53	Pt <sup>+2</sup>	4sq	0.60		6	0.56
Mn <sup>+5</sup>	4	0.33		6	0.80	Th <sup>+4</sup>	6	0.94
Mn <sup>+6</sup>	4	0.26	Pt <sup>+4</sup>	6	0.63		8	1.05
Mn <sup>+7</sup>	4	0.25	Pu <sup>+3</sup>	6	1.00		10	1.13
Mo <sup>+3</sup>	6	0.69	Pu <sup>+4</sup>	6	0.86		12	1.21
Mo <sup>+4</sup>	6	0.65	Pu <sup>+5</sup>	6	0.74	Ti <sup>+2</sup>	6	0.86
Mo <sup>+5</sup>	4	0.46	Pu <sup>+6</sup>	6	0.71	Ti <sup>+3</sup>	6	0.67
	6	0.61	Ra <sup>+2</sup>	8	1.48	Ti <sup>+4</sup>	4	0.42
Mo <sup>+6</sup>	4	0.41		12	1.70		6	0.61
	6	0.59	Rb <sup>+1</sup>	6	1.52		8	0.74
	7	0.73		8	1.61	Tl <sup>+1</sup>	6	1.50
N <sup>+3</sup>	6	0.16		10	1.66		8	1.59
N <sup>+5</sup>	6	0.13		12	1.72		12	1.70
Na <sup>+1</sup>	4	0.99	Re <sup>+4</sup>	6	0.63	Tl <sup>+3</sup>	4	0.75
	6	1.02	Re <sup>+5</sup>	6	0.58		6	0.89
	8	1.18	Re <sup>+6</sup>	6	0.55		8	0.98
	9	1.24	Re <sup>+7</sup>	4	0.38	Tm <sup>+2</sup>	6	1.01
	12	1.39		6	0.53		7	1.09
Nb <sup>+3</sup>	6	0.72	Rh <sup>+3</sup>	6	0.67	Tm <sup>+3</sup>	6	0.88
	8	0.79	Rh <sup>+4</sup>	6	0.60		8	0.99
Nb <sup>+4</sup>	6	0.68	Rh <sup>+5</sup>	6	0.55	U <sup>+3</sup>	6	1.03
Nb <sup>+5</sup>	4	0.48	Ru <sup>+3</sup>	6	0.68	U <sup>+4</sup>	6	0.89
	6	0.64	Ru <sup>+4</sup>	6	0.62		8	1.00
	8	0.74	Ru <sup>+5</sup>	6	0.57		12	1.17
Nd <sup>+3</sup>	6	0.98	Ru <sup>+7</sup>	4	0.38	U <sup>+5</sup>	6	0.76
	8	1.12	Ru <sup>+8</sup>	4	0.36	U <sup>+6</sup>	2	0.45
	9	1.16	S <sup>+4</sup>	6	0.37		4	0.52
	12	1.27	S <sup>+6</sup>	4	0.12		6	0.73
Ni <sup>+2</sup>	4sq	0.49		6	0.29		8	0.86
	6	0.69	Sb <sup>+3</sup>	4py	0.76	V <sup>+2</sup>	6	0.79
Ni <sup>+3</sup>	6	0.56		6	0.76	V <sup>+3</sup>	6	0.64
Np <sup>+3</sup>	6	1.01	Sb <sup>+5</sup>	6	0.60	V <sup>+4</sup>	5	0.53
Np <sup>+4</sup>	6	0.87	Sc <sup>+3</sup>	6	0.75		6	0.58
Np <sup>+5</sup>	6	0.75		8	0.87		8	0.72
Np <sup>+6</sup>	6	0.72	Se <sup>+4</sup>	6	0.50	V <sup>+5</sup>	4	0.36
Os <sup>+4</sup>	6	0.63	Se <sup>+6</sup>	4	0.28		5	0.46
Os <sup>+5</sup>	6	0.58		6	0.42		6	0.54
Os <sup>+6</sup>	6	0.55	Si <sup>+4</sup>	4	0.26	W <sup>+4</sup>	6	0.66
Os <sup>+8</sup>	4	0.39		6	0.40	W <sup>+5</sup>	6	0.62
P <sup>+5</sup>	4	0.17	Sm <sup>+2</sup>	6	1.19	W <sup>+6</sup>	4	0.42
	6	0.38		8	1.27		5	0.51
Pa <sup>+3</sup>	6	1.04	Sm <sup>+3</sup>	6	0.96		6	0.60
Pa <sup>+4</sup>	6	0.90		8	1.08	Y <sup>+3</sup>	6	0.90
Pa <sup>+5</sup>	6	0.78		12	1.24		8	1.02
Pb <sup>+2</sup>	6	1.19	Sn <sup>+4</sup>	4	0.55		9	1.08
	8	1.29		6	0.69	Yb <sup>+2</sup>	6	1.02
	10	1.40		8	0.81		8	1.14
	12	1.49	Sr <sup>+2</sup>	6	1.18	Yb <sup>+3</sup>	8	0.99
Pb <sup>+4</sup>	4	0.65		8	1.26		9	1.04
	6	0.78		10	1.36	Zn <sup>+2</sup>	4	0.60
	8	0.94		12	1.44		6	0.74
Pd <sup>+2</sup>	4sq	0.64	Ta <sup>+3</sup>	6	0.72		8	0.90
	6	0.86	Ta <sup>+4</sup>	6	0.68	Zr <sup>+4</sup>	4	0.59
Pd <sup>+3</sup>	6	0.76	Ta <sup>+5</sup>	6	0.64		6	0.72
Pd <sup>+4</sup>	6	0.62	Tb <sup>+3</sup>	6	0.92		8	0.84
Pm <sup>+3</sup>	6	0.97		8	1.04		9	0.89
	8	1.09	Tb <sup>+4</sup>	6	0.76			
Po <sup>+4</sup>	6	0.97		8	0.88			

# POLARIZABILITIES OF ATOMS AND IONS IN SOLIDS

H. P. R. Frederikse

The polarization of a solid dielectric medium,  $\mathbf{P}$ , is defined as the dipole moment per unit volume averaged over the volume of a crystal cell. A component of  $\mathbf{P}$  can be expanded as a function of the electric field  $\mathbf{E}$ :

$$P_i = \sum_j a_j E_j + \sum_{jk} b_{jk} E_j E_k$$

For relatively small electric fields in isotropic substances  $\mathbf{P} = \chi_e \mathbf{E}$ , where  $\chi_e$  is the electric susceptibility. If the medium is made up of  $N$  atoms (or ions) per unit volume, the polarization is  $\mathbf{P} = N \mathbf{p}_m$  where  $\mathbf{p}_m$  is the average dipole moment per atom. The polarizability  $\alpha$  can be defined as  $\mathbf{p}_m = \alpha \mathbf{E}_0$ , where  $\mathbf{E}_0$  is the local field at the position of the atom. Using the Lorentz method to calculate the local field one finds:

$$\mathbf{P} = N\alpha(\mathbf{E} + 4\pi\mathbf{P}) = \chi_e \mathbf{E}$$

Together with the definition of the dielectric constant (relative permittivity),  $\epsilon = 1 + 4\pi\chi_e$ , this leads to:

$$\alpha = \frac{3}{4\pi N} \left( \frac{\epsilon - 1}{\epsilon + 2} \right)$$

This expression is known as the Clausius-Mossotti equation.

The total polarization associated with atoms, ions, or molecules is due to three different sources:

1. Electronic polarization arises because the center of the local electronic charge cloud around the nucleus is displaced under the action of the field:  $\mathbf{P}_e = N\alpha_e \mathbf{E}_0$  where  $\alpha_e$  is the *electronic polarizability*.

2. Ionic polarization occurs in ionic materials because the electric field displaces cations and anions in opposite directions:  $\mathbf{P}_i = N\alpha_i \mathbf{E}_0$ , where  $\alpha_i$  is the *ionic polarizability*.
3. Orientational polarization can occur in substances composed of molecules that have permanent electric dipoles. The alignment of these dipoles depends on temperature and leads to an *orientational polarizability* per molecule:  $\alpha_{or} = p^2/3kT$ , where  $p$  is the permanent dipole moment per molecule,  $k$  is the Boltzmann constant, and  $T$  is the temperature.

Because of the different nature of these three polarization processes the response of a dielectric solid to an applied electric field will strongly depend on the frequency of the field. The resonance of the electronic excitation in insulators (dielectrics) takes place in the ultraviolet part of the spectrum; the characteristic frequency of the lattice vibrations is located in the infrared, while the orientation of dipoles requires fields of much lower frequencies (below  $10^{10}$  Hz). This response to electric fields of different frequencies is shown in Figure 1. Values of the electronic polarizabilities for selected atoms and ions are given in Table 1.

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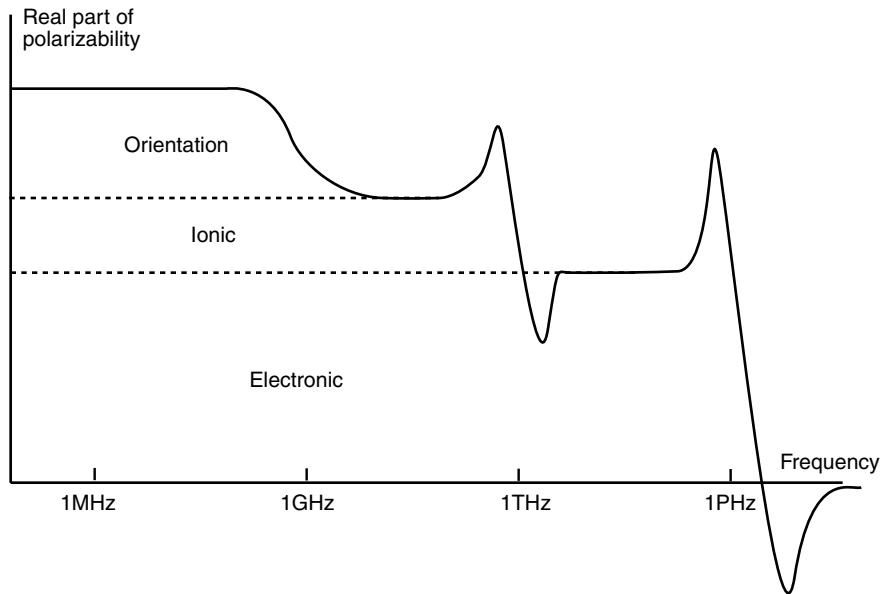


FIGURE 1. Schematic graph of the frequency dependence of the different contributions to polarizability.

TABLE 1. Electronic Polarizabilities in Units of  $10^{-24} \text{ cm}^3$ 

						He 0.201
<b>Li<sup>+</sup></b> 0.029	<b>Be<sup>2+</sup></b> 0.008	<b>B<sup>3+</sup></b> 0.003	<b>C<sup>4+</sup></b> 0.0013	<b>O<sup>2-</sup></b> 3.88	<b>F<sup>-</sup></b> 1.04	<b>Ne</b> 0.39
<b>Na<sup>+</sup></b> 0.179	<b>Mg<sup>2+</sup></b> 0.094	<b>Al<sup>3+</sup></b> 0.052	<b>Si<sup>4+</sup></b> 0.0165	<b>S<sup>2-</sup></b> 10.2	<b>Cl<sup>-</sup></b> 3.66	<b>Ar</b> 1.62
<b>K<sup>+</sup></b> 0.83	<b>Ca<sup>2+</sup></b> 0.47	<b>Sc<sup>3+</sup></b> 0.286	<b>Ti<sup>4+</sup></b> 0.185	<b>Se<sup>2-</sup></b> 10.5	<b>Br<sup>-</sup></b> 4.77	<b>Kr</b> 2.46
<b>Rb<sup>+</sup></b> 1.40	<b>Sr<sup>2+</sup></b> 0.86	<b>Y<sup>3+</sup></b> 0.55	<b>Zr<sup>4+</sup></b> 0.37	<b>Te<sup>2-</sup></b> 14.0	<b>I<sup>-</sup></b> 7.1	<b>Xe</b> 3.99
<b>Cs<sup>+</sup></b> 2.42	<b>Ba<sup>2+</sup></b> 1.55	<b>La<sup>3+</sup></b> 1.04	<b>Ce<sup>4+</sup></b> 0.73			

Data from Pauling, L., *Proc. R. Soc. London*, A114, 181, 1927. See also Jaswal, S.S. and Sharma, T.P., *J. Phys. Chem. Solids*, 34, 509, 1973. Values are appropriate for cgs units. To convert to SI, use the relation  $\alpha(\text{SI})/\text{C m}^2\text{V}^{-1} = 1.11265 \cdot 10^{-16} \alpha(\text{cgs})/\text{cm}^3$

# CRYSTAL STRUCTURES AND LATTICE PARAMETERS OF ALLOTROPES OF THE ELEMENTS

H. W. King

The crystal structures of the allotropic forms of the elements are presented in terms of the Pearson symbol, the Strukturbericht designation, and the prototype of the structure. The temperatures of the phase transformations are listed in degrees Celsius and the pressures are in GPa. A consistent nomenclature is used, whereby all allotropes are labeled by Greek letters. The lattice parameters of the units cells are given in nanometers (nm) and are considered to be accurate to  $\pm 2$  in the last reported digit.

This compilation is restricted to changes in crystal structures that occur as a result of a change in temperature or pressure. Low-

temperature structures are included for the diatomic and rare gases, which show many similarities with respect to the metallic elements. The elements identified with an asterisk (\*) have polymorphic structures based on different molecular configurations. The crystal data given for these elements refer to the most stable structure at room temperature.

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Element	Temperature, °C	Pressure, GPa	Pearson symbol	Space group	Struktur- bericht designation	Prototype	Lattice parameters, nm			Comment, c/a or α or β
							a	b	c	
Ac	25	atm	cF4	Fm3m	A1	Cu	0.5311	...	...	...
Ag	25	atm	cF4	Fm3m	A1	Cu	0.40857	...	...	...
αAl	25	atm	cF4	Fm3m	A1	Cu	0.40496	...	...	...
βAl	25	>20.5	hP2	P6 <sub>3</sub> /mmc	A3	Mg	0.2693	...	0.4398	1.6331
α'Am	25	atm	hP4	P6 <sub>3</sub> /mmc	A3'	αLa	0.34681	...	1.1241	2*1.621
αAm	>769	atm	cF4	Fm3m	A1	Cu	0.4894	...	...	...
βAm	>1074	atm	cI2	Im3m	A2	W	?	...	...	...
γAm	25	>15	oC4	Cmcm	A20	αU	0.3063	0.5968	0.5169	...
αAr	<-189.35	atm	cF4	Fm3m	A1	Cu	0.5316	...	...	...
(βAr)	<-189.40	atm	hP2	P6 <sub>3</sub> /mmc	A3	Mg	0.3760	...	0.6141	1.633
αAs	25	atm	hR2	R3m	A7	αAs	0.41319	...	.....	α = 54.12°
eAs	>448	atm	oC8	Cmca	...	P(black)	0.362	1.085	0.448	...
Au	25	atm	cF4	Fm3m	A1	Cu	0.40782	...	...	...
βB	25	atm	hR105	R3m	...	βB	1.017	...	...	α = 65.12°
αBa	25	atm	cI2	Im3m	A2	W	0.50227	...	...	...
βBa	25	>5.33	hP2	P6 <sub>3</sub> /mmc	A3	Mg	0.3901	...	0.6154	1.5775
γBa	25	>23	?	?	...	...	...	...	...	...
αBe	25	atm	hP2	P6 <sub>3</sub> /mmc	A3	Mg	0.22859	...	0.35845	1.5681
βBe	>1270	atm	cI2	Im3m	A2	W	0.25515	...	...	...
γBe	25	>9.3	?	...	...	...	...	...	...	...
αBi	25	atm	hR2	r3m	A7	αAs	0.47460	...	...	α = 57.23°
βBi	25	>2.6	mC4	C2/m	...	βBi	0.6674	0.6117	0.3304	β = 110.33°
γBi	25	>3.0	mP3	?	...	...	0.605	0.42	0.465	β = 85.33°
σBi	25	>4.3	?	?	...	...	...	...	...	...
eBi	25	>6.5	?	?	...	...	...	...	...	...
ζBi	25	>9.0	cI2	Im3m	A2	W	0.3800	...	...	...
αBk	25	atm	hP4	P6 <sub>3</sub> /mmc	A3'	αLa	0.3416	...	1.1069	2*1.620
βBk	>977	atm	cF4	Fm3m	A1	Cu	0.4997	...	...	...
Br	<7.25	atm	oC8	Cmca	...	Cl	0.668	0.449	0.874	...
C (graphite)	25	atm	hP4	P6 <sub>3</sub> /mmc	A9	C (graphite)	0.24612	...	0.6709	2.7258
C (diamond)	25	>60	cF8	Fd3m	A4	C (diamond)	0.35669	...	...	...
C (hd)	25	HP	hP4	P6 <sub>3</sub> /mmc	...	C (hd)	0.2522	...	0.4119	1.633
αCa	25	atm	cF4	Fm3m	A1	Cu	0.55884	...	...	...
βCa	>443	atm	cI2	Im3m	A2	W	0.4480	...	...	...
γCa	25	>1.5	?	...	...	...	...	...	...	...
Cd	25	atm	hP2	P6 <sub>3</sub> /mmc	A3	Mg	0.29793	...	0.56196	1.8862
αCe	<-177	atm	cF4	Fm3m	A1	Cu	0.485	...	...	...
βCe	25	atm	hP4	P6 <sub>3</sub> /mmc	A3'	αLa	0.36810	...	1.1857	2*1.611
γCe	25	atm	cF4	Fm3m	A1	Cu	0.51610	...	...	...
δ-Ce	>726	atm	cI2	Im3m	A2	W	0.412	...	...	...
α'Ce	25	>5.4	oC4	Cmcm	A20	αU	0.3049	0.5998	0.5215	...

Element	Temperature, °C	Pressure, GPa	Pearson symbol	Space group	Strukturbericht designation	Prototype	Lattice parameters, nm			Comment, $c/a$ or $\alpha$ or $\beta$
							<i>a</i>	<i>b</i>	<i>c</i>	
$\alpha$ Cf	25	atm	<i>hP4</i>	$P6_3/mmc$	A3'	$\alpha$ La	0.339	...	1.1015	2*1.625
$\beta$ Cf	>590	atm	<i>cF4</i>	$Fm3m$	A1	Cu	?	...	...	...
Cl	<-102	atm	<i>oC8</i>	$Cmca$	...	Cl	0.624	0.448	0.826	...
$\alpha$ Cm	25	atm	<i>hP4</i>	$P6_3/mmc$	A3'	$\alpha$ La	0.3496	...	1.1331	2*1.621
$\beta$ Cm	>1277	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.4382	...	...	...
$\epsilon$ Co	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.25071	...	0.40686	1.6228
$\alpha$ Co	>422	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.35447	...	...	...
$\alpha$ Cr	25	atm	<i>cI2</i>	$Im3m$	A2	W	0.28848	...	...	...
$\alpha'$ Cr	25	HP	<i>tI2</i>	$I4/mmm$	...	$\alpha'$ Cr	0.2882	...	0.2887	1.002
$\alpha$ Cs	25	atm	<i>cI2</i>	$Im3m$	A2	W	0.6141	...	...	...
$\beta$ Cs	25	>2.37	<i>cF4</i>	$Fm3m$	A1	Cu	0.6465	...	...	...
$\beta'$ Cs	25	>4.22	<i>cF4</i>	$Fm3m$	A1	Cu	0.5800	...	...	...
$\gamma$ Cs	25	>4.27	?	...	...	...	...	...	...	...
Cu	25	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.36146	...	...	...
$\alpha'$ Dy	<-187	atm	<i>oC4</i>	$Cmcm$	...	$\alpha'$ Dy	0.3595	0.6184	0.5678	...
$\alpha$ Dy	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.35915	...	0.56501	1.5732
$\beta$ Dy	>1381	atm	<i>cI2</i>	$Im3m$	A2	W	0.403	...	...	...
$\gamma$ Dy	25	>7.5	<i>hR3</i>	$R\bar{3}m$	...	$\alpha$ Sm	0.3436	...	2.483	4.5*1.606
Er	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.35592	...	0.55850	1.5692
$\alpha$ Es	25	atm	<i>hP4</i>	$P6_3/mmc$	A3'	$\alpha$ La	?	...	...	...
$\beta$ Es	?	atm	<i>cF4</i>	$Fm3m$	A1	Cu	?	...	...	...
Eu	25	atm	<i>cI2</i>	$Im3m$	A2	W	0.45827	...	...	...
$\alpha$ F	<-227.6	atm	<i>mC8</i>	$C2/c$	...	$\alpha$ F	0.550	0.338	0.728	$\beta = 102.17^\circ$
$\beta$ F	<-219.67	atm	<i>cP16</i>	$Pm3n$	...	$\gamma$ O	0.667	...	...	...
$\alpha$ Fe	25	atm	<i>cI2</i>	$Im3m$	A2	W	0.28665	...	...	...
$\gamma$ Fe	>912	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.36467	...	...	...
$\sigma$ Fe	>1394	atm	<i>cI2</i>	$Im3m$	A2	W	0.29315	...	...	...
$\epsilon$ Fe	25	>13	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.2468	...	0.396	1.603
$\alpha$ Ga	25	atm	<i>oC8</i>	$Cmca$	A11	$\alpha$ Ga	0.45186	0.76570	0.45258	...
$\beta$ Ga	25	>1.2	<i>tI2</i>	$I4/mmm$	A6	In	0.2808	...	0.4458	1.588
$\gamma$ Ga	-53	>3.0	<i>oC40</i>	$Cmcm$	...	$\gamma$ Ga	1.0593	1.3523	0.5203	...
$\alpha$ Gd	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.36336	...	0.57810	0.5910
$\beta$ Gd	>1235	atm	<i>cI2</i>	$Im3m$	A2	W	0.406	...	...	...
$\gamma$ Gd	25	>3.0	<i>hR3</i>	$R3m$	...	$\alpha$ Sm	0.361	...	2.603	4*1.60
$\alpha$ Ge	25	atm	<i>cF8</i>	$Fd3m$	A4	C (diamond)	0.56574	...	...	...
$\beta$ Ge	25	>12	<i>tI4</i>	$I4/amd$	A5	$\beta$ Sn	0.4884	...	0.2692	0.551
$\gamma$ Ge	25	>12→atm	<i>tP12</i>	$P4_12_12$	...	$\sigma$ Ge	0.593	...	0.698	1.18
$\sigma$ Ge	LT	>12	<i>cI16</i>	$Im3m$	...	$\gamma$ Si	0.692	...	...	...
$\alpha$ H	<-271.9	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.5338	...	...	...
$\beta$ H	<-259.34	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.3776	...	0.6162	1.632
$\alpha$ He	<-268.94	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.3555	...	0.5798	1.631
$\beta$ He	>-258	0.125	<i>cF4</i>	$Fm3m$	A1	Cu	0.4240	...	...	...
$\gamma$ He	<-271.47	0.03	<i>cI2</i>	$Im3m$	A2	W	0.4110	...	...	...
$\alpha$ Hf	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.31946	...	0.50510	1.5811
$\beta$ Hf	>1995	atm	<i>cI2</i>	$Im3m$	A2	W	0.3610	...	...	...
$\alpha$ Hg	<-38.84	atm	<i>hR1</i>	$R\bar{3}m$	A10	$\alpha$ Hg	0.3005	...	...	$\alpha = 70.53^\circ$
$\beta$ Hg	<-194	HP	<i>tI2</i>	$I4/mmm$	...	$\beta$ Hg	0.3995	...	0.2825	0.707
$\gamma$ Hg	<-194	c.w.	<i>hR1</i>	?	...	...	...	...	...	...
$\alpha$ Ho	25	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.35778	...	0.56178	1.5702
$\beta$ Ho	25	>7.5	<i>hR3</i>	$R\bar{3}m$	...	$\alpha$ Sm	0.334	...	2.45	4.5*1.63
I	25	atm	<i>oC8</i>	$Cmca$	...	Cl	0.72697	0.47903	0.97942	...
In	25	atm	<i>tI2</i>	$I4/mmm$	A6	In	0.3253	...	0.49470	1.5210
Ir	25	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.38392	...	...	...
K	25	atm	<i>cI2</i>	$Im3m$	A2	W	0.5321	...	...	...
Kr	<-157.39	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.5810	...	...	...
$\alpha$ La	25	atm	<i>hP4</i>	$P6_3/mmc$	A3'	$\alpha$ La	0.37740	...	1.2171	2*1.6125
$\beta$ La	>310	atm	<i>cF4</i>	$Fm3m$	A1	Cu	0.5303	...	...	...
$\gamma$ La	>865	atm	<i>cI2</i>	$Im3m$	A2	W	0.426	...	...	...
$\beta'$ La	25	>2.0	<i>cF4</i>	$Fm3m$	A1	Cu	0.517	...	...	...
$\alpha$ Li	<-193	atm	<i>hP2</i>	$P6_3/mmc$	A3	Mg	0.3111	...	0.5093	1.637

Element	Temperature, °C	Pressure, GPa	Pearson symbol	Space group	Strukturbericht designation	Prototype	Lattice parameters, nm			Comment, c/a or α or β
							a	b	c	
βLi	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.35093	...	...	...
γLi	<-201	c.w.	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.4388	...	...	...
Lu	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.35052	...	0.55494	1.5832
Mg	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.32094	...	0.52107	1.6236
αMn	25	atm	<i>cI58</i>	<i>I43m</i>	A12	αMn	0.89126	...	...	...
βMn	>710	atm	<i>cP20</i>	<i>P4<sub>1</sub>32</i>	A13	βMn	0.63152	...	...	...
γMn	>1079	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.3860	...	...	...
σMn	>1143	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.3080	...	...	...
Mo	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.31470	...	...	...
αN	<-237.6	atm	<i>cP8</i>	<i>Pa3</i>	...	αN	0.5661	...	...	...
βN	<-210.00	atm	<i>hP4</i>	<i>P6<sub>3</sub>/mmc</i>	...	βN	0.4050	...	0.6604	1.631
γN	<-253	>3.3	<i>tP4</i>	<i>P4<sub>2</sub>/mnm</i>	...	γN	0.3957	...	0.5109	1.291
αNa	<-233	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.3767	...	0.6154	1.634
βNa	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.42906	...	...	...
Nb	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.33004	...	...	...
αNd	25	atm	<i>hP4</i>	<i>P6<sub>3</sub>/mmc</i>	A3'	αLa	0.36582	...	1.17966	2*1.6124
βNd	>863	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.413	...	...	...
γNd	25	>5.0	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.480	...	...	...
Ne	<-243.59	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.4462	...	...	...
Ni	25	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.35240	...	...	...
αNp	25	atm	<i>oP8</i>	<i>Pnma</i>	A <sub>c</sub>	αNp	0.6663	0.4723	0.4887	...
βNp	>280	atm	<i>tP4</i>	<i>P4<sub>2</sub>12</i>	A <sub>d</sub>	βNp	0.4883	...	0.3389	0.694
γNp	>576	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.352	...	...	...
αO	<-243.3	atm	<i>mC4</i>	<i>C2m</i>	...	αO	0.5403	0.3429	0.5086	β = 132.53°
βO	<-229.6	atm	<i>hR2</i>	<i>R3m</i>	...	βO	0.4210	...	...	α = 46.27°
γO	<-218.79	atm	<i>cP16</i>	<i>Pm3n</i>	...	γO	0.683	...	...	...
Os	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.27341	...	0.43918	1.6063
P (black)	25	atm	<i>oC8</i>	<i>Cmca</i>	...	P (black)	0.33136	1.0478	0.43763	...
αPa	25	atm	<i>tI2</i>	<i>I4/mmm</i>	A <sub>a</sub>	αPa	0.3921	...	0.3235	0.825
βPa	>1170	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.381	...	...	...
αPb	25	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.49502	...	...	...
βPb	25	>10.3	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.3265	...	0.5387	1.650
Pd	25	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.38903	...	...	...
αPm	25	atm	<i>hP4</i>	<i>P6<sub>3</sub>/mmc</i>	A3'	αLa	0.365	...	1.165	2*1.60
βPm	>890	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	(0.410)	...	...	...
αPo	25	atm	<i>cP1</i>	<i>Pm3m</i>	A <sub>h</sub>	αPo	0.3366	...	...	...
βPo	>54	atm	<i>hR1</i>	<i>R3m</i>	...	βPo	0.3373	...	...	α = 98.08°
αPr	25	atm	<i>hP4</i>	<i>P6<sub>3</sub>/mmc</i>	A3'	αLa	0.36721	...	1.18326	2*1.6111
βPr	>795	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.413	...	...	...
γPr	25	>4.0	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.488	...	...	...
Pt	25	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.39236	...	...	...
αPu	25	atm	<i>mP16</i>	<i>P2<sub>1</sub>/m</i>	...	αPu	0.6183	0.4822	1.0963	β = 101.97°
βPu	>125	atm	<i>mI34</i>	<i>I2/m</i>	...	βPu	0.9284	1.0463	0.7859	β = 92.13°
γPu	>215	atm	<i>oF8</i>	<i>Fddd</i>	...	γPu	0.31587	0.57682	1.0162	...
σPu	>320	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.46371	...	...	...
σ'Pu	>463	atm	<i>tI2</i>	<i>I4/mmm</i>	A6	In	0.33261	...	0.44630	1.3418
ePu	>483	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.36343	...	...	...
Ra	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.5148	...	...	...
αRb	25	atm	<i>cI2</i>	<i>Im3m</i>	A2	W	0.5705	...	...	...
βRb	25	>1.08	?	...	...	...	...	...	...	...
γRb	25	>2.05	?	...	...	...	...	...	...	...
Re	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.27609	...	0.4458	1.6145
Rh	25	atm	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	0.38032	...	...	...
Ru	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.27058	...	0.42816	1.5824
αS	25	atm	<i>oF128</i>	<i>Fddd</i>	A16	αS	1.0464	1.28660	2.44860	...
αSb	25	atm	<i>hR2</i>	<i>R3m</i>	A7	αAs	0.45067	...	...	α = 57.11°
βSb	25	>5.0	<i>cP1</i>	<i>Pm3m</i>	A <sub>h</sub>	αPo	0.2992	...	...	...
γSb	25	>7.5	<i>hP2</i>	<i>P6<sub>3</sub>/mmc</i>	A3	Mg	0.3376	...	0.5341	1.582
σSb	25	>14.0	<i>mP3</i>	?	...	...	0.556	0.404	0.422	β = 86.0°
αSc	25	atm	<i>hP2</i>	<i>P6<sub>3</sub>/mm</i>	A3	Mg	0.33088	...	0.52680	1.5921

Element	Temperature, °C	Pressure, GPa	Pearson symbol	Space group	Strukturbericht designation	Prototype	Lattice parameters, nm			Comment, $c/a$ or $\alpha$ or $\beta$
							$a$	$b$	$c$	
$\beta$ Sc	>1337	atm	$cI2$	$Im\bar{3}m$	A2	W	(0.373)	...	...	...
$\gamma$ Se	25	atm	$hP3$	$P\bar{3}_121$	A8	$\gamma$ Se	0.43659	...	0.49537	1.1346
$\alpha$ Si	25	atm	$cF8$	$Fd\bar{3}m$	A4	C (diamond)	0.54306	...	...	...
$\beta$ Si	25	>9.5	$tI4$	$I4_1/amd$	A5	$\beta$ Sn	0.4686	...	0.2585	0.552
$\gamma$ Si	25	>16.0	$cI16$	$Im\bar{3}m$	...	$\gamma$ Si	0.6636	...	...	...
$\sigma$ Si	25	>16→atm	$hP4$	$P6_3/mmc$	A3'	$\alpha$ La	0.380	...	0.628	1.653
$\alpha$ Sm	25	atm	$hR3$	$R\bar{3}m$	...	$\alpha$ Sm	0.36290	...	2.6207	4*1.6048
$\beta$ Sm	>734	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.36630	...	0.58448	1.5956
$\gamma$ 'Sm	>922	atm	$cI2$	$Im\bar{3}m$	A2	W	(0.410)	...	...	...
$\sigma$ Sm	25	>4.0	$hP4$	$P6_3/mmc$	A3'	$\alpha$ La	0.3618	...	1.166	2*1.611
$\alpha$ Sn	<13	atm	$cF8$	$Fd\bar{3}m$	A4	C (diamond)	0.64892	...	...	...
$\beta$ Sn	25	atm	$tI4$	$I4_1/amd$	A5	$\beta$ Sn	0.58318	...	0.31818	0.5456
$\gamma$ Sn	25	>9.0	$tI2$	?	...	$\gamma$ Sn	0.370	...	0.337	0.91
$\alpha$ Sr	25	atm	$cF4$	$Fm\bar{3}m$	A1	Cu	0.6084	...	...	...
$\beta$ Sr	>547	atm	$cI2$	$Im\bar{3}m$	A2	W	0.487	...	...	...
$\beta$ 'Sr	25	>3.5	$cI2$	$Im\bar{3}m$	A2	W	0.4437	...	...	...
Ta	25	atm	$cI2$	$Im\bar{3}m$	A2	W	0.33030	...	...	...
$\alpha$ 'Tb	<-53	atm	$oC4$	$Cmcm$	...	$\alpha$ 'Dy	0.3605	0.6244	0.5706	...
aTb	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.36055	...	0.56966	1.5800
$\beta$ Tb	>1289	atm	$cI2$	$Im\bar{3}m$	A2	W	(0.407)	...	...	...
$\gamma$ Tb	25	>6.0	$hR3$	$R\bar{3}m$	...	$\alpha$ Sm	0.341	...	2.45	4*1.60
Tc	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.2738	...	0.4393	1.604
$\alpha$ Te	25	atm	$hP3$	$P\bar{3}_121$	A8	$\gamma$ Se	0.44566	...	0.59264	1.3298
$\beta$ Te	25	>2.0	$hR2$	$R\bar{3}m$	A7	$\alpha$ As	0.469	...	...	$\alpha = 53.30^\circ$
$\gamma$ Te	25	>7.0	$hR1$	$R\bar{3}m$	...	$\beta$ Po	0.3002	...	...	$\alpha = 103.3^\circ$
$\alpha$ Th	25	atm	$cF4$	$Fm\bar{3}m$	A1	Cu	0.50842	...	...	...
$\beta$ Th	>1360	atm	$cI2$	$Im\bar{3}m$	A2	W	0.411	...	...	...
$\alpha$ Ti	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.29506	...	0.46835	1.59873
$\beta$ Ti	>882	atm	$cI2$	$Im\bar{3}m$	A2	W	0.33065	...	...	...
$\omega$ Ti	25	HP→atm	$hP3$	$P6/mmm$	...	$\omega$ Ti	0.4625	...	0.2813	0.6082
$\alpha$ Tl	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.34566	...	0.55248	1.5983
$\beta$ Tl	>230	atm	$cI2$	$Im\bar{3}m$	A2	W	0.3879	...	...	...
$\gamma$ Tl	25	HP	$cF4$	$Fm\bar{3}m$	A1	Cu	?	...	...	...
Tm	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.35375	...	0.55540	1.5700
$\alpha$ U	25	atm	$oC4$	$Cmcm$	A20	$\alpha$ U	0.28537	0.58695	0.49548	...
$\beta$ U	>668	atm	$tP30$	$P4_2/mum$	A <sub>b</sub>	$\beta$ U	1.0759	...	0.5656	0.526
$\gamma$ U	>776	atm	$cI2$	$Im\bar{3}m$	A2	W	0.3524	...	...	...
V	25	atm	$cI2$	$Im\bar{3}m$	A2	W	0.30240	...	...	...
W	25	atm	$cI2$	$Im\bar{3}m$	A2	W	0.31652	...	...	...
Xe	<-111.76	atm	$cF4$	$Fm\bar{3}m$	A1	Cu	0.6350	...	...	...
$\alpha$ Y	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.36482	...	0.57318	1.5711
$\beta$ Y	>1478	atm	$cI2$	$Im\bar{3}m$	A2	W	(0.410)	...	...	...
$\alpha$ Yb	<-3	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.38799	...	0.63859	1.6459
$\beta$ Yb	25	atm	$cF4$	$Fm\bar{3}m$	A1	Cu	0.54848	...	...	...
$\gamma$ Yb	>795	atm	$cI2$	$Im\bar{3}m$	A2	W	0.444	...	...	...
Zn	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.26650	...	0.49470	1.8563
$\alpha$ Zr	25	atm	$hP2$	$P6_3/mmc$	A3	Mg	0.32316	...	0.51475	1.5929
$\beta$ Zr	>863	atm	$cI2$	$Im\bar{3}m$	A2	W	0.36090	...	...	...
$\omega$ Zr	25	HP→atm	$hP2$	$P6/mmm$	...	$\omega$ Ti	0.5036	...	0.3109	0.617



# LATTICE ENERGIES

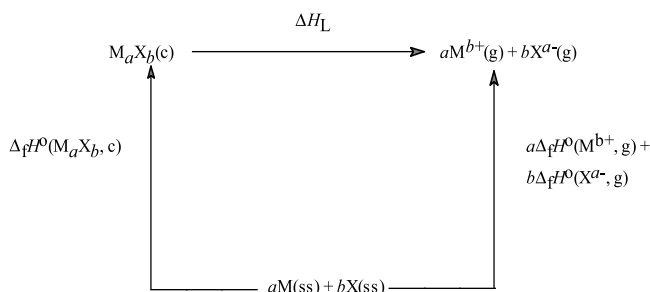
H. D. B. Jenkins and H. K. Roobottom

## THERMOCHEMICAL CYCLE AND CALCULATED VALUES

Table 1 contains calculated values of the lattice energies (total lattice potential energies),  $U_{\text{POT}}$ , of crystalline salts,  $M_aX_b$ .  $U_{\text{POT}}$  is expressed in units of kilojoules per mole,  $\text{kJ mol}^{-1}$ . M and X can be either simple or complex ions. Substances are arranged by chemical class.

Also listed in the table is the lattice energy,  $U_{\text{POT}}^{\text{BFHC}}$ , obtained from the application of the Born - Fajans - Haber cycle (BFHC) described below, using the "Standard Thermochemical Properties of Chemical Substances" table in Section 5 of this *Handbook*, References 1 through 4, and certain other data which are given in Table 3 below.

The lattice enthalpy,  $\Delta H_L$ , is given by the cycle:



where (ss) is the standard state of the element concerned.

The lattice enthalpy,  $\Delta H_L$ , is obtained using the equation:

$$\Delta H_L = a\Delta_f H^\circ(M^{b+}, g) + b\Delta_f H^\circ(X^{a-}, g) - \Delta_f H^\circ(M_aX_b, c)$$

and is further related to the total lattice potential energy,  $U_{\text{POT}}$ , by the relationship:

$$\Delta H_L = U_{\text{POT}} + \left[ a \left( \frac{n_M}{2} - 2 \right) + b \left( \frac{n_X}{2} - 2 \right) \right] RT$$

where  $n_M$  and  $n_X$  equal 3 for monatomic ions, 5 for linear polyatomic ions and 6 for polyatomic non-linear ions.

## METHOD OF ESTIMATION OF VALUES NOT TABULATED

In cases where the lattice energy is not tabulated and we want to furnish an estimate, then the Kapustinskii equation<sup>5</sup> can be used to obtain a value (in  $\text{kJ mol}^{-1}$ ):

$$U_{\text{POT}} = \frac{121.4z_a z_b v}{(r_a + r_b)} \left( 1 - \frac{0.0345}{(r_a + r_b)} \right)$$

where  $z_a$  and  $z_b$  are the moduli of the charges on the  $v$  ions in the lattice and  $r_a$  and  $r_b$  (in nm) are the thermochemical radii given in Table 2. The  $r_a$  for metal ions is taken to be the Goldschmidt<sup>6</sup> radius.

To cite an example, if we wish to estimate the lattice energy of the salt  $[\text{NH}_4^+][\text{HF}_2^-]$  using the above procedure, we see that Table 2 gives the thermochemical radius ( $r_a$ ) for  $\text{NH}_4^+$  to be 0.136 nm and that for  $\text{HF}_2^-$  ( $r_b$ ) to be 0.172 nm. The lattice potential energy is then estimated to be  $700 \text{ kJ mol}^{-1}$  compared with the calculated value of  $705 \text{ kJ mol}^{-1}$  and the Born - Fajans - Haber cycle value of  $658 \text{ kJ mol}^{-1}$ .

## References

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Table 1. Lattice Energies (kJ mol<sup>-1</sup>)

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
<b>Acetates</b>			<b>Borohydrides</b>		
Li(CH <sub>3</sub> COO)	–	843	HoB <sub>6</sub>	7489	–
Na(CH <sub>3</sub> COO)	828	807	ErB <sub>6</sub>	7489	–
K(CH <sub>3</sub> COO)	749	726	TmB <sub>6</sub>	7489	–
Rb(CH <sub>3</sub> COO)	715	–	YbB <sub>6</sub>	5146	–
Cs(CH <sub>3</sub> COO)	682	–	LuB <sub>6</sub>	7489	–
<b>Acetylides</b>			ThB <sub>6</sub>	10167	–
CaC <sub>2</sub>	2911	2902	<b>Borohalides</b>		
SrC <sub>2</sub>	2788	2782	LiBH <sub>4</sub>	778	–
BaC <sub>2</sub>	2647	2652	NaBH <sub>4</sub>	703	694
<b>Azides</b>			KBH <sub>4</sub>	655	638
LiN <sub>3</sub>	861	875	RbBH <sub>4</sub>	648	–
NaN <sub>3</sub>	770	784	CsBH <sub>4</sub>	628	–
KN <sub>3</sub>	697	–	<b>Carbonates</b>		
RbN <sub>3</sub>	674	691	Li <sub>2</sub> CO <sub>3</sub>	2523	2254
CsN <sub>3</sub>	665	674	Na <sub>2</sub> CO <sub>3</sub>	2301	2016
AgN <sub>3</sub>	854	910	K <sub>2</sub> CO <sub>3</sub>	2084	1846
TlN <sub>3</sub>	689	742	Rb <sub>2</sub> CO <sub>3</sub>	2000	1783
Ca(N <sub>3</sub> ) <sub>2</sub>	2186	2316	Cs <sub>2</sub> CO <sub>3</sub>	1920	1722
Sr(N <sub>3</sub> ) <sub>2</sub>	2056	2187	MgCO <sub>3</sub>	3138	3122
Ba(N <sub>3</sub> ) <sub>2</sub>	2021	–	CaCO <sub>3</sub>	2804	2811
Mn(N <sub>3</sub> ) <sub>2</sub>	2408	2348	SrCO <sub>3</sub>	2720	2688
Cu(N <sub>3</sub> ) <sub>2</sub>	2730	2738	BaCO <sub>3</sub>	2615	2554
Zn(N <sub>3</sub> ) <sub>2</sub>	2840	2970	MnCO <sub>3</sub>	3046	3092
Cd(N <sub>3</sub> ) <sub>2</sub>	2446	2576	FeCO <sub>3</sub>	3121	3169
Pb(N <sub>3</sub> ) <sub>2</sub>	–	2300	CoCO <sub>3</sub>	3443	3235
<b>Bihalide Salts</b>			CuCO <sub>3</sub>	3494	–
LiHF <sub>2</sub>	821	847	ZnCO <sub>3</sub>	3121	3273
NaHF <sub>2</sub>	755	748	CdCO <sub>3</sub>	2929	3052
KHF <sub>2</sub>	657	660	SnCO <sub>3</sub>	2904	–
RbHF <sub>2</sub>	627	631	PbCO <sub>3</sub>	2728	2750
CsHF <sub>2</sub>	607	–	<b>Cyanates</b>		
NH <sub>4</sub> HF <sub>2</sub>	705	658	LiNCO	849	–
CsHCl <sub>2</sub>	601	–	NaNCO	807	816
Me <sub>4</sub> NHCl <sub>2</sub>	427	–	KNCO	726	734
Et <sub>4</sub> NHCl <sub>2</sub>	346	–	RbNCO	692	–
Bu <sub>4</sub> NHCl <sub>2</sub>	290	–	CsNCO	661	–
<b>Bicarbonates</b>			NH <sub>4</sub> NCO	724	–
NaHCO <sub>3</sub>	820	656	<b>Cyanides</b>		
KHCO <sub>3</sub>	741	573	LiCN	874	–
RbHCO <sub>3</sub>	707	522	NaCN	766	759
CsHCO <sub>3</sub>	678	520	KCN	692	686
NH <sub>4</sub> HCO <sub>3</sub>	–	577	RbCN	638	–
<b>Borides</b>			CsCN	601	–
CaB <sub>6</sub>	5146	–	Ca(CN) <sub>2</sub>	2268	2240
SrB <sub>6</sub>	5104	–	Sr(CN) <sub>2</sub>	2138	–
BaB <sub>6</sub>	5021	–	Ba(CN) <sub>2</sub>	2001	2009
YB <sub>6</sub>	7447	–	NH <sub>4</sub> CN	617	691
LaB <sub>6</sub>	7406	–	AgCN	(741)	935
CeB <sub>6</sub>	10083	–			
PrB <sub>6</sub>	7447	–			
NdB <sub>6</sub>	7447	–			
PmB <sub>6</sub>	7406	–			
SmB <sub>6</sub>	7447	–			
EuB <sub>6</sub>	5104	–			
GdB <sub>6</sub>	7489	–			
TbB <sub>6</sub>	7489	–			
DyB <sub>6</sub>	7489	–			

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
Zn(CN) <sub>2</sub>	2809	2817	AgI	881	892
Cd(CN) <sub>2</sub>	2583	2591	AuCl	1013	1066
<b>Formates</b>			AuBr	1029	1059
Li(HCO <sub>2</sub> )	865	–	AuI	1027	1070
Na(HCO <sub>2</sub> )	791	804	InCl	–	764
K(HCO <sub>2</sub> )	713	722	InBr	–	767
Rb(HCO <sub>2</sub> )	685	–	InI	–	733
Cs(HCO <sub>2</sub> )	651	–	TlF	–	850
NH <sub>4</sub> (HCO <sub>2</sub> )	715	–	TlCl	738	751
<b>Germanates</b>			TlBr	720	734
Mg <sub>2</sub> GeO <sub>4</sub>	7991	–	TlI	692	710
Ca <sub>2</sub> GeO <sub>4</sub>	7301	7306	Me <sub>4</sub> NCl	566	–
Sr <sub>2</sub> GeO <sub>4</sub>	6987	–	Me <sub>4</sub> NBr	553	–
Ba <sub>2</sub> GeO <sub>4</sub>	6653	6643	Me <sub>4</sub> NI	544	–
<b>Halates</b>			PH <sub>4</sub> Br	616	–
LiBrO <sub>3</sub>	883	880	PH <sub>4</sub> I	590	–
NaBrO <sub>3</sub>	803	791	BeF <sub>2</sub>	3464	3526
KBrO <sub>3</sub>	740	722	BeCl <sub>2</sub>	3004	3033
RbBrO <sub>3</sub>	720	705	BeBr <sub>2</sub>	2950	2914
CsBrO <sub>3</sub>	694	681	BeI <sub>2</sub>	2780	2813
NaClO <sub>3</sub>	770	785	MgF <sub>2</sub>	2926	2978
KClO <sub>3</sub>	711	721	MgCl <sub>2</sub>	2477	2540
RbClO <sub>3</sub>	690	703	MgBr <sub>2</sub>	2406	2451
CsClO <sub>3</sub>	–	679	MgI <sub>2</sub>	2293	2340
LiIO <sub>3</sub>	975	974	CaF <sub>2</sub>	2640	2651
NaIO <sub>3</sub>	883	876	CaCl <sub>2</sub>	2268	2271
KIO <sub>3</sub>	820	780	CaBr <sub>2</sub>	2132	–
RbIO <sub>3</sub>	791	–	CaI <sub>2</sub>	1971	2087
CsIO <sub>3</sub>	761	–	SrF <sub>2</sub>	2476	2513
<b>Halides</b>			SrCl <sub>2</sub>	2142	2170
LiF	1030	1049	SrI <sub>2</sub>	1984	1976
LiCl	834	864	BaF <sub>2</sub>	2347	2373
LiBr	788	820	BaCl <sub>2</sub>	2046	2069
LiI	730	764	BaBr <sub>2</sub>	1971	1995
NaF	910	930	BaI <sub>2</sub>	1862	1890
NaCl	769	790	RaF <sub>2</sub>	2284	–
NaBr	732	754	RaCl <sub>2</sub>	2004	–
NaI	682	705	RaBr <sub>2</sub>	1929	–
KF	808	829	RaI <sub>2</sub>	1803	–
KCl	701	720	ScCl <sub>2</sub>	2380	–
KBr	671	691	ScBr <sub>2</sub>	2291	–
KI	632	650	ScI <sub>2</sub>	2201	–
RbF	774	795	TiF <sub>2</sub>	2724	–
RbCl	680	695	TiCl <sub>2</sub>	2439	2514
RbBr	651	668	TiBr <sub>2</sub>	2360	2430
RbI	617	632	TiI <sub>2</sub>	2259	2342
CsF	744	759	VCl <sub>2</sub>	2607	2593
CsCl	657	670	VBr <sub>2</sub>	–	2534
CsBr	632	647	VI <sub>2</sub>	–	2470
CsI	600	613	CrF <sub>2</sub>	2778	2939
FrF	715	–	CrCl <sub>2</sub>	2540	2601
FrCl	632	–	CrBr <sub>2</sub>	2377	2536
FrBr	611	–	CrI <sub>2</sub>	2269	2440
FrI	582	–	MoCl <sub>2</sub>	2737	2746
CuCl	992	996	MoBr <sub>2</sub>	2742	2753
CuBr	969	978	MoI <sub>2</sub>	2630	–
CuI	948	966	MnF <sub>2</sub>	2644	–
AgF	953	974	MnCl <sub>2</sub>	2510	2551
AgCl	910	918	MnBr <sub>2</sub>	2448	2482
AgBr	897	905	MnI <sub>2</sub>	2212	–
			FeF <sub>2</sub>	2849	2967

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
FeCl <sub>2</sub>	2569	2641	CrCl <sub>3</sub>	5518	5529
FeBr <sub>2</sub>	2515	2577	CrBr <sub>3</sub>	5355	—
FeI <sub>2</sub>	2439	2491	CrI <sub>3</sub>	5275	5294
CoF <sub>2</sub>	3004	3042	MoF <sub>3</sub>	6459	—
CoCl <sub>2</sub>	2707	2706	MoCl <sub>3</sub>	5246	5253
CoBr <sub>2</sub>	2640	2643	MoBr <sub>3</sub>	5156	—
CoI <sub>2</sub>	2569	2561	MoI <sub>3</sub>	5073	—
NiF <sub>2</sub>	3098	3089	MnF <sub>3</sub>	6017	—
NiCl <sub>2</sub>	2753	2786	MnCl <sub>3</sub>	5544	—
NiBr <sub>2</sub>	2729	2721	MnBr <sub>3</sub>	5448	—
NiI <sub>2</sub>	2607	2637	MnI <sub>3</sub>	5330	—
PdCl <sub>2</sub>	2778	2818	TcCl <sub>3</sub>	5270	—
PdBr <sub>2</sub>	2741	2751	TcBr <sub>3</sub>	5215	—
PdI <sub>2</sub>	2748	2760	TcI <sub>3</sub>	5188	—
CuF <sub>2</sub>	3046	3102	FeF <sub>3</sub>	5870	—
CuCl <sub>2</sub>	2774	2824	FeCl <sub>3</sub>	5364	5436
CuBr <sub>2</sub>	2715	2774	FeBr <sub>3</sub>	5333	5347
CuI <sub>2</sub>	2640	—	FeI <sub>3</sub>	5117	—
AgF <sub>2</sub>	2942	2967	RuCl <sub>3</sub>	5245	5257
ZnF <sub>2</sub>	3021	3053	RuBr <sub>3</sub>	5223	5232
ZnCl <sub>2</sub>	2703	2748	RuI <sub>3</sub>	5222	5235
ZnBr <sub>2</sub>	2648	2689	CoF <sub>3</sub>	5991	—
ZnI <sub>2</sub>	2581	2619	RhCl <sub>3</sub>	5641	5665
CdF <sub>2</sub>	2809	2830	IrF <sub>3</sub>	(6112)	—
CdCl <sub>2</sub>	2552	2565	IrBr <sub>3</sub>	(4794)	—
CdBr <sub>2</sub>	2507	2517	NiF <sub>3</sub>	(6111)	—
CdI <sub>2</sub>	2441	2455	AuF <sub>3</sub>	(5777)	—
HgF <sub>2</sub>	2757	—	AuCl <sub>3</sub>	(4605)	—
HgCl <sub>2</sub>	2657	2664	ZnCl <sub>3</sub>	5832	—
HgBr <sub>2</sub>	2628	2639	ZnBr <sub>3</sub>	5732	—
HgI <sub>2</sub>	2628	2624	ZnI <sub>3</sub>	5636	—
SnF <sub>2</sub>	2551	—	AlF <sub>3</sub>	5924	6252
SnCl <sub>2</sub>	2297	2310	AlCl <sub>3</sub>	5376	5513
SnBr <sub>2</sub>	2251	2256	AlBr <sub>3</sub>	5247	5360
SnI <sub>2</sub>	2193	2206	AlI <sub>3</sub>	5070	5227
PbF <sub>2</sub>	2535	2543	GaF <sub>3</sub>	5829	6238
PbCl <sub>2</sub>	2270	2282	GaCl <sub>3</sub>	5217	5665
PbBr <sub>2</sub>	2219	2230	GaBr <sub>3</sub>	4966	5569
PbI <sub>2</sub>	2163	2177	GaI <sub>3</sub>	4611	5496
ScF <sub>3</sub>	5492	5540	InCl <sub>3</sub>	4736	5183
ScCl <sub>3</sub>	4874	4901	InBr <sub>3</sub>	4535	5117
ScBr <sub>3</sub>	4729	4761	InI <sub>3</sub>	4234	5001
ScI <sub>3</sub>	4640	—	TlF <sub>3</sub>	5493	—
YF <sub>3</sub>	4983	—	TlCl <sub>3</sub>	5258	5278
YCl <sub>3</sub>	4506	4524	TlBr <sub>3</sub>	5171	—
YI <sub>3</sub>	4240	4258	TlI <sub>3</sub>	5088	—
TiF <sub>3</sub>	5644	—	AsBr <sub>3</sub>	5497	5365
TiCl <sub>3</sub>	5134	5153	AsI <sub>3</sub>	4824	5295
TiBr <sub>3</sub>	5012	5023	SbF <sub>3</sub>	5295	5324
TiI <sub>3</sub>	4845	—	SbCl <sub>3</sub>	5032	4857
ZrCl <sub>3</sub>	—	4791	SbBr <sub>3</sub>	4954	4776
ZrBr <sub>3</sub>	—	4758	SbI <sub>3</sub>	4867	4692
ZrI <sub>3</sub>	—	4591	BiCl <sub>3</sub>	4689	4707
VF <sub>3</sub>	5895	—	BiI <sub>3</sub>	3774	—
VCl <sub>3</sub>	5322	5329	LaF <sub>3</sub>	4682	—
VBr <sub>3</sub>	5214	5224	LaCl <sub>3</sub>	4263	4242
VI <sub>3</sub>	5121	5136	LaBr <sub>3</sub>	4209	—
NbCl <sub>3</sub>	5062	—	LaI <sub>3</sub>	3916	3986
NbBr <sub>3</sub>	4980	—	CeCl <sub>3</sub>	4394	4348
NbI <sub>3</sub>	4860	—	CeI <sub>3</sub>	—	4061
CrF <sub>3</sub>	6033	6065	PrCl <sub>3</sub>	4322	4387

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
PrI <sub>3</sub>	–	4101	RbH	686	684
NdCl <sub>3</sub>	4343	4415	CsH	648	653
SmCl <sub>3</sub>	4376	4450	VH	1184	(1344)
EuCl <sub>3</sub>	4393	4490	NbH	1163	(1633)
GdCl <sub>3</sub>	4406	4495	PdH	979	1368
DyCl <sub>3</sub>	4481	4529	CuH	828	1254
HoCl <sub>3</sub>	4501	4572	TiH	996	1407
ErCl <sub>3</sub>	4527	4591	ZrH	916	1590
TmCl <sub>3</sub>	4548	4608	HfH	904	–
TmI <sub>3</sub>	–	4340	LaH	828	–
YbCl <sub>3</sub>	–	4651	TaH	1021	–
AcCl <sub>3</sub>	4096	–	CrH	1050	–
UCl <sub>3</sub>	4243	–	NiH	929	–
NpCl <sub>3</sub>	4268	–	PtH	937	–
PuCl <sub>3</sub>	4289	–	AgH	941	–
PuBr <sub>3</sub>	(3959)	–	AuH	1033	1108
AmCl <sub>3</sub>	4293	–	TlH	745	–
TiF <sub>4</sub>	10012	9908	GeH	950	–
TiCl <sub>4</sub>	9431	–	PbH	778	–
TiBr <sub>4</sub>	9288	9059	BeH <sub>2</sub>	3205	3306
TiI <sub>4</sub>	9108	8918	MgH <sub>2</sub>	2791	2718
ZrF <sub>4</sub>	8853	8971	CaH <sub>2</sub>	2410	2406
ZrCl <sub>4</sub>	8021	8144	SrH <sub>2</sub>	2250	2265
ZrBr <sub>4</sub>	7661	7984	BaH <sub>2</sub>	2121	2133
ZrI <sub>4</sub>	7155	7801	ScH <sub>2</sub>	2711	2744
MoF <sub>4</sub>	8795	–	YH <sub>2</sub>	(2598)	2733
MoCl <sub>4</sub>	8556	9603	LaH <sub>2</sub>	2380	2522
MoBr <sub>4</sub>	8510	9500	CeH <sub>2</sub>	2414	2509
MoI <sub>4</sub>	8427	–	PrH <sub>2</sub>	2448	2405
SnCl <sub>4</sub>	8355	8930	NdH <sub>2</sub>	2464	2394
SnBr <sub>4</sub>	7970	8852	PmH <sub>2</sub>	2519	–
PbF <sub>4</sub>	9519	–	SmH <sub>2</sub>	2510	2389
CrF <sub>2</sub> Cl	5795	–	GdH <sub>2</sub>	2494	2651
CrF <sub>2</sub> Br	5753	–	AcH <sub>2</sub>	2372	–
CrF <sub>2</sub> I	5669	–	ThH <sub>2</sub>	2711	2738
CrCl <sub>2</sub> Br	5448	–	PuH <sub>2</sub>	2519	–
CrCl <sub>2</sub> I	5381	5429	AmH <sub>2</sub>	2544	–
CrBr <sub>2</sub> I	5330	5370	TiH <sub>2</sub>	2866	2864
CuFCl	2891	–	ZrH <sub>2</sub>	2711	2999
CuFBr	2853	–	CuH <sub>2</sub>	2941	–
CuFI	2803	–	ZnH <sub>2</sub>	2870	–
CuClBr	2753	–	HgH <sub>2</sub>	2707	–
CuClI	2694	–	AlH <sub>3</sub>	5924	5969
CuBrI	2669	–	FeH <sub>3</sub>	5724	–
FeF <sub>2</sub> Cl	5711	–	ScH <sub>3</sub>	5439	–
FeF <sub>2</sub> Br	5653	–	YH <sub>3</sub>	5063	4910
FeF <sub>2</sub> I	5569	–	LaH <sub>3</sub>	4895	4493
FeCl <sub>2</sub> Br	5339	–	FeH <sub>3</sub>	5724	–
FeCl <sub>2</sub> I	5272	–	GaH <sub>3</sub>	5690	–
FeBr <sub>2</sub> I	5209	–	InH <sub>3</sub>	5092	–
LiIO <sub>2</sub> F <sub>2</sub>	845	–	TlH <sub>3</sub>	5092	–
NaIO <sub>2</sub> F <sub>2</sub>	766	756	<b>Hydroselenides</b>		
KIO <sub>2</sub> F <sub>2</sub>	699	689	NaHSe	703	732
RbIO <sub>2</sub> F <sub>2</sub>	674	–	KHSe	644	712
CsIO <sub>2</sub> F <sub>2</sub>	636	–	RbHSe	623	689
NH <sub>4</sub> IO <sub>2</sub> F <sub>2</sub>	678	–	CsHse	598	669
AgIO <sub>2</sub> F <sub>2</sub>	736	685	<b>Hydrosulphides</b>		
<b>Hydrides</b>			LiHS	768	862
LiH	916	918	NaHS	723	771
NaH	807	807	RbHS	655	682
KH	711	713			

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
CsHS	628	657	CsNO <sub>3</sub>	648	650
NH <sub>4</sub> HS	661	718	AgNO <sub>3</sub>	820	832
Ca(HS) <sub>2</sub>	2184	(2171)	TlNO <sub>3</sub>	690	707
Sr(HS) <sub>2</sub>	2063	–	Mg(NO <sub>3</sub> ) <sub>2</sub>	2481	2521
Ba(HS) <sub>2</sub>	1979	(1956)	Ca(NO <sub>3</sub> ) <sub>2</sub>	2268	2247
<i>Hydroxides</i>			Sr(NO <sub>3</sub> ) <sub>2</sub>	2176	2151
LiOH	1021	1028	Ba(NO <sub>3</sub> ) <sub>2</sub>	2062	2035
NaOH	887	892	Mn(NO <sub>3</sub> ) <sub>2</sub>	2318	2478
KOH	789	796	Fe(NO <sub>3</sub> ) <sub>2</sub>	–	(2580)
RbOH	766	765	Co(NO <sub>3</sub> ) <sub>2</sub>	2560	2647
CsOH	721	732	Ni(NO <sub>3</sub> ) <sub>2</sub>	–	2729
Be(OH) <sub>2</sub>	3477	3620	Cu(NO <sub>3</sub> ) <sub>2</sub>	–	2739
Mg(OH) <sub>2</sub>	2870	2998	Zn(NO <sub>3</sub> ) <sub>2</sub>	2376	2649
Ca(OH) <sub>2</sub>	2506	2637	Cd(NO <sub>3</sub> ) <sub>2</sub>	2238	2462
Sr(OH) <sub>2</sub>	2330	2474	Sn(NO <sub>3</sub> ) <sub>2</sub>	2155	2254
Ba(OH) <sub>2</sub>	2142	2330	Pb(NO <sub>3</sub> ) <sub>2</sub>	2067	2208
Ti(OH) <sub>2</sub>	–	2953	<i>Nitrides</i>		
Mn(OH) <sub>2</sub>	2909	3008	ScN	7547	7506
Fe(OH) <sub>2</sub>	2653	3044	LaN	6876	6793
Co(OH) <sub>2</sub>	2786	3109	TiN	8130	8033
Ni(OH) <sub>2</sub>	2832	3186	ZrN	7633	7723
Pd(OH) <sub>2</sub>	–	3189	VN	8283	8233
Cu(OH) <sub>2</sub>	2870	3229	NbN	7939	8022
CuOH	1006	–	CrN	8269	8358
AgOH	918	845	<i>Nitrites</i>		
AuOH	1033	–	NaNO <sub>2</sub>	774	772
TlOH	705	874	KNO <sub>2</sub>	699	687
Zn(OH) <sub>2</sub>	2795	3151	RbNO <sub>2</sub>	724	765
Cd(OH) <sub>2</sub>	2607	2909	CsNO <sub>2</sub>	690	–
Hg(OH) <sub>2</sub>	2669	–	<i>Oxides</i>		
Sn(OH) <sub>2</sub>	2489	2721	Li <sub>2</sub> O	2799	2814
Pb(OH) <sub>2</sub>	2376	–	Na <sub>2</sub> O	2481	2478
Sc(OH) <sub>3</sub>	5063	5602	K <sub>2</sub> O	2238	2232
Y(OH) <sub>3</sub>	4707	–	Rb <sub>2</sub> O	2163	2161
La(OH) <sub>3</sub>	4443	–	Cs <sub>2</sub> O	2131	2063
Cr(OH) <sub>3</sub>	5556	6299	Cu <sub>2</sub> O	3273	3189
Mn(OH) <sub>3</sub>	6213	–	Ag <sub>2</sub> O	3002	2910
Al(OH) <sub>3</sub>	5627	–	Tl <sub>2</sub> O	2659	2575
Ga(OH) <sub>3</sub>	5732	6368	LiO <sub>2</sub>	(878)	(872)
In(OH) <sub>3</sub>	5280	–	NaO <sub>2</sub>	799	821
Tl(OH) <sub>3</sub>	5314	–	KO <sub>2</sub>	741	751
Ti(OH) <sub>4</sub>	9456	–	RbO <sub>2</sub>	706	721
Zr(OH) <sub>4</sub>	8619	–	CsO <sub>2</sub>	679	696
Mn(OH) <sub>4</sub>	10933	–	Li <sub>2</sub> O <sub>2</sub>	2592	2557
Sn(OH) <sub>4</sub>	9188	9879	Na <sub>2</sub> O <sub>2</sub>	2309	22717
<i>Imides</i>			K <sub>2</sub> O <sub>2</sub>	2114	2064
CaNH	3293	–	Rb <sub>2</sub> O <sub>2</sub>	2025	1994
SrNH	3146	–	Cs <sub>2</sub> O <sub>2</sub>	1948	1512
BaNH	2975	–	MgO <sub>2</sub>	3356	3526
<i>Metavanadates</i>			CaO <sub>2</sub>	3144	3132
Li <sub>3</sub> VO <sub>4</sub>	3945	–	SrO <sub>2</sub>	3037	2977
Na <sub>3</sub> VO <sub>4</sub>	3766	–	KO <sub>3</sub>	697	707
K <sub>3</sub> VO <sub>4</sub>	3376	–	BeO	4514	4443
Rb <sub>3</sub> VO <sub>4</sub>	3243	–	MgO	3795	3791
Cs <sub>3</sub> VO <sub>4</sub>	3137	–	CaO	3414	3401
<i>Nitrates</i>			SrO	3217	3223
LiNO <sub>3</sub>	848	854	BaO	3029	3054
NaNO <sub>3</sub>	755	763	TiO	3832	3811
KNO <sub>3</sub>	685	694	VO	3932	3863
RbNO <sub>3</sub>	662	671	MnO	3724	3745

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
FeO	3795	3865	Ca(ClO <sub>4</sub> ) <sub>2</sub>	1958	1971
CoO	3837	3910	Sr(ClO <sub>4</sub> ) <sub>2</sub>	1862	1862
NiO	3908	4010	Ba(ClO <sub>4</sub> ) <sub>2</sub>	1795	1769
PdO	3736	—			
CuO	4135	4050	<i>Permanganates</i>		
ZnO	4142	3971	NaMnO <sub>4</sub>	661	—
CdO	3806	—	KMnO <sub>4</sub>	607	—
HgO	3907	—	RbMnO <sub>4</sub>	586	—
GeO	3919	—	CsMnO <sub>4</sub>	565	—
SnO	3652	—	Ca(MnO <sub>4</sub> ) <sub>2</sub>	1937	—
PbO	3520	—	Sr(MnO <sub>4</sub> ) <sub>2</sub>	1845	—
Sc <sub>2</sub> O <sub>3</sub>	13557	13708	Ba(MnO <sub>4</sub> ) <sub>2</sub>	1778	—
Y <sub>2</sub> O <sub>3</sub>	12705	—			
La <sub>2</sub> O <sub>3</sub>	12452	—	<i>Phosphates</i>		
Ce <sub>2</sub> O <sub>3</sub>	12661	—	Mg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	11632	11407
Pr <sub>2</sub> O <sub>3</sub>	12703	—	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	10602	10479
Nd <sub>2</sub> O <sub>3</sub>	12736	—	Sr <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	10125	10075
Pm <sub>2</sub> O <sub>3</sub>	12811	—	Ba <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	9652	9654
Sm <sub>2</sub> O <sub>3</sub>	12878	—	MnPO <sub>4</sub>	7397	—
Eu <sub>2</sub> O <sub>3</sub>	12945	—	FePO <sub>4</sub>	7251	7300
Gd <sub>2</sub> O <sub>3</sub>	12996	—	BPO <sub>4</sub>	8201	—
Tb <sub>2</sub> O <sub>3</sub>	13071	—	AlPO <sub>4</sub>	7427	7507
Dy <sub>2</sub> O <sub>3</sub>	13138	—	GaPO <sub>4</sub>	7381	—
Ho <sub>2</sub> O <sub>3</sub>	13180	—			
Er <sub>2</sub> O <sub>3</sub>	13263	—	<i>Selenides</i>		
Tm <sub>2</sub> O <sub>3</sub>	13322	—	Li <sub>2</sub> Se	2364	—
Yb <sub>2</sub> O <sub>3</sub>	13380	—	Na <sub>2</sub> Se	2130	—
Lu <sub>2</sub> O <sub>3</sub>	13665	—	K <sub>2</sub> Se	1933	—
Ac <sub>2</sub> O <sub>3</sub>	12573	—	Rb <sub>2</sub> Se	1837	—
Ti <sub>2</sub> O <sub>3</sub>	—	14149	Cs <sub>2</sub> Se	1745	—
V <sub>2</sub> O <sub>3</sub>	15096	14520	Ag <sub>2</sub> Se	2686	—
Cr <sub>2</sub> O <sub>3</sub>	15276	14957	Tl <sub>2</sub> Se	2209	—
Mn <sub>2</sub> O <sub>3</sub>	15146	15035	BeSe	3431	—
Fe <sub>2</sub> O <sub>3</sub>	14309	14774	MgSe	3071	—
Al <sub>2</sub> O <sub>3</sub>	15916	—	CaSe	2858	2862
Ga <sub>2</sub> O <sub>3</sub>	15590	15220	SrSe	2736	—
In <sub>2</sub> O <sub>3</sub>	13928	—	BaSe	2611	—
Pb <sub>2</sub> O <sub>3</sub>	(14841)	—	MnSe	3176	—
CeO <sub>2</sub>	9627	—			
ThO <sub>2</sub>	10397	—	<i>Selenites</i>		
PaO <sub>2</sub>	10573	—	Li <sub>2</sub> SeO <sub>3</sub>	2171	—
VO <sub>2</sub> (g)	10644	—	Na <sub>2</sub> SeO <sub>3</sub>	1950	1916
NpO <sub>2</sub>	10707	—	K <sub>2</sub> SeO <sub>3</sub>	1774	1749
PuO <sub>2</sub>	10786	—	Rb <sub>2</sub> SeO <sub>3</sub>	1715	1675
AmO <sub>2</sub>	10799	—	Cs <sub>2</sub> SeO <sub>3</sub>	1640	—
CmO <sub>2</sub>	10832	—	Tl <sub>2</sub> SeO <sub>3</sub>	1879	—
TiO <sub>2</sub>	12150	—	Ag <sub>2</sub> SeO <sub>3</sub>	2113	2148
ZrO <sub>2</sub>	11188	—	BeSeO <sub>3</sub>	3322	—
MoO <sub>2</sub>	11648	—	MgSeO <sub>3</sub>	3012	2998
MnO <sub>2</sub>	12970	—	CaSeO <sub>3</sub>	2732	—
SiO <sub>2</sub>	13125	—	SrSeO <sub>3</sub>	2586	2588
GeO <sub>2</sub>	12828	—	BaSeO <sub>3</sub>	2460	2451
SnO <sub>2</sub>	11807	—			
PbO <sub>2</sub>	11217	—	<i>Selenates</i>		
			Li <sub>2</sub> SeO <sub>4</sub>	2054	—
<i>Perchlorates</i>			Na <sub>2</sub> SeO <sub>4</sub>	1879	—
LiClO <sub>4</sub>	709	715	K <sub>2</sub> SeO <sub>4</sub>	1732	—
NaClO <sub>4</sub>	643	641	Rb <sub>2</sub> SeO <sub>4</sub>	1686	—
KClO <sub>4</sub>	599	595	Cs <sub>2</sub> SeO <sub>4</sub>	1615	—
RbClO <sub>4</sub>	564	576	Cu <sub>2</sub> SeO <sub>4</sub>	2201	—
CsClO <sub>4</sub>	636	550	Ag <sub>2</sub> SeO <sub>4</sub>	2033	—
NH <sub>4</sub> ClO <sub>4</sub>	583	580	Tl <sub>2</sub> SeO <sub>4</sub>	1766	—
			Hg <sub>2</sub> SeO <sub>4</sub>	2163	—
			BeSeO <sub>4</sub>	3448	—

Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
MgSeO <sub>4</sub>	2895	—	Cs <sub>2</sub> PdCl <sub>6</sub>	1426	—
CaSeO <sub>4</sub>	2632	—	Rb <sub>2</sub> PbCl <sub>6</sub>	1343	1343
SrSeO <sub>4</sub>	2489	—	Cs <sub>2</sub> PbCl <sub>6</sub>	1344	—
<i>Sulphides</i>			(NH <sub>4</sub> ) <sub>2</sub> PbCl <sub>6</sub>	1355	—
Li <sub>2</sub> S	2464	2472	K <sub>2</sub> PtCl <sub>6</sub>	1468	1471
Na <sub>2</sub> S	2192	2203	Rb <sub>2</sub> PtCl <sub>6</sub>	1464	—
K <sub>2</sub> S	1979	(2052)	Cs <sub>2</sub> PtCl <sub>6</sub>	1444	—
Rb <sub>2</sub> S	1929	1949	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>6</sub>	1468	—
Cs <sub>2</sub> S	1892	1850	Tl <sub>2</sub> PtCl <sub>6</sub>	1546	—
(NH <sub>4</sub> ) <sub>2</sub> S	2008	(2026)	Ag <sub>2</sub> PtCl <sub>6</sub>	1773	1881
Cu <sub>2</sub> S	2786	2865	BaPtCl <sub>6</sub>	2047	2070
Ag <sub>2</sub> S	2606	2677	K <sub>2</sub> PtBr <sub>6</sub>	1423	1392
Au <sub>2</sub> S	2908	—	Ag <sub>2</sub> PtBr <sub>6</sub>	1791	2276
Tl <sub>2</sub> S	2298	2258	K <sub>2</sub> PtI <sub>6</sub>	1421	—
<i>Sulphates</i>			K <sub>2</sub> ReCl <sub>6</sub>	1416	1442
Li <sub>2</sub> SO <sub>4</sub>	2229	2142	Rb <sub>2</sub> ReCl <sub>6</sub>	1414	—
Na <sub>2</sub> SO <sub>4</sub>	1827	1938	Cs <sub>2</sub> ReCl <sub>6</sub>	1398	—
K <sub>2</sub> SO <sub>4</sub>	1700	1796	K <sub>2</sub> ReBr <sub>6</sub>	1375	1375
Rb <sub>2</sub> SO <sub>4</sub>	1636	1748	K <sub>2</sub> SiF <sub>6</sub>	1670	1765
Cs <sub>2</sub> SO <sub>4</sub>	1596	1658	Rb <sub>2</sub> SiF <sub>6</sub>	1639	1673
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	1766	1777	Cs <sub>2</sub> SiF <sub>6</sub>	1604	1498
Cu <sub>2</sub> SO <sub>4</sub>	2276	2166	Tl <sub>2</sub> SiF <sub>6</sub>	1675	—
Ag <sub>2</sub> SO <sub>4</sub>	2104	1989	K <sub>2</sub> SnCl <sub>6</sub>	1363	1390
Tl <sub>2</sub> SO <sub>4</sub>	1828	1722	Rb <sub>2</sub> SnCl <sub>6</sub>	1361	1363
Hg <sub>2</sub> SO <sub>4</sub>	—	2127	Cs <sub>2</sub> SnCl <sub>6</sub>	1358	—
CaSO <sub>4</sub>	2489	2480	Tl <sub>2</sub> SnCl <sub>6</sub>	1437	—
SrSO <sub>4</sub>	2577	2484	(NH <sub>4</sub> ) <sub>2</sub> SnCl <sub>6</sub>	1370	1344
BaSO <sub>4</sub>	2469	2374	Rb <sub>2</sub> SnBr <sub>6</sub>	1309	—
MnSO <sub>4</sub>	2920	2825	Cs <sub>2</sub> SnBr <sub>6</sub>	1306	—
<i>Ternary Salts</i>			Rb <sub>2</sub> SnI <sub>6</sub>	1226	—
Cs <sub>2</sub> CuCl <sub>4</sub>	1393	—	Cs <sub>2</sub> SnBr <sub>6</sub>	1243	—
Rb <sub>2</sub> ZnCl <sub>4</sub>	1529	—	K <sub>2</sub> TeCl <sub>6</sub>	1318	1320
Cs <sub>2</sub> ZnCl <sub>4</sub>	1492	—	Rb <sub>2</sub> TeCl <sub>6</sub>	1321	—
Rb <sub>2</sub> ZnBr <sub>4</sub>	1498	—	Cs <sub>2</sub> TeCl <sub>6</sub>	1323	—
Cs <sub>2</sub> ZnBr <sub>4</sub>	1454	—	Tl <sub>2</sub> TeCl <sub>6</sub>	1392	—
Cs <sub>2</sub> ZnI <sub>4</sub>	1386	—	(NH <sub>4</sub> ) <sub>2</sub> TeCl <sub>6</sub>	1318	—
CsGaCl <sub>4</sub>	494	—	K <sub>2</sub> RuCl <sub>6</sub>	1451	—
NaAlCl <sub>4</sub>	556	—	Rb <sub>2</sub> CoF <sub>6</sub>	1688	—
CsAlCl <sub>4</sub>	486	—	Cs <sub>2</sub> CoF <sub>6</sub>	1632	—
NaFeCl <sub>4</sub>	492	—	K <sub>2</sub> NiF <sub>6</sub>	1721	—
Rb <sub>2</sub> CoCl <sub>4</sub>	1447	—	Rb <sub>2</sub> NiF <sub>6</sub>	1688	—
Cs <sub>2</sub> CoCl <sub>4</sub>	1391	—	Rb <sub>2</sub> SbCl <sub>6</sub>	1357	—
K <sub>2</sub> PtCl <sub>4</sub>	1574	1550	Rb <sub>2</sub> SeCl <sub>6</sub>	1409	—
Cs <sub>2</sub> GeF <sub>6</sub>	1573	—	Cs <sub>2</sub> SeCl <sub>6</sub>	1397	—
(NH <sub>4</sub> ) <sub>2</sub> GeF <sub>6</sub>	1657	—	(NH <sub>4</sub> ) <sub>2</sub> SeCl <sub>6</sub>	1420	—
Cs <sub>2</sub> GeCl <sub>6</sub>	1404	1419	(NH <sub>4</sub> ) <sub>2</sub> PoCl <sub>6</sub>	1338	—
K <sub>2</sub> HfCl <sub>6</sub>	1345	1461	Cs <sub>2</sub> PoBr <sub>6</sub>	1286	—
K <sub>2</sub> IrCl <sub>6</sub>	1442	1440	Cs <sub>2</sub> CrF <sub>6</sub>	1603	—
Na <sub>2</sub> MoCl <sub>6</sub>	1526	1504	Rb <sub>2</sub> MnF <sub>6</sub>	1688	—
K <sub>2</sub> MoCl <sub>6</sub>	1418	1412	Cs <sub>2</sub> MnF <sub>6</sub>	1620	—
Rb <sub>2</sub> MoCl <sub>6</sub>	1399	1399	K <sub>2</sub> MnCl <sub>6</sub>	1462	—
Cs <sub>2</sub> MoCl <sub>6</sub>	1347	1347	Rb <sub>2</sub> MnCl <sub>6</sub>	1451	—
K <sub>2</sub> NbCl <sub>6</sub>	1375	1398	(NH <sub>4</sub> ) <sub>2</sub> MnCl <sub>6</sub>	1464	—
Rb <sub>2</sub> NbCl <sub>6</sub>	1371	1385	Cs <sub>2</sub> TeBr <sub>6</sub>	1306	—
Cs <sub>2</sub> NbCl <sub>6</sub>	1381	1344	Cs <sub>2</sub> TeI <sub>6</sub>	1246	—
K <sub>2</sub> OsCl <sub>6</sub>	1447	1447	K <sub>2</sub> TiCl <sub>6</sub>	1412	1447
Cs <sub>2</sub> OsCl <sub>6</sub>	1409	—	Rb <sub>2</sub> TiCl <sub>6</sub>	1415	1416
K <sub>2</sub> OsBr <sub>6</sub>	1396	—	Cs <sub>2</sub> TiCl <sub>6</sub>	1402	1384
K <sub>2</sub> PdCl <sub>6</sub>	1481	1493	Tl <sub>2</sub> TiCl <sub>6</sub>	1560	1553
Rb <sub>2</sub> PdCl <sub>6</sub>	1449	—	K <sub>2</sub> TiBr <sub>6</sub>	1379	1379
			Rb <sub>2</sub> TiBr <sub>6</sub>	1341	1331



Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$	Substance	Calc. $U_{\text{POT}}$	$U_{\text{POT}}^{\text{BHFC}}$
Cs <sub>2</sub> TiBr <sub>6</sub>	1339	1306	<i>Thiocyanates</i>		
Na <sub>2</sub> UBr <sub>6</sub>	1504	–	LiCNS	764	(765)
K <sub>2</sub> UBr <sub>6</sub>	1484	–	NaCNS	682	682
Rb <sub>2</sub> UBr <sub>6</sub>	1473	–	KCNS	623	616
Cs <sub>2</sub> UBr <sub>6</sub>	1459	–	RbCNS	623	619
K <sub>2</sub> WCl <sub>6</sub>	1398	1423	CsCNS	623	568
Rb <sub>2</sub> WCl <sub>6</sub>	1397	1434	NH <sub>4</sub> CNS	605	611
Cs <sub>2</sub> WCl <sub>6</sub>	1392	1366	Ca(CNS) <sub>2</sub>	2184	2118
K <sub>2</sub> WBr <sub>6</sub>	1408	1408	Sr(CNS) <sub>2</sub>	2063	1957
Rb <sub>2</sub> WBr <sub>6</sub>	1361	1391	Ba(CNS) <sub>2</sub>	1979	1852
Cs <sub>2</sub> WBr <sub>6</sub>	1362	1332	Mn(CNS) <sub>2</sub>	2280	2351
K <sub>2</sub> ZrCl <sub>6</sub>	1339	1371	Zn(CNS) <sub>2</sub>	2335	2560
Rb <sub>2</sub> ZrCl <sub>6</sub>	1341	–	Cd(CNS) <sub>2</sub>	2201	2374
Cs <sub>2</sub> ZrCl <sub>6</sub>	1339	1307	Hg(CNS) <sub>2</sub>	2146	2492
<i>Tellurides</i>			Sn(CNS) <sub>2</sub>	2117	2142
Li <sub>2</sub> Te	2212	–	Pb(CNS) <sub>2</sub>	2058	–
Na <sub>2</sub> Te	1997	2095	<i>Vanadates</i>		
K <sub>2</sub> Te	1830	–	LiVO <sub>3</sub>	810	–
Rb <sub>2</sub> Te	1837	–	NaVO <sub>3</sub>	761	–
Cs <sub>2</sub> Te	1745	–	KVO <sub>3</sub>	686	–
Cu <sub>2</sub> Te	2706	2683	RbVO <sub>3</sub>	657	–
Ag <sub>2</sub> Te	2607	2600	CsVO <sub>3</sub>	628	–
Tl <sub>2</sub> Te	2084	2172			
BeTe	3319	–			
MgTe	2878	3081			
CaTe	2721	–			

TABLE 2. Thermochemical Radii (nm)

Ion	Radius		Ion	Radius	
<i>Singly Charged Anions</i>			GaCl <sub>4</sub> <sup>-</sup>	0.328	± 0.019
AgF <sub>4</sub> <sup>-</sup>	0.231	± 0.019	H <sup>-</sup>	0.148	± 0.019
AlBr <sub>4</sub> <sup>-</sup>	0.321	± 0.023	H <sub>2</sub> AsO <sub>4</sub> <sup>-</sup>	0.227	± 0.019
AlCl <sub>4</sub> <sup>-</sup>	0.317	± 0.019	H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	0.213	± 0.019
AlF <sub>4</sub> <sup>-</sup>	0.214	± 0.023	HCO <sub>2</sub> <sup>-</sup>	0.200	± 0.019
AlH <sub>4</sub> <sup>-</sup>	0.226	± 0.019	HCO <sub>3</sub> <sup>-</sup>	0.207	± 0.019
AlI <sub>4</sub> <sup>-</sup>	0.374	± 0.019	HF <sub>2</sub> <sup>-</sup>	0.172	± 0.019
AsF <sub>6</sub> <sup>-</sup>	0.243	± 0.019	HSO <sub>4</sub> <sup>-</sup>	0.221	± 0.019
AsO <sub>2</sub> <sup>-</sup>	0.211	± 0.019	I <sup>-</sup>	0.211	± 0.019
Au(CN) <sub>2</sub> <sup>-</sup>	0.266	± 0.019	I <sub>2</sub> Br <sup>-</sup>	0.261	± 0.019
AuCl <sub>4</sub> <sup>-</sup>	0.288	± 0.019	I <sub>3</sub> <sup>-</sup>	0.272	± 0.019
AuF <sub>4</sub> <sup>-</sup>	0.240	± 0.019	I <sub>4</sub> <sup>-</sup>	0.300	± 0.019
AuF <sub>6</sub> <sup>-</sup>	0.235	± 0.038	IBr <sub>2</sub> <sup>-</sup>	0.251	± 0.019
B(OH) <sub>4</sub> <sup>-</sup>	0.229	± 0.019	ICl <sub>2</sub> <sup>-</sup>	0.235	± 0.019
BF <sub>4</sub> <sup>-</sup>	0.205	± 0.019	ICl <sub>4</sub> <sup>-</sup>	0.307	± 0.019
BH <sub>4</sub> <sup>-</sup>	0.205	± 0.019	IO <sub>2</sub> F <sub>2</sub> <sup>-</sup>	0.233	± 0.019
Br <sup>-</sup>	0.190	± 0.019	IO <sub>3</sub> <sup>-</sup>	0.218	± 0.019
BrF <sub>4</sub> <sup>-</sup>	0.231	± 0.019	IO <sub>4</sub> <sup>-</sup>	0.231	± 0.019
BrO <sub>3</sub> <sup>-</sup>	0.214	± 0.019	IrF <sub>6</sub> <sup>-</sup>	0.242	± 0.019
CF <sub>3</sub> SO <sub>3</sub> <sup>-</sup>	0.230	± 0.049	MnO <sub>4</sub> <sup>-</sup>	0.220	± 0.019
CH <sub>3</sub> CO <sub>2</sub> <sup>-</sup>	0.194	± 0.019	MoF <sub>6</sub> <sup>-</sup>	0.241	± 0.019
Cl <sup>-</sup>	0.168	± 0.019	MoOF <sub>5</sub> <sup>-</sup>	0.241	± 0.019
ClO <sub>2</sub> <sup>-</sup>	0.195	± 0.019	N <sub>3</sub> <sup>-</sup>	0.180	± 0.019
ClO <sub>3</sub> <sup>-</sup>	0.208	± 0.019	NCO <sup>-</sup>	0.193	± 0.019
ClO <sub>4</sub> <sup>-</sup>	0.225	± 0.019	NbCl <sub>6</sub> <sup>-</sup>	0.338	± 0.049
ClS <sub>2</sub> O <sub>6</sub> <sup>-</sup>	0.260	± 0.049	NbF <sub>6</sub> <sup>-</sup>	0.254	± 0.019
CN <sup>-</sup>	0.187	± 0.023	Nb <sub>2</sub> F <sub>11</sub> <sup>-</sup>	0.311	± 0.038
Cr <sub>3</sub> O <sub>8</sub> <sup>-</sup>	0.276	± 0.019	NbO <sub>3</sub> <sup>-</sup>	0.194	± 0.019
CuBr <sub>4</sub> <sup>-</sup>	0.315	± 0.019	NH <sub>2</sub> <sup>-</sup>	0.168	± 0.019
F <sup>-</sup>	0.126	± 0.019	NH <sub>2</sub> CH <sub>2</sub> COO <sup>-</sup>	0.252	± 0.019
FeCl <sub>4</sub> <sup>-</sup>	0.317	± 0.019	NO <sub>2</sub> <sup>-</sup>	0.187	± 0.019

Ion	Radius		Ion	Radius	
$\text{NO}_3^-$	0.200	$\pm 0.019$	$\text{MoCl}_6^{2-}$	0.338	$\pm 0.019$
$\text{O}_2^-$	0.165	$\pm 0.019$	$\text{MoF}_6^{2-}$	0.274	$\pm 0.019$
$\text{O}_3^-$	0.199	$\pm 0.034$	$\text{MoO}_4^{2-}$	0.231	$\pm 0.019$
$\text{OH}^-$	0.152	$\pm 0.019$	$\text{NbCl}_6^{2-}$	0.343	$\pm 0.019$
$\text{OsF}_6^-$	0.252	$\pm 0.020$	$\text{NH}_2^-$	0.128	$\pm 0.019$
$\text{PaF}_6^-$	0.249	$\pm 0.019$	$\text{Ni}(\text{CN})_4^{2-}$	0.322	$\pm 0.019$
$\text{PdF}_6^-$	0.252	$\pm 0.019$	$\text{NiF}_4^{2-}$	0.211	$\pm 0.019$
$\text{PF}_6^-$	0.242	$\pm 0.019$	$\text{NiF}_6^{2-}$	0.249	$\pm 0.019$
$\text{PO}_3^-$	0.204	$\pm 0.019$	$\text{O}^{2-}$	0.141	$\pm 0.019$
$\text{PtF}_6^-$	0.247	$\pm 0.019$	$\text{O}_2^{2-}$	0.167	$\pm 0.019$
$\text{PuF}_5^-$	0.239	$\pm 0.019$	$\text{OsBr}_6^{2-}$	0.365	$\pm 0.019$
$\text{ReF}_6^-$	0.240	$\pm 0.019$	$\text{OsCl}_6^{2-}$	0.336	$\pm 0.019$
$\text{ReO}_4^-$	0.227	$\pm 0.019$	$\text{OsF}_6^{2-}$	0.276	$\pm 0.019$
$\text{RuF}_6^-$	0.242	$\pm 0.019$	$\text{PbCl}_4^{2-}$	0.279	$\pm 0.019$
$\text{S}_6^{2-}$	0.305	$\pm 0.019$	$\text{PbCl}_6^{2-}$	0.347	$\pm 0.019$
$\text{SCN}^-$	0.209	$\pm 0.019$	$\text{PbF}_6^{2-}$	0.268	$\pm 0.019$
$\text{SbCl}_6^-$	0.320	$\pm 0.019$	$\text{PdB}_6^{2-}$	0.354	$\pm 0.019$
$\text{SbF}_6^-$	0.252	$\pm 0.019$	$\text{PdCl}_4^{2-}$	0.313	$\pm 0.019$
$\text{Sb}_2\text{F}_{11}^-$	0.312	$\pm 0.038$	$\text{PdCl}_6^{2-}$	0.333	$\pm 0.019$
$\text{Sb}_3\text{F}_{14}^-$	0.374	$\pm 0.038$	$\text{PdF}_6^{2-}$	0.252	$\pm 0.019$
$\text{SeCl}_5^-$	0.258	$\pm 0.038$	$\text{PoBr}_6^{2-}$	0.380	$\pm 0.019$
$\text{SeCN}^-$	0.230	$\pm 0.019$	$\text{PoI}_6^{2-}$	0.428	$\pm 0.019$
$\text{SeH}^-$	0.195	$\pm 0.019$	$\text{Pt}(\text{NO}_2)_3\text{Cl}_3^{2-}$	0.364	$\pm 0.019$
$\text{SH}^-$	0.191	$\pm 0.019$	$\text{Pt}(\text{NO}_2)_4\text{Cl}_2^{2-}$	0.383	$\pm 0.019$
$\text{SO}_3\text{F}^-$	0.214	$\pm 0.019$	$\text{Pt}(\text{OH})_2^{2-}$	0.333	$\pm 0.019$
$\text{S}_3\text{N}_3^-$	0.231	$\pm 0.038$	$\text{Pt}(\text{SCN})_6^{2-}$	0.451	$\pm 0.019$
$\text{S}_3\text{N}_3\text{O}_4^-$	0.252	$\pm 0.038$	$\text{PtBr}_4^{2-}$	0.324	$\pm 0.019$
$\text{TaCl}_6^-$	0.352	$\pm 0.019$	$\text{PtBr}_6^{2-}$	0.363	$\pm 0.019$
$\text{TaF}_6^-$	0.250	$\pm 0.019$	$\text{PtCl}_4^{2-}$	0.307	$\pm 0.019$
$\text{TaO}_3^-$	0.192	$\pm 0.019$	$\text{PtCl}_6^{2-}$	0.333	$\pm 0.019$
$\text{UF}_6^-$	0.301	$\pm 0.019$	$\text{PtF}_6^{2-}$	0.245	$\pm 0.019$
$\text{VF}_6^-$	0.235	$\pm 0.019$	$\text{PuCl}_6^{2-}$	0.349	$\pm 0.019$
$\text{VO}_3^-$	0.201	$\pm 0.019$	$\text{ReBr}_6^{2-}$	0.371	$\pm 0.019$
$\text{WCl}_6^-$	0.337	$\pm 0.019$	$\text{ReCl}_6^{2-}$	0.337	$\pm 0.019$
$\text{WF}_6^-$	0.246	$\pm 0.019$	$\text{ReF}_6^{2-}$	0.256	$\pm 0.019$
$\text{WOF}_5^-$	0.241	$\pm 0.019$	$\text{ReF}_8^{2-}$	0.276	$\pm 0.019$
<b>Doubly Charged Anions</b>			$\text{ReH}_9^{2-}$	0.257	$\pm 0.019$
$\text{AmF}_6^{2-}$	0.255	$\pm 0.019$	$\text{ReI}_6^{2-}$	0.421	$\pm 0.026$
$\text{Bi}_2\text{Br}_8^{2-}$	0.392	$\pm 0.055$	$\text{RhF}_6^{2-}$	0.240	$\pm 0.019$
$\text{Bi}_6\text{Cl}_{20}^{2-}$	0.501	$\pm 0.073$	$\text{RuCl}_6^{2-}$	0.336	$\pm 0.019$
$\text{CdCl}_4^{2-}$	0.307	$\pm 0.019$	$\text{RuF}_6^{2-}$	0.248	$\pm 0.019$
$\text{CeCl}_6^{2-}$	0.352	$\pm 0.019$	$\text{S}^{2-}$	0.189	$\pm 0.019$
$\text{CeF}_6^{2-}$	0.249	$\pm 0.019$	$\text{S}_2\text{O}_3^{2-}$	0.251	$\pm 0.019$
$\text{CO}_3^{2-}$	0.189	$\pm 0.019$	$\text{S}_2\text{O}_4^{2-}$	0.262	$\pm 0.019$
$\text{CoCl}_4^{2-}$	0.306	$\pm 0.019$	$\text{S}_2\text{O}_5^{2-}$	0.270	$\pm 0.019$
$\text{CoF}_4^{2-}$	0.209	$\pm 0.019$	$\text{S}_2\text{O}_6^{2-}$	0.283	$\pm 0.019$
$\text{CoF}_6^{2-}$	0.256	$\pm 0.019$	$\text{S}_2\text{O}_7^{2-}$	0.275	$\pm 0.019$
$\text{Cr}_2\text{O}_7^{2-}$	0.292	$\pm 0.019$	$\text{S}_2\text{O}_8^{2-}$	0.291	$\pm 0.019$
$\text{CrF}_6^{2-}$	0.253	$\pm 0.019$	$\text{S}_3\text{O}_6^{2-}$	0.302	$\pm 0.019$
$\text{CrO}_4^{2-}$	0.229	$\pm 0.019$	$\text{S}_4\text{O}_6^{2-}$	0.325	$\pm 0.019$
$\text{CuCl}_4^{2-}$	0.304	$\pm 0.019$	$\text{S}_6\text{O}_6^{2-}$	0.382	$\pm 0.019$
$\text{CuF}_4^{2-}$	0.213	$\pm 0.019$	$\text{ScF}_6^{2-}$	0.276	$\pm 0.019$
$\text{GeCl}_6^{2-}$	0.335	$\pm 0.019$	$\text{Se}^{2-}$	0.181	$\pm 0.019$
$\text{GeF}_6^{2-}$	0.244	$\pm 0.019$	$\text{SeBr}_6^{2-}$	0.363	$\pm 0.019$
$\text{HfF}_6^{2-}$	0.248	$\pm 0.019$	$\text{SeCl}_6^{2-}$	0.336	$\pm 0.019$
$\text{HgI}_4^{2-}$	0.377	$\pm 0.019$	$\text{SeO}_4^{2-}$	0.229	$\pm 0.019$
$\text{IrCl}_6^{2-}$	0.332	$\pm 0.019$	$\text{SiF}_6^{2-}$	0.248	$\pm 0.019$
$\text{MnCl}_6^{2-}$	0.314	$\pm 0.031$	$\text{SiO}_3^{2-}$	0.195	$\pm 0.019$
$\text{MnF}_4^{2-}$	0.219	$\pm 0.019$	$\text{SmF}_4^{2-}$	0.218	$\pm 0.019$
$\text{MnF}_6^{2-}$	0.241	$\pm 0.019$	$\text{Sn}(\text{OH})_6^{2-}$	0.279	$\pm 0.020$
$\text{MoBr}_6^{2-}$	0.364	$\pm 0.019$	$\text{SnBr}_6^{2-}$	0.374	$\pm 0.019$

Ion	Radius		Ion	Radius	
SnCl <sub>6</sub> <sup>2-</sup>	0.345	± 0.019	Ni(NO <sub>2</sub> ) <sub>6</sub> <sup>4-</sup>	0.383	± 0.038
SnF <sub>6</sub> <sup>2-</sup>	0.265	± 0.019	NiF <sub>6</sub> <sup>3-</sup>	0.250	± 0.042
SnI <sub>6</sub> <sup>2-</sup>	0.427	± 0.019	O <sup>3-</sup>	0.288	± 0.038
SO <sub>3</sub> <sup>2-</sup>	0.204	± 0.019	P <sup>3-</sup>	0.224	± 0.042
SO <sub>4</sub> <sup>2-</sup>	0.218	± 0.019	PaF <sub>8</sub> <sup>3-</sup>	0.299	± 0.042
TcBr <sub>6</sub> <sup>2-</sup>	0.363	± 0.019	PO <sub>4</sub> <sup>3-</sup>	0.230	± 0.042
TcCl <sub>6</sub> <sup>2-</sup>	0.337	± 0.019	PrF <sub>6</sub> <sup>3-</sup>	0.281	± 0.038
TcF <sub>6</sub> <sup>2-</sup>	0.244	± 0.019	Rh(NO <sub>2</sub> ) <sub>6</sub> <sup>3-</sup>	0.345	± 0.038
TcH <sub>9</sub> <sup>2-</sup>	0.260	± 0.019	Rh(SCN) <sub>6</sub> <sup>3-</sup>	0.428	± 0.042
TcI <sub>6</sub> <sup>2-</sup>	0.419	± 0.019	TaF <sub>8</sub> <sup>3-</sup>	0.284	± 0.042
Te <sup>2-</sup>	0.220	± 0.019	TbF <sub>7</sub> <sup>3-</sup>	0.290	± 0.038
TeBr <sub>6</sub> <sup>2-</sup>	0.383	± 0.019	Tc(CN) <sub>6</sub> <sup>5-</sup>	0.410	± 0.042
TeCl <sub>6</sub> <sup>2-</sup>	0.353	± 0.019	ThF <sub>7</sub> <sup>3-</sup>	0.282	± 0.042
TeI <sub>6</sub> <sup>2-</sup>	0.430	± 0.019	TiBr <sub>6</sub> <sup>3-</sup>	0.315	± 0.038
TeO <sub>4</sub> <sup>2-</sup>	0.238	± 0.019	TiF <sub>6</sub> <sup>3-</sup>	0.271	± 0.038
Th(NO <sub>3</sub> ) <sub>6</sub> <sup>2-</sup>	0.424	± 0.019	UF <sub>7</sub> <sup>3-</sup>	0.285	± 0.042
ThCl <sub>6</sub> <sup>2-</sup>	0.360	± 0.019	YF <sub>6</sub> <sup>3-</sup>	0.275	± 0.038
ThF <sub>6</sub> <sup>2-</sup>	0.263	± 0.019	ZrF <sub>7</sub> <sup>3-</sup>	0.273	± 0.038
TiBr <sub>6</sub> <sup>2-</sup>	0.356	± 0.019			
TiCl <sub>6</sub> <sup>2-</sup>	0.335	± 0.019	<i>Singly Charged Cations</i>		
TiF <sub>6</sub> <sup>2-</sup>	0.252	± 0.019	N(CH <sub>3</sub> ) <sub>4</sub> <sup>+</sup>	0.234	± 0.019
UCl <sub>6</sub> <sup>2-</sup>	0.354	± 0.019	N <sub>2</sub> H <sub>5</sub> <sup>+</sup>	0.158	± 0.019
UF <sub>6</sub> <sup>2-</sup>	0.256	± 0.019	N <sub>2</sub> H <sub>6</sub> <sup>2+</sup>	0.158	± 0.029
VO <sub>3</sub> <sup>2-</sup>	0.204	± 0.019	NH(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> <sup>+</sup>	0.274	± 0.019
WBr <sub>6</sub> <sup>2-</sup>	0.363	± 0.019	NH <sub>3</sub> C <sub>2</sub> H <sub>5</sub> <sup>+</sup>	0.193	± 0.019
WCl <sub>6</sub> <sup>2-</sup>	0.339	± 0.019	NH <sub>3</sub> C <sub>3</sub> H <sub>7</sub> <sup>+</sup>	0.225	± 0.019
WO <sub>4</sub> <sup>2-</sup>	0.237	± 0.019	NH <sub>3</sub> CH <sub>3</sub> <sup>+</sup>	0.177	± 0.019
WOCl <sub>5</sub> <sup>2-</sup>	0.334	± 0.019	NH <sub>3</sub> OH <sup>+</sup>	0.147	± 0.019
ZnBr <sub>4</sub> <sup>2-</sup>	0.335	± 0.019	NH <sub>4</sub> <sup>+</sup>	0.136	± 0.019
ZnCl <sub>4</sub> <sup>2-</sup>	0.306	± 0.019	NH <sub>3</sub> C <sub>2</sub> H <sub>4</sub> OH <sup>+</sup>	0.203	± 0.019
ZnF <sub>4</sub> <sup>2-</sup>	0.219	± 0.019	As <sub>3</sub> S <sub>4</sub> <sup>+</sup>	0.244	± 0.027
ZnI <sub>4</sub> <sup>2-</sup>	0.384	± 0.019	As <sub>3</sub> Se <sub>4</sub> <sup>+</sup>	0.253	± 0.027
ZrBr <sub>4</sub> <sup>2-</sup>	0.334	± 0.019	AsCl <sub>4</sub> <sup>+</sup>	0.221	± 0.027
ZrCl <sub>4</sub> <sup>2-</sup>	0.306	± 0.019	Br <sub>2</sub> <sup>+</sup>	0.155	± 0.027
ZrCl <sub>6</sub> <sup>2-</sup>	0.348	± 0.019	Br <sub>3</sub> <sup>+</sup>	0.204	± 0.027
ZrF <sub>6</sub> <sup>2-</sup>	0.258	± 0.019	Br <sub>3</sub> <sup>-</sup>	0.238	± 0.027
			Br <sub>5</sub> <sup>-</sup>	0.229	± 0.027
<i>Multi-Charged Anions</i>			BrClCNH <sub>2</sub> <sup>+</sup>	0.175	± 0.027
AlH <sub>6</sub> <sup>3-</sup>	0.256	± 0.042	BrF <sub>2</sub> <sup>+</sup>	0.183	± 0.027
AsO <sub>4</sub> <sup>3-</sup>	0.237	± 0.042	BrF <sub>4</sub> <sup>+</sup>	0.172	± 0.027
CdBr <sub>6</sub> <sup>4-</sup>	0.374	± 0.038	C <sub>10</sub> F <sub>8</sub> <sup>+</sup>	0.265	± 0.027
CdCl <sub>6</sub> <sup>4-</sup>	0.352	± 0.038	C <sub>6</sub> F <sub>6</sub> <sup>+</sup>	0.228	± 0.027
CeF <sub>6</sub> <sup>3-</sup>	0.278	± 0.038	Cl(SNSCN) <sub>2</sub> <sup>+</sup>	0.347	± 0.027
CeF <sub>7</sub> <sup>3-</sup>	0.282	± 0.038	Cl <sub>2</sub> C=NH <sub>2</sub> <sup>+</sup>	0.173	± 0.027
Co(CN) <sub>6</sub> <sup>3-</sup>	0.349	± 0.038	Cl <sub>2</sub> F <sup>+</sup>	0.165	± 0.027
Co(NO <sub>2</sub> ) <sub>6</sub> <sup>3-</sup>	0.343	± 0.038	Cl <sub>3</sub> <sup>+</sup>	0.182	± 0.027
CoCl <sub>5</sub> <sup>3-</sup>	0.320	± 0.038	ClF <sub>2</sub> <sup>+</sup>	0.147	± 0.027
CoF <sub>6</sub> <sup>3-</sup>	0.258	± 0.042	ClO <sub>2</sub> <sup>+</sup>	0.118	± 0.027
Cr(CN) <sub>6</sub> <sup>3-</sup>	0.351	± 0.038	GaBr <sub>4</sub> <sup>-</sup>	0.317	± 0.038
CrF <sub>6</sub> <sup>3-</sup>	0.254	± 0.042	I <sub>2</sub> <sup>+</sup>	0.185	± 0.027
Cu(CN) <sub>4</sub> <sup>3-</sup>	0.312	± 0.038	I <sub>3</sub> <sup>+</sup>	0.225	± 0.027
Fe(CN) <sub>6</sub> <sup>3-</sup>	0.347	± 0.038	I <sub>5</sub> <sup>+</sup>	0.263	± 0.027
FeF <sub>6</sub> <sup>3-</sup>	0.298	± 0.042	IBr <sub>2</sub> <sup>+</sup>	0.196	± 0.027
HfF <sub>7</sub> <sup>3-</sup>	0.277	± 0.042	ICl <sub>2</sub> <sup>+</sup>	0.175	± 0.036
InF <sub>6</sub> <sup>3-</sup>	0.268	± 0.038	IF <sub>6</sub> <sup>+</sup>	0.209	± 0.027
Ir(CN) <sub>6</sub> <sup>3-</sup>	0.347	± 0.038	N(S <sub>3</sub> N <sub>2</sub> ) <sub>2</sub> <sup>+</sup>	0.258	± 0.027
Ir(NO <sub>2</sub> ) <sub>6</sub> <sup>3-</sup>	0.338	± 0.038	N(SCl) <sub>2</sub> <sup>+</sup>	0.186	± 0.027
Mn(CN) <sub>6</sub> <sup>3-</sup>	0.350	± 0.038	N(SeCl) <sub>2</sub> <sup>+</sup>	0.246	± 0.027
Mn(CN) <sub>6</sub> <sup>5-</sup>	0.401	± 0.042	N(SE <sub>2</sub> ) <sub>2</sub> <sup>+</sup>	0.214	± 0.027
MnCl <sub>6</sub> <sup>4-</sup>	0.349	± 0.038	N <sub>2</sub> F <sup>+</sup>	0.156	± 0.027
N <sup>3-</sup>	0.180	± 0.042	NO <sup>+</sup>	0.145	± 0.027
Ni(NO <sub>2</sub> ) <sub>6</sub> <sup>3-</sup>	0.342	± 0.038	NO <sub>2</sub> <sup>+</sup>	0.153	± 0.027

Ion	Radius	Ion	Radius
O <sub>2</sub> <sup>+</sup>	0.140 ± 0.027	(SNPMe) <sub>3</sub> <sup>+</sup>	0.308 ± 0.027
O <sub>2</sub> (SCCF <sub>3</sub> Cl) <sub>2</sub> <sup>+</sup>	0.275 ± 0.027	SNSC(CH <sub>3</sub> )N <sup>+</sup>	0.225 ± 0.027
ONCH <sub>3</sub> CF <sub>3</sub> <sup>+</sup>	0.200 ± 0.027	SNSC(CN)CH <sup>+</sup>	0.209 ± 0.027
OsOF <sub>5</sub>	0.246 ± 0.038	SNSC(Ph)N <sup>+</sup>	0.251 ± 0.027
P(CH <sub>3</sub> ) <sub>3</sub> Cl <sup>+</sup>	0.197 ± 0.027	SNSC(Ph)NS <sub>3</sub> N <sub>2</sub> <sup>+</sup>	0.327 ± 0.027
P(CH <sub>3</sub> ) <sub>3</sub> D <sup>+</sup>	0.196 ± 0.027	SNSC(PhCH <sub>3</sub> )N <sup>+</sup>	0.264 ± 0.027
PCl <sub>4</sub> <sup>+</sup>	0.235 ± 0.027	(Te(N(SiMe <sub>3</sub> ) <sub>2</sub> ) <sub>2</sub> ) <sup>+</sup>	0.371 ± 0.027
ReOF <sub>5</sub> <sup>-</sup>	0.245 ± 0.038	Te(N <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0.226 ± 0.027
S(CH <sub>3</sub> ) <sub>2</sub> Cl <sup>+</sup>	0.207 ± 0.027	Te <sub>4</sub> Nb <sub>3</sub> O <sub>2</sub> Te <sub>2</sub> I <sub>6</sub> <sup>+</sup>	0.407 ± 0.027
S(N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0.439 ± 0.027	TeBr <sub>3</sub> <sup>+</sup>	0.235 ± 0.027
S <sub>2</sub> (CH <sub>3</sub> ) <sub>2</sub> Cl <sup>+</sup>	0.265 ± 0.027	TeCl <sub>3</sub> <sup>+</sup>	0.216 ± 0.027
S <sub>2</sub> (CH <sub>3</sub> ) <sub>2</sub> CN <sup>+</sup>	0.223 ± 0.027	TeCl <sub>3</sub> (15-crown-5) <sup>+</sup>	0.282 ± 0.027
S <sub>2</sub> (CH <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0.233 ± 0.027	TeI <sub>3</sub> <sup>+</sup>	0.243 ± 0.027
S <sub>2</sub> Br <sub>5</sub> <sup>+</sup>	0.267 ± 0.027	XeF <sub>11</sub> <sup>+</sup>	0.266 ± 0.027
S <sub>2</sub> N <sup>+</sup>	0.159 ± 0.034	Xe <sub>2</sub> F <sub>3</sub> <sup>+</sup>	0.221 ± 0.027
S <sub>2</sub> N <sub>2</sub> C <sub>2</sub> H <sub>3</sub> <sup>+</sup>	0.211 ± 0.027	XeF <sup>+</sup>	0.174 ± 0.027
S <sub>2</sub> NC <sub>2</sub> (PhCH <sub>3</sub> ) <sub>2</sub> <sup>+</sup>	0.310 ± 0.027	XeF <sub>5</sub> <sup>+</sup>	0.183 ± 0.027
S <sub>2</sub> NC <sub>3</sub> H <sub>4</sub> <sup>+</sup>	0.218 ± 0.027	XeF <sub>5</sub> <sup>+</sup>	0.186 ± 0.027
S <sub>2</sub> NC <sub>4</sub> H <sub>8</sub> <sup>+</sup>	0.225 ± 0.027	XeOF <sub>3</sub> <sup>+</sup>	0.186 ± 0.027
S <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0.239 ± 0.027		
S <sub>3</sub> Br <sub>3</sub> <sup>+</sup>	0.245 ± 0.027	<i>Doubly Charged Cations</i>	
S <sub>3</sub> C <sub>3</sub> H <sub>7</sub> <sup>+</sup>	0.199 ± 0.027	Co <sub>2</sub> S <sub>2</sub> (CO) <sub>6</sub> <sup>2+</sup>	0.263 ± 0.035
S <sub>3</sub> C <sub>4</sub> F <sub>6</sub> <sup>+</sup>	0.261 ± 0.027	FeW(Se) <sub>2</sub> (CO) <sub>2</sub> <sup>2+</sup>	0.260 ± 0.035
S <sub>3</sub> CF <sub>3</sub> CN <sup>+</sup>	0.263 ± 0.027	I <sub>4</sub> <sup>2+</sup>	0.207 ± 0.035
S <sub>3</sub> Cl <sub>3</sub> <sup>+</sup>	0.233 ± 0.027	Mo(Te <sub>3</sub> )(CO) <sub>4</sub> <sup>2+</sup>	0.234 ± 0.035
S <sub>3</sub> N <sub>2</sub> <sup>+</sup>	0.201 ± 0.027	S <sub>19</sub> <sup>2+</sup>	0.292 ± 0.035
S <sub>3</sub> N <sub>2</sub> Cl <sup>+</sup>	0.232 ± 0.027	S <sub>2</sub> (S(CH <sub>3</sub> ) <sub>2</sub> ) <sub>2</sub> <sup>2+</sup>	0.230 ± 0.035
S <sub>4</sub> N <sub>3</sub> <sup>+</sup>	0.231 ± 0.027	S <sub>2</sub> I <sub>4</sub> <sup>2+</sup>	0.231 ± 0.035
S <sub>4</sub> N <sub>3</sub> (Ph) <sub>2</sub> <sup>+</sup>	0.316 ± 0.027	S <sub>3</sub> N <sub>2</sub> <sup>2+</sup>	0.184 ± 0.035
S <sub>4</sub> N <sub>4</sub> H <sup>+</sup>	0.178 ± 0.027	S <sub>3</sub> NCCNS <sub>3</sub> <sup>2+</sup>	0.220 ± 0.035
S <sub>5</sub> N <sub>5</sub> <sup>+</sup>	0.257 ± 0.027	S <sub>3</sub> Se <sup>2+</sup>	0.326 ± 0.035
S <sub>7</sub> I <sup>+</sup>	0.262 ± 0.027	S <sub>4</sub> N <sub>4</sub> <sup>2+</sup>	0.186 ± 0.035
Sb(NPPPh <sub>3</sub> ) <sub>4</sub> <sup>+</sup>	0.518 ± 0.027	S <sub>6</sub> N <sub>4</sub> <sup>2+</sup>	0.232 ± 0.035
SBr <sub>3</sub> <sup>+</sup>	0.220 ± 0.027	S <sub>8</sub> <sup>2+</sup>	0.182 ± 0.035
SCH <sub>3</sub> O <sub>3</sub> <sup>+</sup>	0.183 ± 0.027	Se <sub>10</sub> <sup>2+</sup>	0.253 ± 0.035
SCH <sub>3</sub> P(CH <sub>3</sub> ) <sub>3</sub> <sup>+</sup>	0.248 ± 0.027	Se <sub>17</sub> <sup>2+</sup>	0.236 ± 0.035
SCH <sub>3</sub> PCH <sub>3</sub> Cl <sub>2</sub> <sup>+</sup>	0.205 ± 0.027	Se <sub>19</sub> <sup>2+</sup>	0.296 ± 0.035
SCl(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> <sup>+</sup>	0.207 ± 0.027	Se <sub>2</sub> I <sub>4</sub> <sup>2+</sup>	0.218 ± 0.035
SCl <sub>2</sub> CF <sub>3</sub> <sup>+</sup>	0.207 ± 0.027	Se <sub>3</sub> N <sub>2</sub> <sup>2+</sup>	0.182 ± 0.035
SCl <sub>2</sub> CH <sub>3</sub> <sup>+</sup>	0.204 ± 0.027	Se <sub>4</sub> <sup>2+</sup>	0.152 ± 0.035
SCl <sub>3</sub> <sup>+</sup>	0.185 ± 0.027	Se <sub>5</sub> S <sub>2</sub> N <sub>4</sub> <sup>2+</sup>	0.224 ± 0.035
Se <sub>3</sub> Br <sub>3</sub> <sup>+</sup>	0.253 ± 0.027	Se <sub>8</sub> <sup>2+</sup>	0.186 ± 0.035
Se <sub>3</sub> Cl <sub>3</sub> <sup>+</sup>	0.245 ± 0.027	SeN <sub>2</sub> S <sub>2</sub> <sup>2+</sup>	0.182 ± 0.035
Se <sub>3</sub> N <sub>2</sub> <sup>+</sup>	0.288 ± 0.042	(SNP(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> ) <sub>2</sub> <sup>2+</sup>	0.312 ± 0.035
Se <sub>3</sub> NC <sub>12</sub> <sup>+</sup>	0.163 ± 0.027	TaBr <sub>6</sub> <sup>-</sup>	0.351 ± 0.049
Se <sub>6</sub> I <sup>+</sup>	0.260 ± 0.027	Te(trtu) <sub>4</sub> <sup>2+</sup>	0.328 ± 0.035
SeBr <sub>3</sub> <sup>+</sup>	0.182 ± 0.027	Te(tu) <sub>4</sub> <sup>2+</sup>	0.296 ± 0.035
SeCl <sub>3</sub> <sup>+</sup>	0.192 ± 0.027	Te <sub>2</sub> (esu) <sub>4</sub> Br <sub>2</sub> <sup>2+</sup>	0.356 ± 0.035
SeF <sub>3</sub> <sup>+</sup>	0.179 ± 0.027	Te <sub>2</sub> (esu) <sub>4</sub> Cl <sub>2</sub> <sup>2+</sup>	0.361 ± 0.035
SeI <sub>3</sub> <sup>+</sup>	0.238 ± 0.027	Te <sub>2</sub> (esu) <sub>4</sub> I <sub>2</sub> <sup>2+</sup>	0.342 ± 0.035
SeN <sub>2</sub> Cl <sup>+</sup>	0.196 ± 0.027	Te <sub>2</sub> Se <sub>2</sub> <sup>2+</sup>	0.192 ± 0.035
SeNCl <sub>2</sub> <sup>+</sup>	0.157 ± 0.027	Te <sub>2</sub> Se <sub>4</sub> <sup>2+</sup>	0.222 ± 0.035
(SeNMe) <sub>3</sub> <sup>+</sup>	0.406 ± 0.027	Te <sub>2</sub> Se <sub>8</sub> <sup>2+</sup>	0.252 ± 0.035
SeS <sub>2</sub> N <sub>2</sub> <sup>+</sup>	0.282 ± 0.042	Te <sub>2</sub> S <sub>3</sub> <sup>2+</sup>	0.217 ± 0.035
SF(C <sub>6</sub> F <sub>5</sub> ) <sub>2</sub> <sup>+</sup>	0.294 ± 0.027	Te <sub>3</sub> Se <sup>2+</sup>	0.193 ± 0.035
SF <sub>2</sub> CF <sub>3</sub> <sup>+</sup>	0.198 ± 0.027	Te <sub>4</sub> <sup>2+</sup>	0.169 ± 0.035
SF <sub>2</sub> N(CH <sub>3</sub> ) <sub>2</sub> <sup>+</sup>	0.210 ± 0.027	Te <sub>8</sub> <sup>2+</sup>	0.187 ± 0.035
SF <sub>3</sub> <sup>+</sup>	0.172 ± 0.027	W(CO) <sub>6</sub> (h3-Te) <sup>2+</sup>	0.234 ± 0.035
SFS(C(CF <sub>3</sub> ) <sub>2</sub> ) <sub>2</sub> <sup>+</sup>	0.275 ± 0.027	W <sub>2</sub> (CO) <sub>10</sub> Se <sub>4</sub> <sup>2+</sup>	0.290 ± 0.035
SH <sub>2</sub> C <sub>3</sub> H <sub>7</sub> <sup>+</sup>	0.210 ± 0.027		
SN <sup>+</sup>	0.158 ± 0.027	<i>Multi-Charged Cations</i>	
SNCl <sub>5</sub> (CH <sub>3</sub> CN) <sup>-</sup>	0.290 ± 0.038	I <sub>15</sub> <sup>3+</sup>	0.442 ± 0.051
		Te <sub>2</sub> (su) <sub>6</sub> <sup>4+</sup>	0.453 ± 0.034

Ligand abbreviations: su = selenourea; esu = ethyleneselenourea; tu = thiourea; ph = phenyl.

TABLE 3. Ancillary Thermochemical Data  
(kJ mol<sup>-1</sup>)

Species	State	$\Delta_f H^\circ$
AsO <sub>4</sub> <sup>3-</sup>	g	(289)
BrO <sub>3</sub> <sup>-</sup>	g	-145
ClO <sub>4</sub> <sup>-</sup>	g	-344
CN <sup>-</sup>	g	66
CO <sub>3</sub> <sup>2-</sup>	g	-321
Fe(NO <sub>3</sub> ) <sub>2</sub>	c	(-448)
HF <sub>2</sub> <sup>-</sup>	g	-774
HfCl <sub>6</sub> <sup>2-</sup>	g	-1640
IO <sub>2</sub> F <sub>2</sub> <sup>-</sup>	g	-693
IO <sub>3</sub> <sup>-</sup>	g	-208
IrCl <sub>6</sub> <sup>2-</sup>	g	-785
LiCH <sub>3</sub> O <sub>2</sub>	c	(-745)
NbCl <sub>6</sub> <sup>2-</sup>	g	-1224
NH <sub>2</sub> CH <sub>2</sub> CO <sub>2</sub> <sup>-</sup>	g	-564
O <sub>2</sub> <sup>2-</sup>	g	553
PdCl <sub>6</sub> <sup>2-</sup>	g	-749
PO <sub>4</sub> <sup>3-</sup>	g	291
PtCl <sub>6</sub> <sup>2-</sup>	g	-774
ReBr <sub>6</sub> <sup>2-</sup>	g	-689
ReCl <sub>6</sub> <sup>2-</sup>	g	-919
Ti(OH) <sub>2</sub>	c	-778

## THE MADELUNG CONSTANT AND CRYSTAL LATTICE ENERGY

If  $U$  is the crystal lattice energy and  $M$  is the Madelung constant, then<sup>a</sup>

$$U = \frac{NMz_1z_2e^2}{r}(1 - 1/n)$$

Substance	Ion type	Crystal form <sup>b</sup>	$M$
Sodium chloride, NaCl	M <sup>+</sup> , X <sup>-</sup>	FCC	1.74756
Cesium chloride, CsCl	M <sup>+</sup> , X <sup>-</sup>	BCC	1.76267
Calcium chloride, CaCl <sub>2</sub>	M <sup>++</sup> , 2X <sup>-</sup>	Cubic	2.365
Calcium fluoride (fluorite), CaF <sub>2</sub>	M <sup>++</sup> , 2X <sup>-</sup>	Cubic	2.51939
Cadmium chloride, CdCl <sub>2</sub>	M <sup>++</sup> , 2X <sup>-</sup>	Hexagonal	2.244 <sup>c</sup>
Cadmium iodide (α), CdI <sub>2</sub>	M <sup>++</sup> , 2X <sup>-</sup>	Hexagonal	2.355 <sup>c</sup>
Magnesium fluoride, MgF <sub>2</sub>	M <sup>++</sup> , 2X <sup>-</sup>	Tetragonal	2.381 <sup>c</sup>
Cuprous oxide (cuprite), Cu <sub>2</sub> O	2M <sup>+</sup> , X <sup>--</sup>	Cubic	2.22124
Zinc oxide, ZnO	M <sup>++</sup> , X <sup>--</sup>	Hexagonal	1.4985 <sup>c</sup>
Sphalerite (zinc blende), ZnS	M <sup>++</sup> , X <sup>--</sup>	FCC	1.63806
Wurtzite, ZnS	M <sup>++</sup> , X <sup>--</sup>	Hexagonal	1.64132 <sup>c</sup>
Titanium dioxide (anatase), TiO <sub>2</sub>	M <sup>4+</sup> , 2X <sup>--</sup>	Tetragonal	2.400 <sup>c</sup>
Titanium dioxide (rutile), TiO <sub>2</sub>	M <sup>4+</sup> , 2X <sup>--</sup>	Tetragonal	2.408 <sup>c</sup>
β-Quartz, SiO <sub>2</sub>	M <sup>4+</sup> , 2X <sup>--</sup>	Hexagonal	2.2197 <sup>c</sup>
Corundum, Al <sub>2</sub> O <sub>3</sub>	2M <sup>3+</sup> , 3X <sup>--</sup>	Rhombohedral	4.1719

<sup>a</sup>  $N$  is Avogadro's number,  $z_1$  and  $z_2$  are the integral charges on the ions (in units of  $e$ ), and  $e$  is the charge on the electron in electrostatic units ( $e = 4.803 \times 10^{-10}$  esu).  $r$  is the shortest distance between cation-anion pairs in centimeters. Then  $U$  is in ergs ( $1 \text{ erg} = 10^{-7} \text{ J}$ ).

<sup>b</sup> FCC = face centered cubic; BCC = body centered cubic.

<sup>c</sup> For tetragonal and hexagonal crystals the value of  $M$  depends on the details of the lattice parameters.

The Born Exponent,  $n$  is:

Ion type	$n$
He, Li <sup>+</sup>	5
Ne, Na <sup>+</sup> , F <sup>-</sup>	7
Ar, K <sup>+</sup> , Cu <sup>+</sup> , Cl <sup>-</sup>	9
Kr, Rb <sup>+</sup> , Ag <sup>+</sup> , Br <sup>-</sup>	10
Xe, Cs <sup>+</sup> , Au <sup>+</sup> , I <sup>-</sup>	12

For a crystal with a mixed-ion type, an average of the values of  $n$  in this table is to be used (6 for LiF, for example).

# ELASTIC CONSTANTS OF SINGLE CRYSTALS

H. P. R. Frederikse

This table gives selected values of elastic constants for single crystals. The values believed most reliable were selected from the original literature. The substances are arranged by crystal system and, within each system, alphabetically by name. A reference to the original literature is given for each value; a useful compilation of published values from many sources may be found in Reference 1 below.

Data are given for the single-crystal density and for the elastic constants  $c_{ij}$ , in units of  $10^{11}$  N/m<sup>2</sup>, which is equivalent to  $10^{12}$  dyn/cm<sup>2</sup>.

## General References

1. Simmons, G., and Wang, H., *Single Crystal Elastic Constants and Calculated Aggregate Properties: A Handbook, Second Edition*, The MIT Press, Cambridge, MA, 1971.
2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw-Hill, New York, 1972.

## CUBIC CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{44}$
Aluminum	Al	2.6970	298	1	1.0675	0.6041	0.2834
Aluminum antimonide	AlSb	4.3600	300	2	0.8939	0.4427	0.4155
Ammonium bromide	NH <sub>4</sub> Br	2.4314	300	3	0.3414	0.0782	0.0722
Ammonium chloride	NH <sub>4</sub> Cl	1.5279	290	4	0.3814	0.0866	0.0903
Argon	Ar	1.7710	4.2	5	0.0529	0.0135	0.0159
Barium fluoride	BaF <sub>2</sub>	4.8860	298	6	0.9199	0.4157	0.2568
Barium nitrate	Ba(NO <sub>3</sub> ) <sub>2</sub>	3.2560	293	7	0.2925	0.2065	0.1277
Calcium fluoride	CaF <sub>2</sub>	3.810	298	8	1.6420	0.4398	0.8406
Calcium telluride	CaTe	5.8544	298	9	0.5351	0.3681	0.1994
Cesium	Cs	1.9800	78	10	0.0247	0.0206	0.0148
Cesium bromide	CsBr	4.4560	298	11	0.3063	0.0807	0.0750
Cesium chloride	CsCl	3.9880	298	11	0.3644	0.0882	0.0804
Cesium iodide	CsI	4.5250	298	11	0.2446	0.0661	0.0629
Chromite	FeCr <sub>2</sub> O <sub>4</sub>	4.4500	RT	12	3.2250	1.4370	1.1670
Chromium	Cr	7.20	298	13	3.398	0.586	0.990
Cobalt oxide	CoO	6.44	298	14	2.6123	1.4699	0.8300
Cobalt zinc ferrite	CoZnFeO <sub>2</sub>	5.43	303	12	2.660	1.530	0.780
Copper	Cu	8.932	298	15	1.683	1.221	0.757
Gallium antimonide	GaSb	5.6137	298	16	0.8839	0.4033	0.4316
Gallium arsenide	GaAs	5.3169	298	17	1.1877	0.5372	0.5944
Gallium phosphide	GaP	4.1297	300	18	1.4120	0.6253	0.7047
Garnet (yttrium-iron)	Y <sub>3</sub> Fe <sub>2</sub> (FeO <sub>4</sub> ) <sub>3</sub>	5.17	298	19	2.680	1.106	0.766
Germanium	Ge	5.313	298	20	1.2835	0.4823	0.6666
Gold	Au	19.283	296.5	21	1.9244	1.6298	0.4200
Indium antimonide	InSb	5.7890	298	22	0.6720	0.3670	0.3020
Indium arsenide	InAs	5.6720	293	23	0.8329	0.4526	0.3959
Indium phosphide	InP	4.78	RT	24	1.0220	0.5760	0.4600
Iridium	Ir	22.52	300	25	5.80	2.42	2.56
Iron	Fe	7.8672	298	26	2.26	1.40	1.16
Lead	Pb	11.34	296	27	0.4966	0.4231	0.1498
Lead fluoride	PbF <sub>2</sub>	7.79	300	28	0.8880	0.4720	0.2454
Lead nitrate	Pb(NO <sub>3</sub> ) <sub>2</sub>	4.547	293	29	0.3729	0.2765	0.1347
Lead telluride	PbTe	8.2379	303.2	30	1.0795	0.0764	0.1343
Lithium	Li	0.5326	298	31	0.1350	0.1144	0.0878
Lithium bromide	LiBr	3.47	RT	32	0.3940	0.1880	0.1910
Lithium chloride	LiCl	2.068	295	33	0.4927	0.2310	0.2495
Lithium fluoride	LiF	2.638	RT	34	1.1397	0.4767	0.6364
Lithium iodide	LiI	4.061	RT	32	0.2850	0.1400	0.1350
Magnesium oxide	MgO	3.579	298	20	2.9708	0.9536	1.5613
Magnetite	Fe <sub>3</sub> O <sub>4</sub>	5.18	RT	32	2.730	1.060	0.971
Manganese oxide	MnO	5.39	298	35	2.23	1.20	0.79
Mercury telluride	HgTe	8.079	290	36	0.548	0.381	0.204
Molybdenum	Mo	10.2284	273	37	4.637	1.578	1.092
Nickel	Ni	8.91	298	15	2.481	1.549	1.242

## CUBIC CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	$T/\text{K}$	Ref.	$C_{11}$	$C_{12}$	$C_{44}$
Niobium	Nb	8.578	300	38	2.4650	1.3450	0.2873
Palladium	Pd	12.038	300	39	2.2710	1.7604	0.7173
Platinum	Pt	21.50	300	40	3.4670	2.5070	0.7650
Potassium	K	0.851	295	41	0.0370	0.0314	0.0188
Potassium bromide	KBr	2.740	298	11	0.3468	0.0580	0.0507
Potassium chloride	KCl	1.984	298	11	0.4069	0.0711	0.0631
Potassium cyanide	KCN	1.553	RT	32	0.1940	0.1180	0.0150
Potassium fluoride	KF	2.480	295	33	0.6490	0.1520	0.1232
Potassium iodide	KI	3.128	300	42	0.2710	0.0450	0.0364
Pyrite	FeS <sub>2</sub>	5.016	RT	43	3.818	0.310	1.094
Rubidium	Rb	1.58	170	44	0.0296	0.0250	0.0171
Rubidium bromide	RbBr	3.350	300	45	0.3152	0.0500	0.0380
Rubidium chloride	RbCl	2.797	300	45	0.3624	0.0612	0.0468
Rubidium iodide	RbI	3.551	300	45	0.2556	0.0382	0.0278
Silicon	Si	2.331	298	46	1.6578	0.6394	0.7962
Silver	Ag	10.50	300	47	1.2399	0.9367	0.4612
Silver bromide	AgBr	5.585	300	48	0.5920	0.3640	0.0616
Sodium	Na	0.971	299	49	0.0739	0.0622	0.0419
Sodium bromate	NaBrO <sub>3</sub>	3.339	RT	32	0.5450	0.1910	0.1500
Sodium bromide	NaBr	3.202	300	33	0.3970	0.1001	0.0998
Sodium chlorate	NaClO <sub>3</sub>	2.485	RT	50	0.4920	0.1420	0.1160
Sodium chloride	NaCl	2.163	298	11	0.4947	0.1288	0.1287
Sodium fluoride	NaF	2.804	300	51	0.9700	0.2380	0.2822
Sodium iodide	NaI	3.6689	300	52	0.3007	0.0912	0.0733
Spinel	MgAl <sub>2</sub> O <sub>4</sub>	3.6193	298	53	2.9857	1.5372	1.5758
Strontium fluoride	SrF <sub>2</sub>	4.277	300	54	1.2350	0.4305	0.3128
Strontium nitrate	Sr(NO <sub>3</sub> ) <sub>2</sub>	2.989	293	29	0.4255	0.2921	0.1590
Strontium oxide	SrO	4.99	300	55	1.601	0.435	0.590
Strontium titanate	SrTiO <sub>3</sub>	5.123	RT	56	3.4817	1.0064	4.5455
Tantalum	Ta	16.626	298	57	2.6023	1.5446	0.8255
Tantalum carbide	TaC	14.65	RT	58	5.05	0.73	0.79
Thallium bromide	TlBr	7.4529	298	59	0.3760	0.1458	0.0757
Thorium	Th	11.694	300	60	0.7530	0.4890	0.4780
Thorium oxide	ThO <sub>2</sub>	9.991	298	61	3.670	1.060	0.797
Tin telluride	SnTe	6.445	300	62	1.1250	0.0750	0.1172
Titanium carbide	TiC	4.940	RT	107	5.00	1.13	1.75
Tungsten	W	19.257	297	64	5.2239	2.0437	1.6083
Uranium carbide	UC	13.63	300	65	3.200	0.850	0.647
Uranium dioxide	UO <sub>2</sub>	10.97	298	66	3.960	1.210	0.641
Vanadium	V	6.022	300	67	2.287	1.190	0.432
Zinc selenide	ZnSe	5.262	298	68	0.8096	0.4881	0.4405
Zinc sulfide	ZnS	4.088	298	68	1.0462	0.6534	0.4613
Zinc telluride	ZnTe	5.636	298	68	0.7134	0.4078	0.3115
Zirconium carbide	ZrC	6.606	298	63	4.720	0.987	1.593



## TETRAGONAL CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{13}$	$C_{16}$	$C_{33}$	$C_{44}$	$C_{66}$
Ammonium dihydrogen arsenate (ADA)	$\text{NH}_4\text{H}_2\text{AsO}_4$	2.3110	298	69	0.6747	-0.106	0.1652		0.3022	0.0685	0.0639
Ammonium dihydrogen phosphate (ADP)	$\text{NH}_4\text{H}_2\text{PO}_4$	1.8030	293	69	0.6200	-0.050	0.1400		0.3000	0.0910	0.0610
Barium titanate	$\text{BaTiO}_3$	5.9988	298	70	2.7512	1.7897	1.5156		1.6486	0.5435	1.1312
Calcium molybdate	$\text{CaMoO}_4$	4.255	298	79	1.447	0.664	0.466	0.134	1.265	0.369	0.451
Indium	In	7.300	RT	71	0.4450	0.3950	0.4050		0.4440	0.0655	0.1220
Magnesium fluoride	$\text{MgF}_2$	3.177	RT	72	1.237	0.732	0.536		1.770	0.552	0.978
Nickel sulfate hexahydrate	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	2.070	RT	73	0.3209	0.2315	0.0209		0.2931	0.1156	0.1779
Potassium dihydrogen arsenate (KDA)	$\text{KH}_2\text{AsO}_4$	2.867	RT	12	0.530	-0.060	-0.020		0.370	0.120	0.070
Potassium dihydrogen phosphate (KDP)	$\text{KH}_2\text{PO}_4$	2.388	RT	71	0.7140	-0.049	0.1290		0.5620	0.1270	0.0628
Rubidium dihydrogen phosphate (RDP)	$\text{RbH}_2\text{PO}_4$	2.800	298	74	0.5562	-0.064	0.0279		0.4398	0.1142	0.0350
Rutile	$\text{TiO}_2$	4.260	298	75	2.7143	1.7796	1.4957		4.8395	1.2443	1.9477
Tellurium oxide	$\text{TeO}_2$	5.99	RT	76	0.5320	0.4860	0.2120		1.0850	0.2440	0.5520
Tin (white)	Sn	7.29	288	77	0.7529	0.6156	0.4400		0.9552	0.2193	0.2336
Zircon	$\text{ZrSiO}_4$	4.70	RT	78	2.585	1.791	1.542		3.805	0.733	1.113

## ORTHORHOMBIC CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{13}$	$C_{22}$	$C_{23}$	$C_{33}$	$C_{44}$	$C_{55}$	$C_{66}$
Acenaphthene	$\text{C}_{12}\text{H}_{10}$	1.220	293	80	0.1380	0.0210	0.0410	0.1262	0.0460	0.1117	0.0265	0.0290	0.0185
Ammonium sulfate	$(\text{NH}_4)_2\text{SO}_4$	1.774	293	81	0.3607	0.1651	0.1580	0.2981	0.1456	0.3534	0.1025	0.0717	0.0974
Aragonite	$\text{CaCO}_3$	2.93	RT	82	1.5958	0.3663	0.0197	0.8697	0.1597	0.8503	0.4132	0.2564	0.4274
Barite	$\text{BaSO}_4$	4.40	RT	82	0.8941	0.4614	0.2691	0.7842	0.2676	1.0548	0.1190	0.2874	0.2778
Benzene	$\text{C}_6\text{H}_6$	1.061	250	83	0.0614	0.0352	0.0401	0.0656	0.0390	0.0583	0.0197	0.0378	0.0153
Benzophenone	$(\text{C}_6\text{H}_5)_2\text{CO}$	1.219	RT	32	0.1070	0.0550	0.0169	0.1000	0.0321	0.0710	0.0203	0.0155	0.0353
Bronzite	$(\text{MgFe})\text{SiO}_3$	3.38	RT	78	1.876	0.686	0.605	1.578	0.561	2.085	0.700	0.592	0.544
Calcium sulfate	$\text{CaSO}_4$	2.962	RT	84	0.9382	0.1650	0.1520	1.845	0.3173	1.1180	0.3247	0.2653	0.0926
Celestine	$\text{SrSO}_4$	3.96	RT	12	1.044	0.773	0.605	1.061	0.619	1.286	0.135	0.279	0.266
Cesium sulfate	$\text{Cs}_2\text{SO}_4$	4.243	293	81	0.4490	0.1958	0.1815	0.4283	0.1800	0.3785	0.1326	0.1319	0.1323
Fosterite	$\text{Mg}_2\text{SiO}_4$	3.224	298	85	3.2848	0.6390	0.6880	1.9980	0.7380	2.3530	0.6515	0.8120	0.8088
Iodic acid	$\text{HIO}_3$	4.630	RT	73	0.3030	0.1194	0.1169	0.5448	0.0548	0.4359	0.1835	0.2193	0.1736
Lithium ammonium tartrate	$\text{LiNH}_4\text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	1.71	RT	12	0.3864	0.1655	0.0875	0.5393	0.2007	0.3624	0.1190	0.0667	0.2326
Magnesium sulfate heptahydrate	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	1.68	RT	86	0.325	0.174	0.182	0.288	0.182	0.315	0.078	0.156	0.090
Natrolite	$(\text{Na,Al})\text{SiO}_3$	2.25	RT	78	0.716	0.261	0.297	0.632	0.297	1.378	0.196	0.248	0.423
Nickel sulfate heptahydrate	$\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$	1.948	RT	86	0.353	0.198	0.201	0.311	0.201	0.335	0.091	0.172	0.099
Olivine	$(\text{MgFe})\text{SiO}_3$	3.324	RT	87	3.240	0.590	0.790	1.980	0.780	2.490	0.667	0.810	0.793
Potassium pentaborate	$\text{KB}_5\text{O}_8 \cdot 4\text{H}_2\text{O}$	1.74	RT	71	0.582	0.229	0.174	0.359	0.231	0.255	0.164	0.046	0.057
Potassium sulfate	$\text{K}_2\text{SO}_4$	2.665	293	81	0.5357	0.1999	0.2095	0.5653	0.1990	0.5523	0.195	0.1879	0.1424
Rochelle salt	$\text{NaK}(\text{C}_4\text{H}_4\text{O}_6) \cdot 4\text{H}_2\text{O}$	1.79	RT	71	0.255	0.141	0.116	0.381	0.146	0.371	0.134	0.032	0.098
Rubidium sulfate	$\text{Rb}_2\text{SO}_4$	3.621	293	81	0.5029	0.1965	0.1999	0.5098	0.1925	0.4761	0.1626	0.1589	0.1407
Sodium ammonium tartrate	$\text{NaNH}_4\text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	1.587	RT	12	0.3685	0.2725	0.3083	0.5092	0.3472	0.5541	0.1058	0.0303	0.0870
Sodium tartrate	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$	1.794	RT	12	0.461	0.286	0.320	0.547	0.352	0.665	0.124	0.031	0.098
Strontium formate dihydrate	$\text{Sr}(\text{CHO}_2)_2 \cdot 2\text{H}_2\text{O}$	2.25	RT	12	0.4391	0.1037	-0.149	0.3484	-0.014	0.3746	0.1538	0.1075	0.1724
Sulfur	S	2.07	RT	12	0.240	0.133	0.171	0.205	0.159	0.483	0.043	0.087	0.076
Thallium sulfate	$\text{TlSO}_4$	6.776	293	81	0.4106	0.2573	0.2288	0.3885	0.2174	0.4268	0.1125	0.1068	0.0751
Topaz	$\text{Al}_2\text{SiO}_5(\text{OH, F})_2$	3.52	RT	82	2.8136	1.2582	0.8464	3.8495	0.8815	2.9452	1.0811	1.3298	1.3089
Uranium (alpha)	U	19.0453	293	88	2.1486	0.4622	0.2176	1.9983	1.0764	2.6763	1.2479	0.7379	0.7454
Zinc sulfate heptahydrate	$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$	1.970	RT	86	0.3320	0.1720	0.2000	0.2930	0.1980	0.3200	0.0780	0.1530	0.0830

## MONOCLINIC CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{13}$	$C_{15}$	$C_{22}$
Aegirine	(NaFe)Si <sub>2</sub> O <sub>6</sub>	3.50	RT	89	1.858	0.685	0.707	0.098	1.813
Anthracene	C <sub>14</sub> H <sub>10</sub>	1.258	RT	90	0.0852	0.0672	0.0590	-0.0192	0.1170
Cobalt sulfate heptahydrate	CoSO <sub>4</sub> ·7H <sub>2</sub> O	1.948	RT	86	0.335	0.205	0.158	0.016	0.378
Diopside	(CaMg)Si <sub>2</sub> O <sub>6</sub>	3.31	RT	91	2.040	0.884	0.0883	-0.193	1.750
Dipotassium tartrate	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	1.97	RT	12	0.4294	0.1399	0.3129	-0.0105	0.3460
Feldspar (microceine)	KAlSi <sub>3</sub> O <sub>8</sub>	2.56	RT	92	0.664	0.438	0.259	-0.033	1.710
Ferrous sulfate heptahydrate	FeSO <sub>4</sub> ·7H <sub>2</sub> O	1.898	RT	86	0.349	0.208	0.174	-0.020	0.376
Lithium sulfate monohydrate	Li <sub>2</sub> SO <sub>4</sub> ·H <sub>2</sub> O	2.221	RT	32	0.5250	0.1715	0.1730	-0.0196	0.5060
Naphthalene	C <sub>10</sub> H <sub>8</sub>	1.127	RT	93	0.0780	0.0445	0.0340	-0.006	0.0990
Potassium tartrate	K <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	1.987	RT	32	0.3110	0.1720	0.1690	0.0287	0.3900
Sodium thiosulfate	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	1.7499	RT	12	0.3323	0.1814	0.1875	0.0225	0.2953
Stilbene	(C <sub>6</sub> H <sub>5</sub> CH) <sub>2</sub>	1.60	RT	94	0.0930	0.0570	0.0670	-0.003	0.0920
Triglycine sulfate (TGS)	(NH <sub>2</sub> CH <sub>2</sub> COOH) <sub>3</sub> · H <sub>2</sub> SO <sub>4</sub>	1.68	RT	32	0.4550	0.1720	0.1980	-0.030	0.3210
Name	$C_{23}$	$C_{25}$	$C_{33}$	$C_{35}$	$C_{44}$	$C_{46}$	$C_{55}$	$C_{66}$	
Aegirine	0.626	0.094	2.344	0.214	0.692	0.077	0.510	0.474	
Anthracene	0.0375	-0.0170	0.1522	-0.0187	0.0272	0.0138	0.0242	0.0399	
Cobalt sulfate heptahydrate	0.158	-0.018	0.371	-0.047	0.060	0.016	0.058	0.101	
Diopside	0.482	-0.196	2.380	-0.336	0.675	-0.113	0.588	0.705	
Dipotassium tartrate	0.1173	0.0176	0.6816	0.0294	0.0961	-0.0044	0.1270	0.0841	
Feldspar (microceine)	0.192	-0.148	1.215	-0.131	0.143	-0.015	0.238	0.361	
Ferrous sulfate heptahydrate	0.172	-0.019	0.360	-0.014	0.064	0.001	0.056	0.096	
Lithium sulfate monohydrate	0.0368	0.0571	0.5400	-0.0254	0.1400	-0.0054	0.1565	0.2770	
Naphthalene	0.0230	-0.0270	0.1190	0.0290	0.0330	-0.0050	0.0210	0.0415	
Potassium tartrate	0.1330	0.0182	0.5540	0.0710	0.0870	0.0072	0.1040	0.0826	
Sodium thiosulfate	0.1713	0.0983	0.4590	-0.0678	0.0569	-0.0268	0.1070	0.0598	
Stilbene	0.0485	-0.005	0.0790	-0.005	0.0325	0.0050	0.0640	0.0245	
Triglycine sulfate (TGS)	0.2080	-0.0036	0.2630	-0.0500	0.0950	-0.0026	0.1110	0.0620	

## HEXAGONAL CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{13}$	$C_{33}$	$C_{55}$
Apatite	$\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F},\text{Cl})$	3.218	RT	12	1.667	0.131	0.655	1.396	0.663
Beryl	$\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$	2.68	RT	12	2.800	0.990	0.670	2.480	0.658
Beryllium	Be	1.8477	300	95	2.923	0.267	0.140	3.364	1.625
Beryllium oxide	BeO	3.01	RT	96	4.70	1.68	1.19	4.94	1.53
Cadmium	Cd	8.652	300	97	1.1450	0.3950	0.3990	0.5085	0.1985
Cadmium selenide	CdSe	5.655	298	68	0.7046	0.4516	0.3930	0.8355	0.1317
Cadmium sulfide	CdS	4.824	298	98	0.8431	0.5208	0.4567	0.9183	0.1458
Cobalt	Co	8.836	298	99	3.071	1.650	1.027	3.581	0.755
Dysprosium	Dy	8.560	298	100	0.7466	0.2616	0.2233	0.7871	0.2427
Erbium	Er	9.064	298	100	0.8634	0.3050	0.2270	0.8554	0.2809
Gadolinium	Gd	7.888	298	101	0.6667	0.2499	0.2132	0.7191	0.2089
Hafnium	Hf	12.727	298	102	1.881	0.772	0.661	1.969	0.557
Ice	$\text{H}_2\text{O}(\text{solid})$	0.920	250	103	0.1410	0.0660	0.0624	0.1515	0.0288
Indium	In	7.2788	300	104	0.4535	0.4006	0.4151	0.4515	0.0651
Magnesium	Mg	1.7364	298	105	0.5950	0.2612	0.2180	0.6155	0.1635
Rhenium	Re	21.024	298	100	6.1820	2.7530	2.0780	6.8350	1.6060
Ruthenium	Ru	12.3615	298	100	5.6260	1.8780	1.6820	6.2420	1.8060
Thallium	Tl	11.560	300	106	0.4080	0.3540	0.2900	0.5280	0.0726
Titanium	Ti	4.5063	298	102	1.6240	0.9200	0.6900	1.8070	0.4670
Titanium diboride	$\text{TiB}_2$	4.95	RT	107	6.90	4.10	3.20	4.40	2.50
Yttrium	Y	4.472	300	108	0.7790	0.2850	0.2100	0.7690	0.2431
Zinc	Zn	7.134	295	109	1.6368	0.3640	0.5300	0.6347	0.3879
Zinc oxide	ZnO	5.6760	298	110	2.0970	1.2110	1.0510	2.1090	0.4247
Zinc sulfide	ZnS	4.089	298	96	1.2420	0.6015	0.4554	1.4000	0.2864
Zirconium	Zr	6.505	298	102	1.434	0.728	0.653	1.648	0.320

## TRIGONAL CRYSTALS

Name	Formula	$\rho/\text{g cm}^{-3}$	T/K	Ref.	$C_{11}$	$C_{12}$	$C_{13}$	$C_{14}$	$C_{33}$	$C_{44}$
Aluminum oxide	$\text{Al}_2\text{O}_3$	3.986	300	111	4.9735	1.6397	1.1220	-0.2358	4.9911	1.4739
Aluminum phosphate	$\text{AlPO}_4$	2.556	RT	73	1.0503	0.2934	0.6927	-0.1271	1.3353	0.2314
Antimony	Sb	6.70	295	112	1.0130	0.3450	0.2920	0.2090	0.4500	0.3930
Bismuth	Bi	9.80	295	112	0.6370	0.2490	0.2470	0.0717	0.3820	0.1123
Calcite	$\text{CaCO}_3$	2.712	300	113	1.4806	0.5578	0.5464	-0.2058	0.8557	0.3269
Hematite	$\text{Fe}_2\text{O}_3$	5.240	RT	82	2.4243	0.5464	0.1542	-0.1247	2.2734	0.8569
Lithium niobate	$\text{LiNbO}_3$	4.70	RT	114	2.030	0.530	0.750	0.090	2.450	0.600
Lithium tantalate	$\text{LiTaO}_3$	7.45	RT	114	2.330	0.470	0.800	-0.110	2.750	0.940
Quartz	$\text{SiO}_2$	2.6485	298	115	0.8680	0.0704	0.1191	-0.1804	1.0575	0.5820
Selenium	Se	4.838	300	116	0.1870	0.0710	0.2620	0.0620	0.7410	0.1490
Sodium nitrate	$\text{NaNO}_3$	2.27	RT	12	0.8670	0.1630	0.1600	0.0820	0.3740	0.2130
Tourmaline		3.05	RT	82	2.7066	0.6927	0.0872	-0.0774	1.6070	0.6682

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## ELECTRICAL RESISTIVITY OF PURE METALS

The first part of this table gives the electrical resistivity, in units of  $10^{-8} \Omega \text{ m}$ , for 28 common metallic elements as a function of temperature. The data refer to polycrystalline samples. The number of significant figures indicates the accuracy of the values. However, at low temperatures (especially below 50 K) the electrical resistivity is extremely sensitive to sample purity. Thus the low-temperature values refer to samples of specified purity and treatment. The references should be consulted for further information on this point, as well as for values at additional temperatures.

The second part of the table gives resistivity values in the neighborhood of room temperature for other metallic elements that have not been studied over an extended temperature range.

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### Electrical Resistivity in $10^{-8} \Omega \text{ m}$

T/K	Aluminum	Barium	Beryllium	Calcium	Cesium	Chromium	Copper
1	0.000100	0.081	0.0332	0.045	0.0026		0.00200
10	0.000193	0.189	0.0332	0.047	0.243		0.00202
20	0.000755	0.94	0.0336	0.060	0.86		0.00280
40	0.0181	2.91	0.0367	0.175	1.99		0.0239
60	0.0959	4.86	0.067	0.40	3.07		0.0971
80	0.245	6.83	0.075	0.65	4.16		0.215
100	0.442	8.85	0.133	0.91	5.28	1.6	0.348
150	1.006	14.3	0.510	1.56	8.43	4.5	0.699
200	1.587	20.2	1.29	2.19	12.2	7.7	1.046
273	2.417	30.2	3.02	3.11	18.7	11.8	1.543
293	2.650	33.2	3.56	3.36	20.5	12.5	1.678
298	2.709	34.0	3.70	3.42	20.8	12.6	1.712
300	2.733	34.3	3.76	3.45	21.0	12.7	1.725
400	3.87	51.4	6.76	4.7		15.8	2.402
500	4.99	72.4	9.9	6.0		20.1	3.090
600	6.13	98.2	13.2	7.3		24.7	3.792
700	7.35	130	16.5	8.7		29.5	4.514
800	8.70	168	20.0	10.0		34.6	5.262
900	10.18	216	23.7	11.4		39.9	6.041

T/K	Gold	Hafnium	Iron	Lead	Lithium	Magnesium	Manganese
1	0.0220	1.00	0.0225		0.007	0.0062	7.02
10	0.0226	1.00	0.0238		0.008	0.0069	18.9
20	0.035	1.11	0.0287		0.012	0.0123	54
40	0.141	2.52	0.0758		0.074	0.074	116
60	0.308	4.53	0.271		0.345	0.261	131
80	0.481	6.75	0.693	4.9	1.00	0.557	132
100	0.650	9.12	1.28	6.4	1.73	0.91	132
150	1.061	15.0	3.15	9.9	3.72	1.84	136
200	1.462	21.0	5.20	13.6	5.71	2.75	139
273	2.051	30.4	8.57	19.2	8.53	4.05	143
293	2.214	33.1	9.61	20.8	9.28	4.39	144
298	2.255	33.7	9.87	21.1	9.47	4.48	144
300	2.271	34.0	9.98	21.3	9.55	4.51	144
400	3.107	48.1	16.1	29.6	13.4	6.19	147
500	3.97	63.1	23.7	38.3		7.86	149
600	4.87	78.5	32.9			9.52	151
700	5.82		44.0			11.2	152
800	6.81		57.1			12.8	
900	7.86					14.4	

T/K	Molybdenum	Nickel	Palladium	Platinum	Potassium	Rubidium	Silver
1	0.00070	0.0032	0.0200	0.002	0.0008	0.0131	0.00100
10	0.00089	0.0057	0.0242	0.0154	0.0160	0.109	0.00115
20	0.00261	0.0140	0.0563	0.0484	0.117	0.444	0.0042
40	0.0457	0.068	0.334	0.409	0.480	1.21	0.0539
60	0.206	0.242	0.938	1.107	0.90	1.94	0.162
80	0.482	0.545	1.75	1.922	1.34	2.65	0.289
100	0.858	0.96	2.62	2.755	1.79	3.36	0.418
150	1.99	2.21	4.80	4.76	2.99	5.27	0.726
200	3.13	3.67	6.88	6.77	4.26	7.49	1.029
273	4.85	6.16	9.78	9.6	6.49	11.5	1.467
293	5.34	6.93	10.54	10.5	7.20	12.8	1.587
298	5.47	7.12	10.73	10.7	7.39	13.1	1.617
300	5.52	7.20	10.80	10.8	7.47	13.3	1.629
400	8.02	11.8	14.48	14.6			2.241
500	10.6	17.7	17.94	18.3			2.87
600	13.1	25.5	21.2	21.9			3.53
700	15.8	32.1	24.2	25.4			4.21
800	18.4	35.5	27.1	28.7			4.91
900	21.2	38.6	29.4	32.0			5.64

T/K	Sodium	Strontium	Tantalum	Tungsten	Vanadium	Zinc	Zirconium
1	0.0009	0.80	0.10	0.000016		0.0100	0.250
10	0.0015	0.80	0.102	0.000137	0.0145	0.0112	0.253
20	0.016	0.92	0.146	0.00196	0.039	0.0387	0.357
40	0.172	1.70	0.751	0.0544	0.304	0.306	1.44
60	0.447	2.68	1.65	0.266	1.11	0.715	3.75
80	0.80	3.64	2.62	0.606	2.41	1.15	6.64
100	1.16	4.58	3.64	1.02	4.01	1.60	9.79
150	2.03	6.84	6.19	2.09	8.2	2.71	17.8
200	2.89	9.04	8.66	3.18	12.4	3.83	26.3
273	4.33	12.3	12.2	4.82	18.1	5.46	38.8
293	4.77	13.2	13.1	5.28	19.7	5.90	42.1
298	4.88	13.4	13.4	5.39	20.1	6.01	42.9
300	4.93	13.5	13.5	5.44	20.2	6.06	43.3
400		17.8	18.2	7.83	28.0	8.37	60.3
500		22.2	22.9	10.3	34.8	10.82	76.5
600		26.7	27.4	13.0	41.1	13.49	91.5
700		31.2	31.8	15.7	47.2		104.2
800		35.6	35.9	18.6	53.1		114.9
900			40.1	21.5	58.7		123.1

Element	T/K	Electrical resistivity 10 <sup>-8</sup> Ω m
Antimony	273	39
Bismuth	273	107
Cadmium	273	6.8
Cerium (β, hex)	290–300	82.8
Cerium (γ, cub)	298	74.4
Cobalt	273	5.6
Dysprosium	290–300	92.6
Erbium	290–300	86.0
Europium	290–300	90.0
Gadolinium	290–300	131
Gallium	273	13.6
Holmium	290–300	81.4
Indium	273	8.0
Iridium	273	4.7
Lanthanum	290–300	61.5
Lutetium	290–300	58.2
Mercury	298	96.1
Neodymium	290–300	64.3
Niobium	273	15.2

Element	T/K	Electrical resistivity 10 <sup>-8</sup> Ω m
Osmium	273	8.1
Polonium	273	40
Praseodymium	290–300	70.0
Promethium	290–300	75 est.
Protactinium	273	17.7
Rhenium	273	17.2
Rhodium	273	4.3
Ruthenium	273	7.1
Samarium	290–300	94.0
Scandium	290–300	56.2
Terbium	290–300	115
Thallium	273	15
Thorium	273	14.7
Thulium	290–300	67.6
Tin	273	11.5
Titanium	273	39
Uranium	273	28
Ytterbium	290–300	25.0
Yttrium	290–300	59.6

## ELECTRICAL RESISTIVITY OF SELECTED ALLOYS

These values were obtained by fitting all available measurements to a theoretical formulation describing the temperature and composition dependence of the electrical resistivity of metals. Some of the values listed here fall in regions of temperature and composition where no actual measurements exist. Details of the procedure may be found in the reference.

Values of the resistivity are given in units of  $10^{-8} \Omega \text{ m}$ . General comments in the preceding table for pure metals also apply here

### Reference

C. Y. Ho, et al., *J. Phys. Chem. Ref. Data*, 12, 183–322, 1983.

Aluminum-Copper						
	100 K	273 K	293 K	300 K	350 K	400 K
Wt % Al						
99 <sup>a</sup>	0.531	2.51	2.74	2.82	3.38	3.95
95 <sup>a</sup>	0.895	2.88	3.10	3.18	3.75	4.33
90 <sup>b</sup>	1.38	3.36	3.59	3.67	4.25	4.86
85 <sup>b</sup>	1.88	3.87	4.10	4.19	4.79	5.42
80 <sup>b</sup>	2.34	4.33	4.58	4.67	5.31	5.99
70 <sup>b</sup>	3.02	5.03	5.31	5.41	6.16	6.94
60 <sup>b</sup>	3.49	5.56	5.88	5.99	6.77	7.63
50 <sup>b</sup>	4.00	6.22	6.55	6.67	7.55	8.52
40 <sup>c</sup>		7.57	7.96	8.10	9.12	10.2
30 <sup>c</sup>		11.2	11.8	12.0	13.5	15.2
25 <sup>f</sup>		16.3	17.2	17.6	19.8	22.2
15 <sup>b</sup>			12.3			
10 <sup>g</sup>	8.71	10.8	11.0	11.1	11.7	12.3
5 <sup>c</sup>	7.92	9.43	9.61	9.68	10.2	10.7
1 <sup>b</sup>	3.22	4.46	4.60	4.65	5.00	5.37

Aluminum-Magnesium						
	100 K	273 K	293 K	300 K	350 K	400 K
Wt % Al						
99 <sup>c</sup>	0.958	2.96	3.18	3.26	3.82	4.39
95 <sup>c</sup>	3.01	5.05	5.28	5.36	5.93	6.51
90 <sup>c</sup>	5.42	7.52	7.76	7.85	8.43	9.02
10 <sup>b</sup>	14.0	17.1	17.4	17.6	18.4	19.2
5 <sup>b</sup>	9.93	13.1	13.4	13.5	14.3	15.2
1 <sup>a</sup>	2.78	5.92	6.25	6.37	7.20	8.03

Copper-Gold						
	100 K	273 K	293 K	300 K	350 K	400 K
Wt % Cu						
99 <sup>c</sup>	0.520	1.73	1.86	1.91	2.24	2.58
95 <sup>c</sup>	1.21	2.41	2.54	2.59	2.92	3.26
90 <sup>c</sup>	2.11	3.29	4.42	3.46	3.79	4.12
85 <sup>c</sup>	3.01	4.20	4.33	4.38	4.71	5.05
80 <sup>c</sup>	3.95	5.15	5.28	5.32	5.65	5.99
70 <sup>c</sup>	5.91	7.12	7.25	7.30	7.64	7.99
60 <sup>c</sup>	8.04	9.18	9.13	9.36	9.70	10.05
50 <sup>c</sup>	9.88	11.07	11.20	11.25	11.60	11.94
40 <sup>c</sup>	11.44	12.70	12.85	12.90	13.27	13.65
30 <sup>c</sup>	12.43	13.77	13.93	13.99	14.38	14.78
25 <sup>c</sup>	12.59	13.93	14.09	14.14	14.54	14.94
15 <sup>c</sup>	11.38	12.75	12.91	12.96	13.36	13.77
10 <sup>c</sup>	9.33	10.70	10.86	10.91	11.31	11.72
5 <sup>c</sup>	5.91	7.25	7.41	7.46	7.87	8.28
1 <sup>c</sup>	2.00	3.40	3.57	3.62	4.03	4.45

Wt % Cu	Copper-Nickel					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>c</sup>	1.45	2.71	2.85	2.91	3.27	3.62
95 <sup>c</sup>	6.19	7.60	7.71	7.82	8.22	8.62
90 <sup>c</sup>	12.08	13.69	13.89	13.96	14.40	14.81
85 <sup>c</sup>	18.01	19.63	19.83	19.90	20.32	20.70
80 <sup>c</sup>	23.89	25.46	25.66	25.72	26.12	26.44
70 <sup>i</sup>	35.73	36.67	36.72	36.76	36.85	36.89
60 <sup>i</sup>	45.76	45.43	45.38	43.35	45.20	45.01
50 <sup>i</sup>	50.22	50.19	50.05	50.01	49.73	49.50
40 <sup>c</sup>	36.77	47.42	47.73	47.82	48.28	48.49
30 <sup>i</sup>	26.73	40.19	41.79	42.34	44.51	45.40
25 <sup>c</sup>	22.22	33.46	35.11	35.69	39.67	42.81
15 <sup>c</sup>	13.49	22.00	23.35	23.85	27.60	31.38
10 <sup>c</sup>	9.28	16.65	17.82	18.26	21.51	25.19
5 <sup>c</sup>	5.20	11.49	12.50	12.90	15.69	18.78
1 <sup>c</sup>	1.81	7.23	8.08	8.37	10.63	13.18

Wt % Cu	Copper-Palladium					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>c</sup>	0.91	2.10	2.23	2.27	2.59	2.92
95 <sup>c</sup>	2.99	4.21	4.35	4.40	4.74	5.08
90 <sup>c</sup>	5.69	6.89	7.03	7.08	7.41	7.74
85 <sup>c</sup>	8.30	9.48	9.61	9.66	10.01	10.36
80 <sup>c</sup>	10.74	11.99	12.12	12.16	12.51	12.87
70 <sup>c</sup>	15.67	16.87	17.01	17.06	17.41	17.78
60 <sup>c</sup>	20.45	21.73	21.87	21.92	22.30	22.69
50 <sup>c</sup>	26.07	27.62	27.79	27.86	28.25	28.64
40 <sup>c</sup>	33.53	35.31	35.51	35.57	36.03	36.47
30 <sup>c</sup>	45.03	46.50	46.66	46.71	47.11	47.47
25 <sup>c</sup>	44.12	46.25	46.45	46.52	46.99	47.43
15 <sup>c</sup>	31.79	36.52	36.99	37.16	38.28	39.35
10 <sup>c</sup>	23.00	28.90	29.51	29.73	31.19	32.56
5 <sup>c</sup>	13.09	20.00	20.75	21.02	22.84	24.54
1 <sup>c</sup>	8.97	11.90	12.67	12.93	14.82	16.68

Wt % Cu	Copper-Zinc					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>b</sup>	0.671	1.84	1.97	2.02	2.36	2.71
95 <sup>b</sup>	1.54	2.78	2.92	2.97	3.33	3.69
90 <sup>b</sup>	2.33	3.66	3.81	3.86	4.25	4.63
85 <sup>b</sup>	2.93	4.37	4.54	4.60	5.02	5.44
80 <sup>b</sup>	3.44	5.01	5.19	5.26	5.71	6.17
70 <sup>b</sup>	4.08	5.87	6.08	6.15	6.67	7.19

Wt % Au	Gold-Palladium					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>c</sup>	1.31	2.69	2.86	2.91	3.32	3.73
95 <sup>c</sup>	3.88	5.21	5.35	5.41	5.79	6.17
90 <sup>i</sup>	6.70	8.01	8.17	8.22	8.56	8.93
85 <sup>b</sup>	9.14	10.50	10.66	10.72	11.10	11.48
80 <sup>b</sup>	11.23	12.75	12.93	12.99	13.45	13.93
70 <sup>c</sup>	16.44	18.23	18.46	18.54	19.10	19.67
60 <sup>b</sup>	24.64	26.70	26.94	27.02	27.63	28.23
50 <sup>a</sup>	23.09	27.23	27.63	27.76	28.64	29.42
40 <sup>a</sup>	19.40	24.65	25.23	25.42	26.74	27.95
30 <sup>b</sup>	14.94	20.82	21.49	21.72	23.35	24.92
25 <sup>b</sup>	12.72	18.86	19.53	19.77	21.51	23.19
15 <sup>a</sup>	8.54	15.08	15.77	16.01	17.80	19.61
10 <sup>a</sup>	6.54	13.25	13.95	14.20	16.00	17.81
5 <sup>a</sup>	4.58	11.49	12.21	12.46	14.26	16.07
1 <sup>a</sup>	3.01	10.07	10.85	11.12	12.99	14.80



Wt % Au	Gold-Silver					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>b</sup>	1.20	2.58	2.75	2.80	3.22	3.63
95 <sup>a</sup>	3.16	4.58	4.74	4.79	5.19	5.59
90 <sup>i</sup>	5.16	6.57	6.73	6.78	7.19	7.58
85 <sup>j</sup>	6.75	8.14	8.30	8.36	8.75	9.15
80 <sup>i</sup>	7.96	9.34	9.50	9.55	9.94	10.33
70 <sup>i</sup>	9.36	10.70	10.86	10.91	11.29	11.68
60 <sup>i</sup>	9.61	10.92	11.07	11.12	11.50	11.87
50 <sup>i</sup>	8.96	10.23	10.37	10.42	10.78	11.14
40 <sup>i</sup>	7.69	8.92	9.06	9.11	9.46	9.81
30 <sup>a</sup>	6.15	7.34	7.47	7.52	7.85	8.19
25 <sup>a</sup>	5.29	6.46	6.59	6.63	6.96	7.30
15 <sup>a</sup>	3.42	4.55	4.67	4.72	5.03	5.34
10 <sup>a</sup>	2.44	3.54	3.66	3.71	4.00	4.31
5 <sup>i</sup>	1.44	2.52	2.64	2.68	2.96	3.25
1 <sup>b</sup>	0.627	1.69	1.80	1.84	2.12	2.42

Wt % Fe	Iron-Nickel				
	100 K	273 K	293 K	300 K	400 K
99 <sup>a</sup>	3.32	10.9	12.0	12.4	18.7
95 <sup>c</sup>	10.0	18.7	19.9	20.2	26.8
90 <sup>c</sup>	14.5	24.2	25.5	25.9	33.2
85 <sup>c</sup>	17.5	27.8	29.2	29.7	37.3
80 <sup>c</sup>	19.3	30.1	31.6	32.2	40.0
70 <sup>b</sup>	20.9	32.3	33.9	34.4	42.4
60 <sup>c</sup>	28.6	53.8	57.1	58.2	73.9
50 <sup>d</sup>	12.3	28.4	30.6	31.4	43.7
40 <sup>d</sup>	7.73	19.6	21.6	22.5	34.0
30 <sup>c</sup>	5.97	15.3	17.1	17.7	27.4
25 <sup>b</sup>	5.62	14.3	15.9	16.4	25.1
15 <sup>c</sup>	4.97	12.6	13.8	14.2	21.1
10 <sup>c</sup>	4.20	11.4	12.5	12.9	18.9
5 <sup>c</sup>	3.34	9.66	10.6	10.9	16.1
1 <sup>b</sup>	1.66	7.17	7.94	8.12	12.8

Wt % Ag	Silver-Palladium					
	100 K	273 K	293 K	300 K	350 K	400 K
99 <sup>b</sup>	0.839	1.891	2.007	2.049	2.35	2.66
95 <sup>b</sup>	2.528	3.58	3.70	3.74	4.04	4.34
90 <sup>b</sup>	4.72	5.82	5.94	5.98	6.28	6.59
85 <sup>k</sup>	6.82	7.92	8.04	8.08	8.38	8.68
80 <sup>k</sup>	8.91	10.01	10.13	10.17	10.47	10.78
70 <sup>k</sup>	13.43	14.53	14.65	14.69	14.99	15.30
60 <sup>i</sup>	19.4	20.9	21.1	21.2	21.6	22.0
50 <sup>k</sup>	29.3	31.2	31.4	31.5	32.0	32.4
40 <sup>m</sup>	40.8	42.2	42.2	42.2	42.3	42.3
30 <sup>b</sup>	37.1	40.4	40.6	40.7	41.3	41.7
25 <sup>k</sup>	32.4	36.67	37.06	37.19	38.1	38.8
15 <sup>i</sup>	21.0	27.08	26.68	27.89	29.3	30.6
10 <sup>i</sup>	14.95	21.69	22.39	22.63	24.3	25.9
5 <sup>b</sup>	8.91	15.98	16.72	16.98	18.8	20.5
1 <sup>a</sup>	3.97	11.06	11.82	12.08	13.92	15.70

<sup>a</sup> Uncertainty in resistivity is  $\pm 2\%$ .

<sup>b</sup> Uncertainty in resistivity is  $\pm 3\%$ .

<sup>c</sup> Uncertainty in resistivity is  $\pm 5\%$ .

<sup>d</sup> Uncertainty in resistivity is  $\pm 7\%$  below 300 K and  $\pm 5\%$  at 300 and 400 K.

<sup>e</sup> Uncertainty in resistivity is  $\pm 7\%$ .

<sup>f</sup> Uncertainty in resistivity is  $\pm 8\%$ .

<sup>g</sup> Uncertainty in resistivity is  $\pm 10\%$ .

<sup>h</sup> Uncertainty in resistivity is  $\pm 12\%$ .

<sup>i</sup> Uncertainty in resistivity is  $\pm 4\%$ .

<sup>j</sup> Uncertainty in resistivity is  $\pm 1\%$ .

<sup>k</sup> Uncertainty in resistivity is  $\pm 3\%$  up to 300 K and  $\pm 4\%$  above 300 K.

<sup>m</sup> Uncertainty in resistivity is  $\pm 2\%$  up to 300 K and  $\pm 4\%$  above 300 K.

# PERMITTIVITY (DIELECTRIC CONSTANT) OF INORGANIC SOLIDS

H. P. R. Frederikse

This table lists the permittivity  $\epsilon$ , frequently called the dielectric constant, of a number of inorganic solids. When the material is not isotropic, the individual components of the permittivity are given. A superscript S indicates a measurement made under constant strain ("clamped" dielectric constant). If the constraint is removed, the measurement yields  $\epsilon^T$ , the "unclamped" or free dielectric constant.

The temperature of the measurement is given when available; the symbol r.t. indicates a value at nominal room temperature. The

frequency of the measurement is given in the last column (i.r. indicates a measurement in the infrared).

Substances are listed in alphabetical order by chemical formula.

## Reference

Young, K. F. and Frederikse, H. P. R., *J. Phys. Chem. Ref. Data*, 2, 313, 1973.

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
Ag <sub>3</sub> AsS <sub>3</sub>	Silver thioarsenate (Proustite)	$\epsilon_{11}^T = 16.5, \epsilon_{11}^S = 14.5$	r.t.	$2 \times 10^7$
		$\epsilon_{33}^T = 20.0, \epsilon_{11}^S = 18.0$	r.t.	$2 \times 10^7$
AgBr	Silver bromide	12.50	r.t.	
AgCN	Silver cyanide	5.6	r.t.	$10^6$
AgCl	Silver chloride	11.15	r.t.	
AgNO <sub>3</sub>	Silver nitrate	9.0	293	$5 \times 10^5$
AgNa(NO <sub>2</sub> ) <sub>2</sub>	Silver sodium nitrite	$4.5 \pm 0.5$	r.t.	$9.4 \times 10^9$
Ag <sub>2</sub> O	Silver oxide	8.8	r.t.	
(AlF) <sub>2</sub> SiO <sub>4</sub>	Aluminum fluosilicate (topaz)	$\epsilon_{11} = 6.62$	297	$7 \times 10^3$
		$\epsilon_{22} = 6.58$	297	$7 \times 10^3$
		$\epsilon_{33} = 6.95$	297	$7 \times 10^3$
		$\epsilon_{11} = \epsilon_{22} = 9.34$	298	$10^2 - 8 \times 10^9$
Al <sub>2</sub> O <sub>3</sub>	Aluminum oxide (alumina)	$\epsilon_{33} = 11.54$	298	$10^2 - 8 \times 10^9$
		$\epsilon_{11}^T = 6.05$	r.t.	$10^3$
AlPO <sub>4</sub>	Aluminum phosphate		r.t.	$10^3$
AlSb	Aluminum antimonide	11.21	300	i.r.
AsF <sub>3</sub>	Arsenic trifluoride	5.7	r.t.	
BN	Boron nitride	7.1	r.t.	i.r.
BaCO <sub>3</sub>	Barium carbonate	8.53	291	$2 \times 10^5$
Ba(COOH) <sub>2</sub>	Barium formate	$\epsilon_{11} = 7.9$	r.t.	$10^3$
		$\epsilon_{22} = 5.9$	r.t.	$10^3$
		$\epsilon_{33} = 7.5$	r.t.	$10^3$
BaCl <sub>2</sub>	Barium chloride	9.81	r.t.	
BaCl <sub>2</sub> · 2H <sub>2</sub> O	Barium chloride dihydrate	9.00	r.t.	$10^3$
BaF <sub>2</sub>	Barium fluoride	7.32	292	$5 \times 10^2 - 10^{11}$
Ba(NO <sub>3</sub> ) <sub>2</sub>	Barium nitrate	4.95	292	$2 \times 10^5$
Ba <sub>2</sub> NaNb <sub>5</sub> O <sub>15</sub>	Barium sodium niobate ("Bananas")	$\epsilon_{11}^S = 222, \epsilon_{11}^T = 235$	296	$10^4$
		$\epsilon_{22}^S = 227, \epsilon_{22}^T = 247$	296	
		$\epsilon_{33}^S = 32, \epsilon_{33}^T = 51$	296	
BaO	Barium oxide (baria)	$34 \pm 1$	248, 333	$60 \times 10^7$
BaO <sub>2</sub>	Barium peroxide	10.7	r.t.	$2 \times 10^6$
BaS	Barium sulfide	19.23	r.t.	$7.25 \times 10^6$
BaSO <sub>4</sub>	Barium sulfate	11.4	288	$10^8$
BaSnO <sub>3</sub>	Barium stannate	18	298	$25 \times 10^5$
BaTiO <sub>3</sub>	Barium titanate	$\epsilon_{11}^T = 3600$	298	$10^5$
		$\epsilon_{11}^S = 2300$	298	$2.5 \times 10^8$
		$\epsilon_{33}^T = 150$	298	$10^5$
		$\epsilon_{33}^S = 80$	298	$2.5 \times 10^8$
Ba <sub>6</sub> Ti <sub>2</sub> Nb <sub>8</sub> O <sub>30</sub>	Barium titanium niobate	$\epsilon_{11} = \epsilon_{22} \approx 190$	298	
		$\epsilon_{33} \approx 220$	298	
BaWO <sub>4</sub>	Barium tungstate	$\epsilon_{11} = \epsilon_{22} = 35.5 \pm 0.2$	297.5	$1.6 \times 10^3$
		$\epsilon_{33} = 37.2 \pm 0.2$	297.5	$1.6 \times 10^3$

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
BaZrO <sub>3</sub>	Barium zirconate	43	rt.	
Be <sub>3</sub> Al <sub>2</sub> Si <sub>6</sub> O <sub>18</sub>	Beryllium aluminum silicate (Beryl)	$\epsilon_{33} = 5.95$	297	$7 \times 10^3$
		$\epsilon_{11} = \epsilon_{22} = 6.86$	297	$7 \times 10^3$
BeCO <sub>3</sub>	Beryllium carbonate	9.7	291	$2 \times 10^5$
BeO	Beryllium oxide (beryllia)	$7.35 \pm 0.2$	293	$2 \times 10^6$
BiFeO <sub>3</sub>	Bismuth iron oxide	$40 \pm 3$	300	$9.4 \times 10^9$
		$\epsilon_{11}^S = 38$	rt.	
Bi <sub>12</sub> GeO <sub>20</sub>	Bismuth germanite		rt.	
Bi(GeO <sub>4</sub> ) <sub>3</sub>	Bismuth germanate	16	293	
Bi <sub>2</sub> O <sub>3</sub>	Bismuth sesquioxide	18.2	rt.	$2 \times 10^6$
Bi <sub>4</sub> Ti <sub>3</sub> O <sub>12</sub>	Bismuth titanate	112	rt.	$10^3$
C	Diamond			
	Type I	$5.87 \pm 0.19$	300	$10^3$
	Type IIa	$5.66 \pm 0.04$	300	$10^3$
C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	Tartaric acid	$\epsilon_{11} = \epsilon_{22} = 4.3$	298	
		$\epsilon_{33} = 4.5$	298	
		$\epsilon_{13} = 0.55$	298	
C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>6</sub>	Ethylene diamine tartrate (EDT)	$\epsilon_{11}^T = 5.0$	293	
		$\epsilon_{22}^T = 8.3$	293	
		$\epsilon_{33}^T = 6.0$	293	
		$\epsilon_{13}^T = 0.7$	293	
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> NaBr	Dextrose sodium bromide	$\epsilon_{11}^T = 4.0$	rt.	$10^3$
(CH <sub>3</sub> NH <sub>3</sub> )Al(SO <sub>4</sub> ) <sub>2</sub> · 2H <sub>2</sub> O	Methyl ammonium alum (MASD)	19	197	
Ca <sub>2</sub> B <sub>6</sub> O <sub>11</sub> · 5H <sub>2</sub> O	Colemanite	$\epsilon_{11} = 20$	293	$10^3$
		$\epsilon_{33} = 25$	293	$10^3$
CaCO <sub>3</sub>	Calcium carbonate	$\epsilon_{11} = 8.67$	rt.	$9.4 \times 10^{10}$
		$\epsilon_{22} = 8.69$	rt.	$9.4 \times 10^{10}$
		$\epsilon_{33} = 8.31$	rt.	$9.4 \times 10^{10}$
CaCeO <sub>3</sub>	Calcium cerate	21	rt.	
CaF <sub>2</sub>	Calcium fluoride	6.81	300	$5 \times 10^2 - 10^{11}$
CaMoO <sub>4</sub>	Calcium molybdate	$\epsilon_{11} = \epsilon_{22} = 24.0 \pm 0.2$	297.5	<10
		$\epsilon_{33} = 20.0 \pm 0.2$	297.5	<10
Ca(NO <sub>3</sub> ) <sub>2</sub>	Calcium nitrate	6.54	292	$2 \times 10^5$
CaNb <sub>2</sub> O <sub>6</sub>	Calcium niobate	$\epsilon_{11} = 22.8 \pm 1.9$	rt.	$(5-500) \times 10^3$
Ca <sub>2</sub> Nb <sub>2</sub> O <sub>7</sub>	Calcium pyroniobate	~45	rt.	$5 \times 10^7$
CaO	Calcium oxide	$11.8 \pm 0.3$	283	$2 \times 10^6$
CaS	Calcium sulfide	6.699	rt.	$7.25 \times 10^6$
CaSO <sub>4</sub> · 2H <sub>2</sub> O	Calcium sulfate dihydrate	$\epsilon_{11} = 5.10$	rt.	
		$\epsilon_{22} = 5.24$	rt.	
		$\epsilon_{33} = 10.30$	rt.	
CaTiO <sub>3</sub>	Calcium titanate	165	rt.	
CaWO <sub>4</sub>	Calcium tungstate	$\epsilon_{11} = \epsilon_{22} = 11.7 \pm 0.1$	297.5	$1.59 \times 10^3$
		$\epsilon_{33} = 9.5 \pm 0.2$	297.5	$1.59 \times 10^3$
Cd <sub>3</sub> As <sub>2</sub>	Cadmium arsenide	$\epsilon_{33} = 18.5$	4	
CdBr <sub>2</sub>	Cadmium bromide	8.6	293	$5 \times 10^5$
CdF <sub>2</sub>	Cadmium fluoride	$8.33 \pm 0.08$	300	$10^5 - 10^7$
CdS	Cadmium sulfide	$\epsilon_{11} = \epsilon_{22} = 8.7$	300	i.r.
		$\epsilon_{33} = 9.25$	300	i.r.
		$\epsilon_{11} = \epsilon_{22} = 8.37$	8	i.r.
		$\epsilon_{33} = 9.00$	8	i.r.
		$\epsilon_{11}^T = 8.48$	77	$10^4$
		$\epsilon_{33}^T = 9.48$	77	$10^4$
		$\epsilon_{11}^S = 9.02, \epsilon_{11}^T = 9.35$	298	$10^4$
		$\epsilon_{33}^S = 9.53, \epsilon_{33}^T = 10.33$	298	$10^4$
CdSe	Cadmium selenide	$\epsilon_{11}^S = 9.53, \epsilon_{11}^T = 9.70$	298	$10^4$

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
		$\epsilon_{33}^S = 10.2, \epsilon_{33}^T = 10.65$	298	$10^4$
CdTe	Cadmium telluride	$\epsilon_{11} = \epsilon_{22} = 10.60 \pm 0.15$	297	i.r.
		$\epsilon_{33} = 7.05 \pm 0.05$	297	i.r.
$\text{Cd}_2\text{Nb}_2\text{O}_7$	Cadmium pyroniobate	500–580	293	$10^3$
$\text{CeO}_2$	Cerium oxide	7.0	r.t.	$2 \times 10^6$
$\text{CoNb}_2\text{O}_6$	Cobalt niobate	$\epsilon_{11} = 18.4 \pm 1.1$	r.t.	$(5-500) \times 10^3$
		$\epsilon_{22} = 21.4 \pm 1.1$	r.t.	$(5-500) \times 10^3$
		$\epsilon_{33} = 33.0 \pm 0.7$	r.t.	$(5-500) \times 10^3$
CoO	Cobalt oxide	12.9	298	$10^2 - 10^{10}$
$\text{Cr}_2\text{O}_3$	Chromic sesquioxide	$\epsilon_{11} = \epsilon_{22} = 13.3$	298.5	$10^3$
		$\epsilon_{33} = 11.9$	298.5	$10^3$
		8	315 ( $T_N$ )	$6 \times 10^{10}$
$\text{CsAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	Cesium alum	5.0	r.t.	$20-20 \times 10^3$
CsBr	Cesium bromide	6.38	298	$1.6 \times 10^3$
$\text{Cs}_2\text{CO}_3$	Cesium carbonate	6.53	291	$2 \times 10^5$
CsCl	Cesium chloride	7.2	298	
$\text{CsH}_2\text{AsO}_4$	Cesium dihydrogen arsenate (CDA)	4.8	273	$9.5 \times 10^9$
$\text{CsH}_2\text{PO}_4$	Cesium dihydrogen phosphate (CDP)	6.15	285	$9.5 \times 10^9$
$\text{CsH}_3(\text{SeO}_3)_2$	Cesium trihydrogen selenite	$\epsilon_{11} = 80$	273	$10^5$
		$\epsilon_{22} = 63$	273	$10^5$
		$\epsilon_{33} = 12$	273	$10^5$
CsI	Cesium iodide	6.31	298	$1.6 \times 10^3$
$\text{CsNO}_3$	Cesium nitrate	$\epsilon_{11} = \epsilon_{22} = 9.4$	r.t.	$5 \times 10^5$
		$\epsilon_{33} = 8.3$	r.t.	$5 \times 10^5$
$\text{CsPbCl}_3$	Cesium lead chloride	14.37	300	$10^5 - 10^6$
CuBr	Cuprous bromide	8.0	293	$5 \times 10^5$
CuCl	Cuprous chloride	$9.8 \pm 0.5$	r.t.	$10^3$
CuO	Cupric oxide	18.1	r.t.	$2 \times 10^6$
$\text{Cu}_2\text{O}$	Cuprous oxide (Cuprite)	$7.60 \pm 0.06$	r.t.	$10^5$
$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	Cupric sulfate pentahydrate	6.60	r.t.	
$\text{EuF}_2$	Europium fluoride	$7.7 \pm 0.2$	298	$(1-300) \times 10^3$
$\text{Eu}_2(\text{MoO}_4)_3$	Europium molybdate	9.5	298	
EuS	Europium sulfide	$13.10 \pm 0.04$	80	$5 \times 10^2 - 10^5$
FeO	Ferrous oxide	14.2	r.t.	$2 \times 10^6$
$\text{Fe}_2\text{O}_3$	Ferric sesquioxide	4.5	r.t.	$10^5 - 10^7$
$\text{Fe}_2\text{O}_3 - \alpha$	Ferric sesquioxide (hematite)	12		$6 \times 10^{10}$
$\text{Fe}_3\text{O}_4$	Ferrosferric oxide (magnetite)	20	r.t.	$10^5 - 10^7$
GaAs	Gallium arsenide	13.13	300	
		12.90	4	i.r.
GaP	Gallium phosphide	11.1	r.t.	
		$10.75 \pm 0.1$	1.6	i.r.
GaSb	Gallium antimonide	15.69	r.t.	
		15.7	4	i.r.
$\text{Gd}_2(\text{MoO}_4)_3$	Gadolinium molybdate	$\epsilon^T = 10$	298	
		$\epsilon^S = 9.5$	298	$10^3$
Ge	Germanium	$16.0 \pm 0.3$	4	$9.2 \times 10^9$
		$15.8 \pm 0.2$	r.t.	$500-3 \times 10^{10}$
$\text{GeO}_2$	Germanium dioxide	$\epsilon_{11} = \epsilon_{22} = 7.44$	r.t.	i.r.
$\text{HIO}_3$	Iodic acid	$\epsilon_{11} = 7.5$	r.t.	$10^3$
		$\epsilon_{22} = 12.4$	r.t.	$10^3$
		$\epsilon_{33} = 8.1$	r.t.	$10^3$
$\text{HNH}_4(\text{ClCH}_2\text{COO})_2$	Hydrogen ammonium dichloroacetate	$\epsilon_{[102]} = 5.9$	r.t.	$10^5$
$\text{H}_2\text{O}$	Ice I (P = 0 kbar)	99	243	
	Ice III (P = 3 kbar)	117	243	
	Ice V (P = 5 kbar)	114	243	
	Ice VI (P = 8 kbar)	193	243	
HgCl	Mercurous chloride (Calumel)	$\epsilon_{11} = \epsilon_{22} = 14.0$	r.t.	$10^{12}$
$\text{HgCl}_2$	Mercuric chloride	6.5	r.t.	$10^{12}$
HgS	Mercurous sulfide (Cinnabar)	$\epsilon_{11} = \epsilon_{22} = 18.0$	r.t.	i.r.
		$\epsilon_{33} = 32.5$	r.t.	i.r.

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
HgSe	Mercurous selenide	25.6	rt.	$10^4-10^6$
I <sub>2</sub>	Iodine	$\epsilon_{11} = 6$	rt.	$5 \times 10^4-10^7$
		$\epsilon_{22} = 3$	rt.	$5 \times 10^4-10^7$
		$\epsilon_{33} = 40$	rt.	$5 \times 10^4-10^7$
InAs	Indium arsenide	14.55 ± 0.3	rt.	i.r.
		15.15	4	i.r.
InP	Indium phosphide	12.61	rt.	i.r.
InSb	Indium antimonide	17.88	4	i.r.
KAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	Potassium alum	6.5	rt.	$20-20 \times 10^3$
KBr	Potassium bromide	4.88	300	
		4.53	4.2	
KBrO <sub>3</sub>	Potassium bromate	7.3	rt.	$2 \times 10^6$
KCN	Potassium cyanide	6.15	rt.	$2 \times 10^6$
K <sub>2</sub> CO <sub>3</sub>	Potassium carbonate	4.96	291	$2 \times 10^5$
K <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> · 1/2 H <sub>2</sub> O	Dipotassium tartrate (DKT)	$\epsilon_{11} = 6.44$	rt.	
		$\epsilon_{22} = 5.80$	rt.	
		$\epsilon_{33} = 6.49$	rt.	
		$\epsilon_{13} = 0.005$	rt.	
KCl	Potassium chloride	4.86 ± 0.02	rt.	$5 \times 10^3$
		4.50	4.2	
KClO <sub>3</sub>	Potassium chlorate	5.1	rt.	$2 \times 10^6$
KClO <sub>4</sub>	Potassium perchlorate	5.9	rt.	$2 \times 10^6$
K <sub>2</sub> CrO <sub>4</sub>	Potassium chromate	7.3	rt.	$6 \times 10^7$
KCr(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	Potassium chrome alum	6.5	100-240	$175 \times 10^3$
KD <sub>2</sub> AsO <sub>4</sub>	Potassium dideuterium arsenate (KDDA)	$\epsilon_{11} = 70$	298	
		$\epsilon_{33} = 31$	298	
KD <sub>2</sub> PO <sub>4</sub>	Potassium dideuterium phosphate (KDDP)	50 ± 2	297	$10^3$
KF	Potassium fluoride	6.05		$2 \times 10^6$
KH <sub>2</sub> AsO <sub>4</sub>	Potassium dihydrogen arsenate (KDA)	$\epsilon_{11} = 60$	298	
		$\epsilon_{33} = 24$	298	
KH <sub>2</sub> PO <sub>4</sub>	Potassium dihydrogen phosphate (KDP)	46	298	$10^3$
		$\epsilon_{11} = 42$	rt.	
		$\epsilon_{33} = 21$	rt.	
K <sub>2</sub> HPO <sub>4</sub>	Dipotassium monohydrogen orthophosphate	9.05	rt.	$2 \times 10^6$
KI	Potassium iodide	5.00	rt.	$9.4 \times 10^{10}$
KIO <sub>3</sub>	Potassium iodate	170	255	$10^5$
		10	293	$10^5$
		$\epsilon_{[101]} \approx 40,70$	rt.	$10^5$
		16.85	rt.	$2 \times 10^6$
(K,H)Al <sub>3</sub> (SiO <sub>3</sub> ) <sub>3</sub>	Mica (muscovite)	5.4	299	$10^2-3 \times 10^9$
(K,H)Mg <sub>3</sub> Al(SiO <sub>3</sub> ) <sub>3</sub>	Mica (Canadian)	$\epsilon_{11} = \epsilon_{22} = 6.9$	298	$10^2-10^4$
		$\epsilon_{33} = 7.3$	298	$10^4$
KNO <sub>2</sub>	Potassium nitrite	25	305	
KNO <sub>3</sub>	Potassium nitrate	4.37	293	$2 \times 10^5$
KNbO <sub>3</sub>	Potassium niobate	700	rt.	
K <sub>3</sub> PO <sub>4</sub>	Potassium orthophosphate	7.75	rt.	$2 \times 10^6$
KSCN	Potassium thiocyanate	7.9	rt.	$2 \times 10^6$
K <sub>2</sub> SO <sub>4</sub>	Potassium sulfate	6.4	rt.	$2 \times 10^6$
K <sub>2</sub> S <sub>3</sub> O <sub>6</sub>	Potassium trithionate	5.7	293	$1.8 \times 10^6$
K <sub>2</sub> S <sub>4</sub> O <sub>6</sub>	Potassium tetrathionate	5.5	293	$1.8 \times 10^6$
K <sub>2</sub> S <sub>5</sub> O <sub>6</sub> · H <sub>2</sub> O	Potassium pentathionate	7.8	293	$1.8 \times 10^6$
K <sub>2</sub> S <sub>6</sub> O <sub>6</sub>	Potassium hexathionate	7.8	293	$1.8 \times 10^6$
		$\epsilon_{11} = 5.9$	rt.	$10^3$
K <sub>2</sub> SeO <sub>4</sub>	Potassium selenate	$\epsilon_{22} = 7.7$	rt.	$10^3$
		$\epsilon_{11} = \epsilon_{11} \approx 1200$	298	
KSr <sub>2</sub> Nb <sub>3</sub> O <sub>15</sub>	Potassium strontium niobate	$\epsilon_{33} \approx 800$	298	
		34,000	273	$10^4$
KTaNbO <sub>3</sub>	Potassium tantalate niobate (KTN)	6,000	293	$10^4$
		242	298	$2 \times 10^5$
KTaO <sub>3</sub>	Potassium tantalate	30	rt.	
LaScO <sub>3</sub>	Lanthanum scandate			

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
LiBr	Lithium bromide	12.1	rt.	$2 \times 10^6$
Li <sub>2</sub> CO <sub>3</sub>	Lithium carbonate	4.9	291	$2 \times 10^5$
LiCl	Lithium chloride	11.05	rt.	$2 \times 10^6$
LiD	Lithium deuteride	14.0 ± 0.5	rt.	i.r.
LiF	Lithium fluoride	9.00	298	$10^2$ – $10^7$
		9.11	353	$10^2$ – $10^7$
LiGaO <sub>2</sub>	Lithium metagallate	$\epsilon_{11}^T = 7.0, \epsilon_{22}^T = 6.0$	rt.	
		$\epsilon_{33}^T = 9.5$	rt.	
		$\epsilon_{11}^S = 6.8, \epsilon_{22}^S = 5.8$	rt.	
Li <sup>6</sup> H	Lithium-6 hydride	13.2 ± 0.5	rt.	
Li <sup>7</sup> H	Lithium-7 hydride	12.9 ± 0.5	rt.	
LiH <sub>3</sub> (SeO <sub>3</sub> ) <sub>2</sub>	Lithium trihydrogen selenite	29	298	$10^4$
		$\epsilon_{11} = 13.0$	rt.	
		$\epsilon_{22} = 12.9$	rt.	
		$\epsilon_{33} = 46$	rt.	
LiI	Lithium iodide	11.03	rt.	$2 \times 10^6$
LiIO <sub>3</sub>	Lithium iodate	$\epsilon_{11} = \epsilon_{22} = 65$	294.5	$10^3$
		$\epsilon_{33} = 554$	298	
LiNH <sub>4</sub> C <sub>4</sub> O <sub>6</sub> · H <sub>2</sub> O	Lithium ammonium tartrate (LAT)	$\epsilon_{11}^T = 7.2$	298	
		$\epsilon_{22}^T = 8.0$	298	
		$\epsilon_{33}^T = 6.9$	298	
LiNa <sub>3</sub> CrO <sub>4</sub> · 6H <sub>2</sub> O	Lithium trisodium chromate	8.0	rt.	$10^3$
LiNa <sub>3</sub> MoO <sub>4</sub> · 6H <sub>2</sub> O	Lithium trisodium molybdate	$\epsilon_{11} = 6.7$	rt.	$10^3$
		$\epsilon_{33} = 5.3$	rt.	$10^3$
LiNbO <sub>3</sub>	Lithium niobate	$\epsilon_{11} = \epsilon_{22} = 82$	298	$10^5$
		$\epsilon_{33} = 30$	298	$10^5$
Li <sub>2</sub> SO <sub>4</sub> · H <sub>2</sub> O	Lithium sulfate monohydrate	$\epsilon_{11} = 5.6$	298	
		$\epsilon_{22} = 10.3$	298	
		$\epsilon_{33} = 6.5$	298	
		$\epsilon_{13} = 0.07$	298	
LiTaO <sub>3</sub>	Lithium tantalate	$\epsilon_{11} = \epsilon_{22} = 53$	rt.	$10^5$
		$\epsilon_{33} = 46$	rt.	$10^5$
		$\epsilon_{11}^S = \epsilon_{22}^S = 41$	rt.	
		$\epsilon_{33}^S = 43$	rt.	
		$\epsilon_{11}^T = \epsilon_{22}^T = 51$	rt.	
		$\epsilon_{33}^T = 45$	rt.	
LiTlC <sub>4</sub> O <sub>6</sub> · H <sub>2</sub> O	Lithium thallium tartrate (LTT)	$\epsilon_{11} \approx 20$	80	
Mg <sub>3</sub> B <sub>7</sub> O <sub>13</sub> Cl	Magnesium borate monochloride (boracite)	$\epsilon_{11} = 14.1$	rt.	$5 \times 10^5$
MgCO <sub>3</sub>	Magnesium carbonate	8.1	291	$2 \times 10^5$
MgNb <sub>2</sub> O <sub>6</sub>	Magnesium niobate	$\epsilon_{11} = 16.4 \pm 0.5$	rt.	$(5-500) \times 10^3$
		$\epsilon_{22} = 20.9 \pm 0.5$	rt.	$(5-500) \times 10^3$
		$\epsilon_{33} = 32.4 \pm 0.5$	rt.	$(5-500) \times 10^3$
MgO	Magnesium oxide (Periclase)	9.65	298	$10^2$ – $10^8$
(MgO) <sub>x</sub> Al <sub>2</sub> O <sub>3</sub>	Spinel	8.6	rt.	
MgSO <sub>4</sub>	Magnesium sulfate	8.2	rt.	
MgSO <sub>4</sub> · 7H <sub>2</sub> O	Magnesium sulfate heptahydrate	5.46	rt.	
MgTiO <sub>3</sub>	Magnesium titanate	13.5	rt.	
MgWO <sub>4</sub>	Magnesium tungstate	$\epsilon_{11} = 18.0 \pm 1$	rt.	$(5-500) \times 10^3$
		$\epsilon_{22} = 18.0 \pm 1$	rt.	$(5-500) \times 10^3$
MnNb <sub>2</sub> O <sub>6</sub>	Manganese niobate	$\epsilon_{11} = 17.4 \pm 2$	rt.	$(5-500) \times 10^3$
		$\epsilon_{22} = 16.1 \pm 0.5$	rt.	$(5-500) \times 10^3$
		$\epsilon_{33} = 30.7 \pm 1$	rt.	$(5-500) \times 10^3$
MnO	Manganese oxide (Pyrolusite)	12.8	rt.	$6 \times 10^{10}$
MnO <sub>2</sub>	Manganese dioxide	$\sim 10^4$	298	$10^4$
Mn <sub>2</sub> O <sub>3</sub>	Manganese sesquioxide	8	rt.	$6 \times 10^{10}$
MnWO <sub>4</sub>	Manganese tungstate	$\epsilon_{11} = 19.3 \pm 1.3$	rt.	$(5-500) \times 10^3$

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
$\text{N}(\text{CH}_3)_4\text{HgBr}_3$	Tetramethylammonium tribromomercurate (TTM)	$\epsilon_{22} = 14.3 \pm 0.5$	rt.	$(5-500) \times 10^3$
		$\epsilon_{33} = 16.5 \pm 1.1$	rt.	$(5-500) \times 10^3$
		$\sim 10$	233-373	
$\text{N}(\text{CH}_3)_4\text{HgI}_3$	Tetramethylammonium triiodo mercurate (TTM)	$\sim 10$	233-373	
$\text{N}_4(\text{CH}_2)_6$	Hexamethylene tetramine (HMTA)	$2.6 \pm 0.2$	rt.	$10^9-10^{10}$
$(\text{ND}_4)_2\text{BeF}_4$	Deuteroammonium fluoberyllate	$\epsilon_{11} = 10$	rt.	
		$\epsilon_{22} = 9$	rt.	
		$\epsilon_{33} = 9$	rt.	
		$\epsilon_{11} = 9$	rt.	
$(\text{ND}_4)_2\text{SO}_4$	Deuteroammonium sulfate	$\epsilon_{22} = 10$	rt.	
		$\epsilon_{33} = 9$	rt.	
		$\epsilon_{11} = 9$	rt.	
$(\text{NH}_2 \cdot \text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{SO}_4$	Triglycine sulfate (TGS)	$\epsilon_{11} = 9$	273	$10^4$
		$\epsilon_{22} = 30$	273	$10^4$
		$\epsilon_{33} = 6.5$	273	$10^4$
$(\text{NH}_2 \cdot \text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{SeO}_4$	Triglycine selenate (TGSe)	200	293	$1.6 \times 10^3$
$(\text{NH}_2 \cdot \text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{BeF}_4$	Triglycine fluorberyllate (TGFB)	$\epsilon_{22} = 12$	273	$10^4$
$\text{NH}_4\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	Ammonium alum	6	rt.	$10^{12}$
$(\text{NH}_4)_2\text{BeF}_4$	Ammonium fluorberyllate	$\epsilon_{11} = \epsilon_{22} = 7.8$	123	$10^5$
		$\epsilon_{33} = 7.1$	123	$10^5$
		$\epsilon_{11} = \epsilon_{22} = 8.8$	293	$10^5$
		$\epsilon_{33} = 9.2$	293	$10^5$
$\text{NH}_4\text{Br}$	Ammonium bromide	7.1	rt.	$7 \times 10^5$
$\text{NH}_4\text{I}$	Ammonium iodide	9.8	rt.	
$(\text{NH}_4)_2\text{C}_2\text{H}_6\text{O}_6$	Ammonium tartrate	$\epsilon_{11} = 6.45$	rt.	$10^3$
		$\epsilon_{22} = 6.8$	rt.	$10^3$
		$\epsilon_{33} = 6.0$	rt.	$10^3$
$(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$	Ammonium cadmium sulfate	10.0	rt.	$10^4$
$\text{NH}_4\text{Cl}$	Ammonium chloride	6.9	rt.	$7 \times 10^5$
$\text{NH}_4(\text{ClCH}_2\text{COO})$	Ammonium monochloroacetate	5	rt.	$2 \times 10^6$
$\text{NH}_4\text{Cr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	Ammonium chrome alum	6.5	rt.	$175 \times 10^3$
$\text{NH}_4\text{HSO}_4$	Ammonium bisulfate	165	273	$5 \times 10^4$
$\text{NH}_4\text{H}_2\text{AsO}_4$	Ammonium dihydrogen arsenate (ADA)	5.1	265	$9.5 \times 10^9$
		$\epsilon_{11} = \epsilon_{22} = 85$	298	$10^3$
		$\epsilon_{33} = 22$	298	
$\text{NH}_4\text{H}_2\text{PO}_4$	Ammonium dihydrogen phosphate (ADP)	$\epsilon_{11} = \epsilon_{22} = 57.1 \pm 0.6$	294.5	$10^5-35 \times 10^9$
		$\epsilon_{33} = 14.0 \pm 0.3$	294	$10^5-36 \times 10^9$
		$\epsilon_{11} = \epsilon_{22} = 74, \epsilon_{33} = 24$	300	
$\text{NH}_4\text{NO}_3$	Ammonium nitrate	10.7	322	$(5-50) \times 10^3$
$(\text{NH}_4)_2\text{SO}_4$	Ammonium sulfate	$\epsilon_{11} = \epsilon_{22} = 8.0$	123	$10^5$
		$\epsilon_{33} = 6.3$	123	$10^5$
		$\epsilon_{11} = \epsilon_{22} = 10.0$	293	$10^5$
		$\epsilon_{33} = 9.3$	293	$10^5$
$(\text{NH}_4)_2\text{UO}_2(\text{C}_2\text{O}_4)_2$	Ammonium uranyl oxalate	8.03	rt.	$10^4-3.3 \times 10^9$
$(\text{NH}_4)_2\text{UO}_2(\text{C}_2\text{O}_4)_2 \cdot 3\text{H}_2\text{O}$	Ammonium uranyl oxalate trihydrate	6.06	rt.	$10^4-3.3 \times 10^9$
$\text{NaBr}$	Sodium bromide	6.44	298	$1.6 \times 10^3$
$\text{NaBrO}_3$	Sodium bromate	$\epsilon_{11}^T = 5.70$	298	$10^3$
$\text{NaCN}$	Sodium cyanide	7.55	293	$10^5$
$\text{NaCO}_3$	Sodium carbonate	8.75	291	$2 \times 10^5$
$\text{NaCO}_3 \cdot 10\text{H}_2\text{O}$	Sodium carbonate decahydrate	5.3	rt.	$6 \times 10^7$
$\text{NaCl}$	Sodium chloride	5.9	298	$10^2-10^7$
		5.45	4.2	
$\text{NaClO}_3$	Sodium chlorate	$\epsilon_{11}^T = 5.76$	301	$10^3$
		5.28	rt.	$10^3$

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
NaClO <sub>4</sub>	Sodium perchlorate	5.76	r.t.	10 <sup>3</sup>
NaF	Sodium fluoride	5.08 ± 0.02	r.t.	5 × 10 <sup>3</sup>
NaH <sub>3</sub> (SeO <sub>3</sub> ) <sub>2</sub>	Sodium trihydrogen selenite	$\epsilon_{11} \approx 75$	273	2 × 10 <sup>5</sup>
NaD <sub>3</sub> (SeO <sub>3</sub> ) <sub>2</sub>	Sodium trideuterium selenite	$\epsilon_{11} \approx 220$	273	2 × 10 <sup>5</sup>
NaI	Sodium iodide	7.28 ± 0.03	r.t.	
NaK(C <sub>4</sub> H <sub>2</sub> D <sub>2</sub> O <sub>6</sub> ) · 4D <sub>2</sub> O	Sodium potassium tartrate tetradeuterate (double deuterated Rochelle salt)	$\epsilon_{11} = 70$ $\epsilon_{22} = 8.9$	273 273	10 <sup>3</sup> 10 <sup>3</sup>
NaK(C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ) · 4H <sub>2</sub> O	Sodium potassium tartrate tetrahydrate (Rochelle salt)	$\epsilon_{11} = 170$ $\epsilon_{22} = 9.1$	273 273	10 <sup>3</sup> 10 <sup>3</sup>
NaNH <sub>4</sub> (C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ) · 4H <sub>2</sub> O	Sodium ammonium tartrate (Ammonium Rochelle salt)	$\epsilon_{11} = 8.4$ $\epsilon_{22} = 9.2$ $\epsilon_{33} = 9.5$	298 298 298	
NaNbO <sub>3</sub>	Sodium niobate	$\epsilon_{33} = 670 \pm 13$ $\epsilon_{11} = \epsilon_{22} = 76 \pm 2$	r.t. r.t.	
NaNO <sub>2</sub>	Sodium nitrite	$\epsilon_{11} = 7.4$ $\epsilon_{22} = 5.5$ $\epsilon_{33} = 5.0$	r.t. r.t. r.t.	5 × 10 <sup>5</sup> 5 × 10 <sup>5</sup> 5 × 10 <sup>5</sup>
NaNO <sub>3</sub>	Sodium nitrate	6.85	292	2 × 10 <sup>5</sup>
NaSO <sub>4</sub>	Sodium sulfate	7.90	r.t.	
NaSO <sub>4</sub> · 10H <sub>2</sub> O	Sodium sulfate decahydrate	5.0	r.t.	
Na <sub>2</sub> SO <sub>4</sub> · 5H <sub>2</sub> O	Sodium sulfate pentahydrate	7	250–290	300–10 <sup>4</sup>
Na <sub>2</sub> UO <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub>	Sodium uranyl oxalate	5.18	r.t.	
NdAlO <sub>3</sub>	Neodymium aluminate	17.5	r.t.	
NdScO <sub>3</sub>	Neodymium scandate	27	r.t.	
Ni <sub>3</sub> B <sub>7</sub> O <sub>13</sub> I	Nickel iodine boracite	$\epsilon_{11} = 14$	260	
NiNb <sub>2</sub> O <sub>6</sub>	Nickel niobate	$\epsilon_{11} = 16.0 \pm 0.5$ $\epsilon_{22} = 23.8 \pm 1.8$ $\epsilon_{33} = 31.3 \pm 2.5$	r.t. r.t. r.t.	(5–500) × 10 <sup>3</sup> (5–500) × 10 <sup>3</sup> (5–500) × 10 <sup>3</sup>
NiO	Nickel oxide	11.9	298	10 <sup>5</sup>
NiSO <sub>4</sub> · 6H <sub>2</sub> O	Nickel sulfate hexahydrate	$\epsilon_{11} = 6.2$ $\epsilon_{33} = 6.8$	r.t. r.t.	
NiWO <sub>4</sub>	Nickel tungstate	$\epsilon_{11} = 17.4 \pm 2.4$ $\epsilon_{22} = 13.6 \pm 1.0$ $\epsilon_{33} = 19.7 \pm 0.6$	r.t. r.t. r.t.	(5–500) × 10 <sup>3</sup> (5–500) × 10 <sup>3</sup> (5–500) × 10 <sup>3</sup>
P	Phosphorous (red)	4.1	r.t.	10 <sup>8</sup>
	Phosphorous (yellow)	3.6	r.t.	10 <sup>8</sup>
[P(CH <sub>3</sub> ) <sub>4</sub> ]HgBr <sub>3</sub>	Tetramethylphosphonium tribromomercurate (TTM)	~10	233–373	
PbBr <sub>2</sub>	Lead bromide	>30	293	(0.5–3) × 10 <sup>6</sup>
PbCO <sub>3</sub>	Lead carbonate	18.6	288	10.8
Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub>	Lead acetate	2.6	290–295	10 <sup>6</sup>
PbCl <sub>2</sub>	Lead chloride	33.5	273	(0.5–3) × 10 <sup>6</sup>
Pb <sub>2</sub> CoWO <sub>6</sub>	Lead cobalt tungstate	~250	r.t.	
PbF <sub>2</sub>	Lead fluoride	26.3	r.t.	
PbHfO <sub>3</sub>	Lead hafnate	390	300	10 <sup>5</sup>
		185	400	
PbI <sub>2</sub>	Lead iodide	20.8	293	(0.5–3) × 10 <sup>6</sup>
Pb <sub>3</sub> MgNb <sub>2</sub> O <sub>9</sub>	Lead magnesium niobate	10,000	297	
PbMoO <sub>4</sub>	Lead molybdate	$\epsilon_{11} = 34.0 \pm 0.4$ $\epsilon_{33} = 40.6 \pm 0.2$	297.5 297.5	1.6 ± 10 <sup>3</sup> 1.6 ± 10 <sup>3</sup>
Pb(NO <sub>3</sub> ) <sub>2</sub>	Lead nitrate	16.8	r.t.	(0.5–3) × 10 <sup>6</sup>
PbNb <sub>2</sub> O <sub>6</sub>	Lead niobate	$\epsilon_{33}^T = 180$	298	
PbO	Lead oxide	25.9	r.t.	2 × 10 <sup>6</sup>
PbS	Lead sulfide (Galena)	190	77	i.r.
		200 ± 35	r.t.	i.r.
PbSO <sub>4</sub>	Lead sulfate	14.3	290–295	10 <sup>6</sup>
PbSe	Lead selenide	280	r.t.	i.r.
PbTa <sub>2</sub> O <sub>6</sub>	Lead metatantalate	$\epsilon_{11} = \epsilon_{22} \approx 300$ $\epsilon_{33} = 150$	r.t. r.t.	10 <sup>4</sup> 10 <sup>4</sup>
PbTe	Lead telluride	450	r.t.	i.r.



Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
		40	77	$10^4\text{--}15 \times 10^4$
		430	4.2	$10^4\text{--}15 \times 10^4$
PbTiO <sub>3</sub>	Lead titanate	~200	rt.	$10^3$
PbWO <sub>4</sub>	Lead tungstate	$\epsilon_{11} = \epsilon_{22} = 23.6 \pm 0.3$	297.5	$1.59 \times 10^3$
		$\epsilon_{33} = 31.0 \pm 0.4$	297.5	$1.59 \times 10^3$
Pb(Zn <sub>1/3</sub> Nb <sub>2/3</sub> )O <sub>3</sub>	Lead zinc niobate	7	300	$10^3, 300 \times 10^3$
PbZrO <sub>3</sub>	Lead zirconate	200	400	
RbAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	Rubidium alum	5.1	rt.	$10^{12}$
RbBr	Rubidium bromide	4.83	300	
Rb <sub>2</sub> CO <sub>3</sub>	Rubidium carbonate	$4.87 \pm 0.02$	rt.	$5 \times 10^3$
RbCl	Rubidium chloride	$4.91 \pm 0.02$	rt.	$5 \times 10^3$
RbCr(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	Rubidium chrome alum	5.0	rt.	$10^{12}$
RbF	Rubidium fluoride	5.91	rt.	$2 \times 10^6$
RbHSO <sub>4</sub>	Rubidium bisulfate	$\epsilon_{11} = 7$	rt.	$10^5$
		$\epsilon_{22} = 8$	rt.	$10^5$
		$\epsilon_{33} = 10$	rt.	$10^5$
RbH <sub>2</sub> AsO <sub>4</sub>	Rubidium dihydrogen arsenate (RDA)	3.90	273	$9.5 \times 10^9$
RbH <sub>2</sub> PO <sub>4</sub>	Rubidium dihydrogen phosphate (RDP)	6.15	285	$9.5 \times 10^9$
RbI	Rubidium iodide	$4.94 \pm 0.02$	rt.	$5 \times 10^3$
RbInSO <sub>4</sub>	Rubidium indium sulfate	6.85	rt.	
RbNO <sub>3</sub>	Rubidium nitrate	20—380	433—488	$10^6$
		30	488—538	$10^6$
S	Sulfur	$\epsilon_{11} = 3.75$	298	$10^2\text{--}10^3$
		$\epsilon_{22} = 3.95$	298	$10^2\text{--}10^3$
		$\epsilon_{33} = 4.44$	298	$10^2\text{--}10^3$
	sublimed	3.69	298	$10^2\text{--}10^3$
SC(NH <sub>2</sub> ) <sub>2</sub>	Thiourea	$\epsilon_{11} = \epsilon_{22} \approx 3$	77—300	$10^3$
		$\epsilon_{22} = 35$	300	$10^3$
Sb <sub>2</sub> O <sub>3</sub>	Antimonous sesquioxide	12.8	rt.	$(1.5\text{--}2) \times 10^3$
Sb <sub>2</sub> S <sub>3</sub>	Antimonous sulfide (stibnite)	$\epsilon_{11} = \epsilon_{33} = 15$	rt.	$10^3$
		$\epsilon_{33} = 180$	rt.	$10^3$
Sb <sub>2</sub> Se <sub>3</sub>	Antimonous selenide	~110	rt.	$(10\text{--}16.5) \times 10^9$
SbSI	Antimonous sulfide iodide	2000	273	$10^5$
		$\epsilon_{11} = \epsilon_{22} \approx 25$	rt.	$10^3\text{--}10^5$
		$\epsilon_{33} \approx 5 \times 10^4$	295	$10^3\text{--}10^5$
Se	Selenium (monocrystal)	$\epsilon_{11} = \epsilon_{22} = 11$	300	$24 \times 10^9$
		$\epsilon_{33} = 21$	300	$24 \times 10^9$
	(amorphous)	6.0	298	$10^2\text{--}10^{10}$
Si	Silicon	12.1	4.2	$10^7\text{--}10^9$
SiC	Silicon carbide			
	cubic	9.72	rt.	i.r.
	6H	$\epsilon_{11} = \epsilon_{22} = 9.66$	rt.	i.r.
		$\epsilon_{33} = 10.03$	rt.	i.r.
		$9.7 \pm 0.1$	1.8	i.r.
Si <sub>3</sub> N <sub>4</sub>	Silicon nitride	4.2 (film)	rt.	$10^3$
SiO	Silicon monoxide	5.8	rt.	$10^3$
SiO <sub>2</sub>	Silicon dioxide	$\epsilon_{11} = 4.42$	rt.	$9.4 \times 10^{10}$
		$\epsilon_{22} = 4.41$	rt.	$9.4 \times 10^{10}$
		$\epsilon_{33} = 4.60$	rt.	$9.4 \times 10^{10}$
Sm <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	Samarium molybdate	12	298	
SnO <sub>2</sub>	Stannic dioxide	$\epsilon_{11} = \epsilon_{22} = 14 \pm 2$	rt.	$10^4\text{--}10^{10}$
		$\epsilon_{33} = 9.0 \pm 0.5$	rt.	$10^4\text{--}10^{10}$
SnSb	Tin antimonide	147	rt.	$10^4\text{--}10^6$
SnTe	Tin telluride	$1770 \pm 300$	rt.	i.r.
Sr(COOH) <sub>2</sub> · 2H <sub>2</sub> O	Strontium formate dihydrate	6.1	rt.	$10^3$
SrCO <sub>3</sub>	Strontium carbonate	8.85	298	$2 \times 10^5$
SrCl <sub>2</sub>	Strontium chloride	9.19	rt.	
SrCl <sub>2</sub> · 6H <sub>2</sub> O	Strontium chloride hexahydrate	8.52	rt.	
SrF <sub>2</sub>	Strontium fluoride	6.50	300	$5 \times 10^2\text{--}10^{11}$
SrMoO <sub>4</sub>	Strontium molybdate	$\epsilon_{11} = \epsilon_{22} = 31.7 \pm 0.2$	297.5	$1.59 \times 10^3$

Formula	Name	$\epsilon_{ijk}$	T/K	$\nu/\text{Hz}$
		$\epsilon_{33} = 41.7 \pm 0.2$	297.5	$1.59 \times 10^3$
$\text{Sr}(\text{NO}_3)_2$	Strontium nitrate	5.33	292	$2 \times 10^5$
$\text{Sr}_2\text{Nb}_2\text{O}_7$	Strontium niobate	$\epsilon_{11} = 75$	r.t.	$10^3$
		$\epsilon_{22} = 46$	r.t.	$10^3$
		$\epsilon_{33} = 43$	r.t.	$10^3$
SrO	Strontium oxide	$13.3 \pm 0.3$	273	$2 \times 10^6$
SrS	Strontium sulfide	11.3	r.t.	$7.25 \times 10^6$
$\text{SrSO}_4$	Strontium sulfate	11.5	r.t.	
$\text{SrTiO}_3$	Strontium titanate	332	298	$10^3$
		2080	78	$10^3$
$\text{SrWO}_4$	Strontium tungstate	$\epsilon_{11} = \epsilon_{22} = 25.7 \pm 0.2$	297.5	$1.6 \times 10^3$
		$\epsilon_{33} = 34.1 \pm 0.2$	297.5	$1.6 \times 10^3$
$\text{Ta}_2\text{O}_5$	Tantalum pentoxide (tantala)			
	$\alpha$ phase	$\epsilon_{11} = \epsilon_{22} = 30$	77	$10^3$
		$\epsilon_{33} = 65$	77	$10^3$
	$\beta$ phase	24	292	$10^3$
$\text{Tb}(\text{MoO}_4)_3$	Terbium molybdate	11	298	
		$\epsilon_{11} = \epsilon_{22} = 33$	100–200	$9.4 \times 10^9$
		$\epsilon_{33} = 53$	100–200	$9.4 \times 10^9$
Te	Tellurium	$\epsilon_{11} = \epsilon_{22} = 33$	r.t.	
		$\epsilon_{33} = 54$	r.t.	
	polycrystalline	27.5	r.t.	i.r.
	monocrystalline	28.0	r.t.	i.r.
$\text{ThO}_2$	Thorium dioxide	$18.9 \pm 0.4$	r.t.	$3 \times 10^5$
$\text{TiO}_2$	Titanium dioxide (rutile)	$\epsilon_{11} = \epsilon_{22} = 86$	300	$10^4$ – $10^6$
		$\epsilon_{33} = 170$	300	$10^4$ – $10^6$
$\text{Ti}_2\text{O}_3$	Titanium sesquioxide	30	77	$6 \times 10^{10}$
TlBr	Thallium bromide	30	293	$10^3$ – $10^7$
TlCl	Thallos chloride	$32.2 \pm 0.2$	293	$10^3$ – $10^5$
TlI	Thallos iodide (orthorhombic)	$20.7 \pm 0.2$	293	$10^4$
		37.3	193	$10^7$
TlNO <sub>3</sub>	Thallos nitrate	16.5	293	$5 \times 10^5$
TlSO <sub>4</sub>	Thallos sulfate	25.5	293	$5 \times 10^5$
UO <sub>2</sub>	Uranium dioxide	24	r.t.	$3 \times 10^5$
WO <sub>3</sub>	Tungsten trioxide	300		
YMnO <sub>3</sub>	Yttrium manganate	20	r.t.	$2 \times 10^7$
Y <sub>2</sub> O <sub>3</sub>	Yttrium sesquioxide	10	r.t.	$10^6$
YbMnO <sub>3</sub>	Ytterbium manganate	20	r.t.	$2 \times 10^7$
Yb <sub>2</sub> O <sub>3</sub>	Ytterbium sesquioxide	5.0 (film)	r.t.	$10^3$
ZnO	Zinc monoxide	$\epsilon_{11}^S = 8.33$	r.t.	
		$\epsilon_{33}^S = 8.84$	r.t.	
		$\epsilon_{11}^T = 9.26$	r.t.	
		$\epsilon_{33}^T = 11.0$	r.t.	
		$\epsilon_{11} = 9.26$	r.t.	
		$\epsilon_{33} = 8.2$	r.t.	
		8.15	r.t.	i.r.
ZnS	Zinc sulfide	$\epsilon_{11}^S = 8.08 \pm 2\%$	77	$10^4$
		$\epsilon_{11}^S = 8.32 \pm 2\%$	298	$10^4$
		$\epsilon_{11}^T = 8.14 \pm 2\%$	77	$10^4$
		$\epsilon_{11}^T = 8.37 \pm 2\%$	298	$10^4$
ZnSe	Zinc selenide	$\epsilon_{11}^T = \epsilon_{11}^S = 9.12 \pm 2\%$	298	$10^4$
ZnTe	Zinc telluride	$\epsilon_{11}^T = \epsilon_{11}^S = 10.10 \pm 2\%$	r.t.	
ZnWO <sub>4</sub>	Zinc tungstate	$\epsilon_{22} = 16.1 \pm 0.5$	r.t.	$(5-500) \times 10^3$
ZrO <sub>2</sub>	Zirconium dioxide (zirconia)	12.5	r.t.	$2 \times 10^6$

# CURIE TEMPERATURE OF SELECTED FERROELECTRIC CRYSTALS

H. P. R. Frederikse

The following table lists the major ferroelectric crystals and their Curie temperatures,  $T_C$ .

## Reference

Young, K. F. and Frederikse, H. P. R., *J. Phys. Chem. Ref. Data*, 2, 313, 1973.

Name or acronym	Formula	$T_C$ /K
<i>Potassium dihydrogen phosphate group</i>		
KDP	$\text{KH}_2\text{PO}_4$	123
KDA	$\text{KH}_2\text{AsO}_4$	97
KDDP	$\text{KD}_2\text{PO}_4$	213
KDDA	$\text{KD}_2\text{AsO}_4$	162
RDP	$\text{RbH}_2\text{PO}_4$	146
RDA	$\text{RbH}_2\text{AsO}_4$	111
RDDP	$\text{RbD}_2\text{PO}_4$	218
RDDA	$\text{RbD}_2\text{AsO}_4$	178
CDP	$\text{CsH}_2\text{PO}_4$	159
CDA	$\text{CsH}_2\text{AsO}_4$	143
CDDA	$\text{CsD}_2\text{AsO}_4$	212
<i>Rochelle salt group</i>		
Rochelle salt	$\text{NaKC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	255–297
Deuterated Rochelle salt	$\text{NaKC}_4\text{H}_2\text{D}_2\text{O}_6 \cdot 4\text{H}_2\text{O}$	251–308
Ammonium Rochelle salt	$\text{NaNH}_4\text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	109
LAT	$\text{LiNH}_4\text{C}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$	106
<i>Triglycine sulfate group</i>		
TGS	$(\text{NH}_2\text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{SO}_4$	322
TGSe	$(\text{NH}_2\text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{SeO}_4$	295
TGFB	$(\text{NH}_2\text{CH}_2\text{COOH})_3 \cdot \text{H}_2\text{BeF}_4$	346
AFB	$(\text{NH}_4)_2\text{BeF}_4$	176
HADA	$\text{HNH}_4(\text{ClCH}_2\text{COO})_2$	128
<i>Perovskites and related compounds</i>		
Barium titanate	$\text{BaTiO}_3$	406, 278, 193
Lead titanate	$\text{PbTiO}_3$	765
Potassium niobate	$\text{KNbO}_3$	712
Potassium tantalate niobate	$\text{KTa}_{2/3}\text{Nb}_{1/3}\text{O}_3$	241, 220, 170
Lithium niobate	$\text{LiNbO}_3$	1483
Lithium tantalate	$\text{LiTaO}_3$	891
Barium titanium niobate	$\text{Ba}_6\text{Ti}_2\text{Nb}_8\text{O}_{30}$	521
Ba-Na niobate ("Bananas")	$\text{Ba}_2\text{NaNb}_5\text{O}_{15}$	833
Potassium iodate	$\text{KIO}_3$	485, 343, 257–263, 83
Lithium iodate	$\text{LiIO}_3$	529
Potassium nitrate	$\text{KNO}_3$	397
Sodium nitrate	$\text{NaNO}_3$	548
Rubidium nitrate	$\text{RbNO}_3$	437–487
<i>Miscellaneous compounds</i>		
Cesium trihydrogen selenite	$\text{CsH}_3(\text{SeO}_3)_2$	143
Lithium trihydrogen selenite	$\text{LiH}_3(\text{SeO}_3)_2$	$T_C > T_{\text{mp}}$
Potassium selenate	$\text{K}_2\text{SeO}_4$	93
Methyl ammonium alum (MASD)	$\text{CH}_3\text{NH}_3\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	177
Ammonium cadmium sulfate	$(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$	95
Ammonium bisulfate	$(\text{NH}_4)\text{HSO}_4$	271
Ammonium sulfate	$(\text{NH}_4)_2\text{SO}_4$	224
Ammonium nitrate	$\text{NH}_4\text{NO}_3$	398, 357, 305, 255
Colemanite	$\text{CaB}_3\text{O}_4(\text{OH})_3 \cdot \text{H}_2\text{O}$	266
Cadmium pyroniobite	$\text{Cd}_2\text{Nb}_2\text{O}_7$	185
Gadolinium molybdate	$\text{Gd}_2(\text{MoO}_4)_3$	432

## PROPERTIES OF ANTIFERROELECTRIC CRYSTALS

H. P. R. Frederikse

Some important antiferroelectric crystals are listed here with their Curie Temperatures  $T_c$ . The last column gives the constant  $T_0$  which appears in the Curie-Weiss law describing the dielectric constant of these materials above the Curie Temperature:

$$\epsilon = \text{const.}/(T - T_0)$$

Name or acronym	Formula	$T_c$ /K	$T_0$ /K
ADP	$\text{NH}_4\text{H}_2\text{PO}_4$	148	
ADA	$\text{NH}_4\text{H}_2\text{AsO}_4$	216	
ADDP	$\text{NH}_4\text{D}_2\text{PO}_4$	242, 245	
ADDA	$\text{NH}_4\text{D}_2\text{AsO}_4$	299	
$A_d$ DDP	$\text{ND}_4\text{D}_2\text{PO}_4$	243	
$A_d$ DDA	$\text{ND}_4\text{D}_2\text{AsO}_4$	304	
Sodium niobate	$\text{NaNbO}_3$	911, 793	
Lead hafnate	$\text{PbHfO}_3$	476	378
Lead zirconate	$\text{PbZrO}_3$	503	475
Lead metaniobate	$\text{PbNb}_2\text{O}_6$	843	530
Lead metatantalate	$\text{PbTa}_2\text{O}_6$	543	533
Tungsten trioxide	$\text{WO}_3$	1010	
Potassium strontium niobate	$\text{KSr}_2\text{Nb}_5\text{O}_{15}$	427	413
Sodium nitrite	$\text{NaNO}_2$	437	437
Sodium trihydrogen selenite	$\text{NaH}_3(\text{SeO}_3)_2$	193	192
Sodium trideuterium selenite	$\text{NaD}_3(\text{SeO}_3)_2$	271	245
Ammonium trihydrogen periodate	$(\text{NH}_4)_2\text{H}_3\text{IO}_6$	245	

## DIELECTRIC CONSTANTS OF GLASSES

Type	Dielectric constant at 100 MHz (20°C)	Volume resistivity (In MΩ cm at 350°C)	Loss factor <sup>a</sup>
Corning 0010	6.32	10	0.015
Corning 0080	6.75	0.13	0.058
Corning 0120	6.65	100	0.012
Pyrex 1710	6.00	2,500	0.025
Pyrex 3320	4.71	–	0.019
Pyrex 7040	4.65	80	0.013
Pyrex 7050	4.77	16	0.017
Pyrex 7052	5.07	25	0.019
Pyrex 7060	4.70	13	0.018
Pyrex 7070	4.00	1,300	0.0048
Vycor 7230	3.83	–	0.0061
Pyrex 7720	4.50	16	0.014
Pyrex 7740	5.00	4	0.040
Pyrex 7750	4.28	50	0.011
Pyrex 7760	4.50	50	0.0081
Vycor 7900	3.9	130	0.0023
Vycor 7910	3.8	1,600	0.00091
Vycor 7911	3.8	4,000	0.00072
Corning 8870	9.5	5,000	0.0085
G. E. Clear (silica glass)	3.81	4,000–30,000	0.00038
Quartz (fused)	3.75 (4.1 at 1 MHz)	–	0.0002 (1 MHz)

<sup>a</sup> Power factor × dielectric constant equals loss factor.

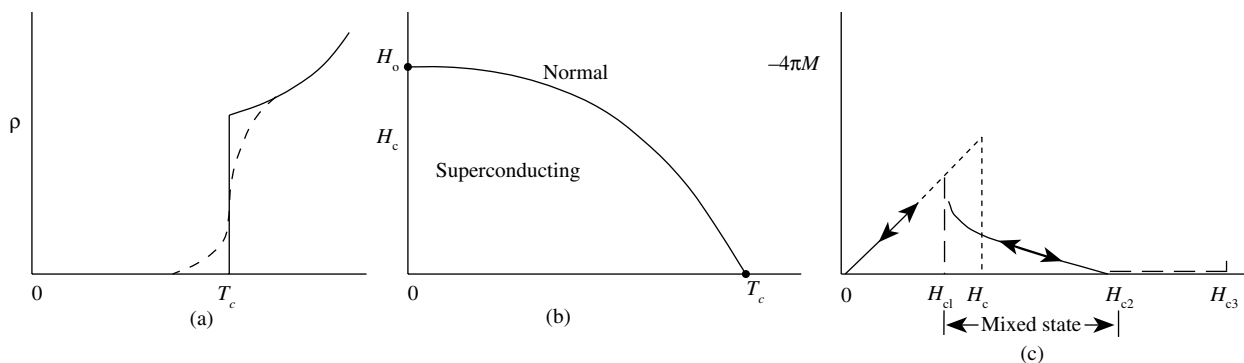
# PROPERTIES OF SUPERCONDUCTORS

L. I. Berger and B. W. Roberts

The following tables include superconductive properties of selected elements, compounds, and alloys. Individual tables are given for thin films, elements at high pressures, superconductors with high critical magnetic fields, and high critical temperature superconductors.

The historically first observed and most distinctive property of a superconductive body is the near total loss of resistance at a critical temperature ( $T_c$ ) that is characteristic of each material. Figure 1(a) below illustrates schematically two types of possible transitions. The sharp vertical discontinuity in resistance is indicated

of that found for a single crystal of a very pure element or one of a few well annealed alloy compositions. The broad transition, illustrated by broken lines, suggests the transition shape seen for materials that are not homogeneous and contain unusual strain distributions. Careful testing of the resistivity limit for superconductors shows that it is less than  $4 \times 10^{-23}$  ohm cm, while the lowest resistivity observed in metals is of the order of  $10^{-13}$  ohm cm. If one compares the resistivity of a superconductive body to that of copper at room temperature, the superconductive body is at least  $10^{17}$  times less resistive.



**FIGURE 1.** Physical properties of superconductors. (a) Resistivity vs. temperature for a pure and perfect lattice (solid line); impure and/or imperfect lattice (broken line). (b) Magnetic-field temperature dependence for Type-I or "soft" superconductors. (c) Schematic magnetization curve for "hard" or Type-II superconductors.

The temperature interval  $\Delta T_c$ , over which the transition between the normal and superconductive states takes place, may be of the order of as little as  $2 \times 10^{-5}$  K or several K in width, depending on the material state. The narrow transition width was attained in 99.9999% pure gallium single crystals.

A Type-I superconductor below  $T_c$ , as exemplified by a pure metal, exhibits perfect diamagnetism and excludes a magnetic field up to some critical field  $H_c$ , whereupon it reverts to the normal state as shown in the  $H$ - $T$  diagram of Figure 1(b).

The magnetization of a typical high-field superconductor is shown in Figure 1(c). The discovery of the large current-carrying capability of  $Nb_3Sn$  and other similar alloys has led to an extensive study of the physical properties of these alloys. In brief, a high-field superconductor, or Type-II superconductor, passes from the perfect diamagnetic state at low magnetic fields to a mixed state and finally to a sheathed state before attaining the normal resistive state of the metal. The magnetic field values separating the four stages are given as  $H_{c1}$ ,  $H_{c2}$ , and  $H_{c3}$ . The superconductive state below  $H_{c1}$  is perfectly diamagnetic, identical to the state of most pure metals of the "soft" or Type-I superconductor. Between  $H_{c1}$  and  $H_{c2}$  a "mixed superconductive state" is found in which fluxons (a minimal unit of magnetic flux) create lines of normal flux in a superconductive matrix. The volume of the normal state is proportional to  $-4\pi M$  in the "mixed state" region. Thus at  $H_{c2}$  the fluxon density has become so great as to drive the interior volume of the superconductive body completely normal. Between  $H_{c2}$  and  $H_{c3}$  the superconductor has a sheath of current-carrying superconductive material at the body surface, and above  $H_{c3}$  the normal state exists. With several types of careful measurement, it is possible to determine  $H_{c1}$ ,  $H_{c2}$ , and  $H_{c3}$ . Table 6 contains some of the available data on high-field superconductive materials.

High-field superconductive phenomena are also related to specimen dimension and configuration. For example, the Type-I superconductor, Hg, has entirely different magnetization behavior in high magnetic fields when contained in the very fine sets of filamentary tunnels found in an unprocessed Vycor glass. The great majority of superconductive materials are Type-II. The elements in very pure form and a very few precisely stoichiometric and well annealed compounds are Type I with the possible exceptions of vanadium and niobium.

**Metallurgical Aspects.** The sensitivity of superconductive properties to the material state is most pronounced and has been used in a reverse sense to study and specify the detailed state of alloys. The mechanical state, the homogeneity, and the presence of impurity atoms and other electron-scattering centers are all capable of controlling the critical temperature and the current-carrying capabilities in high-magnetic fields. Well annealed specimens tend to show sharper transitions than those that are strained or inhomogeneous. This sensitivity to mechanical state underlines a general problem in the tabulation of properties for superconductive materials. The occasional divergent values of the critical temperature and of the critical fields quoted for a Type-II superconductor may lie in the variation in sample preparation. Critical temperatures of materials studied early in the history of superconductivity must be evaluated in light of the probable metallurgical state of the material, as well as the availability of less pure starting elements. It has been noted that recent work has given extended consideration to the metallurgical aspects of sample preparation.

Symbols in tables:  $T_c$ : Critical temperature;  $H_0$ : Critical magnetic field in the  $T = 0$  limit;  $\theta_D$ : Debye temperature; and  $\gamma$ : Electronic specific heat.

**TABLE 1. Selective Properties of Superconductive Elements**

Element	$T_c$ (K)	$H_0$ (oersted)	$\theta_D$ (K)	$\gamma$ (mJ mol <sup>-1</sup> K <sup>-1</sup> )
Al	1.175 ± 0.002	104.9 ± 0.3	420	1.35
Am* (α,?)	0.6			
Am* (β,?)	1.0			
Be	0.026			0.21
Cd	0.517 ± 0.002	28 ± 1	209	0.69
Ga	1.083 ± 0.001	58.3 ± 0.2	325	0.60
Ga (β)	5.9, 6.2	560		
Ga (γ)	7	950, HF <sup>a</sup>		
Ga (Δ)	7.85	815, HF		
Hf	0.128	12.7		2.21
Hg (α)	4.154 ± 0.001	411 ± 2	87, 71.9	1.81
Hg (β)	3.949	339	93	1.37
In	3.408 ± 0.001	281.5 ± 2	109	1.672
Ir	0.1125 ± 0.001	16 ± 0.05	425	3.19
La (α)	4.88 ± 0.02	800 ± 10	151	9.8
La (β)	6.00 ± 0.1	1096, 1600	139	11.3
Lu	0.1 ± 0.03	350 ± 50		
Mo	0.915 ± 0.005	96 ± 3	460	1.83
Nb	9.25 ± 0.02	2060 ± 50, HF	276	7.80
Os	0.66 ± 0.03	70	500	2.35
Pa	1.4			
Pb	7.196 ± 0.006	803 ± 1	96	3.1
Re	1.697 ± 0.006	200 ± 5	4.5	2.35
Ru	0.49 ± 0.015	69 ± 2	580	2.8
Sn	3.722 ± 0.001	305 ± 2	195	1.78
Ta	4.47 ± 0.04	829 ± 6	258	6.15
Tc	7.8 ± 0.1	1410, HF	411	6.28
Th	1.38 ± 0.02	1.60 ± 3	165	4.32
Ti	0.40 ± 0.04	56	415	3.3
Tl	2.38 ± 0.02	178 ± 2	78.5	1.47
U	0.2			
V	5.40 ± 0.05	1408	383	9.82
W	0.0154 ± 0.0005	1.15 ± 0.03	383	0.90
Zn	0.85 ± 0.01	54 ± 0.3	310	0.66
Zr	0.61 ± 0.15	47	290	2.77
Zr (ω)	0.65, 0.95			

**TABLE 2. Range of Critical Temperatures Observed for Superconductive Elements in Thin Films Condensed Usually at Low Temperatures**

Element	$T_c$ Range (K)	Comments	Element	$T_c$ Range (K)	Comments
Al	1.15–5.7	HF <sup>a</sup>	Nb	2.0–10.1	
Be	5–9.75	HF	Pb	1.8–7.5	
Bi	6.17–6.6		Re	1.7–7	
Cd			Sn	3.5–6	
(Disordered)	0.79–0.91		Ta	<1.7–4.51	HF <sup>a</sup>
(Ordered)	0.53–0.59		Tc	4.6–7.7	
Ga	2.5–8.5	HF	Ti	1.3 Max	
Hg	3.87–4.5		Tl	2.33–2.96	
In	2.2–5.6	HF	V	1.8–6.02	
La	3.55–6.74		W	<1.0–4.1	
Mo	3.3–8.0		Zn	0.77–1.9	

<sup>a</sup> HF denotes high magnetic field superconductive properties.

TABLE 3. Elements Exhibiting Superconductivity Under or After Application of High Pressure

Element	$T_c$ Range (K)	Pressure (kbar)	Element	$T_c$ Range (K)	Pressure (kbar)
Al	1.98–0.075	0–62	Pb II	3.55	160
As	0.31–0.5	220–140	Re II	2.3 Max.	"Plastic" compression
	0.2–0.25	140–100			
Ba II	1–1.8	55–85	Sb (prepared 120 kbar, held below 77K)	2.6–2.7	
III	1.8–5	85–144			
IV	4.5–5.4	144–190	Sb II	3.55–3.40	85–150
Bi II	3.9	25–27	Se II	6.75, 6.95	130
III	6.55–7.25	28–38	Si	6.7–7.1	120–130
IV	7.0, 8.7–6.0	43, 43–62	Sn II	5.2–4.85	125–160
V	6.7, 8.3	48–80	III	5.30	113
VI	8.55	90, 92–101	Te II	2.4–5.1	38–55
VII(?)	8.2	30			
Ce ( $\alpha$ )	0.020–0.045	20–35	IV	4.1–4.2	53–62
Ce ( $\alpha'$ )	1.9–1.3	45–125	( )	4.72–4	63–80
Cs V	1.5	>125		3.3–2.8	100–260
Ga II	6.38	$\geq 35$	Tl (cubic form)	1.45	35
II'	7.5	$\geq 35$ then P removed	(hexagonal form)	1.95	35
Ge	5.35	115	U	2.4–0.4	10–85
Lu	0.022–1.0	45–190	Y	1.7–2.5	110–160
P	5.8	170	Zr (omega form, metastable)	1–1.7	60–130

TABLE 4. Superconductive Compounds and Alloys

All compositions are denoted on an atomic basis, i.e., AB, AB<sub>2</sub>, or AB<sub>3</sub> for compounds, unless noted. Solid solutions or odd compositions may be denoted as A<sub>x</sub>B<sub>1-z</sub> or A<sub>z</sub>B. A series of three or more alloys is indicated as A<sub>x</sub>B<sub>1-x</sub> or by actual indication of the atomic fraction range, such as A<sub>0-0.6</sub>B<sub>1-0.4</sub>. The critical temperature of such a series of alloys is denoted by a range of values or possibly the maximum value.

The selection of the critical temperature from a transition in the effective permeability, or the change in resistance, or possibly the incremental changes in frequency observed by certain techniques is not often obvious from the literature. Most authors choose the

mid-point of such curves as the probable critical temperature of the idealized material, while others will choose the highest temperature at which a deviation from the normal state property is observed. In view of the previous discussion concerning the variability of the superconductive properties as a function of purity and other metallurgical aspects, it is recommended that appropriate literature be checked to determine the most probable critical temperature or critical field of a given alloy.

A very limited amount of data on critical fields,  $H_c$ , is available for these compounds and alloys; these values are given at the end of the table.

A. Superconductors with  $T_c < 10$  K

Substance	$T_c$ , K	Crystal structure type	Substance	$T_c$ , K	Crystal structure type
Ag <sub>0.33</sub> Al	0.34	A12-cl58 (Mn)	Ag <sub>7</sub> NO <sub>11</sub>	1.04	Cubic
Ag <sub>x</sub> Al <sub>y</sub> Zn <sub>1-x-y</sub>	0.15	Cubic	Ag <sub>x</sub> Pb <sub>1-x</sub>	7.2 max.	
AgBi <sub>2</sub>	2.87–3.0		Ag <sub>4</sub> Sn	0.1	h**
Ag <sub>0.25</sub> F <sub>0.75</sub> N <sub>0.75</sub> O <sub>10.25</sub>	0.85–0.90		Ag <sub>x</sub> Sn <sub>1-x</sub>	1.5–3.7	
Ag <sub>2</sub> F	0.0066		Ag <sub>x</sub> Sn <sub>1-x</sub> (film)	2.0–3.8	
Ag <sub>7</sub> FO <sub>8</sub>	0.3	Cubic	AgTe <sub>3</sub>	2.6	Cubic
Ag <sub>0.8-0.3</sub> Ga <sub>0.2-0.7</sub>	6.5–8		AgTh	2.2	C16-tH12 (Al <sub>2</sub> Cu)
Ag <sub>4</sub> Ge	0.85	Hex., c.p.	AgTh <sub>2</sub>	2.26	C16
Ag <sub>0.438</sub> Hg <sub>0.562</sub>	0.64	D8 <sub>2</sub>	Ag <sub>0.03</sub> Tl <sub>0.97</sub>	2.67	
AgIn <sub>2</sub>	~2.4	C16	Ag <sub>0.94</sub> Tl <sub>0.06</sub>	2.32	
Ag <sub>0.1</sub> In <sub>0.9</sub> Te (n = 1.4 × 10 <sup>22</sup> )*	1.2–1.89	B1	AgY	0.33	B2-cP2 (CsCl)
Ag <sub>0.2</sub> In <sub>0.8</sub> Te (n = 1.07 × 10 <sup>22</sup> )	0.77–1.00	B1	Ag <sub>x</sub> Zn <sub>1-x</sub>	0.5–0.845	
AgLa	0.94	B2-cP2 (CsCl)	AlAu <sub>4</sub>	0.4–0.7	Like A13
AgLa (9.5 kbar)	1.2	B2	Al <sub>2</sub> Au	0.1	C1-cF12 (CaF <sub>2</sub> )
AgLu	0.33	B2-cP2	Al <sub>2</sub> CMo <sub>3</sub>	9.8–10.2	A13+trace 2nd. phase
AgMo <sub>4</sub> S <sub>5</sub>	9.1	hR15 (Mo <sub>6</sub> PbS <sub>8</sub> )	Al <sub>2</sub> CaSi	5.8	
Ag <sub>1.2</sub> Mo <sub>6</sub> Se <sub>8</sub>	5.9	Same	Al <sub>0.131</sub> Cr <sub>0.088</sub> V <sub>0.781</sub>	1.46	Cubic
			AlGe <sub>2</sub>	1.75	



Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
Al <sub>2</sub> Ge <sub>2</sub> U	1.6	LI <sub>2</sub> -cP4 (Cu <sub>3</sub> Au)	AuPb <sub>2</sub>	3.15	
AlLa <sub>3</sub>	5.57	DO <sub>19</sub>	AuPb <sub>2</sub> (film)	4.3	
Al <sub>2</sub> La	3.23	C15	AuPb <sub>3</sub>	4.40	
Al <sub>2</sub> Lu	1.02	C15-cF24 (Cu <sub>2</sub> Mg)	AuPb <sub>3</sub> (film)	4.25	
Al <sub>3</sub> Mg <sub>2</sub>	0.84	F.C.C.	Au <sub>2</sub> Pb	1.18; 6-7	C15
AlMo <sub>3</sub>	0.58	A15	AuSb <sub>2</sub>	0.58	C2
AlMo <sub>6</sub> Pd	2.1		AuSn	1.25	B8 <sub>1</sub>
AlN	1.55	B4	Au <sub>x</sub> Sn <sub>1-x</sub> (film)	2.0-3.8	
Al <sub>2</sub> NNb <sub>3</sub>	1.3	A13	Au <sub>5</sub> Sn	0.7-1.1	A3
Al <sub>3</sub> Nb	0.64	tI8 (Al <sub>3</sub> Ti)	AuTa <sub>4.3</sub>	0.55	A15-cP8 (Cr <sub>3</sub> Si)
AlOs	0.39	B2	Au <sub>3</sub> Te <sub>5</sub>	1.62	Cubic
Al <sub>3</sub> Os	5.90		AuTh <sub>2</sub>	3.08	C16
AlPb (film)	1.2-7		AuTl	1.92	
Al <sub>2</sub> Pt	0.48-0.55	C1	AuV <sub>3</sub>	0.74	A15
Al <sub>5</sub> Re <sub>24</sub>	3.35	A12	Au <sub>x</sub> Zn <sub>1-x</sub>	0.50-0.845	
AlSb	2.8	B4-tI4 (Sn)	AuZn <sub>3</sub>	1.21	Cubic
Al <sub>2</sub> Sc	1.02	C15-cF24 (Cu <sub>2</sub> Mg)	Au <sub>x</sub> Zr <sub>y</sub>	1.7-2.8	A3
Al <sub>3</sub> Si <sub>2</sub> U	1.34	LI <sub>2</sub> -cP4 (Cu <sub>3</sub> Au)	AuZr <sub>3</sub>	0.92	A15
AlTh <sub>2</sub>	0.1	C16-tI12 (Al <sub>2</sub> Cu)	B <sub>2</sub> Ba <sub>0.67</sub> Pt <sub>3</sub>	5.60	hP12 (B <sub>2</sub> BaPt <sub>3</sub> )
Al <sub>3</sub> Th	0.75	DO <sub>19</sub>	BCMo <sub>2</sub>	5.4	Orthorhombic
Al <sub>x</sub> Ti <sub>y</sub> V <sub>1-x-y</sub>	2.05-3.62	Cubic	BCMo <sub>2</sub>	5.3-7.0	Same
Al <sub>0.108</sub> V <sub>0.892</sub>	1.82	Cubic	B <sub>2</sub> Ca <sub>0.67</sub> Pt <sub>3</sub>	1.57	hP12
Al <sub>2</sub> Y	0.35	C15-cF24 (Cu <sub>2</sub> Mg)	B <sub>3</sub> ErIr <sub>4</sub>	2.1	tP18 (B <sub>4</sub> CeCo <sub>4</sub> )
Al <sub>3</sub> Yb	0.94	LI <sub>2</sub> -cP4 (Cu <sub>3</sub> Au)	B <sub>4</sub> ErRh <sub>4</sub>	4.3	oC108 (B <sub>4</sub> LuRh <sub>4</sub> )
Al <sub>x</sub> Zn <sub>1-x</sub>	0.5-0.845		B <sub>4</sub> ErRh <sub>4</sub>	8.7	tP18 (B <sub>4</sub> CeCo <sub>4</sub> )
AlZr <sub>3</sub>	0.73	LI <sub>2</sub>	BHf	3.1	Cubic
AsBiPb	9.0		B <sub>4</sub> HoIr <sub>4</sub>	2.0	tP18
AsBiPbSb	9.0		B <sub>4</sub> HoRh <sub>4</sub>	1.4	oC108
AsHfOs	3.2	C22-hP9 (Fe <sub>2</sub> P)	B <sub>2</sub> Ir <sub>3</sub> La	1.65	hP6 (CaCu <sub>2</sub> )
AsHfRu	4.9	same	B <sub>2</sub> Ir <sub>3</sub> Th	2.09	Same
As <sub>0.33</sub> InTe <sub>0.67</sub> (n = 1.24 × 10 <sup>22</sup> )	0.85-1.15	B1	B <sub>4</sub> Ir <sub>4</sub> Tm	1.6	tP18
As <sub>0.5</sub> InTe <sub>0.5</sub> (n = 0.97 × 10 <sup>22</sup> )	0.44-0.62	B1	B <sub>6</sub> La	5.7	
As <sub>4</sub> La <sub>3</sub>	0.6	cI28 (Th <sub>3</sub> P <sub>4</sub> )	B <sub>2</sub> LaRh <sub>3</sub>	2.82	hP6
AsNb <sub>3</sub>	0.3	LI <sub>2</sub> -tP32	B <sub>12</sub> Lu	0.48	
As <sub>0.50</sub> Ni <sub>0.06</sub> Pd <sub>0.44</sub>	1.39	C2	B <sub>2</sub> LuOs	2.66	oP16 (B <sub>2</sub> LuRu)
AsNi <sub>0.25</sub> Pd <sub>0.75</sub>	1.6	B8 <sub>1</sub> -hP4 (NiAs)	B <sub>2</sub> LuOs <sub>3</sub>	4.62	hP6
AsOsZr	8.0	C22-hP9 (Fe <sub>2</sub> P)	B <sub>4</sub> LuRh <sub>4</sub>	6.2	oC108
AsPb	8.4		B <sub>2</sub> LuRu	9.86	oP16
AsPd <sub>2</sub> (low-temp. phase)	0.60	Hexagonal	B <sub>3</sub> LuRu <sub>4</sub>	2.0	tI72 (B <sub>4</sub> LuRu <sub>4</sub> )
AsPd <sub>2</sub> (high-temp. phase)	1.70	C22	BMo	0.5	(extrapol.)
AsPd <sub>3</sub>	0.46	Complex	BMo <sub>2</sub>	4.74	C16
As <sub>3</sub> Pd <sub>5</sub>	1.9		BNb	8.25	B <sub>f</sub>
AsRh	0.58	B31	B <sub>4</sub> NdRh <sub>4</sub>	5.3	tP18
AsRh <sub>1.4-1.6</sub>	< 0.03-0.56	Hexagonal	B <sub>2</sub> OsSc	1.34	oP16
AsSn	4.10		B <sub>2</sub> OsY	2.22	oP16
AsSn (n = 2.14 × 10 <sup>22</sup> )	3.41-3.65	B1	B <sub>2</sub> Pt <sub>3</sub> Sr <sub>0.67</sub>	2.78	hP12 (B <sub>2</sub> BaPt <sub>3</sub> )
	3.5-3.6;		BRe <sub>2</sub>	2.80; 4.6	
As <sub>2</sub> Sn <sub>3</sub>	1.21-1.17		B <sub>4</sub> Rh <sub>3.4</sub> Ru <sub>0.6</sub>	8.38	tI72
As <sub>3</sub> Sn <sub>4</sub> (n = 0.56 × 10 <sup>22</sup> )	1.16-1.19	Rhombohedral	B <sub>4</sub> Rh <sub>4</sub> Sm	2.7	tP18
AsV <sub>3</sub>	0.20	A15-cP8 (Cr <sub>3</sub> Si)	B <sub>4</sub> Rh <sub>4</sub> Th	4.3	Same
Au <sub>3</sub> Ba	0.4-0.7	D2 <sub>4</sub>	B <sub>4</sub> Rh <sub>4</sub> Tm	9.8	Same
AuBe	2.64	B20	B <sub>4</sub> Rh <sub>4</sub> Tm	5.4	oC108
Au <sub>2</sub> Bi	1.80	C15	B <sub>0.3</sub> Ru <sub>0.7</sub>	2.58	D10 <sub>2</sub>
Au <sub>5</sub> Ca	0.34-0.38	C15 <sub>b</sub>	B <sub>4</sub> Ru <sub>4</sub> Sc	7.2	tI72
AuGa <sub>2</sub>	1.6	C1-cF12 (CaF <sub>2</sub> )	B <sub>2</sub> Ru <sub>3</sub> Th	1.79	hP6
AuGa	1.2	B31	B <sub>2</sub> Ru <sub>3</sub> Y	2.85	Same
Au <sub>0.40-0.92</sub> Ge <sub>0.60-0.08</sub>	< 0.32-1.63	Complex	B <sub>2</sub> Ru <sub>3</sub> Y	7.80	oP16
AuIn <sub>2</sub>	0.2	C1-cF12	B <sub>4</sub> Ru <sub>4</sub> Y	1.4	tI72
AuIn	0.4-0.6	Complex	B <sub>12</sub> Sc	0.39	
AuLu	< 0.35	B2	BTa	4.0	B <sub>f</sub>
AuNb <sub>3</sub>	1.2	A2			

Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
B <sub>2</sub> Ta <sub>2</sub>	3.12	C16-tI12 (Al <sub>2</sub> Cu)	Bi <sub>2</sub> Pd	1.70	Monoclinic, $\alpha$ -phase
B <sub>6</sub> Th	0.74		Bi <sub>2</sub> Pd	4.25	Tetragonal, $\beta$ -phase
BW <sub>2</sub>	3.1	C16	BiPd <sub>0.45</sub> Pt <sub>0.55</sub>	3.7	B8 <sub>1</sub> -hP4 (NiAs)
B <sub>6</sub> Y	6.5–7.1		BiPdSe	1.0	C2
B <sub>12</sub> Y	4.7		BiPdTe	1.2	C2
BZr	3.4	Cubic	BiPt	1.21	B8 <sub>1</sub>
B <sub>12</sub> Zr	5.82		Bi <sub>0.1</sub> PtSb <sub>0.9</sub>	2.05; 1.5	B8 <sub>1</sub> -hP4 (NiAs)
BaBi <sub>3</sub>	5.69	Tetragonal	BiPtSe	1.45	C2
Ba <sub>2</sub> Mo <sub>15</sub> Se <sub>19</sub>	2.75	hP15 (Mo <sub>6</sub> PbS <sub>8</sub> )	BiPtTe	1.15	C2
Ba <sub>x</sub> O <sub>3</sub> Sr <sub>1-x</sub> Ti (n = 4.2 × 10 <sup>19</sup> )	<0.1–0.55		Bi <sub>2</sub> Pt	0.155	Hexagonal
Ba <sub>0.13</sub> O <sub>3</sub> W	1.9	Tetragonal	Bi <sub>2</sub> Rb	4.25	C15
Ba <sub>0.14</sub> O <sub>3</sub> W	<1.25–2.2	Hexagonal	BiRe <sub>2</sub>	1.9–2.2	
BaRh <sub>2</sub>	6.0	C15	BiRh	2.06	B8 <sub>1</sub>
Be <sub>22</sub> Mo	2.51	Cubic (Be <sub>22</sub> Re)	Bi <sub>3</sub> Rh	3.2	Orthorhombic (NiB <sub>3</sub> )
Be <sub>8</sub> Nb <sub>5</sub> Zr <sub>2</sub>	5.2		Bi <sub>4</sub> Rh	2.7	Hexagonal
Be <sub>0.98–0.92</sub> Re <sub>0.02–0.08</sub> (quenched)	9.5–9.75	Cubic	BiRu	5.7	m**
Be <sub>0.957</sub> Re <sub>0.043</sub>	9.62	Cubic (Be <sub>22</sub> Re)	Bi <sub>2</sub> Sn	3.6–3.8	
BeTc	5.21	Cubic	BiSn	3.8	
Be <sub>22</sub> W	4.12	Cubic (Be <sub>22</sub> Re)	Bi <sub>x</sub> Sn <sub>y</sub>	3.85–4.18	
Be <sub>13</sub> W	4.1	Tetragonal	Bi <sub>3</sub> Sr	5.62	L <sub>12</sub>
Bi <sub>3</sub> Ca	2.0		Bi <sub>3</sub> Te	0.75–1.0	
Bi <sub>0.5</sub> Cd <sub>0.13</sub> Pb <sub>0.25</sub> Sn <sub>0.12</sub> (weight fractions)	8.2		Bi <sub>5</sub> Tl <sub>3</sub>	6.4	
BiCo	0.42–0.49		Bi <sub>0.26</sub> Tl <sub>0.74</sub>	4.4	Cubic, disordered
Bi <sub>2</sub> Cs	4.75	C15	Bi <sub>0.26</sub> Tl <sub>0.74</sub>	4.15	L <sub>12</sub> , ordered (?)
Bi <sub>x</sub> Cu <sub>1-x</sub> (electrodeposited)	2.2		Bi <sub>2</sub> Y <sub>3</sub>	2.25	
BiCu	1.33–1.40		Bi <sub>3</sub> Zn	0.8–0.9	
Bi <sub>3</sub> Fe	1.0	m**	Bi <sub>0.3</sub> Zr <sub>0.7</sub>	1.51	
Bi <sub>0.019</sub> In <sub>0.981</sub>	3.86		BiZr <sub>3</sub>	2.4–2.8	
Bi <sub>0.05</sub> In <sub>0.95</sub>	4.65	$\alpha$ -phase	BrMo <sub>6</sub> Se <sub>7</sub>	7.1	hP15 (Mo <sub>6</sub> PbS <sub>8</sub> )
Bi <sub>0.10</sub> In <sub>0.90</sub>	5.05	Same	Br <sub>3</sub> Mo <sub>6</sub> Se <sub>5</sub>	7.1	Same
Bi <sub>0.15–0.30</sub> In <sub>0.85–0.70</sub>	5.3–5.4	$\alpha$ - and $\beta$ -phases	CCs <sub>x</sub>	0.020–0.135	Hexagonal
Bi <sub>0.34–0.48</sub> In <sub>0.66–0.52</sub>	4.0–4.1		CFe <sub>3</sub>	1.30	DO <sub>11</sub> -oP16 (Fe <sub>3</sub> C)
Bi <sub>3</sub> In <sub>5</sub>	4.1		CGaMo <sub>2</sub>	3.7–4.1	Hexagonal
BiIn <sub>2</sub>	5.65	$\beta$ -phase	CHf <sub>0.5</sub> Mo <sub>0.5</sub>	3.4	B1
Bi <sub>2</sub> Ir	1.7–2.3		CHf <sub>0.3</sub> Mo <sub>0.7</sub>	5.5	B1
Bi <sub>2</sub> Ir (quenched)	3.0–3.96		CHf <sub>0.25</sub> Mo <sub>0.75</sub>	6.6	B1
BiK	3.6		CHf <sub>0.7</sub> Nb <sub>0.3</sub>	6.1	B1
Bi <sub>2</sub> K	3.58	C15	CHf <sub>0.6</sub> Nb <sub>0.4</sub>	4.5	B1
BiLi	2.47	L1 <sub>0</sub> , $\alpha$ -phase	CHf <sub>0.5</sub> Nb <sub>0.5</sub>	4.8	B1
Bi <sub>4–9</sub> Mg	0.7–~1.0		CHf <sub>0.4</sub> Nb <sub>0.6</sub>	5.6	B1
Bi <sub>3</sub> Mo	3–3.7		CHf <sub>0.25</sub> Nb <sub>0.75</sub>	7.0	B1
BiNa	2.25	L1 <sub>0</sub>	CHf <sub>0.2</sub> Nb <sub>0.8</sub>	7.8	B1
BiNb <sub>3</sub>	4.5	A15-cP8 (Cr <sub>3</sub> Si)	CHf <sub>0.9–0.1</sub> Ta <sub>0.1–0.9</sub>	5.0–9.0	B1
BiNb <sub>3</sub> (high pressure and temperature)	3.05	A15	CK (excess K)	0.55	Hexagonal
BiNi	4.25	B8 <sub>1</sub>	C <sub>8</sub> K	0.39	Hexagonal
Bi <sub>3</sub> Ni	4.06	Orthorhombic	C <sub>2</sub> La	1.66	tI6 (CaC <sub>2</sub> )
BiNi <sub>0.5</sub> Rh <sub>0.5</sub>	3.0	B8 <sub>1</sub> -hP4 (AsNi)	C <sub>2</sub> Lu	3.33	Same
Bi <sub>0.5</sub> NiSb <sub>0.5</sub>	2.0	Same	C <sub>0.40–0.44</sub> Mo <sub>0.60–0.56</sub>	9–13	
Bi <sub>1–0</sub> Pb <sub>0–1</sub>	7.26–9.14		C <sub>3</sub> MoRe	3.8	B1-cF8
Bi <sub>1–0</sub> Pb <sub>0–1</sub> (film)	7.25–8.67		C <sub>0.6</sub> Mo <sub>0.48</sub> Si <sub>0.3</sub>	7.6	D8 <sub>8</sub>
Bi <sub>0.05–0.40</sub> Pb <sub>0.95–0.60</sub>	7.35–8.4	H.C.P. to $\epsilon$ -phase	CMo <sub>0.2</sub> Ta <sub>0.8</sub>	7.5	B1
Bi <sub>2</sub> Pb	4.25	t**	CMo <sub>0.5</sub> Ta <sub>0.5</sub>	7.7	B1
BiPbSb	8.9		CMo <sub>0.75</sub> Ta <sub>0.25</sub>	8.5	B1
Bi <sub>0.5</sub> Pb <sub>0.31</sub> Sn <sub>0.19</sub> (weight fractions)	8.5		CMo <sub>0.8</sub> Ta <sub>0.2</sub>	8.7	B1
Bi <sub>0.5</sub> Pb <sub>0.25</sub> Sn <sub>0.25</sub>	8.5		CMo <sub>0.85</sub> Ta <sub>0.15</sub>	8.9	B1
BiPd <sub>2</sub>	4.0		CMo <sub>x</sub> V <sub>1-x</sub>	2.9–9.3	B1
Bi <sub>0.4</sub> Pd <sub>0.6</sub>	3.7–4	Hexagonal, ordered	CMo <sub>x</sub> Zr <sub>1-x</sub>	9.8	B1
BiPd	3.7	Orthorhombic	C <sub>0.984</sub> Nb	9.8	B1
			CNb <sub>2</sub>	9.1	
			CNb <sub>x</sub> Ti <sub>1-x</sub>	<4.2–8.8	B1
			CNb <sub>0.1–0.9</sub> Zr <sub>0.9–0.1</sub>	4.2–8.4	B1

Substance	$T_c$ K	Crystal structure type
CRb <sub>x</sub> (Au)	0.023–0.151	Hexagonal
CRe <sub>0.06</sub> W	5.0	
CRu	2.00	hP2 (CW)
C <sub>0.98</sub> 7Ta	9.7	
C <sub>0.848–0.987</sub>	2.04–9.7	
CTa (film)	5.09	B1
CTa <sub>2</sub>	3.26	L' <sub>3</sub>
CTa <sub>0.4</sub> Ti <sub>0.6</sub>	4.8	B1
Cta <sub>1–0.4</sub> W <sub>0–0.6</sub>	8.5–10.5	B1
CTa <sub>0.2–0.9</sub> Zr <sub>0.8–0.1</sub>	4.6–8.3	B1
CTc (excess C)	3.85	Cubic
CTi <sub>0.5–0.7</sub> W <sub>0.5–0.3</sub>	6.7–2.1	B1
CW	1.0	
CW <sub>2</sub>	2.74	L' <sub>3</sub>
CW <sub>2</sub>	5.2	F.C.C.
C <sub>2</sub> Y	3.88	tI6 (CaC <sub>2</sub> )
Ca <sub>3</sub> Co <sub>4</sub> Sn <sub>13</sub>	5.9	cP40 (Pr <sub>3</sub> Rh <sub>2</sub> Sn <sub>13</sub> )
Ca <sub>3</sub> Ge <sub>13</sub> Rh <sub>4</sub>	2.1	Same
CaHg	1.6	B2-cP2 (CsCl)
CaHg <sub>3</sub>	1.6	hP8 (Ni <sub>3</sub> Sn)
CaIr <sub>2</sub>	6.15	C15
Ca <sub>3</sub> Ir <sub>4</sub> Sn <sub>13</sub>	7.1	cP40
Ca <sub>x</sub> O <sub>3</sub> Sr <sub>1–x</sub> Ti (n = 3.7–11 × 10 <sup>19</sup> )	< 0.1–0.55	
Ca <sub>0.1</sub> O <sub>3</sub> W	1.4–3.4	Hexagonal
CaPb	7.0	
CaRh <sub>2</sub>	6.40	C15
CaRh <sub>1.2</sub> Sn <sub>4.5</sub>	8.7	cP40
CaTl <sub>3</sub>	2.0	B2-cP2
Cd <sub>0.3–0.5</sub> Hg <sub>0.7–0.5</sub>	1.70–1.92	
CdHg	1.77; 2.15	Tetragonal
Cd <sub>0.0075–0.05</sub> In <sub>0.9925–0.95</sub>	3.24–3.36	Tetragonal
Cd <sub>0.97</sub> Pb <sub>0.03</sub>	4.2	
CdSn	3.65	
Cd <sub>0.17</sub> Tl <sub>0.83</sub>	2.3	
Cd <sub>0.18</sub> Tl <sub>0.82</sub>	2.54	
CeCo <sub>2</sub>	0.84	C15
CeCo <sub>1.67</sub> Ni <sub>0.33</sub>	0.46	C15
CeCo <sub>1.67</sub> Rh <sub>0.33</sub>	0.47	C15
Ce <sub>x</sub> Gd <sub>1–x</sub> Ru <sub>2</sub>	3.2–5.2	C15
CeIr <sub>3</sub>	3.34	
CeIr <sub>5</sub>	1.82	
Ce <sub>0.005</sub> La <sub>0.995</sub>	4.6	
Ce <sub>x</sub> La <sub>1–x</sub>	1.3–6.3	
Ce <sub>x</sub> Pr <sub>1–x</sub> Ru <sub>2</sub>	1.4–5.3	C15
Ce <sub>x</sub> Pt <sub>1–x</sub>	0.7–1.55	
CeRu <sub>2</sub>	6.0	C15
Ce <sub>3</sub> Mo <sub>6</sub> Se <sub>5</sub>	5.7	hR15 (Mo <sub>6</sub> PbS <sub>8</sub> )
Ce <sub>2</sub> Mo <sub>6</sub> Te <sub>6</sub>	1.7	Same
Co <sub>x</sub> Fe <sub>1–x</sub> Si <sub>2</sub>	1.4 (max.)	C1
CoHf <sub>2</sub>	0.56	E9 <sub>3</sub>
CoLa <sub>3</sub>	4.28	
Co <sub>4</sub> La <sub>3</sub> Sn <sub>13</sub>	2.8	cP40
CoLu <sub>3</sub>	~0.35	
Co <sub>x</sub> LuSn <sub>y</sub>	1.5	cP40
Co <sub>0–0.01</sub> Mo <sub>0.8</sub> Re <sub>0.2</sub>	2–10	
Co <sub>0.02–0.10</sub> Nb <sub>3</sub> Rh <sub>0.98–0.90</sub>	2.28–1.90	A15
Co <sub>x</sub> Ni <sub>1–x</sub> Si <sub>2</sub>	1.4 (max.)	C1
Co <sub>0.5</sub> Rh <sub>0.5</sub> Si <sub>2</sub>	2.5	
Co <sub>x</sub> Rh <sub>1–x</sub> Si <sub>2</sub>	3.65 (max.)	
Co <sub>–0.3</sub> So <sub>–0.7</sub>	~0.35	

Substance	$T_c$ K	Crystal structure type
Co <sub>2</sub> Sc <sub>5</sub> Si <sub>10</sub>	5.0	tP38 (Co <sub>4</sub> Sc <sub>5</sub> Si <sub>10</sub> )
CoSi <sub>2</sub>	1.40; 1.22	C1
Co <sub>x</sub> Sn <sub>y</sub> Yb	2.5	cP40
Co <sub>3</sub> Th <sub>7</sub>	1.83	D10 <sub>2</sub>
Co <sub>x</sub> Ti <sub>1–x</sub>	2.8 (max.)	Co in α-Ti
Co <sub>x</sub> Ti <sub>1–x</sub>	3.8 (max.)	Co in β-Ti
CoTi <sub>2</sub>	3.44	E9 <sub>3</sub>
CoTi	0.71	A2
CoU	1.7	B2, distorted
CoU <sub>6</sub>	2.29	D2 <sub>c</sub>
Co <sub>0.28</sub> Y <sub>0.72</sub>	0.34	
CoY <sub>3</sub>	<0.34	
CoZr <sub>2</sub>	6.3	C16
Co <sub>0.1</sub> Zr <sub>0.9</sub>	3.9	A3
Cr <sub>0.6</sub> Ir <sub>0.4</sub>	0.4	H.C.P.
Cr <sub>0.65</sub> Ir <sub>0.35</sub>	0.59	H.C.P.
Cr <sub>0.7</sub> Ir <sub>0.3</sub>	0.76	H.C.P.
Cr <sub>0.72</sub> Ir <sub>0.28</sub>	0.83	
Cr <sub>3</sub> Ir	0.45	A15
Cr <sub>0–0.1</sub> Nb <sub>1–0.9</sub>	4.6–9.2	A2
Cr <sub>0.80</sub> Os <sub>0.20</sub>	2.5	Cubic
Cr <sub>3</sub> Os	4.68	A15-cP8 (Cr <sub>3</sub> Si)
Cr <sub>x</sub> Re <sub>1–x</sub>	1.2–5.2	
Cr <sub>0.4</sub> Re <sub>0.6</sub>	2.15	D8 <sub>b</sub>
Cr <sub>0.8–0.6</sub> Rh <sub>0.2–0.4</sub>	0.5–1.10	A3
Cr <sub>3</sub> Rh	0.3	A15-cP8
Cr <sub>3</sub> Ru (annealed)	3.3	A15
Cr <sub>2</sub> Ru	2.02	D8 <sub>b</sub>
Cr <sub>3</sub> Ru <sub>2</sub>	2.10	D8 <sub>b</sub> -tP30 (CrFe)
Cr <sub>0.1–0.5</sub> Ru <sub>0.9–0.5</sub>	0.34–1.65	A3
Cr <sub>x</sub> Ti <sub>1–x</sub>	3.6 (max.)	Cr in α-Ti
Cr <sub>x</sub> Ti <sub>1–x</sub>	4.2 (max.)	Cr in β-Ti
Cr <sub>0.1</sub> Ti <sub>0.3</sub> V <sub>0.6</sub>	5.6	
Cr <sub>0.0175</sub> U <sub>0.9825</sub>	0.75	β-phase
Cs <sub>0.32</sub> O <sub>3</sub> W	1.12	Hexagonal
Cu <sub>0.15</sub> In <sub>0.85</sub> (film)	3.75	
Cu <sub>0.04–0.08</sub> In <sub>0.94–0.92</sub>	4.4	
CuLa	5.85	
Cu <sub>2</sub> Mo <sub>6</sub> O <sub>2</sub> S <sub>6</sub>	9	hR15 (Mo <sub>6</sub> PbS <sub>8</sub> )
Cu <sub>2</sub> Mo <sub>6</sub> Se <sub>8</sub>	5.9	Same
Cu <sub>x</sub> Pb <sub>1–x</sub>	5.7–7.7	
CuS	1.62	B18
CuS <sub>2</sub>	1.48–1.53	C18
CuSSe	1.5–2.0	C18
CuSe <sub>2</sub>	2.3–2.43	C18
CuSeTe	1.6–2.0	C18
Cu <sub>x</sub> Sn <sub>1–x</sub>	3.2–3.7	
Cu <sub>x</sub> Sn <sub>1–x</sub> (film, made at 10K)	3.6–7	
Cu <sub>x</sub> Sn <sub>1–x</sub> (film, made at 300K)	2.8–3.7	
CuTe <sub>2</sub>	<1.25–1.3	C18
CuTh <sub>2</sub>	3.49	C16
Cu <sub>0–0.027</sub> V	3.9–5.3	A2
CuY	0.33	B2-cP2 (CsCl)
Cu <sub>x</sub> Zn <sub>1–x</sub>	0.5–0.845	
DyMo <sub>6</sub> S <sub>8</sub>	2.1	hR15
Er <sub>x</sub> La <sub>1–x</sub>	1.4–6.3	
ErMo <sub>6</sub> S <sub>8</sub>	2.2	hR15
ErMo <sub>6</sub> Se <sub>8</sub>	6.2	hR15
Fe <sub>3</sub> Lu <sub>2</sub> Si <sub>5</sub>	6.1	tP40 (Fe <sub>3</sub> Sc <sub>2</sub> Si <sub>5</sub> )
Fe <sub>0–0.04</sub> Mo <sub>0.8</sub> Re <sub>0.2</sub>	1–10	
Fe <sub>0.05</sub> Ni <sub>0.05</sub> Zr <sub>0.90</sub>	~3.9	

Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
$\text{Fe}_3\text{Re}_2$	6.55	$D8_b$ -tP30 (FeCr)	$\text{GeV}_3$	6.01	A15
$\text{Fe}_3\text{Sc}_2\text{Si}_5$	4.52	tP40	$\text{Ge}_2\text{Y}$	3.80	$C_c$
$\text{Fe}_3\text{Si}_5\text{TM}$	1.3	Same	$\text{Ge}_{1.62}\text{Y}$	2.4	
$\text{Fe}_3\text{Si}_5\text{Y}_2$	2.4	Same	$\text{Ge}_2\text{Zr}$	0.30	oC12 (ZrSi <sub>2</sub> )
$\text{Fe}_3\text{Th}_7$	1.86	D10	$\text{GeZr}_3$	0.4	$L1_2$ -tP32 (Ti <sub>3</sub> P)
$\text{Fe}_x\text{Ti}_{1-x}$	3.2 (max.)	Fe in $\alpha$ -Ti	$\text{H}_{0.33}\text{Nb}_{0.67}$	7.28	B.C.C.
$\text{Fe}_x\text{Ti}_{1-x}$	3.7 (max.)	Fe in $\beta$ -Ti	$\text{H}_{0.1}\text{Nb}_{0.9}$	7.38	Same
$\text{Fe}_x\text{Ti}_{0.6}\text{V}_{1-x}$	6.8 (max.)		$\text{H}_{0.05}\text{Nb}_{0.95}$	7.83	Same
$\text{FeU}_6$	3.86	$D2_c$	$\text{H}_{0.12}\text{Ta}_{0.88}$	2.81	B.C.C.
$\text{Fe}_{0.1}\text{Zr}_{0.9}$	1.0	A3	$\text{H}_{0.08}\text{Ta}_{0.92}$	3.26	Same
$\text{Ga}_{0.5}\text{Ge}_{0.5}\text{Nb}_3$	7.3	A15	$\text{H}_{0.04}\text{Ta}_{0.96}$	3.62	Same
$\text{Ga}_2\text{Ge}_2\text{U}$	0.87	B2-cP2	HfIrSi	3.50	C37-cP12 (Co <sub>2</sub> Si)
$\text{GaHf}_2$	0.21	C16-tI12 (Al <sub>2</sub> Cu)	HfMo <sub>2</sub>	0.05	hP24 (Ni <sub>2</sub> Mn)
$\text{GaLa}_3$	5.84		HfN <sub>0.989</sub>	6.6	B1
$\text{Ga}_3\text{Lu}$	2.3	B2-cP2	$\text{Hf}_{0-0.5}\text{Nb}_{1-0.5}$	8.3–9.5	A2
$\text{Ga}_2\text{Mo}$	9.5		$\text{Hf}_{0.75}\text{Nb}_{0.25}$	> 4.2	
$\text{GaMo}_3$	0.76	A15	HfOs <sub>2</sub>	2.69	C14
GaN (black)	5.85	B4	HfOsP	6.1	C22-hP9 (Fe <sub>2</sub> P)
$\text{Ga}_{0.7}\text{Pt}_{0.3}$	2.9	C1	HfPRu	9.9	Same
GaPt	1.74	B20	HfRe <sub>2</sub>	4.80	C14
GaSb (120kbar, 77K, annealed)	4.24	A5	$\text{Hf}_{0.14}\text{Re}_{0.86}$	5.86	A12
GaSb (unannealed)	~5.9		$\text{Hf}_{0.99-0.96}\text{Rh}_{0.01-0.04}$	0.85–1.51	
$\text{Ga}_{0-1}\text{Sn}_{1-0}$ (quenched)	3.47–4.18		$\text{Hf}_{0-0.55}\text{Ta}_{1-0.45}$	4.4–6.5	A2
$\text{Ga}_{0-1}\text{Sn}_{1-0}$ (annealed)	2.6–3.85		HfV <sub>2</sub>	8.9–9.6	C15
GaTe	0.17	mC24 (GaTe)	$\text{Hg}_x\text{In}_{1-x}$	3.14–4.55	
$\text{Ga}_5\text{V}_2$	3.55	Tetragonal (Mn <sub>2</sub> Hg <sub>5</sub> )	HgIn	3.81	
GaV <sub>4.5</sub>	9.15		HgK	1.20	Orthorhombic
$\text{Ga}_3\text{Zr}$	1.38		Hg <sub>3</sub> K	3.18	
$\text{Ga}_3\text{Zr}_5$	3.8	$D8_b$ -hP16 (Mn <sub>5</sub> Si <sub>3</sub> )	Hg <sub>4</sub> K	3.27	
$\text{Gd}_x\text{La}_{1-x}$	< 1.0–5.5		Hg <sub>8</sub> K	3.42	
$\text{GdMo}_6\text{S}_8$	3.5	hR15	Hg <sub>3</sub> Li	1.7	Hexagonal
$\text{GdMo}_6\text{Se}_8$	5.6	hR15	HgMg <sub>3</sub>	0.17	hP8 (Na <sub>3</sub> As)
$\text{Gd}_x\text{Os}_2\text{Y}_{1-x}$	1.4–4.7		Hg <sub>2</sub> Mg	4.0	tI6 (MoSi <sub>2</sub> )
$\text{Gd}_x\text{Ru}_2\text{Th}_{1-x}$	3.6 (max.)	C15	Hg <sub>3</sub> Mg <sub>3</sub>	0.48	$D8_b$ -hP16 (Mn <sub>3</sub> Si <sub>3</sub> )
$\text{Ge}_{10}\text{As}_4\text{Y}_5$	9.06	tP38 (Co <sub>4</sub> Sc <sub>5</sub> Si <sub>10</sub> )	Hg <sub>2</sub> Na	1.62	Hexagonal
GeIr	4.7	B31	Hg <sub>4</sub> Na	3.05	
GeIrLa	1.64	tI12 (LaPtSi)	$\text{Hg}_x\text{Pb}_{1-x}$	4.14–7.26	
$\text{Ge}_{10}\text{Ir}_4\text{Lu}_5$	2.60	tP38	HgSn	4.2	
$\text{Ge}_{10}\text{Ir}_4\text{Y}_5$	2.62	tP38	$\text{Hg}_x\text{Tl}_{1-x}$	2.30–4.19	
$\text{Ge}_2\text{La}$	1.49; 2.2	Orthorhombic, distorted (Mn <sub>2</sub> Hg <sub>5</sub> )	Hg <sub>5</sub> Tl <sub>2</sub>	3.86	
GeLaPt	3.53	tI12	$\text{Ho}_x\text{La}_{1-x}$	1.3–6.3	
$\text{Ge}_{13}\text{Lu}_3\text{Os}_4$	3.6	cP40 (Pr <sub>3</sub> Rh <sub>2</sub> Sn <sub>13</sub> )	$\text{Ho}_{1.2}\text{Mo}_6\text{Se}_8$	6.1	$D10_2$ -hR12 (Be <sub>3</sub> Nb)
$\text{Ge}_{10}\text{Lu}_2\text{Rh}_4$	2.79	tP38	$\text{In}_{1-0.86}\text{Mg}_{0-0.14}$	3.395–3.363	
$\text{Ge}_{13}\text{Lu}_3\text{Ru}_4$	2.3	cP40	$\text{In}_2\text{Mo}_6\text{Te}_6$	2.6	hR15 (Mo <sub>6</sub> PbS <sub>6</sub> )
$\text{GeMo}_3$	1.43	A15	InNb <sub>3</sub> (high pressure and temp.)	4–8; 9.2	A15
$\text{GeNb}_2$	1.9		$\text{In}_{0.5}\text{Nb}_3\text{Zr}_{0.5}$	6.4	
$\text{Ge}_{0.29}\text{Nb}_{0.71}$	6	A15	$\text{In}_{0.11}\text{O}_3\text{W}$	< 1.25–2.8	Hexagonal
GePt	0.40	B31	$\text{In}_{0.95-0.85}\text{Pb}_{0.05-0.15}$	3.6–5.05	
$\text{Ge}_3\text{Rh}_5$	2.12	Orthorhombic, related to InNi <sub>2</sub>	$\text{In}_{0.98-0.91}\text{Pb}_{0.02-0.09}$	3.45–4.2	
GeRh	0.96	B31-oP8 (MnP)	InPb	6.65	
$\text{Ge}_{13}\text{Rh}_4\text{Sc}_3$	1.9	cP40	InPd	0.7	B2
$\text{Ge}_{10}\text{Rh}_4\text{Y}_5$	1.35	tP38	InSb (quenched from 170 kbar into liquid N <sub>2</sub> )	4.8	Like A5
$\text{Ge}_{13}\text{Ru}_4\text{Y}_3$	1.7	cP40	InSb	2.1	B4
$\text{Ge}_2\text{So}$	1.3		(InSb) <sub>0.95–0.10</sub> Sn <sub>0.05–0.90</sub> (various heat treatments)	3.8–5.1	
$\text{GeTa}_3$	8.0	A15-cP8 (Cr <sub>3</sub> Si)	(InSb) <sub>0–0.07</sub> Sn <sub>1–0.93</sub>	3.67–3.74	
$\text{Ge}_3\text{Te}_4$ ( $n = 1.06 \times 10^{22}$ )	1.55–1.80	Rhombohedral	In <sub>3</sub> Sn	~5.5	
$\text{Ge}_x\text{Te}_{1-x}$ ( $n = 8.5–64 \times 10^{20}$ )	0.07–0.41	R1	$\text{In}_x\text{Sn}_{1-x}$	3.4–7.3	

Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
$\text{In}_{0.82-1} \text{Te}$ ( $n = 0.83-1.71 \times 10^{22}$ )	1.02-3.45	B1	$\text{Ir}_2\text{Y}_3$	1.61	
$\text{In}_{1.000} \text{Te}_{1.002}$	3.5-3.7	B1	$\text{Ir}_3\text{Y}$	3.50	D10 <sub>2</sub> -hR13 ( $\text{Be}_3\text{Nb}$ )
$\text{In}_3\text{Te}_4$ ( $n = 4.7 \times 10^{21}$ )	1.15-1.25	Rhombohedral	$\text{Ir}_x\text{Y}_{1-x}$	0.3-3.7	
$\text{In}_x\text{Tl}_{1-x}$	2.7-3.374		$\text{Ir}_2\text{Zr}$	4.10	C15
$\text{In}_{0.8}\text{Tl}_{0.2}$	3.223		$\text{Ir}_{0.1}\text{Zr}_{0.9}$	5.5	A3
$\text{In}_{0.62}\text{Tl}_{0.38}$	2.760		$\text{K}_2\text{Mo}_{15}\text{S}_{19}$	3.32	hR15
$\text{In}_{0.78-0.69}\text{Tl}_{0.22-0.31}$	3.18-3.32	Tetragonal	$\text{K}_{0.27-0.31}\text{O}_3\text{W}$	0.50	Hexagonal
$\text{In}_{0.69-0.62}\text{Tl}_{0.31-0.38}$	2.98-3.3	F.C.C.	$\text{K}_{0.40-0.57}\text{O}_3\text{W}$	1.5	Tetragonal
$\text{Ir}_2\text{La}$	0.48	C15	$\text{La}_{0.55}\text{Lu}_{0.45}$	2.2	Hexagonal, La type
$\text{Ir}_3\text{La}$	2.32	D10 <sub>2</sub>	$\text{La}_{0.8}\text{Lu}_{0.2}$	3.4	Same
$\text{Ir}_5\text{La}_7$	2.24	D10 <sub>2</sub>	$\text{LaMg}_2$	1.05	C15
$\text{Ir}_5\text{La}$	2.13		$\text{LaMo}_6\text{S}_8$	7.1	hR15
$\text{IrLaSi}_2$	2.03	oC16 ( $\text{CeNiSi}_2$ )	$\text{LaN}$	1.35	
$\text{IrLaSi}_3$	2.7	tI10 ( $\text{BaNiSn}_3$ )	$\text{LaOs}_2$	6.5	C15
$\text{Ir}_2\text{Lu}$	2.47	C15	$\text{LaPt}_2$	0.46	C15
$\text{Ir}_3\text{Lu}$	2.89	C15	$\text{La}_{0.28}\text{Pt}_{0.72}$	0.54	C15
$\text{Ir}_4\text{Lu}_5\text{Si}_{10}$	3.9	tP38 ( $\text{Co}_4\text{Sc}_5\text{Si}_{10}$ )	$\text{LaPtSi}$	3.48	tI12
$\text{IrMo}$	< 1.0	A3	$\text{LaRh}_3$	2.60	
$\text{IrMo}_3$	9.6	A15	$\text{LaRh}_5$	1.62	
$\text{IrMo}_3$	6.8	D8 <sub>b</sub>	$\text{La}_7\text{Rh}_3$	2.58	D10 <sub>2</sub>
$\text{IrNb}_3$	1.9	A15	$\text{LaRhSi}_2$	3.42	oC16 ( $\text{CeNiSi}_2$ )
$\text{Ir}_{0.4}\text{Nb}_{0.6}$	9.8	D8 <sub>b</sub>	$\text{La}_2\text{Rh}_3\text{Si}_5$	4.45	oI40 ( $\text{Co}_3\text{Si}_5\text{U}_2$ )
$\text{Ir}_{0.37}\text{Nb}_{0.63}$	2.32	D8 <sub>b</sub>	$\text{LaRhSi}_3$	2.7	tI10 ( $\text{BaNiSn}_3$ )
$\text{IrNb}$	7.9	D8 <sub>b</sub>	$\text{LaRh}_2\text{Si}_2$	3.90	tI10 ( $\text{Al}_4\text{Ba}$ )
$\text{Ir}_{1.15}\text{Nb}_{0.85}$	4.6	oP12 ( $\text{IrTa}$ )	$\text{LaRu}_2$	1.63	C15
$\text{Ir}_{0.02}\text{Nb}_3\text{Rh}_{0.98}$	2.43	A15	$\text{La}_3\text{S}_4$	6.5	D7 <sub>3</sub>
$\text{Ir}_{0.05}\text{Nb}_3\text{Rh}_{0.95}$	2.38	A15	$\text{La}_3\text{Se}_4$	8.6	D7 <sub>3</sub>
$\text{Ir}_{0.287}\text{O}_{0.14}\text{Ti}_{0.573}$	5.5	E9 <sub>3</sub>	$\text{LaSi}_2$	2.3	C <sub>c</sub>
$\text{Ir}_{0.265}\text{O}_{0.035}\text{Ti}_{0.65}$	2.30	E9 <sub>3</sub>	$\text{LaY}_{x-1-x}$	1.7-5.4	
$\text{Ir}_x\text{Os}_{1-x}$	0.3-0.98		$\text{LaZn}$	1.04	B2
$\text{Ir}_{1.5}\text{Os}_{0.5}$	2.4	C14	$\text{Li}_2\text{Mo}_6\text{S}_8$	4.2	hR15
$\text{IrOsY}$	2.6	C15	$\text{LiPb}$	7.2	
$\text{IrSiY}$	2.70	C37-oP12 ( $\text{Co}_2\text{Si}$ )	$\text{LuOs}_2$	3.49	C14
$\text{IrSiZr}$	2.04	Same	$\text{Lu}_{0.275}\text{Rh}_{0.725}$	1.27	C15
$\text{Ir}_2\text{Sc}$	2.07	C15	$\text{LuRh}_5$	0.49	
$\text{Ir}_{2.5}\text{Sc}$	2.46	C15	$\text{Lu}_5\text{Rh}_4\text{Si}_{10}$	3.95	tP38 ( $\text{Co}_4\text{So}_5\text{Si}_{10}$ )
$\text{Ir}_4\text{Sc}_5\text{Si}_{10}$	8.46	tP38	$\text{LuRu}_2$	0.86	C14
$\text{Ir}_2\text{Si}_2\text{Th}$	2.14	tI10	$\text{Mg}_{1.14}\text{Mo}_{6.6}\text{S}_8$	3.5	hR15
$\text{IrSi}_3\text{Th}$	1.75	tI10	$\text{Mg}_2\text{Nb}$	5.6	
$\text{IrSiTh}$	6.50	tI12 ( $\text{LaPtSi}$ )	$\text{Mg}_{0.47}\text{Tl}_{-0.53}$	2.75	B2
$\text{Ir}_2\text{Si}_2\text{Y}$	2.60	tI10 ( $\text{Al}_4\text{Ba}$ )	$\text{MgZn}$	0.9	A3-oP4 ( $\text{AuCd}$ )
$\text{Ir}_4\text{Si}_{10}\text{Y}_5$	3.10	tP38	$\text{Mn}_x\text{Ti}_{1-x}$	2.3 (max.)	Mn in -Ti
$\text{Ir}_3\text{Si}_5\text{Y}_2$	2.83	oI40	$\text{Mn}_x\text{Ti}_{1-x}$	1.1-3.0	Mn in -Ti
$\text{IrSn}_2$	0.65-0.78	C1	$\text{MnU}_6$	2.32	D2 <sub>c</sub>
$\text{Ir}_2\text{Sr}$	5.70	C15	$\text{Mo}_2\text{N}$	5.0	F.C.C.
$\text{Ir}_7\text{Ta}_{13}$	1.2	D8 <sub>b</sub> -tP30 ( $\text{FeCr}$ )	$\text{Mo}_6\text{Na}_2\text{S}_8$	8.6	hR15
$\text{Ir}_{0.5}\text{Te}_{0.5}$	~3		$\text{Mo}_x\text{Nb}_{1-x}$	0.016-9.2	
$\text{IrTe}_3$	1.18	C2	$\text{Mo}_{5.25}\text{Nb}_{0.75}\text{Se}_8$	6.2	hR15
$\text{IrTh}$	< 0.37	B <sub>f</sub>	$\text{Mo}_6\text{NdSa}_8$	8.2	hR15
$\text{Ir}_2\text{Th}$	6.50	C15	$\text{Mo}_3\text{Os}$	7.2	A15
$\text{Ir}_3\text{Th}$	4.71		$\text{Mo}_{0.62}\text{Cs}_{0.38}$	5.65	D8 <sub>b</sub>
$\text{Ir}_3\text{Th}_7$	1.52	D10 <sub>2</sub>	$\text{Mo}_3\text{P}$	5.31	DO <sub>c</sub>
$\text{Ir}_5\text{Th}$	3.93	D2 <sub>d</sub>	$\text{Mo}_6\text{Pb}_{1.2}\text{Se}_8$	6.75	hR15
$\text{IrTi}_3$	5.40	A15	$\text{Mo}_{0.5}\text{Pd}_{0.5}$	3.52	A3
$\text{IrV}_2$	1.39	A15	$\text{Mo}_6\text{PrSe}_8$	9.2	hR15
$\text{IrW}_3$	3.82		$\text{MoRe}$	7.8	D8 <sub>b</sub> -tP30
$\text{Ir}_{0.28}\text{W}_{0.72}$	4.49		$\text{MoRe}_3$	9.25; 9.89	A12
$\text{Ir}_2\text{Y}$	2.18; 1.38	C15	$\text{Mo}_x\text{Re}_{1-x}$	1.2-12.2	
$\text{Ir}_{0.69}\text{Y}_{0.31}$	1.98; 1.44	C15	$\text{Mo}_{0.42}\text{Re}_{0.58}$	6.35	D8 <sub>b</sub>
$\text{Ir}_{0.70}\text{Y}_{0.30}$	2.16	C15	$\text{MoRh}$	1.97	A3
			$\text{Mo}_x\text{Rh}_{1-x}$	1.5-8.2	B.C.C.

Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
MoRu	9.5–10.5	A3	Nb <sub>3</sub> Rh	2.64	A15
Mo <sub>0.61</sub> Ru <sub>0.39</sub>	7.18	D8 <sub>b</sub>	Nb <sub>0.6</sub> Rh <sub>0.40</sub>	4.21	D8 <sub>b</sub> plus other
Mo <sub>0.2</sub> Ru <sub>0.8</sub>	1.66	A3	Nb <sub>0.9</sub> Rh <sub>1.1</sub>	3.07	A3-oP4 (AuCd)
Mo <sub>3</sub> Ru <sub>2</sub>	7.0	D8 <sub>b</sub> -tP30	Nb <sub>3</sub> Rh <sub>0.98–0.90</sub> Ru <sub>0.02–0.10</sub>	2.42–2.44	A15
Mo <sub>4</sub> Ru <sub>2</sub> Te <sub>8</sub>	1.7	hR15	Nb <sub>x</sub> Ru <sub>1-x</sub>	1.2–4.8	
Mo <sub>6</sub> S <sub>8</sub>	1.85	hR15	NbRuSi	2.65	oI36
Mo <sub>6</sub> S <sub>8</sub> Sc	3.6	hR15	NbS <sub>2</sub>	6.1–6.3	Hexagonal, NbSe <sub>2</sub> type
Mo <sub>6</sub> S <sub>8</sub> Sm <sub>1.2</sub>	2.9	hR15	NbS <sub>2</sub>	5.0–5.5	Hexagonal, three-layer type
Mo <sub>6</sub> S <sub>8</sub> Tb	2.0	hR15	Nb <sub>3</sub> Sb	0.2	L1 <sub>2</sub> -tP32 (Ti <sub>3</sub> P)
Mo <sub>6</sub> S <sub>8</sub> Tl	8.7	hR15	Nb <sub>3</sub> Sb <sub>0–0.7</sub> Sn <sub>1–0.3</sub>	6.8–18	A15
Mo <sub>6</sub> S <sub>8</sub> Tm <sub>1.2</sub>	2.1	hR15	NbSe <sub>2</sub>	5.15–5.62	Hexagonal
Mo <sub>6</sub> S <sub>8</sub> Y <sub>1.2</sub>	3.0	hR15	Nb <sub>1–1.05</sub> Se <sub>2</sub>	2.2–7.0	Same
Mo <sub>6</sub> S <sub>8</sub> Yb	9.2	hR15	Nb <sub>3</sub> Se <sub>4</sub>	2.0	hP14
Mo <sub>6.6</sub> S <sub>8</sub> Zn <sub>11</sub>	3.6	hR15	Nb <sub>3</sub> Si	1.5	L1 <sub>2</sub>
Mo <sub>3</sub> Sb <sub>4</sub>	2.1		Nb <sub>3</sub> SiSnV <sub>3</sub>	4.0	
Mo <sub>6</sub> Se <sub>8</sub>	6.3	hR15	NbSn <sub>2</sub>	2.60	Orthorhombic
Mo <sub>6</sub> Se <sub>8</sub> Sm <sub>1.2</sub>	6.8	hR15	Nb <sub>6</sub> Sn <sub>5</sub>	2.8	oI44 (Sn <sub>3</sub> Ti <sub>6</sub> )
Mo <sub>6</sub> Se <sub>8</sub> Sn <sub>1.2</sub>	6.8	hR15	NbSnTaV	6.2	A15
Mo <sub>6</sub> Se <sub>8</sub> Tb	5.7	hR15	NbSnV <sub>2</sub>	5.5	A15
Mo <sub>3</sub> Se <sub>3</sub> Tl	4.0	hP14	Nb <sub>2</sub> SnV	9.8	A15
Mo <sub>6</sub> Se <sub>8</sub> Tm <sub>1.2</sub>	6.3	hR15	Nb <sub>x</sub> Ta <sub>1-x</sub>	4.4–9.2	A2
Mo <sub>6</sub> Se <sub>8</sub> Yb	6.2	hR15	Nb <sub>3</sub> Te <sub>4</sub>	1.8	hP14
Mo <sub>3</sub> Si	1.30	A15	Nb <sub>x</sub> Ti <sub>1-x</sub>	0.6–9.8	
MoSi <sub>0.7</sub>	1.34		Nb <sub>0.6</sub> Ti <sub>0.4</sub>	9.8	
Mo <sub>x</sub> SiV <sub>3-x</sub>	4.54–16.0	A15	Nb <sub>x</sub> U <sub>1-x</sub>	1.95 (max.)	
Mo <sub>5.25</sub> Ta <sub>0.75</sub> Te <sub>8</sub>	1.7	hR15	Nb <sub>0.88</sub> V <sub>0.12</sub>	5.7	A2
Mo <sub>6</sub> Te <sub>8</sub>	1.7	hR15	Nb <sub>0.5</sub> V <sub>1.5</sub> Zr	4.3	C15-hP12 (MgZn <sub>2</sub> )
Mo <sub>0.16</sub> Ti <sub>0.84</sub>	4.18; 4.25		Ni <sub>0.3</sub> Th <sub>0.7</sub>	1.98	D10 <sub>2</sub>
Mo <sub>0.913</sub> Ti <sub>0.087</sub>	2.95		NiZr <sub>2</sub>	1.52	
Mo <sub>0.04</sub> Ti <sub>0.96</sub>	2.0	Cubic	Ni <sub>0.1</sub> Zr <sub>0.9</sub>	1.5	A3
Mo <sub>0.025</sub> Ti <sub>0.975</sub>	1.8		O <sub>3</sub> Rb <sub>0.27–0.29</sub> W	1.98	Hexagonal
Mo <sub>x</sub> U <sub>1-x</sub>	0.7–2.1		OSn	3.81	tP4 (PbO)
Mo <sub>x</sub> V <sub>1-x</sub>	0–5.3		O <sub>3</sub> SrTi (n = 1.7–12.0 × 10 <sup>19</sup> )	0.12–0.37	
Mo <sub>2</sub> Zr	4.25–4.75	C15	O <sub>3</sub> SrTi (n = 10 <sup>18</sup> –10 <sup>21</sup> )	0.05–0.47	
NNb (film)	6–9	B1	O <sub>3</sub> SrTi (n = 10 <sup>20</sup> )	0.47	
N <sub>x</sub> O <sub>y</sub> Ti <sub>z</sub>	2.9–5.6	Cubic	O <sub>3</sub> Sr <sub>0.08</sub> W	2–4	Hexagonal
N <sub>x</sub> O <sub>y</sub> V <sub>z</sub>	5.8–8.2	Cubic	OTi	0.58	
N <sub>0.34</sub> Re	4–5	F.C.C.	O <sub>3</sub> Tl <sub>0.30</sub> W	2.0–2.14	Hexagonal
NTa (film)	4.84	B1	OV <sub>3</sub> Zr <sub>3</sub>	7.5	E9 <sub>3</sub>
N <sub>0.6–0.987</sub> Ti	< 1.17–5.8	B1	OW <sub>3</sub> (film)	3.35; 1.1	A15
N <sub>0.82–0.99</sub> V	2.9–7.9	B1	OsPt <sub>i</sub>	1.2	C22-hP9 (Fe <sub>2</sub> P)
NZr	9.8	B1	OsPZr	7.4	Same
N <sub>0.906–0.984</sub> Zr	3.0–9.5	B1	OsReY	2.0	C14
Na <sub>0.28–0.35</sub> O <sub>3</sub> W	0.56	Tetragonal	Os <sub>2</sub> Sc	4.6	C14
Na <sub>0.28</sub> Pb <sub>0.72</sub>	7.2		OsTa	1.95	A12
NbO	1.25		Os <sub>3</sub> Th <sub>7</sub>	1.51	D10 <sub>2</sub>
NbOs <sub>2</sub>	2.52	A12	Os <sub>x</sub> W <sub>1-x</sub>	0.9–4.1	
Nb <sub>3</sub> Os	1.05	A15	OsW <sub>3</sub>	~3	
Nb <sub>0.6</sub> Os <sub>0.4</sub>	1.89; 1.78	D8 <sub>b</sub>	Os <sub>2</sub> Y	4.7	C14
Nb <sub>3</sub> Os <sub>0.02–0.10</sub> Rh <sub>0.98–0.90</sub>	2.42–2.30	A15	Os <sub>2</sub> Zr	3.0	C14
Nb <sub>3</sub> P	1.8	L1 <sub>2</sub> tP32 (Ti <sub>3</sub> P)	Os <sub>x</sub> Zr <sub>1-x</sub>	1.5–5.6	
NbPRh	4.08	C37-oP12 (Co <sub>2</sub> Si)	PPb	7.8	
Nb <sub>0.6</sub> Pd <sub>0.4</sub>	1.60	D8 <sub>f</sub> plus cubic	OsW <sub>2</sub>	3.81	D8 <sub>b</sub> -tP30 (FeCr)
Nb <sub>3</sub> Pd <sub>0.02–0.10</sub> Rh <sub>0.92–0.90</sub>	2.49–2.55	A15	PPd <sub>3.0–3.2</sub>	<0.35–0.7	DO <sub>11</sub>
Nb <sub>0.62</sub> Pt <sub>0.38</sub>	4.21	D8 <sub>b</sub>	P <sub>3</sub> Pd <sub>7</sub> (high temperature)	1.0	Rhombohedral
Nb <sub>5</sub> Pt <sub>3</sub>	3.73	D8 <sub>b</sub>	P <sub>3</sub> Pd <sub>7</sub> (low temperature)	0.70	Complex
Nb <sub>3</sub> Pt <sub>0.02–0.98</sub> Rh <sub>0.98–0.02</sub>	2.52–9.6	A15	PRh	1.22	
NbRe <sub>3</sub>	5.27	D8 <sub>b</sub> -tP30 (FeCr)	PRh <sub>2</sub>	1.3	C1
Nb <sub>0.38–0.18</sub> Re <sub>0.62–0.82</sub>	2.43–9.70	A15	P <sub>4</sub> Rh <sub>5</sub>	1.22	oP28 (CaFe <sub>2</sub> O <sub>4</sub> )
NbRe	3.8	D8 <sub>b</sub> -tP30	PRhTa	4.41	C37-oP12 (Co <sub>2</sub> Si)
NbReSi	5.1	oI36 (FeTiSi)			

Substance	$T_c$ K	Crystal structure type	Substance	$T_c$ K	Crystal structure type
PRhZr	1.55	Same	PtV <sub>3.5</sub>	1.26	A15
PRuTi	1.3	C22-hP9 (Fe <sub>2</sub> P)	Pt <sub>0.5</sub> W <sub>0.5</sub>	1.45	A1
PRuZr	3.46	C37-oP12	Pt <sub>x</sub> W <sub>1-x</sub>	0.4–2.7	
PW <sub>3</sub>	2.26	DO <sub>e</sub>	Pt <sub>2</sub> Y <sub>3</sub>	0.90	
Pb <sub>2</sub> Pd	2.95	C16	Pt <sub>2</sub> Y	1.57; 1.70	C15
Pb <sub>4</sub> Pt	2.80	Related to C16	Pt <sub>3</sub> Y <sub>7</sub>	0.82	D10 <sub>2</sub>
Pb <sub>2</sub> Rh	2.66	C16	PtZr	3.0	A3
PbSb	6.6		Re <sub>2</sub> Sc	4.2	C15-hP12 (MgZn <sub>2</sub> )
PbTe (plus 0.1 w/o Pb)	5.19		Re <sub>24</sub> Sc <sub>5</sub>	2.2	A12-cl58 (Mg)
PbTe (plus 0.1 w/o Te)	5.24–5.27		ReSiTa	4.4	oI36 (FeTiSi)
PbTl <sub>0.27</sub>	6.43		Re <sub>3</sub> Si <sub>15</sub> Y <sub>2</sub>	1.76	tP40 (Fe <sub>3</sub> Sc <sub>2</sub> Si <sub>3</sub> )
PbTl <sub>0.17</sub>	6.73		Re <sub>3</sub> Ta <sub>2</sub>	1.4	D8 <sub>b</sub> -tP30 (FeCr)
PbTl <sub>0.12</sub>	6.88		Re <sub>0.64</sub> Ta <sub>0.36</sub>	1.46	A12
PbTl <sub>0.075</sub>	6.98		Re <sub>3</sub> Ta	6.78	A12-cl58 (Mn)
PbTl <sub>0.04</sub>	7.06		Re <sub>24</sub> Ti <sub>5</sub>	6.60	A12
Pb <sub>1-0.26</sub> Tl <sub>0-0.74</sub>	7.20–3.68		Re <sub>x</sub> Ti <sub>1-x</sub>	6.6 (max.)	
PbTl <sub>2</sub>	3.75–4.1		Re <sub>0.76</sub> V <sub>0.24</sub>	4.52	D8 <sub>b</sub>
Pb <sub>3</sub> Zr <sub>5</sub>	4.60	D8 <sub>8</sub>	Re <sub>3</sub> V	6.26	D8 <sub>b</sub> -tP30
PbZr <sub>3</sub>	0.76	A15	Re <sub>0.92</sub> V <sub>0.08</sub>	6.8	A3
Pd <sub>0.9</sub> Pt <sub>0.1</sub> Te <sub>2</sub>	1.65	C6	Re <sub>0.6</sub> W <sub>0.4</sub>	6.0	
Pd <sub>0.05</sub> Ru <sub>0.05</sub> Zr <sub>0.9</sub>	~9		Re <sub>0.5</sub> W <sub>0.5</sub>	5.12	D8 <sub>b</sub>
Pd <sub>2.2</sub> S (quenched)	1.63	Cubic	Re <sub>13</sub> W <sub>12</sub>	5.2	D8 <sub>b</sub> -tP30
PdSb <sub>2</sub>	1.25	C2	Re <sub>3</sub> W	9.0	A12-cl58
PdSb	1.5	B8 <sub>1</sub>	Re <sub>2</sub> Y	1.83	C14
PdSbSe	1.0	C2	Re <sub>2</sub> Zr	5.9	C14
PdSbTe	1.2	C2	Re <sub>3</sub> Zr	7.40	A12-cl58
Pd <sub>4</sub> Se	0.42	Tetragonal	Re <sub>6</sub> Zr	7.40	Same
Pd <sub>6-7</sub> Se	0.66	Like Pd <sub>4</sub> Te	Rh <sub>17</sub> S <sub>15</sub>	5.8	Cubic
Pd <sub>2.8</sub> Se	2.3		Rh <sub>-0.24</sub> Sc <sub>0.76</sub>	0.88; 0.92	
Pd <sub>x</sub> Se <sub>1-x</sub>	2.5 (max.)		Rh <sub>4</sub> Sc <sub>5</sub> Si <sub>10</sub>	8.54	tP38
PdSi	0.93	B31	Rh <sub>4</sub> Sc <sub>3</sub> Sn <sub>13</sub>	4.5	cP40
PdSn	0.41	B31	Rh <sub>x</sub> Se <sub>1-x</sub>	6.0 (max.)	
PdSn <sub>2</sub>	3.34		RhSi <sub>3</sub> Th	1.76	tI10
Pd <sub>2</sub> Sn	0.41	C37	Rh <sub>0.86</sub> Sc <sub>1.04</sub> Th	6.45	tI12
Pd <sub>3</sub> Sn	0.47–0.64	B8 <sub>2</sub>	Rh <sub>2</sub> Si <sub>2</sub> Y	3.11	tI10
Pd <sub>2</sub> SnTm	1.77	DO <sub>3</sub> -cF16 (BiF <sub>3</sub> )	Rh <sub>3</sub> Si <sub>5</sub> Y <sub>2</sub>	2.70	oI40
Pd <sub>2</sub> SnY	4.92	Same	Rh <sub>4</sub> Sn <sub>13</sub> Sr <sub>3</sub>	4.3	cP40
Pd <sub>2</sub> SnYb	1.79	Same	Rh <sub>x</sub> Sn <sub>y</sub> Th	1.9	cl2 (W)
PdTe	2.3; 3.85	B8 <sub>1</sub>	Rh <sub>x</sub> Sn <sub>y</sub> Tm	2.3	cP40
PdTe <sub>1.02-1.08</sub>	2.56–1.88	B8 <sub>1</sub>	Rh <sub>4</sub> Sn <sub>13</sub> Y <sub>3</sub>	3.2	cP40
PdTe <sub>2</sub>	1.69	C6	Rh <sub>2</sub> Sr	6.2	C15
PdTe <sub>2.1</sub>	1.89	C6	Rh <sub>0.4</sub> Ta <sub>0.6</sub>	2.35	D8 <sub>b</sub>
PdTe <sub>2.3</sub>	1.85	C6	RhTe <sub>2</sub>	1.51	C2
Pd <sub>1.1</sub> Te	4.07	B8 <sub>1</sub>	Rh <sub>0.67</sub> Te <sub>0.33</sub>	0.49	
Pd <sub>3</sub> Te	0.76	cl2 (W)	Rh <sub>x</sub> Te <sub>1-x</sub>	1.51 (max.)	
PdTh <sub>2</sub>	0.85	C16	RhTh	0.36	B <sub>f</sub>
Pd <sub>0.1</sub> Zr <sub>0.9</sub>	7.5	A3	Rh <sub>3</sub> Th <sub>7</sub>	2.15	D10 <sub>2</sub>
PtSb	2.1	B8 <sub>1</sub>	Rh <sub>5</sub> Th	1.07	
PtSi	0.88	B31	Rh <sub>x</sub> Ti <sub>1-x</sub>	2.25–3.95	
PtSn	0.37	B8 <sub>1</sub>	Rh <sub>0.02</sub> U <sub>0.98</sub>	0.96	
PtSn <sub>4</sub>	2.38	C16-oC20 (PdSn <sub>4</sub> )	RhV <sub>3</sub>	0.38	A15
Pt <sub>3</sub> Ta <sub>7</sub>	1.5	D8 <sub>b</sub> -tP30	RhW	~3.4	A3
PtTa <sub>3</sub>	0.4	A15-cP8 (Cr <sub>3</sub> Si)	RhY <sub>3</sub>	0.65	
PtTe	0.59	Orthorhombic	Rh <sub>2</sub> Y <sub>3</sub>	1.48	
PtTh	0.44	B <sub>f</sub>	Rh <sub>3</sub> Y	1.07	C15
Pt <sub>3</sub> Th <sub>7</sub>	0.98	D10 <sub>2</sub>	Rh <sub>5</sub> Y	0.56	
Pt <sub>5</sub> Th	3.13		Rh <sub>3</sub> Y <sub>7</sub>	0.32	hP20 (Fe <sub>3</sub> Th <sub>5</sub> )
PtTi <sub>3</sub>	0.58	A15	Rh <sub>0.005</sub> Zr (annealed)	5.8	
Pt <sub>0.02</sub> U <sub>0.98</sub>	0.87	β-phase	Rh <sub>0-0.45</sub> Zr <sub>1-0.55</sub>	2.1–10.8	
PtV <sub>2.5</sub>	1.36	A15	Rh <sub>0.1</sub> Zr <sub>0.9</sub>	9.0	H.C.P.
PtV <sub>3</sub>	2.87–3.20	A15	Ru <sub>2</sub> Sc	1.67	C14
			RuSiTa	3.15	oI36

Substance	$T_c$ , K	Crystal structure type
$Ru_3Si_2Th$	3.98	hP12
$Ru_3Si_2Y$	3.51	hP12
$Ru_{1.1}Sn_{3.1}Y$	1.3	cP40
$Ru_2Th$	3.56	C15
$RuTi$	1.07	B2
$Ru_{0.05}Ti_{0.95}$	2.5	
$Ru_{0.1}Ti_{0.9}$	3.5	
$Ru_xTi_{0.6}V_y$	6.6 (max.)	
$Ru_3U$	0.15	L1 <sub>2</sub> -cP4
$Ru_{0.45}V_{0.55}$	4.0	B2
$RuW$	7.5	A3
$Ru_2Y$	1.52	C14
$Ru_2Zr$	1.84	C14
$Ru_{0.1}Zr_{0.9}$	5.7	A3
STh	0.5	B1-cF8 (NaCl)
SbSn	1.30–1.42	B1 or distorted
SbTa <sub>3</sub>	0.72	A15-cP8 (Cr <sub>3</sub> Si)
SbTi <sub>3</sub>	5.8	Same
Sb <sub>2</sub> Ti <sub>7</sub>	5.2	
$Sb_{0.01-0.03}V_{0.99-0.97}$	3.76–2.63	A2
SbV <sub>3</sub>	0.80	A15
SeTh	1.7	B1-cF8
SiMo <sub>3</sub>	1.4	A15-cP8
Si <sub>2</sub> Th	3.2	C <sub>2</sub> , α-phase
Si <sub>3</sub> Th	2.4	C32, β-phase
$SiV_{2.7}Ru_{0.3}$	2.9	A15
$Si_2W_3$	2.8; 2.84	
SiZr <sub>3</sub>	0.5	L1 <sub>2</sub> -tP32 (Ti <sub>3</sub> P)
$Sn_{0.174-0.104}Ta_{0.826-0.896}$	6.5–< 4.2	A15
SnTa <sub>3</sub>	8.35	A15, highly ordered
SnTa <sub>3</sub>	6.2	A15, partially ordered
SnTaV <sub>2</sub>	2.8	A15
SnTa <sub>2</sub> V	3.7	A15
$Sn_xTe_{1-x}$ (n = 10.5–20 × 10 <sup>20</sup> )	0.07–0.22	B1
Sn <sub>3</sub> Th	3.33	L1 <sub>2</sub> -cP4
SnTi <sub>3</sub>	5.80	A15-cP8
$Sn_xTi_{1-x}$	2.37–5.2	
SnV <sub>3</sub>	3.8	A15
$Sn_{0.02-0.057}V_{0.98-0.943}$	2.87–~1.6	A2
SnZr <sub>3</sub>	0.92	A15-cP8
$Ta_{0.025}Ti_{0.975}$	1.3	Hexagonal
$Ta_{0.05}Ti_{0.95}$	2.9	Hexagonal
$Ta_{0.05-0.75}V_{0.95-0.25}$	4.30–2.65	A2
$Ta_{0.8-1}W_{0.2-0}$	1.2–4.4	A2
$Tc_{0.1-0.4}W_{0.9-0.6}$	1.25–7.18	Cubic
$Tc_{0.50}W_{0.50}$	7.52	α plus
$Tc_{0.60}W_{0.40}$	7.88	plus α
Tc <sub>6</sub> Zr	9.7	A12
TeY	1.02	B1-cF8
ThTi <sub>3</sub>	0.87	L1 <sub>2</sub> -cP4
$Th_{0-0.55}Y_{1-0.45}$	1.2–1.8	
$Ti_{0.70}V_{0.30}$	6.14	Cubic
$Ti_xV_{1-x}$	0.2–7.5	
Ti <sub>0.5</sub> Zr <sub>0.5</sub> (annealed)	1.23	
Ti <sub>0.5</sub> Zr <sub>0.5</sub> (quenched)	2.0	
Tl <sub>3</sub> Y	1.52	L1 <sub>2</sub> -cP4
V <sub>2</sub> Zr	8.80	C15
$V_{0.26}Zr_{0.74}$	5.9	
W <sub>2</sub> Zr	2.16	C15
YZn	0.33	B2-cP2 (CsCl)

\* n denotes current carriers concentration in cm<sup>-3</sup>.B. Superconductors with  $T_c > 10K$ 

Substance	$T_c$ , K	Crystal structure type
Al <sub>2</sub> CMo <sub>3</sub>	10.0	A13
Al <sub>0.5</sub> Ge <sub>0.5</sub> Nb	12.6	A15
Al <sub>1-0.8</sub> Ge <sub>-0.2</sub> Nb <sub>3</sub>	20.7	A15
AlNb <sub>3</sub>	18.0	A15 (Cr <sub>3</sub> Si)
AlNb <sub>3</sub>	12.0	(FeCr)
Al <sub>x</sub> Nb <sub>1-x</sub>	<4.2–13.5	D8 <sub>b</sub>
Al <sub>x</sub> Nb <sub>1-x</sub>	12–17.5	A15
$Al_{0.27}Nb_{0.73-0.48}V_{0-0.25}$	14.5–17.5	A15
AlNb <sub>x</sub> V <sub>1-x</sub>	4.4–13.5	
$Al_{0.1}Si_{0.9}V_3$	14.05	
AlV <sub>3</sub>	11.8	A15 (Cr <sub>3</sub> Si)
AuNb <sub>3</sub>	11.5	A15
$Au_{0-0.3}Nb_{1-0.7}$	1.1–11.0	
$Au_{0.02-0.98}Nb_{0.98-0.02}Rh$	2.53–10.9	A15
$AuNb_{3(1-x)}V_{3x}$	1.5–11.0	A15
$B_{0.03}C_{0.51}Mo_{0.47}$	12.5	
B <sub>4</sub> LuRh <sub>4</sub>	11.7	(B <sub>4</sub> CeCo <sub>4</sub> )
B <sub>2</sub> LuRu	10	
B <sub>4</sub> Rh <sub>4</sub> Y	11.3	(B <sub>4</sub> CeCo <sub>4</sub> )
$B_{0.1}Si_{0.9}V_3$	15.8	A15
BaBi <sub>0.2</sub> O <sub>3</sub> Pb <sub>0.8</sub>	13.2	
Ba <sub>2</sub> CaCu <sub>2</sub> O <sub>8</sub> Tl <sub>2</sub>	120	
Ba <sub>2</sub> Cu <sub>3</sub> LaO <sub>6</sub>	80	
Ba <sub>2</sub> Cu <sub>3</sub> O <sub>7</sub> Tm	101	
Ba <sub>2</sub> Cu <sub>3</sub> O <sub>7</sub> Y	90	
(Ba,La) <sub>2</sub> CuO <sub>4</sub>	36	A15 (K <sub>2</sub> NiF <sub>4</sub> )
Bi <sub>2</sub> CaCu <sub>2</sub> O <sub>8</sub> Sr <sub>2</sub>	110	
Br <sub>2</sub> Mo <sub>6</sub> S <sub>6</sub>	13.8	(Mo <sub>6</sub> PbS <sub>8</sub> )
C <sub>3</sub> La	11.0	(C <sub>3</sub> Pu <sub>2</sub> )
CMo	14.3	B1 (NaCl)
CMo <sub>2</sub>	12.2	o**
$C_{0.5}Mo_xNb_{1-x}$	10.8–12.5	B1
$CMo_xTi_{1-x}$	10.2(max)	B1
$CMo_{0.83}Ti_{0.17}$	10.2	B1
$C_{0-0.38}N_{1-0.62}Ta$	10.0–11.3	
CNb (whiskers)	7.5–10.5	
CNb	11.5	B1
$C_{0.7-1.0}Nb_{0.3-0}$	6–11	B1
$CNb_xTa_{1-x}$	8.2–13.9	
$CNb_{0.6-0.9}W_{0.4-0.1}$	12.5–11.6	B1
$C_{0.1}Si_{0.9}V_3$	16.4	A15
CTa	10.3	B1
$CTa_{1-0.4}W_{0-0.6}$	8.5–10.5	B1
$C_{0.66}Th_{0.13}Y_{0.21}$	17	(C <sub>3</sub> Pu <sub>2</sub> )
C <sub>3</sub> Y <sub>2</sub>	11.5	(C <sub>3</sub> Pu <sub>2</sub> )
CW	10	B1
(Ca,La) <sub>2</sub> CuO <sub>4</sub>	18	(K <sub>2</sub> NiF <sub>4</sub> )
Cu(La,Sr) <sub>2</sub> O <sub>4</sub>	39	
$Cu_{1.8}Mo_6S_8$	10.8	(Mo <sub>6</sub> PbS <sub>8</sub> )
$Cr_{0.3}SiV_{2.7}$	11.3	A15
GaNb <sub>3</sub>	14.5	A15 (Cr <sub>3</sub> Si)
$Ga_xNb_3Sn_{1-x}$	14–18.37	A15
GaV <sub>3</sub>	16.8	A15
$GaV_{2.1-3.5}$	6.3–14.45	A15
GeNb <sub>3</sub>	23.2	A15
GeNb <sub>3</sub> (quenched)	6–17	A15
$Ge_xNb_3Sn_{1-x}$	17.6–18.0	A15
$Ge_{0.5}Nb_3Sn_{0.5}$	11.3	
$Ge_{0.1}Si_{0.9}V_3$	14.0	A15
GeV <sub>3</sub>	11	A15
InLa <sub>3</sub>	9.83; 10.4	L1 <sub>2</sub> (AuCu <sub>3</sub> )



Substance	$T_c, K$	Crystal structure type	Substance	$T_c, K$	Crystal structure type
$In_{0-0.3}Nb_3Sn_{1-0.7}$	18.0–18.19	A15	$Ni_{100-42w/o}Nb_{0-58w/o}Ti$	15–16.8	
$InV_3$	13.9	A15	$Ni_{100-75w/o}Nb_{0-25w/o}Zr$	12.5–16.35	
$Ir_{0.4}Nb_{0.6}$	10	(FeCr)	$NNb_xZr_{1-x}$	9.8–13.8	B1
$LaMo_6Se_8$	11.4	( $Mo_6PbS_8$ )	$Ni_{0.93}Nb_{0.85}Zr_{0.15}$	13.8	B1
$LiO_4Ti_2$	13.7	( $Al_2MgO_4$ )	NTa	12–14	B1
$MgB_2$	39.0±0.5	C32	NZr	10.7	B1
MoN	12; 14.8	$h^*$	$Nb_3Pt$	10.9	A15
$Mo_3Os$	12.7	A15	$Nb_{0.18}Re_{0.82}$	10	(Mn)
$Mo_6Pb_{0.9}S_{7.5}$	15.2	( $Mo_6PbS_8$ )	$Nb_3Si$	19	A15
$Mo_3Re$	10.0; 15	A15	$Nb_{0.3}SiV_{2.7}$	12.8	A15
$Mo_xRe_{1-x}$	1.2–12.2		$Nb_3Sn$	18.05	A15
$Mo_{0.52}Re_{0.48}$	11.1		$Nb_{0.8}Sn_{0.2}$	18.18; 18.5	A15
$Mo_{0.57}Re_{0.43}$	14.0		$Nb_xSn_{1-x}$ (film)	2.6–18.5	$o^*$
$Mo_{-0.60}Re_{0.395}$	10.6		$Nb_3Sn_2$	16.6	$t^*$
MoRu	9.5–10.5	A3	$NbSnTa_2$	10.8	A15
$Mo_3Ru$	10.6	A15	$Nb_2SnTa$	16.4	A15
$Mo_6Se_8Tl$	12.2	( $Mo_6PbS_8$ )	$Nb_{2.5}SnTa_{0.5}$	17.6	A15
$Mo_{0.3}SiV_{2.7}$	11.7	A15	$Nb_{2.75}SnTa_{0.25}$	17.8	A15
$Mn_3Si$	12.5	A15	$Nb_{3x}SnTa_{3(1-x)}$	6.0–18.0	
$Mo_3Tc$	15	A15	$Nb_2SnTa_{0.5}V_{0.5}$	12.2	A15
$Mo_{0.3}Tc_{0.7}$	12.0	A15	$NbTc_3$	10.5	A12
$Mo_xTc_{1-x}$	10.8–15.8		$Nb_{0.75}Zr_{0.25}$	10.8	
MoTc <sub>3</sub>	15.8		$Nb_{0.66}Zr_{0.33}$	10.8	
NNb (whiskers)	10–14.5		PbTa <sub>3</sub>	17	A15
NNb (diffusion wires)	16.10		RhTa <sub>3</sub>	10	A15
$Ni_{0.988}Nb$	14.9; 17.3	B1	RhZr <sub>2</sub>	10.8; 11.3	C16
$Ni_{0.824-0.988}Nb$	14.4–15.3	B1	$Rh_{0-0.45}Zr_{1-0.55}$	2.1–10.8	( $Al_2Cu$ )
$Ni_{0.7-0.795}Nb$	11.3–12.9		$SiTi_{0.3}V_{2.7}$	10.9	A15
$NNb_xO_y$	13.5–17.0	B1	SiV <sub>3</sub>	17.1	A15
$NNb_xO_y$	6.0–11		$SiV_{2.7}Zr_{0.3}$	13.2	A15

TABLE 5. Critical Field Data

Substance	$H_0$ (oersteds)	Substance	$H_0$ (oersteds)
Ag <sub>2</sub> F	2.5	InSb	1100
Ag <sub>2</sub> NO <sub>11</sub>	57	$In_xTl_{1-x}$	252–284
Al <sub>2</sub> CMo <sub>3</sub>	1700	$In_{0.8}Tl_{0.2}$	252
BaBi <sub>3</sub>	740	$Mg_{0.47}Tl_{0.53}$	220
Bi <sub>2</sub> Pt	10	$Mo_{0.16}Tl_{0.84}$	<985
Bi <sub>3</sub> Sr	530	NbSn <sub>2</sub>	620
Bi <sub>5</sub> Tl <sub>3</sub>	>400	PbTl <sub>0.27</sub>	756
CdSn	>266	PbTl <sub>0.17</sub>	796
CoSi <sub>2</sub>	105	PbTl <sub>0.12</sub>	849
$Cr_{0.1}Ti_{0.3}V_{0.6}$	1360	PbTl <sub>0.075</sub>	880
$In_{1-0.86}Mg_{0-0.14}$	272.4–259.2	PbTl <sub>0.04</sub>	864

TABLE 6. High Critical Magnetic-Field Superconductive Compounds and Alloys

Substance	$T_c$ , K	$H_{c1}$ , kOe	$H_{c2}$ , kOe	$H_{c3}$ , kOe	$T_{obs}$ , K <sup>a</sup>
Al <sub>2</sub> CMo <sub>3</sub>	9.8–10.2	0.091	156		1.2
AlNb <sub>3</sub>		0.375			
Ba <sub>x</sub> O <sub>3</sub> Sr <sub>1-x</sub> Ti	<0.1–0.55	0.0039 max.			
Bi <sub>0.5</sub> Cd <sub>0.1</sub> Pb <sub>0.27</sub> Sn <sub>0.13</sub>			>24		3.06
Bi <sub>x</sub> Pb <sub>1-x</sub>	7.35–8.4	0.122 max.	30 max.		4.2
Bi <sub>0.56</sub> Pb <sub>0.44</sub>	8.8		15		4.2
Bi <sub>7.5w/o</sub> Pb <sub>92.5w/o</sub> <sup>b</sup>			2.32		
Bi <sub>0.099</sub> Pb <sub>0.901</sub>		0.29	2.8		
Bi <sub>0.02</sub> Pb <sub>0.98</sub>		0.46	0.73		
Bi <sub>0.53</sub> Pb <sub>0.32</sub> Sn <sub>0.16</sub>			>25		3.06
Bi <sub>1-0.93</sub> Sn <sub>0-0.07</sub>			0–0.032		3.7
Bi <sub>5</sub> Tl <sub>3</sub>	6.4		>5.6		3.35
C <sub>8</sub> K (excess K)	0.55		0.160 (H⊥c)		0.32
			0.730 (H c)		0.32
C <sub>8</sub> K	0.39		0.025 (H⊥c)		0.32
			0.250 (H c)		0.32
C <sub>0.44</sub> Mo <sub>0.56</sub>	12.5–13.5	0.087	98.5		1.2
CNb	8–10	0.12	16.9		4.2
CNb <sub>0.4</sub> Ta <sub>0.6</sub>	10–13.6	0.19	14.1		1.2
CTa	9–11.4	0.22	4.6		1.2
Ca <sub>x</sub> O <sub>3</sub> Sr <sub>1-x</sub> Ti	<0.1–0.55	0.002–0.004			
Cd <sub>0.1</sub> Hg <sub>0.9</sub> (by weight)		0.23	0.34		2.04
Cd <sub>0.05</sub> Hg <sub>0.95</sub>		0.28	0.31		2.16
Cr <sub>0.10</sub> Ti <sub>0.30</sub> V <sub>0.60</sub>	5.6	0.071	84.4		0
GaN	5.85	0.725			4.2
Ga <sub>x</sub> Nb <sub>1-x</sub>			>28		4.2
GaSb (annealed)	4.24		2.64		3.5
GaV <sub>1.95</sub>	5.3		73 <sup>c</sup>		
GaV <sub>2.1-3.5</sub>	6.3–14.45		230–300 <sup>d</sup>		0
GaV <sub>3</sub>		0.4	350 <sup>e</sup>		0
			500 <sup>d</sup>		
GaV <sub>4.5</sub>	9.15		121 <sup>c</sup>		0
Hf <sub>x</sub> Nb <sub>y</sub>			>52–>102		1.2
Hf <sub>x</sub> Ta <sub>y</sub>			>28–>86		1.2
Hg <sub>0.05</sub> Pb <sub>0.95</sub>		0.235	2.3		
Hg <sub>0.101</sub> Pb <sub>0.899</sub>		0.23	4.3		4.2
Hg <sub>0.15</sub> Pb <sub>0.85</sub>	6.75		>13		2.93
In <sub>0.98</sub> Pb <sub>0.02</sub>	3.45	0.1		0.12	2.76
In <sub>0.96</sub> Pb <sub>0.04</sub>	3.68	0.1	0.12	0.25	2.94
In <sub>0.94</sub> Pb <sub>0.06</sub>	3.90	0.095	0.18	0.35	3.12
In <sub>0.913</sub> Pb <sub>0.087</sub>	4.2	~10.17	0.55	2.65	
In <sub>0.316</sub> Pb <sub>0.684</sub>		0.155	3.7		4.2
In <sub>0.17</sub> Pb <sub>0.83</sub>			2.8	5.5	4.2
In <sub>1.000</sub> Te <sub>1.002</sub>	3.5–3.7		1.2 <sup>c</sup>		0
In <sub>0.95</sub> Tl <sub>0.05</sub>		0.263	0.263		3.3
In <sub>0.90</sub> Tl <sub>0.10</sub>		0.257	0.257		3.25
In <sub>0.83</sub> Tl <sub>0.17</sub>		0.242	0.39		3.21
In <sub>0.75</sub> Tl <sub>0.25</sub>		0.216	0.50		3.16
LaN	1.35	0.45			0.76
La <sub>3</sub> S <sub>4</sub>	6.5	≈0.15	>25		1.3
La <sub>3</sub> Se <sub>4</sub>	8.6	≈0.2	>25		1.25
Mo <sub>0.52</sub> Re <sub>0.48</sub>	11.1		14–21	22–33	4.2
			18–28	37–43	1.3
Mo <sub>0.6</sub> Re <sub>0.395</sub>	10.6		14–20	20–37	4.2
			19–26	26–37	1.3
Mo <sub>0.5</sub> Ti <sub>0.5</sub>			75 <sup>c</sup>		0
Mo <sub>0.16</sub> Ti <sub>0.84</sub>	4.18	0.028	98.7 <sup>c</sup>		0
			36–38		3.0
Mo <sub>0.913</sub> Ti <sub>0.087</sub>	2.95	0.060	15		4.2
Mo <sub>0.1-0.3</sub> U <sub>0.9-0.7</sub>	1.85–2.06		>25		
Mo <sub>0.17</sub> Zr <sub>0.83</sub>			30		

Substance	$T_c$ , K	$H_{c1}$ , kOe	$H_{c2}$ , kOe	$H_{c3}$ , kOe	$T_{obs}$ , K <sup>a</sup>
N <sub>(12.8 w/o)</sub> Nb	15.2		>9.5		13.2
NNb (wires)	16.1		153 <sup>c</sup>		0
			132		4.2
			95		8
			53		12
NNb <sub>x</sub> O <sub>1-x</sub>	13.5–17.0		38		
NNb <sub>x</sub> Zr <sub>1-x</sub>	9.8–13.8		4– >130		4.2
N <sub>0.93</sub> Nb <sub>0.85</sub> Zr <sub>0.15</sub>	13.8		>130		4.2
Na <sub>0.086</sub> Pb <sub>0.914</sub>		0.19	6.0		
Na <sub>0.016</sub> Pb <sub>0.984</sub>		0.28	2.05		
Nb	9.15		2.020		1.4
			1.710		4.2
Nb		0.4–1.1	3–5.5		4.2
Nb (unstrained)		1.1–1.8	3.40	6–9.1	4.2
Nb (strained)		1.25–1.92	3.44	6.0–8.7	4.2
Nb (cold-drawn wire)		2.48	4.10	≈10	4.2
Nb (film)			>25		4.2
NbSc			>30		
Nb <sub>3</sub> Sn		0.170	221		4.2
			70		14.15
			54		15
			34		16
			17		17
Nb <sub>0.1</sub> Ta <sub>0.9</sub>		0.084	0.154		4.195
Nb <sub>0.2</sub> Ta <sub>0.8</sub>			10		4.2
Nb <sub>0.65-0.73</sub> Ta <sub>0.02-0.10</sub> Zr <sub>0.25</sub>			>70–>90		4.2
Nb <sub>x</sub> Ti <sub>1-x</sub>			148 max.		1.2
			120 max.		4.2
Nb <sub>0.222</sub> U <sub>0.778</sub>		1.98	23		1.2
Nb <sub>x</sub> Zr <sub>1-x</sub>			127 max.		1.2
			94 max.		4.2
O <sub>3</sub> SrTi	0.43	0.0049 <sup>c</sup>	0.504 <sup>c</sup>		0
O <sub>3</sub> SrTi	0.33	0.00195 <sup>c</sup>	0.420 <sup>c</sup>		0
PbSb <sub>1 w/o</sub> (quenched)			>1.5		4.2
PbSb <sub>1 w/o</sub> (annealed)			>0.7		4.2
PbSb <sub>2.8 w/o</sub> (quenched)			>2.3		4.2
PbSb <sub>2.8 w/o</sub> (annealed)			>0.7		4.2
Pb <sub>0.871</sub> Sn <sub>0.129</sub>		0.45	1.1		
Pb <sub>0.965</sub> Sn <sub>0.035</sub>		0.53	0.56		
Pb <sub>1-0.26</sub> Tl <sub>0-0.74</sub>	7.20–3.68		2–6.9 <sup>c</sup>		0
PbTl <sub>0.17</sub>	6.73		4.5 <sup>c</sup>		0
Re <sub>0.26</sub> W <sub>0.74</sub>			>30		
Sb <sub>0.93</sub> Sn <sub>0.07</sub>			0.12		3.7
SiV <sub>3</sub>	17.0	0.55	156 <sup>c</sup>		
Sn <sub>x</sub> Te <sub>1-x</sub>		0.00043–0.00236	0.005–0.0775		0.012–0.079
Ta (99.95%)		0.425	1.850		1.3
		0.325	1.425		2.27
		0.275	1.175		2.66
		0.090	0.375		3.72
Ta <sub>0.5</sub> Nb <sub>0.5</sub>			3.55		4.2
Ta <sub>0.65-0</sub> Ti <sub>0.35-1</sub>	4.4–7.8		>14–138		1.2
Ta <sub>0.5</sub> Ti <sub>0.5</sub>			138		1.2
Te	3.3	0.25 <sup>c</sup>			0
Tc <sub>x</sub> W <sub>1-x</sub>	5.75–7.88		8–44		4.2
Ti				2.7	4.2
Ti <sub>0.75</sub> V <sub>0.25</sub>	5.3	0.029 <sup>c</sup>	199 <sup>c</sup>		0
Ti <sub>0.775</sub> V <sub>0.225</sub>	4.7	0.024 <sup>c</sup>	172 <sup>c</sup>		0
Ti <sub>0.615</sub> V <sub>0.385</sub>	7.07	0.050	34		4.2
Ti <sub>0.516</sub> V <sub>0.484</sub>	7.20	0.062	28		4.2
Ti <sub>0.415</sub> V <sub>0.585</sub>	7.49	0.078	25		4.2
Ti <sub>0.12</sub> V <sub>0.88</sub>			17.3	28.1	4.2
Ti <sub>0.09</sub> V <sub>0.91</sub>			14.3	16.4	4.2
Ti <sub>0.06</sub> V <sub>0.94</sub>			8.2	12.7	4.2

Substance	$T_c$ , K	$H_{c1}$ , kOe	$H_{c2}$ , kOe	$H_{c3}$ , kOe	$T_{obs}$ , K <sup>a</sup>
Ti <sub>0.03</sub> V <sub>0.97</sub>			3.8	6.8	4.2
Ti <sub>x</sub> V <sub>1-x</sub>			108 max.		1.2
V	5.31	0.8	3.4		1.79
		0.75	3.15		2
		0.45	2.2		3
		0.30	1.2		4
V <sub>0.26</sub> Zr <sub>0.74</sub>	≈5.9	0.238			1.05
		0.227			1.78
		0.185			3.04
		0.165			3.5
W (film)	1.7–4.1		>34		1

<sup>a</sup> Temperature of critical field measurement.

<sup>b</sup> w/o denotes weight percent.

<sup>c</sup> Extrapolated.

<sup>d</sup> Linear extrapolation.

<sup>e</sup> Parabolic extrapolation

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# HIGH TEMPERATURE SUPERCONDUCTORS

C. N. R. Rao and A. K. Raychaudhuri

The following tables give properties of a number of high temperature superconductors. Table 1 lists the crystal structure (space group and lattice constants) and the critical transition temperature  $T_c$  for the more important high temperature superconductors so far studied. Table 2 gives energy gap, critical current density, and penetration depth in the superconducting state. Table 3 gives electrical and thermal properties of some of these materials in the normal state. The tables were prepared in November 1992 and updated in November 1994.

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TABLE 1. Structural Parameters and Approximate  $T_c$  Values of High-Temperature Superconductors

Material	Structure	$T_c$ /K (maximum value)
$\text{La}_2\text{CuO}_{4,\delta}$	Bmab; $a = 5.355$ , $b = 5.401$ , $c = 13.15$ Å	39
$\text{La}_{2-x}\text{Sr}_x(\text{Ba}_y)\text{CuO}_4$	I4/mmm; $a = 3.779$ , $c = 13.23$ Å	35
$\text{La}_2\text{Ca}_{1-x}\text{Sr}_x\text{Cu}_2\text{O}_6$	I4/mmm; $a = 3.825$ , $c = 19.42$ Å	60
$\text{YBa}_2\text{Cu}_3\text{O}_7$	Pmmm; $a = 3.821$ , $b = 3.885$ , $c = 11.676$ Å	93
$\text{YBa}_2\text{Cu}_4\text{O}_8$	Ammm; $a = 3.84$ , $b = 3.87$ , $c = 27.24$ Å	80
$\text{Y}_2\text{Ba}_4\text{Cu}_7\text{O}_{15}$	Ammm; $a = 3.851$ , $b = 3.869$ , $c = 50.29$ Å	93
$\text{Bi}_2\text{Sr}_2\text{CuO}_6$	Amaa; $a = 5.362$ , $b = 5.374$ , $c = 24.622$ Å	10
$\text{Bi}_2\text{CaSr}_2\text{Cu}_2\text{O}_8$	$A_2aa$ ; $a = 5.409$ , $b = 5.420$ , $c = 30.93$ Å	92
$\text{Bi}_2\text{Ca}_2\text{Sr}_2\text{Cu}_3\text{O}_{10}$	$A_2aa$ ; $a = 5.39$ , $b = 5.40$ , $c = 37$ Å	110
$\text{Bi}_2\text{Sr}_2(\text{Ln}_{1-x}\text{Ce}_x)_2\text{Cu}_2\text{O}_{10}$	P4/mmm; $a = 3.888$ , $c = 17.28$ Å	25
$\text{Tl}_2\text{Ba}_2\text{CuO}_6$	$A_2aa$ ; $a = 5.468$ , $b = 5.472$ , $c = 23.238$ Å; I4/mmm; $a = 3.866$ , $c = 23.239$ Å	92
$\text{Tl}_2\text{CaBa}_2\text{Cu}_2\text{O}_8$	I4/mmm; $a = 3.855$ , $c = 29.318$ Å	119
$\text{Tl}_2\text{Ca}_2\text{Ba}_2\text{Cu}_3\text{O}_{10}$	I4/mmm; $a = 3.85$ , $c = 35.9$ Å	128
$\text{Tl}(\text{BaLa})\text{CuO}_5$	P4/mmm; $a = 3.83$ , $c = 9.55$ Å	40
$\text{Tl}(\text{SrLa})\text{CuO}_5$	P4/mmm; $a = 3.7$ , $c = 9$ Å	40
$(\text{Tl}_{0.5}\text{Pb}_{0.5})\text{Sr}_2\text{CuO}_5$	P4/mmm; $a = 3.738$ , $c = 9.01$ Å	40
$\text{TlCaBa}_2\text{Cu}_2\text{O}_7$	P4/mmm; $a = 3.856$ , $c = 12.754$ Å	103
$(\text{Tl}_{0.5}\text{Pb}_{0.5})\text{CaSr}_2\text{Cu}_2\text{O}_7$	P4/mmm; $a = 3.80$ , $c = 12.05$ Å	90
$\text{TlSr}_2\text{Y}_{0.5}\text{Ca}_{0.5}\text{Cu}_2\text{O}_7$	P4/mmm; $a = 3.80$ , $c = 12.10$ Å	90
$\text{TlCa}_2\text{Ba}_2\text{Cu}_3\text{O}_8$	P4/mmm; $a = 3.853$ , $c = 15.913$ Å	110
$(\text{Tl}_{0.5}\text{Pb}_{0.5})\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_9$	P4/mmm; $a = 3.81$ , $c = 15.23$ Å	120
$\text{TlBa}_2(\text{La}_{1-x}\text{Ce}_x)_2\text{Cu}_2\text{O}_9$	I4/mmm; $a = 3.8$ , $c = 29.5$ Å	40
$\text{Pb}_2\text{Sr}_2\text{La}_{0.5}\text{Ca}_{0.5}\text{Cu}_3\text{O}_8$	Cmmm; $a = 5.435$ , $b = 5.463$ , $c = 15.817$ Å	70
$\text{Pb}_2(\text{SrLa})_2\text{Cu}_2\text{O}_6$	P22 <sub>2</sub> ; $a = 5.333$ , $b = 5.421$ , $c = 12.609$ Å	32
$(\text{Pb,Cu})\text{Sr}_2(\text{La,Ca})\text{Cu}_2\text{O}_7$	P4/mmm; $a = 3.820$ , $c = 11.826$ Å	50
$(\text{Pb,Cu})(\text{Sr,Eu})(\text{Eu,Ce})\text{Cu}_2\text{O}_x$	I4/mmm; $a = 3.837$ , $c = 29.01$ Å	25
$\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_4$	I4/mmm; $a = 3.95$ , $c = 12.07$ Å	30
$\text{Ca}_{1-x}\text{Sr}_x\text{CuO}_2$	P4/mmm; $a = 3.902$ , $c = 3.35$ Å	110
$\text{Sr}_{1-x}\text{Nd}_x\text{CuO}_2$	P4/mmm; $a = 3.942$ , $c = 3.393$ Å	40
$\text{Ba}_{0.6}\text{K}_{0.4}\text{BiO}_3$	Pm3m; $a = 4.287$ Å	31
$\text{Rb}_2\text{CsC}_{60}$	$a = 14.493$ Å	31
$\text{NdBa}_2\text{Cu}_3\text{O}_7$	Pmmm; $a = 3.878$ , $b = 3.913$ , $c = 11.753$	58
$\text{SmBaSrCu}_3\text{O}_7$	I4/mmm; $a = 3.854$ , $c = 11.62$	84
$\text{EuBaSrCu}_3\text{O}_7$	I4/mmm; $a = 3.845$ , $c = 11.59$	88
$\text{GdBaSrCu}_3\text{O}_7$	I4/mmm; $a = 3.849$ , $c = 11.53$	86
$\text{DyBaSrCu}_3\text{O}_7$	Pmmm; $a = 3.802$ , $b = 3.850$ , $c = 11.56$	90
$\text{HoBaSrCu}_3\text{O}_7$	Pmmm; $a = 3.794$ , $b = 3.849$ , $c = 11.55$	87
$\text{ErBaSrCu}_3\text{O}_7$ (multiphase)	Pmmm; $a = 3.787$ , $b = 3.846$ , $c = 11.54$	82
$\text{TmBaSrCu}_3\text{O}_7$ (multiphase)	Pmmm; $a = 3.784$ , $b = 3.849$ , $c = 11.55$	88
$\text{YBaSrCu}_3\text{O}_7$	Pmmm; $a = 3.803$ , $b = 3.842$ , $c = 11.54$	84
$\text{HgBa}_2\text{CuO}_4$	I4/mmm; $a = 3.878$ , $c = 9.507$	94
$\text{HgBa}_2\text{CaCu}_2\text{O}_6$ (annealed in $\text{O}_2$ )	I4/mmm; $a = 3.862$ , $c = 12.705$	127
$\text{HgBa}_2\text{Ca}_2\text{Cu}_3\text{O}_8$	Pmmm; $a = 3.85$ , $c = 15.85$	133
$\text{HgBa}_2\text{Ca}_3\text{Cu}_4\text{O}_{10}$	Pmmm; $a = 3.854$ , $c = 19.008$	126

**TABLE 2. Superconducting Properties**

$J_c(0)$ : Critical current density extrapolated to 0 K

$\lambda_{ab}$ : Penetration depth in  $a$ - $b$  plane

$k_B$ : Boltzmann constant

Material	Form	Energy gap ( $\Delta$ )		$10^{-6} \times J_c(0)/A\text{ cm}^{-2}$	$\lambda_{ab}/\text{\AA}$
		$2\Delta_{pp}/k_B T_c^*$	$2\Delta_{fit}/k_B T_c^\dagger$		
YBa <sub>2</sub> Cu <sub>3</sub> O <sub>7</sub>	Single Crystal	5-6	4-5	30 (film)	1400
Bi <sub>2</sub> Sr <sub>2</sub> CaCu <sub>2</sub> O <sub>8</sub>	Single Crystal	8-9	5.5-6.5	2	2700
Tl <sub>2</sub> Ba <sub>3</sub> CaCu <sub>2</sub> O <sub>8</sub>	Ceramic	6-7	4-6	10 (film, 80 K)	2000
La <sub>2-x</sub> Sr <sub>x</sub> CuO <sub>4</sub> , $x = 0.15$	Ceramic	7-9	4-6		
Nd <sub>2-x</sub> Ce <sub>x</sub> CuO <sub>4</sub>	Ceramic	8	4-5	0.2 (film)	

\* Obtained from peak to peak value.

† Obtained from fit to BCS-type relation.

**TABLE 3. Normal State Properties**

$\rho_{ab}$ : Resistivity in the  $a$ - $b$  plane

$\rho_c$ : Resistivity along the  $c$  axis

+ve:  $\rho_c$  has positive temperature coefficient of resistivity

-ve:  $\rho_c$  has negative temperature coefficient of resistivity

$n_H$ : Hall density

$k$ : Thermal conductivity

in plane: Along  $a$ - $b$  plane

out of plane: Perpendicular to  $a$ - $b$  plane

Material	Form	$\rho_{ab}/\mu\Omega\text{ cm}$		$\rho_c/\text{m}\Omega\text{ cm}$	$d\rho_c/dT$	$10^{-21} \times n_H/\text{cm}^{-3}$		$k/(\text{mW}/\text{cm K})$ at 300 K	
		300 K	100 K	300 K		300 K	100 K	in plane	out of plane
YBa <sub>2</sub> Cu <sub>3</sub> O <sub>7</sub>	Single crystal	110	35	5	+ve	11-16	4-6	120	3
	Film	200-300	60-100			5-9	2-3		
YBa <sub>2</sub> Cu <sub>4</sub> O <sub>8</sub>	Single crystal	75	20	10	-ve	14			
	Film	100-200	20-50			22	17		
Bi <sub>2</sub> Sr <sub>2</sub> CuO <sub>6</sub>	Single crystal	300	150	5000	-ve	6	5		
Bi <sub>2</sub> Sr <sub>2</sub> CaCu <sub>2</sub> O <sub>8</sub>	Single crystal	150	50	>1000	-ve	4	3	60	8
Tl <sub>2</sub> Ba <sub>2</sub> CuO <sub>6</sub>	Single crystal	300-400	50-75	200-300	+ve	3.1	2.5		
Tl <sub>2</sub> Ba <sub>2</sub> Ca <sub>2</sub> Cu <sub>3</sub> O <sub>10</sub>	Ceramic	***	**				$\approx 2^*$		
La <sub>2-x</sub> Sr <sub>x</sub> CuO <sub>4</sub> , $x = 0.12$	Single crystal	900	350	200	+ve for $T > 225\text{ K}$	2.5			
La <sub>2-x</sub> Sr <sub>x</sub> CuO <sub>4</sub> , $x = 0.20$	Single crystal	400	200	80	+ve for $T > 150\text{ K}$	10		50 (for $x = 0.04$ )	20
	Film	400	160			8.4	6.3		
Nd <sub>2-x</sub> Ce <sub>x</sub> CuO <sub>4</sub> , $x = 0.17$	Single crystal	500	275			53	17		
	Film	140-180	35			32	11	250 (for $x = 0.15$ )	

\* At 200 K

\*\*  $\rho \sim 0.4\text{ m}\Omega\text{ cm}$  at 120 K

\*\*\*  $\rho \sim 1.5\text{ m}\Omega\text{ cm}$  at 300 K

# ORGANIC SUPERCONDUCTORS

H.P.R. Frederikse

Although the vast majority of organic compounds are insulators, a small number of organic solids show considerable electrical conductivity. Some of these materials appear to be superconductors. The superconducting organics fall primarily into two groups: those containing fulvalenes (pentagonal rings containing sulfur or selenium) and those based on fullerenes, involving the nearly spherical cluster  $C_{60}$ .

The transition temperatures  $T_c$  of the fulvalene derivatives are shown in Table 1. The abbreviations of the various molecular groups are listed in Table 2 and their chemical structures are depicted in Figure 1. Most of the  $T_c$ 's are between 1 and 12 K. Several of the compounds only show superconductivity under pressure.

The fullerenes are  $A_3C_{60}$  compounds, where A represents a single or a combination of alkali atoms. The  $C_{60}$  cluster is shown in

Figure 2a, while Figure 2b illustrates how the alkali atoms fit into the  $A_3C_{60}$  molecule to form the A15 crystallographic structure. Their superconducting transition temperatures range from 8 to 31.3 K (see Table 3).

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TABLE 1. Critical Pressure and Maximum Critical Temperature of Organic Superconductors

Material	$P_c$ /kbar	$T_c$ /K	Material	$P_c$ /kbar	$T_c$ /K
(TMTSF) <sub>2</sub> PF <sub>6</sub>	6.5	1.2	$\beta$ -(ET) <sub>2</sub> IBr <sub>2</sub>	0	2.8
(TMTSF) <sub>2</sub> AsF <sub>6</sub>	9	1.3	$\beta$ -(ET) <sub>2</sub> AuI <sub>2</sub>	0	4.8
(TMTSF) <sub>2</sub> SbF <sub>6</sub>	11	0.4	(ET) <sub>4</sub> Hg <sub>2.89</sub> Cl <sub>8</sub>	0	4.2
(TMTSF) <sub>2</sub> TaF <sub>6</sub>	12	1.4	(ET) <sub>4</sub> Hg <sub>2.89</sub> Br <sub>8</sub>	12	1.8
(TMTSF) <sub>2</sub> ClO <sub>4</sub>	0	1.4	(ET) <sub>3</sub> Cl <sub>2</sub> (H <sub>2</sub> O) <sub>2</sub>	16	2
(TMTSF) <sub>2</sub> ReO <sub>4</sub>	9.5	1.3	$\kappa$ -(ET) <sub>2</sub> Cu(NCS) <sub>2</sub>	0	10.4
(TMTSF) <sub>2</sub> FSO <sub>3</sub>	5	3	$\kappa$ -(d-ET) <sub>2</sub> Cu(NCS) <sub>2</sub>	0	11.4
(ET) <sub>4</sub> (ReO <sub>4</sub> ) <sub>2</sub>	4.5	2	(DMET) <sub>2</sub> Au(CN) <sub>2</sub>	1.5	0.9
$\beta_L$ -(ET) <sub>2</sub> I <sub>3</sub>	0	1.4	(DMET) <sub>2</sub> AuI <sub>2</sub>	5	0.6
$\beta_H$ -(ET) <sub>2</sub> I <sub>3</sub>	0	8.1	(DMET) <sub>2</sub> AuBr <sub>2</sub>	0	1.9
$\gamma$ -(ET) <sub>3</sub> I <sub>2.5</sub>	0	2.5	(DMET) <sub>2</sub> AuCl <sub>2</sub>	0	0.9
$\epsilon$ -(ET) <sub>2</sub> I <sub>3</sub> (I <sub>8</sub> ) <sub>0.5</sub>	0	2.5	(DMET) <sub>2</sub> I <sub>3</sub>	0	0.6
$\alpha$ -(ET) <sub>2</sub> I <sub>3</sub> I <sub>2</sub> -doped	0	3.3	(DMET) <sub>2</sub> I <sub>2</sub> Br <sub>2</sub>	0	0.7
$\alpha_t$ -(ET) <sub>2</sub> I <sub>3</sub>	0	8	(MDT-TTF) <sub>2</sub> AuI <sub>2</sub>	0	3.5
$\epsilon \rightarrow \beta$ -(ET) <sub>2</sub> I <sub>3</sub> <sup>a</sup>	0	6	TTF[Ni(dmit) <sub>2</sub> ] <sub>2</sub>	2	1.6 <sup>b</sup>
$\theta$ -(ET) <sub>2</sub> I <sub>3</sub>	0	3.6	TTF[Pd(dmit) <sub>2</sub> ] <sub>2</sub>	20	6.5
$\kappa$ -(ET) <sub>2</sub> I <sub>3</sub>	0	3.6	(CH <sub>3</sub> ) <sub>4</sub> N[Ni(dmit) <sub>2</sub> ] <sub>2</sub>	7	5

<sup>a</sup> Converted from  $\epsilon$ -type to  $\beta$ -type by thermal treatment.

<sup>b</sup> For 7 kbar.

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TABLE 2. List of Symbols and Abbreviations

TTF	tetrathiafulvalene
TMTSF	tetramethyltetraselenafulvalene
BEDT-TTF or "ET"	bis(ethylenedithio)tetrathiafulvalene
MDT-TTF	methylenedithiotetrathiafulvalene
DMET	[dimethyl(ethylenedithio)diselenadithiafulvalene]
dmit	4,5-dimercapto-1,3-dithiole-2-thione
$T_c$	transition temperature to superconducting state
$P_c$	minimum pressure required for superconducting transition



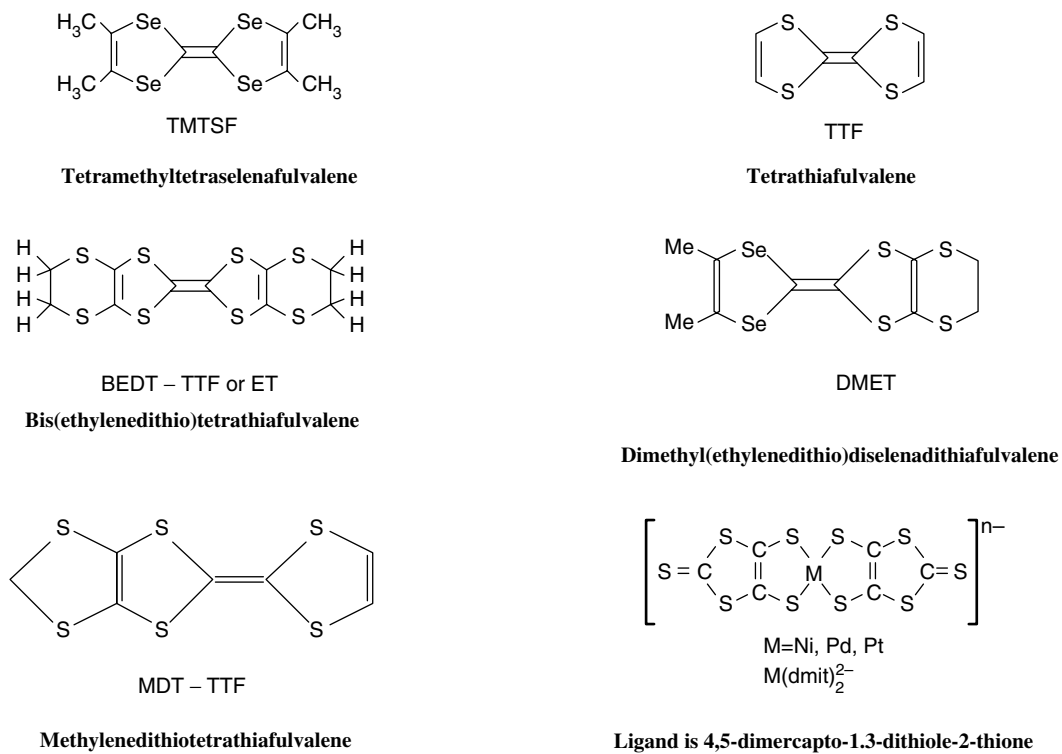
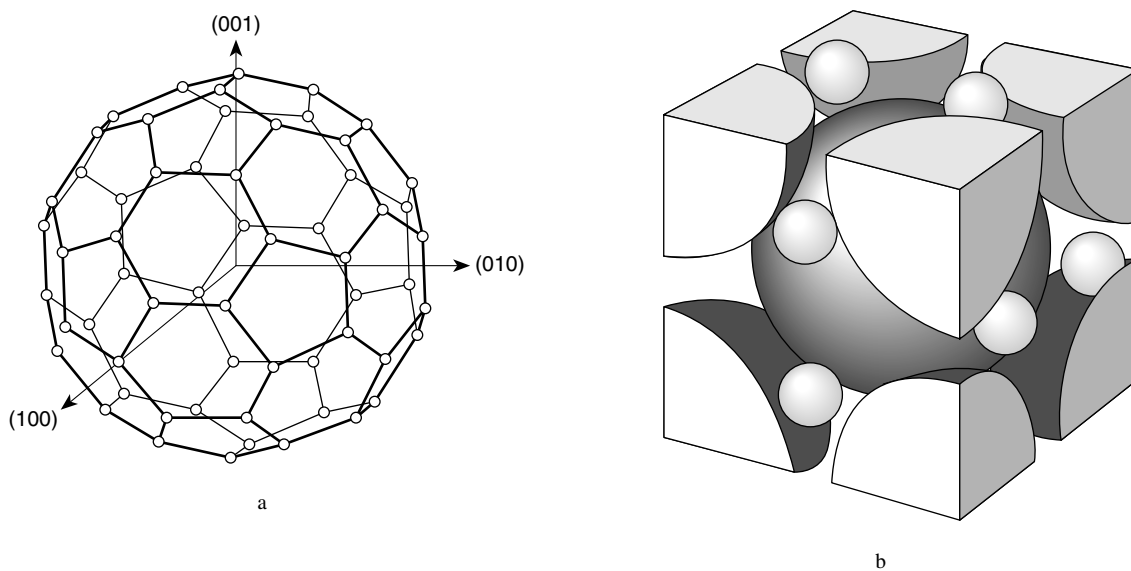


FIGURE 1. Structures of various donor molecules and acceptor species.

FIGURE 2. (a)  $C_{60}$  cluster placed in a fcc lattice. Each crystal axis crosses a double bond shared by two hexagons. (b) A hypothetical  $A_3C_{60}$  with the A15 structure. The structure can be seen to be an ordered defect structure of  $A_6C_{60}$ .

**TABLE 3. Unit Cell and  $T_c$  for FCC- $A_3C_{60}$** 

	Lattice parameter(s) (Å)	$T_c$ /K
$Na_2Rb_{0.5}Cs_{0.5}C_{60}$	14.148(3)	8.0
$Na_2CsC_{60}$ No. 1 <sup>a</sup>	14.132(2)	10.5
$Na_2CsC_{60}$ No. 2 <sup>a</sup>	14.176(9)	14.0
$K_3C_{60}$	14.253(3)	19.3
$K_2RbC_{60}$	14.299(2)	21.8
$Rb_2KC_{60}$ No. 1 <sup>a</sup>	14.336(1)	24.4
$Rb_2KC_{60}$ No. 2 <sup>a</sup>	14.364(5)	26.4
$Rb_3C_{60}$	14.436(2)	29.4
$Rb_2CsC_{60}$	14.493(2)	31.3

<sup>a</sup> Samples labeled No. 1 and No. 2 have the same nominal composition.

From Schluter, M et. al., *The Fullerenes*, Ed.: Krato, H.W., Fisher, J.E., and Cox, D.E., Pergamon Press, Oxford, 1993. With permission.

# PROPERTIES OF SEMICONDUCTORS

L. I. Berger

The term *semiconductor* is applied to a material in which electric current is carried by electrons or holes and whose electrical conductivity, when extremely pure, rises exponentially with temperature and may be increased from its low "intrinsic" value by many orders of magnitude by "doping" with electrically active impurities.

Semiconductors are characterized by an energy gap in the allowed energies of electrons in the material that separates the normally filled energy levels of the *valence band* (where "missing" electrons behave like positively charged current carriers "holes") and the *conduction band* (where electrons behave rather like a gas of free negatively charged carriers with an effective mass dependent on the material and the direction of the electrons' motion). This energy gap depends on the nature of the material and varies with direction in anisotropic crystals. It is slightly dependent on

temperature and pressure, and this dependence is usually almost linear at normal temperatures and pressures.

Data are presented in five tables. Table 1 lists the main crystallographic and semiconducting properties of a large number of semiconducting materials in three main categories: "Tetrahedral Semiconductors" in which every atom is tetrahedrally coordinated to four nearest neighbor atoms (or atomic sites) as for example in the diamond structure; "Octahedral Semiconductors" in which every atom is octahedrally coordinated to six nearest neighbor atoms—as for example the halite structure; and "Other Semiconductors."

Table 2 gives electrical, magnetic, and optical properties, while Tables 3 and 4 give more details on the semiconducting properties and band structures of the most common semiconductors. Table 5 lists semiconducting minerals with typical resistivity ranges.

TABLE 1. Physico-Chemical Properties of Semiconductors (Listed by Crystal Structure)

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)	Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg-K (300 K)	Debye temp. (K)	Coefficient of thermal linear expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm-K (300K)]
<b>I.1. Tetrahedral (Adamantine) Semiconductors</b>										
<i>1.1.1. Diamond Structure Elements (Strukturbericht symbol A4, Space Group Fd3m-O<sub>h</sub><sup>7</sup>)</i>										
C (Diamond)	12.01	3.56683	3.513	≈4713 (12.4 GPa) Transition to graphite > 980	10 (M)	471.5	2340	1.18	9900(I) 23200(IIA) 13600(IIIB)	
Si	28.09	5.43072	2.329	1687	11270	702	645	2.6	1240	
Ge	72.64	5.65754	5.323	1211.35	7644	321.9	374	5.8	640	
α-Sn	118.71	6.4912	5.769	505.1 (Tr. 286.4)		213	230	5.4 (220 K)		
<i>1.1.2. Sphalerite (Zinc Blende) Structure Compounds (Strukturbericht symbol B3 Space Group F<math>\bar{4}</math> 3m-T<sub>d</sub><sup>2</sup>)</i>										
<b>I-VII Compounds</b>										
CuF	82.54	41.27	4.255	1181						
CuCl	98.99	49.49	5.4057	3.53	695	2.3 (M)	490	240	12.1	8.4
CuBr	143.45	71.73	5.6905	4.98	770	2.5 (M)	381	207	15.4	12.5
CuI	190.45	95.23	6.60427	5.63	878	192	276	181	19.2	16.8
AgBr	187.77	93.89		6.473	>1570 (Tr. 410)	2.5 (M)	270			
AgI	234.77	117.39	6.502	5.67	831	2.5 (M)	232	134	-2.5	4.2
<b>II-VI Compounds</b>										
BeS	41.08	20.54	4.865	2.36	dec.					
BeSe	87.97	43.99	5.139	4.315						
BeTe	136.61	68.31	5.626	5.090						
BePo	(2318)	(109)	5.838	7.3						
ZnO	81.39	40.69	4.63	5.675	2248	5.0 (M)	494	416	2.9	234
ZnS	97.46	48.72	5.4093	4.079	2100 (Tr. 1295)	1780	472	530	6.36	251

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)	Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg·K (300 K)	Debye temp. (K)	Coefficient of thermal linear expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm·K (300K)]
ZnSe	144.34	72.17	5.6676	5.42	1790	1350	339	400	7.2	140
ZnTe	192.99	96.5	6.101	6.34	1568	900	264	223	8.19	108
ZnPo	(274)	(137)	6.309							
CdS	144.48	72.24	5.832	4.826	1750	1250	330	219	4.7	200
CdSe	191.37	95.68	6.05	5.674	1512	1300	255	181	3.8	90
CdTe	240.01	120.00	6.477	5.86	1365	600	205	200	4.9	58.5
CdPo	(321)	(161)	6.665							
HgS	232.66	116.33	5.8517	7.73	1820	3 (M)	210			
HgSe	279.55	139.78	6.084	8.25	1070	2.5 (M)	178	151	5.46	10
HgTe	328.19	164.10	6.4623	8.17	943	300	164	242	4.6	20

**III-V Compounds**

BN	24.82	12.41	3.615	3.49	3239	10 (M)	793	≈1900		200
BP(L.T.)	41.78	20.87	4.538	2.9	1398 (dec)	37000		≈980		
BAs	85.73	42.87	4.777		≈2300	19000		≈625		
AlP	57.95	28.98	5.451	2.42	≈2100	5.5 (M)		588		920
AlAs	101.90	50.95	5.6622	3.81	2013	5000		417	3.5	840
AlSb	148.74	74.37	6.1355	4.218	1330	4000		292	4.2	600
GaP	100.70	50.35	5.4905	4.13	1750	9450		446	5.3	752
GaAs	144.64	72.32	5.65315	5.316	1510	7500		344	5.4	560
GaSb	191.48	95.74	6.0954	5.619	980	4480	320	265	6.1	270
InP	145.79	72.90	5.86875	4.787	1330	4100		321	4.6	800
InAs	189.74	94.87	6.05838	5.66	1215	3300	268	249	4.7	290
InSb	236.58	118.29	6.47877	5.775	798	2200	144	202	4.7	160

**Other sphalerite structure compounds**

MnS	87.00	43.5	5.011							
MnSe	133.90	66.95	5.82							
β-SiC (3-C SiC)	40.10	20.1	4.348	3.21	3070				2.9	4.9
Ga <sub>2</sub> Se <sub>3</sub>	376.32	75.26	5.429	4.92	1020	3160			8.9	50
Ga <sub>2</sub> Te <sub>3</sub>	522.24	104.45	5.899	5.75	1063	2370				47
In <sub>2</sub> Te <sub>3</sub> (H.T.)	608.44	121.7	6.173	5.8	940	1660				69
MgGeP <sub>2</sub>	158.84	39.71	5.652							
ZnSnP <sub>2</sub>	246.00	61.5	5.65		1200					
ZnSnAs <sub>2</sub> (H.T.)	333.90	82.38	5.851	5.53	1050					76
ZnSnSb <sub>2</sub>	427.56	106.89	6.281	5.67	870	2500				76

**1.1.3. Wurtzite (Zincite) Structure Compounds (Strukturbericht symbol B4, Space Group P 6<sub>3</sub>mc-C<sub>6v</sub><sup>4</sup>)**

**I-VII Compounds**

CuCl	99.0	49.5	3.91	6.42	703					
CuBr	143.45	71.73	4.06	6.66	770					
CuI	190.45	95.23	4.31	7.09						
Agl	234.77	117.40	4.580	7.494						

**II-VI Compounds**

BeO	25.01	12.51	2.698	4.380	2800					
MgTe	151.9	76.0	4.54	7.39	3.85	≈2800				
ZnO	81.37	40.69	3.24950	5.2069	5.66	2250				600
ZnS	97.43	48.72	3.8140	6.2576	4.1	2100				460

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)		Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg·K (300 K)	Debye temp. (K)	Coefficient of thermal expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm·K (300K)]
ZnTe	192.99	46.50	4.27	6.99		1568					
CdS	144.48	72.23	4.1348	6.7490	4.82	1748				401	
CdSe	191.37	95.68	4.299	7.010	5.66	1512				316	
CdTe	240.01	120.00	4.57	7.47							
<b>III-V Compounds</b>											
BP(H.T.)	41.79	20.90	3.562	5.900							
AlN	40.99	20.50	3.111	4.978	3.26	≈2500					823
GaN	83.73	41.87	3.190	5.189	6.10	1500					656
InN	128.83	64.42	3.533	5.693	6.88	1200					556
<b>Other wurtzite structure compounds</b>											
MnS	87.00	43.5	3.985	6.45	3.248						
MnSe	133.90	66.95	4.12	6.72							
SiC	40.10	20.1	3.076	5.048							
MnTe	182.54	91.27	4.078	6.701							
Al <sub>2</sub> S <sub>3</sub>	150.14	30.03	3.579	5.829	2.55	1400					
Al <sub>2</sub> Se <sub>3</sub>	290.84	58.17	3.890	6.30	3.91	1250					
<i>1.1.4. Chalcopyrite Structure Compounds (Strukturbericht symbol E1<sub>1</sub>, Space Group I <math>\bar{4} 2d-D_{2d}^{12}</math>)</i>											
<b>I-III-VI<sub>2</sub> Compounds</b>											
CuAlS <sub>2</sub>	154.65	38.66	5.323	10.44	3.47	2500					
CuAlSe <sub>2</sub>	248.45	62.11	5.617	10.92	4.70	2260					
CuAlTe <sub>2</sub>	345.73	86.43	5.976	11.80	5.50	2550					
CuGaS <sub>2</sub>	197.39	49.53	5.360	10.49	4.35	2300					
CuGaSe <sub>2</sub>	291.19	72.80	5.618	11.01	5.56	1970	4200	275	5.4		42
CuGaTe <sub>2</sub>	388.47	97.12	6.013	11.93	5.99	2400	3500		6.9		27
CuInS <sub>2</sub>	242.49	60.62	5.528	11.08	4.75	1400	2550				
CuInSe <sub>2</sub>	336.29	84.07	5.785	11.56	5.77	1600	2050			6.6	37
CuInTe <sub>2</sub>	433.57	108.39	6.179	12.365	6.10	1660	400	195	7.1		49
CuTlS <sub>2</sub>	322.05	83.01	5.580	11.17	6.32						
CuTlSe <sub>2</sub> (L.T.)	425.85	106.46	5.844	11.65	7.11	900					
CuFeS <sub>2</sub>	183.51	45.88	5.29	10.32	4.088	1135					
CuFeSe <sub>2</sub>	277.31	69.33				850					
CuLaS <sub>2</sub>	266.58	66.65	5.65	10.86							
AgAlS <sub>2</sub>	198.97	49.74	5.707	10.28	3.94						
AgAlSe <sub>2</sub>	292.77	73.19	5.968	10.77	5.07	1220					
AgAlTe <sub>2</sub>	390.05	97.51	6.309	11.85	6.18	1000					
AgGaS <sub>2</sub>	241.71	60.43	5.755	10.28	4.72						
AgGaSe <sub>2</sub>	335.51	83.88	5.985	10.90	5.84	1120	4400				
AgGaTe <sub>2</sub>	432.79	108.2	6.301	11.96	6.05	990	1800	212			10
AgInS <sub>2</sub> (L.T.)	286.87	71.70	5.828	11.19	5.00		2250				
AgInSe <sub>2</sub>	380.61	95.15	6.102	11.69	5.81	1053	1850				30
AgInTe <sub>2</sub>	477.89	119.47	6.42	12.59	6.12	965			9.49, 0.69		
AgFeS <sub>2</sub>	227.83	56.96	5.66	10.30	4.53						
<b>II-IV-V<sub>2</sub> Compounds</b>											
ZnSiP <sub>2</sub>	155.40	38.85	5.400	10.441	3.39	1640	1100				
ZnGeP <sub>2</sub>	199.90	49.98	5.465	10.771	4.17	1295	8100				180
ZnSnP <sub>2</sub>	246.00	61.5					6500				
CdSiP <sub>2</sub>	202.43	50.61	5.678	10.431	4.00	≈1470	10500	282			

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)		Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg·K (300 K)	Debye temp. (K)	Coefficient of thermal expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm·K (300K)]
CdGeP <sub>2</sub>	246.94	61.74	5.741	10.775	4.48	1049	5650				110
CdSnP <sub>2</sub>	243.03	73.26	5.900	11.518		840	5000		195		140
ZnSiAs <sub>2</sub>	242.20	60.55	5.61	10.88	4.70	1311	9200				
ZnGeAs <sub>2</sub>	287.80	71.95	5.672	11.153	5.32	1150	6800		263		110
ZnSnAs <sub>2</sub>	333.90	83.48	5.8515	11.704	5.53	1048	4550		271		150
CdSiAs <sub>2</sub>	290.34	72.58	5.884	10.882		>1120	6850				
CdGeAs <sub>2</sub>	334.83	83.71	5.9427	11.217	5.60	938	4700				48
CdSnAs <sub>2</sub>	380.93	95.23	6.0944	11.918	5.72	880	3450				40

1.1.5. Other Ternary Semiconductors with Tetrahedral Coordination

I <sub>2</sub> -IV-VI <sub>3</sub> Compounds											
Cu <sub>2</sub> SiS <sub>3</sub> (H.T.)	251.36	41.89	3.684	6.004	3.81	1200					23
Cu <sub>2</sub> SiS <sub>3</sub> (L.T.)			5.290	10.156	3.63						
Cu <sub>2</sub> SiTe <sub>3</sub>	537.98	89.66	5.93		5.47						
Cu <sub>2</sub> GeS <sub>3</sub> (H.T.)	295.88	49.31	5.317		4.45	1210	4550	510	254	7.2	12
Cu <sub>2</sub> GeS <sub>3</sub> (L.T.)			5.327	5.215	4.46						
Cu <sub>2</sub> GeSe <sub>3</sub>	436.56	72.76	5.589	5.485	5.57	1030	3840	340	168	8.4	24
Cu <sub>2</sub> GeTe <sub>3</sub>	582.51	97.09	5.958	5.935	5.92		2890				130
Cu <sub>2</sub> SnS <sub>3</sub>	341.98	57.00	5.436		5.02	1110	2770	440	214	7.8	28
CuSnSe <sub>3</sub>	482.66	80.44	5.687		5.94	960	2510	310	148	8.9	35
Cu <sub>2</sub> SnTe <sub>3</sub>	628.61	104.77	6.048		6.51	680	1970				144
Ag <sub>2</sub> GeSe <sub>3</sub>	525.21	87.54				810					
Ag <sub>2</sub> SnSe <sub>3</sub>	571.31	95.22									
Ag <sub>2</sub> GeTe <sub>3</sub>	671.13	111.86				600					
Ag <sub>2</sub> SnTe <sub>3</sub>	717.23	119.54									
I <sub>3</sub> -V -VI <sub>4</sub> -Compounds											
Cu <sub>3</sub> PS <sub>4</sub>	349.85	40.73	7.44	6.19							
Cu <sub>3</sub> AsS <sub>4</sub>	393.79	49.22	6.43	6.14	4.37	931				3.2	30.2
Cu <sub>3</sub> AsSe <sub>4</sub>	581.37	72.67	5.570	10.957	5.61	733		169		9.5	19
Cu <sub>3</sub> SbS <sub>4</sub>	440.64	55.08	5.38	16.76	4.90	830					
Cu <sub>3</sub> SbSe <sub>4</sub>	628.22	78.53	5.654	11.256	6.0	700		131		12.4	14.6
I-IV <sub>2</sub> -V <sub>3</sub> Compounds											
CuSi <sub>2</sub> P <sub>3</sub>	212.64	35.44	5.25								
CuGe <sub>2</sub> P <sub>3</sub>	301.65	50.28	5.375		4.318	1113	8500	429	8.21	37.6	
AgGe <sub>2</sub> P <sub>3</sub>	345.97	57.66				1015	6150				

1.1.6. "Defect Chalcopyrite" Structure Compounds (Strukturbericht symbol E3, Space Group I  $\bar{4}$ -S<sub>4</sub><sup>2</sup>)

ZnAl <sub>2</sub> Se <sub>4</sub>	435.18	62.17	5.503	10.90	4.37						
ZnAl <sub>2</sub> Te <sub>4</sub> (?)	629.74	84.96	5.904	12.05	4.95						
ZnGa <sub>2</sub> S <sub>4</sub> (?)	333.06	47.58	5.274	10.44	3.80						
ZnGa <sub>2</sub> Se <sub>4</sub> (?)	520.66	74.38	5.496	10.99	5.21						
ZnGa <sub>2</sub> Te <sub>4</sub> (?)	715.22	102.17	5.937	11.87	5.67						
ZnIn <sub>2</sub> Se <sub>4</sub>	610.86	87.27	5.711	11.42	5.44	1250					
ZnIn <sub>2</sub> Te <sub>4</sub>	805.42	115.06	6.122	12.24	5.83	1075					
CdAl <sub>2</sub> S <sub>4</sub>	294.61	42.09	5.564	10.32	3.06						
CdAl <sub>2</sub> Se <sub>4</sub>	482.21	68.89	5.747	10.68	4.54						
CdAl <sub>2</sub> Te <sub>4</sub> (?)	676.77	97.68	6.011	12.21	5.10						

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)		Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg·K (300 K)	Debye temp. (K)	Coefficient of thermal linear expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm·K (300K)]
CdGa <sub>2</sub> S <sub>4</sub>	380.09	54.30	5.577	10.08	4.03						
CdGa <sub>2</sub> Se <sub>4</sub>	567.69	81.10	5.743	10.73	5.32						
CdGa <sub>2</sub> Te <sub>4</sub>	762.25	108.89	6.093	11.81	5.77						
CdIn <sub>2</sub> Te <sub>4</sub>	852.45	121.78	6.205	12.41	5.9	1060					
HgAl <sub>2</sub> S <sub>4</sub>	382.79	54.68	5.488	10.26	4.11						
HgAl <sub>2</sub> Se <sub>4</sub>	570.39	82.48	5.708	10.74	5.05						
HgAl <sub>2</sub> Te <sub>4</sub> (?)	764.48	109.28	6.004	12.11	5.81						
HgGa <sub>2</sub> S <sub>4</sub>	468.27	66.90	5.507	10.23	5.00						
HgGa <sub>2</sub> Se <sub>4</sub>	655.87	93.70	5.715	10.78	6.18						
HgIn <sub>2</sub> Se <sub>4</sub>	746.07	106.58	5.764	11.80	6.3	1100					
HgIn <sub>2</sub> Te <sub>4</sub> (?)	940.63	134.38	6.186	12.37	6.3	980					

### 1.1.7. Other Adamantine Compounds

α-SiC	40.10	20.10	3.0817	15.12	3.21	3070					
Hg <sub>5</sub> Ga <sub>2</sub> Te <sub>8</sub>	2163.19	144.21	6.235								
Hg <sub>5</sub> In <sub>2</sub> Te <sub>8</sub>	2253.39	150.23	6.328								
CdIn <sub>2</sub> Se <sub>4</sub>	657.89	93.98	a = c = 5.823								

## 1.2. Octahedral Semiconductors

### 1.2.1. Halite Structure Semiconductors (Strukturbericht symbol B1, Space Group Fm3m-O<sub>h</sub><sup>5</sup>)

GeTe	200.21	100.10	5.98		6.14						
SnSe	197.67	98.83	6.020			1133					
SnTe	246.31	123.15	6.313		6.45	1080 (max)					91
PbS	239.3	119.63	5.9362		7.61	1390					23
PbSe	286.2	143.08	6.1243		8.15	1340					17
PbTe	334.8	167.4	6.454		8.16	1180					23

### 1.2.2. Selected Other Binary Halites

BiSe	287.94	143.97	5.99		7.98	880					
BiTe	336.58	168.29	6.47								
EuSe	230.92	115.46	6.191			2300					2.4
GdSe	236.21	118.11	5.771			2400					
NiO	74.69	37.35	4.1684		6.6	2260					
CdO	128.41	64.21	4.6953			1700					7
SrS	119.69	59.84	6.0199		3.643	3000					

## 1.3. Other Semiconductors

### 1.3.1. Antifluorite Structure Compounds (Fm3m-O<sub>h</sub><sup>5</sup>)

Mg <sub>2</sub> Si	76.70	25.57	6.338		1.88	1375			11.5		
Mg <sub>2</sub> Ge	121.22	40.4	6.380		3.08	1388			15.0		
Mg <sub>2</sub> Sn	167.32	55.77	6.765		3.53	1051			9.9		92
Mg <sub>2</sub> Pb	225.81	85.27	6.836		5.1	823			10.0		

### 1.3.2. Tetradymite Structure Compounds ( $\bar{R}3m-D_{3d}^5$ )

Sb <sub>2</sub> Te <sub>3</sub>	626.3	125.26	4.25	30.3	6.44	895					
Bi <sub>2</sub> Se <sub>3</sub>	654.84	130.97	4.14	28.7	7.51	979	167				24
Bi <sub>2</sub> Te <sub>3</sub>	800.76	160.15	4.38	30.45	7.73	858	155	16			30

Substance	Molecular weight	Average atomic weight	Lattice parameters (Å, room temp.)	Density (g/cm <sup>3</sup> )	Melting point (K)	Microhardness, N/mm <sup>2</sup> (M-Mohs Scale)	Specific heat, J/kg·K (300 K)	Debye temp. (K)	Coefficient of thermal linear expansion [10 <sup>-6</sup> K <sup>-1</sup> (300K)]	Thermal conductivity [mW/cm·K (300K)]	
<b>1.3.3. Skutterudite Structure Compounds (<i>Im</i>3-<i>T</i><sub>h</sub><sup>5</sup>)</b>											
CoP <sub>3</sub>	151.85	37.96	7.7073		>1270						
CoAs <sub>3</sub>	286.70	71.65	8.2060	6.73	1230						
CoSb <sub>3</sub>	424.18	106.05	9.0385		1123			307		50	
NiAs <sub>3</sub>	283.45	70.86	8.330	6.43							
RhP <sub>3</sub>	195.83	48.96	7.9951		>1470						
RhAs <sub>3</sub>	327.67	81.92	8.4427		>1270					100	
RhSb <sub>3</sub>	468.16	117.04	9.2322		1170						
IrP <sub>3</sub>	285.14	71.29	8.0151	7.36	>1470						
IrAs <sub>3</sub>	416.98	104.25	8.4673	9.12	>1470					90	
IrSb <sub>3</sub>	557.47	139.37	9.2533	9.35	1170			303			
<b>1.3.4. Selected Multinary Compounds</b>											
AgSbSe <sub>2</sub>	387.54	96.88	5.786	6.60	910					10.5	
AgSbTe <sub>2</sub> (or Ag <sub>19</sub> Sb <sub>29</sub> Te <sub>52</sub> )	484.82	121.2	6.078	7.12	830					86	
AgBiS <sub>2</sub> (H.T.)	380.97	95.24	5.648								
AgBiSe <sub>2</sub> (H.T.)	474.77	118.69	5.82								
AgBiTe <sub>2</sub> (H.T.)	572.05	143.01	6.155								
Cu <sub>2</sub> CdSnS <sub>4</sub>	486.43	60.80	5.586	10.83							
<b>1.3.5. Some Elemental Semiconductors</b>											
B		10.81	4.91	12.6	2.34	2348	9.5 (M)	1277	1370	8.3	600
Se(gray)		78.96	4.36	4.95	4.81	493	350	292.6		(  C) 17.89 (⊥C) 74.09	(  C) 45.2 (⊥C) 13.1
Te		127.60	4.45	5.91	6.23	723		196.5		16.8	(  C) 33.8 (⊥C) 19.7

TABLE 2. Basic Thermodynamic, Electrical, and Magnetic Properties of Semiconductors (Listed by Crystal Structure)

Substance	Heat of formation [kJ/mol (300K)]	Volume compressibility (10 <sup>-10</sup> m <sup>2</sup> /N)	Static dielectric constant	Atomic magnetic susceptibility (10 <sup>-6</sup> cgs)	Index of refraction	Minimum room temperature energy gap (eV)	Mobility (room temp.) (cm <sup>2</sup> /V·s)		Optical transition	Breakdown voltage kV/mm	Remarks
							Electrons	Holes			
<b>2.1. Adamantine Semiconductors</b>											
<b>2.1.1. Diamond Structure Elements (<i>Strukturbericht</i> symbol A4, <i>Space Group</i> <i>Fd</i> 3<i>m</i>-<i>O</i><sub>h</sub><sup>7</sup>)</b>											
C	714.4	18	5.7	-5.88	2.419 (589 nm)	5.4	1800	1400	i*	500	
Si	324	0.306	11.9	-3.9	3.49 (589 nm)	1.12	1900	500	i	30	
Ge	291	0.768	16	-0.12	3.99 (589 nm)	0.67	3800	1820	i		
α-Sn	267.5		24		2.75 (589 nm)	0.0; 0.8	2500	2400			
<b>2.1.2. Sphalerite (Zinc Blende) Structure Compounds (<i>Strukturbericht</i> symbol B3 <i>Space Group</i> <i>F</i> 4̄ 3<i>m</i>-<i>T</i><sub>d</sub><sup>2</sup>)</b>											
<b>I-VII Compounds</b>											
CuF											
CuCl	481	0.26	7.9		1.93	3.17			d		Nantokite





Substance	Heat of formation [kJ/mol (300K)]	Volume compressibility (10 <sup>-10</sup> m <sup>2</sup> /N)	Static dielectric constant	Atomic magnetic susceptibility (10 <sup>-6</sup> cgs)	Index of refraction	Minimum room temperature energy gap (eV)	Mobility (room temp.) (cm <sup>2</sup> /V·s)		Optical transition	Breakdown voltage kV/mm	Remarks
							Electrons	Holes			
CdS				8.45; 9.12	2.32	2.42	350	40	d		Greenockide
CdSe						1.74	900	50	d		Cadmoselite
CdTe						1.50	650				
<b>III-V Compounds</b>											
BP(H.T.)											
AlN						6.02					
GaN						3.34					
InN						2.0					
<b>Other wurtzite structure compounds</b>											
MnS											
MnSe											
SiC					2.654						
MnTe						≈1.0					
Al <sub>2</sub> S <sub>3</sub>	426					4.1					
Al <sub>2</sub> Se <sub>3</sub>	367					3.1					

2.1.4 Chalcopyrite Structure Compounds (Strukturbericht symbol E1<sub>1</sub>, Space Group I $\bar{4}$ 2d-D<sub>2d</sub><sup>12</sup>)

<b>I-III-VI<sub>2</sub> Compounds</b>											
CuAlS <sub>2</sub>		0.106				2.5					
CuAlSe <sub>2</sub>						2.67					
CuAlTe <sub>2</sub>						0.88					
CuCaS <sub>2</sub>		0.106				2.38					
CuGaSe <sub>2</sub>		0.141				0.96, 1.63					
CuGaTe <sub>2</sub>		0.227				0.82, 1.0					
CuInS <sub>2</sub>		0.141				1.2					
CuInSe <sub>2</sub>		0.187				0.86, 0.92					
CuInTe <sub>2</sub>		0.278				0.95					
CuTlS <sub>2</sub>											
CuTlSe <sub>2</sub>						1.07					
(L.T.)											
CuFeS <sub>2</sub>						0.53					Chalcopyrite
CuFeSe <sub>2</sub>						0.16					
CuLaS <sub>2</sub>											
AgAlS <sub>2</sub>											
AgAlSe <sub>2</sub>						0.7					
AgAlTe <sub>2</sub>						0.56					
AgGaS <sub>2</sub>		0.150				1.66					
AgGaSe <sub>2</sub>		0.182				1.1					
AgGaTe <sub>2</sub>		0.280				1.9					
AgInS <sub>2</sub>		0.185				1.18					
(L.T.)											
AgInSe <sub>2</sub>		0.238				0.96, 0.52					
AgInTe <sub>2</sub>		0.338									
AgFeS <sub>2</sub>											
<b>II-IV-V<sub>2</sub> Compounds</b>											
ZnSiP <sub>2</sub>	312					2.3	1000				
ZnGeP <sub>2</sub>	293					2.2					
ZnSnP <sub>2</sub>	275					1.45					
CdSiP <sub>2</sub>		0.103				2.2	1000				
CdGeP <sub>2</sub>	289					1.8					
CdSnP <sub>2</sub>	270					1.5					
ZnSiAs <sub>2</sub>	290					1.7		50			
ZnGeAs <sub>2</sub>	271			-14.4		0.85					
ZnSnAs <sub>2</sub>	252			-18.4		0.65		300			Disorders at 910 K
CdSiAs <sub>2</sub>		0.143				1.6					
CdGeAs <sub>2</sub>	266			-23.4		0.53	70	25			Disorders at 903 K
CdSnAs <sub>2</sub>	247		13.7	-21.5		0.26	22000	250			

Substance	Heat of formation [kJ/mol (300K)]	Volume compressibility ( $10^{-10}\text{m}^2/\text{N}$ )	Static dielectric constant	Atomic magnetic susceptibility ( $10^{-6}$ cgs)	Index of refraction	Minimum room temperature energy gap (eV)	Mobility (room temp.) ( $\text{cm}^2/\text{V}\cdot\text{s}$ )		Optical transition	Breakdown voltage kV/mm	Remarks
							Electrons	Holes			
<b>2.1.5. Other Ternary Semiconductors with Tetrahedral Coordination</b>											
<b>II<sub>2</sub>-IV-VI<sub>3</sub> Compounds</b>											
Cu <sub>2</sub> SiS <sub>3</sub> (H.T.)											Wurtzite
Cu <sub>2</sub> SiS <sub>3</sub> (L.T.)											Tetragonal
Cu <sub>2</sub> SiTe <sub>3</sub>											Cubic
Cu <sub>2</sub> GeS <sub>3</sub> (H.T.)				-18.7							Cubic
Cu <sub>2</sub> GeS <sub>3</sub> (L.T.)								360			Tetragonal
Cu <sub>2</sub> GeSe <sub>3</sub>	211.5			-21.3		0.94		238			Same
Cu <sub>2</sub> GeTe <sub>3</sub>	190.2			-23.4							Same
Cu <sub>2</sub> SnS <sub>3</sub>				-18.2		0.91		405			Cubic
CuSnSe <sub>3</sub>				-21.0		0.66		870			Cubic
Cu <sub>2</sub> SnTe <sub>3</sub>				-28.4							Cubic
Ag <sub>2</sub> GeSe <sub>3</sub>				-29.6		0.91 (77K)					
Ag <sub>2</sub> SnSe <sub>3</sub>				-29.5		0.81					
Ag <sub>2</sub> GeTe <sub>3</sub>				-31.4		0.25					
Ag <sub>2</sub> SnTe <sub>3</sub>				-31.0		0.08					
<b>II<sub>3</sub>-V-VI<sub>4</sub> Compounds</b>											
Cu <sub>3</sub> PS <sub>4</sub>											Enargite
Cu <sub>3</sub> AsS <sub>4</sub>	269.6			-15.8		1.24					
Cu <sub>3</sub> AsSe <sub>4</sub>	161.3			-13.1		0.88					Famatinite
Cu <sub>3</sub> SbS <sub>4</sub>				-8.3		0.74					Famatinite
Cu <sub>3</sub> SbSe <sub>4</sub>	127.1			-20.5		0.31					
<b>II-IV<sub>2</sub>-V<sub>3</sub> Compounds</b>											
CuSi <sub>2</sub> P <sub>3</sub>											El
CuGe <sub>2</sub> P <sub>3</sub>		0.12				0.90					El
AgGe <sub>2</sub> P <sub>3</sub>											
<b>2.1.6. "Defect Chalcopyrite" Structure Compounds (Strukturbericht symbol E3, Space Group <math>I\bar{4}-S_4^2</math>)</b>											
ZnAl <sub>2</sub> Se <sub>4</sub>											
ZnAl <sub>2</sub> Te <sub>4</sub> (?)											
ZnGa <sub>2</sub> S <sub>4</sub> (?)						≈3.4					
ZnGa <sub>2</sub> Se <sub>4</sub> (?)						≈2.2					
ZnGa <sub>2</sub> Te <sub>4</sub> (?)						1.35					
ZnIn <sub>2</sub> Se <sub>4</sub>	206					1.82		35			
ZnIn <sub>2</sub> Te <sub>4</sub>	198					1.2					
CdAl <sub>2</sub> S <sub>4</sub>											
CdAl <sub>2</sub> Se <sub>4</sub>											
CdAl <sub>2</sub> Te <sub>4</sub> (?)											
CdGa <sub>2</sub> S <sub>4</sub>	256					3.44		60			
CdGa <sub>2</sub> Se <sub>4</sub>	216					2.43		33			
CdGa <sub>2</sub> Te <sub>4</sub>											
CdIn <sub>2</sub> Te <sub>4</sub>	195					(1.26 or 0.9)		4000			
HgAl <sub>2</sub> S <sub>4</sub>											
HgAl <sub>2</sub> Se <sub>4</sub>											
HgAl <sub>2</sub> Te <sub>4</sub> (?)											
HgGa <sub>2</sub> S <sub>4</sub>	249					2.84					
HgGa <sub>2</sub> Se <sub>4</sub>	204					1.95		400			
HgIn <sub>2</sub> Se <sub>4</sub>	196					0.6		290			
HgIn <sub>2</sub> Te <sub>4</sub> (?)	188					0.86		200			
<b>2.1.7. Other Adamantine Compounds</b>											
α-SiC			10.2	-6.4	2.67	2.86		400			6H structure
Hg <sub>5</sub> Ga <sub>2</sub> Te <sub>8</sub>											B3 with superlattice
Hg <sub>5</sub> In <sub>2</sub> Te <sub>8</sub>						0.7		2000			B3 with superlattice
CdIn <sub>2</sub> Se <sub>4</sub>						1.55					

Substance	Heat of formation [kJ/mol (300K)]	Volume compressibility (10 <sup>-10</sup> m <sup>2</sup> /N)	Static dielectric constant	Atomic magnetic susceptibility (10 <sup>-6</sup> cgs)	Index of refraction	Minimum room temperature energy gap (eV)	Mobility (room temp.) (cm <sup>2</sup> /V·s)		Optical transition	Breakdown voltage kV/mm	Remarks
							Electrons	Holes			
<b>2.2. Octahedral Semiconductors</b>											
<i>2.2.1. Halite Structure Semiconductors (Strukturbericht symbol B1, Space Group Fm3m-O<sub>h</sub><sup>5</sup>)</i>											
GeTe											
SnSe											
SnTe											
PbS	435					0.5	600	600			
PbSe	393		161			0.37	1000	900			
PbTe	393		280			0.26	1600	600			Altaite
			360			0.25					
<i>2.2.2. Selected Other Binary Halites</i>											
BiSe											
BiTe						0.4					
EuSe											
GdSe						1.8	4				
NiO						2.0 or 3.7	100				
CdO	531					2.5					
SrS						4.1					
<b>2.3. Other Semiconductors</b>											
<i>2.3.1. Antifluorite Structure Compounds (Fm3m-O<sub>h</sub><sup>5</sup>)</i>											
Mg <sub>2</sub> Si	79.08					0.77	405	70			
Mg <sub>2</sub> Ge						0.74	520	110			
Mg <sub>2</sub> Sn	76.57					0.36	320	260			
Mg <sub>2</sub> Pb	52.72					0.1					
<i>2.3.2. Tetradymite Structure Compounds (R3m-D<sub>3d</sub><sup>5</sup>)</i>											
Sb <sub>2</sub> Te <sub>3</sub>						0.3		360			
Bi <sub>2</sub> Se <sub>3</sub>						0.35	600				
Bi <sub>2</sub> Te <sub>3</sub>						0.21	1140	680			R3m (166)
<i>2.3.3. Skutterudite Structure Compounds (Im3-T<sub>h</sub><sup>5</sup>)</i>											
CoP <sub>3</sub>						0.43					
CoAs <sub>3</sub>						0.69		~4000			
CoSb <sub>3</sub>						0.63	70	~3000			
RhP <sub>3</sub>								700			
RhAs <sub>3</sub>						0.85		~3000			
RhSb <sub>3</sub>						0.80		~7000			
IrSb <sub>3</sub>						1.18		1500			
<i>2.3.4. Selected Multinary Compounds</i>											
AgSbSe <sub>2</sub>						0.58					
AgSbTe <sub>2</sub>						0.7, 0.27					
(or Ag <sub>19</sub> Sb <sub>29</sub> Te <sub>52</sub> )											
AgBiS <sub>2</sub>											
(H.T.)											
AgBiSe <sub>2</sub>											
(H.T.)											
AgBiTe <sub>2</sub>											
(H.T.)											
Cu <sub>2</sub> CdSnS <sub>4</sub>						1.16	<2				
<i>2.3.5. Some Elemental Semiconductors</i>											
B	397.1			-6.7	3.4	1.55	10				
Se(gray)			6.6	-22.1	2.5	1.5		5			P3 <sub>1</sub> 21(152)
			(0.1 GHz)								
Te				-39.5	3.3	0.33	1700	1200			Same



TABLE 4. Band Properties of Semiconductors

4.1. Data on Valence Bands of Semiconductors (Room Temperature)

Substance	Band curvature effective mass (Expressed as fraction of free electron mass)			Energy separation of "split-off" band (eV)	Measured (light) hole mobility (cm <sup>2</sup> /V·s)
	Heavy holes	Light holes	"Split-off" band holes		
<i>4.1.1. Semiconductors with Valence Band Maximum at the Center of the Brillouin Zone ("F")</i>					
Si	0.52	0.16	0.25	0.044	500
Ge	0.34	0.043	0.08	0.3	1820
Sn	0.3				2400
AlAs					
AlSb	0.4			0.7	550
GaP				0.13	100
GaAs	0.8	0.12	0.20	0.34	400
GaSb	0.23	0.06		0.7	1400
InP				0.21	150
InAs	0.41	0.025	0.083	0.43	460
InSb	0.4	0.015		0.85	750
CdTe	0.35				50
HgTe	0.5				350

4.1.2. Semiconductors with Multiple Band Maxima

Substance	Number of equivalent valleys and direction	Band curvature effective masses		Anisotropy $K = m_L/m_T$	Measured (light) hole mobility (cm <sup>2</sup> /V·s)
		Longitudinal $m_L$	Transverse $m_T$		
PbSe	4 "L" [111]	0.095	0.047	2.0	1500
PbTe	4 "L" [111]	0.27	0.02	10	750
Bi <sub>2</sub> Te <sub>3</sub>	6	0.207	~0.045	4.5	515

4.2. Data on Conduction Bands of Semiconductors (Room Temperature Data)

4.2.1. Single Valley Semiconductors

Substance	Energy gap (eV)	Effective mass ( $m_0$ )	Mobility (cm <sup>2</sup> /V·s)	Comments
GaAs	1.35	0.067	8500	3(or 6?) equivalent [100] valleys 0.36 eV above this maximum with a mobility of ~50.
InP	1.27	0.067	5000	3(or 6?) equivalent [100] valleys 0.4 eV above this minimum.
InAs	0.36	0.022	33,000	Equivalent valleys ~1.0 eV above this minimum.
InSb	0.165	0.014	78,000	
CdTe	1.44	0.11	1000	4(or 8?) equivalent [111] valleys 0.51 eV above this minimum.

4.2.2. Multivalley Semiconductors

Substance	Energy gap	Number of equivalent valleys and direction	Band curvature effective mass		Anisotropy $K = m_L/m_T$
			Longitudinal $m_L$	Transverse $m_T$	
Si	1.107	6 in [100] "Δ"	0.00	0.192	4.7
Ge	0.67	4 in [111] at "L"	1.588	0.0815	19.5
GaSb	0.67	as Ge (?)	~1.0	~0.2	~5
PbSe	0.26	4 in [111] at "L"	0.085	0.05	1.7
PbTe	0.25	4 in [111] at "L"	0.21	0.029	5.5
Bi <sub>2</sub> Te <sub>3</sub>	0.13	6			~0.05

TABLE 5. Resistivity of Semiconducting Minerals

Mineral	$\rho$ (ohm · m)	Mineral	$\rho$ (ohm · m)
Diamond (C)	2.7	Pentlandite, (Fe, Ni) <sub>4</sub> S <sub>4</sub>	1 to 11 × 10 <sup>-6</sup>
Sulfides		Pyrrhotite, Fe <sub>7</sub> S <sub>4</sub>	2 to 160 × 10 <sup>-6</sup>
Argentite, Ag <sub>2</sub> S	1.5 to 2.0 × 10 <sup>-3</sup>	Pyrite, FeS <sub>2</sub>	1.2 to 600 × 10 <sup>-3</sup>
Bismuthinite, Bi <sub>2</sub> S <sub>3</sub>	3 to 570	Sphalerite, ZnS	2.7 × 10 <sup>-3</sup> to 1.2 × 10 <sup>4</sup>
Bornite, Fe <sub>2</sub> S <sub>3</sub> · nCu <sub>2</sub> S	1.6 to 6000 × 10 <sup>-6</sup>	Antimony-sulfur compounds	
Chalcocite, Cu <sub>2</sub> S	80 to 100 × 10 <sup>-6</sup>	Berthierite, FeSb <sub>2</sub> S <sub>4</sub>	0.0083 to 2.0
Chalcopyrite, Fe <sub>2</sub> S <sub>3</sub> · Cu <sub>2</sub> S	150 to 9000 × 10 <sup>-6</sup>	Boulangerite, Pb <sub>5</sub> Sb <sub>3</sub> S <sub>11</sub>	2 × 10 <sup>3</sup> to 4 × 10 <sup>4</sup>
Covellite, CuS	0.30 to 83 × 10 <sup>-6</sup>	Cylindrite, Pb <sub>3</sub> Sn <sub>4</sub> Sb <sub>2</sub> S <sub>14</sub>	2.5 to 60
Galena, PbS	6.8 × 10 <sup>-6</sup> to 9.0 × 10 <sup>-2</sup>	Franckeite, Pb <sub>5</sub> Sn <sub>3</sub> Sb <sub>2</sub> S <sub>14</sub>	1.2 to 4
Haverite, MnS <sub>2</sub>	10 to 20	Hauchecornite, Ni <sub>4</sub> (Bi, Sb) <sub>2</sub> S <sub>14</sub>	1 to 83 × 10 <sup>-6</sup>
Marcasite, FeS <sub>2</sub>	1 to 150 × 10 <sup>-3</sup>	Jamesonite, Pb <sub>4</sub> FeSb <sub>6</sub> S <sub>14</sub>	0.020 to 0.15
Metacinnabarite, HgS	2 × 10 <sup>-6</sup> to 1 × 10 <sup>-3</sup>	Tetrahedrite, Cu <sub>3</sub> Sb <sub>3</sub> S <sub>3</sub>	0.30 to 30,000
Millerite, NiS	2 to 4 × 10 <sup>-7</sup>	Arsenic-sulfur compounds	

Mineral	$\rho$ (ohm · m)
Molybdenite, MoS <sub>2</sub>	0.12 to 7.5
Cobaltite, CoAsS	6.5 to $130 \times 10^{-3}$
Enargite, Cu <sub>3</sub> AsS <sub>4</sub>	0.2 to $40 \times 10^{-3}$
Gersdorffite, NiAsS	1 to $160 \times 10^{-6}$
Glaucoodote, (Co, Fe)AsS	5 to $100 \times 10^{-6}$
Antimonide	
Dyscrasite, Ag <sub>3</sub> Sb	0.12 to $1.2 \times 10^{-6}$
Arsenides	
Allemoite, SbAs <sub>3</sub>	70 to 60,000
Lollingite, FeAs <sub>2</sub>	2 to $270 \times 10^{-6}$
Nicollite, NiAs	0.1 to $2 \times 10^{-6}$
Skutterudite, CoAs <sub>3</sub>	1 to $400 \times 10^{-6}$
Smaltite, CoAs <sub>2</sub>	1 to $12 \times 10^{-6}$
Tellurides	
Altaite, PbTe	20 to $200 \times 10^{-6}$
Calavarite, AuTe <sub>2</sub>	6 to $12 \times 10^{-6}$
Coloradoite, HgTe	4 to $100 \times 10^{-6}$

Mineral	$\rho$ (ohm · m)
Arsenopyrite, FeAsS	20 to $300 \times 10^{-6}$
Hessite, Ag <sub>2</sub> Te	4 to $100 \times 10^{-6}$
Nagyagite, Pb <sub>6</sub> Au(S,Te) <sub>14</sub>	20 to $80 \times 10^{-6}$
Sylvanite, AgAuTe <sub>4</sub>	4 to $20 \times 10^{-6}$
Oxides	
Braunite, Mn <sub>2</sub> O <sub>3</sub>	0.16 to 1.0
Cassiterite, SnO <sub>2</sub>	$4.5 \times 10^{-4}$ to 10,000
Cuprite, Cu <sub>2</sub> O	10 to 50
Hollandite, (Ba, Na, K) Mn <sub>8</sub> O <sub>16</sub>	2 to $100 \times 10^{-3}$
Ilmenite, FeTiO <sub>3</sub>	0.001 to 4
Magnetite, Fe <sub>3</sub> O <sub>4</sub>	$52 \times 10^{-6}$
Manganite, MnO · OH	0.018 to 0.5
Melaconite, CuO	6000
Psilomelane, BaMn <sub>3</sub> O <sub>18</sub> · 2H <sub>2</sub> O	0.04 to 6000
Pyrolusite, MnO <sub>2</sub>	0.007 to 30
Rutile, TiO <sub>2</sub>	29 to 910
Uraninite, UO <sub>2</sub>	1.5 to 200

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# DIFFUSION DATA FOR SEMICONDUCTORS

B. L. Sharma

The diffusion coefficient  $D$  in many semiconductors may be expressed by an Arrhenius-type relation

$$D = D_0 \exp(-Q/kT)$$

where  $D_0$  is a frequency factor,  $Q$  is the activation energy for diffusion,  $k$  is the Boltzmann constant, and  $T$  is the absolute temperature. This table lists  $D_0$  and  $Q$  for various diffusants in common semiconductors.

Abbreviations used in the table are

- AES – Auger Electron Spectroscopy
- DLTS – Deep Level Transient Spectroscopy
- SEM – Scanning Electron Microscopy
- SIMS – Secondary Ion Mass Spectrometry
- $D(c)$  – Concentration Dependent Diffusion Coefficient
- $D_{\max}$  – Maximum Diffusion Coefficient
- (f) – Fast Diffusion Component
- (i) – Interstitial Diffusion Component
- (s) – Slow Diffusion Component
- (||) – Parallel to  $c$  Direction
- ( $\perp$ ) – Perpendicular to  $c$  Direction

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.
Si	H	$6 \times 10^{-1}$	1.03	120–1207	Electrical and SIMS	1
	Li	$2.5 \times 10^{-3}$	0.65	25–1350	Electrical	2
	Na	$1.65 \times 10^{-3}$	0.72	530–800	Electrical and flame photometry	3
	K	$1.1 \times 10^{-3}$	0.76	740–800	Electrical and flame photometry	3
Cu		$4 \times 10^{-2}$	1.0	800–1100	Radioactive	4
		$4.7 \times 10^{-3}$	0.43 (i)	300–700	Radioactive	5
Ag		$2 \times 10^{-3}$	1.6	1100–1350	Radioactive	6
Au		$2.4 \times 10^{-4}$	0.39 (i)	700–1300	Radioactive	7
		$2.75 \times 10^{-3}$	2.05 (s)			
Be		( $D \sim 10^{-7}$ )	–	1050	Electrical	8
Ca		( $D \sim 6 \times 10^{-14}$ )	–	1100	Electrical and SIMS	1
Zn		$1 \times 10^{-1}$	1.4	980–1270	Electrical	9
B		2.46	3.59	1100–1250	Electrical	10
		$2.4 \times 10^1$	3.87	840–1250	Electrical	11
Al		1.38	3.41	1119–1390	Electrical	12
		1.8	3.2	1025–1175	Electrical	13
Ga		$3.74 \times 10^{-1}$	3.39	1143–1393	Electrical	12
		$6 \times 10^1$	3.89	900–1050	Radioactive	14
In		$7.85 \times 10^{-1}$	3.63	1180–1389	Electrical	12
		$1.94 \times 10^1$	3.86	1150–1242	Radioactive	15
Tl		1.37	3.7	1244–1338	Electrical	12
		$1.65 \times 10^1$	3.9	1105–1360	Electrical	16
Sc		$8 \times 10^{-2}$	3.2	1100–1250	Radioactive	1
Ce		( $D \sim 3.9 \times 10^{-13}$ )	–	1050	SIMS	1
Pr		$2.5 \times 10^{-7}$	1.74	1100–1280	Electrical	1
Pm		$7.5 \times 10^{-9}$	1.2 (s)	730–1270	Radioactive	1
		$4.2 \times 10^{-12}$	0.13 (f)			
Er		$2 \times 10^{-3}$	2.9	1100–1250	Radioactive	1
Tm		$8 \times 10^{-3}$	3.0	1100–1280	Radioactive	1
Yb		$2.8 \times 10^{-5}$	0.95	947–1097	Neutron activation	1
Ti		$1.45 \times 10^{-2}$	1.79	950–1200	DLTS	17
C		$3.3 \times 10^{-1}$	2.92	1070–1400	Radioactive	18
Si (self)		$1.54 \times 10^2$	4.65	855–1175	SIMS	19
		$1.6 \times 10^3$	4.77	1200–1400	Radioactive	20
Ge		$3.5 \times 10^{-1}$	3.92	855–1000	Radioactive	21
		$2.5 \times 10^3$	4.97	1030–1302	Radioactive	21
		$7.55 \times 10^3$	5.08	1100–1300	SIMS	22
Sn		$3.2 \times 10^1$	4.25	1050–1294	Neutron activation	23
N		$2.7 \times 10^{-3}$	2.8	800–1200	Out Diffusion; SIMS	1



Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.
Ge	P	$2.02 \times 10^1$	3.87	1100–1250	Electrical	10
		1.1	3.4	900–1200	Radioactive	24
		$7.4 \times 10^{-2}$	3.3	1130–1405	Electrical	25
	As	$6.0 \times 10^1$	4.2	950–1350	Radioactive	26
		$6.55 \times 10^{-2}$	3.44	1167–1394	Electrical	27
		$2.29 \times 10^1$	4.1	900–1250	Electrical	28
	Sb	$1.29 \times 10^1$	3.98	1190–1398	Radioactive	29
		$2.14 \times 10^{-1}$	3.65	1190–1405	Electrical	27
	Bi	$1.03 \times 10^3$	4.64	1220–1380	Electrical	16
		1.08	3.85	1190–1394	Electrical	27
	Cr	$1 \times 10^{-2}$	1	1100–1250	Radioactive	30
	Mo	( $D \sim 2 \times 10^{-10}$ )	–	1000	DLTS	1
	W	( $D \sim 10^{-12}$ )	–	1100	DLTS	1
	O	$7 \times 10^{-2}$	2.44	700–1250	SIMS	31
		$1.4 \times 10^{-1}$	2.53	700–1160	SIMS	32
	S	$5.95 \times 10^{-3}$	1.83	975–1200	Radioactive	33
	Se	$9.5 \times 10^{-1}$	2.6	1050–1250	Electrical	34
	Te	$5 \times 10^{-1}$	3.34	900–1250	SIMS	1
	Mn	$6.9 \times 10^{-4}$	0.63	900–1200	Radioactive	35
	Fe	$1.3 \times 10^{-3}$	0.68	30–1250	Radioactive	36
	Co	$2 \times 10^{-3}$	0.69	700–1300	Radioactive	37
	Ni	$2 \times 10^{-3}$	0.47	800–1300	Radioactive	38
	Ru	( $D \sim 5 \times 10^{-7}$ $- 5 \times 10^{-6}$ )	–	1000–1280	Electrical	1
	Rh	( $D \sim 10^{-6}$ – $10^{-4}$ )	–	1000–1200	Electrical	39
	Pd	$2.95 \times 10^{-4}$	0.22 (i)	702–1320	Nuclear Activation	1
	Pt	$1.5 \times 10^2$	2.22	800–1000	Electrical	1
	Os	( $D \sim 2 \times 10^{-6}$ )	–	1280	Electrical	40
	Ir	$4.2 \times 10^{-2}$	1.3	950–1250	Electrical	41
	Li	$1.3 \times 10^{-3}$	0.46	350–800	Electrical	42
		$9.1 \times 10^{-3}$	0.57	800–500	Electrical	43
	Na	$3.95 \times 10^{-1}$	2.03	700–850	Radioactive	44
	Cu	$1.9 \times 10^{-4}$	0.18 (i)	750–900	Radioactive	45
		$4 \times 10^{-2}$	0.99 (s)	600–700		
		$4 \times 10^{-3}$	0.33 (i)	350–750	Radioactive	5
	Ag	$4.4 \times 10^{-2}$	1.0 (i)	700–900	Radioactive	46, 47
		$4 \times 10^{-2}$	2.23 (s)	800–900	Radioactive	48
	Au	$2.25 \times 10^2$	2.5	600–900	Radioactive	49
	Be	$5 \times 10^{-1}$	2.5	720–900	Electrical	50
	Mg	( $D \sim 8 \times 10^{-9}$ )	–	900	Electrical	1
	Zn	5	2.7	600–900	Radioactive and electrical	51
	Cd	$1.75 \times 10^9$	4.4	760–915	Radioactive	52
	B	$1.8 \times 10^9$	4.55	600–900	Electrical	51
	Al	$1.0 \times 10^3$	3.45	554–905	SIMS	53
		$\sim 1.6 \times 10^2$	$\sim 3.24$	750–850	Electrical	54
	Ga	$1.4 \times 10^2$	3.35	554–916	SIMS	55
	$3.4 \times 10^1$	3.1	600–900	Electrical	51	
In	$1.8 \times 10^4$	3.67	554–919	SIMS	56	
	$3.3 \times 10^1$	3.02	700–855	Radioactive	57	
Tl	$1.7 \times 10^3$	3.4	800–930	Radioactive	58	
Si	$2.4 \times 10^{-1}$	2.9	650–900	( $\gamma$ ) resonance	59	
Ge (self)	$2.48 \times 10^1$	3.14	549–891	Radioactive	60	
	7.8	2.95	766–928	Radioactive	61	
Sn	$1.7 \times 10^{-2}$	1.9	–	Radioactive	45	
P	3.3	2.5	600–900	Electrical	51	
As	2.1	2.39	700–900	Electrical	62	
Sb	3.2	2.41	700–855	Radioactive	57	
	$1.0 \times 10^1$	2.5	600–900	Radioactive and electrical	51	

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.
GaAs	Bi	3.3	2.57	650–850	–	63
	O	$4 \times 10^{-1}$	2.08	–	Optical	64
	S	( $D \sim 10^{-9}$ )	–	920	–	65
	Se	( $D \sim 10^{-10}$ )	–	920	–	65
	Te	5.6	2.43	750–900	Radioactive	66
	Fe	$1.3 \times 10^{-1}$	1.08	750–900	Radioactive	67
	Co	$1.6 \times 10^{-1}$	1.12	750–850	Radioactive	47
	Ni	$8 \times 10^{-1}$	0.9	670–900	Electrical	68
	Li	$5.3 \times 10^{-1}$	1.0	250–500	Electrical and chemical	69
	Cu	$3 \times 10^{-2}$	0.53	100–500	Radioactive	69
		$6 \times 10^{-2}$	0.98	450–750	Ultrasonic	69
		$1.5 \times 10^{-3}$	0.6	800–1000	Radioactive	69
	Ag	$4 \times 10^{-4}$	0.8	500–1150	Radioactive	69
	Au	$1 \times 10^{-3}$	1.0	740–1025	Radioactive	69
	Be	$7.3 \times 10^{-6}$	1.2	800–990	Electrical	69
	Mg	$4 \times 10^{-5}$	1.22	800–1200	Electrical	69
	Zn	$1.5 \times 10^1$	2.49	600–980	Radioactive	69
		$2.5 \times 10^{-1}$	3.0	750–1000	Radioactive	69
	Cd	$1.3 \times 10^{-3}$	2.2	800–1100	Radioactive	69
		$5 \times 10^{-2}$	2.43	868–1149	Radioactive	69
Hg	( $D \sim 5 \times 10^{-14}$ )	–	1100	Radioactive	69	
Al	( $D \sim 4 \times 10^{-18} - 10^{-14}$ )	4.3	850–1100	AES	70	
Ga (self)	$4 \times 10^{-5}$	2.6	1025–1100	Radioactive	69	
	$1 \times 10^7$	5.6	1125–1230	Radioactive	69	
In	( $D \sim 7 \times 10^{-11}$ )	–	1000	Radioactive	69	
C	( $D \sim 1.04 \times 10^{-16}$ )	–	825	SIMS	69	
Si	$1.1 \times 10^{-1}$	2.5	850–1050	SIMS	69	
Ge	$1.6 \times 10^{-5}$	2.06	650–850	SIMS	69	
Sn	$6 \times 10^{-4}$	2.5	1060–1200	Radioactive	69	
	$1 \times 10^{-5}$	2	800–1000	Radioactive	69	
P	( $D \sim 10^{-12} - 10^{-10}$ )	2.9	800–1150	Reflectance measurements	69	
As (self)	$7 \times 10^{-1}$	3.2	–	Radioactive	69	
Cr	$2.04 \times 10^{-6}$	0.83 (f)	750–1000	SIMS	69	
		1.7 (s)	700–900			
	$7.9 \times 10^{-3}$	2.2	800–1100	Chemical analysis	69	
O	$2 \times 10^{-3}$	1.1	700–900	Mass spectroscopy	69	
S	$1.85 \times 10^{-2}$	2.6	1000–1300	Radioactive	69	
	$1.1 \times 10^1$	2.95	750–900	Electrical	69	
Se	$3 \times 10^3$	4.16	1025–1200	Radioactive	69	
Te	$1.5 \times 10^{-1}$	3.5	1000–1150	Radioactive	69	
Mn	$6.5 \times 10^{-1}$	2.49	850–1100	Radioactive	69	
Fe	$4.2 \times 10^{-2}$	1.8	850–1150	Radioactive	69	
	$2.2 \times 10^{-3}$	2.32	750–1050	Radioactive	69	
Co	$5 \times 10^2$	2.5	800–1000	Radioactive	69	
	$1.2 \times 10^{-1}$	2.64	750–1050	Radioactive	69	
Tm	$2.3 \times 10^{-16}$	1.0	800–1000	Radioactive	69	
GaSb	Li	$2.3 \times 10^{-4}$	1.9 (s)	527–657	Electrical and flame photometry	69
		$1.2 \times 10^{-1}$	0.7 (f)	277–657		
	Cu	$4.7 \times 10^{-3}$	0.9	470–650	Radioactive	69
	Zn	( $D \sim 2 \times 10^{-13} - 1 \times 10^{-11}$ )	2	510–600	Radioactive	69
	Cd	$1.5 \times 10^{-6}$	0.72	640–800	Electrical	69
Ga (self)	$3.2 \times 10^3$	3.15	658–700	Radioactive	69	
In	$1.2 \times 10^{-7}$	0.53	320–650	Radioactive	69	
Sn	$2.4 \times 10^{-5}$	0.8	320–650	Radioactive	69	
	$1.3 \times 10^{-5}$	1.1	500–650	Radioactive	69	
Sb (self)	$3.4 \times 10^4$	3.45	658–700	Radioactive	69	
	Se	( $D \sim 2.4 \times 10^{-13} - 1.37 \times 10^{-11}$ )	–	400–500	Radioactive	69

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.	
GaP	Te	$3.8 \times 10^{-4}$	1.20	320–650	Radioactive	69	
	Fe	$5 \times 10^{-2}$	1.9 (I)	500–650	Radioactive	69	
		$5 \times 10^2$	2.3 (II)	500–650			
	Ag	–	–	1000–1300	Radioactive	69	
	Au	8	2.5 (I)	1050–1250	Radioactive	69	
		20	2.4 (II)	1100–1250	Diffusion (I) A face and (II) B face		
	Be	$(D_{\max} \sim 2.4 \times 10^{-9} - 8.5 \times 10^{-8})$	–	900–1000	Atomic absorption analysis	69	
	Mg	$5 \times 10^{-5}$	1.4	700–1050	Electrical	69	
	Zn	1.0	2.1	700–1300	Radioactive	69	
	Ge	–	–	900–1000	Radioactive	69	
	Cr	$6.2 \times 10^{-4}$	1.2	900–1130	Radioactive; ESR	69	
	S	$3.2 \times 10^3$	4.7	1120–1305	Radioactive	69	
	Mn	$2.1 \times 10^9$	4.7	T < 950	Radioactive; ESR	69	
		$1.1 \times 10^{-6}$	0.9	950–1130			
InP	Fe	$1.6 \times 10^{-1}$	2.3	980–1180	Radioactive	69	
	Co	$2.8 \times 10^{-3}$	2.9	850–1100	Radioactive	69	
	Cu	$3.8 \times 10^{-3}$	0.69	600–900	Radioactive	69	
	Ag	$3.6 \times 10^{-4}$	0.59	500–900	Radioactive	69	
	Au	$1.32 \times 10^{-5}$	0.48	600–820	Radioactive	69	
		$1.37 \times 10^{-4}$	0.73	600–900	Radioactive	69	
	Zn	$1.6 \times 10^{-8}$	0.3	750–900	Electrical	69	
		$(D \sim 2 \times 10^{-9} - 4 \times 10^{-8})$	–	700–900	Radioactive	69	
	Cd	1.8	1.9	700–900	Radioactive	69	
		$1.1 \times 10^{-7}$	0.72	700–900	Electrical	69	
		$(D \sim 7 \times 10^{-13} - 2 \times 10^{-10})$	–	450–650	Electrical	69	
	In (self)	$1 \times 10^5$	3.85	830–990	Radioactive	69	
	Sn	$(D \sim 3 \times 10^{-8})$	–	550	Etching and cathodo- luminescence	69	
	P (self)	$7 \times 10^{10}$	5.65	900–1000	Radioactive	69	
	Cr	–	–	600–900	Radioactive	69	
	S	$3.6 \times 10^{-4}$	1.94	585–708	Electrical	69	
	Se	$(D \sim 2 \times 10^{-8})$	–	550	Cathodoluminescence	69	
	Mn	–	2.9	650–750	SIMS	69	
	Fe	3	2	600–950	Radioactive	69	
		$6.8 \times 10^5$	3.4	600–700	SIMS	69	
InAs	Co	$9 \times 10^{-1}$	1.8	600–950	Radioactive	69	
	Cu	$3.6 \times 10^{-3}$	0.52	342–875	Radioactive	69	
		$2.2 \times 10^{-2}$	0.54	525–890	Radioactive	69	
	Ag	$7.3 \times 10^{-4}$	0.26	450–900	Radioactive	69	
	Au	$5.8 \times 10^{-3}$	0.65	600–900	Radioactive	69	
	Mg	$1.98 \times 10^{-6}$	1.17	600–900	Electrical	69	
	Zn	$4.2 \times 10^{-3}$	0.96	600–900	Radioactive	69	
		$3.11 \times 10^{-3}$	1.17	600–900	Electrical	69	
	Cd	$7.4 \times 10^{-4}$	1.15	650–900	Radioactive	69	
	Hg	$1.45 \times 10^{-5}$	1.32	650–850	Radioactive	69	
	In (self)	$6 \times 10^5$	4.0	740–900	Radioactive	69	
	Ge	$3.74 \times 10^{-6}$	1.17	600–900	Electrical	69	
	Sn	$1.49 \times 10^{-6}$	1.17	600–900	Electrical	69	
	As (self)	$3 \times 10^7$	4.45	740–900	Radioactive	69	
	S	6.78	2.2	600–900	Electrical	69	
	Se	12.6	2.2	600–900	Electrical	69	
	Te	$3.43 \times 10^{-5}$	1.28	600–900	Electrical	69	
	InSb	Li	$7 \times 10^{-4}$	0.28	0–210	Electrical	69
		Cu	$9 \times 10^{-4}$	1.08	200–500	Radioactive	69
			$3 \times 10^{-5}$	0.37	230–490	Radioactive	69
Ag		$1 \times 10^{-7}$	0.25	440–510	Radioactive	69	
Au		$7 \times 10^{-4}$	0.32	140–510	Radioactive	69	
Zn		$5 \times 10^{-1}$	1.35	362–508	Radioactive	69	

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.
		–	1.5	355–455	SIMS	69
	Cd	$1 \times 10^{-5}$	1.1	250–500	Radioactive	69
		$1.3 \times 10^{-4}$	1.2	360–500	Electrical	69
	Hg	$4 \times 10^{-6}$	1.17	425–500	Radioactive	69
	In (self)	$6 \times 10^{-7}$	1.45	400–500	Radioactive	69
		$1.8 \times 10^{13}$	4.3	475–517	Radioactive	69
	Sn	$5.5 \times 10^{-8}$	0.75	390–512	Radioactive	69
	Pb	( $D \sim 2.7 \times 10^{-15}$ )	–	500	Radioactive	71
	Sb (self)	$5.35 \times 10^{-4}$	1.91	400–500	Radioactive	69
		$3.1 \times 10^{13}$	4.3	475–517	Radioactive	69
	S	$9 \times 10^{-2}$	1.4	360–500	Electrical	69
	Se	1.6	1.87	380–500	Electrical	69
	Te	$1.7 \times 10^{-7}$	0.57	300–500	Radioactive	69
	Fe	$1 \times 10^{-7}$	0.25	440–510	Radioactive	69
	Co	$2.7 \times 10^{-11}$	0.39	420–500	Radioactive	69
AlAs	Ga	( $D \sim 2 \times 10^{-18} - 10^{-15}$ )	3.6	850–1100	AES	70
	Zn	( $D \sim 9 \times 10^{-11}$ )	–	557	SEM	69
AlSb	Cu	$3.5 \times 10^{-3}$	0.36	150–500	Radioactive	69
	Zn	$3.3 \times 10^{-1}$	1.93	660–860	Radioactive	69
	Cd	$D(c) \sim 4 \times 10^{-12} - 3 \times 10^{-10}$	–	900	Radioactive	69
	Al (self)	2	1.88	570–620	X-ray	69
	Sb (self)	1	1.7	570–620	X-ray	69
ZnS	Cu	$2.6 \times 10^{-3}$	0.79	470–750	Radioactive	69
		$4.3 \times 10^{-4}$	0.64	250–1200	Electroluminescence	69
		$9.75 \times 10^{-3}$	1.04	400–800	Luminescence	69
	Au	$1.75 \times 10^{-4}$	1.16	500–800	Radioactive	69
	Zn (self)	$3 \times 10^{-4}$	1.5	$925 < T < 940$	Radioactive	69
		$1.5 \times 10^4$	3.26	$940 < T < 1030$		
		$1 \times 10^{16}$	6.5	$1030 < T < 1075$		
	Cd	( $D \sim 10^{-10}$ )	–	1100	Luminescence	72
	Al	$5.69 \times 10^{-4}$	1.28	800–1000	Luminescence	69
	In	$3 \times 10^1$	2.2	750–1000	Radioactive	69
	S (self)	$2.16 \times 10^4$	3.15	600–800	Radioactive	69
		$8 \times 10^{-5}$	2.2	740–1100	Radioactive	69
	Se	( $D \sim 5 \times 10^{-13}$ )	–	1070	X-ray microprobe	69
	Mn	$2.3 \times 10^3$	2.46	500–800	Radioactive	69
ZnSe	Li	$2.66 \times 10^{-6}$	0.49	950–980	Electrical	69
	Cu	$1 \times 10^{-4}$	0.66	400–800	Luminescence	69
		$1.7 \times 10^{-5}$	0.56	200–570	Radioactive	69
	Ag	$2.2 \times 10^{-2}$	1.18	400–800	Luminescence	69
	Zn (self)	9.8	3.0	760–1150	Radioactive	69
	Cd	$6.39 \times 10^{-4}$	1.87	700–950	Photoluminescence	69
	Al	$2.3 \times 10^{-2}$	1.8	800–1100	Luminescence	69
	Ga	$1.81 \times 10^2$	3.0	900–1100	Luminescence	69
		–	1.3	700–850	Electron probe	69
	In	( $D \sim 2 \times 10^{-12}$ )	–	940	–	69
	S	( $D \sim 8 \times 10^{-12}$ )	–	1060	X-ray microprobe	69
	Se (self)	$1.3 \times 10^1$	2.5	860–1020	Radioactive	69
		$2.3 \times 10^{-1}$	2.7	1000–1050	Radioactive	69
	Ni	( $D \sim 1.5 \times 10^{-8} - 1.7 \times 10^{-7}$ )	–	740–910	Luminescence	69
ZnTe	Li	$2.9 \times 10^{-2}$	1.22 (s)	400–700	Nuclear and chemical analysis	69
		$1.7 \times 10^{-4}$	0.78 (f)			
	Zn (self)	2.34	2.56	760–860	Radioactive	69
		$1.4 \times 10^1$	2.69	667–1077	Radioactive	69
	Al	–	2.0	700–1000	Electrical and optical	69
	In	4	1.96	1100–1300	Radioactive	69
	Te (self)	$2 \times 10^4$	3.8	727–977	Radioactive	69
CdS	Li	$3 \times 10^{-6}$	0.68	610–960	Microhardness	69
	Na	( $D \sim 3 \times 10^{-7}$ )	–	800	Radioactive	69

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.
CdSe	Cu	$1.5 \times 10^{-3}$	0.76	400–700	Radioactive	69
		$1.2 \times 10^{-2}$	1.05	300–700	Ultrasonic	69
		$8 \times 10^{-5}$	0.72	20–200	Electrical	69
	Ag	$2.5 \times 10^1$	1.2 (s)	300–500	Radioactive	69
		$2.4 \times 10^{-1}$	0.8 (f)			
	Au	$2 \times 10^2$	1.8	500–800	Radioactive	69
	Zn	$1.27 \times 10^{-9}$	0.86 (s)	720–1000	Radioactive	69
		$1.22 \times 10^{-8}$	0.66 (f)			
	Cd (self)	3.4	2.0	700–1100	Radioactive	69
	Ga	–	–	667–967	Optical and microprobe	69
	In	$6 \times 10^1$	2.3 (  )	650–930	Radioactive, optical and microprobe	69
		$1 \times 10^1$	2.03 (⊥)			
	P	$6.5 \times 10^{-4}$	1.6	800–1100	Radioactive	69
	S (self)	$1.6 \times 10^{-2}$	2.05	800–900	Radioactive	69
		–	2.4	750–1050	Radioactive	69
	Se	( $D \sim 1.2 \times 10^{-9}$ )	–	900	Radioactive	69
	Te	$1.3 \times 10^{-7}$	10.4	700–1000	Radioactive	69
	Cl	( $D \sim 3 \times 10^{-10}$ )	–	800	Electrical	69
	I	( $D \sim 5 \times 10^{-12}$ )	–	1000	Radioactive	69
	Ni	$6.75 \times 10^{-3}$	10.9	570–900	Luminescence	69
	Yb	( $D \sim 1.3 \times 10^{-9}$ )	–	960	Photoluminescence	69
	Ag	$2 \times 10^{-4}$	0.53	22–400	Ultrasonic	69
	Cd (self)	$1.6 \times 10^{-3}$	1.5	700–1000	Radioactive	69
	$6.3 \times 10^{-2}$	1.25 (I)	600–900	Radioactive;	69	
	$4.12 \times 10^{-2}$	2.18 (II)	600–900	(I) saturated Cd and (II) saturated Se pressure		
P	( $D \sim 5.3 \times 10^{-12}$ – $6 \times 10^{-11}$ )	–	900–1000	Radioactive	69	
Se (self)	$2.6 \times 10^3$	1.55	700–1000	Radioactive; saturated Se pressure	69	
CdTe	Li	( $D \sim 1.5 \times 10^{-10}$ )	–	300	Ion microprobe	69
	Cu	$3.7 \times 10^{-4}$	0.67	97–300	Radioactive	69
		$8.2 \times 10^{-8}$	0.64	290–350	Ion backscattering	69
	Ag	–	–	700–800	Electrical and photoluminescence	69
	Au	$6.7 \times 10^1$	2.0	600–1000	Radioactive	69
	Cd (self)	1.26	2.07	700–1000	Radioactive	69
		$3.26 \times 10^2$	2.67 (I)	650–900	Radioactive;	69
		$1.58 \times 10^1$	2.44 (II)		(I) saturated Cd and (II) saturated Te pressure	
	In	$8 \times 10^{-2}$	1.61	650–1000	Radioactive	69
		$1.17 \times 10^2$	2.21 (I)	500–850	Radioactive; (I) saturated Cd and (II) saturated Te pressure	69
		$6.48 \times 10^{-4}$	1.15 (II)			
	Sn	$8.3 \times 10^{-2}$	2.2	700–925	Radioactive	69
	P	( $D \sim 1.2 \times 10^{-10}$ )	–	900	Radioactive	69
	As	–	–	850	–	69
	O	$5.6 \times 10^{-9}$	1.22	200–650	Mass spectrometry	69
		$6.0 \times 10^{-10}$	0.29	650–900		
	Se	$1.7 \times 10^{-4}$	1.35	700–1000	Radioactive	69
	Te (self)	$8.54 \times 10^{-7}$	1.42 (I)	600–900	Radioactive; (I) saturated Cd and (II) saturated Te pressure	69
		$1.66 \times 10^{-4}$	1.38 (II)	500–800		
	Cl	$7.1 \times 10^{-2}$	1.6	520–800	Radioactive	69
	Fe	( $D \sim 4 \times 10^{-8}$ )	0.77	900	Radioactive	69

Semiconductor	Diffusant	Frequency factor, $D_0$ (cm <sup>2</sup> /s)	Activation energy, $Q$ (eV)	Temperature range (°C)	Method of measurement	Ref.	
HgSe	Sb	$6.3 \times 10^{-5}$	0.85	540–630	Radioactive	69	
	Se (self)	–	–	200–400	Radioactive	69	
HgTe	Ag	$6 \times 10^{-4}$	0.8	250–350	Radioactive	69	
	Zn	$5 \times 10^{-8}$	0.6	250–350	Radioactive	69	
	Cd	$3.1 \times 10^{-4}$	0.66	250–350	Radioactive	69	
	Hg (self)	$2 \times 10^{-8}$	0.6	200–350	Radioactive	69	
	In	$6 \times 10^{-6}$	0.9	200–300	Radioactive	69	
	Sn	$1.72 \times 10^{-6}$	0.66 (s)	200–300	Radioactive	69	
			$1.8 \times 10^{-3}$	0.80 (f)			
	Te (self)	$10^{-6}$	1.4	200–400	Radioactive	69	
	Mn	$1.5 \times 10^{-4}$	1.3	250–350	Radioactive	69	
PbS	Cu	$4.6 \times 10^{-4}$	0.36	150–450	Electrical	69	
		$5 \times 10^{-3}$	0.31	100–400	Electrical	69	
	Pb (self)	$8.6 \times 10^{-5}$	1.52	500–800	Radioactive	69	
	S (self)	$6.8 \times 10^{-5}$	1.38	500–750	Radioactive	69	
	Ni	$1.78 \times 10^1$	0.95	200–500	Electrical	69	
PbSe	Na	$1.5 \times 10^1$	1.74 (s)	400–850	Radioactive	69	
		$5.6 \times 10^{-6}$	0.4 (f)				
	Cu	$2 \times 10^{-5}$	0.31	93–520	Radioactive	69	
	Ag	$7.4 \times 10^{-4}$	0.35	400–850	Radioactive	69	
	Pb (self)	$4.98 \times 10^{-6}$	0.83	400–800	Radioactive	69	
	Sb	$3.4 \times 10^{-1}$	2.0	650–850	Radioactive	69	
	Se (self)	$2.1 \times 10^{-5}$	1.2	650–850	Radioactive	69	
	Cl	$1.6 \times 10^{-8}$	0.45	400–850	Radioactive	69	
	Ni	( $D \sim 1 \times 10^{-10}$ )	–	700	Radioactive	69	
	PbTe	Na	$1.7 \times 10^{-1}$	1.91	600–850	Radioactive	69
		Sn	$3.1 \times 10^{-2}$	1.56	500–800	Radioactive	69
		Pb (self)	$2.9 \times 10^{-5}$	0.6	250–500	Radioactive	69
Sb		$4.9 \times 10^{-2}$	1.54	500–800	Radioactive	69	
Te		$2.7 \times 10^{-6}$	0.75	500–800	Radioactive	69	
Cl		( $D > 2.3 \times 10^{-10}$ )	–	700	Radioactive	69	
Ni		( $D > 1 \times 10^{-6}$ )	–	700	Radioactive	69	

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# PROPERTIES OF MAGNETIC MATERIALS

H. P. R. Frederikse

## Glossary of Symbols

Quantity	Symbol	Units	
		SI	emu
Magnetic field	$H$	A m <sup>-1</sup>	Oe (oersted)
Magnetic induction	$B$	T (tesla)	G (gauss)
Magnetization	$M$	A m <sup>-1</sup>	emu cm <sup>-3</sup>
Spontaneous magnetization	$M_s$	A m <sup>-1</sup>	emu cm <sup>-3</sup>
Saturation magnetization	$M_0$	A m <sup>-1</sup>	emu cm <sup>-3</sup>
Magnetic flux	$\Phi$	Wb (weber)	maxwell
Magnetic moment	$m, \mu$	A m <sup>2</sup>	erg/G
Coercive field	$H_c$	A m <sup>-1</sup>	Oe
Remanence	$B_r$	T	G
Saturation magnetic polarization	$J_s$	T	G
Magnetic susceptibility	$\chi$		
Magnetic permeability	$\mu$	H m <sup>-1</sup> (henry/meter)	
Magnetic permeability of free space	$\mu_0$	H m <sup>-1</sup>	
Saturation magnetostriction	$\lambda (\Delta l/l)$		
Curie temperature	$T_C$	K	K
Néel temperature	$T_N$	K	K

Magnetic moment  $\mu = \gamma \hbar J = g \mu_B J$

where

$\gamma$  = gyromagnetic ratio;  $J$  = angular momentum;  $g$  = spectroscopic splitting factor ( $\sim 2$ )

$\mu_B$  = bohr magneton =  $9.2741 \cdot 10^{-24}$  J/T =  $9.2741 \cdot 10^{-21}$  erg/G

Earth's magnetic field  $H = 56 \text{ A m}^{-1} = 0.7 \text{ Oe}$

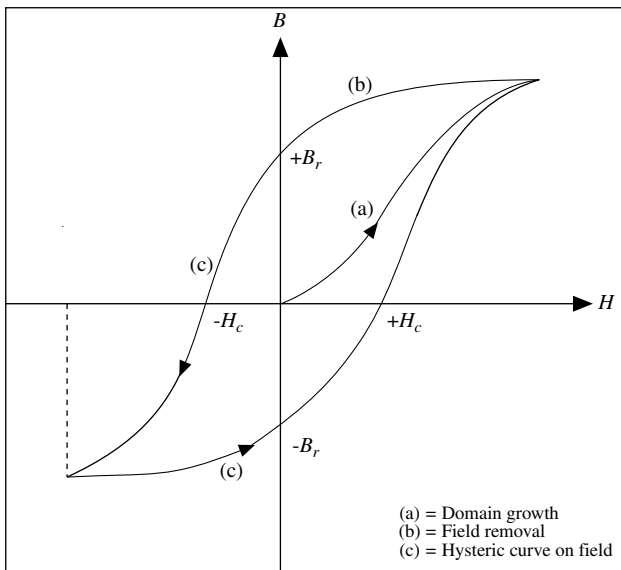
For iron:  $M_0 = 1.7 \cdot 10^6 \text{ A m}^{-1}$ ;  $B_r = 0.8 \cdot 10^6 \text{ A m}^{-1}$

1 Oe =  $(1000/4\pi) \text{ A m}^{-1}$ ; 1 G =  $10^{-4} \text{ T}$ ; 1 emu cm<sup>-3</sup> =  $10^3 \text{ A m}^{-1}$

1 maxwell =  $10^{-8} \text{ Wb}$

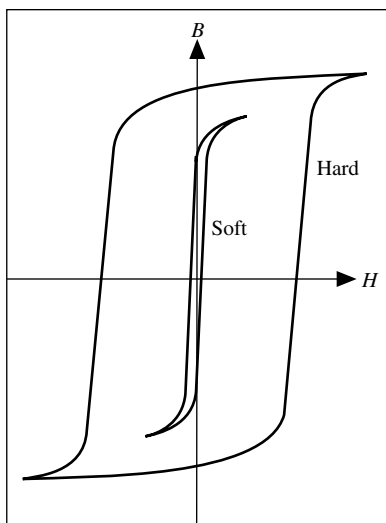
$\mu_0 = 4\pi \cdot 10^{-7} \text{ H m}^{-1}$

### Relation Between Magnetic Induction and Magnetic Field



**FIGURE 1.** Typical curve representing the dependence of magnetic induction  $B$  on magnetic field  $H$  for a ferromagnetic material. When  $H$  is first applied,  $B$  follows curve **a** as the favorably oriented magnetic domains grow. This curve flattens as saturation is approached. When  $H$  is then reduced,  $B$  follows curve **b**, but retains a finite value (the remanence  $B_r$ ) at  $H = 0$ . In order to demagnetize the material, a negative field  $-H_c$  (where  $H_c$  is called the coercive field or coercivity) must be applied. As  $H$  is further decreased and then increased to complete the cycle (curve **c**), a hysteresis loop is obtained. The area within this loop is a measure of the energy loss per cycle for a unit volume of the material.



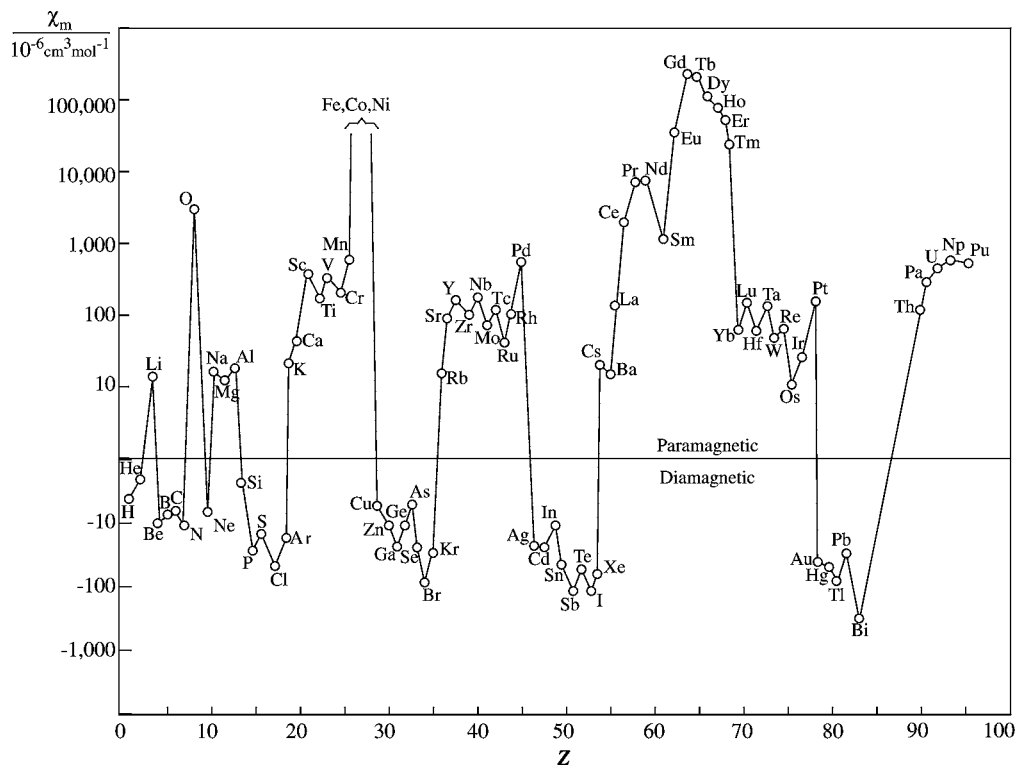


**FIGURE 2.** Schematic curve illustrating the  $B$  vs.  $H$  dependence for hard and soft magnetic materials. Hard materials have a larger remanence and coercive field, and a correspondingly large hysteresis loss.

**Reference**

Ralls, K. M., Courtney, T. H., and Wulff, J., *Introduction to Materials Science and Engineering*, J. Wiley & Sons, New York, 1976, p. 577, 582. With permission.

**Magnetic Susceptibility of the Elements**



**FIGURE 3.** Molar susceptibility of the elements at room temperature (cgs units of  $10^{-6} \text{ cm}^3/\text{mol}$ ). Values are not available for  $Z = 9, 61,$  and  $84-89$ ; Fe, Co, and Ni ( $Z = 26-28$ ) are ferromagnetic. Data taken from the table “Magnetic Susceptibility of the Elements and Inorganic Compounds” in Section 4.

**Reference**

Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972, p. 5-224. With permission.

Ground State of Ions with Partly Filled *d* or *f* Shells

<i>Z</i>	Element	<i>n</i>	<i>S</i>	<i>L</i>	<i>J</i>	Gr. state	$p_{\text{calc}}^a$	$p_{\text{calc}}^b$	$p_{\text{meas}}$
22	Ti <sup>3+</sup>	1	1/2	2	3/2	<sup>2</sup> D <sub>3/2</sub>	1.73	1.55	1.8
23	V <sup>4+</sup>	1	1/2	2	3/2	<sup>2</sup> D <sub>3/2</sub>	1.73	1.55	1.8
23	V <sup>3+</sup>	2	1	3	2	<sup>3</sup> F <sub>2</sub>	2.83	1.63	2.8
23	V <sup>2+</sup>	3	3/2	3	3/2	<sup>4</sup> F <sub>3/2</sub>	3.87	0.77	3.8
24	Cr <sup>3+</sup>	3	3/2	3	3/2	<sup>4</sup> F <sub>3/2</sub>	3.87	0.77	3.7
25	Mn <sup>4+</sup>	3	3/2	3	3/2	<sup>4</sup> F <sub>3/2</sub>	3.87	0.77	4.0
24	Cr <sup>2+</sup>	4	2	2	0	<sup>5</sup> D <sub>0</sub>	4.90	0	4.9
25	Mn <sup>3+</sup>	4	2	2	0	<sup>5</sup> D <sub>0</sub>	4.90	0	5.0
25	Mn <sup>2+</sup>	5	5/2	0	5/2	<sup>6</sup> S <sub>5/2</sub>	5.92	5.92	5.9
26	Fe <sup>3+</sup>	5	5/2	0	5/2	<sup>6</sup> S <sub>5/2</sub>	5.92	5.92	5.9
26	Fe <sup>2+</sup>	6	2	2	4	<sup>5</sup> D <sub>4</sub>	4.90	6.70	5.4
27	Co <sup>2+</sup>	7	3/2	3	9/2	<sup>4</sup> F <sub>9/2</sub>	3.87	6.54	4.8
28	Ni <sup>2+</sup>	8	1	3	4	<sup>3</sup> F <sub>4</sub>	2.83	5.59	3.2
29	Cu <sup>2+</sup>	9	1/2	2	5/2	<sup>2</sup> D <sub>5/2</sub>	1.73	3.55	1.9
							$p_{\text{calc}}^c$		
58	Ce <sup>3+</sup>	1	1/2	3	5/2	<sup>2</sup> F <sub>5/2</sub>	2.54		2.4
59	Pr <sup>3+</sup>	2	1	5	4	<sup>3</sup> H <sub>4</sub>	3.58		3.5
60	Nd <sup>3+</sup>	3	3/2	6	9/2	<sup>4</sup> I <sub>9/2</sub>	3.62		3.5
61	Pm <sup>3+</sup>	4	2	6	4	<sup>5</sup> I <sub>4</sub>	2.68		
62	Sm <sup>3+</sup>	5	5/2	5	5/2	<sup>6</sup> H <sub>5/2</sub>	0.84		1.5
63	Eu <sup>3+</sup>	6	3	3	0	<sup>7</sup> F <sub>0</sub>	0.0		3.4
64	Gd <sup>3+</sup>	7	7/2	0	7/2	<sup>8</sup> S <sub>7/2</sub>	7.94		8.0
65	Tb <sup>3+</sup>	8	3	3	6	<sup>7</sup> F <sub>6</sub>	9.72		9.5
66	Dy <sup>3+</sup>	9	5/2	5	15/2	<sup>6</sup> H <sub>15/2</sub>	10.63		10.6
67	Ho <sup>3+</sup>	10	2	6	8	<sup>5</sup> I <sub>8</sub>	10.60		10.4
68	Er <sup>3+</sup>	11	3/2	6	15/2	<sup>4</sup> I <sub>15/2</sub>	9.59		9.5
69	Tm <sup>3+</sup>	12	1	5	6	<sup>3</sup> H <sub>6</sub>	7.57		7.3
70	Yb <sup>3+</sup>	13	1/2	3	7/2	<sup>2</sup> F <sub>7/2</sub>	4.54		4.5

$$^a p_{\text{calc}} = 2[S(S+1)]^{1/2}$$

$$^b p_{\text{calc}} = 2[J(J+1)]^{1/2}$$

$$^c p_{\text{calc}} = g[J(J+1)]^{1/2}$$

## References

1. Jiles, D., *Magnetism and Magnetic Materials*, Chapman & Hall, London, 1991, p. 243.
2. Kittel, C., *Introduction to Solid State Physics, 6th Edition*, J. Wiley & Sons, New York, 1986, pp. 405–406.
3. Ashcroft, N. W. and Mermin, N. D., *Solid State Physics*, Holt, Rinehart, and Winston, New York, 1976, p. 652.

**Ferro- and Antiferromagnetic Elements**

$M_0$  is the saturation magnetization at  $T = 0$  K  
 $n_B$  is the number of Bohr magnetons per atom

$T_C$  is the Curie temperature  
 $T_N$  is the Néel temperature

	$M_0$ /gauss	$n_B$	$T_C$ /K	$T_N$ /K	Comments
Fe	22020	2.22	1043		
Co	18170	1.72	1388		
Ni	6410	0.62	627		
Cr				311	
Mn				100	
Ce				12.5	<i>c</i> -Axis antiferromagnetic
Nd				19.2	Basal plane modulation on hexagonal sites
				7.8	Cubic sites order (periodicity different from high-T phase)
Sm				106	Ordering on hexagonal sites
				13.8	Cubic site order
Eu				90.5	Spiral along cube axis
Gd	24880	7	293		
Tb		9	220		Basal plane ferromagnet
				230.2	Basal plane spiral
Dy		10	87		Basal plane ferromagnet
				176	Basal plane spiral
Ho		10	20		Bunched cone structure
				133	Basal plane spiral
Er		9	32		<i>c</i> -Axis ferrimagnetic cone structure
				80	<i>c</i> -Axis modulated structure
Tm		7	32		<i>c</i> -Axis ferrimagnetic cone structure
				56	<i>c</i> -Axis modulated structure

**References**

1. Ashcroft, N. W., and Mermin, N. D., *Solid State Physics*, Holt, Rinehart, and Winston, New York, 1976, p.652.
2. Gschneidner, K. A., and Eyring, L., *Handbook on the Physics and Chemistry of Rare Earths*, North Holland Publishing Co., Amsterdam, 1978.

**Selected Ferromagnetic Compounds**

$M_0$  is the saturation magnetization at  $T = 293$  K

$T_C$  is the Curie temperature

Compound	$M_0$ /gauss	$T_C$ /K	Crystal system
MnB	152	578	orthorh(FeB)
MnAs	670	318	hex(FeB)
MnBi	620	630	hex(FeB)
MnSb	710	587	hex(FeB)
Mn <sub>4</sub> N	183	743	
MnSi		34	cub(FeSi)
CrTe	247	339	hex(NiAs)
CrBr <sub>3</sub>	270	37	hex(BiI <sub>3</sub> )
CrI <sub>3</sub>		68	hex(BiI <sub>3</sub> )
CrO <sub>2</sub>	515	386	tetr(TiO <sub>2</sub> )
EuO	1910*	77	cub
EuS	1184*	16.5	cub
GdCl <sub>3</sub>	550*	2.2	orthorh
FeB		598	orthorh
Fe <sub>2</sub> B		1043	tetr (CuAl <sub>2</sub> )
FeBe <sub>5</sub>		75	cub(MgCu <sub>2</sub> )
Fe <sub>3</sub> C		483	orthorh
FeP		215	orthorh (MnP)

\* At  $T = 0$  K

**References**

1. Kittel, C., *Introduction to Solid State Physics, 6th Edition*, J. Wiley & Sons, New York, 1986.
2. Ashcroft, N. W., and Mermin, N. D., *Solid State Physics*, Holt, Rinehart, and Winston, New York, 1976.

### Magnetic Properties of High-Permeability Metals and Alloys (Soft)

$\mu_i$  is the initial permeability  
 $\mu_m$  is the maximum permeability  
 $H_c$  is the coercive force

$J_s$  is the saturation polarization  
 $W_H$  is the hysteresis loss per cycle  
 $T_C$  is the Curie temperature

Material	Composition (mass %)	$\mu_i/\mu_0$	$\mu_m/\mu_0$	$H_c/A\text{ m}^{-1}$	$J_s/T$	$W_H/J\text{ m}^{-3}$	$T_C/K$
Iron	Commercial 99Fe	200	6000	70	2.16	500	1043
Iron	Pure 99.9Fe	25000	350000	0.8	2.16	60	1043
Silicon-iron	96Fe-4Si	500	7000	40	1.95	50–150	1008
Silicon-iron (110) [001]	97Fe-3Si	9000	40000	12	2.01	35–140	1015
Silicon-iron {100} <100>	97Fe-3Si		100000	6	2.01		1015
Mild steel	Fe-0.1C-0.1Si-0.4Mn	800	1100	200			
Hypernik	50Fe-50Ni	4000	70000	4	1.60	22	753
Deltamax {100} <100>	50Fe-50Ni	500	200000	16	1.55		773
Isoperm {100} <100>	50Fe-50Ni	90	100	480	1.60		
78 Permalloy	78Ni-22Fe	4000	100000	4	1.05	50	651
Supermalloy	79Ni-16Fe-5Mo	100000	1000000	0.15	0.79	2	673
Mumetal	77Ni-16Fe-5Cu-2Cr	20000	100000	4	0.75	20	673
Hyperco	64Fe-35Co-0.5Cr	650	10000	80	2.42	300	1243
Permendur	50Fe-50Co	500	6000	160	2.46	1200	1253
2V-Permendur	49Fe-49Co-2V	800	4000	160	2.45	600	1253
Supermendur	49Fe-49Co-2V		60000	16	2.40	1150	1253
25Perminvar	45Ni-30Fe-25Co	400	2000	100	1.55		
7Perminvar	70Ni-23Fe-7Co	850	4000	50	1.25		
Perminvar (magnet. annealed)	43Ni-34Fe-23Co		400000	2.4	1.50		
Alfenol (or Alperm)	84Fe-16Al	3000	55000	3.2	0.8		723
Alfer	87Fe-13Al	700	3700	53	1.20		673
Aluminum-Iron	96.5Fe-3.5Al	500	19000	24	1.90		
Sendust	85Fe-10Si-5Al	36000	120000	1.6	0.89		753

### References

1. McCurrie, R. A., *Structure and Properties of Ferromagnetic Materials*, Academic Press, London, 1994, p. 42.

2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972, p. 5–224.

### Applications of High-Permeability Materials

#### Applications

#### Requirements

#### Power applications

Distribution and power transformers

Low core losses, high permeability, high saturation magnetic polarization

High-quality motors and generators, stators and armatures, switched-mode power supplies

#### Instrument transformers

Audiofrequency transformers

Low core losses, high permeability, high magnetic polarization

Pulse transformers

High permeability

#### Cores for inductor coils

Audiofrequency

Low hysteresis, high permeability

Carrier frequency

Very low hysteresis and eddy current loss

Radiofrequency

High permeability at low fields

#### Miscellaneous

Relays, switches  
 Earth leakage circuit }

High permeability, low remanence, low coercivity

Magnetic shielding

Low core loss for AC applications

**Applications of High-Permeability Materials**

Applications	Requirements
Magnetic recording heads	High initial permeability, low or zero remanence
Magnetic amplifiers } Saturable reactors } Saturable transformers } Transformer cores }	Rectangular hysteresis loops, low hysteresis loss
Magnetic shunts for temperature compensation in magnetic circuits	Low Curie temperature, appropriate decrease in permeability with increase in temperature
Electromagnets in indicating instruments, fire detection, quartz watches, electromechanical devices	High permeability, high saturation magnetic polarization
Magnetic yokes in permanent magnet devices, such as lifting and holding magnets, loudspeakers	High permeability, high saturation magnetic polarization

**Reference**

McCurrie, R. A., *Structure and Properties of Ferromagnetic Materials*, Academic Press, London, 1994. With permission.

**Saturation Magnetostriction of Selected Materials**

The tabulated parameter  $\lambda_s$  is related to the fractional change in length  $\Delta l/l$  by  $\Delta l/l = (3/2)\lambda_s(\cos^2\theta - 1/3)$ , where  $\theta$  is the angle of rotation.

Material	$\lambda_s \times 10^6$
Iron	-7
Fe - 3.2% Si	+9
Nickel	-33
Cobalt	-62
45 Permalloy, 45% Ni - 55% Fe	+27
Permalloy, 82% Ni - 18% Fe	0
Permendur, 49% Co - 49% Fe - 2% V	+70
Alfer, 87% Fe - 13% Al	+30
Magnetite, Fe <sub>3</sub> O <sub>4</sub>	+40
Cobalt ferrite, CoFe <sub>2</sub> O <sub>4</sub>	-110
SmFe <sub>2</sub>	-1560
TbFe <sub>2</sub>	+1753
Tb <sub>0.3</sub> Dy <sub>0.7</sub> Fe <sub>1.93</sub> (Terfenol D)	+2000
Fe <sub>66</sub> Co <sub>18</sub> B <sub>15</sub> Si (amorphous)	+35
Co <sub>72</sub> Fe <sub>3</sub> B <sub>6</sub> A <sub>13</sub> (amorphous)	0

**Reference**

McCurrie, R.A., *Structure and Properties of Ferromagnetic Materials*, Academic Press, London, 1994, p. 91; additional data provided by A.E. Clark, Adelphi, MD.

**Properties of Various Permanent Magnetic Materials (Hard)**

$B_r$  is the remanence

$H_c$  is the flux coercivity

$H_i$  is the intrinsic coercivity

$(BH)_{max}$  is the maximum energy product

$T_c$  is the Curie temperature

$T_{max}$  is the maximum operating temperature

Composition	$B_r/T$	$H_c/10^3 \text{ A m}^{-1}$	$H_i/10^3 \text{ A m}^{-1}$	$(BH)_{max}/\text{kJ m}^{-3}$	$T_c/^\circ\text{C}$	$T_{max}/^\circ\text{C}$
Alnico1 20Ni;12Al;5Co	0.72		35	25		
Alnico2 17Ni;10Al;12.5Co;6Cu	0.72		40-50	13-14		
Alnico3 24-30Ni;12-14Al;0-3Cu	0.5-0.6		40-54	10		
Alnico4 21-28Ni;11-13Al;3-5Co;2-4Cu	0.55-0.75		36-56	11-12		
Alnico5 14Ni;8Al;24Co;3Cu	1.25	53	54	40	850	520
Alnico6 16Ni;8Al;24Co;3Cu;2Ti	1.05		75	52		
Alnico8 15Ni;7Al;35Co;4Cu;5Ti	0.83	1.6	160	45		
Alnico9 15Ni;7Al;35Co;4Cu;5Ti	1.10	1.45	1.45	75	850	520
Alnico12 13.5Ni;8Al;24.5Co;2Nb	1.20		64	76.8		

Composition	$B_i/T$	$B_i H_c / 10^3 \text{ A m}^{-1}$	$H_c / 10^3 \text{ A m}^{-1}$	$(BH)_{\max} / \text{kJ m}^{-3}$	$T_c / ^\circ\text{C}$	$T_{\max} / ^\circ\text{C}$
BaFe <sub>12</sub> O <sub>19</sub> (Ferroxdur)	0.4	1.6	192	29	450	400
SrFe <sub>12</sub> O <sub>19</sub>	0.4	2.95	3.3	30	450	400
LaCo <sub>5</sub>	0.91			164	567	
CeCo <sub>5</sub>	0.77			117	380	
PrCo <sub>5</sub>	1.20			286	620	
NdCo <sub>5</sub>	1.22			295	637	
SmCo <sub>5</sub>	1.00	7.9	696	196	700	250
Sm(Co <sub>0.76</sub> Fe <sub>0.10</sub> Cu <sub>0.14</sub> ) <sub>6.8</sub>	1.04	4.8	5	212	800	300
Sm(Co <sub>0.65</sub> Fe <sub>0.28</sub> Cu <sub>0.05</sub> Zr <sub>0.02</sub> ) <sub>7.7</sub>	1.2	10	16	264	800	300
Nd <sub>2</sub> Fe <sub>14</sub> B sintered	1.22	8.4	1120	280	300	100
Fe;52Co;14V (Vicalloy II)	1.0	42		28	700	500
Fe;24Cr;15Co;3Mo (anisotropic)	1.54	67		76	630	500
Fe;28Cr;10.5Co (Chromindur II)	0.98	32		16	630	500
Fe;23Cr;15Co;3V;2Ti	1.35	4		44	630	500
Cu;20Ni;20Fe (Cunife)	0.55	4		12	410	350
Cu;21Ni;29Fe (Cunico)	0.34	0.5		8		
Pt;23Co	0.64	4		76	480	350
Mn;29.5Al;0.5C (anisotropic)	0.61	2.16	2.4	56	300	120

## References

1. McCurrie, R. A., *Structure and Properties of Ferromagnetic Materials*, Academic Press, London, 1994, p. 204.
2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972, p. 5–165.
3. Jiles, D., *Magnetism and Magnetic Materials*, Chapman & Hall, London, 1991.

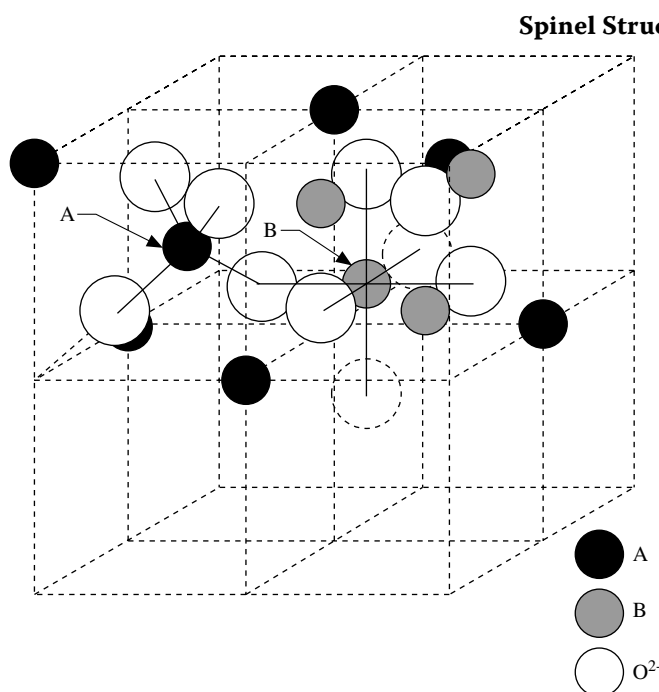
## Selected Ferrites

$J_s$  is the saturation magnetic polarization  
 $T_c$  is the Curie temperature  
 $\Delta H$  is the line width

Material	$J_s/T$	$T_c / ^\circ\text{C}$	$\Delta H / \text{kA m}^{-1}$	Applications
<b>Spinels</b>				
$\gamma\text{-Fe}_2\text{O}_3$	0.52	575		
Fe <sub>3</sub> O <sub>4</sub>	0.60	585		
NiFe <sub>2</sub> O <sub>4</sub>	0.34	575	350	Microwave devices
MgFe <sub>2</sub> O <sub>4</sub>	0.14	440	70	
NiZnFe <sub>2</sub> O <sub>4</sub>	0.50	375	120	Transformer cores
MnFe <sub>2</sub> O <sub>4</sub>	0.50	300	50	Microwave devices
NiCoFe <sub>2</sub> O <sub>4</sub>	0.31	590	140	Microwave devices
NiCoAlFe <sub>2</sub> O <sub>4</sub>	0.15	450	330	Microwave devices
NiAl <sub>0.35</sub> Fe <sub>1.65</sub> O <sub>4</sub>	0.12	430	67	Microwave devices
NiAlFe <sub>2</sub> O <sub>4</sub>	0.05	1860	32	Microwave devices
Mg <sub>0.9</sub> Mn <sub>0.1</sub> Fe <sub>2</sub> O <sub>4</sub>	0.25	290	56	Microwave devices
Ni <sub>0.5</sub> Zn <sub>0.5</sub> Al <sub>0.8</sub> Fe <sub>1.2</sub> O <sub>4</sub>	0.14		17	Microwave devices
CuFe <sub>2</sub> O <sub>4</sub>	0.17	455		Electromechanical transducers
CoFe <sub>2</sub> O <sub>4</sub>	0.53	520		
LiFe <sub>5</sub> O <sub>8</sub>	0.39	670		Microwave devices
<b>Garnets</b>				
Y <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	0.178	280	55	Microwave devices
Y <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub> (single crys.)	0.178	292	0.5	Microwave devices
(Y,Al) <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	0.12	250	80	Microwave devices
(Y,Gd) <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	0.06	250	150	Microwave devices
Sm <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	0.170	305		Microwave devices
Eu <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	0.116	293		Microwave devices
GdFe <sub>5</sub> O <sub>12</sub>	0.017	291		Microwave devices
<b>Hexagonal crystals</b>				
BaFe <sub>12</sub> O <sub>19</sub>	0.45	430	1.5	Permanent magnets
Ba <sub>3</sub> Co <sub>2</sub> Fe <sub>24</sub> O <sub>41</sub>	0.34	470	12	Microwave devices
Ba <sub>2</sub> Zn <sub>2</sub> Fe <sub>12</sub> O <sub>22</sub>	0.28	130	25	Microwave devices
Ba <sub>3</sub> Co <sub>1.35</sub> Zn <sub>0.65</sub> Fe <sub>24</sub> O <sub>41</sub>		390	16	Microwave devices
Ba <sub>2</sub> Ni <sub>2</sub> Fe <sub>12</sub> O <sub>22</sub>	0.16	500	8	Microwave devices
SrFe <sub>12</sub> O <sub>19</sub>	0.4	450		Permanent magnets

## Reference

McCurrie, R. A., *Structure and Properties of Ferromagnetic Materials*, Academic Press, London, 1994.



**FIGURE 4.** Arrangement of metal ions in the two octants A and B, showing tetrahedrally (A) and octahedrally (B) coordinated sites. (Reprinted from McCurrie, R.A., *Ferromagnetic Materials*, Academic Press, London, 1994. With permission.)

### Selected Antiferromagnetic Solids

$T_N$  is the Néel temperature

Material	Structure	$T_N$ /K	Material	Structure	$T_N$ /K
<i>Binary oxides</i>			ZnCr <sub>2</sub> O <sub>4</sub>	cub	15
MnO	cub(fcc)	122	ZnFe <sub>2</sub> O <sub>4</sub>	cub	9
FeO	cub(fcc)	198	GeFe <sub>2</sub> O <sub>4</sub>	cub	10
CoO	cub(fcc)	291	MgV <sub>2</sub> O <sub>4</sub>	cub	45
NiO	cub(fcc)	525	MnGa <sub>2</sub> O <sub>4</sub>	cub	33
$\alpha$ -Mn <sub>2</sub> O <sub>3</sub>	cub	90	<i>NiAs and related structures</i>		
CuO	monocl	230	CrAs	orth	300
UO <sub>2</sub>	cub	30.8	CrSb	hex	705–723
Er <sub>2</sub> O <sub>3</sub>	cub	3.4	CrSe	hex	300
Gd <sub>2</sub> O <sub>3</sub>	cub	1.6	MnTe	hex	320–323
<i>Perovskites</i>			NiS	hex	263
LaCrO <sub>3</sub>	orth	282	CrS	monocl	460
LaMnO <sub>3</sub>	orth	100	<i>Rutile and related structures</i>		
LaFeO <sub>3</sub>	orth	750	CoF <sub>2</sub>	tetr	38
NdCrO <sub>3</sub>	orth	224	CrF <sub>2</sub>	monocl	53
NdFeO <sub>3</sub>	orth	760	FeF <sub>2</sub>	tetr	79
YbCrO <sub>3</sub>	orth	118	MnF <sub>2</sub>	tetr	67
CaMnO <sub>3</sub>	cub	110	NiF <sub>2</sub>	tetr	83
EuTiO <sub>3</sub>	cub	5.3	CrCl <sub>2</sub>	orth	20
YCrO <sub>3</sub>	orth	141	MnO <sub>2</sub>	tetr	84
BiFeO <sub>3</sub>	cub*	673	FeOF	tetr	315
KCoF <sub>3</sub>	cub	125	<i>Corundum and related structures</i>		
KMnF <sub>3</sub>	cub*	88.3	Cr <sub>2</sub> O <sub>3</sub>	rhomb	318
KFeF <sub>3</sub>	cub	115	$\alpha$ -Fe <sub>2</sub> O <sub>3</sub>	rhomb	948
KNiF <sub>3</sub>	cub	275	FeTiO <sub>3</sub>	rhomb	68
NaMnF <sub>3</sub>	cub*	60	MnTiO <sub>3</sub>	rhomb	41
NaNiF <sub>3</sub>	orth	149	CoTiO <sub>3</sub>	rhomb	38
RbMnF <sub>3</sub>	cub	82	<i>VF<sub>3</sub> and related structures</i>		
<i>Spinel</i>			CoF <sub>3</sub>	rhomb	460
Co <sub>3</sub> O <sub>4</sub>	cub	40	CrF <sub>3</sub>	rhomb	80
NiCr <sub>2</sub> O <sub>4</sub>	tetr	65			

Material	Structure	$T_N/K$
FeF <sub>3</sub>	rhomb	394
MnF <sub>3</sub>	monocl	43
MoF <sub>3</sub>	rhomb	185
<i>Miscellaneous</i>		
K <sub>2</sub> NiF <sub>4</sub>	tetr	97
MnI <sub>2</sub>	hex	3.4
CoUO <sub>4</sub>	orth	12
CaMn <sub>2</sub> O <sub>4</sub>	orth	225
CrN	cub*	273
CeC <sub>2</sub>	tetr	33
FeSn	hex	373
Mn <sub>2</sub> P	hex	103

\* Distorted.

## References

1. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972, p. 5-168 to 5-183.
2. Kittel, C., *Introduction to Solid State Physics, 6th Edition*, J. Wiley & Sons, New York, 1986.
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## ELECTRON WORK FUNCTION OF THE ELEMENTS

The electron work function  $\Phi$  is a measure of the minimum energy required to extract an electron from the surface of a solid. It is defined more precisely as the energy difference between the state in which an electron has been removed to a distance from the surface of a single crystal face that is large enough that the image force is negligible but small compared to the distance to any other face (typically about  $10^{-4}$  cm) and the state in which the electron is in the bulk solid. In general,  $\Phi$  differs for each face of a monocrystalline sample.

Since  $\Phi$  is dependent on the cleanliness of the surface, measurements reported in the literature often cover a considerable range. This table contains selected values for the electron work function of the elements which may be regarded as typical values for a reasonably clean surface. The method of measurement is indicated for each value. The following abbreviations appear:

TE – Thermionic emission  
 PE – Photoelectric effect  
 FE – Field emission  
 CPD – Contact potential difference  
 polycr – Polycrystalline sample  
 amorp – Amorphous sample

Values in parentheses are only approximate.

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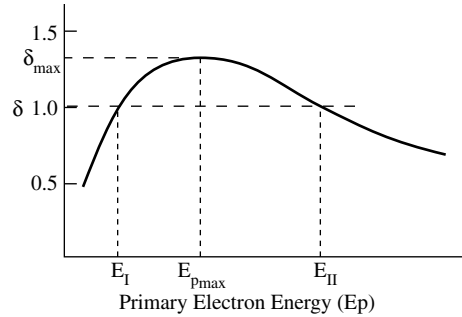
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3. Michaelson, H. B., *J. Appl. Phys.*, 48, 4729, 1977.

Element	Plane	$\Phi$ /eV	Method	Element	Plane	$\Phi$ /eV	Method	Element	Plane	$\Phi$ /eV	Method	
Ag	100	4.64	PE	K	210	5.00	PE	Ru	polycr	4.71	PE	
	110	4.52	PE		La	polycr	2.29	PE	Sb	amorp	4.55	
	111	4.74	PE		Li	polycr	3.5	PE	100	4.7		
Al	100	4.20	PE		Lu	polycr	2.93	FE	Sc	polycr	3.5	PE
	110	4.06	PE		Mg	polycr	(3.3)	CPD	Se	polycr	5.9	PE
	111	4.26	PE		Mn	polycr	3.66	PE	Si	n	4.85	CPD
As	polycr	(3.75)	PE		Mo	polycr	4.1	PE	p 100	(4.91)	CPD	
Au	100	5.47	PE		110	4.53	PE	Sm	polycr	2.7	PE	
	110	5.37	PE		111	4.95	PE	Sn	polycr	4.42	CPD	
	111	5.31	PE		112	4.55	PE	Sr	polycr	(2.59)	TH	
B	polycr	(4.45)	TH		114	4.36	PE	Ta	polycr	4.25	TH	
Ba	polycr	2.52	TH		332	4.50	PE	100	4.15	TH		
Be	polycr	4.98	PE		Na	polycr	2.36	PE	110	4.80	TH	
Bi	polycr	4.34	PE		Nb	001	4.02	TH	111	4.00	TH	
C	polycr	(5.0)	CPD	110	4.87	TH	Tb	polycr	3.0	PE		
Ca	polycr	2.87	PE	111	4.36	TH	Te	polycr	4.95	PE		
Cd	polycr	4.08	CPD	112	4.63	TH	Th	polycr	3.4	TH		
Ce	polycr	2.9	PE	113	4.29	TH	Ti	polycr	4.33	PE		
Co	polycr	5.0	PE	116	3.95	TH	Tl	polycr	(3.84)	CPD		
Cr	polycr	4.5	PE	310	4.18	TH	U	polycr	3.63	PE		
Cs	polycr	1.95	PE	Nd	polycr	3.2	PE	100	3.73	PE		
Cu	100	5.10	FE	Ni	100	5.22	PE	110	3.90	PE		
	110	4.48	PE	110	5.04	PE	113	3.67	PE			
	111	4.94	PE	111	5.35	PE	V	polycr	4.3	PE		
	112	4.53	PE	Os	polycr	5.93	PE	W	polycr	4.55	CPD	
Eu	polycr	2.5	PE	Pb	polycr	4.25	PE	100	4.63	FE		
Fe	100	4.67	PE	Pd	polycr	5.22	PE	110	5.22	FE		
	111	4.81	PE	111	5.6	PE	111	4.45	FE			
Ga	polycr	4.32	PE	Pt	polycr	5.64	PE	113	4.46	FE		
Gd	polycr	2.90	CPD	110	5.84	FE	116	4.32	TH			
Ge	polycr	5.0	CPD	111	5.93	FE	Y	polycr	3.1	PE		
Hf	polycr	3.9	PE	320	5.22	FE	Zn	polycr	3.63	PE		
Hg	liquid	4.475	PE	331	5.12	FE	polycr	(4.9)	CPD			
In	polycr	4.09	PE	Rb	polycr	2.261	PE	Zr	polycr	4.05	PE	
Ir	100	5.67	PE	Re	polycr	4.72	TE					
	110	5.42	PE	Rh	polycr	4.98	PE					
	111	5.76	PE									

## SECONDARY ELECTRON EMISSION

The secondary emission yield, or secondary emission ratio,  $\delta$ , is the average number of secondary electrons emitted from a bombarded material for every incident primary electron. It is a function of the primary electron energy  $E_p$ . The maximum yield  $\delta_{\text{max}}$  corresponds to a primary electron energy  $E_{\text{pmax}}$  (see figure). The two primary electron energies corresponding to a yield of unity are denoted the first and second crossovers ( $E_I$  and  $E_{II}$ ). An insulat-

ing target, or a conducting target that is electrically floating, will charge positively or negatively depending on the primary electron energy. For  $E_I < E_p < E_{II}$ ,  $\delta > 1$  and the surface charges positively provided there is a collector present that is positive with respect to the target. For  $E_p < E_I$  or  $E_p > E_{II}$ ,  $\delta < 1$ , and the surface charges negatively with respect to the potential of the source of primary electrons.



Element	$\delta_{\text{max}}$	$E_{\text{pmax}}$ (eV)	$E_I$ (eV)	$E_{II}$ (eV)	Element	$\delta_{\text{max}}$	$E_{\text{pmax}}$ (eV)	$E_I$ (eV)	$E_{II}$ (eV)
Ag	1.5	800	200	>2000	Li	0.5	85	None	None
Al	1.0	300	300	300	Mg	0.95	300	None	None
Au	1.4	800	150	>2000	Mo	1.25	375	150	1200
B	1.2	150	50	600	Na	0.82	300	None	None
Ba	0.8	400	None	None	Nb	1.2	375	150	1050
Bi	1.2	550	None	None	Ni	1.3	550	150	>1500
Be	0.5	200	None	None	Pb	1.1	500	250	1000
C (diamond)	2.8	750	None	>5000	Pd	>1.3	>250	120	None
C (graphite)	1.0	300	300	300	Pt	1.8	700	350	3000
C (soot)	0.45	500	None	None	Rb	0.9	350	None	None
Cd	1.1	450	300	700	Sb	1.3	600	250	2000
Co	1.2	600	200	None	Si	1.1	250	125	500
Cs	0.7	400	None	None	Sn	1.35	500	None	None
Cu	1.3	600	200	1500	Ta	1.3	600	250	>2000
Fe	1.3	400	120	1400	Th	1.1	800	None	None
Ga	1.55	500	75	None	Ti	0.9	280	None	None
Ge	1.15	500	150	900	Tl	1.7	650	70	>1500
Hg	1.3	600	350	>1200	W	1.4	650	250	>1500
K	0.7	200	None	None	Zr	1.1	350	None	None

Compound	$\delta_{\text{max}}$	$E_{\text{pmax}}$ (eV)	Compound	$\delta_{\text{max}}$	$E_{\text{pmax}}$ (eV)
Alkali halides			BeO	3.4	2000
CsCl	6.5		CaO	2.2	500
KBr (crystal)	14	1800	Cu <sub>2</sub> O	1.2	400
KCl (crystal)	12	1600	MgO (crystal)	20–25	1500
KCl (layer)	7.5	1200	MgO (layer)	3–15	400–1500
KI (crystal)	10	1600	MoO <sub>2</sub>	1.2	
KI (layer)	5.6		SiO <sub>2</sub> (quartz)	2.1–4	400
LiF (crystal)	8.5		SnO <sub>2</sub>	3.2	640
LiF (layer)	5.6	700	Sulfides		
NaBr (crystal)	24	1800	MoS <sub>2</sub>	1.1	
NaBr (layer)	6.3		PbS	1.2	500
NaCl (crystal)	14	1200	WS <sub>2</sub>	1.0	
NaCl (layer)	6.8	600	ZnS	1.8	350
NaF (crystal)	14	1200	Others		
NaF (layer)	5.7		BaF <sub>2</sub> (layer)	4.5	
NaI (crystal)	19	1300	CaF <sub>2</sub> (layer)	3.2	
NaI (layer)	5.5		BiCs <sub>3</sub>	6	1000
RbCl (layer)	5.8		BiCs	1.9	1000
Oxides			GeCs	7	700
Ag <sub>2</sub> O	1.0		Rb <sub>2</sub> Sb	7.1	450
Al <sub>2</sub> O <sub>3</sub> (layer)	2–9		SbCs <sub>3</sub>	6	700
BaO (layer)	2.3–4.8	400	Mica	2.4	350
			Glasses	2–3	300–450

# OPTICAL PROPERTIES OF SELECTED ELEMENTS

J. H. Weaver and H. P. R. Frederikse

These tables list the index of refraction  $n$ , the extinction coefficient  $k$ , and the normal incidence reflection  $R(\phi = 0)$  as a function of photon energy  $E$ , which is expressed in electron volts (eV). To convert the energy in eV to the wavelength in  $\mu\text{m}$ , use  $\lambda = 1.2398/E$ . To compute the dielectric function  $\tilde{\epsilon} = \epsilon_1 + i\epsilon_2$  from the complex index of refraction  $\tilde{N} = n + ik$ , use  $\epsilon_1 = n^2 - k^2$  and  $\epsilon_2 = 2nk$ .

The optical constants in these tables are abridged from three more extensive tabulations:

- *Optical Properties of Metals* (OPM), Volumes I and II, *Physics Data*, Nr. 18-1 and 18-2, J. H. Weaver, C. Krafft, D. W. Lynch, and E. E. Koch, Fachinformationzentrum, Karlsruhe, Germany.
- *Handbook of Optical Constants* (HOC), Vol. I, 1985, and Vol. II, 1991. E. D. Palik, Ed., Academic Press, Inc., London.
- *American Institute of Physics Handbook* (AIPH), 3rd Edition, D. E. Gray, Ed., McGraw-Hill, New York, 1972.

The first two of these major sources provide detailed comparisons of all optical data available in the literature at the time of the compilation. For critical applications the reader should refer to the original work. References for individual metals and semiconduc-

tors are listed at the end of the tables. Generally, tabulated values for the optical properties are accurate to better than 10%. Data in parentheses are extrapolated or interpolated values. For most elements the spectral range covered is from the far infrared (0.010 or 0.10 eV) to the far ultraviolet (10, 30 or 300 eV). The intervals between successive energies in the tables are chosen in such a way that the major spectral features are preserved.

Very small values of  $k$  are expressed in exponential notation, e.g., 1.23E-5 means  $1.23 \times 10^{-5}$ .

The following table is convenient for associating the energy entries in these tables with the corresponding wavelengths:

$\lambda$	E/eV	$\lambda$	E/eV
1 mm	0.00124	6000 Å	2.066
500 $\mu\text{m}$	0.00248	5000 Å	2.480
100 $\mu\text{m}$	0.01240	4000 Å	3.100
50 $\mu\text{m}$	0.02480	3000 Å	4.133
10 $\mu\text{m}$	0.12398	2000 Å	6.199
5 $\mu\text{m}$	0.24797	1000 Å	12.398
1 $\mu\text{m}$	1.240	400 Å	30.996

Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
<i>Aluminum<sup>1</sup></i>				2.200	1.018	6.846	0.9200	14.400	0.058	0.327	0.8102
0.040	98.595	203.701	0.9923	2.400	0.826	6.283	0.9228	14.600	0.067	0.273	0.7802
0.050	74.997	172.199	0.9915	2.600	0.695	5.800	0.9238	14.800	0.086	0.211	0.7202
0.060	62.852	150.799	0.9906	2.800	0.598	5.385	0.9242	15.000	0.125	0.153	0.6119
0.070	53.790	135.500	0.9899	3.000	0.523	5.024	0.9241	15.200	0.178	0.108	0.4903
0.080	45.784	123.734	0.9895	3.200	0.460	4.708	0.9243	15.400	0.234	0.184	0.3881
0.090	39.651	114.102	0.9892	3.400	0.407	4.426	0.9245	15.600	0.280	0.073	0.3182
0.100	34.464	105.600	0.9889	3.600	0.363	4.174	0.9246	15.800	0.318	0.065	0.2694
0.125	24.965	89.250	0.9884	3.800	0.326	3.946	0.9247	16.000	0.351	0.060	0.2326
0.150	18.572	76.960	0.9882	4.000	0.294	3.740	0.9248	16.200	0.380	0.055	0.2031
0.175	14.274	66.930	0.9879	4.200	0.267	3.552	0.9248	16.400	0.407	0.050	0.1789
0.200	11.733	59.370	0.9873	4.400	0.244	3.380	0.9249	16.750	0.448	0.045	0.1460
0.250	8.586	48.235	0.9858	4.600	0.223	3.222	0.9249	17.000	0.474	0.042	0.1278
0.300	6.759	40.960	0.9844	4.800	0.205	3.076	0.9249	17.250	0.498	0.040	0.1129
0.350	5.438	35.599	0.9834	5.000	0.190	2.942	0.9244	17.500	0.520	0.038	0.1005
0.400	4.454	31.485	0.9826	6.000	0.130	2.391	0.9257	17.750	0.540	0.036	0.0899
0.500	3.072	25.581	0.9817	6.500	0.110	2.173	0.9260	18.000	0.558	0.035	0.0809
0.600	2.273	21.403	0.9806	7.000	0.095	1.983	0.9262	18.500	0.591	0.032	0.0664
0.700	1.770	18.328	0.9794	7.500	0.082	1.814	0.9265	19.000	0.620	0.030	0.0554
0.800	1.444	15.955	0.9778	8.000	0.072	1.663	0.9269	19.500	0.646	0.028	0.0467
0.900	1.264	14.021	0.9749	8.500	0.063	1.527	0.9272	20.000	0.668	0.027	0.0398
1.000	1.212	12.464	0.9697	9.000	0.056	1.402	0.9277	20.500	0.689	0.025	0.0342
1.100	1.201	11.181	0.9630	9.500	0.049	1.286	0.9282	21.000	0.707	0.024	0.0296
1.200	1.260	10.010	0.9521	10.000	0.044	1.178	0.9286	21.500	0.724	0.023	0.0258
1.300	1.468	8.949	0.9318	10.500	0.040	1.076	0.9293	22.000	0.739	0.022	0.0226
1.400	2.237	8.212	0.8852	11.000	0.036	0.979	0.9298	22.500	0.753	0.021	0.0199
1.500	2.745	8.309	0.8678	11.500	0.033	0.883	0.9283	23.000	0.766	0.021	0.0177
1.600	2.625	8.597	0.8794	12.000	0.033	0.791	0.9224	23.500	0.778	0.020	0.0157
1.700	2.143	8.573	0.8972	12.500	0.034	0.700	0.9118	24.000	0.789	0.019	0.0140
1.800	1.741	8.205	0.9069	13.000	0.038	0.609	0.8960	24.500	0.799	0.018	0.0126
1.900	1.488	7.821	0.9116	13.500	0.041	0.517	0.8789	25.000	0.809	0.018	0.0113
2.000	1.304	7.479	0.9148	14.000	0.048	0.417	0.8486	25.500	0.817	0.017	0.0102
				14.200	0.053	0.373	0.8312	26.000	0.826	0.016	0.0092



Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
<i>Chromium<sup>4</sup></i>				11.00	1.05	0.69	0.103	2.20	2.07	3.70	0.642
0.06	21.19	42.00	0.962	11.50	1.09	0.69	0.100	2.30	2.01	3.59	0.634
0.10	11.81	29.76	0.955	12.00	1.13	0.70	0.101	2.40	1.95	3.49	0.627
0.14	15.31	26.36	0.936	12.50	1.15	0.73	0.108	2.50	1.88	3.40	0.622
0.18	8.73	25.37	0.53	13.00	1.15	0.77	0.119	2.60	1.81	3.32	0.618
0.22	5.30	20.62	0.954	13.50	1.12	0.80	0.128	2.70	1.73	3.24	0.615
0.26	3.91	17.12	0.951	14.00	1.09	0.82	0.135	2.80	1.66	3.13	0.607
0.30	3.15	14.28	0.943	14.50	1.03	0.82	0.142	2.90	1.61	3.05	0.600
0.42	3.47	8.97	0.862	15.00	1.00	0.82	0.143	3.00	1.55	2.96	0.594
0.54	3.92	7.06	0.788	15.50	0.96	0.80	0.141	3.20	1.46	2.80	0.579
0.66	3.96	5.95	0.736	16.00	0.92	0.77	0.139	3.40	1.38	2.64	0.563
0.78	4.13	5.03	0.680	16.50	0.31	0.75	0.134	3.60	1.31	2.48	0.544
0.90	4.43	4.60	0.650	17.00	0.90	0.73	0.132	3.80	1.28	2.33	0.519
1.00	4.47	4.43	0.639	17.50	0.88	0.72	0.130	4.00	1.26	2.20	0.495
1.12	4.53	4.31	0.631	18.00	0.87	0.70	0.129	4.20	1.25	2.10	0.471
1.24	4.50	4.28	0.629	18.50	0.84	0.69	0.130	4.40	1.24	2.01	0.452
1.36	4.42	4.30	0.631	19.00	0.82	0.68	0.131	4.60	1.24	1.94	0.435
1.46	4.31	4.32	0.632	20.00	0.77	0.64	0.130	4.80	1.23	1.88	0.423
1.77	3.84	4.37	0.639	20.5	0.76	0.63	0.129	5.00	1.22	1.83	0.411
2.00	3.48	4.36	0.644	21.0	0.74	0.58	0.121	5.20	1.21	1.79	0.403
2.20	3.18	4.41	0.656	21.5	0.72	0.55	0.116	5.40	1.19	1.77	0.399
2.40	2.75	4.46	0.677	22.0	0.71	0.52	0.112	5.60	1.16	1.75	0.400
2.60	2.22	4.36	0.698	22.5	0.70	0.50	0.109	5.80	1.10	1.73	0.406
2.80	1.80	4.06	0.703	23.0	0.69	0.48	0.105	6.00	1.03	1.68	0.407
3.00	1.54	3.71	0.695	23.5	0.68	0.45	0.101	6.20	0.97	1.62	0.401
3.20	1.44	3.40	0.670	24.0	0.68	0.43	0.096	6.40	0.94	1.53	0.386
3.40	1.39	3.24	0.657	24.5	0.67	0.39	0.089	6.60	0.91	1.46	0.368
3.60	1.26	3.12	0.661	25.0	0.68	0.36	0.080	6.80	0.91	1.38	0.345
3.80	1.12	2.95	0.660	25.5	0.68	0.33	0.072	7.00	0.91	1.32	0.326
4.00	1.02	2.76	0.651	26.0	0.70	0.31	0.063	7.00	0.91	1.26	0.305
4.20	0.94	2.58	0.639	26.5	0.71	0.28	0.055	7.40	0.92	1.21	0.286
4.40	0.90	2.42	0.620	27.0	0.72	0.26	0.048	7.60	0.93	1.17	0.269
4.50	0.89	2.35	0.607	27.5	0.73	0.25	0.043	7.80	0.94	1.13	0.253
4.60	0.88	2.28	0.598	28.0	0.75	0.23	0.037	8.00	0.95	1.09	0.239
4.70	0.86	2.21	0.586	29.0	0.77	0.22	0.032	<i>Cobalt, single crystal, <math>\vec{E} \perp \vec{c}^5</math></i>			
4.80	0.86	2.13	0.572	30.0	0.78	0.21	0.030	0.10	5.83	32.36	0.979
4.90	0.86	2.07	0.557	<i>Cobalt, single crystal, <math>\vec{E} \parallel \vec{c}^5</math></i>				0.15	4.24	21.37	0.965
5.00	0.85	2.01	0.542	0.10	6.71	37.87	0.982	0.20	3.87	15.53	0.042
5.10	0.86	1.94	0.523	0.15	4.66	25.47	0.973	0.30	4.34	10.01	0.865
5.20	0.87	1.87	0.503	0.20	3.55	18.78	0.962	0.40	4.66	7.39	0.785
5.40	0.93	1.80	0.466	0.25	3.98	14.59	0.933	0.50	5.17	5.75	0.709
5.60	0.95	1.74	0.443	0.30	4.04	12.16	0.907	0.60	5.77	5.17	0.682
5.80	0.97	1.74	0.437	0.40	4.24	9.13	0.847	0.70	6.15	5.20	0.685
6.00	0.94	1.73	0.444	0.50	4.41	7.19	0.782	0.80	6.08	5.61	0.702
6.20	0.89	1.69	0.446	0.60	4.91	6.13	0.729	0.90	5.57	5.93	0.715
6.40	0.85	1.66	0.447	0.70	5.24	5.85	0.713	1.00	4.83	5.94	0.721
6.60	0.80	1.59	0.444	0.80	5.17	5.89	0.716	1.10	4.31	5.60	0.711
6.80	0.75	1.51	0.439	0.90	4.94	5.95	0.720	1.20	4.02	5.34	0.701
7.00	0.74	1.45	0.425	1.00	4.46	5.86	0.722	1.30	3.78	5.16	0.694
7.20	0.71	1.39	0.414	1.10	4.07	5.61	0.715	1.40	3.55	5.05	0.692
7.40	0.69	1.33	0.404	1.20	3.81	5.36	0.706	1.50	3.26	4.93	0.692
7.60	0.66	1.23	0.378	1.30	3.60	5.20	0.701	1.60	3.03	4.74	0.687
7.80	0.67	1.15	0.347	1.40	3.37	5.09	0.701	1.70	2.83	4.60	0.684
8.00	0.68	1.07	0.315	1.50	3.10	4.96	0.701	1.80	2.61	4.45	0.683
8.20	0.71	1.00	0.278	1.60	2.84	4.77	0.697	1.90	2.41	4.27	0.677
8.50	0.74	0.92	0.235	1.70	2.66	4.57	0.690	2.00	2.25	4.09	0.670
9.0	0.83	0.81	0.170	1.80	2.45	4.41	0.687	2.10	2.13	3.89	0.659
9.50	0.92	0.74	0.132	1.90	2.31	4.18	0.675	2.20	2.04	3.72	0.646
10.00	0.98	0.73	0.120	2.00	2.21	4.00	0.664	2.30	1.99	3.56	0.632
10.50	1.01	0.72	0.112	2.10	2.13	3.85	0.654	2.40	1.95	3.44	0.620

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	
2.50	1.90	3.34	0.611	5.60	1.18	1.74	0.391	58.00	0.96	0.11	0.004	
2.60	1.86	3.26	0.605	5.80	1.10	1.67	0.389	59.00	0.97	0.11	0.003	
2.70	1.79	3.19	0.602	6.00	1.04	1.59	0.380	60.00	0.97	0.11	0.003	
2.80	1.72	3.11	0.596	6.50	0.96	1.37	0.329	61.00	0.97	0.11	0.003	
2.90	1.66	3.03	0.591	7.00	0.97	1.20	0.271	62.00	0.97	0.11	0.003	
3.00	1.60	2.94	0.586	7.50	1.00	1.09	0.230	63.00	0.96	0.10	0.003	
3.20	1.50	2.78	0.571	8.00	1.03	1.03	0.206	64.00	0.96	0.10	0.003	
3.40	1.42	2.62	0.553	8.50	1.03	0.98	0.189	65.00	0.97	0.10	0.003	
3.60	1.36	2.47	0.533	9.00	1.03	0.92	0.171	66.00	0.97	0.10	0.003	
3.80	1.33	2.33	0.511	9.50	1.03	0.87	0.154	67.00	0.97	0.09	0.003	
4.00	1.31	2.21	0.488	10.00	1.04	0.82	0.139	68.00	0.97	0.09	0.002	
4.20	1.28	2.12	0.471	11.00	1.07	0.75	0.118	69.00	0.97	0.09	0.002	
4.40	1.27	2.03	0.452	12.00	1.09	0.73	0.111	70.00	0.97	0.09	0.002	
4.60	1.26	1.95	0.435	13.00	1.08	0.72	0.109	75.00	0.98	0.09	0.002	
4.80	1.25	1.90	0.423	14.00	1.06	0.72	0.111	80.00	0.98	0.09	0.002	
5.00	1.24	1.84	0.411	14.50	1.03	0.72	0.111	85.00	0.97	0.09	0.002	
5.20	1.22	1.80	0.403	15.00	1.01	0.71	0.111	90.00	0.96	0.08	0.002	
5.40	1.21	1.78	0.399	15.50	0.98	0.69	0.109	<i>Gallium (liquid)</i> <sup>7</sup>				
5.60	1.17	1.76	0.400	16.00	0.95	0.67	0.106	1.425	2.40	9.20	0.900	
5.80	1.11	1.74	0.406	17.00	0.91	0.62	0.097	1.550	2.09	8.50	0.898	
6.00	1.04	1.69	0.407	18.00	0.89	0.56	0.084	1.771	1.65	7.60	0.898	
6.20	0.98	1.62	0.401	19.00	0.88	0.51	0.071	2.066	1.25	6.60	0.897	
6.40	0.94	1.54	0.386	20.00	0.88	0.45	0.059	2.480	0.89	5.60	0.898	
6.60	0.92	1.46	0.368	21.00	0.90	0.41	0.048	3.100	0.59	4.50	0.896	
6.80	0.91	1.38	0.345	22.00	0.92	0.38	0.040	<i>Germanium, single crystal</i> <sup>8</sup>				
7.00	0.91	1.32	0.326	23.00	0.94	0.37	0.035	0.01240	(4.0065)	3.00E-03	0.361	
7.20	0.91	1.26	0.305	24.00	0.96	0.37	0.035	0.01364	4.0063	2.40E-03	0.361	
7.40	0.92	1.21	0.285	25.00	0.96	0.40	0.040	0.01488	(4.0060)	1.70E-03	0.361	
7.60	0.93	1.17	0.269	26.00	0.92	0.40	0.044	0.01612	(4.0060)	1.55E-03	0.361	
7.80	0.94	1.13	0.253	27.00	0.88	0.38	0.043	0.01736	(4.0060)	1.50E-03	0.361	
<i>Copper</i> <sup>6</sup>				28.00	0.86	0.35	0.039	0.01860		1.50E-03		
0.10	29.69	71.57	0.980	29.00	0.85	0.30	0.032	0.01984		1.60E-03		
0.50	1.71	17.63	0.979	30.00	0.86	0.26	0.025	0.02108		1.60E-03		
1.00	0.44	8.48	0.976	31.00	0.88	0.24	0.020	0.02232		1.55E-03		
1.50	0.26	5.26	0.965	32.00	0.89	0.22	0.017	0.02356		1.53E-03		
1.70	0.22	4.43	0.958	33.00	0.90	0.21	0.015	0.02480		1.50E-03		
1.75	0.21	4.25	0.956	34.00	0.91	0.20	0.014	0.02604		1.25E-03		
1.80	0.21	4.04	0.952	35.00	0.92	0.20	0.013	0.02728		8.50E-04		
1.85	0.22	3.85	0.947	36.00	0.92	0.19	0.012	0.02852		6.50E-04		
1.90	0.21	3.67	0.943	37.00	0.92	0.19	0.011	0.02976		7.00E-04		
2.00	0.27	3.24	0.910	38.00	0.93	0.18	0.010	0.03100	3.9827	8.50E-04	0.358	
2.10	0.47	2.81	0.814	39.00	0.93	0.17	0.009	0.03224		1.55E-03		
2.20	0.83	2.60	0.673	40.00	0.93	0.17	0.009	0.03348		2.75E-03		
2.30	1.04	2.59	0.618	41.00	0.94	0.16	0.008	0.03472		3.55E-03		
2.40	1.12	2.60	0.602	42.00	0.94	0.16	0.007	0.03596	(3.9900)	3.05E-03	0.359	
2.60	1.15	2.50	0.577	43.00	0.94	0.15	0.007	0.03720		2.75E-03		
2.80	1.17	2.36	0.545	44.00	0.95	0.15	0.007	0.03844		2.70E-03		
3.00	1.18	2.21	0.509	45.00	0.95	0.15	0.006	0.03968	(3.9930)	2.90E-03	0.359	
3.20	1.23	2.07	0.468	46.00	0.95	0.15	0.006	0.04092		2.95E-03		
3.40	1.27	1.95	0.434	47.00	0.95	0.14	0.006	0.04215		3.20E-03		
3.60	1.31	1.87	0.407	48.00	0.95	0.14	0.006	0.04339		6.30E-03		
3.80	1.34	1.81	0.387	49.00	0.95	0.14	0.005	0.04463		3.40E-03		
4.00	1.34	1.72	0.364	50.00	0.95	0.13	0.005	0.04587	(3.9955)	2.50E-03	0.360	
4.20	1.42	1.64	0.336	51.00	0.95	0.13	0.005	0.04711		2.10E-03		
4.40	1.49	1.64	0.329	52.00	0.95	0.13	0.005	0.04835		2.00E-03		
4.60	1.52	1.67	0.334	53.00	0.96	0.12	0.004	0.04959		8.00E-04		
4.80	1.53	1.71	0.345	54.00	0.96	0.12	0.004	0.05083		1.40E-03		
5.00	1.47	1.78	0.366	55.00	0.96	0.12	0.004	0.05207		1.35E-03		
5.20	1.38	1.80	0.380	56.00	0.96	0.11	0.004	0.05331		1.10E-03		
5.40	1.28	1.78	0.389	57.00	0.96	0.11	0.004	0.05455		8.00E-04		

Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$				
0.05579		6.00E-04		3.7	3.958	2.863	0.517	2.20	0.24	2.54	0.880				
0.05703		9.0 E-04		3.8	3.936	2.986	0.527	2.40	0.50	1.86	0.647				
0.05827		6.5 E-04		3.9	3.920	3.137	0.539	2.50	0.82	1.59	0.438				
0.05951		4.6 E-04		4.0	3.905	3.336	0.556	2.60	1.24	1.54	0.331				
0.06075		4.0 E-04		4.1	3.869	3.614	0.579	2.70	1.43	1.72	0.356				
0.06199	3.9992	3.98E-04	0.360	4.2	3.745	4.009	0.612	2.80	1.46	1.77	0.368				
0.06323		4.0 E-04		4.3	3.338	4.507	0.659	2.90	1.50	1.79	0.368				
0.06447		4.3 E-04		4.4	2.516	4.669	0.705	3.00	1.54	1.80	0.369				
0.06571		4.4 E-04		4.5	1.953	4.297	0.713	3.10	1.54	1.81	0.371				
0.06695	(4.0000)	4.3 E-04	0.360	4.6	1.720	3.960	0.702	3.20	1.54	1.80	0.368				
0.06819		3.1 E-04		4.7	1.586	3.709	0.690	3.30	1.55	1.78	0.362				
0.06943		3.3 E-04		4.8	1.498	3.509	0.677	3.40	1.56	1.76	0.356				
0.07067		3.8 E-04		4.9	1.435	3.342	0.664	3.50	1.58	1.73	0.349				
0.07191		3.3 E-04		5.0	1.394	3.197	0.650	3.60	1.62	1.73	0.346				
0.07315		2.5 E-04		5.1	1.370	3.073	0.636	3.70	1.64	1.75	0.351				
0.07439		1.9 E-04		5.2	1.364	2.973	0.622	3.80	1.63	1.79	0.360				
0.07514		1.58E-04		5.3	1.371	2.897	0.609	3.90	1.59	1.81	0.366				
0.07749	4.0009	9.55E-05	0.360	5.4	1.383	2.854	0.600	4.00	1.55	1.81	0.369				
0.07999	4.0011	1.71E-04	0.360	5.5	1.380	2.842	0.598	4.10	1.51	1.79	0.368				
0.08266	4.0013	9.78E-05	0.360	5.6	1.360	2.846	0.602	4.20	1.48	1.78	0.367				
0.08551	4.0015	5.77E-05	0.360	5.7	1.293	2.163	0.479	4.30	1.45	1.77	0.368				
0.08920		3.98E-05		5.8	1.209	2.873	0.632	4.40	1.41	1.76	0.370				
0.09460		4.59E-05		5.9	1.108	2.813	0.641	4.50	1.35	1.74	0.370				
0.09840		3.51E-05		6.0	1.30	2.34	0.517	4.60	1.30	1.69	0.364				
0.1	4.0063	3.70E-05	0.361	6.5	1.10	2.05	0.489	4.70	1.27	1.64	0.354				
0.2	4.0108		0.361	7.0	1.00	1.80	0.448	4.80	1.25	1.59	0.344				
0.3	4.0246		0.362	7.5		1.60		4.90	1.23	1.54	0.332				
0.4	4.0429		0.364	8.0	0.92	1.40	0.348	5.00	1.22	1.49	0.319				
0.5	(4.074)		0.367	8.5	0.92	1.20	0.282	5.20	1.21	1.40	0.295				
0.6	(4.104)	6.58E-07	0.370	9.0	0.92	1.14	0.262	5.40	1.21	1.33	0.275				
0.7	4.180	1.27E-04	0.377	9.5		1.00		5.60	1.21	1.27	0.256				
0.8	4.275	5.67E-03	0.385	10.0	0.93	0.86	0.167	5.80	1.21	1.20	0.236				
0.9	4.285	7.45E-02	0.386	20.0		0.237		6.00	1.22	1.14	0.218				
1.0	4.325	8.09E-02	0.390	22.0		0.179		6.20	1.24	1.09	0.203				
1.1	4.385	0.103	0.395	24.0		0.144		6.40	1.25	1.05	0.190				
1.2	4.420	0.123	0.398	26.0		0.110		6.60	1.27	1.01	0.177				
1.3	4.495	0.167	0.405	28.0		0.0747		6.80	1.30	0.97	0.167				
1.4	4.560	0.190	0.411	30.0		0.1020		7.00	1.34	0.95	0.162				
1.5	4.635	0.298	0.418	32.0		0.0999		7.20	1.36	0.95	0.161				
1.6	4.763	0.345	0.428	34.0		0.0856		7.40	1.38	0.96	0.164				
1.7	4.897	0.401	0.439	36.0		0.0740		7.60	1.38	0.98	0.169				
1.8	5.067	0.500	0.453	38.0		0.0651		7.80	1.35	0.99	0.171				
1.9	5.380	0.540	0.475	40.0		0.0604		8.00	1.31	0.96	0.165				
2.0	5.588	0.933	0.495					8.20	1.30	0.92	0.155				
2.1	5.748	1.634	0.523					8.40	1.30	0.89	0.147				
2.2	5.283	2.049	0.516	<i>Gold, electropolished, Au (110)<sup>9</sup></i>								8.60	1.31	0.88	0.144
2.3	5.062	2.318	0.519	0.10	8.17	82.83	0.995	8.80	1.31	0.86	0.140				
2.4	4.610	2.455	0.508	0.20	2.13	41.73	0.995	9.00	1.30	0.83	0.133				
2.5	4.340	2.384	0.492	0.30	0.99	27.82	0.995	9.20	1.31	0.81	0.126				
2.6	4.180	2.309	0.480	0.40	0.59	20.83	0.995	9.40	1.33	0.78	0.122				
2.7	4.082	2.240	0.471	0.50	0.39	16.61	0.994	9.60	1.36	0.78	0.121				
2.8	4.035	2.181	0.464	0.60	0.28	13.78	0.994	9.80	1.37	0.79	0.124				
2.9	4.037	2.140	0.461	0.70	0.22	11.75	0.994	10.00	1.37	0.80	0.126				
3.0	4.082	2.145	0.463	0.80	0.18	10.21	0.993	10.20	1.36	0.80	0.127				
3.1	4.141	2.215	0.471	0.90	0.15	9.01	0.993	10.40	1.35	0.80	0.125				
3.2	4.157	2.340	0.482	1.00	0.13	8.03	0.992	10.60	1.34	0.79	0.123				
3.3	4.128	2.469	0.490	1.20	0.10	6.54	0.991	10.80	1.34	0.77	0.120				
3.4	4.070	2.579	0.497	1.40	0.08	5.44	0.989	11.00	1.34	0.76	0.116				
3.5	4.020	2.667	0.502	1.60	0.08	4.56	0.986	11.20	1.34	0.74	0.113				
3.6	3.985	2.759	0.509	1.80	0.09	3.82	0.979	11.40	1.35	0.73	0.111				
				2.00	0.13	3.16	0.953								
				2.10	0.18	2.84	0.925								



Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
11.60	1.36	0.72	0.109	1.10	4.28	3.08	0.547	9.20	1.50	1.10	0.201
11.80	1.38	0.71	0.108	1.20	4.08	3.10	0.544	9.40	1.48	1.14	0.211
12.00	1.39	0.71	0.109	1.30	3.87	3.04	0.536	9.60	1.46	1.18	0.222
12.40	1.44	0.73	0.115	1.40	3.72	2.95	0.525	9.80	1.41	1.21	0.230
12.80	1.45	0.79	0.127	1.50	3.60	2.85	0.514	10.00	1.36	1.22	0.235
13.20	1.42	0.84	0.137	1.60	3.52	2.73	0.500	10.20	1.32	1.22	0.238
13.60	1.37	0.86	0.140	1.70	3.52	2.61	0.488	10.40	1.28	1.22	0.240
14.00	1.33	0.86	0.140	1.80	3.57	2.56	0.485	10.60	1.24	1.21	0.241
14.40	1.29	0.86	0.139	1.90	3.63	2.59	0.489	10.80	1.20	1.20	0.242
14.80	1.26	0.84	0.135	2.00	3.65	2.67	0.498	11.00	1.16	1.19	0.242
15.20	1.24	0.83	0.132	2.10	3.64	2.81	0.511	11.20	1.13	1.17	0.241
15.60	1.22	0.81	0.127	2.20	3.53	2.99	0.526	11.40	1.10	1.16	0.241
16.00	1.21	0.79	0.123	2.30	3.34	3.09	0.534	11.60	1.07	1.14	0.239
16.40	1.20	0.78	0.119	2.40	3.15	3.11	0.537	11.80	1.04	1.12	0.238
16.80	1.19	0.76	0.116	2.50	2.99	3.13	0.540	12.00	1.02	1.10	0.236
17.20	1.19	0.75	0.114	2.60	2.83	3.12	0.542	12.40	0.96	1.06	0.232
17.60	1.19	0.74	0.111	2.70	2.68	3.10	0.542	12.80	0.92	1.01	0.225
18.00	1.19	0.74	0.109	2.80	2.54	3.08	0.543	13.20	0.88	0.96	0.218
18.40	1.19	0.73	0.109	2.90	2.40	3.04	0.544	13.60	0.84	0.90	0.205
18.80	1.20	0.74	0.110	3.00	2.27	3.00	0.544	14.00	0.83	0.83	0.186
19.20	1.21	0.76	0.116	3.10	2.14	2.95	0.544	14.40	0.83	0.80	0.172
19.60	1.21	0.80	0.125	3.20	2.00	2.89	0.544	14.80	0.81	0.76	0.167
20.00	1.18	0.83	0.133	3.30	1.87	2.79	0.538	15.20	0.79	0.70	0.153
20.40	1.14	0.85	0.141	3.40	1.78	2.68	0.528	15.60	0.79	0.64	0.132
20.80	1.10	0.87	0.149	3.50	1.71	2.58	0.517	16.00	0.83	0.60	0.111
21.20	1.05	0.88	0.156	3.60	1.66	2.48	0.503	16.40	0.81	0.60	0.114
21.60	1.00	0.88	0.162	3.70	1.63	2.40	0.491	16.80	0.79	0.55	0.105
22.00	0.94	0.86	0.164	3.80	1.60	2.33	0.481	17.20	0.79	0.50	0.089
22.40	0.89	0.83	0.163	3.90	1.56	2.27	0.473	17.60	0.80	0.46	0.077
22.80	0.85	0.79	0.157	4.00	1.52	2.21	0.466	18.00	0.81	0.42	0.064
23.20	0.82	0.75	0.149	4.10	1.48	2.14	0.455	18.40	0.84	0.38	0.051
23.60	0.80	0.70	0.138	4.20	1.45	2.07	0.442	18.80	0.87	0.34	0.040
24.00	0.80	0.66	0.125	4.30	1.43	2.01	0.431	19.00	0.89	0.33	0.036
24.40	0.80	0.62	0.113	4.40	1.41	1.95	0.420	19.60	0.93	0.32	0.030
24.80	0.80	0.58	0.101	4.50	1.39	1.89	0.407	20.00	0.94	0.31	0.027
25.20	0.82	0.56	0.090	4.60	1.39	1.83	0.394	20.60	0.97	0.30	0.023
25.60	0.83	0.54	0.084	4.70	1.39	1.79	0.382	21.00	0.99	0.29	0.022
26.00	0.84	0.52	0.079	4.80	1.38	1.75	0.373	21.60	1.01	0.28	0.020
26.40	0.85	0.51	0.074	4.90	1.38	1.71	0.364	22.00	1.03	0.28	0.020
26.80	0.85	0.50	0.071	5.00	1.37	1.68	0.356	22.60	1.06	0.28	0.020
27.20	0.86	0.49	0.068	5.20	1.36	1.61	0.341	23.00	1.07	0.28	0.021
27.60	0.86	0.49	0.065	5.40	1.35	1.55	0.324	23.60	1.09	0.29	0.022
28.00	0.87	0.48	0.063	5.60	1.35	1.51	0.314	24.00	1.09	0.30	0.023
28.40	0.88	0.48	0.062	5.80	1.32	1.48	0.308	24.60	1.10	0.31	0.024
28.80	0.88	0.48	0.062	6.00	1.28	1.41	0.295	<i>Hafnium, single crystal, <math>\vec{E} \parallel \vec{c}^{10}</math></i>			
29.20	0.88	0.48	0.062	6.20	1.26	1.35	0.278	0.52	2.25	4.65	0.723
29.60	0.87	0.48	0.064	6.40	1.26	1.28	0.258	0.56	2.34	3.66	0.623
30.00	0.86	0.48	0.064	6.60	1.27	1.22	0.240	0.60	2.84	2.89	0.512
<i>Hafnium, single crystal, <math>\vec{E} \parallel \vec{c}^{10}</math></i>				6.80	1.28	1.16	0.224	0.66	3.71	2.35	0.469
0.52	1.48	4.11	0.747	7.00	1.31	1.13	0.212	0.70	4.26	2.21	0.482
0.56	1.84	3.29	0.615	7.20	1.33	1.10	0.204	0.76	4.97	2.33	0.521
0.60	2.34	2.62	0.486	7.40	1.34	1.07	0.197	0.80	5.41	2.62	0.554
0.66	3.21	2.13	0.428	7.60	1.36	1.05	0.191	0.86	5.46	3.36	0.593
0.70	3.70	2.03	0.441	7.80	1.37	1.02	0.183	0.90	5.22	3.62	0.601
0.76	4.31	2.10	0.476	8.00	1.40	1.01	0.179	0.95	4.95	3.72	0.602
0.80	4.61	2.31	0.504	8.20	1.43	1.01	0.178	1.00	4.76	3.76	0.602
0.86	4.71	2.70	0.533	8.40	1.45	1.01	0.180	1.10	4.43	3.80	0.601
0.90	4.64	2.85	0.541	8.60	1.47	1.02	0.183	1.20	4.07	3.74	0.594
0.95	4.54	2.96	0.545	8.80	1.48	1.04	0.186	1.30	3.79	3.55	0.578
1.00	4.45	3.00	0.545	9.00	1.49	1.07	0.193	1.40	3.61	3.36	0.561



Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
1.50	3.55	3.13	0.540	10.00	1.32	1.21	0.230	1.60	2.68	5.08	0.728
1.60	3.58	3.01	0.529	10.20	1.27	1.21	0.234	1.70	2.69	4.92	0.716
1.70	3.63	2.98	0.526	10.40	1.23	1.20	0.235	1.80	2.64	4.81	0.710
1.80	3.66	3.02	0.530	10.60	1.19	1.20	0.237	1.90	2.57	4.68	0.704
1.90	3.63	3.14	0.541	10.80	1.15	1.19	0.237	2.00	2.50	4.57	0.699
2.00	3.51	3.26	0.551	11.00	1.12	1.17	0.237	2.10	2.40	4.48	0.697
2.10	3.35	3.33	0.558	11.20	1.08	1.16	0.237	2.20	2.29	4.38	0.695
2.20	3.18	3.36	0.563	11.40	1.05	1.14	0.236	2.30	2.18	4.26	0.692
2.30	2.99	3.39	0.568	11.60	1.03	1.12	0.235	2.40	2.07	4.14	0.689
2.40	2.78	3.35	0.569	11.80	1.00	1.10	0.233	2.50	1.98	4.00	0.682
2.50	2.65	3.26	0.562	12.00	0.97	1.08	0.231	2.60	1.91	3.86	0.673
2.60	2.54	3.22	0.560	12.40	0.92	1.04	0.226	2.70	1.85	3.73	0.665
2.70	2.42	3.17	0.559	12.80	0.88	0.99	0.219	2.80	1.81	3.61	0.655
2.80	2.31	3.13	0.558	13.20	0.83	0.94	0.211	2.90	1.77	3.51	0.646
2.90	2.20	3.08	0.558	13.60	0.80	0.88	0.196	3.00	1.73	3.43	0.640
3.00	2.08	3.05	0.561	14.00	0.79	0.81	0.177	3.20	1.62	3.26	0.629
3.10	1.94	2.98	0.560	14.40	0.80	0.77	0.160	3.40	1.53	3.05	0.610
3.20	1.83	2.88	0.555	14.80	0.77	0.73	0.154	3.60	1.52	2.81	0.573
3.30	1.74	2.78	0.547	15.20	0.76	0.68	0.140	3.80	1.61	2.69	0.541
3.40	1.68	2.69	0.538	15.60	0.76	0.61	0.119	4.00	1.64	2.68	0.535
3.50	1.62	2.61	0.529	16.00	0.81	0.58	0.099	4.20	1.58	2.71	0.549
3.60	1.57	2.52	0.519	16.40	0.78	0.57	0.102	4.40	1.45	2.68	0.561
3.70	1.53	2.45	0.510	16.80	0.77	0.53	0.092	4.60	1.31	2.60	0.567
3.80	1.49	2.38	0.501	17.20	0.77	0.48	0.077	4.80	1.18	2.49	0.570
3.90	1.45	2.32	0.493	17.60	0.79	0.44	0.065	5.00	1.10	2.35	0.559
4.00	1.41	2.25	0.484	18.00	0.80	0.39	0.053	5.20	1.04	2.22	0.543
4.10	1.38	2.18	0.474	18.40	0.82	0.36	0.041	5.40	1.00	2.09	0.522
4.20	1.35	2.11	0.462	18.80	0.86	0.33	0.032	5.60	0.98	1.98	0.499
4.30	1.33	2.05	0.451	19.00	0.88	0.32	0.030	5.80	0.96	1.86	0.474
4.40	1.31	1.99	0.438	19.60	0.91	0.31	0.025	6.00	0.95	1.78	0.454
4.50	1.30	1.93	0.427	20.00	0.93	0.30	0.023	6.20	0.94	1.68	0.427
4.60	1.29	1.88	0.415	20.60	0.96	0.29	0.021	6.40	0.94	1.59	0.401
4.70	1.28	1.82	0.402	21.00	0.97	0.29	0.020	6.60	0.94	1.50	0.375
4.80	1.28	1.77	0.389	21.60	1.00	0.28	0.019	6.80	0.95	1.42	0.345
4.90	1.27	1.73	0.379	22.00	1.01	0.28	0.019	7.00	0.97	1.34	0.318
5.00	1.27	1.69	0.367	22.60	1.03	0.27	0.018	7.20	0.99	1.27	0.290
5.20	1.27	1.62	0.349	23.00	1.05	0.28	0.019	7.40	1.02	1.20	0.262
5.40	1.27	1.57	0.335	23.60	1.06	0.28	0.020	7.60	1.03	1.14	0.241
5.60	1.26	1.52	0.322	24.00	1.07	0.29	0.021	7.80	1.08	1.06	0.208
5.80	1.24	1.48	0.313	24.60	1.09	0.30	0.022	8.00	1.13	1.03	0.191
6.00	1.21	1.42	0.302					8.20	1.18	1.00	0.179
6.20	1.19	1.36	0.285	<i>Iridium<sup>II</sup></i>				8.40	1.22	0.98	0.171
6.40	1.18	1.29	0.265	0.10	28.49	60.62	0.975	8.60	1.26	0.96	0.164
6.60	1.19	1.22	0.244	0.15	15.32	45.15	0.973	8.80	1.29	0.95	0.160
6.80	1.21	1.18	0.230	0.20	9.69	35.34	0.972	9.00	1.33	0.94	0.157
7.00	1.22	1.14	0.217	0.25	6.86	28.84	0.969	9.20	1.36	0.95	0.159
7.20	1.23	1.10	0.206	0.30	5.16	24.25	0.967	9.40	1.39	0.95	0.161
7.40	1.26	1.06	0.194	0.35	4.11	20.79	0.964	9.60	1.42	0.97	0.163
7.60	1.28	1.04	0.187	0.40	3.42	18.06	0.960	9.80	1.44	0.99	0.169
7.80	1.30	1.02	0.180	0.45	3.05	15.82	0.954	10.00	1.45	1.01	0.175
8.00	1.33	1.00	0.174	0.50	2.98	14.06	0.944	10.20	1.45	1.04	0.182
8.20	1.35	0.99	0.173	0.60	2.79	11.58	0.925	10.40	1.44	1.07	0.187
8.40	1.38	0.99	0.173	0.70	2.93	9.78	0.895	10.60	1.43	1.09	0.193
8.60	1.40	1.00	0.174	0.80	3.14	8.61	0.862	10.80	1.41	1.12	0.200
8.80	1.42	1.02	0.178	0.90	3.19	7.88	0.840	11.00	1.38	1.13	0.206
9.00	1.43	1.04	0.184	1.00	3.15	7.31	0.822	11.20	1.34	1.14	0.208
9.20	1.45	1.08	0.193	1.10	3.04	6.84	0.808	11.40	1.31	1.13	0.208
9.40	1.43	1.12	0.204	1.20	2.96	6.41	0.791	11.60	1.28	1.12	0.206
9.60	1.40	1.16	0.214	1.30	2.85	6.07	0.779	11.80	1.25	1.10	0.203
9.80	1.37	1.19	0.223	1.40	2.72	5.74	0.767	12.00	1.24	1.08	0.199
				1.50	2.65	5.39	0.750				



Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
19.50	0.75	0.47	0.086	6.15	0.376	0.522	0.306	4.24	1.85	2.14	0.417
19.67	0.75	0.47	0.085	6.45	0.408	0.460	0.256	4.36	1.85	2.08	0.406
19.83	0.75	0.46	0.084	6.75	0.440	0.407	0.214	4.49	1.86	2.03	0.395
20.00	0.74	0.45	0.083	7.05	0.466	0.364	0.183	4.61	1.85	1.99	0.388
20.17	0.74	0.44	0.081	7.35	0.492	0.320	0.155	4.74	1.84	1.94	0.378
20.33	0.74	0.44	0.081	7.65	0.517	0.282	0.131	4.86	1.83	1.91	0.372
20.50	0.74	0.42	0.080	7.95	0.545	0.246	0.109	4.98	1.82	1.86	0.362
20.67	0.73	0.43	0.079	8.25	0.572	0.214	0.091	5.11	1.82	1.82	0.354
20.83	0.73	0.42	0.078	8.55	0.601	0.189	0.075	5.23	1.81	1.79	0.348
21.00	0.73	0.41	0.077	8.85	0.624	0.163	0.063	5.36	1.78	1.76	0.342
21.17	0.72	0.40	0.076	9.15	0.657	0.144	0.050	5.48	1.74	1.73	0.337
21.33	0.72	0.39	0.074	9.45	0.680	0.130	0.042	5.60	1.73	1.70	0.331
21.50	0.72	0.38	0.073	9.75	0.708	0.119	0.034	5.73	1.72	1.67	0.325
21.67	0.72	0.38	0.071	10.1	0.726	0.108	0.029	5.85	1.70	1.64	0.319
21.83	0.72	0.37	0.070	10.4	0.743	0.102	0.025	5.98	1.67	1.61	0.313
22.00	0.72	0.36	0.068	10.6	0.753	0.080	0.022	6.10	1.63	1.58	0.307
22.17	0.71	0.35	0.067	<i>Magnesium (evaporated)<sup>13</sup></i>				6.22	1.62	1.55	0.301
22.33	0.72	0.34	0.064	2.145	0.48	3.71	0.880	6.35	1.59	1.52	0.295
22.50	0.72	0.34	0.063	2.270	0.57	3.47	0.843	6.47	1.55	1.50	0.292
22.67	0.72	0.33	0.062	2.522	0.53	2.92	0.805	6.60	1.48	1.47	0.288
22.83	0.72	0.32	0.059	2.845	0.52	2.65	0.777	<i>Mercury (liquid)<sup>15</sup></i>			
23.00	0.72	0.31	0.058	3.064	0.52	2.05	0.681	0.2	13.99	14.27	0.869
23.17	0.72	0.30	0.056	5.167	0.10	1.60	0.894	0.3	11.37	11.95	0.846
23.33	0.72	0.29	0.054	5.636	0.15	1.50	0.832	0.4	9.741	10.65	0.830
23.50	0.73	0.28	0.050	6.200	0.20	1.40	0.765	0.5	8.528	9.805	0.818
23.67	0.73	0.28	0.049	6.889	0.25	1.30	0.693	0.6	7.574	9.195	0.808
23.83	0.74	0.27	0.047	7.750	0.20	1.20	0.722	0.8	6.086	8.312	0.796
24.00	0.74	0.27	0.045	8.857	0.15	0.95	0.730	1.0	4.962	7.643	0.789
24.17	0.74	0.26	0.044	10.335	0.25	0.40	0.419	1.2	4.050	7.082	0.786
24.33	0.74	0.26	0.043	<i>Manganese<sup>14</sup></i>				1.4	3.324	6.558	0.785
24.50	0.74	0.25	0.042	0.64	3.89	5.95	0.738	1.6	2.746	6.054	0.783
24.67	0.75	0.25	0.040	0.77	3.78	5.41	0.710	1.8	2.284	5.582	0.782
24.83	0.75	0.24	0.039	0.89	3.65	5.02	0.688	2.0	1.910	5.150	0.782
25.00	0.75	0.24	0.038	1.02	3.48	4.74	0.673	2.2	1.620	4.751	0.780
26.00	0.76	0.21	0.031	1.14	3.30	4.53	0.662	2.4	1.384	4.407	0.779
27.00	0.78	0.18	0.026	1.26	3.10	4.35	0.653	2.6	1.186	4.090	0.779
28.00	0.79	0.16	0.021	1.39	2.97	4.18	0.643	2.8	1.027	3.802	0.779
29.00	0.81	0.14	0.017	1.51	2.83	4.03	0.634	3.0	0.898	3.538	0.777
30.00	0.82	0.13	0.014	1.64	2.70	3.91	0.627	3.2	0.798	3.294	0.773
<i>Lithium<sup>12</sup></i>				1.76	2.62	3.78	0.617	3.4	0.713	3.074	0.770
0.14	0.659	38.0	0.998	1.88	2.56	3.65	0.606	3.6	0.644	2.860	0.763
0.54	0.661	12.6	0.984	2.01	2.51	3.54	0.596	3.8	0.589	2.665	0.755
0.75	0.561	7.68	0.963	2.13	2.47	3.43	0.585	4.0	0.542	2.502	0.749
1.05	0.448	5.58	0.946	2.26	2.39	3.33	0.577	4.2	0.507	2.341	0.738
1.35	0.338	4.36	0.935	2.38	2.32	3.23	0.567	4.4	0.477	2.195	0.727
1.65	0.265	3.55	0.925	2.50	2.25	3.14	0.559	4.6	0.452	2.058	0.715
1.95	0.221	2.94	0.913	2.63	2.19	3.06	0.552	4.8	0.431	1.929	0.701
2.25	0.206	2.48	0.892	2.75	2.11	2.98	0.545	5.0	0.414	1.806	0.685
2.55	0.217	2.11	0.854	2.88	2.06	2.90	0.536	5.2	0.401	1.687	0.666
2.85	0.247	1.82	0.797	3.00	2.00	2.82	0.528	5.4	0.394	1.569	0.642
3.15	0.304	1.60	0.715	3.12	1.96	2.74	0.518	5.6	0.386	1.454	0.617
3.45	0.334	1.45	0.656	3.25	1.92	2.67	0.509	5.7	0.386	1.396	0.601
3.75	0.345	1.32	0.611	3.37	1.89	2.59	0.498	5.8	0.386	1.341	0.585
4.05	0.346	1.21	0.578	3.50	1.89	2.51	0.484	5.9	0.385	1.287	0.569
4.35	0.333	1.11	0.557	3.62	1.87	2.45	0.475	6.0	0.386	1.232	0.551
4.65	0.317	1.01	0.540	3.74	1.86	2.38	0.463	6.1	0.388	1.176	0.531
4.95	0.302	0.906	0.520	3.87	1.86	2.32	0.451	6.2	0.390	1.118	0.510
5.25	0.299	0.795	0.484	3.99	1.86	2.25	0.438	6.3	0.399	1.058	0.481
5.55	0.310	0.688	0.434	4.12	1.86	2.19	0.427	6.4	0.412	1.002	0.450
5.85	0.342	0.594	0.365					6.5	0.428	0.949	0.418



Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
36.00	0.82	0.34	0.043	6.60	1.01	1.40	0.325	25.00	0.89	0.42	0.050
37.00	0.81	0.30	0.038	6.80	1.02	1.35	0.308	26.00	0.88	0.39	0.046
38.00	0.81	0.27	0.033	7.00	1.03	1.30	0.291	27.00	0.87	0.37	0.042
39.00	0.82	0.25	0.029	7.20	1.03	1.27	0.282	28.00	0.87	0.35	0.040
40.00	0.83	0.23	0.025	7.40	1.03	1.24	0.273	29.00	0.86	0.34	0.037
<i>Nickel</i> <sup>17</sup>				7.60	1.02	1.22	0.265	30.00	0.86	0.32	0.034
0.10	9.54	45.82	0.983	7.80	1.01	1.18	0.256	35.00	0.86	0.24	0.022
0.15	5.45	30.56	0.978	8.00	1.01	1.15	0.248	40.00	0.87	0.18	0.014
0.20	4.12	22.48	0.969	8.20	1.00	1.13	0.242	45.00	0.88	0.13	0.008
0.25	4.25	17.68	0.950	8.40	0.99	1.11	0.235	50.00	0.92	0.10	0.004
0.30	4.19	15.05	0.934	8.60	0.98	1.08	0.228	60.00	0.96	0.08	0.002
0.35	4.03	13.05	0.918	8.80	0.97	1.05	0.220	65.00	0.98	0.09	0.002
0.40	3.84	11.43	0.900	9.00	0.97	1.01	0.211	68.00	0.96	0.12	0.004
0.50	4.03	9.64	0.864	9.20	0.96	0.99	0.203	70.00	0.94	0.11	0.004
0.60	3.84	8.35	0.835	9.40	0.95	0.96	0.194	75.00	0.94	0.09	0.003
0.70	3.59	7.48	0.813	9.60	0.95	0.93	0.185	80.00	0.94	0.07	0.002
0.80	3.38	6.82	0.794	9.80	0.95	0.89	0.175	90.00	0.94	0.06	0.002
0.90	3.18	6.23	0.774	10.00	0.95	0.87	0.166	<i>Niobium</i> <sup>18</sup>			
1.00	3.06	5.74	0.753	10.20	0.95	0.83	0.155	0.12	15.99	53.20	0.979
1.10	2.97	5.38	0.734	10.40	0.95	0.80	0.145	0.20	7.25	34.14	0.976
1.20	2.85	5.10	0.721	10.60	0.97	0.76	0.129	0.24	5.47	28.88	0.975
1.30	2.74	4.85	0.708	10.80	0.99	0.75	0.123	0.28	4.26	24.95	0.974
1.40	2.65	4.63	0.695	11.00	1.01	0.73	0.115	0.35	3.11	20.03	0.970
1.50	2.53	4.47	0.688	11.25	1.04	0.72	0.111	0.45	2.28	15.58	0.964
1.60	2.43	4.31	0.679	11.50	1.05	0.71	0.109	0.55	1.83	12.67	0.956
1.70	2.28	4.18	0.677	11.75	1.07	0.71	0.108	0.65	1.57	10.59	0.947
1.80	2.14	4.01	0.670	12.00	1.07	0.71	0.108	0.75	1.41	9.00	0.935
1.90	2.02	3.82	0.659	12.25	1.07	0.71	0.107	0.85	1.35	7.74	0.918
2.00	1.92	3.65	0.649	12.50	1.08	0.71	0.106	0.95	1.35	6.70	0.893
2.10	1.85	3.48	0.634	12.75	1.08	0.71	0.106	1.05	1.44	5.86	0.857
2.20	1.80	3.33	0.620	13.00	1.08	0.71	0.105	1.15	1.55	5.18	0.814
2.30	1.75	3.19	0.605	13.25	1.08	0.71	0.105	1.25	1.65	4.63	0.768
2.40	1.71	3.06	0.590	13.50	1.07	0.70	0.105	1.35	1.76	4.13	0.715
2.50	1.67	2.93	0.575	13.75	1.07	0.70	0.105	1.45	1.95	3.68	0.650
2.60	1.65	2.81	0.557	14.00	1.07	0.71	0.106	1.55	2.15	3.37	0.595
2.70	1.64	2.71	0.542	14.25	1.06	0.70	0.106	1.65	2.36	3.13	0.552
2.80	1.63	2.61	0.525	14.50	1.05	0.70	0.106	1.75	2.54	2.99	0.527
2.90	1.62	2.52	0.509	14.75	1.04	0.70	0.107	1.85	2.69	2.89	0.510
3.00	1.61	2.44	0.495	15.00	1.03	0.70	0.107	1.95	2.82	2.86	0.505
3.10	1.61	2.36	0.480	15.25	1.02	0.69	0.106	2.05	2.89	2.87	0.505
3.20	1.61	2.30	0.467	15.50	1.01	0.69	0.105	2.15	2.92	2.87	0.505
3.30	1.61	2.23	0.454	15.75	1.00	0.68	0.104	2.25	2.93	2.87	0.505
3.40	1.62	2.17	0.441	16.00	0.99	0.67	0.103	2.35	2.92	2.88	0.506
3.50	1.63	2.11	0.428	16.50	0.98	0.66	0.101	2.45	2.89	2.90	0.509
3.60	1.64	2.07	0.416	17.00	0.96	0.64	0.098	2.55	2.83	2.92	0.512
3.70	1.66	2.02	0.405	17.50	0.94	0.63	0.096	2.65	2.74	2.90	0.511
3.80	1.69	1.99	0.397	18.00	0.92	0.61	0.092	2.75	2.66	2.86	0.507
3.90	1.72	1.98	0.393	18.50	0.91	0.58	0.087	2.85	2.58	2.80	0.500
4.00	1.73	1.98	0.392	19.00	0.90	0.56	0.082	3.00	2.51	2.68	0.485
4.20	1.74	2.01	0.396	19.50	0.90	0.54	0.077	3.10	2.48	2.60	0.475
4.40	1.71	2.06	0.409	20.00	0.89	0.51	0.071	3.20	2.45	2.53	0.465
4.60	1.63	2.09	0.421	20.50	0.89	0.49	0.066	3.30	2.44	2.45	0.453
4.80	1.53	2.11	0.435	21.00	0.90	0.47	0.061	3.40	2.46	2.38	0.442
5.00	1.40	2.10	0.449	21.50	0.91	0.46	0.057	3.50	2.48	2.33	0.435
5.20	1.27	2.04	0.454	22.00	0.91	0.45	0.055	3.60	2.52	2.29	0.428
5.40	1.16	1.94	0.449	22.50	0.91	0.44	0.053	3.70	2.56	2.27	0.426
5.60	1.09	1.83	0.435	23.00	0.92	0.44	0.051	3.80	2.59	2.28	0.427
5.80	1.04	1.73	0.417	23.50	0.91	0.44	0.052	3.90	2.62	2.29	0.429
6.20	1.00	1.54	0.371	24.00	0.90	0.43	0.051	4.00	2.64	2.33	0.434
6.40	1.01	1.46	0.345	24.50	0.90	0.43	0.051	4.20	2.64	2.42	0.447

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
4.40	2.53	2.56	0.467	20.60	0.71	0.55	0.119	2.20	4.58	1.62	0.457
4.60	2.39	2.56	0.470	21.00	0.72	0.50	0.100	2.30	4.84	1.76	0.479
4.80	2.32	2.52	0.465	21.60	0.75	0.43	0.075	2.40	5.10	2.01	0.506
5.00	2.26	2.57	0.475	22.00	0.78	0.40	0.063	2.50	5.28	2.38	0.532
5.20	2.16	2.62	0.487	22.60	0.82	0.35	0.045	2.60	5.36	2.82	0.557
5.40	2.00	2.68	0.505	23.00	0.85	0.33	0.038	2.70	5.30	3.29	0.580
5.60	1.81	2.67	0.518	23.60	0.88	0.30	0.029	2.80	5.07	3.78	0.603
5.80	1.63	2.60	0.522	24.00	0.91	0.29	0.025	2.90	4.65	4.18	0.624
6.00	1.49	2.49	0.520	24.60	0.94	0.28	0.022	3.00	4.05	4.40	0.639
6.20	1.38	2.38	0.512	25.00	0.96	0.27	0.020	3.20	3.29	3.96	0.614
6.40	1.31	2.25	0.496	25.60	0.99	0.26	0.018	3.40	2.93	3.79	0.607
6.60	1.26	2.14	0.480	26.00	1.00	0.26	0.017	3.60	2.75	3.45	0.577
6.80	1.24	2.04	0.460	26.60	1.03	0.25	0.016	3.80	2.73	3.32	0.562
7.00	1.23	1.96	0.441	27.00	1.04	0.25	0.015	4.00	2.71	3.34	0.565
7.20	1.22	1.91	0.430	27.60	1.06	0.25	0.015	4.20	2.53	3.44	0.584
7.40	1.20	1.88	0.427	28.00	1.08	0.24	0.015	4.40	2.24	3.44	0.599
7.60	1.14	1.85	0.430	28.60	1.11	0.24	0.016	4.60	2.01	3.31	0.598
7.80	1.07	1.78	0.428	29.00	1.13	0.25	0.017	4.80	1.88	3.19	0.592
8.00	1.02	1.69	0.412	29.60	1.16	0.26	0.020	5.00	1.74	3.12	0.596
8.20	1.00	1.60	0.390	30.00	1.18	0.28	0.023	5.20	1.58	3.00	0.597
8.40	0.99	1.51	0.365	31.00	1.18	0.31	0.026	5.40	1.46	2.88	0.593
8.60	0.99	1.43	0.340	32.00	1.20	0.34	0.031	5.60	1.36	2.77	0.589
8.70	0.99	1.39	0.328	33.00	1.21	0.38	0.038	5.80	1.27	2.65	0.582
8.80	1.00	1.36	0.315	34.00	1.20	0.42	0.044	6.00	1.20	2.54	0.575
9.00	1.01	1.29	0.290	35.20	1.17	0.47	0.051	6.20	1.13	2.44	0.571
9.20	1.04	1.22	0.265	36.00	1.15	0.50	0.056	6.40	1.06	2.33	0.562
9.40	1.07	1.18	0.245	37.50	1.07	0.53	0.064	6.60	1.01	2.21	0.548
9.60	1.10	1.13	0.227	39.50	0.95	0.50	0.063	6.80	0.97	2.11	0.532
9.80	1.13	1.09	0.209	40.50	0.92	0.47	0.059	7.00	0.95	2.00	0.514
10.00	1.18	1.05	0.194					7.20	0.92	1.91	0.497
10.20	1.23	1.04	0.187	<i>Osmium (Polycrystalline)<sup>9</sup></i>				7.40	0.91	1.81	0.476
10.40	1.27	1.04	0.185	0.10	4.08	50.23	0.994	7.60	0.90	1.72	0.451
10.60	1.30	1.06	0.190	0.15	2.90	33.60	0.990	7.80	0.90	1.63	0.426
10.80	1.32	1.08	0.195	0.20	2.44	25.11	0.985	8.00	0.91	1.55	0.400
11.00	1.32	1.10	0.200	0.25	2.35	19.99	0.977	8.20	0.91	1.48	0.375
11.20	1.31	1.12	0.204	0.30	2.23	16.54	0.969	8.40	0.94	1.40	0.344
11.40	1.30	1.13	0.207	0.35	2.33	14.06	0.955	8.60	0.96	1.34	0.319
11.60	1.28	1.13	0.209	0.40	2.45	12.32	0.940	8.80	0.98	1.29	0.296
11.80	1.27	1.13	0.210	0.45	2.43	11.02	0.927	9.00	1.01	1.24	0.274
12.00	1.25	1.12	0.209	0.50	2.41	9.97	0.913	9.20	1.04	1.19	0.255
12.40	1.24	1.10	0.204	0.55	2.33	9.12	0.901	9.40	1.08	1.16	0.238
12.80	1.24	1.09	0.200	0.60	2.21	8.37	0.890	9.60	1.10	1.14	0.229
13.20	1.24	1.09	0.201	0.65	2.11	7.68	0.877	9.80	1.13	1.11	0.217
13.60	1.23	1.12	0.208	0.70	2.02	7.04	0.862	10.00	1.16	1.10	0.209
14.00	1.20	1.13	0.216	0.75	2.00	6.46	0.842	10.20	1.19	1.08	0.203
14.40	1.16	1.15	0.225	0.80	2.00	5.95	0.820	10.30	1.20	1.08	0.201
14.80	1.11	1.16	0.234	0.85	2.01	5.51	0.796	10.40	1.22	1.08	0.200
15.00	1.08	1.16	0.238	0.90	2.03	5.10	0.769	10.50	1.23	1.09	0.201
15.60	0.99	1.14	0.247	0.95	2.05	4.74	0.742	10.60	1.24	1.10	0.203
16.00	0.92	1.11	0.250	1.00	2.09	4.41	0.712	10.80	1.25	1.11	0.206
16.60	0.85	1.04	0.245	1.10	2.15	3.84	0.651	11.00	1.24	1.13	0.213
17.00	0.80	0.99	0.240	1.20	2.16	3.35	0.592	11.20	1.23	1.14	0.217
17.20	0.79	0.96	0.236	1.30	2.25	2.77	0.506	11.40	1.19	1.15	0.223
17.40	0.77	0.93	0.230	1.40	2.49	2.23	0.419	11.60	1.17	1.12	0.216
17.80	0.75	0.87	0.217	1.50	2.84	1.80	0.369	11.80	1.16	1.10	0.211
18.00	0.74	0.85	0.209	1.60	3.36	1.62	0.379	12.00	1.15	1.08	0.205
18.60	0.73	0.77	0.185	1.70	3.70	1.75	0.411	12.40	1.14	1.03	0.191
19.00	0.72	0.72	0.170	1.80	3.78	1.83	0.423	12.80	1.15	1.01	0.183
19.60	0.72	0.66	0.150	1.90	3.81	1.75	0.418	13.20	1.16	0.98	0.174
20.00	0.72	0.62	0.137	2.00	3.98	1.60	0.418	13.60	1.17	0.97	0.170
				2.10	4.26	1.54	0.432				





Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
1.70	2.63	4.64	0.697	12.80	1.29	0.94	0.158	4.00	0.34	0.08	0.245
1.80	2.51	4.43	0.686	13.20	1.31	0.93	0.155	4.065	0.38	0.07	0.204
1.90	2.38	4.26	0.678	13.60	1.31	0.93	0.155	4.133	0.41	0.07	0.177
2.00	2.30	4.07	0.664	14.00	1.31	0.93	0.155	4.203	0.45	0.06	0.145
2.10	2.23	3.92	0.654	14.40	1.30	0.93	0.156	4.275	0.48	0.06	0.125
2.20	2.17	3.77	0.642	14.80	1.27	0.93	0.157	4.350	0.52	0.05	0.101
2.30	2.10	3.67	0.636	15.20	1.27	0.93	0.155	4.428	0.55	0.05	0.085
2.40	2.03	3.54	0.626	15.60	1.25	0.92	0.151	4.509	0.58	0.05	0.072
2.50	1.96	3.42	0.616	16.00	1.24	0.89	0.146	4.592	0.61	0.05	0.060
2.60	1.91	3.30	0.605	16.50	1.24	0.87	0.142	4.679	0.64	0.04	0.049
2.70	1.87	3.20	0.595	17.00	1.25	0.86	0.138	4.769	0.66	0.04	0.043
2.80	1.83	3.10	0.585	17.50	1.27	0.85	0.135	4.862	0.68	0.04	0.037
2.90	1.79	3.01	0.575	18.00	1.31	0.88	0.142	4.959	0.70	0.04	0.032
3.00	1.75	2.92	0.565	18.50	1.30	0.94	0.157	5.061	0.72	0.04	0.027
3.20	1.68	2.76	0.546	19.00	1.28	0.99	0.171	5.166	0.74	0.04	0.023
3.40	1.63	2.62	0.527	19.50	1.23	1.03	0.184	5.276	0.76	0.04	0.019
3.60	1.58	2.48	0.507	20.00	1.18	1.06	0.197	5.391	0.78	0.04	0.016
3.80	1.53	2.37	0.491	20.50	1.11	1.09	0.212	5.510	0.79	0.05	0.015
4.00	1.49	2.25	0.472	21.00	1.03	1.10	0.226	5.637	0.81	0.05	0.012
4.20	1.45	2.14	0.452	21.50	0.94	1.08	0.238	5.767	0.83	0.05	0.009
4.40	1.43	2.04	0.432	22.00	0.87	1.04	0.240	6.048	0.85	0.05	0.007
4.60	1.39	1.95	0.415	22.50	0.81	0.98	0.235	6.199	0.87	0.05	0.006
4.80	1.38	1.85	0.392	23.00	0.77	0.92	0.226	6.358	0.88	0.05	0.005
5.00	1.36	1.76	0.372	23.50	0.75	0.87	0.213	6.526	0.90	0.06	0.004
5.20	1.36	1.67	0.350	24.00	0.74	0.82	0.201	6.702	0.91	0.06	0.003
5.40	1.36	1.61	0.332	24.50	0.73	0.77	0.187	6.888	0.92	0.06	0.003
5.60	1.36	1.54	0.315	25.00	0.73	0.73	0.174	7.085	0.92	0.06	0.003
5.80	1.36	1.47	0.295	25.50	0.73	0.70	0.162	7.293	0.93	0.06	0.002
6.00	1.38	1.40	0.276	26.00	0.74	0.67	0.150	7.514	0.93	0.06	0.002
6.20	1.39	1.35	0.261	26.50	0.74	0.65	0.142	7.749	0.94	0.06	0.002
6.40	1.42	1.29	0.246	27.00	0.74	0.63	0.136	7.999	0.94	0.06	0.002
6.60	1.45	1.26	0.236	27.50	0.74	0.62	0.130	8.260	0.94	0.06	0.002
6.80	1.48	1.24	0.231	28.00	0.75	0.60	0.125	8.551	0.94	0.06	0.002
7.00	1.50	1.24	0.230	28.50	0.75	0.59	0.121	8.856	0.94	0.05	0.002
7.20	1.50	1.25	0.231	29.00	0.75	0.58	0.118	9.184	0.94	0.05	0.002
7.40	1.49	1.23	0.228	29.50	0.74	0.58	0.120	9.537	0.94	0.04	0.001
7.60	1.48	1.22	0.225	30.00	0.73	0.58	0.124	9.919	0.94	0.04	0.001
7.80	1.48	1.20	0.221					10.33	0.94	0.03	0.001
8.00	1.47	1.18	0.216	<i>Potassium</i> <sup>21</sup>				11.0		0.03	
8.20	1.47	1.17	0.212	0.55	0.139	7.10	0.989	12.0		0.028	
8.40	1.47	1.15	0.209	0.58	0.119	6.72	0.990				
8.60	1.47	1.14	0.205	0.63	0.106	6.32	0.990	<i>Rhenium, single crystal, E    c<sup>o</sup></i>			
8.80	1.47	1.13	0.202	0.67	0.091	5.79	0.990	0.10	6.06	51.03	0.991
9.00	1.48	1.12	0.200	0.73	0.079	5.30	0.989	0.15	4.66	33.96	0.984
9.20	1.49	1.11	0.198	0.81	0.066	4.75	0.989	0.20	4.16	25.36	0.975
9.40	1.49	1.12	0.200	0.92	0.056	4.19	0.988	0.25	4.03	20.10	0.962
9.60	1.49	1.13	0.203	1.05	0.044	3.58	0.987	0.30	4.37	16.69	0.943
9.80	1.48	1.15	0.207	1.23	0.040	3.04	0.985	0.35	4.50	14.53	0.925
10.00	1.46	1.15	0.209	1.44	0.040	2.56	0.979	0.40	4.53	12.96	0.909
10.20	1.43	1.16	0.211	1.65	0.044	2.19	0.970	0.45	4.53	11.78	0.893
10.40	1.40	1.15	0.210	1.87	0.050	1.84	0.955	0.50	4.53	10.88	0.878
10.60	1.37	1.14	0.207	2.07	0.053	1.62	0.943	0.55	4.50	10.26	0.867
10.80	1.35	1.12	0.203	2.27	0.049	1.43	0.938	0.60	4.29	9.75	0.861
11.00	1.33	1.10	0.199	2.45	0.046	1.28	0.933	0.65	4.07	9.35	0.856
11.20	1.31	1.08	0.194	2.64	0.043	1.14	0.928	0.70	3.80	8.94	0.853
11.40	1.30	1.06	0.188	2.82	0.043	1.02	0.919	0.75	3.48	8.55	0.850
11.60	1.29	1.04	0.183	2.95	0.041	0.898	0.913	0.80	3.21	8.10	0.846
11.80	1.29	1.01	0.177	3.06	0.041	0.799	0.905	0.85	2.96	7.68	0.841
12.00	1.29	1.00	0.173	3.40	0.052	0.549	0.852	0.90	2.73	7.24	0.835
12.40	1.29	0.97	0.165	3.71	0.089	0.288	0.719	0.95	2.56	6.79	0.826
				3.97	0.287	0.091	0.310	1.00	2.45	6.36	0.813



Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
1.10	2.38	5.61	0.778	11.40	1.28	1.28	0.252	50.00	0.80	0.30	0.038
1.20	2.35	5.02	0.742	11.60	1.26	1.28	0.252	52.00	0.78	0.30	0.044
1.30	2.39	4.54	0.702	11.80	1.24	1.26	0.249	54.00	0.72	0.30	0.055
1.40	2.44	4.13	0.662	12.00	1.23	1.24	0.244	56.00	0.66	0.24	0.061
1.50	2.50	3.79	0.624	12.40	1.22	1.21	0.237	58.00	0.65	0.16	0.055
1.60	2.59	3.49	0.587	12.80	1.21	1.18	0.230	<i>Rhenium, single crystal, <math>\bar{E} \perp c^p</math></i>			
1.70	2.70	3.27	0.557	13.20	1.22	1.16	0.222	0.10	4.25	42.83	0.991
1.80	2.82	3.10	0.535	13.60	1.22	1.13	0.215	0.15	3.28	28.08	0.984
1.90	2.90	3.00	0.520	14.00	1.24	1.12	0.209	0.20	3.28	20.66	0.971
2.00	2.97	2.91	0.510	14.40	1.27	1.11	0.204	0.25	3.47	16.27	0.951
2.10	3.03	2.86	0.504	14.80	1.29	1.15	0.213	0.30	3.73	13.44	0.926
2.20	3.06	2.84	0.501	15.20	1.29	1.19	0.225	0.35	3.93	11.54	0.900
2.30	3.07	2.82	0.499	15.60	1.26	1.22	0.236	0.40	3.99	10.15	0.875
2.40	3.06	2.81	0.498	16.00	1.23	1.25	0.248	0.45	4.17	9.03	0.846
2.50	3.02	2.80	0.497	16.40	1.19	1.27	0.259	0.50	4.34	8.26	0.821
2.60	2.96	2.77	0.493	16.80	1.14	1.29	0.269	0.55	4.45	7.73	0.801
2.70	2.89	2.68	0.482	17.00	1.12	1.30	0.275	0.60	4.53	7.40	0.788
2.80	2.89	2.57	0.468	17.40	1.07	1.30	0.286	0.65	4.44	7.26	0.784
2.90	2.99	2.47	0.457	18.00	0.99	1.30	0.300	0.70	4.13	7.09	0.784
3.00	3.11	2.57	0.470	18.40	0.93	1.29	0.311	0.75	3.77	6.75	0.779
3.20	2.90	2.68	0.482	18.80	0.87	1.28	0.321	0.80	3.55	6.32	0.766
3.40	2.83	2.50	0.459	19.20	0.81	1.25	0.330	0.85	3.39	5.95	0.752
3.60	2.93	2.48	0.457	19.60	0.77	1.21	0.332	0.90	3.26	5.61	0.737
3.80	2.86	2.56	0.467	20.00	0.73	1.18	0.333	0.95	3.17	5.27	0.719
4.00	2.81	2.51	0.460	20.40	0.70	1.14	0.332	1.00	3.09	4.96	0.701
4.20	2.86	2.55	0.466	20.80	0.67	1.11	0.332	1.10	3.05	4.39	0.658
4.40	2.81	2.74	0.489	21.20	0.64	1.08	0.334	1.20	3.08	3.89	0.613
4.60	2.56	2.83	0.504	21.60	0.61	1.04	0.335	1.30	3.20	3.56	0.578
4.80	2.41	2.71	0.493	22.00	0.58	1.01	0.340	1.40	3.23	3.38	0.559
5.00	2.39	2.68	0.488	22.40	0.55	0.97	0.341	1.50	3.23	3.12	0.532
5.20	2.34	2.75	0.500	22.80	0.53	0.93	0.338	1.60	3.29	2.88	0.507
5.40	2.20	2.81	0.515	23.20	0.51	0.89	0.334	1.70	3.38	2.72	0.491
5.60	2.02	2.84	0.530	23.60	0.50	0.85	0.329	1.80	3.47	2.59	0.480
5.80	1.83	2.80	0.538	24.00	0.48	0.80	0.319	1.90	3.54	2.50	0.473
6.00	1.65	2.71	0.541	24.40	0.48	0.76	0.207	2.00	3.63	2.43	0.469
6.20	1.54	2.59	0.532	24.80	0.47	0.72	0.296	2.10	3.74	2.40	0.470
6.40	1.45	2.50	0.526	25.20	0.47	0.68	0.282	2.20	3.83	2.38	0.472
6.80	1.32	2.31	0.508	25.60	0.47	0.65	0.270	2.30	3.93	2.44	0.481
7.00	1.26	2.23	0.500	26.00	0.47	0.61	0.255	2.40	4.00	2.55	0.492
7.20	1.20	2.15	0.493	26.40	0.48	0.57	0.240	2.50	4.01	2.70	0.505
7.40	1.16	2.06	0.480	26.80	0.48	0.54	0.225	2.60	3.90	2.84	0.514
7.60	1.12	1.99	0.470	27.20	0.49	0.51	0.208	2.70	3.74	2.92	0.517
7.80	1.08	1.89	0.454	27.60	0.50	0.48	0.193	2.80	3.57	2.88	0.511
8.00	1.05	1.80	0.435	28.00	0.51	0.45	0.176	2.90	3.49	2.75	0.497
8.20	1.05	1.71	0.411	29.00	0.54	0.39	0.145	3.00	3.53	2.71	0.493
8.40	1.05	1.62	0.386	30.00	0.57	0.33	0.114	3.20	3.55	2.84	0.506
8.60	1.06	1.55	0.360	31.00	0.62	0.29	0.086	3.40	3.34	2.88	0.508
8.80	1.09	1.48	0.336	32.00	0.66	0.26	0.065	3.60	3.25	2.83	0.501
9.00	1.11	1.43	0.317	33.00	0.68	0.24	0.054	3.80	3.24	2.84	0.502
9.20	1.13	1.39	0.301	34.00	0.72	0.21	0.041	4.00	3.19	2.94	0.513
9.40	1.16	1.34	0.281	35.00	0.76	0.20	0.031	4.20	3.05	3.06	0.526
9.60	1.18	1.32	0.274	36.00	0.79	0.20	0.025	4.40	2.88	3.15	0.539
9.80	1.20	1.29	0.264	37.00	0.82	0.19	0.021	4.60	2.67	3.18	0.548
10.00	1.23	1.26	0.252	38.00	0.85	0.20	0.018	4.80	2.44	3.17	0.554
10.20	1.25	1.25	0.246	39.00	0.89	0.21	0.016	5.00	2.25	3.12	0.556
10.40	1.28	1.25	0.242	40.00	0.88	0.26	0.022	5.20	2.10	3.04	0.555
10.60	1.29	1.25	0.242	42.00	0.88	0.26	0.022	5.40	1.96	2.96	0.553
10.80	1.30	1.26	0.244	44.00	0.89	0.29	0.026	5.60	1.84	2.88	0.551
11.00	1.30	1.27	0.247	46.00	0.85	0.32	0.035	5.80	1.73	2.81	0.549
11.20	1.29	1.28	0.249	48.00	0.82	0.30	0.036	6.00	1.61	2.74	0.549

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
6.20	1.51	2.64	0.545	24.80	0.48	0.75	0.303	3.10	1.41	4.20	0.760
6.40	1.42	2.56	0.541	25.20	0.47	0.72	0.295	3.20	1.30	4.09	0.764
6.80	1.28	2.37	0.526	25.60	0.47	0.68	0.286	3.30	1.20	3.97	0.767
7.00	1.22	2.28	0.517	26.00	0.46	0.64	0.276	3.40	1.11	3.84	0.769
7.20	1.16	2.19	0.508	26.40	0.46	0.61	0.263	3.50	1.04	3.71	0.768
7.40	1.12	2.08	0.493	26.80	0.46	0.57	0.249	3.60	0.99	3.58	0.764
7.60	1.12	1.98	0.468	27.20	0.47	0.53	0.231	3.70	0.95	3.45	0.759
7.80	1.08	1.93	0.463	27.60	0.48	0.50	0.216	3.80	0.91	3.34	0.753
8.00	1.05	1.83	0.443	28.00	0.49	0.47	0.198	3.90	0.88	3.23	0.747
8.20	1.05	1.74	0.418	29.00	0.51	0.41	0.164	4.00	0.86	3.12	0.739
8.40	1.05	1.66	0.397	30.00	0.55	0.34	0.129	4.20	0.83	2.94	0.722
8.60	1.06	1.58	0.372	31.00	0.59	0.29	0.097	4.40	0.80	2.76	0.706
8.80	1.07	1.52	0.351	32.00	0.64	0.26	0.072	4.60	0.78	2.60	0.684
9.00	1.09	1.46	0.327	33.00	0.67	0.24	0.060	4.80	0.79	2.46	0.659
9.20	1.11	1.41	0.309	34.00	0.70	0.22	0.047	5.00	0.79	2.34	0.635
9.40	1.14	1.36	0.290	35.00	0.74	0.20	0.036	5.20	0.79	2.23	0.613
9.60	1.17	1.31	0.273	36.00	0.77	0.19	0.029	5.40	0.80	2.14	0.591
9.80	1.20	1.27	0.258	37.00	0.80	0.19	0.023	5.60	0.80	2.06	0.573
10.00	1.24	1.24	0.244	38.00	0.84	0.19	0.018	5.80	0.79	2.00	0.561
10.20	1.29	1.22	0.234	39.00	0.88	0.21	0.016	6.00	0.76	1.93	0.556
10.40	1.33	1.23	0.233	40.00	0.87	0.25	0.023	6.20	0.73	1.85	0.544
10.60	1.36	1.25	0.238	42.00	0.87	0.25	0.023	6.40	0.70	1.77	0.534
10.80	1.38	1.28	0.245	44.00	0.88	0.28	0.026	6.60	0.68	1.69	0.518
11.00	1.37	1.31	0.253	46.00	0.84	0.31	0.035	6.80	0.67	1.60	0.498
11.20	1.36	1.33	0.259	48.00	0.82	0.30	0.036	7.00	0.66	1.52	0.476
11.40	1.33	1.34	0.264	50.00	0.80	0.30	0.039	7.20	0.66	1.43	0.452
11.60	1.31	1.34	0.266	52.00	0.77	0.30	0.044	7.40	0.66	1.35	0.423
11.80	1.28	1.33	0.266	54.00	0.71	0.29	0.055	7.60	0.67	1.27	0.394
12.00	1.26	1.32	0.264	56.00	0.66	0.23	0.061	7.80	0.68	1.20	0.363
12.40	1.23	1.29	0.257	58.00	0.64	0.16	0.055	8.00	0.69	1.12	0.329
12.80	1.22	1.26	0.251					8.20	0.71	1.04	0.288
13.20	1.20	1.23	0.245	<i>Rhodium<sup>II</sup></i>				8.40	0.74	0.97	0.252
13.60	1.19	1.20	0.236	0.10	18.48	69.43	0.986	8.60	0.78	0.89	0.212
14.00	1.20	1.16	0.225	0.20	8.66	37.46	0.977	8.80	0.83	0.83	0.179
14.40	1.22	1.13	0.214	0.30	5.85	25.94	0.967	9.00	0.88	0.77	0.148
14.80	1.27	1.12	0.207	0.40	4.74	19.80	0.955	9.20	0.95	0.73	0.125
15.20	1.31	1.17	0.218	0.50	4.20	16.07	0.941	9.40	1.01	0.71	0.110
15.60	1.31	1.23	0.234	0.60	3.87	13.51	0.925	9.60	1.07	0.69	0.102
16.00	1.28	1.28	0.251	0.70	3.67	11.72	0.908	9.80	1.12	0.69	0.098
16.40	1.24	1.33	0.270	0.80	3.63	10.34	0.887	10.00	1.17	0.69	0.098
16.80	1.17	1.37	0.288	0.90	3.62	9.36	0.867	10.60	1.26	0.73	0.106
17.00	1.14	1.38	0.297	1.00	3.71	8.67	0.848	11.00	1.29	0.76	0.113
17.40	1.06	1.39	0.314	1.10	3.67	8.26	0.837	11.60	1.32	0.80	0.124
18.00	0.95	1.38	0.334	1.20	3.51	7.94	0.832	12.00	1.32	0.82	0.127
18.40	0.88	1.36	0.346	1.30	3.26	7.63	0.829	12.60	1.32	0.82	0.129
18.80	0.82	1.33	0.355	1.40	3.01	7.31	0.827	13.00	1.32	0.83	0.131
19.20	0.76	1.29	0.360	1.50	2.78	6.97	0.823	13.60	1.32	0.85	0.134
19.60	0.72	1.25	0.363	1.60	2.60	6.64	0.818	14.00	1.32	0.86	0.138
20.00	0.67	1.21	0.369	1.70	2.42	6.33	0.813	14.60	1.30	0.89	0.144
20.40	0.64	1.15	0.364	1.80	2.30	6.02	0.805	15.00	1.28	0.90	0.147
20.80	0.61	1.10	0.357	1.90	2.20	5.76	0.798	15.60	1.25	0.90	0.147
21.20	0.60	1.06	0.349	2.00	2.12	5.51	0.789	16.00	1.24	0.89	0.147
21.60	0.58	1.02	0.342	2.10	2.05	5.30	0.780	16.50	1.23	0.88	0.145
22.00	0.57	0.98	0.336	2.20	2.00	5.11	0.772	17.00	1.22	0.88	0.144
22.40	0.56	0.95	0.328	2.30	1.94	4.94	0.765	17.50	1.22	0.87	0.143
22.80	0.55	0.92	0.325	2.40	1.90	4.78	0.756	18.00	1.23	0.88	0.145
23.20	0.53	0.89	0.322	2.50	1.88	4.65	0.748	18.50	1.25	0.92	0.155
23.60	0.52	0.85	0.317	2.60	1.85	4.55	0.743	19.00	1.24	0.98	0.172
24.00	0.50	0.82	0.314	2.70	1.80	4.49	0.742	19.50	1.18	1.05	0.193
24.40	0.49	0.79	0.309	2.90	1.63	4.36	0.748	20.00	1.10	1.09	0.213
				3.00	1.53	4.29	0.753				

Energy (eV)	$n$	$k$	$R(\phi = 0)$
20.50	1.00	1.09	0.230
21.00	0.91	1.05	0.234
21.50	0.86	1.00	0.228
22.00	0.83	0.95	0.219
22.50	0.81	0.92	0.214
23.00	0.79	0.90	0.213
23.50	0.75	0.87	0.214
24.00	0.73	0.84	0.210
24.50	0.70	0.81	0.208
25.00	0.69	0.77	0.202
25.50	0.67	0.74	0.195
26.00	0.66	0.70	0.188
26.50	0.65	0.66	0.176
27.00	0.65	0.64	0.168
27.50	0.65	0.61	0.159
28.00	0.65	0.59	0.152
29.00	0.65	0.54	0.137
30.00	0.66	0.51	0.127
31.00	0.64	0.49	0.127
32.00	0.61	0.44	0.126
33.00	0.60	0.37	0.110
34.00	0.65	0.30	0.074
35.00	0.69	0.28	0.058
36.00	0.73	0.27	0.049
37.00	0.74	0.28	0.047
38.00	0.74	0.27	0.045
39.00	0.75	0.25	0.041

*Ruthenium, single crystal,  $\vec{E} \parallel \vec{c}^p$*

0.10	11.50	51.38	0.984
0.20	5.93	27.14	0.970
0.30	4.33	18.50	0.953
0.40	3.60	13.97	0.933
0.50	3.18	11.04	0.909
0.60	3.28	8.89	0.865
0.70	3.62	7.73	0.822
0.80	3.42	7.02	0.801
0.90	3.25	6.12	0.766
1.00	3.39	5.33	0.715
1.10	3.66	4.83	0.675
1.20	3.84	4.57	0.654
1.30	3.94	4.38	0.638
1.40	4.02	4.19	0.624
1.50	4.16	4.07	0.614
1.60	4.33	4.08	0.615
1.70	4.42	4.21	0.624
1.80	4.40	4.38	0.636
1.90	4.29	4.61	0.651
2.00	4.04	4.81	0.667
2.10	3.69	4.90	0.679
2.20	3.35	4.82	0.683
2.30	3.09	4.70	0.681
2.40	2.89	4.55	0.677
2.50	2.74	4.40	0.671
2.60	2.64	4.25	0.663
2.70	2.58	4.14	0.656
2.80	2.54	4.05	0.650
2.90	2.48	4.03	0.650
3.00	2.38	4.03	0.656
3.10	2.26	4.00	0.661
3.20	2.13	3.96	0.666

Energy (eV)	$n$	$k$	$R(\phi = 0)$
3.30	2.00	3.91	0.671
3.40	1.87	3.83	0.673
3.50	1.76	3.74	0.674
3.60	1.66	3.65	0.675
3.70	1.57	3.55	0.673
3.80	1.49	3.45	0.672
3.90	1.42	3.35	0.668
4.00	1.37	3.24	0.661
4.20	1.29	3.08	0.649
4.40	1.22	2.93	0.639
4.60	1.16	2.79	0.628
4.80	1.11	2.67	0.617
5.00	1.06	2.56	0.607
5.20	1.01	2.46	0.600
5.40	0.95	2.35	0.593
5.60	0.92	2.23	0.576
5.80	0.90	2.14	0.559
6.00	0.88	2.05	0.545
6.20	0.87	1.98	0.531
6.40	0.84	1.91	0.521
6.60	0.82	1.84	0.510
6.80	0.79	1.77	0.500
7.00	0.76	1.69	0.489
7.20	0.75	1.61	0.472
7.40	0.73	1.54	0.455
7.60	0.73	1.46	0.433
7.80	0.73	1.39	0.411
8.00	0.72	1.33	0.391
8.20	0.72	1.26	0.366
8.40	0.73	1.20	0.342
8.60	0.74	1.14	0.318
8.80	0.74	1.08	0.295
9.00	0.75	1.02	0.267
9.20	0.77	0.97	0.243
9.40	0.79	0.91	0.217
9.60	0.82	0.86	0.190
9.80	0.85	0.81	0.167
10.00	0.88	0.76	0.144
10.20	0.92	0.72	0.125
10.40	0.96	0.69	0.110
10.60	1.01	0.67	0.100
10.80	1.05	0.66	0.094
11.00	1.09	0.65	0.090
11.20	1.12	0.65	0.088
11.40	1.15	0.65	0.087
11.60	1.18	0.65	0.088
11.80	1.21	0.66	0.090
12.00	1.23	0.67	0.092
12.40	1.26	0.69	0.098
12.80	1.27	0.72	0.104
13.20	1.28	0.74	0.108
13.60	1.28	0.75	0.111
14.00	1.28	0.76	0.114
14.40	1.27	0.76	0.114
14.80	1.27	0.76	0.114
15.00	1.27	0.76	0.114
15.60	1.28	0.77	0.115
16.00	1.30	0.78	0.118
16.50	1.32	0.80	0.123
17.00	1.34	0.85	0.136

Energy (eV)	$n$	$k$	$R(\phi = 0)$
17.50	1.32	0.93	0.155
18.00	1.26	0.99	0.173
18.50	1.18	1.02	0.185
19.00	1.11	1.02	0.192
19.50	1.05	1.02	0.199
20.00	0.99	1.02	0.208
20.50	0.92	0.99	0.212
21.00	0.86	0.94	0.209
21.50	0.83	0.90	0.203
22.00	0.81	0.86	0.193
23.00	0.77	0.79	0.182
24.00	0.74	0.74	0.171
25.00	0.71	0.69	0.163
26.00	0.68	0.63	0.154
27.00	0.67	0.57	0.140
28.00	0.66	0.51	0.124
29.00	0.67	0.46	0.107
30.00	0.67	0.43	0.097
31.00	0.67	0.37	0.084
32.00	0.69	0.33	0.070
33.00	0.71	0.30	0.058
34.00	0.73	0.27	0.048
35.00	0.75	0.25	0.039
36.00	0.77	0.24	0.035
37.00	0.79	0.23	0.039
38.00	0.80	0.22	0.027
39.00	0.82	0.22	0.024
40.00	0.83	0.22	0.022

*Ruthenium, single crystal,  $\vec{E} \perp \vec{c}^s$*

0.10	11.85	50.81	0.983
0.20	6.68	27.18	0.966
0.30	4.94	18.92	0.950
0.40	3.90	14.51	0.933
0.50	3.27	11.63	0.915
0.60	2.98	9.54	0.888
0.70	2.82	7.99	0.856
0.80	2.73	6.71	0.815
0.90	2.82	5.54	0.751
1.00	3.17	4.59	0.670
1.10	3.69	3.91	0.604
1.20	4.28	3.66	0.585
1.30	4.66	3.72	0.593
1.40	4.86	3.79	0.601
1.50	4.99	3.89	0.609
1.60	5.08	4.03	0.618
1.70	5.12	4.22	0.629
1.80	5.10	4.45	0.642
1.90	4.96	4.78	0.660
2.00	4.61	5.06	0.677
2.10	4.21	5.09	0.682
2.20	3.94	5.00	0.681
2.30	3.69	4.97	0.684
2.40	3.44	4.88	0.684
2.50	3.27	4.77	0.681
2.60	3.14	4.66	0.677
2.70	3.06	4.59	0.674
2.80	2.99	4.59	0.676
2.90	2.87	4.64	0.686
3.00	2.64	4.69	0.701
3.10	2.40	4.64	0.710

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
3.20	2.18	4.55	0.717
3.30	2.00	4.43	0.721
3.40	1.84	4.30	0.723
3.50	1.71	4.16	0.723
3.60	1.60	4.03	0.722
3.70	1.50	3.90	0.721
3.80	1.41	3.77	0.718
3.90	1.35	3.64	0.713
4.00	1.29	3.53	0.707
4.20	1.21	3.31	0.694
4.40	1.16	3.13	0.679
4.60	1.13	2.97	0.662
4.80	1.09	2.86	0.652
5.00	1.03	2.75	0.648
5.20	0.97	2.64	0.643
5.40	0.91	2.52	0.635
5.60	0.88	2.40	0.622
5.80	0.86	2.29	0.605
6.00	0.84	2.20	0.591
6.20	0.82	2.11	0.576
6.40	0.81	2.04	0.564
6.60	0.78	1.97	0.556
6.80	0.76	1.89	0.545
7.00	0.73	1.82	0.538
7.20	0.70	1.75	0.527
7.40	0.68	1.67	0.513
7.60	0.67	1.59	0.496
7.80	0.66	1.51	0.476
8.00	0.66	1.44	0.454
8.20	0.65	1.36	0.430
8.40	0.66	1.29	0.403
8.60	0.66	1.22	0.378
8.80	0.68	1.15	0.346
9.00	0.69	1.09	0.317
9.20	0.70	1.02	0.286
9.40	0.73	0.95	0.251
9.60	0.77	0.89	0.216
9.80	0.82	0.84	0.185
10.00	0.86	0.81	0.163
10.20	0.90	0.77	0.143
10.40	0.94	0.74	0.127
10.60	0.99	0.72	0.115
10.80	1.04	0.71	0.108
11.00	1.08	0.70	0.104
11.20	1.11	0.70	0.102
11.40	1.14	0.70	0.101
11.60	1.17	0.71	0.102
11.80	1.20	0.72	0.104
12.00	1.22	0.73	0.107
12.40	1.25	0.76	0.113
12.80	1.26	0.78	0.118
13.20	1.27	0.81	0.124
13.60	1.27	0.83	0.129
14.00	1.26	0.84	0.132
14.40	1.25	0.84	0.132
14.80	1.25	0.84	0.133
15.00	1.25	0.84	0.133
15.60	1.25	0.85	0.134
16.00	1.27	0.85	0.134
16.50	1.28	0.89	0.145

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
17.00	1.28	0.94	0.158
17.50	1.25	1.00	0.175
18.00	1.19	1.04	0.190
18.50	1.12	1.05	0.200
19.00	1.07	1.05	0.205
19.50	1.02	1.04	0.212
20.00	0.97	1.04	0.219
20.50	0.91	1.03	0.228
21.00	0.85	1.01	0.234
21.50	0.80	0.97	0.234
22.00	0.77	0.94	0.233
23.00	0.71	0.87	0.229
24.00	0.67	0.79	0.218
25.00	0.64	0.73	0.205
26.00	0.61	0.66	0.194
27.00	0.60	0.59	0.177
28.00	0.60	0.53	0.155
29.00	0.61	0.48	0.134
30.00	0.62	0.45	0.123
31.00	0.61	0.40	0.114
32.00	0.63	0.34	0.093
33.00	0.65	0.31	0.077
34.00	0.67	0.28	0.065
35.00	0.70	0.26	0.054
36.00	0.72	0.25	0.047
37.00	0.73	0.23	0.041
38.00	0.75	0.22	0.035
39.00	0.77	0.22	0.031
40.00	0.79	0.22	0.028
<i>Selenium, single crystal, <math>\vec{E} \parallel c^{22}</math></i>			
0.01364	2.914	0.248	0.242
0.01488	3.175	9.95E-02	0.272
0.01612	3.263	2.13E-03	0.282
0.01736	3.306	3.81E-02	0.287
0.01860	3.330	7.04E-03	0.290
0.01984	3.346	4.23E-02	0.291
0.02108	3.358	3.40E-03	0.293
0.02232	3.366	5.31E-02	0.294
0.02356	3.372	1.96E-03	0.294
0.02480	3.377	2.39E-02	0.295
0.02604	3.380		0.295
0.02728		1.16E-02	
0.02976		7.96E-03	
0.03224		8.57E-03	
0.03472		2.70E-02	
0.03720	3.397	1.72E-02	0.297
0.04463		1.13E-02	
0.04959	3.403	2.79E-03	0.298
0.05703		1.56E-03	
0.06199	3.405	1.35E-03	0.298
0.06819		5.79E-04	
0.07439	3.407	4.44E-04	0.298
0.08059		4.41E-04	
0.08679	3.408	4.32E-04	0.298
0.09299		2.44E-04	
0.09919	3.409	3.23E-04	0.299
0.1116	3.409	2.87E-04	0.299
0.1240	3.410	2.71E-04	0.299
0.2480	3.417	2.67E-04	0.299
0.3720	3.427	1.90E-04	0.301

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
0.4959	3.442	1.41E-04	0.302
0.6199	3.462	1.12E-04	0.304
0.7439	3.486	9.42E-05	0.307
0.8679	3.516	8.07E-05	0.310
0.9919	3.551	7.11E-05	0.314
1.116	3.592	6.37E-05	0.319
1.240	3.640	5.81E-05	0.324
1.50		1.33E-04	
1.60		1.59E-04	
1.70		6.27E-04	
1.80	4.46	2.20E-02	0.402
2.0	4.79	0.76	0.438
2.2	4.49	1.19	0.431
2.4	4.28	1.21	0.417
2.6	4.40	1.32	0.430
2.8	4.59	1.70	0.462
3.0	4.44	2.29	0.490
3.2	3.92	2.59	0.493
3.4	3.69	2.76	0.502
3.6	3.39	3.01	0.521
3.8	(3.00)		
4.0	(2.65)		
4.2	(2.30)		
4.5	1.92	2.78	0.528
5.0	1.50	2.31	0.482
6.0	1.57	1.49	0.288
7.0	1.84	1.45	0.276
8.0	1.35	1.68	0.353
9.0	1.35	1.64	0.342
10.0	0.92	1.07	0.238
12.0	1.00	1.10	0.232
14.0	0.81	0.91	0.211
16.0	0.65	0.61	0.160
18.0	0.65	0.48	0.120
20.0	0.69	0.36	0.076
22.0	0.81	0.25	0.030
24.0	0.91	0.18	0.011
26.0	0.86	0.15	0.012
28.0	0.85	0.13	0.011
30.0	0.87	0.11	0.008
<i>Selenium, single crystal, <math>\vec{E} \perp c^{22}</math></i>			
0.01364	2.854	0.0239	0.231
0.01488	2.932	0.0325	0.241
0.01612	3.140	0.1750	0.269
0.01736	2.959	1.3300	0.321
0.01860	2.111	0.2550	0.133
0.01984	2.356	0.0746	0.164
0.02108	2.462	0.0276	0.178
0.02232	2.502	0.0442	0.184
0.02356	2.543	0.0097	0.190
0.02480	2.550	0.0239	0.191
0.02604	2.582		0.195
0.02728	2.600	0.0101	0.198
0.02976	2.576	9.95E-03	0.194
0.03224	2.598	1.16E-02	0.197
0.03472	2.607	1.68E-02	0.199
0.03720	2.613	1.54E-02	0.199
0.04463		1.17E-02	
0.04959	2.627	3.58E-03	0.201
0.05703		8.65E-04	

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
0.06199	2.632	2.07E-03	0.202	0.04959	3.4201	9.15E-05	0.300	3.6	5.296	2.987	0.564
0.06819		2.89E-04		0.05703		1.56E-04		3.7	5.156	3.058	0.563
0.07439	2.635	1.59E-04	0.202	0.06199	3.4204	2.86E-04	0.300	3.8	5.065	3.182	0.568
0.08059		1.35E-04		0.06943		3.84E-04		3.9	5.016	3.346	0.577
0.08679	2.636	1.42E-04	0.202	0.07439		7.16E-04		4.0	5.010	3.587	0.591
0.09299		1.04E-04		0.08059	(3.4207)	1.52E-04	0.300	4.1	5.020	3.979	0.614
0.09919	2.637	8.95E-05	0.203	0.08679		1.02E-04		4.2	4.888	4.639	0.652
0.1116	2.638	8.84E-05	0.203	0.09299		2.59E-04		4.3	4.086	5.395	0.703
0.1240	2.639	8.51E-05	0.203	0.09919		1.77E-04		4.4	3.120	5.344	0.726
0.2480	2.645	5.97E-05	0.204	0.1054		1.53E-04		4.5	2.451	5.082	0.740
0.3720	2.652	5.44E-05	0.205	0.1116		2.02E-04		4.6	1.988	4.678	0.742
0.4959	2.654	4.58E-05	0.205	0.1178		1.22E-04		4.7	1.764	4.278	0.728
0.6199	2.675	3.82E-05	0.208	0.1240	3.4215	6.76E-05	0.300	4.8	1.658	3.979	0.710
0.7439	2.692	3.32E-05	0.210	0.1364		5.49E-05		4.9	1.597	3.749	0.693
0.8679	2.713	2.96E-05	0.213	0.1488		2.41E-05		5.0	1.570	3.565	0.675
0.9919	2.739	2.69E-05	0.216	0.1612		2.49E-05		5.1	1.571	3.429	0.658
1.116	2.772	2.48E-05	0.221	0.1736	(3.4230)	1.68E-05	0.300	5.2	1.589	3.354	0.646
1.240	2.816	2.31E-05	0.226	0.1798		2.45E-05		5.3	1.579	3.353	0.647
1.50		7.37E-05		0.1860		2.66E-06		5.4	1.471	3.366	0.663
1.60		8.63E-05		0.1922		1.74E-06		5.5	1.340	3.302	0.673
1.70		3.60E-04		0.1984		8.46E-07		5.6	1.247	3.206	0.675
1.80	3.32	0.11	0.289	0.2046		5.64E-07		5.7	1.180	3.112	0.673
2.00	3.38	0.65	0.310	0.2108	(3.4244)	4.17E-07	0.300	5.8	1.133	3.045	0.672
2.20	3.07	0.73	0.282	0.2170		4.05E-07		5.9	1.083	2.982	0.673
2.40	2.93	0.61	0.259	0.2232		3.94E-07		6.0	1.010	2.909	0.677
2.60	3.00	0.53	0.263	0.2294		3.26E-07		6.5	0.847	2.73	0.688
2.80	3.12	0.58	0.279	0.2356		2.97E-07		7.0	0.682	2.45	0.691
3.00	3.30	0.70	0.305	0.2418		2.82E-07		7.5	0.563	2.21	0.693
3.20	3.35	1.01	0.328	0.2480	3.4261	1.99E-07	0.300	8.0	0.478	2.00	0.691
3.40	3.22	1.24	0.334	0.3100	3.4294		0.301	8.5	0.414	1.82	0.688
3.60	3.06	1.47	0.344	0.3626	3.4327		0.301	9.0	0.367	1.66	0.683
3.80	2.84	1.66	0.351	0.4568	3.4393	2.50E-09	0.302	9.5	0.332	1.51	0.672
4.00	2.51	1.81	0.356	0.6199	3.4490		0.303	10.0	0.306	1.38	0.661
4.20	2.18	1.83	0.352	0.8093	3.4784		0.306	12.0	0.257	0.963	0.590
4.50	1.75	1.94	0.382	1.033	3.5193		0.311	14.0	0.275	0.641	0.460
5.00	1.25	1.50	0.316	1.1	(3.5341)	1.30E-05	0.312	16.0	0.345	0.394	0.297
6.00	1.32	0.73	0.107	1.2		1.80E-04		18.0	0.455	0.219	0.159
7.00	1.62	0.61	0.105	1.3		2.26E-03		20.0	0.567	0.0835	0.079
8.00	1.81	0.69	0.135	1.4		7.75E-03		22.14	0.675	0.0405	0.038
9.00	1.66	1.02	0.182	1.5	3.673	5.00E-03	0.327	24.31	0.752	0.0243	0.020
10.00	1.72	0.95	0.171	1.6	3.714	8.00E-03	0.331	26.38	0.803	0.0178	0.012
12.00	1.25	1.02	0.181	1.7	3.752	1.00E-02	0.335	28.18	0.834	0.0152	0.008
14.00	0.98	0.92	0.178	1.8	3.796	0.013	0.340	30.24	0.860	0.0138	0.006
16.00	0.68	0.96	0.274	1.9	3.847	0.016	0.345	31.79	0.877	0.0132	0.004
18.00	0.61	0.65	0.191	2.0	3.906	0.022	0.351	34.44	0.899	0.0121	0.003
20.00	0.73	0.48	0.094	2.1	3.969	0.030	0.357	36.47	0.913	0.0113	0.002
22.00	0.78	0.39	0.060	2.2	4.042	0.032	0.364	38.75	0.925	0.0104	0.002
24.00	0.78	0.32	0.046	2.3	4.123	0.048	0.372	40.00	0.930	0.0100	0.001
26.00	0.78	0.26	0.036	2.4	4.215	0.060	0.380				
28.00	0.80	0.19	0.023	2.5	4.320	0.073	0.390				
30.00	0.79	0.14	0.020	2.6	4.442	0.090	0.400	<i>Silver</i> <sup>6</sup>			
				2.7	4.583	0.130	0.412	0.10	9.91	90.27	0.995
				2.8	4.753	0.163	0.426	0.20	2.84	45.70	0.995
				2.9	4.961	0.203	0.442	0.30	1.41	30.51	0.994
				3.0	5.222	0.269	0.461	0.40	0.91	22.89	0.993
				3.1	5.570	0.387	0.486	0.50	0.67	18.32	0.992
				3.2	6.062	0.630	0.518	1.00	0.28	9.03	0.987
				3.3	6.709	1.321	0.561	1.50	0.27	5.79	0.969
				3.4	6.522	2.705	0.592	2.00	0.27	4.18	0.944
				3.5	5.610	3.014	0.575	2.50	0.24	3.09	0.914
								3.00	0.23	2.27	0.864
								3.25	0.23	1.86	0.816

**Silicon, single crystal<sup>23</sup>**

Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )	Energy (eV)	<i>n</i>	<i>k</i>	<i>R</i> ( $\phi = 0$ )
3.50	0.21	1.42	0.756	46.00	0.90	0.32	0.031	11.08	0.870		0.005
3.60	0.23	1.13	0.671	48.00	0.89	0.31	0.030	11.83	0.887		0.004
3.70	0.30	0.77	0.475	50.00	0.88	0.29	0.027	12.73	0.907		0.002
3.77	0.53	0.40	0.154	52.00	0.89	0.28	0.024	13.05	0.913		0.002
3.80	0.73	0.30	0.053	54.00	0.88	0.17	0.024	13.42	0.914		0.002
3.90	1.30	0.36	0.040	56.00	0.87	0.26	0.024	13.73	0.917		0.002
4.00	1.61	0.60	0.103	58.00	0.87	0.24	0.021	14.07	0.922		0.002
4.10	1.73	0.85	0.153	60.00	0.87	0.22	0.018	14.83	0.934		0.001
4.20	1.75	1.06	0.194	62.00	0.88	0.21	0.016	15.05	0.936		0.001
4.30	1.73	1.13	0.208	64.00	0.88	0.21	0.016	15.46	0.942		0.001
4.50	1.69	1.28	0.238	66.00	0.88	0.21	0.016	16.21	0.948		0.001
4.75	1.61	1.34	0.252	68.00	0.87	0.21	0.017	18.10	0.964		0.000
5.00	1.55	1.36	0.257	70.00	0.83	0.20	0.021	21.12	0.979		0.000
5.50	1.45	1.34	0.257	72.00	0.85	0.18	0.016	25.51	0.993		0.000
6.00	1.34	1.28	0.246	74.00	0.85	0.17	0.014	26.95	1.00		0.000
6.50	1.25	1.18	0.225	76.00	0.85	0.16	0.013	27.68	1.01		0.000
7.00	1.18	1.06	0.196	78.00	0.85	0.15	0.013	28.37	1.01		0.000
7.50	1.14	0.91	0.157	80.00	0.85	0.14	0.012	29.52	1.02		0.000
8.00	1.16	0.75	0.114	85.00	0.85	0.11	0.011				
9.00	1.33	0.56	0.074	90.00	0.85	0.08	0.009				
10.00	1.46	0.56	0.082	95.00	0.86	0.06	0.007				
11.00	1.52	0.56	0.088	100.00	0.87	0.04	0.005				
12.00	1.61	0.59	0.100								
13.00	1.66	0.64	0.112								
14.00	1.72	0.78	0.141								
14.50	1.64	0.88	0.152								
15.00	1.56	0.92	0.156								
16.00	1.42	0.91	0.151								
17.00	1.33	0.86	0.139								
18.00	1.28	0.80	0.124								
19.00	1.27	0.75	0.111								
20.00	1.29	0.71	0.103								
21.00	1.35	0.75	0.112								
21.50	1.37	0.80	0.124								
22.00	1.34	0.87	0.141								
22.50	1.26	0.93	0.157								
23.00	1.17	0.94	0.163								
23.50	1.10	0.93	0.165								
24.00	1.04	0.90	0.165								
24.50	0.99	0.87	0.160								
25.00	0.95	0.83	0.154								
25.50	0.91	0.78	0.144								
26.00	0.90	0.74	0.133								
26.50	0.89	0.69	0.121								
27.00	0.89	0.65	0.109								
27.50	0.89	0.62	0.099								
28.00	0.90	0.59	0.090								
28.50	0.91	0.57	0.084								
29.00	0.92	0.56	0.079								
30.00	0.93	0.54	0.074								
31.00	0.93	0.53	0.072								
32.00	0.92	0.53	0.072								
33.00	0.90	0.51	0.071								
34.00	0.88	0.49	0.067								
35.00	0.86	0.45	0.061								
36.00	0.89	0.44	0.055								
38.00	0.89	0.39	0.043								
40.00	0.90	0.37	0.039								
42.00	0.90	0.35	0.036								
44.00	0.90	0.33	0.033								
				<i>Sodium</i> <sup>24</sup>							
				0.55	0.262	9.97	0.990				
				0.58	0.241	9.45	0.989				
				0.63	0.207	8.80	0.990				
				0.67	0.175	8.09	0.990				
				0.73	0.147	7.42	0.990				
				0.81	0.123	6.67	0.989				
				0.92	0.099	5.82	0.989				
				1.05	0.078	5.11	0.989				
				1.23	0.064	4.35	0.987				
				1.44	0.053	3.72	0.986				
				1.65	0.050	3.22	0.983				
				1.87	0.049	2.76	0.978				
				2.07	0.053	2.48	0.971				
				2.27	0.059	2.23	0.961				
				2.45	0.063	2.07	0.953				
				2.64	0.066	1.88	0.943				
				2.82	0.068	1.76	0.936				
				2.95	0.068	1.63	0.928				
				3.06	0.069	1.54	0.921				
				3.20	0.065	1.47	0.921				
				3.40	0.061	1.33	0.916				
				3.71	0.055	1.13	0.908				
				3.97	0.049	1.01	0.908				
				6.199	0.390		0.193				
				6.358	0.454		0.141				
				6.526	0.485		0.120				
				6.702	0.533		0.093				
				6.888	0.574		0.073				
				7.130	0.616		0.056				
				7.328	0.641		0.048				
				7.583	0.674		0.038				
				7.847	0.700		0.031				
				8.015	0.710		0.029				
				8.634	0.762		0.018				
				9.143	0.800		0.012				
				9.709	0.819		0.010				
				10.20	0.843		0.007				
								<i>Tantalum</i> <sup>16</sup>			
								0.10	10.14	66.39	0.984
								0.15	9.45	46.41	0.9834
								0.20	5.77	35.46	0.982
								0.26	3.67	27.53	0.981
								0.30	2.87	23.90	0.980
								0.38	2.03	18.87	0.978
								0.50	1.37	14.26	0.974
								0.58	1.15	12.19	0.970
								0.70	0.96	9.92	0.962
								0.78	0.89	8.77	0.956
								0.90	0.84	7.38	0.942
								1.00	0.89	6.47	0.992
								1.10	0.93	5.75	0.899
								1.20	0.98	5.14	0.872
								1.30	1.00	4.62	0.842
								1.40	1.04	4.15	0.805
								1.50	1.09	3.73	0.762
								1.60	1.15	3.33	0.707
								1.70	1.24	2.95	0.640
								1.80	1.35	2.60	0.560
								1.90	1.57	2.24	0.460
								2.00	1.83	1.99	0.388
								2.10	2.10	1.84	0.354
								2.20	2.36	1.81	0.351
								2.30	2.56	1.86	0.365
								2.40	2.68	1.92	0.378
								2.50	2.75	1.98	0.388
								2.60	2.80	2.02	0.395
								2.70	2.84	2.08	0.405
								2.80	2.85	2.14	0.412
								2.90	2.84	2.20	0.420
								3.00	2.81	2.24	0.425
								3.20	2.73	2.31	0.432
								3.40	2.61	2.33	0.435
								3.60	2.49	2.30	0.430
								3.80	2.40	2.22	0.418
								4.00	2.36	2.14	0.406
								4.20	2.35	2.06	0.392
								4.40	2.39	2.01	0.384
								4.60	2.45	2.00	0.384
								4.80	2.53	2.06	0.394



Energy (eV)	$n$	$k$	$R(\phi = 0)$
5.00	2.58	2.20	0.416
5.20	2.52	2.44	0.450
5.40	2.31	2.61	0.480
5.60	2.06	2.67	0.501
5.80	1.83	2.63	0.510
6.00	1.63	2.56	0.515
6.20	1.48	2.45	0.512
6.40	1.37	2.33	0.504
6.60	1.29	2.22	0.492
6.80	1.23	2.11	0.478
7.00	1.18	2.01	0.462
7.20	1.15	1.91	0.445
7.40	1.13	1.82	0.425
7.60	1.12	1.75	0.406
7.80	1.11	1.68	0.390
8.00	1.11	1.61	0.370
8.20	1.12	1.55	0.350
8.40	1.13	1.50	0.332
8.60	1.14	1.45	0.317
8.80	1.17	1.41	0.301
9.00	1.19	1.40	0.294
9.20	1.21	1.38	0.289
9.40	1.21	1.38	0.287
9.60	1.21	1.38	0.285
9.80	1.21	1.37	0.285
10.00	1.20	1.37	0.286
10.20	1.19	1.37	0.286
10.40	1.18	1.37	0.287
10.60	1.16	1.36	0.288
10.80	1.15	1.36	0.289
11.00	1.13	1.35	0.290
11.20	1.11	1.35	0.292
11.40	1.09	1.34	0.293
11.60	1.07	1.33	0.294
11.80	1.05	1.32	0.295
12.00	1.02	1.31	0.296
12.20	1.00	1.29	0.295
12.40	0.98	1.28	0.294
12.60	0.96	1.26	0.292
12.80	0.94	1.24	0.289
13.00	0.93	1.22	0.286
13.60	0.91	1.16	0.272
14.00	0.90	1.15	0.272
14.60	0.85	1.15	0.285
15.00	0.80	1.13	0.293
15.60	0.72	1.08	0.301
16.00	0.68	1.04	0.304
16.60	0.63	0.97	0.301
17.00	0.60	0.92	0.296
17.60	0.60	0.92	0.296
18.00	0.55	0.79	0.274
18.60	0.53	0.71	0.254
19.00	0.53	0.65	0.236
19.60	0.53	0.57	0.207
20.00	0.54	0.52	0.185
20.60	0.55	0.44	0.153
21.00	0.57	0.39	0.127
21.60	0.64	0.34	0.089
22.00	0.64	0.32	0.081
22.60	0.69	0.27	0.058

Energy (eV)	$n$	$k$	$R(\phi = 0)$
23.00	0.73	0.24	0.043
23.60	0.80	0.26	0.033
24.00	0.80	0.26	0.034
24.60	0.82	0.25	0.029
25.00	0.83	0.25	0.026
25.60	0.86	0.24	0.022
26.00	0.88	0.25	0.022
26.60	0.87	0.26	0.023
27.00	0.87	0.25	0.022
27.60	0.89	0.23	0.019
28.00	0.90	0.23	0.017
28.60	0.91	0.22	0.015
29.00	0.92	0.22	0.014
29.60	0.94	0.22	0.014
30.00	0.95	0.22	0.014
31.00	0.97	0.23	0.014
32.00	0.98	0.24	0.015
33.00	0.98	0.25	0.015
34.00	0.99	0.25	0.016
35.00	0.99	0.26	0.017
36.00	0.99	0.27	0.018
37.00	0.99	0.28	0.019
38.00	0.98	0.28	0.021
39.00	0.97	0.29	0.022
40.00	0.95	0.29	0.023
<i>Tellurium, <math>\vec{E} \parallel \hat{c}^{25}</math></i>			
0.01364	4.82	0.118	0.431
0.01488	5.26	0.0505	0.463
0.01612	5.47	0.0278	0.477
0.01736	5.59	0.0174	0.485
0.01860		0.0796	
0.01984		0.0696	
0.02108		0.0749	
0.02232		0.1900	
0.02356		0.2220	
0.02480		0.0716	
0.02604		0.0682	
0.02728		0.0832	
0.02976		0.0149	
0.03224		2.14E-03	
0.03472		1.71E-02	
0.03720	5.94	3.71E-03	0.507
0.03968		2.44E-03	
0.04339	5.96	1.59E-03	0.508
0.04711		7.85E-04	
0.05083		7.38E-04	
0.05579		3.89E-04	
0.06199	5.98	3.09E-04	0.509
0.07439		2.52E-04	
0.08679		2.96E-04	
0.09919		3.68E-04	
0.12400	6.246	3.34E-04	0.524
0.15500	6.253		0.525
0.20660	6.286		0.526
0.24800	6.316	7.48E-05	0.528
0.31	6.372	1.18E-05	0.531
0.35		4.93E-04	
0.41		6.74E-03	
0.5	6.53	2.30E-02	0.539
0.6	6.71	7.50E-02	0.549

Energy (eV)	$n$	$k$	$R(\phi = 0)$
0.7	7.00	0.24	0.563
0.8	7.23	0.48	0.574
0.9	7.48	0.94	0.589
1.0	7.70	1.56	0.606
1.2	6.99	2.22	0.593
1.4	7.11	2.46	0.604
1.6	6.75	2.91	0.606
1.8	6.89	3.70	0.637
2.0	4.67	4.67	0.654
2.2	4.94	5.16	0.681
2.4	3.94	5.08	0.686
2.6	3.25	4.77	0.681
2.8	2.73	4.42	0.674
3.0	2.30	4.16	0.674
3.5	1.69	3.44	0.646
4.0	1.33	2.64	0.571
4.5	1.32	1.96	0.428
5.0	1.63	1.60	0.312
5.5	1.72	1.57	0.302
6.0	1.73	1.45	0.276
6.5	1.78	1.36	0.257
7.0	1.83	1.36	0.257
7.5	1.72	1.51	0.289
8.0	1.54	1.37	0.260
8.5	1.55	1.23	0.226
9.0	0.99	0.93	0.179
9.5	1.47	1.25	0.233
10.0	0.86	0.86	0.181
11.0	0.80	0.77	0.165
12.0	0.79	0.76	0.164
14.0	0.67	0.59	0.146
16.0	0.59	0.49	0.147
18.0	0.48	0.31	0.160
20.0	0.74	0.20	0.035
22.0	0.83	0.18	0.018
24.0	0.85	0.15	0.013
26.0	0.87	0.12	0.009
28.0	0.89	0.090	0.006
30.0	0.90	0.045	0.003
<i>Tellurium, <math>\vec{E} \perp \hat{c}^{25}</math></i>			
0.01364	2.61	0.2980	0.204
0.01488	3.65	0.0894	0.325
0.01612	4.10	0.0535	0.370
0.01736	4.63	0.4990	0.420
0.01860		0.1170	
0.01984		0.0343	
0.02108	(4.42)	0.0421	0.398
0.02232		0.1060	
0.02356		0.0880	
0.02480		0.0458	
0.02604		0.0928	
0.02728		0.0886	
0.02976		0.0232	
0.03224		3.06E-03	
0.03472		1.25E-02	
0.03720	4.71	2.65E-03	0.422
0.03968		1.89E-03	
0.04339	4.74	1.41E-03	0.425
0.04711		8.38E-04	
0.05083		6.79E-04	





Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
<i>Tungsten</i> <sup>27</sup>				5.40	2.92	3.58	0.586	22.80	0.49	0.69	0.272
0.10	14.06	54.71	0.983	5.60	2.43	3.70	0.618	23.20	0.49	0.66	0.263
0.20	3.87	28.30	0.981	5.80	2.00	3.61	0.637	23.60	0.48	0.62	0.252
0.25	2.56	22.44	0.980	6.00	1.70	3.42	0.643	24.00	0.49	0.57	0.234
0.30	1.83	18.32	0.979	6.20	1.47	3.24	0.646	24.40	0.50	0.53	0.213
0.34	1.71	15.71	0.973	6.40	1.32	3.04	0.640	24.80	0.51	0.49	0.191
0.38	1.86	13.88	0.963	6.60	1.21	2.87	0.631	25.20	0.53	0.46	0.171
0.42	1.92	12.63	0.954	6.80	1.12	2.70	0.619	25.60	0.55	0.43	0.150
0.46	1.69	11.59	0.952	7.00	1.06	2.56	0.607	26.00	0.57	0.40	0.132
0.50	1.40	10.52	0.952	7.20	1.01	2.43	0.593	26.40	0.59	0.38	0.117
0.54	1.23	9.45	0.948	7.40	0.98	2.30	0.573	26.80	0.61	0.37	0.105
0.58	1.17	8.44	0.938	7.60	0.95	2.18	0.556	27.00	0.62	0.36	0.099
0.62	1.28	7.52	0.917	7.80	0.93	2.06	0.533	27.50	0.64	0.34	0.085
0.66	1.45	6.78	0.888	8.00	0.94	1.95	0.505	28.00	0.67	0.32	0.073
0.70	1.59	6.13	0.856	8.20	0.94	1.86	0.481	28.50	0.69	0.31	0.065
0.74	1.83	5.52	0.810	8.40	0.96	1.76	0.449	29.00	0.71	0.30	0.057
0.78	2.12	5.00	0.759	8.60	0.99	1.70	0.422	29.50	0.73	0.30	0.052
0.82	2.36	4.61	0.710	8.80	1.01	1.65	0.401	30.00	0.75	0.29	0.047
0.86	2.92	4.37	0.661	9.00	1.01	1.60	0.388	31.00	0.78	0.29	0.042
0.90	3.11	4.44	0.660	9.20	1.02	1.55	0.369	32.00	0.79	0.29	0.040
0.94	3.15	4.43	0.658	9.40	1.03	1.50	0.352	33.00	0.82	0.28	0.033
0.98	3.15	4.36	0.653	9.60	1.05	1.44	0.329	34.00	0.84	0.29	0.032
1.00	3.14	4.32	0.649	9.80	1.09	1.38	0.307	35.00	0.85	0.31	0.033
1.10	3.05	4.04	0.627	10.00	1.13	1.34	0.287	36.00	0.85	0.32	0.036
1.20	3.00	3.64	0.590	10.20	1.19	1.33	0.274	37.00	0.84	0.33	0.039
1.30	3.12	3.24	0.545	10.40	1.24	1.34	0.270	38.00	0.83	0.33	0.040
1.40	3.29	2.96	0.515	10.60	1.27	1.36	0.274	39.00	0.81	0.33	0.042
1.50	3.48	2.79	0.500	10.80	1.29	1.39	0.282	40.00	0.80	0.33	0.045
1.60	3.67	2.68	0.494	11.00	1.28	1.42	0.290	<i>Vanadium</i> <sup>9</sup>			
1.70	3.84	2.79	0.507	11.20	1.27	1.44	0.297	0.10	12.83	45.89	0.978
1.80	3.82	2.91	0.518	11.40	1.25	1.46	0.305	0.20	3.90	24.30	0.975
1.90	3.70	2.94	0.518	11.60	1.22	1.48	0.313	0.28	2.13	17.35	0.973
2.00	3.60	2.89	0.512	11.80	1.20	1.48	0.318	0.36	1.54	13.32	0.966
2.10	3.54	2.84	0.506	12.00	1.16	1.48	0.323	0.44	1.28	10.74	0.957
2.20	3.49	2.76	0.497	12.40	1.10	1.47	0.329	0.52	1.16	8.93	0.945
2.30	3.49	2.72	0.494	12.80	1.04	1.44	0.333	0.60	1.10	7.59	0.929
2.40	3.45	2.72	0.493	13.20	0.98	1.40	0.332	0.68	1.07	6.54	0.909
2.50	3.38	2.68	0.487	13.60	0.94	1.35	0.325	0.76	1.08	5.67	0.882
2.60	3.34	2.62	0.480	14.00	0.91	1.28	0.312	0.80	1.10	5.30	0.864
2.70	3.31	2.55	0.472	14.40	0.90	1.23	0.296	0.90	1.18	4.50	0.811
2.80	3.31	2.49	0.466	14.80	0.90	1.17	0.276	1.00	1.34	3.80	0.730
2.90	3.32	2.45	0.461	15.20	0.93	1.13	0.255	1.10	1.60	3.26	0.632
3.00	3.35	2.42	0.459	15.60	0.97	1.12	0.246	1.20	1.93	2.88	0.543
3.10	3.39	2.41	0.460	16.00	0.98	1.14	0.249	1.30	2.25	2.71	0.498
3.20	3.43	2.45	0.465	16.40	0.97	1.17	0.260	1.40	2.48	2.72	0.491
3.30	3.45	2.55	0.476	16.80	0.94	1.19	0.273	1.50	2.57	2.79	0.499
3.40	3.39	2.66	0.485	17.20	0.90	1.21	0.289	1.60	2.57	2.84	0.507
3.50	3.24	2.70	0.488	17.60	0.85	1.21	0.304	1.70	2.52	2.88	0.512
3.60	3.13	2.67	0.482	18.00	0.80	1.20	0.317	1.80	2.45	2.88	0.515
3.70	3.05	2.62	0.476	18.40	0.74	1.18	0.330	1.90	2.36	2.85	0.514
3.80	2.99	2.56	0.468	18.80	0.69	1.15	0.340	2.00	2.34	2.81	0.509
3.90	2.96	2.50	0.460	19.20	0.64	1.11	0.347	2.10	2.31	2.78	0.506
4.00	2.95	2.43	0.451	19.60	0.60	1.07	0.353	2.20	2.28	2.80	0.510
4.20	3.02	2.33	0.440	20.00	0.56	1.02	0.354	2.30	2.23	2.83	0.516
4.40	3.13	2.32	0.442	20.40	0.54	0.97	0.350	2.40	2.15	2.88	0.528
4.60	3.24	2.41	0.455	20.80	0.52	0.92	0.342	2.50	2.02	2.91	0.540
4.80	3.33	2.57	0.475	21.20	0.50	0.87	0.331	2.60	1.89	2.92	0.552
5.00	3.40	2.85	0.505	21.60	0.50	0.82	0.318	2.70	1.74	2.89	0.561
5.20	3.27	3.27	0.548	22.00	0.49	0.77	0.303	2.80	1.61	2.85	0.569
				22.40	0.49	0.73	0.287	2.90	1.48	2.80	0.577

Energy (eV)	$n$	$k$	$R(\phi = 0)$
3.00	1.36	2.73	0.582
3.20	1.16	2.55	0.585
3.40	0.99	2.37	0.586
3.60	0.87	2.17	0.575
3.80	0.80	1.96	0.547
4.00	0.78	1.76	0.503
4.20	0.80	1.60	0.449
4.40	0.83	1.47	0.400
4.60	0.87	1.38	0.355
4.80	0.90	1.31	0.326
5.00	0.91	1.26	0.304
5.25	0.93	1.18	0.271
5.50	0.94	1.14	0.258
5.75	0.96	1.09	0.235
6.00	0.98	1.06	0.223
6.25	0.97	1.02	0.212
6.50	0.97	0.98	0.199
6.75	0.97	0.94	0.185
7.00	0.98	0.91	0.175
7.33	0.97	0.89	0.170
7.66	0.98	0.87	0.162
8.00	0.98	0.85	0.155
8.33	0.98	0.81	0.146
8.66	0.98	0.81	0.145
9.00	0.96	0.79	0.142
9.50	0.94	0.77	0.136
10.00	0.91	0.74	0.133
10.50	0.89	0.71	0.126
11.00	0.87	0.65	0.112
11.50	0.88	0.58	0.091
12.00	0.90	0.58	0.089
12.50	0.89	0.57	0.086
13.00	0.88	0.55	0.082
13.50	0.87	0.53	0.079
14.00	0.86	0.51	0.075
14.50	0.86	0.49	0.070
15.00	0.86	0.47	0.065
15.50	0.86	0.46	0.062
16.00	0.85	0.45	0.061
16.50	0.84	0.43	0.059
17.00	0.84	0.41	0.056
17.50	0.83	0.40	0.054
18.00	0.82	0.38	0.051
18.50	0.82	0.37	0.048
19.00	0.82	0.35	0.045
19.50	0.82	0.34	0.043
20.00	0.81	0.32	0.041
20.50	0.81	0.31	0.038
21.00	0.81	0.29	0.036
21.50	0.81	0.28	0.033
22.00	0.81	0.27	0.032
22.50	0.81	0.25	0.029
23.00	0.82	0.24	0.027
23.50	0.82	0.23	0.025
24.00	0.82	0.22	0.024
24.50	0.83	0.21	0.022
25.00	0.83	0.20	0.020
25.50	0.83	0.19	0.019
26.00	0.83	0.18	0.018
26.50	0.84	0.17	0.016

Energy (eV)	$n$	$k$	$R(\phi = 0)$
27.00	0.84	0.16	0.015
27.50	0.85	0.16	0.014
28.00	0.85	0.15	0.013
28.50	0.86	0.14	0.012
29.00	0.86	0.14	0.011
29.50	0.86	0.13	0.010
30.00	0.87	0.13	0.009
31.00	0.88	0.12	0.008
32.00	0.90	0.11	0.007
33.00	0.90	0.10	0.005
34.00	0.91	0.10	0.005
35.00	0.92	0.09	0.004
36.00	0.94	0.10	0.004
37.00	0.94	0.10	0.004
38.00	0.95	0.11	0.004
39.00	0.95	0.12	0.004
40.00	0.95	0.13	0.005
<i>Zinc, <math>\vec{E} \parallel c^{28}</math></i>			
0.7514	1.9241	7.5619	0.883
0.827	1.7921	6.9973	0.874
0.866	1.5571	6.7753	0.881
0.952	1.4824	6.2296	0.868
0.992	1.5762	5.8843	0.847
1.033	1.5407	5.3192	0.823
1.078	1.5853	4.9013	0.793
1.127	1.7768	4.5307	0.748
1.181	1.9808	4.2004	0.701
1.240	2.8821	3.4766	0.575
1.305	3.2039	3.0042	0.520
1.377	2.9459	3.5761	0.584
1.459	3.2523	4.2447	0.640
1.550	3.8086	4.6212	0.657
1.653	3.7577	4.6239	0.659
1.722	3.5908	4.4614	0.650
1.823	3.4234	4.3232	0.642
1.937	3.0132	3.9974	0.624
1.984	1.8562	3.9706	0.690
2.066	1.4856	4.0555	0.737
2.094	1.2525	3.9961	0.762
2.119	1.0017	3.8683	0.789
2.275	0.7737	3.9129	0.832
2.445	0.6395	3.4013	0.821
2.666	0.4430	3.1379	0.851
2.917	0.3589	2.8140	0.853
3.220	0.3069	2.5088	0.847
3.594	0.2737	2.1737	0.828
4.065	0.2510	1.8528	0.799
4.678	0.2354	1.6357	0.776
<i>Zinc, <math>\vec{E} \perp c^{28}</math></i>			
0.751	1.4469	7.4158	0.905
0.827	1.4744	6.9688	0.892
0.866	1.3628	6.6886	0.892
0.952	1.3165	6.2212	0.881
0.992	1.3835	5.8910	0.863
1.033	1.2889	5.4001	0.850
1.078	1.3095	4.9025	0.822
1.127	1.6897	4.4062	0.746
1.181	1.9701	4.0176	0.684
1.240	2.8717	3.2873	0.555

Energy (eV)	$n$	$k$	$R(\phi = 0)$
1.305	3.3991	2.7684	0.497
1.377	3.1807	3.4709	0.569
1.459	3.5064	4.1994	0.630
1.550	4.1241	4.7768	0.664
1.653	4.0269	4.8027	0.667
1.722	3.9369	4.6356	0.657
1.823	3.7549	4.3042	0.635
1.937	3.4512	4.1942	0.631
1.984	3.2515	4.2980	0.644
2.066	2.0802	4.7231	0.738
2.094	1.7084	4.7923	0.774
2.119	1.3329	4.4751	0.791
2.275	0.9725	4.2879	0.825
2.455	0.7568	3.7627	0.824
2.666	0.5470	3.4277	0.845
2.917	0.4774	3.0476	0.834
3.220	0.3911	2.7463	0.835
3.594	0.3147	2.3041	0.821
4.065	0.3013	2.0077	0.789
4.678	0.2806	1.7997	0.770
<i>Zirconium (Polycrystalline)<sup>28</sup></i>			
0.10	6.18	1.76	0.300
0.15	3.37	1.30	0.123
0.20	2.34	1.08	0.058
0.26	2.24	1.06	0.052
0.30	2.59	1.14	0.073
0.36	3.17	1.26	0.110
0.40	3.09	1.24	0.105
0.46	3.36	1.30	0.123
0.50	4.13	1.44	0.175
0.56	5.01	1.58	0.231
0.60	5.18	1.61	0.242
0.70	4.54	1.51	0.202
0.80	4.03	1.42	0.168
0.90	3.74	1.37	0.149
0.96	3.69	1.36	0.145
1.00	3.66	1.35	0.143
1.10	3.65	1.35	0.142
1.20	3.53	1.33	0.134
1.30	3.25	1.27	0.116
1.40	3.10	1.25	0.106
1.50	3.02	1.23	0.100
1.60	2.88	1.20	0.091
1.70	2.68	1.16	0.078
1.80	2.49	1.12	0.067
2.00	2.14	1.03	0.047
2.10	1.99	1.00	0.040
2.20	1.87	0.97	0.034
2.30	1.78	0.94	0.030
2.40	1.71	0.92	0.027
2.50	1.62	0.90	0.024
2.60	1.54	0.88	0.022
2.70	1.46	0.86	0.019
2.80	1.40	0.84	0.018
2.90	1.34	0.82	0.016
3.00	1.30	0.81	0.016
3.10	1.26	0.80	0.015
3.30	1.19	0.77	0.014
3.40	1.16	0.76	0.013
3.50	1.13	0.75	0.013

Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$	Energy (eV)	$n$	$k$	$R(\phi = 0)$
3.60	1.10	0.74	0.013	9.00	1.65	0.91	0.025	17.20	1.09	0.74	0.013
3.70	1.07	0.73	0.013	9.20	1.63	0.90	0.025	17.60	1.13	0.75	0.013
3.80	1.04	0.72	0.012	9.40	1.60	0.89	0.024	18.00	1.17	0.76	0.014
3.90	1.01	0.71	0.012	9.60	1.57	0.89	0.023	18.40	1.21	0.78	0.014
4.00	0.98	0.70	0.012	9.80	1.52	0.87	0.021	18.80	1.24	0.79	0.014
4.20	0.94	0.68	0.013	10.00	1.47	0.86	0.020	19.20	1.27	0.80	0.015
4.40	0.89	0.67	0.013	10.20	1.42	0.84	0.018	19.60	1.29	0.80	0.015
4.60	0.85	0.65	0.014	10.40	1.35	0.82	0.016	20.00	1.30	0.81	0.015
4.80	0.81	0.64	0.014	10.50	1.32	0.81	0.016	20.60	1.29	0.80	0.015
5.00	0.78	0.63	0.015	10.60	1.28	0.80	0.015	21.00	1.27	0.80	0.015
5.20	0.77	0.62	0.016	10.80	1.23	0.78	0.014	21.60	1.23	0.78	0.014
5.40	0.77	0.62	0.016	11.00	1.19	0.77	0.014	22.00	1.20	0.77	0.014
5.60	0.80	0.63	0.014	11.20	1.16	0.76	0.013	22.60	1.15	0.76	0.013
5.80	0.87	0.66	0.013	11.40	1.13	0.75	0.013	23.00	1.12	0.75	0.013
6.00	1.00	0.71	0.012	11.60	1.11	0.74	0.013	23.60	1.08	0.73	0.013
6.20	1.11	0.75	0.013	11.80	1.09	0.74	0.013	24.00	1.05	0.73	0.013
6.40	1.23	0.78	0.014	12.00	1.08	0.73	0.013	24.60	1.02	0.71	0.012
6.60	1.33	0.81	0.016	12.40	1.05	0.72	0.012	25.00	1.00	0.71	0.012
6.80	1.42	0.84	0.018	12.80	1.01	0.71	0.012	25.60	0.97	0.69	0.012
7.00	1.49	0.86	0.020	13.20	0.98	0.70	0.012	26.00	0.95	0.69	0.013
7.20	1.54	0.88	0.022	13.60	0.95	0.69	0.013	26.60	0.91	0.67	0.013
7.40	1.58	0.89	0.023	14.00	0.92	0.68	0.013	27.00	0.88	0.66	0.013
7.60	1.61	0.90	0.024	14.40	0.89	0.67	0.013	27.60	0.84	0.65	0.014
7.80	1.63	0.90	0.025	14.80	0.90	0.67	0.013	28.00	0.83	0.64	0.014
8.00	1.66	0.91	0.026	15.20	0.92	0.68	0.013	28.60	0.82	0.64	0.014
8.20	1.67	0.91	0.026	15.60	0.95	0.69	0.013	29.00	0.81	0.64	0.014
8.40	1.68	0.92	0.026	16.00	0.98	0.70	0.012	29.60	0.82	0.64	0.014
8.60	1.68	0.92	0.026	16.40	1.01	0.71	0.012	30.00	0.82	0.64	0.014
8.80	1.66	0.91	0.026	16.80	1.04	0.72	0.012				

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## ELASTO-OPTIC, ELECTRO-OPTIC, AND MAGNETO-OPTIC CONSTANTS

When a crystal is subjected to a stress field, an electric field, or a magnetic field, the resulting optical effects are in general dependent on the orientation of these fields with respect to the crystal axes. It is useful, therefore, to express the optical properties in terms of the refractive index ellipsoid (or indicatrix):

$$\frac{x^2}{n_x^2} + \frac{y^2}{n_y^2} + \frac{z^2}{n_z^2} = 1$$

or

$$\sum_{ij} B_{ij} x_i x_j = 1 (i, j = 1, 2, 3)$$

where

$$B_{ij} = \left[ \frac{1}{\epsilon} \right]_{ij} = \left[ \frac{1}{n^2} \right]_{ij}$$

$\epsilon$  is the dielectric constant or permeability; the quantity  $B_{ij}$  is called impermeability.

A crystal exposed to a *stress*  $\mathbf{S}$  will show a change of its impermeability. The photo-elastic (or elasto-optic) constants,  $P_{ijkl}$ , are defined by

$$\Delta \left[ \frac{1}{\epsilon} \right]_{ij} = \Delta \left[ \frac{1}{n^2} \right]_{ij} = \sum_{kl} P_{ijkl} S_{kl}$$

where  $n$  is the refractive index and  $S_{kl}$  are the strain tensor elements; the  $P_{ijkl}$  are the elements of a 4th rank tensor.

When a crystal is subjected to an *electric field*  $\mathbf{E}$ , two possible changes of the refractive index may occur depending on the symmetry of the crystal.

1. All materials, including isotropic solids and polar liquids, show an electro-optic birefringence (Kerr effect) which is proportional to the square of the electric field,  $\mathbf{E}$ :

$$\Delta \left[ \frac{1}{n^2} \right]_{ij} = \sum_k K_{ijk} E_k E_l = \sum_{k,l=1,2,3} g_{ijkl} P_k P_l$$

where  $E_k$  and  $E_l$  are the components of the electric field and  $P_k$  and  $P_l$  the electric polarizations. The coefficients,  $K_{ijk}$ , are the quadratic electro-optic coefficients, while the constants  $g_{ijkl}$  are known as the Kerr constants.

2. The other electro-optic effect only occurs in the 20 piezoelectric crystal classes (no center of symmetry). This effect is known as the Pockels effect. The optical impermeability changes linearly with the static field

$$\Delta \left[ \frac{1}{n^2} \right]_{ij} = \sum_k r_{ij,k} E_k$$

The coefficients  $r_{ij,k}$  have the name (linear) electro-optic coefficients.

The values of the electro-optic coefficients depend on the boundary conditions. If the superscripts T and S denote, respectively, the conditions of zero stress (free) and zero strain (clamped) one finds:

$$r_{ij}^T = r_{ij}^S + q_{ik}^E e_{jk} = r_{ij}^S + P_{ik}^E d_{jk}$$

where  $e_{jk} = (\partial T_k / \partial E_j)_S$  and  $d_{jk} = (\partial S_k / \partial E_j)_T$  are the appropriate piezoelectric coefficients.

The interaction between a *magnetic field* and a light wave propagating in a solid or in a liquid gives rise to a rotation of the plane of polarization. This effect is known as *Faraday rotation*. It results from a difference in propagation velocity for left and right circular polarized light.

The Faraday rotation,  $\theta_F$ , is linearly proportional to the magnetic field  $H$ :

$$\theta_F = V l H$$

where  $l$  is the light path length and  $V$  is the *Verdet* constant (minutes/oersted-cm).

For ferromagnetic, ferrimagnetic, and antiferromagnetic materials the magnetic field in the above expression is replaced by the magnetization  $M$  and the magneto-optic coefficient in this case is known as the Kund constant  $K$ :

$$\text{Specific Faraday rotation } F = KM$$

In the tables below the *Faraday rotation* is listed at the saturation magnetization per unit length, together with the absorption coefficient  $\alpha$ , the temperature  $T$ , the critical temperature  $T_c$  (or  $T_N$ ), and the wavelength of the measurement.

In the tables that follow, the properties are presented in groups:

- Elasto-optic coefficients (photoelastic constants)
- Linear electro-optic coefficients (Pockels constants)
- Quadratic electro-optic coefficients (Kerr constants)
- Magneto-optic coefficients:
  - Verdet constants
  - Faraday rotation parameters

Within each group, materials are classified by crystal system or physical state. References are given at the end of each group of tables.

## ELASTO-OPTIC COEFFICIENTS (PHOTOELASTIC CONSTANTS)

Name									
Cubic (43m, 432, m3m)	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{44}$	$p_{11}-p_{12}$			Ref.
Sodium fluoride	NaF	0.633	0.08	0.20	-0.03	-0.12			1
Sodium chloride	NaCl	0.589	0.115	0.159	-0.011	-0.042			2
Sodium bromide	NaBr	0.589	0.148	0.184	-0.0036	-0.035			1
Sodium iodide	NaI	0.589	-	-	0.0048	-0.0141			3
Potassium fluoride	KF	0.546	0.26	0.20	-0.029	0.06			1
Potassium chloride	KCl	0.633	0.22	0.16	-0.025	0.06			4
Potassium bromide	KBr	0.589	0.212	0.165	-0.022	0.047			5
Potassium iodide	KI	0.590	0.212	0.171	-	0.041			6
Rubidium chloride	RbCl	0.589	0.288	0.172	-0.041	0.116			7,8
Rubidium bromide	RbBr	0.589	0.293	0.185	-0.034	0.108			7,8
Rubidium iodide	RbI	0.589	0.262	0.167	-0.023	0.095			7,8
Lithium fluoride	LiF	0.589	0.02	0.13	-0.045	-0.11			5
Lithium chloride	LiCl	0.589	-	-	-0.0177	-0.0407			3
Ammonium chloride	NH <sub>4</sub> Cl	0.589	0.142	0.245	0.042	-0.103			9
Cadmium telluride	CdTe	1.06	-0.152	-0.017	-0.057	-0.135			10
Calcium fluoride	CaF <sub>2</sub>	0.55-0.65	0.038	0.226	0.0254	-0.183			11
Copper chloride	CuCl	0.633	0.120	0.250	-0.082	-0.130			12
Copper bromide	CuBr	0.633	0.072	0.195	-0.083	-0.123			12
Copper iodide	CuI	0.633	0.032	0.151	-0.068	-0.119			12
Diamond	C	0.540-0.589	-0.278	0.123	-0.161	-0.385			13
Germanium	Ge	3.39	-0.151	-0.128	-0.072	-0.023			14
Gallium arsenide	GaAs	1.15	-0.165	-0.140	-0.072	-0.025			15
Gallium phosphide	GaP	0.633	-0.151	-0.082	-0.074	-0.069			15
Strontium fluoride	SrF <sub>2</sub>	0.633	0.080	0.269	0.0185	-0.189			16
Strontium titanate	SrTiO <sub>3</sub>	0.633	0.15	0.095	0.072	-			17
KRS-5	Tl(Br,I)	0.633	-0.140	0.149	-0.0725	-0.289			18,20
KRS-6	Tl(Br,Cl)	0.633	-0.451	-0.337	-0.164	-0.114			19,20
Zinc sulfide	ZnS	0.633	0.091	-0.01	0.075	0.101			15
Rare Gases	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{44}$	$p_{11}-p_{12}$			Ref.
Neon ( $T = 24.3$ K)	Ne	0.488	0.157	0.168	0.004	-0.011			21
Argon ( $T = 82.3$ K)	Ar	0.488	0.256	0.302	0.015	-0.046			22
Krypton ( $T = 115.6$ K)	Kr	0.488	0.34	0.34	0.037	0			21
Xenon ( $T = 160.5$ K)	Xe	0.488	0.284	0.370	0.029	-0.086			22
Garnets	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{44}$	$p_{11}-p_{12}$			Ref.
GGG	Gd <sub>3</sub> Ga <sub>5</sub> O <sub>12</sub>	0.514	-0.086	-0.027	-0.078	-0.059			23
YIG	Y <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub>	1.15	0.025	0.073	0.041	-			15
YGG	Y <sub>3</sub> Ga <sub>5</sub> O <sub>12</sub>	0.633	0.091	0.019	0.079	-			17
YAG	Y <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	0.633	-0.029	0.0091	-0.0615	-0.038			15
Cubic (23, m3)	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{44}$	$p_{13}$			Ref.
Barium nitrate	Ba(NO <sub>3</sub> ) <sub>2</sub>	0.589	-	$p_{11}-p_{22} = 0.992$	-0.0205	$p_{11}-p_{13} = 0.713$			13
Lead nitrate	Pb(NO <sub>3</sub> ) <sub>2</sub>	0.589	0.162	0.24	-0.0198	0.20			24,25
Sodium bromate	NaBrO <sub>3</sub>	0.589	0.185	0.218	-0.0139	0.213			26
Sodium chlorate	NaClO <sub>3</sub>	0.589	0.162	0.24	-0.0198	0.20			26
Strontium nitrate	Sr(NO <sub>3</sub> ) <sub>2</sub>	0.41	0.178	0.362	-0.014	0.316			27
Hexagonal (mmc, 6mm)	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{13}$	$p_{31}$	$p_{33}$	$p_{44}$	Ref.
Beryl	Be <sub>3</sub> Al <sub>2</sub> Si <sub>6</sub> O <sub>18</sub>	0.589	0.0099	0.175	0.191	0.313	0.023	-0.152	28
Cadmium sulfide	CdS	0.633	-0.142	-0.066	-0.057	-0.041	-0.20	-0.099	15,2
Zinc oxide	ZnO	0.633	$\pm 0.222$	$\pm 0.099$	-0.111	$\pm 0.088$	-0.235	0.0585	30
Zinc sulfide	ZnS	0.633	-0.115	0.017	0.025	0.0271	-0.13	-0.0627	31





Isotropic	Formula	$\lambda/\mu\text{m}$	$p_{11}$	$p_{12}$	$p_{44}$	Ref.
Fused silica	SiO <sub>2</sub>	0.633	0.121	0.270	-0.075	15
Water	H <sub>2</sub> O	0.633	±0.31	±0.31		15
Polystyrene		0.633	±0.30	±0.31		25
Lucite		0.633	±0.30	0.28		25
Orpiment	As <sub>2</sub> S <sub>3</sub> -glass	1.15	0.308	0.299	0.0045	15
Tellurium oxide	TeO <sub>2</sub> -glass	0.633	0.257	0.241	0.0079	56
Laser glasses	LGS-247-2	0.488	±0.168	±0.230		57
	LGS-250-3		±0.135	±0.198		
	LGS-1		±0.214	±0.250		
	KGSS-1621		±0.205	±0.239		
Dense flint glasses (examples)	LaSF <sub>6</sub>	0.633	0.088	0.147	-0.030	58
	SF <sub>6</sub>		0.215	0.243	-0.014	
	U10502		0.172	0.179	-0.004	
	TaF <sub>5</sub>		0.099	0.138	-0.020	

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## LINEAR ELECTRO-OPTIC COEFFICIENTS

Name					
Cubic ( $\bar{4}3m$ )		Formula	$\lambda/\mu\text{m}$	$r_{41}$	
				pm/V	
	Cuprous bromide	CuBr	0.525	0.85	
	Cuprous chloride	CuCl	0.633	3.6	
	Cuprous iodide	CuI	0.55	-5.0	
	Eulytite (BSO)	$\text{Bi}_4\text{Si}_3\text{O}_{12}$	0.63	0.54	
	Germanium eulytite (BGO)	$\text{Bi}_4\text{Ge}_3\text{O}_{12}$	0.63	1.0	
	Gallium arsenide	GaAs	10.6	1.6	
	Gallium phosphide	GaP	0.56	-1.07	
	Hexamethylenetetramine	$\text{C}_6\text{H}_{12}\text{N}_4$	0.633	0.78	
	Sphalerite	ZnS	0.65	2.1	
	Zinc selenide	ZnSe	0.546	2.0	
	Zinc telluride	ZnTe	3.41	4.2	
	Cadmium telluride	CdTe	3.39	6.8	

Cubic (23)		Formula	$\lambda/\mu\text{m}$	$r_{41}$	
				pm/V	
	Ammonium chloride (77 K)	$\text{NH}_4\text{Cl}$	-	1.5	
	Ammonium cadmium langbeinite	$(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$	0.546	0.70	
	Ammonium manganese langbeinite	$(\text{NH}_4)_2\text{Mn}_2(\text{SO}_4)_3$	0.546	0.53	
	Thallium cadmium langbeinite	$\text{Tl}_2\text{Cd}_2(\text{SO}_4)_3$	0.546	0.37	
	Potassium magnesium langbeinite	$\text{K}_2\text{Mg}_2(\text{SO}_4)_3$	0.546	0.40	
	Bismuth monogermanate	$\text{Bi}_{12}\text{GeO}_{20}$	-	3.3	
	Bismuth monosilicate	$\text{Bi}_{12}\text{SiO}_{20}$	-	3.3	
	Sodium chlorate	$\text{NaClO}_3$	0.589	0.4	
	Sodium uranyl acetate	$\text{NaUO}_2(\text{CH}_3\text{COO})_3$	0.546	0.87	
	Trenhydrobromide	$\text{N}(\text{CH}_2\text{CH}_2\text{NH}_2)_3 \cdot 3\text{HBr}$	-	1.5	
	Trenhydrochloride	$\text{N}(\text{CH}_2\text{CH}_2\text{NH}_2)_3 \cdot 3\text{HCl}$	-	1.7	

Tetragonal ( $\bar{4}2m$ )		Formula	$T_{\text{tran}}$	$r_{41}$	$r_{63}$
			K	pm/V	pm/V
	Ammonium dihydrogen phosphate (ADP)	$\text{NH}_4\text{H}_2\text{PO}_4$	148	24.5	-8.5
	Ammonium dideuterium phosphate (AD*P)	$\text{NH}_4\text{D}_2\text{PO}_4$	242	-	11.9
	Ammonium dihydrogen arsenate (ADA)	$\text{NH}_4\text{H}_2\text{AsO}_4$	-	-	9.2
	Cesium dihydrogen arsenate (CsDA)	$\text{CsH}_2\text{AsO}_4$	143	-	18.6
	Cesium dideuterium arsenate (CsD*A)	$\text{CsD}_2\text{AsO}_4$	212	-	36.6
	Potassium dihydrogen phosphate (KDP)	$\text{KH}_2\text{PO}_4$	123	8.6	-10.5
	Potassium dideuterium phosphate (KD*P)	$\text{KD}_2\text{PO}_4$	222	8.8	23.8
	Potassium dihydrogen arsenate (KDA)	$\text{KH}_2\text{AsO}_4$	97	12.5	10.9
	Potassium dideuterium arsenate (KD*A)	$\text{KD}_2\text{AsO}_4$	162	-	18.2
	Rubidium dihydrogen phosphate (RDP)	$\text{RbH}_2\text{PO}_4$	147	-	15.5
	Rubidium dihydrogen arsenate (RDA)	$\text{RbH}_2\text{AsO}_4$	110	-	13.0
	Rubidium dideuterium arsenate (RD*A)	$\text{RbD}_2\text{AsO}_4$	178	-	21.4

Tetragonal (4mm)		Formula	$T_{\text{tran}}$	$r_{13}$	$r_{33}$	$r_{51}$
			K	pm/V	pm/V	pm/V
	Barium titanate	$\text{BaTiO}_3$	406	8	28	-
	Potassium lithium niobate	$\text{K}_3\text{Li}_2\text{Nb}_5\text{O}_{15}$	693	8.9	5.9	-
	Lead titanate	$\text{PbTiO}_3$	765	13.8	5.9	-
	Strontium barium niobate (SBN75)	$\text{Sr}_{0.75}\text{Ba}_{0.25}\text{Nb}_2\text{O}_6$	330	6.7	1340	42
	Strontium barium niobate (SBN46)	$\text{Sr}_{0.46}\text{Ba}_{0.54}\text{Nb}_2\text{O}_6$	602	~180	35	-



Hexagonal (6mm)		Formula	$r_{13}$ pm/V	$r_{33}$ pm/V	$r_{42}$ pm/V	$r_{51}$ pm/V
Greenockite	CdS		3.1	2.9	2.0	3.7
Greenockite (const. strain)	CdS		1.1	2.4	–	–
Wurzite	ZnS		0.9	1.8	–	–
Zincite	ZnO		-1.4	+2.6	–	–

Hexagonal (6)		Formula	$r_{13}$ pm/V	$r_{33}$ pm/V	$r_{42}$ pm/V	$r_{51}$ pm/V
Lithium iodate	LiIO <sub>3</sub>		4.1	6.4	1.4	3.3
Lithium potassium sulfate	LiKSO <sub>4</sub>		$r_{13}-r_{33} = 1.6$	–	–	–

Trigonal (3m)		Formula	$T_{\text{tran}}$ K	$r_{13}$ pm/V	$r_{22}$ pm/V	$r_{33}$ pm/V	$r_{42}$ pm/V
Cesium nitrate	CsNO <sub>3</sub>		425	–	0.43	–	–
Lithium niobate	LiNbO <sub>3</sub>		1483	8.6	7.0	30.8	28
Lithium tantalate	LiTaO <sub>3</sub>		890	8.4	–	30.5	–
Lithium sodium sulfate	LiNaSO <sub>4</sub>		–	–	<0.02	–	–
Tourmaline	–		–	–	0.3	–	–

Trigonal (32)		Formula	$T_{\text{tran}}$ K	$r_{11}$ pm/V	$r_{41}$ pm/V
Cesium tartrate	Cs <sub>2</sub> C <sub>4</sub> H <sub>4</sub> O <sub>6</sub>		–	1.0	–
Cinnabar	HgS		659	3.1	1.5
Potassium dithionate	K <sub>2</sub> S <sub>2</sub> O <sub>6</sub>		–	0.26	–
Strontium dithionate	SrS <sub>2</sub> O <sub>6</sub> ·4H <sub>2</sub> O		–	0.1	–
Quartz	SiO <sub>2</sub>		1140	-0.47	0.2
Selenium	Se		398	2.5	–

Orthorhombic (222)		Formula	$T_{\text{tran}}$ K	$r_{41}$ pm/V	$r_{52}$ pm/V	$r_{63}$ pm/V
Ammonium oxalate	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> ·4H <sub>2</sub> O		–	230	330	250
Rochelle salt	KNaC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ·4H <sub>2</sub> O		$T_u = 297$ $T_l = 255$	-2.0	-1.7	+0.32

Orthorhombic (mm2)		Formula	$T_{\text{trans}}$ K	$r_{13}$ pm/V	$r_{23}$ pm/V	$r_{33}$ pm/V	$r_{42}$ pm/V	$r_{51}$ pm/V
Barium sodium niobate (BSN)	Ba <sub>2</sub> NaNbO <sub>15</sub>		833	15	13	48	92	90
Potassium niobate	KNbO <sub>3</sub>		476	28	1.3	64	380	105

Monoclinic (2)		Formula	$T_{\text{trans}}$ K	$r_{22}$ pm/V	$r_{32}$ pm/V
Calcium pyroniobate	Ca <sub>2</sub> Nb <sub>2</sub> O <sub>7</sub>		–	0.33	13.7
Triglycine sulfate (TGS)	(NH <sub>2</sub> CH <sub>2</sub> COOH) <sub>3</sub> ·H <sub>2</sub> SO <sub>4</sub>		322	7.2	13.6

## References

1. Narasimhamurty, T. S., *Photoelastic and Electro-Optic Properties of Crystals*, Plenum Press, New York, 1981, pp. 405–407.
2. Weber, M. J., Ed., *CRC Handbook of Laser Science and Technology*, Vol. IV, CRC Press, Boca Raton, FL, 1986, pp. 258–278.

## QUADRATIC ELECTRO-OPTIC COEFFICIENTS

Kerr Constants of Ferroelectric Crystals<sup>1,2</sup>

Name	Formula	$T_{\text{tran}}$ K	$\lambda$ $\mu\text{m}$	$g_{11}$ $10^{10}$ esu	$g_{12}$ $10^{10}$ esu	$g_{11}-g_{12}$ $10^{10}$ esu	$g_{44}$ $10^{10}$ esu
Barium titanate	BaTiO <sub>3</sub>	406	0.633	1.33	-0.11	1.44	-
Strontium titanate	SrTiO <sub>3</sub>	-	0.633	-	-	1.56	-
Potassium tantalate niobate	KTa <sub>0.65</sub> Nb <sub>0.35</sub> O <sub>3</sub>	330	0.633	1.50	-0.42	1.92	1.63
Potassium tantalate	KTaO <sub>3</sub>	13	0.633	-	-	1.77	1.33
Lithium niobate	LiNbO <sub>3</sub>	1483	-	0.94	0.25	0.7	0.6
Lithium tantalate	LiTaO <sub>3</sub>	938	-	1.0	0.17	0.8	0.7
Barium sodium niobate (BSN)	Ba <sub>0.8</sub> Na <sub>0.4</sub> Nb <sub>2</sub> O <sub>6</sub>	833	-	1.55	0.44	1.11	-

Kerr Constants of Selected Liquids<sup>2</sup>

$K$  is the Kerr constant at a wavelength of 589 nm and at room temperature;  $\epsilon$  is the static dielectric constant;  $t_m$  is the melting point; and  $t_b$  is the normal boiling point

Name	Molecular formula	$K$ $10^{-7}$ esu	$\epsilon$	$t_m$ °C	$t_b$ °C
Carbon disulfide	CS <sub>2</sub>	+3.23	2.63	-111.5	+46.3
Acetone	C <sub>3</sub> H <sub>6</sub> O	+16.3	21.0	-94.8	+56.1
Methyl ethyl ketone	C <sub>4</sub> H <sub>8</sub> O	+13.6	18.56	-86.67	+79.6
Pyridine	C <sub>5</sub> H <sub>5</sub> N	+20.4	13.26	-42	+115.23
Ethyl cyanoacetate	C <sub>5</sub> H <sub>7</sub> NO <sub>2</sub>	+38.8	31.6	-22.5	205
<i>o</i> -Dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	+42.6	10.12	-16.7	180
Benzenesulfonyl chloride	C <sub>6</sub> H <sub>5</sub> ClO <sub>2</sub> S	+89.9	28.90	+14.5	247
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	+326	35.6	+5.7	210.8
Ethyl 3-aminocrotonate	C <sub>6</sub> H <sub>11</sub> NO <sub>2</sub>	+31.0	-	+33.9	210
Paraldehyde	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	-23.0	14.7	+12.6	124
			12.0 <sup>a</sup>		
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	+80.8	17.85	-26	179.05
			14.1 <sup>a</sup>		
<i>p</i> -Chlorotoluene	C <sub>7</sub> H <sub>7</sub> Cl	+23.0	6.25	+7.5	162.4
<i>o</i> -Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	+174	26.26	-10	222.3
<i>m</i> -Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	+177	24.95	+15.5	232
<i>p</i> -Nitrotoluene	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	+222	22.2	+51.6	238.3
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	-15.4	11.92	-15.3	205.8
			10.8 <sup>a</sup>		
<i>m</i> -Cresol	C <sub>7</sub> H <sub>8</sub> O	+21.2	12.44	+11.8	202.27
			5.0 <sup>a</sup>		
<i>m</i> -Chloroacetophenone	C <sub>8</sub> H <sub>7</sub> ClO	+69.1			
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	+66.6	17.44	+19.7	202.3
			15.8 <sup>a</sup>		
Quinoline	C <sub>9</sub> H <sub>7</sub> N	+15.0	9.16	-14.78	237.16
Ethyl salicylate	C <sub>9</sub> H <sub>10</sub> O <sub>3</sub>	+19.6	8.48	+1.3	231.5
Carvone	C <sub>10</sub> H <sub>14</sub> O	+23.6	11.2	<0	230
Ethyl benzoylacetate	C <sub>11</sub> H <sub>12</sub> O <sub>3</sub>	+16.0	13.50	<0	270
Water	H <sub>2</sub> O	+4.0	80.10	0.00	100.0

<sup>a</sup> Dielectric constant at radio frequencies (108–109 Hz).

## References

1. Narasimhamurty, T. S., *Photoelastic and Electro-Optic Properties of Crystals*, Plenum Press, New York, 1981, p. 408.
2. Gray, D. E., Ed., *AIP Handbook of Physics*, McGraw Hill, New York, 1972, p. 6–241.

## MAGNETO-OPTIC CONSTANTS

Verdet Constants of Non-Magnetic Crystals<sup>1</sup>

$V$  is the Verdet constant;  $n$  is the refractive index; and  $\lambda$  is the wavelength. "min" is minutes of angle.

Material	$T$ K	$\lambda$ nm	$n$	$V$ min/Oe cm
Al <sub>2</sub> O <sub>3</sub>	300	546.1	1.771	0.0240
	300	589.3	1.768	0.0210
BaTaO <sub>3</sub>	403	427		0.95
	403	496		0.38
	403	620		0.18
	403	826		0.072
Bi <sub>4</sub> Ge <sub>3</sub> O <sub>12</sub>	300	442	2.077	0.289
	300	632.8	2.048	0.099
	300	1064	2.031	0.026
C (diamond)	300	589.3	2.417	0.0233
CaCO <sub>3</sub>	300	589.3	1.658	0.019
CaF <sub>2</sub>	300	589.3	1.434	0.0088
Cd <sub>0.55</sub> Mn <sub>0.45</sub> Te	300	632.8		6.87
CuCl	300	546.1	1.93	0.20
GaSe	298	632.8		0.80
KAl(SO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	300	589.3	1.456	0.0124
KBr	300	546.1	1.564	0.0500
	300	589.3	1.560	0.0425
	300	589.3	1.490	0.0275
KCl	300	589.3	1.490	0.0275
KI	300	546.1	1.673	0.083
	300	589.3	1.666	0.070
	296	352		0.44
KTaO <sub>3</sub>	296	413		0.19
	296	496		0.096
	296	620		0.051
	296	826		0.022
	300	325	1.639	0.054
LaF <sub>3</sub> (H  c)	300	442	1.615	0.028
	300	632.8	1.601	0.012
	300	1064	1.592	0.006
	300	589.3	1.718	0.021
MgAl <sub>2</sub> O <sub>4</sub>	300	589.3	1.718	0.021
NH <sub>4</sub> AlSO <sub>4</sub> ·12H <sub>2</sub> O	300	589.3	1.459	0.0128
NH <sub>4</sub> Br	300	589.3	1.711	0.0504
NH <sub>4</sub> Cl	300	546.1		0.0410
	300	589.3	1.643	0.0362
NaBr	300	546.1		0.0621
	300	546.1		0.0410
	300	589.3	1.544	0.0345
NaClO <sub>3</sub>	300	546.1		0.0105
	300	589.3	1.515	0.0081
NiSO <sub>4</sub> ·6H <sub>2</sub> O	297	546.1		0.0256
	297	589.3	1.511	0.0221
SiO <sub>2</sub>	300	546.1	1.546	0.0195
	300	589.3	1.544	0.0166
SrTiO <sub>3</sub>	298	413	2.627	0.78
	298	496		0.31
	298	620		0.14
	298	826		0.066
	300	546.1		0.287
ZnS	300	589.3	2.368	0.226
	300	546.1		0.287
ZnSe	300	476	2.826	1.50
	300	496	2.759	1.04
	300	514	2.721	0.839
	300	587	2.627	0.529
	300	632.8	2.592	0.406

Verdet Constants of Rare-Earth Aluminum Garnets at Various Wavelengths<sup>1</sup>

The absorption coefficient  $\alpha$  for these materials ranges from 0.2 to 0.6 cm<sup>-1</sup> at 300 K.

Material	T/K	V in min/Oe cm							
		$\lambda = 405 \text{ nm}$	450 nm	480 nm	520 nm	546 nm	578 nm	635 nm	670 nm
Tb <sub>2</sub> Al <sub>5</sub> O <sub>12</sub>	300	-2.266	-1.565	-1.290	-1.039	-0.912	-0.787	-0.620	-0.542
	77		-102.16	-83.45	-3.425	-3.051	-2.603	-2.008	-1.815
	4.2				-64.80	-58.35	-53.77	48.39	-45.15
	1.45		-200.95	-172.52	-139.28	-125.07	-111.27	97.47	-93.42
Dy <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	300	-1.241	-0.942	-0.803	-0.667	-0.592	-0.518	-0.411	-0.359
Ho <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	300	-0.709	-0.320	-0.260	-0.335	-0.304	-0.299		-0.206
Er <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	300	-0.189	-0.240	-0.154	-0.162	-0.157	-0.145	-0.105	-0.089
Tm <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	300	+0.151	+0.103	+0.093	0.076	0.069	+0.059	+0.048	
Yb <sub>3</sub> Al <sub>5</sub> O <sub>12</sub>	298	0.287	0.215	0.186	0.140	0.133	0.116	0.094	
	77	0.718	0.540	0.481	0.393	0.342	0.302	0.239	

Verdet Constants for KDP-Type Crystals<sup>1</sup>

Measurements refer to  $T = 298 \text{ K}$  and  $\lambda = 632.8 \text{ nm}$ , with  $k \parallel [001]$ .

Material	V min/Oe cm
KH <sub>2</sub> PO <sub>4</sub> (KDP)	0.0124
KH <sub>0.3</sub> D <sub>1.7</sub> PO <sub>4</sub> (KD*P)	0.145
NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub> (ADP)	0.138
KH <sub>2</sub> AsO <sub>4</sub> (KDA)	0.238
KH <sub>0.1</sub> D <sub>1.9</sub> AsO <sub>4</sub> (KD*A)	0.245
NH <sub>4</sub> H <sub>2</sub> AsO <sub>4</sub> (ADH)	0.244

Verdet Constants of Gases<sup>2</sup>

Values refer to  $T = 0 \text{ }^\circ\text{C}$  and  $P = 101.325 \text{ kPa}$  (760 mmHg);  $n_D$  is the refractive index at a wavelength of 589 nm.

Gas	$(n_D - 1) \times 10^3$	$10^6 \times V$ min/Oe cm
He	0.036	+0.40
Ar	2.81	+9.36
H <sub>2</sub>		+6.29
N <sub>2</sub>	0.297	+6.46
O <sub>2</sub>	0.272	+5.69
Air	0.293	+6.27
Cl <sub>2</sub>	0.773	+31.9
HCl	0.447	+21.5
H <sub>2</sub> S	0.63	+41.5
NH <sub>3</sub>	0.376	+19.0
CO	0.34	+11.0
CO <sub>2</sub>	0.45	+9.39
NO	0.297	-58
CH <sub>4</sub>	0.444	+17.4
<i>n</i> -C <sub>4</sub> H <sub>10</sub>		+44.0

Verdet Constants of Liquids<sup>2</sup>

$n_D$  is the refractive index at a wavelength of 589 nm and a temperature of 20 °C, unless otherwise indicated.  $V$  is the Verdet constant.

Liquid	$\lambda/\text{nm}$	$t/^\circ\text{C}$	$10^2 \times V$ min/Oe cm	$n_D$
P	589	33	+13.3	
S	589	114	+8.1	1.929 (110 °C)
H <sub>2</sub> O	589	20	+1.309	1.3328
D <sub>2</sub> O	589	19.7	+1.257	1.3384
H <sub>3</sub> PO <sub>4</sub>	578	97.4	+1.35	
CS <sub>2</sub>	589	20	+4.255	1.6255
CCl <sub>4</sub>	578-589	25.1	+1.60	1.463 (15 °C)
SbCl <sub>5</sub>	578	18	+7.45	1.601 (14 °C)
TiCl <sub>4</sub>	578	17	-1.65	1.61
TiBr <sub>4</sub>	578	46	-5.3	
Methanol	589	18.7	+0.958	1.3289
Acetone	578-589	20.0	+1.116	1.3585
Toluene	578-589	15.0	+2.71	1.4950
Benzene	578-589	15.0	+3.00	1.5005
Chlorobenzene	589	15	+2.92	1.5246
Nitrobenzene	589	15	+2.17	1.5523
Bromoform	589	17.9	+3.13	1.5960

Verdet Constants of Rare-Earth Paramagnetic Crystals<sup>1</sup>

$n$  is the refractive index, and  $V$  is the Verdet constant at the wavelength and temperature indicated.

Rare Earth	Host	$T/K$	$\lambda/nm$	$n$	$V$ min/Oe cm		
Ce <sup>3+</sup> (30%)	CaF <sub>2</sub>	300	325	1.516	-0.956		
		300	442	1.502	-0.297		
		300	633	1.494	-0.111		
		300	1064	1.489	-0.035		
Ce <sup>3+</sup>	CeF <sub>3</sub>	300	442	1.613	-1.05		
		300	633	1.598	-0.406		
		77	633		-1.418		
		300	1064	1.589	-0.113		
Pr <sup>3+</sup> (5%)	CaF <sub>2</sub>	300	266	1.471	-0.172		
		300	325	1.461	-0.0818		
		300	442	1.451	-0.0089		
		300	633	1.445	-0.0168		
Nd <sup>3+</sup> (2.9%)	CaF <sub>2</sub>	300	1064	1.441	-0.0045		
		4.2	426		-0.19		
		Nd <sup>3+</sup>	NdF <sub>3</sub>	300	442	1.60	-0.553
				290	633	1.59	-0.209
		77	633		-0.755		
		300	1064	1.58	-0.097		
Eu <sup>3+</sup> (3%)	CaF <sub>2</sub>	4.2	430		29		
		4.2	440		22		
Eu <sup>2+</sup>	EuF <sub>2</sub>	300	450		-4.5		
		300	500		-2.6		
		300	550		-1.6		
		300	600		-1.1		
		300	650		-0.8		
		300	1064		-0.19		
Tb <sup>3+</sup>	KTb <sub>3</sub> F <sub>10</sub>	300	325	1.531	-2.174		
		300	442	1.518	-0.933		
		300	633	1.510	-0.386		
		77	633		-1.94		
		300	1064	1.505	-0.114		
Tb <sup>3+</sup>	LiTbF <sub>4</sub>	300	325	1.493	-1.9		
		300	442	1.481	-0.98		
		300	633	1.473	-0.44		
		300	1064	1.469	-0.13		
Tb <sup>3+</sup>	Tb <sub>3</sub> Ga <sub>5</sub> O <sub>12</sub>	300	500	1.989	-0.749		
		300	570	1.981	-0.581		
		300	633	1.976	-0.461		
		300	830	1.967	-0.21		
		300	1060	1.954	-0.12		

Verdet Constants of Paramagnetic Glasses<sup>1</sup>

The Verdet constant  $V$  is given at room temperature for the wavelengths indicated.

Rare-earth phosphate glasses of composition  $R_2O_3 \cdot xP_2O_5$ , where  $x$  is given in the second column

R	$x$	Verdet constant $V$ in min/Oe cm									
		$\lambda = 405$ nm	$\lambda = 436$ nm	$\lambda = 480$ nm	$\lambda = 500$ nm	$\lambda = 520$ nm	$\lambda = 546$ nm	$\lambda = 578$ nm	$\lambda = 600$ nm	$\lambda = 635$ nm	$\lambda = 670$ nm
La		0.037	0.030	0.024	0.022	0.020	0.018	0.015	-0.014	0.013	-
Ce	2.67	-0.672	0.510	-0.366	-0.326	-0.287	-0.253	-0.217	-0.197	-0.173	-0.150
Pr	3.09	-0.447	-0.332	-0.283	-0.261	-0.236	-0.208	-0.182	-0.170	-0.150	-0.132
Nd	2.92	-0.250	-0.209	-0.167	-0.155	-0.136	-0.134	-0.094	-0.080	-0.080	-0.071
Sm	2.87	0.026	0.024	0.020	0.020	0.017	0.015	0.014	0.012	0.011	0.010
Eu	2.93	-0.025	-0.017	-0.010	-0.006	-0.006	-0.005	-0.004	-0.003	-0.002	-0.002
Gd	3.01	0.018	0.015	0.014	0.012	0.012	0.011	0.011	0.010	0.009	0.009
Tb	2.94	-0.560	-0.458	-0.357	-0.323	-0.295	-0.261	-0.226	-0.206	-0.190	-0.164
Dy	2.51	-0.540	-0.453	-0.359	-0.331	-0.301	0.268	-0.237	-0.217	-0.197	-0.173
Ho	2.94	-0.299	-0.313	-0.156	-0.153	-0.138	-0.138	-0.119	-0.110	-0.098	-0.084
Er	3.01	-0.139	-0.121	-0.100	-0.111	-0.095	-0.062	-0.060	-0.057	-0.051	-0.044
Tm	2.79	0.019	0.013	0.012	0.009	0.008	0.006	0.005	0.004	0.004	0.007
Yb	3.01	0.087	0.072	0.056	0.050	0.045	0.041	0.036	0.032	0.029	0.024

The following are rare-earth borate glasses with composition:

for La and Pr:  $R_2O_3 \cdot xP_2O_5$ ; for Tb-Pr and Dy-Pr:  $R_2O_3 \cdot xB_2O_3$ ; and for other elements:  $R_2O_3 \cdot 0.85La_2O_3 \cdot xB_2O_3$ .

La	3.04	0.043	0.036	0.029	0.026	0.023	0.022	0.019	0.018	0.016	0.014
Pr-La	5.44	-0.380	-0.307	-0.230	-0.220	-0.201	-0.178	-0.153	-0.146	-0.128	-0.110
Nd-La	5.41	-0.180	-0.147	-0.120	-0.111	-0.096	-0.094	-0.100	-0.059	-0.056	-0.046
Sm-La	4.97	0.032	0.030	0.025	0.024	0.022	0.019	0.017	0.016	0.014	0.012
Eu-La	4.69	-0.081	-0.060	-0.038	-0.033	-0.029	-0.024	0.019	-0.016	0.014	-0.012
Gd-La	4.71	0.032	0.026	0.024	0.022	0.021	0.020	0.018	0.017	0.015	0.013
Tb-La	4.73	-0.512	-0.419	-0.319	-0.288	-0.262	-0.234	-0.205	-0.186	-0.167	-0.142
Dy-La	4.88	-0.436	-0.361	-0.299	-0.273	-0.246	-0.220	-0.193	-0.177	-0.159	-0.138
Ho-La	4.36	-0.269	-0.252	-0.123	-0.131	-0.112	-0.128	-0.104	-0.096	-	-0.074
Er-La	4.50	-0.093	-0.078	-0.068	-0.082	-	-0.045	-0.042	-0.040	-0.035	-0.034
Tm-La	4.75	0.060	0.046	0.039	0.034	0.031	0.026	0.023	0.021	0.018	0.016
Yb-La	8.58	0.115	0.094	0.073	0.066	0.060	0.054	0.046	0.043	0.037	0.033
Tb-Pr	4.99	-0.940	-0.786	-0.560	-0.536	-0.489	-0.436	-0.380	-0.348	-0.306	-0.265
Dy-Pr	4.63	-0.850	-	-	-0.497	-0.465	-0.413	-0.358	-0.332	-0.290	-0.252
Pr	2.56	-0.843	-0.646	-0.471	-0.480	-0.432	-0.390	-0.334	-0.317	-0.271	-0.243

Verdet Constants of Diamagnetic Glasses<sup>1</sup>

The Verdet constant  $V$  is given at room temperature for the wavelengths indicated.

Glass type	Composition (wt. %)	Verdet constant $V$ in min/Oe cm			
		$\lambda = 325$ nm	$\lambda = 442$ nm	$\lambda = 633$ nm	$\lambda = 1064$ nm
SiO <sub>2</sub>	100% SiO <sub>2</sub>			0.013	
B <sub>2</sub> O <sub>3</sub>	100% B <sub>2</sub> O <sub>3</sub>			0.010	
CdO	47.5% CdO, 52.5% P <sub>2</sub> O <sub>5</sub>	0.079	0.033	0.022	
ZnO	36.4% ZnO, 63.6% P <sub>2</sub> O <sub>5</sub>	0.072	0.044	0.020	
TeO <sub>2</sub>	88.9% TeO <sub>2</sub> , 11.1% P <sub>2</sub> O <sub>5</sub>		0.196	0.076	0.022
ZrF <sub>4</sub>	63.1% ZrF <sub>4</sub> , 14.9% BaF <sub>2</sub> , 7.2% LaF <sub>3</sub> , 1.9% AlF <sub>3</sub> , 9.1% PbF <sub>2</sub> , 3.8% LiF			0.011	

		$\lambda = 700 \text{ nm}$	$\lambda = 853 \text{ nm}$	$\lambda = 1060 \text{ nm}$
$\text{Bi}_2\text{O}_3$	95% $\text{Bi}_2\text{O}_3$ , 5% $\text{B}_2\text{O}_3$	0.086	0.051	0.033
PbO	95% PbO, 5% $\text{B}_2\text{O}_3$	0.093	0.061	0.031
	82% PbO, 18% $\text{SiO}_2$	0.077	0.045	0.027
	50% PbO, 15% $\text{K}_2\text{O}$ , 35% $\text{SiO}_2$	0.032	0.020	0.011
$\text{Tl}_2\text{O}$	95% $\text{Tl}_2\text{O}$ , 5% $\text{B}_2\text{O}_3$	0.092	0.061	0.032
	82% $\text{Tl}_2\text{O}$ , 18% $\text{SiO}_2$	0.100	0.067	0.043
	50% $\text{Tl}_2\text{O}$ , 15% $\text{K}_2\text{O}$ , 35% $\text{SiO}_2$	0.036	0.022	0.012
SnO	76% SnO, 13% $\text{B}_2\text{O}_3$ , 11% $\text{SiO}_2$	0.071	0.046	0.026
$\text{TeO}_3$	75% $\text{TeO}_2$ , 25% $\text{Sb}_2\text{O}_3$	0.076	0.052	0.032
	80% $\text{TeO}_2$ , 20% $\text{ZnCl}_2$	0.073	0.046	0.025
	84% $\text{TeO}_2$ , 16% BaO	0.056	0.041	0.029
	70% $\text{TeO}_2$ , 30% $\text{WO}_3$	0.052	0.035	0.022
	20% $\text{TeO}_2$ , 80% PbO	0.128	0.075	0.048
$\text{Sb}_2\text{O}_3$	25% $\text{Sb}_2\text{O}_3$ , 75% $\text{TeO}_2$	0.076	0.050	0.032
	75% $\text{Sb}_2\text{O}_3$ , 75% $\text{Cs}_2\text{O}$ , 5% $\text{Al}_2\text{O}_3$	0.074	0.044	0.025
	75% $\text{Sb}_2\text{O}_3$ , 10% $\text{Cs}_2\text{O}$ , 10% $\text{Rb}_2\text{O}$ , 5% $\text{Al}_2\text{O}_3$	0.078	0.052	0.030

### Verdet Constants of Commercial Glasses<sup>1</sup>

This table gives the density,  $\rho$ , refractive index at 589 nm,  $n_D$ , and Verdet constant,  $V$ , for the wavelengths indicated; the data refer to room temperature.

Glass type	$\rho$ g/cm <sup>3</sup>	$n_D$	$V$ in min/Oe cm				
			$\lambda = 365.0 \text{ nm}$	$\lambda = 404.7 \text{ nm}$	$\lambda = 435.8 \text{ nm}$	$\lambda = 546.1 \text{ nm}$	$\lambda = 578.0 \text{ nm}$
BSC	2.49	1.5096	0.0499	0.0392	0.0333	0.02034	0.01798
HC	2.53	1.5189	0.0561	0.0440	0.0372	0.0225	0.01995
LBC	2.87	1.5406	0.0609	0.0477	0.0403	0.0245	0.0216
LF	3.23	1.5785	0.1143	0.0850	0.0693	0.0394	0.0344
BLF	3.48	1.6047	0.1112	0.0832	0.0685	0.0393	0.0344
DBC	3.56	1.6122	0.0662	0.0517	0.0435	0.0261	0.0231
DF	3.63	1.6203	0.1473	0.1076	0.0872	0.0485	0.0423
EDF	3.9	1.6533	0.1725	0.1248	0.1007	0.0556	0.0483

The composition of the glasses in weight percent is:

Glass type	$\text{SiO}_2$	$\text{B}_2\text{O}_3$	$\text{K}_2\text{O}$	CaO	$\text{Al}_2\text{O}_3$	$\text{As}_2\text{O}_3$	$\text{Na}_2\text{O}$	BaO	ZnO	PbO
BSC	69.6	6.7	20.5	2.9	0.3	0.1	–	–	–	–
HC	72.0	–	10.1	11.4	0.3	0.2	6.1	–	–	–
LBC	57.1	1.8	13.7	0.3	0.2	0.1	–	26.9	–	–
LF	52.5	–	9.5	0.3	0.2	0.1	–	–	–	37.6
BLF	45.2	–	7.8	–	–	0.4	–	16.0	8.3	22.2
DBC	36.2	7.7	0.2	0.2	3.5	0.7	–	44.6	6.7	–
DF	46.3	–	1.1	0.3	0.2	0.1	5.0	–	–	47.0
EDF	40.6	–	7.5	0.2	0.2	0.2	0.1	–	–	51.5

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## FARADAY ROTATION

## Ferro-, Ferri-, and Antiferromagnetic Solids

Material	$T_c$ K	$4\pi M_s$ gauss	$F$ deg/cm	$\alpha$ cm <sup>-1</sup>	$2F/\alpha$ deg	$T$ K	$\lambda$ nm			
Fe	1043	21,800	$4.4 \times 10^5$	$6.5 \times 10^5$	1.4	300	500			
			$6.5 \times 10^5$	$5.0 \times 10^5$	2.6	300	1000			
			$7 \times 10^5$	$4.2 \times 10^5$	3.3	300	1500			
			$7 \times 10^5$	$3.5 \times 10^5$	4.0	300	2000			
Co	1390	18,200	$2.9 \times 10^5$	—	—	300	500			
			$5.5 \times 10^5$	$6.1 \times 10^5$	1.8	300	1000			
			$5.5 \times 10^5$	$4.5 \times 10^5$	2.4	300	1500			
			$5.5 \times 10^5$	$3.6 \times 10^5$	2.7	300	2000			
Ni	633	6,400	$0.8 \times 10^5$	—	—	300	500			
			$2.6 \times 10^5$	$5.8 \times 10^5$	0.9	300	1000			
			$1.5 \times 10^5$	$4.8 \times 10^5$	0.6	300	1500			
			$1 \times 10^5$	$4.1 \times 10^5$	0.25	300	2000			
Permalloy (Ni/Fe = 82/18)	803	10,700	$1.2 \times 10^5$	$6 \times 10^5$	0.4	300	500			
			Ni/Fe = 100/0	6,000	$1.2 \times 10^5$	$7.05 \times 10^5$	0.34	300	632.8	
			Ni/Fe = 80/20	10,800	$2.2 \times 10^5$	$7.10 \times 10^5$	0.62	300	632.8	
			Ni/Fe = 60/40	14,900	$2.9 \times 10^5$	$7.54 \times 10^5$	0.77	300	632.8	
			Ni/Fe = 40/60	14,400	$2.2 \times 10^5$	$8.17 \times 10^5$	0.54	300	632.8	
			Ni/Fe = 20/80	19,400	$3.3 \times 10^5$	$8.10 \times 10^5$	0.81	300	632.8	
			Ni/Fe = 0/100	639	21,600	$3.5 \times 10^5$	$8.13 \times 10^5$	0.86	300	632.8
			MnBi	7,700	$4.2 \times 10^5$	$6.1 \times 10^5$	1.4	300	450	
					$7.5 \times 10^5$	$4.2 \times 10^5$	3.6	300	900	
			MnAs	313	—	$0.44 \times 10^5$	$5.0 \times 10^5$	0.174	300	500
$0.62 \times 10^5$	$4.4 \times 10^5$	0.28				300	900			
CrTe	334	1015	$0.5 \times 10^5$	$2.0 \times 10^5$	0.5	300	550			
			$0.4 \times 10^5$	$1.2 \times 10^5$	0.7	300	900			
FeRh	333	—	$0.9 \times 10^5$	$3.3 \times 10^5$	0.56	348	700			
Y <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub> (YIG)	560	2500	2400	1500	3.2	300	555			
			1250	1400	1.8	300	625			
			750	450	3.3	300	770			
			175	<0.06	> $3 \times 10^3$	300	5000 to 1500			
Gd <sub>3</sub> Fe <sub>5</sub> O <sub>12</sub> (GdIG)	$T_n = 564$ $T = 286$	7300	-2000	6000	0.6	300	500			
			-1050	900	2.3	300	600			
			-300	100	6.0	300	800			
			-80	70	2.3	300	1000			
NiFe <sub>2</sub> O <sub>4</sub>	858	3350	$2.0 \times 10^4$	$5.9 \times 10^4$	0.7	300	286			
			$-1.0 \times 10^4$	$10 \times 10^4$	0.2	300	500			
			-120	38	6	300	1500			
			+75	15	10	300	3000			
			+110	32	7	300	5000			
CoFe <sub>2</sub> O <sub>4</sub>	793	4930	$2.75 \times 10^4$	$12 \times 10^4$	0.5	300	286			
			$3.6 \times 10^4$	$17 \times 10^4$	0.4	300	400			
			$-2.5 \times 10^4$	$6 \times 10^4$	0.8	300	660			
MgFe <sub>2</sub> O <sub>4</sub>	593-713 <sup>c</sup>	1450 <sup>c</sup>	-60	100	1	300	2500			
			0	12	0	300	4000			
			+35	6	11	300	6000			
Li <sub>0.5</sub> Fe <sub>2.5</sub> O <sub>4</sub>	863-953 <sup>c</sup>	3240 <sup>c</sup> to 3900	-440	150	6	300	1500			
			+10	85	0.2	300	3000			
			+110	44	5	300	5000			
			+135	80	3	300	7000			
BaFe <sub>12</sub> O <sub>19</sub>	723	—	-50	-38	3	300	2000			
			+75	20	7.5	300	3000			
			+150	20	15	300	5000			
			+165	22	15	300	7000			
Ba <sub>2</sub> Zn <sub>2</sub> Fe <sub>12</sub> O <sub>19</sub>	—	—	90	120	1.5	300	5000			



Material	$T_c$ K	$4\pi M_s$ gauss	$F$ deg/cm	$\alpha$ cm <sup>-1</sup>	$2F/\alpha$ deg	$T$ K	$\lambda$ nm
RbNiF <sub>3</sub>	220	1250	75	65	2.0	300	7000
			360	35	20	77	450 <sup>a</sup>
			70	10	14	77	600 <sup>a</sup>
			310	70	9	77	800 <sup>a</sup>
			75	25	6	77	1000 <sup>a</sup>
RbNi <sub>0.75</sub> Co <sub>0.25</sub> F <sub>3</sub>	109	–	180	9	40	77	600 <sup>b</sup>
RbFeF <sub>3</sub>	102	–	3400	7	900	82	300 <sup>c</sup>
			1600	3	1100	82	400 <sup>c</sup>
			620	1.5	830	82	600 <sup>c</sup>
			300	2.5	240	82	800 <sup>c</sup>
FeF <sub>3</sub>	365	40 at 300 K	670	14	95	300	349 <sup>d</sup>
			180	4.4	82	300	522.5 <sup>d</sup>
CrCl <sub>3</sub>	16.8	3880	2000	200	20	1.5	410
			–500	300	3	1.5	450
			–1000	70	30	1.5	590
CrBr <sub>3</sub>	32.5	3390	$3 \times 10^5$	$3 \times 10^3$	200	1.5	478
			$1.6 \times 10^5$	$1.4 \times 10^4$	23	1.5	500
CrI <sub>3</sub>	68	2690	$1.1 \times 10^5$	$6.3 \times 10^3$	35	1.5	970
			$0.8 \times 10^5$	$3 \times 10^3$	53	1.5	1000
FeBO <sub>3</sub>	348	115 at 300 K	3200	140	45	300	500
			450	38	24	300	700
EuO	69	23700	$-1.0 \times 10^5$	$0.5 \times 10^4$	40	5	1100
			$5 \times 10^5$	$9.7 \times 10^4$	10	5	700
			$0.5 \times 10^5$	$7.8 \times 10^4$	1.3	5	500
			$3 \times 10^4$	>0.5	~105	20	2500
			660	>1.0	1300	20	10600
EuS	16.3	–	$-1.6 \times 10^5$	0	–	6	825
			$-9.6 \times 10^5$	$3.3 \times 10^4$	58	6	690
			$+5.5 \times 10^5$	$1.2 \times 10^5$	9.2	6	563
EuSe	7.0	13,200	$1.45 \times 10^5$	80	3600	4.2	750
			$0.95 \times 10^5$	60	3170	4.2	800

<sup>a</sup> Measured along the C-axis (magnetic hard axis).

<sup>b</sup> Measured along the C-axis (magnetic easy axis).

<sup>c</sup> Measured along the C-axis ([100]-direction at room temperature).

<sup>d</sup> Strong natural birefringence interferes with the Faraday effect.

<sup>e</sup> Depends on heat treatment.

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# NONLINEAR OPTICAL CONSTANTS

H. P. R. Frederikse

The relation between the polarization density  $P$  of a dielectric medium and the electric field  $E$  is linear when  $E$  is small, but becomes nonlinear as  $E$  acquires values comparable with interatomic electric fields ( $10^5$  to  $10^8$  V/cm). Under these conditions the relation between  $P$  and  $E$  can be expanded in a Taylor's series

$$P = \epsilon_0 \chi^{(1)} E + 2\chi^{(2)} E^2 + 4\chi^{(3)} E^3 + \dots \quad (1)$$

where  $\epsilon_0$  is the permittivity of free space, while  $\chi^{(1)}$  is the linear and  $\chi^{(2)}$ ,  $\chi^{(3)}$  etc. the nonlinear optical susceptibilities.

If we consider two optical fields, the first  $E_j^{\omega_1}$  (along the  $j$ -direction at frequency  $\omega_1$ ) and the second  $E_k^{\omega_2}$  (along the  $k$ -direction at frequency  $\omega_2$ ) one can write the second term of the Taylor's series as follows

$$P_i(\omega_1, \omega_2) = 2\chi_{ijk}^{\omega_3=\omega_1 \pm \omega_2} E_j^{\omega_1} E_k^{\omega_2}$$

When  $\omega_1 \neq \omega_2$  the (parametric) mixing of the two fields gives rise to two new polarizations at the frequencies  $\omega_3 = \omega_1 + \omega_2$  and  $\omega_3' = \omega_1 - \omega_2$ . When the two frequencies are equal,  $\omega_1 = \omega_2 = \omega$ , the result is Second Harmonic Generation (SHG):  $\chi_{ijk}(2\omega, \omega, \omega)$ , while equal and opposite frequencies,  $\omega_1 = \omega$  and  $\omega_2 = -\omega$  leads to Optical Rectification (OR):  $\chi_{ijk}(0, \omega, -\omega)$ . In the SHG case the following convention is adopted: the second order nonlinear coefficient  $d$  is equal to one half of the second order nonlinear susceptibility

$$d_{ijk} = 1/2\chi^{(2)}$$

Because of the symmetry of the indices  $j$  and  $k$  one can replace these two by a single index (subscript)  $m$ . Consequently the notation for the SHG nonlinear coefficient in reduced form is  $d_{im}$  where  $m$  takes the values 1 to 6. Only noncentrosymmetric crystals can possess a nonvanishing  $d_{ijk}$  tensor (third rank). The unit of the SHG coefficients is m/V (in the MKSQ/SI system).

In centrosymmetric media the dominant nonlinearity is of the third order. This effect is represented by the third term in the Taylor's series (Equation 1); it is the result of the interaction of a number of optical fields (one to three) producing a new frequency  $\omega_4 = \omega_1 + \omega_2 + \omega_3$ . The third order polarization is given by

$$P_j(\omega_1, \omega_2, \omega_3) = g_4 \chi_{jklm} E_k^{\omega_1} E_l^{\omega_2} E_m^{\omega_3}$$

Third Harmonic Generation (THG) is achieved when  $\omega_1 = \omega_2 = \omega_3 = \omega$ . In this case the constant  $g_4 = 1/4$ . The third order nonlinear coefficient  $C$  is related to the third order susceptibility as follows:

$$C_{jklm} = 1/4\chi_{jklm}$$

This coefficient is a fourth rank tensor. In the THG case the matrices must be invariant under permutation of the indices  $k, l$ , and  $m$ ; as a result the notation for the third order nonlinear coefficient can be simplified to  $C_{jm}$ . The unit of  $C_{jm}$  is  $m^2 \cdot V^{-2}$  (in the MKSQ/SI system).

Applications of second order nonlinear optical materials include the generation of higher (up to sixth) optical harmonics, the mixing of monochromatic waves to generate sum or difference frequencies (frequency conversion), the use of two monochromatic waves to amplify a third wave (parametric amplification) and the addition of feedback to such an amplifier to create an oscillation (parametric oscillation).

Third order nonlinear optical materials are used for THG, self-focusing, four wave mixing, optical amplification, and optical conjugation. Many of these effects – as well as the variation and modulation of optical propagation caused by mechanical, electric, and magnetic fields (see the preceding table on "Elasto-Optic, Electro-Optic, and Magneto-Optic Constants") are used in the areas of optical communication, optical computing, and optical imaging.

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## Selected SHG Coefficients of NLO Crystals\*

Material	Symmetry class	$d_{im} \times 10^{12}$ m/V	$\lambda$ $\mu\text{m}$	Material	Symmetry class	$d_{im} \times 10^{12}$ m/V	$\lambda$ $\mu\text{m}$
GaAs	$\bar{4}3m$	$d_{14} = 134.1 \pm 42$	10.6	AgGaSe <sub>2</sub>	$\bar{4}2m$	$d_{36} = 37.4 \pm 6.0$	10.6
GaP	$\bar{4}3m$	$d_{14} = 71.8 \pm 12.3$	1.058	(NH <sub>2</sub> ) <sub>2</sub> CO (urea)	$\bar{4}2m$	$d_{36} = 1.3$	1.06
InAs	$\bar{4}3m$	$d_{14} = 364 \pm 47$	1.058	AlPO <sub>4</sub>	32	$d_{11} = 0.35 \pm 0.03$	1.058
ZnSe	$\bar{4}3m$	$d_{14} = 210$	10.6	Se	32	$d_{11} = 97 \pm 25$	10.6
$\beta$ -ZnS	$\bar{4}3m$	$d_{14} = 78.4 \pm 29.3$	10.6	Te	32	$d_{11} = 650 \pm 30$	10.6
ZnTe	$\bar{4}3m$	$d_{14} = 26.6 \pm 1.7$	1.058	SiO <sub>2</sub> (quartz)	32	$d_{11} = 0.335$	1.064
CdTe	$\bar{4}3m$	$d_{14} = 30.6 \pm 8.4$	10.6	HgS	32	$d_{11} = 50.3 \pm 17$	10.6
Bi <sub>4</sub> GeO <sub>12</sub>	$\bar{4}3m$	$d_{36} = 20.7 \pm 1.3$	1.058	(C <sub>6</sub> H <sub>5</sub> CO) <sub>2</sub> [benzil]	32	$d_{11} = 3.6 \pm 0.5$	1.064
N <sub>4</sub> (CH <sub>2</sub> ) <sub>6</sub> (hexamine)	$\bar{4}3m$	$d_{14} = 92.2 \pm 33.5$	10.6	$\beta$ -BaB <sub>2</sub> O <sub>4</sub> [BBO]	3 m	$d_{22} = 2.22 \pm 0.09$	1.06
LiI O <sub>3</sub>	6	$d_{14} = 83.2 \pm 8.4$	1.058	LiNbO <sub>3</sub>	3 m	$d_{31} = 0.16 \pm 0.08$	1.06
ZnO	6 mm	$d_{36} = 89.6 \pm 5.7$	1.058	LiTaO <sub>3</sub>	3 m	$d_{33} = 34.4$	1.06
$\alpha$ -ZnS	6 mm	$d_{14} = 167.6 \pm 63$	10.6	Ag <sub>3</sub> AsS <sub>3</sub> [proustite]	3 m	$d_{31} = -5.95$	1.06
CdS	6 mm	$d_{14} = 1.28$	1.064	Ag <sub>3</sub> SbS <sub>3</sub> [pyrargirite]	3m	$d_{22} = 2.76$	1.06
CdSe	6 mm	$d_{14} = 4.1$	1.06	$\alpha$ -HIO <sub>3</sub>	222	$d_{33} = -16.4 \pm 2$	1.058
BaTiO <sub>3</sub>	4 mm	$d_{33} = -7.02$	1.06	NO <sub>2</sub> · CH <sub>3</sub> NOC <sub>5</sub> H <sub>4</sub> · (POM)	222	$d_{31} = -1.07 \pm 0.2$	1.058
PbTiO <sub>3</sub>	4 mm	$d_{31} = -5.53 \pm 0.3$	1.064	Ba <sub>2</sub> NaNb <sub>5</sub> O <sub>15</sub> [Banana]	mm 2	$d_{22} = +1.76 \pm 0.2$	1.058
K <sub>3</sub> Li <sub>2</sub> Nb <sub>5</sub> O <sub>15</sub>	4 mm	$d_{33} = -5.86 \pm 0.16$	1.058	C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> [MDB]	mm 2	$d_{31} = 11.3 \pm 2.5$	10.6
K <sub>0.8</sub> Na <sub>0.2</sub> Ba <sub>2</sub> Nb <sub>5</sub> O <sub>15</sub>	4 mm	$d_{31} = 1.76 \pm 0.16$	1.058	Gd <sub>2</sub> (MoO <sub>4</sub> ) <sub>3</sub>	mm 2	$d_{22} = 18.0 \pm 2.5$	10.6
SrBaNb <sub>5</sub> O <sub>15</sub>	4 mm	$d_{15} = 1.93 \pm 0.16$	1.058	KNbO <sub>3</sub>	mm 2	$d_{31} = 12.6 \pm 4$	10.6
NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub> (ADP)	$\bar{4}2m$	$d_{33} = 37.3 \pm 12.6$	10.6	KTiOPO <sub>4</sub> [KTP]	mm 2	$d_{22} = 13.4 \pm 4$	10.6
KH <sub>2</sub> PO <sub>4</sub> (KDP)	$\bar{4}2m$	$d_{31} = -18.9 \pm 6.3$	10.6	NO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> · NH <sub>2</sub> [mNA]	mm 2	$d_{31} = 5.15 \pm 0.16$	1.064
KD <sub>2</sub> PO <sub>4</sub> (KD*P)	$\bar{4}2m$	$d_{15} = 21.37 \pm 8.4$	10.6	C <sub>10</sub> H <sub>12</sub> N <sub>3</sub> O <sub>6</sub> [MAP]	2	$d_{36} = 6.4 \pm 1.0$	1.064
KH <sub>2</sub> AsO <sub>4</sub> (KDA)	$\bar{4}2m$	$d_{33} = 25.8 \pm 1.6$	1.058	(NH <sub>2</sub> CH <sub>2</sub> COOH) <sub>3</sub> H <sub>2</sub> SO <sub>4</sub> [TGS]	2	$d_{33} = -17.6 \pm 1.28$	1.064
CdGeAs <sub>2</sub>	$\bar{4}2m$	$d_{31} = -13.1 \pm 0.8$	1.058			$d_{31} = -12.8 \pm 1.28$	1.064
AgGaS <sub>2</sub>	$\bar{4}2m$	$d_{15} = 14.4 \pm 0.8$	1.058			$d_{31} = -12.8 \pm 1.03$	1.064
		$d_{33} = 54.5 \pm 12.6$	10.6			$d_{32} = +11.34 \pm 1.03$	1.064
		$d_{31} = -26.8 \pm 2.7$	10.6			$d_{31} = -12.88 \pm 1.03$	1.064
		$d_{33} = 6.8 \pm 1.0$	1.064			$d_{32} = +13.7$	1.06
		$d_{31} = 15.7 \pm 1.8$	1.064			$d_{32} = \pm 5.0$	1.06
		$d_{15} = 17.0 \pm 1.8$	1.064			$d_{31} = \pm 6.5$	1.06
		$d_{33} = 7.5 \pm 1.2$	1.064			$d_{33} = 13.12 \pm 1.28$	1.064
		$d_{31} = 37.6 \pm 5.6$	1.064			$d_{32} = 1.02 \pm 0.22$	1.064
		$d_{15} = 33.3 \pm 5$	1.064			$d_{31} = 12.48 \pm 1.28$	1.064
		$d_{33} = 11.2 \pm 1.6$	1.064			$d_{23} = 10.67 \pm 1.3$	1.064
		$d_{31} = 6.18 \pm 1.28$	1.064			$d_{22} = 11.7 \pm 1.3$	1.064
		$d_{15} = 5.45 \pm 0.54$	1.064			$d_{21} = 2.35 \pm 0.5$	1.064
		$d_{31} = 13.6 \pm 1.6$	1.064			$d_{25} = -0.35 \pm 0.3$	1.064
		$d_{33} = 11.3 \pm 3.3$	1.064			$d_{23} = 0.32$	0.694
		$d_{31} = 4.31 \pm 1.32$	1.064				
		$d_{15} = 5.98 \pm 2$	1.064				
		$d_{36} = 0.53$	1.064				
		$d_{36} = 0.85$	0.694				
		$d_{36} = 0.44$	1.064				
		$d_{36} = 0.47 \pm 0.07$	0.694				
		$d_{36} = 0.38 \pm 0.016$	1.058				
		$d_{36} = 0.34 \pm 0.06$	0.694				
		$d_{14} = 0.37$	1.058				
		$d_{36} = 0.43 \pm 0.025$	1.06				
		$d_{36} = 0.39 \pm 0.4$	0.694				
		$d_{36} = 351 \pm 105$	10.6				
		$d_{36} = 18 \pm 2.7$	10.6				

\* These data are taken from References 1 and 2.

## Selected THG Coefficients of Some NLO Materials\*

Material	NLO process	$C_m \times 10^{20}$ $m^2/V^{-2}$	$\lambda$ $\mu m$
$NH_4H_2PO_4$ [ADP]	$(-3\omega, \omega, \omega, \omega)$	$C_{11} = 0.0104$	1.06
		$C_{18} = 0.0098$	1.06
$C_6H_6$ [benzene]	$(-3\omega, \omega, \omega, \omega)$	$C_{11} = 0.0184 \pm 0.0042$	1.89
$CdGeAs_2$	$(-3\omega, \omega, \omega, \omega)$	$C_{11} = 182 \pm 84$	10.6
p-type: $5 \times 10^{16} \text{ cm}^{-3}$		$C_{16} = 175$	10.6
		$C_{18} = -35$	10.6
$C_{40}H_{56}$ [ $\beta$ -carotene]	$(-3\omega, \omega, \omega, \omega)$	$C_{11} = 0.263 \pm 0.08$	1.89
GaAs high-resistivity	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 62 \pm 31$	1.06
Ge	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 23.5 \pm 12$	1.06
$LiIO_3$	$(-3\omega, \omega, \omega, -\omega)$	$C_{12} = 0.2285$	1.06
		$C_{35} = 6.66 \pm 1$	1.06
KBr	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 0.0392$	1.06
		$C_{18}/C_{11} = 0.3667$	1.06
KCl	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 0.0168$	1.06
		$C_{18}/C_{11} = 0.28$	1.06
$KH_2PO_4$ [KDP]	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} - 3C_{18} = 0.04$	1.06
Si p-type: $10^{14} \text{ cm}^{-3}$	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 82.8 \pm 25$	1.06
NaCl	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 0.0168$	1.06
		$C_{18}/C_{11} = 0.4133$	1.06
NaF	$(-3\omega, \omega, \omega, -\omega)$	$C_{11} = 0.0035$	1.06

\* These data are taken from Reference 1.

# PHASE DIAGRAMS

H. P. R. Frederikse

A phase is a structurally homogeneous portion of matter. Regardless of the number of chemical constituents of a gas, there is only one vapor phase. This is true also for the liquid form of a pure substance, although a mixture of several liquid substances may exist as one or several phases, depending on the interactions among the substances. On the other hand a pure solid may exist in several phases at different temperatures and pressures because of differences in crystal structure (Reference 1). At the phase transition temperature,  $T_{tr}$ , the chemical composition of the solid remains the same, but a change in the physical properties often will take place. Such changes are found in ferroelectric crystals (example  $BaTiO_3$ ) which develop a spontaneous polarization below  $T_{tr}$ , in superconductors (example Pb) which lose all electrical resistance below the transition point, and in many other classes of solids.

In quite a few cases it is difficult to bring about the phase transition, and the high- (or low-) temperature phase persists in its metastable form. Many liquids remain in the liquid state for shorter or longer periods of time when cooled below the melting point (supercooling). However, often the slightest disturbance will cause solidification. Persistence of the high temperature phase in solid-solid transitions is usually of much longer duration. An example of this behavior is found in white tin; although gray tin is the thermodynamically stable form below  $T_{tr}$  (286.4 K), the metal remains in its undercooled, white tin state all the way to  $T = 0$  K, and crystals of gray tin are very difficult to produce.

A *phase diagram* is a map that indicates the areas of stability of the various phases as a function of external conditions (temperature and pressure). Pure materials, such as mercury, helium, water, and methyl alcohol are considered one-component systems and they have *unary* phase diagrams. The equilibrium phases in two-component systems are presented in *binary* phase diagrams. Because many important materials consist of three, four, and more components, many attempts have been made to deduce their multicomponent phase diagrams. However, the vast majority of systems with three or more components are very complex, and no overall maps of the phase relationships have been worked out.

It has been shown during the last 20 to 25 years that very useful partial phase diagrams of complex systems can be obtained by means of thermodynamic modeling (References 2, 3). Especially for complicated, multicomponent alloy systems the CALPHAD method has proved to be a successful approach for producing valuable portions of very intricate phase diagrams (Reference 4). With this method thermodynamic descriptions of the free energy functions of various phases are obtained that are consistent with existing (binary) phase diagram information and other thermodynamic data. Extrapolation methods are then used to extend the thermodynamic functions into a ternary system. Comparison of the results of this procedure with available experimental data is then used to fine-tune the phase diagram and add ternary interaction functions if necessary. In principle this approximation strategy can be extended to four, five, and more component systems.

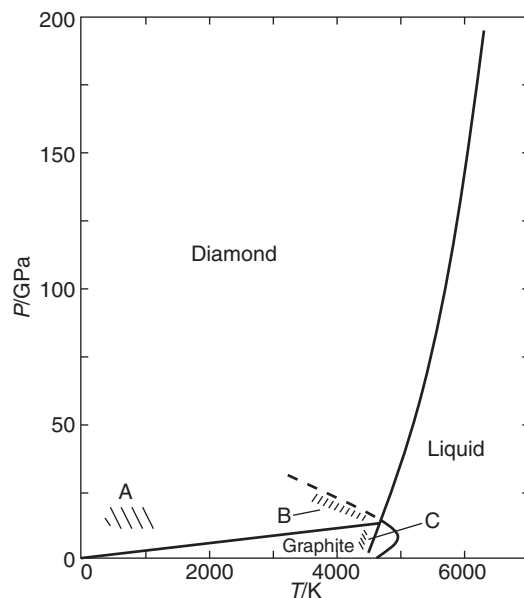
The nearly two dozen phase diagrams shown below present the reader with examples of some important types of single and multicomponent systems, especially for ceramics and metal alloys. This makes it possible to draw attention to certain features like the kinetic aspects of phase transitions (see Figure 22, which presents a time-temperature-transformation, or TTT, diagram for the precipitation of  $\alpha$ -phase particles from the  $\beta$ -phase in a Ti-Mo alloy; Reference 1, pp. 358–360). The general references listed below and the references to individual figures contain phase diagrams for many additional systems.

## General References

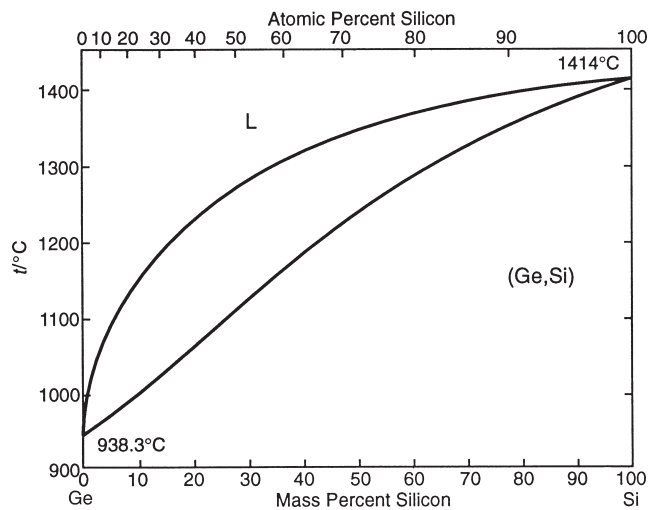
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## References to Individual Phase Diagrams

- Figure 1. Carbon: Reference 7, Vol. X (1994), Figure 8930. Reprinted with permission.
- Figure 2. Si-Ge: Ref. 5, p. 2.231. Reprinted with permission.
- Figure 3.  $H_2O$  (ice): See figure.
- Figure 4.  $SiO_2$ : Reference 7, Vol. XI (1995), Figure 9174. Reprinted with permission.
- Figure 5. Fe-O: Darken, L.S., and Gurry, R.W., *J. Am. Chem. Soc.*, 68, 798, 1946. Reprinted with permission.
- Figure 6. Ti-O: Reference 5, p. 2.324. Reprinted with permission.
- Figure 7. BaO-TiO<sub>2</sub>: Reference 7, Vol. III (1975), Figure 4302. Reprinted with permission.
- Figure 8. MgO-Al<sub>2</sub>O<sub>3</sub>: Reference 7, Vol. XI (1995), Figure 9239. Reprinted with permission.
- Figure 9. Y<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub>: Reference 7, Vol. XI (1995), Figure 9348. Reprinted with permission.
- Figure 10. Si-N-Al-O (Sialon): Reference 7, Vol. X (1994), Figure 8759. Reprinted with permission.
- Figure 11. PbO-ZrO<sub>2</sub>-TiO<sub>2</sub> (PZT): Reference 7, Vol. III (1975), Figure 4587. Reprinted with permission.
- Figure 12. Al-Si-Ca-O: Reference 7 (1964), Vol. I, Figure 630. Reprinted with permission.
- Figure 13. Y-Ba-Cu-O: Whitler, J.D., and Roth, R.S., *Phase Diagrams for High T<sub>c</sub> Superconductors*, Figure S-082, American Ceramic Society, Waterville, OH, 1990. Reprinted with permission.
- Figure 14. Al-Cu: Reference 5, p. 2.44. Reprinted with permission.
- Figure 15. Fe-C: Ralls, K.M., Courtney, T.H., and Wulff, J., *Introduction to Materials Science and Engineering*, Figure 16.13, John Wiley & Sons, New York, 1976. Reprinted with permission.
- Figure 16. Fe-Cr: Reference 5, p. 2.152. Reprinted with permission.
- Figure 17. Cu-Sn: Reference 5, p. 2.178. Reprinted with permission.
- Figure 18. Cu-Ni: Reference 5, p. 2.173. Reprinted with permission.
- Figure 19. Pb-Sn (solder): Reference 5, p. 2.335. Reprinted with permission.
- Figure 20. Cu-Zn (brass): Subramanian, P.R., Chakrabarti, D.J., and Laughlin, D.E., Eds., *Phase Diagrams of Binary Copper Alloys*, p. 487, ASM International, Materials Park, OH, 1994. Reprinted with permission.
- Figure 21. Co-Sm: Reference 5, p. 2.148. Reprinted with permission.
- Figure 22. Ti-Mo: Reference 5, p. 2.296; Reference 1, p. 359. Reprinted with permission.
- Figure 23. Fe-Cr-Ni: Reference 5, Figure 48. Reprinted with permission.

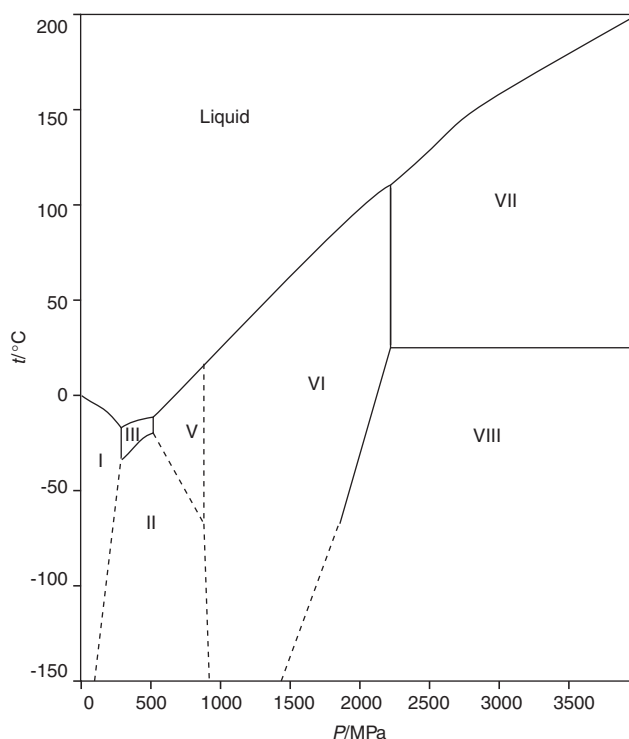


**FIGURE 1.** Phase diagram of carbon. (A) Martensitic transition: hex graphite → hex diamond. (B) Fast graphite-to-diamond transition. (C) Fast diamond-to-graphite transition.



**FIGURE 2.** Si-Ge system.

Phase	Composition, mass % Si	Pearson symbol	Space group
(Ge,Si)	0 to 100	<i>cF8</i>	<i>Fd3̄m</i>
High-pressure phases			
GeII	–	<i>tI4</i>	<i>I4<sub>1</sub>/amd</i>
SiII	–	<i>tI4</i>	<i>I4<sub>1</sub>/amd</i>



**FIGURE 3.** Diagram of the principal phases of ice. Solid lines are measured boundaries between stable phases; dotted lines are extrapolated. Ice IV is a metastable phase that exists in the region of ice V. Ice IX exists in the region below  $-100^{\circ}\text{C}$  and pressures in the range 200–400 MPa. Ice X exists at pressures above 44 GPa. See Table 1 for the coordinates of the triple points, where liquid water is in equilibrium with two adjacent solid phases.

**TABLE 1. Crystal Structure, Density, and Transition Temperatures for the Phases of Ice**

Phase	Crystal system	Cell parameters	Z	n	$\rho/\text{g cm}^{-3}$	Triple points
Ih	Hexagonal	$a = 4.513; c = 7352$	4	4	0.93	I-III: $-21.99^{\circ}\text{C}, 209.9 \text{ MPa}$
Ic	Cubic	$a = 6.35$	8	4	0.94	
II	Rhombohedral	$a = 7.78; \alpha = 113.1^{\circ}$	12	4	1.18	
III	Tetragonal	$a = 6.73; c = 6.83$	12	4	1.15	III-V: $-16.99^{\circ}\text{C}, 350.1 \text{ MPa}$
IV	Rhombohedral	$a = 7.60; \alpha = 70.1^{\circ}$	16	4	1.27	
V	Monoclinic	$a = 9.22; b = 7.54, c = 10.35; \beta = 109.2^{\circ}$	28	4	1.24	V-VI: $0.16^{\circ}\text{C}, 632.4 \text{ MPa}$
VI	Tetragonal	$a = 6.27; c = 5.79$	10	4	1.31	VI-VII: $82^{\circ}\text{C}, 2216 \text{ MPa}$
VII	Cubic	$a = 3.41$	2	8	1.56	
VIII	Tetragonal	$a = 4.80; c = 6.99$	8	8	1.56	
IX	Tetragonal	$a = 6.73; c = 6.83$	12	4	1.16	
X	Cubic	$a = 2.83$	2	8	2.51	

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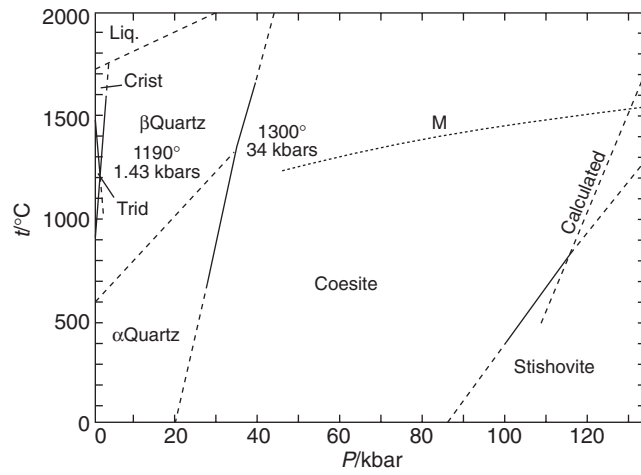


FIGURE 4. SiO<sub>2</sub> system. Crist = cristobalite; Trid = tridymite.

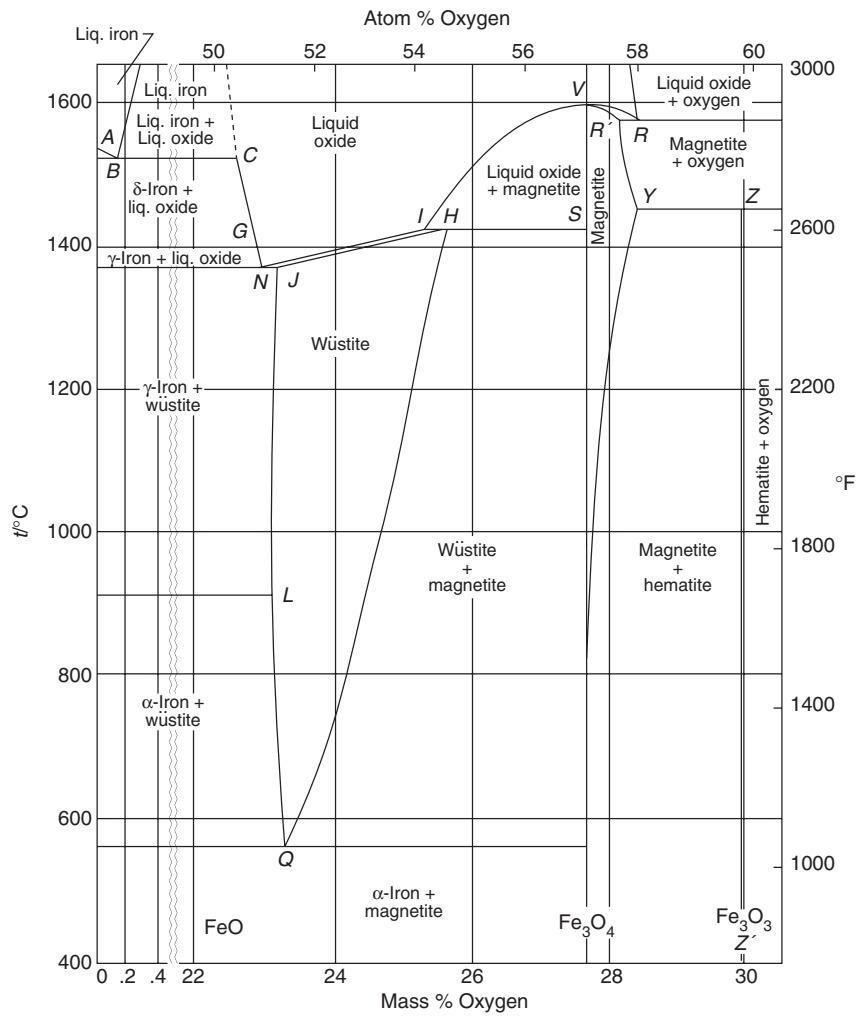


FIGURE 5. Fe-O system.



Point	$t/^{\circ}\text{C}$	% O	$p_{\text{CO}_2}/p_{\text{CO}}$	Point	$t/^{\circ}\text{C}$	% O	$p_{\text{CO}_2}/p_{\text{CO}}$	$p_{\text{O}_2}/\text{atm}$
A	1539			Q	560	23.26	1.05	
B	1528	0.16	0.209	R	1583	28.30		1
C	1528	22.60	0.209	R'	1583	28.07		1
G	1400 <sup>a</sup>	22.84	0.263	S	1424	27.64	16.2	
H	1424	25.60	16.2	V	1597	27.64		0.0575
I	1424	25.31	16.2	Y	1457	28.36		1
J	1371	23.16	0.282	Z	1457	30.04		1
L	911 <sup>a</sup>	23.10	0.447	Z'		30.6		
N	1371	22.91	0.282					

<sup>a</sup> Values for pure iron.

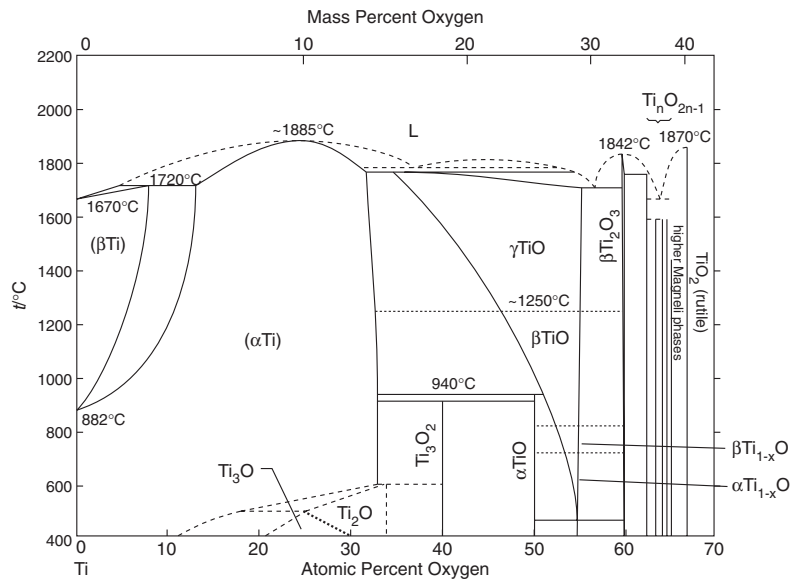


FIGURE 6. Ti-O system.

Phase	Composition, mass % O	Pearson symbol	Space group
( $\beta$ Ti)	0 to 3	<i>cI2</i>	<i>Im</i> $\bar{3}m$
( $\alpha$ Ti)	0 to 13.5	<i>hP2</i>	<i>P63/mmc</i>
Ti <sub>3</sub> O	~8 to ~13	<i>hP</i> ~16	<i>P</i> $\bar{3}c$
Ti <sub>2</sub> O	~10 to 14.4	<i>hP3</i>	<i>P</i> $\bar{3}m1$
$\gamma$ TiO	15.2 to 29.4	<i>cF8</i>	<i>Fm</i> $\bar{3}m$
Ti <sub>5</sub> O <sub>2</sub>	~18	<i>hP</i> ~5	<i>P6/mmm</i>
$\beta$ TiO	~24 to ~29.4	<i>c</i> **	—
$\alpha$ TiO	~25.0	<i>mC16</i>	<i>A2/m</i> or <i>B</i> <sup>2</sup> / <i>*</i>
$\beta$ Ti <sub>1-x</sub> O	~29.5	<i>oI12</i>	<i>I222</i>
$\alpha$ Ti <sub>1-x</sub> O	~29.5	<i>tI18</i>	<i>I4/m</i>
$\beta$ Ti <sub>2</sub> O <sub>3</sub>	33.2 to 33.6	<i>hR30</i>	<i>R</i> $\bar{3}c$
$\alpha$ Ti <sub>2</sub> O <sub>3</sub>	33.2 to 33.6	<i>hR30</i>	<i>R</i> $\bar{3}c$
$\beta$ Ti <sub>3</sub> O <sub>5</sub>	35.8	<i>m</i> **	—
$\alpha$ Ti <sub>3</sub> O <sub>5</sub>	35.8	<i>mC32</i>	<i>C2/m</i>
$\alpha'$ Ti <sub>3</sub> O <sub>5</sub>	35.8	<i>mC32</i>	<i>Cc</i>
$\gamma$ Ti <sub>4</sub> O <sub>7</sub>	36.9	<i>aP44</i>	<i>P</i> $\bar{1}$
$\beta$ Ti <sub>4</sub> O <sub>7</sub>	36.9	<i>aP44</i>	<i>P</i> $\bar{1}$
$\alpha$ Ti <sub>4</sub> O <sub>7</sub>	36.9	<i>aP44</i>	<i>P</i> $\bar{1}$
$\gamma$ Ti <sub>5</sub> O <sub>9</sub>	37.6	<i>aP28</i>	<i>P</i> $\bar{1}$
$\beta$ Ti <sub>6</sub> O <sub>11</sub>	38.0	<i>aC68</i>	<i>A</i> $\bar{1}$
Ti <sub>7</sub> O <sub>13</sub>	38.3	<i>aP40</i>	<i>P</i> $\bar{1}$
Ti <sub>8</sub> O <sub>15</sub>	38.5	<i>aC92</i>	<i>A</i> $\bar{1}$
Ti <sub>9</sub> O <sub>17</sub>	38.7	<i>aP52</i>	<i>P</i> $\bar{1}$
Rutile TiO <sub>2</sub>	40.1	<i>tP6</i>	<i>P4</i> <sub>2</sub> / <i>mnm</i>
Metastable phases			
Anatase	—	<i>tI12</i>	<i>I4</i> <sub>1</sub> / <i>amd</i>
Brookite	—	<i>oP24</i>	<i>Pbca</i>
High-pressure phases			
TiO <sub>2</sub> -II	—	<i>oP12</i>	<i>Pbcn</i>
TiO <sub>2</sub> -III	—	<i>hP</i> ~48	—

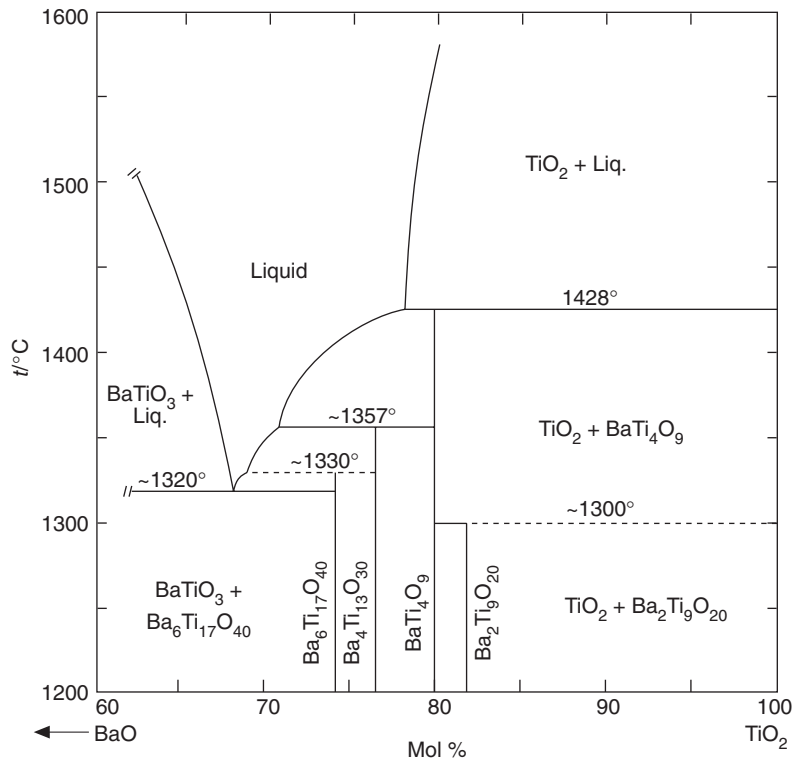


FIGURE 7. BaO-TiO<sub>2</sub> system.

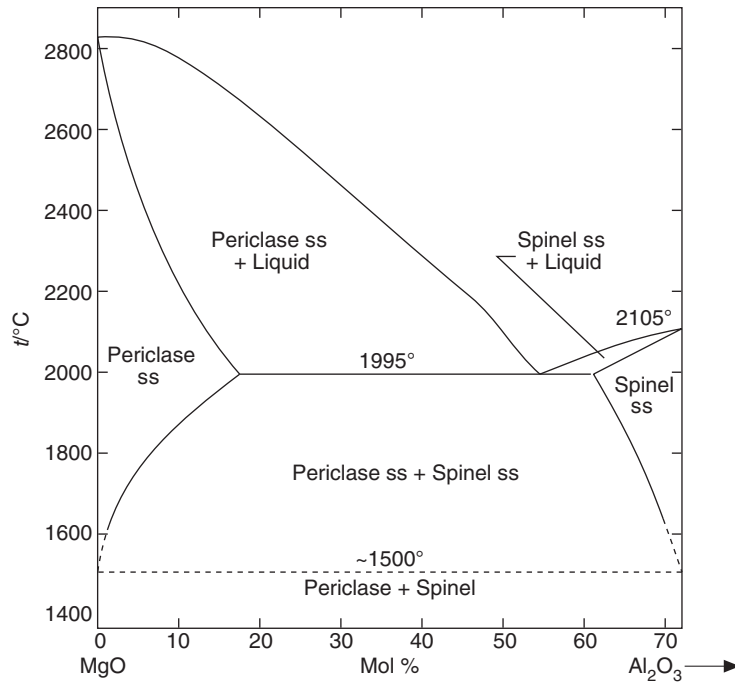
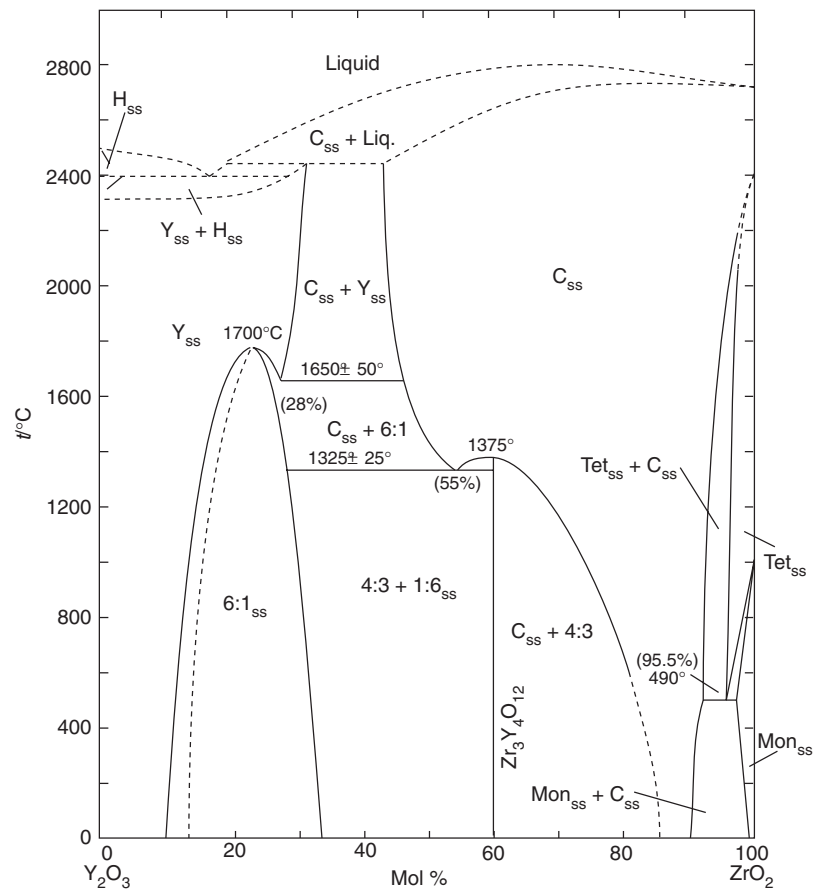
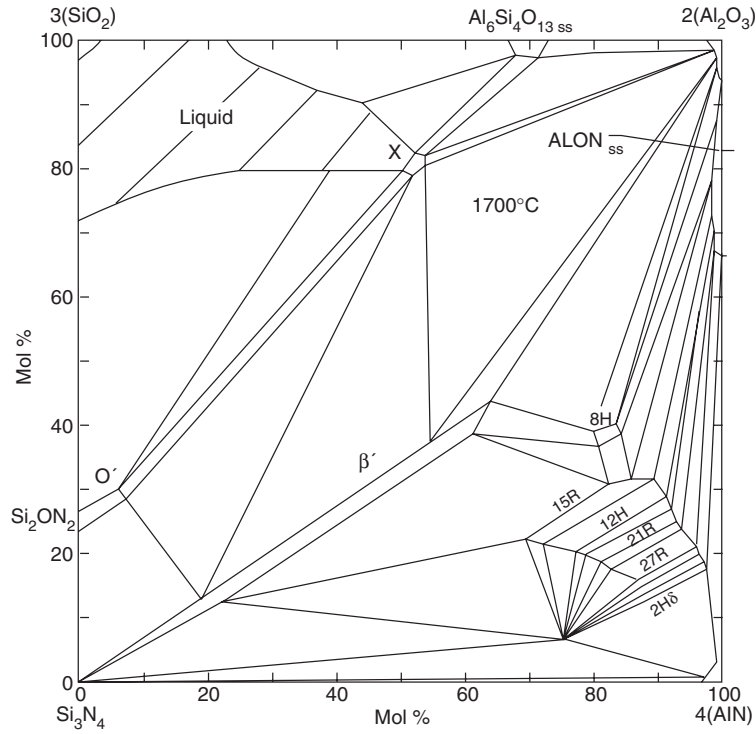


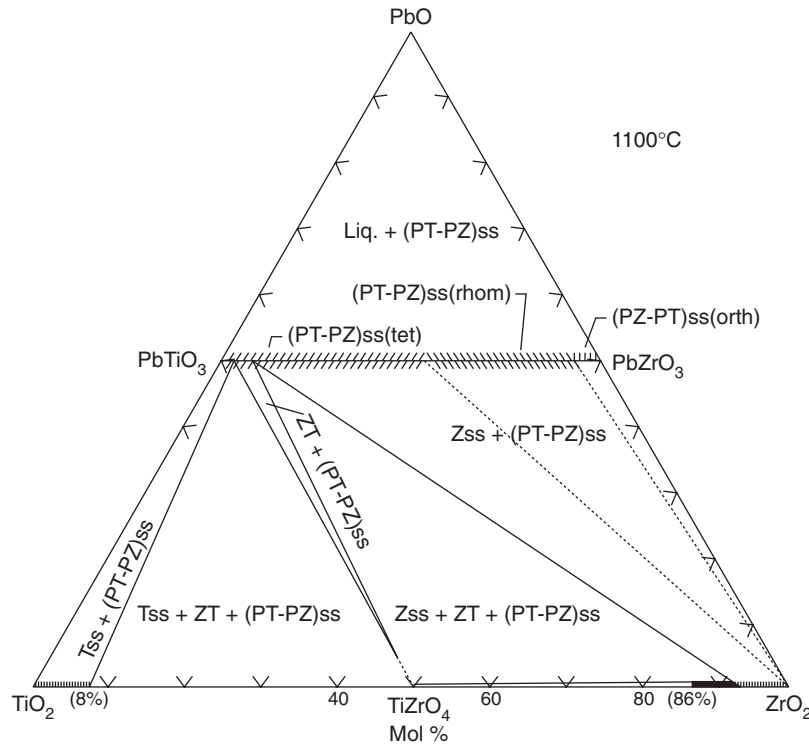
FIGURE 8. MgO-Al<sub>2</sub>O<sub>3</sub> system.



**FIGURE 9.**  $Y_2O_3$ - $ZrO_2$  system.  $C_{ss}$  = cubic  $ZrO_2$  ss (fluorite-type ss);  $Y_{ss}$  = cubic  $Y_2O_3$  ss;  $Tet_{ss}$  = tetragonal  $ZrO_2$  ss;  $Mon_{ss}$  = monoclinic  $ZrO_2$  ss;  $H_{ss}$  = hexagonal  $Y_2O_3$  ss;  $3:4 = Zr_3Y_4O_{12}$ ;  $1:6 = ZrY_6O_{11}$  ss.



**FIGURE 10.**  $3(\text{SiO}_2)\text{-Si}_3\text{N}_4\text{-4(AlN)-2(Al}_2\text{O}_3)$  system. “Behavior” diagram at  $1700^\circ\text{C}$ . The labels 8H, 15R, 12H, 21R, 27R,  $2\text{H}^6$  indicate defect AlN polytypes.  $\beta'$  = 3-sialon ( $\text{Si}_{6-x}\text{Al}_x\text{O}_x\text{N}_{8-x}$ );  $\text{O}'$  = sialon of  $\text{Si}_2\text{ON}_2$  type; X =  $\text{SiAlO}_2\text{N}$  (“nitrogen mullite”). ALON ss = aluminum oxynitride ss extending from approximately  $\text{Al}_7\text{O}_9\text{N}$  to  $\text{Al}_3\text{O}_3\text{N}$ .



**FIGURE 11.**  $\text{PbO-ZrO}_2\text{-TiO}_2$  (PZT) system, subsolidus at  $1100^\circ\text{C}$ .  $P = \text{PbO}$ ;  $T = \text{TiO}_2$ ;  $Z = \text{ZrO}_2$ .

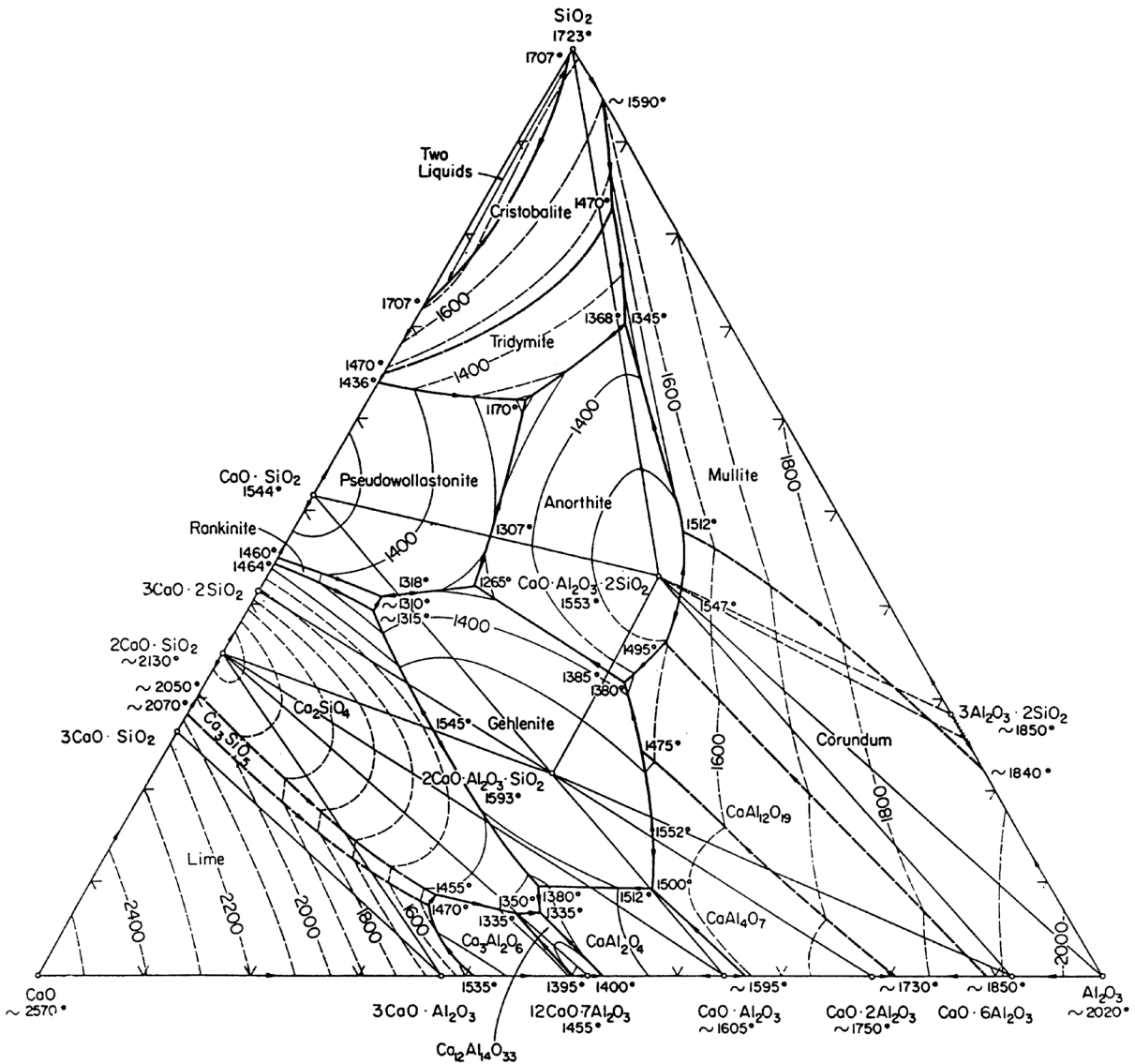


FIGURE 12. CaO-Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> system (temperatures in °C).

**Crystalline Phases**

Notation	Oxide formula
Cristobalite } Tridymite }	SiO <sub>2</sub>
Pseudowollastonite	CaO·SiO <sub>2</sub>
Rankinite	3CaO·2SiO <sub>2</sub>
Lime	CaO
Corundum	Al <sub>2</sub> O <sub>3</sub>
Mullite	3Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>
Anorthite	CaO·Al <sub>2</sub> O <sub>3</sub> ·2SiO <sub>2</sub>
Gehlenite	2CaO·Al <sub>2</sub> O <sub>3</sub> ·SiO <sub>2</sub>

Temperatures up to approximately 1550°C are on the Geophysical Laboratory Scale; those above 1550°C are on the 1948 International Scale.

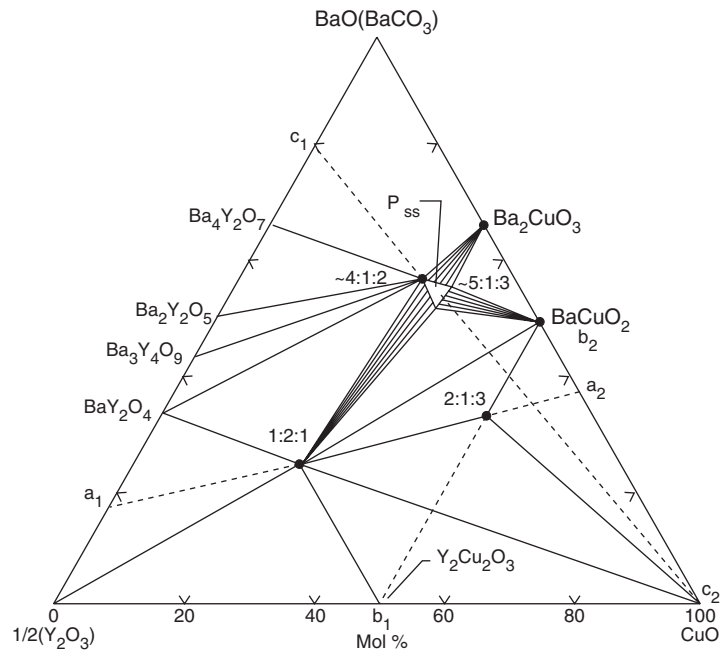


FIGURE 13. BaO-Y<sub>2</sub>O<sub>3</sub>-CuO system. 2:1:3 = Ba<sub>2</sub>YCu<sub>3</sub>O<sub>7-x</sub>; 1:2:1 = BaY<sub>2</sub>CuO<sub>5</sub>; 4:1:2 = Ba<sub>4</sub>YCu<sub>2</sub>O<sub>7.5+x</sub>; and 5:1:3 = Ba<sub>5</sub>YCu<sub>3</sub>O<sub>9.5+x</sub>. The superconducting 2:1:3 phase was prepared using barium peroxide.

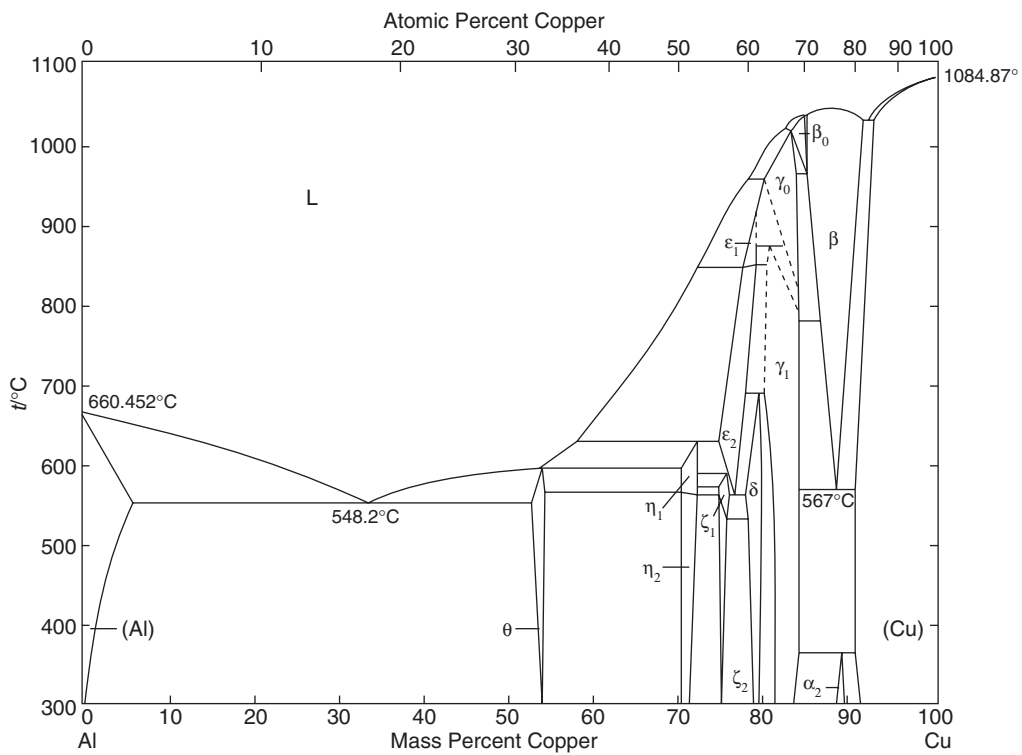


FIGURE 14. Al-Cu system.

Phase	Composition, wt % Cu	Pearson symbol	Space group
(Al)	0 to 5.65	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>
$\theta$	52.5 to 53.7	<i>tI12</i>	<i>I4/mcm</i>
$\eta_1$	70.0 to 72.2	<i>oP16</i> or <i>oC16</i>	<i>Pban</i> or <i>Cmmm</i>
$\eta_2$	70.0 to 72.1	<i>mC20</i>	<i>C2/m</i>
$\zeta_1$	74.4 to 77.8	<i>hP42</i>	<i>P6/mmm</i>
$\zeta_2$	74.4 to 75.2	(a)	–
$\epsilon_1$	77.5 to 79.4	(b)	–
$\epsilon_2$	72.2 to 78.7	<i>hP4</i>	<i>P6<math>\bar{3}</math>/mmc</i>
$\delta$	77.4 to 78.3	(c)	<i>R<math>\bar{3}m</math></i>
$\gamma_0$	77.8 to 84	(d)	–
$\gamma_1$	79.7 to 84	<i>cP52</i>	<i>P4<math>\bar{3}m</math></i>
$\beta_0$	83.1 to 84.7	(d)	–
$\beta$	85.0 to 91.5	<i>cI2</i>	<i>Im<math>\bar{3}m</math></i>
$\alpha_2$	88.5 to 89	(e)	–
(Cu)	90.6 to 100	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>
Metastable phases			
$\theta'$	–	<i>tP6</i>	–
$\beta'$	–	<i>cF16</i>	<i>Fm<math>\bar{3}m</math></i>
$Al_3Cu_2$	61 to 70	<i>hP5</i>	<i>P<math>\bar{3}m1</math></i>

(a) Monoclinic? (b) Cubic? (c) Rhombohedral. (d) Unknown. (e)  $D0_{22}$ -type long-period superlattice.

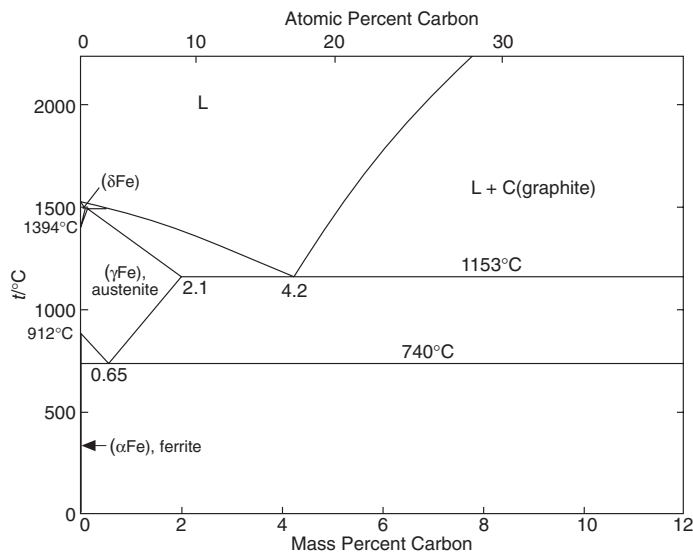


FIGURE 15. Fe-C system.

Phase	Composition, mass % C	Pearson symbol	Space group
(δFe)	0 to 0.09	<i>cI2</i>	<i>Im<math>\bar{3}m</math></i>
(γFe)	0 to 2.1	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>
(αFe)	0 to 0.021	<i>cI2</i>	<i>Im<math>\bar{3}m</math></i>
(C)	100	<i>hP4</i>	<i>P6<math>\bar{3}</math>/mmc</i>
Metastable/high-pressure phases			
(εFe)	0	<i>hP2</i>	<i>P6<math>\bar{3}</math>/mmc</i>
Martensite	< 2.1	<i>tI4</i>	<i>I4/mmm</i>
$Fe_4C$	5.1	<i>cP5</i>	<i>P4<math>\bar{3}m</math></i>
$Fe_3C$ ( $\theta$ )	6.7	<i>oP16</i>	<i>Pnma</i>
$Fe_5C_2$ ( $\chi$ )	7.9	<i>mC28</i>	<i>C2/c</i>
$Fe_7C_3$	8.4	<i>hP20</i>	<i>P6<math>\bar{3}mc</math></i>
$Fe_7C_3$	8.4	<i>oP40</i>	<i>Pnma</i>
$Fe_2C$ ( $\eta$ )	9.7	<i>oP6</i>	<i>Pnmm</i>
$Fe_2C$ ( $\epsilon$ )	9.7	<i>hP*</i>	<i>P6<math>\bar{3}22</math></i>
$Fe_2C$	9.7	<i>hP*</i>	<i>P<math>\bar{3}m1</math></i>
(C)	100	<i>cF8</i>	<i>Fd<math>\bar{3}m</math></i>

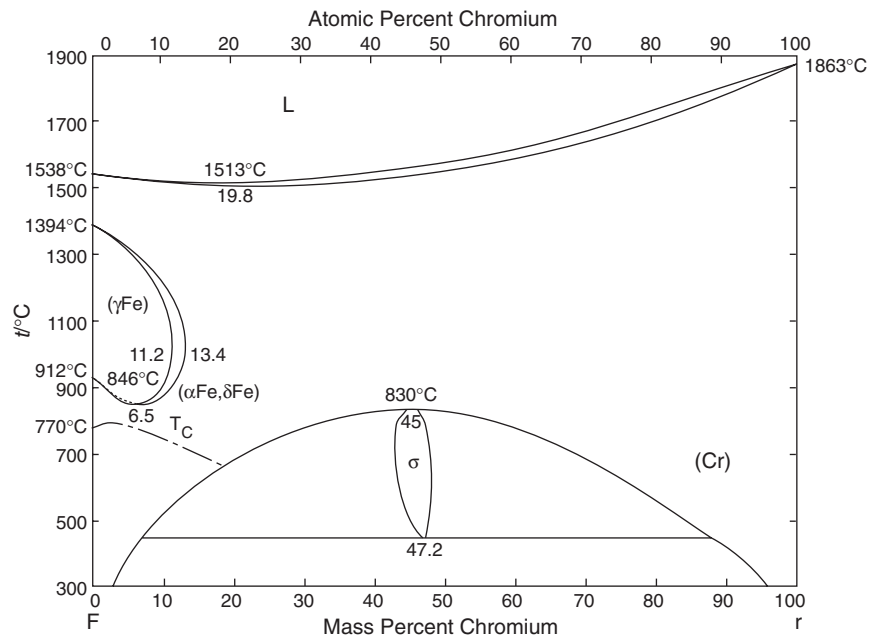


FIGURE 16. Fe-Cr system.

Phase	Composition, mass % Cr	Pearson symbol	Space group
(aFe, Cr)	0 to 100	<i>cI2</i>	<i>Im</i> $\bar{3}m$
(γFe)	0 to 11.2	<i>cF4</i>	<i>Fm</i> $\bar{3}m$
σ	42.7 to 48.2	<i>tP30</i>	<i>P4</i> <sub>2</sub> / <i>mmm</i>

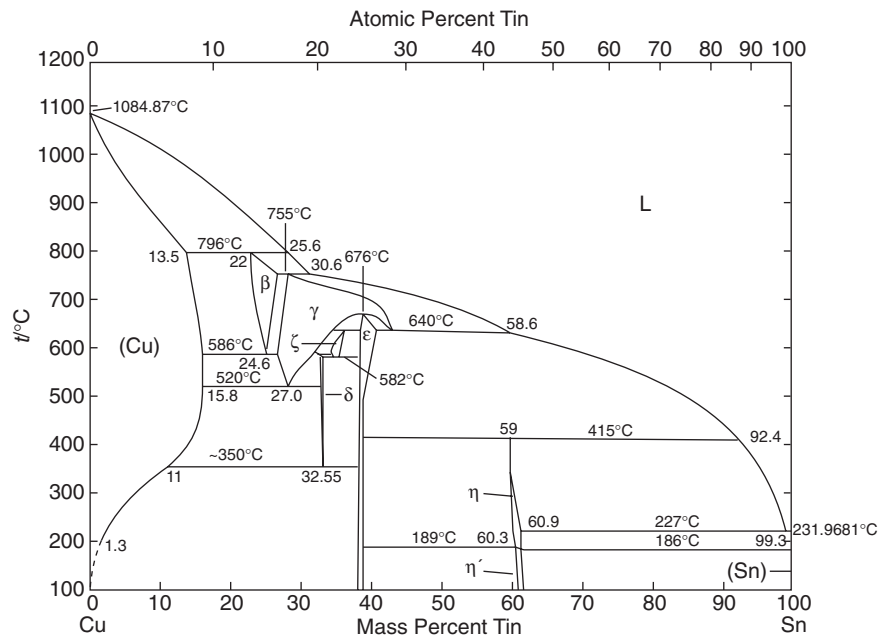


FIGURE 17. Cu-Sn system.



Phase	Composition, mass % Sn	Pearson symbol	Space group
$\alpha$	0 to 15.8	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>
$\beta$	22.0 to 27.0	<i>cI2</i>	<i>Im<math>\bar{3}m</math></i>
$\gamma$	25.5 to 41.5	<i>cF16</i>	<i>Fm<math>\bar{3}m</math></i>
$\delta$	32 to 33	<i>cF416</i>	<i>F<math>\bar{4}3m</math></i>
$\zeta$	32.2 to 35.2	<i>hP26</i>	<i>P6<math>_3</math></i>
$\epsilon$	27.7 to 39.5	<i>oC80</i>	<i>Cmcm</i>
$\eta$	59.0 to 60.9	<i>hP4</i>	<i>P6<math>_3/mmc</math></i>
$\eta'$	44.8 to 60.9	(a)	-
( $\beta$ Sn)	~100	<i>tI4</i>	<i>I4<math>_1/amd</math></i>
( $\alpha$ Sn)	100	<i>cF8</i>	<i>Fd<math>\bar{3}m</math></i>

(a) Hexagonal; superlattice based on NiAs-type structure.

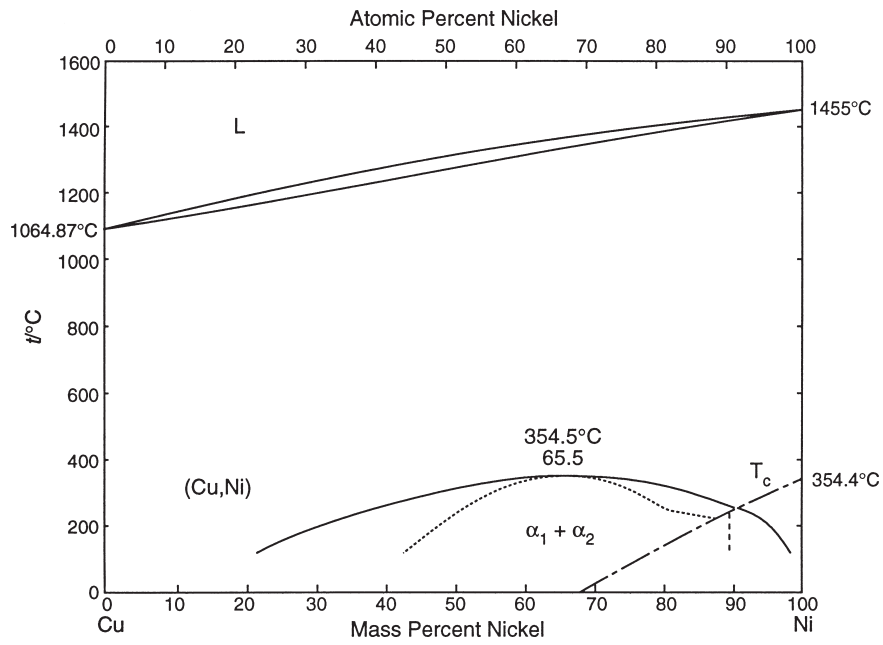


FIGURE 18. Cu-Ni system.

Phase	Composition, mass % Ni	Pearson symbol	Space group
(Cu, Ni) (above 354.5°C)	0 to 100	<i>cF4</i>	<i>Fm<math>\bar{3}m</math></i>

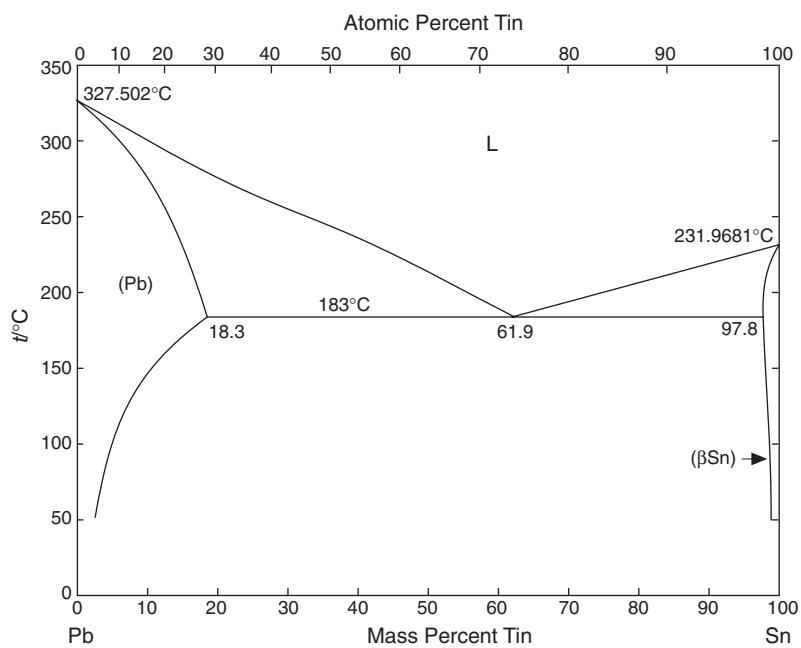


FIGURE 19. Pb-Sn system.

Phase	Composition, mass % Sn	Pearson symbol	Space group
(Pb)	0 to 18.3	$cF4$	$Fm\bar{3}m$
(βSn)	97.8 to 100	$tI4$	$I4_1/amd$
(αSn)	100	$cF8$	$Fd\bar{3}m$
High-pressure phases			
$\epsilon$ (a)	52 to 74	$hP1$	$P6/mmm$
$\epsilon'$ (b)	52	$hP2$	$P6_3/mmc$

(a) From phase diagram calculated at 2500 MPa. (b) This phase was claimed for alloys at 350°C and 5500 MPa.

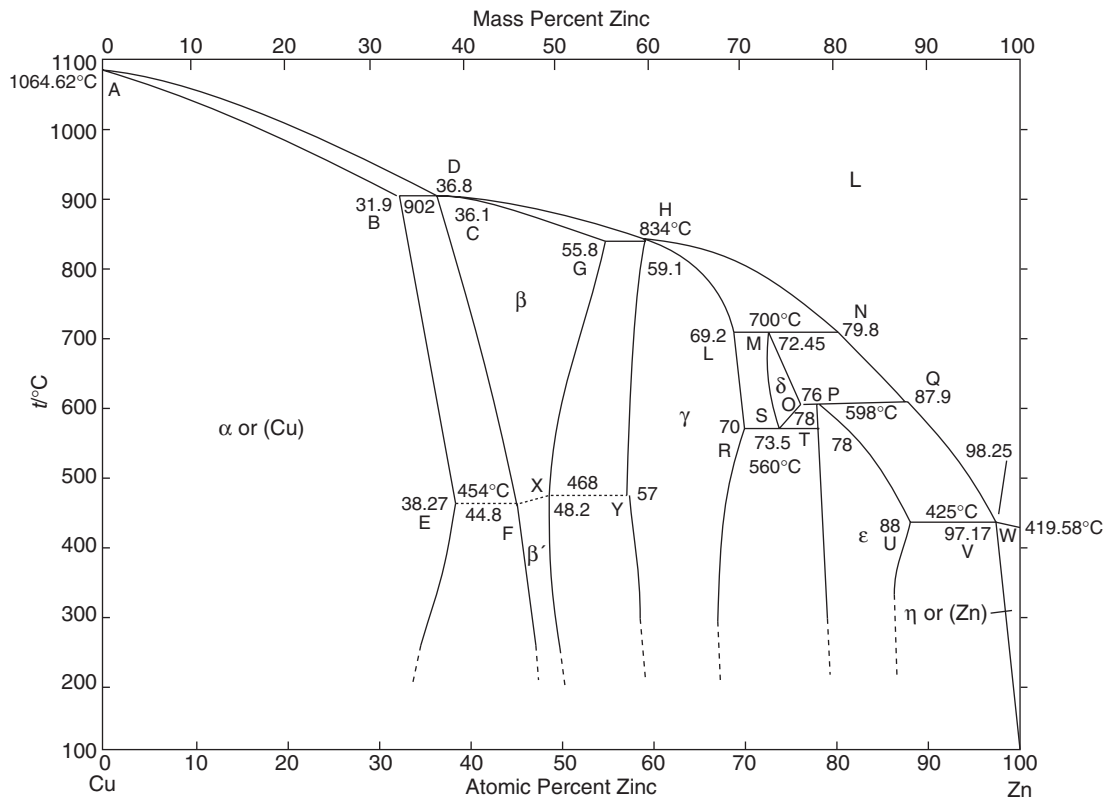


FIGURE 20. Cu-Zn system.

Phase	Composition, mass % Zn	Pearson symbol	Space group
$\alpha$ or (Cu)	0 to 38.95	$cF4$	$Fm\bar{3}m$
$\beta$	36.8 to 56.5	$cI2$	$Im\bar{3}m$
$\beta'$	45.5 to 50.7	$cP2$	$Pm\bar{3}m$
$\gamma$	57.7 to 70.6	$cI52$	$I\bar{4}3m$
$\delta$	73.02 to 76.5	$hP3$	$P\bar{6}$
$\epsilon$	78.5 to 88.3	$hP2$	$P6_3/mmc$
$\eta$ or (Zn)	97.25 to 100	$hP2$	$P6_3/mmc$

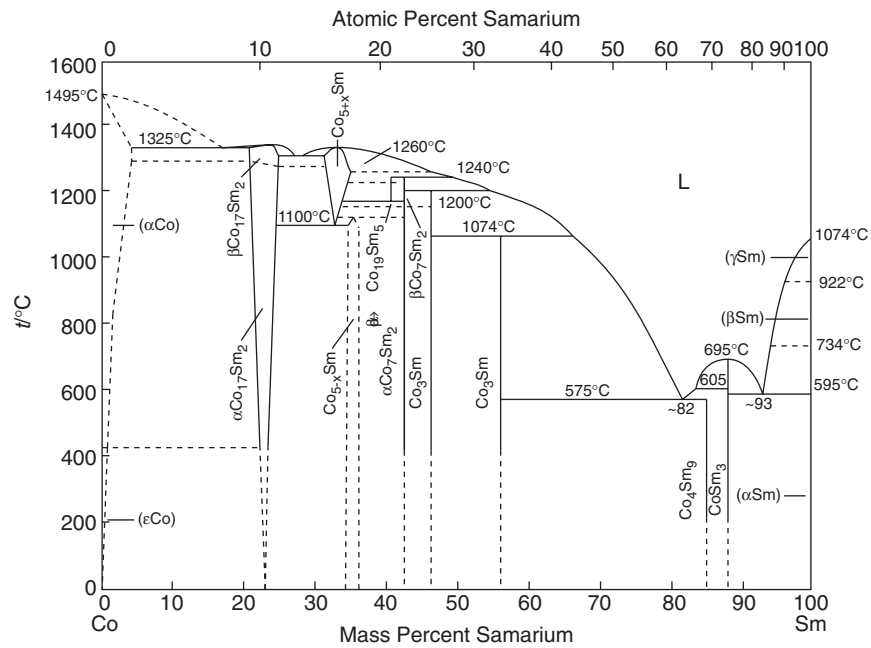


FIGURE 21. Co-Sm system.

Phase	Composition, mass % Sm	Pearson symbol	Space group
( $\alpha$ Co)	0 to ~3.7	$cF4$	$Fm\bar{3}m$
( $\epsilon$ Co)	~0	$hP2$	$P6_3/mmc$
$\beta\text{Co}_{17}\text{Sm}_2$	~23.0	$hP38$	$P6_3/mmc$
$\alpha\text{Co}_{17}\text{Sm}_2$	~23.0	$hR19$	$R\bar{3}m$
		$hP8$	$P6/mmm$
$\text{Co}_{5+x}\text{Sm}$	~33 to 34	—	—
$\text{Co}_{5-x}\text{Sm}$	~34 to 35	—	—
$\text{Co}_{19}\text{Sm}_5$	~40.1	$hR24$	$R\bar{3}m$
		$hP48$	$P6_3/mmc$
$\alpha\text{Co}_7\text{Sm}_2$	~42.1	$hR18$	$R\bar{3}m$
$\beta\text{Co}_7\text{Sm}_2$	~42.1	$hP36$	$P6_3/mmc$
$\text{Co}_3\text{Sm}$	46	$hR12$	$R\bar{3}m$
$\text{Co}_2\text{Sm}$	56.0	$hR4$	$R\bar{3}m$
		$cF24$	$Fd\bar{3}m$
$\text{Co}_4\text{Sm}_9$	~85.1	$o^{**}$	—
$\text{CoSm}_3$	88	$oP16$	$Pnma$
( $\gamma$ Sm)	~100	$cI2$	$Im\bar{3}m$
( $\beta$ Sm)	~100	$hP2$	$P6_3/mmc$
( $\alpha$ Sm)	~100	$hR3$	$R\bar{3}m$
<b>Other reported phases</b>			
$\text{Co}_5\text{Sm}$	~33.8	$hP6$	$P6/mmm$
$\text{Co}_2\text{Sm}_5$	~86.4	$mC28$	$C2/c$

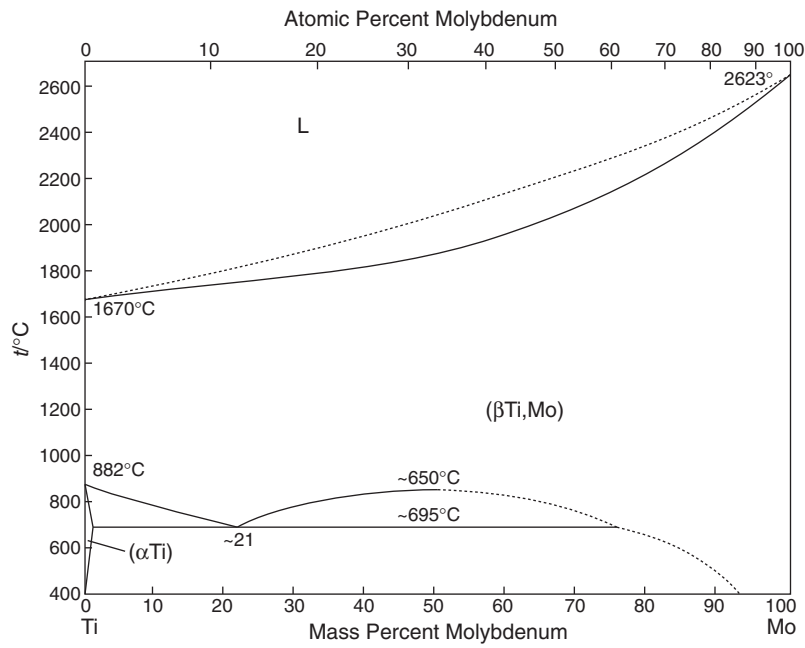
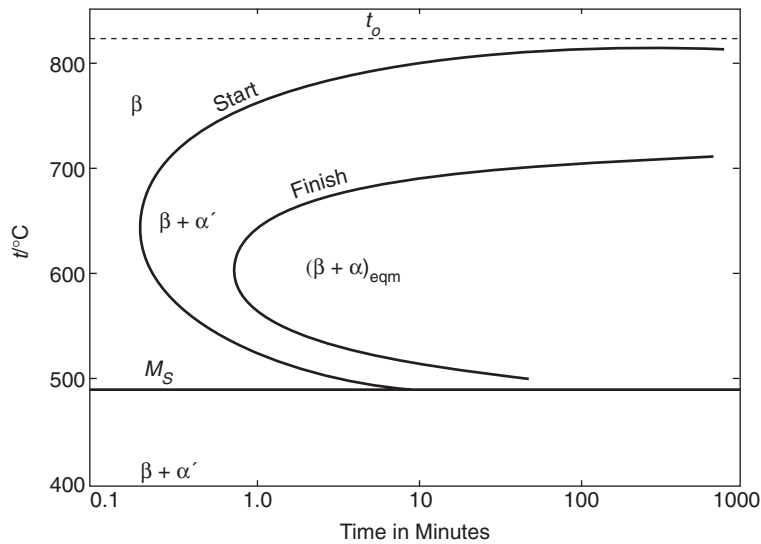


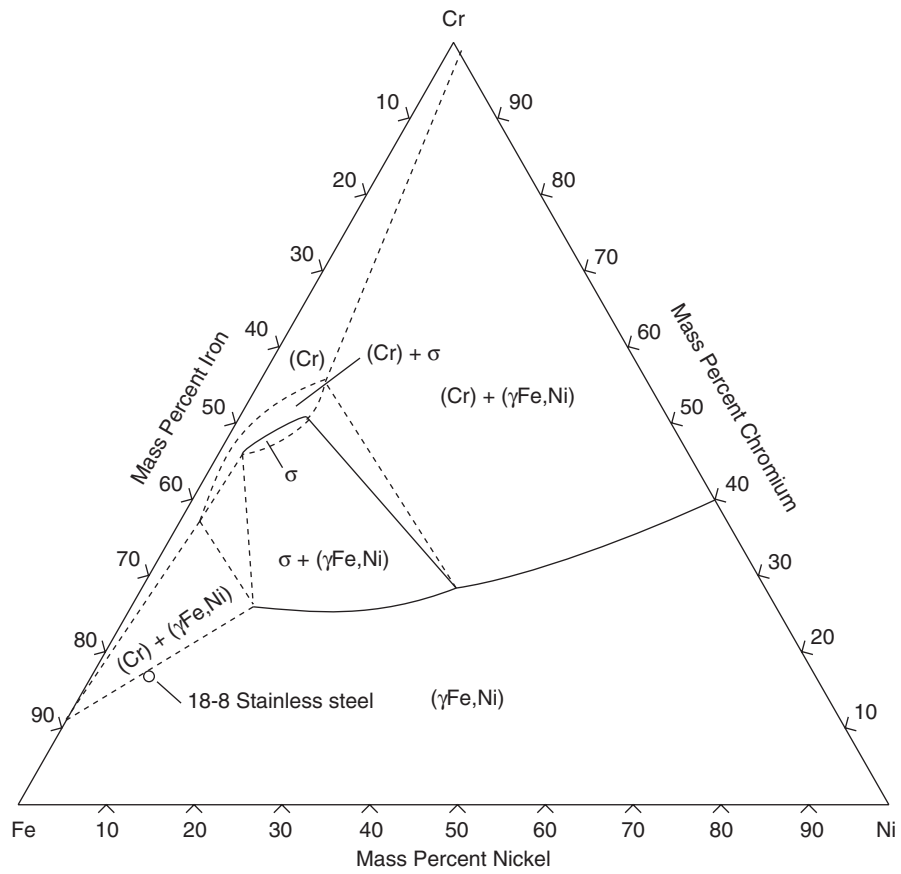
FIGURE 22. Ti-Mo system.

Phase	Composition, mass % Mo	Pearson symbol	Space group
(βTi, Mo)	0 to 100	<i>cI2</i>	<i>Im</i> $\bar{3}$ <i>m</i>
(αTi)	0 to 0.8	<i>hP2</i>	<i>P6</i> <sub>3</sub> <i>/mmc</i>
α'	(a)	<i>hP2</i>	<i>P6</i> <sub>3</sub> <i>/mmc</i>
α''	(a)	<i>oC4</i>	<i>Cmcm</i>
ω	(a)	<i>hP3</i>	<i>P6/mmm</i>

(a) Metastable.



Experimental time–temperature–transformation (TTT) diagram for Ti-Mo. The start and finish times of the isothermal precipitation reaction vary with temperature as a result of the temperature dependence of the nucleation and growth processes. Precipitation is complete, at any temperature, when the equilibrium fraction of  $\alpha$  is established in accordance with the lever rule. The solid horizontal line represents the athermal (or nonthermally activated) martensitic transformation that occurs when the  $\beta$  phase is quenched.



**FIGURE 23.** The isothermal section at 900°C (1652°F) of the iron-chromium-nickel ternary phase diagram, showing the nominal composition of 18-8 stainless steel.

## HEAT CAPACITY OF SELECTED SOLIDS

This table gives the molar heat capacity at constant pressure of representative metals, semiconductors, and other crystalline solids as a function of temperature in the range 200 to 600 K.

2. Garvin, D., Parker, V. B., and White, H. J., *CODATA Thermodynamic Tables*, Hemisphere Press, New York, 1987.
3. DIPPR Database of Pure Compound Properties, Design Institute for Physical Properties Data, American Institute of Chemical Engineers, New York, 1987.

### References

1. Chase, M. W., et al., *JANAF Thermochemical Tables, 3rd ed., J. Phys. Chem. Ref. Data*, 14, Suppl. 1, 1985.

Name	$C_p$ in J/mol K						
	200 K	250 K	300 K	350 K	400 K	500 K	600 K
Aluminum	21.33	23.08	24.25	25.11	25.78	26.84	27.89
Aluminum oxide	51.12	67.05	79.45	88.91	96.14	106.17	112.55
Anthracene	138.6	173.9	210.7	248.8	288.4		
Benzoic acid	102.7	123.5	147.4	172.0			
Beryllium	9.98	13.58	16.46	18.53	19.95	21.94	23.34
Biphenyl	131.0	162.5	197.2				
Boron	5.99	8.82	11.40	13.65	15.69	18.72	20.78
Calcium	24.54	25.41	25.94	26.32	26.87	28.49	30.38
Calcium carbonate	66.50	75.66	83.82	91.51	96.97	104.52	109.86
Calcium oxide	33.64	38.59	42.18	45.07	46.98	49.33	50.72
Cesium chloride	50.13	51.34	52.48	53.58	54.68	56.90	59.10
Chromium	19.86	22.30	23.47	24.39	25.23	26.63	27.72
Cobalt	22.23	23.98	24.83	25.68	26.53	28.20	29.66
Copper	22.63	23.77	24.48	24.95	25.33	25.91	26.48
Copper oxide	34.80		42.41	44.95	46.78	49.19	50.83
Copper sulfate	77.01	89.25	99.25	107.65	114.93	127.19	136.31
Germanium			23.25	23.85	24.31	24.96	25.45
Gold			25.41	25.37	25.51	26.06	26.65
Graphite	5.01	6.82	8.58	10.24	11.81	14.62	16.84
Hexachlorobenzene	162.7	183.6	202.4				
Iodine	51.57	53.24	54.51	58.60			
Iron	21.59	23.74	25.15	26.28	27.39	29.70	32.05
Lead	25.87	26.36	26.85	27.30	27.72	28.55	29.40
Lithium	21.57	23.42	24.64	25.96	27.60	29.28	
Lithium chloride	43.35	46.08	48.10	49.66	50.97	53.34	55.59
Magnesium	22.72	24.02	24.90	25.57	26.14	27.17	28.18
Magnesium oxide			37.38	40.59	42.77	45.56	47.30
Manganese	23.05	24.95	26.35	27.52	28.53	30.29	31.90
Naphthalene	105.8	134.1	167.8	204.1			
Potassium	27.00	28.01	29.60				
Potassium chloride	48.44	50.10	51.37	52.31	53.08	54.71	56.35
Silicon	15.64	18.22	20.04	21.28	22.14	23.33	24.15
Silicon dioxide	32.64	39.21	44.77	49.47	53.43	59.64	64.42
Silver			25.36	25.55	25.79	26.36	26.99
Sodium	22.45	27.01	28.20	30.14			
Sodium chloride	46.89	48.85	50.21	51.25	52.14	53.96	55.81
Tantalum	24.08	24.86	25.31	25.60	25.84	26.35	26.84
Titanium	22.37	24.07	25.28	26.17	26.86	27.88	28.60
Tungsten	22.49	23.69	24.30	24.65	24.92	25.36	25.79
Vanadium	21.88	23.70	24.93	25.68	26.23	26.94	27.49
Zinc	24.05	25.02	25.45	25.88	26.35	27.39	28.59
Zirconium	23.87	24.69	25.22	25.61	25.93	26.56	27.28

# THERMAL AND PHYSICAL PROPERTIES OF PURE METALS

This table gives the following properties for the metallic elements:

- $t_m$ : Melting point in °C  
 $t_b$ : Normal boiling point in °C, at a pressure of 101.325 kPa (760 Torr)  
 $\Delta_{\text{fus}}H$ : Enthalpy of fusion at the melting point in J/g  
 $\rho_{25}$ : Density at 25 °C in g/cm<sup>3</sup>  
 $\alpha$ : Coefficient of linear expansion at 25 °C in K<sup>-1</sup> (the quantity listed is 10<sup>6</sup> ×  $\alpha$ )  
 $c_p$ : Specific heat capacity at constant pressure at 25 °C in J/g K  
 $\lambda$ : Thermal conductivity at 27 °C in W/cm K

3. Ho, C. Y., Powell, R. W., and Liley, P. E., *J. Phys. Chem. Ref. Data*, 3, Suppl. 1, 1974 (thermal conductivity).
4. Cox, J. D., Wagman, D. D., and Medvedev, V. A., *CODATA Key Values for Thermodynamics*, Hemisphere Publishing Corp., New York, 1989 (heat capacity).
5. Glushko, V. P., Ed., *Thermal Constants of Substances*, VINITI, Moscow, (enthalpy of fusion, heat capacity).
6. Wagman, D. D., et al., *The NBS Tables of Chemical Thermodynamic Properties*, *J. Phys. Chem. Ref. Data*, 11, Suppl. 2, 1982 (heat capacity).
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Metal (symbol)	Atomic weight	$t_m$ °C	$t_b$ °C	$\Delta_{\text{fus}}H$ J/g	$\rho_{25}$ g/cm <sup>3</sup>	$\alpha \times 10^6$ K <sup>-1</sup>	$c_p$ J/g K	$\lambda$ W/cm K
Actinium (Ac)		1050	3198		10		0.12	
Aluminum (Al)	26.98	660.32	2519	399.9	2.70	23.1	0.897	2.37
Antimony (Sb)	121.76	630.628	1587	162.5	6.68	11.0	0.207	0.243
Barium (Ba)	137.33	727	1897	51.8	3.62	20.6	0.205	0.184
Beryllium (Be)	9.01	1287	2471	876.0	1.85	11.3	1.82	2.00
Bismuth (Bi)	208.98	271.406	1564	53.3	9.79	13.4	0.122	0.0787
Cadmium (Cd)	112.41	321.069	767	55.2	8.69	30.8	0.231	0.968
Calcium (Ca)	40.08	842	1484	213.1	1.54	22.3	0.646	2.00
Cerium (Ce)	140.11	799	3443	39.0	6.77	6.3	0.192	0.113
Cesium (Cs)	132.91	28.44	671	15.7	1.93	97	0.242	0.359
Chromium (Cr)	52.00	1907	2671	404	7.15	4.9	0.450	0.937
Cobalt (Co)	58.93	1495	2927	272.5	8.86	13.0	0.421	1.00
Copper (Cu)	63.55	1084.62	2562	203.5	8.96	16.5	0.384	4.01
Dysprosium (Dy)	162.50	1412	2567	68.1	8.55	9.9	0.170	0.107
Erbium (Er)	167.26	1529	2868	119	9.07	12.2	0.168	0.145
Europium (Eu)	151.96	822	1529	60.6	5.24	35.0	0.182	0.139 <sup>a</sup>
Gadolinium (Gd)	157.25	1313	3273	63.6	7.90	9.4 <sup>b</sup>	0.235	0.105
Gallium (Ga)	69.72	29.7666	2204	80.0	5.91	18	0.374	0.406
Gold (Au)	196.97	1064.18	2856	64.6	19.3	14.2	0.129	3.17
Hafnium (Hf)	178.49	2233	4603	152.4	13.3	5.9	0.144	0.230
Holmium (Ho)	164.93	1472	2700	103 <sup>a</sup>	8.80	11.2	0.165	0.162
Indium (In)	114.82	156.60	2072	28.6	7.31	32.1	0.233	0.816
Iridium (Ir)	192.22	2446	4428	213.9	22.5	6.4	0.131	1.47
Iron (Fe)	55.85	1538	2861	247.3	7.87	11.8	0.449	0.802
Lanthanum (La)	138.91	920	3464	44.6	6.15	12.1	0.195	0.134
Lead (Pb)	207.20	327.462	1749	23.1	11.3	28.9	0.127	0.353
Lithium (Li)	6.94	180.5	1342	432	0.534	46	3.57	0.847
Lutetium (Lu)	174.97	1663	3402	126 <sup>a</sup>	9.84	9.9	0.154	0.164
Magnesium (Mg)	24.30	650	1090	348.9	1.74	24.8	1.024	1.56
Manganese (Mn)	54.94	1246	2061	235.0	7.3	21.7	0.479	0.0782
Mercury (Hg)	200.59	-38.8290	356.62	11.4	13.5336	60.4	0.139	0.0834
Molybdenum (Mo)	95.94	2623	4639	390.7	10.2	4.8	0.251	1.38
Neodymium (Nd)	144.24	1016	3074	49.5	7.01	9.6	0.191	0.165
Neptunium (Np)		644		13.5	20.2			0.063
Nickel (Ni)	58.69	1455	2913	290.3	8.90	13.4	0.445	0.907



Metal (symbol)	Atomic weight	$t_m$ °C	$t_b$ °C	$\Delta_{fus} H$ J/g	$\rho_{25}$ g/cm <sup>3</sup>	$\alpha \times 10^6$ K <sup>-1</sup>	$c_p$ J/g K	$\lambda$ W/cm K
Niobium (Nb)	92.91	2477	4744	323	8.57	7.3	0.265	0.537
Osmium (Os)	190.23	3033	5012	304.1	22.59	5.1	0.130	0.876
Palladium (Pd)	106.42	1554.8	2963	157.3	12.0	11.8	0.244	0.718
Platinum (Pt)	195.08	1768.2	3825	113.6	21.5	8.8	0.133	0.716
Plutonium (Pu)		640	3228	11.6	19.7	46.7		0.0674
Polonium (Po)		254	962		9.20	23.5		0.20
Potassium (K)	39.10	63.38	759	59.6	0.89	83.3	0.757	1.024
Praseodymium (Pr)	140.91	931	3520	48.9	6.77	6.7	0.193	0.125
Promethium (Pm)		1042	3000 <sup>a</sup>		7.26	11 <sup>a</sup>	0.19 <sup>a</sup>	0.15 <sup>a</sup>
Protactinium (Pa)	231.04	1572		53.4	15.4			
Radium (Ra)		696			5			
Rhenium (Re)	186.21	3185	5596	324.5	20.8	6.2	0.137	0.479
Rhodium (Rh)	102.91	1964	3695	258.4	12.4	8.2	0.243	1.50
Rubidium (Rb)	85.47	39.30	688	25.6	1.53		0.364	0.582
Ruthenium (Ru)	101.07	2333	4150	381.8	12.1	6.4	0.238	1.17
Samarium (Sm)	150.36	1072	1794	57.3	7.52	12.7	0.196	0.133
Scandium (Sc)	44.96	1541	2836	314	2.99	10.2	0.567	0.158
Silver (Ag)	107.87	961.78	2162	104.6	10.5	18.9	0.235	4.29
Sodium (Na)	22.99	97.794	882.94	113.1	0.97	71	1.225	1.41
Strontium (Sr)	87.62	777	1382	84.8	2.64	22.5	0.306	0.353
Tantalum (Ta)	180.95	3017	5458	202.1	16.4	6.3	0.140	0.575
Technetium (Tc)		2157	4265	339.7	11			0.506
Terbium (Tb)	158.93	1359	3230	67.9	8.23	10.3	0.182	0.111
Thallium (Tl)	204.38	304	1473	20.3	11.8	29.9	0.129	0.461
Thorium (Th)	232.04	1750	4788	59.5	11.7	11.0	0.118	0.540
Thulium (Tm)	168.93	1545	1950	99.7	9.32	13.3	0.160	0.169
Tin (Sn)	118.71	231.93	2602	60.4	7.26	22.0	0.227	0.666
Titanium (Ti)	47.88	1668	3287	295.6	4.51	8.6	0.522	0.219
Tungsten (W)	183.84	3422	5555	284.5	19.3	4.5	0.132	1.74
Uranium (U)	238.03	1135	4131	38.4	19.1	13.9	0.116	0.276
Vanadium (V)	50.94	1910	3407	422	6.0	8.4	0.489	0.307
Ytterbium (Yb)	173.04	824	1196	44.3	6.90	26.3	0.154	0.385
Yttrium (Y)	88.91	1522	3345	128	4.47	10.6	0.298	0.172
Zinc (Zn)	65.39	419.53	907	108.1	7.14	30.2	0.388	1.16
Zirconium (Zr)	91.22	1854.7	4409	230.2	6.52	5.7	0.278	0.227

<sup>a</sup> Estimated.<sup>b</sup> At 100 °C.

# THERMAL CONDUCTIVITY OF METALS AND SEMICONDUCTORS AS A FUNCTION OF TEMPERATURE

This table gives the temperature dependence of the thermal conductivity of several metals and of carbon, germanium, and silicon. For graphite, separate entries are given for the thermal conductivity parallel ( $\parallel$ ) and perpendicular ( $\perp$ ) to the layer planes. The thermal conductivity of all these materials is very sensitive to impurities at low temperatures, especially below 100 K. Therefore, the values given here should be regarded as typical values for a highly purified specimen; the thermal conductivity of different specimens can vary by more than an order of magnitude in the low-temperature range. See Reference 2 for details.

## References

1. Ho, C. Y., Powell, R. W., and Liley, P. E., *J. Phys. Chem. Ref. Data*, 1, 279, 1972.
2. White, G. K., and Minges, M. L., *Thermophysical Properties of Some Key Solids*, CODATA Bulletin No. 59, 1985.

T/K	Thermal Conductivity in W/cm K										
				Carbon (C)							
	Ag	Al	Au	Diamond (type)			Pyrolytic graphite		Cr	Cu	
			I	IIa	IIb	$\parallel$	$\perp$				
1	39.4	41.1	5.46						0.402*	42.2	
2	78.3	81.8	10.9	0.0138*	0.033*	0.0200*			0.803	84.0	
3	115	121	16.1	0.0461	0.111	0.0676			1.20	125	
4	147	157	20.9	0.108	0.261	0.160			1.60	162	
5	172	188	25.2	0.206	0.494	0.307			2.00	195	
6	187	213	28.5	0.344	0.820	0.510			2.39	222	
7	193	229	30.9	0.523	1.24	0.778			2.27	239	
8	190	237	32.3	0.762	1.77	1.12			3.14	248	
9	181	239	32.7	1.05	2.41	1.53			3.50	249	
10	168	235	32.4	1.40	3.17	2.03	0.811	0.0116	3.85	243	
15	96.0	176	24.6	3.96	8.65	5.66			5.24	171	
20	51.0	117	15.8	7.87	16.8	11.2	4.20	0.0397	5.93	108	
30	19.3	49.5	7.55	18.8	38.9	26.5	9.86	0.0786	5.49	44.5	
40	10.5	24.0	5.15	29.4	65.9	44.0	16.4	0.120	4.25	21.7	
50	7.0	13.5	4.21	35.3	92.1	59.1	23.1	0.152	3.17	12.5	
60	5.5	8.5	3.74	37.4	112	67.5	29.8	0.173	2.48	8.29	
70	4.97	5.85	3.48	36.9	119	69.1	36.6	0.181	2.07	6.47	
80	4.71	4.32	3.32	35.1	117	65.7	42.8	0.181	1.84	5.57	
90	4.60	3.42	3.28	32.7	109	60.0	47.5	0.176	1.69	5.08	
100	4.50	3.02	3.27	30.0	100	54.2	49.7	0.168	1.59	4.82	
150	4.32	2.48	3.25	19.5	60.2	32.5	45.1	0.125	1.29	4.29	
200	4.30	2.37	3.23	14.1	40.3	22.6	32.3	0.0923	1.11	4.13	
250	4.29	2.35	3.21	11.0	29.7	17.0	24.4	0.0711	1.00	4.06	
300	4.29	2.37	3.17	8.95	23.0	13.5	19.5	0.0570	0.937	4.01	
350	4.27	2.40	3.14	7.55*	18.5*	11.1*	16.2	0.0477	0.929	3.96	
400	4.25	2.40	3.11	6.5*	15.4*	9.32*	13.9	0.0409	0.909	3.93	
500	4.19	2.36	3.04				10.8	0.0322	0.860	3.86	
600	4.12	2.31	2.98				8.92	0.0268	0.807	3.79	
800	3.96	2.18	2.84				6.67	0.0201	0.713	3.66	
1000	3.79		2.70				5.34	0.0160	0.654	3.52	
1200	3.61*		2.55				4.48	0.0134	0.619	3.39	
1400							3.84	0.0116	0.588		
1600							3.33	0.0100	0.556		
1800							2.93	0.00895	0.526*		
2000							2.62	0.00807	0.494*		

T/K	Fe	Ge <sup>a</sup>	Mg	Ni	Pb	Pt	Si <sup>a</sup>	Sn	Ti	W
1	1.71	0.274	9.86	2.17	27.9	2.31	0.0693*	183	0.0144*	14.4
2	3.42	2.06	19.6	4.34	44.6	4.60	0.454	323	0.0288*	28.7
3	5.11	5.35	29.0	6.49	35.8	6.79	1.38	297	0.0432	42.8
4	6.77	8.77	37.6	8.59	22.2	8.8	2.97	181	0.0575	56.3
5	8.39	11.6	45.0	10.6	13.8	10.5	5.27	117	0.0719	68.7
6	9.93	13.9	50.8	12.5	8.10	11.8	8.23	76	0.0863	79.5
7	11.4	15.5	54.7	14.2	4.86	12.6	11.7	52	0.101	88.0
8	12.7	16.6	56.7	15.8	3.20	12.9	15.5	36	0.115	93.8
9	13.9	17.3	57.0	17.1	2.30	12.8	19.5	26	0.129	96.8
10	14.8	17.7	55.8	18.1	1.78	12.3	23.3	19.3	0.143	97.1
15	17.0	17.3	41.1	19.5	0.845	8.41	41.6	6.3	0.212	72.0
20	15.4	14.9	27.2	16.5	0.591	4.95	49.8	3.2	0.275	40.5
30	10.0	10.8	12.9	9.56	0.477	2.15	48.1	1.79	0.365	14.4
40	6.23	7.98	7.19	5.82	0.451	1.39	35.3	1.33	0.390	6.92
50	4.05	6.15	4.65	4.00	0.436	1.09	26.8	1.15	0.374	4.27
60	2.85	4.87	3.27	3.08	0.425	0.947	21.1	1.04	0.355	3.14
70	2.16	3.93	2.49	2.50	0.416	0.862	16.8	0.96	0.340	2.58
80	1.75	3.25	2.02	2.10	0.409	0.815	13.4	0.915	0.326	2.29
90	1.50	2.70	1.78	1.83	0.403	0.789	10.8	0.880	0.315	2.17
100	1.34	2.32	1.69	1.64	0.397	0.775	8.84	0.853	0.305	2.08
150	1.04	1.32	1.61	1.22	0.379	0.740	4.09	0.779	0.270	1.92
200	0.94	0.968	1.59	1.07	0.367	0.726	2.64	0.733	0.245	1.85
250	0.865	0.749	1.57	0.975	0.360	0.718	1.91	0.696	0.229	1.80
300	0.802	0.599	1.56	0.907	0.353	0.716	1.48	0.666	0.219	1.74
350	0.744	0.495	1.55	0.850	0.347	0.717	1.19	0.642	0.210	1.67
400	0.695	0.432	1.53	0.802	0.340	0.718	0.989	0.622	0.204	1.59
500	0.613	0.338	1.51	0.722	0.328	0.723	0.762	0.596	0.197	1.46
600	0.547	0.273	1.49	0.656	0.314	0.732	0.619		0.194	1.37
800	0.433	0.198	1.46*	0.676		0.756	0.422		0.197	1.25
1000	0.323	0.174		0.718		0.787	0.312		0.207	1.18
1200	0.283	0.174		0.762		0.826	0.257		0.220	1.12
1400	0.312			0.804		0.871	0.235		0.236	1.08
1600	0.330					0.919	0.221		0.253	1.04
1800	0.345*					0.961			0.270*	1.01
2000						0.994*				0.98

<sup>a</sup> Values below 300 K are typical values.

\* Extrapolated.

# THERMAL CONDUCTIVITY OF ALLOYS AS A FUNCTION OF TEMPERATURE

This table lists the thermal conductivity of selected alloys at various temperatures. The indicated compositions refer to weight percent. Since the thermal conductivity is sensitive to exact composition and processing history, especially at low temperatures, these values should be considered approximate.

## References

1. Powell, R. L., and Childs, G. E., in *American Institute of Physics Handbook, 3rd Edition*, Gray, D. E., Ed., McGraw-Hill, New York, 1972.
2. Ho, C. Y., et al., *J. Phys. Chem. Ref. Data*, 7, 959, 1978.

		Thermal conductivity in W/m K								
Alloy		4 K	20 K	77 K	194 K	273 K	373 K	573 K	973 K	
Aluminum:	1100	50	240	270	220	220				
	2024	3.2	17	56	95	130				
	3003	11	58	140	150	160				
	5052	4.8	25	77	120	140				
	5083, 5086	3	17	55	95	120				
	Duralumin	5.5	30	91	140	160	180			
Bismuth:	Rose metal		5.5	8.3	14	16				
	Wood's metal	4	17	23						
Copper:	electrolytic tough pitch	330	1300	550	400	390	380	370	350	
	free cutting, leaded	200	800	460	380	380				
	phosphorus, deoxidized	7.5	42	120	190	220				
	brass, leaded	2.3	12	39	70	120				
	bronze, 68% Cu; 32% Zn	2.3	16	48	92	110				
	beryllium	2	17	36	70	90	113	172		
	german silver	0.75	7.5	17	20	23	25	30	40	
	silicon bronze A		3.4	11	23	30				
	manganin	0.48	3.2	14	17	22				
	constantan	0.9	8.6	17	19	22				
Ferrous:	commercial pure iron	15	72	106	82	76	66	54	34	
	plain carbon steel(AISI 1020)	13	20	58	65	65				
	plain carbon steel(AISI 1095)		8.5	31	41	45				
	3% Ni; 0.7% Cr; 0.6% Mo		6	22			33	35	36	30
	4% Si						20	24	28	26
	stainless steel	0.3	2	8	13	14	16	19	25	
	27% Ni; 15% Cr		1.7	55		11	12	16	21	
Gold:	colbalt thermocouple	1.2	8.6	20						
	65% Au; 35% Ag		12	24		61	89			
Indium:	85.5% In; 14.5% Pb	1.9	7.8	24	41					
Lead:	60% Pb; 40% Sn (soft solder)		28	44						
	64.35% Pb; 35.65% In	0.8	3.26	9.1		20.2				
Nickel:	80% Ni; 20% Cr					12	14	17	23	
	contracid	0.2	2	7.3	9.5	13				
	inconel	0.5	4.2	12.5	13	15	16	19	26	
	monel	0.9	7.1	15	20	21	24	30	43	
Platinum:	90% Pt; 10% Ir					31	31.4			
	90% Pt; 10% Rh					30.1	30.5			
Silver:	silver solder		12	34	58					
	normal Ag thermocouple	48	230	310						
Tin:	60% Sn; 40% Pb	16	55	51						
Titanium:	5.5% Al; 2.5% Sn; 0.2% Fe		1.8	4.3	6.4	7.8	8.4	10.8		
	4.7% Mn; 3.99% Al; 0.14% C		1.7	4.5	6.5	8.5				

# THERMAL CONDUCTIVITY OF CRYSTALLINE DIELECTRICS

This table lists the thermal conductivity of a number of crystalline dielectrics, including some which find use as optical materials. Values are given at temperatures for which data are available.

## Reference

Powell, R. L., and Childs, G. E., in *American Institute of Physics Handbook, 3rd Edition*, Gray, D. E., Ed., McGraw-Hill, New York, 1972.

Material	T/K	Ther. cond. W/m K	
AgCl	223	1.3	
	273	1.2	
	323	1.1	
	373	1.1	
Al,B silicate (tourmaline)    to c axis	398	2.9	
	540	3.2	
	723	3.5	
Al,Be silicate (beryl)	315	6.4	
Al,F silicate (topaz)    to c axis	315	17.7	
	358	15.6	
	417	13.3	
Al,Fe silicate (garnet)	315	35.8	
	358	35.4	
	377	35.6	
Al <sub>2</sub> O <sub>3</sub> (sapphire): 36° to c axis	4.2	110	
	20	3500	
	35	6000	
	77	1100	
	⊥ to c axis	373	2.6
		523	3.9
		773	5.8
	Al <sub>2</sub> O <sub>3</sub> (sintered)	4.2	0.5
		20	23
		77	150
194		48	
273		35	
373		26	
973		8	
Ar	8	6.0	
	10	3.7	
	20	1.4	
	77	0.31	
As <sub>2</sub> S <sub>3</sub> (glass)	283	0.16	
	323	0.21	
	373	0.27	
BN	1047	36.2	
	1475	22.7	
	1928	21.9	
	2111	18.5	
	BaF <sub>2</sub>	225	20
260		13.4	
305		10.9	
370		10.5	
BaTiO <sub>3</sub>		5	4.2
	30	24.0	
	40	25.0	
	100	12.0	
	250	4.8	
300	6.2		
BeO	4.2	0.3	

Material	T/K	Ther. cond. W/m K	
	20	16	
	77	270	
	373	210	
	573	120	
	1273	29	
Bi <sub>2</sub> Te <sub>3</sub>	80	6.4	
	204	2.8	
	303	3.6	
	370	4.6	
	C (diamond) type I	4.2	13
		20	800
77		3550	
	194	1450	
	273	1000	
	CaCO <sub>3</sub>    to c axis	83	25
		273	5.5
		⊥ to c axis	83
194	6.5		
273	4.6		
CaF <sub>2</sub>	373	3.6	
	83	39	
	223	18	
	273	10	
	323	9.2	
CaWO <sub>4</sub> (scheelite)	373	9	
	422	11.3	
	CdTe	160	7.0
297		3.6	
422		2.9	
CsBr	223	1.2	
	273	0.94	
	323	0.81	
	373	0.77	
CsI	223	1.4	
	273	1.2	
	323	1	
Cu <sub>2</sub> O (cuprite)	373	0.95	
	102	3.74	
	163	7.76	
	299	5.58	
	360	4.86	
Fe <sub>3</sub> O <sub>4</sub> (magnetite)	4.5	27.4	
	20.5	293.0	
	126.5	7.4	
Glass:	304	7.0	
	phoenix	4.2	0.095
		20	0.13
77		0.37	
plastic perspex	4.2	0.058	

Material	T/K	Ther. cond. W/m K	Material	T/K	Ther. cond. W/m K
	20	0.074	NaCl	4.2	440
pyrex	77	0.44		20	300
	194	0.88		77	30
	273	1		273	6.4
H <sub>2</sub> (para + 0.5% ortho)	2.5	100		323	5.6
	3	150		373	5.4
	4	200	NaF	5	1100
	6	30		50	250
	10	3		100	90
H <sub>2</sub> O (ice)	173	3.5	Ne	2	3.0
	223	2.8		3	4.6
	273	2.2		4.2	4.2
He <sup>3</sup> (high pressure)	0.6	25		10	0.8
	1	2		20	0.3
	1.5	0.57	NH <sub>4</sub> Cl	77	17
	2	0.21		194	23
He <sup>4</sup> (high pressure)	0.5	42		230	38
	0.8	120		273	27
	1	24	NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>		
	2	0.18	to optic axis	315	0.71
I <sub>2</sub>	300	0.45		339	0.71
	325	0.42	⊥ to optic axis	313	1.26
	350	0.4		342	1.34
KBr	2	150	NiO	4.2	5.9
	4.2	360		40	400
	100	12		194	82
	273	5	SiO <sub>2</sub> (quartz)		
	323	4.8	to c axis	20	720
	373	4.8		194	20
KCl	4.2	500	⊥ to c axis	273	12
	25	140		20	370
	80	35		194	10
	194	10		273	6.8
	273	7.0	SiO <sub>2</sub> (fused silica)	4.2	0.25
	323	6.5		20	0.7
	373	6.3		77	0.8
KI	4.2	700		194	1.2
	80	13		273	1.4
	194	4.6		373	1.6
	273	3.1		673	1.8
Kr	4.2	0.48	SrTiO <sub>3</sub>	5	2.4
	10	1.7		30	21.0
	20	1.2		40	19.2
	77	0.36		100	18.5
LaF <sub>3</sub>	78	7.8		250	12.5
	197	5.0		300	11.2
	274	5.4	TlBr	316	0.59
LiF	4.2	620	TlCl	311	0.75
	20	1800	TiO <sub>2</sub> (rutile)		
	77	150	to optic axis	4.2	200
MgO·Al <sub>2</sub> O <sub>3</sub> (spinel)	373	13		20	1000
	773	8.5		273	13
MnO	4.2	0.25	⊥ to optic axis	4.2	160
	40	55		20	690
	120	8		273	9
	573	3.5			

# THERMAL CONDUCTIVITY OF CERAMICS AND OTHER INSULATING MATERIALS

Thermal conductivity values for ceramics, refractory oxides, and miscellaneous insulating materials are given here. The thermal conductivity refers to samples with density indicated in the second column. Since most of these materials are highly variable, the values should only be considered as a rough guide.

Material	Dens. g/cm <sup>3</sup>	t °C	Ther. cond. W/m K
Alumina (Al <sub>2</sub> O <sub>3</sub> )	3.8	100	30
		400	13
		1300	6
		1800	7.4
		3.5	100
Al <sub>2</sub> O <sub>3</sub> + MgO	3.5	800	7.6
		100	15
		400	10
Asbestos	0.4	1000	5.6
		-100	0.07
		0	0.09
Asbestos + 85% MgO	0.4	100	0.10
		30	0.08
Asphalt	2.1	20	0.06
Beryllia (BeO)	2.8	100	210
		400	90
		1000	20
		1800	15
		1.85	50
Brick, dry	1.54	200	40
		600	23
		0	0.04
Brick, refractory: alosite	1.99	1000	1.3
		400	1.2
aluminous	1.99	1000	1.3
		100	0.2
diatomaceous	0.77	500	0.24
		0.4	100
fireclay	2	500	0.1
		400	1
		1000	1.2
silicon carbide	2	200	2
		600	2.4
vermiculite	0.77	200	0.26
		600	0.31
Calcium oxide	2	100	16
		400	9
		1000	7.5
Cement mortar	2	90	0.55
Charcoal	0.2	20	0.055
Coal	1.35	20	0.26
Concrete	1.6	0	0.8
Cork	0.05	0	0.03
		100	0.04
		0.35	0
Cotton wool	0.08	100	0.08
		30	0.04
Diatomite	0.2	0	0.05

## References

1. Powell, R. L., and Childs, G. E., in *American Institute of Physics Handbook, 3rd Edition*, Gray, D. E., Ed., McGraw-Hill, New York, 1972.
2. Perry, R. H., and Green, D., *Perry's Chemical Engineers' Handbook, Sixth Edition*, McGraw-Hill, New York, 1984.

Material	Dens. g/cm <sup>3</sup>	t °C	Ther. cond. W/m K				
Ebonite	0.5	400	0.09				
		0	0.09				
		400	0.16				
		1.2	0	0.16			
Felt, flax	0.2	30	0.05				
		30	0.04				
Fuller's earth	0.53	30	0.1				
Glass wool	0.2	-200 to 20	0.005				
		50	0.04				
		100	0.05				
Graphite	0.48	300	0.08				
		40	0.18				
		40	1.29				
100 mesh	0.7	40	1.29				
20-40 mesh	0.54	20	0.08				
Linoleum cork	0.54	20	0.08				
Magnesia (MgO)	0.54	100	36				
		400	18				
		1200	5.8				
MgO + SiO <sub>2</sub>	0.54	1700	9.2				
		100	5.3				
		400	3.5				
Mica:	0.54	1500	2.3				
		100	0.72				
		300	0.65				
muscovite	0.54	600	0.69				
		100	0.66				
		300	0.19				
phlogopite	0.54	600	0.2				
		30	0.3				
Canadian	0.54	300	0.19				
Micanite	0.54	30	0.3				
Mineral wool	0.15	30	0.04				
Perlite, expanded	0.1	-200 to 20	0.002				
Plastics:	0.1	-200 to 20	0.002				
				bakelite	1.3	20	1.4
				celluloid	1.4	30	0.02
				polystyrene foam	0.05	-200 to 20	0.033
				mylar foil	0.05	-200 to 20	0.0001
				nylon	0.05	-253	0.10
						-193	0.23
						25	0.30
				polytetrafluoroethylene		-253	0.13
						-193	0.16
		25	0.26				
		230	2.5				
urethane foam	0.07	20	0.06				
Porcelain		90	1				
Rock:	0.07	20	2				
				basalt	20	0.92	
chalk		20	0.92				

Material	Dens. g/cm <sup>3</sup>	<i>t</i> °C	Ther. cond. W/m K	Material	Dens. g/cm <sup>3</sup>	<i>t</i> °C	Ther. cond. W/m K
granite	2.8	20	2.2	Uranium dioxide		100	9.8
limestone	2	20	1			400	5.5
sandstone	2.2	20	1.3			1000	3.4
slate, ⊥		95	1.4	Wood:			
slate,		95	2.5	balsa, ⊥	0.11	30	0.04
Rubber:				fir, ⊥	0.54	20	0.14
sponge	0.2	20	0.05	fir,	0.54	20	0.35
92 percent		25	0.16	oak		20	0.16
Sand, dry	1.5	20	0.33	plywood		20	0.11
Sawdust	0.2	30	0.06	pine, ⊥	0.45	60	0.11
Shellac		20	0.23	pine,	0.45	60	0.26
Silica aerogel	0.1	-200 to 20	0.003	walnut, ⊥	0.65	20	0.14
Snow	0.25	0	0.16	Wool	0.09	30	0.04
Steel wool	0.1	55	0.09	Zinc oxide		200	17
Thoria (ThO <sub>2</sub> )		100	10			800	5.3
		400	5.8	Zirconia (ZrO <sub>2</sub> )		100	2
		1500	2.4			400	2
Titanium dioxide		100	6.5			1500	2.5
		400	3.8	Zirconia + silica		200	5.6
		1200	3.3			600	4.6
						1500	3.7



## THERMAL CONDUCTIVITY OF GLASSES

This table gives the composition of various types of glasses and of the variability of glasses, the data should be regarded as only the thermal conductivity  $k$  as a function of temperature. Because approximate.

Type of glass	Composition		$t$ °C	$k$ W/m K		
	SiO <sub>2</sub> (wt%)	Other oxides (wt%)				
Vitreous silica	100		-150	0.85		
			-100	1.05		
			-50	1.20		
			0	1.30		
			50	1.40		
			100	1.50		
Vycor glass	96	B <sub>2</sub> O <sub>3</sub> 3	-100	1.00		
			0	1.25		
			100	1.40		
Pyrex type chemically-resistant borosilicate glasses	80-81	B <sub>2</sub> O <sub>3</sub> 12-13 Na <sub>2</sub> O                              4 Al                                      2	-100	0.90		
			0	1.10		
			100	1.25		
Borosilicate crown glasses	60-65	B <sub>2</sub> O <sub>3</sub> 15-20	-100	0.65-0.75		
			0	0.90-0.95		
			100	1.00-1.05		
	65-70	B <sub>2</sub> O <sub>3</sub> 10-15	-100	0.75-0.80		
			0	0.95-1.00		
			100	1.05-1.15		
70-75	B <sub>3</sub> O <sub>3</sub> 5-10	-100	0.80-0.85			
		0	1.05-1.10			
		100	1.15-1.20			
		Zinc crown glasses (i)	55-65	ZnO                              5-15 Remainder: B <sub>2</sub> O <sub>3</sub> , Al <sub>2</sub> O <sub>3</sub>	-100	0.88-0.92
					0	1.10-1.15
					100	1.15-1.25
Zinc crown glasses (ii)	65-75	ZnO                              5-15 Remainder: B <sub>2</sub> O <sub>3</sub> , Al <sub>2</sub> O <sub>3</sub>	-100	0.88-0.92		
			0	1.15-1.15		
			100	1.20-1.30		
		ZnO                              5-15 Remainder: Na <sub>2</sub> O, K <sub>2</sub> O	-100	0.70-0.85		
			0	0.90-1.05		
			100	1.00-1.15		
Zinc crown glasses (ii)	65-75	ZnO                              5-15 Remainder: B <sub>2</sub> O <sub>3</sub> , Al <sub>2</sub> O <sub>3</sub>	-100	0.88-0.92		
			0	1.15-1.15		
			100	1.20-1.30		
		ZnO                              5-15 Remainder: Na <sub>2</sub> O, K <sub>2</sub> O	-100	0.70-0.85		
			0	0.90-1.05		
			100	1.00-1.15		
Zinc crown glasses (ii)	65-75	ZnO                              5-15 Remainder: B <sub>2</sub> O <sub>3</sub> , Al <sub>2</sub> O <sub>3</sub>	-100	0.88-0.92		
			0	1.15-1.15		
			100	1.20-1.30		
		ZnO                              5-15 Remainder: Na <sub>2</sub> O, K <sub>2</sub> O	-100	0.70-0.85		
			0	0.90-1.05		
			100	1.00-1.15		

Type of glass	Composition		<i>t</i> °C	<i>k</i> W/m K
	SiO <sub>2</sub> (wt%)	Other oxides (wt%)		
		Remainder:	0	1.15–1.15
		B <sub>2</sub> O <sub>3</sub> , Al <sub>2</sub> O <sub>3</sub>	100	1.20–1.25
		ZnO 15–25	–100	0.65–0.85
		Remainder:	0	0.85–1.00
		Na <sub>2</sub> O, K <sub>2</sub> O	100	1.05–1.20
Barium crown glasses	31	B <sub>2</sub> O <sub>3</sub>	–100	0.55
		Al <sub>2</sub> O <sub>3</sub>	0	0.70
		BaO	100	0.80
	41	B <sub>2</sub> O <sub>3</sub>	–100	0.60
		Al <sub>2</sub> O <sub>3</sub>	0	0.75
		ZnO	100	0.85
		BaO	43	
	47	B <sub>2</sub> O <sub>3</sub>	–100	0.65
		Na <sub>2</sub> O	0	0.75
		K <sub>2</sub> O	100	0.90
		ZnO	8	
		BaO	32	
	65	B <sub>2</sub> O <sub>3</sub>	–100	0.70
		Na <sub>2</sub> O	0	0.90
		K <sub>2</sub> O	100	1.00
ZnO		2		
BaO		10		
Borate glasses Borate flint glass	9	B <sub>2</sub> O <sub>3</sub>	–100	0.55
		Na <sub>2</sub> O	0	0.65
		K <sub>2</sub> O	100	0.80
		PbO	36	
		Al <sub>2</sub> O <sub>3</sub>	10	
		ZnO	6	
Borate flint glass	0	B <sub>2</sub> O <sub>3</sub>	–100	0.50
		Al <sub>2</sub> O <sub>3</sub>	0	0.65
		PbO	100	0.85
Borate flint glass	0	B <sub>2</sub> O <sub>3</sub>	–100	0.40
		Al <sub>2</sub> O <sub>3</sub>	0	0.55
		PbO	100	0.70
Borate glass	4	B <sub>2</sub> O <sub>3</sub>	–100	0.65
		Al <sub>2</sub> O <sub>3</sub>	0	0.80
		PbO	100	0.90
		K <sub>2</sub> O	4	
		ZnO	12	
Borate crown glass	0	B <sub>2</sub> O <sub>3</sub>	–100	0.50
		Na <sub>2</sub> O	0	0.65
		K <sub>2</sub> O	100	0.85
		BaO	4	
		PbO	3	
		Al <sub>2</sub> O <sub>3</sub>	18	
Light borate crown glass	0	B <sub>2</sub> O <sub>3</sub>	–100	0.55
		Na <sub>2</sub> O	0	0.70

Type of glass	Composition		$t$ °C	$k$ W/m K	
	SiO <sub>2</sub> (wt%)	Other oxides (wt%)			
Zinc borate glass	0	BaO	5	100	0.90
		Al <sub>2</sub> O <sub>3</sub>	18		
		B <sub>2</sub> O <sub>3</sub>	40	-100	0.65
		ZnO	60	0	0.75
			100	0.85	
Phosphate crown glasses	0	P <sub>2</sub> O <sub>5</sub>	70	0	0.75
Potash phosphate glass		B <sub>2</sub> O <sub>3</sub>	3	100	0.85
		K <sub>2</sub> O	12		
		Al <sub>2</sub> O <sub>3</sub>	10		
		MgO	4		
Baryta phosphate glass	0	P <sub>2</sub> O <sub>5</sub>	60	45	0.75
		B <sub>2</sub> O <sub>3</sub>	3		
		Al <sub>2</sub> O <sub>3</sub>	8		
		BaO	28		
Soda-lime glasses	75	Na <sub>2</sub> O	17	-100	0.75
		CaO	8	0	0.95
				100	1.10
	75	Na <sub>2</sub> O	12	-100	0.90
		CaO	13	0	1.10
				100	1.15
	72	Na <sub>2</sub> O	15	-100	0.80
		CaO	11	0	1.00
		Al <sub>2</sub> O <sub>3</sub>	2	100	1.15
	65	Na <sub>2</sub> O	25	-100	0.65
		CaO	10	0	0.85
				100	0.95
	65	Na <sub>2</sub> O	15	-100	0.85
		CaO	20	0	1.00
				100	1.10
	60	Na <sub>2</sub> O	20	-100	0.75
		CaO	20	0	0.90
				100	1.00
Other crown glasses	75	Na <sub>2</sub> O	9	-100	0.80
Crown glass		K <sub>2</sub> O	11	0	1.00
		CaO	5	100	1.10
High dispersion crown glass	68	Na <sub>2</sub> O	16	-100	0.65
		ZnO	3	0	0.85
		PbO	13	100	1.00
Miscellaneous flint glasses	65	PbO	25	-100	0.65–0.70
(i) Silicate flint glasses		Others	10	0	0.88–0.92
Light flint glasses					100
	55	PbO	35	-100	0.60–0.65

Type of glass	Composition		$t$ °C	$k$ W/m K	
	SiO <sub>2</sub> (wt%)	Other oxides			
		(wt%)			
		Others	10	0 0.75–0.85 100 0.88–0.92	
Ordinary flint glass	45	PbO	45	–100 0 100	0.50–0.60 0.65–0.75 0.80–0.85
		Others	10		
Heavy flint glass	35	PbO	60	–100 0 100	0.45–0.50 0.60–0.65 0.70–0.75
		Others	5		
Very heavy flint glasses	25	PbO	73	–100 0 100	0.40–0.45 0.55–0.60 0.63–0.67
		Others	2		
(ii) Borosilicate flint glass	20	PbO	80	–100 0 100	0.40 0.50 0.60
(ii) Borosilicate flint glass	33	B <sub>2</sub> O <sub>3</sub>	31	–100	0.65
		PbO	25	0	0.85
		Al <sub>2</sub> O <sub>3</sub>	7	100	0.95
		K <sub>2</sub> O	3		
		Na <sub>2</sub> O	1		
(iii) Barium flint glass	50	BaO	24	–100	0.60
		PbO	6	0	0.70
		K <sub>2</sub> O	8	100	0.85
		Na <sub>2</sub> O	3		
		ZnO	8		
		Sb <sub>2</sub> O <sub>3</sub>	1		
Other glasses					
Potassium glass	59	K <sub>2</sub> O	33	50	0.88–0.92
		CaO	8		
Iron glasses	63	Fe <sub>2</sub> O <sub>3</sub>	10	–100	0.80
		Na <sub>2</sub> O	17	0	0.95
		MgO	4	100	1.05
		CaO	3		
		Al <sub>2</sub> O <sub>3</sub>	2		
67	Fe <sub>2</sub> O <sub>3</sub>	15	0	0.88–0.92	
	Na <sub>2</sub> O	18	100	1.00–1.05	
62	Fe <sub>2</sub> O <sub>3</sub>	20	0	0.85–0.90	
	Na <sub>2</sub> O	18	100	0.95–1.00	
Rock glasses					
Obsidian				0	1.35
Artificial diabase				100	1.25

## PROPERTIES OF COMMERCIAL METALS AND ALLOYS

This table gives typical values of mechanical, thermal, and electrical properties of several common commercial metals and alloys. Values refer to ambient temperature (0 to 25 °C). All values should be regarded as typical, since these properties are dependent on the particular type of alloy, heat treatment, and other factors. Values for individual specimens can vary widely.

### References

1. *ASM Metals Reference Book, Second Edition*, American Society for Metals, Metals Park, OH, 1983.
2. Lynch, C. T., *CRC Practical Handbook of Materials Science*, CRC Press, Boca Raton, FL, 1989.
3. Shackelford, J. F., and Alexander, W., *CRC Materials Science and Engineering Handbook*, CRC Press, Boca Raton, FL, 1991.

Common name	Thermal conductivity W/cm K	Density g/cm <sup>3</sup>	Coeff. of linear expansion 10 <sup>-6</sup> /°C	Electrical resistivity μΩ cm	Modulus of elasticity GPa	Tensile strength MPa	Approx. melting point °C
Ingot iron	0.7	7.86	11.7	9.7	205	–	1540
Plain carbon steel AISI-SAE 1020	0.52	7.86	11.7	18	205	450	1515
Stainless steel type 304	0.15	7.9	17.3	72	195	550	1425
Cast gray iron	0.47	7.2	10.5	67	90	180	1175
Malleable iron		7.3	12	30	170	345	1230
Hastelloy C	0.12	8.94	11.3	125	200	780	1350
Inconel	0.15	8.25	11.5	103	200	800	1370
Aluminum alloy 3003, rolled	1.9	2.73	23.2	3.7	70	110	650
Aluminum alloy 2014, annealed	1.9	2.8	23.0	3.4	70	185	650
Aluminum alloy 360	1.5	2.64	21.0	7.5	70	325	565
Copper, electrolytic (ETP)	3.9	8.94	16.5	1.7	120	300	1080
Yellow brass (high brass)	1.2	8.47	20.3	6.4	100	300-800	930
Aluminum bronze	0.7	7.8	16.4	12	120	400-600	1050
Beryllium copper 25	0.8	8.23	17.8	7	130	500-1400	925
Cupronickel 30%	0.3	8.94	16.2		150	400-600	1200
Red brass, 85%	1.6	8.75	18.7	11	90	300-700	1000
Chemical lead	0.35	11.34	29.3	21	13	17	327
Antimonial lead (hard lead)	0.3	10.9	26.5	23	20	47	290
Solder 50-50	0.5	8.89	23.4	15	–	42	215
Magnesium alloy AZ31B	1.0	1.77	26	9	45	260	620
Monel	0.3	8.84	14.0	58	180	545	1330
Nickel (commercial)	0.9	8.89	13.3	10	200	460	1440
Cupronickel 55-45 (constantan)	0.2	8.9	18.8	49	160	–	1260
Titanium (commercial)	1.8	4.5	8.5	43	110	330-500	1670
Zinc (commercial)	1.1	7.14	32.5	6	–	130	419
Zirconium (commercial)	0.2	6.5	5.85	41	95	450	1855

## HARDNESS OF MINERALS AND CERAMICS

There are several hardness scales for describing the resistance of a material to indentation or scratching. This table lists a number of common materials in order of increasing hardness. Values are given, when available, on three different hardness scales: the original Mohs Scale (range 1 to 10); the modified Mohs Scale (range 1

to 15), and the Knoop Hardness Scale. In the last case, a load of 100 g is assumed.

### Reference

Shackelford, J. F. and Alexander, W., *CRC Materials Science and Engineering Handbook*, CRC Press, Boca Raton, FL, 1991.

Material	Formula	Mohs	Modified mohs	Knoop
Graphite	C	0.5		
Talc	3MgO·4SiO <sub>2</sub> ·H <sub>2</sub> O	1	1	
Alabaster	CaSO <sub>4</sub> ·2H <sub>2</sub> O	1.7		
Gypsum	CaSO <sub>4</sub> ·2H <sub>2</sub> O	2	2	32
Halite (rock salt)	NaCl	2		
Stibnite (antimonite)	Sb <sub>2</sub> S <sub>3</sub>	2.0		
Galena	PbS	2.5		
Mica		2.8		
Calcite	CaCO <sub>3</sub>	3	3	135
Barite	BaSO <sub>4</sub>	3.3		
Marble		3.5		
Aragonite	CaCO <sub>3</sub>	3.5		
Dolomite	CaMg(CO <sub>3</sub> ) <sub>2</sub>	3.5		
Fluorite	CaF <sub>2</sub>	4	4	163
Magnesia	MgO	5		370
Apatite	CaF <sub>2</sub> ·3Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	5	5	430
Opal		5		
Feldspar (orthoclase)	K <sub>2</sub> O·Al <sub>2</sub> O <sub>3</sub> ·6SiO <sub>2</sub>	6	6	560
Augite		6		
Hematite	Fe <sub>2</sub> O <sub>3</sub>	6		750
Magnetite	Fe <sub>3</sub> O <sub>4</sub>	6		
Rutile	TiO <sub>2</sub>	6.2		
Pyrite	FeS <sub>2</sub>	6.3		
Agate	SiO <sub>2</sub>	6.5		
Uranium dioxide	UO <sub>2</sub>	6.7		600
Silica (fused)	SiO <sub>2</sub>		7	
Quartz	SiO <sub>2</sub>	7	8	820
Flint		7		
Silicon	Si	7		
Andalusite	Al <sub>2</sub> OSiO <sub>4</sub>	7.5		
Zircon	ZrSiO <sub>4</sub>	7.5		
Zirconia	ZrO <sub>2</sub>			1200
Aluminum nitride	AlN			1225
Beryl	Be <sub>3</sub> Al <sub>2</sub> Si <sub>6</sub> O <sub>18</sub>	7.8		
Beryllia	BeO			1300
Topaz	Al <sub>2</sub> SiO <sub>4</sub> (OH,F) <sub>2</sub>	8	9	1340
Garnet	Al <sub>2</sub> O <sub>3</sub> ·3FeO·3SiO <sub>2</sub>		10	1360
Emery	Al <sub>2</sub> O <sub>3</sub> (impure)	8		
Zirconium nitride	ZrN	8+		1510
Zirconium boride	ZrB <sub>2</sub>			1560
Titanium nitride	TiN	9		1770
Zirconia (fused)	ZrO <sub>2</sub>		11	
Tantalum carbide	TaC			1800
Tungsten carbide	WC			1880
Corundum (alumina)	Al <sub>2</sub> O <sub>3</sub>	9		2025
Zirconium carbide	ZrC			2150
Alumina (fused)	Al <sub>2</sub> O <sub>3</sub>		12	
Beryllium carbide	Be <sub>2</sub> C			2400
Titanium carbide	TiC			2470
Carborundum (silicon carbide)	SiC	9.3	13	2500
Aluminum boride	AlB			2500
Tantalum boride	TaB <sub>2</sub>			2600
Boron carbide	B <sub>4</sub> C		14	2800
Boron	B	9.5		
Titanium boride	TiB <sub>2</sub>			2850
Diamond	C	10	15	7000

# ORGANIC MAGNETS

J.S. Miller

Magnetic ordering, e.g., ferromagnetism, like superconductivity, is a property of a solid, not of an individual molecule or ion, and very rarely occurs for organic compounds. In contrast to superconductivity, where all electron spins pair to form a perfect diamagnetic material, magnetic ordering requires unpaired electron spins; hence, superconductivity and ferromagnetism are mutually exclusive.

The vast majority of organic compounds are diamagnetic (i.e., all electron spins are paired), and a relative few possess unpaired electrons (designated by an arrow,  $\uparrow$ ) and are paramagnetic (PM), i.e., they are oriented in random directions. A few organic solids, however, exhibit strong magnetic behavior and magnetically order as ferromagnets (FO) with all spins aligned in the same direc-

tion. In some cases the spins align in the opposite direction and compensate to form an antiferromagnet (AF). In some cases these spins are not opposed to each other and do not compensate and lead to a canted antiferromagnet or weak ferromagnet (WF). If the number of spins that align in the opposite direction differs from the number of spins that align in the opposite direction, the spins cannot compensate and a ferrimagnet (FI) results. Metamagnets (MM) are antiferromagnets in which all the spins become aligned like a ferromagnet in an applied magnetic field. Above the ordering or critical temperature,  $T_c$ , all magnets are paramagnets (PM). Organic magnets all possess electron spins in  $p$ -orbitals, but these may be in conjunction with metal ion-based spins.

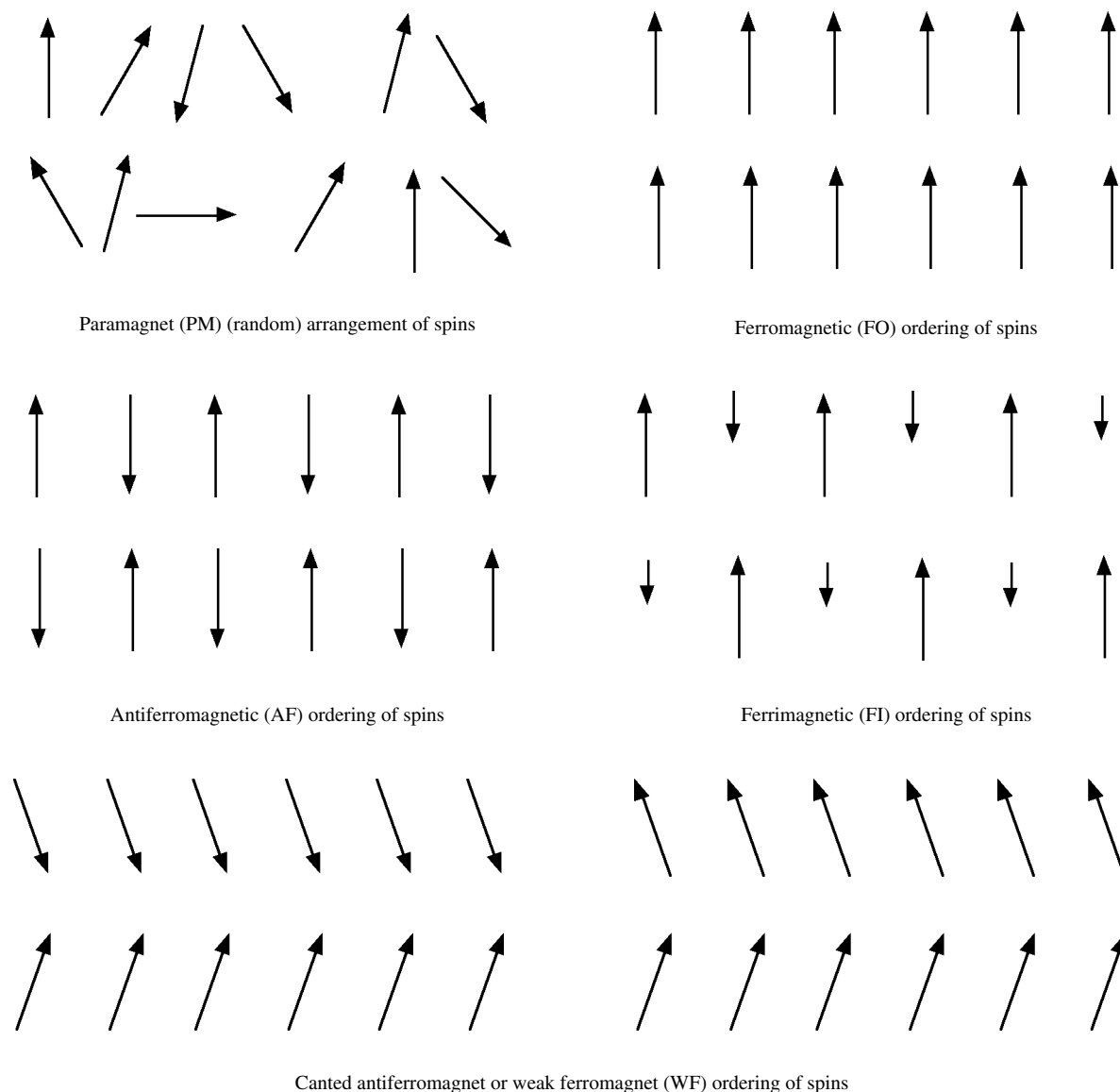


FIGURE 1. Schematic illustration of the different types of magnetic behavior.

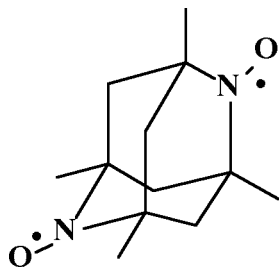
Summary of the Critical Temperature,  $T_c$ , Saturation Magnetization,  $M_s$ , Coercive Field,  $H_{cr}$ , and Remanent Magnetization,  $M_r$ , for Selected Organic-Based Magnets

Magnet	Type	$T_c$ /K	$M_s$ /A m <sup>-1</sup>	$H_{cr}$ /T	$M_r$ /A m <sup>-1</sup>
$\alpha$ -1,3,5,7-Tetramethyl-2,6-diazaadamantane- $N,N'$ -doxyl	FO	1.48	48,300	<0.00001	—
$\beta$ -2-(4'-Nitrophenyl)-4,4,5,5-tetramethyl-4,5-dihydro-1H-imidazol-1-oxyl-3- $N$ -oxide	FO	0.6	22,300	0.00008	<200
{Fe <sup>III</sup> [C <sub>5</sub> (CH <sub>3</sub> ) <sub>5</sub> ] <sub>2</sub> }[TCNE]	FO	4.8	37,600	0.10	2,300
{Mn <sup>III</sup> [C <sub>5</sub> (CH <sub>3</sub> ) <sub>5</sub> ] <sub>2</sub> }[TCNE]	FO	8.8	58,200	0.12	3,700
{Cr <sup>III</sup> [C <sub>5</sub> (CH <sub>3</sub> ) <sub>5</sub> ] <sub>2</sub> }[TCNE]	FO	3.65	46,300	—	—
$\alpha$ -{Fe <sup>III</sup> [C <sub>5</sub> (CH <sub>3</sub> ) <sub>5</sub> ] <sub>2</sub> }[TCNQ]	MM	2.55	34,200	—	—
$\beta$ -{Fe <sup>III</sup> [C <sub>5</sub> (CH <sub>3</sub> ) <sub>5</sub> ] <sub>2</sub> }[TCNQ]	FO	3.0	21,600	—	—
Tanol subarate	MM	0.38	20,700	—	—
NCC <sub>6</sub> F <sub>4</sub> CN <sub>2</sub> S <sub>2</sub>	WF	35.5	45	0.00009	—
Mn <sup>II</sup> (hfac) <sub>2</sub> NITC <sub>2</sub> H <sub>5</sub>	FI	7.8	39,400	0.03	27,600
Mn <sup>II</sup> (hfac) <sub>2</sub> NIT( <i>i</i> -C <sub>3</sub> H <sub>8</sub> )	FI	7.6	42,400	<0.0005	<420
[Mn(hfac) <sub>2</sub> ] <sub>3</sub> {[ON[C <sub>6</sub> H <sub>3</sub> ( <i>t</i> -C(CH <sub>3</sub> ) <sub>3</sub> ) <sub>2</sub> NO] <sub>2</sub> }	FI	46	24,400	—	—
[MnTPP][TCNE]·2C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub>	FI	13	18,400	2.4	10,300
V[TCNE] <sub><i>x,y</i></sub> CH <sub>2</sub> Cl <sub>2</sub> ( <i>x</i> ~ 2; <i>y</i> ~ 0.5)	FI	~400	28,200	0.0015 - 0.006	1,650
Mn[TCNE] <sub><i>x,y</i></sub> CH <sub>2</sub> Cl <sub>2</sub> ( <i>x</i> ~ 2; <i>y</i> ~ 0.5)	FI	75	52,000	0.002	270
Fe[TCNE] <sub><i>x,y</i></sub> CH <sub>2</sub> Cl <sub>2</sub> ( <i>x</i> ~ 2; <i>y</i> ~ 0.5)	FI	97	46,300	0.23	3
Co[TCNE] <sub><i>x,y</i></sub> CH <sub>2</sub> Cl <sub>2</sub> ( <i>x</i> ~ 2; <i>y</i> ~ 0.5)	FI	44	22,000	0.65	—

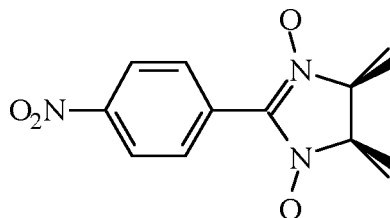
List of Symbols and Abbreviations

$M_s$	Saturation magnetization at 2 K
$H_{cr}$	Coercive Field
$T_c$	Critical Temperature
$M_r$	Remanent magnetization at 2 K
TCNE	Tetracyanoethylene
TCNQ	7,7,8,8-Tetracyano- <i>p</i> -quinodimethane

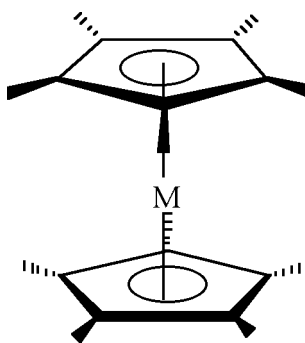
hfac	Hexafluoroacetate
NIT	Nitronyl nitroxide
FO	Ferromagnet
FI	Ferrimagnet
MM	Metamagnet
WF	Weak ferromagnet



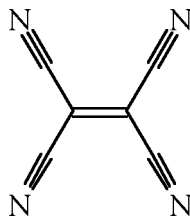
1,3,5,7-Tetramethyl-2,6-diazaadamantane- $N,N'$ -doxyl



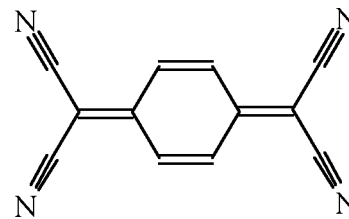
2-(4'-Nitrophenyl)-4,4,5,5-tetramethyl-4,5-dihydro-1H-imidazol-1-oxyl-3- $N$ -oxide



$M[C_5(CH_3)_5]_2$  ( $M = Cr, Mn, Fe$ )

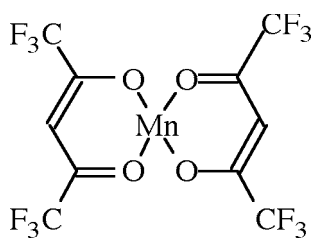
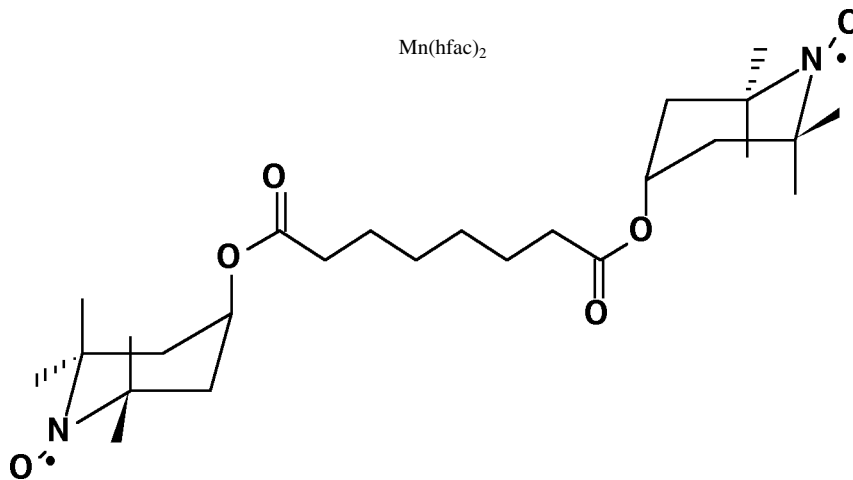


TCNE

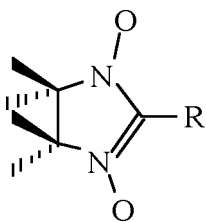
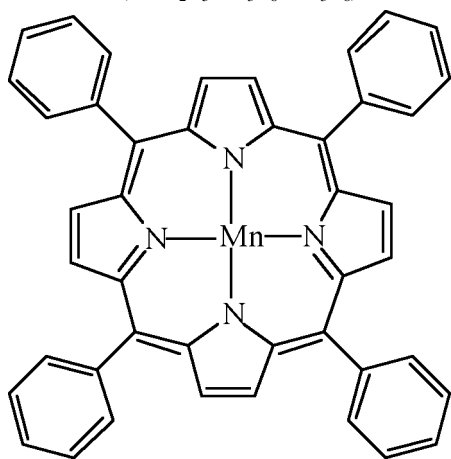


TCNQ

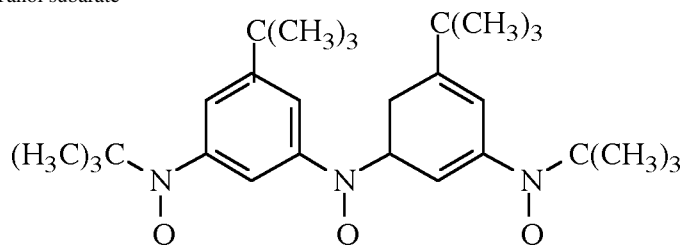
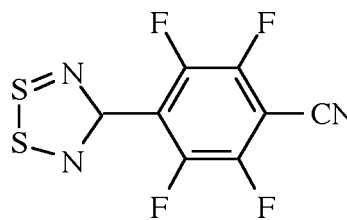


Mn(hfac)<sub>2</sub>

Tanol subarate

NITR (R = C<sub>2</sub>H<sub>5</sub>, *i*-C<sub>3</sub>H<sub>8</sub>, *n*-C<sub>3</sub>H<sub>8</sub>)

MnTPP

{ON[C<sub>6</sub>H<sub>3</sub>(*t*-C(CH<sub>3</sub>)<sub>3</sub>)<sub>2</sub>NO]<sub>2</sub>}NCC<sub>6</sub>F<sub>4</sub>CN<sub>2</sub>S<sub>2</sub>

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# OPTICAL PROPERTIES OF SELECTED INORGANIC AND ORGANIC SOLIDS

L. I. Berger

Optical properties of materials are closely related to their dielectric properties. The complex dielectric function (relative permittivity) of a material is equal to

$$\varepsilon(\omega) = \varepsilon'(\omega) - j\varepsilon''(\omega),$$

where  $\varepsilon'(\omega)$  and  $\varepsilon''(\omega)$  are its real and imaginary parts, respectively, and  $\omega$  is the angular frequency of the applied electric field. For a non-absorbing medium, the index of refraction is  $n = (\varepsilon\mu)^{1/2}$ , where  $\mu$  is the relative magnetic permeability of the medium (material); in the majority of dielectrics,  $\mu \cong 1$ .

For many applications, the most important optical properties of materials are the index of refraction, the extinction coefficient,  $k$ , and the reflectivity,  $R$ . The common index of refraction of a material is equal to the ratio of the phase velocity of propagation of an electromagnetic wave of a given frequency in vacuum to that in the material. Hence,  $n \cong 1$ . The optical properties of highly conductive materials like metals and semiconductors (at photon energy range above the energy gap) differ from those of optically transparent media. Free electrons absorb the incident electromagnetic wave in a thin surface layer (a few hundred nanometers thick) and then release the absorbed energy in the form of secondary waves reflected from the surface. Thus, the light reflection becomes very strong; for example, highly conductive sodium reflects 99.8% of the incident wave (at 589 nm). Introduction of the effective index of refraction,  $n_{\text{eff}} = (\varepsilon')^{1/2} = n - jk$ , where  $\varepsilon' = \varepsilon - j\delta/\omega \varepsilon_0$ ,  $\delta$  is the electrical conductivity of the material in S/m, and  $\varepsilon_0 = 8.8542 \cdot 10^{-12}$  F/m is the permittivity of vacuum, allows one to apply the expressions of the optics of transparent media to the conductive materials. It is clear that the effective index of refraction may be smaller than 1. For example,  $n = 0.05$  for pure sodium and  $n = 0.18$  for pure silver (at 589.3 nm). At very high photon energies, the quantum effects, such as the internal photoeffect, start playing a greater role, and the optical properties of these materials become similar to those of insulators (low reflectance, existence of Brewster's angle, etc.).

The extinction coefficient characterizes absorption of the electromagnetic wave energy in the process of propagation of a wave through a material. The wave intensity,  $I$ , after it passes a distance  $x$  in an isotropic medium is equal to

$$I = I_0 \exp(-\alpha x),$$

where  $I_0$  is the intensity at  $x = 0$  and  $\alpha$  is called the absorption coefficient. For many applications, the extinction coefficient,  $k$ , which is equal to

$$k = \alpha \frac{\lambda}{4\pi},$$

where  $\lambda$  is the wavelength of the wave in the medium, is more commonly used for characterization of the electromagnetic losses in materials.

Reflection of an electromagnetic wave from the interface between two media depends on the media indices of refraction and on the angle of incidence. It is characterized by the reflectivity, which is equal to the ratio of the intensity of the wave reflected back into the first medium to the intensity of the wave approaching the interface. For polarized light and two non-absorbing media,

$$R = \frac{(N_1 - N_2)^2}{(N_1 + N_2)^2},$$

where  $N_1 = n_1/\cos\theta_1$  and  $N_2 = n_2/\cos\theta_2$  for the wave polarized in the plane of incidence, and  $N_1 = n_1\cos\theta_1$  and  $N_2 = n_2\cos\theta_2$  for the wave polarized normal to the plane of incidence;  $\theta_1$  and  $\theta_2$  are the angles between the normal to the interface in the point of incidence and the directions of the beams in the first and second medium, respectively. The reflectivity at normal incidence in this case is

$$R = [(n_1 - n_2)/(n_1 + n_2)]^2$$

For any two opaque (absorbing) media, the normal incidence reflectivity is

$$R = \frac{(n_1 - n_2)^2 + k_2^2}{(n_1 + n_2)^2 + k_2^2}.$$

In the majority of experiments, the first medium is air ( $n \approx 1$ ), and hence,

$$R = \frac{(1 - n)^2 + k^2}{(1 + n)^2 + k^2}.$$

The data on  $n$  and  $k$  in the following table are abridged from the sources listed in the references. The reflectivity at normal incidence,  $R$ , has been calculated from the last equation. For convenience, the energy  $E$ , wavenumber  $\bar{\nu}$ , and wavelength  $\lambda$  are given for the incidence radiation.

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
<b>Crystalline Arsenic Selenide (<math>\text{As}_2\text{Se}_3</math>) [Ref. 1]*</b>											
2.194	17700	0.565					0.30				
2.168	17480	0.572					0.25				
2.141	17270	0.579					0.20				
2.123	17120	0.584					0.17				
2.098	16920	0.591					0.13				
2.094	16890	0.592						0.26			
2.091	16860	0.593						0.26			
2.073	16720	0.598					0.10	0.23			
2.060	16610	0.602						0.20			
2.049	16530	0.605					0.079	0.17			
2.036	16420	0.609						0.15			
2.023	16310	0.613						0.12			
2.013	16230	0.616					0.050				
2.009	16210	0.617						0.097			
2.000	16130	0.620						0.082			
1.987	16030	0.624						0.063			
1.977	15940	0.627					0.031				
1.974	15920	0.628						0.051			
1.962	15820	0.632						0.038			
1.953	15750	0.635						0.030			
1.949	15720	0.636					0.020				
1.937	15630	0.640						0.022			
1.925	15530	0.644						0.017			
1.922	15500	0.645					0.012				
1.905	15360	0.651					$8.6 \cdot 10^{-3}$				
1.893	15270	0.655					6.4				
1.881	15170	0.659					5.2				
1.859	14990	0.667					3.1				
1.848	14900	0.671						$1.7 \cdot 10^{-3}$			
1.845	14880	0.672					2.0				
1.842	14860	0.673						$1.2 \cdot 10^{-3}$			
1.831	14770	0.677					$1.3 \cdot 10^{-3}$	$9.0 \cdot 10^{-4}$			
1.826	14730	0.679						6.4			
1.821	14680	0.681						4.7			
1.818	14660	0.682					$8.6 \cdot 10^{-4}$				
1.815	14640	0.683						3.4			
1.807	14580	0.686					5.5				
1.802	14530	0.688					4.1				
0.06199	500.0	20.0		3.2	2.9		$1.7 \cdot 10^{-3}$	$1.8 \cdot 10^{-3}$		0.27	0.24
0.05904	476.2	21.0		3.1	2.9		$2.1 \cdot 10^{-3}$	$2.2 \cdot 10^{-3}$		0.26	0.24
0.05636	454.5	22.0		3.1	2.9		$2.5 \cdot 10^{-3}$	$2.6 \cdot 10^{-3}$		0.26	0.24
0.05391	434.8	23.0		3.1	2.9		$3.0 \cdot 10^{-3}$	$3.1 \cdot 10^{-3}$			
0.04592	370.4	27.0		3.0	2.8		$6.3 \cdot 10^{-3}$	$6.4 \cdot 10^{-3}$		0.25	0.22
0.04428	357.1	28.0		3.0	2.8		$7.6 \cdot 10^{-3}$	$7.7 \cdot 10^{-3}$		0.25	0.22
0.04275	344.8	29.0		3.0	2.8		0.0092	0.0093		0.25	0.22
0.04133	333.3	30.0		3.0	2.7		0.011	0.011		0.25	0.21
0.03542	285.7	35.0		2.7	2.5			0.037	0.034	0.21	0.18
0.03100	250.0	40.0		1.9	1.7			0.38	1.0	0.19	0.18
0.03061	247.0	40.5		2.0	2.6			0.33	0.95	0.12	0.25
0.03024	244.0	41.0		1.7	2.4			0.41	0.46	0.088	0.18
0.02883	232.6	43.0		1.2	1.3			2.2	0.94	0.50	0.16
0.02850	229.9	43.5		1.6	1.2			2.8	1.4	0.56	0.29
0.02818	227.3	44.0		2.3	1.2		3.3	2.0		0.58	0.48
0.02755	222.2	45.0		4.2	2.0		2.5	3.3		0.50	0.60
0.02480	200.0	50.0		6.5	4.0		3.6	0.26		0.62	0.36
0.02254	181.8	55.0		4.5	3.5		0.17	0.10		0.40	0.31
0.02066	166.7	60.0		4.0	3.2		0.089	0.10		0.36	0.27
0.01907	153.8	65.0		3.8	3.1		0.097	0.16		0.34	0.26
0.01771	142.9	70.0		3.6	3.0		0.19	0.30		0.32	0.25

$E/eV$	$\bar{\nu}/cm^{-1}$	$\lambda/\mu m$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.01653	133.3	75.0		3.7	3.0		0.41	0.44		0.34	0.26
0.01550	125.0	80.0		3.8	3.1		0.29	0.40		0.34	0.27
0.01459	117.6	85.0		3.6	2.9		0.20	0.34		0.32	0.24
0.01378	111.1	90.0		3.2	2.6		0.43	0.49		0.28	0.21
0.01305	105.3	95.0		4.7	3.0		1.5	1.5		0.46	0.34
0.01240	100.0	100.0		4.4	2.7		0.22	0.81		0.40	0.25
0.01181	95.24	105.0		4.2	3.0		0.094	3.9		0.38	0.62
0.01127	90.91	110.0		4.1	5.3		0.059	0.70		0.37	0.47
0.01033	83.33	120.0		3.9	4.2		0.034	0.13		0.35	0.38
0.009537	76.92	130.0		3.9	4.0		0.024	0.069		0.35	0.36
0.008856	71.43	140.0		3.9	3.8		0.019	0.048		0.35	0.34
0.007749	63.50	160.0		3.8	3.7		0.014	0.032		0.34	0.33
0.006888	55.55	180.0		3.8	3.7		0.011	0.024		0.34	0.33
0.006199	50.0	200.0		3.8	3.6		0.0091	0.019		0.34	0.32

\*Indices a and c relate to the radiation electric field parallel to the a and c axes of the crystal, respectively.

#### Vitreous Arsenic Selenide ( $As_2Se_3$ ) [Ref. 1]

2.056	16580	0.603				0.12					
2.026	16340	0.612				0.11					
2.006	16180	0.618				0.099					
1.990	16050	0.623				9.0					
1.925	15530	0.644				5.6					
1.826	14730	0.679				1.4					
1.810	14600	0.685				0.012					
1.794	14470	0.691				0.0089					
1.771	14290	0.700				6.2					
1.715	13830	0.723				2.6					
1.701	13720	0.729				0.0022					
1.647	13280	0.753				0.00046					
1.629	13140	0.761	3.07			4.0			0.62		
1.596	12870	0.777	3.06			2.7			0.49		
1.579	12740	0.785	3.05			1.9			0.39		
1.562	12590	0.794	3.05			0.00013			0.26		
1.544	12450	0.803	3.04			0.000094			0.25		
1.529	12330	0.811	3.03			6.3			0.78		
1.512	12200	0.820	3.03			4.2			0.64		
1.494	12050	0.830	3.02			2.8			0.50		
1.476	11910	0.840	3.01			1.8			0.38		
1.378	11110	0.90	2.98								
1.240	10000	1.00	2.93								
1.127	9091	1.10	2.90								
1.051	8475	1.18	2.89								
1.033	8333	1.20	2.88								
0.2555	1980	5.05				$1.6 \cdot 10^{-7}$					
0.2380	1919	5.21				$9.9 \cdot 10^{-8}$					
0.2344	1890	5.29				$1.1 \cdot 10^{-7}$					
0.1345	1085	9.22				4.4					
0.1339	1080	9.26				3.7					
0.1333	1075	9.30				4.4					
0.1308	1055	9.48				4.5					
0.1215	980	10.20				8.9					
0.1203	970	10.31				$9.9 \cdot 10^{-7}$					
0.1196	965	10.36				$1.0 \cdot 10^{-6}$					
0.1178	950	10.53				1.1					
0.1116	900	11.11				1.8					
0.1004	810	12.35				4.9					
0.09919	800	12.50				$7.0 \cdot 10^{-6}$					
0.09795	790	12.66				$1.0 \cdot 10^{-5}$					
0.09671	780	12.82				1.5					
0.09299	750	13.33				3.7					
0.08555	690	14.49				6.9					

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.08431	680	14.71				5.9					
0.08059	650	15.38				6.1					
0.07811	630	15.87				6.3					
0.07687	620	16.13				7.7					
0.07563	610	16.39				7.8					
0.07439	600	16.67				$9.3 \cdot 10^{-5}$					
0.07315	590	16.95	2.8			$1.2 \cdot 10^{-4}$			0.22		
0.07191	580	17.24	2.8			1.4			0.32		
0.07067	570	17.54	2.8			1.8			0.37		
0.06943	560	17.86	2.8			2.8			0.50		
0.06633	535	18.69	2.8			5.2			0.73		
0.06571	530	18.87	2.8			$7.2 \cdot 10^{-4}$			0.22		
0.06509	525	19.05	2.8			$1.2 \cdot 10^{-3}$			0.22		
0.06447	520	19.23	2.8			1.7			0.35		
0.06075	490	20.41	2.7			4.9			0.71		
0.06024	485.9	20.58	2.7			5.2			0.73		
0.05331	430	23.26	2.7			1.4			0.31		
0.05269	425	23.53	2.7			$1.1 \cdot 10^{-3}$			0.21		
0.05207	420	23.81	2.7			$8.5 \cdot 10^{-4}$			0.21		
0.05145	415	24.10	2.7			7.3			0.84		
0.05083	410	24.39	2.7			8.3			0.87		
0.05021	405	24.69	2.7			$9.4 \cdot 10^{-4}$			0.21		
0.04959	400	25.0	2.7			$1.2 \cdot 10^{-3}$			0.21		
0.04862	392.2	25.5	2.6			1.6			0.33		
0.04679	377.4	26.5	2.6			5.0			0.73		
0.04592	370.4	27.0	2.6			$8.0 \cdot 10^{-3}$			0.20		
0.04509	363.6	27.5	2.6			$1.2 \cdot 10^{-2}$			0.20		
0.04428	357.1	28.0	2.6			1.7			0.34		
0.03875	312.5	32.0	2.5			8.2			0.87		
0.03815	307.7	32.5	2.5			$9.3 \cdot 10^{-3}$			0.18		
0.03757	303.0	33.0	2.4			0.11			0.17		
0.02988	241.0	41.5	2.2			0.89			0.20		
0.02952	238.1	42.0	2.2			1.0			0.22		
0.02725	219.8	45.5	3.2			1.8			0.39		
0.02362	190.5	52.5	3.6			0.30			0.32		
0.01937	156.2	64.0	3.2			0.10			0.27		
0.01922	155.0	64.5	3.2			$9.6 \cdot 10^{-2}$			0.27		
0.01907	153.8	65.0	3.2			9.4			0.88		
0.01734	139.9	71.5	3.1			8.7			0.87		
0.01653	133.3	75.0	3.1			9.4			0.88		
0.01642	132.5	75.5	3.1			0.096			0.26		
0.01494	120.5	83.0	3.0			0.15			0.25		
0.01246	100.5	99.5	3.2			0.60			0.26		
0.007606	61.35	163.0	3.3			0.12			0.29		
0.006199	50.00	200.0	3.2								
0.004592	37.04	270.0	3.1			0.072			0.26		
0.002799	22.57	443.0	3.0			4.5			0.67		
0.001826	14.73	679.0	3.0			2.8			0.50		
0.001273	10.27	974.0	3.0			2.1			0.41		
0.0006491	5.236	1910.0	3.0			$1.1 \cdot 10^{-2}$			0.25		
0.0004376	3.530	2833.0	3.0			$7.5 \cdot 10^{-3}$			0.25		
0.0002903	2.341	4271.0	3.0			5.0			0.71		
0.0001716	1.384	7224.0	3.0			3.1			0.53		
0.00009047	0.7297	13704	3.0			$1.6 \cdot 10^{-3}$			0.25		
0.00005621	0.4534	22056	3.0			$9.9 \cdot 10^{-4}$			0.25		
0.00002774	0.2237	44699	3.0			5.2			0.72		
0.00001439	0.1161	86153	3.0			2.6			0.47		

**Vitreous Arsenic Sulfide ( $\text{As}_2\text{S}_3$ ) - [Ref. 2]**

4.959	40000	0.2500	2.48			1.21			0.27		
3.100	25000	0.40	3.09			0.34			0.27		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
2.48	20000	0.4999	2.83			0.013			0.23		
1.879	15150	0.66	2.59			$1.7 \cdot 10^{-6}$			0.20		
1.240	10000	1.0	2.48			$2.4 \cdot 10^{-7}$			0.18		
0.6199	5000	2.0	2.43						0.17		
0.3100	2500	4.0	2.41						0.17		
0.2480	2000	5.0	2.41						0.17		
0.1736	1400	7.143	2.40			$7.4 \cdot 10^{-7}$			0.17		
0.1240	1000	10.00	2.38			$1.3 \cdot 10^{-4}$			0.17		
0.09299	750	13.33	2.35			$3.0 \cdot 10^{-3}$			0.16		
0.07439	600	16.67	2.31			$4.6 \cdot 10^{-4}$			0.16		
0.04959	400.0	25.0	1.79			0.2			0.085		
0.03757	303.0	33.0	3.59			1.4			0.38		
0.03100	250.0	40.0	2.98			0.15			0.25		
0.02480	200.0	50	2.66			0.11			0.21		
0.02066	166.7	60	2.64			0.57			0.22		
0.01771	142.9	70	2.99			0.17			0.25		
0.01550	125.0	80	2.89			0.14			0.24		
0.01378	111.1	90	2.84			0.12			0.23		
0.01240	100	100	2.81			0.10			0.23		
0.008183	66	152	2.76			0.072			0.22		
0.004029	32.5	308	2.74			0.044			0.22		
0.002418	19.5	513	2.74			0.031			0.22		
0.001984	16	625	2.74			0.025			0.22		
0.001048	8.45	1180	2.73			$8.8 \cdot 10^{-3}$			0.22		
0.0001033	0.833	12000	2.73			$1.3 \cdot 10^{-3}$			0.22		
$4.129 \cdot 10^{-12}$	$3.33 \cdot 10^{-8}$	$3 \cdot 10^{11}$	2.73						0.22		

## Cadmium Telluride (CdTe) - [Ref. 3]

4.9	39520	0.2530	2.48			2.04			0.39		
4.1	33070	0.3024	2.33			1.59			0.32		
3.9	31460	0.3179	2.57			1.90			0.37		
3.5	28230	0.3542	2.89			1.52			0.34		
3.1	25000	0.4000	3.43			1.02			0.34		
3.0	24200	0.4133	3.37			0.861			0.32		
2.755	22220	0.45	3.080			0.485			0.27		
2.75	22180	0.4509	3.23			0.636			0.29		
2.610	21050	0.475	3.045								
2.5	20160	0.4959	3.14			0.525			0.28		
2.25	18150	0.5510	3.05			0.411			0.26		
1.771	14290	0.70	2.861			0.210			0.23		
1.512	12200	0.82	2.880			0.040			0.23		
1.50	12100	0.8266	2.98			0.319			0.25		
1.475	11900	0.840	2.905			0.00134			0.24		
1.47	11860	0.8434				0.000671					
1.465	11820	0.8463				3.37					
1.46	11780	0.8492				1.89					
1.459	11760	0.850	2.948						0.24		
1.455	11740	0.8521				$1.08 \cdot 10^{-4}$					
1.45	11690	0.8551	2.9565			$5.10 \cdot 10^{-5}$			0.24		
1.445	11650	0.8580				2.73					
1.442	11630	0.860	2.952						0.24		
1.44	11610	0.8610	2.9479			1.37			0.32		
1.43	11530	0.8670	2.9402						0.24		
1.30	10490	0.9537	2.8720						0.23		
1.24	10000	1.0	2.840						0.23		
1.20	9679	1.033	2.8353						0.23		
1.10	8872	1.127	2.8050						0.23		
1.00	8065	1.240	2.7793						0.22		
0.90	7259	1.378	2.7537						0.22		
0.80	6452	1.550	2.7384						0.22		
0.70	5646	1.771	2.7223						0.21		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.60	4839	2.066	2.7086						0.21		
0.50	4033	2.480	2.6972						0.21		
0.40	3226	3.100	2.6878						0.21		
0.30	2420	4.133	2.6800						0.21		
0.20	1613	6.199	2.6722						0.21		
0.10	806.5	12.40	2.6535						0.20		
0.09	725.9	13.78	2.6482						0.20		
0.06819	550	18.18	2.623						0.20		
0.0573	462	21.6				$3.8 \cdot 10^{-6}$					
0.05	403.3	24.80	2.5801						0.19		
0.0469	378	26.5				$8.0 \cdot 10^{-5}$					
0.04592	370.3	27				$9.88 \cdot 10^{-5}$					
0.04133	333.3	30	2.55916			$2.86 \cdot 10^{-4}$			0.19		
0.04092	330	30.30	2.531			3.34			0.57		
0.03720	300	33.33	2.494			4.97			0.73		
0.03647	294.1	34.00				8.93					
0.03596	290	34.48	2.478			$5.77 \cdot 10^{-3}$			0.18		
0.03493	281.7	35.5				7.91					
0.03472	280	35.71	2.459			6.76			0.83		
0.03100	250	40	2.378			$1.18 \cdot 10^{-2}$			0.17		
0.02917	235.3	42.5				6.93					
0.02852	230	43.48	2.289			1.87			0.36		
0.02728	220	45.45	2.224			$2.47 \cdot 10^{-2}$			0.14		
0.02604	210	47.62	2.137			$3.4 \cdot 10^{-2}$			0.13		
0.02480	200	50.00	2.013			$4.97 \cdot 10^{-2}$			0.11		
0.02384	192.3	52.0				6.21					
0.01798	145	68.97	1.8			5.2			0.79		
0.01736	140	71.43	6.778			4.50			0.66		
0.01550	125	80.0	4.598			0.294			0.41		
0.01364	110	90.91	3.868			$9.47 \cdot 10^{-2}$			0.35		
0.01240	100	100	3.649			$5.68 \cdot 10^{-2}$			0.32		
0.009919	80	125	3.415			0.0262			0.30		
0.008679	70	142.9	3.348			0.0189			0.29		
0.007439	60	166.7	3.299			1.39			0.35		
0.006199	50	200	3.263			1.03			0.32		
0.004959	40	250	3.236			$7.52 \cdot 10^{-3}$			0.28		
0.003720	30	333.3	3.217						0.28		
0.023015	18.563		538.71			3.2096			0.28		
0.001550	12.50	800				6.18					

## Gallium Arsenide (GaAs) - [Ref. 4]

155		0.007999				0.0181					
145		0.008551				0.0203					
130		0.009537				0.0224					
110		0.01127				0.0278					
90		0.01378				0.0323					
70		0.01771				0.0376					
40		0.03100				0.0426					
23		0.05391	1.037			0.228					
7.0		0.1771	1.063			1.838					
6.0	48390	0.2066	1.264			2.472			0.61		
5.00	40330	0.2480	2.273			4.084			0.67		
4.00	32260	0.3100	3.601			1.920			0.42		
3.00	24200	0.4133	4.509			1.948			0.47		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
2.50	20160	0.4959	4.333			0.441			0.39		
2.00	16130	0.6199	3.878			0.211			0.35		
1.80	14520	0.8888	3.785			0.151			0.34		
1.60	12900	0.7749	3.700			0.091			0.33		
1.50	12100	0.8266	3.666			0.080			0.33		
1.40	11290	0.8856	3.6140			$1.69 \cdot 10^{-3}$			0.32		
1.20	9679	1.033	3.4920						0.31		
1.00	8065	1.240	3.4232						0.30		
0.80	6452	1.550	3.3737						0.29		
0.50	4033	2.480	3.3240						0.29		
0.25	2016	4.959	3.2978						0.29		
0.15	1210	8.266	3.2831						0.28		
0.100	806.5	12.40	3.2597			$4.93 \cdot 10^{-6}$			0.28		
0.090	725.9	13.78	3.2493			$1.64 \cdot 10^{-5}$			0.28		
0.070	564.6	17.71	3.2081			$2.32 \cdot 10^{-4}$			0.28		
0.060	483.9	20.66	3.1609			$3.45 \cdot 10^{-3}$			0.27		
0.0495	399.2	25.05	3.058			$2.07 \cdot 10^{-3}$			0.26		
0.03968	320	31.25	2.495			$2.43 \cdot 10^{-2}$			0.18		
0.03496	282	35.46	0.307			$294 \cdot 10^{-2}$					
0.02976	240	41.67	4.57			$4.26 \cdot 10^{-2}$			0.41		
0.02066	166.7	60	3.77			$3.89 \cdot 10^{-3}$			0.34		
0.01550	125	80	3.681			$1.84 \cdot 10^{-3}$			0.33		
0.008266	66.67	150	3.62			$2.14 \cdot 10^{-3}$			0.32		
0.002480	20	500	3.607			$1.3 \cdot 10^{-3}$			0.32		
0.001240	10	1000	3.606						0.32		

## Gallium Phosphide (GaP) - [Ref. 5]

154.0		0.00805				$1.7 \cdot 10^{-2}$					
110.0		0.0113				$2.15 \cdot 10^{-2}$					
100.0		0.0124				$215 \cdot 10^{-2}$					
80.0		0.0155				$3.0 \cdot 10^{-2}$					
50.0		0.0248				$4.7 \cdot 10^{-2}$					
27.0		0.0459				$9.3 \cdot 10^{-2}$					
25.0		0.0496				0.122					
20.0		0.0620				0.180					
15.0		0.0826	0.748			0.628					
5.5	44360	0.2254	1.543			3.556			0.68		
4.68	37750	0.2649	4.181			2.634			0.50		
3.50	28230	0.3542	5.050			0.819			0.46		
3.00	24200	0.4133	4.081			0.224			0.37		
2.78	22420	0.4460	3.904			0.103			0.35		
2.621	21140	0.473	3.73			$6.37 \cdot 10^{-3}$			0.33		
2.480	20000	0.500	3.590			$2.47 \cdot 10^{-3}$			0.32		
2.18	17580	0.5687	3.411			$2.8 \cdot 10^{-7}$			0.30		
2.000	16130	0.62	3.3254						0.29		
1.6	12900	0.7749	3.209						0.28		
1.240	10000	1.0	3.1192						0.26		
0.6888	5556	1.8	3.0439						0.26		
0.4769	3846	2.6	3.0271						0.25		
0.1907	1538	6.5	2.995			$4.29 \cdot 10^{-4}$			0.25		
0.1550	1250	8.0	2.984						0.25		
0.1240	1000	10	2.964						0.25		
0.06199	500	20	2.615			$7.16 \cdot 10^{-3}$			0.20		
0.03100	250	40	3.594			$1.81 \cdot 10^{-2}$			0.32		



$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.02480	200	50	3.461			$5.77 \cdot 10^{-3}$			0.30		
0.01727	139.27	71.80	3.3922			$4.34 \cdot 10^{-3}$			0.30		
0.01168	94.21	106.1	3.3621			$4.26 \cdot 10^{-3}$			0.29		
0.006199	50.00	200	3.3447			$1.3 \cdot 10^{-4}$			0.29		
0.004133	33.33	300	3.3413						0.29		
0.001240	10.00	1000	3.3319						0.29		

**Indium Antimonide (InSb) - [Ref. 6]**

155		0.007999				$4.77 \cdot 10^{-3}$					
60		0.02066				$7.30 \cdot 10^{-2}$					
25		0.04959	1.15			.015					
24		0.05166	1.15			0.18					
15		0.08266	0.97			0.230					
10		0.1240	0.74			0.88					
5.00	40330	0.2480	1.307			2.441			0.53		
4.50	36290	0.2755	1.443			2.894			0.60		
4.00	32260	0.3100	2.632			3.694			0.61		
3.34	26940	0.3712	3.528			2.280			0.45		
2.84	22910	0.4366	3.340			2.021			0.45		
1.80	14520	0.6888	4.909			1.396			0.47		
1.50	12100	0.8266	4.418			0.643			0.41		
0.6	4839	2.066	4.03						0.36		
0.2480	2000	5.0	4.14			$9.1 \cdot 10^{-2}$			0.37		
0.1907	1538	6.5	4.30			$6.3 \cdot 10^{-2}$			0.39		
0.1653	1333	7.5	4.18			$2.7 \cdot 10^{-2}$			0.38		
0.06199	500	20.00	3.869			$2.0 \cdot 10^{-3}$			0.35		
0.03100	250	40.00	2.98			$2.6 \cdot 10^{-3}$			0.25		
0.02480	200	50.00	2.22			0.165			0.14		
0.02244	181	55.25	3.05			7.59			0.84		
0.02207	178	56.18	9.61			4.20			0.70		
0.02033	164	60.98	4.94			0.140			0.44		
0.01054	85	117.6	2.12			0.423			0.14		
0.005579	45	222.2	1.02			5.59			0.88		
0.001860	15	666.7	6.03			17.9			0.93		
0.001240	10	1000	10.7			24.0			0.94		

**Indium Arsenide (InAs) - [Ref. 7]**

25		0.04959				1.139			0.168		
20		0.06199				1.125			0.225		
15		0.08266				0.894			0.336		
10		0.1240				0.835			1.071		
6	48390	0.2066	1.434			2.112			0.45		
5.0	40330	0.2480	1.524			2.871			0.58		
4.0	32260	0.3100	3.313			1.799			0.39		
3.5	28230	0.3542	3.008			1.754			0.37		
3.0	24200	0.4133	3.197			2.034			0.41		
2.5	20160	0.4959	4.364			1.786			0.45		
2.44	19680	0.5081	4.489			1.446			0.44		
1.86	15000	0.6666	3.889			0.554			0.36		
1.8	14520	0.6888	3.851			0.530			0.35		
1.7	13710	0.7293	3.798			0.493			0.35		
1.6	12900	0.7749	3.755			0.463			0.34		
1.5	12100	0.8266	3.714			0.432			0.34		
1.2	9679	1.033	3.613						0.32		
1.0	8065	1.240	3.548						0.31		
0.6	4839	2.066				0.161					
0.35	2823	3.542	3.608			$9.58 \cdot 10^{-3}$			0.32		
0.32	2581	3.875	3.512			$1.23 \cdot 10^{-4}$			0.31		
0.20	1613	6.199	3.427						0.30		
0.1240	1000	10.00	3.402						0.30		
0.06199	500	20.00	3.334						0.29		
0.04959	400	25.00	3.264						0.28		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.04339	350	28.57	3.182			$5.46 \cdot 10^{-3}$			0.27		
0.03720	300	33.33	2.988						0.25		
0.03100	250	40.00	1.970			$6.37 \cdot 10^{-2}$			0.11		
0.02765	222	44.84	5.90			6.53			0.74		
0.02480	200	50.00	6.91			0.30			0.56		
0.01984	160	62.50	5.27			0.41			0.47		
0.01860	150	66.67	5.27			0.51			0.47		
0.01736	140	71.43	3.99			$1.1 \cdot 10^{-2}$			0.36		
0.01488	120	83.33	3.91			$6.6 \cdot 10^{-3}$			0.35		
0.01240	100	100.0	3.85			$4.3 \cdot 10^{-3}$			0.35		
0.009919	80	125.0	3.817						0.34		
0.007439	60	166.7	3.793						0.34		
0.004959	40	250.0	3.778						0.34		
0.002480	20	500	3.769						0.37		
0.001240	10	1000	3.766						0.34		

**Indium Phosphide (InP) - [Ref. 8]**

20		0.06199	0.793			0.494					
15		0.08266	0.695			0.574					
10		0.1240	0.806			1.154					
5.5	44360	0.2254	1.426			2.562			0.79		
5.0	40330	0.2480	2.131			3.495			0.61		
4.0	32260	0.3100	3.141			1.730			0.38		
3.0	24200	0.4133	4.395			1.247			0.43		
2.0	16130	0.6199	3.549			0.317			0.32		
1.5	12100	0.8266	3.456			0.203			0.31		
1.25	10085	0.9915	3.324						0.29		
1.00	8068	1.239	3.220						0.28		
0.50	4034	2.479	3.114						0.26		
0.30	2420	4.131	3.089						0.26		
0.10	806.8	12.39	3.012						0.25		
0.075	605.1	16.53	2.932						0.24		
0.060	484.1	20.66	2.780			$1.46 \cdot 10^{-2}$			0.22		
0.050	403.4	24.79	2.429			$3.35 \cdot 10^{-2}$			0.17		
0.03992	322	31.06	0.307			3.57					
0.03496	282	35.46	3.89			0.282			0.35		
0.03100	250	40.00	4.27			$3.0 \cdot 10^{-2}$			0.39		
0.02728	220	45.45	3.93			$1.3 \cdot 10^{-2}$			0.35		
0.02480	200	50.0	3.81			$8.7 \cdot 10^{-3}$			0.34		
0.02418	195	51.28	3.19						0.27		
0.02232	180	55.56	3.19						0.27		
0.01860	150	66.67	3.65						0.32		
0.01240	100	100	3.57						0.32		
0.009919	80	125.0	3.551						0.31		
0.007439	60	166.7	3.538						0.31		
0.004959	40	250.0	3.529						0.31		
0.002480	20	500	3.523						0.31		
0.001240	10	1000.0	3.522						0.31		

**Lead Selenide (PbSe) - [Ref. 9]**

14.5		0.08551	0.72			0.20					
10		0.1240	0.68			0.50					
5	40330	0.2480	0.54			1.2					
2.0	16130	0.6199	3.65			2.9			0.51		
1.65	13310	0.7514	4.51			1.73			0.46		
1.5	12100	0.8266	4.64			2.64			0.52		
1.0	8065	1.240	4.65			1.1			0.44		
0.75	6049	1.653				0.269					
0.62	5001	2.000	4.59			0.770			0.42		
0.48	3871	2.583	4.90						0.44		
0.40	3226	3.100	4.91						0.44		
0.32	2581	3.875	4.98			0.173			0.44		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.20	1613	6.199	4.82						0.43		
0.1190	960	10.42	4.74			$1.20 \cdot 10^{-3}$			0.42		
0.09919	800	12.50	4.72			$2.09 \cdot 10^{-3}$			0.42		
0.07935	640	15.63	4.68			$4.12 \cdot 10^{-3}$			0.42		
0.05951	480	20.83	4.59			$1.00 \cdot 10^{-2}$			0.41		
0.04959	400	25.00	4.49			$1.77 \cdot 10^{-2}$			0.40		
0.03968	320	31.25	4.31			$3.62 \cdot 10^{-2}$			0.39		
0.02976	240	41.67	3.89			$9.61 \cdot 10^{-2}$			0.24		
0.01984	160	62.50	2.34			0.56			0.18		
0.009919	80	125.0	1.73			7.38			0.88		
0.007935	64	156.3	2.91			10.1			0.90		
0.004959	40	250.0	11.2			14.6			0.88		
0.002480	20	500.0	12.6			12.2					
0.001736	14	714.3	14.1			16.6					
0.001240	10	1000	17.4			21.1					

## Lead Sulfide (PbS) - [Ref. 10]

150		0.008266				$3.86 \cdot 10^{-3}$					
125		0.009919				$5.59 \cdot 10^{-3}$					
100		0.01240				$1.54 \cdot 10^{-2}$					
80		0.01550				$2.88 \cdot 10^{-2}$					
60		0.02066				$6.17 \cdot 10^{-2}$					
25		0.04959	0.845			0.171					
18.0		0.06888	0.846			0.294					
14.0		0.08856	0.651			0.665					
10.0		0.1240	0.879			1.050					
4.95	39920	0.2505	1.52			2.10			0.43		
4.0	32260	0.3100	1.73			2.83			0.55		
3.00	24200	0.4133	3.88			3.00			0.53		
2.90	23390	0.4275	4.12			2.70			0.51		
2.75	22180	0.4509	4.25			2.33			0.48		
2.55	20570	0.4862	4.35			2.00			0.47		
2.00	16130	0.6199	4.29			1.48			0.43		
1.60	12910	0.7749	4.62			0.94			0.43		
1.24	10000	1.00	4.43			0.597			0.41		
1.03	8333	1.2	4.30			0.458			0.39		
0.650	5263	1.9	4.24			0.318			0.39		
0.496	4000	2.5	4.30			0.235			0.39		
0.400	3226	3.1	4.30			$2.27 \cdot 10^{-2}$			0.39		
0.3100	2500	4.0	4.16			$6.38 \cdot 10^{-4}$			0.38		
0.2480	2000	5	4.115			$9.25 \cdot 10^{-4}$			0.37		
0.1240	1000	10	4.01			$6.32 \cdot 10^{-3}$			0.36		
0.1033	833.3	12	3.90			$1.14 \cdot 10^{-2}$			0.35		
0.08059	650	15.38	3.90						0.35		
0.06819	550	18.18	3.81						0.34		
0.04959	400	25.00	3.53						0.31		
0.03720	300	33.33	2.99						0.25		
0.02480	200.0	50	0.514			1.59					
0.01378	111.1	90	1.175			8.48			0.94		
0.01240	100.0	100	1.79			10.51			0.94		
0.008856	71.43	140	17.41			17.94			0.89		
0.006199	50.0	200	16.27			2.20			0.79		
0.003100	25.00	400	12.96			0.495			0.73		
0.001653	13.33	750	12.44			0.228			0.72		
0.001240	10.00	1000	12.35			0.167			0.72		
0.0006199	5.000	2000	12.27			0.0815			0.72		

## Lead Telluride (PbTe) - [Ref. 11]

150		0.008266				$2.37 \cdot 10^{-3}$					
125		0.009919				$9.71 \cdot 10^{-3}$					
100		0.01240				$4.39 \cdot 10^{-2}$					
75		0.01653				$6.43 \cdot 10^{-2}$					



$E/eV$	$\bar{\nu}/cm^{-1}$	$\lambda/\mu m$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.2480	2000	5.0	1.3266			$1.8 \cdot 10^{-6}$			0.02		
0.2000	1613	6.2	1.2912								
0.1698	1370	7.3	1.2499								
0.1494	1205	8.3	1.2036								
0.1240	1000	10.0	1.1005			$2.6 \cdot 10^{-3}$					
0.1127	909.1	11.0	1.0208			$8.0 \cdot 10^{-3}$					
0.1033	833.3	12.0				$1.9 \cdot 10^{-2}$					
0.09537	769.2	13.0				$3.7 \cdot 10^{-2}$					
0.08679	700	14.29	0.508			$7.74 \cdot 10^{-2}$					
0.07439	600	16.67	0.124			0.804					
0.06199	500	20.00	0.306			1.47			0.68		
0.05579	450	22.22	0.191			1.88			0.85		
0.04959	400	25.00	0.208			2.71			0.91		
0.03720	300	33.33	8.76			3.91			0.68		
0.03100	250	40.00	4.64			0.287			0.42		
0.02480	200	50.00	3.69			0.102			0.33		
0.01240	100.0	100	3.067			0.106			0.26		
0.06199	50.0	200	3.067			$4.0 \cdot 10^{-2}$			0.26		
0.04959	40.00	250	3.067			$2.2 \cdot 10^{-2}$			0.26		
0.02480	20.00	500	3.067			$6.3 \cdot 10^{-3}$					
0.01378	11.11	900				$3.1 \cdot 10^{-3}$					
$4.798 \cdot 10^{-4}$	3.870	2584	3.023			$1.19 \cdot 10^{-3}$			0.25		
$1.464 \cdot 10^{-4}$	1.181	8469	3.023			$6.20 \cdot 10^{-4}$			0.25		
$4.053 \cdot 10^{-5}$	0.3269	30590	3.023			$2.63 \cdot 10^{-4}$			0.25		
$1.861 \cdot 10^{-7}$	$1.501 \cdot 10^{-3}$	$6.662 \cdot 10^6$	3.018			$1.6 \cdot 10^{-5}$					
$3.718 \cdot 10^{-8}$	$2.999 \cdot 10^{-4}$	$3.335 \cdot 10^7$	3.018			$1.6 \cdot 10^{-5}$					

## Potassium Chloride (KCl) - [Ref. 13]

2860.3		$4.3347 \cdot 10^{-4}$				$3.93 \cdot 10^{-6}$					
2855.3		$4.3423 \cdot 10^{-4}$				$3.39 \cdot 10^{-6}$					
2849.3		$4.3514 \cdot 10^{-4}$				$4.61 \cdot 10^{-6}$					
2835.8		$4.3721 \cdot 10^{-4}$				$5.85 \cdot 10^{-6}$					
2832.3		$4.3775 \cdot 10^{-4}$				$5.85 \cdot 10^{-6}$					
2829.8		$4.3814 \cdot 10^{-4}$				$1.57 \cdot 10^{-6}$					
2828.3		$4.3837 \cdot 10^{-4}$				$4.19 \cdot 10^{-7}$					
219		$5.661 \cdot 10^{-3}$				$1.82 \cdot 10^{-3}$					
215		$5.767 \cdot 10^{-3}$				$1.84 \cdot 10^{-3}$					
212.5		$5.834 \cdot 10^{-3}$				$2.19 \cdot 10^{-3}$					
211		$5.876 \cdot 10^{-3}$				$1.82 \cdot 10^{-3}$					
185.1		$6.7 \cdot 10^{-3}$	0.99874						$1.01 \cdot 10^{-3}$		
109.7		$1.13 \cdot 10^{-2}$	0.99578						$4.22 \cdot 10^{-3}$		
43		0.02883	0.96			$3.0 \cdot 10^{-2}$					
40		0.03179	0.925			$1.8 \cdot 10^{-2}$					
29.9		0.04147	0.756			0.145					
20.1		0.06168	0.910			0.495					
15.1		0.08211	0.965			0.344					
10.0		0.1240	1.16			0.38			0.035		
9.0		0.1378	1.99			0.50			0.13		
8.0		0.1550	1.15			0.46			0.048		
7.0		0.1771	2.0			$8.46 \cdot 10^{-7}$			0.11		
6.199	50000	0.20	1.71739						0.070		
4.959	40000	0.25	1.58972								
3.999	32260	0.31	1.54005								
2.952	23810	0.42	1.50701								
2.695	21740	0.46	1.50115						0.040		
2.616	21100	0.474				$7.6 \cdot 10^{-11}$					
2.384	19230	0.52	1.49501								
2.066	16670	0.60	1.48969						0.039		
1.550	12500	0.80	1.48291						0.038		
1.033	8333	1.2	1.47813						0.037		
0.5166	4167	2.4	1.47464						0.037		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.2480	2000	5.0	1.47048						0.036		
0.2000	1.613	6.2	1.46796						0.036		
0.1512	1220	8.2	1.46260						0.035		
0.09999	806.5	12.4	1.44611						0.033		
0.07560	609.8	16.4	1.42295						0.030		
0.04959	400.0	25.0	1.34059			$6.57 \cdot 10^{-4}$			0.021		
0.03999	322.6	31.0	1.2431						0.012		
0.02976	240	41.67	0.85			0.16					
0.02728	220	45.45	0.53			0.35					
0.02232	180	55.56	0.31			1.05					
0.01860	150	66.67	0.44			4.0					
0.01612	130	76.92	4.1			0.32			0.37		
0.01240	100	100.0	2.7			0.11			0.21		
0.008679	70	142.9	2.4			$9.2 \cdot 10^{-2}$			0.17		
0.006199	50	200.0	2.2						0.14		
0.001240	10.00	1000				$9.0 \cdot 10^{-3}$					
0.0006199	5.000	2000				$3.7 \cdot 10^{-3}$					
0.0004133	3.333	3000				$2.0 \cdot 10^{-3}$					

## Silicon Dioxide (Glass) - [Ref. 14]

2000		$6.199 \cdot 10^{-4}$	0.99993			$1.503 \cdot 10^{-5}$					
1860		$6.665 \cdot 10^{-4}$	0.99991			$1.936 \cdot 10^{-5}$					
1609		$7.705 \cdot 10^{-4}$	0.99989			$9.941 \cdot 10^{-6}$					
1496		$8.287 \cdot 10^{-4}$	0.99987			$1.308 \cdot 10^{-5}$					
1204		$1.030 \cdot 10^{-3}$	0.99980			$2.916 \cdot 10^{-5}$					
1093		$1.134 \cdot 10^{-3}$	0.99975			$4.155 \cdot 10^{-5}$					
1016		$1.220 \cdot 10^{-3}$	0.99971			$5.423 \cdot 10^{-5}$					
798		$1.554 \cdot 10^{-3}$	0.99954			$1.289 \cdot 10^{-4}$					
597		$2.077 \cdot 10^{-3}$	0.99917			$3.560 \cdot 10^{-4}$					
396		$3.131 \cdot 10^{-3}$	0.99812			$4.04 \cdot 10^{-4}$					
303		$4.092 \cdot 10^{-3}$	0.99678			$9.91 \cdot 10^{-4}$					
201		$6.168 \cdot 10^{-3}$	0.99269			$3.63 \cdot 10^{-3}$					
151.2		$8.2 \cdot 10^{-3}$	0.9871			$7.3 \cdot 10^{-3}$					
99.99		$1.24 \cdot 10^{-2}$	0.9813			$7.0 \cdot 10^{-3}$					
49.59		$2.50 \cdot 10^{-2}$	0.9164			$6.5 \cdot 10^{-2}$					
40.00		$3.10 \cdot 10^{-2}$	0.907			$9.2 \cdot 10^{-2}$					
31.00		$4.00 \cdot 10^{-2}$	0.851			0.156					
25.00		0.04959	0.733			0.325					
20.00		0.06199	0.859			0.585					
15.00		0.08266	1.168			0.711			0.10		
13.00		0.09537	1.368			0.747			0.11		
11.00		0.1127	1.739			0.569			0.11		
10.00		0.1240	2.330			0.323			0.17		
9.00		0.1378	1.904			$1.89 \cdot 10^{-2}$			0.097		
7.00		0.1771	1.600						0.053		
6.00	48390	0.2066	1.543						0.046		
4.9939	40278.4	0.248272	1.50841						0.041		
4.1034	33096.1	0.302150	1.48719						0.038		
3.0640	24712.3	0.404656	1.46961						0.036		
2.5504	20570.5	0.486133	1.46313						0.035		
2.4379	19662.5	0.508582	1.46187						0.035		
2.2705	18312.5	0.546074	1.46008						0.035		
2.1489	17332.3	0.576959	1.45885						0.035		
2.1411	17269.2	0.579065	1.45877						0.035		
2.1102	17019.5	0.587561	1.45847						0.035		
2.1041	16970.4	0.589262	1.45841						0.035		
1.9257	15531.6	0.643847	1.45671						0.035		
1.8892	15237.6	0.656272	1.45637						0.035		
1.8566	14974.2	0.667815	1.45608						0.034		
1.7549	14153.9	0.706519	1.45515						0.034		
1.4550	11735.6	0.852111	1.45248						0.034		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
1.0985	8860.06	1.12866	1.44888						0.034		
0.60243	4858.9	2.0581	1.43722						0.032		
0.35354	2851.4	3.5070	1.40568						0.028		
0.2976	2400	4.176	1.383			$1.07 \cdot 10^{-4}$			0.026		
0.2728	2200	4.545	1.365			$2.56 \cdot 10^{-4}$			0.024		
0.2480	2000	5.000	1.342			$3.98 \cdot 10^{-3}$			0.021		
0.2232	1800	5.556	1.306			$5.63 \cdot 10^{-3}$					
0.1984	1600	6.250	1.239			$6.52 \cdot 10^{-3}$					
0.1736	1400	7.143	1.053			$1.06 \cdot 10^{-2}$					
0.1674	1350	7.407	0.9488			$1.48 \cdot 10^{-2}$					
0.1612	1300	7.692	0.7719			$3.72 \cdot 10^{-2}$					
0.1500	1210	8.265	0.4530			0.704			0.30		
0.1401	1130	8.850	0.3563			1.53			0.66		
0.1302	1050	9.524	2.760			1.65			0.35		
0.1209	975	10.26	2.448			0.231			0.18		
0.1091	880	11.36	1.784			$7.75 \cdot 10^{-2}$			0.079		
0.09919	800	12.50	1.753			0.343			0.089		
0.08989	725	13.79	1.698			0.175			0.071		
0.06943	560	17.86	1.337			0.298			0.036		
0.06199	500	20.00	0.6616						0.882		
0.04959	400	25.0	2.739			0.397			0.23		
0.03720	300	33.33	2.210			$6.7 \cdot 10^{-2}$			0.14		
0.01240	100	100.0	1.967			$1.59 \cdot 10^{-2}$			0.11		
0.007439	60	166.7	1.959			$8.62 \cdot 10^{-3}$			0.11		
0.002480	20	500.0	1.955			$7.96 \cdot 10^{-3}$			0.10		

**Silicon Monoxide (Noncrystalline) - [Ref. 15]**

25		0.04959	0.8690			0.2717					
20		0.06199	0.8853			0.4919					
17.5		0.07085	0.9825			0.5961					
15		0.08266	1.132			0.6651			0.092		
12.5		0.09919	1.283			0.6523			0.090		
10		0.1240	1.378			0.6843			0.10		
7.5		0.1653	1.593			0.7473			0.12		
5	40330	0.2480	2.001			0.6052			0.15		
4	32260	0.3100	2.141			0.4006			0.15		
3	24200	0.4133	2.116			0.1211			0.13		
2.8	22580	0.4428	2.085			0.08374			0.12		
2.6	20970	0.4769	2.053			0.05544			0.12		
2.4	19360	0.5166	2.021			0.03533			0.11		
2.2	17740	0.5636	1.994			0.02153			0.11		
2	16130	0.6199	1.969			0.01175			0.11		
1.8	14520	0.6888	1.948			0.00523			0.10		
1.6	12900	0.7749	1.929			0.00151			0.10		
1.240	10000	1.000	1.87						0.092		
0.6199	5000	2.000	1.84						0.087		
0.3100	2500	4.000	1.80						0.082		
0.2480	2000	5.000	1.75						0.074		
0.2066	1667	6.000	1.70						0.067		
0.1771	1492	7.000	1.60						0.053		
0.1653	1333	7.500	1.42								
0.1459	1176	8.500	0.90			0.18					
0.1305	1053	9.500	1.20			1.20			0.024		
0.1240	1000	10.00	2.00			1.38			0.27		
0.1181	952.4	10.50	2.85			0.90			0.27		
0.1153	930.2	10.75	2.86			0.58			0.25		
0.1127	909.1	11.00	2.82			0.40			0.24		
0.1078	869.6	11.50	2.50			0.20			0.19		
0.1033	833.3	12.00	2.13			0.14			0.13		
0.09537	769.2	13.00	2.04			0.20			0.12		
0.08856	714.3	14.00	2.01			0.30			0.12		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
<b>Noncrystalline Silicon Nitride (<math>\text{Si}_3\text{N}_4</math>) - [Ref. 16]</b>											
24		0.05166	0.655			0.420			0.28		
23		0.05391	0.625			0.481			0.22		
22		0.05636	0.611			0.560			0.16		
21		0.05904	0.617			0.647			0.19		
20		0.06199	0.635			0.743			0.21		
19		0.06526	0.676			0.841			0.23		
18		0.06888	0.735			0.936			0.26		
17		0.07293	0.810			1.03			0.25		
16		0.07749	0.902			1.11			0.26		
15		0.08266	1.001			1.18			0.26		
14		0.08856	1.111			1.26			0.26		
13		0.09537	1.247			1.35			0.27		
12	96790	0.1033	1.417			1.43			0.28		
11	88720	0.1127	1.657			1.52			0.29		
10.5	84690	0.1181	1.827			1.53			0.29		
10	80650	0.1240	2.000			1.49			0.29		
9.5	76620	0.1305	2.162			1.44			0.28		
9	72590	0.1378	2.326			1.32			0.27		
8	64520	0.1550	2.651			0.962			0.26		
7	56460	0.1771	2.752			0.493			0.23		
6	48390	0.2066	2.541			0.102			0.19		
5	40330	0.2480	2.278			$4.9 \cdot 10^{-3}$			0.15		
4.75	38310	0.2610	2.234			$1.2 \cdot 10^{-3}$			0.15		
4.5	36290	0.2755	2.198			$2.2 \cdot 10^{-4}$			0.14		
4	32260	0.3100	2.141						0.13		
3.5	28230	0.3542	2.099						0.13		
3	24200	0.4133	2.066						0.12		
2.5	20160	0.4959	2.041						0.12		
2	16130	0.6199	2.022						0.11		
1.5	12100	0.8266	2.008						0.11		
1	8065	1.240	1.998						0.11		
<b>Sodium Chloride (NaCl) - [Ref. 17]</b>											
209.5		$5.918 \cdot 10^{-3}$				$2.54 \cdot 10^{-3}$					
206		$6.019 \cdot 10^{-3}$				$2.62 \cdot 10^{-3}$					
203		$6.107 \cdot 10^{-3}$				$2.08 \cdot 10^{-3}$					
200		$6.199 \cdot 10^{-3}$				$1.92 \cdot 10^{-3}$					
26.0		0.04769	0.83			0.15			0.015		
25.0		0.04959	0.83			0.18			0.018		
22.0		0.05636	0.83			0.31			0.057		
20.0		0.06199	0.88			0.34			0.036		
18.0		0.06888	0.89			0.33			0.033		
16.1		0.07700	0.74			0.45			0.084		
14.0		0.08856	0.98			0.89			0.17		
12.0		0.1033	1.22			0.79			0.12		
10.0		0.1240	1.55			0.71			0.12		
8.00		0.1550	1.38			1.10			0.20		
6.00	48390	0.2066	1.75						0.074		
5.00	40330	0.2480	1.65						0.060		
2.952	23810	0.42	1.56324						0.048		
2.480	20000	0.50	1.55157						0.047		
2.214	17860	0.56	1.54613						0.046		
2.000	16130	0.62	1.54228						0.045		
1.771	14290	0.70	1.53865						0.045		
1.675	13510	0.74	1.53728						0.045		
1.550	12500	0.80	1.53560						0.045		
1.240	10000	1.00	1.53200						0.044		
1.033	8333	1.2	1.53000						0.044		
0.6888	5556	1.8	1.52712						0.043		
0.4959	4000	2.5	1.52531						0.043		



$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.4000	3226	3.1	1.52395						0.043		
0.3263	2632	3.8	1.52226			(1.8±0.2) ·10 <sup>-9</sup>			0.043		
0.2952	2381	4.2	1.52121						0.043		
0.2755	2222	4.5	1.52036						0.043		
0.2480	2000	5.0	1.51883						0.042		
0.1240	1000	10.0	1.49473						0.039		
0.1033	833.3	12.0	1.48000						0.037		
0.08856	714.3	14.0	1.46188						0.035		
0.07749	625.0	16.0	1.4399						0.033		
0.06888	555.5	18.0	1.41364						0.029		
0.06199	500.0	20.0	1.3822						0.026		
0.04959	400	25.0				1.27			0.014		
0.04215	340	29.41	1.12						0.0032		
0.03720	300	33.33	0.85						0.18		
0.03410	275	36.36	0.59			0.85			0.18		
0.03286	265	37.74	0.42			0.22			0.084		
0.03224	260	38.46	0.45			0.50			0.26		
0.02480	200	50.00	0.14			0.45			0.22		
0.02108	170	58.82	1.35			1.99			0.89		
0.01984	160	62.50	6.92			6.03			0.87		
0.01922	155	64.52	5.50			2.14			0.59		
0.01860	150	66.67	4.52			0.87			0.49		
0.01736	140	71.43	3.72			0.380			0.41		
0.01612	130	76.92	3.31			0.219			0.33		
0.01488	120	83.33	3.02			0.135			0.29		
0.01240	100	100.0	2.74			0.110			0.25		
0.009919	80	125.0	2.57			0.087			0.22		
0.07439	60	166.7	2.48			0.077			0.19		
0.04959	40	250.00	2.44			0.055			0.18		
0.002480	20	500.0	2.43			0.041			0.18		
0.001240	10	1000	2.43			0.024			0.17		
0.001033	8.333	1200				0.006			0.17		
0.0006888	5.556	1800				8.8·10 <sup>-3</sup>					
0.0006199	5.000	2000	2.43			5.4·10 <sup>-3</sup>					
0.0004959	4.000	2500							0.17		
0.0004797	3.869	2584	2.43			4.4·10 <sup>-3</sup>					
0.0003875	3.125	3200				2.1·10 <sup>-3</sup>			0.17		
0.0001464	1.181	8469	2.43			3.3·10 <sup>-3</sup>					
0.00004053	0.3269	30590	2.43			5.8·10 <sup>-4</sup>			0.17		
						2.5·10 <sup>-4</sup>					

## Cubic Zinc Sulfide (ZnS) - [Ref. 18]

2000		6.199·10 <sup>-4</sup>	0.999904			1.76·10 <sup>-5</sup>					
1204		1.030·10 <sup>-3</sup>	0.999777			1.00·10 <sup>-4</sup>					
1016		1.220·10 <sup>-3</sup>	0.999838			3.61·10 <sup>-5</sup>					
901		1.376·10 <sup>-3</sup>	0.999647			5.42·10 <sup>-5</sup>					
798		1.554·10 <sup>-3</sup>	0.999520			8.28·10 <sup>-5</sup>					
707		1.754·10 <sup>-3</sup>	0.999372			1.25·10 <sup>-4</sup>					
597		2.077·10 <sup>-3</sup>	0.999160			2.19·10 <sup>-4</sup>					
377		9.50·10 <sup>-3</sup>	0.99789			9.50·10 <sup>-4</sup>					
201		6.168·10 <sup>-3</sup>	0.99553			4.82·10 <sup>-3</sup>					
100		1.240·10 <sup>-2</sup>	0.99061			1.17·10 <sup>-2</sup>					
61.99		2.000·10 <sup>-2</sup>	0.964			3.32·10 <sup>-2</sup>			6.2·10 <sup>-4</sup>		
41.33		3.000·10 <sup>-2</sup>	0.941			5.10·10 <sup>-2</sup>					
31.00		4.000·10 <sup>-2</sup>	0.847			9.95·10 <sup>-2</sup>					
24.80		5.000·10 <sup>-2</sup>	0.796			0.171			2.2·10 <sup>-2</sup>		
17.71		7.000·10 <sup>-2</sup>	0.747			0.431			7.7·10 <sup>-2</sup>		
13.78		9.000·10 <sup>-2</sup>	0.758			0.824			0.20		
12.40		0.1000	0.862			0.876			0.19		
9.919		0.125	1.02			1.36			0.31		
8.266		0.150	1.41			1.47			0.29		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
6.199		0.200	2.32			1.62			0.32		
6.00	48390	0.2066	2.24			1.65			0.59		
4.00	32260	0.3100	2.70			0.44			0.22		
3.00	24200	0.4133	2.54			$4 \cdot 10^{-2}$			0.19		
2.50	20160	0.4959	2.42			$3 \cdot 10^{-2}$			0.17		
2.30	18550	0.5391	2.3950						0.17		
2.00	16130	0.6199	2.3576						0.16		
1.75	14110	0.7085	2.3319						0.16		
1.55	12500	0.7999	2.3146			$3.50 \cdot 10^{-6}$			0.16		
1.40	11290	0.8856	2.3033						0.16		
1.240	10000	1.000	2.2907			$3.02 \cdot 10^{-6}$			0.15		
1.00	8065	1.240	2.2795						0.15		
0.80	6452	1.550	2.2706						0.15		
0.6199	5000	2.000	2.2631			$6.2 \cdot 10^{-6}$			0.15		
0.45	3629	2.755	2.2587						0.15		
0.30	2420	4.133	2.2529						0.15		
0.20	1613	6.199	2.2443						0.15		
0.1550	1250	8.0	2.2213			$4.5 \cdot 10^{-6}$			0.14		
0.1240	1000	10.00	2.1986			$8.8 \cdot 10^{-6}$			0.14		
0.100	806.5	12.4	2.1969						0.14		
0.09	725.9	13.78	2.1793						0.14		
0.07999	645.2	15.5	2.1518			$3.82 \cdot 10^{-3}$			0.14		
0.07	564.6	17.71	2.1040						0.13		
0.06075	490	20.41	2.03			$8.0 \cdot 10^{-3}$			0.12		
0.05	403.3	24.80	1.6866						0.065		
0.03546	286	34.97	3.29			$8.3 \cdot 10^{-2}$			0.28		
0.03472	280	35.71	9.54			$5.2 \cdot 10^{-2}$			0.66		
0.02480	200	50.00	3.48			$3.1 \cdot 10^{-2}$			0.31		
0.01240	100	100.0	3.06			$5.8 \cdot 10^{-3}$			0.26		
0.004955	40	250.0	2.903			$6.2 \cdot 10^{-3}$			0.24		
0.004339	35	285.7	2.899			$7.0 \cdot 10^{-3}$			0.24		
0.003720	30	333.3	2.896						0.24		
0.003100	25	400.0	2.894						0.24		
0.002480	20	500.0	2.892						0.24		
0.001860	15	666.7	2.890						0.24		

**Polytetrafluoroethylene (Teflon) - [Ref. 19]**

4.960	40000	0.250							0.970		
4.769	38462	0.260							0.972		
4.593	37037	0.270							0.975		
4.426	35714	0.280							0.978		
4.276	34483	0.290							0.980		
4.133	33333	0.300							0.983		
4.000	32258	0.310							0.986		
3.875	31250	0.320							0.988		
3.758	30303	0.330							0.990		
3.647	29412	0.340							0.991		
3.543	28571	0.350							0.992		
3.444	27778	0.360							0.992		
3.351	27027	0.370							0.993		
2.255	18182	0.550							0.993		
2.067	16667	0.600							0.992		
1.378	11111	0.900							0.992		
1.305	10526	0.950							0.991		
1.078	8696	1.150							0.991		
1.033	8333	1.200							0.990		
0.9920	8000	1.250							0.990		
0.9538	7692	1.300							0.989		
0.9185	7407	1.350							0.988		
0.8857	7143	1.400							0.988		
0.8552	6897	1.450							0.989		

$E/eV$	$\bar{\nu}/\text{cm}^{-1}$	$\lambda/\mu\text{m}$	$n$	$n_a$	$n_c$	$k$	$k_a$	$k_c$	$R$	$R_a$	$R_c$
0.8267	6667	1.500							0.989		
0.8000	6452	1.550							0.988		
0.7750	6250	1.600							0.988		
0.7515	6061	1.650							0.987		
0.7294	5882	1.700							0.986		
0.7086	5714	1.750							0.986		
0.6889	5556	1.800							0.985		
0.6703	5405	1.850							0.980		
0.6526	5263	1.900							0.978		
0.6359	51282	1.950							0.978		
0.6200	5000	2.000							0.970		
0.6049	4878	2.050							0.959		
0.5905	4762	2.100							0.951		
0.5767	4651	2.150							0.946		
0.5636	4545	2.200							0.966		
0.5511	44444	2.250							0.965		
0.5487	44247	2.260							0.964		
0.5439	4386	2.280							0.963		
0.5415	4367	2.290							0.961		
0.5368	4329	2.310							0.959		
0.5345	4310	2.320							0.957		
0.5322	4292	2.330							0.956		
0.5299	4274	2.340							0.954		
0.5277	4255	2.350							0.951		
0.5232	4219	2.370							0.950		
0.5188	4184	2.390							0.949		
0.5167	4167	2.400							0.947		
0.5061	4082	2.450							0.946		
0.4960	4000	2.500							0.945		

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# FERMI ENERGY AND RELATED PROPERTIES OF METALS

## Lev. I. Berger

In the classical Drude theory of metals, the Maxwell-Boltzmann velocity distribution of electrons is used. It states that the number of electrons per unit volume with velocities in the range of  $d\vec{v}$  about any magnitude  $\vec{v}$  at temperature  $T$  is

$$f_B(\vec{v})d\vec{v} = n \left( \frac{m}{2\pi k_B T} \right)^3 \exp\left( -\frac{mv^2}{2k_B T} \right) d\vec{v}$$

where  $n$  is the total number of conduction electrons in a unit volume of a metal,  $m$  is the free electron mass, and  $k_B$  is the Boltzmann constant. In an attempt to explain a substantial discrepancy between the experimental data on the specific heat of metals and the values calculated on the basis of the Drude model, Sommerfeld suggested a model of the metal in which the Pauli exclusion principle is applied to free electrons. In this case, the Maxwell-Boltzmann distribution is replaced by the Fermi-Dirac distribution:

$$f(\vec{v})d\vec{v} = 2 \left( \frac{m}{h} \right)^3 d\vec{v} \left\{ \exp\left[ \left( \frac{mv^2}{2} - k_B T_0 \right) / k_B T \right] + 1 \right\}^{-1}$$

Here  $h$  is the Planck constant and  $T_0$  is a characteristic temperature which is determined by the normalization condition

$$n = \int d\vec{v} \cdot f(\vec{v})$$

The magnitude of  $T_0$  is quite high; usually,  $T_0 > 10^4$  K. So, at common temperatures ( $T < 10^3$  K), the free electron density of a metal is much smaller than in the case of the Maxwell-Boltzmann distribution. This allows us to explain why the experimental data on specific heat for metals are close to those for insulators.

The maximum kinetic energy the electrons of a metal may possess at  $T = 0$  K is called the Fermi energy, e.g.,

$$E_F = \frac{\hbar^2 k_F^2}{2m} = \left( \frac{e^2}{2k_B} \right) (k_F r_B)^2$$

where  $k_F$  is the Fermi momentum or the Fermi wave vector

$$k_F = (3\pi^2 n)^{1/3}$$

$e$  is the electron charge, and  $r_B$  is the Bohr radius

$$r_B = \hbar^2 / m e^2 = 0.529 \cdot 10^{-10} \text{ m}$$

Another, more common expression for the Fermi energy is

$$E_F = \frac{1}{2} m v_F^2$$

where  $v_F = \hbar k_F / m$  is the Fermi velocity which can be expressed using the concept of the electron radius,  $r_s$ . It is equal to radius of a sphere occupied by one free electron. If the total volume of a metal sample is  $V$  and the number of conduction electrons in this volume is  $N$ , then the volume per electron is equal to

$$\frac{V}{N} = \frac{1}{n} = \frac{4}{3} \pi r_s^3$$

and

$$r_s = \left( \frac{3}{4\pi n} \right)^{1/3}$$

The following table contains information pertinent to the Sommerfeld model for some metals. The magnitudes of  $T_0$  are calculated using the expression

$$T_0 = \frac{E_F}{k_B} = \frac{58.2 \cdot 10^4}{(r_s / r_B)^2} \text{ K}$$

**Ground State Properties of the Electron Gas in Some Metals**

Metal	Valency	$n/10^{28} \text{ m}^{-3}$	$r_s/\text{pm}$	$r_s/r_B$	$E_F/\text{eV}$	$T_0/10^4 \text{ K}$	$k_F/10^{10} \text{ m}^{-1}$	$v_F/10^6 \text{ m s}^{-1}$
Li <sup>a</sup>	1	4.70	172	3.25	4.74	5.51	1.12	1.29
Na <sup>b</sup>	1	2.65	208	3.93	3.24	3.77	0.92	1.07
K <sup>b</sup>	1	1.40	257	4.86	2.12	2.46	0.75	0.86
Rb <sup>b</sup>	1	1.15	275	5.20	1.85	2.15	0.70	0.81
Cs <sup>b</sup>	1	0.91	298	5.62	1.59	1.84	0.65	0.75
Cu	1	8.47	141	2.67	7.00	8.16	1.36	1.57
Ag	1	5.86	160	3.02	5.49	6.38	1.20	1.39
Au	1	5.90	159	3.01	5.53	6.42	1.21	1.40
Be	2	24.7	99	1.87	14.3	16.6	1.94	2.25
Mg	2	8.61	141	2.66	7.08	8.23	1.36	1.58
Ca	2	4.61	173	3.27	4.69	5.44	1.11	1.28
Sr	2	3.55	189	3.57	3.93	4.57	1.02	1.18
Ba	2	3.15	196	3.71	3.64	4.23	0.98	1.13
Nb	1	5.56	163	3.07	5.32	6.18	1.18	1.37
Fe	2	17.0	112	2.12	11.1	13.0	1.71	1.98
Mn <sup>c</sup>	2	16.5	113	2.14	10.9	12.7	1.70	1.96
Zn	2	13.2	122	2.30	9.47	11.0	1.58	1.83
Cd	2	9.27	137	2.59	7.47	8.68	1.40	1.62

Metal	Valency	$n/10^{28} \text{ m}^{-3}$	$r_s/\text{pm}$	$r_s/r_B$	$E_F/\text{eV}$	$T_0/10^4 \text{ K}$	$k_F/10^{10} \text{ m}^{-1}$	$v_F/10^6 \text{ m s}^{-1}$
Hg <sup>a</sup>	2	8.65	140	2.65	7.13	8.29	1.37	1.58
Al	3	18.1	110	2.07	11.7	13.6	1.75	2.03
Ga	3	15.4	116	2.19	10.4	12.1	1.66	1.92
In	3	11.5	127	2.41	8.63	10.0	1.51	1.74
Tl	3	10.5	131	2.48	8.15	9.46	1.46	1.69
Sn	4	14.8	117	2.22	10.2	11.8	1.64	1.90
Pb	4	13.2	122	2.30	9.47	11.0	1.58	1.83
Bi	5	14.1	119	2.25	9.90	11.5	1.61	1.87
Sb	5	16.5	113	2.14	10.9	12.7	1.70	1.96

<sup>a</sup> At 78 K.

<sup>b</sup> At 5 K.

<sup>c</sup>  $\alpha$ -phase.

The data in the table are for atmospheric pressure and room temperature unless otherwise noted.

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# ELECTRON INELASTIC MEAN FREE PATHS

Cedric J. Powell

The inelastic mean free path (IMFP) of electrons is defined as the average of distances, measured along the trajectories, that electrons with a given energy travel between inelastic collisions in the substance. It is an important parameter in analyzing results from surface-characterization techniques such as Auger electron spectroscopy, x-ray photoelectron spectroscopy, low-energy electron diffraction, and others. IMFPs can be measured by the elastic-peak electron spectroscopy technique and other methods, and they can be calculated from optical data. A detailed analysis of the experimental and theoretical considerations in obtaining reliable IMFP values can be found in reference 4.

The table below gives recommended IMFP values for several elements, simple inorganic compounds, and organic materials. Values are given in Ångström units ( $1 \text{ \AA} = 10^{-10} \text{ m}$ ) for a range of

electron energies. Substances are given in alphabetical order by name, with elements and inorganic compounds listed before the organic materials.

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## Electron Inelastic Mean Free Path in Å

### Electron Energy in eV

Substance	Formula	50	100	150	200	300	400	600	800	1000	1200	1400	1600	1800	2000	Ref.
Aluminum	Al	3.5	4.6	5.7	6.8	8.9	10.9	14.5	18.0	21.3	24.6	27.8	31.0	34.1	37.2	5
Bismuth	Bi	4.9	5.5	6.3	7.2	8.8	10.6	14.0	17.2	20.2	23.2	26.1	28.9	31.6	34.4	1
Carbon	C	5.9	6.4	7.5	8.8	11.2	13.7	18.4	22.8	27.0	31.1	35.2	39.1	43.0	46.8	1
Chromium	Cr	4.4	4.3	5.0	5.7	7.2	8.6	11.4	14.0	16.6	19.1	21.6	24.0	26.3	28.6	1
Copper	Cu	5.2	5.0	5.4	6.0	7.3	8.6	11.3	13.9	16.5	18.9	21.3	23.7	26.0	28.3	4
Gallium phosphide	GaP	5.6	6.5	7.8	9.0	11.4	13.7	18.1	22.3	26.3	30.2	34.1	37.8	41.5	45.2	2
Gold	Au	6.3	4.7	4.7	5.1	6.1	7.2	9.5	11.7	13.8	15.8	17.8	19.7	21.6	23.4	4
Hafnium	Hf	5.8	6.2	7.1	8.0	10.2	12.0	15.6	19.0	22.2	25.3	28.4	31.4	34.4	37.3	1
Indium phosphide	InP	4.8	4.9	5.6	6.4	8.1	9.7	12.8	15.7	18.7	21.4	24.2	26.8	29.4	32.0	2
Iridium	Ir	5.3	4.3	4.7	5.2	6.4	7.5	9.7	11.8	13.8	15.7	17.6	19.4	21.2	22.9	1
Iron	Fe	4.3	4.4	5.1	5.8	7.2	8.5	11.2	13.7	16.2	18.6	20.9	23.2	25.5	27.7	1
Lead(II) sulfide	PbS	4.8	5.6	6.7	7.8	10.0	12.1	16.1	19.8	23.6	27.1	30.6	33.9	37.2	40.5	2
Lead(II) telluride	PbTe	4.3	5.5	6.6	7.7	9.8	11.9	15.8	19.6	23.4	26.9	30.3	33.7	37.0	40.2	2
Magnesium	Mg	4.0	5.4	6.8	8.2	10.7	13.0	17.5	21.7	25.9	29.9	33.9	37.7	41.6	45.3	1
Molybdenum	Mo	5.1	4.5	5.0	5.6	7.1	8.5	11.3	14.0	16.5	18.9	21.2	23.5	25.8	28.0	1
Nickel	Ni	4.9	4.5	4.9	5.4	6.5	7.7	10.1	12.4	14.6	16.7	18.8	20.8	22.8	24.7	4
Niobium	Nb	6.0	6.0	6.7	7.7	9.7	11.7	15.6	19.2	22.6	25.9	29.1	32.3	35.3	38.4	1
Osmium	Os	5.5	4.3	4.5	5.0	6.0	7.1	9.1	11.1	12.9	14.7	16.4	18.1	19.8	21.5	1
Palladium	Pd	4.8	4.8	5.4	6.2	7.8	9.4	12.5	15.4	18.2	20.9	23.5	26.0	28.4	30.9	1
Platinum	Pt	5.0	4.2	4.5	4.9	6.0	7.1	9.2	11.2	13.1	14.9	16.7	18.5	20.2	21.9	1
Potassium chloride	KCl	7.5	7.8	9.3	10.9	14.2	17.3	23.2	28.7	34.0	39.2	44.2	49.1	54.0	58.8	2
Rhenium	Re	5.2	3.8	3.9	4.3	5.1	6.0	7.7	9.4	10.9	12.5	14.0	15.4	16.9	18.3	1
Rhodium	Rh	4.8	4.1	4.5	5.0	6.1	7.3	9.7	12.0	14.1	16.2	18.2	20.1	22.0	23.9	1
Ruthenium	Ru	4.9	4.2	4.6	5.2	6.5	7.8	10.4	12.8	15.1	17.4	19.5	21.6	23.7	25.7	1
Silicon	Si	4.1	5.3	6.5	7.8	10.3	12.5	16.6	20.6	24.4	28.2	31.8	35.4	39.0	42.5	1
Silicon carbide	SiC	4.7	4.9	5.8	6.8	8.7	10.5	13.9	17.1	20.3	23.3	26.3	29.2	32.1	35.0	2
Silicon dioxide (vitreous)	SiO <sub>2</sub>	8.0	7.7	8.8	10.0	12.6	15.2	20.0	24.7	29.3	33.7	38.0	42.2	46.4	50.5	2
Silver	Ag	6.4	4.7	4.8	5.2	6.4	7.7	10.2	12.6	14.9	17.2	19.3	21.4	23.5	25.5	4
Tantalum	Ta	4.8	4.5	5.0	5.5	6.8	8.0	10.4	12.7	14.8	16.9	19.0	21.0	22.9	24.9	1
Titanium	Ti	4.5	5.1	6.2	7.3	9.5	11.6	15.6	19.5	23.2	26.8	30.2	33.6	36.9	40.2	1
Tungsten	W	5.0	4.1	4.5	5.0	6.1	7.3	9.4	11.4	13.4	15.2	17.1	18.9	20.6	22.4	1
Vanadium	V	4.2	4.9	5.9	6.8	8.8	10.7	14.3	17.7	21.0	24.3	27.4	30.5	33.5	36.4	1
Yttrium	Y	5.0	5.5	6.4	7.5	9.8	11.9	16.0	19.8	23.4	27.0	30.4	33.8	37.1	40.4	1
Zinc sulfide	ZnS	5.8	6.5	7.7	8.9	11.3	13.6	17.9	22.0	26.0	29.8	33.6	37.3	40.9	44.5	2
Zirconium	Zr	4.4	4.8	5.7	6.6	8.6	10.5	14.1	17.5	20.7	23.8	26.9	29.9	32.8	35.7	1
Adenine	C <sub>5</sub> H <sub>5</sub> N <sub>5</sub>	6.4	6.6	7.8	9.2	11.8	14.4	19.2	24.1	28.6	33.1	37.4	41.6	45.8	49.9	3
Bovine plasma albumin		7.3	7.2	8.5	9.9	12.7	15.4	20.7	25.8	30.8	35.6	40.2	44.8	49.4	53.8	3
β-Carotene	C <sub>40</sub> H <sub>56</sub>	6.4	7.0	8.5	10.0	13.0	15.9	21.4	26.9	32.0	37.0	41.9	46.6	51.3	56.0	3

Substance	Formula	50	100	150	200	300	400	600	800	1000	1200	1400	1600	1800	2000	Ref.
Deoxyribonucleic acid (DNA)		7.3	7.3	8.5	9.8	12.6	15.4	20.7	25.9	30.8	35.6	40.3	44.9	49.4	53.8	3
1,6-Diphenyl-1,3,5-hexatriene	$C_{18}H_{16}$	6.4	7.0	8.4	9.9	12.9	15.8	21.3	26.7	31.8	36.8	41.7	46.4	51.1	55.7	3
Guanine	$C_5H_5N_5O$	6.2	6.2	7.2	8.4	10.8	13.1	17.5	21.8	25.9	29.9	33.8	37.6	41.4	45.1	3
Hexacosane	$C_{26}H_{54}$	7.0	7.6	9.2	10.9	14.1	17.2	23.2	29.2	34.7	40.1	45.4	50.6	55.7	60.7	3
Kapton		7.0	6.8	7.9	9.2	11.7	14.2	19.0	23.7	28.2	32.5	36.7	40.9	44.9	49.0	3
Polyacetylene		5.3	5.7	6.8	7.9	10.2	12.5	16.9	21.1	25.1	29.0	32.8	36.5	40.2	43.8	3
Poly(butene-1-sulfone)		7.1	7.2	8.5	9.9	12.7	15.4	20.7	25.8	30.6	35.3	39.9	44.4	48.8	53.2	3
Polyethylene		6.9	7.2	8.6	10.1	13.0	15.9	21.4	26.8	31.8	36.8	41.6	46.3	51.0	55.6	3
Poly(methyl methacrylate)		7.8	7.9	9.3	10.8	13.9	16.9	22.7	28.3	33.7	38.8	43.9	48.9	53.8	58.6	3
Polystyrene		6.9	7.3	8.7	10.2	13.2	16.1	21.6	27.1	32.2	37.2	42.1	46.9	51.6	56.2	3
Poly(2-vinylpyridine)		6.9	7.3	8.7	10.3	13.3	16.2	21.8	27.3	32.5	37.5	42.4	47.3	52.0	56.7	3



# SELECTED PROPERTIES OF SEMICONDUCTOR SOLID SOLUTIONS

L.I. Berger

Alloy system	Limits of solubility	Energy gap in eV (300 K)	Remarks, references
<b>Adamantine Semiconductors IV-IV</b>			
$\text{Si}_x\text{Ge}_{1-x}$	$0 \leq x \leq 1$	$0.8941+0.0421x+0.1691x^2$ $0.7596+1.0860x+0.3306x^2$	Transition $\Gamma - X$ [Ref.1] Trans. $\Gamma - L$ [Ref. 1]
<b>Adamantine Semiconductors III-V/III-V</b>			
<i>Common Anion</i>			
$\text{Al}_x\text{Ga}_{1-x}\text{N}$	$0 \leq x \leq 1$		Wurtzite Structure [Ref. 2 & 3]
$\text{Al}_x\text{Ga}_{1-x}\text{P}$	$0 \leq x \leq 0.5$	$2.28+0.16x$	[Ref. 2]
$\text{Al}_x\text{In}_{1-x}\text{P}$	$0 \leq x \leq 0.44$	at $\Gamma$ : $1.34+2.23x$ ; at X: $2.24+0.18x$	[Ref. 2]
$\text{Al}_x\text{Ga}_{1-x}\text{As}$	$0 \leq x \leq 0.5$	$1.42=0.75x$ [Ref.3]; $1.424+1.429x-0.14x^2$ [Ref.4]	
$\text{Al}_x\text{In}_{1-x}\text{As}$	$0 \leq x \leq 1$	at $\Gamma$ : $0.37+1.91x+0.74x^2$ ; at X: $1.8+0.4x$	[Ref. 2 and 6]
$\text{Al}_x\text{Ga}_{1-x}\text{Sb}$	$0 \leq x \leq 1$	$0.73+1.10x+0.47x^2$	Trans. $\Gamma_{8v} - \Gamma_{6c}$ [Ref. 2]
$\text{Al}_x\text{In}_{1-x}\text{Sb}$	$0 \leq x \leq 1$		[Ref. 6]
$\text{Ga}_x\text{In}_{1-x}\text{N}$	$0 \leq x \leq 1$	$1.950+1.487x-1.000x(1-x)$	Wurtzite [Ref. 8 and 10]
$\text{Ga}_x\text{In}_{1-x}\text{P}$	$0 \leq x \leq 1$		[Ref. 2]
$\text{Ga}_x\text{In}_{1-x}\text{As}$	$0 \leq x \leq 1$	$0.360+0.629x+0.436x^2$	[Ref. 5]
$\text{Ga}_x\text{In}_{1-x}\text{Sb}$	$0 < x < 1$	$0.235+0.1653x+0.413x^2$	[Ref. 2, see also Ref. 9]
<i>Common Cation</i>			
$\text{GaN}_x\text{As}_{1-x}$	$0 \leq x \leq 0.05$	$1.42-9.9x$	[Ref. 2]
$\text{GaP}_x\text{As}_{1-x}$	$0 < x < 1$	$2.270-0.846x$	[Ref. 2]
$\text{GaP}_x\text{Sb}_{1-x}$	$0 \leq x \leq 0.05$	$1.515+1.172x+0.186x^2$ $1.9715+0.144x+0.211x^2$	(at 2K, $\Gamma-\Gamma$ ) [Ref. 7] [Ref. 2]
$\text{GaAs}_x\text{Sb}_{1-x}$	$0 \leq x \leq 0.45, 0.6 \leq x \leq 1$	$1.43-1.9x+1.2x^2$	[Ref. 5]
$\text{InP}_x\text{As}_{1-x}$	$0 < x < 1$	$0.356+0.675x+0.32x^2$	[Ref. 2]
<b>Adamantine Binary Semiconductors II-VI/II-VI [Ref. 3 and 6]</b>			
<i>Common Anion</i>			
$\text{Zn}_x\text{Cd}_{1-x}\text{S}$	$0 \leq x \leq 1$		Wurtzite Structure
$\text{Zn}_x\text{Hg}_{1-x}\text{S}$	$0 \leq x \leq 1$		
$\text{Cd}_x\text{Hg}_{1-x}\text{S}$	$0 \leq x \leq 1$		Wurtzite Structure at $x < 0.6$
$\text{Zn}_x\text{Cd}_{1-x}\text{Se}$	$0.7 \leq x \leq 1$		
$\text{Zn}_x\text{Hg}_{1-x}\text{Se}$	$0 \leq x \leq 1$		
$\text{Cd}_x\text{Hg}_{1-x}\text{Se}$	$0 \leq x \leq 0.7$ and $0.75 \leq x^* \leq 1$		$x^*$ - Wurtzite Structure
$\text{Zn}_x\text{Cd}_{1-x}\text{Te}$	$0 \leq x \leq 1$		
$\text{Zn}_x\text{Hg}_{1-x}\text{Te}$	$0 \leq x \leq 1$		
$\text{Cd}_x\text{Hg}_{1-x}\text{Te}$	$0 \leq x \leq 1$		
<i>Common Cation</i>			
$\text{ZnS}_x\text{Se}_{1-x}$	$0 \leq x \leq 1$		
$\text{ZnS}_x\text{Te}_{1-x}$	$0 \leq x \leq 0.1$ and $0.9 \leq x^* \leq 1$		$x^*$ - Wurtzite Structure
$\text{ZnSe}_x\text{Te}_{1-x}$	$0 \leq x \leq 1$		
$\text{CdS}_x\text{Se}_{1-x}$	$0 \leq x \leq 1$		Wurtzite Structure
$\text{CdS}_x\text{Te}_{1-x}$	$0 \leq x \leq 0.25$ and $0.8 \leq x^* \leq 1$		$x^*$ - Wurtzite Structure
$\text{CdSe}_x\text{Te}_{1-x}$	$0 \leq x \leq 0.4$ and $0.6 \leq x^* \leq 1$		$x^*$ - Wurtzite Structure
$\text{HgS}_x\text{Se}_{1-x}$	$0 \leq x \leq 1$		
$\text{HgS}_x\text{Te}_{1-x}$	$0 \leq x \leq 1$		
$\text{HgSe}_x\text{Te}_{1-x}$	$0 \leq x \leq 1$		
<b>Quaternary Adamantine Semiconductors II-VI/III-V [Ref. 6]</b>			
$(\text{ZnS})_x(\text{AlP})_{1-x}$	$0.99 \leq x \leq 1$		
$(\text{ZnSe})_x(\text{GaAs})_{1-x}$	$0 \leq x < 1$		
$(\text{CdTe})_x(\text{InAs})_{1-x}$	$0 < x \leq 0.2$ and $0.7 \leq x \leq 1$		
$(\text{CdTe})_x(\text{AlSb})_{1-x}$	$0 \leq x \leq 1$		
$(\text{HgTe})_x(\text{InAs})_{1-x}$	$0 \leq x \leq 1$		

Alloy system	Limits of solubility	Energy gap in eV (300 K)	Remarks, references
$\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$	$0 \leq x \leq 1, 0 \leq y \leq 1$	<b>Quaternary Adamantine Semiconductors III<sub>x</sub>-III<sub>1-x</sub>-V<sub>y</sub>-V<sub>1-y</sub></b>	
		$1.35 + 0.668x - 1.068y + 0.758x^2 + 0.078y^2 - 0.069xy - 0.322x^2y + 0.03xy^2$ [Ref. 2 and 6]	
$\text{Al}_x\text{Ga}_y\text{In}_{1-x-y}\text{Sb}$	$0 \leq x \leq 1, 0 \leq y \leq 1$	<b>Quaternary Adamantine Semiconductors III<sub>1-x-y</sub>-III<sub>x</sub>-III<sub>y</sub>-V</b>	
		$0.095 + 1.76x + 0.28y + 0.345(x^2 + y^2) + 0.085(1-x-y)^2 + xy(1-x-y)(23-28y)$ [Ref. 2 and 6]	

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# PROPERTIES OF ORGANIC SEMICONDUCTORS

L. I. Berger

Substance	Energy Gap, $E_g$ (in $E/2kT$ ) eV	Room Temperature Electrical Resistivity, ohm · cm	Mobility, $\mu$ , $\text{cm}^2/\text{V} \cdot \text{s}$	Sign of Majority Carriers	Temperature Range, $^{\circ}\text{C}$	Ref.
<i>Metal-Free Molecular Crystals</i>						
3-Acetylamino- <i>N</i> -methylphthalimide	3.46				67 to 100	1
3-Acetylamino- <i>N</i> -phenylphthalimide	3.50				54 to 124	1
4-Amino- <i>N</i> -cyclohexylphthalimide	2.90				73 to 100	1
4-Aminophthalimide	2.78				123 to 151	1
Acridine	3.90					1
Anthanthrene	1.67	$1.5 \cdot 10^{19}$			40 to 105	1
Anthanthrene	0.84	$1.5 \cdot 10^{19}$ (15 $^{\circ}\text{C}$ )				2
Anthanthrone	1.70	$7.7 \cdot 10^{18}$			20 to 150	1
Anthracene	0.83	$1.3 \cdot 10^{14}$ (15 $^{\circ}\text{C}$ )				2
Anthracene	2.50	$1.5 \cdot 10^{11}$	2.3	+	20 to 130	1
Anthracene	3.88 to 4.1	$>10^{15}$	1.74(n), 2.07(p)	+ & -		4
1,2-Benzanthracene	1.04	$10^{16}$ (30 $^{\circ}\text{C}$ )				2
Benzanthrene	3.12	$1.6 \cdot 10^{16}$				1
Benzene (liquid)	0.41					2
Benzene (amorphous)	0.84	$10^{15}$			-14 to 5	1
Benzene (cryst.)	7		2	-	-23	4
Benzimidazole	3.0 to 4.0	$5 \cdot 10^{13}$			84 to 144	1
Benzophenone	3.34				-23 to 14	1
Benzo[ <i>f</i> ]quinoline	2.77				30 to 50	1
Benzo[ <i>h</i> ]quinoline	2.72					1
3-Benzoylamino- <i>N</i> -methylphthalimide	3.28				84 to 112	1
Benzpentacene	1.72				0 to 150	1
Biphenyl	1.46	$1.7 \cdot 10^{15}$ (50 $^{\circ}\text{C}$ )				2
Biphenyl	1.45				20 to 70	1
<i>o</i> -Chloranil	3.0	$10^{15}$				1
<i>p</i> -Chloranil	0.61					1
Chlorpromazine	2.1	$10^{12}$ (32 $^{\circ}\text{C}$ )		+ & -	32 to 80	1
Chrysene	1.1	$4 \cdot 10^{19}$ (15 $^{\circ}\text{C}$ )				2
Chrysene	2.20	$4 \cdot 10^{19}$			25 to 90	1
Circumanthracene	1.8	$6 \cdot 10^{12}$				1
Coronene	1.7	$1.7 \cdot 10^{17}$			60 to 80	1
Coronene	0.85	$1.7 \cdot 10^{17}$ (15 $^{\circ}\text{C}$ )				2
Cyananthrone	0.20	$1.2 \cdot 10^7$			30 to 125	1
1,6-Diaminopyrene	0.6	$10^8$				
Dibenzpentacene	1.50				0 to 150	1
Dinaphthopyrene	1.60				25 to 90	1
1,8-Diphenyl-1,3,5,7-octatetraene	1.7				72 to 191	1
Diphenylpentacene	1.60				0 to 150	1
4,4'-Diphenylstilbene	1.56				160 to 280	1
4,4'-Diphenylstilbene	0.80					2
Ferrocene	1.22	$10^{14}$		+		1
Flavanthrene	0.70	$1.4 \cdot 10^{11}$				1
Fluorene	2.7					2
Fluorene	1.4					2
Fluoridine	1.6	$6 \cdot 10^{13}$		+	20 to 140	1
Hexacene	0.57	$3.8 \cdot 10^{10}$ (50 $^{\circ}\text{C}$ )				2
Hexacene	1.3					1
Hexamethylbenzene	1.86			+	20 to 140	1
3-Hydroxy- <i>N</i> -methylphthalimide	3.80				60 to 91	1
Imidazole	2.6	$10^{11}$			28 to 68	1

Substance	Energy Gap, $E_g$ (in $E/2kT$ ) eV	Room Temperature Electrical Resistivity, ohm · cm	Mobility, $\mu$ , cm <sup>2</sup> /V · s	Sign of Majority Carriers	Temperature Range, °C	Ref.
Indanthrazine	0.66	$1.4 \cdot 10^{15}$			30 to 125	1
Indanthrone	0.64	$7.5 \cdot 10^{14}$			30 to 125	1
Indanthrone (black)	0.56	$2.5 \cdot 10^8$			30 to 125	1
Mesitylene (liquid)	0.19					2
Mesonaphthodanthracene	0.6	$4.0 \cdot 10^{18}$ (15°C)				2
Mesonaphthodanthrene	1.48				45 to 250	1
Mesonaphthodanthrone	0.86				5 to 110	1
3-Methoxy- <i>N</i> -methyl-phthalimide	3.18				54 to 78	1
Naphthacene	1.7	$1 \cdot 10^{15}$				1
Naphthalene	3.5	$10^{14}$			27 to 47	1
Naphthalene	1.15	$2.8 \cdot 10^{14}$ (50°C)				2
Naphthalene	4.9 to 5.1		0.64(n), 1.50(p)	+ & -		4
<i>m</i> -Naphthodanthrene	1.20	$4 \cdot 10^{18}$			40 to 150	1
<i>m</i> -Naphthodanthrone	1.30	$1.5 \cdot 10^{18}$			40 to 150	1
$\beta$ -Naphthol	2.36	$2 \cdot 10^5$			60 to 110	1
$\beta$ -Naphthoquinoline	2.77					1
1-Naphthylamine	2.2				25 to 42	1
1-Naphthylamine picrate	2.7				28 to 98	1
2-Naphthylphenyl sulphone	3.5				67 to 102	1
1-Nitronaphthalene	2.5				25 to 44	1
Ovalene	1.13	$2.3 \cdot 10^{15}$				1
Pentacene	0.58	$2.4 \cdot 10^9$ (50°C)				2
Pentacene	1.5	$6 \cdot 10^{13}$			20 to 140	1
Perylene	2.1	$4.1 \cdot 10^{13}$			40 to 100	1
Perylene	3.10		5.53(n), 87.4(p)	+ & -	-213	4
Phenanthrene	1.15	$1.3 \cdot 10^{14}$			12 to 72	1
Phenanthrene	0.65					2
1,10-Phenanthroline	2.73				50 to 90	1
Phenazine	2.1	$7 \cdot 10^{14}$ (100°C)			98 to 143	1
Phenazine	1.1			-		4
Phenothiazine	1.6	$10^{11}$			50 to 150	1
Phenothiazine			2.45(n), 0.02(p)	+ & -		4
Phenylanthranilic acid	3.30				87 to 119	1
4-Phenylstilbene	1.74				140 to 220	1
4-Phenylstilbene	0.86					2
Phosphonitrilic chloride trimer	1.68	$10^{15}$				1
Phthalocyanine, PcH <sub>2</sub>	1.66	$10^{13}$	0.1 to 0.4	+	26 to 350	1
Phthalocyanine, PcH <sub>2</sub>	2	$10^7$	1.2(n), 1.1(p)	+ & -	100	4
Pyranthrene	1.11	$1 \cdot 10^{15}$				1
Pyranthrene	0.51	$4.5 \cdot 10^{16}$ (15°C)				2
Pyranthrene	1.06	$3.9 \cdot 10^{15}$			40 to 150	1
Pyrene	2.02	$5 \cdot 10^{17}$				1
Pyrene			0.50	+		4
5,6- <i>N</i> -Pyridine-1,9-benzanthrone	1.60					2
<i>p</i> -Quaterphenyl	0.89	$1.0 \cdot 10^{15}$ (50°C)				2
Quaterrylene	0.6	$10^5$		-		1
<i>p</i> -Quinquiphenyl	0.91	$2.0 \cdot 10^{15}$ (50°C)				2
$\alpha$ -Resorcin	2.10	$2 \cdot 10^{16}$			30 to 94	1
$\beta$ -Resorcin	3.27	$2 \cdot 10^{18}$			30 to 94	1
Salanil	4.1	$10^4$			20 to 40	1
<i>p</i> -Sexiphenyl	0.91	$7.0 \cdot 10^{14}$ (50°C)				2
<i>cis</i> -Stilbene	2.4			+	at 20	1
<i>trans</i> -Stilbene	1.80		2.4	+	70 to 120	1
<i>trans</i> -Stilbene	0.91					2
<i>trans</i> -Stilbene	1.4			+		4
<i>o</i> -Terphenyl		$3 \cdot 10^{-5}$		+		1
<i>m</i> -Terphenyl			$10^{-5}$	+		1
<i>p</i> -Terphenyl	0.6	$10^{14}$ (25°C)				2
<i>p</i> -Terphenyl	1.2		0.025	+		1

Substance	Energy Gap, $E_g$ (in $E/2kT$ ) eV	Room Temperature Electrical Resistivity, ohm · cm	Mobility, $\mu$ , $\text{cm}^2/\text{V} \cdot \text{s}$	Sign of Majority Carriers	Temperature Range, °C	Ref.
<i>p</i> -Terphenyl			1.2(n), 0.80(p)	+ & -		4
Tetracene	0.66	$3.2 \cdot 10^{12}$ (50°C)				2
Tetracene	1.7					1
Tetracene	3.4		0.85	+		4
1,1,10,10-Tetracyanodecapentaene	2.24	$10^{13}$			>68	1
1,1,6,6-Tetracyanohexatriene	1.54	$10^{14}$		-		1
Tetracyanoethylene			0.26(max)	+		4
7,7,8,8-Tetracyanoquinodimethane			0.65	-		4
1,1,8,8-Tetracyanooctatetraene	1.42	$10^{12}$		-		1
Tetraphenylpentacene	1.62				0 to 150	1
Tetrathiotetracene	0.46	$10^4$				1
Triphenodioxazine	1.65	$5 \cdot 10^{14}$		-	20 to 140	1
Triphenyldiamine			$2 \cdot 10^{-2}$		at 20	1
Violanthrene	0.85	$2.1 \cdot 10^{14}$			40 to 105	1
Isoviolanthrene	0.82	$8.4 \cdot 10^{13}$			40 to 150	1
Violanthrone	0.78	$2.3 \cdot 10^{10}$			40 to 150	1
Isoviolanthrone	0.76	$5.7 \cdot 10^9$			40 to 150	1
<i>o</i> -Xylene (liquid)	0.45					2
<i>m</i> -Xylene (liquid)	0.41					2
<i>p</i> -Xylene (liquid)	0.41					2
<b>Long-Chain Compounds and Polymers</b>						
Acrylic acid-amyproparylaniline copolymers		$10^9-10^{10}$				3
Acrylic acid-methylproparylaniline copolymers		$10^9-10^{10}$				3
Acrylic acid-octylproparylaniline copolymers		$10^9-10^{10}$				3
Anthrone polymers		$0.28 \geq 100$ at 1.8 kbar $\geq 2$ at 33 kbar				3
$[\text{CH}(\text{AsF}_6)_{0.1}]_x$		0.0005		+		3
$[\text{CH} \cdot \text{I}_{0.22}]_x$	1.9	<i>trans</i> $10^5$ , <i>cis</i> $10^9$				3
1,6-Diacetylenes (cyclopolymerized)		$10^{10}-10^{14}$				3
Ionene elastomers		$2.7 \cdot 10^7$ to $2.2 \cdot 10^8$			-80 to 60	3
1,3,4-Oxydiazole polymers	0.81	$3 \cdot 10^{12}$			20 to 140	3
Oxypyrrrole polymer films		0.125				3
Phenylformaldehyde polymeric pyrolysates						3
a) Pyrolysis Temperature 600°C		27	0.0014	-		
b) 1200°C		0.0044	7.84	+		
Phenylthiocyanate polymers	0.5 to 0.8	$10^5-10^8$				3
Polyacetylene (undoped)		$10^{10}$				3
Polyacetylene ( $\text{I}_2$ doped)		0.04				3
Polyacetylene ( <i>cis</i> -rich, undoped)		$10^7$				3
<i>trans</i> -Polyacetylene ( $\text{I}_2$ doped, 0.22 mole %)				+		3
Polyacrylonitrile (heat treated 700°C)			0.01	-	-100 to 100	3
Poly-5,5'-biisatyl	air 0.84	air $2.6 \cdot 10^9$		+	20 to 140	3
thiophene-indophene	vacuum 1.0	vacuum $3.1 \cdot 10^9$				
Poly bis(amino)-phosphazenes	1.75	$1.8 \cdot 10^{11}$			20 to 180	3
Poly-5,5'-diisatylmetane-thiophene-indophenine	0.45	$7.3 \cdot 10^4$		+	20 to 140	3
Polyethylene	2.74				20 to 70	3
Polyethylene (low density)	0.17	$4 \cdot 10^9$			above $T_g$	3
Polyimide	2.84					3
Polymalonitrile	1.72			-		3
Poly(metalphthalocyanines) :Cu	0.12	$7 \cdot 10^6$				3
:Fe	0.15	$1.1 \cdot 10^6$				3
:Ni	0.46	100				3
:Sb		$3.1 \cdot 10^6$				3
:Zn	0.12	$5.3 \cdot 10^3$				3
Poly- <i>N</i> -methylpyrrole		$2 \cdot 10^6$				3
Polyoxypyrrrole (black)	0.044	1790			-173 to 27	3
Polyphthalocyanines	0.01	7 to 58				3
Polypyrrrole	0.01				-193 to 250	3

Substance	Energy Gap, $E$ , (in $E/2kT$ ) eV	Room Temperature Electrical Resistivity, ohm · cm	Mobility, $\mu$ , $\text{cm}^2/\text{V} \cdot \text{s}$	Sign of Majority Carriers	Temperature Range, °C	Ref.
Polypyrroline II	1.74					3
Polyselenomethylene	0.7 to 2.62	$>10^{13}$			20 to 120	3
Poly(2-vinylpyridine):I <sub>2</sub> (1:2)	0.12	1000			-73 to 27	3
PVC (commercial)	2.84–3.04				$T < T_g$	3
PVC (commercial)	1.24–1.96				$T > T_g$	3
PVC (pure)	1.0±0.1				0 to 30	3
Salicylal- <i>N</i> -alkyliminate-Cu	1.62	$1.7 \cdot 10^{14}$				4
TTF-acetylacetonate polymers		$1.6 \cdot 10^4$				3
TTF-metal polymers		$1.6 \cdot 10^4$				3

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## PHASE TRANSITIONS IN THE SOLID ELEMENTS AT ATMOSPHERIC PRESSURE

This table gives the phase transition temperatures for the elements that can exist in two or more crystalline forms (allotropes). The crystal phases are labeled by Greek letters in the most common conventions, although some variation is found. All data refer to normal atmospheric pressure.

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Element	Symbol	Transition	$t/^\circ\text{C}$	Comments
Americium	Am	$\alpha \rightarrow \beta$	769	
	Am	$\beta \rightarrow \gamma$	1077	
	Am	$\gamma \rightarrow \text{liq}$	1176	
Beryllium	Be	$\alpha \rightarrow \beta$	1270	
	Be	$\beta \rightarrow \text{liq}$	1287	
Boron	B	$\alpha \rightarrow \beta$	1100	
	B	$\beta \rightarrow \gamma$	1500	
	B	$\gamma \rightarrow \text{liq}$	2075	
Calcium	Ca	$\alpha \rightarrow \beta$	443	
	Ca	$\beta \rightarrow \text{liq}$	842	
Californium	Cf	$\alpha \rightarrow \beta$	590	
	Cf	$\beta \rightarrow \text{liq}$	900	
Cerium	Ce	$\alpha \rightarrow \beta$	-177	
	Ce	$\beta \rightarrow \gamma$	61	$\beta$ -Ce and $\gamma$ -Ce are magnetic
	Ce	$\gamma \rightarrow \delta$	726	
	Ce	$\delta \rightarrow \text{liq}$	799	
Cobalt	Co	$\epsilon \rightarrow \alpha$	422	magnetic transition at 1115 °C
	Co	$\alpha \rightarrow \text{liq}$	1495	
Curium	Cm	$\alpha \rightarrow \beta$	1277	magnetic transition at -221 °C
	Cm	$\beta \rightarrow \text{liq}$	1345	
Dysprosium	Dy	$\alpha' \rightarrow \alpha$	-187	
	Dy	$\alpha \rightarrow \beta$	1381	magnetic transitions in $\alpha$ -Dy at -184 °C and -94 °C
	Dy	$\beta \rightarrow \text{liq}$	1412	
Fluorine	F <sub>2</sub>	$\alpha \rightarrow \beta$	-227.60	
	F <sub>2</sub>	$\beta \rightarrow \text{liq}$	-219.67	
Gadolinium	Gd	$\alpha \rightarrow \beta$	1235	
	Gd	$\beta \rightarrow \text{liq}$	1313	
Hafnium	Hf	$\alpha \rightarrow \beta$	1743	
	Hf	$\beta \rightarrow \text{liq}$	2233	
Iron	Fe	$\alpha \rightarrow \gamma$	912	magnetic transition in $\alpha$ -Fe at 771 °C
	Fe	$\gamma \rightarrow \delta$	1394	
	Fe	$\delta \rightarrow \text{liq}$	1538	
Lanthanum	La	$\alpha \rightarrow \beta$	277	
	La	$\beta \rightarrow \gamma$	860	
	La	$\gamma \rightarrow \text{liq}$	920	
Lithium	Li	$\alpha \rightarrow \beta$	-193	
	Li	$\beta \rightarrow \text{liq}$	180.50	
Manganese	Mn	$\alpha \rightarrow \beta$	727	magnetic transition in $\alpha$ -Mn at -100 °C
	Mn	$\beta \rightarrow \gamma$	1100	
	Mn	$\gamma \rightarrow \delta$	1138	
	Mn	$\delta \rightarrow \text{liq}$	1246	
Neodymium	Nd	$\alpha \rightarrow \beta$	855	magnetic transition in $\alpha$ -Nd at -253 °C
	Nd	$\beta \rightarrow \text{liq}$	1016	
Neptunium	Np	$\alpha \rightarrow \beta$	280	
	Np	$\beta \rightarrow \gamma$	576	
	Np	$\gamma \rightarrow \text{liq}$	644	

Element	Symbol	Transition	$t/^\circ\text{C}$	Comments
Nitrogen	$\text{N}_2$	$\alpha \rightarrow \beta$	-237.54	
	$\text{N}_2$	$\beta \rightarrow \text{liq}$	-210.0	
Oxygen	$\text{O}_2$	$\alpha \rightarrow \beta$	-249.29	
	$\text{O}_2$	$\beta \rightarrow \gamma$	-229.35	
	$\text{O}_2$	$\gamma \rightarrow \text{liq}$	-218.79	
Phosphorus	P	brown $\rightarrow$ $\beta$ -white	-190	several amorphous phases (red, black, gray) exist (Ref. 3)
	P	$\beta$ -white $\rightarrow$ $\alpha$ -white	-76.9	
	P	$\alpha$ -white $\rightarrow$ liq	44.15	
Plutonium	Pu	$\alpha \rightarrow \beta$	124.5	
	Pu	$\beta \rightarrow \gamma$	214.8	
	Pu	$\gamma \rightarrow \delta$	320.0	
	Pu	$\delta \rightarrow \delta'$	462.9	
	Pu	$\delta' \rightarrow \epsilon$	482.6	
	Pu	$\epsilon \rightarrow \text{liq}$	640	
Polonium	Po	$\alpha \rightarrow \beta$	54	
	Po	$\beta \rightarrow \text{liq}$	254	
Praseodymium	Pr	$\alpha \rightarrow \beta$	795	
	Pr	$\beta \rightarrow \text{liq}$	931	
Promethium	Pm	$\alpha \rightarrow \beta$	890	magnetic transition in $\alpha$ -Pm at $-175^\circ\text{C}$
	Pm	$\beta \rightarrow \text{liq}$	1042	
Protactinium	Pa	$\alpha \rightarrow \beta$	1170	
	Pa	$\beta \rightarrow \text{liq}$	1572	
Samarium	Sm	$\alpha \rightarrow \beta$	734	magnetic transition in $\alpha$ -Sm at $-167^\circ\text{C}$
	Sm	$\beta \rightarrow \gamma$	922	
	Sm	$\gamma \rightarrow \text{liq}$	1072	
Scandium	Sc	$\alpha \rightarrow \beta$	1337	
	Sc	$\beta \rightarrow \text{liq}$	1541	
Selenium	Se	$\alpha$ -red $\rightarrow$ gray	180	many allotropes exist (Ref. 3)
	Se	gray $\rightarrow$ liq	220.8	
Sodium	Na	$\alpha \rightarrow \beta$	-233	
	Na	$\beta \rightarrow \text{liq}$	97.794	
Strontium	Sr	$\alpha \rightarrow \beta$	547	
	Sr	$\beta \rightarrow \text{liq}$	777	
Sulfur	S	$\alpha \rightarrow \beta$	95.3	many allotropes exist (Ref. 3)
	S	$\beta \rightarrow \text{liq}$	115.21	
Terbium	Tb	$\alpha' \rightarrow \alpha$	-53	magnetic transition in $\alpha$ -Tb at $-230^\circ\text{C}$
	Tb	$\alpha \rightarrow \beta$	1289	
	Tb	$\beta \rightarrow \text{liq}$	1359	
Thallium	Tl	$\alpha \rightarrow \beta$	230	
	Tl	$\beta \rightarrow \text{liq}$	304	
Thorium	Th	$\alpha \rightarrow \beta$	1360	
	Th	$\beta \rightarrow \text{liq}$	1750	
Tin	Sn	$\alpha$ (gray) $\rightarrow$ $\beta$ (white)	13.2	defining fixed point on ITS-90
	Sn	$\beta$ (white) $\rightarrow$ liq	231.928	
Titanium	Ti	$\alpha \rightarrow \beta$	882	
	Ti	$\beta \rightarrow \text{liq}$	1668	
Uranium	U	$\alpha \rightarrow \beta$	669	
	U	$\beta \rightarrow \gamma$	776	
	U	$\gamma \rightarrow \text{liq}$	1135	
Ytterbium	Yb	$\alpha \rightarrow \beta$	3	
	Yb	$\beta \rightarrow \gamma$	795	
	Yb	$\gamma \rightarrow \text{liq}$	824	
Yttrium	Y	$\alpha \rightarrow \beta$	1478	
	Y	$\beta \rightarrow \text{liq}$	1522	
Zirconium	Zr	$\alpha \rightarrow \beta$	866	
	Zr	$\beta \rightarrow \text{liq}$	1854.7	



## THERMOPHYSICAL PROPERTIES OF STAINLESS STEEL 310

Stainless steel is used in a wide variety of applications, especially at high temperatures. This table gives properties of a reference standard Stainless Steel 310 certified by the U. K. National Physical Laboratory. The properties are:

- $a$ : thermal diffusivity in  $\text{mm}^2 \text{s}^{-1}$
- $c_p$ : specific heat capacity at constant pressure in  $\text{J g}^{-1} \text{K}^{-1}$
- $\rho$ : density in  $\text{g cm}^{-3}$
- $k$ : thermal conductivity in  $\text{W m}^{-1} \text{K}^{-1}$

With kind permission from Springer Science+Business Media: International Journal of Thermophysics, 28, 674, 2007, Table II.

### Reference

Blumm, J., Lindemann, A. Niedrig, B., and Campbell, R., *Int. J. Thermophys.* 28, 674, 2007.

$t/^\circ\text{C}$	$a/\text{mm}^2 \text{s}^{-1}$	$c_p/\text{J g}^{-1} \text{K}^{-1}$	$\rho/\text{g cm}^{-3}$	$k/\text{W m}^{-1} \text{K}^{-1}$
-125	3.170	0.376	7.878	9.39
-100	3.130	0.411	7.871	10.12
-75	3.145	0.435	7.863	10.76
-50	3.170	0.451	7.855	11.23
-25	3.210	0.464	7.846	11.69
0	3.256	0.475	7.838	12.12
25	3.352	0.483	7.829	12.67
50	3.439	0.490	7.820	13.18
101	3.611	0.501	7.801	14.11
150	3.763	0.512	7.782	14.99
200	3.917	0.518	7.762	15.75
250	4.075	0.525	7.742	16.56
300	4.205	0.533	7.722	17.31
350	4.331	0.541	7.701	18.04
400	4.455	0.548	7.681	18.75
450	4.571	0.555	7.660	19.43
500	4.686	0.562	7.639	20.12
550	4.806	0.570	7.618	20.86
600	4.920	0.595	7.596	22.24
651	5.058	0.601	7.574	23.02
701	5.179	0.607	7.551	23.74
750	5.207	0.611	7.529	23.95
800	5.288	0.617	7.506	24.49
850	5.404	0.624	7.483	25.23
901	5.506	0.633	7.460	26.00
950	5.618	0.645	7.436	26.94
1000	5.707	0.655	7.411	27.70

# THERMOELECTRIC PROPERTIES OF METALS AND SEMICONDUCTORS

L. I. Berger

There are three thermoelectric phenomena that result from correlation between propagation of heat through a conductor and displacement of the current carriers in the conductor. The Seebeck effect (Ref. 1) consists of formation of an electric current in an electrical circuit formed by two dissimilar conductors if the contacts between the conductors are held at different temperatures. A reverse phenomenon, the Peltier effect (Ref. 2), consists of formation of a temperature difference between the contacts in a circuit of this type if an electric current is created in the circuit by an external current source to which the circuit is connected. W. Thomson (Lord Kelvin), who explained both effects (Refs. 3,4), predicted and experimentally confirmed the existence of another thermoelectric phenomenon, named the Thomson effect, which consists of absorption or release of heat in a uniform conductor with a current passing through it when a temperature gradient (positive or negative) is present along the current direction.

The electromotive force,  $\Delta U$ , which creates the Seebeck current in the circuit, is the algebraic sum of the emf's created in each of the conductors, and is proportional to the temperature difference,  $\Delta T$ , between the electrical contact points:  $\Delta U = \Delta U_1 + \Delta U_2 = \alpha_1 \Delta T + \alpha_2 \Delta T$ . The coefficient of proportionality,  $\alpha$ , called the Seebeck coefficient or thermoelectric power or thermal electromotive force (thermal emf), of each of the two materials depends on the electrical properties and temperature of the material. The Peltier effect is measured by the amount of heat,  $\Delta Q$ , released or absorbed in a unit of time (in addition to the Joule heat) at a contact of two dissimilar conductors with electric current  $\Delta I$  passing through the contact:  $\Delta Q = \Pi \Delta I$ . Thomson showed that  $\Pi = \alpha T$ . The Thomson effect's heat,  $dQ$ , released or absorbed in a unit of time along a part of a conductor of length  $dx$  is proportional to the current magnitude  $I$ , the temperature gradient along the conductor  $\partial T/\partial x$ , and the increment  $dx$ :  $dQ = \tau I (\partial T/\partial x) dx$ . Thomson showed that the magnitude of the coefficient of proportionality,  $\tau$ , later named the Thomson coefficient, depends on only the properties of the conductor and the ambient temperature and correlates with the other thermoelectric parameters of a material through the equation  $\tau = T(\partial\alpha/\partial T)$ .

Another thermoelectric phenomenon, called the Bridgman effect or the internal Peltier effect (Ref. 5), occurs when an electric current passes through an anisotropic crystal, resulting in absorption or liberation of heat because of non-uniformity in current distribution.

In view of the correlations between  $\alpha$ ,  $\Pi$ , and  $\tau$ , we need only to present data for one of these parameters, namely, thermal emf  $\alpha$

and its dependence on temperature. These values are presented below, first for metals and then for semiconductors. In accordance with modern theory of solids, thermal emf in semiconductors is up to three or even four orders of magnitude higher than that in metals (Ref. 9).

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## Thermoelectric Properties of Elemental Metals

	Thermal emf $\alpha(T)$ in $\mu\text{V/K}$ at Temperature $T$				
	100 K	300 K	500 K	1000 K	1500 K
Ag	0.73	1.51	2.82	7.95	
Al	-2.2	-1.66	1.96		
Au	0.82	1.94	2.86	3.85	
Ba	-4	12.1	28.5		
Be	-2.5	1.7	2.7	7.9	
Ca	1.05	10.3	17.1		
Cd	-0.05	2.55			
Ce	13.6	6.2	5.2	-4.8	
Co	-8.43	-30.8	-44.8	-35.9	-7.8
Cr	5	21.8	16.6	17.9	5.7

	Thermal emf $\alpha(T)$ in $\mu\text{V/K}$ at Temperature $T$				
	100 K	300 K	500 K	1000 K	1500 K
Cs		-0.9			
Cu	1.19	1.83	2.83	5.36	
Dy	-4.1	-1.8	0.9	2.3	
Er	-3.8	-0.1	1.9	4.2	
Eu	5.3	24.5	46		
Fe	11.6	15	3	0.4	
Ga	0.5				
Gd	-4.6	-1.6	-0.5	-0.8	
Hf	0	5.5	5.7	-0.5	
Ho	-6.7	-1.6	1.4	2.8	

	Thermal emf $\alpha(T)$ in $\mu\text{V}/\text{K}$ at Temperature $T$						Thermal emf $\alpha(T)$ in $\mu\text{V}/\text{K}$ at Temperature $T$				
	100 K	300 K	500 K	1000 K	1500 K		100 K	300 K	500 K	1000 K	1500 K
In	0.56	1.68				Re	-1.4	-5.9	-5.9	-1.9	1.8
Ir	1.42	0.86	-0.1	-2.7	-5.7	Rh	0.8	0.6	0.5	-1.5	
K	-5.2	-13.7				Ru	0.3	-1.4	-1.8	-4.2	-7.5
La	0.1	1.7	2	-1.7		Sc	-14.3	-19	-17.5	-5.4	10.2
Li	4.3					Sm	0.7	1.2	0.6	-3	
Lu	-6.9	-4.3	-2.6	0		Sn	-0.04	-1			
Mg	-2.1	-1.46				Sr	-3	1.1	4.2		
Mn	-2.5	-9.8	-8.4	-1.5		Ta	0.7	-1.9	-2.3	1.6	7.2
Mo	0.1	5.6	11.4	17.4	13.7	Tb	-1.6	-1	0.3	0.6	
Na	-2.6	-6.3				Th	0.6	-3.2	-9.2	-14.3	-10.4
Nb	1.05	-0.44	-1.1	0.45	3.2	Ti	-2	9.1	5.3	-3.1	-0.5
Nd	-4	-2.3	0	-1.2		Tl	0.6	0.3	-1.5		
Ni	-8.5	-19.5	-25.8	-29.9		Tm	-1.3	1.9	2.7	2.2	
Np	8.9	-3.1				U	3	7.1	11	16.7	
Os	-3.2	-4.4	-4.7	-6.3	-8.5	V	2.9	0.23	1.1	4.6	
Pb	-0.58	-1.05	-1.5			W	-4.4	0.9	9	19.8	21.3
Pd	1.1	-10.7	-16.3	-32.3	-46.4	Y	-5.1	-0.7	0.3	2.9	6.6
Pt	4.1	-5.3	-7.9	-8.2		Yb	5.1	30	20.3	12.3	
Pu	12					Zn	0.7	2.4			
Rb	-3.6	-10				Zr	4.4	8.9	4.6	-3	1.1

### Thermoelectric Properties of Selected Semiconductors; Values Near Room Temperature unless Otherwise Indicated

Material	$\alpha/\mu\text{V K}^{-1}$	Material	$\alpha/\mu\text{V K}^{-1}$	Material	$\alpha/\mu\text{V K}^{-1}$
<i>Elemental Semiconductors</i>					
B	600 (500 K)	n-Si	300	p-Si	-500
n-Ge	600	p-Ge	-830	$\alpha$ -Sn	-40 (250 K)
<i>I-VI Compounds</i>					
Cu <sub>2</sub> S	327	Cu <sub>2</sub> Se	135	Cu <sub>2</sub> Te	40
Ag <sub>2</sub> Te	120				
<i>II-VI Compounds</i>					
ZnO	300	CdS	700	ZnSe	55
CdSe	200				
<i>III-V Compounds</i>					
GaN	70	GaP	1200	InP	-400
AlAs	70	n-GaAs	380	p-GaAs	-310
InAs	200	AlSb	500	n-GaSb	250
p-GaSb	-55	n-InSb	240	p-InSb	200
<i>V-VI Compounds</i>					
Sb <sub>2</sub> Te <sub>3</sub>	110	n-Bi <sub>2</sub> Te <sub>3</sub>	224	p-Bi <sub>2</sub> Te <sub>3</sub>	-227
<i>I-III-VI Compounds</i>					
CuAlS <sub>2</sub>	50	AgInSe <sub>2</sub>	-370	CuTlTe <sub>2</sub>	80
CuGaSe	40	AgTlSe <sub>2</sub>	800	AgAlTe <sub>2</sub>	321
CuInSe <sub>2</sub>	340	CuGaTe <sub>2</sub>	340	AgGaTe <sub>2</sub>	950
CuTlSe <sub>2</sub>	-5	CuInTe <sub>2</sub>	260	AgInTe <sub>2</sub>	298
AgGaSe <sub>2</sub>	90	CuTlTe <sub>2</sub>	80		
<i>I-IV-VI Compounds</i>					
Cu <sub>2</sub> GeS <sub>3</sub>	300	Cu <sub>2</sub> GeSe <sub>3</sub>	100	Cu <sub>2</sub> GeTe <sub>3</sub>	10
Cu <sub>2</sub> SnS <sub>3</sub>	600	Cu <sub>2</sub> SnSe <sub>3</sub>	250	Cu <sub>2</sub> SnTe <sub>3</sub>	30
<i>I-V-VI Compounds</i>					
Cu <sub>3</sub> AsS <sub>4</sub>	130	Cu <sub>3</sub> AsSe <sub>4</sub>	120	Cu <sub>3</sub> SbSe <sub>4</sub>	200
<i>II-IV-V Compounds</i>					
ZnGeP <sub>2</sub>	1200	ZnSiAs <sub>2</sub>	1100	CdGeAs <sub>2</sub>	190
CdSnAs <sub>2</sub>	600				

# NOMENCLATURE FOR ORGANIC POLYMERS

Robert B. Fox and Edward S. Wilks

Organic polymers have traditionally been named on the basis of the monomer used, a hypothetical monomer, or a semi-systematic structure. Alternatively, they may be named in the same way as organic compounds, i.e., on the basis of a structure as drawn. The former method, often called “source-based nomenclature” or “monomer-based nomenclature”, sometimes results in ambiguity and multiple names for a single material. The latter method, termed “structure-based nomenclature”, generates a sometimes cumbersome unique name for a given polymer, independent of its source. Within their limitations, both types of names are acceptable and well-documented.<sup>1</sup> The use of stereochemical descriptors with both types of polymer nomenclature has been published.<sup>2</sup>

## Traditional Polymer Names

### Monomer-Based Names

“Polystyrene” is the name of a homopolymer made from the single monomer styrene. When the name of a monomer comprises two or more words, the name should be enclosed in parentheses, as in “poly(methyl methacrylate)” or “poly(4-bromostyrene)” to identify the monomer more clearly. This method can result in several names for a given polymer: thus, “poly(ethylene glycol)”, “poly(ethylene oxide)”, and “poly(oxirane)” describe the same polymer. Sometimes, the name of a hypothetical monomer is used, as in “poly(vinyl alcohol)”. Even though a name like “polyethylene” covers a multitude of materials, the system does provide understandable names when a single monomer is involved in the synthesis of a single polymer. When one monomer can yield more than one polymer, e.g. 1,3-butadiene or acrolein, some sort of structural notation must be used to identify the product, and one is not far from a formal structure-based name.

*Copolymers, Block Polymers, and Graft Polymers.* When more than one monomer is involved, monomer-based names are more complex. Some common polymers have been given names based on an apparent structure, as with “poly(ethylene terephthalate)”. A better system has been approved by the IUPAC.<sup>1</sup> With this method, the arrangement of the monomeric units is introduced through use of an italicized connective placed between the names of the monomers. For monomer names represented by A, B, and C, the various types of arrangements are shown in Table 1.

Table 2 contains examples of common or semi-systematic names of copolymers. The systematic names of comonomers may also be used; thus, the polyacrylonitrile-*block*-polybutadiene-*block*-polystyrene polymer in Table 2 may also be named poly(prop-2-enenitrile)-*block*-polybuta-1,3-diene-*block*-poly(ethenylbenzene). IUPAC does not require alphabetized names of comonomers within a polymer name; many names are thus possible for some copolymers.

These connectives may be used in combination and with small, non-repeating (i.e. non-polymeric) junction units; see, for example, Table 2, line 8. A long dash may be used in place of the con-

nective *-block-*; thus, in Table 2, the polymers of lines 7 and 8 may also be written as shown on lines 9 and 10.

IUPAC also recommends an alternative scheme for naming copolymers that comprises use of “copoly” as a prefix followed by the names of the comonomers, a solidus (an oblique stroke) to separate comonomer names, and addition before “copoly” of any applicable connectives listed in Table 2 except *-co-*.

Table 3 gives the same examples shown in Table 2 but with the alternative format. Comonomer names need not be parenthesized.

TABLE 1. IUPAC Source-Based Copolymer Classification

No.	Copolymer type	Connective	Example
1	Unspecified or unknown	<i>-co-</i>	poly(A- <i>co</i> -B)
2	Random (obeys Bernoullian distribution)	<i>-ran-</i>	poly(A- <i>ran</i> -B)
3	Statistical (obeys known statistical laws)	<i>-stat-</i>	poly(A- <i>stat</i> -B)
4	Alternating (for two monomeric units)	<i>-alt-</i>	poly(A- <i>alt</i> -B)
5	Periodic (ordered sequence for 2 or more monomeric units)	<i>-per-</i>	poly(A- <i>per</i> -B- <i>per</i> -C)
6	Block (linear block arrangement)	<i>-block-</i>	polyA- <i>block</i> -polyB
7	Graft (side chains connected to main chains)	<i>-graft-</i>	polyA- <i>graft</i> -polyB

TABLE 2. Examples of Source-Based Copolymer Nomenclature

No.	Copolymer name
1	poly(propene- <i>co</i> -methacrylonitrile)
2	poly[(acrylic acid)- <i>ran</i> -(ethyl acrylate)]
3	poly(butene- <i>stat</i> -ethylene- <i>stat</i> -styrene)
4	poly[(sebacic acid)- <i>alt</i> -butanediol]
5	poly[(ethylene oxide)- <i>per</i> -(ethylene oxide)- <i>per</i> -tetrahydrofuran]
6	polyisoprene- <i>graft</i> -poly(methacrylic acid)
7	polyacrylonitrile- <i>block</i> -polybutadiene- <i>block</i> -polystyrene
8	polystyrene- <i>block</i> -dimethylsilylene- <i>block</i> -polybutadiene
9	polyacrylonitrile—polybutadiene—polystyrene
10	polystyrene—dimethylsilylene—polybutadiene

TABLE 3. Examples of Source-Based Copolymer Nomenclature (Alternative Format)

No.	Polymer name
1	copoly(propene/methacrylonitrile)
2	<i>ran</i> -copoly(acrylic acid/ethyl acrylate)
3	<i>stat</i> -copoly(butene/ethylene/styrene)
4	<i>alt</i> -copoly(sebacic acid/butanediol)
5	<i>block</i> -copoly(acrylonitrile/butadiene/styrene)
6	<i>per</i> -copoly(ethylene oxide/ethylene oxide/tetrahydrofuran)
7	<i>graft</i> -copoly(isoprene/methacrylic acid)

Source-based nomenclature for non-linear macromolecules and macromolecular assemblies is covered by a 1997 IUPAC document.<sup>11</sup> The types of polymers in these classes, together with their connectives, are given in Table 4; the terms shown may be used as connectives, prefixes, or both to designate the features present.

**TABLE 4. Connectives for Non-Linear Macromolecules and Macromolecular Assemblies**

No.	Type	Connective
1	Branched (type unspecified)	branch
2	Branched with branch point of functionality <i>f</i>	<i>f</i> -branch
3	Comb	comb
4	Cross-link	<i>ι</i> (Greek iota)
5	Cyclic	cyclo
6	Interpenetrating polymer network	ipn
7	Long-chain branched	l-branch
8	Network	net
9	Polymer blend	blend
10	Polymer-polymer complex	compl
11	Semi-interpenetrating polymer network	sipn
12	Short-chain branched	sh-branch
13	Star	star
14	Star with <i>f</i> arms	<i>f</i> -star

Non-linear polymers are named by using the italicized connective as a *prefix* to the source-based name of the polymer component or components to which the prefix applies; some examples are listed in Table 5.

**TABLE 5. Non-Linear Macromolecules**

No.	Polymer name	Polymer structural features
1	poly(methacrylic acid)- <i>comb</i> -polyacrylonitrile	Comb polymer with a poly(methacrylic acid) backbone and polyacrylonitrile side chains
2	<i>comb</i> -poly[ethylene- <i>stat</i> -(vinyl chloride)]	Comb polymer with unspecified backbone composition and statistical ethylene/vinyl chloride copolymer side chains
3	polybutadiene- <i>comb</i> -(polyethylene; polypropene)	Comb polymer with butadiene backbone and side chains of polyethylene and polypropene
4	<i>star</i> -(polyA; polyB; polyC; polyD; polyE)	Star polymer with arms derived from monomers A, B, C, D, and E, respectively
5	<i>star</i> -(polyA- <i>block</i> -polyB- <i>block</i> -polyC)	Star polymer with every arm comprising a tri-block segment derived from comonomers A, B, and C
6	<i>star</i> -poly(propylene oxide)	A star polymer prepared from propylene oxide
7	5- <i>star</i> -poly(propylene oxide)	A 5-arm star polymer prepared from propylene oxide
8	<i>star</i> -(polyacrylonitrile; polypropylene) ( $M_r$ 10000: 25000)	A star polymer containing polyacrylonitrile arms of MW 10000 and polypropylene arms of MW 25000

Macromolecular assemblies held together by forces other than covalent bonds are named by inserting the appropriate italicized connective between names of individual components; Table 6 gives examples.

**TABLE 6. Examples of Polymer Blends and Nets**

No.	Polymer name
1	polyethylene- <i>blend</i> -polypropene
2	poly(methacrylic acid)- <i>blend</i> -poly(ethyl acrylate)
3	<i>net</i> -poly(4-methylstyrene- <i>t</i> -divinylbenzene)
4	<i>net</i> -poly[styrene- <i>alt</i> -(maleic anhydride)]- <i>t</i> -(polyethylene glycol; polypropylene glycol)
5	<i>net</i> -poly(ethyl methacrylate)- <i>sipn</i> -polyethylene
6	[ <i>net</i> -poly(butadiene- <i>stat</i> -styrene)]- <i>ipn</i> -[ <i>net</i> -poly(4-methylstyrene- <i>t</i> -divinylbenzene)]

## Structure-Based Polymer Nomenclature

### Regular Single-Strand Polymers

Structure-based nomenclature has been approved by the IUPAC<sup>4</sup> and is currently being updated; it is used by *Chemical Abstracts*.<sup>5</sup> Monomer names are not used. To the extent that a polymer chain can be described by a repeating unit in the chain, it can be named “poly(repeating unit)”. For regular single-strand polymers, “repeating unit” is a bivalent group; for regular double-strand (ladder and spiro) polymers, “repeating unit” is usually a tetravalent group.<sup>9</sup>

Since there are usually many possible repeating units in a given chain, it is necessary to select one, called the “constitutional repeating unit” (CRU) to provide a unique and unambiguous name, “poly(CRU)”, where “CRU” is a recitation of the names of successive units as one proceeds through the CRU from left to right. For this purpose, a portion of the main chain structure that includes at least two repeating sequences is written out. These sequences will typically be composed of bivalent subunits such as  $-\text{CH}_2-$ ,  $-\text{O}-$ , and groups from ring systems, each of which can be named by the usual nomenclature rules.<sup>6,7</sup>

Where a chain is simply one long sequence comprising repetition of a single subunit, that subunit is itself the CRU, as in “poly(methylene)” or “poly(1,4-phenylene)”. In chains having more than one kind of subunit, a seniority system is used to determine the beginning of the CRU and the direction in which to move along the main chain atoms (following the shortest path in rings) to complete the CRU. Determination of the first, most senior, subunit, is based on a descending order of seniority: (1) heterocyclic rings, (2) hetero atoms, (3) carbocyclic rings, and, lowest, (4) acyclic carbon chains.

Within each of these classes, there is a further order of seniority that follows the usual rules of nomenclature.

**Heterocycles:** A nitrogen-containing ring system is senior to a ring system not containing nitrogen.<sup>4,9</sup> Further descending order of seniority is determined by:

- (i) the highest number of rings in the ring system
- (ii) the largest individual ring in the ring system
- (iii) the largest number of hetero atoms
- (iv) the greatest variety of hetero atoms

**Hetero atoms:** The senior bivalent subunit is the one nearest the top, right-hand corner of the Periodic Table; the order of seniority is: O, S, Se, Te, N, P, As, Sb, Bi, Si, Ge, Sn, Pb, B, Hg.

**Carbocycles:** Seniority<sup>4</sup> is determined by:

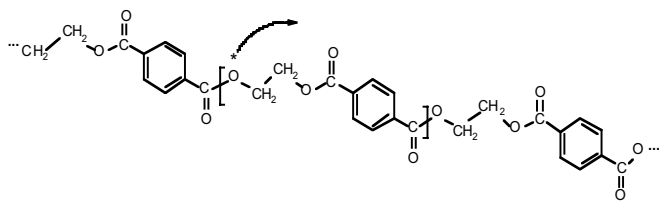
- (i) the highest number of rings in the ring system
- (ii) the largest individual ring in the ring system
- (iii) degree of ring saturation; an unsaturated ring is senior to a saturated ring of the same size

**Carbon chains:** Descending order of seniority is determined by:

- (i) chain length (longer is senior to shorter)
- (ii) highest degree of unsaturation
- (iii) number of substituents (higher number is senior to lower number)
- (iv) ascending order of locants
- (v) alphabetical order of names of substituent groups

Among equivalent ring systems, preference is given to the one having lowest locants for the free valences in the subunit, and among otherwise identical ring systems, the one having least hydrogenation is senior. Lowest locants in unsaturated chains are also given preference. Lowest locants for substituents are the final determinant of seniority.

Direction within the repeating unit depends upon the shortest path, which is determined by counting main chain atoms, both cyclic and acyclic, from the most senior subunit to another subunit of the same kind or to a subunit next lower in seniority. When identification and orientation of the CRU have been accomplished, the CRU is named by writing, in sequence, the names of the largest possible subunits within the CRU from left to right. For example, the main chain of the polymer traditionally named “poly(ethylene terephthalate)” has the structure shown in Figure 1.



**Figure 1.** Structure-based name: poly(oxyethyleneoxyterephthaloyl); traditional name: poly(ethylene terephthalate).

The CRU in Figure 1 is enclosed in brackets and read from left to right. It is selected because (1) either backbone oxygen atom qualifies as the “most senior subunit”, (2) the shortest path length from either -O- to the other -O- is via the ethylene subunit. Orientation of the CRU is thus defined by (1) beginning at the -O- marked with an asterisk, and (2) reading in the direction of the arrow. The structure-based name of this polymer is therefore “poly(oxyethyleneoxyterephthaloyl)”, not much longer than the traditional name and much more adaptable to the complexities of substitution. As organic nomenclature evolves, more systematic names may be used for subunits, e.g. “ethane-1,2-diyl” instead of “ethylene”. IUPAC still prefers “ethylene” for the -CH<sub>2</sub>-CH<sub>2</sub>- unit, however, but also accepts “ethane-1,2-diyl”.

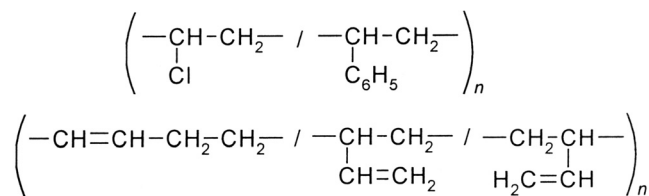
Structure-based nomenclature can also be used when the CRU backbone has no carbon atoms. An example is the polymer traditionally named “poly(dimethylsiloxane)”, which on the basis of structure would be named “poly(oxydimethylsilylene)” or “poly(oxydimethylsilanediy)”. This nomenclature method has also been applied to inorganic and coordination polymers<sup>8</sup> and to double-strand (ladder and spiro) organic polymers.<sup>9</sup>

### Irregular Single-Strand Polymers

Polymers that cannot be described by the repetition of a single CRU or comprise units not all connected identically in a directional sense can also be named on a structure basis.<sup>10</sup> These include copolymers, block and graft polymers, and star polymers. They are given names of the type “poly(A/B/C...)”, where A, B, C, etc. are the names of the component constitutional units, the

number of which are minimized. The constitutional units may include regular or irregular blocks as well as atoms or atomic groupings, and each is named by the method described above or by the rules of organic nomenclature.

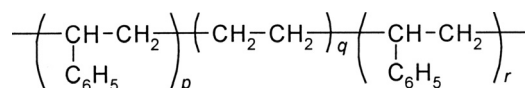
The solidus denotes an unspecified arrangement of the units within the main chain.<sup>10</sup> For example, a statistical copolymer derived from styrene and vinyl chloride with the monomeric units joined head-to-tail is named “poly(1-chloroethylene/1-phenylethylene)”. A polymer obtained by 1,4-polymerization and both head-to-head and head-to-tail 1,2-polymerization of 1,3-butadiene would be named “poly(but-1-ene-1,4-diyl/1-vinylethylene/2-vinylethylene)”.<sup>12</sup> In graphic representations of these polymers, shown in Figure 2, the hyphens or dashes at each end of each CRU depiction are shown *completely within* the enclosing parentheses; this indicates that they are not necessarily the terminal bonds of the macromolecule.



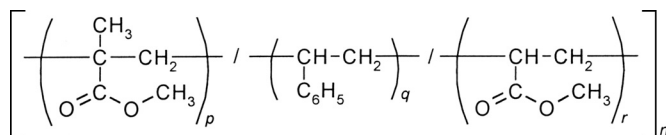
**Figure 2.** Graphic representations of copolymers.

A long hyphen is used to separate components in names of block polymers, as in “poly(A)—poly(B)—poly(C)”, or “poly(A)—X—poly(B)” in which X is a non-polymeric junction unit, e.g. dimethylsilylene.

In graphic representations of these polymers, the blocks are shown connected when the bonding is known (Figure 3, for example); when the bonding between the blocks is unknown, the blocks are separated by solidi and are shown *completely within* the outer set of enclosing parentheses (Figure 4, for example).<sup>10,13</sup>



**Figure 3.** polystyrene—polyethylene—polystyrene.



**Figure 4.** poly[poly(methyl methacrylate)—polystyrene—poly(methyl acrylate)].

Graft polymers are named in the same way as a substituted polymer but without the ending “yl” for the grafted chain; the name of a regular polymer, comprising Z units in which some have grafts of “poly(A)”, is “poly[Z/poly(A)Z]”. Star polymers are treated as a central unit with substituent blocks, as in “tet-rakis(polymethylene)silane”.<sup>10,13</sup>

### Other Nomenclature Articles and Publications

In addition to the *Chemical Abstracts* and IUPAC documents cited above and listed below, other articles on polymer nomenclature are available. A 1999 article lists significant documents on polymer nomenclature published during the last 50 years in books, encyclopedias, and journals by *Chemical Abstracts*,

IUPAC, and individual authors.<sup>14</sup> A comprehensive review of source-based and structure-based nomenclature for all of the major classes of polymers,<sup>15</sup> and a short tutorial on the correct identification, orientation, and naming of most commonly encountered constitutional repeating units were both published in 2000.<sup>16</sup>

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## SOLVENTS FOR COMMON POLYMERS

Abbreviations:

HC: hydrocarbons  
MEK: methyl ethyl ketone

THF: tetrahydrofuran  
DMF: dimethylformamide  
DMSO: dimethylsulfoxide

Polyethylene (HDPE)	HC and halogenated HC
Polypropylene (atactic)	HC and halogenated HC
Polybutadiene	HC, THF, ketones
Polystyrene	ethylbenzene, CHCl <sub>3</sub> , CCl <sub>4</sub> , THF, MEK
Polyacrylates	aromatic HC, chlorinated HC, THF, esters, ketones
Polymethacrylates	aromatic HC, chlorinated HC, THF, esters, MEK
Polyacrylamide	water
Poly(vinyl ethers)	halogenated HC, MEK, butanol
Poly(vinyl alcohol)	glycols (hot), DMF
Poly(vinyl acetate)	aromatic HC, chlorinated HC, THF, esters, DMF
Poly(vinyl chloride)	THF, DME, DMSO
Poly(vinylidene chloride)	THF (hot), dioxane, DMF
Poly(vinyl fluoride)	DME, DMSO (hot)
Polyacrylonitrile	DME, DMSO
Poly(oxyethylene)	aromatic HC, CHCl <sub>3</sub> , alcohols, esters, DMF
Poly(2,6-dimethylphenylene oxide)	aromatic HC, halogenated HC
Poly(ethylene terephthalate)	phenol, DMSO (hot)
Polyurethanes (linear)	aromatic HC, THF, DMF
Polyureas	phenol, formic acid
Polysiloxanes	HC, THF, DMF
Poly[bis(2,2,2-trifluoroethoxy)-phosphazene]	THF, ketones, ethyl acetate



# GLASS TRANSITION TEMPERATURE FOR SELECTED POLYMERS

Robert B. Fox

Polymer names are based on the IUPAC structure-based nomenclature system described in the table "Naming Organic Polymers". Within each category, names are listed in alphabetical order. Source-based and trivial names are also given (in italics) for the most common polymers. The table does not include polymers for which  $T_g$  is not clearly defined because of variability of structure or because of reactions taking place near the glass transition.

All values of  $T_g$  cited in this table have been determined by differential scanning calorimetry (DSC) except those values indicated by:

(D) dynamic method  
(Dil) dilatometry  
(M) mechanical method

Polymer name	Glass transition temperature ( $T_g$ /K)
<b>ACYCLIC CARBON CHAINS</b>	
<i>Polyalkadienes</i>	
Poly(alkenylene) <i>Polyalkadiene</i> $-\text{[CH=CHCH}_2\text{CH}_2\text{]}-$	
Poly( <i>cis</i> -1-butenylene)	171
<i>cis</i> -1,3-polybutadiene [PBD]	
Poly( <i>trans</i> -1-butenylene)	215
<i>trans</i> -1,3-polybutadiene [PBD]	
Poly(1-chloro- <i>cis</i> -1-butenylene)	253
<i>cis</i> -1,3-polychloroprene	
Poly(1-chloro- <i>trans</i> -1-butenylene)	233
<i>trans</i> -1,3-polychloroprene	
Poly(1-methyl- <i>cis</i> -1-butenylene)	200
<i>cis</i> -1,3-polyisoprene	
Poly(1-methyl- <i>trans</i> -1-butenylene)	207
<i>trans</i> -1,3-polyisoprene	
Poly(1,4,4-trifluoro-1-butenylene)	238
<i>Polyalkenes</i>	
Poly(alkylethylene) <i>Poly(alkylethylene)</i> $-\text{[RCHCH}_2\text{]}-$	
Poly(1-benzylethylene)	333
Poly(1-butylethylene)	223
Poly(1-cyclohexylethylene) (atactic)	393
Poly(1-cyclohexylethylene) (isotactic)	406 (D)
Poly(1,1-dimethylethylene)	200
<i>Polyisobutylene</i> [PIB]	
Poly(ethylene)	148
Poly(methylene)	155
Poly(1-phenethylethylene)	283
Poly(propylene) (isotactic)	272
Poly(propylene) (syndiotactic)	ca. 265
Poly[1-(2-pyridyl)ethylene]	377
Poly[1-(4-pyridyl)ethylene]	415
Poly(1-vinylethylene)	273
<i>Polyacrylics</i>	
Poly[1-(alkoxycarbonyl)ethylene] <i>Poly(alkyl acrylate)</i> $-\text{[(ROCO)CHCH}_2\text{]}-$	
Poly[1-(benzyloxycarbonyl)ethylene]	279
Poly[1-(butoxycarbonyl)ethylene]	219 (M)
<i>Poly(butyl acrylate)</i> [PBA]	
Poly[1-( <i>sec</i> -butoxycarbonyl)ethylene]	251
Poly[1-(butoxycarbonyl)-1-cyanoethylene]	358
Poly[1-(butylcarbamoylethylene)]	319 (M)
Poly(1-carbamoylethylene)	438
<i>Polyacrylamide</i> [PAM]	
Poly(1-carboxyethylene)	379

Polymer name	Glass transition temperature ( $T_g$ /K)
<i>Poly(acrylic acid)</i> [PAA]	
Poly[1-(2-chlorophenoxy)carbonyl]ethylene]	326
Poly[1-(4-chlorophenoxy)carbonyl]ethylene]	331
Poly[1-(4-cyanobenzoyloxy)carbonyl]ethylene]	317
Poly[1-(2-cyanoethoxy)carbonyl]ethylene]	277
Poly[1-(cyanomethoxy)carbonyl]ethylene]	433 Dil
Poly[1-(4-cyanophenoxy)carbonyl]ethylene]	363
Poly[1-(cyclohexyloxy)carbonyl]ethylene]	292
Poly[1-(2,4-dichlorophenoxy)carbonyl]ethylene]	333
Poly[1-(dimethylcarbamoyl]ethylene]	362
Poly[1-(ethoxy)carbonyl]ethylene]	249
<i>Poly(ethyl acrylate)</i> [PEA]	
Poly[1-(ethoxy)carbonyl]-1-fluoroethylene]	316
Poly[1-(2-ethoxy)carbonylphenoxy]carbonyl]ethylene]	303
Poly[1-(3-ethoxy)carbonylphenoxy]carbonyl]ethylene]	297
Poly[1-(4-ethoxy)carbonylphenoxy]carbonyl]ethylene]	310
Poly[1-(2-ethoxyethoxy)carbonyl]ethylene]	223
Poly[1-(3-ethoxypropoxy)carbonyl]ethylene]	218
Poly[1-(isopropoxy)carbonyl]ethylene]	267-270
Poly[1-(methoxy)carbonyl]ethylene]	283
<i>Poly(methyl acrylate)</i> [PMA]	
Poly[1-(2-methoxy)carbonylphenoxy]carbonyl]ethylene]	319
Poly[1-(3-methoxy)carbonylphenoxy]carbonyl]ethylene]	311
Poly[1-(4-methoxy)carbonylphenoxy]carbonyl]ethylene]	340
Poly[1-(2-methoxyethoxy)carbonyl]ethylene]	223
Poly[1-(4-methoxyphenoxy)carbonyl]ethylene]	324
Poly[1-(3-methoxypropoxy)carbonyl]ethylene]	198
Poly[1-(2-naphthyl)oxy]carbonyl]ethylene]	358
Poly[1-(pentachlorophenoxy)carbonyl]ethylene]	420
Poly[1-(phenethoxy)carbonyl]ethylene]	270
Poly[1-(phenoxy)carbonyl]ethylene]	330
Poly[1-( <i>m</i> -tolyl)oxy]carbonyl]ethylene]	298
Poly[1-( <i>o</i> -tolyl)oxy]carbonyl]ethylene]	325
Poly[1-( <i>p</i> -tolyl)oxy]carbonyl]ethylene]	316
Poly[1-(2,2,2-trifluoroethoxy)carbonyl]ethylene]	263
<i>Polymethacrylics</i>	
Poly[1-(alkoxy)carbonyl]-1-methylethylene] <i>Poly(alkyl methacrylate)</i> -[(ROCO)(Me)CCH <sub>2</sub> ]-	
Poly[1-(benzyloxy)carbonyl]-1-methylethylene]	327
Poly[1-(2-bromoethoxy)carbonyl]-1-methylethylene]	325
Poly[1-(1-butoxy)carbonyl]-1-methylethylene]	293
<i>Poly(butyl methacrylate)</i> [PBMA]	
Poly[1-( <i>sec</i> -butoxy)carbonyl]-1-methylethylene]	333
Poly[1-( <i>tert</i> -butoxy)carbonyl]-1-methylethylene]	391
Poly[1-(2-chloroethoxy)carbonyl]-1-methylethylene]	ca 315
Poly[1-(2-cyanoethoxy)carbonyl]-1-methylethylene]	364
Poly[1-(4-cyanophenoxy)carbonyl]-1-methylethylene]	428
Poly[1-(cyclohexyloxy)carbonyl]-1-methylethylene] (atactic)	356
Poly[1-(cyclohexyloxy)carbonyl]-1-methylethylene] (isotactic)	324
Poly[1-(dimethylaminoethoxy)carbonyl]-1-methylethylene]	292
Poly[1-(ethoxy)carbonyl]-1-methylethylene]	300
Poly[1-(ethoxy)carbonyl]-1-methylethylene] (atactic) <i>Poly(ethyl methacrylate)</i> [PEMA]	338
Poly[1-(ethoxy)carbonyl]-1-methylethylene] (isotactic)	285
Poly[1-(ethoxy)carbonyl]-1-methylethylene] (syndiotactic)	339
Poly[1-(hexyloxy)carbonyl]-1-methylethylene]	268
Poly[1-(isobutoxy)carbonyl]-1-methylethylene]	326
Poly[1-(isopropoxy)carbonyl]-1-methylethylene]	354
Poly[1-(methoxy)carbonyl]-1-methylethylene] (atactic) <i>Poly(methyl methacrylate)</i> [PMMA]	378
Poly[1-(methoxy)carbonyl]-1-methylethylene] (isotactic)	311
Poly[1-(methoxy)carbonyl]-1-methylethylene] (syndiotactic)	378
Poly[1-(4-methoxy)carbonylphenoxy]-1-methylethylene]	379

Polymer name	Glass transition temperature ( $T_g$ /K)
Poly[1-(methoxycarbonyl)-1-phenylethylene] (atactic)	391
Poly[1-(methoxycarbonyl)-1-phenylethylene] (isotactic)	397
Poly[1-methyl-1-(phenethoxycarbonyl)ethylene]	299
Poly[1-methyl-1-(phenoxy carbonyl)ethylene]	383
<i>Polyvinyl ethers, alcohols, and ketones</i>	
Poly(1-alkoxyethylene) <i>Poly(alkyl vinyl ether)</i> –[ROCHCH <sub>2</sub> ]–	
Poly(1-hydroxyethylene) <i>Poly(vinyl alcohol)</i> –[HOCHCH <sub>2</sub> ]–	
Poly(1-alkanoyl ethylene) <i>Poly(alkyl vinyl ketone)</i> –[RCOCHCH <sub>2</sub> ]–	
Poly(1-butoxyethylene)	218
Poly(1- <i>sec</i> -butoxyethylene)	253
Poly(1- <i>tert</i> -butoxyethylene)	361
Poly[1-(butylthio)ethylene]	253
Poly(1-ethoxyethylene)	230
Poly[1-(4-ethylbenzoyl)ethylene]	325
Poly(1-hydroxyethylene)	358 (D)
<i>Poly(vinyl alcohol)</i> [PVA]	
Poly(hydroxymethylene)	407
Poly(1-isopropoxyethylene)	270
Poly[1-(4-methoxybenzoyl)ethylene]	319 (M)
Poly(1-methoxyethylene)	242
<i>Poly(methyl vinyl ether)</i> [PMVE]	
Poly[1-(methylthio)ethylene]	272
Poly(1-propoxyethylene)	224
Poly[1-(trifluoromethoxy)trifluoroethylene]	268
<i>Polyvinyl halides and nitriles</i>	
Poly(1-haloethylene) <i>Poly(vinyl halide)</i> –[XCHCH <sub>2</sub> ]–	
Poly(1-cyanoethylene) <i>Poly(acrylonitrile)</i> –[NCCHCH <sub>2</sub> ]–	
Poly(1-chloroethylene)	354
<i>Poly(vinyl chloride)</i> [PVC]	
Poly(chlorotrifluoroethylene)	373
Poly(1-cyanoethylene)	370
<i>Polyacrylonitrile</i> [PAN]	
Poly(1-cyano-1-methylethylene)	393
<i>Polymethacrylonitrile</i>	
Poly(1,1-dichloroethylene)	255
<i>Poly(vinylidene chloride)</i>	
Poly(1,1-difluoroethylene)	ca 233
<i>Poly(vinylidene fluoride)</i>	
Poly(1-fluoroethylene)	314 (M)
<i>Poly(vinyl fluoride)</i>	
Poly(1-hexafluoropropylene)	425
Poly[1-(2-iodoethyl)ethylene]	343
Poly(tetrafluoroethylene)	(160)
Poly[1-(trifluoromethyl)ethylene]	300
<i>Polyvinyl esters</i>	
Poly[1-(alkanoyloxy)ethylene] <i>Poly(vinyl alkanoate)</i> –[RCOOCHCH <sub>2</sub> ]–	
Poly(1-acetoxyethylene)	305
<i>Poly(vinyl acetate)</i> [PVAc]	
Poly[1-(benzoyloxy)ethylene]	344
Poly[1-(4-bromobenzoyloxy)ethylene]	365
Poly[1-(2-chlorobenzoyloxy)ethylene]	335
Poly[1-(3-chlorobenzoyloxy)ethylene]	338
Poly[1-(4-chlorobenzoyloxy)ethylene]	357
Poly[1-(cyclohexanoyloxy)ethylene]	349 (M)
Poly[1-(4-ethoxybenzoyloxy)ethylene]	343
Poly[1-(4-ethylbenzoyloxy)ethylene]	326

Polymer name	Glass transition temperature ( $T_g$ /K)
Poly[1-(4-isopropylbenzoyloxy)ethylene]	342
Poly[1-(2-methoxybenzoyloxy)ethylene]	338
Poly[1-(3-methoxybenzoyloxy)ethylene]	ca 317
Poly[1-(4-methoxybenzoyloxy)ethylene]	360
Poly[1-(4-methylbenzoyloxy)ethylene]	343
Poly[1-(4-nitrobenzoyloxy)ethylene]	395
Poly[1-(propionoyloxy)ethylene]	283 (M)
<i>Polystyrenes</i>	
Poly(1-phenylethylene) <i>Polystyrene</i> $-\text{[C}_6\text{H}_5\text{CHCH}_2\text{]}-$	
Poly[1-(4-acetylphenyl)ethylene]	389 (M)
Poly[1-(4-benzoylphenyl)ethylene]	371 (M)
Poly[1-(4-bromophenyl)ethylene]	391
Poly[1-(4-butoxyphenyl)ethylene]	ca 320 (M)
Poly[1-(4-butoxycarbonylphenyl)ethylene]	349 (M)
Pol[(1-(4-butylphenyl)ethylene]	279
Poly[1-(4-carboxyphenyl)ethylene]	386 (M)
Poly[1-(2-chlorophenyl)ethylene]	392
Poly[1-(3-chlorophenyl)ethylene]	363
Poly[1-(4-chlorophenyl)ethylene]	383
Poly[1-(2,4-dichlorophenyl)ethylene]	406
Poly[1-(2,5-dichlorophenyl)ethylene]	379
Poly[1-(2,6-dichlorophenyl)ethylene]	440
Poly[1-(3,4-dichlorophenyl)ethylene]	401
Poly[1-(2,4-dimethylphenyl)ethylene]	385
Poly[1-(4-(dimethylamino)phenyl)ethylene]	398 (M)
Poly[1-(4-ethoxyphenyl)ethylene]	ca 359 (M)
Poly[1-(4-ethoxycarbonylphenyl)ethylene]	367 (M)
Poly[1-(4-fluorophenyl)ethylene]	368
Poly[1-(4-iodophenyl)ethylene]	429
Poly[1-(4-methoxyphenyl)ethylene]	386
Poly[1-(4-methoxycarbonylphenyl)ethylene]	386 (M)
Poly(1-methyl-1-phenylethylene)	373
<i>Poly(<math>\alpha</math>-methylstyrene)</i>	
Poly[1-(2-(methylamino)phenyl)ethylene]	462 (M)
Poly(1-phenylethylene)	373
<i>Polystyrene</i> [PS]	
Poly[1-(4-propoxyphenyl)ethylene]	343 (M)
Poly[1-(4-propoxycarbonylphenyl)ethylene]	365 (M)
Poly(1- <i>o</i> -tolylethylene)	409

## CHAINS WITH CARBOCYCLIC UNITS

Poly(arylenealkylene) $-\text{[Ar-(CH}_2\text{)}_n\text{]}-$	
Poly[1-(2-bromo-1,4-phenylene)ethylene]	353 (M)
Poly[1-(2-chloro-1,4-phenylene)ethylene]	343 (M)
Poly[1-(2-cyano-1,4-phenylene)ethylene]	363 (M)
Poly[1-(2,5-dimethyl-1,4-phenylene)ethylene]	373 (M)
Poly[1-(2-ethyl-1,4-phenylene)ethylene]	298 (M)
Poly[1-(1,4-naphthylene)ethylene]	433 (M)
Poly[1-(1,4-phenylene)ethylene]	ca 353 (M)

## CHAINS WITH HETEROATOM UNITS

*Main chain oxide units*

Poly(oxyalkylene) <i>Poly(alkylene oxide)</i> $-\text{[O(CH}_2\text{)}_n\text{]}-$	
Poly[oxy(1,1-bis(chloromethyl)trimethylene)]	265
Poly[oxy(1-(bromomethyl)ethylene)]	259
Poly[oxy(1-(butoxymethyl)ethylene)]	194
Poly[oxy(1-butylethylene)]	203
Poly[oxy(1- <i>tert</i> -butylethylene)]	308
Poly[oxy(1-(chloromethyl)ethylene)]	251

Polymer name	Glass transition temperature ( $T_g$ /K)
<i>Poly(epichlorohydrin)</i>	
Poly[oxy(2,6-dimethoxy-1,4-phenylene)]	440
Poly[oxy(1,1-dimethylethylene)]	264
Poly[oxy(2,6-dimethyl-1,4-phenylene)]	482
Poly[oxy(2,6-diphenyl-1,4-phenylene)]	493
Poly[oxy(1-ethylethylene)]	203
Poly(oxyethylidene)	243
<i>Polyacetaldehyde</i>	
Poly[oxy(1-(methoxymethyl)ethylene)]	211
Poly[oxy(2-methyl-6-phenyl-1,4-phenylene)]	428
Poly[oxy(1-methyltrimethylene)]	223 (D)
Poly[oxy(2-methyltrimethylene)]	218
Poly(oxy-1,4-phenylene)	358
<i>Poly(phenylene oxide)</i> [PPO]	
Poly[oxy(1-phenylethylene)]	313
Poly(oxytetramethylene)	189
<i>Poly(tetrahydrofuran)</i> [PTMO]	
Poly(oxytrimethylene)	195
<i>Main-chain ester or anhydride units</i>	
Poly(oxyalkyleneoxyalkanediyl) <i>Poly(alkylene alkanedioate)</i> --[O(CH <sub>2</sub> ) <sub>m</sub> OCO(CH <sub>2</sub> ) <sub>n</sub> CO]--	
Poly(oxyadipoyloxydecamethylene)	217
Poly(oxyadipoyloxy-1,4-phenyleneisopropylidene-1,4-phenylene)	341
Poly(oxycarbonyloxy-1,4-phenylene-isopropylidene-1,4-phenylene)	422
<i>Bisphenol A polycarbonate</i>	
Poly(oxycarbonylpentamethylene)	213
Poly(oxycarbonyl-1,4-phenylenemethylene-1,4-phenylene)	395
Poly(oxycarbonyl-1,4-phenyleneisopropylidene-1,4-phenylene)	333
Poly[oxy(2,6-dimethyl-1,4-phenyleneisopropylidene-3,5-dimethyl-1,4-phenylene)oxysebacoyl]	318
Poly(oxyethylenecarbonyl-1,4-cyclohexylenecarbonyl) (trans)	291
Poly(oxyethyleneoxycarbonyl-1,4-naphthylenecarbonyl)	337
Poly(oxyethyleneoxycarbonyl-1,5-naphthylenecarbonyl)	344
Poly(oxyethyleneoxycarbonyl-2,6-naphthylenecarbonyl)	386
Poly(oxyethyleneoxycarbonyl-2,7-naphthylenecarbonyl)	392
Poly(oxyethyleneoxyterephthaloyl)	342
<i>Poly(ethylene terephthalate)</i> [PET]	
Poly(oxyisophthaloyl)	403 (D)
Poly(oxy(1-oxo-2,2-dimethyltrimethylene))	263
<i>Poly(pivalolactone)</i>	
Poly(oxy-1,4-phenyleneisopropylidene-1,4-phenyleneoxysebacoyl)	280
Poly(oxy-1,4-phenyleneoxy-1,4-phenyleneoxy-carbonyl-1,4-phenylene) [PEEK]	416
Poly(oxypropyleneoxyterephthaloyl)	341
Poly[oxyterephthaloyloxy(2,6-dimethyl-1,4-phenyleneisopropylidene-3,5-dimethyl-1,4-(D)phenylene)]	498
Poly(oxyterephthaloyloxyoctamethylene)	318 (D)
Poly(oxyterephthaloyloxy-1,4-phenyleneisopropylidene-1,4-phenylene)	478
<i>Poly(bisphenol A terephthalate)</i>	
Poly(oxytetramethyleneoxyterephthaloyl)	323
<i>Poly(butylene terephthalate)</i> [PBT]	
<i>Main-chain amide units</i>	
Poly(iminoalkyleneiminoalkanediyl) <i>Poly(alkylene alkanediamide)</i> --[NH(CH <sub>2</sub> ) <sub>m</sub> NHCO(CH <sub>2</sub> ) <sub>n</sub> CO]--	
Poly(iminoadipoyliminodecamethylene)	313
<i>Nylon 10,6</i>	
Poly(iminoadipoyliminohexamethylene)	ca 323
<i>Nylon 6,6</i>	
Poly(iminoadipoyliminooctamethylene)	318
<i>Nylon 8,6</i>	
Poly(iminoadipoyliminotrimethylene(methylimino)trimethylene]	278
Poly(iminocarbonyl-1,4-cyclohexylenemethylene)	466
Poly(iminocarbonyl-1,4-phenylene(2-oxoethylene)iminohexamethylene]	377
Poly(iminoethylene-1,4-phenyleneethyleneiminosebacoyl)	378 (D)

Polymer name	Glass transition temperature ( $T_g$ /K)
Poly(iminohexamethyleneiminoazelaoyl) <i>Nylon 6,9</i>	331
Poly(iminohexamethyleneiminododecanedioyl) <i>Nylon 6, 12</i>	319
Poly(iminohexamethyleneiminopimeloyl) <i>Nylon 6,7</i>	331
Poly(iminohexamethyleneiminosebacoyl) <i>Nylon 6,10</i>	323
Poly(iminohexamethyleneiminosuberoyl) <i>Nylon 6,8</i>	330
Poly(iminoisophthaloylimino-4,4'-biphenylene)	558
Poly(iminoisophthaloyliminohexamethylene)	390
Poly(iminoisophthaloyliminomethylene-1,4-cyclohexylenemethylene)	481
Poly(iminoisophthaloyliminomethylene-1,3-phenylenemethylene)	438 (M)
Poly[iminomethylene(2,5-dimethyl-1,4-phenylene)methyleneiminosuberoyl]	351
Poly(imino-1,5-naphthyleneiminoisophthaloyl)	598
Poly(imino-1,5-naphthyleneiminoterephthaloyl)	578
Poly(iminooctamethyleneiminodecanedioyl) <i>Nylon 8,10</i>	333
Poly(iminooxalyliminohexamethylene) <i>Nylon 6,2</i>	430
Poly[imino(1-oxohexamethylene)] <i>Nylon 6</i>	326
Poly[imino(1-oxodecamethylene)] <i>Nylon 10</i>	315
Poly[imino(1-oxoheptamethylene)] <i>Nylon 7</i>	325
Poly[imino(1-oxo-3-methyltrimethylene)]	369
Poly[imino(1-oxononamethylene)] <i>Nylon 9</i>	319
Poly[imino(1-oxooctamethylene)] <i>Nylon 8</i>	323
Poly[imino(1-oxotrimethylene)] <i>Nylon 3</i>	384
Poly(iminopentamethyleneiminoadipoyl) <i>Nylon 5,6</i>	318
Poly[iminopentamethyleneiminocarbonyl-1,4-phenylene(2-oxoethylene)]	376
Poly(imino-1,3-phenyleneiminoisophthaloyl)	553 (M)
Poly(imino-1,4-phenyleneiminoterephthaloyl)	618
Poly(iminopimeloyliminoheptamethylene) <i>Nylon 7,7</i>	328
Poly(iminoterephthaloylimino-4,4'-biphenylene)	613
Poly(iminotetramethyleneiminoadipoyl) <i>Nylon 4,6</i>	316
Poly[iminotetramethyleneiminocarbonyl-1,4-phenylene(2-oxoethylene)]	357
Poly(iminotrimethyleneiminoadipoyliminotrimethylene)	307
Poly[iminotrimethyleneiminocarbonyl-1,4-phenylene(2-oxoethylene)]	382
Poly(oxy-1,4-phenyleneiminoterephthaloyl-imino-1,4-phenylene)	613
Poly(sulfonylimino-1,4-phenyleneiminoadipoylimino-1,4-phenylene)	467
<i>Main-chain urethane units</i>	
Poly(oxyalkyleneoxycarbonyliminoalkyleneiminocarbonyl)-[O(CH <sub>2</sub> ) <sub>m</sub> OCONH(CH <sub>2</sub> ) <sub>n</sub> NHCO]-	
Poly(oxyethyleneoxycarbonyliminohexamethyleneiminocarbonyl)	329
Poly[oxyethyleneoxycarbonylimino(6-methyl-1,3-phenylene)iminocarbonyl]	325
Poly(oxyethyleneoxycarbonylimino-1,4-phenylenemethylene-1,4-phenyleneiminocarbonyl)	412
Poly(oxyhexamethyleneoxycarbonyliminohexamethyleneiminocarbonyl)	332
Poly[oxyhexamethyleneoxycarbonylimino(6-methyl-1,3-phenylene)iminocarbonyl]	305
Poly(oxyhexamethyleneoxycarbonylimino-1,4-phenylenemethylene-1,4-phenyleneiminocarbonyl)	364
Poly(oxyoctamethyleneoxycarbonyliminohexamethyleneiminocarbonyl)	331
Poly[oxyoctamethyleneoxycarbonylimino(6-methyl-1,3-phenylene)iminocarbonyl]	337
Poly(oxyoctamethyleneoxycarbonylimino-1,4-phenylenemethylene-1,4-phenyleneiminocarbonyl)	352

Polymer name	Glass transition temperature ( $T_g$ /K)
Poly(oxytetramethyleneoxycarbonyliminohexamethyleneiminocarbonyl)	332
Poly[oxytetramethyleneoxycarbonylimino(6-methyl-1,3-phenylene)iminocarbonyl]	315
Poly(oxytetramethyleneoxycarbonylimino-1,4-phenylenemethylene-1,4-phenyleneiminocarbonyl)	382
<i>Main-chain siloxanes</i>	
Poly[oxy(dialkylsilylene)] <i>Poly(dialkylsiloxane)</i> –[O(R <sub>2</sub> Si)–	
Poly[oxy(dimethylsilylene)]	148
<i>Poly(dimethylsiloxane)</i> [PDMS]	
Poly[oxy(dimethylsilylene)oxy-1,4-phenylene]	363 (M)
Poly[oxy(dimethylsilylene)oxy-1,4-phenyleneisopropylidene-1,4-phenylene]	318 (M)
Poly[oxy(diphenylsilylene)]	238
<i>Poly(diphenylsiloxane)</i>	
Poly[oxy(diphenylsilylene)-1,3-phenylene]	ca 331
Poly[oxy((methyl)phenylsilylene)]	187
Poly[oxy((methyl)-3,3,3-trifluoropropylsilylene)]	<193
<i>Main-chain sulfur-containing units</i>	
Poly(dithioethylene)	223
Poly(dithiomethylene-1,4-phenylenemethylene)	296
Poly(oxy-4,4'-biphenylene-1,4-phenylenesulfonyl-1,4-phenylene)	503 (M)
Poly(oxycarbonyloxy-1,4-phenylenethio-1,4-phenylene)	ca 383
Poly(oxyethylenedithioethylene)	220 (M)
Poly[oxy(2-hydroxytrimethylene)oxy-1,4-phenylenesulfonyl-1,4-phenylene]	428
Poly(oxymethyleneoxyethylenedithioethylene)	214
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenylenecarbonyl-1,4-phenylene)	478 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenyleneisopropylidene-1,4-phenylene)	438 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenylene)	487
Poly(oxy-1,4-phenylenesulfonyl-4,4'-biphenylenesulfonyl-1,4-phenylene)	533
Poly[oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy(2,6-dimethyl-1,4-phenylene)isopropylidene(3,5-dimethyl-1,4-phenylene)]	508 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenylenecarbonyl-1,4-phenylene)	478 (M)
Poly[oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenylene(hexafluoroisopropylidene)1,4-phenylene]	478 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenyleneisopropylidene-1,4-phenylene)	449
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenylenemethylene-1,4-phenylene)	453 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenylenethio-1,4-phenylene)	448 (M)
Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxyterephthaloyl)	522
Poly(oxytetramethylenedithiotetramethylene)	197
Poly(sulfonyl-1,2-cyclohexylene)	401
Poly(sulfonyl-1,3-cyclohexylene)	381
Poly(sulfonyl-1,4-phenylenemethylene-1,4-phenylene)	497
Poly(thio-1,3-cyclohexylene)	221
Poly[thio(difluoromethylene)]	155
Poly(thioethylene)	223
Poly[thio(1-ethylethylene)]	218
Poly[thio(1-methyl-3-oxotrimethylene)]	285
Poly[thio(1-methyltrimethylene)]	214
Pol[(thio(1-oxohexamethylene)]	292
Poly(thio-1,4-phenylene)	370
Poly(thiopropylene)	226
<i>Main-chain heterocyclic units</i>	
Poly(1,3-dioxo-4,6-cyclohexylenemethylene)	378
<i>Poly(vinyl formal)</i>	
Poly[(2,6-dioxopiperidine-1,4-diyl)trimethylene]	363
Poly[(2-methyl-1,3-dioxo-4,6-cyclohexylene)methylene]	355
<i>Poly(vinyl acetal)</i>	
Poly(1,4-piperazinediylcarbonyloxyethyleneoxycarbonyl)	333
Poly(1,4-piperazinediylisophthaloyl)	465 (M)
Poly[(2-propyl-1,3-dioxo-4,6-cyclohexylene)methylene]	322
<i>Poly(vinyl butyral)</i>	
Poly(3,6-pyridazinediyl-1,4-phenyleneisopropylidene-1,4-phenyleneoxy)	453 (M)
Poly(2,5-pyridinediylcarbonyliminohexamethyleneiminocarbonyl)	322

## DIELECTRIC CONSTANT OF SELECTED POLYMERS

This table lists typical values of the dielectric constant (more properly called relative permittivity) of some important polymers. Values are given for frequencies of 1 kHz, 1 MHz, and 1 GHz; in most cases the dielectric constant at frequencies below 1 kHz does not differ significantly from the value at 1 kHz. Since the dielectric constant of a polymeric material can vary with density, degree of crystallinity, and other details of a particular sample, the values given here should be regarded as only typical or average values.

### References

1. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, p. 5-132, McGraw Hill, New York, 1972.
2. Anderson, H. L., Ed., *A Physicist's Desk Reference*, American Institute of Physics, New York, 1989.
3. Brandrup, J., and Immergut, E. H., *Polymer Handbook, Third Edition*, John Wiley & Sons, New York, 1989.

Name	$t/^\circ\text{C}$	1 kHz	1 MHz	1 GHz
Polyacrylonitrile	25	5.5	4.2	
Polyamides (nylons)	25	3.50	3.14	2.8
	84	11	4.4	2.8
Polybutadiene	25	2.5		
Polycarbonate	23	2.92	2.8	
Polychloroprene (neoprene)	25	6.6	6.3	4.2
Polychlorotrifluoroethylene	23	2.65	2.46	2.39
Polyethylene	23	2.3		
Poly(ethylene terephthalate) (Mylar)	23	3.25	3.0	2.8
Polyisoprene (natural rubber)	27	2.6	2.5	2.4
Poly(methyl methacrylate)	27	3.12	2.76	2.6
	80	3.80	2.7	2.6
Polyoxymethylene (polyformaldehyde)	25	3.8		
Poly(phenylene oxide)	23	2.59	2.59	
Polypropylene	25	2.3	2.3	2.3
Polystyrene	25	2.6	2.6	2.6
Polysulfones	25	3.13	2.10	
Polytetrafluoroethylene (teflon)	25	2.1	2.1	2.1
Poly(vinyl acetate)	50		3.5	
	150		8.3	
Poly(vinyl chloride)	25	3.39	2.9	2.8
	100	5.3	3.3	2.7
Poly(vinylidene chloride)	23	4.6	3.2	2.7
Poly(vinylidene fluoride)	23	12.2	8.9	4.7



# PRESSURE-VOLUME-TEMPERATURE RELATIONSHIP FOR POLYMER MELTS

Christian Wohlfarth

Numerous theoretical equations of state for polymer liquids have been developed. These, at the minimum, have to provide accurate fitting functions to experimental data. However, for the purpose of this table, the empirical Tait equation along with a polynomial expression for the zero pressure isobar is used. This equation is able to represent the experimental data for the melt state within the limits of experimental errors, i.e., the maximum deviations between measured and calculated specific volumes are about 0.001-0.002 cm<sup>3</sup>/g.

The general form of the Tait equation is:

$$V(P,T) = V(0,T)\{1 - C \ln[1 + P/B(T)]\} \quad (1)$$

where the coefficient  $C$  is usually taken to be a universal constant equal to 0.0894.  $T$  is the absolute temperature in K and  $P$  the pressure in MPa. The volume  $V$  is the specific volume in cm<sup>3</sup>/g. The Tait parameter  $B(T)$  has the very simple meaning that it is inversely proportional to the compressibility  $\kappa$  at constant temperature and zero pressure:

$$\kappa(0,T) = -[1/V(0,T)](dV/dP) = C/B(T) \quad (2)$$

The  $B(T)$  function is usually given by:

$$B(T) = B_0 \exp[-B_1(T-273.15)] \quad (3)$$

but, sometimes a polynomial expression is used:

$$B(T) = b_0 + b_1(T-273.15) + b_2(T-273.15)^2 \quad (4)$$

The zero-pressure isobar  $V(0,T)$  is usually given by:

$$V(0,T) = A_0 + A_1(T-273.15) + A_2(T-273.15)^2 \quad (5)$$

where  $A_0, A_1, A_2$  are specific constants for a given polymer (the expression  $T-273.15$  is used because fitting to the zero-pressure isobar is usually done in terms of Celsius temperature). Other forms for  $V(0,T)$  are also found in the literature, such as

$$V(0,T) = A_3 \exp[A_4(T-273.15)] \quad (6)$$

or

$$V(0,T) = A_5 \exp(A_6 T^{1.5}) \quad (7)$$

where  $A_3$  and  $A_4$  or  $A_5$  and  $A_6$  are again specific constants for a given polymer.

The Tait equation is particularly useful to calculate derivative quantities, such as the isothermal compressibility and the thermal expansivity coefficients. The isothermal compressibility  $\kappa(P,T)$  is derived from equation (1) as:

$$\kappa(P,T) = -(1/V)(dV/dP) = 1/\{[P + B(T)][1/C - \ln(1 + P/B(T))]\} \quad (8)$$

and the thermal expansivity  $\alpha(P,T)$  as:

$$\alpha(P,T) = (1/V)(dV/dT) = \alpha(0,T) - PB_1\kappa(P,T) \quad (9)$$

where  $\alpha(0,T)$  represents the thermal expansivity at zero (atmospheric) pressure and is calculated from any suitable fit for the zero-pressure volume, such as equations (5) through (7) above.

Because polymer melt PVT-behavior depends only slightly on polymer molar mass above the oligomeric region, usually no information is given in the original literature for the average molar mass of the polymers.

Table 1 summarizes the polymers or copolymers considered here and the experimental ranges of pressure and temperature over which data are available. In Table 2 the Tait-equation functions, with parameters obtained from the fit, are given for 90 polymer or copolymer melts.

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**TABLE 1. Names of the Polymers, Abbreviation Used, and Range of Experimental Data Applied in the Determination of the Equation Constants**

Polymer	Symbol	T/K	P/MPa	Ref.
Ethylene/propylene copolymer (50 wt%)	EP50	413-523	0.1-63	4
Ethylene/vinyl acetate copolymer				
18 wt% vinyl acetate	EVA18	385-491	0.1-177	4
25 wt% vinyl acetate	EVA25	367-506	0.1-177	4
28 wt% vinyl acetate	EVA28	367-508	0.1-177	4
40 wt% vinyl acetate	EVA40	348-508	0.1-177	4
Polyamide-6	PA6	509-569	0.1-196	4
Polyamide-11	PA11	478-542	0.1-200	5
Polyamide-66	PA66	519-571	0.1-196	4
<i>cis</i> -1,4-Polybutadiene	cPBD	277-328	0.1-284	4
Polybutadiene, 8% 1,2-content	PBD-8	298-473	0.1-200	6
Polybutadiene, 24% 1,2-content	PBD-24	298-473	0.1-200	6
Polybutadiene, 40% 1,2-content	PBD-40	298-473	0.1-200	6
Polybutadiene, 50% 1,2-content	PBD-50	298-473	0.1-200	6
Polybutadiene, 87% 1,2-content	PBD-87	298-473	0.1-200	6
Poly(1-butene), isotactic	iPB	406-519	0.1-196	4
Poly(butyl methacrylate)	PnBMA	307-473	0.1-200	4
Poly(butylene terephthalate)	PBT	508-576	0.1-200	3
Poly( $\epsilon$ -caprolactone)	PCL	373-421	0.1-200	4
Polycarbonate-bisphenol-A	PC	424-613	0.1-177	4
Polycarbonate-bisphenol-chloral	BCPC	428-557	0.1-200	4
Polycarbonate-hexafluorobisphenol-A	HFPC	432-553	0.1-200	4
Polycarbonate-tetramethylbisphenol-A	TMPC	491-563	0.1-160	4
Poly(cyclohexyl methacrylate)	PcHMA	396-471	0.1-200	4
Poly(2,5-dimethylphenylene oxide)	PPO	473-593	0.1-177	4
Poly(dimethyl siloxane)	PDMS	298-343	0.1-100	4
Poly(dimethyl siloxane) $M_n = 1000$	PDMS-10	304-420	0.1-250	10
Poly(dimethyl siloxane) $M_n = 4000$	PDMS-40	298-418	0.1-250	10
Poly(dimethyl siloxane) $M_n = 6000$	PDMS-60	291-423	0.1-250	10
Poly(epichlorohydrin)	PECH	333-413	0.1-200	4
Poly(ether ether ketone)	PEEK	619-671	0.1-200	4
Poly(ethyl acrylate)	PEA	310-490	0.1-196	4
Poly(ethyl methacrylate)	PEMA	386-434	0.1-196	4
Polyethylene, high density	HDPE	413-476	0.1-196	4
Polyethylene, linear	LPE	415-473	0.1-200	4
Polyethylene, linear, high MW	HMLPE	410-473	0.1-200	4
Polyethylene, branched	BPE	398-471	0.1-200	4
Polyethylene, low density	LDPE	394-448	0.1-196	4
Polyethylene, low density, type A	LDPE-A	385-498	0.1-196	1
Polyethylene, low density, type B	LDPE-B	385-498	0.1-196	1
Polyethylene, low density, type C	LDPE-C	385-498	0.1-196	1
Poly(ethylene oxide)	PEO	361-497	0.1- 68	4
Poly(ethylene terephthalate)	PET	547-615	0.1-196	4
Poly(4-hexylstyrene)	P4HS	303-403	30-100	4
Polyisobutylene	PIB	326-383	0.1-100	4
Polyisoprene, 8% 3,4-content	PI-8	298-473	0.1-200	6
Polyisoprene, 14% 3,4-content	PI-14	298-473	0.1-200	6
Polyisoprene, 41% 3,4-content	PI-41	298-473	0.1-200	6
Polyisoprene, 56% 3,4-content	PI-56	298-473	0.1-200	6
Poly(methyl acrylate)	PMA	310-493	0.1-196	4
Poly(methyl methacrylate)	PMMA	387-432	0.1-200	4
Poly(4-methyl-1-pentene)	P4MP	514-592	0.1-196	4
Poly( $\alpha$ -methylstyrene)	P $\alpha$ MS	473-533	0.1-170	7
Poly( <i>o</i> -methylstyrene)	P <i>o</i> MS	412-471	0.1-180	4
Polyoxymethylene	POM	463-493	0.1-196	2
Phenoxy <sup>a</sup>	PH	341-573	0.1-177	4
Polysulfone <sup>b</sup>	PSF	475-644	0.1-196	4
Polyarylate <sup>c</sup>	PAr	450-583	0.1-177	4
Polypropylene, atactic	aPP	353-393	0.1-100	4

Polymer	Symbol	T/K	P/MPa	Ref.
Polypropylene, isotactic	iPP	443-570	0.1-196	4
Polystyrene	PS	388-469	0.1-200	4
Poly(tetrafluoroethylene)	PTFE	603-645	0.1- 39	4
Poly(tetrahydrofuran)	PTHF	335-439	0.1- 78	4
Poly(vinyl acetate)	PVAc	308-373	0.1- 80	4
Poly(vinyl chloride)	PVC	373-423	0.1-200	4
Poly(vinyl methyl ether)	PVME	303-471	0.1-200	4
Poly(vinylidene fluoride)	PVdF	451-521	0.1-200	5
Styrene/acrylonitrile copolymer				
2.7 wt% acrylonitrile	SAN3	378-539	0.1-200	4
5.7 wt% acrylonitrile	SAN6	370-540	0.1-200	4
15.3 wt% acrylonitrile	SAN15	405-531	0.1-200	4
18.0 wt% acrylonitrile	SAN18	377-528	0.1-200	4
40 wt% acrylonitrile	SAN40	373-543	0.1-200	4
70 wt% acrylonitrile	SAN70	373-544	0.1-200	4
Styrene/butadiene copolymer				
10 wt% styrene	SBR10	393-533	0.1-196	8
23.5 wt% styrene	SBR23	393-533	0.1-196	8
60 wt% styrene	SBR60	393-533	0.1-196	8
85 wt% styrene	SBR85	393-533	0.1-196	8
Styrene/methyl methacrylate copolymer				
20 wt% methyl methacrylate	SMMA20	383-543	0.1-200	4
60 wt% methyl methacrylate	SMMA60	383-543	0.1-200	4
N-Vinylcarbazole/4-ethylstyrene copolymer				
50 mol% ethylstyrene	VCES50	393-443	30-100	9
N-Vinylcarbazole/4-hexylstyrene copolymer				
80 mol% hexylstyrene	VCHS80	313-423	30-100	9
67 mol% hexylstyrene	VCHS67	333-423	30-100	9
60 mol% hexylstyrene	VCHS60	383-453	30-100	9
50 mol% hexylstyrene	VCHS50	373-443	30-100	9
40 mol% hexylstyrene	VCHS40	423-493	30-100	9
33 mol% hexylstyrene	VCHS33	463-523	30-100	9
20 mol% hexylstyrene	VCHS20	473-523	30-100	9
N-Vinylcarbazole/4-octylstyrene copolymer				
50 mol% octylstyrene	VCOS50	403-453	30-100	9
N-Vinylcarbazole/4-pentylstyrene copolymer				
50 mol% pentylstyrene	VCPS50	383-443	30-100	9

<sup>a</sup> Phenoxy = Poly(oxy-2-hydroxytrimethyleneoxy-1,4-phenyleneisopropylidene-1,4-phenylene)

<sup>b</sup> Polysulfone = Poly(oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-1,4-phenyleneisopropylidene-1,4-phenylene)

<sup>c</sup> Polyarylate = Poly(oxyterephthaloyl/isophthaloyl T/I=50/50)oxy-1,4-phenyleneisopropylidene-1,4-phenylene

TABLE 2. Tait Equation Parameter Functions for Polymer Melts

Polymer	$V(0,T)/\text{cm}^3\text{g}^{-1}$	$B(T)/\text{MPa}$
EP50	$1.2291 + 5.799 \cdot 10^{-5}(T-273.15) + 1.964 \cdot 10^{-6}(T-273.15)^2$	$487.0 \exp[-8.103 \cdot 10^{-3}(T-273.15)]$
EVA18	$1.02391 \exp(2.173 \cdot 10^{-5}T^{1.5})$	$188.2 \exp[-4.537 \cdot 10^{-3}(T-273.15)]$
EVA25	$1.00416 \exp(2.244 \cdot 10^{-5}T^{1.5})$	$184.4 \exp[-4.734 \cdot 10^{-3}(T-273.15)]$
EVA28	$1.00832 \exp(2.241 \cdot 10^{-5}T^{1.5})$	$183.5 \exp[-4.457 \cdot 10^{-3}(T-273.15)]$
EVA40	$1.06332 \exp(2.288 \cdot 10^{-5}T^{1.5})$	$205.1 \exp[-4.989 \cdot 10^{-3}(T-273.15)]$
PA6	$0.7597 \exp[4.701 \cdot 10^{-4}(T-273.15)]$	$376.7 \exp[-4.660 \cdot 10^{-3}(T-273.15)]$
PA11	$0.9581 \exp[6.664 \cdot 10^{-4}(T-273.15)]$	$254.7 \exp[-4.178 \cdot 10^{-3}(T-273.15)]$
PA66	$0.7657 \exp[6.600 \cdot 10^{-4}(T-273.15)]$	$316.4 \exp[-5.040 \cdot 10^{-3}(T-273.15)]$
cPBD	$1.0970 \exp[6.600 \cdot 10^{-4}(T-273.15)]$	$177.7 \exp[-3.593 \cdot 10^{-3}(T-273.15)]$
PBD-8	$1.1004 + 6.718 \cdot 10^{-4}(T-273.15) + 6.584 \cdot 10^{-7}(T-273.15)^2$	$200.0 \exp[-4.606 \cdot 10^{-3}(T-273.15)]$
PBD-24	$1.1049 + 6.489 \cdot 10^{-4}(T-273.15) + 7.099 \cdot 10^{-7}(T-273.15)^2$	$193.0 \exp[-4.519 \cdot 10^{-3}(T-273.15)]$
PBD-40	$1.1013 + 6.593 \cdot 10^{-4}(T-273.15) + 5.776 \cdot 10^{-7}(T-273.15)^2$	$188.0 \exp[-4.437 \cdot 10^{-3}(T-273.15)]$
PBD-50	$1.1037 + 5.955 \cdot 10^{-4}(T-273.15) + 7.789 \cdot 10^{-7}(T-273.15)^2$	$183.0 \exp[-4.425 \cdot 10^{-3}(T-273.15)]$
PBD-87	$1.1094 + 6.729 \cdot 10^{-4}(T-273.15) + 4.470 \cdot 10^{-7}(T-273.15)^2$	$175.0 \exp[-4.538 \cdot 10^{-3}(T-273.15)]$
iPB	$1.1417 \exp[6.751 \cdot 10^{-4}(T-273.15)]$	$167.5 \exp[-4.533 \cdot 10^{-3}(T-273.15)]$
PnBMA	$0.9341 + 5.5254 \cdot 10^{-4}(T-273.15) + 6.5803 \cdot 10^{-6}(T-273.15)^2 + 1.5691 \cdot 10^{-10}(T-273.15)^3$	$226.7 \exp[-5.344 \cdot 10^{-3}(T-273.15)]$
PBT	$0.9640 - 1.017 \cdot 10^{-3}(T-273.15) + 3.065 \cdot 10^{-6}(T-273.15)^2$	$263.0 \exp[-3.444 \cdot 10^{-3}(T-273.15)]$
PCL	$0.9049 \exp[6.392 \cdot 10^{-4}(T-273.15)]$	$189.0 \exp[-3.931 \cdot 10^{-3}(T-273.15)]$
PC	$0.73565 \exp(1.859 \cdot 10^{-5}T^{1.5})$	$310.0 \exp[-4.078 \cdot 10^{-3}(T-273.15)]$
BCPC	$0.6737 + 3.634 \cdot 10^{-4}(T-273.15) + 2.370 \cdot 10^{-7}(T-273.15)^2$	$363.4 \exp[-4.921 \cdot 10^{-3}(T-273.15)]$
HFPC	$0.6111 + 4.898 \cdot 10^{-4}(T-273.15) + 1.730 \cdot 10^{-7}(T-273.15)^2$	$236.6 \exp[-5.156 \cdot 10^{-3}(T-273.15)]$
TMPC	$0.8497 + 5.073 \cdot 10^{-4}(T-273.15) + 3.832 \cdot 10^{-7}(T-273.15)^2$	$231.4 \exp[-4.242 \cdot 10^{-3}(T-273.15)]$
PcHMA	$0.8793 + 4.0504 \cdot 10^{-4}(T-273.15) + 7.774 \cdot 10^{-7}(T-273.15)^2 - 7.7534 \cdot 10^{-10}(T-273.15)^3$	$295.2 \exp[-5.220 \cdot 10^{-3}(T-273.15)]$
PPO	$0.78075 \exp(2.151 \cdot 10^{-5}T^{1.5})$	$227.8 \exp[-4.290 \cdot 10^{-3}(T-273.15)]$
PDMS	$1.0079 \exp[9.121 \cdot 10^{-4}(T-273.15)]$	$89.4 \exp[-5.701 \cdot 10^{-3}(T-273.15)]$
PDMS-10	$0.8343 + 5.991 \cdot 10^{-4}(T-273.15) + 5.734 \cdot 10^{-7}(T-273.15)^2$	$542.63 \exp[-6.69 \cdot 10^{-3}(T-273.15)]$
PDMS-40	$0.8018 + 7.072 \cdot 10^{-4}(T-273.15) + 3.635 \cdot 10^{-7}(T-273.15)^2$	$482.73 \exp[-6.09 \cdot 10^{-3}(T-273.15)]$
PDMS-60	$0.8146 + 5.578 \cdot 10^{-4}(T-273.15) + 5.774 \cdot 10^{-7}(T-273.15)^2$	$482.73 \exp[-6.09 \cdot 10^{-3}(T-273.15)]$
PECH	$0.7216 \exp[5.825 \cdot 10^{-4}(T-273.15)]$	$238.3 \exp[-4.171 \cdot 10^{-3}(T-273.15)]$
PEEK	$0.7158 \exp[6.690 \cdot 10^{-4}(T-273.15)]$	$388.0 \exp[-4.124 \cdot 10^{-3}(T-273.15)]$
PEA	$0.8756 \exp[7.241 \cdot 10^{-4}(T-273.15)]$	$193.2 \exp[-4.839 \cdot 10^{-3}(T-273.15)]$
PEMA	$0.8614 \exp[7.468 \cdot 10^{-4}(T-273.15)]$	$260.9 \exp[-5.356 \cdot 10^{-3}(T-273.15)]$
HDPE	$1.1595 + 8.0394 \cdot 10^{-4}(T-273.15)$	$179.9 \exp[-4.739 \cdot 10^{-3}(T-273.15)]$
LPE	$0.9172 \exp[7.806 \cdot 10^{-4}(T-273.15)]$	$176.7 \exp[-4.661 \cdot 10^{-3}(T-273.15)]$
HMLPE	$0.8992 \exp[8.502 \cdot 10^{-4}(T-273.15)]$	$168.3 \exp[-4.292 \cdot 10^{-3}(T-273.15)]$
BPE	$0.9399 \exp[7.341 \cdot 10^{-4}(T-273.15)]$	$177.1 \exp[-4.699 \cdot 10^{-3}(T-273.15)]$
LDPE	$1.1944 + 2.841 \cdot 10^{-4}(T-273.15) + 1.872 \cdot 10^{-6}(T-273.15)^2$	$202.2 \exp[-5.243 \cdot 10^{-3}(T-273.15)]$
LDPE-A	$1.1484 \exp[6.950 \cdot 10^{-4}(T-273.15)]$	$192.9 \exp[-4.701 \cdot 10^{-3}(T-273.15)]$
LDPE-B	$1.1524 \exp[6.700 \cdot 10^{-4}(T-273.15)]$	$196.6 \exp[-4.601 \cdot 10^{-3}(T-273.15)]$
LDPE-C	$1.1516 \exp[6.730 \cdot 10^{-4}(T-273.15)]$	$186.7 \exp[-4.391 \cdot 10^{-3}(T-273.15)]$
PEO	$0.8766 \exp[7.087 \cdot 10^{-4}(T-273.15)]$	$207.7 \exp[-3.947 \cdot 10^{-3}(T-273.15)]$
PET	$0.6883 + 5.90 \cdot 10^{-4}(T-273.15)$	$369.7 \exp[-4.150 \cdot 10^{-3}(T-273.15)]$
P4HS	$0.8251 + 6.77 \cdot 10^{-4}T$	$103.1 \exp[-2.417 \cdot 10^{-3}(T-273.15)]$
PIB	$1.0750 \exp[5.651 \cdot 10^{-4}(T-273.15)]$	$200.3 \exp[-4.329 \cdot 10^{-3}(T-273.15)]$
PI-8	$1.1030 + 6.488 \cdot 10^{-4}(T-273.15) + 5.125 \cdot 10^{-7}(T-273.15)^2$	$188.0 \exp[-4.541 \cdot 10^{-3}(T-273.15)]$
PI-14	$1.0943 + 6.293 \cdot 10^{-4}(T-273.15) + 6.231 \cdot 10^{-7}(T-273.15)^2$	$202.0 \exp[-4.653 \cdot 10^{-3}(T-273.15)]$
PI-41	$1.0951 + 6.188 \cdot 10^{-4}(T-273.15) + 6.629 \cdot 10^{-7}(T-273.15)^2$	$199.0 \exp[-4.622 \cdot 10^{-3}(T-273.15)]$
PI-56	$1.0957 + 6.655 \cdot 10^{-4}(T-273.15) + 5.661 \cdot 10^{-7}(T-273.15)^2$	$200.0 \exp[-4.644 \cdot 10^{-3}(T-273.15)]$
PMA	$0.8365 \exp[6.795 \cdot 10^{-4}(T-273.15)]$	$235.8 \exp[-4.493 \cdot 10^{-3}(T-273.15)]$
PMMA	$0.8254 + 2.8383 \cdot 10^{-4}(T-273.15) + 7.792 \cdot 10^{-7}(T-273.15)^2$	$287.5 \exp[-4.146 \cdot 10^{-3}(T-273.15)]$
P4MP	$1.4075 - 9.095 \cdot 10^{-4}(T-273.15) + 3.497 \cdot 10^{-6}(T-273.15)^2$	$37.67 + 0.2134(T-273.15) - 7.0445 \cdot 10^{-4}(T-273.15)^2$
PαMS	$0.89365 + 3.4864 \cdot 10^{-4}(T-273.15) + 5.0184 \cdot 10^{-7}(T-273.15)^2$	$297.7 \exp[-4.074 \cdot 10^{-3}(T-273.15)]$
PoMS	$0.9396 \exp[5.306 \cdot 10^{-4}(T-273.15)]$	$261.9 \exp[-4.114 \cdot 10^{-3}(T-273.15)]$
POM	$0.7484 \exp[6.770 \cdot 10^{-4}(T-273.15)]$	$305.6 \exp[-4.326 \cdot 10^{-3}(T-273.15)]$
PH	$0.76644 \exp(1.921 \cdot 10^{-5}T^{1.5})$	$359.9 \exp[-4.378 \cdot 10^{-3}(T-273.15)]$
PSF	$0.7644 + 3.419 \cdot 10^{-4}(T-273.15) + 3.126 \cdot 10^{-7}(T-273.15)^2$	$365.9 \exp[-3.757 \cdot 10^{-3}(T-273.15)]$
PAr	$0.73381 \exp(1.626 \cdot 10^{-5}T^{1.5})$	$296.9 \exp[-3.375 \cdot 10^{-3}(T-273.15)]$
aPP	$1.1841 - 1.091 \cdot 10^{-4}(T-273.15) + 5.286 \cdot 10^{-6}(T-273.15)^2$	$162.1 \exp[-6.604 \cdot 10^{-3}(T-273.15)]$
iPP	$1.1606 \exp[6.700 \cdot 10^{-4}(T-273.15)]$	$149.1 \exp[-4.177 \cdot 10^{-3}(T-273.15)]$

Polymer	$V(0,T)/\text{cm}^3\text{g}^{-1}$	$B(T)/\text{MPa}$
PS	$0.9287 \exp[5.131 \cdot 10^{-4}(T-273.15)]$	$216.9 \exp[-3.319 \cdot 10^{-3}(T-273.15)]$
PTFE	$0.3200 + 9.5862 \cdot 10^{-4}(T-273.15)$	$425.2 \exp[-9.380 \cdot 10^{-3}(T-273.15)]$
PTHF	$1.0043 \exp[6.691 \cdot 10^{-4}(T-273.15)]$	$178.6 \exp[-4.223 \cdot 10^{-3}(T-273.15)]$
PVAc	$0.82496 + 5.820 \cdot 10^{-4}(T-273.15) + 2.940 \cdot 10^{-7}(T-273.15)^2$	$204.9 \exp[-4.346 \cdot 10^{-3}(T-273.15)]$
PVC	$0.7196 + 5.581 \cdot 10^{-5}(T-273.15) + 1.468 \cdot 10^{-6}(T-273.15)^2$	$294.2 \exp[-5.321 \cdot 10^{-3}(T-273.15)]$
PVME	$0.9585 \exp[6.653 \cdot 10^{-4}(T-273.15)]$	$215.8 \exp[-4.588 \cdot 10^{-3}(T-273.15)]$
PVdF	$0.5790 \exp[8.051 \cdot 10^{-4}(T-273.15)]$	$244.0 \exp[-5.210 \cdot 10^{-3}(T-273.15)]$
SAN3	$0.9233 + 3.936 \cdot 10^{-4}(T-273.15) + 5.685 \cdot 10^{-7}(T-273.15)^2$	$239.8 \exp[-4.376 \cdot 10^{-3}(T-273.15)]$
SAN6	$0.9211 + 4.370 \cdot 10^{-4}(T-273.15) + 5.846 \cdot 10^{-7}(T-273.15)^2$	$226.9 \exp[-4.286 \cdot 10^{-3}(T-273.15)]$
SAN15	$0.9044 + 4.207 \cdot 10^{-4}(T-273.15) + 4.077 \cdot 10^{-7}(T-273.15)^2$	$238.4 \exp[-3.943 \cdot 10^{-3}(T-273.15)]$
SAN18	$0.9016 + 4.036 \cdot 10^{-4}(T-273.15) + 4.206 \cdot 10^{-7}(T-273.15)^2$	$240.4 \exp[-3.858 \cdot 10^{-3}(T-273.15)]$
SAN40	$0.8871 + 3.406 \cdot 10^{-4}(T-273.15) + 4.938 \cdot 10^{-7}(T-273.15)^2$	$289.3 \exp[-4.431 \cdot 10^{-3}(T-273.15)]$
SAN70	$0.8528 + 3.616 \cdot 10^{-4}(T-273.15) + 2.634 \cdot 10^{-7}(T-273.15)^2$	$335.4 \exp[-3.923 \cdot 10^{-3}(T-273.15)]$
SBR10	$0.9053 \exp(2.437 \cdot 10^{-5}T^{1.5})$	$530.3 \exp[-3.99 \cdot 10^{-3}(T-273.15)]$
SBR23	$0.8986 \exp(2.317 \cdot 10^{-5}T^{1.5})$	$551.6 \exp[-4.17 \cdot 10^{-3}(T-273.15)]$
SBR60	$0.8812 \exp(2.031 \cdot 10^{-5}T^{1.5})$	$486.0 \exp[-4.34 \cdot 10^{-3}(T-273.15)]$
SBR85	$0.8704 \exp(1.846 \cdot 10^{-5}T^{1.5})$	$356.7 \exp[-4.24 \cdot 10^{-3}(T-273.15)]$
SMMA20	$0.9063 + 3.570 \cdot 10^{-4}(T-273.15) + 6.532 \cdot 10^{-7}(T-273.15)^2$	$232.0 \exp[-4.143 \cdot 10^{-3}(T-273.15)]$
SMMA60	$0.8610 + 3.350 \cdot 10^{-4}(T-273.15) + 6.980 \cdot 10^{-7}(T-273.15)^2$	$261.0 \exp[-4.611 \cdot 10^{-3}(T-273.15)]$
VCES50	$0.6676 + 6.63 \cdot 10^{-4}T$	$5281.7 \exp[-9.264 \cdot 10^{-3}(T-273.15)]$
VCHS80	$0.7753 + 6.17 \cdot 10^{-4}T$	$247.6 \exp[-2.604 \cdot 10^{-3}(T-273.15)]$
VCHS67	$0.8028 + 6.50 \cdot 10^{-4}T$	$581.7 \exp[-4.553 \cdot 10^{-3}(T-273.15)]$
VCHS60	$0.8213 + 6.23 \cdot 10^{-4}T$	$229.1 \exp[-2.133 \cdot 10^{-3}(T-273.15)]$
VCHS50	$0.7827 + 5.05 \cdot 10^{-4}T$	$136.0 \exp[-1.083 \cdot 10^{-3}(T-273.15)]$
VCHS40	$0.7805 + 4.92 \cdot 10^{-4}T$	$155.0 \exp[-1.605 \cdot 10^{-3}(T-273.15)]$
VCHS33	$0.7710 + 4.86 \cdot 10^{-4}T$	$460.4 \exp[-3.453 \cdot 10^{-3}(T-273.15)]$
VCHS20	$0.6416 + 5.42 \cdot 10^{-4}T$	$489.8 \exp[-3.193 \cdot 10^{-3}(T-273.15)]$
VCOS50	$0.7081 + 7.40 \cdot 10^{-4}T$	$666.5 \exp[-4.503 \cdot 10^{-3}(T-273.15)]$
VCPS50	$0.7814 + 4.36 \cdot 10^{-4}T$	$880.1 \exp[-4.393 \cdot 10^{-3}(T-273.15)]$

# UPPER CRITICAL (UCST) AND LOWER CRITICAL (LCST) SOLUTION TEMPERATURES OF BINARY POLYMER SOLUTIONS

Christian Wohlfarth

Liquid-liquid demixing in solutions of polymers in low molar mass solvents is not a rare phenomenon. Demixing depends on concentration, temperature, pressure, molar mass and molar mass distribution function of the polymer, chain branching and end groups of the polymer, the chemical nature of the solvent, isotope substitution in solvents or polymers, chemical composition of copolymers and its distributions, and other variables. Phase diagrams of polymer solutions can therefore show a quite complicated behavior when they have to be considered in detail (see Ref. 1a).

Polymer solutions can undergo demixing when cooling a homogeneous solution as well as when heating such a solution. The corresponding cloud-point curves show a maximum (UCST behavior) or a minimum (LCST behavior). For common polymer solutions, the LCST region is at higher temperatures (in many cases near the critical temperature of the solvent) than the UCST region. The temperature range between both extrema provides the essential information where the one-phase region of a polymer solution can be found. In the case of monodisperse polymers the extrema are equal to the critical points. However, in the case of polydisperse polymers with distribution functions, these extrema are threshold temperatures whereas the critical point shifts to higher concentrations on the shoulder of the cloud-point curve. Usually, the critical concentration is much more strongly influenced than the critical temperature. Thus, the table below does not distinguish between threshold and critical temperatures.

UCST and LCST values depend somewhat on pressure. LCST values in the table are usually given at the vapor pressure of the solvent at this temperature. UCST values are measured in most cases at normal pressure; data at higher pressures are neglected here. The interested reader can find such information, for example, in Refs. 76, 84, 104, 157, 165, 177, 185-187, or 192.

However, UCST and LCST values of a given polymer/solvent pair depend strongly on the molar mass of the polymer. In the case of monodisperse polymers, this dependency can be described in good approximation by the so-called Shultz-Flory plot (see Refs. 6 and 8):

$$\frac{1}{T_{\text{crit}}} = \frac{1}{\theta} \left[ 1 + \text{const.} \left( \frac{1}{\sqrt{r}} - \frac{1}{2r} \right) \right] \quad (1)$$

where  $r$  denotes the number of segments of a polymer (being proportional to the degree of polymerization or to the molar mass or molar volume of the polymer). Extrapolation to  $r \rightarrow \infty$ , i.e., to infinite molar mass, leads to the value of the  $\theta$ -temperature. This  $\theta$ -temperature is the highest temperature for UCST behavior or the lowest temperature for LCST behavior and a given polymer/solvent pair. In the case of polydisperse polymers, the segment number in equation (1) is to be replaced by its weight average,  $r_w$  (related to  $M_w$ ). The constant in equation (1) reflects further thermodynamic properties of the given polymer/solvent pair, but should not depend on molar mass. A detailed discussion can be found in Ref. 1b.

The printed table in the *Handbook* provides only one data line for a given polymer/solvent pair and does not show the molar mass dependence of UCST or LCST data. The entire table with all data at different molar masses for many of the systems is given in the electronic version, however. Nevertheless, the necessary molar mass information for a system is always provided in the table by the corresponding number average,  $M_n$ , mass average,  $M_w$ , or viscosity average,  $M_\eta$ , values of the polymer as given in the original sources.

Polymer	$M_n/\text{g mol}^{-1}$	$M_w/\text{g mol}^{-1}$	$M_\eta/\text{g mol}^{-1}$	Solvent	UCST/K	LCST/K	Ref
Acrylonitrile/butadiene copolymer							
(18% Acrylonitrile)			840000	Ethyl acetate		427	220
(26% Acrylonitrile)			1000000	Ethyl acetate		412	220
Butadiene/ $\alpha$ -methylstyrene copolymer							
(10% $\alpha$ -Methylstyrene)			100000	Ethyl acetate	387	393	220
Carbon monoxide/ethylene copolymer							
(1:1, alternating)		1000000		1,1,1,3,3,3-Hexafluoro-2-propanol		453	159
Cellulose diacetate			120000	Benzyl alcohol	372		86
	59900	75500		2-Butanone	279.7	471.5	111
	59300			2-Propanone	216.2	438.2	42
Cellulose diacetate/styrene graft copolymer							
(77.4 wt% grafted polystyrene)		750000		<i>N,N</i> -Dimethylformamide	262	399	106
		750000		Tetrahydrofuran		363	106
Cellulose nitrate (13.3 wt% N)							
	unknown			2-Propanone	328	182	148

Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_\eta/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
Cellulose triacetate			20000	Benzyl alcohol	322		86
		100500		2-Propanone	290.0	472.0	42
Cellulose tricaprylate	infinite			<i>N,N</i> -Dimethylformamide	413		5
	infinite			3-Phenyl-1-propanol	321		5
Decamethyltetrasiloxane	310.69			Tetradecafluorohexane	332.59		195
<i>N,N</i> -Dimethylacrylamide/2-butoxyethyl acrylate copolymer (50 wt% 2-butoxyethyl acrylate)				Water		<273.2	164
<i>N,N</i> -Dimethylacrylamide/butyl acrylate copolymer (15 wt% Butyl acrylate) (20 wt% Butyl acrylate) (30 wt% Butyl acrylate) (35 wt% Butyl acrylate)				Water		346.2	164
				Water		323.2	164
				Water		294.2	164
				Water		281.2	164
<i>N,N</i> -Dimethylacrylamide/2-ethoxyethyl acrylate copolymer (50 wt% 2-Ethoxyethyl acrylate) (75 wt% 2-Ethoxyethyl acrylate)				Water		319.2	164
				Water		285.2	164
<i>N,N</i> -Dimethylacrylamide/ethyl acrylate copolymer (25 wt% Ethyl acrylate) (30 wt% Ethyl acrylate) (50 wt% Ethyl acrylate) (55 wt% Ethyl acrylate)				Water		347.2	164
				Water		334.2	164
				Water		287.2	164
				Water		<273.2	164
<i>N,N</i> -Dimethylacrylamide/2-methoxyethyl acrylate copolymer (38 mol% 2-Methoxyethyl acrylate) (45 mol% 2-Methoxyethyl acrylate) (55 mol% 2-Methoxyethyl acrylate) (68 mol% 2-Methoxyethyl acrylate) (82 mol% 2-Methoxyethyl acrylate) (92 mol% 2-Methoxyethyl acrylate)				Water		353	184
				Water		333	184
				Water		315	184
				Water		305	184
				Water		288	184
				Water		283	184
<i>N,N</i> -Dimethylacrylamide/methyl acrylate copolymer (30 wt% Methyl acrylate) (40 wt% Methyl acrylate) (50 wt% Methyl acrylate) (55 wt% Methyl acrylate) (60 wt% Methyl acrylate) (70 wt% Methyl acrylate)				Water		371.2	164
				Water		338.2	164
				Water		314.2	164
				Water		294.2	164
				Water		279.2	164
				Water		<273.2	164
<i>N,N</i> -Dimethylacrylamide/propyl acrylate copolymer (20 wt% Propyl acrylate) (30 wt% Propyl acrylate) (40 wt% Propyl acrylate) (50 wt% Propyl acrylate)				Water		353.2	164
				Water		337.2	164
				Water		294.2	164
				Water		281.2	164
Dimethylsiloxane/methylphenylsiloxane copolymer (15 wt% methylphenylsiloxane)	9100	41200		Anisole	291.45		198

Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_v/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
Ethylene/propylene copolymer (33 mol% ethylene)	9100	41200		2-Propanone	282.45		198
			145000	Cyclohexane		534	101
			145000	Cyclopentane		490	101
			145000	2,2-Dimethylbutane		428	101
			145000	2,3-Dimethylbutane		452	101
			145000	3,4-Dimethylhexane		541	101
			145000	2,2-Dimethylpentane		472	101
			145000	2,3-Dimethylpentane		500	101
			145000	2,4-Dimethylpentane		464	101
			145000	3-Ethylpentane		511	101
			145000	Heptane		502	101
			145000	Hexane		455	101
			145000	2-Methylbutane		396	101
			145000	Methylcyclohexane		558	101
			145000	Methylcyclopentane		512	101
			145000	2-Methylhexane		486	101
			145000	Nonane		558	101
			145000	Octane		528	101
			145000	Pentane		409	101
			145000	2,2,4,4-Tetramethylpentane		539	101
		145000	2,2,3-Trimethylbutane		500	101	
		145000	2,2,4-Trimethylpentane		503	101	
Ethylene/propylene copolymer (43 mol% ethylene)	70000	140000		Hexane		436	127
	70000	140000		2-Methylpentane		474	127
	70000	140000		Pentane		441	127
Ethylene/propylene copolymer (53 mol% ethylene)			154000	2,2-Dimethylbutane		407	101
			154000	2,3-Dimethylbutane		437	101
			154000	2,2-Dimethylpentane		453	101
			154000	2,3-Dimethylpentane		488	101
			154000	2,4-Dimethylpentane		445	101
			154000	3-Ethylpentane		500	101
			154000	Heptane		493	101
			154000	Hexane		443	101
			154000	Pentane		395	101
			154000	2,2,3-Trimethylbutane		488	101
			154000	2,3,4-Trimethylhexane		565	101
			154000	2,2,4-Trimethylpentane		484	101
	Ethylene/propylene copolymer (63 mol% ethylene)			236000	Cyclohexane		526
			236000	Cyclopentane		481	101
			236000	2,3-Dimethylbutane		429	101
			236000	3,4-Dimethylhexane		530	101
			236000	2,2-Dimethylpentane		444	101
			236000	2,3-Dimethylpentane		482	101
			236000	2,4-Dimethylpentane		434	101



Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_v/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
			236000	3-Ethylpentane		492	101
			236000	Heptane		485	101
			236000	Hexane		436	101
			236000	2-Methylbutane		348	101
			236000	Methylcyclopentane		498	101
			236000	Nonane		547	101
			236000	Octane		512	101
			236000	Pentane		387	101
			236000	2,2,4,4-Tetramethylpentane		528	101
			236000	2,2,3-Trimethylbutane		479	101
			236000	2,2,4-Trimethylpentane		479	101
Ethylene/propylene copolymer (75 mol% ethylene)			109000	2,2-Dimethylpentane		431	101
			109000	2,4-Dimethylpentane		425	101
			109000	Heptane		475	101
			109000	Hexane		427	101
			109000	Nonane		542	101
			109000	Octane		509	101
			109000	Pentane		378	101
			109000	2,2,4,4-Tetramethylpentane		523	101
			109000	2,2,4-Trimethylpentane		469	101
Ethylene/propylene copolymer (81 mol% ethylene)			195000	Cyclohexane		522	101
			195000	Cyclopentane		474	101
			195000	2,2-Dimethylbutane		381	101
			195000	2,3-Dimethylbutane		413	101
			195000	2,4-Dimethylhexane		478	101
			195000	2,5-Dimethylhexane		466	101
			195000	3,4-Dimethylhexane		522	101
			195000	2,2-Dimethylpentane		425	101
			195000	2,3-Dimethylpentane		471	101
			195000	2,4-Dimethylpentane		420	101
			195000	3-Ethylpentane		478	101
			195000	Heptane		468	101
			195000	Hexane		425	101
			195000	2-Methylbutane		327	101
			195000	Methylcyclohexane		541	101
			195000	Methylcyclopentane		493	101
			195000	2-Methylhexane		453	101
			195000	3-Methylhexane		459	101
			195000	Nonane		540	101
			195000	Octane		506	101
			195000	Pentane		370	101
			195000	2,2,4,4-Tetramethylpentane		519	101
			195000	2,2,3-Trimethylbutane		461	101
			195000	2,2,4-Trimethylpentane		460	101
Ethylene/vinyl acetate copolymer ( 2.3 wt% Vinyl acetate)	52000	465000		Diphenyl ether	404.2		143
( 4.0 wt% Vinyl acetate)	47000	280000		Diphenyl ether	392.5		143

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
( 7.1 wt% Vinyl acetate)	34000	460000		Diphenyl ether	378.2		143
( 9.5 wt% Vinyl acetate)	53000	350000		Diphenyl ether	367.3		143
( 9.7 wt% Vinyl acetate)	55000	490000		Diphenyl ether	370.8		143
(12.1 wt% Vinyl acetate)	66000	300000		Diphenyl ether	360.4		143
(42.6 mol% Vinyl acetate)	14800	41500		Methyl acetate	307.0		130
Ethylene/vinyl alcohol copolymer							
(87.2 mol% Vinyl alcohol)			infinite	Water	463.55	285.65	44
(88.9 mol% Vinyl alcohol)			infinite	Water	449.15	290.75	44
(91.0 mol% Vinyl alcohol)			infinite	Water	428.45	302.95	44
(94.1 mol% Vinyl alcohol)			infinite	Water	389.25	324.45	44
Ethylene oxide/propylene oxide copolymer							
(20.0 mol% Ethylene oxide)	3400			Water		303	211
(27.0 mol% Ethylene oxide)	3000			Water		309	210
(30.0 mol% Ethylene oxide)	5400			Water		313	211
(38.5 mol% Ethylene oxide)	5000			Water		309	210
(50.0 mol% Ethylene oxide)	3900			Water		323	211
(58.8 mol% Ethylene oxide)	3000			Water		326.65	210
(72.4 mol% Ethylene oxide)		36000		Water		333	153
(79.5 mol% Ethylene oxide)		30800		Water		345	153
(86.6 mol% Ethylene oxide)		30100		Water		355.5	153
Gutta Percha							
			194000	Propyl acetate	318.95		7
Hydroxypropylcellulose							
		75000		Water		318.45	43
		300000		Water		331.25	43
<i>N</i> -Isopropylacrylamide/acrylamide copolymer							
(15 mol% Acrylamide)		3100000		Water		315.15	172
(30 mol% Acrylamide)		4500000		Water		326.15	172
(45 mol% Acrylamide)		3900000		Water		347.15	172
<i>N</i> -Isopropylacrylamide/1-deoxy-1-methacrylamido- <i>D</i> -glucitol							
(12.9 mol% Glucitol)	78000	170000		Water		311.3	218
(13.7 mol% Glucitol)	51600	110000		Water		314.9	218
(14.0 mol% Glucitol)	145000	432000		Water		307.5	218
<i>N</i> -Isopropylacrylamide/ <i>N</i> -isopropylmethacrylamide copolymer							
(10.56 mol% <i>N</i> -Isopropylmethacrylamide)	55300	177000		Water		307.15	212
(30.00 mol% <i>N</i> -Isopropylmethacrylamide)	28800	92000		Water		309.75	212
(39.99 mol% <i>N</i> -Isopropylmethacrylamide)	23100	74000		Water		311.05	212
(59.89 mol% <i>N</i> -Isopropylmethacrylamide)	23100	74000		Water		314.65	212
(79.81 mol% <i>N</i> -Isopropylmethacrylamide)	16600	53000		Water		317.35	212
(89.99 mol% <i>N</i> -Isopropylmethacrylamide)	14700	47000		Water		318.75	212
Methylcellulose (about 30 mol% methyl substitution)							
			70000	Water		324.75	47
Methylcellulose/hydroxypropylcellulose copolymer (25 mol% methyl, 8 mol% hydroxypropyl substitution)							
			80000	Water		340.15	63
Natural rubber							
		300000		Pentane		403	10
			74500	2-Pentanone	274.45		7

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
Phenol-formaldehyde resin (acetylated)				2-Ethoxyethanol	378.2		200
Poly(acrylic acid)		120000		Tetrahydrofuran		268.3	189
Poly[bis(2,3-dimethoxypropanoxy)phosphazene]	1070000	1500000		Water		317.15	183
Poly[bis(2-(2'-methoxyethoxy)ethoxy)phosphazene]	667000	1000000		Water		338.15	183
Poly[bis(2,3-bis(2-methoxyethoxy)propanoxy)phosphazene]	714000	1000000		Water		311.15	183
Poly[bis(2,3-bis(2-(2'-methoxyethoxy)ethoxy)propanoxy)phosphazene]	1420000	1700000		Water		322.65	183
Poly[bis(2,3-bis(2-(2'-(2"-dimethoxyethoxy)ethoxy)ethoxy)propanoxy)phosphazene]	857000	1200000		Water		334.65	183
Poly(1-butene) (atactic)		infinite		Anisole	359.4		11
		infinite		Toluene	356.2		28
Poly(1-butene) (isotactic)		infinite		Anisole	362.3		11
			530000	Cyclopentane		498	102
			530000	2,2-Dimethylbutane		444	102
			530000	2,5-Dimethylhexane		519	102
			530000	3,4-Dimethylhexane		559	102
			530000	2,3-Dimethylpentane		517	102
			530000	2,4-Dimethylpentane		480	102
			530000	3-Ethylpentane		523	102
			530000	Heptane		509	102
		infinite		Hexane		464	102
			530000	2-Methylbutane		416	102
		infinite		Nonane		564	102
			530000	Octane		540	102
		infinite		Pentane		421	102
			530000	2,2,3-Trimethylbutane		507	102
Poly(butyl methacrylate)							
	278000	470000		1-Butanol	287.15		132
	278000	470000		Decane	357.25		132
	278000	470000		Ethanol	315.25		132
	278000	470000		Heptane	342.55		132
	278000	470000		Octane	345.80		132
	278000	470000		1-Pentanol	286.30		132
	278000	470000		2-Propanol	294.90		132
	278000	470000		2,2,4-Trimethylpentane	347.50		132
Poly(2-chlorostyrene)							
		infinite		Benzene		298	40
Poly(4-chlorostyrene)							
		infinite		Benzene	274.0		22
		infinite		2-(Butoxyethoxy)ethanol		323.25	46
		infinite		Butyl acetate		502.4	22
		infinite		<i>tert</i> -Butyl acetate		338.55	46

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref	
	infinite			Chlorobenzene	128.8		22	
	infinite			2-(Ethoxyethoxy)ethanol		300.95	46	
	infinite			Ethyl acetate		613.2	22	
	infinite			Ethylbenzene	283.2		22	
	infinite			Ethylbenzene	258.45		46	
	infinite			Ethyl chloroacetate	271.35		46	
	infinite			Isopropyl acetate		348.65	46	
	infinite			Isopropylbenzene	332.15		46	
	infinite			Isopropyl chloroacetate	264.95		46	
	infinite			Methyl chloroacetate	337.75		46	
	infinite			Propyl acetate		908.7	22	
	infinite			Tetrachloroethene	317.55		46	
	infinite			Tetrachloromethane	323.85		46	
	infinite			Toluene	236.8		22	
	Poly(decyl methacrylate)	390000	468000		1-Butanol	304.85		113
390000		468000		1-Pentanol	278.40		113	
220000		252000		2-Propanol	346.85		132	
Polydimethylsiloxane (cyclic)	9810	10300		2,2-Dimethylpropane		433	133	
	9810	10300		Tetramethylsilane		448	133, 171	
Polydimethylsiloxane			626000	Butane		392.95	53	
	infinite			Decane		603	30	
	14750	16370		2,2-Dimethylpropane		428	133	
	infinite			Dodecane		643	30	
			626000	Ethane		259.65	53	
			100000	Ethoxybenzene	341.99		108	
	infinite			Heptane		528	30	
	infinite			Hexadecane		708	30	
	infinite			Hexane		493	30	
	infinite			Octane		553	30	
	infinite			Pentane		453	30	
			203000	Propane		340.15	53	
	14750	16370		Tetramethylsilane		443	133, 171	
	Poly(ethyl acrylate)			48000	1-Butanol	310.05		27
				48000	Ethanol	301.15		27
			380000	Methanol	287.25		27	
			48000	1-Propanol	305.15		27	
Polyethylene (branched)	8400	32000		Diphenyl ether	384.7		95, 98	
	24000	123000		Diphenyl ether	396.7		95, 98	
	65000	425000		Diphenyl ether	415.3		95, 98	
Polyethylene (linear)			20000	Anisole	368.15		24	
			20000	Benzyl acetate	459.65		24	
			20000	Benzyl phenyl ether	437.15		24	
			20000	Benzyl propionate	436.15		24	
			50900	Biphenyl	383.55		25	
			61100	Butyl acetate	448	497	70	

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref	
Poly(ethylene glycol)	36700	49300	20000	4- <i>tert</i> -Butylphenol	466.15		24	
			134000	Cyclohexane		518	101	
			20000	Cyclohexanone	389.65		24	
			134000	Cyclopentane		472	101	
				Decane		563.75	91	
				20000	1-Decanol	400.15		24
				20000	Dibenzyl ether	448.65		24
				134000	3,4-Dimethylhexane		515	101
				134000	2,2-Dimethylpentane		399	101
				134000	2,3-Dimethylpentane		463	101
				134000	2,4-Dimethylpentane		395	101
				12000	150000		Diphenyl ether	416.2
				97200	Diphenylmethane	400.25		25
		60400	82600		Dodecane		610.85	91
			218000		1-Dodecanol	405.15		141
				134000	3-Ethylpentane		471	101
		36700	49300		Heptane		464.70	91
				20000	1-Heptanol	440.15		24
		36700	49300		Hexane		414.65	91
		7900	92000		1-Hexanol	458.15		154
				20000	2-Methoxynaphthalene	427.65		24
				20000	3-Methylbutyl acetate	407.15		24
				134000	Methylcyclohexane		537	101
				134000	Methylcyclopentane		488	101
		60400	82600		Nonane		531.90	91
				20000	1-Nonanol	431.15		24
				20000	4-Nonylphenol	410.15		24
		36700	49300		Octane		502.40	91
		7900	92000		1-Octanol	426.65		154
				20000	4-Octylphenol	424.65		24
				134000	Pentane		353	101
				20000	1-Pentanol	445.15		24
				175000	Pentyl acetate	421	528	70
				20000	4- <i>tert</i> -Pentylphenol	443.65		24
				20000	Phenetole	366.65		24
				134000	2,2,4,4-Tetramethylpentane		513	101
	60400	82600		Tridecane		639.30	91	
			134000	2,2,3-Trimethylbutane		444	101	
			134000	2,3,4-Trimethylhexane		545	101	
			134000	2,2,4-Trimethylpentane		495	101	
	97700	135900		Undecane		583.95	91	
			8000	<i>tert</i> -Butyl acetate	321.2	464.2	83	
			21200	<i>tert</i> -Butyl acetate	353.2	431.2	83	
	6100	6200		Water		404.79	185	
	10457	11615		Water		394.33	205	
	40800	151000		Water		378.25	205	
Poly(ethylene oxide)-b-poly[bis(methoxyethoxyethoxy)-phosphazene] block copolymer (about 67 mol% Ethylene oxide)	22000	31500		Water		338	222	

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
Poly(ethylene oxide)-b-poly(propylene oxide)-b-poly(ethylene oxide) triblock copolymer (about 30 mol% Ethylene oxide)		4400		Water		286.65	209
Polyethylethylene	48000	52000		Diphenyl ether	411.2		95, 98
Poly( <i>p</i> -hexylstyrene)	infinite			2-Butanone	302.6		135
Poly(2-hydroxyethyl methacrylate)			77400	1-Butanol	337.25		35
			233600	2-Butanol	287		35
			233600	2-Metyl-1-propanol	342		35
			77400	1,2,3-Propanetriol	345		35
			77400	1-Propanol	311		35
Polyisobutylene	infinite			Anisole	377		3
			72000	Benzene		540.5	39
			703000	Butane		264.75	53
	infinite			Cycloheptane		572	34
			1500000	Cyclohexane		412	10
	infinite			Cyclooctane		637	34
			1500000	Cyclopentane		344	10
	infinite			Decane		535	34
			1500000	2,2-Dimethylbutane		376	10
			1500000	2,3-Dimethylbutane		404	10
	infinite			2,2-Dimethylhexane		454	34
	infinite			2,4-Dimethylhexane		458	34
	infinite			2,5-Dimethylhexane		446	34
	infinite			3,4-Dimethylhexane		497	34
	infinite			2,2-Dimethylpentane		404	34
	infinite			2,3-Dimethylpentane		451	34
	infinite			2,4-Dimethylpentane		403	34
	infinite			3,3-Dimethylpentane		451	34
	infinite			Diphenyl ether	306		3
	infinite			Decane		585	30
	infinite			Dodecane		582	34
	infinite			Ethylbenzene	249		3
	infinite			Ethylcyclopentane		524	34
	infinite			Ethyl heptanoate	306		3
	infinite			Ethyl hexanoate	330		3
	infinite			3-Ethylpentane		458	34
	infinite			Heptane		442	34
			72000	Hexane		428.5	39
			6030	2-Methylbutane		357.85	53
	infinite			Methylcyclohexane		526	34
infinite			Methylcyclopentane		478	34	
infinite			2-Methylheptane		466	34	
infinite			3-Methylheptane		478	34	
infinite			2-Methylhexane		426	34	
infinite			3-Methylhexane		446	34	
infinite			2-Methylpentane		376	34	

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
1,4- <i>cis</i> -Polyisoprene	infinite			3-Methylpentane		405	34
			470	2-Methylpropane		387	10
			72000	Octane		506.0	39
			6030	Pentane		403.55	53
			72000	Pentane		373.5	39
		infinite		Phenetole	357		3
			470	Propane		358	10
		infinite		Propylcyclopentane		547	34
		infinite		Toluene	260		3
		infinite		2,2,3-Trimethylbutane		445	34
		infinite		2,2,4-Trimethylpentane		435	34
			780000	2,5-Dimethylhexane		474.15	140
			780000	3,4-Dimethylhexane		520.15	140
			780000	2,2-Dimethylpentane		445.15	140
			780000	2,3-Dimethylpentane		484.15	140
		780000	2,4-Dimethylpentane		442.15	140	
		780000	3-Methylpentane		483.15	140	
		780000	Heptane		488.15	140	
		780000	Hexane		434.15	140	
		780000	Nonane		541.15	140	
		780000	Octane		509.15	140	
		780000	2,2,4,4-Tetramethylpentane		518.15	140	
		780000	2,3,4-Trimethylhexane		548.15	140	
		780000	2,2,4-Trimethylpentane		471.15	140	
1,4- <i>trans</i> -Polyisoprene			180000	2,5-Dimethylhexane		451.15	140
			180000	3,4-Dimethylhexane		521.15	140
			180000	2,2-Dimethylpentane		405.15	140
			180000	2,3-Dimethylpentane		460.15	140
			180000	2,4-Dimethylpentane		404.15	140
			180000	3-Methylpentane		473.15	140
			180000	Heptane		467.15	140
			180000	Hexane		407.15	140
			180000	Nonane		540.15	140
			180000	Octane		503.15	140
			180000	2,2,4,4-Tetramethylpentane		519.15	140
			180000	2,3,4-Trimethylhexane		548.15	140
Poly( <i>N</i> -isopropylacrylamide)	5400	14000		Water		307.45	146
	146000	530000		Water		305.85	146
Poly( <i>N</i> -isopropylacrylamide)-poly[( <i>N</i> -acetylimino)ethylene] block copolymer (80 wt% <i>N</i> -Isopropylacrylamide)	5500			Water		306.2	223
	6030			Water		306.2	223
Poly( <i>N</i> -isopropylacrylamide)-poly[( <i>N</i> -acetylimino)ethylene] graft copolymer (75 wt% <i>N</i> -Isopropylacrylamide)	6030			Water		306.2	223
	6250	20000		Water		319.95	212
Poly(methyl methacrylate)				Water			

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref	
Poly(methyl methacrylate) (isotactic)			127000	Acetonitrile	267.15		16	
			970000	Acetonitrile	303.15		16	
			50000	1-Butanol	353.25		2	
			infinite	2-Butanone		482	80	
			infinite	1-Chlorobutane	320	463	80	
				2,2-Dimethyl-3-pentanone	301.55		16	
			127000	2,4-Dimethyl-3-pentanone	280.15		16	
		200000	264000	2-Ethoxyethanol	312.15		196	
			77000	Ethyl acetate	290	533	190	
				127000	2-Ethylbutanal	264.65		16
			infinite	3-Heptanone	307.7		126	
				970000	4-Heptanone	299.95		16
			infinite	3-Hexanone		522	80	
			infinite	Methyl acetate		451	80	
				50000	1-Methyl-4-isopropylbenzene	400.15		2
				1400000	2-Octanone	321.15		16
		572400	595300		3-Octanone	329.88		166
				infinite	3-Pentanone		506	80
				50000	1-Propanol	349.95		2
			infinite		2-Propanone		439	80
		200000	264000		Tetra(ethylene glycol)	390.15		196
				400000	Toluene	225.35		2
				50000	Trichloromethane	231.15		2
		200000	264000		Tri(ethylene glycol)	407.15		196
				infinite	Acetonitrile	301	461	80
				infinite	2-Butanone		464	80
				infinite	1-Chlorobutane	309	454	80
			infinite	4-Heptanone	319	522	80	
			infinite	3-Hexanone	279	511	80	
			infinite	Methyl acetate		441	80	
			infinite	3-Pentanone		497	80	
			infinite	2-Propanone		428	80	
Poly(4-methyl-1-pentene) (isotactic)			152000	Butane		388	102	
			152000	Cyclopentane		505	102	
			152000	2,2-Dimethylbutane		462	102	
			152000	2,2-Dimethylpentane		499	102	
			152000	2,4-Dimethylpentane		499	102	
			infinite	Diphenyl	467.8		62	
			infinite	Diphenyl ether	483.2		62	
			infinite	Diphenylmethane	449.8		62	
			152000	3-Ethylpentane		532	102	
			152000	Heptane		522	102	
			152000	Hexane		487	102	
			152000	2-Methylbutane		431	102	
			152000	Nonane		579	102	
			152000	Octane		553	102	
			152000	Pentane		441	102	
			152000	2,2,3-Trimethylbutane		521	102	



Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
Poly( $\alpha$ -methylstyrene)	58500	61400		Butyl acetate	262.05	457.15	181
	99100	113000		Cyclohexane	293.55		152
	26000	31200		Cyclopentane	276.7	435.95	181
		289000		<i>trans</i> -Decahydronaphthalene	273		181
	69500	76500		Hexyl acetate	285.05	508.15	181
	72000	75600		Methylcyclohexane	328.9		203
	58500	61400		Pentyl acetate	287.1	484.6	181
	Poly(2-methyl-5-vinylpyridine)			600000	Butyl acetate	287.95	
			263000	Ethyl butyrate	319.05		20
			335000	Ethyl propionate	293.55		20
			275000	3-Methylbutyl acetate	314.75		20
			335000	4-Methyl-2-pentanone	299.95		20
			170000	2-Methylpropyl acetate	312.35		20
			165000	Pentyl acetate	316.95		20
			284000	Propionitrile	262.35		20
			152000	Propyl acetate	282.65		20
			181000	Propyl propionate	312.15		20
			233000	Tetrahydronaphthalene	316.95		20
Poly(1-pentene) (isotactic)			4500000	Cyclopentane		502	102
			4500000	2,2-Dimethylbutane		457	102
			4500000	3,4-Dimethylhexane		>569	102
			4500000	2,2-Dimethylpentane		502	102
			4500000	2,3-Dimethylpentane		529	102
			4500000	2,4-Dimethylpentane		493	102
			4500000	3-Ethylpentane		537	102
			4500000	Heptane		522	102
			4500000	Hexane		482	102
			4500000	2-Methylbutane		422	102
			4500000	Octane		556	102
			4500000	Pentane		433	102
			4500000	2,2,4-Trimethylpentane		527	102
	Polypropylene (atactic)	infinite			Diphenyl ether	426.5	
infinite				Diethyl ether		383	68
			242000	Heptane		511	101
infinite				Hexane		441	68
			242000	2-Methylbutane		413	101
			242000	Methylcyclohexane		564	101
infinite				Pentane		397	68
Polypropylene (isotactic)				28000	Benzyl phenyl ether	429.2	
			28000	Benzyl propionate	405.2		31
			28000	1-Butanol	395.2		31
			28000	4- <i>tert</i> -Butylphenol	413.2		31
			242000	Cyclohexane		540	101
			242000	Cyclopentane		495	101
			28000	Dibenzyl ether	433.2		31

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
			242000	2,2-Dimethylbutane		441	101
			242000	2,3-Dimethylbutane		465	101
			242000	3,4-Dimethylhexane		553	101
			242000	2,2-Dimethylpentane		489	101
			242000	2,3-Dimethylpentane		513	101
			242000	2,4-Dimethylpentane		481	101
			28000	Diphenyl	388.2		31
			28000	Diphenyl ether	395.2		31
			28000	Diphenylmethane	389.7		31
			242000	3-Ethylpentane		520	101
			28000	4-Ethylphenol	457.2		31
			242000	Heptane		511	101
			242000	Hexane		470	101
			242000	2-Methylbutane		413	101
			28000	3-Methylbutyl benzyl ether	384.2		31
			242000	Methylcyclohexane		564	101
			242000	Methylcyclopentane		518	101
			28000	4-Methylphenol	479.2		31
			28000	2-Methyl-1-propanol	395.2		31
			242000	Nonane		571	101
			242000	Octane		542	101
			28000	4-Octylphenol	379.2		31
			28000	4-Isooctylphenol	383.2		31
			242000	Pentane		422	101
			242000	2,2,4,4-Tetramethylpentane		548	101
			242000	2,2,3-Trimethylbutane		511	101
			242000	2,3,4-Trimethylhexane		585	101
			242000	2,2,4-Trimethylpentane		510	101
Poly(propylene glycol)	1000			Hexane	288.15		88
	575			Water		318.2	65
Polystyrene	34900	37000		Benzene		538.7	61
			62600	Butanedioic acid dimethyl ester	335.15		2
	3700	4000		1-Butanol	383.45		154
	91700	97200		2-Butanone		448.8	61
	545500	600000		Butyl acetate		489	181
	104000	110000		<i>tert</i> -Butyl acetate	250.0	417.9	74
			62600	Butyl stearate	387.15		2
	18400	19200		1-Chlorododecane	274.65		154
	18400	19200		1-Chlorohexadecane	337.05		154
	18400	19200		1-Chlorooctadecane	365.55		154
	18400	19200		1-Chlorotetradecane	309.35		154
	46400	51000		Cyclodecane	278.9		128
	46400	51000		Cycloheptane	276.2		128
	34900	37000		Cyclohexane	285.6	510.9	60
			236000	Cyclohexanol	353.5		8
	46400	51000		Cyclooctane	275.2		128
	91700	97200		Cyclopentane	275.2	445.5	61

Polymer	$M_n$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	$M_w$ /g mol <sup>-1</sup>	Solvent	UCST/K	LCST/K	Ref
	91500	97000		<i>trans</i> -Decahydronaphthalene	281.95		81
		4800		Decane	360.95		154
	3700	4000		1-Decanol	375.15		154
			570000	Decyl acetate		650	64
	18700	19800		Diethyl ether	235.6	314.5	51
	187000	200000		Diethyl malonate	285.8	589.6	74
	47200	50000		Diethyl oxalate	280.05		131
	151000	160000		Dimethoxymethane		401.2	51
		240000		1,4-Dimethylcyclohexane	387	482	116
			62600	Dimethyl malonate	409.15		2
			62600	Dimethyl oxalate	453.15		2
	116000	123000		Dodecadeuterocyclohexane	298.10		224
		25000		Dodecadeuteromethylcyclopentane	310.07		180
		4800		Dodecane	368.65		154
	3700	4000		1-Dodecanol	379.75		154
	infinite			Dodecyl acetate	285.2		206
	104000	110000		Ethyl acetate	213.9	435.4	72
	104000	110000		Ethyl butanoate		490.8	74
	221000	239000		Ethylcyclohexane	330.52		18
	9440	10000		Ethyl formate	272	451	74
		900000		Bis(2-ethylhexyl) phthalate	283.05		136
	4530	4800		Heptane	359	477	112
	3700	4000		1-Dexadecanol	386.25		154
	5500	5770		1,1,1,3,3,3-Hexadeutero-2-propanone	270	436	157
	1920	2030		Hexane	318	470	112
			62600	Hexanoic acid	448.15		2
	3700	4000		1-Hexanol	372.15		154
			62600	3-Hexanol	396.65		2
			90000	Hexyl acetate		578	64
	104000	110000		Methyl acetate	284.2	415.7	72
	104000	110000		3-Methyl-1-butyl acetate	210.1	510.1	72
	91700	97200		Methylcyclohexane	321.8	505.9	60
	10750	11500		Methylcyclopentane	295	480	157
	104000	110000		2-Methyl-1-propyl acetate	210.4	468.5	72
		48000		Nitroethane	303.1		151
		4800		Octadecane	403.55		154
	3700	4000		1-Octadecanol	390.55		154
	4530	4800		Octane	353	527	112
	3700	4000		1-Octanol	372.35		154
			62600	1-Octene	355.15		2
		4800		Pentadecane	385.25		154
		1100		Pentane	292		137
	3700	4000		1-Pentanol	375.05		154
	219800	233000		Pentyl acetate		519	181
		100000		1-Phenyldecane	283.60		105
	5500	5770		2-Propanone	251	452	157
	12750	13500		Propionitrile	312		187
	104000	110000		Propyl acetate	183.7	469.0	72
	104000	110000		2-Propyl acetate	220.9	414.2	72

Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_\eta/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
Polystyrene (three-arm star)	3700	4000	62600	1-Tetradecanol	383.25		154
	34900	37000		Toluene		567.2	60
				Vinyl acetate	384.15		2
Polystyrene (four-arm star)		230000		Cyclohexane	297.1	496.8	93
Poly(trimethylene oxide)		155000		Cyclohexane	294.13		199
Poly(vinyl alcohol)		infinite		Cyclohexane	300		79
Poly( <i>N</i> -vinyl caprolactam)		40000		Water		514	45
Poly(vinyl chloride)		150000		Water		306.45	217
	55000			Dibutyl phthalate	353		114
Poly( <i>N</i> -vinylisobutyramide)	55000			Tricresyl phosphate	383		114
			85000	Dimethyl phthalate	355		219
	66000	105600		Water		313.25	208
Poly(vinyl methyl ether)	46500	98600		Deuterium oxide		307.2	173
Poly( <i>N</i> -vinyl- <i>N</i> -propylacetamide)	83000	155000		Water		306.95	146
			30000	Water		313.5	176
Styrene/acrylonitrile copolymer (21.1 wt% acrylonitrile)	infinite			Toluene	325.4		52
(23.2 wt% Acrylonitrile)	infinite			Toluene	355.1		52
(25.0 wt% Acrylonitrile)	90000	147000		Toluene	313.15		198
(51.0 wt% Acrylonitrile)		347000		Ethyl acetate		344.15	107
Styrene/methyl methacrylate copolymer (52.0 mol% Styrene)		infinite		Cyclohexanol	334.65		38
Styrene/ $\alpha$ -methylstyrene copolymer (20.0 mol% Styrene)	100000	114000		Butyl acetate	288.85	453.05	181
	100000	114000		Cyclohexane	285.85	484.85	181
	100000	114000		Cyclopentane	290.95	421.05	181
	100000	114000		<i>trans</i> -Decahydronaphthalene	264.15		181
	100000	114000		Hexyl acetate	288.55	514.15	181
	100000	114000		Pentyl acetate	303.15	480.65	181
Trifluoronitrosomethane/ tetrafluoroethylene copolymer (1:1) alternating	infinite			1,1,2-Trichloro-1,2,2-trifluoroethane	301.6		12
<i>N</i> -Vinylacetamide/vinyl acetate copolymer (58 mol% Vinyl acetate)	30000	57000		Water		340.15	225
(63 mol% Vinyl acetate)	27000	48600		Water		323.15	225
(78 mol% Vinyl acetate)	26000	46800		Water		282.15	225
Vinyl alcohol/vinyl butyrate copolymer (7.5 mol% Butyralized PVA)	infinite			Water	408.0	298.25	121

Polymer	$M_n/g\ mol^{-1}$	$M_w/g\ mol^{-1}$	$M_z/g\ mol^{-1}$	Solvent	UCST/K	LCST/K	Ref
<i>N</i> -Vinylcaprolactam/ <i>N</i> -vinylamine copolymer (3.8 mol% Vinyl amine)			160000	Water		308.8	176
<i>N</i> -Vinylformamide/vinyl acetate copolymer							
(60 mol% Vinyl acetate)	24000	45600		Water		310.15	225
(66 mol% Vinyl acetate)	25000	47500		Water		291.15	225
(73 mol% Vinyl acetate)	23000	50600		Water		277.15	225

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# VAPOR PRESSURES (SOLVENT ACTIVITIES) FOR BINARY POLYMER SOLUTIONS

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The vapor pressure of a binary polymer solution is given by the activity of the solvent A,  $a_A$ . Solvent activities in polymer solutions are measured either by the isopiestic method applying a reference system whose solvent activity is precisely known or by determining the solvent partial pressure,  $P_A$ , and calculating the activity of the solvent by equation (1):

$$a_A = (P_A/P_A^s) \exp \left[ \frac{(B_{AA} - V_A^L)(P - P_A^s)}{RT} \right] \quad (1)$$

where  $B_{AA}$  is the second virial coefficient,  $P_A^s$  is the saturation vapor pressure, and  $V_A^L$  is the molar volume of the pure solvent A at the measuring temperature  $T$ . The exponential term is neglected in quite a lot of original papers, however, and only the reduced vapor pressures are given (such data are indicated by an asterisk in the table below). Vapor pressures of polymer solutions have been measured since the 1940s, but the amount of experimental data for polymer solutions is still relatively small in comparison to low-molecular mixtures and solutions. The data scatter with respect to temperature, concentration, molar mass, and other polymer characterization variables. Furthermore, the concentration range for measuring vapor pressures in good thermodynamic quality is often limited to the polymer mass fraction range between 0.4 and 0.85. A recent review on methods for the measurement of vapor pressures/solvent activities of polymer solutions and on related problems is given in Ref. [1]. Experimental data have been collected in several books [2-6].

The table in this *Handbook* provides data for a number of polymer solutions as smoothed values over the complete range of solvent activities between 0 (polymer mass fraction = 1) and 1 (polymer mass fraction = 0). For this purpose, the data were selected from data books [4-6] as well as from a number of original sources [7-22] which are not included in these books. The appropriate data were smoothed. The final table provides then the polymer mass fractions at given fixed solvent activities between 0.1 and 0.9. Of course, the user must keep in mind that the activity vs. concentration range of the experimental data is sometimes smaller than the below given complete range, thus the smoothed data should be used with sufficient care.

Generally, vapor pressures or solvent activities of binary polymer solutions depend on molar mass. However, for high molecular weight polymers (well above the oligomer region), this molar-mass dependence can be neglected in many cases. Therefore, the table below presents only data for polymer solutions where the number average molar mass,  $M_n$ , is in the order of  $10^5$  g/mol or even higher, therefore, the molar mass is not specified. The temperature is

stated, even though the temperature dependence of  $a_A$  is relatively small for the temperature ranges where most of the experimental data exist.

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Solvent Activity  $a_A$  as Function of Temperature and Mass Fraction

Polymer/ solvents	$a_A$ : T/K	Mass Fraction of the Polymer								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
<i>Acrylonitrile/Styrene Copolymer (28 wt% Acrylonitrile)</i>										
Benzene <sup>*)</sup>	343.15	0.982	0.962	0.940	0.915	0.886	0.851	0.809	0.753	0.670
1,2-Dimethylbenzene <sup>*)</sup>	398.15	0.983	0.964	0.942	0.918	0.890	0.857	0.817	0.764	0.685
1,3-Dimethylbenzene <sup>*)</sup>	398.15	0.983	0.965	0.944	0.921	0.893	0.861	0.821	0.769	0.690
1,4-Dimethylbenzene <sup>*)</sup>	398.15	0.983	0.964	0.942	0.918	0.890	0.857	0.817	0.763	0.684
Propylbenzene <sup>*)</sup>	398.15	0.987	0.972	0.955	0.935	0.913	0.885	0.851	0.804	0.732
Toluene <sup>*)</sup>	343.15	0.982	0.962	0.940	0.915	0.886	0.851	0.809	0.753	0.669



Polymer/ solvents	$a_1$ : T/K	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Mass Fraction of the Polymer										
<i>Butadiene/Styrene Copolymer (41 wt% Styrene)</i>										
Benzene <sup>*)</sup>	343.15	0.968	0.934	0.896	0.853	0.805	0.748	0.680	0.591	0.461
Cyclohexane <sup>*)</sup>	343.15	0.978	0.953	0.925	0.893	0.856	0.811	0.754	0.678	0.556
Ethylbenzene <sup>*)</sup>	398.15	0.974	0.945	0.912	0.875	0.831	0.779	0.713	0.625	0.491
Mesitylene <sup>*)</sup>	398.15	0.977	0.950	0.921	0.887	0.847	0.799	0.738	0.656	0.526
Toluene <sup>*)</sup>	343.15	0.970	0.936	0.899	0.857	0.808	0.751	0.682	0.591	0.456
<i>Cellulose Triacetate</i>										
Dichloromethane	298.15	0.979	0.956	0.930	0.899	0.863	0.819	0.762	0.683	0.554
Trichloromethane	298.15	0.978	0.953	0.924	0.892	0.853	0.806	0.747	0.665	0.533
<i>Dextran</i>										
Water	313.15	0.988	0.975	0.960	0.942	0.921	0.894	0.860	0.810	0.725
<i>Hydroxyethylcellulose</i>										
Water	368.15	0.988	0.974	0.958	0.939	0.915	0.884	0.841	0.775	0.650
<i>Hydroxypropylstarch</i>										
Water	293.15	0.989	0.977	0.963	0.947	0.927	0.903	0.872	0.827	0.749
<i>Nitrocellulose</i>										
Ethyl acetate	293.15	0.938	0.885	0.835	0.786	0.737	0.685	0.627	0.560	0.471
Ethyl formate	293.15	0.958	0.916	0.873	0.828	0.780	0.728	0.668	0.595	0.494
Ethyl propionate	293.15	0.941	0.889	0.839	0.789	0.739	0.685	0.625	0.555	0.460
Methyl acetate	293.15	0.890	0.820	0.763	0.711	0.660	0.609	0.554	0.490	0.406
2-Propanone	293.15	0.922	0.861	0.807	0.756	0.706	0.653	0.596	0.530	0.443
Propyl acetate	293.15	0.937	0.881	0.827	0.775	0.722	0.665	0.602	0.528	0.426
<i>Polybutadiene (random cis-trans-vinyl)</i>										
Benzene	298.15	0.964	0.925	0.884	0.839	0.788	0.731	0.663	0.578	0.455
Cyclohexane	298.15	0.974	0.945	0.913	0.876	0.833	0.782	0.719	0.635	0.507
Dichloromethane	298.15	0.951	0.902	0.852	0.800	0.745	0.684	0.616	0.532	0.415
Hexane	298.15	0.984	0.965	0.943	0.916	0.881	0.837	0.775	0.683	0.534
Tetrachloromethane	298.15	0.932	0.865	0.799	0.731	0.660	0.585	0.503	0.409	0.288
Toluene	298.15	0.969	0.935	0.898	0.856	0.809	0.754	0.688	0.603	0.476
Trichloromethane	298.15	0.925	0.855	0.788	0.720	0.650	0.578	0.498	0.406	0.289
<i>1,4-cis-Polybutadiene</i>										
Benzene	298.15	0.966	0.930	0.890	0.846	0.796	0.738	0.668	0.580	0.450
Cyclohexane	298.15	0.977	0.951	0.922	0.888	0.849	0.803	0.747	0.677	0.581
Dichloromethane	298.15	0.948	0.898	0.848	0.796	0.742	0.683	0.616	0.536	0.424
Hexane	298.15	0.983	0.963	0.941	0.916	0.886	0.850	0.804	0.741	0.639
Tetrachloromethane	298.15	0.936	0.871	0.805	0.736	0.665	0.588	0.505	0.409	0.287
Toluene	298.15	0.969	0.936	0.900	0.860	0.815	0.763	0.701	0.622	0.506
Trichloromethane	298.15	0.915	0.840	0.770	0.702	0.634	0.562	0.485	0.396	0.283
<i>Poly(butyl acrylate)</i>										
Benzene	298.15	0.964	0.926	0.887	0.845	0.799	0.749	0.691	0.619	0.519
Dichloromethane	298.15	0.868	0.801	0.744	0.690	0.636	0.577	0.511	0.430	0.318
Tetrachloromethane	298.15	0.932	0.868	0.805	0.742	0.677	0.607	0.529	0.438	0.317
Toluene	298.15	0.967	0.932	0.893	0.849	0.801	0.744	0.676	0.590	0.463
Trichloromethane	298.15	0.901	0.811	0.733	0.662	0.595	0.529	0.459	0.381	0.282
<i>Poly(butyl methacrylate)</i>										
Benzene	313.15	0.971	0.939	0.902	0.861	0.813	0.756	0.685	0.592	0.453
1-Butanol	313.15	0.991	0.980	0.968	0.953	0.936	0.914	0.885	0.842	0.762
2-Butanol	313.15	0.992	0.982	0.969	0.953	0.933	0.906	0.869	0.815	0.719
2-Butanone	313.15	0.982	0.963	0.940	0.914	0.884	0.846	0.799	0.732	0.623
Butyl acetate <sup>*)</sup>	308.15	0.982	0.961	0.936	0.908	0.875	0.836	0.789	0.730	0.652
Cyclohexane	313.15	0.985	0.968	0.948	0.925	0.899	0.866	0.823	0.764	0.666
Cyclopentane	313.15	0.984	0.965	0.944	0.918	0.886	0.846	0.792	0.714	0.579
Diethyl ether <sup>*)</sup>	298.15	0.987	0.973	0.956	0.937	0.914	0.885	0.848	0.795	0.703
1,4-Dimethylbenzene	333.15	0.971	0.940	0.905	0.866	0.822	0.770	0.706	0.622	0.497
Ethylbenzene	333.15	0.969	0.935	0.899	0.859	0.815	0.764	0.704	0.627	0.517
Methyl acetate	313.15	0.984	0.965	0.944	0.920	0.891	0.856	0.811	0.748	0.645

Polymer/ solvents	$a_1$ : T/K	0.1	0.2	0.3	Mass Fraction of the Polymer					
					0.4	0.5	0.6	0.7	0.8	0.9
2-Methyl-1-propanol	333.15	0.988	0.974	0.958	0.940	0.919	0.893	0.860	0.815	0.744
Octane	313.15	0.988	0.974	0.959	0.942	0.921	0.896	0.865	0.823	0.758
1-Propanol	333.15	0.990	0.980	0.967	0.952	0.934	0.911	0.881	0.834	0.746
2-Propanol	313.15	0.991	0.981	0.970	0.956	0.939	0.918	0.889	0.845	0.755
2-Propanone	313.15	0.989	0.976	0.961	0.944	0.921	0.892	0.850	0.783	0.647
Propyl acetate	313.15	0.980	0.957	0.932	0.903	0.870	0.830	0.780	0.714	0.612
Toluene	313.15	0.971	0.939	0.903	0.863	0.818	0.764	0.698	0.613	0.485
<i>Poly(<math>\epsilon</math>-caprolacton)</i>										
Tetrachloromethane <sup>*)</sup>	338.15	0.956	0.910	0.864	0.815	0.762	0.704	0.637	0.554	0.438
<i>Poly(dimethylsiloxane)</i>										
Chlorodifluoromethane	298.15	0.976	0.950	0.921	0.888	0.850	0.805	0.750	0.677	0.565
Cyclohexane	303.15	0.979	0.955	0.928	0.898	0.863	0.822	0.770	0.702	0.596
Hexane	303.15	0.982	0.962	0.939	0.912	0.880	0.842	0.793	0.724	0.611
Pentane	308.15	0.982	0.962	0.940	0.913	0.881	0.842	0.791	0.720	0.600
Pentane	423.15	0.984	0.966	0.946	0.922	0.893	0.858	0.813	0.749	0.641
<i>Poly(ethyl acrylate)</i>										
Benzene	298.15	0.970	0.939	0.904	0.866	0.823	0.774	0.716	0.641	0.533
Dichloromethane	298.15	0.900	0.830	0.768	0.709	0.648	0.584	0.512	0.427	0.313
Tetrachloromethane	298.15	0.950	0.900	0.848	0.794	0.736	0.672	0.598	0.509	0.385
Toluene	298.15	0.972	0.942	0.910	0.874	0.833	0.786	0.730	0.659	0.555
Trichloromethane	298.15	0.866	0.776	0.701	0.632	0.566	0.499	0.428	0.349	0.248
<i>Poly(ethylene oxide)</i>										
Benzene	323.15	0.972	0.942	0.908	0.869	0.824	0.771	0.706	0.620	0.490
2-Butanone	353.15	0.981	0.959	0.934	0.902	0.863	0.813	0.746	0.651	0.503
Cyclohexane	353.15	0.989	0.976	0.960	0.943	0.921	0.893	0.855	0.798	0.688
Methanol	303.15	0.964	0.927	0.887	0.844	0.797	0.744	0.682	0.604	0.494
2-Propanone	353.15	0.979	0.947	0.896	0.815	0.719	0.625	0.532	0.434	0.315
Water	293.15	0.977	0.951	0.923	0.890	0.852	0.806	0.748	0.671	0.550
<i>Poly(ethylenimine)</i>										
Water	353.15	0.975	0.947	0.917	0.883	0.845	0.801	0.748	0.680	0.581
<i>Poly(ethyl methacrylate)</i>										
Benzene	298.15	0.970	0.938	0.903	0.864	0.821	0.771	0.712	0.637	0.529
Dichloromethane	298.15	0.912	0.838	0.769	0.703	0.636	0.567	0.491	0.404	0.292
Tetrachloromethane	298.15	0.935	0.873	0.812	0.750	0.686	0.616	0.540	0.449	0.328
Toluene	298.15	0.974	0.945	0.913	0.877	0.836	0.787	0.727	0.647	0.527
Trichloromethane	298.15	0.859	0.760	0.678	0.604	0.533	0.464	0.392	0.313	0.217
<i>Polyisobutylene</i>										
Benzene	313.15	0.984	0.965	0.945	0.921	0.892	0.858	0.813	0.751	0.645
Cyclohexane	313.15	0.976	0.950	0.921	0.888	0.850	0.805	0.749	0.676	0.563
Cyclopentane	313.15	0.977	0.952	0.924	0.892	0.855	0.812	0.758	0.687	0.579
1,4-Dimethylbenzene	313.15	0.979	0.955	0.929	0.899	0.863	0.821	0.767	0.694	0.579
2,2-Dimethylbutane	298.15	0.983	0.964	0.942	0.917	0.887	0.852	0.806	0.743	0.640
Ethylbenzene	313.15	0.979	0.955	0.927	0.895	0.857	0.810	0.750	0.668	0.535
Heptane	298.15	0.983	0.964	0.942	0.917	0.887	0.851	0.804	0.741	0.637
Hexane	298.15	0.980	0.959	0.934	0.906	0.873	0.834	0.784	0.715	0.606
Octane	298.15	0.983	0.963	0.940	0.914	0.883	0.845	0.797	0.729	0.617
Tetrachloromethane	298.15	0.962	0.921	0.877	0.829	0.776	0.715	0.643	0.552	0.423
Toluene	313.15	0.984	0.966	0.944	0.918	0.884	0.840	0.779	0.688	0.537
Trichloromethane	298.15	0.969	0.935	0.899	0.858	0.813	0.761	0.698	0.619	0.503
2,4,4-Trimethylpentane	298.15	0.981	0.961	0.937	0.911	0.879	0.842	0.794	0.730	0.628
<i>1,4-cis-Polyisoprene</i>										
Benzene	313.15	0.982	0.962	0.937	0.908	0.873	0.827	0.766	0.679	0.537
2-Butanone	353.15	0.986	0.970	0.953	0.933	0.910	0.883	0.850	0.808	0.746
Cyclohexane	313.15	0.978	0.954	0.928	0.899	0.865	0.825	0.778	0.716	0.625
Dichloromethane	298.15	0.969	0.935	0.898	0.857	0.811	0.757	0.693	0.610	0.488
1,4-Dimethylbenzene	313.15	0.977	0.951	0.923	0.892	0.857	0.816	0.767	0.704	0.613

Polymer/ solvents	$a_1$ : T/K	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Ethylbenzene	313.15	0.978	0.954	0.928	0.898	0.864	0.823	0.774	0.709	0.612
Methyl acetate	313.15	0.968	0.935	0.900	0.862	0.820	0.773	0.717	0.649	0.554
Octane	313.15	0.984	0.967	0.948	0.926	0.901	0.871	0.834	0.785	0.711
Propyl acetate	333.15	0.983	0.964	0.942	0.916	0.886	0.850	0.803	0.738	0.633
Tetrachloromethane	298.15	0.929	0.864	0.800	0.737	0.672	0.602	0.526	0.435	0.316
Toluene	313.15	0.978	0.954	0.927	0.898	0.865	0.827	0.782	0.725	0.645
Trichloromethane	298.15	0.930	0.867	0.807	0.747	0.685	0.620	0.547	0.462	0.346
<i>Poly(methyl acrylate)</i>										
Benzene	298.15	0.979	0.956	0.930	0.901	0.867	0.826	0.776	0.710	0.608
Dichloromethane	298.15	0.917	0.851	0.791	0.732	0.671	0.605	0.532	0.444	0.326
Tetrachloromethane	298.15	0.963	0.924	0.882	0.838	0.788	0.733	0.668	0.586	0.470
Toluene	298.15	0.981	0.960	0.936	0.909	0.878	0.840	0.792	0.727	0.626
Trichloromethane	298.15	0.912	0.830	0.753	0.678	0.603	0.527	0.446	0.357	0.248
<i>Poly(methyl methacrylate)</i>										
Benzene	298.15	0.982	0.961	0.938	0.912	0.881	0.843	0.795	0.729	0.622
2-Butanone <sup>a)</sup>	308.15	0.989	0.976	0.961	0.945	0.925	0.900	0.869	0.825	0.751
Cyclohexanone <sup>a)</sup>	323.15	0.978	0.954	0.928	0.899	0.866	0.827	0.781	0.723	0.640
Dichloromethane	298.15	0.939	0.882	0.825	0.766	0.704	0.637	0.560	0.468	0.343
Ethyl acetate <sup>a)</sup>	308.15	0.986	0.969	0.950	0.928	0.902	0.869	0.826	0.763	0.649
Toluene	298.15	0.981	0.959	0.935	0.908	0.877	0.841	0.795	0.736	0.646
Trichloromethane	298.15	0.924	0.848	0.771	0.694	0.616	0.536	0.451	0.358	0.246
<i>Poly(<math>\alpha</math>-methylstyrene)</i>										
Cumene	338.15	0.984	0.965	0.944	0.918	0.887	0.848	0.796	0.721	0.593
$\alpha$ -Methylstyrene	338.15	0.978	0.954	0.927	0.896	0.859	0.816	0.761	0.687	0.570
<i>Poly(propylene oxide)</i>										
Benzene	333.15	0.967	0.932	0.893	0.850	0.801	0.744	0.675	0.588	0.460
Methanol	298.15	0.992	0.982	0.970	0.955	0.936	0.910	0.872	0.812	0.689
<i>Polystyrene</i>										
Benzene	333.15	0.978	0.953	0.924	0.891	0.852	0.804	0.742	0.657	0.521
2-Butanone <sup>a)</sup>	298.15	0.986	0.971	0.954	0.935	0.912	0.885	0.851	0.804	0.724
Cyclohexane	313.15	0.990	0.978	0.965	0.949	0.931	0.908	0.877	0.833	0.754
Cyclohexanone <sup>a)</sup>	313.15	0.970	0.937	0.900	0.858	0.810	0.753	0.684	0.593	0.459
Dichloromethane	298.15	0.949	0.899	0.849	0.797	0.743	0.684	0.617	0.536	0.423
1,3-Dimethylbenzene <sup>a)</sup>	323.15	0.980	0.956	0.926	0.891	0.846	0.791	0.723	0.638	0.524
1,4-Dimethylbenzene	423.15	0.974	0.944	0.911	0.872	0.826	0.770	0.698	0.601	0.452
Ethyl acetate <sup>a)</sup>	313.15	0.976	0.948	0.918	0.882	0.841	0.791	0.728	0.642	0.507
Hexane	423.15	0.980	0.958	0.933	0.904	0.869	0.827	0.772	0.697	0.574
2-Propanone	323.15	0.991	0.980	0.969	0.955	0.938	0.918	0.892	0.854	0.788
Propyl acetate	343.15	0.983	0.965	0.943	0.919	0.891	0.858	0.815	0.758	0.667
Tetrachloromethane	298.15	0.961	0.917	0.869	0.814	0.751	0.678	0.592	0.486	0.344
Toluene	313.15	0.981	0.959	0.933	0.901	0.861	0.809	0.738	0.638	0.481
Trichloromethane	298.15	0.949	0.898	0.847	0.793	0.736	0.675	0.604	0.519	0.400
<i>Poly(tetramethylene glycol)</i>										
Methanol	303.15	0.981	0.961	0.938	0.913	0.883	0.849	0.806	0.751	0.671
<i>Poly(vinyl acetate)</i>										
Benzene	313.15	0.985	0.967	0.945	0.919	0.886	0.844	0.784	0.696	0.548
1-Butanol	313.15	0.992	0.982	0.971	0.958	0.942	0.923	0.896	0.856	0.779
2-Butanol	313.15	0.987	0.972	0.956	0.937	0.915	0.889	0.856	0.813	0.747
2-Butanone	313.15	0.980	0.958	0.934	0.906	0.873	0.835	0.787	0.724	0.626
1,2-Dichloroethane <sup>a)</sup>	300.15	0.955	0.906	0.851	0.790	0.722	0.644	0.556	0.450	0.315
1,4-Dimethylbenzene	313.15	0.990	0.978	0.964	0.948	0.928	0.903	0.868	0.814	0.705
Ethylbenzene	313.15	0.990	0.979	0.966	0.950	0.932	0.910	0.880	0.836	0.759
Methanol	333.15	0.990	0.978	0.965	0.949	0.931	0.908	0.877	0.834	0.757
Methyl acetate	313.15	0.976	0.949	0.919	0.886	0.849	0.805	0.752	0.684	0.583
2-Methyl-1-propanol	353.15	0.984	0.966	0.946	0.924	0.899	0.868	0.832	0.784	0.715
1-Propanol	353.15	0.987	0.972	0.955	0.936	0.914	0.888	0.856	0.815	0.753
2-Propanol	353.15	0.988	0.974	0.958	0.940	0.919	0.894	0.863	0.820	0.754

Polymer/ solvents	$a_A$ : T/K	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
2-Propanone	333.15	0.983	0.963	0.940	0.913	0.880	0.838	0.784	0.707	0.578
Propyl acetate	333.15	0.979	0.955	0.930	0.901	0.869	0.831	0.786	0.728	0.645
Tetrahydrofuran	323.15	0.973	0.943	0.911	0.874	0.831	0.781	0.720	0.640	0.519
Toluene	333.15	0.983	0.965	0.944	0.920	0.891	0.857	0.815	0.756	0.664
<i>Poly(vinyl chloride)</i>										
2-Butanone <sup>a)</sup>	313.15	0.976	0.949	0.920	0.887	0.849	0.804	0.749	0.676	0.566
Cyclohexanone <sup>a)</sup>	333.15	0.971	0.934	0.889	0.839	0.781	0.714	0.635	0.536	0.397
<i>Poly(vinyl methyl ether)</i>										
Benzene <sup>a)</sup>	298.15	0.969	0.935	0.897	0.855	0.807	0.751	0.683	0.596	0.466
Chlorobenzene <sup>a)</sup>	343.15	0.972	0.941	0.906	0.867	0.822	0.769	0.705	0.620	0.494
1,2-Dimethylbenzene <sup>a)</sup>	363.15	0.973	0.943	0.910	0.871	0.826	0.772	0.705	0.616	0.478
Ethylbenzene <sup>a)</sup>	343.15	0.978	0.954	0.927	0.895	0.857	0.811	0.753	0.672	0.542
Propylbenzene <sup>a)</sup>	373.15	0.977	0.951	0.923	0.890	0.852	0.808	0.752	0.678	0.563
<i>Poly(4-vinylpyridine)</i>										
Methanol	343.15	0.986	0.971	0.953	0.931	0.905	0.871	0.825	0.756	0.627
2-Propanol	343.15	0.989	0.977	0.964	0.948	0.928	0.904	0.872	0.826	0.743
<i>Poly(1-vinyl-2-pyrrolidinone)</i>										
Water	368.15	0.984	0.966	0.946	0.924	0.899	0.870	0.835	0.790	0.727
<i>Starch (amorphous)</i>										
Water	383.15	0.991	0.981	0.970	0.956	0.939	0.918	0.889	0.845	0.754
<i>Styrene/Methyl methacrylate Copolymer (41.45 wt% Styrene)</i>										
Benzene <sup>a)</sup>	308.15	0.982	0.963	0.940	0.913	0.881	0.841	0.789	0.716	0.590
<i>Vinyl acetate/Vinyl chloride Copolymer (12 wt% Vinyl acetate)</i>										
Benzene	398.15	0.976	0.949	0.918	0.883	0.841	0.791	0.728	0.643	0.509
Chlorobenzene	398.15	0.984	0.965	0.944	0.920	0.891	0.856	0.810	0.746	0.638
1,4-Dimethylbenzene	398.15	0.989	0.977	0.963	0.946	0.926	0.899	0.863	0.807	0.692
Ethylbenzene	398.15	0.989	0.976	0.961	0.944	0.924	0.899	0.866	0.818	0.735
Octane	398.15	0.992	0.982	0.971	0.958	0.942	0.922	0.893	0.847	0.739

<sup>a)</sup>  $a_A = P_A / P_A^S$

# SPECIFIC ENTHALPIES OF SOLUTION OF POLYMERS AND COPOLYMERS

Christian Wohlfarth

Enthalpies of solution or mixing, expressed as the enthalpy change per unit mass of polymer, are given in the table at infinite dilution, i.e., a very small amount of polymer and a large excess of solvent were mixed isothermally to form a homogeneous solution. By thermodynamics,  $\Delta_{\text{sol}}H_{\text{B}}^{\infty}$  or  $\Delta_{\text{M}}H_{\text{B}}^{\infty}$  are obtained from the following derivatives:

$$\Delta_{\text{sol}}H_{\text{B}}^{\infty} = \lim_{m_{\text{B}} \rightarrow 0} (\partial \Delta_{\text{sol}}h / \partial m_{\text{B}})_{P,T,m_{j \neq \text{B}}} \quad (1)$$

$$\Delta_{\text{M}}H_{\text{B}}^{\infty} = \lim_{m_{\text{B}} \rightarrow 0} (\partial \Delta_{\text{M}}h / \partial m_{\text{B}})_{P,T,m_{j \neq \text{B}}} \quad (2)$$

with a unit of J/g. Thus, they are the partial specific enthalpies of solution or mixing of the polymer B at infinite dilution where  $\Delta_{\text{sol}}h$  or  $\Delta_{\text{M}}h$  is the extensive enthalpy of the solution or mixing process.

The state of the polymer before dissolution can significantly affect the enthalpy of solution. The dissolving of a semicrystalline polymer requires an additional amount of heat associated with the disordering of crystalline regions. Consequently, its enthalpy of

solution is usually positive and depends on the degree of crystallinity of the given polymer sample. An amorphous polymer below its glass transition temperature,  $T_{\text{g}}$  (see the  $T_{\text{g}}$ -table of this Section), often dissolves with the release of heat. The enthalpy of solution of a glassy polymer is additionally dependent to some extent on the thermal history of the glass-forming process. An amorphous polymer above  $T_{\text{g}}$  can show endothermic or exothermic dissolution behavior depending on the nature of the solvent and the interaction energies involved as is the case for any enthalpy of mixing. This enthalpy of mixing is then independent of any crystalline or glassy aspects of the polymer. It can be obtained without difficulties for liquid/molten polymers mixed with a solvent. Therefore, the enthalpies given in the table are either enthalpies of solution or enthalpies of mixing, depending on the state of the polymer.

The enthalpies depend on temperature and molar mass. The necessary molar mass information for a system is provided in the table (if available) by the corresponding number average,  $M_{\text{n}}$ , mass average,  $M_{\text{w}}$ , or viscosity average,  $M_{\text{\eta}}$ , values of the polymer as given in the original sources. Outside the oligomer range, specific enthalpies of solution or mixing do not remarkably depend on molar mass, however. More enthalpy data of polymer-solvent systems can be found in Ref. 106.

Polymer	$M_{\text{n}}/$ g/mol	$M_{\text{w}}/$ g/mol	$M_{\text{\eta}}/$ g/mol	Solvent	$T/\text{K}$	$\Delta H_{\text{B}}^{\infty}/$ J/g	Ref.
<i>Acrylonitrile/butadiene copolymer</i>							
(18 wt% Acrylonitrile)				Benzene	298.15	0.0	18
(26 wt% Acrylonitrile)				Benzene	298.15	-1.9	18
(40 wt% Acrylonitrile)				Benzene	298.15	-2.9	18
<i>Acrylonitrile/isoprene copolymer</i>							
(15 mol% Isoprene)				<i>N,N</i> -Dimethylformamide	323.15	-32	66
<i>Acrylonitrile/vinyl chloride copolymer</i>							
(13 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	293.15	-38	35
(13 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	308.15	-22	35
(13 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	323.15	-18	35
(13 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	338.15	-15	35
(13 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	353.15	-12	35
(29 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	295.15	-42	35
(29 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	308.15	-27	35
(29 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	323.15	-21	35
(29 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	338.15	-19	35
(29 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	353.15	-16	35
(40 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	295.15	-47	35
(40 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	308.15	-30	35
(40 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	323.15	-28	35
(40 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	338.15	-18	35
(40 wt% Acrylonitrile)				<i>N,N</i> -Dimethylformamide	353.15	-17	35
<i>Benzylcellulose</i>							
				Benzene	298.15	-11	8
				Cyclohexanone	298.15	-15	25
				Trichloromethane	298.15	-38	25

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
<b><i>Bisphenol A-isophthaloyl chloride/terephthaloyl chloride</i></b>							
(50/50 Iso/terephthaloyl chloride)				<i>N,N</i> -Dimethylacetamide	298.15	-56	69
(50/50 Iso/terephthaloyl chloride)				1,1,2,2-Tetrachloroethane	298.15	+72	69
<b><i>Butadiene/styrene copolymer</i></b>							
(10 wt% Styrene)				Benzene	293.65	4.9	17
(30 wt% Styrene)				Benzene	293.65	3.0	17
(30 wt% Styrene)				Benzene	298.15	3.0	25
(50 wt% Styrene)				Benzene	293.65	1.8	17
(60 wt% Styrene)				Benzene	293.65	0.0	17
(70 wt% Styrene)				Benzene	293.65	0.0	17
(75 wt% Styrene)				Benzene	298.15	1.5	7
(80 wt% Styrene)				Benzene	293.65	-0.6	17
(90 wt% Styrene)				Benzene	293.65	-4.9	17
<b><i>Butyl methacrylate/isobutyl methacrylate copolymer (50 wt%/50 wt%)</i></b>							
Glass		150000		Cyclohexanone	303.15	5.9	98
Liquid		150000		Cyclohexanone	303.15	14.0	98
<b><i>Butyl methacrylate/methyl methacrylate copolymer (45 wt%/55 wt%)</i></b>							
Glass	107000	250000		Cyclohexanone	304.15	-5.4	99
Liquid	107000	250000		Cyclohexanone	304.15	+9.1	99
<b><i>Cellulose acetate</i></b>							
(52.2 wt% Acetate)				Formic acid	298.15	-30	10
(55.8 wt% Acetate)				Formic acid	298.15	-44	10
(52.5 wt% Acetate)				Methyl acetate	298.15	-80	1
(48 wt% Acetate)				2-Propanone	298.15	-35	25
(52.2 wt% Acetate)				2-Propanone	298.15	-30	10
(55.8 wt% Acetate)				2-Propanone	298.15	-26	10
(56 wt% Acetate)				2-Propanone	298.15	-45	25
(56 wt% Acetate)				2-Propanone	298.15	-30	4
<b><i>Cellulose triacetate</i></b>							
				2-Propanone	298.15	-29	4
				Trichloromethane	298.15	-47	4
<b><i>Dextran</i></b>							
	8200	10400		Dimethylsulfoxide	298.15	-185	75
	75900	101000		Dimethylsulfoxide	298.15	-187	70
	75900	101000		1,2-Ethanediol	298.15	-98	70
	75900	101000		Formamide	298.15	-228	70
	8200	10400		Water	298.15	-140	75
	75900	101000		Water	298.15	-150	75
(amorph)				Water	298.15	-123	65
<b><i>Ethylene/propylene copolymer</i></b>							
(33 mol% Ethylene)				Cyclohexane	298.15	1.4	74
(63 mol% Ethylene)				Cyclohexane	298.15	8.1	74
(75 mol% Ethylene)				Cyclohexane	298.15	11.8	74
(33 mol% Ethylene)				Cyclooctane	298.15	1.2	74

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
(63 mol% Ethylene)				Cyclooctane	298.15	6.9	74
(75 mol% Ethylene)				Cyclooctane	298.15	8.6	74
(33 mol% Ethylene)				Cyclopentane	298.15	-3.5	74
(63 mol% Ethylene)				Cyclopentane	298.15	1.1	74
(33 mol% Ethylene)				<i>cis</i> -Decahydronaphthalene	298.15	-2.4	74
(63 mol% Ethylene)				<i>cis</i> -Decahydronaphthalene	298.15	2.4	74
(75 mol% Ethylene)				<i>cis</i> -Decahydronaphthalene	298.15	3.9	74
(33 mol% Ethylene)				<i>trans</i> -Decahydronaphthalene	298.15	-4.8	74
(63 mol% Ethylene)				<i>trans</i> -Decahydronaphthalene	298.15	-1.3	74
(75 mol% Ethylene)				<i>trans</i> -Decahydronaphthalene	298.15	-0.3	74
(63 mol% Ethylene)				3,3-Diethylpentane	298.15	-1.4	74
(75 mol% Ethylene)				3,3-Diethylpentane	298.15	<0.1	74
(63 mol% Ethylene)				2,2-Dimethylpentane	298.15	5.3	74
(75 mol% Ethylene)				2,2-Dimethylpentane	298.15	2.3	74
(63 mol% Ethylene)				2,3-Dimethylpentane	298.15	0.7	74
(75 mol% Ethylene)				2,3-Dimethylpentane	298.15	0.4	74
(33 mol% Ethylene)				2,4-Dimethylpentane	298.15	-1.2	74
(63 mol% Ethylene)				2,4-Dimethylpentane	298.15	3.0	74
(75 mol% Ethylene)				2,4-Dimethylpentane	298.15	0.2	74
(33 mol% Ethylene)				3,3-Dimethylpentane	298.15	-2.7	74
(63 mol% Ethylene)				3,3-Dimethylpentane	298.15	0.3	74
(33 mol% Ethylene)				Dodecane	298.15	-0.1	73
(63 mol% Ethylene)				Dodecane	298.15	0.8	73
(75 mol% Ethylene)				Dodecane	298.15	-4.0	73
(63 mol% Ethylene)				3-Ethylpentane	298.15	2.6	74
(75 mol% Ethylene)				3-Ethylpentane	298.15	-0.6	74
(33 mol% Ethylene)				2,2,4,4,6,8,8- Heptamethylnonane	298.15	-0.5	73
(63 mol% Ethylene)				2,2,4,4,6,8,8- Heptamethylnonane	298.15	2.2	73
(75 mol% Ethylene)				2,2,4,4,6,8,8- Heptamethylnonane	298.15	-0.9	73
(33 mol% Ethylene)				Hexadecane	298.15	0.7	73
(63 mol% Ethylene)				Hexadecane	298.15	-1.1	73
(75 mol% Ethylene)				Hexadecane	298.15	-4.6	73
(63 mol% Ethylene)				3-Methylhexane	298.15	0.7	74
(75 mol% Ethylene)				3-Methylhexane	298.15	1.7	74
(33 mol% Ethylene)				Octane	298.15	-1.6	73
(63 mol% Ethylene)				Octane	298.15	3.6	73
(75 mol% Ethylene)				Octane	298.15	0.3	73
(33 mol% Ethylene)				2,2,4,6,6-Pentamethylheptane	298.15	-0.3	73
(63 mol% Ethylene)				2,2,4,6,6-Pentamethylheptane	298.15	3.6	73
(75 mol% Ethylene)				2,2,4,6,6-Pentamethylheptane	298.15	0.0	73
(63 mol% Ethylene)				2,2,4,4-Tetramethylpentane	298.15	2.7	74
(75 mol% Ethylene)				2,2,4,4-Tetramethylpentane	298.15	3.1	74
(33 mol% Ethylene)				2,2,4-Trimethylpentane	298.15	-0.2	73
(63 mol% Ethylene)				2,2,4-Trimethylpentane	298.15	1.9	73
(75 mol% Ethylene)				2,2,4-Trimethylpentane	298.15	3.5	73

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	T/K	$\Delta H_B^\infty$ / J/g	Ref.
<i>Ethylene/vinylacetate copolymer</i>							
(85 wt% Vinyl acetate)				Cyclopentanone	298.15	-0.5	104
(70 wt% Vinyl acetate)		220000		Tetrahydrofuran	304.65	-1.3	93
<i>Gelatine</i>							
				Water	293.15	-92	29
				Water	323.15	-63	29
<i>Guttapercha</i>							
				Trichloromethane	303.15	47	22
<i>Isobutyl methacrylate/methyl methacrylate copolymer (51 wt%/49 wt%)</i>							
Glass		150000		Cyclohexanone	303.15	-11	98
Liquid		150000		Cyclohexanone	303.15	15	98
<i>Natural rubber</i>							
				Benzene	298.15	10	25
				Benzene	298.15	12	20
<i>Nitrocellulose</i>							
			16600	2-Butanone	298.15	-80	4
			23000	2-Butanone	298.15	-81	4
			40000	2-Butanone	298.15	-81	4
				Butyl acetate	293.15	-75	23
				Butyl acetate	298.15	-75	23
				Butyl acetate	298.15	-73	26
				Butyl acetate	303.15	-75	23
				Butyl acetate	308.15	-71	23
				Butyl acetate	313.15	-65	23
				Butyl acetate	313.15	-67	26
				Butyl acetate	318.15	-59	23
				Butyl acetate	323.15	-54	23
				Butyl acetate	328.15	-50	23
				Butyl acetate	333.15	-59	26
				Butyl acetate	343.15	-55	26
				Butyl acetate	353.15	-47	26
				Diethyl ether	295.15	-62	3
				Dibutyl phthalate	273.15	-45	26
				Dibutyl phthalate	298.15	-46	26
				Dibutyl phthalate	313.15	-46	26
				Dibutyl phthalate	333.15	-42	26
				Ethanol	295.15	-46	3
				Ethyl acetate	293.15	-76	23
				Ethyl acetate	298.15	-75	23
				Ethyl acetate	303.15	-69	23
				Ethyl acetate	308.15	-61	23
				Ethyl acetate	313.15	-54	23
				Ethyl acetate	318.15	-50	23
				Ethyl acetate	323.15	-50	23
				Ethyl acetate	328.15	-50	23
				Methanol	293.15	-69	23



Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
				Methanol	298.15	-56	23
				Methanol	303.15	-50	23
				Methanol	308.15	-50	23
				Methanol	313.15	-50	23
				Methanol	318.15	-50	23
				Methanol	323.15	-50	23
				Methanol	328.15	-50	23
				2,4-Pentanedione	298.15	-74	4
				2-Pentanone	298.15	-64	4
				2-Propanone	273.15	-75	26
				2-Propanone	293.15	-75	23
				2-Propanone	298.15	-83	2
				2-Propanone	298.15	-68	4
				2-Propanone	298.15	-71	8
				2-Propanone	298.15	-74	23
				2-Propanone	298.15	-79	25
				2-Propanone	298.15	-75	26
				2-Propanone	303.15	-60	23
				2-Propanone	308.15	-51	23
				2-Propanone	313.15	-50	23
				2-Propanone	313.15	-65	26
				2-Propanone	318.15	-50	23
				2-Propanone	323.15	-50	23
				2-Propanone	323.15	-50	26
				2-Propanone	328.15	-50	23
				Pyridine	298.15	-106	2
				Tri(4-methylphenyl) phosphate	298.15	-16	26
				Tri(4-methylphenyl) phosphate	313.15	-28	26
				Tri(4-methylphenyl) phosphate	333.15	-41	26
				Tri(4-methylphenyl) phosphate	343.15	-44	26
				Tri(4-methylphenyl) phosphate	353.15	-47	26
<i>Nylon-6 (unoriented)</i>				Formic acid	295.15	-53	24
				Tricresol	323.55	-66	22
				Tricresol	345.55	-66	22
<i>Poly(acrylonitrile)</i>				Benzene	298.15	0.0	18
				<i>N,N</i> -Dimethylformamide	295.15	-23	35
				<i>N,N</i> -Dimethylformamide	298.15	-21	18
				<i>N,N</i> -Dimethylformamide	298.15	-43	42
				<i>N,N</i> -Dimethylformamide	308.15	-17	35
				<i>N,N</i> -Dimethylformamide	323.15	-13	35

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
				<i>N,N</i> -Dimethylformamide	323.15	-15	66
				<i>N,N</i> -Dimethylformamide	338.15	-10	35
				Dimethylsulfoxide	298.15	-70	42
<i>Poly(<math>\gamma</math>-benzyl-L-glutamate)</i>							
		160000		Dichloroacetic acid	303.15	-35	46
		160000		1,2-Dichloroethane	303.15	-1.6	46
<i>Polybutadiene</i>							
				Benzene	298.15	6.1	7
				Benzene	298.15	7.1	25
				Benzene	298.15	10.5	32
				2,2,4-Trimethylpentane	298.15	1.1	32
<i>1,4-cis-Polybutadiene</i>							
	low			Cyclohexane	298.15	5.4	74
	low			Cyclooctane	298.15	5.8	74
	low			Cyclopentane	298.15	<0.1	74
	low			<i>cis</i> -Decahydronaphthalene	298.15	4.2	74
	low			<i>trans</i> -Decahydronaphthalene	298.15	2.6	74
	low			3,3-Diethylpentane	298.15	5.2	74
	low			2,2-Dimethylpentane	298.15	4.1	74
	low			2,3-Dimethylpentane	298.15	4.5	74
	low			2,4-Dimethylpentane	298.15	3.2	74
	low			3,3-Dimethylpentane	298.15	3.2	74
	low			Dodecane	298.15	4.2	74
	low			3-Ethylpentane	298.15	3.7	74
	low			2,2,4,4,6,8,8-Heptamethylnonane	298.15	4.8	74
	low			Hexadecane	298.15	4.9	74
	low			3-Methylhexane	298.15	3.6	74
	low			Octane	298.15	4.3	74
	low			2,2,4,6,6-Pentamethylheptane	298.15	5.0	74
	low			2,2,4,4-Tetramethylpentane	298.15	5.8	74
	low			2,3,3,4-Tetramethylpentane	298.15	5.1	74
<i>Poly(1-butene)</i>							
			20000	Cyclohexane	298.15	1.0	74
			20000	Cyclooctane	298.15	1.8	74
			20000	Cyclopentane	298.15	-2.9	74
			20000	<i>cis</i> -Decahydronaphthalene	298.15	<0.1	74
			20000	<i>trans</i> -Decahydronaphthalene	298.15	-2.0	74
			20000	Decane	298.15	1.2	62
			20000	3,3-Diethylpentane	298.15	-2.6	74
			20000	2,2-Dimethylpentane	298.15	-4.0	74
			20000	2,3-Dimethylpentane	298.15	-2.8	74
			20000	2,4-Dimethylpentane	298.15	-2.3	74
			20000	3,3-Dimethylpentane	298.15	-2.2	74
			20000	Dodecane	298.15	2.1	74

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			20000	3-Ethylpentane	298.15	-2.8	74
			20000	Heptane	298.15	0.0	73
			20000	Hexadecane	298.15	3.0	62
			20000	Hexane	298.15	-1.2	62
			20000	3-Methylhexane	298.15	-2.1	74
			20000	Nonane	298.15	0.9	73
			20000	Octane	298.15	0.4	73
			20000	2,2,4,6,6-Pentamethylheptane	298.15	0.6	73
			20000	Pentane	298.15	-2.6	62
			20000	Tetradecane	298.15	2.7	62
			20000	2,2,4,4-Tetramethylpentane	298.15	-1.4	74
			20000	2,3,3,4-Tetramethylpentane	298.15	-2.2	74
			20000	2,2,4-Trimethylpentane	298.15	-0.5	73
<i>Poly(butyl acrylate)</i>							
				2-Propanone	298.15	0.8	25
<i>Poly(butyl methacrylate)</i>							
Glass	91300	210000		Cyclohexanone	304.15	7.7	99
Liquid	91300	210000		Cyclohexanone	304.15	8.2	99
				2-Propanone	298.15	19.5	25
<i>Polychloroprene</i>							
				Benzene	298.15	0.5	7
<i>Poly(2,6-dimethyl phenylene oxide)</i>							
	17000	46400		1,2-Dichlorobenzene	303.05	55	89
<i>Poly(dimethylsiloxane)</i>							
	13000			Benzene	298.15	11.2	50
			20000	Benzene	298.15	13.5	61
			100000	Benzene	298.15	14.2	40
			170000	Bromocyclohexane	303.15	10.2	51
			80000	2-Butanone	293.15	14.4	77
	30900			2-Butanone	303.15	14.2	44
			170000	2-Butanone	303.15	14.7	51
			80000	2-Butanone	308.15	14.3	77
			80000	2-Butanone	323.15	14.3	77
			80000	Butyl acetate	298.15	6.1	41
			80000	Butyl propanoate	298.15	4.9	41
			100000	Chlorobenzene	298.15	7.5	40
	13000			Cyclohexane	298.15	3.0	50
			20000	Cyclohexane	298.15	5.2	74
			100000	Cyclohexane	298.15	5.2	40
			20000	Cyclooctane	298.15	6.8	74
			20000	Cyclopentane	298.15	1.0	74
			20000	<i>cis</i> -Decahydronaphthalene	298.15	7.1	74
			20000	<i>trans</i> -Decahydronaphthalene	298.15	4.3	74
			20000	Decamethyltetrasiloxane	297.65	0.45	37
			20000	Decane	298.15	3.8	37
			20000	Decane	298.15	3.9	61

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			80000	Decane	298.15	3.8	41
			80000	Decyl acetate	298.15	4.5	41
			80000	Dibutyl ether	298.15	0.6	41
			80000	Diethoxymethane	298.15	1.8	41
			80000	Diethyl ether	298.15	-1.3	41
			20000	3,3-Diethylpentane	298.15	1.9	74
			80000	Dihexyl ether	298.15	3.0	41
			80000	1,2-Dimethoxyethane	298.15	12.2	41
			80000	Dimethoxymethane	298.15	7.4	41
	13000			1,2-Dimethylbenzene	298.15	4.3	50
	13000			1,3-Dimethylbenzene	298.15	3.0	50
	13000			1,4-Dimethylbenzene	298.15	3.2	50
			20000	1,4-Dimethylbenzene	298.15	4.2	61
			80000	2,6-Dimethyl-4-heptanone	293.15	6.1	77
			20000	2,2-Dimethylpentane	298.15	0.8	74
			20000	2,3-Dimethylpentane	298.15	1.4	74
			20000	2,4-Dimethylpentane	298.15	1.6	74
			20000	3,3-Dimethylpentane	298.15	0.5	74
			80000	Dipentyl ether	298.15	2.1	41
			80000	Dipropyl ether	298.15	-1.2	41
			20000	Dodecamethylpentasiloxane	297.65	-0.3	37
			20000	Dodecane	297.65	4.5	37
			20000	Dodecane	298.15	4.4	73
			80000	Dodecane	298.15	4.5	41
			80000	Ethyl acetate	298.15	12.7	41
			170000	Ethyl acetate	303.15	13.7	51
	13000			Ethylbenzene	298.15	6.4	50
			20000	Ethylbenzene	298.15	6.2	61
			80000	Ethyl butanoate	298.15	6.0	41
			80000	Ethyl decanoate	298.15	3.8	41
			80000	Ethyl dodecanoate	298.15	3.8	41
			80000	Ethyl heptanoate	298.15	4.1	41
			80000	Ethyl hexanoate	298.15	4.3	41
			80000	Ethyl nonanoate	298.15	3.7	41
			80000	Ethyl octanoate	298.15	3.8	41
			20000	3-Ethylpentane	298.15	0.6	74
			80000	Ethyl propanoate	298.15	8.0	41
			20000	2,2,4,4,6,8,8-Heptamethylnonane	298.15	3.5	74
	13000			Heptane	298.15	1.8	50
			20000	Heptane	298.15	1.9	73
			20000	Heptane	297.65	2.0	37
			20000	Heptane	298.15	2.0	61
			80000	Heptane	298.15	2.0	41
			100000	Heptane	298.15	2.1	40
			170000	Heptane	303.15	1.9	51
			80000	3-Heptanone	308.15	8.8	77
			80000	3-Heptanone	323.15	8.8	77

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			20000	Hexadecane	297.65	5.5	37
			20000	Hexadecane	298.15	5.5	73
			20000	Hexamethyldisiloxane	298.15	-1.2	37
			20000	Hexamethyldisiloxane	298.15	-1.6	61
			170000	Hexamethyldisiloxane	303.15	-1.5	51
			20000	Hexane	297.65	0.7	37
			20000	Hexane	298.15	0.7	61
			80000	Hexane	298.15	0.7	41
			170000	Hexane	303.15	0.3	51
			80000	Hexyl acetate	298.15	5.0	41
	13000			Isopropylbenzene	298.15	4.1	50
			80000	Methyl butanoate	298.15	8.6	41
	13000			Methylcyclohexane	298.15	2.9	50
			100000	Methylcyclohexane	298.15	1.9	40
			80000	Methyl decanoate	298.15	4.8	41
			20000	3-Methylhexane	298.15	1.3	74
			80000	Methyl hexanoate	298.15	5.3	41
			80000	Methyl octanoate	298.15	5.0	41
			80000	4-Methyl-2-pentanone	293.15	9.9	77
			80000	4-Methyl-2-pentanone	308.15	9.0	77
			80000	Methyl propanoate	298.15	12.1	41
			20000	Nonane	297.65	3.4	37
			20000	Nonane	298.15	3.3	73
			80000	Nonane	298.15	3.4	41
			80000	Octamethylcyclotetrasiloxane	293.15	-0.4	78
			20000	Octamethyltrisiloxane	297.65	-0.6	37
			20000	Octamethyltrisiloxane	298.15	-0.8	61
			170000	Octamethyltrisiloxane	303.15	-1.0	51
			20000	Octane	297.65	2.6	37
			20000	Octane	298.15	2.4	73
			20000	Octane	298.15	2.6	61
			80000	Octane	298.15	2.6	41
			20000	2,2,4,6,6-Pentamethylheptane	298.15	2.7	73
			20000	Pentane	298.15	-0.9	37
			20000	Pentane	298.15	-0.9	61
			80000	Pentane	298.15	-1.0	41
			80000	Pentyl acetate	298.15	5.8	41
			80000	Pentyl propanoate	298.15	3.8	41
			80000	Propyl acetate	298.15	8.6	41
			170000	Propyl acetate	303.15	9.9	51
			80000	Propyl propanoate	298.15	5.6	41
			100000	Tetrachloromethane	298.15	2.4	40
			20000	Tetradecane	297.65	5.1	37
			20000	Tetradecane	298.15	5.1	61
			80000	Tetradecane	298.15	5.1	41
			20000	2,2,4,4-Tetramethylpentane	298.15	2.1	73
			20000	2,2,4,4-Tetramethylpentane	298.15	2.3	74

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			20000	2,3,3,4-Tetramethylpentane	298.15	1.9	74
	13000			Toluene	298.15	5.5	50
			20000	Toluene	298.15	6.7	61
			20000	Tridecane	297.65	4.8	37
			80000	Tridecane	298.15	4.8	41
	13000			1,3,5-Trimethylbenzene	298.15	3.7	50
			20000	2,2,4-Trimethylpentane	298.15	1.4	73
			20000	Undecane	297.65	4.2	37
			80000	Undecane	298.15	4.3	41
<i>Polyethylene</i>							
Semicrystalline		65000		1-Chloronaphthalene	373.15	780	47
Semicrystalline		65000		1-Chloronaphthalene	383.15	980	47
Semicrystalline		65000		1-Chloronaphthalene	393.15	800	47
Liquid		65000		1-Chloronaphthalene	403.15	49	47
Semicrystalline		144000		1-Chloronaphthalene	383.15	920	47
Semicrystalline		144000		1-Chloronaphthalene	393.15	990	47
Semicrystalline		144000		1-Chloronaphthalene	403.15	690	47
Liquid		144000		1-Chloronaphthalene	413.15	67	47
Liquid		144000		1-Chloronaphthalene	423.15	85	47
Semicrystalline		670000		1-Chloronaphthalene	363.15	380	47
Semicrystalline		670000		1-Chloronaphthalene	373.15	430	47
Semicrystalline		670000		1-Chloronaphthalene	383.15	165	47
Liquid		670000		1-Chloronaphthalene	393.15	39	47
Liquid		670000		1-Chloronaphthalene	403.15	36	47
Semicrystalline		900000		1-Chloronaphthalene	391.80	245	105
Semicrystalline		900000		Cyclohexane	379.50	205	105
Semicrystalline		900000		Cyclopentane	380.00	190	105
Alkathene				Decahydronaphthalene	349.85	142	56
Rigidex-3				Decahydronaphthalene	366.65	180	56
Rigidex-50				Decahydronaphthalene	374.05	233	56
Semicrystalline		900000		Decahydronaphthalene	384.00	260	105
Semicrystalline				1,2-Dichloroethane	333.15	30	27
Semicrystalline				1,2-Dichloroethane	338.15	38	27
Semicrystalline				1,2-Dichloroethane	343.15	54	27
Semicrystalline				1,2-Dichloroethane	348.15	65	27
Semicrystalline			10000	1,4-Dimethylbenzene	354.15	139	5
Semicrystalline			11800	1,4-Dimethylbenzene	352.15	139	5
Semicrystalline			15600	1,4-Dimethylbenzene	353.65	154	5
Semicrystalline			15600	1,4-Dimethylbenzene	363.65	113	5
Semicrystalline			15600	1,4-Dimethylbenzene	368.65	104	5
Semicrystalline		900000		2,4-Dimethylpentane	393.00	230	105
Semicrystalline		900000		2,2,4,4,6,8,8-Heptamethylnonane	399.50	170	105
Semicrystalline		900000		Hexadecane	399.50	262	105
Semicrystalline		900000		2-Methylbutane	394.20	165	105
Semicrystalline		65000		1,2,3,4-Tetrahydronaphthalene	373.15	940	47

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	T/K	$\Delta H_B^\infty$ / J/g	Ref.
Semicrystalline		65000		1,2,3,4- Tetrahydronaphthalene	383.15	990	47
Semicrystalline		65000		1,2,3,4- Tetrahydronaphthalene	393.15	790	47
Liquid		65000		1,2,3,4- Tetrahydronaphthalene	403.15	58	47
Semicrystalline		84000		1,2,3,4- Tetrahydronaphthalene	373.15	835	47
Semicrystalline		130000		1,2,3,4- Tetrahydronaphthalene	353.15	630	47
Semicrystalline		130000		1,2,3,4- Tetrahydronaphthalene	373.15	520	47
Liquid		130000		1,2,3,4- Tetrahydronaphthalene	393.15	69	47
Semicrystalline		144000		1,2,3,4- Tetrahydronaphthalene	373.15	610	47
Semicrystalline		144000		1,2,3,4- Tetrahydronaphthalene	383.15	1200	47
Semicrystalline		144000		1,2,3,4- Tetrahydronaphthalene	393.15	1130	47
Semicrystalline		144000		1,2,3,4- Tetrahydronaphthalene	403.15	800	47
Liquid		144000		1,2,3,4- Tetrahydronaphthalene	413.15	136	47
Liquid		144000		1,2,3,4- Tetrahydronaphthalene	423.15	88	47
Semicrystalline		310000		1,2,3,4- Tetrahydronaphthalene	343.15	485	47
Semicrystalline		670000		1,2,3,4- Tetrahydronaphthalene	353.15	560	47
Semicrystalline		670000		1,2,3,4- Tetrahydronaphthalene	363.15	560	47
Semicrystalline		670000		1,2,3,4- Tetrahydronaphthalene	373.15	460	47
Semicrystalline		670000		1,2,3,4- Tetrahydronaphthalene	383.15	155	47
Liquid		670000		1,2,3,4- Tetrahydronaphthalene	393.15	67	47
Liquid		670000		1,2,3,4- Tetrahydronaphthalene	403.15	39	47
Semicrystalline			16000	Toluene	353.15	110	22
Semicrystalline			22000	Toluene	358.35	118	22
Semicrystalline			22000	Toluene	367.35	106	22
Semicrystalline		900000		1,2,4-Trichlorobenzene	386.50	255	105
<i>Poly(ethylene glycol)</i>							
	180			Benzene	303.15	110	71
	385			Benzene	303.15	60	71
	560			Benzene	303.15	40	71
	1050			Benzene	303.15	90	71
	1610			Benzene	303.15	140	71
	1940			Benzene	303.15	215	71
	3200			Benzene	303.15	195	71
	4330			Benzene	303.15	195	71

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
	5850			Benzene	303.15	190	71
	9950			Benzene	303.15	195	71
			43400	Benzene	303.15	190	71
	400	420		Trichloromethane	303.15	-79	95
	590	615		Trichloromethane	303.15	-88	95
	180			Water	303.15	-136	71
	200			Water	321.35	-125	83
	355			Water	303.15	-159	71
	400			Water	321.35	-150	83
	560			Water	303.15	-150	71
	990			Water	321.35	-101	83
	1050			Water	303.15	-106	71
	1460			Water	321.35	-137	83
	1610			Water	303.15	-6	71
	1940			Water	303.15	57	71
	3200			Water	303.15	58	71
	4330			Water	303.15	28	71
	5850			Water	303.15	39	71
	9950			Water	303.15	30	71
			14000	Water	303.15	7	55
			14000	Water	313.15	27	55
			20300	Water	303.15	45	71
			34500	Water	303.15	34	71
			43300	Water	303.15	+40	71
<i>Poly(ethylene glycol) dimethyl ether</i>							
	250			Tetrachloromethane	303.15	-12	95
	250			Tetrachloromethane	318.15	-7.6	95
	400			Tetrachloromethane	303.15	-12	95
	520	550		Tetrachloromethane	303.15	-12	95
	520	550		Tetrachloromethane	303.15	-7.6	95
	250			Trichloromethane	303.15	-184	95
	520	550		Trichloromethane	303.15	-135	95
<i>Poly(ethylene glycol) monododecyl ether</i>							
	230			Dodecane	302.15	42	68
	274			Dodecane	302.15	23	68
	318			Dodecane	302.15	34	68
	362			Dodecane	302.15	37	68
	406			Dodecane	302.15	42	68
<i>Poly(ethylene glycol) monomethyl ether</i>							
	353	377		Trichloromethane	303.15	-125	95
	550	580		Trichloromethane	303.15	-117	95
<i>Poly(ethylene oxide)</i>							
Semicrystalline	6000			Dichloromethane	303.15	+84	58
Liquid	6000			Dichloromethane	303.15	-160	58



Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
Semicrystalline	6000			Trichloromethane	303.15	+52	58
Liquid	6000			Trichloromethane	303.15	-186	58
Quenched	1520	1720		Water	293.15	-403	64
Annealed	1520	1720		Water	293.15	-392	64
Quenched	1520	1720		Water	298.15	-180	64
Annealed	1520	1720		Water	298.15	-150	64
Quenched	1520	1720		Water	303.15	+68	64
Annealed	1520	1720		Water	303.15	+109	64
Liquid	6000			Water	303.15	-50	58
Quenched	6840	7525		Water	293.15	-28	64
Annealed	6840	7525		Water	293.15	+209	64
Quenched	6840	7525		Water	298.15	+241	64
Annealed	6840	7525		Water	298.15	+540	64
Quenched	16600	19600		Water	293.15	-160	64
Annealed	16600	19600		Water	293.15	-143	64
Quenched	16600	19600		Water	298.15	+59	64
Annealed	16600	19600		Water	298.15	+155	64
Quenched	16600	19600		Water	303.15	+353	64
Annealed	16600	19600		Water	303.15	+490	64
Semicrystalline		20000		Water	298.15	+10	84
<b><i>Polyindene</i></b>							
	765	1023		Anisole	299.15	2.1	102
	765	1023		Benzene	299.15	-0.04	102
	765	1023		Benzonitrile	299.15	-4.4	102
	765	1023		Bromobenzene	299.15	-3.9	102
	765	1023		2-Butanone	299.15	1.9	102
	765	1023		Chlorobenzene	299.15	-3.9	102
	765	1023		1-Chlorobutane	299.15	-4.0	102
	765	1023		1-Chloroheptane	299.15	1.5	102
	765	1023		Cyclohexane	299.15	15	102
	765	1023		<i>N,N</i> -dimethylaniline	299.15	-8.2	102
	765	1023		Ethyl acetate	299.15	4.2	102
	765	1023		Ethylbenzene	299.15	-1.4	102
	765	1023		Ethyl benzoate	299.15	-0.7	102
	765	1023		Nitrobenzene	299.15	4.6	102
	765	1023		1-Nitropropane	299.15	8.4	102
	765	1023		Pyridine	299.15	-6.7	102
	765	1023		1,1,2,2-Tetrachloroethane	299.15	-19	102
	765	1023		Tetrachloromethane	299.15	-2.5	102
	765	1023		1,1,1-Trichloroethane	299.15	-1.8	102
	765	1023		Trichloromethane	299.15	-20	102
<b><i>Polyisobutylene</i></b>							
	360		700	Benzene	298.15	30	67
	1000		2000	Benzene	298.15	25	67
	1300		2500	Benzene	298.15	23	67
			30000	Benzene	297.65	19	38
			30000	Benzene	298.15	19	40

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
	44700			Benzene	303.15	16	44
			48000	Benzene	303.4	19	72
			50000	Benzene	303.15	16	45
			72000	Benzene	300.15	19	53
			72000	Benzene	323.15	18	53
			72000	Benzene	343.15	16	53
			72000	Benzene	375.15	13	53
			72000	Benzene	394.15	9.2	53
			72000	Benzene	423.15	3.5	53
			72000	Benzene	437.15	-0.5	53
			72000	Benzene	453.15	-4.7	53
			90000	Benzene	298.15	6.7	32
			160000	Benzene	303.15	16	51
			560000	Benzene	298.15	18	34
				Benzene	298.15	6.8	7
				Benzene	298.15	6.8	10
			30000	Chlorobenzene	297.65	12	38
			30000	Chlorobenzene	298.15	13	40
			50000	Chlorobenzene	303.15	12	45
			160000	Chlorobenzene	303.15	12	51
			560000	Chlorobenzene	298.15	12	34
	360		700	Cyclohexane	298.15	3.8	67
	1000		2000	Cyclohexane	298.15	1.2	67
	1300		2500	Cyclohexane	298.15	1.1	67
			4500	Cyclohexane	298.15	-0.6	74
			30000	Cyclohexane	297.65	-0.7	38
			30000	Cyclohexane	298.15	-0.6	40
			50000	Cyclohexane	303.15	-0.7	45
			160000	Cyclohexane	303.15	-0.6	51
			1990000	Cyclohexane	298.15	-0.7	39
			4500	Cyclooctane	298.15	+0.3	74
			4500	Cyclopentane	298.15	-5.9	74
			4500	<i>cis</i> -Decahydronaphthalene	298.15	0.2	74
			4500	<i>trans</i> -Decahydronaphthalene	298.15	-0.8	74
			30000	Decane	297.65	-0.5	38
			50000	Decane	303.15	-0.5	45
			30000	Dibutyl ether	297.65	1.2	37
			30000	Diethyl ether	297.65	2.8	37
			30000	Diethyl ether	297.65	2.8	38
			4500	3,3-Diethylpentane	298.15	-1.4	74
			30000	Dihexyl ether	297.65	0.9	37
			4500	2,2-Dimethylpentane	298.15	-1.1	74
			4500	2,3-Dimethylpentane	298.15	-1.9	74
			4500	2,4-Dimethylpentane	298.15	-1.1	74
			4500	3,3-Dimethylpentane	298.15	-1.7	74
			30000	Dipentyl ether	297.65	1.0	37
			30000	Dipropyl ether	297.65	1.8	37

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
	360		700	Dodecane	298.15	1.9	67
	1000		2000	Dodecane	298.15	0.7	67
	1300		2500	Dodecane	298.15	0.5	67
			4500	Dodecane	298.15	0.2	73
			30000	Dodecane	297.65	-0.1	38
			30000	Dodecane	298.15	-0.1	40
			48000	Ethylbenzene	291.15	9.5	72
			48000	Ethylbenzene	343.15	3.6	72
			30000	Ethyl decanoate	297.65	3.0	37
			30000	Ethyl heptanoate	297.65	5.6	37
			30000	Ethyl hexadecanoate	297.65	1.3	37
			30000	Ethyl hexanoate	297.65	6.7	37
			30000	Ethyl nonanoate	297.65	3.7	37
			30000	Ethyl octanoate	297.65	4.6	37
			4500	3-Ethylpentane	298.15	-2.0	74
			30000	Ethyl tetradecanoate	297.65	1.8	37
			4500	2,2,4,4,6,8,8- Heptamethylnonane	298.15	-0.5	74
	360		700	Heptane	298.15	-0.5	67
	1000		2000	Heptane	298.15	-1.0	67
	1300		2500	Heptane	298.15	-1.4	67
			4500	Heptane	298.15	-1.7	73
			30000	Heptane	297.65	-1.8	38
			30000	Heptane	298.15	-2.0	40
			50000	Heptane	303.15	-1.8	45
			160000	Heptane	303.15	-1.6	51
				Heptane	298.15	-1.4	7
				Heptane	298.15	-1.4	10
	360		700	Hexadecane	298.15	4.5	67
	1000		2000	Hexadecane	298.15	2.1	67
	1300		2500	Hexadecane	298.15	1.0	67
			4500	Hexadecane	298.15	0.9	73
			30000	Hexadecane	297.65	0.04	38
			30000	Hexane	297.65	-2.5	38
			30000	Hexane	298.15	-2.6	40
			50000	Hexane	303.15	-2.5	45
			72000	Hexane	303.15	-1.8	53
			72000	Hexane	324.15	-2.3	53
			72000	Hexane	348.15	-2.9	53
			72000	Hexane	373.15	-3.7	53
			72000	Hexane	393.15	-5.3	53
			72000	Hexane	408.15	-6.7	53
			72000	Hexane	423.15	-9.0	53
			72000	Hexane	433.15	-9.9	53
			160000	Hexane	303.15	-2.5	51
			30000	2-Methylbutane	297.65	-3.1	38
			30000	Methylcyclohexane	297.65	-1.2	38
			50000	Methylcyclohexane	303.15	-1.2	45

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			160000	Methylcyclohexane	303.15	-1.2	51
			4500	3-Methylhexane	298.15	-1.0	74
			30000	3-Methylpentane	297.65	-2.8	38
			30000	Nonane	297.65	-0.8	38
			4500	Nonane	298.15	-0.8	73
			4500	Octane	298.15	-1.1	73
			30000	Octane	297.65	-1.2	38
			72000	Octane	303.15	-0.3	53
			72000	Octane	324.15	-0.8	53
			72000	Octane	348.15	-0.9	53
			72000	Octane	373.15	-1.1	53
			72000	Octane	393.15	-1.3	53
			72000	Octane	423.15	-3.6	53
			4500	2,2,4,6,6-Pentamethylheptane	298.15	-0.1	73
	360		700	Pentane	298.15	-1.9	67
	1000		2000	Pentane	298.15	-2.9	67
	1300		2500	Pentane	298.15	-3.2	67
			30000	Pentane	297.65	-3.6	38
			72000	Pentane	303.15	-2.8	53
			72000	Pentane	333.15	-3.4	53
			72000	Pentane	352.15	-4.5	53
			72000	Pentane	365.15	-5.5	53
	360		700	Tetrachloromethane	298.15	5.9	67
	1000		2000	Tetrachloromethane	298.15	5.8	67
	1300		2500	Tetrachloromethane	298.15	5.0	67
			1990000	Tetrachloromethane	298.15	4.1	39
			30000	Tetradecane	297.65	0.0	38
			4500	2,2,4,4-Tetramethylpentane	298.15	-0.6	74
			4500	2,3,3,4-Tetramethylpentane	298.15	-2.3	74
			50000	Toluene	303.15	7.4	45
			160000	Toluene	303.15	7.4	51
			1990000	Toluene	298.15	8.8	39
				Toluene	298.15	1.8	7
				Toluene	298.15	1.8	10
			30000	Tridecane	297.65	-0.04	38
			4500	2,2,4-Trimethylpentane	298.15	-0.4	73
			30000	2,2,4-Trimethylpentane	297.65	-0.6	38
			1990000	2,2,4-Trimethylpentane	298.15	0.0	39
				2,2,4-Trimethylpentane	298.15	0.0	7
				2,2,4-Trimethylpentane	298.15	0.0	10
			30000	Undecane	297.65	-0.4	38
<i>Poly(isobutyl methacrylate)</i>							
Glass		260000		Cyclohexanone	303.15	-5.2	98
Liquid		260000		Cyclohexanone	303.15	13	98
<i>Poly(methyl acrylate)</i>							
				2-Propanone	298.15	0.0	25

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
<i>Poly(methyl methacrylate)</i>							
Glass	73900	170000		Cyclohexanone	304.15	-14	98
Liquid	73900	170000		Cyclohexanone	304.15	17	98
	1930			1,2-Dichloroethane	298.15	-20	32
	240000			1,2-Dichloroethane	298.15	-27	32
			53000	Ethylbenzene	298.15	-31	28
			180000	Ethylbenzene	298.15	-29	28
	28900	35900		4-Methyl-2-pentanone	303.15	-21	76
	93940	101000		4-Methyl-2-pentanone	303.15	-24	76
	137000	215000		4-Methyl-2-pentanone	303.15	-28	76
				2-Propanone	298.15	-30	25
	93940	101000		Toluene	303.15	-22	76
	689000	782000		Toluene	303.15	-24	76
			12000	Trichloromethane	298.15	-65	52
			54000	Trichloromethane	298.15	-80	52
			80000	Trichloromethane	298.15	-81	52
			100000	Trichloromethane	298.15	-84	52
			320000	Trichloromethane	298.15	-83	52
	93940	101000		Trichloromethane	303.15	-71	76
	689000	782000		Trichloromethane	303.15	-72	76
		2320000		Trichloromethane	303.15	-73	76
<i>Poly(4-methyl-1-pentene)</i>							
Semicrystalline			350000	Cyclohexane	303.15	30	79
<i>Poly(<math>\alpha</math>-methylstyrene)</i>							
	1030	1180		Toluene	298.15	-7.1	43
		1430		Toluene	298.15	-30	43
	1820	2230		Toluene	298.15	-34	43
	1920			Toluene	298.15	-37	43
	2700	3300		Toluene	298.15	-39	43
	3280			Toluene	298.15	-46	43
	5260			Toluene	298.15	-46	43
	8600			Toluene	298.15	-45	43
	12200			Toluene	298.15	-46	43
		10500		Toluene	310.15	-8.4	92
		53000		Toluene	310.15	-13	92
		55000		Toluene	333.15	-16	96
		87000		Toluene	298.15	-17	90
		87000		Toluene	310.15	-16	92
		87000		Toluene	333.15	-11	90
<i>Poly(2-methyl-5-vinyltetrazole)</i>							
				Acetic acid	298.15	47	100
				Acetonitrile	298.15	14	100
				1,2-Dichloroethane	298.15	17	100
				<i>N,N</i> -Diethylacetamide	298.15	17	100
				<i>N,N</i> -Dimethylformamide	298.15	33	100
				Dimethylsulfoxide	298.15	10	100

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
				Formamide	298.15	12	100
				Formic acid	298.15	110	100
				Nitromethane	298.15	10	100
				Pyridine	298.15	16	100
<i>Poly(octamethylene oxide)</i>							
	7000			Benzene	298.15	20	64
	7000			Benzene	303.15	22	64
	7000			Benzene	308.15	25	64
<i>Polypentenamer</i>							
			50000	Cyclohexane	298.15	4.6	74
			50000	Cyclooctane	298.15	5.1	74
			50000	Cyclopentane	298.15	-2.3	74
			50000	<i>cis</i> -Decahydronaphthalene	298.15	2.6	74
			50000	<i>trans</i> -Decahydronaphthalene	298.15	<0.1	74
			50000	3,3-Diethylpentane	298.15	2.4	74
			50000	2,2-Dimethylpentane	298.15	3.3	74
			50000	2,3-Dimethylpentane	298.15	2.2	74
			50000	2,4-Dimethylpentane	298.15	3.3	74
			50000	3,3-Dimethylpentane	298.15	2.7	74
			50000	Dodecane	298.15	2.9	74
			50000	3-Ethylpentane	298.15	2.1	74
			50000	2,2,4,4,6,8,8-Heptamethylnonane	298.15	3.2	74
			50000	Hexadecane	298.15	2.6	74
			50000	3-Methylhexane	298.15	2.4	74
			50000	Octane	298.15	2.2	74
			50000	2,2,4,6,6-Pentamethylheptane	298.15	3.8	74
			50000	2,2,4,4-Tetramethylpentane	298.15	4.5	74
			50000	2,3,3,4-Tetramethylpentane	298.15	2.4	74
			50000	2,2,4-Trimethylpentane	298.15	4.3	74
<i>Poly(m-phenyleneisophthalamide)</i>							
Glass				<i>N,N</i> -Dimethylacetamide	298.15	-171	60
Semicrystalline				<i>N,N</i> -Dimethylacetamide	298.15	-128	60
Glass				<i>N,N</i> -Dimethylformamide	298.15	-149	60
Semicrystalline				<i>N,N</i> -Dimethylformamide	298.15	-125	60
Glass				1-Methyl-2-pyrrolidone	298.15	-177	60
Semicrystalline				1-Methyl-2-pyrrolidone	298.15	-118	60
<i>Polypropylene (atactic)</i>							
			18000	Benzene	298.15	31	80
			6000	Cyclohexane	298.15	2.3	74
			18000	Cyclohexane	298.15	3.9	80
			6000	Cyclooctane	298.15	3.0	74
			6000	Cyclopentane	298.15	-2.3	74
			6000	<i>cis</i> -Decahydronaphthalene	298.15	0.5	74

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
	6000			<i>trans</i> -Decahydronaphthalene	298.15	-2.4	74
	18000			Decane	298.15	3.1	80
	6000			3,3-Diethylpentane	298.15	-3.9	74
	18000			1,2-Dimethylbenzene	298.15	13	80
	18000			1,3-Dimethylbenzene	298.15	12	80
	18000			1,4-Dimethylbenzene	298.15	10	80
	6000			2,2-Dimethylpentane	298.15	-2.2	74
	6000			2,3-Dimethylpentane	298.15	-2.5	74
	6000			2,4-Dimethylpentane	298.15	-1.8	74
	6000			3,3-Dimethylpentane	298.15	-3.0	74
	6000			Dodecane	298.15	1.7	73
	18000			Ethylbenzene	298.15	14	80
	6000			3-Ethylpentane	298.15	-2.5	74
	6000			2,2,4,4,6,8,8- Heptamethylnonane	298.15	-0.7	73
	6000			Heptane	298.15	-1.6	73
	18000			Heptane	298.15	0.5	80
	6000			Hexadecane	298.15	2.3	73
	18000			Hexane	298.15	-1.4	80
	6000			3-Methylhexane	298.15	-1.8	74
	6000			Nonane	298.15	0.8	73
	18000			Nonane	298.15	2.4	80
	6000			Octane	298.15	-1.2	73
	18000			Octane	298.15	1.0	80
	6000			2,2,4,6,6-Pentamethylheptane	298.15	-0.2	73
	18000			Pentane	298.15	-4.7	80
	18000			Tetrachloromethane	298.15	6.6	80
	6000			2,2,4,4-Tetramethylpentane	298.15	-0.8	74
	6000			2,3,3,4-Tetramethylpentane	298.15	-3.1	74
	18000			Toluene	298.15	17	80
	18000			Trichloromethane	298.15	17	80
	6000			2,2,4-Trimethylpentane	298.15	-1.0	73
<i>Polypropylene (isotactic)</i>				1-Chloronaphthalene	383.15	26	47
				1-Chloronaphthalene	393.15	170	47
				1-Chloronaphthalene	403.15	245	47
				1-Chloronaphthalene	423.15	275	47
				1,2,3,4- Tetrahydronaphthalene	373.15	140	47
				1,2,3,4- Tetrahydronaphthalene	383.15	215	47
				1,2,3,4- Tetrahydronaphthalene	393.15	330	47
				1,2,3,4- Tetrahydronaphthalene	403.15	330	47
				1,2,3,4- Tetrahydronaphthalene	413.15	335	47
				1,2,3,4- Tetrahydronaphthalene	423.15	290	47

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
<i>Poly(propylene glycol)</i>							
	150			Benzene	321.35	200	103
	425			Benzene	321.35	80	103
	2025			Benzene	321.35	45	103
	150			Ethanol	321.35	40	103
	425			Ethanol	321.35	60	103
	2025			Ethanol	321.35	65	103
	396	412		Tetrachloromethane	303.15	4.7	95
	396	412		Tetrachloromethane	318.15	5.2	95
	1900			Tetrachloromethane	303.15	-8.2	95
	1900			Tetrachloromethane	318.15	11	95
	1900			Trichloromethane	303.15	-81	95
		400		Water	298.15	-165	97
	150			Water	321.35	-90	103
	425			Water	321.35	-95	103
<i>Polystyrene</i>							
		600		Benzene	298.15	-1.3	54
		600		Benzene	313.15	-2.5	54
		900		Benzene	291.15	-10	54
		900		Benzene	318.15	-5.8	54
		2000		Benzene	291.15	-16	54
		2000		Benzene	318.15	-6.8	54
		5000		Benzene	291.15	-23	54
		5000		Benzene	318.15	-12	54
		10300		Benzene	291.15	-26	54
		10300		Benzene	318.15	-18	54
			18000	Benzene	298.15	-4.1	19
	20000			Benzene	296.15	-15	9
			29000	Benzene	298.15	-5.0	19
			30000	Benzene	298.15	-7.5	19
			59000	Benzene	298.15	-13	19
			91000	Benzene	298.15	-15	19
		97200		Benzene	318.15	-21	54
			142000	Benzene	298.15	-17	19
			190000	Benzene	303.15	-18	51
	214000			Benzene	300.15	-16	85
			216000	Benzene	298.15	-18	19
			272000	Benzene	298.15	-21	19
			300000	Benzene	298.15	-21	12
				Benzene	298.15	-27	25
				Benzene	298.15	-10	7
	20000			Butyl acetate	296.15	-13	9
	20000			2-Butanone	296.15	-15	9
			142000	2-Butanone	296.15	-17	30
			190000	Butylbenzene	303.15	-14	51
	150000			Chlorobenzene	293.15	-32	49
			266000	Chlorobenzene	298.15	5.4	34



Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
				Chlorobenzene	293.15	-39	21
	1260			Cyclohexane	298.15	10	16
	1910			Cyclohexane	298.15	5.4	16
	3160			Cyclohexane	298.15	-5.4	16
	3980			Cyclohexane	298.15	-6.9	16
	5630			Cyclohexane	298.15	-9.3	16
	9070			Cyclohexane	298.15	-11	16
	20000			Cyclohexane	296.15	2.5	9
			190000	Cyclohexane	303.15	-2.1	51
				Cyclohexane	293.15	-14	21
	22400			Cyclohexanone	298.15	-29	25
	20000			Cyclohexene	296.15	-9.4	9
			190000	Decahydronaphthalene	303.15	3.8	51
	110000	115000		1,2-Dichlorobenzene	303.05	26	89
	20000			1,2-Dimethylbenzene	296.15	-13	9
	20000			1,3-Dimethylbenzene	296.15	-12	9
			190000	1,3-Dimethylbenzene	303.15	-15	51
			190000	1,4-Dioxane	303.15	-12	51
	20000			Ethyl acetate	296.15	-11	9
			142000	Ethyl acetate	296.15	-13	30
			785	Ethylbenzene	298.15	0.0	14
			18000	Ethylbenzene	298.15	-3.8	14
			18000	Ethylbenzene	298.15	-3.9	19
			30000	Ethylbenzene	298.15	-5.7	19
			35000	Ethylbenzene	298.15	-6.5	19
			45000	Ethylbenzene	298.15	-8.4	19
			91000	Ethylbenzene	298.15	-11	19
			142000	Ethylbenzene	298.15	-13	19
			216000	Ethylbenzene	298.15	-17	19
	60000			Ethylbenzene	303.15	-22	57
	113000	122000		Ethylbenzene	306.65	-24	63
	113000	122000		Ethylbenzene	317.15	-19	63
	113000	122000		Ethylbenzene	337.15	-11	63
	113000	122000		Ethylbenzene	347.15	-6.4	63
	113000	122000		Ethylbenzene	350.65	-4.9	63
	113000	122000		Ethylbenzene	366.65	-2.3	63
	113000	122000		Ethylbenzene	367.15	-2.1	63
	113000	122000		Ethylbenzene	368.65	-2.6	63
	113000	122000		Ethylbenzene	372.15	-4.2	63
	113000	122000		Ethylbenzene	378.15	-4.6	63
	113000	122000		Ethylbenzene	385.15	-5.7	63
	150000			Ethylbenzene	293.15	-34	49
			190000	Ethylbenzene	303.15	-15	51
			272000	Ethylbenzene	298.15	-18	14
			272000	Ethylbenzene	298.15	-18	19
			413000	Ethylbenzene	298.15	-24	39
				Ethylbenzene	293.15	-34	21

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
				Ethylbenzene	298.15	-17	11
				Ethylbenzene	298.15	-30	28
	1260			2-Propanone	298.15	-0.6	16
	1910			2-Propanone	298.15	-7.7	16
	3160			2-Propanone	298.15	-16	16
	3980			2-Propanone	298.15	-17	16
	5630			2-Propanone	298.15	-19	16
	9070			2-Propanone	298.15	-21	16
	20000			2-Propanone	296.15	-11	9
			190000	Propylbenzene	303.15	-14	51
	20000			Styrene	296.15	-18	9
				Styrene	296.15	-35	6
			413000	Tetrachloromethane	298.15	-22	39
	600			Toluene	296.15	-2.1	16
	600			Toluene	309.15	-1.8	16
	600			Toluene	318.15	-1.5	16
	1260			Toluene	296.15	-11	16
	1260			Toluene	303.15	-8.0	16
	1260			Toluene	309.15	-5.9	16
	1260			Toluene	318.15	-3.4	16
	1260			Toluene	328.15	-2.3	16
	1260			Toluene	338.15	-1.9	16
	1260			Toluene	346.65	-1.3	16
	1910			Toluene	298.15	-16	16
	1910			Toluene	318.15	-6.7	16
	1910			Toluene	338.15	-3.4	16
	1910			Toluene	348.15	-2.5	16
	3160			Toluene	298.15	-23	16
	3980			Toluene	298.15	-24	16
	3980			Toluene	318.15	-17	16
	3980			Toluene	338.15	-10	16
	5630			Toluene	298.15	-26	16
	9070			Toluene	298.15	-28	16
	270000			Toluene	298.15	-33	16
		600		Toluene	298.15	-1.4	54
		600		Toluene	313.15	-3.2	54
		900		Toluene	291.15	-7.3	54
		900		Toluene	318.15	-6.6	54
		2000		Toluene	291.15	-11	54
		2000		Toluene	318.15	-7.2	54
		5000		Toluene	291.15	-21	54
		5000		Toluene	318.15	-11	54
		10300		Toluene	291.15	-24	54
		10300		Toluene	318.15	-15	54
		97200		Toluene	318.15	-17	54
		9000		Toluene	310.15	-9.2	92
	20000			Toluene	296.15	-17	9

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
	20400			Toluene	298.15	-8.2	90
	20400			Toluene	310.15	-8.4	92
	20400			Toluene	333.15	-6.4	90
	47000			Toluene	310.15	-5.0	92
	50000			Toluene	333.15	-6.8	96
	60000			Toluene	303.15	-21	57
	113000	122000		Toluene	304.15	-29	63
	113000	122000		Toluene	306.15	-27	63
	113000	122000		Toluene	306.65	-26	63
	113000	122000		Toluene	316.15	-23	63
	113000	122000		Toluene	333.15	-15	63
	113000	122000		Toluene	337.15	-12	63
	113000	122000		Toluene	346.15	-8.3	63
	113000	122000		Toluene	347.15	-7.8	63
	113000	122000		Toluene	348.15	-8.2	63
	113000	122000		Toluene	350.65	-6.5	63
	113000	122000		Toluene	359.15	-4.3	63
	113000	122000		Toluene	362.15	-2.7	63
	113000	122000		Toluene	369.15	-3.3	63
	113000	122000		Toluene	372.15	-2.8	63
	115000			Toluene	310.15	-5.0	92
	150000			Toluene	293.15	-34	49
			190000	Toluene	303.15	-18	51
	214000			Toluene	300.15	-19	85
			250000	Toluene	303.15	-18	51
				Toluene	293.15	-34	21
				Toluene	298.65	-39	27
				Toluene	308.15	-34	27
				Toluene	318.15	-30	27
				Toluene	333.15	-23	27
				Toluene	343.15	-13	27
				Toluene	353.15	-13	27
		600		Trichloromethane	298.15	-13	54
		600		Trichloromethane	313.15	-9.9	54
		900		Trichloromethane	291.15	-22	54
		900		Trichloromethane	313.15	-15	54
		2000		Trichloromethane	291.15	-28	54
		2000		Trichloromethane	313.15	-16	54
		5000		Trichloromethane	291.15	-30	54
		5000		Trichloromethane	313.15	-18	54
		10300		Trichloromethane	291.15	-33	54
		10300		Trichloromethane	313.15	-23	54
	22400			Trichloromethane	298.15	-17	25
		97200		Trichloromethane	313.15	-25	54
	20000			1,3,5-Trimethylbenzene	296.15	-11	9
			190000	1,3,5-Trimethylbenzene	303.15	-13	51

*Poly(tetramethylene oxide)*

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
	650			Benzene	313.15	4.0	86
	1000			Benzene	313.15	2.0	86
	2000			Benzene	313.15	1.1	86
	650			1,2-Dichloroethane	313.35	3.1	88
	2000			1,2-Dichloroethane	313.35	0.3	88
	650			1,2-Dimethylbenzene	313.15	5.9	87
	1000			1,2-Dimethylbenzene	313.15	1.8	87
	2000			1,2-Dimethylbenzene	313.15	0.9	87
	650			1,3-Dimethylbenzene	313.15	6.4	87
	1000			1,3-Dimethylbenzene	313.15	0.6	87
	2000			1,3-Dimethylbenzene	313.15	0.8	87
	650			1,4-Dimethylbenzene	313.15	4.3	87
	1000			1,4-Dimethylbenzene	313.15	1.8	87
	2000			1,4-Dimethylbenzene	313.15	0.7	87
	650			1,4-Dioxane	321.35	4.0	81
	1000			1,4-Dioxane	321.35	2.3	81
	2000			1,4-Dioxane	321.35	1.0	81
	650			Ethylbenzene	313.15	6.9	86
	1000			Ethylbenzene	313.15	3.4	86
	2000			Ethylbenzene	313.15	-0.05	86
	650			Propylbenzene	313.15	5.8	86
	1000			Propylbenzene	313.15	1.3	86
	2000			Propylbenzene	313.15	0.9	86
	650			Tetrachloromethane	313.15	3.3	88
	1000			Tetrachloromethane	313.15	1.4	88
	2000			Tetrachloromethane	321.35	0.7	82
	650			Toluene	313.15	4.3	86
	1000			Toluene	313.15	2.0	86
	2000			Toluene	313.15	0.9	86
	650			1,3,5-Trimethylbenzene	313.15	6.1	87
	1000			1,3,5-Trimethylbenzene	313.15	2.7	87
	2000			1,3,5-Trimethylbenzene	313.15	0.6	87
<i>Poly(vinyl acetate)</i>							
			140000	Benzene	298.15	2.3	13
			350000	2-Butanone	303.15	-1.7	51
			350000	Butyl acetate	303.15	1.0	51
			135000	Chlorobenzene	298.15	5.0	34
			350000	Ethyl acetate	303.15	-6.7	51
				Ethyl acetate	303.15	0.0	11
			26000	3-Heptanone	303.15	7.0	44
			350000	3-Heptanone	303.15	4.9	51
			140000	Methanol	298.15	-45	13
			350000	Methyl acetate	303.15	-9.7	51
			350000	2-Pentanone	303.15	0.0	51
			93000	2-Propanone	303.15	-0.4	32
			350000	2-Propanone	303.15	-3.9	51
				2-Propanone	303.15	-2.9	25

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T/K$	$\Delta H_B^\infty$ / J/g	Ref.
			350000	Propyl acetate	303.15	-2.7	51
		150000		Tetrahydrofuran	304.65	4.5	93
			140000	Trichloromethane	298.15	28	13
<i>Poly(vinyl alcohol)</i>							
				Ethanol	298.15	3.8	11
				Ethanol	298.15	9.6	31
	7260			Water	303.15	-34	15
	17000			Water	303.15	-18	32
	61600			Water	303.15	-41	15
				Water	303.15	-8.4	11
<i>Poly(vinyl chloride)</i>							
				Chlorobenzene	298.15	-17	36
Glass	23200			Cyclohexanone	303.15	-27	59
Liquid	23200			Cyclohexanone	303.15	-7.5	59
Glass	38700			Cyclohexanone	303.15	-29	59
Liquid	38700			Cyclohexanone	303.15	-6.6	59
Glass	53500			Cyclohexanone	303.15	-28	59
Liquid	53500			Cyclohexanone	303.15	-6.3	59
Glass	66700			Cyclohexanone	303.15	-29	59
Liquid	66700			Cyclohexanone	303.15	-6.1	59
Glass	136000			Cyclohexanone	303.15	-31	59
Liquid	136000			Cyclohexanone	303.15	-5.8	59
Glass	155400			Cyclohexanone	303.15	-32	59
Liquid	155400			Cyclohexanone	303.15	-5.8	59
	48000			Cyclopentanone	298.15	-28	104
				1,2-Dichloroethane	323.65	24	27
				1,2-Dichloroethane	328.15	34	27
				1,2-Dichloroethane	333.15	38	27
				1,2-Dichloroethane	368.15	44	27
				1,2-Dichloroethane	373.15	46	27
				1,2-Dichloroethane	378.15	46	27
				<i>N,N</i> -Dimethylformamide	293.15	-28	35
				<i>N,N</i> -Dimethylformamide	308.15	-19	35
				<i>N,N</i> -Dimethylformamide	323.15	-14	35
				<i>N,N</i> -Dimethylformamide	338.15	-7.5	35
				<i>N,N</i> -Dimethylformamide	353.15	2.4	35
Glass	23200			Tetrahydrofuran	303.15	-34	59
Liquid	23200			Tetrahydrofuran	303.15	-14	59
Glass	38700			Tetrahydrofuran	303.15	-35	59
Liquid	38700			Tetrahydrofuran	303.15	-14	59
Glass	53500			Tetrahydrofuran	303.15	-39	59
Liquid	53500			Tetrahydrofuran	303.15	-14	59
Glass	66700			Tetrahydrofuran	303.15	-36	59
Liquid	66700			Tetrahydrofuran	303.15	-14	59
Glass	136000			Tetrahydrofuran	303.15	-39	59
Liquid	136000			Tetrahydrofuran	303.15	-14	59
Glass	155400			Tetrahydrofuran	303.15	-39	59

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	$T$ /K	$\Delta H_B^\infty$ / J/g	Ref.
Liquid	155400			Tetrahydrofuran	303.15	-14	59
<i>Poly(1-vinyl-3,5-dimethyl-1,2,4-triazole)</i>							
				<i>N,N</i> -Dimethylformamide	298.15	-28	94
				Water	298.15	-139	94
<i>Poly(1-vinylimidazole)</i>							
	20700			Acetic acid	298.15	-393	94
	20700			Butanoic acid	298.15	-322	94
	20700			<i>N,N</i> -Dimethylacetamide	298.15	-48	94
	20700			<i>N,N</i> -Dimethylformamide	298.15	-48	94
	20700			1-Methyl-2-pyrrolidinone	298.15	-54	91
	20700			Pentanoic acid	298.15	-325	94
	20700			Propanoic acid	298.15	-278	94
	20700			Water	298.15	-119	91
<i>Poly(1-vinylpyrazole)</i>							
	18900			Acetic acid	298.15	-88	94
	18900			Butanoic acid	298.15	-60	94
	18900			<i>N,N</i> -Dimethylacetamide	298.15	-26	94
	18900			<i>N,N</i> -Dimethylformamide	298.15	-28	94
	18900			Pentanoic acid	298.15	-52	94
	18900			Propanoic acid	298.15	-36	94
<i>Poly(1-vinyl-2-pyrrolidone)</i>							
			32000	Trichloromethane	298.15	-75	48
			32000	Water	298.15	-150	48
<i>Poly(1-vinyl-1,2,4-triazole)</i>							
	69500			Acetic acid	298.15	-85	94
	69500			Butanoic acid	298.15	-74	94
	69500			<i>N,N</i> -Dimethylacetamide	298.15	-49	94
	69500			<i>N,N</i> -Dimethylformamide	298.15	-47	94
	69500			1-Methyl-2-pyrrolidinone	298.15	-55	91
	69500			Pentanoic acid	298.15	-75	94
	69500			Propanoic acid	298.15	-72	94
	69500			Water	298.15	-68	91
<i>Vinyl acetate/vinyl alcohol copolymer</i>							
(9 wt% Vinyl acetate)				2-Propanone	298.15	6.3	33
(44 wt% Vinyl acetate)				2-Propanone	298.15	4.6	33
(57 wt% Vinyl acetate)				2-Propanone	298.15	0.0	33
(67 wt% Vinyl acetate)				2-Propanone	298.15	-1.3	33
(4.2 mol% Vinyl acetate)							
7560				Water	303.15	-41	15
(4.3 mol% Vinyl acetate)							
64300				Water	303.15	-49	15
(9.0 mol% Vinyl acetate)							
66900				Water	303.15	-55	15
(10.3 mol% Vinyl acetate)							
7970				Water	303.15	-41	15
(15.3 mol% Vinyl acetate)							
8300				Water	303.15	-60	15

Polymer	$M_n$ / g/mol	$M_w$ / g/mol	$M_v$ / g/mol	Solvent	T/K	$\Delta H_B^\infty$ / J/g	Ref.
(15.4 mol% Vinyl acetate) 70700				Water	303.15	-65	15
(19.5 mol% Vinyl acetate) 73100				Water	303.15	-66	15
(22.1 mol% Vinyl acetate) 8800				Water	303.15	-60	15
(26.2 mol% Vinyl acetate) 77000				Water	303.15	-64	15
(30.6 mol% Vinyl acetate) 9370				Water	303.15	-53	15
(34.0 mol% Vinyl acetate) 81600				Water	303.15	-60	15
(34.7 mol% Vinyl acetate) 9670				Water	303.15	-44	15
<b>Vinyl acetate/vinyl chloride copolymer (90 wt% Vinyl chloride)</b>							
Glass	12400	26000		Cyclohexanone	304.15	-37	101
Liquid	12400	26000		Cyclohexanone	304.15	-16	101
<b>Vinyl chloride/vinylidene chloride copolymer</b>							
				Trichloromethane	297.15	-17	2

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# SOLUBILITY PARAMETERS OF SELECTED POLYMERS

Christian Wohlfarth

The concept of cohesive energy density and solubility parameter was introduced by Hildebrand:

$$\delta^2 = \frac{\Delta U_m^{LV}}{V_m} = \frac{\Delta H_m^{LV} - RT}{V_m} \quad (1)$$

$V_m$  is the molar volume,  $\Delta U_m^{LV}$  is the molar energy of vaporization, and  $\Delta H_m^{LV}$  is the molar enthalpy of vaporization. Units for the solubility parameter are  $(\text{MPa})^{1/2} = (\text{J}/\text{cm}^3)^{1/2} = 0.4887(\text{cal}/\text{cm}^3)^{1/2}$ . The energy of vaporization is not accessible for polymers, but cohesive energy density of polymers can be determined from *PVT*-data. However, common ways for determining polymer solubility parameters use thermodynamic properties of polymer solutions and their relations to excess enthalpy or excess Gibbs energy per unit volume. These excess quantities are related to the (square) difference between the solubility parameters of solvents and polymers, i.e.  $(\delta_1 - \delta_2)^2$ .

$$\frac{H^E}{V} \sim (\delta_1 - \delta_2)^2 \quad \text{or} \quad \frac{G^E}{V} \sim (\delta_1 - \delta_2)^2 \quad (2)$$

Often, the Flory-Huggins solvent-polymer interaction parameter is applied instead of  $H^E$  or  $G^E$ . There are some books (Refs. 1–3) giving details for such procedures as well as extensive tables of polymer solubility parameters from which the table below is extracted. Methods for calculating solubility parameters can be found in Refs. 4–7.

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Polymer	T/K	$\delta/(\text{J}/\text{cm}^3)^{1/2}$	Polymer	T/K	$\delta/(\text{J}/\text{cm}^3)^{1/2}$
Benzyl cellulose	298	25.2	(11 wt% vinyl acetate)	323	16.6
Butadiene/acrylonitrile copolymer			(16 wt% vinyl acetate)	323	17.1
(25 wt % acrylonitrile)	298	19.4	(24 wt% vinyl acetate)	323	16.8
(30 wt % acrylonitrile)	298	19.2	(37 wt% vinyl acetate)	323	17.0
(34 wt % acrylonitrile)	298	20.4	(42 wt% vinyl acetate)	323	17.2
(39 wt % acrylonitrile)	298	21.35	Gelatine	298	24.6
Butadiene/styrene copolymer			Hydroxypropyl cellulose	298	26.8
(6 wt % styrene)	298	16.5	Natural rubber	298	16.6
(12.5 wt % styrene)	298	16.5	Poly(acrylonitrile)	298	26.0
(15 wt% styrene)	298	17.5	Polyamide 4	298	24.0
(25 wt% styrene)	298	17.6	Polyamide 6	298	21.7
(40 wt% styrene)	298	17.8	Polyamide 66	298	22.9
Cellulose	298	26.0	Polyamide 7	298	24.1
Cellulose acetate	298	25.1	Polyamide 8	298	20.3
Cellulose diacetate	298	22.3	Polyamide 9	298	22.6
Cellulose nitrate	298	22.0	Polyamide 10	298	19.4
Cellulose triacetate	298	19.0	Polyamide 11	298	22.9
Ethyl cellulose	298	21.1	Polyamide 12	298	20.8
Ethylene/1-octene copolymer			Poly( <i>p</i> -benzamide)	298	23.0
(2.0 wt% 1-octene)	473	17.2	Poly(benzyl methacrylate)	298	15.3
(7.5 wt% 1-octene)	473	16.7	Polybutadiene	298	16.6
(12.0 wt% 1-octene)	473	16.5	1,2-Polybutadiene	298	16.5
(25.0 wt% 1-octene)	473	16.5	1,4- <i>cis</i> -Polybutadiene	298	16.5
(39.4 wt% 1-octene)	473	16.4	Poly(1-butene), <i>isotactic</i>	298	16.0
(55.0 wt% 1-octene)	473	16.3	Poly(butyl acrylate)	298	18.0
(64.0 wt% 1-octene)	473	16.3	Poly(butyl methacrylate)	298	17.9
Ethylene/vinyl acetate copolymer			Poly(2-butyl methacrylate)	413	14.7

Polymer	T/K	$\delta/(J/cm^3)^{1/2}$	Polymer	T/K	$\delta/(J/cm^3)^{1/2}$
Poly( $\epsilon$ -caprolactone)	298	19.9	Poly(methylvinylsiloxane)	298	15.65
Polycarbonate bisphenol-A	298	20.0	Polynorbornene	298	14.0
Polycarbonate hexafluorobisphenol-A	298	20.1	Poly(1-octene)	298	16.6
Poly(chloroprene)	298	17.6	Poly(octyl methacrylate)	298	18.0
Poly(4-chlorostyrene)	298	19.3	Poly(propyl acrylate)	298	18.4
Poly(cyclohexyl methacrylate)	298	19.8	Poly(propyl methacrylate)	298	16.0
Poly(3,3-diethyloxetane)	298	16.2	Polypropylene, <i>atactic</i>	298	15.5
Poly(3,3-dimethyloxetane)	298	16.2	Polypropylene, <i>isotactic</i>	298	17.5
Poly(2,6-dimethyl-1,4-phenylene ether)	298	18.1	Polypropylene, <i>syndiotactic</i>	298	17.6
Poly(dimethylsiloxane)	298	15.4	Poly(propylene glycol)	298	19.5
Poly(1,3-dioxepane)	298	18.8	Poly(propylene oxide)	298	18.5
Poly(1,3-dioxolane)	298	20.7	Poly(propyl methacrylate)	298	20.0
Poly(dodecyl methacrylate)	298	16.8	Polystyrene	298	19.0
Poly(epichlorohydrin)	298	16.2	Polysulfone	298	19.9
Poly(ethoxyethyl methacrylate)	298	18.4	Poly(tetrafluoroethylene)	298	19.6
Poly(ethyl acrylate)	298	19.2	Poly(tetramethylene oxide)	298	16.8
Polyethylene, branched	298	16.2	Poly(thioethylene)	298	18.8
Polyethylene, linear	298	16.2	Poly(trimethylene sulfide)	298	23.0
Poly(ethylene adipate)	298	19.8	Poly(vinyl acetate)	298	20.6
Poly(ethylene glycol)	298	23.7	Poly(vinyl alcohol)	298	22.0
Poly(ethylene oxide)	298	20.5	Poly(vinyl bromide)	298	19.4
Poly(ethylene terephthalate)	298	21.9	Poly(vinyl butyl ether)	298	19.2
Poly(ethyl methacrylate)	298	18.3	Poly( <i>N</i> -vinylcarbazole)	298	19.2
Poly(hexyl methacrylate)	298	17.7	Poly(vinyl chloride)	298	19.6
Poly(4-hydroxystyrene)	298	24.0	Poly(vinyl ethyl ether)	298	19.5
Poly(isobornyl acrylate)	298	16.8	Poly(vinylidene fluoride)	298	23.2
Poly(isobornyl methacrylate)	298	17.0	Poly(vinyl methyl ether)	298	21.0
Poly(isobutylene)	298	16.2	Poly(vinyl phenyl ether)	298	20.2
Poly(isobutyl methacrylate)	413	14.6	Poly(vinyl propionate)	298	18.1
1,4- <i>cis</i> -Poly(isoprene)	298	16.5	Poly(vinyl propyl ether)	298	19.3
Poly( <i>N</i> -isopropylacrylamide)	298	23.5	Poly(1-vinyl-2-pyrrolidinone)	298	25.6
Poly( <i>DL</i> -lactic acid)	298	20.5	Vinyl acetate/vinyl alcohol copolymer		
Poly( <i>L</i> -lactide)	298	19.3	(43.4 mol% vinyl acetate)	298	21.8
Poly(methacrylonitrile)	298	21.0	(60.9 mol% vinyl acetate)	298	21.4
Poly(methyl acrylate)	298	20.5	(74.4 mol% vinyl acetate)	298	20.9
Poly(methyl methacrylate)	298	19.3	(94.8 mol% vinyl acetate)	298	20.2
Poly(4-methyl-1-pentene)	298	15.3	Vinyl acetate/vinyl chloride copolymer		
Poly(2-methylpropene)	298	17.7	(3 wt% vinyl acetate)	298	18.8
Poly(2-methylstyrene)	298	18.4	(10 wt% vinyl acetate)	298	17.3
Poly(4-methylstyrene)	298	19.3	(17 wt% vinyl acetate)	298	19.1

# ASTRONOMICAL CONSTANTS

Victor Abalakin

The constants in this table are based originally on the set of constants adopted by the International Astronomical Union (IAU) in 1976. Updates have been made when new data were available. All values are given in SI Units; thus masses are expressed in kilograms and distances in meters.

The astronomical unit of time is a time interval of one day (1 d) equal to 86400 s. An interval of 36525 d is one Julian century (1 cy).

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### Defining constants

Gaussian gravitational constant

$$k = 0.01720209895 \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

Speed of light

$$c = 299792458 \text{ m s}^{-1}$$

### Primary constants

Light-time for unit distance (1 ua)

$$\tau_A = 499.004786 \text{ s}$$

Equatorial radius of Earth

$$a_e = 6378140 \text{ m}$$

Equatorial radius of Earth (IUGG value)

$$a_e = 6378136 \text{ m}$$

Dynamical form-factor for Earth

$$J_2 = 0.001082636$$

Geocentric gravitational constant

$$GE = 3.986004 \times 10^{14} \text{ m}^3 \text{ s}^{-2}$$

Constant of gravitation

$$G = 6.67428 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

Ratio of mass of moon to that of Earth

$$\mu = 0.01230002$$

$$1/\mu = 81.300587$$

General precession in longitude, per Julian century, at standard epoch J2000

$$\rho = 5028''.796$$

Obliquity of the ecliptic at standard epoch J2000

$$\varepsilon = 23^\circ 26' 21''.448$$

### Derived constants

Constant of nutation at standard epoch J2000

$$N = 9''.2025$$

Unit distance ( $ua = c\tau_A$ )

$$ua = 1.49597871464 \times 10^{11} \text{ m}$$

Solar parallax ( $\pi_0 = \arcsin(a_e/ua)$ )

$$\pi_0 = 8''.794143$$

Constant of aberration for standard epoch J2000

$$\kappa = 20''.49552$$

Flattening factor for the Earth

$$f = 1/298.256 = 0.00335282$$

Heliocentric gravitational constant ( $GS = A^3 k^2 / D^2$ )

$$GS = 1.32712438 \times 10^{20} \text{ m}^3 \text{ s}^{-2}$$

Ratio of mass of sun to that of the Earth ( $S/E = (GS)/(GE)$ )

$$S/E = 332946.0$$

Ratio of mass of sun to that of Earth + moon

$$(S/E)/(1 + \mu) = 328900.56$$

Mass of the sun ( $S = (GS)/G$ )

$$S = 1.98844 \times 10^{30} \text{ kg}$$

### Ratios of mass of sun to masses of the planets

Mercury

$$6023600$$

Venus

$$408523.7$$

Earth + moon

$$328900.56$$

Mars

$$3098708$$

Jupiter

$$1047.349$$

Saturn

$$3497.898$$

Uranus

$$22902.98$$

Neptune

$$19412.24$$

## PROPERTIES OF THE SOLAR SYSTEM

The following tables give various properties of the planets and characteristics of their orbits in the solar system. Certain properties of the sun and of the earth's moon are also included.

Explanations of the column headings:

- *Mass*: mass of the planet in units of  $10^{24}$  kg
- *Radius*: radius at the equator in km
- *Density*: mean density in  $\text{g/cm}^3$
- *Flattening*: degree of oblateness, defined as  $(r_e - r_p) / r_e$ , where  $r_e$  and  $r_p$  are the equatorial and polar radii, respectively
- *Potential coefficients*: coefficients in the spherical harmonic representation of the gravitational potential  $U$  by the equation

$$U(r, \phi) = (GM/r) [1 - \sum_n (a/r)^n P_n(\sin \phi)],$$

where  $G$  is the gravitational constant,  $r$  the distance from the center of the planet,  $a$  the radius of the planet,  $M$  the mass,  $\phi$  the latitude, and  $P_n$  the Legendre polynomial of degree  $n$ .

- *Gravity*: acceleration due to gravity at the surface
- *Escape vel.*: velocity needed at the surface of the planet to escape the gravitational pull
- *Dist. to sun*: semi-major axis of the elliptical orbit in astronomical units (1 ua  $\approx$   $1.496 \cdot 10^8$  km)
- $\epsilon$ : eccentricity of the orbit
- *Ecliptic angle*: angle between the planetary orbit and the plane of the earth's orbit around the sun
- *Inclin.*: angle between the equatorial plane of the planet and the plane of the planetary orbit
- *Orbit period*: period of revolution around the sun measured in years
- *Rotation period*: period of rotation of the planet measured in hours. A negative value indicates retrograde rotation.
- *Albedo*: ratio of the light reflected from the planet to the light incident on it
- *No. of satellites*: Number of confirmed satellites; this includes satellites that have not been named.
- $T_{\text{sur}}$ : mean temperature at the surface
- $P_{\text{sur}}$ : pressure of the atmosphere at the surface

The last four entries in the table are *dwarf planets* as defined by the International Astronomical Union. These are bodies in orbit around the sun that are massive enough to adopt a near-spherical shape as a result of their self-gravity, but are appreciably smaller than the major planets. *Plutoids* form a subset of the dwarf plan-

ets; their orbits are larger than that of Neptune (see Ref. 9). As of 2008, the IAU has recognized the names for three plutoids: Pluto, Eris, and Makemake.

The following general information on the solar system is of interest:

- Mass of the earth =  $M_e = 5.9736 \cdot 10^{24}$  kg
- Total mass of planetary system =  $2.669 \cdot 10^{27}$  kg =  $447 M_e$
- Total angular momentum of planetary system =  $3.148 \cdot 10^{43}$   $\text{kg m}^2 \text{s}^{-1}$
- Total kinetic energy of the planets =  $1.99 \cdot 10^{35}$  J
- Total rotational energy of planets =  $0.7 \cdot 10^{35}$  J

Properties of the sun:

- Mass =  $1.9884 \cdot 10^{30}$  kg =  $332943 M_e$
- Radius =  $6.9551 \cdot 10^8$  m
- Surface area =  $6.079 \cdot 10^{18}$   $\text{m}^2$
- Volume =  $1.409 \cdot 10^{27}$   $\text{m}^3$
- Mean density =  $1.411$   $\text{g/cm}^3$
- Gravity at surface =  $27398$   $\text{cm/s}^2$
- Escape velocity at surface =  $6.177 \cdot 10^5$  m/s
- Effective temperature =  $5780$  K
- Total radiant power emitted (luminosity) =  $3.8427 \cdot 10^{26}$  W
- Surface flux of radiant energy =  $6.322 \cdot 10^7$   $\text{W/m}^2$
- Flux of radiant energy at the earth (Solar Constant) =  $1366.4$   $\text{W/m}^2$  (Ref. 8)

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## SATELLITES OF THE PLANETS

This table gives characteristics of the known satellites of the planets. The parameters covered are:

- Orbital period in units of earth days. An R following the value indicates a retrograde motion.
- Distance from the planet, as measured by the semi-major axis of the orbit
- Eccentricity of the orbit
- Inclination of the satellite orbit with respect to the equator of the planet
- Mass of the satellite in kilograms
- Radius of the satellite in kilometers
- Geometric albedo, which is a measure of the fraction of incident sunlight reflected by the satellite.

Since this is a very active field of research, the Internet sites listed below should be consulted for the most recent data.

## References

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Planet	Satellite	Orb. period Earth days	Distance 10 <sup>3</sup> km	Eccentricity	Inclination	Mass kg	Radius km	Albedo
Earth	Moon	27.321661	384.400	0.054900489	18.28–28.58°	7.3483·10 <sup>22</sup>	1737.5	0.12
Mars	I Phobos	0.31891023	9.378	0.0151	1.0°	1.06·10 <sup>16</sup>	13.5×10.8×9.4	0.07
	II Deimos	1.2624407	23.460	0.0005	0.9–2.7°	2.4·10 <sup>15</sup>	7.5×6.1×5.5	0.07
Jupiter	I Io	1.769137786	421.8	0.0041	0.04°	8.932·10 <sup>22</sup>	1821.6	0.63
	II Europa	3.551181041	671.1	0.0101	0.47°	4.8·10 <sup>22</sup>	1560.8	0.67
	III Ganymede	7.15455296	1070.4	0.0015	0.21°	1.4819·10 <sup>23</sup>	2631.2	0.43
	IV Callisto	16.6890184	1882.7	0.007	0.51°	1.0759·10 <sup>23</sup>	2410.3	0.17
	V Amalthea	0.49817905	181.4	0.003	0.40°	7.17·10 <sup>18</sup>	131×73×67	0.09
	VI Himalia	250.5662	11460	0.162	27.63°	9.56·10 <sup>18</sup>	85	0.04
	VII Elara	259.6528	11737	0.217	24.77°	7.77·10 <sup>17</sup>	40	0.04
	VIII Pasiphae	743.63 R	23620	0.409	145°	1.91·10 <sup>17</sup>	18	0.04
	IX Sinope	758.90 R	23940	0.250	153°	7.77·10 <sup>16</sup>	14	0.04
	X Lysithea	259.20	11720	0.112	29.02°	7.77·10 <sup>16</sup>	12	0.04
	XI Carme	734.17 R	23400	0.253	164°	9.56·10 <sup>16</sup>	15	0.04
	XII Ananke	629.77 R	21280	0.244	147°	3.82·10 <sup>16</sup>	10	0.04
	XIII Leda	240.92	11170	0.164	26.07°	5.68·10 <sup>15</sup>	5	0.04
	XIV Thebe	0.6745	221.9	0.018	0.8°	7.77·10 <sup>17</sup>	55×45	0.05
	XV Adrastea	0.29826	129	0.0015		1.91·10 <sup>16</sup>	13×10×8	0.10
	XVI Metis	0.29478	128	0.0002		9.56·10 <sup>16</sup>	20	0.06
	XVII Callirrhoe	758.77	24100	0.283		8.7·10 <sup>14</sup>	4	0.04
	XVIII Themisto	130.02	7507	0.242		6.9·10 <sup>14</sup>	4	0.04
XIX Megaclite	752.86	23810	0.425		2.1·10 <sup>14</sup>	2.7	0.04	
XX Taygete	732.41	23360	0.251		1.6·10 <sup>14</sup>	2.5	0.04	
XXI Chaldene	723.72	23180	0.238		7.5·10 <sup>13</sup>	1.9	0.04	
XXII Harpalyke	623.32	21110	0.227		1.2·10 <sup>14</sup>	2.2	0.04	
XXIII Kalyke	742.06	23580	0.243		1.9·10 <sup>14</sup>	2.6	0.04	
XXIV Iocaste	631.60	21270	0.218		1.9·10 <sup>14</sup>	2.6	0.04	
XXV Erinome	728.46	23280	0.270		4.5·10 <sup>13</sup>	1.6	0.04	
XXVI Isonoe	726.63	23220	0.261		7.5·10 <sup>13</sup>	1.9	0.04	
XXVII Praxidike	625.39	21150	0.220		4.3·10 <sup>14</sup>	3.4	0.04	
XXVIII Autonoe	760.95	23039	0.334		9.0·10 <sup>13</sup>	2.0	0.04	
XXIX Thyone	627.21	20940	0.229		9.0·10 <sup>13</sup>	2.0	0.04	
XXX Hermippe	633.90	21131	0.210		9.0·10 <sup>13</sup>	2.0	0.04	
XXXI Aitne	730.18	23231	0.264		4.5·10 <sup>13</sup>	1.5	0.04	
XXXII Eurydome	717.33	22685	0.276		4.5·10 <sup>13</sup>	1.5	0.04	
XXXIII Euanthe	620.49	20721	0.232		4.5·10 <sup>13</sup>	1.5	0.04	
XXXIV Euporie	550.74	19302	0.144		1.5·10 <sup>13</sup>	1	0.04	
XXXV Orthosie	622.56	20721	0.281		1.5·10 <sup>13</sup>	1	0.04	
XXXVI Sponde	748.34	23487	0.312		1.5·10 <sup>13</sup>	1	0.04	

Planet	Satellite	Orb. period Earth days	Distance 10 <sup>3</sup> km	Eccentricity	Inclination	Mass kg	Radius km	Albedo	
	XXXVII	Kale	729.47	23217	0.260	1.5·10 <sup>13</sup>	1	0.04	
	XXXVIII	Pasithee	719.44	23096	0.267	1.5·10 <sup>13</sup>	1	0.04	
	XXXIX	Hegemone	739.6	23947	0.328	4.5·10 <sup>13</sup>	1.5		
	XL	Mneme	620.0	21069	0.227	1.5·10 <sup>13</sup>	1		
	XLI	Aoede	761.5	23981	0.432	9.0·10 <sup>13</sup>	2.0		
	XLII	Thelxinoe	628.1	21162	0.221	1.5·10 <sup>13</sup>	1		
	XLIII	Arche	723.9	22931	0.259	4.5·10 <sup>13</sup>	1.5		
	XLIV	Kallichore	764.7	24043	0.264	1.5·10 <sup>13</sup>	1		
	XLV	Helike	634.8	21263	0.156	9.0·10 <sup>13</sup>	2.0		
	XLVI	Carpo	456.1	16989	0.430	4.5·10 <sup>13</sup>	1.5		
	XLVII	Eukelade	746.4	23661	0.272	9.0·10 <sup>13</sup>	2.0		
	XLVIII	Cyllene	737.8	24349	0.319	1.5·10 <sup>13</sup>	1		
	XLIX	Kore	779.2	24543	0.325		1		
Saturn	I	Mimas	0.942421813	185.52	0.0202	1.53°	3.75·10 <sup>19</sup>	196	0.5
	II	Enceladus	1.370217855	238.02	0.00452	1.86°	6.50·10 <sup>19</sup>	250	1.0
	III	Tethys	1.887802160	294.66	0.00000	1.86°	6.27·10 <sup>20</sup>	530	0.9
	IV	Dione	2.736914742	377.40	0.002230	0.02°	1.10·10 <sup>21</sup>	560	0.7
	V	Rhea	4.517500436	527.04	0.00100	0.35°	2.31·10 <sup>21</sup>	765	0.7
	VI	Titan	15.94542068	1221.83	0.029192	0.33°	1.3455·10 <sup>23</sup>	2575	0.21
	VII	Hyperion	21.2766088	1481.1	0.104	0.43°	1.59·10 <sup>19</sup>	205×130×110	0.3
	VIII	Iapetus	79.3301825	3561.3	0.02828	14.72°	1.59·10 <sup>21</sup>	730	0.6
	IX	Phoebe	550.31 R	12952	0.16326	177°	7.2·10 <sup>18</sup>	110	0.08
	X	Janus	0.6945	151.472	0.007	0.14°	1.92·10 <sup>18</sup>	110×100×80	0.6
	XI	Epimetheus	0.6942	151.422	0.009	0.34°	5.4·10 <sup>17</sup>	70×60×50	0.5
	XII	Helene	2.7369	377.40	0.005	0.0°	2.5·10 <sup>16</sup>	18×16×15	0.6
	XIII	Telesto	1.8878	294.66			7.2·10 <sup>15</sup>	17×14×13	1.0
	XIV	Calypso	1.8878	294.66			3.6·10 <sup>15</sup>	17×11×11	0.7
	XV	Atlas	0.6019	137.670		0.3°	1.1·10 <sup>16</sup>	20×10	0.4
	XVI	Prometheus	0.6130	139.353	0.0024	0.0°	3.3·10 <sup>17</sup>	70×50×40	0.6
	XVII	Pandora	0.6285	141.70	0.0042	0.0°	1.9·10 <sup>17</sup>	55×45×35	0.5
	XVIII	Pan	0.5750	133.583			2.7·10 <sup>15</sup>	10	0.5
	XIX	Ymir	1315.14	23096	0.470		4.9·10 <sup>15</sup>	8	0.06
	XX	Paaliaq	686.95	15199	0.364		8.2·10 <sup>15</sup>	9.5	0.06
	XXI	Tarvos	926.23	18247	0.536		2.7·10 <sup>15</sup>	6.5	0.06
	XXII	Ijiraq	451.42	11440	0.322		1.2·10 <sup>15</sup>	5	0.06
	XXIII	Suttungr	1016.67	19463	0.114		2.1·10 <sup>14</sup>	2.8	0.06
	XXIV	Kiviuq	449.22	11365	0.334		3.3·10 <sup>15</sup>	7	0.06
	XXV	Mundilfari	952.77	18709	0.208		2.1·10 <sup>14</sup>	2.8	0.06
	XXVI	Albiorix	783.45	16404	0.478		2.1·10 <sup>16</sup>	13	0.06
	XXVII	Skathi	728.20	15647	0.270		3.1·10 <sup>14</sup>	3.2	0.06
	XXVIII	Erriapus	871.19	17616	0.474		7.6·10 <sup>14</sup>	4.3	0.06
	XXIX	Siarnaq	895.53	18160	0.295		3.9·10 <sup>16</sup>	16	0.06
	XXX	Thrymr	1094.11	20382	0.470		2.1·10 <sup>14</sup>	2.8	0.06
	XXXI	Narvi	1003.86	19007	0.431		4.9·10 <sup>15</sup>	3.3	0.04
	XXXII	Methone	1.010	194			1.65·10 <sup>13</sup>	1.5	
	XXXIII	Pallene	1.154	211			3.92·10 <sup>13</sup>	2	
	XXXIV	Polydeuces	2.737	377.4				4	
	XXXV	Daphnis	0.594	136.5				3.5	
	XXXVI	Aegir	1117.52	20735				3.5	
	XXXVII	Bebhionn	834.84	17119				3	
	XXXVIII	Bergelmir	1005.74	19338				3	
	XXXIX	Bestla	1088.72	20129				3.5	
	XL	Farbauti	1085.55	20390				2.5	
	XLI	Fenrir	1260.35	22453				2	
	XLII	Fornjot	1494.20	25108				3	
	XLIII	Hati	1038.61	19856				3	
	XLIV	Hyrrokkin	931.86	18437				4	
	XLV	Kari	1230.97	22118				3.5	
	XLVI	Loge	1311.36	23065				3	
	XLVII	Skoll	878.29	17665				3	



Planet	Satellite	Orb. period Earth days	Distance 10 <sup>3</sup> km	Eccentricity	Inclination	Mass kg	Radius km	Albedo	
	XLVIII	Surtur	1297.36				3		
	XLIX	Anthe					1		
	L	Jarnsaxa					3		
	LI	Greip					3		
	LII	Tarqeq					3.5		
Uranus	I	Ariel	2.52037935	191.02	0.0034	0.3°	1.35·10 <sup>21</sup>	579	0.39
	II	Umbriel	4.1441772	266.30	0.0050	0.36°	1.17·10 <sup>21</sup>	584.7	0.21
	III	Titania	8.7058717	435.91	0.0022	0.14°	3.52·10 <sup>21</sup>	788.9	0.27
	IV	Oberon	13.4632389	583.52	0.0008	0.10°	3.01·10 <sup>21</sup>	761.4	0.23
	V	Miranda	1.41347925	129.39	0.0027	4.2°	6.59·10 <sup>19</sup>	236	0.32
	VI	Cordelia	0.335033	49.77	0.0003	0.1°	5.4·10 <sup>16</sup>	20.1	0.07
	VII	Ophelia	0.376409	53.79	0.0099	0.1°	5.4·10 <sup>16</sup>	21.4	0.07
	VIII	Bianca	0.434577	59.17	0.0009	0.2°	9.3·10 <sup>16</sup>	25.7	0.07
	IX	Cressida	0.463570	61.78	0.0004	0.0°	3.4·10 <sup>17</sup>	39.8	0.07
	X	Desdemona	0.473651	62.68	0.0001	0.2°	1.8·10 <sup>17</sup>	32.0	0.07
	XI	Juliet	0.493066	64.35	0.0007	0.1°	5.6·10 <sup>17</sup>	46.8	0.07
	XII	Portia	0.513196	66.09	0.0001	0.1°	1.7·10 <sup>18</sup>	67.6	0.07
	XIII	Rosalind	0.558459	69.94	0.0001	0.3°	2.6·10 <sup>17</sup>	36.0	0.07
	XIV	Belinda	0.623525	75.26	0.0001	0.0°	3.6·10 <sup>17</sup>	40.3	0.07
	XV	Puck	0.761832	86.01	0.0001	0.31°	2.9·10 <sup>18</sup>	81.0	0.07
	XVI	Caliban	579.73	7231	0.1587		7.4·10 <sup>17</sup>	49	0.07
	XVII	Sycorax	1288.30	12179	0.5224		5.4·10 <sup>18</sup>	95	0.07
	XVIII	Prospero	1978.29	16256	0.4448		2.1·10 <sup>16</sup>	15	0.07
	XIX	Setebos	2225.21	17418	0.5914		2.1·10 <sup>16</sup>	15	0.07
	XX	Stephano	677.36	8004	0.2292		6.0·10 <sup>15</sup>	10	0.07
	XXI	Trinculo	749.24	8504	0.2200		7.5·10 <sup>14</sup>	5	0.04
	XXII	Francisco	266.56	4276	0.146		1.3·10 <sup>15</sup>	11	
	XXIII	Margaret	1687.01	14345	0.661		1.0·10 <sup>15</sup>	5.5	
	XXIV	Ferdinand	2887.21	20901	0.368		1.3·10 <sup>15</sup>	6	
	XXV	Perdita	0.638	76.42	0.0		4.0·10 <sup>17</sup>	40	
	XXVI	Mab	0.923	97.73	0.0		4.0·10 <sup>15</sup>	8	
	XXVII	Cupid	0.613	74.8	0.0		1.2·10 <sup>15</sup>	6	
Neptune	I	Triton	5.8768541 R	354.76	0.000016	157.345°	2.147·10 <sup>22</sup>	1353.4	0.76
	II	Nereid	360.13619	5513.4	0.7512	27.6°	3.1·10 <sup>19</sup>	170	0.15
	III	Naiad	0.294396	48.227	0.0003	4.74°	1.3·10 <sup>17</sup>	33	0.07
	IV	Thalassa	0.311485	50.075	0.0002	0.21°	3.5·10 <sup>17</sup>	41	0.09
	V	Despina	0.334655	52.526	0.0001	0.07°	2.3·10 <sup>18</sup>	75	0.09
	VI	Galatea	0.428745	61.953	0.0001	0.05°	2.7·10 <sup>18</sup>	88	0.08
	VII	Larissa	0.554654	73.548	0.0014	0.20°	4.8·10 <sup>18</sup>	104×89	0.09
	VIII	Proteus	1.122315	117.647	0.0004	0.55°	4.9·10 <sup>19</sup>	218×208×201	0.10
	IX	Halimede	1879.08	16611	0.2646				
	X	Psamathe	9074.30	48096	0.3809		1.5·10 <sup>16</sup>	14	
	XI	Sao	2912.72	22228	0.1365				
	XII	Laomedeia	3171.33	23567	0.3969				
	XIII	Neso	9740.73	49285	0.5714				
Plutoids*									
Pluto	I	Charon	6.387	17.536	0.0022	99°	1.6·10 <sup>21</sup>	593	0.37
	II	Nix	24.86	48.708	0.0030		5·10 <sup>16</sup>	22–65	
	III	Hydra	38.20	64.749	0.0051		5·10 <sup>16</sup>	22–65	
Eris	I	Dysnomia		30				100–200	

\* In June 2008 the International Astronomical Union decided on the name *plutoid* for the category of transneptunian dwarf planets. Plutoids are celestial bodies in orbit around the sun at a semimajor axis greater than that of Neptune and sufficiently massive to adopt a near-spherical shape. See <[www.iau.org/public\\_press/news/release/iau0804/](http://www.iau.org/public_press/news/release/iau0804/)>.



# MASS, DIMENSIONS, AND OTHER PARAMETERS OF THE EARTH

This table is a collection of data on various properties of the Earth. Most of the values are given in SI units. Note that 1 ua (astronomical unit) = 149,597,870 km.

## References

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Quantity	Symbol	Value	Unit
Mass	$M$	$5.9723 \cdot 10^{27}$	g
Major orbital semi-axis	$a_{orb}$	1.000000	ua
		$1.4959787 \cdot 10^8$	km
Distance from sun at perihelion	$r_{\pi}$	0.9833	ua
Distance from sun at aphelion	$r_{\alpha}$	1.0167	ua
Moment of perihelion passage	$T_{\pi}$	Jan. 2, 4 h 52 min	
Moment of aphelion passage	$T_{\alpha}$	July 4, 5 h 05 min	
Siderial rotation period around sun	$P_{orb}$	$31.5581 \cdot 10^6$	s
		365.25636	d
Mean rotational velocity	$U_{orb}$	29.78	km/s
Mean equatorial radius	$\bar{a}$	6378.140	km
Mean polar compression (flattening factor)	$\alpha$	$1/298.257$	
Difference in equatorial and polar semi-axes	$a - c$	21.385	km
Compression of meridian of major equatorial axis	$\alpha_a$	$1/295.2$	
Compression of meridian of minor equatorial axis	$\alpha_b$	$1/298.0$	
Equatorial compression	$\epsilon$	$1/30\,000$	
Difference in equatorial semi-axes	$a - b$	213	m
Difference in polar semi-axes	$c_N - c_S$	$\sim 70$	m
Polar asymmetry	$\eta$	$\sim 1 \cdot 10^{-5}$	
Mean acceleration of gravity at equator	$g_e$	9.78036	m/s <sup>2</sup>
Mean acceleration of gravity at poles	$g_p$	9.83208	m/s <sup>2</sup>
Difference in acceleration of gravity at pole and at equator	$g_p - g_e$	5.172	cm/s <sup>2</sup>
Mean acceleration of gravity for entire surface of terrestrial ellipsoid	$g$	9.7978	m/s <sup>2</sup>
Mean radius	$R$	6371.0	km
Area of surface	$S$	$5.10 \cdot 10^8$	km <sup>2</sup>
Volume	$V$	$1.0832 \cdot 10^{12}$	km <sup>3</sup>
Mean density	$\rho$	5.515	g/cm <sup>3</sup>
Siderial rotational period	$P$	86,164.09	s
Rotational angular velocity	$\omega$	$7.292116 \cdot 10^{-5}$	rad/s
Mean equatorial rotational velocity	$v$	0.46512	km/s
Rotational angular momentum	$L$	$5.861 \cdot 10^{33}$	J s
Rotational energy	$E$	$2.137 \cdot 10^{29}$	J
Ratio of centrifugal force to force of gravity at equator	$q_c$	$0.0034677 = 1/288$	
Moment of inertia	$I$	$8.070 \cdot 10^{37}$	kg m <sup>2</sup>
Relative braking of earth's rotation due to tidal friction	$\Delta\omega_e/\omega$	$-4.2 \cdot 10^{-8}$	century <sup>-1</sup>
Relative secular acceleration of earth's rotation	$\Delta\omega_l/\omega$	$+1.4 \cdot 10^{-8}$	century <sup>-1</sup>
Not secular braking of earth's rotation	$\Delta\omega/\omega$	$-2.8 \cdot 10^{-8}$	century <sup>-1</sup>
Probable value of total energy of tectonic deformation of earth	$E_t$	$\sim 1 \cdot 10^{23}$	J/century
Secular loss of heat of earth through radiation into space	$\Delta E_k$	$1 \cdot 10^{23}$	J/century
Portion of earth's kinetic energy transformed into heat as a result of lunar and solar tides in the hydrosphere	$\Delta''E_k$	$1.3 \cdot 10^{23}$	J/century
Differences in duration of days in March and August	$\Delta P$	0.0025 (March-August)	s
Corresponding relative annual variation in earth's rotational velocity	$\Delta^*\omega/\omega$	$2.9 \cdot 10^{-8}$ (Aug.-March)	
Presumed variation in earth's radius between August and March	$\Delta^*R$	-9.2 (Aug.-March)	cm
Annual variation in level of world ocean	$\Delta h_o$	$\sim 10$ (Sept.-March)	cm
Area of continents	$S_c$	$1.49 \cdot 10^8$	km <sup>2</sup>
		29.2	% of surface

Quantity	Symbol	Value	Unit
Area of world ocean	$S_o$	$3.61 \cdot 10^8$	km <sup>2</sup>
Mean height of continents above sea level	$h_c$	70.8	% of surface
Mean depth of world ocean	$h_o$	3794	m
Mean thickness of lithosphere within the limits of the continents	$h_{c.l.}$	35	km
Mean thickness of lithosphere within the limits of the ocean	$h_{o.l.}$	4.7	km
Mean rate of thickening of continental lithosphere	$\Delta h / \Delta t$	10 – 40	m/10 <sup>6</sup> y
Mean rate of horizontal extension of continental lithosphere	$\Delta l / \Delta t$	0.75 – 20	km/10 <sup>6</sup> y
Mass of crust	$m_1$	$2.36 \cdot 10^{22}$	kg
Mass of mantle		$4.05 \cdot 10^{24}$	kg
Amount of water released from the mantle and core in the course of geological time		$3.40 \cdot 10^{21}$	kg
Total reserve of water in the mantle		$2 \cdot 10^{23}$	kg
Present content of free and bound water in the earth's lithosphere		$2.4 \cdot 10^{21}$	kg
Mass of hydrosphere	$m_h$	$1.664 \cdot 10^{21}$	kg
Amount of oxygen bound in the earth's crust		$1.300 \cdot 10^{21}$	kg
Amount of free oxygen		$1.5 \cdot 10^{18}$	kg
Mass of atmosphere	$m_a$	$5.136 \cdot 10^{18}$	kg
Mass of biosphere	$m_b$	$1.148 \cdot 10^{16}$	kg
Mass of living matter in the biosphere		$3.6 \cdot 10^{14}$	kg
Density of living matter on dry land		0.1	g/cm <sup>2</sup>
Density of living matter in ocean		$15 \cdot 10^{-8}$	g/cm <sup>3</sup>
Age of the earth		$4.55 \cdot 10^9$	y
Age of oldest rocks		$4.0 \cdot 10^9$	y
Age of most ancient fossils		$3.4 \cdot 10^9$	y

## GEOLOGICAL TIME SCALE

Period or epoch	Beginning and end, in 10 <sup>6</sup> years	Key events
<i>Cenozoic era</i>		
Quaternian		
Contemporary	0–10,000 y ± 2,000 y	
Pleistocene	10,000–1,000,000 y ± 50,000 y	Homo Erectus breakout
Tertiary		
Pliocene	1.8–5.3	Ape man fossils
Miocene	5–25	Origin of grass
Oligocene	25–37	Rise of cats, dogs, pigs
Eocene	37–55	Debut of hoofed mammals
Paleocene	55–67	Earliest primates
<i>Mesozoic era</i>		
Cretaceous	67–138	Demise of dinosaurs
Jurassic	138–208	First birds
Triassic	208–245	Appearance of dinosaurs
<i>Paleozoic era</i>		
Permian	245–290	Flowers, insect pollination
Carboniferous	290–360	First conifers
Devonian	360–410	First vertebrates ashore
Silurian	410–435	Spore-bearing plants
Ordovician	435–520	First animals ashore
Cambrian	520–570	Vertebrates appear
<i>Pre-Cambrian</i>		
Pre-Cambrian III (Proterozoic)	570–2500	First plants, jellyfish
Pre-Cambrian II (Archean)	2500–3800	Photosynthetic bacteria
Pre-Cambrian I (Hadean)	3800–4450	Earth formed 4600 million years ago

Reference: Calder, N., *Timescale - An Atlas of the Fourth Dimension*, Viking Press, New York, 1983.

## ACCELERATION DUE TO GRAVITY

The acceleration due to gravity is tabulated here as a function of latitude and height above the earth's surface. Values were calculated from the expression

$$g/(\text{m/s}^2) = 9.780356 (1 + 0.0052885 \sin^2 \phi - 0.0000059 \sin^2 2 \phi) - 0.003086 H$$

where  $\phi$  is the latitude and  $H$  is the height in kilometers.

### Reference

Jursa, A. S., Ed., *Handbook of Geophysics and the Space Environment*, 4th ed., Air Force Geophysics Laboratory, 1985, p. 14–17.

$\phi$	$H = 0$	$H = 1 \text{ km}$	$H = 5 \text{ km}$	$H = 10 \text{ km}$
0	9.78036	9.77727	9.76493	9.74950
5	9.78075	9.77766	9.76532	9.74989
10	9.78191	9.77882	9.76648	9.75105
15	9.78381	9.78072	9.76838	9.75295
20	9.78638	9.78330	9.77095	9.75552
25	9.78956	9.78647	9.77413	9.75870
30	9.79324	9.79016	9.77781	9.76238
35	9.79732	9.79424	9.78189	9.76646
40	9.80167	9.79858	9.78624	9.77081
45	9.80616	9.80307	9.79073	9.77530
50	9.81065	9.80757	9.79522	9.77979
55	9.81501	9.81193	9.79958	9.78415
60	9.81911	9.81602	9.80368	9.78825
65	9.82281	9.81972	9.80738	9.79195
70	9.82601	9.82292	9.81058	9.79515
75	9.82860	9.82551	9.81317	9.79774
80	9.83051	9.82743	9.81508	9.79965
85	9.83168	9.82860	9.81625	9.80082
90	9.83208	9.82899	9.81665	9.80122

# DENSITY, PRESSURE, AND GRAVITY AS A FUNCTION OF DEPTH WITHIN THE EARTH

This table gives the density  $\rho$ , pressure  $p$ , and acceleration due to gravity  $g$  as a function of depth below the earth's surface, as calculated from the model of the structure of the earth in Reference 1. The model assumes a radius of 6371 km for the earth. The boundary between the crust and mantle (the Mohorovicic discontinuity) is taken as 21 km, while in reality it varies considerable with location.

## References

1. Anderson, D. L., and Hart, R. S., *J. Geophys. Res.*, 81, 1461, 1976.
2. Carmichael, R. S., *CRC Practical Handbook of Physical Properties of Rocks and Minerals*, p. 467, CRC Press, Boca Raton, FL, 1989.

Depth km	$\rho$ g/cm <sup>3</sup>	$p$ kbar	$g$ cm/s <sup>2</sup>
<i>Crust</i>			
0	1.02	0	981
3	1.02	3	982
3	2.80	3	982
21	2.80	5	983
<i>Mantle (solid)</i>			
21	3.49	5	983
41	3.51	12	983
61	3.52	19	984
81	3.48	26	984
101	3.44	33	984
121	3.40	39	985
171	3.37	56	987
221	3.34	73	989
271	3.37	89	991
321	3.47	106	993
371	3.59	124	994
571	3.95	199	999
871	4.54	328	997
1171	4.67	466	992
1471	4.81	607	991

Depth km	$\rho$ g/cm <sup>3</sup>	$p$ kbar	$g$ cm/s <sup>2</sup>
1771	4.96	752	994
2071	5.12	903	1002
2371	5.31	1061	1017
2671	5.45	1227	1042
2886	5.53	1352	1069
<i>Outer core (liquid)</i>			
2886	9.96	1352	1069
2971	10.09	1442	1050
3371	10.63	1858	953
3671	11.00	2154	874
4071	11.36	2520	760
4471	11.69	2844	641
4871	11.99	3116	517
5156	12.12	3281	427
<i>Inner core (solid)</i>			
5156	12.30	3281	427
5371	12.48	3385	355
5771	12.52	3529	218
6071	12.53	3592	122
6371	12.58	3617	0

## OCEAN PRESSURE AS A FUNCTION OF DEPTH AND LATITUDE

The following table is based upon an ocean model which takes into account the equation of state of standard seawater and the dependence on latitude of the acceleration of gravity. The tabulated pressure value is the excess pressure over the ambient atmospheric pressure at the surface.

### References

1. *International Oceanographic Tables, Volume 4*, Unesco Technical Papers in Marine Science No. 40, Unesco, Paris, 1987.
2. Saunders, P. M., and Fofonoff, N. P., *Deep-Sea Res.* 23, 109–111, 1976.

Depth (meters)	Pressure in MPa at the Specified Latitude						
	0°	15°	30°	45°	60°	75°	90°
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
500	5.0338	5.0355	5.0404	5.0471	5.0537	5.0586	5.0605
1000	10.0796	10.0832	10.0930	10.1064	10.1198	10.1296	10.1333
1500	15.1376	15.1431	15.1577	15.1778	15.1980	15.2127	15.2182
2000	20.2076	20.2148	20.2344	20.2613	20.2882	20.3080	20.3153
2500	25.2895	25.2985	25.3231	25.3568	25.3905	25.4153	25.4244
3000	30.3831	30.3940	30.4236	30.4641	30.5047	30.5345	30.5453
3500	35.4886	35.5012	35.5358	35.5832	35.6307	35.6654	35.6782
4000	40.6056	40.6201	40.6598	40.7140	40.7683	40.8082	40.8229
4500	45.7342	45.7505	45.7952	45.8564	45.9176	45.9626	45.9791
5000	50.8742	50.8924	50.9421	51.0102	51.0785	51.1285	51.1469
5500	56.0255	56.0456	56.1004	56.1755	56.2508	56.3059	56.3262
6000	61.1882	61.2100	61.2700	61.3521	61.4344	61.4947	61.5168
6500	66.3619	66.3857	66.4508	66.5399	66.6292	66.6947	66.7187
7000	71.5467	71.5724	71.6427	71.7388	71.8352	71.9059	71.9318
7500	76.7426	76.7701	76.8456	76.9488	77.0523	77.1282	77.1560
8000	81.9493	81.9788	82.0594	82.1697	82.2804	82.3614	82.3911
8500	87.1669	87.1983	87.2841	87.4016	87.5193	87.6057	87.6373
9000	92.3950	92.4284	92.5194	92.6440	92.7689	92.8606	92.8941
9500	97.6346	97.6698	97.7661	97.8978	98.0300	98.1269	98.1624
10000	102.8800	102.9170	103.0185	103.1572	103.2961	103.3981	103.4355

## PROPERTIES OF SEAWATER

In addition to the dependence on temperature and pressure, the physical properties of seawater vary with the concentration of the dissolved constituents. A convenient parameter for describing the composition is the salinity,  $S$ , which is defined in terms of the electrical conductivity of the seawater sample. The defining equation for the practical salinity is:

$$S = a_0 + a_1 K^{1/2} + a_2 K + a_3 K^{3/2} + a_4 K^2 + a_5 K^{5/2},$$

where  $K$  is the ratio of the conductivity of the seawater sample at 15°C and atmospheric pressure to the conductivity of a potassium chloride solution in which the mass fraction of KCl is 0.0324356, at the same temperature and pressure. The values of the coefficients are:

$$\begin{aligned} a_0 &= 0.0080 & a_3 &= 14.0941 \\ a_1 &= -0.1692 & a_4 &= -7.0261 \\ a_2 &= 25.3851 & a_5 &= 2.7081 \\ \Sigma a_i &= 35.0000 \end{aligned}$$

Thus when  $K = 1$ ,  $S = 35$  exactly ( $S$  is normally quoted in units of ‰, i.e., parts per thousand). The value of  $S$  can be roughly equated with the mass of dissolved material in grams per kilogram of seawater. Salinity values in the open oceans at mid latitudes typically fall between 34 and 36.

It is customary in oceanography to define the pressure at a given point as the pressure due to the column of water between that point and the surface. Thus by convention  $P = 0$  at the sea surface. To a good approximation the pressure in decibars (dbar) can be equated to the depth in meters. Thus at 45° latitude the pressure is 5000 dbar at 4902 m, 10000 dbar at 9700 m.

The first table below gives several properties of seawater as a function of temperature for a salinity of 35. The second and third give density and electrical conductivity as a function of salinity at several temperatures, and the fourth lists typical concentrations of the main constituents of seawater as a function of salinity. The final table gives the freezing point as a function of salinity and pressure.

### References

1. *The Practical Salinity Scale 1978 and the International Equation of State of Seawater 1980*, Unesco Technical Papers in Marine Science No. 36, Unesco, Paris, 1981; sections No. 37, 38, 39, and 40 in this series give background papers and detailed tables.
2. Kennish, M. J., *CRC Practical Handbook of Marine Science*, CRC Press, Boca Raton, FL, 1989.
3. Poisson, A. *IEEE J. Ocean. Eng.* OE-5, 50, 1981.
4. Webster, F., in *AIP Physics Desk Reference*, E. R. Cohen, D. R. Lide and G. L. Trigg, Eds., Springer-Verlag, New York, 2003.

### Properties of Seawater as a Function of Temperature at Salinity $S = 35$ and Normal Atmospheric Pressure

$\rho$  = density in  $\text{g/cm}^3$

$\beta = (1/\rho) (d\rho/dS)$  = fractional change in density per unit change in salinity

$\alpha = -(1/\rho) (d\rho/dt)$  = fractional change in density per unit change in temperature ( $^{\circ}\text{C}^{-1}$ )

$\kappa$  = electrical conductivity in  $\text{S/cm}$

$\eta$  = viscosity in  $\text{mPa s}$  (equal to  $\text{cP}$ )

$c_p$  = specific heat in  $\text{J/kg } ^{\circ}\text{C}$

$\nu$  = speed of sound in  $\text{m/s}$

$t/^{\circ}\text{C}$	$\rho/\text{g cm}^{-3}$	$10^7\beta$	$10^7\alpha/^{\circ}\text{C}^{-1}$	$\kappa/\text{S cm}^{-1}$	$\eta/\text{mPa s}$	$c_p/\text{J kg}^{-1}\text{ } ^{\circ}\text{C}^{-1}$	$\nu/\text{m s}^{-1}$
0	1.028106	7854	526	0.029048	1.892	3986.5	1449.1
5	1.027675	7717	1136	0.033468	1.610		
10	1.026952	7606	1668	0.038103	1.388	3986.3	1489.8
15	1.025973	7516	2141	0.042933	1.221		
20	1.024763	7444	2572	0.047934	1.085	3993.9	1521.5
25	1.023343	7385	2970	0.053088	0.966		
30	1.021729	7338	3341	0.058373	0.871	4000.7	1545.6
35	1.019934	7300	3687				
40		7270	4004			4003.5	1563.2

### Density of Surface Seawater in $\text{g/cm}^3$ as a Function of Temperature and Salinity

$t/^{\circ}\text{C}$	$S = 0$	$S = 5$	$S = 10$	$S = 15$	$S = 20$	$S = 25$	$S = 30$	$S = 35$	$S = 40$
0	0.999843	1.003913	1.007955	1.011986	1.016014	1.020041	1.024072	1.028106	1.032147
5	0.999967	1.003949	1.007907	1.011858	1.015807	1.019758	1.023714	1.027675	1.031645
10	0.999702	1.003612	1.007501	1.011385	1.015269	1.019157	1.023051	1.026952	1.030862
15	0.999102	1.002952	1.006784	1.010613	1.014443	1.018279	1.022122	1.025973	1.029834
20	0.998206	1.002008	1.005793	1.009576	1.013362	1.017154	1.020954	1.024763	1.028583
25	0.997048	1.000809	1.004556	1.008301	1.012050	1.015806	1.019569	1.023343	1.027128
30	0.995651	0.999380	1.003095	1.006809	1.010527	1.014252	1.017985	1.021729	1.025483
35	0.994036	0.997740	1.001429	1.005118	1.008810	1.012509	1.016217	1.019934	1.023662
40	0.992220	0.995906	0.999575	1.003244	1.006915	1.010593	1.014278	1.017973	1.021679

### Electrical Conductivity of Seawater in S/cm as a Function of Temperature and Salinity

$t/^{\circ}\text{C}$	$S = 5$	$S = 10$	$S = 15$	$S = 20$	$S = 25$	$S = 30$	$S = 35$	$S = 40$
0	0.004808	0.009171	0.013357	0.017421	0.021385	0.025257	0.029048	0.032775
5	0.005570	0.010616	0.015441	0.020118	0.024674	0.029120	0.033468	0.037734
10	0.006370	0.012131	0.017627	0.022947	0.028123	0.033171	0.038103	0.042935
15	0.007204	0.013709	0.019905	0.025894	0.031716	0.037391	0.042933	0.048355
20	0.008068	0.015346	0.022267	0.028948	0.035438	0.041762	0.047934	0.053968
25	0.008960	0.017035	0.024703	0.032097	0.039276	0.046267	0.053088	0.059751
30	0.009877	0.018771	0.027204	0.035330	0.043213	0.050888	0.058373	0.065683

### Composition of Seawater and Ionic Strength at Various Salinities (Ref. 2)

Constituent	Expressed as molality			As grams per kilogram of seawater		
	$S = 30$	$S = 35$	$S = 40$	$S = 30$	$S = 35$	$S = 40$
$\text{Cl}^-$	0.482	0.562	0.650	16.58	19.33	22.36
$\text{Br}^-$	0.00074	0.00087	0.00100	0.057	0.067	0.078
$\text{F}^-$		0.00007			0.001	
$\text{SO}_4^{2-}$	0.0104	0.0114	0.0122	0.97	1.06	1.14
$\text{HCO}_3^-$	0.00131	0.00143	0.00100	0.078	0.085	0.059
$\text{NaSO}_4^-$	0.0085	0.0108	0.0139	0.98	1.25	1.60
$\text{KSO}_4^-$	0.00010	0.00012	0.00015	0.013	0.016	0.020
$\text{Na}^+$	0.405	0.472	0.544	9.03	10.53	12.13
$\text{K}^+$	0.00892	0.01039	0.01200	0.338	0.394	0.455
$\text{Mg}^{2+}$	0.0413	0.0483	0.0561	0.974	1.139	1.323
$\text{Ca}^{2+}$	0.00131	0.00143	0.00154	0.051	0.056	0.060
$\text{Sr}^{2+}$	0.00008	0.00009	0.00011	0.007	0.008	0.009
$\text{MgHCO}_3^+$	0.00028	0.00036	0.00045	0.023	0.030	0.037
$\text{MgSO}_4$	0.00498	0.00561	0.00614	0.582	0.655	0.717
$\text{CaSO}_4$	0.00102	0.00115	0.00126	0.135	0.152	0.166
$\text{NaHCO}_3$	0.00015	0.00020	0.00024	0.012	0.016	0.020
$\text{H}_3\text{BO}_3$	0.00032	0.00037	0.00042	0.019	0.022	0.025
Ionic strength	0.5736	0.6675	0.7701			

### Freezing Point of Seawater in $^{\circ}\text{C}$ as a Function of Salinity and Pressure

$P/\text{dbar}$	$S = 0$	5	10	15	20	25	30	35	40
0	0.000	-0.274	-0.542	-0.812	-1.083	-1.358	-1.638	-1.922	-2.212
50	-0.038	-0.311	-0.580	-0.849	-1.121	-1.396	-1.676	-1.960	-2.250
100	-0.075	-0.349	-0.618	-0.887	-1.159	-1.434	-1.713	-1.998	-2.287
500	-0.377	-0.650	-0.919	-1.188	-1.460	-1.735	-2.014	-2.299	-2.589



## ABUNDANCE OF ELEMENTS IN THE EARTH'S CRUST AND IN THE SEA

This table gives the estimated abundance of the elements in the continental crust (in mg/kg, equivalent to parts per million by mass) and in seawater near the surface (in mg/L). Values represent the median of reported measurements. The concentrations of the less abundant elements may vary with location by several orders of magnitude.

Element	Abundance	
	Crust mg/kg	Sea mg/L
Ac	$5.5 \times 10^{-10}$	
Ag	$7.5 \times 10^{-2}$	$4 \times 10^{-5}$
Al	$8.23 \times 10^4$	$2 \times 10^{-3}$
Ar	3.5	$4.5 \times 10^{-1}$
As	1.8	$3.7 \times 10^{-3}$
Au	$4 \times 10^{-3}$	$4 \times 10^{-6}$
B	$1.0 \times 10^1$	4.44
Ba	$4.25 \times 10^2$	$1.3 \times 10^{-2}$
Be	2.8	$5.6 \times 10^{-6}$
Bi	$8.5 \times 10^{-3}$	$2 \times 10^{-5}$
Br	2.4	$6.73 \times 10^1$
C	$2.00 \times 10^2$	$2.8 \times 10^1$
Ca	$4.15 \times 10^4$	$4.12 \times 10^2$
Cd	$1.5 \times 10^{-1}$	$1.1 \times 10^{-4}$
Ce	$6.65 \times 10^1$	$1.2 \times 10^{-6}$
Cl	$1.45 \times 10^2$	$1.94 \times 10^4$
Co	$2.5 \times 10^1$	$2 \times 10^{-5}$
Cr	$1.02 \times 10^2$	$3 \times 10^{-4}$
Cs	3	$3 \times 10^{-4}$
Cu	$6.0 \times 10^1$	$2.5 \times 10^{-4}$
Dy	5.2	$9.1 \times 10^{-7}$
Er	3.5	$8.7 \times 10^{-7}$
Eu	2.0	$1.3 \times 10^{-7}$
F	$5.85 \times 10^2$	1.3
Fe	$5.63 \times 10^4$	$2 \times 10^{-3}$
Ga	$1.9 \times 10^1$	$3 \times 10^{-5}$
Gd	6.2	$7 \times 10^{-7}$
Ge	1.5	$5 \times 10^{-5}$
H	$1.40 \times 10^3$	$1.08 \times 10^5$
He	$8 \times 10^{-3}$	$7 \times 10^{-6}$
Hf	3.0	$7 \times 10^{-6}$
Hg	$8.5 \times 10^{-2}$	$3 \times 10^{-5}$
Ho	1.3	$2.2 \times 10^{-7}$
I	$4.5 \times 10^{-1}$	$6 \times 10^{-2}$
In	$2.5 \times 10^{-1}$	$2 \times 10^{-2}$
Ir	$1 \times 10^{-3}$	
K	$2.09 \times 10^4$	$3.99 \times 10^2$
Kr	$1 \times 10^{-4}$	$2.1 \times 10^{-4}$
La	$3.9 \times 10^1$	$3.4 \times 10^{-6}$
Li	$2.0 \times 10^1$	$1.8 \times 10^{-1}$
Lu	$8 \times 10^{-1}$	$1.5 \times 10^{-7}$
Mg	$2.33 \times 10^4$	$1.29 \times 10^3$
Mn	$9.50 \times 10^2$	$2 \times 10^{-4}$
Mo	1.2	$1 \times 10^{-2}$

## References

1. Carmichael, R. S., Ed., *CRC Practical Handbook of Physical Properties of Rocks and Minerals*, CRC Press, Boca Raton, FL, 1989.
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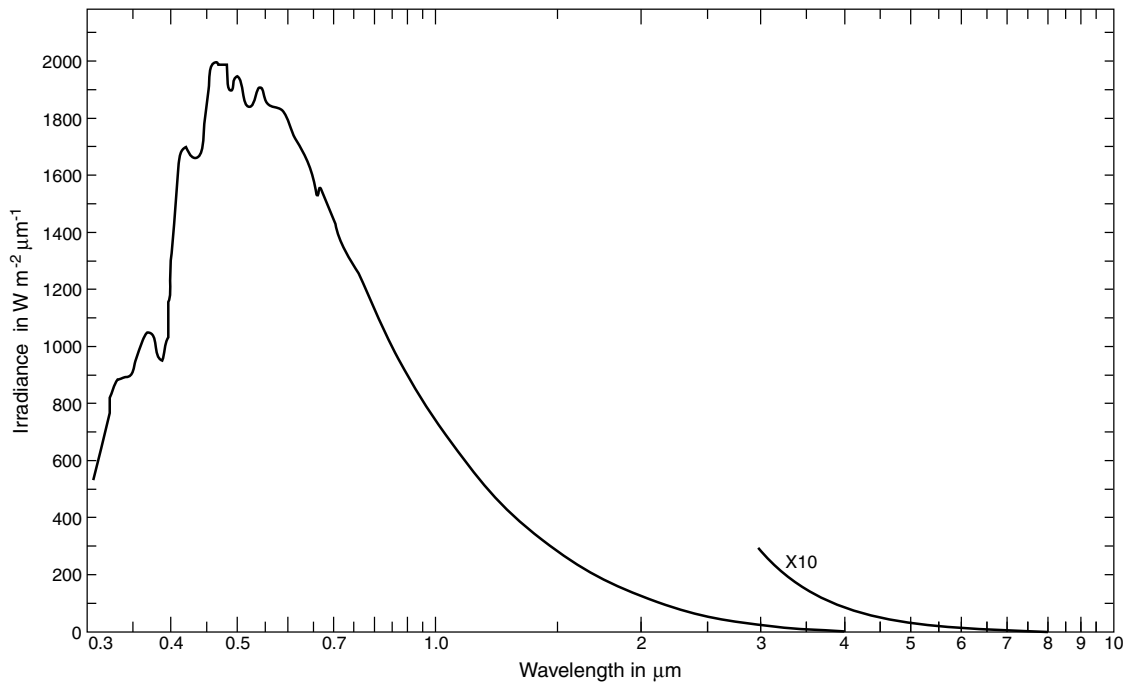
Element	Abundance	
	Crust mg/kg	Sea mg/L
N	$1.9 \times 10^1$	$5 \times 10^{-1}$
Na	$2.36 \times 10^4$	$1.08 \times 10^4$
Nb	$2.0 \times 10^1$	$1 \times 10^{-5}$
Nd	$4.15 \times 10^1$	$2.8 \times 10^{-6}$
Ne	$5 \times 10^{-3}$	$1.2 \times 10^{-4}$
Ni	$8.4 \times 10^1$	$5.6 \times 10^{-4}$
O	$4.61 \times 10^5$	$8.57 \times 10^5$
Os	$1.5 \times 10^{-3}$	
P	$1.05 \times 10^3$	$6 \times 10^{-2}$
Pa	$1.4 \times 10^{-6}$	$5 \times 10^{-11}$
Pb	$1.4 \times 10^1$	$3 \times 10^{-5}$
Pd	$1.5 \times 10^{-2}$	
Po	$2 \times 10^{-10}$	$1.5 \times 10^{-14}$
Pr	9.2	$6.4 \times 10^{-7}$
Pt	$5 \times 10^{-3}$	
Ra	$9 \times 10^{-7}$	$8.9 \times 10^{-11}$
Rb	$9.0 \times 10^1$	$1.2 \times 10^{-1}$
Re	$7 \times 10^{-4}$	$4 \times 10^{-6}$
Rh	$1 \times 10^{-3}$	
Rn	$4 \times 10^{-13}$	$6 \times 10^{-16}$
Ru	$1 \times 10^{-3}$	$7 \times 10^{-7}$
S	$3.50 \times 10^2$	$9.05 \times 10^2$
Sb	$2 \times 10^{-1}$	$2.4 \times 10^{-4}$
Sc	$2.2 \times 10^1$	$6 \times 10^{-7}$
Se	$5 \times 10^{-2}$	$2 \times 10^{-4}$
Si	$2.82 \times 10^5$	2.2
Sm	7.05	$4.5 \times 10^{-7}$
Sn	2.3	$4 \times 10^{-6}$
Sr	$3.70 \times 10^2$	7.9
Ta	2.0	$2 \times 10^{-6}$
Tb	1.2	$1.4 \times 10^{-7}$
Te	$1 \times 10^{-3}$	
Th	9.6	$1 \times 10^{-6}$
Ti	$5.65 \times 10^3$	$1 \times 10^{-3}$
Tl	$8.5 \times 10^{-1}$	$1.9 \times 10^{-5}$
Tm	$5.2 \times 10^{-1}$	$1.7 \times 10^{-7}$
U	2.7	$3.2 \times 10^{-3}$
V	$1.20 \times 10^2$	$2.5 \times 10^{-3}$
W	1.25	$1 \times 10^{-4}$
Xe	$3 \times 10^{-5}$	$5 \times 10^{-5}$
Y	$3.3 \times 10^1$	$1.3 \times 10^{-5}$
Yb	3.2	$8.2 \times 10^{-7}$
Zn	$7.0 \times 10^1$	$4.9 \times 10^{-3}$
Zr	$1.65 \times 10^2$	$3 \times 10^{-5}$

## SOLAR SPECTRAL IRRADIANCE

The solar luminosity (total radiant power emitted) is  $3.86 \cdot 10^{26}$  W, of which  $1373 \text{ W/m}^2$  reaches the top of the earth's atmosphere. To a zeroth approximation the sun can be considered a black body with an effective temperature of 5780 K, which implies a peak in the radiation at around  $0.520 \text{ }\mu\text{m}$  ( $5200 \text{ \AA}$ ). The actual solar spectral emission is more complex, especially at ultraviolet and shorter wavelengths. The graph below, which was taken from Reference 1, summarizes the solar irradiance at the top of the atmosphere in the range 0.3 to  $10 \text{ }\mu\text{m}$ .

### References

1. Jursa, A. S., Ed., *Handbook of Geophysics and the Space Environment*, Air Force Geophysics Laboratory, 1985.
2. Pierce, A. K., and Allen, R. G., "The Solar Spectrum between 0.3 and  $10 \text{ }\mu\text{m}$ ", in *The Solar Output and Its Variation*, White, O. R., Ed., Colorado Associated University Press, Boulder, CO, 1977.
3. Lang, K. R., *Astrophysical Data. Planets and Stars*, Springer-Verlag, New York, 1992.



## U.S. STANDARD ATMOSPHERE (1976)

A Standard Atmosphere is a hypothetical vertical distribution of atmospheric temperature, pressure, and density that is roughly representative of year-round, midlatitude conditions. Typical uses are to serve as a basis for pressure altimeter calibrations, aircraft performance calculations, aircraft and rocket design, ballistic tables, meteorological diagrams, and various types of atmospheric modeling. The air is assumed to be dry and to obey the perfect gas law and the hydrostatic equation which, taken together, relate temperature, pressure, and density with vertical position. The atmosphere is considered to rotate with the Earth and to be an average over the diurnal cycle, the semiannual variation, and the range from active to quiet geomagnetic and sunspot conditions.

The U.S. Standard Atmosphere (1976) is an idealized, steady-state representation of mean annual conditions of the Earth's atmosphere from the surface to 1000 km at latitude 45° N, as it is assumed to exist during a period with moderate solar activity. The defining meteorological elements are sea-level temperature and pressure and a temperature-height profile to 1000 km. The 1976 Standard Atmosphere uses the following sea-level values that have been standard for many decades:

Temperature — 288.15 K (15 °C)  
 Pressure — 101325 Pa (1013.25 mbar, 760 mm of Hg, or 29.92 in. of Hg)

Density — 1225 g/m<sup>3</sup> (1.225 g/L)  
 Mean molar mass — 28.964 g/mol

The parameters included in this condensed version of the U.S. Standard Atmosphere are:

$Z$  — Height (geometric) above mean sea level in meters  
 $T$  — Temperature in kelvins  
 $P$  — Pressure in pascals (1 Pa = 0.01 millibars)  
 $\rho$  — Density in kilograms per cubic meter (1 kg/m<sup>3</sup> = 1 g/L)  
 $n$  — Number density in molecules per cubic meter  
 $\nu$  — Mean collision frequency in collisions per second  
 $l$  — Mean free path in meters  
 $\eta$  — Absolute viscosity in pascal seconds (1 Pa s = 1000 cP)  
 $k$  — Thermal conductivity in joules per meter second kelvin (W/m K)  
 $\nu_s$  — Speed of sound in meters per second  
 $g$  — Acceleration of gravity in meters per second square

The sea-level composition (percent by volume) is taken to be:

N <sub>2</sub> — 78.084%	He — 0.000524
O <sub>2</sub> — 20.9476	Kr — 0.000114
Ar — 0.934	Xe — 0.0000087
CO <sub>2</sub> — 0.0314	CH <sub>4</sub> — 0.0002
Ne — 0.001818	H <sub>2</sub> — 0.00005

The  $T$  and  $P$  columns for the troposphere and lower stratosphere were generated from the following formulas:

	$T/K$	$P/Pa$
$H \leq 11000$ m	$288.15 - 0.0065 H$	$101325(288.15/T)^{-5.25577}$
$11000$ m $< H \leq 20000$ m	216.65	$22632 e^{-0.00015768832(H-11000)}$
$20000$ m $< H \leq 32000$ m	$216.65 + 0.0010(H-20000)$	$5474.87(216.65/T)^{34.16319}$

where  $H = rZ/(r + Z)$  is the geopotential height in meters and  $r$  is the mean Earth radius at 45° N latitude, taken as 6356766 m. For altitudes up to 32 km,  $\rho = 0.003483677(P/T)$  in the units used here. Formulas for the other quantities may be found in the references.

### References

1. COESA, *U.S. Standard Atmosphere*, 1976, U.S. Government Printing Office, Washington, D.C., 1976.
2. Jursa, A. S., Ed., *Handbook of Geophysics and the Space Environment*, Air Force Geophysics Laboratory, 1985.

Z/m	T/K	P/Pa	$\rho/\text{kg m}^{-3}$	$n/\text{m}^{-3}$	$v/\text{s}^{-1}$	$l/\text{m}$	$\eta/\text{Pa s}$	$W \text{ m}^{-1} \text{ K}^{-1}$	$v_s/\text{m s}^{-1}$	$g/\text{m s}^{-2}$
-5000	320.68	1.778E+05	1.931	4.015E+25	1.151E+10	4.208E-08	1.942E-05	0.02788	359.0	9.822
-4500	317.42	1.685E+05	1.849	3.845E+25	1.096E+10	4.395E-08	1.927E-05	0.02763	357.2	9.830
-4000	314.17	1.596E+05	1.770	3.680E+25	1.044E+10	4.592E-08	1.912E-05	0.02738	355.3	9.819
-3500	310.91	1.511E+05	1.693	3.520E+25	9.933E+09	4.800E-08	1.897E-05	0.02713	353.5	9.818
-3000	307.66	1.430E+05	1.619	3.366E+25	9.448E+09	5.019E-08	1.882E-05	0.02688	351.6	9.816
-2500	304.41	1.352E+05	1.547	3.217E+25	8.982E+09	5.252E-08	1.867E-05	0.02663	349.8	9.814
-2000	301.15	1.278E+05	1.478	3.102E+25	8.623E+09	5.447E-08	1.852E-05	0.02638	347.9	9.813
-1500	297.90	1.207E+05	1.411	2.935E+25	8.106E+09	5.757E-08	1.836E-05	0.02613	346.0	9.811
-1000	294.65	1.139E+05	1.347	2.801E+25	7.693E+09	6.032E-08	1.821E-05	0.02587	344.1	9.810
-500	291.40	1.075E+05	1.285	2.672E+25	7.298E+09	6.324E-08	1.805E-05	0.02562	342.2	9.808
0	288.15	1.013E+05	1.225	2.547E+25	6.919E+09	6.633E-08	1.789E-05	0.02533	340.3	9.807
500	284.90	9.546E+04	1.167	2.427E+25	6.556E+09	6.961E-08	1.774E-05	0.02511	338.4	9.805
1000	281.65	8.988E+04	1.112	2.311E+25	6.208E+09	7.310E-08	1.758E-05	0.02485	336.4	9.804
1500	278.40	8.456E+04	1.058	2.200E+25	5.874E+09	7.680E-08	1.742E-05	0.02459	334.5	9.802
2000	275.15	7.950E+04	1.007	2.093E+25	5.555E+09	8.073E-08	1.726E-05	0.02433	332.5	9.801
2500	271.91	7.469E+04	0.957	1.990E+25	5.250E+09	8.491E-08	1.710E-05	0.02407	330.6	9.799
3000	268.66	7.012E+04	0.909	1.891E+25	4.959E+09	8.937E-08	1.694E-05	0.02381	328.6	9.797
3500	265.41	6.579E+04	0.863	1.795E+25	4.680E+09	9.411E-08	1.678E-05	0.02355	326.6	9.796
4000	262.17	6.166E+04	0.819	1.704E+25	4.414E+09	9.917E-08	1.661E-05	0.02329	324.6	9.794
4500	258.92	5.775E+04	0.777	1.616E+25	4.160E+09	1.046E-07	1.645E-05	0.02303	322.6	9.793
5000	255.68	5.405E+04	0.736	1.531E+25	3.918E+09	1.103E-07	1.628E-05	0.02277	320.6	9.791
5500	252.43	5.054E+04	0.697	1.450E+25	3.687E+09	1.165E-07	1.612E-05	0.02250	318.5	9.790
6000	249.19	4.722E+04	0.660	1.373E+25	3.467E+09	1.231E-07	1.595E-05	0.02224	316.5	9.788
6500	245.94	4.408E+04	0.664	1.299E+25	3.258E+09	1.302E-07	1.578E-05	0.02197	314.4	9.787
7000	242.70	4.111E+04	0.590	1.227E+25	3.058E+09	1.377E-07	1.561E-05	0.02170	312.3	9.785
7500	239.46	3.830E+04	0.557	1.159E+25	2.869E+09	1.458E-07	1.544E-05	0.02144	310.2	9.784
8000	236.22	3.565E+04	0.526	1.093E+25	2.689E+09	1.545E-07	1.527E-05	0.02117	308.1	9.782
8500	232.97	3.315E+04	0.496	1.031E+25	2.518E+09	1.639E-07	1.510E-05	0.02090	306.0	9.781
9000	229.73	3.080E+04	0.467	9.711E+24	2.356E+09	1.740E-07	1.493E-05	0.02063	303.9	9.779
9500	226.49	2.858E+04	0.440	9.141E+24	2.202E+09	1.848E-07	1.475E-05	0.02036	301.7	9.777
10000	223.25	2.650E+04	0.414	8.598E+24	2.056E+09	1.965E-07	1.458E-05	0.02009	299.5	9.776
10500	220.01	2.454E+04	0.389	8.079E+24	1.918E+09	2.091E-07	1.440E-05	0.01982	297.4	9.774
11000	216.77	2.270E+04	0.365	7.585E+24	1.787E+09	2.227E-07	1.422E-05	0.01954	295.2	9.773
11500	216.65	2.098E+04	0.337	7.016E+24	1.653E+09	2.408E-07	1.422E-05	0.01953	295.1	9.771
12000	216.65	1.940E+04	0.312	6.486E+24	1.528E+09	2.605E-07	1.422E-05	0.01953	295.1	9.770
12500	216.65	1.793E+04	0.288	5.996E+24	1.412E+09	2.818E-07	1.422E-05	0.01953	295.1	9.768
13000	216.65	1.658E+04	0.267	5.543E+24	1.306E+09	3.048E-07	1.422E-05	0.01953	295.1	9.767
13500	216.65	1.533E+04	0.246	5.124E+24	1.207E+09	3.297E-07	1.422E-05	0.01953	295.1	9.765
14000	216.65	1.417E+04	0.228	4.738E+24	1.116E+09	3.566E-07	1.422E-05	0.01953	295.1	9.764
14500	216.65	1.310E+04	0.211	4.380E+24	1.032E+09	3.857E-07	1.422E-05	0.01953	295.1	9.762
15000	216.65	1.211E+04	0.195	4.049E+24	9.538E+08	4.172E-07	1.422E-05	0.01953	295.1	9.761
16000	216.65	1.035E+04	0.166	3.461E+24	8.153E+08	4.881E-07	1.422E-05	0.01953	295.1	9.758
17000	216.65	8.850E+03	0.142	2.959E+24	6.969E+08	5.710E-07	1.422E-05	0.01953	295.1	9.754
18000	216.65	7.565E+03	0.122	2.529E+24	5.958E+08	6.680E-07	1.422E-05	0.01953	295.1	9.751
19000	216.65	6.467E+03	0.104	2.162E+24	5.093E+08	7.814E-07	1.422E-05	0.01953	295.1	9.748
20000	216.65	5.529E+03	8.891E-02	1.849E+24	4.354E+08	9.139E-07	1.422E-05	0.01953	295.1	9.745
21000	217.58	4.729E+03	7.572E-02	1.574E+24	3.716E+08	1.073E-06	1.427E-05	0.01961	295.1	9.742
22000	218.57	4.048E+03	6.451E-02	1.341E+24	3.173E+08	1.260E-06	1.432E-05	0.01970	296.4	9.739
23000	219.57	3.467E+03	5.501E-02	1.144E+24	2.712E+08	1.477E-06	1.438E-05	0.01978	297.1	9.736
24000	220.56	2.972E+03	4.694E-02	9.759E+23	2.319E+08	1.731E-06	1.443E-05	0.01986	297.7	9.733
25000	221.55	2.549E+03	4.008E-02	8.334E+23	1.985E+08	2.027E-06	1.448E-05	0.01995	298.4	9.730
26000	222.54	2.188E+03	3.426E-02	7.123E+23	1.700E+08	2.372E-06	1.454E-05	0.02003	299.1	9.727
27000	223.54	1.880E+03	2.930E-02	6.092E+23	1.458E+08	2.773E-06	1.459E-05	0.02011	299.7	9.724
28000	224.53	1.610E+03	2.508E-02	5.214E+23	1.250E+08	3.240E-06	1.465E-05	0.02020	300.4	9.721
29000	225.52	1.390E+03	2.148E-02	4.466E+23	1.073E+08	3.783E-06	1.470E-05	0.02028	301.1	9.718
30000	226.51	1.197E+03	1.841E-02	3.828E+23	9.219E+07	4.414E-06	1.475E-05	0.02036	301.7	9.715
31000	227.50	1.031E+03	1.579E-02	3.283E+23	7.925E+07	5.146E-06	1.481E-05	0.02044	302.4	9.712
32000	228.49	8.891E+02	1.356E-02	2.813E+23	6.818E+07	5.995E-06	1.486E-05	0.02053	303.0	9.709
33000	230.97	7.673E+02	1.157E-02	2.406E+23	5.852E+07	7.021E-06	1.499E-05	0.02073	304.7	9.706
34000	233.74	6.634E+02	9.887E-03	2.056E+23	5.030E+07	8.218E-06	1.514E-05	0.02096	306.5	9.703
35000	236.51	5.746E+02	8.463E-03	1.760E+23	4.331E+07	9.601E-06	1.529E-05	0.02119	308.3	9.700

Z/m	T/K	P/Pa	$\rho/\text{kg m}^{-3}$	$n/\text{m}^{-3}$	$v/\text{s}^{-1}$	$l/\text{m}$	$\eta/\text{Pa s}$	$W \text{ m}^{-1} \text{ K}^{-1}$	$v_s/\text{m s}^{-1}$	$g/\text{m s}^{-2}$
36000	239.28	4.985E+02	7.258E-03	1.509E+23	3.736E+07	1.120E-05	1.543E-05	0.02142	310.1	9.697
38000	244.82	3.771E+02	5.367E-03	1.116E+23	2.794E+07	1.514E-05	1.572E-05	0.02188	313.7	9.690
40000	250.35	2.871E+02	3.996E-03	8.308E+22	2.104E+07	2.034E-05	1.601E-05	0.02233	317.2	9.684
42000	255.88	2.200E+02	2.995E-03	6.227E+22	1.594E+07	2.713E-05	1.629E-05	0.02278	320.7	9.678
44000	261.40	1.695E+02	2.259E-03	4.697E+22	1.215E+07	3.597E-05	1.657E-05	0.02323	324.1	9.672
46000	266.93	1.313E+02	1.714E-03	3.564E+22	9.318E+06	4.740E-05	1.685E-05	0.02376	327.5	9.666
48000	270.65	1.023E+02	1.317E-03	2.738E+22	7.208E+06	6.171E-05	1.704E-05	0.02397	329.8	9.660
50000	270.65	7.978E+01	1.027E-03	2.135E+22	5.620E+06	7.913E-05	1.703E-05	0.02397	329.8	9.654
52000	269.03	6.221E+01	8.056E-04	1.675E+22	4.397E+06	1.009E-04	1.696E-05	0.02384	328.8	9.648
54000	263.52	4.834E+01	6.390E-04	1.329E+22	3.452E+06	1.272E-04	1.660E-05	0.02340	325.4	9.642
56000	258.02	3.736E+01	5.045E-04	1.049E+22	2.696E+06	1.611E-04	1.640E-05	0.02296	322.0	9.636
58000	252.52	2.872E+01	3.963E-04	8.239E+21	2.095E+06	2.051E-04	1.612E-05	0.02251	318.6	9.632
60000	247.02	2.196E+01	3.097E-04	6.439E+21	1.620E+06	2.624E-04	1.584E-05	0.02206	315.1	9.624
65000	233.29	1.093E+01	1.632E-04	3.393E+21	8.294E+05	4.979E-04	1.512E-05	0.02093	306.2	9.609
70000	219.59	5.221	8.283E-05	1.722E+21	4.084E+05	9.810E-04	1.438E-05	0.01978	297.1	9.594
75000	208.40	2.388	3.992E-05	8.300E+20	1.918E+05	2.035E-03	1.376E-05	0.01883	289.4	9.579
80000	198.64	1.052	1.846E-05	3.838E+20	8.656E+04	4.402E-03	1.321E-05	0.01800	282.5	9.564
85000	188.89	4.457E-01	8.220E-06	1.709E+20	3.766E+04	9.886E-03	1.265E-05	0.01716	275.5	9.550
90000	186.87	1.836E-01	3.416E-06	7.116E+19	1.560E+04	2.370E-02				9.535
95000	188.42	7.597E-02	1.393E-06	2.920E+19	6.440E+03	5.790E-02				9.520
100000	195.08	3.201E-02	5.604E-07	1.189E+19	2.680E+03	1.420E-01				9.505
110000	240.00	7.104E-03	9.708E-08	2.144E+18	5.480E+02	7.880E-01				9.476
120000	360.00	2.538E-03	2.222E-08	5.107E+17	1.630E+02	3.310				9.447
130000	469.27	1.251E-03	8.152E-09	1.930E+17	7.100E+01	8.800				9.418
140000	559.63	7.203E-04	3.831E-09	9.322E+16	3.800E+01	1.800E+01				9.389
150000	634.39	4.542E-04	2.076E-09	5.186E+16	2.300E+01	3.300E+01				9.360
160000	696.29	3.040E-04	1.233E-09	3.162E+16	1.500E+01	5.300E+01				9.331
170000	747.57	2.121E-04	7.815E-10	2.055E+16	1.000E+01	8.200E+01				9.302
180000	790.07	1.527E-04	5.194E-10	1.400E+16	7.200	1.200E+02				9.274
190000	825.16	1.127E-04	3.581E-10	9.887E+15	5.200	1.700E+02				9.246
200000	854.56	8.474E-05	2.541E-10	7.182E+15	3.900	2.400E+02				9.218
220000	899.01	5.015E-05	1.367E-10	4.040E+15	2.300	4.200E+02				9.162
240000	929.73	3.106E-05	7.858E-11	2.420E+15	1.400	7.000E+02				9.106
260000	950.99	1.989E-05	4.742E-11	1.515E+15	9.300E-01	1.100E+03				9.051
280000	965.75	1.308E-05	2.971E-11	9.807E+14	6.100E-01	1.700E+03				8.997
300000	976.01	8.770E-06	1.916E-11	6.509E+14	4.200E-01	2.600E+03				8.943
320000	983.16	5.980E-06	1.264E-11	4.405E+14	2.900E-01	3.800E+03				8.889
340000	988.15	4.132E-06	8.503E-12	3.029E+14	2.000E-01	5.600E+03				8.836
360000	991.65	2.888E-06	5.805E-12	2.109E+14	1.400E-01	8.000E+03				8.784
380000	994.10	2.038E-06	4.013E-12	1.485E+14	1.000E-01	1.100E+04				8.732
400000	995.83	1.452E-06	2.803E-12	1.056E+14	7.200E-02	1.600E+04				8.680
450000	998.22	6.447E-07	1.184E-12	4.678E+13	3.300E-02	3.600E+04				8.553
500000	999.24	3.024E-07	5.215E-13	2.192E+13	1.600E-02	7.700E+04				8.429
550000	999.67	1.514E-07	2.384E-13	1.097E+13	8.400E-03	1.500E+05				8.307
600000	999.85	8.213E-08	1.137E-13	5.950E+12	4.800E-03	2.800E+05				8.188
650000	999.93	4.887E-08	5.712E-14	3.540E+12	3.100E-03	4.800E+05				8.072
700000	999.97	3.191E-08	3.070E-14	2.311E+12	2.200E-03	7.300E+05				7.958
750000	999.98	2.260E-08	1.788E-14	1.637E+12	1.700E-03	1.000E+06				7.846
800000	999.99	1.704E-08	1.136E-14	1.234E+12	1.400E-03	1.400E+06				7.737
850000	1000.00	1.342E-08	7.824E-15	9.717E+11	1.200E-03	1.700E+06				7.630
900000	1000.00	1.087E-08	5.759E-15	7.876E+11	1.000E-03	2.100E+06				7.525
950000	1000.00	8.982E-09	4.453E-15	6.505E+11	8.700E-04	2.600E+06				7.422
1000000	1000.00	7.514E-09	3.561E-15	5.442E+11	7.500E-04	3.100E+06				7.322

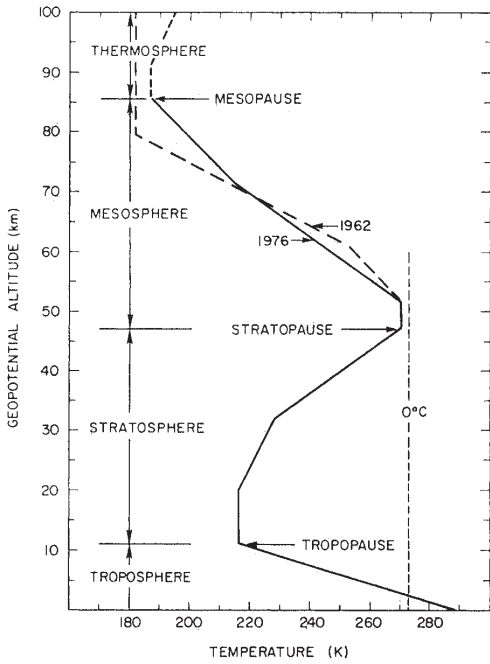


FIGURE 1. Temperature-height profile for U.S. Standard Atmosphere.

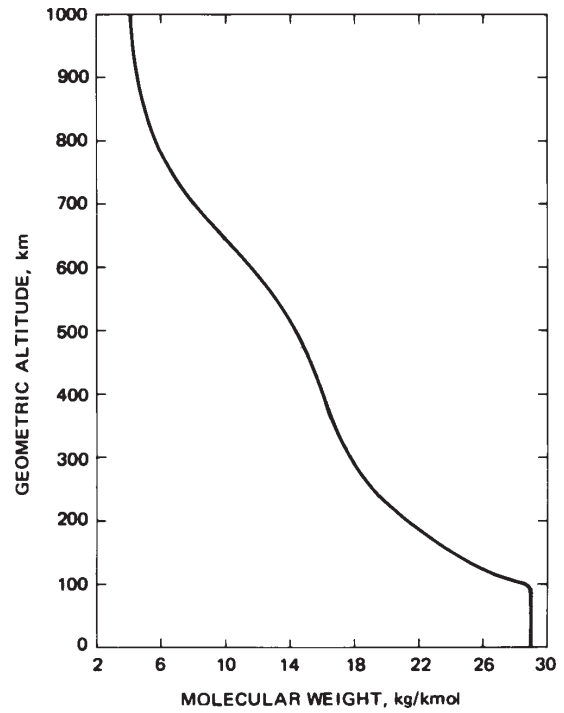


FIGURE 3. Mean molecular weight as a function of geometric altitude.

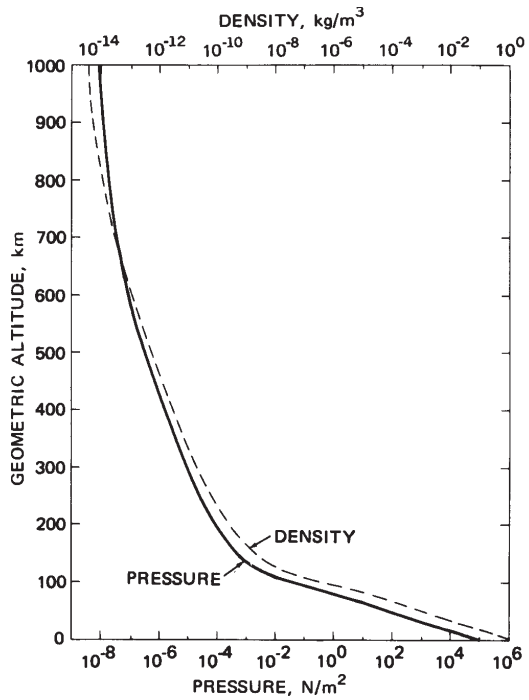


FIGURE 2. Total pressure and mass density as a function of geometric altitude.

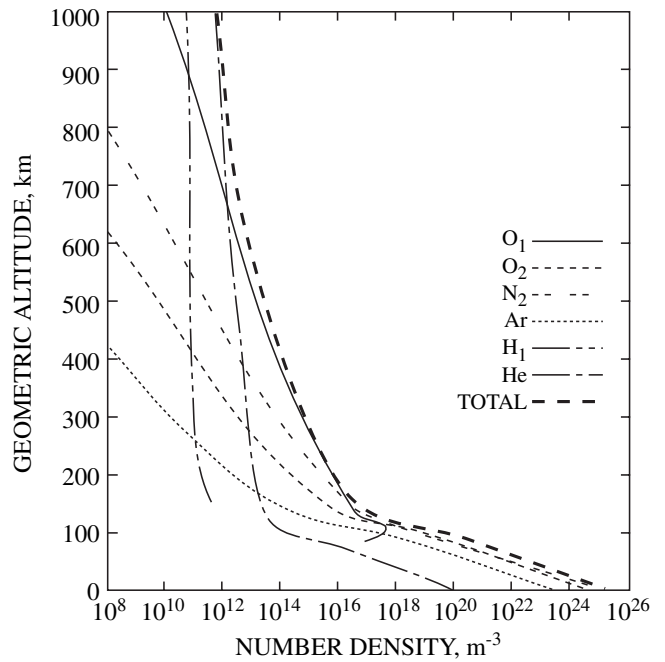


FIGURE 4. Number density of individual species and total number density as a function of geometric altitude.

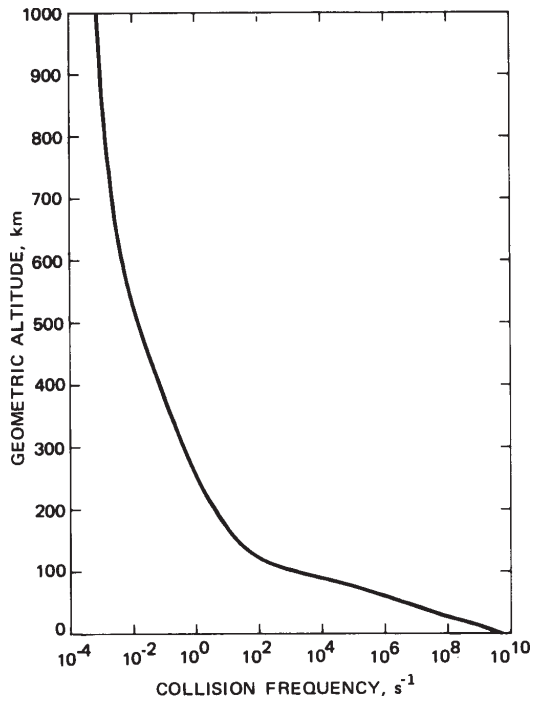


FIGURE 5. Collision frequency as a function of geometric altitude.

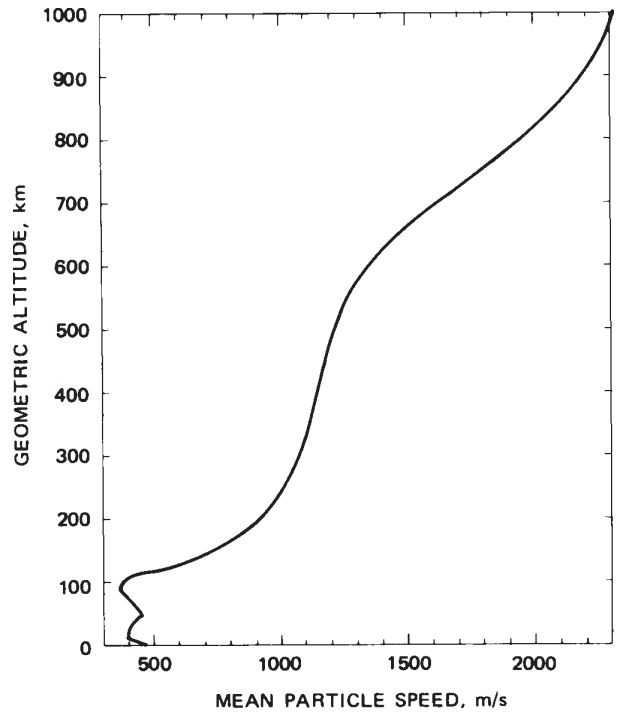


FIGURE 7. Mean air-particle speed as a function of geometric altitude.

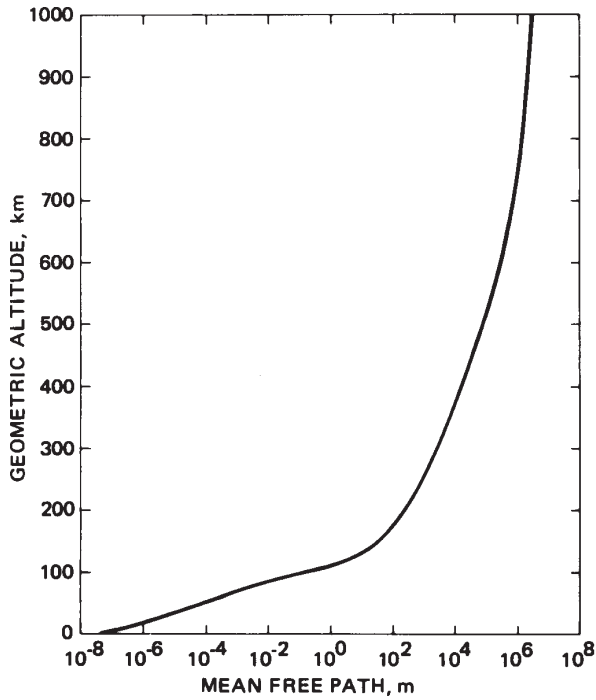


FIGURE 6. Mean free path as a function of geometric altitude.

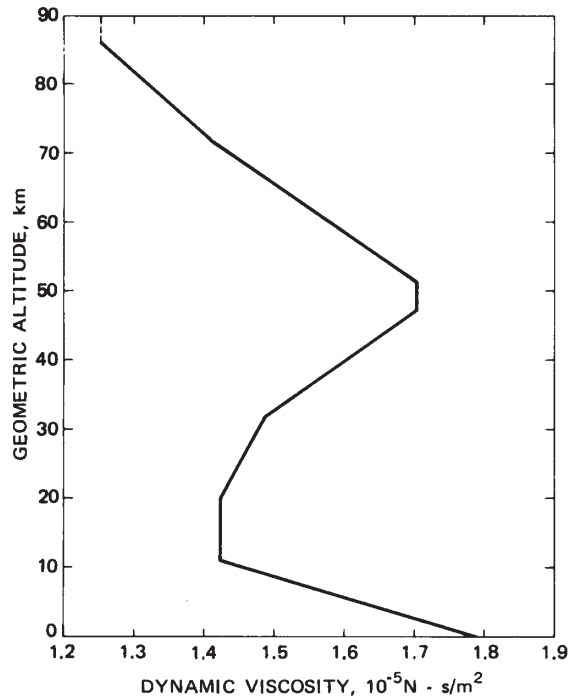


FIGURE 8. Dynamic viscosity as a function of geometric altitude.

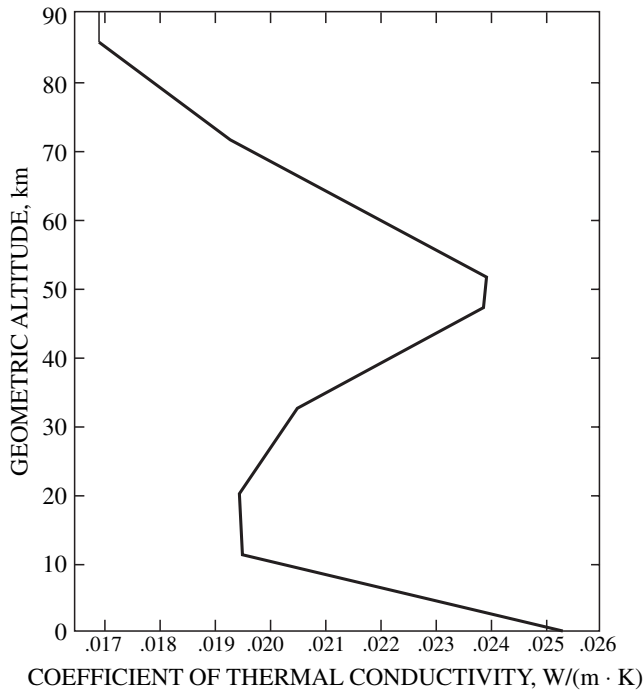


FIGURE 9. Coefficient of thermal conductivity as a function of geometric altitude.

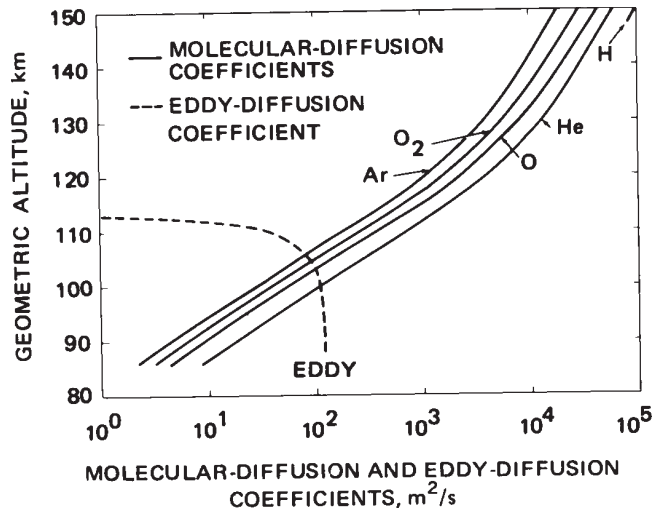


FIGURE 11. Molecular-diffusion and eddy-diffusion coefficients as a function of geometric altitude.

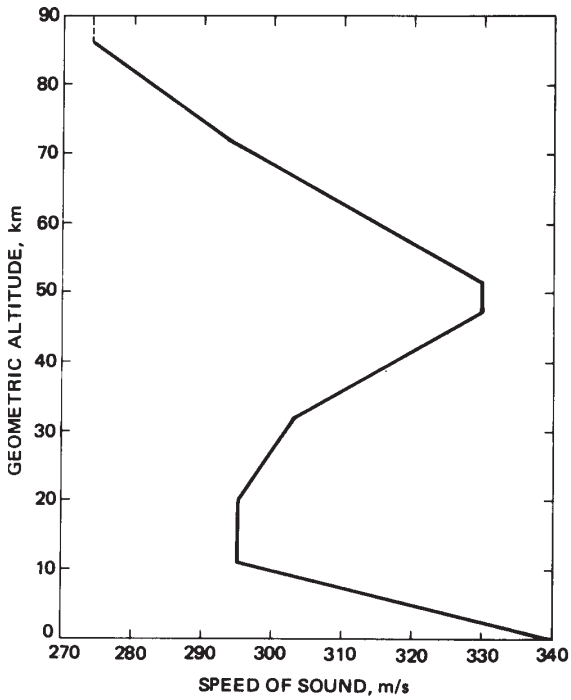


FIGURE 10. Speed of sound as a function of geometric altitude.

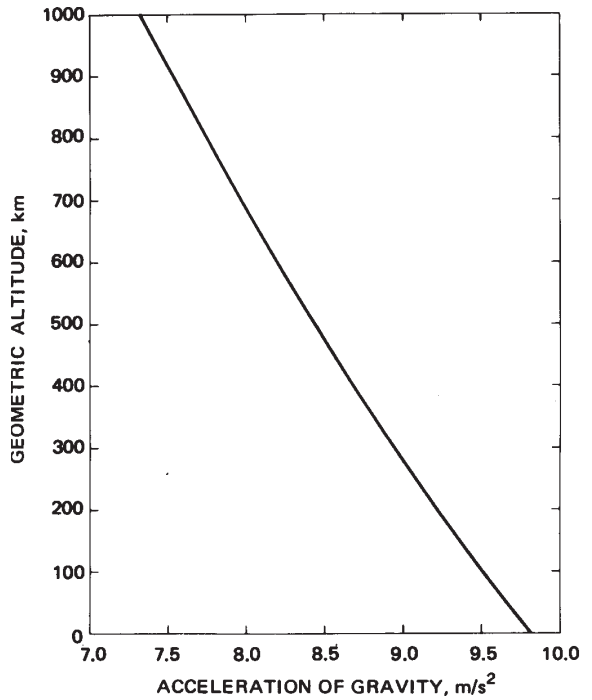


FIGURE 12. Acceleration of gravity as a function of geometric altitude.



## GEOGRAPHICAL AND SEASONAL VARIATION IN SOLAR RADIATION

This table gives the amount of solar radiation reaching a unit area at the top of the earth's atmosphere per day as a function of latitude and approximate date. It is based upon a solar constant (total energy per unit area at the earth's average orbital distance) of 1373 W/m<sup>2</sup>. Absorption of radiation by the atmosphere is not taken into consideration.

### Reference

List, R. J., *Smithsonian Meteorological Tables, Seventh Edition*, Smithsonian Institution Press, Washington, D.C., 1962.

Daily Solar Radiation in MJ/m <sup>2</sup>								
Lat.	Mar. 21	Apr. 13	May 6	May 29	Jun. 2	Jul. 15	Aug. 8	Aug. 31
90°		18.0	32.8	42.4	45.7	42.2	32.5	17.7
80	6.6	18.0	32.3	41.8	45.0	41.6	32.0	17.7
70	13.0	22.3	31.8	39.9	43.0	39.7	31.5	22.0
60	19.0	27.0	34.4	39.7	41.6	39.4	34.0	26.7
50	24.4	31.1	36.8	40.7	42.0	40.5	36.5	30.8
40	29.1	34.3	38.6	41.3	42.1	41.1	38.3	33.9
30	32.9	36.7	39.4	41.1	41.4	40.8	39.1	36.3
20	35.7	38.0	39.2	39.7	39.7	39.5	38.9	37.5
10	37.4	38.1	37.9	37.4	37.1	37.2	37.6	37.7
0	38.0	37.1	35.5	34.1	33.5	34.0	35.2	36.6
-10	37.4	35.0	32.3	30.0	29.2	29.9	32.0	34.6
-20	35.7	31.8	28.0	25.2	24.1	25.1	27.8	31.5
-30	32.9	27.8	23.1	19.7	18.5	19.7	22.8	27.4
-40	29.1	22.8	17.5	14.0	12.6	13.9	17.4	22.6
-50	24.4	17.3	11.7	8.2	7.0	8.2	11.6	17.2
-60	19.0	11.4	5.9	2.9	2.0	2.9	5.9	11.3
-70	13.0	5.4	1.0				1.0	5.3
-80	6.6	0.3						0.3
-90								

Lat.	Sep. 23	Oct. 16	Nov. 8	Nov. 30	Dec. 22	Jan. 13	Feb. 4	Feb. 26
90°								
80	6.5	0.3						0.3
70	12.9	5.5	1.0				1.0	5.6
60	18.8	11.6	6.2	3.1	2.1	3.1	6.2	11.7
50	24.1	17.6	12.1	8.7	7.5	8.7	12.3	17.8
40	28.7	23.1	18.2	14.8	13.5	14.9	18.4	23.5
30	32.5	28.2	23.9	20.9	19.8	21.0	24.1	28.4
20	35.3	32.3	29.1	26.6	25.7	26.7	29.3	32.7
10	37.0	35.5	33.5	31.8	31.1	31.9	33.8	35.9
0	37.6	37.6	36.9	36.1	35.8	36.3	37.3	38.0
-10	37.0	38.6	39.4	39.5	39.6	39.7	39.7	39.1
-20	35.3	38.5	40.7	42.0	42.4	42.2	41.1	39.0
-30	32.5	37.2	40.9	43.3	44.2	43.5	41.3	37.7
-40	28.7	34.8	40.1	43.6	45.0	43.8	40.5	35.2
-50	24.1	31.5	38.3	43.1	44.8	43.2	38.6	31.9
-60	18.8	27.3	35.7	41.9	44.4	42.1	36.0	27.7
-70	12.9	22.6	33.0	42.2	45.9	42.4	33.3	22.9
-80	6.5	18.2	33.5	44.2	48.1	44.4	33.8	18.4
-90		18.2	34.0	44.8	48.8	45.1	34.4	18.4

## INFRARED ABSORPTION BY THE EARTH'S ATMOSPHERE

Several constituents of the earth's atmosphere absorb infrared radiation. At ground level the strongest absorbers are H<sub>2</sub>O and CO<sub>2</sub>, but 30 to 40 other compounds can make significant contributions. The centers of the most important absorption bands are listed below:

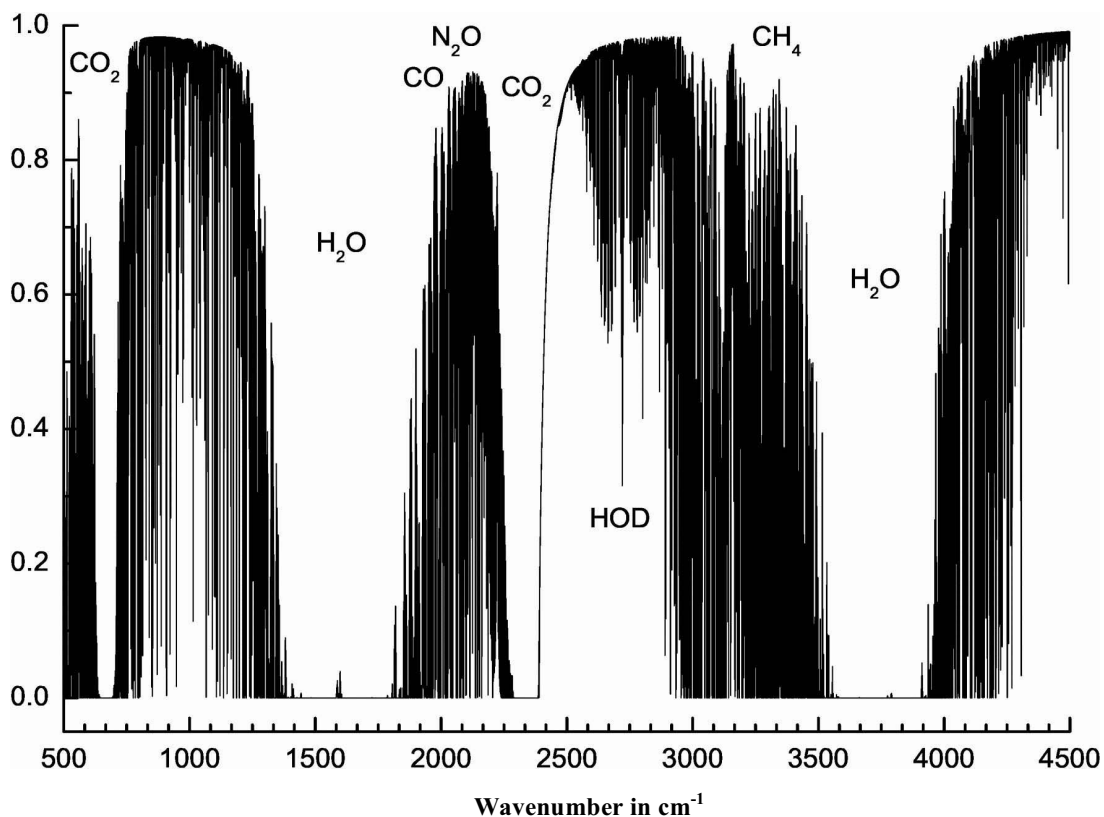
Molecule	Vibrational mode	Band center in cm <sup>-1</sup>
H <sub>2</sub> O	Bend	1595
H <sub>2</sub> O	Symmetric O-H stretch	3657
H <sub>2</sub> O	Antisymmetric O-H stretch	3756
CO <sub>2</sub>	Bend	667
CO <sub>2</sub>	Antisymmetric C-O stretch	2349
O <sub>3</sub>	Bend	701
O <sub>3</sub>	Antisymmetric O-O stretch	1042
O <sub>3</sub>	Symmetric O-O stretch	1103
N <sub>2</sub> O	Bend	589
N <sub>2</sub> O	N-O stretch	1285
N <sub>2</sub> O	N-N stretch	2224
CO	C-O stretch	2143
CH <sub>4</sub>	Degenerate deformation	1306
CH <sub>4</sub>	Degenerate stretch	3019

The HITRAN Molecular Spectroscopy Database (References 1 and 2) is a compilation of wavenumbers and intensities of more than 1.7 million spectral lines of atmospheric constituents. It is a valuable resource for calculating transmission of the atmosphere, radiative energy transfer, and other phenomena. The graph below, which was supplied by Walter J. Lafferty (Reference 3), gives the transmittance of the atmosphere for one set of conditions.

### References

1. Rothman, L. S., et al., *J. Quant. Spectros. Radiat. Transfer* 82, 5, 2003; *ibid.*, to be published, 2005.
2. HITRAN Molecular Spectroscopy Database, <<http://cfa-www.harvard.edu/HITRAN/hitranda04/>>.
3. Lafferty, W. J., Some Aspects of High Resolution Molecular Spectroscopy, in *Lectures on Molecular Physics*, Institute for the Structure of Matter, Centro de Fisica Miguel A. Catalan, Madrid, 1997.

**Transmittance of U.S. Standard Atmosphere at Ground Level for a Path of 1 km at 296 K**



## ATMOSPHERIC CONCENTRATION OF CARBON DIOXIDE, 1958–2004

The data in this table were taken at the Mauna Loa Observatory in Hawaii and represent averages adjusted to the 15th of each month. The last column gives the average over the year. The concentration of CO<sub>2</sub> is given in parts per million by volume. Data from other measurement sites may be found in Reference 1.

The first graph illustrates the seasonal variation of CO<sub>2</sub> concentration and the steady increase over the last 45 years. The second graph summarizes the growth in the emissions of CO<sub>2</sub> into the atmosphere as a result of burning of fossil fuels (Reference 2).

### References

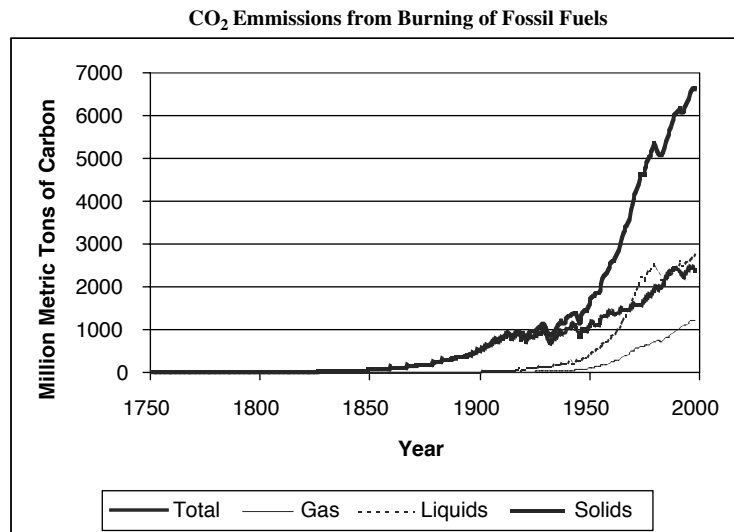
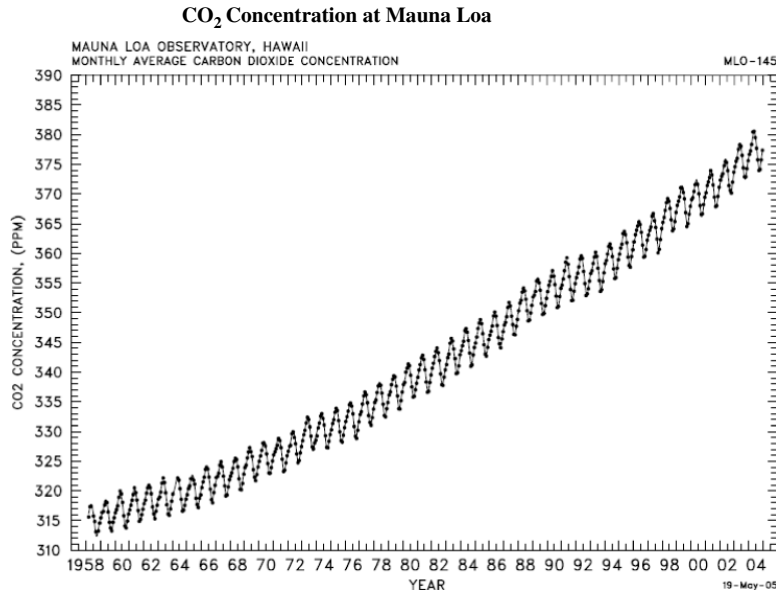
1. Keeling, C.D., and Whorf, T.P., Atmospheric carbon dioxide record from Mauna Loa, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN, 2005; <[cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm](http://cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm)>.
2. Marland, G., Boden, T. A., and Andres, R. J., Global, Regional, and National CO<sub>2</sub> Emissions. In *Trends: A Compendium of Data on Global Change, 2001*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN; <[cdiac.esd.ornl.gov/trends/emis/tre\\_glob.htm](http://cdiac.esd.ornl.gov/trends/emis/tre_glob.htm)>.

### CO<sub>2</sub> Concentration in ppm at Mauna Loa

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1958			315.71	317.45	317.50		315.85	314.93	313.19		313.34	314.67	
1959	315.58	316.47	316.65	317.72	318.29	318.16	316.55	314.80	313.84	313.34	314.82	315.59	315.98
1960	316.43	316.97	317.58	319.03	320.03	319.59	318.18	315.91	314.16	313.84	315.00	316.19	316.91
1961	316.89	317.70	318.54	319.48	320.58	319.77	318.58	316.79	314.99	315.31	316.10	317.01	317.65
1962	317.94	318.56	319.69	320.58	321.01	320.61	319.61	317.40	316.26	315.42	316.69	317.69	318.45
1963	318.74	319.08	319.86	321.39	322.24	321.47	319.74	317.77	316.21	315.99	317.06	318.36	318.99
1964	319.57				322.24	321.89	320.44	318.70	316.70	316.87	317.68	318.71	
1965	319.44	320.44	320.89	322.13	322.16	321.87	321.21	318.87	317.81	317.30	318.87	319.42	320.03
1966	320.62	321.59	322.39	323.70	324.07	323.75	322.41	320.37	318.64	318.10	319.79	321.03	321.37
1967	322.33	322.50	323.04	324.42	325.00	324.09	322.55	320.92	319.26	319.39	320.72	321.96	322.18
1968	322.57	323.15	323.89	325.03	325.57	325.36	324.14	322.11	320.33	320.25	321.33	322.90	323.05
1969	324.00	324.42	325.64	326.66	327.38	326.70	325.89	323.67	322.38	321.78	322.85	324.12	324.62
1970	325.06	325.98	326.93	328.14	328.07	327.66	326.35	324.69	323.10	323.07	324.01	325.13	325.68
1971	326.17	326.68	327.18	327.78	328.92	328.57	327.37	325.43	323.36	323.57	324.80	326.01	326.32
1972	326.77	327.63	327.75	329.72	330.07	329.09	328.05	326.32	324.84	325.20	326.50	327.55	327.46
1973	328.54	329.56	330.30	331.50	332.48	332.07	330.87	329.31	327.51	327.18	328.16	328.64	329.68
1974	329.35	330.71	331.48	332.65	333.08	332.25	331.18	329.40	327.44	327.37	328.46	329.58	330.25
1975	330.40	331.41	332.04	333.31	333.96	333.59	331.91	330.06	328.56	328.34	329.49	330.76	331.15
1976	331.74	332.56	333.50	334.58	334.87	334.34	333.05	330.94	329.30	328.94	330.31	331.68	332.15
1977	332.92	333.41	334.70	336.07	336.74	336.27	334.93	332.75	331.58	331.16	332.40	333.85	333.90
1978	334.97	335.39	336.64	337.76	338.01	337.89	336.54	334.68	332.76	332.54	333.92	334.95	335.50
1979	336.23	336.76	337.96	338.89	339.47	339.29	337.73	336.09	333.91	333.86	335.29	336.73	336.85
1980	338.01	338.36	340.08	340.77	341.46	341.17	339.56	337.60	335.88	336.02	337.10	338.21	338.69
1981	339.23	340.47	341.38	342.51	342.91	342.25	340.49	338.43	336.69	336.85	338.36	339.61	339.93
1982	340.75	341.61	342.70	343.57	344.13	343.35	342.06	339.82	337.97	337.86	339.26	340.49	341.13
1983	341.37	342.52	343.10	344.94	345.75	345.32	343.99	342.39	339.86	339.99	341.16	342.99	342.78
1984	343.70	344.50	345.29	347.08	347.43	346.79	345.40	343.28	341.07	341.35	342.98	344.22	344.42
1985	344.97	346.00	347.43	348.35	348.93	348.25	346.56	344.69	343.09	342.80	344.24	345.56	345.91
1986	346.29	346.96	347.86	349.55	350.21	349.54	347.94	345.91	344.86	344.17	345.66	346.90	347.15
1987	348.02	348.47	349.42	350.99	351.84	351.25	349.52	348.11	346.44	346.36	347.81	348.96	348.93
1988	350.43	351.72	352.22	353.59	354.22	353.79	352.39	350.44	348.72	348.88	350.07	351.34	351.48
1989	352.76	353.07	353.68	355.42	355.67	355.13	353.90	351.67	349.80	349.99	351.30	352.53	352.91
1990	353.66	354.70	355.39	356.20	357.16	356.22	354.82	352.91	350.96	351.18	352.83	354.21	354.19
1991	354.72	355.75	357.16	358.60	359.33	358.24	356.18	354.03	352.16	352.21	353.75	354.99	355.59
1992	355.98	356.72	357.81	359.15	359.66	359.25	357.03	355.00	353.01	353.31	354.16	355.40	356.37
1993	356.70	357.16	358.38	359.46	360.28	359.59	357.58	355.52	353.70	353.98	355.33	356.80	357.04
1994	358.36	358.91	359.97	361.27	361.68	360.94	359.55	357.49	355.84	355.99	357.58	359.04	358.89
1995	359.96	361.00	361.64	363.45	363.79	363.26	361.90	359.46	358.06	357.75	359.56	360.70	360.88
1996	362.05	363.25	364.03	364.72	365.41	364.97	363.65	361.49	359.46	359.60	360.76	362.33	362.64
1997	363.18	364.00	364.57	366.35	366.80	365.62	364.47	362.51	360.19	360.77	362.43	364.28	363.76
1998	365.32	366.15	367.31	368.61	369.29	368.87	367.64	365.77	363.90	364.23	365.46	366.97	366.63
1999	368.15	368.87	369.59	371.14	371.00	370.35	369.27	366.94	364.63	365.12	366.67	368.01	368.31
2000	369.14	369.46	370.52	371.66	371.82	371.70	370.12	368.12	366.62	366.73	368.29	369.53	369.48
2001	370.28	371.50	372.12	372.87	374.02	373.30	371.62	369.55	367.96	368.09	369.68	371.24	371.02

Atmospheric Concentration of Carbon Dioxide, 1958–2004

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
2002	372.43	373.09	373.52	374.86	375.55	375.40	374.02	371.49	370.71	370.24	372.08	373.78	373.10
2003	374.68	375.63	376.11	377.65	378.35	378.13	376.62	374.50	372.99	373.00	374.35	375.70	375.64
2004	376.79	377.37	378.41	380.52	380.63	379.57	377.79	375.86	374.06	374.24	375.86	377.48	377.38



## MEAN TEMPERATURES IN THE UNITED STATES, 1900–1992

Historical records of atmospheric temperatures have been analyzed to obtain mean temperatures in °C for 23 climatically distinct regions of the United States. The table below gives the average over these 23 regions, which cover completely the contiguous 48 states. Data for the individual regions and for other parts of the world may be found in the references.

The data are presented as temperature anomalies, i.e., as deviations (in °C) from the average temperature at each individual recording station over a 1961–1990 reference period. The trend in the temperature anomaly thus gives an indication of the long-term variation in average temperatures.

CY Mean: Calendar year mean (January–December)

Winter: December–February

Spring: March–May

Summer: June–August

Fall: September–November

### References

1. Karl, T. R., Easterling, D. R., Knight, R. W., and Hughes, P. Y., in *Trends '93: A Compendium of Data on Global Change*, p. 686, Boden, T. A., Kaiser, D. P., Sepanski, R. J., and Stoss, F. W., Eds., ORNL/CDIAC-65, Oak Ridge National Laboratory, Oak Ridge, TN, 1994.
2. Carbon Dioxide Information Analysis Center, WWW site <<http://cdiac.esd.ornl.gov/ftp/trends93>>.

Year	CY Mean	Winter	Spring	Summer	Fall
1900	0.46		0.21	0.27	0.85
1901	-0.21	0.07	-0.46	0.48	-0.28
1902	-0.14	-0.69	0.48	-0.58	0.12
1903	-0.77	-0.84	0.10	-0.83	-1.02
1904	-0.72	-1.86	-0.39	-0.92	-0.21
1905	-0.45	-1.86	0.67	-0.32	-0.25
1906	-0.04	0.23	-0.69	-0.42	-0.10
1907	-0.23	1.09	-0.61	-0.85	-0.39
1908	-0.11	0.73	0.36	-0.64	-0.59
1909	-0.36	0.82	-1.06	0.06	0.01
1910	-0.14	-2.08	0.95	-0.55	0.13
1911	0.02	0.52	0.20	-0.19	-0.62
1912	-0.88	-1.50	-0.75	-0.76	-0.51
1913	-0.23	-0.74	-0.65	-0.07	0.22
1914	-0.05	0.48	0.04	0.14	0.32
1915	-0.11	-0.37	-0.18	-1.16	0.31
1916	-0.77	-0.29	-0.36	-0.30	-1.23
1917	-1.34	-1.93	-1.75	-0.73	-1.04
1918	-0.14	-2.02	0.30	0.03	-0.09
1919	-0.16	0.69	0.00	0.12	-0.13
1920	-0.37	-0.83	-0.96	-0.67	0.02
1921	0.87	1.56	0.83	0.52	0.32
1922	0.01	-0.44	0.15	0.16	0.41
1923	-0.10	0.23	-1.02	-0.07	-0.09
1924	-1.01	0.13	-1.27	-0.64	-0.53
1925	0.20	-0.44	0.57	0.05	-0.41
1926	-0.01	0.97	-0.58	-0.27	0.02
1927	0.20	1.11	0.41	-0.83	0.83
1928	-0.08	-0.40	-0.28	-0.43	-0.08
1929	-0.68	-1.94	0.30	-0.39	-0.78
1930	-0.12	0.07	0.09	-0.07	-0.25
1931	0.81	1.16	-0.71	0.51	1.41
1932	-0.14	1.75	-0.58	0.26	-0.78
1933	0.35	-0.60	-0.08	0.45	0.54
1934	0.86	1.45	0.77	0.86	0.82
1935	0.12	0.84	0.12	0.31	-0.47
1936	-0.10	-2.23	0.48	1.00	-0.32
1937	-0.13	-0.65	-0.24	0.66	-0.03
1938	0.71	1.31	0.98	0.39	0.08
1939	0.38	0.36	0.34	0.18	0.15
1940	0.06	0.03	-0.10	0.18	0.12
1941	0.79	1.56	0.44	0.28	0.85

## Mean Temperatures in the United States, 1900-1992

<b>Year</b>	<b>CY Mean</b>	<b>Winter</b>	<b>Spring</b>	<b>Summer</b>	<b>Fall</b>
1942	0.01	0.35	0.22	0.08	0.06
1943	-0.17	0.20	-0.46	0.54	-0.79
1944	0.04	0.61	-0.38	-0.20	0.43
1945	-0.02	0.30	0.25	-0.47	0.08
1946	0.53	-0.26	1.21	-0.21	0.18
1947	0.10	0.47	-0.42	0.03	0.85
1948	-0.22	-0.67	-0.01	0.02	-0.15
1949	0.05	-0.77	0.39	0.33	0.23
1950	-0.37	0.39	-1.02	-0.86	0.13
1951	-0.45	0.05	-0.69	-0.30	-0.70
1952	0.03	0.68	-0.40	0.49	-1.22
1953	0.61	1.91	0.03	0.31	0.31
1954	0.57	1.47	-0.22	0.36	0.70
1955	-0.25	-0.33	0.12	0.19	-0.60
1956	-0.05	-0.16	-0.42	0.01	-0.37
1957	0.45	1.02	0.44	0.25	-0.13
1958	0.14	0.93	0.06	0.11	0.45
1959	0.12	-0.60	0.16	0.50	-0.52
1960	-0.27	0.43	-0.98	0.01	0.56
1961	-0.01	-0.02	-0.17	0.18	-0.29
1962	-0.04	-0.52	-0.09	-0.41	0.65
1963	-0.06	-1.35	0.61	0.12	1.38
1964	-0.27	-1.30	-0.24	-0.08	-0.40
1965	-0.03	-0.07	-0.56	-0.42	0.28
1966	-0.34	-0.31	-0.25	-0.07	-0.13
1967	-0.13	0.23	-0.05	-0.37	-0.32
1968	-0.28	-0.31	-0.16	-0.12	0.01
1969	-0.06	-0.36	-0.54	0.12	-0.16
1970	-0.12	-0.17	-0.44	0.32	-0.07
1971	-0.04	-0.08	-0.99	0.01	0.56
1972	-0.13	0.20	0.26	-0.19	0.05
1973	0.48	-0.23	0.47	0.22	0.90
1974	0.16	0.52	0.74	-0.32	-0.39
1975	-0.09	0.63	-0.79	0.03	-0.20
1976	-0.62	0.88	-0.09	-0.54	-1.72
1977	0.32	-1.95	1.07	0.60	0.68
1978	-0.37	-1.31	0.23	0.09	0.21
1979	-0.53	-2.92	0.09	-0.21	-0.07
1980	0.18	0.72	-0.25	0.43	-0.04
1981	0.64	0.90	0.80	0.57	0.36
1982	-0.08	-0.86	0.03	-0.11	0.06
1983	0.40	2.33	-0.36	0.58	0.94
1984	0.21	-0.78	-0.30	0.31	0.07
1985	-0.26	-0.78	1.24	-0.23	0.05
1986	0.93	0.22	1.22	0.45	0.49
1987	0.67	1.52	0.97	0.33	-0.17
1988	-0.07	-0.26	-0.06	0.57	0.04
1989	-0.30	-0.28	0.36	0.12	-0.27
1990	0.72	0.41	0.72	0.41	0.66
1991	0.77	0.32	1.36	0.56	-0.31
1992		2.48	0.82	-0.70	

## GLOBAL TEMPERATURE TREND, 1856–2004

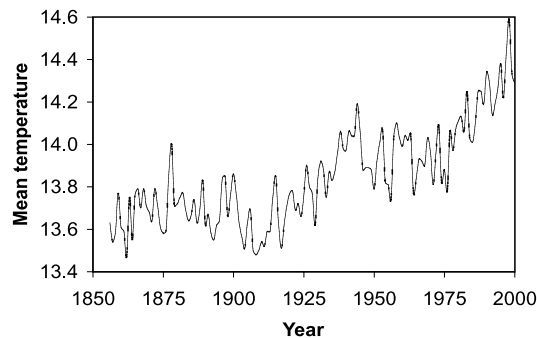
This table and graph summarize the trend in annual mean global surface temperature from 1856 to 2004. The values were calculated from mean temperature anomalies by assuming an absolute global mean of 14.00°C, which is the best estimate for the 1961–1990 period. The 95% confidence interval for the annual mean temperature values since 1951 is  $\pm 0.12^\circ\text{C}$ ; prior to 1900 this interval is  $\pm 0.18^\circ\text{C}$ .

### Reference

Jones, P. D., Parker, D. E., Osborn, T. J., and Briffa, K. R., Global and hemispheric temperature anomalies--land and marine instrumental records, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN; <[cdiac.esd.ornl.gov/trends/temp/jonescru/jones.html](http://cdiac.esd.ornl.gov/trends/temp/jonescru/jones.html)>.

Year	t/°C	Year	t/°C	Year	t/°C	Year	t/°C	Year	t/°C
1856	13.621	1887	13.657	1918	13.590	1949	13.903	1980	14.102
1857	13.538	1888	13.689	1919	13.708	1950	13.790	1981	14.133
1858	13.584	1889	13.800	1920	13.707	1951	13.907	1982	14.019
1859	13.775	1890	13.587	1921	13.783	1952	13.975	1983	14.226
1860	13.628	1891	13.647	1922	13.677	1953	14.045	1984	14.031
1861	13.596	1892	13.593	1923	13.701	1954	13.830	1985	14.014
1862	13.473	1893	13.551	1924	13.653	1955	13.811	1986	14.096
1863	13.727	1894	13.586	1925	13.754	1956	13.728	1987	14.253
1864	13.526	1895	13.638	1926	13.884	1957	13.994	1988	14.240
1865	13.733	1896	13.801	1927	13.782	1958	14.061	1989	14.163
1866	13.777	1897	13.814	1928	13.773	1959	14.014	1990	14.310
1867	13.709	1898	13.661	1929	13.639	1960	13.972	1991	14.251
1868	13.775	1899	13.750	1930	13.848	1961	14.015	1992	14.116
1869	13.695	1900	13.808	1931	13.901	1962	14.008	1993	14.179
1870	13.704	1901	13.744	1932	13.863	1963	14.039	1994	14.232
1871	13.649	1902	13.651	1933	13.761	1964	13.767	1995	14.373
1872	13.734	1903	13.555	1934	13.861	1965	13.834	1996	14.227
1873	13.673	1904	13.557	1935	13.828	1966	13.916	1997	14.411
1874	13.624	1905	13.629	1936	13.879	1967	13.907	1998	14.579
1875	13.576	1906	13.708	1937	13.976	1968	13.895	1999	14.340
1876	13.548	1907	13.495	1938	14.076	1969	14.040	2000	14.290
1877	13.789	1908	13.523	1939	13.962	1970	13.969	2001	14.422
1878	13.943	1909	13.553	1940	13.917	1971	13.813	2002	14.475
1879	13.713	1910	13.558	1941	14.028	1972	13.959	2003	14.475
1880	13.704	1911	13.535	1942	13.980	1973	14.093	2004	14.455
1881	13.754	1912	13.594	1943	14.001	1974	13.829		
1882	13.738	1913	13.607	1944	14.158	1975	13.877		
1883	13.682	1914	13.752	1945	14.039	1976	13.800		
1884	13.651	1915	13.841	1946	13.880	1977	14.057		
1885	13.650	1916	13.627	1947	13.895	1978	13.964		
1886	13.746	1917	13.505	1948	13.907	1979	14.067		

**Annual Mean Global Temperature in °C**



# ATMOSPHERIC ELECTRICITY

Hans Dolezalek, Hannes Tammet, John Latham, and Martin A. Uman

## I. SURVEY AND GLOBAL CIRCUIT

Hans Dolezalek

The science of atmospheric electricity originated in 1752 by an experimental proof of a related earlier hypothesis (that lightning is an electrical event). In spite of a large effort, in part by such eminent physicists as Coulomb, Lord Kelvin, and many others, an overall, proven theory able to generate models with sufficient resolution is not yet available. Generally accepted and encompassing text books are now more than 20 years old. The voluminous proceedings of the, so far, nine international atmospheric electricity conferences (1954 to 1992) give much valuable detail and demonstrate impressive progress, as do a number of less comprehensive textbooks published in the last 20 years, but a general theory as indicated above is not yet created. Only now, certain related measuring techniques and mathematical possibilities are emerging.

Applications to practical purposes do exist in the field of lightning research (including the electromagnetic radiation emanating from lightning) by the establishment of lightning-location networks and by the now developing possibility to detect electrified clouds which pose hazards to aircraft. Application of atmospheric electricity to other parts of meteorology seems to be promising but so far has seldom been instituted. Because some atmospheric electric signals propagate around the earth and because of the existence of a global circuit, applications for the monitoring of global change processes and conditions are now being proposed. Significant secular changes in the global circuit would indicate a change in the global climate; the availability of many old data (about a span of 100 years) could help detect a long-term trend.

The concept of the "global circuit" is based on the theory of the global spherical capacitor: both, the solid (and liquid) earth as one electrode, and the high atmospheric layers (about the ionosphere) as the other, are by orders of magnitude more electrically conductive than the atmosphere between them. According to the "classical picture of atmospheric electricity", this capacitor is continuously charged by the common action of all thunderstorms to a d.c. voltage difference of several hundred kilovolts, the earth being negative. The much smaller but still existing conductivity of the atmosphere allows a current flowing from the ionosphere to the ground, integrated for all sink areas of the whole earth, of the order of 1.5 kA. In this way, a global circuit is created with many generators and sink-areas both interspaced and distributed over the whole globe, all connected to two nodes: ionosphere and ground. Within the scope of the global circuit, for each location, the current density (order of several pA/m<sup>2</sup>) is determined by the voltage difference between ionosphere and ground (which is the same for all locations but varying in time) and the columnar resistance reaching from the ground up to the ionosphere (in the order of 10<sup>17</sup> Ωm<sup>2</sup>).

Natural processes, especially meteorological processes and some human activity, which produce or move electric charges ("space charges") or affect the ion distribution, constitute local generators and thereby "local circuits", horizontally and/or in parallel or antiparallel to the local part of the global circuit. In many cases, the local currents are much stronger than the global ones, making the measurement of the global current at a given location and/or during a period of time very difficult or, often, impossible. The strongest local circuits usually occur with certain weather conditions (precipitation, fog, high wind, blown-up dust or snow, heavy cloudiness) which make measurement of the global circuit impossible everywhere: but even in their absence local generators exist in varying magnitudes and of different characters. The separation

of the local and global shares in the measured values of current density is a central problem of the science of atmospheric electricity. Aerological measurements are of high value in this regard.

The above description is within the "classical picture" of atmospheric electricity, a group of hypotheses to explain the electrification of the atmosphere. It is probably fundamentally correct but certainly not complete; it has not yet been confirmed by systems of measurements resulting in no inner contradictions. In particular, extraterrestrial influences must be permitted; their general significance is still under debate.

Within this "classical picture" a kind of electric standard atmosphere may be constructed as shown in Table 1.

Values with a star, \*, are rough average values from measurement. A star in parentheses, (\*), points to a typical value from one or a few measurements. All other values have been calculated from starred values, under the assumption that at 2 km 50% and at 12 km 90% of the columnar resistance is reached. Voltage drop along one of the partial columns can be calculated by subtracting the value for the lower column from that of the upper one. Columnar resistances, conductances, and capacitances are valid for that particular part of the column which is indicated at the left. Capacitances are calculated with the formula for plate capacitors, and this fact must be considered also for the time constants for columns.

According to measurements,  $U$ , the potential difference between 0 m and 65 km may vary by a factor of approximately 2. The total columnar resistance,  $R_c$ , is estimated to vary up to a factor of 3, the variation being due to either reduction of conductivity in the exchange layer (about lowest 2 km of this table) or to the presence of high mountains; in both cases the variation is caused in the troposphere. Smaller variations in the stratosphere and mesosphere are being discussed because of aerosols there. The air-earth current density in fair weather varies by a factor of 3 to 6 accordingly. Conductivity near the ground varies by a factor of about 3 but only decreasing; increase of conductivity due to extraordinary radioactivity is a singular event. The field strength near the ground varies as a consequence of variations of air-earth current density and conductivity from about 1/3 to about 10 times of the value quoted in the table. Conductivity near the ground shows a diurnal and an annual variation which depends strongly on the locality: air-earth current density shows a diurnal and annual variation because the earth-ionosphere potential difference undergoes such variations, and also because the columnar resistance is supposed to have a diurnal and probably an annual variation.

Conductivities and air-earth current densities on high mountains are greater than at sea level by factors of up to 10. Conductivity decreases when atmospheric humidity increases. Values for space charges are not quoted because measurements are too few to allow calculation of average values. Values of parameters over the oceans are still rather uncertain.

Theoretically, in fair-weather conditions, Ohm's law must be fulfilled for the electric field, the conduction current density, and the electrical conductivity of the atmosphere. Deviations point to shortcomings in the applied measuring techniques. Data which are representative for a large area (in the extreme, "globally representative data", i.e. data on the global circuit), can on the ground be obtained only by stations on an open plane and only if local generators are either small or constant or are independently measured. Certain measurements with instrumented aircraft provide globally representative information valid for the period of the actual measurement.



**TABLE 1. Electrical Parameters of the Clear (Fair-Weather) Atmosphere, Pertinent to the Classical Picture of Atm. Electricity (Electric Standard Atmosphere)**

Part of atmosphere for which the values are calculated (elements are in free, cloudless atmosphere)	Currents, $I$ , in A; and current densities, $i$ , in A/m <sup>2</sup>	Potential differences, $U$ , in V; field strength $E$ in V/m; $U = 0$ at sea level	Resistances, $R$ , in $\Omega$ ; columnar resistances, $R_c$ , in $\Omega$ m <sup>2</sup> and resistivities, $\rho$ , in $\Omega$ m	Conductances, $G$ , in $\Omega^{-1}$ ; columnar conductances $G_c$ , in $\Omega^{-1}$ m <sup>2</sup> ; total conductivities, $\gamma$ , in $\Omega^{-1}$ m <sup>-1</sup>	Capacitances, $C$ , in F; columnar capacitances, $C_c$ , in F m <sup>-2</sup> and capacitivities, $\epsilon$ , in F m <sup>-1</sup>	Time constants $\tau$ , in seconds
Volume element at about sea level, 1 m <sup>3</sup>	$i = 3 \times 10^{-12}$	$E_0 = 1.2 \times 10^2$	$\rho_0 = 4 \times 10^{13}$	$\gamma_0 = 2.5 \times 10^{-14}$	$\epsilon_0 = 8.9 \times 10^{-12}$	$\tau_0 = 3.6 \times 10^2$
Lower column of 1 m <sup>2</sup> cross section from sea level to 2 km height	$i = 3 \times 10^{-12}$	At upper end: $U_1 = 1.8 \times 10^5$	$R_{c1} = 6 \times 10^{16}$	$G_{c1} = 1.7 \times 10^{-17}$	$C_{c1} = 4.4 \times 10^{-15}$	$\tau_{c1} = 2.6 \times 10^2$
Volume element at about 2 km height, 1 m <sup>3</sup>	$i = 3 \times 10^{-12}$	$E_2 = 6.6 \times 10^1$	$\rho_2 = 2.2 \times 10^{13(*)}$	$\gamma_2 = 4.5 \times 10^{-14}$	$\epsilon_2 = 8.9 \times 10^{-12}$	$\tau_2 = 2 \times 10^2$
Center column of 1 m <sup>2</sup> cross section from 2 to 12 km	$i = 3 \times 10^{-12}$	At upper end: $U_m = 3.15 \times 10^5$	$R_{cm} = 4.5 \times 10^{16}$	$G_{cm} = 5 \times 10^{-17}$	$C_{cm} = 8.8 \times 10^{-16}$	$\tau_{cm} = 1.8 \times 10^1$
Volume element at about 12 km height, 1 m <sup>3</sup>	$i = 3 \times 10^{-12}$	$E_{12} = 3.9 \times 10^0$	$\rho_{12} = 1.3 \times 10^{12(*)}$	$\gamma_{12} = 7.7 \times 10^{-13}$	$\epsilon_{12} = 8.9 \times 10^{-12}$	$\tau_{12} = 1.2 \times 10^1$
Upper column of 1 m <sup>2</sup> cross section from 12 to 65 km height	$i = 3 \times 10^{-12}$	At upper end: $U_u = 3.5 \times 10^5$	$R_{cu} = 1.5 \times 10^{16}$	$G_{cu} = 2.5 \times 10^{-17}$	$C_{cu} = 1.67 \times 10^{-16}$	$\tau_{cu} = 6.7 \times 10^0$
Whole column of 1 m <sup>2</sup> cross section from 0 to 65 km height	$i = 3 \times 10^{-12}$	At upper end: $U = 3.5 \times 10^5$	$R_c = 1.2 \times 10^{17}$	$G_c = 8.3 \times 10^{-18}$	$C_c = 1.36 \times 10^{-16}$	$\tau_c = 1.64 \times 10^1$
Total spherical capacitor area: $5 \times 10^{14}$ m <sup>2</sup>	$i = 1.5 \times 10^3$	$U = 3.5 \times 10^5$	$R = 2.4 \times 10^2$	$G = 4.2 \times 10^{-3}$	$C = 6.8 \times 10^{-2}$	$\tau = 1.64 \times 10^1$

Note: All currents and fields listed are part of the global circuit, i.e., circuits of local generators are not included. Values are subject to variations due to latitude and altitude of the point of observation above sea level, locality with respect to sources of disturbances, meteorological and climatological factors, and man-made changes. For more explanations, see text.

## II. AIR IONS

### Hannes Tamm

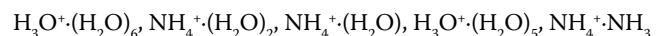
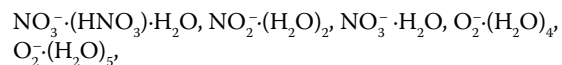
The term "air ions" signifies all airborne particles which are the carriers of the electrical current in the air and have drift velocities determined by the electric field.

The probability of electrical dissociation of molecules in the atmospheric air under thermodynamic equilibrium is near to zero. The average ionization at the ground level over the ocean is  $2 \cdot 10^6$  ion pairs  $m^{-3}s^{-1}$ . This ionization is produced mainly by cosmic rays. Over the continents the ionizing radiation from soil and from radioactive substances in the air each add about  $4 \cdot 10^6$   $m^{-3}s^{-1}$ . The total average ionization rate of  $10^7$   $m^{-3}s^{-1}$  is equivalent to 17  $\mu R/h$  which is a customary expression of the background level of the ionizing radiations. The ionization rate over the ground varies in space due to the radioactivity of soil, and in time depending on the exchange of air between the atmosphere and radon-containing soil. Radioactive pollution increases the ionization rate. A temporary increase of about 10 times was registered in Sweden after the Chernobyl accident in 1986. The emission of  $Kr^{85}$  from nuclear power plants can noticeably increase the global ionization rate in the next century. The ionization rate decreases with altitude near the ground and increases at higher altitudes up to 15 km, where it has a maximum of about  $5 \cdot 10^7$   $m^{-3}s^{-1}$ . Solar X-ray and extreme UV radiation cause a new increase at altitudes over 60 km.

Local sources of air ions are point discharges in strong electric fields, fluidization of charged drops from waves, etc.

The enhanced chemical activity of an ion results in a chain of ion-molecule reactions with the colliding neutrals, and, in the first microsecond of the life of an air ion, a charged molecular cluster called the *cluster ion* is formed. According to theoretical calcula-

tions in the air free from exotic trace gases the following cluster ions should be dominant:



A measurable parameter of air ions is the electrical mobility  $k$ , characterizing the drift velocity in the unit electric field. The mobility is inversely proportional to the density of air, and the results of measurements are as a rule reduced to normal conditions. According to mobility the air ions are called: fast or small or light ions with mobility  $k > 5 \cdot 10^{-5}$   $m^2V^{-1}s^{-1}$ , intermediate ions, and slow or large or heavy ions with mobility  $k > 10^{-6}$   $m^2V^{-1}s^{-1}$ . The boundary between intermediate and slow ions is conventional.

Cluster ions are fast ions. The masses of cluster ions may be measured with mass spectrometers, but the possible ion-molecule reactions during the passage of the air through nozzles to the vacuum chamber complicate the measurement. Mass and mobility of cluster ions are highly correlated. The experimental results<sup>5</sup> can be expressed by the empirical formula

$$m \approx \frac{850 u}{[0.3 + k / (10^{-4} m^2 V^{-1} s^{-1})]^3}$$

where  $u$  is the unified atomic mass unit.

The value of the transport cross-section of a cluster ion is needed to calculate its mobility according to the kinetic theory of Chapman and Enskog. The theoretical estimation of transport cross-sections is rough and cannot be used to identify the chemi-

cal structures of cluster ions. Mass spectrometry is the main technique of identification of cluster ions.<sup>2</sup>

Märk and Castleman<sup>4</sup> presented an overview of over 1000 publications on the experimental studies of cluster ions. Most of them present information about ions of millisecond age range. The low concentration makes it difficult to get detailed information about masses and mobilities of the natural atmospheric ions at ground level. The results of a 1-year continuous measurement<sup>6</sup> are as follows:

	+ ions	- ions	unit
Average mobility	1.36	1.56	$10^{-4}\text{m}^2\text{V}^{-1}\text{s}^{-1}$
The corresponding mass	190	130	u
The corresponding diameter	0.69	0.61	nm
The average concentration	400	360	$10^6\text{m}^{-3}$
The corresponding conductivity	8.7	9.0	fS

The distribution of tropospheric cluster ions according to the mobility and estimated mass is depicted in Figure 1.

The problems and results of direct mass spectrometry of natural cluster ions are analyzed by Eisele<sup>2</sup> for ground level and by Meyerott, Reagan and Joiner<sup>5</sup> for stratospheric measurements. Air ions in the high atmosphere are a subject of ionospheric physics.

During its lifetime (about 1 min), a cluster ion at ground level collides with nearly  $10^{12}$  molecules. Thus the cluster ions are able to concentrate trace gases of very low concentration if they have an extra high electron or proton affinity. For example, Eisele<sup>2</sup> demon-

$d$	3	10	30	100	300	1000	3000	nm
$P_0$	98	90	70	42	24	14	8	%
$P_{-1}+P_1$	2	10	30	48	41	25	15	%
$P_{-2}+P_2$	0	0	0	10	23	21	14	%
$P_{q>2}$	0	0	0	0	12	40	63	%
$k_1$	15000	1900	250	28	5.1	1.11	0.33	$10^{-9}\text{m}^2\text{V}^{-1}\text{s}^{-1}$

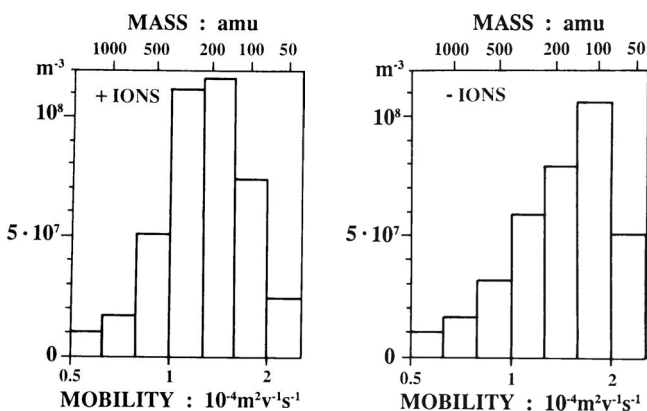


FIGURE 1. Average mobility and mass spectra of natural tropospheric cluster ions. Concentrations of the mobility fractions were measured in a rural site every 5 min over 1 year.<sup>6</sup> Ion mass is estimated according to the above empirical formula.

strated that a considerable fraction of positive atmospheric cluster ions in the unpolluted atmosphere at ground level probably consist of a molecule derived from pyridine. The concentration of these constituents is estimated to be about  $10^{-12}$ . Therefore, air-ion mass and mobility spectrometry is considered as a promising technique for trace analysis in the air. Mass and mobility spectrometry of millisecond-age air ions has been developed as a technique of chemical analysis known as “plasma chromatography”.<sup>1</sup> The sensitivity of the detection grows with the age of the cluster ions measured.

The mechanisms of annihilation of cluster ions are ion-ion recombination (on the average 3%) and sedimentation on aerosol particles (on the average 97% of cluster ions at ground level). The result of the combination of a cluster ion and neutral particle is a charged particle called an *aerosol ion*. In conditions of detailed thermodynamic equilibrium the probability that a spherical particle of diameter  $d$  carries  $q$  elementary charges is calculated from the Boltzmann distribution:

$$p_q(d) = (2\pi d/d_0)^{1/2} \exp(-q^2 d_0/2d)$$

where  $d_0 = 115$  nm (at  $18^\circ\text{C}$ ). The supposition about the detailed equilibrium is an approximation and the formula is not valid for particles less than  $d_0$ . On the basis of numerical calculations by Hoppel and Frick<sup>3</sup> the following charge probabilities can be derived:

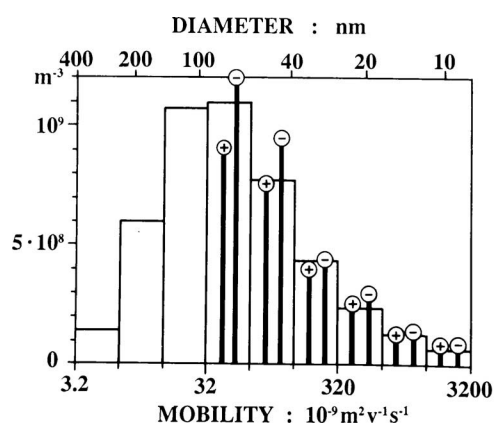


FIGURE 2. Mobility and size spectra of tropospheric aerosol ions.<sup>6</sup> The wide bars mark the fraction concentrations theoretically estimated on the basis of the standard size distribution of tropospheric aerosol. The pin bars with head + and - mark average values of positive and negative aerosol ion fraction concentrations measured in a rural site every 5 min during 4 months.

The last line of the table presents the mobility of a particle carrying one elementary charge. The distribution of the atmospheric aerosol ions over mobility is demonstrated in Figure 2.

Although the concentration of aerosol in continental air at ground level is an order of magnitude higher than the concentration of cluster ions, the mobilities of aerosol ions are so small that their percentage in air conductivity is less than 1%.

A specific class of aerosol ions are condensed aerosol ions produced as a result of the condensation of gaseous matter on the cluster ions. In aerosol physics the process is called ion-induced nucleation; it is considered as one among the processes of gas-to-particle conversion. The condensed aerosol ions have an inherent charge. Their sizes and mobilities are between the sizes and mobilities of cluster ions and of ordinary aerosol ions. Water and standard constituents of atmospheric air are not able to condense on the cluster ions in the real atmosphere. Thus the concentration of condensed aerosol ions depends on the trace constituents in the air and is very low in unpolluted air. Knowledge about condensed aerosol ions is poor because of measurement difficulties.

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## III. THUNDERSTORM ELECTRICITY

**John Latham**

The development of improved radar techniques and instruments for in-cloud electrical and physical measurements, coupled with a much clearer recognition by the research community that establishment of the mechanism or mechanisms responsible for electric field development in thunderclouds, culminating in lightning, is inextricably linked to the concomitant dynamical and microphysical evolution of the clouds, has led to significant progress over the past decade.

Field studies indicate that in most thunderclouds the electrical development is associated with the process of glaciation, which can occur in a variety of incompletely understood ways. In the absence of ice, field growth is slow, individual hydrometeor charges are low, and lightning is produced only rarely. Precipitation — in the solid form, as graupel — also appears to be a necessary ingredient for significant electrification, as does significant convective activity and mixing between the clouds and their environments, via entrainment.

Increasingly, the view is being accepted that charge transfer leading to field-growth is largely a consequence of rebounding collisions between graupel pellets and smaller vapor-grown ice crystals, followed by the separation under gravity of these two types

of hydrometeor. These collisions occur predominantly within the temperature range  $-15$  to  $-30^{\circ}\text{C}$ , and for significant charge transfer need to occur in the presence of supercooled cloud droplets.

The field evidence is inconsistent with an inductive mechanism, and extensive laboratory studies indicate that the principal charging mechanism is non-inductive and associated — in ways yet to be identified — with differences in surface characteristics of the interacting hydrometeors.

Laboratory studies indicate that the two most favored sites for corona emission leading to the lightning discharge are the tips of ephemeral liquid filaments, produced during the glancing collisions of supercooled raindrops, and protuberances on large ice crystals or graupel pellets. The relative importance of these alternatives will depend on the hydrometeor characteristics and the temperature in the regions of strongest fields; these features are themselves dependent on air-mass characteristics and climatological considerations.

A recently identified but unresolved question is why, in continental Northern Hemisphere thunderclouds at least, the sign of the charge brought to ground by lightning is predominantly negative in summer but more evenly balanced in winter.

## IV. LIGHTNING

**Martin A. Uman**

From both ground-based weather-station data and satellite measurements, it has been estimated that there are about 100 lightning discharges, both cloud and ground flashes, over the whole earth each second; representing an average global lightning flash density of about  $6\text{ km}^{-2}\text{yr}^{-1}$ . Most of this lightning occurs over the earth's land masses. For example, in central Florida, where thunderstorms occur about 90 days/yr, the flash density for discharges to earth is about  $15\text{ km}^{-2}\text{yr}^{-1}$ . Some tropical areas of the earth have thunderstorms up to 300 days/yr.

Lightning can be defined as a transient, high-current electric discharge whose path length is measured in kilometers and whose most common source is the electric charge separated in the ordinary thunderstorm or cumulonimbus cloud. Well over half of all lightning discharges occur totally within individual thunderstorm clouds and are referred to as intracloud discharges. Cloud-to-ground lightning, however, has been studied more extensively than any other lightning form because of its visibility and its more practical interest. Cloud-to-cloud and cloud-to-air discharges are less common than intracloud or cloud-to-ground lightning.

Lightning between the cloud and earth can be categorized in terms of the direction of motion, upward or downward, and the sign of the charge, positive or negative, of the developing discharge (called a *leader*) which initiates the overall event. Over 90% of the worldwide cloud-to-ground discharges is initiated in the thundercloud by downward-moving negatively charged leaders and subsequently results in the lowering of negative charge to earth. Cloud-to-ground lightning can also be initiated by downward-moving positive leaders, less than 10% of the worldwide cloud-to-ground lightning being of this type although the exact percentage is a function of season and latitude. Lightning between cloud and ground can also be initiated by leaders which develop upward from the earth. These upward-initiated discharges are relatively rare, may be of either polarity, and generally occur from mountaintops and tall man-made structures.

We discuss next the most common type of cloud-to-ground lightning. A negative cloud-to-ground discharge or *flash* has an overall duration of some tenths of a second and is made up of vari-

ous components, among which are typically three or four high-current pulses called *strokes*. Each stroke lasts about a millisecond, the separation time between strokes being typically several tens of milliseconds. Such lightning often appears to “flicker” because the human eye can just resolve the individual light pulse associated with each stroke. A drawing of the components of a negative cloud-to-ground flash is found in Figure 3. Some values for salient parameters are found in Table 1. The negatively charged *stepped leader* initiates the first stroke in a flash by propagating from cloud to ground through virgin air in a series of discrete steps. Photographically observed leader steps in clear air are typically 1  $\mu$ s in duration and tens of meters in length, with a pause time between steps of about 50  $\mu$ s. A fully developed stepped leader lowers up to 10 or more coulombs of negative cloud charge toward ground in tens of milliseconds with an average downward speed of about  $2 \times 10^5$  m/s. The average leader current is in the 100 to 1000 A range. The steps have pulse currents of at least 1 kA. Associated with these currents are electric- and magnetic-field pulses with widths of about 1  $\mu$ s or less and risetimes of about 0.1  $\mu$ s or less. The stepped leader, during its trip toward ground, branches in a downward direction, resulting in the characteristic downward-branched geometrical structure commonly observed. The electric potential of the bottom of the negatively charged leader channel with respect to ground has a magnitude in excess of  $10^7$  V. As the leader tip nears ground, the electric field at sharp objects on the ground or at irregularities of the ground itself exceeds the breakdown value of air, and one or more upward-moving discharges (often called upward leaders) are initiated from those points, thus beginning the *attachment process*. An understanding of the physics of the attachment process is central to an understanding of the operation of lightning protection of ground-based objects and the effects of lightning on humans and animals, since it is the attachment process that determines where the lightning connects to objects on the ground and the value of the early currents which flow. When one of the upward-moving discharges from the ground (or from a lightning rod or an individual) contacts the tip of the downward-moving stepped leader, typically some tens of meters above the ground, the leader tip is effectively connected to ground potential. The negatively charged leader channel is then discharged to earth when a ground potential wave, referred to as the first *return stroke*, propagates continuously up the leader path. The upward speed of a return stroke near the ground is typically near one third the speed of light, and the speed decreases with height. The first return stroke produces a peak current near ground of typically 30 kA, with a time from zero to peak of a few microseconds. Currents measured at the ground fall to half of the peak value in about 50  $\mu$ s, and currents of the order of hundreds of amperes may flow for times of a few milliseconds up to several hundred milliseconds. The longer-lasting currents are known as *continuing currents*. The rapid release of return stroke energy heats the leader channel to a temperature near 30,000 K and creates a high-pressure channel which expands and generates the shock waves that eventually become thunder, as further discussed later. The return stroke effectively lowers to ground the charge originally deposited onto the stepped-leader channel and additionally initiates the lowering of other charges which may be available to the top of its channel. First return-stroke electric fields exhibit a microsecond scale rise to peak with a typical peak value of 5 V/m, normalized to a distance of 100 km by an inverse distance relationship. Roughly half of the field rise to peak, the so-called “fast transition”, takes place in tenths of a microsecond, an observation that can only be made if the field propagation is over a highly conducting surface such as salt water.

After the first return-stroke current has ceased to flow, the flash, including charge motion in the cloud, may end. The lightning is then called a single-stroke flash. On the other hand, if additional charge is made available to the top of the channel, a continuous or *dart leader* may propagate down the residual first-stroke channel at a typical speed of about  $1 \times 10^7$  m/s. The dart leader lowers a charge of the order of 1 C by virtue of a current of about 1 kA. The dart leader then initiates the second (or any subsequent) return stroke. Subsequent return-stroke currents generally have faster zero-to-peak rise times than do first-stroke currents, but similar maximum rates of change, about 100 kA/ $\mu$ s. Some leaders begin as dart leaders, but toward the end of their trip toward ground become stepped leaders. These leaders are known as *dart-stepped leaders* and may have different ground termination points (and separate upward leaders) from the first stroke. Most often the dart-stepped leaders are associated with the second stroke of the flash. Nearly half of all flashes exhibit more than one termination point on ground with the distance between separate terminations being up to several kilometers. Subsequent return-stroke radiated electric and magnetic fields are similar to, but usually a factor of two or so smaller, than first return-stroke fields. About one third of all multiple-stroke flashes has at least one subsequent stroke which is larger than the first stroke.

Cloud-to-ground flashes that lower positive charge, though not common, are of considerable practical interest because their peak currents and total charge transfer can be much larger than for the more common negative ground flash. The largest recorded peak currents, those in the 200- to 300-kA range, are due to the return strokes of positive lightning. Such positive flashes to ground are initiated by downward-moving leaders which do not exhibit the distinct steps of their negative counterparts. Rather, they show a luminosity which is more or less continuous but modulated in intensity. Positive flashes are generally composed of a single stroke followed by a period of continuing current. Positive flashes are probably initiated from the upper positive charge in the thundercloud charge dipole when that cloud charge is horizontally separated from the negative charge beneath it, the source of the usual negative cloud-to-ground lightning. Positive flashes are relatively common in winter thunderstorms (snow storms), which produce few flashes overall, and are relatively uncommon in summer thunderstorms. The fraction of positive lightning in summer thunderstorms apparently increases with increasing latitude and with increasing height of the ground above sea level.

Distant lightning return stroke fields are often referred to as sferics (called “atmospherics” in the older literature). The peak in the sferics frequency spectrum is near 5 kHz due to the bipolar or ringing nature of the distant return-stroke electromagnetic signal and to the effects of propagation.

Thunder, the acoustic radiation associated with lightning, is sometimes divided into the categories “audible”, sounds that one can hear, and “infrasonic”, below a few tens of hertz, a frequency range that is inaudible. This division is made because it is thought that the mechanisms that produce audible and infrasonic thunder are different. Audible thunder is thought to be due to the expansion of a rapidly heated return stroke channel, as noted earlier, whereas infrasonic thunder is thought to be associated with the conversion to sound of the energy stored in the electrostatic field of the thundercloud when lightning rapidly reduces that cloud field.

The technology of artificially initiating lightning by firing upward small rocket trailing grounded wire of a few hundred meters length has been well-developed during the past decade. Such “triggered” flashes are similar to natural upward-initiated discharges from tall structure. They often contain subsequent strokes which,

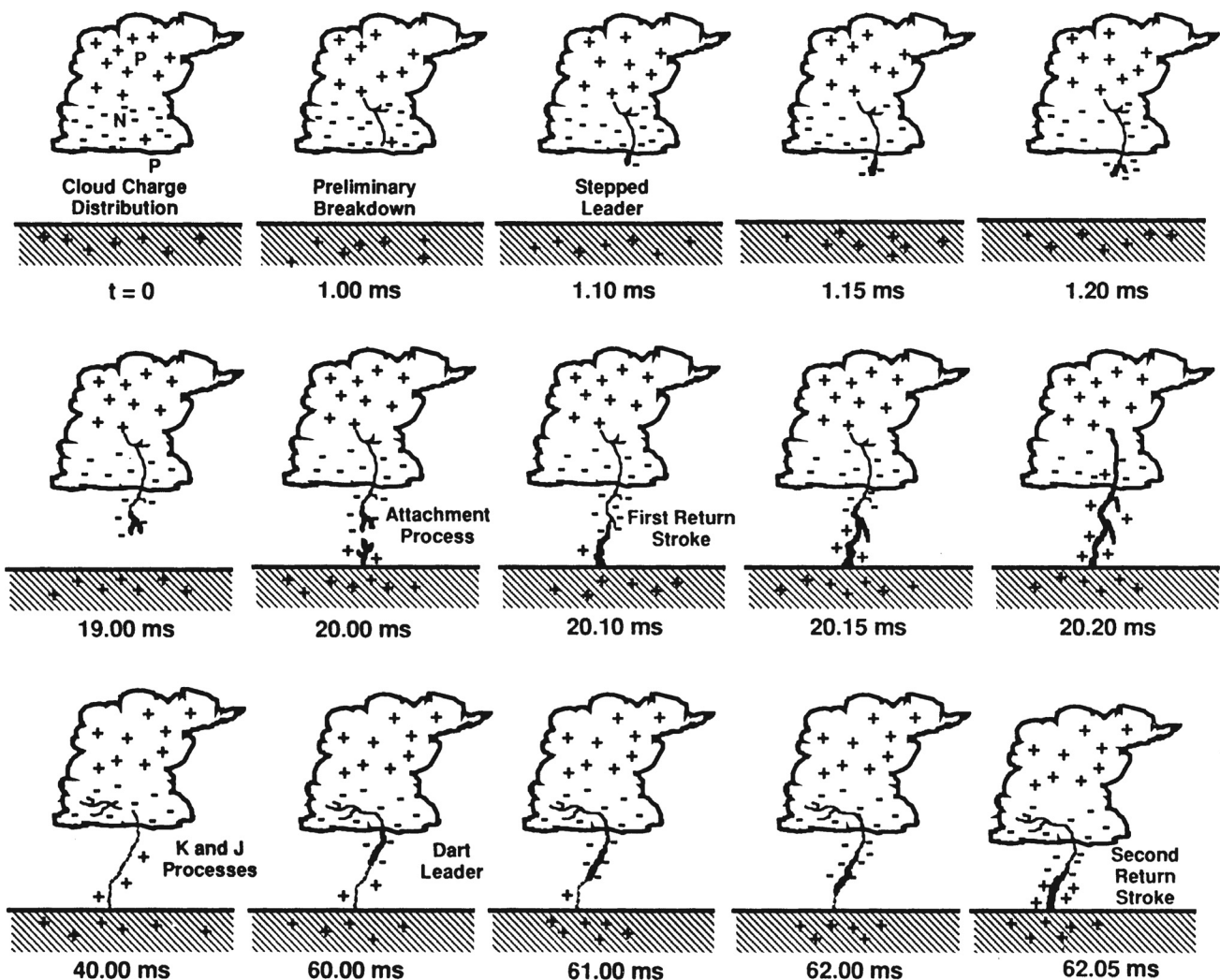


FIGURE 3. Sequence of steps in cloud-to-ground lightning.

when they occur, are similar to the subsequent strokes in natural lightning. These triggered subsequent strokes have been the subject of considerable recent research.

Also in the past 10 years or so sophisticated lightning locating equipment has been installed throughout the world. For example, all ground flashes in the U.S. are now centrally monitored for research, for better overall weather prediction, and for hazard warning for aviation, electric utilities and other lightning-sensitive facilities.

Information on lightning physics can be found in M. A. Uman, *The Lightning Discharge*, Academic Press, San Diego, 1987; on lightning death and injury in *Medical Aspects of Lightning Injury*, C. Andrews, M. A. Cooper, M. Darveniza, and D. Mackerras, Eds.,

CRC Press, 1992. Ground flash location information for the U.S., in real time or archived, is available from Geomet Data Service of Tucson, AZ, which is also a source of the names of providers of those data in other countries.

Table 2 has data for cloud-to-ground lightning discharges bringing negative charge to earth. The values listed are intended to convey a rough feeling for the various physical parameters of lightning. No great accuracy is claimed since the results of different investigators are often not in good agreement. These values may, in fact, depend on the particular environment in which the lightning discharge is generated. The choice of some of the entries in the table is arbitrary.

TABLE 2. Data for Cloud-to-Ground Lightning Discharges

	Minimum <sup>a</sup>	Representative values	Maximum <sup>a</sup>
Stepped leader			
Length of step, m	3	50	200
Time interval between steps, $\mu\text{s}$	30	50	125
Average speed of propagation of stepped leader, m/s <sup>b</sup>	$1.0 \times 10^5$	$2.0 \times 10^5$	$3.0 \times 10^6$
Charged deposited on stepped-leader channel, coulombs	3	5	20
Dart leader			
Speed of propagation, m/s <sup>b</sup>	$1.0 \times 10^6$	$1.0 \times 10^7$	$2.4 \times 10^7$
Charged deposited on dart-leader channel, coulombs	0.2	1	6
Return stroke <sup>c</sup>			
Speed of propagation, m/s <sup>b</sup>	$2.0 \times 10^7$	$1.0 \times 10^8$	$2.0 \times 10^8$
Maximum current rate of increase, kA/ $\mu\text{s}$	<1	100	400
Time to peak current, $\mu\text{s}$	<1	2	30
Peak current, kA	2	30	200
Time to half of peak current, $\mu\text{s}$	10	50	250
Charge transferred excluding continuing current, coulombs	0.02	3	20
Channel length, km	2	5	15
Lightning flash			
Number of strokes per flash	1	4	26
Time interval between strokes in absence of continuing current, ms	3	60	100
Time duration of flash, s	$10^{-2}$	0.5	2
Charge transferred including continuing current, coulombs	3	30	200

<sup>a</sup> The words maximum and minimum are used in the sense that most measured values fall between these limits.

<sup>b</sup> Speeds of propagation are generally determined from photographic data and are "two-dimensional". Since many lightning flashes are not vertical, values stated are probably slight underestimates of actual values.

<sup>c</sup> First return strokes have longer times to current peak and generally larger charge transfer than do subsequent return strokes.

Adapted from Uman, M.A., *Lightning*, Dover Paperbook, New York, 1986, and Uman, M.A., *The Lightning Discharge*, Academic Press, San Diego, 1987.

## SPEED OF SOUND IN VARIOUS MEDIA

The speed of sound in various solids, liquids, and gases is given in these tables. While only a single parameter  $v$  is needed for liquids and gases, sound propagation in isotropic solids is characterized by three velocity parameters. For a solid of infinite extent (or of finite extent if all dimensions are much larger than a wavelength), there are two relevant quantities,

$v_l$ : velocity of longitudinal waves  
 $v_s$ : velocity of shear waves.

For a cylindrical rod with diameter much smaller than a wavelength,

$v_{ext}$ : velocity of extensional waves along the rod. (Torsional waves in the rod are propagated at the same speed as shear waves in an infinite solid.)

Table 1 lists values for a variety of solid materials. Table 2 covers gases liquids and gases; values for cryogenic liquids are given at the normal boiling point. Table 3 gives the speed of sound in pure

water and in seawater of salinity  $S = 3.5\%$  as a function of temperature. All values are in meters per second and are given for normal atmospheric pressure.

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**TABLE 1. Speed of Sound in Solids at Room Temperature**

Name	$v_l/m\ s^{-1}$	$v_s/m\ s^{-1}$	$v_{ext}/m\ s^{-1}$	Name	$v_l/m\ s^{-1}$	$v_s/m\ s^{-1}$	$v_{ext}/m\ s^{-1}$
<i>Metals</i>							
Aluminum, rolled	6420	3040	5000	Steel, K9	5940	3250	5250
Beryllium	12890	8880	12870	Tin, rolled	3320	1670	2730
Brass (70 Cu, 30 Zn)	4700	2110	3480	Titanium	6070	3125	5090
Constantan	5177	2625	4270	Tungsten, annealed	5220	2890	4620
Copper, annealed	4760	2325	3810	Tungsten, drawn	5410	2640	4320
Copper, rolled	5010	2270	3750	Zinc, rolled	4210	2440	3850
Duralumin 17S	6320	3130	5150	<i>Other materials</i>			
Gold, hard-drawn	3240	1200	2030	Fused silica	5968	3764	5760
Iron, cast	4994	2809	4480	Glass, heavy silicate flint	3980	2380	3720
Iron, electrolytic	5950	3240	5120	Glass, light borate crown	5100	2840	4540
Iron, Armco	5960	3240	5200	Glass, pyrex	5640	3280	5170
Lead, annealed	2160	700	1190	Lucite	2680	1100	1840
Lead, rolled	1960	690	1210	Nylon 6-6	2620	1070	1800
Magnesium, annealed	5770	3050	4940	Polyethylene	1950	540	920
Molybdenum	6250	3350	5400	Polystyrene	2350	1120	1840
Monel metal	5350	2720	4400	Rubber, butyl	1830		
Nickel	6040	3000	4900	Rubber, gum	1550		
Platinum	3260	1730	2800	Rubber, neoprene	1600		
Silver	3650	1610	2680	Tungsten carbide	6655	3980	6220
Steel (1% C)	5940	3220	5180				
Steel, 347 Stainless	5790	3100	5000				

TABLE 2. Speed of Sound in Liquids and Gases

Name	$t/^\circ\text{C}$	$\nu/\text{m s}^{-1}$	Name	$t/^\circ\text{C}$	$\nu/\text{m s}^{-1}$
<i>Liquids</i>			1-Pentadecene	20	1351
Acetone	20	1203	Pentane	20	1008
Argon	-185.9	813	Propane	-42.1	1158
Benzene	25	1310	1-Propanol	20	1223
Bromobenzene	20	1169	Tetrachloromethane	25	930
Butane	-0.5	1034	Trichloromethane	25	987
1-Butanol	20	1258	1-Undecene	20	1275
Carbon disulphide	25	1140	Water	25	1497
Chlorobenzene	20	1311	Water (sea, $S = 3.5\%$ )	25	1535
Cyclohexane	19	1280	<i>Gases at 1 atm</i>		
1-Decene	20	1250	Air, dry	25	346
Diethyl ether	25	976	Ammonia	0	415
Ethane	-88.6	1326	Argon	27	323
Ethanol	20	1162	Carbon monoxide	0	338
Ethylene	-103.8	1309	Carbon dioxide	0	259
Ethylene glycol	25	1658	Chlorine	0	206
Fluorobenzene	20	1183	Deuterium	0	890
Glycerol	25	1904	Ethane	27	312
Helium	-268.9	180	Ethylene	27	331
Heptane	20	1162	Helium	0	965
1-Heptene	20	1128	Hydrogen	27	1310
Hexane	20	1083	Hydrogen bromide	0	200
Hydrogen	-252.9	1101	Hydrogen chloride	0	296
Iodobenzene	20	1114	Hydrogen iodide	0	157
Mercury	25	1450	Hydrogen sulfide	0	289
Methane	-161.5	1337	Methane	27	450
Methanol	20	1121	Neon	0	435
Nitrobenzene	25	1463	Nitric oxide	10	325
Nitrogen	-195.8	939	Nitrogen	27	353
1-Nonene	20	1218	Nitrous oxide	0	263
Octane	20	1197	Oxygen	27	330
1-Octene	20	1184	Sulfur dioxide	0	213
Oxygen	-183.0	906	Water (steam)	100	473

TABLE 3. Speed of Sound in Water and Seawater ( $S = 3.5\%$ ) at Different Temperatures

$t/^\circ\text{C}$	$\nu/\text{m s}^{-1}$	
	Water	Seawater
0	1401.0	1449.4
10	1447.8	1490.4
20	1483.2	1522.2
25	1497.4	1535.1
30	1509.5	1546.2
40	1528.4	
50	1541.4	
60	1549.5	
70	1553.2	
80	1552.8	



# ATTENUATION AND SPEED OF SOUND IN AIR AS A FUNCTION OF HUMIDITY AND FREQUENCY

This table gives the attenuation and speed of sound as a function of frequency at various values of relative humidity. All values refer to still air at 20 °C.

## References

1. Tables of Absorption and Velocity of Sound in Still Air at 68 °F (20 °C), AD-738576, National Technical Information Service, Springfield, VA.
2. Evans, L. B., Bass, H. E., and Sutherland, L. C., *J. Acoust. Soc. Am.*, 51, 1565, 1972.

Frequency (Hz)	Attenuation (dB/km)	Speed (m/s)	Frequency (Hz)	Attenuation (dB/km)	Speed (m/s)
<i>Relative humidity 0%</i>			<i>Relative humidity 60%</i>		
20	0.51	343.477	20	0.02	344.182
40	1.07	343.514	40	0.06	344.183
50	1.26	343.525	50	0.09	344.183
63	1.43	343.536	63	0.15	344.184
100	1.67	343.550	100	0.34	344.185
200	1.84	343.559	200	0.99	344.190
400	1.96	343.561	400	1.94	344.197
630	2.11	343.562	630	2.57	344.200
800	2.27	343.562	800	2.94	344.201
1250	2.82	343.562	1250	4.01	344.202
2000	4.14	343.562	2000	6.55	344.203
4000	8.84	343.564	4000	18.73	344.204
6300	14.89	343.565	6300	42.51	344.204
10000	26.28	343.566	10000	101.84	344.206
12500	35.81	343.566	12500	155.67	344.208
16000	52.15	343.567	16000	247.78	344.211
20000	75.37	343.567	20000	373.78	344.215
40000	267.01	343.567	40000	1195.37	344.238
63000	644.66	343.567	63000	2220.64	344.262
80000	1032.14	343.567	80000	2951.71	344.274
<i>Relative humidity 30%</i>			<i>Relative humidity 100%</i>		
20	0.03	343.807	20	0.01	344.685
40	0.11	343.808	40	0.04	344.685
50	0.17	343.810	50	0.06	344.685
63	0.25	343.810	63	0.09	344.685
100	0.50	343.814	100	0.22	344.686
200	1.01	343.821	200	0.77	344.689
400	1.59	343.826	400	2.02	344.695
630	2.24	343.827	630	3.05	344.699
800	2.85	343.828	800	3.57	344.701
1250	5.09	343.828	1250	4.59	344.704
2000	10.93	343.829	2000	6.29	344.705
4000	38.89	343.831	4000	13.58	344.706
6300	90.61	343.836	6300	27.72	344.706
10000	204.98	343.846	10000	63.49	344.706
12500	294.08	343.854	12500	96.63	344.707
16000	422.51	343.865	16000	154.90	344.708
20000	563.66	343.877	20000	237.93	344.709
40000	1110.97	343.911	40000	884.28	344.718
63000	1639.47	343.924	63000	1973.62	344.731
80000	2083.08	343.929	80000	2913.01	344.742

## SPEED OF SOUND IN DRY AIR

Eric W. Lemmon

These values were calculated from the equation of state for dry air (average molecular weight 28.96) treated as a real gas. Values refer to standard atmospheric pressure. The speed of sound varies only slightly with pressure; at two atmospheres and  $-100\text{ }^{\circ}\text{C}$  the value decreases by 0.16%, while at two atmospheres and  $80\text{ }^{\circ}\text{C}$  the speed increases by 0.05%. For additional values, see the table in Section 6 labeled "Thermophysical Properties of Air."

### Reference

Lemmon, E.W., Jacobsen, R.T, Penoncello, S.G., and Friend, D.G., Thermodynamic Properties of Air and Mixtures of Nitrogen, Argon, and Oxygen from 60 to 2000 K at Pressures to 2000 MPa, *J. Phys. Chem. Ref. Data* 29, 331, 2000.

$t/^{\circ}\text{C}$	$v_s/\text{m s}^{-1}$	$t/^{\circ}\text{C}$	$v_s/\text{m s}^{-1}$	$t/^{\circ}\text{C}$	$v_s/\text{m s}^{-1}$
-100	263.5	-30	312.7	40	354.9
-95	267.3	-25	315.9	45	357.7
-90	271.1	-20	319.1	50	360.4
-85	274.8	-15	322.2	55	363.2
-80	278.5	-10	325.4	60	365.9
-75	282.1	-5	328.4	65	368.7
-70	285.7	0	331.5	70	371.3
-65	289.2	5	334.5	75	374.0
-60	292.7	10	337.5	80	376.7
-55	296.1	15	340.5	85	379.3
-50	299.5	20	343.4	90	381.9
-45	302.9	25	346.3	95	384.5
-40	306.2	30	349.2	100	387.0
-35	309.5	35	352.0		

# MUSICAL SCALES

## Equal Tempered Chromatic Scale

A<sub>4</sub> = 440 Hz

### International Concert Pitch

Note	Frequency	Note	Frequency	Note	Frequency	Note	Frequency
C <sub>0</sub>	16.35	C <sub>2</sub>	65.41	C <sub>4</sub>	261.63	C <sub>6</sub>	1046.50
C# <sub>0</sub>	17.32	C# <sub>2</sub>	69.30	C# <sub>4</sub>	277.18	C# <sub>6</sub>	1108.73
D <sub>0</sub>	18.35	D <sub>2</sub>	73.42	D <sub>4</sub>	293.66	D <sub>6</sub>	1174.66
D# <sub>0</sub>	19.45	D# <sub>2</sub>	77.78	D# <sub>4</sub>	311.13	D# <sub>6</sub>	1244.51
E <sub>0</sub>	20.60	E <sub>2</sub>	82.41	E <sub>4</sub>	329.63	E <sub>6</sub>	1318.51
F <sub>0</sub>	21.83	F <sub>2</sub>	87.31	F <sub>4</sub>	349.23	F <sub>6</sub>	1396.91
F# <sub>0</sub>	23.12	F# <sub>2</sub>	92.50	F# <sub>4</sub>	369.99	F# <sub>6</sub>	1479.98
G <sub>0</sub>	24.50	G <sub>2</sub>	98.00	G <sub>4</sub>	392.00	G <sub>6</sub>	1567.98
G# <sub>0</sub>	25.96	G# <sub>2</sub>	103.83	G# <sub>4</sub>	415.30	G# <sub>6</sub>	1661.22
A <sub>0</sub>	27.50	A <sub>2</sub>	110.00	A <sub>4</sub>	440.00	A <sub>6</sub>	1760.00
A# <sub>0</sub>	29.14	A# <sub>2</sub>	116.54	A# <sub>4</sub>	466.16	A# <sub>6</sub>	1864.66
B <sub>0</sub>	30.87	B <sub>2</sub>	123.47	B <sub>4</sub>	493.88	B <sub>6</sub>	1975.53
C <sub>1</sub>	32.70	C <sub>3</sub>	130.81	C <sub>5</sub>	523.25	C <sub>7</sub>	2093.00
C# <sub>1</sub>	34.65	C# <sub>3</sub>	138.59	C# <sub>5</sub>	554.37	C# <sub>7</sub>	2217.46
D <sub>1</sub>	36.71	D <sub>3</sub>	146.83	D <sub>5</sub>	587.33	D <sub>7</sub>	2349.32
D# <sub>1</sub>	38.89	D# <sub>3</sub>	155.56	D# <sub>5</sub>	622.25	D# <sub>7</sub>	2489.02
E <sub>1</sub>	41.20	E <sub>3</sub>	164.81	E <sub>5</sub>	659.26	E <sub>7</sub>	2637.02
F <sub>1</sub>	43.65	F <sub>3</sub>	174.61	F <sub>5</sub>	698.46	F <sub>7</sub>	2793.83
F# <sub>1</sub>	46.25	F# <sub>3</sub>	185.00	F# <sub>5</sub>	739.99	F# <sub>7</sub>	2959.96
G <sub>1</sub>	49.00	G <sub>3</sub>	196.00	G <sub>5</sub>	783.99	G <sub>7</sub>	3135.96
G# <sub>1</sub>	51.91	G# <sub>3</sub>	207.65	G# <sub>5</sub>	830.61	G# <sub>7</sub>	3322.44
A <sub>1</sub>	55.00	A <sub>3</sub>	220.00	A <sub>5</sub>	880.00	A <sub>7</sub>	3520.00
A# <sub>1</sub>	58.27	A# <sub>3</sub>	233.08	A# <sub>5</sub>	932.33	A# <sub>7</sub>	3729.31
B <sub>1</sub>	61.74	B <sub>3</sub>	246.94	B <sub>5</sub>	987.77	B <sub>7</sub>	3951.07
						C <sub>8</sub>	4186.01

### Scientific or Just Scale

C<sub>4</sub> = 256 Hz

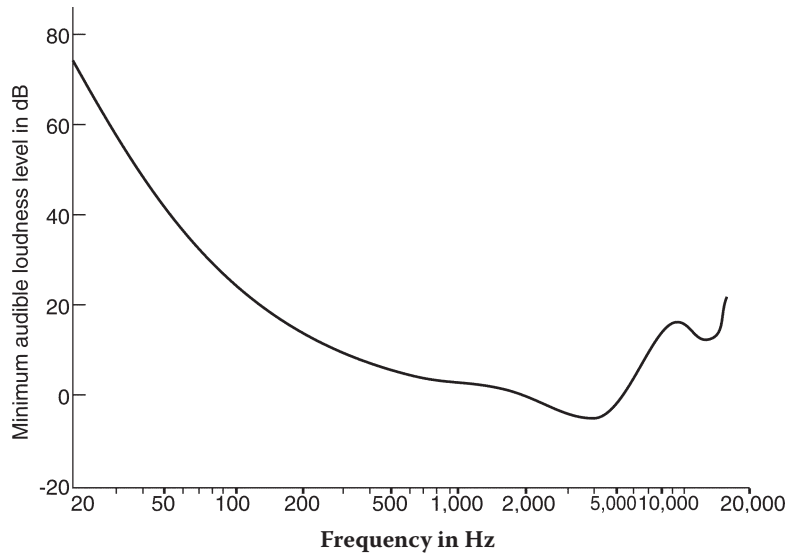
Note	Frequency	Note	Frequency	Note	Frequency	Note	Frequency
C <sub>0</sub>	16	C <sub>2</sub>	64	C <sub>4</sub>	256	C <sub>6</sub>	1024
D <sub>0</sub>	18	D <sub>2</sub>	72	D <sub>4</sub>	288	D <sub>6</sub>	1152
E <sub>0</sub>	20	E <sub>2</sub>	80	E <sub>4</sub>	320	E <sub>6</sub>	1280
F <sub>0</sub>	21.33	F <sub>2</sub>	85.33	F <sub>4</sub>	341.33	F <sub>6</sub>	1365.33
G <sub>0</sub>	24	G <sub>2</sub>	96	G <sub>4</sub>	384	G <sub>6</sub>	1536
A <sub>0</sub>	26.67	A <sub>2</sub>	106.67	A <sub>4</sub>	426.67	A <sub>6</sub>	1706.67
B <sub>0</sub>	30	B <sub>2</sub>	120	B <sub>4</sub>	480	B <sub>6</sub>	1920
C <sub>1</sub>	32	C <sub>3</sub>	128	C <sub>5</sub>	512	C <sub>7</sub>	2048
D <sub>1</sub>	36	D <sub>3</sub>	144	D <sub>5</sub>	576	D <sub>7</sub>	2304
E <sub>1</sub>	40	E <sub>3</sub>	160	E <sub>5</sub>	640	E <sub>7</sub>	2560
F <sub>1</sub>	42.67	F <sub>3</sub>	170.67	F <sub>5</sub>	682.67	F <sub>7</sub>	2730.67
G <sub>1</sub>	48	G <sub>3</sub>	192	G <sub>5</sub>	768	G <sub>7</sub>	3072
A <sub>1</sub>	53.33	A <sub>3</sub>	213.33	A <sub>5</sub>	853.33	A <sub>7</sub>	3413.33
B <sub>1</sub>	60	B <sub>3</sub>	240	B <sub>5</sub>	960	B <sub>7</sub>	3840
						C <sub>8</sub>	4096

## CHARACTERISTICS OF HUMAN HEARING

The human ear is sensitive to sound waves with frequencies in the range from a few hertz to almost 20 kHz. Auditory response is usually expressed in terms of the *loudness level* of a sound, which is a measure of the sound pressure. The reference level, which is given in the unit *phon*, is a pure tone of frequency 1000 Hz with sound pressure of 20  $\mu\text{Pa}$  (in cgs units,  $2 \cdot 10^{-4}$  dyn/cm<sup>2</sup>); loudness level is usually expressed in decibels (dB) relative to this reference level. If a normal observer perceives an arbitrary sound to

be equally loud as this reference sound, the sound is said to have the loudness level of the reference. The sensitivity of the typical human ear ranges from about 0 dB, the threshold loudness level, to about 140 dB, the level at which pain sets in. The minimum detectable level thus represents a sound wave of pressure 20  $\mu\text{Pa}$  and intensity (power density)  $10^{-16}$  W/cm<sup>2</sup>.

The following figure illustrates the frequency dependence of the threshold for an average young adult.



The relation between loudness level and frequency for a typical person is expressed by the following table:

Sound pressure level in dB relative to 20 $\mu\text{Pa}$	Frequency in Hz					
	125	500	1000	4000	8000	10000
10			10	18		
20		16	20	28	11	
30	4	27	30	37	21	17
40	17	39	40	45	30	26
50	34	52	50	54	38	35
60	52	65	60	64	47	44
70	70	76	70	73	56	54
80	86	86	80	83	66	64
90	98	96	90	94	77	74
100	108	105	100	106	88	86

Thus, a 10,000 Hz tone at a pressure level of 50 dB seems equally loud as a 1000 Hz tone at a pressure of 35 dB.

The term *noise* refers to any unwanted sound, either a pure tone or a mixture of frequencies. Since the sensitivity of the ear is fre-

quency dependent, as illustrated by the above table, noise level is expressed in a frequency-weighted scale, known as A-weighting. Decibel readings on this scale are designated as dBa. Typical noise levels from various sources are illustrated in this table:

Source	Noise level in dBa
Rocket engine	200
Jet aircraft engine	160
Light aircraft, cruising	140
Tractor, 150 hp	115
Electric motor, 100 hp at 2600 rpm	105
Pneumatic drill	100
Subway train	90
Vacuum cleaner	85
Heavy automobile traffic	75
Conversational speech	65
Whispered speech	40
Background noise, recording studio	25-30

Recommended noise thresholds in the workplace have been established by the American Conference of Government Industrial

Hygienists. Some examples of the maximum safe levels for different daily exposure times are given below.

Duration of exposure	Max. level in dBa
24 h	80
8 h	85
4 h	88
1 h	94
30 min	97
15 min	100
2 min	109
28 s	115
0.11 s	139

No exposure greater than 140 dBa is permitted. Further details may be found in Reference 3.

### References

1. Anderson, H. L., Ed., *A Physicist's Desk Reference*, American Institute of Physics, New York, 1989, chap. 2.
2. Gray, D. E., Ed., *American Institute of Physics Handbook, Third Edition*, McGraw Hill, New York, 1972, chap. 3.
3. *Threshold Limit Values for Chemical Substances and Physical Agents; Biological Exposure Indices*, 2008 Edition, American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634; <www.acgih.org>.

# INTERSTELLAR MOLECULES

Frank J. Lovas and Lewis E. Snyder

A number of molecules have been detected in the interstellar medium, in circumstellar envelopes around evolved stars, and comae and tails of comets through observation of their microwave, infrared, or optical spectra. The following list gives the molecules and the particular isotopic species that have been reported so far. Molecules are listed by molecular formula in the Hill order. All species not footnoted otherwise are observed in interstellar clouds, while some are also found in comets and circumstellar clouds. The list was last updated in October 2008 and lists 162 molecules (298 isotopic forms).

## References

1. Lovas, F. J., Recommended Rest Frequencies for Observed Interstellar Molecule Microwave Transitions — 2002 Revision, *J. Phys. Chem. Ref. Data* 33, 177–355 (2004); and update appearing at <http://physics.nist.gov/PhysRefData/micro/html/contents.html>
2. Snyder, L. E., Cometary Molecules, Internat. Astron. Union Symposium No. 150, *Astrochemistry of Cosmic Phenomena*, ed. P. D. Singh, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 427–434 (1992).

Molecular formula	Name	Isotopic species
AlCl	Aluminum monochloride	Al <sup>35</sup> Cl <sup>a</sup> Al <sup>37</sup> Cl <sup>a</sup>
AlF	Aluminum monofluoride	AlF <sup>a</sup>
AlN	Aluminum isocyanide	AlNC <sup>a</sup>
CF <sup>+</sup>	Fluoromethylidynium ion	CF <sup>+</sup>
CH	Methylidyne	CH
CH <sup>+</sup>	Methyliumylidene	CH <sup>+</sup>
CHN	Hydrogen cyanide	HCN H <sup>13</sup> CN HC <sup>15</sup> N DCN
CHN	Hydrogen isocyanide	HNC H <sup>15</sup> NC HN <sup>13</sup> C DNC D <sup>15</sup> NC
CHNO	Isocyanic acid	HNCO DNCO
CHNO	Hydroxyl cyanide	HOCN
CHNS	Isothiocyanic acid	HNCS
CHO	Oxomethyl	HCO
CHO <sup>+</sup>	Oxomethylium	HCO <sup>+</sup> H <sup>13</sup> CO <sup>+</sup> HC <sup>17</sup> O <sup>+</sup> HC <sup>18</sup> O <sup>+</sup> DCO <sup>+</sup> D <sup>13</sup> CO <sup>+</sup>
CHO <sup>+</sup>	Hydroxymethylidyne	HOC <sup>+</sup>
CHO <sub>2</sub> <sup>+</sup>	Hydroxyoxomethylium	HOCO <sup>+</sup>
CHP	Phosphaethyne	HCP <sup>a</sup>
CHS <sup>+</sup>	Thiooxomethylium	HCS <sup>+</sup>
CH <sub>2</sub>	Methylene	CH <sub>2</sub>
CH <sub>2</sub> N <sup>+</sup>	Iminomethylium	HCNH <sup>+</sup>
CH <sub>2</sub> N	Methylene amidogen	CH <sub>2</sub> N
CH <sub>2</sub> N <sub>2</sub>	Cyanamide	NH <sub>2</sub> CN
CH <sub>2</sub> O	Formaldehyde	H <sub>2</sub> CO H <sub>2</sub> <sup>13</sup> CO H <sub>2</sub> C <sup>18</sup> O HDCO D <sub>2</sub> CO
CH <sub>2</sub> O <sub>2</sub>	Formic acid	HCOOH H <sup>13</sup> COOH

Molecular formula	Name	Isotopic species
		HCOOD DCOOH
CH <sub>2</sub> S	Thioformaldehyde	H <sub>2</sub> CS H <sub>2</sub> <sup>13</sup> CS H <sub>2</sub> C <sup>34</sup> S HDCS D <sub>2</sub> CS
CH <sub>3</sub>	Methyl	CH <sub>3</sub> <sup>a</sup>
CH <sub>3</sub> N	Methanimine	CH <sub>2</sub> NH <sup>13</sup> CH <sub>2</sub> NH
CH <sub>3</sub> NO	Formamide	NH <sub>2</sub> CHO NH <sub>2</sub> <sup>13</sup> CHO
CH <sub>3</sub> O <sup>+</sup>	Hydroxymethylium ion	H <sub>2</sub> COH <sup>+</sup>
CH <sub>4</sub>	Methane	CH <sub>4</sub>
CH <sub>4</sub> O	Methanol	CH <sub>3</sub> OH <sup>13</sup> CH <sub>3</sub> OH CH <sub>3</sub> <sup>18</sup> OH CH <sub>2</sub> DOH CH <sub>3</sub> OD CHD <sub>2</sub> OH CD <sub>3</sub> OH
CH <sub>4</sub> S	Methanethiol	CH <sub>3</sub> SH
CH <sub>3</sub> N	Methylamine	CH <sub>3</sub> NH <sub>2</sub>
CMgN	Magnesium cyanide	MgCN <sup>a</sup>
CMgN	Magnesium isocyanide	<sup>24</sup> MgNC <sup>a</sup> <sup>25</sup> MgNC <sup>a</sup> <sup>26</sup> MgNC <sup>a</sup>
CN	Cyanide radical	CN <sup>13</sup> CN C <sup>15</sup> N
CN <sup>+</sup>	Cyanide radical ion	CN <sup>+</sup> <sup>b</sup>
CNNa	Sodium cyanide	NaCN <sup>a</sup>
CNSi	Silicon cyanide	SiCN <sup>a</sup>
CNSi	Silicon isocyanide	SiNC <sup>a</sup>
CN <sub>2</sub>	Cyanoimidogen	NCN <sup>b</sup>
CO	Carbon monoxide	CO <sup>13</sup> CO C <sup>17</sup> O C <sup>18</sup> O <sup>13</sup> C <sup>17</sup> O <sup>13</sup> C <sup>18</sup> O <sup>14</sup> CO

Molecular formula	Name	Isotopic species	Molecular formula	Name	Isotopic species
CO <sup>+</sup>	Carbon monoxide ion	CO <sup>+</sup>	C <sub>3</sub>	Tricarbon	C <sub>3</sub>
COS	Carbon oxysulfide	OCS	C <sub>3</sub> H	Cyclopropenylidyne	<i>c</i> -C <sub>3</sub> H
		OC <sup>34</sup> S			<i>c</i> -CC <sup>13</sup> CH
		O <sup>13</sup> CS	C <sub>3</sub> H	Propenylidyne	<i>l</i> -C <sub>3</sub> H
		<sup>18</sup> OCS	C <sub>3</sub> HN	Cyanoacetylene	HCCCN
CO <sub>2</sub>	Carbon dioxide	CO <sub>2</sub>			H <sup>13</sup> CCCN
CO <sub>2</sub> <sup>+</sup>	Carbon dioxide ion	CO <sub>2</sub> <sup>+</sup> <sup>b</sup>			HC <sup>13</sup> CCN
CP	Carbon phosphide	CP <sup>a</sup>			HCC <sup>13</sup> CN
CS	Carbon monosulfide	CS			HCCC <sup>15</sup> N
		C <sup>33</sup> S			DCCCN
		C <sup>34</sup> S	C <sub>3</sub> HN	Isocyanoacetylene	HCCNC
		C <sup>36</sup> S	C <sub>3</sub> HN	3-Imino-1,2-propadienylidene	HNCCC
		<sup>13</sup> CS	C <sub>3</sub> H <sub>2</sub>	Cyclopropenylidene	<i>c</i> -C <sub>3</sub> H <sub>2</sub>
		<sup>13</sup> C <sup>34</sup> S			<i>c</i> -H <sup>13</sup> CCCH
CSi	Silicon carbide	SiC <sup>a</sup>			<i>c</i> -HC <sup>13</sup> CCH
C <sub>2</sub>	Dicarbon	C <sub>2</sub>			<i>c</i> -C <sub>2</sub> HD
C <sub>2</sub> H	Ethynyl	C <sub>2</sub> H	C <sub>3</sub> H <sub>2</sub>	Propadienylidene	<i>l</i> -H <sub>2</sub> CCC
		<sup>13</sup> CCH	C <sub>3</sub> H <sub>2</sub> N <sup>+</sup>	Protonated cyanoacetylene	HCCCNH <sup>+</sup>
		C <sup>13</sup> CH	C <sub>3</sub> H <sub>2</sub> O	2-Propynal	HCCCHO
		C <sub>2</sub> D	C <sub>3</sub> H <sub>2</sub> O	Cyclopropenone	<i>c</i> -C <sub>3</sub> H <sub>2</sub> O
C <sub>2</sub> HN	Cyanomethylene	HCCN	C <sub>3</sub> H <sub>3</sub> N	Acrylonitrile (vinyl cyanide)	CH <sub>2</sub> CHCN
C <sub>2</sub> HNO	Cyanoformaldehyde	CNCHO			<sup>13</sup> CH <sub>2</sub> CHCN
C <sub>2</sub> H <sub>2</sub>	Acetylene	HCCH			CH <sub>2</sub> <sup>13</sup> CHCN
C <sub>2</sub> H <sub>2</sub> N	Cyanomethyl	CH <sub>2</sub> CN	C <sub>3</sub> H <sub>4</sub>	Propyne	CH <sub>3</sub> CCH
C <sub>2</sub> H <sub>2</sub> O	Ketene	H <sub>2</sub> CCO			CH <sub>3</sub> C <sup>13</sup> CH
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	CH <sub>3</sub> CN			<sup>13</sup> CH <sub>3</sub> CCH
		<sup>13</sup> CH <sub>3</sub> CN			CH <sub>2</sub> DCCH
		CH <sub>3</sub> <sup>13</sup> CN			CH <sub>3</sub> CCD
		CH <sub>3</sub> C <sup>15</sup> N	C <sub>3</sub> H <sub>4</sub> O	Propenal	CH <sub>2</sub> CHCHO
		CH <sub>2</sub> DCN	C <sub>3</sub> H <sub>5</sub> N	Propanenitrile (ethyl cyanide)	CH <sub>3</sub> CH <sub>2</sub> CN
		CH <sub>3</sub> NC			<sup>13</sup> CH <sub>3</sub> CH <sub>2</sub> CN
C <sub>2</sub> H <sub>3</sub> N	Isocyanomethane	CH <sub>2</sub> CNH			CH <sub>3</sub> <sup>13</sup> CH <sub>2</sub> CN
C <sub>2</sub> H <sub>3</sub> N	Keteneimine	H <sub>2</sub> CCH <sub>2</sub>			CH <sub>3</sub> CH <sub>2</sub> <sup>13</sup> CN
C <sub>2</sub> H <sub>4</sub>	Ethylene	NH <sub>2</sub> CH <sub>2</sub> CN	C <sub>3</sub> H <sub>6</sub>	Propylene	CH <sub>2</sub> CHCH <sub>3</sub>
C <sub>2</sub> H <sub>4</sub> N <sub>2</sub>	Aminoacetonitrile		C <sub>3</sub> H <sub>6</sub> O	Acetone	(CH <sub>3</sub> ) <sub>2</sub> CO
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde		C <sub>3</sub> H <sub>6</sub> O	Propanal	CH <sub>3</sub> CH <sub>2</sub> CHO
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	<i>c</i> -C <sub>2</sub> H <sub>4</sub> O	C <sub>3</sub> N	Cyanoethynyl	CCCN
C <sub>2</sub> H <sub>4</sub> O	<i>anti</i> -Ethenol	<i>a</i> -CH <sub>2</sub> CHOH			<sup>13</sup> CCCN
C <sub>2</sub> H <sub>4</sub> O	<i>syn</i> -Ethenol	<i>s</i> -CH <sub>2</sub> CHOH			C <sup>13</sup> CCN
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	CH <sub>3</sub> OCHO			CC <sup>13</sup> CN
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	CH <sub>3</sub> COOH			CC <sup>13</sup> CN
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Glycolaldehyde	CH <sub>2</sub> OHCHO	C <sub>3</sub> N <sup>-</sup>	Cyanoethynyl anion	CCCN <sup>-</sup>
C <sub>2</sub> H <sub>5</sub> NO	Acetamide	CH <sub>3</sub> CONH <sub>2</sub>	C <sub>3</sub> O	1,2-Propadienylidene, 3-oxo	CCCO
C <sub>2</sub> H <sub>6</sub>	Ethane	CH <sub>3</sub> CH <sub>3</sub> <sup>b</sup>	C <sub>3</sub> S	1,2-Propadienylidene, 3-thioxo	CCCS
C <sub>2</sub> H <sub>6</sub> O	<i>trans</i> -Ethanol	<i>t</i> -CH <sub>3</sub> CH <sub>2</sub> OH			CCC <sup>34</sup> S
C <sub>2</sub> H <sub>6</sub> O	<i>gauche</i> -Ethanol	<i>g</i> -CH <sub>3</sub> CH <sub>2</sub> OH			C <sup>13</sup> CCS
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	CH <sub>3</sub> OCH <sub>3</sub>	C <sub>3</sub> Si	Silicon tricarbon	SiC <sub>3</sub>
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	HOCH <sub>2</sub> CH <sub>2</sub> OH	C <sub>4</sub> H	1,3-Butadiynyl radical	HCCCC
C <sub>2</sub> O	Oxoethenylidene	CCO			H <sup>13</sup> CCCC
C <sub>2</sub> P	Phosphaethenylidene	CCP <sup>a</sup>			HC <sup>13</sup> CCC
C <sub>2</sub> S	Thioxoethenylidene	CCS			HCC <sup>13</sup> CC
		CC <sup>34</sup> S			HCCC <sup>13</sup> C
		<sup>13</sup> CCS			DCCCC
		C <sup>13</sup> CS	C <sub>4</sub> H <sup>-</sup>	1,3-Butadiynyl anion	HCCCC <sup>-</sup>
C <sub>2</sub> Si	Silicon dicarbide	<i>c</i> -SiC <sub>2</sub>	C <sub>4</sub> HN	3-Cyano-1,2-propadienylidene	HCCCCN
		<i>c</i> - <sup>29</sup> SiC <sub>2</sub>	C <sub>4</sub> H <sub>2</sub>	Butatrienylidene	H <sub>2</sub> CCCC
		<i>c</i> - <sup>30</sup> SiC <sub>2</sub>	C <sub>4</sub> H <sub>2</sub>	1,3-Butadiyne	HCCCCH <sup>a</sup>
		<i>c</i> -Si <sup>13</sup> CC	C <sub>4</sub> H <sub>3</sub> N	2-Butynenitrile	CH <sub>3</sub> CCCN

Molecular formula	Name	Isotopic species	Molecular formula	Name	Isotopic species
C <sub>4</sub> H <sub>3</sub> N	Cyanoallene	CH <sub>2</sub> CCHCN	H <sub>2</sub> O	Water	H <sub>2</sub> O
C <sub>4</sub> Si	Silicon tetracarbide	SiC <sub>4</sub> <sup>a</sup> SiCCCC <sup>13</sup> C			H <sub>2</sub> <sup>18</sup> O HDO D <sub>2</sub> O
C <sub>5</sub>	Pentacarbon	C <sub>5</sub> <sup>a</sup>			H <sub>2</sub> O <sup>+ b</sup>
C <sub>5</sub> H	2,4-Pentadiynylidyne	HCCCCC	H <sub>2</sub> O <sup>+</sup>	Oxoniumyl	H <sub>2</sub> S
C <sub>5</sub> HN	2,4-Pentadiyenenitrile	HCCCCCN H <sup>13</sup> CCCCCN HC <sup>13</sup> CCCCN HCC <sup>13</sup> CCCN HCCC <sup>13</sup> CCN HCCCC <sup>13</sup> CN DCCCCCN	H <sub>2</sub> S	Hydrogen sulfide	H <sub>2</sub> <sup>34</sup> S HDS D <sub>2</sub> S
C <sub>5</sub> H <sub>4</sub>	1,3-Pentadiyne	CH <sub>3</sub> C <sub>4</sub> H	H <sub>3</sub> <sup>+</sup>	Trihydrogen ion	H <sub>3</sub> <sup>+</sup> H <sub>2</sub> D <sup>+</sup> D <sub>2</sub> H <sup>+</sup>
C <sub>5</sub> N	1,3-Butadiynylum, 4-cyano	C <sub>5</sub> N	H <sub>3</sub> N	Ammonia	NH <sub>3</sub> <sup>15</sup> NH <sub>3</sub>
C <sub>6</sub> H	1,3,5-Hexatriynyl	HCCCCCC			NH <sub>2</sub> D NHD <sub>2</sub> ND <sub>3</sub>
C <sub>6</sub> H <sup>-</sup>	1,3,5-Hexatriynyl anion	HCCCCCC <sup>-</sup>			H <sub>3</sub> O <sup>+</sup>
C <sub>6</sub> H <sub>2</sub>	1,3,5-Hexatriyne	HCCCCCCCH <sup>a</sup>	H <sub>3</sub> O <sup>+</sup>	Oxonium hydride	SiH <sub>4</sub> <sup>a</sup>
C <sub>6</sub> H <sub>2</sub>	1,2,3,4,5-Hexapentaenylidene	H <sub>2</sub> CCCCCC	NO	Nitric oxide	NO
C <sub>6</sub> H <sub>3</sub> N	Methylcyanodiacetylene	CH <sub>3</sub> C <sub>4</sub> CN	NP	Phosphorous nitride	PN
C <sub>6</sub> H <sub>6</sub>	Benzene	C <sub>6</sub> H <sub>6</sub>	NS	Nitrogen sulfide	NS N <sup>34</sup> S
C <sub>7</sub> H	2,4,6-Heptatriynylidyne	HCCCCCCC	NSi	Silicon nitride	SiN
C <sub>7</sub> HN	2,4,6-Heptatriyenenitrile	HC <sub>7</sub> N	N <sub>2</sub>	Nitrogen	N <sub>2</sub>
C <sub>7</sub> H <sub>4</sub>	Methyltriacyetylene	CH <sub>3</sub> C <sub>6</sub> H	N <sub>2</sub> <sup>+</sup>	Nitrogen ion	N <sub>2</sub> <sup>+ b</sup>
C <sub>8</sub> H	1,3,5,7-Octatetraynyl	HC <sub>8</sub>	N <sub>2</sub> O	Nitrous oxide	N <sub>2</sub> O
C <sub>8</sub> H <sup>-</sup>	1,3,5,7-Octatetraynyl anion	HC <sub>8</sub> <sup>-</sup>	OP	Phosphorus monoxide	PO <sup>a</sup>
C <sub>9</sub> HN	2,4,6,8-Nonatetraynenitrile	HC <sub>9</sub> N	OS	Sulfur monoxide	SO <sup>34</sup> SO <sup>33</sup> SO
C <sub>11</sub> HN	2,4,6,8,10-Undecapentaynenitrile	HC <sub>11</sub> N	OS <sup>+</sup>	Sulfur monoxide ion	S <sup>18</sup> O SO <sup>+</sup>
ClH	Hydrogen chloride	H <sup>35</sup> Cl H <sup>37</sup> Cl	OSi	Silicon monoxide	SiO Si <sup>18</sup> O <sup>29</sup> SiO <sup>30</sup> SiO
ClK	Potassium chloride	K <sup>35</sup> Cl <sup>a</sup> K <sup>37</sup> Cl <sup>a</sup>	O <sub>2</sub>	Oxygen	O <sub>2</sub> SO <sub>2</sub> <sup>33</sup> SO <sub>2</sub> <sup>34</sup> SO <sub>2</sub> OS <sup>17</sup> O OS <sup>18</sup> O
ClNa	Sodium chloride	Na <sup>35</sup> Cl <sup>a</sup> Na <sup>37</sup> Cl <sup>a</sup>	O <sub>2</sub> S	Sulfur dioxide	SiS Si <sup>33</sup> S Si <sup>34</sup> S <sup>29</sup> SiS <sup>30</sup> SiS <sup>30</sup> Si <sup>34</sup> S S <sub>2</sub> <sup>b</sup>
FH	Hydrogen fluoride	HF			
FeO	Iron monoxide	FeO			
HLi	Lithium hydride	<sup>7</sup> LiH			
HN	Imidogen	HN			
HNO	Nitrosyl hydride	HNO			
HN <sub>2</sub> <sup>+</sup>	Hydrodinitrogen(1+)	N <sub>2</sub> H <sup>+</sup> <sup>15</sup> NNH <sup>+</sup> N <sup>15</sup> NH <sup>+</sup> N <sub>2</sub> D <sup>+</sup>			
HO	Hydroxyl	OH <sup>17</sup> OH <sup>18</sup> OH			
HO <sup>+</sup>	Oxoniumylidene	OH <sup>+ b</sup>			
HS	Mercapto	SH			
H <sub>2</sub>	Hydrogen	H <sub>2</sub>			
H <sub>2</sub> N	Amidogen	NH <sub>2</sub>			
			S <sub>2</sub>	Sulfur	

*l*- before the isotopic species indicates a linear configuration, while *c*- indicates a cyclic molecule.

<sup>a</sup> Reported only in circumstellar clouds.

<sup>b</sup> Reported only in comets.



## WEATHER-RELATED SCALES

### Saffir-Simpson Hurricane Scale

- **Tropical Storm**  
Winds 39–73 mph
- **Category 1 Hurricane** — winds 74–95 mph (64–82 knots); pressure greater than 980 mbar; storm surge 3–5 ft (1.0–1.7 m)  
No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Also, some coastal flooding and minor pier damage.  
— Examples: Irene 1999 and Allison 1995
- **Category 2 Hurricane** — winds 96–110 mph (83–95 knots); pressure 979–965 mbar; storm surge 6–8 ft (1.8–2.6 m)  
Some damage to building roofs, doors and windows. Considerable damage to mobile homes. Flooding damages piers and small craft in unprotected moorings may break their moorings. Some trees blown down.  
— Examples: Bonnie 1998, Georges (FL & LA) 1998 and Gloria 1985
- **Category 3 Hurricane** — winds 111–130 mph (96–113 knots); pressure 964–945 mbar; storm surge 9–12 ft (2.7–3.8 m)  
Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built signs destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.  
— Examples: Keith 2000, Fran 1996, Opal 1995, Alicia 1983 and Betsy 1965

- **Category 4 Hurricane** — winds 131–155 mph (114–135 knots); pressure 944–920 mbar; storm surge 13–18 ft (3.9–5.6 m)  
More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.  
— Examples: Hugo 1989 and Donna 1960
- **Category 5 Hurricane** — winds 156 mph and up (135+ knots); pressure less than 920 mbar; storm surge 19+ ft (5.7+ m)  
Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.  
— Examples: Andrew (FL) 1992, Camille 1969 and Labor Day 1935

### Fujita Tornado Damage Scale

The original Fujita Scale was modified by NOAA in February 2007 and is now called the Enhanced Fujita Scale (EF). It is an operational scale based on the estimated speed of three-second wind gusts, as indicated by typical damage levels. The table below describes the damage levels according to the original scale. In the enhanced scale, the damage is measured by a more elaborate set of criteria (see <http://www.spc.noaa.gov/efscale/ef-scale.html>).

EF Number	3 s Gusts (mph)	Typical damage (according to the original Fujita Scale)
0	65–85	<b>Light damage.</b> Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
1	86–110	<b>Moderate damage.</b> Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
2	111–135	<b>Considerable damage.</b> Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
3	136–165	<b>Severe damage.</b> Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
4	166–200	<b>Devastating damage.</b> Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
5	Over 200	<b>Incredible damage.</b> Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yd); trees debarked; incredible phenomena will occur.

### Beaufort Wind Scale

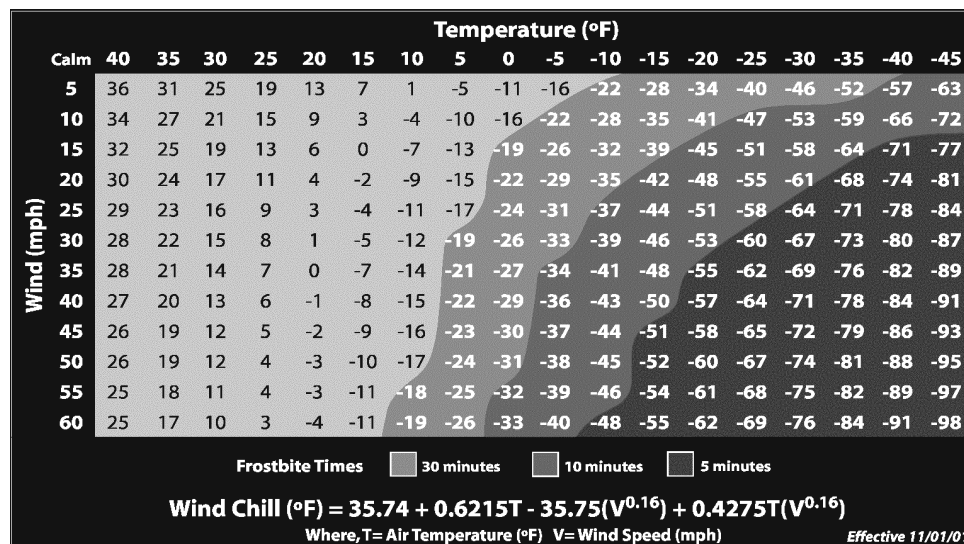
The Beaufort Wind Scale was devised by British Rear-Admiral Sir Francis Beaufort in 1805 based on observations of the effects of the wind.

Force	Wind (knots)	WMO classification	Appearance of wind effects	
			On the water	On land
0	< 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1–3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4–6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7–10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended

Force	Wind (knots)	WMO classification	Appearance of wind effects	
			On the water	On land
4	11–16	Moderate Breeze	Small waves 1–4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17–21	Fresh Breeze	Moderate waves 4–8 ft taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22–27	Strong Breeze	Larger waves 8–13 ft, whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28–33	Near Gale	Sea heaps up, waves 13–20 ft, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34–40	Gale	Moderately high (13–20 ft) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41–47	Strong Gale	High waves (20 ft), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48–55	Storm	Very high waves (20–30 ft) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56–63	Violent Storm	Exceptionally high (30–45 ft) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft, sea completely white with driving spray, visibility greatly reduced	

**Wind Chill**

The following chart prepared by the U. S. National Weather Service gives the temperature perceived by an average person as a function of the real air temperature and the wind speed. The current scale was adopted in 2001.



**Reference**

National Oceanic and Atmospheric Administration, <http://www.noaa.gov>

## GLOBAL WARMING POTENTIAL OF GREENHOUSE GASES

The Global Warming Potential (GWP) of a gas is a measure of the degree, relative to carbon dioxide, to which the presence of that gas in the atmosphere will contribute to a long-term increase in global temperature. The calculation of the GWP for a given gas takes into account the efficiency of the gas in absorbing solar radiation (primarily determined by the infrared spectrum of the compound) and the time the compound will remain in the atmosphere before it is removed by natural processes. Thus if a pulse of 1 kg of the gas is emitted to the atmosphere at the same time as a pulse of 1 kg of CO<sub>2</sub>, the GWP compares the warming effect of the gas relative to CO<sub>2</sub> over various time horizons.

This table, which is taken from the 2007 report of the Intergovernmental Panel of Climate Change (IPCC), gives the lifetime in years and the radiative efficiency in watts per square meter for a concentration of one part per billion for the major compounds identified in the Kyoto Protocol as contributing to global climate change. Radiative efficiency is a measure of the radiative forcing that influences the energy balance in the Earth-atmosphere system. The last four columns of the table give the Global Warming Potential, first as estimated in 1995 for a 100 year time horizon, and then as estimated with improved data in 2007 for 20-,

100-, and 500-year horizons. The calculation of a GWP involves a number of assumptions, and other measures have been proposed (see Reference).

The list of compounds includes those identified in the Montreal Protocol as contributing to ozone depletion, since these compounds also contribute to global warming. It also includes compounds used or proposed as replacements for the ozone-depleting compounds but which still have global warming potential.

### Reference

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D. W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz, and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Sin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H.L. Miller (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available on the Internet at < <http://ipcc-wg1.ucar.edu/wg1/wg1-report.html> >.

Compound	Synonym/Code	Formula	Lifetime (years)	Rad. eff. W m <sup>-2</sup> ppb <sup>-1</sup>	GWP for given time horizon			
					1995 100 yr	Current estimate		
					20 yr	100 yr	500 yr	
<i>Natural atmospheric constituents</i>								
Carbon dioxide		CO <sub>2</sub>		1.4×10 <sup>-5</sup>	1	1	1	1
Methane		CH <sub>4</sub>	12	3.7×10 <sup>-4</sup>	21	72	25	7.6
Nitrous oxide		N <sub>2</sub> O	114	3.03×10 <sup>-3</sup>	310	289	298	153
<i>Substances controlled by the Montreal Protocol</i>								
Trichlorofluoromethane	CFC-11	CCl <sub>3</sub> F	45	0.25	3800	6730	4750	1620
Dichlorodifluoromethane	CFC-12	CCl <sub>2</sub> F <sub>2</sub>	100	0.32	8100	11000	10900	5200
Chlorotrifluoromethane	CFC-13	CClF <sub>3</sub>	640	0.25		10800	14400	16400
1,1,2-Trichloro-1,2,2-trifluoroethane	CFC-113	CCl <sub>2</sub> FCClF <sub>2</sub>	85	0.3	4800	6540	6130	2700
1,2-Dichloro-1,1,2,2-tetrafluoroethane	CFC-114	CClF <sub>2</sub> CClF <sub>2</sub>	300	0.31		8040	10000	8730
Chloropentafluoroethane	CFC-115	CClF <sub>2</sub> CF <sub>3</sub>	1700	0.18		5310	7370	9990
Bromotrifluoromethane	Halon-1301	CBrF <sub>3</sub>	65	0.32	5400	8480	7140	2760
Bromochlorodifluoromethane	Halon-1211	CBrClF <sub>2</sub>	16	0.3		4750	1890	575
1,2-Dibromotetrafluoroethane	Halon-2402	CBrF <sub>2</sub> CBrF <sub>2</sub>	20	0.33		3680	1640	503
Tetrachloromethane	Carbon tetrachloride	CCl <sub>4</sub>	26	0.13	1400	2700	1400	435
Bromomethane	Methyl bromide	CH <sub>3</sub> Br	0.7	0.01		17	5	1
1,1,1-Trichloroethane	Methyl chloroform	CH <sub>3</sub> CCl <sub>3</sub>	5	0.06		506	146	45
Chlorodifluoromethane	HCFC-22	CHClF <sub>2</sub>	12	0.2	1500	5160	1810	549
2,2-Dichloro-1,1,1-trifluoroethane	HCFC-123	CHCl <sub>2</sub> CF <sub>3</sub>	1.3	0.14	90	273	77	24
1-Chloro-1,2,2,2-tetrafluoroethane	HCFC-124	CHClF <sub>2</sub> CF <sub>3</sub>	5.8	0.22	470	2070	609	185
1,1-Dichloro-1-fluoroethane	HCFC-141b	CH <sub>3</sub> CCl <sub>2</sub> F	9.3	0.14		2250	725	220
1-Chloro-1,1-difluoroethane	HCFC-142b	CH <sub>3</sub> CClF <sub>2</sub>	17.9	0.2	1800	5490	2310	705
3,3-Dichloro-1,1,1,2,2-pentafluoropropane	HCFC-225ca	CHCl <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>	1.9	0.2		429	122	37
1,3-Dichloro-1,1,2,2,3-pentafluoropropane	HCFC-225cb	CHClF <sub>2</sub> CF <sub>2</sub> CF <sub>2</sub>	5.8	0.32		2030	595	181
<i>Hydrofluorocarbons</i>								
Trifluoromethane	HFC-23	CHF <sub>3</sub>	270	0.19	11700	12000	14800	12200
Difluoromethane	HFC-32	CH <sub>2</sub> F <sub>2</sub>	4.9	0.11	650	2330	675	205
Pentafluoroethane	HFC-125	CHF <sub>2</sub> CF <sub>3</sub>	29	0.23	2800	6350	3500	1100

Compound	Synonym/Code	Formula	Lifetime (years)	Rad. eff. W m <sup>-2</sup> ppb <sup>-1</sup>	GWP for given time horizon			
					1995 100 yr	Current estimate		
						20 yr	100 yr	500 yr
1,1,1,2-Tetrafluoroethane	HFC-134a	CH <sub>2</sub> FCF <sub>3</sub>	14	0.16	1300	3830	1430	435
1,1,1-Trifluoroethane	HFC-143a	CH <sub>3</sub> CF <sub>3</sub>	52	0.13	3800	5890	4470	1590
1,1-Difluoroethane	HFC-152a	CH <sub>3</sub> CHF <sub>2</sub>	1.4	0.09	140	437	124	38
1,1,1,2,3,3,3-Heptafluoropropane	HFC-227ea	CF <sub>3</sub> CHFCF <sub>3</sub>	34.2	0.26	2900	5310	3220	1040
1,1,1,3,3,3-Hexafluoropropane	HFC-236fa	CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>	240	0.28	6300	8100	9810	7660
1,1,1,3,3-Pentafluoropropane	HFC-245fa	CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	7.6	0.28		3380	1030	314
1,1,1,3,3-Pentafluorobutane	HFC-365mfc	CH <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	8.6	0.21		2520	794	241
1,1,1,2,3,4,4,5,5,5-Decafluoropentane	HFC-43-10mee	CF <sub>3</sub> CHFCHF <sub>2</sub> CF <sub>3</sub>	15.9	0.4	1300	4140	1640	500
<i>Perfluorinated compounds</i>								
Sulfur hexafluoride		SF <sub>6</sub>	3200	0.52	23900	16300	22800	32600
Nitrogen trifluoride		NF <sub>3</sub>	740	0.21		12300	17200	20700
Tetrafluoromethane	PFC-14	CF <sub>4</sub>	50000	0.10	6500	5210	7390	11200
Hexafluoroethane	PFC-116	C <sub>2</sub> F <sub>6</sub>	10000	0.26	9200	8630	12200	18200
Perfluoropropane	PFC-218	C <sub>3</sub> F <sub>8</sub>	2600	0.26	7000	6310	8830	12500
Perfluorocyclobutane	PFC-318	c-C <sub>4</sub> F <sub>8</sub>	3200	0.32	8700	7310	10300	14700
Perfluorobutane	PFC-3-1-10	C <sub>4</sub> F <sub>10</sub>	2600	0.33	7000	6330	8860	12500
Perfluoropentane	PFC-4-1-12	C <sub>5</sub> F <sub>12</sub>	4100	0.41		6510	9160	13300
Perfluorohexane	PFC-5-1-14	C <sub>6</sub> F <sub>14</sub>	3200	0.49	7400	6600	9300	13300
Perfluorodecalin	PFC-9-1-18	C <sub>10</sub> F <sub>18</sub>	>1,000	0.56		>5500	>7500	>9500
(Trifluoromethyl)sulfur pentafluoride		SF <sub>5</sub> CF <sub>3</sub>	800	0.57		13200	17700	21200
<i>Fluorinated ethers</i>								
Trifluoromethyl difluoromethyl ether	HFE-125	CHF <sub>2</sub> OCF <sub>3</sub>	136	0.44		13800	14900	8490
Bis(difluoromethyl) ether	HFE-134	CHF <sub>2</sub> OCHF <sub>2</sub>	26	0.45		12200	6320	1960
Methyl trifluoromethyl ether	HFE-143a	CH <sub>3</sub> OCF <sub>3</sub>	4.3	0.27		2630	756	230
2-Chloro-2-(difluoromethoxy)-1,1,1-trifluoroethane	HCFE-235da2	CHF <sub>2</sub> OCHClCF <sub>3</sub>	2.6	0.38		1230	350	106
Methyl 1,1,2,2-tetrafluoroethyl ether	HFE-245cb2	CH <sub>3</sub> OCF <sub>2</sub> CHF <sub>2</sub>	5.1	0.32		2440	708	215
2-(Difluoromethoxy)-1,1,1-trifluoroethane	HFE-245fa2	CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>	4.9	0.31		2280	659	200
Methyl pentafluoroethyl ether	HFE-254cb2	CH <sub>3</sub> OCF <sub>2</sub> CHF <sub>2</sub>	2.6	0.28		1260	359	109
Perfluoropropyl methyl ether	HFE-347mcc3	CH <sub>3</sub> OCF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>	5.2	0.34		1980	575	175
1,1,2,2-Tetrafluoroethyl 1,1,1-trifluoroethyl ether	HFE-347pcf2	CHF <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>	7.1	0.25		1900	580	175
1-Methoxy-1,1,2,2,3,3-hexafluoropropane	HFE-356pcc3	CH <sub>3</sub> OCF <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>	0.33	0.93		386	110	33
Methyl nonafluorobutyl ether	HFE-449sl (HFE-7100)	C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub>	3.8	0.31		1040	297	90
1-Ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane	HFE-569sf2 (HFE-7200)	C <sub>4</sub> F <sub>9</sub> OC <sub>2</sub> H <sub>5</sub>	0.77	0.3		207	59	18
1-(Difluoromethoxy)-2-[(difluoromethoxy)difluoromethoxy]-1,1,2,2-tetrafluoroethane	HFE-43-10pccc124 (H-Galden 1040x)	CHF <sub>2</sub> OCF <sub>2</sub> OC <sub>2</sub> F <sub>4</sub> OCHF <sub>2</sub>	6.3	1.37		6320	1870	569
Bis(difluoromethoxy)difluoromethane	HFE-236ca12 (HG-10)	CHF <sub>2</sub> OCF <sub>2</sub> OCHF <sub>2</sub>	12.1	0.66		8000	2800	860
1,2-Bis(difluoromethoxy)-1,1,2,2-tetrafluoroethane	HFE-338pcc13 (HG-01)	CHF <sub>2</sub> OCF <sub>2</sub> CF <sub>2</sub> OCHF <sub>2</sub>	6.2	0.87		5100	1500	460
Perfluoropolymethylisopropyl ether	PPPMIE	CF <sub>3</sub> OCF(CF <sub>3</sub> )CF <sub>2</sub> OCF <sub>2</sub> OCF <sub>3</sub>	800	0.65		7620	10300	12400
<i>Other compounds - Direct effects</i>								
Dimethyl ether	Methyl ether	CH <sub>3</sub> OCH <sub>3</sub>	0.015	0.02		1	1	<<1
Dichloromethane	Methylene chloride	CH <sub>2</sub> Cl <sub>2</sub>	0.38	0.03		31	8.7	2.7
Chloromethane	Methyl chloride	CH <sub>3</sub> Cl	1	0.01		45	13	4

## MAJOR WORLD EARTHQUAKES

The United States Geological Survey maintains a database of historic earthquakes throughout the world (Reference 1). The table below is extracted from that database; it includes about 300 major earthquakes, based upon the magnitude and the degree of destruction. All recorded earthquakes of magnitude 7.5 or greater are listed, even if the fatalities are unknown or small. The death toll is often a rough estimate; in many cases the true toll could be much greater. More details on the exact location and degree of destruction can be found in References 2 and 3.

The magnitude is given on the Richter scale, which was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is measured by the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquake. On

the Richter Scale, magnitude is expressed in whole numbers and decimal fractions, e.g. 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a ten-fold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

### References

1. Historic Worldwide Earthquakes, <http://earthquake.usgs.gov/regional/world/historical.php>.
2. Most Destructive Known Earthquakes on Record in the World, [http://earthquake.usgs.gov/regional/world/most\\_destructive.php](http://earthquake.usgs.gov/regional/world/most_destructive.php).
3. Earthquakes with 1,000 or More Deaths since 1900, [http://earthquake.usgs.gov/regional/world/world\\_deaths.php](http://earthquake.usgs.gov/regional/world/world_deaths.php).

Date	Location	Magnitude	Fatalities	Date	Location	Magnitude	Fatalities
856/12/22	Damghan, Iran		200,000	1868/08/13	Arica, Peru (now Chile)	9.0	400
893/03/23	Ardabil, Iran		150,000	1872/03/26	Owens Valley, California	7.4	27
1138/08/09	Aleppo, Syria		230,000	1877/05/10	Offshore Tarapaca, Chile	8.3	34
1268	Silicia, Asia Minor		60,000	1886/09/01	Charleston, South Carolina	7.3	60
1290/09/27	Chihli, China		100,000	1887/05/03	Northern Sonora, Mexico	7.4	51
1556/01/23	Shensi, China	8.0	830,000	1891/10/27	Mino-Owari, Japan	8.0	
1619/02/14	Trujillo, Peru	7.7	350	1892/02/24	Imperial Valley, California	7.8	
1667/11	Shemakha, Caucasia		80,000	1896/06/15	Sanriku, Japan	8.5	28,000
1668/08/17	Anatolia, Turkey	8.0		1897/06/12	Assam, India	8.3	1,500
1687/10/20	Lima, Peru	8.5		1899/09/04	Cape Yakataga, Alaska	7.9	
1693/01/11	Sicily, Italy	7.5	60,000	1899/09/10	Yakutat Bay, Alaska	8.0	
1700/01/26	Cascadia Subduction Zone (Oregon to British Columbia)	9.0		1900/10/09	Kodiak Island, Alaska	7.7	
1727/11/18	Tabriz, Iran		77,000	1902/04/19	Quezaltenango and San Marcos, Guatemala	7.5	2,000
1730/07/08	Valparaiso, Chile	8.7		1902/12/16	Eastern Uzbekistan (Turkestan)	6.4	4,700
1755/11/01	Lisbon, Portugal	8.7	70,000	1903/04/28	Malazgirt, Turkey	7.0	3,500
1783/02/04	Calabria, Italy		50,000	1903/05/28	Gole, Turkey (Ottoman Empire)	5.8	1,000
1787/05/02	Puerto Rico	8.0		1903/08/11	Southern Greece	8.3	
1811/12/16	New Madrid Region, Missouri	8.1		1905/04/04	Kangra, India	7.5	19,000
1812/02/07	New Madrid Region, Missouri	8.0		1905/07/09	Mongolia	8.4	
1812/03/26	Caracas, Venezuela	7.7		1905/09/08	Calabria, Italy	7.9	557
1812/12/08	Southwest of San Bernardino County, California	6.9	40	1906/01/31	Off the Coast of Esmeraldas, Ecuador	8.8	1,000
1812/12/21	West of Ventura, California	7.1	1	1906/03/16	Chia-i, Taiwan	6.8	1,250
1821/07/10	Camana, Peru	8.2	162	1906/04/18	San Francisco, California	7.8	3,000
1835/02/20	Concepcion, Chile	8.2	500	1906/08/17	Valparaiso, Chile	8.2	20,000
1843/02/08	Leeward Islands	8.3		1907/01/14	Kingston, Jamaica	6.5	800-1,000
1855/01/23	Wellington, New Zealand	8.0	4	1907/04/15	Guerrero, Mexico	7.7	
1857/01/09	Fort Tejon, California	7.9	1	1907/10/21	Qaratog, Tajikistan, Russia	8.0	12,000
1868/04/03	Ka'u District, Island of Hawaii	7.9	77	1908/12/12	Off the Coast of Central Peru	8.2	
				1908/12/28	Messina, Italy	7.2	72,000
				1909/01/23	Silakhor, Iran (Persia)	7.3	5,000-6,000

Date	Location	Magnitude	Fatalities	Date	Location	Magnitude	Fatalities
1910/04/12	Taiwan region	7.6		1940/05/24	Callao, Peru	8.2	249
1911/01/03	Chong-Kemin, Kyrgyzstan	7.8	450	1940/11/10	Vrancea, Romania	7.3	1,000
1911/02/18	Sarez, Tajikistan	7.4	90	1942/08/06	Guatemala	7.9	38
1911/06/07	Off Guerrero, Mexico	7.7	45	1942/08/24	Off the coast of central Peru	8.2	30
1912/08/09	Murefte, Turkey (Ottoman Empire)	7.8	2,800	1942/11/26	Turkey	7.6	
1914/10/03	Burdur, Turkey (Ottoman Empire)	7.0	4,000	1942/12/20	Erbaa, Turkey	7.3	1,100
1915/01/13	Avezzano, Italy	7.0	32,610	1943/04/06	Illapel — Salamanca, Chile	8.2	25
1917/01/20	Bali, Indonesia		1,500	1943/09/10	Tottori, Japan	7.4	1,190
1917/07/30	Daguan, Yunnan, China	7.5	1,800	1943/11/26	Ladik, Turkey	7.6	4,000
1918/02/13	Nan'ao, Guangdong, (Kwangtung), China	7.3	1,000	1944/01/15	San Juan, Argentina	7.4	8,000
1918/10/11	Mona Passage	7.5	116	1944/02/01	Gerede, Turkey	7.4	2,790
1920/06/05	Taiwan region	8.0		1944/12/07	Tonankai, Japan	8.1	998
1920/12/16	Haiyuan, Ningxia, China	7.8	200,000	1945/01/12	Mikawa, Japan	7.1	1,961
1922/11/11	Chile-Argentina Border	8.5	100	1945/11/27	Makran Coast, Pakistan	8.0	4,000
1923/02/03	Kamchatka Peninsula	8.5		1946/04/01	Unimak Island, Alaska	8.1	165
1923/03/24	Near Luhuo, Sichuan, China	7.3	3,500	1946/05/31	Ustukran, Turkey	5.9	840-1,300
1923/05/25	Torbat-e Heydariyeh, Iran	5.7	2,200	1946/08/04	Samana, Dominican Republic	8.0	100
1923/09/01	Kanto (Kwanto), Japan	7.9	142,800	1946/11/10	Ancash, Peru	7.3	1,400
1925/03/16	Yunnan, China	7.1	5,800	1946/12/20	Nankaido, Japan	8.1	1,362
1927/03/07	Tango, Japan	7.6	3,020	1947/11/01	Satipo, Peru	7.3	233
1927/05/22	Tsinghai (Kansu), China	7.6	40,900	1948/05/11	Moquegua, Peru	7.4	70
1928/12/01	Talca, Chile	7.6	225	1948/05/25	Sichuan, China	7.3	800
1929/03/07	Fox Islands, Aleutian Islands, Alaska	7.8		1948/06/28	Fukui, Japan	7.3	3,769
1929/05/01	Koppeh Dagh, Iran (Persia)	7.4	3,800	1948/10/05	Ashgabat, Turkmenistan	7.3	110,000
1930/05/06	Salmas, Iran (Persia)	7.2	2,500	1949/04/13	Puget Sound, Washington	7.1	8
1930/07/23	Irpinia, Italy	6.5	1,400	1949/07/10	Khait, Tajikistan	7.5	12,000
1931/01/15	Oaxaca, Mexico	7.8	114	1949/08/05	Ambato, Ecuador	6.8	5,050
1931/02/02	Hawke's Bay, New Zealand	7.9	256	1949/08/22	Queen Charlotte Islands, British Columbia, Canada	8.1	
1931/03/31	Managua, Nicaragua	6.0	2,500	1950/08/15	Assam — Tibet	8.6	1,526
1931/04/27	Zangezur Mountains, Armenia — Azerbaijan border	5.7	2,800	1951/08/02	Cosiguina, Nicaragua	5.8	1,000
1931/08/10	Xinjiang, China	8.0	10,000	1952/07/21	Kern County, California	7.3	12
1932/06/03	Jalisco, Mexico	8.1	45	1952/11/04	Kamchatka Peninsula	9.0	
1932/06/18	Colima, Mexico	7.8		1953/02/12	Torud, Iran	6.5	970
1932/12/25	Gansu, China	7.6	275	1953/03/18	Yenice-Gonen, Turkey	7.3	1,070
1933/03/02	Sanriku, Japan	8.4	3,000	1953/08/12	Kefallinia, Greece	7.1	455
1933/03/11	Long Beach, California	6.4	115	1953/12/12	Tumbes, Peru	7.4	7
1933/08/25	Sichuan, China	7.4	9,300	1954/03/29	Spain	7.9	
1934/01/15	Bihar, India — Nepal	8.1	10,700	1954/04/30	Greece	7.1	31
1935/04/20	Taiwan (Formosa)	7.1	3,270	1954/09/09	Orleansville, Algeria	6.8	1,250
1935/05/30	Quetta, Pakistan	7.5	30,000	1957/03/09	Andreanof Islands, Alaska	8.6	
1935/07/16	Taiwan (Formosa)	6.5	2,740	1957/04/25	Fethiye, Turkey	7.1	15
1938/02/01	Banda Sea, Indonesia	8.5		1957/05/26	Bolu Province, Turkey	7.1	66
1938/11/10	Shumagin Islands, Alaska	8.2		1957/06/27	Stanovoy Mountains, Russia (USSR)	7.6	1,200
1939/01/25	Chillan, Chile	7.8	28,000	1957/07/02	Mazandaran, Iran	7.1	1,200
1939/12/26	Erzincan, Turkey	7.8	32,700	1957/07/28	Guerrero, Mexico	7.9	68
1940/05/19	Imperial Valley, California	7.1	9	1957/12/04	Gobi-Altay, Mongolia	8.1	30
				1957/12/13	Sahneh, Iran	7.1	1,130

## Major World Earthquakes

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Date	Location	Magnitude	Fatalities	Date	Location	Magnitude	Fatalities
1958/01/15	Arequipa, Peru	7.3	26	1974/10/08	Leeward Islands	7.5	
1958/07/10	Lituya Bay, Alaska	7.7	5	1974/12/28	Northern Pakistan	6.2	5,300
1958/11/06	Kuril Islands	8.3		1975/02/02	Near Islands, Alaska	7.6	
1959/04/26	Taiwan region	7.5	2	1975/02/04	Haicheng, China	7.0	2,000
1959/08/18	Hebgen Lake, Montana	7.3	28	1975/09/06	Diyarbakir Province, Turkey	6.7	2,300
1960/01/13	Arequipa, Peru	7.5	57	1975/11/29	Kalapana, Hawaii	7.2	2
1960/02/29	Agadir, Morocco	5.7	12,000- 15,000	1976/02/04	Guatemala	7.5	23,000
1960/05/21	Arauco Peninsula, Chile	7.9		1976/05/06	Northeastern Italy	6.5	1,000
1960/05/22	Chile (off coast)	9.5	1,655	1976/06/25	Papua, Indonesia	7.1	422
1962/05/11	Guerrero, Mexico	7.0	4	1976/07/27	Tangshan, China	7.5	255,000
1962/05/19	Guerrero, Mexico	7.1	3	1976/08/16	Mindanao, Philippines	7.9	8,000
1962/09/01	Qazvin, Iran	7.1	12,225	1976/11/24	Turkey-Iran border region	7.3	5,000
1963/07/26	Skopje, Macedonia	6.0	1,100	1977/03/04	Romania	7.2	1,500
1963/10/13	Kuril Islands	8.5		1978/09/16	Iran	7.8	15,000
1964/03/28	Prince William Sound, Alaska	9.2	128	1979/02/28	Mt. St. Elias, Alaska	7.5	
1964/06/16	Niigata, Japan	7.5	26	1980/10/10	El Asnam (formerly Orleansville), Algeria	7.7	5,000
1964/10/06	Western Turkey	7.0	36	1981/02/24	Greece	6.8	3,000
1965/01/24	Sanana, Indonesia (Ceram Sea)	7.6	71	1981/06/11	Southern Iran	6.9	3,000
1965/02/04	Rat Islands, Alaska	8.7		1981/07/28	Southern Iran	7.3	1,500
1965/03/14	Hindu Kush, Afghanistan	7.8		1982/12/13	Yemen	6.0	2,800
1965/03/28	La Ligua, Chile	7.4	400	1983/10/30	Erzurum Province, Turkey	6.9	1,342
1965/03/31	Central Greece	7.1	6	1985/03/03	Offshore Valparaiso, Chile	7.8	177
1965/08/23	Oaxaca, Mexico	7.3	6	1985/09/19	Michoacan, Mexico	8.0	9,500
1966/03/07	Hebei, China	7.0	1,000	1986/05/07	Andreanof Islands, Alaska	7.9	
1966/03/22	Hebei, China	6.9	1,000	1986/10/10	El Salvador	5.5	1,000
1966/08/19	Varto, Turkey	6.8	2,529	1987/03/06	Colombia-Ecuador	7.0	1,000
1966/10/17	Near the Coast of Peru	8.1	125	1987/11/30	Gulf of Alaska	7.8	
1967/07/22	Mudurnu Valley, Turkey	7.3	173	1988/03/06	Gulf of Alaska	7.7	
1968/05/23	Inangahua, New Zealand	7.1	2	1988/08/20	Nepal-India border region	6.8	1,000
1968/08/02	Oaxaca, Mexico	7.1	18	1988/12/07	Spitak, Armenia	6.8	25,000
1968/08/31	Dasht-e Bayaz, Iran	7.3	12,000	1989/10/18	Loma Prieta, California	6.9	63
1969/02/28	Portugal-Morocco area	7.8	13	1990/06/20	Western Iran	7.4	50,000
1969/07/25	Guangdong, China	5.9	3,000	1990/07/16	Luzon, Philippine Islands	7.7	1,621
1970/01/04	Yunnan Province, China	7.5	10,000	1991/04/22	Costa Rica	7.6	47
1970/03/28	Gediz, Turkey	6.9	1,086	1991/10/19	Northern India	6.8	2,000
1970/05/31	Chimbote, Peru	7.9	70,000	1992/09/02	Nicaragua	7.6	116
1970/07/31	Colombia	8.0	1	1992/12/12	Flores Region, Indonesia	7.8	2,500
1971/02/09	San Fernando, California	6.6	65	1993/08/08	South of the Mariana Islands	7.8	
1971/05/22	Eastern Turkey	6.9	1,000	1993/09/29	Latur-Killari, India	6.2	9,748
1971/07/09	Valparaiso region, Chile	7.5	90	1994/01/17	Northridge, California	6.7	60
1972/01/25	Taiwan region	7.5		1994/06/09	Bolivia	8.2	10
1972/04/10	Southern Iran	7.1	5,054	1995/01/16	Kobe, Japan	6.9	5,502
1972/04/24	Taiwan region	7.2	4	1995/05/27	Sakhalin Island	7.1	1,989
1972/07/30	Sitka, Alaska	7.6		1996/06/10	Andreanof Islands, Alaska	7.9	
1972/12/23	Nicaragua	6.2	5,000	1997/05/10	Northern Iran	7.3	1,567
1974/05/10	Near Zhaotong, China	6.8	20,000	1997/10/14	South of Fiji Islands	7.8	
1974/07/13	Panama-Colombia border region	7.3	11	1997/12/05	Near East Coast of Kamchatka	7.8	
1974/10/03	Near the Coast of Central Peru	8.1	78	1998/01/04	Loyalty Islands Region	7.5	



Date	Location	Magnitude	Fatalities	Date	Location	Magnitude	Fatalities
1998/02/04	Afghanistan-Tajikistan Border Region	5.9	2,323	2003/09/25	Hokkaido, Japan Region	8.3	
1998/03/25	Balleny Islands Region (off Antarctica)	8.1		2003/09/27	Southwestern Siberia, Russia	7.3	3
1998/05/03	Southeast of Taiwan	7.5		2003/11/17	Rat Islands, Aleutian Islands, Alaska	7.8	
1998/05/30	Afghanistan-Tajikistan Border Region	6.6	4,000	2003/12/26	Southeastern Iran	6.6	31,000
1998/07/17	Near North Coast of New Guinea, Papua New Guinea	7.0	2,183	2004/02/05	Irian Jaya, Indonesia	7.0	37
1999/01/25	Colombia	6.1	1,185	2004/11/11	Kepulauan Alor, Indonesia	7.5	34
1999/08/17	Izmit, Turkey	7.6	17,118	2004/11/26	Papua, Indonesia	7.1	32
1999/09/20	Taiwan	7.6	2,400	2004/12/23	North of Macquarie Island, New Zealand	8.1	
1999/09/30	Oaxaca, Mexico	7.5		2004/12/26	Sumatra-Andaman Islands	9.1	227,898
1999/11/12	Duzce, Turkey	7.2	894	2005/03/28	Northern Sumatra, Indonesia	8.6	1,313
2000/06/04	Southern Sumatera, Indonesia	7.9	103	2005/06/13	Tarapaca, Chile	7.8	11
2000/06/18	South Indian Ocean	7.9		2005/09/09	New Ireland Region, Papua New Guinea	7.6	
2000/11/16	New Ireland Region, Papua New Guinea	8.0	2	2005/09/26	Northern Peru	7.5	5
2001/01/01	Mindanao, Philippines	7.5		2005/10/08	Pakistan	7.6	86,000
2001/01/13	El Salvador	7.7	852	2006/01/27	Banda Sea	7.6	
2001/01/26	Gujarat, India	7.6	20,085	2006/02/22	Mozambique	7.0	4
2001/02/13	El Salvador	6.6	315	2006/04/20	Koryakia, Russia	7.6	
2001/06/23	Near the Coast of Peru	8.4	138	2006/05/03	Tonga	8.0	
2002/03/03	Hindu Kush Region, Afghanistan	7.4	166	2006/05/26	Java, Indonesia	6.3	5,749
2002/03/05	Mindanao, Philippines	7.5	15	2006/07/17	South of Java, Indonesia	7.7	730
2002/03/25	Hindu Kush Region, Afghanistan	6.1	1,000	2006/11/15	Kuril Islands	8.3	
2002/03/31	Taiwan region	7.1	5	2006/12/26	Taiwan Region	7.1	2
2002/08/19	Fiji Islands	7.7		2007/01/13	East of the Kuril Islands	8.1	
2002/09/08	New Guinea, Papua New Guinea	7.6		2007/01/21	Molucca Sea	7.5	
2002/10/10	Irian Jaya, Indonesia	7.6	8	2007/04/01	Solomon Islands	8.1	40
2002/11/02	Northern Sumatera, Indonesia	7.4	3	2007/08/08	Java, Indonesia	7.5	
2002/11/03	Denali Fault, Alaska	7.9		2007/08/15	Near the Coast of Central Peru	8.0	514
2003/01/22	Offshore Colima, Mexico	7.6	29	2007/09/12	Southern Sumatra, Indonesia	8.5	25
2003/05/21	Northern Algeria	6.8	2,226	2007/09/12	Kepulauan Mentawai region, Indonesia	7.9	
2003/05/26	Halmahera, Indonesia	7.0	1	2007/09/28	Mariana Islands region	7.5	
2003/07/15	Carlsberg Ridge	7.6		2007/11/14	Antofagasta, Chile	7.7	2
2003/08/04	Scotia Sea	7.6		2007/12/09	South of the Fiji Islands	7.8	
				2008/05/12	Eastern Sichuan, China	7.9	87,652
				2008/07/05	Sea of Okhotsk	7.7	



## STANDARD ITS-90 THERMOCOUPLE TABLES

The Instrument Society of America (ISA) has assigned standard letter designations to a number of thermocouple types having specified emf-temperature relations. These designations and the approximate metal compositions which meet the required relations, as well as the useful temperature ranges, are given below:

Type B	(Pt + 30% Rh) vs. (Pt + 6% Rh)	0 to 1820°C
Type E	(Ni + 10% Cr) vs. (Cu + 43% Ni)	-270 to 1000°C
Type J	Fe vs. (Cu + 43% Ni)	-210 to 1200°C
Type K	(Ni + 10% Cr) vs. (Ni + 2% Al + 2% Mn + 1% Si)	-270 to 1372°C
Type N	(Ni + 14% Cr + 1.5% Si) vs. (Ni + 4.5% Si + 0.1% Mg)	-270 to 1300°C
Type R	(Pt + 13% Rh) vs. Pt	-50 to 1768°C
Type S	(Pt + 10% Rh) vs. Pt	-50 to 1768°C
Type T	Cu vs. (Cu + 43% Ni)	-270 to 400°C

The compositions are given in weight percent, and the positive leg is listed first. It should be emphasized that the standard letter

designations do not imply a precise composition but rather that the specified emf-temperature relation is satisfied.

The first set of tables below lists, for each thermocouple type, the emf as a function of temperature on the International Temperature Scale of 1990 (ITS-90). The coefficients in the equation used to generate the table are also given. The second set of tables gives the inverse relationships, i.e., the coefficients in the polynomial equation which expresses the temperature as a function of thermocouple emf. The accuracy of these equations is also stated.

Further details and tables at closer intervals may be found in Reference 1.

### References

1. Burns, G. W., Seroger, M. G., Strouse, G. F., Croarkin, M. C., and Guthrie, W. E., *Temperature-Electromotive Force Reference Functions and Tables for the Letter-Designated Thermocouple Types Based on the ITS-90*, Natl. Inst. Stand. Tech. (U.S.) Monogr. 175, 1993.
2. Schooley, J. E., *Thermometry*, CRC Press, Boca Raton, FL, 1986.

**Type B Thermocouples: emf-Temperature (°C) Reference Table and Equations**  
Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts										
	0	10	20	30	40	50	60	70	80	90	100
0	0.000	-0.002	-0.003	-0.002	-0.000	0.002	0.006	0.011	0.017	0.025	0.033
100	0.033	0.043	0.053	0.065	0.078	0.092	0.107	0.123	0.141	0.159	0.178
200	0.178	0.199	0.220	0.243	0.267	0.291	0.317	0.344	0.372	0.401	0.431
300	0.431	0.462	0.494	0.527	0.561	0.596	0.632	0.669	0.707	0.746	0.787
400	0.787	0.828	0.870	0.913	0.957	1.002	1.048	1.095	1.143	1.192	1.242
500	1.242	1.293	1.344	1.397	1.451	1.505	1.561	1.617	1.675	1.733	1.792
600	1.792	1.852	1.913	1.975	2.037	2.101	2.165	2.230	2.296	2.363	2.431
700	2.431	2.499	2.569	2.639	2.710	2.782	2.854	2.928	3.002	3.078	3.154
800	3.154	3.230	3.308	3.386	3.466	3.546	3.626	3.708	3.790	3.873	3.957
900	3.957	4.041	4.127	4.213	4.299	4.387	4.475	4.564	4.653	4.743	4.834
1000	4.834	4.926	5.018	5.111	5.205	5.299	5.394	5.489	5.585	5.682	5.780
1100	5.780	5.878	5.976	6.075	6.175	6.276	6.377	6.478	6.580	6.683	6.786
1200	6.786	6.890	6.995	7.100	7.205	7.311	7.417	7.524	7.632	7.740	7.848
1300	7.848	7.957	8.066	8.176	8.286	8.397	8.508	8.620	8.731	8.844	8.956
1400	8.956	9.069	9.182	9.296	9.410	9.524	9.639	9.753	9.868	9.984	10.099
1500	10.099	10.215	10.331	10.447	10.563	10.679	10.796	10.913	11.029	11.146	11.263
1600	11.263	11.380	11.497	11.614	11.731	11.848	11.965	12.082	12.199	12.316	12.433
1700	12.433	12.549	12.666	12.782	12.898	13.014	13.130	13.246	13.361	13.476	13.591
1800	13.591	13.706	13.820								

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the tem-

perature in degrees Celsius (ITS- 90), and  $c_0, c_1, c_2, c_3,$  etc. are the coefficients. These coefficients are extracted from Reference 1.

0 °C to 630.615 °C		630.615 °C to 1820 °C	
$c_0$	= 0.000 000 000 0	$c_0$	= -3.893 816 862 1 ...
$c_1$	= -2.465 081 834 6 × 10 <sup>-4</sup>	$c_1$	= 2.857 174 747 0 × 10 <sup>-2</sup>
$c_2$	= 5.904 042 117 1 × 10 <sup>-6</sup>	$c_2$	= -8.488 510 478 5 × 10 <sup>-5</sup>
$c_3$	= -1.325 793 163 6 × 10 <sup>-9</sup>	$c_3$	= 1.578 528 016 4 × 10 <sup>-7</sup>
$c_4$	= 1.566 829 190 1 × 10 <sup>-12</sup>	$c_4$	= -1.683 534 486 4 × 10 <sup>-10</sup>
$c_5$	= -1.694 452 924 0 × 10 <sup>-15</sup>	$c_5$	= 1.110 979 401 3 × 10 <sup>-13</sup>
$c_6$	= 6.299 034 709 4 × 10 <sup>-19</sup>	$c_6$	= -4.451 543 103 3 × 10 <sup>-17</sup>
$c_7$	= .....	$c_7$	= 9.897 564 082 1 × 10 <sup>-21</sup>
$c_8$	= .....	$c_8$	= -9.379 133 028 9 × 10 <sup>-25</sup>

**Type E Thermocouples: emf-Temperature (°C) Reference Table and Equations**  
 Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts									Reference junctions at 0 °C		
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100	
-200	-8.825	-9.063	-9.274	-9.455	-9.604	-9.718	-9.797	-9.835				
-100	-5.237	-5.681	-6.107	-6.516	-6.907	-7.279	-7.632	-7.963	-8.273	-8.561	-8.825	
0	0.000	-0.582	-1.152	-1.709	-2.255	-2.787	-3.306	-3.811	-4.302	-4.777	-5.237	
°C	0	10	20	30	40	50	60	70	80	90	100	
0	0.000	0.591	1.192	1.801	2.420	3.048	3.685	4.330	4.985	5.648	6.319	
100	6.319	6.998	7.685	8.379	9.081	9.789	10.503	11.224	11.951	12.684	13.421	
200	13.421	14.164	14.912	15.664	16.420	17.181	17.945	18.713	19.484	20.259	21.036	
300	21.036	21.817	22.600	23.386	24.174	24.964	25.757	26.552	27.348	28.146	28.946	
400	28.946	29.747	30.550	31.354	32.159	32.965	33.772	34.579	35.387	36.196	37.005	
500	37.005	37.815	38.624	39.434	40.243	41.053	41.862	42.671	43.479	44.286	45.093	
600	45.093	45.900	46.705	47.509	48.313	49.116	49.917	50.718	51.517	52.315	53.112	
700	53.112	53.908	54.703	55.497	56.289	57.080	57.870	58.659	59.446	60.232	61.017	
800	61.017	61.801	62.583	63.364	64.144	64.922	65.698	66.473	67.246	68.017	68.787	
900	68.787	69.554	70.319	71.082	71.844	72.603	73.360	74.115	74.869	75.621	76.373	
1000	76.373											

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the tem-

perature in degrees Celsius (ITS- 90), and  $c_0, c_1, c_2, c_3$ , etc. are the coefficients. These coefficients are extracted from Reference 1.

-270 to 0°C		0°C to 1000°C	
$c_0$	= 0.000 000 000 0 ...	$c_0$	= 0.000 000 000 0 ...
$c_1$	= 5.866 550 870 8 × 10 <sup>-2</sup>	$c_1$	= 5.866 550 871 0 × 10 <sup>-2</sup>
$c_2$	= 4.541 097 712 4 × 10 <sup>-5</sup>	$c_2$	= 4.503 227 558 2 × 10 <sup>-5</sup>
$c_3$	= -7.799 804 868 6 × 10 <sup>-7</sup>	$c_3$	= 2.890 840 721 2 × 10 <sup>-8</sup>
$c_4$	= -2.580 016 084 3 × 10 <sup>-8</sup>	$c_4$	= -3.305 689 665 2 × 10 <sup>-10</sup>
$c_5$	= -5.945 258 305 7 × 10 <sup>-10</sup>	$c_5$	= 6.502 440 327 0 × 10 <sup>-13</sup>
$c_6$	= -9.321 405 866 7 × 10 <sup>-12</sup>	$c_6$	= -1.919 749 550 4 × 10 <sup>-16</sup>
$c_7$	= -1.028 760 553 4 × 10 <sup>-13</sup>	$c_7$	= -1.253 660 049 7 × 10 <sup>-18</sup>
$c_8$	= -8.037 012 362 1 × 10 <sup>-16</sup>	$c_8$	= 2.148 921 756 9 × 10 <sup>-21</sup>
$c_9$	= -4.397 949 739 1 × 10 <sup>-18</sup>	$c_9$	= -1.438 804 178 2 × 10 <sup>-24</sup>
$c_{10}$	= -1.641 477 635 5 × 10 <sup>-20</sup>	$c_{10}$	= 3.596 089 948 1 × 10 <sup>-28</sup>
$c_{11}$	= -3.967 361 951 6 × 10 <sup>-23</sup>	$c_{11}$	= .....
$c_{12}$	= -5.582 732 872 1 × 10 <sup>-26</sup>	$c_{12}$	= .....
$c_{13}$	= -3.465 784 201 3 × 10 <sup>-29</sup>	$c_{13}$	= .....

**Type J Thermocouples: emf-Temperature (°C) Reference Table and Equations**  
 Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts									Reference junctions at 0 °C		
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100	
-200	-7.890	-8.095										
-100	-4.633	-5.037	-5.426	-5.801	-6.159	-6.500	-6.821	-7.123	-7.403	-7.659	-7.890	
0	0.000	-0.501	-0.995	-1.482	-1.961	-2.431	-2.893	-3.344	-3.786	-4.215	-4.633	

°C	emf in Millivolts							Reference junctions at 0 °C			
	0	10	20	30	40	50	60	70	80	90	100
0	0.000	0.507	1.019	1.537	2.059	2.585	3.116	3.650	4.187	4.726	5.269
100	5.269	5.814	6.360	6.909	7.459	8.010	8.562	9.115	9.669	10.224	10.779
200	10.779	11.334	11.889	12.445	13.000	13.555	14.110	14.665	15.219	15.773	16.327
300	16.327	16.881	17.434	17.986	18.538	19.090	19.642	20.194	20.745	21.297	21.848
400	21.848	22.400	22.952	23.504	24.057	24.610	25.164	25.720	26.276	26.834	27.393
500	27.393	27.953	28.516	29.080	29.647	30.216	30.788	31.362	31.939	32.519	33.102
600	33.102	33.689	34.279	34.873	35.470	36.071	36.675	37.284	37.896	38.512	39.132
700	39.132	39.755	40.382	41.012	41.645	42.281	42.919	43.559	44.203	44.848	45.494
800	45.494	46.141	46.786	47.431	48.074	48.715	49.353	49.989	50.622	51.251	51.877
900	51.877	52.500	53.119	53.735	54.347	54.956	55.561	56.164	56.763	57.360	57.953
1000	57.953	58.545	59.134	59.721	60.307	60.890	61.473	62.054	62.634	63.214	63.792
1100	63.792	64.370	64.948	65.525	66.102	66.679	67.255	67.831	68.406	68.980	69.553
1200	69.553										

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the tem-

perature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3$ , etc. are the coefficients. These coefficients are extracted from Reference 1.

	-260°C to 760°C	760°C to 1200°C
$c_0$	= 0.000 000 000 0 ...	$2.964\ 562\ 568\ 1 \times 10^2$
$c_1$	= $5.038\ 118\ 781\ 5 \times 10^{-2}$	$-1.497\ 612\ 778\ 6 \dots$
$c_2$	= $3.047\ 583\ 693\ 0 \times 10^{-5}$	$3.178\ 710\ 392\ 4 \times 10^{-3}$
$c_3$	= $-8.568\ 106\ 572\ 0 \times 10^{-8}$	$-3.184\ 768\ 670\ 1 \times 10^{-6}$
$c_4$	= $1.322\ 819\ 529\ 5 \times 10^{-10}$	$1.572\ 081\ 900\ 4 \times 10^{-9}$
$c_5$	= $-1.705\ 295\ 833\ 7 \times 10^{-13}$	$-3.069\ 136\ 905\ 6 \times 10^{-13}$
$c_6$	= $2.094\ 809\ 069\ 7 \times 10^{-16}$	.....
$c_7$	= $-1.253\ 839\ 533\ 6 \times 10^{-19}$	.....
$c_8$	= $1.563\ 172\ 569\ 7 \times 10^{-23}$	.....

**Type K Thermocouples: emf-Temperature (°C) Reference Table and Equations**

Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts							Reference junctions at 0 °C			
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
-200	-5.891	-6.035	-6.158	-6.262	-6.344	-6.404	-6.441	-6.458	-5.550	-5.730	-5.891
-100	-3.554	-3.852	-4.138	-4.411	-4.669	-4.913	-5.141	-5.354	-2.920	-3.243	-3.554
0	0.000	-0.392	-0.778	-1.156	-1.527	-1.889	-2.243	-2.587			
°C	0	10	20	30	40	50	60	70	80	90	100
0	0.000	0.397	0.798	1.203	1.612	2.023	2.436	2.851	3.267	3.682	4.096
100	4.096	4.509	4.920	5.328	5.735	6.138	6.540	6.941	7.340	7.739	8.138
200	8.138	8.539	8.940	9.343	9.747	10.153	10.561	10.971	11.382	11.795	12.209
300	12.209	12.624	13.040	13.457	13.874	14.293	14.713	15.133	15.554	15.975	16.397
400	16.397	16.820	17.243	17.667	18.091	18.516	18.941	19.366	19.792	20.218	20.644
500	20.644	21.071	21.497	21.924	22.350	22.776	23.203	23.629	24.055	24.480	24.905
600	24.905	25.330	25.755	26.179	26.602	27.025	27.447	27.869	28.289	28.710	29.129
700	29.129	29.548	29.965	30.382	30.798	31.213	31.628	32.041	32.453	32.865	33.275
800	33.275	33.685	34.093	34.501	34.908	35.313	35.718	36.121	36.524	36.925	37.326
900	37.326	37.725	38.124	38.522	38.918	39.314	39.708	40.101	40.494	40.885	41.276
1000	41.276	41.665	42.053	42.440	42.826	43.211	43.595	43.978	44.359	44.740	45.119
1100	45.119	45.497	45.873	46.249	46.623	46.995	47.367	47.737	48.105	48.473	48.838
1200	48.838	49.202	49.565	49.926	50.286	50.644	51.000	51.355	51.708	52.060	52.410
1300	52.410	52.759	53.106	53.451	53.795	54.138	54.479	54.819			

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the temperature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3$ , etc. are the coefficients. In the 0°C to 1372°C range there is also an exponen-

tial term that must be evaluated and added to the equation. The exponential term is of the form:  $c_0 e^{c_1 (t-126.9686)^2}$ , where t is the temperature in °C, e is the natural logarithm base, and  $c_0$  and  $c_1$  are the coefficients. These coefficients are extracted from Reference 1.

	-270°C to 0°C	0°C to 1372°C	0°C to 1372°C (Exponential term)
$c_0$	= 0.000 000 000 0	-1.760 041 368 6 × 10 <sup>-2</sup>	1.185 976 × 10 <sup>-1</sup>
$c_1$	= 3.945 012 802 5 × 10 <sup>-2</sup>	3.892 120 497 5 × 10 <sup>-2</sup>	-1.183 432 × 10 <sup>-4</sup>
$c_2$	= 2.362 237 359 8 × 10 <sup>-5</sup>	1.855 877 003 2 × 10 <sup>-5</sup>	.....
$c_3$	= -3.285 890 678 4 × 10 <sup>-7</sup>	-9.945 759 287 4 × 10 <sup>-8</sup>	.....
$c_4$	= -4.990 482 877 7 × 10 <sup>-9</sup>	3.184 094 571 9 × 10 <sup>-10</sup>	.....
$c_5$	= -6.750 905 917 3 × 10 <sup>-11</sup>	-5.607 284 488 9 × 10 <sup>-13</sup>	.....
$c_6$	= -5.741 032 742 8 × 10 <sup>-13</sup>	5.607 505 905 9 × 10 <sup>-16</sup>	.....
$c_7$	= -3.108 887 289 4 × 10 <sup>-15</sup>	-3.202 072 000 3 × 10 <sup>-19</sup>	.....
$c_8$	= -1.045 160 936 5 × 10 <sup>-17</sup>	9.715 114 715 2 × 10 <sup>-23</sup>	.....
$c_9$	= -1.988 926 687 8 × 10 <sup>-20</sup>	-1.210 472 127 5 × 10 <sup>-26</sup>	.....
$c_{10}$	= -1.632 269 748 6 × 10 <sup>-23</sup>	.....	.....

**Type N Thermocouples: emf-Temperature (°C) Reference Table and Equations**  
 Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts							Reference junctions at 0 °C				
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100	
-200	3.990	-4.083	-4.162	-4.226	-4.277	-4.313	-4.336	-4.345				
-100	-2.407	-2.612	2.808	2.994	3.171	3.336	-3.491	3.634	-3.766	-3.884	-3.990	
0	0.000	-0.260	-0.518	-0.772	-1.023	-1.269	-1.509	1.744	-1.972	-2.193	-2.407	
°C	0	10	20	30	40	50	60	70	80	90	100	
0	0.000	0.261	0.525	0.793	1.065	1.340	1.619	1.902	2.189	2.480	2.774	
100	2.774	3.072	3.374	3.680	3.989	4.302	4.618	4.937	5.259	5.585	5.913	
200	5.913	6.245	6.579	6.916	7.255	7.597	7.941	8.288	8.637	8.988	9.341	
300	9.341	9.696	10.054	10.413	10.774	11.136	11.501	11.867	12.234	12.603	12.974	
400	12.974	13.346	13.719	14.094	14.469	14.846	15.225	15.604	15.984	16.366	16.748	
500	16.748	17.131	17.515	17.900	18.286	18.672	19.059	19.447	19.835	20.224	20.613	
600	20.613	21.003	21.393	21.784	22.175	22.566	22.958	23.350	23.742	24.134	24.527	
700	24.527	24.919	25.312	25.705	26.098	26.491	26.883	27.276	27.669	28.062	28.455	
800	28.455	28.847	29.239	29.632	30.024	30.416	30.807	31.199	31.590	31.981	32.371	
900	32.371	32.761	33.151	33.541	33.930	34.319	34.707	35.095	35.482	35.869	36.256	
1000	36.256	36.641	37.027	37.411	37.795	38.179	38.562	38.944	39.326	39.706	40.087	
1100	40.087	40.466	40.845	41.223	41.600	41.976	42.352	42.727	43.101	43.474	43.846	
1200	43.846	44.218	44.588	44.958	45.326	45.694	46.060	46.425	46.789	47.152	47.513	
1300	47.513											

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the tem-

perature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3$ , etc. are the coefficients. These coefficients are extracted from Reference 1.

	-270°C to 0°C	0°C to 1300°C
$c_0$	= 0.000 000 000 0 ...	0.000 000 000 0...
$c_1$	= 2.615 910 596 2 × 10 <sup>-2</sup>	2.592 939 460 1 × 10 <sup>-2</sup>
$c_2$	= 1.095 748 422 8 × 10 <sup>-5</sup>	1.571 014 188 0 × 10 <sup>-5</sup>
$c_3$	= -9.384 111 155 4 × 10 <sup>-8</sup>	4.382 562 723 7 × 10 <sup>-8</sup>
$c_4$	= -4.641 203 975 9 × 10 <sup>-11</sup>	-2.526 116 979 4 × 10 <sup>-10</sup>
$c_5$	= -2.630 335 771 6 × 10 <sup>-12</sup>	6.431 181 933 9 × 10 <sup>-13</sup>
$c_6$	= -2.265 343 800 3 × 10 <sup>-14</sup>	-1.006 347 151 9 × 10 <sup>-15</sup>
$c_7$	= -7.608 930 079 1 × 10 <sup>-17</sup>	9.974 533 899 2 × 10 <sup>-19</sup>
$c_8$	= -9.341 966 783 5 × 10 <sup>-20</sup>	-6.086 324 560 7 × 10 <sup>-22</sup>
$c_9$	= .....	2.084 922 933 9 × 10 <sup>-25</sup>
$c_{10}$	= .....	-3.068 219 615 1 × 10 <sup>-29</sup>

**Type R Thermocouples: emf-Temperature (°C) Reference Table and Equations**

Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts										
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
0	0.000	-0.051	-0.100	-0.145	-0.188	-0.226					
°C	0	10	20	30	40	50	60	70	80	90	100
0	0.000	0.054	0.111	0.171	0.232	0.296	0.363	0.431	0.501	0.573	0.647
100	0.647	0.723	0.800	0.879	0.959	1.041	1.124	1.208	1.294	1.381	1.469
200	1.469	1.558	1.648	1.739	1.831	1.923	2.017	2.112	2.207	2.304	2.401
300	2.401	2.498	2.597	2.696	2.796	2.896	2.997	3.099	3.201	3.304	3.408
400	3.408	3.512	3.616	3.721	3.827	3.933	4.040	4.147	4.255	4.363	4.471
500	4.471	4.580	4.690	4.800	4.910	5.021	5.133	5.245	5.357	5.470	5.583
600	5.583	5.697	5.812	5.926	6.041	6.157	6.273	6.390	6.507	6.625	6.743
700	6.743	6.861	6.980	7.100	7.220	7.340	7.461	7.583	7.705	7.827	7.950
800	7.950	8.073	8.197	8.321	8.446	8.571	8.697	8.823	8.950	9.077	9.205
900	9.205	9.333	9.461	9.590	9.720	9.850	9.980	10.111	10.242	10.374	10.506
1000	10.506	10.638	10.771	10.905	11.039	11.173	11.307	11.442	11.578	11.714	11.850
1100	11.850	11.986	12.123	12.260	12.397	12.535	12.673	12.812	12.950	13.089	13.228
1200	13.228	13.367	13.507	13.646	13.786	13.926	14.066	14.207	14.347	14.488	14.629
1300	14.629	14.770	14.911	15.052	15.193	15.334	15.475	15.616	15.758	15.899	16.040
1400	16.040	16.181	16.323	16.464	16.605	16.746	16.887	17.028	17.169	17.310	17.451
1500	17.451	17.591	17.732	17.872	18.012	18.152	18.292	18.431	18.571	18.710	18.849
1600	18.849	18.988	19.126	19.264	19.402	19.540	19.677	19.814	19.951	20.087	20.222
1700	20.222	20.356	20.488	20.620	20.749	20.877	21.003				

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the temperature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3, \dots$  etc. are the coefficients. These coefficients are extracted from Reference 1.

	-50°C to 1064.18°C	1064.18°C to 1664.5°C	1664.5°C to 1768.1°C
$c_0$	= 0.000 000 000 00 ...	2.951 579 253 16 ...	1.522 321 182 09 × 10 <sup>2</sup>
$c_1$	= 5.289 617 297 65 × 10 <sup>-3</sup>	-2.520 612 513 32 × 10 <sup>-3</sup>	-2.688 198 885 45 × 10 <sup>-1</sup>
$c_2$	= 1.391 665 897 82 × 10 <sup>-5</sup>	1.595 645 018 65 × 10 <sup>-5</sup>	1.712 802 804 71 × 10 <sup>-4</sup>
$c_3$	= -2.388 556 930 17 × 10 <sup>-8</sup>	-7.640 859 475 76 × 10 <sup>-9</sup>	-3.458 957 064 53 × 10 <sup>-8</sup>
$c_4$	= 3.569 160 010 63 × 10 <sup>-11</sup>	2.053 052 910 24 × 10 <sup>-12</sup>	-9.346 339 710 46 × 10 <sup>-15</sup>
$c_5$	= -4.623 476 662 98 × 10 <sup>-14</sup>	-2.933 596 681 73 × 10 <sup>-16</sup>	.....
$c_6$	= 5.007 774 410 34 × 10 <sup>-17</sup>	.....	.....
$c_7$	= -3.731 058 861 91 × 10 <sup>-20</sup>	.....	.....
$c_8$	= 1.577 164 823 67 × 10 <sup>-23</sup>	.....	.....
$c_9$	= -2.810 386 252 51 × 10 <sup>-27</sup>	.....	.....

**Type S Thermocouples: emf-Temperature (°C) Reference Table and Equations.**

Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts										
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
0	0.000	-0.053	-0.103	-0.150	-0.194	-0.236					
°C	0	10	20	30	40	50	60	70	80	90	100
0	0.000	0.055	0.113	0.173	0.235	0.299	0.365	0.433	0.502	0.573	0.646
100	0.646	0.720	0.795	0.872	0.950	1.029	1.110	1.191	1.273	1.357	1.441
200	1.441	1.526	1.612	1.698	1.786	1.874	1.962	2.052	2.141	2.232	2.323
300	2.323	2.415	2.507	2.599	2.692	2.786	2.880	2.974	3.069	3.164	3.259
400	3.259	3.355	3.451	3.548	3.645	3.742	3.840	3.938	4.036	4.134	4.233
500	4.233	4.332	4.432	4.532	4.632	4.732	4.833	4.934	5.035	5.137	5.239
600	5.239	5.341	5.443	5.546	5.649	5.753	5.857	5.961	6.065	6.170	6.275
700	6.275	6.381	6.486	6.593	6.699	6.806	6.913	7.020	7.128	7.236	7.345
800	7.345	7.454	7.563	7.673	7.783	7.893	8.003	8.114	8.226	8.337	8.449
900	8.449	8.562	8.674	8.787	8.900	9.014	9.128	9.242	9.357	9.472	9.587
1000	9.587	9.703	9.819	9.935	10.051	10.168	10.285	10.403	10.520	10.638	10.757
1100	10.757	10.875	10.994	11.113	11.232	11.351	11.471	11.590	11.710	11.830	11.951
1200	11.951	12.071	12.191	12.312	12.433	12.554	12.675	12.796	12.917	13.038	13.159

**Type S Thermocouples: emf-Temperature (°C) Reference Table and Equations.**

Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts										
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
1300	13.159	13.280	13.402	13.523	13.644	13.766	13.887	14.009	14.130	14.251	14.373
1400	14.373	14.494	14.615	14.736	14.857	14.978	15.099	15.220	15.341	15.461	15.582
1500	15.582	15.702	15.822	15.942	16.062	16.182	16.301	16.420	16.539	16.658	16.777
1600	16.777	16.895	17.013	17.131	17.249	17.366	17.483	17.600	17.717	17.832	17.947
1700	17.947	18.061	18.174	18.285	18.395	18.503	18.609				

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the temperature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3,$  etc. are the coefficients. These coefficients are extracted from Reference 1.

	-50°C to 1064.18°C	1064.18°C to 1664.5°C	1664.5°C to 1768.1°C
$c_0$	= 0.000 000 000 00 ...	1.329 004 440 85 ...	1.466 282 326 36 × 10 <sup>2</sup>
$c_1$	= 5.403 133 086 31 × 10 <sup>-3</sup>	3.345 093 113 44 × 10 <sup>-3</sup>	-2.584 305 167 52 × 10 <sup>-1</sup>
$c_2$	= 1.259 342 897 40 × 10 <sup>-5</sup>	6.548 051 928 18 × 10 <sup>-6</sup>	1.636 935 746 41 × 10 <sup>-4</sup>
$c_3$	= -2.324 779 686 89 × 10 <sup>-8</sup>	-1.648 562 592 09 × 10 <sup>-9</sup>	-3.304 390 469 87 × 10 <sup>-8</sup>
$c_4$	= 3.220 288 230 36 × 10 <sup>-11</sup>	1.299 896 051 74 × 10 <sup>-14</sup>	-9.432 236 906 12 × 10 <sup>-15</sup>
$c_5$	= -3.314 651 963 89 × 10 <sup>-14</sup>	.....	.....
$c_6$	= 2.557 442 517 86 × 10 <sup>-17</sup>	.....	.....
$c_7$	= -1.250 688 713 93 × 10 <sup>-20</sup>	.....	.....
$c_8$	= 2.714 431 761 45 × 10 <sup>-24</sup>	.....	.....

**Type T Thermocouples: emf-Temperature (°C) Reference Table and Equations.**

Thermocouple emf as a Function of Temperature in Degrees Celsius (ITS-90)

°C	emf in Millivolts										
	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100
-200	-5.603	-5.753	-5.888	-6.007	-6.105	-6.180	-6.232	-6.258			
-100	-3.379	-3.657	-3.923	-4.177	-4.419	-4.648	-4.865	-5.070	-5.261	-5.439	-5.603
0	0.000	-0.383	-0.757	-1.121	-1.475	-1.819	-2.153	-2.476	-2.788	-3.089	-3.379
°C	0	10	20	30	40	50	60	70	80	90	100
0	0.000	0.391	0.790	1.196	1.612	2.036	2.468	2.909	3.358	3.814	4.279
100	4.279	4.750	5.228	5.714	6.206	6.704	7.209	7.720	8.237	8.759	9.288
200	9.288	9.822	10.362	10.907	11.458	12.013	12.574	13.139	13.709	14.283	14.862
300	14.862	15.445	16.032	16.624	17.219	17.819	18.422	19.030	19.641	20.255	20.872
400	20.872										

Temperature ranges and coefficients of equations used to compute the above table: The equations are of the form:  $E = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + \dots + c_n t^n$ , where E is the emf in millivolts, t is the temperature in degrees Celsius (ITS-90), and  $c_0, c_1, c_2, c_3,$  etc. are the coefficients. These coefficients are extracted from Reference 1.

	270 °C to 0 °C	0 °C to 400 °C
$c_0$	= 0.000 000 000 0 ...	0.000 000 000 0 ...
$c_1$	= 3.874 810 636 4 × 10 <sup>-2</sup>	3.874 810 636 4 × 10 <sup>-2</sup>
$c_2$	= 4.419 443 434 7 × 10 <sup>-5</sup>	3.329 222 788 0 × 10 <sup>-5</sup>
$c_3$	= 1.184 432 310 5 × 10 <sup>-7</sup>	2.061 824 340 4 × 10 <sup>-7</sup>
$c_4$	= 2.003 297 355 4 × 10 <sup>-8</sup>	-2.188 225 684 6 × 10 <sup>-9</sup>
$c_5$	= 9.013 801 955 9 × 10 <sup>-10</sup>	1.099 688 092 8 × 10 <sup>-11</sup>
$c_6$	= 2.265 115 659 3 × 10 <sup>-11</sup>	-3.081 575 877 2 × 10 <sup>-14</sup>
$c_7$	= 3.607 115 420 5 × 10 <sup>-13</sup>	4.547 913 529 0 × 10 <sup>-17</sup>
$c_8$	= 3.849 393 988 3 × 10 <sup>-15</sup>	-2.751 290 167 3 × 10 <sup>-20</sup>
$c_9$	= 2.821 352 192 5 × 10 <sup>-17</sup>	.....
$c_{10}$	= 1.425 159 477 9 × 10 <sup>-19</sup>	.....
$c_{11}$	= 4.876 866 228 6 × 10 <sup>-22</sup>	.....
$c_{12}$	= 1.079 553 927 0 × 10 <sup>-24</sup>	.....
$c_{13}$	= 1.394 502 706 2 × 10 <sup>-27</sup>	.....
$c_{14}$	= 7.979 515 392 7 × 10 <sup>-31</sup>	.....

**Type B Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	250 °C to 700 °C	700 °C to 1820 °C
emf range:	0.291 mV to 2.431 mV	2.431 mV to 13.820 mV
$c_0 =$	$9.842\ 332\ 1 \times 10^1$	$2.131\ 507\ 1 \times 10^2$
$c_1 =$	$6.997\ 150\ 0 \times 10^2$	$2.851\ 050\ 4 \times 10^2$
$c_2 =$	$-8.476\ 530\ 4 \times 10^2$	$-5.274\ 288\ 7 \times 10^1$
$c_3 =$	$1.005\ 264\ 4 \times 10^3$	$9.916\ 080\ 4 \dots$
$c_4 =$	$-8.334\ 595\ 2 \times 10^2$	$-1.296\ 530\ 3 \dots$
$c_5 =$	$4.550\ 854\ 2 \times 10^2$	$1.119\ 587\ 0 \times 10^{-1}$
$c_6 =$	$-1.552\ 303\ 7 \times 10^2$	$-6.062\ 519\ 9 \times 10^{-3}$
$c_7 =$	$2.988\ 675\ 0 \times 10^1$	$1.866\ 169\ 6 \times 10^{-4}$
$c_8 =$	$-2.474\ 286\ 0 \dots$	$-2.487\ 858\ 5 \times 10^{-6}$

NOTE— The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.03$  °C with the values given in Table 10.2.

**Type E Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-200 °C TO 0 °C	0 °C to 1000 °C
emf range:	-8.825 mV to 0.0 mV	0.0 mV to 76.373 mV
$c_0 =$	0.000 000 0 ...	0.000 000 0 ...
$c_1 =$	$1.697\ 728\ 8 \times 10^1$	$1.705\ 703\ 5 \times 10^1$
$c_2 =$	$-4.351\ 497\ 0 \times 10^{-1}$	$-2.330\ 175\ 9 \times 10^{-1}$
$c_3 =$	$-1.585\ 969\ 7 \times 10^{-1}$	$6.543\ 558\ 5 \times 10^{-3}$
$c_4 =$	$-9.250\ 287\ 1 \times 10^{-2}$	$-7.356\ 274\ 9 \times 10^{-5}$
$c_5 =$	$-2.608\ 431\ 4 \times 10^{-2}$	$-1.789\ 600 \times 10^{-6}$
$c_6 =$	$-4.136\ 019\ 9 \times 10^{-3}$	$8.403\ 616\ 5 \times 10^{-8}$
$c_7 =$	$-3.403\ 403\ 0 \times 10^{-4}$	$-1.373\ 587\ 9 \times 10^{-9}$
$c_8 =$	$-1.156\ 489\ 0 \times 10^{-5}$	$1.062\ 982\ 3 \times 10^{-11}$
$c_9 =$	.....	$-3.244\ 708\ 7 \times 10^{-14}$

NOTE— The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.02$  °C with the values given in Table 10.4

**Type J Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-210 °C to 0 °C	0 °C to 760 °C	760 °C to 1200 °C
emf Range:	-8.095 mV to 0.0 mV	0.0 mV to 42.919 mV	42.919 mV to 69.553 mV
$c_0 =$	0.000 000 0...	0.000 000 ...	$-3.113\ 581\ 87 \times 10^3$
$c_1 =$	$1.952\ 826\ 8 \times 10^1$	$1.978\ 425 \times 10^1$	$3.005\ 436\ 84 \times 10^2$
$c_2 =$	$-1.228\ 618\ 5 \dots$	$-2.001\ 204 \times 10^{-1}$	$-9.947\ 732\ 30 \dots$
$c_3 =$	$-1.075\ 217\ 8 \dots$	$1.036\ 969 \times 10^{-2}$	$1.702\ 766\ 30 \times 10^{-1}$
$c_4 =$	$-5.908\ 693\ 3 \times 10^{-1}$	$-2.549\ 687 \times 10^{-4}$	$1.430\ 334\ 68 \times 10^{-3}$
$c_5 =$	$-1.725\ 671\ 3 \times 10^{-1}$	$3.585\ 153 \times 10^{-6}$	$4.438\ 860\ 84 \times 10^{-6}$
$c_6 =$	$-2.813\ 151\ 3 \times 10^{-2}$	$-5.344\ 285 \times 10^{-8}$	.....
$c_7 =$	$-2.396\ 337\ 0 \times 10^{-3}$	$5.099\ 890 \times 10^{-10}$	.....
$c_8 =$	$-8.382\ 332\ 1 \times 10^{-5}$	.....	.....

NOTE— The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.5$  °C with the values given in Table 10.6.

**Type K Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-200 °C to 0 °C	0 °C to 500 °C	500 °C to 1372 °C
emf Range:	-5.891 mV to 0.0 mV	0.0 mV to 20.644 mV	20.644 mV to 54.886 mV
$c_0 =$	0.000 000 0 ...	0.000 000 ...	$-1.318\ 058 \times 10^2$
$c_1 =$	$2.517\ 346\ 2 \times 10^1$	$2.508\ 355 \times 10^1$	$4.830\ 222 \times 10^1$
$c_2 =$	$-1.166\ 287\ 8 ...$	$7.860\ 106 \times 10^{-2}$	$-1.646\ 031 ...$
$c_3 =$	$-1.083\ 363\ 8 ...$	$-2.503\ 131 \times 10^{-1}$	$5.464\ 731 \times 10^{-2}$
$c_4 =$	$-8.977\ 354\ 0 \times 10^{-1}$	$8.315\ 270 \times 10^{-2}$	$-9.650\ 715 \times 10^{-4}$
$c_5 =$	$-3.734\ 237\ 7 \times 10^{-1}$	$-1.228\ 034 \times 10^{-2}$	$8.802\ 193 \times 10^{-6}$
$c_6 =$	$-8.663\ 264\ 3 \times 10^{-2}$	$9.804\ 036 \times 10^{-4}$	$3.110\ 810 \times 10^{-8}$
$c_7 =$	$-1.045\ 059\ 8 \times 10^{-2}$	$-4.413\ 030 \times 10^{-5}$	.....
$c_8 =$	$-5.192\ 057\ 7 \times 10^{-4}$	$1.057\ 734 \times 10^{-6}$	.....
$c_9 =$	.....	$-1.052\ 755 \times 10^{-8}$	.....

NOTE—The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.05$  °C with the values given in Table 10.8.

**Type N Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-200 °C to 0 °C	0 °C to 600 °C	600 °C to 1300 °C
emf Range:	-3.990 mV to 0.0 mV	0.0 mV to 20.613 mV	20.613 mV to 47.513 mV
$c_0 =$	0.000 000 0 ...	0.000 00 ...	$1.972\ 485 \times 10^1$
$c_1 =$	$3.843\ 684\ 7 \times 10^1$	$3.868\ 96 \times 10^1$	$3.300\ 943 \times 10^1$
$c_2 =$	$1.101\ 048\ 5 ...$	$-1.082\ 67 ...$	$-3.915\ 159 \times 10^{-1}$
$c_3 =$	$5.222\ 931\ 2 ...$	$4.702\ 05 \times 10^{-2}$	$9.855\ 391 \times 10^{-3}$
$c_4 =$	$7.206\ 052\ 5 ...$	$-2.121\ 69 \times 10^{-6}$	$-1.274\ 371 \times 10^{-4}$
$c_5 =$	$5.848\ 858\ 6 ...$	$-1.172\ 72 \times 10^{-4}$	$7.767\ 022 \times 10^{-7}$
$c_6 =$	$2.775\ 491\ 6 ...$	$5.392\ 80 \times 10^{-6}$	.....
$c_7 =$	$7.707\ 516\ 6 \times 10^{-1}$	$-7.981\ 56 \times 10^{-8}$	.....
$c_8 =$	$1.158\ 266\ 5 \times 10^{-1}$	.....	.....
$c_9 =$	$7.313\ 886\ 8 \times 10^{-3}$	.....	.....

NOTE—The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.04$  °C with the values given in Table 10.10.

**Type R Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-50 °C to 250 °C	250 °C to 1200 °C	1064 °C to 1664.5 °C	1664.5 °C to 1768.1 °C
emf Range:	-0.226 mV to 1.923 mV	1.923 mV to 13.228 mV	11.361 mV to 19.739 mV	19.739 mV to 21.103 mV
$c_0 =$	0.000 000 0 ...	$1.334\ 584\ 505 \times 10^1$	$-8.199\ 599\ 416 \times 10^1$	$3.406\ 177\ 836 \times 10^4$
$c_1 =$	$1.889\ 138\ 0 \times 10^3$	$1.472\ 644\ 573 \times 10^2$	$1.553\ 962\ 042 \times 10^2$	$-7.023\ 729\ 171 \times 10^3$
$c_2 =$	$-9.383\ 529\ 0 \times 10^1$	$-1.844\ 024\ 844 \times 10^1$	$-8.342\ 197\ 663$	$5.582\ 903\ 813 \times 10^2$
$c_3 =$	$1.306\ 861\ 9 \times 10^2$	$4.031\ 129\ 726 ...$	$4.279\ 433\ 549 \times 10^{-1}$	$-1.952\ 394\ 635 \times 10^1$
$c_4 =$	$-2.270\ 358\ 0 \times 10^2$	$-6.249\ 428\ 360 \times 10^{-1}$	$-1.191\ 577\ 910 \times 10^{-2}$	$2.560\ 740\ 231 \times 10^{-1}$
$c_5 =$	$3.514\ 565\ 9 \times 10^2$	$6.468\ 412\ 046 \times 10^{-2}$	$1.492\ 290\ 091 \times 10^{-4}$	.....
$c_6 =$	$-3.895\ 390\ 0 \times 10^2$	$-4.458\ 750\ 426 \times 10^{-3}$	.....	.....
$c_7 =$	$2.823\ 947\ 1 \times 10^3$	$1.994\ 710\ 149 \times 10^{-4}$	.....	.....
$c_8 =$	$-1.260\ 728\ 1 \times 10^3$	$-5.313\ 401\ 790 \times 10^{-6}$	.....	.....
$c_9 =$	$3.135\ 361\ 1 \times 10^1$	$6.481\ 976\ 217 \times 10^{-8}$	.....	.....
$c_{10} =$	$-3.318\ 776\ 9 ...$	.....	.....	.....

NOTE—The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.02$  °C with the values given in Table 10.12.



**Type S Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of Temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-50 °C to 250 °C	250 °C to 1200 °C	1064 °C to 1664.5 °C	1664.5 °C to 1768.1 °C
emf Range:	-0.235 mV to 1.874 mV	1.874 mV to 11.950 mV	10.332 mV to 17.536 mV	17.536 mV to 18.693 mV
$c_0 =$	0.000 000 00 . . .	$1.291\ 507\ 177 \times 10^1$	$-8.087\ 801\ 117 \times 10^1$	$5.333\ 875\ 126 \times 10^4$
$c_1 =$	$1.849\ 494\ 60 \times 10^2$	$1.466\ 298\ 863 \times 10^2$	$1.621\ 573\ 104 \times 10^2$	$-1.235\ 892\ 298 \times 10^4$
$c_2 =$	$-8.005\ 040\ 62 \times 10^1$	$-1.534\ 713\ 402 \times 10^1$	$-8.536\ 869\ 453 . . .$	$1.092\ 657\ 613 \times 10^3$
$c_3 =$	$1.022\ 374\ 30 \times 10^2$	$3.145\ 945\ 973 . . .$	$4.719\ 686\ 976 \times 10^{-1}$	$-4.265\ 693\ 686 \times 10^1$
$c_4 =$	$-1.522\ 485\ 92 \times 10^2$	$-4.163\ 257\ 839 \times 10^{-1}$	$-1.441\ 693\ 666 \times 10^{-2}$	$6.247\ 205\ 420 \times 10^{-1}$
$c_5 =$	$1.888\ 213\ 43 \times 10^2$	$3.187\ 963\ 771 \times 10^{-2}$	$2.081\ 618\ 890 \times 10^{-4}$	.....
$c_6 =$	$-1.590\ 859\ 41 \times 10^2$	$-1.291\ 637\ 500 \times 10^{-3}$	.....	.....
$c_7 =$	$8.230\ 278\ 80 \times 10^1$	$2.183\ 475\ 087 \times 10^{-5}$	.....	.....
$c_8 =$	$-2.341\ 819\ 44 \times 10^1$	$-1.447\ 379\ 511 \times 10^{-7}$	.....	.....
$c_9 =$	$2.797\ 862\ 60 . . .$	$8.211\ 272\ 125 \times 10^{-9}$	.....	.....

NOTE—The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.02$  °C with the values given in Table 10.14.

**Type T Thermocouples: Coefficients ( $c_i$ ) of Polynomials for the Computation of temperatures in °C as a Function of the Thermocouple emf in Various Temperature and emf Ranges**

Temperature range:	-200 °C to 0 °C	0 °C to 400 °C
emf Range:	-5.603 mV to 0.0 mV	0.0 mV to 20.872 mV
$c_0 =$	0.000 000 0 . . .	0.000 000 . . .
$c_1 =$	$2.594\ 919\ 2 \times 10^1$	$2.592\ 800 \times 10^1$
$c_2 =$	$-2.131\ 696\ 7 \times 10^{-1}$	$-7.602\ 961 \times 10^{-1}$
$c_3 =$	$7.901\ 869\ 2 \times 10^{-1}$	$4.637\ 791 \times 10^{-2}$
$c_4 =$	$4.252\ 777\ 7 \times 10^{-1}$	$-2.165\ 394 \times 10^{-3}$
$c_5 =$	$1.330\ 447\ 3 \times 10^{-1}$	$6.048\ 144 \times 10^{-5}$
$c_6 =$	$2.024\ 144\ 6 \times 10^{-2}$	$-7.293\ 422 \times 10^{-7}$
$c_7 =$	$1.266\ 817\ 1 \times 10^{-3}$	.....

NOTE—The above coefficients are extracted from Reference 1 and are for an expression of the form shown in Section 10.3.2. They yield approximate values of temperature that agree within  $\pm 0.04$  °C with the values given in Table 10.16.

## LABORATORY SOLVENTS AND OTHER LIQUID REAGENTS

This table summarizes the properties of 575 liquids that are commonly used in the laboratory as solvents or chemical reagents.

The properties tabulated are:

$M_r$ :	Molecular weight
$t_m$ :	Melting point in °C
$t_b$ :	Normal boiling point in °C
$\rho$ :	Density in g/mL at the temperature in °C indicated by the superscript
$\eta$ :	Viscosity in mPa s (1 mPa s = 1 centipoise) at 25 °C
$\epsilon$ :	Dielectric constant at ambient temperature (15 to 30 °C)
$\mu$ :	Dipole moment in D
$c_p$ :	Specific heat capacity of the liquid at constant pressure at 25 °C in J/g K
vp:	Vapor pressure at 25 °C in kPa (1 kPa = 7.50 mmHg)
FP:	Flash point in °C
Fl.Lim:	Flammable (explosive) limit in air in percent by volume
IT:	Autoignition temperature in °C
TLV:	Threshold limit for allowable airborne concentration in parts per million by volume at 25 °C and atmospheric pressure

Data on the temperature dependence of viscosity, dielectric constant, and vapor pressure can be found in the pertinent tables in this *Handbook*.

### References

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5. Urben, P. G., Ed., *Bretherick's Handbook of Reactive Chemical Hazards, 5th Edition*, Butterworth-Heinemann, Oxford, 1995.
6. *2004 TLVs and BEIs*, American Conference of Governmental Industrial Hygienists, Cincinnati, OH, 2004.

Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	vp/kPa	FP/ °C	Fl. lim.	IT/°C	TLV/ppm
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	44.052	-123.37	20.1	0.7834 <sup>18</sup>		21.0	2.750	2.020	120	-39	4-60%	175	25
Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	60.052	16.64	117.9	1.0446 <sup>25</sup>	1.056	6.20	1.70	2.053	2.07	39	4-20%	463	10
Acetic anhydride	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	102.089	-74.1	139.5	1.082 <sup>20</sup>	0.843	22.45	≈ 2.8	1.648	0.680	49	2.7-10.3%	316	5
Acetone	C <sub>3</sub> H <sub>6</sub> O	58.079	-94.7	56.05	0.7845 <sup>25</sup>	0.306	21.01	2.88	2.175	30.8	-20	3-13%	465	500
Acetone cyanohydrin	C <sub>4</sub> H <sub>7</sub> NO	85.105	-19	95	0.932 <sup>19</sup>						74	2.2-12%	688	4.6
Acetonitrile	C <sub>2</sub> H <sub>3</sub> N	41.052	-43.82	81.65	0.7857 <sup>20</sup>	0.369	36.64	3.92	2.229	11.9	6	3-16%	524	20
Acetophenone	C <sub>8</sub> H <sub>8</sub> O	120.149	20.5	202	1.0281 <sup>20</sup>	1.681	17.44	3.02	1.703	0.049	77		570	10
Acetyl bromide	C <sub>2</sub> H <sub>3</sub> BrO	122.948	-96	76	1.6625 <sup>16</sup>						16.2			
Acetyl chloride	C <sub>2</sub> H <sub>3</sub> ClO	78.497	-112.8	50.7	1.1051 <sup>20</sup>	0.368	15.8	2.72	1.491	38.4	4		390	
Acrolein	C <sub>3</sub> H <sub>4</sub> O	56.063	-87.7	52.6	0.840 <sup>20</sup>			3.1		36.2	-26	2.8-31%	220	0.1
Acrylic acid	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	72.063	12.5	141	1.0511 <sup>20</sup>				2.022	0.53	50	2.4-8%	438	2
Acrylonitrile	C <sub>3</sub> H <sub>3.5</sub> N	53.063	-83.48	77.3	0.8007 <sup>25</sup>		33.0	3.87	2.05	14.1	0	3-17%	481	2
Allyl alcohol	C <sub>3</sub> H <sub>6</sub> O	58.079	-129	97.0	0.8540 <sup>20</sup>	1.218	19.7	1.60	2.392	3.14	21	3-18%	378	0.5
Allylamine	C <sub>3</sub> H <sub>5</sub> N	57.095	-88.2	53.3	0.758 <sup>20</sup>			1.2		33.1	-29	2-22%	374	
2-Amino-2-methyl-1-propanol	C <sub>4</sub> H <sub>11</sub> NO	89.136	25.5	165.5	0.934 <sup>20</sup>						67			
3-Amino-1-propanol	C <sub>3</sub> H <sub>7</sub> NO	75.109	12.4	187.5	0.9824 <sup>26</sup>						80			
Aniline	C <sub>6</sub> H <sub>7</sub> N	93.127	-6.02	184.17	1.0217 <sup>20</sup>	3.85	7.06	1.13	2.061	0.090	70	1.3-11%	615	2
Anisole	C <sub>7</sub> H <sub>8</sub> O	108.138	-37.13	153.7	0.9940 <sup>20</sup>	1.056	4.30	1.38	1.840	0.472	52		475	
Antimony(V) chloride	Cl <sub>5</sub> Sb	299.024	4	140 dec	2.34		3.222							
Antimony(V) fluoride	F <sub>5</sub> Sb	216.752	8.3	141	3.10									
Arsenic(III) chloride	AsCl <sub>3</sub>	181.280	-16	130	2.150			1.59		5.38				
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	106.122	-57.1	178.8	1.0401 <sup>25</sup>		17.85	3.0	1.621	0.169	63		192	
Benzene	C <sub>6</sub> H <sub>6</sub>	78.112	5.49	80.09	0.8765 <sup>20</sup>	0.604	2.2825	0	1.741	12.7	-11	1-8%	498	0.5
Benzeneacetonitrile	C <sub>8</sub> H <sub>7</sub> N	117.149	-23.8	233.5	1.0205 <sup>15</sup>		17.87	3.5		0.012	113			
Benzeneethanamine	C <sub>8</sub> H <sub>11</sub> N	121.180	<0	195	0.9640 <sup>25</sup>									
Benzeneethanol	C <sub>8</sub> H <sub>10</sub> O	122.164	-27	218.2	1.0202 <sup>20</sup>		12.31		2.068	0.01	96			
Benzenemethanethiol	C <sub>7</sub> H <sub>8</sub> S	124.204	-30	194.5	1.058 <sup>20</sup>		4.705							
Benzenesulfonyl chloride	C <sub>6</sub> H <sub>5</sub> ClO <sub>2</sub> S	176.621	14.5	251 dec	1.3470 <sup>15</sup>		28.90			0.008				
Benzenethiol	C <sub>6</sub> H <sub>6</sub> S	110.177	-14.93	169.1	1.0775 <sup>20</sup>		4.26	1.23	1.572	0.26				0.1
Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	103.122	-13.99	191.1	1.0093 <sup>15</sup>	1.267	25.9	4.18	1.602	0.11				
Benzoyl chloride	C <sub>7</sub> H <sub>5</sub> ClO	140.567	-0.4	197.2	1.2120 <sup>20</sup>		23.0			0.084	72			0.5
Benzyl acetate	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	150.174	-51.3	213	1.0550 <sup>20</sup>		5.34	1.22	0.989	0.022	90		460	10
Benzyl alcohol	C <sub>7</sub> H <sub>8</sub> O	108.138	-15.4	205.31	1.0419 <sup>24</sup>	5.47	11.916	1.71	2.015	0.015	93		436	
Benzylamine	C <sub>7</sub> H <sub>9</sub> N	107.153		185	0.9813 <sup>20</sup>	1.624	5.18			0.096				
2,2'-Bioxirane	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	86.090	2.0	144	1.113 <sup>20</sup>									

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
Bis(2-aminoethyl)amine	$\text{C}_4\text{H}_{11}\text{N}_3$	103.166	-39	207	0.9569 <sup>20</sup>		12.62	1.9	2.462	0.03	98	2-7%	358	1
<i>N,N'</i> -Bis(2-aminoethyl)-1,2-ethanediamine	$\text{C}_6\text{H}_{16}\text{N}_4$	146.234	12	266.5			10.76							
Bis(2-chloroethyl) ether	$\text{C}_4\text{H}_8\text{Cl}_2\text{O}$	143.012	-51.9	178.5	1.22 <sup>20</sup>		21.20	2.6	1.545	0.143	55	3%-	369	5
Bis(chloromethyl) ether	$\text{C}_2\text{H}_4\text{Cl}_2\text{O}$	114.958	-41.5	106	1.323 <sup>15</sup>		3.51							0.001
Bis(2-ethylhexyl) phthalate	$\text{C}_{24}\text{H}_{38}\text{O}_4$	390.557	-55	384	0.981 <sup>25</sup>		5.3	2.84	1.804	0.00000005	218			0.3
Bis(2-hydroxyethyl) sulfide	$\text{C}_4\text{H}_{10}\text{O}_2\text{S}$	122.186	-10.2	282	1.1793 <sup>25</sup>		28.61			0.08	160		298	
Boron tribromide	$\text{BBr}_3$	250.523	-45	91	2.6			0						1
Boron trichloride	$\text{BCl}_3$	117.169	-107	12.65				0	0.911	156				
Bromine	$\text{Br}_2$	159.808	-7.2	58.8	3.1028	0.944	3.1484	0	0.474	28.2				0.1
Bromobenzene	$\text{C}_6\text{H}_5\text{Br}$	157.008	-30.72	156.06	1.4950 <sup>20</sup>	1.074	5.45	1.70	0.983	0.556	51		565	
1-Bromobutane	$\text{C}_4\text{H}_9\text{Br}$	137.018	-112.6	101.6	1.2758 <sup>20</sup>	0.606	7.315	2.08	0.798	5.26	18	2.6-6.6%	265	
2-Bromobutane, ( $\pm$ )-	$\text{C}_4\text{H}_9\text{Br}$	137.018	-112.65	91.3	1.2585 <sup>20</sup>		8.64	2.23		9.32	21			
Bromochloromethane	$\text{CH}_2\text{BrCl}$	129.384	-87.9	68.0	1.9344 <sup>20</sup>			1.7	0.41	19.5				200
Bromodichloromethane	$\text{CHBrCl}_2$	163.829	-57	90	1.980 <sup>20</sup>									
Bromoethane	$\text{C}_2\text{H}_5\text{Br}$	108.965	-118.6	38.5	1.4604 <sup>20</sup>	0.374	9.01	2.03	0.925	62.5		7-8%	511	5
Bromoethene	$\text{C}_2\text{H}_3\text{Br}$	106.949	-139.54	15.8	1.4933 <sup>20</sup>		5.63	1.42	1.007	141		9-15%	530	0.5
2-Bromo-2-methylpropane	$\text{C}_4\text{H}_9\text{Br}$	137.018	-16.2	73.3	1.4278 <sup>20</sup>		10.98	2.17	1.102	17.7				
1-Bromopentane	$\text{C}_5\text{H}_{11}\text{Br}$	151.045	-88.0	129.8	1.2182 <sup>20</sup>		6.31	2.20	0.875	1.68	32			
1-Bromopropane	$\text{C}_3\text{H}_7\text{Br}$	122.992	-110.3	71.1	1.3537 <sup>20</sup>	0.489	8.09	2.18	0.702	18.6			490	
2-Bromopropane	$\text{C}_3\text{H}_7\text{Br}$	122.992	-89.0	59.5	1.3140 <sup>20</sup>	0.458	9.46	2.21	1.075	28.9				
3-Bromopropene	$\text{C}_3\text{H}_5\text{Br}$	120.976	-119	70.1	1.398 <sup>20</sup>	0.471	7.0	$\approx 1.9$		18.6	-1	4.4-7.3%	295	
2-Bromotoluene	$\text{C}_7\text{H}_7\text{Br}$	171.035	-27.8	181.7	1.4232 <sup>20</sup>		4.641			0.17	79			
Bromotrchloromethane	$\text{CBrCl}_3$	198.274	-5.65	105	2.012 <sup>25</sup>		2.405			5.35				
Butanal	$\text{C}_4\text{H}_8\text{O}$	72.106	-96.86	74.8	0.8016 <sup>20</sup>		13.45	2.72	2.270	15.7	-22	2-12.5%	218	
1,3-Butanediol	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	-77	207.5	1.0053 <sup>20</sup>		28.8		2.521	0.008	121		395	
1,4-Butanediol	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	20.4	235	1.0171 <sup>20</sup>		31.9	2.58	2.220	0.002	121			
2,3-Butanediol	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	7.6	182.5	1.0033 <sup>20</sup>				2.363	0.02			402	
2,3-Butanedione	$\text{C}_4\text{H}_6\text{O}_2$	86.090	-1.2	88	0.9808 <sup>18</sup>		4.04			7.45	27			
Butanenitrile	$\text{C}_4\text{H}_7\text{N}$	69.106	-111.9	117.6	0.7936 <sup>20</sup>	0.553	24.83	3.9	2.301	2.55	24	>1.6%	501	
1-Butanethiol	$\text{C}_4\text{H}_{10}\text{S}$	90.187	-115.7	98.5	0.8416 <sup>20</sup>		5.204	1.53	1.898	6.07	2			0.5
2-Butanethiol	$\text{C}_4\text{H}_{10}\text{S}$	90.187	-165	85.0	0.8295 <sup>20</sup>		5.645			10.8	-23			
Butanoic acid	$\text{C}_4\text{H}_8\text{O}_2$	88.106	-5.1	163.75	0.9528 <sup>25</sup>	1.426	2.98	1.65	2.027	0.221	72	2-10%	443	
Butanoic anhydride	$\text{C}_8\text{H}_{14}\text{O}_3$	158.195	-75	200	0.9668 <sup>20</sup>		12.8		1.793	0.07	54	0.9-5.8%	279	
1-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	74.121	-88.6	117.73	0.8095 <sup>20</sup>	2.54	17.84	1.66	2.391	0.86	37	1-11%	343	20
2-Butanol	$\text{C}_4\text{H}_{10}\text{O}$	74.121	-88.5	99.51	0.8063 <sup>20</sup>	3.10	17.26	1.8	2.656	2.32	24	2-10%	405	100
2-Butanone	$\text{C}_4\text{H}_8\text{O}$	72.106	-86.64	79.59	0.7999 <sup>25</sup>	0.405	18.56	2.78	2.201	12.6	-9	1-11%	404	200
<i>trans</i> -2-Butenal	$\text{C}_4\text{H}_6\text{O}$	70.090	-76	102.2	0.8516 <sup>20</sup>			3.67	1.361	4.92	13	2.1-15.5%	232	0.3
<i>cis</i> -2-Butenoic acid	$\text{C}_4\text{H}_6\text{O}_2$	86.090	15	169	1.0267 <sup>20</sup>					0.06				
2-Butoxyethanol	$\text{C}_6\text{H}_{14}\text{O}_2$	118.174	-74.8	168.4	0.9015 <sup>20</sup>		9.30	2.1	2.378	0.15	69	4-13%	238	20
Butyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	116.158	-78	126.1	0.8825 <sup>20</sup>	0.685	5.07	1.9	1.961	1.66	22	2-8%	425	150
<i>sec</i> -Butyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	116.158	-98.9	112	0.8748 <sup>20</sup>		5.135	1.87			31	1.7-9.8%		200
Butyl acrylate	$\text{C}_8\text{H}_{12}\text{O}_2$	128.169	-64.6	145	0.8898 <sup>20</sup>		5.25		1.958	0.731	29	1.7-9.9%	292	2
Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	73.137	-49.1	77.00	0.7414 <sup>20</sup>	0.574	4.71	1.0	2.450	12.2	-12	2-10%	312	5
<i>sec</i> -Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	73.137	<-72	62.73	0.7246 <sup>20</sup>			1.28			-9			
<i>tert</i> -Butylamine	$\text{C}_4\text{H}_{11}\text{N}$	73.137	-66.94	44.04	0.6958 <sup>20</sup>		58.5	1.3	2.627	48.4	-9	2-9%	380	
Butylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-87.85	183.31	0.8601 <sup>20</sup>	0.950	2.359	$\approx 0$	1.813	0.150	71	0.8-5.8%	410	
<i>tert</i> -Butylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-57.8	169.1	0.8665 <sup>20</sup>		2.359	$\approx 0.83$	1.773	0.280	60	0.7-5.7%	450	
Butyl benzoate	$\text{C}_{11}\text{H}_{14}\text{O}_2$	178.228	-22.4	250.3	1.000 <sup>20</sup>		5.52			0.005	107			
<i>tert</i> -Butyl ethyl ether	$\text{C}_6\text{H}_{14}\text{O}$	102.174	-94	72.6	0.736 <sup>25</sup>				2.13	16.5				5
<i>tert</i> -Butyl hydroperoxide	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	6	89 dec	0.8960 <sup>20</sup>						27			
1- <i>tert</i> -Butyl-4-methylbenzene	$\text{C}_{11}\text{H}_{16}$	148.245	-52	190	0.8612 <sup>20</sup>			$\approx 0$		0.09	68			1
Butyl vinyl ether	$\text{C}_6\text{H}_{12}\text{O}$	100.158	-92	94	0.7888 <sup>20</sup>			1.25	2.316	6.65	-9		255	
$\gamma$ -Butyrolactone	$\text{C}_4\text{H}_6\text{O}_2$	86.090	-43.61	204	1.1296 <sup>20</sup>		39.0	4.27	1.642	0.43	98			
Carbon disulfide	$\text{CS}_2$	76.141	-112.1	46	1.2632 <sup>20</sup>	0.352	2.6320	0	1.003	48.2	-30	1-50%	90	10
Chloroacetaldehyde	$\text{C}_2\text{H}_3\text{ClO}$	78.497	-16.3	85.5	1.19									1
Chloroacetone	$\text{C}_3\text{H}_5\text{ClO}$	92.524	-44.5	119	1.15 <sup>20</sup>					2				1
Chloroacetyl chloride	$\text{C}_2\text{H}_2\text{Cl}_2\text{O}$	112.942	-22	106	1.4202 <sup>20</sup>			2.23		3.33				0.05
2-Chloroaniline	$\text{C}_6\text{H}_6\text{ClN}$	127.572	-1.9	208.8		3.32	13.40	1.77		0.034				
3-Chloroaniline	$\text{C}_6\text{H}_6\text{ClN}$	127.572	-10.28	230.5	1.2161 <sup>20</sup>		13.3		1.558	0.0156			705	
Chlorobenzene	$\text{C}_6\text{H}_5\text{Cl}$	112.557	-45.31	131.72	1.1058 <sup>20</sup>	0.753	5.6895	1.69	1.334	1.6	28	1-10%	593	10
2-Chloro-1,3-butadiene	$\text{C}_4\text{H}_5\text{Cl}$	88.536	-130	59.4	0.956 <sup>20</sup>		4.914			29.5	-20	4-20%		10
1-Chlorobutane	$\text{C}_4\text{H}_9\text{Cl}$	92.567	-123.1	78.4	0.8857 <sup>20</sup>	0.422	7.276	2.05	1.891	13.7	-12	2-10%	240	
2-Chlorobutane	$\text{C}_4\text{H}_9\text{Cl}$	92.567	-131.3	68.2	0.8732 <sup>20</sup>		8.564	2.04		21.0	-10			
Chlorocyclohexane	$\text{C}_6\text{H}_{11}\text{Cl}$	118.604	-43.81	142	1.000 <sup>20</sup>		7.9505	2.1		1.0	32			
Chlorodibromomethane	$\text{CHBr}_2\text{Cl}$	208.280	-20	120	2.451 <sup>20</sup>									
Chloroethane	$\text{C}_2\text{H}_5\text{Cl}$	64.514	-138.4	12.3	0.9239 <sup>9</sup>		9.45	2.05	1.617	160	-50	4-15%	519	100

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
2-Chloroethanol	$\text{C}_2\text{H}_5\text{ClO}$	80.513	-67.5	128.6	1.2019 <sup>20</sup>		25.80	1.78		1.2	60	5-16%	425	1
2-Chloroethyl vinyl ether (Chloromethyl)benzene	$\text{C}_6\text{H}_9\text{ClO}$	106.551	-70	108	1.0495 <sup>20</sup>						27			
Chloromethyl methyl ether	$\text{C}_2\text{H}_5\text{ClO}$	80.513	-103.5	59.5	1.063 <sup>10</sup>		6.854	1.8	1.44	0.164	67	1%-	585	1
1-Chloro-2-methylpropane	$\text{C}_4\text{H}_9\text{Cl}$	92.567	-130.3	68.5	0.8773 <sup>20</sup>		7.027	2.00	1.713	19.9	-6	2-8.7%		
2-Chloro-2-methylpropane	$\text{C}_4\text{H}_9\text{Cl}$	92.567	-25.60	50.9	0.8420 <sup>20</sup>		9.663	2.13	1.867	42.7	0			
1-Chloronaphthalene	$\text{C}_{10}\text{H}_7\text{Cl}$	162.616	-2.5	259	1.1880 <sup>25</sup>		5.04	1.57	1.307	0.003	121		>558	
1-Chlorooctane	$\text{C}_8\text{H}_{17}\text{Cl}$	148.674	-57.8	183.5	0.8734 <sup>20</sup>		5.05	2.00	1.335	0.11	70			
1-Chloropentane	$\text{C}_5\text{H}_{11}\text{Cl}$	106.594	-99.0	108.4	0.8820 <sup>20</sup>		6.654	2.16		4.36	13	1.6-8.6%	260	
2-Chlorophenol	$\text{C}_6\text{H}_5\text{ClO}$	128.556	9.4	174.9	1.2634 <sup>20</sup>	3.59	7.40		1.468	0.308	64			
1-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	78.541	-122.9	46.5	0.8899 <sup>20</sup>	0.334	8.588	2.05	1.683	45.8	<-18	2.6-11%	520	
2-Chloropropane	$\text{C}_3\text{H}_7\text{Cl}$	78.541	-117.18	35.7	0.8617 <sup>20</sup>	0.303		2.17		68.9	-32	2.8-11%	593	
3-Chloro-1,2-propanediol	$\text{C}_3\text{H}_7\text{ClO}_2$	110.540		213 dec	1.325 <sup>18</sup>									
3-Chloropropanenitrile	$\text{C}_3\text{H}_4\text{ClN}$	89.524	-51	175.5	1.1573 <sup>20</sup>						76			
2-Chloropropene	$\text{C}_3\text{H}_4\text{Cl}$	76.525	-137.4	22.6	0.9017 <sup>20</sup>		8.92	1.647		110	-37	4.5-16%		
3-Chloropropene	$\text{C}_3\text{H}_4\text{Cl}$	76.525	-134.5	45.1	0.9376 <sup>20</sup>	0.314	8.2	1.94	1.635	48.9	-32	2.9-11%	485	1
Chlorosulfonic acid	$\text{ClHO}_3\text{S}$	116.525	-80	152	1.75					0.42				
2-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	126.584	-35.8	159.0	1.0825 <sup>20</sup>	0.964	4.721	1.56	1.318	0.482				50
4-Chlorotoluene	$\text{C}_7\text{H}_7\text{Cl}$	126.584	7.5	162.4	1.0697 <sup>20</sup>	0.837	6.25	2.21		0.4				
Chromyl chloride	$\text{Cr}_2\text{O}_2\text{Cl}_2$	154.900	-96.5	117	1.91									0.025
<i>trans</i> -Cinnamaldehyde	$\text{C}_9\text{H}_8\text{O}$	132.159	-7.5	246	1.0497 <sup>20</sup>		17.72			0.005				
<i>o</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	108.138	31.03	191.04	1.0327 <sup>35</sup>		6.76	1.45	2.160	0.041	81	>1.4%	599	5
<i>m</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	108.138	12.24	202.27	1.0339 <sup>20</sup>	12.91	12.44	1.48	2.080	0.019	86	>1.1%	558	5
<i>p</i> -Cresol	$\text{C}_7\text{H}_8\text{O}$	108.138	34.77	201.98	1.0185 <sup>40</sup>		13.05	1.48	2.044	0.017	86	>1.1%	558	5
Cyanogen chloride	$\text{CClN}$	61.471	-6.5	13	1.186 <sup>20</sup>			2.8331						0.3
Cyclobutane	$\text{C}_4\text{H}_8$	56.107	-90.7	12.6	0.7038 <sup>0</sup>			0		157	<10	>1.8%		
Cyclohexane	$\text{C}_6\text{H}_{12}$	84.159	6.59	80.73	0.7739 <sup>25</sup>	0.894	2.0243	$\approx 0$	1.841	13.0	-20	1-8%	245	100
Cyclohexanol	$\text{C}_6\text{H}_{12}\text{O}$	100.158	25.93	160.84	0.9624 <sup>20</sup>	57.5	16.40		2.079	0.10	68	1-9%	300	50
Cyclohexanone	$\text{C}_6\text{H}_{10}\text{O}$	98.142	-27.9	155.43	0.9478 <sup>20</sup>	2.02	16.1	2.87	1.856	0.53	44	1-9%	420	20
Cyclohexene	$\text{C}_6\text{H}_{10}$	82.143	-103.5	82.98	0.8110 <sup>20</sup>	0.625	2.2176	0.33	1.805	11.8	-12	>1.2%	310	300
Cyclohexylamine	$\text{C}_6\text{H}_{13}\text{N}$	99.174	-17.8	134	0.8191 <sup>20</sup>	1.944	4.547	1.3		1.20	31	1-9%	293	10
1,3-Cyclopentadiene	$\text{C}_5\text{H}_8$	66.102	-85	41	0.8021 <sup>20</sup>			0.419		58.5				75
Cyclopentane	$\text{C}_5\text{H}_{10}$	70.133	-93.4	49.3	0.7457 <sup>20</sup>	0.413	1.9687	$\approx 0$	1.837	42.3	-25	2%-	361	600
Cyclopentanol	$\text{C}_5\text{H}_{10}\text{O}$	86.132	-17.5	140.42	0.9488 <sup>20</sup>		18.5		2.119	0.294	51			
Cyclopentanone	$\text{C}_5\text{H}_8\text{O}$	84.117	-51.90	130.57	0.9487 <sup>20</sup>		13.58	3.3	1.84	1.55	26			
<i>cis</i> -Decahydronaphthalene	$\text{C}_{10}\text{H}_{18}$	138.250	-42.9	195.8	0.8965 <sup>20</sup>	3.04	2.219	$\approx 0$	1.678	0.10				
<i>trans</i> -Decahydronaphthalene	$\text{C}_{10}\text{H}_{18}$	138.250	-30.4	187.3	0.8659 <sup>25</sup>	1.948	2.184	$\approx 0$	1.653	0.164	54	1-5%	255	
Decamethylcyclopenta-siloxane	$\text{C}_{10}\text{H}_{30}\text{O}_5\text{Si}_5$	370.770	-38	210	0.9593 <sup>20</sup>		2.50			0.02				
Decanal	$\text{C}_{10}\text{H}_{20}\text{O}$	156.265	-4.0	208.5	0.830 <sup>15</sup>					0.02				
Decane	$\text{C}_{10}\text{H}_{22}$	142.282	-29.6	174.15	0.7266 <sup>25</sup>	0.838	1.9853	$\approx 0$	2.210	0.170	51	0.8-5.4%	210	
Decanoic acid	$\text{C}_{10}\text{H}_{20}\text{O}_2$	172.265	31.4	268.7	0.8858 <sup>40</sup>				2.761					
1-Decanol	$\text{C}_{10}\text{H}_{22}\text{O}$	158.281	6.9	231.1	0.8297 <sup>20</sup>	10.91	7.93		2.341	0.009	82		288	
1-Decene	$\text{C}_{10}\text{H}_{20}$	140.266	-66.3	170.5	0.7408 <sup>20</sup>	0.756	2.136	$\approx 0$	2.144	0.210	<55		235	
Diacetone alcohol	$\text{C}_8\text{H}_{16}\text{O}_2$	116.158	-44	167.9	0.9387 <sup>20</sup>	2.80	18.2	3.2	1.905	0.224	58	2-7%	643	50
Dibenzyl ether	$\text{C}_{14}\text{H}_{14}\text{O}$	198.260	1.8	298	1.0428 <sup>20</sup>		3.821			135				
Dibromodifluoromethane	$\text{CBr}_2\text{F}_2$	209.816	-110.1	22.76				0.66		110				100
1,2-Dibromoethane	$\text{C}_2\text{H}_4\text{Br}_2$	187.861	9.84	131.6	2.1683 <sup>25</sup>	1.595	4.9612	1.2	0.724	1.55				
Dibromomethane	$\text{CH}_2\text{Br}_2$	173.835	-52.5	97	2.4969 <sup>20</sup>	0.980	7.77	1.43	0.61	6.12				
1,2-Dibromotetrafluoroethane	$\text{C}_2\text{Br}_2\text{F}_4$	259.823	-110.32	47.35	2.149 <sup>25</sup>		2.34		0.69	43.4				
Dibutylamine	$\text{C}_8\text{H}_{19}\text{N}$	129.244	-62	159.6	0.7670 <sup>20</sup>	0.918	2.765	1.0	2.266	0.34	47	1-6%		
Dibutyl ether	$\text{C}_8\text{H}_{18}\text{O}$	130.228	-95.2	140.28	0.7684 <sup>20</sup>	0.637	3.0830	1.17	2.136	0.898	25	1.5-7.6%	194	
Di- <i>tert</i> -butyl peroxide	$\text{C}_8\text{H}_{18}\text{O}_2$	146.228	-40	111	0.704 <sup>20</sup>					3.43	18			
Dibutyl phthalate	$\text{C}_{16}\text{H}_{22}\text{O}_4$	278.344	-35	340	1.0465 <sup>20</sup>	16.63	6.58	2.82	1.789		157	>0.5%	402	0.4
Dibutyl sebacate	$\text{C}_{18}\text{H}_{34}\text{O}_4$	314.461	-10	344.5	0.9405 <sup>15</sup>		4.54	2.48	1.968		178	>0.4%	365	
Dibutyl sulfide	$\text{C}_8\text{H}_{18}\text{S}$	146.294	-79.7	185	0.8386 <sup>20</sup>		4.29	1.61	1.943	0.09	76			
Dichloroacetic acid	$\text{C}_2\text{H}_2\text{Cl}_2\text{O}_2$	128.942	10	194	1.5634 <sup>20</sup>		8.33			0.03				
<i>o</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	147.002	-17.0	180	1.3059 <sup>20</sup>	1.324	10.12	2.50	1.105	0.18	66	2-9%	648	25
<i>m</i> -Dichlorobenzene	$\text{C}_6\text{H}_4\text{Cl}_2$	147.002	-24.8	173	1.2884 <sup>20</sup>	1.044	5.02	1.72	1.163	0.252	72			
<i>trans</i> -1,4-Dichloro-2-butene	$\text{C}_4\text{H}_6\text{Cl}_2$	124.997	1.0	155.4	1.183 <sup>25</sup>									0.005
Dichlorodimethylsilane	$\text{C}_2\text{H}_6\text{Cl}_2\text{Si}$	129.061	-16	70.3	1.064 <sup>25</sup>					18.9	<21	3.4-9.5%		
1,1-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	98.959	-96.9	57.3	1.1757 <sup>20</sup>	0.464	10.10	2.06	1.276	30.5	-17	5-11%	458	100
1,2-Dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_2$	98.959	-35.7	83.5	1.2454 <sup>25</sup>	0.779	10.42	1.8	1.298	10.6	13	6-16%	413	10
1,1-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	96.943	-122.56	31.6	1.213 <sup>20</sup>		4.60	1.34	1.148	80.0	-28	7-16%	570	5
<i>cis</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	96.943	-80.0	60.1	1.2837 <sup>20</sup>	0.445	9.20	1.90	1.201	26.8	6	3-15%	460	200
<i>trans</i> -1,2-Dichloroethene	$\text{C}_2\text{H}_2\text{Cl}_2$	96.943	-49.8	48.7	1.2565 <sup>20</sup>	0.317	2.14	0	1.205	44.2	2	6-13%	460	200
Dichloromethane	$\text{CH}_2\text{Cl}_2$	84.933	-97.2	40	1.3266 <sup>20</sup>	0.413	8.93	1.60	1.192	58.2		13-23%	556	50

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
(Dichloromethyl)benzene	$\text{C}_7\text{H}_7\text{Cl}_2$	161.029	-17	205	1.26 <sup>25</sup>		6.9	2.1		0.06				
1,1-Dichloropropane	$\text{C}_3\text{H}_5\text{Cl}_2$	112.986		88.1	1.1321 <sup>20</sup>					9.09				
1,2-Dichloropropane, ( $\pm$ )-	$\text{C}_3\text{H}_5\text{Cl}_2$	112.986	-100.53	96.4	1.1560 <sup>20</sup>		8.37	1.8	1.320	6.62	21	3-15%	557	75
1,3-Dichloropropane	$\text{C}_3\text{H}_5\text{Cl}_2$	112.986	-99.5	120.9	1.1785 <sup>25</sup>		10.27	2.08		2.44				
2,3-Dichloropropene	$\text{C}_3\text{H}_3\text{Cl}_2$	110.970	10	94	1.211 <sup>20</sup>						15	2.6-7.8%		
2,4-Dichlorotoluene	$\text{C}_7\text{H}_6\text{Cl}_2$	161.029	-13.5	201	1.2476 <sup>20</sup>		5.68	1.70		0.055				
Dicyclohexylamine	$\text{C}_{12}\text{H}_{23}\text{N}$	181.318	-0.1	256 dec	0.9123 <sup>20</sup>					0.003	>99			
Diethanolamine	$\text{C}_4\text{H}_{11}\text{NO}_2$	105.136	28	268.8	1.0966 <sup>20</sup>		25.75	2.8	2.22	<0.01	172	2-13%	662	0.5
1,1-Diethoxyethane	$\text{C}_6\text{H}_{14}\text{O}_2$	118.174	-100	102.25	0.8254 <sup>20</sup>		3.80	1.4	2.01	3.68	-21	2-10%	230	
1,2-Diethoxyethane	$\text{C}_6\text{H}_{14}\text{O}_2$	118.174	-74.0	121.2	0.8351 <sup>25</sup>		3.90		2.195	4.33	27		205	
Diethylamine	$\text{C}_4\text{H}_{11}\text{N}$	73.137	-49.8	55.5	0.7056 <sup>20</sup>	0.319	3.680	0.92	2.313	30.1	-23	2-10%	312	5
<i>N,N</i> -Diethylaniline	$\text{C}_{10}\text{H}_{15}\text{N}$	149.233	-38.8	216.3	0.9307 <sup>20</sup>		5.15			0.025	85		630	
<i>o</i> -Diethylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-31.2	184	0.8800 <sup>20</sup>		2.594			0.13	57		395	
<i>m</i> -Diethylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-83.9	181.1	0.8602 <sup>20</sup>		2.369			0.14	56		450	
<i>p</i> -Diethylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-42.83	183.7	0.8620 <sup>20</sup>		2.259			0.13	55	0.7-6%	430	
Diethyl carbonate	$\text{C}_8\text{H}_{16}\text{O}_3$	118.131	-43	126	0.9692 <sup>25</sup>		2.820	1.10	1.80	1.63	25			
Diethylene glycol	$\text{C}_4\text{H}_{10}\text{O}_3$	106.120	-10.4	245.8	1.1197 <sup>15</sup>	30.2	31.82	2.3	2.307	0.001	124	2-17%	224	
Diethylene glycol diethyl ether	$\text{C}_8\text{H}_{16}\text{O}_3$	162.227	-45	188	0.9063 <sup>20</sup>		5.70		2.104	0.10	82			
Diethylene glycol dimethyl ether	$\text{C}_6\text{H}_{14}\text{O}_3$	134.173	-68	162	0.9434 <sup>20</sup>	0.989	7.23	2.0	2.043	0.315	67			
Diethylene glycol monobutyl ether	$\text{C}_8\text{H}_{16}\text{O}_3$	162.227	-68	231	0.9553 <sup>20</sup>				2.188	0.0032				
Diethylene glycol monoethyl ether	$\text{C}_6\text{H}_{14}\text{O}_3$	134.173		196	0.9885 <sup>20</sup>			1.6	2.243	0.017	96			
Diethylene glycol monoethyl ether acetate	$\text{C}_8\text{H}_{16}\text{O}_4$	176.211	-25	218.5	1.0096 <sup>20</sup>			1.8		0.029	110		425	
Diethylene glycol monomethyl ether	$\text{C}_5\text{H}_{12}\text{O}_3$	120.147		193	1.035 <sup>20</sup>			1.6	2.256	0.024	96	1-23%	240	
Diethyl ether	$\text{C}_4\text{H}_{10}\text{O}$	74.121	-116.2	34.5	0.7138 <sup>20</sup>	0.224	4.2666	1.15	2.369	71.7	-45	2-36%	180	400
Diethyl maleate	$\text{C}_8\text{H}_{12}\text{O}_4$	172.179	-8.8	223	1.0662 <sup>20</sup>		7.560			0.015	121		350	
Diethyl malonate	$\text{C}_8\text{H}_{14}\text{O}_4$	160.168	-50	200	1.0551 <sup>20</sup>		7.550	2.54	1.779	0.048	93			
Diethyl oxalate	$\text{C}_8\text{H}_{14}\text{O}_4$	146.141	-40.6	185.7	1.0785 <sup>20</sup>		8.266	2.49	1.784	0.030	76			
Diethyl phthalate	$\text{C}_{12}\text{H}_{14}\text{O}_4$	222.237	-40.5	295	1.232 <sup>14</sup>		7.86		1.647	0.002	161	>0.7%	457	0.6
Diethyl succinate	$\text{C}_8\text{H}_{14}\text{O}_4$	174.195	-21	217.7	1.0402 <sup>20</sup>		6.098			0.15	90			
Diethyl sulfate	$\text{C}_8\text{H}_{16}\text{O}_4\text{S}$	154.185	-24	208	1.172 <sup>25</sup>		29.2			0.05	104		436	
Diethyl sulfide	$\text{C}_4\text{H}_{10}\text{S}$	90.187	-103.91	92.1	0.8362 <sup>20</sup>	0.422	5.723	1.54	1.900	7.78				
Diiodomethane	$\text{CH}_2\text{I}_2$	267.836	6.1	182	3.3211 <sup>20</sup>		5.32	1.08	0.500	0.172				
Diiodosilane	$\text{H}_2\text{I}_2\text{Si}$	283.911	-1	150										
Diisobutylamine	$\text{C}_8\text{H}_{19}\text{N}$	129.244	-73.5	139.6		0.723				0.972	29			
Diisopentyl ether	$\text{C}_{10}\text{H}_{22}\text{O}$	158.281		172.5	0.7777 <sup>20</sup>		2.817	1.23	2.394	0.210				
Diisopropylamine	$\text{C}_6\text{H}_{15}\text{N}$	101.190	-61	83.9	0.7153 <sup>20</sup>	0.393		1.15		10.7	-1	1.1-7.1%	316	5
Diisopropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	102.174	-85.4	68.4	0.7192 <sup>25</sup>	0.379	3.805	1.13	2.122	19.9	-28	1-8%	443	250
1,2-Dimethoxyethane	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	-69.20	84.5	0.8637 <sup>25</sup>	0.455	7.30		2.145	9.93	-2		202	
Dimethoxymethane	$\text{C}_3\text{H}_8\text{O}_2$	76.095	-105.1	42	0.8593 <sup>20</sup>		2.644	0.7	2.129	53.1	-32	2-14%	237	1000
Dimethylacetal	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	-113.2	64.5	0.8501 <sup>20</sup>					22.9				
<i>N,N</i> -Dimethylacetamide	$\text{C}_4\text{H}_9\text{NO}$	87.120	-18.59	165	0.9372 <sup>25</sup>	1.927	38.85	3.7	2.016	0.075	70	2-12%	490	10
2,3-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	121.180	<-15	221.5	0.9931 <sup>20</sup>					97	>1%			
2,6-Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	121.180	11.2	215	0.9842 <sup>20</sup>			1.63	1.971	0.45	96			
<i>N,N</i> -Dimethylaniline	$\text{C}_8\text{H}_{11}\text{N}$	121.180	2.42	194.15	0.9557 <sup>20</sup>	1.300	4.90	1.68	1.771	0.107	63		371	5
2,2-Dimethylbutane	$\text{C}_6\text{H}_{14}$	86.175	-98.8	49.73	0.6444 <sup>25</sup>	0.351	1.869	$\approx 0$	2.227	42.5	-48	1.2-7%	405	500
2,3-Dimethylbutane	$\text{C}_6\text{H}_{14}$	86.175	-128.10	57.93	0.6616 <sup>20</sup>	0.361	1.889	$\approx 0$	2.201	31.3	-29	1.2-7%	405	500
3,3-Dimethyl-2-butanone	$\text{C}_6\text{H}_{12}\text{O}$	100.158	-52.5	106.1	0.7229 <sup>25</sup>		12.73			4.27				
Dimethylcarbamic chloride	$\text{C}_3\text{H}_6\text{ClNO}$	107.539	-33	167	1.168 <sup>25</sup>									
Dimethyl disulfide	$\text{C}_2\text{H}_6\text{S}_2$	94.199	-84.67	109.74	1.0625 <sup>20</sup>		9.6	1.8	1.551	3.82	24			
<i>N,N</i> -Dimethylethanolamine	$\text{C}_4\text{H}_{11}\text{NO}$	89.136	-59	134	0.8866 <sup>20</sup>					0.9				
<i>N,N</i> -Dimethylformamide	$\text{C}_4\text{H}_9\text{NO}$	73.094	-60.48	153	0.9445 <sup>25</sup>	0.794	38.25	3.82	2.060	0.439	58	2-15%	445	10
2,6-Dimethyl-4-heptanone	$\text{C}_{10}\text{H}_{18}\text{O}$	142.238	-41.5	169.4	0.8062 <sup>20</sup>		9.91	2.7	2.090	0.23	49	1-7%	396	25
1,1-Dimethylhydrazine	$\text{C}_2\text{H}_8\text{N}_2$	60.098	-57.20	63.9	0.791 <sup>22</sup>				2.731	20.9	-15	2-95%	249	0.01
Dimethyl phthalate	$\text{C}_{10}\text{H}_{10}\text{O}_4$	194.184	5.5	283.7	1.1905 <sup>20</sup>	14.36	8.66		1.561	0.001	146	>0.9%	490	0.6
2,6-Dimethylpyridine	$\text{C}_8\text{H}_{11}\text{N}$	107.153	-6.1	144.01	0.9226 <sup>20</sup>		7.33	1.7	1.728	0.746				
Dimethyl sulfate	$\text{C}_6\text{H}_{14}\text{O}_4\text{S}$	126.132	-31.7	188 dec	1.3322 <sup>20</sup>		55.0			0.13	83		188	0.1
Dimethyl sulfide	$\text{C}_2\text{H}_6\text{S}$	62.134	-98.24	37.33	0.8483 <sup>20</sup>	0.284	6.70	1.554	1.901	64.4	-37	2.2-20%	206	10
Dimethyl sulfoxide	$\text{C}_2\text{H}_6\text{OS}$	78.133	17.89	189	1.1010 <sup>25</sup>	1.987	47.24	3.96	1.958	0.084	95	3-42%	215	
1,4-Dioxane	$\text{C}_4\text{H}_8\text{O}_2$	88.106	11.85	101.5	1.0337 <sup>20</sup>	1.177	2.2189	0	1.726	4.95	12	2-22%	180	20
1,3-Dioxolane	$\text{C}_3\text{H}_6\text{O}_2$	74.079	-97.22	78	1.060 <sup>20</sup>			1.19	1.593	14.6	2		20	
Dipentyl ether	$\text{C}_{10}\text{H}_{22}\text{O}$	158.281	-69	190	0.7833 <sup>20</sup>		2.798	1.20	1.579	0.13	57		170	
Dipropylamine	$\text{C}_6\text{H}_{15}\text{N}$	101.190	-63	109.3	0.7400 <sup>20</sup>	0.517	2.923	1.03	2.500	3.21	17		299	

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$vp/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
Dipropylene glycol monomethyl ether	$\text{C}_7\text{H}_{16}\text{O}_3$	148.200	-80	188.3	0.95									
Dipropyl ether	$\text{C}_6\text{H}_{14}\text{O}$	102.174	-114.8	90.08	0.7466 <sup>20</sup>	0.396	3.38	1.21	2.169	8.35	21	1.3-7%	188	
Dodecane	$\text{C}_{12}\text{H}_{26}$	170.334	-9.57	216.32	0.7495 <sup>20</sup>	1.383	2.0120	$\approx 0$	2.206	0.016	74	>0.6%	203	
1-Dodecanol	$\text{C}_{12}\text{H}_{26}\text{O}$	186.333	23.9	260	0.8309 <sup>24</sup>		5.82		2.351	0.000016	127		275	
1-Dodecene	$\text{C}_{12}\text{H}_{24}$	168.319	-35.2	213.8	0.7584 <sup>20</sup>	1.20	2.152	$\approx 0$	2.143	0.019	79			
Epichlorohydrin	$\text{C}_3\text{H}_5\text{ClO}$	92.524	-26	118	1.1812 <sup>20</sup>	1.073	22.6	1.8	1.422	2.2	31	4-21%	411	0.5
1,2-Epoxybutane	$\text{C}_4\text{H}_8\text{O}$	72.106	-150	63.4	0.8297 <sup>20</sup>			1.891	2.039	31.7	-22	1.7-19%	439	
1,2-Epoxy-4-(epoxyethyl)cyclohexane	$\text{C}_8\text{H}_{12}\text{O}_2$	140.180	<-55	227	1.0966 <sup>20</sup>									0.1
1,2-Ethanediamine	$\text{C}_2\text{H}_6\text{N}_2$	60.098	11.14	117	0.8979 <sup>20</sup>		13.82	1.99	2.872	1.62	40	3-12%	385	10
1,2-Ethandiol	$\text{C}_2\text{H}_6\text{O}_2$	62.068	-12.69	197.3	1.1135 <sup>20</sup>	16.06	41.4	2.28	2.394	0.01	111	3-22%	398	40
1,2-Ethandiol, diacetate	$\text{C}_6\text{H}_{10}\text{O}_4$	146.141	-31	190	1.1043 <sup>20</sup>		7.7	2.34	2.121	0.030	88	1.6-8.4%	482	
1,2-Ethandiol, dinitrate	$\text{C}_2\text{H}_4\text{N}_2\text{O}_6$	152.062	-22.3	198.5	1.4918 <sup>20</sup>		28.26			0.009				0.05
1,2-Ethanedithiol	$\text{C}_2\text{H}_6\text{S}_2$	94.199	-41.2	146.1	1.234 <sup>20</sup>		7.26	2.03						
Ethanedithiol	$\text{C}_2\text{H}_4\text{S}$	62.134	-147.88	35.0	0.8315 <sup>25</sup>	0.287	6.667	1.60	1.898	70.3	-17	2.8-18%	300	0.5
Ethanol	$\text{C}_2\text{H}_6\text{O}$	46.068	-114.14	78.29	0.7893 <sup>20</sup>	1.074	25.3	1.69	2.438	7.87	13	3-19%	363	1000
Ethanolamine	$\text{C}_2\text{H}_7\text{NO}$	61.083	10.5	171	1.0180 <sup>20</sup>	21.1	31.94	2.3	3.201	0.05	86	3-24%	410	3
4-Ethoxyaniline	$\text{C}_8\text{H}_9\text{NO}$	137.179	4.6	254	1.0652 <sup>16</sup>		7.43			0.0007	116			
Ethoxybenzene	$\text{C}_8\text{H}_{10}\text{O}$	122.164	-29.43	169.81	0.9651 <sup>20</sup>	1.197	4.216	1.45	1.870	0.204	63			
2-Ethoxyethanol	$\text{C}_4\text{H}_{10}\text{O}_2$	90.121	-70	135	0.9253 <sup>25</sup>		13.38	2.1	2.339	0.71	43	3-18%	235	5
2-Ethoxyethyl acetate	$\text{C}_8\text{H}_{16}\text{O}_3$	132.157	-61.7	156.4	0.9740 <sup>20</sup>		7.567	2.2	2.845	0.24	56	2-8%	379	5
Ethyl acetate	$\text{C}_4\text{H}_8\text{O}_2$	88.106	-83.8	77.11	0.9003 <sup>20</sup>	0.423	6.0814	1.78	1.937	12.6	-4	2-12%	426	400
Ethyl acetoacetate	$\text{C}_8\text{H}_{16}\text{O}_3$	130.141	-45	180.8	1.0368 <sup>10</sup>		14.0		1.906	0.095	57	1-10%	295	
Ethyl acrylate	$\text{C}_8\text{H}_{14}\text{O}_2$	100.117	-71.2	99.4	0.9234 <sup>20</sup>		6.05	1.96		5.14	10	1.4-14%	372	5
Ethylamine	$\text{C}_2\text{H}_7\text{N}$	45.084	-80.5	16.5	0.689 <sup>15</sup>		8.7	1.22	2.884	141	-16	4-14%	385	5
N-Ethylaniline	$\text{C}_8\text{H}_9\text{N}$	121.180	-63.5	203.0	0.9625 <sup>20</sup>	2.05	5.87			0.039	85			
Ethylbenzene	$\text{C}_8\text{H}_{10}$	106.165	-94.96	136.19	0.8626 <sup>25</sup>	0.631	2.4463	0.59	1.726	1.28	21	1-7%	432	100
Ethyl benzoate	$\text{C}_{10}\text{H}_{12}\text{O}_2$	150.174	-34	212	1.0415 <sup>25</sup>		6.20	2.00	1.638	0.04	88		490	
Ethyl butanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	116.158	-98	121.3	0.8735 <sup>25</sup>	0.639	5.18	1.74	1.963	2.01	24		463	
2-Ethyl-1-butanol	$\text{C}_8\text{H}_{18}\text{O}$	102.174	<-15	147	0.8326 <sup>20</sup>		6.19			0.206	57			
Ethyl chloroacetate	$\text{C}_4\text{H}_7\text{ClO}_2$	122.551	-21	144.3	1.1585 <sup>20</sup>					0.640	64			
Ethyl chloroformate	$\text{C}_4\text{H}_7\text{ClO}_2$	108.524	-80.6	95	1.1352 <sup>20</sup>		9.736				16		500	
Ethyl cyanoacetate	$\text{C}_5\text{H}_9\text{NO}_2$	113.116	-22.5	205	1.0654 <sup>20</sup>		31.62	2.17	1.947	0.003	110			
Ethyleneimine	$\text{C}_2\text{H}_5\text{N}$	43.068	-77.9	56	0.832 <sup>25</sup>		18.3	1.90		28.9	-11	3.3-55%	320	0.5
Ethyl formate	$\text{C}_4\text{H}_8\text{O}_2$	74.079	-79.6	54.4	0.9208 <sup>20</sup>	0.380	8.57	1.9	2.015	32.3	-20	3-16%	455	100
2-Ethylhexanal	$\text{C}_{10}\text{H}_{20}\text{O}$	128.212	<-100	163	0.8540 <sup>20</sup>						44	0.9-7.2%	190	
2-Ethyl-1,3-hexanediol	$\text{C}_{10}\text{H}_{22}\text{O}_2$	146.228	-40	244	0.9325 <sup>22</sup>		18.73				127		360	
2-Ethyl-1-hexanol	$\text{C}_{10}\text{H}_{20}\text{O}$	130.228	-70	184.6	0.8319 <sup>25</sup>	6.27	7.58	1.74	2.438	0.019	73	0.8-9.7%	231	
2-Ethylhexyl acetate	$\text{C}_{10}\text{H}_{20}\text{O}_2$	172.265	-80	199	0.8718 <sup>20</sup>			1.8		0.09	71	1-8%	268	
Ethyl lactate	$\text{C}_6\text{H}_{12}\text{O}_3$	118.131	-26	154.5	1.0328 <sup>20</sup>		15.4	2.4	2.150		46	>1.5%	400	
Ethyl 3-methylbutanoate	$\text{C}_9\text{H}_{18}\text{O}_2$	130.185	-99.3	135.0	0.8656 <sup>20</sup>		4.71			1.07				
Ethyl 2-methylpropanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	116.158	-88.2	110.1	0.868 <sup>20</sup>					3.25	13			
Ethyl nitrite	$\text{C}_2\text{H}_5\text{NO}_2$	75.067		18	0.899 <sup>15</sup>					135	-35	4-50%	90	
Ethyl propanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	102.132	-73.9	99.1	0.8843 <sup>25</sup>	0.501	5.76	1.74	1.920	4.97	12	1.9-11%	440	
Ethyl silicate	$\text{C}_8\text{H}_{20}\text{O}_4\text{Si}$	208.329	-82.5	168.8	0.9320 <sup>20</sup>		2.50		1.749	1.17	52			10
Eucalyptol	$\text{C}_{10}\text{H}_{18}\text{O}$	154.249	0.8	176.4	0.9267 <sup>20</sup>		4.57			0.260	48			
Fluorobenzene	$\text{C}_6\text{H}_5\text{F}$	96.102	-42.18	84.73	1.0225 <sup>20</sup>	0.550	5.465	1.60	1.523	10.4	-15			
Fluorosulfonic acid	$\text{FHSO}_3$	100.070	-89	163	1.726					0.08				
Formamide	$\text{CH}_3\text{NO}$	45.041	2.49	220	1.1334 <sup>20</sup>	3.34	111.0	3.73	2.389	0.01	154		10	
Formic acid	$\text{CH}_2\text{O}_2$	46.026	8.3	101	1.220 <sup>20</sup>	1.607	51.1	1.425	2.151	5.75	50	18-57%	434	5
Furan	$\text{C}_4\text{H}_4\text{O}$	68.074	-85.61	31.5	0.9514 <sup>20</sup>	0.361	2.94	0.66	1.686	80.0	-36	2-14%		
Furfural	$\text{C}_5\text{H}_4\text{O}_2$	96.085	-38.1	161.7	1.1594 <sup>20</sup>	1.587	42.1	3.5	1.698	0.29	60	2-19%	316	2
Furfuryl alcohol	$\text{C}_5\text{H}_6\text{O}_2$	98.101	-14.6	171	1.1296 <sup>20</sup>		16.85	1.9	2.079	0.097	75	2-16%	491	10
Germanium(IV) chloride	$\text{Cl}_4\text{Ge}$	214.42	-51.50	86.55	1.88			0						
Glycerol	$\text{C}_3\text{H}_8\text{O}_3$	92.094	18.1	290	1.2613 <sup>20</sup>	934	46.53	2.6	2.377	<0.01	199	3-19%	370	2.7
Glycerol triacetate	$\text{C}_9\text{H}_{14}\text{O}_6$	218.203	-78	259	1.1583 <sup>20</sup>		7.11		1.763	<0.01	138	1%-	433	
Glycerol trioleate	$\text{C}_{57}\text{H}_{104}\text{O}_6$	885.432	-4		0.915 <sup>15</sup>		3.109							
Heptanal	$\text{C}_7\text{H}_{14}\text{O}$	114.185	-43.4	152.8	0.8132 <sup>25</sup>		9.07		2.015	0.46				
Heptane	$\text{C}_7\text{H}_{16}$	100.202	-90.55	98.4	0.6795 <sup>25</sup>	0.387	1.9209	$\approx 0$	2.242	6.09	-4	1-7%	204	400
Heptanoic acid	$\text{C}_7\text{H}_{14}\text{O}_2$	130.185	-7.17	222.2	0.9124 <sup>25</sup>	3.84	3.04		2.039	0.001			275	
1-Heptanol	$\text{C}_7\text{H}_{16}\text{O}$	116.201	-33.2	176.45	0.8219 <sup>20</sup>	5.81	11.75		2.342	0.0044				
2-Heptanone	$\text{C}_7\text{H}_{14}\text{O}$	114.185	-35	151.05	0.8111 <sup>20</sup>	0.714	11.95	2.6	2.037	0.49	39	1-8%	393	50
3-Heptanone	$\text{C}_7\text{H}_{14}\text{O}$	114.185	-39	147	0.8183 <sup>20</sup>		12.7	2.78		0.5	46		50	
4-Heptanone	$\text{C}_7\text{H}_{14}\text{O}$	114.185	-33	144	0.8174 <sup>20</sup>		12.60			0.164	49		50	
1-Heptene	$\text{C}_7\text{H}_{14}$	98.186	-118.9	93.64	0.6970 <sup>20</sup>	0.340	2.092	$\approx 0$	2.157	7.52	-1		260	
Hexachloro-1,3-butadiene	$\text{C}_4\text{Cl}_6$	260.761	-21	215	1.556 <sup>25</sup>		2.55			0.13			610	0.02

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
Hexachloro-1,3-cyclopentadiene	$\text{C}_5\text{Cl}_6$	272.772	-9	239	1.7019 <sup>25</sup>									0.01
Hexafluorobenzene	$\text{C}_6\text{F}_6$	186.054	5.03	80.26	1.6184 <sup>20</sup>	2.79	2.029	0	1.191	11.3				
Hexamethyldisiloxane	$\text{C}_6\text{H}_{18}\text{OSi}_2$	162.377	-66	99	0.7638 <sup>20</sup>		2.179		1.918	5.57				
Hexamethylphosphoric triamide	$\text{C}_6\text{H}_{18}\text{N}_3\text{OP}$	179.200	7.2	232.5	1.03 <sup>20</sup>		31.3	5.5	1.791					
Hexanal	$\text{C}_6\text{H}_{12}\text{O}$	100.158	-56	131	0.8335 <sup>20</sup>				2.101	1.48	32			
Hexane	$\text{C}_6\text{H}_{14}$	86.175	-95.35	68.73	0.6606 <sup>25</sup>	0.300	1.8865	$\approx 0$	2.270	20.2	-22	1-8%	225	50
Hexanedinitrile	$\text{C}_6\text{H}_8\text{N}_2$	108.141	1	295	0.9676 <sup>20</sup>				1.190	<0.01	93	2-5%	550	2
Hexanoic acid	$\text{C}_6\text{H}_{12}\text{O}_2$	116.158	-3	205.2	0.9212 <sup>25</sup>		2.600	1.13	1.937	0.005	102		380	
1-Hexanol	$\text{C}_6\text{H}_{14}\text{O}$	102.174	-47.4	157.6	0.8136 <sup>20</sup>	4.58	13.03		2.353	0.11	63		290	
2-Hexanone	$\text{C}_6\text{H}_{12}\text{O}$	100.158	-55.5	127.6	0.8113 <sup>20</sup>	0.583	14.56	2.7	2.130	1.54	25	1-8%	423	5
1-Hexene	$\text{C}_6\text{H}_{12}$	84.159	-139.76	63.48	0.6685 <sup>25</sup>	0.252	2.077	$\approx 0$	2.178	24.8	-26	1.2-6.9%	253	50
Hexyl acetate	$\text{C}_8\text{H}_{16}\text{O}_2$	144.212	-80.9	171.5	0.8779 <sup>15</sup>		4.42		1.961	0.185	45			
Hydrazine	$\text{H}_4\text{N}_2$	32.045	1.4	113.55	1.0036	0.876	51.7	1.75	3.086	1.91	38	5-100%		0.01
Hydrazoic acid	$\text{HN}_3$	43.028	-80	35.7				1.70		68.2				0.11
Hydrogen cyanide	HCN	27.026	-13.29	26	0.6876 <sup>20</sup>	0.183	114.9	2.985	2.612	98.8	-18	6-40%	538	4.7
Hydrogen peroxide	$\text{H}_2\text{O}_2$	34.015	-0.43	150.2	1.44		74.6	1.573	2.619	0.26				1
3-Hydroxypropanenitrile	$\text{C}_3\text{H}_5\text{NO}$	71.078	-46	221	1.0404 <sup>25</sup>			3.2		0.010	129			
Indan	$\text{C}_9\text{H}_{10}$	118.175	-51.38	177.97	0.9639 <sup>20</sup>	1.357			1.609	0.2				
Indene	$\text{C}_9\text{H}_8$	116.160	-1.5	182	0.9960 <sup>25</sup>				1.609	0.220				10
Iodine bromide	BrI	206.808	40	116 dec	4.3			0.726						
Iodine chloride	ClI	162.357	27.39	100 dec	3.24			1.24		3.59				
Iodobenzene	$\text{C}_6\text{H}_5\text{I}$	204.008	-31.3	188.4	1.8308 <sup>20</sup>	1.554	4.59	1.70	0.778	0.133				
1-Iodobutane	$\text{C}_4\text{H}_9\text{I}$	184.018	-103	130.5	1.6154 <sup>20</sup>		6.27	1.93		1.85				
Iodoethane	$\text{C}_2\text{H}_5\text{I}$	155.965	-111.1	72.3	1.9357 <sup>20</sup>	0.556	7.82	1.976	0.738	18.2				
Iodomethane	$\text{CH}_3\text{I}$	141.939	-66.4	42.43	2.2789 <sup>20</sup>	0.469	6.97	1.62	0.888	53.9				2
1-Iodopropane	$\text{C}_3\text{H}_7\text{I}$	169.992	-101.3	102.5	1.7489 <sup>20</sup>	0.703	7.07	2.04	0.746	5.75				
2-Iodopropane	$\text{C}_3\text{H}_7\text{I}$	169.992	-90	89.5	1.7042 <sup>20</sup>	0.653	8.19	1.95	0.535	9.36				
Iron pentacarbonyl	$\text{C}_5\text{FeO}_5$	195.896	-20	103	1.5 <sup>20</sup>		2.602		1.228	4				0.1
Isobutanal	$\text{C}_4\text{H}_8\text{O}$	72.106	-65.9	64.5	0.7891 <sup>20</sup>			2.75		23.0	-18	1.6-10.6%	196	
Isobutyl acetate	$\text{C}_6\text{H}_{12}\text{O}_2$	116.158	-98.8	116.5	0.8712 <sup>20</sup>	0.676	5.068	1.9	2.013	2.39	18	1-11%	421	150
Isobutyl acrylate	$\text{C}_7\text{H}_{12}\text{O}_2$	128.169	-61	132	0.8896 <sup>20</sup>					30			427	
Isobutylamine	$\text{C}_4\text{H}_{11}\text{N}$	73.137	-86.7	67.75	0.724 <sup>25</sup>	0.571	4.43	1.3	2.505	19.0	-9	2-12%	378	
Isobutylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-51.4	172.79	0.8532 <sup>20</sup>		2.318	$\approx 0$	1.793	0.257	55	0.8-6%	427	
Isobutyl formate	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	-95.8	98.2	0.8776 <sup>20</sup>		6.41	1.88		5.34	5	2-9%	320	
Isobutyl isobutanoate	$\text{C}_8\text{H}_{16}\text{O}_2$	144.212	-80.7	148.6	0.8542 <sup>20</sup>			1.9		0.552	38	1-8%	432	
Isopentane	$\text{C}_5\text{H}_{12}$	72.149	-159.77	27.88	0.6201 <sup>20</sup>	0.214	1.845	0.13	2.284	91.7	-51	1.4-7.6%	420	600
Isopentyl acetate	$\text{C}_7\text{H}_{14}\text{O}_2$	130.185	-78.5	142.5	0.876 <sup>15</sup>		4.72	1.9	1.909	0.728	25	1-8%	360	50
Isophorone	$\text{C}_9\text{H}_{18}\text{O}$	138.206	-8.1	215.2	0.9255 <sup>20</sup>	2.33			1.834	0.06	84	1-4%	460	5
Isopropenyl acetate	$\text{C}_5\text{H}_8\text{O}_2$	100.117	-92.9	94	0.9090 <sup>20</sup>					6.02	26		432	
Isopropenylbenzene	$\text{C}_9\text{H}_{10}$	118.175	-23.2	165.4	0.9106 <sup>20</sup>		2.28		1.711	0.40	54	1.9-6.1%	574	50
Isopropyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	-73.4	88.6	0.8718 <sup>20</sup>				1.952	7.88	2	2-8%	460	100
Isopropylamine	$\text{C}_3\text{H}_7\text{N}$	59.110	-95.13	31.76	0.6891 <sup>20</sup>	0.325	5.6268	1.19	2.771	78.0	-37		402	5
Isopropylbenzene	$\text{C}_9\text{H}_{12}$	120.191	-96.02	152.41	0.8640 <sup>25</sup>	0.737	2.381	0.79	1.753	0.61	36	1-7%	424	50
Isopropylbenzene hydroperoxide	$\text{C}_9\text{H}_{12}\text{O}_2$	152.190		153	1.03 <sup>20</sup>					0.004				
1-Isopropyl-2-methylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-71.5	178.1	0.8766 <sup>20</sup>					0.2				
1-Isopropyl-3-methylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-63.7	175.1	0.8610 <sup>20</sup>					0.22				
1-Isopropyl-4-methylbenzene	$\text{C}_{10}\text{H}_{14}$	134.218	-67.94	177.1	0.8573 <sup>20</sup>		2.2322	$\approx 0$	1.761	0.19	47	1-6%	436	
Isoquinoline	$\text{C}_8\text{H}_7\text{N}$	129.159	26.47	243.22	1.0910 <sup>30</sup>		11.0	2.73	1.519	0.007				
<i>d</i> -Limonene	$\text{C}_{10}\text{H}_{16}$	136.234	-74.0	178	0.8411 <sup>20</sup>	1.47	2.3746		1.828	0.277	45	0.7-6.1%	237	
<i>l</i> -Limonene	$\text{C}_{10}\text{H}_{16}$	136.234		178	0.843 <sup>20</sup>		2.3738			0.254				
Mesityl oxide	$\text{C}_8\text{H}_{10}\text{O}$	98.142	-59	130	0.8653 <sup>20</sup>	0.602	15.6	2.8	2.165	1.47	31	1-7%	344	15
Methacrylic acid	$\text{C}_4\text{H}_6\text{O}_2$	86.090	16	162.5	1.0153 <sup>20</sup>			1.65	1.871	0.12	77	1.6-8.8%	68	20
Methanol	$\text{CH}_3\text{O}$	32.042	-97.53	64.6	0.7914 <sup>20</sup>	0.544	33.0	1.70	2.531	16.9	11	6-36%	464	200
2-Methoxyaniline	$\text{C}_7\text{H}_7\text{NO}$	123.152	6.2	224	1.0923 <sup>20</sup>		5.230			0.013	118			0.1
4-Methoxybenzaldehyde	$\text{C}_8\text{H}_8\text{O}_2$	136.149	0	248	1.119 <sup>15</sup>		22.0			0.004				
2-Methoxyethanol	$\text{C}_4\text{H}_{10}\text{O}_2$	76.095	-85.1	124.1	0.9647 <sup>20</sup>		17.2	2.36	2.249	1.31	39	2-14%	285	5
2-Methoxyethyl acetate	$\text{C}_6\text{H}_{12}\text{O}_3$	118.131	-70	143	1.0074 <sup>19</sup>		8.25	2.1	2.624	0.67	49	2-12%	392	5
Methyl acetate	$\text{C}_3\text{H}_6\text{O}_2$	74.079	-98.25	56.87	0.9342 <sup>20</sup>	0.364	7.07	1.72	1.916	28.8	-10	3-16%	454	200
Methyl acrylate	$\text{C}_5\text{H}_8\text{O}_2$	86.090	<-75	80.7	0.9535 <sup>20</sup>		7.03	1.77	1.845	11.0	-3	2.8-25%	468	2
2-Methylacrylonitrile	$\text{C}_5\text{H}_7\text{N}$	67.090	-35.8	90.3	0.8001 <sup>20</sup>			3.69	1.883	8.26	1	2-6.8%	1	
2-Methylaniiline	$\text{C}_7\text{H}_7\text{N}$	107.153	-14.41	200.3	0.9984 <sup>20</sup>	3.82	6.138	1.6	1.96	0.043	85		482	2
3-Methylaniiline	$\text{C}_7\text{H}_7\text{N}$	107.153	-31.3	203.3	0.9889 <sup>20</sup>	3.31	5.816	1.45	2.118	0.036				2
<i>N</i> -Methylaniiline	$\text{C}_7\text{H}_7\text{N}$	107.153	-57	196.2	0.9891 <sup>20</sup>	2.04	5.96		1.933	0.05				0.5
Methyl benzoate	$\text{C}_8\text{H}_8\text{O}_2$	136.149	-12.4	199	1.0837 <sup>25</sup>	1.857	6.642	1.9	1.625	0.052	83			

Name	Mol. form.	$M_f$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
2-Methyl-1,3-butadiene	$\text{C}_6\text{H}_8$	68.118	-145.9	34.0	0.679 <sup>9</sup>		2.098	0.25	2.240	73.4	-54	1.5-8.9%	395	
Methyl butanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	102.132	-85.8	102.8	0.8984 <sup>20</sup>	0.541	5.48		1.941	4.30	14			
3-Methylbutanoic acid	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	-29.3	176.5	0.931 <sup>20</sup>			0.63	1.930	0.067			416	
3-Methyl-1-butanol	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-117.2	131.1	0.8104 <sup>20</sup>	3.69	15.63		2.382	0.315	43	1.2-9%	350	100
2-Methyl-2-butanol	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-9.1	102.4	0.8096 <sup>20</sup>	3.55	5.78	1.82	2.803	2.19	19	1.2-9%	437	
3-Methyl-2-butanol, ( $\pm$ )-	$\text{C}_5\text{H}_{12}\text{O}$	88.148		112.9	0.8180 <sup>20</sup>		12.1			1.20	38			
3-Methyl-2-butanone	$\text{C}_5\text{H}_{10}\text{O}$	86.132	-93.1	94.33	0.8051 <sup>20</sup>		10.37		2.089	6.99				200
2-Methyl-1-butene	$\text{C}_5\text{H}_{10}$	70.133	-137.53	31.2	0.6504 <sup>20</sup>		2.180		2.241	81.4	-20			
2-Methyl-2-butene	$\text{C}_5\text{H}_{10}$	70.133	-133.72	38.56	0.6623 <sup>20</sup>	0.203	1.979		2.179	62.1	-20			
Methyl <i>tert</i> -butyl ether	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-108.6	55.0	0.7353 <sup>25</sup>				2.127	33.6				50
Methyl chloroacetate	$\text{C}_3\text{H}_5\text{ClO}_2$	108.524	-32.1	129.5	1.236 <sup>20</sup>		12.0			1.0	57	7.5-18.5%		
Methylcyclohexane	$\text{C}_7\text{H}_{14}$	98.186	-126.6	100.93	0.7694 <sup>20</sup>	0.679	2.024	$\approx 0$	1.882	6.18	-4	1-7%	250	400
Methylcyclopentane	$\text{C}_6\text{H}_{12}$	84.159	-142.42	71.8	0.7486 <sup>20</sup>	0.479	1.9853	$\approx 0$	1.886	18.3	-29	1-8%	258	
<i>N</i> -Methylformamide	$\text{C}_2\text{H}_5\text{NO}$	59.067	-3.8	199.51	1.011 <sup>19</sup>	1.678	189.0	3.83	2.096	0.03				
Methyl formate	$\text{C}_2\text{H}_4\text{O}_2$	60.052	-99	31.7	0.9713 <sup>20</sup>	0.325	9.20	1.77	1.983	78.1	-19	5-23%	449	100
5-Methyl-2-hexanone	$\text{C}_7\text{H}_{14}\text{O}$	114.185		144	0.888 <sup>20</sup>		13.53			0.691	36	1-8%	191	50
Methylhydrazine	$\text{CH}_6\text{N}_2$	46.072	-52.36	87.5					2.928	6.61	-8	2.5-92%	194	0.01
Methyl isocyanate	$\text{C}_2\text{H}_3\text{NO}$	57.051	-45	39.5	0.9230 <sup>27</sup>		21.75	$\approx 2.8$		57.7	-7	5.3-26%	534	0.02
Methyl lactate, ( $\pm$ )-	$\text{C}_4\text{H}_8\text{O}_3$	104.105		144.8	1.0928 <sup>20</sup>					0.62	49	>2.2%	385	
Methyl methacrylate	$\text{C}_5\text{H}_8\text{O}_2$	100.117	-47.55	100.5	0.9377 <sup>25</sup>		6.32	1.67	1.910	5.10	10	1.7-8.2%		50
1-Methylnaphthalene	$\text{C}_{11}\text{H}_{10}$	142.197	-30.43	244.7	1.0202 <sup>20</sup>		2.915	$\approx 0$	1.578	0.009			529	
Methyloxirane	$\text{C}_3\text{H}_6\text{O}$	58.079	-111.9	35	0.859 <sup>9</sup>			2.01	2.073	71.7	-37	3.1-27.5%	449	2
2-Methylpentane	$\text{C}_6\text{H}_{14}$	86.175	-153.6	60.26	0.650 <sup>25</sup>	0.286	1.886	$\approx 0$	2.248	28.2	<-29	1-7%	264	500
3-Methylpentane	$\text{C}_6\text{H}_{14}$	86.175	-162.90	63.27	0.6598 <sup>25</sup>	0.306	1.886	$\approx 0$	2.213	25.3	-7	1.2-7%	278	500
2-Methyl-2,4-pentanediol	$\text{C}_6\text{H}_{14}\text{O}_2$	118.174	-50	197.1	0.923 <sup>15</sup>		23.4	2.9	2.843	<-0.01	102	1-9%	306	25
2-Methyl-1-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	102.174		149	0.8263 <sup>20</sup>				2.427	0.236	54	1.1-9.65%	310	
4-Methyl-2-pentanol	$\text{C}_6\text{H}_{14}\text{O}$	102.174	-90	131.6	0.8075 <sup>20</sup>	4.07			2.672	0.698	41	1-6%		25
4-Methyl-2-pentanone	$\text{C}_6\text{H}_{12}\text{O}$	100.158	-84	116.5	0.7965 <sup>25</sup>	0.545	13.11		2.130	2.64	18	1-8%	448	50
2-Methylpropanenitrile	$\text{C}_4\text{H}_7\text{N}$	69.106	-71.5	103.9	0.7704 <sup>20</sup>		24.42	4.29			8		482	
2-Methyl-2-propanethiol	$\text{C}_4\text{H}_9\text{S}$	90.187	-0.5	64.2	0.7943 <sup>25</sup>		5.475	1.66		24.2	<-29			
Methyl propanoate	$\text{C}_4\text{H}_8\text{O}_2$	88.106	-87.5	79.8	0.9150 <sup>20</sup>	0.431	6.200		1.943	11.5	-2	2.5-13%	469	
2-Methylpropanoic acid	$\text{C}_4\text{H}_8\text{O}_2$	88.106	-46	154.45	0.9681 <sup>20</sup>	1.226	2.58	1.08	1.964	0.17	56	2-9.2%	481	
2-Methyl-1-propanol	$\text{C}_4\text{H}_{10}\text{O}$	74.121	-101.9	107.89	0.8018 <sup>20</sup>	3.33	17.93	1.64	2.449	1.39	28	2-11%	415	50
2-Methyl-2-propanol	$\text{C}_4\text{H}_{10}\text{O}$	74.121	25.69	82.4	0.7887 <sup>20</sup>	4.31	12.47	1.7	2.949	5.52	11	2-8%	478	100
2-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	93.127	-66.68	129.38	0.9443 <sup>20</sup>		10.18	1.85	1.703	1.5	39		538	
3-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	93.127	-18.14	144.14	0.9566 <sup>20</sup>		11.10	2.40	1.704	0.795				
4-Methylpyridine	$\text{C}_6\text{H}_7\text{N}$	93.127	3.67	145.36	0.9548 <sup>20</sup>		12.2	2.70	1.707	0.759	57			
<i>N</i> -Methyl-2-pyrrolidone	$\text{C}_5\text{H}_9\text{NO}$	99.131	-23.09	202	1.0230 <sup>25</sup>		32.55	4.1	3.105	0.04	96	1-10%	346	
Methyl salicylate	$\text{C}_8\text{H}_8\text{O}_3$	152.148	-8	222.9	1.181 <sup>25</sup>		8.80	2.47	1.637	0.015	96		454	
4-Methylstyrene	$\text{C}_9\text{H}_{10}$	118.175	-34.1	172.8	0.9173 <sup>25</sup>					0.245	53	0.8-11%	538	50
Morpholine	$\text{C}_4\text{H}_9\text{NO}$	87.120	-4.8	128	1.0005 <sup>20</sup>	2.02	7.42	1.55	1.892	1.34	37	1-11%	290	20
$\beta$ -Myrcene	$\text{C}_{10}\text{H}_{16}$	136.234		167	0.8013 <sup>15</sup>		2.3			0.280				
Nickel carbonyl	$\text{C}_5\text{NiO}_4$	170.734	-19.3	43 (exp 60)	1.31 <sup>25</sup>				1.198					0.05
<i>L</i> -Nicotine	$\text{C}_{10}\text{H}_{14}\text{N}_2$	162.231	-79	247	1.0097 <sup>20</sup>		8.937							0.1
Nitric acid	$\text{HNO}_3$	63.013	-41.6	83	1.55			2.17	1.744	8.34				2
2-Nitroanisole	$\text{C}_7\text{H}_9\text{NO}_3$	153.136	10.5	272	1.2540 <sup>20</sup>		45.75	5.0		0.002				
Nitrobenzene	$\text{C}_6\text{H}_5\text{NO}_2$	123.110	5.7	210.8	1.2037 <sup>20</sup>	1.863	35.6	4.22	1.509	0.03	88	2-9%	482	1
Nitroethane	$\text{C}_2\text{H}_5\text{NO}_2$	75.067	-89.5	114.0	1.0448 <sup>25</sup>	0.688	29.11	3.23	1.790	2.79	28	3-17%	414	100
Nitromethane	$\text{CH}_3\text{NO}_2$	61.041	-28.38	101.19	1.1371 <sup>20</sup>	0.630	37.27	3.46	1.746	4.79	35	7-22%	418	20
1-Nitropropane	$\text{C}_3\text{H}_7\text{NO}_2$	89.094	-108	131.1	0.9961 <sup>25</sup>	0.798	24.70	3.66	1.97	1.36	36	2%-	421	25
2-Nitropropane	$\text{C}_3\text{H}_7\text{NO}_2$	89.094	-91.3	120.2	0.9821 <sup>25</sup>		26.74	3.73	1.911	2.3	24	3-11%	428	10
<i>N</i> -Nitrosodiethylamine	$\text{C}_4\text{H}_{10}\text{N}_2\text{O}$	102.134		176.9	0.9422 <sup>20</sup>									
<i>N</i> -Nitrosodimethylamine	$\text{C}_2\text{H}_6\text{N}_2\text{O}$	74.081		152	1.0048 <sup>20</sup>					0.73				
2-Nitrotoluene	$\text{C}_7\text{H}_7\text{NO}_2$	137.137	-10.4	222	1.1611 <sup>19</sup>		26.26		1.474	0.0014	106			2
3-Nitrotoluene	$\text{C}_7\text{H}_7\text{NO}_2$	137.137	15.5	232	1.1581 <sup>20</sup>		24.95		1.474	0.03	106			2
Nonane	$\text{C}_9\text{H}_{20}$	128.255	-53.46	150.82	0.7192 <sup>20</sup>	0.665	1.9722	$\approx 0$	2.217	0.570	31	0.8-2.9%	205	200
Nonanoic acid	$\text{C}_9\text{H}_{18}\text{O}_2$	158.238	12.4	254.5	0.9052 <sup>20</sup>	7.01	2.475	0.79	2.290	0.00005				
1-Nonanol	$\text{C}_9\text{H}_{20}\text{O}$	144.254	-5	213.37	0.8280 <sup>20</sup>	9.12	8.83		2.470	0.00050			260	
1-Nonene	$\text{C}_9\text{H}_{18}$	126.239	-81.3	146.9	0.7253 <sup>25</sup>	0.586	2.180	$\approx 0$	2.142	0.714	26			
4-Nonylphenol	$\text{C}_{15}\text{H}_{24}\text{O}$	220.351	42	$\approx 295$	0.950 <sup>20</sup>									
<i>cis,cis</i> -9,12-Octadecadienoic acid	$\text{C}_{18}\text{H}_{32}\text{O}_2$	280.446	-7		0.9022 <sup>20</sup>		2.754							
<i>cis</i> -9-Octadecenoic acid	$\text{C}_{18}\text{H}_{34}\text{O}_2$	282.462	13.4	360	0.8935 <sup>20</sup>		2.336	1.18	2.043	0.000001	189		363	
Octane	$\text{C}_8\text{H}_{18}$	114.229	-56.82	125.67	0.6986 <sup>25</sup>	0.508	1.948	$\approx 0$	2.229	1.86	13	1-7%	206	300
Octanoic acid	$\text{C}_8\text{H}_{16}\text{O}_2$	144.212	16.5	239	0.9073 <sup>25</sup>	5.02	2.85	1.15	2.066	0.0002				
1-Octanol	$\text{C}_8\text{H}_{18}\text{O}$	130.228	-14.8	195.16	0.8262 <sup>25</sup>	7.29	10.30	1.8	2.344	0.01	81		270	
2-Octanol	$\text{C}_8\text{H}_{18}\text{O}$	130.228	-31.6	179.3	0.8193 <sup>20</sup>	6.49	8.13	1.71	2.535		88		265	



Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/g\text{ mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/J\text{ g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
2-Octanone	$\text{C}_8\text{H}_{16}\text{O}$	128.212	-16	172.5	0.820 <sup>20</sup>		9.51	2.7	2.132	0.12	52			
1-Octene	$\text{C}_8\text{H}_{16}$	112.213	-101.7	121.29	0.7149 <sup>20</sup>	0.447	2.113	$\approx 0$	2.148	2.30	21		230	
Oxetane	$\text{C}_3\text{H}_6\text{O}$	58.079	-97	47.6	0.8930 <sup>25</sup>			1.94						
2-Oxetanone	$\text{C}_3\text{H}_4\text{O}_2$	72.063	-33.4	162	1.1460 <sup>20</sup>			4.18	1.694	0.3	74	>2.9%		0.5
Oxirane	$\text{C}_2\text{H}_4\text{O}$	44.052	-112.5	10.6	0.8821 <sup>10</sup>		12.42	1.89	1.998	175	-20	3-100%	429	1
Oxiranemethanol, ( $\pm$ )-	$\text{C}_3\text{H}_6\text{O}_2$	74.079	-45	167 dec	1.1143 <sup>25</sup>									2
Paraldehyde	$\text{C}_6\text{H}_{12}\text{O}_3$	132.157	12.6	124.3	0.9943 <sup>20</sup>	1.079		1.43		1.6	36	>1.3%	238	
Parathion	$\text{C}_{10}\text{H}_{14}\text{NO}_5\text{PS}$	291.261	6.1	375	1.2681 <sup>20</sup>									0.01
Pentachloroethane	$\text{C}_2\text{HCl}_5$	202.294	-28.78	162.0	1.6796 <sup>20</sup>	2.25	3.716	0.92	0.859	0.478				
cis-1,3-Pentadiene	$\text{C}_5\text{H}_8$	68.118	-140.8	44.1	0.6910 <sup>20</sup>		2.319	0.500		50.6				
trans-1,3-Pentadiene	$\text{C}_5\text{H}_8$	68.118	-87.4	42	0.6710 <sup>25</sup>			0.585		54.7				
Pentanal	$\text{C}_5\text{H}_{10}\text{O}$	86.132	-91.5	103	0.8095 <sup>20</sup>		10.00			4.58	12		222	50
Pentane	$\text{C}_5\text{H}_{12}$	72.149	-129.67	36.06	0.6262 <sup>20</sup>	0.224	1.8371	$\approx 0$	2.317	68.3	-40	2-8%	260	600
Pentanedial	$\text{C}_5\text{H}_8\text{O}_2$	100.117	-14	188 dec										0.05
1,5-Pentanediol	$\text{C}_5\text{H}_{12}\text{O}_2$	104.148	-18	239	0.9914 <sup>20</sup>		26.2	2.5	3.08	0.001	129		335	
2,4-Pentanedione	$\text{C}_5\text{H}_8\text{O}_2$	100.117	-23	138	0.9721 <sup>25</sup>		26.524	2.8	2.08	1.02	34		340	
1-Pentanethiol	$\text{C}_5\text{H}_{12}\text{S}$	104.214	-75.65	126.6	0.850 <sup>20</sup>		4.847			1.83	18			
Pentanoic acid	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	-33.6	186.1	0.9339 <sup>25</sup>		2.661	1.61	2.059	0.024	96		400	
1-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-77.6	137.98	0.8144 <sup>20</sup>	3.62	15.13	1.7	2.361	0.259	33	1-10%	300	
2-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-73	119.3	0.8094 <sup>20</sup>	3.47	13.71	1.66	2.716	0.804	34	1.2-9%	343	
3-Pentanol	$\text{C}_5\text{H}_{12}\text{O}$	88.148	-69	116.25	0.8203 <sup>20</sup>	4.15	13.35	1.64	2.719	1.10	41	1.2-9%	435	
2-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	86.132	-76.8	102.26	0.809 <sup>20</sup>	0.470	15.45	2.7	2.137	4.97	7	2-8%	452	200
3-Pentanone	$\text{C}_5\text{H}_{10}\text{O}$	86.132	-39	101.7	0.8098 <sup>25</sup>	0.444	17.00	2.82	2.216	4.72	13	>1.6%	450	200
1-Pentene	$\text{C}_5\text{H}_{10}$	70.133	-165.12	29.96	0.6405 <sup>20</sup>	0.195	2.011	$\approx 0.5$	2.196	85.0	-18	1.5-8.7%	275	
cis-2-Pentene	$\text{C}_5\text{H}_{10}$	70.133	-151.36	36.93	0.6556 <sup>20</sup>			$\approx 0$	2.163	66.0	<-20			
trans-2-Pentene	$\text{C}_5\text{H}_{10}$	70.133	-140.21	36.34	0.6431 <sup>25</sup>			$\approx 0$	2.239	67.4	<-20			
Pentyl acetate	$\text{C}_7\text{H}_{14}\text{O}_2$	130.185	-70.8	149.2	0.8756 <sup>20</sup>		4.79	1.75	2.005	0.60	16	1-8%	360	50
Pentylamine	$\text{C}_5\text{H}_{13}\text{N}$	87.164	-55	104.3	0.7544 <sup>20</sup>	0.702	4.27		2.501	4.00	-1	2.2-22%		
Perchloric acid	$\text{ClHO}_4$	100.459	-112	$\approx 90$ dec	1.77									
Peroxyacetic acid	$\text{C}_2\text{H}_4\text{O}_3$	76.051	-0.2	110	1.226 <sup>15</sup>					1.93	41			
Phenol	$\text{C}_6\text{H}_6\text{O}$	94.111	40.89	181.87	1.0545 <sup>45</sup>		12.40	1.224	2.123	0.055	79	1.8-8.6%	715	5
2-Phenoxyethanol	$\text{C}_8\text{H}_{10}\text{O}_2$	138.164	14	245	1.102 <sup>22</sup>					0.001	121			
Phenylhydrazine	$\text{C}_6\text{H}_8\text{N}_2$	108.141	20.6	243.5	1.0986 <sup>20</sup>	13.03	7.15		2.007	0.003	88			0.1
1-Phenyl-2-propylamine, ( $\pm$ )-	$\text{C}_9\text{H}_{13}\text{N}$	135.206		203	0.9306 <sup>25</sup>					0.06	<100			
Phosphinic acid	$\text{H}_3\text{O}_2\text{P}$	65.997	26.5	130	1.49									
Phosphoric acid	$\text{H}_3\text{O}_4\text{P}$	97.995	42.4	407					1.480					0.25
Phosphorothioc trichloride	$\text{Cl}_3\text{PS}$	169.398	-36.2	125	1.635		4.94							
Phosphorus(III) bromide	$\text{Br}_3\text{P}$	270.686	-41.5	173.2	2.8					0.38				
Phosphorus(III) chloride	$\text{Cl}_3\text{P}$	137.332	-93.6	76.1	1.574	0.529	3.498	0.56		16.1				0.2
Phosphoryl chloride	$\text{Cl}_3\text{OP}$	153.331	1.18	105.5	1.645		14.1	2.54	0.905	4.97				0.1
$\alpha$ -Pinene	$\text{C}_{10}\text{H}_{16}$	136.234	-64	156.2	0.8539 <sup>25</sup>		2.1787			0.64	33		255	
$\beta$ -Pinene	$\text{C}_{10}\text{H}_{16}$	136.234	-61.5	166	0.860 <sup>25</sup>		2.4970			0.61	38		275	
Piperidine	$\text{C}_5\text{H}_{11}\text{N}$	85.148	-11.02	106.22	0.8606 <sup>20</sup>	1.573	4.33	1.2	2.113	4.28	16	1-10%		
Propanal	$\text{C}_3\text{H}_6\text{O}$	58.079	-80	48	0.8657 <sup>25</sup>	0.321	18.5	2.72	2.362	42.2	-30	2.6-17%	207	20
1,2-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	76.095	-60	187.6	1.0361 <sup>20</sup>	40.4	27.5	2.2	2.507	0.02	99	3-13%	371	
1,3-Propanediol	$\text{C}_3\text{H}_8\text{O}_2$	76.095	-27.7	214.4	1.0538 <sup>20</sup>		35.1	2.5		0.007			400	
Propanenitrile	$\text{C}_3\text{H}_5\text{N}$	55.079	-92.78	97.14	0.7818 <sup>20</sup>	0.294	29.7	4.05	2.166	6.14	2	3-14%	512	
Propanoic acid	$\text{C}_3\text{H}_6\text{O}_2$	74.079	-20.5	141.15	0.9882 <sup>25</sup>	1.030	3.44	1.75	2.063	0.553	52	2.9-12.1%	465	10
Propanoic anhydride	$\text{C}_6\text{H}_{10}\text{O}_3$	130.141	-45	170	1.0110 <sup>20</sup>		18.30		1.806	0.45	63	1.3-9.5%	285	
1-Propanol	$\text{C}_3\text{H}_8\text{O}$	60.095	-124.39	97.2	0.7997 <sup>25</sup>	1.945	20.8	1.55	2.395	2.76	23	2-14%	412	200
2-Propanol	$\text{C}_3\text{H}_8\text{O}$	60.095	-87.9	82.3	0.7809 <sup>25</sup>	2.04	20.18	1.56	2.604	6.02	12	2-13%	399	200
Propargyl alcohol	$\text{C}_3\text{H}_4\text{O}$	56.063	-51.8	113.6	0.9478 <sup>20</sup>		20.8	1.13			36			1
Propyl acetate	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	-93	101.54	0.8878 <sup>20</sup>	0.544	5.62	1.8	1.921	4.49	13	2-8%	450	200
Propylamine	$\text{C}_3\text{H}_7\text{N}$	59.110	-84.75	47.22	0.7173 <sup>20</sup>	0.376	5.08	1.17	2.776	42.1	-37	2-10%	318	
Propylbenzene	$\text{C}_9\text{H}_{12}$	120.191	-99.6	159.24	0.8593 <sup>25</sup>		2.370	$\approx 0$	1.786	0.45	30	1-6%	450	
Propyl butanoate	$\text{C}_7\text{H}_{14}\text{O}_2$	130.185	-95.2	143.0	0.8730 <sup>20</sup>		4.3			0.618	37			
Propylene carbonate	$\text{C}_4\text{H}_6\text{O}_3$	102.089	-48.8	242	1.2047 <sup>20</sup>		66.14	4.9	2.141	0.05	135			
Propyl formate	$\text{C}_4\text{H}_8\text{O}_2$	88.106	-92.9	80.9	0.9073 <sup>20</sup>	0.485	6.92	1.89	1.945	10.9	-3		455	
Propyl propanoate	$\text{C}_6\text{H}_{12}\text{O}_2$	116.158	-75.9	122.5	0.8809 <sup>20</sup>		5.249			1.88	79			
Pyridine	$\text{C}_5\text{H}_5\text{N}$	79.101	-41.70	115.23	0.9819 <sup>20</sup>	0.879	13.260	2.21	1.678	2.76	20	2-12%	482	1
Pyrrrole	$\text{C}_4\text{H}_5\text{N}$	67.090	-23.39	129.79	0.9698 <sup>20</sup>	1.225	8.00	1.74	1.903	1.10	39			
Pyrrrolidine	$\text{C}_4\text{H}_9\text{N}$	71.121	-57.79	86.56	0.8586 <sup>20</sup>	0.704	8.30	1.6	2.202	8.40	3			
2-Pyrrolidone	$\text{C}_4\text{H}_7\text{NO}$	85.105	25	251	1.120 <sup>20</sup>		28.18	3.5	1.99		129			
Quinoline	$\text{C}_8\text{H}_7\text{N}$	129.159	-14.78	237.16	1.0977 <sup>15</sup>	3.34	9.16	2.29	1.51	0.011			480	
Safrole	$\text{C}_{10}\text{H}_{10}\text{O}_2$	162.185	11.2	234.5	1.1000 <sup>20</sup>					0.01	100			
Salicylaldehyde	$\text{C}_7\text{H}_6\text{O}_2$	122.122	-7	197	1.1674 <sup>20</sup>		18.35	2.86	1.818	0.075	78			

Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$v_p/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
Selenium chloride	$\text{Cl}_2\text{Se}_2$	228.83	-85	130 dec	2.774									
Selenium oxychloride	$\text{Cl}_2\text{OSe}$	165.86	8.5	177	2.44		46.2							
Selenium oxyfluoride	$\text{F}_2\text{OSe}$	132.96	15	125	2.8					0.02				
Styrene	$\text{C}_8\text{H}_8$	104.150	-30.65	145	0.9016 <sup>25</sup>	0.695	2.4737	0.123	1.747	0.81	31	1-7%	490	20
Sulfolane	$\text{C}_4\text{H}_6\text{O}_2\text{S}$	120.171	27.6	287.3	1.2723 <sup>18</sup>		43.26	4.8	1.498	<0.01	177			
Sulfur chloride	$\text{Cl}_2\text{S}_2$	135.037	-77	137	1.69		4.79			1.27				1
Sulfur dichloride	$\text{Cl}_2\text{S}$	102.971	-122	59.6	1.62		2.915	0.36		17.9				
Sulfuric acid	$\text{H}_2\text{O}_4\text{S}$	98.080	10.31	337	1.8				1.416					0.05
Sulfuryl chloride	$\text{Cl}_2\text{O}_2\text{S}$	134.970	-51	69.4	1.680		9.1	1.81	0.993	18.7				
$\alpha$ -Terpinene	$\text{C}_{10}\text{H}_{16}$	136.234		174	0.8375 <sup>19</sup>		2.4526							
1,1,2,2-Tetrabromoethane	$\text{C}_2\text{H}_2\text{Br}_4$	345.653	0	243.5	2.9655 <sup>20</sup>		6.72	1.38	0.479	0.003			335	1
Tetrabromosilane	$\text{Br}_4\text{Si}$	347.702	5.39	154	2.8			0						
1,1,2,2-Tetrachloro-1,2-difluoroethane	$\text{C}_2\text{Cl}_2\text{F}_2$	203.830	24.8	92.8	1.5951 <sup>50</sup>		2.52		0.852	7.51				500
1,1,1,2-Tetrachloroethane	$\text{C}_2\text{HCl}_4$	167.849	-70.2	130.2	1.5406 <sup>20</sup>	1.437			0.92	1.6	47	5-12%		
1,1,2,2-Tetrachloroethane	$\text{C}_2\text{H}_2\text{Cl}_4$	167.849	-42.4	145.2	1.5953 <sup>20</sup>		8.50	1.32	0.967	0.622	62	20-54%		1
Tetrachloroethene	$\text{C}_2\text{Cl}_4$	165.833	-22.3	121.3	1.6230 <sup>20</sup>	0.844	2.268	0	0.865	2.42	45			25
Tetrachloromethane	$\text{CCl}_4$	153.823	-22.62	76.8	1.5940 <sup>20</sup>	0.908	2.2379	0	0.850	15.2				5
Tetrachlorosilane	$\text{Cl}_4\text{Si}$	169.897	-68.74	57.65	1.5	99.4		0	0.855	31.3				
Tetradecane	$\text{C}_{14}\text{H}_{30}$	198.388	5.82	253.58	0.7596 <sup>20</sup>	2.13	2.0343	$\approx 0$		0.002	112	>0.5%	200	
Tetraethylene glycol	$\text{C}_8\text{H}_{18}\text{O}_5$	194.226	-6.2	328	1.1285 <sup>15</sup>		20.44		2.208	0.000001	182			
Tetrafluoroboric acid	$\text{BF}_3\text{H}$	87.813		130 dec	-1.8									
Tetrahydrofuran	$\text{C}_4\text{H}_8\text{O}$	72.106	-108.44	65	0.8833 <sup>25</sup>	0.456	7.52	1.75	1.720	21.6	-14	2-12%	321	200
Tetrahydrofurfuryl alcohol	$\text{C}_5\text{H}_{10}\text{O}_2$	102.132	<-80	178	1.0524 <sup>20</sup>		13.48	2.1	1.774	0.100	75	1.5-9.7%	282	
1,2,3,4-Tetrahydronaphthalene	$\text{C}_{10}\text{H}_{12}$	132.202	-35.7	207.6	0.9645 <sup>25</sup>	2.14	2.771	$\approx 0$	1.645	0.05	71	1-5%	385	
Tetrahydropyran	$\text{C}_6\text{H}_{10}\text{O}$	86.132	-49.1	88	0.8814 <sup>20</sup>		5.66	1.74	1.82	9.54	-20			
Tetrahydrothiophene	$\text{C}_4\text{H}_8\text{S}$	88.172	-96.2	121.1	0.9987 <sup>20</sup>	0.973		1.90		2.45				
Tetramethylsilane	$\text{C}_4\text{H}_{12}\text{Si}$	88.224	-99.06	26.6	0.648 <sup>19</sup>		1.921	0	2.313	94.2				
Tetramethylurea	$\text{C}_4\text{H}_{12}\text{N}_2\text{O}$	116.161	-0.6	176.5	0.9687 <sup>20</sup>		23.10	3.5	0.138	77				
Tetranitromethane	$\text{CN}_4\text{O}_8$	196.033	13.8	126.1	1.6380 <sup>20</sup>		2.317	0		1.13				0.005
Thionyl bromide	$\text{Br}_2\text{OS}$	207.873	-50	140			9.06			0.84				
Thionyl chloride	$\text{Cl}_2\text{OS}$	118.970	-101	75.6	1.631		8.675	1.45	1.017	16.0				1
Thiophene	$\text{C}_4\text{H}_4\text{S}$	84.140	-38.21	84.0	1.0649 <sup>20</sup>		2.739	0.55	1.471	10.6	-1			
Tin(IV) chloride	$\text{Cl}_4\text{Sn}$	260.521	-34.07	114.15	2.234			0	0.634					
Titanium(IV) chloride	$\text{Cl}_4\text{Ti}$	189.678	-24.12	136.45	1.73				0.766					
Toluene	$\text{C}_7\text{H}_8$	92.139	-94.95	110.63	0.8668 <sup>20</sup>	0.560	2.379	0.37	1.707	3.79	4	1-7%	480	50
Toluene-2,4-diisocyanate	$\text{C}_9\text{H}_8\text{N}_2\text{O}_2$	174.156	20.5	251	1.2244 <sup>20</sup>		8.433		1.653	0.003	127	0.9-9.5%		0.005
Tribromomethane	$\text{CHBr}_3$	252.731	8.69	149.1	2.8788 <sup>25</sup>	1.857	4.404	0.99	0.517	0.726	83			0.5
Tributylamine	$\text{C}_{12}\text{H}_{27}\text{N}$	185.349	-70	216.5	0.7770 <sup>20</sup>		2.340	0.8	0.01	63	1-5%			
Tributyl borate	$\text{C}_{12}\text{H}_{27}\text{BO}_3$	230.151	<-70	234	0.8567 <sup>20</sup>		2.23	0.77		93				
Tributyrin	$\text{C}_{15}\text{H}_{26}\text{O}_6$	302.363	-75	307.5	1.0350 <sup>20</sup>		5.72		1.837		180	>0.5%	407	
Trichloroacetaldehyde	$\text{C}_2\text{HCl}_3\text{O}$	147.387	-57.5	97.8	1.512 <sup>20</sup>		6.8		1.025	6.66				
1,2,4-Trichlorobenzene	$\text{C}_6\text{H}_3\text{Cl}_3$	181.447	16.92	213.5	1.459 <sup>25</sup>					0.057	105	2.5-6.6%	571	5
1,1,1-Trichloroethane	$\text{C}_2\text{HCl}_3$	133.404	-30.01	74.09	1.3390 <sup>20</sup>	0.793	7.243	1.76	1.082	16.5	-1	8-13%	500	350
1,1,2-Trichloroethane	$\text{C}_2\text{H}_2\text{Cl}_3$	133.404	-36.3	113.8	1.4397 <sup>20</sup>		7.1937	1.4	1.131	3.1	32	6-28%	460	10
Trichloroethene	$\text{C}_2\text{HCl}_3$	131.388	-84.7	87.21	1.4642 <sup>20</sup>	0.545	3.390	0.8	0.947	9.91	32	8-11%	420	50
Trichloroethylsilane	$\text{C}_2\text{H}_2\text{Cl}_3\text{Si}$	163.506	-105.6	100.5	1.2373 <sup>20</sup>			2.04		6.29	22			
Trichlorofluoromethane	$\text{CCl}_2\text{F}$	137.368	-110.44	23.7	1.4879 <sup>20</sup>	0.421	3.00	0.46	0.885	106				1000
Trichloromethane	$\text{CHCl}_3$	119.378	-63.41	61.17	1.4788 <sup>25</sup>	0.537	4.8069	1.04	0.957	26.2				10
(Trichloromethyl)benzene	$\text{C}_7\text{H}_5\text{Cl}_3$	195.474	-4.42	221	1.3723 <sup>20</sup>		6.9	2.03		0.35	127		211	0.1
Trichloromethylsilane	$\text{CH}_3\text{Cl}_2\text{Si}$	149.480	-90	65.6	1.273 <sup>20</sup>			1.91	1.091	22.5	-9	7.6->20%	>404	
Trichloronitromethane	$\text{CCl}_3\text{NO}_2$	164.376	-64	112	1.6558 <sup>20</sup>		7.319			3.18				0.1
1,2,3-Trichloropropane	$\text{C}_3\text{H}_3\text{Cl}_3$	147.431	-14.7	157	1.3889 <sup>20</sup>		7.5		1.245	0.492	71	3.2-12.6%		10
Trichlorosilane	$\text{Cl}_3\text{HSi}$	135.452	-128.2	33	1.331	0.326		0.86			-50		104	
1,1,2-Trichloro-1,2,2-trifluoroethane	$\text{C}_2\text{Cl}_2\text{F}_3$	187.375	-36.22	47.7	1.5635 <sup>25</sup>	0.656	2.41		0.908	44.8				1000
Tri- <i>o</i> -cresyl phosphate	$\text{C}_{21}\text{H}_{21}\text{O}_4\text{P}$	368.363	11	410	1.1955 <sup>20</sup>		6.7	2.87	1.57	0.0000002	225		385	0.01
Tridecane	$\text{C}_{13}\text{H}_{28}$	184.361	-5.4	235.47	0.7564 <sup>20</sup>	1.724	2.0213	$\approx 0$	2.206	0.005	79			
1-Tridecene	$\text{C}_{13}\text{H}_{26}$	182.345	-13	232.8	0.7658 <sup>20</sup>	1.50	2.139	$\approx 0$	2.149	0.0047	79			
Triethanolamine	$\text{C}_6\text{H}_{15}\text{NO}_3$	149.188	20.5	335.4	1.1242 <sup>20</sup>	609	29.36	3.6	2.61	<0.01	179	1-10%		0.8
Triethylamine	$\text{C}_6\text{H}_{15}\text{N}$	101.190	-114.7	89	0.7275 <sup>20</sup>	0.347	2.418	0.66	2.173	7.70	-7	1-8%	249	1
Triethylene glycol	$\text{C}_8\text{H}_{18}\text{O}_4$	150.173	-7	285	1.1274 <sup>15</sup>		23.69		2.18	0.0002	177	1-9%	371	
Triethylene glycol dimethyl ether	$\text{C}_8\text{H}_{18}\text{O}_4$	178.227	-45	216	0.986 <sup>20</sup>		7.62				111			
Triethyl phosphate	$\text{C}_6\text{H}_{15}\text{O}_4\text{P}$	182.154	-56.4	215.5	1.0695 <sup>20</sup>		13.20	3.1			115		454	
Trifluoroacetic acid	$\text{C}_2\text{HF}_3\text{O}_2$	114.023	-15.2	73	1.5351 <sup>25</sup>	0.808	8.42	2.28		15.1				
(Trifluoromethyl)benzene	$\text{C}_7\text{H}_5\text{F}_3$	146.110	-28.95	102.1	1.1884 <sup>20</sup>		9.22	2.86	1.289	5.14	12			

Name	Mol. form.	$M_r$	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$	$\rho/\text{g mL}^{-1}$	$\eta/\text{mPa s}$	$\epsilon$	$\mu/\text{D}$	$c_p/\text{J g}^{-1}\text{K}^{-1}$	$vp/\text{kPa}$	FP/ $^\circ\text{C}$	Fl. lim.	IT/ $^\circ\text{C}$	TLV/ppm
1,2,3-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	120.191	-25.4	176.12	0.8944 <sup>20</sup>		2.656	$\approx 0$	1.800	0.20	44	0.8-6.6%	470	25
1,2,4-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	120.191	-43.77	169.38	0.8758 <sup>20</sup>		2.377	$\approx 0$	1.789	0.30	44	1-6%	500	25
1,3,5-Trimethylbenzene	$\text{C}_9\text{H}_{12}$	120.191	-44.72	164.74	0.8615 <sup>25</sup>		2.279	0	1.741	0.33	50	1-5%	559	25
Trimethyl borate	$\text{C}_3\text{H}_9\text{BO}_3$	103.912	-29.3	67.5	0.915 <sup>25</sup>		2.2762		1.828	17.2	-8			
Trimethylchlorosilane	$\text{C}_3\text{H}_9\text{ClSi}$	108.642	-40	60	0.856 <sup>25</sup>					30.7	-28		395	
2,2,4-Trimethylpentane	$\text{C}_8\text{H}_{18}$	114.229	-107.3	99.22	0.6878 <sup>25</sup>		1.943	$\approx 0$	2.093	6.50	-12		418	300
2,3,3-Trimethylpentane	$\text{C}_8\text{H}_{18}$	114.229	-100.9	114.8	0.7262 <sup>20</sup>		1.9780	$\approx 0$	2.150	3.60	<21		425	300
Trimethyl phosphate	$\text{C}_3\text{H}_9\text{O}_4\text{P}$	140.074	-46	197.2	1.2144 <sup>20</sup>		20.6	3.2		0.11	107			
2,4,6-Trimethylpyridine	$\text{C}_8\text{H}_{11}\text{N}$	121.180	-46	170.6	0.9166 <sup>22</sup>		7.807	2.05		4.1				
Trinitroglycerol	$\text{C}_3\text{H}_5\text{N}_3\text{O}_9$	227.087	13.5	exp 218	1.5931 <sup>20</sup>		19.25			0.00005			270	0.05
Undecane	$\text{C}_{11}\text{H}_{24}$	156.309	-25.5	195.9	0.7402 <sup>20</sup>	1.098	1.9972	$\approx 0$	2.207	0.05	69			
Vanadium(IV) chloride	$\text{Cl}_4\text{V}$	192.753	-25.7	148	1.816		3.05							
Vanadyl trichloride	$\text{Cl}_3\text{OV}$	173.299	-79	127	1.829		3.4							
Vinyl acetate	$\text{C}_4\text{H}_6\text{O}_2$	86.090	-93.2	72.8	0.9256 <sup>25</sup>			1.79	1.969	15.4	-8	2.6-13.4%	402	10
4-Vinylcyclohexene	$\text{C}_8\text{H}_{12}$	108.181	-108.9	128	0.8299 <sup>20</sup>					1.87	16		269	0.1
Water	$\text{H}_2\text{O}$	18.015	0.00	100.0	0.9970	0.890	80.100	1.8546	4.180	3.17				
<i>o</i> -Xylene	$\text{C}_8\text{H}_{10}$	106.165	-25.2	144.5	0.8802 <sup>10</sup>	0.760	2.562	0.64	1.753	0.88	32	1-7%	463	100
<i>m</i> -Xylene	$\text{C}_8\text{H}_{10}$	106.165	-47.8	139.12	0.8596 <sup>25</sup>	0.581	2.359	$\approx 0$	1.724	1.13	27	1-7%	527	100
<i>p</i> -Xylene	$\text{C}_8\text{H}_{10}$	106.165	13.25	138.37	0.8566 <sup>25</sup>	0.603	2.2735	0	1.710	1.19	27	1-7%	528	100
2,4-Xylenol	$\text{C}_8\text{H}_{10}\text{O}$	122.164	24.5	210.98	0.9650 <sup>20</sup>		5.060	1.4		0.022				

## DEPENDENCE OF BOILING POINT ON PRESSURE

The normal boiling point of a liquid is defined as the temperature at which the vapor pressure reaches standard atmospheric pressure, 101.325 kPa. The change in boiling point with pressure may be calculated from the representation of the vapor pressure by the Antoine Equation,

$$\ln p = A_1 - A_2/(T + A_3)$$

where  $p$  is the vapor pressure,  $T$  the absolute temperature, and  $A_1$ ,  $A_2$ , and  $A_3$  are constants. This table, which has been calculated using the Antoine constants in Reference 1, gives values of  $\Delta t/\Delta p$  for a number of liquids, in units of both °C/kPa and °C/mmHg. The correction to the boiling point is generally accurate to 0.1 to 0.2 °C as long as the pressure is within 10% of standard atmospheric pressure.

A slightly less accurate estimate of  $\Delta t/\Delta p$  may be obtained from the Clausius-Clapeyron equation, with the assumption that the

change in volume upon vaporization equals the ideal-gas volume of the vapor. This leads to the equation

$$\Delta t/\Delta p = RT_b^2/p_0 \Delta_{\text{vap}} H(T_b)$$

where  $R$  is the molar gas constant,  $p_0$  is 101.325 kPa,  $T_b$  is the normal boiling point temperature (absolute), and  $\Delta_{\text{vap}} H(T_b)$  is the molar enthalpy of vaporization at the normal boiling point. Values of the last quantity may be obtained from the table "Enthalpy of Vaporization" in Section 6.

### Reference

1. Lide, D. R., and Kehiaian, H. V., *CRC Handbook of Thermophysical and Thermochemical Data*, CRC Press, Boca Raton, FL, 1994, pp. 49-59.

Compound	$t_b$ °C	$\Delta t/\Delta p$	
		°C/kPa	°C/mmHg
Acetaldehyde	20.1	0.261	0.0348
Acetic acid	117.9	0.324	0.0432
Acetone	56.0	0.289	0.0385
Acetonitrile	81.6	0.316	0.0421
Ammonia	-33.33	0.198	0.0264
Aniline	184.1	0.378	0.0504
Anisole	153.7	0.367	0.0489
Benzaldehyde	179.0	0.392	0.0523
Benzene	80.0	0.321	0.0428
Bromine	58.8	0.300	0.0400
Butane	-0.5	0.267	0.0356
1-Butanol	117.7	0.278	0.0371
Carbon disulfide	46.2	0.304	0.0405
Chlorine	-34.04	0.224	0.0299
Chlorobenzene	131.7	0.365	0.0487
1-Chlorobutane	78.6	0.321	0.0428
Chloroethane	12.3	0.262	0.0349
Chloroethylene	-13.3	0.241	0.0321
Cyclohexane	80.7	0.328	0.0437
Cyclohexanol	160.8	0.344	0.0459
Cyclohexanone	155.4	0.382	0.0509
Decane	174.1	0.388	0.0517
Dibutyl ether	140.2	0.363	0.0484
Dichloromethane	39.6	0.276	0.0368
Diethyl ether	34.5	0.278	0.0371
Dimethyl sulfoxide	189.0	0.379	0.0505
1,4-Dioxane	101.5	0.321	0.0428
Dipropyl ether	90.0	0.326	0.0435
Ethanol	78.2	0.249	0.0332
Ethyl acetate	77.1	0.300	0.0400
Ethylene glycol	197.3	0.331	0.0441
Heptane	98.5	0.336	0.0448
Hexafluorobenzene	80.2	0.305	0.0407
Hexane	68.7	0.314	0.0419

Compound	$t_b$ °C	$\Delta t/\Delta p$	
		°C/kPa	°C/mmHg
1-Hexanol	157.6	0.318	0.0424
Hydrogen fluoride	20.1	0.276	0.0368
Iodomethane	42.5	0.291	0.0388
Isobutane	-11.7	0.254	0.0339
Methanol	64.6	0.251	0.0335
Methyl acetate	56.8	0.282	0.0376
Methyl formate	31.7	0.582	0.0776
N-Methylaniline	196.2	0.396	0.0528
N-Methylformamide	199.5	0.371	0.0495
Nitrobenzene	210.8	0.418	0.0557
Nitromethane	101.1	0.320	0.0427
1-Octanol	195.1	0.360	0.0480
Pentane	36.0	0.289	0.0385
1-Pentanol	137.9	0.296	0.0395
Phenol	181.8	0.349	0.0465
Propane	-42.1	0.224	0.0299
1-Propanol	97.2	0.261	0.0348
2-Propanol	82.3	0.247	0.0329
Pyridine	115.2	0.340	0.0453
Pyrrrole	129.7	0.330	0.0440
Pyrrrolidine	86.5	0.309	0.0412
Styrene	145.1	0.369	0.0492
Sulfur dioxide	-10.05	0.221	0.0295
Tetrachloroethylene	121.3	0.354	0.0472
Tetrachloromethane	76.8	0.325	0.0433
Toluene	110.6	0.353	0.0471
Trichloroethylene	87.2	0.330	0.0440
Trichloromethane	61.1	0.302	0.0403
Trimethylamine	2.8	0.248	0.0331
Water	100.0	0.276	0.0368
<i>o</i> -Xylene	144.5	0.373	0.0497
<i>m</i> -Xylene	139.1	0.368	0.0491
<i>p</i> -Xylene	138.3	0.369	0.0492

## EBULLIOSCOPIC CONSTANTS FOR CALCULATION OF BOILING POINT ELEVATION

The boiling point  $T_b$  of a dilute solution of a non-volatile, non-dissociating solute is elevated relative to that of the pure solvent. If the solution is ideal (i.e., follows Raoult's Law), the amount of elevation depends only on the number of particles of solute present. Hence the change in boiling point  $\Delta T_b$  can be expressed as

$$\Delta T_b = E_b m_2$$

where  $m_2$  is the molality (moles of solute per kilogram of solvent) and  $E_b$  is the Ebullioscopic Constant, a characteristic property of

the solvent. The Ebullioscopic Constant may be calculated from the relation

$$E_b = R T_b^2 M / \Delta_{\text{vap}} H$$

where  $R$  is the molar gas constant,  $T_b$  is the normal boiling point temperature (absolute) of the solvent,  $M$  the molar mass of the solvent, and  $\Delta_{\text{vap}} H$  the molar enthalpy (heat) of vaporization of the solvent at its normal boiling point.

This table lists  $E_b$  values for some common solvents, as calculated from data in the table "Enthalpy of Vaporization" in Section 6.

Compound	$E_b/\text{K kg mol}^{-1}$
Acetic acid	3.22
Acetone	1.80
Acetonitrile	1.44
Aniline	3.82
Anisole	4.20
Benzaldehyde	4.24
Benzene	2.64
1-Butanol	2.17
Carbon disulfide	2.42
Chlorobenzene	4.36
1-Chlorobutane	3.13
Cyclohexane	2.92
Cyclohexanol	3.5
Decane	6.10
Dichloromethane	2.42
Diethyl ether	2.20
Dimethyl sulfoxide	3.22
1,4-Dioxane	3.01
Ethanol	1.23
Ethyl acetate	2.82
Ethylene glycol	2.26
Heptane	3.62

Compound	$E_b/\text{K kg mol}^{-1}$
Hexane	2.90
Iodomethane	4.31
Methanol	0.86
Methyl acetate	2.21
<i>N</i> -Methylaniline	4.3
<i>N</i> -Methylformamide	2.2
Nitrobenzene	5.2
Nitromethane	2.09
1-Octanol	5.06
Phenol	3.54
1-Propanol	1.66
2-Propanol	1.58
Pyridine	2.83
Pyrrrole	2.33
Pyrrrolidine	2.32
Tetrachloroethylene	6.18
Tetrachloromethane	5.26
Toluene	3.40
Trichloroethylene	4.52
Trichloromethane	3.80
Water	0.513
<i>o</i> -Xylene	4.25

## CRYOSCOPIC CONSTANTS FOR CALCULATION OF FREEZING POINT DEPRESSION

The freezing point  $T_f$  of a dilute solution of a non-volatile, non-dissociating solute is depressed relative to that of the pure solvent. If the solution is ideal (i.e., follows Raoult's Law), this lowering is a function only of the number of particles of solute present. Thus the absolute value of the lowering of freezing point  $\Delta T_f$  can be expressed as

$$\Delta T_f = E_f m_2$$

where  $m_2$  is the molality (moles of solute per kilogram of solvent) and  $E_f$  is the Cryoscopic Constant, a characteristic property of the

solvent. The Cryoscopic Constant may be calculated from the relation

$$E_f = R T_b^2 M / \Delta_{\text{fus}} H$$

where  $R$  is the molar gas constant,  $T_b$  is the freezing point temperature (absolute) of the solvent,  $M$  the molar mass of the solvent, and  $\Delta_{\text{fus}} H$  the molar enthalpy (heat) of fusion of the solvent.

This table lists cryoscopic constants for selected substances, as calculated from data in the table "Enthalpy of Fusion" in Section 6.

Compound	$E_f/\text{K kg mol}^{-1}$	Compound	$E_f/\text{K kg mol}^{-1}$
Acetamide	3.92	1,4-Dioxane	4.63
Acetic acid	3.63	Diphenylamine	8.38
Acetophenone	5.16	Ethylene glycol	3.11
Aniline	5.23	Formamide	4.25
Benzene	5.07	Formic acid	2.38
Benzonitrile	5.35	Glycerol	3.56
Benzophenone	8.58	Methylcyclohexane	2.60
(+)-Camphor	37.8	Naphthalene	7.45
1-Chloronaphthalene	7.68	Nitrobenzene	6.87
<i>o</i> -Cresol	5.92	Phenol	6.84
<i>m</i> -Cresol	7.76	Pyridine	4.26
<i>p</i> -Cresol	7.20	Quinoline	6.73
Cyclohexane	20.8	Succinonitrile	19.3
Cyclohexanol	42.2	1,1,2,2-Tetrabromoethane	21.4
<i>cis</i> -Decahydronaphthalene	6.42	1,1,2,2-Tetrachloro-1,2-difluoroethane	41.0
<i>trans</i> -Decahydronaphthalene	4.70	Toluene	3.55
Dibenzyl ether	6.17	<i>p</i> -Toluidine	4.91
<i>p</i> -Dichlorobenzene	7.57	Tribromomethane	15.0
Diethanolamine	3.16	Water	1.86
Dimethyl sulfoxide	3.85	<i>p</i> -Xylene	4.31

# FREEZING POINT LOWERING BY ELECTROLYTES IN AQUEOUS SOLUTION

## Reference

Forsythe, W. E., *Smithsonian Physical Tables, Ninth Edition*, Smithsonian Institution, Washington, 1956.

Compound	Lowering of freezing point of water (in °C) as function of molality (mol/kg)									
	0.05	0.10	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00
CaCl <sub>2</sub>	0.25	0.49	1.27	2.66	4.28	6.35	10.78	15.27	20.42	28.08
CuSO <sub>4</sub>	0.13	0.23	0.47	0.96						
HCl	0.18	0.36	0.90	1.86	2.90	4.02	6.63	9.94		
HNO <sub>3</sub>	0.18	0.35	0.88	1.80	2.78	3.80	5.98	8.34	10.95	13.92
H <sub>2</sub> SO <sub>4</sub>	0.20	0.39	0.96	1.95	3.04	4.28	7.35	11.35	16.32	
KBr	0.18	0.36	0.92	1.78						
KCl	0.17	0.35	0.86	1.68	2.49	3.29	4.88	6.50	8.14	9.77
KNO <sub>3</sub>	0.17	0.33	0.78	1.47	2.11	2.66				
K <sub>2</sub> SO <sub>4</sub>	0.23	0.43	1.01	1.87						
LiCl	0.18	0.35	0.88	1.80	2.78					
MgSO <sub>4</sub>	0.13	0.24	0.55	1.01	1.50	2.08	3.41			
NH <sub>4</sub> Cl	0.17	0.34	0.85	1.70	2.55					
NaCl	0.18	0.35	0.85	1.68	2.60					
NaNO <sub>3</sub>	0.18	0.36	0.80	1.62	2.63	3.10				

## DETERMINATION OF RELATIVE HUMIDITY FROM DEW POINT

The relative humidity of a water vapor-air mixture is defined as 100 times the partial pressure of water divided by the saturation vapor pressure of water at the same temperature. The relative humidity may be determined from the dew point  $t_{\text{dew}}$ , which is the temperature at which liquid water first condenses when the

mixture is cooled from an initial temperature  $t$ . This table gives relative humidity as a function of the dew point depression  $t - t_{\text{dew}}$  for several values of the dew point. Values are calculated from the vapor pressure table in Section 6.

$t - t_{\text{dew}}$	$t_{\text{dew}}/^{\circ}\text{C}$					$t - t_{\text{dew}}$	$t_{\text{dew}}/^{\circ}\text{C}$				
	-10	0	10	20	30		-10	0	10	20	30
0.0	100	100	100	100	100	8.2	54	56	59	61	63
0.2	99	99	99	99	99	8.4	53	56	58	60	63
0.4	97	97	97	98	98	8.6	52	55	57	60	62
0.6	95	96	96	96	97	8.8	51	54	57	59	61
0.9	94	94	95	95	96	9.0	51	53	56	58	61
1.0	92	93	94	94	94	9.2	50	53	55	58	60
1.2	91	92	92	93	93	9.4	49	52	55	57	59
1.4	90	90	91	92	92	9.6	48	51	54	56	59
1.6	88	89	90	91	91	9.8	48	51	53	56	58
1.8	87	88	89	90	90	10.0	47	50	53	55	57
2.0	86	87	88	88	89	10.5	45	48	51	54	56
2.2	84	85	86	87	89	11.0	44	47	49	52	55
2.4	83	84	85	86	87	11.5	42	45	48	51	53
2.6	82	83	84	85	86	12.0	41	44	47	49	52
2.8	80	82	83	84	85	12.5	39	42	45	48	50
3.0	79	81	82	83	84	13.0	38	41	44	46	49
3.2	78	80	81	82	83	13.5	37	40	43	45	48
3.4	77	79	80	81	82	14.0	35	38	41	44	47
3.6	76	77	79	80	82	14.5	34	37	40	43	45
3.8	75	76	78	79	81	15.0	33	36	39	42	44
4.0	73	75	77	78	80	15.5	32	35	38	40	
4.2	72	74	76	77	79	16.0	31	34	37	39	
4.4	71	73	75	77	78	16.5	30	33	36	38	
4.6	70	72	74	76	77	17.0	29	32	35	37	
4.8	69	71	73	75	76	17.5	28	31	34	36	
5.0	69	70	72	74	75	18.0	27	30	33	35	
5.2	67	69	71	73	75	18.5	26	29	32	34	
5.4	66	68	70	72	74	19.0	25	28	31	33	
5.6	65	67	69	71	73	19.5	24	27	30	33	
5.9	64	66	69	70	72	20.0	24	26	29	32	
6.0	63	66	68	70	71	21.0	22	25	27	30	
6.2	62	65	67	69	71	22.0	21	23	26	29	
6.4	61	64	66	68	70	23.0	19	22	24	27	
6.6	60	63	65	67	69	24.0	18	21	23	26	
6.8	60	62	64	66	68	25.0	17	19	22	24	
7.0	59	61	63	66	68	26.0	16	18	21	23	
7.2	58	60	63	65	67	27.0	15	17	20	22	
7.4	57	60	62	64	66	28.0	14	16	19	21	
7.6	56	59	61	63	65	29.0	13	15	18	20	
7.8	55	58	60	63	65	30.0	12	14	17	19	
8.0	54	57	60	62	64						



## DETERMINATION OF RELATIVE HUMIDITY FROM WET AND DRY BULB TEMPERATURES

Relative humidity may be determined by comparing temperature readings of wet and dry bulb thermometers. The following table, extracted from more extensive U.S. National Weather Service tables, gives the relative humidity as a function of air temperature

$t_d$  (dry bulb) and the difference  $t_d - t_w$  between dry and wet bulb temperatures. The data assume a pressure near normal atmospheric pressure and an instrumental configuration with forced ventilation.

$t_d/^\circ\text{C}$	$(t_d - t_w)/^\circ\text{C}$											
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
-10	83	67	51	35	19							
-8	86	71	57	43	29	15						
-6	88	74	61	49	37	25	8					
-4	89	77	66	55	44	33	23	12				
-2	90	79	69	60	50	40	31	22	12			
0	91	81	72	64	55	46	38	29	21	13	5	
2	91	84	76	68	60	52	44	37	29	22	14	7
4	92	85	78	71	63	57	49	43	36	29	22	16
6	93	86	79	73	66	60	54	48	41	35	29	24
8	93	87	81	75	69	63	57	51	46	40	35	29
10	94	88	82	77	71	66	60	55	50	44	39	34
12	94	89	83	78	73	68	63	58	53	48	43	39
14	95	90	85	79	75	70	65	60	56	51	47	42
16	95	90	85	81	76	71	67	63	58	54	50	46
18	95	91	86	82	77	73	69	65	61	57	53	49
20	96	91	87	83	78	74	70	66	63	59	55	51
22	96	92	87	83	80	76	72	68	64	61	57	54
24	96	92	88	84	80	77	73	69	66	62	59	56
26	96	92	88	85	81	78	74	71	67	64	61	58
28	96	93	89	85	82	78	75	72	69	65	62	59
30	96	93	89	86	83	79	76	73	70	67	64	61
35	97	94	90	87	84	81	78	75	72	69	67	64
40	97	94	91	88	85	82	80	77	74	72	69	67

$t_d/^\circ\text{C}$	$(t_d - t_w)/^\circ\text{C}$											
	6.5	7.0	7.5	8.0	8.5	9.0	10.0	11.0	12.0	13.0	14.0	15.0
4	9											
6	17	11	5									
8	24	19	14	8								
10	29	24	20	15	10	6						
12	34	29	25	21	16	12	5					
14	38	34	30	26	22	18	10					
16	42	38	34	30	26	23	15	8				
18	45	41	38	34	30	27	20	14	7			
20	48	44	41	37	34	31	24	18	12	6		
22	50	47	44	40	37	34	28	22	17	11	6	
24	53	49	46	43	40	37	31	26	20	15	10	5
26	54	51	49	46	43	40	34	29	24	19	14	10
28	56	53	51	48	45	42	37	32	27	22	18	13
30	58	55	52	50	47	44	39	35	30	25	21	17
32	60	57	54	51	49	46	41	37	32	28	24	20
34	61	58	56	53	51	48	43	39	35	30	26	23
36	62	59	57	54	52	50	45	41	37	33	29	25
38	63	61	58	56	54	51	47	43	39	35	31	27
40	64	62	59	57	54	53	48	44	40	36	33	29

# CONSTANT HUMIDITY SOLUTIONS

Anthony Wexler

An excess of a water soluble salt in contact with its saturated solution and contained within an enclosed space produces a constant relative humidity and water vapor pressure according to

$$RH = A \exp(B/T)$$

where  $RH$  is the percent relative humidity (generally accurate to  $\pm 2\%$ ),  $T$  is the temperature in kelvin, and the constants  $A$  and  $B$  and the range of valid temperatures are given in the table below. The vapor pressure,  $p$ , can be calculated from

$$p = (RH/100) \times p_0$$

where  $p_0$  is the vapor pressure of pure water at temperature  $T$  as given in the table in Section 6 titled "Vapor Pressure of Water from 0 to 370°C".

## References

1. Wexler, A. S. and Seinfeld, J. H., *Atmospheric Environment*, 25A, 2731, 1991.
2. Greenspan, L., *J. Res. National Bureau of Standards*, 81A, 89, 1977.
3. Broul, et al., *Solubility of Inorganic Two-Component Systems*, Elsevier, New York, 1981.
4. Wagman, D. D. et al., *J. Phys. Chem. Ref. Data*, Vol. 11, Suppl. 2, 1982.

Compound	Temperature range (°C)	RH (25°C)	A	B
NaOH · H <sub>2</sub> O	15—60	6	5.48	27
LiBr · 2H <sub>2</sub> O	10—30	6	0.23	996
ZnBr <sub>2</sub> · 2H <sub>2</sub> O	5—30	8	1.69	455
KOH · 2H <sub>2</sub> O	5—30	9	0.014	1924
LiCl · H <sub>2</sub> O	20—65	11	14.53	-75
CaBr <sub>2</sub> · 6H <sub>2</sub> O	11—22	16	0.17	1360
LiI · 3H <sub>2</sub> O	15—65	18	0.15	1424
CaCl <sub>2</sub> · 6H <sub>2</sub> O	15—25	29	0.11	1653
MgCl <sub>2</sub> · 6H <sub>2</sub> O	5—45	33	29.26	34
NaI · 2H <sub>2</sub> O	5—45	38	3.62	702
Ca(NO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	10—30	51	1.89	981
Mg(NO <sub>3</sub> ) <sub>2</sub> · 6H <sub>2</sub> O	5—35	53	25.28	220
NaBr · 2H <sub>2</sub> O	0—35	58	20.49	308
NH <sub>4</sub> NO <sub>3</sub>	10—40	62	3.54	853
KI	5—30	69	29.35	254
SrCl <sub>2</sub> · 6H <sub>2</sub> O	5—30	71	31.58	241
NaNO <sub>3</sub>	10—40	74	26.94	302
NaCl	10—40	75	69.20	25
NH <sub>4</sub> Cl	10—40	79	35.67	235
KBr	5—25	81	40.98	203
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	10—40	81	62.06	79
KCl	5—25	84	49.38	159
Sr(NO <sub>3</sub> ) <sub>2</sub> · 4H <sub>2</sub> O	5—25	85	28.34	328
BaCl <sub>2</sub> · 2H <sub>2</sub> O	5—25	90	69.99	75
CsI	5—25	91	70.77	75
KNO <sub>3</sub>	0—50	92	43.22	225
K <sub>2</sub> SO <sub>4</sub>	10—50	97	86.75	34

## STANDARD SALT SOLUTIONS FOR HUMIDITY CALIBRATION

Saturated aqueous solutions of inorganic salts are convenient secondary standards for calibration of instruments for measurement of relative humidity. The International Union of Pure and Applied Chemistry has recommended salt solutions for calibrations in the range of 10% to 90% relative humidity, and the American Society for Testing and Materials has published similar standards. The data in this table are taken from the IUPAC recommendations, except for  $K_2CO_3$  and  $K_2SO_4$ , which are ASTM recommendations.

Details on the preparation and use of these standards may be found in References 1 and 2. Data for other salts are given in Reference 3.

### References

1. Marsh, K. N., Editor, *Recommended Reference Materials for the Realization of Physicochemical Properties*, Blackwell Scientific Publications, Oxford, 1987, pp.157-162.
2. *Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions*, ASTM Standard E 104-85, Reapproved 1991.
3. Greenspan, L., *J. Res. Nat. Bur. Stand.*, 81A, 89, 1977.

$t/^\circ C$	Relative Humidity in %						
	LiCl	MgCl <sub>2</sub>	K <sub>2</sub> CO <sub>3</sub>	Mg(NO <sub>3</sub> ) <sub>2</sub>	NaCl	KCl	K <sub>2</sub> SO <sub>4</sub>
0		33.66 ± 0.33	43.1 ± 0.7	60.35 ± 0.55	75.51 ± 0.34	88.61 ± 0.53	98.8 ± 2.1
5		33.60 ± 0.28	43.1 ± 0.5	58.86 ± 0.43	75.65 ± 0.27	87.67 ± 0.45	98.5 ± 0.9
10		33.47 ± 0.24	43.1 ± 0.4	57.36 ± 0.33	75.67 ± 0.22	86.77 ± 0.39	98.2 ± 0.8
15		33.30 ± 0.21	43.2 ± 0.3	55.87 ± 0.27	75.61 ± 0.18	85.92 ± 0.33	97.9 ± 0.6
20	11.31 ± 0.31	33.07 ± 0.18	43.2 ± 0.3	54.38 ± 0.23	75.47 ± 0.14	85.11 ± 0.29	97.6 ± 0.5
25	11.30 ± 0.27	32.78 ± 0.16	43.2 ± 0.4	52.89 ± 0.22	75.29 ± 0.12	84.34 ± 0.26	97.3 ± 0.5
30	11.28 ± 0.24	32.44 ± 0.14	43.2 ± 0.5	51.40 ± 0.24	75.09 ± 0.11	83.62 ± 0.25	97.0 ± 0.4
35	11.25 ± 0.22	32.05 ± 0.13		49.91 ± 0.29	74.87 ± 0.12	82.95 ± 0.25	96.7 ± 0.4
40	11.21 ± 0.21	31.60 ± 0.13		48.42 ± 0.37		82.32 ± 0.25	96.4 ± 0.4
45	11.16 ± 0.21	31.10 ± 0.13		46.93 ± 0.47		81.74 ± 0.28	96.1 ± 0.4
50	11.10 ± 0.22	30.54 ± 0.14		45.44 ± 0.60		81.20 ± 0.31	95.8 ± 0.5
55	11.03 ± 0.23	29.93 ± 0.16				80.70 ± 0.35	
60	10.95 ± 0.26	29.26 ± 0.18				80.25 ± 0.41	
65	10.86 ± 0.29	28.54 ± 0.21				79.85 ± 0.48	
70	10.75 ± 0.33	27.77 ± 0.25				79.49 ± 0.57	
75	10.64 ± 0.38	26.94 ± 0.29				79.17 ± 0.66	
80	10.51 ± 0.44	26.05 ± 0.34				78.90 ± 0.77	

## LOW TEMPERATURE BATHS FOR MAINTAINING CONSTANT TEMPERATURE

A liquid-solid slurry is a convenient means of maintaining a constant temperature environment below room temperature. The following is a list of readily available organic liquids suitable for

this purpose, arranged in order of their melting (freezing) points  $t_m$ . The normal boiling points  $t_b$  are also given.

Compound	$t_m/^\circ\text{C}$	$t_b/^\circ\text{C}$
Isopentane (2-Methylbutane)	-159.9	27.8
Methylcyclopentane	-142.5	71.8
3-Chloropropene (Allyl chloride)	-134.5	45.1
Pentane	-129.7	36.0
Allyl alcohol	-129	97.0
Ethanol	-114.1	78.2
Carbon disulfide	-111.5	46
Isobutyl alcohol	-108	107.8
Toluene	-94.9	110.6
Acetone	-94.8	56.0
Ethyl acetate	-83.6	77.1
Dry ice + acetone	-78	
<i>p</i> -Cymene	-68.9	177.1
Trichloromethane (Chloroform)	-63.6	61.1
<i>N</i> -Methylaniline	-57	196.2
Chlorobenzene	-45.2	131.7
Anisole	-37.5	153.7
Bromobenzene	-30.6	156.0
Tetrachloromethane (Carbon tetrachloride)	-23	76.8
Benzonitrile	-12.7	191.1

## WIRE TABLES

The resistance per unit length of wires of various metals is tabulated here. Values were calculated from resistivity values in the tables "Electrical Resistivity of Pure Metals" and "Electrical Resistivity of Selected Alloys", which appear in Section 12. In prac-

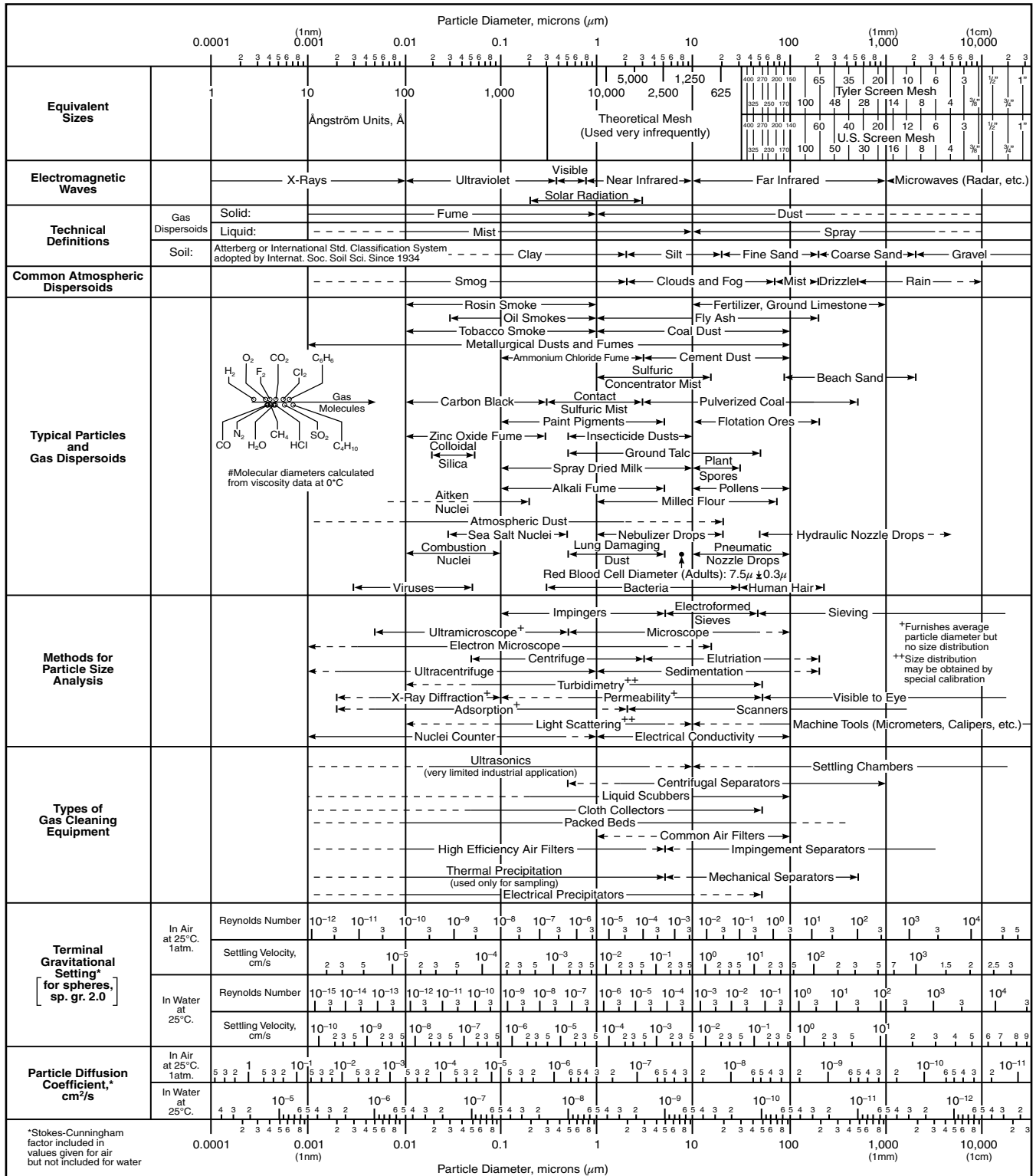
tice, resistance may vary because of differing heat treatments and metal composition. The values in the table refer to 20°C, but values at other temperatures may be calculated from the following resistivity data:

Metal	Resistivity in $10^{-8} \Omega \cdot m$ at temperature			
	0°C	20°C	25°C	100°C
Aluminum	2.417	2.650	2.709	3.56
Brass (70% Cu, 30% Zn)	5.87	6.08	6.13	6.91
Constantan (60% Cu, 40% Ni)	45.43	45.38	45.35	45.11
Copper	1.543	1.678	1.712	2.22
Nichrome (79% Ni, 21% Cr)	107.3	107.5	107.6	108.3
Platinum	9.6	10.5	10.7	13.6
Silver	1.467	1.587	1.617	2.07
Tungsten	4.82	5.28	5.39	7.18

AWG Gauge <sup>a</sup>	Diameter (mm)	Resistance per unit length at 20°C in $\Omega/m$							
		Aluminum	Brass	Constantan	Copper	Nichrome	Platinum	Silver	Tungsten
0	8.252	0.000495	0.00114	0.00848	0.000314	0.0201	0.00196	0.000297	0.00099
2	6.543	0.000788	0.00181	0.0135	0.000499	0.0320	0.00312	0.000472	0.00157
4	5.189	0.00125	0.00287	0.0214	0.000793	0.0508	0.00496	0.000750	0.00250
6	4.115	0.00199	0.00457	0.0341	0.00126	0.0808	0.00789	0.00119	0.00397
8	3.264	0.00317	0.00727	0.0542	0.00200	0.128	0.0125	0.00190	0.00631
10	2.588	0.00504	0.0115	0.0863	0.00319	0.204	0.0200	0.00302	0.0100
12	2.053	0.00800	0.0184	0.137	0.00507	0.325	0.0317	0.00479	0.0159
14	1.628	0.0127	0.0292	0.218	0.00806	0.516	0.0504	0.00762	0.0254
16	1.291	0.0202	0.0464	0.347	0.0128	0.821	0.0802	0.0121	0.0403
18	1.024	0.0322	0.0738	0.551	0.0204	1.30	0.127	0.0193	0.0641
20	0.8118	0.0512	0.117	0.877	0.0324	2.08	0.203	0.0307	0.102
22	0.6439	0.0814	0.187	1.39	0.0515	3.30	0.322	0.0487	0.162
24	0.5105	0.129	0.297	2.22	0.0820	5.25	0.513	0.0775	0.258
26	0.4049	0.206	0.472	3.52	0.130	8.35	0.815	0.123	0.410
28	0.3211	0.327	0.751	5.60	0.207	13.3	1.30	0.196	0.652
30	0.2548	0.520	1.19	8.90	0.329	21.1	2.06	0.311	1.03
32	0.2019	0.828	1.90	14.2	0.524	33.6	3.28	0.496	1.65
34	0.1601	1.32	3.02	22.5	0.833	53.4	5.22	0.788	2.62
36	0.1270	2.09	4.80	35.8	1.32	84.9	8.29	1.25	4.17
38	0.1007	3.33	7.63	57.0	2.11	135	13.2	1.99	6.63
40	0.07988	5.29	12.1	90.5	3.35	214	20.9	3.17	10.5

<sup>a</sup> Often called Brown & Sharpe Gauge.

# CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSOIDS



C.E. Lapple, Stanford Research Institute Journal, Vol. 5, p.95 (Third Quarter, 1961)

## DENSITY OF VARIOUS SOLIDS

This table gives the range of density for miscellaneous solid materials whose characteristics depend on the source or method of preparation.

2. Kaye, G. W. C., and Laby, T. H., *Tables of Physical and Chemical Constants, 16th Edition*, Longman, London, 1995.
3. Brandrup, J., and Immergut, E. H., *Polymer Handbook, Third Edition*, John Wiley & Sons, New York, 1989.

### References

1. Forsythe, W. E., *Smithsonian Physical Tables, Ninth Edition*, Smithsonian Institution, Washington, D.C., 1956.

Material	$\rho / \text{g cm}^{-3}$	Material	$\rho / \text{g cm}^{-3}$	Material	$\rho / \text{g cm}^{-3}$
Agate	2.5-2.7	Pyrex	2.23	Solder	8.7-9.4
Alabaster,		Granite	2.64-2.76	Starch	1.53
carbonate	2.69-2.78	Graphite	2.30-2.72	Steel, stainless	7.8
sulfate	2.26-2.32	Gum arabic	1.3-1.4	Sugar	1.59
Albite	2.62-2.65	Gypsum	2.31-2.33	Talc	2.7-2.8
Amber	1.06-1.11	Hematite	4.9-5.3	Tallow, beef	0.94
Amphiboles	2.9-3.2	Hornblende	3.0	Tar	1.02
Anorthite	2.74-2.76	Ice	0.917	Topaz	3.5-3.6
Asbestos	2.0-2.8	Iron, cast	7.0-7.4	Tourmaline	3.0-3.2
Asbestos slate	1.8	Ivory	1.83-1.92	Tungsten carbide	14.0-15.0
Asphalt	1.1-1.5	Kaolin	2.6	Wax, sealing	1.8
Basalt	2.4-3.1	Leather, dry	0.86	Wood (seasoned)	
Beeswax	0.96-0.97	Lime, slaked	1.3-1.4	alder	0.42-0.68
Beryl	2.69-2.70	Limestone	2.68-2.76	apple	0.66-0.84
Biotite	2.7-3.1	Linoleum	1.18	ash	0.65-0.85
Bone	1.7-2.0	Magnetite	4.9-5.2	balsa	0.11-0.14
Brasses	8.44-8.75	Malachite	3.7-4.1	bamboo	0.31-0.40
Brick	1.4-2.2	Marble	2.6-2.84	basswood	0.32-0.59
Bronzes	8.74-8.89	Meerschaum	0.99-1.28	beech	0.70-0.90
Butter	0.86-0.87	Mica	2.6-3.2	birch	0.51-0.77
Calamine	4.1-4.5	Muscovite	2.76-3.00	blue gum	1.00
Calcspars	2.6-2.8	Ochre	3.5	box	0.95-1.16
Camphor	0.99	Opal	2.2	butternut	0.38
Cardboard	0.69	Paper	0.7-1.15	cedar	0.49-0.57
Celluloid	1.4	Paraffin	0.87-0.91	cherry	0.70-0.90
Cement, set	2.7-3.0	Peat blocks	0.84	dogwood	0.76
Chalk	1.9-2.8	Pitch	1.07	ebony	1.11-1.33
Charcoal,		Polyamides	1.15-1.25	elm	0.54-0.60
oak	0.57	Polyethylene	0.92-0.97	hickory	0.60-0.93
pine	0.28-0.44	Poly(methyl methacrylate)	1.19	holly	0.76
Cinnabar	8.12	Polypropylene	0.91-0.94	juniper	0.56
Clay	1.8-2.6	Polystyrene	1.06-1.12	larch	0.50-0.56
Coal,		Polytetrafluoroethylene	2.28-2.30	locust	0.67-0.71
anthracite	1.4-1.8	Poly(vinyl acetate)	1.19	logwood	0.91
bituminous	1.2-1.5	Poly(vinyl chloride)	1.39-1.42	mahogany	0.66-0.85
Coke	1.0-1.7	Porcelain	2.3-2.5	maple	0.62-0.75
Copal	1.04-1.14	Porphyry	2.6-2.9	oak	0.60-0.90
Cork	0.22-0.26	Pyrite	4.95-5.10	pear	0.61-0.73
Corundum	3.9-4.0	Quartz ( $\alpha$ )	2.65	pine, pitch	0.83-0.85
Diamond	3.51	Resin	1.07	white	0.35-0.50
Dolomite	2.84	Rock salt	2.18	yellow	0.37-0.60
Ebonite	1.15	Rubber,		plum	0.66-0.78
Emery	4.0	hard	1.19	poplar	0.35-0.50
Epidote	3.25-3.50	soft	1.1	satinwood	0.95
Feldspar	2.55-2.75	pure gum	0.91-0.93	spruce	0.48-0.70
Flint	2.63	Neoprene	1.23-1.25	sycamore	0.40-0.60
Fluorite	3.18	Sandstone	2.14-2.36	teak, Indian	0.66-0.98
Galena	7.3-7.6	Serpentine	2.50-2.65	walnut	0.64-0.70
Garnet	3.15-4.3	Silica, fused,	2.21	water gum	1.00
Gelatin	1.27	Silicon carbide	3.16	willow	0.40-0.60
Glass,		Slag	2.0-3.9	Wood's metal	9.70
common	2.4-2.8	Slate	2.6-3.3		
lead	3-4	Soapstone	2.6-2.8		

# DIELECTRIC STRENGTH OF INSULATING MATERIALS

L. I. Berger

The loss of the dielectric properties by a sample of a gaseous, liquid, or solid insulator as a result of application to the sample of an electric field\* greater than a certain critical magnitude is called *dielectric breakdown*. The critical magnitude of electric field at which the breakdown of a material takes place is called the *dielectric strength* of the material (or *breakdown voltage*). The dielectric strength of a material depends on the specimen thickness (as a rule, thin films have greater dielectric strength than that of thicker samples of a material), the electrode shape\*\*, the rate of the applied voltage increase, the shape of the voltage vs. time curve, and the medium surrounding the sample, e.g., air or other gas (or a liquid — for solid materials only).

## Breakdown in Gases

The current carriers in gases are free electrons and ions generated by external radiation. The equilibrium concentration of these particles at normal pressure is about  $10^3 \text{ cm}^{-3}$ , and hence the electrical conductivity is very small, of the order of  $10^{-16} - 10^{-15} \text{ S/cm}$ . But in a strong electric field, these particles acquire kinetic energy along their free path, large enough to ionize the gas molecules. The new charged particles ionize more molecules; this avalanche-like process leads to formation between the electrodes of channels of conducting plasma (streamers), and the electrical resistance of the space between the electrodes decreases virtually to zero.

Because the dielectric strength (breakdown voltage) of gases strongly depends on the electrode geometry and surface condition and the gas pressure, it is generally accepted to present the data for a particular gas as a fraction of the dielectric strength of either nitrogen or sulfur hexafluoride measured at the same conditions. In Table 1, the data are presented in comparison with the dielectric strength of nitrogen, which is considered equal to 1.00. For convenience to the reader, a few average magnitudes of the dielectric strength of some gases are expressed in kilovolts per millimeter. The data in the table relate to the standard conditions, unless indicated otherwise.

## Breakdown in Liquids

If a liquid is pure, the breakdown mechanism in it is similar to that in gases. If a liquid contains liquid impurities in the form of small drops with greater dielectric constant than that of the main liquid, the breakdown is the result of formation of ellipsoids from these drops by the electric field. In a strong enough electric field, these ellipsoids merge and form a high-conductivity channel between the electrodes. The current increases the temperature in the channel, liquid boils, and the current along the steam canal leads to breakdown. Formation of a conductive channel (bridge) between

the electrodes is observed also in liquids with solid impurities. If a liquid contains gas impurities in the form of small bubbles, breakdown is the result of heating of the liquid in strong electric fields. In the locations with the highest current density, the liquid boils, the size of the gas bubbles increases, they merge and form gaseous channels between the electrodes, and the breakdown medium is again the gas plasma.

## Breakdown in Solids

It is known that the current in solid insulators does not obey Ohm's law in strong electric fields. The current density increases almost exponentially with the electric field, and at a certain field magnitude it jumps to very high magnitudes at which a specimen of a material is destroyed. The two known kinds of electric breakdown are thermal and electrical breakdowns. The former is the result of material heating by the electric current. Destruction of a sample of a material happens when, at a certain voltage, the amount of heat produced by the current exceeds the heat release through the sample surface; the breakdown voltage in this case is proportional to the square root of the ratio of the thermal conductivity and electrical conductivity of the material. A semi-empirical expression for dependence of the breakdown voltage,  $V_b$ , on the physical properties and geometry of a sample of a solid material for the one-dimensional case is

$$V_b = [A\rho\kappa / a\phi(d)]^{1/2}$$

where  $A$  is a numerical constant related to the system of units used,  $\rho$  and  $\kappa$  are the volume resistivity and thermal conductivity of the sample material,  $a$  is a constant related to the chemical bond nature and crystal structure of the sample material, and  $\phi(d)$  is a function of the sample geometry, first of all, thickness,  $d$  (see, e.g., Ref. R6). In the majority of materials,  $\phi(d)$  increases with  $d$ , hence, the magnitude of  $V_b$  is greater in the thinner samples of a particular material.

The electrical breakdown results from the tunneling of the charge carriers from electrodes or from the valence band or from the impurity levels into the conduction band, or by the impact ionization. The tunnel effect breakdown happens mainly in thin layers, e.g., in thin p-n junctions. Otherwise, the impact ionization mechanism dominates. For this mechanism, the dielectric strength of an insulator can be estimated using Boltzmann's kinetic equation for electrons in a crystal.

In the following tables, the dielectric strength values are for room temperature and normal atmospheric pressure, unless indicated otherwise.

\* The unit of electric field in the SI system is newton per coulomb or volt per meter.

\*\* For example, the U.S. standard ASTM D149 is based on use of symmetrical electrodes, while per U.K. standard BS2918 one electrode is a plane and the other is a rod with the axis normal to the plane.



TABLE 1. Dielectric Strength of Gases

Material	Dielectric* strength	Ref.	Material	Dielectric* strength	Ref.
Nitrogen, N <sub>2</sub>	1.00		Trichlorofluoromethane, CCl <sub>3</sub> F	3.50	1
Hydrogen, H <sub>2</sub>	0.50	1,2		4.53	2
Helium, He	0.15	1	Trichloromethane, CHCl <sub>3</sub>	4.2	1
Oxygen, O <sub>2</sub>	0.92	2		4.39	2
Air	0.97	6	Methylamine, CH <sub>3</sub> NH <sub>2</sub>	0.81	1
Air (flat electrodes), kV/mm	3.0	3	Difluoromethane, CH <sub>2</sub> F <sub>2</sub>	0.79	2
Air, kV/mm	0.4-0.7	4	Trifluoromethane, CHF <sub>3</sub>	0.71	2
Air, kV/mm	1.40	5	Bromochlorodifluoromethane, CF <sub>2</sub> ClBr	3.84	2
Neon, Ne	0.25	1	Chlorodifluoromethane, CHClF <sub>2</sub>	1.40	1
	0.16	2		1.11	2
Argon, Ar	0.18	2	Dichlorofluoromethane, CHCl <sub>2</sub> F	1.33	1
Chlorine, Cl <sub>2</sub>	1.55	1		2.61	2
Carbon monoxide, CO	1.02	1	Chlorofluoromethane, CH <sub>2</sub> ClF	1.03	1
	1.05	2	Hexafluoroethane, C <sub>2</sub> F <sub>6</sub>	1.82	1
Carbon dioxide, CO <sub>2</sub>	0.88	1		2.55	2
	0.82	2	Ethyne (Acetylene), C <sub>2</sub> H <sub>2</sub>	1.10	1
	0.84	6		1.11	2
Nitrous oxide, N <sub>2</sub> O	1.24	2	Chloropentafluoroethane, C <sub>2</sub> ClF <sub>5</sub>	2.3	1
Sulfur dioxide, SO <sub>2</sub>	2.63	2		3.0	6
	2.68	6	Dichlorotetrafluoroethane, C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	2.52	1
Sulfur monochloride, S <sub>2</sub> Cl <sub>2</sub>	1.02	1	Chlorotrifluoroethylene, C <sub>2</sub> ClF <sub>3</sub>	1.82	2
(at 12.5 Torr)			1,1,1-Trichloro-2,2,2-trifluoroethane	6.55	2
Thionyl fluoride, SOF <sub>2</sub>	2.50	1	1,1,2-Trichloro-1,2,2-trifluoroethane	6.05	2
Sulfur hexafluoride, SF <sub>6</sub>	2.50	1	Chloroethane, C <sub>2</sub> H <sub>5</sub> Cl	1.00	1
	2.63	2	1,1-Dichloroethane	2.66	2
Sulfur hexafluoride, SF <sub>6</sub> , kV/mm	8.50	7	Trifluoroacetonitrile, CF <sub>3</sub> CN	3.5	1
	9.8	8	Acetonitrile, CH <sub>3</sub> CN	2.11	2
Perchloryl fluoride, ClO <sub>3</sub> F	2.73	1	Dimethylamine, (CH <sub>3</sub> ) <sub>2</sub> NH	1.04	1
Tetrachloromethane, CCl <sub>4</sub>	6.33	1	Ethylamine, C <sub>2</sub> H <sub>5</sub> NH <sub>2</sub>	1.01	1
	6.21	2	Ethylene oxide (oxirane), CH <sub>3</sub> CHO	1.01	1
Tetrafluoromethane, CF <sub>4</sub>	1.01	1	Perfluoropropene, C <sub>3</sub> F <sub>6</sub>	2.55	2
Methane, CH <sub>4</sub>	1.00	1	Octafluoropropane, C <sub>3</sub> F <sub>8</sub>	2.19	1
	1.13	2		2.47	2
Bromotrifluoromethane, CF <sub>3</sub> Br	1.35	1	3,3,3-Trifluoro-1-propene, CH <sub>2</sub> CHCF <sub>3</sub>	2.11	2
	1.97	2	Pentafluoroisocynoethane, C <sub>2</sub> F <sub>5</sub> NC	4.5	1
Bromomethane, CH <sub>3</sub> Br	0.71	2	1,1,1,4,4,4-Hexafluoro-2-butyne, CF <sub>3</sub> CCCCF <sub>3</sub>	5.84	2
Chloromethane, CH <sub>3</sub> Cl	1.29	2	Octafluorocyclobutane, C <sub>4</sub> F <sub>8</sub>	3.34	2
Iodomethane, CH <sub>3</sub> I	3.02	2	1,1,1,2,3,4,4,4-Octafluoro-2-butene	2.8	1
Iodomethane, CH <sub>3</sub> I, at 370 Torr	2.20	7	Decafluorobutane, C <sub>4</sub> F <sub>10</sub>	3.08	1
Dichloromethane, CH <sub>2</sub> Cl <sub>2</sub>	1.92	2	Perfluorobutanenitrile, C <sub>3</sub> F <sub>7</sub> CN	5.5	1
Dichlorodifluoromethane, CCl <sub>2</sub> F <sub>2</sub>	2.42	1	Perfluoro-2-methyl-1,3-butadiene, C <sub>5</sub> F <sub>8</sub>	5.5	1
	2.63	2,6	Hexafluorobenzene, C <sub>6</sub> F <sub>6</sub>	2.11	2
Chlorotrifluoromethane, CClF <sub>3</sub>	1.43	1	Perfluorocyclohexane, C <sub>6</sub> F <sub>12</sub> , (saturated vapor)	6.18	2
	1.53	2			

\* Relative to nitrogen, unless units of kV/mm are indicated.

TABLE 2. Dielectric Strength of Liquids

Material	Dielectric strength kV/mm	Ref.	Material	Dielectric strength kV/mm	Ref.
Helium, He, liquid, 4.2 K	10	9		20.4	15
Static	10	11		179	17,18
Dynamic	5	11	Ethylbenzene, C <sub>8</sub> H <sub>10</sub>	226	17,18
	23	12	Propylbenzene, C <sub>9</sub> H <sub>12</sub>	250	17,18
Nitrogen, N <sub>2</sub> , liquid, 77K			Isopropylbenzene, C <sub>9</sub> H <sub>12</sub>	238	17,18
Coaxial cylinder electrodes	20	10	Decane, C <sub>10</sub> H <sub>22</sub>	192	17,18
Sphere to plane electrodes	60	10	Synthetic Paraffin Mixture		
Water, H <sub>2</sub> O, distilled	65-70	13	Synfluid 2cSt PAO	29.5	37
Carbon tetrachloride, CCl <sub>4</sub>	5.5	14	Butylbenzene, C <sub>10</sub> H <sub>14</sub>	275	17,18
	16.0	15	Isobutylbenzene, C <sub>10</sub> H <sub>14</sub>	222	17,18
Hexane, C <sub>6</sub> H <sub>14</sub>	42.0	16	Silicone oils—polydimethylsiloxanes, (CH <sub>3</sub> ) <sub>3</sub> Si-O-[Si(CH <sub>3</sub> ) <sub>2</sub> ] <sub>x</sub> -O-Si(CH <sub>3</sub> ) <sub>3</sub>		
Two 2.54 cm diameter spherical electrodes, 50.8 μm space	156	17,18	Polydimethylsiloxane silicone fluid	15.4	20
Cyclohexane, C <sub>6</sub> H <sub>12</sub>	42-48	16	Dimethyl silicone	24.0	21,22
2-Methylpentane, C <sub>6</sub> H <sub>14</sub>	149	17,18	Phenylmethyl silicone	23.2	22
2,2-Dimethylbutane, C <sub>6</sub> H <sub>14</sub>	133	17,18	Silicone oil, Basilone M50	10-15	23
2,3-Dimethylbutane, C <sub>6</sub> H <sub>14</sub>	138	17,18	Mineral insulating oils	11.8	6
Benzene, C <sub>6</sub> H <sub>6</sub>	163	17,18	Polybutene oil for capacitors	13.8	6
Chlorobenzene, C <sub>6</sub> H <sub>5</sub> Cl	7.1	14	Transformer dielectric liquid	28-30	6
	18.8	15	Isopropylbiphenyl capacitor oil	23.6	6
2,2,4-Trimethylpentane, C <sub>8</sub> H <sub>18</sub>	140	17,18	Transformer oil	110.7	24
Phenylxylylethane	23.6	19	Transformer oil Agip ITE 360	9-12.6	23
Heptane, C <sub>7</sub> H <sub>16</sub>	166	17,18	Perfluorinated hydrocarbons		
2,4-Dimethylpentane, C <sub>7</sub> H <sub>16</sub>	133	17,18	Fluorinert FC 6001	8.0	23
Toluene, C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub>	199	17,18	Fluorinert FC 77	10.7	23
	46	16	Perfluorinated polyethers		
	12.0	14	Galden XAD (Mol. wt. 800)	10.5	23
	20.4	15	Galden D40 (Mol. wt. 2000)	10.2	23
Octane, C <sub>8</sub> H <sub>18</sub>	16.6	14	Castor oil	65	25

TABLE 3. Dielectric Strength of Solids

Material	Dielectric strength kV/mm	Ref	Material	Dielectric strength kV/mm	Ref
Sodium chloride, NaCl, crystalline	150	26	Phlogopite, amber, natural	118	6
Potassium bromide, KBr, crystalline	80	26	Fluorophlogopite, synthetic	118	6
Ceramics			Glass-bonded mica	14.0-15.7	6
Alumina (99.9% Al <sub>2</sub> O <sub>3</sub> )	13.4	6,27a	Thermoplastic Polymers		
Aluminum silicate, Al <sub>2</sub> SiO <sub>5</sub>	5.9	6	Polypropylene	23.6	6
Berillia (99% BeO)	13.8	6,27b	Amide polymer nylon 6/6, dry	23.6	6
Boron nitride, BN	37.4	6	Polyamide-imide copolymer	22.8	6
Cordierite, Mg <sub>2</sub> Al <sub>4</sub> Si <sub>5</sub> O <sub>18</sub>	7.9	6,27c	Modified polyphenylene oxide	21.7	6
Forsterite, Mg <sub>2</sub> SiO <sub>4</sub>	9.8	28	Polystyrene	19.7	6
Porcelain	35-160	26	Polymethyl methacrylate	19.7	6
Steatite, Mg <sub>3</sub> Si <sub>4</sub> O <sub>11</sub> •H <sub>2</sub> O	9.1-15.4	6	Polyetherimide	18.9	6
Titanates of Mg, Ca, Sr, Ba, and Pb	20-120	3	Amide polymer nylon 11(dry)	16.7	6
Barium titanate, glass bonded	>30	36	Polysulfone	16.7	6
Zirconia, ZrO <sub>2</sub>	11.4	29	Styrene-acrylonitrile copolymer	16.7	6
Glasses			Acrylonitrile-butadiene-styrene	16.7	6
Fused silica, SiO <sub>2</sub>	470-670	26	Polyethersulfone	15.7	6
Alkali-silicate glass	200	26	Polybutylene terephthalate	15.7	6
Standard window glass	9.8-13.8	28	Polystyrene-butadiene copolymer	15.7	6
Micas			Acetal homopolymer	15.0	6
Muscovite, ruby, natural	118	6	Acetal copolymer	15.0	6
			Polyphenylene sulfide	15.0	6

Material	Dielectric strength kV/mm	Ref	Material	Dielectric strength kV/mm	Ref
Polycarbonate	15.0	6	Rigid, two-part	70.9	6
Acetal homopolymer resin (molding resin)	15.0	6	Semiflexible high-bond thixotropic	78.7	6
Acetal copolymer resin	15.0	6	Rigid high-bond high-flash freon-resistant	68.9	6
Thermosetting Molding Compounds			Baking type epoxy varnish		
Glass-filled allyl (Type GDI-30 per MIL-M-14G)	15.7	6	Solventless, rigid, low viscosity, one-part	90.6	6
Glass-filled epoxy, electrical grade	15.4	6	Solventless, semiflexible, one-part	82.7	6
Glass-filled phenolic (Type GPI-100 per MIL-M-14G)	15.0	6	Solventless, semirigid, chemical resistant, low dielectric constant	106.3	6
Glass-filled alkyd/polyester (Type MAI-60 per MIL-M-14G)	14.8	6	Solvable, for hermetic electric motors	181.1	6
Glass-filled melamine (Type MMI-30 per MIL-M-14G)	13.4	6	Polyurethane coating		
Extrusion Compounds for High-Temperature Insulation			Clear conformal, fast cure		
Polytetrafluoroethylene	19.7	6	Standard conditions	78.7	6
Perfluoroalkoxy polymer	21.7	6	Immersion conditions	47.2	6
Fluorinated ethylene-propylene copolymer	19.7	6	Insulating Films and Tapes		
Ethylene-tetrafluoroethylene copolymer	15.7	6	Low-density polyethylene film (40 μm thick)	300	31
Polyvinylidene fluoride	10.2	6	Poly- <i>p</i> -xylylene film	410-590	32
Ethylene-chlorotrifluoroethylene copolymer	19.3	6	Aromatic polymer films		
Polychlorotrifluoroethylene	19.7	6	Kapton H (Du Pont)	389-430	33
Extrusion Compounds for Low-Temperature Insulation			Ultem (GE Plastic and Roem AG)	437-565	33
Polyvinyl chloride			Hostaphan (Hoechst AG)	338-447	33
Flexible	11.8-15.7	30	Amorphous Stabar K2000 (ICI film)	404-422	33
Rigid	13.8-19.7	30	Stabar S100 (ICI film)	353-452	33
Polyethylene	18.9	28	Polyetherimide film (26 μm)	486	34
Polyethylene, low-density	21.7	6	Parylene N/D (poly- <i>p</i> -xylylene/poly- dichloro- <i>p</i> -xylylene) 25 μm film	275	6
	300	31	Cellulose acetate film	157	6
Polyethylene, high-density	19.7	6	Cellulose triacetate film	157	6
Polypropylene/polyethylene copolymer	23.6	6	Polytetrafluoroethylene film	87-173	6
Embedding Compounds			Perfluoroalkoxy film	157-197	6
Basic epoxy resin:	19.7	6	Fluorinated ethylene-propylene copolymer film	197	6
bisphenol-A/epichlorohydrin polycondensate			Ethylene-tetrafluoroethylene film	197	6
Cycloaliphatic epoxy: alicyclic diepoxy carboxylate	19.7	6	Ethylene-chlorotrifluoroethylene copolymer film	197	6
Polyetherketone	18.9	30	Polychlorotrifluoroethylene film	118-153.5	6
Polyurethanes			High-voltage rubber insulating tape	28	6
Two-component, polyol-cured	25.4	6	Composites		
Two-part solventless, polybutylene-based	24.0	6	Isophthalic polyester (vinyl toluene monomer) filled with		
Silicones			Calcium carbonate, CaCO <sub>3</sub>	15.0	38
Clear two-part heat curing electrical grade silicone embedding resin	21.7	6	Gypsum, CaSO <sub>4</sub>	14.4	38
Red insulating enamel (MIL-E-22118)			Alumina trihydrate	15.4	38
Dry	47.2	6	Clay	14.4	38
Wet	11.8	6	BPA fumarate polyester (vinyl toluene monomer) filled with		
Enamels			Calcium carbonate	6.1	38
Red enamel, fast cure			Gypsum	5.9	38
Standard conditions	78.7	6	Alumina trihydrate	11.8	38
Immersion conditions	47.2	6	Clay	12.6	38
Black enamel			Polysulfone resin—30% glass fiber	16.5-18.7	38
Standard conditions	70.9	6	Polyamid resin (Nylon 66)— 30% carbon fiber	13.0	38
Immersion conditions	47.2	6	Polyimide thermoset resin, glass reinforced	12.0	39
Varnishes			Polyester resin (thermoplastic)—		
Vacuum-pressure impregnated baking type solventless polyester varnish					

Material	Dielectric strength kV/mm	Ref	Material	Dielectric strength kV/mm	Ref
40% glass fiber	20.0	38	Room-temperature vulcanized silicone rubber	9.2-10.9	35
Epoxy resin (diglycidyl ether of bisphenol A), glass reinforced	16.0	40	Ureas (from carbamide to tetraphenylurea)	11.8-15.7	28
Various Insulators			Dielectric papers		
Rubber, natural	100-215	26	Aramid paper, calendered	28.7	6
Butyl rubber	23.6	6	Aramid paper, uncalendered	12.2	6
Neoprene	15.7-27.6	6	Aramid with Mica	39.4	6
Silicone rubber	26-36	6			

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# ALLOCATION OF FREQUENCIES IN THE RADIO SPECTRUM

In the United States the National Telecommunications and Information Administration (NTIA) has responsibility for assigning each portion of the radio spectrum (9 kHz to 300 GHz) for different uses. These assignments must be compatible with the rules of the International Telecommunications Union (ITU), to which the United States is bound by treaty. The current assignments are given in a wall chart (Reference 1) and may also be found on the NTIA web site (Reference 2). The list below summarizes the broad features of the spectrum allocation, with particular attention to those sections of scientific interest. The references should be con-

sulted for details of the allocations in the frequency bands listed here, which in some cases are quite complex.

## References

1. *United States Frequency Allocations*, 1996 Spectrum Wall Chart, Stock No. 003-000-00652-2, U. S. Government Printing Office, P. O. Box 371954, Pittsburgh, PA 15250-7954.
2. <http://www.ntia.doc.gov/osmhome/allochrt.html>

Frequency range	Allocation
9 - 19.95 kHz	Maritime communication, navigation
19.95 - 20.05 kHz	Standard frequency and time signal (also at 60 kHz and 2.5, 5, 10, 15, 20, 25 MHz)
20.05 - 535 kHz	Maritime and aeronautical communication, navigation
535 - 1605 kHz	AM radio broadcasting
1605 - 3500 kHz	Mobile communication and navigation, amateur radio (1800-1900 kHz)
3.5 - 4.0 MHz	Amateur radio
4.0 - 5.95 MHz	Mobile communication
5.95 - 13.36 MHz	Mobile communication, amateur, short-wave broadcasting
13.36 - 13.41 MHz	Radioastronomy
13.41 - 25.55 MHz	Mobile communication, amateur, short-wave broadcasting
25.55 - 25.67 MHz	Radioastronomy
25.67 - 37.5 MHz	Mobile communication, amateur, short-wave broadcasting
37.5 - 38.25 MHz	Radioastronomy
38.25 - 50.0 MHz	Mobile communication
50.0 - 54.0 MHz	Amateur
54.0 - 72.0 MHz	TV channels 2-4
72.0 - 73.0 MHz	Mobile communication
73.0 - 74.6 MHz	Radioastronomy
74.6 - 76.0 MHz	Mobile communication
76.0 - 88.0 MHz	TV channels 5-6
88.0 - 108.0 MHz	FM radio broadcasting
108.0 - 118.0 MHz	Aeronautical navigation
118.0 - 174.0 MHz	Mobile communication, space research, meteorological satellites
174.0 - 216.0 MHz	TV channels 7-13
216.0 - 400.05 MHz	Mobile communication
400.05 - 400.15 MHz	Standard frequency and time satellite (also 20 and 25 GHz)
400.15 - 406.1 MHz	Meteorological aids (radiosonde)
406.1 - 410.0 MHz	Radioastronomy
410.0 - 470.0 MHz	Mobile communication, amateur
470.0 - 512.0 MHz	TV channels 14-20
512.0 - 608.0 MHz	TV channels 21-36
608.0 - 614.0 MHz	Radioastronomy
614.0 - 806.0 MHz	TV channels 38-69
806 - 1400 MHz	Mobile communication, navigation
1400 - 1427 MHz	Radioastronomy, space research
1427 - 1660 MHz	Various navigation and satellite applications
1660 - 1710 MHz	Radioastronomy, space research, meteorology
1710 - 2655 MHz	Various navigation and satellite applications
2655 - 2700 MHz	Radioastronomy, space research
2.7 - 4.99 GHz	Various navigation and satellite applications
4.99 - 5.0 GHz	Radioastronomy, space research
5.0 - 10.6 GHz	Various navigation and satellite applications
10.6 - 10.7 GHz	Radioastronomy, space research
10.7 - 15.35 GHz	Various navigation and satellite applications
15.35 - 15.4 GHz	Radioastronomy, space research
15.4 - 22.21 GHz	Various navigation and satellite applications

<b>Frequency range</b>	<b>Allocation</b>
22.21 - 22.5 GHz	Radioastronomy, space research
22.25 - 23.6 GHz	Various navigation and satellite applications
23.6 - 24.0 GHz	Radioastronomy, space research
24.0 - 31.3 GHz	Various navigation and satellite applications
31.3 - 31.8 GHz	Radioastronomy, space research
31.8 - 42.5 GHz	Various navigation and satellite applications
42.5 - 43.5 GHz	Radioastronomy
43.5 - 51.4 GHz	Various navigation and satellite applications
51.4 - 54.25 GHz	Radioastronomy, space research
54.25 - 58.2 GHz	Space research
58.2 - 59.0 GHz	Radioastronomy, space research
59.0 - 64.0 GHz	Satellite applications
64.0 - 65.0 GHz	Radioastronomy, space research
65.0 - 72.77 GHz	Various navigation and satellite applications
72.77 - 72.91 GHz	Radioastronomy, space research
72.91 - 86.0 GHz	Various navigation and satellite applications
86.0 - 92.0 GHz	Radioastronomy, space research
92.0 - 105.0 GHz	Various navigation and satellite applications
105.0 - 116.0 GHz	Radioastronomy, space research
116.0 - 164.0 GHz	Various navigation and satellite applications
164.0 - 168.0 GHz	Radioastronomy, space research
168.0 - 182.0 GHz	Various navigation and satellite applications
182.0 - 185.0 GHz	Radioastronomy, space research
185.0 - 217.0 GHz	Various navigation and satellite applications
217.0 - 231.0 GHz	Radioastronomy, space research
231.0 - 265.0 GHz	Various navigation and satellite applications
265.0 - 275.0 GHz	Radioastronomy
275.0 - 300.0 GHz	Mobile communications

## CORRECTION OF BAROMETER READINGS TO 0 °C TEMPERATURE

The following corrections are used to reduce the reading of a mercury barometer with a brass scale to 0 °C. The number in the table should be subtracted from the observed height of the mercury column to give the true pressure in mmHg (1mmHg = 133.322 Pa). The table is calculated from the formula

$$\Delta h = -0.0001634 ht / (1 + 0.0001818 t),$$

where  $h$  is the observed column height in mm and  $t$  the Celsius temperature. This relation is based on thermal expansion coefficients of  $181.8 \cdot 10^{-6} \text{ } ^\circ\text{C}^{-1}$  for mercury and  $18.4 \cdot 10^{-6} \text{ } ^\circ\text{C}^{-1}$  for brass.

$t/^\circ\text{C}$	Observed Height in mm																		
	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13
2	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.26	0.26
3	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39
4	0.40	0.41	0.42	0.42	0.43	0.44	0.44	0.45	0.46	0.46	0.47	0.48	0.48	0.49	0.50	0.50	0.51	0.52	0.52
5	0.51	0.51	0.52	0.53	0.54	0.55	0.56	0.56	0.57	0.58	0.59	0.60	0.60	0.61	0.62	0.63	0.64	0.64	0.65
6	0.61	0.62	0.63	0.64	0.65	0.66	0.67	0.68	0.69	0.70	0.71	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78
7	0.71	0.72	0.73	0.74	0.75	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.85	0.86	0.87	0.88	0.89	0.90	0.91
8	0.81	0.82	0.84	0.85	0.86	0.87	0.89	0.90	0.91	0.93	0.94	0.95	0.97	0.98	0.99	1.01	1.02	1.03	1.04
9	0.91	0.92	0.94	0.95	0.97	0.98	1.00	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.16	1.17
10	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.22	1.24	1.26	1.27	1.29	1.30
11	1.11	1.13	1.15	1.17	1.18	1.20	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44
12	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.55	1.57
13	1.31	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.50	1.53	1.55	1.57	1.59	1.61	1.63	1.65	1.67	1.70
14	1.41	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.60	1.62	1.64	1.67	1.69	1.71	1.73	1.76	1.78	1.80	1.83
15	1.52	1.54	1.56	1.59	1.61	1.64	1.66	1.69	1.71	1.74	1.76	1.78	1.81	1.83	1.86	1.88	1.91	1.93	1.96
16	1.62	1.64	1.67	1.69	1.72	1.75	1.77	1.80	1.82	1.85	1.88	1.90	1.93	1.96	1.98	2.01	2.03	2.06	2.09
17	1.72	1.74	1.77	1.80	1.83	1.86	1.88	1.91	1.94	1.97	1.99	2.02	2.05	2.08	2.10	2.13	2.16	2.19	2.22
18	1.82	1.85	1.88	1.91	1.93	1.96	1.99	2.02	2.05	2.08	2.11	2.14	2.17	2.20	2.23	2.26	2.29	2.32	2.35
19	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13	2.17	2.20	2.23	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.48
20	2.02	2.05	2.08	2.12	2.15	2.18	2.21	2.25	2.28	2.31	2.34	2.38	2.41	2.44	2.47	2.51	2.54	2.57	2.60
21	2.12	2.15	2.19	2.22	2.26	2.29	2.32	2.36	2.39	2.43	2.46	2.50	2.53	2.56	2.60	2.63	2.67	2.70	2.73
22	2.22	2.26	2.29	2.33	2.36	2.40	2.43	2.47	2.51	2.54	2.58	2.61	2.65	2.69	2.72	2.76	2.79	2.83	2.86
23	2.32	2.36	2.40	2.43	2.47	2.51	2.54	2.58	2.62	2.66	2.69	2.73	2.77	2.81	2.84	2.88	2.92	2.96	2.99
24	2.42	2.46	2.50	2.54	2.58	2.62	2.66	2.69	2.73	2.77	2.81	2.85	2.89	2.93	2.97	3.01	3.05	3.08	3.12
25	2.52	2.56	2.60	2.64	2.68	2.72	2.77	2.81	2.85	2.89	2.93	2.97	3.01	3.05	3.09	3.13	3.17	3.21	3.25
26	2.62	2.66	2.71	2.75	2.79	2.83	2.88	2.92	2.96	3.00	3.04	3.09	3.13	3.17	3.21	3.26	3.30	3.34	3.38
27	2.72	2.77	2.81	2.85	2.90	2.94	2.99	3.03	3.07	3.12	3.16	3.20	3.25	3.29	3.34	3.38	3.42	3.47	3.51
28	2.82	2.87	2.91	2.96	3.00	3.05	3.10	3.14	3.19	3.23	3.28	3.32	3.37	3.41	3.46	3.51	3.55	3.60	3.64
29	2.92	2.97	3.02	3.06	3.11	3.16	3.21	3.25	3.30	3.35	3.39	3.44	3.49	3.54	3.58	3.63	3.68	3.72	3.77
30	3.02	3.07	3.12	3.17	3.22	3.27	3.32	3.36	3.41	3.46	3.51	3.56	3.61	3.66	3.71	3.75	3.80	3.85	3.90
31	3.12	3.17	3.22	3.27	3.32	3.37	3.43	3.48	3.53	3.58	3.63	3.68	3.73	3.78	3.83	3.88	3.93	3.98	4.03
32	3.22	3.28	3.33	3.38	3.43	3.48	3.54	3.59	3.64	3.69	3.74	3.79	3.85	3.90	3.95	4.00	4.05	4.11	4.16
33	3.32	3.38	3.43	3.48	3.54	3.59	3.64	3.70	3.75	3.81	3.86	3.91	3.97	4.02	4.07	4.13	4.18	4.23	4.29
34	3.42	3.48	3.53	3.59	3.64	3.70	3.75	3.81	3.87	3.92	3.98	4.03	4.09	4.14	4.20	4.25	4.31	4.36	4.42
35	3.52	3.58	3.64	3.69	3.75	3.81	3.86	3.92	3.98	4.03	4.09	4.15	4.21	4.26	4.32	4.38	4.43	4.49	4.55
36	3.62	3.68	3.74	3.80	3.86	3.92	3.97	4.03	4.09	4.15	4.21	4.27	4.32	4.38	4.44	4.50	4.56	4.62	4.68
37	3.72	3.78	3.84	3.90	3.96	4.02	4.08	4.14	4.20	4.26	4.32	4.38	4.44	4.50	4.56	4.62	4.68	4.74	4.80
38	3.82	3.88	3.95	4.01	4.07	4.13	4.19	4.25	4.32	4.38	4.44	4.50	4.56	4.62	4.69	4.75	4.81	4.87	4.93
39	3.92	3.99	4.05	4.11	4.18	4.24	4.30	4.37	4.43	4.49	4.56	4.62	4.68	4.75	4.81	4.87	4.94	5.00	5.06
40	4.02	4.09	4.15	4.22	4.28	4.35	4.41	4.48	4.54	4.61	4.67	4.74	4.80	4.87	4.93	5.00	5.06	5.13	5.19

# METALS AND ALLOYS WITH LOW MELTING TEMPERATURE

L. I. Berger

Metal or alloy system	Composition, %*		Melting temperature (°C)	Comments	Ref.
	Weight	Atomic			
Hg	100	100	-38.84		
Cs-K	77.0-23.0	50.0-50.0	-37.5	Eutectic (?)	1
Cs-Na	94.5-5.5	75.0-25.0	-30.0	Eutectic	2
K-Na	76.7-23.3	65.9-34.1	-12.65	Eutectic	3
Na-Rb	8.0-92.0	24.4-75.6	-5	Eutectic	4
Ga-In-Sn	62.5-21.5-16.0	73.6-15.3-11.1	11	Eutectic	5
Ga-Sn-Zn	82.0-12.0-6.0	86.0-7.3-6.7	17	Eutectic	5
Cs	100	100	28.44		
Ga	100	100	29.77		
K-Rb	32.0-68.0	50-50	33	Eutectic	4
Bi-Cd-In-Pb-Sn	44.7-5.3-19.1-22.6-8.3	35.1-8.2-27.3-17.9-11.5	46.7	Eutectic	6
Bi-In-Pb-Sn	49.5-21.3-17.6-11.6	39.2-30.7-14.0-16.2	58.2	Eutectic	6
Bi-In-Sn	32.5-51.0-16.5	21.1-60.1-18.8	60.5	Eutectic	7
K	100	100	63.38		
Bi-Cd-Pb-Sn	50.0-12.5-25.0-12.5	41.5-19.3-21.0-18.2	70	Wood's alloy	6
Bi-In	33.0-67.0	21.3-78.7	72	Eutectic	8
Bi-Cd-Pb	51.6-8.2-40.2	48.1-14.2-37.7	91.5	Eutectic	6
Bi-Pb-Sn	52.5-32.0-15.5	46.8-28.7-24.5	95	Eutectic	6
Na	100	100	97.8		
Bi-Cd-Sn	54.0-20.0-26.0	39.4-27.2-33.4	102.5	Eutectic	6
In-Sn	51.8-48.2	52.6-47.4	119	Eutectic	9
Cd-In	25.3-74.7	25.7-74.3	120	Eutectic	10
Bi-Pb	55.5-44.5	55.3-44.7	124	Eutectic	11
Bi-Sn-Zn	56.0-40.0-4.0	40.2-50.6-9.2	130	Eutectic	6, 7
Bi-Sn	70-30	57.0-43.0	138.5	Eutectic	6, 12
Bi-Cd	60.3-39.7	45.0-55.0	145.5	Eutectic	13, 14
In	100	100	156.6		
Li	100	100	180.5		
Pb-Sn	38.1-61.9	26.1-73.9	183	Eutectic	6,15
Bi-Tl	48.0-52.0	47.5-52.5	185	Eutectic	13
Sn-Zn	91.0-9.0	85.0-15.0	198	Eutectic	14
Sb-Sn	8.0-92.0	7.8-92.2	199	White Metal	16
Au-Pb	14.6-85.4	15.2-84.8	212	Eutectic	17
Ag-Sn	3.5-96.5	3.8-96.2	221	Eutectic	13,18
Bi-Pb-Sb-Sn	48.0-28.5-9.0-14.5	40.8-24.5-13.1-21.6	226	Matrix Alloy	6
Cu-Sn	0.75-99.25	1.3-98.7	227	Eutectic	13, 19
Sn	100	100	231.9		

\* The useful expression for correlations between the atomic and weight concentrations of an alloy components are:

$$f(a, A_k) = \frac{f(w, A_k)}{M_k \sum_{i=1}^N \frac{f(w, A_i)}{M_i}} \quad \text{and} \quad f(w, A_k) = \frac{M_k \cdot f(a, A_k)}{\sum_{i=1}^N M_i \cdot f(a, A_i)} \quad (i = 1, \dots, k, \dots, N)$$

where  $f(a, A_i)$  and  $f(w, A_i)$  are the atomic and weight concentrations of component  $A_i$ , respectively, and  $M_i$  is the atomic weight of this component.

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## FLAME TEMPERATURES

This table gives the adiabatic flame temperature for stoichiometric mixtures of various fuels and oxidizers. The temperatures are calculated from thermodynamic and transport properties under ideal adiabatic conditions, using methods described in the reference.

### Reference

Fristrom, R. M., *Flame Structures and Processes*, Oxford University Press, New York, 1995.

**Adiabatic Flame Temperature in K for Various Fuel-Oxidizer Combinations**

Fuel	Oxidizer					
	Air	O <sub>2</sub>	F <sub>2</sub>	Cl <sub>2</sub>	N <sub>2</sub> O	NO
<i>Organic liquids and gases</i>						
Acetaldehyde	2288					
Acetone	2253					
Acetylene	2607					
Benzene	2363					
Butane	2248					
Carbon disulfide	2257					
Cyanogen	2596	4855				
Cyclohexane	2250					
Cyclopropane	2370					
Decane	2286					
Ethane	2244					
Ethanol	2238					
Ethylene	2375					
Hexane	2238					
Methane	2236					
Methanol	2222					
Oxirane	2177					
Pentane	2250					
Propane	2250					
Toluene	2344					
<i>Solids</i>						
Aluminum		4005				
Lithium		2711				
Phosphorus (white)		3242				
Zirconium		4278				
<i>Other</i>						
Ammonia		2845				
Carbon monoxide	1388					
Diborane		3350				
Hydrazine		3037				
Hydrogen	2169	3000	4006	2493	2965	3127
Hydrogen sulfide	2091	3414				
Phosphine		3139				
Silane		3043				

## DENSITY OF ETHANOL-WATER MIXTURES

This table gives the density of mixtures of ethanol and water as a function of composition and temperature. The composition is specified in weight percent of ethanol, i.e., mass of ethanol per 100 g of solution. Values from the reference have been converted to true densities.

### Reference

Washburn, E. W., Ed., *International Critical Tables of Numerical Data of Physics, Chemistry, and Technology*, Vol. 3, McGraw-Hill, New York, 1926-1932.

Weight % Ethanol	Density in g/cm <sup>3</sup>						
	10 °C	15 °C	20 °C	25 °C	30 °C	35 °C	40 °C
0	0.99970	0.99910	0.99820	0.99705	0.99565	0.99403	0.99222
5	0.99095	0.99029	0.98935	0.98814	0.98667	0.98498	0.98308
10	0.98390	0.98301	0.98184	0.98040	0.97872	0.97682	0.97472
15	0.97797	0.97666	0.97511	0.97331	0.97130	0.96908	0.96667
20	0.97249	0.97065	0.96861	0.96636	0.96392	0.96131	0.95853
25	0.96662	0.96421	0.96165	0.95892	0.95604	0.95303	0.94988
30	0.95974	0.95683	0.95379	0.95064	0.94738	0.94400	0.94052
35	0.95159	0.94829	0.94491	0.94143	0.93787	0.93422	0.93048
40	0.94235	0.93879	0.93515	0.93145	0.92767	0.92382	0.91989
45	0.93223	0.92849	0.92469	0.92082	0.91689	0.91288	0.90881
50	0.92159	0.91773	0.91381	0.90982	0.90577	0.90165	0.89747
55	0.91052	0.90656	0.90255	0.89847	0.89434	0.89013	0.88586
60	0.89924	0.89520	0.89110	0.88696	0.88275	0.87848	0.87414
65	0.88771	0.88361	0.87945	0.87524	0.87097	0.86664	0.86224
70	0.87599	0.87184	0.86763	0.86337	0.85905	0.85467	0.85022
75	0.86405	0.85985	0.85561	0.85131	0.84695	0.84254	0.83806
80	0.85194	0.84769	0.84341	0.83908	0.83470	0.83027	0.82576
85	0.83948	0.83522	0.83093	0.82658	0.82218	0.81772	0.81320
90	0.82652	0.82225	0.81795	0.81360	0.80920	0.80476	0.80026
95	0.81276	0.80850	0.80422	0.79989	0.79553	0.79112	0.78668
100	0.79782	0.79358	0.78932	0.78504	0.78073	0.77639	0.77201

## MISCIBILITY OF ORGANIC SOLVENTS

The chart below gives qualitative information on the miscibility of pairs of organic liquids. Two liquids are considered miscible (indicated by **M** in the chart) if mixing equal volumes produces a single liquid phase. If two phases separate, they are considered immiscible (**I**). An entry of **P** indicates two phases whose volumes dif-

fer appreciably, suggesting a partial miscibility of the components. The symbol **R** indicates a reaction between the components. All data refer to room temperature.

The codes for the columns are:

<b>A</b> Acetone	<b>J</b> Diethyl ether	<b>S</b> Methyl isopropyl ketone
<b>B</b> Benzaldehyde	<b>K</b> <i>N,N</i> -Dimethylaniline	<b>T</b> Nitromethane
<b>C</b> Benzene	<b>L</b> Dipentylamine	<b>U</b> 1-Octanol
<b>D</b> Butyl acetate	<b>M</b> Ethyl alcohol	<b>V</b> 1,3-Propanediol
<b>E</b> Butyl alcohol	<b>N</b> Ethylene glycol	<b>W</b> Pyridine
<b>F</b> Carbon tetrachloride	<b>O</b> Ethylene glycol monoethyl ether	<b>X</b> Triethylenetetramine
<b>G</b> 2-Chloroethanol	<b>P</b> Formamide	<b>Y</b> Triethyl phosphate
<b>H</b> Chloroform	<b>Q</b> Furfuryl alcohol	
<b>I</b> <i>o</i> -Cresol	<b>R</b> Glycerol	

### References

1. Drury, J. S., *Ind. Eng. Chem.* 44, 2744, 1959.
2. Jackson, W. M., and Drury, J. S., *Ind. Eng. Chem.* 51, 1491, 1959.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Acetone	-	M	M	M	M	M	M	M		M	M	M	M	M	M	M	M	I	M	M	M	M	M	M	M
Adiponitrile	M		M		M	I				I	M		M	I		M	M	I				M	M		
2-Amino-2-methyl-1-propanol	M	M	M	M	M	M				M	M		M	M		M	M	M		M	M	M	M		
<i>p</i> -Anisaldehyde								M							I	M		I				I			M
Benzaldehyde	M	-	M	M	M	M				M	M		M	P		M	M	P		M	M	M	M		
Benzene	M	M	-	M	M	M	M	M		M	M	M	M	I	M	I	M	I	M	I	M	I	M	M	M
Benzonitrile	M	M	M	M	M					M	M		M	I		I	M	I				I	M		
Benzothiazole	M		M	M	M					M	M		M	M		I	M	I				M	M		
Benzyl alcohol	M	M	M	M	M	M				M	M		M	M		M	M	M		M	M	M	M		
Benzyl mercaptan	M		M		M	M				M	M		M	I		I	M	I				I	M		
2-Bromoethyl acetate	M		P					M				R	M							M					R
1,3-Butanediol	M		I					M	M	P		M	M							M			M	M	
2,3-Butanediol	M		P					M	M	M		M	M							M			M	M	
Butyl acetate	M	M	M	-	M	M				M	M		M	P		I	M	I		M	M	P	M		
Butyl alcohol	M	M	M	M	-	M				M	M		M	M		M	M	M		M	M	M	M		
Carbon tetrachloride	M	M	M	M	M	-				M	M		M	I		I	M	I		M	M	I	M		
2-Chloroethanol	M		M					-	M	M		M								M			M	M	M
Chloroform	M		M			M	-		M	M	P	M						I	M			M	M	M	M
3-Chloro-1,2-propanediol	M		I					M	M	M		R	M							M			M	R	
Cinnamaldehyde	M		M			M	M					M	M	I	M			I	M			I		R	M
<i>o</i> -Cresol							M	-						M	M			M				M			M
Diacetone alcohol	M	M	P	M	M	P				M	M		M	M		M	M	I		M	M	M	M		
Dibenzyl ether	M		M			M	M					M		I	M			I	M					M	M
Dibutylamine							R							M	M			P							M
Dibutyl carbonate	M		M					M				M	M							M					I
Dibutyl ether	M	M	M	M	M	M				M	M		M	I		I	M	I		I	M	I	M		
Diethanolamine	M	I	I	I	M	I				I	P		M	M		M	M	M		I	M	M	M		
Diethylacetic acid	M		M			M	M					R	M	M	M			I	M			M		R	M
Diethylene glycol dibutyl ether	M		M			M	M	M				R	M							M			M		
Diethylene glycol diethyl ether	M		M			M	M	M				M	M							M			M	M	
Diethylene glycol monobutyl ether	M		M			M	M	M				M	M							M			M	M	
Diethylene glycol monoethyl ether	M		M			M	M	M				M	M							M			M	M	
Diethylene glycol monomethyl ether	M		M			M		M				M	M							M			M	M	
Diethylenetriamine	M		M				R	M				I	M	M	M			M	R					M	M
Diethyl ether	M	M	M	M	M	M	M	M		-	M	M	M	I	M	I	M	I	M	M	M	M	I	M	M
Diethylformamide	M		M			M	M					R	M	M	M			M	M			M		R	M
Dihexyl ether	M		M			M	M					M	M	I	M			I	M			I		I	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Diisobutyl ketone	M		M				M	M				M	M	I	M			I	M			I		M	M
Diisopropylamine	M		M				R	M				M	M	M	M			M	M			M		M	M
<i>N,N</i> -Dimethylaniline	M	M	M	M	M	M				M	-		M	I		I	M	I		M	M	I	M		
Dipentylamine	M		M					M	M		-	M	P	M				P	M			M		I	M
<i>N,N</i> -Dipropylaniline	M		M		M	M	M	M		M	M	M	M	I	M	I	M	I	M			I	M	M	M
Dipropylene glycol	M		M				M	M	M	M			M							M			M	M	
Ethyl alcohol	M	M	M	M	M	M		M	M	M	M	-	M	M	M	M	M	M	M	M	M	M	M	M	M
Ethyl benzoate	M	M	M	M	M	M		M	M	M	M	M	I		I	M	I	M	M	M	M	P	M	M	
Ethyl chloroacetate	M		M				M	M				M	M	I	M			I	M			I		R	M
Ethyl cinnamate	M		M					M				M	M	I	M			I	M			I		M	M
Ethylene glycol	M	P	I	P	M	I		P	M	I	I	P	M	-	M	M	M	I	I	M	M	M	M	M	M
Ethylene glycol monobutyl ether	M		M					M	M	M		M	M						M				M	M	
Ethylene glycol monoethyl ether	M		M					M	M	M		M	M		-				M				M	M	
Ethylene glycol monomethyl ether	M		M					M	M			M	M										M	M	
2-Ethyl-1-hexanol	M	M	M	M	M	M				M	M		M	M		I	M	I		I	M	M	M		
Ethyl phenylacetate	M		M				M	M				M		I	M			I	M			I		M	M
Ethyl thiocyanate	M		M		M	M				M	M		M	I		I	M	I				I	M		
Formamide	M	M	I	I	M	I				I	I		M	M		-	M	M		M	I	M	M		
Furfuryl alcohol	M	M	M	M	M	M				M	M		M	M		M	-	M		M	M	M	M		
Glycerol	I	P	I	I	M	I		I	M	I	I	P	M	M		M	M	-	I	I	I	I	M	M	M
1-Heptadecanol	M		M					M				M	M						M					M	
3-Heptanol	M		M				M	M				M	M	M	M			I				M		M	M
Heptyl acetate	M		M				M	M				M		I	M			I	M			I		R	M
Hexanenitrile	M		M				M	M				M	M	I	M			I	M			I		M	M
Isobutyl mercaptan	M		M		M	M				M	M		M	I		I	M	I				R	M		
Isopentyl acetate	M		M				M	M				M	M	I	M			I	M			I		M	M
Isopentyl alcohol	M	M	M	M	M	M				M	M		M	M		M	M	I		M	M	M	M		
Isopentyl sulfide	M		M		M	M				M	M		M	I		I	I	I				I	M		
Methyl disulfide	M		M		M	M				M	M		M	I		I	M	I				R	M		
Methyl isobutyl ketone	M	M	M	M	M	M				M	M		M	I		P	M	I		M	M	I	M		
Methyl isopropyl ketone	M		M				M	M		M		M	M	I	M			I	-			M		R	M
4-Methylpentanoic acid	M		M					M				M	M	M	M			I	M			M		R	M
Nitromethane	M	M	I	M	M	M				M	M		M	I		M	M	I		-	P	I	M		
1-Octanol	M	M	M	M	M	M				M	M		M	M		I	M	I		P	-	M	M		
<i>o</i> -Phenetidine	M		M				M	M				M	M	M	M				M			M		M	
1,2-Propanediol	M		I					M	M	P		M	M						M				M	M	
1,3-Propanediol	M	M	I	P	M	I		M	M	I	I	M	M	M		M	M	M	M	I	M	-	M	M	
Pyridine	M	M	M	M	M	M	M			M	M		M	M	M	M	M	M		M	M	M	-	M	
Tetradecanol	M		M				M	M				M	M	I	M			I	M			P		M	M
Tributyl phosphate	M		M				M	M				M	M	P	M			I	M			M		M	M
Triethylene glycol	M		P					M	M	I		P	M						M				M	M	
Triethylenetetramine	M		M				M	M		M		I	M	M	M			M	R			M		-	M
Triethyl phosphate	M		M					M	M	M		M	M						M				M	M	-
2,6,8-Trimethyl-4-nonanone	M		M				M	M				M	M	I	M			I	M			I		I	M

## DENSITY OF SOLVENTS AS A FUNCTION OF TEMPERATURE

The table below lists the density of several common solvents in the temperature range from 0°C to 100°C. The values have been calculated from the Rackett Equation using parameters in the reference. Density values refer to the liquid at its saturation vapor pressure; thus entries for temperatures above the normal boiling point are for pressures greater than atmospheric.

### Reference

Lide, D. R., and Kehiaian, H. V., *Handbook of Thermophysical and Thermochemical Data*, CRC Press, Boca Raton, FL, 1994.

Solvent	Density in g/mL										
	0°C	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C
Acetic acid			1.051	1.038	1.025	1.012	0.9993	0.9861	0.9728	0.9592	0.9454
Acetone	0.8129	0.8016	0.7902	0.7785	0.7666	0.7545	0.7421	0.7293	0.7163	0.7029	0.6890
Acetonitrile			0.7825	0.7707	0.7591	0.7473	0.7353	0.7231	0.7106	0.6980	0.6851
Aniline	1.041	1.033	1.025	1.016	1.008	1.000	0.9909	0.9823	0.9735	0.9646	0.9557
Benzene		0.8884	0.8786	0.8686	0.8584	0.8481	0.8376	0.8269	0.8160	0.8049	0.7935
1-Butanol	0.8293	0.8200	0.8105	0.8009	0.7912	0.7812	0.7712	0.7609	0.7504	0.7398	0.7289
Butylamine	0.7606	0.7512	0.7417	0.7320	0.7221	0.7120	0.7017	0.6911	0.6803	0.6693	0.6579
Carbon disulfide	1.290	1.277	1.263	1.248	1.234						
Chlorobenzene	1.127	1.116	1.106	1.096	1.085	1.074	1.064	1.053	1.042	1.030	1.019
Cyclohexane		0.7872	0.7784	0.7694	0.7602	0.7509	0.7414	0.7317	0.7218	0.7117	0.7013
Decane	0.7447	0.7374	0.7301	0.7226	0.7151	0.7074	0.6997	0.6919	0.6839	0.6758	0.6676
1-Decanol			0.8294	0.8229	0.8162	0.8093	0.8024	0.7955	0.7884	0.7813	0.7740
Dichloromethane	1.362	1.344	1.326	1.307	1.289	1.269	1.250	1.229	1.208	1.187	1.165
Diethyl ether	0.7368	0.7254	0.7137	0.7018	0.6896	0.6770	0.6639	0.6505	0.6366	0.6220	0.6068
<i>N,N</i> -Dimethylaniline		0.9638	0.9562	0.9483	0.9401	0.9318	0.9234	0.9150	0.9064	0.8978	0.8890
Ethanol	0.8121	0.8014	0.7905	0.7793	0.7680	0.7564	0.7446	0.7324	0.7200	0.7073	0.6942
Ethyl acetate	0.9245	0.9126	0.9006	0.8884	0.8759	0.8632	0.8503	0.8370	0.8234	0.8095	0.7952
Ethylbenzene	0.8836	0.8753	0.8668	0.8582	0.8495	0.8407	0.8318	0.8228	0.8136	0.8043	0.7948
Ethyl formate	0.9472	0.9346	0.9218	0.9087	0.8954	0.8818	0.8678	0.8535	0.8389	0.8238	0.8082
Ethyl propanoate	0.9113	0.9005	0.8895	0.8784	0.8671	0.8556	0.8439	0.8319	0.8197	0.8072	0.7944
Heptane	0.7004	0.6921	0.6837	0.6751	0.6664	0.6575	0.6485	0.6393	0.6298	0.6202	0.6102
Hexane	0.6774	0.6685	0.6594	0.6502	0.6407	0.6311	0.6212	0.6111	0.6006	0.5899	0.5789
1-Hexanol	0.8359	0.8278	0.8195	0.8111	0.8027	0.7941	0.7854	0.7766	0.7676	0.7585	0.7492
Isopropylbenzene	0.8769	0.8696	0.8615	0.8533	0.8450	0.8366	0.8280	0.8194	0.8106	0.8017	0.7927
Methanol	0.8157	0.8042	0.7925	0.7807	0.7685	0.7562	0.7435	0.7306	0.7174	0.7038	0.6898
Methyl acetate	0.9606	0.9478	0.9346	0.9211	0.9074	0.8933	0.8790	0.8643	0.8491	0.8336	0.8176
<i>N</i> -Methylaniline	1.0010	0.9933	0.9859	0.9785	0.9709	0.9633	0.9556	0.9478	0.9399	0.9319	0.9239
Methylcyclohexane	0.7858	0.7776	0.7693	0.7608	0.7522	0.7435	0.7346	0.7255	0.7163	0.7069	0.6973
Methyl formate	1.003	0.9887	0.9739	0.9588	0.9433	0.9275	0.9112	0.8945	0.8772	0.8594	0.8409
Methyl propanoate	0.9383	0.9268	0.9150	0.9030	0.8907	0.8783	0.8656	0.8526	0.8393	0.8257	0.8117
Nitromethane			1.139	1.125	1.111	1.097	1.083	1.069	1.055	1.040	1.026
Nonane	0.7327	0.7252	0.7176	0.7099	0.7021	0.6941	0.6861	0.6779	0.6696	0.6611	0.6525
Octane	0.7185	0.7106	0.7027	0.6945	0.6863	0.6779	0.6694	0.6608	0.6520	0.6430	0.6338
Pentanoic acid	0.9563	0.9476	0.9389	0.9301	0.9211	0.9121	0.9029	0.8937	0.8843	0.8748	0.8652
1-Propanol	0.8252	0.8151	0.8048	0.7943	0.7837	0.7729	0.7619	0.7506	0.7391	0.7273	0.7152
2-Propanol	0.8092	0.7982	0.7869	0.7755	0.7638	0.7519	0.7397	0.7272	0.7143	0.7011	0.6876
Propyl acetate	0.9101	0.8994	0.8885	0.8775	0.8662	0.8548	0.8432	0.8313	0.8192	0.8069	0.7942
Propylbenzene	0.8779	0.8700	0.8619	0.8538	0.8456	0.8373	0.8289	0.8204	0.8117	0.8030	0.7943
Propyl formate	0.9275	0.9166	0.9053	0.8938	0.8821	0.8702	0.8581	0.8457	0.8330	0.8201	0.8068
Tetrachloromethane	1.629	1.611	1.593	1.575	1.557	1.538	1.518	1.499	1.479	1.458	1.437
Toluene	0.8846	0.8757	0.8667	0.8576	0.8483	0.8389	0.8294	0.8197	0.8098	0.7998	0.7896
Trichloromethane	1.524	1.507	1.489	1.471	1.452	1.433	1.414	1.394			
2,2,4-Trimethylpentane			0.6921	0.6836	0.6750	0.6663	0.6574	0.6484	0.6391	0.6296	0.6199
<i>o</i> -Xylene			0.8801	0.8717	0.8633	0.8547	0.8460	0.8372	0.8282	0.8191	0.8099
<i>m</i> -Xylene	0.8813	0.8729	0.8644	0.8558	0.8470	0.8382	0.8292	0.8201	0.8109	0.8015	0.7920
<i>p</i> -Xylene			0.8609	0.8523	0.8436	0.8347	0.8258	0.8167	0.8075	0.7981	0.7886

## COEFFICIENT OF FRICTION

The coefficient of friction between two surfaces is the ratio of the force required to move one over the other to the force pressing the two together. Thus if  $F$  is the minimum force needed to move one surface over the other, and  $W$  is the force pressing the surfaces together, the coefficient of friction  $\mu$  is given by  $\mu = F/W$ . A greater force is generally needed to initiate movement from rest than to continue the motion once sliding has started. Thus the static coefficient of friction  $\mu(\text{static})$  is usually larger than the sliding or kinetic coefficient  $\mu(\text{sliding})$ .

This table gives characteristic values of both the static and sliding coefficients of friction for a number of material combinations. In each case Material 1 is moving over the surface of Material 2.

The type of lubrication or any other special condition is indicated in the third column. All values refer to room temperature unless otherwise indicated. It should be emphasized that the coefficient of friction is very sensitive to the condition of the surface, so that these values represent only a rough guide.

### References

1. Minshall, H., in *CRC Handbook of Chemistry and Physics, 73rd Edition*, Lide, D. R., Ed., CRC Press, Boca Raton, FL, 1992.
2. Fuller, D. D., in *American Institute of Physics Handbook, 3rd Edition*, Gray, D. E., Ed., McGraw-Hill, New York, 1972.

Material 1	Material 2	Conditions	$\mu(\text{static})$	$\mu(\text{sliding})$
<i>Metals</i>				
Hard steel	Hard steel	Dry	0.78	0.42
		Castor oil	0.15	0.081
		Steric acid	0.005	0.029
		Lard	0.11	0.084
		Light mineral oil	0.23	
		Graphite		0.058
Hard steel	Graphite	Dry	0.21	
Mild steel	Mild steel	Dry	0.74	0.57
		Oleic acid		0.09
Mild steel	Phosphor bronze	Dry		0.34
Mild steel	Cast iron	Dry		0.23
Mild steel	Lead	Dry	0.95	0.95
		Mineral oil	0.5	0.3
Mild steel	Brass	Dry	0.35	
Cast iron	Cast iron	Dry	1.10	0.15
Aluminum	Aluminum	Dry	1.05	1.4
Aluminum	Mild steel	Dry	0.61	0.47
Brass	Mild steel	Dry	0.51	0.44
		Castor oil	0.11	
Brass	Cast iron	Dry		0.30
Bronze	Cast iron	Dry		0.22
Cadmium	Mild steel	Dry		0.46
Copper	Copper	Dry	1.6	
Copper	Mild steel	Dry	0.53	0.36
		Oleic acid		0.18
Copper	Cast iron	Dry	1.05	0.29
Copper	Glass	Dry	0.68	0.53
Lead	Cast iron	Dry		0.43
Magnesium	Magnesium	Dry	0.6	
Magnesium	Mild steel	Dry		0.42
Magnesium	Cast iron	Dry		0.25
Nickel	Nickel	Dry	1.10	0.53
Nickel	Mild steel	Dry		0.64
Tin	Cast iron	Dry		0.32
Zinc	Cast iron	Dry	0.85	0.21
<i>Nonmetals</i>				
Diamond	Diamond	Dry	0.1	
Diamond	Metals	Dry	0.12	
Garnet	Mild steel	Dry		0.39
Glass	Glass	Dry	0.94	0.4
Glass	Nickel	Dry	0.78	0.56

Material 1	Material 2	Conditions	$\mu(\text{static})$	$\mu(\text{sliding})$
Graphite	Graphite	Dry	0.1	
Mica	Mica	Freshly cleaved	1.0	
Nylon	Nylon	Dry	0.2	
Nylon	Steel	Dry	0.40	
Polyethylene	Polyethylene	Dry	0.2	
Polyethylene	Steel	Dry	0.2	
Polystyrene	Polystyrene	Dry	0.5	
Polystyrene	Steel	Dry	0.3	
Sapphire	Sapphire	Dry	0.2	
Teflon	Teflon	Dry	0.04	0.04
Teflon	Steel	Dry	0.04	0.04
Tungsten carbide	Tungsten carbide	Dry, room temp.	0.17	
		Dry, 1000°C	0.45	
		Dry, 1600°C	1.8	
		Oleic acid	0.12	
Tungsten carbide	Graphite	Dry	0.15	
Tungsten carbide	Steel	Dry	0.5	
		Oleic acid	0.08	
<i>Miscellaneous materials</i>				
Cotton	Cotton	Threads	0.3	
Leather	Cast iron	Dry	0.6	0.56
Leather	Oak	Parallel to grain	0.61	0.52
Oak	Oak	Parallel to grain	0.62	0.48
		Perpendicular to grain	0.54	0.32
Silk	Silk	Clean	0.25	
Wood	Wood	Dry	0.35	
		Wet	0.2	
Wood	Brick	Dry	0.6	
Wood	Leather	Dry	0.35	
<i>Various materials on ice and snow</i>				
Ice	Ice	Clean, 0°C	0.1	0.02
		Clean, -12°C	0.3	0.035
		Clean, -80°C	0.5	0.09
Aluminum	Snow	Wet, 0°C	0.4	
		Dry, 0°C	0.35	
Brass	Ice	Clean, 0°C		0.02
		Clean, -80°C		0.15
Nylon	Snow	Wet, 0°C	0.4	
		Dry, -10°C	0.3	
Teflon	Snow	Wet, 0°C	0.05	
		Dry, 0°C	0.02	
Wax, ski	Snow	Wet, 0°C	0.1	
		Dry, 0°C	0.04	
		Dry, -10°C	0.2	

## SECONDARY REFERENCE POINTS ON THE ITS-90 TEMPERATURE SCALE

The International Temperature Scale of 1990 is described in Section 1 of this *Handbook*, where the defining fixed points are listed. The Consultative Committee on Thermometry (CCT) of the International Committee on Weights and Measures (CIPM), which oversees the temperature scale, has recommended a number of secondary reference points whose values have been accurately determined with respect to the primary fixed points. The most accurate of these, referred to as “first quality points”, satisfy several criteria involving purity of the material, reproducibility, and documentation of the measurements. The CCT also lists “second quality points” that do not yet satisfy all the criteria but are still useful. Taken together,

these secondary reference points, help fill in the gaps between the primary fixed points.

The table below describes these secondary reference points. The best values resulting from the CCT evaluation are listed on both the Kelvin and Celsius scales, along with an estimate of uncertainty. Full details are given in the reference.

The entries within each quality group are listed in order of increasing temperature.

### Reference

Bedford, R. E., Bonnier, G., Maas, H., and Pavese, F., *Metrologia* 33, 133, 1996.

Substance	Type of Transition	$T_{90}/\text{K}$	$t_{90}/^{\circ}\text{C}$	Uncert.
<i>First quality points</i>				
Zinc	Superconductive transition	0.8500	-272.300	0.0030
Aluminum	Superconductive transition	1.1810	-271.9690	0.0025
Helium ( $^4\text{He}$ )	Superfluid transition	2.1768	-270.9732	0.0001
Indium	Superconductive transition	3.4145	-269.7355	0.0025
Lead	Superconductive transition	7.1997	-265.9503	0.0025
Niobium	Superconductive transition	9.2880	-263.8620	0.0025
Deuterium ( $^2\text{H}_2$ )	Triple point (equilibrium $\text{D}_2$ )	18.689	-254.461	0.001
Deuterium ( $^2\text{H}_2$ )	Triple point (normal $\text{D}_2$ )	18.724	-254.426	0.001
Neon ( $^{20}\text{Ne}$ )	Triple point	24.541	-248.609	0.001
Neon	Boiling point	27.097	-246.053	0.001
Nitrogen	Triple point	63.151	-209.999	0.001
Nitrogen	Boiling point	77.352	-195.798	0.002
Argon	Boiling point	87.303	-185.847	0.001
Oxygen	Condensation point	90.197	-182.953	0.001
Methane	Triple point	90.694	-182.456	0.001
Xenon	Triple point	161.405	-111.745	0.001
Carbon dioxide	Triple point	216.592	-56.558	0.001
Mercury	Freezing point	234.3210	-38.8290	0.0005
Water	Ice point	273.15	0	
Gallium	Triple point	302.9166	29.7666	0.0001
Water	Boiling point	373.124	99.974	0.001
Indium	Triple point	429.7436	156.5936	0.0002
Bismuth	Freezing point	544.552	271.402	0.001
Cadmium	Freezing point	594.219	321.069	0.001
Lead	Freezing point	600.612	327.462	0.001
Antimony	Freezing point	903.778	630.628	0.001
Copper/71.9% silver	Eutectic melting point	1052.78	779.63	0.05
Palladium	Freezing point	1828.0	1554.8	0.1
Platinum	Freezing point	2041.3	1768.2	0.4
Rhodium	Freezing point	2236	1963	3
Iridium	Freezing point	2719	2446	6
Molybdenum	Melting point	2895	2622	4
Tungsten	Melting point	3687	3414	7
<i>Second quality points</i>				
Hydrogen	Triple point (normal $\text{H}_2$ )	13.952	-259.198	0.002
Hydrogen	Boiling point (normal $\text{H}_2$ )	20.388	-252.762	0.002
Oxygen	$\alpha$ - $\beta$ transition	23.868	-249.282	0.005
Nitrogen	$\alpha$ - $\beta$ transition	35.614	-237.536	0.006
Oxygen	$\beta$ - $\gamma$ transition	43.796	-229.354	0.001
Krypton	Triple point	115.775	-157.375	0.001
Carbon dioxide	Sublimation point	194.686	-78.464	0.003



Substance	Type of Transition	$T_{90}/\text{K}$	$t_{90}/^{\circ}\text{C}$	Uncert.
Sulfur hexafluoride	Triple point	223.554	-49.596	0.005
Gallium/20% indium	Eutectic melting point	288.800	15.650	0.001
Gallium/8% tin	Eutectic melting point	293.626	20.476	0.002
Diphenyl ether	Triple point	300.014	26.864	0.001
Ethylene carbonate	Triple point	309.465	36.315	0.001
Succinonitrile	Triple point	331.215	58.065	0.002
Sodium	Freezing point	370.944	97.794	0.005
Benzoic acid	Triple point	395.486	122.336	0.002
Benzoic acid	Freezing point	395.502	122.352	0.007
Mercury	Boiling point	629.769	356.619	0.004
Sulfur	Boiling point	717.764	444.614	0.002
Copper/66.9% aluminum	Eutectic melting point	840.957	567.807	0.010
Silver/30% aluminum	Eutectic melting point	840.957	567.807	0.002
Sodium chloride	Freezing point	1075.168	802.018	0.011
Sodium	Boiling point	1156.090	882.940	0.005
Nickel	Freezing point	1728	1455	1
Cobalt	Freezing point	1768	1495	3
Iron	Freezing point	1811	1538	3
Titanium	Melting point	1943	1670	2
Zirconium	Melting point	2127	1854	8
Aluminum oxide	Melting point	2326	2053	2
Ruthenium	Melting point	2606	2333	10

## DENSITY OF SULFURIC ACID

This table gives the density of aqueous sulfuric acid solutions as a function of concentration (in mass percent of H<sub>2</sub>SO<sub>4</sub>) and temperature.

Mass %	Density in g/mL										
	0°C	10°C	15°C	20°C	25°C	30°C	40°C	50°C	60°C	80°C	100°C
1	1.0074	1.0068	1.0060	1.0051	1.0038	1.0022	0.9986	0.9944	0.9895	0.9779	0.9645
2	1.0147	1.0138	1.0129	1.0118	1.0104	1.0087	1.0050	1.0006	0.9956	0.9839	0.9705
3	1.0219	1.0206	1.0197	1.0184	1.0169	1.0152	1.0113	1.0067	1.0017	0.9900	0.9766
4	1.0291	1.0275	1.0264	1.0250	1.0234	1.0216	1.0176	1.0129	1.0078	0.9961	0.9827
5	1.0364	1.0344	1.0332	1.0317	1.0300	1.0281	1.0240	1.0192	1.0140	1.0022	0.9888
6	1.0437	1.0414	1.0400	1.0385	1.0367	1.0347	1.0305	1.0256	1.0203	1.0084	0.9950
7	1.0511	1.0485	1.0469	1.0453	1.0434	1.0414	1.0371	1.0321	1.0266	1.0146	1.0013
8	1.0585	1.0556	1.0539	1.0522	1.0502	1.0481	1.0437	1.0386	1.0330	1.0209	1.0076
9	1.0660	1.0628	1.0610	1.0591	1.0571	1.0549	1.0503	1.0451	1.0395	1.0273	1.0140
10	1.0735	1.0700	1.0681	1.0661	1.0640	1.0617	1.0570	1.0517	1.0460	1.0338	1.0204
12	1.0886	1.0846	1.0825	1.0802	1.0780	1.0756	1.0705	1.0651	1.0593	1.0469	1.0335
14	1.1039	1.0994	1.0971	1.0947	1.0922	1.0897	1.0844	1.0788	1.0729	1.0603	1.0469
16	1.1194	1.1145	1.1120	1.1094	1.1067	1.1040	1.0985	1.0927	1.0868	1.0740	1.0605
18	1.1351	1.1298	1.1271	1.1243	1.1215	1.1187	1.1129	1.1070	1.1009	1.0879	1.0744
20	1.1510	1.1453	1.1424	1.1394	1.1365	1.1335	1.1275	1.1215	1.1153	1.1021	1.0885
22	1.1670	1.1609	1.1579	1.1548	1.1517	1.1486	1.1424	1.1362	1.1299	1.1166	1.1029
24	1.1832	1.1768	1.1736	1.1704	1.1672	1.1640	1.1576	1.1512	1.1448	1.1313	1.1176
26	1.1996	1.1929	1.1896	1.1862	1.1829	1.1796	1.1730	1.1665	1.1599	1.1463	1.1325
28	1.2160	1.2091	1.2057	1.2023	1.1989	1.1955	1.1887	1.1820	1.1753	1.1616	1.1476
30	1.2326	1.2255	1.2220	1.2185	1.2150	1.2115	1.2046	1.1977	1.1909	1.1771	1.1630
32	1.2493	1.2421	1.2385	1.2349	1.2314	1.2278	1.2207	1.2137	1.2068	1.1928	1.1787
34	1.2661	1.2588	1.2552	1.2515	1.2479	1.2443	1.2371	1.2300	1.2229	1.2088	1.1946
36	1.2831	1.2757	1.2720	1.2684	1.2647	1.2610	1.2538	1.2466	1.2394	1.2251	1.2109
38	1.3004	1.2929	1.2891	1.2855	1.2818	1.2780	1.2707	1.2635	1.2561	1.2418	1.2276
40	1.3179	1.3103	1.3065	1.3028	1.2991	1.2953	1.2880	1.2806	1.2732	1.2589	1.2446
42	1.3357	1.3280	1.3242	1.3205	1.3167	1.3129	1.3055	1.2981	1.2907	1.2762	1.2619
44	1.3538	1.3461	1.3423	1.3384	1.3346	1.3308	1.3234	1.3160	1.3086	1.2939	1.2796
46	1.3724	1.3646	1.3608	1.3569	1.3530	1.3492	1.3417	1.3343	1.3269	1.3120	1.2976
48	1.3915	1.3835	1.3797	1.3758	1.3719	1.3680	1.3604	1.3528	1.3455	1.3305	1.3159
50	1.4110	1.4029	1.3990	1.3951	1.3911	1.3872	1.3795	1.3719	1.3644	1.3494	1.3348
52	1.4310	1.4228	1.4188	1.4148	1.4109	1.4069	1.3991	1.3914	1.3837	1.3687	1.3540
54	1.4515	1.4431	1.4391	1.4350	1.4310	1.4270	1.4191	1.4113	1.4036	1.3884	1.3735
56	1.4724	1.4640	1.4598	1.4557	1.4516	1.4475	1.4396	1.4317	1.4239	1.4085	1.3934
58	1.4937	1.4852	1.4809	1.4768	1.4726	1.4685	1.4604	1.4524	1.4446	1.4290	1.4137
60	1.5154	1.5067	1.5024	1.4983	1.4940	1.4898	1.4816	1.4735	1.4656	1.4497	1.4344
62	1.5375	1.5287	1.5243	1.5200	1.5157	1.5115	1.5031	1.4950	1.4869	1.4708	1.4554
64	1.5600	1.5510	1.5465	1.5421	1.5378	1.5335	1.5250	1.5167	1.5086	1.4923	1.4766
66	1.5828	1.5736	1.5691	1.5646	1.5602	1.5558	1.5472	1.5388	1.5305	1.5140	1.4981
68	1.6059	1.5965	1.5920	1.5874	1.5829	1.5785	1.5697	1.5611	1.5528	1.5359	1.5198
70	1.6293	1.6198	1.6151	1.6105	1.6059	1.6014	1.5925	1.5838	1.5753	1.5582	1.5417
72	1.6529	1.6433	1.6385	1.6338	1.6292	1.6246	1.6155	1.6067	1.5981	1.5806	1.5637
74	1.6768	1.6670	1.6622	1.6574	1.6526	1.6480	1.6387	1.6297	1.6209	1.6031	1.5857
76	1.7008	1.6908	1.6858	1.6810	1.6761	1.6713	1.6619	1.6526	1.6435	1.6252	1.6074
78	1.7247	1.7144	1.7093	1.7043	1.6994	1.6944	1.6847	1.6751	1.6657	1.6469	1.6286
80	1.7482	1.7376	1.7323	1.7272	1.7221	1.7170	1.7069	1.6971	1.6873	1.6680	1.6493
82	1.7709	1.7599	1.7544	1.7491	1.7437	1.7385	1.7281	1.7180	1.7080	1.6882	1.6692
84	1.7916	1.7804	1.7748	1.7693	1.7639	1.7585	1.7479	1.7375	1.7274	1.7072	1.6878
86	1.8095	1.7983	1.7927	1.7872	1.7818	1.7763	1.7657	1.7552	1.7449	1.7245	1.7050
88	1.8243	1.8132	1.8077	1.8022	1.7968	1.7914	1.7809	1.7705	1.7602	1.7397	1.7202
90	1.8361	1.8252	1.8198	1.8144	1.8091	1.8038	1.7933	1.7829	1.7729	1.7525	1.7331
91	1.8410	1.8302	1.8248	1.8195	1.8142	1.8090	1.7986	1.7883	1.7783	1.7581	1.7388
92	1.8453	1.8346	1.8293	1.8240	1.8188	1.8136	1.8033	1.7932	1.7832	1.7633	1.7439
93	1.8490	1.8384	1.8331	1.8279	1.8227	1.8176	1.8074	1.7974	1.7876	1.7681	1.7485
94	1.8520	1.8415	1.8363	1.8312	1.8260	1.8210	1.8109	1.8011	1.7914		
95	1.8544	1.8439	1.8388	1.8337	1.8286	1.8236	1.8137	1.8040	1.7944		
96	1.8560	1.8457	1.8406	1.8355	1.8305	1.8255	1.8157	1.8060	1.7965		
97	1.8569	1.8466	1.8414	1.8364	1.8314	1.8264	1.8166	1.8071	1.7977		
98	1.8567	1.8463	1.8411	1.8361	1.8310	1.8261	1.8163	1.8068	1.7976		
99	1.8551	1.8445	1.8393	1.8342	1.8292	1.8242	1.8145	1.8050	1.7958		
100	1.8517	1.8409	1.8357	1.8305	1.8255	1.8205	1.8107	1.8013	1.7922		

# RELATIVE SENSITIVITY OF BAYARD-ALPERT IONIZATION GAUGES TO VARIOUS GASES

Paul Redhead

The ion current  $I_+$  in a hot-cathode ionization gauge is given by  $I_+ = KI_eP$ . The gauge constant is  $K = (I_+/I_e)(1/P)$ , where  $I_e$  is the electron current, and  $P$  the pressure. The sensitivity is given by  $S = KI_e = I_+/P$ . The constant  $K$  is independent of pressure below about  $10^{-3}$  Pa.

Relative sensitivities for different Bayard-Alpert ionization gauges may differ by as much as  $\pm 15\%$  as a result of differences in applied voltages, electron current, and electrode structure. The table below presents the average of the measurements of 12 experimenters on Bayard-Alpert ionization gauges in various gases. The sensitivity relative to nitrogen is tabulated.

Gas		Relative sensitivity $S/S(N_2)$
Helium	He	0.18
Neon	Ne	0.31
Argon	Ar	1.4
Krypton	Kr	1.9
Xenon	Xe	2.7
Nitrogen	$N_2$	1.00
Hydrogen	$H_2$	0.43
Oxygen	$O_2$	0.96
Carbon monoxide	CO	1.0
Carbon dioxide	$CO_2$	1.4
Water	$H_2O$	0.93
Sulfur hexafluoride	$SF_6$	2.3
Mercury	Hg	3.5
Methane	$CH_4$	1.6
Ethane	$C_2H_6$	2.6
Propane	$C_3H_8$	3.5
Butane	$C_4H_{10}$	4.3
Ethene	$C_2H_4$	1.3
Propene	$C_3H_6$	1.8
Acetylene	$C_2H_2$	0.61
Allene	$C_3H_4$	1.3
1-Propyne (Methyl acetylene)	$C_3H_4$	1.4
Benzene	$C_6H_6$	3.8

## References

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# HANDLING AND DISPOSAL OF CHEMICALS IN LABORATORIES

Robert Joyce and Blaine C. McKusick

The following material has been extracted from two books prepared under the auspices of the Committee on Hazardous Substances in the Laboratory of the National Academy of Sciences – National Research Council. Readers are referred to these books for full details:

*Prudent Practices for Handling Hazardous Chemicals in Laboratories*, National Academy Press, Washington, 1981.

*Prudent Practices for Disposal of Chemicals from Laboratories*, National Academy Press, Washington, 1983.

The permission of the National Academy Press to use these extracts is gratefully acknowledged.

## INCOMPATIBLE CHEMICALS

The term “incompatible chemicals” refers to chemicals that can react with each other

- Violently
- With evolution of substantial heat
- To produce flammable products
- To produce toxic products

Good laboratory safety practice requires that incompatible chemicals be stored, transported, and disposed of in ways that will prevent their coming together in the event of an accident. Tables 1 and 2 give some basic guidelines for the safe handling of acids, bases, reactive metals, and other chemicals. Neither of these tables is exhaustive, and additional information on incompatible chemicals can be found in the following references.

1. Urben, P. G., Ed., *Bretherick's Handbook of Reactive Chemical Hazards*, 5th ed., Butterworth-Heinemann, Oxford, 1995.
2. Luxon, S. G., Ed., *Hazards in the Chemical Laboratory*, 5th ed., Royal Society of Chemistry, Cambridge, 1992.
3. *Fire Protection Guide to Hazardous Materials*, 11th ed., National Fire Protection Association, Quincy, MA, 1994.

TABLE 1. General Classes of Incompatible Chemicals

A	B
Acids	Bases, reactive metals
Oxidizing agents <sup>a</sup>	Reducing agents <sup>a</sup>
Chlorates	Ammonia, anhydrous and aqueous
Chromates	Carbon
Chromium trioxide	Metals
Dichromates	Metal hydrides
Halogens	Nitrites
Halogenating agents	Organic compounds
Hydrogen peroxide	Phosphorus
Nitric acid	Silicon
Nitrates	Sulfur
Perchlorates	
Peroxides	
Permanganates	
Persulfates	

<sup>a</sup> The examples of oxidizing and reducing agents are illustrative of common laboratory chemicals; they are not intended to be exhaustive.

TABLE 2. Examples of Incompatible Chemicals

Chemical	Is incompatible with
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury (in manometers, for example), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids

Chemical	Is incompatible with
Bromine	See Chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Everything
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitro-methane, combustible materials
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing agents

## EXPLOSION HAZARDS

Table 3 lists some common classes of laboratory chemicals that have potential for producing a violent explosion when subjected to shock or friction. These chemicals should never be disposed of as such, but should be handled by procedures given in *Prudent Practices for Disposal of Chemicals from Laboratories*, National Academy Press, 1983, chapters 6 and 7. Additional information on these, as well as on some less common classes of explosives, can be found in L. Bretherick, *Handbook of Reactive Chemical Hazards*, 3rd ed., Butterworths, London–Boston, 1985.

Table 4 lists some illustrative combinations of common laboratory reagents that can produce explosions when they are brought together or that form reaction products that can explode without any apparent external initiating action. This list is not exhaustive, and additional information on potentially explosive reagent combinations can be found in *Manual of Hazardous Chemical Reactions, A Compilation of Chemical Reactions Reported to be Potentially Hazardous*, National Fire Protection Association, NFPA 491M, 1975, NFPA, 470 Atlantic Avenue, Boston, MA 02210.

## WATER-REACTIVE CHEMICALS

Table 5 lists some common laboratory chemicals that react violently with water and that should always be stored and handled so that they do not come into contact with liquid water or water vapor.

Procedures for decomposing laboratory quantities are given in *Prudent Practices for Disposal of Chemicals from Laboratories*, chapter 6; the pertinent section of that chapter is given in parentheses.

## PYROPHORIC CHEMICALS

Many members of the classes of readily oxidized, common laboratory chemicals listed in Table 6 ignite spontaneously in air. A more extensive list can be found in L. Bretherick, *Handbook of Reactive Chemical Hazards*, 3rd ed., Butterworths, London–Boston, 1985. Pyrophoric chemicals should be stored in tightly closed containers under an inert atmosphere (or, for some, an inert liquid),

and all transfers and manipulations of them must be carried out under an inert atmosphere or liquid. Suggested procedures for decomposing them are given in *Prudent Practices for Disposal of Chemicals from Laboratories*, chapter 6; the pertinent section of that chapter is given in parentheses.

## TABLE 3. Shock-Sensitive Compounds

Acetylenic compounds, especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)
Acyl nitrates
Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine
Alkyl and acyl nitrites
Alkyl perchlorates
Ammine metal oxosalts: metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group
Azides, including metal, nonmetal, and organic azides
Chlorite salts of metals, such as $\text{AgClO}_2$ and $\text{Hg}(\text{ClO}_2)_2$
Diazo compounds such as $\text{CH}_2\text{N}_2$
Diazonium salts, when dry
Fulminates (silver fulminate, $\text{AgCNO}$ , can form in the reaction mixture from the Tollens' test for aldehydes if it is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test has been completed)
Hydrogen peroxide becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals
<i>N</i> -Halogen compounds such as difluoroamino compounds and halogen azides
<i>N</i> -Nitro compounds such as <i>N</i> -nitromethylamine, nitrourea, nitroguanidine, and nitric amide
Oxo salts of nitrogenous bases: perchlorates, dichromates, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.
Perchlorate salts. Most metal, nonmetal, and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials
Peroxides and hydroperoxides, organic (see Chapter 6, Section II.P)
Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents (see Chapter 6 and Appendix I)
Peroxides, transition-metal salts
Picrates, especially salts of transition and heavy metals, such as Ni, Pb, Hg, Cu, and Zn; picric acid is explosive but is less sensitive to shock or friction than its metal salts and is relatively safe as a water-wet paste (see Chapter 7)
Polynitroalkyl compounds such as tetranitromethane and dinitroacetoneitrile
Polynitroaromatic compounds, especially polynitro hydrocarbons, phenols, and amines

**TABLE 4. Potentially Explosive Combinations of Some Common Reagents**

Acetone + chloroform in the presence of base  
 Acetylene + copper, silver, mercury, or their salts  
 Ammonia (including aqueous solutions) +  $\text{Cl}_2$ ,  $\text{Br}_2$ , or  $\text{I}_2$   
 Carbon disulfide + sodium azide  
 Chlorine + an alcohol  
 Chloroform or carbon tetrachloride + powdered Al or Mg  
 Decolorizing carbon + an oxidizing agent  
 Diethyl ether + chlorine (including a chlorine atmosphere)  
 Dimethyl sulfoxide + an acyl halide,  $\text{SOCl}_2$  or  $\text{POCl}_3$   
 Dimethyl sulfoxide +  $\text{CrO}_3$   
 Ethanol + calcium hypochlorite  
 Ethanol + silver nitrate  
 Nitric acid + acetic anhydride or acetic acid  
 Picric acid + a heavy-metal salt, such as of Pb, Hg, or Ag  
 Silver oxide + ammonia + ethanol  
 Sodium + a chlorinated hydrocarbon  
 Sodium hypochlorite + an amine

**TABLE 5. Water-Reactive Chemicals**

Alkali metals (III.D)  
 Alkali metal hydrides (III.C.2)  
 Alkali metal amides (III.C.7)  
 Metal alkyls, such as lithium alkyls and aluminum alkyls (IV.A)  
 Grignard reagents (IV.A)  
 Halides of nonmetals, such as  $\text{BCl}_3$ ,  $\text{BF}_3$ ,  $\text{PCl}_3$ ,  $\text{PCl}_5$ ,  $\text{SiCl}_4$ ,  $\text{S}_2\text{Cl}_2$  (III.F)  
 Inorganic acid halides, such as  $\text{POCl}_3$ ,  $\text{SOCl}_2$ ,  $\text{SO}_2\text{Cl}_2$  (III.F)  
 Anhydrous metal halides, such as  $\text{AlCl}_3$ ,  $\text{TiCl}_4$ ,  $\text{ZrCl}_4$ ,  $\text{SnCl}_4$  (III.E)  
 Phosphorus pentoxide (III.I)  
 Calcium carbide (IV.E)  
 Organic acid halides and anhydrides of low molecular weight (II.J)

**TABLE 6. Classes of Pyrophoric Chemicals**

Grignard reagents,  $\text{RMgX}$  (IV.A)  
 Metal alkyls and aryls, such as  $\text{RLi}$ ,  $\text{RNa}$ ,  $\text{R}_3\text{Al}$ ,  $\text{R}_2\text{Zn}$  (IV.A)  
 Metal carbonyls, such as  $\text{Ni}(\text{CO})_4$ ,  $\text{Fe}(\text{CO})_5$ ,  $\text{Co}_2(\text{CO})_8$  (IV.B)  
 Alkali metals such as Na, K (III.D.1)  
 Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr (III.D.2)  
 Metal hydrides, such as  $\text{NaH}$ ,  $\text{LiAlH}_4$  (IV.C.2)  
 Nonmetal hydrides, such as  $\text{B}_2\text{H}_6$  and other boranes,  $\text{PH}_3$ ,  $\text{AsH}_3$  (III.G)  
 Nonmetal alkyls, such as  $\text{R}_3\text{B}$ ,  $\text{R}_3\text{P}$ ,  $\text{R}_3\text{As}$  (IV.C)  
 Phosphorus (white) (III.H)

## HAZARDS FROM PEROXIDE FORMATION

Many common laboratory chemicals can form peroxides when allowed access to air over a period of time. A single opening of a container to remove some of the contents can introduce enough air for peroxide formation to occur. Some types of compounds form peroxides that are treacherously and violently explosive in concentrated solution or as solids. Accordingly, peroxide-containing liquids should never be evaporated near to or to dryness. Peroxide formation can also occur in many polymerizable unsaturated compounds, and these peroxides can initiate a runaway, sometimes explosive, polymerization reaction. Procedures for testing for peroxides and for removing small amounts from laboratory chemicals are given in *Prudent Practices for Disposal of Chemicals from Laboratories*, chapter 6, Section II.P.

Table 7 provides a list of structural characteristics in organic compounds that can peroxidize. These structures are listed in approximate order of decreasing hazard. Reports of serious incidents involving the last five structural types are extremely rare, but these structures are listed because laboratory workers should be aware that they can form peroxides that can influence the course of experiments in which they are used.

Table 8 gives examples of common laboratory chemicals that are prone to form peroxides on exposure to air. The lists are not exhaustive, and analogous organic compounds that have any of the structural features given in Table 7 should be tested for peroxides before being used as solvents or reagents, or before being distilled. The recommended retention times begin with the date of synthesis or of opening the original container.

## DISPOSAL OF TOXIC CHEMICALS

It is often desirable to precipitate toxic cations or hazardous anions from solution to facilitate recovery or disposal. Table 9 lists precipitants for many common cations, and Table 10 gives precipitants for some hazardous anions. Many cations can be precipitated as sulfides by adding sodium sulfide solution (preferable to the highly toxic hydrogen sulfide) to a neutral solution of the cation (Table 11). Control of pH is important because some sulfides will redissolve in excess sulfide ion. After precipitation, excess sulfide can be destroyed by addition of hypochlorite.

Most metal cations are precipitated as hydroxides or oxides at high pH. Since many of these precipitates will redissolve in excess

base, it is often necessary to control pH. Table 12 shows the recommended pH range for precipitating many cations in their most common oxidation state. The notation "1 N" in the right-hand column indicates that the precipitate will not dissolve in 1 N sodium hydroxide (pH 14).

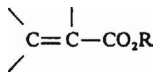
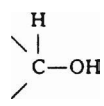
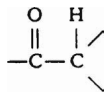

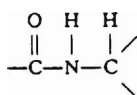
The distinctions between high and low toxicity or hazard are based on toxicological and other data, and are relative. There is no implication of a sharp distinction between high and low, or that any cations or anions are totally without hazard.

TABLE 7. Types of Chemicals That Are Prone to Form Peroxides

## A. Organic structures (in approximate order of decreasing hazard)

1.		Ethers and acetals with $\alpha$ hydrogen atoms
2.		Olefins with allylic hydrogen atoms
3.		Chloroolefins and fluoroolefins
4.		Vinyl halides, esters, and ethers
5.		Dienes
6.		Vinylacetylenes with $\alpha$ hydrogen atoms
7.		Alkylacetylenes with $\alpha$ hydrogen atoms
8.		Alkylarenes that contain tertiary hydrogen atoms
9.		Alkanes and cycloalkanes that contain tertiary hydrogen atoms



10.		Acrylates and methacrylates
11.		Secondary alcohols
12.		Ketones that contain $\alpha$ hydrogen atoms
13.		Aldehydes
14.		Ureas, amides, and lactams that have a hydrogen atom on a carbon atom attached to nitrogen

**B. Inorganic substances**

1. Alkali metals, especially potassium, rubidium, and cesium (see Chapter 6, Section III.D)
2. Metal amides (see Chapter 6, Section III.C.7)
3. Organometallic compounds with a metal atom bonded to carbon (see Chapter 6, Section IV)
4. Metal alkoxides

**TABLE 8. Common Peroxide-Forming Chemicals****LIST A****Severe Peroxide Hazard on Storage with Exposure to Air***Discard within 3 months*

- Diisopropyl ether (isopropyl ether)
- Divinylacetylene (DVA)<sup>a</sup>
- Potassium metal
- Potassium amide
- Sodium amide (sodamide)
- Vinylidene chloride (1,1-dichloroethylene)<sup>a</sup>

**LIST B****Peroxide Hazard on Concentration; Do Not Distill or Evaporate Without First Testing for the Presence of Peroxides***Discard or test for peroxides after 6 months*

- Acetaldehyde diethyl acetal (acetal)
- Cumene (isopropylbenzene)
- Cyclohexene
- Cyclopentene
- Decalin (decahydronaphthalene)
- Diacetylene
- Dicyclopentadiene
- Diethyl ether (ether)
- Diethylene glycol dimethyl ether (diglyme)
- Dioxane
- Ethylene glycol dimethyl ether (glyme)
- Ethylene glycol ether acetates
- Ethylene glycol monoethers (cellosolves)
- Furan
- Methylacetylene
- Methylcyclopentane
- Methyl isobutyl ketone
- Tetrahydrofuran (THF)
- Tetralin (tetrahydronaphthalene)
- Vinyl ethers<sup>a</sup>

**LIST C****Hazard of Rapid Polymerization Initiated by Internally Formed Peroxides<sup>a</sup>****a. Normal Liquids; discard or test for peroxides after 6 months<sup>b</sup>**

- Chloroprene (2-chloro-1,3-butadiene)<sup>c</sup>
- Styrene
- Vinyl acetate
- Vinylpyridine

**b. Normal Gases; discard after 12 months<sup>d</sup>**

- Butadiene<sup>c</sup>
- Tetrafluoroethylene (TFE)<sup>c</sup>
- Vinylacetylene (MVA)<sup>c</sup>
- Vinyl chloride

<sup>a</sup> Polymerizable monomers should be stored with a polymerization inhibitor from which the monomer can be separated by distillation just before use.<sup>b</sup> Although common acrylic monomers such as acrylonitrile, acrylic acid, ethyl acrylate, and methyl methacrylate can form peroxides, they have not been reported to develop hazardous levels in normal use and storage.<sup>c</sup> The hazard from peroxides in these compounds is substantially greater when they are stored in the liquid phase, and if so stored without an inhibitor they should be considered as in LIST A.<sup>d</sup> Although air will not enter a gas cylinder in which gases are stored under pressure, these gases are sometimes transferred from the original cylinder to another in the laboratory, and it is difficult to be sure that there is no residual air in the receiving cylinder. An inhibitor should be put into any such secondary cylinder before one of these gases is transferred into it; the supplier can suggest inhibitors to be used. The hazard posed by these gases is much greater if there is a liquid phase in such a secondary container, and even inhibited gases that have been put into a secondary container under conditions that create a liquid phase should be discarded within 12 months.

Note: Laboratory workers should label all containers of peroxidizable solvents or reagents with one of the following:

[LIST A]

Date	Peroxidizable compound	
	Received	Opened
	Discard 3 months after opening	

[LISTS B AND C]

Date	Peroxidizable compound	
	Received	Opened
	Discard or test for peroxides 6 months after opening	

TABLE 9. Relative Toxicity of Cations

High toxic hazard	Precipitant <sup>a</sup>	Low toxic hazard	Precipitant <sup>a</sup>
Antimony	OH <sup>-</sup> , S <sup>2-</sup>	Aluminum	OH <sup>-</sup>
Arsenic	S <sup>2-</sup>	Bismuth	OH <sup>-</sup> , S <sup>2-</sup>
Barium	SO <sub>4</sub> <sup>2-</sup> , CO <sub>3</sub> <sup>2-</sup>	Calcium	SO <sub>4</sub> <sup>2-</sup> , CO <sub>3</sub> <sup>2-</sup>
Beryllium	OH <sup>-</sup>	Cerium	OH <sup>-</sup>
Cadmium	OH <sup>-</sup> , S <sup>2-</sup>	Cesium	
Chromium (III) <sup>b</sup>	OH <sup>-</sup>	Copper <sup>c</sup>	OH <sup>-</sup> , S <sup>2-</sup>
Cobalt (II) <sup>b</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Gold	OH <sup>-</sup> , S <sup>2-</sup>
Gallium	OH <sup>-</sup>	Iron <sup>c</sup>	OH <sup>-</sup> , S <sup>2-</sup>
Germanium	OH <sup>-</sup> , S <sup>2-</sup>	Lanthanides	OH <sup>-</sup>
Hafnium	OH <sup>-</sup>	Lithium	
Indium	OH <sup>-</sup> , S <sup>2-</sup>	Magnesium	OH <sup>-</sup>
Iridium	OH <sup>-</sup> , S <sup>2-</sup>	Molybdenum (VI) <sup>b,d</sup>	
Lead	OH <sup>-</sup> , S <sup>2-</sup>	Niobium (V)	OH <sup>-</sup>
Manganese (II) <sup>b</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Palladium	OH <sup>-</sup> , S <sup>2-</sup>
Mercury	OH <sup>-</sup> , S <sup>2-</sup>	Potassium	
Nickel	OH <sup>-</sup> , S <sup>2-</sup>	Rubidium	
Osmium (IV) <sup>b,e</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Scandium	OH <sup>-</sup>
Platinum (II) <sup>b</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Sodium	
Rhenium (VII) <sup>b</sup>	S <sup>2-</sup>	Strontium	SO <sub>4</sub> <sup>2-</sup> , CO <sub>3</sub> <sup>2-</sup>
Rhodium (III) <sup>b</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Tantalum	OH <sup>-</sup>
Ruthenium (III) <sup>b</sup>	OH <sup>-</sup> , S <sup>2-</sup>	Tin	OH <sup>-</sup> , S <sup>2-</sup>
Selenium	S <sup>2-</sup>	Titanium	OH <sup>-</sup>
Silver	Cl <sup>-</sup> , OH <sup>-</sup> , S <sup>2-</sup>	Yttrium	OH <sup>-</sup>
Tellurium	S <sup>2-</sup>	Zinc <sup>c</sup>	OH <sup>-</sup> , S <sup>2-</sup>
Thallium	OH <sup>-</sup> , S <sup>2-</sup>	Zirconium	OH <sup>-</sup>
Tungsten (VI) <sup>b,d</sup>			
Vanadium	OH <sup>-</sup> , S <sup>2-</sup>		

<sup>a</sup> Precipitants are listed in order of preference:  
 OH<sup>-</sup> = base (sodium hydroxide or sodium carbonate)  
 S<sup>2-</sup> = sulfide  
 Cl<sup>-</sup> = chloride  
 SO<sub>4</sub><sup>2-</sup> = sulfate  
 CO<sub>3</sub><sup>2-</sup> = carbonate

<sup>b</sup> The precipitant is for the indicated valence state.

<sup>c</sup> Maximum tolerance levels have been set for these low-toxicity ions by the U.S. Public Health Service, and large amounts should not be put into public sewer systems. The small amounts typically used in laboratories will not normally affect water supplies.

<sup>d</sup> These ions are best precipitated as calcium molybdate or calcium tungstate.

<sup>e</sup> CAUTION: OsO<sub>4</sub>, a volatile, extremely poisonous substance, is formed from almost any osmium compound under acid conditions in the presence of air.

TABLE 10. Relative Hazard of Anions

High-hazard anions			Low-hazard anions
Ion	Hazard type <sup>a</sup>	Precipitant	
Aluminum hydride, $\text{AlH}_4^-$	F	—	Bisulfite, $\text{HSO}_3^-$
Amide, $\text{NH}_2^-$	F,E <sup>b</sup>	—	Borate, $\text{BO}_3^{3-}$ , $\text{B}_4\text{O}_7^{2-}$
Arsenate, $\text{AsO}_3^-$ , $\text{AsO}_4^{3-}$	T	$\text{Cu}^{2+}$ , $\text{Fe}^{2+}$	Bromide, $\text{Br}^-$
Arsenite, $\text{AsO}_2^-$ , $\text{AsO}_3^{3-}$	T	$\text{Pb}^{2+}$	Carbonate, $\text{CO}_3^{2-}$
Azide, $\text{N}_3^-$	E, T	—	Chloride, $\text{Cl}^-$
Borohydride, $\text{BH}_4^-$	F	—	Cyanate, $\text{OCN}^-$
Bromate, $\text{BrO}_3^-$	O, E	—	Hydroxide, $\text{OH}^-$
Chlorate, $\text{ClO}_3^-$	O, E	—	Iodide, $\text{I}^-$
Chromate, $\text{CrO}_4^{2-}$ , $\text{Cr}_2\text{O}_7^{2-}$	T, O	<sup>c</sup>	Oxide, $\text{O}^{2-}$
Cyanide, $\text{CN}^-$	T	—	Phosphate, $\text{PO}_4^{3-}$
Ferricyanide, $\text{Fe}(\text{CN})_6^{3-}$	T	$\text{Fe}^{2+}$	Sulfate, $\text{SO}_4^{2-}$
Ferrocyanide, $\text{Fe}(\text{CN})_6^{4-}$	T	$\text{Fe}^{3+}$	Sulfite, $\text{SO}_3^{2-}$
Fluoride, $\text{F}^-$	T	$\text{Ca}^{2+}$	Thiocyanate, $\text{SCN}^-$
Hydride, $\text{H}^-$	F	—	
Hydroperoxide, $\text{O}_2\text{H}^-$	O, E	—	
Hydrosulfide, $\text{SH}^-$	T	—	
Hypochlorite, $\text{OCl}^-$	O	—	
Iodate, $\text{IO}_3^-$	O, E	—	
Nitrate, $\text{NO}_3^-$	O	—	
Nitrite, $\text{NO}_2^-$	T, O	—	
Perchlorate, $\text{ClO}_4^-$	O, E	—	
Permanganate, $\text{MnO}_4^-$	T, O	<sup>d</sup>	
Peroxide, $\text{O}_2^{2-}$	O, E	—	
Persulfate, $\text{S}_2\text{O}_8^{2-}$	O	—	
Selenate, $\text{SeO}_4^{2-}$	T	$\text{Pb}^{2+}$	
Selenide, $\text{Se}^{2-}$	T	$\text{Cu}^{2+}$	
Sulfide, $\text{S}^{2-}$	T	<sup>e</sup>	

<sup>a</sup> Toxic, T; oxidant, O; flammable, F; explosive, E.

<sup>b</sup> Metal amides readily form explosive peroxides on exposure to air.

<sup>c</sup> Reduce and precipitate as Cr(III); see Table 9.

<sup>d</sup> Reduce and precipitate as Mn(II); see Table 9.

<sup>e</sup> See Table 11.

TABLE 11. Precipitation of Sulfides

Precipitated at pH 7	Not precipitated at low pH	Forms a soluble complex at high pH
$\text{Ag}^+$		
$\text{As}^{3+a}$		X
$\text{Au}^{+a}$		X
$\text{Bi}^{3+}$		
$\text{Cd}^{2+}$		
$\text{Co}^{2+}$	X	
$\text{Cr}^{3+a}$		
$\text{Cu}^{2+}$		
$\text{Fe}^{2+a}$	X	
$\text{Ge}^{2+}$		X
$\text{Hg}^{2+}$		X
$\text{In}^{3+}$	X	
$\text{Ir}^{4+}$		X
$\text{Mn}^{2+a}$	X	
$\text{Mo}^{3+}$		X
$\text{Ni}^{2+}$	X	
$\text{Os}^{4+}$		
$\text{Pb}^{2+}$		
$\text{Pd}^{2+a}$		
$\text{Pt}^{2+a}$		X
$\text{Re}^{4+}$		
$\text{Rh}^{2+a}$		
$\text{Ru}^{4+}$		

TABLE 11. Precipitation of Sulfides

Precipitated at pH 7	Not precipitated at low pH	Forms a soluble complex at high pH
Sb <sup>3+/4</sup>		X
Se <sup>2+</sup>		X
Sn <sup>2+</sup>		X
Te <sup>4+</sup>		X
Tl <sup>+</sup> <sup>a</sup>	X	
V <sup>4+/5</sup>		
Zn <sup>2+</sup>	X	

<sup>a</sup> Higher oxidation states of this ion are reduced by sulfide ion and precipitated as this sulfide.

TABLE 12. pH Range for Precipitation of Metal Hydroxides and Oxides

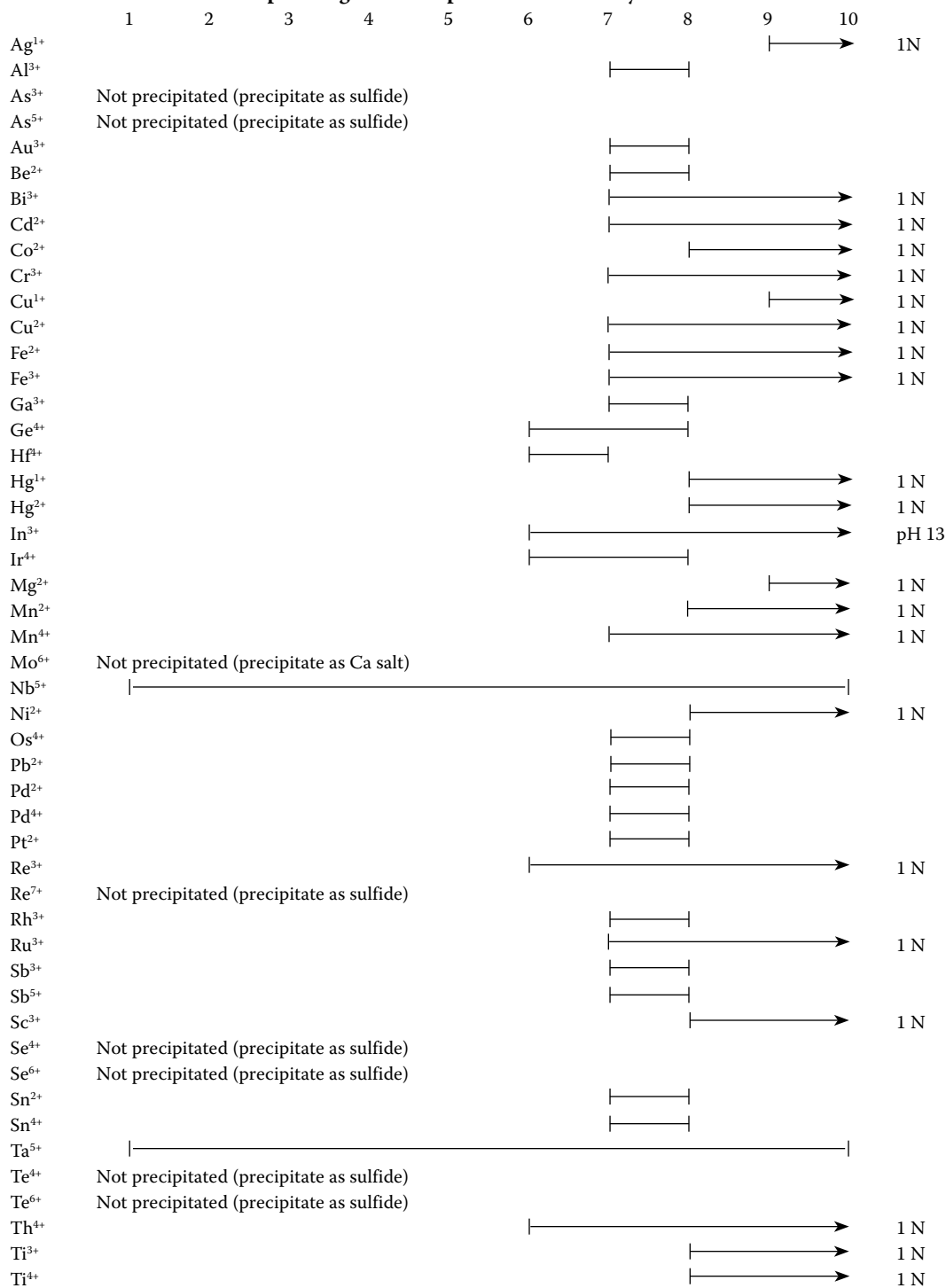


TABLE 12. pH Range for Precipitation of Metal Hydroxides and Oxides

	1	2	3	4	5	6	7	8	9	10	1 N
Tl <sup>3+</sup>									→		
V <sup>4+</sup>							—	—			
V <sup>5+</sup>							—	—			
W <sup>6+</sup>	Not precipitated (precipitate as Ca salt)										
Zn <sup>2+</sup>							—	—			
Zr <sup>4+</sup>						—	—				

### References

- L. Erdey, *Gravimetric Analysis*, Part II, Pergamon Press, New York, 1965.  
 D. T. Burns, A. Towsend, and A. H. Carter, *Inorganic Reaction Chemistry*, Vol. 2, Ellis Horwood, New York, 1981.

## FIRE HAZARDS

Flammable solvents are a common source of laboratory fires. The relative ease with which some common laboratory solvents can be ignited is indicated by the following properties.

**Flash Point** — The lowest temperature, as determined by standard tests, at which a liquid emits vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid in a test vessel. Note that many of these common chemicals have flash points below room temperature.

**Ignition Temperature** — The minimum temperature required to initiate self-sustained combustion, regardless of the heat source.

**Flammable Limits** — The lower flammable limit is the minimum concentration (percent by volume) of a vapor in air below which a

flame is not propagated when an ignition source is present. Below this concentration the mixture is too lean to burn. The upper flammable limit is the maximum concentration (percent by volume) of the vapor in air above which a flame is not propagated. Above this concentration the mixture is too rich to burn. The flammable range comprises all concentrations between these two limits. This range becomes wider with increasing temperature and in oxygen-rich atmospheres. Table 13 lists these properties for a few common laboratory chemicals.

## GLOVE MATERIALS

It is good safety practice (and mandated in some laboratories) to wear rubber gloves while handling chemicals that can cause injury when in contact with, or absorbed through, the skin. The various

common rubbers are not equally resistant to all chemicals. Table 14 provides guidelines for selecting the best, and avoiding the poorest, glove material for handling a given chemical.

## RESPIRATORS

In the event of a laboratory accident or spill, it will be necessary for someone to enter the contaminated area for cleanup. If significant quantities of a chemical are spilled, or even minor quantities of a known toxic material, it is essential to wear the correct kind of respirator equipment when entering the area. If it is not known

whether the contamination is of a chemical “immediately dangerous to life or health”, the prudent course is to assume that it is, and to use the corresponding type of respirator. Guidelines are presented in Table 15.

TABLE 13. Flash Points, Boiling Points, Ignition Temperatures, and Flammable Limits of Some Common Laboratory Chemicals

Chemical	Flash point (°C)	Boiling point (°C)	Ignition temp. (°C)	Flammable limit (percent by volume in air)	
				Lower	Upper
Acetaldehyde	-37.8	21.1	175.0	4.0	60.0
Acetone	-19.0	56.0	538.0	2.6	12.8
Benzene	-11.1	80.1	560.0	1.4	8.0
Carbon disulfide	-30.0	45.8	90.0	1.0	44.0
Cyclohexane	-18.0	80.7	260.0	1.3	8.0
Diethyl ether	-45.0	34.4	160.0	1.8	48.0
Ethanol	12.0	78.3	363.0	3.3	19.0
<i>n</i> -Heptane	-3.9	98.4	204.0	1.0	6.7
<i>n</i> -Hexane	-21.7	68.7	223.0	1.2	7.5
Isopropyl alcohol	11.7	82.2	398.9	2.0	12.0
Methanol	11.1	64.5	385.0	6.0	36.5
Methyl ethyl ketone	-6.1	79.6	515.6	1.9	11.0

TABLE 13. Flash Points, Boiling Points, Ignition Temperatures, and Flammable Limits of Some Common Laboratory Chemicals

Chemical	Flash point (°C)	Boiling point (°C)	Ignition temp. (°C)	Flammable limit (percent by volume in air)	
				Lower	Upper
Pentane	-40.0	36.1	260.0	1.4	7.8
Styrene	31.0	145.0	490.0	1.1	6.1
Toluene	4.4	110.6	530.0	1.3	7.0
<i>p</i> -Xylene	25.0	132.4	529.0	1.1	7.0

Note: For a more extensive listing, see the table "Properties of Common Solvents" in Section 15.

TABLE 14. Resistance to Chemicals of Common Glove Materials (E = Excellent, G = Good, F = Fair, P = Poor)

Chemical	Natural rubber	Neoprene	Nitrile	Vinyl
Acetaldehyde	G	G	E	G
Acetic acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	—	F
Ammonium hydroxide (sat)	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
Benzene <sup>a</sup>	P	F	G	F
Benzyl chloride <sup>a</sup>	F	P	G	P
Bromine	G	G	—	G
Butane	P	E	—	P
Butyraldehyde	P	G	—	G
Calcium hypochlorite	P	G	G	G
Carbon disulfide	P	P	G	F
Carbon tetrachloride <sup>a</sup>	P	F	G	F
Chlorine	G	G	—	G
Chloroacetone	F	E	—	P
Chloroform <sup>a</sup>	P	F	G	P
Chromic acid	P	F	F	E
Cyclohexane	F	E	—	P
Dibenzyl ether	F	G	—	P
Dibutyl phthalate	F	G	—	P
Diethanolamine	F	E	—	E
Diethyl ether	F	G	E	P
Dimethyl sulfoxide <sup>b</sup>	—	—	—	—
Ethyl acetate	F	G	G	F
Ethylene dichloride <sup>a</sup>	P	F	G	
Ethylene glycol	G	G	E	E
Ethylene trichloride <sup>a</sup>	P	P	—	P
Fluorine	G	G	—	G
Formaldehyde	G	E	E	E
Formic acid	G	E	E	E
Glycerol	G	G	E	E
Hexane	P	E	—	P
Hydrobromic acid (40%)	G	E	—	E
Hydrochloric acid (conc)	G	G	G	E
Hydrofluoric acid (30%)	G	G	G	E
Hydrogen peroxide	G	G	G	E
Iodine	G	G	—	G
Methylamine	G	G	E	E
Methyl cellosolve	F	E	—	P
Methyl chloride <sup>a</sup>	P	E	—	P
Methyl ethyl ketone	F	G	G	P
Methylene chloride <sup>a</sup>	F	F	G	F
Monoethanolamine	F	E	—	E
Morpholine	F	E	—	E
Naphthalene <sup>a</sup>	G	G	E	G
Nitric acid (conc)	P	P	P	G
Perchloric acid	F	G	F	E

**TABLE 14. Resistance to Chemicals of Common Glove Materials (E = Excellent, G = Good, F = Fair, P = Poor)**

Chemical	Natural rubber	Neoprene	Nitrile	Vinyl
Phenol	G	E	—	E
Phosphoric acid	G	E	—	E
Potassium hydroxide (sat)	G	G	G	E
Propylene dichloride <sup>a</sup>	P	F	—	P
Sodium hydroxide	G	G	G	E
Sodium hypochlorite	G	P	F	G
Sulfuric acid (conc)	G	G	F	G
Toluene <sup>a</sup>	P	F	G	F
Trichloroethylene <sup>a</sup>	P	F	G	F
Tricresyl phosphate	P	F	—	F
Triethanolamine	F	E	E	E
Trinitrotoluene	P	E	—	P

<sup>a</sup> Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic glove materials. Should swelling occur, the user should change to fresh gloves and allow the swollen gloves to dry and return to normal.

<sup>b</sup> No data on the resistance to dimethyl sulfoxide of natural rubber, neoprene, nitrile rubber, or vinyl materials are available; the manufacturer of the substance recommends the use of butyl rubber gloves.

**TABLE 15. Guide for Selection of Respirators**

Type of hazard	Type of respirator
Oxygen deficiency	Self-contained breathing apparatus Hose mask with blower Combination of air-line respirator and auxiliary self-contained air supply or air-storage receiver with alarm
Gas and vapor contaminants	Self-contained breathing apparatus
Immediately dangerous to life or health	Hose mask with blower Air-purifying full-facepiece respirator with chemical canister (gas mask) Self-rescue mouthpiece respirator (for escape only) Combination of air-line respirator and auxiliary self-contained air supply or air-storage receiver with alarm
Not immediately dangerous to life or health	Air-line respirator Hose mask with blower Air-purifying half-mask or mouthpiece respirator with chemical cartridge
Particulate Contaminants	Self-contained breathing apparatus
Immediately dangerous to life or health	Hose mask with blower Air-purifying full-facepiece respirator with appropriate filter Self-rescue mouthpiece respirator (for escape only) Combination of air-line respirator and auxiliary self-contained air supply or air-storage receiver with alarm
Not immediately dangerous to life or health	Air-purifying half-mask or mouthpiece respirator with filter pad or cartridge Air-line respirator Air-line abrasive-blasting respirator Hose mask with blower
Combination of gas, vapor, and particulate contaminants	Self-contained breathing apparatus
Immediately dangerous to life or health	Hose mask with blower Air-purifying full-facepiece respirator with chemical canister and appropriate filter (gas mask with filter) Self-rescue mouthpiece respirator (for escape only) Combination of air-line respirator and auxiliary self-contained air supply or air-storage receiver with alarm
Not immediately dangerous to life or health	Air-line respirator Hose mask without blower Air-purifying half-mask or mouthpiece respirator with chemical cartridge and appropriate filter

Source: ANSI Standard Z88.2 (1969).

## FLAMMABILITY OF CHEMICAL SUBSTANCES

This table gives properties related to the flammability of about 900 chemical substances. The properties listed are:

- $t_B$ : Normal boiling point in °C (at 101.325 kPa pressure).
- FP: Flash point, which is the minimum temperature at which the vapor pressure of a liquid is sufficient to form an ignitable mixture with air near the surface of the liquid. Flash point is not an intrinsic physical property but depends on the conditions of measurement (see Reference 1).
- Fl. Limits: Flammable limits (often called explosive limits), which specify the range of concentration of the vapor in air (in percent by volume) for which a flame can propagate. Below the lower flammable limit, the gas mixture is too lean to burn; above the upper flammable limit, the mixture is too rich. Values refer to ambient temperature and pressure and are dependent on the precise test conditions. A ? indicates that one of the limits is not known.
- IT: Ignition temperature (sometimes called autoignition temperature), which is the minimum temperature required for self-sustained combustion in the absence of an external ignition source. As in the case of flash point, the value depends on specified test conditions.

Even in cases where very careful measurements of flash point have been replicated in several laboratories, observed values can differ by 3 to 6°C (Reference 4). For more typical measurements, larger uncertainties should be assumed in both flash points and autoignition temperatures. The absence of a flash point entry in this table does not mean that the substance is nonflammable, but only that no reliable value is available.

Compounds are listed by molecular formula following the Hill convention. Substances not containing carbon are listed first, followed by those that contain carbon. To locate an organic compound by name or CAS Registry Number when the molecular formula is not known, use the table "Physical Constants of Organic Compounds" in Section 3 and its indexes to determine the molecular formula.

### References

1. *Fire Protection Guide to Hazardous Materials, 11th Edition*, National Fire Protection Association, Quincy, MA, 1994.
2. Urben, P. G., Ed., *Bretherick's Handbook of Reactive Chemical Hazards, 5th Edition*, Butterworth-Heinemann, Oxford, 1995.
3. Daubert, T. E., Danner, R. P., Sibul, H. M., and Stebbins, C. C., *Physical and Thermodynamic Properties of Pure Compounds: Data Compilation*, extant 1994 (core with 4 supplements), Taylor & Francis, Bristol, PA.
4. *Report of Investigation: Flash Point Reference Materials*, National Institute of Standards and Technology, Standard Reference Materials Program, Gaithersburg, MD, 1995.

Mol. form.	Name	$t_B$ /°C	FP/°C	Fl. limits	IT/°C
<b>Compounds not containing carbon</b>					
B <sub>2</sub> H <sub>6</sub>	Diborane	-92.4	-90	1-98%	≈40
B <sub>5</sub> H <sub>9</sub>	Pentaborane(9)	60	30	0.4-?	35
BrH <sub>3</sub> Si	Bromosilane	1.9	<0		≈20
Br <sub>3</sub> HSi	Tribromosilane	109			≈20
Cl <sub>2</sub> H <sub>2</sub> Si	Dichlorosilane	8.3		4.1-99%	36
Cl <sub>3</sub> HSi	Trichlorosilane	33	-50		104
GeH <sub>4</sub>	Germane	-88.1			≈20
Ge <sub>2</sub> H <sub>6</sub>	Digermane	29			≈50
H <sub>2</sub>	Hydrogen	-252.8		4-74%	
H <sub>2</sub> S	Hydrogen sulfide	-59.55		4-44%	260
H <sub>2</sub> S <sub>2</sub>	Hydrogen disulfide	70.7	<22		
H <sub>2</sub> Te	Hydrogen telluride	-2			-50
H <sub>3</sub> N	Ammonia	-33.33		16-25%	
H <sub>3</sub> P	Phosphine	-87.75		1.8-?	
H <sub>4</sub> N <sub>2</sub>	Hydrazine	113.55	38	5-100%	
H <sub>4</sub> P <sub>2</sub>	Diphosphine	63.5			≈20
H <sub>4</sub> Si	Silane	-111.9	-112	1.4-?	≈20
H <sub>6</sub> Si <sub>2</sub>	Disilane	-14.3	-14		≈20
H <sub>8</sub> Si <sub>3</sub>	Trisilane	52.9	<0		≈20
P	Phosphorus (white)	280.5			38
<b>Compounds containing carbon</b>					
CHN	Hydrogen cyanide	26	-18	6-40%	538
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	40		13-23%	556
CH <sub>2</sub> N <sub>2</sub>	Cyanamide		141		
CH <sub>2</sub> O	Formaldehyde	-19.1	85	7.0-73%	424
(CH <sub>2</sub> O) <sub>x</sub>	Paraformaldehyde		70	7.0-73%	300
CH <sub>2</sub> O <sub>2</sub>	Formic acid	101	50	18-57%	434
CH <sub>3</sub> Br	Bromomethane	3.5		10-16%	537
CH <sub>3</sub> Cl	Chloromethane	-24.0		8.1-17.4%	632



Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
CH <sub>3</sub> Cl <sub>3</sub> Si	Methyltrichlorosilane	65.6	-9	7.6->20%	>404
CH <sub>3</sub> NO	Formamide	220	154		
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	101.1	35	7.3-?	418
CH <sub>4</sub>	Methane	-161.5		5.0-15.0%	537
CH <sub>4</sub> Cl <sub>2</sub> Si	Dichloromethylsilane	41	-9	6.0-55%	316
CH <sub>4</sub> O	Methanol	64.6	11	6.0-36%	464
CH <sub>4</sub> S	Methanethiol	5.9	-18	3.9-21.8%	
CH <sub>5</sub> N	Methylamine	-6.3	0	4.9-20.7%	430
CH <sub>6</sub> N <sub>2</sub>	Methylhydrazine	87.5	-8	2.5-92%	194
CO	Carbon monoxide	-191.5		12.5-74%	609
COS	Carbon oxysulfide	-50		12-29%	
CS <sub>2</sub>	Carbon disulfide	46	-30	1.3-50.0%	90
C <sub>2</sub> ClF <sub>3</sub>	Chlorotrifluoroethylene	-27.8		8.4-16.0%	
C <sub>2</sub> F <sub>4</sub>	Tetrafluoroethylene	-75.9		10.0-50.0%	200
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	87.2		8-10.5%	420
C <sub>2</sub> HCl <sub>3</sub> O	Dichloroacetyl chloride	108	66		
C <sub>2</sub> H <sub>2</sub>	Acetylene	-84.7		2.5-100%	305
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethylene	31.6	-28	6.5-15.5%	570
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene	60.1	6	3-15%	460
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	48.7	2	6-13%	460
C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	1,1-Difluoroethylene	-85.7		5.5-21.3%	
C <sub>2</sub> H <sub>3</sub> Br	Bromoethylene	15.8		9-15%	530
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	-13.3	-78	3.6-33.0%	472
C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	1-Chloro-1,1-difluoroethane	-9.7		6-18%	632
C <sub>2</sub> H <sub>3</sub> ClO	Acetyl chloride	50.7	4		390
C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	1,1-Dichloro-1-nitroethane	123.5	76		
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane	74.0		8-10.5%	500
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane	113.8	32	6-28%	460
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> Si	Trichlorovinylsilane	91.5	21		
C <sub>2</sub> H <sub>3</sub> F	Fluoroethylene	-72		2.6-21.7%	
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	81.6	6	3.0-16.0%	524
C <sub>2</sub> H <sub>3</sub> NO	Methyl isocyanate	39.5	-7	5.3-26%	534
C <sub>2</sub> H <sub>4</sub>	Ethylene	-103.7		2.7-36%	450
C <sub>2</sub> H <sub>4</sub> ClNO <sub>2</sub>	1-Chloro-1-nitroethane	124.5	56		
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	57.4	-17	5.4-11.4%	458
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	83.5	13	6.2-16%	413
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	20.1	-39	4.0-60%	175
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	10.6	-20	3.0-100%	429
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	117.9	39	4.0-19.9%	463
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Methyl formate	31.7	-19	4.5-23%	449
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	Ethaneperoxoic acid	110	41		
C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	38.5		6.8-8.0%	511
C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	12.3	-50	3.8-15.4%	519
C <sub>2</sub> H <sub>5</sub> ClO	Ethylene chlorohydrin	128.6	60	4.9-15.9%	425
C <sub>2</sub> H <sub>5</sub> Cl <sub>3</sub> Si	Trichloroethylsilane	100.5	22		
C <sub>2</sub> H <sub>5</sub> N	Ethyleneimine	56	-11	3.3-54.8%	320
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	114.0	28	3.4-17%	414
C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Ethyl nitrite	18	-35	4.0-50%	90
C <sub>2</sub> H <sub>5</sub> NO <sub>3</sub>	Ethyl nitrate	87.2	10	4-?	
C <sub>2</sub> H <sub>6</sub>	Ethane	-88.6		3.0-12.5%	472
C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	Dichlorodimethylsilane	70.3	<21	3.4-9.5%	
C <sub>2</sub> H <sub>6</sub> O	Ethanol	78.2	13	3.3-19%	363
C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	-24.8	-41	3.4-27.0%	350
C <sub>2</sub> H <sub>6</sub> OS	2-Mercaptoethanol	158	74		
C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide	189	95	2.6-42%	215
C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	Ethylene glycol	197.3	111	3.2-22%	398
C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	Dimethyl sulfate		83		188
C <sub>2</sub> H <sub>6</sub> S	Ethanethiol	35.1	-17	2.8-18.0%	300
C <sub>2</sub> H <sub>6</sub> S	Dimethyl sulfide	37.3	-37	2.2-19.7%	206
C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	Dimethyl disulfide	109.8	24		
C <sub>2</sub> H <sub>7</sub> N	Ethylamine	16.5	-16	3.5-14%	385

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	6.8	20	2.8–14.4%	400
C <sub>2</sub> H <sub>7</sub> NO	Ethanolamine	171	86	3.0–23.5%	410
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,2-Ethanediamine	117	40	2.5–12.0%	385
C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	1,1-Dimethylhydrazine	63.9	-15	2–95%	249
C <sub>2</sub> N <sub>2</sub>	Cyanogen	-21.1		6.6–32%	
C <sub>3</sub> H <sub>3</sub> Br	3-Bromo-1-propyne	89	10	3.0–?	324
C <sub>3</sub> H <sub>3</sub> N	2-Propenenitrile	77.3	0	3.0–17.0%	481
C <sub>3</sub> H <sub>4</sub>	Propyne	-23.2		2.1–12.5%	
C <sub>3</sub> H <sub>4</sub> ClN	3-Chloropropanenitrile	175.5	76		
C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	2,3-Dichloropropene	94	15	2.6–7.8%	
C <sub>3</sub> H <sub>4</sub> O	Propargyl alcohol	113.6	36		
C <sub>3</sub> H <sub>4</sub> O	Acrolein	52.6	-26	2.8–31%	220
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	Propenoic acid	141	50	2.4–8.0%	438
C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	2-Oxetanone	162	74	2.9–?	
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	Ethylene carbonate	248	143		
C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	70.1	-1	4.4–7.3%	295
C <sub>3</sub> H <sub>5</sub> Cl	2-Chloropropene	22.6	-37	4.5–16%	
C <sub>3</sub> H <sub>5</sub> Cl	3-Chloropropene	45.1	-32	2.9–11.1%	485
C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	118	31	3.8–21.0%	411
C <sub>3</sub> H <sub>5</sub> ClO	Propanoyl chloride	80	12		
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	2-Chloropropanoic acid	185	107		500
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Ethyl chloroformate	95	16		500
C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	Methyl chloroacetate	129.5	57	7.5–18.5%	
C <sub>3</sub> H <sub>5</sub> Cl <sub>2</sub> NO <sub>2</sub>	1,1-Dichloro-1-nitropropane	145	66		
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,2,3-Trichloropropane	157	71	3.2–12.6%	
C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub> Si	Trichloro-2-propenylsilane	117.5	35		
C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	97.1	2	3.1–14%	512
C <sub>3</sub> H <sub>5</sub> NO	3-Hydroxypropanenitrile	221	129		
C <sub>3</sub> H <sub>5</sub> N <sub>3</sub> O <sub>9</sub>	Trinitroglycerol				270
C <sub>3</sub> H <sub>6</sub>	Propene	-47.6		2.0–11.1%	455
C <sub>3</sub> H <sub>6</sub>	Cyclopropane	-32.8		2.4–10.4%	498
C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	1-Chloro-1-nitropropane	142	62		
C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	2-Chloro-2-nitropropane		57		
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropane	96.4	21	3.4–14.5%	557
C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub> O	1,3-Dichloro-2-propanol	176	74		
C <sub>3</sub> H <sub>6</sub> N <sub>2</sub>	Dimethylcyanamide	163.5	71		
C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	97.0	21	2.5–18.0%	378
C <sub>3</sub> H <sub>6</sub> O	Methyl vinyl ether	5.5			287
C <sub>3</sub> H <sub>6</sub> O	Propanal	48	-30	2.6–17%	207
C <sub>3</sub> H <sub>6</sub> O	Acetone	56.0	-20	2.5–12.8%	465
C <sub>3</sub> H <sub>6</sub> O	Methyloxirane	35	-37	3.1–27.5%	449
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	141.1	52	2.9–12.1%	465
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Ethyl formate	54.4	-20	2.8–16.0%	455
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	56.8	-10	3.1–16%	454
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	1,3-Dioxolane	78	2		
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	Dimethyl carbonate	90.5	19		
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	1,3,5-Trioxane	114.5	45	3.6–29%	414
C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	71.1			490
C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	46.5	<-18	2.6–11.1%	520
C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane	35.7	-32	2.8–10.7%	593
C <sub>3</sub> H <sub>7</sub> ClO	2-Chloro-1-propanol	133.5	52		
C <sub>3</sub> H <sub>7</sub> ClO	1-Chloro-2-propanol	127	52		
C <sub>3</sub> H <sub>7</sub> Cl <sub>3</sub> Si	Trichloropropylsilane	123.5	37		
C <sub>3</sub> H <sub>7</sub> N	Allylamine	53.3	-29	2.2–22%	374
C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	153	58	2.2–15.2%	445
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	131.1	36	2.2–?	421
C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	2-Nitropropane	120.2	24	2.6–11.0%	428
C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	Propyl nitrate	110	20	2–100%	175
C <sub>3</sub> H <sub>8</sub>	Propane	-42.1	-104	2.1–9.5%	450
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	97.2	23	2.2–13.7%	412
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	82.3	12	2.0–12.7%	399

Mol. form.	Name	$t_B/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_3\text{H}_8\text{O}$	Ethyl methyl ether	7.4	-37	2.0–10.1%	190
$\text{C}_3\text{H}_8\text{O}_2$	1,2-Propylene glycol	187.6	99	2.6–12.5%	371
$\text{C}_3\text{H}_8\text{O}_2$	1,3-Propylene glycol	214.4			400
$\text{C}_3\text{H}_8\text{O}_2$	Ethylene glycol monomethyl ether	124.1	39	1.8–14%	285
$\text{C}_3\text{H}_8\text{O}_2$	Dimethoxymethane	42	-32	2.2–13.8%	237
$\text{C}_3\text{H}_8\text{O}_3$	Glycerol	290	199	3–19%	370
$\text{C}_3\text{H}_9\text{BO}_3$	Trimethyl borate	67.5	-8		
$\text{C}_3\text{H}_9\text{ClSi}$	Trimethylchlorosilane	60	-28		395
$\text{C}_3\text{H}_9\text{N}$	Propylamine	47.2	-37	2.0–10.4%	318
$\text{C}_3\text{H}_9\text{N}$	Isopropylamine	31.7	-37		402
$\text{C}_3\text{H}_9\text{N}$	Trimethylamine	2.8	-5	2.0–11.6%	190
$\text{C}_3\text{H}_9\text{NO}$	3-Amino-1-propanol	187.5	80		
$\text{C}_3\text{H}_9\text{NO}$	1-Amino-2-propanol	159.4	77		374
$\text{C}_3\text{H}_9\text{NO}$	<i>N</i> -Methyl-2-ethanolamine	158	74		
$\text{C}_3\text{H}_9\text{O}_3\text{P}$	Trimethyl phosphite	111.5	54		
$\text{C}_3\text{H}_9\text{O}_4\text{P}$	Trimethyl phosphate	197.2	107		
$\text{C}_3\text{H}_{10}\text{N}_2$	1,3-Propanediamine	139.8	24		
$\text{C}_4\text{Cl}_6$	Hexachloro-1,3-butadiene	215			610
$\text{C}_4\text{H}_2\text{O}_3$	Maleic anhydride	202	102	1.4–7.1%	477
$\text{C}_4\text{H}_4$	1-Buten-3-yne	5.1		21–100%	
$\text{C}_4\text{H}_4\text{N}_2$	Succinonitrile	266	132		
$\text{C}_4\text{H}_4\text{O}$	Furan	31.5	-36	2.3–14.3%	
$\text{C}_4\text{H}_4\text{O}_2$	Diketene	126.1	34		
$\text{C}_4\text{H}_4\text{S}$	Thiophene	84.0	-1		
$\text{C}_4\text{H}_5\text{Cl}$	2-Chloro-1,3-butadiene	59.4	-20	4.0–20.0%	
$\text{C}_4\text{H}_5\text{N}$	2-Butenenitrile	120.5	16		
$\text{C}_4\text{H}_5\text{N}$	Methylacrylonitrile	90.3	1	2–6.8%	
$\text{C}_4\text{H}_5\text{N}$	Pyrrole	129.7	39		
$\text{C}_4\text{H}_6$	1,3-Butadiene	-4.4		2.0–12.0%	420
$\text{C}_4\text{H}_6$	2-Butyne	26.9	-31	1.4–?	
$\text{C}_4\text{H}_6\text{O}$	Divinyl ether	28.3	<-30	1.7–27%	360
$\text{C}_4\text{H}_6\text{O}$	Ethoxyacetylene	50	<-7		
$\text{C}_4\text{H}_6\text{O}$	<i>trans</i> -2-Butenal	102.2	13	2.1–15.5%	232
$\text{C}_4\text{H}_6\text{O}$	3-Buten-2-one	81.4	-7	2.1–15.6%	491
$\text{C}_4\text{H}_6\text{O}$	Vinylloxirane	68	<-50		
$\text{C}_4\text{H}_6\text{O}_2$	Methacrylic acid	162.5	77	1.6–8.8%	68
$\text{C}_4\text{H}_6\text{O}_2$	Vinyl acetate	72.5	-8	2.6–13.4%	402
$\text{C}_4\text{H}_6\text{O}_2$	Methyl acrylate	80.7	-3	2.8–25%	468
$\text{C}_4\text{H}_6\text{O}_2$	2,3-Butanedione	88	27		
$\text{C}_4\text{H}_6\text{O}_2$	$\gamma$ -Butyrolactone	204	98		
$\text{C}_4\text{H}_6\text{O}_3$	Acetic anhydride	139.5	49	2.7–10.3%	316
$\text{C}_4\text{H}_6\text{O}_3$	Propylene carbonate	242	135		
$\text{C}_4\text{H}_6\text{O}_6$	<i>L</i> -Tartaric acid		210		425
$\text{C}_4\text{H}_7\text{Br}$	1-Bromo-2-butene	104.5		4.6–12.0%	
$\text{C}_4\text{H}_7\text{BrO}_2$	Ethyl bromoacetate	168.5	48		
$\text{C}_4\text{H}_7\text{Cl}$	2-Chloro-1-butene	58.5	-19	2.3–9.3%	
$\text{C}_4\text{H}_7\text{Cl}$	3-Chloro-2-methylpropene	71.5	-12	3.2–8.1%	
$\text{C}_4\text{H}_7\text{ClO}$	2-Chloroethyl vinyl ether	108	27		
$\text{C}_4\text{H}_7\text{ClO}_2$	Ethyl chloroacetate	144.3	64		
$\text{C}_4\text{H}_7\text{N}$	Butanenitrile	117.6	24	1.6–?	501
$\text{C}_4\text{H}_7\text{N}$	2-Methylpropanenitrile	103.9	8		482
$\text{C}_4\text{H}_7\text{NO}$	Acetone cyanohydrin		74	2.2–12.0%	688
$\text{C}_4\text{H}_7\text{NO}$	2-Pyrrolidone	251	129		
$\text{C}_4\text{H}_8$	1-Butene	-6.2		1.6–10.0%	385
$\text{C}_4\text{H}_8$	<i>cis</i> -2-Butene	3.7		1.7–9.0%	325
$\text{C}_4\text{H}_8$	<i>trans</i> -2-Butene	0.8		1.8–9.7%	324
$\text{C}_4\text{H}_8$	Isobutene	-6.9		1.8–9.6%	465
$\text{C}_4\text{H}_8$	Cyclobutane	12.6	<10	1.8–?	
$\text{C}_4\text{H}_8\text{Cl}_2$	1,2-Dichlorobutane	124.1			275
$\text{C}_4\text{H}_8\text{Cl}_2$	1,4-Dichlorobutane	161	52		
$\text{C}_4\text{H}_8\text{Cl}_2\text{O}$	Bis(2-chloroethyl) ether	178.5	55	2.7–?	369

Mol. form.	Name	$t_B/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_4\text{H}_8\text{O}$	2-Buten-1-ol	121.5	27	4.2–35.3%	349
$\text{C}_4\text{H}_8\text{O}$	2-Methyl-2-propenol	114.5	33		
$\text{C}_4\text{H}_8\text{O}$	Ethyl vinyl ether	35.5	<–46	1.7–28%	202
$\text{C}_4\text{H}_8\text{O}$	1,2-Epoxybutane	63.4	–22	1.7–19%	439
$\text{C}_4\text{H}_8\text{O}$	Butanal	74.8	–22	1.9–12.5%	218
$\text{C}_4\text{H}_8\text{O}$	Isobutanal	64.5	–18	1.6–10.6%	196
$\text{C}_4\text{H}_8\text{O}$	2-Butanone	79.5	–9	1.4–11.4%	404
$\text{C}_4\text{H}_8\text{O}$	Tetrahydrofuran	65	–14	2–11.8%	321
$\text{C}_4\text{H}_8\text{OS}$	1,4-Oxathiane	147	42		
$\text{C}_4\text{H}_8\text{O}_2$	Butanoic acid	163.7	72	2.0–10.0%	443
$\text{C}_4\text{H}_8\text{O}_2$	2-Methylpropanoic acid	154.4	56	2.0–9.2%	481
$\text{C}_4\text{H}_8\text{O}_2$	Propyl formate	80.9	–3		455
$\text{C}_4\text{H}_8\text{O}_2$	Isopropyl formate	68.2	–6		485
$\text{C}_4\text{H}_8\text{O}_2$	Ethyl acetate	77.1	–4	2.0–11.5%	426
$\text{C}_4\text{H}_8\text{O}_2$	Methyl propanoate	79.8	–2	2.5–13%	469
$\text{C}_4\text{H}_8\text{O}_2$	3-Hydroxybutanal		66		250
$\text{C}_4\text{H}_8\text{O}_2$	1,4-Dioxane	101.5	12	2.0–22%	180
$\text{C}_4\text{H}_8\text{O}_2\text{S}$	Sulfolane	287.3	177		
$\text{C}_4\text{H}_8\text{O}_3$	Methyl lactate	144.8	49	2.2–?	385
$\text{C}_4\text{H}_8\text{O}_3$	Ethylene glycol monoacetate	188	102		
$\text{C}_4\text{H}_9\text{Br}$	1-Bromobutane	101.6	18	2.6–6.6%	265
$\text{C}_4\text{H}_9\text{Br}$	2-Bromobutane	91.2	21		
$\text{C}_4\text{H}_9\text{Cl}$	1-Chlorobutane	78.6	–12	1.9–10.1%	240
$\text{C}_4\text{H}_9\text{Cl}$	2-Chlorobutane	68.2	–10		
$\text{C}_4\text{H}_9\text{Cl}$	1-Chloro-2-methylpropane	68.5	–6	2.0–8.7%	
$\text{C}_4\text{H}_9\text{Cl}$	2-Chloro-2-methylpropane	50.9	0		
$\text{C}_4\text{H}_9\text{Cl}_3\text{Si}$	Butyltrichlorosilane	148.5	54		
$\text{C}_4\text{H}_9\text{N}$	Pyrrolidine	86.5	3		
$\text{C}_4\text{H}_9\text{NO}$	<i>N</i> -Ethylacetamide	205	110		
$\text{C}_4\text{H}_9\text{NO}$	<i>N,N</i> -Dimethylacetamide	165	70	1.8–11.5%	490
$\text{C}_4\text{H}_9\text{NO}$	Butanal oxime	154	58		
$\text{C}_4\text{H}_9\text{NO}$	2-Butanone oxime	152.5	$\approx$ 70		
$\text{C}_4\text{H}_9\text{NO}$	Morpholine	128	37	1.4–11.2%	290
$\text{C}_4\text{H}_9\text{NO}_2$	<i>N</i> -Acetyethanolamine		179		460
$\text{C}_4\text{H}_9\text{NO}_3$	Butyl nitrate	133	36		
$\text{C}_4\text{H}_{10}$	Butane	–0.5	–60	1.9–8.5%	287
$\text{C}_4\text{H}_{10}$	Isobutane	–11.7	–87	1.8–8.4%	460
$\text{C}_4\text{H}_{10}\text{N}_2$	Piperazine	146	81		
$\text{C}_4\text{H}_{10}\text{O}$	1-Butanol	117.7	37	1.4–11.2%	343
$\text{C}_4\text{H}_{10}\text{O}$	2-Butanol	99.5	24	1.7–9.8%	405
$\text{C}_4\text{H}_{10}\text{O}$	2-Methyl-1-propanol	107.8	28	1.7–10.6%	415
$\text{C}_4\text{H}_{10}\text{O}$	2-Methyl-2-propanol	82.4	11	2.4–8.0%	478
$\text{C}_4\text{H}_{10}\text{O}$	Diethyl ether	34.5	–45	1.9–36.0%	180
$\text{C}_4\text{H}_{10}\text{O}$	Methyl propyl ether	39.1	–20	2.0–14.8%	
$\text{C}_4\text{H}_{10}\text{O}_2$	1,2-Butanediol	190.5	40		
$\text{C}_4\text{H}_{10}\text{O}_2$	1,3-Butanediol	207.5	121		395
$\text{C}_4\text{H}_{10}\text{O}_2$	1,4-Butanediol	235	121		
$\text{C}_4\text{H}_{10}\text{O}_2$	2,3-Butanediol	182.5			402
$\text{C}_4\text{H}_{10}\text{O}_2$	Ethylene glycol monoethyl ether	135	43	3–18%	235
$\text{C}_4\text{H}_{10}\text{O}_2$	Ethylene glycol dimethyl ether	85	–2		202
$\text{C}_4\text{H}_{10}\text{O}_2$	<i>tert</i> -Butyl hydroperoxide		27		
$\text{C}_4\text{H}_{10}\text{O}_2\text{S}$	2,2'-Thiodiethanol	282	160		298
$\text{C}_4\text{H}_{10}\text{O}_3$	Diethylene glycol	245.8	124	2–17%	224
$\text{C}_4\text{H}_{10}\text{O}_4\text{S}$	Diethyl sulfate	208	104		436
$\text{C}_4\text{H}_{10}\text{S}$	1-Butanethiol	98.5	2		
$\text{C}_4\text{H}_{10}\text{S}$	2-Butanethiol	85	–23		
$\text{C}_4\text{H}_{10}\text{S}$	2-Methyl-1-propanethiol	88.5	2		
$\text{C}_4\text{H}_{10}\text{S}$	2-Methyl-2-propanethiol	64.3	<–29		
$\text{C}_4\text{H}_{10}\text{Se}$	Diethyl selenide	108		2.5–?	
$\text{C}_4\text{H}_{11}\text{N}$	Butylamine	77.0	–12	1.7–9.8%	312
$\text{C}_4\text{H}_{11}\text{N}$	<i>sec</i> -Butylamine	63.5	–9		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_4\text{H}_{11}\text{N}$	<i>tert</i> -Butylamine	44.0	-9	1.7-8.9%	380
$\text{C}_4\text{H}_{11}\text{N}$	Isobutylamine	67.7	-9	2-12%	378
$\text{C}_4\text{H}_{11}\text{N}$	Diethylamine	55.5	-23	1.8-10.1%	312
$\text{C}_4\text{H}_{11}\text{NO}$	2-Amino-1-butanol	178	74		
$\text{C}_4\text{H}_{11}\text{NO}$	2-Amino-2-methyl-1-propanol	165.5	67		
$\text{C}_4\text{H}_{11}\text{NO}_2$	Diethanolamine	268.8	172	2-13%	662
$\text{C}_4\text{H}_{12}\text{Sn}$	Tetramethylstannane	78	-12	1.9-?	
$\text{C}_4\text{H}_{13}\text{N}_3$	Diethylenetriamine	207	98	2-6.7%	358
$\text{C}_5\text{H}_4\text{O}_2$	Furfural	161.7	60	2.1-19.3%	316
$\text{C}_5\text{H}_5\text{N}$	Pyridine	115.2	20	1.8-12.4%	482
$\text{C}_5\text{H}_6$	2-Methyl-1-buten-3-yne	32	<-7		
$\text{C}_5\text{H}_6\text{N}_2$	2-Methylpyrazine	137	50		
$\text{C}_5\text{H}_6\text{O}$	3-Methylfuran	66	-30		
$\text{C}_5\text{H}_6\text{O}_2$	Furfuryl alcohol	171	75	1.8-16.3%	491
$\text{C}_5\text{H}_7\text{N}$	1-Methylpyrrole	115	16		
$\text{C}_5\text{H}_7\text{NO}$	2-Furanmethanamine	145.5	37		
$\text{C}_5\text{H}_7\text{NO}_2$	Ethyl cyanoacetate	205	110		
$\text{C}_5\text{H}_8$	2-Methyl-1,3-butadiene	34.0	-54	1.5-8.9%	395
$\text{C}_5\text{H}_8$	1-Pentyne	40.1	<-20		
$\text{C}_5\text{H}_8$	Cyclopentene	44.2	-29		395
$\text{C}_5\text{H}_8\text{O}$	3-Methyl-3-buten-2-one	98		1.8-9.0%	
$\text{C}_5\text{H}_8\text{O}$	Cyclopentanone	130.5	26		
$\text{C}_5\text{H}_8\text{O}$	3,4-Dihydro-2H-pyran	86	-18		
$\text{C}_5\text{H}_8\text{O}_2$	Allyl acetate	103.5	22		374
$\text{C}_5\text{H}_8\text{O}_2$	Isopropenyl acetate	94	26		432
$\text{C}_5\text{H}_8\text{O}_2$	Vinyl propanoate	91.2	1		
$\text{C}_5\text{H}_8\text{O}_2$	Ethyl acrylate	99.4	10	1.4-14%	372
$\text{C}_5\text{H}_8\text{O}_2$	Methyl methacrylate	100.5	10	1.7-8.2%	
$\text{C}_5\text{H}_8\text{O}_2$	2,4-Pentanedione	138	34		340
$\text{C}_5\text{H}_8\text{O}_3$	Methyl acetoacetate	171.7	77		280
$\text{C}_5\text{H}_9\text{NO}$	<i>N</i> -Methyl-2-pyrrolidone	202	96	1-10%	346
$\text{C}_5\text{H}_{10}$	1-Pentene	29.9	-18	1.5-8.7%	275
$\text{C}_5\text{H}_{10}$	<i>cis</i> -2-Pentene	36.9	<-20		
$\text{C}_5\text{H}_{10}$	<i>trans</i> -2-Pentene	36.3	<-20		
$\text{C}_5\text{H}_{10}$	2-Methyl-1-butene	31.2	-20		
$\text{C}_5\text{H}_{10}$	3-Methyl-1-butene	20.1	-7	1.5-9.1%	365
$\text{C}_5\text{H}_{10}$	2-Methyl-2-butene	38.5	-20		
$\text{C}_5\text{H}_{10}$	Cyclopentane	49.3	-25	1.5-?	361
$\text{C}_5\text{H}_{10}\text{Cl}_2$	1,5-Dichloropentane	179	>27		
$\text{C}_5\text{H}_{10}\text{N}_2$	3-(Dimethylamino)propanenitrile	173	65		
$\text{C}_5\text{H}_{10}\text{O}$	Cyclopentanol	140.4	51		
$\text{C}_5\text{H}_{10}\text{O}$	Pentanal	103	12		222
$\text{C}_5\text{H}_{10}\text{O}$	2-Pentanone	102.2	7	1.5-8.2%	452
$\text{C}_5\text{H}_{10}\text{O}$	3-Pentanone	101.9	13	1.6-?	450
$\text{C}_5\text{H}_{10}\text{O}$	Tetrahydropyran	88	-20		
$\text{C}_5\text{H}_{10}\text{O}$	2-Methyltetrahydrofuran	78	-11		
$\text{C}_5\text{H}_{10}\text{O}_2$	Pentanoic acid	186.1	96		400
$\text{C}_5\text{H}_{10}\text{O}_2$	3-Methylbutanoic acid	176.5			416
$\text{C}_5\text{H}_{10}\text{O}_2$	Butyl formate	106.1	18	1.7-8.2%	322
$\text{C}_5\text{H}_{10}\text{O}_2$	Isobutyl formate	98.2	5	2-9%	320
$\text{C}_5\text{H}_{10}\text{O}_2$	Propyl acetate	101.5	13	1.7-8%	450
$\text{C}_5\text{H}_{10}\text{O}_2$	Isopropyl acetate	88.6	2	1.8-8%	460
$\text{C}_5\text{H}_{10}\text{O}_2$	Ethyl propanoate	99.1	12	1.9-11%	440
$\text{C}_5\text{H}_{10}\text{O}_2$	Methyl butanoate	102.8	14		
$\text{C}_5\text{H}_{10}\text{O}_2$	3-Ethoxypropanal	135.2	38		
$\text{C}_5\text{H}_{10}\text{O}_2$	Tetrahydrofurfuryl alcohol	178	75	1.5-9.7%	282
$\text{C}_5\text{H}_{10}\text{O}_3$	Diethyl carbonate	126	25		
$\text{C}_5\text{H}_{10}\text{O}_3$	Ethylene glycol monomethyl ether acetate	143	49	1.5-12.3%	392
$\text{C}_5\text{H}_{10}\text{O}_3$	Ethyl lactate	154.5	46	1.5-?	400
$\text{C}_5\text{H}_{11}\text{Br}$	1-Bromopentane	129.8	32		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_5\text{H}_{11}\text{Cl}$	1-Chloropentane	107.8	13	1.6–8.6%	260
$\text{C}_5\text{H}_{11}\text{Cl}$	2-Chloro-2-methylbutane	85.6		1.5–7.4%	345
$\text{C}_5\text{H}_{11}\text{Cl}$	1-Chloro-3-methylbutane	98.9	<21	1.5–7.4%	
$\text{C}_5\text{H}_{11}\text{Cl}_3\text{Si}$	Trichloropentylsilane	172	63		
$\text{C}_5\text{H}_{11}\text{N}$	Piperidine	106.2	16		
$\text{C}_5\text{H}_{11}\text{N}$	<i>N</i> -Methylpyrrolidine	81	–14		
$\text{C}_5\text{H}_{11}\text{NO}$	4-Methylmorpholine	116	24		
$\text{C}_5\text{H}_{11}\text{NO}_2$	Isopentyl nitrite	99.2			210
$\text{C}_5\text{H}_{12}$	Pentane	36.0	–40	1.4–8.0%	260
$\text{C}_5\text{H}_{12}$	Isopentane	27.8	–51	1.4–7.6%	420
$\text{C}_5\text{H}_{12}$	Neopentane	9.4	–65	1.4–7.5%	450
$\text{C}_5\text{H}_{12}\text{N}_2$	1-Methylpiperazine	138	42		
$\text{C}_5\text{H}_{12}\text{N}_2\text{O}$	Tetramethylurea	176.5	77		
$\text{C}_5\text{H}_{12}\text{O}$	1-Pentanol	137.9	33	1.2–10.0%	300
$\text{C}_5\text{H}_{12}\text{O}$	2-Pentanol	119.3	34	1.2–9.0%	343
$\text{C}_5\text{H}_{12}\text{O}$	3-Pentanol	116.2	41	1.2–9.0%	435
$\text{C}_5\text{H}_{12}\text{O}$	2-Methyl-1-butanol	128	50		385
$\text{C}_5\text{H}_{12}\text{O}$	3-Methyl-1-butanol	131.1	43	1.2–9.0%	350
$\text{C}_5\text{H}_{12}\text{O}$	2-Methyl-2-butanol	102.4	19	1.2–9.0%	437
$\text{C}_5\text{H}_{12}\text{O}$	3-Methyl-2-butanol	112.9	38		
$\text{C}_5\text{H}_{12}\text{O}$	2,2-Dimethyl-1-propanol	113.5	37		
$\text{C}_5\text{H}_{12}\text{O}$	Ethyl propyl ether	63.2	<–20	1.7–9.0%	
$\text{C}_5\text{H}_{12}\text{O}_2$	1,5-Pentanediol	239	129		335
$\text{C}_5\text{H}_{12}\text{O}_2$	2-Isopropoxyethanol	145	33		
$\text{C}_5\text{H}_{12}\text{O}_2$	2,2-Dimethyl-1,3-propanediol	208	129		399
$\text{C}_5\text{H}_{12}\text{O}_3$	Diethylene glycol monomethyl ether	193	96	1.38–22.7%	240
$\text{C}_5\text{H}_{12}\text{S}$	1-Pentanethiol	126.6	18		
$\text{C}_5\text{H}_{12}\text{S}$	3-Methyl-2-butanethiol		3		
$\text{C}_5\text{H}_{13}\text{N}$	Pentylamine	104.3	–1	2.2–22%	
$\text{C}_5\text{H}_{13}\text{N}$	Butylmethylamine	91	13		
$\text{C}_6\text{H}_2\text{Cl}_4$	1,2,4,5-Tetrachlorobenzene	244.5	155		
$\text{C}_6\text{H}_3\text{Cl}_2\text{N}_2\text{O}_4$	1-Chloro-2,4-dinitrobenzene	315	194	2.0–22%	
$\text{C}_6\text{H}_3\text{Cl}_3$	1,2,4-Trichlorobenzene	213.5	105	2.5–6.6%	571
$\text{C}_6\text{H}_4\text{ClNO}_2$	1-Chloro-4-nitrobenzene	242	127		
$\text{C}_6\text{H}_4\text{Cl}_2$	<i>o</i> -Dichlorobenzene	180	66	2.2–9.2%	648
$\text{C}_6\text{H}_4\text{Cl}_2$	<i>m</i> -Dichlorobenzene	173	72		
$\text{C}_6\text{H}_4\text{Cl}_2$	<i>p</i> -Dichlorobenzene	174	66		
$\text{C}_6\text{H}_4\text{Cl}_2\text{O}$	2,4-Dichlorophenol	210	114		
$\text{C}_6\text{H}_5\text{Br}$	Bromobenzene	156.0	51		565
$\text{C}_6\text{H}_5\text{Cl}$	Chlorobenzene	131.7	28	1.3–9.6%	593
$\text{C}_6\text{H}_5\text{ClO}$	<i>o</i> -Chlorophenol	174.9	64		
$\text{C}_6\text{H}_5\text{ClO}$	<i>p</i> -Chlorophenol	220	121		
$\text{C}_6\text{H}_5\text{Cl}_2\text{N}$	3,4-Dichloroaniline	272	166		
$\text{C}_6\text{H}_5\text{Cl}_3\text{Si}$	Trichlorophenylsilane	201	91		
$\text{C}_6\text{H}_5\text{F}$	Fluorobenzene	84.7	–15		
$\text{C}_6\text{H}_5\text{NO}_2$	Nitrobenzene	210.8	88	1.8–?	482
$\text{C}_6\text{H}_5\text{N}_3\text{O}_4$	2,4-Dinitroaniline		224		
$\text{C}_6\text{H}_6$	1,5-Hexadien-3-yne	85	<–20	1.5–?	
$\text{C}_6\text{H}_6$	Benzene	80.0	–11	1.2–7.8%	498
$\text{C}_6\text{H}_6\text{N}_2\text{O}_2$	<i>p</i> -Nitroaniline	332	199		
$\text{C}_6\text{H}_6\text{O}$	Phenol	181.8	79	1.8–8.6%	715
$\text{C}_6\text{H}_6\text{O}_2$	1,2-Benzenediol	245	127		
$\text{C}_6\text{H}_6\text{O}_2$	Resorcinol		127	1.4–?	608
$\text{C}_6\text{H}_6\text{O}_2$	<i>p</i> -Hydroquinone	287	165		516
$\text{C}_6\text{H}_7\text{N}$	Aniline	184.1	70	1.3–11%	615
$\text{C}_6\text{H}_7\text{N}$	2-Methylpyridine	129.3	39		538
$\text{C}_6\text{H}_7\text{N}$	4-Methylpyridine	145.3	57		
$\text{C}_6\text{H}_8\text{ClN}$	Aniline, hydrochloride		193		
$\text{C}_6\text{H}_8\text{Cl}_2\text{O}_2$	Hexanedioyl dichloride		72		
$\text{C}_6\text{H}_8\text{N}_2$	Adiponitrile	295	93	1.0–?	550
$\text{C}_6\text{H}_8\text{N}_2$	<i>o</i> -Phenylenediamine	257	156	1.5–?	

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_6\text{H}_8\text{N}_2$	Phenylhydrazine	243.5	88		
$\text{C}_6\text{H}_8\text{N}_2$	2,5-Dimethylpyrazine	155	64		
$\text{C}_6\text{H}_8\text{O}$	2,5-Dimethylfuran	93.5	7		
$\text{C}_6\text{H}_8\text{O}_4$	Dimethyl maleate	202	113		
$\text{C}_6\text{H}_{10}$	1,4-Hexadiene	65	-21	2.0–6.1%	
$\text{C}_6\text{H}_{10}$	2-Methyl-1,3-pentadiene	75.8	-12		
$\text{C}_6\text{H}_{10}$	4-Methyl-1,3-pentadiene	76.5	-34		
$\text{C}_6\text{H}_{10}$	2-Hexyne	84.5	-10		
$\text{C}_6\text{H}_{10}$	Cyclohexene	82.9	-12	1.2–?	310
$\text{C}_6\text{H}_{10}\text{O}$	Diallyl ether	94	-7		
$\text{C}_6\text{H}_{10}\text{O}$	Cyclohexanone	155.4	44	1.1–9.4%	420
$\text{C}_6\text{H}_{10}\text{O}$	Mesityl oxide	130	31	1.4–7.2%	344
$\text{C}_6\text{H}_{10}\text{O}_2$	Vinyl butanoate	116.7	20	1.4–8.8%	
$\text{C}_6\text{H}_{10}\text{O}_2$	Ethyl 2-butenolate	136.5	2		
$\text{C}_6\text{H}_{10}\text{O}_2$	Ethyl methacrylate	117	20		
$\text{C}_6\text{H}_{10}\text{O}_2$	2,5-Hexanedione	194	79		499
$\text{C}_6\text{H}_{10}\text{O}_3$	Ethyl acetoacetate	180.8	57	1.4–9.5%	295
$\text{C}_6\text{H}_{10}\text{O}_3$	Propanoic anhydride	170	63	1.3–9.5%	285
$\text{C}_6\text{H}_{10}\text{O}_4$	Adipic acid	337.5	196		420
$\text{C}_6\text{H}_{10}\text{O}_4$	Diethyl oxalate	185.7	76		
$\text{C}_6\text{H}_{10}\text{O}_4$	Ethylene glycol diacetate	190	88	1.6–8.4%	482
$\text{C}_6\text{H}_{11}\text{Cl}$	Chlorocyclohexane	142	32		
$\text{C}_6\text{H}_{11}\text{NO}$	Caprolactam	270	125		
$\text{C}_6\text{H}_{11}\text{NO}_2$	Nitrocyclohexane	205	88		
$\text{C}_6\text{H}_{11}\text{NO}_2$	4-Acetylmorpholine		113		
$\text{C}_6\text{H}_{12}$	1-Hexene	63.4	-26	1.2–6.9%	253
$\text{C}_6\text{H}_{12}$	<i>cis</i> -2-Hexene	68.8	-21		
$\text{C}_6\text{H}_{12}$	2-Methyl-1-pentene	62.1	-28		300
$\text{C}_6\text{H}_{12}$	4-Methyl-1-pentene	53.9	-7		300
$\text{C}_6\text{H}_{12}$	4-Methyl- <i>cis</i> -2-pentene	56.3	-32		
$\text{C}_6\text{H}_{12}$	4-Methyl- <i>trans</i> -2-pentene	58.6	-29		
$\text{C}_6\text{H}_{12}$	2-Ethyl-1-butene	64.7	<-20		315
$\text{C}_6\text{H}_{12}$	2,3-Dimethyl-1-butene	55.6	<-20		360
$\text{C}_6\text{H}_{12}$	2,3-Dimethyl-2-butene	73.3	<-20		401
$\text{C}_6\text{H}_{12}$	Cyclohexane	80.7	-20	1.3–8%	245
$\text{C}_6\text{H}_{12}$	Methylcyclopentane	71.8	-29	1.0–8.35%	258
$\text{C}_6\text{H}_{12}$	Ethylcyclobutane	70.8	-15	1.2–7.7%	210
$\text{C}_6\text{H}_{12}$	2-Methyl-2-pentene	67.3	<-7		
$\text{C}_6\text{H}_{12}\text{Cl}_2\text{O}_2$	1,2-Bis(2-chloroethoxy)ethane	232	121		
$\text{C}_6\text{H}_{12}\text{O}$	<i>cis</i> -3-Hexen-1-ol	156.5	54		
$\text{C}_6\text{H}_{12}\text{O}$	Butyl vinyl ether	94	-9		255
$\text{C}_6\text{H}_{12}\text{O}$	Isobutyl vinyl ether	83	-9		
$\text{C}_6\text{H}_{12}\text{O}$	Hexanal	131	32		
$\text{C}_6\text{H}_{12}\text{O}$	2-Ethylbutanal		21	1.2–7.7%	
$\text{C}_6\text{H}_{12}\text{O}$	2-Methylpentanal	117	17		199
$\text{C}_6\text{H}_{12}\text{O}$	2-Hexanone	127.6	25	1–8%	423
$\text{C}_6\text{H}_{12}\text{O}$	3-Hexanone	123.5	35	1–8%	
$\text{C}_6\text{H}_{12}\text{O}$	4-Methyl-2-pentanone	116.5	18	1.2–8.0%	448
$\text{C}_6\text{H}_{12}\text{O}$	Cyclohexanol	160.8	68	1–9%	300
$\text{C}_6\text{H}_{12}\text{O}_2$	Hexanoic acid	205.2	102		380
$\text{C}_6\text{H}_{12}\text{O}_2$	2-Methylpentanoic acid	195.6	107		378
$\text{C}_6\text{H}_{12}\text{O}_2$	Diethylacetic acid	194	99		400
$\text{C}_6\text{H}_{12}\text{O}_2$	Pentyl formate	130.4	26		
$\text{C}_6\text{H}_{12}\text{O}_2$	Butyl acetate	126.1	22	1.7–7.6%	425
$\text{C}_6\text{H}_{12}\text{O}_2$	<i>sec</i> -Butyl acetate	112	31	1.7–9.8%	
$\text{C}_6\text{H}_{12}\text{O}_2$	Isobutyl acetate	116.5	18	1.3–10.5%	421
$\text{C}_6\text{H}_{12}\text{O}_2$	Propyl propanoate	122.5	79		
$\text{C}_6\text{H}_{12}\text{O}_2$	Ethyl butanoate	121.5	24		463
$\text{C}_6\text{H}_{12}\text{O}_2$	Ethyl 2-methylpropanoate	110.1	13		
$\text{C}_6\text{H}_{12}\text{O}_2$	Diacetone alcohol	167.9	58	1.8–6.9%	643

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_6\text{H}_{12}\text{O}_3$	Ethylene glycol monoethyl ether acetate	156.4	56	2–8%	379
$\text{C}_6\text{H}_{12}\text{O}_3$	Paraldehyde	124.3	36	1.3–?	238
$\text{C}_6\text{H}_{12}\text{S}$	Cyclohexanethiol	158.9	43		
$\text{C}_6\text{H}_{13}\text{Cl}$	1-Chlorohexane	135	35		
$\text{C}_6\text{H}_{13}\text{N}$	Cyclohexylamine	134	31	1.9–9.4%	293
$\text{C}_6\text{H}_{13}\text{NO}$	<i>N</i> -Butylacetamide	229	116		
$\text{C}_6\text{H}_{13}\text{NO}$	2,6-Dimethylmorpholine	146.6	44		
$\text{C}_6\text{H}_{13}\text{NO}$	<i>N</i> -Ethylmorpholine	138.5	32		
$\text{C}_6\text{H}_{13}\text{NO}_2$	4-Morpholineethanol	227	99		
$\text{C}_6\text{H}_{14}$	Hexane	68.7	–22	1.1–7.5%	225
$\text{C}_6\text{H}_{14}$	2-Methylpentane	60.2	<–29	1.0–7.0%	264
$\text{C}_6\text{H}_{14}$	3-Methylpentane	63.2	–7	1.2–7.0%	278
$\text{C}_6\text{H}_{14}$	2,2-Dimethylbutane	49.7	–48	1.2–7.0%	405
$\text{C}_6\text{H}_{14}$	2,3-Dimethylbutane	57.9	–29	1.2–7.0%	405
$\text{C}_6\text{H}_{14}\text{N}_2\text{O}$	1-Piperazineethanol	246	124		
$\text{C}_6\text{H}_{14}\text{O}$	1-Hexanol	157.6	63		
$\text{C}_6\text{H}_{14}\text{O}$	2-Methyl-1-pentanol	149	54	1.1–9.65%	310
$\text{C}_6\text{H}_{14}\text{O}$	4-Methyl-2-pentanol	131.6	41	1.0–5.5%	
$\text{C}_6\text{H}_{14}\text{O}$	2-Ethyl-1-butanol	147	57		
$\text{C}_6\text{H}_{14}\text{O}$	Dipropyl ether	90.0	21	1.3–7.0%	188
$\text{C}_6\text{H}_{14}\text{O}$	Diisopropyl ether	68.5	–28	1.4–7.9%	443
$\text{C}_6\text{H}_{14}\text{O}$	Butyl ethyl ether	92.3	4		
$\text{C}_6\text{H}_{14}\text{O}_2$	2,5-Hexanediol	218	110		
$\text{C}_6\text{H}_{14}\text{O}_2$	2-Methyl-2,4-pentanediol	197.1	102	1–9%	306
$\text{C}_6\text{H}_{14}\text{O}_2$	Ethylene glycol monobutyl ether	168.4	69	4–13%	238
$\text{C}_6\text{H}_{14}\text{O}_2$	1,1-Diethoxyethane	102.2	–21	1.6–10.4%	230
$\text{C}_6\text{H}_{14}\text{O}_2$	Ethylene glycol diethyl ether	119.4	27		205
$\text{C}_6\text{H}_{14}\text{O}_3$	1,2,6-Hexanetriol		191		
$\text{C}_6\text{H}_{14}\text{O}_3$	Diethylene glycol monoethyl ether	196	96		
$\text{C}_6\text{H}_{14}\text{O}_3$	Diethylene glycol dimethyl ether	162	67		
$\text{C}_6\text{H}_{14}\text{O}_3$	Trimethylolpropane		149		
$\text{C}_6\text{H}_{14}\text{O}_4$	Triethylene glycol	285	177	0.9–9.2%	371
$\text{C}_6\text{H}_{15}\text{N}$	Hexylamine	132.8	29		
$\text{C}_6\text{H}_{15}\text{N}$	Butylethylamine	107.5	18		
$\text{C}_6\text{H}_{15}\text{N}$	Dipropylamine	109.3	17		299
$\text{C}_6\text{H}_{15}\text{N}$	Diisopropylamine	83.9	–1	1.1–7.1%	316
$\text{C}_6\text{H}_{15}\text{N}$	Triethylamine	89	–7	1.2–8.0%	249
$\text{C}_6\text{H}_{15}\text{NO}_2$	Diisopropanolamine	250	127		374
$\text{C}_6\text{H}_{15}\text{NO}_3$	Triethanolamine	335.4	179	1–10%	
$\text{C}_6\text{H}_{15}\text{N}_3$	1-Piperazineethanamine	220	93		
$\text{C}_6\text{H}_{15}\text{O}_4\text{P}$	Triethyl phosphate	215.5	115		454
$\text{C}_6\text{H}_{16}\text{N}_2$	<i>N,N</i> -Diethylethylenediamine	144	46		
$\text{C}_7\text{H}_3\text{ClF}_3\text{NO}_2$	1-Chloro-4-nitro-2-(trifluoromethyl)benzene	232	135		
$\text{C}_7\text{H}_4\text{ClF}_3$	1-Chloro-2-(trifluoromethyl)benzene	152.2	59		
$\text{C}_7\text{H}_4\text{F}_3\text{NO}_2$	1-Nitro-3-(trifluoromethyl)benzene	202.8	103		
$\text{C}_7\text{H}_5\text{ClO}$	Benzoyl chloride	197.2	72		
$\text{C}_7\text{H}_5\text{ClO}$	4-Chlorobenzaldehyde	213.5	88		
$\text{C}_7\text{H}_5\text{Cl}_3$	(Trichloromethyl)benzene	221	127		211
$\text{C}_7\text{H}_5\text{F}_3$	(Trifluoromethyl)benzene	102.1	12		
$\text{C}_7\text{H}_6\text{N}_2\text{O}_4$	1-Methyl-2,4-dinitrobenzene		207		
$\text{C}_7\text{H}_6\text{O}$	Benzaldehyde	179.0	63		192
$\text{C}_7\text{H}_6\text{O}_2$	Benzoic acid	249.2	121		570
$\text{C}_7\text{H}_6\text{O}_2$	Salicylaldehyde	197	78		
$\text{C}_7\text{H}_6\text{O}_3$	Salicylic acid		157	1.1–?	540
$\text{C}_7\text{H}_7\text{Br}$	<i>o</i> -Bromotoluene	181.7	79		
$\text{C}_7\text{H}_7\text{Br}$	<i>p</i> -Bromotoluene	184.3	85		
$\text{C}_7\text{H}_7\text{Cl}$	(Chloromethyl)benzene	179	67	1.1–?	585
$\text{C}_7\text{H}_7\text{NO}_2$	<i>o</i> -Nitrotoluene	222	106		
$\text{C}_7\text{H}_7\text{NO}_2$	<i>m</i> -Nitrotoluene	232	106		
$\text{C}_7\text{H}_7\text{NO}_2$	<i>p</i> -Nitrotoluene	238.3	106		



Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_7\text{H}_8$	Toluene	110.6	4	1.1–7.1%	480
$\text{C}_7\text{H}_8$	Bicyclo[2.2.1]hepta-2,5-diene	89.5	–21		
$\text{C}_7\text{H}_8\text{O}$	<i>o</i> -Cresol	191.0	81	1.4–?	599
$\text{C}_7\text{H}_8\text{O}$	<i>m</i> -Cresol	202.2	86	1.1–?	558
$\text{C}_7\text{H}_8\text{O}$	<i>p</i> -Cresol	201.9	86	1.1–?	558
$\text{C}_7\text{H}_8\text{O}$	Benzyl alcohol	205.3	93		436
$\text{C}_7\text{H}_8\text{O}$	Anisole	153.7	52		475
$\text{C}_7\text{H}_8\text{O}_2$	4-Methoxyphenol	243	132		421
$\text{C}_7\text{H}_8\text{O}_3\text{S}$	<i>p</i> -Toluenesulfonic acid		184		
$\text{C}_7\text{H}_9\text{N}$	<i>o</i> -Methylaniline	200.3	85		482
$\text{C}_7\text{H}_9\text{N}$	<i>p</i> -Methylaniline	200.4	87		482
$\text{C}_7\text{H}_9\text{NO}$	<i>o</i> -Anisidine	224	118		
$\text{C}_7\text{H}_{10}\text{O}$	3-Cyclohexene-1-carboxaldehyde	105	57		
$\text{C}_7\text{H}_{10}\text{O}_4$	3,3-Diacetoxy-1-propene	180	82		
$\text{C}_7\text{H}_{12}$	4-Methylcyclohexene	102.7	–1		
$\text{C}_7\text{H}_{12}\text{O}_2$	Butyl acrylate	145	29	1.7–9.9%	292
$\text{C}_7\text{H}_{12}\text{O}_2$	Isobutyl acrylate	132	30		427
$\text{C}_7\text{H}_{12}\text{O}_2$	Cyclohexyl formate	162	51		
$\text{C}_7\text{H}_{12}\text{O}_4$	Diethyl malonate	200	93		
$\text{C}_7\text{H}_{14}$	1-Heptene	93.6	–1		260
$\text{C}_7\text{H}_{14}$	<i>trans</i> -2-Heptene	98	<0		
$\text{C}_7\text{H}_{14}$	Cycloheptane	118.4	<21	1.1–6.7%	
$\text{C}_7\text{H}_{14}$	Methylcyclohexane	100.9	–4	1.2–6.7%	250
$\text{C}_7\text{H}_{14}$	Ethylcyclopentane	103.5	<21	1.1–6.7%	260
$\text{C}_7\text{H}_{14}\text{O}$	2-Heptanone	151.0	39	1.1–7.9%	393
$\text{C}_7\text{H}_{14}\text{O}$	3-Heptanone	147	46		
$\text{C}_7\text{H}_{14}\text{O}$	4-Heptanone	144	49		
$\text{C}_7\text{H}_{14}\text{O}$	5-Methyl-2-hexanone	144	36	1.0–8.2%	191
$\text{C}_7\text{H}_{14}\text{O}$	<i>cis</i> -2-Methylcyclohexanol	165	65		296
$\text{C}_7\text{H}_{14}\text{O}$	<i>trans</i> -2-Methylcyclohexanol	167.5	65		296
$\text{C}_7\text{H}_{14}\text{O}$	<i>cis</i> -3-Methylcyclohexanol	174.5	70		295
$\text{C}_7\text{H}_{14}\text{O}$	<i>trans</i> -3-Methylcyclohexanol	174.5	70		295
$\text{C}_7\text{H}_{14}\text{O}$	<i>cis</i> -4-Methylcyclohexanol	173	70		295
$\text{C}_7\text{H}_{14}\text{O}$	<i>trans</i> -4-Methylcyclohexanol	174	70		295
$\text{C}_7\text{H}_{14}\text{O}_2$	Pentyl acetate	149.2	16	1.1–7.5%	360
$\text{C}_7\text{H}_{14}\text{O}_2$	Isopentyl acetate	142.5	25	1.0–7.5%	360
$\text{C}_7\text{H}_{14}\text{O}_2$	<i>sec</i> -Pentyl acetate	130.5	32		
$\text{C}_7\text{H}_{14}\text{O}_2$	Butyl propanoate	146.8	32		426
$\text{C}_7\text{H}_{14}\text{O}_2$	Propyl butanoate	143.0	37		
$\text{C}_7\text{H}_{15}\text{NO}_2$	Ethyl <i>N</i> -butylcarbamate	202	92		
$\text{C}_7\text{H}_{16}$	Heptane	98.5	–4	1.05–6.7%	204
$\text{C}_7\text{H}_{16}$	2-Methylhexane	90.0	–1	1.0–6.0%	280
$\text{C}_7\text{H}_{16}$	3-Methylhexane	92	–4		280
$\text{C}_7\text{H}_{16}$	2,3-Dimethylpentane	89.7	–56	1.1–6.7%	335
$\text{C}_7\text{H}_{16}$	2,4-Dimethylpentane	80.4	–12		
$\text{C}_7\text{H}_{16}$	2,2,3-Trimethylbutane	80.8	<0		412
$\text{C}_7\text{H}_{16}\text{N}_2\text{O}$	4-Morpholinepropanamine	220	104		
$\text{C}_7\text{H}_{16}\text{O}$	2-Heptanol	159	71		
$\text{C}_7\text{H}_{16}\text{O}$	3-Heptanol	157	60		
$\text{C}_7\text{H}_{16}\text{O}$	2,4-Dimethyl-3-pentanol	138.7	49		
$\text{C}_7\text{H}_{16}\text{O}$	2,3,3-Trimethyl-2-butanol	131	<0		375
$\text{C}_7\text{H}_{17}\text{N}$	Heptylamine	156	54		
$\text{C}_7\text{H}_{18}\text{N}_2$	<i>N,N</i> -Diethyl-1,3-propanediamine	168.5	59		
$\text{C}_8\text{H}_4\text{O}_3$	Phthalic anhydride	295	152	1.7–10.5%	570
$\text{C}_8\text{H}_6\text{O}_4$	Phthalic acid		168		
$\text{C}_8\text{H}_6\text{O}_4$	Terephthalic acid		260		496
$\text{C}_8\text{H}_7\text{ClO}$	$\alpha$ -Chloroacetophenone	247	118		
$\text{C}_8\text{H}_7\text{N}$	Benzeneacetonitrile	233.5	113		
$\text{C}_8\text{H}_8$	Styrene	145	31	0.9–6.8%	490
$\text{C}_8\text{H}_8\text{O}$	Phenyloxirane	194.1	74		498
$\text{C}_8\text{H}_8\text{O}$	Benzeneacetaldehyde	195	71		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_8\text{H}_8\text{O}$	Acetophenone	202	77		570
$\text{C}_8\text{H}_8\text{O}_2$	Benzeneacetic acid	265.5	>100		
$\text{C}_8\text{H}_8\text{O}_2$	Phenyl acetate	196	80		
$\text{C}_8\text{H}_8\text{O}_2$	Methyl benzoate	199	83		
$\text{C}_8\text{H}_8\text{O}_2$	2-Methoxybenzaldehyde	243.5	118		
$\text{C}_8\text{H}_8\text{O}_3$	Methyl salicylate	222.9	96		454
$\text{C}_8\text{H}_9\text{Cl}$	1-Chloro-4-ethylbenzene	184.4	64		
$\text{C}_8\text{H}_9\text{NO}$	Acetanilide	304	169		530
$\text{C}_8\text{H}_9\text{NO}_2$	Methyl 2-aminobenzoate	256	>100		
$\text{C}_8\text{H}_{10}$	Ethylbenzene	136.1	21	0.8–6.7%	432
$\text{C}_8\text{H}_{10}$	<i>o</i> -Xylene	144.5	32	0.9–6.7%	463
$\text{C}_8\text{H}_{10}$	<i>m</i> -Xylene	139.1	27	1.1–7.0%	527
$\text{C}_8\text{H}_{10}$	<i>p</i> -Xylene	138.3	27	1.1–7.0%	528
$\text{C}_8\text{H}_{10}\text{O}$	<i>p</i> -Ethylphenol	217.9	104		
$\text{C}_8\text{H}_{10}\text{O}$	Benzeneethanol	218.2	96		
$\text{C}_8\text{H}_{10}\text{O}$	$\alpha$ -Methylbenzyl alcohol	205	93		
$\text{C}_8\text{H}_{10}\text{O}$	Phenetole	169.8	63		
$\text{C}_8\text{H}_{10}\text{O}$	Benzyl methyl ether	170	135		
$\text{C}_8\text{H}_{10}\text{O}$	4-Methylanisole	175.5	60		
$\text{C}_8\text{H}_{10}\text{O}_2$	2-Phenoxyethanol	245	121		
$\text{C}_8\text{H}_{11}\text{N}$	<i>N</i> -Ethylaniline	203.0	85		
$\text{C}_8\text{H}_{11}\text{N}$	<i>N,N</i> -Dimethylaniline	194.1	63		371
$\text{C}_8\text{H}_{11}\text{N}$	2,3-Xylidine	221.5	97	1.0–?	
$\text{C}_8\text{H}_{11}\text{N}$	2,6-Xylidine	215	96		
$\text{C}_8\text{H}_{11}\text{N}$	$\alpha$ -Methylbenzylamine	187	79		
$\text{C}_8\text{H}_{11}\text{N}$	5-Ethyl-2-picoline	178.3	68	1.1–6.6%	
$\text{C}_8\text{H}_{11}\text{NO}$	<i>N</i> -Phenylethanolamine	279.5	152		
$\text{C}_8\text{H}_{11}\text{NO}$	<i>o</i> -Phenetidine	232.5	115		
$\text{C}_8\text{H}_{11}\text{NO}$	<i>p</i> -Phenetidine	254	116		
$\text{C}_8\text{H}_{12}$	1,5-Cyclooctadiene	150.8	35		
$\text{C}_8\text{H}_{12}$	4-Vinylcyclohexene	128	16		269
$\text{C}_8\text{H}_{12}\text{O}_4$	Diethyl maleate	223	121		350
$\text{C}_8\text{H}_{12}\text{O}_4$	Diethyl fumarate	214	104		
$\text{C}_8\text{H}_{14}\text{O}_2$	Cyclohexyl acetate	173	58		335
$\text{C}_8\text{H}_{14}\text{O}_2$	Butyl methacrylate	160	52		
$\text{C}_8\text{H}_{14}\text{O}_3$	Butanoic anhydride	200	54	0.9–5.8%	279
$\text{C}_8\text{H}_{14}\text{O}_3$	2-Methylpropanoic anhydride	183	59	1.0–6.2%	329
$\text{C}_8\text{H}_{14}\text{O}_3$	Butyl acetoacetate		85		
$\text{C}_8\text{H}_{14}\text{O}_4$	Ethyl succinate	217.7	90		
$\text{C}_8\text{H}_{14}\text{O}_5$	Diethylene glycol diacetate	200	135		
$\text{C}_8\text{H}_{14}\text{O}_6$	Diethyl tartrate	281	93		
$\text{C}_8\text{H}_{15}\text{ClO}$	Octanoyl chloride	195.6	82		
$\text{C}_8\text{H}_{16}$	1-Octene	121.2	21		230
$\text{C}_8\text{H}_{16}$	2,4,4-Trimethyl-1-pentene	101.4	-5	0.8–4.8%	391
$\text{C}_8\text{H}_{16}$	2,4,4-Trimethyl-2-pentene	104.9	2		305
$\text{C}_8\text{H}_{16}$	Ethylcyclohexane	131.9	35	0.9–6.6%	238
$\text{C}_8\text{H}_{16}$	<i>cis</i> -1,2-Dimethylcyclohexane	129.8	16		304
$\text{C}_8\text{H}_{16}$	<i>trans</i> -1,2-Dimethylcyclohexane	123.5	11		304
$\text{C}_8\text{H}_{16}$	<i>cis</i> -1,4-Dimethylcyclohexane	124.4	16		
$\text{C}_8\text{H}_{16}$	Propylcyclopentane	131			269
$\text{C}_8\text{H}_{16}\text{O}$	Octanal	171	52		
$\text{C}_8\text{H}_{16}\text{O}$	2-Ethylhexanal	163	44	0.85–7.2%	190
$\text{C}_8\text{H}_{16}\text{O}$	2-Octanone	172.5	52		
$\text{C}_8\text{H}_{16}\text{O}_2$	Hexyl acetate	171.5	45		
$\text{C}_8\text{H}_{16}\text{O}_2$	<i>sec</i> -Hexyl acetate	147.5	45		
$\text{C}_8\text{H}_{16}\text{O}_2$	2-Ethylbutyl acetate	162.5	54		
$\text{C}_8\text{H}_{16}\text{O}_2$	Pentyl propanoate	168.6	41		378
$\text{C}_8\text{H}_{16}\text{O}_2$	Butyl butanoate	166	53		
$\text{C}_8\text{H}_{16}\text{O}_2$	Isobutyl butanoate	156.9	50		
$\text{C}_8\text{H}_{16}\text{O}_2$	Isobutyl isobutanoate	148.6	38	0.96–7.59%	432
$\text{C}_8\text{H}_{16}\text{O}_2$	Ethyl hexanoate	167	49		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_8\text{H}_{16}\text{O}_2$	1,4-Cyclohexanedimethanol	283	167		316
$\text{C}_8\text{H}_{16}\text{O}_3$	Pentyl lactate		79		
$\text{C}_8\text{H}_{16}\text{O}_4$	Diethylene glycol monoethyl ether acetate	218.5	110		425
$\text{C}_8\text{H}_{17}\text{Cl}$	1-Chlorooctane	181.5	70		
$\text{C}_8\text{H}_{17}\text{Cl}$	3-(Chloromethyl)heptane		60		
$\text{C}_8\text{H}_{18}$	Octane	125.6	13	1.0–6.5%	206
$\text{C}_8\text{H}_{18}$	2,3-Dimethylhexane	115.6	7		438
$\text{C}_8\text{H}_{18}$	2,4-Dimethylhexane	109.5	10		
$\text{C}_8\text{H}_{18}$	3-Ethyl-2-methylpentane	115.6	<21		460
$\text{C}_8\text{H}_{18}$	2,2,3-Trimethylpentane	110	<21		346
$\text{C}_8\text{H}_{18}$	2,2,4-Trimethylpentane	99.2	-12		418
$\text{C}_8\text{H}_{18}$	2,3,3-Trimethylpentane	114.8	<21		425
$\text{C}_8\text{H}_{18}\text{O}$	1-Octanol	195.1	81		
$\text{C}_8\text{H}_{18}\text{O}$	2-Octanol	180	88		
$\text{C}_8\text{H}_{18}\text{O}$	2-Ethyl-1-hexanol	184.6	73	0.88–9.7%	231
$\text{C}_8\text{H}_{18}\text{O}$	Dibutyl ether	140.2	25	1.5–7.6%	194
$\text{C}_8\text{H}_{18}\text{O}_2$	2-Ethyl-1,3-hexanediol	244	127		360
$\text{C}_8\text{H}_{18}\text{O}_2$	2,2,4-Trimethyl-1,3-pentanediol	235	113		346
$\text{C}_8\text{H}_{18}\text{O}_2$	Di- <i>tert</i> -butyl peroxide	111	18		
$\text{C}_8\text{H}_{18}\text{O}_3$	Diethylene glycol diethyl ether	188	82		
$\text{C}_8\text{H}_{18}\text{O}_4$	2,5,8,11-Tetraoxadodecane	216	111		
$\text{C}_8\text{H}_{18}\text{O}_5$	Tetraethylene glycol	328	182		
$\text{C}_8\text{H}_{18}\text{S}$	1-Octanethiol	199.1	69		
$\text{C}_8\text{H}_{18}\text{S}$	Dibutyl sulfide	185	76		
$\text{C}_8\text{H}_{19}\text{N}$	Octylamine	179.6	60		
$\text{C}_8\text{H}_{19}\text{N}$	Dibutylamine	159.6	47	1.1–6%	
$\text{C}_8\text{H}_{19}\text{N}$	Diisobutylamine	139.6	29		
$\text{C}_8\text{H}_{19}\text{N}$	2-Ethylhexylamine	169.2	60		
$\text{C}_8\text{H}_{20}\text{O}_4\text{Si}$	Ethyl silicate	168.8	52		
$\text{C}_8\text{H}_{23}\text{N}_5$	Tetraethylenepentamine	341.5	163		321
$\text{C}_9\text{H}_6\text{N}_2\text{O}_2$	Toluene-2,4-diisocyanate	251	127	0.9–9.5%	
$\text{C}_9\text{H}_7\text{N}$	Quinoline	237.1			480
$\text{C}_9\text{H}_{10}$	<i>o</i> -Methylstyrene	169.8	53	0.8–11.0%	538
$\text{C}_9\text{H}_{10}$	<i>m</i> -Methylstyrene	164	53	0.8–11.0%	538
$\text{C}_9\text{H}_{10}$	<i>p</i> -Methylstyrene	172.8	53	0.8–11.0%	538
$\text{C}_9\text{H}_{10}$	Isopropenylbenzene	165.4	54	1.9–6.1%	574
$\text{C}_9\text{H}_{10}\text{O}$	1-Phenyl-1-propanone	217.5	99		
$\text{C}_9\text{H}_{10}\text{O}$	4-Methylacetophenone	226	96		
$\text{C}_9\text{H}_{10}\text{O}_2$	Ethyl benzoate	212	88		490
$\text{C}_9\text{H}_{10}\text{O}_2$	Benzyl acetate	213	90		460
$\text{C}_9\text{H}_{10}\text{O}_2$	Methyl 2-phenylacetate	216.5	91		
$\text{C}_9\text{H}_{11}\text{NO}$	4-Methylacetanilide	307	168		
$\text{C}_9\text{H}_{12}$	Propylbenzene	159.2	30	0.8–6.0%	450
$\text{C}_9\text{H}_{12}$	Isopropylbenzene	152.4	36	0.9–6.5%	424
$\text{C}_9\text{H}_{12}$	<i>o</i> -Ethyltoluene	165.2			440
$\text{C}_9\text{H}_{12}$	<i>m</i> -Ethyltoluene	161.3			480
$\text{C}_9\text{H}_{12}$	<i>p</i> -Ethyltoluene	162			475
$\text{C}_9\text{H}_{12}$	1,2,3-Trimethylbenzene	176.1	44	0.8–6.6%	470
$\text{C}_9\text{H}_{12}$	1,2,4-Trimethylbenzene	169.3	44	0.9–6.4%	500
$\text{C}_9\text{H}_{12}$	1,3,5-Trimethylbenzene	164.7	50	1–5%	559
$\text{C}_9\text{H}_{12}\text{O}$	$\alpha$ -Ethylbenzyl alcohol	219	100		
$\text{C}_9\text{H}_{12}\text{O}_2$	Ethylene glycol monobenzyl ether	256	129		352
$\text{C}_9\text{H}_{12}\text{O}_3\text{S}$	Ethyl <i>p</i> -toluenesulfonate		158		
$\text{C}_9\text{H}_{13}\text{N}$	Amphetamine	203	<100		
$\text{C}_9\text{H}_{14}\text{O}$	Phorone	197.5	85		
$\text{C}_9\text{H}_{14}\text{O}$	Isophorone	215.2	84	0.8–3.8%	460
$\text{C}_9\text{H}_{14}\text{O}_6$	Triacetin	259	138	1.0–?	433
$\text{C}_9\text{H}_{16}$	Octahydroindene	167			296
$\text{C}_9\text{H}_{16}\text{O}_2$	Allyl hexanoate	186	66		
$\text{C}_9\text{H}_{18}$	1-Nonene	146.9	26		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_9\text{H}_{18}$	Propylcyclohexane	156.7			248
$\text{C}_9\text{H}_{18}$	Isopropylcyclohexane	154.8			283
$\text{C}_9\text{H}_{18}$	Butylcyclopentane	156.6			250
$\text{C}_9\text{H}_{18}\text{O}$	2-Nonanone	195.3	60	0.9–5.9%	360
$\text{C}_9\text{H}_{18}\text{O}$	Diisobutyl ketone	169.4	49	0.8–7.1%	396
$\text{C}_9\text{H}_{18}\text{O}_2$	Pentyl butanoate	186.4	57		
$\text{C}_9\text{H}_{18}\text{O}_2$	Isopentyl butanoate	179	59		
$\text{C}_9\text{H}_{18}\text{O}_2$	Butyl 3-methylbutanoate		53		
$\text{C}_9\text{H}_{20}$	Nonane	150.8	31	0.8–2.9%	205
$\text{C}_9\text{H}_{20}$	3-Ethyl-4-methylhexane	140	24		
$\text{C}_9\text{H}_{20}$	4-Ethyl-2-methylhexane	133.8	<21	0.7–?	280
$\text{C}_9\text{H}_{20}$	2,2,5-Trimethylhexane	124.0	13		
$\text{C}_9\text{H}_{20}$	3,3-Diethylpentane	146.3		0.7–5.7%	290
$\text{C}_9\text{H}_{20}$	3-Ethyl-2,4-dimethylpentane	136.7	390		
$\text{C}_9\text{H}_{20}$	2,2,3,3-Tetramethylpentane	140.2	<21	0.8–4.9%	430
$\text{C}_9\text{H}_{20}$	2,2,3,4-Tetramethylpentane	133.0	<21		
$\text{C}_9\text{H}_{21}\text{BO}_3$	Triisopropyl borate	140	28		
$\text{C}_9\text{H}_{21}\text{N}$	Tripropylamine	156	41		
$\text{C}_9\text{H}_{21}\text{NO}_3$	Triisopropanolamine		160		320
$\text{C}_{10}\text{H}_7\text{Cl}$	1-Chloronaphthalene	259	121		>558
$\text{C}_{10}\text{H}_8$	Naphthalene	217.9	79	0.9–5.9%	526
$\text{C}_{10}\text{H}_8\text{O}$	2-Naphthol	285	153		
$\text{C}_{10}\text{H}_9\text{N}$	1-Naphthalenamine	300.8	157		
$\text{C}_{10}\text{H}_{10}\text{O}_2$	Safrole	234.5	100		
$\text{C}_{10}\text{H}_{10}\text{O}_4$	Dimethyl phthalate	283.7	146	0.9–?	490
$\text{C}_{10}\text{H}_{10}\text{O}_4$	Dimethyl isophthalate	282	138		
$\text{C}_{10}\text{H}_{10}\text{O}_4$	Dimethyl terephthalate	288	153		518
$\text{C}_{10}\text{H}_{11}\text{NO}_2$	Acetoacetanilide		185		
$\text{C}_{10}\text{H}_{12}$	1,2,3,4-Tetrahydronaphthalene	207.6	71	0.8–5.0%	385
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Isopropyl benzoate	216	99		
$\text{C}_{10}\text{H}_{12}\text{O}_2$	Ethyl phenylacetate	227	99		
$\text{C}_{10}\text{H}_{14}$	Butylbenzene	183.3	71	0.8–5.8%	410
$\text{C}_{10}\text{H}_{14}$	<i>sec</i> -Butylbenzene	173.3	52	0.8–6.9%	418
$\text{C}_{10}\text{H}_{14}$	<i>tert</i> -Butylbenzene	169.1	60	0.7–5.7%	450
$\text{C}_{10}\text{H}_{14}$	Isobutylbenzene	172.7	55	0.8–6.0%	427
$\text{C}_{10}\text{H}_{14}$	<i>p</i> -Cymene	177.1	47	0.7–5.6%	436
$\text{C}_{10}\text{H}_{14}$	1,2,3,4-Tetramethylbenzene	205	74		427
$\text{C}_{10}\text{H}_{14}$	1,2,3,5-Tetramethylbenzene	198	71		427
$\text{C}_{10}\text{H}_{14}$	1,2,4,5-Tetramethylbenzene	196.8	54		
$\text{C}_{10}\text{H}_{14}$	<i>o</i> -Diethylbenzene	184	57		395
$\text{C}_{10}\text{H}_{14}$	<i>m</i> -Diethylbenzene	181.1	56		450
$\text{C}_{10}\text{H}_{14}$	<i>p</i> -Diethylbenzene	183.7	55	0.7–6.0%	430
$\text{C}_{10}\text{H}_{14}\text{O}$	Butyl phenyl ether	210	82		
$\text{C}_{10}\text{H}_{14}\text{O}_2$	4- <i>tert</i> -Butyl-1,2-benzenediol	285	130		
$\text{C}_{10}\text{H}_{15}\text{N}$	<i>N</i> -Butylaniline	243.5	107		
$\text{C}_{10}\text{H}_{15}\text{N}$	<i>N,N</i> -Diethylaniline	216.3	85		630
$\text{C}_{10}\text{H}_{15}\text{NO}_2$	<i>N</i> -Phenyl- <i>N,N</i> -diethanolamine		196	0.7–?	387
$\text{C}_{10}\text{H}_{16}$	Dipentene	178	45		237
$\text{C}_{10}\text{H}_{16}$	<i>d</i> -Limonene	178	45	0.7–6.1%	237
$\text{C}_{10}\text{H}_{16}$	$\alpha$ -Pinene	156.2	33		255
$\text{C}_{10}\text{H}_{16}$	$\beta$ -Pinene	166	38		275
$\text{C}_{10}\text{H}_{16}$	$\beta$ -Phellandrene	171.5	49		
$\text{C}_{10}\text{H}_{16}\text{O}$	Camphor	207.4	66	0.6–3.5%	466
$\text{C}_{10}\text{H}_{18}$	<i>trans</i> -Decahydronaphthalene	187.3	54	0.7–5.4%	255
$\text{C}_{10}\text{H}_{18}\text{O}$	Borneol		66		
$\text{C}_{10}\text{H}_{18}\text{O}$	Linalol	198	71		
$\text{C}_{10}\text{H}_{18}\text{O}$	$\alpha$ -Terpineol	220	90		
$\text{C}_{10}\text{H}_{18}\text{O}$	Cineole	176.4	48		
$\text{C}_{10}\text{H}_{18}\text{O}$	<i>trans</i> -Geraniol	230	>100		
$\text{C}_{10}\text{H}_{18}\text{O}_4$	Dibutyl oxalate	241	104		
$\text{C}_{10}\text{H}_{19}\text{NO}_2$	<i>N-tert</i> -Butylaminoethyl methacrylate		96		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_{10}\text{H}_{20}$	1-Decene	170.5	<55		235
$\text{C}_{10}\text{H}_{20}$	Butylcyclohexane	180.9			246
$\text{C}_{10}\text{H}_{20}$	Isobutylcyclohexane	171.3			274
$\text{C}_{10}\text{H}_{20}$	<i>tert</i> -Butylcyclohexane	171.5			342
$\text{C}_{10}\text{H}_{20}\text{O}$	Citronellol	224	96		
$\text{C}_{10}\text{H}_{20}\text{O}_2$	2-Ethylhexyl acetate	199	71	0.76–8.14%	268
$\text{C}_{10}\text{H}_{20}\text{O}_2$	Ethyl octanoate	208.5	79		
$\text{C}_{10}\text{H}_{21}\text{N}$	<i>N</i> -Butylcyclohexanamine		93		
$\text{C}_{10}\text{H}_{22}$	Decane	174.1	51	0.8–5.4%	210
$\text{C}_{10}\text{H}_{22}$	2-Methylnonane	167.1			210
$\text{C}_{10}\text{H}_{22}$	3-Ethyloctane	166.5			230
$\text{C}_{10}\text{H}_{22}$	4-Ethyloctane	163.7			229
$\text{C}_{10}\text{H}_{22}\text{O}$	1-Decanol	231.1	82		288
$\text{C}_{10}\text{H}_{22}\text{O}$	Dipentyl ether	190	57		170
$\text{C}_{10}\text{H}_{22}\text{O}_2$	Ethylene glycol dibutyl ether	203.3	85		
$\text{C}_{10}\text{H}_{22}\text{O}_5$	Tetraethylene glycol dimethyl ether	275.3	141		
$\text{C}_{10}\text{H}_{22}\text{S}$	Dipentyl sulfide		85		
$\text{C}_{10}\text{H}_{23}\text{N}$	Decylamine	220.5	99		
$\text{C}_{10}\text{H}_{23}\text{N}$	Dipentylamine	202.5	51		
$\text{C}_{11}\text{H}_{10}$	1-Methylnaphthalene	244.7			529
$\text{C}_{11}\text{H}_{12}\text{O}_3$	Ethyl benzoylacetate		141		
$\text{C}_{11}\text{H}_{14}\text{O}_2$	Butyl benzoate	250.3	107		
$\text{C}_{11}\text{H}_{16}$	<i>p-tert</i> -Butyltoluene	190	68		
$\text{C}_{11}\text{H}_{16}$	Pentylbenzene	205.4	66		
$\text{C}_{11}\text{H}_{16}$	1,3-Diethyl-5-methylbenzene	205			455
$\text{C}_{11}\text{H}_{16}$	Pentamethylbenzene	232	93		427
$\text{C}_{11}\text{H}_{16}\text{O}$	4- <i>tert</i> -Butyl-2-methylphenol	237	118		
$\text{C}_{11}\text{H}_{17}\text{N}$	<i>p-tert</i> -Pentylaniline	260.5	102		
$\text{C}_{11}\text{H}_{20}\text{O}_2$	2-Ethylhexyl acrylate		82		252
$\text{C}_{11}\text{H}_{22}$	Pentylcyclohexane	203.7			239
$\text{C}_{11}\text{H}_{22}\text{O}$	2-Undecanone	231.5	89		
$\text{C}_{11}\text{H}_{22}\text{O}_2$	Nonyl acetate	210	68		
$\text{C}_{11}\text{H}_{24}$	Undecane	195.9	69		
$\text{C}_{11}\text{H}_{24}$	2-Methyldecane	189.3			225
$\text{C}_{11}\text{H}_{24}\text{O}$	2-Undecanol	228	113		
$\text{C}_{12}\text{H}_9\text{Br}$	4-Bromo-1,1'-biphenyl	310	144		
$\text{C}_{12}\text{H}_{10}$	Biphenyl	256.1	113	0.6–5.8%	540
$\text{C}_{12}\text{H}_{10}\text{Cl}_2\text{Si}$	Dichlorodiphenylsilane	305	142		
$\text{C}_{12}\text{H}_{10}\text{O}$	<i>o</i> -Phenylphenol	286	124		530
$\text{C}_{12}\text{H}_{10}\text{O}$	Diphenyl ether	258.0	112	0.8–1.5%	618
$\text{C}_{12}\text{H}_{11}\text{N}$	2-Aminobiphenyl	299			450
$\text{C}_{12}\text{H}_{11}\text{N}$	Diphenylamine	302	153		634
$\text{C}_{12}\text{H}_{12}$	1-Ethyl-naphthalene	258.6			480
$\text{C}_{12}\text{H}_{14}\text{O}_4$	Diethyl phthalate	295	161	0.7–?	457
$\text{C}_{12}\text{H}_{14}\text{O}_4$	Diethyl terephthalate	302	117		
$\text{C}_{12}\text{H}_{16}$	Cyclohexylbenzene	240.1	99		
$\text{C}_{12}\text{H}_{16}\text{O}_3$	Pentyl salicylate	270	132		
$\text{C}_{12}\text{H}_{17}\text{NO}$	<i>N</i> -Butyl- <i>N</i> -phenylacetamide	281	141		
$\text{C}_{12}\text{H}_{18}$	1,5,9-Cyclododecatriene	240	71		
$\text{C}_{12}\text{H}_{20}\text{O}_4$	Dibutyl maleate	280	141		
$\text{C}_{12}\text{H}_{22}\text{O}_4$	Dimethyl sebacate		145		
$\text{C}_{12}\text{H}_{22}\text{O}_6$	Dibutyl tartrate	320	91		284
$\text{C}_{12}\text{H}_{23}\text{N}$	Dicyclohexylamine		>99		
$\text{C}_{12}\text{H}_{24}$	1-Dodecene	213.8	79		
$\text{C}_{12}\text{H}_{24}\text{O}_2$	Ethyl decanoate	241.5	>100		
$\text{C}_{12}\text{H}_{25}\text{Br}$	1-Bromododecane	276	144		
$\text{C}_{12}\text{H}_{26}$	Dodecane	216.3	74	0.6–?	203
$\text{C}_{12}\text{H}_{26}\text{O}$	1-Dodecanol	259	127		275
$\text{C}_{12}\text{H}_{26}\text{O}$	2-Butyl-1-octanol	246.5	110		
$\text{C}_{12}\text{H}_{26}\text{O}_3$	Diethylene glycol dibutyl ether	256	118		310
$\text{C}_{12}\text{H}_{26}\text{S}$	1-Dodecanethiol	277	128		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_{12}\text{H}_{27}\text{BO}_3$	Tributyl borate	234	93		
$\text{C}_{12}\text{H}_{27}\text{N}$	Tributylamine	216.5	63		
$\text{C}_{12}\text{H}_{27}\text{O}_4\text{P}$	Tributyl phosphate	289	146		
$\text{C}_{13}\text{H}_{12}$	2-Methylbiphenyl	255.5	137		502
$\text{C}_{13}\text{H}_{12}$	Diphenylmethane	265.0	130		485
$\text{C}_{13}\text{H}_{14}\text{N}_2$	<i>p,p'</i> -Diaminodiphenylmethane	398	220		
$\text{C}_{13}\text{H}_{26}$	1-Tridecene	232.8	79		
$\text{C}_{13}\text{H}_{26}\text{O}$	2-Tridecanone	263	107		
$\text{C}_{13}\text{H}_{28}$	Tridecane	235.4	79		
$\text{C}_{13}\text{H}_{28}\text{O}$	1-Tridecanol		121		
$\text{C}_{14}\text{H}_8\text{O}_2$	9,10-Anthracenedione	377	185		
$\text{C}_{14}\text{H}_{10}$	Anthracene	339.9	121	0.6-?	540
$\text{C}_{14}\text{H}_{10}$	Phenanthrene	340	171		
$\text{C}_{14}\text{H}_{12}\text{O}_2$	Benzyl benzoate	323.5	148		480
$\text{C}_{14}\text{H}_{12}\text{O}_3$	Benzyl salicylate	320	>100		
$\text{C}_{14}\text{H}_{14}$	1,1-Diphenylethane	272.6	>100		440
$\text{C}_{14}\text{H}_{14}\text{O}$	Dibenzyl ether	298	135		
$\text{C}_{14}\text{H}_{16}$	1-Butylnaphthalene	289.3	360		
$\text{C}_{14}\text{H}_{16}\text{N}_2\text{O}_2$	<i>o</i> -Dianisidine		206		
$\text{C}_{14}\text{H}_{23}\text{N}$	<i>N,N</i> -Dibutylaniline	274.8	110		
$\text{C}_{14}\text{H}_{28}$	1-Tetradecene	233	110		235
$\text{C}_{14}\text{H}_{30}$	Tetradecane	253.5	112	0.5-?	200
$\text{C}_{14}\text{H}_{30}\text{O}$	1-Tetradecanol	289	141		
$\text{C}_{15}\text{H}_{18}$	1-Pentylnaphthalene	307	124		
$\text{C}_{15}\text{H}_{24}$	Nonylbenzene	280.5	99		
$\text{C}_{15}\text{H}_{24}\text{O}$	2,6-Di- <i>tert</i> -butyl-4-methylphenol	265	127		
$\text{C}_{15}\text{H}_{26}\text{O}_6$	Tributyryl	307.5	180	0.5-?	407
$\text{C}_{15}\text{H}_{33}\text{N}$	Triptylamine	242.5	102		
$\text{C}_{16}\text{H}_{14}\text{O}$	1,3-Diphenyl-2-buten-1-one	342.5	177		
$\text{C}_{16}\text{H}_{18}$	2-Butyl-1,1'-biphenyl		>100		430
$\text{C}_{16}\text{H}_{22}\text{O}_4$	Dibutyl phthalate	340	157	0.5-?	402
$\text{C}_{16}\text{H}_{26}$	Decylbenzene	298	107		
$\text{C}_{16}\text{H}_{34}$	Hexadecane	286.8	136		202
$\text{C}_{16}\text{H}_{34}\text{O}$	Diocetyl ether	283	>100		205
$\text{C}_{16}\text{H}_{35}\text{N}$	Bis(2-ethylhexyl)amine		132		
$\text{C}_{17}\text{H}_{20}\text{N}_2\text{O}$	<i>N,N'</i> -Diethylcarbanilide		150		
$\text{C}_{17}\text{H}_{34}\text{O}$	2-Heptadecanone	320	120		
$\text{C}_{17}\text{H}_{36}\text{O}$	1-Heptadecanol	333	154		
$\text{C}_{18}\text{H}_{14}$	<i>o</i> -Terphenyl	332	163		
$\text{C}_{18}\text{H}_{14}$	<i>m</i> -Terphenyl	363	191		
$\text{C}_{18}\text{H}_{15}\text{O}_3\text{P}$	Triphenyl phosphite	360	218		
$\text{C}_{18}\text{H}_{15}\text{O}_4\text{P}$	Triphenyl phosphate		220		
$\text{C}_{18}\text{H}_{15}\text{P}$	Triphenylphosphine		180		
$\text{C}_{18}\text{H}_{30}$	Dodecylbenzene	328	140		
$\text{C}_{18}\text{H}_{32}\text{O}_7$	Butyl citrate		157		368
$\text{C}_{18}\text{H}_{34}\text{O}_2$	Oleic acid	360	189		363
$\text{C}_{18}\text{H}_{34}\text{O}_4$	Dibutyl sebacate	344.5	178	0.4-?	365
$\text{C}_{18}\text{H}_{36}\text{O}_2$	Stearic acid		196		395
$\text{C}_{18}\text{H}_{37}\text{Cl}_3\text{Si}$	Trichlorooctadecylsilane		89		
$\text{C}_{18}\text{H}_{38}$	Octadecane	316.3	>100		227
$\text{C}_{18}\text{H}_{38}\text{O}$	1-Octadecanol				450
$\text{C}_{19}\text{H}_{16}$	Triphenylmethane	359	>100		
$\text{C}_{19}\text{H}_{38}\text{O}$	2-Nonadecanone		124		
$\text{C}_{19}\text{H}_{38}\text{O}_2$	Methyl stearate	443	153		
$\text{C}_{19}\text{H}_{40}$	Nonadecane	329.9	>100		230
$\text{C}_{20}\text{H}_{14}\text{O}_4$	Diphenyl phthalate		224		
$\text{C}_{20}\text{H}_{28}$	1-Decylnaphthalene	379	177		
$\text{C}_{20}\text{H}_{42}$	Eicosane	343	>100		232
$\text{C}_{21}\text{H}_{21}\text{O}_4\text{P}$	Tri- <i>o</i> -cresyl phosphate	410	225		385
$\text{C}_{21}\text{H}_{26}\text{O}_3$	4-Octylphenyl salicylate		216		416
$\text{C}_{21}\text{H}_{32}\text{O}_2$	Methyl abietate		180		

Mol. form.	Name	$t_b/^\circ\text{C}$	FP/ $^\circ\text{C}$	Fl. limits	IT/ $^\circ\text{C}$
$\text{C}_{22}\text{H}_{42}\text{O}_2$	Butyl oleate		180		
$\text{C}_{22}\text{H}_{42}\text{O}_4$	Bis(2-ethylhexyl) adipate		206	0.4-?	377
$\text{C}_{22}\text{H}_{44}\text{O}_2$	Butyl stearate	343	160		355
$\text{C}_{23}\text{H}_{46}\text{O}_2$	Pentyl stearate		185		
$\text{C}_{24}\text{H}_{20}\text{Sn}$	Tetraphenylstannane	420	232		
$\text{C}_{24}\text{H}_{38}\text{O}_4$	Bis(2-ethylhexyl) phthalate	384	218		
$\text{C}_{25}\text{H}_{48}\text{O}_4$	Bis(2-ethylhexyl) azelate		227	0.3-?	374

## THRESHOLD LIMITS FOR AIRBORNE CONTAMINANTS

Several organizations recommend limits of exposure to airborne contaminants in the workplace. These include the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the non-governmental organization, American Conference of Governmental Industrial Hygienists (ACGIH). The threshold limit value (TLV) for a substance is defined as the concentration level under which the majority of workers may be repeatedly exposed, day after day, without adverse effects. The TLV recommendations are given in two forms:

- Time-weighted average (TWA) concentration for a normal 8-hr workday and 40-hr workweek.
- Short-term exposure limit (STEL), which should not be exceeded for more than 15 min.

Both kinds of limits are specified for some substances.

The following table gives threshold limit values for a number of substances that may be encountered in the atmosphere of a chemical laboratory or industrial facility. All values refer to the concentration in air at 25 °C and normal atmospheric pressure. Data for gases are given in parts per million by volume (ppm). Values for liquids refer to mists or aerosols, and those for solids to dusts or fumes; both are stated in mass concentration (mg/m<sup>3</sup>). A “C” preceding a value indicates a ceiling limit, which should not be exceeded even for very brief periods because of acute toxic effects of

the substance. The notation “levels as low as possible” in the Notes column indicates such a high level of hazard that no safe limit can be recommended.

Substances are listed alphabetically by systematic name. The Notes column gives further information on the form of the substance and the basis to which the TLV is referred. This column also includes common synonyms and acronyms in brackets (e.g., [MTBE]). The Formula column gives the molecular formula in the Hill convention for organic compounds and the customary line formula for inorganic compounds. The TWA and STEL limits appear in the last two columns.

Proposed changes in the limits are given in the Notes column with the notation “NIC”, which stands for Notice of Intended Changes. These are considered trial values in 2008, which may be adopted permanently in subsequent years.

### References

1. *2008 TLV's and BEI's*, American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634, 2008 ([www.acgih.org](http://www.acgih.org)).
2. *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, National Institute for Occupational Health and Safety, U.S. Government Printing Office, Washington, DC, 1994.
3. *Chemical Information Manual*, U.S. Department of Labor, Occupational Safety and Health Administration, Washington, DC, 1991.

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Abate	[Temephos]	C <sub>16</sub> H <sub>20</sub> O <sub>6</sub> P <sub>2</sub> S <sub>3</sub>	3383-96-8	10 mg/m <sup>3</sup>	
Acetaldehyde	[Ethanal]	C <sub>2</sub> H <sub>4</sub> O	75-07-0		C 25 ppm
Acetic acid	[Ethanoic acid]	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	64-19-7	10 ppm	15 ppm
Acetic anhydride	[Acetyl acetate]	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	108-24-7	5 ppm	
Acetone	[2-Propanone]	C <sub>3</sub> H <sub>6</sub> O	67-64-1	500 ppm	750 ppm
Acetone cyanohydrin	as CN	C <sub>4</sub> H <sub>7</sub> NO	75-86-5		C 5 mg/m <sup>3</sup>
Acetonitrile	[Methyl cyanide]	C <sub>2</sub> H <sub>3</sub> N	75-05-8	20 ppm	
Acetophenone	[Methyl phenyl ketone]	C <sub>8</sub> H <sub>8</sub> O	98-86-2	10 ppm	
2-(Acetyloxy)benzoic acid	[Aspirin]	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>	50-78-2	5 mg/m <sup>3</sup>	
Acrolein	[2-Propenal]	C <sub>3</sub> H <sub>4</sub> O	107-02-8		C 0.1 ppm
Acrylamide	[2-Propenamide]	C <sub>3</sub> H <sub>5</sub> NO	79-06-1	0.03 mg/m <sup>3</sup>	
Acrylic acid	[2-Propenoic acid]	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	79-10-7	2 ppm	
Acrylonitrile	[Propenenitrile]	C <sub>3</sub> H <sub>3</sub> N	107-13-1	2 ppm	
Alachlor	[Acetamide, 2-chloro- <i>N</i> -(2,6-diethylphenyl)- <i>N</i> -(methoxymethyl)-]	C <sub>14</sub> H <sub>20</sub> ClNO <sub>2</sub>	15972-60-8	1 mg/m <sup>3</sup>	
Aldrin		C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub>	309-00-2	0.05 mg/m <sup>3</sup>	
Allyl alcohol	[2-Propen-1-ol]	C <sub>3</sub> H <sub>6</sub> O	107-18-6	0.5 ppm	
Allyl glycidyl ether	[AGE]	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	106-92-3	1 ppm	
Allyl propyl disulfide		C <sub>6</sub> H <sub>12</sub> S <sub>2</sub>	2179-59-1	0.5 ppm	
Aluminum	metal dust and insoluble compounds	Al	7429-90-5	1 mg/m <sup>3</sup>	
4-Aminobiphenyl	[ <i>p</i> -Biphenylamine] levels as low as possible	C <sub>12</sub> H <sub>11</sub> N	92-67-1		
4-Amino-3,5,6-trichloro-2-pyridinecarboxylic acid	[Picloram]	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	1918-02-1	10 mg/m <sup>3</sup>	
Ammonia		NH <sub>3</sub>	7664-41-7	25 ppm	35 ppm
Ammonium chloride	fume	NH <sub>4</sub> Cl	12125-02-9	10 mg/m <sup>3</sup>	20 mg/m <sup>3</sup>
Ammonium perfluorooctanoate		C <sub>8</sub> H <sub>4</sub> F <sub>15</sub> NO <sub>2</sub>	3825-26-1	0.01 mg/m <sup>3</sup>	
Ammonium sulfamate		NH <sub>4</sub> NH <sub>2</sub> SO <sub>3</sub>	7773-06-0	10 mg/m <sup>3</sup>	



Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Aniline	[Benzenamine]	C <sub>6</sub> H <sub>7</sub> N	62-53-3	2 ppm	
Antimony	and compounds, as Sb	Sb	7440-36-0	0.5 mg/m <sup>3</sup>	
Antimony trioxide	levels as low as possible	Sb <sub>2</sub> O <sub>3</sub>	1309-64-4		
Arsenic	and inorganic compounds, as As	As	7440-38-2	0.01 mg/m <sup>3</sup>	
Arsine	[Arsenic hydride]	AsH <sub>3</sub>	7784-42-1	0.005 ppm	
Asbestos	all forms		1332-21-4	0.1 fiber/cm <sup>3</sup>	
Asphalt	fume, as aerosol		8052-42-4	0.5 mg/m <sup>3</sup>	
Atrazine	[6-Chloro- <i>N</i> -ethyl- <i>N'</i> -(1-methylethyl)-1,3,5-triazine-2,4-diamine]	C <sub>8</sub> H <sub>14</sub> ClN <sub>5</sub>	1912-24-9	5 mg/m <sup>3</sup>	
Azinphos-methyl		C <sub>10</sub> H <sub>12</sub> N <sub>3</sub> O <sub>3</sub> PS <sub>2</sub>	86-50-0	0.2 mg/m <sup>3</sup>	
Barium	and soluble compounds, as Ba	Ba	7440-39-3	0.5 mg/m <sup>3</sup>	
Barium sulfate	[Barite]	BaSO <sub>4</sub>	7727-43-7	10 mg/m <sup>3</sup>	
Benomyl		C <sub>14</sub> H <sub>18</sub> N <sub>4</sub> O <sub>3</sub>	17804-35-2	1 mg/m <sup>3</sup>	
Benz[a]anthracene	levels as low as possible	C <sub>18</sub> H <sub>12</sub>	56-55-3		
Benzene		C <sub>6</sub> H <sub>6</sub>	71-43-2	0.5 ppm	2.5 ppm
1,2-Benzenediamine	[ <i>o</i> -Phenylenediamine]	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	95-54-5	0.1 mg/m <sup>3</sup>	
1,3-Benzenediamine	[ <i>m</i> -Phenylenediamine]	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	108-45-2	0.1 mg/m <sup>3</sup>	
1,4-Benzenediamine	[ <i>p</i> -Phenylenediamine]	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	106-50-3	0.1 mg/m <sup>3</sup>	
1,3-Benzenedimethanamine	[ <i>m</i> -Xylene diamine]	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	1477-55-0		C 0.1 mg/m <sup>3</sup>
Benzenethiol	[Phenyl mercaptan]	C <sub>6</sub> H <sub>6</sub> S	108-98-5	0.1 ppm	
<i>p</i> -Benzidine	levels as low as possible	C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	92-87-5		
Benzo[b]fluoranthene	levels as low as possible	C <sub>20</sub> H <sub>12</sub>	205-99-2		
Benzo[a]pyrene	levels as low as possible	C <sub>20</sub> H <sub>12</sub>	50-32-8		
<i>p</i> -Benzoquinone	[Quinone]	C <sub>6</sub> H <sub>4</sub> O <sub>2</sub>	106-51-4	0.1 ppm	
Benzoyl chloride	[Benzoic acid, chloride]	C <sub>7</sub> H <sub>5</sub> ClO	98-88-4		C 0.5 ppm
Benzoyl peroxide		C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>	94-36-0	5 mg/m <sup>3</sup>	
Benzyl acetate	[(Acetoxymethyl)benzene]	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	140-11-4	10 ppm	
Beryllium	and compounds, as Be. NIC in 2008 to TWA 0.00005 mg/m <sup>3</sup> , STEL 0.0002 mg/m <sup>3</sup> .	Be	7440-41-7	0.002 mg/m <sup>3</sup>	0.01 mg/m <sup>3</sup>
Biphenyl	[Diphenyl]	C <sub>12</sub> H <sub>10</sub>	92-52-4	0.2 ppm	
Bis(2-aminoethyl)amine	[Diethylenetriamine]	C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>	111-40-0	1 ppm	
Bis(2-chloroethyl) ether	[2,2'-Dichloroethyl ether]	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	111-44-4	5 ppm	10 ppm
Bis(chloromethyl) ether	[Chloromethyl ether]	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	542-88-1	0.001 ppm	
Bis(2-dimethylaminoethyl) ether	[DMAEE]	C <sub>8</sub> H <sub>20</sub> N <sub>2</sub> O	3033-62-3	0.05 ppm	0.15 ppm
Bis(2-ethylhexyl) phthalate	[Di- <i>sec</i> -octyl phthalate; DEHP]	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	117-81-7	5 mg/m <sup>3</sup>	
Bismuth telluride	[Tetradymite]	Bi <sub>2</sub> Te <sub>3</sub>	1304-82-1	10 mg/m <sup>3</sup>	
Boric acid	and inorganic borate compounds	H <sub>3</sub> BO <sub>3</sub>	10043-35-3	2 mg/m <sup>3</sup>	6 mg/m <sup>3</sup>
Boron oxide	[Boric oxide]	B <sub>2</sub> O <sub>3</sub>	1303-86-2	10 mg/m <sup>3</sup>	
Boron tribromide	[Tribromoborane]	BBr <sub>3</sub>	10294-33-4		C 1 ppm
Boron trifluoride	[Trifluoroborane]	BF <sub>3</sub>	7637-07-2		C 1 ppm
Bromacil	[5-Bromo-3- <i>sec</i> -butyl-6-methyluracil]	C <sub>9</sub> H <sub>13</sub> BrN <sub>2</sub> O <sub>2</sub>	314-40-9	10 mg/m <sup>3</sup>	
Bromine		Br <sub>2</sub>	7726-95-6	0.1 ppm	0.2 ppm
Bromine pentafluoride		BrF <sub>5</sub>	7789-30-2	0.1 ppm	
Bromochloromethane	[Halon 1011]	CH <sub>2</sub> BrCl	74-97-5	200 ppm	
2-Bromo-2-chloro-1,1,1-trifluoroethane	[Halothane]	C <sub>2</sub> HBrClF <sub>3</sub>	151-67-7	50 ppm	
Bromoethane	[Ethyl bromide]	C <sub>2</sub> H <sub>5</sub> Br	74-96-4	5 ppm	
Bromoethene	[Vinyl bromide]	C <sub>2</sub> H <sub>3</sub> Br	593-60-2	0.5 ppm	
Bromomethane	[Methyl bromide]	CH <sub>3</sub> Br	74-83-9	1 ppm	
1-Bromopropane	[Propyl bromide]	C <sub>3</sub> H <sub>7</sub> Br	106-94-5	10 ppm	
Bromotrifluoromethane	[Trifluorobromomethane]	CBrF <sub>3</sub>	75-63-8	1000 ppm	
1,3-Butadiene	[Divinyl]	C <sub>4</sub> H <sub>6</sub>	106-99-0	2 ppm	
Butane		C <sub>4</sub> H <sub>10</sub>	106-97-8	1000 ppm	
1-Butanethiol	[Butyl mercaptan]	C <sub>4</sub> H <sub>10</sub> S	109-79-5	0.5 ppm	
1-Butanol	[Butyl alcohol]	C <sub>4</sub> H <sub>10</sub> O	71-36-3	20 ppm	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
2-Butanol	[ <i>sec</i> -Butyl alcohol]	C <sub>4</sub> H <sub>10</sub> O	78-92-2	100 ppm	
2-Butanone	[Methyl ethyl ketone; MEK]	C <sub>4</sub> H <sub>8</sub> O	78-93-3	200 ppm	300 ppm
2-Butanone peroxide	[Methyl ethyl ketone peroxide]	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	1338-23-4		C 0.2 ppm
<i>trans</i> -2-Butenal	[Crotonaldehyde]	C <sub>4</sub> H <sub>6</sub> O	4170-30-3		C 0.3 ppm
1-Butene	[1-Butylene]	C <sub>4</sub> H <sub>8</sub>	106-98-9	250 ppm	
<i>cis</i> -2-Butene		C <sub>4</sub> H <sub>8</sub>	590-18-1	250 ppm	
<i>trans</i> -2-Butene		C <sub>4</sub> H <sub>8</sub>	624-64-6	250 ppm	
3-Buten-2-one	[Methyl vinyl ketone]	C <sub>4</sub> H <sub>6</sub> O	78-94-4		C 0.2 ppm
2-Butoxyethanol	[EGBE]	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	111-76-2	20 ppm	
2-Butoxyethyl acetate	[EGBEA]	C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>	112-07-2	20 ppm	
Butyl acetate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	123-86-4	150 ppm	200 ppm
<i>sec</i> -Butyl acetate	[1-Methylpropyl acetate]	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	105-46-4	200 ppm	
<i>tert</i> -Butyl acetate		C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	540-88-5	200 ppm	
Butyl acrylate	[Butyl 2-propenoate]	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	141-32-2	2 ppm	
Butylamine	[1-Butanamine]	C <sub>4</sub> H <sub>11</sub> N	109-73-9		C 5 ppm
<i>tert</i> -Butyl chromate	as CrO <sub>3</sub>	C <sub>8</sub> H <sub>18</sub> CrO <sub>4</sub>	1189-85-1		C 0.1 mg/m <sup>3</sup>
<i>tert</i> -Butyl ethyl ether	[ETBE]	C <sub>6</sub> H <sub>14</sub> O	637-92-3	5 ppm	
Butyl glycidyl ether	[BGE]	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	2426-08-6	3 ppm	
Butyl lactate		C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	138-22-7	5 ppm	
1- <i>tert</i> -Butyl-4-methylbenzene	[ <i>p-tert</i> -Butyltoluene]	C <sub>11</sub> H <sub>16</sub>	98-51-1	1 ppm	
2- <i>sec</i> -Butylphenol		C <sub>10</sub> H <sub>14</sub> O	89-72-5	5 ppm	
Cadmium	metal	Cd	7440-43-9	0.01 mg/m <sup>3</sup>	
Cadmium	compounds, as Cd	Cd	7440-43-9	0.002 mg/m <sup>3</sup>	
Calcium chromate	as Cr	CaCrO <sub>4</sub>	13765-19-0	0.001 mg/m <sup>3</sup>	
Calcium cyanamide	[Calcium carbimide]	CaCN <sub>2</sub>	156-62-7	0.5 mg/m <sup>3</sup>	
Calcium hydroxide	[Portlandite]	Ca(OH) <sub>2</sub>	1305-62-0	5 mg/m <sup>3</sup>	
Calcium metasilicate	synthetic, nonfibrous	CaSiO <sub>3</sub>	1344-95-2	10 mg/m <sup>3</sup>	
Calcium oxide	[Lime]	CaO	1305-78-8	2 mg/m <sup>3</sup>	
Calcium sulfate	[Anhydrite]	CaSO <sub>4</sub>	7778-18-9	10 mg/m <sup>3</sup>	
Camphor	[1,7,7-Trimethylbicyclo[2.2.1]heptan-2-one], synthetic	C <sub>10</sub> H <sub>16</sub> O	76-22-2	2 ppm	3 ppm
Caprolactam	[Hexahydro-2-azepinone]	C <sub>6</sub> H <sub>11</sub> NO	105-60-2	5 mg/m <sup>3</sup>	
Captafol		C <sub>10</sub> H <sub>9</sub> Cl <sub>4</sub> NO <sub>2</sub> S	2425-06-1	0.1 mg/m <sup>3</sup>	
Captan		C <sub>9</sub> H <sub>8</sub> Cl <sub>3</sub> NO <sub>2</sub> S	133-06-2	5 mg/m <sup>3</sup>	
Carbaryl		C <sub>12</sub> H <sub>11</sub> NO <sub>2</sub>	63-25-2	0.5 mg/m <sup>3</sup>	
Carbofuran	[7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate]	C <sub>12</sub> H <sub>15</sub> NO <sub>3</sub>	1563-66-2	0.1 mg/m <sup>3</sup>	
Carbon black	[Carbon (amorphous)]	C	1333-86-4	3.5 mg/m <sup>3</sup>	
Carbon dioxide		CO <sub>2</sub>	124-38-9	5000 ppm	30,000 ppm
Carbon disulfide	[Carbon bisulfide]	CS <sub>2</sub>	75-15-0	1 ppm	
Carbon monoxide		CO	630-08-0	25 ppm	
Carbonyl chloride	[Phosgene]	CCl <sub>2</sub> O	75-44-5	0.1 ppm	
Carbonyl fluoride		CF <sub>2</sub> O	353-50-4	2 ppm	5 ppm
Cellulose			9004-34-6	10 mg/m <sup>3</sup>	
Cesium hydroxide		CsOH	21351-79-1	2 mg/m <sup>3</sup>	
Chlordane	[1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1 <i>H</i> -indene]	C <sub>10</sub> H <sub>6</sub> Cl <sub>8</sub>	57-74-9	0.5 mg/m <sup>3</sup>	
<i>o</i> -Chlorinated diphenyl oxide			31242-93-0	0.5 mg/m <sup>3</sup>	
Chlorine		Cl <sub>2</sub>	7782-50-5	0.5 ppm	1 ppm
Chlorine dioxide		ClO <sub>2</sub>	10049-04-4	0.1 ppm	0.3 ppm
Chlorine trifluoride		ClF <sub>3</sub>	7790-91-2		C 0.1 ppm
Chloroacetaldehyde	[2-Chloro-1-ethanal]	C <sub>2</sub> H <sub>3</sub> ClO	107-20-0		C 1 ppm
Chloroacetic acid		C <sub>2</sub> H <sub>2</sub> ClO <sub>2</sub>	79-11-8	0.5 ppm	
Chloroacetone		C <sub>3</sub> H <sub>5</sub> ClO	78-95-5		C 1 ppm
$\alpha$ -Chloroacetophenone	[ $\omega$ -Chloroacetophenone]	C <sub>8</sub> H <sub>7</sub> ClO	532-27-4	0.05 ppm	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Chloroacetyl chloride		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O	79-04-9	0.05 ppm	0.15 ppm
Chlorobenzene	[Phenyl chloride]	C <sub>6</sub> H <sub>5</sub> Cl	108-90-7	10 ppm	
<i>o</i> -Chlorobenzylidene malononitrile		C <sub>10</sub> H <sub>5</sub> ClN <sub>2</sub>	2698-41-1		C 0.05 ppm
2-Chloro-1,3-butadiene	[Chloroprene]	C <sub>4</sub> H <sub>5</sub> Cl	126-99-8	10 ppm	
Chlorodifluoromethane	[HCFC-22]	CHClF <sub>2</sub>	75-45-6	1000 ppm	
Chloroethane	[Ethyl chloride]	C <sub>2</sub> H <sub>5</sub> Cl	75-00-3	100 ppm	
2-Chloroethanol	[Ethylene chlorohydrin]	C <sub>2</sub> H <sub>5</sub> ClO	107-07-3		C 1 ppm
Chloroethene	[Vinyl chloride]	C <sub>2</sub> H <sub>3</sub> Cl	75-01-4	1 ppm	
Chloromethane	[Methyl chloride]	CH <sub>3</sub> Cl	74-87-3	50 ppm	100 ppm
(Chloromethyl)benzene	[Benzyl chloride]	C <sub>7</sub> H <sub>7</sub> Cl	100-44-7	1 ppm	
Chloromethyl methyl ether	levels as low as possible	C <sub>2</sub> H <sub>5</sub> ClO	107-30-2		
1-Chloro-4-nitrobenzene	[ <i>p</i> -Nitrochlorobenzene]	C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>	100-00-5	0.1 ppm	
1-Chloro-1-nitropropane		C <sub>3</sub> H <sub>6</sub> ClNO <sub>2</sub>	600-25-9	2 ppm	
Chloropentafluoroethane	[CFC-115]	C <sub>2</sub> ClF <sub>5</sub>	76-15-3	1000 ppm	
2-Chloropropanoic acid	[2-Chloropropionic acid]	C <sub>3</sub> H <sub>5</sub> ClO <sub>2</sub>	598-78-7	0.1 ppm	
2-Chloro-1-propanol	[Propylene chlorohydrin]	C <sub>3</sub> H <sub>7</sub> ClO	78-89-7	1 ppm	
1-Chloro-2-propanol	[ <i>sec</i> -Propylene chlorohydrin]	C <sub>3</sub> H <sub>7</sub> ClO	127-00-4	1 ppm	
3-Chloropropene	[Allyl chloride]	C <sub>3</sub> H <sub>5</sub> Cl	107-05-1	1 ppm	2 ppm
2-Chlorostyrene		C <sub>8</sub> H <sub>7</sub> Cl	2039-87-4	50 ppm	75 ppm
2-Chlorotoluene	[1-Chloro-2-methylbenzene]	C <sub>7</sub> H <sub>7</sub> Cl	95-49-8	50 ppm	
Chlorpyrifos	[Phosphorothioic acid, <i>O,O</i> -diethyl <i>O</i> -(3,5,6-trichloro-2-pyridinyl) ester]	C <sub>9</sub> H <sub>11</sub> Cl <sub>3</sub> NO <sub>3</sub> PS	2921-88-2	0.1 mg/m <sup>3</sup>	
Chromium	metal	Cr	7440-47-3	0.5 mg/m <sup>3</sup>	
Chromium	Cr(III) compounds, as Cr	Cr	7440-47-3	0.5 mg/m <sup>3</sup>	
Chromium	soluble Cr(VI) compounds, as Cr	Cr	7440-47-3	0.05 mg/m <sup>3</sup>	
Chromium	insoluble Cr(VI) compounds, as Cr	Cr	7440-47-3	0.01 mg/m <sup>3</sup>	
Chromium(VI) dichloride dioxide	[Chromyl chloride]	CrO <sub>2</sub> Cl <sub>2</sub>	14977-61-8	0.025 ppm	
Chrysene	levels as low as possible	C <sub>18</sub> H <sub>12</sub>	218-01-9		
Clopidol		C <sub>7</sub> H <sub>7</sub> Cl <sub>2</sub> NO	2971-90-6	10 mg/m <sup>3</sup>	
Coal	dust, anthracite			0.4 mg/m <sup>3</sup>	
Coal	dust, bituminous			0.9 mg/m <sup>3</sup>	
Coal tar	volatiles, as aerosol		65966-93-2	0.2 mg/m <sup>3</sup>	
Cobalt	metal and inorganic compounds, as Co	Co	7440-48-4	0.02 mg/m <sup>3</sup>	
Cobalt carbonyl	as Co	Co <sub>2</sub> (CO) <sub>8</sub>	10210-68-1	0.1 mg/m <sup>3</sup>	
Cobalt hydrocarbonyl	as Co	C <sub>4</sub> HCoO <sub>4</sub>	16842-03-8	0.1 mg/m <sup>3</sup>	
Copper	fume	Cu	7440-50-8	0.2 mg/m <sup>3</sup>	
Copper	dusts & mists, as Cu	Cu	7440-50-8	1 mg/m <sup>3</sup>	
Coumaphos		C <sub>14</sub> H <sub>16</sub> ClO <sub>5</sub> PS	56-72-4	0.05 mg/m <sup>3</sup>	
Cresol	all isomers. NIC in 2008 to 20 mg/m <sup>3</sup>	C <sub>7</sub> H <sub>8</sub> O	1319-77-3	5 ppm	
Crufomate		C <sub>12</sub> H <sub>19</sub> ClNO <sub>3</sub> P	299-86-5	5 mg/m <sup>3</sup>	
Cyanamide	[Cyanogenamide]	CH <sub>2</sub> N <sub>2</sub>	420-04-2	2 mg/m <sup>3</sup>	
Cyanide ion	cyanide salts, as CN	CN <sup>-</sup>	57-12-5		C 5 mg/m <sup>3</sup>
Cyanogen		C <sub>2</sub> N <sub>2</sub>	460-19-5	10 ppm	
Cyanogen chloride	[Chlorine cyanide]	CClN	506-77-4		C 0.3 ppm
Cyclohexane	[Hexahydrobenzene]	C <sub>6</sub> H <sub>12</sub>	110-82-7	100 ppm	
Cyclohexanol	[Cyclohexyl alcohol]	C <sub>6</sub> H <sub>12</sub> O	108-93-0	50 ppm	
Cyclohexanone	[Pimelic ketone]	C <sub>6</sub> H <sub>10</sub> O	108-94-1	20 ppm	50 ppm
Cyclohexene	[Tetrahydrobenzene]	C <sub>6</sub> H <sub>10</sub>	110-83-8	300 ppm	
Cyclohexylamine	[Cyclohexanamine]	C <sub>6</sub> H <sub>13</sub> N	108-91-8	10 ppm	
Cyclonite	[Hexahydro-1,3,5-trinitro-1,3,5-triazine]	C <sub>3</sub> H <sub>6</sub> N <sub>6</sub> O <sub>6</sub>	121-82-4	0.5 mg/m <sup>3</sup>	
1,3-Cyclopentadiene	[Pyropentylene]	C <sub>5</sub> H <sub>6</sub>	542-92-7	75 ppm	
Cyclopentane	[Pentamethylene]	C <sub>5</sub> H <sub>10</sub>	287-92-3	600 ppm	
Cyhexatin	[Tricyclohexylhydroxystannane]	C <sub>18</sub> H <sub>34</sub> OSn	13121-70-5	5 mg/m <sup>3</sup>	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Decaborane(14)		B <sub>10</sub> H <sub>14</sub>	17702-41-9	0.05 ppm	0.15 ppm
Demeton	[Systox]	C <sub>8</sub> H <sub>19</sub> O <sub>3</sub> PS <sub>2</sub>	8065-48-3	0.05 mg/m <sup>3</sup>	
Demeton-S-methyl	[Phosphorothioic acid, S-[2-(ethylthio)ethyl] O,O-dimethyl ester]	C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	919-86-8	0.05 mg/m <sup>3</sup>	
Diacetone alcohol	[4-Hydroxy-4-methyl-2-pentanone]	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	123-42-2	50 ppm	
4,4'-Diaminodiphenylmethane	[4,4-Methylene dianiline]	C <sub>13</sub> H <sub>14</sub> N <sub>2</sub>	101-77-9	0.1 ppm	
Diazinon		C <sub>12</sub> H <sub>21</sub> N <sub>2</sub> O <sub>3</sub> PS	333-41-5	0.01 mg/m <sup>3</sup>	
Diazomethane		CH <sub>2</sub> N <sub>2</sub>	334-88-3	0.2 ppm	
Diborane		B <sub>2</sub> H <sub>6</sub>	19287-45-7	0.1 ppm	
Dibromodifluoromethane		CBr <sub>2</sub> F <sub>2</sub>	75-61-6	100 ppm	
2-Dibutylaminoethanol		C <sub>10</sub> H <sub>23</sub> NO	102-81-8	0.5 ppm	
2,6-Di- <i>tert</i> -butyl-4-methylphenol	[Butylated hydroxytoluene; BHT]	C <sub>15</sub> H <sub>24</sub> O	128-37-0	2 mg/m <sup>3</sup>	
Dibutylphenyl phosphate		C <sub>14</sub> H <sub>23</sub> O <sub>4</sub> P	2528-36-1	0.3 ppm	
Dibutyl phosphate	NIC in 2008 to TWA 5 mg/m <sup>3</sup>	C <sub>8</sub> H <sub>19</sub> O <sub>4</sub> P	107-66-4	1 ppm	2 ppm
Dibutyl phthalate	[Butyl phthalate]	C <sub>16</sub> H <sub>22</sub> O <sub>4</sub>	84-74-2	5 mg/m <sup>3</sup>	
Dichloroacetic acid		C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub>	79-43-6	0.5 ppm	
Dichloroacetylene		C <sub>2</sub> Cl <sub>2</sub>	7572-29-4		C 0.1 ppm
<i>o</i> -Dichlorobenzene	[1,2-Dichlorobenzene]	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	95-50-1	25 ppm	50 ppm
<i>p</i> -Dichlorobenzene	[1,4-Dichlorobenzene]	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	106-46-7	10 ppm	
3,3'-Dichloro- <i>p</i> -benzidine	levels as low as possible	C <sub>12</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub>	91-94-1		
1,4-Dichloro-2-butene	both isomers	C <sub>4</sub> H <sub>6</sub> Cl <sub>2</sub>	764-41-0	0.005 ppm	
Dichlorodifluoromethane	[CFC-12]	CCl <sub>2</sub> F <sub>2</sub>	75-71-8	1000 ppm	
1,3-Dichloro-5,5-dimethyl hydantoin		C <sub>5</sub> H <sub>6</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>2</sub>	118-52-5	0.2 mg/m <sup>3</sup>	0.4 mg/m <sup>3</sup>
Dichlorodiphenyltrichloroethane	[DDT]	C <sub>14</sub> H <sub>9</sub> Cl <sub>5</sub>	50-29-3	1 mg/m <sup>3</sup>	
1,1-Dichloroethane	[Ethylidene dichloride]	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	75-34-3	100 ppm	
1,2-Dichloroethane	[Ethylene dichloride]	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	107-06-2	10 ppm	
1,1-Dichloroethene	[Vinylidene chloride]	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	75-35-4	5 ppm	
1,2-Dichloroethylene	both isomers	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	540-59-0	200 ppm	
Dichlorofluoromethane	[CFC 21]	CHCl <sub>2</sub> F	75-43-4	10 ppm	
Dichloromethane	[Methylene chloride]	CH <sub>2</sub> Cl <sub>2</sub>	75-09-2	50 ppm	
1,1-Dichloro-1-nitroethane	[Ethide]	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> NO <sub>2</sub>	594-72-9	2 ppm	
(2,4-Dichlorophenoxy)acetic acid	[2,4-D]	C <sub>8</sub> H <sub>6</sub> Cl <sub>2</sub> O <sub>3</sub>	94-75-7	10 mg/m <sup>3</sup>	
1,2-Dichloropropane	[Propylene dichloride]	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	78-87-5	10 ppm	
2,2-Dichloropropanoic acid	[2,2-Dichloropropionic acid]	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> O <sub>2</sub>	75-99-0	5 mg/m <sup>3</sup>	
1,3-Dichloropropene	both isomers	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	542-75-6	1 ppm	
1,2-Dichloro-1,1,2,2-tetrafluoroethane	[CFC-114]	C <sub>2</sub> Cl <sub>2</sub> F <sub>4</sub>	76-14-2	1000 ppm	
Dichlorvos	[Phosphoric acid, 2,2-dichloroethenyl dimethyl ester]	C <sub>4</sub> H <sub>7</sub> Cl <sub>2</sub> O <sub>4</sub> P	62-73-7	0.1 mg/m <sup>3</sup>	
Dicrotophos		C <sub>8</sub> H <sub>16</sub> NO <sub>5</sub> P	141-66-2	0.05 mg/m <sup>3</sup>	
<i>m</i> -Dicyanobenzene	[ <i>m</i> -Phthalodinitrile]	C <sub>8</sub> H <sub>4</sub> N <sub>2</sub>	626-17-5	5 mg/m <sup>3</sup>	
Dicyclopentadiene		C <sub>10</sub> H <sub>12</sub>	77-73-6	5 ppm	
Dieldrin		C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub> O	60-57-1	0.25 mg/m <sup>3</sup>	
Diesel fuel	as total hydrocarbons		68334-30-5	100 mg/m <sup>3</sup>	
Diethanolamine	[Bis(2-hydroxyethyl)amine]. NIC in 2008 to 1 mg/m <sup>3</sup> .	C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>	111-42-2	2 mg/m <sup>3</sup>	
Diethylamine	[ <i>N</i> -Ethylethanamine]	C <sub>4</sub> H <sub>11</sub> N	109-89-7	5 ppm	15 ppm
2-Diethylaminoethanol		C <sub>6</sub> H <sub>15</sub> NO	100-37-8	2 ppm	
Diethyl ether	[Ethyl ether]	C <sub>4</sub> H <sub>10</sub> O	60-29-7	400 ppm	500 ppm
Diethyl phthalate		C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>	84-66-2	5 mg/m <sup>3</sup>	
1,1-Difluoroethene	[Vinylidene fluoride]	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub>	75-38-7	500 ppm	
Diglycidyl ether	[DGE]	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	2238-07-5	0.1 ppm	
Diisopropylamine	[ <i>N</i> -Isopropyl-2-propanamine]	C <sub>6</sub> H <sub>15</sub> N	108-18-9	5 ppm	
Diisopropyl ether	[Isopropyl ether]	C <sub>6</sub> H <sub>14</sub> O	108-20-3	250 ppm	310 ppm

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Dimethoxymethane	[Methylal]	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	109-87-5	1000 ppm	
<i>N,N</i> -Dimethylacetamide	[ <i>N,N</i> -Dimethylethanamide]	C <sub>4</sub> H <sub>9</sub> NO	127-19-5	10 ppm	
Dimethylamine	[ <i>N</i> -Methylmethanamine]	C <sub>2</sub> H <sub>7</sub> N	124-40-3	5 ppm	15 ppm
<i>N,N</i> -Dimethylaniline		C <sub>8</sub> H <sub>11</sub> N	121-69-7	5 ppm	
Dimethylaniline	other isomers	C <sub>8</sub> H <sub>11</sub> N	1300-73-8	0.5 ppm	
2,2-Dimethylbutane	[Neohexane]	C <sub>6</sub> H <sub>14</sub>	75-83-2	500 ppm	1000 ppm
2,3-Dimethylbutane	[Diisopropyl]	C <sub>6</sub> H <sub>14</sub>	79-29-8	500 ppm	1000 ppm
Dimethylcarbamic chloride	[Dimethyl carbamoyl chloride]	C <sub>3</sub> H <sub>6</sub> ClNO	79-44-7	0.005 mg/m <sup>3</sup>	
Dimethyl disulfide	[Methyl disulfide]	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	624-92-0	0.5 mg/m <sup>3</sup>	
<i>N,N</i> -Dimethylformamide	[DMF]	C <sub>3</sub> H <sub>7</sub> NO	68-12-2	10 ppm	
2,6-Dimethyl-4-heptanone	[Diisobutyl ketone]	C <sub>9</sub> H <sub>18</sub> O	108-83-8	25 ppm	
1,1-Dimethylhydrazine	[UDMH]	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	57-14-7	0.01 ppm	
Dimethyl mercury	[Mercury dimethyl]	C <sub>2</sub> H <sub>6</sub> Hg	593-74-8	0.01 mg/m <sup>3</sup>	
Dimethyl phthalate	[Methyl phthalate]	C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>	131-11-3	5 mg/m <sup>3</sup>	
2,2-Dimethyl-1-propanol acetate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	926-41-0	50 ppm	100 ppm
Dimethyl sulfate		C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	77-78-1	0.1 ppm	
Dimethyl sulfide	[2-Thiapropane]	C <sub>2</sub> H <sub>6</sub> S	75-18-3	10 ppm	
Dinitrobenzene	all isomers	C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub>	25154-54-5	0.15 ppm	
Dinitrotoluene	all isomers	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	25321-14-6	0.2 mg/m <sup>3</sup>	
1,4-Dioxane	[1,4-Dioxacyclohexane]	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	123-91-1	20 ppm	
Dioxathion		C <sub>12</sub> H <sub>26</sub> O <sub>6</sub> P <sub>2</sub> S <sub>4</sub>	78-34-2	0.1 mg/m <sup>3</sup>	
1,3-Dioxolane	[1,3-Dioxacyclopentane]	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	646-06-0	20 ppm	
Diphenylamine	[ <i>N</i> -Phenylbenzenamine]	C <sub>12</sub> H <sub>11</sub> N	122-39-4	10 mg/m <sup>3</sup>	
Diphenyl ether	[Phenyl ether]	C <sub>12</sub> H <sub>10</sub> O	101-84-8	1 ppm	2 ppm
4,4'-Diphenylmethane diisocyanate	[Methylene diphenyl isocyanate; MDI]	C <sub>15</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>	101-68-8	0.005 ppm	
Dipropylene glycol monomethyl ether	[Bis(2-Methoxypropyl) ether; DPGME]	C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>	34590-94-8	100 ppm	150 ppm
Diquat		C <sub>12</sub> H <sub>12</sub> N <sub>2</sub>	231-36-7	0.5 mg/m <sup>3</sup>	
Disulfiram		C <sub>10</sub> H <sub>20</sub> N <sub>2</sub> S <sub>4</sub>	97-77-8	2 mg/m <sup>3</sup>	
Disulfoton	[Phosphorodithioic acid, <i>O,O</i> -diethyl <i>S</i> -[2-(ethylthio)ethyl] ester]	C <sub>8</sub> H <sub>19</sub> O <sub>2</sub> PS <sub>3</sub>	298-04-4	0.05 mg/m <sup>3</sup>	
Diuron		C <sub>9</sub> H <sub>10</sub> Cl <sub>2</sub> N <sub>2</sub> O	330-54-1	10 mg/m <sup>3</sup>	
Divinyl benzene	all isomers	C <sub>10</sub> H <sub>10</sub>	1321-74-0	10 ppm	
1-Dodecanethiol		C <sub>12</sub> H <sub>26</sub> S	112-55-0	0.1 ppm	
Endosulfan		C <sub>9</sub> H <sub>6</sub> Cl <sub>6</sub> O <sub>3</sub> S	115-29-7	0.1 mg/m <sup>3</sup>	
Endrin		C <sub>12</sub> H <sub>8</sub> Cl <sub>4</sub> O	72-20-8	0.1 mg/m <sup>3</sup>	
Enflurane		C <sub>3</sub> H <sub>2</sub> ClF <sub>5</sub> O	13838-16-9	75 ppm	
Epichlorohydrin	[(Chloromethyl)oxirane]	C <sub>3</sub> H <sub>5</sub> ClO	106-89-8	0.5 ppm	
1,2-Epoxy-4-(epoxyethyl) cyclohexane	[Vinylcyclohexene dioxide]	C <sub>8</sub> H <sub>12</sub> O <sub>2</sub>	106-87-6	0.1 ppm	
Ethane		C <sub>2</sub> H <sub>6</sub>	74-84-0	1000 ppm	
1,2-Ethanediamine	[Ethylenediamine]	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	107-15-3	10 ppm	
1,2-Ethandiol	[Ethylene glycol]	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	107-21-1		C 100 mg/m <sup>3</sup>
1,2-Ethandiol, dinitrate	[Ethylene glycol dinitrate; EGDN]	C <sub>2</sub> H <sub>4</sub> N <sub>2</sub> O <sub>6</sub>	628-96-6	0.05 ppm	
Ethanethiol	[Ethyl mercaptan]	C <sub>2</sub> H <sub>6</sub> S	75-08-1	0.5 ppm	
Ethanol	[Ethyl alcohol]	C <sub>2</sub> H <sub>6</sub> O	64-17-5	1000 ppm	
Ethanolamine	[2-Aminoethanol]	C <sub>2</sub> H <sub>7</sub> NO	141-43-5	3 ppm	6 ppm
Ethion	[Phosphorodithioic acid, <i>S,S'</i> -methylene <i>O,O,O',O'</i> -tetraethyl ester]	C <sub>9</sub> H <sub>22</sub> O <sub>4</sub> P <sub>2</sub> S <sub>4</sub>	563-12-2	0.05 mg/m <sup>3</sup>	
Ethoxydimethylsilane	[Dimethylethoxysilane]	C <sub>4</sub> H <sub>12</sub> OSi	14857-34-2	0.5 ppm	1.5 ppm
2-Ethoxyethanol	[Ethylene glycol monoethyl ether; EGEE]	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	110-80-5	5 ppm	
2-Ethoxyethyl acetate	[Ethylene glycol monoethyl ether acetate; EGEEA]	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	111-15-9	5 ppm	
Ethyl acetate		C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	141-78-6	400 ppm	
Ethyl acrylate	[Ethyl propenoate]	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	140-88-5	5 ppm	15 ppm

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Ethylamine	[Ethanamine]	C <sub>2</sub> H <sub>7</sub> N	75-04-7	5 ppm	15 ppm
Ethylbenzene	[Phenylethane]	C <sub>8</sub> H <sub>10</sub>	100-41-4	100 ppm	125 ppm
Ethyl 2-cyanoacrylate	[Ethyl 2-cyano-2-propenoate]	C <sub>6</sub> H <sub>7</sub> NO <sub>2</sub>	7085-85-0	0.2 ppm	
Ethylene	[Ethene]	C <sub>2</sub> H <sub>4</sub>	74-85-1	200 ppm	
Ethyleneimine	[Aziridine]	C <sub>2</sub> H <sub>3</sub> N	151-56-4	0.5 ppm	
Ethyl formate		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	109-94-4	100 ppm	
2-Ethylhexanoic acid		C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	149-57-5	5 mg/m <sup>3</sup>	
5-Ethylidene-2-norbornene	[5-Ethylidenebicyclo[2.2.1]hept-2-ene]	C <sub>9</sub> H <sub>12</sub>	16219-75-3		C 5 ppm
N-Ethylmorpholine		C <sub>6</sub> H <sub>13</sub> NO	100-74-3	5 ppm	
O-Ethyl O- <i>p</i> -nitrophenyl benzenethiophosphonate	[EPN]	C <sub>14</sub> H <sub>14</sub> NO <sub>4</sub> PS	2104-64-5	0.1 mg/m <sup>3</sup>	
Ethyl silicate		C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si	78-10-4	10 ppm	
Fenamiphos		C <sub>13</sub> H <sub>22</sub> NO <sub>3</sub> PS	22224-92-6	0.05 mg/m <sup>3</sup>	
Fensulfthion	[Phosphorothioic acid, O,O-diethyl O-[4-(methylsulfinyl)phenyl] ester]	C <sub>11</sub> H <sub>17</sub> O <sub>4</sub> PS <sub>2</sub>	115-90-2	0.01 mg/m <sup>3</sup>	
Fenthion	[Phosphorothioic acid, O,O-dimethyl O-[3-methyl-4-(methylthio)phenyl] ester]	C <sub>10</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	55-38-9	0.05 mg/m <sup>3</sup>	
Ferbam	[Iron, tris(dimethylcarbamodithioato-S,S)-, (OC-6-11)-]	C <sub>9</sub> H <sub>18</sub> FeN <sub>3</sub> S <sub>6</sub>	14484-64-1	10 mg/m <sup>3</sup>	
Ferrocene	[Dicyclopentadienyl iron]	C <sub>10</sub> H <sub>10</sub> Fe	102-54-5	10 mg/m <sup>3</sup>	
Ferrovandium	dust		12604-58-9	1 mg/m <sup>3</sup>	3 mg/m <sup>3</sup>
Flour	dust			0.5 mg/m <sup>3</sup>	
Fluoride ion	fluoride salts, as F	F <sup>-</sup>	16984-48-8	2.5 mg/m <sup>3</sup>	
Fluorine		F <sub>2</sub>	7782-41-4	1 ppm	2 ppm
Fluorine monoxide	[Oxygen difluoride]	F <sub>2</sub> O	7783-41-7		C 0.05 ppm
Fluoroethene	[Vinyl fluoride]	C <sub>2</sub> H <sub>2</sub> F	75-02-5	1 ppm	
Fonofos	[Phosphonodithioic acid, ethyl-, O-ethyl S-phenyl ester]	C <sub>10</sub> H <sub>15</sub> OPS <sub>2</sub>	944-22-9	0.01 mg/m <sup>3</sup>	
Formaldehyde	[Methanal]	CH <sub>2</sub> O	50-00-0		C 0.3 ppm
Formamide	[Methanamide]	CH <sub>3</sub> NO	75-12-7	10 ppm	
Formic acid	[Methanoic acid]	CH <sub>2</sub> O <sub>2</sub>	64-18-6	5 ppm	10 ppm
Furfural	[2-Furaldehyde]	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	98-01-1	2 ppm	
Furfuryl alcohol	[2-Furanmethanol]	C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>	98-00-0	10 ppm	15 ppm
Gallium arsenide		GaAs	1303-00-0	0.0003 mg/m <sup>3</sup>	
Gasoline			8006-61-9	300 ppm	500 ppm
Germane	[Germanium tetrahydride]	GeH <sub>4</sub>	7782-65-2	0.2 ppm	
Glycerol	[1,2,3-Propanetriol], mist	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	56-81-5	10 mg/m <sup>3</sup>	
Glyoxal		C <sub>2</sub> H <sub>2</sub> O <sub>2</sub>	107-22-2	0.1 mg/m <sup>3</sup>	
Grain	dust			4 mg/m <sup>3</sup>	
Graphite	except fibers	C	7440-44-0	2 mg/m <sup>3</sup>	
Hafnium	metal and compounds, as Hf	Hf	7440-58-6	0.5 mg/m <sup>3</sup>	
Heptachlor		C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub>	76-44-8	0.05 mg/m <sup>3</sup>	
Heptachlor epoxide		C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub> O	1024-57-3	0.05 mg/m <sup>3</sup>	
Heptane	all isomers	C <sub>7</sub> H <sub>16</sub>	142-82-5	400 ppm	500 ppm
2-Heptanone	[Methyl pentyl ketone]	C <sub>7</sub> H <sub>14</sub> O	110-43-0	50 ppm	
3-Heptanone	[Ethyl butyl ketone]	C <sub>7</sub> H <sub>14</sub> O	106-35-4	50 ppm	75 ppm
4-Heptanone	[Dipropyl ketone]	C <sub>7</sub> H <sub>14</sub> O	123-19-3	50 ppm	
Hexachlorobenzene	[Perchlorobenzene]	C <sub>6</sub> Cl <sub>6</sub>	118-74-1	0.002 mg/m <sup>3</sup>	
Hexachloro-1,3-butadiene	[Perchlorobutadiene]	C <sub>4</sub> Cl <sub>6</sub>	87-68-3	0.02 ppm	
1,2,3,4,5,6-Hexachlorocyclohexane	[Lindane]	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	58-89-9	0.5 mg/m <sup>3</sup>	
Hexachloro-1,3-cyclopentadiene	[Perchlorocyclopentadiene]	C <sub>5</sub> Cl <sub>6</sub>	77-47-4	0.01 ppm	
Hexachloroethane	[Perchloroethane]	C <sub>2</sub> Cl <sub>6</sub>	67-72-1	1 ppm	
Hexachloronaphthalene	all isomers	C <sub>10</sub> H <sub>2</sub> Cl <sub>6</sub>	1335-87-1	0.2 mg/m <sup>3</sup>	



Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Hexahydro-1,3-isobenzofurandione	[Hexahydrophthalic anhydride]	C <sub>8</sub> H <sub>10</sub> O <sub>3</sub>	85-42-7		C 0.005 mg/m <sup>3</sup>
Hexamethylene diisocyanate		C <sub>8</sub> H <sub>12</sub> N <sub>2</sub> O <sub>2</sub>	822-06-0	0.005 ppm	
Hexane		C <sub>6</sub> H <sub>14</sub>	110-54-3	50 ppm	
1,6-Hexanediamine	[Hexamethylenediamine]	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>	124-09-4	0.5 ppm	
Hexanedinitrile	[Adiponitrile]	C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	111-69-3	2 ppm	
1,6-Hexanedioic acid	[Adipic acid]	C <sub>6</sub> H <sub>10</sub> O <sub>4</sub>	124-04-9	5 mg/m <sup>3</sup>	
2-Hexanone	[Butyl methyl ketone]	C <sub>6</sub> H <sub>12</sub> O	591-78-6	5 ppm	10 ppm
1-Hexene		C <sub>6</sub> H <sub>12</sub>	592-41-6	50 ppm	
sec-Hexyl acetate	[4-Methyl-2-pentyl acetate]	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	108-84-9	50 ppm	
Hydrazine		N <sub>2</sub> H <sub>4</sub>	302-01-2	0.01 ppm	
Hydrazoic acid	vapor	HN <sub>3</sub>	7782-79-8		C 0.11 ppm
Hydrogen bromide	[Hydrobromic acid]	HBr	10035-10-6		C 2 ppm
Hydrogen chloride	[Hydrochloric acid]	HCl	7647-01-0		C 2 ppm
Hydrogen cyanide	[Hydrocyanic acid]	HCN	74-90-8		C 4.7 ppm
Hydrogen fluoride	[Hydrofluoric acid]	HF	7664-39-3	0.5 ppm	C 2 ppm
Hydrogen peroxide		H <sub>2</sub> O <sub>2</sub>	7722-84-1	1 ppm	
Hydrogen selenide		H <sub>2</sub> Se	7783-07-5	0.05 ppm	
Hydrogen sulfide		H <sub>2</sub> S	7783-06-4	10 ppm	15 ppm
p-Hydroquinone	[1,4-Benzenediol]	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	123-31-9	1 mg/m <sup>3</sup>	
2-Hydroxypropyl acrylate		C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	999-61-1	0.5 ppm	
Indene	[Indonaphthene]	C <sub>9</sub> H <sub>8</sub>	95-13-6	5 ppm	
Indium	metal and compounds, as In	In	7440-74-6	0.1 mg/m <sup>3</sup>	
Iodine	and volatile iodides	I <sub>2</sub>	7553-56-2	0.01 ppm	C 0.1 ppm
Iodomethane	[Methyl iodide]	CH <sub>3</sub> I	74-88-4	2 ppm	
Iron ion [Fe <sup>+2</sup> ]	soluble ferrous salts, as Fe	Fe <sup>+2</sup>	15438-31-0	1 mg/m <sup>3</sup>	
Iron ion [Fe <sup>+3</sup> ]	soluble ferric salts, as Fe	Fe <sup>+3</sup>	20074-52-6	1 mg/m <sup>3</sup>	
Iron(III) oxide	dust and fume, as Fe	Fe <sub>2</sub> O <sub>3</sub>	1309-37-1	5 mg/m <sup>3</sup>	
Iron pentacarbonyl	as Fe	C <sub>5</sub> FeO <sub>5</sub>	13463-40-6	0.1 ppm	0.2 ppm
Isobutane	[2-Methylpropane]	C <sub>4</sub> H <sub>10</sub>	75-28-5	1000 ppm	
Isobutene	[2-Methyl-1-propene]	C <sub>4</sub> H <sub>8</sub>	115-11-7	250 ppm	
Isobutyl acetate	[2-Methylpropyl acetate]	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	110-19-0	150 ppm	
Isobutyl nitrite		C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	542-56-3		C 1 ppm
Isopentane	[2-Methylbutane]	C <sub>5</sub> H <sub>12</sub>	78-78-4	600 ppm	
Isopentyl acetate	[Isoamyl acetate]	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	123-92-2	50 ppm	100 ppm
Isophorone	[3,5,5-Trimethyl-2-cyclohexen-1-one]	C <sub>9</sub> H <sub>14</sub> O	78-59-1		C 5 ppm
Isophorone diisocyanate		C <sub>12</sub> H <sub>18</sub> N <sub>2</sub> O <sub>2</sub>	4098-71-9	0.005 ppm	
Isopropenylbenzene	[α-Methyl styrene]	C <sub>9</sub> H <sub>10</sub>	98-83-9	50 ppm	100 ppm
2-Isopropoxyethanol		C <sub>5</sub> H <sub>12</sub> O <sub>2</sub>	109-59-1	25 ppm	
Isopropyl acetate	[1-Methylethyl acetate]	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	108-21-4	100 ppm	200 ppm
Isopropylamine	[2-Propanamine]	C <sub>3</sub> H <sub>9</sub> N	75-31-0	5 ppm	10 ppm
N-Isopropylaniline		C <sub>9</sub> H <sub>13</sub> N	768-52-5	2 ppm	
Isopropylbenzene	[Cumene]	C <sub>9</sub> H <sub>12</sub>	98-82-8	50 ppm	
Isopropyl glycidyl ether	[IGE]	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	4016-14-2	50 ppm	75 ppm
Kaolin			1332-58-7	2 mg/m <sup>3</sup>	
Kerosene			8008-20-6	200 mg/m <sup>3</sup>	
Ketene		C <sub>2</sub> H <sub>2</sub> O	463-51-4	0.5 ppm	1.5 ppm
Lead	metal and inorganic compounds, as Pb	Pb	7439-92-1	0.05 mg/m <sup>3</sup>	
Lead(II) arsenate		Pb <sub>3</sub> (AsO <sub>4</sub> ) <sub>2</sub>	3687-31-8	0.15 mg/m <sup>3</sup>	
Lead(II) chromate	as Pb	PbCrO <sub>4</sub>	7758-97-6	0.05 mg/m <sup>3</sup>	
Lithium hydride		LiH	7580-67-8	0.025 mg/m <sup>3</sup>	
Magnesium oxide	[Magnesia]	MgO	1309-48-4	10 mg/m <sup>3</sup>	
Malathion		C <sub>10</sub> H <sub>19</sub> O <sub>6</sub> PS <sub>2</sub>	121-75-5	1 mg/m <sup>3</sup>	
Maleic anhydride		C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>	108-31-6	0.1 ppm	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Manganese	metal and inorganic compounds, as Mn	Mn	7439-96-5	0.2 mg/m <sup>3</sup>	
Manganese cyclopentadienyl tricarbonyl	as Mn	C <sub>8</sub> H <sub>5</sub> MnO <sub>3</sub>	12079-65-1	0.1 mg/m <sup>3</sup>	
Manganese 2-methylcyclopentadienyl tricarbonyl	as Mn	C <sub>9</sub> H <sub>7</sub> MnO <sub>3</sub>	12108-13-3	0.2 mg/m <sup>3</sup>	
Mercury	metal and inorganic compounds, as Hg	Hg	7439-97-6	0.025 mg/m <sup>3</sup>	
Mercury	alkyl compounds, as Hg	Hg	7439-97-6	0.01 mg/m <sup>3</sup>	0.03 mg/m <sup>3</sup>
Mercury	aryl compounds, as Hg	Hg	7439-97-6	0.1 mg/m <sup>3</sup>	
Mesityl oxide	[Isobutenyl methyl ketone]	C <sub>6</sub> H <sub>10</sub> O	141-79-7	15 ppm	25 ppm
Methacrylic acid	[2-Methylpropenoic acid]	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	79-41-4	20 ppm	
Methane		CH <sub>4</sub>	74-82-8	1000 ppm	
Methanethiol	[Methyl mercaptan]	CH <sub>4</sub> S	74-93-1	0.5 ppm	
Methanol	[Methyl alcohol]	CH <sub>4</sub> O	67-56-1	200 ppm	250 ppm
Methomyl	[Acetimidic acid, N-[(methylcarbamoyl)oxy]thio-, methyl ester]	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub> S	16752-77-5	2.5 mg/m <sup>3</sup>	
2-Methoxyaniline	[ <i>o</i> -Anisidine]	C <sub>7</sub> H <sub>9</sub> NO	90-04-0	0.5 mg/m <sup>3</sup>	
4-Methoxyaniline	[ <i>p</i> -Anisidine]	C <sub>7</sub> H <sub>9</sub> NO	104-94-9	0.5 mg/m <sup>3</sup>	
Methoxychlor		C <sub>16</sub> H <sub>15</sub> Cl <sub>3</sub> O <sub>2</sub>	72-43-5	10 mg/m <sup>3</sup>	
2-Methoxyethanol	[Ethylene glycol monomethyl ether; EGME]	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	109-86-4	0.1 ppm	
2-Methoxyethyl acetate	[Ethylene glycol monomethyl ether acetate; EGMEA]	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	110-49-6	0.1 ppm	
2-Methoxy-2-methylbutane	[Methyl <i>tert</i> -pentyl ether; TAME]	C <sub>6</sub> H <sub>14</sub> O	994-05-8	20 ppm	
4-Methoxyphenol		C <sub>7</sub> H <sub>8</sub> O <sub>2</sub>	150-76-5	5 mg/m <sup>3</sup>	
1-Methoxy-2-propanol	[1,2-Propylene glycol monomethyl ether; PGME]	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	107-98-2	100 ppm	150 ppm
Methyl acetate		C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	79-20-9	200 ppm	250 ppm
Methyl acrylate	[Methyl propenoate]	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	96-33-3	2 ppm	
2-Methylacrylonitrile	[2-Methylpropenenitrile]	C <sub>4</sub> H <sub>5</sub> N	126-98-7	1 ppm	
Methylamine	[Methanamine]	CH <sub>5</sub> N	74-89-5	5 ppm	15 ppm
2-Methylaniline	[ <i>o</i> -Toluidine]	C <sub>7</sub> H <sub>9</sub> N	95-53-4	2 ppm	
3-Methylaniline	[ <i>m</i> -Toluidine]	C <sub>7</sub> H <sub>9</sub> N	108-44-1	2 ppm	
4-Methylaniline	[ <i>p</i> -Toluidine]	C <sub>7</sub> H <sub>9</sub> N	106-49-0	2 ppm	
<i>N</i> -Methylaniline	[ <i>N</i> -Methylbenzenamine]	C <sub>7</sub> H <sub>9</sub> N	100-61-8	0.5 ppm	
3-Methyl-1-butanol	[Isoamyl alcohol]	C <sub>5</sub> H <sub>12</sub> O	123-51-3	100 ppm	125 ppm
2-Methyl-1-butanol acetate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	624-41-9	50 ppm	100 ppm
3-Methyl-2-butanol acetate		C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	5343-96-4	50 ppm	100 ppm
3-Methyl-2-butanone	[Methyl isopropyl ketone]	C <sub>5</sub> H <sub>10</sub> O	563-80-4	200 ppm	
Methyl <i>tert</i> -butyl ether	[MTBE]	C <sub>5</sub> H <sub>12</sub> O	1634-04-4	50 ppm	
Methyl 2-cyanoacrylate	[Mecrylate]	C <sub>5</sub> H <sub>5</sub> NO <sub>2</sub>	137-05-3	0.2 ppm	
Methylcyclohexane		C <sub>7</sub> H <sub>14</sub>	108-87-2	400 ppm	
Methylcyclohexanol	all isomers	C <sub>7</sub> H <sub>14</sub> O	25639-42-3	50 ppm	
2-Methylcyclohexanone		C <sub>7</sub> H <sub>12</sub> O	583-60-8	50 ppm	75 ppm
Methyl demeton		C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> PS <sub>2</sub>	8022-00-2	0.05 mg/m <sup>3</sup>	
2-Methyl-3,5-dinitrobenzamide	[3,5-Dinitro- <i>o</i> -toluamide; Dinitolmide]	C <sub>8</sub> H <sub>5</sub> N <sub>3</sub> O <sub>5</sub>	148-01-6	1 mg/m <sup>3</sup>	
2-Methyl-4,6-dinitrophenol	[Dinitro- <i>o</i> -cresol]	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>5</sub>	534-52-1	0.2 mg/m <sup>3</sup>	
4,4'-Methylenebis[2-chloroaniline]	[MBOCA]	C <sub>13</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub>	101-14-4	0.01 ppm	
Methylenebis(4-cyclohexylisocyanate)		C <sub>15</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	5124-30-1	0.005 ppm	
Methyl formate		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	107-31-3	100 ppm	150 ppm
6-Methyl-1-heptanol	[Isooctyl alcohol]	C <sub>8</sub> H <sub>18</sub> O	26952-21-6	50 ppm	
5-Methyl-3-heptanone	[Ethyl amyl ketone]	C <sub>8</sub> H <sub>16</sub> O	541-85-5	10 ppm	
5-Methyl-3-heptanone	[Ethyl 2-methylbutyl ketone]	C <sub>8</sub> H <sub>16</sub> O	541-85-5	10 ppm	
5-Methyl-2-hexanone	[Methyl isopentyl ketone]	C <sub>7</sub> H <sub>14</sub> O	110-12-3	50 ppm	
Methylhydrazine		CH <sub>6</sub> N <sub>2</sub>	60-34-4	0.01 ppm	



Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Methyl isocyanate		C <sub>2</sub> H <sub>3</sub> NO	624-83-9	0.02 ppm	
Methyl methacrylate	[Methyl 2-methyl-2-propenoate]	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-62-6	50 ppm	100 ppm
1-Methylnaphthalene		C <sub>11</sub> H <sub>10</sub>	90-12-0	0.5 ppm	
2-Methylnaphthalene		C <sub>11</sub> H <sub>10</sub>	91-57-6	0.5 ppm	
2-Methyl-5-nitroaniline		C <sub>7</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	99-55-8	1 mg/m <sup>3</sup>	
Methyloxirane	[1,2-Propylene oxide]	C <sub>3</sub> H <sub>6</sub> O	75-56-9	2 ppm	
Methyl parathion		C <sub>8</sub> H <sub>10</sub> NO <sub>5</sub> PS	298-00-0	0.2 mg/m <sup>3</sup>	
2-Methylpentane	[Isohexane]	C <sub>6</sub> H <sub>14</sub>	107-83-5	500 ppm	1000 ppm
3-Methylpentane		C <sub>6</sub> H <sub>14</sub>	96-14-0	500 ppm	1000 ppm
2-Methyl-2,4-pentanediol	[Hexylene glycol]	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	107-41-5		C 25 ppm
4-Methyl-2-pentanol	[Methyl isobutyl carbinol]	C <sub>6</sub> H <sub>14</sub> O	108-11-2	25 ppm	40 ppm
4-Methyl-2-pentanone	[Isobutyl methyl ketone]	C <sub>6</sub> H <sub>12</sub> O	108-10-1	50 ppm	75 ppm
2-Methyl-1-propanol	[Isobutyl alcohol]	C <sub>4</sub> H <sub>10</sub> O	78-83-1	50 ppm	
2-Methyl-2-propanol	[ <i>tert</i> -Butyl alcohol]	C <sub>4</sub> H <sub>10</sub> O	75-65-0	100 ppm	
Methylstyrene	all isomers	C <sub>9</sub> H <sub>10</sub>	25013-15-4	50 ppm	100 ppm
<i>N</i> -Methyl- <i>N</i> ,2,4,6-tetranitroaniline	[Tetryl]	C <sub>7</sub> H <sub>5</sub> N <sub>5</sub> O <sub>8</sub>	479-45-8	1.5 mg/m <sup>3</sup>	
Metribuzin		C <sub>8</sub> H <sub>14</sub> N <sub>4</sub> OS	21087-64-9	5 mg/m <sup>3</sup>	
Mevinphos		C <sub>7</sub> H <sub>13</sub> O <sub>6</sub> P	7786-34-7	0.01 ppm	
Mica			12001-26-2	3 mg/m <sup>3</sup>	
Mineral oil	mist			5 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Molybdenum	metal and insoluble compounds, as Mo	Mo	7439-98-7	10 mg/m <sup>3</sup>	
Molybdenum	soluble compounds, as Mo	Mo	7439-98-7	0.5 mg/m <sup>3</sup>	
Monocrotophos	[ <i>trans</i> -Dimethyl 1-methyl-3-(methylamino)-3-oxo-1-propenyl phosphate]	C <sub>7</sub> H <sub>14</sub> NO <sub>5</sub> P	6923-22-4	0.05 mg/m <sup>3</sup>	
Morpholine	[Tetrahydro-1,4-oxazine]	C <sub>4</sub> H <sub>9</sub> NO	110-91-8	20 ppm	
Naled	[1,2-Dibromo-2,2-dichloroethylphosphoric acid, dimethyl ester]	C <sub>4</sub> H <sub>7</sub> Br <sub>2</sub> Cl <sub>2</sub> O <sub>4</sub> P	300-76-5	0.1 mg/m <sup>3</sup>	
Naphtha			8030-30-6	400 ppm	
Naphthalene		C <sub>10</sub> H <sub>8</sub>	91-20-3	10 ppm	15 ppm
1-Naphthalenylthiourea	[ANTU]	C <sub>11</sub> H <sub>10</sub> N <sub>2</sub> S	86-88-4	0.3 mg/m <sup>3</sup>	
2-Naphthylamine	levels as low as possible	C <sub>10</sub> H <sub>9</sub> N	91-59-8		
Neopentane	[2,2-Dimethylpropane]	C <sub>5</sub> H <sub>12</sub>	463-82-1	600 ppm	
Nickel	metal	Ni	7440-02-0	1.5 mg/m <sup>3</sup>	
Nickel	soluble compounds, as Ni	Ni	7440-02-0	0.1 mg/m <sup>3</sup>	
Nickel	insoluble compounds, as Ni	Ni	7440-02-0	0.2 mg/m <sup>3</sup>	
Nickel carbonyl	as Ni	C <sub>4</sub> NiO <sub>4</sub>	13463-39-3	0.05 ppm	
Nickel subsulfide	as Ni	Ni <sub>3</sub> S <sub>2</sub>	12035-72-2	0.1 mg/m <sup>3</sup>	
Nicotine	[3-(1-Methyl-2-pyrrolidinyl)pyridine, ( <i>S</i> -)]	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>	54-11-5	0.5 mg/m <sup>3</sup>	
Nitrapyrin	[Pyridine, 2-chloro-6-(trichloromethyl)-]	C <sub>6</sub> H <sub>3</sub> Cl <sub>4</sub> N	1929-82-4	10 mg/m <sup>3</sup>	
Nitric acid		HNO <sub>3</sub>	7697-37-2	2 ppm	4 ppm
Nitric oxide		NO	10102-43-9	25 ppm	
4-Nitroaniline		C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	100-01-6	3 mg/m <sup>3</sup>	
Nitrobenzene		C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	98-95-3	1 ppm	
4-Nitrobiphenyl	levels as low as possible	C <sub>12</sub> H <sub>9</sub> NO <sub>2</sub>	92-93-3		
Nitroethane		C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	79-24-3	100 ppm	
Nitrogen dioxide		NO <sub>2</sub>	10102-44-0	3 ppm	5 ppm
Nitrogen trifluoride		NF <sub>3</sub>	7783-54-2	10 ppm	
Nitromethane	[Nitrocarbol]	CH <sub>3</sub> NO <sub>2</sub>	75-52-5	20 ppm	
1-Nitropropane		C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	108-03-2	25 ppm	
2-Nitropropane	[Isonitropropane]	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	79-46-9	10 ppm	
<i>N</i> -Nitrosodimethylamine	levels as low as possible	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	62-75-9		
Nitrotoluene	all isomers	C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	1321-12-6	2 ppm	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Nitrous oxide		N <sub>2</sub> O	10024-97-2	50 ppm	
3,3,4,4,5,5,6,6,6,-Nonafluoro-1-hexene	[Perfluorobutylethene]	C <sub>6</sub> H <sub>3</sub> F <sub>9</sub>	19430-93-4	100 ppm	
Nonane	all isomers	C <sub>9</sub> H <sub>20</sub>	111-84-2	200 ppm	
Octachloronaphthalene	[Perchloronaphthalene]	C <sub>10</sub> Cl <sub>8</sub>	2234-13-1	0.1 mg/m <sup>3</sup>	0.3 mg/m <sup>3</sup>
Octane	all isomers	C <sub>8</sub> H <sub>18</sub>	111-65-9	300 ppm	375 ppm
Osmium(VIII) oxide	[Osmium tetroxide]	OsO <sub>4</sub>	20816-12-0	0.0002 ppm	0.0006 ppm
Oxalic acid		C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	144-62-7	1 mg/m <sup>3</sup>	2 mg/m <sup>3</sup>
2-Oxetanone	[β-Propiolactone]	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	57-57-8	0.5 ppm	
Oxirane	[Ethylene oxide]	C <sub>2</sub> H <sub>4</sub> O	75-21-8	1 ppm	
Oxiranemethanol	[Glycidol]	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	556-52-5	2 ppm	
4,4'-Oxybis(benzenesulfonylhydrazide)		C <sub>12</sub> H <sub>14</sub> N <sub>4</sub> O <sub>5</sub> S <sub>2</sub>	80-51-3	0.1 mg/m <sup>3</sup>	
Ozone	depends on workload	O <sub>3</sub>	10028-15-6	0.1 ppm	
Paraquat		C <sub>12</sub> H <sub>14</sub> N <sub>2</sub>	4685-14-7	0.5 mg/m <sup>3</sup>	
Parathion		C <sub>10</sub> H <sub>14</sub> NO <sub>5</sub> PS	56-38-2	0.05 mg/m <sup>3</sup>	
Pentaborane(9)		B <sub>5</sub> H <sub>9</sub>	19624-22-7	0.005 ppm	0.015 ppm
Pentachloronaphthalene	all isomers	C <sub>10</sub> H <sub>3</sub> Cl <sub>5</sub>	1321-64-8	0.5 mg/m <sup>3</sup>	
Pentachloronitrobenzene	[Quintozene]	C <sub>6</sub> Cl <sub>5</sub> NO <sub>2</sub>	82-68-8	0.5 mg/m <sup>3</sup>	
Pentachlorophenol		C <sub>6</sub> HCl <sub>5</sub> O	87-86-5	0.5 mg/m <sup>3</sup>	
Pentaerythritol		C <sub>5</sub> H <sub>12</sub> O <sub>4</sub>	115-77-5	10 mg/m <sup>3</sup>	
Pentanal	[Valeraldehyde]	C <sub>5</sub> H <sub>10</sub> O	110-62-3	50 ppm	
Pentane	all isomers	C <sub>5</sub> H <sub>12</sub>	109-66-0	600 ppm	750 ppm
Pentanedial	[Glutaraldehyde]	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	111-30-8		C 0.05 ppm
2-Pentanone	[Methyl propyl ketone]	C <sub>5</sub> H <sub>10</sub> O	107-87-9		150 ppm
3-Pentanone	[Diethyl ketone]	C <sub>5</sub> H <sub>10</sub> O	96-22-0	200 ppm	300 ppm
Pentyl acetate	[Amyl acetate]; all isomers	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	628-63-7	50 ppm	100 ppm
Perchloryl fluoride	[Chlorine trioxide fluoride]	ClO <sub>3</sub> F	7616-94-6	3 ppm	6 ppm
Perfluoroacetone	[Hexafluoroacetone]	C <sub>3</sub> F <sub>6</sub> O	684-16-2	0.1 ppm	
Perfluoroisobutene	[Perfluoroisobutylene]	C <sub>4</sub> F <sub>8</sub>	382-21-8		C 0.01 ppm
Perfluoropropene	[Hexafluoropropene]	C <sub>3</sub> F <sub>6</sub>	116-15-4	0.1 mg/m <sup>3</sup>	
Phenol	[Hydroxybenzene]	C <sub>6</sub> H <sub>6</sub> O	108-95-2	5 ppm	
10H-Phenothiazine	[Thiodiphenylamine]	C <sub>12</sub> H <sub>9</sub> NS	92-84-2	5 mg/m <sup>3</sup>	
Phenyl glycidyl ether	[PGE]	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	122-60-1	0.1 ppm	
Phenylhydrazine		C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>	100-63-0	0.1 ppm	
N-Phenyl-2-naphthalenamine	levels as low as possible	C <sub>16</sub> H <sub>13</sub> N	135-88-6		
Phenylphosphine	[Monophenylphosphine]	C <sub>6</sub> H <sub>7</sub> P	638-21-1		C 0.05 ppm
Phorate	[Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester]	C <sub>7</sub> H <sub>17</sub> O <sub>2</sub> PS <sub>3</sub>	298-02-2	0.05 mg/m <sup>3</sup>	0.2 mg/m <sup>3</sup>
Phosphine	[Phosphorus hydride]	PH <sub>3</sub>	7803-51-2	0.3 ppm	1 ppm
Phosphoric acid	[Orthophosphoric acid]	H <sub>3</sub> PO <sub>4</sub>	7664-38-2	1 mg/m <sup>3</sup>	3 mg/m <sup>3</sup>
Phosphorus (yellow)	[White phosphorus]	P	7723-14-0	0.1 mg/m <sup>3</sup>	
Phosphorus(III) chloride	[Phosphorus trichloride]	PCl <sub>3</sub>	7719-12-2	0.2 ppm	0.5 ppm
Phosphorus(V) chloride	[Phosphorus pentachloride]	PCl <sub>5</sub>	10026-13-8	0.1 ppm	
Phosphorus(V) sulfide	[Phosphorus pentasulfide]	P <sub>2</sub> S <sub>5</sub>	1314-80-3	1 mg/m <sup>3</sup>	3 mg/m <sup>3</sup>
Phosphoryl chloride	[Phosphorus(V) oxychloride]	POCl <sub>3</sub>	10025-87-3	0.1 ppm	
Phthalic anhydride		C <sub>8</sub> H <sub>4</sub> O <sub>3</sub>	85-44-9	1 ppm	
α-Pinene	[2-Pinene]	C <sub>10</sub> H <sub>16</sub>	80-56-8	20 ppm	
β-Pinene	[Nopinene]	C <sub>10</sub> H <sub>16</sub>	127-91-3	20 ppm	
Piperazine dihydrochloride	[Diethylenediamine dihydrochloride]	C <sub>4</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub>	142-64-3	5 mg/m <sup>3</sup>	
2-Pivaloyl-1,3-indandione	[Pindone]	C <sub>14</sub> H <sub>14</sub> O <sub>3</sub>	83-26-1	0.1 mg/m <sup>3</sup>	
Platinum	metal dust	Pt	7440-06-4	1 mg/m <sup>3</sup>	
Platinum	soluble salts, as Pt	Pt	7440-06-4	0.002 mg/m <sup>3</sup>	
Polychlorinated biphenyls (42% chlorine)	[PCBs]		53469-21-9	1 mg/m <sup>3</sup>	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Polychlorinated biphenyls (54% chlorine)	[PCBs]		11097-69-1	0.5 mg/m <sup>3</sup>	
Poly(vinyl chloride)	[PVC]		9002-86-2	1 mg/m <sup>3</sup>	
Portland cement			65997-15-1	10 mg/m <sup>3</sup>	
Potassium hydroxide		KOH	1310-58-3		C 2 mg/m <sup>3</sup>
Propanal	[Propionaldehyde]	C <sub>3</sub> H <sub>6</sub> O	123-38-6	20 ppm	
Propane	[LPG]	C <sub>3</sub> H <sub>8</sub>	74-98-6	1000 ppm	
1,3-Propane sultone	levels as low as possible	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> S	1120-71-4		
Propanoic acid	[Propionic acid]	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	79-09-4	10 ppm	
1-Propanol	[Propyl alcohol]	C <sub>3</sub> H <sub>8</sub> O	71-23-8	100 ppm	400 ppm
2-Propanol	[Isopropyl alcohol]	C <sub>3</sub> H <sub>8</sub> O	67-63-0	200 ppm	400 ppm
Propargyl alcohol	[2-Propyn-1-ol]	C <sub>3</sub> H <sub>4</sub> O	107-19-7	1 ppm	
Propene	[Propylene]	C <sub>3</sub> H <sub>6</sub>	115-07-1	500 ppm	
Propoxur	[Phenol, 2-(1-methylethoxy)-, methylcarbamate]	C <sub>11</sub> H <sub>15</sub> NO <sub>3</sub>	114-26-1	0.5 mg/m <sup>3</sup>	
Propyl acetate		C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	109-60-4	200 ppm	250 ppm
1,2-Propylene glycol dinitrate		C <sub>3</sub> H <sub>6</sub> N <sub>2</sub> O <sub>6</sub>	6423-43-4	0.05 ppm	
Propyleneimine	[2-Methylaziridine]	C <sub>3</sub> H <sub>7</sub> N	75-55-8	2 ppm	
Propyl nitrate		C <sub>3</sub> H <sub>7</sub> NO <sub>3</sub>	627-13-4	25 ppm	40 ppm
Propyne	[Methylacetylene]	C <sub>3</sub> H <sub>4</sub>	74-99-7	1000 ppm	
Pyrethrin I	[Pyrethrum]	C <sub>21</sub> H <sub>28</sub> O <sub>3</sub>	8003-34-7	5 mg/m <sup>3</sup>	
2-Pyridinamine	[2-Aminopyridine]	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>	504-29-0	0.5 ppm	
Pyridine	[Azine]	C <sub>5</sub> H <sub>5</sub> N	110-86-1	1 ppm	
Pyrocatechol	[Catechol]	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	120-80-9	5 ppm	
Resorcinol	[1,3-Benzenediol]	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	108-46-3	10 ppm	20 ppm
Rhodium	metal and insoluble compounds, as Rh	Rh	7440-16-6	1 mg/m <sup>3</sup>	
Rhodium	soluble compounds, as Rh	Rh	7440-16-6	0.01 mg/m <sup>3</sup>	
Ronnel		C <sub>8</sub> H <sub>8</sub> Cl <sub>3</sub> O <sub>3</sub> PS	299-84-3	5 mg/m <sup>3</sup>	
Rotenone		C <sub>23</sub> H <sub>22</sub> O <sub>6</sub>	83-79-4	5 mg/m <sup>3</sup>	
Rubber	natural latex, as inhalable proteins			0.0001 mg/m <sup>3</sup>	
Selenium	element and compounds, as Se	Se	7782-49-2	0.2 mg/m <sup>3</sup>	
Selenium hexafluoride		SeF <sub>6</sub>	7783-79-1	0.05 ppm	
Sesone	[Sodium 2-(2,4-dichlorophenoxy)ethyl sulfate]	C <sub>8</sub> H <sub>7</sub> Cl <sub>2</sub> NaO <sub>5</sub> S	136-78-7	10 mg/m <sup>3</sup>	
Silane	[Silicon tetrahydride]	SiH <sub>4</sub>	7803-62-5	5 ppm	
Silicon carbide	lower limits for fibrous SiC	SiC	409-21-2	10 mg/m <sup>3</sup>	
Silicon dioxide (α-quartz)	[Quartz]	SiO <sub>2</sub>	14808-60-7	0.025 mg/m <sup>3</sup>	
Silicon dioxide (cristobalite)	[Cristobalite]	SiO <sub>2</sub>	14464-46-1	0.025 mg/m <sup>3</sup>	
Silver	metal	Ag	7440-22-4	0.1 mg/m <sup>3</sup>	
Silver	soluble compounds, as Ag	Ag	7440-22-4	0.01 mg/m <sup>3</sup>	
Sodium azide	[Smite]	NaN <sub>3</sub>	26628-22-8		C 0.29 mg/m <sup>3</sup>
Sodium fluoroacetate		C <sub>2</sub> H <sub>2</sub> FN <sub>2</sub> O <sub>2</sub>	62-74-8	0.05 mg/m <sup>3</sup>	
Sodium hydrogen sulfite	[Sodium bisulfite]	NaHSO <sub>3</sub>	7631-90-5	5 mg/m <sup>3</sup>	
Sodium hydroxide	[Caustic soda]	NaOH	1310-73-2		C 2 mg/m <sup>3</sup>
Sodium metabisulfite	[Sodium pyrosulfite]	Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub>	7681-57-4	5 mg/m <sup>3</sup>	
Sodium tetraborate decahydrate	[Borax]	Na <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·10H <sub>2</sub> O	1303-96-4	2 mg/m <sup>3</sup>	6 mg/m <sup>3</sup>
Starch			9005-25-8	10 mg/m <sup>3</sup>	
Stibine	[Antimony hydride]	SbH <sub>3</sub>	7803-52-3	0.1 ppm	
Stoddard solvent			8052-41-3	100 ppm	
Strontium chromate	as Cr	SrCrO <sub>4</sub>	7789-06-2	0.0005 mg/m <sup>3</sup>	
Strychnine		C <sub>21</sub> H <sub>22</sub> N <sub>2</sub> O <sub>2</sub>	57-24-9	0.15 mg/m <sup>3</sup>	
Styrene	[Vinylbenzene]	C <sub>8</sub> H <sub>8</sub>	100-42-5	20 ppm	40 ppm
Subtilisins	as crystalline active enzyme		9014-01-1		C 0.00006 mg/m <sup>3</sup>

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Sucrose		C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	57-50-1	10 mg/m <sup>3</sup>	
Sulfometuron methyl		C <sub>15</sub> H <sub>16</sub> N <sub>4</sub> O <sub>5</sub> S	74222-97-2	5 mg/m <sup>3</sup>	
Sulfotep	[Tetraethyl thiodiphosphate; TEDP]	C <sub>8</sub> H <sub>20</sub> O <sub>5</sub> P <sub>2</sub> S <sub>2</sub>	3689-24-5	0.2 mg/m <sup>3</sup>	
Sulfur chloride	[Disulfur dichloride]	S <sub>2</sub> Cl <sub>2</sub>	10025-67-9		C 1 ppm
Sulfur decafluoride	[Sulfur pentafluoride]	S <sub>2</sub> F <sub>10</sub>	5714-22-7		C 0.01 ppm
Sulfur dioxide		SO <sub>2</sub>	7446-09-5	2 ppm	5 ppm
Sulfur hexafluoride		SF <sub>6</sub>	2551-62-4	1000 ppm	
Sulfuric acid	[Oil of vitriol]	H <sub>2</sub> SO <sub>4</sub>	7664-93-9	0.2 mg/m <sup>3</sup>	
Sulfur tetrafluoride		SF <sub>4</sub>	7783-60-0		C 0.1 ppm
Sulfuryl fluoride		SO <sub>2</sub> F <sub>2</sub>	2699-79-8	5 ppm	10 ppm
Sulprofos		C <sub>12</sub> H <sub>19</sub> O <sub>2</sub> PS <sub>3</sub>	35400-43-2	1 mg/m <sup>3</sup>	
Talc		3MgO4SiO <sub>2</sub> H <sub>2</sub> O	14807-96-6	2 mg/m <sup>3</sup>	
Tantalum	dust	Ta	7440-25-7	5 mg/m <sup>3</sup>	
Tantalum(V) oxide	dust, as Ta	Ta <sub>2</sub> O <sub>5</sub>	1314-61-0	5 mg/m <sup>3</sup>	
Tellurium	and compounds, as Te (except H <sub>2</sub> Te)	Te	13494-80-9	0.1 mg/m <sup>3</sup>	
Tellurium hexafluoride		TeF <sub>6</sub>	7783-80-4	0.02 ppm	
Terbufos		C <sub>9</sub> H <sub>21</sub> O <sub>2</sub> PS <sub>3</sub>	13071-79-9	0.01 mg/m <sup>3</sup>	
Terephthalic acid	[1,4-Benzenedicarboxylic acid]	C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	100-21-0	10 mg/m <sup>3</sup>	
Terphenyl	all isomers	C <sub>18</sub> H <sub>14</sub>	26140-60-3		5 mg/m <sup>3</sup>
1,1,2,2-Tetrabromoethane	[Acetylene tetrabromide]	C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>	79-27-6	0.1 ppm	
Tetrabromomethane	[Carbon tetrabromide]	CBr <sub>4</sub>	558-13-4	0.1 ppm	0.3 ppm
1,1,1,2-Tetrachloro-2,2-difluoroethane	[Tetrachloro-1,1-difluoroethane]	C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	76-11-9	100 ppm	
1,1,2,2-Tetrachloro-1,2-difluoroethane	[Tetrachloro-1,2-difluoroethane]	C <sub>2</sub> Cl <sub>4</sub> F <sub>2</sub>	76-12-0	50 ppm	
1,1,2,2-Tetrachloroethane	[Acetylene tetrachloride]	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	79-34-5	1 ppm	
Tetrachloroethene	[Perchloroethylene]	C <sub>2</sub> Cl <sub>4</sub>	127-18-4	25 ppm	100 ppm
Tetrachloromethane	[Carbon tetrachloride]	CCl <sub>4</sub>	56-23-5	5 ppm	10 ppm
Tetrachloronaphthalene	all isomers	C <sub>10</sub> H <sub>4</sub> Cl <sub>4</sub>	1335-88-2	2 mg/m <sup>3</sup>	
Tetraethyl lead	as Pb	C <sub>8</sub> H <sub>20</sub> Pb	78-00-2	0.1 mg/m <sup>3</sup>	
Tetraethyl pyrophosphate	[TEPP]	C <sub>8</sub> H <sub>20</sub> O <sub>7</sub> P <sub>2</sub>	107-49-3	0.01 mg/m <sup>3</sup>	
Tetrafluoroethene	[Tetrafluoroethylene]	C <sub>2</sub> F <sub>4</sub>	116-14-3	2 ppm	
Tetrahydrofuran	[Oxolane]	C <sub>4</sub> H <sub>8</sub> O	109-99-9	50 ppm	100 ppm
Tetramethyl lead	as Pb	C <sub>4</sub> H <sub>12</sub> Pb	75-74-1	0.15 mg/m <sup>3</sup>	
Tetramethyl silicate	[Methyl silicate]	C <sub>4</sub> H <sub>12</sub> O <sub>4</sub> Si	681-84-5	1 ppm	
Tetramethylsuccinonitrile	[Tetramethylbutanedinitrile]	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>	3333-52-6	0.5 ppm	
Tetranitromethane		CN <sub>4</sub> O <sub>8</sub>	509-14-8	0.005 ppm	
Thallium	and soluble compounds, as Tl	Tl	7440-28-0	0.1 mg/m <sup>3</sup>	
4,4'-Thiobis(6- <i>tert</i> -butyl- <i>m</i> -cresol)	[Bis(5- <i>tert</i> -butyl-4-hydroxy-2-methylphenyl) sulfide]	C <sub>22</sub> H <sub>30</sub> O <sub>2</sub> S	96-69-5	10 mg/m <sup>3</sup>	
Thioglycolic acid		C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> S	68-11-1	1 ppm	
Thionyl chloride	[Sulfinyl dichloride]	SOCl <sub>2</sub>	7719-09-7		C 1 ppm
Thiram		C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> S <sub>4</sub>	137-26-8	0.05 mg/m <sup>3</sup>	
Tin	metal	Sn	7440-31-5	2 mg/m <sup>3</sup>	
Tin	inorganic compounds, as Sn	Sn	7440-31-5	2 mg/m <sup>3</sup>	
Tin	organic compounds, as Sn	Sn	7440-31-5	0.1 mg/m <sup>3</sup>	
Titanium(IV) oxide	[Titanium dioxide]	TiO <sub>2</sub>	13463-67-7	10 mg/m <sup>3</sup>	
Toluene	[Methylbenzene]	C <sub>7</sub> H <sub>8</sub>	108-88-3	20 ppm	
Toluene-2,4-diisocyanate		C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	584-84-9	0.005 ppm	0.02 ppm
Toluene-2,6-diisocyanate		C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	91-08-7	0.005 mg/m <sup>3</sup>	0.02 ppm
Toxaphene	[Polychlorocamphene]	C <sub>10</sub> H <sub>10</sub> Cl <sub>8</sub>	8001-35-2	0.5 mg/m <sup>3</sup>	
1 <i>H</i> -1,2,4-Triazol-3-amine	[Amitrole]	C <sub>2</sub> H <sub>4</sub> N <sub>4</sub>	61-82-5	0.2 mg/m <sup>3</sup>	
Tribromomethane	[Bromoform]	CHBr <sub>3</sub>	75-25-2	0.5 ppm	
Tributyl phosphate	[Butyl phosphate]	C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P	126-73-8	0.2 ppm	
Trichlorfon	[Trichlorphon]	C <sub>4</sub> H <sub>8</sub> Cl <sub>3</sub> O <sub>4</sub> P	52-68-6	1 mg/m <sup>3</sup>	

Substance	Notes	Formula	CAS Reg. No.	Time-weighted average	Short-term exposure limit
Trichloroacetic acid		$C_2HCl_3O_2$	76-03-9	1 ppm	
1,2,4-Trichlorobenzene		$C_6H_3Cl_3$	120-82-1		C 5 ppm
1,1,1-Trichloroethane	[Methyl chloroform]	$C_2H_3Cl_3$	71-55-6	350 ppm	450 ppm
1,1,2-Trichloroethane	[Vinyl trichloride]	$C_2H_3Cl_3$	79-00-5	10 ppm	
Trichloroethene	[Trichloroethylene]	$C_2HCl_3$	79-01-6	10 ppm	25 ppm
Trichlorofluoromethane	[CFC-11]	$CCl_3F$	75-69-4		C 1000 ppm
Trichloromethane	[Chloroform]	$CHCl_3$	67-66-3	10 ppm	
Trichloromethanesulfonyl chloride	[Perchloromethyl mercaptan]	$CCl_3S$	594-42-3	0.1 ppm	
(Trichloromethyl)benzene	[Benzotrichloride]	$C_7H_5Cl_3$	98-07-7		C 0.1 ppm
Trichloronaphthalene	all isomers	$C_{10}H_5Cl_3$	1321-65-9	5 mg/m <sup>3</sup>	
Trichloronitromethane	[Chloropicrin]	$CCl_3NO_2$	76-06-2	0.1 ppm	
2,4,5-Trichlorophenoxyacetic acid	[2,4,5-T]	$C_8H_5Cl_3O_3$	93-76-5	10 mg/m <sup>3</sup>	
1,2,3-Trichloropropane	[Allyl trichloride]	$C_3H_5Cl_3$	96-18-4	10 ppm	
1,1,2-Trichloro-1,2,2-trifluoroethane	[CFC-113]	$C_2Cl_3F_3$	76-13-1	1000 ppm	1250 ppm
Tri- <i>o</i> -cresyl phosphate	[Tri- <i>o</i> -tolyl phosphate]	$C_{21}H_{21}O_4P$	78-30-8	0.1 mg/m <sup>3</sup>	
Triethanolamine	[Tris(2-hydroxyethyl)amine]	$C_6H_{15}NO_3$	102-71-6	5 mg/m <sup>3</sup>	
Triethylamine	[ <i>N,N</i> -Diethylethanamine]	$C_6H_{15}N$	121-44-8	1 ppm	3 ppm
1,3,5-Triglycidyl- <i>s</i> -triazinetriene	[1,3,5-Tris(oxiranemethyl)-1,3,5-triazine-2,4,6(1 <i>H</i> ,3 <i>H</i> ,5 <i>H</i> )-trione]	$C_{12}H_{15}N_3O_6$	2451-62-9	0.05 mg/m <sup>3</sup>	
Triiodomethane	[Iodoform]	$CHI_3$	75-47-8	0.6 ppm	
Trimellitic anhydride	[1,2,4-Benzenetricarboxylic anhydride]	$C_9H_4O_5$	552-30-7	0.0005 mg/m <sup>3</sup>	C 0.002 mg/m <sup>3</sup>
Trimethylamine	[ <i>N,N</i> -Dimethylmethanamine]	$C_3H_9N$	75-50-3	5 ppm	15 ppm
Trimethylbenzene	all isomers	$C_9H_{12}$	25551-13-7	25 ppm	
Trimethyl phosphite		$C_3H_9O_3P$	121-45-9	2 ppm	
Trinitroglycerol	[Nitroglycerin; NG]	$C_3H_5N_3O_9$	55-63-0	0.05 ppm	
2,4,6-Trinitrophenol	[Picric acid]	$C_6H_3N_3O_7$	88-89-1	0.1 mg/m <sup>3</sup>	
2,4,6-Trinitrotoluene	[TNT]	$C_7H_5N_3O_6$	118-96-7	0.1 mg/m <sup>3</sup>	
Triphenyl phosphate		$C_{18}H_{15}O_4P$	115-86-6	3 mg/m <sup>3</sup>	
Tungsten	metal and insoluble compounds, as W	W	7440-33-7	5 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Tungsten	soluble compounds, as W	W	7440-33-7	1 mg/m <sup>3</sup>	3 mg/m <sup>3</sup>
Turpentine			8006-64-2	20 ppm	
Uranium	metal and compounds, as U	U	7440-61-1	0.2 mg/m <sup>3</sup>	0.6 mg/m <sup>3</sup>
Vanadium(V) oxide	dust or fume; [Vanadium pentoxide]	$V_2O_5$	1314-62-1	0.05 mg/m <sup>3</sup>	
Vinyl acetate		$C_4H_6O_2$	108-05-4	10 ppm	15 ppm
4-Vinylcyclohexene		$C_8H_{12}$	100-40-3	0.1 ppm	
1-Vinyl-2-pyrrolidinone		$C_6H_9NO$	88-12-0	0.05 ppm	
Warfarin	[Coumadin]	$C_{19}H_{16}O_4$	81-81-2	0.1 mg/m <sup>3</sup>	
Xylene	[Dimethylbenzene], all isomers	$C_8H_{10}$	1330-20-7	100 ppm	150 ppm
Xylidine	[Dimethylaniline], all isomers	$C_8H_{11}N$	1300-73-8	0.5 ppm	
Yttrium	metal and compounds, as Y	Y	7440-65-5	1 mg/m <sup>3</sup>	
Zinc chloride	fume	$ZnCl_2$	7646-85-7	1 mg/m <sup>3</sup>	2 mg/m <sup>3</sup>
Zinc chromate	as Cr	$ZnCrO_4$	13530-65-9	0.01 mg/m <sup>3</sup>	
Zinc oxide	[Zincite]	$ZnO$	1314-13-2	2 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Zirconium	metal and compounds, as Zr	Zr	7440-67-7	5 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>

## OCTANOL-WATER PARTITION COEFFICIENTS

The octanol-water partition coefficient,  $P$ , is a widely used parameter for correlating biological effects of organic substances. It is a property of the two-phase system in which water and 1-octanol are in equilibrium at a fixed temperature and the substance is distributed between the water-rich and octanol-rich phases.  $P$  is defined as the ratio of the equilibrium concentration of the substance in the octanol-rich phase to that in the water-rich phase, in the limit of zero concentration. In general,  $P$  tends to be large for compounds with extended non-polar structures (such as long chain or multi-ring hydrocarbons) and small for compounds with highly polar groups. Thus  $P$  (or, in its more common form of expression,  $\log P$ ) provides a measure of the lipophilic vs. hydrophilic nature of a compound, which is an important consideration in assessing the potential toxicity. A discussion of methods of measurement and accuracy considerations for  $\log P$  may be found in Reference 1.

This table gives selected values of  $\log P$  for about 450 organic compounds, including many of environmental importance. All values refer to a nominal temperature of 25°C. The source of each value is indicated in the last column. These references contain data on many more compounds than are included here.

Compounds are listed by molecular formula following the Hill convention. To locate a compound by name or CAS Registry Number when the molecular formula is not known, use the table "Physical Constants of Organic Compounds" in Section 3 and its indexes to determine the molecular formula.

### References

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Mol. form.	Name	$\log P$	Ref.	Mol. form.	Name	$\log P$	Ref.
CCl <sub>2</sub> F <sub>2</sub>	Dichlorodifluoromethane	2.16	2	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Acetic acid	-0.17	1
CCl <sub>3</sub> F	Trichlorofluoromethane	2.53	2	C <sub>2</sub> H <sub>5</sub> Br	Bromoethane	1.6	2
CCl <sub>4</sub>	Tetrachloromethane	2.64	2	C <sub>2</sub> H <sub>5</sub> Cl	Chloroethane	1.43	2
CHBr <sub>3</sub>	Tribromomethane	2.38	2	C <sub>2</sub> H <sub>5</sub> I	Iodoethane	2	2
CHCl <sub>3</sub>	Trichloromethane	1.97	2	C <sub>2</sub> H <sub>5</sub> NO	Acetamide	-1.26	1
CH <sub>2</sub> BrCl	Bromochloromethane	1.41	2	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>	Nitroethane	0.18	1
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	2.3	2	C <sub>2</sub> H <sub>6</sub> O	Ethanol	-0.30	1
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	1.25	2	C <sub>2</sub> H <sub>6</sub> O	Dimethyl ether	0.10	1
CH <sub>2</sub> F <sub>2</sub>	Difluoromethane	0.20	1	C <sub>2</sub> H <sub>6</sub> OS	Dimethyl sulfoxide	-1.35	1
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane	2.5	2	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> S	Dimethyl sulfone	-1.41	1
CH <sub>2</sub> O	Formaldehyde	0.35	1	C <sub>2</sub> H <sub>7</sub> N	Ethylamine	-0.13	1
CH <sub>2</sub> O <sub>2</sub>	Formic acid	-0.54	1	C <sub>2</sub> H <sub>7</sub> N	Dimethylamine	-0.38	1
CH <sub>3</sub> Br	Bromomethane	1.19	2	C <sub>2</sub> H <sub>3</sub> N	2-Propenenitrile	0.25	1
CH <sub>3</sub> Cl	Chloromethane	0.91	2	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub>	<i>cis</i> -1,3-Dichloropropene	2.03	2
CH <sub>3</sub> F	Fluoromethane	0.51	1	C <sub>3</sub> H <sub>3</sub> O	Propargyl alcohol	-0.38	1
CH <sub>3</sub> I	Iodomethane	1.5	2	C <sub>3</sub> H <sub>4</sub> O	Acrolein	-0.01	1
CH <sub>3</sub> NO	Formamide	-1.51	1	C <sub>3</sub> H <sub>5</sub> Br	3-Bromopropene	1.79	1
CH <sub>3</sub> NO <sub>2</sub>	Nitromethane	-0.33	1	C <sub>3</sub> H <sub>5</sub> ClO	Epichlorohydrin	0.30	2
CH <sub>4</sub> O	Methanol	-0.74	1	C <sub>3</sub> H <sub>5</sub> Cl <sub>3</sub>	1,2,3-Trichloropropane	2.63	2
CH <sub>5</sub> N	Methylamine	-0.57	1	C <sub>3</sub> H <sub>5</sub> N	Propanenitrile	0.16	1
C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>	1,1,2-Trichlorotrifluoroethane	3.16	2	C <sub>3</sub> H <sub>5</sub> NO	Acrylamide	-0.78	1
C <sub>2</sub> Cl <sub>4</sub>	Tetrachloroethylene	2.88	2	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	1,2-Dichloropropane	2.0	2
C <sub>2</sub> Cl <sub>6</sub>	Hexachloroethane	4.00	4	C <sub>3</sub> H <sub>6</sub> O	Allyl alcohol	0.17	1
C <sub>2</sub> HCl <sub>3</sub>	Trichloroethylene	2.53	2	C <sub>3</sub> H <sub>6</sub> O	Propanal	0.59	1
C <sub>2</sub> HCl <sub>5</sub>	Pentachloroethane	2.89	2	C <sub>3</sub> H <sub>6</sub> O	Acetone	-0.24	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1,1-Dichloroethylene	2.13	2	C <sub>3</sub> H <sub>6</sub> O	Methyloxirane	0.03	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>cis</i> -1,2-Dichloroethylene	1.86	2	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Propanoic acid	0.33	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	<i>trans</i> -1,2-Dichloroethylene	1.93	2	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acetate	0.18	1
C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	1,1,2,2-Tetrachloroethane	2.39	2	C <sub>3</sub> H <sub>7</sub> Br	1-Bromopropane	2.1	2
C <sub>2</sub> H <sub>3</sub> Cl	Chloroethylene	1.38	2	C <sub>3</sub> H <sub>7</sub> Br	2-Bromopropane	1.9	2
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,1-Trichloroethane	2.49	2	C <sub>3</sub> H <sub>7</sub> Cl	1-Chloropropane	2.04	1
C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	1,1,2-Trichloroethane	2.38	2	C <sub>3</sub> H <sub>7</sub> Cl	2-Chloropropane	1.90	1
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile	-0.34	1	C <sub>3</sub> H <sub>7</sub> I	1-Iodopropane	2.5	2
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,1-Dichloroethane	1.79	2	C <sub>3</sub> H <sub>7</sub> N	Allylamine	0.03	1
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1,2-Dichloroethane	1.48	2	C <sub>3</sub> H <sub>7</sub> NO	<i>N,N</i> -Dimethylformamide	-1.01	1
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde	0.45	1	C <sub>3</sub> H <sub>7</sub> NO	<i>N</i> -Methylacetamide	-1.05	1
C <sub>2</sub> H <sub>4</sub> O	Ethylene oxide	-0.30	1	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	1-Nitropropane	0.87	1

Mol. form.	Name	log P	Ref.	Mol. form.	Name	log P	Ref.
C <sub>3</sub> H <sub>8</sub> O	1-Propanol	0.25	1	C <sub>5</sub> H <sub>10</sub> O	2-Methyltetrahydrofuran	1.85	2
C <sub>3</sub> H <sub>8</sub> O	2-Propanol	0.05	1	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Pentanoic acid	1.39	1
C <sub>3</sub> H <sub>8</sub> S	1-Propanethiol	1.81	1	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propyl acetate	1.24	1
C <sub>3</sub> H <sub>9</sub> N	Propylamine	0.48	1	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl propanoate	1.21	1
C <sub>3</sub> H <sub>9</sub> N	Isopropylamine	0.26	1	C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	Diethyl carbonate	1.21	1
C <sub>3</sub> H <sub>9</sub> N	Ethylmethylamine	0.15	1	C <sub>5</sub> H <sub>11</sub> Br	1-Bromopentane	3.37	1
C <sub>3</sub> H <sub>9</sub> N	Trimethylamine	0.16	1	C <sub>5</sub> H <sub>11</sub> F	1-Fluoropentane	2.33	1
C <sub>4</sub> H <sub>4</sub> O	Furan	1.34	1	C <sub>5</sub> H <sub>11</sub> N	Piperidine	0.84	1
C <sub>4</sub> H <sub>4</sub> S	Thiophene	1.81	1	C <sub>5</sub> H <sub>11</sub> NO <sub>2</sub>	1-Nitropentane	2.01	1
C <sub>4</sub> H <sub>5</sub> N	Pyrrrole	0.75	1	C <sub>5</sub> H <sub>12</sub>	Pentane	3.45	1
C <sub>4</sub> H <sub>6</sub>	1,3-Butadiene	1.99	1	C <sub>5</sub> H <sub>12</sub>	Neopentane	3.11	1
C <sub>4</sub> H <sub>6</sub>	2-Butyne	1.46	1	C <sub>5</sub> H <sub>12</sub> O	1-Pentanol	1.51	1
C <sub>4</sub> H <sub>6</sub> O	2,5-Dihydrofuran	0.46	1	C <sub>5</sub> H <sub>12</sub> O	2-Pentanol	1.25	1
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methacrylic acid	0.93	1	C <sub>5</sub> H <sub>12</sub> O	3-Pentanol	1.21	1
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Vinyl acetate	0.73	1	C <sub>5</sub> H <sub>12</sub> O	3-Methyl-1-butanol	1.28	1
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Methyl acrylate	0.80	1	C <sub>5</sub> H <sub>12</sub> O	2-Methyl-2-butanol	0.89	1
C <sub>4</sub> H <sub>7</sub> N	Butanenitrile	0.60	1	C <sub>5</sub> H <sub>12</sub> O	3-Methyl-2-butanol	1.28	1
C <sub>4</sub> H <sub>8</sub>	<i>cis</i> -2-Butene	2.33	1	C <sub>5</sub> H <sub>12</sub> O	2,2-Dimethyl-1-propanol	1.31	1
C <sub>4</sub> H <sub>8</sub>	<i>trans</i> -2-Butene	2.31	1	C <sub>5</sub> H <sub>12</sub> O	Methyl <i>tert</i> -butyl ether	0.94	1
C <sub>4</sub> H <sub>8</sub>	Isobutene	2.35	1	C <sub>5</sub> H <sub>13</sub> N	Pentylamine	1.49	1
C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	Bis(2-chloroethyl) ether	1.12	2	C <sub>6</sub> Cl <sub>6</sub>	Hexachlorobenzene	5.47	5
C <sub>4</sub> H <sub>8</sub> O	Ethyl vinyl ether	1.04	1	C <sub>6</sub> HCl <sub>5</sub>	Pentachlorobenzene	5.03	5
C <sub>4</sub> H <sub>8</sub> O	Butanal	0.88	1	C <sub>6</sub> HCl <sub>5</sub> O	Pentachlorophenol	5.07	4
C <sub>4</sub> H <sub>8</sub> O	2-Butanone	0.29	1	C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	1,2,3,4-Tetrachlorobenzene	4.55	5
C <sub>4</sub> H <sub>8</sub> O	Tetrahydrofuran	0.46	1	C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	1,2,3,5-Tetrachlorobenzene	4.65	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Butanoic acid	0.79	1	C <sub>6</sub> H <sub>2</sub> Cl <sub>4</sub>	1,2,4,5-Tetrachlorobenzene	4.51	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Propyl formate	0.83	1	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,3-Trichlorobenzene	4.04	5
C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acetate	0.73	1	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,2,4-Trichlorobenzene	3.98	5
C <sub>4</sub> H <sub>9</sub> Br	1-Bromobutane	2.75	1	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	1,3,5-Trichlorobenzene	4.02	5
C <sub>4</sub> H <sub>9</sub> Cl	1-Chlorobutane	2.64	2	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>o</i> -Dichlorobenzene	3.38	5
C <sub>4</sub> H <sub>9</sub> F	1-Fluorobutane	2.58	1	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>m</i> -Dichlorobenzene	3.48	5
C <sub>4</sub> H <sub>9</sub> I	1-Iodobutane	3	2	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	<i>p</i> -Dichlorobenzene	3.38	5
C <sub>4</sub> H <sub>9</sub> N	Pyrrrolidine	0.46	1	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> O	2,4-Dichlorophenol	3.23	4
C <sub>4</sub> H <sub>9</sub> NO	Butanamide	-0.21	1	C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene	2.99	2
C <sub>4</sub> H <sub>9</sub> NO	<i>N,N</i> -Dimethylacetamide	-0.77	1	C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene	2.84	1
C <sub>4</sub> H <sub>9</sub> NO <sub>2</sub>	1-Nitrobutane	1.47	1	C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene	2.27	2
C <sub>4</sub> H <sub>10</sub>	Isobutane	2.8	2	C <sub>6</sub> H <sub>5</sub> I	Iodobenzene	3.28	2
C <sub>4</sub> H <sub>10</sub> O	1-Butanol	0.84	1	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	Nitrobenzene	1.85	1
C <sub>4</sub> H <sub>10</sub> O	2-Butanol	0.65	1	C <sub>6</sub> H <sub>6</sub>	Benzene	2.13	1
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-1-propanol	0.76	1	C <sub>6</sub> H <sub>6</sub> O	Phenol	1.48	4
C <sub>4</sub> H <sub>10</sub> O	2-Methyl-2-propanol	0.35	1	C <sub>6</sub> H <sub>6</sub> S	Benzenethiol	2.52	1
C <sub>4</sub> H <sub>10</sub> O	Diethyl ether	0.89	1	C <sub>6</sub> H <sub>7</sub> N	Aniline	0.90	1
C <sub>4</sub> H <sub>10</sub> S	1-Butanethiol	2.28	1	C <sub>6</sub> H <sub>7</sub> N	2-Methylpyridine	1.11	1
C <sub>4</sub> H <sub>10</sub> S	Diethyl sulfide	1.95	1	C <sub>6</sub> H <sub>7</sub> N	3-Methylpyridine	1.20	1
C <sub>4</sub> H <sub>11</sub> N	Butylamine	0.86	1	C <sub>6</sub> H <sub>7</sub> N	4-Methylpyridine	1.22	1
C <sub>4</sub> H <sub>11</sub> N	<i>tert</i> -Butylamine	0.40	1	C <sub>6</sub> H <sub>8</sub>	1,4-Cyclohexadiene	2.3	2
C <sub>4</sub> H <sub>11</sub> N	Diethylamine	0.58	1	C <sub>6</sub> H <sub>8</sub> O	5-Hexyn-2-one	0.58	1
C <sub>5</sub> H <sub>5</sub> N	Pyridine	0.65	1	C <sub>6</sub> H <sub>8</sub> O	2-Cyclohexen-1-one	0.61	1
C <sub>5</sub> H <sub>6</sub> O	2-Methylfuran	1.85	1	C <sub>6</sub> H <sub>8</sub> O	2-Ethylfuran	2.40	1
C <sub>5</sub> H <sub>7</sub> N	1-Methylpyrrrole	1.21	1	C <sub>6</sub> H <sub>10</sub>	1,5-Hexadiene	2.8	2
C <sub>5</sub> H <sub>8</sub>	1,4-Pentadiene	2.48	1	C <sub>6</sub> H <sub>10</sub>	1-Hexyne	2.73	2
C <sub>5</sub> H <sub>8</sub>	1-Pentyne	1.98	1	C <sub>6</sub> H <sub>10</sub>	Cyclohexene	2.86	1
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Methyl methacrylate	1.38	1	C <sub>6</sub> H <sub>10</sub> O	5-Hexen-2-one	1.02	1
C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	Ethyl acrylate	1.32	1	C <sub>6</sub> H <sub>10</sub> O	Cyclohexanone	0.81	1
C <sub>5</sub> H <sub>9</sub> N	Pentanenitrile	0.94	1	C <sub>6</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl methacrylate	1.94	1
C <sub>5</sub> H <sub>10</sub>	1-Pentene	2.2	2	C <sub>6</sub> H <sub>11</sub> Br	Bromocyclohexane	3.20	1
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	3.00	1	C <sub>6</sub> H <sub>11</sub> N	Hexanenitrile	1.66	1
C <sub>5</sub> H <sub>10</sub> O	2-Pentanone	0.84	1	C <sub>6</sub> H <sub>12</sub>	1-Hexene	3.40	1
C <sub>5</sub> H <sub>10</sub> O	3-Pentanone	0.82	1	C <sub>6</sub> H <sub>12</sub>	4-Methyl-1-pentene	2.5	2
C <sub>5</sub> H <sub>10</sub> O	3-Methyl-2-butanone	0.56	1	C <sub>6</sub> H <sub>12</sub>	Cyclohexane	3.44	1
C <sub>5</sub> H <sub>10</sub> O	Tetrahydropyran	0.82	1	C <sub>6</sub> H <sub>12</sub>	Methylcyclopentane	3.37	2

Mol. form.	Name	log <i>P</i>	Ref.	Mol. form.	Name	log <i>P</i>	Ref.
C <sub>6</sub> H <sub>12</sub> O	Cyclohexanol	1.23	1	C <sub>8</sub> H <sub>6</sub> O	Benzofuran	2.67	1
C <sub>6</sub> H <sub>12</sub> O	Hexanal	1.78	1	C <sub>8</sub> H <sub>6</sub> S	Benzo[b]thiophene	3.12	1
C <sub>6</sub> H <sub>12</sub> O	2-Hexanone	1.38	1	C <sub>8</sub> H <sub>7</sub> N	Benzeneacetonitrile	1.56	1
C <sub>6</sub> H <sub>12</sub> O	4-Methyl-2-pentanone	1.31	1	C <sub>8</sub> H <sub>7</sub> N	Indole	2.14	1
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Hexanoic acid	1.92	1	C <sub>8</sub> H <sub>8</sub>	Styrene	3.05	1
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Butyl acetate	1.82	1	C <sub>8</sub> H <sub>8</sub> O	Acetophenone	1.63	1
C <sub>6</sub> H <sub>13</sub> Br	1-Bromohexane	3.80	1	C <sub>8</sub> H <sub>8</sub> O	2-Methylbenzaldehyde	2.26	1
C <sub>6</sub> H <sub>13</sub> N	Cyclohexylamine	1.49	1	C <sub>8</sub> H <sub>8</sub> O	Benzeneacetaldehyde	1.78	1
C <sub>6</sub> H <sub>14</sub>	Hexane	4.00	1	C <sub>8</sub> H <sub>8</sub> O	2,3-Dihydrobenzofuran	2.14	1
C <sub>6</sub> H <sub>14</sub>	3-Methylpentane	3.60	2	C <sub>8</sub> H <sub>8</sub> O	Phenylloxirane	1.61	1
C <sub>6</sub> H <sub>14</sub>	2,2-Dimethylbutane	3.82	1	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>o</i> -Toluic acid	2.32	4
C <sub>6</sub> H <sub>14</sub>	2,3-Dimethylbutane	3.85	2	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>m</i> -Toluic acid	2.37	1
C <sub>6</sub> H <sub>14</sub> O	1-Hexanol	2.03	1	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	<i>p</i> -Toluic acid	2.34	1
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol	1.76	1	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Benzeneacetic acid	1.41	1
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol	1.65	1	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Phenyl acetate	1.49	1
C <sub>6</sub> H <sub>14</sub> O	3,3-Dimethyl-2-butanol	1.48	1	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	Methyl benzoate	2.20	1
C <sub>6</sub> H <sub>14</sub> O	Dipropyl ether	2.03	1	C <sub>8</sub> H <sub>10</sub>	Ethylbenzene	3.15	1
C <sub>6</sub> H <sub>14</sub> O	Diisopropyl ether	1.52	1	C <sub>8</sub> H <sub>10</sub>	<i>o</i> -Xylene	3.12	1
C <sub>6</sub> H <sub>15</sub> N	Hexylamine	2.06	1	C <sub>8</sub> H <sub>10</sub>	<i>m</i> -Xylene	3.20	1
C <sub>6</sub> H <sub>15</sub> N	Dipropylamine	1.67	1	C <sub>8</sub> H <sub>10</sub>	<i>p</i> -Xylene	3.15	1
C <sub>6</sub> H <sub>15</sub> N	Triethylamine	1.45	1	C <sub>8</sub> H <sub>10</sub> O	<i>o</i> -Ethylphenol	2.47	1
C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	2-Bromobenzoic acid	2.20	4	C <sub>8</sub> H <sub>10</sub> O	<i>m</i> -Ethylphenol	2.50	1
C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	3-Bromobenzoic acid	2.87	4	C <sub>8</sub> H <sub>10</sub> O	<i>p</i> -Ethylphenol	2.50	1
C <sub>7</sub> H <sub>5</sub> BrO <sub>2</sub>	4-Bromobenzoic acid	2.86	4	C <sub>8</sub> H <sub>10</sub> O	2,4-Xylenol	2.35	1
C <sub>7</sub> H <sub>5</sub> N	Benzonitrile	1.56	1	C <sub>8</sub> H <sub>10</sub> O	2,5-Xylenol	2.34	1
C <sub>7</sub> H <sub>6</sub> O	Benzaldehyde	1.48	1	C <sub>8</sub> H <sub>10</sub> O	2,6-Xylenol	2.36	1
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Benzoic acid	1.88	4	C <sub>8</sub> H <sub>10</sub> O	3,4-Xylenol	3.23	1
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	Phenyl formate	1.26	1	C <sub>8</sub> H <sub>10</sub> O	3,5-Xylenol	2.35	1
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	Salicylic acid	2.20	4	C <sub>8</sub> H <sub>10</sub> O	Benzeneethanol	1.36	1
C <sub>7</sub> H <sub>7</sub> Br	(Bromomethyl)benzene	2.92	1	C <sub>8</sub> H <sub>10</sub> O	$\alpha$ -Methylbenzyl alcohol	1.42	1
C <sub>7</sub> H <sub>7</sub> Cl	<i>o</i> -Chlorotoluene	3.42	1	C <sub>8</sub> H <sub>10</sub> O	3-Methylbenzenemethanol	1.60	1
C <sub>7</sub> H <sub>7</sub> Cl	<i>m</i> -Chlorotoluene	3.28	1	C <sub>8</sub> H <sub>10</sub> O	4-Methylbenzenemethanol	1.58	1
C <sub>7</sub> H <sub>7</sub> Cl	<i>p</i> -Chlorotoluene	3.33	1	C <sub>8</sub> H <sub>10</sub> O	Phenetole	2.51	1
C <sub>7</sub> H <sub>7</sub> Cl	(Chloromethyl)benzene	2.30	1	C <sub>8</sub> H <sub>10</sub> O	Benzyl methyl ether	1.35	1
C <sub>7</sub> H <sub>7</sub> NO <sub>2</sub>	<i>p</i> -Nitrotoluene	2.42	1	C <sub>8</sub> H <sub>10</sub> O	2-Methylanisole	2.74	1
C <sub>7</sub> H <sub>8</sub>	Toluene	2.73	1	C <sub>8</sub> H <sub>10</sub> O	3-Methylanisole	2.66	1
C <sub>7</sub> H <sub>8</sub>	1,3,5-Cycloheptatriene	2.63	2	C <sub>8</sub> H <sub>10</sub> O	4-Methylanisole	2.81	1
C <sub>7</sub> H <sub>8</sub> O	<i>o</i> -Cresol	1.98	1	C <sub>8</sub> H <sub>11</sub> N	<i>p</i> -Ethylaniline	1.96	1
C <sub>7</sub> H <sub>8</sub> O	<i>m</i> -Cresol	1.98	1	C <sub>8</sub> H <sub>11</sub> N	<i>N,N</i> -Dimethylaniline	2.31	1
C <sub>7</sub> H <sub>8</sub> O	<i>p</i> -Cresol	1.97	1	C <sub>8</sub> H <sub>11</sub> N	Benzeneethanamine	1.41	1
C <sub>7</sub> H <sub>8</sub> O	Benzyl alcohol	1.05	1	C <sub>8</sub> H <sub>14</sub> O <sub>2</sub>	Butyl methacrylate	2.88	1
C <sub>7</sub> H <sub>8</sub> O	Anisole	2.11	1	C <sub>8</sub> H <sub>15</sub> N	Octanenitrile	2.75	1
C <sub>7</sub> H <sub>9</sub> N	Benzylamine	1.09	1	C <sub>8</sub> H <sub>16</sub>	1-Octene	4.57	1
C <sub>7</sub> H <sub>9</sub> N	<i>o</i> -Methylaniline	1.32	1	C <sub>8</sub> H <sub>16</sub>	Cyclooctane	4.45	2
C <sub>7</sub> H <sub>9</sub> N	<i>m</i> -Methylaniline	1.40	1	C <sub>8</sub> H <sub>16</sub> O	2-Octanone	2.37	1
C <sub>7</sub> H <sub>9</sub> N	<i>p</i> -Methylaniline	1.39	1	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>	Octanoic acid	3.05	1
C <sub>7</sub> H <sub>9</sub> N	<i>N</i> -Methylaniline	1.66	1	C <sub>8</sub> H <sub>17</sub> Br	1-Bromoocane	4.89	1
C <sub>7</sub> H <sub>14</sub>	1-Heptene	3.99	1	C <sub>8</sub> H <sub>18</sub>	Octane	5.15	1
C <sub>7</sub> H <sub>14</sub>	Methylcyclohexane	3.88	1	C <sub>8</sub> H <sub>18</sub> O	1-Octanol	3.07	1
C <sub>7</sub> H <sub>14</sub> O	2-Heptanone	1.98	1	C <sub>8</sub> H <sub>18</sub> O	2-Octanol	2.90	1
C <sub>7</sub> H <sub>14</sub> O	5-Methyl-2-hexanone	1.88	1	C <sub>8</sub> H <sub>18</sub> O	4-Octanol	2.68	1
C <sub>7</sub> H <sub>15</sub> Br	1-Bromoheptane	4.36	1	C <sub>8</sub> H <sub>18</sub> O	Dibutyl ether	3.21	1
C <sub>7</sub> H <sub>15</sub> Cl	1-Chloroheptane	4.15	1	C <sub>9</sub> H <sub>7</sub> N	Quinoline	2.03	1
C <sub>7</sub> H <sub>15</sub> I	1-Iodoheptane	4.70	1	C <sub>9</sub> H <sub>7</sub> N	Isoquinoline	2.08	1
C <sub>7</sub> H <sub>16</sub>	Heptane	4.50	1	C <sub>9</sub> H <sub>8</sub>	Indene	2.92	1
C <sub>7</sub> H <sub>16</sub> O	1-Heptanol	2.62	1	C <sub>9</sub> H <sub>8</sub> O <sub>2</sub>	<i>trans</i> -Cinnamic acid	2.13	1
C <sub>7</sub> H <sub>16</sub> O	2-Heptanol	2.31	1	C <sub>9</sub> H <sub>9</sub> N	Benzenepropanenitrile	1.72	1
C <sub>7</sub> H <sub>16</sub> O	3-Heptanol	2.24	1	C <sub>9</sub> H <sub>10</sub>	Indan	3.33	1
C <sub>7</sub> H <sub>16</sub> O	4-Heptanol	2.22	1	C <sub>9</sub> H <sub>10</sub> O	1-Phenyl-1-propanone	2.19	1
C <sub>7</sub> H <sub>17</sub> N	Heptylamine	2.57	1	C <sub>9</sub> H <sub>10</sub> O	1-Phenyl-2-propanone	1.44	1
C <sub>8</sub> H <sub>6</sub>	Phenylacetylene	2.40	1	C <sub>9</sub> H <sub>10</sub> O	4-Methylacetophenone	2.19	1



Mol. form.	Name	log P	Ref.	Mol. form.	Name	log P	Ref.
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	2-Phenylpropanoic acid	1.80	1	C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub>	2,3,4,5-Tetrachlorobiphenyl	5.72	3
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Benzyl acetate	1.96	1	C <sub>12</sub> H <sub>6</sub> Cl <sub>4</sub>	2,2',4',5'-Tetrachlorobiphenyl	5.73	7
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	4-Methylphenyl acetate	2.11	1	C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	2,4,5-Trichlorobiphenyl	5.60	3
C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	Ethyl benzoate	2.64	1	C <sub>12</sub> H <sub>7</sub> Cl <sub>3</sub>	2,4,6-Trichlorobiphenyl	5.47	3
C <sub>9</sub> H <sub>12</sub>	Propylbenzene	3.69	1	C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	2,5-Dichlorobiphenyl	5.10	3
C <sub>9</sub> H <sub>12</sub>	Isopropylbenzene	3.66	1	C <sub>12</sub> H <sub>8</sub> Cl <sub>2</sub>	2,6-Dichlorobiphenyl	5.00	3
C <sub>9</sub> H <sub>12</sub>	<i>o</i> -Ethyltoluene	3.53	1	C <sub>12</sub> H <sub>8</sub> O	Dibenzofuran	4.12	1
C <sub>9</sub> H <sub>12</sub>	<i>p</i> -Ethyltoluene	3.63	2	C <sub>12</sub> H <sub>9</sub> Cl	2-Chlorobiphenyl	4.52	1
C <sub>9</sub> H <sub>12</sub>	1,2,3-Trimethylbenzene	3.60	1	C <sub>12</sub> H <sub>9</sub> Cl	3-Chlorobiphenyl	4.58	1
C <sub>9</sub> H <sub>12</sub>	1,2,4-Trimethylbenzene	3.63	1	C <sub>12</sub> H <sub>9</sub> Cl	4-Chlorobiphenyl	4.61	1
C <sub>9</sub> H <sub>12</sub>	1,3,5-Trimethylbenzene	3.42	1	C <sub>12</sub> H <sub>9</sub> N	Carbazole	3.72	1
C <sub>9</sub> H <sub>12</sub> O	2-Propylphenol	2.93	1	C <sub>12</sub> H <sub>10</sub>	Acenaphthene	3.96	4
C <sub>9</sub> H <sub>12</sub> O	4-Propylphenol	3.20	1	C <sub>12</sub> H <sub>10</sub>	Biphenyl	3.76	6
C <sub>9</sub> H <sub>12</sub> O	2,3,6-Trimethylphenol	2.67	1	C <sub>12</sub> H <sub>10</sub> N <sub>2</sub>	Azobenzene	3.82	1
C <sub>9</sub> H <sub>12</sub> O	2,4,6-Trimethylphenol	2.46	1	C <sub>12</sub> H <sub>10</sub> O	Diphenyl ether	4.21	1
C <sub>9</sub> H <sub>12</sub> O	Benzenepropanol	1.88	1	C <sub>12</sub> H <sub>10</sub> S	Diphenyl sulfide	4.45	1
C <sub>9</sub> H <sub>13</sub> N	<i>N,N</i> -Dimethylbenzylamine	1.98	1	C <sub>12</sub> H <sub>11</sub> N	Diphenylamine	3.44	4
C <sub>9</sub> H <sub>13</sub> N	Amphetamine	1.76	1	C <sub>12</sub> H <sub>12</sub>	1-Ethyl-naphthalene	4.40	1
C <sub>9</sub> H <sub>18</sub>	1-Nonene	5.15	1	C <sub>12</sub> H <sub>12</sub>	1,2-Dimethylnaphthalene	4.31	1
C <sub>9</sub> H <sub>18</sub> O	2-Nonanone	3.16	1	C <sub>12</sub> H <sub>12</sub>	1,4-Dimethylnaphthalene	4.37	1
C <sub>9</sub> H <sub>18</sub> O	5-Methyl-2-octanone	2.92	1	C <sub>12</sub> H <sub>14</sub> O	4-Phenylcyclohexanone	2.45	1
C <sub>9</sub> H <sub>20</sub>	Nonane	5.65	1	C <sub>12</sub> H <sub>18</sub>	Hexylbenzene	5.52	1
C <sub>9</sub> H <sub>20</sub> O	1-Nonanol	4.02	1	C <sub>12</sub> H <sub>18</sub>	Hexamethylbenzene	4.69	4
C <sub>9</sub> H <sub>21</sub> N	Tripropylamine	2.79	1	C <sub>12</sub> H <sub>22</sub> O	Cyclododecanone	4.10	1
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene	3.90	1	C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>	Dodecanoic acid	4.6	1
C <sub>10</sub> H <sub>7</sub> Cl	2-Chloronaphthalene	3.98	1	C <sub>12</sub> H <sub>26</sub> O	1-Dodecanol	5.13	1
C <sub>10</sub> H <sub>8</sub>	Naphthalene	3.34	4	C <sub>13</sub> H <sub>18</sub> O	9H-Fluoren-9-one	3.58	1
C <sub>10</sub> H <sub>8</sub>	Azulene	3.22	1	C <sub>13</sub> H <sub>9</sub> N	Acridine	3.40	1
C <sub>10</sub> H <sub>8</sub> O	1-Naphthol	2.84	1	C <sub>13</sub> H <sub>10</sub>	9H-Fluorene	4.20	4
C <sub>10</sub> H <sub>8</sub> O	2-Naphthol	2.70	1	C <sub>13</sub> H <sub>10</sub> O	Benzophenone	3.18	1
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Isopropyl benzoate	3.18	1	C <sub>13</sub> H <sub>10</sub> O <sub>2</sub>	Phenyl benzoate	3.59	1
C <sub>10</sub> H <sub>14</sub>	Butylbenzene	4.26	1	C <sub>13</sub> H <sub>11</sub> NO	<i>N</i> -Phenylbenzamide	2.62	1
C <sub>10</sub> H <sub>14</sub>	<i>tert</i> -Butylbenzene	4.11	1	C <sub>13</sub> H <sub>12</sub>	Diphenylmethane	4.14	1
C <sub>10</sub> H <sub>14</sub>	Isobutylbenzene	4.01	2	C <sub>13</sub> H <sub>12</sub>	4-Methylbiphenyl	4.63	1
C <sub>10</sub> H <sub>14</sub>	<i>p</i> -Cymene	4.10	1	C <sub>13</sub> H <sub>12</sub> O	Diphenylmethanol	2.67	1
C <sub>10</sub> H <sub>14</sub>	1,2,4,5-Tetramethylbenzene	4.10	2	C <sub>13</sub> H <sub>12</sub> O	Benzyl phenyl ether	3.79	1
C <sub>10</sub> H <sub>14</sub>	1,2,3,4-Tetramethylbenzene	4.00	1	C <sub>14</sub> H <sub>10</sub>	Anthracene	4.56	4
C <sub>10</sub> H <sub>14</sub>	1,2,3,5-Tetramethylbenzene	4.10	1	C <sub>14</sub> H <sub>10</sub>	Phenanthrene	4.52	4
C <sub>10</sub> H <sub>14</sub> O	4-Butylphenol	3.65	1	C <sub>14</sub> H <sub>12</sub>	<i>trans</i> -Stilbene	4.81	1
C <sub>10</sub> H <sub>20</sub> O	2-Decanone	3.77	1	C <sub>14</sub> H <sub>12</sub>	1-Methylfluorene	4.97	1
C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>	Decanoic acid	4.09	1	C <sub>14</sub> H <sub>12</sub> O	2-Phenylacetophenone	3.18	1
C <sub>10</sub> H <sub>22</sub>	Decane	6.25	1	C <sub>14</sub> H <sub>12</sub> O <sub>2</sub>	Benzyl benzoate	3.97	1
C <sub>10</sub> H <sub>22</sub> O	1-Decanol	4.57	1	C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylethane	4.70	1
C <sub>11</sub> H <sub>9</sub> N	4-Phenylpyridine	2.59	1	C <sub>14</sub> H <sub>14</sub>	4,4'-Dimethylbiphenyl	5.09	1
C <sub>11</sub> H <sub>10</sub>	1-Methylnaphthalene	3.87	1	C <sub>14</sub> H <sub>22</sub>	Octylbenzene	6.30	1
C <sub>11</sub> H <sub>10</sub>	2-Methylnaphthalene	4.00	1	C <sub>14</sub> H <sub>28</sub> O <sub>2</sub>	Tetradecanoic acid	6.1	1
C <sub>11</sub> H <sub>16</sub>	Pentylbenzene	4.90	1	C <sub>15</sub> H <sub>12</sub>	2-Methylanthracene	5.15	2
C <sub>11</sub> H <sub>16</sub>	Pentamethylbenzene	4.56	1	C <sub>15</sub> H <sub>12</sub>	9-Methylanthracene	5.07	1
C <sub>11</sub> H <sub>22</sub> O	2-Undecanone	4.09	1	C <sub>15</sub> H <sub>12</sub>	1-Methylphenanthrene	5.14	2
C <sub>11</sub> H <sub>22</sub> O <sub>2</sub>	Methyl decanoate	4.41	1	C <sub>16</sub> H <sub>10</sub>	Fluoranthene	5.07	4
C <sub>12</sub> Cl <sub>10</sub>	Decachlorobiphenyl	8.26	3	C <sub>16</sub> H <sub>10</sub>	Pyrene	5.08	4
C <sub>12</sub> HCl <sub>9</sub>	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	8.16	3	C <sub>16</sub> H <sub>14</sub>	9,10-Dimethylanthracene	5.69	1
C <sub>12</sub> H <sub>2</sub> Cl <sub>8</sub>	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	7.10	3	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	Hexadecanoic acid	7.17	1
C <sub>12</sub> H <sub>3</sub> Cl <sub>7</sub>	2,2',3,3',4,4',6-Heptachlorobiphenyl	6.70	3	C <sub>17</sub> H <sub>12</sub>	11H-Benzo[a]fluorene	5.40	1
C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	2,2',3,3',4,4'-Hexachlorobiphenyl	7.00	3	C <sub>17</sub> H <sub>12</sub>	11H-Benzo[b]fluorene	5.75	1
C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	2,2',4,4',6,6'-Hexachlorobiphenyl	7.00	3	C <sub>18</sub> H <sub>12</sub>	Benz[a]anthracene	5.91	1
C <sub>12</sub> H <sub>4</sub> Cl <sub>6</sub>	2,2',3,3',6,6'-Hexachlorobiphenyl	6.70	3	C <sub>18</sub> H <sub>12</sub>	Chrysene	5.73	4
C <sub>12</sub> H <sub>5</sub> Cl <sub>5</sub>	2,3,4,5,6-Pentachlorobiphenyl	6.30	3	C <sub>18</sub> H <sub>12</sub>	Naphthacene	5.76	1
C <sub>12</sub> H <sub>5</sub> Cl <sub>5</sub>	2,2',4,5,5'-Pentachlorobiphenyl	6.40	3	C <sub>18</sub> H <sub>12</sub>	Triphenylene	5.49	4
				C <sub>18</sub> H <sub>15</sub> N	Triphenylamine	5.74	1
				C <sub>18</sub> H <sub>30</sub> O <sub>2</sub>	Linolenic acid	6.46	1

Mol. form.	Name	log <i>P</i>	Ref.	Mol. form.	Name	log <i>P</i>	Ref.
C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	Linoleic acid	7.05	1	C <sub>20</sub> H <sub>40</sub> O <sub>2</sub>	Arachidic acid	9.29	1
C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	Oleic acid	7.64	1	C <sub>21</sub> H <sub>16</sub>	1,2-Dihydro-3-methylbenz[j] aceanthrylene	6.75	1
C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>	Stearic acid	8.23	1	C <sub>22</sub> H <sub>12</sub>	Benzo[ghi]perylene	6.90	1
C <sub>19</sub> H <sub>16</sub> O	Triphenylmethanol	3.68	1	C <sub>24</sub> H <sub>12</sub>	Coronene	6.05	4
C <sub>20</sub> H <sub>12</sub>	Perylene	6.25	1				
C <sub>20</sub> H <sub>12</sub>	Benzo[a]pyrene	6.20	4				
C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	Arachidonic acid	6.98	1				

# PROTECTION AGAINST IONIZING RADIATION

The following data and rules of thumb are helpful in estimating the penetrating capability of and danger of exposure to various types of ionizing radiation. More precise data should be used for critical applications.

## Alpha Particles

Alpha particles of at least 7.5 MeV are required to penetrate the epidermis, the protective layer of skin, 0.07 mm thick.

## Electrons

Electrons of at least 70 keV are required to penetrate the epidermis, the protective layer of skin, 0.07 mm thick.

The range of electrons in  $\text{g/cm}^2$  is approximately equal to the maximum energy ( $E$ ) in MeV divided by 2.

The range of electrons in air is about 3.65 m per MeV; for example, a 3 MeV electron has a range of about 11 m in air.

A chamber wall thickness of  $30 \text{ mg/cm}^2$  will transmit 70% of the initial fluence of 1 MeV electrons and 20% of that of 0.4 MeV electrons.

When electrons of 1 to 2 MeV pass through light materials such as water, aluminum, or glass, less than 1% of their energy is dissipated as bremsstrahlung.

The bremsstrahlung from 1 Ci of  $^{32}\text{P}$  aqueous solution in a glass bottle is about 1 mR/h at 1 meter distance.

When electrons from a 1 Ci source of  $^{90}\text{Sr} - ^{90}\text{Y}$  are absorbed, the bremsstrahlung hazard is approximately equal to that presented by the gamma radiation from 12 mg of radium. The average energy of the bremsstrahlung is about 300 keV.

## Gamma Rays

The air-scattered radiation (sky-shine) from a 100 Ci  $^{60}\text{Co}$  source placed 1 ft behind a 4 ft high shield is about 100 mrad/h at 6 ft from the outside of the shield.

Within  $\pm 20\%$  for point source gamma emitters with energies between 0.07 and 4 MeV, the exposure rate (R/h) at 1 ft is  $6C \cdot E \cdot n$  where  $C$  is the activity in curies,  $E$  is the energy in MeV, and  $n$  is the number of gammas per disintegration.

## Neutrons

An approximate HVL (thickness of absorber for which the neutron flux falls to half its initial value) for 1 MeV neutrons is 3.2 cm of paraffin; that for 5 MeV neutrons is 6.9 cm of paraffin.

## Miscellaneous

The activity of any radionuclide is reduced to less than 1% after 7 half-lives (i.e.,  $2^{-7} = 0.8\%$ ).

For nuclides with a half-life greater than 6 days, the change in activity in 24 hours will be less than 10%.

10 HVL (half-value layers) attenuates approximately by  $10^{-3}$ .

There is  $0.64 \text{ mm}^3$  of radon gas at STP in transient equilibrium with 1 Ci of radium.

The natural background from all sources in most parts of the world leads to an equivalent dose rate of about 0.04 to 4 mSv per year for the average person. About 84% of this comes from terrestrial sources, the remainder from cosmic rays. The U. S. average is about 3.6 mSv/yr but can range up to 50 mSv/yr in some areas. A passenger in a plane flying at 12,000 meters receives  $5 \mu\text{Sv/hr}$  from cosmic rays (as compared to about  $0.03 \mu\text{Sv/hr}$  at sea level).

The ICRP recommended exposure limit to man-made sources of ionizing radiation (Reference 2) is 20 mSv/yr averaged over 5 years, with the dose in any one year not to exceed 50 mSv.

A whole-body dose of about 3 Gy over a short time interval will typically lead to 50% mortality in 30 days assuming no medical treatment.

## Units

The gray (Gy) is the SI unit of absorbed dose; it is a measure of the mean energy imparted to a sample of irradiated matter, divided by the mass of the sample. Gy is a special name for the SI unit J/kg.

The sievert (Sv) is the SI unit of equivalent dose, which is defined as the absorbed dose multiplied by a weighting factor that expresses the long-term biological risk from low-level chronic exposure to a specified type of radiation. The Sv is another special name for J/kg.

1 curie (Ci) =  $3.7 \cdot 10^{10}$  becquerel (Bq); i.e.,  $3.7 \cdot 10^{10}$  disintegrations per second.

1 roentgen (R) =  $2.58 \cdot 10^{-4}$  coulomb per kilogram (C/kg); a measure of the charge (positive or negative) liberated by x-ray or gamma radiation in air, divided by the mass of air.

1 rad = 0.01 Gy

1 rem = 0.01 Sv

## References

1. Padikal, T. N., and Fivozinsky, S. P., *Medical Physics Data Book, National Bureau of Standards Handbook 138*, U.S. Government Printing Office, Washington, D.C., 1981.
2. *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, *Annals of the ICRP*, Pergamon Press, Oxford, 1991.
3. *Radiation: Doses, Effects, Risks*, United Nations Sales No. E.86.III.D.4, 1985.
4. Eidelman, S., et al., *Physics Letters*, B592, 1, 2004.

# ANNUAL LIMITS ON INTAKES OF RADIONUCLIDES

K. F. Eckerman

The following table lists, for workers, the annual limits on oral and inhalation intakes (ALI) for selected radionuclides based on the occupational radiation protection guidance of the International Commission on Radiological Protection (References 1 and 2). An intake of one ALI corresponds to an annual whole body dose of 0.02 Sv (2 rem).

The ALI is expressed in the SI unit of activity, the becquerel (Bq), and in the conventional unit, the microcurie ( $\mu\text{Ci}$ );  $1 \mu\text{Ci} = 3.7 \cdot 10^4 \text{ Bq}$ . The chemical form of inhaled radionuclides is, in most instances, stated in terms of the rate of absorption to blood from the lungs and the fractional absorption from the small intestine. Type F, M, and S denote chemical forms which are absorbed from the lungs at rates characterized as fast, moderate, and slow, respectively. The time to absorb 90% of the deposited radionuclide, in the absence of radioactive decay, corresponds to about 10 minutes, 150 days, and 7000 days for Type F, M, and S compounds, respec-

tively. Type F compounds can be considered to be more soluble than M or S, S being the most insoluble. Chemical form consideration for ingestion is specified by the fractional absorption from the small intestine, denoted as  $f_1$ . The  $f_1$  values range from  $10^{-5}$  to 1. Higher fractional absorption is associated with greater solubility of the compound.

## References

1. *1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, Annals of the ICRP 21, (1-3)*, Pergamon Press, Oxford, 1991.
2. *Dose Coefficients for Intakes of Radionuclides by Workers, ICRP Publication 68, Annals of the ICRP, 24(4)*, Pergamon Press, Oxford, 1995.

	Physical half-life	Inhalation intakes			Oral intakes		
		Chemical form Type/ $f_1$	ALI		Chemical form $f_1$	ALI	
			Bq	$\mu\text{Ci}$		Bq	$\mu\text{Ci}$
<sup>3</sup> H	12.3 y	HT gas	1.1E+13	3.0E+08	1.000	1.1E+13	3.0E+08
<sup>11</sup> C	0.340 h	HTO vapor	1.1E+09	3.0E+04	1.000	8.3E+08	2.3E+04
		CO	1.7E+10	4.5E+05			
<sup>14</sup> C	5730 y	CO <sub>2</sub>	9.1E+09	2.5E+05	1.000	3.4E+07	9.3E+02
		Organic compounds	6.2E+09	1.7E+05			
		CO	2.5E+10	6.8E+05			
		CO <sub>2</sub>	3.1E+09	8.3E+04			
<sup>18</sup> F	1.83 h	Organic compounds	3.4E+07	9.3E+02	1.000	4.1E+08	1.1E+04
		F 1.000	3.7E+08	1.0E+04			
		M 1.000	2.2E+08	6.1E+03			
<sup>22</sup> Na	2.60 y	S 1.000	2.2E+08	5.8E+03	1.000	6.3E+06	1.7E+02
		F 1.000	1.0E+07	2.7E+02			
<sup>24</sup> Na	15.0 h	F 1.000	3.8E+07	1.0E+03	1.000	4.7E+07	1.3E+03
		F 0.800	1.8E+07	4.9E+02			
<sup>32</sup> P	14.3 d	M 0.800	6.9E+06	1.9E+02	0.800	8.3E+06	2.3E+02
		Inorganic compounds					
<sup>35</sup> S	87.4 d	F 0.800	2.5E+08	6.8E+03	0.800	1.4E+08	3.9E+03
		M 0.800	1.8E+07	4.9E+02			
		Vapor	1.7E+08	4.5E+03			
		Organic compounds					
<sup>42</sup> K	12.4 h	F 1.000	1.0E+08	2.7E+03	1.000	2.6E+07	7.0E+02
<sup>43</sup> K	22.6 h	F 1.000	7.7E+07	2.1E+03	1.000	4.7E+07	1.3E+03
<sup>45</sup> Ca	163 d	M 0.300	8.7E+06	2.4E+02	0.300	8.0E+07	2.2E+03
<sup>47</sup> Ca	4.53 d	M 0.300	9.5E+06	2.6E+02	0.300	2.6E+07	7.1E+02
<sup>51</sup> Cr	27.7 d	F 0.100	6.7E+08	1.8E+04	0.100	5.3E+08	1.4E+04
		M 0.100	5.9E+08	1.6E+04			
		S 0.100	5.6E+08	1.5E+04			
<sup>54</sup> Mn	312 d	F 0.100	1.8E+07	4.9E+02	0.100	2.8E+07	7.6E+02
		M 0.100	1.7E+07	4.5E+02			
<sup>52</sup> Fe	8.28 h	F 0.100	2.9E+07	7.8E+02	0.100	1.4E+07	3.9E+02
		M 0.100	2.1E+07	5.7E+02			
<sup>55</sup> Fe	2.70 y	F 0.100	2.2E+07	5.9E+02	0.100	6.1E+07	1.6E+03
		M 0.100	6.1E+07	1.6E+03			

	Physical half-life	Inhalation intakes			Oral intakes		
		Chemical form Type/ $f_1$	ALI		Chemical form $f_1$	ALI	
			Bq	$\mu\text{Ci}$		Bq	$\mu\text{Ci}$
<sup>59</sup> Fe	44.5 d	F 0.100	6.7E+06	1.8E+02	0.100	1.1E+07	3.0E+02
		M 0.100	6.3E+06	1.7E+02			
<sup>57</sup> Co	271 d	M 0.100	5.1E+07	1.4E+03	0.100	9.5E+07	2.6E+03
		S 0.050	3.3E+07	9.0E+02	0.050	1.1E+08	2.8E+03
<sup>58</sup> Co	70.8 d	M 0.100	1.4E+07	3.9E+02	0.100	2.7E+07	7.3E+02
		S 0.050	1.2E+07	3.2E+02	0.050	2.9E+07	7.7E+02
<sup>60</sup> Co	5.27 y	M 0.100	2.8E+06	7.6E+01	0.100	5.9E+06	1.6E+02
		S 0.050	1.2E+06	3.2E+01	0.050	8.0E+06	2.2E+02
<sup>64</sup> Cu	12.7 h	F 0.500	2.9E+08	7.9E+03	0.500	1.7E+08	4.5E+03
		M 0.500	1.3E+08	3.6E+03			
		S 0.500	1.3E+08	3.6E+03			
<sup>59</sup> Ni	75000 y	F 0.050	9.1E+07	2.5E+03	0.050	3.2E+08	8.6E+03
		M 0.050	2.1E+08	5.8E+03			
		Vapor	2.4E+07	6.5E+02			
<sup>63</sup> Ni	96.0 y	F 0.050	3.8E+07	1.0E+03	0.050	1.3E+08	3.6E+03
		M 0.050	6.5E+07	1.7E+03			
		Vapor	1.0E+07	2.7E+02			
<sup>65</sup> Zn	244 d	S 0.500	7.1E+06	1.9E+02	0.500	5.1E+06	1.4E+02
<sup>67</sup> Ga	3.26 d	F 0.001	1.8E+08	4.9E+03	0.001	1.1E+08	2.8E+03
		M 0.001	7.1E+07	1.9E+03			
<sup>68</sup> Ga	1.13 h	F 0.001	4.1E+08	1.1E+04	0.001	2.0E+08	5.4E+03
		M 0.001	2.5E+08	6.7E+03			
<sup>68</sup> Ge	288 d	F 1.000	2.4E+07	6.5E+02	1.000	1.5E+07	4.2E+02
		M 1.000	2.5E+06	6.8E+01			
<sup>75</sup> Se	120 d	F 0.800	1.4E+07	3.9E+02	0.800	7.7E+06	2.1E+02
		M 0.800	1.2E+07	3.2E+02	0.050	4.9E+07	1.3E+03
<sup>79</sup> Se	65000 y	F 0.800	1.3E+07	3.4E+02	0.800	6.9E+06	1.9E+02
		M 0.800	6.5E+06	1.7E+02	0.050	5.1E+07	1.4E+03
<sup>86</sup> Rb	18.6 d	F 1.000	1.5E+07	4.2E+02	1.000	7.1E+06	1.9E+02
<sup>85</sup> Sr	64.8 d	F 0.300	3.6E+07	9.7E+02	0.300	3.6E+07	9.7E+02
		S 0.010	3.1E+07	8.4E+02	0.010	6.1E+07	1.6E+03
<sup>87m</sup> Sr	2.80 h	F 0.300	9.1E+08	2.5E+04	0.300	6.7E+08	1.8E+04
		S 0.010	5.7E+08	1.5E+04	0.010	6.1E+08	1.6E+04
<sup>89</sup> Sr	50.5 d	F 0.300	1.4E+07	3.9E+02	0.300	7.7E+06	2.1E+02
		S 0.010	3.6E+06	9.7E+01	0.010	8.7E+06	2.4E+02
<sup>90</sup> Sr	29.1 y	F 0.300	6.7E+05	1.8E+01	0.300	7.1E+05	1.9E+01
		S 0.010	2.6E+05	7.0E+00	0.010	7.4E+06	2.0E+02
<sup>99</sup> Mo	2.75 d	F 0.800	5.6E+07	1.5E+03	0.800	2.7E+07	7.3E+02
		S 0.050	1.8E+07	4.9E+02	0.050	1.7E+07	4.5E+02
<sup>99m</sup> Tc	6.02 h	F 0.800	1.0E+09	2.7E+04	0.800	9.1E+08	2.5E+04
		M 0.800	6.9E+08	1.9E+04			
<sup>99</sup> Tc	213000 y	F 0.800	5.0E+07	1.4E+03	0.800	2.6E+07	6.9E+02
		M 0.800	6.3E+06	1.7E+02			
<sup>106</sup> Ru	1.01 y	F 0.050	2.0E+06	5.5E+01	0.050	2.9E+06	7.7E+01
		M 0.050	1.2E+06	3.2E+01			
		S 0.050	5.7E+05	1.5E+01			
<sup>111</sup> In	2.83 d	F 0.020	9.1E+07	2.5E+03	0.020	6.9E+07	1.9E+03
		M 0.020	6.5E+07	1.7E+03			
<sup>113m</sup> In	1.66 h	F 0.020	1.1E+09	2.8E+04	0.020	7.1E+08	1.9E+04
		M 0.020	6.3E+08	1.7E+04			
<sup>113</sup> Sn	115 d	F 0.020	2.5E+07	6.8E+02	0.020	2.7E+07	7.4E+02
		M 0.020	1.1E+07	2.8E+02			
<sup>123</sup> I	13.2 h	F 1.000	1.8E+08	4.9E+03	1.000	9.5E+07	2.6E+03
		Vapor	9.5E+07	2.6E+03			
<sup>125</sup> I	60.1 d	F 1.000	2.7E+06	7.4E+01	1.000	1.3E+06	3.6E+01
		Vapor	1.4E+06	3.9E+01			
<sup>129</sup> I	1.57·10 <sup>7</sup> y	F 1.000	3.9E+05	1.1E+01	1.000	1.8E+05	4.9E+00
		Vapor	2.1E+05	5.6E+00			

	Physical half-life	Inhalation intakes			Oral intakes		
		Chemical form Type/ $f_1$	ALI		Chemical form $f_1$	ALI	
			Bq	$\mu\text{Ci}$		Bq	$\mu\text{Ci}$
<sup>131</sup> I	8.04 d	F 1.000 Vapor	1.8E+06 1.0E+06	4.9E+01 2.7E+01	1.000	9.1E+05	2.5E+01
<sup>129</sup> Cs	1.34 d	F 1.000	2.5E+08	6.7E+03	1.000	3.3E+08	9.0E+03
<sup>134</sup> Cs	2.06 y	F 1.000	2.1E+06	5.6E+01	1.000	1.1E+06	2.8E+01
<sup>136</sup> Cs	13.1 d	F 1.000	1.1E+07	2.8E+02	1.000	6.7E+06	1.8E+02
<sup>137</sup> Cs	30.0 y	F 1.000	3.0E+06	8.1E+01	1.000	1.5E+06	4.2E+01
<sup>141</sup> Ce	32.5 d	M 5.0E-04 S 5.0E-04	7.4E+06 6.5E+06	2.0E+02 1.7E+02	5.0E-04	2.8E+07	7.6E+02
<sup>144</sup> Ce	284 d	M 5.0E-04 S 5.0E-04	8.7E+05 6.9E+05	2.4E+01 1.9E+01	5.0E-04	3.8E+06	1.0E+02
<sup>133</sup> Ba	10.7 y	F 0.100	1.1E+07	3.0E+02	0.100	2.0E+07	5.4E+02
<sup>140</sup> Ba	12.7 d	F 0.100	1.3E+07	3.4E+02	0.100	8.0E+06	2.2E+02
<sup>169</sup> Yb	32.0 d	M 5.0E-04 S 5.0E-04	9.5E+06 8.3E+06	2.6E+02 2.3E+02	5.0E-04	2.8E+07	7.6E+02
<sup>198</sup> Au	2.69 d	F 0.100 M 0.100 S 0.100	5.1E+07 2.0E+07 1.8E+07	1.4E+03 5.5E+02 4.9E+02	0.100	2.0E+07	5.4E+02
<sup>198m</sup> Au	2.30 d	F 0.100 M 0.100 S 0.100	3.4E+07 1.0E+07 1.1E+07	9.2E+02 2.7E+02 2.8E+02	0.100	1.5E+07	4.2E+02
<sup>197</sup> Hg	2.67 d	Inorganic compounds F 0.400	2.4E+08	6.4E+03	1.000 0.400	2.0E+08 1.2E+08	5.5E+03 3.2E+03
		Vapor Organic compounds F 0.020 M 0.020	4.5E+06 2.0E+08 7.1E+07	1.2E+02 5.4E+03 1.9E+03	0.020	8.7E+07	2.4E+03
<sup>203</sup> Hg	46.6 d	Inorganic compounds F 0.400	2.7E+07	7.2E+02	1.000 0.400	1.1E+07 1.8E+07	2.8E+02 4.9E+02
		Vapor Organic compounds F 0.020 M 0.020	2.9E+06 3.4E+07 1.1E+07	7.7E+01 9.2E+02 2.8E+02	0.020	3.7E+07	1.0E+03
<sup>201</sup> Tl	3.04 d	F 1.000	2.6E+08	7.1E+03	1.000	2.1E+08	5.7E+03
<sup>210</sup> Pb	22.3 y	F 0.200	1.8E+04	4.9E-01	0.200	2.9E+04	7.9E-01
<sup>207</sup> Bi	38.0 y	F 0.050 M 0.050	2.4E+07 6.3E+06	6.4E+02 1.7E+02	0.050	1.5E+07	4.2E+02
<sup>210</sup> Po	138 d	F 0.100 M 0.100	2.8E+04 9.1E+03	7.6E-01 2.5E-01	0.100	8.3E+04	2.3E+00
<sup>224</sup> Ra	3.66 d	M 0.200	8.3E+03	2.3E-01	0.200	3.1E+05	8.3E+00
<sup>226</sup> Ra	1600 y	M 0.200	1.7E+03	4.5E-02	0.200	7.1E+04	1.9E+00
<sup>228</sup> Ra	5.75 y	M 0.200	1.2E+04	3.2E-01	0.200	3.0E+04	8.1E-01
<sup>228</sup> Th	1.91 y	M 5.0E-04 S 2.0E-04	8.7E+02 6.3E+02	2.4E-02 1.7E-02	5.0E-04 2.0E-04	2.9E+05 5.7E+05	7.7E+00 1.5E+01
<sup>230</sup> Th	77000 y	M 5.0E-04 S 2.0E-04	7.1E+02 2.8E+03	1.9E-02 7.5E-02	5.0E-04 2.0E-04	9.5E+04 2.3E+05	2.6E+00 6.2E+00
<sup>232</sup> Th	1.40·10 <sup>10</sup> y	M 5.0E-04 S 2.0E-04	6.9E+02 1.7E+03	1.9E-02 4.5E-02	5.0E-04 2.0E-04	9.1E+04 2.2E+05	2.5E+00 5.9E+00
<sup>234</sup> U	2.44·10 <sup>5</sup> y	F 0.020 M 0.020 S 0.002	3.1E+04 9.5E+03 2.9E+03	8.4E-01 2.6E-01 7.9E-02	0.020 0.002	4.1E+05 2.4E+06	1.1E+01 6.5E+01
<sup>235</sup> U	7.04·10 <sup>8</sup> y	F 0.020 M 0.020	3.3E+04 1.1E+04	9.0E-01 3.0E-01	0.020 0.002	4.3E+05 2.4E+06	1.2E+01 6.5E+01

	Physical half-life	Inhalation intakes			Oral intakes		
		Chemical form Type/ $f_1$	ALI		Chemical form $f_1$	ALI	
			Bq	$\mu\text{Ci}$		Bq	$\mu\text{Ci}$
$^{238}\text{U}$	$4.47 \cdot 10^9$ y	S 0.002	3.3E+03	8.9E-02			
		F 0.020	3.4E+04	9.3E-01	0.020	4.5E+05	1.2E+01
		M 0.020	1.3E+04	3.4E-01	0.002	2.6E+06	7.1E+01
		S 0.002	3.5E+03	9.5E-02			
$^{237}\text{Np}$	$2.14 \cdot 10^6$ y	M 5.0E-04	1.3E+03	3.6E-02	5.0E-04	1.8E+05	4.9E+00
$^{239}\text{Np}$	2.36 d	M 5.0E-04	1.8E+07	4.9E+02	5.0E-04	2.5E+07	6.8E+02
$^{238}\text{Pu}$	87.7 y	M 5.0E-04	6.7E+02	1.8E-02	5.0E-04	8.7E+04	2.4E+00
		S 1.0E-05	1.8E+03	4.9E-02	1.0E-05	2.3E+06	6.1E+01
$^{239}\text{Pu}$	24100 y	M 5.0E-04	6.3E+02	1.7E-02	1.0E-04	4.1E+05	1.1E+01
		S 1.0E-05	2.4E+03	6.5E-02	5.0E-04	8.0E+04	2.2E+00
					1.0E-05	2.2E+06	6.0E+01
$^{241}\text{Pu}$	14.4 y	M 5.0E-04	3.4E+04	9.3E-01	1.0E-04	3.8E+05	1.0E+01
		S 1.0E-05	2.4E+05	6.4E+00	5.0E-04	4.3E+06	1.2E+02
					1.0E-05	1.8E+08	4.9E+03
$^{241}\text{Am}$	432 y	M 5.0E-04	7.4E+02	2.0E-02	1.0E-04	2.1E+07	5.6E+02
$^{244}\text{Cm}$	18.1 y	M 5.0E-04	1.2E+03	3.2E-02	5.0E-04	1.0E+05	2.7E+00
$^{252}\text{Cf}$	2.64 y	M 5.0E-04	1.5E+03	4.2E-02	5.0E-04	1.7E+05	4.5E+00
					5.0E-04	2.2E+05	6.0E+00

## CHEMICAL CARCINOGENS

The following substances are listed in the 11th Report on Carcinogens 2004 released by the National Institute of Environmental Health Sciences (NIEHS) under the National Toxicology Program (NTP). Substances are grouped in two classes:

- **Known to be human carcinogens:** There is sufficient evidence of carcinogenicity from studies in humans which indicates a causal relationship between exposure to the substance and human cancer.
- **Reasonably anticipated to be human carcinogens:** There is limited evidence of carcinogenicity from studies in humans which indicates that causal interpretation is credible, but that alternative explanations, such as chance, bias, or confounding factors, could not be adequately excluded; or there is sufficient evidence of carcinogenicity from studies in experimental animals.

The NTP report also lists many poorly defined materials such as soots, tars, mineral oils, coke oven emissions, etc. These materials are not included here.

The table lists the name normally used in the *Handbook of Chemistry and Physics*, followed by additional names and acronyms by which the substance is known. In many cases the primary name given here is different from that used in the NTP report; however, names used in the NTP report appear in the Other Names column. The Chemical Abstracts Service Registry Number (CAS RN), given in the last column, is taken from the NTP report. Extensive details on each substance are given in the reference.

### Reference

Public Health Service, National Toxicology Program, 11th Report on Carcinogens, available on the Internet at <<http://ntp.niehs.nih.gov/>>.

Substance	Other Names	CAS RN
<i>Known to be Human Carcinogens</i>		
Aflatoxins		1402-68-2
4-Aminobiphenyl	<i>p</i> -Biphenylamine	92-67-1
Arsenic compounds, inorganic		
Asbestos		1332-21-4
Azathioprine	6-[(1-Methyl-4-nitro-1 <i>H</i> -imidazol-5-yl)thio]-1 <i>H</i> -purine	446-86-6
Benzene		71-43-2
<i>p</i> -Benzidine (includes dyes metabolized to benzidene)	[1,1'-Biphenyl]-4,4'-diamine	92-87-5
Beryllium and beryllium compounds		7440-41-7
Bis(2-chloroethyl) sulfide	Mustard gas	505-60-2
Bis(chloromethyl) ether		542-88-1
1,3-Butadiene		106-99-0
1,4-Butanediol dimethylsulfonate	Myleran; Busulfan	55-98-1
Cadmium and cadmium compounds		7440-43-9
Chlorambucil		305-03-3
Chloroethene	Vinyl chloride; Chloroethylene	75-01-4
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	MeCCNU	13909-09-6
Chloromethyl methyl ether		107-30-2
Chromium hexavalent compounds		
Cyclophosphamide	Cyclophosphane; 2 <i>H</i> -1,3,2-Oxazaphosphorin-2-amine, <i>N,N</i> -bis(2-chloroethyl)tetrahydro-, 2-oxide	50-18-0
Cyclosporin A	Cyclosporine	59865-13-3
Diethylstilbestrol		56-53-1
Erionite		66733-21-9
Estrogens, steroidal		
<i>N</i> -(4-Ethoxyphenyl)acetamide	Phenacetin	62-44-2
Melphalan	<i>L</i> -Phenylalanine, 4-[bis(2-chloroethyl)amino]-	148-82-3
Methoxsalen (with UV therapy)	PUVA; 9-Methoxy-7 <i>H</i> -furo[3,2- <i>g</i> ][1]benzopyran-7-one	298-81-7
2-Naphthylamine	2-Aminonaphthalene; $\beta$ -Naphthylamine	91-59-8
Nickel compounds		
Oxirane	Ethylene oxide	75-21-8



Substance	Other Names	CAS RN
Radon		10043-92-2
Silicon dioxide (respirable size)	Quartz; Silica	14808-60-7
Silicon dioxide (respirable size)	Cristobalite; Silica	14464-46-1
Silicon dioxide (respirable size)	Tridymite; Silica	15468-32-3
Sulfuric acid (strong acid mists)	Oil of vitriol	7664-93-9
Tamoxifen		10540-29-1
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin	TCDD; Dioxin	1746-01-6
Thorium(IV) oxide	Thorium dioxide	1314-20-1
Triethylenethiophosphoramidate	Thiotepa; Tris(1-aziridinyl)phosphine, sulfide	52-24-4
<b>Reasonably Anticipated to be Human Carcinogens</b>		
Acetaldehyde	Ethanal	75-07-0
2-(Acetylamino)fluorene		53-96-3
Acrylamide	2-Propenamamide	79-06-1
Acrylonitrile	Propenenitrile	107-13-1
4-Allyl-1,2-dimethoxybenzene	Methyleugenol; 1,2-Dimethoxy-4-allylbenzene	93-15-2
2-Amino-9,10-anthracenedione	2-Aminoanthraquinone	117-79-3
1-Amino-2,4-dibromo-9,10-anthracenedione	1-Amino-2,4-dibromoanthraquinone	81-49-2
2-Amino-3,4-dimethylimidazo[4,5-f]quinoline	MeIQ	77094-11-2
2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline	MeIQx	77500-04-0
1-Amino-2-methyl-9,10-anthracenedione	1-Amino-2-methylantraquinone	82-28-0
2-Amino-3-methyl-3 <i>H</i> -imidazo[4,5-f]quinoline	IQ	76180-96-6
2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine	PhIP	105650-23-5
Azacitidine	5-Azacitidine; 4-Amino-1- $\beta$ - <i>D</i> -ribofuranosyl-1,3,5-triazine-2(1 <i>H</i> )-one	320-67-2
Benz[a]anthracene		56-55-3
Benzo[b]fluoranthene	Benzo[e]acephenanthrylene	205-99-2
Benzo[j]fluoranthene		205-82-3
Benzo[k]fluoranthene	2,3,1',8'-Binaphthylene	207-08-9
Benzo[a]pyrene		50-32-8
2,2'-Bioxirane	Diepoxybutane	1464-53-5
Bis(4-amino-3-chlorophenyl)methane	4,4-Methylene-bis(2-chloraniline); MBOCA	101-14-4
2,2-Bis(bromomethyl)-1,3-propanediol	BBMP; Pentaerythritol dibromide	3296-90-0
Bis(2-chloroethyl)methylamine	Nitrogen mustard hydrochloride	55-86-7
<i>N,N'</i> -Bis(2-chloroethyl)- <i>N</i> -nitrosourea	BCNU; Carmustine	154-93-8
Bis[4-(dimethylamino)phenyl]methane	Michler's Base; 4,4-Methylenebis( <i>N,N</i> -dimethylbenzenamine)	101-61-1
1,3-Bis(2,3-epoxypropoxy)benzene	Diglycidyl resorcinol ether	101-90-6
Bis(2-ethylhexyl) phthalate	DEHP; Di(2-ethylhexyl) phthalate	117-81-7
Bromodichloromethane		75-27-4
Bromoethene	Vinyl bromide	593-60-2
<i>tert</i> -Butyl-4-hydroxyanisole	BHA; Butylated hydroxyanisole	25013-16-5
Chloramphenicol		56-75-7
Chlorendic acid	1,4,5,6,7,7-Hexachloro-5-norbornene-2,3-dicarboxylic acid	115-28-6
Chlorinated paraffins (C <sub>12</sub> , 60% Cl)		108171-26-2
4-Chloro-1,2-benzenediamine	4-Chloro- <i>o</i> -phenylenediamine	95-83-0
2-Chloro-1,3-butadiene	Chloroprene	126-99-8
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea	CCNU; Lomustine; Belustine	13010-47-4
4-Chloro-2-methylaniline	<i>p</i> -Chloro- <i>o</i> -toluidine	95-69-2
4-Chloro-2-methylaniline hydrochloride	<i>p</i> -Chloro- <i>o</i> -toluidine hydrochloride	3165-93-3

Substance	Other Names	CAS RN
1-Chloro-2-methylpropene	Dimethylvinyl chloride	513-37-1
3-Chloro-2-methylpropene		563-47-3
Chlorozotocin	2-[[[(2-Chloroethyl)nitrosoamino]carbonyl]amino]-2-deoxy- <i>D</i> -glucose	54749-90-5
Fuchsin	C.I. Basic Red 9, monohydrochloride	569-61-9
Cobalt(II) sulfate	Cobaltous sulfate	10124-43-3
Cupferron		135-20-6
Dacarbazine	5-(3,3-Dimethyl-1-triazenyl)-1 <i>H</i> -imidazole-4-carboxamide	4342-03-4
Decabromobiphenyl		13654-09-6
cis-Diaminedichloroplatinum	Cisplatin	15663-27-1
2,4-Diaminoanisole sulfate	1,3-Benzenediamine, 4-methoxy, sulfate	39156-41-7
4,4'-Diaminodiphenyl ether	4,4'-Oxydianiline	101-80-4
4,4'-Diaminodiphenylmethane	4,4'-Methylenedianiline	101-77-9
4,4'-Diaminodiphenylmethane dihydrochloride	4,4'-Methylenedianiline dihydrochloride	13552-44-8
4,4'-Diaminodiphenyl sulfide	4,4'-Thiodianiline	139-65-1
Dibenz[a,h]acridine		226-36-8
Dibenz[a,j]acridine	7-Azadibenz[a,j]anthracene	224-42-0
Dibenz[a,h]anthracene	1,2:5,6-Dibenzanthracene	53-70-3
7 <i>H</i> -Dibenzo[c,g]carbazole		194-59-2
Dibenzo[a,e]pyrene	Naphtho[1,2,3,4-def]chrysene	192-65-4
Dibenzo[a,h]pyrene	Dibenzo[b,def]chrysene	189-64-0
Dibenzo[a,i]pyrene	Benzo[ <i>rst</i> ]pentaphene	189-55-9
Dibenzo[a,l]pyrene	Dibenzo[def,p]chrysene	191-30-0
1,2-Dibromo-3-chloropropane		96-12-8
1,2-Dibromoethane	Ethylene dibromide; EDB	106-93-4
2,3-Dibromo-1-propanol	DBP	96-13-9
2,3-Dibromo-1-propanol, phosphate (3:1)	Tris(2,3-dibromopropyl) phosphate	126-72-7
<i>p</i> -Dichlorobenzene	1,4-Dichlorobenzene	106-46-7
3,3'-Dichloro- <i>p</i> -benzidine	3,3'-Dichloro[1,1'-biphenyl]-4,4'-diamine	91-94-1
3,3'-Dichloro- <i>p</i> -benzidine dihydrochloride	3,3'-Dichloro-[1,1'-biphenyl]-4,4'-diamine dihydrochloride	612-83-9
1,2-Dichloroethane	Ethylene dichloride	107-06-2
Dichloromethane	Methylene chloride	75-09-2
1,3-Dichloropropene (unspecified isomer)		542-75-6
Diethyl sulfate		64-67-5
2,3-Dihydro-6-propyl-2-thioxo-4(1 <i>H</i> )-pyrimidinone	Propylthiouracil	51-52-5
1,8-Dihydroxy-9,10-anthracenedione	Danthron; 1,8-Dihydroxyanthraquinone	117-10-2
3,3'-Dimethoxybenzidine (and dyes metabolized to 3,3'-Dimethoxybenzidine)	Dianisidine	119-90-4
<i>p</i> -(Dimethylamino)azobenzene		60-11-7
2,3-Dimethyl-4-aminoazobenzene	<i>o</i> -Aminoazotoluene; 4- <i>o</i> -Tolylazo- <i>o</i> -toluidine	97-56-3
Dimethylcarbamic chloride	Dimethylcarbamoyl chloride	79-44-7
1,1-Dimethylhydrazine	UDMH	57-14-7
Dimethyl sulfate		77-78-1
1,6-Dinitropyrene		42397-64-8
1,8-Dinitropyrene		42397-65-9
1,4-Dioxane		123-91-1
1,2-Diphenylhydrazine	Hydrazobenzene	122-66-7
1,3-Diphenyl-1-triazene	Diazoaminobenzene	136-35-6

Substance	Other Names	CAS RN
Disperse Blue No. 1	1,4,5,8-Tetraamino-9,10-anthracenedione	2475-45-8
Doxorubicin hydrochloride	Adriamycin	23214-92-8
Epichlorohydrin	(Chloromethyl)oxirane	106-89-8
1,2-Epoxy-4-(epoxyethyl)cyclohexane	4-Vinyl-1-cyclohexene dioxide	106-87-6
Ethyl carbamate	Urethane	51-79-6
Ethyl methanesulfonate		62-50-0
<i>N</i> -Ethyl- <i>N</i> -nitrosourea	ENU; <i>N</i> -Nitroso- <i>N</i> -ethylurea	759-73-9
Fluoroethene	Vinyl fluoride	75-02-5
Formaldehyde (gas)	Methanal	50-00-0
Furan		110-00-9
Hexabromobiphenyl isomers	Firemaster FF-1	67774-32-7
Hexachlorobenzene	Perchlorobenzene	118-74-1
Hexachlorocyclohexane isomers		608-73-1
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\beta$ ,6 $\beta$ )	$\alpha$ -Hexachlorocyclohexane	319-84-6
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\beta$ ,3 $\alpha$ ,4 $\beta$ ,5 $\alpha$ ,6 $\beta$ )	$\beta$ -Hexachlorocyclohexane	319-85-7
1,2,3,4,5,6-Hexachlorocyclohexane, (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\alpha$ ,6 $\beta$ )	Lindane; $\gamma$ -Hexachlorocyclohexane	58-89-9
Hexachloroethane	Perchloroethane	67-72-1
Hexamethylphosphoric triamide	Hexamethylphosphoramide; Tris(dimethylamino)phosphine oxide	680-31-9
Hydrazine		302-01-2
Hydrazine sulfate		10034-93-2
2-Imidazolidinethione	Ethylene thiourea	96-45-7
Indeno[1,2,3- <i>cd</i> ]pyrene	1,10-(1,2-Phenylene)pyrene	193-39-5
Kepone	Chlordecone	143-50-0
Lead and lead compounds	Includes all lead compounds	7439-92-1
<i>o</i> -Methoxyaniline hydrochloride	<i>o</i> -Anisidine hydrochloride	134-29-2
2-Methoxy-5-methylaniline	<i>p</i> -Cresidine; 5-Methyl- <i>o</i> -anisidine	120-71-8
<i>o</i> -Methylaniline	<i>o</i> -Toluidine	95-53-4
<i>o</i> -Methylaniline hydrochloride	<i>o</i> -Toluidine hydrochloride	636-21-5
2-Methyl-1,3-butadiene	Isoprene	78-79-5
5-Methylchrysene		3697-24-3
4,4'-Methylenedianiline dihydrochloride	Benzenamine, 4,4'-methylenedi-, dihydrochloride	13552-44-8
Methyl methanesulfonate		66-27-3
<i>N</i> -Methyl- <i>N'</i> -nitro- <i>N</i> -nitrosoguanidine		70-25-7
<i>N</i> -Methyl- <i>N</i> -nitrosourea	<i>N</i> -Nitroso- <i>N</i> -methylurea	684-93-5
Methyloxirane	1,2-Propylene oxide	75-56-9
Metronidazole	2-Methyl-5-nitro-1 <i>H</i> -imidazole-1-ethanol	443-48-1
Mirex	Hexachloropentadiene dimer	2385-85-5
Naphthalene		91-20-3
Nickel (metallic)		7440-02-0
Nitrilotriacetic acid	<i>N,N</i> -Bis(carboxymethyl)glycine	139-13-9
2-Nitroanisole	1-Methoxy-2-nitrobenzene	91-23-6
Nitrobenzene		98-95-3
6-Nitrochrysene		7496-02-8
Nitrofen	2,4-Dichloro-1-(4-nitrophenoxy)benzene	1836-75-5
Nitromethane		75-52-5
2-Nitropropane		79-46-9
1-Nitropyrene		5522-43-0

Substance	Other Names	CAS RN
4-Nitropyrene		57835-92-4
<i>N</i> -Nitrosodibutylamine	Dibutylnitrosamine	924-16-3
<i>N</i> -Nitrosodiethanolamine	2,2'-(Nitrosoimino)ethanol	1116-54-7
<i>N</i> -Nitrosodiethylamine	DEN; Diethylnitrosamine	55-18-5
<i>N</i> -Nitrosodimethylamine	DMN; Dimethylnitrosamine	62-75-9
4-( <i>N</i> -Nitrosomethylamino)-1-(3-pyridyl)-1-butanone	NNK; Ketone, 3-pyridyl-3-( <i>N</i> -methyl- <i>N</i> -nitrosamino)propyl	64091-91-4
<i>N</i> -Nitroso- <i>N</i> -methylvinylamine	<i>N</i> -Methyl- <i>N</i> -nitrosoethenamine	4549-40-0
4-Nitrosomorpholine	<i>N</i> -Nitrosomorpholine	59-89-2
<i>N</i> -Nitrosornicotine	<i>N</i> '-Nitroso-3-(2-pyrrolidinyl)pyridine	16543-55-8
<i>N</i> -Nitrosopiperidine	1-Nitrosopiperidine	100-75-4
<i>N</i> -Nitroso- <i>N</i> -propyl-1-propanamine	<i>N</i> -Nitrosodipropylamine	621-64-7
<i>N</i> -Nitrosopyrrolidine		930-55-2
<i>N</i> -Nitrososarcosine	<i>N</i> -Methyl- <i>N</i> -nitrosoglycine	13256-22-9
Norethisterone	19-Norpregn-4-en-20-yn-3-one, 17-hydroxy-, (17 $\alpha$ )-	68-22-4
Ochratoxin A		303-47-9
Octabromobiphenyl isomers		61288-13-9
2-Oxetanone	$\beta$ -Propiolactone	57-57-8
Oxiranemethanol	Glycidol	556-52-5
Oxymetholone	Androstan-3-one, 17-hydroxy-2-(hydroxymethylene)-17-methyl-	434-07-1
Phenazopyridine hydrochloride	3-(Phenylazo)-2,6-pyridinediamine, monohydrochloride	136-40-3
Phenolphthalein	3,3-Bis(4-hydroxyphenyl)-1(3 <i>H</i> )-isobenzofuranone	77-09-8
Phenoxybenzamine hydrochloride		63-92-3
Phenylloxirane	Styrene-7,8-oxide	96-09-3
Phenytoin	5,5-Diphenyl-2,4-imidazolidinedione	57-41-0
Polybrominated biphenyls	PBBs	
Polychlorinated biphenyls	PCBs	1336-36-3
Procarbazine hydrochloride		366-70-1
Progesterone	Pregn-4-ene-3,20-dione	57-83-0
1,3-Propane sultone	1,2-Oxathiolane, 2,2-dioxide	1120-71-4
Propyleneimine	2-Methylaziridine	75-55-8
Reserpine		50-55-5
Safrole	5-(2-Propenyl)-1,3-benzodioxole	94-59-7
Selenium sulfide		7446-34-6
Streptozotocin	<i>D</i> -Glucopyranose, 2-deoxy-2-[(methylnitrosoamino)carbonyl]amino]-	18883-66-4
Sulfallate	<i>N,N</i> -Diethyldithiocarbamic acid, 2-chloroallyl ester	95-06-7
Tetrachloroethene	Tetrachloroethylene; Perchloroethylene	127-18-4
Tetrachloromethane	Carbon tetrachloride	56-23-5
Tetrafluoroethene	Tetrafluoroethylene	116-14-3
<i>N,N,N,N'</i> -Tetramethyl-4,4'-diaminobenzophenone	Bis(dimethylamino)benzophenone; Michler's Ketone	90-94-8
Tetranitromethane		509-14-8
Thioacetamide	Ethanethioamide	62-55-5
Thiourea	Thiocarbamide	62-56-6
<i>o</i> -Tolidine	3,3'-Dimethylbenzidine	119-93-7
Toluene-2,4-diamine	2,4-Diaminotoluene	95-80-7
Toluene diisocyanate (unspecified isomer)		26471-62-5
Toxaphene	Polychlorocamphene	8001-35-2

Substance	Other Names	CAS RN
1 <i>H</i> -1,2,4-Triazol-3-amine	Amitrole	61-82-5
1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane	DDT; Dichlorodiphenyltrichloroethane	50-29-3
Trichloroethene	Trichloroethylene	79-01-6
Trichloromethane	Chloroform	67-66-3
(Trichloromethyl)benzene	Benzotrichloride	98-07-7
2,4,6-Trichlorophenol		88-06-2
1,2,3-Trichloropropane		96-18-4

## MISCELLANEOUS MATHEMATICAL CONSTANTS

### $\pi$ CONSTANTS

$\pi$	=	3.14159 26535 89793 23846 26433 83279 50288 41971 69399 37511
$1/\pi$	=	0.31830 98861 83790 67153 77675 26745 02872 40689 19291 48091
$\pi^2$	=	9.86960 44010 89358 61883 44909 99876 15113 53136 99407 24079
$\log_e \pi$	=	1.14472 98858 49400 17414 34273 51353 05871 16472 94812 91531
$\log_{10} \pi$	=	0.49714 98726 94133 85435 12682 88290 89887 36516 78324 38044
$\log_{10} \sqrt{2\pi}$	=	0.39908 99341 79057 52478 25035 91507 69595 02099 34102 92128

### CONSTANTS INVOLVING $e$

$e$	=	2.71828 18284 59045 23536 02874 71352 66249 77572 47093 69996
$1/e$	=	0.36787 94411 71442 32159 55237 70161 46086 74458 11131 03177
$e^2$	=	7.38905 60989 30650 22723 04274 60575 00781 31803 15570 55185
$M$	=	$\log_{10} e = 0.43429 44819 03251 82765 11289 18916 60508 22943 97005 80367$
$1/M$	=	$\log_e 10 = 2.30258 50929 94045 68401 79914 54684 36420 76011 01488 62877$
$\log_{10} M$	=	9.63778 43113 00536 78912 29674 98645 – 10

### $\pi^e$ AND $e^\pi$ CONSTANTS

$\pi^e$	=	22.45915 77183 61045 47342 71522
$e^\pi$	=	23.14069 26327 79269 00572 90864
$e^{-\pi}$	=	0.04321 39182 63772 24977 44177
$e^{\pi/2}$	=	4.81047 73809 65351 65547 30357
$i^i$	=	$e^{-\pi/2} = 0.20787 95763 50761 90854 69556$

### NUMERICAL CONSTANTS

$\sqrt{2}$	=	1.41421 35623 73095 04880 16887 24209 69807 85696 71875 37695
$\sqrt[3]{2}$	=	1.25992 10498 94873 16476 72106 07278 22835 05702 51464 70151
$\log_e 2$	=	0.69314 71805 59945 30941 72321 21458 17656 80755 00134 36026
$\log_{10} 2$	=	0.30102 99956 63981 19521 37388 94724 49302 67881 89881 46211
$\sqrt{3}$	=	1.73205 08075 68877 29352 74463 41505 87236 69428 05253 81039
$\sqrt[3]{3}$	=	1.44224 95703 07408 38232 16383 10780 10958 83918 69253 49935
$\log_e 3$	=	1.09861 22886 68109 69139 52452 36922 52570 46474 90557 82275
$\log_{10} 3$	=	0.47712 12547 19662 43729 50279 03255 11530 92001 28864 19070

### OTHER CONSTANTS

Euler's Constant $\gamma$	=	0.57721 56649 01532 86061
$\log_e \gamma$	=	-0.54953 93129 81644 82234
Golden Ratio $\phi$	=	1.61803 39887 49894 84820 45868 34365 63811 77203 09180

## DECIMAL EQUIVALENTS OF COMMON FRACTIONS

		1/64	0.015625			33/64	0.515625
	1/32	2/64	0.03125		17/32	34/64	0.53125
		3/64	0.046875			35/64	0.546875
1/16	2/32	4/64	0.0625	9/16	18/32	36/64	0.5625
		5/64	0.078125			37/64	0.578125
	3/32	6/64	0.09375		19/32	38/64	0.59375
		7/64	0.109375			39/64	0.609375
1/8	4/32	8/64	0.125	5/8	20/32	40/64	0.625
		9/64	0.140625			41/64	0.640625
	5/32	10/64	0.15625		21/32	42/64	0.65625
		11/64	0.171875			43/64	0.671875
3/16	6/32	12/64	0.1875	11/16	22/32	44/64	0.6875
		13/64	0.203125			45/64	0.703125
	7/32	14/64	0.21875		23/32	46/64	0.71875
		15/64	0.234375			47/64	0.734375
1/4	8/32	16/64	0.25	3/4	24/32	48/64	0.75
		17/64	0.265625			49/64	0.765625
	9/32	18/64	0.28125		25/32	50/64	0.78125
		19/64	0.296875			51/64	0.796875
5/16	10/32	20/64	0.3125	13/16	26/32	52/64	0.8125
		21/64	0.328125			53/64	0.828125
	11/32	22/64	0.34375		27/32	54/64	0.84375
		23/64	0.359375			55/64	0.859375
3/8	12/32	24/64	0.375	7/8	28/32	56/64	0.875
		25/64	0.390625			57/64	0.890625
	13/32	26/64	0.40625		29/32	58/64	0.90625
		27/64	0.421875			59/64	0.921875
7/16	14/32	28/64	0.4375	15/16	30/32	60/64	0.9375
		29/64	0.453125			61/64	0.953125
	15/32	30/64	0.46875		31/32	62/64	0.96875
		31/64	0.484375			63/64	0.984375
1/2	16/32	32/64	0.5	1/1	32/32	64/64	1

## QUADRATIC FORMULA

The solutions of the equation  $ax^2 + bx + c = 0$ , where  $a \neq 0$ , are given by:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$



## EXPONENTIAL AND HYPERBOLIC FUNCTIONS AND THEIR COMMON LOGARITHMS

$x$	$e^x$		$e^{-x}$		$\sinh x$		$\cosh x$		$\tanh x$
	Value	$\log_{10}$	Value	Value	$\log_{10}$	Value	$\log_{10}$	Value	
0.00	1.0000	0.00000	1.00000	0.0000	$-\infty$	1.0000	0.00000	0.00000	
0.01	1.0101	.00434	0.99005	.0100	-2.00001	1.0001	.00002	.01000	
0.02	1.0202	.00869	.98020	.0200	-2.30106	1.0002	.00009	.02000	
0.03	1.0305	.01303	.97045	.0300	-2.47719	1.0005	.00020	.02999	
0.04	1.0408	.01737	.96079	.0400	-2.60218	1.0008	.00035	.03998	
0.05	1.0513	.02171	.95123	.0500	-2.69915	1.0013	.00054	.04996	
0.06	1.0618	.02606	.94176	.0600	-2.77841	1.0018	.00078	.05993	
0.07	1.0725	.03040	.93239	.0701	-2.84545	1.0025	.00106	.06989	
0.08	1.0833	.03474	.92312	.0801	-2.90355	1.0032	.00139	.07983	
0.09	1.0942	.03909	.91393	.0901	-2.95483	1.0041	.00176	.08976	
0.10	1.1052	.04343	.90484	.1002	-1.00072	1.0050	.00217	.09967	
0.11	1.1163	.04777	.89583	.1102	-1.04227	1.0061	.00262	.10956	
0.12	1.1275	.05212	.88692	.1203	-1.08022	1.0072	.00312	.11943	
0.13	1.1388	.05646	.87809	.1304	-1.11517	1.0085	.00366	.12927	
0.14	1.1503	.06080	.86936	.1405	-1.14755	1.0098	.00424	.13909	
0.15	1.1618	.06514	.86071	.1506	-1.17772	1.0113	.00487	.14889	
0.16	1.1735	.06949	.85214	.1607	-1.20597	1.0128	.00554	.15865	
0.17	1.1853	.07383	.84366	.1708	-1.23254	1.0145	.00625	.16838	
0.18	1.1972	.07817	.83527	.1810	-1.25762	1.0162	.00700	.17808	
0.19	1.2092	.08252	.82696	.1911	-1.28136	1.0181	.00779	.18775	
0.20	1.2214	.08686	.81873	.2013	-1.30392	1.0201	.00863	.19738	
0.21	1.2337	.09120	.81058	.2115	-1.32541	1.0221	.00951	.20697	
0.22	1.2461	.09554	.80252	.2218	-1.34592	1.0243	.01043	.21652	
0.23	1.2586	.09989	.79453	.2320	-1.36555	1.0266	.01139	.22603	
0.24	1.2712	.10423	.78663	.2423	-1.38437	1.0289	.01239	.23550	
0.25	1.2840	.10857	.77880	.2526	-1.40245	1.0314	.01343	.24492	
0.26	1.2969	.11292	.77105	.2629	-1.41986	1.0340	.01452	.25430	
0.27	1.3100	.11726	.76338	.2733	-1.43663	1.0367	.01564	.26362	
0.28	1.3231	.12160	.75578	.2837	-1.45282	1.0395	.01681	.27291	
0.29	1.3364	.12595	.74826	.2941	-1.46847	1.0423	.01801	.28213	
0.30	1.3499	.13029	.74082	.3045	-1.48362	1.0453	.01926	.29131	
0.31	1.3634	.13463	.73345	.3150	-1.49830	1.0484	.02054	.30044	
0.32	1.3771	.13897	.72615	.3255	-1.51254	1.0516	.02187	.30951	
0.33	1.3910	.14332	.71892	.3360	-1.52637	1.0549	.02323	.31852	
0.34	1.4049	.14766	.71177	.3466	-1.53981	1.0584	.02463	.32748	
0.35	1.4191	.15200	.70469	.3572	-1.55290	1.0619	.02607	.33638	
0.36	1.4333	.15635	.69768	.3678	-1.56564	1.0655	.02755	.34521	
0.37	1.4477	.16069	.69073	.3785	-1.57807	1.0692	.02907	.35399	
0.38	1.4623	.16503	.68386	.3892	-1.59019	1.0731	.03063	.36271	
0.39	1.4770	.16937	.67706	.4000	-1.60202	1.0770	.03222	.37136	
0.40	1.4918	.17372	.67032	.4108	-1.61358	1.0811	.03385	.37995	
0.41	1.5063	.17806	.66365	.4216	-1.62488	1.0852	.03552	.38847	
0.42	1.5220	.18240	.65705	.4325	-1.63594	1.0895	.03723	.39693	
0.43	1.5373	.18675	.65051	.4434	-1.64677	1.0939	.03897	.40532	
0.44	1.5527	.19109	.64404	.4543	-1.65738	1.0984	.04075	.41364	
0.45	1.5683	.19543	.63763	.4653	-1.66777	1.1030	.04256	.42190	
0.46	1.5841	.19978	.63128	.4764	-1.67797	1.1077	.04441	.43008	
0.47	1.6000	.20412	.62500	.4875	-1.68797	1.1125	.04630	.43820	
0.48	1.6161	.20846	.61878	.4986	-1.69779	1.1174	.04822	.44624	
0.49	1.6323	.21280	.61263	.5098	-1.70744	1.1225	.05018	.45422	
0.50	1.6487	.21715	.60653	.5211	-1.71692	1.1276	.05217	.46212	
0.51	1.6653	.22149	.60050	.5324	-1.72624	1.1329	.05419	.46995	
0.52	1.6820	.22583	.59452	.5438	-1.73540	1.1383	.05625	.47770	
0.53	1.6989	.23018	.58860	.5552	-1.74442	1.1438	.05834	.48538	

$x$	$e^x$		$e^{-x}$		$\sinh x$		$\cosh x$		$\tanh x$
	Value	$\log_{10}$	Value	Value	$\log_{10}$	Value	$\log_{10}$	Value	
0.54	1.7160	.23452	.58275	.5666	-1.75330	1.1494	.06046	.49299	
0.55	1.7333	.23886	.57695	.5782	-1.76204	1.1551	.06262	.50052	
0.56	1.7507	.24320	.57121	.5897	-1.77065	1.1609	.06481	.50798	
0.57	1.7683	.24755	.56553	.6014	-1.77914	1.1669	.06703	.51536	
0.58	1.7860	.25189	.55990	.6131	-1.78751	1.1730	.06929	.52267	
0.59	1.8040	.25623	.55433	.6248	-1.79576	1.1792	.07157	.52990	
0.60	1.8221	.26058	.54881	.6367	-1.80390	1.1855	.07389	.53705	
0.61	1.8404	.26492	.54335	.6485	-1.81194	1.1919	.07624	.54413	
0.62	1.8589	.26926	.53794	.6605	-1.81987	1.1984	.07861	.55113	
0.63	1.8776	.27361	.53259	.6725	-1.82770	1.2051	.08102	.55805	
0.64	1.8965	.27795	.52729	.6846	-1.83543	1.2119	.08346	.56490	
0.65	1.9155	.28229	.52205	.6967	-1.84308	1.2188	.08593	.57167	
0.66	1.9348	.28664	.51685	.7090	-1.85063	1.2258	.08843	.57836	
0.67	1.9542	.29098	.51171	.7213	-1.85809	1.2330	.09095	.58498	
0.68	1.9739	.29532	.50662	.7336	-1.86548	1.2402	.09351	.59152	
0.69	1.9937	.29966	.50158	.7461	-1.87278	1.2476	.09609	.59798	
0.70	2.0138	.30401	.49659	.7586	-1.88000	1.2552	.09870	.60437	
0.71	2.0340	.30835	.49164	.7712	-1.88715	1.2628	.10134	.61068	
0.72	2.0544	.31269	.48675	.7838	-1.89423	1.2706	.10401	.61691	
0.73	2.0751	.31703	.48191	.7966	-1.90123	1.2785	.10670	.62307	
0.74	2.0959	.32138	.47711	.8094	-1.90817	1.2865	.10942	.62915	
0.75	2.1170	.32572	.47237	.8223	-1.91504	1.2947	.11216	.63515	
0.76	2.1383	.33006	.46767	.8353	-1.92185	1.3030	.11493	.64108	
0.77	2.1598	.33441	.46301	.8484	-1.92859	1.3114	.11773	.64693	
0.78	2.1815	.33875	.45841	.8615	-1.93527	1.3199	.12055	.65271	
0.79	2.2034	.34309	.45384	.8748	-1.94190	1.3286	.12340	.65841	
0.80	2.2255	.34744	.44933	.8881	-1.94846	1.3374	.12627	.66404	
0.81	2.2479	.35178	.44486	.9015	-1.95498	1.3464	.12917	.66959	
0.82	2.2705	.35612	.44043	.9150	-1.96144	1.3555	.13209	.67507	
0.83	2.2933	.36046	.43605	.9286	-1.96784	1.3647	.13503	.68048	
0.84	2.3164	.36481	.43171	.9423	-1.97420	1.3740	.13800	.68581	
0.85	2.3396	.36915	.42741	.9561	-1.98051	1.3835	.14099	.69107	
0.86	2.3632	.37349	.42316	.9700	-1.98677	1.3932	.14400	.69626	
0.87	2.3869	.37784	.41895	.9840	-1.99299	1.4029	.14704	.70137	
0.88	2.4100	.38218	.41478	.9981	-1.99916	1.4128	.15009	.70642	
0.89	2.4351	.38652	.41066	1.0122	0.00528	1.4229	.15317	.71139	
0.90	2.4596	.39087	.40657	1.0265	.01137	1.4331	.15627	.71630	
0.91	2.4843	.39521	.40242	1.0409	.01741	1.4434	.15939	.72113	
0.92	2.5093	.39955	.39852	1.0554	.02341	1.4539	.16254	.72590	
0.93	2.5345	.40389	.39455	1.0700	.02937	1.4645	.16570	.73059	
0.94	2.5600	.40824	.39063	1.0847	.03530	1.4753	.16888	.73522	
0.95	2.5857	.41258	.38674	1.0995	.04119	1.4862	.17208	.73978	
0.96	2.6117	.41692	.38289	1.1144	.04704	1.4973	.17531	.74428	
0.97	2.6379	.42127	.37908	1.1294	.05286	1.5085	.17855	.74870	
0.98	2.6645	.42561	.37531	1.1446	.05864	1.5199	.18181	.75307	
0.99	2.6912	.42995	.37158	1.1598	.06439	1.5314	.18509	.75736	
1.00	2.7183	.43429	.36788	1.1752	.07011	1.5431	.18839	.76159	
1.10	3.0042	.47772	.33287	1.3356	.12569	1.6685	.22233	.80050	
1.20	3.3201	.52115	.30119	1.5095	.17882	1.8107	.25784	.83365	
1.30	3.6693	.56458	.27253	1.6984	.23004	1.9709	.29467	.86172	
1.40	4.0552	.60801	.24660	1.9043	.27974	2.1509	.33262	.88535	
1.50	4.4817	.65144	.22313	2.1293	.32823	2.3524	.37151	.90515	
1.60	4.9530	.69487	.20190	2.3756	.37577	2.5775	.41119	.92167	
1.70	5.4739	.73830	.18268	2.6456	.42253	2.8283	.45153	.93541	
1.80	6.0496	.78173	.16530	2.9422	.46867	3.1075	.49241	.94681	
1.90	6.6859	.82516	.14957	3.2682	.51430	3.4177	.53374	.95624	
2.00	7.3891	.86859	.13534	3.6269	.55953	3.7622	.57544	.96403	

$x$	$e^x$		$e^{-x}$	$\sinh x$		$\cosh x$		$\tanh x$ Value
	Value	$\log_{10}$		Value	$\log_{10}$	Value	$\log_{10}$	
2.10	8.1662	.91202	.12246	4.0219	.60443	4.1443	.61745	.97045
2.20	9.0250	.95545	.11080	4.4571	.64905	4.5679	.65972	.97574
2.30	9.9742	.99888	.10026	4.9370	.69346	5.0372	.70219	.98010
2.40	11.023	1.04231	.09072	5.4662	.73769	5.5569	.74484	.98367
2.50	12.182	1.08574	.08208	6.0502	.78177	6.1323	.78762	.98661
2.60	13.464	1.12917	.07427	6.6947	.82573	6.7690	.83052	.98903
2.70	14.880	1.17260	.06721	7.4063	.86960	7.4735	.87352	.99101
2.80	16.445	1.21602	.06081	8.1919	.91339	8.2527	.91660	.99263
2.90	18.174	1.25945	.05502	9.0596	.95711	9.1146	.95974	.99396
3.00	20.086	1.30288	.04979	10.018	1.00078	10.068	1.00293	0.99505
3.50	33.115	1.52003	.03020	16.543	1.21860	16.573	1.21940	0.99818
4.00	54.598	1.73718	.01832	27.290	1.43600	27.308	1.43629	0.99933
4.50	90.017	1.95433	.01111	45.003	1.65324	45.014	1.65335	0.99975
5.00	148.41	2.17147	.00674	74.203	1.87042	74.210	1.87046	0.99991
5.50	244.69	2.38862	.00409	122.34	2.08758	122.35	2.08760	0.99997
6.00	403.43	2.60577	.00248	201.71	2.30473	201.72	2.30474	0.99999
6.50	665.14	2.82291	.00150	332.57	2.52188	332.57	2.52189	1.00000
7.00	1096.6	3.04006	.00091	548.32	2.73904	548.32	2.73903	1.00000
7.50	1808.0	3.25721	.00055	904.02	2.95618	904.02	2.95618	1.00000
8.00	2981.0	3.47436	.00034	1490.5	3.17333	1490.5	3.17333	1.00000
8.50	4914.8	3.69150	.00020	2457.4	3.39047	2457.4	3.39047	1.00000
9.00	8103.1	3.90865	.00012	4051.5	3.60762	4051.5	3.60762	1.00000
9.50	13360.	4.12580	.00007	6679.9	3.82477	6679.9	3.82477	1.00000
10.00	22026.	4.34294	.00005	11013.	4.04191	11013.	4.04191	1.00000

## NATURAL TRIGONOMETRIC FUNCTIONS TO FOUR PLACES

$x$ radians	$x$ degrees	$\sin x$	$\cos x$	$\tan x$	$\cot x$	$\sec x$	$\csc x$		
.0000	0° 00'	.000	1.0000	.0000	–	1.000	–	90° 00'	1.5708
.0029	10	.0029	1.0000	.0029	343.8	1.000	343.8	50	1.5679
.0058	20	.0058	1.0000	.0058	171.9	1.000	171.9	40	1.5650
.0087	30	.0087	1.0000	.0087	114.6	1.000	114.6	30	1.5621
.0116	40	.0116	.9999	.0116	85.94	1.000	85.95	20	1.5592
.0145	50	.0145	.9999	.0145	68.75	1.000	68.76	10	1.5563
.0175	1° 00'	.0175	.9998	.0175	57.29	1.000	57.30	89° 00'	1.5533
.0262	30	.0262	.9997	.0262	38.19	1.000	38.20	30	1.5446
.0349	2° 00'	.0349	.9994	.0349	28.64	1.001	28.65	88° 00'	1.5359
.0436	30	.0436	.9990	.0437	22.90	1.001	22.93	30	1.5272
.0524	3° 00'	.0523	.9986	.0524	19.08	1.001	19.11	87° 00'	1.5184
.0611	30	.0610	.9981	.0612	16.35	1.002	16.38	30	1.5097
.0698	4° 00'	.0698	.9976	.0699	14.30	1.002	14.34	86° 00'	1.5010
.0785	30	.0785	.9969	.0787	12.71	1.003	12.75	30	1.4923
.0873	5° 00'	.0872	.9962	.0875	11.43	1.004	11.47	85° 00'	1.4835
.0960	30	.0958	.9954	.0963	10.39	1.005	10.43	30	1.4748
.1047	6° 00'	.1045	.9945	.1051	9.514	1.006	9.597	84° 00'	1.4661
.1134	30	.1132	.9936	.1139	8.777	1.006	8.834	30	1.4573
.1222	7° 00'	.1219	.9925	.1228	8.144	1.008	8.206	83° 00'	1.4486
.1309	30	.1305	.9914	.1317	7.596	1.009	7.661	30	1.4399
.1396	8° 00'	.1392	.9903	.1405	7.115	1.010	7.185	82° 00'	1.4312
.1484	30	.1478	.9890	.1495	6.691	1.011	6.765	30	1.4224
.1571	9° 00'	.1564	.9877	.1584	6.314	1.012	6.392	81° 00'	1.4137
.1658	30	.1650	.9863	.1673	5.976	1.014	6.059	30	1.4050
.1745	10° 00'	.1736	.9848	.1763	5.671	1.015	5.759	80° 00'	1.3963
.1833	30	.1822	.9833	.1853	5.396	1.017	5.487	30	1.3875
.1920	11° 00'	.1908	.9816	.1944	5.145	1.019	5.241	79° 00'	1.3788
.2007	30	.1994	.9799	.2035	4.915	1.020	5.016	30	1.3701
.2094	12° 00'	.2079	.9781	.2126	4.705	1.022	4.810	78° 00'	1.3614
.2182	30	.2164	.9763	.2217	4.511	1.025	4.620	30	1.3526
.2269	13° 00'	.2250	.9744	.2309	4.331	1.026	4.445	77° 00'	1.3439
.2356	30	.2334	.9724	.2401	4.165	1.028	4.284	30	1.3352
.2443	14° 00'	.2419	.9703	.2493	4.011	1.031	4.134	76° 00'	1.3265
.2531	30	.2404	.9681	.2586	3.867	1.033	3.994	30	1.3177
.2618	15° 00'	.2588	.9659	.2679	3.732	1.035	3.864	75° 00'	1.3090
.2705	30	.2672	.9636	.2773	3.606	1.038	3.742	30	1.3003
.2793	16° 00'	.2756	.9613	.2867	3.487	1.040	3.628	74° 00'	1.2915
.2880	30	.2840	.9588	.2962	3.376	1.043	3.521	30	1.2828
.2967	17° 00'	.2924	.9563	.3057	3.271	1.046	3.420	73° 00'	1.2741
.3054	30	.3007	.9537	.3153	3.172	1.049	3.326	30	1.2654
.3142	18° 00'	.3090	.9511	.3249	3.078	1.051	3.236	72° 00'	1.2566
.3229	30	.3173	.9483	.3346	2.989	1.054	3.152	30	1.2479
.3316	19° 00'	.3256	.9455	.3443	2.904	1.058	3.072	71° 00'	1.2392
.3403	30	.3338	.9426	.3541	2.824	1.061	2.996	30	1.2305
.3491	20° 00'	.3420	.9397	.3640	2.747	1.064	2.924	70° 00'	1.2217
.3578	30	.3502	.9367	.3739	2.675	1.068	2.855	30	1.2130
.3665	21° 00'	.3584	.9336	.3839	2.605	1.071	2.790	69° 00'	1.2043
.3752	30	.3665	.9304	.3939	2.539	1.075	2.729	30	1.1956
.3840	22° 00'	.3746	.9272	.4040	2.475	1.079	2.669	68° 00'	1.1868
.3927	30	.3827	.9239	.4142	2.414	1.082	2.613	30	1.1781
.4014	23° 00'	.3907	.9205	.4245	2.356	1.086	2.559	67° 00'	1.1694
.4102	30	.3987	.9171	.4348	2.300	1.090	2.508	30	1.1606
.4189	24° 00'	.4067	.9135	.4452	2.246	1.095	2.459	66° 00'	1.1519
		$\cos y$	$\sin y$	$\cot y$	$\tan y$	$\csc y$	$\sec y$	$y$ degrees	$y$ radians

$x$ radians	$x$ degrees	$\sin x$	$\cos x$	$\tan x$	$\cot x$	$\sec x$	$\csc x$		
.4276	30	.4147	.9100	.4557	2.194	1.099	2.411	30	1.1432
.4363	25° 00'	.4226	.9063	.4663	2.145	1.103	2.366	65° 00'	1.1345
.4451	30	.4305	.9026	.4770	2.097	1.108	2.323	30	1.1257
.4538	26° 00'	.4384	.8988	.4877	2.050	1.113	2.281	64° 00'	1.1170
.4625	30	.4462	.8949	.4986	2.006	1.117	2.241	30	1.1083
.4712	27° 00'	.4540	.8910	.5095	1.963	1.122	2.203	63° 00'	1.0996
.4800	30	.4617	.8870	.5206	1.921	1.127	2.166	30	1.0908
.4887	28° 00'	.4695	.8829	.5317	1.881	1.133	2.130	62° 00'	1.0821
.4974	30	.4772	.8788	.5430	1.842	1.138	2.096	30	1.0734
.5061	29° 00'	.4848	.8746	.5543	1.804	1.143	2.063	61° 00'	1.0647
.5149	30	.4924	.8704	.5658	1.767	1.149	2.031	30	1.0559
.5236	30° 00'	.5000	.8660	.5774	1.732	1.155	2.000	60° 00'	1.0472
.5323	30	.5075	.8616	.5890	1.698	1.161	1.970	30	1.0385
.5411	31° 00'	.5150	.8572	.6009	1.664	1.167	1.942	59° 00'	1.0297
.5498	30	.5225	.8526	.6128	1.632	1.173	1.914	30	1.0210
.5585	32° 00'	.5299	.8480	.6249	1.600	1.179	1.887	58° 00'	1.0123
.5672	30	.5373	.8434	.6371	1.570	1.186	1.861	30	1.0036
.5760	33° 00'	.5446	.8397	.6494	1.540	1.192	1.836	57° 00'	.9948
.5847	30	.5519	.8359	.6619	1.511	1.199	1.812	30	.9861
.5934	34° 00'	.5592	.8320	.6745	1.483	1.206	1.788	56° 00'	.9774
.6021	30	.5664	.8281	.6873	1.455	1.213	1.766	30	.9687
.6109	35° 00'	.5736	.8192	.7002	1.428	1.221	1.743	55° 00'	.9599
.6196	30	.5807	.8141	.7133	1.402	1.228	1.722	30	.9512
.6283	36° 00'	.5878	.8090	.7265	1.376	1.236	1.701	54° 00'	.9425
.6370	30	.5948	.8039	.7400	1.351	1.244	1.681	30	.9338
.6458	37° 00'	.6018	.7986	.7536	1.327	1.252	1.662	53° 00'	.9250
.6545	30	.6088	.7934	.7673	1.303	1.260	1.643	30	.9163
.6632	38° 00'	.6157	.7880	.7813	1.280	1.269	1.624	52° 00'	.9076
.6720	30	.6225	.7826	.7954	1.257	1.278	1.606	30	.8988
.6807	39° 00'	.6293	.7771	.8098	1.235	1.287	1.589	51° 00'	.8901
.6894	30	.6361	.7716	.8243	1.213	1.296	1.572	30	.8814
.6981	40° 00'	.6428	.7660	.8391	1.192	1.305	1.556	50° 00'	.8727
.7069	30	.6494	.7604	.8541	1.171	1.315	1.540	30	.8639
.7156	41° 00'	.6561	.7547	.8693	1.150	1.325	1.524	49° 00'	.8552
.7243	30	.6626	.7490	.8847	1.130	1.335	1.509	30	.8465
.7330	42° 00'	.6691	.7431	.9004	1.111	1.346	1.494	48° 00'	.8378
.7418	30	.6756	.7373	.9163	1.091	1.356	1.480	30	.8290
.7505	43° 00'	.6820	.7314	.9325	1.072	1.367	1.466	47° 00'	.8203
.7592	30	.6884	.7254	.9490	1.054	1.379	1.453	30	.8116
.7679	44° 00'	.6947	.7193	.9657	1.036	1.390	1.440	46° 00'	.8029
.7767	30	.7009	.7133	.9827	1.018	1.402	1.427	30	.7941
.7854	45° 00'	.7071	.7071	1.0000	1.0000	1.414	1.414	45° 00'	.7854
		$\cos y$	$\sin y$	$\cot y$	$\tan y$	$\csc y$	$\sec y$	$y$ degrees	$y$ radians

## RELATION OF ANGULAR FUNCTIONS IN TERMS OF ONE ANOTHER

### Trigonometric Functions

Function	$\sin \alpha$	$\cos \alpha$	$\tan \alpha$	$\cot \alpha$	$\sec \alpha$	$\csc \alpha$
$\sin \alpha$	$\sin \alpha$	$\pm\sqrt{1-\cos^2 \alpha}$	$\frac{\tan \alpha}{\pm\sqrt{1+\tan^2 \alpha}}$	$\frac{1}{\pm\sqrt{1+\cot^2 \alpha}}$	$\frac{\pm\sqrt{\sec^2 \alpha - 1}}{\sec \alpha}$	$\frac{1}{\csc \alpha}$
$\cos \alpha$	$\pm\sqrt{1-\sin^2 \alpha}$	$\cos \alpha$	$\frac{1}{\pm\sqrt{1+\tan^2 \alpha}}$	$\frac{\cot \alpha}{\pm\sqrt{1+\cot^2 \alpha}}$	$\frac{1}{\sec \alpha}$	$\frac{\pm\sqrt{\csc^2 \alpha - 1}}{\csc \alpha}$
$\tan \alpha$	$\frac{\sin \alpha}{\pm\sqrt{1-\sin^2 \alpha}}$	$\frac{\pm\sqrt{1-\cos^2 \alpha}}{\cos \alpha}$	$\tan \alpha$	$\frac{1}{\cot \alpha}$	$\pm\sqrt{\sec^2 \alpha - 1}$	$\frac{1}{\pm\sqrt{\csc^2 \alpha - 1}}$
$\cot \alpha$	$\frac{\pm\sqrt{1-\sin^2 \alpha}}{\sin \alpha}$	$\frac{\cos \alpha}{\pm\sqrt{1-\cos^2 \alpha}}$	$\frac{1}{\tan \alpha}$	$\cot \alpha$	$\frac{1}{\pm\sqrt{\sec^2 \alpha - 1}}$	$\pm\sqrt{\csc^2 \alpha - 1}$
$\sec \alpha$	$\frac{1}{\pm\sqrt{1-\sin^2 \alpha}}$	$\frac{1}{\cos \alpha}$	$\pm\sqrt{1+\tan^2 \alpha}$	$\frac{\pm\sqrt{1+\cot^2 \alpha}}{\cot \alpha}$	$\sec \alpha$	$\frac{\csc \alpha}{\pm\sqrt{\csc^2 \alpha - 1}}$
$\csc \alpha$	$\frac{1}{\sin \alpha}$	$\frac{1}{\pm\sqrt{1-\cos^2 \alpha}}$	$\frac{\pm\sqrt{1+\tan^2 \alpha}}{\tan \alpha}$	$\pm\sqrt{1+\cot^2 \alpha}$	$\frac{\sec \alpha}{\pm\sqrt{\sec^2 \alpha - 1}}$	$\csc \alpha$

*Note:* The choice of sign depends upon the quadrant in which the angle terminates.

### Hyperbolic Functions

Function	$\sinh x$	$\cosh x$	$\tanh x$
$\sinh x =$	$\sinh x$	$\pm\sqrt{\cosh^2 x - 1}$	$\frac{\tanh x}{\sqrt{1-\tanh^2 x}}$
$\cosh x =$	$\sqrt{1+\sinh^2 x}$	$\cosh x$	$\frac{1}{\sqrt{1-\tanh^2 x}}$
$\tanh x =$	$\frac{\sinh x}{\sqrt{1+\sinh^2 x}}$	$\pm\frac{\sqrt{\cosh^2 x - 1}}{\cosh x}$	$\tanh x$
$\operatorname{cosech} x =$	$\frac{1}{\sinh x}$	$\pm\frac{1}{\sqrt{\cosh^2 x - 1}}$	$\frac{\sqrt{1-\tanh^2 x}}{\tanh x}$
$\operatorname{sech} x =$	$\frac{1}{\sqrt{1+\sinh^2 x}}$	$\frac{1}{\cosh x}$	$\sqrt{1-\tanh^2 x}$
$\operatorname{coth} x =$	$\frac{\sqrt{1+\sinh^2 x}}{\sinh x}$	$\frac{\pm\cosh x}{\sqrt{\cosh^2 x - 1}}$	$\frac{1}{\tanh x}$

Function	$\operatorname{cosech} x$	$\operatorname{sech} x$	$\operatorname{coth} x$
$\sinh x =$	$\frac{1}{\operatorname{cosech} x}$	$\pm\frac{\sqrt{1-\operatorname{sech}^2 x}}{\operatorname{sech} x}$	$\frac{\pm 1}{\sqrt{\operatorname{coth}^2 x - 1}}$
$\cosh x =$	$\pm\frac{\sqrt{\operatorname{cosech}^2 x + 1}}{\operatorname{cosech} x}$	$\frac{1}{\operatorname{sech} x}$	$\pm\frac{\operatorname{coth} x}{\sqrt{\operatorname{coth}^2 x - 1}}$
$\tanh x =$	$\frac{1}{\sqrt{\operatorname{cosech}^2 x + 1}}$	$\pm\sqrt{1+\operatorname{sech}^2 x}$	$\frac{1}{\operatorname{coth} x}$
$\operatorname{cosech} x =$	$\operatorname{cosech} x$	$\pm\frac{\operatorname{sech} x}{\sqrt{1-\operatorname{sech}^2 x}}$	$\pm\frac{\sqrt{\operatorname{coth}^2 x - 1}}{1}$
$\operatorname{sech} x =$	$\pm\frac{\operatorname{cosech} x}{\sqrt{\operatorname{cosech}^2 x + 1}}$	$\operatorname{sech} x$	$\pm\frac{\sqrt{\operatorname{coth}^2 x - 1}}{\operatorname{coth} x}$
$\operatorname{coth} x =$	$\sqrt{\operatorname{cosech}^2 x + 1}$	$\pm\frac{1}{\sqrt{1-\operatorname{sech}^2 x}}$	$\operatorname{coth} x$

Whenever two signs are shown, choose + sign if  $x$  is positive, - sign if  $x$  is negative.

## DERIVATIVES

In the following formulas  $u, v, w$  represent functions of  $x$ , while  $a, c, n$  represent fixed real numbers. All arguments in the trigonometric functions are measured in radians, and all inverse trigonometric and hyperbolic functions represent principal values. \*Let  $y = f(x)$  and  $\frac{dy}{dx} = \frac{d[f(x)]}{dx} = f'(x)$  define, respectively, a function and its derivative for any value  $x$  in their common domain. The differential for the function at such a value  $x$  is accordingly defined as

$$dy = d[f(x)] = \frac{dy}{dx} dx = \frac{d[f(x)]}{dx} dx = f'(x) dx$$

Each derivative formula has an associated differential formula. For example, formula 6 below has the differential formula

$$d(uvw) = uv dw + vw du + uw dv$$

$$1. \quad \frac{d}{dx}(a) = 0$$

$$2. \quad \frac{d}{dx}(x) = 1$$

$$3. \quad \frac{d}{dx}(au) = a \frac{du}{dx}$$

$$4. \quad \frac{d}{dx}(u + v - w) = \frac{du}{dx} + \frac{dv}{dx} - \frac{dw}{dx}$$

$$5. \quad \frac{d}{dx}(uv) = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$6. \quad \frac{d}{dx}(uvw) = uv \frac{dw}{dx} + vw \frac{du}{dx} + uw \frac{dv}{dx}$$

$$7. \quad \frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2} = \frac{1}{v} \frac{du}{dx} - \frac{u}{v^2} \frac{dv}{dx}$$

$$8. \quad \frac{d}{dx}(u^n) = nu^{n-1} \frac{du}{dx}$$

$$9. \quad \frac{d}{dx}(\sqrt{u}) = \frac{1}{2\sqrt{u}} \frac{du}{dx}$$

$$10. \quad \frac{d}{dx}\left(\frac{1}{u}\right) = -\frac{1}{u^2} \frac{du}{dx}$$

$$11. \quad \frac{d}{dx}\left(\frac{1}{u^n}\right) = -\frac{n}{u^{n+1}} \frac{du}{dx}$$

$$12. \quad \frac{d}{dx}\left(\frac{u^n}{v^m}\right) = \frac{u^{n-1}}{v^{m+1}} \left( n v \frac{du}{dx} - m u \frac{dv}{dx} \right)$$

$$13. \quad \frac{d}{dx}(u^n v^m) = u^{n-1} v^{m-1} \left( n v \frac{du}{dx} + m u \frac{dv}{dx} \right)$$

$$14. \quad \frac{d}{dx}[f(u)] = \frac{d}{du}[f(u)] \cdot \frac{du}{dx}$$

$$15. \quad \frac{d^2}{dx^2}[f(u)] = \frac{df(u)}{du} \cdot \frac{d^2 u}{dx^2} + \frac{d^2 f(u)}{du^2} \cdot \left(\frac{du}{dx}\right)^2$$

$$16. \quad \frac{d^n}{dx^n}[uv] = \binom{n}{0} v \frac{d^n u}{dx^n} + \binom{n}{1} \frac{dv}{dx} \frac{d^{n-1} u}{dx^{n-1}} + \binom{n}{2} \frac{d^2 v}{dx^2} \frac{d^{n-2} u}{dx^{n-2}} \\ + \dots + \binom{n}{k} \frac{d^k v}{dx^k} \frac{d^{n-k} u}{dx^{n-k}} + \dots + \binom{n}{n} u \frac{d^n v}{dx^n}$$

where  $\binom{n}{r} = \frac{n!}{r!(n-r)!}$  is the binomial coefficient,  $n$  non-negative integer, and  $\binom{n}{0} = 1$ .

$$17. \quad \frac{du}{dx} = \frac{1}{\frac{dx}{du}} \quad \text{if } \frac{dx}{du} \neq 0$$

$$18. \quad \frac{d}{dx}(\log_a u) = (\log_a e) \frac{1}{u} \frac{du}{dx}$$

19.  $\frac{d}{dx}(\log_e u) = \frac{1}{u} \frac{du}{dx}$
20.  $\frac{d}{dx}(a^u) = a^u(\log_e a) \frac{du}{dx}$
21.  $\frac{d}{dx}(e^u) = e^u \frac{du}{dx}$
22.  $\frac{d}{dx}(u^v) = v u^{v-1} \frac{du}{dx} + (\log_e u) u^v \frac{dv}{dx}$
23.  $\frac{d}{dx}(\sin u) = (\cos u) \frac{du}{dx}$
24.  $\frac{d}{dx}(\cos u) = -(\sin u) \frac{du}{dx}$
25.  $\frac{d}{dx}(\tan u) = (\sec^2 u) \frac{du}{dx}$
26.  $\frac{d}{dx}(\cot u) = -(\csc^2 u) \frac{du}{dx}$
27.  $\frac{d}{dx}(\sec u) = \sec u \cdot \tan u \frac{du}{dx}$
28.  $\frac{d}{dx}(\csc u) = -\csc u \cdot \cot u \frac{du}{dx}$
29.  $\frac{d}{dx}(\text{vers } u) = \sin u \frac{du}{dx}$
30.  $\frac{d}{dx}(\arcsin u) = \frac{1}{\sqrt{1-u^2}} \frac{du}{dx}, \quad \left(-\frac{\pi}{2} \leq \arcsin u \leq \frac{\pi}{2}\right)$
31.  $\frac{d}{dx}(\arccos u) = -\frac{1}{\sqrt{1-u^2}} \frac{du}{dx}, \quad (0 \leq \arccos u \leq \pi)$
32.  $\frac{d}{dx}(\arctan u) = \frac{1}{1+u^2} \frac{du}{dx}, \quad \left(-\frac{\pi}{2} < \arctan u < \frac{\pi}{2}\right)$
33.  $\frac{d}{dx}(\text{arc cot } u) = -\frac{1}{1+u^2} \frac{du}{dx}, \quad (0 \leq \text{arc cot } u \leq \pi)$
34.  $\frac{d}{dx}(\text{arc sec } u) = \frac{1}{u\sqrt{u^2-1}} \frac{du}{dx}, \quad \left(0 \leq \text{arc sec } u < \frac{\pi}{2}, -\pi \leq \text{arc sec } u < -\frac{\pi}{2}\right)$
35.  $\frac{d}{dx}(\text{arc csc } u) = -\frac{1}{u\sqrt{u^2-1}} \frac{du}{dx}, \quad \left(0 < \text{arc csc } u \leq \frac{\pi}{2}, -\pi < \text{arc csc } u \leq -\frac{\pi}{2}\right)$
36.  $\frac{d}{dx}(\text{arc vers } u) = \frac{1}{\sqrt{2u-u^2}} \frac{du}{dx}, \quad (0 \leq \text{arc vers } u \leq \pi)$
37.  $\frac{d}{dx}(\sinh u) = (\cosh u) \frac{du}{dx}$
38.  $\frac{d}{dx}(\cosh u) = (\sinh u) \frac{du}{dx}$
39.  $\frac{d}{dx}(\tanh u) = (\text{sech}^2 u) \frac{du}{dx}$
40.  $\frac{d}{dx}(\text{coth } u) = -(\text{csch}^2 u) \frac{du}{dx}$
41.  $\frac{d}{dx}(\text{sech } u) = -(\text{sech } u \cdot \tanh u) \frac{du}{dx}$
42.  $\frac{d}{dx}(\text{csch } u) = -(\text{csch } u \cdot \text{coth } u) \frac{du}{dx}$
43.  $\frac{d}{dx}(\sinh^{-1} u) = \frac{d}{dx}[\log(u + \sqrt{u^2 + 1})] = \frac{1}{\sqrt{u^2 + 1}} \frac{du}{dx}$
44.  $\frac{d}{dx}(\cosh^{-1} u) = \frac{d}{dx}[\log(u + \sqrt{u^2 - 1})] = \frac{1}{\sqrt{u^2 - 1}} \frac{du}{dx}, \quad (u > 1, \cosh^{-1} u > 0)$



45.  $\frac{d}{dx}(\tanh^{-1} u) = \frac{d}{dx} \left[ \frac{1}{2} \log \frac{1+u}{1-u} \right] = \frac{1}{1-u^2} \frac{du}{dx}, \quad (u^2 < 1)$
46.  $\frac{d}{dx}(\coth^{-1} u) = \frac{d}{dx} \left[ \frac{1}{2} \log \frac{u+1}{u-1} \right] = \frac{1}{1-u^2} \frac{du}{dx}, \quad (u^2 > 1)$
47.  $\frac{d}{dx}(\operatorname{sech}^{-1} u) = \frac{d}{dx} \left[ \log \frac{1+\sqrt{1-u^2}}{u} \right] = -\frac{1}{u\sqrt{1-u^2}} \frac{du}{dx}, \quad (0 < u < 1, \operatorname{sech}^{-1} u > 0)$
48.  $\frac{d}{dx}(\operatorname{csch}^{-1} u) = \frac{d}{dx} \left[ \log \frac{1+\sqrt{1+u^2}}{u} \right] = -\frac{1}{|u|\sqrt{1+u^2}} \frac{du}{dx}$
49.  $\frac{d}{dq} \int_p^q f(x) dx = f(q), \quad [p \text{ constant}]$
50.  $\frac{d}{dp} \int_p^q f(x) dx = -f(p), \quad [q \text{ constant}]$
51.  $\frac{d}{da} \int_p^q f(x, a) dx = \int_p^q \frac{\partial}{\partial a} [f(x, a)] dx + f(q, a) \frac{dq}{da} - f(p, a) \frac{dp}{da}$

## INTEGRATION

The following is a brief discussion of some integration techniques. A more complete discussion can be found in a number of good textbooks. However, the purpose of this introduction is simply to discuss a few of the important techniques which may be used, in conjunction with the integral table which follows, to integrate particular functions.

No matter how extensive the integral table, it is a fairly uncommon occurrence to find in the table the exact integral desired. Usually some form of transformation will have to be made. The simplest type of transformation, and yet the most general, is substitution. Simple forms of substitution, such as  $y = ax$ , are employed almost unconsciously by experienced users of integral tables. Other substitutions may require more thought. In some sections of the tables, appropriate substitutions are suggested for integrals that are similar to, but not exactly like, integrals in the table. Finding the right substitution is largely a matter of intuition and experience.

Several precautions must be observed when using substitutions:

1. Be sure to make the substitution in the  $dx$  term, as well as everywhere else in the integral.
2. Be sure that the function substituted is one-to-one and continuous. If this is not the case, the integral must be restricted in such a way as to make it true. See the example following.
3. With definite integrals, the limits should also be expressed in terms of the new dependent variable. With indefinite integrals, it is necessary to perform the reverse substitution to obtain the answer in terms of the original independent variable. This may also be done for definite integrals, but it is usually easier to change the limits.

**Example:**

$$\int \frac{x^4}{\sqrt{a^2 - x^2}} dx$$

Here we make the substitution  $x = |a| \sin \theta$ . Then  $dx = |a| \cos \theta d\theta$ , and

$$\sqrt{a^2 - x^2} = \sqrt{a^2 - a^2 \sin^2 \theta} = |a| \sqrt{1 - \sin^2 \theta} = |a \cos \theta|$$

Notice the absolute value signs. It is very important to keep in mind that a square root radical always denotes the positive square root, and to assure the sign is always kept positive. Thus  $\sqrt{x^2} = |x|$ . Failure to observe this is a common cause of errors in integration.

Notice also that the indicated substitution is not a one-to-one function; that is, it does not have a unique inverse. Thus we must restrict the range of  $\theta$  in such a way as to make the function one-to-one. Fortunately, this is easily done by solving for  $\theta$

$$\theta = \sin^{-1} \frac{x}{|a|}$$

and restricting the inverse sine to the principal values,  $-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$ .

Thus the integral becomes

$$\int \frac{a^4 \sin^4 \theta |a| \cos \theta d\theta}{|a| |\cos \theta|}$$

Now, however, in the range of values chosen for  $\theta$ ,  $\cos \theta$  is always positive. Thus we may remove the absolute value signs from  $\cos \theta$  in the denominator. (This is one of the reasons that the principal values of the inverse trigonometric functions are defined as they are.) Then the  $\cos \theta$  terms cancel, and the integral becomes

$$a^4 \int \sin^4 \theta d\theta$$

By application of integral formulas 299 and 296, we integrate this to

$$-a^4 \frac{\sin^3 \theta \cos \theta}{4} - \frac{3a^4}{8} \cos \theta \sin \theta + \frac{3a^4}{8} \theta + C$$

We now must perform the inverse substitution to get the result in terms of  $x$ . We have

$$\begin{aligned} \theta &= \sin^{-1} \frac{x}{|a|} \\ \sin \theta &= \frac{x}{|a|} \end{aligned}$$

Then

$$\cos \theta = \pm \sqrt{1 - \sin^2 \theta} = \pm \sqrt{1 - \frac{x^2}{a^2}} = \pm \frac{\sqrt{a^2 - x^2}}{|a|}.$$

Because of the previously mentioned fact that  $\cos \theta$  is positive, we may omit the  $\pm$  sign. The reverse substitution then produces the final answer

$$\int \frac{x^4}{\sqrt{a^2 - x^2}} dx = -\frac{1}{4} x^3 \sqrt{a^2 - x^2} - \frac{3}{8} a^2 x \sqrt{a^2 - x^2} + \frac{3}{8} a^4 \sin^{-1} \frac{x}{|a|} + C.$$

Any rational function of  $x$  may be integrated, if the denominator is factored into linear and irreducible quadratic factors. The function may then be broken into partial fractions, and the individual partial fractions integrated by use of the appropriate formula from the integral table. See the section on partial fractions for further information.

Many integrals may be reduced to rational functions by proper substitutions. For example,

$$z = \tan \frac{x}{2}$$

will reduce any rational function of the six trigonometric functions of  $x$  to a rational function of  $z$ . (Frequently there are other substitutions that are simpler to use, but this one will always work. See integral formula number 484.)

Any rational function of  $x$  and  $\sqrt{ax+b}$  may be reduced to a rational function of  $z$  by making the substitution

$$z = \sqrt{ax+b}.$$

Other likely substitutions will be suggested by looking at the form of the integrand.

The other main method of transforming integrals is integration by parts. This involves applying formula number 5 or 6 in the accompanying integral table. The critical factor in this method is the choice of the functions  $u$  and  $v$ . In order for the method to be successful,  $v = \int dv$  and  $\int v du$  must be easier to integrate than the original integral. Again, this choice is largely a matter of intuition and experience.

**Example:**

$$\int x \sin x dx$$

Two obvious choices are  $u = x$ ,  $dv = \sin x dx$ , or  $u = \sin x$ ,  $dv = x dx$ . Since a preliminary mental calculation indicates that  $\int v du$  in the second choice would be more, rather than less, complicated than the original integral (it would contain  $x^2$ ), we use the first choice.

$$\begin{aligned} u &= x & dv &= \sin x dx & du &= dx & v &= -\cos x \\ \int x \sin x dx &= \int u dv = uv - \int v du = -x \cos x + \int \cos x dx \\ &= \sin x - x \cos x \end{aligned}$$

Of course, this result could have been obtained directly from the integral table, but it provides a simple example of the method. In more complicated examples the choice of  $u$  and  $v$  may not be so obvious, and several different choices may have to be tried. Of course, there is no guarantee that any of them will work.

Integration by parts may be applied more than once, or combined with substitution. A fairly common case is illustrated by the following example.

**Example:**

$$\int e^x \sin x \, dx$$

Let

$$\begin{array}{ll} u = e^x & \text{Then } du = e^x \, dx \\ dv = \sin x \, dx & v = -\cos x \end{array}$$

$$\int e^x \sin x \, dx = \int u \, dv = uv - \int v \, du = -e^x \cos x + \int e^x \cos x \, dx$$

In this latter integral,

$$\begin{array}{ll} \text{Let } u = e^x & \text{Then } du = e^x \, dx \\ dv = \cos x \, dx & v = \sin x \end{array}$$

$$\begin{aligned} \int e^x \sin x \, dx &= -e^x \cos x + \int e^x \cos x \, dx = -e^x \cos x + \int u \, dv \\ &= -e^x \cos x + uv - \int v \, du \\ &= -e^x \cos x + e^x \sin x - \int e^x \sin x \, dx \end{aligned}$$

This looks as if a circular transformation has taken place, since we are back at the same integral we started from. However, the above equation can be solved algebraically for the required integral:

$$\int e^x \sin x \, dx = \frac{1}{2} e^x \sin x - \frac{1}{2} e^x \cos x$$

In the second integration by parts, if the parts had been chosen as  $u = \cos x$ ,  $dv = e^x \, dx$ , we would indeed have made a circular transformation, and returned to the starting place.

In general, when doing repeated integration by parts, one should never choose the function  $u$  at any stage to be the same as the function  $v$  at the previous stage, or a constant times the previous  $v$ .

The following rule is called the extended rule for integration by parts. It is the result of  $n + 1$  successive applications of integration by parts. If

$$\begin{aligned} g_1(x) &= \int g(x) \, dx, & g_2(x) &= \int g_1(x) \, dx, \\ g_3(x) &= \int g_2(x) \, dx, \dots, & g_m(x) &= \int g_{m-1}(x) \, dx, \dots, \end{aligned}$$

then

$$\begin{aligned} \int f(x) \cdot g(x) \, dx &= f(x) \cdot g_1(x) - f'(x) \cdot g_2(x) + f''(x) \cdot g_3(x) - + \dots \\ &+ (-1)^n f^{(n)}(x) g_{n+1}(x) + (-1)^{n+1} \int f^{(n+1)}(x) g_{n+1}(x) \, dx. \end{aligned}$$

A useful special case of the above rule is when  $f(x)$  is a polynomial of degree  $n$ . Then  $f^{(n+1)}(x) = 0$ , and

$$\int f(x) \cdot g(x) \, dx = f(x) \cdot g_1(x) - f'(x) \cdot g_2(x) + f''(x) \cdot g_3(x) - + \dots + (-1)^n f^{(n)}(x) g_{n+1}(x) + C.$$

**Example:** If  $f(x) = x^2$ ,  $g(x) = \sin x$

$$\int x^2 \sin x \, dx = -x^2 \cos x + 2x \sin x + 2 \cos x + C.$$

Another application of this formula occurs if

$$f''(x) = af(x) \quad \text{and} \quad g''(x) = bg(x),$$

where  $a$  and  $b$  are unequal constants. In this case, by a process similar to that used in the above example for  $\int e^x \sin x \, dx$ , we get the formula

$$\int f(x)g(x) \, dx = \frac{f(x) \cdot g'(x) - f'(x) \cdot g(x)}{b - a} + C.$$

This formula could have been used in the example mentioned. Here is another example.

**Example:** If  $f(x) = e^{2x}$ ,  $g(x) = \sin 3x$ , then  $a = 4$ ,  $b = -9$ , and

$$\int e^{2x} \sin 3x \, dx = \frac{3e^{2x} \cos 3x - 2e^{2x} \sin 3x}{-9 - 4} + C = \frac{e^{2x}}{13}(2 \sin 3x - 3 \cos 3x) + C$$

The following additional points should be observed when using this table.

1. A constant of integration is to be supplied with the answers for indefinite integrals.
2. Logarithmic expressions are to base  $e = 2.71828 \dots$ , unless otherwise specified, and are to be evaluated for the absolute value of the arguments involved therein.
3. All angles are measured in radians, and inverse trigonometric and hyperbolic functions represent principal values, unless otherwise indicated.
4. If the application of a formula produces either a zero denominator or the square root of a negative number in the result, there is usually available another form of the answer which avoids this difficulty. In many of the results, the excluded values are specified, but when such are omitted it is presumed that one can tell what these should be, especially when difficulties of the type herein mentioned are obtained.
5. When inverse trigonometric functions occur in the integrals, be sure that any replacements made for them are strictly in accordance with the rules for such functions. This causes little difficulty when the argument of the inverse trigonometric function is positive, since then all angles involved are in the first quadrant. However, if the argument is negative, special care must be used. Thus if  $u > 0$ ,

$$\sin^{-1} u = \cos^{-1} \sqrt{1 - u^2} = \csc^{-1} \frac{1}{u}, \text{ etc.}$$

However, if  $u < 0$ ,

$$\sin^{-1} u = -\cos^{-1} \sqrt{1 - u^2} = -\pi - \csc^{-1} \frac{1}{u}, \text{ etc.}$$

See the section on inverse trigonometric functions for a full treatment of the allowable substitutions.

6. In integrals 340–345 and some others, the right side includes expressions of the form

$$A \tan^{-1}[B + C \tan f(x)].$$

In these formulas, the  $\tan^{-1}$  does not necessarily represent the principal value. Instead of always employing the principal branch of the inverse tangent function, one must instead use that branch of the inverse tangent function upon which  $f(x)$  lies for any particular choice of  $x$ . (This is not an issue when the antiderivative is continuous.)

**Example:**

$$\begin{aligned} \int_0^{4\pi} \frac{dx}{2 + \sin x} &= \frac{2}{\sqrt{3}} \tan^{-1} \frac{2 \tan(x/2 + 1)}{\sqrt{3}} \Big|_0^{4\pi} \\ &= \frac{2}{\sqrt{3}} \left[ \tan^{-1} \left( \frac{2 \tan 2\pi + 1}{\sqrt{3}} \right) - \tan^{-1} \left( \frac{2 \tan 0 + 1}{\sqrt{3}} \right) \right] \\ &= \frac{2}{\sqrt{3}} \left[ \frac{13\pi}{6} - \frac{\pi}{6} \right] = \frac{4\pi}{\sqrt{3}} = \frac{4\sqrt{3}\pi}{3} \end{aligned}$$

Here

$$\tan^{-1} \frac{2 \tan 2\pi + 1}{\sqrt{3}} = \tan^{-1} \frac{1}{\sqrt{3}} = \frac{13\pi}{6},$$

since  $f(x) = 2\pi$ ; and

$$\tan^{-1} \frac{2 \tan 0 + 1}{\sqrt{3}} = \tan^{-1} \frac{1}{\sqrt{3}} = \frac{\pi}{6},$$

since  $f(x) = 0$ .

7.  $B_n$  and  $E_n$  where used in integrals represents the Bernoulli and Euler numbers as defined in tables of Bernoulli and Euler polynomials contained in certain mathematics reference and handbooks.

# INTEGRALS

## ELEMENTARY FORMS

1.  $\int a \, dx = ax$
2.  $\int a \cdot f(x) \, dx = a \int f(x) \, dx$
3.  $\int \phi(y) \, dx = \int \frac{\phi(y)}{y'} \, dy$ , where  $y' = \frac{dy}{dx}$
4.  $\int (u + v) \, dx = \int u \, dx + \int v \, dx$ , where  $u$  and  $v$  are any functions of  $x$
5.  $\int u \, dv = u \int dv - \int v \, du = uv - \int v \, du$
6.  $\int u \frac{dv}{dx} \, dx = uv - \int v \frac{du}{dx} \, dx$
7.  $\int x^n \, dx = \frac{x^{n+1}}{n+1}$ , except  $n = -1$
8.  $\int \frac{f'(x) \, dx}{f(x)} = \log f(x)$ , ( $df(x) = f'(x) \, dx$ )
9.  $\int \frac{dx}{x} = \log x$
10.  $\int \frac{f'(x) \, dx}{2\sqrt{f(x)}} = \sqrt{f(x)}$ , ( $df(x) = f'(x) \, dx$ )
11.  $\int e^x \, dx = e^x$
12.  $\int e^{ax} \, dx = e^{ax}/a$
13.  $\int b^{ax} \, dx = \frac{b^{ax}}{a \log b}$ , ( $b > 0$ )
14.  $\int \log x \, dx = x \log x - x$
15.  $\int a^x \log a \, dx = a^x$ , ( $a > 0$ )
16.  $\int \frac{dx}{a^2 + x^2} = \frac{1}{a} \tan^{-1} \frac{x}{a}$
17.  $\int \frac{dx}{a^2 - x^2} = \begin{cases} \frac{1}{a} \tanh^{-1} \frac{x}{a} \\ \text{or} \\ \frac{1}{2a} \log \frac{a+x}{a-x}, \quad (a^2 > x^2) \end{cases}$
18.  $\int \frac{dx}{x^2 - a^2} = \begin{cases} -\frac{1}{a} \coth^{-1} \frac{x}{a} \\ \text{or} \\ \frac{1}{2a} \log \frac{x-a}{x+a}, \quad (x^2 > a^2) \end{cases}$

$$\begin{aligned}
 19. \quad \int \frac{dx}{\sqrt{a^2 - x^2}} &= \begin{cases} \sin^{-1} \frac{x}{|a|} \\ \text{or} \\ -\cos^{-1} \frac{x}{|a|}, \quad (a^2 > x^2) \end{cases} \\
 20. \quad \int \frac{dx}{\sqrt{x^2 \pm a^2}} &= \log(x + \sqrt{x^2 \pm a^2}) \\
 21. \quad \int \frac{dx}{x\sqrt{x^2 - a^2}} &= \frac{1}{|a|} \sec^{-1} \frac{x}{a} \\
 22. \quad \int \frac{dx}{x\sqrt{a^2 \pm x^2}} &= -\frac{1}{a} \log \left( \frac{a + \sqrt{a^2 \pm x^2}}{x} \right)
 \end{aligned}$$

FORMS CONTAINING  $(a + bx)$ 

For forms containing  $a + bx$ , but not listed in the table, the substitution  $u = \frac{a+bx}{x}$  may prove helpful.

$$\begin{aligned}
 23. \quad \int (a + bx)^n dx &= \frac{(a + bx)^{n+1}}{(n+1)b}, \quad (n \neq -1) \\
 24. \quad \int x(a + bx)^n dx &= \frac{1}{b^2(n+2)}(a + bx)^{n+2} - \frac{a}{b^2(n+1)}(a + bx)^{n+1}, \quad (n \neq -1, -2) \\
 25. \quad \int x^2(a + bx)^n dx &= \frac{1}{b^3} \left[ \frac{(a + bx)^{n+3}}{n+3} - 2a \frac{(a + bx)^{n+2}}{n+2} + a^2 \frac{(a + bx)^{n+1}}{n+1} \right] \\
 26. \quad \int x^m(a + bx)^n dx &= \begin{cases} \frac{x^{m+1}(a+bx)^n}{m+n+1} + \frac{an}{m+n+1} \int x^m(a + bx)^{n-1} dx \\ \text{or} \\ \frac{1}{a(n+1)} \left[ -x^{m+1}(a + bx)^{n+1} + (m+n+2) \int x^m(a + bx)^{n+1} dx \right] \\ \text{or} \\ \frac{1}{b(m+n+1)} \left[ x^m(a + bx)^{n+1} - ma \int x^{m-1}(a + bx)^n dx \right] \end{cases} \\
 27. \quad \int \frac{dx}{a + bx} &= \frac{1}{b} \log(a + bx) \\
 28. \quad \int \frac{dx}{(a + bx)^2} &= -\frac{1}{b(a + bx)} \\
 29. \quad \int \frac{dx}{(a + bx)^3} &= -\frac{1}{2b(a + bx)^2} \\
 30. \quad \int \frac{x dx}{a + bx} &= \begin{cases} \frac{1}{b^2} [a + bx - a \log(a + bx)] \\ \text{or} \\ \frac{x}{b} - \frac{a}{b^2} \log(a + bx) \end{cases} \\
 31. \quad \int \frac{x dx}{(a + bx)^2} &= \frac{1}{b^2} \left[ \log(a + bx) + \frac{a}{a + bx} \right] \\
 32. \quad \int \frac{x dx}{(a + bx)^n} &= \frac{1}{b^2} \left[ \frac{-1}{(n-2)(a + bx)^{n-2}} + \frac{a}{(n-1)(a + bx)^{n-1}} \right], \quad n \neq 1, 2 \\
 33. \quad \int \frac{x^2 dx}{a + bx} &= \frac{1}{b^3} \left[ \frac{1}{2}(a + bx)^2 - 2a(a + bx) + a^2 \log(a + bx) \right] \\
 34. \quad \int \frac{x^2 dx}{(a + bx)^2} &= \frac{1}{b^3} \left[ a + bx - 2a \log(a + bx) - \frac{a^2}{a + bx} \right] \\
 35. \quad \int \frac{x^2 dx}{(a + bx)^3} &= \frac{1}{b^3} \left[ \log(a + bx) + \frac{2a}{a + bx} - \frac{a^2}{2(a + bx)^2} \right] \\
 36. \quad \int \frac{x^2 dx}{(a + bx)^n} &= \frac{1}{b^3} \left[ \frac{-1}{(n-3)(a + bx)^{n-3}} + \frac{2a}{(n-2)(a + bx)^{n-2}} - \frac{a^2}{(n-1)(a + bx)^{n-1}} \right], \quad n \neq 1, 2, 3 \\
 37. \quad \int \frac{dx}{x(a + bx)} &= -\frac{1}{a} \log \frac{a + bx}{x} \\
 38. \quad \int \frac{dx}{x(a + bx)^2} &= \frac{1}{a(a + bx)} - \frac{1}{a^2} \log \frac{a + bx}{x}
 \end{aligned}$$



$$39. \int \frac{dx}{x(a+bx)^3} = \frac{1}{a^3} \left[ \frac{1}{2} \left( \frac{2a+bx}{a+bx} \right)^2 + \log \frac{x}{a+bx} \right]$$

$$40. \int \frac{dx}{x^2(a+bx)} = -\frac{1}{ax} + \frac{b}{a^2} \log \frac{a+bx}{x}$$

$$41. \int \frac{dx}{x^3(a+bx)} = \frac{2bx-a}{2a^2x^2} + \frac{b^2}{a^3} \log \frac{x}{a+bx}$$

$$42. \int \frac{dx}{x^2(a+bx)^2} = -\frac{a+2bx}{a^2x(a+bx)} + \frac{2b}{a^3} \log \frac{a+bx}{x}$$

FORMS CONTAINING  $c^2 \pm x^2$  or  $x^2 - c^2$ 

$$43. \int \frac{dx}{c^2+x^2} = \frac{1}{c} \tan^{-1} \frac{x}{c}$$

$$44. \int \frac{dx}{c^2-x^2} = \frac{1}{2c} \log \frac{c+x}{c-x}, \quad (c^2 > x^2)$$

$$45. \int \frac{dx}{x^2-c^2} = \frac{1}{2c} \log \frac{x-c}{x+c}, \quad (x^2 > c^2)$$

$$46. \int \frac{x dx}{c^2 \pm x^2} = \pm \frac{1}{2} \log(c^2 \pm x^2)$$

$$47. \int \frac{x dx}{(c^2 \pm x^2)^{n+1}} = \mp \frac{1}{2n(c^2 \pm x^2)^n}$$

$$48. \int \frac{dx}{(c^2 \pm x^2)^n} = \frac{1}{2c^2(n-1)} \left[ \frac{x}{(c^2 \pm x^2)^{n-1}} + (2n-3) \int \frac{dx}{(c^2 \pm x^2)^{n-1}} \right]$$

$$49. \int \frac{dx}{(x^2 - c^2)^n} = \frac{1}{2c^2(n-1)} \left[ -\frac{x}{(x^2 - c^2)^{n-1}} - (2n-3) \int \frac{dx}{(x^2 - c^2)^{n-1}} \right]$$

$$50. \int \frac{x dx}{x^2 - c^2} = \frac{1}{2} \log(x^2 - c^2)$$

$$51. \int \frac{x dx}{(x^2 - c^2)^{n+1}} = -\frac{1}{2n(x^2 - c^2)^n}$$

FORMS CONTAINING  $a + bx$  AND  $c + dx$ Define  $u = a + bx$ ,  $v = c + dx$ , and  $k = ad - bc$ . If  $k = 0$ , then  $v = \frac{c}{a}u$ .

$$52. \int \frac{dx}{u \cdot v} = \frac{1}{k} \cdot \log \left( \frac{v}{u} \right)$$

$$53. \int \frac{x dx}{u \cdot v} = \frac{1}{k} \left[ \frac{a}{b} \log(u) - \frac{c}{d} \log(v) \right]$$

$$54. \int \frac{dx}{u^2 \cdot v} = \frac{1}{k} \left( \frac{1}{u} + \frac{d}{k} \log \frac{v}{u} \right)$$

$$55. \int \frac{x dx}{u^2 \cdot v} = \frac{-a}{bku} - \frac{c}{k^2} \log \frac{v}{u}$$

$$56. \int \frac{x^2 dx}{u^2 \cdot v} = \frac{a^2}{b^2ku} + \frac{1}{k^2} \left[ \frac{c^2}{d} \log(v) + \frac{a(k-bc)}{b^2} \log(u) \right]$$

$$57. \int \frac{dx}{u^n \cdot v^m} = \frac{1}{k(m-1)} \left[ \frac{-1}{u^{n-1} \cdot v^{m-1}} - (m+n-2)b \int \frac{dx}{u^n \cdot v^{m-1}} \right]$$

$$58. \int \frac{u}{v} dx = \frac{bx}{d} + \frac{k}{d^2} \log(v)$$

$$59. \int \frac{u^m dx}{v^n} = \begin{cases} \frac{-1}{k(n-1)} \left[ \frac{u^{m+1}}{v^{n-1}} + b(n-m-2) \int \frac{u^m}{v^{n-1}} dx \right] \\ \text{or} \\ \frac{-1}{d(n-m-1)} \left[ \frac{u^m}{v^{n-1}} + mk \int \frac{u^{m-1}}{v^n} dx \right] \\ \text{or} \\ \frac{-1}{d(n-1)} \left[ \frac{u^m}{v^{n-1}} - mb \int \frac{u^{m-1}}{v^{n-1}} dx \right] \end{cases}$$

FORMS CONTAINING  $(a + bx^n)$ 

60.  $\int \frac{dx}{a + bx^2} = \frac{1}{\sqrt{ab}} \tan^{-1} \frac{x\sqrt{ab}}{a}, \quad (ab > 0)$
61.  $\int \frac{dx}{a + bx^2} = \begin{cases} \frac{1}{2\sqrt{-ab}} \log \frac{a+x\sqrt{-ab}}{a-x\sqrt{-ab}}, & (ab < 0) \\ \text{or} \\ \frac{1}{\sqrt{-ab}} \tanh^{-1} \frac{x\sqrt{-ab}}{a}, & (ab < 0) \end{cases}$
62.  $\int \frac{dx}{a^2 + b^2x^2} = \frac{1}{ab} \tan^{-1} \frac{bx}{a}$
63.  $\int \frac{x dx}{a + bx^2} = \frac{1}{2b} \log(a + bx^2)$
64.  $\int \frac{x^2 dx}{a + bx^2} = \frac{x}{b} - \frac{a}{b} \int \frac{dx}{a + bx^2}$
65.  $\int \frac{dx}{(a + bx^2)^2} = \frac{x}{2a(a + bx^2)} + \frac{1}{2a} \int \frac{dx}{a + bx^2}$
66.  $\int \frac{dx}{a^2 - b^2x^2} = \frac{1}{2ab} \log \frac{a + bx}{a - bx}$
67.  $\int \frac{dx}{(a + bx^2)^{m+1}} = \begin{cases} \frac{1}{2ma} \frac{x}{(a+bx^2)^m} + \frac{2m-1}{2ma} \int \frac{dx}{(a+bx^2)^m} \\ \text{or} \\ \frac{(2m)!}{(m!)^2} \left[ \frac{x}{2a} \sum_{r=1}^m \frac{r!(r-1)!}{(4a)^{m-r}(2r)!(a+bx^2)^r} + \frac{1}{(4a)^m} \int \frac{dx}{a+bx^2} \right] \end{cases}$
68.  $\int \frac{x dx}{(a + bx^2)^{m+1}} = -\frac{1}{2bm(a + bx^2)^m}$
69.  $\int \frac{x^2 dx}{(a + bx^2)^{m+1}} = \frac{-x}{2mb(a + bx^2)^m} + \frac{1}{2mb} \int \frac{dx}{(a + bx^2)^m}$
70.  $\int \frac{dx}{x(a + bx^2)} = \frac{1}{2a} \log \frac{x^2}{a + bx^2}$
71.  $\int \frac{dx}{x^2(a + bx^2)} = -\frac{1}{ax} - \frac{b}{a} \int \frac{dx}{a + bx^2}$
72.  $\int \frac{dx}{x(a + bx^2)^{m+1}} = \begin{cases} \frac{1}{2am(a+bx^2)^m} + \frac{1}{a} \int \frac{dx}{x(a+bx^2)^m} \\ \text{or} \\ \frac{1}{2a^{m+1}} \left[ \sum_{r=1}^m \frac{a^r}{r(a+bx^2)^r} + \log \frac{x^2}{a+bx^2} \right] \end{cases}$
73.  $\int \frac{dx}{x^2(a + bx^2)^{m+1}} = \frac{1}{a} \int \frac{dx}{x^2(a + bx^2)^m} - \frac{b}{a} \int \frac{dx}{(a + bx^2)^{m+1}}$
74.  $\int \frac{dx}{a + bx^3} = \frac{k}{3a} \left[ \frac{1}{2} \log \frac{(k+x)^3}{a + bx^3} + \sqrt{3} \tan^{-1} \frac{2x-k}{k\sqrt{3}} \right], \quad \left( k = \sqrt[3]{\frac{a}{b}} \right)$
75.  $\int \frac{x dx}{a + bx^3} = \frac{1}{3bk} \left[ \frac{1}{2} \log \frac{a + bx^3}{(k+x)^3} + \sqrt{3} \tan^{-1} \frac{2x-k}{k\sqrt{3}} \right], \quad \left( k = \sqrt[3]{\frac{a}{b}} \right)$
76.  $\int \frac{x^2 dx}{a + bx^3} = \frac{1}{3b} \log(a + bx^3)$
77.  $\int \frac{dx}{a + bx^4} = \frac{k}{2a} \left[ \frac{1}{2} \log \frac{x^2 + 2kx + 2k^2}{x^2 - 2kx + 2k^2} + \tan^{-1} \frac{2kx}{2k^2 - x^2} \right], \quad (ab > 0, k = \sqrt[4]{\frac{a}{4b}})$
78.  $\int \frac{dx}{a + bx^4} = \frac{k}{2a} \left[ \frac{1}{2} \log \frac{x+k}{x-k} + \tan^{-1} \frac{x}{k} \right], \quad (ab < 0, k = \sqrt[4]{-\frac{a}{b}})$
79.  $\int \frac{x dx}{a + bx^4} = \frac{1}{2bk} \tan^{-1} \frac{x^2}{k}, \quad (ab > 0, k = \sqrt{\frac{a}{b}})$
80.  $\int \frac{x dx}{a + bx^4} = \frac{1}{4bk} \log \frac{x^2 - k}{x^2 + k}, \quad (ab < 0, k = \sqrt{-\frac{a}{b}})$
81.  $\int \frac{x^2 dx}{a + bx^4} = \frac{1}{4bk} \left[ \frac{1}{2} \log \frac{x^2 - 2kx + 2k^2}{x^2 + 2kx + 2k^2} + \tan^{-1} \frac{2kx}{2k^2 - x^2} \right], \quad (ab > 0, k = \sqrt[4]{\frac{a}{4b}})$
82.  $\int \frac{x^2 dx}{a + bx^4} = \frac{1}{4bk} \left[ \log \frac{x-k}{x+k} + 2 \tan^{-1} \frac{x}{k} \right], \quad (ab < 0, k = \sqrt[4]{-\frac{a}{b}})$
83.  $\int \frac{x^3 dx}{a + bx^4} = \frac{1}{4b} \log(a + bx^4)$
84.  $\int \frac{dx}{x(a + bx^n)} = \frac{1}{an} \log \frac{x^n}{a + bx^n}$

$$\begin{aligned}
85. \quad & \int \frac{dx}{(a+bx^n)^{m+1}} = \frac{1}{a} \int \frac{dx}{(a+bx^n)^m} - \frac{b}{a} \int \frac{x^n dx}{(a+bx^n)^{m+1}} \\
86. \quad & \int \frac{x^m dx}{(a+bx^n)^{p+1}} = \frac{1}{b} \int \frac{x^{m-n} dx}{(a+bx^n)^p} - \frac{a}{b} \int \frac{x^{m-n} dx}{(a+bx^n)^{p+1}} \\
87. \quad & \int \frac{dx}{x^m(a+bx^n)^{p+1}} = \frac{1}{a} \int \frac{dx}{x^m(a+bx^n)^p} - \frac{b}{a} \int \frac{dx}{x^{m-n}(a+bx^n)^{p+1}} \\
88. \quad & \int x^m(a+bx^n)^p dx = \begin{cases} \frac{1}{b(np+m+1)} [x^{m-n+1}(a+bx^n)^{p+1} - a(m-n+1) \int x^{m-n}(a+bx^n)^p dx] \\ \text{or} \\ \frac{1}{np+m+1} [x^{m+1}(a+bx^n)^p + anp \int x^m(a+bx^n)^{p-1} dx] \\ \text{or} \\ \frac{1}{a(m+1)} [x^{m+1}(a+bx^n)^{p+1} - (m+1+np+n)b \int x^{m+n}(a+bx^n)^p dx] \\ \text{or} \\ \frac{1}{an(p+1)} [-x^{m+1}(a+bx^n)^{p+1} + (m+1+np+n) \int x^m(a+bx^n)^{p+1} dx] \end{cases}
\end{aligned}$$

FORMS CONTAINING  $c^3 \pm x^3$ 

$$\begin{aligned}
89. \quad & \int \frac{dx}{c^3 \pm x^3} = \pm \frac{1}{6c^2} \log \frac{(c \pm x)^3}{c^3 \pm x^3} + \frac{1}{c^2\sqrt{3}} \tan^{-1} \frac{2x \mp c}{c\sqrt{3}} \\
90. \quad & \int \frac{dx}{(c^3 \pm x^3)^2} = \frac{x}{3c^3(c^3 \pm x^3)} + \frac{2}{3c^3} \int \frac{dx}{c^3 \pm x^3} \\
91. \quad & \int \frac{dx}{(c^3 \pm x^3)^{n+1}} = \frac{1}{3nc^3} \left[ \frac{x}{(c^3 \pm x^3)^n} + (3n-1) \int \frac{dx}{(c^3 \pm x^3)^n} \right] \\
92. \quad & \int \frac{x dx}{c^3 \pm x^3} = \frac{1}{6c} \log \frac{c^3 \pm x^3}{(c \pm x)^3} \pm \frac{1}{c\sqrt{3}} \tan^{-1} \frac{2x \mp c}{c\sqrt{3}} \\
93. \quad & \int \frac{x dx}{(c^3 \pm x^3)^2} = \frac{x^2}{3c^3(c^3 \pm x^3)} + \frac{1}{3c^3} \int \frac{x dx}{c^3 \pm x^3} \\
94. \quad & \int \frac{x dx}{(c^3 \pm x^3)^{n+1}} = \frac{1}{3nc^3} \left[ \frac{x^2}{(c^3 \pm x^3)^n} + (3n-2) \int \frac{x dx}{(c^3 \pm x^3)^n} \right] \\
95. \quad & \int \frac{x^2 dx}{c^3 \pm x^3} = \pm \frac{1}{3} \log(c^3 \pm x^3) \\
96. \quad & \int \frac{x^2 dx}{(c^3 \pm x^3)^{n+1}} = \mp \frac{1}{3n(c^3 \pm x^3)^n} \\
97. \quad & \int \frac{dx}{x(c^3 \pm x^3)} = \frac{1}{3c^3} \log \frac{x^3}{c^3 \pm x^3} \\
98. \quad & \int \frac{dx}{x(c^3 \pm x^3)^2} = \frac{1}{3c^3(c^3 \pm x^3)} + \frac{1}{3c^6} \log \frac{x^3}{c^3 \pm x^3} \\
99. \quad & \int \frac{dx}{x(c^3 \pm x^3)^{n+1}} = \frac{1}{3nc^3(c^3 \pm x^3)^n} + \frac{1}{c^3} \int \frac{dx}{x(c^3 \pm x^3)^n} \\
100. \quad & \int \frac{dx}{x^2(c^3 \pm x^3)} = -\frac{1}{c^3x} \mp \frac{1}{c^3} \int \frac{x dx}{c^3 \pm x^3} \\
101. \quad & \int \frac{dx}{x^2(c^3 \pm x^3)^{n+1}} = \frac{1}{c^3} \int \frac{dx}{x^2(c^3 \pm x^3)^n} \mp \frac{1}{c^3} \int \frac{x dx}{(c^3 \pm x^3)^{n+1}}
\end{aligned}$$

FORMS CONTAINING  $c^4 \pm x^4$ 

$$\begin{aligned}
102. \quad & \int \frac{dx}{c^4 + x^4} = \frac{1}{2c^3\sqrt{2}} \left[ \frac{1}{2} \log \frac{x^2 + cx\sqrt{2} + c^2}{x^2 - cx\sqrt{2} + c^2} + \tan^{-1} \frac{cx\sqrt{2}}{c^2 - x^2} \right] \\
103. \quad & \int \frac{dx}{c^4 - x^4} = \frac{1}{2c^3} \left[ \frac{1}{2} \log \frac{c+x}{c-x} + \tan^{-1} \frac{x}{c} \right] \\
104. \quad & \int \frac{x dx}{c^4 + x^4} = \frac{1}{2c^2} \tan^{-1} \frac{x^2}{c^2} \\
105. \quad & \int \frac{x dx}{c^4 - x^4} = \frac{1}{4c^2} \log \frac{c^2 + x^2}{c^2 - x^2} \\
106. \quad & \int \frac{x^2 dx}{c^4 + x^4} = \frac{1}{2c\sqrt{2}} \left[ \frac{1}{2} \log \frac{x^2 - cx\sqrt{2} + c^2}{x^2 + cx\sqrt{2} + c^2} + \tan^{-1} \frac{cx\sqrt{2}}{c^2 - x^2} \right]
\end{aligned}$$

$$107. \int \frac{x^2 dx}{c^4 - x^4} = \frac{1}{2c} \left[ \frac{1}{2} \log \frac{c+x}{c-x} - \tan^{-1} \frac{x}{c} \right]$$

$$108. \int \frac{x^3 dx}{c^4 \pm x^4} = \pm \frac{1}{4} \log(c^4 \pm x^4)$$

FORMS CONTAINING  $(a + bx + cx^2)$ 

Define  $X = a + bx + cx^2$  and  $q = 4ac - b^2$ . If  $q = 0$ , then  $X = c(x + \frac{b}{2c})^2$ , and formulas starting with 23 should be used in place of these.

$$109. \int \frac{dx}{X} = \frac{2}{\sqrt{q}} \tan^{-1} \frac{2cx+b}{\sqrt{q}}, \quad (q > 0)$$

$$110. \int \frac{dx}{X} = \begin{cases} \frac{-2}{\sqrt{-q}} \tanh^{-1} \frac{2cx+b}{\sqrt{-q}} \\ \text{or} \\ \frac{1}{\sqrt{-q}} \log \frac{2cx+b-\sqrt{-q}}{2cx+b+\sqrt{-q}}, \end{cases} \quad (q < 0)$$

$$111. \int \frac{dx}{X^2} = \frac{2cx+b}{qX} + \frac{2c}{q} \int \frac{dx}{X}$$

$$112. \int \frac{dx}{X^3} = \frac{2cx+b}{q} \left( \frac{1}{2X^2} + \frac{3c}{qX} \right) + \frac{6c^2}{q^2} \int \frac{dx}{X}$$

$$113. \int \frac{dx}{X^{n+1}} = \begin{cases} \frac{2cx+b}{nqX^n} + \frac{2(2n-1)c}{qn} \int \frac{dx}{X^n} \\ \text{or} \\ \frac{(2n)!}{(n!)^2} \left( \frac{c}{q} \right)^n \left[ \frac{2cx+b}{q} \sum_{r=1}^n \left( \frac{q}{cX} \right)^r \left( \frac{(r-1)!r!}{(2r)!} \right) + \int \frac{dx}{X} \right] \end{cases}$$

$$114. \int \frac{x dx}{X} = \frac{1}{2c} \log X - \frac{b}{2c} \int \frac{dx}{X}$$

$$115. \int \frac{x dx}{X^2} = \frac{bx+2a}{qX} - \frac{b}{q} \int \frac{dx}{X}$$

$$116. \int \frac{x dx}{X^{n+1}} = -\frac{2a+bx}{nqX^n} - \frac{b(2n-1)}{nq} \int \frac{dx}{X^n}$$

$$117. \int \frac{x^2 dx}{X} = \frac{x}{c} - \frac{b}{2c^2} \log X + \frac{b^2-2ac}{2c^2} \int \frac{dx}{X}$$

$$118. \int \frac{x^2 dx}{X^2} = \frac{(b^2-2ac)x+ab}{cqX} + \frac{2a}{q} \int \frac{dx}{X}$$

$$119. \int \frac{x^m dx}{X^{n+1}} = -\frac{x^{m-1}}{(2n-m+1)cX^n} - \frac{n-m+1}{2n-m+1} \cdot \frac{b}{c} \int \frac{x^{m-1} dx}{X^{n+1}} + \frac{m-1}{2n-m+1} \cdot \frac{a}{c} \int \frac{x^{m-2} dx}{X^{n+1}}$$

$$120. \int \frac{dx}{xX} = \frac{1}{2a} \log \frac{x^2}{X} - \frac{b}{2a} \int \frac{dx}{X}$$

$$121. \int \frac{dx}{x^2 X} = \frac{b}{2a^2} \log \frac{X}{x^2} - \frac{1}{ax} + \left( \frac{b^2}{2a^2} - \frac{c}{a} \right) \int \frac{dx}{X}$$

$$122. \int \frac{dx}{xX^n} = \frac{1}{2a(n-1)X^{n-1}} - \frac{b}{2a} \int \frac{dx}{X^n} + \frac{1}{a} \int \frac{dx}{xX^{n-1}}$$

$$123. \int \frac{dx}{x^m X^{n+1}} = -\frac{1}{(m-1)ax^{m-1}X^n} - \frac{n+m-1}{m-1} \cdot \frac{b}{a} \int \frac{dx}{x^{m-1}X^{n+1}} - \frac{2n+m-1}{m-1} \cdot \frac{c}{a} \int \frac{dx}{x^{m-2}X^{n+1}}$$

FORMS CONTAINING  $\sqrt{a+bx}$ 

$$124. \int \sqrt{a+bx} dx = \frac{2}{3b} \sqrt{(a+bx)^3}$$

$$125. \int x\sqrt{a+bx} dx = -\frac{2(2a-3bx)\sqrt{(a+bx)^3}}{15b^2}$$

$$126. \int x^2\sqrt{a+bx} dx = \frac{2(8a^2-12abx+15b^2x^2)\sqrt{(a+bx)^3}}{105b^3}$$

$$127. \int x^m\sqrt{a+bx} dx = \begin{cases} \frac{2}{b(2m+3)} \left[ x^m\sqrt{(a+bx)^3} - ma \int x^{m-1}\sqrt{a+bx} dx \right] \\ \text{or} \\ \frac{2}{b^{m+1}} \sqrt{a+bx} \sum_{r=0}^m \frac{m!(-a)^{m-r}}{r!(m-r)!(2r+3)} (a+bx)^{r+1} \end{cases}$$

128.  $\int \frac{\sqrt{a+bx}}{x} dx = 2\sqrt{a+bx} + a \int \frac{dx}{x\sqrt{a+bx}}$
129.  $\int \frac{\sqrt{a+bx}}{x^2} dx = \frac{\sqrt{a+bx}}{x} + \frac{b}{2} \int \frac{dx}{x\sqrt{a+bx}}$
130.  $\int \frac{\sqrt{a+bx}}{x^m} dx = -\frac{1}{(m-1)a} \left[ \frac{\sqrt{(a+bx)^3}}{x^{m-1}} + \frac{(2m-5)b}{2} \int \frac{\sqrt{a+bx}}{x^{m-1}} dx \right]$
131.  $\int \frac{dx}{\sqrt{a+bx}} = \frac{2\sqrt{a+bx}}{b}$
132.  $\int \frac{x dx}{\sqrt{a+bx}} = -\frac{2(2a-bx)}{3b^2} \sqrt{a+bx}$
133.  $\int \frac{x^2 dx}{\sqrt{a+bx}} = \frac{2(8a^2 - 4abx - 3b^2x^2)}{15b^3} \sqrt{a+bx}$
134.  $\int \frac{x^m dx}{\sqrt{a+bx}} = \begin{cases} \frac{2}{(2m+1)b} \left[ x^m \sqrt{a+bx} - ma \int \frac{x^{m-1} dx}{\sqrt{a+bx}} \right] \\ \text{or} \\ \frac{2(-a)^m \sqrt{a+bx}}{b^{m+1}} \sum_{r=0}^m \frac{(-1)^r m!(a+bx)^r}{(2r+1)r!(m-r)!a^r} \end{cases}$
135.  $\int \frac{dx}{x\sqrt{a+bx}} = \frac{1}{\sqrt{a}} \log \left( \frac{\sqrt{a+bx} - \sqrt{a}}{\sqrt{a+bx} + \sqrt{a}} \right), \quad (a > 0)$
136.  $\int \frac{dx}{x\sqrt{a+bx}} = \frac{2}{\sqrt{-a}} \tan^{-1} \sqrt{\frac{a+bx}{-a}}, \quad (a < 0)$
137.  $\int \frac{dx}{x^2\sqrt{a+bx}} = -\frac{\sqrt{a+bx}}{ax} - \frac{b}{2a} \int \frac{dx}{x\sqrt{a+bx}}$
138.  $\int \frac{dx}{x^n\sqrt{a+bx}} = \begin{cases} -\frac{\sqrt{a+bx}}{(n-1)ax^{n-1}} - \frac{(2n-3)b}{(2n-2)a} \int \frac{dx}{x^{n-1}\sqrt{a+bx}} \\ \text{or} \\ \frac{(2n-2)!}{[(n-1)!]^2} \left[ -\frac{\sqrt{a+bx}}{a} \sum_{r=1}^{n-1} \frac{r!(r-1)!}{x^r 2(r)!} \left(-\frac{b}{4a}\right)^{n-r-1} + \left(-\frac{b}{4a}\right)^{n-1} \int \frac{dx}{x\sqrt{a+bx}} \right] \end{cases}$
139.  $\int (a+bx)^{\pm \frac{n}{2}} dx = \frac{2(a+bx)^{\frac{2\pm n}{2}}}{b(2\pm n)}$
140.  $\int x(a+bx)^{\pm \frac{n}{2}} dx = \frac{2}{b^2} \left[ \frac{(a+bx)^{\frac{4\pm n}{2}}}{4\pm n} - \frac{a(a+bx)^{\frac{2\pm n}{2}}}{2\pm n} \right]$
141.  $\int \frac{dx}{x(a+bx)^{\frac{m}{2}}} = \frac{1}{a} \int \frac{dx}{x(a+bx)^{\frac{m-2}{2}}} - \frac{b}{a} \int \frac{dx}{(a+bx)^{\frac{m}{2}}}$
142.  $\int \frac{(a+bx)^{n/2} dx}{x} = b \int (a+bx)^{(n-2)/2} dx + a \int \frac{(a+bx)^{(n-2)/2}}{x} dx$
143.  $\int f(x, \sqrt{a+bx}) dx = \frac{2}{b} \int f\left(\frac{z^2-a}{b}, z\right) z dz, \quad (z = \sqrt{a+bx})$

FORMS CONTAINING  $\sqrt{a+bx}$  and  $\sqrt{c+dx}$ 

Define  $u = a + bx$ ,  $v = c + dx$ , and  $k = ad - bc$ . If  $k = 0$ , then,  $v = \left(\frac{c}{a}\right)u$ , and formulas starting with 124 should be used in place of these.

144.  $\int \frac{dx}{\sqrt{uv}} = \begin{cases} \frac{2}{\sqrt{bd}} \tanh^{-1} \frac{\sqrt{bd}uv}{bv}, & bd > 0, \quad k < 0 \\ \text{or} \\ \frac{2}{\sqrt{bd}} \tanh^{-1} \frac{\sqrt{bd}uv}{du}, & bd > 0, \quad k > 0 \\ \text{or} \\ \frac{1}{\sqrt{bd}} \log \frac{(bv + \sqrt{bd}uv)^2}{v}, & (bd > 0) \end{cases}$
145.  $\int \frac{dx}{\sqrt{uv}} = \begin{cases} \frac{2}{\sqrt{-bd}} \tan^{-1} \frac{\sqrt{-bd}uv}{bv} \\ \text{or} \\ -\frac{1}{\sqrt{-bd}} \sin^{-1} \left( \frac{2bdx+ad+bc}{|k|} \right), & (bd < 0) \end{cases}$

146.  $\int \sqrt{uv} \, dx = \frac{k+2bv}{4bd} \sqrt{uv} - \frac{k^2}{8bd} \int \frac{dx}{\sqrt{uv}}$
147.  $\int \frac{dx}{v\sqrt{u}} = \begin{cases} \frac{1}{\sqrt{kd}} \log \frac{d\sqrt{u}-\sqrt{kd}}{d\sqrt{u}+\sqrt{kd}} \\ \text{or} \\ \frac{1}{\sqrt{kd}} \log \frac{(d\sqrt{u}-\sqrt{kd})^2}{v} \end{cases}, \quad (kd > 0)$
148.  $\int \frac{dx}{v\sqrt{u}} = \frac{2}{\sqrt{-kd}} \tan^{-1} \frac{d\sqrt{u}}{\sqrt{-kd}}, \quad (kd < 0)$
149.  $\int \frac{x \, dx}{\sqrt{uv}} = \frac{\sqrt{uv}}{bd} - \frac{ad+bc}{2bd} \int \frac{dx}{\sqrt{uv}}$
150.  $\int \frac{dx}{v\sqrt{uv}} = \frac{-2\sqrt{uv}}{kv}$
151.  $\int \frac{v \, dx}{\sqrt{uv}} = \frac{\sqrt{uv}}{b} - \frac{k}{2b} \int \frac{dx}{\sqrt{uv}}$
152.  $\int \sqrt{\frac{v}{u}} \, dx = \frac{v}{|v|} \int \frac{v \, dx}{\sqrt{uv}}$
153.  $\int v^m \sqrt{u} \, dx = \frac{1}{(2m+3)d} \left( 2v^{m+1} \sqrt{u} + k \int \frac{v^m \, dx}{\sqrt{u}} \right)$
154.  $\int \frac{dx}{v^m \sqrt{u}} = -\frac{1}{(m-1)k} \left( \frac{\sqrt{u}}{v^{m-1}} + \left( m - \frac{3}{2} \right) b \int \frac{dx}{v^{m-1} \sqrt{u}} \right)$
155.  $\int \frac{v^m \, dx}{\sqrt{u}} = \begin{cases} \frac{2}{b(2m+1)} \left[ v^m \sqrt{u} - mk \int \frac{v^{m-1}}{\sqrt{u}} \, dx \right] \\ \text{or} \\ \frac{2(m!)^2 \sqrt{u}}{b(2m+1)!} \sum_{r=0}^m \left( -\frac{4k}{b} \right)^{m-r} \frac{(2r)!}{(r!)^2} v^r \end{cases}$

FORMS CONTAINING  $\sqrt{x^2 \pm a^2}$ 

156.  $\int \sqrt{x^2 \pm a^2} \, dx = \frac{1}{2} \left[ x\sqrt{x^2 \pm a^2} \pm a^2 \log(x + \sqrt{x^2 \pm a^2}) \right]$
157.  $\int \frac{dx}{\sqrt{x^2 \pm a^2}} = \log(x + \sqrt{x^2 \pm a^2})$
158.  $\int \frac{dx}{x\sqrt{x^2 - a^2}} = \frac{1}{|a|} \sec^{-1} \frac{x}{a}$
159.  $\int \frac{dx}{x\sqrt{x^2 + a^2}} = -\frac{1}{a} \log \left( \frac{a + \sqrt{x^2 + a^2}}{x} \right)$
160.  $\int \frac{\sqrt{x^2 + a^2}}{x} \, dx = \sqrt{x^2 + a^2} - a \log \left( \frac{a + \sqrt{x^2 + a^2}}{x} \right)$
161.  $\int \frac{\sqrt{x^2 - a^2}}{x} \, dx = \sqrt{x^2 - a^2} - |a| \sec^{-1} \frac{x}{a}$
162.  $\int \frac{x \, dx}{\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2}$
163.  $\int x\sqrt{x^2 \pm a^2} \, dx = \frac{1}{3} \sqrt{(x^2 \pm a^2)^3}$
164.  $\int \sqrt{(x^2 \pm a^2)^3} \, dx = \frac{1}{4} \left[ x\sqrt{(x^2 \pm a^2)^3} \pm \frac{3a^2 x}{2} \sqrt{x^2 \pm a^2} + \frac{3a^4}{2} \log(x + \sqrt{x^2 \pm a^2}) \right]$
165.  $\int \frac{dx}{\sqrt{(x^2 \pm a^2)^3}} = \frac{\pm x}{a^2 \sqrt{x^2 \pm a^2}}$
166.  $\int \frac{x \, dx}{\sqrt{(x^2 \pm a^2)^3}} = \frac{-1}{\sqrt{x^2 \pm a^2}}$
167.  $\int x\sqrt{(x^2 \pm a^2)^3} \, dx = \frac{1}{5} \sqrt{(x^2 \pm a^2)^5}$
168.  $\int x^2 \sqrt{x^2 \pm a^2} \, dx = \frac{x}{4} \sqrt{(x^2 \pm a^2)^3} \mp \frac{a^2}{8} x \sqrt{x^2 \pm a^2} - \frac{a^4}{8} \log(x + \sqrt{x^2 \pm a^2})$

169.  $\int x^3 \sqrt{x^2 + a^2} dx = \left(\frac{1}{5}x^2 - \frac{2}{15}a^2\right)\sqrt{(x^2 + a^2)^3}$
170.  $\int x^3 \sqrt{x^2 - a^2} dx = \frac{1}{5}\sqrt{(x^2 - a^2)^5} + \frac{a^2}{3}\sqrt{(x^2 - a^2)^3}$
171.  $\int \frac{x^2 dx}{\sqrt{x^2 \pm a^2}} = \frac{x}{2}\sqrt{x^2 \pm a^2} \mp \frac{a^2}{2} \log(x + \sqrt{x^2 \pm a^2})$
172.  $\int \frac{x^3 dx}{\sqrt{x^2 \pm a^2}} = \frac{1}{3}\sqrt{(x^2 \pm a^2)^3} \mp a^2 \sqrt{x^2 \pm a^2}$
173.  $\int \frac{dx}{x^2 \sqrt{x^2 \pm a^2}} = \mp \frac{\sqrt{x^2 \pm a^2}}{a^2 x}$
174.  $\int \frac{dx}{x^3 \sqrt{x^2 + a^2}} = \frac{\sqrt{x^2 + a^2}}{2a^2 x^2} + \frac{1}{2a^3} \log \frac{a + \sqrt{x^2 + a^2}}{x}$
175.  $\int \frac{dx}{x^3 \sqrt{x^2 - a^2}} = \frac{\sqrt{x^2 - a^2}}{2a^2 x^2} + \frac{1}{2|a^3|} \sec^{-1} \frac{x}{a}$
176.  $\int x^2 \sqrt{(x^2 \pm a^2)^3} dx = \frac{x}{6}\sqrt{(x^2 \pm a^2)^5} \mp \frac{a^2 x}{24}\sqrt{(x^2 \pm a^2)^3} - \frac{a^4 x}{16}\sqrt{x^2 \pm a^2} \mp \frac{a^6}{16} \log(x + \sqrt{x^2 \pm a^2})$
177.  $\int x^3 \sqrt{(x^2 \pm a^2)^3} dx = \frac{1}{7}\sqrt{(x^2 \pm a^2)^7} \mp \frac{a^2}{5}\sqrt{(x^2 \pm a^2)^5}$
178.  $\int \frac{\sqrt{x^2 \pm a^2} dx}{x^2} = -\frac{\sqrt{x^2 \pm a^2}}{x} + \log(x + \sqrt{x^2 \pm a^2})$
179.  $\int \frac{\sqrt{x^2 + a^2}}{x^3} dx = -\frac{\sqrt{x^2 + a^2}}{2x^2} - \frac{1}{2a} \log \frac{a + \sqrt{x^2 + a^2}}{x}$
180.  $\int \frac{\sqrt{x^2 - a^2}}{x^3} dx = -\frac{\sqrt{x^2 - a^2}}{2x^2} + \frac{1}{2|a|} \sec^{-1} \frac{x}{a}$
181.  $\int \frac{\sqrt{x^2 \pm a^2}}{x^4} dx = \mp \frac{\sqrt{(x^2 \pm a^2)^3}}{3a^2 x^3}$
182.  $\int \frac{x^2 dx}{\sqrt{(x^2 \pm a^2)^3}} = \frac{-x}{\sqrt{x^2 \pm a^2}} + \log(x + \sqrt{x^2 \pm a^2})$
183.  $\int \frac{x^3 dx}{\sqrt{(x^2 \pm a^2)^3}} = \sqrt{x^2 \pm a^2} \pm \frac{a^2}{\sqrt{x^2 \pm a^2}}$
184.  $\int \frac{dx}{x\sqrt{(x^2 + a^2)^3}} = \frac{1}{a^2 \sqrt{x^2 + a^2}} - \frac{1}{a^3} \log \frac{a + \sqrt{x^2 + a^2}}{x}$
185.  $\int \frac{dx}{x\sqrt{(x^2 - a^2)^3}} = -\frac{1}{a^2 \sqrt{x^2 - a^2}} - \frac{1}{|a^3|} \sec^{-1} \frac{x}{a}$
186.  $\int \frac{dx}{x^2 \sqrt{(x^2 \pm a^2)^3}} = -\frac{1}{a^4} \left[ \frac{\sqrt{x^2 \pm a^2}}{x} + \frac{x}{\sqrt{x^2 \pm a^2}} \right]$
187.  $\int \frac{dx}{x^3 \sqrt{(x^2 + a^2)^3}} = -\frac{1}{2a^2 x^2 \sqrt{x^2 + a^2}} - \frac{3}{2a^4 \sqrt{x^2 + a^2}} + \frac{3}{2a^5} \log \frac{a + \sqrt{x^2 + a^2}}{x}$
188.  $\int \frac{dx}{x^3 \sqrt{(x^2 - a^2)^3}} = \frac{1}{2a^2 x^2 \sqrt{x^2 - a^2}} - \frac{3}{2a^4 \sqrt{x^2 - a^2}} - \frac{3}{2|a^5|} \sec^{-1} \frac{x}{a}$
189.  $\int \frac{x^m}{\sqrt{x^2 \pm a^2}} dx = \frac{1}{m} x^{m-1} \sqrt{x^2 \pm a^2} \mp \frac{m-1}{m} a^2 \int \frac{x^{m-2}}{\sqrt{x^2 \pm a^2}} dx$
190.  $\int \frac{x^{2m}}{\sqrt{x^2 \pm a^2}} dx = \frac{(2m)!}{2^{2m}(m!)^2} \left[ \sqrt{x^2 \pm a^2} \sum_{r=1}^m \frac{r!(r-1)!}{(2r)!} (\mp a^2)^{m-r} (2x)^{2r-1} + (\mp a^2)^m \log(x + \sqrt{x^2 \pm a^2}) \right]$
191.  $\int \frac{x^{2m+1}}{\sqrt{x^2 \pm a^2}} dx = \sqrt{x^2 \pm a^2} \sum_{r=0}^m \frac{(2r)!(m!)^2}{(2m+1)!(r!)^2} (\mp 4a^2)^{m-r} x^{2r}$
192.  $\int \frac{dx}{x^m \sqrt{x^2 \pm a^2}} = \mp \frac{\sqrt{x^2 \pm a^2}}{(m-1)a^2 x^{m-1}} \mp \frac{(m-2)}{(m-1)a^2} \int \frac{dx}{x^{m-2} \sqrt{x^2 \pm a^2}}$

193. 
$$\int \frac{dx}{x^{2m}\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2} \sum_{r=0}^{m-1} \frac{(m-1)!m!(2r)!2^{2m-2r-1}}{(r!)^2(2m)!(\mp a^2)^{m-r}x^{2r+1}}$$
194. 
$$\int \frac{dx}{x^{2m+1}\sqrt{x^2+a^2}} = \frac{(2m)!}{(m!)^2} \left[ \frac{\sqrt{x^2+a^2}}{a^2} \sum_{r=1}^m (-1)^{m-r+1} \frac{r!(r-1)!}{2(2r)!(4a^2)^{m-r}x^{2r}} + \frac{(-1)^{m+1}}{2^{2m}a^{2m+1}} \log \frac{\sqrt{x^2+a^2}+a}{x} \right]$$
195. 
$$\int \frac{dx}{x^{2m+1}\sqrt{x^2-a^2}} = \frac{(2m)!}{(m!)^2} \left[ \frac{\sqrt{x^2-a^2}}{a^2} \sum_{r=1}^m \frac{r!(r-1)!}{2(2r)!(4a^2)^{m-r}x^{2r}} + \frac{1}{2^{2m}|a|^{2m+1}} \sec^{-1} \frac{x}{a} \right]$$
196. 
$$\int \frac{dx}{(x-a)\sqrt{x^2-a^2}} = -\frac{\sqrt{x^2-a^2}}{a(x-a)}$$
197. 
$$\int \frac{dx}{(x+a)\sqrt{x^2-a^2}} = \frac{\sqrt{x^2-a^2}}{a(x+a)}$$
198. 
$$\int f(x, \sqrt{x^2+a^2}) dx = a \int f(a \tan u, a \sec u) \sec^2 u du, \quad \left(u = \tan^{-1} \frac{x}{a}, a > 0\right)$$
199. 
$$\int f(x, \sqrt{x^2-a^2}) dx = a \int f(a \sec u, a \tan u) \sec u \tan u du, \quad \left(u = \sec^{-1} \frac{x}{a}, a > 0\right)$$

FORMS CONTAINING  $\sqrt{a^2-x^2}$ 

200. 
$$\int \sqrt{a^2-x^2} dx = \frac{1}{2} \left[ x\sqrt{a^2-x^2} + a^2 \sin^{-1} \frac{x}{|a|} \right]$$
201. 
$$\int \frac{dx}{\sqrt{a^2-x^2}} = \begin{cases} \sin^{-1} \frac{x}{|a|} \\ \text{or} \\ -\cos^{-1} \frac{x}{|a|} \end{cases}$$
202. 
$$\int \frac{dx}{x\sqrt{a^2-x^2}} = -\frac{1}{a} \log \left( \frac{a + \sqrt{a^2-x^2}}{x} \right)$$
203. 
$$\int \frac{\sqrt{a^2-x^2}}{x} dx = \sqrt{a^2-x^2} - a \log \left( \frac{a + \sqrt{a^2-x^2}}{x} \right)$$
204. 
$$\int \frac{x dx}{\sqrt{a^2-x^2}} = -\sqrt{a^2-x^2}$$
205. 
$$\int x\sqrt{a^2-x^2} dx = -\frac{1}{3} \sqrt{(a^2-x^2)^3}$$
206. 
$$\int \sqrt{(a^2-x^2)^3} dx = \frac{1}{4} \left[ x\sqrt{(a^2-x^2)^3} + \frac{3a^2x}{2} \sqrt{a^2-x^2} + \frac{3a^4}{2} \sin^{-1} \frac{x}{|a|} \right]$$
207. 
$$\int \frac{dx}{\sqrt{(a^2-x^2)^3}} = \frac{x}{a^2\sqrt{a^2-x^2}}$$
208. 
$$\int \frac{x dx}{\sqrt{(a^2-x^2)^3}} = \frac{1}{\sqrt{a^2-x^2}}$$
209. 
$$\int x\sqrt{(a^2-x^2)^3} dx = -\frac{1}{5} \sqrt{(a^2-x^2)^5}$$
210. 
$$\int x^2\sqrt{a^2-x^2} dx = -\frac{x}{4} \sqrt{(a^2-x^2)^3} + \frac{a^2}{8} \left( x\sqrt{a^2-x^2} + a^2 \sin^{-1} \frac{x}{|a|} \right)$$
211. 
$$\int x^3\sqrt{a^2-x^2} dx = \left(-\frac{1}{5}x^2 - \frac{2}{15}a^2\right) \sqrt{(a^2-x^2)^3}$$
212. 
$$\int x^2\sqrt{(a^2-x^2)^3} dx = -\frac{1}{6}x\sqrt{(a^2-x^2)^5} + \frac{a^2x}{24} \sqrt{(a^2-x^2)^3} + \frac{a^4x}{16} \sqrt{a^2-x^2} + \frac{a^6}{16} \sin^{-1} \frac{x}{|a|}$$
213. 
$$\int x^3\sqrt{(a^2-x^2)^3} dx = \frac{1}{7} \sqrt{(a^2-x^2)^7} - \frac{a^2}{5} \sqrt{(a^2-x^2)^5}$$
214. 
$$\int \frac{x^2 dx}{\sqrt{a^2-x^2}} = -\frac{x}{2} \sqrt{a^2-x^2} + \frac{a^2}{2} \sin^{-1} \frac{x}{|a|}$$
215. 
$$\int \frac{dx}{x^2\sqrt{a^2-x^2}} = -\frac{\sqrt{a^2-x^2}}{a^2x}$$
216. 
$$\int \frac{\sqrt{a^2-x^2}}{x^2} dx = -\frac{\sqrt{a^2-x^2}}{x} - \sin^{-1} \frac{x}{|a|}$$



217.  $\int \frac{\sqrt{a^2 - x^2}}{x^3} dx = -\frac{\sqrt{a^2 - x^2}}{2x^2} + \frac{1}{2a} \log \frac{a + \sqrt{a^2 - x^2}}{x}$
218.  $\int \frac{\sqrt{a^2 - x^2}}{x^4} dx = -\frac{\sqrt{a^2 - x^2}}{3a^2 x^3}$
219.  $\int \frac{x^2 dx}{\sqrt{(a^2 - x^2)^3}} = \frac{x}{\sqrt{a^2 - x^2}} - \sin^{-1} \frac{x}{|a|}$
220.  $\int \frac{x^3 dx}{\sqrt{a^2 - x^2}} = -\frac{2}{3}(a^2 - x^2)^{3/2} - x^2(a^2 - x^2)^{1/2} = -\frac{1}{3}\sqrt{a^2 - x^2}(x^2 + 2a^2)$
221.  $\int \frac{x^3 dx}{\sqrt{(a^2 - x^2)^3}} = 2(a^2 - x^2)^{1/2} + \frac{x^2}{(a^2 - x^2)^{1/2}} = -\frac{a^2}{\sqrt{a^2 - x^2}} + \sqrt{a^2 - x^2}$
222.  $\int \frac{dx}{x^3 \sqrt{a^2 - x^2}} = -\frac{\sqrt{a^2 - x^2}}{2a^2 x^2} - \frac{1}{2a^3} \log \frac{a + \sqrt{a^2 - x^2}}{x}$
223.  $\int \frac{dx}{x \sqrt{(a^2 - x^2)^3}} = \frac{1}{a^2 \sqrt{a^2 - x^2}} - \frac{1}{a^3} \log \frac{a + \sqrt{a^2 - x^2}}{x}$
224.  $\int \frac{dx}{x^2 \sqrt{(a^2 - x^2)^3}} = \frac{1}{a^4} \left[ -\frac{\sqrt{a^2 - x^2}}{x} + \frac{x}{\sqrt{a^2 - x^2}} \right]$
225.  $\int \frac{dx}{x^3 \sqrt{(a^2 - x^2)^3}} = -\frac{1}{2a^2 x^2 \sqrt{a^2 - x^2}} + \frac{3}{2a^4 \sqrt{a^2 - x^2}} - \frac{3}{2a^5} \log \frac{a + \sqrt{a^2 - x^2}}{x}$
226.  $\int \frac{x^m}{\sqrt{a^2 - x^2}} dx = -\frac{x^{m-1} \sqrt{a^2 - x^2}}{m} + \frac{(m-1)a^2}{m} \int \frac{x^{m-2}}{\sqrt{a^2 - x^2}} dx$
227.  $\int \frac{x^{2m}}{\sqrt{a^2 - x^2}} dx = \frac{(2m)!}{(m!)^2} \left[ -\sqrt{a^2 - x^2} \sum_{r=1}^m \frac{r!(r-1)!}{2^{2m-2r+1}(2r)!} a^{2m-2r} x^{2r-1} + \frac{a^{2m}}{2^{2m}} \sin^{-1} \frac{x}{|a|} \right]$
228.  $\int \frac{x^{2m+1}}{\sqrt{a^2 - x^2}} dx = -\sqrt{a^2 - x^2} \sum_{r=0}^m \frac{(2r)!(m!)^2}{(2m+1)!(r!)^2} (4a^2)^{m-r} x^{2r}$
229.  $\int \frac{dx}{x^m \sqrt{a^2 - x^2}} = -\frac{\sqrt{a^2 - x^2}}{(m-1)a^2 x^{m-1}} + \frac{m-2}{(m-1)a^2} \int \frac{dx}{x^{m-2} \sqrt{a^2 - x^2}}$
230.  $\int \frac{ax}{x^{2m} \sqrt{a^2 - x^2}} = -\sqrt{a^2 - x^2} \sum_{r=0}^{m-1} \frac{(m-1)!m!(2r)!2^{2m-2r-1}}{(r!)^2(2m)!a^{2m-2r} x^{2r+1}}$
231.  $\int \frac{dx}{x^{2m+1} \sqrt{a^2 - x^2}} = \frac{(2m)!}{(m!)^2} \left[ -\frac{\sqrt{a^2 - x^2}}{a^2} \sum_{r=1}^m \frac{r!(r-1)!}{2(2r)!(4a^2)^{m-r} x^{2r}} + \frac{1}{2^{2m} a^{2m+1}} \log \frac{a - \sqrt{a^2 - x^2}}{x} \right]$
232.  $\int \frac{dx}{(b^2 - x^2)\sqrt{a^2 - x^2}} = \frac{1}{2b\sqrt{a^2 - b^2}} \log \frac{(b\sqrt{a^2 - x^2} + x\sqrt{a^2 - b^2})^2}{b^2 - x^2}, \quad (a^2 > b^2)$
233.  $\int \frac{dx}{(b^2 - x^2)\sqrt{a^2 - x^2}} = \frac{1}{b\sqrt{b^2 - a^2}} \tan^{-1} \frac{x\sqrt{b^2 - a^2}}{b\sqrt{a^2 - x^2}}, \quad (b^2 > a^2)$
234.  $\int \frac{dx}{(b^2 + x^2)\sqrt{a^2 - x^2}} = \frac{1}{b\sqrt{a^2 + b^2}} \tan^{-1} \frac{x\sqrt{a^2 + b^2}}{b\sqrt{a^2 - x^2}}$
235.  $\int \frac{\sqrt{a^2 - x^2}}{b^2 + x^2} dx = \frac{\sqrt{a^2 + b^2}}{|b|} \sin^{-1} \frac{x\sqrt{a^2 + b^2}}{|a|\sqrt{x^2 + b^2}} - \sin^{-1} \frac{x}{|a|}$
236.  $\int f(x, \sqrt{a^2 - x^2}) dx = a \int f(a \sin u, a \cos u) \cos u du, \quad \left( u = \sin^{-1} \frac{x}{a}, a > 0 \right)$

FORMS CONTAINING  $\sqrt{a + bx + cx^2}$ 

Define  $X = a + bx + cx^2$ ,  $q = 4ac - b^2$ , and  $k = \frac{4c}{q}$ . If  $q = 0$ , then  $\sqrt{X} = \sqrt{c} \left| x + \frac{b}{2c} \right|$ .

237.  $\int \frac{dx}{\sqrt{x}} = \begin{cases} \frac{1}{\sqrt{c}} \log(2\sqrt{cX} + 2cx + b) \\ \text{or} \\ \frac{1}{\sqrt{c}} \sinh^{-1} \frac{2cx+b}{\sqrt{q}}, \quad (c > 0) \end{cases}$
238.  $\int \frac{dx}{\sqrt{x}} = -\frac{1}{\sqrt{-c}} \sin^{-1} \frac{2cx+b}{\sqrt{-q}}, \quad (c < 0)$

239.  $\int \frac{dx}{X\sqrt{x}} = \frac{2(2cx+b)}{q\sqrt{x}}$
240.  $\int \frac{dx}{X^2\sqrt{x}} = \frac{2(2cx+b)}{3q\sqrt{x}} \left( \frac{1}{X} + 2k \right)$
241.  $\int \frac{dx}{X^n\sqrt{x}} = \begin{cases} \frac{2(2cx+b)\sqrt{x}}{(2n-1)qX^n} + \frac{2k(n-1)}{2n-1} \int \frac{dx}{X^{n-1}\sqrt{x}} \\ \text{or} \\ \frac{(2cx+b)(n!(n-1)!4^n k^{n-1})}{q!(2n)! \sqrt{x}} \sum_{r=0}^{n-1} \frac{(2r)!}{(4kX)^r (r!)^2} \end{cases}$
242.  $\int \sqrt{x} dx = \frac{(2cx+b)\sqrt{x}}{4c} + \frac{1}{2k} \int \frac{dx}{\sqrt{x}}$
243.  $\int X\sqrt{x} dx = \frac{(2cx+b)\sqrt{x}}{8c} \left( X + \frac{3}{2k} \right) + \frac{3}{8k^2} \int \frac{dx}{\sqrt{x}}$
244.  $\int X^2\sqrt{x} dx = \frac{(2cx+b)\sqrt{x}}{12c} \left( X^2 + \frac{5X}{4k} + \frac{15}{8k^2} \right) + \frac{5}{16k^3} \int \frac{dx}{\sqrt{x}}$
245.  $\int X^n\sqrt{x} dx = \begin{cases} \frac{(2cx+b)X^n\sqrt{x}}{4(n+1)c} + \frac{2n+1}{2(n+1)k} \int X^{n-1}\sqrt{x} dx \\ \text{or} \\ \frac{(2n+2)!}{[(n+1)!]^2(4k)^{n+1}} \left[ \frac{k(2cx+b)\sqrt{x}}{c} \sum_{r=0}^n \frac{r!(r+1)!(4kX)^r}{(2r+2)!} + \int \frac{dx}{\sqrt{x}} \right] \end{cases}$
246.  $\int \frac{x dx}{\sqrt{x}} = \frac{\sqrt{x}}{c} - \frac{b}{2c} \int \frac{dx}{\sqrt{x}}$
247.  $\int \frac{x dx}{X\sqrt{x}} = -\frac{2(bx+2a)}{q\sqrt{x}}$
248.  $\int \frac{x dx}{X^n\sqrt{x}} = -\frac{\sqrt{x}}{(2n-1)cX^n} - \frac{b}{2c} \int \frac{dx}{X^n\sqrt{x}}$
249.  $\int \frac{x^2 dx}{\sqrt{x}} = \left( \frac{x}{2c} - \frac{3b}{4c^2} \right) \sqrt{x} + \frac{3b^2-4ac}{8c^2} \int \frac{dx}{\sqrt{x}}$
250.  $\int \frac{x^2 dx}{X\sqrt{x}} = \frac{(2b^2-4ac)x+2ab}{cq\sqrt{x}} + \frac{1}{c} \int \frac{dx}{\sqrt{x}}$
251.  $\int \frac{x^2 dx}{X^n\sqrt{x}} = \frac{(2b^2-4ac)x+2ab}{(2n-1)cqX^{n-1}\sqrt{x}} + \frac{4ac+(2n-3)b^2}{(2n-1)cq} \int \frac{dx}{X^{n-1}\sqrt{x}}$
252.  $\int \frac{x^3 dx}{\sqrt{x}} = \left( \frac{x^2}{3c} - \frac{5bx}{12c^2} + \frac{5b^2}{8c^3} - \frac{2a}{3c^2} \right) \sqrt{x} + \left( \frac{3ab}{4c^2} - \frac{5b^3}{16c^3} \right) \int \frac{dx}{\sqrt{x}}$
253.  $\int \frac{x^n dx}{\sqrt{x}} = \frac{1}{nc} x^{n-1} \sqrt{x} - \frac{(2n-1)b}{2nc} \int \frac{x^{n-1} dx}{\sqrt{x}} - \frac{(n-1)a}{nc} \int \frac{x^{n-2} dx}{\sqrt{x}}$
254.  $\int x\sqrt{x} dx = \frac{X\sqrt{x}}{3c} - \frac{b(2cx+b)}{8c^2} \sqrt{x} - \frac{b}{4ck} \int \frac{dx}{\sqrt{x}}$
255.  $\int xX\sqrt{x} dx = \frac{X^2\sqrt{x}}{5c} - \frac{b}{2c} \int X\sqrt{x} dx$
256.  $\int xX^n\sqrt{x} dx = \frac{X^{n+1}\sqrt{x}}{(2n+3)c} - \frac{b}{2c} \int X^n\sqrt{x} dx$
257.  $\int x^2\sqrt{x} dx = \left( x - \frac{5b}{6c} \right) \frac{X\sqrt{x}}{4c} + \frac{5b^2-4ac}{16c^2} \int \sqrt{x} dx$
258.  $\int \frac{dx}{x\sqrt{x}} = -\frac{1}{\sqrt{a}} \log \frac{2\sqrt{a}X+bx+2a}{x}, \quad (a > 0)$
259.  $\int \frac{dx}{x\sqrt{x}} = \frac{1}{\sqrt{-a}} \sin^{-1} \left( \frac{bx+2a}{|x|\sqrt{-q}} \right), \quad (a < 0)$
260.  $\int \frac{dx}{x\sqrt{x}} = -\frac{2\sqrt{x}}{bx}, \quad (a = 0)$
261.  $\int \frac{dx}{x^2\sqrt{x}} = -\frac{\sqrt{x}}{ax} - \frac{b}{2a} \int \frac{dx}{x\sqrt{x}}$
262.  $\int \frac{\sqrt{x} dx}{x} = \sqrt{x} + \frac{b}{2} \int \frac{dx}{\sqrt{x}} + a \int \frac{dx}{x\sqrt{x}}$
263.  $\int \frac{\sqrt{x} dx}{x^2} = -\frac{\sqrt{x}}{x} + \frac{b}{2} \int \frac{dx}{x\sqrt{x}} + c \int \frac{dx}{\sqrt{x}}$

FORMS INVOLVING  $\sqrt{2ax - x^2}$ 

264.  $\int \sqrt{2ax - x^2} dx = \frac{1}{2} \left[ (x - a) \sqrt{2ax - x^2} + a^2 \sin^{-1} \frac{x - a}{|a|} \right]$
265.  $\int \frac{dx}{\sqrt{2ax - x^2}} = \begin{cases} \cos^{-1} \frac{a-x}{|a|} \\ \text{or} \\ \sin^{-1} \frac{x-a}{|a|} \end{cases}$
266.  $\int x^n \sqrt{2ax - x^2} dx = \begin{cases} -\frac{x^{n-1}(2ax-x^2)^{3/2}}{n+2} + \frac{(2n+1)a}{n+2} \int x^{n-1} \sqrt{2ax - x^2} dx \\ \text{or} \\ \sqrt{2ax - x^2} \left[ \frac{x^{n+1}}{n+2} - \sum_{r=0}^n \frac{(2n+1)!(r!)^2 a^{n-r+1}}{2^{n-r}(2r+1)!(n+2)!n!} x^r \right] \\ + \frac{(2n+1)!a^{n+2}}{2^n n!(n+2)!} \sin^{-1} \frac{x-a}{|a|} \end{cases}$
267.  $\int \frac{\sqrt{2ax - x^2}}{x^n} dx = \frac{(2ax - x^2)^{1/2}}{(3 - 2n)ax^n} + \frac{n - 3}{(2n - 3)a} \int \frac{\sqrt{2ax - x^2}}{x^{n-1}} dx$
268.  $\int \frac{x^n dx}{\sqrt{2ax - x^2}} = \begin{cases} -\frac{x^{n-1} \sqrt{2ax - x^2}}{n} + \frac{a(2n-1)}{n} \int \frac{x^{n-1}}{\sqrt{2ax - x^2}} dx \\ \text{or} \\ -\sqrt{2ax - x^2} \sum_{r=1}^n \frac{(2n)!r!(r-1)!a^{n-r}}{2^{n-r}(2r)!(n!)^2} x^{r-1} + \frac{(2n)!a^n}{2^n (n!)^2} \sin^{-1} \frac{x-a}{|a|} \end{cases}$
269.  $\int \frac{dx}{x^n \sqrt{2ax - x^2}} = \begin{cases} \frac{\sqrt{2ax - x^2}}{a(1-2n)x^n} + \frac{n-1}{(2n-1)a} \int \frac{dx}{x^{n-1} \sqrt{2ax - x^2}} \\ \text{or} \\ -\sqrt{2ax - x^2} \sum_{r=0}^{n-1} \frac{2^{n-r}(n-1)!m!(2r)!}{(2n)!(r!)^2 a^{n-r} x^{r+1}} \end{cases}$
270.  $\int \frac{dx}{(2ax - x^2)^{3/2}} = \frac{x - a}{a^2 \sqrt{2ax - x^2}}$
271.  $\int \frac{x dx}{(2ax - x^2)^{3/2}} = \frac{x}{a \sqrt{2ax - x^2}}$

## MISCELLANEOUS ALGEBRAIC FORMS

272.  $\int \frac{dx}{\sqrt{2ax + x^2}} = \log(x + a + \sqrt{2ax + x^2})$
273.  $\int \sqrt{ax^2 + c} dx = \frac{x}{2} \sqrt{ax^2 + c} + \frac{c}{2\sqrt{a}} \log(x\sqrt{a} + \sqrt{ax^2 + c}), \quad (a > 0)$
274.  $\int \sqrt{ax^2 + c} dx = \frac{x}{2} \sqrt{ax^2 + c} + \frac{c}{2\sqrt{-a}} \sin^{-1} \left( x \sqrt{-\frac{a}{c}} \right), \quad (a < 0)$
275.  $\int \sqrt{\frac{1+x}{1-x}} dx = \sin^{-1} x - \sqrt{1-x^2}$
276.  $\int \frac{dx}{x\sqrt{ax^n + c}} = \begin{cases} \frac{1}{n\sqrt{c}} \log \frac{\sqrt{ax^n + c} - \sqrt{c}}{\sqrt{ax^n + c} + \sqrt{c}} \\ \text{or} \\ \frac{2}{n\sqrt{c}} \log \frac{\sqrt{ax^n + c} - \sqrt{c}}{\sqrt{x^n}}, \quad (c > 0) \end{cases}$
277.  $\int \frac{dx}{x\sqrt{ax^n + c}} = \frac{2}{n\sqrt{-c}} \sec^{-1} \sqrt{-\frac{ax^n}{c}}, \quad (c < 0)$
278.  $\int \frac{dx}{\sqrt{ax^2 + c}} = \frac{1}{\sqrt{a}} \log(x\sqrt{a} + \sqrt{ax^2 + c}), \quad (a > 0)$
279.  $\int \frac{dx}{\sqrt{ax^2 + c}} = \frac{1}{\sqrt{-a}} \sin^{-1} \left( x \sqrt{-\frac{a}{c}} \right), \quad (a < 0)$
280.  $\int (ax^2 + c)^{m+1/2} dx = \begin{cases} \frac{x(ax^2+c)^{m+1/2}}{2(m+1)} + \frac{(2m+1)c}{2(m+1)} \int (ax^2 + c)^{m-1/2} dx \\ \text{or} \\ x\sqrt{ax^2 + c} \sum_{r=0}^m \frac{(2m+1)!(r!)^2 c^{m-r}}{2^{2m-2r+1} m!(m+1)!(2r+1)!} (ax^2 + c)^r \\ + \frac{(2m+1)!c^{m+1}}{2^{2m+1} m!(m+1)!} \int \frac{dx}{\sqrt{ax^2 + c}} \end{cases}$
281.  $\int x(ax^2 + c)^{m+\frac{1}{2}} dx = \frac{(ax^2 + c)^{m+\frac{3}{2}}}{(2m+3)a}$

$$282. \int \frac{(ax^2 + c)^{m+1/2}}{x} dx = \begin{cases} \frac{(ax^2+c)^{m+1/2}}{2m+1} + c \int \frac{(ax^2+c)^{m-1/2}}{x} dx \\ \text{or} \\ \sqrt{ax^2+c} \sum_{r=0}^m \frac{c^{m-r}(ax^2+c)^r}{2r+1} + c^{m+1} \int \frac{dx}{x\sqrt{ax^2+c}} \end{cases}$$

$$283. \int \frac{dx}{(ax^2+c)^{m+1/2}} = \begin{cases} \frac{x}{(2m-1)c(ax^2+c)^{m-1/2}} + \frac{2m-2}{(2m-1)c} \int \frac{dx}{(ax^2+c)^{m-1/2}} \\ \text{or} \\ \frac{x}{\sqrt{ax^2+c}} \sum_{r=0}^{m-1} \frac{2^{2m-2r-1}(m-1)!m!(2r)!}{(2m)!(r!)^2 c^{m-r}(ax^2+c)^r} \end{cases}$$

$$284. \int \frac{dx}{x^m \sqrt{ax^2+c}} = -\frac{\sqrt{ax^2+c}}{(m-1)cx^{m-1}} - \frac{(m-2)a}{(m-1)c} \int \frac{dx}{x^{m-2} \sqrt{ax^2+c}}$$

$$285. \int \frac{1+x^2}{(1-x^2)\sqrt{1+x^4}} dx = \frac{1}{\sqrt{2}} \log \frac{x\sqrt{2} + \sqrt{1+x^4}}{1-x^2}$$

$$286. \int \frac{1-x^2}{(1+x^2)\sqrt{1+x^4}} dx = \frac{1}{\sqrt{2}} \tan^{-1} \frac{x\sqrt{2}}{\sqrt{1+x^4}}$$

$$287. \int \frac{dx}{x\sqrt{x^n+a^2}} = -\frac{2}{na} \log \frac{a + \sqrt{x^n+a^2}}{\sqrt{x^n}}$$

$$288. \int \frac{dx}{x\sqrt{x^n-a^2}} = -\frac{2}{na} \sin^{-1} \frac{a}{\sqrt{x^n}}$$

$$289. \int \sqrt{\frac{x}{a^3-x^3}} dx = \frac{2}{3} \sin^{-1} \left( \frac{x}{a} \right)^{3/2}$$

## FORMS INVOLVING TRIGONOMETRIC FUNCTIONS

$$290. \int (\sin ax) dx = -\frac{1}{a} \cos ax$$

$$291. \int (\cos ax) dx = \frac{1}{a} \sin ax$$

$$292. \int (\tan ax) dx = -\frac{1}{a} \log \cos ax = \frac{1}{a} \log \sec ax$$

$$293. \int (\cot ax) dx = \frac{1}{a} \log \sin ax = -\frac{1}{a} \log \csc ax$$

$$294. \int (\sec ax) dx = \frac{1}{a} \log(\sec ax + \tan ax) = \frac{1}{a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$$

$$295. \int (\csc ax) dx = \frac{1}{a} \log(\csc ax - \cot ax) = \frac{1}{a} \log \tan \frac{ax}{2}$$

$$296. \int (\sin^2 ax) dx = -\frac{1}{2a} \cos ax \sin ax + \frac{1}{2}x = \frac{1}{2}x - \frac{1}{4a} \sin 2ax$$

$$297. \int (\sin^3 ax) dx = -\frac{1}{3a} (\cos ax)(\sin^2 ax + 2)$$

$$298. \int (\sin^4 ax) dx = \frac{3x}{8} - \frac{\sin 2ax}{4a} + \frac{\sin 4ax}{32a}$$

$$299. \int (\sin^n ax) dx = -\frac{\sin^{n-1} ax \cos ax}{na} + \frac{n-1}{n} \int (\sin^{n-2} ax) dx$$

$$300. \int (\sin^{2m} ax) dx = -\frac{\cos ax}{a} \sum_{r=0}^{m-1} \frac{(2m)!(r!)^2}{2^{2m-2r}(2r+1)!(m!)^2} \sin^{2r+1} ax + \frac{(2m)!}{2^{2m}(m!)^2} x$$

$$301. \int (\sin^{2m+1} ax) dx = -\frac{\cos ax}{a} \sum_{r=0}^m \frac{2^{2m-2r}(m!)^2(2r)!}{(2m+1)!(r!)^2} \sin^{2r} ax$$

$$302. \int (\cos^2 ax) dx = \frac{1}{2a} \sin ax \cos ax + \frac{1}{2}x = \frac{1}{2}x + \frac{1}{4a} \sin 2ax$$

$$303. \int (\cos^3 ax) dx = \frac{1}{3a} (\sin ax)(\cos^2 ax + 2)$$

$$304. \int (\cos^4 ax) dx = \frac{3x}{8} + \frac{\sin 2ax}{4a} + \frac{\sin 4ax}{32a}$$

$$305. \int (\cos^n ax) dx = \frac{1}{na} \cos^{n-1} ax \sin ax + \frac{n-1}{n} \int (\cos^{n-2} ax) dx$$

$$306. \int (\cos^{2m} ax) dx = \frac{\sin ax}{a} \sum_{r=0}^{m-1} \frac{(2m)!(r!)^2}{2^{2m-2r}(2r+1)!(m!)^2} \cos^{2r+1} ax + \frac{(2m)!}{2^{2m}(m!)^2} x$$

$$307. \int (\cos^{2m+1} ax) dx = \frac{\sin ax}{a} \sum_{r=0}^m \frac{2^{2m-2r}(m!)^2(2r)!}{(2m+1)!(r!)^2} \cos^{2r} ax$$

$$308. \int \frac{dx}{\sin^2 ax} = \int (\csc^2 ax) dx = -\frac{1}{a} \cot ax$$

$$309. \int \frac{dx}{\sin^m ax} = \int (\csc^m ax) dx = -\frac{1}{(m-1)a} \cdot \frac{\cos ax}{\sin^{m-1} ax} + \frac{m-2}{m-1} \int \frac{dx}{\sin^{m-2} ax}$$

$$310. \int \frac{dx}{\sin^{2m} ax} = \int (\csc^{2m} ax) dx = -\frac{1}{a} \cos ax \sum_{r=0}^{m-1} \frac{2^{2m-2r-1}(m-1)!m!(2r)!}{(2m)!(r!)^2 \sin^{2r+1} ax}$$

$$311. \int \frac{dx}{\sin^{2m+1} ax} = \int (\csc^{2m+1} ax) dx = -\frac{1}{a} \cos ax \sum_{r=0}^{m-1} \frac{(2m)!(r!)^2}{2^{2m-2r}(m!)^2(2r+1)! \sin^{2r+2} ax} + \frac{1}{a} \cdot \frac{(2m)!}{2^{2m}(m!)^2} \log \tan \frac{ax}{2}$$

$$312. \int \frac{dx}{\cos^2 ax} = \int (\sec^2 ax) dx = \frac{1}{a} \tan ax$$

$$313. \int \frac{dx}{\cos^n ax} = \int (\sec^n ax) dx = \frac{1}{(n-1)a} \cdot \frac{\sin ax}{\cos^{n-1} ax} + \frac{n-2}{n-1} \int \frac{dx}{\cos^{n-2} ax}$$

$$314. \int \frac{dx}{\cos^{2m} ax} = \int (\sec^{2m} ax) dx = \frac{1}{a} \sin ax \sum_{r=0}^{m-1} \frac{2^{2m-2r-1}(m-1)!m!(2r)!}{(2m)!(r!)^2 \cos^{2r+1} ax}$$

$$315. \int \frac{dx}{\cos^{2m+1} ax} = \int (\sec^{2m+1} ax) dx = \frac{1}{a} \sin ax \sum_{r=0}^{m-1} \frac{(2m)!(r!)^2}{2^{2m-2r}(m!)^2(2r+1)! \cos^{2r+2} ax} + \frac{1}{a} \cdot \frac{(2m)!}{2^{2m}(m!)^2} \log(\sec ax + \tan ax)$$

$$316. \int (\sin mx)(\sin nx) dx = \frac{\sin(m-n)x}{2(m-n)} - \frac{\sin(m+n)x}{2(m+n)}, \quad (m^2 \neq n^2)$$

$$317. \int (\cos mx)(\cos nx) dx = \frac{\sin(m-n)x}{2(m-n)} + \frac{\sin(m+n)x}{2(m+n)}, \quad (m^2 \neq n^2)$$

$$318. \int (\sin ax)(\cos ax) dx = \frac{1}{2a} \sin^2 ax$$

$$319. \int (\sin mx)(\cos nx) dx = -\frac{\cos(m-n)x}{2(m-n)} - \frac{\cos(m+n)x}{2(m+n)}, \quad (m^2 \neq n^2)$$

$$320. \int (\sin^2 ax)(\cos^2 ax) dx = -\frac{1}{32a} \sin 4ax + \frac{x}{8}$$

$$321. \int (\sin ax)(\cos^m ax) dx = -\frac{\cos^{m+1} ax}{(m+1)a}$$

$$322. \int (\sin^m ax)(\cos ax) dx = \frac{\sin^{m+1} ax}{(m+1)a}$$

$$323. \int (\cos^m ax)(\sin^n ax) dx = \begin{cases} \frac{\cos^{m-1} ax \sin^{n+1} ax}{(m+n)a} + \frac{m-1}{m+n} \int (\cos^{m-2} ax)(\sin^n ax) dx \\ \text{or} \\ -\frac{\sin^{n-1} ax \cos^{m+1} ax}{(m+n)a} + \frac{n-1}{m+n} \int (\cos^m ax)(\sin^{n-2} ax) dx \end{cases}$$

$$324. \int \frac{\cos^m ax}{\sin^n ax} dx = \begin{cases} -\frac{\cos^{m+1} ax}{(n-1)a \sin^{n-1} ax} - \frac{m-n+2}{n-1} \int \frac{\cos^m ax}{\sin^{n-2} ax} dx \\ \text{or} \\ \frac{\cos^{m-1} ax}{a(m-n) \sin^{n-1} ax} + \frac{m-1}{m-n} \int \frac{\cos^{m-2} ax}{\sin^n ax} dx \end{cases}$$

$$325. \int \frac{\sin^m ax}{\cos^n ax} dx = \begin{cases} \frac{\sin^{m+1} ax}{a(n-1) \cos^{n-1} ax} - \frac{m-n+2}{n-1} \int \frac{\sin^m ax}{\cos^{n-2} ax} dx \\ \text{or} \\ -\frac{\sin^{m-1} ax}{a(m-n) \cos^{n-1} ax} + \frac{m-1}{m-n} \int \frac{\sin^{m-2} ax}{\cos^n ax} dx \end{cases}$$

$$326. \int \frac{\sin ax}{\cos^2 ax} dx = \frac{1}{a \cos ax} = \frac{\sec ax}{a}$$

327.  $\int \frac{\sin^2 ax}{\cos ax} dx = -\frac{1}{a} \sin ax + \frac{1}{a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$
328.  $\int \frac{\cos ax}{\sin^2 ax} dx = -\frac{1}{a \sin ax} = -\frac{\csc ax}{a}$
329.  $\int \frac{dx}{(\sin ax)(\cos ax)} = \frac{1}{a} \log \tan ax$
330.  $\int \frac{dx}{(\sin ax)(\cos^2 ax)} = \frac{1}{a} \left( \sec ax + \log \tan \frac{ax}{2} \right)$
331.  $\int \frac{dx}{(\sin ax)(\cos^n ax)} = \frac{1}{a(n-1) \cos^{n-1} ax} + \int \frac{dx}{(\sin ax)(\cos^{n-2} ax)}$
332.  $\int \frac{dx}{(\sin^2 ax)(\cos ax)} = -\frac{1}{a} \csc ax + \frac{1}{a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$
333.  $\int \frac{dx}{(\sin^2 ax)(\cos^2 ax)} = -\frac{2}{a} \cot 2ax$
334.  $\int \frac{dx}{\sin^m ax \cos^n ax} = \begin{cases} -\frac{1}{a(m-1)(\sin^{m-1} ax)(\cos^{n-1} ax)} \\ + \frac{m+n-2}{m-1} \int \frac{dx}{(\sin^{m-2} ax)(\cos^n ax)} \\ \text{or} \\ \frac{1}{a(n-1)\sin^{m-1} ax \cos^{n-1} ax} + \frac{m+n-2}{n-1} \int \frac{dx}{\sin^m ax \cos^{n-2} ax} \end{cases}$
335.  $\int \sin(a+bx) dx = -\frac{1}{b} \cos(a+bx)$
336.  $\int \cos(a+bx) dx = \frac{1}{b} \sin(a+bx)$
337.  $\int \frac{dx}{1 \pm \sin ax} = \mp \frac{1}{a} \tan \left( \frac{\pi}{4} \mp \frac{ax}{2} \right)$
338.  $\int \frac{dx}{1 + \cos ax} = \frac{1}{a} \tan \frac{ax}{2}$
339.  $\int \frac{dx}{1 - \cos ax} = -\frac{1}{a} \cot \frac{ax}{2}$
340.  $\int \frac{dx}{a + b \sin x} = \begin{cases} \frac{2}{\sqrt{a^2-b^2}} \tan^{-1} \frac{a \tan \frac{x}{2} + b}{\sqrt{a^2-b^2}} \\ \text{or} \\ \frac{1}{\sqrt{b^2-a^2}} \log \frac{a \tan \frac{x}{2} + b - \sqrt{b^2-a^2}}{a \tan \frac{x}{2} + b + \sqrt{b^2-a^2}} \end{cases}$
341.  $\int \frac{dx}{a + b \cos x} = \begin{cases} \frac{2}{\sqrt{a^2-b^2}} \tan^{-1} \frac{\sqrt{a^2-b^2} \tan \frac{x}{2}}{a+b} \\ \text{or} \\ \frac{1}{\sqrt{b^2-a^2}} \log \left( \frac{\sqrt{b^2-a^2} \tan \frac{x}{2} + a + b}{\sqrt{b^2-a^2} \tan \frac{x}{2} - a - b} \right) \end{cases}$
342.  $\int \frac{dx}{a + b \sin x + c \cos x} = \begin{cases} \frac{1}{\sqrt{b^2+c^2-a^2}} \log \left( \frac{b - \sqrt{b^2+c^2-a^2} + (a-c) \tan \frac{x}{2}}{b + \sqrt{b^2+c^2-a^2} + (a-c) \tan \frac{x}{2}} \right) & (\text{if } a^2 < b^2 + c^2, a \neq c), \\ \frac{2}{\sqrt{a^2-b^2-c^2}} \tan^{-1} \left( \frac{b+(a-c) \tan \frac{x}{2}}{\sqrt{a^2-b^2-c^2}} \right) & (\text{if } a^2 > b^2 + c^2), \\ \frac{1}{a} \left[ \frac{a-(b+c) \cos x - (b-c) \sin x}{a-(b-c) \cos x + (b+c) \sin x} \right] & (\text{if } a^2 = b^2 + c^2, a \neq c). \end{cases}$
343.  $\int \frac{\sin^2 x dx}{a + b \cos^2 x} = \frac{1}{b} \sqrt{\frac{a+b}{a}} \tan^{-1} \left( \sqrt{\frac{a}{a+b}} \tan x \right) - \frac{x}{b}, \quad (ab > 0, \text{ or } |a| > |b|)$
344.  $\int \frac{dx}{a^2 \cos^2 x + b^2 \sin^2 x} = \frac{1}{ab} \tan^{-1} \left( \frac{b \tan x}{a} \right)$
345.  $\int \frac{\cos^2 cx}{a^2 + b^2 \sin^2 cx} dx = \frac{\sqrt{a^2+b^2}}{ab^2c} \tan^{-1} \frac{\sqrt{a^2+b^2} \tan cx}{a} - \frac{x}{b^2}$
346.  $\int \frac{\sin cx \cos cx}{a \cos^2 cx + b \sin^2 cx} dx = \frac{1}{2c(b-a)} \log(a \cos^2 cx + b \sin^2 cx)$

347. 
$$\int \frac{\cos cx}{a \cos cx + b \sin cx} dx = \int \frac{dx}{a + b \tan cx} = \frac{1}{c(a^2 + b^2)} [acx + b \log(a \cos cx + b \sin cx)]$$
348. 
$$\int \frac{\sin cx}{a \sin cx + b \cos cx} dx = \int \frac{dx}{a + b \cot cx} = \frac{1}{c(a^2 + b^2)} [acx - b \log(a \sin cx + b \cos cx)]$$
349. 
$$\int \frac{dx}{a \cos^2 x + 2b \cos x \sin x + c \sin^2 x} = \begin{cases} \frac{1}{2\sqrt{b^2 - ac}} \log \frac{c \tan x + b - \sqrt{b^2 - ac}}{c \tan x + b + \sqrt{b^2 - ac}}, & (b^2 > ac) \\ \text{or} \\ \frac{1}{\sqrt{ac - b^2}} \tan^{-1} \frac{c \tan x + b}{\sqrt{ac - b^2}}, & (b^2 < ac) \\ \text{or} \\ -\frac{1}{c \tan x + b}, & (b^2 = ac) \end{cases}$$
350. 
$$\int \frac{\sin ax}{1 \pm \sin ax} dx = \pm x + \frac{1}{a} \tan \left( \frac{\pi}{4} \mp \frac{ax}{2} \right)$$
351. 
$$\int \frac{dx}{(\sin ax)(1 \pm \sin ax)} = \frac{1}{a} \tan \left( \frac{\pi}{4} \mp \frac{ax}{2} \right) + \frac{1}{a} \log \tan \frac{ax}{2}$$
352. 
$$\int \frac{dx}{(1 + \sin ax)^2} = -\frac{1}{2a} \tan \left( \frac{\pi}{4} - \frac{ax}{2} \right) - \frac{1}{6a} \tan^3 \left( \frac{\pi}{4} - \frac{ax}{2} \right)$$
353. 
$$\int \frac{dx}{(1 - \sin ax)^2} = \frac{1}{2a} \cot \left( \frac{\pi}{4} - \frac{ax}{2} \right) + \frac{1}{6a} \cot^3 \left( \frac{\pi}{4} - \frac{ax}{2} \right)$$
354. 
$$\int \frac{\sin ax}{(1 + \sin ax)^2} dx = -\frac{1}{2a} \tan \left( \frac{\pi}{4} - \frac{ax}{2} \right) + \frac{1}{6a} \tan^3 \left( \frac{\pi}{4} - \frac{ax}{2} \right)$$
355. 
$$\int \frac{\sin ax}{(1 - \sin ax)^2} dx = -\frac{1}{2a} \cot \left( \frac{\pi}{4} - \frac{ax}{2} \right) + \frac{1}{6a} \cot^3 \left( \frac{\pi}{4} - \frac{ax}{2} \right)$$
356. 
$$\int \frac{\sin x dx}{a + b \sin x} = \frac{x}{b} - \frac{a}{b} \int \frac{dx}{a + b \sin x}$$
357. 
$$\int \frac{dx}{(\sin x)(a + b \sin x)} = \frac{1}{a} \log \tan \frac{x}{2} - \frac{b}{a} \int \frac{dx}{a + b \sin x}$$
358. 
$$\int \frac{dx}{(a + b \sin x)^2} = \frac{b \cos x}{(a^2 - b^2)(a + b \sin x)} + \frac{a}{a^2 - b^2} \int \frac{dx}{a + b \sin x}$$
359. 
$$\int \frac{\sin x dx}{(a + b \sin x)^2} = \frac{a \cos x}{(b^2 - a^2)(a + b \sin x)} + \frac{b}{b^2 - a^2} \int \frac{dx}{a + b \sin x}$$
360. 
$$\int \frac{dx}{a^2 + b^2 \sin^2 cx} = \frac{1}{ac\sqrt{a^2 + b^2}} \tan^{-1} \frac{\sqrt{a^2 + b^2} \tan cx}{a}$$
361. 
$$\int \frac{dx}{a^2 - b^2 \sin^2 cx} = \begin{cases} \frac{1}{ac\sqrt{a^2 - b^2}} \tan^{-1} \frac{\sqrt{a^2 - b^2} \tan cx}{a}, & (a^2 > b^2) \\ \text{or} \\ \frac{1}{2ac\sqrt{b^2 - a^2}} \log \frac{\sqrt{b^2 - a^2} \tan cx + a}{\sqrt{b^2 - a^2} \tan cx - a}, & (a^2 < b^2) \end{cases}$$
362. 
$$\int \frac{\cos ax}{1 + \cos ax} dx = x - \frac{1}{a} \tan \frac{ax}{2}$$
363. 
$$\int \frac{\cos ax}{1 - \cos ax} dx = -x - \frac{1}{a} \cot \frac{ax}{2}$$
364. 
$$\int \frac{dx}{(\cos ax)(1 + \cos ax)} = \frac{1}{a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right) - \frac{1}{a} \tan \frac{ax}{2}$$
365. 
$$\int \frac{dx}{(\cos ax)(1 - \cos ax)} = \frac{1}{a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right) - \frac{1}{a} \cot \frac{ax}{2}$$
366. 
$$\int \frac{dx}{(1 + \cos ax)^2} = \frac{1}{2a} \tan \frac{ax}{2} + \frac{1}{6a} \tan^3 \frac{ax}{2}$$
367. 
$$\int \frac{dx}{(1 - \cos ax)^2} = -\frac{1}{2a} \cot \frac{ax}{2} - \frac{1}{6a} \cot^3 \frac{ax}{2}$$
368. 
$$\int \frac{\cos ax}{(1 + \cos ax)^2} dx = \frac{1}{2a} \tan \frac{ax}{2} - \frac{1}{6a} \tan^3 \frac{ax}{2}$$
369. 
$$\int \frac{\cos ax}{(1 - \cos ax)^2} dx = \frac{1}{2a} \cot \frac{ax}{2} - \frac{1}{6a} \cot^3 \frac{ax}{2}$$
370. 
$$\int \frac{\cos x dx}{a + b \cos x} = \frac{x}{b} - \frac{a}{b} \int \frac{dx}{a + b \cos x}$$
371. 
$$\int \frac{dx}{(\cos x)(a + b \cos x)} = \frac{1}{a} \log \tan \left( \frac{x}{2} + \frac{\pi}{4} \right) - \frac{b}{a} \int \frac{dx}{a + b \cos x}$$
372. 
$$\int \frac{dx}{(a + b \cos x)^2} = \frac{b \sin x}{(b^2 - a^2)(a + b \cos x)} - \frac{a}{b^2 - a^2} \int \frac{dx}{a + b \cos x}$$

$$373. \int \frac{\cos x}{(a + b \cos x)^2} dx = \frac{a \sin x}{(a^2 - b^2)(a + b \cos x)} - \frac{b}{a^2 - b^2} \int \frac{dx}{a + b \cos x}$$

$$374. \int \frac{dx}{a^2 + b^2 - 2ab \cos cx} = \frac{2}{c(a^2 - b^2)} \tan^{-1} \left( \frac{a + b}{a - b} \tan \frac{cx}{2} \right)$$

$$375. \int \frac{dx}{a^2 + b^2 \cos^2 cx} = \frac{1}{ac\sqrt{a^2 + b^2}} \tan^{-1} \frac{a \tan cx}{\sqrt{a^2 + b^2}}$$

$$376. \int \frac{dx}{a^2 - b^2 \cos^2 cx} = \begin{cases} \frac{1}{ac\sqrt{a^2 - b^2}} \tan^{-1} \frac{a \tan cx}{\sqrt{a^2 - b^2}}, & (a^2 > b^2) \\ \text{or} \\ \frac{1}{2ac\sqrt{b^2 - a^2}} \log \frac{a \tan cx - \sqrt{b^2 - a^2}}{a \tan cx + \sqrt{b^2 - a^2}}, & (b^2 > a^2) \end{cases}$$

$$377. \int \frac{\sin ax}{1 \pm \cos ax} dx = \mp \frac{1}{a} \log(1 \pm \cos ax)$$

$$378. \int \frac{\cos ax}{1 \pm \sin ax} dx = \pm \frac{1}{a} \log(1 \pm \sin ax)$$

$$379. \int \frac{dx}{(\sin ax)(1 \pm \cos ax)} = \pm \frac{1}{2a(1 \pm \cos ax)} + \frac{1}{2a} \log \tan \frac{ax}{2}$$

$$380. \int \frac{dx}{(\cos ax)(1 \pm \sin ax)} = \mp \frac{1}{2a(1 \pm \sin ax)} + \frac{1}{2a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$$

$$381. \int \frac{\sin ax}{(\cos ax)(1 \pm \cos ax)} dx = \frac{1}{a} \log(\sec ax \pm 1)$$

$$382. \int \frac{\cos ax}{(\sin ax)(1 \pm \sin ax)} dx = -\frac{1}{a} \log(\csc ax \pm 1)$$

$$383. \int \frac{\sin ax}{(\cos ax)(1 \pm \sin ax)} dx = \frac{1}{2a(1 \pm \sin ax)} \pm \frac{1}{2a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$$

$$384. \int \frac{\cos ax}{(\sin ax)(1 \pm \cos ax)} dx = -\frac{1}{2a(1 \pm \cos ax)} \pm \frac{1}{2a} \log \tan \frac{ax}{2}$$

$$385. \int \frac{dx}{\sin ax \pm \cos ax} = \frac{1}{a\sqrt{2}} \log \tan \left( \frac{ax}{2} \pm \frac{\pi}{8} \right)$$

$$386. \int \frac{dx}{(\sin ax \pm \cos ax)^2} = \frac{1}{2a} \tan \left( ax \mp \frac{\pi}{4} \right)$$

$$387. \int \frac{dx}{1 + \cos ax \pm \sin ax} = \pm \frac{1}{a} \log \left( 1 \pm \tan \frac{ax}{2} \right)$$

$$388. \int \frac{dx}{a^2 \cos^2 cx - b^2 \sin^2 cx} = \frac{1}{2abc} \log \frac{b \tan cx + a}{b \tan cx - a}$$

$$389. \int x(\sin ax) dx = \frac{1}{a^2} \sin ax - \frac{x}{a} \cos ax$$

$$390. \int x^2(\sin ax) dx = \frac{2x}{a^2} \sin ax - \frac{a^2 x^2 - 2}{a^3} \cos ax$$

$$391. \int x^3(\sin ax) dx = \frac{3a^2 x^2 - 6}{a^4} \sin ax - \frac{a^2 x^3 - 6x}{a^3} \cos ax$$

$$392. \int x^m \sin ax dx = \begin{cases} -\frac{1}{a} x^m \cos ax + \frac{m}{a} \int x^{m-1} \cos ax dx \\ \text{or} \\ \cos ax \sum_{r=0}^{\lfloor \frac{m}{2} \rfloor} (-1)^{r+1} \frac{m!}{(m-2r)!} \cdot \frac{x^{m-2r}}{a^{2r+1}} \\ + \sin ax \sum_{r=0}^{\lfloor \frac{m-1}{2} \rfloor} (-1)^r \frac{m!}{(m-2r-1)!} \cdot \frac{x^{m-2r-1}}{a^{2r+2}} \end{cases}$$

Note:  $[s]$  means greatest integer  $\leq s$ ; Thus  $[3.5]$  means 3;  $[5] = 5$ ,  $[\frac{1}{2}] = 0$ .

$$393. \int x(\cos ax) dx = \frac{1}{a^2} \cos ax + \frac{x}{a} \sin ax$$

$$394. \int x^2(\cos ax) dx = \frac{2x \cos ax}{a^2} + \frac{a^2 x^2 - 2}{a^3} \sin ax$$

$$395. \int x^3(\cos ax) dx = \frac{3a^2 x^2 - 6}{a^4} \cos ax + \frac{a^2 x^3 - 6x}{a^3} \sin ax$$

$$396. \int x^m(\cos ax) dx = \begin{cases} \frac{x^m \sin ax}{a} - \frac{m}{a} \int x^{m-1} \sin ax dx \\ \text{or} \\ \sin ax \sum_{r=0}^{\lfloor m/2 \rfloor} (-1)^r \frac{m!}{(m-2r)!} \cdot \frac{x^{m-2r}}{a^{2r+1}} \\ + \cos ax \sum_{r=0}^{\lfloor (m-1)/2 \rfloor} (-1)^r \frac{m!}{(m-2r-1)!} \cdot \frac{x^{m-2r-1}}{a^{2r+2}} \end{cases}$$

Note:  $[s]$  means greatest integer  $\leq s$ ; Thus  $[3.5]$  means 3;  $[5] = 5$ ,  $[\frac{1}{2}] = 0$ .



397.  $\int \frac{\sin ax}{x} dx = \sum_{n=0}^r (-1)^n \frac{(ax)^{2n+1}}{(2n+1)(2n+1)!}$
398.  $\int \frac{\cos ax}{x} dx = \log x + \sum_{n=1}^r (-1)^n \frac{(ax)^{2n}}{2n(2n)!}$
399.  $\int x(\sin^2 ax) dx = \frac{x^2}{4} - \frac{x \sin 2ax}{4a} - \frac{\cos 2ax}{8a^2}$
400.  $\int x^2(\sin^2 ax) dx = \frac{x^3}{6} - \left(\frac{x^2}{4a} - \frac{1}{8a^3}\right) \sin 2ax - \frac{x \cos 2ax}{4a^2}$
401.  $\int x(\sin^3 ax) dx = \frac{x \cos 3ax}{12a} - \frac{\sin 3ax}{36a^2} - \frac{3x \cos ax}{4a} + \frac{3 \sin ax}{4a^2}$
402.  $\int x(\cos^2 ax) dx = \frac{x^2}{4} + \frac{x \sin 2ax}{4a} + \frac{\cos 2ax}{8a^2}$
403.  $\int x^2(\cos^2 ax) dx = \frac{x^3}{6} + \left(\frac{x^2}{4a} - \frac{1}{8a^3}\right) \sin 2ax + \frac{x \cos 2ax}{4a^2}$
404.  $\int x(\cos^3 ax) dx = \frac{x \sin 3ax}{12a} + \frac{\cos 3ax}{36a^2} + \frac{3x \sin ax}{4a} + \frac{3 \cos ax}{4a^2}$
405.  $\int \frac{\sin ax}{x^m} dx = -\frac{\sin ax}{(m-1)x^{m-1}} + \frac{a}{m-1} \int \frac{\cos ax}{x^{m-1}} dx$
406.  $\int \frac{\cos ax}{x^m} dx = -\frac{\cos ax}{(m-1)x^{m-1}} - \frac{a}{m-1} \int \frac{\sin ax}{x^{m-1}} dx$
407.  $\int \frac{x}{1 \pm \sin ax} dx = \mp \frac{x \cos ax}{a(1 \pm \sin ax)} + \frac{1}{a^2} \log(1 \pm \sin ax)$
408.  $\int \frac{x}{1 + \cos ax} dx = \frac{x}{a} \tan \frac{ax}{2} + \frac{2}{a^2} \log \cos \frac{ax}{2}$
409.  $\int \frac{x}{1 - \cos ax} dx = -\frac{x}{a} \cot \frac{ax}{2} + \frac{2}{a^2} \log \sin \frac{ax}{2}$
410.  $\int \frac{x + \sin x}{1 + \cos x} dx = x \tan \frac{x}{2}$
411.  $\int \frac{x - \sin x}{1 - \cos x} dx = -x \cot \frac{x}{2}$
412.  $\int \sqrt{1 - \cos ax} dx = -\frac{2 \sin ax}{a\sqrt{1 - \cos ax}} = -\frac{2\sqrt{2}}{a} \cos\left(\frac{ax}{2}\right)$
413.  $\int \sqrt{1 + \cos ax} dx = \frac{2 \sin ax}{a\sqrt{1 + \cos ax}} = \frac{2\sqrt{2}}{a} \sin\left(\frac{ax}{2}\right)$
414.  $\int \sqrt{1 + \sin x} dx = \pm 2 \left( \sin \frac{x}{2} - \cos \frac{x}{2} \right)$ ,  
[use + if  $(8k-1)\frac{\pi}{2} < x \leq (8k+3)\frac{\pi}{2}$ , otherwise -;  $k$  an integer]
415.  $\int \sqrt{1 - \sin x} dx = \pm 2 \left( \sin \frac{x}{2} + \cos \frac{x}{2} \right)$ ,  
[use + if  $(8k-3)\frac{\pi}{2} < x \leq (8k+1)\frac{\pi}{2}$ , otherwise -;  $k$  an integer]
416.  $\int \frac{dx}{\sqrt{1 - \cos x}} = \pm\sqrt{2} \log \tan \frac{x}{4}$ ,  
[use + if  $4k\pi < x < (4k+2)\pi$ , otherwise -;  $k$  an integer]
417.  $\int \frac{dx}{\sqrt{1 + \cos x}} = \pm\sqrt{2} \log \tan \left( \frac{x + \pi}{4} \right)$ ,  
[use + if  $(4k-1)\pi < x < (4k+1)\pi$ , otherwise -;  $k$  an integer]
418.  $\int \frac{dx}{\sqrt{1 - \sin x}} = \pm\sqrt{2} \log \tan \left( \frac{x}{4} - \frac{\pi}{8} \right)$ ,  
[use + if  $(8k+1)\frac{\pi}{2} < x < (8k+5)\frac{\pi}{2}$ , otherwise -;  $k$  an integer]
419.  $\int \frac{dx}{\sqrt{1 + \sin x}} = \pm\sqrt{2} \log \tan \left( \frac{x}{4} + \frac{\pi}{8} \right)$ ,  
[use + if  $(8k-1)\frac{\pi}{2} < x < (8k+3)\frac{\pi}{2}$ , otherwise -;  $k$  an integer]
420.  $\int \tan^2(ax) dx = \frac{1}{a} \tan ax - x$
421.  $\int \tan^3(ax) dx = \frac{1}{2a} \tan^2 ax + \frac{1}{a} \log \cos ax$

422.  $\int \tan^4(ax) dx = \frac{\tan^3 ax}{3a} - \frac{1}{a} \tan ax + x$
423.  $\int \tan^n(ax) dx = \frac{\tan^{n-1} ax}{a(n-1)} - \int (\tan^{n-2} ax) dx$
424.  $\int \cot^2(ax) dx = -\frac{1}{a} \cot ax - x$
425.  $\int \cot^3(ax) dx = -\frac{1}{2a} \cot^2 ax - \frac{1}{a} \log \sin ax$
426.  $\int \cot^4(ax) dx = -\frac{1}{3a} \cot^3 ax + \frac{1}{a} \cot ax + x$
427.  $\int \cot^n(ax) dx = -\frac{\cot^{n-1} ax}{a(n-1)} - \int (\cot^{n-2} ax) dx$
428.  $\int \frac{x}{\sin^2 ax} dx = \int x(\csc^2 ax) dx = -\frac{x \cot ax}{a} + \frac{1}{a^2} \log \sin ax$
429.  $\int \frac{x}{\sin^n ax} dx = \int x(\csc^n ax) dx = -\frac{x \cos ax}{a(n-1) \sin^{n-1} ax} - \frac{1}{a^2(n-1)(n-2) \sin^{n-2} ax} + \frac{(n-2)}{(n-1)} \int \frac{x}{\sin^{n-2} ax} dx$
430.  $\int \frac{x}{\cos^2 ax} dx = \int x(\sec^2 ax) dx = \frac{1}{a} x \tan ax + \frac{1}{a^2} \log \cos ax$
431.  $\int \frac{x}{\cos^n(ax)} dx = \int x(\sec^n ax) dx = \frac{x \sin ax}{a(n-1) \cos^{n-1} ax} - \frac{1}{a^2(n-1)(n-2) \cos^{n-2} ax} + \frac{n-2}{n-1} \int \frac{x}{\cos^{n-2} ax} dx$
432.  $\int \frac{\sin ax}{\sqrt{1+b^2 \sin^2 ax}} dx = -\frac{1}{ab} \sin^{-1} \frac{b \cos ax}{\sqrt{1+b^2}}$
433.  $\int \frac{\sin ax}{\sqrt{1-b^2 \sin^2 ax}} dx = -\frac{1}{ab} \log(b \cos ax + \sqrt{1-b^2 \sin^2 ax})$
434.  $\int \sin(ax) \sqrt{1+b^2 \sin^2 ax} dx = -\frac{\cos ax}{2a} \sqrt{1+b^2 \sin^2 ax} - \frac{1+b^2}{2ab} \sin^{-1} \frac{b \cos ax}{\sqrt{1+b^2}}$
435.  $\int \sin(ax) \sqrt{1-b^2 \sin^2 ax} dx = -\frac{\cos ax}{2a} \sqrt{1-b^2 \sin^2 ax} - \frac{1-b^2}{2ab} \log(b \cos ax + \sqrt{1-b^2 \sin^2 ax})$
436.  $\int \frac{\cos ax}{\sqrt{1+b^2 \sin^2 ax}} dx = \frac{1}{ab} \log(b \sin ax + \sqrt{1+b^2 \sin^2 ax})$
437.  $\int \frac{\cos ax}{\sqrt{1-b^2 \sin^2 ax}} dx = \frac{1}{ab} \sin^{-1}(b \sin ax)$
438.  $\int \cos(ax) \sqrt{1+b^2 \sin^2 ax} dx = \frac{\sin ax}{2a} \sqrt{1+b^2 \sin^2 ax} + \frac{1}{2ab} \log(b \sin ax + \sqrt{1+b^2 \sin^2 ax})$
439.  $\int \cos(ax) \sqrt{1-b^2 \sin^2 ax} dx = \frac{\sin ax}{2a} \sqrt{1-b^2 \sin^2 ax} + \frac{1}{2ab} \sin^{-1}(b \sin ax)$
440.  $\int \frac{dx}{\sqrt{a+b \tan^2 cx}} = \frac{\pm 1}{c\sqrt{a-b}} \sin^{-1} \left( \sqrt{\frac{a-b}{a}} \sin cx \right), \quad (a > |b|)$   
 [use + if  $(2k-1)\frac{\pi}{2} < x \leq (2k+1)\frac{\pi}{2}$ , otherwise -;  $k$  an integer]

## FORMS INVOLVING INVERSE TRIGONOMETRIC FUNCTIONS

441.  $\int \sin^{-1}(ax) dx = x \sin^{-1} ax + \frac{\sqrt{1-a^2x^2}}{a}$
442.  $\int \cos^{-1}(ax) dx = x \cos^{-1} ax - \frac{\sqrt{1-a^2x^2}}{a}$
443.  $\int \tan^{-1}(ax) dx = x \tan^{-1} ax - \frac{1}{2a} \log(1+a^2x^2)$
444.  $\int \cot^{-1}(ax) dx = x \cot^{-1} ax + \frac{1}{2a} \log(1+a^2x^2)$

$$445. \int \sec^{-1}(ax) dx = x \sec^{-1} ax - \frac{1}{a} \log(ax + \sqrt{a^2x^2 - 1})$$

$$446. \int \csc^{-1}(ax) dx = x \csc^{-1} ax + \frac{1}{a} \log(ax + \sqrt{a^2x^2 - 1})$$

$$447. \int \sin^{-1} \frac{x}{a} dx = x \sin^{-1} \frac{x}{a} + \sqrt{a^2 - x^2}, \quad (a > 0)$$

$$448. \int \cos^{-1} \frac{x}{a} dx = x \cos^{-1} \frac{x}{a} - \sqrt{a^2 - x^2}, \quad (a > 0)$$

$$449. \int \tan^{-1} \frac{x}{a} dx = x \tan^{-1} \frac{x}{a} - \frac{a}{2} \log(a^2 + x^2)$$

$$450. \int \cot^{-1} \frac{x}{a} dx = x \cot^{-1} \frac{x}{a} + \frac{a}{2} \log(a^2 + x^2)$$

$$451. \int x \sin^{-1}(ax) dx = \frac{1}{4a^2} [(2a^2x^2 - 1) \sin^{-1}(ax) + ax \sqrt{1 - a^2x^2}]$$

$$452. \int x \cos^{-1}(ax) dx = \frac{1}{4a^2} [(2a^2x^2 - 1) \cos^{-1}(ax) - ax \sqrt{1 - a^2x^2}]$$

$$453. \int x^n \sin^{-1}(ax) dx = \frac{x^{n+1}}{n+1} \sin^{-1}(ax) - \frac{a}{n+1} \int \frac{x^{n+1} dx}{\sqrt{1 - a^2x^2}}, \quad (n \neq -1)$$

$$454. \int x^n \cos^{-1}(ax) dx = \frac{x^{n+1}}{n+1} \cos^{-1}(ax) + \frac{a}{n+1} \int \frac{x^{n+1} dx}{\sqrt{1 - a^2x^2}}, \quad (n \neq -1)$$

$$455. \int x \tan^{-1}(ax) dx = \frac{1 + a^2x^2}{2a^2} \tan^{-1} ax - \frac{x}{2a}$$

$$456. \int x^n \tan^{-1}(ax) dx = \frac{x^{n+1}}{n+1} \tan^{-1} ax - \frac{a}{n+1} \int \frac{x^{n+1}}{1 + a^2x^2} dx$$

$$457. \int x(\cot^{-1} ax) dx = \frac{1 + a^2x^2}{2a^2} \cot^{-1} ax + \frac{x}{2a}$$

$$458. \int x^n \cot^{-1}(ax) dx = \frac{x^{n+1}}{n+1} \cot^{-1} ax + \frac{a}{n+1} \int \frac{x^{n+1}}{1 + a^2x^2} dx$$

$$459. \int \frac{\sin^{-1}(ax)}{x^2} dx = a \log \left( \frac{1 - \sqrt{1 - a^2x^2}}{x} \right) - \frac{\sin^{-1}(ax)}{x}$$

$$460. \int \frac{\cos^{-1}(ax) dx}{x^2} = -\frac{1}{x} \cos^{-1}(ax) + a \log \frac{1 + \sqrt{1 - a^2x^2}}{x}$$

$$461. \int \frac{\tan^{-1}(ax) dx}{x^2} = -\frac{1}{x} \tan^{-1}(ax) - \frac{a}{2} \log \frac{1 + a^2x^2}{x^2}$$

$$462. \int \frac{\cot^{-1}(ax) dx}{x^2} = -\frac{1}{x} \cot^{-1} ax - \frac{a}{2} \log \frac{x^2}{a^2x^2 + 1}$$

$$463. \int \sin^{-1}(ax)^2 dx = x(\sin^{-1} ax)^2 - 2x + \frac{2\sqrt{1 - a^2x^2}}{a} \sin^{-1} ax$$

$$464. \int \cos^{-1}(ax)^2 dx = x(\cos^{-1} ax)^2 - 2x - \frac{2\sqrt{1 - a^2x^2}}{a} \cos^{-1} ax$$

$$465. \int (\sin^{-1} ax)^n dx = \begin{cases} x(\sin^{-1} ax)^n + \frac{n\sqrt{1 - a^2x^2}}{a} (\sin^{-1} ax)^{n-1} - n(n-1) \int (\sin^{-1} ax)^{n-2} dx \\ \text{or} \\ \sum_{r=0}^{[n/2]} (-1)^r \frac{n!}{(n-2r)!} x(\sin^{-1} ax)^{n-2r} + \sum_{r=0}^{[n-1/2]} (-1)^r \frac{n! \sqrt{1 - a^2x^2}}{(n-2r-1)!a} (\sin^{-1} ax)^{n-2r-1} \end{cases}$$

Note: [s] means greatest integer  $\leq s$ . Thus [3.5] means 3; [5] = 5, [ $\frac{1}{2}$ ] = 0.

$$466. \int (\cos^{-1} ax)^n dx = \begin{cases} x(\cos^{-1} ax)^n - \frac{n\sqrt{1 - a^2x^2}}{a} (\cos^{-1} ax)^{n-1} - n(n-1) \int (\cos^{-1} ax)^{n-2} dx \\ \text{or} \\ \sum_{r=0}^{[n/2]} (-1)^r \frac{n!}{(n-2r)!} x(\cos^{-1} ax)^{n-2r} \times \sum_{r=0}^{[n-1/2]} (-1)^r \frac{n! \sqrt{1 - a^2x^2}}{(n-2r-1)!a} (\cos^{-1} ax)^{n-2r-1} \end{cases}$$

$$467. \int \frac{1}{\sqrt{1 - a^2x^2}} (\sin^{-1} ax) dx = \frac{1}{2a} (\sin^{-1} ax)^2$$

$$468. \int \frac{x^n}{\sqrt{1 - a^2x^2}} (\sin^{-1} ax) dx = -\frac{x^{n-1}}{na^2} \sqrt{1 - a^2x^2} \sin^{-1} ax + \frac{x^n}{n^2a} + \frac{n-1}{na^2} \int \frac{x^{n-2}}{\sqrt{1 - a^2x^2}} \sin^{-1} ax dx$$

469.  $\int \frac{1}{\sqrt{1-a^2x^2}} (\cos^{-1} ax) dx = -\frac{1}{2a} (\cos^{-1} ax)^2$
470.  $\int \frac{x^n}{\sqrt{1-a^2x^2}} (\cos^{-1} ax) dx = -\frac{x^{n-1}}{na^2} \sqrt{1-a^2x^2} \cos^{-1} ax - \frac{x^n}{n^2a} + \frac{n-1}{na^2} \int \frac{x^{n-2}}{\sqrt{1-a^2x^2}} \cos^{-1} ax dx$
471.  $\int \frac{\tan^{-1} ax}{a^2x^2+1} dx = \frac{1}{2a} (\tan^{-1} ax)^2$
472.  $\int \frac{\cot^{-1} ax}{a^2x^2+1} dx = -\frac{1}{2a} (\cot^{-1} ax)^2$
473.  $\int x \sec^{-1} ax dx = \frac{x^2}{2} \sec^{-1} ax - \frac{1}{2a^2} \sqrt{a^2x^2-1}$
474.  $\int x^n \sec^{-1} ax dx = \frac{x^{n+1}}{n+1} \sec^{-1} ax - \frac{1}{n+1} \int \frac{x^n dx}{\sqrt{a^2x^2-1}}$
475.  $\int \frac{\sec^{-1} ax}{x^2} dx = -\frac{\sec^{-1} ax}{x} + \frac{\sqrt{a^2x^2-1}}{x}$
476.  $\int x \csc^{-1} ax dx = \frac{x^2}{2} \csc^{-1} ax + \frac{1}{2a^2} \sqrt{a^2x^2-1}$
477.  $\int x^n \csc^{-1} ax dx = \frac{x^{n+1}}{n+1} \csc^{-1} ax + \frac{1}{n+1} \int \frac{x^n dx}{\sqrt{a^2x^2-1}}$
478.  $\int \frac{\csc^{-1} ax}{x^2} dx = -\frac{\csc^{-1} ax}{x} - \frac{\sqrt{a^2x^2-1}}{x}$

## FORMS INVOLVING TRIGONOMETRIC SUBSTITUTIONS

479.  $\int f(\sin x) dx = 2 \int f\left(\frac{2z}{1+z^2}\right) \frac{dz}{1+z^2}, \quad (z = \tan \frac{x}{2})$
480.  $\int f(\cos x) dx = 2 \int f\left(\frac{1-z^2}{1+z^2}\right) \frac{dz}{1+z^2}, \quad (z = \tan \frac{x}{2})$
481.  $\int f(\sin x) dx = \int f(u) \frac{du}{\sqrt{1-u^2}}, \quad (u = \sin x)$
482.  $\int f(\cos x) dx = -\int f(u) \frac{du}{\sqrt{1-u^2}}, \quad (u = \cos x)$
483.  $\int f(\sin x, \cos x) dx = \int f\left(u, \sqrt{1-u^2}\right) \frac{du}{\sqrt{1-u^2}}, \quad (u = \sin x)$
484.  $\int f(\sin x, \cos x) dx = 2 \int f\left(\frac{2z}{1+z^2}, \frac{1-z^2}{1+z^2}\right) \frac{dz}{1+z^2}, \quad (z = \tan \frac{x}{2})$

## LOGARITHMIC FORMS

485.  $\int (\log x) dx = x \log x - x$
486.  $\int x(\log x) dx = \frac{x^2}{2} \log x - \frac{x^2}{4}$
487.  $\int x^2(\log x) dx = \frac{x^3}{3} \log x - \frac{x^3}{9}$
488.  $\int x^n(\log ax) dx = \frac{x^{n+1}}{n+1} \log ax - \frac{x^{n+1}}{(n+1)^2}$
489.  $\int (\log x)^2 dx = x(\log x)^2 - 2x \log x + 2x$
490.  $\int (\log x)^n dx = \begin{cases} x(\log x)^n - n \int (\log x)^{n-1} dx, & (n \neq -1) \\ \text{or} \\ (-1)^n n! x \sum_{r=0}^n \frac{(-\log x)^r}{r!} \end{cases}$
491.  $\int \frac{(\log x)^n}{x} dx = \frac{1}{n+1} (\log x)^{n+1}$
492.  $\int \frac{dx}{\log x} = \log(\log x) + \log x + \frac{(\log x)^2}{2 \cdot 2!} + \frac{(\log x)^3}{3 \cdot 3!} + \dots$
493.  $\int \frac{dx}{x \log x} = \log(\log x)$

$$494. \int \frac{dx}{x(\log x)^n} = -\frac{1}{(n-1)(\log x)^{n-1}}$$

$$495. \int \frac{x^m dx}{(\log x)^n} = -\frac{x^{m+1}}{(n-1)(\log x)^{n-1}} + \frac{m+1}{n-1} \int \frac{x^m dx}{(\log x)^{n-1}}$$

$$496. \int x^m (\log x)^n dx = \begin{cases} \frac{x^{m+1}(\log x)^n}{m+1} - \frac{n}{m+1} \int x^m (\log x)^{n-1} dx \\ \text{or} \\ (-1)^n \frac{n!}{m+1} x^{m+1} \sum_{r=0}^n \frac{(-\log x)^r}{r!(m+1)^{n-r}} \end{cases}$$

$$497. \int x^p \cos(b \ln x) dx = \frac{x^{p+1}}{(p+1)^2 + b^2} [b \sin(b \ln x) + (p+1) \cos(b \ln x)] + c$$

$$498. \int x^p \sin(b \ln x) dx = \frac{x^{p+1}}{(p+1)^2 + b^2} [(p+1) \sin(b \ln x) - b \cos(b \ln x)] + c$$

$$499. \int [\log(ax+b)] dx = \frac{ax+b}{a} \log(ax+b) - x$$

$$500. \int \frac{\log(ax+b)}{x^2} dx = \frac{a}{b} \log x - \frac{ax+b}{bx} \log(ax+b)$$

$$501. \int x^m [\log(ax+b)] dx = \frac{1}{m+1} \left[ x^{m+1} - \left(-\frac{b}{a}\right)^{m+1} \right] \log(ax+b) - \frac{1}{m+1} \left(-\frac{b}{a}\right)^{m+1} \sum_{r=1}^{m+1} \frac{1}{r} \left(-\frac{ax}{b}\right)^r$$

$$502. \int \frac{\log(ax+b)}{x^m} dx = -\frac{1}{m-1} \frac{\log(ax+b)}{x^{m-1}} + \frac{1}{m-1} \left(-\frac{a}{b}\right)^{m-1} \log \frac{ax+b}{x} + \frac{1}{m-1} \left(-\frac{a}{b}\right)^{m-1} \sum_{r=1}^{m-2} \frac{1}{r} \left(-\frac{b}{ax}\right)^r, (m > 2)$$

$$503. \int \left[ \log \frac{x+a}{x-a} \right] dx = (x+a) \log(x+a) - (x-a) \log(x-a)$$

$$504. \int x^m \left[ \log \frac{x+a}{x-a} \right] dx = \frac{x^{m+1} - (-a)^{m+1}}{m+1} \log(x+a) - \frac{x^{m+1} - a^{m+1}}{m+1} \log(x-a) + \frac{2a^{m+1}}{m+1} \sum_{r=1}^{\lfloor \frac{m+1}{2} \rfloor} \frac{1}{m-2r+2} \left(\frac{x}{a}\right)^{m-2r+2}$$

Note:  $[s]$  means greatest integer  $\leq s$ ; Thus  $[3.5]$  means 3;  $[5] = 5$ ,  $[\frac{1}{2}] = 0$ .

$$505. \int \frac{1}{x^2} \left[ \log \frac{x+a}{x-a} \right] dx = \frac{1}{x} \log \frac{x-a}{x+a} - \frac{1}{a} \log \frac{x^2-a^2}{x^2}$$

$$506. \int (\log X) dx = \begin{cases} \left(x + \frac{b}{2c}\right) \log X - 2x + \frac{\sqrt{4ac-b^2}}{c} \tan^{-1} \frac{2cx+b}{\sqrt{4ac-b^2}}, & (b^2 - 4ac < 0) \\ \text{or} \\ \left(x + \frac{b}{2c}\right) \log X - 2x + \frac{\sqrt{b^2-4ac}}{c} \tanh^{-1} \frac{2cx+b}{\sqrt{b^2-4ac}}, & (b^2 - 4ac > 0) \end{cases}$$

where  
 $X = a + bx + cx^2$

$$507. \int x^n (\log(a + bx + cx^2)) dx = \frac{x^{n+1}}{n+1} \log X - \frac{2c}{n+1} \int \frac{x^{n+2}}{X} dx - \frac{b}{n+1} \int \frac{x^{n+1}}{X} dx$$

$$508. \int \log(x^2 + a^2) dx = x \log(x^2 + a^2) - 2x + 2a \tan^{-1} \frac{x}{a}$$

$$509. \int \log(x^2 - a^2) dx = x \log(x^2 - a^2) - 2x + a \log \frac{x+a}{x-a}$$

$$510. \int x \log(x^2 \pm a^2) dx = \frac{1}{2} (x^2 \pm a^2) \log(x^2 \pm a^2) - \frac{1}{2} x^2$$

$$511. \int \log(x + \sqrt{x^2 \pm a^2}) dx = x \log(x + \sqrt{x^2 \pm a^2}) - \sqrt{x^2 \pm a^2}$$

$$512. \int x \log(x + \sqrt{x^2 \pm a^2}) dx = \left(\frac{x^2}{2} \pm \frac{a^2}{4}\right) \log(x + \sqrt{x^2 \pm a^2}) - \frac{x\sqrt{x^2 \pm a^2}}{4}$$

$$513. \int x^m \log(x + \sqrt{x^2 \pm a^2}) dx = \frac{x^{m+1}}{m+1} \log(x + \sqrt{x^2 \pm a^2}) - \frac{1}{m+1} \int \frac{x^{m+1}}{\sqrt{x^2 \pm a^2}} dx$$

$$514. \int \frac{\log(x + \sqrt{x^2 + a^2})}{x^2} dx = -\frac{\log(x + \sqrt{x^2 + a^2})}{x} - \frac{1}{a} \log \frac{a + \sqrt{x^2 + a^2}}{x}$$

$$515. \int \frac{\log(x + \sqrt{x^2 - a^2})}{x^2} dx = -\frac{\log(x + \sqrt{x^2 - a^2})}{x} + \frac{1}{|a|} \sec^{-1} \frac{x}{a}$$

$$516. \int x^n \log(x^2 - a^2) dx = \frac{1}{n+1} \left[ x^{n+1} \log(x^2 - a^2) - a^{n+1} \log(x-a) - (-a)^{n+1} \log(x+a) - 2 \sum_{r=0}^{\lfloor n/2 \rfloor} \frac{a^{2r} x^{n-2r+1}}{n-2r+1} \right]$$

Note:  $[s]$  means greatest integer  $\leq s$ ; Thus  $[3.5]$  means 3;  $[5] = 5$ ,  $[\frac{1}{2}] = 0$ .

## EXPONENTIAL FORMS

517.  $\int e^x dx = e^x$
518.  $\int e^{-x} dx = -e^{-x}$
519.  $\int e^{ax} dx = \frac{e^{ax}}{a}$
520.  $\int x e^{ax} dx = \frac{e^{ax}}{a^2}(ax - 1)$
521.  $\int x^m e^{ax} dx = \begin{cases} \frac{x^m e^{ax}}{a} - \frac{m}{a} \int x^{m-1} e^{ax} dx \\ \text{or} \\ e^{ax} \sum_{r=0}^m (-1)^r \frac{m! x^{m-r}}{(m-r)! a^{r+1}} \end{cases}$
522.  $\int \frac{e^{ax}}{x} dx = \log x + \frac{ax}{1!} + \frac{a^2 x^2}{2 \cdot 2!} + \frac{a^3 + x^3}{3 \cdot 3!} + \dots$
523.  $\int \frac{e^{ax}}{x^m} dx = -\frac{1}{m-1} \frac{e^{ax}}{x^{m-1}} + \frac{a}{m-1} \int \frac{e^{ax}}{x^{m-1}} dx$
524.  $\int e^{ax} \log x dx = \frac{e^{ax} \log x}{a} - \frac{1}{a} \int \frac{e^{ax}}{x} dx$
525.  $\int \frac{dx}{1+e^x} = x - \log(1+e^x) = \log \frac{e^x}{1+e^x}$
526.  $\int \frac{dx}{a+be^{px}} = \frac{x}{a} - \frac{1}{ap} \log(a+be^{px})$
527.  $\int \frac{dx}{ae^{mx} + be^{-mx}} = \frac{1}{m\sqrt{ab}} \tan^{-1} \left( e^{mx} \sqrt{\frac{a}{b}} \right), \quad (a > 0, b > 0)$
528.  $\int \frac{dx}{ae^{mx} - be^{-mx}} = \begin{cases} \frac{1}{2m\sqrt{ab}} \log \frac{\sqrt{a} e^{mx} - \sqrt{b}}{\sqrt{a} e^{mx} + \sqrt{b}} \\ \text{or} \\ \frac{-1}{m\sqrt{ab}} \tanh^{-1} \left( \sqrt{\frac{a}{b}} e^{mx} \right), \quad (a > 0, b > 0) \end{cases}$
529.  $\int (a^x - a^{-x}) dx = \frac{a^x + a^{-x}}{\log a}$
530.  $\int \frac{e^{ax}}{b+ce^{ax}} dx = \frac{1}{ac} \log(b+ce^{ax})$
531.  $\int \frac{x e^{ax}}{(1+ax)^2} dx = \frac{e^{ax}}{a^2(1+ax)}$
532.  $\int x e^{-x^2} dx = -\frac{1}{2} e^{-x^2}$
533.  $\int e^{ax} \sin(bx) dx = \frac{e^{ax}[a \sin(bx) - b \cos(bx)]}{a^2 + b^2}$
534.  $\int e^{ax} \sin(bx) \sin(cx) dx = \frac{e^{ax}[(b-c) \sin(b-c)x + a \cos(b-c)x]}{2[a^2 + (b-c)^2]} - \frac{e^{ax}[(b+c) \sin(b+c)x + a \cos(b+c)x]}{2[a^2 + (b+c)^2]}$
535.  $\int e^{ax} \sin(bx) \cos(cx) dx = \begin{cases} \frac{e^{ax}[a \sin(b-c)x - (b-c) \cos(b-c)x]}{2[a^2 + (b-c)^2]} + \frac{e^{ax}[a \sin(b+c)x - (b+c) \cos(b+c)x]}{2[a^2 + (b+c)^2]} \\ \text{or} \\ \frac{e^{ax}}{\rho} [(a \sin bx - b \cos bx) \cos(cx - \alpha)] - c(\sin bx) \sin(cx - \alpha) \end{cases}$   
where  
 $\rho = \sqrt{(a^2 + b^2 - c^2)^2 + 4a^2 c^2},$   
 $\rho \cos \alpha = a^2 + b^2 - c^2, \quad \rho \sin \alpha = 2ac$
536.  $\int e^{ax} \sin(bx) \sin(bx+c) dx = \frac{e^{ax} \cos c}{2a} - \frac{e^{ax}[a \cos(2bx+c) + 2b \sin(2bx+c)]}{2(a^2 + 4b^2)}$
537.  $\int e^{ax} \sin(bx) \cos(bx+c) dx = -\frac{e^{ax} \sin c}{2a} + \frac{e^{ax}[a \sin(2bx+c) - 2b \cos(2bx+c)]}{2(a^2 + 4b^2)}$
538.  $\int e^{ax} \cos(bx) dx = \frac{e^{ax}}{a^2 + b^2} [a \cos(bx) + b \sin(bx)]$
539.  $\int e^{ax} \cos(bx) \cos(cx) dx = \frac{e^{ax}[(b-c) \sin(b-c)x + a \cos(b-c)x]}{2[a^2 + (b-c)^2]} + \frac{e^{ax}[(b+c) \sin(b+c)x + a \cos(b+c)x]}{2[a^2 + (b+c)^2]}$
540.  $\int e^{ax} \cos(bx) \cos(bx+c) dx = \frac{e^{ax} \cos c}{2a} + \frac{e^{ax}[a \cos(2bx+c) + 2b \sin(2bx+c)]}{2(a^2 + 4b^2)}$
541.  $\int e^{ax} \cos(bx) \sin(bx+c) dx = \frac{e^{ax} \sin c}{2a} + \frac{e^{ax}[a \sin(2bx+c) - 2b \cos(2bx+c)]}{2(a^2 + 4b^2)}$

$$542. \int e^{ax} \sin^n(bx) dx = \frac{1}{a^2 + n^2 b^2} \left[ (a \sin bx - nb \cos bx) e^{ax} \sin^{n-1} bx + n(n-1)b^2 \int e^{ax} [\sin^{n-2} bx] dx \right]$$

$$543. \int e^{ax} \cos^n(bx) dx = \frac{1}{a^2 + n^2 b^2} \left[ (a \cos bx + nb \sin bx) e^{ax} \cos^{n-1} bx + n(n-1)b^2 \int e^{ax} [\cos^{n-2} bx] dx \right]$$

$$544. \int x^m e^x \sin x dx = \frac{1}{2} x^m e^x (\sin x - \cos x) - \frac{m}{2} \int x^{m-1} e^x \sin x dx + \frac{m}{2} \int x^{m-1} e^x \cos x dx$$

$$545. \int x^m e^{ax} \sin(bx) dx = \begin{cases} x^m e^{ax} \frac{a \sin bx - b \cos bx}{a^2 + b^2} - \frac{m}{a^2 + b^2} \int x^{m-1} e^{ax} (a \sin bx - b \cos bx) dx \\ \text{or} \\ e^{ax} \sum_{r=0}^m \frac{(-1)^r m! x^{m-r}}{\rho^{r+1} (m-r)!} \sin[bx - (r+1)\alpha] \\ \text{where} \\ \rho = \sqrt{a^2 + b^2}, \quad \rho \cos \alpha = a, \quad \rho \sin \alpha = b \end{cases}$$

$$546. \int x^m e^x \cos x dx = \frac{1}{2} x^m e^x (\sin x + \cos x) - \frac{m}{2} \int x^{m-1} e^x \sin x dx - \frac{m}{2} \int x^{m-1} e^x \cos x dx$$

$$547. \int x^m e^{ax} \cos(bx) dx = \begin{cases} x^m e^{ax} \frac{a \cos bx + b \sin bx}{a^2 + b^2} - \frac{m}{a^2 + b^2} \int x^{m-1} e^{ax} (a \cos bx + b \sin bx) dx \\ \text{or} \\ e^{ax} \sum_{r=0}^m \frac{(-1)^r m! x^{m-r}}{\rho^{r+1} (m-r)!} \cos[bx - (r+1)\alpha] \\ \rho = \sqrt{a^2 + b^2}, \quad \rho \cos \alpha = a, \quad \rho \sin \alpha = b \end{cases}$$

$$548. \int e^{ax} (\cos^m x) (\sin^n x) dx = \begin{cases} \frac{e^{ax} \cos^{m-1} x \sin^n x [a \cos x + (m+n) \sin x]}{(m+n)^2 + a^2} \\ - \frac{na}{(m+n)^2 + a^2} \int e^{ax} (\cos^{m-1} x) (\sin^{n-1} x) dx \\ + \frac{(m-1)(m+n)}{(m+n)^2 + a^2} \int e^{ax} (\cos^{m-2} x) (\sin^n x) dx \\ \text{or} \\ \frac{e^{ax} \cos^m x \sin^{n-1} x [a \sin x - (m+n) \cos x]}{(m+n)^2 + a^2} \\ + \frac{ma}{(m+n)^2 + a^2} \int e^{ax} (\cos^{m-1} x) (\sin^{n-1} x) dx \\ + \frac{(n-1)(m+n)}{(m+n)^2 + a^2} \int e^{ax} (\cos^m x) (\sin^{n-2} x) dx \\ \text{or} \\ \frac{e^{ax} (\cos^{m-1} x) (\sin^{n-1} x) (a \sin x \cos x + m \sin^2 x - n \cos^2 x)}{(m+n)^2 + a^2} \\ + \frac{m(m-1)}{(m+n)^2 + a^2} \int e^{ax} (\cos^{m-2} x) (\sin^n x) dx \\ + \frac{n(n-1)}{(m+n)^2 + a^2} \int e^{ax} (\cos^m x) (\sin^{n-2} x) dx \\ \text{or} \\ \frac{e^{ax} (\cos^{m-1} x) (\sin^{n-1} x) (a \cos x \sin x + m \sin^2 x - n \cos^2 x)}{(m+n)^2 + a^2} \\ + \frac{m(m-1)}{(m+n)^2 + a^2} \int e^{ax} (\cos^{m-2} x) (\sin^{n-2} x) dx \\ + \frac{(n-m)(n+m-1)}{(m+n)^2 + a^2} \int e^{ax} (\cos^m x) (\sin^{n-2} x) dx \end{cases}$$

$$549. \int x e^{ax} \sin(bx) dx = \frac{x e^{ax}}{a^2 + b^2} (a \sin bx - b \cos bx) - \frac{e^{ax}}{(a^2 + b^2)^2} [(a^2 - b^2) \sin bx - 2ab \cos bx]$$

$$550. \int x e^{ax} \cos(bx) dx = \frac{x e^{ax}}{a^2 + b^2} (a \cos bx + b \sin bx) - \frac{e^{ax}}{(a^2 + b^2)^2} [(a^2 - b^2) \cos bx + 2ab \sin bx]$$

$$551. \int \frac{e^{ax}}{\sin^n x} dx = -\frac{e^{ax} [a \sin x + (n-2) \cos x]}{(n-1)(n-2) \sin^{n-1} x} + \frac{a^2 + (n-2)^2}{(n-1)(n-2)} \int \frac{e^{ax}}{\sin^{n-2} x} dx$$

$$552. \int \frac{e^{ax}}{\cos^n x} dx = -\frac{e^{ax} [a \cos x - (n-2) \sin x]}{(n-1)(n-2) \cos^{n-1} x} + \frac{a^2 + (n-2)^2}{(n-1)(n-2)} \int \frac{e^{ax}}{\cos^{n-2} x} dx$$

$$553. \int e^{ax} \tan^n x dx = e^{ax} \frac{\tan^{n-1} x}{n-1} - \frac{a}{n-1} \int e^{ax} \tan^{n-1} x dx - \int e^{ax} \tan^{n-2} x dx$$

## HYPERBOLIC FORMS

$$554. \int \sinh x dx = \cosh x$$

$$555. \int \cosh x dx = \sinh x$$

$$556. \int \tanh x dx = \log \cosh x$$

557.  $\int \coth x \, dx = \log \sinh x$
558.  $\int \operatorname{sech} x \, dx = \tan^{-1}(\sinh x)$
559.  $\int \operatorname{csch} x \, dx = \log \tanh \left( \frac{x}{2} \right)$
560.  $\int x \sinh x \, dx = x \cosh x - \sinh x$
561.  $\int x^n \sinh x \, dx = x^n \cosh x - n \int x^{n-1} (\cosh x) \, dx$
562.  $\int x \cosh x \, dx = x \sinh x - \cosh x$
563.  $\int x^n \cosh x \, dx - x^n \sinh x - n \int x^{n-1} (\sinh x) \, dx$
564.  $\int \operatorname{sech} x \tanh x \, dx = -\operatorname{sech} x$
565.  $\int \operatorname{csch} x \coth x \, dx = -\operatorname{csch} x$
566.  $\int \sinh^2 x \, dx = \frac{\sinh 2x}{4} - \frac{x}{2}$
567.  $\int (\sinh^m x)(\cosh^n x) \, dx = \begin{cases} \frac{1}{m+n} (\sinh^{m+1} x)(\cosh^{n-1} x) + \frac{n-1}{m+n} \int (\sinh^m x)(\cosh^{n-2} x) \, dx \\ \text{or} \\ \frac{1}{m+n} \sinh^{m-1} x \cosh^{n+1} x - \frac{m-1}{m+n} \int (\sinh^{m-2} x)(\cosh^n x) \, dx, \quad (m+n \neq 0) \end{cases}$
568.  $\int \frac{dx}{(\sinh^m x)(\cosh^n x)} \begin{cases} -\frac{1}{(m-n)(\sinh^{m-1} x)(\cosh^{n-1} x)} - \frac{m+n-2}{m-1} \int \frac{dx}{(\sinh^{m-2} x)(\cosh^n x)}, \quad (m \neq 1) \\ \text{or} \\ \frac{1}{(n-1) \sinh^{m-1} x \cosh^{n-1} x} + \frac{m+n-2}{n-1} \int \frac{dx}{(\sinh^m x)(\cosh^{n-2} x)}, \quad (n \neq 1) \end{cases}$
569.  $\int \tanh^2 x \, dx = x - \tanh x$
570.  $\int \tanh^n x \, dx = -\frac{\tanh^{n-1} x}{n-1} + \int (\tanh^{n-2} x) \, dx, \quad (n \neq 1)$
571.  $\int \operatorname{sech}^2 x \, dx = \tanh x$
572.  $\int \cosh^2 x \, dx = \frac{\sinh 2x}{4} + \frac{x}{2}$
573.  $\int \coth^2 x \, dx = x - \coth x$
574.  $\int \coth^n x \, dx = -\frac{\coth^{n-1} x}{n-1} + \int \coth^{n-2} x \, dx, \quad (n \neq 1)$
575.  $\int \operatorname{csch}^2 x \, dx = -\operatorname{ctnh} x$
576.  $\int \sinh(mx) \sinh(nx) \, dx = \frac{\sinh(m+n)x}{2(m+n)} - \frac{\sinh(m-n)x}{2(m-n)}, \quad (m^2 \neq n^2)$
577.  $\int \cosh(mx) \cosh(nx) \, dx = \frac{\sinh(m+n)x}{2(m+n)} + \frac{\sinh(m-n)x}{2(m-n)}, \quad (m^2 \neq n^2)$
578.  $\int \sinh(mx) \cosh(nx) \, dx = \frac{\cosh(m+n)x}{2(m+n)} + \frac{\cosh(m-n)x}{2(m-n)}, \quad (m^2 \neq n^2)$
579.  $\int \sinh^{-1} \frac{x}{a} \, dx = x \sinh^{-1} \frac{x}{a} - \sqrt{x^2 + a^2}, \quad (a > 0)$
580.  $\int x \sinh^{-1} \frac{x}{a} \, dx = \left( \frac{x^2}{2} + \frac{a^2}{4} \right) \sinh^{-1} \frac{x}{a} - \frac{x}{4} \sqrt{x^2 + a^2}, \quad (a > 0)$
581.  $\int x^n \sinh^{-1} x \, dx = \left( \frac{x^{n+1}}{n+1} \right) \sinh^{-1} x - \frac{1}{n+1} \int \frac{x^{n+1}}{(1+x^2)^{\frac{1}{2}}} \, dx, \quad (n \neq -1)$
582.  $\int \cosh^{-1} \frac{x}{a} \, dx = \begin{cases} x \cosh^{-1} \frac{x}{a} - \sqrt{x^2 - a^2}, \quad \left( \cosh^{-1} \frac{x}{a} > 0 \right) \\ \text{or} \\ x \cosh^{-1} \frac{x}{a} + \sqrt{x^2 - a^2}, \quad \left( \cosh^{-1} \frac{x}{a} < 0 \right), \quad (a > 0) \end{cases}$



583.  $\int x \cosh^{-1} \frac{x}{a} dx = \frac{2x^2 - a^2}{4} \cosh^{-1} \frac{x}{a} - \frac{x}{4}(x^2 - a^2)^{\frac{1}{2}}$
584.  $\int x^n (\cosh^{-1} x) dx = \frac{x^{n+1}}{n+1} \cosh^{-1} x - \frac{1}{n+1} \int \frac{x^{n+1}}{(x^2 - 1)^{\frac{1}{2}}} dx, \quad (n \neq -1)$
585.  $\int \tanh^{-1} \frac{x}{a} dx = x \tanh^{-1} \frac{x}{a} + \frac{a}{2} \log(a^2 - x^2), \quad \left(\left|\frac{x}{a}\right| < 1\right)$
586.  $\int \coth^{-1} \frac{x}{a} dx = x \coth^{-1} \frac{x}{a} + \frac{a}{2} \log(x^2 - a^2), \quad \left(\left|\frac{x}{a}\right| > 1\right)$
587.  $\int x \tanh^{-1} \frac{x}{a} dx = \frac{x^2 - a^2}{2} \tanh^{-1} \frac{x}{a} + \frac{ax}{2}, \quad \left(\left|\frac{x}{a}\right| < 1\right)$
588.  $\int x^n \tanh^{-1} x dx = \frac{x^{n+1}}{n+1} \tanh^{-1} x - \frac{1}{n+1} \int \frac{x^{n+1}}{1 - x^2} dx, \quad (n \neq -1)$
589.  $\int x \coth^{-1} \frac{x}{a} dx = \frac{x^2 - a^2}{2} \coth^{-1} \frac{x}{a} + \frac{ax}{2}, \quad \left(\left|\frac{x}{a}\right| > 1\right)$
590.  $\int x^n \coth^{-1} x dx = \frac{x^{n+1}}{n+1} \coth^{-1} x + \frac{1}{n+1} \int \frac{x^{n+1}}{x^2 - 1} dx, \quad (n \neq -1)$
591.  $\int \operatorname{sech}^{-1} x dx = x \operatorname{sech}^{-1} x + \sin^{-1} x$
592.  $\int x \operatorname{sech}^{-1} x dx = \frac{x^2}{2} \operatorname{sech}^{-1} x - \frac{1}{2} \sqrt{1 - x^2}$
593.  $\int x^n \operatorname{sech}^{-1} x dx = \frac{x^{n+1}}{n+1} \operatorname{sech}^{-1} x + \frac{1}{n+1} \int \frac{x^n}{\sqrt{1 - x^2}} dx, \quad (n \neq -1)$
594.  $\int \operatorname{csch}^{-1} x dx = x \operatorname{csch}^{-1} x + \frac{x}{|x|} \sinh^{-1} x$
595.  $\int x \operatorname{csch}^{-1} x dx = \frac{x^2}{2} \operatorname{csch}^{-1} x + \frac{1}{2} \frac{x}{|x|} \sqrt{1 + x^2}$
596.  $\int x^n \operatorname{csch}^{-1} x dx = \frac{x^{n+1}}{n+1} \operatorname{csch}^{-1} x + \frac{1}{n+1} \frac{x}{|x|} \int \frac{x^n}{\sqrt{x^2 + 1}} dx, \quad (n \neq -1)$

## DEFINITE INTEGRALS

597.  $\int_0^{\infty} x^{n-1} e^{-x} dx = \int_0^1 \left(\log \frac{1}{x}\right)^{n-1} dx = \frac{1}{n} \prod_{m=1}^{\infty} \frac{\left(1 + \frac{1}{m}\right)^n}{1 + \frac{n}{m}} = \Gamma(n)$   
 for  $n \neq 0, -1, -2, -3, \dots$  (This is the Gamma function)
598.  $\int_0^{\infty} t^n p^{-t} dt = \frac{n!}{(\log p)^{n+1}}, \quad (n = 0, 1, 2, 3, \dots \text{ and } p > 0)$
599.  $\int_0^{\infty} t^{n-1} e^{-(a+1)t} dt = \frac{\Gamma(n)}{(a+1)^n}, \quad (n > 0, a > -1)$
600.  $\int_0^1 x^m \left(\log \frac{1}{x}\right)^n dx = \frac{\Gamma(n+1)}{(m+1)^{n+1}}, \quad (m > -1, n > -1)$
601.  $\Gamma(n)$  is finite if  $n > 0$ ;  $\Gamma(n+1) = n\Gamma(n)$
602.  $\Gamma(n) \cdot \Gamma(1-n) = \frac{\pi}{\sin n\pi}$
603.  $\Gamma(n) = (n-1)!$  if  $n = \text{integer} > 0$
604.  $\Gamma\left(\frac{1}{2}\right) = 2 \int_0^{\infty} e^{-t^2} dt = \sqrt{\pi} = 1.7724538509 \dots = \left(-\frac{1}{2}\right)!$
605.  $\Gamma\left(n + \frac{1}{2}\right) = \frac{1 \cdot 3 \cdot 5 \dots (2n-1)}{2^n} \sqrt{\pi} \quad n = 1, 2, 3, \dots$
606.  $\Gamma\left(-n + \frac{1}{2}\right) = \frac{(-1)^n 2^n \sqrt{\pi}}{1 \cdot 3 \cdot 5 \dots (2n-1)} \quad n = 1, 2, 3, \dots$
607.  $\int_0^1 x^{m-1} (1-x)^{n-1} dx = \int_0^{\infty} \frac{x^{m-1}}{(1+x)^{m+n}} dx = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)} = B(m, n)$   
 (This is the Beta function)
608.  $B(m, n) = B(n, m) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$ , where  $m$  and  $n$  are any positive real numbers.
609.  $\int_a^b (x-a)^m (b-x)^n dx = (b-a)^{m+n+1} \frac{\Gamma(m+1) \cdot \Gamma(n+1)}{\Gamma(m+n+2)}, \quad (m > -1, n > -1, b > a)$
610.  $\int_1^{\infty} \frac{dx}{x^m} = \frac{1}{m-1}, \quad [m > 1]$
611.  $\int_0^{\infty} \frac{dx}{(1+x)x^p} = \pi \csc p\pi, \quad [0 < p < 1]$

612.  $\int_0^\infty \frac{dx}{(1-x)x^p} = -\pi \cot p\pi, \quad [0 < p < 1]$
613.  $\int_0^\infty \frac{x^{p-1} dx}{(1+x)} = \frac{\pi}{\sin p\pi} = B(p, 1-p) = \Gamma(p)\Gamma(1-p), \quad [0 < p < 1]$
614.  $\int_0^\infty \frac{x^{m-1} dx}{1+x^n} = \frac{\pi}{n \sin \frac{m\pi}{n}}, \quad [0 < m < n]$
615.  $\int_0^\infty \frac{x^a dx}{(m+x^b)^c} = \frac{m^{\frac{a+1-bc}{b}}}{b} \left[ \frac{\Gamma(\frac{a+1}{b}) \Gamma(c - \frac{a+1}{b})}{\Gamma(c)} \right] \quad (a > -1, b > 0, m > 0, c > \frac{a+1}{b})$
616.  $\int_0^\infty \frac{dx}{(1+x)\sqrt{x}} = \pi$
617.  $\int_0^\infty \frac{a dx}{a^2 + x^2} = \begin{cases} \frac{\pi}{2} & (\text{if } a > 0), \\ 0 & (\text{if } a = 0), \\ -\frac{\pi}{2} & (\text{if } a < 0) \end{cases}$
618.  $\int_0^a (a^2 - x^2)^{n/2} dx = \frac{1}{2} \int_{-a}^a (a^2 - x^2)^{n/2} dx = \frac{1 \cdot 3 \cdot 5 \dots n}{2 \cdot 4 \cdot 6 \dots (n+1)} \cdot \frac{\pi}{2} \cdot a^{n+1} \quad (n \text{ odd}, a > 0)$
619.  $\int_0^a x^m (a^2 - x^2)^{n/2} dx = \begin{cases} \frac{1}{2} a^{m+n+1} B\left(\frac{m+1}{2}, \frac{n+2}{2}\right) & (a > 0, m > -1, n > -2) \\ \text{or} \\ \frac{1}{2} a^{m+n+1} \frac{\Gamma(\frac{m+1}{2}) \Gamma(\frac{n+2}{2})}{\Gamma(\frac{m+n+3}{2})} & (a > 0, m > -1, n > -2) \end{cases}$
620.  $\int_0^{\pi/2} \sin^n x dx = \begin{cases} \int_0^{\pi/2} (\cos^n x) dx \\ \frac{1 \cdot 3 \cdot 5 \dots (n-1)}{2 \cdot 4 \cdot 6 \dots (n)} \frac{\pi}{2}, & (n \text{ an even integer}, n \neq 0), \\ \frac{1 \cdot 3 \cdot 5 \dots (n-1)}{2 \cdot 4 \cdot 6 \dots (n)}, & (n \text{ an odd integer}, n \neq 0), \\ \frac{\sqrt{\pi}}{2} \frac{\Gamma(\frac{n+1}{2})}{\Gamma(\frac{n}{2}+1)} & (n > -1) \end{cases}$
621.  $\int_0^\infty \frac{\sin mx dx}{x} = \frac{\pi}{2}; \text{ if } m > 0; 0, \text{ if } m = 0; -\frac{\pi}{2}, \text{ if } m < 0$
622.  $\int_0^\infty \frac{\cos x dx}{x} = \infty$
623.  $\int_0^\infty \frac{\tan x dx}{x} = \frac{\pi}{2}$
624.  $\int_0^\pi \sin ax \cdot \sin bx dx = \int_0^\pi \cos ax \cdot \cos bx dx = 0, \quad (a \neq b; a, b \text{ integers})$
625.  $\int_0^{\pi/a} [\sin(ax)][\cos(ax)] dx = \int_0^\pi [\sin(ax)][\cos(ax)] dx = 0$
626.  $\int_0^\pi [\sin(ax)][\cos(bx)] dx = \frac{2a}{a^2 - b^2}, \text{ if } a - b \text{ is odd, or } 0 \text{ if } a - b \text{ is even}$
627.  $\int_0^\infty \frac{\sin x \cos mx dx}{x} = 0, \quad \text{if } m < -1 \text{ or } m > 1; \frac{\pi}{4}, \text{ if } m = \pm 1; \frac{\pi}{2}, \text{ if } m^2 < 1$
628.  $\int_0^\infty \frac{\sin ax \sin bx}{x^2} dx = \frac{\pi a}{2}, \quad (a \leq b)$
629.  $\int_0^\pi \sin^2 mx dx = \int_0^\pi \cos^2 mx dx = \frac{\pi}{2} \quad (m \text{ is a non-zero integer})$
630.  $\int_0^\infty \frac{\sin^2(px)}{x^2} dx = \frac{\pi|p|}{2}$
631.  $\int_0^\infty \frac{\sin x}{x^p} dx = \frac{\pi}{2\Gamma(p) \sin(p\pi/2)}, \quad 0 < p < 1$
632.  $\int_0^\infty \frac{\cos x}{x^p} dx = \frac{\pi}{2\Gamma(p) \cos(p\pi/2)}, \quad 0 < p < 1$
633.  $\int_0^\infty \frac{1 - \cos px}{x^2} dx = \frac{\pi|p|}{2}$
634.  $\int_0^\infty \frac{\sin px \cos qx}{x} dx = \begin{cases} 0, & q > p > 0; \\ \frac{\pi}{2}, & p > q > 0; \\ \frac{\pi}{4}, & p = q > 0 \end{cases}$
635.  $\int_0^\infty \frac{\cos(mx)}{x^2 + a^2} dx = \frac{\pi}{2|a|} e^{-|ma|}$

$$636. \int_0^{\infty} \cos(x^2) dx = \int_0^{\infty} \sin(x^2) dx = \frac{1}{2} \sqrt{\frac{\pi}{2}}$$

$$637. \int_0^{\infty} \sin ax^n dx = \frac{1}{na^{1/n}} \Gamma(1/n) \sin \frac{\pi}{2n}, \quad \text{if } n > 1$$

$$638. \int_0^{\infty} \cos ax^n dx = \frac{1}{na^{1/n}} \Gamma(1/n) \cos \frac{\pi}{2n}, \quad \text{if } n > 1$$

$$639. \int_0^{\infty} \frac{\sin x}{\sqrt{x}} dx = \int_0^{\infty} \frac{\cos x}{\sqrt{x}} dx = \sqrt{\frac{\pi}{2}}$$

$$640. (a) \int_0^{\infty} \frac{\sin^3 x}{x} dx = \frac{\pi}{4} \quad (b) \int_0^{\infty} \frac{\sin^3 x}{x^2} dx = \frac{3}{4} \log 3$$

$$641. \int_0^{\infty} \frac{\sin^3 x}{x^3} dx = \frac{3\pi}{8}$$

$$642. \int_0^{\infty} \frac{\sin^4 x}{x^4} dx = \frac{\pi}{3}$$

$$643. \int_0^{\pi/2} \frac{dx}{1+a \cos x} = \frac{\cos^{-1} a}{\sqrt{1-a^2}}, \quad (|a| < 1)$$

$$644. \int_0^{\pi} \frac{dx}{a+b \cos x} = \frac{\pi}{\sqrt{a^2-b^2}}, \quad (a > b \geq 0)$$

$$645. \int_0^{2\pi} \frac{dx}{1+a \cos x} = \frac{2\pi}{\sqrt{1-a^2}}, \quad (a^2 < 1)$$

$$646. \int_0^{\infty} \frac{\cos ax - \cos bx}{x} dx = \log \left| \frac{b}{a} \right|$$

$$647. \int_0^{\pi/2} \frac{dx}{a^2 \sin^2 x + b^2 \cos^2 x} = \frac{\pi}{2|ab|}$$

$$648. \int_0^{\pi/2} \frac{dx}{(a^2 \sin^2 x + b^2 \cos^2 x)^2} = \frac{\pi(a^2 + b^2)}{4a^3 b^3}, \quad (a, b > 0)$$

$$649. \int_0^{\pi/2} \sin^{n-1} x \cos^{m-1} x dx = \frac{1}{2} B\left(\frac{n}{2}, \frac{m}{2}\right), \quad (\text{if } m \text{ and } n \text{ are positive integers})$$

$$650. \int_0^{\pi/2} (\sin^{2n+1} \theta) d\theta = \frac{2 \cdot 4 \cdot 6 \dots (2n)}{1 \cdot 3 \cdot 5 \dots (2n+1)}, \quad (n = 1, 2, 3, \dots)$$

$$651. \int_0^{\pi/2} (\sin^{2n} \theta) d\theta = \frac{1 \cdot 3 \cdot 5 \dots (2n-1)}{2 \cdot 4 \dots (2n)} \left(\frac{\pi}{2}\right), \quad (n = 1, 2, 3, \dots)$$

$$652. \int_0^{\pi/2} \frac{x}{\sin x} dx = 2 \left\{ \frac{1}{1^2} - \frac{1}{3^2} + \frac{1}{5^2} - \frac{1}{7^2} + \dots \right\}$$

$$653. \int_0^{\pi/2} \frac{dx}{1+\tan^m x} = \frac{\pi}{4}$$

$$654. \int_0^{\pi/2} \sqrt{\cos \theta} d\theta = \frac{(2\pi)^{\frac{3}{2}}}{[\Gamma(\frac{1}{4})]^2}$$

$$655. \int_0^{\pi/2} (\tan^b \theta) d\theta = \frac{\pi}{2 \cos(\frac{b\pi}{2})}, \quad (0 < b < 1)$$

$$656. \int_0^{\infty} \frac{\tan^{-1}(ax) - \tan^{-1}(bx)}{x} dx = \frac{\pi}{2} \log \frac{a}{b}, \quad (a, b > 0)$$

657. The area enclosed by a curve defined through the equation  $x^{\frac{b}{c}} + y^{\frac{b}{c}} = a^{\frac{b}{c}}$  where  $a > 0$ ,  $c$  a positive odd integer and  $b$  a positive even integer is given by  $\frac{[\Gamma(\frac{c}{b})]^2}{\Gamma(\frac{2c}{b})} \left(\frac{2ca^2}{b}\right)$

658.  $I = \iiint_R x^{b-1} y^{m-1} z^{n-1} dv$ , where  $R$  denotes the region of space bounded by the co-ordinate planes and that portion of

the surface  $\left(\frac{x}{a}\right)^p + \left(\frac{y}{b}\right)^q + \left(\frac{z}{c}\right)^k = 1$ , which lies in the first octant and where  $h, m, n, p, q, k, a, b, c$ , denote positive real numbers is given by

$$\int_0^a x^{b-1} dx \int_0^b \left[1 - \left(\frac{x}{a}\right)^p\right]^{\frac{1}{q}} y^m dy \int_0^c \left[1 - \left(\frac{x}{a}\right)^p - \left(\frac{y}{b}\right)^q\right]^{\frac{1}{k}} z^{n-1} dz = \frac{a^b b^m c^n}{p q k} \frac{\Gamma\left(\frac{b}{p}\right) \Gamma\left(\frac{m}{q}\right) \Gamma\left(\frac{n}{k}\right)}{\Gamma\left(\frac{b}{p} + \frac{m}{q} + \frac{n}{k} + 1\right)}$$

659.  $\int_0^{\infty} e^{-ax} dx = \frac{1}{a}, \quad (a > 0)$
660.  $\int_0^{\infty} \frac{e^{-ax} - e^{-bx}}{x} dx = \log \frac{b}{a}, \quad (a, b > 0)$
661.  $\int_0^{\infty} x^n e^{-ax} dx = \begin{cases} \frac{\Gamma(n+1)}{a^{n+1}} & (\text{if } n > -1 \text{ and } a > 0) \\ \text{or} \\ \frac{n!}{a^{n+1}} & (\text{if } a > 0 \text{ and } n \text{ is a positive integer}) \end{cases}$
662.  $\int_0^{\infty} x^n \exp(-ax^p) dx = \frac{\Gamma(k)}{pa^k}, \quad \left(n > -1, p > 0, a > 0, k = \frac{n+1}{p}\right)$
663.  $\int_0^{\infty} e^{-a^2 x^2} dx = \frac{1}{2a} \sqrt{\pi} = \frac{1}{2a} \Gamma\left(\frac{1}{2}\right), \quad (a > 0)$
664.  $\int_0^{\infty} x e^{-x^2} dx = \frac{1}{2}$
665.  $\int_0^{\infty} x^2 e^{-x^2} dx = \frac{\sqrt{\pi}}{4}$
666.  $\int_0^{\infty} x^{2n} e^{-ax^2} dx = \frac{1 \cdot 3 \cdot 5 \dots (2n-1)}{2^{n+1} a^n} \sqrt{\frac{\pi}{a}} \quad (a > 0, n > -\frac{1}{2})$
667.  $\int_0^{\infty} x^{2n+1} e^{-ax^2} dx = \frac{n!}{2a^{n+1}}, \quad (a > 0, n > -1)$
668.  $\int_0^1 x^m e^{-ax} dx = \frac{m!}{a^{m+1}} \left[1 - e^{-a} \sum_{r=0}^m \frac{a^r}{r!}\right]$
669.  $\int_0^{\infty} e^{\left(-x^2 - \frac{a^2}{x^2}\right)} dx = \frac{e^{-2a} \sqrt{\pi}}{2}, \quad (a \geq 0)$
670.  $\int_0^{\infty} e^{-nx} \sqrt{x} dx = \frac{1}{2n} \sqrt{\frac{\pi}{n}} \quad (n > 0)$
671.  $\int_0^{\infty} \frac{e^{-nx}}{\sqrt{x}} dx = \sqrt{\frac{\pi}{n}} \quad (n > 0)$
672.  $\int_0^{\infty} e^{-ax} (\cos mx) dx = \frac{a}{a^2 + m^2}, \quad (a > 0)$
673.  $\int_0^{\infty} e^{-ax} (\sin mx) dx = \frac{m}{a^2 + m^2}, \quad (a > 0)$
674.  $\int_0^{\infty} x e^{-ax} [\sin(bx)] dx = \frac{2ab}{(a^2 + b^2)^2}, \quad (a > 0)$
675.  $\int_0^{\infty} x e^{-ax} [\cos(bx)] dx = \frac{a^2 - b^2}{(a^2 + b^2)^2}, \quad (a > 0)$
676.  $\int_0^{\infty} x^n e^{-ax} [\sin(bx)] dx = \frac{n![(a+ib)^{n+1} - (a-ib)^{n+1}]}{2i(a^2 + b^2)^{n+1}}, \quad (i^2 = -1, a > 0)$
677.  $\int_0^{\infty} x^n e^{-ax} [\cos(bx)] dx = \frac{n![(a-ib)^{n+1} + (a+ib)^{n+1}]}{2(a^2 + b^2)^{n+1}}, \quad (i^2 = -1, a > 0, n > -1)$
678.  $\int_0^{\infty} \frac{e^{-ax} \sin x}{x} dx = \cot^{-1} a, \quad (a > 0)$
679.  $\int_0^{\infty} e^{-a^2 x^2} \cos bx dx = \frac{\sqrt{\pi}}{2|a|} \exp\left(-\frac{b^2}{4a^2}\right), \quad (ab \neq 0)$
680.  $\int_0^{\infty} e^{-t \cos \phi} t^{b-1} [\sin(t \sin \phi)] dt - [\Gamma(b)] \sin(b\phi), \quad \left(b > 0, -\frac{\pi}{2} < \phi < \frac{\pi}{2}\right)$
681.  $\int_0^{\infty} e^{-t \cos \phi} t^{b-1} [\cos(t \sin \phi)] dt - [\Gamma(b)] \cos(b\phi), \quad \left(b > 0, -\frac{\pi}{2} < \phi < \frac{\pi}{2}\right)$
682.  $\int_0^{\infty} t^{b-1} \cos t dt = [\Gamma(b)] \cos\left(\frac{b\pi}{2}\right), \quad (0 < b < 1)$
683.  $\int_0^{\infty} t^{b-1} (\sin t) dt = [\Gamma(b)] \sin\left(\frac{b\pi}{2}\right), \quad (0 < b < 1)$
684.  $\int_0^1 (\log x)^n dx = (-1)^n \cdot n! \quad (n > -1)$
685.  $\int_0^1 \left(\log \frac{1}{x}\right)^{\frac{1}{2}} dx = \frac{\sqrt{\pi}}{2}$
686.  $\int_0^1 \left(\log \frac{1}{x}\right)^{-\frac{1}{2}} dx = \sqrt{\pi}$

687.  $\int_0^1 \left(\log \frac{1}{x}\right)^n dx = n!$
688.  $\int_0^1 x \log(1-x) dx = -\frac{3}{4}$
689.  $\int_0^1 x \log(1+x) dx = \frac{1}{4}$
690.  $\int_0^1 x^m (\log x)^n dx = \frac{(-1)^n n!}{(m+1)^{n+1}}, \quad (m > -1, n = 0, 1, 2, \dots)$   
 If  $n \neq 0, 1, 2, \dots$  replace  $n!$  by  $\Gamma(n+1)$ .
691.  $\int_0^1 \frac{\log x}{1+x} dx = -\frac{\pi^2}{12}$
692.  $\int_0^1 \frac{\log x}{1-x} dx = -\frac{\pi^2}{6}$
693.  $\int_0^1 \frac{\log(1+x)}{x} dx = \frac{\pi^2}{12}$
694.  $\int_0^1 \frac{\log(1-x)}{x} dx = -\frac{\pi^2}{6}$
695.  $\int_0^1 \log(x) \log(1+x) dx = 2 - 2 \log 2 - \frac{\pi^2}{12}$
696.  $\int_0^1 \log(x) \log(1-x) dx = 2 - \frac{\pi^2}{6}$
697.  $\int_0^1 \frac{\log x}{1-x^2} dx = -\frac{\pi^2}{8}$
698.  $\int_0^1 \log\left(\frac{1+x}{1-x}\right) \cdot \frac{dx}{x} = \frac{\pi^2}{4}$
699.  $\int_0^1 \frac{\log x dx}{\sqrt{1-x^2}} = -\frac{\pi}{2} \log 2$
700.  $\int_0^1 x^m \left[\log\left(\frac{1}{x}\right)\right]^n dx = \frac{\Gamma(n+1)}{(m+1)^{n+1}}, \quad (\text{if } m+1 > 0 \text{ and } n+1 > 0)$
701.  $\int_0^1 \frac{(x^p - x^q) dx}{\log x} = \log\left(\frac{p+1}{q+1}\right), \quad (p+1 > 0, q+1 > 0)$
702.  $\int_0^1 \frac{dx}{\sqrt{\log\left(\frac{1}{x}\right)}} = \sqrt{\pi}, \quad (\text{same as integral 686})$
703.  $\int_0^\infty \log\left(\frac{e^x+1}{e^x-1}\right) dx = \frac{\pi^2}{4}$
704.  $\int_0^{\pi/2} \log(\sin x) dx = \int_0^{\pi/2} \log \cos x dx = -\frac{\pi}{2} \log 2$
705.  $\int_0^{\pi/2} \log(\sec x) dx = \int_0^{\pi/2} \log \csc x dx = \frac{\pi}{2} \log 2$
706.  $\int_0^\pi x \log(\sin x) dx = -\frac{\pi^2}{2} \log 2$
707.  $\int_0^{\pi/2} \sin x \log(\sin x) dx = \log 2 - 1$
708.  $\int_0^{\pi/2} \log \tan x dx = 0$
709.  $\int_0^\pi \log(a \pm b \cos x) dx = \pi \log\left(\frac{a + \sqrt{a^2 - b^2}}{2}\right), \quad (a \geq b)$
710.  $\int_0^\pi \log(a^2 - 2ab \cos x + b^2) dx = \begin{cases} 2\pi \log a & a \geq b > 0 \\ 2\pi \log b & b \geq a > 0 \end{cases}$
711.  $\int_0^\infty \frac{\sin ax}{\sinh bx} dx = \frac{\pi}{2|b|} \tanh \frac{a\pi}{2b}$
712.  $\int_0^\infty \frac{\cos ax}{\cosh bx} dx = \frac{\pi}{2|b|} \operatorname{sech} \frac{a\pi}{2b}$
713.  $\int_0^\infty \frac{dx}{\cosh ax} = \frac{\pi}{2|a|}$

$$714. \int_0^{\infty} \frac{x dx}{\sinh ax} = \frac{\pi^2}{4a^2} \quad (a > 0)$$

$$715. \int_0^{\infty} e^{-ax} \cosh bx dx = \frac{a}{a^2 - b^2}, \quad (0 \leq |b| < a)$$

$$716. \int_0^{\infty} e^{-ax} \sinh bx dx = \frac{b}{a^2 - b^2}, \quad (0 \leq |b| < a)$$

$$717. \int_0^{\infty} \frac{\sinh ax}{e^{bx} + 1} dx = \frac{\pi}{2b} \csc \frac{a\pi}{b} - \frac{1}{2a} \quad (b > 0)$$

$$718. \int_0^{\infty} \frac{\sinh ax}{e^{bx} - 1} dx = \frac{1}{2a} - \frac{\pi}{2b} \cot \frac{a\pi}{b} \quad (b > 0)$$

$$719. \int_0^{\pi/2} \frac{dx}{\sqrt{1 - k^2 \sin^2 x}} = \frac{\pi}{2} \left[ 1 + \left(\frac{1}{2}\right)^2 k^2 + \left(\frac{1 \cdot 3}{2 \cdot 4}\right)^2 k^4 + \left(\frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6}\right)^2 k^6 + \dots \right], \quad \text{if } k^2 < 1$$

$$720. \int_0^{\pi/2} \sqrt{1 - k^2 \sin^2 x} dx = \frac{\pi}{2} \left[ 1 - \left(\frac{1}{2}\right)^2 k^2 - \left(\frac{1 \cdot 3}{2 \cdot 4}\right)^2 \frac{k^4}{3} - \left(\frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6}\right)^2 \frac{k^6}{5} - \dots \right], \quad \text{if } k^2 < 1$$

$$721. \int_0^{\infty} e^{-x} \log x dx = -\gamma = -0.5772157 \dots$$

$$722. \int_0^{\infty} e^{-x^2} \log x dx = -\frac{\sqrt{\pi}}{4} (\gamma + 2 \log 2)$$

$$723. \int_0^{\infty} \left( \frac{1}{1 - e^{-x}} - \frac{1}{x} \right) e^{-x} dx = \gamma = 0.5772157 \dots \quad [\text{Euler's Constant}]$$

$$724. \int_0^{\infty} \frac{1}{x} \left( \frac{1}{1+x} - e^{-x} \right) dx = \gamma = 0.5772157 \dots$$

For  $n$  even :

$$725. \int \cos^n x dx = \frac{1}{2^{n-1}} \sum_{k=0}^{n/2-1} \binom{n}{k} \frac{\sin(n-2k)x}{(n-2k)} + \frac{1}{2^n} \binom{n}{n/2} x$$

$$726. \int \sin^n x dx = \frac{1}{2^{n-1}} \sum_{k=0}^{n/2-1} \binom{n}{k} \frac{\sin[(n-2k)(\frac{\pi}{2}-x)]}{2k-n} + \frac{1}{2^n} \binom{n}{n/2} x$$

For  $n$  odd:

$$727. \int \cos^n x dx = \frac{1}{2^{n-1}} \sum_{k=0}^{(n-1)/2} \binom{n}{k} \frac{\sin(n-2k)x}{n-2k}$$

$$728. \int \sin^n x dx = \frac{1}{2^{n-1}} \sum_{k=0}^{(n-1)/2} \binom{n}{k} \frac{\sin[(n-2k)(\frac{\pi}{2}-x)]}{2k-n}$$

## DIFFERENTIAL EQUATIONS

Certain types of differential equations occur sufficiently often to justify the use of formulas for the corresponding particular solutions. The following set of Tables I to XIV covers all first, second, and  $n$ th order ordinary linear differential equations with constant coefficients for which the right members are of the form  $P(x)e^{rx} \sin sx$  or  $P(x)e^{rx} \cos sx$ , where  $r$  and  $s$  are constants and  $P(x)$  is a polynomial of degree  $n$ .

When the right member of a reducible linear partial differential equation with constant coefficients is not zero, particular solutions for certain types of right members are contained in Tables XV to XXI. In these tables both  $F$  and  $P$  are used to denote polynomials, and it is assumed that no denominator is zero. In any formula the roles of  $x$  and  $y$  may be reversed throughout, changing a formula in which  $x$  dominates to one in which  $y$  dominates. Tables XIX, XX, XXI are applicable whether the equations are reducible or not. The symbol  $\binom{m}{n}$  stands for  $\frac{m!}{(m-n)!n!}$  and is the  $(n+1)$ st coefficient in the expansion of  $(a+b)^m$ . Also  $0! = 1$  by definition.

The tables as herewith given are those contained in the text *Differential Equations* by Ginn and Company (1955) and are published with their kind permission and that of the author, Professor Frederick H. Steen.

### SOLUTION OF LINEAR DIFFERENTIAL EQUATIONS WITH CONSTANT COEFFICIENTS

Any linear differential equation with constant coefficients may be written in the form

$$p(D)y = R(x)$$

where

- $D$  is the differential operation:  $Dy = \frac{dy}{dx}$
- $p(D)$  is a polynomial in  $D$ ,
- $y$  is the dependent variable,
- $x$  is the independent variable,
- $R(x)$  is an arbitrary function of  $x$ .

A power of  $D$  represents repeated differentiation, that is

$$D^n y = \frac{d^n y}{dx^n}$$

For such an equation, the general solution may be written in the form

$$y = y_c + y_p$$

where  $y_p$  is any particular solution, and  $y_c$  is called the *complementary function*. This complementary function is defined as the general solution of the *homogeneous equation*, which is the original differential equation with the right side replaced by zero, i.e.,

$$p(D)y = 0$$

The complementary function  $y_c$  may be determined as follows:

1. Factor the polynomial  $p(D)$  into real and complex linear factors, just as if  $D$  were a variable instead of an operator.
2. For each nonrepeated linear factor of the form  $(D - a)$ , where  $a$  is real, write down a term of the form

$$ce^{ax}$$

where  $c$  is an arbitrary constant.

3. For each repeated real linear factor of the form  $(D - a)^n$ , write down  $n$  terms of the form

$$c_1 e^{ax} + c_2 x e^{ax} + c_3 x^2 e^{ax} + \dots + c_n x^{n-1} e^{ax}$$

where the  $c_i$ 's are arbitrary constants.

4. For each non-repeated conjugate complex pair of factors of the form  $(D - a + ib)(D - a - ib)$ , write down two terms of the form

$$c_1 e^{ax} \cos bx + c_2 e^{ax} \sin bx$$

5. For each repeated conjugate complex pair of factors of the form  $(D - a + ib)^n (D - a - ib)^n$ , write down  $2n$  terms of the form

$$c_1 e^{ax} \cos bx + c_2 e^{ax} \sin bx + c_3 x e^{ax} \cos bx + c_4 x e^{ax} \sin bx \\ + \dots + c_{2n-1} x^{n-1} e^{ax} \cos bx + c_{2n} x^{n-1} e^{ax} \sin bx$$

6. The sum of all the terms thus written down is the complementary function  $y_c$ .

To find the particular solution  $y_p$ , use the following tables, as shown in the examples. For cases not shown in the tables, there are various methods of finding  $y_p$ . The most general method is called *variation of parameters*. The following example illustrates the method:

**Example:** Find  $y_p$  for  $(D^2 - 4)y = e^x$ .

This example can be solved most easily by use of equation 63 in the tables following. However, it is given here as an example of the method of variation of parameters.

The complementary function is

$$y_c = c_1 e^{2x} + c_2 e^{-2x}$$

To find  $y_p$ , replace the constants in the complementary function with unknown functions,

$$y_p = u e^{2x} + v e^{-2x}$$



We now prepare to substitute this assumed solution into the original equation. We begin by taking all the necessary derivatives:

$$\begin{aligned}y_p &= ue^{2x} + ve^{-2x} \\y'_p &= 2ue^{2x} - 2ve^{-2x} + u'e^{2x} + v'e^{-2x}\end{aligned}$$

For each derivative of  $y_p$  except the highest, we set the sum of all the terms containing  $u'$  and  $v'$  to 0. Thus the above equation becomes

$$u'e^{2x} + v'e^{-2x} = 0 \quad \text{and} \quad y'_p = 2ue^{2x} - 2ve^{-2x}$$

Continuing to differentiate, we have

$$y''_p = 4ue^{2x} + 4ve^{-2x} + 2u'e^{2x} - 2v'e^{-2x}$$

When we substitute into the original equation, all the terms not containing  $u'$  or  $v'$  cancel out. This is a consequence of the method by which  $y_p$  was set up.

Thus all that is necessary is to write down the terms containing  $u'$  or  $v'$  in the highest order derivative of  $y_p$ , multiply by the constant coefficient of the highest power of  $D$  in  $p(D)$ , and set it equal to  $R(x)$ . Together with the previous terms in  $u'$  and  $v'$  which were set equal to 0, this gives us as many linear equations in the first derivatives of the unknown functions as there are unknown functions. The first derivatives may then be solved for by algebra, and the unknown functions found by integration. In the present example, this becomes

$$\begin{aligned}u'e^{2x} + v'e^{-2x} &= 0 \\2u'e^{2x} - 2v'e^{-2x} &= e^x\end{aligned}$$

We eliminate  $v'$  and  $u'$  separately, getting

$$\begin{aligned}4u'e^{2x} &= e^x \\4v'e^{-2x} &= -e^x\end{aligned}$$

Thus

$$\begin{aligned}u' &= \frac{1}{4}e^{-x} \\v' &= -\frac{1}{4}e^{3x}\end{aligned}$$

Therefore, by integrating

$$\begin{aligned}u &= -\frac{1}{4}e^{-x} \\v &= -\frac{1}{12}e^{3x}\end{aligned}$$

A constant of integration is not needed, since we need only one particular solution. Thus

$$\begin{aligned}y_p = ue^{2x} + ve^{-2x} &= -\frac{1}{4}e^{-x}e^{2x} - \frac{1}{12}e^{3x}e^{-2x} \\&= -\frac{1}{4}e^x - \frac{1}{12}e^x = -\frac{1}{3}e^x\end{aligned}$$

and the general solution is

$$y = y_c + y_p = c_1e^{2x} + c_2e^{-2x} - \frac{1}{3}e^x$$

The following samples illustrate the use of the tables.

**Example 1:** Solve  $(D^2 - 4)y = \sin 3x$ . Substitution of  $q = -4$ ,  $s = 3$  in formula 24 gives

$$y_p = \frac{\sin 3x}{-9 - 4}$$

wherefore the general solution is

$$y = c_1e^{2x} + c_2e^{-2x} - \frac{\sin 3x}{13}$$

**Example 2:** Obtain a particular solution of  $(D^2 - 4D + 5)y = x^2 e^{3x} \sin x$ .

Applying formula 40 with  $a = 2$ ,  $b = 1$ ,  $r = 3$ ,  $s = 1$ ,  $P(x) = x^2$ ,  $s + b = 2$ ,  $s - b = 0$ ,  $a - r = -1$ ,  $(a - r)^2 + (s + b)^2 = 5$ ,  $(a - r)^2 + (s - b)^2 = 1$ , we have

$$\begin{aligned} y_p &= \frac{e^{3x} \sin x}{2} \left[ \left( \frac{2}{5} - \frac{0}{1} \right) x^2 + \left( \frac{2(-1)2}{25} - \frac{2(-1)0}{1} \right) 2x + \left( \frac{3 \cdot 1 \cdot 2 - 2^3}{125} - \frac{3 \cdot 1 \cdot 0 - 0}{1} \right) 2 \right] \\ &\quad - \frac{e^{3x} \cos x}{2} \left[ \left( \frac{-1}{5} - \frac{-1}{1} \right) x^2 + \left( \frac{1-4}{25} - \frac{1-0}{1} \right) 2x + \left( \frac{-1-3(-1)4}{125} - \frac{-1-3(-1)0}{1} \right) 2 \right] \\ &= \left( \frac{1}{5} x^2 - \frac{4}{25} x - \frac{2}{125} \right) e^{3x} \sin x + \left( -\frac{2}{5} x^2 + \frac{28}{25} - \frac{136}{125} \right) e^{3x} \cos x \end{aligned}$$

The special formulas effect a very considerable saving of time in problems of this type.

**Example 3:** Obtain a particular solution of  $(D^2 - 4D + 5)y = x^2 e^{2x} \cos x$ . (Compare with Example 2.)

Formula 40 is not applicable here since for this equation  $r = a$ ,  $s = b$ , wherefore the denominator  $(a - r)^2 + (s - b)^2 = 0$ . We turn instead to formula 44. Substituting  $a = 2$ ,  $b = 1$ ,  $P(x) = x^2$  and replacing  $\sin$  by  $\cos$ ,  $\cos$  by  $-\sin$ , we obtain

$$\begin{aligned} y_p &= \frac{e^{2x} \cos x}{4} \left( x^2 - \frac{2}{4} \right) + \frac{e^{2x} \sin x}{2} \int \left( x^2 - \frac{1}{2} \right) dx \\ &= \left( \frac{x^2}{4} - \frac{1}{8} \right) e^{2x} \cos x + \left( \frac{x^3}{6} - \frac{x}{4} \right) e^{2x} \sin x \end{aligned}$$

which is the required solution.

**Example 4:** Find  $z_p$  for  $(D_x - 3D_y)z = \ln(y + 3x)$ . Referring to Table XV we note that formula 69 (not 68) is applicable. This gives

$$z_p = x \ln(y + 3x)$$

It is easily seen that  $-y/3 \ln(y + 3x)$  would serve equally well.

**Example 5:** Solve  $(D_x + 2D_y - 4)z = y \cos(y - 2x)$ .

Since  $R$  in formula 76 contains a polynomial in  $x$ , not  $y$ , we rewrite the given equation in the form  $(D_y + \frac{1}{2}D_x - 2)z = \frac{1}{2}y \cos(y - 2x)$ . Then

$$z_c = e^{2y} F \left( x - \frac{1}{2}y \right) = e^{2x} f(2x - y)$$

and by the formula

$$z_p = -\frac{1}{2} \cos(y - 2x) \cdot \left( \frac{y}{2} + \frac{1}{2} \right) = -\frac{1}{8} (2y + 1) \cos(y - 2x)$$

**Example 6:** Find  $z_p$  for  $(D_x + 4D_y)^3 z = (2x - y)^2$ .

Using formula 79, we obtain

$$z_p = \frac{\iiint u^2 du^3}{[2 + 4(-1)]^3} = \frac{u^5}{5 \cdot 4 \cdot 3 \cdot (-8)} = -\frac{(2x - y)^5}{480}$$

**Example 7:** Find  $z_p$  for  $(D_x^3 + 5D_x^2 D_y - 7D_x + 4)z = e^{2x+3y}$ . By formula 87

$$z_p = \frac{e^{2x+3y}}{2^3 + 5 \cdot 2^2 \cdot 3 - 7 \cdot 2 + 4} = \frac{e^{2x+3y}}{58}$$

**Example 8:** Find  $z_p$  for

$$(D_x^4 + 6D_x^3 D_y + D_x D_y + D_y^2 + 9)z = \sin(3x + 4y)$$

Since every term in the left number is of even degree in the two operators  $D_x$  and  $D_y$ , formula 90 is applicable. It gives

$$\begin{aligned} z_p &= \frac{\sin(3x + 4y)}{(-9)^2 + 6(-9)(-12) + (-12) + (-16) + 9} \\ &= \frac{\sin(3x + 4y)}{710} \end{aligned}$$

Table I:  $(D - a)y = R$ 

R	$y_p$
1. $e^{rx}$	$\frac{e^{rx}}{r-a}$
2. $\sin sx^*$	$-\frac{1}{a} \frac{\sin sx + s \cos sx}{a^2 + s^2} = \frac{1}{\sqrt{a^2 + s^2}} \sin \left( sx + \tan^{-1} \frac{s}{a} \right)$
3. $P(x)$	$-\frac{1}{a} \left[ P(x) + \frac{P'(x)}{a} + \frac{P''(x)}{a^2} + \dots + \frac{P^{(n)}(x)}{a^n} \right]$
4. $e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 2 and multiply by $e^{rx}$ .
5. $P(x) e^{rx}$	Replace $a$ by $a - r$ in formula 3 and multiply by $e^{rx}$ .
6. $P(x) \sin sx^*$	$-\sin sx \left[ \frac{a}{a^2 + s^2} P(x) + \frac{a^2 - s^2}{(a^2 + s^2)^2} P'(x) + \frac{a^3 - 3as^2}{(a^2 + s^2)^3} P''(x) + \dots + \frac{a^k - \binom{k}{2} a^{k-2} s^2 + \binom{k}{4} a^{k-4} s^4 - \dots}{(a^2 + s^2)^k} P^{(k-1)}(x) + \dots \right]$ $-\cos sx \left[ \frac{s}{a^2 + s^2} P(x) + \frac{2as}{(a^2 + s^2)^2} P'(x) + \frac{3a^2 s - s^3}{(a^2 + s^2)^3} P''(x) + \dots + \frac{\binom{k}{1} a^{k-1} s - \binom{k}{3} a^{k-3} s^3 + \dots}{(a^2 + s^2)^k} P^{(k-1)}(x) + \dots \right]$
7. $P(x)e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 6 and multiply by $e^{rx}$ .
8. $e^{ax}$	$x e^{ax}$
9. $e^{ax} \sin sx^*$	$-\frac{e^{ax} \cos sx}{s}$
10. $P(x)e^{ax}$	$e^{ax} \int^s P(x) dx$
11. $P(x)e^{ax} \sin sx$	$\frac{e^{ax} \sin sx}{s} \left[ \frac{P'(x)}{s^3} - \frac{P'''(x)}{s^3} + \frac{P^{(5)}(x)}{s^3} - \dots \right] - \frac{e^{ax} \cos sx}{s} \left[ P(x) - \frac{P''(x)}{s^2} + \frac{P^{(4)}(x)}{s^4} - \dots \right]$ * For $\cos sx$ in $R$ replace "sin" by "cos" and "cos" by "-sin" in $y_p$ .

$$D^n = \frac{d^n}{dx^n} \quad \binom{m}{n} = \frac{m!}{(m-n)!n!} \quad 0! = 1$$

Table II:  $(D - a)^2 y = R$ 

R	$y_p$
12. $e^{rx}$	$\frac{e^{rx}}{(r-a)^2}$
13. $\sin sx^*$	$\frac{1}{(a^2 + s^2)} [(a^2 - s^2) \sin sx + 2as \cos sx] = \frac{1}{a^2 + s^2} \sin \left( sx + \tan^{-1} \frac{2as}{a^2 - s^2} \right)$
14. $P(x)$	$\frac{1}{a^2} \left[ P(x) + \frac{2P'(x)}{a} + \frac{3P''(x)}{a^2} + \dots + \frac{(n+1)P^{(n)}(x)}{a^n} \right]$
15. $e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 13 and multiply by $e^{rx}$ .
16. $P(x)e^{rx}$	Replace $a$ by $a - r$ in formula 14 and multiply by $e^{rx}$ .
17. $P(x) \sin sx^*$	$\sin sx \left[ \frac{a^2 - s^2}{(a^2 + s^2)^2} P(x) + 2 \frac{a^3 - 3as^2}{(a^2 + s^2)^3} P'(x) + 3 \frac{a^4 - 6a^2 s^2 + s^4}{(a^2 + s^2)^4} P''(x) + \dots \right]$ $+ (k-1) \frac{a^k - \binom{k}{2} a^{k-2} s^2 + \binom{k}{4} a^{k-4} s^4 - \dots}{(a^2 + s^2)^k} P^{(k-2)}(x) + \dots$ $+ \cos sx \left[ \frac{2as}{(a^2 + s^2)^2} P(x) + 2 \frac{3a^2 s - s^3}{(a^2 + s^2)^3} P'(x) + 3 \frac{4a^3 s - 4as^3}{(a^2 + s^2)^4} P''(x) + \dots \right]$ $+ (k-1) \frac{\binom{k}{1} a^{k-1} s - \binom{k}{3} a^{k-3} s^3 + \dots}{(a^2 + s^2)^k} P^{(k-2)}(x) + \dots$
18. $P(x)e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 17 and multiply by $e^{rx}$ .
19. $e^{ax}$	$\frac{1}{2} x^2 e^{ax}$
20. $e^{ax} \sin sx^*$	$-\frac{e^{ax} \sin sx}{s^2}$
21. $P(x)e^{ax}$	$e^{ax} \int \int P(x) dx dx$
22. $P(x)e^{ax} \sin sx^*$	$-\frac{e^{ax} \sin sx}{s^2} \left[ P(x) - \frac{3P''(x)}{s^2} + \frac{5P^{(4)}(x)}{s^4} - \frac{7P^{(6)}(x)}{s^6} + \dots \right]$ $-\frac{e^{ax} \cos sx}{s^2} \left[ \frac{2P'(x)}{s} + \frac{4P'''(x)}{s^3} - \frac{6P^{(5)}(x)}{s^5} - \dots \right]$ * For $\cos sx$ in $R$ replace "sin" by "cos" and "cos" by "-sin" in $y_p$ .

Table III:  $(D^2 + q)y = R$

R	$y_p$
23. $e^{rx}$	$\frac{e^{rx}}{r^2+q}$
24. $\sin sx^*$	$\frac{\sin sx}{-s^2+q}$
25. $P(x)$	$\frac{1}{q} \left[ P(x) - \frac{P'(x)}{q} + \frac{P^{iv}(x)}{q^2} - \dots + (-1)^k \frac{P^{(2k)}(x)}{q^k} \dots \right]$
26. $e^{rx} \sin sx$	$\frac{(r^2-s^2+q)e^{rx} \sin sx - 2rs e^{rx} \cos sx}{(r^2-s^2+q)^2+(2rs)^2} = \frac{e^{rx}}{\sqrt{(r^2-s^2+q)^2+(2rs)^2}} \sin \left[ sx - \tan^{-1} \frac{2rs}{r^2-s^2+q} \right]$
27. $P(x)e^{rx}$	$\frac{e^{rx}}{r^2+q} \left[ P(x) - \frac{2r}{r^2+q} P'(x) + \frac{3r^2-q}{(r^2+q)^2} P''(x) - \frac{4r^3-4qr}{(r^2+q)^3} P'''(x) + \dots \right. \\ \left. + \dots + (-1)^{k-1} \frac{\binom{k}{1} r^{k-1} - \binom{k}{3} r^{k-3} q + \binom{k}{5} r^{k-5} q^2 - \dots}{(r^2+q)^{k-1}} P^{(k-1)}(x) + \dots \right]$
28. $P(x) \sin sx^*$	$\frac{\sin sx}{(-s^2+q)} \left[ P(x) - \frac{3s^2+q}{(-s^2+q)^2} P''(x) + \frac{5s^4+10s^2q+q^2}{(-s^2+q)^4} P^{iv}(x) + \dots \right. \\ \left. + (-1)^k \frac{\binom{2k+1}{1} s^{2k+1} - \binom{2k+1}{3} s^{2k-2} q + \binom{2k+1}{5} s^{2k-4} q^2 + \dots}{(-s^2+q)^{2k}} P^{(2k)}(x) + \dots \right] \\ - \frac{s \cos sx}{(-s^2+q)} \left[ \frac{2P'(x)}{(-s^2+q)} - \frac{4s^2+4q}{(-s^2+q)^3} P'''(x) + \dots \right. \\ \left. + (-1)^{k+1} \frac{\binom{2k}{1} s^{2k-2} + \binom{2k}{3} s^{2k-4} q + \dots}{(-s^2+q)^{2k-1}} P^{(2k-1)}(x) + \dots \right]$

Table IV:  $(D^2 + b^2)y = R$

29. $\sin bx^*$	$-\frac{x \cos bx}{2b}$
30. $P(x) \sin bx^*$	$\frac{\sin bx}{(2b)^2} \left[ P(x) - \frac{P''(x)}{(2b)^2} + \frac{P^{iv}(x)}{(2b)^4} - \dots \right] - \frac{\cos bx}{2b} \int \left[ P(x) - \frac{P''(x)}{(2b)^2} + \dots \right] dx$

\* For  $\cos sx$  in R replace “sin” by “cos” and “cos” by “- sin” in  $y_p$ .

Table V:  $(D^2 pD + q)y = R$

R	$y_p$
31. $e^{rx}$	$\frac{e^{rx}}{r^2+pr+q}$
32. $\sin sx^*$	$\frac{(q-s^2) \sin sx - ps \cos sx}{(q-s^2)^2+(ps)^2} = \frac{1}{\sqrt{(q-s^2)^2+(ps)^2}} \sin \left( sx - \tan^{-1} \frac{ps}{q-s^2} \right)$
33. $P(x)$	$\frac{1}{q} \left[ P(x) - \frac{p}{q} P'(x) + \frac{p^2-q}{q^2} P''(x) - \frac{p^3-2pq}{q^3} P'''(x) + \dots + (-1)^n \frac{p^n - \binom{n-1}{1} p^{n-2} q + \binom{n-2}{2} p^{n-4} q^2 - \dots}{q^n} P^{(n)}(x) \right]$
34. $e^{rx} \sin sx^*$	Replace $p$ by $p + 2r$ , $q$ by $q + pr + r^2$ in formula 32 and multiply by $e^{rx}$ .
35. $P(x)e^{rx}$	Replace $p$ by $p + 2r$ , $q$ by $q + pr + r^2$ in formula 33 and multiply by $e^{rx}$ .

Table VI:  $(D - b)(D - a)y = R$

36. $P(x) \sin sx^*$	$\frac{\sin sx}{b-a} \left[ \left( \frac{a}{a^2+s^2} - \frac{b}{b^2+s^2} \right) P(x) + \left( \frac{a^2-s^2}{(a^2+s^2)^2} - \frac{b^2-s^2}{(b^2+s^2)^2} \right) P'(x) \right. \\ \left. + \left( \frac{a^3-3as^2}{(a^2+s^2)^3} - \frac{b^3-3bs^2}{(b^2+s^2)^3} \right) P''(x) + \dots \right] \\ + \frac{\cos sx}{b-a} \left( \frac{s}{a^2+s^2} - \frac{s}{b^2+s^2} \right) P(x) + \left( \frac{2as}{(a^2+s^2)^2} - \frac{2bs}{(b^2+s^2)^2} \right) P'(x) \\ + \left( \frac{3a^2s-s^2}{(a^2+s^2)^3} - \frac{3b^2s-s^2}{(b^2+s^2)^3} \right) P''(x) + \dots \dagger$
37. $P(x)e^{rx} \sin sx^*$	Replace $a$ by $a-r$ , $b$ by $b-r$ in formula 36 and multiply by $e^{rx}$ .
38. $P(x)e^{ax}$	$\frac{e^{ax}}{a-b} \left[ \int P(x) dx + \frac{P(x)}{(b-a)} + \frac{P'(x)}{(b-a)^2} + \frac{P''(x)}{(b-a)^3} + \dots + \frac{P^{(n)}(x)}{(b-a)^{n+1}} \right]$

\* For  $\cos sx$  in R replace “sin” by “cos” and “cos” by “- sin” in  $y_p$ .  
 † For additional terms, compare with formula 6.

Table VII:  $(D^2 - 2aD + a^2 + b^2)y = R$

R	$y_p$
39. $P(x) \sin sx^*$	$\frac{\sin sx}{2b} \left[ \left( \frac{s+b}{a^2+(s+b)^2} - \frac{s-b}{a^2+(s-b)^2} \right) P(x) + \left( \frac{2a(s+b)}{[a^2+(s+b)^2]^2} - \frac{2a(s-b)}{[a^2+(s-b)^2]^2} \right) P'(x) \right.$ $\left. + \left( \frac{3a^2(s+b)-(s+b)^3}{[a^2+(s+b)^2]^3} - \frac{3a^2(s-b)-(s-b)^3}{[a^2+(s-b)^2]^3} \right) P''(x) + \dots \right]$ $- \frac{\cos sx}{2b} \left[ \left( \frac{a}{a^2+(s+b)^2} - \frac{a}{a^2+(s-b)^2} \right) P(x) + \left( \frac{a^2-(s+b)^2}{[a^2+(s+b)^2]^2} - \frac{a^2-(s-b)^2}{[a^2+(s-b)^2]^2} \right) P'(x) \right.$ $\left. + \left( \frac{a^2-3a(s+b)^2}{[a^2+(s+b)^2]^3} - \frac{a^2-3a(s-b)^2}{[a^2+(s-b)^2]^3} \right) P''(x) + \dots \right]^\dagger$
40. $P(x)e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 39 and multiply by $e^{rx}$ .
41. $P(x)e^{ax}$	$\frac{e^{ax}}{b^2} \left[ P(x) - \frac{P'(x)}{b^2} + \frac{P^{iv}(x)}{b^4} - \dots \right]$
42. $e^{ax} \sin sx^*$	$\frac{e^{ax} \sin sx}{-s^2+b^2}$
43. $e^{ax} \sin bx^*$	$-\frac{x e^{ax} \cos bx}{2b}$
44. $P(x)e^{ax} \sin bx^*$	$\frac{e^{ax} \sin bx}{(2b)^2} \left[ P(x) - \frac{P'(x)}{(2b)^2} + \frac{P^{iv}(x)}{(2b)^4} - \dots \right]$ $- \frac{e^{ax} \cos bx}{2b} \int \left[ P(x) - \frac{P'(x)}{(2b)^2} + \frac{P^{iv}(x)}{(2b)^4} - \dots \right] dx$

\* For  $\cos sx$  in R replace “sin” by “cos” and “cos” by “- sin” in  $y_p$ .  
 † For additional terms, compare with formula 6.

Table VIII:  $f(D)y = [D^n + a_{n-1}D^{n-1} + \dots + a_1D + a_0]y = R$

R	$y_p$
45. $e^{rx}$	$\frac{e^{rx}}{f(r)}$
46. $\sin sx^*$	$\frac{[a_0 - a_2s^2 + a_4s^4 - \dots] \sin sx - [a_1s - a_3s^3 + a_5s^5 - \dots] \cos sx}{[a_0 - a_2s^2 + a_4s^4 - \dots]^2 + [a_1s - a_3s^3 + a_5s^5 - \dots]^2}$

Table IX:  $f(D^2)y = R$

47. $\sin sx^*$	$\frac{\sin sx}{f(-s^2)} = \frac{\sin sx}{a_0 - a_2s^2 + \dots \pm s^{2n}}$
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Table X:  $(D - a)^n y = R$

R	$y_p$
48. $e^{rx}$	$\frac{e^{rx}}{(r-a)^n}$
49. $\sin sx^*$	$\frac{(-1)^n}{(a^2+s^2)^2} \{ [a^n - \binom{n}{2}a^{n-2}s^2 + \binom{n}{4}a^{n-4}s^4 - \dots] \sin sx$ $+ [ \binom{n}{1}a^{n-1}s - \binom{n}{3}a^{n-3}s^3 + \dots ] \cos sx \}$
50. $P(x)$	$\frac{(-1)^n}{a^n} \left[ P(x) + \binom{n}{1} \frac{P'(x)}{a} + \binom{n+1}{2} \frac{P''(x)}{a^2} + \binom{n+2}{3} \frac{P'''(x)}{a^3} + \dots \right]$
51. $e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 49 and multiply by $e^{rx}$ .
52. $e^{rx} P(x)$	Replace $a$ by $a - r$ in formula 50 and multiply by $e^{rx}$ .
53. $P(x) \sin sx^*$	$(-1)^n \sin sx [A_n P(x) + \binom{n}{1} A_{n+1} P'(x) + \binom{n+1}{2} A_{n+2} P''(x) + \binom{n+2}{3} A_{n+3} P'''(x) + \dots]$ $+ (-1)^n \cos sx [B_n P(x) + \binom{n}{1} B_{n+1} P'(x) + \binom{n+1}{2} B_{n+2} P''(x) + \binom{n+2}{3} B_{n+3} P'''(x) + \dots]$ $A_1 = \frac{a}{a^2 + s^2}, A_2 = \frac{a^2 - s^2}{(a^2 + s^2)^2}, \dots, A_k = \frac{a^k - \binom{k}{2}a^{k-2}s^2 + \binom{k}{4}a^{k-4}s^4 - \dots}{(a^2 + s^2)^k}$ $B_1 = \frac{a}{a^2 + s^2}, B_2 = \frac{2as}{(a^2 + s^2)^2}, \dots, B_k = \frac{\binom{k}{1}a^{k-1}s - \binom{k}{3}a^{k-3}s^3 + \dots}{(a^2 + s^2)^k}$
54. $e^{rx} \sin sx^*$	Replace $a$ by $a - r$ in formula 53 and multiply by $e^{rx}$ .
55. $e^{ax} P(x)$	$e^{ax} \int \dots \int P(x) dx^n$
56. $P(x)e^{ax} \sin sx^*$	$\frac{(-1)^{\frac{n-1}{2}} e^{ax} \sin sx}{s^n} \left[ \binom{n}{n-1} \frac{P'(x)}{s} - \binom{n+2}{n-1} \frac{P'''(x)}{s^3} + \binom{n+4}{n-1} \frac{P^{v}(x)}{s^5} - \dots \right]$ $+ \frac{(-1)^{\frac{n+1}{2}} e^{ax} \cos sx}{s^n} \left[ \binom{n-1}{n-1} P(x) - \binom{n+1}{n-1} \frac{P''(x)}{s^2} + \binom{n+3}{n-1} \frac{P^{iv}(x)}{s^4} - \dots \right] \quad (n \text{ odd})$ $\frac{(-1)^{\frac{n}{2}} e^{ax} \sin sx}{s^n} \left[ \binom{n-1}{n-1} P(x) - \binom{n+1}{n-1} \frac{P''(x)}{s^2} + \binom{n+3}{n-1} \frac{P^{iv}(x)}{s^4} - \dots \right]$ $+ \frac{(-1)^{\frac{n}{2}} e^{ax} \cos sx}{s^n} \left[ \binom{n}{n-1} \frac{P'(x)}{s} - \binom{n+2}{n-1} \frac{P'''(x)}{s^3} + \binom{n+4}{n-1} \frac{P^{v}(x)}{s^5} - \dots \right] \quad (n \text{ even})$

\* For  $\cos sx$  in R replace “sin” by “cos” and “cos” by “- sin” in  $y_p$ .

Table XI:  $(D - a)^n f(D)y = R$

57.  $e^{ax}$   $\frac{x^n}{n!} \cdot \frac{e^{ax}}{f(a)}$   
 \* For  $\cos sx$  in  $R$  replace “sin” by “cos” and “cos” by “- sin” in  $y_p$ .

Table XII:  $(D^2 + q)^n y = R$

R  $y_p$

58.  $e^{rx}$   $e^{rx}/(r^2 + q)^n$

59.  $\sin sx^*$   $\sin sx/(q - s^2)^n$

60.  $P(x)$   $\frac{1}{q^n} \left[ P(x) - \binom{n}{1} \frac{P'(x)}{q^2} + \binom{n+1}{2} \frac{P''(x)}{q^2} - \binom{n+2}{3} \frac{P'''(x)}{q^3} + \dots \right]$

61.  $e^{rx} \sin sx^*$   $\frac{e^{rx}}{(A^2 + B^2)^n} \left\{ \left[ A^n - \binom{n}{2} A^{n-2} B^2 + \binom{n}{4} A^{n-4} B^4 - \dots \right] \sin sx \right.$   
 $\left. - \left[ \binom{n}{1} A^{n-1} B - \binom{n}{3} A^{n-3} B^3 + \dots \right] \cos sx \right\}$   
 $A = r^2 - s^2 + q, \quad B = 2rs$

Table XIII:  $(D^2 + b^2)^n y = R$

62.  $\sin bx^*$   $(-1)^{n+1/2} \frac{x^n \cos bx}{n!(2b)^n}$  ( $n$  odd),  $(-1)^{n/2} \frac{x^n \sin bx}{n!(2b)^n}$  ( $n$  even)

Table XIV:  $(D^n - q)y = R$

63.  $e^{rx}$   $e^{rx}/(r^n - q)$

64.  $P(x)$   $-\frac{1}{q} \left[ P(x) \frac{P^{(n)}(x)}{q} + \frac{P^{(2n)}(x)}{q^2} + \dots \right]$

65.  $\sin sx^*$   $-\frac{q \sin sx + (-1)^{\frac{n-1}{2}} s^n \cos sx}{q^2 + s^{2n}}$  ( $n$  odd),  $\frac{\sin sx}{(-s^2)^{n/2} - q}$  ( $n$  even)

66.  $e^{rx} \sin sx^*$   $\frac{Ae^{rx} \sin sr - Be^{rx} \cos sx}{A^2 + B^2} = \frac{e^{rx}}{\sqrt{A^2 + B^2}} \sin \left( sx - \tan^{-1} \frac{B}{A} \right)$   
 $A = \left[ r^n - \binom{n}{2} r^{n-2} s^2 + \binom{n}{4} r^{n-4} s^4 - \dots \right] - q,$   
 $B = \left[ \binom{n}{1} r^{n-1} s - \binom{n}{3} r^{n-3} s^3 + \dots \right]$   
 \* For  $\cos sx$  in  $R$  replace “sin” by “cos” and cos by “- sin” in  $y_p$ .

Table XV:  $(D_x + mD_y)z = R$

R  $z_p$

67.  $e^{ax+by}$   $\frac{e^{ax+by}}{a+mb}$

68.  $f(ax + by)$   $\frac{\int f(u) du}{a+mb}, \quad u = ax + by$

69.  $f(y - mx)$   $x f(y - mx)$

70.  $\phi(x, y) f(y - mx)$   $f(y - mx) \int \phi(x, a + mx) dx$  ( $a = y - mx$  after integration)

Table XVI:  $(D_x + mD_y - k)z = R$

71.  $e^{ax+by}$   $\frac{e^{ax+by}}{a+mb-k}$

72.  $\sin(ax + by)^*$   $\frac{e^{i(ax+by)}}{(a+bm) \cos(ax+by) + k \sin(ax+by)}$

73.  $e^{\alpha x + \beta y} \sin(ax + by)^*$  Replace  $k$  in 72 by  $k - \alpha - m\beta$  and multiply by  $e^{\alpha x + \beta y}$

74.  $e^{kx} f(ax + by)$   $\frac{e^{kx} \int f(u) du}{a+mb}, \quad u = ax + by$

75.  $f(y - mx)$   $-\frac{f(y - mx)}{k}$

76.  $p(x) f(y - mx)$   $-\frac{1}{k} f(y - mx) \left[ p(x) + \frac{p'(x)}{k} + \frac{p''(x)}{k^2} + \dots + \frac{p^{(n)}(x)}{k^n} \right]$

77.  $e^{kx} f(y - mx)$   $x e^{kx} f(y - mx)$   
 \* For  $\cos(ax + by)$  replace “sin” by “cos” and “cos” by “- sin” in  $z_p$ .  
 $D_x = \frac{\partial}{\partial x}; \quad D_y = \frac{\partial}{\partial y}; \quad D_x^k D_y^r = \frac{\partial^{k+r}}{\partial x^k \partial y^r}$

Table XVII:  $(D_z + mD_y)^n z = R$

R	$z_p$
78. $e^{ax+by}$	$\frac{e^{ax+by}}{(a+mb)^n}$
79. $f(ax + by)$	$\frac{\int \dots \int f(u) du^n}{(a+mb)^n}, u = ax + by$
80. $f(y - mx)$	$\frac{x^n}{n!} f(y - mx)$
81. $\phi(x, y) f(y + mx)$	$\frac{1}{n!} \int \dots \int \phi(x, a + mx) dx^n (a = y - mx \text{ after integration})$

Table XVIII:  $(D_x + mD_y - k)^n z = R$

82. $e^{ax+by}$	$\frac{e^{ax+by}}{(a+mb-k)^n}$
83. $f(y - mx)$	$\frac{(-1)^n f(y-mx)}{k^n}$
84. $P(x) f(y - mx)$	$\frac{(-1)^n f(y - mx)}{k^n} \left[ p(x) + \binom{n}{1} \frac{p'(x)}{k} + \binom{n+1}{2} \frac{p''(x)}{k^2} + \binom{n+2}{3} \frac{p'''(x)}{k^3} + \dots \right]$
85. $e^{kx} f(ax + by)$	$\frac{e^{kx} \int \dots \int f(u) du^n}{(a+mb)^n}, u = ax + by$
86. $e^{kx} f(y - mx)$	$\frac{x^n}{n!} e^{kx} f(y - mx)$

Table XIX:  $[D_x^n + a_1 D_x^{n-1} D_y + a_2 D_x^{n-2} D_y^2 + \dots + a_n D_y^n] z = R$

87. $e^{ax+by}$	$\frac{e^{ax+by}}{a + a_1 a^{n-1} b + a_2 a^{n-2} b^2 + \dots + a_n b^n}$
88. $f(ax + by)$	$\frac{\int \dots \int f(u) du^n}{a^n + a_1 a^{n-1} b + a_2 a^{n-2} b^2 + \dots + a_n b^n}, (u = ax + by)$

Table XX:  $F(D_x, D_y) z = R$

89. $e^{ax+by}$	$\frac{e^{ax+by}}{F(a,b)}$
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Table XXI:  $F(D_x^2, D_x D_y, D_y^2) z = R$

90. $\sin(ax + by)*$	$\frac{\sin(ax+by)}{F(-a^2, -ab, -b^2)}$
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\* For  $\cos(ax + by)$  replace "sin" by "cos", and "cos" by "-sin" in  $z_p$ .

Differential equation	Method of solution
$yF(xy) dx + xG(xy) dy = 0$	$\ln x = \int \frac{G(v) dv}{v\{G(v) - F(v)\}} + c$ where $v = xy$ . If $G(v) = F(v)$ , then the solution is $xy = c$ .
<p><b>Linear, homogeneous, second order equation</b></p> $\frac{d^2 y}{dx^2} + b \frac{dy}{dx} + cy = 0$ where $b$ and $c$ are real constants	Let $m_1, m_2$ be the roots of $m^2 + bm + c = 0$ . Then there are 3 cases: Case 1. $m_1, m_2$ real and distinct: $y = c_1 e^{m_1 x} + c_2 e^{m_2 x}$ Case 2. $m_1, m_2$ real and equal: $y = c_1 e^{m_1 x} + c_2 x e^{m_1 x}$ Case 3. $m_1 = p + qi, m_2 = p - qi$ : $y = e^{px}(c_1 \cos qx + c_2 \sin qx)$ where $p = -b/2, q = \sqrt{4c - b^2}/2$
<p><b>Linear, nonhomogeneous, second order equation</b></p> $\frac{d^2 y}{dx^2} + b \frac{dy}{dx} + cy = R(x)$ where $b$ and $c$ are real constants	There are 3 cases corresponding to those above: Case 1. $y = c_1 e^{m_1 x} + c_2 e^{m_2 x} + \frac{e^{m_1 x}}{m_1 - m_2} \int e^{-m_1 x} R(x) dx + \frac{e^{m_2 x}}{m_2 - m_1} \int e^{-m_2 x} R(x) dx$ Case 2. $y = c_1 e^{m_1 x} + c_2 x e^{m_1 x} + x e^{m_1 x} \int e^{-m_1 x} R(x) dx - e^{m_1 x} \int x e^{-m_1 x} R(x) dx$ Case 3. $y = e^{px}(c_1 \cos qx + c_2 \sin qx) + \frac{e^{px} \sin qx}{q} \int e^{-px} R(x) \cos qx dx - \frac{e^{px} \cos qx}{q} \int e^{-px} R(x) \sin qx dx$



Differential equation	Method of solution
<b>Euler or Cauchy equation</b> $x^2 \frac{d^2 y}{dx^2} + bx \frac{dy}{dx} + cy = S(x)$	Putting $x = e^t$ , the equation becomes $\frac{d^2 y}{dt^2} + (b-1) \frac{dy}{dt} + cy = S(e^t)$ and can then be solved as a linear second order equation.
<b>Bessel's equation</b> $x^2 \frac{d^2 y}{dx^2} + x \frac{dy}{dx} + (\lambda^2 x^2 - n^2)y = 0$	$y = c_1 J_n(\lambda x) + c_2 Y_n(\lambda x)$
<b>Transformed Bessel's equation</b> $x^2 \frac{d^2 y}{dx^2} + (2p+1)x \frac{dy}{dx} + (\alpha^2 x^{2r} + \beta^2)y = 0$	$y = x^{-p} \left\{ c_1 J_{q/r} \left( \frac{\alpha}{r} x^r \right) + c_2 Y_{q/r} \left( \frac{\alpha}{r} x^r \right) \right\}$ where $q = \sqrt{p^2 - \beta^2}$ .
<b>Legendre's equation</b> $(1-x^2) \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + n(n+1)y = 0$	$y = c_1 P_n(x) + c_2 Q_n(x)$
<b>Separation of variables</b> $f_1(x)g_1(y) dx + f_2(x)g_2(y) dy = 0$	$\int \frac{f_1(x)}{f_2(x)} dx + \int \frac{g_2(y)}{g_1(y)} dy = c$
<b>Exact equation</b> $M(x, y) dx + N(x, y) dy = 0$ where $\partial M/\partial y = \partial N/\partial x$	$\int M \partial x + \int \left( n - \frac{\partial}{\partial y} \int M \partial x \right) dy = c$ where $\partial x$ indicates that the integration is to be performed with respect to $x$ keeping $y$ constant.
<b>Linear first order equation</b> $\frac{dy}{dx} + P(x)y = Q(x)$	$ye^{\int P dx} = \int Qe^{\int P dx} dx + c$
<b>Bernoulli's equation</b> $\frac{dy}{dx} + P(x)y = Q(x)y^n$	$ve^{(1-n) \int P dx} = \int Qe^{(1-n) \int P dx} dx + c$ where $v = y^{1-n}$ . If $n = 1$ , then the solution is $\ln y = \int (Q - P) dx + c$ .
<b>Homogeneous equation</b> $\frac{dy}{dx} = F\left(\frac{y}{x}\right)$	$\ln x = \int \frac{dv}{F(v)-v} + c$ where $v = y/x$ . If $F(v) = v$ , then the solution is $y = cx$ .
<b>Reducible to homogeneous</b> $(a_1 x + b_1 y + c_1) dx + (a_2 x + b_2 y + c_2) dy = 0$ with $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$	Set $u = a_1 x + b_1 y + c_1$ and $v = a_2 x + b_2 y + c_2$ . Then eliminate $x$ and $y$ and the equation becomes homogeneous.
<b>Reducible to separable</b> $(a_1 x + b_1 y + c_1) dx + (a_2 x + b_2 y + c_2) dy = 0$ with $\frac{a_1}{a_2} = \frac{b_1}{b_2}$	Set $u = a_1 x + b_1 y$ . Then eliminate $x$ or $y$ and the equation becomes separable.

## FOURIER SERIES

1. If  $f(x)$  is a bounded periodic function of period  $2L$  (i.e.,  $f(x + 2L) = f(x)$ ), and satisfies the *Dirichlet conditions*:

- (a) In any period  $f(x)$  is continuous, except possibly for a finite number of jump discontinuities.
- (b) In any period  $f(x)$  has only a finite number of maxima and minima.

Then  $f(x)$  may be represented by the *Fourier series*

$$\frac{a_0}{2} + \sum_{n=1}^{\infty} \left( a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right)$$

where  $a_n$  and  $b_n$  are as determined below. This series will converge to  $f(x)$  at every point where  $f(x)$  is continuous, and to

$$\frac{f(x^+) + f(x^-)}{2}$$

(i.e., the average of the left-hand and right-hand limits) at every point where  $f(x)$  has a jump discontinuity.

$$\begin{aligned} a_n &= \frac{1}{L} \int_{-L}^L f(x) \cos \frac{n\pi x}{L} dx, \quad n = 0, 1, 2, 3, \dots, \\ b_n &= \frac{1}{L} \int_{-L}^L f(x) \sin \frac{n\pi x}{L} dx, \quad n = 1, 2, 3, \dots \end{aligned}$$

We may also write

$$a_n = \frac{1}{L} \int_{\alpha}^{\alpha+2L} f(x) \cos \frac{n\pi x}{L} dx \quad \text{and} \quad b_n = \frac{1}{L} \int_{\alpha}^{\alpha+2L} f(x) \sin \frac{n\pi x}{L} dx$$

where  $\alpha$  is any real number. Thus if  $\alpha = 0$ ,

$$\begin{aligned} a_n &= \frac{1}{L} \int_0^{2L} f(x) \cos \frac{n\pi x}{L} dx, \quad n = 0, 1, 2, 3, \dots, \\ b_n &= \frac{1}{L} \int_0^{2L} f(x) \sin \frac{n\pi x}{L} dx, \quad n = 1, 2, 3, \dots \end{aligned}$$

2. If in addition to the restrictions in (1),  $f(x)$  is an even function (i.e.,  $f(-x) = f(x)$ ), then the Fourier series reduces to

$$\frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos \frac{n\pi x}{L}$$

That is,  $b_n = 0$ . In this case, a simpler formula for  $a_n$  is

$$a_n = \frac{2}{L} \int_0^L f(x) \cos \frac{n\pi x}{L} dx, \quad n = 0, 1, 2, 3, \dots$$

3. If in addition to the restrictions in (1),  $f(x)$  is an odd function (i.e.,  $f(-x) = -f(x)$ ), then the Fourier series reduces to

$$\sum_{n=1}^{\infty} b_n \sin \frac{n\pi x}{L}$$

That is,  $a_n = 0$ . In this case, a simpler formula for the  $b_n$  is

$$b_n = \frac{2}{L} \int_0^L f(x) \sin \frac{n\pi x}{L} dx, \quad n = 1, 2, 3, \dots$$

4. If in addition to the restrictions in (2) above,  $f(x) = -f(L - x)$ , then  $a_n$  will be 0 for all even values of  $n$ , including  $n = 0$ . Thus in this case, the expansion reduces to

$$\sum_{m=1}^{\infty} a_{2m-1} \cos \frac{(2m-1)\pi x}{L}$$

5. If in addition to the restrictions in (3) above,  $f(x) = f(L - x)$ , then  $b_n$  will be 0 for all even values of  $n$ . Thus in this case, the expansion reduces to

$$\sum_{m=1}^{\infty} b_{2m-1} \sin \frac{(2m-1)\pi x}{L}$$

(The series in (4) and (5) are known as *odd-harmonic series*, since only the odd harmonics appear. Similar rules may be stated for even-harmonic series, but when a series appears in the even-harmonic form, it means that  $2L$  has not been taken as the smallest period of  $f(x)$ . Since any integral multiple of a period is also a period, series obtained in this way will also work, but in general computation is simplified if  $2L$  is taken to be the smallest period.)

6. If we write the Euler definitions for  $\cos \theta$  and  $\sin \theta$ , we obtain the complex form of the Fourier series known either as the “Complex Fourier Series” or the “Exponential Fourier Series” of  $f(x)$ . It is represented as

$$f(x) = \frac{1}{2} \sum_{n=-\infty}^{n=+\infty} c_n e^{i\omega_n x}$$

where

$$c_n = \frac{1}{L} \int_{-L}^L f(x) e^{-i\omega_n x} dx, \quad n = 0, \pm 1, \pm 2, \pm 3, \dots$$

with  $\omega_n = \frac{n\pi}{L}$  for  $n = 0, \pm 1, \pm 2, \dots$ . The set of coefficients  $c_n$  is often referred to as the Fourier spectrum.

7. If both sine and cosine terms are present and if  $f(x)$  is of period  $2L$  and expandable by a Fourier series, it can be represented as

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} c_n \sin \left( \frac{n\pi x}{L} + \phi_n \right), \quad \text{where}$$

$$a_n = c_n \sin \phi_n, \quad b_n = c_n \cos \phi_n, \quad c_n = \sqrt{a_n^2 + b_n^2}, \quad \phi_n = \arctan \left( \frac{a_n}{b_n} \right)$$

It can also be represented as

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} c_n \cos \left( \frac{n\pi x}{L} + \phi_n \right), \quad \text{where}$$

$$a_n = c_n \cos \phi_n, \quad b_n = -c_n \sin \phi_n, \quad c_n = \sqrt{a_n^2 + b_n^2}, \quad \phi_n = \arctan \left( -\frac{b_n}{a_n} \right)$$

where  $\phi_n$  is chosen so as to make  $a_n, b_n$ , and  $c_n$  hold.

8. The following table of trigonometric identities should be helpful for developing Fourier series.

	$n$	$n$ even	$n$ odd	$n/2$ odd	$n/2$ even
$\sin n\pi$	0	0	0	0	0
$\cos n\pi$	$(-1)^n$	+1	-1	+1	+1
* $\sin \frac{n\pi}{2}$		0	$(-1)^{(n-1)/2}$	0	0
* $\cos \frac{n\pi}{2}$		$(-1)^{n/2}$	0	-1	+1
$\sin \frac{n\pi}{4}$			$\frac{\sqrt{2}}{2} (-1)^{(n^2+4n+11)/8}$	$(-1)^{(n-2)/4}$	0

\*A useful formula for  $\sin \frac{n\pi}{2}$  and  $\cos \frac{n\pi}{2}$  is given by

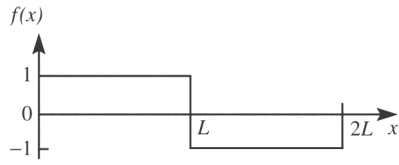
$$\sin \frac{n\pi}{2} = \frac{(i)^{n+1}}{2} [(-1)^n - 1] \quad \text{and} \quad \cos \frac{n\pi}{2} = \frac{(i)^n}{2} [(-1)^n + 1], \quad \text{where } i^2 = -1.$$

### Auxiliary Formulas for Fourier Series

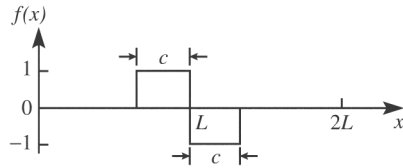
$$\begin{aligned}
 1 &= \frac{4}{\pi} \left[ \sin \frac{\pi x}{k} + \frac{1}{3} \sin \frac{3\pi x}{k} + \frac{1}{5} \sin \frac{5\pi x}{k} + \dots \right] & [0 < x < k] \\
 x &= \frac{2k}{\pi} \left[ \sin \frac{\pi x}{k} - \frac{1}{2} \sin \frac{2\pi x}{k} + \frac{1}{3} \sin \frac{3\pi x}{k} - \dots \right] & [-k < x < k] \\
 x &= \frac{k}{2} - \frac{4k}{\pi^2} \left[ \cos \frac{\pi x}{k} + \frac{1}{3^2} \cos \frac{3\pi x}{k} + \frac{1}{5^2} \cos \frac{5\pi x}{k} + \dots \right] & [0 < x < k] \\
 x^2 &= \frac{2k^2}{\pi^3} \left[ \left( \frac{\pi^2}{1} - \frac{4}{1} \right) \sin \frac{\pi x}{k} - \frac{\pi^2}{2} \sin \frac{2\pi x}{k} + \left( \frac{\pi^2}{3} - \frac{4}{3^3} \right) \sin \frac{3\pi x}{k} \right. \\
 &\quad \left. - \frac{\pi^2}{4} \sin \frac{4\pi x}{k} + \left( \frac{\pi^2}{5} - \frac{4}{5^3} \right) \sin \frac{5\pi x}{k} + \dots \right] & [0 < x < k] \\
 x^2 &= \frac{k^2}{3} - \frac{4k^2}{\pi^2} \left[ \cos \frac{\pi x}{k} - \frac{1}{2^2} \cos \frac{2\pi x}{k} + \frac{1}{3^2} \cos \frac{3\pi x}{k} - \frac{1}{4^2} \cos \frac{4\pi x}{k} + \dots \right] \\
 &\hspace{15em} [-k < x < k]
 \end{aligned}$$

$$\begin{aligned}
 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots &= \frac{\pi}{4} \\
 1 - \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots &= \frac{\pi^2}{6} \\
 1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots &= \frac{\pi^2}{12} \\
 1 + \frac{1}{3^2} + \frac{1}{5^2} - \frac{1}{7^2} + \dots &= \frac{\pi^2}{8} \\
 \frac{1}{2^2} + \frac{1}{4^2} + \frac{1}{6^2} + \frac{1}{8^2} + \dots &= \frac{\pi^2}{24}
 \end{aligned}$$

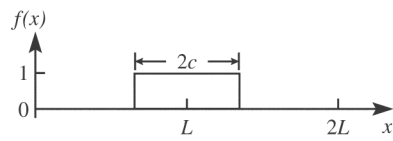
## FOURIER EXPANSIONS FOR BASIC PERIODIC FUNCTIONS



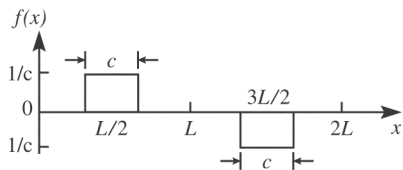
$$f(x) = \frac{4}{\pi} \sum_{n=1,3,5,\dots} \frac{1}{n} \sin \frac{n\pi x}{L}$$



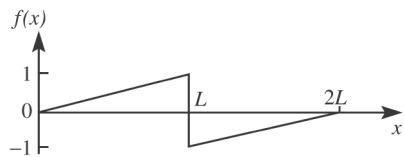
$$f(x) = \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \left( \cos \frac{n\pi c}{L} - 1 \right) \sin \frac{n\pi x}{L}$$



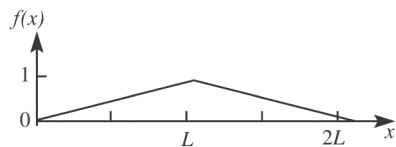
$$f(x) = \frac{c}{L} + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \sin \frac{n\pi c}{L} \cos \frac{n\pi x}{L}$$



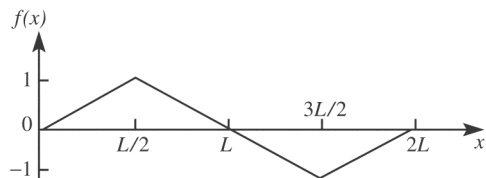
$$f(x) = \frac{2}{L} \sum_{n=1}^{\infty} \sin \frac{n\pi}{2} \frac{\sin(\frac{1}{2} n\pi c/L)}{\frac{1}{2} n\pi c/L} \sin \frac{n\pi x}{L}$$



$$f(x) = \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n} \sin \frac{n\pi x}{L}$$



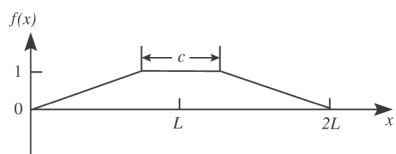
$$f(x) = \frac{1}{2} - \frac{4}{\pi^2} \sum_{n=1,3,5,\dots} \frac{1}{n^2} \cos \frac{n\pi x}{L}$$



$$f(x) = \frac{8}{\pi^2} \sum_{n=1,3,5,\dots} \frac{(-1)^{(n-1)/2}}{n^2} \sin \frac{n\pi x}{L}$$

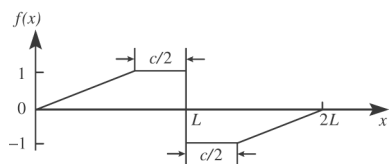


$$f(x) = \frac{1}{2} - \frac{1}{\pi} \sum_{n=1}^{\infty} \frac{1}{n} \sin \frac{n\pi x}{L}$$

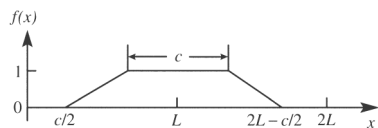


$$f(x) = \frac{1}{2}(1+a) + \frac{2}{\pi^2(1-a)} \sum_{n=1}^{\infty} \frac{1}{n^2} [(-1)^n \cos n\pi a - 1] \cos \frac{n\pi x}{L};$$

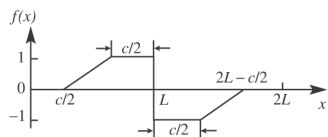
$$(a = \frac{c}{2L})$$



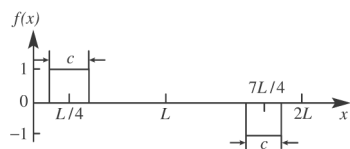
$$f(x) = \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{n} \left[ 1 + \frac{\sin n\pi a}{n\pi(1-a)} \right] \sin \frac{n\pi x}{L}; (a = \frac{c}{2L})$$



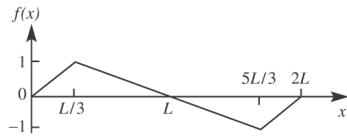
$$f(x) = \frac{1}{2} - \frac{4}{\pi^2(1-2a)} \sum_{n=1,3,5,\dots} \frac{1}{n^2} \cos n\pi a \cos \frac{n\pi x}{L}; (a = \frac{c}{2L})$$



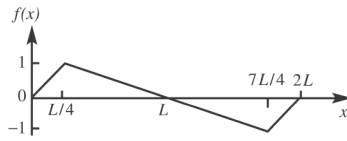
$$f(x) = \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^n}{n} \left[ 1 + \frac{1+(-1)^n}{n\pi(1-2a)} \sin n\pi a \right] \sin \frac{n\pi x}{L}; (a = \frac{c}{2L})$$



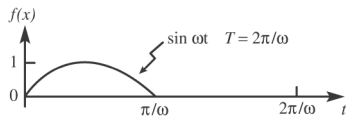
$$f(x) \frac{4}{\pi} \sum_{n=1}^{\infty} \frac{1}{n} \sin \frac{n\pi x}{4} \sin n\pi a \sin \frac{n\pi x}{L}; (a = \frac{c}{2L})$$



$$f(x) = \frac{9}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} \sin \frac{n\pi}{3} \sin \frac{n\pi x}{L}; \left(a = \frac{c}{2L}\right)$$



$$f(x) = \frac{32}{3\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} \sin \frac{n\pi}{4} \sin \frac{n\pi x}{L}; \left(a = \frac{c}{2L}\right)$$



$$f(x) = \frac{1}{\pi} + \frac{1}{2} \sin \omega t - \frac{2}{\pi} \sum_{n=2,4,6,\dots}^{\infty} \frac{1}{n^2-1} \cos n\omega t$$

Extracted from graphs and formulas, pages 372, 373, *Differential Equations in Engineering Problems*, Salvadori and Schwarz, published by Prentice-Hall, Inc., 1954.

## THE FOURIER TRANSFORMS

For a piecewise continuous function  $F(x)$  over a finite interval  $0 \leq x \leq \pi$ ; the *finite Fourier cosine transform* of  $F(x)$  is

$$f_c(n) = \int_0^\pi F(x) \cos nx \, dx \quad (n = 0, 1, 2, \dots)$$

If  $x$  ranges over the interval  $0 \leq x \leq L$ , the substitution  $x' = \pi x/L$  allows the use of this definition, also. The inverse transform is written.

$$\bar{F}(x) = \frac{1}{\pi} f_c(0) - \frac{2}{\pi} \sum_{n=1}^{\infty} f_c(n) \cos nx \quad (0 < x < \pi)$$

where  $F(x) = \frac{F(x+\epsilon) + F(x-\epsilon)}{2}$ . We observe that  $F(x+) = F(x-) = F(x)$  at points of continuity. The formula

$$\begin{aligned} f_c^{(2)}(n) &= \int_0^\pi F''(x) \cos nx \, dx \\ &= -n^2 f_c(n) - F'(0) + (-1)^n F'(\pi) \end{aligned} \quad (1)$$

makes the finite Fourier cosine transform useful in certain boundary value problems. Analogously, the *finite Fourier sine transform* of  $F(x)$  is

$$f_s(n) = \int_0^\pi F(x) \sin nx \, dx \quad (n = 1, 2, 3, \dots)$$

and

$$\bar{F}(x) = \frac{2}{\pi} \sum_{n=1}^{\infty} f_s(n) \sin nx \quad (0 < x < \pi)$$

Corresponding to (1) we have

$$\begin{aligned} f_s^{(2)}(n) &= \int_0^\pi F''(x) \sin nx \, dx \\ &= -n^2 f_s(n) - n F(0) - n(-1)^n F(\pi) \end{aligned} \quad (2)$$

If  $F(x)$  is defined for  $x \leq 0$  and is piecewise continuous over any finite interval, and if  $\int_0^x F(x) \, dx$  is absolutely convergent, then

$$f_c(\alpha) = \sqrt{\frac{2}{\pi}} \int_0^x F(x) \cos(\alpha x) \, dx$$



is the *Fourier cosine transform* of  $F(x)$ . Furthermore,

$$\bar{F}(x) = \sqrt{\frac{2}{\pi}} \int_0^x f_c(\alpha) \cos(\alpha x) d\alpha.$$

If  $\lim_{x \rightarrow \infty} d^n F/dx^n = 0$ , then an important property of the Fourier cosine transform is

$$f_c^{(2r)}(\alpha) = \sqrt{\frac{2}{\pi}} \int_0^x \left( \frac{d^{2r} F}{dx^{2r}} \right) \cos(\alpha x) dx = -\sqrt{\frac{2}{\pi}} \sum_{n=0}^{r-1} (-1)^n a_{2r-2n-1} \alpha^{2n} + (-1)^r \alpha^{2r} f_c(\alpha) \quad (3)$$

where  $\lim_{x \rightarrow \infty} d^r F/dx^r = a_r$ , makes it useful in the solution of many problems.

Under the same conditions,

$$f_s(\alpha) = \sqrt{\frac{2}{\pi}} \int_0^x F(x) \sin(\alpha x) dx$$

defines the *Fourier sine transform* of  $F(x)$ , and

$$\bar{F}(x) = \sqrt{\frac{2}{\pi}} \int_0^x f_s(\alpha) \sin(\alpha x) d\alpha$$

Corresponding to (3) we have

$$f_s^{(2r)}(\alpha) = \sqrt{\frac{2}{\pi}} \int_0^\infty \frac{d^{2r} F}{dx^{2r}} \sin(\alpha x) dx = -\sqrt{\frac{2}{\pi}} \sum_{n=1}^r (-1)^n \alpha^{2n-1} a_{2r-2n} + (-1)^{r-1} \alpha^{2r} f_s(\alpha)$$

Similarly, if  $F(x)$  is defined for  $-\infty < x < \infty$ , and if  $\int_{-\infty}^\infty F(x) dx$  is absolutely convergent, then

$$f(\alpha) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^\infty F(x) e^{i\alpha x} dx$$

is the *Fourier transform* of  $F(x)$ , and

$$\bar{F}(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^\infty f(\alpha) e^{-i\alpha x} d\alpha$$

Also, if

$$\lim_{|x| \rightarrow \infty} \left| \frac{d^n F}{dx^n} \right| = 0 \quad (n = 1, 2, \dots, r-1)$$

then

$$f^{(r)}(\alpha) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^\infty F^{(r)}(x) e^{i\alpha x} dx = (-i\alpha)^r f(\alpha)$$

Finite Sine Transforms

$f_s(n)$	$F(x)$
1. $f_s(n) = \int_0^\pi F(x) \sin nx \, dx \ (n = 1, 2, \dots)$	$F(x)$
2. $(-1)^{n+1} f_s(n)$	$F(\pi - x)$
3. $\frac{1}{n}$	$\frac{\pi - x}{\pi}$
4. $\frac{(-1)^{n+1}}{n}$	$\frac{x}{\pi}$
5. $\frac{1 - (-1)^n}{n}$	1
6. $\frac{2}{n^2} \sin \frac{n\pi}{2}$	$\begin{cases} x & \text{when } 0 < x < \pi/2 \\ \pi - x & \text{when } \pi/2 < x < \pi \end{cases}$
7. $\frac{(-1)^{n+1}}{n^3}$	$\frac{x(\pi^2 - x^2)}{6\pi}$
8. $\frac{1 - (-1)^n}{n^3}$	$\frac{x(\pi - x)}{2}$
9. $\frac{\pi^2(-1)^{n-1}}{n} - \frac{2[1 - (-1)^n]}{n^3}$	$x^2$
10. $\pi(-1)^n \left( \frac{6}{n^3} - \frac{\pi^2}{n} \right)$	$x^3$
11. $\frac{n}{n^2 + c^2} [1 - (-1)^n e^{c\pi}]$	$e^{cx}$
12. $\frac{n}{n^2 + c^2}$	$\frac{\sinh c(\pi - x)}{\sinh c\pi}$

$f_s(n)$	$F(x)$
13. $\frac{n}{n^2 - k^2} \ (k \neq 0, 1, 2, \dots)$	$\frac{\sin k(\pi - x)}{\sin k\pi}$
14. $\begin{cases} \frac{\pi}{2} & \text{when } n = m \\ 0 & \text{when } n \neq m \end{cases} \ (m = 1, 2, \dots)$	$\sin mx$
15. $\frac{n}{n^2 - k^2} [1 - (-1)^n \cos k\pi]$ $(k \neq 1, 2, \dots)$	$\cos kx$
16. $\begin{cases} \frac{n}{n^2 - m^2} [1 - (-1)^{n+m}] & \text{when } n \neq m = 1, 2, \dots \\ 0 & \text{when } n = m \end{cases}$	$\cos mx$
17. $\frac{n}{(n^2 - k^2)^2} \ (k \neq 0, 1, 2, \dots)$	$\frac{\pi \sin kx}{2k \sin^2 k\pi} - \frac{x \cos k(\pi - x)}{2k \sin k\pi}$
18. $\frac{b^n}{n} \ ( b  \leq 1)$	$\frac{2}{\pi} \arctan \frac{b \sin x}{1 - b \cos x}$
19. $\frac{1 - (-1)^n b^n}{n} \ ( b  \leq 1)$	$\frac{2}{\pi} \arctan \frac{2b \sin x}{1 - b^2}$

Finite Cosine Transforms

$f_c(n)$	$F(x)$
1. $f_c(n) = \int_0^n F(x) \cos nx \, dx \quad (n = 0, 1, 2, \dots)$	$F(x)$
2. $(-1)^n f_c(n)$	$F(\pi - x)$
3. 0 when $n = 1, 2, \dots$ ; $f_c(0) = \pi$	1
4. $\frac{2}{n} \sin \frac{n\pi}{2}$ ; $f_c(0) = 0$	$\begin{cases} 1 & \text{when } 0 < x < \pi/2 \\ -1 & \text{when } \pi/2 < x < \pi \end{cases}$
5. $-\frac{1-(-1)^n}{n^2}$ ; $f_c(0) = \frac{\pi^2}{2}$	$x$
6. $\frac{(-1)^n}{n^2}$ ; $f_c(0) = \frac{\pi^2}{6}$	$\frac{x^2}{2\pi}$
7. $\frac{1}{n^2}$ ; $f_c(0) = 0$	$\frac{(\pi-x)^2}{2\pi} - \frac{\pi}{6}$
8. $3\pi^2 \frac{(-1)^n}{n^2} - 6 \frac{1-(-1)^n}{n^4}$ ; $f_c(0) = \frac{\pi^4}{4}$	$x^3$
9. $\frac{(-1)^n e^{\pi n^2} - 1}{n^2 + c^2}$	$\frac{1}{c} e^{cx}$
10. $\frac{1}{n^2 + c^2}$	$\frac{\cosh c(\pi-x)}{\cosh c\pi}$
11. $\frac{1}{n^2 - k^2} [(-1)^n \cos \pi k - 1]$ $(k \neq 0, 1, 2, \dots)$	$\sin kx$
12. $\frac{(-1)^{n+m} - 1}{n^2 - m^2}$ ; $f_c(m) = 0 \quad (m = 1, 2, \dots)$	$\frac{1}{m} \sin mx$
13. $\frac{1}{n^2 - k^2} \quad (k \neq 0, 1, 2, \dots)$	$-\frac{\cos k(\pi-x)}{k \sin k\pi}$
14. $\begin{cases} 0 & \text{for } n = 1, 2, \dots; n \neq m \\ \frac{\pi}{2} & \text{for } n = m \end{cases}$	$\cos mx \quad \text{for } m = 1, 2, 3, \dots$

Fourier Sine Transforms

$F(x)$	$f_s(\alpha)$
1. $\begin{cases} 1 & (0 < x < a) \\ 0 & (x > a) \end{cases}$	$\sqrt{\frac{2}{\pi}} \left[ \frac{1 - \cos \alpha a}{\alpha} \right]$
2. $x^{p-1} \quad (0 < p < 1)$	$\sqrt{\frac{2}{\pi}} \frac{\Gamma(p)}{\alpha^p} \sin \frac{p\pi}{2}$
3. $\begin{cases} \sin x & (0 < x < a) \\ 0 & (x > a) \end{cases}$	$\frac{1}{\sqrt{2\pi}} \left[ \frac{\sin[a(1-\alpha)]}{1-\alpha} - \frac{\sin[a(1+\alpha)]}{1+\alpha} \right]$
4. $e^{-x}$	$\sqrt{\frac{2}{\pi}} \left[ \frac{\alpha}{1+\alpha^2} \right]$
5. $xe^{-x^2/2}$	$\alpha e^{-\alpha^2/2}$
6. $\cos \frac{x^2}{2}$	$\sqrt{2} \left[ \sin \frac{\alpha^2}{2} C \left( \frac{\alpha^2}{2} \right) - \cos \frac{\alpha^2}{2} S \left( \frac{\alpha^2}{2} \right) \right]^*$
7. $\sin \frac{x^2}{2}$	$\sqrt{2} \left[ \cos \frac{\alpha^2}{2} C \left( \frac{\alpha^2}{2} \right) + \sin \frac{\alpha^2}{2} S \left( \frac{\alpha^2}{2} \right) \right]^*$

Here  $C(y)$  and  $S(y)$  are the Fresnel integrals:

$$C(y) = \frac{1}{\sqrt{2\pi}} \int_0^y \frac{1}{\sqrt{t}} \cos t \, dt, \quad S(y) = \frac{1}{\sqrt{2\pi}} \int_0^y \frac{1}{\sqrt{t}} \sin t \, dt$$

\*More extensive tables of the Fourier sine and cosine transforms can be found in Fritz Oberhettinger, *Tabellen zur-Fourier Transformation*, Springer, 1957.

Fourier Cosine Transforms

$F(x)$	$f_c(\alpha)$
1. $\begin{cases} 1 & (0 < x < a) \\ 0 & (x > a) \end{cases}$	$\sqrt{\frac{2}{\pi}} \frac{\sin \alpha a}{\alpha}$
2. $x^{p-1} \quad (0 < p < 1)$	$\sqrt{\frac{2}{\pi}} \frac{\Gamma(p)}{\alpha^p} \cos \frac{p\pi}{2}$
3. $\begin{cases} \cos x & (0 < x < a) \\ 0 & (x > a) \end{cases}$	$\frac{1}{\sqrt{2\pi}} \left[ \frac{\sin[a(1-\alpha)]}{1-\alpha} + \frac{\sin[a(1+\alpha)]}{1+\alpha} \right]$
4. $e^{-x}$	$\sqrt{\frac{2}{\pi}} \left( \frac{1}{1+\alpha^2} \right)$
5. $e^{-x^2/2}$	$e^{-\alpha^2/2}$
6. $\cos \frac{x^2}{2}$	$\cos \left( \frac{\alpha^2}{2} - \frac{\pi}{4} \right)$
7. $\sin \frac{x^2}{2}$	$\cos \left( \frac{\alpha^2}{2} + \frac{\pi}{4} \right)$

### Fourier Transforms

$F(x)$	$f(\alpha)$
1. $\frac{\sin ax}{x}$	$\begin{cases} \sqrt{\frac{\pi}{2}} &  \alpha  < a \\ 0 &  \alpha  > a \end{cases}$
2. $\begin{cases} e^{iwx} & (p < x < q) \\ 0 & (x < p, x > q) \end{cases}$	$\frac{i}{\sqrt{2\pi}} \frac{e^{ip(w+\alpha)} - e^{iq(w+\alpha)}}{(w+\alpha)}$
3. $\begin{cases} e^{-cx+ixx} & (x > 0) \\ 0 & (x < 0) \end{cases} \quad (c > 0)$	$\frac{i}{\sqrt{2\pi}(w+\alpha+ic)}$
4. $e^{-px^2} \quad R(p) > 0$	$\frac{1}{\sqrt{2p}} e^{-\alpha^2/4p}$
5. $\cos px^2$	$\frac{1}{\sqrt{2p}} \cos \left[ \frac{\alpha^2}{4p} - \frac{\pi}{4} \right]$
6. $\sin px^2$	$\frac{1}{\sqrt{2p}} \cos \left[ \frac{\alpha^2}{4p} + \frac{\pi}{4} \right]$
7. $ x ^{-p} \quad (0 < p < 1)$	$\sqrt{\frac{2}{\pi}} \frac{\Gamma(1-p) \sin \frac{p\pi}{2}}{ \alpha ^{1-p}}$
8. $\frac{e^{-a x }}{\sqrt{ x }}$	$\sqrt{\frac{a^2+\alpha^2}{a^2+\alpha^2}}$
9. $\frac{\cosh ax}{\cosh \pi x} \quad (-\pi < a < \pi)$	$\sqrt{\frac{2}{\pi}} \frac{\cos \frac{a}{2} \cosh \frac{a}{2}}{\cosh \alpha + \cos a}$
10. $\frac{\sinh ax}{\sinh \pi x} \quad (-\pi < a < \pi)$	$\frac{1}{\sqrt{2\pi}} \frac{\sin a}{\cosh \alpha + \cos a}$
11. $\begin{cases} \frac{1}{\sqrt{a^2-x^2}} & ( x  < a) \\ 0 & ( x  > a) \end{cases}$	$\sqrt{\frac{\pi}{2}} J_0(a\alpha)$
12. $\frac{\sin[b\sqrt{a^2+x^2}]}{\sqrt{a^2+x^2}}$	$\begin{cases} 0 & ( \alpha  > b) \\ \sqrt{\frac{\pi}{2}} J_0(a\sqrt{b^2-\alpha^2}) & ( \alpha  < b) \end{cases}$
13. $\begin{cases} p_n(x) & ( x  < 1) \\ 0 & ( x  > 1) \end{cases}$	$\frac{i^n}{\sqrt{\alpha}} J_{n+\frac{1}{2}}(\alpha)$
14. $\begin{cases} \frac{\cos[b\sqrt{a^2-x^2}]}{\sqrt{a^2-x^2}} & ( x  < a) \\ 0 & ( x  > a) \end{cases}$	$\sqrt{\frac{\pi}{2}} J_0(a\sqrt{a^2+b^2})$
15. $\begin{cases} \frac{\cosh[b\sqrt{a^2-x^2}]}{\sqrt{a^2-x^2}} & ( x  < a) \\ 0 & ( x  > a) \end{cases}$	$\sqrt{\frac{\pi}{2}} J_0(a\sqrt{a^2-b^2})$

\*More extensive tables of Fourier transforms can be found in W. Magnus and F. Oberhettinger, *Formulas and Theorems of the Special Functions of Mathematical Physics*. Chelsea, 1949, 116-120.

## SERIES EXPANSION

The expression in parentheses following certain of the series indicates the region of convergence. If not otherwise indicated it is to be understood that the series converges for all finite values of  $x$ .

### Binomial Series

$$\begin{aligned}(x + y)^n &= x^n + nx^{n-1}y + \frac{n(n-1)}{2!}x^{n-2}y^2 + \frac{n(n-1)(n-2)}{3!}x^{n-3}y^3 + \dots (y^2 < x^2) \\(1 \pm x)^n &= 1 \pm nx + \frac{n(n-1)x^2}{2!} \pm \frac{n(n-1)(n-2)x^3}{3!} + \dots (x^2 < 1) \\(1 \pm x)^{-n} &= 1 \mp nx + \frac{n(n+1)x^2}{2!} \mp \frac{n(n+1)(n+2)x^3}{3!} + \dots (x^2 < 1) \\(1 \pm x)^{-1} &= 1 \mp x + x^2 \mp x^3 + x^4 \mp x^5 + \dots (x^2 < 1) \\(1 \pm x)^{-2} &= 1 \mp 2x + 3x^2 \mp 4x^3 + 5x^4 \mp 6x^5 + \dots (x^2 < 1)\end{aligned}$$

### Reversion of Series

Let a series be represented by

$$y = a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6 + \dots$$

with  $a_1 \neq 0$ . The coefficients of the series

$$x = A_1y + A_2y^2 + A_3y^3 + A_4y^4 + \dots$$

are

$$A_1 = \frac{1}{a_1} \quad A_2 = -\frac{a_2}{a_1^3} \quad A_3 = \frac{1}{a_1^5}(2a_2^2 - a_1a_3)$$

$$A_4 = \frac{1}{a_1^7}(5a_1a_2a_3 - a_1^2a_4 - 5a_2^3)$$

$$A_5 = \frac{1}{a_1^9}(6a_1^2a_2a_4 + 3a_1^2a_3^2 + 14a_2^4 - a_1^3a_5 - 21a_1a_2^2a_3)$$

$$A_6 = \frac{1}{a_1^{11}}(7a_1^3a_2a_5 + 7a_1^3a_3a_4 + 84a_1a_2^3a_3 - a_1^4a_6 - 28a_1^2a_2^2a_4 - 28a_1^2a_2a_3^2 - 42a_2^5)$$

$$A_7 = \frac{1}{a_1^{13}}(8a_1^4a_2a_6 + 8a_1^4a_3a_5 + 4a_1^4a_4^2 + 120a_1^2a_2^3a_4 + 180a_1^2a_2^2a_3^2 + 132a_2^6 - a_1^5a_7 - 36a_1^3a_2^2a_5 - 72a_1^3a_2a_3a_4 - 12a_1^3a_3^3 - 330a_1a_2^4a_3)$$

### Taylor Series

$$1. \quad f(x) = f(a) + (x-a)f'(a) + \frac{(x-a)^2}{2!}f''(a) + \frac{(x-a)^3}{3!}f'''(a) + \dots + \frac{(x-a)^n}{n!}f^{(n)}(a) + \dots \quad (\text{Taylor Series})$$

(Increment form)

$$2. \quad f(x+h) = f(x) + hf'(x) + \frac{h^2}{2!}f''(x) + \frac{h^3}{3!}f'''(x) + \dots \\ = f(h) + xf'(h) + \frac{x^2}{2!}f''(h) + \frac{x^3}{3!}f'''(h) + \dots$$

3. If  $f(x)$  is a function possessing derivatives of all orders throughout the interval  $a \leq x \leq b$ , then there is a value  $X$ , with  $a < X < b$ , such that

$$f(b) = f(a) + (b-a)f'(a) + \frac{(b-a)^2}{2!}f''(a) + \dots + \frac{(b-a)^{n-1}}{(n-1)!}f^{(n-1)}(a) + \frac{(b-a)^n}{n!}f^{(n)}(X)$$

$$f(a+h) = f(a) + hf'(a) + \frac{h^2}{2!}f''(a) + \dots + \frac{h^{n-1}}{(n-1)!}f^{(n-1)}(a) + \frac{h^n}{n!}f^{(n)}(a+\theta h)$$

where  $b = a+h$  and  $0 < \theta < 1$ . Or

$$f(x) = f(a) + (x-a)f'(a) + \frac{(x-a)^2}{2!}f''(a) + \dots + (x-a)^{n-1}\frac{f^{(n-1)}(a)}{(n-1)!} + R_n,$$

where

$$R_n = \frac{f^{(n)}[a + \theta \cdot (x-a)]}{n!}(x-a)^n, \quad 0 < \theta < 1.$$

The above forms are known as Taylor series with the remainder term.

4. Taylor series for a function of two variables

$$\text{If } \left(h\frac{\partial}{\partial x} + k\frac{\partial}{\partial y}\right) f(x, y) = h\frac{\partial f(x, y)}{\partial x} + k\frac{\partial f(x, y)}{\partial y};$$

$$\left(h\frac{\partial}{\partial x} + k\frac{\partial}{\partial y}\right)^2 f(x, y) = h^2\frac{\partial^2 f(x, y)}{\partial x^2} + 2hk\frac{\partial^2 f(x, y)}{\partial x\partial y} + k^2\frac{\partial^2 f(x, y)}{\partial y^2}$$

etc., and if  $\left(h\frac{\partial}{\partial x} + k\frac{\partial}{\partial y}\right)^n f(x, y)\Big|_{x=a}^{y=b}$  where the bar and subscripts mean that after differentiation we are to replace  $x$  by  $a$  and  $y$  by  $b$ , then

$$f(a+h, b+k) = f(a, b) + \left(h\frac{\partial}{\partial x} + k\frac{\partial}{\partial y}\right) f(x, y)\Big|_{x=a}^{y=b} + \dots + \frac{1}{n!} \left(h\frac{\partial}{\partial x} + k\frac{\partial}{\partial y}\right)^n f(x, y)\Big|_{x=a}^{y=b} + \dots$$

## Maclaurin Series

$$f(x) = f(0) + xf'(0) + \frac{x^2}{2!} f''(0) + \frac{x^3}{3!} f'''(0) + \cdots + x^{n-1} \frac{f^{(n-1)}(0)}{(n-1)!} + R_n,$$

where

$$R_n = \frac{x^n f^{(n)}(\theta x)}{n!}, \quad 0 < \theta < 1.$$

## Exponential Series

$$e = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \cdots$$

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \cdots$$

$$a^x = 1 + x \log_e a + \frac{(x \log_e a)^2}{2!} + \frac{(x \log_e a)^3}{3!} + \cdots$$

$$e^x = e^a \left[ 1 + (x-a) + \frac{(x-a)^2}{2!} + \frac{(x-a)^3}{3!} + \cdots \right]$$

## Logarithmic Series

$$\log_e x = \frac{x-1}{x} + \frac{1}{2} \left( \frac{x-1}{x} \right)^2 + \frac{1}{3} \left( \frac{x-1}{x} \right)^3 + \cdots \quad (x > \frac{1}{2})$$

$$\log_e x = (x-1) - \frac{1}{2}(x-1)^2 + \frac{1}{3}(x-1)^3 - \cdots \quad (2 \geq x > 0)$$

$$\log_e x = 2 \left[ \frac{x-1}{x+1} + \frac{1}{3} \left( \frac{x-1}{x+1} \right)^3 + \frac{1}{5} \left( \frac{x-1}{x+1} \right)^5 + \cdots \right] \quad (x > 0)$$

$$\log_e(1+x) = x - \frac{1}{2}x^2 + \frac{1}{3}x^3 - \frac{1}{4}x^4 + \cdots \quad (-1 < x \leq 1)$$

$$\log_e(n+1) - \log_e(n-1) = 2 \left[ \frac{1}{n} + \frac{1}{3n^3} + \frac{1}{5n^5} + \cdots \right]$$

$$\log_e(a+x) = \log_e a + 2 \left[ \frac{x}{2a+x} + \frac{1}{3} \left( \frac{x}{2a+x} \right)^3 + \frac{1}{5} \left( \frac{x}{2a+x} \right)^5 + \cdots \right] \quad (a > 0, -a < x < +\infty)$$

$$\log_e \frac{1+x}{1-x} = 2 \left[ x + \frac{x^3}{3} + \frac{x^5}{5} + \cdots + \frac{x^{2n-1}}{2n-1} + \cdots \right] \quad -1 < x < 1$$

$$\log_e x = \log_e a + \frac{(x-a)}{a} - \frac{(x-a)^2}{2a^2} + \frac{(x-a)^3}{3a^3} - + \cdots \quad 0 < x \leq 2a$$

## Trigonometric Series

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots \quad (\text{all real values of } x)$$

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots \quad (\text{all real values of } x)$$

$$\tan x = x + \frac{x^3}{3} + \frac{2x^5}{15} + \frac{17x^7}{315} + \frac{62x^9}{2835} + \cdots + \frac{(-1)^{n-1} 2^{2n} (2^{2n}-1) B_{2n}}{(2n)!} x^{2n-1} + \cdots,$$

$[x^2 < \frac{\pi^2}{4} \text{ and } B_n \text{ represents the } n^{\text{th}} \text{ Bernoulli number}]$

$$\cot x = \frac{1}{x} - \frac{x}{3} - \frac{x^3}{45} - \frac{2x^5}{945} - \frac{x^7}{4725} - \cdots - \frac{(-1)^{n+1} 2^{2n}}{(2n)!} B_{2n} x^{2n-1} - \cdots,$$

$[x^2 < \pi^2 \text{ and } B_n \text{ represents the } n^{\text{th}} \text{ Bernoulli number}]$

$$\sec x = 1 + \frac{x^2}{2} + \frac{5}{24}x^4 + \frac{61}{720}x^6 + \frac{277}{8064}x^8 + \cdots + \frac{(-1)^n E_{2n}}{(2n)!} x^{2n} + \cdots,$$

$[x^2 < \frac{\pi^2}{4} \text{ and } E_n \text{ represents the } n^{\text{th}} \text{ Euler number}]$

$$\csc x = \frac{1}{x} + \frac{x}{6} + \frac{7}{360}x^3 + \frac{31}{15,120}x^5 + \frac{127}{604,800}x^7 + \cdots + \frac{(-1)^{n+1} 2(2^{2n-1}-1)}{(2n)!} B_{2n} x^{2n-1} + \cdots,$$

$[x^2 < \pi^2 \text{ and } B_n \text{ represents the } n^{\text{th}} \text{ Bernoulli number}]$

$$\sin x = x \left( 1 - \frac{x^2}{\pi^2} \right) \left( 1 - \frac{x^2}{2^2 \pi^2} \right) \left( 1 - \frac{x^2}{3^2 \pi^2} \right) \cdots \quad (x^2 < \infty)$$

$$[2pt] \cos x = \left( 1 - \frac{4x^2}{\pi^2} \right) \left( 1 - \frac{4x^2}{3^2 \pi^2} \right) \left( 1 - \frac{4x^2}{5^2 \pi^2} \right) \cdots \quad (x^2 < \infty)$$

$$[2pt] \sin^{-1} x = x + \frac{x^3}{2 \cdot 3} + \frac{1 \cdot 3}{2 \cdot 4 \cdot 5} x^5 + \frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6 \cdot 7} x^7 + \cdots \quad \left( x^2 < 1, -\frac{\pi}{2} < \sin^{-1} x < \frac{\pi}{2} \right)$$

$$[2pt] \cos^{-1} x = \frac{\pi}{2} - \left( x + \frac{x^3}{2 \cdot 3} + \frac{1 \cdot 3}{2 \cdot 4 \cdot 5} x^5 + \frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6 \cdot 7} x^7 + \cdots \right) \quad (x^2 < 1, 0 < \cos^{-1} x < \pi)$$

$$[2pt] \tan^{-1} x = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \cdots \quad (x^2 < 1)$$

$$[2pt] \tan^{-1} x = \frac{\pi}{2} - \frac{1}{x} + \frac{1}{3x^3} - \frac{1}{5x^5} + \frac{1}{7x^7} - \cdots \quad (x > 1)$$

$$[2pt] \tan^{-1} x = -\frac{\pi}{2} - \frac{1}{x} + \frac{1}{3x^3} - \frac{1}{5x^5} + \frac{1}{7x^7} - \cdots \quad (x < -1)$$

$$[2pt] \cot^{-1} x = \frac{\pi}{2} - x + \frac{x^3}{3} - \frac{x^5}{5} + \frac{x^7}{7} - \cdots \quad (x^2 < 1)$$

$$\begin{aligned}
\log_e \sin x &= \log_e x - \frac{x^2}{6} - \frac{x^4}{180} - \frac{x^6}{2835} - \dots && (x^2 < \pi^2) \\
\log_e \cos x &= -\frac{x^2}{2} - \frac{x^4}{12} - \frac{x^6}{45} - \frac{17x^8}{2520} - \dots && \left(x^2 < \frac{\pi^2}{4}\right) \\
\log_e \tan x &= \log_e x + \frac{x^2}{3} + \frac{7x^4}{90} + \frac{62x^6}{2835} + \dots && \left(x^2 < \frac{\pi^2}{4}\right) \\
e^{\sin x} &= 1 + x + \frac{x^2}{2!} - \frac{3x^4}{4!} - \frac{8x^5}{5!} - \frac{3x^6}{6!} + \frac{56x^7}{7!} + \dots \\
e^{\cos x} &= e \left(1 - \frac{x^2}{2!} + \frac{4x^4}{4!} - \frac{31x^6}{6!} + \dots\right) \\
e^{\tan x} &= 1 + x + \frac{x^2}{2!} + \frac{3x^3}{3!} + \frac{9x^4}{4!} + \frac{37x^5}{5!} + \dots && \left(x^2 < \frac{\pi^2}{4}\right) \\
\sin x &= \sin a + (x-a) \cos a - \frac{(x-a)^2}{2!} \sin a \\
&\quad - \frac{(x-a)^3}{3!} \cos a + \frac{(x-a)^4}{4!} \sin a + \dots
\end{aligned}$$



# VECTOR ANALYSIS

## Definitions

Any quantity that is completely determined by its magnitude is called a *scalar*. Examples of such are mass, density, temperature, etc. Any quantity that is completely determined by its magnitude and direction is called a *vector*. Examples of such are velocity, acceleration, force, etc. A vector quantity is represented by a directed line segment, the length of which represents the magnitude of the vector. A vector quantity is usually represented by a boldfaced letter such as  $\mathbf{V}$ . Two vectors  $\mathbf{V}_1$  and  $\mathbf{V}_2$  are equal to one another if they have equal magnitudes and are acting in the same directions. A negative vector, written as  $-\mathbf{V}$ , is one that acts in the opposite direction to  $\mathbf{V}$ , but is of equal magnitude to it. If we represent the magnitude of  $\mathbf{V}$  by  $v$ , we write  $|\mathbf{V}| = v$ . A vector parallel to  $\mathbf{V}$ , but equal to the reciprocal of its magnitude is written as  $\mathbf{V}^{-1}$  or as  $1/\mathbf{V}$ .

The *unit vector*  $\mathbf{V}/v$  (when  $v \neq 0$ ) is that vector which has the same direction as  $\mathbf{V}$ , but has a magnitude of unity (sometimes represented as  $\mathbf{V}_0$  or  $\hat{\mathbf{v}}$ ).

## Vector Algebra

The vector sum of  $\mathbf{V}_1$  and  $\mathbf{V}_2$  is represented by  $\mathbf{V}_1 + \mathbf{V}_2$ . The vector sum of  $\mathbf{V}_1$  and  $-\mathbf{V}_2$ , or the difference of the vector  $\mathbf{V}_2$  from  $\mathbf{V}_1$  is represented by  $\mathbf{V}_1 - \mathbf{V}_2$ .

If  $r$  is a scalar, then  $r\mathbf{V} = \mathbf{V}r$ , and represents a vector  $r$  times the magnitude of  $\mathbf{V}$ , in the same direction as  $\mathbf{V}$  if  $r$  is positive, and in the opposite direction if  $r$  is negative. If  $r$  and  $s$  are scalars,  $\mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$ , vectors, then the following rules of scalars and vectors hold:

$$\begin{aligned} \mathbf{V}_1 + \mathbf{V}_2 &= \mathbf{V}_2 + \mathbf{V}_1 \\ (r + s)\mathbf{V}_1 &= r\mathbf{V}_1 + s\mathbf{V}_1; \quad r(\mathbf{V}_1 + \mathbf{V}_2) = r\mathbf{V}_1 + r\mathbf{V}_2 \\ \mathbf{V}_1 + (\mathbf{V}_2 + \mathbf{V}_3) &= (\mathbf{V}_1 + \mathbf{V}_2) + \mathbf{V}_3 = \mathbf{V}_1 + \mathbf{V}_2 + \mathbf{V}_3 \end{aligned}$$

## Vectors in Space

A plane is described by two distinct vectors  $\mathbf{V}_1$  and  $\mathbf{V}_2$ . Should these vectors not intersect each other, then one is displaced parallel to itself until they do (Figure 1). Any other vector  $\mathbf{V}$  lying in this plane is given by

$$\mathbf{V} = r\mathbf{V}_1 + s\mathbf{V}_2$$

A *position vector* specifies the position in space of a point relative to a fixed origin. If therefore  $\mathbf{V}_1$  and  $\mathbf{V}_2$  are the position vectors of the points  $A$  and  $B$ , relative to the origin  $O$ , then any point  $P$  on the line  $AB$  has a position vector  $\mathbf{V}$  given by

$$\mathbf{V} = r\mathbf{V}_1 + (1 - r)\mathbf{V}_2$$

The scalar “ $r$ ” can be taken as the metric representation of  $P$  since  $r = 0$  implies  $P = B$  and  $r = 1$  implies  $P = A$  (Figure 2). If  $P$  divides the line  $AB$  in the ratio  $r:s$  then

$$\mathbf{V} = \left( \frac{r}{r+s} \right) \mathbf{V}_1 + \left( \frac{s}{r+s} \right) \mathbf{V}_2$$

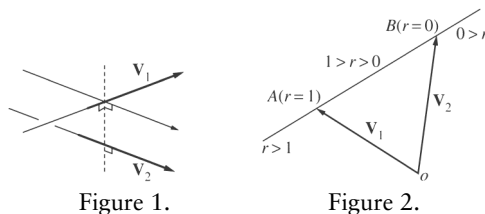


Figure 1.

Figure 2.

The vectors  $\mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3, \dots, \mathbf{V}_n$  are said to be *linearly dependent* if there exist scalars  $r_1, r_2, r_3, \dots, r_n$ , not all zero, such that

$$r_1\mathbf{V}_1 + r_2\mathbf{V}_2 + \dots + r_n\mathbf{V}_n = 0$$

A vector  $\mathbf{V}$  is linearly dependent upon the set of vectors  $\mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3, \dots, \mathbf{V}_n$  if

$$\mathbf{V} = r_1\mathbf{V}_1 + r_2\mathbf{V}_2 + r_3\mathbf{V}_3 + \dots + r_n\mathbf{V}_n$$

Three vectors are linearly dependent if and only if they are co-planar.

All points in space can be uniquely determined by linear dependence upon three *base vectors*, i.e., three vectors any one of which is linearly independent of the other two. The simplest set of base vectors is the unit vectors along the coordinate  $Ox$ ,  $Oy$  and  $Oz$  axes. These are usually designated by  $\mathbf{i}$ ,  $\mathbf{j}$  and  $\mathbf{k}$ , respectively.

If  $\mathbf{V}$  is a vector in space, and  $a$ ,  $b$  and  $c$  are the respective magnitudes of the projections of the vector along the axes then

$$\mathbf{V} = a\mathbf{i} + b\mathbf{j} + c\mathbf{k}$$

and

$$v = \sqrt{a^2 + b^2 + c^2}$$

and the direction cosines of  $\mathbf{V}$  are

$$\cos \alpha = a/v, \quad \cos \beta = b/v, \quad \cos \gamma = c/v.$$

The law of addition yields

$$\mathbf{V}_1 + \mathbf{V}_2 = (a_1 + a_2)\mathbf{i} + (b_1 + b_2)\mathbf{j} + (c_1 + c_2)\mathbf{k}$$

### The Scalar, Dot, or Inner Product of Two Vectors

This product is represented as  $\mathbf{V}_1 \cdot \mathbf{V}_2$  and is defined to be equal to  $v_1v_2 \cos \theta$ , where  $\theta$  is the angle from  $\mathbf{V}_1$  to  $\mathbf{V}_2$ , i.e.,

$$\mathbf{V}_1 \cdot \mathbf{V}_2 = v_1v_2 \cos \theta$$

The following rules apply for this product:

$$\mathbf{V}_1 \cdot \mathbf{V}_2 = a_1a_2 + b_1b_2 + c_1c_2 = \mathbf{V}_2 \cdot \mathbf{V}_1$$

It should be noted that this verifies that scalar multiplication is commutative.

$$\begin{aligned} (\mathbf{V}_1 + \mathbf{V}_2) \cdot \mathbf{V}_3 &= \mathbf{V}_1 \cdot \mathbf{V}_3 + \mathbf{V}_2 \cdot \mathbf{V}_3 \\ \mathbf{V}_1 \cdot (\mathbf{V}_2 + \mathbf{V}_3) &= \mathbf{V}_1 \cdot \mathbf{V}_2 + \mathbf{V}_1 \cdot \mathbf{V}_3 \end{aligned}$$

If  $\mathbf{V}_1$  is perpendicular to  $\mathbf{V}_2$  then  $\mathbf{V}_1 \cdot \mathbf{V}_2 = 0$ , and if  $\mathbf{V}_1$  is parallel to  $\mathbf{V}_2$ , then  $\mathbf{V}_1 \cdot \mathbf{V}_2 = v_1v_2 = rv_1^2$ . In particular

$$\mathbf{i} \cdot \mathbf{i} = \mathbf{j} \cdot \mathbf{j} = \mathbf{k} \cdot \mathbf{k} = 1,$$

and

$$\mathbf{i} \cdot \mathbf{j} = \mathbf{j} \cdot \mathbf{k} = \mathbf{k} \cdot \mathbf{i} = 0$$

### The Vector or Cross Product of Two Vectors

This product is represented as  $\mathbf{V}_1 \times \mathbf{V}_2$  and is defined to be equal to  $v_1v_2(\sin \theta)\mathbf{1}$ , where  $\theta$  is the angle from  $\mathbf{V}_1$  to  $\mathbf{V}_2$  and  $\mathbf{1}$  is a unit vector perpendicular to the plane of  $\mathbf{V}_1$  and  $\mathbf{V}_2$  and so directed that a right-handed screw driven in the direction of  $\mathbf{1}$  would carry  $\mathbf{V}_1$  into  $\mathbf{V}_2$ , i.e.,

$$\mathbf{V}_1 \times \mathbf{V}_2 = v_1v_2(\sin \theta)\mathbf{1}$$

and  $\tan \theta = \frac{|\mathbf{V}_1 \times \mathbf{V}_2|}{\mathbf{V}_1 \cdot \mathbf{V}_2}$

The following rules apply for vector products:

$$\begin{aligned} \mathbf{V}_1 \times \mathbf{V}_2 &= -\mathbf{V}_2 \times \mathbf{V}_1 \\ \mathbf{V}_1 \times (\mathbf{V}_2 + \mathbf{V}_3) &= \mathbf{V}_1 \times \mathbf{V}_2 + \mathbf{V}_1 \times \mathbf{V}_3 \\ (\mathbf{V}_1 + \mathbf{V}_2) \times \mathbf{V}_3 &= \mathbf{V}_1 \times \mathbf{V}_3 + \mathbf{V}_2 \times \mathbf{V}_3 \\ \mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3) &= \mathbf{V}_2(\mathbf{V}_3 \cdot \mathbf{V}_1) - \mathbf{V}_3(\mathbf{V}_1 \cdot \mathbf{V}_2) \\ \mathbf{i} \times \mathbf{i} &= \mathbf{j} \times \mathbf{j} = \mathbf{k} \times \mathbf{k} = \mathbf{0} \quad (\text{the zero vector}) \\ \mathbf{i} \times \mathbf{j} &= \mathbf{k}, \quad \mathbf{j} \times \mathbf{k} = \mathbf{i}, \quad \mathbf{k} \times \mathbf{i} = \mathbf{j} \end{aligned}$$

If  $\mathbf{V}_1 = a_1\mathbf{i} + b_1\mathbf{j} + c_1\mathbf{k}$ ,  $\mathbf{V}_2 = a_2\mathbf{i} + b_2\mathbf{j} + c_2\mathbf{k}$ , and  $\mathbf{V}_3 = a_3\mathbf{i} + b_3\mathbf{j} + c_3\mathbf{k}$ , then

$$\mathbf{V}_1 \times \mathbf{V}_2 = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = (b_1c_2 - b_2c_1)\mathbf{i} + (c_1a_2 - c_2a_1)\mathbf{j} + (a_1b_2 - a_2b_1)\mathbf{k}$$

It should be noted that, since  $\mathbf{V}_1 \times \mathbf{V}_2 = -\mathbf{V}_2 \times \mathbf{V}_1$ , the vector product is not commutative.

### Scalar Triple Product

There is only one possible interpretation of the expression  $\mathbf{V}_1 \cdot (\mathbf{V}_2 \times \mathbf{V}_3)$  and that is  $\mathbf{V}_1 \cdot (\mathbf{V}_2 \times \mathbf{V}_3)$  which is obviously a scalar. Further

$$\begin{aligned}\mathbf{V}_1 \cdot (\mathbf{V}_2 \times \mathbf{V}_3) &= (\mathbf{V}_1 \times \mathbf{V}_2) \cdot \mathbf{V}_3 = \mathbf{V}_2 \cdot (\mathbf{V}_3 \times \mathbf{V}_1) \\ &= \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} \\ &= r_1 r_2 r_3 \cos \phi \sin \theta,\end{aligned}$$

Where  $\theta$  is the angle between  $\mathbf{V}_2$  and  $\mathbf{V}_3$  and  $\phi$  is the angle between  $\mathbf{V}_1$  and the normal to the plane of  $\mathbf{V}_2$  and  $\mathbf{V}_3$ .

This product is called the *scalar triple product* and is written as  $[\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3]$ .

The determinant indicates that it can be considered as the volume of the parallelepiped whose three determining edges are  $\mathbf{V}_1$ ,  $\mathbf{V}_2$  and  $\mathbf{V}_3$ .

It also follows that cyclic permutation of the subscripts does not change the value of the scalar triple product so that

$$\begin{aligned}[\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3] &= [\mathbf{V}_2 \mathbf{V}_3 \mathbf{V}_1] = [\mathbf{V}_3 \mathbf{V}_1 \mathbf{V}_2] \\ \text{but } [\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3] &= -[\mathbf{V}_2 \mathbf{V}_1 \mathbf{V}_3] \quad \text{etc.} \quad \text{and} \quad [\mathbf{V}_1 \mathbf{V}_1 \mathbf{V}_2] \equiv 0 \quad \text{etc.}\end{aligned}$$

Given three non-coplanar reference vectors  $\mathbf{V}_1$ ,  $\mathbf{V}_2$  and  $\mathbf{V}_3$ , the *reciprocal system* is given by  $\mathbf{V}_1^*$ ,  $\mathbf{V}_2^*$  and  $\mathbf{V}_3^*$ , where

$$\begin{aligned}1 &= v_1 v_1^* = v_2 v_2^* = v_3 v_3^* \\ 0 &= v_1 v_2^* = v_1 v_3^* = v_2 v_1^* \quad \text{etc.} \\ \mathbf{V}_1^* &= \frac{\mathbf{V}_2 \times \mathbf{V}_3}{[\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3]}, \quad \mathbf{V}_2^* = \frac{\mathbf{V}_3 \times \mathbf{V}_1}{[\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3]}, \quad \mathbf{V}_3^* = \frac{\mathbf{V}_1 \times \mathbf{V}_2}{[\mathbf{V}_1 \mathbf{V}_2 \mathbf{V}_3]}\end{aligned}$$

The system  $\mathbf{i}, \mathbf{j}, \mathbf{k}$  is its own reciprocal.

### Vector Triple Product

The product  $\mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3)$  defines the *vector triple product*. Obviously, in this case, the brackets are vital to the definition.

$$\begin{aligned}\mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3) &= (\mathbf{V}_1 \cdot \mathbf{V}_3) \mathbf{V}_2 - (\mathbf{V}_1 \cdot \mathbf{V}_2) \mathbf{V}_3 \\ &= \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & b_1 & c_1 \\ \begin{vmatrix} b_2 & c_2 \\ b_3 & c_3 \end{vmatrix} & \begin{vmatrix} c_2 & a_2 \\ c_3 & a_3 \end{vmatrix} & \begin{vmatrix} a_2 & b_2 \\ a_3 & b_3 \end{vmatrix} \end{vmatrix}\end{aligned}$$

i.e., it is a vector, perpendicular to  $\mathbf{V}_1$ , lying in the plane of  $\mathbf{V}_2, \mathbf{V}_3$ . Similarly

$$\begin{aligned}(\mathbf{V}_1 \times \mathbf{V}_2) \times \mathbf{V}_3 &= \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ \begin{vmatrix} b_1 & c_1 \\ b_2 & c_2 \end{vmatrix} & \begin{vmatrix} c_1 & a_1 \\ c_2 & a_2 \end{vmatrix} & \begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix} \\ a_3 & b_3 & c_3 \end{vmatrix} \\ \mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3) + \mathbf{V}_2 \times (\mathbf{V}_3 \times \mathbf{V}_1) + \mathbf{V}_3 \times (\mathbf{V}_1 \times \mathbf{V}_2) &\equiv 0\end{aligned}$$

If  $\mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3) = (\mathbf{V}_1 \times \mathbf{V}_2) \times \mathbf{V}_3$ , then  $\mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$  form an *orthogonal set*. Thus  $\mathbf{i}, \mathbf{j}, \mathbf{k}$  form an orthogonal set.

### Geometry of the Plane, Straight Line and Sphere

The position vectors of the fixed points  $A, B, C, D$  relative to  $O$  are  $\mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3, \mathbf{V}_4$  and the position vector of the variable point  $P$  is  $\mathbf{V}$ .

The vector form of the equation of the straight line through  $A$  parallel to  $\mathbf{V}_2$  is

$$\begin{aligned}\mathbf{V} &= \mathbf{V}_1 + r \mathbf{V}_2 \\ \text{or } (\mathbf{V} - \mathbf{V}_1) &= r \mathbf{V}_2 \\ \text{or } (\mathbf{V} - \mathbf{V}_1) \times \mathbf{V}_2 &= 0\end{aligned}$$

while that of the plane through  $A$  perpendicular to  $\mathbf{V}_2$  is

$$(\mathbf{V} - \mathbf{V}_1) \cdot \mathbf{V}_2 = 0$$

The equation of the line  $AB$  is

$$\mathbf{V} = r \mathbf{V}_1 + (1 - r) \mathbf{V}_2$$

and those of the bisectors of the angles between  $\mathbf{V}_1$  and  $\mathbf{V}_2$  are

$$\begin{aligned}\mathbf{V} &= r \left( \frac{\mathbf{V}_1}{v_1} \pm \frac{\mathbf{V}_2}{v_2} \right) \quad \text{or} \\ \mathbf{V} &= r (\hat{\mathbf{v}}_1 \pm \hat{\mathbf{v}}_2)\end{aligned}$$

The perpendicular from  $C$  to the line through  $A$  parallel to  $\mathbf{V}_2$  has as its equation

$$\mathbf{V} = \mathbf{V}_1 - \mathbf{V}_3 - \hat{\mathbf{v}}_2 \cdot (\mathbf{V}_1 - \mathbf{V}_3) \hat{\mathbf{v}}_2.$$

The condition for the intersection of the two lines,  $\mathbf{V} = \mathbf{V}_1 + r\mathbf{V}_3$  and  $\mathbf{V} = \mathbf{V}_2 + s\mathbf{V}_4$ , is

$$[(\mathbf{V}_1 - \mathbf{V}_2)\mathbf{V}_3\mathbf{V}_4] = 0.$$

The common perpendicular to the above two lines is the line of intersection of the two planes

$$[(\mathbf{V} - \mathbf{V}_1)\mathbf{V}_3(\mathbf{V}_3 \times \mathbf{V}_4)] = 0 \quad \text{and} \quad [(\mathbf{V} - \mathbf{V}_2)\mathbf{V}_4(\mathbf{V}_3 \times \mathbf{V}_4)] = 0$$

and the length of this perpendicular is

$$\frac{[(\mathbf{V}_1 - \mathbf{V}_2)\mathbf{V}_3\mathbf{V}_4]}{|\mathbf{V}_3 \times \mathbf{V}_4|}.$$

The equation of the line perpendicular to the plane  $ABC$  is

$$\mathbf{V} = \mathbf{V}_1 \times \mathbf{V}_2 + \mathbf{V}_2 \times \mathbf{V}_3 + \mathbf{V}_3 \times \mathbf{V}_1$$

and the distance of the plane from the origin is

$$\frac{[\mathbf{V}_1\mathbf{V}_2\mathbf{V}_3]}{|(\mathbf{V}_2 - \mathbf{V}_1) \times (\mathbf{V}_3 - \mathbf{V}_1)|}.$$

In general the vector equation

$$\mathbf{V} \cdot \mathbf{V}_2 = r$$

defines the plane which is perpendicular to  $\mathbf{V}_2$ , and the perpendicular distance from  $A$  to this plane is

$$\frac{r - \mathbf{V}_1 \cdot \mathbf{V}_2}{v_2}$$

The distance from  $A$ , measured along a line parallel to  $\mathbf{V}_3$ , is

$$\frac{r - \mathbf{V}_1 \cdot \mathbf{V}_2}{\mathbf{V}_2 \cdot \hat{\mathbf{v}}_3} \quad \text{or} \quad \frac{r - \mathbf{V}_1 \cdot \mathbf{V}_2}{v_2 \cos \theta}$$

where  $\theta$  is the angle between  $\mathbf{V}_2$  and  $\mathbf{V}_3$ . (If this plane contains the point  $C$  then  $r = \mathbf{V}_3 \cdot \mathbf{V}_2$  and if it passes through the origin, then  $r = 0$ .) Given two planes

$$\begin{aligned} \mathbf{V} \cdot \mathbf{V}_1 &= r \\ \mathbf{V} \cdot \mathbf{V}_2 &= s \end{aligned}$$

then any plane through the line of intersection of these two planes is given by

$$\mathbf{V} \cdot (\mathbf{V}_1 + \lambda\mathbf{V}_2) = r + \lambda s$$

where  $\lambda$  is a scalar parameter. In particular  $\lambda = \pm v_1/v_2$  yields the equation of the two planes bisecting the angle between the given planes.

The plane through  $A$  parallel to the plane of  $\mathbf{V}_2, \mathbf{V}_3$  is

$$\begin{aligned} \mathbf{V} &= \mathbf{V}_1 + r\mathbf{V}_2 + s\mathbf{V}_3 \\ \text{or } (\mathbf{V} - \mathbf{V}_1) \cdot \mathbf{V}_2 \times \mathbf{V}_3 &= 0 \\ \text{or } [\mathbf{V}\mathbf{V}_2\mathbf{V}_3] - [\mathbf{V}_1\mathbf{V}_2\mathbf{V}_3] &= 0 \end{aligned}$$

so that the expansion in rectangular Cartesian coordinates yields (where  $\mathbf{V} \equiv x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ ):

$$\begin{vmatrix} (x - a_1) & (y - b_1) & (z - c_1) \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = 0$$

which is obviously the usual linear equation in  $x, y$ , and  $z$ .

The plane through  $AB$  parallel to  $\mathbf{V}_3$  is given by

$$\begin{aligned} [(\mathbf{V} - \mathbf{V}_1)(\mathbf{V}_1 - \mathbf{V}_2)\mathbf{V}_3] &= 0 \\ \text{or } [\mathbf{V}\mathbf{V}_2\mathbf{V}_3] - [\mathbf{V}\mathbf{V}_1\mathbf{V}_3] - [\mathbf{V}_1\mathbf{V}_2\mathbf{V}_3] &= 0 \end{aligned}$$

The plane through the three points  $A, B$  and  $C$  is

$$\begin{aligned} \mathbf{V} &= \mathbf{V}_1 + s(\mathbf{V}_2 - \mathbf{V}_1) + t(\mathbf{V}_3 - \mathbf{V}_1) \\ \text{or } \mathbf{V} &= r\mathbf{V}_1 + s\mathbf{V}_2 + t\mathbf{V}_3 \quad (r + s + t \equiv 1) \\ \text{or } [(\mathbf{V} - \mathbf{V}_1)(\mathbf{V}_1 - \mathbf{V}_2)(\mathbf{V}_2 - \mathbf{V}_3)] &= 0 \\ \text{or } [\mathbf{V}\mathbf{V}_1\mathbf{V}_2] + [\mathbf{V}\mathbf{V}_2\mathbf{V}_3] + [\mathbf{V}\mathbf{V}_3\mathbf{V}_1] - [\mathbf{V}_1\mathbf{V}_2\mathbf{V}_3] &= 0 \end{aligned}$$

For four points  $A, B, C, D$  to be coplanar, then

$$r\mathbf{V}_1 + s\mathbf{V}_2 + t\mathbf{V}_3 + u\mathbf{V}_4 \equiv 0 \equiv r + s + t + u$$

The following formulas relate to a sphere when the vectors are taken to lie in three-dimensional space and to a circle when the space is two dimensional. For a circle in three dimensions, take the intersection of the sphere with a plane.

The equation of a sphere with center  $O$  and radius  $OA$  is

$$\begin{aligned} \mathbf{V} \cdot \mathbf{V} &= v_1^2 \quad (\text{not } \mathbf{V} = \mathbf{V}_1) \\ \text{or } (\mathbf{V} - \mathbf{V}_1) \cdot (\mathbf{V} + \mathbf{V}_1) &= 0 \end{aligned}$$

while that of a sphere with center  $B$  radius  $v_1$  is

$$\begin{aligned} (\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) &= v_1^2 \\ \text{or } \mathbf{V} \cdot (\mathbf{V} - 2\mathbf{V}_2) &= v_1^2 - v_2^2 \end{aligned}$$

If the above sphere passes through the origin, then

$$\mathbf{V} \cdot (\mathbf{V} - 2\mathbf{V}_2) = 0$$

Note that in two-dimensional polar coordinates this is simply

$$r = 2a \cdot \cos \theta$$

while in three-dimensional Cartesian coordinates it is

$$x^2 + y^2 + z^2 - 2(a_2x + b_2y + c_2z) = 0.$$

The equation of a sphere having the points  $A$  and  $B$  as the extremities of a diameter is

$$(\mathbf{V} - \mathbf{V}_1) \cdot (\mathbf{V} - \mathbf{V}_2) = 0.$$

The square of the length of the tangent from  $C$  to the sphere with center  $B$  and radius  $v_1$  is given by

$$(\mathbf{V}_3 - \mathbf{V}_2) \cdot (\mathbf{V}_3 - \mathbf{V}_2) = v_1^2$$

The condition that the plane  $\mathbf{V} \cdot \mathbf{V}_3 = s$  is tangential to the sphere  $(\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) = v_1^2$  is

$$(s - \mathbf{V}_3 \cdot \mathbf{V}_2) \cdot (s - \mathbf{V}_3 \cdot \mathbf{V}_2) = v_1^2 v_3^2.$$

The equation of the tangent plane at  $D$ , on the surface of sphere  $(\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) = v_1^2$ , is

$$\begin{aligned} (\mathbf{V} - \mathbf{V}_4) \cdot (\mathbf{V}_4 - \mathbf{V}_2) &= 0 \\ \text{or } \mathbf{V} \cdot \mathbf{V}_4 - \mathbf{V}_2 \cdot (\mathbf{V} + \mathbf{V}_4) &= v_1^2 - v_2^2 \end{aligned}$$

The condition that the two circles  $(\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) = v_1^2$  and  $(\mathbf{V} - \mathbf{V}_4) \cdot (\mathbf{V} - \mathbf{V}_4) = v_3^2$  intersect orthogonally is clearly

$$(\mathbf{V}_2 - \mathbf{V}_4) \cdot (\mathbf{V}_2 - \mathbf{V}_4) = v_1^2 + v_3^2$$

The polar plane of  $D$  with respect to the circle

$$\begin{aligned} (\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) &= v_1^2 \quad \text{is} \\ \mathbf{V} \cdot \mathbf{V}_4 - \mathbf{V}_2 \cdot (\mathbf{V} + \mathbf{V}_4) &= v_1^2 - v_2^2 \end{aligned}$$

Any sphere through the intersection of the two spheres  $(\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) = v_1^2$  and  $(\mathbf{V} - \mathbf{V}_4) \cdot (\mathbf{V} - \mathbf{V}_4) = v_3^2$  is given by

$$(\mathbf{V} - \mathbf{V}_2) \cdot (\mathbf{V} - \mathbf{V}_2) + \lambda(\mathbf{V} - \mathbf{V}_4) \cdot (\mathbf{V} - \mathbf{V}_4) = v_1^2 + \lambda v_3^2$$

while the radical plane of two such spheres is

$$\mathbf{V} \cdot (\mathbf{V}_2 - \mathbf{V}_4) = -\frac{1}{2}(v_1^2 - v_2^2 - v_3^2 + v_4^2)$$

**Differentiation of Vectors**

If  $\mathbf{V}_1 = a_1\mathbf{i} + b_1\mathbf{j} + c_1\mathbf{k}$ , and  $\mathbf{V}_2 = a_2\mathbf{i} + b_2\mathbf{j} + c_2\mathbf{k}$ , and if  $\mathbf{V}_1$  and  $\mathbf{V}_2$  are functions of the scalar  $t$ , then

$$\begin{aligned} \frac{d}{dt}(\mathbf{V}_1 + \mathbf{V}_2 + \dots) &= \frac{d\mathbf{V}_1}{dt} + \frac{d\mathbf{V}_2}{dt} + \dots \\ \frac{d\mathbf{V}_1}{dt} &= \frac{da_1}{dt}\mathbf{i} + \frac{db_1}{dt}\mathbf{j} + \frac{dc_1}{dt}\mathbf{k}, \quad \text{etc} \\ \frac{d}{dt}(\mathbf{V}_1 \cdot \mathbf{V}_2) &= \frac{d\mathbf{V}_1}{dt} \cdot \mathbf{V}_2 + \mathbf{V}_1 \cdot \frac{d\mathbf{V}_2}{dt} \\ \frac{d}{dt}(\mathbf{V}_1 \times \mathbf{V}_2) &= \frac{d\mathbf{V}_1}{dt} \times \mathbf{V}_2 + \mathbf{V}_1 \times \frac{d\mathbf{V}_2}{dt} \\ \mathbf{V} \cdot \frac{d\mathbf{V}}{dt} &= v \cdot \frac{dv}{dt} \end{aligned}$$

In particular, if  $\mathbf{V}$  is a vector of constant length, then the right-hand side of the last equation is identically zero showing that  $\mathbf{V}$  is perpendicular to its derivative.

The derivatives of the triple products are

$$\begin{aligned} \frac{d}{dt}[\mathbf{V}_1\mathbf{V}_2\mathbf{V}_3] &= \left[ \left( \frac{d\mathbf{V}_1}{dt} \right) \mathbf{V}_2\mathbf{V}_3 \right] + \left[ \mathbf{V}_1 \left( \frac{d\mathbf{V}_2}{dt} \right) \mathbf{V}_3 \right] + \left[ \mathbf{V}_1\mathbf{V}_2 \left( \frac{d\mathbf{V}_3}{dt} \right) \right] \quad \text{and} \\ \frac{d}{dt}\{\mathbf{V}_1 \times (\mathbf{V}_2 \times \mathbf{V}_3)\} &= \left( \frac{d\mathbf{V}_1}{dt} \right) \times (\mathbf{V}_2 \times \mathbf{V}_3) + \mathbf{V}_1 \times \left( \left( \frac{d\mathbf{V}_2}{dt} \right) \times \mathbf{V}_3 \right) + \mathbf{V}_1 \times \left( \mathbf{V}_2 \times \left( \frac{d\mathbf{V}_3}{dt} \right) \right) \end{aligned}$$

**Geometry of Curves in Space**

$s$  = the *length of arc*, measured from some fixed point on the curve (Figure 3).

$\mathbf{V}_1$  = the position vector of the point  $A$  on the curve.

$\mathbf{V}_1 + \delta\mathbf{V}_1$  = the position vector of the point  $P$  in the neighborhood of  $A$ .

$\hat{\mathbf{t}}$  = the *unit tangent* to the curve at the point  $A$ , measured in the direction of  $s$  increasing.

The *normal plane* is that plane which is perpendicular to the unit tangent. The principal normal is defined as the intersection of the normal plane with the plane defined by  $\mathbf{V}_1$  and  $\mathbf{V}_1 + \delta\mathbf{V}_1$  in the limit as  $\delta\mathbf{V}_1 \rightarrow 0$ .

$\hat{\mathbf{n}}$  = the *unit normal* (principal) at the point  $A$ . The plane defined by  $\hat{\mathbf{t}}$  and  $\hat{\mathbf{n}}$  is called the *osculating plane* (alternatively plane of curvature or local plane).

$\rho$  = the radius of curvature at  $A$ .

$\delta\theta$  = the angle subtended at the origin by  $\delta\mathbf{V}_1$ .

$$\kappa = \frac{d\theta}{ds} = \frac{1}{\rho}$$

$\hat{\mathbf{b}}$  = the *unit binormal* i.e., the unit vector which is parallel to  $\hat{\mathbf{t}} \times \hat{\mathbf{n}}$  at the point  $A$

$\lambda$  = the *torsion* of the curve at  $A$ .

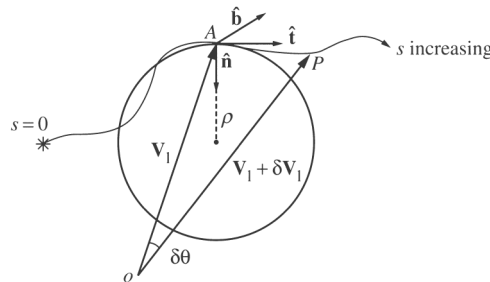


Figure 3.

*Frenet's Formulas:*

$$\begin{aligned} \frac{d\hat{\mathbf{t}}}{ds} &= \kappa \hat{\mathbf{n}} \\ \frac{d\hat{\mathbf{n}}}{ds} &= -\kappa \hat{\mathbf{t}} + \lambda \hat{\mathbf{b}} \\ \frac{d\hat{\mathbf{b}}}{ds} &= -\lambda \hat{\mathbf{n}} \end{aligned}$$

The following formulas are also applicable:

Unit tangent	$\hat{\mathbf{t}} = \frac{d\mathbf{V}_1}{ds}$
Equation of the tangent	$(\mathbf{V} - \mathbf{V}_1) \times \hat{\mathbf{t}} = 0 \quad \text{or} \quad \mathbf{V} = \mathbf{V}_1 + q\hat{\mathbf{t}}$
Unit normal	$\hat{\mathbf{n}} = \frac{1}{\kappa} \frac{d^2\mathbf{V}_1}{ds^2}$
Equation of the normal plane	$(\mathbf{V} - \mathbf{V}_1) \cdot \hat{\mathbf{t}} = 0$
Equation of the normal	$(\mathbf{V} - \mathbf{V}_1) \times \hat{\mathbf{n}} = 0 \quad \text{or} \quad \mathbf{V} = \mathbf{V}_1 + r\hat{\mathbf{n}}$
Unit binormal	$\hat{\mathbf{b}} = \hat{\mathbf{t}} \times \hat{\mathbf{n}}$
Equation of the binormal	$(\mathbf{V} - \mathbf{V}_1) \times \hat{\mathbf{b}} = 0$ or $\mathbf{V} = \mathbf{V}_1 + u\hat{\mathbf{b}}$
Equation of the osculating plane	$[(\mathbf{V} - \mathbf{V}_1)\hat{\mathbf{t}}\hat{\mathbf{n}}] = 0$ or $\left[ (\mathbf{V} - \mathbf{V}_1) \left( \frac{d\mathbf{V}_1}{ds} \right) \left( \frac{d^2\mathbf{V}_1}{ds^2} \right) \right] = 0$

**Differential Operators—Rectangular Coordinates**

$$dS = \frac{\partial S}{\partial x} \cdot dx + \frac{\partial S}{\partial y} \cdot dy + \frac{\partial S}{\partial z} \cdot dz$$

By definition

$$\nabla \equiv \text{del} \equiv \mathbf{i} \frac{\partial}{\partial x} + \mathbf{j} \frac{\partial}{\partial y} + \mathbf{k} \frac{\partial}{\partial z}$$

$$\nabla^2 \equiv \text{Laplacian} \equiv \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

If  $S$  is a scalar function, then  $\nabla S \equiv \text{grad } S \equiv \frac{\partial S}{\partial x} \mathbf{i} + \frac{\partial S}{\partial y} \mathbf{j} + \frac{\partial S}{\partial z} \mathbf{k}$ .

Grad  $S$  defines both the direction and magnitude of the maximum rate of increase of  $S$  at any point. Hence the name *gradient* and also its vectorial nature.  $\nabla S$  is independent of the choice of rectangular coordinates.

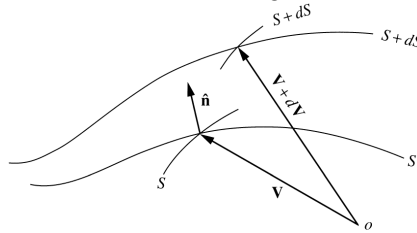


Figure 4.

$$\nabla S = \frac{\partial S}{\partial n} \hat{\mathbf{n}} \tag{4}$$

where  $\hat{\mathbf{n}}$  is the unit normal to the surface  $S = \text{constant}$ , in the direction of  $S$  increasing. The total derivative of  $S$  at a point having the position vector  $\mathbf{V}$  is given by (Figure 4)

$$dS = \frac{\partial S}{\partial n} \hat{\mathbf{n}} \cdot d\mathbf{V}$$

$$= d\mathbf{V} \cdot \nabla S$$

and the directional derivative of  $S$  in the direction of  $\mathbf{U}$  is

$$\mathbf{U} \cdot \nabla S = \mathbf{U} \cdot (\nabla S) = (\mathbf{U} \cdot \nabla) S$$

Similarly the directional derivative of the vector  $\mathbf{V}$  in the direction of  $\mathbf{U}$  is

$$(\mathbf{U} \cdot \nabla) \mathbf{V}$$

The *distributive* law holds for finding a gradient. Thus if  $S$  and  $T$  are scalar functions

$$\nabla(S + T) = \nabla S + \nabla T$$

The *associative* law becomes the rule for differentiating a product:

$$\nabla(ST) = S\nabla T + T\nabla S$$

If  $\mathbf{V}$  is a vector function with the magnitudes of the components parallel to the three coordinate axes  $V_x, V_y, V_z$ , then

$$\nabla \cdot \mathbf{V} \equiv \text{div } \mathbf{V} \equiv \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z}$$

The divergence obeys the distributive law. Thus, if  $\mathbf{V}$  and  $\mathbf{U}$  are vector functions, then

$$\begin{aligned}\nabla \cdot (\mathbf{V} + \mathbf{U}) &= \nabla \cdot \mathbf{V} + \nabla \cdot \mathbf{U} \\ \nabla \cdot (S\mathbf{V}) &= (\nabla S) \cdot \mathbf{V} + S(\nabla \cdot \mathbf{V}) \\ \nabla \cdot (\mathbf{U} \times \mathbf{V}) &= \mathbf{V} \cdot (\nabla \times \mathbf{U}) - \mathbf{U} \cdot (\nabla \times \mathbf{V})\end{aligned}$$

As with the gradient of a scalar, the divergence of a vector is invariant under a transformation from one set of rectangular coordinates to another.

$$\begin{aligned}\nabla \times \mathbf{V} &\equiv \text{curl } \mathbf{V} \quad (\text{sometimes } \nabla \wedge \mathbf{V} \text{ or } \text{rot } \mathbf{V}) \\ &\equiv \left( \frac{\partial V_x}{\partial y} - \frac{\partial V_y}{\partial x} \right) \mathbf{i} + \left( \frac{\partial V_x}{\partial z} - \frac{\partial V_z}{\partial x} \right) \mathbf{j} + \left( \frac{\partial V_y}{\partial z} - \frac{\partial V_z}{\partial y} \right) \mathbf{k} \\ &= \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ V_x & V_y & V_z \end{vmatrix}\end{aligned}$$

The *curl* (or *rotation*) of a vector is a vector that is invariant under a transformation from one set of rectangular coordinates to another.

$$\begin{aligned}\nabla \times (\mathbf{U} + \mathbf{V}) &= \nabla \times \mathbf{U} + \nabla \times \mathbf{V} \\ \nabla \times (S\mathbf{V}) &= (\nabla S) \times \mathbf{V} + S(\nabla \times \mathbf{V}) \\ \nabla \times (\mathbf{U} \times \mathbf{V}) &= (\mathbf{V} \cdot \nabla)\mathbf{U} - (\mathbf{U} \cdot \nabla)\mathbf{V} + \mathbf{U}(\nabla \cdot \mathbf{V}) - \mathbf{V}(\nabla \cdot \mathbf{U})\end{aligned}$$

If  $\mathbf{V} = V_x\mathbf{i} + V_y\mathbf{j} + V_z\mathbf{k}$ , then

$$\begin{aligned}\nabla \cdot \mathbf{V} &= \nabla V_x \cdot \mathbf{i} + \nabla V_y \cdot \mathbf{j} + \nabla V_z \cdot \mathbf{k} \\ \text{and } \nabla \times \mathbf{V} &= \nabla V_x \times \mathbf{i} + \nabla V_y \times \mathbf{j} + \nabla V_z \times \mathbf{k}\end{aligned}$$

The operator  $\nabla$  can be used more than once. The possibilities where  $\nabla$  is used twice are:

$$\begin{aligned}\nabla \cdot (\nabla\theta) &\equiv \text{div grad } \theta \\ \nabla \times (\nabla\theta) &\equiv \text{curl grad } \theta \\ \nabla(\nabla \cdot \mathbf{V}) &\equiv \text{grad div } \mathbf{V} \\ \nabla \cdot (\nabla \times \mathbf{V}) &\equiv \text{div curl } \mathbf{V} \\ \nabla \times (\nabla \times \mathbf{V}) &\equiv \text{curl curl } \mathbf{V}\end{aligned}$$

Thus, if  $S$  is a scalar and  $\mathbf{V}$  is a vector:

$$\begin{aligned}\text{div grad } S &\equiv \nabla \cdot (\nabla S) \equiv \text{Laplacian } S \equiv \nabla^2 S \equiv \frac{\partial^2 S}{\partial x^2} + \frac{\partial^2 S}{\partial y^2} + \frac{\partial^2 S}{\partial z^2} \\ \text{curl grad } S &\equiv 0 \\ \text{curl curl } \mathbf{V} &\equiv \text{grad div } \mathbf{V} - \nabla^2 \mathbf{V}; \\ \text{div curl } \mathbf{V} &\equiv 0\end{aligned}$$

Taylor expansion in three dimensions can be written

$$\begin{aligned}f(\mathbf{V} + \boldsymbol{\varepsilon}) &= e^{\boldsymbol{\varepsilon} \cdot \nabla} f(\mathbf{V}) \quad \text{where } \mathbf{V} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k} \\ \text{and } \boldsymbol{\varepsilon} &= h\mathbf{i} + l\mathbf{j} + m\mathbf{k}\end{aligned}$$



## ORTHOGONAL CURVILINEAR COORDINATES

If at a point  $P$  there exist three uniform point functions  $u$ ,  $v$  and  $w$  so that the surfaces  $u = \text{const.}$ ,  $v = \text{const.}$ , and  $w = \text{const.}$ , intersect in three distinct curves through  $P$ , then the surfaces are called the *coordinate surfaces* through  $P$ . The three lines of intersection are referred to as the *coordinate lines* and their tangents  $a$ ,  $b$ , and  $c$  as the *coordinate axes*. When the coordinate axes form an orthogonal set the system is said to define *orthogonal curvilinear coordinates* at  $P$ .

Consider an infinitesimal volume enclosed by the surfaces  $u, v, w, u + du, v + dv, \text{ and } w + dw$  (Figure 5).

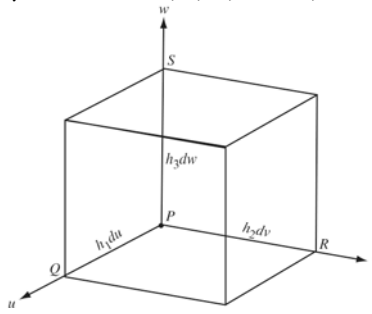


Figure 5.

The surface  $PRS \equiv u = \text{constant}$ , and the face of the curvilinear figure immediately opposite this is  $u + du = \text{constant}$ , etc. In terms of these surface constants

$$\begin{aligned} P &= P(u, v, w) \\ Q &= Q(u + du, v, w) \quad \text{and} \quad PQ = h_1 du \\ R &= R(u, v + dv, w) \quad \text{and} \quad PR = h_2 dv \\ S &= S(u, v, w + dw) \quad \text{and} \quad PS = h_3 dw \end{aligned}$$

where  $h_1, h_2, \text{ and } h_3$  are functions of  $u, v, \text{ and } w$ .

- In rectangular Cartesians  $\hat{i}, \hat{j}, \hat{k}$

$$\begin{aligned} h_1 &= 1, \quad h_2 = 1, \quad h_3 = 1. \\ \frac{\hat{\mathbf{a}}}{h_1} \frac{\partial}{\partial u} &= \hat{\mathbf{i}} \frac{\partial}{\partial x}, \quad \frac{\hat{\mathbf{b}}}{h_2} \frac{\partial}{\partial v} = \hat{\mathbf{j}} \frac{\partial}{\partial y}, \quad \frac{\hat{\mathbf{c}}}{h_3} \frac{\partial}{\partial w} = \hat{\mathbf{k}} \frac{\partial}{\partial z}. \end{aligned}$$

- In cylindrical Cartesians  $\hat{\mathbf{r}}, \hat{\theta}, \hat{\mathbf{z}}$

$$\begin{aligned} h_1 &= 1, \quad h_2 = r, \quad h_3 = 1. \\ \frac{\hat{\mathbf{a}}}{h_1} \frac{\partial}{\partial u} &= \hat{\mathbf{r}} \frac{\partial}{\partial r}, \quad \frac{\hat{\mathbf{b}}}{h_2} \frac{\partial}{\partial v} = \frac{\hat{\theta}}{r} \frac{\partial}{\partial \theta}, \quad \frac{\hat{\mathbf{c}}}{h_3} \frac{\partial}{\partial w} = \hat{\mathbf{z}} \frac{\partial}{\partial z}. \end{aligned}$$

- In spherical coordinates  $\hat{\mathbf{r}}, \hat{\theta}, \hat{\psi}$

$$\begin{aligned} h_1 &= 1, \quad h_2 = r, \quad h_3 = r \sin \theta \\ \frac{\hat{\mathbf{a}}}{h_1} \frac{\partial}{\partial u} &= \hat{\mathbf{r}} \frac{\partial}{\partial r}, \quad \frac{\hat{\mathbf{b}}}{h_2} \frac{\partial}{\partial v} = \frac{\hat{\theta}}{r} \frac{\partial}{\partial \theta}, \quad \frac{\hat{\mathbf{c}}}{h_3} \frac{\partial}{\partial w} = \frac{\hat{\psi}}{r \sin \theta} \frac{\partial}{\partial \psi} \end{aligned}$$

The general expressions for grad, div and curl together with those for  $\nabla^2$  and the directional derivative are, in orthogonal curvilinear coordinates, given by:

$$\begin{aligned} \nabla S &= \frac{\hat{\mathbf{a}}}{h_1} \frac{\partial S}{\partial u} + \frac{\hat{\mathbf{b}}}{h_2} \frac{\partial S}{\partial v} + \frac{\hat{\mathbf{c}}}{h_3} \frac{\partial S}{\partial w} \\ (\mathbf{V} \cdot \nabla) S &= \frac{V_1}{h_1} \frac{\partial S}{\partial u} + \frac{V_2}{h_2} \frac{\partial S}{\partial v} + \frac{V_3}{h_3} \frac{\partial S}{\partial w} \\ \nabla \cdot \mathbf{V} &= \frac{1}{h_1 h_2 h_3} \left\{ \frac{\partial}{\partial u} (h_2 h_3 V_1) + \frac{\partial}{\partial v} (h_3 h_1 V_2) + \frac{\partial}{\partial w} (h_1 h_2 V_3) \right\}. \\ \nabla \times \mathbf{V} &= \frac{\hat{\mathbf{a}}}{h_2 h_3} \left\{ \frac{\partial}{\partial v} (h_3 V_3) - \frac{\partial}{\partial w} (h_2 V_2) \right\} + \frac{\hat{\mathbf{b}}}{h_3 h_1} \left\{ \frac{\partial}{\partial w} (h_1 V_1) - \frac{\partial}{\partial u} (h_3 V_3) \right\} \\ &\quad + \frac{\hat{\mathbf{c}}}{h_1 h_2} \left\{ \frac{\partial}{\partial u} (h_2 V_2) - \frac{\partial}{\partial v} (h_1 V_1) \right\} \\ \nabla^2 S &= \frac{1}{h_1 h_2 h_3} \left\{ \frac{\partial}{\partial u} \left( \frac{h_2 h_3}{h_1} \frac{\partial S}{\partial u} \right) + \frac{\partial}{\partial v} \left( \frac{h_3 h_1}{h_2} \frac{\partial S}{\partial v} \right) + \frac{\partial}{\partial w} \left( \frac{h_1 h_2}{h_3} \frac{\partial S}{\partial w} \right) \right\} \end{aligned}$$

## Formulas of Vector Analysis

	Rectangular coordinates	Cylindrical coordinates	Spherical coordinates
Conversion to rectangular coordinates		$x = r \cos \varphi \quad y = r \sin \varphi \quad z = z$	$x = r \cos \varphi \sin \theta \quad y = r \sin \varphi \sin \theta$ $z = r \cos \theta$
Gradient...	$\nabla \phi = \frac{\partial \phi}{\partial x} \mathbf{i} + \frac{\partial \phi}{\partial y} \mathbf{j} + \frac{\partial \phi}{\partial z} \mathbf{k}$	$\nabla \phi = \frac{\partial \phi}{\partial r} \mathbf{r} + \frac{1}{r} \frac{\partial \phi}{\partial \varphi} \Phi + \frac{\partial \phi}{\partial z} \mathbf{k}$	$\nabla \phi = \frac{\partial \phi}{\partial r} \mathbf{r} + \frac{1}{r} \frac{\partial \phi}{\partial \theta} \theta + \frac{1}{r \sin \theta} \frac{\partial \phi}{\partial \varphi} \Phi$
Divergence...	$\nabla \cdot \mathbf{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$	$\nabla \cdot \mathbf{A} = \frac{1}{r} \frac{\partial(r A_r)}{\partial r} + \frac{1}{r} \frac{\partial A_\varphi}{\partial \varphi} + \frac{\partial A_z}{\partial z}$	$\nabla \cdot \mathbf{A} = \frac{1}{r^2} \frac{\partial(r^2 A_r)}{\partial r} + \frac{1}{r \sin \theta} \frac{\partial(A_\theta \sin \theta)}{\partial \theta} + \frac{1}{r \sin \theta} \frac{\partial A_\varphi}{\partial \varphi}$
Curl...	$\nabla \times \mathbf{A} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$	$\nabla \times \mathbf{A} = \begin{vmatrix} \frac{1}{r} \mathbf{r} & \Phi & \frac{1}{r} \mathbf{k} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \varphi} & \frac{\partial}{\partial z} \\ A_r & r A_\varphi & A_z \end{vmatrix}$	$\nabla \times \mathbf{A} = \begin{vmatrix} \frac{r}{r^2} \frac{\theta}{\sin \theta} \frac{\Phi}{r} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \varphi} \\ A_r & r A_\theta & r A_\varphi \sin \theta \end{vmatrix}$
Laplacian...	$\nabla^2 \phi = \frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2}$	$\nabla^2 \phi = \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial \phi}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 \phi}{\partial \varphi^2} + \frac{\partial^2 \phi}{\partial z^2}$	$\nabla^2 \phi = \frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \frac{\partial \phi}{\partial r} \right) + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left( \sin \theta \frac{\partial \phi}{\partial \theta} \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2 \phi}{\partial \varphi^2}$

## TRANSFORMATION OF INTEGRALS

If

1.  $s$  is the distance along a curve "C" in space and is measured from some fixed point.
2.  $S$  is a surface area
3.  $V$  is a volume contained by a specified surface
4.  $\hat{\mathbf{t}}$  = the unit tangent to  $C$  at the point
5.  $\hat{\mathbf{n}}$  = the unit outward pointing normal
6.  $F$  is some vector function
7.  $ds$  is the vector element of curve ( $= \hat{\mathbf{t}} ds$ )
8.  $dS$  is the vector element of surface ( $= \hat{\mathbf{n}} dS$ )

then

$$\int_{(c)} \mathbf{F} \cdot \hat{\mathbf{t}} ds = \int_{(c)} \mathbf{F}$$

and when  $F = \nabla\phi$

$$\int_C (\nabla\phi) \cdot \hat{\mathbf{t}} ds = \int_C d\phi$$

*Gauss' Theorem*

When  $S$  defines a closed region having a volume  $V$ :

$$\iiint_V (\nabla \cdot \mathbf{F}) dV = \iint_S \mathbf{F} \cdot (\hat{\mathbf{n}}) dS = \iint_S \mathbf{F} \cdot dS$$

also

$$\iiint_V (\nabla\phi) dV = \iint_S \phi \hat{\mathbf{n}} dS$$

and

$$\iiint_V (\nabla \times \mathbf{F}) dV = \iint_S (\hat{\mathbf{n}} \times \mathbf{F}) dS$$

*Stokes' Theorem*

When  $C$  is closed and bounds the open surface  $S$ :

$$\iint_S \hat{\mathbf{n}} \cdot (\nabla \times \mathbf{F}) dS = \int_C \mathbf{F} \cdot ds$$

also

$$\iint_S (\hat{\mathbf{n}} \times \nabla\phi) dS = \int_{(c)} \phi ds$$

*Green's Theorem*

$$\begin{aligned} \iint_S (\nabla\phi \cdot \nabla\theta) dS &= \iint_S \phi \hat{\mathbf{n}} \cdot (\nabla\theta) dS = \iiint_V \phi (\nabla^2\theta) dV \\ &= \iint_S \theta \cdot \hat{\mathbf{n}} (\nabla\phi) dS = \iiint_V \phi (\nabla^2\theta) dV \end{aligned}$$

## MOMENT OF INERTIA FOR VARIOUS BODIES OF MASS

The mass of the body is indicated by  $m$

Body	Axis	Moment of inertia
Uniform thin rod of length $l$	Normal to the length, at one end	$m\frac{1}{3}l^2$
Uniform thin rod of length $l$	Normal to the length, at the center	$m\frac{1}{12}l^2$
Thin rectangular sheet, sides $a$ and $b$	Through the center parallel to $b$	$m\frac{1}{12}a^2$
Thin rectangular sheet, sides $a$ and $b$	Through the center perpendicular to the sheet	$m\frac{1}{12}(a^2 + b^2)$
Thin circular sheet of radius $r$	Normal to the plate through the center	$m\frac{1}{2}r^2$
Thin circular sheet of radius $r$	Along any diameter	$m\frac{1}{4}r^2$
Thin circular ring. Radii $r_1$ and $r_2$	Through center normal to plane of ring	$m\frac{1}{2}(r_1^2 + r_2^2)$
Thin circular ring. Radii $r_1$ and $r_2$	Any diameter	$m\frac{1}{4}(r_1^2 + r_2^2)$
Rectangular parallelepiped, edges $a$ , $b$ , and $c$	Through center perpendicular to face $ab$ , (parallel to edge $c$ )	$m\frac{1}{12}(a^2 + b^2)$
Sphere, radius $r$	Any diameter	$m\frac{2}{5}r^2$
Spherical shell, external radius, $r_1$ , internal radius $r_2$	Any diameter	$m\frac{2}{5}\frac{(r_1^5 - r_2^5)}{(r_1^3 - r_2^3)}$
Spherical shell, very thin, mean radius, $r$	Any diameter	$m\frac{2}{3}r^2$
Right circular cylinder of radius $r$ , length $l$	The longitudinal axis of the solid	$m\frac{1}{2}r^2$
Right circular cylinder of radius $r$ , length $l$	Transverse diameter	$m\left(\frac{r^2}{4} + \frac{l^2}{12}\right)$
Hollow circular cylinder, length $l$ , radii $r_1$ and $r_2$	The longitudinal axis of the figure	$m\frac{1}{2}(r_1^2 + r_2^2)$
Thin cylindrical shell, length $l$ , mean radius, $r$	The longitudinal axis of the figure	$mr^2$
Hollow circular cylinder, length $l$ , radii $r_1$ and $r_2$	Transverse diameter	$m\left(\frac{r_1^2 + r_2^2}{4} + \frac{l^2}{12}\right)$
Hollow circular cylinder, length $l$ , very thin, mean radius $r$	Transverse diameter	$m\left(\frac{r^2}{2} + \frac{l^2}{12}\right)$
Elliptic cylinder, length $l$ , transverse semiaxes $a$ and $b$	Longitudinal axis	$m\frac{1}{4}(a^2 + b^2)$
Right cone, altitude $h$ , radius of base $r$	Axis of the figure	$m\frac{3}{10}r^2$
Spheroid of revolution, equatorial radius $r$	Polar axis	$m\frac{2}{5}r^2$
Ellipsoid, axes $2a$ , $2b$ , $2c$	Axis $2a$	$m\frac{1}{5}(b^2 + c^2)$

## BESSEL FUNCTIONS

1. Bessel's differential equation for a real variable  $x$  is

$$x^2 \frac{d^2 y}{dx^2} + x \frac{dy}{dx} + (x^2 - n^2)y = 0$$

2. When  $n$  is not an integer, two independent solutions of the equation are  $J_n(x)$  and  $J_{-n}(x)$  where

$$J_n(x) = \sum_{k=0}^{\infty} \frac{(-1)^k}{k! \Gamma(n+k+1)} \left(\frac{x}{2}\right)^{n+2k}$$

3. If  $n$  is an integer, then  $J_n(x) = (-1)^n J_{-n}(x)$ , where

$$J_n(x) = \frac{x^n}{2^n n!} \left\{ 1 - \frac{x^2}{2^2 \cdot 1!(n+1)} + \frac{x^4}{2^4 \cdot 2!(n+1)(n+2)} + \frac{x^6}{2^6 \cdot 3!(n+1)(n+2)(n+3)} + \dots \right\}$$

4. For  $n = 0$  and  $n = 1$ , this formula becomes

$$J_0(x) = 1 - \frac{x^2}{2^2(1!)^2} + \frac{x^4}{2^4(2!)^2} - \frac{x^6}{2^6(3!)^2} + \frac{x^8}{2^8(4!)^2} - \dots$$

$$J_1(x) = \frac{x}{2} - \frac{x^3}{2^3 \cdot 1!2!} + \frac{x^5}{2^5 \cdot 2!3!} - \frac{x^7}{2^7 \cdot 3!4!} + \frac{x^9}{2^9 \cdot 4!5!} - \dots$$

5. When  $x$  is large and positive, the following asymptotic series may be used

$$J_0(x) = \left(\frac{2}{\pi x}\right)^{\frac{1}{2}} \left\{ P_0(x) \cos\left(x - \frac{\pi}{4}\right) - Q_0(x) \sin\left(x - \frac{\pi}{4}\right) \right\}$$

$$J_1(x) = \left(\frac{2}{\pi x}\right)^{\frac{1}{2}} \left\{ P_1(x) \cos\left(x - \frac{3\pi}{4}\right) - Q_1(x) \sin\left(x - \frac{3\pi}{4}\right) \right\}$$

where

$$P_0(x) \sim 1 - \frac{1^2 \cdot 3^2}{2!(8x)^2} + \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7^2}{4!(8x)^4} - \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7^2 \cdot 9^2 \cdot 11^2}{6!(8x)^6} + \dots$$

$$Q_0(x) \sim -\frac{1^2}{1!8x} + \frac{1^2 \cdot 3^2 \cdot 5^2}{3!(8x)^3} - \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7^2 \cdot 9^2}{5!(8x)^5} + \dots$$

$$P_1(x) \sim 1 + \frac{1^2 \cdot 3 \cdot 5}{2!(8x)^2} - \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7 \cdot 9}{4!(8x)^4} + \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7^2 \cdot 9^2 \cdot 11 \cdot 13}{6!(8x)^6} - \dots$$

$$Q_1(x) \sim \frac{1 \cdot 3}{1!8x} - \frac{1^2 \cdot 3^2 \cdot 5 \cdot 7}{3!(8x)^3} + \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7^2 \cdot 9 \cdot 11}{5!(8x)^5} - \dots$$

[In  $P_1(x)$  the signs alternate from + to - after the first term]

6. The zeros of  $J_0(x)$  and  $J_1(x)$ .

If  $j_{0s}$  and  $j_{1s}$  are the  $s$ th zeros of  $J_0(x)$  and  $J_1(x)$ , respectively, and if  $a = 4_s - 1$ ,  $b = 4_s + 1$

$$j_{0,s} \sim \frac{1}{4} \pi a \left\{ 1 + \frac{2}{\pi^2 a^2} - \frac{62}{3\pi^4 a^4} + \frac{15,116}{15\pi^6 a^6} - \frac{12,554,474}{105\pi^8 a^8} + \frac{8,368,654,292}{315\pi^{10} a^{10}} - \dots \right\}$$

$$j_{1,s} \sim \frac{1}{4} \pi b \left\{ 1 - \frac{6}{\pi^2 b^2} + \frac{6}{\pi^4 b^4} - \frac{4716}{5\pi^6 b^6} + \frac{3,902,418}{35\pi^8 b^8} - \frac{895,167,324}{35\pi^{10} b^{10}} + \dots \right\}$$

$$J_1(j_{0,s}) \sim \frac{(-1)^{s+1} 2^{\frac{3}{2}}}{\pi a^{\frac{1}{2}}} \left\{ 1 - \frac{56}{3\pi^4 a^4} + \frac{9664}{5\pi^6 a^6} - \frac{7,381,280}{21\pi^8 a^8} + \dots \right\}$$

$$J_0(j_{1,s}) \sim \frac{(-1)^s 2^{\frac{3}{2}}}{\pi b^{\frac{1}{2}}} \left\{ 1 + \frac{24}{\pi^4 b^4} - \frac{19,584}{10\pi^6 b^6} + \frac{2,466,720}{7\pi^8 b^8} - \dots \right\}$$

7. Table of zeros for  $J_0(x)$  and  $J_1(x)$

Define  $\{\alpha_n, \beta_n\}$  by  $J_0(\alpha_n) = 0$  and  $J_1(\beta_n) = 0$ .

Roots $\alpha_n$	$J_1(\alpha_n)$	Roots $\beta_n$	$J_0(\beta_n)$
2.4048	0.5191	0.0000	1.0000
5.5201	-0.3403	3.8317	-0.4028
8.6537	0.2715	7.0156	0.3001
11.7915	-0.2325	10.1735	-0.2497
14.9309	0.2065	13.3237	0.2184
18.0711	-0.1877	16.4706	-0.1965
21.2116	0.1733	19.6159	0.1801

8. Recurrence formulas

$$\begin{aligned} J_{n-1}(x) + J_{n+1}(x) &= \frac{2n}{x} J_n(x) & nJ_n(x) + xJ'_n(x) &= xJ_{n-1}(x) \\ J_{n-1}(x) - J_{n+1}(x) &= 2J'_n(x) & nJ_n(x) - xJ'_n(x) &= xJ_{n+1}(x) \end{aligned}$$

9. If  $J_n$  is written for  $J_n(x)$  and  $J_n^{(k)}$  is written for  $\frac{d^k}{dx^k}\{J_n(x)\}$ , then the following derivative relationships are important

$$\begin{aligned} J_0^{(r)} &= -J_1^{(r-1)} \\ J_0^{(2)} &= -J_0 + \frac{1}{x}J_1 = \frac{1}{2}(J_2 - J_0) \\ J_0^{(3)} &= \frac{1}{x}J_0 + \left(1 - \frac{2}{x^2}\right)J_1 = \frac{1}{4}(-J_3 + 3J_1) \\ J_0^{(4)} &= \left(1 - \frac{3}{x^2}\right)J_0 - \left(\frac{2}{x} - \frac{6}{x^3}\right)J_1 = \frac{1}{8}(J_4 - 4J_2 + 3J_0), \text{ etc.} \end{aligned}$$

10. Half-order Bessel functions

$$\begin{aligned} J_{\frac{1}{2}}(x) &= \sqrt{\frac{2}{\pi x}} \sin x \\ J_{-\frac{1}{2}}(x) &= \sqrt{\frac{2}{\pi x}} \cos x \\ J_{n+\frac{3}{2}}(x) &= -x^{n+\frac{1}{2}} \frac{d}{dx} \{x^{-(n+\frac{1}{2})} J_{n+\frac{1}{2}}(x)\} \\ J_{n-\frac{1}{2}}(x) &= x^{-(n+\frac{1}{2})} \frac{d}{dx} \{x^{n+\frac{1}{2}} J_{n+\frac{1}{2}}(x)\} \end{aligned}$$

n	$\left(\frac{\pi x}{2}\right)^{\frac{1}{2}} J_{n+\frac{1}{2}}(x)$	$\left(\frac{\pi x}{2}\right)^{\frac{1}{2}} J_{-(n+\frac{1}{2})}(x)$
0	$\sin x$	$\cos x$
1	$\frac{\sin x}{x} - \cos x$	$-\frac{\cos x}{x} - \sin x$
2	$\left(\frac{3}{x^2} - 1\right) \sin x - \frac{3}{x} \cos x$	$\left(\frac{3}{x^2} - 1\right) \cos x + \frac{3}{x} \sin x$
3	$\left(\frac{15}{x^3} - \frac{6}{x}\right) \sin x - \left(\frac{15}{x^2} - 1\right) \cos x$ etc.	$-\left(\frac{15}{x^3} - \frac{6}{x}\right) \cos x - \left(\frac{15}{x^2} - 1\right) \sin x$

11. Additional solutions to Bessel's equation are

$$\begin{aligned} Y_n(x) & \text{ (also called Weber's function, and sometimes denoted by } N_n(x)) \\ H_n^{(1)}(x) & \text{ and } H_n^{(2)}(x) \text{ (also called Hankel functions)} \end{aligned}$$

These solutions are defined as follows

$$Y_n(x) = \begin{cases} \frac{J_n(x) \cos(n\pi) - J_{-n}(x)}{\sin(n\pi)} & n \text{ not an integer} & H_n^{(1)}(x) = J_n(x) + iY_n(x) \\ \lim_{\nu \rightarrow n} \frac{J_\nu(x) \cos(\nu\pi) - J_{-\nu}(x)}{\sin(\nu\pi)} & n \text{ an integer} & H_n^{(2)}(x) = J_n(x) - iY_n(x) \end{cases}$$

The additional properties of these functions may all be derived from the above relations and the known properties of  $J_n(x)$ .

12. Complete solutions to Bessel's equation may be written as

$$c_1 J_n(x) + c_2 J_{-n}(x) \quad \text{if } n \text{ is not an integer}$$

or, for any value of  $n$ ,

$$c_1 J_n(x) + c_2 Y_n(x) \quad \text{or} \quad c_1 H_n^{(1)}(x) + c_2 H_n^{(2)}(x)$$

13. The modified (or hyperbolic) Bessel's differential equation is

$$x^2 \frac{d^2 y}{dx^2} + x \frac{dy}{dx} - (x^2 + n^2)y = 0$$

14. When  $n$  is not an integer, two independent solutions of the equation are  $I_n(x)$  and  $I_{-n}(x)$ , where

$$I_n(x) = \sum_{k=0}^{\infty} \frac{1}{k! \Gamma(n+k+1)} \left(\frac{x}{2}\right)^{n+2k}$$

15. If  $n$  is an integer,

$$I_n(x) = I_{-n}(x) = \frac{x^n}{2^n n!} \left\{ 1 + \frac{x^2}{2^2 \cdot 1!(n+1)} + \frac{x^4}{2^4 \cdot 2!(n+1)(n+2)} + \frac{x^6}{2^6 \cdot 3!(n+1)(n+2)(n+3)} + \dots \right\}$$

16. For  $n = 0$  and  $n = 1$ , this formula becomes

$$I_0(x) = 1 + \frac{x^2}{2^2(1!)^2} + \frac{x^4}{2^4(2!)^2} + \frac{x^6}{2^6(3!)^2} + \frac{x^8}{2^8(4!)^2} + \dots$$

$$I_1(x) = \frac{x}{2} + \frac{x^3}{2^3 \cdot 1!2!} + \frac{x^5}{2^5 \cdot 2!3!} + \frac{x^7}{2^7 \cdot 3!4!} + \frac{x^9}{2^9 \cdot 4!5!} + \dots$$

17. Another solution to the modified Bessel's equation is

$$K_n(x) = \begin{cases} \frac{1}{2} \pi \frac{I_{-n}(x) - I_n(x)}{\sin(n\pi)} & n \text{ not an integer} \\ \lim_{\nu \rightarrow n} \frac{1}{2} \pi \frac{I_{-\nu}(x) - I_{\nu}(x)}{\sin(\nu\pi)} & n \text{ an integer} \end{cases}$$

This function is linearly independent of  $I_n(x)$  for all values of  $n$ . Thus the complete solution to the modified Bessel's equation may be written as

$$c_1 I_n(x) + c_2 I_{-n}(x) \quad n \text{ not an integer}$$

or

$$c_1 I_n(x) + c_2 K_n(x) \quad \text{any } n$$

18. The following relations hold among the various Bessel functions:

$$I_n(z) = i^{-n} J_n(iz)$$

$$Y_n(iz) = (i)^{n+1} I_n(z) - \frac{2}{\pi} i^{-n} K_n(z)$$

Most of the properties of the modified Bessel function may be deduced from the known properties of  $J_n(x)$  by use of these relations and those previously given.

19. Recurrence formulas

$$I_{n-1}(x) - I_{n+1}(x) = \frac{2n}{x} I_n(x) \quad I_{n-1}(x) + I_{n+1}(x) = 2I'_n(x)$$

$$I_{n-1}(x) - \frac{n}{x} I_n(x) = I'_n(x) \quad I'_n(x) = I_{n+1}(x) + \frac{n}{x} I_n(x)$$



## THE FACTORIAL FUNCTION

For non-negative integers  $n$ , the factorial of  $n$ , denoted  $n!$ , is the product of all positive integers less than or equal to  $n$ ;  $n! = n \cdot (n-1) \cdot (n-2) \cdots 2 \cdot 1$ . If  $n$  is a negative integer ( $n = -1, -2, \dots$ ), then  $n! = \pm\infty$ .

Approximations to  $n!$  for large  $n$  include Stirling's formula

$$n! \approx \sqrt{2\pi e} \left(\frac{n}{e}\right)^{n+\frac{1}{2}},$$

and Burnside's formula

$$n! \approx \sqrt{2\pi} \left(\frac{n+\frac{1}{2}}{e}\right)^{n+\frac{1}{2}}.$$

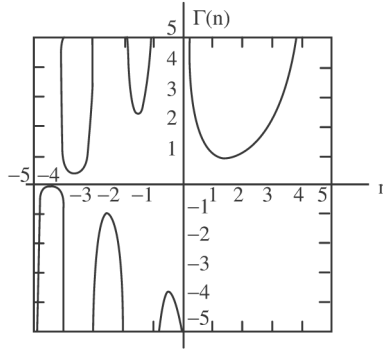
$n$	$n!$	$\log_{10} n!$	$n$	$n!$	$\log_{10} n!$
0	1	0.00000	1	1	0.00000
2	2	0.30103	3	6	0.77815
4	24	1.38021	5	120	2.07918
6	720	2.85733	7	5040	3.70243
8	40320	4.60552	9	$3.6288 \times 10^5$	5.55976
10	$3.6288 \times 10^6$	6.55976	11	$3.9917 \times 10^7$	7.60116
12	$4.7900 \times 10^8$	8.68034	13	$6.2270 \times 10^9$	9.79428
14	$8.7178 \times 10^{10}$	10.94041	15	$1.3077 \times 10^{12}$	12.11650
16	$2.0923 \times 10^{13}$	13.32062	17	$3.5569 \times 10^{14}$	14.55107
18	$6.4024 \times 10^{15}$	15.80634	19	$1.2165 \times 10^{17}$	17.08509
20	$2.4329 \times 10^{18}$	18.38612	25	$1.5511 \times 10^{25}$	25.19065
30	$2.6525 \times 10^{32}$	32.42366	40	$8.1592 \times 10^{47}$	47.91165
50	$3.0414 \times 10^{64}$	64.48307	60	$8.3210 \times 10^{81}$	81.92017
70	$1.1979 \times 10^{100}$	100.07841	80	$7.1569 \times 10^{118}$	118.85473
90	$1.4857 \times 10^{138}$	138.17194	100	$9.3326 \times 10^{157}$	157.97000
110	$1.5882 \times 10^{178}$	178.20092	120	$6.6895 \times 10^{198}$	198.82539
130	$6.4669 \times 10^{219}$	219.81069	150	$5.7134 \times 10^{262}$	262.75689
500	$1.2201 \times 10^{1134}$	1134.0864	1000	$4.0239 \times 10^{2567}$	2567.6046

## THE GAMMA FUNCTION

*Definition:*  $\Gamma(n) = \int_0^{\infty} t^{n-1} e^{-t} dt \quad n > 0$

*Recursion Formula:*  $\Gamma(n+1) = n\Gamma(n)$   
 $\Gamma(n+1) = n!$  if  $n = 0, 1, 2, \dots$  where  $0! = 1$   
 For  $n < 0$  the gamma function can be defined by using  
 $\Gamma(n) = \frac{\Gamma(n+1)}{n}$

*Graph:*



*Special Values:*

$$\Gamma(1/2) = \sqrt{\pi}$$

$$\Gamma(m+1/2) = \frac{1 \cdot 3 \cdot 5 \cdots (2m-1)}{2^m} \sqrt{\pi} \quad m = 1, 2, 3, \dots$$

$$\Gamma(-m+1/2) = \frac{(-1)^m 2^m \sqrt{\pi}}{1 \cdot 3 \cdot 5 \cdots (2m-1)} \quad m = 1, 2, 3, \dots$$

*Definition:*

$$\Gamma(x+1) = \lim_{k \rightarrow \infty} \frac{1 \cdot 2 \cdot 3 \cdots k}{(x+1)(x+2)\cdots(x+k)} k^x$$

$$\frac{1}{\Gamma(x)} = x e^{\gamma x} \prod_{m=1}^{\infty} \left\{ \left(1 + \frac{x}{m}\right) e^{-x/m} \right\}$$

This is an infinite product representation for the gamma function where  $\gamma$  is Euler's constant.

Properties:

$$\Gamma'(1) = \int_0^{\infty} e^{yx} \ln x dx = -\gamma$$

$$\frac{\Gamma'(x)}{\Gamma(x)} = -\gamma + \left(\frac{1}{1} - \frac{1}{x}\right) + \left(\frac{1}{2} - \frac{1}{x+1}\right) + \dots + \left(\frac{1}{n} - \frac{1}{x+n-1}\right) + \dots$$

$$\Gamma(x+1) = \sqrt{2\pi x} x^x e^{-x} \left\{1 + \frac{1}{12x} + \frac{1}{288x^2} - \frac{139}{51,840x^3} + \dots\right\}$$

This is called *Stirling's asymptotic series*.

$$\text{Values of } \Gamma(n) = \int_0^{\infty} e^{-x} x^{n-1} dx; \quad \Gamma(n+1) = n\Gamma(n)$$

$n$	$\Gamma(n)$	$n$	$\Gamma(n)$	$n$	$\Gamma(n)$	$n$	$\Gamma(n)$
1.00	1.00000	1.25	.90640	1.50	.88623	1.75	.91906
1.01	.99433	1.26	.90440	1.51	.88659	1.76	.92137
1.02	.98884	1.27	.90250	1.52	.88704	1.77	.92376
1.03	.98355	1.28	.90072	1.53	.88757	1.78	.92623
1.04	.97844	1.29	.89904	1.54	.88818	1.79	.92877
1.05	.97350	1.30	.89747	1.55	.88887	1.80	.93138
1.06	.96874	1.31	.89600	1.56	.88964	1.81	.93408
1.07	.96415	1.32	.89464	1.57	.89049	1.82	.93685
1.08	.95973	1.33	.89338	1.58	.89142	1.83	.93969
1.09	.95546	1.34	.89222	1.59	.89243	1.84	.94261
1.10	.95135	1.35	.89115	1.60	.89352	1.85	.94561
1.11	.94740	1.36	.89018	1.61	.89468	1.86	.94869
1.12	.94359	1.37	.88931	1.62	.89592	1.87	.95184
1.13	.93993	1.38	.88854	1.63	.89724	1.88	.95507
1.14	.93642	1.39	.88785	1.64	.89864	1.89	.95838
1.15	.93304	1.40	.88726	1.65	.90012	1.90	.96177
1.16	.92980	1.41	.88676	1.66	.90167	1.91	.96523
1.17	.92670	1.42	.88636	1.67	.90330	1.92	.96877
1.18	.92373	1.43	.88604	1.68	.90500	1.93	.97240
1.19	.92089	1.44	.88581	1.69	.90678	1.94	.97610
1.20	.91817	1.45	.88566	1.70	.90864	1.95	.97988
1.21	.91558	1.46	.88560	1.71	.91057	1.96	.98374
1.22	.91311	1.47	.88563	1.72	.91258	1.97	.98768
1.23	.91075	1.48	.88575	1.73	.91466	1.98	.99171
1.24	.90852	1.49	.88595	1.74	.91683	1.99	.99581
						2.00	1.00000

## THE BETA FUNCTION

*Definition:*  $B(m, n) = \int_0^1 t^{m-1}(1-t)^{n-1} dt \quad m > 0, n > 0$

*Relationship with Gamma function:*  $B(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$

*Properties:*

$$B(m, n) = B(n, m)$$

$$B(m, n) = 2 \int_0^{\pi/2} \sin^{2m-1} \theta \cos^{2n-1} \theta d\theta$$

$$B(m, n) = \int_0^{\infty} \frac{t^{m-1}}{(1+t)^{m+n}} dt$$

$$B(m, n) = r^n (r+1)^m \int_0^1 \frac{t^{m-1}(1-t)^{n-1}}{(r+t)^{m+n}} dt$$

## THE ERROR FUNCTION

*Definition:*  $\operatorname{erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$

*Series:*  $\operatorname{erf}(x) = \frac{2}{\sqrt{\pi}} \left( x - \frac{x^3}{3} + \frac{1}{2!} \frac{x^5}{5} - \frac{1}{3!} \frac{x^7}{7} + \dots \right)$

*Property:*  $\operatorname{erf}(x) = -\operatorname{erf}(-x)$

*Relationship with Normal Probability Function*  $f(t) : \int_0^x f(t) dt = \frac{1}{2} \operatorname{erf} \left( \frac{x}{\sqrt{2}} \right)$  To evaluate  $\operatorname{erf}(2.3)$ , one proceeds as follows:

For  $\frac{x}{\sqrt{2}} = 2.3$ , one finds  $x = (2.3)(\sqrt{2}) = 3.25$ . In the normal probability function table (page A-104), one finds the entry 0.4994 opposite the value 3.25. Thus  $\operatorname{erf}(2.3) = 2(0.4994) = 0.9988$ .

$$\operatorname{erfc}(z) = 1 - \operatorname{erf}(z) = \frac{2}{\sqrt{\pi}} \int_z^{\infty} e^{-t^2} dt$$

is known as the complementary error function.

## ORTHOGONAL POLYNOMIALS

### I: Legendre

Name: Legendre    Symbol:  $P_n(x)$     Interval:  $[-1, 1]$   
Differential Equation:  $(1 - x^2)y'' - 2xy' + n(n + 1)y = 0$

Explicit Expression:  $P_n(x) = \frac{1}{2^n} \sum_{m=0}^{\lfloor n/2 \rfloor} (-1)^m \binom{n}{m} \binom{2n - 2m}{n} x^{n-2m}$

Recurrence Relation:  $(n + 1)P_{n+1}(x) = (2n + 1)xP_n(x) - nP_{n-1}(x)$   
Weight: 1

Standardization:  $P_n(1) = 1$

Norm:  $\int_{-1}^{+1} [P_n(x)]^2 dx = \frac{2}{2n + 1}$

Rodrigues' Formula:  $P_n(x) = \frac{(-1)^n}{2^n n!} \frac{d^n}{dx^n} \{(1 - x^2)^n\}$

Generating Function:  $R^{-1} = \sum_{n=0}^{\infty} P_n(x)z^n; -1 < x < 1, |z| < 1,$   
 $R = \sqrt{1 - 2xz + z^2}$

Inequality:  $|P_n(x)| \leq 1, -1 \leq x \leq 1.$

### II: Tschebysheff, First Kind

Name: Tschebysheff, First Kind    Symbol:  $T_n(x)$     Interval:  $[-1, 1]$   
Differential Equation:  $(1 - x^2)y - xy' + n^2y = 0$

Explicit Expression:  $\frac{n}{2} \sum_{m=0}^{\lfloor n/2 \rfloor} (-1)^m \frac{(n - m - 1)!}{m!(n - 2m)!} (2x)^{n-2m} = \cos(n \arccos x) = T_n(x)$

Recurrence Relation:  $T_{n+1}(x) = 2xT_n(x) - T_{n-1}(x)$

Weight:  $(1 - x^2)^{-1/2}$

Standardization:  $T_n(1) = 1$

$$\text{Norm: } \int_{-1}^{+1} (1-x^2)^{-1/2} [T_n(x)]^2 dx = \begin{cases} \pi/2, & n \neq 0 \\ \pi, & n = 0 \end{cases}$$

$$\text{Rodrigues' Formula: } \frac{(-1)^n (1-x^2)^{1/2} \sqrt{\pi}}{2^{n+1} \Gamma(n + \frac{1}{2})} \frac{d^n}{dx^n} \{(1-x^2)^{n-(1/2)}\} = T_n(x)$$

$$\text{Generating Function: } \frac{1-xz}{1-2xz-z^2} = \sum_{n=0}^{\infty} T_n(x) z^n, \quad -1 < x < 1, \quad |z| < 1$$

$$\text{Inequality: } |T_n(x)| \leq 1, \quad -1 \leq x \leq 1.$$

### III: Tschebysheff, Second Kind

$$\text{Name: Tschebysheff, Second Kind} \quad \text{Symbol } U_n(x) \quad \text{Interval: } [-1, 1]$$

$$\text{Differential Equation: } (1-x^2)y'' - 3xy' + n(n+2)y = 0$$

$$\text{Explicit Expression: } U_n(x) = \sum_{m=0}^{\lfloor n/2 \rfloor} (-1)^m \frac{(m-n)!}{m!(n-2m)!} (2x)^{n-2m}$$

$$U_n(\cos \theta) = \frac{\sin[(n+1)\theta]}{\sin \theta}$$

$$\text{Recurrence Relation: } U_{n+1}(x) = 2xU_n(x) - U_{n-1}(x)$$

$$\text{Weight: } (1-x^2)^{1/2} \quad \text{Standardization: } U_n(1) = n+1$$

$$\text{Norm: } \int_{-1}^{+1} (1-x^2)^{1/2} [U_n(x)]^2 dx = \frac{\pi}{2}$$

$$\text{Rodrigues' Formula: } U_n(x) = \frac{(-1)^n (n+1) \sqrt{\pi}}{(1-x^2)^{1/2} 2^{n+1} \Gamma(n + \frac{3}{2})} \frac{d^n}{dx^n} \{(1-x^2)^{n+(1/2)}\}$$

$$\text{Generating Function: } \frac{1}{1-2xz+z^2} = \sum_{n=0}^{\infty} U_n(x) z^n, \quad -1 < x < 1, \quad |z| < 1$$

$$\text{Inequality: } |U_n(x)| \leq n+1, \quad -1 \leq x \leq 1.$$

### IV: Jacobi

$$\text{Name: Jacobi} \quad \text{Symbol: } P_n^{(\alpha, \beta)}(x) \quad \text{Interval: } [-1, 1]$$

$$\text{Differential Equation: } (1-x^2)y'' + [\beta - \alpha - (\alpha + \beta + 2)x]y' + n(n + \alpha + \beta + 1)y = 0$$

$$\text{Explicit Expression: } P_n^{(\alpha, \beta)}(x) = \frac{1}{2^n} \sum_{m=0}^n \binom{n+\alpha}{m} \binom{n+\beta}{n-m} (x-1)^{n-m} (x+1)^m$$

Recurrence Relation:

$$\begin{aligned} & 2(n+1)(n+\alpha+\beta+1)(2n+\alpha+\beta)P_{n+1}^{(\alpha, \beta)}(x) \\ &= (2n+\alpha+\beta+1)[(\alpha^2-\beta^2) + (2n+\alpha+\beta+2) \\ & \times (2n+\alpha+\beta)x]P_n^{(\alpha, \beta)}(x) \\ & - 2(n+\alpha)(n+\beta)(2n+\alpha+\beta+2)P_{n-1}^{(\alpha, \beta)}(x) \end{aligned}$$

$$\text{Weight: } (1-x)^\alpha (1+x)^\beta; \quad \alpha, \beta > 1$$

$$\text{Standardization: } P_n^{(\alpha, \beta)}(x) = \binom{n+\alpha}{n}$$

$$\text{Norm: } \int_{-1}^{+1} (1-x)^\alpha (1+x)^\beta [P_n^{(\alpha, \beta)}(x)]^2 dx = \frac{2^{\alpha+\beta+1} \Gamma(n+\alpha+1) \Gamma(n+\beta+1)}{(2n+\alpha+\beta+1)n! \Gamma(n+\alpha+\beta+1)}$$

$$\text{Rodrigues' Formula: } P_n^{(\alpha, \beta)}(x) = \frac{(-1)^n}{2^n n! (1-x)^\alpha (1+x)^\beta} \frac{d^n}{dx^n} \{(1-x)^{n+\alpha} (1+x)^{n+\beta}\}$$

$$\text{Generating Function: } R^{-1}(1-z+R)^{-\alpha} (1+z+R)^{-\beta} = \sum_{n=0}^{\infty} 2^{-\alpha-\beta} P_n^{(\alpha, \beta)}(x) z^n,$$

$$R = \sqrt{1-2xz+z^2}, \quad |z| < 1$$



$$\text{Inequality: } \max_{-1 \leq x \leq 1} |P_n^{(\alpha, \beta)}(x)| = \begin{cases} \binom{n+q}{n} \sim n^q \text{ if } q = \max(\alpha, \beta) \geq -\frac{1}{2} \\ |P_n^{(\alpha, \beta)}(x')| \sim n^{-1/2} \text{ if } q < -\frac{1}{2} \\ x' \text{ is one of the two maximum points nearest } \frac{\beta - \alpha}{\alpha + \beta + 1} \end{cases}$$

**V: Generalized Laguerre**

Name: Generalized Laguerre    Symbol:  $L_n^{(\alpha)}(x)$     Interval:  $[0, \infty]$

Differential Equation:  $xy'' + (\alpha + 1 - x)y' + ny = 0$

Explicit Expression:  $L_n^{(\alpha)}(x) = \sum_{m=0}^n (-1)^m \binom{n+\alpha}{n-m} \frac{1}{m!} x^m$

Recurrence Relation:  $(n+1)L_n^{(\alpha)} + 1(x) = [(2n+\alpha+1) - x]L_n^{(\alpha)}(x) - (n+\alpha)L_n^{(\alpha)} - 1(x)$

Weight:  $x^\alpha e^{-x}, \alpha > -1$  Standardization:  $L_n^{(\alpha)}(x) = \frac{(-1)^n}{n!} x^n + \dots$

Norm:  $\int_0^\infty x^\alpha e^{-x} [L_n^{(\alpha)}(x)]^2 dx = \frac{\Gamma(n+\alpha+1)}{n!}$

Rodrigues' Formula:  $L_n^{(\alpha)}(x) = \frac{1}{n! x^\alpha e^{-x}} \frac{d^n}{dx^n} \{x^{n+\alpha} e^{-x}\}$

Generating Function:  $(1-z)^{-\alpha-1} \exp\left(\frac{xz}{z-1}\right) = \sum_{n=0}^\infty L_n^{(\alpha)}(x) z^n$

Inequality:  $|L_n^{(\alpha)}(x)| \leq \frac{\Gamma(n+\alpha+1)}{n! \Gamma(\alpha+1)} e^{x/2}; \quad \begin{matrix} x \geq 0 \\ \alpha > 0 \end{matrix}$

$|L_n^{(\alpha)}(x)| \leq \left[2 - \frac{\Gamma(\alpha+n+1)}{n! \Gamma(\alpha+1)}\right] e^{x/2}; \quad \begin{matrix} x \geq 0 \\ -1 < \alpha < 0 \end{matrix}$

**VI: Hermite**

Name: Hermite    Symbol:  $H_n(x)$     Interval:  $[-\infty, \infty]$

Differential Equation:  $y'' - 2xy' + 2ny = 0$

Explicit Expression:  $H_n(x) = \sum_{m=0}^{\lfloor n/2 \rfloor} \frac{(-1)^m n! (2x)^{n-2m}}{m!(n-2m)!}$

Recurrence Relation:  $H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$

Weight:  $e^{-x^2}$  Standardization:  $H_n(1) = 2^n x^n + \dots$

Norm:  $\int_{-\infty}^\infty e^{-x^2} [H_n(x)]^2 dx = 2^n n! \sqrt{\pi}$

Rodrigues' Formula:  $H_n(x) = (-1)^n e^{x^2} \frac{d^n}{dx^n} (e^{-x^2})$

Generating Function:  $e^{-x^2+2zx} = \sum_{n=0}^\infty H_n(x) \frac{z^n}{n!}$

Inequality:  $|H_n(x)| e^{x^2/2} k 2^{n/2} \sqrt{n!} k \approx 1.086435$

## TABLES OF ORTHOGONAL POLYNOMIALS

$H_0 = 1$	$x^{10} = (30240H_0 + 75600H_2 + 25200H_4 + 2520H_6 + 90H_8 + H_{10})/1024$
$H_1 = 2x$	$x^9 = (15120H_1 + 10080H_3 + 1512H_5 + 72H_7 + H_9)/512$
$H_2 = 4x^2 - 2$	$x^8 = (1680H_0 + 3360H_2 + 840H_4 + 56H_6 + H_8)/256$
$H_3 = 8x^3 - 12x$	$x^7 = (840H_1 + 420H_3 + 42H_5 + H_7)/128$
$H_4 = 16x^4 - 48x^2 + 12$	$x^6 = (120H_0 + 180H_2 + 30H_4 + H_6)/64$
$H_5 = 32x^5 - 160x^3 + 120x$	$x^5 = (60H_1 + 20H_3 + H_5)/32$
$H_6 = 64x^6 - 480x^4 + 720x^2 - 120$	$x^4 = (12H_0 + 12H_2 + H_4)/16$
$H_7 = 128x^7 - 1344x^5 + 3360x^3 - 1680x$	$x^3 = (6H_1 + H_3)/8$
$H_8 = 256x^8 - 3584x^6 + 13440x^4 - 13440x^2 + 1680$	$x^2 = (2H_0 + H_2)/4$
$H_9 = 512x^9 - 9216x^7 + 48384x^5 - 80640x^3 + 30240x$	$x = (H_1)/2$
$H_{10} = 1024x^{10} - 23040x^8 + 161280x^6 - 403200x^4 + 302400x^2 - 30240$	$1 = H_0$

$L_0 = 1$	$x^6 = 720L_0 - 4320L_1 + 10800L_2 - 14400L_3 + 10800L_4 - 4320L_5 + 720L_6$
$L_1 = -x + 1$	$x^5 = 120L_0 - 600L_1 + 1200L_2 - 1200L_3 + 600L_4 - 120L_5$
$L_2 = (x^2 - 4x + 2)/2$	$x^4 = 24L_0 - 96L_1 + 144L_2 - 96L_3 + 24L_4$
$L_3 = (-x^3 + 9x^2 - 18x + 6)/6$	$x^3 = 6L_0 - 18L_1 + 18L_2 - 6L_3$
$L_4 = (x^4 - 16x^3 + 72x^2 - 96x + 24)/24$	$x^2 = 2L_0 - 4L_1 + 2L_2$
$L_5 = (-x^5 + 25x^4 - 200x^3 + 600x^2 - 600x + 120)/120$	$x = L_0 - L_1$
$L_6 = (x^6 - 36x^5 + 450x^4 - 2400x^3 + 5400x^2 - 4320x + 720)/720$	$1 = L_0$

$P_0 = 1$	$x^{10} = (4199P_0 + 16150P_2 + 15504P_4 + 7904P_6 + 2176P_8 + 256P_{10})/46189$
$P_1 = x$	$x^9 = (3315P_1 + 4760P_3 + 2992P_5 + 960P_7 + 128P_9)/12155$
$P_2 = (3x^2 - 1)/2$	$x^8 = (715P_0 + 2600P_2 + 2160P_4 + 832P_6 + 128P_8)/6435$
$P_3 = (5x^3 - 3x)/2$	$x^7 = (143P_1 + 182P_3 + 88P_5 + 16P_7)/429$
$P_4 = (35x^4 - 30x^2 + 3)/8$	$x^6 = (33P_0 + 110P_2 + 72P_4 + 16P_6)/231$
$P_5 = (63x^5 - 70x^3 + 15x)/8$	$x^5 = (27P_1 + 28P_3 + 8P_5)/63$
$P_6 = (231x^6 - 315x^4 + 105x^2 - 5)/16$	$x^4 = (7P_0 + 20P_2 + 8P_4)/35$
$P_7 = (429x^7 - 693x^5 + 315x^3 - 35x)/16$	$x^3 = (3P_1 + 2P_3)/5$
$P_8 = (6435x^8 - 12012x^6 + 6930x^4 - 1260x^2 + 35)/128$	$x^2 = (P_0 + 2P_2)/3$
$P_9 = (12155x^9 - 25740x^7 + 18018x^5 - 4620x^3 + 315x)/128$	$x = P_1$
$P_{10} = (46189x^{10} - 109395x^8 + 90090x^6 - 30030x^4 + 3465x^2 - 63)/256$	$1 = P_0$

$T_0 = 1$	$x^{10} = (126T_0 + 210T_2 + 120T_4 + 45T_6 + 10T_8 + T_{10})/512$
$T_1 = x$	$x^9 = (126T_1 + 84T_3 + 36T_5 + 9T_7 + T_9)/256$
$T_2 = 2x^2 - 1$	$x^8 = (35T_0 + 56T_2 + 28T_4 + 8T_6 + T_8)/128$
$T_3 = 4x^3 - 3x$	$x^7 = (35T_1 + 21T_3 + 7T_5 + T_7)/64$
$T_4 = 8x^4 - 8x^2 + 1$	$x^6 = (10T_0 + 15T_2 + 6T_4 + T_6)/32$
$T_5 = 16x^5 - 20x^3 + 5x$	$x^5 = (10T_1 + 5T_3 + T_5)/16$
$T_6 = 32x^6 - 48x^4 + 18x^2 - 1$	$x^4 = (3T_0 + 4T_2 + T_4)/8$
$T_7 = 64x^7 - 112x^5 + 56x^3 - 7x$	$x^3 = (3T_1 + T_3)/4$
$T_8 = 128x^8 - 256x^6 + 160x^4 - 32x^2 + 1$	$x^2 = (T_0 + T_2)/2$
$T_9 = 256x^9 - 576x^7 + 432x^5 - 120x^3 + 9x$	$x = T_1$
$T_{10} = 512x^{10} - 1280x^8 + 1120x^6 - 400x^4 + 50x^2 - 1$	$1 = T_0$

$U_0 = 1$	$x^{10} = (42U_0 + 90U_2 + 75U_4 + 35U_6 + 9U_8 + U_{10})/1024$
$U_1 = 2x$	$x^9 = (42U_1 + 48U_3 + 27U_5 + 8U_7 + U_9)/512$
$U_2 = 4x^2 - 1$	$x^8 = (14U_0 + 28U_2 + 20U_4 + 7U_6 + U_8)/256$
$U_3 = 8x^3 - 4x$	$x^7 = (14U_1 + 14U_3 + 6U_5 + U_7)/128$
$U_4 = 16x^4 - 12x^2 + 1$	$x^6 = (5U_0 + 9U_2 + 5U_4 + U_6)/64$
$U_5 = 32x^5 - 32x^3 + 6x$	$x^5 = (5U_1 + 4U_3 + U_5)/32$
$U_6 = 64x^6 - 80x^4 + 24x^2 - 1$	$x^4 = (2U_0 + 3U_2 + U_4)/16$
$U_7 = 128x^7 - 192x^5 + 80x^3 - 8x$	$x^3 = (2U_1 + U_3)/8$
$U_8 = 256x^8 - 448x^6 + 240x^4 - 40x^2 + 1$	$x^2 = (U_0 + U_2)/4$
$U_9 = 512x^9 - 1024x^7 + 672x^5 - 160x^3 + 10x$	$x = (U_1)/2$
$U_{10} = 1024x^{10} - 2304x^8 + 1792x^6 - 560x^4 + 60x^2 - 1$	$1 = U_0$

## CLEBSCH–GORDAN COEFFICIENTS

$$\begin{aligned} \begin{pmatrix} j_1 & j_2 & j \\ m_1 & m_2 & m \end{pmatrix} &= \delta_{m, m_1+m_2} \sqrt{\frac{(j_1+j_2-j)!(j+j_1-j_2)!(j+j_2-j_1)!(2j+1)}{(j+j_1+j_2+1)!}} \\ &\times \sum_k \frac{(-1)^k \sqrt{(j_1+m_1)!(j_1-m_1)!(j_2+m_2)!(j_2-m_2)!(j+m)!(j-m)!}}{k!(j_1+j_2-j-k)!(j_1-m_1-k)!(j_2+m_2-k)!(j-j_2+m_1+k)!(j-j_1-m_2+k)!}. \end{aligned}$$

1. Conditions:

- (a) Each of  $\{j_1, j_2, j, m_1, m_2, m\}$  may be an integer, or half an integer. Additionally:  $j > 0$ ,  $j_1 > 0$ ,  $j_2 > 0$  and  $j + j_1 + j_2$  is an integer.
- (b)  $j_1 + j_2 - j \geq 0$ .
- (c)  $j_1 - j_2 + j \geq 0$ .
- (d)  $-j_1 + j_2 + j \geq 0$ .
- (e)  $|m_1| \leq j_1$ ,  $|m_2| \leq j_2$ ,  $|m| \leq j$ .

2. Special values:

- (a)  $\begin{pmatrix} j_1 & j_2 & j \\ m_1 & m_2 & m \end{pmatrix} = 0$  if  $m_1 + m_2 \neq m$ .
- (b)  $\begin{pmatrix} j_1 & 0 & j \\ m_1 & 0 & m \end{pmatrix} = \delta_{j_1, j} \delta_{m_1, m}$ .
- (c)  $\begin{pmatrix} j_1 & j_2 & j \\ 0 & 0 & 0 \end{pmatrix} = 0$  when  $j_1 + j_2 + j$  is an odd integer.
- (d)  $\begin{pmatrix} j_1 & j_1 & j \\ m_1 & m_1 & m \end{pmatrix} = 0$  when  $2j_1 + j$  is an odd integer.

3. Symmetry relations: all of the following are equal to  $\begin{pmatrix} j_1 & j_2 & j \\ m_1 & m_2 & m \end{pmatrix}$ :

- (a)  $\begin{pmatrix} j_2 & j_1 & j \\ -m_2 & -m_1 & -m \end{pmatrix}$ ,
- (b)  $(-1)^{j_1+j_2-j} \begin{pmatrix} j_2 & j_1 & j \\ m_1 & m_2 & m \end{pmatrix}$ ,
- (c)  $(-1)^{j_1+j_2-j} \begin{pmatrix} j_1 & j_2 & j \\ -m_1 & -m_2 & -m \end{pmatrix}$ ,
- (d)  $\sqrt{\frac{2j+1}{2j_1+1}} (-1)^{j_2+m_2} \begin{pmatrix} j & j_2 & j_1 \\ -m & m_2 & -m_1 \end{pmatrix}$ ,
- (e)  $\sqrt{\frac{2j+1}{2j_1+1}} (-1)^{j_1-m_1+j-m} \begin{pmatrix} j & j_2 & j_1 \\ m & -m_2 & m_1 \end{pmatrix}$ ,
- (f)  $\sqrt{\frac{2j+1}{2j_1+1}} (-1)^{j-m+j_1-m_1} \begin{pmatrix} j_2 & j & j_1 \\ m_2 & -m & -m_1 \end{pmatrix}$ ,
- (g)  $\sqrt{\frac{2j+1}{2j_2+1}} (-1)^{j_1-m_1} \begin{pmatrix} j_1 & j & j_2 \\ m_1 & -m & -m_2 \end{pmatrix}$ ,
- (h)  $\sqrt{\frac{2j+1}{2j_2+1}} (-1)^{j_1-m_1} \begin{pmatrix} j & j_1 & j_2 \\ m & -m_1 & m_2 \end{pmatrix}$ .

By use of the symmetry relations, Clebsch–Gordan coefficients may be put in the standard form  $j_1 \leq j_2 \leq j$  and  $m \geq 0$ .

$m_2$	$m$	$j_1$	$j$	$\left( \begin{array}{c c} j_1 & \frac{1}{2} \\ m_1 & m_2 \end{array} \middle  j \right)$
$-\frac{1}{2}$	0	$\frac{1}{2}$	1	$\frac{\sqrt{2}}{2} \approx 0.707107$
0	$\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{\sqrt{3}}{2} \approx 0.866025$
$\frac{1}{2}$	0	$\frac{1}{2}$	1	$\frac{\sqrt{2}}{2} \approx 0.707107$
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{\sqrt{3}}{2} \approx 0.866025$
$\frac{1}{2}$	1	$\frac{1}{2}$	1	1 $\approx 1.000000$

$m_2$	$m$	$j_1$	$j$	$\left( \begin{array}{c c} j_1 & 1 \\ m_1 & m_2 \end{array} \middle  j \right)$
-1	0	1	1	$\frac{\sqrt{2}}{2} \approx 0.707107$
-1	0	1	2	$\frac{\sqrt{6}}{6} \approx 0.408248$
$-\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{2}}{2} \approx 0.707107$
$-\frac{1}{2}$	$\frac{1}{2}$	1	1	$\frac{3}{4} \approx 0.750000$
$-\frac{1}{2}$	$\frac{1}{2}$	1	2	$\frac{\sqrt{5}}{4} \approx 0.559017$
0	0	1	2	$\frac{\sqrt{6}}{3} \approx 0.816496$
0	0	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{3}}{2} \approx 0.866025$
0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{6}}{3} \approx 0.8164967$
0	$\frac{1}{2}$	1	1	$\frac{\sqrt{2}}{4} \approx 0.353553$
0	$\frac{1}{2}$	1	2	$\frac{\sqrt{10}}{4} \approx 0.790569$
0	1	1	1	$\frac{\sqrt{2}}{2} \approx 0.707107$

$m_2$	$m$	$j_1$	$j$	$\left( \begin{array}{c c} j_1 & 1 \\ m_1 & m_2 \end{array} \middle  j \right)$
0	1	1	2	$\frac{\sqrt{2}}{2} \approx 0.707107$
$\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{2}}{2} \approx 0.707107$
$\frac{1}{2}$	$\frac{1}{2}$	1	1	$-\frac{\sqrt{2}}{4} \approx -0.353553$
$\frac{1}{2}$	$\frac{1}{2}$	1	2	$\frac{\sqrt{10}}{4} \approx 0.790569$
$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{30}}{6} \approx 0.912871$
$\frac{1}{2}$	$\frac{3}{2}$	1	2	$\frac{\sqrt{105}}{12} \approx 0.853913$
1	0	1	1	$-\frac{\sqrt{2}}{2} \approx -0.707107$
1	0	1	2	$\frac{\sqrt{6}}{6} \approx 0.408248$
1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{3}}{3} \approx 0.577350$
1	$\frac{1}{2}$	1	1	$-\frac{3}{4} \approx -0.750000$
1	$\frac{1}{2}$	1	2	$\frac{\sqrt{5}}{4} \approx 0.559017$
1	1	$\frac{1}{2}$	$\frac{3}{2}$	$\frac{\sqrt{10}}{4} \approx 0.790569$
1	1	1	1	$-\frac{\sqrt{2}}{2} \approx -0.707107$
1	1	1	2	$\frac{\sqrt{2}}{2} \approx 0.707107$
1	$\frac{3}{2}$	$\frac{1}{2}$	$\frac{3}{2}$	1 $\approx 1.000000$
1	$\frac{3}{2}$	1	2	$\frac{\sqrt{105}}{12} \approx 0.853913$
1	2	1	2	1 $\approx 1.000000$

## NORMAL PROBABILITY FUNCTION

**Table of the Normal Distribution**

For a standard normal random variable ( $\Phi(z)$  is the area under the Standard Normal Curve from  $-\infty$  to  $z$ ).

Limits		Proportion of the total area	Remaining area
$\mu - \lambda\sigma$	$\mu + \lambda\sigma$	(%)	(%)
$\mu - \sigma$	$\mu + \sigma$	68.27	31.73
$\mu - 1.65\sigma$	$\mu + 1.65\sigma$	90	10
$\mu - 1.96\sigma$	$\mu + 1.96\sigma$	95	5
$\mu - 2\sigma$	$\mu + 2\sigma$	95.45	4.55
$\mu - 2.58\sigma$	$\mu + 2.58\sigma$	99.0	0.99
$\mu - 3\sigma$	$\mu + 3\sigma$	99.73	0.27
$\mu - 3.09\sigma$	$\mu + 3.09\sigma$	99.8	0.2
$\mu - 3.29\sigma$	$\mu + 3.29\sigma$	99.9	0.1

$x$	1.282	1.645	1.960	2.326	2.576	3.090
$\Phi(x)$	0.90	0.95	0.975	0.99	0.995	0.999
$2[1 - \Phi(x)]$	0.20	0.10	0.05	0.02	0.01	0.002

$x$	3.09	3.72	4.26	4.75	5.20	5.61	6.00	6.36
$1 - \Phi(x)$	$10^{-3}$	$10^{-4}$	$10^{-5}$	$10^{-6}$	$10^{-7}$	$10^{-8}$	$10^{-9}$	$10^{-10}$



Common sample size calculations

Parameter	Estimate	Sample size
$\mu$	$\bar{x}$	$n = \left(\frac{z_{\alpha/2} \cdot \sigma}{E}\right)^2$
$p$	$\hat{p}$	$n = \frac{(z_{\alpha/2})^2 \cdot pq}{E^2}$
$\mu_1 - \mu_2$	$\bar{x}_1 - \bar{x}_2$	$n_1 = n_2 = \frac{(z_{\alpha/2})^2(\sigma_1^2 + \sigma_2^2)}{E^2}$
$p_1 - p_2$	$\hat{p}_1 - \hat{p}_2$	$n_1 = n_2 = \frac{(z_{\alpha/2})^2(p_1q_1 + p_2q_2)}{E^2}$

Common one-sample confidence intervals

Parameter	Assumptions	100(1 - $\alpha$ )% Confidence interval
$\mu$	$n$ large, $\sigma^2$ known, or normality, $\sigma^2$ known	$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$
$\mu$	normality, $\sigma^2$ unknown	$\bar{x} \pm t_{\alpha/2, n-1} \cdot \frac{s}{\sqrt{n}}$
$\sigma^2$	normality	$\left(\frac{(n-1)s^2}{\chi_{\alpha/2, n-1}^2}, \frac{(n-1)s^2}{\chi_{1-\alpha/2, n-1}^2}\right)$
$p$	binomial experiment, $n$ large	$\hat{p} \pm z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

Common two-sample confidence intervals

Parameter	Assumptions	100(1 - $\alpha$ )% Confidence interval
$\mu_1 - \mu_2$	normality, independence, $\sigma_1^2, \sigma_2^2$ known or $n_1, n_2$ large, independence, $\sigma_1^2, \sigma_2^2$ known	$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \cdot \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$
$\mu_1 - \mu_2$	normality, independence, $\sigma_1^2 = \sigma_2^2$ unknown	$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2, n_1+n_2-2} \cdot s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$ $s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$
$\mu_1 - \mu_2$	normality, independence, $\sigma_1^2 \neq \sigma_2^2$ unknown	$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2, v} \cdot \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ $v \approx \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{(s_1^2/n_1)^2}{n_1-1} + \frac{(s_2^2/n_2)^2}{n_2-1}}$
$\mu_1 - \mu_2$	normality, $n$ pairs, dependence	$\bar{d} \pm t_{\alpha/2, n-1} \cdot \frac{s_d}{\sqrt{n}}$
$p_1 - p_2$	binomial experiments, $n_1, n_2$ large, independence	$(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$

## PERCENTAGE POINTS, STUDENT'S *T*-DISTRIBUTION

This table gives values of  $t$  such that

$$F(t) = \int_{-\infty}^t \frac{\Gamma\left(\frac{n+1}{2}\right)}{\sqrt{n\pi}\Gamma\left(\frac{n}{2}\right)} \left(1 + \frac{x^2}{n}\right)^{-\frac{n+1}{2}} dx$$

for  $n$ , the number of degrees of freedom, equal to 1, 2, ..., 30, 40, 60, 120,  $\infty$ ; and for  $F(t) = 0.60, 0.75, 0.90, 0.95, 0.975, 0.99, 0.995$ , and  $0.9995$ . The  $t$ -distribution is symmetrical, so that  $F(-t) = 1 - F(t)$

$n/F$	.60	.75	.90	.95	.975	.99	.995	.9995
1	.325	1.000	3.078	6.314	12.706	31.821	63.657	636.619
2	.289	.816	1.886	2.920	4.303	6.965	9.925	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	3.373
$\infty$	.253	.674	1.282	1.645	1.960	2.326	2.576	3.291

\*This table is abridged from the *Statistical Tables* by R. A. Fisher and Frank Yates published by Oliver & Boyd, Ltd., Edinburgh and London, 1938. It is published here with the kind permission of the authors and their publishers.



## PERCENTAGE POINTS, CHI-SQUARE DISTRIBUTION

This table gives values of  $\chi^2$  such that

$$F(\chi)^2 = \int_0^{\chi^2} \frac{1}{2^{n/2} \Gamma(\frac{n}{2})} x^{(n-2)/2} e^{-x/2} dx$$

for  $n$ , the number of degrees of freedom, equal to 1, 2, ..., 30. For  $n > 30$ , a normal approximation is quite accurate. The expression  $\sqrt{2x^2} - \sqrt{2n-1}$  is approximately normally distributed as the standard normal distribution. Thus  $\chi_\alpha^2$ , the  $\alpha$ -point of the distribution, may be computed by the formula

$$\chi_\alpha^2 = \frac{1}{2} [x_\alpha + \sqrt{2n-1}]^2,$$

where  $x_\alpha$  is the  $\alpha$ -point of the cumulative normal distribution. For even values of  $n$ ,  $F(\chi^2)$  can be written as

$$1 - F(\chi^2) = \sum_{x=0}^{x'-1} \frac{e^{-\lambda} \lambda^x}{x!}$$

with  $\lambda = \frac{1}{2}\chi^2$  and  $x' = \frac{1}{2}n$ . Thus the cumulative chi-square distribution is related to the cumulative Poisson distribution.

Another approximate formula for large  $n$

$$\chi_\alpha^2 = n \left( 1 - \frac{2}{9n} + z_\alpha \sqrt{\frac{2}{9n}} \right)^3$$

$n$  = degrees of freedom

$z_\alpha$  = the normal deviate (the value of  $x$  for which  $F(x)$  = the desired percentile).

$x$	1.282	1.645	1.960	2.326	2.576	3.090
$F(x)$	.90	.95	.975	.99	.995	.999

$\chi_{.99}^2 = 60[1 - 0.00370 + 2.326(0.06086)]^3 = 88.4$  is the 99th percentile for 60 degrees of freedom.

$$F(\chi^2) = \int_0^{\chi^2} \frac{1}{2^{n/2} \Gamma(\frac{n}{2})} x^{n-2/2} e^{-x/2} dx$$

$n \backslash F$	.005	.010	.025	.050	.100	.250	.500	.750	.900	.950	.975	.990	.995
1	.0000393	.000157	.000982	.00393	.0158	.102	.455	1.32	2.71	3.84	5.02	6.63	7.88
2	.0100	.0201	.0506	.103	.211	.575	1.39	2.77	4.61	5.99	7.38	9.21	10.6
3	.0717	.115	.216	.352	.584	1.21	2.37	4.11	6.25	7.81	9.35	11.3	12.8
4	.207	.297	.484	.711	1.06	1.92	3.36	5.39	7.78	9.49	11.1	13.3	14.9
5	.412	.554	.831	1.15	1.61	2.67	4.35	6.63	9.24	11.1	12.8	15.1	16.7
6	.676	.872	1.24	1.64	2.20	3.45	5.35	7.84	10.6	12.6	14.4	16.8	18.5
7	.989	1.24	1.69	2.17	2.83	4.25	6.35	9.04	12.0	14.1	16.0	18.5	20.3
8	1.34	1.65	2.18	2.73	3.49	5.07	7.34	10.2	13.4	15.5	17.5	20.1	22.0
9	1.73	2.09	2.70	3.33	4.17	5.90	8.34	11.4	14.7	16.9	19.0	21.7	23.6
10	2.16	2.56	3.25	3.94	4.87	6.74	9.34	12.5	16.0	18.3	20.5	23.2	25.2
11	2.60	3.05	3.82	4.57	5.58	7.58	10.3	13.7	17.3	19.7	21.9	24.7	26.8
12	3.07	3.57	4.40	5.23	6.30	8.44	11.3	14.8	18.5	21.0	23.3	26.2	28.3
13	3.57	4.11	5.01	5.89	7.04	9.30	12.3	16.0	19.8	22.4	24.7	27.7	29.8
14	4.07	4.66	5.63	6.57	7.79	10.2	13.3	17.1	21.1	23.7	26.1	29.1	31.3
15	4.60	5.23	6.26	7.26	8.55	11.0	14.3	18.2	22.3	25.0	27.5	30.6	32.8
16	5.14	5.81	6.91	7.96	9.31	11.9	15.3	19.4	23.5	26.3	28.8	32.0	34.3
17	5.70	6.41	7.56	8.67	10.1	12.8	16.3	20.5	24.8	27.6	30.2	33.4	35.7
18	6.26	7.01	8.23	9.39	10.9	13.7	17.3	21.6	26.0	28.9	31.5	34.8	37.2
19	6.84	7.63	8.91	10.1	11.7	14.6	18.3	22.7	27.2	30.1	32.9	36.2	38.6
20	7.43	8.26	9.59	10.9	12.4	15.5	19.3	23.8	28.4	31.4	34.2	37.6	40.0
21	8.03	8.90	10.3	11.6	13.2	16.3	20.3	24.9	29.6	32.7	35.5	38.9	41.4
22	8.64	9.54	11.0	12.3	14.0	17.2	21.3	26.0	30.8	33.9	36.8	40.3	42.8
23	9.26	10.2	11.7	13.1	14.8	18.1	22.3	27.1	32.0	35.2	38.1	41.6	44.2
24	9.89	10.9	12.4	13.8	15.7	19.0	23.3	28.2	33.2	36.4	39.4	43.0	45.6
25	10.5	11.5	13.1	14.6	16.5	19.9	24.3	29.3	34.4	37.7	40.6	44.3	46.9
26	11.2	12.2	13.8	15.4	17.3	20.8	25.3	30.4	35.6	38.9	41.9	45.6	48.3
27	11.8	12.9	14.6	16.2	18.1	21.7	26.3	31.5	36.7	40.1	43.2	47.0	49.6
28	12.5	12.6	15.3	16.9	18.9	22.7	27.3	32.6	37.9	41.3	44.5	48.3	51.0
29	13.1	14.3	16.0	17.7	19.8	23.6	28.3	33.7	39.1	42.6	45.7	49.6	52.3
30	13.8	15.0	16.8	18.5	20.6	24.5	29.3	34.8	40.3	43.8	47.0	50.9	53.7

## PERCENTAGE POINTS, *F*-DISTRIBUTION

This table gives values of *F* such that

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right)}{\Gamma\left(\frac{m}{2}\right)\Gamma\left(\frac{n}{2}\right)} m^{m/2} n^{n/2} x^{m-2/2} (n+mx)^{-(m+n)/2} dx$$

for selected values of *m*, the number of degrees of freedom of the numerator of *F*; and for selected values of *n*, the number of degrees of freedom of the denominator of *F*. The table also provides values corresponding to  $F(F) = .10, .05, .025, .01, .005, .001$  since  $F_{1-\alpha}$  for *m* and *n* degrees of freedom is the reciprocal of  $F_\alpha$  for *n* and *m* degrees of freedom. Thus

$$F_{.05}(4, 7) = \frac{1}{F_{.95}(7, 4)} = \frac{1}{6.09} = .164$$

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right)}{\Gamma\left(\frac{m}{2}\right)\Gamma\left(\frac{n}{2}\right)} m^{m/2} n^{n/2} x^{(m/2)-1} (n+mx)^{-(m+n)/2} dx = .90$$

<i>n</i> \ <i>m</i>	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	39.86	49.50	53.59	55.83	57.24	58.20	58.91	59.44	59.86	60.19	60.71	61.22	61.74	62.00	62.26	62.53	62.79	63.06	63.33
2	8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.41	9.42	9.44	9.45	9.46	9.47	9.47	9.48	9.49
3	5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.22	5.20	5.18	5.18	5.17	5.16	5.15	5.14	5.13
4	4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.94	3.92	3.90	3.87	3.84	3.83	3.82	3.80	3.79	3.78	3.76
5	4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.27	3.24	3.21	3.19	3.17	3.16	3.14	3.12	3.10
6	3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.90	2.87	2.84	2.82	2.80	2.78	2.76	2.74	2.72
7	3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.67	2.63	2.59	2.58	2.56	2.54	2.51	2.49	2.47
8	3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.50	2.46	2.42	2.40	2.38	2.36	2.34	2.32	2.29
9	3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.38	2.34	2.30	2.28	2.25	2.23	2.21	2.18	2.16
10	3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.28	2.24	2.20	2.18	2.16	2.13	2.11	2.08	2.06
11	3.23	2.86	2.66	2.54	2.45	2.39	2.34	2.30	2.27	2.25	2.21	2.17	2.12	2.10	2.08	2.05	2.03	2.00	1.97
12	3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.15	2.10	2.06	2.04	2.01	1.99	1.96	1.93	1.90
13	3.14	2.76	2.56	2.43	2.35	2.28	2.23	2.20	2.16	2.14	2.10	2.05	2.01	1.98	1.96	1.93	1.90	1.88	1.85
14	3.10	2.73	2.52	2.39	2.31	2.24	2.19	2.15	2.12	2.10	2.05	2.01	1.96	1.94	1.91	1.89	1.86	1.83	1.80
15	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	2.02	1.97	1.92	1.90	1.87	1.85	1.82	1.79	1.76
16	3.05	2.67	2.46	2.33	2.24	2.18	2.13	2.09	2.06	2.03	1.99	1.94	1.89	1.87	1.84	1.81	1.78	1.75	1.72
17	3.03	2.64	2.44	2.31	2.22	2.15	2.10	2.06	2.03	2.00	1.96	1.91	1.86	1.84	1.81	1.78	1.75	1.72	1.69
18	3.01	2.62	2.42	2.29	2.20	2.13	2.08	2.04	2.00	1.98	1.93	1.89	1.84	1.81	1.78	1.75	1.72	1.69	1.66
19	2.99	2.61	2.40	2.27	2.18	2.11	2.06	2.02	1.98	1.96	1.91	1.86	1.81	1.79	1.76	1.73	1.70	1.67	1.63
20	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.89	1.84	1.79	1.77	1.74	1.71	1.68	1.64	1.61
21	2.96	2.57	2.36	2.23	2.14	2.08	2.02	1.98	1.95	1.92	1.87	1.83	1.78	1.75	1.72	1.69	1.66	1.62	1.59
22	2.95	2.56	2.35	2.22	2.13	2.06	2.01	1.97	1.93	1.90	1.86	1.81	1.76	1.73	1.70	1.67	1.64	1.60	1.57
23	2.94	2.55	2.34	2.21	2.11	2.05	1.99	1.95	1.92	1.89	1.84	1.80	1.74	1.72	1.69	1.66	1.62	1.59	1.55
24	2.93	2.54	2.33	2.19	2.10	2.04	1.98	1.94	1.91	1.88	1.83	1.78	1.73	1.70	1.67	1.64	1.61	1.57	1.53
25	2.92	2.53	2.32	2.18	2.09	2.02	1.97	1.93	1.89	1.87	1.82	1.77	1.72	1.69	1.66	1.63	1.59	1.56	1.52
26	2.91	2.52	2.31	2.17	2.08	2.01	1.96	1.92	1.88	1.86	1.81	1.76	1.71	1.68	1.65	1.61	1.58	1.54	1.50
27	2.90	2.51	2.30	2.17	2.07	2.00	1.95	1.91	1.87	1.85	1.80	1.75	1.70	1.67	1.64	1.60	1.57	1.53	1.49
28	2.89	2.50	2.29	2.16	2.06	2.00	1.94	1.90	1.87	1.84	1.79	1.74	1.69	1.66	1.63	1.59	1.56	1.52	1.48
29	2.89	2.50	2.28	2.15	2.06	1.99	1.93	1.89	1.86	1.83	1.78	1.73	1.68	1.65	1.62	1.58	1.55	1.51	1.47
30	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.77	1.72	1.67	1.64	1.61	1.57	1.54	1.50	1.46
40	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76	1.71	1.66	1.61	1.57	1.54	1.51	1.47	1.42	1.38
60	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.66	1.60	1.54	1.51	1.48	1.44	1.40	1.35	1.29
120	2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65	1.60	1.55	1.48	1.45	1.41	1.37	1.32	1.26	1.19
∞	2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60	1.55	1.49	1.42	1.38	1.34	1.30	1.24	1.17	1.00

$F = \frac{s_1^2}{s_2^2} = \frac{S_1/m}{S_2/n}$ , where  $s_1^2 = S_1/m$  and  $s_2^2 = S_2/n$  are independent mean squares estimating a common variance  $\sigma^2$  and based on *m* and *n* degrees of freedom, respectively.

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right)}{\Gamma\left(\frac{m}{2}\right)\Gamma\left(\frac{n}{2}\right)} m^{m/2} n^{n/2} x^{(m/2)-1} (n+mx)^{-(m+n)/2} dx = .95$$

<i>n</i> \ <i>m</i>	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

$F = \frac{s_1^2}{s_2^2} = \frac{S_1/m}{S_2/n}$ , where  $s_1^2 = S_1/m$  and  $s_2^2 = S_2/n$  are independent mean squares estimating a common variance  $\sigma^2$  and based on  $m$  and  $n$  degrees of freedom, respectively.

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right)}{\Gamma\left(\frac{m}{2}\right)\Gamma\left(\frac{n}{2}\right)} m^{m/2} n^{n/2} x^{(m/2)-1} (n+mx)^{-(m+n)/2} dx = .975$$

<i>n</i> \ <i>m</i>	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	647.8	799.5	864.2	899.6	921.8	937.1	948.2	956.7	963.3	968.6	976.7	984.9	993.1	997.2	1001	1006	1010	1014	1018
2	38.51	39.00	39.17	39.25	39.30	39.33	39.36	39.37	39.39	39.40	39.41	39.43	39.45	39.46	39.46	39.47	39.48	39.49	39.50
3	17.44	16.04	15.44	15.10	14.88	14.73	14.62	14.54	14.47	14.42	14.34	14.25	14.17	14.12	14.08	14.04	13.99	13.95	13.90
4	12.22	10.65	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.75	8.66	8.56	8.51	8.46	8.41	8.36	8.31	8.26
5	10.01	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.52	6.43	6.33	6.28	6.23	6.18	6.12	6.07	6.02
6	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.37	5.27	5.17	5.12	5.07	5.01	4.96	4.90	4.85
7	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.67	4.57	4.47	4.42	4.36	4.31	4.25	4.20	4.14
8	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4.20	4.10	4.00	3.95	3.89	3.84	3.78	3.73	3.67
9	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.87	3.77	3.67	3.61	3.56	3.51	3.45	3.39	3.33
10	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.62	3.52	3.42	3.37	3.31	3.26	3.20	3.14	3.08
11	6.72	5.26	4.63	4.28	4.04	3.88	3.76	3.66	3.59	3.53	3.43	3.33	3.23	3.17	3.12	3.06	3.00	2.94	2.88
12	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.28	3.18	3.07	3.02	2.96	2.91	2.85	2.79	2.72
13	6.41	4.97	4.35	4.00	3.77	3.60	3.48	3.39	3.31	3.25	3.15	3.05	2.95	2.89	2.84	2.78	2.72	2.66	2.60
14	6.30	4.86	4.24	3.89	3.66	3.50	3.38	3.29	3.21	3.15	3.05	2.95	2.84	2.79	2.73	2.67	2.61	2.55	2.49
15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.96	2.86	2.76	2.70	2.64	2.59	2.52	2.46	2.40
16	6.12	4.69	4.08	3.73	3.50	3.34	3.22	3.12	3.05	2.99	2.89	2.79	2.68	2.63	2.57	2.51	2.45	2.38	2.32
17	6.04	4.62	4.01	3.66	3.44	3.28	3.16	3.06	2.98	2.92	2.82	2.72	2.62	2.56	2.50	2.44	2.38	2.32	2.25
18	5.98	4.56	3.95	3.61	3.38	3.22	3.10	3.01	2.93	2.87	2.77	2.67	2.56	2.50	2.44	2.38	2.32	2.26	2.19
19	5.92	4.51	3.90	3.56	3.33	3.17	3.05	2.96	2.88	2.82	2.72	2.62	2.51	2.45	2.39	2.33	2.27	2.20	2.13
20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.41	2.35	2.29	2.22	2.16	2.09
21	5.83	4.42	3.82	3.48	3.25	3.09	2.97	2.87	2.80	2.73	2.64	2.53	2.42	2.37	2.31	2.25	2.18	2.11	2.04
22	5.79	4.38	3.78	3.44	3.22	3.05	2.93	2.84	2.76	2.70	2.60	2.50	2.39	2.33	2.27	2.21	2.14	2.08	2.00
23	5.75	4.35	3.75	3.41	3.18	3.02	2.90	2.81	2.73	2.67	2.57	2.47	2.36	2.30	2.24	2.18	2.11	2.04	1.97
24	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70	2.64	2.54	2.44	2.33	2.27	2.21	2.15	2.08	2.01	1.94
25	5.69	4.29	3.69	3.35	3.13	2.97	2.85	2.75	2.68	2.61	2.51	2.41	2.30	2.24	2.18	2.12	2.05	1.98	1.91
26	5.66	4.27	3.67	3.33	3.10	2.94	2.82	2.73	2.65	2.59	2.49	2.39	2.28	2.22	2.16	2.09	2.03	1.95	1.88
27	5.63	4.24	3.65	3.31	3.08	2.92	2.80	2.71	2.63	2.57	2.47	2.36	2.25	2.19	2.13	2.03	2.00	1.93	1.85
28	5.61	4.22	3.63	3.29	3.06	2.90	2.78	2.69	2.61	2.55	2.45	2.34	2.23	2.17	2.11	2.05	1.98	1.91	1.83
29	5.59	4.20	3.61	3.27	3.04	2.88	2.76	2.67	2.59	2.53	2.43	2.32	2.21	2.15	2.09	2.03	1.96	1.89	1.81
30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.14	2.07	2.01	1.94	1.87	1.79
40	5.42	4.05	3.46	3.13	2.90	2.74	2.62	2.53	2.45	2.39	2.29	2.18	2.07	2.01	1.94	1.88	1.80	1.72	1.64
60	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33	2.27	2.17	2.06	1.94	1.88	1.82	1.74	1.67	1.58	1.48
120	5.15	3.80	3.23	2.89	2.67	2.52	2.39	2.30	2.22	2.16	2.05	1.94	1.82	1.76	1.69	1.61	1.53	1.43	1.31
∞	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11	2.05	1.94	1.83	1.71	1.64	1.57	1.48	1.39	1.27	1.00

$F = \frac{s_1^2}{s_2^2} = \frac{S_1}{m} / \frac{S_2}{n}$ , where  $s_1^2 = S_1/m$  and  $s_2^2 = S_2/n$  are independent mean squares estimating a common variance  $\sigma^2$  and based on  $m$  and  $n$  degrees of freedom, respectively.

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right)}{\Gamma\left(\frac{m}{2}\right)\Gamma\left(\frac{n}{2}\right)} m^{m/2} n^{n/2} x^{(m/2)-1} (n+mx)^{-(m+n)/2} dx = .99$$

<i>n</i> \ <i>m</i>	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	4052	4999.5	5403	5625	5764	5859	5928	5982	6022	6056	6106	6157	6209	6235	6261	6287	6313	6339	6366
2	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.49	99.50
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	27.05	26.87	26.69	26.60	26.50	26.41	26.32	26.22	26.13
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.37	14.20	14.02	13.93	13.84	13.75	13.65	13.56	13.46
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02
6	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.69	3.60
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.45	3.36
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.66	3.59	3.51	3.43	3.34	3.25	3.17
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.18	3.09	3.00
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.96	2.87
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.93	2.84	2.75
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.83	2.75	2.65
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.58	2.49
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.69	2.61	2.52	2.42
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.17
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.96	2.81	2.66	2.58	2.50	2.42	2.33	2.23	2.13
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.93	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.10
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.90	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.06
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.87	2.73	2.57	2.49	2.41	2.33	2.23	2.14	2.03
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.80
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.38
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00

$F = \frac{s_1^2}{s_2^2} = \frac{S_1/m}{S_2/n}$ , where  $s_1^2 = S_1/m$  and  $s_2^2 = S_2/n$  are independent mean squares estimating a common variance  $\sigma^2$  and based on  $m$  and  $n$  degrees of freedom, respectively.

## SOURCES OF PHYSICAL AND CHEMICAL DATA

In addition to the primary research journals, there are many useful sources of property data of the type contained in the *CRC Handbook of Chemistry and Physics*. A selected list of these is presented here, with emphasis on print and electronic sources whose contents have been subject to a reasonable level of quality control.

### A. Data Journals

1. **Journal of Physical and Chemical Reference Data** — Published jointly by the National Institute of Standards and Technology and the American Institute of Physics, this quarterly journal contains compilations of evaluated data in chemistry, physics, and materials science. It is available in print and on the Internet. [ojps.aip.org/jpcrd/]
2. **Journal of Chemical and Engineering Data** — This bimonthly journal of the American Chemical Society publishes articles reporting original experimental measurements carried out under carefully controlled conditions. The main emphasis is on thermochemical and thermophysical properties. Review articles with evaluated data from the literature are also published. [pubs.acs.org/journals/jceaax/index.html]
3. **Journal of Chemical Thermodynamics** — This journal publishes original research papers that include highly accurate measurements of thermodynamic and thermophysical properties. [www.sciencedirect.com/science/journal/00219614]
4. **Atomic Data and Nuclear Data Tables** — This is a bimonthly journal containing compilations of data in atomic physics, nuclear physics, and related fields. [www.science.direct.com/science/journal/0092640X]
5. **Journal of Phase Equilibria and Diffusion** — This journal presents critically evaluated phase diagrams and related data on alloy systems. It is published by ASM International and is the successor to the previous ASM periodical *Bulletin of Alloy Phase Diagrams*. [www.asm-intl.org]

### B. Data Centers

This section lists selected organizations that perform a continuing function of compiling and critically evaluating data in specific fields of science.

1. **National Institute of Standards and Technology** — Under its Standard Reference Data program, NIST supports a number of data centers in chemistry, physics, and materials science. Topics covered include thermodynamics, fluid properties, chemical kinetics, mass spectroscopy, atomic spectroscopy, fundamental physical constants, ceramics, and crystallography. Address: Office of Standard Reference Data, National Institute of Standards and Technology, Gaithersburg, MD 20899 [www.nist.gov/srd/].
2. **Thermodynamics Research Center** — Now located at the National Institute of Standards and Technology, TRC maintains an extensive archive of data covering thermodynamic, thermochemical, and transport properties of organic compounds and mixtures. Data are distributed in both print and electronic form. Address: Mail code 838.00, 325 Broadway, Boulder, CO 80305-3328 [www.trc.nist.gov].
3. **Design Institute for Physical Property Data** — Under the auspices of the American Institute of Chemical Engineers [www.aiche.org/dippr/], DIPPR offers evaluated data on industrially important chemical compounds. The largest project deals with physical, thermodynamic, and transport properties of pure compounds. Address: Brigham Young University, Provo, UT 84602 [dippr.byu.edu].
4. **Dortmund Data Bank** — Maintains extensive databases on thermodynamic and transport properties of pure compounds and mixtures of industrial interest. The data are distributed through DECHEMA, FIZ CHEMIE, and other outlets. An abbreviated database system is also available for educational use. Address: DDBST GmbH, Industriestr. 1, 26121 Oldenburg, Germany [www.ddbst.de].
5. **Cambridge Crystallographic Data Centre** — Maintains the Cambridge Structural Database of over 430,000 organic compounds. The data files and manipulation software are distributed in several ways. Address: 12 Union Rd., Cambridge CB2 1EZ, U.K. [www.ccdc.cam.ac.uk].
6. **FIZ Karlsruhe** — In addition to many bibliographic databases, FIZ Karlsruhe maintains the Inorganic Crystal Structure Database in collaboration with the National Institute of Standards and Technology. The ICSD contains the atomic coordinates and related data on over 50,000 inorganic crystals. Address: Fachinformationszentrum (FIZ) Karlsruhe, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany [www.fiz-karlsruhe.de].
7. **International Centre for Diffraction Data** — Maintains and distributes the Powder Diffraction File (PDF), a file of over 500,000 X-ray powder diffraction patterns used for identification of crystalline materials. The ICDD also distributes the NIST Crystal Data file, which contains lattice parameters for over 235,000 inorganic, organic, metal, and mineral crystalline materials. Address: 12 Campus Blvd., Newton Square, PA 19073-3273 [www.icdd.com].
8. **Research Collaboratory for Structural Bioinformatics** — Maintains the Protein Data Bank (PDB), a file of 3-dimensional structures of proteins and other biological macromolecules. Address: Department of Chemistry and Chemical Biology, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854-8087 [www.rcsb.org].
9. **Toth Information Systems** — Maintains the Metals Crystallographic Data File (CRYSTMET). Address: 2045 Quincy Ave., Gloucester, ON, Canada K1J 6B2 [www.tothcanada.com].
10. **Atomic Mass Data Center** — Collects and evaluates high-precision data on masses of individual isotopes and maintains a comprehensive database. Address: C.S.N.S.M (IN2P3-CNRS), Batiment 108, F-91405 Orsay Campus, France [www.nndc.bnl.gov/amdc].
11. **Particle Data Group** — International center for data of high-energy physics; maintains a database of properties of fundamental particles that is published in both print and electronic form. Address: MS 50-308, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 [pdg.lbl.gov].
12. **National Nuclear Data Center** — Maintains databases on nuclear structure and reactions, including neutron cross sections. The NNDC is the U.S. node in an international network of nuclear data centers. Address: Brookhaven National Laboratory, Upton, NY 11973-5000 [www.nndc.bnl.gov].

13. **International Union of Pure and Applied Chemistry** — Address: PO Box 13757, Research Triangle Park, NC 27709-3757 [www.iupac.org]. IUPAC supports a number of long-term data projects, including these examples:
  - a. **Solubility Data Project** — Carries out evaluation of all types of solubility data. The results are published in the Solubility Data Series, whose current outlet is the *Journal of Physical and Chemical Reference Data*. [www.iupac.org/divisions/V/cp5.html]
  - b. **Kinetic Data for Atmospheric Chemistry** — Maintains a comprehensive database on the kinetics of reactions important in the chemistry of the atmosphere. [www.iupac-kinetic.ch.cam.ac.uk/]
  - c. **International Thermodynamic Tables for the Fluid State** — Prepares definitive tables of the thermodynamic properties of industrially important fluids. Thirteen volumes have been published by IUPAC. [www.iupac.org/publications/books/seriestitles/]
  - d. **Stability Constants Database** — Collection of metal-ligand stability constants and associated software. [www.acadsoft.co.uk]

### C. Major Multi-Volume Handbook Series

1. **Chapman & Hall/CRC Chemical Dictionaries** — These originally appeared in print form as the *Dictionary of Organic Compounds*, *Dictionary of Natural Products*, etc. They are now published in electronic form and are available in DVD format [www.crcpress.com] and on the Internet [www.chemnetbase.com]. The consolidated version, called the *Combined Chemical Dictionary*, has data on more than 550,000 compounds spanning all branches of chemistry. The coverage includes physical properties, biological sources, hazard information, uses, and literature references.
2. **Properties of Organic Compounds** — Originally published in three editions as the *Handbook of Data on Organic Compounds*, it is now in electronic form as *Properties of Organic Compounds*. The database includes about 30,000 compounds; physical properties and spectral data (mass, infrared, Raman, ultraviolet, and NMR) are covered. It is offered as CDROM [www.crcpress.com] and by Web access [www.chemnetbase.com].
3. **Beilstein Handbook of Organic Chemistry** — The classic source of data on organic compounds, dating from the 19th century, *Beilstein* was converted to electronic form in the last decade of the 20th century. Over 8 million compounds and 10 million chemical reactions are now covered, with a broad range of physical properties as well as synthetic methods and ecological data. The database is accessed by the CrossFire software [www.beilstein.com].
4. **Gmelin Handbook of Inorganic and Organometallic Chemistry** — A subset of the information in the print series has been converted to electronic form and is now distributed in the same manner as *Beilstein*. In addition to the standard physical properties, the coverage includes a wide range of optical, magnetic, spectroscopic, thermal, and transport properties for about 1.4 million compounds [www.mdli.com].
5. **DECHEMA Chemical Data Series** — DECHEMA distributes the DETHERM database, which emphasizes data used in process design in the chemical industry, including thermodynamic and transport properties of about 20,000 pure compounds and 90,000 mixtures. Access is available

through in-house databases and via the Internet [www.dechema.de].

6. **Landolt-Börnstein Numerical Data and Functional Relationships in Science and Technology** — *Landolt-Börnstein* covers a very broad range of data in physics, chemistry, crystallography, materials science, biophysics, astronomy, and geophysics. Hard-copy volumes in the New Series (started in 1961) are still being published, and the entire New Series is now accessible on the Internet [www.landolt-boernstein.com].

### D. Selected Single-Volume Handbooks

The following handbooks offer broad coverage of high-quality data in a single volume. This list is only representative; an extensive listing of handbooks in all fields of science may be found in *Handbooks and Tables in Science and Technology, Third Edition* (Russell H. Powell, ed., Oryx Press, Westport, CT, 1994).

1. **American Institute of Physics Handbook** — Although an old book, it contains much data that are still useful, especially in acoustics, mechanics, optics, and solid state physics. (Dwight E. Gray, ed., McGraw-Hill, New York, 1972)
2. **Constants of Inorganic Substances** — This book presents physical constants, thermodynamic data, solubility, reactivity, and other information on over 3000 inorganic compounds. Since it draws heavily on Russian literature, it contains a great deal of data that do not make their way into most U.S. handbooks. (R. A. Lidin, L. L. Andreeva, and V. A. Molochko, Begell House, New York, 1995)
3. **Handbook of Chemistry and Physics** — Now in the 90th Edition, the *CRC Handbook* covers data from most branches of chemistry and physics. The annual revisions permit regular updating of the information. Also available on CDROM [www.crcpress.com] and the Web [hbcnetbase.com]. (David R. Lide, ed., CRC Press, Boca Raton, FL, 2009)
4. **Handbook of Inorganic Compounds** — This book covers physical constants and solubility for about 3300 inorganic compounds. Also available on CDROM [www.crcpress.com]. (Dale L. Perry and Sidney L. Phillips, eds., CRC Press, Boca Raton, FL, 1995)
5. **Handbook of Physical Properties of Liquids and Gases** — This is a valuable source of data on all types of fluids, ranging from liquid and gaseous hydrocarbons to molten metals and ionized gases. Detailed tables of physical, thermodynamic, and transport properties are given for temperatures from the cryogenic region to 6000 K. Western and Russian literature is covered. (N. B. Vargaftik, Y. K. Vinogradov, and V. S. Yargin, Begell House, New York, 1996)
6. **Handbook of Physical Quantities** — The range of coverage is somewhat similar to the *CRC Handbook of Chemistry and Physics*, but with a stronger emphasis on physics than on chemistry. Solid state physics, lasers, nuclear physics, geophysics, and astronomy receive considerable attention. (Igor S. Grigoriev and Evgenii Z. Meilikhov, eds., CRC Press, Boca Raton, FL, 1997)
7. **Kaye & Laby Tables of Physical and Chemical Constants** — *Kaye & Laby* dates from 1911, and the 16th Edition was prepared in 1995 by a committee of experts. The coverage extends to almost every field of physics and chemistry; data on a limited number of representative substances or materials are given for each topic. (Longman Group Limited, Harlow, Essex, U.K., 1995)



8. *Lange's Handbook of Chemistry* — Provides broad coverage of chemical data; last updated in 2005. Also available on the Web [www.knovel.com]. (James G. Speight, ed., McGraw-Hill, New York, 2005)
9. *Recommended Reference Materials for the Realization of Physicochemical Properties* — This IUPAC book emphasizes highly accurate data on substances and materials that can be used as calibration standards. It covers physical, thermal, optical, and electrical properties. (K. N. Marsh, ed., Blackwell Scientific Publications, Oxford, 1987)
10. *The Merck Index* — Now in its 14th Edition (published in 2006), *The Merck Index* is a widely used source of data on over 10,000 compounds, chosen particularly for their importance in biology, medicine, and ecology. A short mono-

graph on each compound gives information on the synthesis and uses as well as physical and toxicological properties. A CD-ROM accompanies the book. (Maryadele J. O'Neil, ed., John Wiley & Sons, Indianapolis, IN, 2006)

### E. Summary of Useful Web Sites for Physical and Chemical Properties

Most of the Web sites in the following list provide direct access to factual data on physical and chemical properties. However, the list also includes portals that link to different property databases or describe the procedure for gaining access to electronic sources of property data. There are also a few chemical directory sites that are useful for obtaining formulas, synonyms, and registry numbers for substances of interest.

Web Site	Address	Comments
ACD/Labs Spectral Data	www.acdlabs.com/products/spec_lab/exp_spectra/spec_libraries/	Infrared, Raman and NMR spectra collections from Coblenz Society and other sources
Acronyms and Symbols	www3.interscience.wiley.com/stasa/	Free service; useful for identifying acronyms for chemicals
Advanced Chemistry Development	www.acdlabs.com	Chemical directory, with programs for estimating physical and spectral properties
Alloy Center	products.asminternational.org/alloycenter/	Physical, electrical, thermal, and mechanical properties of alloys
American Mineralogist Crystal Structure Database	www.geo.arizona.edu/AMS/amcsd.php	Lattice constants of minerals
Atomic Mass Data Center	www.nndc.bnl.gov/amdc	See B.10
Beilstein	www.mdl.com/products/knowledge/crossfire_beilstein.com	See C.3
Biocatalysis/Biodegradation Database	umbbd.ahc.umn.edu/	Biocatalytic reactions, biodegradation of chemical compounds
BioCyc	biocyc.org/	Metabolic pathways of microorganisms
BioInfo Bank	gibk26.bse.kyutech.ac.jp/jouhou/jouhoubank.html	Portal to ProTherm (protein thermodynamics), ProNit (protein–nucleic acid interactions), biomolecule structures
Biological Macromolecule Crystallization Database	xpdb.nist.gov:8060/BMCD4/index.faces	Crystal data and crystallization conditions for proteins, nucleic acids, and complexes
BRENDA	www.brenda-enzymes.info/	Enzyme nomenclature and properties
Cambridge Structural Database	www.ccdc.cam.ac.uk	See B.5
Carbon Dioxide Information Center	cdiac.esd.ornl.gov/	Data on atmospheric carbon dioxide
Ceramic Properties Databases	www.ceramics.org/publications_ceramic_properties_databases.aspx	Mechanical, thermal, and other properties of ceramic materials
ChemExper	www.chemexper.com/	Consolidated chemical catalogs from various suppliers; provides physical properties and safety data; links to molfiles and MSDS
Chemfinder	www.chemfinder.com	Chemical directory, with links to several property databases
Chemical Acronyms Database	www.oscar.chem.indiana.edu/cfdocs/libchem/acronyms/acronymsearch.html	Useful for associating chemical names and acronyms
Chemical Entities of Biological Interest (ChEBI)	www.ebi.ac.uk/chebi/	Dictionary of molecules and fragments, with identifiers and structures
Chemical Information Sources–Physical Property Information	cheminfo.informatics.indiana.edu/cicc/cis/index.php/Physical_Property_Information	Extensive listing of print and electronic sources of chemical data
ChemIDplus	chem.sis.nlm.nih.gov/chemidplus/	Chemical directory
ChemIndustry	www.chemindustry.com/chemicals/	Chemical directory
CHEMnetBASE	www.chemnetbase.com	Portal to <i>CRC Chemical Dictionaries, Handbook of Chemistry and Physics, Properties of Organic Compounds</i> , etc.
ChemSynthesis Chemical Database	www.chemsynthesis.com	References to synthesis; limited property data
ChemWeb Databases	www.chemweb.com/content/databases	Portal to databases from John Wiley and others
CODATA Databases	www.codata.org/resources/databases/index.html	Thermodynamic key values and fundamental constants

Web Site	Address	Comments
Comparative Toxicogenomics Database (CTD)	ctd.mdibl.org/	Chemical – gene/protein interactions
CRC Combined Chemical Dictionary	www.chemnetbase.com/scripts/ccdweb.exe	See C.1
Crystallography Open Database (COD)	www.crystallography.net	Crystal data on 52,000 compounds
DECHEMA (DETERM)	www.dechema.de/en/isystems.html	See C.5
DIPPR Pure Compound Database	dippr.byu.edu	See B.3
Dortmund Data Bank	www.ddbst.de	See B.4
Enzyme Nomenclature Database	www.expasy.ch/enzyme/	IUBMB nomenclature for enzymes
Enzyme Structures Database	www.ebi.ac.uk/thornton-srv/databases/enzymes/	Structures of enzymes in Protein Data Bank
European Bioinformatics Institute	www.ebi.ac.uk/Databases/	Nucleotide and protein sequences, protein structures, enzyme nomenclature and reactions
FDM Reference Spectra Databases	www.fdmspectra.com/	Infrared, Raman, and mass spectra
FIZ Chemie Berlin	www.fiz-chemie.de	Portal to DETERM (C.5), Dortmund Data Bank (B.4), Infotherm, Acronyms
FIZ Karlsruhe — ICSD	www.fiz-karlsruhe.de	See B.6
Fundamental Physical Constants	physics.nist.gov/constants	CODATA fundamental constants
Gmelin	www.mdli.com/products/knowledge/crossfire_gmelin/	See C.4
<i>Handbook of Chemistry and Physics</i>	hbcnetbase.com	Web version of <i>CRC Handbook</i>
Hazardous Substances Data Bank	toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB	Physical and toxicological properties of chemicals of health or environmental importance
HITRAN Database	cfa-www.harvard.edu/hitran/	High resolution spectroscopic data for constituents of the atmosphere; parameters for calculating atmospheric transmission
Human Metabolome Database	hmdb.ca	Chemical and biological data on small molecule metabolites in humans
Infotherm	www.fiz-chemie.de/infotherm/servlet/infothermsearch	Physical and thermal properties of pure compounds and mixtures
International Centre for Diffraction Data	www.icdd.com	See B.7
International Spectroscopic Data Bank	www.is-db.org	All types of spectra, deposited by users. Access is free
Ionic Liquids Database (ILThermo)	ilthermo.boulder.nist.gov/	Thermodynamic and thermophysical properties of ionic liquids and mixtures
Ionic Liquids Catalogue	ildb.merck.de/ionliquids/en/startpage.htm	Miscibility and other properties of organic liquids
IUBMB	www.chem.qmw.ac.uk/iubmb/	Enzyme and nucleic acid nomenclature
IUCr Data Activities	www.iucr.org/iucr-top/data/index.html#database3	Portal to crystallographic databases
IUPAC Home Page	www.iupac.org	See B.13
IUPAC Kinetics Data	www.iupac-kinetic.ch.cam.ac.uk/	See B.13.b
IUPAC Nomenclature Rules	www.chem.qmul.ac.uk/iupac/	Useful site for organic and biochemical nomenclature
IUPAC-NIST Solubility Database	srdata.nist.gov/solubility/	See B.13.a
Klotho Biochemical Compounds Declarative Database	www.biocheminfo.org/klotho/	Structure diagrams of biochemical molecules
Knovel.com	www.knovel.com	Portal to <i>Lange's Handbook</i> , <i>Perry's Chemical Engineers' Handbook</i> , etc.
Kyoto Encyclopedia of Genes and Genomes (KEGG)	www.genome.ad.jp/kegg/	Includes data on drugs and other biochemical compounds
<i>Landolt-Börnstein</i> Online	www.landolt-boernstein.com	See C.6
Lipidat	www.lipidat.ul.ie/	Structures and thermodynamic properties of lipids; crystal polymorphic transitions
MatWeb	www.matweb.com	Thermal, electrical, and mechanical properties of engineering materials
Metals Crystallographic Data File	www.tothcanada.com	See B.9
NASA Chemical Kinetics Data	jpldataeval.jpl.nasa.gov	Kinetic and photochemical data for stratospheric modeling
National Center for Biotechnology Information	www.ncbi.nlm.nih.gov	Portal to GenBank and other sequence databases
National Nuclear Data Center	www.nndc.bnl.gov	See B.12
National Toxicology Program	ntp-server.niehs.nih.gov	Chemical health and safety data
NIST Atomic Spectra Database	physics.nist.gov/PhysRefData/contents-atomic.html	Energy levels, wavelengths, and transition probabilities of atoms and atomic ions
NIST Ceramics Webbook	www.ceramics.nist.gov/	See B.1
NIST Chemistry Webbook	webbook.nist.gov	Broad range of physical, thermal, and spectral properties

Web Site	Address	Comments
NIST Data Gateway	<a href="http://srdata.nist.gov/gateway/">srdata.nist.gov/gateway/</a>	Portal to all NIST data systems; see B.1
NIST Physical Reference Data	<a href="http://physics.nist.gov/PhysRefData/">physics.nist.gov/PhysRefData/</a>	Atomic and molecular spectra, cross sections, X-ray attenuation, and dosimetry data
NLM Gateway	<a href="http://gateway.nlm.nih.gov/gw/Cmd">gateway.nlm.nih.gov/gw/Cmd</a>	Portal to all National Library of Medicine databases
NMR Shift DB	<a href="http://www.nmrshiftdb.org">www.nmrshiftdb.org</a>	NMR data submitted by users
Nucleic Acid Database	<a href="http://ndbserver.rutgers.edu/">ndbserver.rutgers.edu/</a>	Crystal structures of nucleic acids
Particle Data Group	<a href="http://pdg.lbl.gov">pdg.lbl.gov</a>	See B.11
Physical Property Information	<a href="http://cheminfo.informatics.indiana.edu/cicc/cis/index.php/Physical_Property_Information">cheminfo.informatics.indiana.edu/cicc/cis/index.php/Physical_Property_Information</a>	Useful list of data sources from Indiana University
Polymers — A Property Database	<a href="http://www.polymersdatabase.com/">www.polymersdatabase.com/</a>	Properties of commercial polymers
Powder Diffraction File	<a href="http://www.icdd.com">www.icdd.com</a>	See B.7
Properties of Organic Compounds	<a href="http://www.chemnetbase.com/scripts/pocweb.exe">www.chemnetbase.com/scripts/pocweb.exe</a>	See C.2
Protein Data Bank	<a href="http://www.rcsb.org">www.rcsb.org</a>	See B.8
PubChem	<a href="http://pubchem.ncbi.nlm.nih.gov/">pubchem.ncbi.nlm.nih.gov/</a>	Chemical directory with links to biological information
SABIO-Reaction Kinetics Database	<a href="http://sabio.villa-bosch.de/SABIORK/">sabio.villa-bosch.de/SABIORK/</a>	Data on kinetics of biochemical reactions
Sigma-Aldrich	<a href="http://www.sigmaaldrich.com/">www.sigmaaldrich.com/</a>	Chemical catalogs; includes some physical property data
Spectral Database for Organic Compounds	<a href="http://riodb01.ibase.aist.go.jp/sdbs/cgi-bin/cre_index.cgi?lang=eng">riodb01.ibase.aist.go.jp/sdbs/cgi-bin/cre_index.cgi?lang=eng</a>	MS, NMR, IR, Raman, and ESR spectra; 32,000 compounds measured at AIST, Japan
SpecInfo	<a href="http://www3.interscience.wiley.com/cgi-bin/mrwhome/109609148/HOME">www3.interscience.wiley.com/cgi-bin/mrwhome/109609148/HOME</a>	IR, NMR, and mass spectra
Spectra Online	<a href="http://www.ftirsearch.com/">www.ftirsearch.com/</a>	FTIR and Raman spectra
SPRESI-web	<a href="http://www.spresi.de/">www.spresi.de/</a>	Structures, reactions, and some physical properties
STN Easy	<a href="http://stneasy.cas.org">stneasy.cas.org</a>	Chemical directory (and access to Chemical Abstracts databases)
STN Easy-Europe	<a href="http://stneasy.fiz-karlsruhe.de">stneasy.fiz-karlsruhe.de</a>	European node of STN Easy
STN Easy-Japan	<a href="http://stneasy-japan.cas.org">stneasy-japan.cas.org</a>	Japanese node of STN Easy
Swissprot	<a href="http://bo.expasy.org/enzyme/">bo.expasy.org/enzyme/</a>	Enzyme nomenclature and related information
Syracuse Research Corporation	<a href="http://www.syrres.com/esc/databases.htm">www.syrres.com/esc/databases.htm</a>	Properties of environmental interest
Table of Isotopes	<a href="http://ie.lbl.gov/education/isotopes.htm">ie.lbl.gov/education/isotopes.htm</a>	Nuclear energy levels, moments, and other properties
Thermodynamics of Enzyme-Catalyzed Reactions	<a href="http://xpdb.nist.gov/enzyme_thermodynamics/">xpdb.nist.gov/enzyme_thermodynamics/</a>	Equilibrium constants of biochemical reactions
Thermodynamics Research Center	<a href="http://www.trc.nist.gov">www.trc.nist.gov</a>	See B.2
TOXNET	<a href="http://toxnet.nlm.nih.gov">toxnet.nlm.nih.gov</a>	Portal to HSDB and other databases on hazardous chemicals
Wiley Interscience	<a href="http://www3.interscience.wiley.com/reference.html">www3.interscience.wiley.com/reference.html</a>	Portal to <i>Kirk-Othmer Encyclopedia of Chemical Technology</i> , <i>Ullmann's Encyclopedia of Industrial Chemistry</i> , <i>Encyclopedia of Reagents for Organic Synthesis</i> , SpecInfo Database, etc.

## Tables Relocated or Removed from CRC Handbook of Chemistry and Physics, 71st through 89th Editions

The following tables appeared in previous editions of the *CRC Handbook of Chemistry and Physics* but have been removed, retitled, or rearranged in subsequent editions. In most cases, some or all of the information contained in the original table has been incorporated, in updated form, in a different table (or tables). In such cases the appropriate page references to the 90th Edition (2009-2010) are given in the last column, and the older table should be considered obsolete. The last edition in which the older table appeared is indicated.

Table Title	Last Ed.	Comments
Abbreviations Used in Polymerization Processes	75 Ed.	Removed; general abbreviations in 90 Ed., p. 2-29
Absorption and Velocity of Sound in Still Air	76 Ed.	Updated; see 90 Ed., p. 14-50, 14-51
Allowable Carrying Capacities of Conductors	75 Ed.	Removed
Aluminum Wire Table	75 Ed.	Data included in 90 Ed., p. 15-37
Biochemical Symbols and Abbreviations	77 Ed.	See 90 Ed., p. 2-29
Boiling Point of Water at Various Pressures	89 Ed.	Removed; can be calculated from vapor pressure table in 90 Ed., p. 6-5
Boiling Point Index of Organic Compounds	83 Ed.	Searching available in Internet and CDROM versions
Brazing Filler Metals (Solders)	75 Ed.	Removed
Chemical Composition of Rocks	73 Ed.	Removed
Classification of Comparative Life Hazards of Gases and Vapors	76 Ed.	Removed
Constants for Satellite Geodesy	74 Ed.	Removed
Cross-Section and Mass of Wires	75 Ed.	Data included in 90 Ed., p. 15-37
Density and Composition of Fuming Sulfuric Acid	75 Ed.	Removed
Density of D <sub>2</sub> O	89 Ed.	See 90 Ed., p. 6-10
Diamagnetic Susceptibility Data on Organosilicon Compounds	74 Ed.	Removed
Diffusivities of Metallic Solutes in Molten Metals	76 Ed.	Removed
Diffusivities of Metallic Tracers in Mercury	75 Ed.	Removed
Dissociation Constants of Acids in Water at Various Temperatures	74 Ed.	Removed
Dissociation Constants of Aqueous Ammonia from 0 to 50° C	74 Ed.	Removed
Dissociation Constants of Inorganic Acids in Aqueous Solution	74 Ed.	See 90 Ed., p. 8-40 (acids and bases combined)
Dissociation Constants of Inorganic Bases in Aqueous Solution at 298 K	74 Ed.	See 90 Ed., p. 8-40 (acids and bases combined)
Dissociation Constants of Organic Acids in Aqueous Solution	74 Ed.	See 90 Ed., p. 8-42 (acids and bases combined)
Dissociation Constants of Organic Bases in Aqueous Solution	74 Ed.	See 90 Ed., p. 8-42 (acids and bases combined)
Efficacies and Other Characteristics of Illuminants	76 Ed.	Removed
Efficiency of Drying Agents	76 Ed.	Removed
Emergent Stem Corrections for Liquid-in-Glass Thermometers	75 Ed.	Removed
Emissivity of Total Radiation for Various Materials	77 Ed.	Removed
Emissivity of Tungsten	77 Ed.	Removed
Enthalpy of Vaporization of Water	89 Ed.	See 90 Ed., p. 6-5
Fats and Oils	76 Ed.	See 90 Ed., p. 7-9
Gibbs Energy of Formation of Metal Oxides	77 Ed.	Included in comprehensive table of thermodynamic properties; see 90 Ed., p. 5-4
Heat Capacity of Liquids and Gases at 25° C	76 Ed.	Included in comprehensive table of thermodynamic properties; see 90 Ed., p. 5-4
Heat Capacity of Mercury	73 Ed.	Included with other thermal properties of mercury; see 90 Ed., p. 6-158
Index of Refraction of Fused Quartz	76 Ed.	See 90 Ed., p. 10-250
Index of Refraction of Rock Salt, Sylvine, Calcite, Fluorite, and Quartz	76 Ed.	See 90 Ed., p. 4-149
Introduction to X-Ray Cross Sections	74 Ed.	Removed
Ion Exchange Resins	77 Ed.	Removed
Isothermal Compressibility of Liquids	76 Ed.	Data included in 90 Ed., p. 6-140
Kinetic and Photochemical Data for Atmospheric Chemistry	79 Ed.	See 90 Ed., p. 5-90 (emphasis on stratospheric chemistry)
Kinetic Data for Combustion Modelling	79 Ed.	Removed from book; still present in electronic versions
Lattice Constants for Cubic Crystals	76 Ed.	Removed; some data included in 90 Ed., p. 4-156
Lattice Spacing of Common Analyzing Crystals	76 Ed.	Removed
Lowering of Vapor Pressure by Salts in Aqueous Solution	77 Ed.	Removed; related data in 90 Ed., p. 6-110
Magnetic Rotatory Power	74 Ed.	Removed
Melting Point Index of Organic Compounds	83 Ed.	Searching available in Internet and CDROM versions
Minerals Arranged in Order of Increasing Vickers Hardness Numbers	75 Ed.	See 90 Ed., p. 12-222, for hardness of minerals and ceramics (Mohs and Knoop scales); can be sorted in electronic versions.
Molecular Depression of the Freezing Point	75 Ed.	See 90 Ed., p. 15-28
Molecular Elevation of the Boiling Point	75 Ed.	See 90 Ed., p. 15-27
Nomenclature of Inorganic Chemistry	74 Ed.	See 90 Ed., p. 2-15 (references only), 2-16
Nomenclature of Organic Compounds	74 Ed.	See 90 Ed., p. 2-15 (references only), 2-23
Nomograph and Table for Doppler Linewidths	76 Ed.	Removed
Optical Properties of Metals	73 Ed.	See 90 Ed., p. 12-123
Organic Compounds Listed in Order of Index of Refraction	74 Ed.	Removed; electronic versions permit sorting in this order.
Oxygen Solubility in Aqueous Electrolyte Solutions	76 Ed.	Removed

Permittivity (Dielectric Constant) of Water as a Function of Temperature and Pressure	89 Ed. See 90 Ed., p. 6-1
Physical and Photometric Data for Planets and Satellites	74 Ed. Related data included in 90 Ed., p. 14-2, 14-4
Physical Constants of Clear Fused Quartz	76 Ed. Removed
Physical Constants of Minerals	75 Ed. See 90 Ed., p. 4-149, for physical & optical properties
Platinum Wire	73 Ed. Data included in 90 Ed., p. 15-37
Properties of Carbohydrates	77 Ed. Removed as separate table; data included in 90 Ed., p. 3-1 to 3-523
Properties of Large Production and Priority Organic Pollutants	77 Ed. See 90 Ed., p. 6-72, 8-85, 16-43 for the data in this table
Properties of Sulfuric Acid	75 Ed. Removed; for density, see 90 Ed., p. 15-40
Properties of Tungsten	76 Ed. Removed
Properties of Water in the Range 0-100 °C	89 Ed. See 90 Ed., pp. 6-1, 6-5
Radiative Transition Probabilities for X-Ray Lines	77 Ed. Removed
Radioactive Tracer Diffusion Data for Pure Metals	75 Ed. Removed
Recommended Daily Dietary Allowances	77 Ed. Removed
Reduction of Barometer to Sea Level	75 Ed. Removed
Refractory Materials	76 Ed. Some data included in 90 Ed., p. 12-211
Resistance of Wires	75 Ed. See 90 Ed., p. 15-37
Resistivity of Semiconducting Minerals	73 Ed. Data included in 90 Ed., pp. 12-80
Solvents for Liquid Chromatography	78 Ed. Removed; data included in other tables on solvents
Spark-Gap Voltages	73 Ed. Removed
Specific Heat and Enthalpy of Some Solids at Low Temperature	73 Ed. Removed
Spectral Emissivity	76 Ed. Removed
Spectral Emissivity of Oxides	76 Ed. Removed
Standard Test Sieves and Mesh Size Conversion	75 Ed. Removed
Standard Types of Stainless and Heat Resisting Steels	74 Ed. Removed
Steam Tables	79 Ed. Replaced by 90 Ed., p. 6-1
Steroid Hormones and Other Steroidal Synthetics	76 Ed. Removed as separate table; data included in 90 Ed., p. 3-1 to 3-523
Sublimation Pressure for Organic Compounds	73 Ed. See 90 Ed., p. 6-70
Surface Tension of Liquid Elements	73 Ed. Removed
Temperature Correction for Barometer Readings	75 Ed. See 90 Ed., p. 15-30
Temperature Correction for Glass Volumetric Apparatus	75 Ed. Removed
Temperature Correction for Volumetric Solutions	75 Ed. Removed
Temperature Correction, Glass Scale	73 Ed. Removed
Temperature Dependence of the Permittivity (Dielectric Constant) of Liquids	78 Ed. See 90 Ed., p. 6-166 (Temperature dependence included in general table of permittivity)
The Earth: Its Mass, Dimensions, and Other Related Quantities	74 Ed. Updated table in 90 Ed., p. 14-10
The Limits of Superheat of Pure Liquids	76 Ed. Removed
The pH of Natural Media and its Relation to Precipitation of Hydroxides	73 Ed. See 90 Ed., p. 8-37
Thermal Conductivity of Certain Metals	73 Ed. See 90 Ed., p. 12-203, 12-205, 12-206, 12-208
Thermal Conductivity of Rocks	73 Ed. Removed; certain data included in 90 Ed., p. 12-211
Thermal Conductivity of Saturated H <sub>2</sub> O and D <sub>2</sub> O	89 Ed. See 90 Ed., pp. 6-1, 6-10
Thermal Conductivity of the Elements	73 Ed. See 90 Ed., p. 12-203 & 12-206 for solid elements; 6-218 for gases.
Total Monthly Solar Radiation in a Cloudless Sky	76 Ed. Removed; related data in 90 Ed., p. 14-26
Transmission of Corning Colored Filters	74 Ed. Removed
Transmission of Light by Common Optical Materials	76 Ed. See 90 Ed., p. 10-250
Transmission of Wratten Filters	74 Ed. Removed
Ultraviolet Spectra of Common Liquids	77 Ed. Removed
Units, Symbols, and Equations for Radiometric and Photometric Quantities	77 Ed. Removed (this information is contained in 90 Ed., p. 2-1 and 2-29)
Values for the Langevin Function	77 Ed. Removed
Vapor Pressure at Elevated Temperatures	77 Ed. See 90 Ed., p. 6-72
Vapor Pressure in the Range -25 °C to 150 °C	77 Ed. See 90 Ed., p. 6-72
Velocity of Sound in Dry Air	76 Ed. See 90 Ed., p. 14-51
Velocity of Sound in Various Media	77 Ed. See 90 Ed., p. 14-48
Viscosity of Aqueous Solutions	78 Ed. See 90 Ed., p. 8-52
Weight of One Gallon of Water	75 Ed. See 90 Ed., p. 8-139 for related data
Wire Table:Standard Annealed Copper	75 Ed. See 90 Ed., p. 15-37
Wire Tables:Comparison of Wire Gauges	75 Ed. See 90 Ed., p. 15-37
X-Ray Crystallographic Data on Inorganic Substances and Minerals	76 Ed. See 90 Ed., p. 4-156
X-Ray Wavelengths	76 Ed. Removed

## ALLOWABLE CARRYING CAPACITIES OF CONDUCTORS

(National Electrical Code)

The ratings in the following tabulation are those permitted by the National Electrical Code for flexible cords and for interior wiring of houses, hotels, office buildings, industrial plants, and other buildings.

The values are for copper wire. For aluminum wire the allowable carrying capacities shall be taken as 84% of those given in the table for the respective sizes of copper wire with the same kind of covering.

Size A.W.G.	Area Circular Mils	Diameter of Solid Wires Mils	Rubber Insulation Amperes	Varnished Cambric Insulation Amperes	Other Insulations and Bare Conductors Amperes	Size A.W.G.	Area Circular Mils	Diameter of Solid Wires Mils	Rubber Insulation Amperes	Varnished Cambric Insulation Amperes	Other Insulations and Bare Conductors Amperes
18	1,624.	40.3	3*		6†	4	41,740.	204.3	70	85	90
16	2,583.	50.8	6*		10†	3	52,630.	229.4	80	95	100
14	4,107.	64.1	15	18	20	2	66,370.	257.6	90	110	125
12	6,530.	80.8	20	25	30	1	83,690.	289.3	100	120	150
10	10,380.	101.9	25	30	35	0	105,500.	325.0	125	150	200
8	16,510.	128.5	35	40	50	00	135,100.	364.8	150	180	225
6	26,250.	162.0	50	60	70	000	167,800.	409.6	175	210	275
5	33,100.	181.9	55	65	80	0000	211,600.	460	225	270	325

\* The allowable carrying capacities of No. 18 and 16 are 5 and 7 amperes respectively, when in flexible cords.

† The allowable carrying capacities of No. 18 and 16 are 10 and 15 amperes respectively, when in cords for portable heaters. Types AFS, AFSJ, HC, HPD, and HSJ.

## ALUMINUM WIRE TABLE

Hard-Drawn Aluminum Wire at 20°C (or, 68°F) American Wire Gauge (B. & S.) English Units

Gauge No.	Diameter in mils	Cross section		Ohms per 1000 ft	Pounds per 1000 ft	Pounds per ohm	Feet per ohm	Gauge No.	Diameter in mm	Cross section in mm <sup>2</sup>	Ohms per kilometer	Kilograms per kilometer	Grams per ohm	Meters per ohm
		Circular mils	Square inches											
0000	460	212000	0.166	0.0804	195	2420	12400	0000	11.7	107	.0264	289	1100000	3790
000	410	168000	.132	.101	154	1520	9860	000	10.4	85.0	.333	230	690000	3010
00	365	133000	.105	.128	122	957	7820	00	9.3	67.4	.419	182	434000	2380
0	325	106000	.0829	.161	97.0	602	6200	0	8.3	53.5	.529	144	273000	1890
1	289	83700	.0657	.203	76.9	379	4920	1	7.3	42.4	.667	114.	172000	1500
2	258	66400	.0521	.256	61.0	238	3900	2	6.5	33.6	.841	90.8	108000	1190
3	229	52600	.0413	.323	48.4	150	3090	3	5.8	26.7	1.06	72.0	67900	943
4	204	41700	.0328	.408	38.4	94.2	2450	4	5.2	21.2	1.34	57.1	42700	748
5	182	33100	.0260	.514	30.4	59.2	1950	5	4.6	16.8	1.69	45.3	26900	593
6	162	26300	.0206	.648	24.1	37.2	1540	6	4.1	13.3	2.13	35.9	16900	470
7	144	20800	.0164	.817	19.1	23.4	1220	7	3.7	10.5	2.68	28.5	10600	373
8	128	16500	.0130	1.03	15.2	14.7	970	8	3.3	8.37	3.38	22.6	6680	296
9	114	13100	.0103	1.30	12.0	9.26	770	9	2.91	6.63	4.26	17.9	4200	235
10	102	10400	.00815	1.64	9.55	5.83	610	10	2.59	5.26	5.38	14.2	2640	186
11	91	8230	.00647	2.07	7.57	3.66	484	11	2.30	4.17	6.78	11.3	1660	148
12	81	6530	.00513	2.61	6.00	2.30	384	12	2.05	3.31	8.55	8.93	1050	117
13	72	5180	.00407	3.29	4.76	1.45	304	13	1.83	2.62	10.8	7.08	657	92.8
14	64	4110	.00323	4.14	3.78	0.911	241	14	1.63	2.08	13.6	5.62	413	73.6
15	57	3260	.00256	5.22	2.99	.573	191	15	1.45	1.65	17.1	4.46	260	58.4
16	51	2580	.00203	6.59	2.37	.360	152	16	1.29	1.31	21.6	3.53	164	46.3
17	45	2050	.00161	8.31	1.88	.227	120	17	1.15	1.04	27.3	2.80	103	36.7
18	40	1620	.00128	10.5	1.49	.143	95.5	18	1.02	0.823	34.4	2.22	64.7	29.1
19	36	1290	.00101	13.2	1.18	.0897	75.7	19	0.91	.653	43.3	1.76	40.7	23.1
20	32	1020	.000802	16.7	0.939	.0564	60.0	20	.81	.518	54.6	1.40	25.6	18.3
21	28.5	810	.000636	21.0	.745	.0355	47.6	21	.72	.411	68.9	1.11	16.1	14.5
22	25.3	642	.000505	26.5	.591	.0223	37.8	22	.64	.326	86.9	0.879	10.1	11.5
23	22.6	509	.000400	33.4	.468	.0140	29.9	23	.57	.258	110	.697	6.36	9.13
24	20.1	404	.000317	42.1	.371	.00882	23.7	24	.51	.205	138	.553	4.00	7.24
25	17.9	320	.000252	53.1	.295	.00555	18.8	25	.45	.162	174	.438	2.52	5.74
26	15.9	254	.000200	67.0	.234	.00349	14.9	26	.40	.129	220	.348	1.58	4.55
27	14.2	202	.000158	84.4	.185	.00219	11.8	27	.36	.102	277	.276	0.995	3.61
28	12.6	160	.000126	106.	.147	.00138	9.39	28	.32	.0810	349	.219	.626	2.86
29	11.3	127	.0000995	134.	.117	.000868	7.45	29	.29	.0642	440	.173	.394	2.27
30	10.0	101	.0000789	169.	.0924	.000546	5.91	30	.25	.0509	555	.138	.248	1.80
31	8.9	79.7	.0000626	213.	.0733	.000343	4.68	31	.227	.0404	700	.109	.156	1.43
32	8.0	63.2	.0000496	269.	.0581	.000216	3.72	32	.202	.0320	883	.0865	.0979	1.13
33	7.1	50.1	.0000394	339.	.0461	.000136	2.95	33	.180	.0254	1110	.0686	.0616	0.899
34	6.3	39.8	.0000312	428.	.0365	.0000854	2.34	34	.160	.0201	1400	.0544	.0387	.712
35	5.6	31.5	.0000248	540.	.0290	.0000537	1.85	35	.143	.0160	1770	.0431	.0244	.565
36	5.0	25.0	.0000196	681.	.0230	.0000338	1.47	36	.127	.0127	2230	.0342	.0153	.448
37	4.5	19.8	.0000156	858.	.0182	.0000212	1.17	37	.113	.0100	2820	.0271	.00963	.355
38	4.0	15.7	.0000123	1080.	.0145	.0000134	0.924	38	.101	.0080	3550	.0215	.00606	.282
39	3.5	12.5	.00000979	1360.	.0115	.00000840	.733	39	.090	.0063	4480	.0171	.00381	.223
40	3.1	9.9	.0000077	1720.	.0091	.00000528	.581	40	.080	.0050	5640	.0135	.00240	.177



**BRAZING FILLER METALS (SOLDERS)**

AWS-ASTM Classification	Solidus, °F	Liquidus, °F	Braze Temperature Range, °F	Ag	Al	As	Au	B	Be	Bi	C	Cd	Cr	Cu	Fe	Li	Mg	Mn	Ni	P	Pb	Sb	Si	Sn	Ti	Zn	Other		AWS-ASTM Classification
																											Each	Total	
<b>ALUMINUM-SILICON</b>																													
BAISI-2	1070	1135	1110-1150		Bal.									0.25	0.8			0.10				6.8-8.2				0.20	0.05	0.15	BAISI-2
BAISI-3	970	1085	1060-1120		Bal.								0.15	3.3-4.7	0.8		0.15	0.15				9.3-10.7				0.20	0.05	0.15	BAISI-3
BAISI-4	1070	1080	1080-1120		Bal.									0.30	0.8		0.10	0.15				11.0-13.0				0.20	0.05	0.15	BAISI-4
BAISI-5	1070	1095	1090-1120		Bal.									0.30	0.8		0.05	0.05				9.0-11.0		0.20	0.10	0.05	0.15	BAISI-5	
<b>COPPER-PHOSPHORUS</b>																													
BCuP-1	1310	1650	1450-1700											Bal.							4.75-5.25							0.15	BCuP-1
BCuP-2	1310	1460	1350-1550											Bal.							7.00-7.25							0.15	BCuP-2
BCuP-3	1190	1485	1300-1500	4.75-5.25										Bal.							5.75-6.25							0.15	BCuP-3
BCuP-4	1190	1335	1300-1450	5.75-6.25										Bal.							7.00-7.50							0.15	BCuP-4
BCuP-5	1190	1475	1300-1500	14.50-15.50										Bal.							4.75-5.25							0.15	BCuP-5
<b>SILVER</b>																													
BAG-1	1125	1145	1145-1400	44-46								23-25		14-16											14-18			0.15	BAG-1
BAG-1a	1160	1175	1175-1400	49-51								17-19		14.5-16.5											14.5-18.5			0.15	BAG-1a
BAG-2	1125	1295	1295-1550	34-36								17-19		25-27											23			0.15	BAG-2
BAG-3	1170	1270	1270-1500	49-51								15-17		14.5-16.5				2.5-3.5						13.5-17.5				0.15	BAG-3
BAG-4	1240	1435	1435-1650	39-41								17		29-31				2.5						26-30				0.15	BAG-4
BAG-5	1250	1370	1370-1550	44-46										29-31										23-27				0.15	BAG-5
BAG-6	1270	1425	1425-1600	49-51										33-35										14-18				0.15	BAG-6
BAG-7	1145	1205	1205-1400	55-57										21-23									4.5-5.5	15-19				0.15	BAG-7
BAG-8	1435	1435	1435-1650	71-73										Bal.														0.15	BAG-8
BAG-8a	1410	1410	1410-1600	71-73										Bal.	0.15-0.3													0.15	BAG-8a
BAG-13	1325	1575	1575-1775	53-55										Bal.											4.0-6.0			0.15	BAG-13
BAG-18	1115	1125	1325-1550	59-61										Bal.						0.025				9.5-10.5				0.15	BAG-18
BAG-19	1435	1635	1610-1800	92-93										Bal.	0.15-0.3													0.15	BAG-19
<b>PRECIOUS METALS</b>																													
BAu-1	1815	1860	1860-2000			37.0+1-0								Bal.														0.15	BAu-1
BAu-2	1635	1635	1635-1850			79.5+1-0								Bal.														0.15	BAu-2
BAu-3	1785	1885	1885-1995			34.5+1-0								Bal.				2.5-3.5										0.15	BAu-3
BAu-4	1740	1740	1740-1840			81.5+1-0								Bal.				Bal.										0.15	BAu-4
<b>COPPER AND COPPER-ZINC</b>																													
BCu-1	1980	1980	2000-2100		0.01									99.90 min.						0.075	0.02							0.10	BCu-1
BCu-1a	1980	1980	2000-2100											99.0 min.														0.30*	BCu-1a
BCu-2	1980	1980	2000-2100											86.5 min.														0.50*	BCu-2 <sup>b</sup>
RBCuZn-A	1630	1650	1670-1750		0.01*									57-61	*						0.05*	*	0.25-1.00		Bal.			0.50 <sup>d</sup>	RBCuZn-A*
RBCuZn-D	1690	1715	1720-1800		0.01*									46-50				9.0-11.0	0.25	0.05*		0.04-0.25		Bal.				0.50 <sup>d</sup>	RBCuZn-D*
<b>MAGNESIUM</b>																													
BMg-1	830	1110	1120-1160		8.3-9.7				0.0002-0.0008					0.05	0.005		Bal.	0.15 min.	0.005			0.05		1.7-2.3			0.30	BMg-1	
BMg-2	770	1050	1080-1130		11.0-13.0												Bal.						4.5-5.5				0.30	BMg-2	
BMg-2a	770	1050	1080-1130		11.0-13.0				0.0002-0.0008								Bal.						4.5-5.5				0.30	BMg-2a	

\* Total other elements requirement pertains only to the metallic elements for this filler metal.

<sup>b</sup> These chemical requirements pertain only to the copper oxide and do not include requirements for the organic vehicle in which the copper oxide is suspended.

<sup>c</sup> Total other elements requirement pertains only to metallic elements for this filler metal. The following limitations are placed on the nonmetallic elements:

Constituent	per cent (max)
Chlorides	0.4
Sulfates	0.1
Oxygen	remainder
Nitric acid insoluble	0.3
Acetic acid soluble matter	0.5

<sup>d</sup> Total other elements, including the elements marked with an asterisk (\*), shall not exceed the value specified.

\* This AWS-ASTM classification is intended to be identical with the same classification that appears in the Specification for Copper and Copper-Alloy Welding Rods (AWS Designation A5.7; ASTM Designation B 259).<sup>3</sup>



**BRAZING FILLER METALS (SOLDERS) (Continued)**

AWS-ASTM Classification	Solidus, °F	Liquidus, °F	Brazing Temperature Range, °F	Ag	Al	As	Au	B	Be	Bi	C	Cd	Cr	Cu	Fe	Li	Mg	Mn	Ni	P	Pb	Sb	Si	Sn	Ti	Zn	Other		AWS-ASTM Classification		
																											Each	Total			
<b>NICKEL</b>																															
BNi-1	1790	1900	1950-2200					2.75-4.00		0.6-0.9			13.0-15.0	4.0-5.0						Bal.								0.50		BNi-1	
BNi-2	1780	1830	1850-2150					2.75-3.5		0.15			6.0-8.0	2.0-4.0						Bal.								0.50		BNi-2	
BNi-3	1800	1900	1850-2150					2.75-3.5		0.06				1.5						Bal.								0.50		BNi-3	
BNi-4	1800	1950	1850-2150					1.0-2.2		0.06				1.5						Bal.								0.50		BNi-4	
BNi-5	1975	2075	2100-2200							0.15			18.0-20.0							Bal.								0.50		BNi-5	
BNi-6	1610	1610	1700-1875							0.15										Bal.	10.0-12.0							0.50		BNi-6	
BNi-7	1630	1630	1700-1900										11.0-15.0							Bal.	9.0-11.0							0.50		BNi-7	
<b>SOLDERS—ASTM DESIGNATION B-32-60T, REVISED 1966</b>																															
70A	361	378			0.005	0.03				0.25				0.08	0.02						30				70		0.005			70A	
70B					max	max				max				max	max						30	0.2-0.5			70		max			70B	
63A	361	361			0.005	0.03				0.25				0.08	0.02						37	0.12			63		max			63A	
63B					max	max				max				max	max						37	max			63		max			63B	
60A	361	374			0.005	0.03				0.25				0.08	0.02						40	0.12			60		max			60A	
60B					max	max				max				max	max						40	max			60		max			60B	
50A	361	421			0.005	0.03				0.25				0.08	0.02						50	0.12			50		max			50A	
50B	360	420			max	max				max				max	max						50	max			50		max			50B	
45A	361	441			0.005	0.03				0.25				0.08	0.02						55	0.12			45		max			45A	
45B					max	max				max				max	max						55	max			45		max			45B	
40A	361	460			0.005	0.03				0.25				0.08	0.02						60	0.12			40		max			40A	
40B	360	460			max	max				max				max	max						60	max			40		max			40B	
40C	365	448			0.005	0.03				0.25				0.08	0.02						58	1.8-2.4			40		max			40C	
35A	361	477			0.005	0.03				0.25				0.08	0.02						65	0.25			35		max			35A	
35B					max	max				max				max	max						65	max			35		max			35B	
35C	365	470			0.005	0.03				0.25				0.08	0.02						63.2	0.5			35		max			35C	
30A	361	491			max	max				max				max	max						70	1.6-2.0			30		max			30A	
30B					0.005	0.03				0.25				0.08	0.02							70	0.2-0.5			30		max			30B
30C	364	482			max	max				max				max	max						68.4	1.4-1.8			30		max			30C	
25A	361	511			0.005	0.03				0.25				0.08	0.02						75	0.25			25		max			25A	
25B	360	510			max	max				max				max	max						75	max			25		max			25B	
25C					0.005	0.03				0.25				0.08	0.02						73.7	0.5			25		max			25C	
20B	361	531			max	max				max				max	max						80	1.1-1.5			20		max			20B	
20C	363	517			0.005	0.03				0.25				0.08	0.02						79	0.8-1.2			20		max			20C	
15B	440	550			max	max				max				max	max						85	0.2-0.5			15		max			15B	
10B					0.005	0.03				0.25				0.08	0.02						90	0.2-0.5			10		max			10B	
5A	518	594			max	max				max				max	max						95	0.12		5*			max			5A	
5B					0.005	0.03				max				max	max						95	max		5*			max			5B	
2A					max	max				max				max	max						98	0.5		2**			max			2A	
2B					0.005	0.03				max				max	max						98	0.12		2**			max			2B	
2.5S	579	579			max	max				max				max	max						97.5	0.2-0.5		0***			max			2.5S	
1.5S	588	588		2.3-2.7	0.005	0.03				max				max	max						97.5	0.4		1****			max			1.5S	
95TA	452	464		1.3-1.7	max	max				max				max	max						0.2	4.5-5.5			95		max			95TA	
96.5TS				3.3-3.7	0.005	0.03				max				max	max						0.2	0.2-0.5			96.5		max			96.5TS	

\* Permissible tin range, 4.5-5.5%.  
 \*\* Permissible tin range, 1.5-2.5%.  
 \*\*\* Tin maximum, 0.25%.  
 \*\*\*\* Permissible tin range, 0.75-1.25%.

### CHEMICAL COMPOSITION OF ROCKS

Reprinted from "Sedimentary Rocks" (1948) with the permission of F. J. Pettijohn, author, and Harper Brothers, publishers.

Element	Average igneous rock	Average shale	Average sandstone	Average limestone	Average sediment
SiO <sub>2</sub>	59.14	58.10	78.33	5.19	57.95
TiO <sub>2</sub>	1.05	0.65	0.25	0.06	0.57
Al <sub>2</sub> O <sub>3</sub>	15.34	15.40	4.77	0.81	13.39
Fe <sub>2</sub> O <sub>3</sub>	3.08	4.02	1.07	0.54	3.47
FeO	3.80	2.45	0.30		2.08
MgO	3.49	2.44	1.16	7.89	2.65
CaO	5.08	3.11	5.50	42.57	5.89
Na <sub>2</sub> O	3.84	1.30	0.45	0.05	1.13
K <sub>2</sub> O	3.13	3.24	1.31	0.33	2.86
H <sub>2</sub> O	1.15	5.00	1.63	0.77	3.23
P <sub>2</sub> O <sub>5</sub>	0.30	0.17	0.08	0.04	0.13
CO <sub>2</sub>	0.10	2.63	5.03	41.54	5.38
SO <sub>3</sub>		0.64	0.07	0.05	0.54
BaO	0.06	0.05	0.05		
C		0.80			0.66
	99.56	100.00	100.00	99.84	99.93

**UNDERWRITERS' LABORATORIES' CLASSIFICATION OF COMPARATIVE  
LIFEHAZARD OF GASES AND VAPORS  
(Group number definition)**

Group	Definition	Examples
1	Gases or vapors which in concentrations of the order of 1/2 to 1% for durations of exposure of the order of 5 min are lethal or produce serious injury.	Sulfur dioxide
2	Gases or vapors which in concentrations of the order of 1/2 to 1% for duration of exposure of the order of 1/2 h are lethal or produce serious injury	Ammonia, methyl bromide
3	Gases or vapors which in concentrations of the order of 2 to 2 1/2% for durations of exposure of the order of 1 hr are lethal or produce serious injury.	Bromochloromethane carbon tetrachloride, chloroform, methyl formate
4	Gases or vapors which in concentrations of the order of 2 to 2 1/2% for durations of exposure of the order of 2 h are lethal or produce serious injury	Dichloroethylene methyl chloride, ethylbromide
Between 4 and 5	Appear to classify as somewhat less toxic than Group 4.	Methylene chloride, ethyl chloride.
	Much less toxic than group 4 but somewhat more toxic than Group 5.	Refrigerant 112 <sup>a</sup> Refrigerant 113 Refrigerant 21
5a	Gases or vapors much less toxic than Group 4 but more toxic than Group 6.	Refrigerant 11 Refrigerant 22 Refrigerant 114B2 Refrigerant 502 Carbon dioxide
5b	Gases or vapors which available data indicate would classify as either Group 5a or Group 6.	Ethane, propane, butane
6	Gases or vapors which in concentrations up to at least about 20% by volume for duration of exposure of the order of 2 h do not appear to produce injury.	Refrigerant 13B1 Refrigerant 12 Refrigerant 114 Refrigerant 115 Refrigerant 13 <sup>a</sup> Refrigerant 14 <sup>a</sup> Refrigerant 23 <sup>a</sup> Refrigerant 116 <sup>a</sup> Refrigerant C318 <sup>a</sup>

<sup>a</sup> Not tested by U.L. but estimated to belong in group indicated.

## CONSTANTS FOR SATELLITE GEODESY

### Defining Constants

1. Number of ephemeris seconds in 1 tropical year (1900) .....  $s = 31\,556\,925.9747$
2. Gaussian gravitational constant, defining the a. u. ....  $k = 0.017\,202\,09895$

### Primary Constants

3. Velocity of light in meters per second (in vacuum) .....  $c = 2.99792458(1.2) \times 10^8$
4. Dynamical form-factor for Earth .....  $J_2 = 0.001\,082\,7$
5. Sidereal mean motion of Moon in radians per second (1900) .....  $n_{\zeta}^* = 2.661\,699\,489 \times 10^{-6}$
6. General precession in longitude per tropical century (1900) .....  $p = 5025''.64$
7. Constant of nutation (1900) .....  $N = 9''.210$

### Auxiliary Constants and Factors

- $k/86400$ , for use when the unit of time is 1 second .....  $k' = 1.990\,983\,675 \times 10^{-7}$
- Number of seconds of arc in 1 radian ..... = 206 264.806
- Factor for constant of aberration (note 10) .....  $F_1 = 1.000\,142$
- Factor for mean distance of Moon (note 12) .....  $F_2 = 0.999\,093\,142$
- Factor for parallactic inequality (note 15) .....  $F_3 = 49853''.2$

### Derived Constants

8. Solar parallax .....  $\arcsin(\alpha_s/A) = \pi_s = 8''.79405 (8''.794)$
9. Light-time for unit distance .....  $A/c' = \tau_A = 499.012$   
 $= 1^s/0.002\,003\,96$
10. Constant of aberration .....  $F_1 k' \tau_A = \kappa = 20''.4958 (20''.496)$
11. Ratio of masses of Sun to (Earth + Moon) .....  $S/E(1 + \mu) = 328\,912$
12. Perturbed mean distance of Moon, in meters .....  $F_2(GE(1 + \mu)/n_{\zeta}^{*2})^3 = \alpha_{\zeta} = 384\,400 \times 10^3$
13. Constant of sine parallax for Moon .....  $\alpha_{\zeta}/\alpha_{\zeta} = \sin \pi_{\zeta} = 3422''.451$
14. Constant of lunar inequality .....  $\frac{\mu}{1 + \mu} \frac{\alpha_{\zeta}}{A} = L = 6''.43987 (6''.440)$
15. Constant of parallactic inequality .....  $F_3 \frac{1 - \mu}{1 + \mu} \frac{\alpha_{\zeta}}{A} = P_{\zeta} = 124''.986$

## CROSS-SECTION AND MASS OF WIRES

### U. S. Measure

Diameters are given in mils (1 mil = .001 in), and area in square mils (1 sq mil = .00001 sq in). For sections and masses for one-tenth the diameters given, divide by 100 and for sections and masses for ten times the diameter multiply by 100.

Pounds per foot						Pounds per foot					
Diam. in mils	Cross-sec. in sq mils	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67	Diam. in mils	Cross-sec. in sq mils	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67
10	78.54	0.000303	0.0002656	0.0002915	0.0000909	40	1256.64	0.004849	0.004249	0.004664	0.001455
11	95.03	0367	03214	03527	01100	41	1320.25	5094	4465	4900	1528
12	113.10	0436	03825	04197	01309	42	1385.44	5346	4685	5141	1604
13	132.73	0512	04488	04926	01536	43	1452.20	5603	4911	5389	1681
14	153.94	0594	05206	05713	01782	44	1520.53	5867	5142	5643	1760
15	176.71	0682	05976	06558	02045	45	1590.43	6137	5378	5902	1841
16	201.06	0776	06799	07461	02327	46	1661.90	6412	5620	6167	1924
17	226.98	0876	07675	08423	02627	47	1734.94	6694	5867	6438	2008
18	254.47	0982	08605	09443	02946	48	1809.56	6982	6119	6715	2095
19	283.53	1094	09588	10522	03282	49	1885.74	7276	6377	6998	2183
20	314.16	1212	1062	1166	03636	50	1963.50	7576	6640	7287	2273
21	346.36	1336	1171	1285	04009	51	2042.82	7882	6908	7581	2365
22	380.13	1467	1286	1411	04400	52	2123.72	8194	7181	7881	2458
23	415.48	1603	1405	1542	04809	53	2206.18	8512	7460	8187	2554
24	452.39	1746	1530	1679	05237	54	2290.22	8837	7744	8499	2651
25	490.87	1894	1660	1822	05682	55	2375.83	9167	8034	8817	2750
26	530.93	2046	1795	1970	06147	56	2463.01	9504	8329	9140	2851
27	572.56	2209	1936	2125	06628	57	2551.76	9846	8629	9470	2954
28	615.75	2376	2082	2285	07127	58	2642.08	10195	8934	9805	3058
29	660.52	2549	2234	2451	07646	59	2733.97	10549	9245	10146	3165
30	706.86	2727	2390	2623	08182	60	2827.43	1091	956	1049	3273
31	754.77	2912	2552	2801	08737	61	2922.47	1128	988	1085	3383
32	804.25	3103	2720	2985	09309	62	3019.07	1165	1021	1120	3495
33	855.30	3300	2892	3174	09900	63	3117.25	1203	1054	1157	3608
34	907.92	3503	3070	3369	10509	64	3216.99	1241	1088	1194	3724
35	962.11	3712	3253	3570	1114	65	3318.31	1280	1122	1231	3841
36	1017.88	3927	3442	3777	1178	66	3421.19	1320	1157	1270	3960
37	1075.21	4149	3636	3990	1245	67	3525.65	1360	1192	1308	4081
38	1134.11	4376	3844	4218	1316	68	3631.68	1401	1228	1348	4204
39	1194.59	4609	4040	4433	1383	69	3739.28	1443	1264	1388	4328



## CROSS-SECTION AND MASS OF WIRES (continued)

### U. S. Measure

Pounds per foot						Pounds per foot					
Diam. in mils	Cross-sec. in sq mils	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67	Diam. in mils	Cross-sec. in sq mils	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67
70	3848.45	0.01485	0.01302	0.01429	0.004456	86	5808.80	0.02241	0.01964	0.02156	0.006724
71	3959.19	1528	1339	1469	4583	87	5944.68	2294	2010	2206	6881
72	4071.50	1571	1377	1511	4713	88	6082.12	2347	2057	2257	7040
73	4185.39	1615	1415	1553	4845	89	6221.14	2400	2104	2309	7201
74	4300.84	1660	1454	1596	4978	90	6361.73	2455	2151	2360	7364
75	4417.86	1705	1494	1639	5114	91	6503.88	2509	2199	2414	7528
76	4536.46	1751	1534	1684	5251	92	6647.61	2565	2248	2467	7695
77	4656.63	1797	1575	1728	5390	93	6792.91	2621	2297	2521	7863
78	4778.36	1844	1616	1773	5531	94	6939.78	2678	2347	2575	8033
79	4901.67	1892	1658	1819	5674	95	7088.22	2735	2397	2630	8205
80	5026.55	1939	1700	1865	5818	96	7238.23	2793	2448	2686	8378
81	5153.00	1988	1743	1912	5965	97	7389.81	2851	2499	2742	8554
82	5281.02	2038	1786	1960	6113	98	7542.96	2910	2551	2799	8731
83	5410.61	2088	1830	2008	6263	99	7697.69	2970	2603	2857	8910
84	5541.77	2138	1874	2057	6415	100	7853.98	3030	2656	2915	9091
85	5674.50	2189	1919	2106	6568						

### Metric Measure

Diameters are given in thousandths of a centimeter and area of section in square thousandths of a centimeter.  $1 \text{ (cm/1000)}^2 = .00001 \text{ sq cm}$ . For sections and masses for diameters 1/10 or 10 times those of the table, divide or multiply by 100.

Grams per meter						Grams per meter					
Diam. in thousandths of a cm	Cross-section in square thousandths of a cm	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67	Diam. in thousandths of a cm	Cross-section in square thousandths of a cm	Copper, density 8.90	Iron, density 7.80	Brass, density 8.56	Aluminum, density 2.67
10	78.54	0.06990	0.06126	0.06723	0.02097	55	235.83	2.114	1.853	2.034	0.6343
11	95.03	.08458	.07412	.08135	.02537	56	2463.01	.192	.921	.108	.6576
12	113.10	.10065	.08822	.09681	.03020	57	2551.76	.271	.990	.184	.6813
13	132.73	.11813	.10353	.11362	.03544	58	2642.08	.351	2.061	.262	.7054
14	153.94	.13701	.12008	.13177	.04110	59	2733.97	.433	.132	.340	.7300
15	176.71	.1573	.1378	.1513	.04718	60	2827.43	2.516	2.205	2.420	.7549
16	201.06	.1789	.1568	.1721	.05368	61	2922.47	.601	.280	.502	.7803
17	226.98	.2020	.1770	.1943	.06060	62	3019.07	.687	.355	.584	.8061
18	254.47	.2265	.1985	.2178	.06794	63	3117.25	.774	.431	.668	.8323
19	283.53	.2523	.2212	.2427	.07570	64	3216.99	.863	.509	.760	.8589
20	314.16	.2796	.2450	.2689	.08388	65	3318.31	2.953	2.588	2.840	.8860
21	346.36	.3083	.2702	.2965	.09248	66	3421.19	3.045	.669	.929	.9135
22	380.13	.3383	.2965	.3254	.10149	67	3525.65	.138	.750	3.018	.9413
23	415.48	.3698	.3241	.3557	.11093	68	3631.68	.232	.833	.109	.9697
24	452.39	.4026	.3529	.3872	.12079	69	3739.28	.328	.917	.201	.9984
25	490.87	.4369	.3829	.4202	.13111	70	3848.45	3.426	3.003	3.295	1.028
26	530.93	.4725	.4141	.4545	.1418	71	3959.19	.524	.088	.389	.057
27	572.56	.5096	.4466	.4901	.1529	72	4071.50	.624	.176	.485	.087
28	615.75	.5480	.4803	.5271	.1644	73	4185.39	.725	.265	.583	.117
29	660.52	.5879	.5152	.5654	.1764	74	4300.84	.828	.355	.682	.148
30	706.86	.6291	.5514	.6051	.1887	75	4417.86	3.932	3.446	3.782	1.180
31	754.77	.6717	.5887	.6461	.2015	76	4536.46	4.037	.538	.883	.211
32	804.25	.7158	.6273	.6884	.2147	77	4656.63	.144	.632	.986	.243
33	855.30	.7612	.6671	.7321	.2284	78	4778.36	.253	.727	4.090	.276
34	907.92	.8081	.7082	.7772	.2424	79	4901.67	.362	.823	.177	.309
35	962.11	.856	.7504	.8236	.2569	80	5026.55	4.474	3.921	4.303	1.342
36	1017.88	.906	.7939	.8713	.2718	81	5153.00	.586	4.019	.411	.376
37	1075.21	.957	.8387	.9204	.2871	82	5281.02	.700	.119	.521	.410
38	1134.11	1.012	.8866	.9730	.3035	83	5410.61	.815	.220	.631	.445
39	1194.59	.063	.9318	1.0230	.3190	84	5541.77	.932	.323	.744	.480
40	1256.64	1.118	.980	1.076	.3355	85	5674.50	5.050	4.426	4.857	1.515
41	1320.25	.175	1.030	.130	.3525	86	5808.80	.170	.531	.972	.551
42	1385.44	.233	.081	.186	.3699	87	5944.68	.291	.637	5.089	.587
43	1452.20	.292	.133	.243	.3877	88	6082.12	.413	.744	.206	.624
44	1520.53	.353	.186	.302	.4060	89	6221.14	.537	.852	.325	.661
45	1590.43	1.415	1.241	1.361	.4246	90	6361.73	5.662	4.962	5.446	1.699
46	1661.90	.479	.296	.423	.4437	91	6503.88	.788	5.073	.567	.737
47	1734.94	.544	.353	.485	.4632	92	6647.61	.916	.185	.690	.775
48	1809.56	.611	.411	.549	.4832	93	6792.91	6.046	.298	.815	.814
49	1885.74	.678	.471	.614	.5035	94	6939.78	.176	.413	.940	.853
50	1963.50	1.748	1.532	1.681	.5243	95	7088.22	6.309	5.529	6.068	1.893
51	2042.82	.818	.593	.753	.5454	96	7238.23	.442	.646	.196	.933
52	2123.72	.890	.657	.818	.5670	97	7389.81	.577	.764	.326	.973
53	2206.18	.964	.721	.888	.5891	98	7542.96	.713	.884	.457	2.014
54	2290.22	2.038	.786	.960	.6115	99	7697.69	.851	6.004	.589	.055
						100	7853.98	6.990	6.126	6.723	2.097

**DENSITY AND COMPOSITION OF  
FUMING SULFURIC ACID**

Actual H <sub>2</sub> SO <sub>4</sub> , %	Spe- cific grav- ity	Equiv. H <sub>2</sub> SO <sub>4</sub> , %	Weight, lb /cu ft	Weight, lb per U.S. gal	Comb. H <sub>2</sub> O, %	Free SO <sub>3</sub> , %	Total SO <sub>3</sub> , %	SO <sub>3</sub> , lb /cu ft
100	1.839	100.00	114.70	15.33	18.37	0	81.63	93.63
99	1.845	100.22	115.07	15.38	18.19	1	81.81	94.14
98	1.851	100.45	115.33	15.41	18.00	2	82.00	94.57
97	1.855	100.67	115.70	15.46	17.82	3	82.18	95.08
96	1.858	100.89	115.88	15.49	17.64	4	82.36	95.44
95	1.862	101.13	116.13	15.52	17.45	5	82.55	95.87
94	1.865	101.35	116.32	15.55	17.27	6	82.73	96.23
93	1.869	101.58	116.57	15.58	17.08	7	82.92	96.66
92	1.873	101.80	116.82	15.61	16.90	8	83.10	97.12
91	1.877	102.02	117.07	15.64	16.72	9	83.28	97.50
90	1.880	102.25	117.26	15.67	16.57	10	83.47	97.88
89	1.884	102.47	117.51	15.70	16.35	11	83.65	98.30
88	1.887	102.71	117.69	15.73	16.17	12	83.83	98.66
87	1.891	102.92	117.94	15.76	15.98	13	84.02	99.09
86	1.895	103.15	118.19	15.79	15.80	14	84.20	99.52
85	1.899	103.38	118.44	15.82	15.61	15	84.39	99.95
84	1.902	103.60	118.63	15.86	15.43	16	84.57	100.33
83	1.905	103.82	118.81	15.89	15.25	17	84.75	100.69
82	1.909	104.05	119.06	15.92	15.06	18	84.94	101.13
81	1.911	104.28	119.28	15.95	14.88	19	85.12	101.45
80	1.915	104.50	119.50	15.98	14.70	20	85.30	101.93
79	1.920	104.73	119.75	16.01	14.51	21	85.49	102.37
78	1.923	104.95	119.94	16.04	14.33	22	85.67	102.75
77	1.927	105.18	120.19	16.07	14.14	23	85.86	103.20
76	1.931	105.40	120.44	16.10	13.96	24	86.04	103.63
75	1.934	105.62	120.62	16.12	13.78	25	86.22	104.00
74	1.939	105.85	120.94	16.16	13.59	26	86.41	104.50
73	1.943	106.08	121.18	16.19	13.41	27	86.59	104.93
72	1.946	106.29	121.37	16.22	13.28	28	86.72	105.31
71	1.949	106.53	121.56	16.25	13.04	29	86.96	105.71
70	1.952	106.75	121.75	16.28	12.86	30	87.14	106.09
69	1.955	106.97	121.93	16.30	12.68	31	87.32	106.47
68	1.958	107.20	122.12	16.33	12.49	32	87.51	106.87
67	1.961	107.42	122.31	16.35	12.31	33	87.69	107.25
66	1.965	107.65	122.56	16.38	12.12	34	87.88	107.71
65	1.968	107.87	122.74	16.40	11.94	35	88.06	108.08
64	1.972	108.10	122.99	16.43	11.76	36	88.24	108.53
63	1.976	108.33	123.24	16.46	11.57	37	88.43	108.98
62	1.979	108.55	123.43	16.50	11.39	38	88.61	109.37
61	1.981	108.77	123.55	16.52	11.21	39	88.79	109.70
60	1.983	109.00	123.74	16.54	11.02	40	88.98	110.10
59	1.985	109.22	123.80	16.55	10.84	41	89.16	110.38
58	1.987	109.45	123.93	16.56	10.65	42	89.35	110.83
57	1.989	109.68	124.05	16.58	10.47	43	89.53	111.06
56	1.991	109.90	124.18	16.60	10.29	44	89.71	111.40
55	1.993	110.13	124.30	16.62	10.10	45	89.90	111.75
50	2.001	111.25	124.80	16.68	9.18	50	90.72	113.34
40	2.102	113.50	131.10	17.53	7.35	60	92.65	121.46
30	1.982	115.75	123.62	16.50	5.51	70	94.49	116.81
20	1.949	118.00	121.56	16.25	3.67	80	96.33	117.10
10	1.911	120.25	119.19	15.92	1.84	90	98.16	117.00
0	1.857	122.50	115.83	15.50	0.00	100	100.00	115.83

\* By permission from the 7th edition of Chemical Plant Control Data, Chemical Construction Corporation (1957).

## DIAMAGNETIC SUSCEPTIBILITY DATA ON ORGANOSILICON COMPOUNDS

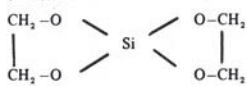
**R. R. Gupta**

The molar susceptibility is represented by  $\chi_M$  and expressed in c.g.s. units. For some of the compounds volume or specific susceptibility is available in the literature and in such cases  $\chi_M$  has been calculated by the relation

$$\chi_M = M\chi = M(\kappa/\rho)$$

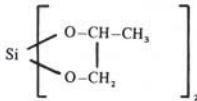
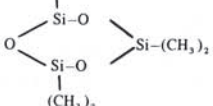
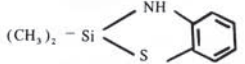
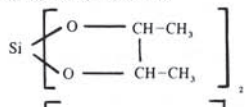
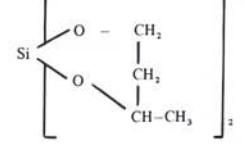
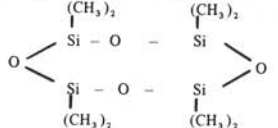
where  $M$  is the molar mass of the substance,  $\chi$  is the specific or mass susceptibility,  $\kappa$  is the volume susceptibility, and  $\rho$  is the density of the substance.

The compounds are arranged in the increasing order of C, H, Si, O, Cl, Br, I, S, and N.

Compound	Molecular formula	Structural formula	$-\chi_M \cdot 10^6$	Ref.
Methyl trichlorosilane	$\text{CH}_3\text{SiCl}_3$	$\text{CH}_3-\text{Si}-\text{Cl}_3$	85.40, 87.45	2, 8
Methyl tribromosilane	$\text{CH}_3\text{SiBr}_3$	$\text{CH}_3-\text{Si}-\text{Br}_3$	126.00, 128.00, 155.50	10, 11, 4
Methyl dichlorosilane	$\text{CH}_3\text{SiCl}_2$	$\text{CH}_3-\text{SiH}-\text{Cl}_2$	66.90	4
Ethyl trichlorosilane	$\text{C}_2\text{H}_5\text{SiCl}_3$	$\text{C}_2\text{H}_5-\text{Si}-\text{Cl}_3$	98.00, 98.84, 96.40	2, 9, 7
Ethyl tribromosilane	$\text{C}_2\text{H}_5\text{SiBr}_3$	$\text{C}_2\text{H}_5-\text{Si}-\text{Br}_3$	147.50	4
Ethyl triiodosilane	$\text{C}_2\text{H}_5\text{SiI}_3$	$\text{C}_2\text{H}_5-\text{Si}-\text{I}_3$	171.50	4
Ethyl dichlorosilane	$\text{C}_2\text{H}_5\text{SiCl}_2$	$\text{C}_2\text{H}_5-\text{SiH}-\text{Cl}_2$	78.90	4
Dimethyl dichlorosilane	$\text{C}_2\text{H}_6\text{SiCl}_2$	$(\text{CH}_3)_2-\text{Si}-\text{Cl}_2$	81.30, 82.45	4, 8
Dimethyl diiodosilane	$\text{C}_2\text{H}_6\text{SiI}_2$	$(\text{CH}_3)_2-\text{Si}-\text{I}_2$	131.80	4
Dimethyl silanediol	$\text{C}_2\text{H}_6\text{SiO}_2$	$(\text{CH}_3)_2-\text{Si}-(\text{OH})_2$	58.40	17, 18
<i>n</i> -Propyl trichlorosilane	$\text{C}_3\text{H}_7\text{SiCl}_3$	$\text{CH}_3-(\text{CH}_2)_2-\text{Si}-\text{Cl}_3$	108.00, 110.20	4, 8
Trimethyl chlorosilane	$\text{C}_3\text{H}_9\text{SiCl}$	$(\text{CH}_3)_3-\text{SiCl}$	79.00, 73.76	4, 8
Trimethyl bromosilane	$\text{C}_3\text{H}_9\text{SiBr}$	$(\text{CH}_3)_3-\text{Si}-\text{Br}$	91.30	4
Trimethyl iodosilane	$\text{C}_3\text{H}_9\text{SiI}$	$(\text{CH}_3)_3-\text{Si}-\text{I}$	104.10	4
1,4,6,9-Tetraoxa-5-silaspiro[4,4]nonane	$\text{C}_4\text{H}_8\text{SiO}_4$		80.94	5
Diethyl dichlorosilane	$\text{C}_4\text{H}_{10}\text{SiCl}_2$	$(\text{C}_2\text{H}_5)_2-\text{SiCl}_2$	105.80	8
Tetramethylsilane	$\text{C}_4\text{H}_{10}\text{Si}$	$\text{Si}-(\text{CH}_3)_4$	74.80	1
Trimethyl methoxysilane	$\text{C}_4\text{H}_{10}\text{SiO}$	$(\text{CH}_3)_3-\text{Si}-\text{OCH}_3$	78.80	1
Dimethyl dimethoxysilane	$\text{C}_4\text{H}_{12}\text{SiO}_2$	$(\text{CH}_3)_2-\text{Si}-(\text{OCH}_3)_2$	81.70, 81.60, 81.95	1, 17, 5
Diethyl silanediol	$\text{C}_4\text{H}_{12}\text{SiO}_2$	$(\text{C}_2\text{H}_5)_2-\text{Si}-(\text{OH})_2$	81.00	17, 18



DIAMAGNETIC SUSCEPTIBILITY DATA ON ORGANOSILICON COMPOUNDS (continued)

Compound	Molecular formula	Structural formula	$-\chi_M \cdot 10^6$	Ref.
Methyl trimethoxysilane	C <sub>4</sub> H <sub>10</sub> SiO <sub>3</sub>	CH <sub>3</sub> -Si-(OCH <sub>3</sub> ) <sub>2</sub>	85.6	17
Tetramethoxysilane	C <sub>4</sub> H <sub>10</sub> SiO <sub>4</sub>	Si-(OCH <sub>3</sub> ) <sub>4</sub>	83.68	5
Trimethylacetoxysilane	C <sub>6</sub> H <sub>14</sub> SiO <sub>2</sub>	(CH <sub>3</sub> ) <sub>3</sub> -Si-OCOCH <sub>3</sub>	85.00, 86.09	16, 5
Trimethylsilylchloromethylamidoxime	C <sub>4</sub> H <sub>13</sub> SiOClN <sub>2</sub>	NH <sub>2</sub> -C-(CH <sub>2</sub> Cl)=N-O-Si-(CH <sub>3</sub> ) <sub>3</sub>	109.60	15
Trimethylethylsilane	C <sub>6</sub> H <sub>14</sub> Si	C <sub>2</sub> H <sub>5</sub> -Si-(CH <sub>3</sub> ) <sub>3</sub>	86.00	2
Trimethylethoxysilane	C <sub>6</sub> H <sub>14</sub> SiO	(CH <sub>3</sub> ) <sub>3</sub> -Si-OC <sub>2</sub> H <sub>5</sub>	89.50	1, 17
Phenyl trichlorosilane	C <sub>6</sub> H <sub>5</sub> SiCl <sub>3</sub>	C <sub>6</sub> H <sub>5</sub> -Si-Cl <sub>3</sub>	120.4	8
Dimethyl diacetoxysilane	C <sub>8</sub> H <sub>18</sub> SiO <sub>4</sub>	(CH <sub>3</sub> ) <sub>2</sub> -Si-(OCOCH <sub>3</sub> ) <sub>2</sub>	98.3, 101.18	16, 5
1,4,6,9-Tetraoxa-2,7-dimethyl-5-silaspiro[4,4]nonane	C <sub>6</sub> H <sub>12</sub> SiO <sub>4</sub>		104.34	5
Trimethylpropionoxysilane	C <sub>8</sub> H <sub>18</sub> SiO <sub>2</sub>	(CH <sub>3</sub> ) <sub>3</sub> -Si-O-COC <sub>2</sub> H <sub>5</sub>	99.09	5
Dimethyldiethylsilane	C <sub>8</sub> H <sub>18</sub> Si	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> -Si-(CH <sub>3</sub> ) <sub>2</sub>	97.90	1
Triethylsilane	C <sub>6</sub> H <sub>14</sub> Si	(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> -Si-H	95.00	3
Trimethylpropoxysilane	C <sub>8</sub> H <sub>18</sub> SiO	(CH <sub>3</sub> ) <sub>3</sub> -Si-O-(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub>	101.1	1
Trimethylsilylethylamidoxime	C <sub>6</sub> H <sub>14</sub> SiON <sub>2</sub>	(NH <sub>2</sub> )-C(C <sub>2</sub> H <sub>5</sub> )=N-O-Si(CH <sub>3</sub> ) <sub>3</sub>	101.00	15
Dimethyldiethoxysilane	C <sub>8</sub> H <sub>18</sub> SiO <sub>2</sub>	(CH <sub>3</sub> ) <sub>2</sub> -Si-(OC <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	103.60, 104.70, 104.1, 104.6	1, 18, 5, 8
Trimethylthio- <i>n</i> -propylsilane	C <sub>8</sub> H <sub>18</sub> SiS	(CH <sub>3</sub> ) <sub>3</sub> -Si-S-(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub>	114.09	12
Trimethylthio- <i>isopropyl</i> silane	C <sub>8</sub> H <sub>18</sub> SiS	(CH <sub>3</sub> ) <sub>3</sub> -Si-S-(CH <sub>3</sub> ) <sub>2</sub>	115.11	12
Hexamethylsiloxane	C <sub>6</sub> H <sub>14</sub> Si <sub>2</sub> O	(CH <sub>3</sub> ) <sub>6</sub> -Si-O-Si-(CH <sub>3</sub> ) <sub>6</sub>	118.9	8
Hexamethylcyclotrisiloxane	C <sub>6</sub> H <sub>12</sub> Si <sub>3</sub> O <sub>3</sub>		140.5	8
Methyltriacetoxysilane	C <sub>8</sub> H <sub>16</sub> SiO <sub>4</sub>	(CH <sub>3</sub> ) <sub>3</sub> -Si-(OCOCH <sub>3</sub> ) <sub>3</sub>	112.50	5
Triethylmethylsilane	C <sub>8</sub> H <sub>18</sub> Si	(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> -Si-CH <sub>3</sub>	109.30	2
Trimethylbutylsilane	C <sub>8</sub> H <sub>18</sub> Si	(CH <sub>3</sub> ) <sub>3</sub> -Si-(CH <sub>2</sub> ) <sub>3</sub> -CH <sub>3</sub>	109.00	2
Trimethylbutoxysilane	C <sub>8</sub> H <sub>18</sub> SiO	(CH <sub>3</sub> ) <sub>3</sub> -Si-O-(CH <sub>2</sub> ) <sub>3</sub> -CH <sub>3</sub>	114.2	5
Trimethylsilyl- <i>n</i> -propylamidoxime	C <sub>6</sub> H <sub>14</sub> SiON <sub>2</sub>	NH <sub>2</sub> -C-(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub> =N-O-Si-(CH <sub>3</sub> ) <sub>3</sub>	123.8	15
Methyltriethoxysilane	C <sub>8</sub> H <sub>18</sub> SiO <sub>3</sub>	CH <sub>3</sub> -Si-(OC <sub>2</sub> H <sub>5</sub> ) <sub>3</sub>	120.3	17
Trimethylthio- <i>n</i> -butylsilane	C <sub>10</sub> H <sub>20</sub> SiS	(CH <sub>3</sub> ) <sub>3</sub> -Si-S-(CH <sub>2</sub> ) <sub>3</sub> -CH <sub>3</sub>	125.73	12
Trimethylthio- <i>tert</i> -butylsilane	C <sub>10</sub> H <sub>20</sub> SiS	(CH <sub>3</sub> ) <sub>3</sub> -Si-S-C(CH <sub>3</sub> ) <sub>3</sub>	126.55	12
Trimethyl- <i>N</i> -dimethylsilane	C <sub>8</sub> H <sub>18</sub> SiN	(CH <sub>3</sub> ) <sub>3</sub> -Si-N-(CH <sub>3</sub> ) <sub>2</sub>	91.3	1
2,2-Dimethyl-2-sila-2,3-dihydrobenzothiazole	C <sub>8</sub> H <sub>11</sub> SiN		144.44	12
Tetraacetoxysilane	C <sub>8</sub> H <sub>16</sub> SiO <sub>4</sub>	Si-(OCOCH <sub>3</sub> ) <sub>4</sub>	129.26	5
Dimethyldipropionoxysilane	C <sub>10</sub> H <sub>20</sub> SiO <sub>2</sub>	(CH <sub>3</sub> ) <sub>2</sub> -Si-(OCOC <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	122.0, 123.97	16, 5
1,4,6,9-Tetraoxa-2,3,7,8-tetramethyl-5-silaspiro[4,4]nonane	C <sub>10</sub> H <sub>18</sub> SiO <sub>4</sub>		127.12	5
1,5,7,11-Tetraoxa-2,8-dimethyl-6-silaspiro[5,5]undecane	C <sub>14</sub> H <sub>26</sub> SiO <sub>4</sub>		126.34	5
Dimethyldi- <i>n</i> -propylsilane	C <sub>10</sub> H <sub>22</sub> OSi	(CH <sub>3</sub> ) <sub>2</sub> -Si-[(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub> ] <sub>2</sub>	121.70	1
Tetraethylsilane	C <sub>8</sub> H <sub>18</sub> OSi	Si-(C <sub>2</sub> H <sub>5</sub> ) <sub>4</sub>	120.30, 120.40, 117.00	1, 4, 5
Dimethyl-di- <i>n</i> -propoxysilane	C <sub>10</sub> H <sub>20</sub> OSiO <sub>2</sub>	(CH <sub>3</sub> ) <sub>2</sub> -Si-[O(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub> ] <sub>2</sub>	125.70, 126.90	1, 5
Tetraethoxysilane	C <sub>8</sub> H <sub>18</sub> OSiO <sub>4</sub>	Si-(OC <sub>2</sub> H <sub>5</sub> ) <sub>4</sub>	83.68, 134.50	5, 17
Bis-(trimethylsilyl)-methylamidoxime	C <sub>12</sub> H <sub>22</sub> SiO <sub>2</sub> N <sub>2</sub>	(CH <sub>3</sub> ) <sub>3</sub> -Si-NH-C(CH <sub>3</sub> )=N-O-Si-(CH <sub>3</sub> ) <sub>3</sub>	156.60	15
Octamethyltrisiloxane	C <sub>12</sub> H <sub>24</sub> Si <sub>3</sub> O <sub>2</sub>	(CH <sub>3</sub> ) <sub>6</sub> -Si-O-Si-O-Si(CH <sub>3</sub> ) <sub>2</sub> (CH <sub>3</sub> ) <sub>2</sub>	165.00	16
Octamethyltetraacyclosiloxane	C <sub>12</sub> H <sub>24</sub> Si <sub>4</sub> O <sub>2</sub>		188.00	5
Tri- <i>n</i> -propylsilane	C <sub>12</sub> H <sub>26</sub> Si	CH <sub>3</sub> -(CH <sub>2</sub> ) <sub>2</sub> -Si-H	130.00	3
Trimethyl- <i>N</i> -( <i>n</i> -propyl)silane	C <sub>12</sub> H <sub>26</sub> SiN	(CH <sub>3</sub> ) <sub>3</sub> -Si-N-[(CH <sub>2</sub> ) <sub>2</sub> -CH <sub>3</sub> ] <sub>2</sub>	113.4	1
Bis(trimethyl)-ethylamidoxime	C <sub>10</sub> H <sub>18</sub> SiON <sub>2</sub>	(CH <sub>3</sub> ) <sub>3</sub> -Si-NH-C(C <sub>2</sub> H <sub>5</sub> )=N-O-Si(CH <sub>3</sub> ) <sub>3</sub>	168.00	15
Bis(trimethyl)-phenylamidoxime	C <sub>10</sub> H <sub>16</sub> SiON <sub>2</sub>	NH <sub>2</sub> -C-(C <sub>6</sub> H <sub>5</sub> )=N-O-Si(CH <sub>3</sub> ) <sub>3</sub>	141.7	15

DIAMAGNETIC SUSCEPTIBILITY DATA ON ORGANOSILICON COMPOUNDS (continued)

Compound	Molecular formula	Structural formula	$-\chi_M \cdot 10^6$	Ref.
2,2-Diacetoxy-4,4,6,6-tetramethyl-1,3-dioxane-2-sila-cyclohexane	$C_{10}H_{20}SiO_4$		150.65	5
Dimethyl di- <i>n</i> -butylsilane	$C_{10}H_{24}Si$	$(CH_3)_2-Si-[(CH_2)_4-CH_3]_2$	145.80	1
Methyl tri- <i>n</i> -butylsilane	$C_{10}H_{24}Si$	$CH_3-Si-[(CH_2)_4-CH_3]_3$	143.90	1
Dimethyl di- <i>n</i> -butoxysilane	$C_{10}H_{24}SiO_2$	$(CH_3)_2-Si-[O(CH_2)_4CH_3]_2$	147.40, 149.40	1, 5
Dimethyl di- <i>iso</i> -butoxysilane	$C_{10}H_{24}SiO_2$	$(CH_3)_2-Si-[O-CH_2-CH-(CH_3)_2]_2$	150.73	5
Dimethyl di-(1-methylpropoxy)silane	$C_{10}H_{24}SiO_2$	$(CH_3)_2-Si-[O-CH(CH_3)-C_2H_5]_2$	150.83	5
Di- <i>n</i> -propyl-diethoxysilane	$C_{10}H_{24}SiO_2$	$[CH_3-(CH_2)_2]_2-Si-(OC_2H_5)_2$	150.80	17, 18
Bis(trimethylsilyl)- <i>n</i> -propylamidoxime	$C_{10}H_{24}SiON_2$	$(CH_3)_3-Si-NH-C(CH_3)_2-CH_2=N-O-Si-(CH_3)_3$	179.00	15
Trimethyl- <i>n</i> -octylsilane	$C_{11}H_{26}Si$	$(CH_3)_3-Si-(CH_2)_7-CH_3$	156.00	2
Trimethyl- <i>n</i> -octoxysilane	$C_{11}H_{26}SiO$	$(CH_3)_3-Si-O(CH_2)_7-CH_3$	149.00	1
Trimethyl- <i>N</i> -(di- <i>N</i> -butyl)silane	$C_{11}H_{26}SiN$	$(CH_3)_3-Si-N-[(CH_2)_4-CH_3]_2$	158.5	1
2,2'-Spirobis(6-chloro-2,3-dihydrobenzothiazole)silane	$C_{12}H_{16}SiCl_2S_2N_2$		183.29	12
2,2'-Spirobis(6-bromo-2,3-dihydrobenzothiazole)silane	$C_{12}H_{16}SiBr_2S_2N_2$		199.37	12
2,2'-Spirobis(2,3-dihydrobenzothiazole)silane	$C_{12}H_{16}SiS_2N_2$		153.71	12
Diphenylsilanediol	$C_{12}H_{12}SiO_2$	$(C_6H_5)_2-Si-(OH)_2$	131.60	8
Tetrapropionoxysilane	$C_{12}H_{20}SiO_4$	$Si-(OCOC_2H_5)_4$	129.26	5
1,4,6,9-Tetraoxo-2,3,7,8-octamethyl-1-5-silaspiro[4,4]nonane	$C_{12}H_{24}SiO_4$		127.45	5
1,5,7,11-Tetraoxa-2,4,8,10-hexamethyl-1-6-silaspiro[5,5]undecane	$C_{12}H_{24}SiO_4$		172.48	5
Dodecyltrichlorosilane	$C_{12}H_{26}SiCl_3$	$CH_3-(CH_2)_{11}-Si-Cl_3$	210.40, 209.20	2, 8
Dimethyl di- <i>n</i> -pentylsilane	$C_{12}H_{28}Si$	$(CH_3)_2-Si-[(CH_2)_5-CH_3]_2$	167.60	1
Tetra- <i>n</i> -propylsilane	$C_{12}H_{28}Si$	$Si-[(CH_2)_3-CH_3]_4$	165.80	1
Tri- <i>n</i> -butylsilane	$C_{12}H_{28}Si$	$H-Si-[(CH_2)_4-CH_3]_3$	172.00	3
Dimethyl di- <i>n</i> -pentoxysilane	$C_{12}H_{28}SiO_2$	$(CH_3)_2-Si-[O-(CH_2)_5-CH_3]_2$	172.37	5
Hexaethoxydisiloxane	$C_{12}H_{28}Si_2O_6$	$(H_3C)_2-Si-O-Si-(OC_2H_5)_4$	217.00	13
Bis-(trimethylsilyl)-phenylamidoxime	$C_{12}H_{24}Si_2ON_2$	$(CH_3)_3-Si-NH-C(C_6H_5)=N-O-Si-(CH_3)_3$	199.50	15
Methyltri- <i>n</i> -butylsilane	$C_{12}H_{28}Si$	$CH_3-Si-[(CH_2)_4-CH_3]_3$	178.50	1
2,2'-Spirobis(6-methyl-2,3-dihydrobenzothiazole)silane	$C_{12}H_{18}Si_2N_2S_2$		170.06	12
Diphenyldimethoxysilane	$C_{14}H_{18}SiO_2$	$(C_6H_5)_2-Si-(OCH_3)_2$	156.80	19
Trimethyldodecylsilane	$C_{14}H_{30}Si$	$(CH_3)_3-Si-(CH_2)_{11}-CH_3$	192.00	2
Trimethyl- <i>n</i> -dodeconoxysilane	$C_{14}H_{30}SiO$	$(CH_3)_3-Si-O-(CH_2)_{11}-CH_3$	205.6	1
Diphenyl diethoxysilane	$C_{14}H_{22}SiO_2$	$(C_6H_5)_2-Si-(OC_2H_5)_2$	179.25	19
Hexadodecyltrichlorosilane	$C_{14}H_{30}SiCl_3$	$C_{14}H_{30}-Si-Cl_3$	259.00, 252.40	2, 8
Tetra- <i>n</i> -butylsilane	$C_{14}H_{34}Si$	$Si-[(CH_2)_4-CH_3]_4$	202.50	3
Hexa-dodecamethylheptasiloxane	$C_{16}H_{38}O_6Si_7$	$(CH_3)_3-Si-(O-Si)_5-O-Si-(CH_3)_2$	351.3	8
Triphenylhydroxysilane	$C_{18}H_{18}SiO$	$(C_6H_5)_3-Si-OH$	176.0	8
Dephenyl di- <i>n</i> -propoxysilane	$C_{18}H_{30}SiO_2$	$(C_6H_5)_2-Si-[O(CH_2)_3-CH_3]_2$	201.58	19

## DIAMAGNETIC SUSCEPTIBILITY DATA ON ORGANOSILICON COMPOUNDS (continued)

Compound	Molecular formula	Structural formula	$-\chi_M \cdot 10^6$	Ref.
Diphenyl di-isopropoxysilane	$C_{18}H_{22}SiO_2$	$(C_6H_5)_2Si-[OCH-(CH_3)]_2$	202.46	19
<i>n</i> -Octadecyltrichlorosilane	$C_{18}H_{37}SiCl_3$	$CH_3-(CH_2)_{17}-Si-Cl_3$	278.00, 273.7	2, 8
Diphenyl di- <i>n</i> -butoxysilane	$C_{26}H_{34}SiO_2$	$(C_6H_5)_2Si-[O-(CH_2)_4-CH_3]_2$	223.62	19
Diphenyl di-iso-butoxy silane	$C_{26}H_{34}SiO_2$	$(C_6H_5)_2Si-[O-CH_2-CH(CH_3)]_2$	224.46	19
Trimethyl- <i>n</i> -octadeconyl silane	$C_{21}H_{44}Si$	$CH_3-(CH_2)_{17}-Si-(CH_3)_3$	278.00	2
Tetraphenylsilane	$C_{24}H_{20}Si$	$Si-(C_6H_5)_4$	212.20	7
Tetrabenzylsilane	$C_{24}H_{28}Si$	$Si-(CH_2-C_6H_5)_4$	266.20	6
Tetra- <i>p</i> -tolylsilane	$C_{24}H_{28}Si$	$Si-(C_6H_4-CH_3)_4$	276.40	6
Other silicon compounds				
Carborundum (silicon carbide)	CSi	C-Si	12.80	20
Silane	SiH <sub>4</sub>	Si-H <sub>4</sub>	20.4	13
Silicon dioxide	SiO <sub>2</sub>	O=Si=O	29.6	11
Tetrachlorosilane	SiCl <sub>4</sub>	Si-Cl <sub>4</sub>	87.40, 84.60, 88.30	4, 11, 10
Tetrabromosilane	SiBr <sub>4</sub>	Si-Br <sub>4</sub>	123.30	4
Tetraiodosilane	SiI <sub>4</sub>	Si-I <sub>4</sub>	186.20	4
Trichlorosilane	HSiCl <sub>3</sub>	H-Si-Cl <sub>3</sub>	70.50, 71.30, 70.60	2, 7, 4
Silicic acid	H <sub>2</sub> SiO <sub>3</sub>	O=S-(OH) <sub>2</sub>	33.30	11
Ortho silicic acid	H <sub>4</sub> SiO <sub>4</sub>	Si-(OH) <sub>4</sub>	42.60	21
Disilane	Si <sub>2</sub> H <sub>6</sub>	H <sub>3</sub> -Si-Si-H <sub>3</sub>	37.3	4
Hexachlorodisilane	Si <sub>2</sub> Cl <sub>6</sub>	Cl <sub>3</sub> -Si-Si-Cl <sub>3</sub>	138.00	7

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# DIFFUSIVITIES OF METALLIC SOLUTES IN MOLTEN METALS

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Solute	Solvent	Temperature (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s	Solute	Solvent	Temperature (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s		
Au	Ag	1253	2.46	Tc		980	2.94		
		1300	2.80			1030	4.00		
		1350	3.19			1080	5.30		
		1400	3.59			1130	6.83		
		1450	4.00			1180	8.62		
		1500	4.44			1230	10.68		
		1533	4.73			1280	13.01		
In		1253	3.81	Zn		1320	15.07		
		1300	4.20			970	6.20		
		1350	4.63			1073	14.00		
		1400	5.06			Ag	Bi	573	2.24
		1450	5.50					673	5.17
		1500	5.95					773	9.61
		1533	6.25					873	16.00
Sb		1253	4.11	Au		973	22.63		
		1300	4.47			773	5.22		
		1350	4.85			Sn	773	4.90	
		1400	5.23				773	6.50	
		1450	5.62			Ag	Cu	873	5.50
		1500	6.00					873	8.20
		1533	6.25					1373	2.33
Sn		1248	3.87	Au		1473	2.82		
		1298	4.25			1573	3.32		
		1348	4.63			Co	1373	2.42	
		1398	5.02				1473	2.79	
		1448	5.41			1573	3.17		
		1498	5.80			Ga	1373	3.61	
		1548	6.20				1423	4.18	
1623	6.78	1473	4.80						
Ag	Al	1183	11.00			1523	5.45		
		1183	20.00			1573	6.14		
Co		980	2.82	In		1373	4.63		
		1080	3.85			1423	5.13		
		1180	4.98			1473	5.65		
		1280	6.20			1523	6.18		
		1320	6.70			1573	6.72		
Cu		973	7.20	Ni		1373	2.56		
		1000	6.00			1473	3.28		
		1050	6.87			1573	4.08		
		1100	7.78			Sb	1373	3.62	
		1150	8.71				1423	4.15	
		1200	9.67				1473	4.70	
		1250	10.63			1523	5.29		
		1273	15.00			1573	5.90		
		1300	11.61			1373	2.25		
		Fe				973	1.40	1473	3.07
1273	20.00			1573	4.03				
Ga		1000	7.70	In	Ga	473	3.67		
		1050	8.67			523	4.33		
		1100	9.64			573	4.97		
		1150	10.63			623	5.58		
		1200	11.62			673	6.16		
		1250	12.62			723	6.70		
		1300	13.61			Ga	In	473	3.08
Mg	973	2.70	523	3.75					
	973	7.54	573	4.41					
	1073	6.40	623	5.05					
Ni		980	3.86	Ag	Pb	673	5.67		
		1080	5.22			623	1.74		
		1180	6.70			673	1.96		
		1280	8.27			723	2.16		
		1320	8.92			773	2.36		



DIFFUSIVITIES OF METALLIC SOLUTES IN MOLTEN METALS (continued)

Solute	Solvent	Temperature (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s	Solute	Solvent	Temperature (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s
Au		773	3.70			800	6.52
Bi		773	4.93			900	8.29
		773	5.60			1000	10.06
		823	6.23			1100	11.83
		873	8.30			1300	15.37
Cd		723	3.90			1500	18.91
		773	5.00			1683	22.10
		823	6.00			1853	26.10
		873	6.80	Bi		723	3.60
Cu		723	3.43			773	4.60
		773	3.92			823	5.80
		823	4.41			873	6.60
		873	4.89	Co		623	2.70
		923	5.37	Cu		560	4.13
		973	5.83			600	5.31
		1040	6.44			650	6.97
Na		625	2.75			700	8.79
		673	1.21			750	10.75
		773	1.42	Na		550	1.24
		853	5.25			600	1.67
		873	1.79			625	1.90
		903	5.91			700	2.66
Sb		723	3.10			853	6.39
		773	4.10			903	6.98
		823	5.50	Ni		560	3.92
		873	6.40			600	5.15
Sn		723	2.60			650	6.89
		773	3.52			700	8.86
		783	1.75			750	11.00
		823	4.30	Pb		773	3.68
		873	5.50			823	3.68
Ag	Sn	560	3.02	Sb		600	3.15
		600	3.71			700	4.14
		650	4.57			800	5.36
		700	5.43			900	6.42
		750	6.29			1000	7.48
		773	4.80			1100	8.54
		943	10.20			1300	10.66
		1108	11.80			1500	12.78
Al		560	1.76	Zn		560	7.72
		600	2.41			600	10.34
		650	3.37			650	14.20
		700	4.50			700	18.56
		750	5.77			750	23.46
Au		600	2.98	Mn	Zn	973	3.28
		700	4.75			1023	3.75
		773	5.37			1073	4.22

## DIFFUSIVITIES OF METALLIC TRACERS IN MERCURY

R. P. Chhabra

There are several sources for these data in the literature. Different investigators have obtained different results. That is the reason there are different diffusivity values listed for the same temperature.

Tracer	Temp. (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s	Tracer	Temp. (K)	Diffusivity $\times 10^5$ cm <sup>2</sup> /s	
Ag	273	0.7	Li	281.3	0.77	
	298	1.30		298	0.92	
	298	1.05	Mg	298	1.20	
	393	2.67		Mn	293	0.94
Al	293	1.54	293		1.84	
	303	1.90	298		0.81	
	323	2.36	298		0.98	
Au	293	0.61	Na	282.7	0.74	
	298	0.73		293	0.76	
	298	0.96		293	0.97	
Ba	280.9	0.62		924	0.80	
	293	0.49	298	0.84		
	293	1.04	298	0.97		
	333	1.44	333	1.78		
Bi	293	1.33	Ni	293	0.64	
	293	1.44		298	0.54	
	298	0.99		298	0.65	
	298	1.62	Pb	273	0.97	
Cd	281.9	1.68		282.5	1.74	
	283	1.52		288.7	1.58	
	288	1.81		293	1.25	
	293	0.92		295	1.41	
	2.93	3.06		298	1.15	
	298	2.00		298	1.39	
	313	1.80		372.3	2.21	
	333	2.01		Rb	280.4	0.53
	372.2	3.42			293	0.75
	421	3.05	Sb	293	1.30	
Cs	280.3	0.52		293	1.47	
	293	0.54		298	1.64	
298	0.63	298		1.64		
Cu	293	0.88	343	1.37		
	293	1.19	363	2.42		
	298	0.83	Sn	282.7	1.80	
	298	1.06		283.8	1.77	
	363	1.01		293	1.43	
Ga	293	1.64	295	1.53		
	293	1.72	298	1.30		
	298	1.57	298	1.68		
	298	1.74	Tl	284.6	1.00	
In	293	1.36		293	0.91	
	293	1.42		293	1.05	
	294	1.47		298	1.00	
	295	1.57		298	1.60	
	298	1.31	Zn	273	1.51	
298	1.39	284.6		2.52		
K	283.6	0.61		288	2.42	
	293	0.66		293	1.46	
	293	0.85		293	1.89	
	298	0.71		298	1.57	
	550	3.10		298	2.40	
	550	3.68		303	1.20	
	550	3.50		303	1.80	
	550	5.32		323	2.06	
	650	5.23	372.4	3.35		
	650	6.11				

### DISSOCIATION CONSTANTS OF ACIDS IN WATER AT VARIOUS TEMPERATURES

Acids		0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°
Formic	$K_a \cdot 10^4$	1.638	1.691	1.728	1.749	1.765	1.772	1.768	1.747	1.716	1.685	1.650
Acetic	$K_a \cdot 10^5$	1.657	1.700	1.729	1.745	1.753	1.754	1.750	1.728	1.703	1.670	1.633
Propionic	$K_a \cdot 10^5$	1.274	1.305	1.326	1.336	1.338	1.336	1.326	1.310	1.280	1.257	1.229
<i>n</i> -Butyric	$K_a \cdot 10^5$	1.563	1.574	1.576	1.569	1.542	1.515	1.484	1.439	1.395	1.347	1.302
Chloroacetic	$K_a \cdot 10^3$	1.528	—	1.488	—	—	1.379	—	—	1.230	—	—
Lactic	$K_a \cdot 10^4$	1.287	—	—	—	—	1.374	—	—	—	—	1.270
Glycollic	$K_a \cdot 10^4$	1.334	—	—	—	—	1.475	—	—	—	—	1.415
Oxalic	$K_{2a} \cdot 10^5$	5.91	5.82	5.70	5.55	5.40	5.18	4.92	4.67	4.41	4.09	3.83
Malonic	$K_{2a} \cdot 10^3$	2.140	2.165	2.152	2.124	2.076	2.014	1.948	1.863	1.768	1.670	1.575
Phosphoric	$K_a \cdot 10^3$	8.968	—	—	—	—	7.516	—	—	—	—	5.495
Phosphoric	$K_{2a} \cdot 10^8$	4.85	5.24	5.57	5.89	6.12	6.34	6.46	6.53	6.58	6.59	6.55
Boric	$K_a \cdot 10^{10}$	—	3.63	4.17	4.72	5.26	5.79	6.34	6.86	7.38	—	8.32
Carbonic	$K_{1a} \cdot 10^7$	2.64	3.04	3.44	3.81	4.16	4.45	4.71	4.90	5.04	5.13	5.19
Phenol-sulfonic	$K_{2a} \cdot 10^{10}$	4.45	5.20	6.03	6.92	7.85	8.85	9.89	10.94	12.00	13.09	14.16
Glycine	$K_{1a} \cdot 10^7$	—	3.82	3.99	4.17	4.32	4.46	4.57	4.66	4.73	4.77	4.79
Citric	$K_{1a} \cdot 10^4$	6.03	6.31	6.69	6.92	7.21	7.45	7.66	7.78	7.96	7.99	8.04
	$K_{2a} \cdot 10^5$	1.45	1.54	1.60	1.65	1.70	1.73	1.76	1.77	1.78	1.76	1.75
	$K_{3a} \cdot 10^7$	4.05	4.11	4.14	4.13	4.09	4.02	3.99	3.78	3.69	3.45	3.28

Reproducibility between various workers is about  $\pm (0.01-0.02) \cdot 10^5$ .

### DISSOCIATION CONSTANTS ( $K_b$ ) OF AQUEOUS AMMONIA FROM 0 TO 50°C

Temperature (°C)	$pK_b$	$K_b$
0	4.862	$1.374 \times 10^{-5}$
5	4.830	$1.479 \times 10^{-5}$
10	4.804	$1.570 \times 10^{-5}$
15	4.782	$1.652 \times 10^{-5}$
20	4.767	$1.710 \times 10^{-5}$
25	4.751	$1.774 \times 10^{-5}$
30	4.740	$1.820 \times 10^{-5}$
35	4.733	$1.849 \times 10^{-5}$
40	4.730	$1.862 \times 10^{-5}$
45	4.726	$1.879 \times 10^{-5}$
50	4.723	$1.892 \times 10^{-5}$

Values of  $K_b$  accurate to  $\pm 0.005$ ; determined by e.m.f. method by: Bates, R. G. and Pinching, G. D., *J. Am. Chem. Soc.*, 72, 1393, 1950.



## EFFICACIES AND OTHER CHARACTERISTICS OF ILLUMINANTS

Gordon D. Rowe

### A. Incandescent Lamps (120 volt; Inside Frost)

Nominal lamp watts	Bulb	Base	Approximate rated life (hr)	Approximate initial lumens	Approximate initial efficacy	Chromaticity (°K)
25	A-19	Medium	2500	235	9.4	Note: The chromaticity of incandescent lamps is generally in the order of 2900—3000 K; the color rendering index, 99+. These factors will vary with changes in the voltage.
40	A-19	Medium	1000	480	12.0	
60	A-19	Medium	1000	870	14.5	
75	A-19	Medium	750	1,190	15.9	
100	A-19	Medium	750	1,750	17.5	
150	A-21	Medium	750	2,850	19.0	
200	A-23	Medium	750	4,010	20.0	
500	PS-35	Mogul	1000	10,850	21.7	
750	PS-52	Mogul	1000	17,040	22.7	
1000	PS-52	Mogul	1000	23,740	23.7	
1500	Clear PS-52	Mogul	1000	34,400	22.9	
5000	Clear G-64	Mogul bipost	150	145,000	29.0	
10000	Clear G-96	Mogul bipost	75	335,000	33.6	

### B. Fluorescent Lamp (F40T12)

	Nominal lamp watts	Approximate rated life (h)*	Approximate initial lumens	Approximate initial efficacy (lm/lamp W)	Chromaticity (K)	Chromaticity coordinates		Color-rendering index
						X	Y	
Cool white	40	20,000+	3150	78.75	4150	0.377	0.385	62
Deluxe cool white	40	20,000+	2250	56.25	4175	0.372	0.371	89
Warm white	40	20,000+	3200	80.00	3000	0.443	0.411	52
Deluxe warm white	40	20,000+	2200	55.00	3025	0.435	0.404	77
Daylight	40	20,000+	2600	65.00	6250	0.316	0.341	75
White	40	20,000+	3150	78.75	3450	0.410	0.400	60
Sign white	40	20,000+	2400	60.00	5200	0.340	0.354	82
Natural	40	20,000+	2100	52.50	3700	0.389	0.368	90
Chroma 50	40	20,000+	2210	55.25	5000	0.346	0.362	90
Chroma 75	40	20,000+	2000	50.00	7500	0.303	0.319	92
Regal white®	40	20,000+	2850	71.25	3000	0.434	0.403	81
Lite white	40	15,000 <sup>b</sup>	3450	86.25	4200	0.377	0.393	49
SP30	40	15,000	3325	83.10	3000	0.438	0.403	70
SP35	40	15,000 <sup>b</sup>	3325	83.10	3500	0.413	0.401	73
SP41	40	15,000	3265	81.60	4100	0.376	0.390	70
Green	40	20,000+	4350	108.75	6975	0.244	0.628	—
Cool green	40	20,000+	2850	71.25	6450	0.307	0.376	68
Blue	40	20,000+	1200	30.00	—	0.191	0.202	—
Gold	40	20,000+	2400	60.00	2500	0.516	0.476	38
Pink	40	20,000+	1100	27.50	—	0.538	0.343	—
Red	40	20,000+	200	5.00	—	0.691	0.303	—
Plant light	40	20,000+	850	21.25	6750	0.323	0.240	-2
Plant light (wide spectrum)	40	20,000+	1950	48.75	3050	0.412	0.360	90
Cool white (Watt-Miser® Plus)	32	15,000+	2750	86.00	4150	0.377	0.385	62
Warm white (Watt-Miser® Plus)	32	15,000+	2800	87.50	3000	0.443	0.411	52
SP30 (Watt-Miser® Plus)	32	15,000+	2900	90.60	3000	0.438	0.403	70
SP35 (Watt-Miser® Plus)	32	15,000+	2900	90.60	3500	0.413	0.401	73
SP41 (Watt-Miser® Plus)	32	15,000+	2850	89.00	4100	0.376	0.390	70
Lite white (Watt-Miser® Plus)	32	15,000+	2925	91.40	4200	0.377	0.393	49
Cool white (Watt-Miser®)	34	20,000	2750	80.90	4150	0.377	0.385	62
Deluxe cool white (Watt-Miser®)	32	20,000	1925	56.60	4175	0.372	0.371	89
Warm white (Watt-Miser®)	32	20,000	2800	82.35	3000	0.443	0.411	52
Deluxe warm white (Watt-Miser®)	32	20,000	1925	56.60	3025	0.435	0.404	77
Daylight (Watt-Miser®)	32	20,000	2300	67.65	6250	0.316	0.341	75
White (Watt-Miser®)	32	20,000	2800	82.35	3450	0.410	0.400	60

	Nominal lamp watts	Approximate rated life (h) <sup>a</sup>	Approximate initial lumens	Approximate initial efficacy (lm/lamp W)	Chromaticity (K)	Chromaticity coordinates		Color-rendering index
						X	Y	
Regal White <sup>b</sup> (Watt-Miser <sup>b</sup> )	32	20,000	2450	72.00	3000	0.434	0.403	81
SP30 (Watt-Miser <sup>b</sup> )	32	20,000	2900	85.30	3000	0.438	0.403	70
SP35 (Watt-Miser <sup>b</sup> )	32	20,000	2900	85.30	3500	0.413	0.401	73
SP41 (Watt-Miser <sup>b</sup> )	32	20,000	2850	83.80	4100	0.376	0.390	70
Lite white (Watt-Miser <sup>b</sup> II)	32	20,000	2925	86.00	4200	0.377	0.393	49
Cool white	75	12,000 <sup>c</sup>	6300	84.00				
Deluxe cool white	75	12,000 <sup>c</sup>	4500	60.00				
Warm white	75	12,000 <sup>c</sup>	6500	86.65				
Deluxe warm white	75	12,000 <sup>c</sup>	4350	58.00				
Daylight	75	12,000 <sup>c</sup>	5450	72.65				
White	75	12,000 <sup>c</sup>	6400	85.30				
Cool white (Watt-Miser <sup>b</sup> )	60	12,000 <sup>c</sup>	5600	93.30				
Deluxe cool white (Watt-Miser <sup>b</sup> )	60	12,000 <sup>c</sup>	4000	66.65				
Warm white (Watt-Miser <sup>b</sup> )	60	12,000 <sup>c</sup>	5800	96.65				
Daylight (Watt-Miser <sup>b</sup> )	60	12,000 <sup>c</sup>	4840	80.65				
White (Watt-Miser <sup>b</sup> )	60	12,000 <sup>c</sup>	5600	93.30				
Lite white (Watt-Miser <sup>b</sup> II)	60	12,000 <sup>c</sup>	6000	100.00				
High-output (F96T12, 800ma)								
Cool white	110	12,000 <sup>c</sup>	9200	83.60				
Deluxe cool white	110	12,000 <sup>c</sup>	6600	60.00				
Warm white	110	12,000 <sup>c</sup>	9200	83.60				
Deluxe warm white	110	12,000 <sup>c</sup>	6550	59.50				
Daylight	110	12,000 <sup>c</sup>	7800	71.00				
White	110	12,000 <sup>c</sup>	9200	83.60				
Cool white (Watt-Miser <sup>b</sup> )	95	12,000 <sup>c</sup>	8300	87.35				
Deluxe cool white (Watt-Miser <sup>b</sup> )	95	12,000 <sup>c</sup>	6100	64.20				
Warm white (Watt-Miser <sup>b</sup> )	95	12,000 <sup>c</sup>	8500	89.50				
White (Watt-Miser <sup>b</sup> )	95	12,000 <sup>c</sup>	8300	87.35				
Lite white (Watt-Miser <sup>b</sup> II)	95	12,000 <sup>c</sup>	8800	92.60				
Cool white	215	12,000 <sup>c</sup>	16,000	74.40				
Deluxe cool white	215	12,000 <sup>c</sup>	11,000	51.15				
Warm white	215	12,000 <sup>c</sup>	15,000	69.75				
Daylight	215	12,000 <sup>c</sup>	13,300	61.85				
Cool white (Watt-Miser <sup>b</sup> )	185	12,000 <sup>c</sup>	14,000	75.65				
Lite white (Watt-Miser <sup>b</sup> II)	185	12,000 <sup>c</sup>	14,900	80.50				

Note: Chromaticity, Chromaticity Index, and Color Rendering Index (CRI) are the same as for the equivalent colors of the 40-W lamps listed in the F40T12 section of this table.

### C. High-Intensity Discharge (HID)

	Bulb	ANSI Code	Nominal lamp watts	Approximate rated life (h) <sup>a</sup>	Approximate initial lumens <sup>d</sup>	Approximate initial efficacy (lm/lamp W) <sup>d</sup>
Mercury-vapor						
Clear	E-37	H33CD-R400	400	24,000+	21,000	52.50
Deluxe white	E-37	H33GL-R400/DX	400	24,000+	22,500	56.25
Warm deluxe white	E-37	H33GL-R400WDX	400	24,000+	19,500	48.75
Clear	BT-56	H36GV-R1000	1000	24,000+	57,000	57.00
Deluxe white	BT-56	H36GW-R1000/DX	1000	24,000+	63,000	63.00
Warm deluxe white	BT-56	H36GW-R1000/WDX	1000	24,000+	58,000	58.00
Metal halide (Multi-Vapor <sup>®</sup> )						
Clear; vertical, base up	E-23 <sup>1</sup> / <sub>2</sub>	M57PE-R175/XBU	175	10,000	16,600	94.85
Diffuse; vertical, base up	E-23 <sup>1</sup> / <sub>2</sub>	M57PF-R175/XBU	175	10,000	15,750	90.00
Clear; vertical, base down	E-23 <sup>1</sup> / <sub>2</sub>	M57PE-R175/XBD	175	10,000	16,600	94.85
Diffuse; vertical, base down	E-23 <sup>1</sup> / <sub>2</sub>	M57PF-R175/XBD	175	10,000	15,750	90.00
Clear; "any position"	E-28	M57PE-R175/U	175	10,000	14,000	80.00
Phosphor-coated; "any position"	E-28	M57PF-R175/U	175	10,000	14,000	80.00
Clear; "any position"	E-28	M58PG-R250/U	250	10,000	20,500	82.00
Phosphor-coated; "any position"	E-28	M58PH-R250/U	250	10,000	20,500	82.00
Clear; "any position"	E-37	M59PJ-R400/U	400	20,000	36,000	90.00
Phosphor-coated; "any position"	E-37	M59PK-R400/U	400	20,000	36,000	90.00
Clear; "any position"	BT-56	M47PA-R1000/U	1000	12,000	110,000	111.00
Phosphor-coated; "any position"	BT-56	M47PB-R1000/U	1000	12,000	105,000	105.00
High-pressure sodium (Lucalox <sup>®</sup> )						
Clear; medium base	E-17	S76HA-35	35	16,000	2,250	64.80
Diffuse; medium base	E-17	S76HB-35	35	16,000	2,150	61.40
Clear; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S68MS-50	50	24,000+	4,000	80.00
Diffuse; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S68MY-50	50	24,000+	3,800	76.00
Clear; medium base	E-17	S68XX-50	50	24,000+	4,000	80.00
Diffuse; medium base	E-17	S68YY-50	50	24,000+	3,800	76.00
Clear; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S62-ME70	70	24,000+	5,800	82.85
Diffuse; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S62-MF70	70	24,000+	5,400	77.00
Clear; medium base	E-17	S62-LG70	70	24,000+	5,800	82.85
Diffuse; medium base	E-17	S62LH-70	70	24,000+	5,400	77.00
Clear; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S54SB-100	100	24,000+	9,500	95.00
Diffuse; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S54MC-100	100	24,000+	8,800	88.00
Clear; medium base	E-17	S54SG-100	100	24,000+	9,500	95.00
Diffuse; medium base	E-17	S54SH-100	100	24,000+	8,800	88.00
Clear; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S55SC-150	150	24,000+	16,000	106.65
Diffuse; mogul base	E-23 <sup>1</sup> / <sub>2</sub>	S55MD-150	150	24,000+	15,000	100.00
Clear; mogul base	E-28	S56SD-150	150	24,000+	15,000	100.00
Clear; mogul base	E-18	S66MN-200	200	24,000+	22,000	110.00
Clear; mogul base	E-18	S50VA-250	250	24,000+	27,500	110.00
Clear; mogul base	E-18	S50VA-250/S	250	24,000+	30,000	120.00
Diffuse; mogul base	E-28	S50VC-250	250	24,000+	26,000	104.00

	Bulb	ANSI Code	Nominal lamp watts	Approximate rated life (hr.)	Approximate initial lumens <sup>d</sup>	Approximate initial efficacy (lm/lamp W) <sup>d</sup>
Clear; mogul base (deluxe color)	E-18	S50VA-250/DX	250	10,000	22,500	90.00
Clear; mogul base	E-18	S67MR-310	310	24,000+	37,000	119.35
Clear; mogul base	E-18	S51WA-400	400	24,000+	50,000	125.00
Diffuse; mogul base	E-37	S51WB-400	400	24,000+	47,500	118.75
Clear; mogul base	E-25	S52XB-1000	1000	24,000+	140,000	140.00

Note: \* = Registered trademark of the General Electric Company.

<sup>a</sup> Life rating at 3 or more hours per start on rapid-start circuits, 15,000 hr.

<sup>b</sup> Life with rapid-start circuits; on preheat circuits, 12,000 hr.

<sup>c</sup> Rated average life at 3 hr/start; at 12 hr/start, 18,000 hr.

<sup>d</sup> Initial lumen rating as measured when lamp is operated in vertical position.

### APPROXIMATE LUMINANCE OF VARIOUS LIGHT SOURCES

Compiled by C.J. Allen and G.D. Rowe

Luminance of source is given in candelas per square centimeter

Source		Approx. avg. luminance* (cd cm <sup>-2</sup> )	Source		Approx. avg. luminance* (cd cm <sup>-2</sup> )
Natural sources			High-output (96T12)	800 mA	1.13
Clear sky	Average luminance	0.8	Grooved bulb (96T17)	1500 mA	1.50
Sun (as observed from earth's surface)	At meridian	160000	Fluorescent lamps (other than cool white)		
Sun (as observed from earth's surface)	Near horizon	600	Daylight (40wT12)	430 mA	0.62
Moon (as observed from earth's surface)	Bright spot	0.25	Blue (40wT12)	430 mA	0.30
Combustion sources			Green (40wT12)	430 mA	1.17
Candle flame (sperm)	Bright spot	1.0	Red (40wT12)	430 mA	0.05
Welsbach mantle	Bright spot	6.2	High-intensity discharge (HID)		
Acetylene flame	Mees burner	10.5	Mercury-vapor (E-37)		
Photoflash lamps		16000-40000 peak	Clear	400 watt	970
Incandescent electric lamps			Color-improved	400 watt	11.0
Carbon filament	3 Lumens per watt	52	Deluxe-white	400 watt	12.1
Tungsten filament	Vacuum lamp--10 lumens per watt	200	Mercury-vapor (BT-56)		
Tungsten filament	Gas-filled lamp--20 lumens per watt	1200	Clear	1000 watt	980
Tungsten filament	750-watt projection lamp--26 lumens per watt	7500	Color-improved	1000 watt	15.0
Fluorescent lamps (cool white)			Deluxe white	1000 watt	17.2
Rapid start (40wT12)	430 mA	0.82	Metal halide (E-37)		
			Clear	400 watt	810
			Color-improved	1000 watt	930
			Deluxe white	1500 watt	1620
			High pressure sodium (Lucalox <sup>®</sup> )	250 watt	520
				400 watt	780
				1000 watt	810

<sup>®</sup>Registered trademark of the General Electric Company

\*Luminance values perpendicular to lamp axis

## EFFICIENCY OF DRYING AGENTS

Compiled by John H. Yoe

### A. Drying agents depending upon chemical action (absorption) for their efficiency:\*

Substance	Residual water, mg per liter of dry air**	Reference
P <sub>2</sub> O <sub>5</sub>	<1 mg in 40,000 liters	Morley, Am. J. Sci., 34, 199 (1887); J.A.C.S., 26, 1171 (1904).
Mg(ClO <sub>4</sub> ) <sub>2</sub> anhyd.	"Unweighable" in 210 liters	Willard and Smith, J.A.C.S., 44, 2255 (1922).
BaO	0.00065	Bower, Bur. Std. J. Res., 12, 241 (1934).
KOH fused	0.002	Baxter and Starkweather, J.A.C.S., 38, 2038 (1916).
CaO	0.003	Bower, loc. cit.
H <sub>2</sub> SO <sub>4</sub>	0.003	Baxter and Starkweather, loc. cit.
CaSO <sub>4</sub> anhyd.	0.005	Bower loc. cit.
Al <sub>2</sub> O <sub>3</sub>	0.005	Ibid.
KOH sticks	0.014	Ibid.
NaOH fused	0.16	Baxter and Starkweather, loc. cit.
CaBr <sub>2</sub>	0.18	Baxter and Warren, J.A.C.S., 33, 340 (1911).
CaCl <sub>2</sub> fused	0.34	Baxter and Starkweather, loc. cit.
NaOH sticks	0.80	Bower loc. cit.
Ba(ClO <sub>4</sub> ) <sub>2</sub>	0.82	Ibid.
ZnCl <sub>2</sub>	0.85	Baxter and Warren, loc. cit.
ZnBr <sub>2</sub>	1.16	Ibid.
CaCl <sub>2</sub> granular	1.5	Bower, loc. cit.
CuSO <sub>4</sub> anhyd.	2.8	Ibid.

### B. Drying agents depending upon physical action (adsorption) for their efficiency:\* Alumina (low temperature fired), asbestos, charcoal, clay and porcelain (low temperature fired), glass wool, kieselguhr, silica gel, refrigeration.

\* It should be noted that the efficiency of some drying agents (e.g. Al<sub>2</sub>O<sub>3</sub> and anhydrous CaCl<sub>2</sub>, and probably also BaO, anhydrous Mg(ClO<sub>4</sub>)<sub>2</sub>, Mg(ClO<sub>4</sub>)<sub>2</sub>·3H<sub>2</sub>O, anhydrous Ba(ClO<sub>4</sub>)<sub>2</sub>, and CaSO<sub>4</sub>) depends upon both adsorption and absorption.

\*\* 30°C. for Bower's values; others 25°C. or room temp.



## EMERGENT STEM CORRECTION FOR LIQUID-IN-GLASS THERMOMETERS

Accurate thermometers are calibrated with the entire stem immersed in the bath which determines the temperature of the thermometer bulb. However, for reasons of convenience it is common practice when using a thermometer to permit its stem to extend out of the apparatus. Under these conditions both the stem and the mercury in the exposed stem are at a temperature different from that of the bulb. This introduces an error into the observed temperature. Since the coefficient of thermal expansion of glass is less than that of mercury, the observed temperature will be less than the true temperature if the bulb is hotter than the stem and greater than the true temperature, providing the thermal gradient is reversed. For exact work the magnitude of this error can only be determined by experiment. However, for most purposes it is sufficiently accurate to apply the following equation which takes into account the difference of the thermal expansion of glass and mercury:

$$T_c = T_o + F \times L(T_o - T_m)$$

Where

$T_c$  = corrected temperature

$T_o$  = observed temperature

$T_m$  = mean temperature of exposed stem. The mean temperature of the exposed stem may be determined by fastening the bulb of a second thermometer against the midpoint of the exposed liquid column.

$L$  = the length of the exposed column in degrees above the surface of the substance whose temperature is being determined.

$F$  = correction factor. For approximate work and when the liquid in the thermometer is mercury a value for  $F$  of 0.00016 is generally used. For more accurate work with mercury filled thermometers values as given in the following table are used. For thermometers filled with organic liquids it is customary to use 0.001 for the value of  $F$ .

Values of  $F$  for various glasses

$T_m$ °C.	Corning 0041	Corning 8800	Corning 8810	Jena 16 III	Jena 59 III
50	0.000157	0.000166	0.000156	0.000158	0.000164
150	0.000159	0.000167	0.000157	0.000158	0.000165
250	0.000163	0.000168	0.000161	0.000161	0.000170
350	0.000168	0.000173	0.000166	—	0.000177

## EMISSION OF TOTAL RADIATION FOR VARIOUS MATERIALS

Material	Temperature (°C)	$\epsilon_{tot}$	Material	Temperature (°C)	$\epsilon_{tot}$
<b>Alloys</b>			<b>Lamp black</b>	25	0.94
Nickel-Chromium			<b>Lead</b>	20—400	0.96
20 Ni—25 Cr—55 Fe, oxidized	200	0.90	Oxidized	200	0.05
60 Ni—12 Cr—28 Fe, oxidized	270	0.89	Unoxidized	200	0.63
80 Ni—20 Cr	100	0.87	Mercury	25	0.10
	560	0.82	Unoxidized	100	0.12
	600	0.87	<b>Molybdenum</b>	600—1000	0.08—0.13
	1300	0.89		1500—2200	0.19—0.26
<b>Aluminum</b>			<b>Monel metal</b>		
Polished	50—500	0.04—0.06	Oxidized	200	0.43
Rough surface	20—50	0.06—0.07		600	0.43
Strongly oxidized	55—500	0.2—0.3	<b>Nichrome</b>		
	25	0.022	Wire		
	100	0.028	Clean	50	0.65
	500	0.060	Oxidized	500—1000	0.71—0.79
Oxidized	200	0.11	Nickel	50—500	0.95—0.98
	600	0.19	Industrial, polished		
<b>Asbestos board</b>	20	0.96	Oxidized	200—400	0.07—0.09
<b>Bismuth</b>			Oxidized at 600°C	200	0.37
Unoxidized	25	0.048	Unoxidized	200—600	0.37—0.48
<b>Brass</b>				25	0.045
Dull tarnished	200	0.61		100	0.06
Oxidized at 600°C	200	0.61		500	0.12
	600	0.59		1000	0.19
Unoxidized	25	0.035	<b>Platinum</b>		
	100	0.035	Clean, polished	200—600	0.05—0.1
Polished	200	0.03	Unoxidized	25	0.037
Rolled sheet	20	0.06		100	0.047
<b>Bronze</b>				500	0.096
Polished	50	0.1		1000	0.152
<b>Carbon</b>				1500	0.191
Filament	1000—1400	0.53	Wire	50—200	0.06—0.07
Graphite	0—3600	0.7—0.8		500—1000	0.1—0.16
Lamp black	20—400	0.96		1400	0.18
Soot applied to solid	50—1000	0.96	<b>Porcelain</b>		
Soot with water glass	20—200	0.96	Glazed	20	0.92
Unoxidized	100	0.81	<b>Rubber</b>		
<b>Chromium</b>			Hard	20	0.95
Polished	50	0.1	Soft, gray, rough	20	0.86
	500—1000	0.28—0.38	<b>Silica brick</b>	1000	0.80
<b>Colbalt</b>				1100	0.85
Unoxidized	500	0.13	<b>Silver</b>		
	1000	0.23	Clean, polished	200—600	0.02—0.03
<b>Columbium</b>			Unoxidized	100	0.02
Unoxidized	1500	0.19		500	0.035
<b>Copper</b>			Soot applied to a solid surface	50—1000	0.94—0.91
Calorized	100	0.26	Soot with water glass	20—200	0.96
Calorized, oxidized	200	0.18	<b>Steel</b>		
	600	0.19	Alloyed (8% Ni, 18% Cr)	500	0.35
Commercial, scoured to a shine	20	0.07	Aluminized	50—500	0.79
Oxidized	50	0.6—0.7	Dull nickel plated	20	0.11
	500	0.88	Flat, rough surface	50	0.95—0.98
Polished	50—100	0.02	Cast, polished	750—1050	0.52—0.56
Unoxidized	100	0.02	Sheet, ground	50	0.56
Unoxidized, liquid	—	0.15		950—1100	0.55—0.61
<b>Fire brick</b>	1000	0.75	Oxidized	200—600	0.8
<b>Glass</b>			Calorized, oxidized	200	0.52
20—100	0.94—0.91			600	0.57
250—1000	0.87—0.72		Sheet with shiny layer of oxide	20	0.82
1100—1500	0.7—0.67		Strongly oxidized	50	0.88
<b>Gold</b>				500	0.98
Carefully polished	200—600	0.02—0.03	Unoxidized	100	0.08
Unoxidized	100	0.02	Unoxidized, liquid	—	0.28
Enamel	100	0.37	<b>Tantalum</b>		
<b>Graphite</b>	0—3600	0.7—0.8	Unoxidized	1500	0.21
<b>Gypsum</b>	20	0.93		2000	0.26
<b>Iron</b>			<b>Tungsten</b>		
Cast			Unoxidized	25	0.024
Oxidized	200	0.64		100	0.032
600	0.78			500	0.071
Strongly oxidized	40	0.95		1000	0.15
	250	0.95		1500	0.23
Unoxidized	100	0.21		2000	0.28
Unoxidized, liquid	—	0.29	<b>Varnish</b>		
Oxidized	100	0.74	Dull black	40—100	0.8—0.95
	500	0.84	Glossy black sprayed on iron	40—100	0.96—0.98
	1200	0.89		20	0.87
Rusted	25	0.65	<b>Zinc</b>		
Wrought, dull	100	0.05	Polished	200—300	0.04—0.05
			Unoxidized	300	0.05

**EMISSIVITY OF TUNGSTEN**  
Wavelengths in  $\mu\text{m}$

Temperature K	0.25	0.30	0.35	0.40	0.50	0.60	0.70	Temperature K	0.80	0.90	1.0	1.1	1.2	1.3	1.4
1600	.448*	.482	.478	.481	.469	.455	.444	2400	.408	.391	.372	.355	.340	.324	.309
1800	.442*	.478*	.476	.477	.465	.452	.44	2600	.404	.386	.369	.352	.338	.325	.310
2000	.436*	.474	.473	.474	.462	.448	.436	2800	.400	.383	.367	.352	.337	.325	.313
2200	.429*	.470	.470	.471	.458	.445	.431								
2400	.422	.465	.466	.468	.455	.441	.427	Temperature K	1.5	1.6	1.8	2.0	2.2	2.4	2.6
2600	.418	.461	.464	.464	.451	.437	.423	1600	.279*	.263*	.234*	.210*	.19*	.175*	.164*
2800	.411	.456	.461	.461	.448	.434	.419	1800	.282	.267*	.241*	.218*	.20*	.182*	.174*
								2000	.288	.273	.247	.227	.209*	.197	.175
Temperature K	0.80	0.90	1.0	1.1	1.2	1.3	1.4	2200	.291	.278	.254	.235	.218	.205	.194
1600	.431	.413	.39	.366	.345	.322*	.300*	2400	.296	.283	.262	.244	.228	.215	.205
1800	.425	.407	.385	.364	.344	.323*	.302*	2600	.299	.288	.269	.251	.236	.224	.214
2000	.419	.401	.381	.361	.343	.323	.305	2800	.302	.292	.274	.259	.245	.233	.224
2200	.415	.396	.378	.359	.342	.324	.306								

\* Values by extrapolation.





INTRODUCTION TO X-RAY CROSS SECTIONS

Alex F. Burr

These tables are part of an extensive report published by W. H. McMaster, et al. as UCRL 50174 and available from the National Technical Information Service, Springfield, Va. 22151. Section I of UCRL 50174 describes the data base and the treatment given it. Section II contains the total cross sections between 1 and 1000 keV for all the elements. Section III contains results used in producing Section II, and Section IV contains total cross sections for selected energies and is reproduced in part here. To obtain these values existing experimental x-ray total cross section data and theoretical cross section calculations were surveyed. The coherent (Rayleigh) scattering cross sections and the incoherent (Compton) scattering cross sections were computed. The photo-electric cross sections were obtained by least squares fitting of experimental data, theory, and interpolation of experiment and theory. The following table contains cross sections interpolated from the basic compilation at those wavelengths of most use to x-ray crystallographers. The wavelengths chosen were selected to correspond to those given in the International Tables for X-Ray Crystallography. The energy-to-wavelength conversion is given below.

Table I. Energy-to-wavelength conversion

Target radiation	$\lambda$	keV	Target radiation	$\lambda$	keV
Ag K $\alpha$	0.5608	22.105	Ni K $\alpha$	1.6591	7.472
K $\beta_1$	0.4970	24.942	K $\beta_1$	1.5001	8.265
Pd K $\alpha$	0.5869	21.125	Co K $\alpha$	1.7902	6.925
K $\beta_1$	0.5205	23.819	K $\beta_1$	1.6208	7.649
Rh K $\alpha$	0.6147	20.169	Fe K $\alpha$	1.9373	6.400
K $\beta_1$	0.5456	22.724	K $\beta_1$	1.7565	7.058
Mo K $\alpha$	0.7107	17.444	Mn K $\alpha$	2.1031	5.895
K $\beta_1$	0.6323	19.608	K $\beta_1$	1.9102	6.490
Zn K $\alpha$	1.4364	8.631	Cr K $\alpha$	2.2909	5.412
K $\beta_1$	1.2952	9.572	K $\beta_1$	2.0848	5.947
Cu K $\alpha$	1.5418	8.041	Ti K $\alpha$	2.7496	4.509
K $\beta_1$	1.3922	8.905	K $\beta_1$	2.5138	4.932

Table II. Total Cross Section in cm<sup>2</sup>/g

Z	keV	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca
4.51	432	432	661	2.10	5.63	12.9	25.6	43.0	64.8	91.8	125	168	220	264	336	386	464	518	577	679	805
4.93	421	550	1.62	4.25	9.69	19.4	32.6	49.4	70.3	95.9	129	168	220	264	336	386	464	518	577	679	805
5.41	412	465	1.24	3.18	7.33	14.5	24.4	37.2	53.1	72.7	98.5	129	171	206	263	304	364	411	456	542	638
5.90	405	405	986	2.45	5.53	11.1	18.7	28.6	41.1	56.4	76.6	102	131	158	203	236	282	322	356	427	500
5.95	405	400	964	2.39	5.39	10.8	18.2	27.9	40.0	54.9	74.7	99.6	121	156	160	186	223	256	282	342	398
6.40	400	362	798	1.92	4.28	8.55	14.5	22.2	32.0	44.0	59.9	80.2	97.5	121	136	148	177	205	225	275	319
6.49	400	355	770	1.84	4.10	8.18	13.9	21.3	30.6	42.2	57.5	77	93.7	121	142	148	170	197	217	264	307
6.93	397	329	659	1.52	3.36	6.68	11.3	17.4	25.1	34.7	47.3	63.5	77.5	100	118	118	141	165	181	222	257
7.06	396	322	631	1.44	3.17	6.30	10.7	16.5	23.7	32.8	44.7	60.1	73.4	95.1	112	134	134	156	172	211	244
7.47	394	303	555	1.23	2.67	5.28	8.96	13.8	19.9	27.6	37.7	50.8	62.2	80.7	95.2	114	134	147	181	209	244
7.65	393	297	528	1.15	2.49	4.92	8.33	12.9	18.6	25.7	35.2	47.4	58.1	75.4	89.1	107	125	137	170	196	244
8.04	391	284	477	1.01	2.14	4.22	7.14	11.0	16.0	22.1	30.3	40.9	50.2	65.3	77.3	92.5	109	120	148	171	211
8.27	390	277	452	936	1.98	3.88	6.56	10.1	14.7	20.4	27.9	37.6	46.3	60.2	71.3	85.5	101	111	138	159	209
8.63	389	268	417	837	1.74	3.40	5.74	8.87	12.8	17.9	24.4	33.0	40.7	53.0	62.9	75.4	89.4	97.7	122	141	181
8.91	388	262	394	774	1.59	3.09	5.22	8.06	11.7	16.2	22.2	30.1	37.1	48.4	57.4	68.9	81.8	89.3	112	129	169
9.57	386	250	349	651	1.30	2.49	4.19	6.47	9.36	13.1	17.9	24.2	30.0	39.1	46.6	55.9	66.7	72.7	91.4	106	146
17.44	373	202	197	245	345	535	790	1.15	1.58	2.21	2.94	3.98	5.04	6.53	7.87	9.63	11.6	12.6	16.2	19	24
19.61	370	197	187	222	293	429	605	855	1.15	1.60	2.10	2.83	3.59	4.62	5.57	6.84	8.26	8.95	11.5	13.6	16.2
20.17	369	196	185	217	283	408	570	799	1.07	1.48	1.94	2.60	3.30	4.26	5.13	6.30	7.61	8.24	10.6	12.5	15.5
21.13	368	195	182	210	268	379	519	717	952	1.31	1.70	2.28	2.89	3.71	4.47	5.50	6.63	7.18	9.24	10.9	13.6
22.11	366	193	179	205	256	354	476	648	851	1.16	1.50	2.00	2.54	3.25	3.91	4.82	5.80	6.28	8.08	9.57	11.9
22.72	366	192	177	201	249	340	452	610	795	1.08	1.36	1.86	2.35	3.00	3.61	4.45	5.35	5.79	7.45	8.84	11.1
23.82	364	191	175	196	239	319	416	553	711	0.963	1.23	1.63	2.06	2.62	3.15	3.88	4.66	5.04	6.49	7.71	9.57
24.94	363	189	173	192	229	301	385	504	640	0.861	1.09	1.44	1.81	2.30	2.76	3.40	4.08	4.41	5.67	6.75	8.41

X-RAY CROSS SECTIONS (Continued)  
Table II. Total Cross Section in cm<sup>2</sup>/g (Continued)

Z keV	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	37 Rb	38 Sr	39 Y	40 Zr
4.51	819	111	125	143	160	188	206	240	257	280	309	329	368	403	435	464	508	552	599	648
4.93	658	86.8	97.3	111	125	147	161	188	201	220	242	258	288	317	342	366	400	436	473	511
5.41	521	75.1	85.7	96.1	96.1	113	125	146	155	172	187	200	224	246	266	285	312	339	369	399
5.90	420	459	513	674	75.6	88.8	98.4	113	123	137	148	158	178	195	211	226	248	270	294	317
5.95	411	449	501	658	73.8	86.8	96.1	113	120	134	144	155	173	190	206	221	242	263	287	310
6.40	339	370	411	462	59.9	70.4	78.3	91.8	110	117	126	136	152	169	181	198	215	235	255	284
6.49	327	357	396	445	57.6	67.7	75.3	88.3	93.6	106	113	122	136	150	162	174	191	207	227	244
6.93	276	301	333	375	405	53.3	62.9	73.8	78.1	88.7	94.2	102	114	125	136	146	160	174	190	205
7.06	262	286	316	357	385	53.3	59.6	70.0	74.1	84.3	89.3	96.8	108	119	129	138	152	165	181	195
7.47	226	246	271	307	331	367	50.9	59.8	63.2	72.4	76.2	82.9	92.5	101	110	119	132	145	155	167
7.65	212	231	255	288	311	346	47.7	56.1	59.2	68.0	71.4	77.8	86.8	95.1	104	111	122	132	145	157
8.04	186	202	223	252	273	304	339	48.8	51.5	59.5	62.1	67.9	75.7	82.9	90.3	97	106	115	127	137
8.27	173	188	206	234	253	283	315	45.2	47.7	55.3	57.5	63.0	70.1	77.8	83.7	89.9	98.5	107	118	127
8.63	153	167	183	208	225	253	281	306	42.3	49.2	50.9	56.0	62.2	68.0	74.2	79.8	87.4	94.7	105	113
8.91	141	153	168	191	207	234	259	283	38.7	45.3	46.7	51.4	57.0	62.3	68.1	73.2	80.2	86.8	96.2	103
9.57	116	126	138	157	170	194	214	236	245	37.4	38.1	42.3	46.7	51.0	55.8	60.0	65.7	71.0	79.0	84.8
17.44	21.0	23.3	25.2	29.3	31.9	37.7	41.0	47.2	49.3	55.5	56.9	60.5	66.0	68.8	74.7	79.1	83.0	88.0	97.6	161
19.61	15.0	16.7	18.1	21.0	22.9	27.2	29.5	34.2	35.8	40.3	41.7	44.3	48.6	51.2	55.6	58.6	62.1	63.6	72.6	75.2
20.17	13.8	15.4	16.7	19.4	21.1	25.1	27.2	31.6	33.1	37.2	38.6	41.0	45.1	47.6	51.7	54.5	57.8	61.0	67.5	70.1
21.13	12.1	13.4	14.6	17.0	18.5	22.0	23.8	27.7	29.0	32.7	34.0	36.1	39.7	42.1	45.6	48.1	51.1	54.0	59.7	62.1
22.11	10.5	11.8	12.8	14.9	16.2	19.3	20.9	24.3	25.5	28.7	29.9	31.8	35.0	37.2	40.4	42.5	45.3	47.9	53.0	55.2
22.72	9.72	10.9	11.8	13.7	15.0	17.8	19.3	22.5	23.6	26.6	27.7	29.4	32.4	34.6	37.5	39.5	42.1	44.5	49.2	51.4
23.82	8.47	9.48	10.3	12.0	13.1	15.6	16.9	19.7	20.7	23.3	24.3	25.8	28.5	30.5	33.1	34.8	37.2	39.3	43.5	45.5
24.94	7.40	8.30	9.02	10.5	11.5	13.7	14.8	17.3	18.2	20.4	21.4	22.7	25.1	26.9	29.2	30.7	32.9	34.8	38.5	40.4

Z keV	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd
4.51	697	738	786	832	892	928	987	1064	1151	1128	997	753	293	300	324	334	355	383	414	433
4.93	552	585	621	660	708	739	785	842	906	899	926	843	921	683	729	266	282	304	330	344
5.41	432	457	486	518	555	581	617	659	706	709	733	769	835	755	803	587	623	640	661	671
5.90	344	365	387	414	444	466	495	526	561	569	592	617	666	701	742	660	677	721	718	718
5.95	336	357	378	404	434	455	484	514	548	557	579	603	651	685	725	645	662	709	705	713
6.40	276	293	310	333	357	375	398	422	449	460	479	497	535	565	597	615	636	692	650	664
6.49	266	282	299	320	344	361	384	407	433	443	462	479	516	545	575	593	613	671	610	647
6.93	223	237	251	269	289	304	324	342	363	374	391	404	434	459	484	499	519	559	596	632
7.06	212	225	238	256	275	289	308	325	345	356	373	385	413	437	460	475	494	532	567	606
7.47	182	193	204	220	236	249	265	279	295	307	322	331	355	376	395	408	427	459	488	506
7.65	170	181	192	207	222	234	249	262	277	289	303	312	333	353	372	384	402	432	459	476
8.04	149	158	168	181	194	205	218	229	242	253	267	273	292	310	325	336	354	379	402	418
8.27	138	147	156	168	180	190	203	213	225	236	248	254	271	288	302	312	329	352	374	389
8.63	122	130	138	149	160	169	180	189	200	210	221	226	241	256	269	278	294	314	333	347
8.91	112	120	127	137	147	156	166	174	183	193	204	208	222	236	248	256	271	290	307	320
9.57	92.0	98.2	104	113	121	128	137	143	151	159	168	172	183	195	204	211	224	240	253	265
17.44	17.0	18.4	19.8	21.3	23.1	24.4	26.4	27.7	29.1	31.2	33.0	33.9	36.3	38.3	40.4	42.4	45.3	48.6	50.8	53.3
19.61	13.3	14.3	15.3	16.4	17.6	18.6	19.1	20.1	21.2	22.6	23.9	24.7	26.5	27.9	29.5	31.0	33.1	35.5	37.1	38.9
20.17	12.5	13.5	14.5	15.6	16.7	17.7	18.6	19.6	20.6	22.0	23.5	24.2	26.0	27.4	29.1	30.7	32.7	35.0	37.4	39.0
21.13	11.5	12.5	13.5	14.6	15.7	16.7	17.6	18.5	19.4	20.9	22.1	22.8	24.6	25.8	27.3	28.7	30.7	33.0	34.4	36.0
22.11	10.5	11.5	12.5	13.6	14.7	15.7	16.5	17.3	18.1	19.4	20.4	21.1	22.7	24.0	25.4	27.0	29.1	31.3	31.7	33.3
22.72	9.52	10.5	11.5	12.6	13.7	14.7	15.5	16.3	17.1	18.3	19.2	19.9	21.5	22.7	24.1	25.5	27.9	29.7	26.8	28.0
23.82	8.55	9.5	10.5	11.6	12.7	13.7	14.4	15.1	15.8	17.0	17.8	18.6	19.8	20.9	22.1	23.5	25.9	27.9	24.9	26.0
23.82	49.1	51.5	53.7	56.6	58.3	60.6	62.7	64.8	66.9	69.0	71.1	73.2	75.3	77.4	79.5	81.6	83.7	85.8	87.9	90.0
24.94	43.6	45.7	47.7	50.3	52.0	54.0	56.0	58.0	60.0	62.0	64.0	66.0	68.0	70.0	72.0	74.0	76.0	78.0	80.0	82.0

X-RAY CROSS SECTIONS (Continued)  
Table II. Total Cross Section in cm<sup>2</sup>/g (Continued)

Z keV	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg
4.51	455	473	503	510	546	568	589	615	644	664	696	720	736	753	796	824	871	934	906	938
4.93	361	375	398	405	432	449	465	485	508	524	549	568	581	598	631	653	688	734	720	760
5.41	285	295	313	319	339	352	363	380	397	410	430	445	455	470	496	512	540	572	568	598
5.90	229	237	251	256	271	281	290	303	317	327	343	355	363	378	397	410	431	455	457	480
5.95	224	232	245	250	265	275	283	296	310	319	335	347	355	369	388	401	422	444	447	469
6.40	186	192	203	207	219	227	234	244	255	263	276	286	293	306	321	332	348	365	371	388
6.49	476	185	195	200	211	219	225	235	246	254	266	276	282	295	310	320	336	351	358	375
6.93	401	412	165	170	179	185	190	198	207	214	225	233	238	250	262	270	283	295	303	317
7.06	536	392	420	161	170	176	181	185	197	204	214	222	227	238	249	257	270	281	289	302
7.47	535	475	361	369	147	152	156	163	170	175	184	191	195	206	215	222	233	241	250	261
7.65	503	446	477	347	367	143	146	153	160	165	173	180	184	194	203	209	219	226	236	246
8.04	441	454	418	427	322	337	128	134	140	145	152	158	162	171	178	184	192	198	208	216
8.27	410	422	450	397	420	313	333	125	131	135	142	147	150	159	166	171	179	184	194	202
8.63	366	376	401	410	375	392	296	318	117	120	126	131	134	142	149	153	160	164	174	180
8.91	336	347	369	377	400	360	272	292	289	111	117	121	124	132	137	141	148	151	161	167
9.57	278	287	305	312	330	344	364	336	239	232	247	256	103	110	114	118	123	125	134	139
17.44	55.5	58.0	61.2	62.8	66.8	68.9	72.1	75.6	79.0	80.2	84.2	86.3	89.5	95.8	98.7	100	103	109	111	115
19.61	40.5	42.4	44.7	46.0	48.9	50.4	52.8	55.1	57.9	59.2	62.0	64.2	66.1	70.6	72.5	74.1	77.2	80.2	82.3	85.3
20.17	37.6	39.3	41.5	42.6	45.3	46.7	48.9	51.0	53.8	55.0	57.6	59.7	61.4	65.5	67.3	68.9	71.9	74.6	76.5	79.4
21.13	33.1	34.7	36.6	37.6	40.0	41.2	43.2	45.0	47.5	48.7	51.0	52.9	54.4	58.0	59.5	61.1	63.8	66.0	67.8	70.4
22.11	29.3	30.7	32.4	33.3	35.4	36.5	38.3	39.8	42.1	43.2	45.3	46.9	48.3	51.4	52.8	54.2	56.8	58.6	60.2	62.6
22.72	27.1	28.5	30.1	30.9	32.9	33.9	35.6	37.0	39.1	40.2	42.1	43.7	44.9	47.8	49.1	50.5	52.9	54.5	56.0	58.3
23.82	23.9	25.1	26.5	27.3	29.0	29.9	31.4	32.6	34.5	35.5	37.2	38.6	39.7	42.2	43.3	44.6	46.8	48.2	49.5	51.7
24.94	21.1	22.2	23.4	24.1	25.6	26.4	27.8	28.8	30.6	31.5	33.0	34.2	35.2	37.4	38.4	39.6	41.6	42.7	43.9	45.9

Z keV	81 Tl	82 Pb	83 Bi	86 Rn	90 Th	92 U	95 Pu
4.51	991	1035	1066	1174	1098	1084	960
4.93	785	820	847	930	993	862	1023
5.41	617	645	667	731	844	774	803
5.90	494	517	536	586	678	672	731
5.95	483	505	524	573	663	657	772
6.40	400	418	435	474	549	545	638
6.49	386	403	419	458	530	526	615
6.93	326	341	355	387	449	446	520
7.06	311	325	338	369	428	425	495
7.47	268	280	293	318	370	368	427
7.65	253	264	276	300	348	347	402
8.04	222	232	243	264	307	306	353
8.27	207	216	227	246	286	285	329
8.63	185	194	203	220	256	256	294
8.91	171	179	188	203	237	236	271
9.57	142	149	156	169	197	197	225
17.44	119	123	126	117	99.5	96.7	48.8
19.61	88.3	90.6	93.5	101	73.3	72.6	79.0
20.17	82.0	84.1	87.0	93.8	95.0	67.8	73.7
21.13	72.7	74.5	77.2	83.3	97.2	84.2	65.7
22.11	64.6	66.1	68.7	74.1	86.3	86.9	58.8
22.72	60.1	61.5	64.0	69.1	80.3	81.1	76.4
23.82	53.2	54.4	56.7	61.2	71.0	72.1	78.3
24.94	47.2	48.2	50.4	54.4	62.9	64.2	69.8



## ION EXCHANGE RESINS

### ANION EXCHANGE RESINS

The following table is divided into two parts; the first lists properties of some anionic resins and the second, properties of some cationic resins.

Character S=strong W=weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity: meq/ml	Total exchange capacity: meq/gm	Maximum thermal stability: °C	Physical form: s = sphere b = beads	Standard mesh range	Ionic form as shipped	Shipping density: lb./cu. ft.
S	Dowex 1	1	Trimethyl benzyl ammonium	Polystyrene	0-14	Cl/H approx. 25	I, NO <sub>3</sub> , Br, Cl, Acetate, OH, F	1.33	3.5	OH <sup>-</sup> 50 Cl <sup>-</sup> 150	s	20-50 (wet)	Cl <sup>-</sup>	44
S	Dowex 21 K	1	Trimethyl benzyl ammonium	Polystyrene	0-14	Cl/H approx. 15	I, NO <sub>3</sub> , Br, Cl, Acetate, OH, F	1.25	4.5	OH <sup>-</sup> 50 Cl <sup>-</sup> 150	s	20-50 (wet)	Cl <sup>-</sup>	43
S	Duolite A-101 D	2	Quaternary ammonium	Polystyrene	0-14	--	--	1.4	4.2	OH <sup>-</sup> 60 Cl <sup>-</sup> 100	b	16-50	Cl <sup>-</sup>	--
S	Ionac A-540	3	Quaternary ammonium	Polystyrene	0-14	--	--	1.0	3.6	salt 100 OH <sup>-</sup> 60	b	16-50	salt	43-66
S	Dowex 2	1	Dimethyl ethanol benzyl ammonium	Polystyrene	0-14	Cl/H approx. 1.5	I, NO <sub>3</sub> , Br, Cl, Acetate, OH, F	1.33	3.5	OH <sup>-</sup> 30 Cl <sup>-</sup> 150	s	20-50 (wet)	Cl <sup>-</sup>	44
S	Duolite A-102 D	2	Quaternary ammonium	Polystyrene	0-14	--	--	1.4	4.2	OH <sup>-</sup> 40 Cl <sup>-</sup> 100	b	16-50	Cl <sup>-</sup>	--
S	Ionac A-550	3	Dimethyl ethanol benzyl ammonium	Polystyrene	0-14	--	--	1.3	3.5	salt 100 OH <sup>-</sup> 40	b	16-50	salt	43-46
W	Duolite A-30 B	2	Tertiary amine; Quaternary ammonium	Epoxy polyamines	0-9	--	--	2.6	8.7	80	b	16-50	salt	--
W	Ionac A-300	3	Tertiary amine; Quaternary ammonium	Epoxy amine	0-12	--	--	1.8	5.5	40	g	16-50	salt	19-21
W	Duolite A-6	2	Tertiary amine	Phenolic	0-5	--	--	2.4	7.6	60	g	16-50	salt	--
W	Duolite A-7	2	Secondary amine	Phenolic	0-4	--	--	2.4	9.1	40	g	16-50	salt	--

### CATION EXCHANGE RESINS

Character S=strong W=weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity: meq/ml	Total exchange capacity: meq/mg	Maximum thermal stability: °C	Physical form: s = sphere b = beads	Standard mesh range	Ionic form as shipped	Shipping density: lb./cu. ft.
S	Dowex 50	1	Nuclear sulfonic acid	Polystyrene	0-14	Na/H approx. 1.2	Ag, Cs, Rb, K, NH <sub>4</sub> , Na, H, Li, Ba, Sr, Ca, Mg, Be	Na <sup>+</sup> 1.9 H <sup>+</sup> 1.7	Na <sup>+</sup> 4.8 H <sup>+</sup> 5.0	150	s	20-50 (wet)	H <sup>+</sup> or Na <sup>+</sup>	H <sup>+</sup> 50 Na <sup>+</sup> 53
S	Dowex MPC-1	4	Nuclear sulfonic acid	Polystyrene	0-14	--	--	1.6-1.8 H <sup>+</sup> form	4.5-4.9 H <sup>+</sup> form	150	b	20-40 (wet)	Na <sup>+</sup>	50
S	Duolite C-20	2	Nuclear sulfonic acid	Polystyrene	0-14	--	--	2.2	5.1	150	b	16-50	Na <sup>+</sup>	--
S	Ionac 240	3	Nuclear sulfonic acid	Polystyrene	0-14	--	--	1.9	4.6	140 (Na <sup>+</sup> ) 130 (H <sup>+</sup> )	b	16-50	Na <sup>+</sup>	50-55
S	Duolite C-3	2	Methylene sulfonic	Phenolic	0-9	--	--	1.1	2.9	60	g	16-50	H <sup>+</sup>	--
W	Dowex CCR-1	4	Carboxylic	Phenolic	0-9	--	--	--	--	38	g	20-50 (wet)	H <sup>+</sup> (dry)	21
W	Duolite ES-63	2	Phosphonic	Polystyrene	4-14	--	--	3.3	6.5	100	b	16-50	H <sup>+</sup>	--
W	Duolite ES-80	2	Aliphatic	Acrylic	6-14	--	--	3.5	10.2	100	b	16-50	H <sup>+</sup>	--

- \* 1. Dow
- 2. Diamond Shamrock
- 3. Ionac
- 4. Nalco

# LATTICE CONSTANTS FOR CUBIC CRYSTALS

From Volume 14, pages 689, 690, and 691 of the Analytical Edition of *Industrial and Engineering Chemistry*, with permission.

$a/\text{\AA}$	Substance	$a/\text{\AA}$	Substance
3.56	A 4 C (diamond)	4.44	ScN
5.42	Si	4.446	TaC
5.62	Ge	4.458	HfC
6.46	$\alpha$ -Sn	4.615	NaF
		4.62	ZrN
	A 1 Ni	4.69	CdO
3.517	$\alpha$ -Co	4.69	ZrC
3.554	Taenite (57.7% Fe, 40.8% Ni, 0.5% P)	4.80	CaO
3.60	Cu	4.82	( $\text{Na}_2\text{CeO}_3$ )
3.608	$\gamma$ -Fe (1370 K.)	4.84	( $\text{Na}_2\text{PrO}_3$ )
3.63	Rh	4.88	NaH
3.797	Ir	4.92	AgF
3.831	Pd	5.006	CaNH
3.880	Pd-H	5.13	SrO
3.88—4.04	Pt	5.14	LiCl
3.912	Al	5.14	NdN
4.041	Au	5.19	MgS
4.070	Ag	5.192	MnS (130 K.)
4.077	Co-N	5.210	MnS (299 K.)
4.30	Ti-H	5.33	KF
4.40—4.46	Ne (4 K.)	5.45	MgSe
4.52	Zr-H	5.45	MnSe
4.66	$\beta$ -Ti	5.45	SrNH
4.84	Pb	5.49	LiBr
4.939	Th	5.52	BaO
5.08	$\alpha$ -Ce	5.545	AgCl
5.14	$\beta$ -La	5.55—5.76	AgCl-AgBr
5.296	A (4 K.)	5.627	NaCl
5.43	Ca	5.63	RbF
5.56	Kr (20 K.)	5.68	CaS
5.59	Kr (92 K.)	5.69	SnAs
5.70	Sr	5.70	KH
6.05	X (88 K.)	5.755	AgBr
6.20		5.76—5.92	AgBr-AgI
	A 2 $\alpha$ -Fe	5.83	NdP
2.861	$\alpha$ -Cr	5.83	NaCN
2.875	$\beta$ -Fe (1070 K.)	5.84	BaNH
2.90	$\delta$ -Fe (1700 K.)	5.87	SrS
2.93	V	5.91	CaSe
3.03	V-C	5.94	PbS
3.03—3.41	Mo	5.95	NaBr
3.140	W	5.957	EuS
3.157	Cb	5.96	NdAs
3.295	Ta	6.00	PrAs
3.30	$\beta$ -Ti (1200 K.)	6.00	LiI
3.32	Li (~80 K.)	6.01	CsF
3.46	Li	6.04	RbH
3.50	Li	6.05	$\beta$ -NaSH (>360 K.)
3.61	$\beta$ -Zr (1120 K.)	6.06	CeAs
4.24	Na (~80 K.)	6.13	LaAs
4.29	Na	6.14	PbSe
5.02	Ba	6.23	SrSe
5.20	K (120 K.)	6.278	KCl
5.33	K	6.285	SnTe
5.62	Rb (~80 K.)	6.31	NdSb
6.05	Cs (~80 K.)	6.345	CaTe
	B 1 LiF	6.35	PrSb
4.018	LiD	6.36	BaS
4.065	VO	6.38	CsH
4.08	LiH	6.40	CeSb
4.09	( $\text{Li}_2\text{TiO}_3$ )	6.44	PbTe
4.12	( $\text{Li}_2\text{TiO}_3$ -MgO)	6.462	NaI
4.12—4.20	VN	6.45	PrBi
4.13	CrN	6.48	LaSb
4.14	VC	6.49	CeBi
4.14	( $63\text{Li}_2\text{Fe}_2\text{O}_4 \cdot 37\text{Li}_2\text{TiO}_3$ )	6.53	KCN
4.142	NiO	6.53	$\text{NH}_4\text{Cl}$ (>457 K.)
4.173	MgO	6.56	RbCl
4.207	MgO (1570 K.)	6.57	LaBi
4.282	TiN	6.58	KBr
4.225	TiO	6.59	BaSe
4.235	80 TiN-20 TiC	6.60	$\beta$ -KSH (>440 K.)
4.24	CoO	6.65	SrTe
4.27	V-N	6.82	RbCN
4.28	FeO (160 K.)	6.86	RbBr
4.283	FeO (299 K.)	6.90	$\text{NH}_4\text{Br}$ (>411 K.)
4.290	VC ( $\epsilon$ -phase)	6.93	$\beta$ -RbSH (470 K.)
4.30	TiC	6.99	BaTe
4.315	CbC	7.052	KI
4.40	CbN	7.10	$\beta$ -CsCl (>730 K.)
4.41	MnO (117 K.)	7.24	$\text{NH}_4\text{I}$ (>255 K.)
4.426	MnO (299 K.)	7.325	RbI
4.436		6.96 $\pm$ 0.04	H 0 <sub>s</sub> AgClO <sub>4</sub> (453 $\pm$ 20 K.)

LATTICE CONSTANTS FOR CUBIC CRYSTALS (continued)

$a/\text{\AA}$	Substance	$a/\text{\AA}$	Substance
7.16 ± 0.10	NaClO <sub>4</sub> (618 ± 35 K.)	3.86	CeCd
7.49 ± 0.02	KClO <sub>4</sub> (598 ± 15 K.)	3.88	MgPr
7.65 ± 0.05	TlClO <sub>4</sub> (553 K.)	3.90	LaCd
7.65 ± 0.02	NH <sub>4</sub> ClO <sub>4</sub> (528 ± 15 K.)	3.97	TlBr
7.68 ± 0.03	RbClO <sub>4</sub> (583 ± 10 K.)	3.98	TlBi
7.97 ± 0.01	CsClO <sub>4</sub> (513 ± 10 K.)	4.024	SrTi
		4.05	NH <sub>4</sub> Br (<411 K.)
4.255	B 3 CuF	4.112	CsCl
4.36	CSi IV	4.20	TlI
4.855	BeS	4.20	CsCl (<720 K.)
5.10	BeSe	4.25	CsCN
5.304	(Cu, Fe, Mo, Sn) <sub>4</sub> (S, As, Te) <sub>2</sub> , cousite	4.287	CsBr
5.41	CuCl	4.29	CsSH
5.425	β-ZnS	4.37	NH <sub>4</sub> I (290 K.)
5.43	AlP	4.56	CsI
5.44	GaP		
5.58	BeTe	4.07	D 2 <sub>1</sub> YB <sub>6</sub>
5.60	MnS (red)	4.07	ErB <sub>6</sub>
5.63	AlAs	4.10	NdB <sub>6</sub>
5.635	GaAs	4.12	GdB <sub>6</sub>
5.655	ZnSe	4.12	PrB <sub>6</sub>
5.68	CuBr	4.13	CeB <sub>6</sub>
5.82	β-CdS	4.13	YbB <sub>6</sub>
5.84	HgS	4.14	CaB <sub>6</sub>
5.86	InP	4.15	LaB <sub>6</sub>
6.04	CdSe	4.15	ThB <sub>6</sub>
6.04	InAs	4.19	SrB <sub>6</sub>
6.05	CuI	4.33	BaB <sub>6</sub>
6.07	HgSe		
6.08	ZnTe		
6.103	α-Cu <sub>2</sub> HgI <sub>4</sub>	4.33	C 1 Be <sub>2</sub> C
6.12	AlSb	4.619	Li <sub>2</sub> O
6.12	GaSb	5.06	(3ZrO <sub>2</sub> · MgO)
6.13	SnSb	5.07	ZrO <sub>2</sub>
6.383	α-Ag <sub>2</sub> HgI <sub>4</sub>	5.08	(95ZrO <sub>2</sub> · 5CeO <sub>2</sub> )
6.40	HgTe	5.13	(95HfO <sub>2</sub> · 5CeO <sub>2</sub> )
6.43	CdTe	5.38	PrO <sub>2</sub>
6.45	InSb	5.40	CeO <sub>2</sub>
6.48	AgI	5.40	CdF <sub>2</sub>
		5.406	CuF <sub>2</sub>
6.195	B 32 LiGa	5.45	CaF <sub>2</sub>
6.209	LiZn	5.47	UO <sub>2</sub>
6.36	LiAl	5.526	(66CaF <sub>2</sub> · 33YF <sub>3</sub> )
6.687	LiCd	5.53	(91CaF <sub>2</sub> · 9ThF <sub>4</sub> )
6.786	LiIn	5.54	HgF <sub>2</sub>
7.297	NaIn	5.55	Na <sub>2</sub> O
7.373	(CeMg <sub>3</sub> )	5.58	ThO <sub>2</sub>
7.373	(PrMg <sub>3</sub> )	5.59	Cu <sub>2</sub> S
7.473	NaTl	5.704	Li <sub>2</sub> S
		5.749	Cu <sub>2</sub> Se
4.437	B 20 NiSi	5.782	SrF <sub>2</sub>
4.438	FeSi	5.796	EuF <sub>2</sub>
4.438	CoSi	5.838	(66SrF <sub>2</sub> · 33LaF <sub>3</sub> )
4.548	MnSi	5.91	PtAl <sub>3</sub>
4.620	CrSi	5.91	PtGa <sub>2</sub>
		5.935	β-PbF <sub>2</sub> (520 K.)
2.603	B 2 NiBe	5.99	Al <sub>2</sub> Au
2.606	CoBe	6.005	Li <sub>2</sub> Se
2.69	CuBe	6.06	AuGa <sub>2</sub>
2.813	PdBe	6.19	BaF <sub>2</sub>
2.82	AlNi	6.34	Mg <sub>2</sub> Si
2.945	CuZn	6.35	PtIn <sub>2</sub>
2.989	CuPd	6.368	RaF <sub>2</sub>
3.146	AuZn	6.379	Mg <sub>2</sub> Ge
3.156	AgZn	6.436	K <sub>2</sub> O
3.168	AgLi	6.50	Li <sub>2</sub> Te
3.259	AuMg	6.50	AuIn <sub>2</sub>
3.275	AgMg	6.526	Na <sub>2</sub> S
3.287	HgLi	6.763	Mg <sub>2</sub> Sn
3.325	AgCd	6.809	Na <sub>2</sub> Se
3.34	AuCd (670 K.)	6.81	Mg <sub>2</sub> Pb
3.424	LiTi	6.98	SrCl <sub>2</sub>
3.442	HgMg	7.314	Na <sub>2</sub> Te
3.628	MgTi	7.38	K <sub>2</sub> S
3.67	PrZn	7.65	RbS <sub>2</sub>
3.70	CeZn	7.676	K <sub>2</sub> Se
3.73	AlNd	8.152	K <sub>2</sub> Te
3.74	α-RbCl (83 K.)		
3.75	LaZn	5.94	C 15 Be <sub>2</sub> Cu
3.82	TlCn	6.287	Be <sub>2</sub> Ag
3.82	PrCd	6.435	Be <sub>2</sub> Ti
3.84	TlSb	6.96	MgNiZn
3.835	TlCl	7.03	Cu <sub>2</sub> Mg
3.847	CaTi	7.61	W <sub>2</sub> Zr
3.86	NH <sub>4</sub> Cl (<457 K.)	7.79	Au <sub>2</sub> Na

LATTICE CONSTANTS FOR CUBIC CRYSTALS (continued)

$a/\text{\AA}$	Substance	$a/\text{\AA}$	Substance
7.91	Au <sub>2</sub> Pb	3.83	NaWO <sub>3</sub>
7.94	Au <sub>2</sub> Bi	3.85	(Na, Ce, Ca)(Ti, Cb)O <sub>3</sub> Loparite
8.02	Al <sub>2</sub> Ca	3.88	NaTaO <sub>3</sub>
8.04	Al <sub>2</sub> Ce	3.89	LaGaO <sub>3</sub>
8.16	Al <sub>2</sub> La	3.89	NaCbO <sub>3</sub>
9.50	Bi <sub>2</sub> K	3.91	SrTiO <sub>3</sub>
		3.92	CaSnO <sub>3</sub>
5.41	C 2	3.97	BaTiO <sub>3</sub>
5.42	FeS <sub>2</sub>	3.98	KTaO <sub>3</sub>
5.57	(Fe, Ni)S <sub>2</sub> (6.5% Ni)	3.99	CaZrO <sub>3</sub>
5.57	RbS <sub>2</sub>	4.00	KMgF <sub>3</sub>
5.57	RuS <sub>2</sub>	4.005	KNiF <sub>3</sub>
	Bravoite (53.8% NiS <sub>2</sub> , 39.1% FeS <sub>2</sub> , 7.1% CoS <sub>2</sub> )	4.01	KCBO <sub>3</sub>
5.62	OsS <sub>2</sub>	4.03	SrSnO <sub>3</sub>
5.64	CoS <sub>2</sub>	4.05	KZnF <sub>3</sub>
5.65	(Cu, Ni, Co, Fe)(S, Se) <sub>2</sub>	4.07	KCOF <sub>3</sub>
5.68	PtP <sub>2</sub>	4.07	SrHfO <sub>3</sub>
5.74	NiS <sub>2</sub>	4.09	SrZrO <sub>3</sub>
5.85	CoSe <sub>2</sub>	4.18	BaZrO <sub>3</sub>
5.92	RuSe <sub>2</sub>	4.35	BaPrO <sub>3</sub>
5.93	OsSe <sub>2</sub>	4.38	BaCeO <sub>3</sub>
5.94	PtAs <sub>2</sub>	4.46	KIO <sub>3</sub>
5.97	PdAs <sub>2</sub>	4.48	BaThO <sub>3</sub>
6.02	NiSe <sub>2</sub>	4.5	NH <sub>4</sub> IO <sub>3</sub>
6.096	MnS <sub>2</sub>	4.52	RbIO <sub>3</sub>
6.36	RuTe <sub>2</sub>	4.66	CsIO <sub>3</sub>
6.37	OsTe <sub>2</sub>	5.12	MgZrO <sub>3</sub>
6.43	PtSb <sub>2</sub>	5.20	CsCdCl <sub>3</sub>
6.44	PdSb <sub>2</sub>	5.33	CsCdBr <sub>3</sub>
6.64	AuSb <sub>2</sub>	5.44	CsHgCl <sub>3</sub>
6.94	MnTe <sub>2</sub>	5.77	CsHgBr <sub>3</sub>
			G 0 <sub>3</sub>
4.25	Cu <sub>2</sub> O	6.57	NaClO <sub>3</sub>
4.73	Ag <sub>2</sub> O	6.71	NaBrO <sub>3</sub>
			G 2 <sub>1</sub>
5.55	F 1	7.60	Ca(NO <sub>3</sub> ) <sub>2</sub>
5.68	CoAsS	7.81	Sr(NO <sub>3</sub> ) <sub>2</sub>
5.90	NiAsS	7.84	Pb(NO <sub>3</sub> ) <sub>2</sub>
	NiSbS	8.11	Ba(NO <sub>3</sub> ) <sub>2</sub>
	(Ni, Fe)AsS, plessite		
	Ni(As, Sb)S, corynite		
	Ni(Sb, Bi)S, kallilite	8.045	H 1 <sub>1</sub>
	(Co, Ni)SbS, willyamite	8.07	NiAl <sub>2</sub> O <sub>4</sub>
		8.07	CuAl <sub>2</sub> O <sub>4</sub>
		8.07	CoCo <sub>2</sub> O <sub>4</sub>
		8.07	MgAl <sub>2</sub> O <sub>4</sub>
		8.08	CoAl <sub>2</sub> O <sub>4</sub>
		8.08	ZnAl <sub>2</sub> O <sub>4</sub>
		8.10	FeAl <sub>2</sub> O <sub>4</sub>
		8.11	(Ni, Co)(Co, Ni) <sub>2</sub> O <sub>4</sub>
		8.11	(Zn, Co)Co <sub>2</sub> O <sub>4</sub>
		8.11	MgCo <sub>2</sub> O <sub>4</sub>
		8.27	MnAl <sub>2</sub> O <sub>4</sub>
		8.27	(Mn, Co)(Co, Mn) <sub>2</sub> O <sub>4</sub>
			H 1 <sub>1</sub>
		8.28	MgGa <sub>2</sub> O <sub>4</sub>
		8.30	NiCr <sub>2</sub> O <sub>4</sub>
		8.30	MgCr <sub>2</sub> O <sub>4</sub>
		8.31	ZnCr <sub>2</sub> O <sub>4</sub>
		8.32	CoCr <sub>2</sub> O <sub>4</sub>
		8.32	ZnGa <sub>2</sub> O <sub>4</sub>
		8.35	NiFe <sub>2</sub> O <sub>4</sub>
		8.35	Cu <sub>2</sub> Cr <sub>2</sub> O <sub>4</sub>
		8.35	FeCr <sub>2</sub> O <sub>4</sub>
		8.36	MgFe <sub>2</sub> O <sub>4</sub>
		8.38	CoFe <sub>2</sub> O <sub>4</sub>
		8.38	NiMn <sub>2</sub> O <sub>4</sub>
		8.40	ZnFe <sub>2</sub> O <sub>4</sub>
		8.40	FeFe <sub>2</sub> O <sub>4</sub>
		8.42	(Mn, Mg)Fe <sub>2</sub> O <sub>4</sub>
		8.42	TiCo <sub>2</sub> O <sub>4</sub>
		8.43	MnCr <sub>2</sub> O <sub>4</sub>
		8.43	TiMg <sub>2</sub> O <sub>4</sub>
		8.43	TiZn <sub>2</sub> O <sub>4</sub>
		8.44	CuFe <sub>2</sub> O <sub>4</sub>
		8.47	FeV <sub>2</sub> O <sub>4</sub>
		8.49	MnCr <sub>2</sub> O <sub>4</sub>
		8.50	TiFe <sub>2</sub> O <sub>4</sub>
		8.54	MnFe <sub>2</sub> O <sub>4</sub>
		8.58	CdCr <sub>2</sub> O <sub>4</sub>
		8.58	SnMg <sub>2</sub> O <sub>4</sub>
		8.61	SnCo <sub>2</sub> O <sub>4</sub>
		8.63	SnZn <sub>2</sub> O <sub>4</sub>
		8.67	CdFe <sub>2</sub> O <sub>4</sub>
		8.67	TiMn <sub>2</sub> O <sub>4</sub>
		8.81	MgIn <sub>2</sub> O <sub>4</sub>
		9.26	Ag <sub>2</sub> MoO <sub>4</sub>
8.13	D 5 <sub>1</sub>		
9.37	Be <sub>2</sub> N <sub>2</sub>		
9.42	(Mn, Fe) <sub>2</sub> O <sub>3</sub>		
9.74	Mn <sub>2</sub> O <sub>3</sub>		
9.79	Zn <sub>3</sub> N <sub>2</sub>		
9.79	Sc <sub>2</sub> O <sub>3</sub>		
9.94	Mg <sub>3</sub> N <sub>2</sub>		
10.12	In <sub>2</sub> O <sub>3</sub>		
10.15	Be <sub>3</sub> P <sub>2</sub>		
10.37	Lu <sub>2</sub> O <sub>3</sub>		
10.39	Yb <sub>2</sub> O <sub>3</sub>		
10.52	Tm <sub>2</sub> O <sub>3</sub>		
10.54	Er <sub>2</sub> O <sub>3</sub>		
10.57	Tl <sub>2</sub> O <sub>3</sub>		
10.58	Ho <sub>2</sub> O <sub>3</sub>		
10.60	Y <sub>2</sub> O <sub>3</sub>		
10.63	Dy <sub>2</sub> O <sub>3</sub>		
10.70	Tb <sub>2</sub> O <sub>3</sub>		
10.79	Gd <sub>2</sub> O <sub>3</sub>		
10.79	Cd <sub>2</sub> N <sub>2</sub>		
10.84	Eu <sub>2</sub> O <sub>3</sub>		
10.85	Sm <sub>2</sub> O <sub>3</sub>		
11.05	Nd <sub>2</sub> O <sub>3</sub>		
11.40	$\alpha$ -Ca <sub>2</sub> N <sub>2</sub>		
12.02	Mg <sub>3</sub> P <sub>2</sub>		
12.33	Mg <sub>3</sub> As <sub>2</sub>		
11.05	D 6 <sub>1</sub>		
11.14	As <sub>2</sub> O <sub>3</sub>		
	Sb <sub>2</sub> O <sub>3</sub>		
10.32	D 1 <sub>1</sub>		
11.25	ZrCl <sub>4</sub>		
(11.34)	TiBr <sub>4</sub>		
(11.62)	(CBr <sub>4</sub> ) (>320 K.)		
11.89	(Cl <sub>4</sub> )		
11.99	GeI <sub>4</sub>		
12.00	SiI <sub>4</sub>		
12.23	TiI <sub>4</sub>		
	SnI <sub>4</sub>		
	E 2 <sub>1</sub>		
3.67	YAlO <sub>3</sub>		
3.75	CdTiO <sub>3</sub>		
3.78	LaAlO <sub>3</sub>		
3.80	CaTiO <sub>3</sub>		



LATTICE CONSTANTS FOR CUBIC CRYSTALS (continued)

$a/\text{\AA}$	Substance	$a/\text{\AA}$	Substance
9.4	CoCo <sub>2</sub> S <sub>4</sub>	10.47	Mg(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>
9.45	(Co, Ni) <sub>3</sub> S <sub>4</sub>	10.48	K <sub>2</sub> SnBr <sub>6</sub>
9.46	CuCo <sub>2</sub> O <sub>4</sub>	10.51	Co(NH <sub>3</sub> ) <sub>6</sub> SO <sub>4</sub> Br
9.5	NiN <sub>2</sub> S <sub>4</sub>	10.52	Mn(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>
9.92	ZnCr <sub>2</sub> S <sub>4</sub>	10.54	Sr <sub>2</sub> Ni(NO <sub>2</sub> ) <sub>6</sub>
10.05	MnCr <sub>2</sub> S <sub>4</sub>	10.55	Pb <sub>2</sub> Ni(NO <sub>2</sub> ) <sub>6</sub>
10.19	CdCr <sub>2</sub> S <sub>4</sub>	10.57	(NH <sub>3</sub> ) <sub>2</sub> SnBr <sub>4</sub>
12.54	K <sub>2</sub> Zn(CN) <sub>4</sub>	10.58	Rb <sub>2</sub> SnBr <sub>4</sub>
12.76	K <sub>2</sub> Hg(CN) <sub>4</sub>	10.62	Co(NH <sub>3</sub> ) <sub>5</sub> H <sub>2</sub> OSO <sub>4</sub> I
12.84	K <sub>2</sub> Cd(CN) <sub>4</sub>	10.63	Co(NH <sub>3</sub> ) <sub>6</sub> SeO <sub>4</sub> Br
	H 5 <sub>8</sub>	10.67	Ba <sub>2</sub> Ni(NO <sub>2</sub> ) <sub>6</sub>
10.08	2Na <sub>2</sub> SO <sub>4</sub> · NaCl · NaF	10.71	Ca(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>
	H 4 <sub>13</sub>	10.71	Co(NH <sub>3</sub> ) <sub>6</sub> SO <sub>4</sub> I
12.11	KCr(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.77	Cs <sub>2</sub> SnBr <sub>4</sub>
12.12	KAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.79	Co(NH <sub>3</sub> ) <sub>6</sub> SeO <sub>4</sub> I
12.15	NH <sub>4</sub> Al(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.9	Ni(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
12.20	RbAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.91	Co(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
12.21	TlAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.96	Zn(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
12.31	CsAl(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O	10.97	Fe(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
12.44	NH <sub>3</sub> · CH <sub>3</sub> Al(SO <sub>4</sub> ) <sub>2</sub> · 12H <sub>2</sub> O (β-alum)	10.98	Mg(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
	Langbeinite	11.04	Mn(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
9.93	K <sub>2</sub> Mg(SO <sub>4</sub> ) <sub>2</sub>	11.04	Cd(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
10.2	K <sub>2</sub> (Ca <sub>2</sub> Mg)SO <sub>4</sub> ) <sub>2</sub>	11.24	Ca(NH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
	H 2 <sub>1</sub>	11.27	Ni(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
6.00	Ag <sub>3</sub> PO <sub>4</sub>	11.3	Co(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
6.120	Ag <sub>3</sub> AsO <sub>4</sub> (90 K)	(11.3)	Zn(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
6.130	Ag <sub>3</sub> AsO <sub>4</sub> (380 K)	11.34	Mg(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
	H 2 <sub>4</sub>	11.34	Fe(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
5.37	Cu <sub>3</sub> VS <sub>4</sub>	11.37	Mn(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
	J 1 <sub>1</sub>	11.38	Cd(NH <sub>3</sub> ) <sub>6</sub> (BF <sub>4</sub> ) <sub>2</sub>
8.17	K <sub>2</sub> SiF <sub>6</sub>	11.41	Ni(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.35	(NH <sub>4</sub> ) <sub>2</sub> SiF <sub>6</sub>	11.43	Co(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.38	Rb <sub>2</sub> CrF <sub>6</sub> · H <sub>2</sub> O	11.46	Ni(NH <sub>3</sub> ) <sub>6</sub> (SO <sub>3</sub> F) <sub>2</sub>
8.41	Tl <sub>2</sub> CrF <sub>6</sub> · H <sub>2</sub> O	11.49	Co(NH <sub>3</sub> ) <sub>6</sub> (SO <sub>3</sub> F) <sub>2</sub>
8.42	(NH <sub>4</sub> ) <sub>2</sub> VF <sub>6</sub> · H <sub>2</sub> O	11.52	Fe(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.42	Rb <sub>2</sub> VF <sub>6</sub> · H <sub>2</sub> O	11.53	Mg(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.45	Tl <sub>2</sub> VF <sub>6</sub> · H <sub>2</sub> O	11.54	Cd(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>
8.45	Rb <sub>2</sub> SiF <sub>6</sub>	11.54	Fe(NH <sub>3</sub> ) <sub>6</sub> (SO <sub>3</sub> F) <sub>2</sub>
8.58	Tl <sub>2</sub> SiF <sub>6</sub>	11.58	Mn(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.87	Cs <sub>2</sub> SiF <sub>6</sub>	11.59	Cd(NH <sub>3</sub> ) <sub>6</sub> (ClO <sub>4</sub> ) <sub>2</sub>
8.99	Cs <sub>2</sub> GeF <sub>6</sub>	11.59	Mn(NH <sub>3</sub> ) <sub>6</sub> (SO <sub>3</sub> F) <sub>2</sub>
9.73	K <sub>2</sub> PtCl <sub>6</sub>	11.62	Cd(NH <sub>3</sub> ) <sub>6</sub> (SO <sub>3</sub> F) <sub>2</sub>
9.73	K <sub>2</sub> OsCl <sub>6</sub>	11.91	Ni(NH <sub>3</sub> ) <sub>6</sub> (PF <sub>6</sub> ) <sub>2</sub>
9.76	Tl <sub>2</sub> PtCl <sub>6</sub>	11.94	Co(NH <sub>3</sub> ) <sub>6</sub> (PF <sub>6</sub> ) <sub>2</sub>
9.84	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>6</sub>	12.03	Ni(NH <sub>3</sub> · CH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
9.86	K <sub>2</sub> ReCl <sub>6</sub>	12.05	Co(NH <sub>3</sub> · CH <sub>3</sub> ) <sub>6</sub> I <sub>2</sub>
9.88	Rb <sub>2</sub> PtCl <sub>6</sub>	12.19	{NH(CH <sub>3</sub> ) <sub>2</sub> } <sub>2</sub> SnCl <sub>6</sub>
9.92	Rb <sub>2</sub> TiCl <sub>6</sub>	12.41	{S(CH <sub>3</sub> ) <sub>2</sub> } <sub>2</sub> SnCl <sub>6</sub>
9.94	(NH <sub>4</sub> ) <sub>2</sub> SeCl <sub>6</sub>	12.65	{N(CH <sub>3</sub> ) <sub>2</sub> } <sub>2</sub> PtCl <sub>6</sub>
9.97	K <sub>2</sub> SnCl <sub>6</sub>	12.80	{S(CH <sub>3</sub> ) <sub>2</sub> }(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> SnCl <sub>6</sub>
9.97	Tl <sub>2</sub> SnCl <sub>6</sub>	12.87	{N(CH <sub>3</sub> ) <sub>2</sub> }(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> SnCl <sub>6</sub>
9.98	Rb <sub>2</sub> SeCl <sub>6</sub>	13.17	{N(CH <sub>3</sub> ) <sub>2</sub> }(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> SnCl <sub>6</sub>
10.02	Rb <sub>2</sub> PdBr <sub>6</sub>	13.51	{N(CH <sub>3</sub> )(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> SnCl <sub>6</sub>
10.04	(NH <sub>4</sub> ) <sub>2</sub> SnCl <sub>6</sub>	13.93	{P(CH <sub>3</sub> )(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> SnCl <sub>6</sub>
10.08	Ni(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>2</sub>		J 2 <sub>1</sub> and Related Structures
10.10	Rb <sub>2</sub> SnCl <sub>6</sub>	8.88	Li <sub>3</sub> FeF <sub>6</sub>
10.10	Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>2</sub>	8.90	(NH <sub>4</sub> ) <sub>3</sub> AlF <sub>6</sub>
10.11	Tl <sub>2</sub> TeCl <sub>6</sub>	9.01	(NH <sub>4</sub> ) <sub>2</sub> CrF <sub>6</sub>
10.14	(NH <sub>4</sub> ) <sub>2</sub> PbCl <sub>6</sub>	9.04	(NH <sub>4</sub> ) <sub>2</sub> VF <sub>6</sub>
10.14	K <sub>2</sub> TeCl <sub>6</sub>	9.10	(NH <sub>4</sub> ) <sub>2</sub> FeF <sub>6</sub>
10.15	Fe(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>2</sub>	9.10	(NH <sub>4</sub> ) <sub>2</sub> MoO <sub>2</sub> F <sub>2</sub>
10.16	Mg(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>2</sub>	9.26	Na <sub>2</sub> FeF <sub>6</sub>
10.17	Cs <sub>2</sub> PtCl <sub>6</sub>	9.93	K <sub>2</sub> FeF <sub>6</sub>
	J 1 <sub>1</sub>	9.96	CuLi <sub>2</sub> Fe(CN) <sub>6</sub>
10.18	Rb <sub>2</sub> ZrCl <sub>6</sub>	10.0	CuR <sub>2</sub> Fe(CN) <sub>6</sub> R = Na, K, Rb, NH <sub>4</sub> , Tl
10.18	(NH <sub>4</sub> ) <sub>2</sub> TeCl <sub>6</sub>	10.15	K <sub>2</sub> CdFe(NO <sub>2</sub> ) <sub>6</sub>
10.20	Mn(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>2</sub>	10.17	K <sub>2</sub> CaCo(NO <sub>2</sub> ) <sub>6</sub>
10.20	Rb <sub>2</sub> PbCl <sub>6</sub>	10.19	K <sub>2</sub> CaFe(NO <sub>2</sub> ) <sub>6</sub>
10.22	Cs <sub>2</sub> TiCl <sub>6</sub>	10.2	Fe <sup>III</sup> RFe <sup>II</sup> (CN) <sub>6</sub> R = Na, K, Rb, NH <sub>4</sub>
10.23	Rb <sub>2</sub> TeCl <sub>6</sub>	10.22	K <sub>2</sub> HgFe(NO <sub>2</sub> ) <sub>6</sub>
10.25	Zn(NH <sub>3</sub> ) <sub>6</sub> (ClI <sub>4</sub> ) <sub>2</sub>	10.23	K <sub>2</sub> SrCo(NO <sub>2</sub> ) <sub>6</sub>
10.26	Cs <sub>2</sub> SeCl <sub>6</sub>	10.25	(NH <sub>4</sub> ) <sub>2</sub> CaFe(NO <sub>2</sub> ) <sub>6</sub>
10.30	K <sub>2</sub> OSBr <sub>6</sub>	10.25	NaTi <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.35	Cs <sub>2</sub> SnCl <sub>6</sub>	10.28	K <sub>2</sub> CdNi(NO <sub>2</sub> ) <sub>6</sub>
10.36	K <sub>2</sub> SeBr <sub>6</sub>	10.28	(NH <sub>4</sub> ) <sub>2</sub> CdFe(NO <sub>2</sub> ) <sub>6</sub>
10.36	K <sub>2</sub> PtBr <sub>6</sub>	10.29	K <sub>2</sub> HgNi(NO <sub>2</sub> ) <sub>6</sub>
10.39	Co(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	10.30	K <sub>2</sub> SrFe(NO <sub>2</sub> ) <sub>6</sub>
10.4	Ni(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	10.30	Tl <sub>2</sub> CaFe(NO <sub>2</sub> ) <sub>6</sub>
10.41	Cs <sub>2</sub> ZrCl <sub>6</sub>	10.31	K <sub>2</sub> PbFe(NO <sub>2</sub> ) <sub>6</sub>
10.42	Cs <sub>2</sub> PbCl <sub>6</sub>	10.32	K <sub>2</sub> CaNi(NO <sub>2</sub> ) <sub>6</sub>
10.45	Cs <sub>2</sub> TeCl <sub>6</sub>	10.34	(NH <sub>4</sub> ) <sub>2</sub> SrFe(NO <sub>2</sub> ) <sub>6</sub>
10.45	Co(NH <sub>3</sub> ) <sub>5</sub> H <sub>2</sub> OSO <sub>4</sub> Br	10.37	(NH <sub>4</sub> ) <sub>2</sub> PbFe(NO <sub>2</sub> ) <sub>6</sub>
10.46	(NH <sub>4</sub> ) <sub>2</sub> SeBr <sub>6</sub>	10.37	Tl <sub>2</sub> CdNi(NO <sub>2</sub> ) <sub>6</sub>
10.46	Zn(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	10.37	Tl <sub>2</sub> PbFe(NO <sub>2</sub> ) <sub>6</sub>
10.47	Fe(NH <sub>3</sub> ) <sub>6</sub> Br <sub>2</sub>	10.39	



LATTICE CONSTANTS FOR CUBIC CRYSTALS (continued)

$a/\text{\AA}$		Substance
10.39		NaRb <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.40		Tl <sub>2</sub> SrFe(NO <sub>2</sub> ) <sub>6</sub>
10.4		K <sub>2</sub> PbCo(NO <sub>2</sub> ) <sub>6</sub>
10.41		(NH <sub>4</sub> ) <sub>2</sub> CdNi(NO <sub>2</sub> ) <sub>6</sub>
10.42		Tl <sub>2</sub> HgNi(NO <sub>2</sub> ) <sub>6</sub>
10.43		K <sub>2</sub> BaFe(NO <sub>2</sub> ) <sub>6</sub>
10.45		K <sub>2</sub> BaCo(NO <sub>2</sub> ) <sub>6</sub>
10.45		K <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.46		(NH <sub>4</sub> ) <sub>2</sub> HgNi(NO <sub>2</sub> ) <sub>6</sub>
10.47		Rb <sub>2</sub> HgNi(NO <sub>2</sub> ) <sub>6</sub>
10.49		K <sub>2</sub> SrNi(NO <sub>2</sub> ) <sub>6</sub>
10.49		K <sub>4</sub> Ni(NO <sub>2</sub> ) <sub>6</sub>
10.50		(NH <sub>4</sub> ) <sub>2</sub> BaFe(NO <sub>2</sub> ) <sub>6</sub>
10.54		K <sub>2</sub> LiBi(NO <sub>2</sub> ) <sub>6</sub>
10.55		K <sub>2</sub> PbNi(NO <sub>2</sub> ) <sub>6</sub>
10.55		Tl <sub>2</sub> BaFe(NO <sub>2</sub> ) <sub>6</sub>
10.58		Rb <sub>2</sub> CdNi, Cd(NO <sub>2</sub> ) <sub>6</sub>
10.58		K <sub>2</sub> Ir(NO <sub>2</sub> ) <sub>6</sub>
10.59		Rb <sub>2</sub> LiBi(NO <sub>2</sub> ) <sub>6</sub>
10.6		K <sub>2</sub> PbCu(NO <sub>2</sub> ) <sub>6</sub>
10.63		K <sub>2</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>
10.63		(NH <sub>4</sub> ) <sub>2</sub> LiBi(NO <sub>2</sub> ) <sub>6</sub>
10.64		Tl <sub>2</sub> LiBi(NO <sub>2</sub> ) <sub>6</sub>
10.67		K <sub>2</sub> BaNi(NO <sub>2</sub> ) <sub>6</sub>
10.70		NaCs <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.70		Ba <sub>2</sub> {Rh(NO <sub>2</sub> ) <sub>6</sub> } <sub>2</sub>
10.72		Tl <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.73		Rb <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.73		(NH <sub>4</sub> ) <sub>2</sub> Ir(NO <sub>2</sub> ) <sub>6</sub>
10.73		Tl <sub>2</sub> Ir(NO <sub>2</sub> ) <sub>6</sub>
10.77		Rb <sub>2</sub> Ir(NO <sub>2</sub> ) <sub>6</sub>
10.8		(NH <sub>4</sub> ) <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
10.81		Cs <sub>2</sub> Cd{Ni, Cd(NO <sub>2</sub> ) <sub>6</sub> }
10.82		Co(NH <sub>3</sub> ) <sub>4</sub> H <sub>2</sub> OI <sub>3</sub>
10.83		Rb <sub>2</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>
10.88		K <sub>2</sub> NaBi(NO <sub>2</sub> ) <sub>6</sub>
10.89		Co(NH <sub>3</sub> ) <sub>4</sub> I <sub>3</sub>
10.91		Tl <sub>2</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>
10.91		(NH <sub>4</sub> ) <sub>2</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>
10.94		Cs <sub>2</sub> LiBi(NO <sub>2</sub> ) <sub>6</sub>
10.95		K <sub>2</sub> AgBi(NO <sub>2</sub> ) <sub>6</sub>
10.98		Rb <sub>2</sub> NaBi(NO <sub>2</sub> ) <sub>6</sub>
10.99		(NH <sub>4</sub> ) <sub>2</sub> NaBi(NO <sub>2</sub> ) <sub>6</sub>
11.01		Tl <sub>2</sub> NaBi(NO <sub>2</sub> ) <sub>6</sub>
11.05		Rb <sub>2</sub> AgBi(NO <sub>2</sub> ) <sub>6</sub>
11.06		Tl <sub>2</sub> AgBi(NO <sub>2</sub> ) <sub>6</sub>
11.10		(NH <sub>4</sub> ) <sub>2</sub> AgBi(NO <sub>2</sub> ) <sub>6</sub>
11.15		Cs <sub>2</sub> NaBi(NO <sub>2</sub> ) <sub>6</sub>
11.15		Cs <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>
11.17		Cs <sub>2</sub> Ir(NO <sub>2</sub> ) <sub>6</sub>
11.19		Cs <sub>2</sub> Bi(NO <sub>2</sub> ) <sub>6</sub>
11.19		Cs <sub>2</sub> AgBi(NO <sub>2</sub> ) <sub>6</sub>
11.21		Co(NH <sub>3</sub> ) <sub>4</sub> (BF <sub>4</sub> ) <sub>3</sub>
11.30		Cs <sub>2</sub> Rh(NO <sub>2</sub> ) <sub>6</sub>
11.32		{Co(NH <sub>3</sub> ) <sub>4</sub> ·H <sub>2</sub> O}(ClO <sub>4</sub> ) <sub>3</sub>
11.39		Co(NH <sub>3</sub> ) <sub>4</sub> (ClO <sub>4</sub> ) <sub>3</sub>
11.67		Co(NH <sub>3</sub> ) <sub>4</sub> (PF <sub>6</sub> )
	K 6 <sub>1</sub>	
7.46		SiP <sub>2</sub> O <sub>7</sub>
7.80		TiP <sub>2</sub> O <sub>7</sub>
7.98		SnP <sub>2</sub> O <sub>7</sub>
8.18		HfP <sub>2</sub> O <sub>7</sub>
8.20		ZrP <sub>2</sub> O <sub>7</sub>
8.61		UP <sub>2</sub> O <sub>7</sub>
	S 1 <sub>4</sub>	
11.51		Al <sub>2</sub> (Mg, Fe) <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> , pyrope
11.51		Al <sub>2</sub> Fe <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> , almandite
11.60		Al <sub>2</sub> Mn <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> , spessartite
11.87		Al <sub>2</sub> Ca <sub>2</sub> (SiO <sub>4</sub> ) <sub>3</sub> , grossularite
11.89		(Al, Fe) <sub>2</sub> Ca <sub>2</sub> (SiO <sub>4</sub> ) <sub>3</sub> , hessonite
11.95		Cr <sub>2</sub> Ca <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> , uvarovite
12.03		Fe <sub>2</sub> Ca <sub>3</sub> (SiO <sub>4</sub> ) <sub>3</sub> , andradite
12.10		(Na, Li) <sub>3</sub> AlF <sub>6</sub> , cryolithionite
12.35—12.46		(Mg, Mn) <sub>2</sub> (Ca, Na) <sub>3</sub> AsO <sub>4</sub> <sub>3</sub> , berzelite
	S 6 <sub>1</sub>	
13.68		NaAlSi <sub>2</sub> O <sub>8</sub> H <sub>2</sub> O
	S 0 <sub>6</sub>	
13.82		Al <sub>12</sub> Si <sub>3</sub> O <sub>20</sub> (OH, F) <sub>18</sub> Cl, zunyite
	S 6 <sub>2</sub>	
8.87		Na <sub>4</sub> (AlSiO <sub>4</sub> ) <sub>3</sub> Cl, sodalite
	Tetrahedrite	
10.19		(Cu, Fe) <sub>12</sub> As <sub>4</sub> S <sub>13</sub> , binnite
10.2—10.6		(Cu, Ag) <sub>10</sub> (Zn, Fe) <sub>2</sub> (Sb, As) <sub>4</sub> S <sub>13</sub>

### LATTICE SPACING OF COMMON ANALYZING CRYSTALS

Crystal	Reflection plane	<i>d</i> Spacing (Å)	Crystal	Reflection plane	<i>d</i> Spacing (Å)
ADP <sup>a</sup>	101	5.31	Lead stearate		51
ADP <sup>a</sup>	110	5.325	LiF	200	2.014
ADP <sup>a</sup>	200	3.75	LiF	220	1.424
Beryl	10 $\bar{1}$ 0	7.98	Mica	002	9.96
Calcite	100	3.036	NaCl	200	2.820
EDDT <sup>b</sup>	020	4.404	Oxalic acid	001	5.85
Germanium	111	3.265	PET <sup>d</sup>	002	4.371
Graphite	001	6.69	Quartz	10 $\bar{1}$ 0	4.225
Gypsum	010	7.600	Quartz	10 $\bar{1}$ 1	3.343
KAP <sup>c</sup>	001	13.32	Quartz	11 $\bar{2}$ 0	2.456
KBr	200	3.29	Silicon	111	3.13
KCl	200	3.14	Topaz	303	1.356

While several of the above spacings have been measured to more than four significant figures, no more than four figures are given here because complications introduced by the index of refraction, anomalous dispersion, temperature coefficient of expansion, and crystal impurities must be considered before the additional figures are useful.

<sup>a</sup> Ammonium dihydrogen phosphate.

<sup>b</sup> Ethylenediamine *d*-tartrate.

<sup>c</sup> Potassium acid phthalate.

<sup>d</sup> Pentaerythritol.



## MAGNETIC ROTATORY POWER

The rotation of the plane of polarization of light by transparent substances subjected to a magnetic field may be applied to problems of molecular structure. This rotary effect is known as the Faraday effect. Investigations of this effect by E. Verdet showed the angle of rotation ( $\alpha$ ) to depend on the nature of the substance and to be proportional to the length ( $l$ ) of the column of the substance which the light traverses and to the strength ( $H$ ) of the magnetic field. Thus

$$\alpha = \Lambda/H$$

where  $\Lambda$  is the Verdet constant for the experimental material.

Other symbols in the table have the following significance:

$\lambda$  = Wavelength in  $\mu\text{m}$

$t$  = Temperature in  $^{\circ}\text{C}$

$\rho_m$  = Molecular magnetic rotation of the substance under consideration compared to that of water determined in the same apparatus in the same magnetic field.

Thus

$$\rho_m = M \alpha \rho / M' \alpha' \rho'$$

where  $M$  is the molecular weight,  $\alpha$  the angle of rotation and  $\rho$  the density of the given substance, and  $M'$ ,  $\alpha'$ , and  $\rho'$  are the same quantities of water.

$[\Lambda]_M^{\lambda, t}$  = Molecular rotatory value of the substance at the given temperature and at the wavelength  $\lambda$ . Values are in (radians)(gauss $^{-1}$ )(cm $^{-1}$ ).

Values in this table are reproduced by permission from Volume 3, Tables de Constantes et Donnees Numeriques, "Pouvoir Rotatoire Magnetique, Effet Magneto-Optique de Kerr."

A much greater listing of values for both organic and inorganic compounds is in the above publication.

Formula	Name	$\lambda$	$t$	$Q_m$	$10^4[\Lambda]_M^{\lambda, t}$	$10^4\Lambda^{\lambda, t}$ Verdet
CH <sub>4</sub>	Methane	578	0	—	—	*17.4
CCl <sub>4</sub>	Tetrachloromethane	589	25.1	6.58	45.3	1.60
CHCl <sub>3</sub>	Trichloromethane	589	20.0	5.535	37.98	1.60
CHBr <sub>3</sub>	Tribromomethane	589	17.9	11.63	80.00	3.13
CH <sub>2</sub> O <sub>2</sub>	Formic acid	589	20.8	1.671	11.50	1.046
CH <sub>2</sub> Cl <sub>2</sub>	Dichloromethane	589	11.9	4.31	29.7	1.60
CH <sub>2</sub> Br <sub>2</sub>	Dibromomethane	589	15.9	8.11	55.8	2.74
CH <sub>2</sub> I <sub>2</sub>	Diiodomethane	589	15.0	10.83	129.5	1.51
CH <sub>2</sub> Cl	Monochloromethane	589	23.0	2.99	20.5	1.37
CH <sub>2</sub> Br	Monobromomethane	589	1.5	4.64	31.9	2.04
CH <sub>2</sub> I	Monoiodomethane	589	19.5	9.01	63.2	3.35
CH <sub>3</sub> O	Methylalcohol	589	18.7	1.640	11.28	0.958
CH <sub>3</sub> N	Methylamine	578	—	—	—	*22.7
CF <sub>2</sub> Cl <sub>2</sub>	Diffluorodichloromethane (Freon)	—	—	—	—	*32.7
CH <sub>3</sub> ON <sub>2</sub>	Mononitromethane	589	9.9	1.86	12.8	0.826
CH <sub>3</sub> ON <sub>2</sub>	Urea (carbamide) 40% aqueous solution	578	20.0	2.38	22.7	—
C <sub>2</sub> H <sub>2</sub>	Acetylene (ethyne)	578	—	—	—	*33.0
C <sub>2</sub> H <sub>4</sub>	Ethylene (ethene)	578	—	—	—	*34.5
C <sub>2</sub> H <sub>4</sub>	Ethane	578	—	—	—	*23.5
C <sub>2</sub> N <sub>2</sub>	Cyanogen	—	—	—	—	—
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	Oxalic acid (aqueous sol. 8.3%)	578	20	2.88	20.6	—
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub> · 2H <sub>2</sub> O	Oxalic acid (alcohol sol. 16.5%)	578	24	2.82	20.2	—
C <sub>2</sub> H <sub>3</sub> Br	Vinylbromide	589	7.8	6.22	42.8	2.10
C <sub>2</sub> H <sub>3</sub> N	Acetonitrile (ethanonitrile)	589	25.0	2.32	16.0	*21.0
C <sub>2</sub> H <sub>3</sub> O	Ethyleneoxide (1,2-epoxyethane)	589	8.0	1.935	13.3	0.92
C <sub>2</sub> H <sub>4</sub> O	Acetaldehyde (ethanal)	589	16.3	2.38	16.4	1.00
C <sub>2</sub> H <sub>4</sub> O	Acetic acid	589	21.0	2.525	17.37	1.044
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	Formic acid methylester (methylformate)	589	16.5	2.49	17.1	0.96
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	Ethylidenechloride (1,1-dichloroethane)	589	14.4	5.33	36.7	1.51
C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	Ethylenechloride (1,2-dichloroethane)	589	14.4	5.49	37.7	1.65
C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	Ethylenebromide (1,2-dibromoethane)	589	15.2	9.70	66.7	2.66
C <sub>2</sub> H <sub>4</sub> Cl	Monochloroethane	589	5.0	4.04	27.8	1.36
C <sub>2</sub> H <sub>4</sub> Br	Monobromoethane	589	19.7	5.85	40.2	1.82
C <sub>2</sub> H <sub>4</sub> I	Monoiodoethane	589	18.1	10.07	69.3	2.95
C <sub>2</sub> H <sub>5</sub> O	Ethylalcohol (ethanol)	589	16.8	2.780	19.13	1.131
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Glycol (1,2-ethanediol)	589	15.1	2.94	20.2	1.25
C <sub>2</sub> H <sub>5</sub> S	Ethylmercaptan	578	16.0	5.52	39.5	1.85
C <sub>2</sub> H <sub>5</sub> N	Ethylamine (aminoethane)	589	5.8	3.61	24.8	*34.5
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> Cl <sub>2</sub>	Dichloroacetic acid (dichloroethanoic acid)	589	13.5	5.30	3.65	1.52
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> Cl	Chloroacetic acid (chloroethanoic acid)	589	64.5	3.89	26.7	1.33
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> Cl <sub>2</sub>	Chloralhydrate (2-2-2-trichloro-1,1-ethanediol)	589	54.6	7.10	48.8	1.65
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> N	Mononitroethane	589	10.2	2.84	19.5	0.946
C <sub>2</sub> H <sub>6</sub>	Propane	578	—	—	—	*34.0
C <sub>2</sub> H <sub>5</sub> O	Acrolein (propenal)	578	20.0	4.74	34.0	1.76
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Pyruvic acid (2-oxopropanoic acid)	589	14.5	3.56	24.2	1.21
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Malonic acid (propanoic acid) 2 <i>n</i> -aqueous sol.	589	23.0	3.47	—	—
C <sub>2</sub> H <sub>5</sub> O	Allyl alcohol	589	18.3	4.68	32.2	1.60
C <sub>2</sub> H <sub>5</sub> O	Propyl alcohol (1-propanol)	589	13.6	3.33	22.9	1.09
C <sub>2</sub> H <sub>5</sub> O	Acetone (2-propanone)	589	20.0	3.472	23.89	1.1136
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Propionic acid (propanoic acid)	589	20.3	3.462	23.82	1.10
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Formic acid ethylester (ethylmethanoate)	589	18.8	3.56	24.5	1.05
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Acetic acid methylester (methylacetate)	589	20.0	3.42	23.5	1.03
C <sub>2</sub> H <sub>5</sub> Cl	Propylchloride (1-chloropropane)	589	16.1	5.04	34.7	1.34
C <sub>2</sub> H <sub>5</sub> Cl	Isopropylchloride (2-chloropropane)	589	17.2	5.16	35.5	1.34
C <sub>2</sub> H <sub>5</sub> Br	Propylbromide (1-bromopropane)	589	19.2	6.88	47.8	1.79
C <sub>2</sub> H <sub>5</sub> Br	Isopropylbromide (2-bromopropane)	589	17.1	7.00	48.2	1.77
C <sub>2</sub> H <sub>5</sub> I	Propyliodide (1-iodopropane)	589	18.1	11.08	76.2	2.69
C <sub>2</sub> H <sub>5</sub> I	Isopropyliodide (2-iodopropane)	589	26.3	11.18	76.9	2.63
C <sub>2</sub> H <sub>5</sub> O	<i>n</i> -Propyl alcohol (1-propanol)	589	15.6	3.77	25.9	1.23
C <sub>2</sub> H <sub>5</sub> O	Isopropyl alcohol (2-propanol)	589	20.0	3.90	26.8	1.23
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub>	Glycerine (1,2,3-propanetriol)	589	16.0	4.11	28.3	1.33
C <sub>2</sub> H <sub>5</sub> N	<i>n</i> -Propylamine	589	9.6	4.56	31.4	1.33
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> N <sub>3</sub>	Nitroglycerine	589	13.5	5.405	37.2	0.900
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> N	1-Nitropropane	589	18.9	3.82	26.3	1.018
C <sub>2</sub> H <sub>6</sub>	1,3-Butadiene (erythrene)	589	15.0	7.94	54.6	2.16
C <sub>2</sub> H <sub>6</sub>	1-Butene ( $\alpha$ -butylene)	589	15.0	5.53	38.0	1.39
C <sub>2</sub> H <sub>6</sub>	cis-2-Butene ( $\beta$ -butylene)	589	15.0	5.27	36.3	1.38
C <sub>2</sub> H <sub>6</sub>	trans-2-Butene	589	15.0	5.07	34.9	1.29
C <sub>2</sub> H <sub>10</sub>	Butane	589	15.0	4.59	31.6	1.09
C <sub>2</sub> H <sub>10</sub>	Isobutane (2-methylpropane)	589	15.0	4.87	33.5	1.11
C <sub>2</sub> H <sub>2</sub> O <sub>3</sub>	Maleic anhydride (cis-butenedioic anhydride)	589	25.0	4.5	31.0	—

\* Verdet constant factor =  $10^4$ .



## MAGNETIC ROTATORY POWER (Continued)

Formula	Name	$\lambda$	$l$	$Q_M$	$10^3[\alpha]_D^{25}$	$10^3 M^+ \text{Verdet}$
C <sub>4</sub> H <sub>6</sub> O	Furan (furfuran)	589	20.0	5.48	37.7	1.78
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	Maleic acid (cis-butenedioic acid) 2 <i>n</i> aqueous solution	589	25.0	5.63	38.7	—
C <sub>4</sub> H <sub>4</sub> S	Thiophene (thiofuran)	589	20.0	9.40	64.7	2.83
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	Acetic anhydride (ethanoic anhydride)	589	20.0	4.28	29.5	1.115
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Succinic acid (butanedioic acid) 5.9% aqueous sol.	578	20.0	4.68	33.5	—
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	Tartaric acid (47.8% aqueous sol.)	578	20.0	4.79	34.3	—
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	<i>n</i> -Butyric acid (butanoic acid)	589	18.8	4.47	30.8	1.15
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Ethylacetate (ethyl ethanoate)	589	20.0	4.47	30.8	1.08
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Propionic acid methyl ester (methylpropanoate)	589	20.0	4.37	30.1	1.07
C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	Lactic acid methyl ester (methyl 2-hydroxypropanoate)	589	—	4.66	32.1	—
C <sub>4</sub> H <sub>10</sub> O	Ethyl ether (ethoxyethane)	589	20.0	4.78	32.9	1.09
C <sub>4</sub> H <sub>10</sub> O	<i>n</i> -Butyl alcohol (1-butanol)	589	20.0	4.60	31.6	1.23
C <sub>4</sub> H <sub>10</sub> O	Isobutyl alcohol (2-methyl-1-propanol)	589	17.7	4.94	34.0	1.27
C <sub>4</sub> H <sub>10</sub> O	sec-Butyl alcohol (methyl ethyl carbinol)	589	20.0	4.91	33.8	1.27
C <sub>5</sub> H <sub>8</sub>	Cyclopentadiene	589	15.0	7.03	48.8	2.02
C <sub>5</sub> H <sub>8</sub>	1,3-Pentadiene	589	15.0	8.80	60.5	2.08
C <sub>5</sub> H <sub>8</sub>	Isoprene (2-methyl-1,3-butadiene)	589	15.0	8.80	60.5	2.08
C <sub>5</sub> H <sub>8</sub>	Cyclopentene	589	15.0	5.69	39.1	1.52
C <sub>5</sub> H <sub>10</sub>	1-Pentene	589	15.0	6.45	44.4	1.39
C <sub>5</sub> H <sub>10</sub>	Isopentane (2-methyl-1-butane)	589	15.0	6.36	43.8	1.39
C <sub>5</sub> H <sub>10</sub>	Cyclopentane	589	20.0	4.89	33.6	1.23
C <sub>5</sub> H <sub>12</sub>	Pentane	589	15.0	5.60	38.5	1.15
C <sub>5</sub> H <sub>12</sub>	Isopentane (2-methylbutane)	589	15.0	5.75	39.6	1.17
C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	Furfural (2-furancarbalal)	578	20.0	7.01	50.2	2.06
C <sub>5</sub> H <sub>7</sub> N	Pyridine	589	11.9	8.76	60.3	2.58
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	Glutaric acid (pentanedioic acid) 2 <i>N</i> aqueous sol.	589	16.0	5.48	37.7	—
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Propionic acid ethylester	589	20.0	5.46	37.6	1.13
C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>	Acetic acid propylester	589	15.7	5.45	37.5	1.13
C <sub>5</sub> H <sub>14</sub> N <sub>2</sub>	Cadaverine (1,5-pentanediamine)	589	14.7	7.49	51.6	1.53
C <sub>6</sub> H <sub>6</sub>	Benzene	589	15.0	11.27	77.5	3.00
C <sub>6</sub> H <sub>12</sub>	Cyclohexane	589	20.0	5.66	39.0	1.24
C <sub>6</sub> H <sub>14</sub>	Hexane	589	15.0	6.62	45.5	1.20
C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	1,4-Dichlorobenzene ( <i>p</i> -dichlorobenzene)	589	64.5	13.55	93.2	2.69
C <sub>6</sub> H <sub>5</sub> F	Fluorobenzene (phenyl fluoride)	589	19.0	9.96	68.5	2.51
C <sub>6</sub> H <sub>5</sub> Cl	Chlorobenzene (phenyl chloride)	589	15.0	12.51	86.1	2.92
C <sub>6</sub> H <sub>5</sub> Br	Bromobenzene (phenyl bromide)	589	15.0	14.51	99.8	3.26
C <sub>6</sub> H <sub>5</sub> I	Iodobenzene (phenyl iodide)	589	15.0	19.11	131.4	4.06
C <sub>6</sub> H <sub>5</sub> O	Phenol (hydroxybenzene)	589	39.0	12.07	83.5	3.21
C <sub>6</sub> H <sub>5</sub> N	Aniline (aminobenzene)	589	15.0	16.08	110.6	4.18
C <sub>6</sub> H <sub>11</sub> Cl	Chlorocyclohexane (cyclohexyl chloride)	589	13.0	7.50	51.6	1.46
C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>	Paraldehyde (paraacetaldehyde)	589	17.3	6.66	45.8	1.19
C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	Glucose 11H <sub>2</sub> O (dextrose) (1 <i>M</i> aqueous sol.)	589	15.0	6.72	46.2	—
C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	Galactose 10H <sub>2</sub> O (1 <i>M</i> aqueous sol.)	589	15.0	6.89	47.4	—
C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	Fructose 10H <sub>2</sub> O (levulose) (1 <i>M</i> aqueous sol.)	589	15.0	6.73	46.3	—
C <sub>6</sub> H <sub>14</sub> O	2-Hexanol (butyl methyl carbinol)	589	20.0	6.89	47.4	1.31
C <sub>6</sub> H <sub>14</sub> O	3-Hexanol (ethyl propyl carbinol)	589	20.0	6.85	47.1	1.30
C <sub>6</sub> H <sub>14</sub> O	2-Methyl-3-Pentanol (ethyl isopropyl carbinol)	589	20.0	6.90	47.5	1.32
C <sub>6</sub> H <sub>4</sub> O <sub>4</sub> N <sub>2</sub>	1,3-Dinitrobenzene ( <i>m</i> -Dinitrobenzene)	589	17.1	9.65	66.4	2.17
C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> N	Nitrobenzene	589	15.0	9.36	64.4	2.17
C <sub>6</sub> H <sub>5</sub>	Toluene (methylbenzene)	589	15.0	12.16	83.7	2.71
C <sub>6</sub> H <sub>14</sub>	1-Heptene ( $\alpha$ -heptylene)	589	18.0	8.48	58.3	1.43
C <sub>6</sub> H <sub>16</sub>	Heptane	589	15.0	7.61	52.7	1.23
C <sub>6</sub> H <sub>5</sub> N	Benzonitrile (benzenecarbonitrile)	589	15.7	11.85	81.5	2.74
C <sub>6</sub> H <sub>5</sub> O <sub>2</sub>	Benzoic acid (20% alcohol sol.)	578	20.0	11.8	84.7	—
C <sub>6</sub> H <sub>4</sub> Cl	<i>o</i> -Chlorotoluene (2-chloro-1-methylbenzene)	589	15.4	13.72	94.3	2.95
C <sub>6</sub> H <sub>4</sub> Cl	<i>p</i> -Chlorotoluene (4-chloro-1-methylbenzene)	589	15.2	13.25	90.8	2.65
C <sub>6</sub> H <sub>4</sub> Br	<i>o</i> -Bromotoluene (2-bromo-1-methylbenzene)	589	16.7	15.67	107.3	3.08
C <sub>6</sub> H <sub>4</sub> Br	<i>p</i> -Bromotoluene (4-bromo-1-methylbenzene)	589	39.0	15.09	103.6	2.88
C <sub>6</sub> H <sub>4</sub> O	<i>o</i> -Cresol ( <i>o</i> -methylphenol)	589	16.0	13.38	92.1	3.07
C <sub>6</sub> H <sub>4</sub> O	<i>m</i> -Cresol ( <i>m</i> -methylphenol)	589	17.9	12.77	87.6	2.89
C <sub>6</sub> H <sub>4</sub> O	<i>p</i> -Cresol ( <i>p</i> -methylphenol)	589	17.0	12.86	88.5	2.91
C <sub>6</sub> H <sub>5</sub> N	<i>o</i> -Toluidine ( <i>o</i> -methylaniline)	589	17.3	17.18	118.2	3.79
C <sub>6</sub> H <sub>5</sub> N	<i>m</i> -Toluidine ( <i>m</i> -methylaniline)	589	15.0	16.21	111.5	3.56
C <sub>6</sub> H <sub>5</sub> N	<i>p</i> -Toluidine ( <i>p</i> -methylaniline)	589	50.0	15.92	109.5	3.37
C <sub>6</sub> H <sub>10</sub> O	Enanthaldehyde (heptanal)	589	16.2	7.42	51.1	1.26
C <sub>6</sub> H <sub>14</sub> O	1-Heptanol ( <i>n</i> -heptyl alcohol)	589	12.6	7.85	54.0	1.33
C <sub>6</sub> H <sub>14</sub> O	2-Heptanol (amyl methyl carbinol)	589	20.0	7.94	54.6	1.32
C <sub>6</sub> H <sub>14</sub> O	3-Heptanol (butyl ethyl carbinol)	589	20.0	7.86	54.1	1.37
C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> N	<i>o</i> -Nitrotoluene	589	18.0	10.80	74.3	2.16
C <sub>6</sub> H <sub>5</sub> O <sub>2</sub> N	<i>p</i> -Nitrotoluene	589	54.3	10.20	70.2	1.97
C <sub>6</sub> H <sub>10</sub>	Ethylbenzene (phenylethane)	589	15.0	13.41	92.3	2.80
C <sub>6</sub> H <sub>10</sub>	<i>o</i> -Xylene (1,2-dimethylbenzene)	589	15.0	13.36	91.9	2.62
C <sub>6</sub> H <sub>10</sub>	<i>m</i> -Xylene (1,3-dimethylbenzene)	589	15.0	12.82	88.2	2.47
C <sub>6</sub> H <sub>10</sub>	<i>p</i> -Xylene (1,4-dimethylbenzene)	589	15.0	12.80	88.1	2.46
C <sub>6</sub> H <sub>16</sub>	1-Octene ( $\alpha$ -octylene)	589	15.0	9.00	65.5	1.44
C <sub>6</sub> H <sub>16</sub>	2-Octene ( $\beta$ -octylene)	589	15.0	9.33	64.2	1.43
C <sub>6</sub> H <sub>18</sub>	Octane	589	15.0	8.65	59.5	1.26
C <sub>6</sub> H <sub>14</sub> O	1-Octanol ( <i>n</i> -octyl alcohol)	589	20.0	8.88	61.1	1.33
C <sub>6</sub> H <sub>14</sub> O	2-Octanol (methyl hexyl carbinol)	589	20.0	9.00	61.8	1.34
C <sub>6</sub> H <sub>14</sub> O	3-Octanol (ethyl amyl carbinol)	589	20.0	8.90	61.2	1.33
C <sub>9</sub> H <sub>12</sub>	<i>o</i> -Ethyltoluene (1-ethyl-2-ethylbenzene)	589	15.0	14.56	100.2	2.32
C <sub>9</sub> H <sub>12</sub>	<i>m</i> -Ethyltoluene (1-ethyl-3-ethylbenzene)	589	15.0	14.18	97.6	2.91
C <sub>9</sub> H <sub>12</sub>	<i>p</i> -Ethyltoluene (1-ethyl-4-ethylbenzene)	589	15.0	13.98	96.2	2.37
C <sub>9</sub> H <sub>12</sub>	Mesitylene (1,3,5-trimethylbenzene)	589	15.0	13.36	91.9	2.28
C <sub>9</sub> H <sub>20</sub>	Nonane	589	15.0	9.70	66.7	1.28
C <sub>10</sub> H <sub>8</sub>	Naphthalene	589	89.5	24.98	171.8	4.47
C <sub>10</sub> H <sub>16</sub>	1-Decene ( <i>n</i> -decylene)	589	21.0	11.65	80.1	1.45
C <sub>10</sub> H <sub>18</sub>	Decane	589	15.0	10.70	73.6	1.30
C <sub>10</sub> H <sub>7</sub> Cl	1-Chloronaphthalene ( $\alpha$ -chloronaphthalene)	578	18.0	28.15	201.5	4.91
C <sub>10</sub> H <sub>7</sub> Br	1-Bromonaphthalene ( $\alpha$ -bromonaphthalene)	578	20.0	31.05	222.0	5.19
C <sub>10</sub> H <sub>8</sub> O	$\beta$ -Naphthol (2-hydroxynaphthalene)	578	136.0	27.1	194.0	4.80
C <sub>10</sub> H <sub>9</sub> N	1-Naphthylamine ( $\alpha$ -naphthylamine)	589	32.6	37.23	256.1	6.84
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Eugenol (4-propenylguaiaacal)	589	19.3	21.44	147.5	3.55
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Eugenol (4-allylguaiacol)	589	15.4	18.72	128.8	2.88
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Benzoic acid propylester ( <i>n</i> -propylbenzoate)	589	15.4	14.87	102.3	2.20
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	<i>o</i> -Toluic acid ethylester	589	15.2	15.06	103.6	2.25
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	<i>p</i> -Toluic acid ethylester	589	15.0	14.74	101.4	2.18
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	$\alpha$ -Toluic acid ethylester (ethylphenylacetate)	589	14.0	14.09	103.1	2.25
C <sub>10</sub> H <sub>12</sub> O <sub>2</sub>	Methylsalicylic acid ethylester	589	18.6	17.14	117.9	2.50
C <sub>10</sub> H <sub>15</sub> N	<i>N,N</i> -Diethylaniline ( <i>N</i> -phenyldiethylamine)	589	15.3	25.16	173.1	3.74

### MAGNETIC ROTATORY POWER (Continued)

Formula	Name	$\lambda$	$l$	$Q_M$	$10^6[\alpha]_M^{\lambda, l}$	$10^6\Lambda^{\lambda, l}$ Verdet
C <sub>10</sub> H <sub>16</sub> O	Camphor	589	14.0	9.26	63.7	—
C <sub>10</sub> H <sub>16</sub> O	$\alpha$ -Terpineol	589	16.0	10.84	76.6	1.56
C <sub>10</sub> H <sub>16</sub> O	Citronellal	589	14.5	11.48	79.0	1.51
C <sub>10</sub> H <sub>16</sub> O <sub>4</sub>	Dipropylsuccinate	589	11.4	10.36	71.3	1.22
C <sub>10</sub> H <sub>10</sub> O <sub>6</sub>	Tartaric acid dipropylester (propyltartrate)	589	15.4	10.83	74.5	1.24
C <sub>10</sub> H <sub>20</sub> O	Menthol	589	45.2	10.51	72.3	1.40
C <sub>11</sub> H <sub>24</sub>	Undecane	589	20.5	11.65	80.1	1.31
C <sub>12</sub> H <sub>26</sub>	Dodecane	589	21.5	12.71	87.4	1.32
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	Saccharose 19H <sub>2</sub> O (1 M aqueous sol.)	589	15.0	12.59	86.6	—
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	Maltose 20H <sub>2</sub> O (1 M aqueous sol.)	589	15.0	12.69	87.3	—
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	Lactose 41H <sub>2</sub> O (1 M aqueous sol.)	589	18.3	12.71	87.5	—
C <sub>14</sub> H <sub>10</sub>	Phenanthrene	578	100.0	39.7	284.0	5.84
C <sub>14</sub> H <sub>24</sub>	Hexadecane	589	15.0	16.8	115.6	1.35
C <sub>14</sub> H <sub>14</sub>	1,2-Diphenylbenzene	589	15.0	40.2	276.3	4.70
C <sub>14</sub> H <sub>14</sub>	1,3-Diphenylbenzene (m-phenyldiphenyl)	589	15.0	41.0	282.4	—
C <sub>14</sub> H <sub>22</sub>	1,6-Diphenylhexane	589	20.0	—	—	2.75

## NOMOGRAPH AND TABLE FOR DOPPLER LINEWIDTHS

Sidney O. Kastner

The Doppler width of a spectral line is given by the well-known relation  $\Delta\lambda = (7.162 \times 10^{-7}) \lambda T^{1/2} M^{-1/2}$ , where wavelength units are in Angstroms, temperature is in degrees Kelvin and M is the atomic mass. This relation between four variables is amenable to representation by a nomograph, which does not appear to have been constructed but which would seem to be of practical value. Therefore such a nomograph is presented here. Its construction is briefly described so that the reader who has not made a plot of this type may follow the steps.

The Doppler relation is first rewritten as

$$\ln \Delta\lambda = \ln k\lambda + \frac{1}{2} \ln T - \frac{1}{2} \ln M$$

or equivalently  $u_4 = u_1 + u_2 + u_3$ , with  $k = 7.162 \times 10^{-7}$ . Putting  $\xi = u_1 + u_2$ , first, one has a linear relation  $\xi - u_1 - u_2 = 0$  between three variables which can be represented (Menzel\*) by the determinantal equation

$$\begin{vmatrix} \xi/2 & 1/2 & 1 \\ u_1 & 1 & 1 \\ u_2 & 0 & 1 \end{vmatrix} = 0$$

so that in the Cartesian (x,y) plane the function  $u_2$  lies along the x axis, the function  $u_1$  along the line  $y = 1$  and the function  $\xi/2$  along the line  $y = 1/2$ . These lines form three parallel scales with which to obtain a value of  $\xi$ , given the pair  $(u_1, u_2)$ .

The original equation  $u_4 = \xi + u_3$  provides a second linear relation  $u_4 - \xi - u_3 = 0$ , so that a second set of scales similarly results with  $u_3$  along the x axis,  $\xi$  along the line  $y = 1$  and  $u_4/2$  along the line  $y = 1/2$ . The function  $u_4 \equiv \log \Delta\lambda$  can then be obtained from the known pair  $(\xi, u_3)$ .

In practice, for the nomograph scales to represent useful ranges of the physical variables, some shifting and magnification of the individual scales will be found to be necessary, after completion of the first diagram. The nomograph arrived at here is shown in Figure 1. The x axis runs horizontally through the values  $x = 0$ ,  $T = 10^5$ , and the ordinates of the six scales from left to right are given by:

$$\begin{aligned} y_1 &= 5 \ln(10^{5/2} k\lambda) & y_2 &= 10 \ln(k\lambda T^{1/2}) \\ y_3 &= \frac{5}{2} \ln(k\lambda T^{1/2}) & y_4 &= 5 \ln \Delta\lambda + \frac{5}{2} \ln 10 \\ y_5 &= 5 \ln(T^{1/2}/10^{5/2}) & y_6 &= 5 \ln(10/M) \end{aligned}$$

The approximate range of temperatures covered by the figure is a slowly varying function of wavelength, being  $1000^\circ\text{K} - 10^6 \text{ K}$  for  $\lambda = 10,000\text{\AA}$ ;  $4000 \text{ K} - 5 \times 10^6 \text{ K}$  for  $\lambda = 5000\text{\AA}$ ;  $80,000 \text{ K} - 10^7 \text{ K}$  for  $\lambda = 1000\text{\AA}$ ; and  $300,000 \text{ K} - 10^7 \text{ K}$  for  $\lambda = 500\text{\AA}$ .

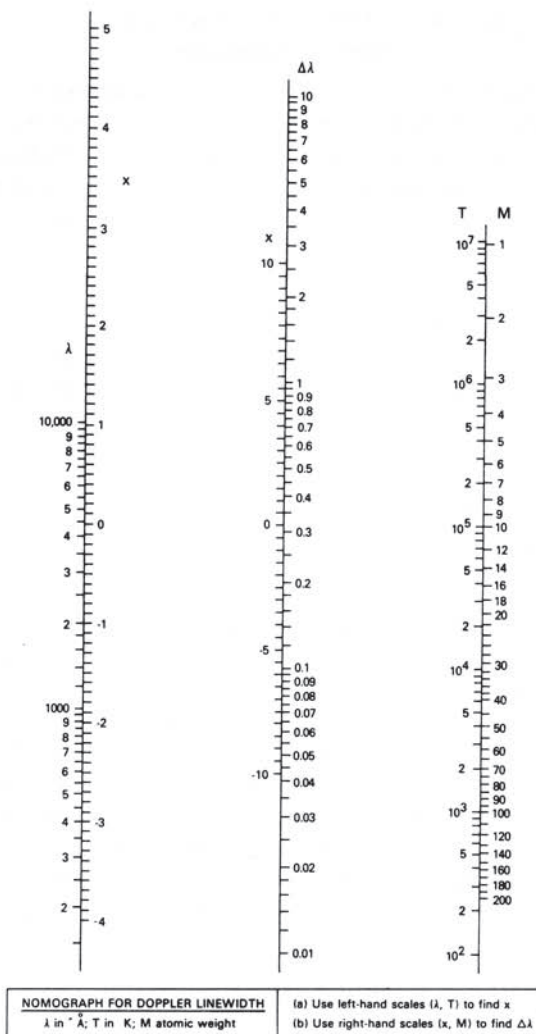
In use, the left-hand sides of the three lines are used to find the value of the intermediate variable  $x$  corresponding to given  $\lambda$  and  $T$ . The right-hand sides then give the Doppler width  $\Delta\lambda$  in  $\text{\AA}$ , for this value of  $x$  and the given  $M$ .

For example, suppose one wishes to find the Doppler width of the solar coronal forbidden line of Fe XIV (atomic mass  $M = 56$ ) at  $5303\text{\AA}$ , emitted at a temperature of about  $T = 2 \times 10^6 \text{ K}$ . A straight line drawn between  $\lambda = 5300\text{\AA}$  and  $T = 2 \times 10^6$  intersects the x scale at about 4.2. A second line then drawn between  $x = 4.2$  and  $M = 56$  intersects the middle line at  $\Delta\lambda \approx 0.73\text{\AA}$ .

To use the nomograph, one must know the appropriate atomic weight  $M$  for a given element of interest. An alternative and more accurate procedure, if a calculator is available, for obtaining any required Doppler width is to use Table I, which gives the value of the constant  $k_z \equiv 7.162 M_z^{-1/2}$  for any given atomic number  $Z$ , in the equivalent Doppler relation  $\Delta\lambda = k_z(\lambda T^{1/2}) \times 10^{-7}$ . This table thereby avoids the necessity of looking up the atomic weight  $M$ . For the forbidden line example above, where  $Z = 26$ , the Doppler width obtained from the table is  $\Delta\lambda = (0.9584)(5303)(2,000,000)^{1/2}(10^{-7}) = 0.719\text{\AA}$ .

\* D. H. Menzel, *Fundamental Formulas of Physics*, Dover Publications, New York, 1960, ch. 3.





**TABLE 1**  
**Values of  $k_z$  ( $Z$  Atomic Number) for Use in**  
**Doppler Linewidth Formula**

$$\Delta\lambda = k_z(\lambda T^{1/2}) \times 10^{-7}$$

Z	$k_z$	Z	$k_z$	Z	$k_z$	Z	$k_z$
1	7.1335	21	1.0682	41	0.7430	61	0.5927
2	3.5798	22	1.0348	42	0.7312	62	0.5840
3	2.7185	23	1.0035	43	0.7202	63	0.5810
4	2.3857	24	0.9932	44	0.7124	64	0.5711
5	2.1782	25	0.9663	45	0.7060	65	0.5681
6	2.0665	26	0.9584	46	0.6943	66	0.5618
7	1.9137	27	0.9329	47	0.6896	67	0.5577
8	1.7905	28	0.9347	48	0.6755	68	0.5538
9	1.6431	29	0.8984	49	0.6684	69	0.5510
10	1.5944	30	0.8858	50	0.6574	70	0.5492
11	1.4937	31	0.8577	51	0.6491	71	0.5414
12	1.4527	32	0.8406	52	0.6340	72	0.5361
13	1.3788	33	0.8274	53	0.6358	73	0.5324
14	1.3514	34	0.8060	54	0.6250	74	0.5282
15	1.2869	35	0.8012	55	0.6212	75	0.5249
16	1.2649	36	0.7824	56	0.6111	76	0.5193
17	1.2028	37	0.7747	57	0.6077	77	0.5166
18	1.1331	38	0.7651	58	0.6050	78	0.5128
19	1.1453	39	0.7596	59	0.6033	79	0.5103
20	1.1313	40	0.7499	60	0.5963	80	0.5057



## OXYGEN SOLUBILITY IN AQUEOUS ELECTROLYTE SOLUTIONS

The Bunsen coefficients,  $\alpha$ , and the standard deviation among a number of tests performed under identical conditions are presented. The Bunsen coefficient is defined as the gas volume at STP (0.101 325 MPa and 273.15 K) absorbed per unit volume of pure liquid at the temperature of the measurement. All data refer to a temperature of 310.2 K and a pressure of 0.101 325 MPa.

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Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> $\alpha$	Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> $\alpha$	Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> $\alpha$
HCl	2.005	211 ± 4	CuCl <sub>2</sub>	6.122	60 ± 2	HNO <sub>3</sub>	1.017	164 ± 4
	3.050	198 ± 7		0.497	192 ± 2		1.069	158 ± 3
	3.910	191 ± 4		0.519	189 ± 1		1.250	154 ± 1
	4.000	185 ± 2		0.763	169 ± 1		1.460	149 ± 1
AlCl <sub>3</sub>	0.501	173 ± 1	FeCl <sub>3</sub>	0.994	155 ± 1	Al(NO <sub>3</sub> ) <sub>3</sub>	1.939	132 ± 3
	0.745	144 ± 3		1.002	156 ± 1		2.005	132 ± 2
	1.006	119 ± 2		1.499	122 ± 1		2.959	108 ± 2
	1.081	113 ± 3		1.517	124 ± 1		1.000	236 ± 4
BaCl <sub>2</sub>	2.009	63 ± 3	KCl	0.500	186 ± 3	Ba(NO <sub>3</sub> ) <sub>2</sub>	2.000	230 ± 2
	2.503	41 ± 2		1.016	148 ± 2		4.000	221 ± 4
	0.507	178 ± 3		2.064	84 ± 7		0.308	202 ± 5
	0.997	131 ± 2		0.503	208 ± 1		0.602	171 ± 3
CaCl <sub>2</sub>	1.509	96 ± 2	LaCl <sub>3</sub>	1.002	178 ± 2	Ca(NO <sub>3</sub> ) <sub>2</sub>	1.095	127 ± 7
	0.494	184 ± 2		1.502	158 ± 5		0.158	222 ± 3
	0.747	162 ± 2		1.992	134 ± 3		0.298	207 ± 4
	0.987	144 ± 1		2.976	105 ± 1		0.497	195 ± 4
CdCl <sub>2</sub>	1.021	141 ± 1	LiCl	0.514	162 ± 2	Ce(NO <sub>3</sub> ) <sub>3</sub>	0.990	155 ± 6
	1.421	110 ± 2		0.992	112 ± 1		1.961	101 ± 3
	1.490	107 ± 1		1.993	50 ± 1		0.551	194 ± 5
	2.985	51 ± 2		2.478	37 ± 2		0.740	181 ± 3
CdCl <sub>2</sub>	3.557	37 ± 1	MgCl <sub>2</sub>	0.985	194 ± 4	Co(NO <sub>3</sub> ) <sub>2</sub>	1.548	133 ± 2
	3.894	34 ± 1		1.069	189 ± 8		2.046	110 ± 3
	4.477	23 ± 1		1.482	174 ± 6		0.997	137 ± 3
	0.260	213 ± 4		1.993	159 ± 7		1.862	85 ± 2
CdCl <sub>2</sub>	0.479	196 ± 1	MnCl <sub>2</sub>	2.336	150 ± 3	CsNO <sub>3</sub>	2.952	50 ± 3
	0.505	194 ± 3		3.978	109 ± 3		0.502	194 ± 4
	0.523	193 ± 3		0.503	190 ± 3		0.753	177 ± 4
	0.747	179 ± 3		0.523	187 ± 4		1.002	157 ± 2
CdCl <sub>2</sub>	0.760	178 ± 2	NaCl	0.982	153 ± 1	Cu(NO <sub>3</sub> ) <sub>2</sub>	1.487	126 ± 2
	0.966	164 ± 1		0.998	149 ± 3		0.314	226 ± 2
	0.997	163 ± 2		1.463	120 ± 2		0.325	228 ± 2
	1.025	161 ± 3		1.592	113 ± 2		0.615	215 ± 2
CeCl <sub>3</sub>	1.046	164 ± 3	NiCl <sub>2</sub>	1.745	106 ± 3	Fe(NO <sub>3</sub> ) <sub>3</sub>	0.624	209 ± 1
	1.264	149 ± 3		2.126	91 ± 1		0.930	198 ± 2
	1.457	141 ± 3		2.879	64 ± 2		0.298	213 ± 5
	1.491	141 ± 3		0.840	159 ± 2		0.497	198 ± 1
CoCl <sub>2</sub>	1.503	138 ± 3	NH <sub>4</sub> Cl	1.230	134 ± 3	La(NO <sub>3</sub> ) <sub>3</sub>	0.613	188 ± 3
	1.922	120 ± 1		1.756	106 ± 2		0.987	160 ± 1
	1.996	116 ± 2		2.127	88 ± 1		1.267	144 ± 1
	2.041	116 ± 2		1.001	177 ± 4		0.498	189 ± 5
CoCl <sub>2</sub>	2.029	115 ± 1	RbCl	1.265	164 ± 8	Mg(NO <sub>3</sub> ) <sub>2</sub>	0.739	169 ± 1
	0.498	159 ± 7		1.503	152 ± 2		0.999	147 ± 3
	0.979	111 ± 2		2.016	130 ± 3		1.037	147 ± 1
	1.974	51 ± 1		2.989	100 ± 2		0.746	201 ± 1
CoCl <sub>2</sub>	2.462	33 ± 4	ZnCl <sub>2</sub>	3.030	98 ± 3	KNO <sub>3</sub>	1.013	191 ± 3
	0.501	184 ± 2		4.017	71 ± 2		1.510	169 ± 2
	0.749	162 ± 2		1.002	200 ± 3		1.852	161 ± 6
	0.993	144 ± 3		2.008	172 ± 1		0.493	184 ± 2
CsCl	1.494	114 ± 2	NiCl <sub>2</sub>	2.215	160 ± 1	LiNO <sub>3</sub>	0.966	141 ± 2
	0.515	212 ± 5		3.001	144 ± 2		2.227	69 ± 2
	1.001	192 ± 2		0.744	167 ± 2		0.955	201 ± 4
	1.028	187 ± 4		0.991	145 ± 1		1.916	169 ± 4
CsCl	1.505	170 ± 3	RbCl	1.490	117 ± 2	Mg(NO <sub>3</sub> ) <sub>2</sub>	2.070	164 ± 3
	1.993	152 ± 3		0.990	187 ± 3		2.869	140 ± 3
	2.203	138 ± 2		1.014	184 ± 7		0.861	175 ± 6
	2.517	132 ± 3		1.359	166 ± 2		0.992	162 ± 2
CsCl	3.002	119 ± 2	ZnCl <sub>2</sub>	1.984	143 ± 1	Mn(NO <sub>3</sub> ) <sub>2</sub>	1.663	124 ± 2
	3.382	105 ± 1		2.957	112 ± 2		2.238	99 ± 3
	4.003	97 ± 1		0.250	213 ± 7		0.506	198 ± 2
	4.028	98 ± 1		0.493	190 ± 3		1.011	161 ± 3
CsCl	5.003	78 ± 2		0.762	176 ± 3		1.482	132 ± 5
	6.003	64 ± 2		0.816	174 ± 2		1.936	112 ± 1

**OXYGEN SOLUBILITY IN AQUEOUS ELECTROLYTE SOLUTIONS (continued)**

Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> α	Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> α	Electrolyte	Concn of solution (mol/dm <sup>3</sup> )	10 <sup>4</sup> α
NaNO <sub>3</sub>	0.762	200 ± 3	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	0.741	155 ± 3	KHSO <sub>4</sub>	1.499	95 ± 3
	1.017	189 ± 4		0.959	139 ± 1		1.783	82 ± 1
	1.533	166 ± 3		1.000	133 ± 1		2.151	66 ± 1
NH <sub>4</sub> NO <sub>3</sub>	2.078	151 ± 4	K <sub>2</sub> SO <sub>4</sub>	0.487	148 ± 2	NaHSO <sub>4</sub>	0.565	192 ± 2
	0.998	210 ± 4		0.723	115 ± 2		0.771	176 ± 1
	1.991	185 ± 4		0.940	94 ± 2		1.011	162 ± 3
Ni(NO <sub>3</sub> ) <sub>2</sub>	2.050	181 ± 4	Li <sub>2</sub> SO <sub>4</sub>	0.247	200 ± 3	MgSO <sub>4</sub>	1.484	141 ± 2
	3.120	158 ± 2		0.297	190 ± 2		1.522	137 ± 3
	0.752	173 ± 1		0.397	177 ± 2		1.638	133 ± 2
RbNO <sub>3</sub>	0.852	167 ± 2	MnSO <sub>4</sub>	0.405	174 ± 3	NH <sub>4</sub> HSO <sub>4</sub>	1.798	128 ± 3
	1.385	135 ± 1		0.500	166 ± 3		1.805	127 ± 2
	2.062	99 ± 1		0.582	157 ± 2		2.017	115 ± 2
Th(NO <sub>3</sub> ) <sub>4</sub>	0.487	219 ± 3	Na <sub>2</sub> SO <sub>4</sub>	0.510	177 ± 2	CsOH	0.489	194 ± 2
	0.522	216 ± 5		1.007	127 ± 2		0.519	193 ± 1
	0.958	193 ± 3		1.903	71 ± 1		0.776	175 ± 3
Zn(NO <sub>3</sub> ) <sub>2</sub>	1.006	192 ± 3	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	0.497	174 ± 3	LiOH	0.995	159 ± 2
	1.058	192 ± 5		0.750	148 ± 4		1.018	159 ± 2
	1.360	177 ± 4		0.996	128 ± 1		1.503	135 ± 1
H <sub>2</sub> SO <sub>4</sub>	1.989	158 ± 1	NiSO <sub>4</sub>	1.196	112 ± 2	NaOH	1.574	132 ± 2
	2.017	155 ± 7		1.202	113 ± 2		1.939	118 ± 3
	0.488	174 ± 1		1.500	89 ± 2		2.628	92 ± 2
Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	0.741	145 ± 2	Rb <sub>2</sub> SO <sub>4</sub>	2.003	66 ± 3	RbOH	1.031	176 ± 3
	0.974	121 ± 3		2.013	66 ± 2		1.503	153 ± 2
	1.385	92 ± 1		0.503	179 ± 2		1.982	135 ± 2
CdSO <sub>4</sub>	0.499	196 ± 3	ZnSO <sub>4</sub>	0.691	161 ± 4	KOH	2.643	116 ± 1
	0.756	178 ± 3		0.998	132 ± 3		3.010	108 ± 2
	0.995	159 ± 5		1.386	108 ± 2		0.890	174 ± 1
CoSO <sub>4</sub>	1.239	146 ± 3	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	1.407	108 ± 1	LiOH	2.142	108 ± 3
	1.506	128 ± 4		1.740	88 ± 1		2.325	100 ± 1
	1.651	119 ± 1		0.498	163 ± 2		0.938	169 ± 1
Cs <sub>2</sub> SO <sub>4</sub>	1.000	209 ± 7	NiSO <sub>4</sub>	0.748	136 ± 2	NaOH	1.030	164 ± 2
	1.500	189 ± 5		0.883	120 ± 2		1.844	122 ± 1
	1.600	190 ± 1		0.993	113 ± 2		2.135	108 ± 2
CuSO <sub>4</sub>	2.000	177 ± 5	Rb <sub>2</sub> SO <sub>4</sub>	1.325	87 ± 1	LiOH	2.311	102 ± 1
	2.500	163 ± 4		1.487	76 ± 2		2.329	100 ± 1
	0.197	175 ± 2		1.762	63 ± 1		3.077	79 ± 1
NiSO <sub>4</sub>	0.298	151 ± 3	ZnSO <sub>4</sub>	1.016	140 ± 2	NaOH	3.502	67 ± 1
	0.396	129 ± 2		1.047	137 ± 2		4.848	42 ± 1
	1.012	132 ± 2		1.988	86 ± 2		4.871	37 ± 1
CoSO <sub>4</sub>	1.583	96 ± 3	NiSO <sub>4</sub>	2.007	82 ± 2	LiOH	1.015	175 ± 1
	1.989	70 ± 2		2.498	66 ± 2		1.856	135 ± 1
	2.510	50 ± 2		2.984	51 ± 1		3.075	95 ± 2
Cs <sub>2</sub> SO <sub>4</sub>	2.735	45 ± 1	Rb <sub>2</sub> SO <sub>4</sub>	3.499	44 ± 1	NaOH	4.059	65 ± 4
	3.026	36 ± 1		0.499	176 ± 2		1.000	164 ± 1
	0.497	174 ± 2		0.749	150 ± 1		1.139	155 ± 2
CuSO <sub>4</sub>	0.767	150 ± 1	ZnSO <sub>4</sub>	1.181	116 ± 3	LiOH	2.000	114 ± 1
	1.001	128 ± 2		1.489	95 ± 3		2.105	104 ± 1
	1.494	96 ± 1		0.401	181 ± 1		2.122	106 ± 1
NiSO <sub>4</sub>	0.500	171 ± 1	Rb <sub>2</sub> SO <sub>4</sub>	0.803	138 ± 2	NaOH	3.035	74 ± 1
	1.015	120 ± 1		1.199	104 ± 1		4.071	49 ± 1
	1.525	86 ± 1		0.501	170 ± 2		1.112	157 ± 2
CuSO <sub>4</sub>	1.909	66 ± 1	ZnSO <sub>4</sub>	0.719	148 ± 5	RbOH	2.070	109 ± 3
	0.496	177 ± 1		1.006	122 ± 4		3.187	76 ± 3
	0.591	168 ± 4		1.481	98 ± 2			

**PHYSICAL CONSTANTS OF CLEAR FUSED QUARTZ**  
**Based on information contained in Fused Quartz Catalogue Q-7A**  
**General Electric Company**

Property	Clear fused quartz
Density	2.2 g cm <sup>-3</sup>
Hardness	4.9 (Mohs')
Tensile strength	7000 psi
Compressive strength	>160,000 psi
Bulk modulus	(approx.) 5.3 × 10 <sup>6</sup> psi
Rigidity modulus	4.5 × 10 <sup>6</sup> psi
Young's modulus	10.4 × 10 <sup>6</sup> psi
Poisson's ratio	0.16
Coefficient of thermal expansion	(av.) 5.5 × 10 <sup>-7</sup> cm cm <sup>-1</sup> °C <sup>-1</sup> { 20°C 320°C
Thermal conductivity	0.0033 cal cm <sup>-1</sup> s <sup>-1</sup> °C <sup>-1</sup> cm <sup>-1</sup>
Specific heat	0.18 cal g <sup>-1</sup>
Softening point	(approx.) 1665°C
Annealing point	(approx.) 1140°C
Strain point	1070°C
Electrical resistance	9.5 log <sub>10</sub> R for cm <sup>3</sup> at 350°C
Dielectric constant	3.75 at 20°C. 1 MHz
Dielectric loss factor	less than 0.0004 at 20°C. 1 MHz
Dissipation factor	less than 0.0001 at 20°C. 1 MHz
Index of refraction	1.4585
Velocity of sound — shear wave	3.75 × 10 <sup>5</sup> cm s <sup>-1</sup>
Velocity of sound — compressional wave	5.90 × 10 <sup>5</sup> cm s <sup>-1</sup>
Sonic attenuation	less than 0.033 dB ft <sup>-1</sup> MHz <sup>-1</sup>

## PLATINUM WIRE

Mass in Grams per Foot

B. & S. Gauge	Diameter, inches	Mass, g per ft	B. & S. Gauge	Diameter, inches	Mass, g per ft
10	.1019	37.5	23	.02257	1.8
11	.09074	28.0	24	.02010	1.4
12	.08081	22.0	25	.01790	1.1
13	.07196	17.5	26	.01594	0.9
14	.06408	14.0	27	.01420	0.7
15	.05707	11.0	28	.01264	0.6
16	.05082	9.0	29	.01126	0.45
17	.04526	7.0	30	.01003	0.35
18	.04030	5.7	31	.008928	0.28
19	.03589	4.4	32	.007950	0.22
20	.03196	3.4	33	.007080	0.17
21	.02846	2.9	34	.006305	0.15
22	.02535	2.3	35	.005615	0.11

## PROPERTIES OF CARBOHYDRATES

These data for carbohydrates were compiled originally for the Biology Data Book by M. L. Wolfram, G. G. Maher and R. G. Pagnucco (1964). Data are reproduced here by permission of the copyright owners of the above publication, the Federation of American Societies for Experimental Biology, Washington, D.C. pp. 351-359.

All data are for crystalline substances, unless otherwise specified. Selection of substances was restricted to natural carbohydrates found free (or in chemical combination and released on hydrolysis) and to biological oxidation products of the natural carbohydrates. The nomenclature conforms with that of the British-American report as published in the *Journal of Organic Chemistry*, 28:281 (1963). Substances have been arranged alphabetically under the name of the parent sugar within groups formulated according to increasing carbon content (excluding carbon in substituents), with synonymous common names in parentheses. **Melting Point:** b.p. = boiling point; d. = decomposes; s. = sinters. **Specific Rotation** was determined in water at concentrations of 1-5 g per 100 ml. of solution and at 20°-25°C, unless otherwise specified; other temperatures or wavelengths are shown in brackets; c = grams solute per 100 ml of solution.

### Part I. NATURAL MONOSACCHARIDES: ALDOSES AND KETOSES

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Aldoses			
1 D-Glyceraldehyde	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	.....	+13.5 ± 0.5 (syrup)
2 D-Glyceraldehyde, 3-deoxy-3,3-C-bis-(hydroxymethyl)- (Cordycepose)	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	.....	-26 (c 0.6, C <sub>7</sub> H <sub>14</sub> OH)
3 D-Glyceraldehyde, 3,3-bis(C'-hydroxymethyl)- (Apiose)	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	.....	+5.6 (c 10) [15°] syrup
4 β-D-Arabinose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	155	-175 → -103
5 D-Arabinose, 2-O-methyl-	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	Syrup	-102
6 α-L-Arabinose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	158 amorphous	+55.4 → +105
7 β-L-Arabinose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	160	+190.6 → +104.5
8 DL-Arabinose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	163.5-164.5	None
9 α-L-Lyxose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	105	+5.8 → +13.5
10 L-Lyxose, 5-deoxy-3-C'-formyl- (Streptose)	C <sub>6</sub> H <sub>10</sub> O <sub>5</sub>	.....	.....
11 L-Lyxose, 3-C'-formyl- (Hydroxystreptose)	C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	.....	.....
12 Pentose, 4,5-anhydro-5-deoxy-D-erythro-	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	.....	.....
13 Pentose, 2-deoxy-D-erythro-	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	96-98	-91 → -58
14 D-Ribose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	87	-23.1 → -23.7
15 D-Ribose, 2-C'-hydroxymethyl- (Hamamelose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	.....	-7.1 [λ578]
16 α-D-Xylose	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	145	+93.6 → +18.8
17 D-Xylose, 5-deoxy-	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	.....	+16
18 β-D-Xylose, 2-O-methyl-	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	137-138	-21 → +34
19 α-D-Xylose, 3-O-methyl-	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	95	+45 → +19
20 D-Allose, 6-deoxy-	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	140-143	+1.6 [18°] (c 0.6)
		146-148	-4.7 → 0
		102-106	-46 → -29
21 D-Allose, 6-deoxy-2,3-di-O-methyl- (Mycinose)	C <sub>6</sub> H <sub>14</sub> O <sub>5</sub>	.....	.....
22 Amicitose (a trideoxy hexose)	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	Oil, b.p. 65-70	+28.6 (CHCl <sub>3</sub> )
23 Antiarose	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	.....	Levo
24 α-D-Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	167	+150.7 → +80.2
25 β-D-Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	143-145	+52.8 → +80.2
26 D-Galactose, 3,6-anhydro-	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	.....	+21.3 [10°]
27 α-D-Galactose, 6-deoxy- (D-Fucose; Rhodeose)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	140-145	+127 → +76.3 (c 10)
28 D-Galactose, 6-deoxy-3-O-methyl- (Digitalose)	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	106 <sup>1</sup> , 119 <sup>2</sup>	+106
29 D-Galactose, 6-deoxy-4-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	131-132	+82
30 D-Galactose, 6-deoxy-2,3-di-O-methyl-	C <sub>8</sub> H <sub>16</sub> O <sub>5</sub>	.....	+73
31 α-D-Galactose, 3-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	144-147	+150.6 → +108.6
32 α-D-Galactose, 6-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	122-123	+117 → +77.3
33 L-Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	.....	See D-Galactose
34 α-L-Galactose, 3,6-anhydro-	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	.....	-39.4 → -25.2
35 α-L-Galactose, 6-deoxy- (L-Fucose)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	145	-124.1 → -76.4
36 L-Galactose, 6-deoxy-2-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	149-150	-75 ± 4 (c 0.5)
37 L-Galactose, 6-sulfate	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> S	.....	-47 (c 0.2) (Na salt)
38 DL-Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	143-144, 163	None (racemic)
39 α-D-Glucose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	146, 83 (H <sub>2</sub> O)	+112 → +52.7
40 β-D-Glucose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	148-150	+18.7 → +52.7
41 D-Glucose, 6-acetate	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	135	+48
42 D-Glucose, 2,3-di-O-methyl-	C <sub>8</sub> H <sub>16</sub> O <sub>6</sub>	85-86, 121	+50
43 D-Glucose, 6-O-benzoyl- (Vaccinin)	C <sub>12</sub> H <sub>16</sub> O <sub>7</sub>	Amorphous	+48 (C <sub>2</sub> H <sub>5</sub> OH)
44 α-D-Glucose, 6-deoxy- (Chinovose; Epirhamnose; Glucomethyllose; Isorhamnose; Isorhodeose; Quinovose)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	139-140	+73.3 → +29.7 (c 8)
45 α-D-Glucose, 6-deoxy-3-O-methyl- (D-Thevetose)	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	116	+84 → +33



**PROPERTIES OF CARBOHYDRATES (continued)**

**Part I. NATURAL MONOSACCHARIDES: ALDOSES AND KETOSES (Continued)**

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Aldoses (Con't)			
46 D-Glucose, 6-sulfonic acid, 6-deoxy- (6-Sulfoquinovose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> S	173-174	+87 <sup>a</sup>
47 D-Glucose, 3-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	162-167	+98 → +59.5
48 α-L-Glucose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	141-143	-95.5 → -51.4
49 L-Glucose, 6-deoxy-3-O-methyl- (L-Thevetose)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	126-129	-36.9 ± 2
50 D-Gulose, 6-deoxy-	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	.....	.....
51 Hexose, 2-deoxy-D-arabino- <sup>4</sup>	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	148	+46.6 [18°]
52 Hexose, 2,6-dideoxy-3-O-methyl-D-arabino- (D-Oleandrose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	.....	-11
53 Hexose, 3,6-dideoxy-D-arabino- (Tyvelose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	+24 ± 2
54 Hexose, 2,6-dideoxy-3-O-methyl-L-arabino- (L-Oleandrose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	62-63	+11.9 ± 2.5
55 Hexose, 3,6-dideoxy-L-arabino- (Ascarylose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	-24 ± 2
56 Hexose, 2,6-dideoxy-3-O-methyl-D-lyxo- (Diginose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	90-92	+56 ± 4
57 Hexose, 2,6-dideoxy-L-lyxo- (L-Fucose, 2-deoxy-)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	103-106	-61.6
58 Hexose, 2,6-dideoxy-3-O-methyl-L-lyxo-	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	78-85	-65
59 Hexose, 2,6-dideoxy-D-ribo- (Digi- toxose; D-Altrose, 2,6-dideoxy-)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	110	+46.4
60 Hexose, 2,6-dideoxy-3-O-methyl-D-ribo- (Cymarose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	93	+52
61 Hexose, 3,6-dideoxy-D-ribo- (Paratose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	+10 ± 2 (c 0.9)
62 Hexose, 4,6-dideoxy-3-O-methyl-D-ribo- (D-Gulose, 4,6-dideoxy-3-O-methyl-; Chalcose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	96-99	+120 → +76
63 Hexose, 2,6-dideoxy-D-xylo- (Boivinose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	96-98	-3.9 → +3.9
64 Hexose, 2,6-dideoxy-3-O-methyl-D-xylo- (Sarmetose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	78-79	+12 → +15.8
65 Hexose, 3,6-dideoxy-D-xylo- (Abe- quose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	-3.2 ± 0.6
66 Hexose, 2,6-dideoxy-3-C-methyl-L-xylo- (Mycarose)	C <sub>7</sub> H <sub>14</sub> O <sub>4</sub>	129-129	-31.1
67 Hexose, 2,6-dideoxy-3-C-methyl-3-O-methyl-L-xylo- (Cladinose)	C <sub>8</sub> H <sub>16</sub> O <sub>4</sub>	oil, b.p. 120-132 (0.25 mm)	-23.1
68 Hexose, 3,6-dideoxy-L-xylo- (Colitose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	+4 (H <sub>2</sub> O); -51 ± 2 (CH <sub>3</sub> OH)
69 D-Idose <sup>5</sup>	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	.....	.....
70 L-Idose, 1,6-anhydro-	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	.....	.....
71 α-D-Mannose	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	133	+29.3 → +14.5
72 β-D-Mannose	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	132	-16.3 → +14.5
73 D-Mannose, 6-deoxy- (D-Rhamnose)	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	86-90	-7.0
74 α-L-Mannose, 6-deoxy-monohydrate (L-Rhamnose)	C <sub>6</sub> H <sub>14</sub> O <sub>4</sub>	93-94	-8.6 → +8.2
75 β-L-Mannose, 6-deoxy-	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	123-125	+38.4 → +8.9
76 L-Mannose, 6-deoxy-2-O-methyl-	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	.....	.....
77 L-Mannose, 6-deoxy-3-O-methyl- (L-Acofriose)	C <sub>7</sub> H <sub>14</sub> O <sub>5</sub>	114-115	+30 [18°]
78 L-Mannose, 6-deoxy-2,4-di-O-methyl-	C <sub>8</sub> H <sub>16</sub> O <sub>5</sub>	82	-19 [16°]
79 L-Mannose, 6-deoxy-5-C-methyl-4-O-methyl- (Noviose)	C <sub>8</sub> H <sub>16</sub> O <sub>5</sub>	128-130	+19.9 (50% C <sub>2</sub> H <sub>5</sub> OH)
80 Rhodinose (a 2,3,6-trideoxyhexose)	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	.....	-11 ± 1.6
81 D-Talose	C <sub>6</sub> H <sub>12</sub> O <sub>4</sub>	128-132	+16.9
82 D-Talose, 6-deoxy- (D-Talomethylose)	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	129-131	+20.6
83 L-Talose, 6-deoxy- (L-Talomethylose)	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	116-118	-19.5 ± 2 [18°]
84 L-Talose, 6-deoxy-2-O-methyl- (L-Acovenose)	C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	.....	-19.4
85 Heptose, D-glycero-D-galacto-	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	139-140	+47 → +64 (c 0.5)
86 Heptose, D-glycero-D-manno-	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	.....	.....
87 Heptose, D-glycero-L-manno-	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	.....	.....
Ketoses			
88 Dihydroxyacetone	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	80 (dimer)	None
89 Tetrulose, L-glycero- <sup>8</sup> (L-Erythrulose; Ketoerythritol; L-Threulose)	C <sub>4</sub> H <sub>8</sub> O <sub>4</sub>	Syrup	+12
90 Pentulose, D-erythro- (Adonose; D-Ribulose)	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	Syrup	+16.6 [27°]
91 Pentulose, L-erythro- (L-Ribulose)	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	.....	-16.6

**PROPERTIES OF CARBOHYDRATES (continued)**

**Part I. NATURAL MONOSACCHARIDES: ALDOSES AND KETOSES (Continued)**

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Ketoses (Con't)			
92 Pentulose, <i>D-threo</i> - ( <i>D</i> -Xylulose)	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	.....	-33
93 Pentulose, 5-deoxy- <i>D-threo</i> -	C <sub>5</sub> H <sub>10</sub> O <sub>4</sub>	.....	-5 ± 1 (CH <sub>2</sub> OH)
94 Pentulose, <i>L-threo</i> - ( <i>L</i> -Xylulose; <i>L</i> -Lyxulose; Xyloketose)	C <sub>5</sub> H <sub>10</sub> O <sub>5</sub>	Syrup	+33.1
95 Hexulose, $\beta$ - <i>D-arabino</i> - ( $\beta$ - <i>D</i> -Fructose; Levulose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	102-104 <sup>1</sup>	-133.5 → -92
96 Hexulose, 6-deoxy- <i>D-arabino</i> - ( <i>D</i> -Rhamnulose)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	.....	-13 ± 2
97 Hexulose, <i>D-lyxo</i> - ( <i>D</i> -Tagatose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	131-132	+2.7 → -4, -5
98 5-Hexulose, <i>D-lyxo</i>	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	158	-86.6
99 Hexulose, 6-deoxy- <i>L-lyxo</i> - ( <i>L</i> -Fuculose)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	.....	.....
100 Hexulose, <i>D-ribo</i> - ( <i>D</i> -Psicose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	Amorphous	+4.7
101 Hexulose, <i>L-xyllo</i> - ( <i>L</i> -Sorbosose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	159-161	-43.1
102 Hexulose, 6-deoxy- <i>L-xyllo</i> -	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	88	-25 ± 2 ( <i>c</i> 0.7)
103 Heptulose, <i>D-altra</i> - (Sedoheptulose; Sedoheptose)	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	Amorphous	+2.5 ( <i>c</i> 10)
104 Heptulose-hemihydrate, <i>L-galacto</i> - (Perseulose)	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub> · $\frac{1}{2}$ H <sub>2</sub> O	110-115	-90 → -80
105 Heptulose, <i>L-gulo</i> -	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	.....	-28
106 Heptulose, <i>D-ido</i> -	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	172	-34 ± 8 ( <i>c</i> 0.3)
107 Heptulose, <i>D-manno</i> - (Mannoketose; <i>D</i> -Mannotagatoheptose)	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	152	+29.4
108 Heptulose, <i>D-talo</i> -	C <sub>7</sub> H <sub>14</sub> O <sub>7</sub>	.....	.....
109 Octulose, <i>D-glycero-L-galacto</i> -	C <sub>8</sub> H <sub>16</sub> O <sub>8</sub>	.....	-57, -43.4 → -13.4
110 Octulose, <i>D-glycero-D-manno</i> -	C <sub>8</sub> H <sub>16</sub> O <sub>8</sub>	.....	+20 (CH <sub>2</sub> OH)

<sup>1</sup> Original melting point. <sup>2</sup> Melting point after four-months' storage. <sup>3</sup> As a methyl glycoside cyclohexylamine salt. <sup>4</sup> Included because of speculations concerning it in biological processes. <sup>5</sup> Either *D*-idose or *L*-altrose is in the polysaccharide varianose. <sup>6</sup> Early literature refers to this as *D*-erythrose. <sup>7</sup> The  $\frac{1}{2}$ H<sub>2</sub>O and  $\cdot 2$ H<sub>2</sub>O forms also exist.

**Part II. NATURAL MONOSACCHARIDES: AMINO SUGARS**

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Aldosamines			
1 <i>D</i> -Ribose, 3-amino-3-deoxy-	C <sub>5</sub> H <sub>11</sub> NO <sub>4</sub>	158-158.5 d.	-24.6 (hydrochloride)
2 <i>D</i> -Galactose, 2-amino-2-deoxy- (Galactosamine; Chondrosamine)	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	185	+121 → +80 (hydrochloride)
3 $\alpha$ - <i>L</i> -Galactose, 2-amino-2,6-dideoxy- ( <i>L</i> -Fucosamine)	C <sub>6</sub> H <sub>13</sub> NO <sub>4</sub>	192-193 d.	-119 → -92 [27°] (hydrochloride)
4 $\alpha$ - <i>D</i> -Glucose, 2-amino-2-deoxy- (Glucosamine; Chitosamine)	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	88	+100 → +47.5
5 $\beta$ - <i>D</i> -Glucose, 2-amino-2-deoxy-	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	110-111	+28 → +47.5
6 <i>D</i> -Glucose, 3-amino-3-deoxy- (Kanosamine)	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	128 d.	+19 [14°]
7 <i>D</i> -Glucose, 6-amino-6-deoxy-	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	161-162 d.	+23 → +50.1 (hydrochloride)
8 <i>D</i> -Glucose, 2,6-diamino-2,6-dideoxy- (Neosamine C)	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub>	>230	+61.5 (dihydrochloride)
9 <i>D</i> -Glucose, 3,6-dideoxy-3-dimethylamino- (Mycaminose)	C <sub>8</sub> H <sub>17</sub> NO <sub>4</sub>	115-116	+31 (hydrochloride)
10 <i>D</i> -Glucose, 4,6-dideoxy-4-dimethylamino-	C <sub>8</sub> H <sub>17</sub> NO <sub>4</sub>	192-193	+45.5 (hydrochloride)
11 <i>L</i> -Glucose, 2-deoxy-2-methylamino-	C <sub>7</sub> H <sub>15</sub> NO <sub>5</sub>	130-132	-64
12 <i>D</i> -Gulose, 2-amino-1,6-anhydro-2-deoxy-	C <sub>6</sub> H <sub>11</sub> NO <sub>4</sub>	250-260 d.	+41 ± 2 (hydrochloride)
13 <i>D</i> -Gulose, 2-amino-2-deoxy-	C <sub>6</sub> H <sub>13</sub> NO <sub>5</sub>	152-162 d.	+5.6 → -18.7 (hydrochloride)
14 Hexose, 3,4,6-trideoxy-3-dimethylamino- <i>D-xyllo</i> - (Desosamine; Pirocine)	C <sub>6</sub> H <sub>17</sub> NO <sub>3</sub>	189-191 d.	+49.5 ( <i>c</i> 10) (hydrochloride)
15 Hexose, a 4-acetamido-2-amino-2,4,6-trideoxy-	C <sub>8</sub> H <sub>16</sub> N <sub>2</sub> O <sub>4</sub>	216-219	+115 → +94 [26°] ( <i>c</i> 0.05)
16 Hexose, an amino-deoxy-3- <i>O</i> -carboxyethyl-	C <sub>6</sub> H <sub>17</sub> NO <sub>7</sub>	.....	.....
17 Hexose, a 2,6-diamino-2,6-dideoxy- (Neosamine B; Paramose)	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub>	135-150 d.	+17.5 ( <i>c</i> 0.9) (hydrochloride)

**PROPERTIES OF CARBOHYDRATES (continued)**

**Part II. NATURAL MONOSACCHARIDES: AMINO SUGARS (Continued)**

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Aldosamines (Con't)			
18 Hexose, a 3-dimethylamino-2,3,6-trideoxy- (Rhodosamine)	$C_6H_{17}NO_3$	.....	.....
19 D-Mannose, 2-amino-2-deoxy- (Mannosamine)	$C_6H_{13}NO_5$	142 d.	-4.3 (c 9) (hydrochloride)
20 D-Mannose, 3-amino-3,6-dideoxy- (Mycosamine)	$C_6H_{13}NO_4$	162	-11.5 (hydrochloride)
21 D-Talose, 2-amino-2-deoxy- (Talosamine)	$C_6H_{13}NO_5$	151-153	+3.4 → -5.7 (c 0.9) (hydrochloride)
22 L-Talose, 2-amino-2,6-dideoxy- (Pneumosamine)	$C_6H_{13}NO_4$	162-163	+6.9 → +10.4 (hydrochloride)
Ketosamines			
23 Pentulose, 1-( <i>o</i> -carboxyanilino)-1-deoxy-D-erythro-	$C_{12}H_{14}NO_6$	.....	.....
24 Hexulose, 1-( <i>o</i> -carboxyanilino)-1-deoxy-D-arabino-	$C_{13}H_{16}NO_7$	.....	.....
25 Hexulose, 5-amino-5-deoxy-L-xylo-	$C_6H_{13}NO_5$	174-176	-62
26 Hexulose, 6-deoxy-6-( <i>N</i> -methylacetamido)-L-xylo-	$C_6H_{17}NO_6$	.....	.....

**Part III. NATURAL ALDITOLS AND INOSITOLS (with Inososes and Inosamines)**

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Alditols			
1 Glycerol	$C_3H_8O_3$	20	None
2 Glycerol, 1-deoxy- (1,2-Propane-diol) <sup>1</sup>	$C_3H_6O_2$	Oil, b.p. 188-189	None (racemic)
3 Erythritol	$C_4H_{10}O_4$	118-120	None (meso)
4 Erythritol, 1,4-dideoxy- (2,3-Butylene-glycol)	$C_4H_{10}O_2$	25, 34	None (meso)
5 D-Threitol, 1,4-dideoxy-	$C_4H_{10}O_2$	19	-13.0
6 L-Threitol, 1,4-dideoxy-	$C_4H_{10}O_2$	.....	+10.2
7 DL-Threitol, 1,4-dideoxy-	$C_4H_{10}O_2$	7.6	None (racemic)
8 D-Arabinitol	$C_5H_{12}O_5$	103	+7.82 (c 8, borax solution)
9 L-Arabinitol	$C_5H_{12}O_5$	101-102	-32 (c 0.4, 5% molybdate)
10 Ribitol (Adomitol)	$C_5H_{12}O_5$	102	None (meso)
11 Galactitol (Dulcitol)	$C_6H_{14}O_6$	186-188	None (meso)
12 D-Glucitol (Sorbitol)	$C_6H_{14}O_6$	112	-1.8 [15°]
13 D-Glucitol, 1,5-anhydro- (Polygalitol)	$C_6H_{12}O_5$	140-141	+42.4
14 L-Iditol	$C_6H_{14}O_6$	73.5	-3.5 (c 10)
15 D-Mannitol	$C_6H_{14}O_6$	166	-0.21
16 D-Mannitol, 1,5-anhydro- (Styracitol)	$C_6H_{12}O_5$	157	-49.9
17 Heptitol, D-glycero-D-galacto- (Heptitol, L-glycero-D-manno-; Perseitil)	$C_7H_{16}O_7$	183-185, 188	-1.1
18 Heptitol, D-glycero-D-gluco- (Heptitol, L-glycero-D-talo-; β-Sedoheptitol)	$C_7H_{16}O_7$	131-132	+46 (5% NH <sub>4</sub> molybdate)
19 Heptitol, D-glycero-D-manno- (Heptitol, D-glycero-D-talo-; Volemitil)	$C_7H_{16}O_7$	153	+2.65
20 Octitol, D-erythro-D-galacto-	$C_8H_{18}O_8$ , H <sub>2</sub> O	169-170	-11 (5% NH <sub>4</sub> molybdate)
Inositols			
21 Betitol (a dideoxy inositol)	$C_6H_{12}O_4$	224	.....
22 Bioinosose ( <i>scylla</i> -Inosose; <i>myo</i> -Inosose-2; a deoxy keto inositol)	$C_6H_{10}O_4$	198-200	None (meso)
23 <i>h</i> -Bornesitol (a <i>myo</i> -inositol monomethyl ether)	$C_7H_{14}O_4$	200	+31.6
24 <i>l</i> -Bornesitol (a <i>myo</i> -inositol monomethyl ether)	$C_7H_{14}O_4$	205-206	-32.1
25 Conduritol (a 2,3-dehydro-2,3-dideoxyinositol)	$C_6H_{10}O_4$	142-143	None (meso)
26 Cordycepic acid (a tetrahydroxycyclohexanecarboxylic acid) <sup>2</sup>	$C_7H_{12}O_6$	.....	.....
27 Dambonitol (a <i>myo</i> -inositol dimethyl ether)	$C_8H_{16}O_6$	206	None (meso)
28 DL-Inositol	$C_6H_{12}O_6$	253	None (racemic)



PROPERTIES OF CARBOHYDRATES (continued)

Part III. NATURAL ALDITOLS AND INOSITOLS  
(with Inososes and Inosamines) (Continued)

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation [α] <sub>D</sub>
(A)	(B)	(C)	(D)
Inositols (Con't)			
29 <i>d</i> -Inositol	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	.....	+60
30 <i>l</i> -Inositol	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	240	-65
31 Laminitol (a <i>C</i> -methyl <i>myo</i> -inositol)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	266-269	-3
32 Liriodendritol (a <i>myo</i> -inositol dimethyl ether)	C <sub>8</sub> H <sub>16</sub> O <sub>6</sub>	224	-25
33 <i>muco</i> -Inositol monomethyl ether	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	322-325	.....
34 <i>myo</i> -Inositol ( <i>meso</i> -Inositol)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	217-218	None ( <i>meso</i> )
35 <i>d</i> - <i>myo</i> -Inosose-1 (a deoxy keto inositol)	C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	138-139	+19.6
36 Mytilitol (a <i>C</i> -methyl <i>scyllo</i> -inositol)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	259	None ( <i>meso</i> )
37 <i>neo</i> -Inosamine-2 (a deoxy amino inositol)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub> N	239-241 d.	None ( <i>meso</i> )
38 <i>d</i> -Ononitol (a <i>myo</i> -inositol monomethyl ether)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	172	+6.6
39 <i>h</i> -Pinitol (a <i>dextro</i> -inositol monomethyl ether)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	186	+65.5
40 <i>l</i> -Pinitol (a <i>levo</i> -inositol monomethyl ether)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	186	-65
41 <i>L</i> -Quebrachitol (a <i>levo</i> -inositol monomethyl ether)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	190-191	-80.2 [28°]
42 <i>d</i> -Quercitol (a deoxy <i>dextro</i> -inositol)	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	235	+24.2
43 <i>d</i> -Quinic acid (a trideoxy carboxy <i>dextro</i> -inositol)	C <sub>7</sub> H <sub>12</sub> O <sub>6</sub>	164	+44 (c 10)
44 <i>L</i> -Quinic acid (a trideoxy carboxy <i>levo</i> -inositol)	C <sub>7</sub> H <sub>12</sub> O <sub>6</sub>	162	-42.1
45 Quinic acid, 5-dehydro-	C <sub>7</sub> H <sub>10</sub> O <sub>6</sub>	140-142 (138 s.)	-82.4 [28°]
46 Scyllitol ( <i>scyllo</i> -Inositol; Cocositol)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	352-353	None ( <i>meso</i> )
47 Sequoyitol (a <i>myo</i> -inositol monomethyl ether)	C <sub>7</sub> H <sub>14</sub> O <sub>6</sub>	234-235	None ( <i>meso</i> )
48 Shikimic acid (a 3,4-anhydro-quinic acid)	C <sub>7</sub> H <sub>10</sub> O <sub>5</sub>	183-184	-200 [16°]
49 Shikimic acid, 5-dehydro-	C <sub>7</sub> H <sub>8</sub> O <sub>5</sub>	150-152	-57.5 [28°] (EtOH)
50 Streptamine (2,4-diaminodideoxy-scyllitol)	C <sub>6</sub> H <sub>14</sub> O <sub>4</sub> N <sub>2</sub>	88, 210-250 d.	None ( <i>meso</i> )
51 Streptamine, 2-deoxy-	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub> N <sub>2</sub>	.....	None ( <i>meso</i> )
52 Streptadine (1,3-Dideoxy-1,3-diguandino-scyllitol)	C <sub>6</sub> H <sub>12</sub> N <sub>4</sub> O <sub>4</sub>	.....	None ( <i>meso</i> )
53 Viburnitol (a deoxy <i>levo</i> -inositol) <sup>3</sup>	C <sub>6</sub> H <sub>12</sub> O <sub>5</sub>	174	-73.9

<sup>1</sup> The 1-phosphate ester of this diol is said to occur in brain tissue and sea-urchin eggs. <sup>2</sup> Strong evidence that cordycepic acid is really *D*-mannitol. <sup>3</sup> Not an enantiomorph of *d*-quercitol; other isomeric relationship is involved.

Part IV. NATURAL ALDONIC, URONIC, AND ALDARIC ACIDS

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation [α] <sub>D</sub>
(A)	(B)	(C)	(D)
Aldonic Acids			
1 <i>D</i> -Glyceric acid	C <sub>3</sub> H <sub>6</sub> O <sub>4</sub>	Gum	Dextro
2 <i>L</i> -Glyceric acid	C <sub>3</sub> H <sub>6</sub> O <sub>4</sub>	Gum	Levo
3 <i>D</i> -Arabinonic acid	C <sub>5</sub> H <sub>10</sub> O <sub>6</sub>	114-116	+10.5 (c 6)
4 <i>L</i> -Arabinonic acid	C <sub>5</sub> H <sub>10</sub> O <sub>6</sub>	118-119	-9.6 → -41.7 <sup>1</sup>
5 <i>L</i> -Arabinonic-1,4-lactone	C <sub>5</sub> H <sub>8</sub> O <sub>5</sub>	97-99	-72
6 <i>D</i> -Ribonic acid	C <sub>5</sub> H <sub>10</sub> O <sub>6</sub>	112-113	-17.0
7 <i>D</i> -Xylonic acid	C <sub>5</sub> H <sub>10</sub> O <sub>6</sub>	.....	-2.9 → +20.1 <sup>1</sup>
8 <i>L</i> -Xylonic acid	C <sub>5</sub> H <sub>10</sub> O <sub>6</sub>	.....	-91.8 <sup>1</sup>
9 <i>D</i> -Altronic acid	C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	.....	+11.5 → +24.8 <sup>1</sup> (Ca salt, <i>N</i> HCl)
0 <i>D</i> -Galactonic acid	C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	122	-11.2 → +57.6 <sup>1</sup>
1 <i>D</i> -Gluconic acid	C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	130-132 (110-112 s.)	-6.7 → +11.9 <sup>1</sup>
2 <i>L</i> -Gulonic acid	C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	Exists only in soln.	[ca. 0°]
3 Hexosonic acid, 2-deoxy- <i>D</i> -arabino-	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	93-95	+68 (lactone)
4 2-Hexulosonic acid, <i>D</i> -arabino-	C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	.....	-81.7 (Na salt)
5 2-Hexulosonic acid, 3-deoxy- <i>D</i> -erythro-	C <sub>6</sub> H <sub>10</sub> O <sub>6</sub>	.....	-29.2 (c 6, Ca salt)
6 2-Hexulosonic acid, <i>D</i> -lyxo-	C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	169	-5
7 5-Hexulosonic acid, <i>D</i> -arabino-	C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	108-109	.....
8 5-Hexulosonic acid, <i>D</i> -xylo-	C <sub>6</sub> H <sub>10</sub> O <sub>7</sub>	.....	-14.5
9 <i>D</i> -Mannonic acid	C <sub>6</sub> H <sub>12</sub> O <sub>7</sub>	.....	-15.6
0 <i>D</i> -Gluconic acid, <i>O</i> -β- <i>D</i> -galactopyranosyl- (1 → 4)- (Lactobionic acid)	C <sub>12</sub> H <sub>22</sub> O <sub>12</sub>	.....	+25.1 (Ca salt)

## PROPERTIES OF CARBOHYDRATES (continued)

### Part IV. NATURAL ALDONIC, URONIC, AND ALDARIC ACIDS (Continued)

Substance (Synonym)	Chemical Formula	Melting Point °C	Specific Rotation $[\alpha]_D$
(A)	(B)	(C)	(D)
Uronic Acids			
21 <i>l</i> -Lyxuronic acid	$C_5H_8O_6$	.....	.....
22 $\beta$ -D-Galacturonic acid	$C_6H_{10}O_7$	160	+27 → +55.6
23 $\alpha$ -D-Galacturonic acid-monohydrate	$C_6H_{12}O_8$	159–160 (110–115 s.)	+97.9 → +50.9
24 D-Galacturonic acid, 2-amino-2-deoxy-	$C_6H_{11}O_6N$	160 d.	+84.5 (pH 2 HCl)
25 $\beta$ -D-Glucuronic acid	$C_6H_{10}O_7$	156	+11.7 → +36.3
26 D-Glucuronic acid, 2-amino-2-deoxy-	$C_6H_{11}O_6N$	120–172 d.	+55
27 D-Glucuronic acid, 3-O-methyl-	$C_7H_{12}O_7$	Syrup	+6
28 <i>l</i> -Guluronic acid	$C_6H_{10}O_7$	.....	.....
29 <i>l</i> -Iduronic acid	$C_6H_{10}O_7$	.....	+30
30 $\beta$ -D-Mannuronic acid	$C_6H_{10}O_7$	165–167	–47.9 → –23.9
31 $\alpha$ -D-Mannuronic acid-monohydrate	$C_6H_{12}O_8$	110 s., 120–130 d.	+16 → –6.1 (c 6.8)
Aldaric Acids			
32 D-Tartaric acid	$C_4H_6O_6$	170	–15
33 <i>l</i> -Tartaric acid	$C_4H_6O_6$	170	+15 [15°]
34 <i>l</i> -Malic acid	$C_4H_6O_5$	100	–2.3 (c 8.4)

<sup>1</sup> Equilibrates with the lactone.

**PROPERTIES OF SULFURIC ACID**  
**Values at 20°C; specific gravity is referred to water at 4°C**

Bé	Sp gr	Percent H <sub>2</sub> SO <sub>4</sub>	g per liter	Lbs per cu ft	Lbs per gal	Bé	Sp gr	Percent H <sub>2</sub> SO <sub>4</sub>	g per liter	Lbs per cu ft	Lbs per gal
0.7	1.0051	1	10.05	0.6275	0.0839	41.8	1.4049	51	716.5	44.73	5.979
1.7	1.0118	2	20.24	1.263	0.1689	42.5	1.4148	52	735.7	45.93	6.140
2.6	1.0184	3	30.55	1.907	0.2550	43.2	1.4248	53	755.1	47.14	6.302
3.5	1.0250	4	41.00	2.560	0.3422	44.0	1.4350	54	774.9	48.37	6.467
4.5	1.0317	5	51.59	3.220	0.4305	44.7	1.4453	55	794.9	49.62	6.634
5.4	1.0385	6	62.31	3.890	0.5200	45.4	1.4557	56	815.2	50.89	6.803
6.3	1.0453	7	73.17	4.568	0.6106	46.1	1.4662	57	835.7	52.17	6.974
7.2	1.0522	8	84.18	5.255	0.7025	46.8	1.4768	58	856.5	53.47	7.148
8.1	1.0591	9	95.32	5.950	0.7955	47.5	1.4875	59	877.6	54.79	7.324
9.0	1.0661	10	106.6	6.655	0.8897	48.2	1.4983	60	899.0	56.12	7.502
9.9	1.0731	11	118.0	7.369	0.9851	48.9	1.5091	61	920.6	57.47	7.682
10.8	1.0802	12	129.6	8.092	1.082	49.6	1.5200	62	942.4	58.83	7.865
11.7	1.0874	13	141.4	8.825	1.180	50.3	1.5310	63	964.5	60.21	8.049
12.5	1.0947	14	153.3	9.567	1.279	51.0	1.5421	64	986.9	61.61	8.236
13.4	1.1020	15	165.3	10.32	1.379	51.7	1.5533	65	1010	63.03	8.426
14.3	1.1094	16	177.5	11.08	1.481	52.3	1.5646	66	1033	64.46	8.618
15.2	1.1168	17	189.9	11.85	1.584	53.0	1.5760	67	1056	65.92	8.812
16.0	1.1243	18	202.4	12.63	1.689	53.7	1.5874	68	1079	67.39	9.008
16.9	1.1318	19	215.0	13.42	1.795	54.3	1.5989	69	1103	68.87	9.207
17.7	1.1394	20	227.9	14.23	1.902	55.0	1.6105	70	1127	70.38	9.408
18.6	1.1471	21	240.9	15.04	2.010	55.6	1.6221	71	1152	71.90	9.611
19.4	1.1548	22	254.1	15.86	2.120	56.3	1.6338	72	1176	73.44	9.817
20.3	1.1626	23	267.4	16.69	2.231	56.9	1.6456	73	1201	74.99	10.02
21.1	1.1704	24	280.9	17.54	2.344	57.5	1.6574	74	1226	76.57	10.24
21.9	1.1783	25	294.6	18.39	2.458	58.1	1.6692	75	1252	78.15	10.45
22.8	1.1862	26	308.4	19.25	2.574	58.7	1.6810	76	1278	79.75	10.66
23.6	1.1942	27	322.4	20.13	2.691	59.3	1.6927	77	1303	81.37	10.88
24.4	1.2023	28	336.6	21.02	2.809	59.9	1.7043	78	1329	82.99	11.09
25.2	1.2104	29	351.0	21.91	2.929	60.5	1.7158	79	1355	84.62	11.31
26.0	1.2185	30	365.6	22.82	3.051	61.1	1.7272	80	1382	86.26	11.53
26.8	1.2267	31	380.3	23.74	3.173	61.6	1.7383	81	1408	87.90	11.75
27.6	1.2349	32	395.2	24.67	3.298	62.1	1.7491	82	1434	89.54	11.97
28.4	1.2432	33	410.3	25.61	3.424	62.6	1.7594	83	1460	91.16	12.19
29.1	1.2515	34	425.5	26.56	3.551	63.0	1.7693	84	1486	92.78	12.40
29.9	1.2599	35	441.0	27.53	3.680	63.5	1.7786	85	1512	94.38	12.62
30.7	1.2684	36	456.6	28.51	3.811	63.9	1.7872	86	1537	95.95	12.83
31.4	1.2769	37	472.5	29.49	3.943	64.2	1.7951	87	1562	97.49	13.03
32.2	1.2855	38	488.5	30.49	4.077	64.5	1.8022	88	1586	99.01	13.23
33.0	1.2941	39	504.7	31.51	4.212	64.8	1.8087	89	1610	100.5	13.42
33.7	1.3028	40	521.1	32.53	4.349	65.1	1.8144	90	1633	101.9	13.63
34.5	1.3116	41	537.8	33.57	4.488	65.3	1.8195	91	1656	103.4	13.82
35.2	1.3205	42	554.6	34.62	4.628	65.5	1.8240	92	1678	104.8	14.00
35.9	1.3294	43	571.6	35.69	4.770	65.7	1.8279	93	1700	106.1	14.19
36.7	1.3384	44	588.9	36.76	4.914	65.8	1.8312	94	1721	107.5	14.36
37.4	1.3476	45	606.4	37.86	5.061	65.9	1.8337	95	1742	108.7	14.54
38.1	1.3569	46	624.2	38.97	5.209	66.0	1.8355	96	1762	110.0	14.70
38.9	1.3663	47	642.2	40.09	5.359	66.0	1.8364	97	1781	111.2	14.87
39.6	1.3758	48	660.4	41.23	5.511	66.0	1.8361	98	1799	112.3	15.02
40.3	1.3854	49	678.8	42.38	5.665	65.9	1.8342	99	1816	113.4	15.15
41.1	1.3951	50	697.6	43.55	5.821	65.8	1.8305	100	1831	114.3	15.28

# PROPERTIES OF TUNGSTEN

Jones and Langmuir, General Electric Review

Temp. K	Resis- tivity mi- crohm cm	Electron emission amp./cm <sup>2</sup>	Evaporation g/cm <sup>2</sup> -s	Vapor pressure dynes/cm <sup>2</sup>	Thermal expan- sion per cent <sub>at</sub> 293°	Atomic heat cal/g atom/ °C
300	5.65	—	—	—	.003	6.0
400	8.06	—	—	—	.044	6.0
500	10.56	—	—	—	.086	6.1
600	13.23	—	—	—	.130	6.1
700	16.09	—	—	—	.175	6.2
800	19.00	—	—	—	.222	6.2
900	21.94	—	—	—	.270	6.3
1000	24.93	$1.07 \times 10^{-15}$	$5.32 \times 10^{-34}$	$1.98 \times 10^{-29}$	.320	6.4
1100	27.94	$1.52 \times 10^{-13}$	$2.17 \times 10^{-30}$	$1.22 \times 10^{-25}$	.371	6.4
1200	30.98	$9.73 \times 10^{-12}$	$3.21 \times 10^{-27}$	$1.87 \times 10^{-22}$	.424	6.5
1300	34.08	$3.21 \times 10^{-10}$	$1.35 \times 10^{-24}$	$8.18 \times 10^{-20}$	.479	6.7
1400	37.19	$6.62 \times 10^{-9}$	$2.51 \times 10^{-22}$	$1.62 \times 10^{-17}$	.535	6.8
1500	40.36	$9.14 \times 10^{-8}$	$2.37 \times 10^{-20}$	$1.54 \times 10^{-15}$	.593	7.0
1600	43.55	$9.27 \times 10^{-7}$	$1.25 \times 10^{-18}$	$8.43 \times 10^{-14}$	.652	7.1
1700	46.78	$7.08 \times 10^{-6}$	$4.17 \times 10^{-17}$	$2.82 \times 10^{-12}$	.713	7.2
1800	50.05	$4.47 \times 10^{-5}$	$8.81 \times 10^{-16}$	$6.31 \times 10^{-11}$	.775	7.4
1900	53.35	$2.28 \times 10^{-4}$	$1.41 \times 10^{-14}$	$1.01 \times 10^{-9}$	.839	7.6
2000	56.67	$1.00 \times 10^{-3}$	$1.76 \times 10^{-13}$	$1.33 \times 10^{-8}$	.904	7.7
2100	60.06	$3.93 \times 10^{-3}$	$1.66 \times 10^{-12}$	$1.28 \times 10^{-7}$	.971	7.8
2200	63.48	$1.33 \times 10^{-2}$	$1.25 \times 10^{-11}$	$9.88 \times 10^{-7}$	1.039	8.0
2300	66.91	$4.07 \times 10^{-2}$	$8.00 \times 10^{-11}$	$6.47 \times 10^{-6}$	1.109	8.2
2400	70.39	$1.16 \times 10^{-1}$	$4.26 \times 10^{-10}$	$3.52 \times 10^{-5}$	1.180	8.3
2500	73.91	$2.98 \times 10^{-1}$	$2.03 \times 10^{-9}$	$1.71 \times 10^{-4}$	1.253	8.4
2600	77.49	$7.16 \times 10^{-1}$	$8.41 \times 10^{-9}$	$7.24 \times 10^{-4}$	1.328	8.6
2700	81.04	1.63	$3.19 \times 10^{-8}$	$2.86 \times 10^{-3}$	1.404	8.7
2800	84.70	3.54	$1.10 \times 10^{-7}$	$9.84 \times 10^{-3}$	1.479	8.9
2900	88.33	7.31	$3.30 \times 10^{-7}$	$3.00 \times 10^{-2}$	1.561	9.0
3000	92.04	$1.42 \times 10$	$9.95 \times 10^{-7}$	$9.20 \times 10^{-2}$	1.642	9.2
3100	95.76	$2.64 \times 10$	$2.60 \times 10^{-6}$	$2.50 \times 10^{-1}$	1.724	9.4
3200	99.54	$4.78 \times 10$	$6.38 \times 10^{-6}$	$6.13 \times 10^{-1}$	1.808	9.5
3300	103.3	$8.44 \times 10$	$1.56 \times 10^{-5}$	1.51	1.893	9.6
3400	107.2	$1.42 \times 10^2$	$3.47 \times 10^{-5}$	3.41	1.980	9.8
3500	111.1	$2.33 \times 10^2$	$7.54 \times 10^{-5}$	7.52	2.068	9.9
3600	115.0	$3.73 \times 10^2$	$1.51 \times 10^{-4}$	$1.53 \times 10$	2.158	10.1
3655	117.1	$4.79 \times 10^2$	$2.28 \times 10^{-4}$	$2.33 \times 10$	2.209	10.2

Roesser and Wensel, National Bureau of Standards

Temp. K	Normal brightness new can- dles per cm <sup>2</sup>	Spectral emissivity		Color emis- sivity	Total emis- sivity	Bright- ness temp. 0.65μm	Color temp
		0.65μm	0.467μm				
300	—	0.472	0.505	—	0.032	—	—
400	—	—	—	—	.042	—	—
500	—	—	—	—	.053	—	—
600	—	—	—	—	.064	—	—
700	—	—	—	—	.076	—	—
800	—	—	—	—	.088	—	—
900	—	—	—	—	.101	—	—
1000	0.0001	.458	.486	.395	.114	966	1007
1100	0.001	.456	.484	.392	.128	1059	1108
1200	0.006	.454	.482	.390	.143	1151	1210
1300	0.029	.452	.480	.387	.158	1242	1312
1400	0.11	.450	.478	.385	.175	1332	1414
1500	0.33	.448	.476	.382	.192	1422	1516
1600	0.92	.446	.475	.380	.207	1511	1619
1700	2.3	.444	.473	.377	.222	1599	1722
1800	5.1	.442	.472	.374	.236	1687	1825
1900	10.4	.440	.470	.371	.249	1774	1928
2000	20.0	.438	.469	.368	.260	1861	2032
2100	36	.436	.467	.365	.270	1946	2136
2200	61	.434	.466	.362	.279	2031	2241
2300	101	.432	.464	.359	.288	2115	2345
2400	157	.430	.463	.356	.296	2198	2451
2500	240	.428	.462	.353	.303	2280	2556
2600	350	.426	.460	.349	.311	2362	2662
2700	500	.424	.459	.346	.318	2443	2769
2800	690	.422	.458	.343	.323	2523	2876
2900	950	.420	.456	.340	.329	2602	2984
3000	1260	.418	.455	.336	.334	2681	3092
3100	1650	.416	.454	.333	.337	2759	3200
3200	2100	.414	.452	.330	.341	2837	3310
3300	2700	.412	.451	.326	.344	2913	3420
3400	3400	.410	.450	.323	.348	2989	3530
3500	4200	.408	.449	.320	.351	3063	3642
3600	5200	.406	.447	.317	.354	3137	3754



## RADIATIVE TRANSITION PROBABILITIES FOR X-RAY LINES

### Ratios of Transition Probabilities for K X-Ray Lines

Element	$K\alpha_2/K\alpha_1$	$K\alpha_3/K\alpha_1$	$K\beta_1/K\alpha_1$	$K\beta'_2/K\alpha_1$	$K\beta_4/K\alpha_1$	$K\beta_5/K\alpha_1$	$K\beta_3/K\beta_1$	$K\beta/K\alpha$
<sup>12</sup> Mg								0.013
<sup>14</sup> Si								0.027
<sup>16</sup> S								0.059
<sup>18</sup> Ar								0.105
<sup>20</sup> Ca	0.502							0.128
<sup>22</sup> Ti	0.503							0.133
<sup>24</sup> Cr	0.504							0.133
<sup>26</sup> Fe	0.506							0.134
<sup>28</sup> Ni	0.508							0.135
<sup>30</sup> Zn	0.510							0.136
<sup>32</sup> Ge	0.513							0.147
<sup>34</sup> Se	0.515							0.157
<sup>36</sup> Kr	0.517			0.019				0.172
<sup>38</sup> Sr	0.520			0.030				0.180
<sup>40</sup> Ze	0.523			0.037				0.190
<sup>42</sup> Mo	0.525			0.041				0.197
<sup>44</sup> Ru	0.527			0.045			0.513	0.204
<sup>46</sup> Pd	0.529			0.048			0.513	0.210
<sup>48</sup> Cd	0.532			0.053			0.514	0.213
<sup>50</sup> Sn	0.534			0.055			0.514	0.220
<sup>52</sup> Te	0.537		0.187	0.058			0.514	0.225
<sup>54</sup> Xe	0.539		0.188	0.064			0.516	0.232
<sup>56</sup> Ba	0.543		0.189	0.070			0.516	0.237
<sup>58</sup> Ce	0.546		0.190	0.076			0.516	0.242
<sup>60</sup> Nd	0.549	$0.11 \times 10^{-3}$	0.191	0.083			0.516	0.247
<sup>62</sup> Sm	0.552	$0.14 \times 10^{-3}$	0.192	0.086			0.516	0.250
<sup>64</sup> Gd	0.556	$0.17 \times 10^{-3}$	0.194	0.089	$0.85 \times 10^{-3}$	$3.02 \times 10^{-3}$	0.517	0.255
<sup>66</sup> Dy	0.560	$0.21 \times 10^{-3}$	0.198	0.089	$0.92 \times 10^{-3}$	$3.43 \times 10^{-3}$	0.517	0.257
<sup>68</sup> Er	0.564	$0.26 \times 10^{-3}$	0.202	0.088	$0.96 \times 10^{-3}$	$3.85 \times 10^{-3}$	0.518	0.260
<sup>70</sup> Yb	0.567	$0.30 \times 10^{-3}$	0.207	0.087	$1.04 \times 10^{-3}$	$4.23 \times 10^{-3}$	0.518	0.264
<sup>72</sup> Hf	0.572	$0.36 \times 10^{-3}$	0.212	0.085	$1.16 \times 10^{-3}$	$4.62 \times 10^{-3}$	0.518	0.267
<sup>74</sup> W	0.576	$0.43 \times 10^{-3}$	0.216	0.086	$1.28 \times 10^{-3}$	$5.04 \times 10^{-3}$	0.518	0.269
<sup>76</sup> Os	0.580	$0.51 \times 10^{-3}$	0.222	0.087	$1.43 \times 10^{-3}$	$5.44 \times 10^{-3}$	0.519	0.273
<sup>78</sup> Pt	0.583	$0.63 \times 10^{-3}$	0.226	0.091	$1.61 \times 10^{-3}$	$5.84 \times 10^{-3}$	0.520	0.275
<sup>80</sup> Hg	0.588	$0.76 \times 10^{-3}$	0.228	0.096	$1.80 \times 10^{-3}$	$6.24 \times 10^{-3}$	0.520	0.278
<sup>82</sup> Pb	0.593	$0.91 \times 10^{-3}$	0.228	0.102	$2.02 \times 10^{-3}$	$6.64 \times 10^{-3}$	0.521	0.280
<sup>84</sup> Po	0.597	$1.12 \times 10^{-3}$	0.228	0.108	$2.26 \times 10^{-3}$	$7.05 \times 10^{-3}$	0.522	0.283
<sup>86</sup> Rn	0.602	$1.32 \times 10^{-3}$	0.228	0.113	$2.52 \times 10^{-3}$	$7.48 \times 10^{-3}$	0.523	0.286
<sup>88</sup> Ra	0.608	$1.58 \times 10^{-3}$	0.230	0.117	$2.80 \times 10^{-3}$	$7.80 \times 10^{-3}$	0.524	0.287
<sup>90</sup> Th	0.613	$1.85 \times 10^{-3}$	0.232	0.120	$3.13 \times 10^{-3}$	$8.25 \times 10^{-3}$	0.525	0.288
<sup>92</sup> U	0.619	$2.15 \times 10^{-3}$	0.234	0.123	$3.47 \times 10^{-3}$	$8.65 \times 10^{-3}$	0.527	0.289
<sup>94</sup> Pu	0.625		0.234	0.125			0.528	0.291
<sup>96</sup> Cm	0.632		0.234	0.128			0.529	0.293
<sup>98</sup> Cf	0.642		0.238	0.132			0.531	0.295
<sup>100</sup> Fm	0.648		0.240	0.135			0.533	0.297

**RADIATIVE TRANSITION PROBABILITIES FOR X-RAY LINES (continued)**

**$L_1$  X-Ray Lines Normalized to  $L\beta_3 = 100$**

Element	$L\beta_3$	$L\beta_4$	$L\gamma_2$	$L\gamma_3$	Element	$L\beta_3$	$L\beta_4$	$L\gamma_2$	$L\gamma_3$
<sup>32</sup> Ge	100			17.3	<sup>66</sup> Dy	100	61.8	19.5	28.0
<sup>34</sup> Se	100			18.0	<sup>68</sup> Er	100	63.5	19.8	29.0
<sup>36</sup> Kr	100			18.2	<sup>70</sup> Yb	100	65.5	20.7	29.8
<sup>38</sup> Sr	100			18.8	<sup>72</sup> Hf	100	67.8	21.2	30.7
<sup>40</sup> Zr	100			19.0	<sup>74</sup> W	100	70.5	21.8	31.8
<sup>42</sup> Mo	100	70.6		19.6	<sup>76</sup> Os	100	73.2	23.0	32.8
<sup>44</sup> Ru	100	67.8		20.2	<sup>78</sup> Pt	100	76.5	24.5	33.8
<sup>46</sup> Pd	100	65.5		20.6	<sup>80</sup> Hg	100	80.3	26.3	35.0
<sup>48</sup> Cd	100	63.5		21.3	<sup>82</sup> Pb	100	84.2	28.6	36.0
<sup>50</sup> Sn	100	62.1		22.0	<sup>84</sup> Po	100	88.5	31.3	37.2
<sup>52</sup> Te	100	60.7		22.6	<sup>86</sup> Rn	100	93.4	34.2	38.2
<sup>54</sup> Xe	100	59.8		23.3	<sup>88</sup> Ra	100	98.9	37.5	39.6
<sup>56</sup> Ba	100	59.5		24.0	<sup>90</sup> Th	100	104.5	41.2	41.0
<sup>58</sup> Ce	100	59.2		24.6	<sup>92</sup> U	100	110.2	45.0	42.6
<sup>60</sup> Nd	100	59.4		25.4	<sup>94</sup> Pu	100	116.2	49.5	44.0
<sup>62</sup> Sm	100	60.0		26.3	<sup>96</sup> Cm	100	123.0	55.7	45.7
<sup>64</sup> Gd	100	60.8	19.2	27.0					

**$L_2$  X-Ray Lines Normalized to  $L\beta_1 = 100$**

Element	$L\beta_1$	$L\eta$	$L\gamma_1$	$L\gamma_6$	Element	$L\beta_1$	$L\eta$	$L\gamma_1$	$L\gamma_6$
<sup>28</sup> Ni	100	7.60			<sup>64</sup> Gd	100	2.35	17.00	
<sup>30</sup> Zn	100	6.80			<sup>66</sup> Dy	100	2.25	17.40	
<sup>32</sup> Ge	100	6.28			<sup>68</sup> Er	100	2.16	17.80	
<sup>34</sup> Se	100	5.80			<sup>70</sup> Yb	100	2.10	18.17	
<sup>36</sup> Kr	100	5.35			<sup>72</sup> Hf	100	2.08	18.43	
<sup>38</sup> Sr	100	4.93			<sup>74</sup> W	100	2.10	18.80	0.72
<sup>40</sup> Zr	100	4.60	3.30		<sup>76</sup> Os	100	2.12	19.34	1.65
<sup>42</sup> Mo	100	4.30	5.50		<sup>78</sup> Pt	100	2.18	19.73	2.40
<sup>44</sup> Ru	100	4.00	7.33		<sup>80</sup> Hg	100	2.25	20.35	3.10
<sup>46</sup> Pd	100	3.75	10.67		<sup>82</sup> Pb	100	2.30	20.93	3.65
<sup>48</sup> Cd	100	3.55	10.60		<sup>84</sup> Po	100	2.40	21.54	4.15
<sup>50</sup> Sn	100	3.35	11.80		<sup>86</sup> Rn	100	2.46	22.20	4.55
<sup>52</sup> Te	100	3.20	12.70		<sup>88</sup> Ra	100	2.50	22.87	4.87
<sup>54</sup> Xe	100	3.00	14.00		<sup>90</sup> Th	100	2.60	23.43	5.02
<sup>56</sup> Ba	100	2.85	14.50		<sup>92</sup> U	100	2.65	24.10	5.12
<sup>58</sup> Ce	100	2.70	15.30		<sup>94</sup> Pu	100	2.70	24.40	5.16
<sup>60</sup> Nd	100	2.60	16.00		<sup>96</sup> Cm	100	2.75	25.07	5.20
<sup>62</sup> Sn	100	2.45	16.50						

**RADIATIVE TRANSITION PROBABILITIES FOR X-RAY LINES (continued)**

**$L_3$  X-Ray Lines Normalized to  $L\alpha_1 = 100$**

Element	$L\alpha_1$	$L\beta_{2,15}$	$L\alpha_2$	$L\beta_5$	$L\beta_6$	$L\epsilon$
$_{26}\text{Fe}$	100					12.22
$_{28}\text{Ni}$	100					8.95
$_{30}\text{Zn}$	100					7.34
$_{32}\text{Ge}$	100					6.45
$_{34}\text{Se}$	100					7.76
$_{36}\text{Kr}$	100					5.28
$_{38}\text{Sr}$	100					4.92
$_{40}\text{Zr}$	100	0.70	11.10			4.67
$_{42}\text{Mo}$	100	5.17	11.10			4.45
$_{44}\text{Ru}$	100	9.30	11.12			4.28
$_{46}\text{Pd}$	100	11.80	11.12			4.11
$_{48}\text{Cd}$	100	14.33	11.12			4.07
$_{50}\text{Sn}$	100	16.00	11.13			4.00
$_{52}\text{Te}$	100	18.00	11.13			4.00
$_{54}\text{Xe}$	100	19.40	11.13			4.00
$_{56}\text{Ba}$	100	20.67	11.13			4.02
$_{58}\text{Ce}$	100	21.00	11.14			4.09
$_{60}\text{Nd}$	100	21.33	11.14		0.875	4.13
$_{62}\text{Sm}$	100	21.07	11.14		0.925	4.16
$_{64}\text{Gd}$	100	20.83	11.14		0.99	4.20
$_{66}\text{Dy}$	100	20.50	11.14		1.05	4.26
$_{68}\text{Er}$	100	20.04	11.15		1.12	4.33
$_{70}\text{Yb}$	100	19.40	11.15		1.17	4.47
$_{72}\text{Hf}$	100	21.33	11.15	0.30	1.21	4.59
$_{74}\text{W}$	100	22.74	11.16	0.50	1.25	4.76
$_{76}\text{Os}$	100	23.40	11.16	1.32	1.37	4.95
$_{78}\text{Pt}$	100	24.00	11.16	1.98	1.43	5.14
$_{80}\text{Hg}$	100	24.50	11.17	2.62	1.50	5.37
$_{82}\text{Pb}$	100	24.83	11.17	3.21	1.56	5.58
$_{84}\text{Po}$	100	25.13	11.17	3.73	1.62	5.80
$_{86}\text{Rn}$	100	25.60	11.18	4.25	1.68	6.00
$_{88}\text{Ra}$	100	25.92	11.18	4.73	1.76	6.26
$_{90}\text{Th}$	100	26.17	11.18	5.18	1.82	6.54
$_{92}\text{U}$	100	26.40	11.18	5.58	1.89	6.79
$_{94}\text{Pu}$	100	26.67	11.18	5.92	1.95	7.02
$_{96}\text{Cm}$	100	26.93	11.18	6.26	2.01	7.34

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## RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS

John Askill

The data in these tables are the most reliable set of radioactive tracer diffusion data for pure metals published in the literature from 1938 through December, 1970. For a complete listing of all published data on this subject up to December 1968 see "Tracer Diffusion Data for Metals, Alloys and Simple Oxides" by John Askill, published by Plenum Press, New York, 1970.

The diffusion coefficient  $D_T$  at a temperature  $T$ (°K) is given by the following relation:

$$D_T = D_0 e^{-Q/RT}$$

Abbreviations used in the tables are:

A.R.G. = Autoradiography	S. = Single Crystal
R.A. = Residual Activity	⊥c. = Perpendicular to c Direction
S.D. = Surface Decrease	∥c. = Parallel to c Direction
S.S. = Serial Sectioning	99.95 = 99.95%
P. = Polycrystalline	

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , cm <sup>2</sup> /sec	Reference
<b>Aluminum</b>						
Ag <sup>110</sup>	S 99.999	371-655	S.S.	27.83	0.118	1
Al <sup>27</sup>	S	450-650	S.S.	34.0	1.71	2
Au <sup>198</sup>	S 99.999	423-609	S.S.	27.0	0.077	3
Cd <sup>113</sup>	S 99.999	441-631	S.S.	29.7	1.04	3
Ce <sup>141</sup>	P 99.995	450-630	R.A.	26.60	$1.9 \times 10^{-6}$	5
Co <sup>60</sup>	S 99.999	369-655	S.S.	27.79	0.131	1
Cr <sup>51</sup>	S 99.999	422-654	S.S.	41.74	464	1
Cu <sup>64</sup>	S 99.999	433-652	S.S.	32.27	0.647	1
Fe <sup>59</sup>	S 99.99	550-636	S.S.	46.0	135	3
Ga <sup>-</sup>	S 99.999	406-652	S.S.	29.24	0.49	1
Ge <sup>7</sup>	S 99.999	401-653	S.S.	28.98	0.481	1
In <sup>114</sup>	P 99.99	400-600	S.S., R.A.	27.6	0.123	4
La <sup>140</sup>	P 99.995	500-630	R.A.	27.0	$1.4 \times 10^{-6}$	5
Mn <sup>54</sup>	P 99.99	450-650	S.S.	28.8	0.22	2
Mo <sup>99</sup>	P 99.995	400-630	R.A.	13.1	$1.04 \times 10^{-9}$	6
Nb <sup>95</sup>	P 99.95	350-480	R.A.	19.65	$1.66 \times 10^{-7}$	7
Nd <sup>147</sup>	P 99.995	450-630	R.A.	25.0	$4.8 \times 10^{-7}$	5
Ni <sup>63</sup>	P 99.99	360-630	R.A.	15.7	$2.9 \times 10^{-8}$	8
Pd <sup>103</sup>	P 99.995	400-630	R.A.	20.2	$1.92 \times 10^{-7}$	9
Pt <sup>142</sup>	P 99.995	520-630	R.A.	23.87	$3.58 \times 10^{-7}$	5
Sb <sup>124</sup>	P	448-620	R.A.	29.1	0.09	10
Sm <sup>153</sup>	P 99.995	450-630	R.A.	22.88	$3.45 \times 10^{-7}$	5
Sn <sup>113</sup>	P	400-600	S.S., R.A.	28.5	0.245	4
V <sup>48</sup>	P 99.995	400-630	R.A.	19.6	$6.05 \times 10^{-8}$	11
Zn <sup>65</sup>	S 99.999	357-653	S.S.	28.86	0.259	1
<b>Beryllium</b>						
Ag <sup>110</sup>	S ⊥c 99.75	650-900	R.A.	43.2	1.76	12
Ag <sup>110</sup>	S ⊥c 99.75	650-900	R.A.	39.3	0.43	12
Be <sup>-</sup>	S ⊥c 99.75	565-1065	R.A.	37.6	0.52	13
Be <sup>-</sup>	S ⊥c 99.75	565-1065	R.A.	39.4	0.62	13
Fe <sup>59</sup>	S 99.75	700-1076	R.A.	51.6	0.67	12
Ni <sup>63</sup>	P	800-1250	R.A.	58.0	0.2	14
<b>Cadmium</b>						
Ag <sup>110</sup>	S 99.99	180-300		25.4	2.21	15
Cd <sup>113</sup>	S 99.95	110-283	R.A.	19.3	0.14	16
Zn <sup>65</sup>	S 99.99	180-300		19.0	0.0016	15
<b>Calcium</b>						
C <sup>14</sup>	99.95	550-800	R.A.	29.8	$3.2 \times 10^{-5}$	17
Ca <sup>45</sup>	99.95	500-800	R.A.	38.5	8.3	17
Fe <sup>59</sup>	99.95	500-800	R.A.	23.3	$2.7 \times 10^{-3}$	17
Ni <sup>63</sup>	99.95	550-800		28.9	$1.0 \times 10^{-5}$	17
U <sup>235</sup>	99.95	500-700	R.A.	34.8	$1.1 \times 10^{-5}$	17
<b>Carbon</b>						
Ag <sup>110</sup>	⊥c	750-1050	R.A.	64.3	9280	18
C <sup>14</sup>		2000-2200		163	5	19
Ni <sup>63</sup>	⊥c	540-920	R.A.	47.2	102	18
Ni <sup>63</sup>	∥c	750-1060	R.A.	53.3	2.2	18
Th <sup>228</sup>	⊥c	1400-2200	R.A.	145.4	$1.33 \times 10^{-5}$	18
Th <sup>228</sup>	∥c	1800-2200	R.A.	114.7	2.48	18
U <sup>232</sup>	⊥c	1400-2200	R.A.	115.0	6760	18
U <sup>232</sup>	∥c	1400-1820	R.A.	129.5	385	18
<b>Chromium</b>						
C <sup>14</sup>	P	1200-1500	R.A.	26.5	$9.0 \times 10^{-3}$	20
Cr <sup>51</sup>	P 99.98	1030-1545	S.S.	73.7	0.2	21
Fe <sup>59</sup>	P 99.8	980-1420	R.A.	79.3	0.47	22
Mo <sup>99</sup>	P	1100-1420	R.A.	58.0	$2.7 \times 10^{-3}$	20
<b>Cobalt</b>						
C <sup>14</sup>	P 99.82	600-1400	R.A.	34.0	0.21	23
Co <sup>60</sup>	P 99.9	1100-1405	S.S.	67.7	0.83	24
Fe <sup>59</sup>	P 99.9	1104-1303	S.S.	62.7	0.21	24
Ni <sup>63</sup>	P	1192-1297	R.A.	60.2	0.10	25
S <sup>35</sup>	P 99.99	1150-1250	R.A.	5.4	1.3	26
<b>Copper</b>						
Ag <sup>110</sup>	S, P	580-980	R.A.	46.5	0.61	27
As <sup>76</sup>	P	810-1075	R.A.	42.13	0.20	28
Au <sup>198</sup>	S, P	400-1050	S.S.	42.6	0.03	29
Cd <sup>113</sup>	S 99.98	725-950	S.S.	45.7	0.935	30



RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS (Continued)

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , $\text{cm}^2/\text{s}$	Reference
Ce <sup>141</sup>	P 99.999	766-947	R.A.	27.6	$2.17 \times 10^{-8}$	31
Cr <sup>51</sup>	S, P	800-1070	R.A.	53.5	1.02	32
Co <sup>60</sup>	S 99.998	701-1077	S.S.	54.1	1.93	33
Cu <sup>67</sup>	S 99.999	698-1061	S.S.	50.5	0.78	34
Eu <sup>152</sup>	P 99.999	750-970	S.S., R.A.	26.85	$1.17 \times 10^{-7}$	31
Fe <sup>59</sup>	S, P	460-1070	R.A.	52.0	1.36	32
Ga <sup>72</sup>		—	—	45.90	0.55	35
Ge <sup>68</sup>	S 99.998	653-1015	S.S.	44.76	0.397	36
Hg <sup>203</sup>	P	—	—	44.0	0.35	35
Lu <sup>177</sup>	P 99.999	857-1010	R.A.	26.15	$4.3 \times 10^{-9}$	31
Mn <sup>54</sup>	S 99.99	754-950	S.S.	91.4	$10^7$	37
Nb <sup>95</sup>	P 99.999	807-906	R.A.	60.06	2.04	38
Ni <sup>63</sup>	P	620-1080	R.A.	53.8	1.1	39
Pd <sup>102</sup>	S 99.999	807-1056	S.S.	54.37	1.71	40
Pm <sup>147</sup>	P 99.999	720-955	R.A.	27.5	$3.62 \times 10^{-8}$	31
Pt <sup>195</sup>	P	843-997	S.S.	37.5	$4.8 \times 10^{-4}$	41
S <sup>35</sup>	S 99.999	800-1000	R.A.	49.2	23	42
Sb <sup>124</sup>	S 99.999	600-1000	S.S.	42.0	0.34	43
Sn <sup>113</sup>	P	680-910	—	45.0	0.11	44
Tb <sup>160</sup>	P 99.999	770-980	R.A.	27.45	$8.96 \times 10^{-9}$	31
Tl <sup>204</sup>	S 99.999	785-996	S.S.	43.3	0.71	45
Tm <sup>170</sup>	P 99.999	705-950	R.A.	24.15	$7.28 \times 10^{-9}$	31
Zn <sup>65</sup>	P 99.999	890-1000	S.S.	47.50	0.73	46
<b>Germanium</b>						
Cd <sup>115</sup>	S	750-950	R.A.	102.0	$1.75 \times 10^9$	47
Fe <sup>59</sup>	S	775-930	R.A.	24.8	0.13	48
Ge <sup>71</sup>	S	766-928	S.S.	68.5	7.8	49
In <sup>114</sup>	S	600-920	—	39.9	$2.9 \times 10^{-4}$	50
Sb <sup>124</sup>	S	720-900	—	50.2	0.22	51
Te <sup>125</sup>	S	770-900	S.S.	56.0	2.0	52
Tl <sup>204</sup>	S	800-930	S.S.	78.4	1700	53
<b>Gold</b>						
Ag <sup>110</sup>	S 99.99	699-1007	S.S.	40.2	0.072	54
Au <sup>198</sup>	S 99.97	850-1050	S.S.	42.26	0.107	224
Co <sup>60</sup>	P 99.93	702-948	R.A.	41.6	0.068	55
Fe <sup>59</sup>	P 99.93	701-948	R.A.	41.6	0.082	55
Hg <sup>203</sup>	S 99.994	600-1027	—	37.38	0.116	56
Ni <sup>63</sup>	P 99.96	880-940	S.S.	46.0	0.30	57
Pt <sup>195</sup>	P, S 99.98	800-1060	S.S.	60.9	7.6	58
<b><math>\beta</math>-Hafnium</b>						
Hf <sup>181</sup>	P 97.9	1795-1995	S.S.	38.7	$1.2 \times 10^{-3}$	59
<b>Indium</b>						
Ag <sup>110</sup>	S, Lc 99.99	25-140	S.S.	12.8	0.52	60
Ag <sup>110</sup>	S, lc 99.99	25-140	S.S.	11.5	0.11	60
Au <sup>198</sup>	S 99.99	25-140	S.S.	6.7	$9 \times 10^{-3}$	60
In <sup>114</sup>	S, Lc 99.99	44-144	S.S.	18.7	3.7	61
In <sup>114</sup>	S, lc 99.99	44-144	S.S.	18.7	2.7	61
Tl <sup>204</sup>	S 99.99	49-157	S.S.	15.5	0.049	62
<b><math>\alpha</math>-Iron</b>						
Ag <sup>110</sup>	P	748-888	S.S.	69.0	1950	63
Au <sup>198</sup>	P 99.999	800-900	R.A.	62.4	31	64
C <sup>14</sup>	P 99.98	616-844	R.A.	29.3	2.2	65
Co <sup>60</sup>	P 99.995	638-768	R.A.	62.2	7.19	62
Cr <sup>51</sup>	P 99.95	775-875	R.A.	57.5	2.53	66
Cu <sup>64</sup>	P 99.9	800-1050	R.A.	57.0	0.57	67
Fe <sup>55</sup>	P 99.92	809-889	—	60.3	5.4	68
K <sup>42</sup>	P 99.92	500-800	R.A.	42.3	0.036	69
Mn <sup>54</sup>	P 99.97	800-900	R.A.	52.5	0.35	70
Mo <sup>99</sup>	P	750-875	R.A.	73.0	7800	71
Ni <sup>63</sup>	P 99.97	680-800	R.A.	56.0	1.3	72
P <sup>32</sup>	P	860-900	R.A.	55.0	2.9	73
Sb <sup>124</sup>	P	800-900	R.A.	66.6	1100	74
V <sup>48</sup>	P	755-875	R.A.	55.4	1.43	75
W <sup>185</sup>	P	755-875	R.A.	55.1	0.29	75
<b><math>\gamma</math>-Iron</b>						
Be <sup>7</sup>	P 99.9	1100-1350	R.A.	57.6	0.1	76
C <sup>14</sup>	P 99.34	800-1400	—	34.0	0.15	23
Co <sup>60</sup>	P 99.98	1138-1340	S.S.	72.9	1.25	77
Cr <sup>51</sup>	P 99.99	950-1400	R.A.	69.7	10.8	78
Fe <sup>59</sup>	P 99.98	1171-1361	S.S.	67.86	0.49	79
Hf <sup>181</sup>	P 99.99	1110-1360	R.A.	97.3	3600	78
Mn <sup>54</sup>	P 99.97	920-1280	R.A.	62.5	0.16	70
Ni <sup>63</sup>	P 99.97	930-2050	R.A.	67.0	0.77	72
P <sup>32</sup>	P 99.99	950-1200	R.A.	43.7	0.01	80
S <sup>35</sup>	P	900-1250	R.A.	53.0	1.7	81
V <sup>48</sup>	P 99.99	1120-1380	R.A.	69.3	0.28	78
W <sup>185</sup>	P 99.5	1050-1250	R.A.	90.0	1000	82
<b><math>\delta</math>-Iron</b>						
Co <sup>60</sup>	P 99.995	1428-1521	R.A.	61.4	6.38	83
Fe <sup>59</sup>	P 99.95	1428-1492	S.S.	57.5	2.01	83
P <sup>32</sup>	P 99.99	1370-1460	R.A.	55.0	2.9	73
<b>Lanthanum</b>						
Au <sup>198</sup>	P 99.97	600-800	S.S.	45.1	1.5	84
La <sup>140</sup>	P 99.97	690-850	S.S.	18.1	$2.2 \times 10^{-2}$	84
<b>Lead</b>						
Ag <sup>110</sup>	P 99.9	200-310	R.A.	14.4	0.064	85
Au <sup>198</sup>	S 99.999	190-320	S.S.	10.0	$8.7 \times 10^{-3}$	86

## RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS (Continued)

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , cm <sup>2</sup> /s	Reference
Cd <sup>115</sup>	S 99.999	150-320	S.S.	21.23	0.409	87
Cu <sup>64</sup>	S	150-320	S.S.	14.44	0.046	88
Pb <sup>204</sup>	S 99.999	150-320	S.S.	25.52	0.887	87
Tl <sup>205</sup>	P 99.999	207-322	S.S.	24.33	0.511	89
<b>Lithium</b>						
Ag <sup>110</sup>	P 92.5	65-161	S.S.	12.83	0.37	90
Au <sup>195</sup>	P 92.5	47-153	S.S.	10.49	0.21	90
Bi	P 99.95	141-177	S.S.	47.3	$5.3 \times 10^{13}$	91
Cd <sup>115</sup>	P 92.5	80-174	S.S.	16.05	2.35	90
Cu <sup>64</sup>	P 99.98	51-120	S.S.	9.22	0.47	93
Ga <sup>72</sup>	P 99.98	58-173	S.S.	12.9	0.21	93
Hg <sup>203</sup>	P 99.98	58-173	S.S.	14.18	1.04	93
In <sup>114</sup>	P 92.5	80-175	S.S.	15.87	0.39	90
Li <sup>6</sup>	P 99.98	35-178	S.S.	12.60	0.14	94
Na <sup>22</sup>	P 92.5	52-176	S.S.	12.61	0.41	90
Pb <sup>204</sup>	P 99.95	129-169	S.S.	25.2	160	91
Sb <sup>124</sup>	P 99.95	141-176	S.S.	41.5	$1.6 \times 10^{10}$	91
Sn <sup>113</sup>	P 99.95	108-174	S.S.	15.0	0.62	91
Zn <sup>65</sup>	P 92.5	60-175	S.S.	12.98	0.57	92
<b>Magnesium</b>						
Ag <sup>110</sup>	P 99.9	476-621	S.S.	28.50	0.34	95
Fe <sup>59</sup>	P 99.95	400-600	R.A.	21.2	$4 \times 10^{-6}$	96
In <sup>114</sup>	P 99.9	472-610	S.S.	28.4	$5.2 \times 10^{-2}$	95
Mg <sup>28</sup>	S.L.c	467-635	S.S.	32.5	1.5	97
Mg <sup>28</sup>	S c	467-635	S.S.	32.2	1.0	97
Ni <sup>63</sup>	P 99.95	400-600	R.A.	22.9	$1.2 \times 10^{-5}$	96
U <sup>235</sup>	P 99.95	500-620	R.A.	27.4	$1.6 \times 10^{-5}$	96
Zn <sup>65</sup>	P 99.9	467-620	S.S.	28.6	0.41	95
<b>Molybdenum</b>						
C <sup>14</sup>	P 99.98	1200-1600	R.A.	41.0	$2.04 \times 10^{-2}$	99
Co <sup>60</sup>	P 99.98	1850-2350	S.S.	106.7	18	100
Cr <sup>51</sup>	P	1000-1500	R.A.	54.0	$2.5 \times 10^{-4}$	20
Cs <sup>134</sup>	S 99.99	1000-1470	R.A., A.R.G.	28.0	$8.7 \times 10^{-11}$	101
K <sup>42</sup>	S	800-1100	R.A.	25.04	$5.5 \times 10^{-9}$	102
Mo <sup>99</sup>	P	1850-2350	S.S.	96.9	0.5	103
Na <sup>24</sup>	S	800-1100	R.A.	21.25	$2.95 \times 10^{-9}$	102
Nb <sup>95</sup>	P 99.98	1850-2350	S.S.	108.1	14	100
P <sup>32</sup>	P 99.97	2000-2200	S.S.	80.5	0.19	104
Re <sup>186</sup>	P	1700-2100	A.R.G.	94.7	0.097	105
S <sup>35</sup>	S 99.97	2220-2470	S.S.	101.0	320	106
Ta <sup>182</sup>	P	1700-2150	R.A.	83.0	$3.5 \times 10^{-4}$	20
U <sup>235</sup>	P 99.98	1500-2000	R.A.	76.4	$7.6 \times 10^{-3}$	107
W <sup>185</sup>	P 99.98	1700-2260	S.S.	110	1.7	108
<b>Nickel</b>						
Au <sup>198</sup>	S, P 99.999	700-1075	S.S.	55.0	0.02	109
Be <sup>7</sup>	P 99.9	1020-1400	R.A.	46.2	0.019	76
C <sup>14</sup>	P 99.86	600-1400	—	34.0	0.012	23
Co <sup>60</sup>	P 99.97	1149-1390	R.A.	65.9	1.39	110
Cr <sup>51</sup>	P 99.95	1100-1270	S.S.	65.1	1.1	111
Cu <sup>64</sup>	P 99.95	1050-1360	S.S.	61.7	0.57	111
Fe <sup>59</sup>	P	1020-1263	S.S.	58.6	0.074	112
Mo <sup>99</sup>	P	900-1200	R.A.	51.0	$1.6 \times 10^{-3}$	20
Ni <sup>63</sup>	P 99.95	1042-1404	S.S.	68.0	1.9	111
Pu <sup>238</sup>	P	1025-1125	A.R.G.	51.0	0.5	113
Sb <sup>124</sup>	P 99.97	1020-1220	—	27.0	$1.8 \times 10^{-5}$	114
Sn <sup>113</sup>	P 99.8	700-1350	A.R.G.	58.0	0.83	115
V <sup>48</sup>	P 99.99	800-1300	R.A.	66.5	0.87	11
W <sup>185</sup>	P 99.95	1100-1300	S.S.	71.5	2.0	116
<b>Niobium</b>						
C <sup>14</sup>	P	800-1250	R.A.	32.0	$1.09 \times 10^{-5}$	117
Co <sup>60</sup>	P 99.85	1500-2100	A.R.G.	70.5	0.74	118
Cr <sup>51</sup>	S	943-1435	S.S.	83.5	0.30	119
Fe <sup>55</sup>	P 99.85	1400-2100	A.R.G.	77.7	1.5	118
K <sup>42</sup>	S	900-1100	R.A.	22.10	$2.38 \times 10^{-7}$	102
Nb <sup>95</sup>	P, S 99.99	878-2395	S.S.	96.0	1.1	120
P <sup>32</sup>	P 99.0	1300-1800	S.S.	51.5	$5.1 \times 10^{-2}$	104
S <sup>35</sup>	S 99.9	1100-1500	R.A.	73.1	2600	121
Sn <sup>113</sup>	P 99.85	1850-2400	S.S.	78.9	0.14	122
Ta <sup>182</sup>	P, S 99.997	878-2395	S.S.	99.3	1.0	120
Ti <sup>44</sup>	S	994-1492	S.S.	86.9	0.099	123
U <sup>235</sup>	P 99.55	1500-2000	R.A.	76.8	$8.9 \times 10^{-3}$	107
V <sup>48</sup>	S 99.99	1000-1400	R.A.	85.0	2.21	124
W <sup>185</sup>	P 99.8	1800-2200	R.A.	91.7	$5 \times 10^{-4}$	125
<b>Palladium</b>						
Pd <sup>103</sup>	S 99.999	1060-1500	S.S.	63.6	0.205	126
<b>Phosphorus</b>						
P <sup>32</sup>	P	0-44	S.S.	9.4	$1.07 \times 10^{-3}$	127
<b>Platinum</b>						
Co <sup>60</sup>	P 99.99	900-1050	—	74.2	19.6	129
Cu <sup>64</sup>	P	1098-1375	S.S.	59.5	0.074	41
Pt <sup>195</sup>	P 99.99	1325-1600	S.S.	68.2	0.33	130
<b>Potassium</b>						
Au <sup>198</sup>	P 99.95	5.6-52.5	S.S.	3.23	$1.29 \times 10^{-3}$	131
K <sup>42</sup>	S 99.7	-52-61	S.S.	9.36	0.16	132
Na <sup>22</sup>	P 99.7	0-62	S.S.	7.45	0.058	133
Rb <sup>86</sup>	P 99.95	0.1-59.9	S.S.	8.78	0.090	134

RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS (Continued)

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , cm <sup>2</sup> /s	Reference
<b><math>\gamma</math>-Plutonium</b>						
Pu <sup>238</sup>	P	190-310	S.S.	16.7	$2.1 \times 10^{-5}$	135
<b><math>\delta</math>-Plutonium</b>						
Pu <sup>238</sup>	P	350-440	S.S.	23.8	$4.5 \times 10^{-3}$	136
<b><math>\epsilon</math>-Plutonium</b>						
Pu <sup>238</sup>	P	500-612	R.A.	18.5	$2.0 \times 10^{-2}$	137
<b><math>\alpha</math>-Praseodymium</b>						
Ag <sup>110</sup>	P 99.93	610-730	S.S.	25.4	0.14	138
Au <sup>195</sup>	P 99.93	650-780	S.S.	19.7	$4.3 \times 10^{-2}$	138
Co <sup>60</sup>	P 99.93	660-780	S.S.	16.4	$4.7 \times 10^{-2}$	138
Zn <sup>65</sup>	P 99.96	766-603	S.S.	24.8	0.18	139
<b><math>\beta</math>-Praseodymium</b>						
Ag <sup>110</sup>	P 99.93	800-900	S.S.	21.5	$3.2 \times 10^{-2}$	138
Au <sup>195</sup>	P 99.93	800-910	S.S.	20.1	$3.3 \times 10^{-2}$	138
Ho <sup>166</sup>	P 99.96	800-930	S.S.	26.3	9.5	140
In <sup>114</sup>	P 99.96	800-930	S.S.	28.9	9.6	140
La <sup>140</sup>	P 99.96	800-930	S.S.	25.7	1.8	140
Pt <sup>192</sup>	P 99.93	800-900	S.S.	29.4	8.7	140
Zn <sup>65</sup>	P 99.96	822-921	S.S.	27.0	0.63	139
<b>Selenium</b>						
Fe <sup>59</sup>	P	40-100	R.A.	8.88	—	141
Hg <sup>203</sup>	P 99.996	25-100	R.A.	1.2	—	141
S <sup>35</sup>	S.L.c	60-90	S.D.	29.9	1700	142
S <sup>35</sup>	S c	60-90	S.D.	15.6	1100	142
Se <sup>75</sup>	P	35-140	—	11.7	$1.4 \times 10^{-4}$	143
<b>Silicon</b>						
Au <sup>198</sup>	S	700-1300	S.S.	47.0	$2.75 \times 10^{-3}$	145
C <sup>14</sup>	P	1070-1400	R.A.	67.2	0.33	146
Cu <sup>64</sup>	P	800-1100	R.A.	23.0	$4 \times 10^{-2}$	147
Fe <sup>59</sup>	S	1000-1200	R.A.	20.0	$6.2 \times 10^{-3}$	148
Ni <sup>63</sup>	P	450-800	—	97.5	1000	149
Pb <sup>210</sup>	S	1100-1250	R.A.	41.5	—	150
Sb <sup>124</sup>	S	1190-1398	R.A.	91.7	12.9	151
Si <sup>31</sup>	S 99.99999	1225-1400	S.S.	110.0	1800	146
<b>Silver</b>						
Au <sup>198</sup>	P 99.99	718-942	S.S.	48.28	0.85	54
Ag <sup>110</sup>	S 99.999	640-955	S.S.	45.2	0.67	152
Cd <sup>115</sup>	S 99.99	592-937	S.S.	41.69	0.44	153
Co <sup>60</sup>	S 99.999	700-940	—	48.75	1.9	154
Cu <sup>64</sup>	P 99.99	717-945	S.S.	46.1	1.23	155
Fe <sup>59</sup>	S 99.99	720-930	S.S.	49.04	2.42	156
Ge <sup>77</sup>	P	640-870	S.S.	36.5	0.084	157
Hg <sup>203</sup>	P 99.99	653-948	S.S.	38.1	0.079	155
In <sup>114</sup>	S 99.99	592-937	S.S.	40.80	0.41	153
Ni <sup>63</sup>	S 99.99	749-950	S.S.	54.8	21.9	158
Pb <sup>210</sup>	P	700-865	S.S.	38.1	0.22	159
Pd <sup>102</sup>	S 99.999	736-939	S.S.	56.75	9.56	140
Ru <sup>103</sup>	S 99.99	793-945	S.S.	65.8	180	160
S <sup>35</sup>	S 99.999	600-900	R.A.	40.0	1.65	161
Sb <sup>124</sup>	P 99.999	780-950	S.S., R.A.	39.07	0.234	162
Sn <sup>113</sup>	S 99.99	592-937	S.S.	39.30	0.255	153
Te <sup>125</sup>	P	770-940	R.A.	38.90	0.47	163
Tl <sup>204</sup>	P	640-870	S.S.	37.9	0.15	157
Zn <sup>65</sup>	S 99.99	640-925	S.S.	41.7	0.54	164
<b>Sodium</b>						
Au <sup>198</sup>	P 99.99	1.0-77	S.S.	2.21	$3.34 \times 10^{-4}$	165
K <sup>42</sup>	P 99.99	0-91	S.S.	8.43	0.08	133
Na <sup>22</sup>	P 99.99	0-98	S.S.	10.09	0.145	166
Rb <sup>86</sup>	P 99.99	0-85	S.S.	8.49	0.15	133
<b>Tantalum</b>						
C <sup>14</sup>	P	1450-2200	S.S.	40.3	$1.2 \times 10^{-2}$	167
Fe <sup>59</sup>	P	930-1240	—	71.4	0.505	168
Mo <sup>99</sup>	P	1750-2220	R.A.	81.0	$1.8 \times 10^{-3}$	20
Nb <sup>95</sup>	P, S 99.996	921-2484	S.S.	98.7	0.23	169
S <sup>35</sup>	P 99.0	1970-2110	R.A.	70.0	100	170
Ta <sup>182</sup>	P, S 99.996	1250-2200	S.S.	98.7	1.24	226
<b>Tellurium</b>						
Hg <sup>203</sup>	P	270-440	—	18.7	$3.14 \times 10^{-5}$	171
Se <sup>75</sup>	P	320-440	—	28.6	$2.6 \times 10^{-2}$	171
Tl <sup>204</sup>	P	360-430	—	41.0	320	172
Te <sup>127</sup>	S.L.c 99.9999	300-400	S.S.	46.7	$3.91 \times 10^4$	173
Te <sup>127</sup>	S c 99.9999	300-400	S.S.	35.5	130	173
<b><math>\alpha</math>-Thallium</b>						
Ag <sup>110</sup>	P.L.c 99.999	80-250	S.S.	11.8	$3.8 \times 10^{-2}$	174
Ag <sup>110</sup>	P c 99.999	80-250	S.S.	11.2	$2.7 \times 10^{-2}$	174
Au <sup>198</sup>	P.L.c 99.999	110-260	S.S.	2.8	$2.0 \times 10^{-5}$	174
Au <sup>198</sup>	P c 99.999	110-260	S.S.	5.2	$5.3 \times 10^{-4}$	174
Tl <sup>204</sup>	S.L.c 99.9	135-230	S.S.	22.6	0.4	175
Tl <sup>204</sup>	S c 99.9	135-230	S.S.	22.9	0.4	175
<b><math>\beta</math>-Thallium</b>						
Ag <sup>110</sup>	P 99.999	230-310	S.S.	11.9	$4.2 \times 10^{-2}$	174
Au <sup>198</sup>	P 99.999	230-310	S.S.	6.0	$5.2 \times 10^{-4}$	174
Tl <sup>204</sup>	S 99.9	230-280	S.S.	20.7	0.7	175

## RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS (Continued)

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , $\text{cm}^2/\text{s}$	Reference
<b><math>\alpha</math>-Thorium</b>						
Pa <sup>231</sup>	P 99.85	770-910	—	74.7	126	176
Th <sup>228</sup>	P 99.85	720-880	—	71.6	395	176
U <sup>233</sup>	P 99.85	700-880	—	79.3	2210	176
<b>Tin</b>						
Ag <sup>110</sup>	S.Lc	135-225	S.S.	18.4	0.18	177
Ag <sup>110</sup>	S c	135-225	S.S.	12.3	$7.1 \times 10^{-3}$	177
Au <sup>198</sup>	S.Lc	135-225	S.S.	17.7	0.16	177
Au <sup>198</sup>	S c	135-225	S.S.	11.0	$5.8 \times 10^{-3}$	177
Co <sup>60</sup>	S, P	140-217	R.A.	22.0	5.5	178
In <sup>114</sup>	S.Lc 99.998	181-221	S.S.	25.8	34.1	179
In <sup>114</sup>	S c 99.998	181-221	S.S.	25.6	12.2	179
Sn <sup>113</sup>	S.Lc 99.999	160-226	S.S.	25.1	10.7	180
Sn <sup>113</sup>	S c 99.999	160-226	S.S.	25.6	7.7	180
Tl <sup>204</sup>	P 99.999	137-216	S.S.	14.7	$1.2 \times 10^{-3}$	181
<b><math>\alpha</math>-Titanium</b>						
Ti <sup>44</sup>	P 99.99	700-850	R.A.	35.9	$8.6 \times 10^{-6}$	182
<b><math>\beta</math>-Titanium</b>						
Ag <sup>110</sup>	P 99.95	940-1570	S.S.	43.2	$3 \times 10^{-3}$	183
Be <sup>7</sup>	P 99.96	915-1300	R.A.	40.2	0.8	184
C <sup>14</sup>	P 99.62	1100-1600	R.A.	20.0	$3.02 \times 10^{-3}$	185
Cr <sup>51</sup>	P 99.7	950-1600	A.R.G.	35.1	$5 \times 10^{-3}$	186
				61.0	4.9	
Co <sup>60</sup>	P 99.7	900-1600	S.S.	30.6	$1.2 \times 10^{-2}$	186
				52.5	2.0	
Fe <sup>59</sup>	P 99.7	900-1600	A.R.G.	31.6	$7.8 \times 10^{-3}$	186
				55.0	2.7	
Mo <sup>99</sup>	P 99.7	900-1600	S.S.	43.0	$8.0 \times 10^{-3}$	186
				73.0	20	
Mn <sup>54</sup>	P 99.7	900-1600	S.S.	33.7	$6.1 \times 10^{-3}$	186
				58.0	20	
Nb <sup>95</sup>	P 99.7	1000-1600	A.R.G.	39.3	$5.0 \times 10^{-3}$	186
				73.0	20	
Ni <sup>63</sup>	P 99.7	925-1600	A.R.G.	29.6	$9.2 \times 10^{-3}$	186
				52.5	2.0	
P <sup>32</sup>	P 99.7	950-1600	S.S.	24.1	$3.62 \times 10^{-3}$	187
				56.5	5	
Sc <sup>46</sup>	P 99.95	940-1590	S.S.	32.4	$4.0 \times 10^{-3}$	183
Sn <sup>113</sup>	P 99.7	950-1600	S.S.	31.6	$3.8 \times 10^{-4}$	187
				69.2	10	
Ti <sup>44</sup>	P 99.95	900-1540	S.S.	31.2	$3.58 \times 10^{-4}$	188
				60.0	1.09	
U <sup>235</sup>	P 99.9	900-1400	R.A.	29.3	$5.1 \times 10^{-4}$	189
V <sup>48</sup>	P 99.95	900-1545	S.S.	32.2	$3.1 \times 10^{-4}$	190
				57.2	1.4	
W <sup>185</sup>	P 99.94	900-1250	R.A.	43.9	$3.6 \times 10^{-3}$	191
Zr <sup>95</sup>	P 98.94	920-1500	R.A.	35.4	$4.7 \times 10^{-3}$	191
<b>Tungsten</b>						
C <sup>14</sup>	P 99.51	1200-1600	R.A.	53.5	$8.91 \times 10^{-3}$	99
Fe <sup>59</sup>	P	940-1240	—	66.0	$1.4 \times 10^{-2}$	168
Mo <sup>99</sup>	P	1700-2100	R.A.	101.0	0.3	20
Nb <sup>95</sup>	P 99.99	1305-2367	S.S.	137.6	3.01	192
Re <sup>186</sup>	S	2100-2400	R.A.	141.0	19.5	193
Ta <sup>182</sup>	P 99.99	1305-2375	S.S.	139.9	3.05	192
W <sup>185</sup>	P 99.99	1800-2403	S.S.	140.3	1.88	192
<b><math>\alpha</math>-Uranium</b>						
U <sup>234</sup>	P	580-650	—	40.0	$2 \times 10^{-3}$	194
<b><math>\beta</math>-Uranium</b>						
Co <sup>60</sup>	P 99.999	692-763	S.S.	27.45	$1.5 \times 10^{-2}$	195
U <sup>235</sup>	P	690-750	R.A.	44.2	$2.8 \times 10^{-3}$	196
<b><math>\gamma</math>-Uranium</b>						
Au <sup>195</sup>	P 99.99	785-1007	S.S.	30.4	$4.86 \times 10^{-3}$	197
Co <sup>60</sup>	P 99.99	783-989	S.S.	12.57	$3.51 \times 10^{-4}$	198
Cr <sup>51</sup>	P 99.99	797-1037	S.S.	24.46	$5.37 \times 10^{-3}$	198
Cu <sup>64</sup>	P 99.99	787-1039	S.S.	24.06	$1.96 \times 10^{-3}$	198
Fe <sup>55</sup>	P 99.99	787-990	S.S.	12.0	$2.69 \times 10^{-4}$	198
Mn <sup>54</sup>	P 99.99	787-939	S.S.	13.88	$1.81 \times 10^{-4}$	198
Nb <sup>95</sup>	P 99.99	791-1102	S.S.	39.65	$4.87 \times 10^{-2}$	198
Ni <sup>63</sup>	P 99.99	787-1039	S.S.	15.66	$5.36 \times 10^{-4}$	198
U <sup>233</sup>	P 99.99	800-1070	S.S.	28.5	$2.33 \times 10^{-3}$	227
Zr <sup>95</sup>	P	800-1000	R.A.	16.5	$3.9 \times 10^{-4}$	228
<b>Vanadium</b>						
C <sup>14</sup>	P 99.7	845-1130	S.S.	27.3	$4.9 \times 10^{-3}$	199
Cr <sup>51</sup>	P 99.8	960-1200	R.A.	64.6	$9.54 \times 10^{-3}$	200
Fe <sup>59</sup>	P	960-1350	S.S.	71.0	0.373	201
P <sup>32</sup>	P 99.8	1200-1450	R.A.	49.8	$2.45 \times 10^{-2}$	202
S <sup>35</sup>	P 99.8	1320-1520	R.A.	34.0	$3.1 \times 10^{-2}$	184
V <sup>48</sup>	S, P 99.99	880-1360	S.S.	73.65	0.36	203
V <sup>48</sup>	S, P 99.99	1360-1830	S.S.	94.14	214.0	203
<b>Yttrium</b>						
Y <sup>90</sup>	S.Lc	900-1300	R.A.	67.1	5.2	204
Y <sup>90</sup>	S c	900-1300	R.A.	60.3	0.82	204
<b>Zinc</b>						
Ag <sup>110</sup>	S.Lc 99.999	271-413	S.S.	27.6	0.45	205
Ag <sup>110</sup>	S c 99.999	271-413	S.S.	26.0	0.32	205



## RADIOACTIVE TRACER DIFFUSION DATA FOR PURE METALS (Continued)

Solute (tracer)	Material (metal, crystalline form and purity)	Temperature range, °C	Form of analysis	Activation energy, $Q$ , Kcal/mole	Frequency factor, $D_0$ , cm <sup>2</sup> /s	Reference
Au <sup>198</sup>	S.L.c 99.999	315-415	S.S.	29.72	0.29	206
Au <sup>198</sup>	S  c 99.999	315-415	S.S.	29.73	0.97	206
Cd <sup>115</sup>	S.L.c 99.999	225-416	S.S.	20.12	0.117	206
Cd <sup>115</sup>	S  c 99.999	225-416	S.S.	20.54	0.114	206
Cu <sup>64</sup>	S.L.c 99.999	338-415	S.S.	29.92	2.0	206
Cu <sup>64</sup>	S  c 99.999	338-415	S.S.	29.53	2.22	207
Ga <sup>72</sup>	S.L.c	240-403	S.S.	18.15	0.018	207
Ga <sup>72</sup>	S  c	240-403	S.S.	18.4	0.016	207
Hg <sup>203</sup>	S.L.c	260-413	S.S.	20.18	0.073	208
Hg <sup>203</sup>	S  c	260-413	S.S.	19.70	0.056	208
In <sup>114</sup>	S.L.c	271-413	S.S.	19.60	0.14	205
In <sup>114</sup>	S  c	271-413	S.S.	19.10	0.062	205
Sn <sup>113</sup>	S.L.c	298-400	S.S.	18.4	0.13	209
Sn <sup>113</sup>	S  c	298-400	S.S.	19.4	0.15	209
Zn <sup>65</sup>	S.L.c 99.999	240-418	S.S.	23.0	0.18	210
Zn <sup>65</sup>	S  c 99.999	240-418	S.S.	21.9	0.13	210
<b><math>\alpha</math>-Zirconium</b>						
Cr <sup>51</sup>	P 99.9	700-850	R.A.	18.0	$1.19 \times 10^{-8}$	211
Fe <sup>55</sup>	P	750-840	—	48.0	$2.5 \times 10^{-2}$	212
Mo <sup>99</sup>	P	600-850	R.A.	24.76	$6.22 \times 10^{-8}$	213
Nb <sup>95</sup>	P 99.99	740-857	R.A.	31.5	$6.6 \times 10^{-6}$	182
Sn <sup>113</sup>	P	300-700	A.R.G.	22.0	$1.0 \times 10^{-8}$	214
Ta <sup>182</sup>	P 99.6	700-800	R.A.	70.0	100	215
V <sup>48</sup>	P 99.99	600-850	R.A.	22.9	$1.12 \times 10^{-8}$	124
Zr <sup>95</sup>	P 99.95	750-850	S.S.	45.5	$5.6 \times 10^{-4}$	216
<b><math>\beta</math>-Zirconium</b>						
Be <sup>7</sup>	P 99.7	915-1300	R.A.	31.1	$8.33 \times 10^{-2}$	184
C <sup>14</sup>	P 96.6	1100-1600	R.A.	34.2	$3.57 \times 10^{-2}$	217
Ce <sup>141</sup>	P	880-1600	R.A.	41.4	3.16	218
				74.1	42.17	
Co <sup>60</sup>	P 99.99	920-1600	S.S.	21.82	$3.26 \times 10^{-3}$	219
Cr <sup>51</sup>	P 99.9	700-850	R.A.	18.0	$1.19 \times 10^{-8}$	211
Fe <sup>55</sup>	P	750-840	—	48.0	$2.5 \times 10^{-2}$	212
Mo <sup>99</sup>	P	900-1635	R.A.	35.2	$1.99 \times 10^{-6}$	218
				68.55	2.63	
Nb <sup>95</sup>	P	1230-1635	R.A.	36.6	$7.8 \times 10^{-4}$	220
P <sup>32</sup>	P 99.94	950-1200	R.A.	33.3	0.33	221
Sn <sup>113</sup>	P	300-700	A.R.G.	22.0	$1 \times 10^{-8}$	214
Ta <sup>182</sup>	P 99.6	900-1200	R.A.	27.0	$5.5 \times 10^{-5}$	215
U <sup>235</sup>	P	900-1065	S.S.	30.5	$5.7 \times 10^{-4}$	222
V <sup>48</sup>	P 99.99	870-1200	R.A.	45.8	$7.59 \times 10^{-3}$	223
V <sup>48</sup>	P 99.99	1200-1400	R.A.	57.7	0.32	223
W <sup>185</sup>	P 99.7	900-1250	R.A.	55.8	0.41	223
Zr <sup>95</sup>	P	1100-1500	S.S.	30.1	$2.4 \times 10^{-4}$	225

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**RECOMMENDED DAILY DIETARY ALLOWANCES**  
**Designed for the Maintenance of Good Nutrition of Practically all Healthy People in the United States\***  
**1989 Recommendations of the Food and Nutrition Board, National Academy of Sciences**

Age (years) or Condition	Weight <sup>b</sup> (kg)	Height <sup>b</sup> (cm)	Height <sup>b</sup> (in)	Protein (g)	Fat-Soluble Vitamins					Water-Soluble Vitamins					Minerals										
					Vita- min A ( $\mu$ g RE) <sup>f</sup>	Vita- min D <sup>g</sup> ( $\mu$ g)	Vita- min E (mg $\alpha$ -TE) <sup>f</sup>	Vita- min K ( $\mu$ g)	Vita- min C (mg)	Thia- min (mg)	Ribo- flavin (mg)	Niacin (mg NE) <sup>f</sup>	Vita- min B <sub>6</sub> (mg)	Fo- late ( $\mu$ g)	Vitamin B <sub>12</sub> ( $\mu$ g)	Cal- cium (mg)	Phos- phorus (mg)	Mag- nesium (mg)	Iron (mg)	Zinc (mg)	Iodine ( $\mu$ g)	Sele- nium ( $\mu$ g)			
Infants	6	13	60	24	13	375	7.5	3	5	30	0.3	0.4	5	0.3	25	0.3	400	300	40	6	5	40	10		
0.5-1.0	9	20	71	28	14	375	10	4	10	35	0.4	0.5	6	0.6	35	0.5	600	500	60	10	5	50	15		
Children	13	29	90	35	16	400	10	6	15	40	0.7	0.8	9	1.0	50	0.7	800	800	80	10	10	70	20		
1-3	20	44	112	44	24	500	10	7	20	45	0.9	1.1	12	1.1	75	1.0	800	800	120	10	10	90	20		
4-6	28	62	132	52	28	700	10	7	30	45	1.0	1.2	13	1.4	100	1.4	800	800	170	10	10	120	30		
Males	45	99	157	62	45	1,000	10	10	45	50	1.3	1.5	17	1.7	150	2.0	1,200	1,200	270	12	15	150	40		
11-14	66	145	176	69	59	1,000	10	10	65	60	1.5	1.8	20	2.0	200	2.0	1,200	1,200	400	12	15	150	50		
15-18	72	160	177	70	58	1,000	10	10	70	60	1.5	1.7	19	2.0	200	2.0	1,200	1,200	350	10	15	150	70		
19-24	79	174	176	70	63	1,000	5	10	80	60	1.5	1.7	19	2.0	200	2.0	800	800	350	10	15	150	70		
25-30	77	170	173	68	63	1,000	5	10	80	60	1.2	1.4	15	2.0	200	2.0	800	800	350	10	15	150	70		
51+	46	101	157	62	46	800	10	8	45	50	1.1	1.3	15	1.4	150	2.0	1,200	1,200	280	15	12	150	45		
Females	55	120	163	64	44	800	10	8	55	60	1.1	1.3	15	1.5	180	2.0	1,200	1,200	300	15	12	150	50		
11-14	58	128	164	65	46	800	10	8	60	60	1.1	1.3	15	1.6	180	2.0	1,200	1,200	280	15	12	150	55		
15-18	63	138	163	64	50	800	5	8	65	60	1.1	1.3	15	1.6	180	2.0	800	800	280	15	12	150	55		
19-24	63	138	163	64	50	800	5	8	65	60	1.1	1.3	15	1.6	180	2.0	800	800	280	15	12	150	55		
25-50	65	143	160	63	50	800	5	8	65	60	1.0	1.2	13	1.6	180	2.0	800	800	280	10	12	150	55		
51+	60	800	10	10	65	70	1.5	1.6	17	2.2	400	2.2	1,200	1,200	320	30	15	175	65						
Pregnant	65	1,300	10	12	65	95	1.6	1.8	20	2.1	280	2.6	1,200	1,200	355	15	19	200	75						
Lactating	62	1,200	10	11	65	90	1.6	1.7	20	2.1	260	2.6	1,200	1,200	340	15	16	200	75						
1st 6 months																									
2nd 6 months																									

<sup>a</sup> The allowances, expressed as average daily intakes over time, are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined.

<sup>b</sup> Weights and heights of Reference Adults are actual medians for the U.S. population of the designated age. The use of these figures does not imply that the height-to-weight ratios are ideal.

<sup>c</sup> Retinol equivalents. 1 retinol equivalent = 1  $\mu$ g retinol or 6  $\mu$ g  $\beta$ -carotene.

<sup>d</sup> As cholecalciferol. 10  $\mu$ g cholecalciferol = 400 IU of vitamin D.

<sup>e</sup>  $\alpha$ -Tocopherol equivalents. 1 mg d- $\alpha$ -tocopherol = 1  $\alpha$ -TE.

<sup>f</sup> 1 NE (niacin equivalent) is equal to 1 mg of niacin or 60 mg of dietary tryptophan.



**RECOMMENDED DAILY DIETARY ALLOWANCES (continued)**

**Estimated Safe and Adequate Daily Dietary Intakes of Selected Vitamins and Minerals<sup>a</sup>**

Category	Age (years)	Vitamins	
		Biotin (µg)	Pantothenic Acid (mg)
Infants	0-0.5	10	2
	0.5-1	15	3
Children and adolescents	1-3	20	3
	4-6	25	3-4
	7-10	30	4-5
	11+	30-100	4-7
Adults		30-100	4-7

Category	Age (years)	Trace Elements <sup>b</sup>				
		Copper (mg)	Manganese (mg)	Fluoride (mg)	Chromium (µg)	Molybdenum (µg)
Infants	0-0.5	0.4-0.6	0.3-0.6	0.1-0.5	10-40	15-30
	0.5-1	0.6-0.7	0.6-1.0	0.2-1.0	20-60	20-40
Children and adolescents	1-3	0.7-1.0	1.0-1.5	0.5-1.5	20-80	25-50
	4-6	1.0-1.5	1.5-2.0	1.0-2.5	30-120	30-75
	7-10	1.0-2.0	2.0-3.0	1.5-2.5	50-200	50-150
	11+	1.5-2.5	2.0-5.0	1.5-2.5	50-200	75-250
Adults		1.5-3.0	2.0-5.0	1.5-4.0	50-200	75-250

<sup>a</sup> Because there is less information on which to base allowances, these figures are not given in the main table of RDA and are provided here in the form of ranges of recommended intakes.

<sup>b</sup> Since the toxic levels for many trace elements may be only several times usual intakes, the upper levels for the trace elements given in this table should not be habitually exceeded.

## REDUCTION OF BAROMETER TO SEA LEVEL

The correction to be added to reduce barometric readings to "sea level" values depends principally on three factors: The temperature of the air column (assumed) from the station to sea level, the altitude of the station, and the value of the reading itself. Two tables are provided. Table I is entered with the altitude and assumed temperature and is a factor "2000 m" taken out. Table II is entered with the above factor and the approximate barometer reading and the final correction taken out.

The correction is to be added. If  $B_0$  is the corrected or sea level value; B the barometer reading at the station; C the correction,—

$$C = B_0 - B = B(10^m - 1)$$

The actual barometer reading at the station should be corrected for temperature of the mercury column by the usual methods before entering the tables or applying the sea level correction.

A complete explanation of the theory of the corrections and a more extended set of tables will be found in the Smithsonian Meteorological Tables.

### Latitude Factor

The influence of the latitude on the value of the correction is usually negligible, being overshadowed by uncertainties in the assumed temperature of the air column. For cases where this correction is desirable the table below is provided. The value of the temperature-altitude factor "2000 m" obtained in Table I is corrected for latitude by subtracting for latitudes 0-45° and adding for latitudes from 45-90° the values found. With this corrected value of "2000 m" Table II is entered for the value of the correction.

## LATITUDE FACTOR

To be used in connection with Tables I and II, either English or metric units, to obtain latitude corrections to temperature-altitude factor. For latitudes 0-45° subtract the correction. For latitudes 45-90° add the correction.

Temp.-Alt. from Table I	Latitude			
	0°	15°	30°	45°
100	0.3	0.2	0.1	0.0
200	0.5	0.5	0.3	0.0
300	0.8	0.7	0.4	0.0
	90°	75°	60°	45°

## METRIC UNITS—TABLE I

Values of the temperature-altitude factor (2000 m ) for entering table II.

Altitude in meters	Assumed temperature of air column °C										Altitude in meters	Assumed temperature of air column °C									
	-16°	-8°	0°	+4°	+8°	+12°	+16°	+20°	+24°	+28°		-16°	-8°	0°	+4°	+8°	+12°	+16°	+20°	+24°	+28°
10	1.2	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1500	172.6	167.3	162.3	159.8	157.3	154.9	152.5	150.3	148.0	145.9
50	5.8	5.6	5.4	5.3	5.2	5.2	5.1	5.0	4.9	4.9	1550	178.3	172.9	167.7	165.1	162.6	160.1	157.6	155.3	153.0	150.7
100	11.5	11.2	10.8	10.7	10.5	10.3	10.2	10.0	9.9	9.7	1600	184.1	178.5	173.1	170.4	167.8	165.2	162.7	160.3	157.9	155.6
150	17.3	16.7	16.2	16.0	15.7	15.5	15.3	15.0	14.8	14.6	1650	189.8	184.0	178.5	175.7	173.0	170.4	167.8	165.3	162.8	160.5
200	23.0	22.3	21.6	21.3	21.0	20.7	20.3	20.0	19.7	19.5	1700	195.6	189.6	183.9	181.1	178.3	175.6	172.9	170.3	167.8	165.3
250	28.8	27.9	27.0	26.6	26.2	25.8	25.4	25.0	24.7	24.3	1750	201.4	195.2	189.3	186.4	183.5	180.7	178.0	175.3	172.7	170.2
300	34.5	33.5	32.5	32.0	31.5	31.0	30.5	30.1	29.6	29.2	1800	207.1	200.8	194.7	191.7	188.8	185.9	183.1	180.3	177.6	175.0
350	40.3	39.0	37.9	37.3	36.7	36.2	35.6	35.1	34.6	34.0	1850	212.9	206.3	200.1	197.0	194.0	191.0	188.1	185.3	182.6	179.9
400	46.0	44.6	43.3	42.6	42.0	41.3	40.7	40.1	39.5	38.9	1900	218.6	211.9	205.5	202.4	199.3	196.2	193.2	190.3	187.5	184.8
450	51.8	50.2	48.7	47.9	47.2	46.5	45.8	45.1	44.4	43.8	1950	224.4	217.5	210.9	207.7	204.5	201.4	198.3	195.3	192.4	189.6
500	57.5	55.8	54.1	53.3	52.4	51.6	50.9	50.1	49.4	48.6	2000	230.1	223.0	216.3	213.0	209.7	206.5	203.4	200.3	197.4	194.5
550	63.3	61.4	59.5	58.6	57.7	56.8	55.9	55.1	54.3	53.5	2050	235.9	228.6	221.7	218.3	215.0	211.7	208.5	205.3	202.3	199.3
600	69.0	66.9	64.9	63.9	62.9	62.0	61.0	60.1	59.2	58.3	2100	241.6	234.2	227.1	223.7	220.2	216.8	213.5	210.4	207.2	204.2
650	74.8	72.5	70.3	69.2	68.2	67.1	66.1	65.1	64.2	63.2	2150	247.4	239.8	232.5	229.0	225.5	222.0	218.6	215.4	212.2	209.1
700	80.6	78.1	75.7	74.6	73.4	72.3	71.2	70.1	69.1	68.1	2200	253.1	245.4	237.9	234.3	230.7	227.2	223.7	220.4	217.1	213.9
750	86.3	83.7	81.1	79.9	78.7	77.5	76.3	75.1	74.0	72.9	2250	258.9	250.9	243.4	239.6	235.9	232.3	228.8	225.4	222.0	218.8
800	92.1	89.2	86.5	85.2	83.9	82.6	81.4	80.1	79.0	77.8	2300	264.6	256.5	248.8	245.0	241.2	237.5	233.9	230.4	227.0	223.6
850	97.8	94.8	92.0	90.5	89.2	87.8	86.4	85.2	83.9	82.7	2350	270.4	262.1	254.2	250.3	246.4	242.7	239.0	235.4	231.9	228.5
900	103.6	100.4	97.4	95.9	94.4	93.0	91.5	90.2	88.8	87.5	2400	276.1	267.7	259.6	255.6	251.7	247.8	244.0	240.4	236.8	233.4
950	109.3	106.0	102.8	101.2	99.6	98.1	96.6	95.2	93.8	92.4	2450	281.9	273.2	265.0	260.9	256.9	253.0	249.1	245.4	241.8	238.2
1000	115.1	111.5	108.2	106.5	104.9	103.3	101.7	100.2	98.7	97.3	2500	287.6	278.8	270.4	266.2	262.2	258.1	254.2	250.4	246.7	243.1
1050	120.8	117.1	113.6	111.8	110.1	108.4	106.8	105.2	103.6	102.1	2550	293.4	284.4	275.8	271.6	267.4	263.3	259.3	255.4	251.6	247.9
1100	126.6	122.7	119.0	117.2	115.4	113.6	111.9	110.2	108.6	107.0	2600	299.1	290.0	281.2	276.9	272.6	268.5	264.4	260.4	256.6	252.8
1150	132.3	128.3	124.4	122.5	120.6	118.8	117.0	115.2	113.5	111.8	2650	304.9	295.5	286.6	282.2	277.9	273.6	269.5	265.4	261.5	257.7
1200	138.1	133.8	129.8	127.8	125.9	123.9	122.0	120.2	118.4	116.7	2700	310.6	301.1	292.0	287.5	283.1	278.8	274.5	270.4	266.4	262.5
1250	143.8	139.4	135.2	133.1	131.1	129.1	127.1	125.2	123.4	121.6	2750	316.4	306.7	297.4	292.9	288.4	283.9	279.6	275.4	271.4	267.4
1300	149.6	145.0	140.6	138.5	136.3	134.3	132.2	130.2	128.3	126.4	2800	322.1	312.3	302.8	298.2	293.6	289.1	284.7	280.4	276.3	272.2
1350	155.3	150.6	146.0	143.8	141.6	139.4	137.3	135.2	133.2	131.3	2850	327.9	317.8	308.2	303.5	298.8	294.3	289.8	285.4	281.2	277.1
1400	161.1	156.2	151.4	149.1	146.8	144.6	142.4	140.2	138.2	136.2	2900	333.6	323.4	313.6	308.8	304.1	299.4	294.9	290.4	286.2	282.0
1450	166.8	161.7	156.8	154.5	152.1	149.7	147.5	145.3	143.1	141.0	2950	339.4	329.0	319.0	314.2	309.3	304.6	299.9	295.5	291.1	286.8
											3000	345.1	334.5	324.4	319.5	314.6	309.7	305.0	300.5	296.0	291.7





## ENGLISH UNITS — TABLE II

Value of Correction to be Added.

Temp alt. factor	Barometer reading					Temp alt. factor	Barometer reading					Temp alt. factor	Barometer reading					Temp alt. factor	Barometer reading			
	31	30	29	28	27		26	25	24	23	22		28	27	26	25	24		23	22	21	20
1	0.04	0.03	0.03	—	—	165	5.44	5.23	5.02	—	—	75	2.53	2.43	2.34	—	—	250	7.67	7.34	—	—
5	0.18	0.17	0.17	—	—	170	5.62	5.40	5.19	—	—	80	2.70	2.60	2.51	—	—	255	7.85	7.51	—	—
10	0.36	0.35	0.34	0.32	—	175	—	5.58	5.36	—	—	85	2.88	2.78	2.67	—	—	260	8.03	7.68	7.33	—
15	0.54	0.52	0.51	0.49	—	180	—	5.76	5.53	5.30	—	90	3.06	2.95	2.84	—	—	265	8.21	7.85	7.49	—
20	0.72	0.70	0.68	0.65	—	185	—	5.93	5.70	5.46	—	95	3.24	3.12	3.01	—	—	270	8.39	8.02	7.66	—
25	—	0.88	0.85	0.82	—	190	—	6.11	5.87	5.62	—	100	3.42	3.29	3.17	—	—	275	8.57	8.19	7.82	—
30	—	1.05	1.02	0.98	—	195	—	6.29	6.04	5.79	—	105	3.60	3.47	3.34	3.21	—	280	—	8.37	7.99	—
35	—	1.23	1.19	1.15	—	200	—	—	6.21	5.96	—	110	—	3.85	3.51	3.38	—	285	—	8.54	8.16	—
40	—	1.41	1.37	1.32	1.27	205	—	—	6.39	6.12	—	115	—	3.82	3.68	3.54	—	290	—	8.72	8.32	—
45	—	1.60	1.54	1.49	1.44	210	—	—	6.56	6.29	—	120	—	4.00	3.85	3.70	—	295	—	8.90	8.49	8.09
50	—	—	1.72	1.66	1.60	215	—	—	6.74	6.46	—	125	—	4.18	4.02	3.87	—	300	—	9.08	8.66	8.25
55	—	—	1.90	1.83	1.76	220	—	—	6.92	6.63	6.34	130	—	4.36	4.20	4.04	—	305	—	9.26	8.83	8.41
60	—	—	2.07	2.00	1.93	225	—	—	7.10	6.80	6.51	135	—	4.54	4.37	4.20	—	310	—	9.44	9.01	8.58
65	—	—	2.25	2.18	2.10	230	—	—	7.28	6.97	6.67	140	—	—	4.55	4.37	4.20	315	—	9.62	9.18	8.74
70	—	—	2.43	2.35	2.27	235	—	—	7.46	7.15	6.84	145	—	—	4.72	4.54	4.36	320	—	9.80	9.35	8.91
75	—	—	—	2.53	2.43	240	—	—	—	7.32	7.00	150	—	—	4.90	4.71	4.52	325	—	—	9.53	9.08
80	—	—	—	2.70	2.60	245	—	—	—	7.49	7.17	155	—	—	5.08	4.88	4.69	330	—	—	9.71	9.24
												160	—	—	5.26	5.06	4.85					

## REDUCTION OF BAROMETER TO GRAVITY AT SEA LEVEL

Metric Units  
Correction to be subtracted given in millimeters  
(From Smithsonian Physical Tables)

Height above sea level in meters	Observed Height of Barometer in Millimeters							Height above sea level in meters	Observed Height of Barometer in Millimeters						
	500	550	600	650	700	750	800		500	550	600	650	700	750	800
100	—	—	—	—	.02	.02	.02	2400	.38	.42	.45	—	—	—	—
200	—	—	—	—	.04	.05	.05	2500	.39	.43	.47	—	—	—	—
300	—	—	—	—	.07	.07	.07	English Units							
400	—	—	—	—	.09	.10	.10	Observed Height in Inches							
500	—	—	—	—	.11	.12	.13	18	20	22	24	26	28	30	
600	—	—	—	.12	.13	.14	—	1000	—	—	—	.003	.003	.003	
700	—	—	—	.14	.15	.16	—	2000	—	—	.004	.005	.005	.006	
800	—	—	—	.16	.18	.19	—	3000	—	—	.007	.007	.008	.008	
900	—	—	—	.18	.20	.22	—	4000	—	—	.009	.009	.010	—	
1000	—	.18	.19	.20	.22	.24	—	4500	—	—	0.10	0.10	0.11	—	
1100	—	.19	.21	.22	.24	—	—	5000	—	0.10	0.11	0.11	0.12	—	
1200	—	.21	.23	.24	.26	—	—	5500	—	0.11	0.12	0.13	—	—	
1300	—	.22	.24	.26	.29	—	—	6000	—	0.11	0.13	0.14	—	—	
1400	—	.24	.26	.28	.31	—	—	6500	0.11	0.12	0.14	0.15	—	—	
1500	.24	.26	.28	.30	.33	—	—	7000	0.12	0.13	0.15	0.16	—	—	
1600	.25	.28	.30	.32	—	—	—	7500	0.13	0.14	0.16	0.17	—	—	
1700	.27	.30	.32	.34	—	—	—	8000	0.14	0.15	0.17	—	—	—	
1800	.28	.31	.34	.36	—	—	—	8500	0.15	0.16	0.18	—	—	—	
1900	.30	.33	.36	.39	—	—	—	9000	0.16	0.17	0.19	—	—	—	
2000	.31	.34	.38	.41	—	—	—	9500	0.16	0.18	0.20	—	—	—	
2100	.33	.36	.40	—	—	—	—								
2200	.35	.38	.41	—	—	—	—								
2300	.36	.40	.43	—	—	—	—								

## REDUCTION OF BAROMETER TO LATITUDE 45°

Metric Scale  
For latitudes below 45°, subtract the correction; for latitudes greater than 45° it is to be added. Corrections in cm.  
(From Smithsonian Meteorological Tables.)

Observed Height of Barometer in Centimeters							English Scale (Corrections in inches)						
Latitude	68	70	72	74	76	78	Latitude	25	26	27	28	29	30
25° 65°	0.116	0.120	0.123	0.127	0.130	0.133	25° 65°	0.043	0.044	0.046	0.048	0.050	0.051
26 64	.111	.115	.118	.121	.125	.128	26 64	.041	.043	.044	.046	.048	.049
27 63	.106	.110	.113	.116	.119	.122	27 63	.039	.041	.042	.044	.045	.047
28 62	.101	.104	.107	.110	.113	.116	28 62	.037	.039	.040	.042	.043	.045
29 61	.096	.099	.102	.104	.107	.110	29 61	.035	.037	.038	.039	.041	.042
30 60	.091	.094	.096	.098	.101	.104	30 60	.033	.035	.036	.037	.039	.040
31 59	.085	.087	.090	.092	.095	.097	31 59	.031	.032	.034	.035	.036	.037
32 58	.079	.082	.084	.086	.089	.091	32 58	.029	.030	.032	.033	.034	.035
33 57	.074	.076	.078	.080	.082	.084	33 57	.027	.028	.029	.030	.031	.032
34 56	.068	.070	.072	.074	.076	.078	34 56	.025	.026	.027	.028	.029	.030
35 55	.062	.064	.066	.067	.069	.071	35 55	.023	.024	.025	.025	.026	.027
36 54	.056	.058	.059	.061	.063	.064	36 54	.021	.021	.022	.023	.024	.025
37 53	.050	.051	.053	.054	.056	.057	37 53	.018	.019	.020	.021	.021	.022
38 52	.044	.045	.046	.048	.049	.050	38 52	.016	.017	.017	.018	.019	.019
39 51	.038	.039	.040	.041	.042	.043	39 51	.014	.014	.015	.015	.016	.017
40 50	.031	.032	.033	.034	.035	.036	40 50	.012	.012	.012	.013	.013	.014
41 49	.025	.026	.027	.027	.028	.029	41 49	.009	.010	.010	.010	.011	.011
42 48	.019	.019	.020	.021	.021	.022	42 48	.007	.007	.008	.008	.008	.008
43 47	.013	.013	.013	.14	.014	.014	43 47	.005	.005	.005	.005	.005	.006
44 46	.006	.007	.007	.007	.007	.007	44 46	.002	.002	.003	.003	.003	.003



REFRACTORY MATERIALS

Borides

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density, g/cm <sup>3</sup>
Chromium boride	CrB <sub>2</sub>	73.65	1,850 <sup>(29)</sup> a	Hexagonal AlB <sub>2</sub> type [C 32]	a = 2.969 c = 3.066 <sup>(39)</sup>	5.16
Hafnium boride	HfB <sub>2</sub>	200.14	3,100 <sup>(31)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.14 <sup>(6)</sup> c = 3.47	10.5
Molybdenum boride	MoB	106.77	2,180 <sup>(40)</sup>	Tetragonal	a = 3.110 <sup>(41)</sup> c = 16.95	8.77
	MoB <sub>2</sub>	117.59	2,100 <sup>(40)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.05 c = 3.113 <sup>(42)</sup>	7.78
Niobium boride	Mo <sub>2</sub> B	202.72	2,000 <sup>(40)</sup> (decomposes)	Tetragonal CuAl <sub>2</sub> type [C 16]	a = 5.543 <sup>(41)</sup> c = 4.735	9.31
	NbB	103.73	>0.2000 <sup>(3)</sup>	Orthorhombic	a = 3.298 b = 8.724 c = 3.137 <sup>(35)</sup>	
Tantalum boride	NbB <sub>2</sub>	114.55	2,900 <sup>(36)</sup> (decomposes)	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.086 <sup>(28)</sup> c = 3.306	7.21
	TaB	191.77	>0.2000 <sup>(3)</sup>	Orthorhombic	a = 3.276 b = 8.669 c = 3.157 <sup>(37)</sup>	14.29
Thorium boride	TaB <sub>2</sub>	202.59	3,000 <sup>(6)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.088 <sup>(28)</sup> c = 3.241	12.60
	ThB <sub>4</sub>	275.53	>0.2500 <sup>(6)</sup>	Tetragonal D <sub>4h</sub> <sup>19</sup> -P4/mbm	a = 7.256 <sup>(43)</sup> c = 4.113	8.45
Titanium boride	TiB <sub>2</sub>	69.54	2,980 <sup>(6)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.028 <sup>(28)</sup> c = 3.228	4.52
Tungsten boride	WB	194.68	2,860 <sup>(29)</sup>	Tetragonal	a = 3.115 <sup>(6)</sup> c = 16.92	16.0
	W <sub>2</sub> B	378.54	2,770 <sup>(29)</sup>	Tetragonal CuAl <sub>2</sub> type [C 16]	a = 5.564 <sup>(41)</sup> c = 4.740	16.72
Uranium boride	UB <sub>1,2</sub>	367.91	>0.1500 <sup>(6)</sup> (decomposes)	Face-centered cubic	a = 7.473 <sup>(44)</sup>	5.82
Vanadium boride	VB <sub>2</sub>	72.59	2,100 <sup>(29)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 2.998 <sup>(28)</sup> c = 3.057	5.10
Zirconium boride	ZrB <sub>2</sub>	112.86	3,040 ± 50 <sup>(30)</sup>	Hexagonal AlB <sub>2</sub> type [C 32]	a = 3.169 <sup>(28)</sup> c = 3.530	6.09
	ZrB <sub>1,2</sub>	221.06	2,680 <sup>(30)</sup>	Face-centered cubic	a = 7.408 <sup>(33)</sup>	

Name	Thermal conductivity, cal-sec <sup>-1</sup> -cm <sup>-2</sup> -cm <sup>-2</sup> -C <sup>-1</sup>	Electrical resistivity, microhm-cm	Ductility relative scale <sup>b</sup>	Resistance to oxidation <sup>c</sup>	Hardness <sup>d</sup>
Chromium boride		21 at room temperature <sup>(38)</sup>			1,800 kg/mm <sup>2</sup> <sup>(29)</sup>
Hafnium boride		10 <sup>(31)</sup>	3 <sup>(3)</sup>		
Molybdenum boride		α-MoB = 45 at room temperature <sup>(40)</sup> β-MoB = 25 at room temperature <sup>(40)</sup> 45 at room temperature <sup>(40)</sup> 40 at room temperature <sup>(40)</sup>	3 <sup>(3)</sup>	3 <sup>(3)</sup>	8 Mohs <sup>(20)</sup> 1,570 kg/mm <sup>2</sup> <sup>(29)</sup> 1,280 kg/mm <sup>2</sup> <sup>(29)</sup> 8-9 Mohs <sup>(20)</sup>
Niobium boride	0.040 at 20°C <sup>(36)</sup>	6.45 at room temperature <sup>(36)</sup> 32.0 at room temperature <sup>(36)</sup>			>0.8 Mohs <sup>(36)</sup>
Tantalum boride	0.026 at 20°C <sup>(6)</sup>	100 at room temperature <sup>(38)</sup> 68 at room temperature <sup>(38)</sup>	3 <sup>(3)</sup>	3 <sup>(3)</sup>	
Thorium boride		28.4 <sup>(28)</sup>	3 <sup>(3)</sup>	2-3 <sup>(3)</sup>	3,400 kg/mm <sup>2</sup> <sup>(29)</sup>
Titanium boride	0.0624 at 200°C <sup>(28)</sup> (15% porosity)		3 <sup>(3)</sup>	3 <sup>(3)</sup>	9 Mohs <sup>(6)</sup>
Tungsten boride					
Uranium boride					
Vanadium boride	16 at 20°C <sup>(34)</sup>				8-9 Mohs <sup>(6)</sup>
Zirconium boride	0.0550 at 200°C <sup>(28)</sup> 0.029 at room temperature <sup>(33)</sup>	9.2 at 20°C <sup>(31)</sup> 60-80 at room temperature <sup>(30)</sup>	2 <sup>(3)</sup>	2-3 <sup>(3)</sup>	8 Mohs <sup>(32)</sup>

Carbides

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density, g/cm <sup>3</sup>
Boron carbide	B <sub>4</sub> C	55.29	2,450	Hexagonal	a <sub>0</sub> = 5.60 <sup>(6)</sup> c <sub>0</sub> = 12.12	2.52
Chromium carbide	Cr <sub>3</sub> C <sub>2</sub>	180.05	1,895 <sup>(15)</sup>	Orthorhombic (D <sub>5h</sub> )	a = 2.82 b = 5.53 c = 11.47 <sup>(16)</sup>	6.7
	Cr <sub>7</sub> Cr <sub>3</sub>	400.01	1,780 <sup>(15)</sup>	Hexagonal [C <sub>3</sub> v <sup>4</sup> ]	a = 14.01 c = 4.532 <sup>(17)</sup>	6.92
Graphite	C	12.01	3,700 ± 100 <sup>(3)</sup>	Hexagonal	Orthorhombic axes a <sub>0</sub> = 2.46 b <sub>0</sub> = 4.28 c <sub>0</sub> = 6.71	2.25
Hafnium carbide	HfC	190.51	3,890 <sup>(9)</sup>	Cubic NaCl type (B1)	a = 4.46 <sup>(10)</sup>	12.7

**REFRACTORY MATERIALS (Continued)**  
Carbides (Continued)

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density, g/cm <sup>3</sup>
Molybdenum carbide	MoC	107.96	2,695 <sup>(9)</sup>	Face-centered cubic	a = 4.28 <sup>(19)</sup>	9.2
	Mo <sub>2</sub> C	203.91	2,690 <sup>(6)</sup>	Hexagonal (L'3)	a = 3.002 c = 4.724 <sup>(18)</sup>	
Niobium carbide	NbC	104.92	3,500 <sup>(9)</sup>	Cubic NaCl type (B1)	a = 4.461	7.85
Silicon carbide	β	40.07	Trans. to α at 2,100 2,700 <sup>(6)</sup>	Face-centered cubic	a <sub>0</sub> = 4.3590 <sup>(6)</sup>	3.22
	α					
Tantalum carbide	TaC	192.96	3,880 <sup>(9)</sup> , 4,730 <sup>(4)</sup>	Cubic NaCl type (B1)	a = 4.455 <sup>(14)</sup>	14.5
Thorium carbide	ThC	244.06	2,625 <sup>(23)</sup>	Cubic NaCl type (B1)	a = 5.34 <sup>(9)</sup>	10.67
	ThC <sub>2</sub>	256.07	2,655 <sup>(29)</sup>	Monoclinic [C 2/e]	a = 6.53 <sup>(24)</sup> b = 4.24 c = 4.71	9.6
Titanium carbide	TiC	59.91	3,160 <sup>(4)</sup>	Cubic NaCl type (B1)	a = 4.32 <sup>(6)</sup>	4.938
Tungsten carbide	W <sub>2</sub> C	379.73	2,730 <sup>(21)</sup>	Hexagonal (L'3)	a = 2.98 <sup>(6)</sup> c = 4.71	17.34
	WC	195.87	2,630 <sup>(21)</sup> (decomposes)	Hexagonal (L'3)	a = 2.900 <sup>(22)</sup> c = 2.831	15.77
Uranium carbide	UC	250.08	2,450–2,500 <sup>(25)</sup>	Cubic NaCl type (B1)	a = 4.955 <sup>(26)</sup>	13.6
	UC <sub>2</sub>	262.09	2,350–2,400 <sup>(25)</sup>	Body-centered tetragonal CaCl <sub>2</sub> type	a = 3.517 <sup>(27)</sup> c = 5.987	11.68
Vanadium carbide	VC	62.96	2,830 <sup>(11)</sup>	Cubic NaCl type (B1)	a = 4.16 <sup>(6)</sup>	5.8
Zirconium carbide	ZrC	103.23	3,030 <sup>(4)</sup>	Cubic NaCl type (B1)	a = 4.689 <sup>(5)</sup>	6.44

Name	Thermal conductivity, cal-sec <sup>-1</sup> -cm <sup>-2</sup> -cm <sup>-2</sup> C <sup>-1</sup>	Electrical resistivity, microhm-cm	Ductility relative scale <sup>b</sup>	Resistance to oxidation <sup>c</sup>	Hardness <sup>d</sup>
Boron carbide	0.05 at 20–425°C <sup>(1)</sup>	0.30–0.80 <sup>(1)</sup>	3(3)	3(3)	9.3 Mohs
Chromium carbide			3(3)	3(3)	1,300 kg/mm <sup>2</sup> (8)
Graphite	0.268–0.451 at room temperature	65 at room temperature <sup>(71)</sup>	3(3)	3(3)	
Hafnium carbide		109 at room temperature <sup>(1)</sup>	3(3)	4(3)	
Molybdenum carbide		97 <sup>(6)</sup>	3(3)	3(3)	1,800 kg/mm <sup>2</sup> (6)
			3(3)	5(3)	>0.7 Mohs <sup>(20)</sup>
Niobium carbide	0.034 at room temperature <sup>(7)</sup>	74 <sup>(6)</sup>	2–3 <sup>(3)</sup>	3(3)	2,470 kg/mm <sup>2</sup> (13)
Silicon carbide	0.10 at 20–425°C <sup>(1)</sup>	107–200 ohm cm <sup>(1)</sup> at room temperature	3(3)	2(3)	9.2 Mohs
Tantalum carbide	0.053 at room temperature <sup>(6)</sup>	30 <sup>(6)</sup>	2–3 <sup>(3)</sup>	3(3)	1,800 kg/mm <sup>2</sup> (8)
Thorium carbide			3(3)	3(3)	
Titanium carbide	0.049 at room temperature <sup>(6)</sup>	180–250 <sup>(4)</sup>	3(3)	3(4)	3,200 kg/mm <sup>2</sup> (8)
Tungsten carbide		80 <sup>(6)</sup>	3(3)	5(3)	3,000 kg/mm <sup>2</sup> (6)
		53 <sup>(6)</sup>	3(3)	5(3)	2,400 kg/mm <sup>2</sup> (6)
Uranium carbide			3(3)	5(3)	
Vanadium carbide		150 <sup>(6)</sup>	3(3)	5(3)	2,800 kg/mm <sup>2</sup> (11) 2,100 kg/mm <sup>2</sup> (12)
Zirconium carbide	0.049 at room temperature <sup>(6)</sup>	70 at room temperature <sup>(4)</sup>	3(3)	3(3)	2,600 kg/mm <sup>2</sup> (6)

Nitrides

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density, g/cm <sup>3</sup>
Boron nitride	BN	24.83	2,730 <sup>(6)</sup>	Hexagonal (B 12)	a = 2.51 ± .02 c = 6.70 ± .04 <sup>(52)</sup>	2.25
Chromium nitride	CrN	66.02	1,500 (decomposes)	Cubic NaCl type (B1)	a = 4.140 <sup>(6)</sup>	6.14
Hafnium nitride	HfN	192.60	3,310 <sup>(6)</sup>			
Niobium nitride	NbN	106.92	2,050 <sup>(46)</sup>	Cubic NaCl type (B1)	a = 4.41–4.375 <sup>(6)</sup>	7.28
Tantalum nitride	Ta <sub>2</sub> N	375.77	3,090 <sup>(46)</sup>	Hexagonal	a = 3.05 <sup>(48)</sup> c = 4.95 <sup>(53)</sup>	14.1
Thorium nitride	ThN	246.13	2,630 <sup>(48)</sup>	Cubic NaCl type (B1)	a = 5.2 <sup>(48)</sup>	
Titanium nitride	TiN	61.91	2,930 N <sub>2</sub> liberated on melting <sup>(46)</sup>	Cubic NaCl type (B1)	a = 4.23 <sup>(53)</sup>	5.43
Uranium nitride	UN		2,650	Cubic NaCl type (B1)	a = 4.880 <sup>(58)</sup>	14.32
Vanadium nitride	VN	64.96	2,050 <sup>(46)</sup>	Cubic NaCl type (B1)	a = 4.129 <sup>(6)</sup>	6.102
Zirconium nitride	ZrN	105.22	2,980 <sup>(47)</sup>	Cubic NaCl type (B1)	a = 4.567 <sup>(53)</sup>	7.349

**REFRACTORY MATERIALS (Continued)**

**Nitrides (Continued)**

Name	Thermal conductivity, cal-sec <sup>-1</sup> -cm <sup>-2</sup> -cm <sup>-2</sup> -C <sup>-1</sup>	Electrical resistivity, microhm-cm	Ductility relative scale <sup>b</sup>	Resistance to oxidation <sup>c</sup>	Hardness <sup>d</sup>
Boron nitride		1,900 at 2,000°C <sup>(1)</sup>	3 <sup>(3)</sup>	2 <sup>(3)</sup>	2.0 Mohs
Chromium nitride					
Hafnium nitride					
Niobium nitride		200 at room temperature <sup>(46)</sup>	5 <sup>(3)</sup>	3 <sup>(3)</sup>	+8 Mohs <sup>(46)</sup>
Tantalum nitride		135 at room temperature <sup>(47)</sup>	3 <sup>(3)</sup>	5 <sup>(3)</sup>	+8
Thorium nitride					
Titanium nitride		21.7 at room temperature	3 <sup>(3)</sup>	3 <sup>(3)</sup>	Between 9 and 10 Mohs <sup>(46)</sup>
Uranium nitride					
Vanadium nitride		200 at room temperature <sup>(46)</sup>	3 <sup>(3)</sup>		
Zirconium nitride		13.6 at room temperature <sup>(46)</sup>	3 <sup>(3)</sup>	3 <sup>(3)</sup>	+8 Mohs <sup>(6)</sup>

**Oxides**

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density, g/cm <sup>3</sup>
Aluminum oxide	Al <sub>2</sub> O <sub>3</sub>	101.92	2,015 <sup>(1)</sup>	Rhombohedral	a = 5.13 axial angle = 55° 6'	3.965
Beryllium oxide	BeO	25.02	2,550 <sup>(1)</sup>	Hexagonal	a = 2.70 c = 4.39	3.03
Cerium oxide	CeO <sub>2</sub>	172.3	2,600 <sup>(1)</sup>	Face-centered cubic	a = 5.41	7.13
Chromic oxide	Cr <sub>2</sub> O <sub>3</sub>	152.02	2,265 <sup>(1)</sup>	Rhombohedral	a = 5.38 axial angle = 54° 50'	5.21
Hafnium oxide	HfO <sub>2</sub>	210.6	2,777 <sup>(1)</sup>	Face-centered cubic	a = 5.11	9.68
Magnesium oxide	MgO	40.32	2,800 <sup>(1)</sup>	Face-centered cubic	a = 4.20	3.58
Silicon oxide	SiO <sub>2</sub>	60.06	1,728 <sup>(1)</sup>	Hexagonal	a = 4.90 c = 5.39	2.32 (low cristobalite)
Thorium oxide	ThO <sub>2</sub>	264.12	3,300 <sup>(1)</sup>	Face-centered cubic	a = 5.59	9.69
Titanium oxide	TiO <sub>2</sub>	79.90	1,840 <sup>(1)</sup>	Tetragonal	a = 4.58 c = 2.98	4.24
Uranium oxide	UO <sub>2</sub>	270.07	2,280 <sup>(1)</sup>	Face-centered cubic	a = 5.47	10.96
Zirconium oxide	ZrO <sub>2</sub>	123.22	2,677 <sup>(1)</sup>	Monoclinic	a = 5.21 c = 5.37	5.56

Name	Thermal conductivity, cal-sec <sup>-1</sup> -cm <sup>-2</sup> -cm <sup>-2</sup> -C <sup>-1</sup>	Electrical resistivity, microhm-cm	Ductility relative scale <sup>b</sup>	Resistance to oxidation <sup>c</sup>	Hardness <sup>d</sup>
Aluminum oxide	0.0723 at 100°C <sup>(2)</sup>	1 × 10 <sup>12</sup> at 14°C <sup>(1)</sup> 3 × 10 <sup>13</sup> at 300°C <sup>(1)</sup> 3.5 × 10 <sup>14</sup> at 800°C <sup>(1)</sup>	3 <sup>(3)</sup>	1 <sup>(3)</sup>	9 Mohs <sup>(1)</sup>
Beryllium oxide	0.525 at 100°C <sup>(2)</sup>	4 × 10 <sup>14</sup> at 600°C <sup>(1)</sup> 5 × 10 <sup>12</sup> at 1,100°C <sup>(1)</sup> 8 × 10 <sup>8</sup> at 2,100°C <sup>(1)</sup>			9 Mohs <sup>(1)</sup>
Cerium oxide		6.5 × 10 <sup>10</sup> at 800°C <sup>(1)</sup> 3.4 × 10 <sup>8</sup> at 1,200°C <sup>(1)</sup>			6 Mohs <sup>(1)</sup>
Chromium oxide		1.3 × 10 <sup>9</sup> at 350°C <sup>(1)</sup> 2.3 × 10 <sup>7</sup> at 1,200°C <sup>(1)</sup> 6.8 × 10 <sup>3</sup> at 600°C <sup>(1)</sup> 4.5 × 10 <sup>3</sup> at 1,100°C <sup>(1)</sup> 5 × 10 <sup>15</sup> at 400°C <sup>(1)</sup> 1 × 10 <sup>3</sup> at 1,500°C <sup>(1)</sup>	3 <sup>(3)</sup>	1 <sup>(3)</sup>	
Hafnium oxide					
Magnesium oxide	0.0860 at 100°C <sup>(2)</sup>	2 × 10 <sup>14</sup> at 850°C <sup>(1)</sup> 3 × 10 <sup>13</sup> at 980°C <sup>(1)</sup> 4.5 × 10 <sup>8</sup> at 2,100°C <sup>(1)</sup>			6 Mohs <sup>(1)</sup>
Silicon oxide		1 × 10 <sup>11</sup> at 20°C <sup>(1)</sup> 7 × 10 <sup>12</sup> at 600°C <sup>(1)</sup> 4 × 10 <sup>9</sup> at 1,300°C <sup>(1)</sup> (vitreous)	3 <sup>(4)</sup> (vitreous)	1 <sup>(4)</sup> (vitreous)	6-7 Mohs <sup>(1)</sup> (cristobalite)
Thorium oxide	0.0245 at 100°C <sup>(2)</sup>	2.6 × 10 <sup>13</sup> at 550°C <sup>(1)</sup> 8 × 10 <sup>11</sup> at 800°C <sup>(1)</sup> 1.5 × 10 <sup>10</sup> at 1,200°C <sup>(1)</sup>			6.5 Mohs <sup>(1)</sup>
Titanium oxide	0.0156 at 100°C <sup>(2)</sup>	1.2 × 10 <sup>10</sup> at 800°C <sup>(1)</sup> 8.5 × 10 <sup>6</sup> at 1,200°C <sup>(1)</sup>			5.5-6.0 Mohs <sup>(1)</sup>
Uranium oxide	0.0234 at 100°C <sup>(2)</sup>	3.8 × 10 <sup>10</sup> at 20°C <sup>(1)</sup> 5 × 10 <sup>8</sup> at 500°C <sup>(1)</sup>			
Zirconium oxide	0.00466 at 100°C <sup>(2)</sup>	1 × 10 <sup>12</sup> at 385°C <sup>(1)</sup> 2.2 × 10 <sup>10</sup> at 700°C <sup>(1)</sup> 3.6 × 10 <sup>8</sup> at 1,200°C <sup>(1)</sup>	3 <sup>(3)</sup>	1 <sup>(3)</sup>	6.5 Mohs <sup>(1)</sup>



## REFRACTORY MATERIALS (Continued)

### Silicides

Name	Formula	Molecular weight	Melting point, °C	Crystalline form	Lattice parameter, Å	X-ray density g/cm <sup>3</sup>
Chromium silicide	CrSi <sub>2</sub>	108.13	1,570 <sup>(51)</sup>	Hexagonal	a = 4.42 c = 6.35 <sup>(51)</sup>	
	CrSi	80.07	1,870 (decomposes in presence of C)	Tetragonal (C 11b)	a = 3.20 c = 7.86 <sup>(6)</sup>	
Molybdenum silicide	MoSi <sub>2</sub>	152.07	1,870 (decomposes in presence of C)	Tetragonal (C 11b)	a = 3.20 c = 7.86 <sup>(64)(51)</sup>	6.24
Niobium silicide	NbSi <sub>2</sub>		1,950 <sup>(50)</sup>	Hexagonal CrSi <sub>2</sub> type	a = 4.785 c = 6.576 <sup>(51)</sup>	5.29
Tantalum silicide	TaSi <sub>2</sub>	237.00	2,400 <sup>(50)</sup>	Hexagonal CrSi <sub>2</sub> type	a = 4.773 c = 6.552 <sup>(51)</sup>	8.83
Titanium silicide	TiSi <sub>2</sub>	104.02	1,540 <sup>(49)</sup>	Orthorhombic	a = 8.24 b = 4.79 c = 8.52 <sup>(59)</sup>	4.13
	Ti <sub>3</sub> Si <sub>3</sub>	323.68	2,120 <sup>(49)</sup>	Hexagonal	a = 7.465 c = 5.162 <sup>(60)</sup>	4.32
Tungsten silicide	WSi <sub>2</sub>	240.04	2,050 <sup>(50)</sup>	Tetragonal MoSi <sub>2</sub> Structure (C 11b)	a = 3.21 c = 7.83 <sup>(66)</sup>	9.3
Uranium silicide	βUSi <sub>2</sub>	294.19	1,700 <sup>(6)</sup>	Hexagonal	a = 3.85 <sup>(6)</sup> c = 4.06	9.25
	U <sub>3</sub> Si <sub>2</sub>	770.33	1,665 <sup>(6)</sup>	Tetragonal	a = 7.3151 <sup>(6)</sup> c = 3.8925	12.20
Vanadium silicide	VSi <sub>2</sub>	107.07	1,750 <sup>(50)</sup>	Hexagonal CrSi <sub>2</sub> type	a = 4.562 c = 6.359 <sup>(51)</sup>	4.71

Name	Thermal conductivity, cal-sec <sup>-1</sup> -cm <sup>-2</sup> -cm <sup>-2</sup> -C <sup>-1</sup>	Electrical resistivity, microhm-cm	Ductility relative scale <sup>b</sup>	Resistance to oxidation <sup>c</sup>	Hardness <sup>d</sup>
Chromium silicide					1,150 kg/mm <sup>2</sup> (50)
Molybdenum silicide	0.075 at room temperature to 200°C <sup>(6)</sup>	21.5 at room temperature 18.9 at -80°C <sup>(69)</sup> 6.3 <sup>(68)</sup>	2 <sup>(3)</sup>	1 <sup>(3)</sup>	1,290 kg/mm <sup>2</sup> (50)
Niobium silicide			2 <sup>(3)</sup>	4 <sup>(3)</sup>	1,050 kg/mm <sup>2</sup> (50)
Tantalum silicide		8.5 <sup>(68)</sup>	2 <sup>(3)</sup>	3 <sup>(3)</sup>	1,560 kg/mm <sup>2</sup> (50)
Titanium silicide		123 (hot pressed) <sup>(1)</sup>	3 <sup>(3)</sup>	4 <sup>(3)</sup>	870 kg/mm <sup>2</sup> (70)
Tungsten silicide		33.4 <sup>(68)</sup>	3 <sup>(3)</sup>	4 <sup>(3)</sup>	986 kg/mm <sup>2</sup> (49)
				1-2 <sup>(3)</sup>	1,310 kg/mm <sup>2</sup> (68) 1,090 kg/mm <sup>2</sup> (68)
Uranium silicide					
Vanadium silicide		9.5 <sup>(68)</sup>			1,090 kg/mm <sup>2</sup> (50)

<sup>a</sup>Numbers in parentheses refer to references at end of table.

<sup>b</sup>Ductility - 1: capable of being severely drawn, rolled, or otherwise worked without failure; 2: capable of withstanding slight deformation, or consisting of individually ductile crystals fragily bound together; 3: incapable of being worked, of glasslike brittleness.

<sup>c</sup>Resistance to oxidation - classed according to the temperature range in which the rate of attack by air would cause severe erosion or failure of the coated specimen within a few hours. 1: above 1,700°C; 2: 1,400 to 1,700°C; 1,100 to 1,400°C; 4: 800 to 1,000°C; 5: 500 to 800°C.

<sup>d</sup>Microhardness values taken with 100-g load.

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# SOLVENTS FOR LIQUID CHROMATOGRAPHY

Solvent	Viscosity (mPa·s; 20 °C)	UV cutoff (nm)	Refractive index (20 °C)	Normal boiling point (°C)	Dielectric constant (20 °C)
Acetic acid	1.31(15)		1.372	117.9	6.15
Acetone	0.30(25)	330	1.359	56.1	20.7(25)
Acetonitrile	0.34(25)	190	1.344	81.6	37.5
Benzene	0.65	278	1.501	80.1	2.284
1-Butanol	2.95	215	1.399	117.7	17.8
2-Butanol	4.21	260	1.397	99.5	15.8(25)
<i>n</i> -Butyl acetate	0.73	254	1.394	126.1	
<i>n</i> -Butyl chloride	0.47(15)	220	1.402	78.4	
Carbon tetrachloride	0.97	263	1.460	76.8	2.238
Chlorobenzene	0.80	287	1.525	131.7	2.708
Chloroform	0.58	245	1.446	61.2	4.806
Cyclohexane	0.98	200	1.426	80.7	2.023
Cyclopentane	0.44	200	1.406	49.3	1.965
<i>o</i> -Dichlorobenzene	1.32(25)	295	1.551	180.0	9.93(25)
<i>N,N</i> -Dimethylacetamide	2.14	268	1.438	166.0	37.8
Dimethylformamide	0.92	268	1.430	153.0	36.7
Dimethyl sulfoxide	2.20	286	1.478	189.0	4.7
Dioxane	1.44(15)	215	1.422	101.4	2.209(25)
2-Ethoxyethanol	2.05	210	1.408	135.0	
Ethyl acetate	0.46	256	1.372	77.1	6.02(25)
Ethyl ether	0.24	218	1.352	34.4	4.335
Glyme (ethylene glycol dimethyl ether)	0.46(25)	220	1.380	93.0	
Heptane	0.42	200	1.388	98.4	1.92
Hexadecane	3.34	200	1.434	286.9	
Hexane	0.31	200	1.375	68.7	1.890
Isobutyl alcohol	4.70(15)	200	1.396	107.9	15.8(25)
Methanol	0.55	205	1.328	64.6	32.63(25)
2-Methoxyethanol	1.72	210	1.402	124.1	16.9
2-Methoxyethyl acetate		254	1.402	143.0	
Methylene chloride	0.45(15)	233	1.424	39.8	9.08
Methylethylketone	0.42(15)	329	1.379	79.6	18.5
Methylisobutylketone		330	1.406	144.0	
Methylisobutylketone	0.54(25)	334	1.396	116.5	
<i>N</i> -Methyl-2-pyrrolidone	1.67(25)	285	1.488	202.0	32.0
Nonane	0.72	200	1.405	150.8	1.972
Pentane	0.24	200	1.357	36.1	1.84
Petroleum ether	0.30	226		30—60	
$\beta$ -Phenethylamine		285	1.529(25)	197—198	
1-Propanol	2.26	210	1.386	97.2	20.1(25)
2-Propanol	2.86(15)	205	1.377	82.2	18.3(25)
Propylene carbonate			1.419	240.0	
Pyridine	0.95	330	1.510	115.3	12.3(25)
Tetrachloroethylene	0.93(15)	295	1.506	121.2	
Tetrahydrofuran	0.55	212	1.407	64.8	7.6
Tetramethyl urea		265	1.449(25)	175.2	23.0
Toluene	0.59	284	1.497	110.6	2.379(25)
Trichloroethylene	0.57	273	1.477	87.2	3.4(16)
1,2,2-Trichloro-1,2,2-trifluoroethane	0.71	231	1.356(25)	47.6	
2,2,4-Trimethylpentane	0.50	215	1.391	99.2	1.94
Water	1.00	<190	1.333	100.0	78.54
<i>o</i> -Xylene	0.81	288	1.505	144.4	2.568
<i>p</i> -Xylene		290	1.496	138.4	2.270

## SPARK-GAP VOLTAGES

Based on results of the American Institute of Electric Engineers Air at 760 mmHg, 25°C.

Peak voltage, kilovolts	Diameter of spherical electrodes, cm				Needle points	Peak voltage, kilovolts	Diameter of spherical electrodes, cm				Needle points
	2.5	5	10	25			2.5	5	10	25	
	Length of spark gap, cm					Length of spark gap, cm					
5	0.13	0.15	0.15	0.16	0.42	110	—	5.79	4.25	3.88	17.7
10	0.27	0.29	0.30	0.32	0.85	120	—	7.07	4.78	4.28	19.8
15	0.42	0.44	0.46	0.48	1.30	130	—	—	5.35	4.69	22.0
20	0.58	0.60	0.62	0.64	1.75	140	—	—	5.97	5.10	24.1
25	0.76	0.77	0.78	0.81	2.20	150	—	—	6.64	5.52	26.1
30	0.95	0.94	0.95	0.98	2.69	160	—	—	7.37	5.95	28.1
35	1.17	1.12	1.12	1.15	2.69	170	—	—	8.16	6.39	30.1
40	1.41	1.30	1.29	1.32	3.81	180	—	—	9.03	6.84	32.0
45	1.68	1.50	1.47	1.49	4.49	190	—	—	10.0	7.30	33.9
50	2.00	1.71	1.65	1.66	5.20	200	—	—	11.1	7.76	35.7
60	2.82	2.17	2.02	2.01	6.81	210	—	—	12.3	8.24	37.6
70	4.05	2.68	2.42	2.37	8.81	220	—	—	13.7	8.73	39.5
80	—	3.26	2.84	2.74	11.1	230	—	—	15.3	9.24	41.4
90	—	3.94	3.28	3.11	13.3	240	—	—	—	9.76	43.4
100	—	4.77	3.75	3.49	15.5	250	—	—	—	10.3	45.2
						300	—	—	—	13.3	54.7

# SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES

R. J. Corruccini and J. J. Gniewek

For a more extensive listing of data one is referred to N.B.S. Monograph 21 (1960)

Metals								
Aluminum			Beryllium		Bismuth		Cadmium	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g
1	0.00010 <sup>a</sup>	—	—	—	—	—	—	—
1	0.000051	0.000025	0.000025	0.000013	0.00000598	0.00000158	0.000008	0.000003
2	0.000108	0.000105	0.000051	0.000051	0.0000461	0.0000233	0.000033	0.000022
3	0.000176	0.000246	0.000079	0.000116	0.000170	0.000123	0.000090	0.000082
4	0.000261	0.000463	0.000109	0.000209	0.000493	0.000432	0.00021	0.00022
6	0.00050	0.00121	0.000180	0.000496	0.00214	0.00288	0.00130	0.0015
8	0.00088	0.0026	0.000271	0.000944	0.00547	0.0102	0.0043	0.0070
10	0.0014	0.0049	0.000389	0.00160	0.0104	0.0259	0.0080	0.109
15	0.0040	0.018	0.000842	0.00457	0.0238	0.111	0.025	0.102
20	0.0089	0.048	0.00161	0.0105	0.0363	0.262	0.046	0.28
25	0.0175	0.112	0.00279	0.0212	0.0477	0.472	0.066	0.56
30	0.0315	0.232	0.00450	0.0392	0.0572	0.734	0.086	0.94
35	0.0515	0.436	—	—	—	—	—	—
40	0.0775	0.755	0.00996	0.109	0.0727	1.38	0.117	1.96
50	0.142	1.85	0.0192	0.253	0.0846	2.17	0.141	3.26
60	0.214	3.64	0.0341	0.523	0.0935	3.06	0.159	4.76
70	0.287	6.15	0.0562	0.971	0.100	4.03	0.172	6.43
80	0.357	9.37	0.0906	1.69	0.105	5.05	0.182	8.20
90	0.422	13.25	0.139	2.82	0.108	6.12	0.190	10.1
100	0.481	17.76	0.199	4.51	0.111	7.21	0.196	12.0

Metals (continued)								
Chromium			Copper		Germanium <sup>b</sup>		Gold	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g
1	0.0000285	0.0000142	0.000012	0.000006	0.00000528	0.00000132	0.000006	0.000002
2	0.000058	0.0000573	0.000028	0.000025	0.00000423	0.00000211	0.000025	0.000016
3	0.000089	0.000131	0.000053	0.000064	0.0000144	0.0000107	0.000070	0.000061
4	0.00014	0.000237	0.000091	0.00013	0.0000344	0.0000343	0.00016	0.00017
6	0.000206	0.000567	0.00023	0.00044	0.000125	0.000179	0.00050	0.00078
6	0.000206	0.000567	0.00023	0.00044	0.000125	0.000179	0.00050	0.00078
8	0.000312	0.00107	0.00047	0.00112	0.000335	0.000612	0.0012	0.0024
10	0.000451	0.00182	0.00086	0.0024	0.000813	0.00169	0.0022	0.0056
15	0.00102	0.00528	0.0027	0.0107	0.00445	0.0136	0.0074	0.028
20	0.00210	0.0128	0.0077	0.034	0.0125	0.0540	0.0159	0.086
25	0.00392	0.0274	0.016	0.090	0.0240	0.145	0.0263	0.191
30	0.00683	0.0532	0.027	0.195	0.0366	0.296	0.0371	0.349
40	0.0171	0.163	0.060	0.61	0.0617	0.786	0.0572	0.821
50	0.0358	0.421	0.099	1.40	0.0858	1.52	0.0726	1.47
60	0.0621	0.904	0.137	2.58	0.108	2.50	0.0842	2.25
70	0.093	1.68	0.173	4.13	0.131	3.70	0.0928	3.14
80	0.127	2.77	0.205	6.02	0.153	5.12	0.0992	4.10
90	0.161	4.21	0.232	8.22	0.173	6.74	0.1043	5.12
100	0.193	5.98	0.254	10.6	0.191	8.55	0.1083	6.18

Metals (continued)								
Indium			α-Iron <sup>c</sup>		γ-Iron <sup>d</sup>		Lead	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g
1	0.000029	0.000011	0.000090	0.000045	—	—	0.000026	0.000010
1	0.000019 <sup>a</sup>	0.000006 <sup>a</sup>	—	—	—	—	0.000012 <sup>a</sup>	0.000003 <sup>a</sup>
2	0.000138	0.000085	0.000183	0.000181	—	—	0.00012	0.00007
2	0.000141 <sup>a</sup>	0.000073 <sup>a</sup>	—	—	—	—	0.00009 <sup>a</sup>	0.00005 <sup>a</sup>
3	0.000410	0.000341	0.000279	0.000412	—	—	0.00033	0.00023 <sup>a</sup>
3	0.000464 <sup>a</sup>	0.000357 <sup>a</sup>	—	—	—	—	0.00031 <sup>a</sup>	—
3.40 <sup>c</sup>	0.000584	0.000537	—	—	—	—	—	—
3.40	0.000669 <sup>a</sup>	0.000581 <sup>a</sup>	—	—	—	—	—	—
4	0.00095	0.00099	0.000382	0.000742	—	—	0.0007	0.0008
4	—	—	—	—	—	—	0.0007 <sup>a</sup>	0.0007 <sup>a</sup>
5	—	—	—	—	—	—	0.0015	0.0018
5	—	—	—	—	—	—	0.0015 <sup>a</sup>	0.0018 <sup>a</sup>
6	0.00359	0.00520	0.000615	0.00173	—	—	0.0029	0.0039
6	—	—	—	—	—	—	0.0030 <sup>a</sup>	0.0040 <sup>a</sup>
7	—	—	—	—	—	—	0.0048	0.008

**SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES (continued)**

		Chromium		Copper		Germanium <sup>b</sup>		Gold	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	
7	—	—	—	—	—	—	0.0050 <sup>a</sup>	0.008 <sup>a</sup>	
8	0.00855	0.0170	0.00090	0.003233	—	—	0.0073	0.014	
10	0.0155	0.0408	0.00124	0.00537	—	—	0.0137	0.034	
15	0.036	0.170	0.00249	0.0145	—	—	0.0335	0.150	
20	0.0608	0.413	0.0045	0.0316	0.007	0	0.0531	0.368	
25	0.0857	0.778	0.0075	0.061	—	—	0.0681	0.672	
30	0.108	1.265	0.0124	0.110	0.016	0.11	0.0796	1.042	
40	0.141	2.52	0.029	0.31	0.041	0.39	0.0944	1.920	
50	0.162	4.04	0.055	0.73	0.090	1.0 <sup>2</sup>	0.103	2.91	
60	0.176	5.73	0.087	1.43	0.13 <sup>7</sup>	2.1 <sup>6</sup>	0.108	3.97	
70	0.186	7.53	0.121	2.46	0.18 <sup>0</sup>	3.7 <sup>5</sup>	0.112	5.07	
80	0.193	9.42	0.154	3.84	0.21 <sup>8</sup>	5.74 <sup>4</sup>	0.114	6.20	
90	0.198	11.38	0.186	5.55	0.25 <sup>5</sup>	8.1 <sup>1</sup>	0.116	7.35	
100	0.203	13.39	0.216	7.56	0.28 <sup>8</sup>	10 <sup>8</sup>	0.118	853	

		Molybdenum		Nickel		Palladium	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	
1	0.0000229	0.0000105	0.000120	0.000060	0.000099	0.0000493	
2	0.0000472	0.0000445	0.000242	0.000241	0.000203	0.000200	
2	—	—	—	—	—	—	
3	0.0000745	0.000105	0.000369	0.000546	0.000318	0.000459	
3	—	—	—	—	—	—	
4	0.000106	0.000194	0.000503	0.00098	0.000447	0.000840	
4	—	—	—	—	—	—	
5	—	—	—	—	—	—	
5	—	—	—	—	—	—	
6	0.000191	0.000484	0.00082	0.00228	0.000891	0.00231	
6	—	—	—	—	—	—	
7	—	—	—	—	—	—	
7	—	—	—	—	—	—	
8	0.000317	0.000981	0.00119	0.00428	0.00141	0.00460	
8	—	—	—	—	—	—	
9	—	—	—	—	—	—	
9	—	—	—	—	—	—	
10	0.000498	0.00178	0.00162	0.0071	0.00210	0.00807	
15	0.00131	0.00610	0.0031	0.0185	0.00471	0.0245	
20	0.00287	0.0161	0.0058	0.041	0.00922	0.0586	
25	0.00577	0.0374	0.0101	0.079	0.0160	0.120	
30	0.00960	0.0729	0.0167	0.145	0.0258	0.223	
40	0.0236	0.232	0.0381	0.413	0.0507	0.600	
50	0.0410	0.554	0.0682	0.937	0.0777	1.24	
60	0.0619	1.07	0.103	1.79	0.101	2.14	
70	0.0838	1.80	0.139	3.00	0.122	3.26	
80	0.104	2.74	0.173	4.56	0.139	4.56	
90	0.123	3.88	0.204	6.45	0.154	6.03	
100	0.139	5.20	0.232	8.63	0.167	7.63	

		Platinum		Rhodium		Silicon <sup>1</sup>		Silver	
<i>T</i> K	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	<i>C<sub>p</sub></i> J/g K	<i>H - H<sub>0</sub></i> J/g	
1	0.000035	0.0000175	0.000048	0.000024	0.00000263	0.000000658	0.0000072	0.0000032	
2	0.000074	0.000071	0.000097	0.000096	0.00000210	0.00000105	0.0000239	0.0000176	
3	0.000122	0.000168	0.000147	0.000218	0.00000709	0.00000532	0.0000595	0.0000574	
4	0.000186	0.000320	0.000201	0.000392	0.0000168	0.0000168	0.000124	0.000146	
6	0.00037	0.00085	0.00032	0.00091	0.0000596	0.0000853	0.00039	0.00062	
8	0.00067	0.00188	0.00047	0.00170	0.000140	0.000279	0.00091	0.00187	
10	0.00112	0.00365	0.00065	0.00281	0.000275	0.000679	0.0018	0.00452	
15	0.0033	0.0135	0.00135	0.00765	0.00109	0.00374	0.0064	0.0233	
20	0.0074	0.0395	0.00271	0.0174	0.00337	0.0138	0.0155	0.076	
25	0.0137	0.092	0.00561	0.0373	0.00849	0.0423	0.0287	0.185	
30	0.0212	0.182	0.0106	0.0071	0.0171	0.105	0.0442	0.368	
40	0.038	0.048	0.266	0.256	0.0440	0.400	0.078	0.979	
50	0.055	0.95	0.0489	0.633	0.0785	1.00	0.108	1.91	
60	0.068	1.56	0.9724	1.238	0.115	1.97	0.133	3.12	
70	0.079	2.29	0.094	2.07	0.152	3.31	0.151	4.54	
80	0.088	3.12	0.114	3.11	0.188	5.01	0.166	6.13	
90	0.094	4.02	0.132	4.34	0.224	7.06	0.177	7.85	
100	0.100	5.01	0.147	5.74	0.259	9.47	0.187	9.67	



## SPECIFIC HEAT AND ENTHALPY OF SOME SOLIDS AT LOW TEMPERATURES (continued)

T K	Sodium <sup>m</sup>		Tantalum		Tin (white)		Titanium	
	$C_p$ J/g K	$H - H_0$ J/g	$C_p$ J/g K	$H - H_0$ J/g	$C_p$ J/g K	$H - H_0$ J/g	$C_p$ J/g K	$H - H_0$ J/g
1	0.000081	0.000035	0.000032	0.000016	0.0000170	0.0000079	0.000071	0.000035
1	—	—	0.0000063 <sup>a</sup>	0.0000021 <sup>a</sup>	0.0000041 <sup>a</sup>	0.0000009 <sup>a</sup>	—	—
2	0.000289	0.000204	0.000068	0.000065	0.000047	0.0000383	0.000146	0.000143
2	—	—	0.000054 <sup>a</sup>	0.000026 <sup>a</sup>	0.000048 <sup>a</sup>	0.0000228 <sup>a</sup>	—	—
3	0.00076	0.00070	0.000112	0.000155	0.000109	0.000113	0.000226	0.000329
3	—	—	0.000178 <sup>a</sup>	0.000138 <sup>a</sup>	0.000151 <sup>a</sup>	0.000116 <sup>a</sup>	—	—
3.72 <sup>n</sup>	—	—	—	—	0.000198	0.000221	—	—
3.72	—	—	—	—	0.000285 <sup>a</sup>	0.000270 <sup>a</sup>	—	—
4	0.00160	0.00184	0.000171	0.000295	0.000245	0.000283	0.000317	0.000599
4	—	—	0.000352 <sup>a</sup>	0.000400 <sup>a</sup>	—	—	—	—
4.39 <sup>o</sup>	—	—	0.000201	0.000368	—	—	—	—
4.39	—	—	0.000433 <sup>a</sup>	0.000553 <sup>a</sup>	—	—	—	—
5	0.00298	0.00408	—	—	0.00054	0.00065	—	—
6	0.0051	0.0081	0.000333	0.000776	0.00127	0.00151	0.00054	0.00145
8	0.0122	0.0247	0.000648	0.00173	0.0042	0.0068	0.00084	0.00281
10	0.0238	0.0602	0.00117	0.00352	0.0081	0.0190	0.00126	0.00489
12	0.0397	0.123	—	—	—	—	—	—
14	0.063	0.225	—	—	—	—	—	—
15	—	—	0.00360	0.0145	0.226	0.093	0.0033	0.0156
16	0.093	0.380	—	—	—	—	—	—
18	0.124	0.597	—	—	—	—	—	—
20	0.155	0.875	0.00823	0.0432	0.040	0.251	0.0070	0.040
25	0.259	1.90	0.0153	0.102	0.058	0.498	0.0134	0.090
30	0.364	3.45	0.0240	0.202	0.076	0.834	0.0245	0.182
40	0.544	8.03	0.0430	0.540	0.106	1.75	0.0571	0.581
50	0.695	14.2	0.0604	1.06	0.130	2.93	0.0992	1.358
60	0.793	21.7	0.0754	1.74	0.148	4.33	0.1467	2.592
70	0.86	30.0	0.0819	2.47	0.162	5.88	0.189	4.27
80	0.91	38.9	0.0976	3.49	0.173	7.55	0.230	6.37
90	0.95	48.2	0.105	4.50	0.182	9.33	0.267	8.86
100	0.98	57.9	0.111	5.58	0.189	11.18	0.300	11.69

T K	Tungsten		Zinc	
	$C_p$ J/g K	$H - H_0$ J/g	$C_p$ J/g K	$H - H_0$ J/g
1	0.0000074	0.0000037	0.000011	0.000005
2	0.0000158	0.0000152	0.000028	0.000023
3	0.0000262	0.0000360	0.000058	0.000065
4	0.0000393	0.0000685	0.00011	0.00014
6	0.0000783	0.000182	0.00029	0.00053
8	0.000141	0.000396	0.00096	0.0016
10	0.000234	0.000765	0.0025	0.0050
15	0.000725	0.00297	0.011	0.034
20	0.00189	0.00927	0.026	0.125
25	0.00421	0.0237	0.049	0.31
30	0.00783	0.0534	0.076	0.62
40	0.0184	0.181	0.125	1.62
50	0.0332	0.436	0.171	3.11
60	0.0483	0.843	0.208	5.01
70	0.0605	1.39	0.236	7.23
80	0.0715	2.05	0.258	9.70
90	0.0810	2.81	0.277	12.38
100	0.0888	3.66	0.293	15.24

- <sup>l</sup> Superconducting.
- <sup>m</sup> In germanium the electronic specific heat is markedly dependent on impurities. The values given are for pure germanium (negligible electronic specific heat).
- <sup>n</sup>  $\alpha$ -Iron is the form that is thermodynamically stable at low temperatures. It has the body-centered cubic lattice which is the basis of the ferritic steels.
- <sup>o</sup>  $\gamma$ -Iron is stable between 910 and 1400°C. It has the face-centered cubic structure which is the basis of the austenitic steels. Since pure  $\gamma$ -iron is not stable at low temperatures the above values were calculated by application of the Kopp-Neumann rule to experimental data on two austenitic Fe-Mn alloys and of uncertain accuracy.
- <sup>p</sup> Superconducting transition temperature.
- <sup>q</sup> Superconducting transition temperature of mercury.
- <sup>r</sup> Melting temperature of mercury.
- <sup>s</sup> In silicon the electronic specific heat,  $\gamma T$ , is markedly dependent on impurities. Values of the coefficient,  $\gamma$ , from zero to  $2.4 \times 10^{-6}$  J/g K<sup>2</sup> have been reported. The values in the above table are for pure silicon ( $\gamma = 0$ ).
- <sup>t</sup> It has been shown (Barrett 1956, Hull & Rosenberg 1959) that sodium partially transforms at low temperatures from the normal body-centered cubic structure to close-packed hexagonal. The transformation is of the martensitic type and is promoted by cold-working at the low temperatures. Inasmuch as none of the calorimetric measurements on sodium were accompanied by crystallographic analysis, the tabulated data below 100 K are to some degree ambiguous.
- <sup>u</sup> Superconducting transition temperature of tin.
- <sup>v</sup> Superconducting transition temperature of tantalum.

## SPECTRAL EMISSIVITY

Prepared by Roeser and Wensel, National Bureau of Standards  
Spectral Emissivity of Materials, Surface Unoxidized for 0.65 $\mu$ m

Element	Solid	Liquid	Element	Solid	Liquid
Beryllium	0.61	0.61	Thorium	0.36	0.40
Carbon	0.80—0.93	—	Titanium	0.63	0.65
Chromium	0.34	0.39	Tungsten	0.43	—
Cobalt	0.36	0.37	Uranium	0.54	0.34
Columbium	0.37	0.40	Vanadium	0.35	0.32
Copper	0.10	0.15	Yttrium	0.35	0.35
Erbium	0.55	0.38	Zirconium	0.32	0.30
Gold	0.14	0.22	Steel	0.35	0.37
Iridium	0.30	—	Cast Iron	0.37	0.40
Iron	0.35	0.37	Constantan	0.35	—
Manganese	0.59	0.59	Monel	0.37	—
Molybdenum	0.37	0.40	Chromel P (90Ni-10Cr)	0.35	—
Nickel	0.36	0.37	80Ni-20Cr	0.35	—
Palladium	0.33	0.37	60Ni-24Fe-16Cr	0.36	—
Platinum	0.30	0.38	Alumel (95Ni; Bal. Al, Mn, Si)	0.37	—
Rhodium	0.24	0.30	90Pt-10Rh	0.27	—
Silver	0.07	0.07			
Tantalum	0.49	—			

## SPECTRAL EMISSIVITY OF OXIDES

The emissivity of oxides and oxidized metals depends to a large extent upon the roughness of the surface. In general, higher values of emissivity are obtained on the rougher surfaces.

Material	Range of observed values	Probable value for oxide formed on smooth metal
<b>Oxide</b>		
Aluminum	0.22—0.40	0.30
Beryllium	0.07—0.37	0.35
Cerium	0.58—0.80	—
Chromium	0.60—0.80	0.70
Cobalt	—	0.75
Columbium	0.55—0.71	0.70
Copper	0.60—0.80	0.70
Iron	0.63—0.98	0.70
Magnesium	0.10—0.43	0.20
Nickel	0.85—0.96	0.90
Thorium	0.20—0.57	0.50
Tin	0.32—0.60	—
Titanium	—	0.50
Uranium	—	0.30
Vanadium	—	0.70
Yttrium	—	0.60
Zirconium	0.18—0.43	0.40
<b>Oxidized</b>		
Alumel	—	0.87
Cast Iron	—	0.70
Chromel P (90Ni-10Cr)	—	0.87
80Ni-20Cr	—	0.90
60Ni-24Fe-16Cr	—	0.83
55Fe-37.5Cr-7.5Al	—	0.78
70Fe-23Cr-5Al-2Co	—	0.75
Constantan (55Cu-45Ni)	—	0.84
Carbon Steel	—	0.80
Stainless Steel (18-8)	—	0.85
Porcelain	0.25—0.50	—



STANDARD TEST SIEVES (WIRE CLOTH)

PARTICLE SIZE CONVERSION TABLE

Sieve Designation	Nominal Sieve Opening in	Permissible Variation of Average Opening from the Standard Sieve Designation	Maximum Opening Size for Not More than 5 percent of Openings	Maximum Individual Opening	Nominal Wire Diameter, mm*	Mesh size	Approximate micrometer size	Approximate millimeter size	Approximate inch size
(1)	(2)	(3)	(4)	(5)	(6)	(7)			
125 mm	5 in.	5	±3.7 mm	130.0 mm	130.9 mm	8.0	4760	4.76	0.185
106 mm	4.24 in.	4	±3.2 mm	110.2 mm	111.1 mm	6.40	3360	3.36	0.131
90 mm	4 in.	4	±3.0 mm	104.0 mm	104.8 mm	6.30	2380	2.38	0.093
75 mm	3 in.	3	±2.7 mm	93.6 mm	94.4 mm	6.08	1680	1.68	0.065
63 mm	3 in.	3	±2.2 mm	78.1 mm	78.7 mm	5.80	1190	1.19	0.046
53 mm	2 in.	2	±1.9 mm	65.6 mm	66.2 mm	5.50	840	0.84	0.0328
45 mm	2 in.	2	±1.6 mm	55.2 mm	55.7 mm	5.15	590	0.59	0.0232
40 mm	2 in.	2	±1.5 mm	52.1 mm	52.6 mm	5.05	420	0.42	0.0164
37.5 mm	1 1/2 in.	1	±1.4 mm	46.9 mm	47.4 mm	4.85	297	0.29	0.0116
31.5 mm	1 1/4 in.	1	±1.1 mm	39.1 mm	39.5 mm	4.59	250	0.25	0.0097
26.5 mm	1 in.	1	±1.0 mm	32.9 mm	33.2 mm	4.23	210	0.21	0.0082
25.0 mm	1 in.	1	±0.8 mm	27.7 mm	28.0 mm	3.90	177	0.17	0.0069
22.4 mm	1 in.	1	±0.8 mm	26.1 mm	26.4 mm	3.80	149	0.14	0.0058
19.0 mm	3/4 in.	1	±0.7 mm	23.4 mm	23.7 mm	3.50	105	0.10	0.0041
16.0 mm	3/4 in.	1	±0.6 mm	19.9 mm	20.1 mm	3.30	74	0.07	0.0029
13.2 mm	1/2 in.	1	±0.5 mm	16.7 mm	17.0 mm	3.00	62	0.06	0.0024
12.5 mm	1/2 in.	1	±0.41 mm	13.83 mm	14.05 mm	2.75	53	0.05	0.0021
11.2 mm	7/16 in.	1	±0.39 mm	13.10 mm	13.31 mm	2.67	44	0.04	0.0017
9.5 mm	3/8 in.	1	±0.35 mm	11.75 mm	11.94 mm	2.45	37	0.03	0.0015
8.0 mm	5/16 in.	1	±0.30 mm	9.97 mm	10.16 mm	2.27	20	0.02	0.0008
6.7 mm	1/4 in.	1	±0.25 mm	8.41 mm	8.58 mm	2.07	10	0.01	0.0004
6.3 mm	1/4 in.	1	±0.21 mm	7.05 mm	7.20 mm	1.87	5	0.005	0.0002
5.6 mm	3/16 in.	1	±0.20 mm	6.64 mm	6.78 mm	1.82			
4.75 mm	No. 4	1	±0.18 mm	5.90 mm	6.04 mm	1.68			
4.00 mm	No. 5	1	±0.15 mm	5.02 mm	5.14 mm	1.54			
3.35 mm	No. 6	1	±0.13 mm	4.23 mm	4.35 mm	1.37			
2.80 mm	No. 7	1	±0.11 mm	3.55 mm	3.66 mm	1.23			
2.36 mm	No. 8	1	±0.095 mm	2.975 mm	3.070 mm	1.10			
2.00 mm	No. 10	1	±0.080 mm	2.515 mm	2.600 mm	1.00			
1.70 mm	No. 12	1	±0.070 mm	2.135 mm	2.215 mm	0.900			
1.40 mm	No. 14	1	±0.060 mm	1.820 mm	1.890 mm	0.810			
1.18 mm	No. 16	1	±0.055 mm	1.505 mm	1.565 mm	0.725			
1.00 mm	No. 18	1	±0.045 mm	1.270 mm	1.330 mm	0.650			
850 μm	No. 20	1	±0.040 mm	1.080 mm	1.135 mm	0.580			
710 μm	No. 25	1	±0.0394 mm	925 μm	970 μm	0.510			
600 μm	No. 30	1	±0.0331 mm	775 μm	815 μm	0.450			
500 μm	No. 35	1	±0.0278 mm	660 μm	695 μm	0.390			
425 μm	No. 40	1	±0.0234 mm	550 μm	585 μm	0.340			
355 μm	No. 45	1	±0.0197 mm	471 μm	502 μm	0.290			
300 μm	No. 50	1	±0.0165 mm	396 μm	425 μm	0.247			
250 μm	No. 60	1	±0.0139 mm	337 μm	363 μm	0.215			
212 μm	No. 70	1	±0.0117 mm	283 μm	306 μm	0.180			
180 μm	No. 80	1	±0.0098 mm	242 μm	263 μm	0.152			
150 μm	No. 100	1	±0.0083 mm	207 μm	227 μm	0.131			
125 μm	No. 120	1	±0.0070 mm	174 μm	192 μm	0.110			
106 μm	No. 140	1	±0.0059 mm	147 μm	163 μm	0.091			
90 μm	No. 170	1	±0.0049 mm	126 μm	141 μm	0.076			
75 μm	No. 200	1	±0.0035 mm	108 μm	122 μm	0.064			
63 μm	No. 230	1	±0.0029 mm	91 μm	103 μm	0.053			
53 μm	No. 270	1	±0.0025 mm	77 μm	89 μm	0.044			
45 μm	No. 325	1	±0.0021 mm	66 μm	76 μm	0.037			
38 μm	No. 400	1	±0.0017 mm	57 μm	66 μm	0.030			
			±0.0015 mm	48 μm	57 μm	0.025			

\* The average diameter of the warp and of the shoot wires, taken separately, of the cloth of any sieve shall not deviate from the nominal values by more than the following:  
 Sieves coarser than 600 μm 5 percent  
 Sieves 600 to 125 μm 7 1/2 percent  
 Sieves finer than 125 μm 10 percent

# STANDARD TYPES OF STAINLESS AND HEAT RESISTING STEELS

**Chemical Ranges and Limits**  
**Subject to Tolerances for Check Analyses**  
**By permission of American Iron and Steel Institute**

## Chemical composition (%)

Type number	C	Mn Max.	P Max.	S Max.	Si Max.	Cr	Ni	Mo	Zr	Se	Cb-Ta	Ta	Al	N
201 <sup>c</sup>	0.15 Max.	5.50/ 7.50	0.060	0.030	1.00	16.00/ 18.00	3.50/ 5.50							0.25 Max.
202 <sup>c</sup>	0.15 Max.	7.50/ 10.00	0.060	0.030	1.00	17.00/ 19.00	4.00/ 6.00							0.25 Max.
301 <sup>c</sup>	0.15 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	6.00/ 8.00							
302 <sup>c</sup>	0.15 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	8.00/ 10.00							
302B <sup>c</sup>	0.15 Max.	2.00	0.045	0.030	2.00/ 3.00	17.00/ 19.00	8.00/ 10.00							
303 <sup>c</sup>	0.15 Max.	2.00	0.20	0.15 Min.	1.00	17.00/ 19.00	8.00/ 10.00	0.60 Max. <sup>a</sup>	0.60 Max. <sup>a</sup>					
303 Se <sup>c</sup>	0.15 Max.	2.00	0.20	0.06	1.00	17.00/ 19.00	8.00/ 10.00			0.15 Min.				
304 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	8.00/ 12.00							
304L <sup>c</sup>	0.03 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	8.00/ 12.00							
305 <sup>c</sup>	0.12 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	10.00/ 13.00							
308 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	19.00/ 21.00	10.00/ 12.00							
309 <sup>c</sup>	0.20 Max.	2.00	0.045	0.030	1.00	22.00/ 24.00	12.00/ 15.00							
309S <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	22.00/ 24.00	12.00/ 15.00							
310 <sup>c</sup>	0.25 Max.	2.00	0.045	0.030	1.50	24.00/ 26.00	19.00/ 22.00							
310S <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.50	24.00/ 26.00	19.00/ 22.00							
314 <sup>c</sup>	0.25 Max.	2.00	0.045	0.030	1.50/ 3.00	23.00/ 26.00	19.00/ 22.00							
316 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	10.00/ 14.00	2.00/ 3.00						
316L <sup>c</sup>	0.03 Max.	2.00	0.045	0.030	1.00	16.00/ 18.00	10.00/ 14.00	2.00/ 3.00						
317 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	18.00/ 20.00	11.00/ 15.00	3.00/ 4.00						
321 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 12.00				5 × C Min.			
347 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 13.00					10 × C Min.		
348 <sup>c</sup>	0.08 Max.	2.00	0.045	0.030	1.00	17.00/ 19.00	9.00/ 13.00						10 × C Min. 0.10 Max.	
403 <sup>b</sup>	0.15 Max.	1.00	0.040	0.030	0.50	11.50/ 13.00								
405 <sup>d</sup>	0.08 Max.	1.00	0.040	0.030	1.00	11.50/ 14.50							0.10/ 0.30	
410 <sup>b</sup>	0.15 Max.	1.00	0.040	0.030	1.00	11.50/ 13.50								
414 <sup>b</sup>	0.15 Max.	1.00	0.040	0.030	1.00	11.50/ 13.50	1.25/ 2.50							
416 <sup>b</sup>	0.15 Max.	1.25	0.06	0.15 Min.	1.00	12.00/ 14.00		0.60 Max. <sup>a</sup>	0.60 Max. <sup>a</sup>					
416 Se <sup>b</sup>	0.15 Max.	1.25	0.06	0.06	1.00	12.00/ 14.00				0.15 Min.				
420 <sup>b</sup>	Over 0.15	1.00	0.040	0.030	1.00	12.00/ 14.00								
430 <sup>a</sup>	0.12 Max.	1.00	0.040	0.030	1.00	14.00/ 18.00								
430F <sup>d</sup>	0.12 Max.	1.25	0.06	0.15 Min.	1.00	14.00/ 18.00		0.60 Max.	0.60 Max. <sup>a</sup>					
430F Se <sup>d</sup>	0.12 Max.	1.25	0.06	0.06	1.00	14.00/ 18.00				0.15 Min.				
431 <sup>b</sup>	0.20 Max.	1.00	0.040	0.030	1.00	15.00/ 17.00	1.25/ 2.50							
440A <sup>b</sup>	0.60/ 0.75	1.00	0.040	0.030	1.00	16.00/ 18.00		0.75 Max.						

**STANDARD TYPES OF STAINLESS AND HEAT RESISTING STEELS (continued)**

**Chemical composition (%)**

Type number	C	Mn Max.	P Max	S Max.	Si Max.	Cr	Ni	Mo	Zr	Se	Cb-Ta	Ta	Al	N
400B <sup>b</sup>	0.75/ 0.95	1.00	0.040	0.030	1.00	16.00/ 18.00		0.75 Max.						
440C <sup>b</sup>	0.95/ 1.20	1.00	0.040	0.030	1.00	16.00/ 18.00		0.75 Max.						
446 <sup>d</sup>	0.20 Max.	1.50	0.040	0.030	1.00	23.00/ 27.00								0.25 Max.
501 <sup>b</sup>	Over 0.10	1.00	0.040	0.030	1.00	4.00/ 6.00		0.40/ 0.65						
502 <sup>b</sup>	0.10 Max.	1.00	0.040	0.030	1.00	4.00/ 6.00		0.40/ 0.65						

<sup>a</sup> At producer's option; reported only when intentionally added.

<sup>b</sup> Heat treatable

<sup>c</sup> Not heat treatable.

<sup>d</sup> Essentially not heat treatable.



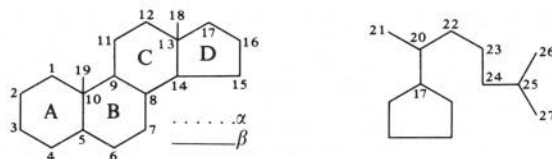
## STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS

Erwin DiCyan

The field of steroids has expanded considerably and rapidly in degree and in kind, because synthetic steroids have been synthesized which though resembling the hormones in the body have no natural counterpart, but exert an effect comparable to those of the natural hormones.

In fact, the term *steroid hormone* thus becomes a misnomer when applied to the newer synthetically prepared steroids which do not have a counterpart in the body of man or other animals—as prednisone. (A hormone, by definition, is a material with certain functions and characteristics, *secreted by the ductless glands*. That part of the definition cannot be met by prednisone or by similar steroids as these are not secreted by the ductless, or endocrine glands.)

All the hormones as well as the synthetic analogues have in common the cyclopentanophenanthrene nucleus. Although chemically very similar, a comparatively slight structural change is in many instances productive of substances which have physiologically dissimilar effects, often acting upon different physiologic systems. But in many cases a small change in structure will result merely in an accentuation of certain effects.



The Cyclopentanophenanthrene Nucleus

**Classification.** Classification becomes a bizarre problem by reason of the (a) overlapping uses to which these substances are put, and (b) the multiple purposes for which the hormones or synthetic substances are used. Indeed, the steroids may be classified by structure; that however would be uninformative to the student as to their use. Classification by origin, as adrenal, would also be unsuitable because, for example, a number of the adrenal corticosteroids are not found in the adrenal cortex at all, but merely resemble the natural hormones found in the adrenal cortex.

For those reasons the hormonal or hormonelike entries in the tables are classified by-and-large, by their predominant pharmacologic effects. Even that classification has its disparities as for example, the use of male sex hormones, i.e. the androgens, is neither limited to men, nor to uses which entail their effect upon male sex characteristics.

**Uses.** Originally, the use of steroid hormones was largely based upon one or more of the following predicates:

- To supplement the progressively declining secretion of a specific hormone due to natural biologic aging of the organism; in the menopause as an example of such declining secretion, a female sex hormone is used for such supplementation;
- To make available to the body a specific hormone, the natural secretion of which is inhibited because of a congenital or developmental anomaly; the underdevelopment of male secondary sex characteristics is an example of such an inhibited secretion, in which a male sex hormone is used—and correspondingly, female sex hormones in underdevelopment in females;
- To cause a reversal of hormonal balance in the treatment of diseases peculiar to a sex; for example, in the case of cancer of the female breast, a male sex hormone is administered, and in cancer of the prostate, a female sex hormone is used;
- To mimic a natural function, as menstruation, by the administration of estrogens—on withdrawal of which bleeding occurs; or by the alternate use of estrogenic and progestational—both female sex hormones.
- To delay a function, as ovulation, as in oral contraceptives, or *birth control pills*.

Since the finding that cortisone ameliorates the symptoms of rheumatoid arthritis (1949) the adrenal corticosteroid hormones and especially the synthetically prepared steroid analogues which have no natural counterpart in the body, have been successfully employed in the treatment of diseases not related to sex or sex function.

**Androgens and Anabolic Agents.** The agents listed in the tables under this classification have the effect of male sex hormones (androgens) i.e., to stimulate sexual maturation, in the "male climacteric," etc. But all androgens have in greater or lesser degree the ability to stimulate muscle development, i.e., an anabolic effect. Among the synthetically prepared agents which have no counterpart in the body (Methandrostenolone or Oxymetholone) are those which have a lessened androgenic, but a heightened anabolic effect. These qualities are determined by biological tests on animals but principally confirmed by clinical use in man. The anabolic effect includes remineralization of bone, which may be partially demineralized (osteoporosis) by age, or by certain drugs, as the adrenal corticosteroids (q.v.).

Anabolic agents are used for muscle and bone nutrition in men as well as women. The reason for the high interest in synthetic steroidal substances for anabolic use, is based on the need for materials, which within a given effective dose have a greater anabolic-to-androgenic ratio than such androgens as methyl testosterone. Otherwise, the administration of androgens to women produces manifestations of virilism, such as growth of hair on the face, a deepening of the voice, etc. Androgens are also used in the female in the suppression of excessive bleeding and in the treatment of cancer of the breast and cervix. (For other androgen-like agents, see also Progestogens and Progestins.)

**Estrogens.** Estrogenic agents hasten sexual maturation in the female. Therefore, they are used in underdevelopment in the female. The widest use of estrogens is in the treatment of the menopause, in which they supplement from without, the secretion of natural estrogens by the ovary, which begins to decline at about the 40th year. The menopause is usually a slow process, and the declining secretion gives rise to various symptoms during the time that the secretion declines, until adjustment to the new status takes place. The menopause, a period of physical and psychological stress, is made less precipitous by estrogens.

Frequently, a menopause must be quickly induced, as in cancer of the ovary or in uterine hemorrhage. This is done by radiation or by the removal of the uterus. Severe vasomotor symptoms occur when the menopause is thus suddenly induced. Estrogens—among other drugs—are used in the amelioration of these symptoms.

Estrogens (especially diethylstilbestrol which though not a hormone has an estrogenic effect) are also used in the control of cancer of the prostate in the male. Note the inverse correspondence to the use of male sex hormones in cancer of the breast in the female.

**Progestogens and Progestins (Including 19-Norsteroid Compounds).** The agents under that listing include progesterone, a female sex hormone, as well as progestins, i.e., synthetic progesterone-like compounds which have no natural counterpart in the body. Their use includes a variety of conditions: functional uterine bleeding, absence of menstruation (amenorrhea) used at times with estrogens, painful menstruation (dysmenorrhea), infertility, habitual abortion in order to maintain pregnancy, and in fact, to suppress ovulation hence their use as antifertility drugs. Certain progestins—as norethindrone combined with



## STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)

an estrogen, are the principal components of birth control pills—suppressing ovulation, there is no egg to fertilize, hence conception does not take place.

**Adrenal Corticosteroids, Including Antiinflammatory, Antiallergic and Antirheumatic Agents.** The adrenal cortex secretes a large number of hormones. They usually differ from each other in the accentuation of some phases of their properties. Virtually all of the cortical hormones are catabolic, thus having an effect in this respect, diametrically opposed to the androgens which are anabolic. Nearly all the cortical hormones—differing in degree from each other—cause retention of sodium and water by the body and hasten the excretion of potassium. These effects are utilized in the treatment of adrenal insufficiency or Addison's disease, in which conversely, there is an undue excretion of sodium and a strong retention of potassium. Desoxycorticosterone is used in Addison's disease because it has a particularly strong sodium retaining and potassium excreting effect.

Since the finding in 1949 of the usefulness of cortisone in profoundly reducing the symptoms of rheumatoid arthritis, the adrenal corticosteroids, including hydrocortisone, a natural hormone secreted by the adrenal cortex, and particularly the synthetic analogues not found in the body, as prednisone, have been used in the treatment of a wide variety of inflammatory diseases—especially diseases of collagen tissue. The same antiinflammatory effect is also brought into use in the reduction of inflammations associated with diseases of the skin, allergy, asthma, and in such systematic diseases as disseminated lupus erythematosus, also a collagen disease.

The drawbacks of cortisone, also shared in lesser measure by hydrocortisone, gave the impetus to the synthesis of steroidal substances not native to the body but differing somewhat from cortisone and hydrocortisone, in order to reduce the drawbacks attendant to the use of the latter. The sideeffects—especially those of cortisone—are retention of water and sodium, excretion of potassium, loss of mineral from bone leading to osteoporosis and fractures, hypertension, at times diabetes, personality changes or gastric ulcer. Prednisone and prednisolone among others (see tables) are two such steroidal synthetics which have the effects of cortisone, but fewer or less severe sideeffects. Whereas the synthetic steroidal substances are superior to cortisone with respect to lessened sideeffects, it cannot be said that the sideeffects are absent—they vary in degree from substance to substance.

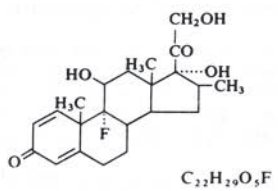
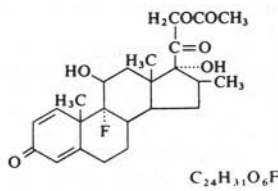
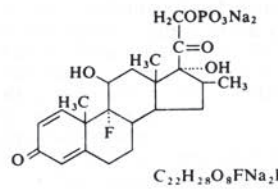
**Diuretic, Antidiuretic and Local Anesthetic Agents.** Aldosterone, a natural hormone of the adrenal cortex promotes retention in the body of sodium and water, and facilitates excretion of potassium. Hence its effect is almost diametrically opposed to diuretics—especially the thiazide diuretics. Aldosterone is much more active in this respect than desoxycorticosterone, and is used in the treatment of Addison's disease, a hypofunction of the adrenal glands.

Spironolactone is an antagonist to aldosterone—the latter when elaborated in the body in excessive amounts gives rise to a syndrome called aldosteronism. Spironolactone, a synthetically produced steroid does not have a natural counterpart in the body, is diuretic when mercurial or thiazide diuretics are ineffective; it prevents sodium retention and potassium excretion—effects opposite to aldosterone. Hence spironolactone is used in aldosteronism, against edema, in the treatment of congestive heart failure and in other conditions in which an accumulation of water, and water-retaining salt, is to be corrected.

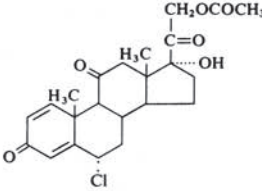
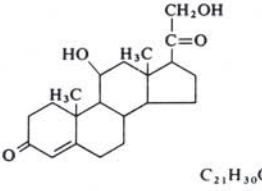
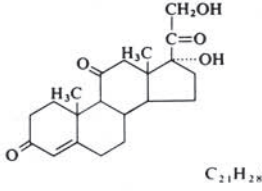
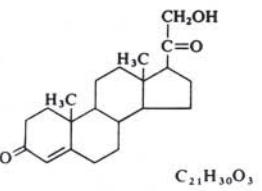
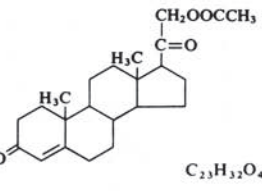
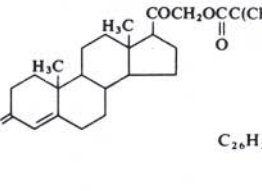
**Doses.** The amount of substance which comprises a dose of steroid hormones, or of the steroidal synthetics varies from substance to substance—from 0.1 mg for an estradiol ester, to 50 mg for a 19-norsteroid compound. The dose is conditioned upon the order of activity of the substance, the purpose for which it is administered, as well as the patient's response. However, as additional steroids for hormonal use are synthesized—especially those with adrenocortical activity, their average dose is usually smaller than the previously available steroid. The smaller effective dose of the more recent steroid is cited as an advantage over the previously available steroid.

However, a smaller dose cannot be claimed as an inherent advantage of a new steroid in comparison with an existing one, unless the lower dosage exhibits either greater or more prolonged activity or lesser sideeffects. One cannot meaningfully compare a dose, milligram for milligram, without taking into consideration if a heightened effect of the smaller dose produces fewer sideeffects. For example, it does not make any difference if a given effect and the same accompanying sideeffects are produced by a 50 mg or a 5 mg dose.

### ADRENAL CORTICOSTEROIDS, INCLUDING ANTIINFLAMMATORY, ANTIALLERGIC AND ANTIRHEUMATIC AGENTS

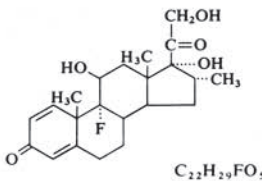
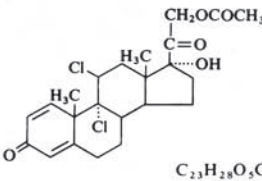
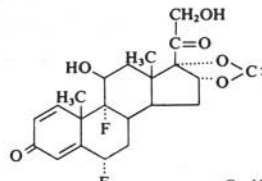
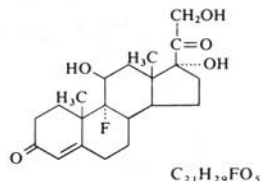
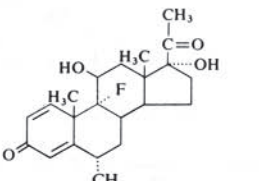
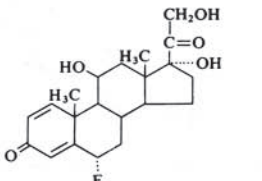
Names & synonyms:	<b>BETAMETHASONE:</b> 9 $\alpha$ -fluoro-16 $\beta$ -methylprednisolone; 16 $\beta$ -methyl-11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-9 $\alpha$ - fluoro-1,4-pregnadiene-3,20-dione.	<b>BETAMETHASONE ACETATE:</b> 9 $\alpha$ -fluoro-16 $\beta$ -methylprednisolone-21- acetate.	<b>BETAMETHASONE DISODIUM PHOSPHATE:</b> 9 $\alpha$ -fluoro-16 $\beta$ -methylprednisolone-21- disodium phosphate.
Formulae:	 C <sub>22</sub> H <sub>29</sub> O <sub>5</sub> F	 C <sub>24</sub> H <sub>31</sub> O <sub>6</sub> F	 C <sub>22</sub> H <sub>28</sub> O <sub>8</sub> FN <sub>2</sub> P
Molecular weight	392.5	434.5	516.4
Melting point (°C)	240 (dec.)	200 to 220 (dec.)	decomposes
Specific rotation	(α) <sub>D</sub> <sup>25</sup> +112 to +120 (100 mg. in 10 ml. dioxane)	(α) <sub>D</sub> <sup>25</sup> +120 to +128 (100 mg. in 10 ml. dioxane)	(α) <sub>D</sub> <sup>25</sup> +99 to +105 (100 mg. in 10 ml. water)
Absorption max.	239 m $\mu$ , E(1%, 1 cm) 390, methanol	239 m $\mu$ , methanol	241 m $\mu$ , water

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

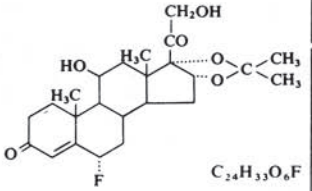
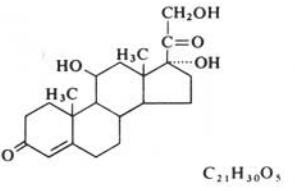
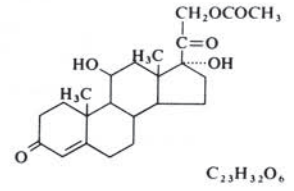
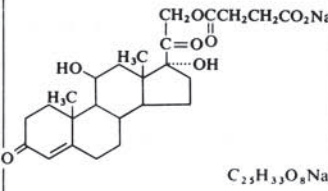
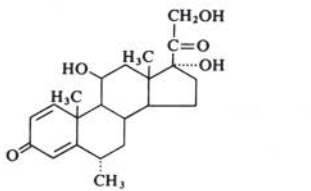
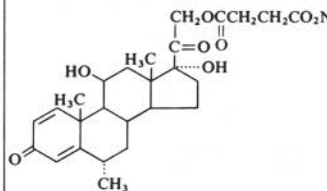
Names & synonyms:	<b>CHLOROPREDNISONE ACETATE;</b> 6 $\alpha$ -chloroprednisone acetate; 6 $\alpha$ -chloro- $\Delta^1$ - $\Delta^4$ -pregnadien-17 $\beta$ ,21-diol-3,11,20-trione 21-acetate.	<b>CORTICOSTERONE;</b> 11,21-dihydroxyprogesterone; $\Delta^4$ -pregnene-11 $\beta$ ,21-diol-3,20-dione; 11 $\beta$ ,21-dihydroxy-4-pregnene-3,20-dione; Kendall compound B; Reichstein substance H.	<b>CORTISONE;</b> 17-hydroxy-11-dehydrocorticosterone; 17 $\alpha$ ,21-dihydroxy-4-pregnene-3,11,20-trione; $\Delta^4$ -pregnene-17 $\alpha$ ,21-diol-3,11,20-trione; Kendall compound E; Wintersteiner compound F.
Formulae:	 <chem>CC(=O)O[C@@]12CC[C@H]3[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3(Cl)C</chem>	 <chem>OCC1=CC(=O)CC[C@]23[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3O</chem> $C_{21}H_{30}O_4$	 <chem>OCC1=CC(=O)CC[C@]23[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3O</chem> $C_{21}H_{28}O_5$
Molecular weight	436.6	346.40	360.4
Melting point (°C)	207–213	180–182	220–224
Specific rotation	$(\alpha) \frac{25}{D} + 137$ to $+ 142$ (100 mg. in 10 ml. chloroform)	$(\alpha) \frac{15}{D} + 222$ (110 mg. in 10 ml. alcohol)	$(\alpha) \frac{25}{D} + 209$ (120 mg. in 10 ml. alcohol)
Absorption max.		240 $m\mu$	237 $m\mu$
Names & synonyms:	<b>DESOXYCORTICOSTERONE;</b> deoxycorticosterone; 11-desoxycorticosterone; 21-hydroxyprogesterone; 4-pregnen-21-ol-3,20-dione; Kendall desoxy compound B; Reichstein substance Q.	<b>DESOXYCORTICOSTERONE ACETATE;</b> DCA; 11-desoxycorticosterone acetate.	<b>DESOXYCORTICOSTERONE PIVALATE;</b> desoxycorticosterone trimethylacetate; 21-hydroxy-4-pregnene-3,20-dione pivalate.
Formulae:	 <chem>OCC1=CC(=O)CC[C@]23[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3O</chem> $C_{21}H_{30}O_3$	 <chem>CC(=O)O[C@@]12CC[C@H]3[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3O</chem> $C_{23}H_{32}O_4$	 <chem>CC(C)(C)C(=O)O[C@@]12CC[C@H]3[C@@H]([C@@H]1CC[C@H]2O)C(=O)C=C[C@@]3O</chem> $C_{26}H_{38}O_4$
Molecular weight	330.2	372.4	414.6
Melting point (°C)	140–142	154–160	198–204
Specific rotation	$(\alpha) \frac{22}{D} + 176$ – $+ 178$ (100 mg. in 10 ml. alcohol)	$(\alpha) \frac{20}{D} + 168$ – $+ 178$ (100 mg. in 10 ml. dioxane)	$(\alpha) \frac{25}{D} + 157 \pm 4$ (1% in dioxane)
Absorption max.	240 $m\mu$		240 $m\mu$ (in ethanol)



**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

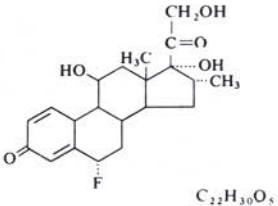
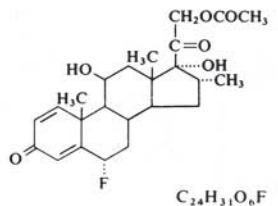
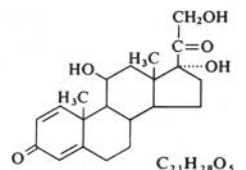
Names & synonyms:	DEXAMETHASONE; hexadecadrol; 9 $\alpha$ -fluoro-16 $\alpha$ -methyl prednisolone; 9 $\alpha$ -fluoro-11 $\beta$ ,17 $\alpha$ -21-trihydroxy-16 $\alpha$ -methyl-1,4-pregnadiene-3,20-dione; 16 $\alpha$ -methyl-9 $\alpha$ -fluoro-1,4-pregnadiene-11 $\beta$ ,17 $\alpha$ -21-triol-3,20-dione; 16 $\alpha$ -methyl-9 $\alpha$ -fluoro- $\Delta^1$ -hydrocortisone; 1-dehydro-16 $\alpha$ -methyl-9 $\alpha$ -fluorohydrocortisone.	DICHLORISONE ACETATE; 9 $\alpha$ -11 $\beta$ -dichloro-1,4-pregnadiene-17 $\alpha$ ,21-diol-3,20-dione-21-acetate	FLUOCINOLONE ACETONIDE; 6 $\alpha$ ,9 $\alpha$ -difluoro-16 $\alpha$ hydroxyprednisolone-16,17-acetonide; 6 $\alpha$ ,9 $\alpha$ -difluoro-16 $\alpha$ ,17 $\alpha$ -isopropylidenediosy-1,4-pregnadiene-3,20-dione.
Formulae:	 C <sub>22</sub> H <sub>29</sub> FO <sub>5</sub>	 C <sub>23</sub> H <sub>28</sub> O <sub>5</sub> Cl	 C <sub>24</sub> H <sub>30</sub> O <sub>6</sub> F <sub>2</sub>
Molecular weight	392.4	455.3	452.50
Melting point (°C)	262–264	235 (dec.)	255–266
Specific rotation	( $\alpha$ ) <sub>D</sub> <sup>25</sup> + 78 (100 mg. in 10 ml. dioxane)	( $\alpha$ ) <sub>D</sub> <sup>25</sup> + 160 – 168 (100 mg. in 10 ml. dioxane)	not less than +95° and not more than +105°C at 25°C.
Absorption max.		237 m $\mu$ – 316 – 337 ( $\epsilon$ )	237 m $\mu$ $\pm$ 1 m $\mu$
Names & synonyms:	FLUOROHYDROCORTISONE; fludrocortisone; 9 $\alpha$ -fluorohydrocortisone; 9 $\alpha$ -fluorocortisol; fluohydrisone; 9 $\alpha$ -fluoro-11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-4-pregnene-3,20-dione; 9 $\alpha$ -fluoro-17-hydroxycorticosterone.	FLUOROMETHOLONE; 9 $\alpha$ -fluoro-11 $\beta$ ,17 $\alpha$ -dihydroxy-6 $\alpha$ -methyl-1,4-pregnadiene-3,20-dione; 21-desoxy-9 $\alpha$ -fluoro-6 $\alpha$ -methyl-prednisolone.	FLUPREDNISOLONE; 6 $\alpha$ -fluoroprednisolone; 6 $\alpha$ -fluoro-1-dehydrohydrocortisone; 6 $\alpha$ -fluoro-11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-1,4-pregnadiene-3,20-dione.
Formulae:	 C <sub>21</sub> H <sub>29</sub> FO <sub>3</sub>	 C <sub>22</sub> H <sub>24</sub> FO <sub>4</sub>	 C <sub>21</sub> H <sub>27</sub> FO <sub>5</sub>
Molecular weight	380.4	376.4	378.4
Melting point (°C)	260–262 (dec.)	290 (dec.)	205–210
Specific rotation	( $\alpha$ ) <sub>D</sub> <sup>23</sup> + 139 (55 mg. in 10 ml. alcohol)	( $\alpha$ ) <sub>D</sub> <sup>25</sup> + 56 (pyridine)	( $\alpha$ ) <sub>D</sub> + 88 (dioxane)
Absorption max.		239 m $\mu$ ( $a_M = 15,050$ ) methanol	$\lambda_{max}$ 241.5 m $\mu$ ( $\epsilon$ 16,000)

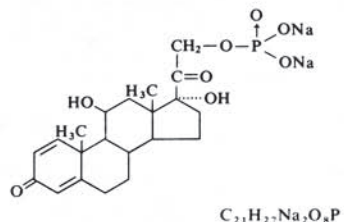
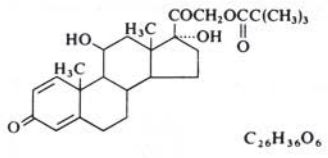
**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>FLURANDRENOLONE:</b> 6-fluoro-16 $\alpha$ -hydroxyhydrocortisone-16,17-acetonide; 6 $\alpha$ -fluoro-11 $\beta$ ,21-dehydroxy-16 $\alpha$ ,17 $\alpha$ -isopropylidenedioxy-pregna-4-ene-3,20-dione.	<b>HYDROCORTISONE:</b> cortisol; 17-hydroxycorticosterone; hydrocortisone free alcohol; 11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-4-pregnene-3,20-dione; 4-pregnene-11 $\beta$ ,17 $\alpha$ ,21-triol-3,20-dione; Kendall compound F; Reichstein substance M.	<b>HYDROCORTISONE ACETATE:</b> cortisol acetate; hydrocortisone-21-acetate; 17-hydroxycorticosterone-21-acetate.
Formulae:	 C <sub>24</sub> H <sub>33</sub> O <sub>6</sub> F	 C <sub>21</sub> H <sub>30</sub> O <sub>5</sub>	 C <sub>23</sub> H <sub>32</sub> O <sub>6</sub>
Molecular weight	436.5	362.5	404.5
Melting point (°C)	240–250	215–220 (dec.)	223 (dec.)
Specific rotation	( $\alpha$ ) <sub>D</sub> <sup>25</sup> = +145 (1% in CHCl <sub>3</sub> )	( $\alpha$ ) <sub>D</sub> <sup>25</sup> +150 – +156 (100 mg. in 10 ml. dioxane)	( $\alpha$ ) <sub>D</sub> <sup>25</sup> +158 – +165 (100 mg. in 10 ml. dioxane)
Absorption max.	236 m $\mu$ (methanol)	242 m $\mu$	242 m $\mu$ (methanol)
Names & synonyms:	<b>HYDROCORTISONE SODIUM SUCCINATE:</b> 11 $\beta$ , 17 $\alpha$ , 21-trihydroxy-4-pregnene-3,20-dione, 21 hydrogen succinate, sodium salt; hydrocortisone, 21 hydrogen succinate, sodium salt.	<b>METHYLPREDNISOLONE:</b> 6 $\alpha$ -methylprednisolone; $\Delta^1$ -6 $\alpha$ -methylhydrocortisone; 1-dehydro-6 $\alpha$ -methylhydrocortisone; 11 $\beta$ , 17 $\alpha$ ,21-trihydroxy-6 $\alpha$ -methyl-1,4-pregnadiene-3,20-dione.	<b>METHYLPREDNISOLONE SODIUM SUCCINATE:</b> 1-dehydro-6 $\alpha$ -methylhydrocortisone, 21-hydrogen succinate, sodium salt; 6 $\alpha$ -methylprednisolone 21-hydrogen succinate, sodium salt; 11 $\beta$ , 17 $\alpha$ , 21-trihydroxy-6 $\alpha$ -methyl-1,4-pregnadiene-3, 20-dione, 21-hydrogen succinate, sodium salt.
Formulae:	 C <sub>25</sub> H <sub>33</sub> O <sub>8</sub> Na	 C <sub>22</sub> H <sub>30</sub> O <sub>5</sub>	 C <sub>26</sub> H <sub>33</sub> O <sub>8</sub> Na
Molecular weight	484.5	374.5	496.5
Melting point (°C)	decomposes	230–240 (dec.)	decomposes
Specific rotation	( $\alpha$ ) <sub>D</sub> +140 $\pm$ 5 (alcohol)	( $\alpha$ ) <sub>D</sub> <sup>25</sup> +85 (dioxane)	( $\alpha$ ) <sub>D</sub> +100 $\pm$ 4 (alcohol)
Absorption max.	$\lambda$ 242 m $\mu$ ( $\epsilon$ 15,700)	243 m $\mu$	$\lambda$ max 242 m $\mu$ ( $\epsilon$ 14,500)

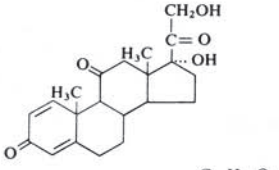
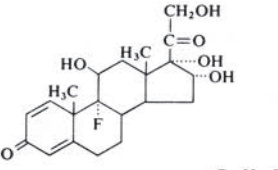
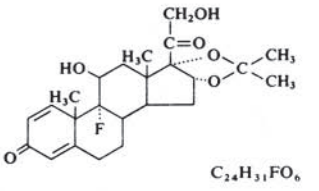
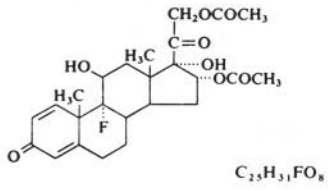


**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	PARAMETHASONE; 6 $\alpha$ -fluoro-16 $\alpha$ -methylprednisolone; 6 $\alpha$ -fluoro-11 $\beta$ -17 $\alpha$ ,21-trihydroxy-16 $\alpha$ -methyl-1,4-pregnadiene-3,20-dione.	PARAMETHASONE ACETATE; 6 $\alpha$ -fluoro-16 $\alpha$ -methylprednisolone-21-acetate; 6 $\alpha$ -fluoro-16 $\alpha$ -methylpregna-1,4-diene-11 $\beta$ ,21-diol-3,20-dione-21-acetate; 6 $\alpha$ -fluoro-17 $\beta$ ,17 $\alpha$ ,21-trihydroxy-16 $\alpha$ -methyl-1,4-pregnadiene-3,20-dione-21-acetate.	PREDNISOLONE; metacortandralone; $\Delta^1$ -dehydrocortisol; delta F; $\Delta^1$ -hydrocortisone; $\Delta^1$ -dehydrohydrocortisone; 1,4-pregnadiene-3,20-dione-11 $\beta$ ,17 $\alpha$ ,21-triol; 11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-1,4-pregnadiene-3,20-dione.
Formulae:	 C <sub>22</sub> H <sub>30</sub> O <sub>5</sub>	 C <sub>24</sub> H <sub>31</sub> O <sub>6</sub> F	 C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>
Molecular weight	392.45	434.5	360.4
Melting point (°C)	228–241	233–246	240 (dec.)
Specific rotation	+59 to +69 at 25°C	( $\alpha$ ) $\frac{25}{D} + 72$ (1% in CHCl <sub>3</sub> )	( $\alpha$ ) $\frac{25}{D} + 97 - +103$ (100 mg. in 10 ml. dioxane)
Absorption max.	242 m $\mu$	242 m $\mu$ (methanol)	242 m $\mu$ ( $\epsilon = 15,000$ ) methanol

Names & synonyms:	PREDNISOLONE PHOSPHATE SODIUM; disodium prednisolone 21-phosphate.	PREDNISOLONE PIVALATE; prednisolone trimethylacetate; 11 $\beta$ ,17 $\alpha$ ,21-trihydroxy-1,4-pregnadiene-3,20-dione 21-pivalate.
Formulae:	 C <sub>21</sub> H <sub>27</sub> Na <sub>2</sub> O <sub>8</sub> P	 C <sub>26</sub> H <sub>36</sub> O <sub>6</sub>
Molecular weight	484.4	444.6
Melting point (°C)		229
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 102.5$ (100 mg. in 10 ml. H <sub>2</sub> O)	+108 $\pm$ 4 (1% in dioxane)
Absorption max.	243 m $\mu$	240 and 263 m $\mu$ (in absolute ethanol)

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>PREDNISON:</b> metacortandricin; $\Delta^1$ -dehydrocortisone; delta E; $\Delta^1$ -cortisone; 1,4-pregnadiene-17 $\alpha$ ,21-diol-3,11,20-trione; 17 $\alpha$ ,21-dihydroxy-1,4-pregnadiene-3,11,20-trione.	<b>TRIAMCINOLONE:</b> 9 $\alpha$ -fluoro-16 $\alpha$ -hydroxyprednisolone; 9 $\alpha$ -fluoro-11 $\beta$ ,16 $\alpha$ ,17 $\alpha$ ,21-tetrahydroxy-1,4-pregnadiene-3,20-dione.
Formulae:	 $C_{21}H_{26}O_5$	 $C_{21}H_{26}FO_6$
Molecular weight	358.4	394.4
Melting point (°C)	225 (dec.)	260–262.5 (dec.)
Specific rotation	$(\alpha) \frac{25}{D} + 167 - +175$ (100 mg. in 10 ml. dioxane)	$(\alpha) \frac{25}{D} + 75$ (200 mg. in 100 ml. acetone)
Absorption max.	239 $m\mu$ ( $\epsilon = 15,500$ ) methanol	238 $m\mu$ ( $\epsilon = 15,800$ )
Names & synonyms:	<b>TRIAMCINOLONE ACETONIDE:</b> 9 $\alpha$ -fluoro-11 $\beta$ ,21-dihydroxy-16 $\alpha$ ,17 $\alpha$ -isopropylidenedioxy-1,4-pregnadiene-3,20-dione; 9 $\alpha$ -fluoro-16 $\alpha$ -hydroxyprednisolone 16,17-acetonide.	<b>TRIAMCINOLONE DIACETATE:</b> 16 $\alpha$ ,21-diacetoxy-9 $\alpha$ -fluoro-11 $\beta$ ,17 $\alpha$ -dihydroxy-1,4-pregnadiene-3,20-dione; 9 $\alpha$ -fluoro-16 $\alpha$ -hydroxyprednisolone 16,21-diacetate.
Formulae:	 $C_{24}H_{31}FO_6$	 $C_{25}H_{31}FO_8$
Molecular weight	434.4	478.49
Melting point (°C)	274–278 (dec.); 292–294	variable: 158–235
Specific rotation	$(\alpha) \frac{25}{D} + 109 - +112$ (53.7 mg. in 10 ml. chloroform)	$(\alpha) \frac{25}{D} + 22$ (78.8 mg. in 10 ml. chloroform)
Absorption max.	238–239 $m\mu$ ( $\epsilon = 14,600$ )	239 $m\mu$ ( $\epsilon = 15,200$ )

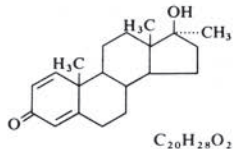
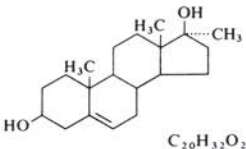
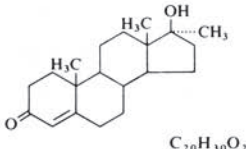
**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

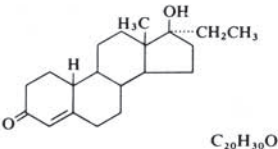
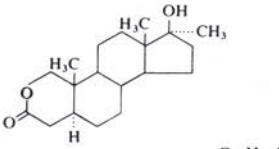
**ANDROGENS AND ANABOLIC AGENTS**

Names & synonyms:	<b>ANDROSTERONE:</b> cis-androsterone; 3 $\alpha$ -hydroxy-17-androstanone; androstane-3 $\alpha$ -ol-17-one.	<b>FLUOXYMESTERONE:</b> 9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-17 $\alpha$ -methyltestosterone 9 $\alpha$ -fluoro-11 $\beta$ ,17 $\beta$ -dihydroxy-17 $\alpha$ -methyl-4-androsten-3-one.	<b>ALDOSTERONE:</b> electrocortin; 18-oxocorticosterone; 18-formyl-11 $\beta$ ,21-dihydroxy-4-pregnene-3,20-dione.
Formulae:	 <chem>C19H30O2</chem>	 <chem>C20H28FO3</chem>	 <chem>C21H28O5</chem>
Molecular weight	290.4	336.4	360.4
Melting point (°C)	185–185.5	270 (dec.)	108–112 (hydrate); 164 (anhydrous)
Specific rotation	( $\alpha$ ) $\frac{15}{D} + 85 - +90$ (150 mg. in 10 ml. dioxane)	( $\alpha$ ) $\frac{25}{D} + 107 - +109$ (alcohol)	( $\alpha$ ) $\frac{25}{D} + 161$ (10 mg. in 10 ml. chloroform)
Absorption max.		240 m $\mu$ ( $\epsilon = 16,700$ ) alcohol	240 m $\mu$ (log $\epsilon = 4.20$ monohydr.; $\epsilon$ mol. 15,000 anhydr.)

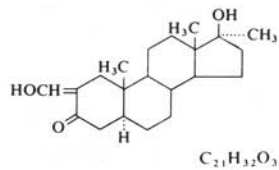
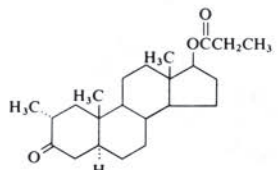
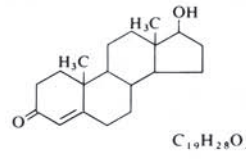
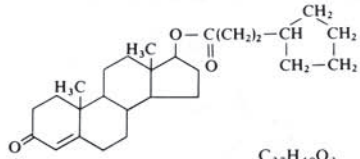
Names & synonyms:	<b>HYDROXYDIONE SODIUM:</b> 21-hydroxypregnane-3,20-dione-21-sodium hemisuccinate.	<b>SPIRONOLACTONE:</b> 3-(3-oxo-7 $\alpha$ -acetylthio-17 $\beta$ -hydroxy-4-androsten-17 $\alpha$ -yl)-propionic acid ; lactone.
Formulae:	 <chem>C25H35O6Na</chem>	 <chem>C24H32O4S</chem>
Molecular weight	454.5	416.5
Melting point (°C)	193–203 (dec.)	135 (preliminary)–202 (dec.)
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 95$ (chloroform) for free acid.	( $\alpha$ ) $\frac{25}{D} - 34$ (chloroform)
Absorption max.	280 m $\mu$ ( $\epsilon = 93.2$ )	$\epsilon^{238} = 20,200$

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>METHANDROSTENOLONE:</b> 17 $\alpha$ -methyl-17 $\beta$ -hydroxy-1,4-androstadien-3-one.	<b>METHYLANDROSTENEDIOL:</b> MAD; methandirol; 17 $\alpha$ -methyl-5-androsten-3 $\beta$ ,17 $\beta$ -diol.	<b>METHYL TESTOSTERONE:</b> 17-methyl testosterone; 17 $\alpha$ -methyl- $\Delta^4$ -androsten-17- $\beta$ -ol-3-one; 17( $\beta$ )-hydroxy-17( $\alpha$ -methyl-4-androsten-3-one.
Formulae:	 C <sub>20</sub> H <sub>28</sub> O <sub>2</sub>	 C <sub>20</sub> H <sub>32</sub> O <sub>2</sub>	 C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>
Molecular weight	300.4	304.4	302.4
Melting point (°C)	166–167	205–207	161–166
Specific rotation	( $\alpha$ ) $\frac{20}{D} + 9 - + 17$ (100 mg. in 10 ml. alcohol)	( $\alpha$ ) $\frac{20}{D} - 73$ (100 mg. in 10 ml. alcohol)	( $\alpha$ ) $\frac{25}{D} + 69 - + 75$ (100 mg. in 10 ml. dioxane)
Absorption max.			

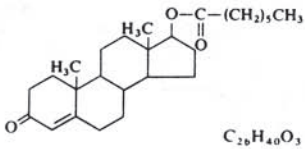
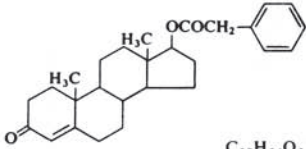
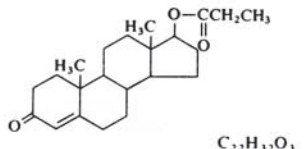
Names & synonyms:	<b>NORETHANDROLONE:</b> 17 $\alpha$ -ethyl-19-nortestosterone; 17 $\alpha$ -ethyl-17-hydroxy-4-norandrosten-3-one; 17 $\alpha$ -ethyl-17-hydroxy-19-norandrost-4-en-3-one.	<b>OXANDROLONE:</b> 17 $\beta$ -hydroxy-17 $\alpha$ -methyl-2-oxa-5 $\alpha$ -androstan-3-one.
Formulae:	 C <sub>20</sub> H <sub>30</sub> O <sub>2</sub>	 C <sub>18</sub> H <sub>30</sub> O <sub>3</sub>
Molecular weight	302.4	306.4
Melting point (°C)	130–136	230–233
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 21$ (dioxane)	( $\alpha$ ) $\frac{25}{D} - 21$ (1% in chloroform)
Absorption max.	240 m $\mu$ ( $\epsilon = 16,500$ )	None

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

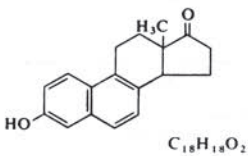
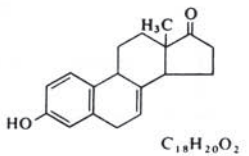
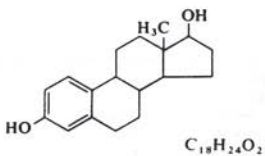
Names & synonyms:	<b>OXYMETHOLONE:</b> 17 $\beta$ -hydroxy-2-hydroxymethylene-17 $\alpha$ -methyl-3-androstanone; 2-hydroxymethylene-17- $\alpha$ -methyl dihydrotestosterone.	<b>PROMETHOLONE:</b> 2 $\alpha$ -methyl-dihydro-testosterone propionate; 2 $\alpha$ -methyl-5 $\alpha$ -androstan-17 $\beta$ -ol-3-one-propionate.
Formulae:	 $C_{21}H_{32}O_3$	 $C_{27}H_{40}O_3$
Molecular weight	332.4	360.5
Melting point (°C)	182	124–130
Specific rotation	$(\alpha)_{25}^D = +36$ (200 mg. in 10 ml. dioxane)	$(\alpha)_{25}^D +22 - +29$ (200 mg. in 10 ml. chloroform)
Absorption max.	$E_{1\%}^1 = 547$ at 315 m $\mu$ (in alkaline methanol made 0.01 N with NaOH)	without significant absorption from 220–300 m $\mu$ (methanol)
Names & synonyms:	<b>TESTOSTERONE:</b> trans-testosterone; $\Delta^4$ -androst-17- $\beta$ -ol-3-one; 17 $\beta$ -hydroxy-4-androsten-3-one.	<b>TESTOSTERONE CYPIONATE:</b> testosterone cyclopentylpropionate; 17 $\beta$ -hydroxy-4-androsten-3-one, cyclopentanepropionate.
Formulae:	 $C_{19}H_{28}O_2$	 $C_{27}H_{40}O_3$
Molecular weight	288.4	412.6
Melting point (°C)	151–156	100–102
Specific rotation	$(\alpha)_{24}^D +109$ (400 mg. in 10 ml. alcohol)	$(\alpha)_{20} +88.5 \pm 3.5$ (CHCl <sub>3</sub> )
Absorption max.	238 m $\mu$	$\lambda_{max} 241$ m $\mu$ ( $\epsilon$ 16,125)



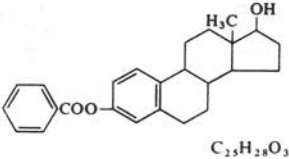
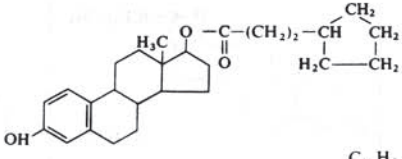
### STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)

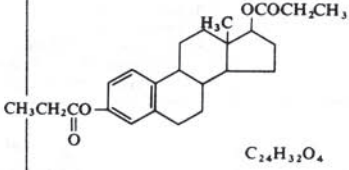
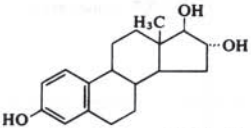
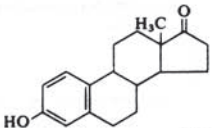
Names & synonyms:	TESTOSTERONE ENANTHATE; testosterone heptanoate; 17 $\beta$ -hydroxyandrost-4-en-3-one-17- enanthate.	TESTOSTERONE PHENYLACETATE; 17 $\beta$ -hydroxy-4-androsten-3-one phenyl- acetate; testosterone $\alpha$ -toluate.	TESTOSTERONE PROPIONATE; $\Delta^4$ -androstene-17- $\beta$ -propionate-3-one.
Formulae:	 $C_{28}H_{40}O_3$	 $C_{27}H_{34}O_3$	 $C_{22}H_{32}O_3$
Molecular weight	400.6	406.5	344.4
Melting point (°C)	34–39	129–131	118–122
Specific rotation	$(\alpha) \frac{25}{D} + 77 - + 82$ (2% in dioxane)	$(\alpha) \frac{25}{D} + 101 \pm 3$ (1% in chloroform)	$(\alpha) \frac{25}{D} + 83 - + 90$ (100 mg. in 10 ml. dioxane)
Absorption max.	241 m $\mu$ (in ethanol)	241 m $\mu$ (in ethanol)	

### ESTROGENS

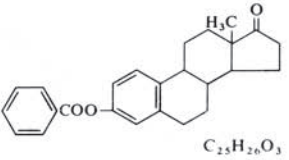
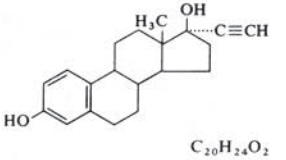
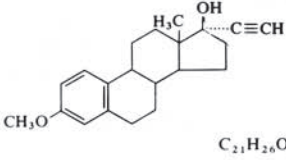
Names & synonyms:	EQUILENIN; 3-hydroxy-17-keto- $\Delta^{1,3,5-10,6,8}$ estrapentaene; 1,3,5-10,6,8-estrapentaen-3- ol-17-one.	EQUILIN; 3-hydroxy-17-keto- $\Delta^{1,3,5-10,7}$ estratetraene; 1,3,5,7-estratetraen-3-ol-17-one.	ESTRADIOL (formerly called $\alpha$ -estradiol); $\beta$ -estradiol; dihydrofolliculin; dihydroxyestrin; 1,3,5-estratriene-3,17 $\beta$ -diol; 3,17-dihydroxy- $\Delta^{1,3,5-10}$ -estratriene; 3,17-epidihydroxyestratriene.
Formulae:	 $C_{18}H_{16}O_2$	 $C_{18}H_{20}O_2$	 $C_{18}H_{24}O_2$
Molecular weight	266.3	268.3	272.3
Melting point (°C)	258–259	236–240	173–179
Specific rotation	$(\alpha) \frac{25}{D} + 89$ (dioxane)	$(\alpha) \frac{25}{D} + 308$ (200 mg. in 10 ml. dioxane); $+ 325$ (200 mg. in 10 ml. alcohol).	$(\alpha) \frac{25}{D} + 76 - + 83$ (100 mg. in 10 ml. dioxane)
Absorption max.	231, 270, 282, 292, 325, 340 m $\mu$	283–285 m $\mu$	225, 280 m $\mu$

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

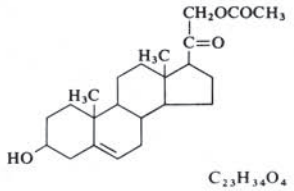
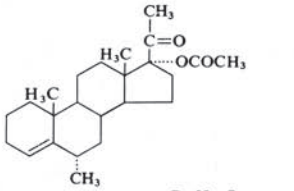
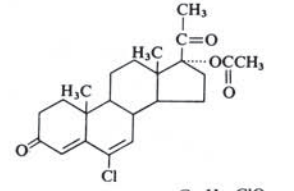
Names & synonyms:	<b>ESTRADIOL BENZOATE;</b> β-estradiol-3-benzoate; estradiol monobenzoate.	<b>ESTRADIOL CYPIONATE;</b> estradiol cyclopentylpropionate; β-estradiol 17-cyclopentanepronate; 1,3,5(10)-estratriene-3,17β-diol,17-cyclopentanepronate.
Formulae:	 C <sub>25</sub> H <sub>28</sub> O <sub>3</sub>	 C <sub>26</sub> H <sub>34</sub> O <sub>3</sub>
Molecular weight	376.4	396.6
Melting point (°C)	191–196	151–154
Specific rotation	(α) <sub>D</sub> <sup>25</sup> + 58 – + 63 (200 mg. in 10 ml. dioxane)	(α) <sub>D</sub> + 41.5 ± 3.5 (dioxane)
Absorption max.		223 mμ

Names & synonyms:	<b>ESTRADIOL DIPROPIONATE;</b> α-estradiol dipropionate; 17β-estradiol dipropionate.	<b>ESTRIOL;</b> trihydroxyestrin; Δ <sup>1,3,5-10</sup> -estratriene-3-16-cis-17-trans-diol; 1,3,5-estratriene-3,16α,17β-triol.	<b>ESTRONE;</b> folliculin; ketohydroxyestrin; 1,3,5-estratrien-3-ol-17-one.
Formulae:	 C <sub>24</sub> H <sub>32</sub> O <sub>4</sub>	 C <sub>18</sub> H <sub>24</sub> O <sub>3</sub>	 C <sub>18</sub> H <sub>22</sub> O <sub>2</sub>
Molecular weight	384.5	288.3	270.3
Melting point (°C)	104–109	282	258–262
Specific rotation	(α) <sub>D</sub> <sup>25</sup> + 39 ± 2 (1% in dioxane)	(α) <sub>D</sub> <sup>25</sup> + 53 – + 63 (40 mg. in 1 ml. dioxane)	(α) <sub>D</sub> <sup>25</sup> + 158 – + 168 (100 mg. in 10 ml. dioxane)
Absorption max.	268 mμ	280 mμ	283–285 mμ

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

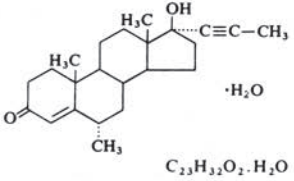
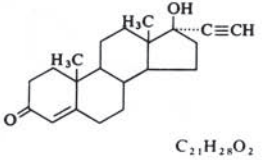
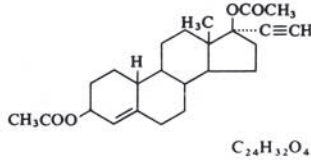
Names & synonyms:	ESTRONE BENZOATE	ETHYNYL ESTRADIOL; 17-ethynyl estradiol; 17 $\alpha$ -ethynyl-1,3,5-estratriene-3,17 $\beta$ -diol.	MESTRANOL; ethynylestradiol 3-methyl ether; 3-methoxy-17 $\alpha$ -ethynyl-1,3,5(10)- estratriene-17 $\beta$ -ol; 17 $\alpha$ -ethynyl-estradiol-3-methyl ether; 3-methoxy-19-nor-17 $\alpha$ -pregna-1,3,5,10- trien-20-yn-17-ol.
Formulae:	 C <sub>25</sub> H <sub>26</sub> O <sub>3</sub>	 C <sub>20</sub> H <sub>24</sub> O <sub>2</sub>	 C <sub>21</sub> H <sub>26</sub> O <sub>2</sub>
Molecular weight	374.4	296.4	310.4
Melting point (°C)	220	141–146	148–154
Specific rotation	( $\alpha$ ) $\frac{25}{D}$ + 120 (dioxane)	( $\alpha$ ) $\frac{25}{D}$ + 1 – + 10 (100 mg. in 10 ml. dioxane)	( $\alpha$ ) $\frac{25}{D}$ + 2 to + 8 (200 mg. in 10 ml. dioxane)
Absorption max.		248 m $\mu$	278 to 287 m $\mu$ (methanol)

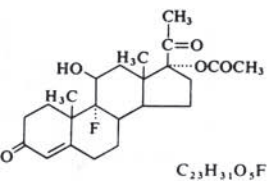
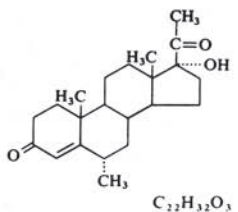
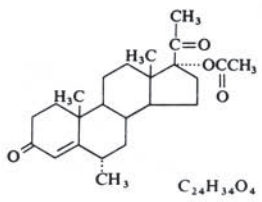
**PROGESTOGENS AND PROGESTINS (INCLUDING 19-NORSTEROID COMPOUNDS)**

Names & synonyms:	ACETOXPREGNENOLONE; 21-acetoxypregnenolone; prebediolone acetate; $\Delta^5$ -pregnene-3 $\beta$ ,21-diol-20-one-21- monoacetate; 21-acetoxy-5-pregnene-3-ol-20-one; 3-hydroxy-21-acetoxy-5-pregnen-20-one.	ANAGESTONE ACETATE; 6 $\alpha$ -methyl-4-pregnen-17 $\alpha$ -ol-20-one acetate; 17 $\alpha$ -acetoxy-6 $\alpha$ -methylpregn-4-en-20-one; 17 $\alpha$ -acetoxy-6 $\alpha$ -methyl-4-pregnen-20-one.	CHLORMADINONE ACETATE; 6-chloro- $\Delta^6$ -dehydro-17 $\alpha$ - acetoxyprogesterone; 6-chloro- $\Delta^4,6$ -pregnadiene-17 $\alpha$ -ol- 3,20-dioneacetate.
Formulae:	 C <sub>23</sub> H <sub>34</sub> O <sub>4</sub>	 C <sub>24</sub> H <sub>36</sub> O <sub>3</sub>	 C <sub>23</sub> H <sub>29</sub> ClO <sub>4</sub>
Molecular weight	374.5	372.6	404.9
Melting point (°C)	184–185	172–178	204–212
Specific rotation	( $\alpha$ ) $\frac{20}{D}$ + 37 – + 43 (dioxane)	( $\alpha$ ) $\frac{25}{D}$ + 40 to + 45 (10 mg. in 10 ml. chloroform)	( $\alpha$ ) $\frac{25}{D}$ 0 to – 6 (200 mg. in 10 ml. chloroform)
Absorption max.			284 m $\mu$ (methanol) Log $\epsilon$ = 4.34 $\pm$ 0.02

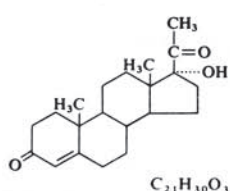
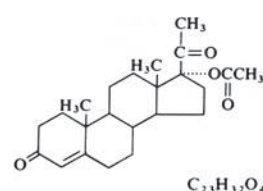
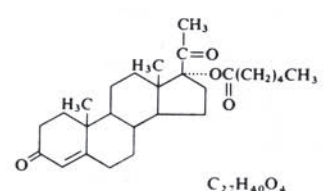
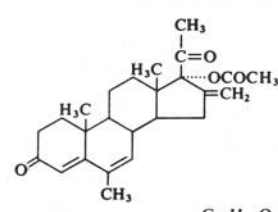


**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

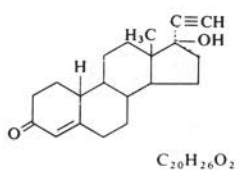
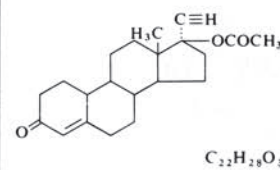
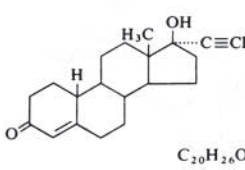
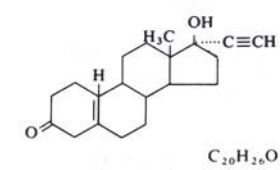
Names & synonyms:	<b>DIMETHISTERONE;</b> 6 $\alpha$ ,21-dimethylethisterone; 6 $\alpha$ ,21-dimethyl-17 $\beta$ -hydroxy-17 $\alpha$ -pregn-4-en-20-yn-3-one; 6 $\alpha$ -methyl-17 $\alpha$ -propynylandrost-4-en-17 $\beta$ -ol-3-one; 17 $\beta$ -hydroxy-6 $\alpha$ -methyl-17 $\alpha$ -(prop-1-ynyl)-androst-4-ene-3-one.	<b>ETHISTERONE;</b> anhydrohydroxyprogesterone; ethinyl testosterone; pregneninolone; 17 $\alpha$ ethynyl testosterone; 17 $\alpha$ -ethynyl-17 $\beta$ -hydroxy-4-androsten-3-one.	<b>ETHYNODIOL DIACETATE;</b> 17 $\alpha$ -ethynyl-4-estrene-3 $\beta$ ,17 $\beta$ -diol-17-diacetate; 19-nor-17 $\alpha$ -pregn-4-en-20-yne-3 $\beta$ ,17-diol diacetate.
Formulae:	 $C_{23}H_{32}O_2 \cdot H_2O$	 $C_{21}H_{28}O_2$	 $C_{24}H_{32}O_4$
Molecular weight	358.5	312.4	384.5
Melting point (°C)	App. 100 (dec.)	266–273	126–132
Specific rotation	( $\alpha$ ) $\frac{20}{D} + 16.5$ to $+ 18.5$ (2% solution in chloroform) (calculated to the anhydrous basis)	( $\alpha$ ) $\frac{25}{D} - 32^\circ$ (100 mg. in 10 ml. pyridine)	( $\alpha$ ) $\frac{25}{D} - 74$ (1% in chloroform)
Absorption max.	App. 240 m $\mu$ (anhydrous ethanol) $E_{1\%}^{1\text{cm}} = 443$	241 m $\mu$ (methanol)	None

Names & synonyms:	<b>FLUROGESTONE ACETATE;</b> 17 $\alpha$ -acetoxy-9 $\alpha$ -fluoro-11 $\beta$ -hydroxy-4-pregnene-3,20-dione.	<b>HYDROXYMETHYLPROGESTERONE;</b> medroxyprogesterone; 17 $\alpha$ -hydroxy-6 $\alpha$ -methylprogesterone; 17 $\alpha$ -hydroxy-6 $\alpha$ -methyl-4-pregnene-3,20-dione.	<b>HYDROXYMETHYLPROGESTERONE ACETATE;</b> medroxyprogesterone acetate; 17 $\alpha$ -hydroxy-6 $\alpha$ -methylprogesterone acetate; 17 $\alpha$ -hydroxy-6 $\alpha$ -methyl-4-pregnene-3,20-dione acetate.
Formulae:	 $C_{23}H_{31}O_5F$	 $C_{22}H_{32}O_3$	 $C_{24}H_{34}O_4$
Molecular weight	406.5	344.5	386.5
Melting point (°C)	250–251	220–223.5	202–207
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 78$	( $\alpha$ ) $\frac{25}{D} + 75$	( $\alpha$ ) $\frac{25}{D} + 51$ (dioxane)
Absorption max.	238 m $\mu$ ( $\epsilon = 17,100$ )	241 m $\mu$ ( $\epsilon = 16,150$ )	241 m $\mu$ ( $\alpha_M = 16,500$ ) ethanol

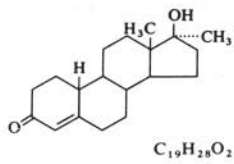
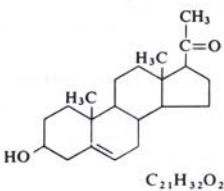
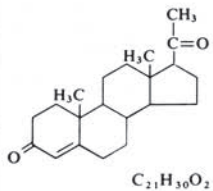
**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>HYDROXYPROGESTERONE:</b> 17 $\alpha$ -hydroxyprogesterone; 17 $\alpha$ -hydroxy-4-pregene-3,20 dione; 4-pregnen-17 $\alpha$ -ol-3,20-dione.	<b>HYDROXYPROGESTERONE ACETATE:</b> 17 $\alpha$ -acetoxyprogesterone; 17 $\alpha$ -hydroxyprogesterone acetate; 17 $\alpha$ -hydroxy-4-pregene-3,20 dione acetate.
Formulae:	 $C_{21}H_{30}O_3$	 $C_{23}H_{32}O_4$
Molecular weight	330.4	372.5
Melting point (°C)	276	249–250
Specific rotation	( $\alpha$ ) $\frac{17}{D}$ + 105 (104 mg. in 10 ml. chloroform)	( $\alpha$ ) $\frac{25}{D}$ + 72 (chloroform)
Absorption max.		240 m $\mu$ ( $a_M = 16,875$ ) ethanol
Names & synonyms:	<b>HYDROXYPROGESTERONE CAPROATE:</b> 17 $\alpha$ -hydroxyprogesterone caproate; 17 $\alpha$ -hydroxy-4-pregene-3,20-dione caproate.	<b>MELENGESTROL ACETATE: MGA:</b> 17 $\alpha$ -hydroxy-6-methyl-16-methylene-4,6-pregnadiene-3,20-dione acetate; 6-dehydro-17-hydroxy-6-methyl-16-methylene-progesterone acetate.
Formulae:	 $C_{27}H_{40}O_4$	 $C_{25}H_{32}O_4$
Molecular weight	428.6	396.51
Melting point (°C)	121–123	215–227
Specific rotation	( $\alpha$ ) $\frac{25}{D}$ + 57 (chloroform)	( $\alpha$ ) <sub>D</sub> – 127 to – 135 (in CHCl <sub>3</sub> )
Absorption max.		288 m $\mu$ ( $\epsilon_1^1 = 24,000$ ) (ethanol)

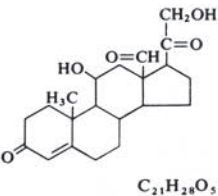
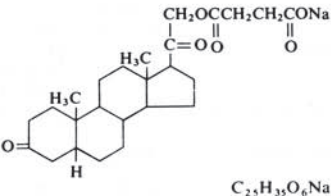
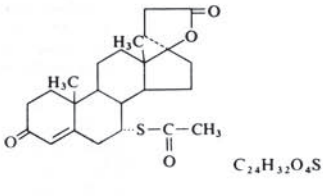
**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>NORETHINDRONE:</b> Norethisterone; 17 $\alpha$ -ethynyl-19-nortestosterone; 17 $\alpha$ -ethynyl-17-hydroxy-19-nor-17 $\alpha$ -4-en-20-yn-3-one.	<b>NORETHINDRONE ACETATE:</b> 17 $\alpha$ -ethynyl-19-nortestosterone acetate.
Formulae:	 <chem>C20H26O2</chem>	 <chem>C22H28O3</chem>
Molecular weight	298.4	340.4
Melting point (°C)	202 and 208	157-163
Specific rotation	( $\alpha$ ) $\frac{25}{D}$ - 30 - - 35 (200 mg. in 10 ml. dioxane)	( $\alpha$ ) $\frac{25}{D}$ - 32 - - 35 (200 mg. in 10 ml. dioxane)
Absorption max.	$\alpha$ (1 %, 1 cm.) $\lambda$ 240 = 535 $\pm$ 15	$\alpha$ (1 %, 1 cm.) $\lambda$ 240 = 490 to 520 (505 $\pm$ 15) (ethanol)
Names & synonyms:	<b>NORETHISTERONE:</b> norethindrone; 19-norethisterone; 17 $\alpha$ -ethynyl-19-nor- $\Delta^4$ -androstan-17 $\beta$ -ol-3-one; 17 $\alpha$ -ethynyl-19-nor-testosterone; 17-hydroxy-3-oxo-19-nor-17 $\alpha$ -pregn-4-ene-20-yne; 17-hydroxy-19-nor-17 $\alpha$ -pregn-4-en-20-yn-3-one.	<b>NORETHYNODREL:</b> 17 $\alpha$ -ethynyl-17 $\beta$ -hydroxy-5(10)-estren-3-one.
Formulae:	 <chem>C20H26O2</chem>	 <chem>C20H26O2</chem>
Molecular weight	298.4	298.4
Melting point (°C)	200-207	174-184
Specific rotation	( $\alpha$ ) $\frac{25}{D}$ - 30 - - 38 (200 mg. in 10 ml. dioxane)	( $\alpha$ ) $\frac{25}{D}$ + 125 (dioxane)
Absorption max.	240 m $\mu$ ( $\epsilon_1^1$ = 576)	

**STEROID HORMONES AND OTHER STEROIDAL SYNTHETICS (Continued)**

Names & synonyms:	<b>NORMETHISTERONE:</b> 19-normethisterone; normethandrolone; metalutin; normetandrone; 17 $\alpha$ -methyl-19-nor- $\Delta^4$ -androstene-17 $\beta$ -ol-3-one; 17 $\alpha$ -methyl-19-nor-testosterone; 17 $\beta$ -hydroxy-3-oxo-17 $\alpha$ -methyl-estra-4-ene; 17 $\beta$ -hydroxy-17-methyl-estr-4-en-3-one.	<b>PREGNENOLONE:</b> $\Delta^5$ -pregnenolone; $\Delta^5$ -pregnen-3 $\beta$ -ol-20-one; 17 $\beta$ (1-ketoethyl)- $\Delta^5$ -androstene-3 $\beta$ -ol.	<b>PROGESTERONE:</b> progestin; progestone; pregnendione; $\Delta^4$ -pregnene-3,20-dione.
Formulae:	 C <sub>19</sub> H <sub>28</sub> O <sub>2</sub>	 C <sub>21</sub> H <sub>32</sub> O <sub>2</sub>	 C <sub>21</sub> H <sub>30</sub> O <sub>2</sub>
Molecular weight	288.4	308.4	314.4
Melting point (°C)	153–158	193	( $\beta$ ) isomer 121; ( $\alpha$ ) isomer 127–131
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 25$ to $+29$ (200 mg. in 10 ml. chloroform)	( $\alpha$ ) $\frac{20}{D} + 28 - +30$ (alcohol)	( $\alpha$ ) $\frac{20}{D} + 172 - +182$ (200 mg. in 10 ml. dioxane)
Absorption max.	241 m $\mu$ – 565 $\pm$ 15		240 m $\mu$

**DIURETIC, ANTIDIURETIC AND LOCAL ANESTHETIC AGENTS**

Names & synonyms:	<b>ALDOSTERONE:</b> electrocortin; 18-oxocorticosterone; 18-formyl-11 $\beta$ ,21-dihydroxy-4-pregnene-3,20-dione.	<b>HYDROXYDIONE SODIUM:</b> 21-hydroxypregnane-3,20-dione-21-sodium hemisuccinate.	<b>SPIRONOLACTONE:</b> 3-(3-oxo-7 $\alpha$ -acetylthio-17 $\beta$ -hydroxy-4-androsten-17 $\alpha$ -yl)-propionic acid $\gamma$ lactone.
Formulae:	 C <sub>21</sub> H <sub>28</sub> O <sub>5</sub>	 C <sub>25</sub> H <sub>35</sub> O <sub>6</sub> Na	 C <sub>24</sub> H <sub>32</sub> O <sub>4</sub> S
Molecular weight	360.4	454.5	416.5
Melting point (°C)	108–112 (hydrate); 164 (anhydrous)	193–203 (dec.)	135; 202 (dec.)
Specific rotation	( $\alpha$ ) $\frac{25}{D} + 161$ (10 mg. in 10 ml. chloroform)	( $\alpha$ ) $\frac{25}{D} + 95$ (chloroform) for free acid.	( $\alpha$ ) $\frac{25}{D} - 34$ (chloroform)
Absorption max.	240 m $\mu$ (log $\epsilon = 4.20$ monohydr.; $\epsilon$ mol. 15,000 anhydr.)	280 m $\mu$ ( $\epsilon = 93.2$ )	$\epsilon^{238} = 20,200$



# SURFACE TENSION OF LIQUID ELEMENTS

## Gernot Lang

The following data were collected from many sources. As a result their accuracy varies. Users of data in this table are advised that:

1. As a rule, results from the "sessile drop" and "maximum bubble pressure" as well as from the "pendant drop" methods are preferable to results obtained from other methods for metals with very high melting points.
2. Values of single measurements are usually not as well supported by experiments as those of serial measurements at various temperatures.
3. Values in parentheses can be considered improbable.

The units of  $\sigma$  are mN/m.

Values of $\sigma$ at various temperatures													
Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	Method	Year	Ref.	
Ag	99.99		H <sub>2</sub>	1000	916					Bubble pressure	1959	134	
	—	(785)	vac.							Pendant drop	1959	182	
	99.96		H <sub>2</sub>	1000	893	1150	862	1250	849	Bubble pressure	1961	127	
	—		vac.	1000	908					Sessile drop	1963	51	
	99.995		H <sub>2</sub>	1000	907	1100	894	1200	876	Bubble pressure	1964	128	
	99.999	(828)	vac.							Pendant drop	1965	65	
	99.99		Ar, H <sub>2</sub>	1000	890					Bubble pressure	1966	169	
	Spect. pure	921	—		$\sigma_t = 1136 - 0.174 \cdot T$ (K) (1300—2200 K)					Bubble pressure	1968	26	
		918	—		$\sigma_t = 918 - 0.149 (t - t_{mp})$ ( $^\circ\text{C}$ )					Bubble pressure	1969	204	
	99.999		Ar	980	905 $\pm$ 10	1108	890 $\pm$ 10			Sessile drop	1971	212	
	99.999	926	vac.		$\sigma_t = 926 - 0.15 (t - t_{mp})$					Sessile drop	1972	224	
	—	—	vac.		$d\sigma/dt = -0.11$					Sessile drop	1961	262	
	99.999	964	H <sub>2</sub> , Ar		$\sigma_t = 964 - 0.185 (t - t_{mp})$ ( $^\circ\text{C}$ ) (-1450 $^\circ\text{C}$ )					Sessile drop	1976	276	
	99.999	957	vac.		$\sigma_t = 957 - 0.14 (t - t_{mp})$ ( $^\circ\text{C}$ ) (-1100 $^\circ\text{C}$ )					Sessile drop	1970	282	
	99.999	918	Ar		$\sigma_t = 918 - 0.16 (t - t_{mp})$ ( $^\circ\text{C}$ ) 985—1240 $^\circ\text{C}$					Bubble pressure	1970	289	
	Al	—	(385)	air							Pendant drop	1897	168
		—	(520)	CO <sub>2</sub>	700—820	(520)					Capillary method	1914	183
		—	(300)	Ar							Bubble pressure	1936	161
		—		Ar	706	(494)	935	(463)			Bubble pressure	1937	208
		—	(502)	air							Ring removal	1937	96
99.5		(915)	N <sub>2</sub>	720	(890)	800	(865)			Bubble pressure	1948	149	
99.99		860 $\pm$ 20	Ar							Bubble pressure	1956	102	
99.72			vac.	950	840					Bubble pressure	1958	46	
99.7		863 $\pm$ 25	Ar		$\sigma_t = (863 \pm 25) - 0.33 (t - t_{mp})$ ( $^\circ\text{C}$ )					Bubble pressure	1959	113	
99.99		865	vac.		$\sigma_t = 865 - 0.14 (t - t_{mp})$ ( $^\circ\text{C}$ )					Sessile drop	1961	56, 137	
99.99		(825)	Ar		$(\sigma_t = 825 - 0.05 (T - 993))$ (T K)					Bubble pressure	1964	38	
99.996		866	He		$\sigma_t = 866 - 0.15 (t - t_{mp})$ ( $^\circ\text{C}$ )					Sessile drop	1968	10	
99.999		873	He	1600	725		$(\sigma_t = 873 - 0.15 (t - t_{mp})$ ( $^\circ\text{C}$ )			Sessile drop	1969	199	
99.99		(760)	vac.		$(\sigma_t = 948 - 0.202T)$ (T K, 980—1090 K)					Sessile drop	1970	213	
99.998		(915)	Ar		$(\sigma_t = 915 - 0.51 (t - t_{mp})$ ( $^\circ\text{C}$ )					Sessile drop	1971	219	
99.996		855 $\pm$ 6	Ar		(660—800 $^\circ\text{C}$ )					Bubble pressure	1972	222	
					$\sigma_t = 855 - 0.104 (t - t_{mp})$ ( $^\circ\text{C}$ )								
					(660—911 $^\circ\text{C}$ )								
99.99		860	vac.		$\sigma_t = 860 - 0.19 (t - t_{mp})$					Sessile drop	1972	225	
99.99			He	1650	718					Sessile drop	1972	228	
99.99		870	vac., He		$\sigma_t = 870 - 0.195 (T - T_{mp})$ (T K)					Sessile drop	1973	225	
99.999		865	vac.		$\sigma_t = 865 - 0.16 (T - 933)$ (T K)					Sessile drop	1971	236	
99.996		868	Ar		$\sigma_t = 868 - 0.152 (t - t_{mp})$ ( $\pm 2$ ) ( $^\circ\text{C}$ )					Bubble pressure	1974	245	
99.99		870	vac.		$\sigma_t = 870 - 0.195 (t - t_{mp})$ ( $^\circ\text{C}$ )					Sessile drop	1974	247	
99.997		(788)	vac.		$(\sigma_t = 788 - 0.286 (t - t_{mp})$ ( $^\circ\text{C}$ ))					Sessile drop	1974	259	
99.996		865	vac.		$\sigma_t = 865 - 0.15 (t - t_{mp}) - 915^\circ\text{C}$					Sessile drop	1976	267	
99.99		865	vac.		$\sigma_t = 865 - 0.16 (T - T_{mp}) - 1473$ K					Sessile drop	1974	273	
99.999		865	vac.		$\sigma_t = 865 - 0.12 (T - T_{mp})$				-1173 K	Sessile drop	1979	288	
99.999		—	Ar		700 $\pm$ 10	860 $\pm$ 10				Bubble pressure	1979	288	
Ar		99.93	13.12	Ar	90 K	11.86	125 K	3.94	145 K	0.57	Bubble pressure	1965	308
			H <sub>2</sub>	1070	(983)					Pendant drop	1868	165	
Au		1134	H <sub>2</sub> , Ar	1120	1128	1200	1120	1310	1109	Bubble pressure	1929	111	
		(754)	vac.							Pendant drop	1959	182	
	99.999	1130	He	1200	1070	1300	1020			Sessile drop	1965	86	
	99.999	(731)	vac.							Pendant drop	1965	65	
	99.999		Ar	1108	1130 $\pm$ 10					Sessile drop	1971	212	
	99.999		He	1100	1130 $\pm$ 10					Sessile drop	1972	225	
	99.99	1185	H <sub>2</sub> , Ar		$\sigma_t = 1185 - 0.25_1 (t - t_{mp})$ ( $^\circ\text{C}$ )					Sessile drop	1976	276	
	99.8	1060 $\pm$ 50	vac.							Sessile and pendant drop	1963	187	
	Ba	—		Ar	720	224					Bubble pressure	1963	3
		99.5	276			$\sigma = 351 - 0.075 \cdot T$ K (1410—1880 K)					Bubble pressure	1968	25
99.9		267.6	He		$\sigma_t = 267.6 (\pm 1.48) - 0.0690 (T - T_{mp})$ (T K) (-1800 K)					Bubble pressure	1977	286	
Be	99.98		vac.	1500	1100				Sessile drop	1960	58		
Bi		378	H <sub>2</sub>	320	375	472	365		Drop pressure	1921	78		

## SURFACE TENSION OF LIQUID ELEMENTS (continued)

Values of $\sigma$ at various temperatures													
Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	Method	Year	Ref.	
Br		390	H <sub>2</sub>	300	388	400	380	962	340	Bubble pressure	1926	19	
		374	H <sub>2</sub>	583	353.9	770	342			Bubble pressure	1926	173	
		393.4	vac.	400	373.8	500	353.2			Drop weight	1927	131	
		393	air	280	392	340	384			Ring removal	1949	98	
		370	vac.	450	358					Drop pressure	1952	163	
				—	400	(310)				Bubble pressure	1953	13	
		376	vac.		$\sigma = 376 - 0.075(t - t_{mp})$					Drop pressure	1954	112	
	99.99	376	vac.							Drop pressure	1956	156	
	99.90	386	H <sub>2</sub>	800	343	1000	328			Bubble pressure	1956	134	
			vac.	450	382					Electro-capillarity	1959	118	
	99.9	380 ± 10	Ar							Bubble pressure	1960	103	
			—	350	362					Drop pressure	1960	76	
			vac.	700	350					Sessile drop	1961	29	
	99.98	380 ± 10	Ar							Bubble pressure	1961	105	
			vac.	450	380					Drop pressure	1962	120	
			vac.	300	379					Sessile drop	1964	64	
		378	vac., Ar,							Drop weight	1966	4	
			H <sub>2</sub>										
	99.99995	375			$\sigma = 423 - 0.088T$ (T K) (1352—1555 K)						Bubble pressure	1968	26
	99.999	380 ± 3	Ar		$\sigma_t = 380 - 0.142(t - t_{mp})$ (t°C)						Bubble pressure	1972	223
	99.999	376	Ar		$\sigma_t = 376 - 0.070(t - t_{mp}) - 565^\circ\text{C}$						Bubble pressure	1976	267
	99.999	372	Ar		$\sigma_t = 372 - 0.089(t - t_{mp}) - 719^\circ\text{C}$						Sessile drop	1976	267
	chem.pure	386	Ar		$\sigma_t = 386 - 0.07(t - t_{mp}) - 680^\circ\text{C}$						Bubble pressure	1977	274
	99.99999	373	vac.		$\sigma_t = 373 - 0.07(t - t_{mp}) - 500^\circ\text{C}$						levitated drop	1964	280
	99.98	46.8	Air		$\sigma = 45.5 - 0.182t$ (t°C) 0—50°C						Capillary rise	1964	306
	Ca	—	Ar		850	337					Bubble pressure	1963	3
	Cd	p.a.	360		$\sigma = 472 - 0.100T$ (T K) (144—1655 K)						Bubble pressure	1968	25
		(693)	H <sub>2</sub>								Drop weight	1868	166
			H <sub>2</sub>	339	606	421	622	544	616		Drop pressure	1921	78
			H <sub>2</sub>	330	570	400	597	600	585		Bubble pressure	1927	20
							(nonlinear)						
		(666.1)	vac.	589	(590.6)						Drop weight	1927	131
			air	420	622						Ring removal	1937	96
		630	—								—	1940	12
	99.97		H <sub>2</sub> , N <sub>2</sub>	330	564	410	600	500	600		Bubble pressure	1947	71
						(nonlinear)							
		—	450	600						Drop pressure	1953	118	
		—	400	600						Bubble pressure	1953	13	
		—	350	586						Drop pressure	1959	69	
99.9	550 ± 10	Ar								Bubble pressure	1960	103	
			390	604						Bubble pressure	1970	1	
	525 ± 30	H <sub>2</sub>								Solid state curvature	1955	217	
99.9999	59. ± 5	—				(nonlinear)				Sessile drop	1972	221	
—	570	—								—	1962	122	
99.999		H <sub>2</sub>	427	609		(nonlinear)				Bubble pressure	1977	287	
99.9995	640			$\sigma = 640 - 0.13(T - 598 \text{ K})$ (325—800 K)							1977	298	
Ce	—	740	vac.	$\sigma_t = 740 - 0.33(t - t_{mp})$						Sessile drop	1955	260	
Co			Ar	1550	1836					Sessile drop	1957	108	
99.99		vac. Al <sub>2</sub> O <sub>3</sub>	1520	1800						Sessile drop	1958	46	
99.99		He, Al <sub>2</sub> O <sub>3</sub>	1520	(1630)						Sessile drop	1958	46	
99.99		He, BeO	1520	(1640)						Sessile drop	1958	46	
99.99		He, MgO	1520	(1560)						Sessile drop	1958	46	
99.99		H <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub>	1520	1780						Sessile drop	1958	46	
99.99		He	1520	(1620)						Bubble pressure	1958	46	
99.99		H <sub>2</sub>	1520	(1590)						Bubble pressure	1958	46	
		vac.	1500	1870						Sessile drop	1959	7	
			1600	(1640)						Sessile drop	1960	135	
			1600	(1600)						Sessile drop	1960	135	
		vac.	1600	1815						Sessile drop	1960	53	
99.99		vac., Al <sub>2</sub> O <sub>3</sub>	1600	1812						Sessile drop	1961	54	
	(1520)	H <sub>2</sub> , He								Bubble pressure	1961	61	
99.99		H <sub>2</sub> , He	1550	1845						Bubble pressure	1962	63	
99.9983	1880	vac.								Pendant drop	1963	5	
99.99			1550	1780						Bubble pressure	1965	59	
—		He	1527	1852						Sessile drop	1971	233	
99.8		vac.	1500	1880						Sessile drop	1962	248	
—		vac.	1530	1864						Sessile drop	1976	283	
99.95	846	He	$\sigma_t = 1846 - 0.41(t - t_{mp})$				(t°C)	-2200°C		Sessile drop	1978	291	
—	—	—	1550	1807						Sessile drop	1972	296	
Cr	—	vac.	1950	1590 ± 50						Sessile drop	1959	47	
99.9997	1700 ± 50	Ar								Dynam.drop weight	1964	6	
—	—	Ar, He	1800	1520						Sessile drop	1979	293	

## SURFACE TENSION OF LIQUID ELEMENTS (continued)

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures								Method	Year	Ref.	
				$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$				
Cs		67.0	Ar	62								-280°	Pendant drop	1962	195
			Ar	62	67.5	146	62.9						Bubble pressure	1962	193
	99.95	70.0	Ar	39	69.5	494	42.8	642	34.6				Bubble pressure	1967	24
	99.99	73.74	Ar		$\sigma = 73.74 - 1.791 \cdot 10^{-2}(t-t_{mp}) - 9610 \cdot 10^{-5}(t-t_{mp})^2 + 6.629 \cdot 10^{-8}(t-t_{mp})^3$ ( $t^\circ\text{C}$ ) (71—1011 $^\circ\text{C}$ )								Bubble pressure	1968	172
Cu	99.995	68.6	He		$= 68.6 - 0.047 (t-t_{mp}) (t^\circ\text{C}) (52-1100^\circ\text{C})$								Bubble pressure	1970	121
			H <sub>2</sub> ,Ar	1140	(1120)	1300	(1226)						Bubble pressure	1929	111
			Ar	1150	(1034)	1350	(1068)	1450	(1061)				Sessile drop	1949	14
			Ar	1120	1269 ± 20								Sessile drop	1953	11
	—	(1150)	vac.										Pendant drop	1957	35
			Ar	1120	1285 ± 10								Sessile drop	1957	108
	99.98		H <sub>2</sub>	1100	1301	1165	1295	1255	1287				Bubble pressure	1959	134
		1270	H <sub>2</sub> ,vac.		$\sigma = 1270 - 0.31(t-t_{mp})$								Sessile drop	1959	7
			vac.	1120	1285								Sessile drop	1959	198
				1440	1298								Bubble pressure	1959	129
		(1085)	vac.										Pendant drop	1959	182
	99.99		He	1250	1290								Bubble pressure	1960	62
	99.99		H <sub>2</sub>	1250	1300								Bubble pressure	1960	62
	99.9	1180 ± 40	Ar										Bubble pressure	1960	103
	—		H <sub>2</sub>	1100	1220								Sessile drop	1960	136
	—			1183	(1130)								Sessile drop	1960	200
	—		vac.	1150	1370								Sessile drop	1960	52
	99.997	1355	He,H <sub>2</sub>										Sessile drop + bubble pressure	1961	138
	99.997	1352	vac.		$\sigma_t = 1352 - 0.17 (t-t_{mp})$								( $t^\circ\text{C}$ ) Sessile drop	1961	137
	99.997	1358	Ar		$\sigma_t = 1358 - 0.20 (t-t_{mp})$								( $t^\circ\text{C}$ ) Bubble pressure	1961	137
	—		Ar,He	1120	1285 ± 10								Sessile drop	1961	110
	99.99		H <sub>2</sub> ,he	1550	1265								Bubble pressure	1962	63
	99.99999	1300	vac.										Pendant drop	1963	5
			vac.	1130	1268 ± 60								Sessile drop	1963	15
	99.98		Ar	1600	1230								Bubble pressure	1964	205
	99.999		N <sub>2</sub>	1100	1341	1150	1338	1200	1335				Bubble pressure	1964	128
	99.9	(1127)	vac.										Pendant drop	1965	65
99.99		Ar,H <sub>2</sub>	1100	1320								Bubble pressure	1966	169	
99.999	1282	vac.		$\sigma_t = 1282 - 0.16 (t-t_{mp})$								Sessile drop	1972	224	
—	1319	He		$\sigma_t = 1319 - 0.27 (t-t_{mp})$								Sessile drop	1971	234	
99.999	1275 ± 10	vac.										Pendant drop	1963	186	
99.994	1275	Ar		$\sigma_t = 1275 - 0.279 (t-t_{mp})$								Sessile drop	1963	66	
—		Ar	1550	1265								Bubble pressure	1963	255	
—	1212	—										Drop weight	1968	257	
99.999	1207	He		$\sigma_t = 1207 - 34.1 \cdot 10^{-3}(t-t_{mp})$								(1100—1400 $^\circ\text{C}$ ) Bubble pressure	1971	258	
—		vac.		$d\sigma/dt = -0.23$								Sessile drop	1961	262	
—	1285	Ar		$\sigma_t = 1285 - 0.2 (t-t_{mp})$								Sessile drop	1971	263	
99.9	(1384)	Ar		$\sigma_t = 1384 - 0.41 (t-t_{mp})$								-1300 $^\circ\text{C}$ Sess. dr., max., bubble pressure	1973	266	
99.99	1282	Ar,N <sub>2</sub>		$\sigma_t = 1282 - 0.15 (t-t_{mp})$								-1364 $^\circ\text{C}$ Sess. Drop	1976	267	
99.99	1290	Ar		$\sigma_t = 1290 - 0.16 (t-t_{mp})$								-1270 $^\circ\text{C}$ Bubble pressure	1976	267	
99.99		N <sub>2</sub>	1200	1300								Bubble pressure	1972	265	
99.99	1360	vac.		$\sigma_t = 1360 - 0.239 (T-T_{mp}) - 1473 \text{ K}$								Sessile drop	1974	273	
99.999	1313			$\sigma_t = 1313(\pm 35) - 0.176 (T-T_{mp})(\pm 0.023)$								1373—1861 K Sessile drop	1977	275	
99.999	1303	H <sub>2</sub> ,Ar		$\sigma_t = 1303 - 0.233 (t-t_{mp}) (^\circ\text{C}) - 1450^\circ\text{C}$								Sessile drop	1976	276	
99.999	(1170)	vac.		$(\sigma_t = 1170 - 0.27 (t-t_{mp})) (t^\circ\text{C}) - 1200^\circ\text{C}$								Sessile drop	1970	282	
99.999	(1390)	H <sub>2</sub>		$(\sigma_t = 1390 - 0.43 (t-t_{mp})(t^\circ\text{C})) - 1300^\circ\text{C}$								Levitated droplets	1977	285	
99.999	1313	Ar		$\sigma_t = 1313(\pm 35) - 0.176(\pm 0.023)(T-T_{mp})$								-1861 K Sessile drop	1977	287	
Fe		(1373)	Ar	1600	(1360)	1700	(1371)					(nonlinear)	Sessile drop	1949	14
	—			1550	(1450)								Sessile drop	1954	92
	—			1570	1731								Sessile drop	1954	95
	—			1550	1860								Sessile drop	1955	74
		1720	He										Sessile drop	1955	74
				1580—1760	(880)								Bubble pressure	1956	100
				1570	(1632)								Sessile drop	1958	93
	99.99		He	1650	(1610)								Sessile drop	1958	46
	99.99		He	1650	1430								Sessile drop	1958	46
	99.99		H <sub>2</sub>	1650	(1400)								Sessile drop	1958	46
	—	(1384)	vac.										Pendant drop	1959	182
		1700	vac.										Sessile drop	1959	7
			vac.,He	1550	1865								Sessile drop	1960	209
	99.99		He	1650	(1430)								Bubble pressure	1960	62
	99.99		H <sub>2</sub>	1650	(1400)								Bubble pressure	1960	62
		(1650)	He,H <sub>2</sub>										Sessile drop	1960	136
99.985		Ar	1550	1788								Bubble pressure	1961	61	
—	(1560)											Sessile drop	1961	110	



## SURFACE TENSION OF LIQUID ELEMENTS (continued)

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures				Method	Year	Ref.	
				$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$				$t/^\circ\text{C}$
Ga	99.94		vac.	1560	1710			Sessile drop	1962	207	
			Al <sub>2</sub> O <sub>3</sub>								
	99.9998	1880	vac.					Pendant drop	1963	5	
	99.93	1860 ± 40 (1510)	He					Sessile drop	1963	116	
			vac.					Drop weight	1963	139	
	99.97		vac., BeO	1550	1830 ± 6			Sessile drop	1963	45	
	Armco		Ar, N <sub>2</sub>	1550	1795			Bubble pressure	1963	164	
			vac.	1550	1754			Sessile drop	1963	42	
	99.987		vac.	1550	1730			Sessile drop	1964	159	
	99.85	(1619)	vac.					Pendant drop	1965	65	
	99.69		He, Al <sub>2</sub> O <sub>3</sub>	1550	1727			Sessile drop	1965	158	
	99.69		H <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub>	1550	1734			Sessile drop	1965	158	
	—	1760 ± 20	He, H <sub>2</sub>		$\sigma_t = 1760 - 0.35(t - t_{mp})$ ( $^\circ\text{C}$ )			Sessile drop	1969	157	
	99.9992	1773	He, H <sub>2</sub>		$\sigma_t = 773 + 0.65 \cdot t$ ( $^\circ\text{C}$ ) (1550—1780 $^\circ\text{C}$ )			Oscillating drop	1971	211	
	—		—		1780			Sessile drop	1971	220	
	—	(1958)	—		$(\sigma_t = 1836 + 0.079t)$ ( $^\circ\text{C}$ ) (1555—1705)			Levitated droplets	1971	227	
	99.988		He	1650	1832			Sessile drop	1972	228	
	99.996		Ar, H <sub>2</sub>	1550	1850 ± 80	1600	1835 ± 80	Sessile drop	1970	231	
	—		He	1527	1820			Sessile drop	1971	233	
	99.997		He	1550	1760	1850	1655	Sessile drop	1971	235	
	99.89		He	1550	1860			Sessile drop	1963	241	
	99.97		H <sub>2</sub>	1600	1710 ± 30			Sessile drop	1973	242	
	99.5		H <sub>2</sub> , Ar	1550	1735			Sessile drop	1974	243	
	99.95	—	Ar	1570—1620	(1650—1680)			Bubble pressure	1962	254	
	—	—	Ar	1550	1835			Sessile drop	1957	108	
	—	—	Ar	1550	(1450)			Sessile drop	1975	269	
	99.9	1806	He		$\sigma_t = 1806 - 0.295(t - t_{mp})$ ( $^\circ\text{C}$ ) - 2200 $^\circ\text{C}$			Sessile drop	1978	191	
	—	—	—	1550	1850			Sessile drop	1968	295	
	—	—	—	100	58.4			Calculated	1969	145	
	Ir							Sessile drop	1921	170	
	Ga		(358.2)	CO <sub>2</sub> , C				Sessile drop	1941	130	
	—			H <sub>2</sub> , CO <sub>2</sub>	30.5	735 ± 20			Sessile drop	1960	197
	99.9	707	Ar, He		$\sigma = 707 - 0.05(t - t_{mp})$ ( $t_{mp} = 505^\circ\text{C}$ )			Bubble pressure	1960	104	
	—	725 ± 10	Ar					Bubble pressure	1960	104	
	—		vac.	350	718			Sessile drop	1964	64	
	—		He, Al <sub>2</sub> O <sub>3</sub>	1500	559			Sessile drop	1966	57	
	99.9998	718	vac., Al <sub>2</sub> O <sub>3</sub>		$\sigma = 718 - 0.101(t - t_{mp})$ ( $^\circ\text{C}$ )			Sessile drop	1967	85	
	99.999	712	vac.		$\sigma_t = 712 - 0.0606(T - 303)$ (T K)			Sessile drop	1971	236	
	—	708	He		$\sigma_t = 708 - 31 \cdot 10^{-4}(T - T_{mp}) - 0.67 \cdot 10^{-4}(T - T_m)^2$			Sessile drop	1965	249	
	99.999	708	vac.		$\sigma_t = 708 - 37 \cdot 10^{-4}(t - t_{mp})$ (30—450 $^\circ\text{C}$ )			Drop pressure	1974	264	
	—	723.9	N <sub>2</sub>		$\sigma_t = 723.9 - 0.068(t - t_{mp})$			Pendant drop	1975	270	
	99.99	712	vac.		$\sigma_t = 712 - 0.0606(T - T_{mp}) - 1473$ K			Sessile drop	1974	273	
	—	706.6	vac.		$\sigma_t = 706.6 - 6.47 \cdot 10^{-4}(t - t_{mp}) - 0.965 \cdot 10^{-4}(t - t_{mp})^2$			Drop pressure	1960	281	
	99.9999	(784)	Ar		$\sigma_t = 784 - 0.11(t - t_{mp})$ ( $^\circ\text{C}$ ) (30—505 $^\circ\text{C}$ ) 900—1100 $^\circ\text{C}$			Bubble pressure	1970	289	
	99.9999	680	H <sub>2</sub>		$\sigma_t = 680 - 0.091(t - t_{mp}) - 1150$ K (T K)			Sessile drop	1983	299	
99.999	810	Ar					Floating zone	1965	238		
Gd			He	959	600			Pendant drop	1953	87	
Ge		621.4						Drop weight	1960	126	
—		650	vac.	1200	530			Sessile drop	1960	99	
—			vac.	1000	650			Sessile drop	1971	214	
—		632 ± 5	N <sub>2</sub> , He					Solid state curvature	1955	217	
—		599	He		$\sigma_t = 599 - 0.099(t - t_{mp})$			Sessile drop	1971	234	
—		580	vac.		$\sigma_t = 580 - 0.119(t - t_{mp})$ (mp-1240 $^\circ\text{C}$ )			Sessile drop	1973	225	
99.999	581	He		$\sigma_t = 581 - 0.12(t - t_{mp})$ (mp-1600 $^\circ\text{C}$ )			Sessile drop	1969	268		
99.999	589	vac.		$\sigma_t = 589 - 0.105(T - T_{mp})$ (mp-1423 K)			Sessile drop	1977	277		
—		vac.	1530	510			Sessile drop	1976	283		
He		0.27	Air		$\sigma = 0.3745 - 0.0096 \cdot T^2$ (K)			Capillary rise	1965	304	
Hf		1460	vac.					Pendant drop	1958	151	
—		97.5 + 2.5	vac.					Pendant drop	1963	5	
Zr											
Hg		1490 ± 10	vac.					Pendant drop	1972	229	
—			H <sub>2</sub>	20	(542)			Pendant drop	1868	165	
—			air	16	(410)			Sessile drop	1897	181	
—			air	20	(435.5)			Oscillating jet	1912	175	
—			vac.	20	472			Oscillating jet	1914	73	
—			vac.	20	(402)			Drop pressure	1920	146	
—			vac.	25	476			Drop weight	1920	75	
—			vac.	20	(436)			Sessile drop	1921	160	
—			vac.	20	(432)			Sessile drop	1921	170	
—			H <sub>2</sub>	25	476			Drop pressure	1921	78	
—				25	472			Drop weight	1923	81	
—				25	(464)			Sessile drop	1924	82	



## SURFACE TENSION OF LIQUID ELEMENTS (continued)

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures				Method	Year	Ref.				
				t/°C	$\sigma$	t/°C	$\sigma$				t/°C	$\sigma$		
I In	99.9		H <sub>2</sub>	19	473				Bubble pressure	1926	173			
				20	(437)				Capillary depression	1928	144			
			vac.	20	480				Drop weight	1928	21			
				25	(516)				Sessile drop	1929	37			
				25	(435)				Sessile drop	1931	90			
				vac.	25	473				Drop weight	1932	31		
					25	488				Sessile drop	1932	32		
					25	(498)				Sessile drop	1934	30		
				vac.	20	(420)				Sessile drop	1935	174		
					25	476				Sessile drop	1936	91		
				vac.	20	(410)				Drop pressure	1937	178		
				vac.	20	(455)				Drop pressure	1941	39		
					25	484 ± 1.5				Sessile drop	1946	89		
				vac.	22	(468)				Drop pressure	1951	162		
				vac.	20	(465.2)	103	449.7	350	387.1	Drop pressure	1951	162	
					25	484.9 ± 1.8					Sessile drop	1953	216	
				vac.	20	485.5 ± 1.0	$\sigma_t = 489.5 - 0.20t$ (°C)				Drop pressure	1953	17	
				Ar	20	(454.7)					Bubble pressure	1954	188	
					21	(505.5)					Bubble pressure	1960	23	
				Ar	20	(500 ± 15)					Bubble pressure	1959	103	
				vac.	-10	487					Drop pressure	1960	69	
				vac.	25	483.5 ± 1.0					Sessile drop	1961	140	
					22	(465)					Bubble pressure	1962	194	
					25	485.1					Sessile drop	1963	142	
					16.5	487.3	25	485.4			Pendant drop	1964	171	
								± 1.2						
						23—25	482.8 ± 9.7				Contact angle	1966	18	
							$(\sigma_t = 468.7 - 1.61 \cdot 10^{-1}t - 1.815 \cdot 10^{-4}t^2)$ (°C)				—	1968	206	
				vac.	20	484.6 ± 1.3					Pendant drop	1968	132	
				Ar	25	480					Bubble pressure	1968	172	
				vac.	20	482.5 ± 3.0					Bubble pressure	1968	172	
						$\sigma_t = 485.5 - 0.149t - 2.84 \cdot 10^{-4}t^2$ (°C)					Bubble pressure	1970	177	
				99.99	491	Ar	21.5	484.9 ± 0.3			Bubble pressure	1972	223	
							20	471 ± 3			Drop weight	1973	239	
				—	490.2	vac.		$\sigma_t = 480.0 - 0.26t$ (°C) (50—250°C)			Drop pressure/capillary rise	1977	278	
				99.99	487	vac.		$\sigma_t = 487 - 0.281(t - t_{mp}) - 450^\circ\text{C}$			Drop pressure	1976	290	
				—	37.92	Ar		$\sigma = 37.92 - 0.0956(T - T_{mp})$ 398—428 K			Capillary rise	1965	303	
				99.95	559	H <sub>2</sub>	600	515			Capillary method	1957	133	
							623	540			Capillary method	1957	77	
				99.995	556.0	Ar, He					Bubble pressure	1959	196	
						vac.	185	592			Drop pressure	1959	69	
						H <sub>2</sub>	600	514			—	1962	16	
							300	541			Sessile drop	1962	83	
				99.999	558	Ar	200	556	400	535	550	527.8	1964	123
								$\sigma = 558 - 0.08(t - t_{mp})$						
	99.9994		vac.	350	539				Drop pressure	1968	106			
	99.9999	560 ± 5	—		$\sigma = 568.0 - 0.04t - 7.08 \cdot 10^{-5}t^2$ (°C)				Sessile drop	1972	221			
	99.999	565.0	vac.		$\sigma_t = 565.0 - 0.09(T - 428)$ (T K)				Sessile drop	1971	236			
	99.99	553	Ar		$\sigma_t = 553 - 0.13(t - t_{mp}) - 450^\circ\text{C}$				Bubble pressure	1976	267			
	99.99	558	vac.		$\sigma_t = 558 - 0.11(t - t_{mp}) - 586^\circ\text{C}$				Sessile drop	1976	267			
	99.99	565	vac.		$\sigma_t = 565 - 0.09(T - T_{mp}) - 1473$ K				Sessile drop	1974	273			
	99.9995	(585)	Ar		$(\sigma_t = 585 - 0.10(t - t_{mp}))$ (°C) 620—1020°C				Bubble pressure	1970	289			
	99.9999	560	H <sub>2</sub>		$\sigma_t = 560 - 0.10(t - t_{mp}) - 1150$ K (T K)				Sessile drop	1983	299			
	99.9980	2250	vac.						Pendant drop	1963	5			
	—		He	2450°C	2264				Sessile drop	1982	300			
	K	(411)	CO <sub>2</sub>						Drop weight	1868	166			
			Ar	79	(400.5)	228	(391.5)		Bubble pressure	1937	208			
	99.895	101	Ar						Bubble pressure	1955	189			
		110.3 ± 1	—						—	1965	84			
	93.0	117	vac.		$\sigma = 117 - 0.066(t - 64)$ (65—800°C)				Drop weight	1966	185			
	—	113	Ar	87	112	457	80	677	64.8	1967	24			
	99.986	116.95	Ar		$\sigma = 116.95 - 6.742 \cdot 10^{-2}(t - t_{mp}) - 3.836 \cdot 10^{-5}(t - t_{mp})^2 + 3.707 \cdot 10^{-8}(t - t_{mp})^3$ (°C) (77—983°C)				Bubble pressure	1968	172			
					$\sigma = 76.8 - 70.2 \cdot 10^{-4}(t - 400)$ (°C) (600—1126°C)				Bubble pressure	1970	121			
	99.936	79.2	He						Drop weight	1954	218			
		95 ± 9.5	—						Bubble pressure	1964	219			
	99.97	111.35 ± 0.64	He		$\sigma = 115.51 - 0.0653t$ (°C) (70—713°C)				Bubble pressure	1965	307			
	—	16.34	vac.		$\sigma = 16.344 - 0.2089(T - 116)$ 115—123 K				Bubble pressure	1965	307			
	La	—	720	vac.	$\sigma_t = 720 - 0.32(t - t_{mp})$				Sessile drop	1955	260			
	99.95	408	Ar	180	397.5	300	380	500	351.5	1955	189			
	99.98	416	Ar	287	386	922	275	1077	253	1967	24			
	Mg	—	air	700	(987)				Ring removal	1937	96			

## SURFACE TENSION OF LIQUID ELEMENTS (continued)

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures								Method	Year	Ref.	
				$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$	$t/^\circ\text{C}$	$\sigma$				
Mn		571	Ar	681	563	789	532	894	502			Bubble pressure	1937	208	
	99.8	559	N <sub>2</sub>	670	552	700	542	740	528			Bubble pressure	1948	149	
	99.9		Ar	700	550 ± 15							Bubble pressure	1959	114	
	99.91	525 ± 10	Ar									Bubble pressure	1961	105	
	99.5	583										Bubble pressure	1968	25	
	99.9	—	vac.	800	543	—	—	—	—			Sessile drop	1977	279	
	99.9985	1100 ± 50	Ar									Dynam. drop weight	1964	6	
	99.94	—	vac.	1550	1030							Sessile drop	1964	159	
	—	—	—	1550	1010							Sessile drop	1971	220	
	Mo	99.7	1915	vac.									Pendant drop	1963	148
		2080	vac.									Drop weight	1963	139	
99.9996		2250	vac.									Pendant drop	1963	5	
99.98		2049	vac.									pendant drop	1965	65	
—		2130	vac.									Pendant drop	1970	210	
N	99.9	11.77	N	75 K	9.41	95 K	5.06	115 K	1.39			Capillary rise	1965	308	
Na		(293.6)	CO <sub>2</sub>									Drop weight	1868	166	
		222	vac.	100	222	250	211					Sessile drop	1926	152	
		206	Ar	110	205.7	263	198.2					Bubble pressure	1937	208	
	99.995	191	Ar									Bubble pressure	1954	188	
		196	vac.	123	198	129	198.5					Drop volume	1955	2	
		200.2 ± 0.6		140	190							Sessile drop	1961	28	
	99.8	202	vac.									—	1965	84	
	p.a.	195	Ar									Drop weight	1966	185	
	99.96	210.12	Ar									Bubble pressure	1967	24	
												Bubble pressure	1968	172	
Nb	99.982	187.4	He									Bubble pressure	1970	121	
	spec. pure	222.46	vac., Ar									Bubble pressure	1979	301	
	99.9986	1900	vac.									Pendant drop	1963	5	
	99.99	1827	vac.									Pendant drop	1965	65	
	—	2020	vac.									Pendant drop	1970	220	
	Nd		688	Ar	1186	674							Bubble pressure	1962	124
		Ni	99.7		He	1470	(1615)							Sessile drop	1953
	99.7			H <sub>2</sub>	1470	(1570)							Sessile drop	1953	94
	99.7			vac.	1470	1735							Sessile drop	1953	94
			1725	vac.									Sessile drop	1955	141
			vac.	1475	1725							Sessile drop	1956	115	
—			Ar	1550	(1934)							Sessile drop	1957	108	
99.99			vac., Al <sub>2</sub> O <sub>3</sub>	1520	1740							Sessile drop	1958	46	
99.99			He, Ar, Al <sub>2</sub> O <sub>3</sub>	1520	1770							Sessile drop	1958	46	
99.99			H <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub>	1520	(1600)							Sessile drop	1958	46	
99.99			He, MgO	1470	(1530)							Sessile drop	1958	46	
99.99		He, BeO	1470	(1500)							Sessile drop	1958	46		
99.99		H <sub>2</sub>	1530	(1650)							Bubble pressure	1958	46		
99.99		H <sub>2</sub>	1470	(1530)							Bubble pressure	1958	46		
99.99		He	1470	(1490)							Bubble pressure	1958	46		
	1725	vac.									Sessile drop	1959	7		
99.99			1600	(1600)							Sessile drop	1960	136		
99.99		vac.	1500	1720							Sessile drop	1960	50		
99.99		vac., Al <sub>2</sub> O <sub>3</sub>	1550	1780							Sessile drop	1961	54		
			1550	1735							Bubble pressure	1961	60		
		H <sub>2</sub> , He	1470	1700							Bubble pressure	1961	61		
99.99		vac.	1640	1705							Sessile drop	1961	56		
—		vac., Al <sub>2</sub> O <sub>3</sub>	1560	1810							Sessile drop	1962	207		
99.9991	1770 ± 13	vac.									Drop weight	1963	5		
99.9991	1728 ± 10	vac.									Drop weight	1963	5		
99.9991	1822 ± 8	vac.									Pendant drop	1963	5		
	(1670)	vac.									Drop weight	1963	139		
	1760	vac.									Sessile drop	1964	55		
	(1687)	vac.									Pendant drop	1965	65		
99.99		vac.	1500	1745							Sessile drop	1966	57		
—	1809 ± 20	H <sub>2</sub> , He, Al <sub>2</sub> O <sub>3</sub>									Sessile drop	1969	157		
99.99975	(1977)	He									Oscillating drop	1971	211		
99.998		He	1550	1735	1850	1620					Sessile drop	1971	235		
—		Ar	1550	(1530)							Sessile drop	1975	269		
99.99	1758	He									Sessile drop	1978	291		
—		—	1550	1797							Sessile drop	1972	296		
Os	99.9998	2500	vac.									Pendant drop	1963	5	
P(white)		71.2		50	69.7	68.7	64.95					Bubble pressure	1943	80	
Pb		448	H <sub>2</sub>									Pendant drop	1868	165	
		(394.2)	vac.									Oscillating jet	1914	73	
		445	H <sub>2</sub>	366	442	444	433	522	429			Drop pressure	1921	78	
		444	H <sub>2</sub>	350	441	600	426	800	409			Bubble pressure	1926	19	

**SURFACE TENSION OF LIQUID ELEMENTS (continued)**

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures				Method	Year	Ref.				
				t/°C	$\sigma$	t/°C	$\sigma$				t/°C	$\sigma$		
99.98	454	469.9	H <sub>2</sub>	350	453	600	436	982	414	Pendant drop	1927	20		
			vac.	507	440.5	657	415.9			Drop weight	1927	131		
			H <sub>2</sub>	750	423	900	407	1000	401	Bubble pressure	1927	40		
			H <sub>2</sub> ,N <sub>2</sub>	340	448	390	442	440	439	Bubble pressure	1947	71		
			air	360	452					Ring removal	1948	97		
			vac.	425	440					Drop pressure	1950	101		
			He	450						Pendant drop	1953	87		
				350—450	450					Ring removal	1953	13		
			99.998	480		H <sub>2</sub>					Capillary method	1957	133	
						vac.	623	474				Capillary method	1957	77
							362	455				Drop pressure	1959	69
							700	428				Sessile drop	1959	27
			99.9			H <sub>2</sub>	1000	388				Bubble pressure	1959	134
			99.9	(410 ± 5)		Ar						Bubble pressure	1960	104
							350	445				Drop pressure	1962	153
			99.98	443		vac.	340	442	400	435		Drop pressure	1963	70
			99.9995	470			$\sigma = 538 - 0.114T$ (T K) (1440—1970 K)					Bubble pressure	1968	26
			99.9994			vac.	450	438				Drop pressure	1968	107
			99.999			He	1600	310				Sessile drop	1969	199
							390	456				Bubble pressure	1970	1
				(424 ± 10)		air						Solid state curvature	1955	217
			99.999	470		Ar	$\sigma_t = 470 - 0.164(t-t_{mp})$ (MP-535°C) (t°C)					Bubble pressure	1972	223
			99.9999	462		vac.	$\sigma_t = 462 - 0.11(t-t_{mp})$					Sessile drop	1972	224
			99.9999	444.5		H <sub>2</sub> ,He	$\sigma_t = 472.7 - 0.085t$ (± 5) (t°C)					Sessile drop	1971	226
			99.95	472		Ar	$\sigma_t = 548 - 0.233t$ (°C) (650—800°C)					Bubble pressure	1971	230
			99.999	468.5		Ar	$\sigma = 512 - 0.133t$ (°C) (t <sub>mp</sub> - 750°C)					Bubble pressure	1961	237
			—	468.6		H <sub>2</sub>	$\sigma = 497 - 0.087t$ (t°C) (350—500°C)					Capillary rise	1973	240
			—				360	449	500	436		Bubble pressure	1947	252
			Chem.pure	456		Ar	$\sigma_t = 456 - 0.14(t-t_{mp})$ (360—650°C)					Bubble pressure	1977	274
			99.999	458		H <sub>2</sub> ,Ar	$\sigma_t = 458 - 0.12t$ (t-t <sub>mp</sub> ) (°C) - 1100°C					Sessile drop	1976	276
99.999	462		vac.	$\sigma_t = 62 - 0.11(T-T_{mp}) - 1173$ K					Sessile drop	1979	288			
—	469		vac.	$\sigma_t = 469 - 0.086(t-t_{mp}) - 450$ °C					Drop pressure	1976	289			
99.99	444.5		H <sub>2</sub>	$\sigma_t = 444.5 - 0.100(t-t_{mp}) - 550$ °C					Sessile drop	1978	292			
Pd	1470		vac.						Sessile drop	1961	49			
99.998	1500		vac.						Pendant drop	1963	5			
99.998	1460		He						Sessile drop	1969	199			
Pt				1780	1673				Capillary method	1868	165			
	1869		CO <sub>2</sub>						Drop weight	1869	167			
99.84	1740 ± 20		vac.						Drop volume	1959	48			
99.999			Ar	1800	1699 ± 20				Sessile drop	1961	109			
99.9980	1865		vac.						Pendant drop	1963	5			
99.99	1746		vac.	$\sigma_t = 1746 - 0.307(t-1774)$ (t°C)					Sessile drop	1975	271			
Pu	550 ± 55		vac.						Pendant drop	1963	186			
Rb	77 ± 5		vac.						Drop diffusion in quartz tube	1956	201			
	99.8	84.6	Ar	52	84	477	55	632	46.8	Bubble pressure	1967	24		
	99.92	91.17	Ar	$\sigma = 91.17 - 9.189 \cdot 10^{-2}(t-t_{mp}) + 7.228 \cdot 10^{-5}(t-t_{mp})^2 - 3.830 \cdot 10^{-8}(t-t_{mp})^3$ (t°C) (104—1006°C)						Bubble pressure	1968	172		
	99.997	85.7	He	$\sigma = 85.7 - 0.054(t-t_{mp})$ (t°C) (53—1115°C)						Bubble pressure	1970	121		
Re	99.4	2610	vac.							Pendant drop	1963	148		
	99.9999	2700	vac.							Pendant drop	1963	5		
Rh		1940	vac.							Sessile drop	1961	49		
	99.9975	2000	vac.							Pendant drop	1963	5		
	99.99	1915	He	$\sigma_t = 1915 - 0.664(t-t_{mp})$ (t°C) - 2200°C						Sessile drop	1975	27		
Ru	99.9980	2250	vac.							Pendant drop	1963	5		
S	—	60.9	vac.	250	51.1					Pendant drop	1957	143		
Sb		350	H <sub>2</sub>	640	349	700	349	974	342	Drop weight	1927	20		
		375	H <sub>2</sub>	750	368	900	361	1100	348	Bubble pressure	1927	40		
		368	vac.	640	367.9	762	364.9			Drop weight	1927	131		
	99.5	383	H <sub>2</sub> ,N <sub>2</sub>	675	384	800	380			Bubble pressure	1947	71		
	99.99	395 ± 20	Ar							Bubble pressure	1960	104		
	99.15	395 ± 20	Ar							Bubble pressure	1961	105		
	99.999	367	N <sub>2</sub>	800	359	1000	351	1100	345	Bubble pressure	1964	128		
	99.995	350	Ar	650	350.2	700	347.6	800	345.0	Bubble pressure	1964	123		
	99.999		He	1600	320					Sessile drop	1969	199		
	99.9999	372	Ar	$\sigma_t = 372 - 0.05(t-t_{mp})$ 670—1010°C						Bubble pressure	1970	289		
Se		70.4								Drop weight	1868	166		
	99.95	105.4	—	260	98.5	300	95.7			Drop weight	1946	8		
	—		Ar	230—250	88.0 ± 5					Bubble pressure	1961	105		
	—	96.7	—	$\log \sigma = 1.8202 + 35.8711/t$ (t°C)						Bubble pressure	1970	251		
	—		vac.	220	95					Sessile drop	1978	284		
	99.995		Ar	$\sigma_t = 90 - 0.075(t-310)$ 310—650°C						Bubble pressure	1970	289		
	99.995	94	Ar	$\sigma_t = 94 - 0.02(t-t_{mp})$ von 220—310°C						Bubble pressure	1970	289		



**SURFACE TENSION OF LIQUID ELEMENTS (continued)**

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures				Method	Year	Ref.		
				t/°C	$\sigma$	t/°C	$\sigma$				t/°C	$\sigma$
Si	99.995	106	Ar	$\sigma_t = 102 - 0.09(t-310)$ 310—650°C				Bubble pressure	1970	289		
	99.995		Ar	$\sigma_t = 106 - 0.02(t-t_{mp})$ 220—310°C				Bubble pressure	1970	289		
			He	1450	725			Pendant drop	1953	87		
			vac.	1550	720			Sessile drop	1961	68		
	99.99		vac.	1550	750			Sessile drop	1964	41		
	99.999		Ar	1500	825			Pendant drop	1970	43		
	99.999		He	$\sigma_t = 720 - 0.073(t-t_{mp})$ ( $t_{mp}$ -1500°C)				Bubble pressure	1972	232		
	99.999		He	$\sigma_t = 727 - 0.01044(t-t_{mp})$ ( $t_{mp}$ -1700°C)				Sessile drop	1979	294		
	99.999		—	—	—	$d\sigma/dT = -0.1290 - 1700^\circ\text{C}$				Sessile drop	1979	302
	Sn		587	H <sub>2</sub>						Pendant drop	1868	165
(681.2)		air						Drop weight	1868	165		
593								Capillary method	1868	166		
612								Capillary method	1897	181		
(352)		air						Capillary waves	1900	72		
(480)								Capillary method	1914	183		
		vac.	247	540				Oscillating jet	1914	73		
531		H <sub>2</sub>						Drop pressure	1921	78		
528		H <sub>2</sub>	253	526	600	525	964	514	Drop weight	1926	19	
565		H <sub>2</sub>	878	508					Bubble pressure	1926	173	
566		H <sub>2</sub> ,Ar	878	508	900	506	1000	497	Bubble pressure	1927	40	
524		N <sub>2</sub>							Drop weight	1927	36	
(662.2)		air	347	(627.8)	418	(617.1)			Drop weight	1927	131	
578.8		vac.	400	545.4	600	506.2			Drop weight	1927	131	
518		vac.							Sessile drop	1935	174	
—		619	N <sub>2</sub>	275	612	500	572	800	520	Bubble pressure	1948	149
		525	air	280	523	340	520			Ring removal	1948	97
99.99		537	vac.	500	524	600	508			Drop pressure	1949	154
		530	He							Pendant drop	1953	87
		594	H <sub>2</sub>	489	543	572	528	692	503	Conical capillaries	1953	9
			—	250	536					Drop pressure	1953	179
			vac.	450	530					Drop pressure	1953	119
			—	250	545					Drop pressure	1954	112
99.93		550	vac.	250	549	400	539	600	526	Drop pressure	1956	156
99.998		566	H <sub>2</sub>	$\sigma = 566 - 0.07(t-t_{mp})$				Capillary method	1957	133		
			—	623	559					Capillary method	1957	77
		610	vac.							Pendant drop	1959	182
			H <sub>2</sub>	800	500					Sessile drop	1959	7
			—	300	538					Drop pressure	1960	190
			—	300	527					Drop pressure	1960	76
		—	290	546					Sessile drop	1960	190	
99.99		H <sub>2</sub> ,He	600	530					Bubble pressure	1960	62	
99.9	526 ± 10	Ar							Bubble pressure	1960	104	
—		vac.	290	600					Sessile drop	1961	147	
99.965	546	H <sub>2</sub>	740	508	950	489.5	1115	479.5	Bubble pressure	1961	127	
99.89	543.7	Ar	$\sigma = 543.7 - 0.07(t-t_{mp})$				Bubble pressure	1964	33			
	562	vac.							Sessile drop	1964	55	
		vac.	300	554					Sessile drop	1964	64	
99.999	590	vac.							Sessile drop	1965	86	
		H <sub>2</sub>	290	520	290	524			Sessile drop	1966	67	
						(vac.)						
99.9999		H <sub>2</sub>	246	552.7					Sessile drop	1968	203	
99.9994		vac.	350	537					Drop pressure	1968	106	
99.999	555.8 ± 1.9		$\sigma = 566.84 - 4.76 \cdot 10^{-2}t$ (t°C)				Bubble pressure	1970	176			
99.96	552	vac.	1000	470					Sessile drop	1971	5	
99.96	552	Ar	$\sigma_t = 552 - 0.167(t-t_{mp})$ (MP-500°C) (t°C)				Bubble pressure	1972	223			
99.9999	550.5	H <sub>2</sub> ,He	$\sigma_t = 569.0 - 0.080t$ (± 5) (t°C)				Sessile drop	1971	226			
99.95	574	Ar	$\sigma_t = 626 - 0.222t$ (t°C) (608—800°C)				Bubble pressure	1971	230			
99.999	540	vac.	$\sigma_t = 540 - 0.064(T-505)$ (T K)				Sessile drop	1971	236			
—	574.5	H <sub>2</sub>	$\sigma_t = 587.5 - 0.056t$ (t°C) (250—500°C)				Capillary rise	1973	240			
—	533	Ar	$\sigma_t = 524 - 0.073(t-360)$ (t°C)				Bubble pressure	1975	244			
99.9	(624)	Ar	$(\sigma_t = 624 - 0.21(t-t_{mp}) - 1300^\circ\text{C})$				Sessile drop and bubble pressure	1973	266			
99.96	561	Ar	$\sigma_t = 561 - 0.13(t-t_{mp}) - 702^\circ\text{C}$				Sessile drop	1976	267			
99.96	551	Ar	$\sigma_t = 551 - 0.17(t-t_{mp}) - 546^\circ\text{C}$				Bubble pressure	1976	267			
99.99	540	vac.	$\sigma_t = 540 - 0.064(T-T_{mp}) - 1473$ K				Sessile drop	1974	273			
99.999	560	H <sub>2</sub> ,Ar	$\sigma_t = 560 - 0.091t$ (t-t <sub>mp</sub> ) (t°C) - 1450°C				Sessile drop	1976	276			
99.999	—	vac.	800	501	—	—	—	—	Sessile drop	1977	279	
99.9998	540	vac.	$\sigma_t = 540 - 0.04(t-t_{mp}) - 500^\circ\text{C}$				levitated drop	1964	280			
99.99	551.4	H <sub>2</sub>	$\sigma_t = 551.4 - 0.089(t-t_{mp}) - 500^\circ\text{C}$				Bubble pressure	1977	287			
99.999	561	vac.	$\sigma_t = 561 - 0.13(T-T_{mp}) - 1173$ K				Sessile drop	1979	288			
99.85	559.8	H <sub>2</sub>	$\sigma_t = 559.8 - 0.095(t-t_{mp}) - 550^\circ\text{C}$				Sessile drop	1978	292			
Sr	287	Ar	775	288	830	282	893	282	Bubble pressure	1963	125	

**SURFACE TENSION OF LIQUID ELEMENTS (continued)**

Element	Purity (wt. %)	$\sigma_{mp}$ (mN/m)	Atm.	Values of $\sigma$ at various temperatures				Method	Year	Ref.		
				t/°C	$\sigma$	t/°C	$\sigma$				t/°C	$\sigma$
				$\sigma = 393 - 392 - 0.085T$ (T°K) (115—1602°K)								
Ta	99.5	303						Bubble pressure	1968	25		
		2360	vac.					Pendant drop	1959	88		
		2030	vac.					Pendant drop	1959	88		
		1910	vac.					Drop weight	1963	139		
		2150	vac.					Pendant drop	1963	5		
	99.9983	(1884)	vac.					Pendant drop	1965	65		
Tc	99.9	(1884)	vac.									
	99.4	186 ± 2	Ar					Bubble pressure	1961	105		
			vac.	460	178 ± 1.5			Capillary method	1962	184		
	—		vac.	475	162			Electro-capillarity	1963	117		
		178			$\sigma = 178 - 0.024(t-t_{mp})$ (t°C)			Bubble pressure	1969	204		
		178.8	vac.		$\sigma_t = 178.8 - 0.07(t-t_{mp})$ (t°C)			Sessile drop	1975	272		
	—		vac.	500	170			Drop pressure	1978	284		
	99.999	190	Ar		$\sigma_t = 190 - 0.035(t-600)$ (t°C) 480—760°C			Bubble pressure	1970	289		
	99.999		Ar		$\sigma_t = 174 + 0.14(t-450)$ 450—560°C			Bubble pressure	1970	289		
	99.99999	192	Ar		$\sigma_t = 192 - 0.03(t-600)$ 470—900°C			Bubble pressure	1970	289		
	99.99999		Ar		$\sigma_t = 179 + 0.095(t-450)$ 450—560°C			Bubble pressure	1970	289		
		978	vac.					Drop weight	1965	261		
	Th	—										
	Ti	98.7	1510	vac.					Capillary method	1956	44	
		99.92	1390	Ar					Pendant drop	1958	151	
		1460	vac.					Drop weight	1963	139		
99.9991		1650	vac.					Pendant drop	1963	5		
99.0			vac.	1680	1576			Drop weight	1963	191		
99.99999			vac.	1680	1588			Drop weight	1963	191		
99.85		(1880)	vac.					Pendant drop	1965	65		
99.69		1402	vac.					Pendant drop	1965	65		
—		1410 ± 10	vac.					Pendant drop	1972	229		
			H <sub>2</sub>	318	436—444			Bubble pressure	1929	11,174		
Tl		464.5	Ar					Bubble pressure	1961	192		
			vac.	450	452			Drop pressure	1962	119		
	—		vac.	450	450			Electro-capillarity	1963	117		
	99.999	467			$\sigma = 536 - 0.119T$ (T K) (1270—1695 K)			Bubble pressure	1968	26		
	99.999		vac.	450	450			Drop pressure	1968	107		
	99.999	451	vac.		$\sigma_t = 451 - 0.106(t-t_{mp}) - 750^\circ\text{C}$			Sessile drop	1978	284		
	99.999	(513)	Ar		$(\sigma_t = 513 - 0.11(t-t_{mp}))$ 500—900°C			Bubble pressure	1979	289		
	U	99.999	1500 ± 75	vac.				Pendant drop	1963	186		
		1550	Ar					Bubble pressure	1965	34		
		99.94	(1294)	vac.				Pendant drop	1965	65		
	99.993		Ar	1190—1600	1450			Sessile drop	1971	256		
V	99.997	1950	vac.					Pendant drop	1963	5		
	—	(1760)	vac.					Pendant drop	1970	210		
W	—	2310	vac.					Pendant drop	1957	35		
	99.9999	2500	vac.					Pendant drop	1963	5		
	99.8	2220	vac.					Pendant drop	1963	148		
	99.9	(2000)	vac.					Pendant drop	1965	65		
	Xe	99.98	18.7	air	162°K	18.7			Capillary rise	1965	305	
Zn		757	vac.	459	754	500	747	600	738	Oscillating jet	1914	73
			air	580—630	(708)					Capillary method	1914	183
		758	H <sub>2</sub>	477	753	543	747			Drop pressure	1921	78
		830	H <sub>2</sub>	600	787	700	763			Bubble pressure	1927	20
		784.4	vac.	545	749.5	635	728.9			Drop weight	1927	131
		802	H <sub>2</sub> ,Ar	510	785	600	768	640	761	Bubble pressure	1929	111
			air,vac.	462	782					Ring removal	1937	96
	99.99		N <sub>2</sub>	440	(816)	500	(798)	600	(774)	Bubble pressure	1948	149
	99.9	750 ± 20	ar							Bubble pressure	1960	104
	99.99	757.0 ± 5	vac.							Sessile drop	1966	202
	99.999	761.0	vac.							Sessile drop	1966	202
	99.9999	767.5	vac.							Sessile drop	1966	202
	99.99	—	vac.	450	770					Sessile drop	1972	250
	99.999	780	vac.		$\sigma_t = 780 - 0.17(t-t_{mp})$ (430—495°C)					Drop pressure	1962	253
	99.999	—	Ar	490 ± 10	780 ± 10					Bubble pressure	1979	288
	99.997	806	vac.		$\sigma_t = 806 - 0.25(t-t_{mp})$ (t°C) 420—800°C					Sessile drop	1979	297
	Zr	—	1400	Ar						Drop weight	1958	151
	99.5	1411 ± 70	vac.							Drop weight	1962	180
	99.9998	1480	vac.							Pendant drop	1963	5
	99.7	(1533)	vac.							Pendant drop	1965	65
—	1430 ± 10	vac.							Pendant drop	1972	229	

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## TEMPERATURE CORRECTION FOR GLASS VOLUMETRIC APPARATUS

This table gives the correction to be added to actual capacity (determined at certain temperatures) to give the capacity at the standard temperature, 20°C. Conversely, by subtracting the corrections from the indicated capacity of an instrument standard at 20°C, the corresponding capacity at other temperatures is obtained. The table assumes for the cubical coefficient of expansion of glass 0.00025 per degree centigrade. The coefficients of expansion of glasses used for volumetric instruments vary from 0.00023 to 0.00028.

Temperature in degrees C.	2,000 ml	1,000 ml	500 ml	400 ml	300 ml	250 ml	Temperature in degrees C.	2,000 ml	1,000 ml	500 ml	400 ml	300 ml	250 ml
15	+0.25	+1.12	+0.06	+0.05	+0.04	+0.031	23	-.15	-.08	-.04	-.03	-.02	-.019
16	+.20	+.10	+.05	+0.04	+.03	+.025	24	-.20	-.10	-.05	-.04	-.03	-.025
17	+.15	+.08	+.04	+.03	+.02	+.019	25	-.25	-.12	-.06	-.05	-.04	-.031
18	+.10	+.05	+.02	+.02	+.02	+.012	26	-.30	-.15	-.08	-.06	-.04	-.038
19	+.05	+.02	+.01	+.01	+.01	+.006	27	-.35	-.18	-.09	-.07	-.05	-.044
21	-.05	-.02	-.01	-.01	-.01	-.006	28	-.40	-.20	-.10	-.08	-.06	-.050
22	-.10	-.05	-.02	-.02	-.02	-.012	29	-.45	-.22	-.11	-.09	-.07	-.056
							30	-.50	-.25	-.12	-.10	-.08	-.062

### TEMPERATURE CORRECTION FOR VOLUMETRIC SOLUTIONS

This table gives the correction to various observed volumes of water, measured at the designated temperatures to give the volume at the standard temperature, 20°C. Conversely, by subtracting the corrections from the volume desired at 20°C., the volume that must be measured out at the designated temperatures in order to give the desired volume at 20°C., will be obtained. It is assumed that the volumes are measured in glass apparatus having a coefficient of cubical expansion of 0.000025 per degree centigrade. The table is applicable to dilute aqueous solutions having the same coefficient of expansion as water.

Temperature of measurement, °C.	Capacity of apparatus in milliliters at 20°C.							Temperature of measurement, °C.	Capacity of apparatus in milliliters at 20°C.						
	2,000	1,000	500	400	300	250	150		2,000	1,000	500	400	300	250	150
	Correction in milliliters to give volume of water at 20°C.								Correction in milliliters to give volume of water at 20°C.						
15	+1.54	+0.77	+0.38	+0.31	+0.23	+0.19	+0.12	24	-1.61	-.81	-.40	-.32	-.24	-.20	-.12
16	+1.28	+.64	+.32	+.26	+.19	+.16	+.10	25	-2.07	-1.03	-.52	-.41	-.31	-.26	-.15
17	+.99	+.50	+.25	+.20	+.15	+.12	+.07	26	-2.54	-1.27	-.64	-.51	-.38	-.32	-.19
18	+.68	+.34	+.17	+.14	+.10	+.08	+.05	27	-3.03	-1.52	-.76	-.61	-.46	-.38	-.23
19	+.35	+.18	+.09	+.07	+.05	+.04	+.03	28	-3.55	-1.77	-.89	-.71	-.53	-.44	-.27
21	-.37	-.18	-.09	-.07	-.06	-.05	-.03	29	-4.08	-2.04	-1.02	-.82	-.61	-.51	-.31
22	-.77	-.38	-.19	-.15	-.12	-.10	-.06	30	-4.62	-2.31	-1.16	-.92	-.69	-.58	-.35
23	-1.18	-.59	-.30	-.24	-.18	-.15	-.09								

In using the above table to correct the volume of certain standard solutions to 20°C. more accurate results will be obtained if the numerical values of the corrections are increased by the percentages given below:

Solution	Normality		
	N	N/2	N/10
HNO <sub>3</sub>	50	25	6
H <sub>2</sub> SO <sub>4</sub>	45	25	5
NaOH	40	25	5
KOH	40	20	4

## TEMPERATURE CORRECTION, GLASS SCALE

Metric

To reduce readings of a mercurial barometer with a glass scale to 0°C. subtract the appropriate quantity as found in table.

Temp °C	Observed height in centimeters.										Temp. °C	Observed height in centimeters.									
	70 cm	71 cm	72 cm	73 cm	74 cm	75 cm	76 cm	77 cm	78 cm	79 cm		80 cm	81 cm	82 cm	83 cm	84 cm	85 cm	86 cm	87 cm	88 cm	
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15	0.181	0.184	0.186	0.189	0.191	0.193	0.196	0.198	0.201	
1	.012	.012	.013	.013	.013	.013	.013	.013	.014	.014	16	.194	.196	.199	.201	.204	.207	.209	.212	.214	
2	.025	.025	.025	.026	.026	.026	.026	.027	.027	.027	17	.205	.208	.210	.213	.216	.219	.221	.224	.227	
3	.036	.036	.037	.037	.038	.038	.039	.039	.040	.040	18	.217	.220	.223	.226	.229	.232	.235	.238	.241	
4	.048	.049	.049	.050	.051	.051	.052	.053	.053	.053	19	.230	.233	.236	.239	.242	.245	.248	.251	.254	
5	.060	.061	.062	.063	.064	.064	.065	.066	.067	.067	20	.242	.245	.248	.252	.255	.258	.261	.264	.268	
6	.073	.074	.074	.076	.077	.077	.078	.079	.080	.080	21	.254	.258	.261	.264	.268	.271	.275	.278	.281	
7	.085	.086	.087	.088	.089	.091	.092	.093	.094	.094	22	.266	.269	.273	.276	.280	.283	.287	.290	.294	
8	.096	.098	.099	.100	.101	.103	.104	.105	.107	.107	23	.278	.282	.285	.289	.293	.296	.300	.304	.308	
9	.109	.110	.111	.113	.114	.116	.117	.119	.120	.120	24	.290	.294	.298	.302	.306	.310	.313	.317	.321	
10	.121	.122	.124	.126	.127	.129	.130	.132	.134	.134	25	.303	.307	.311	.315	.319	.323	.327	.331	.335	
11	.133	.135	.137	.138	.140	.142	.144	.146	.147	.147	26	.315	.319	.323	.327	.332	.336	.340	.344	.348	
12	.144	.146	.148	.150	.152	.154	.156	.158	.160	.160	27	.326	.331	.335	.339	.344	.348	.352	.357	.361	
13	.157	.159	.161	.163	.165	.167	.169	.171	.174	.174	28	.339	.343	.348	.352	.357	.361	.366	.370	.375	
14	.169	.171	.174	.176	.178	.180	.183	.185	.187	.187	29	.351	.356	.360	.365	.370	.374	.379	.384	.388	
											30	.363	.368	.373	.378	.383	.387	.392	.397	.402	



# THE LIMITS OF SUPERHEAT OF PURE LIQUIDS

C. T. Avedisian

The limit of superheat of a liquid, also known as the homogenous nucleation limit, represents the deepest possible penetration of a liquid into the domain of metastable states. At constant pressure ( $P$ ) it is the highest temperature ( $T$ ) below the critical point that a liquid can sustain without undergoing a phase transition; at constant temperature, it is the lowest pressure. The importance of this limit resides in the consequences of the phase transition that eventually occurs when the limit is reached. The phase transition may be explosive or nonexplosive as it relates to such processes as contact vapor explosions in postulated nuclear reactor accidents, spills of liquid natural gas during transport, and burning of fuel droplets.

The perspective upon which the concept of a superheat limit emerges is based on random molecular density fluctuations within the bulk of a liquid producing hole-like regions of molecular dimensions that act as bubbles. A phase transition occurs when a bubble, formed by these molecular processes, grows to a size such that it is in unstable equilibrium (i.e., a "critical size nucleus") with the surrounding liquid. The "nucleation rate",  $J$ , refers to the mean rate of forming such vapor nuclei in units of nuclei/(volume\*time).

According to classical homogeneous nucleation theory, the nucleation rate depends exponentially on the energy ( $\Phi$ ) of forming a critical size nucleus as follows:

$$J = \Gamma k_n N_o \exp[-\Phi/(kT)] \quad (1)$$

where

$$\Phi = 16 \pi \sigma^3 / [3(P_b - P)^2] \quad (2)$$

and  $k$  is the Boltzmann constant,  $k_n$  is the molecular evaporation rate for a nucleus containing  $n$  molecules,  $N_o$  is the number density of liquid molecules,  $P$  is the ambient pressure,  $P_b$  is the gas pressure within the critical size nucleus,  $\sigma$  is surface tension, and  $\Gamma$  is a kinetic pre-factor which accounts for the possibility that nuclei larger than the critical size may decay; if every critical size nucleus continues to grow, then  $\Gamma = 1$ . From Equations (1) and (2), it is evident that 1) a unique superheat limit does not exist because to each nucleation rate corresponds its own superheat limit at a given ambient pressure, 2) if  $J$  increases so should  $T$  at constant pressure, and 3)  $J$  depends very strongly on  $T$  because of the variation of physical properties (surface tension, vapor pressure, and density) with temperature. This strong dependence implies the existence of a threshold temperature above which  $J$  will be large and below which it will be negligibly small. The limit of superheat is defined as the mean temperature in this range of large change of  $J$ .

The limits of superheat given below are organized as follows. All substances are listed in alphabetical order by chemical formula. Inorganic substances are listed first, followed by organic compounds in the order of increasing carbon number. The second and third columns list the nucleation pressures and temperatures at the corresponding nucleation rate. The nucleation rates listed are characteristic of the various experimental methods used to perform the measurements.

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Substance	$P$ [MPa]	$T$ [K]	$J$ [nuclei/(cm <sup>3</sup> -s)]
Ar Argon	-1.220	85.0	10 <sup>2</sup>
	0.101	130.8	10 <sup>2</sup>
	0.190	131.2	10 <sup>2</sup>
	0.260	131.5	10 <sup>5</sup>
	0.360	131.8	10
	0.410	131.9	10 <sup>5</sup>
	0.600	132.8	10 <sup>5</sup>
	0.810	133.5	10 <sup>3</sup>
	1.100	134.3	10
	1.150	135.1	10 <sup>5</sup>
	1.400	135.3	10
	1.420	136.0	10 <sup>5</sup>
	1.720	137.1	10 <sup>5</sup>
2.140	138.6	10 <sup>5</sup>	
2.450	139.5	10 <sup>5</sup>	
2.710	141.3	10 <sup>5</sup>	
H <sub>2</sub> Hydrogen	0.076	27.8	10 <sup>-2</sup>
	0.149	27.9	10 <sup>-2</sup>
	0.381	29.4	10 <sup>-2</sup>
	0.751	30.6	10 <sup>-2</sup>
	0.834	30.8	10 <sup>-2</sup>

THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
H <sub>2</sub> O	-27.700	283.2	10 <sup>3</sup>
Water	0.101	553.0	10 <sup>6</sup>
	0.101	575.2	10 <sup>15</sup>
	1.293	580.4	10 <sup>21</sup>
	2.519	584.9	10 <sup>21</sup>
	2.710	588.3	10 <sup>21</sup>
	5.000	593.6	10 <sup>21</sup>
	6.808	600.4	10 <sup>21</sup>
	8.500	606.5	10 <sup>21</sup>
	9.731	607.2	10 <sup>21</sup>
	10.746	610.3	10 <sup>21</sup>
	11.978	615.6	10 <sup>21</sup>
	12.873	616.7	10 <sup>21</sup>
	13.731	620.2	10 <sup>21</sup>
	15.789	627.0	10 <sup>21</sup>
	17.556	632.3	10 <sup>21</sup>
20.113	642.2	10 <sup>21</sup>	
He I	0.012	4.05	10 <sup>7</sup>
Helium I	0.017	4.12	10 <sup>7</sup>
	0.037	4.22	10 <sup>7</sup>
	0.054	4.31	10 <sup>7</sup>
	0.066	4.37	10 <sup>7</sup>
	0.081	4.45	10 <sup>7</sup>
	0.100	4.55	10 <sup>7</sup>
	0.112	4.62	10 <sup>7</sup>
	0.129	4.70	10 <sup>7</sup>
	0.143	4.76	10 <sup>7</sup>
He II	-0.06	2.09	10 <sup>5</sup>
Helium II			
Kr	0.400	182.5	10 <sup>5</sup>
Krypton	0.820	184.3	10 <sup>5</sup>
	1.200	187.0	10 <sup>5</sup>
	1.410	187.6	10 <sup>5</sup>
	1.630	189.1	10 <sup>5</sup>
	1.900	189.9	10 <sup>5</sup>
	2.200	192.1	10 <sup>5</sup>
	2.430	192.9	10 <sup>5</sup>
	2.800	194.8	10 <sup>5</sup>
	3.140	196.6	10 <sup>5</sup>
	3.460	198.0	10 <sup>5</sup>
	3.800	199.4	10 <sup>5</sup>
N <sub>2</sub>	-1.010	75.0	10 <sup>2</sup>
Nitrogen	0.101	110.0	1.0
	0.410	111.4	10 <sup>5</sup>
	0.520	112.0	10 <sup>5</sup>
	0.610	112.1	10 <sup>5</sup>
	0.700	112.7	10 <sup>5</sup>
	0.820	113.2	10 <sup>5</sup>
	0.940	113.8	10 <sup>5</sup>
	1.060	114.2	10 <sup>5</sup>
	1.210	114.8	10 <sup>5</sup>
	1.240	115.2	10 <sup>5</sup>
	1.330	115.5	10 <sup>5</sup>

THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
	1.360	115.6	10 <sup>5</sup>
	1.460	116.2	10 <sup>5</sup>
	1.590	116.8	10 <sup>5</sup>
	1.620	117.0	10 <sup>5</sup>
	1.730	117.6	10 <sup>5</sup>
	1.770	117.7	10 <sup>5</sup>
	1.870	118.3	10 <sup>5</sup>
	1.920	118.4	10 <sup>5</sup>
	2.070	119.1	10 <sup>5</sup>
N <sub>2</sub> O <sub>4</sub>	0.154	395.6	10 <sup>2</sup>
Nitrogen tetroxide	0.554	396.2	10 <sup>2</sup>
	0.980	398.2	10
	2.000	401.5	10
	3.040	405.2	10
	3.920	408.1	10
	4.500	410.2	10
	5.000	412.5	10
	5.500	414.5	10
	6.000	416.4	10
O <sub>2</sub>	-1.520	75.0	10 <sup>2</sup>
Oxygen	0.101	134.1	1.0
	0.400	135.4	10 <sup>5</sup>
	0.500	136.2	10 <sup>5</sup>
	0.680	136.5	10 <sup>5</sup>
	0.920	137.4	10 <sup>5</sup>
	1.060	137.5	10 <sup>5</sup>
	1.180	138.3	10 <sup>5</sup>
	1.350	138.9	10 <sup>5</sup>
	1.480	139.3	10 <sup>5</sup>
	1.740	140.7	10 <sup>5</sup>
	2.030	141.9	10 <sup>5</sup>
	2.260	142.8	10 <sup>5</sup>
	2.500	143.6	10 <sup>5</sup>
	2.700	144.5	10 <sup>5</sup>
	2.970	145.9	10 <sup>5</sup>
SO <sub>2</sub>	0.101	323.2	10 <sup>2</sup>
Sulfur dioxide			
Xe	0.500	254.1	10 <sup>5</sup>
Xenon	0.830	256.3	10 <sup>5</sup>
	1.070	257.2	10 <sup>5</sup>
	1.260	258.2	10 <sup>5</sup>
	1.470	259.6	10 <sup>5</sup>
	1.550	260.3	10 <sup>5</sup>
	1.680	261.0	10 <sup>5</sup>
	1.750	261.6	10 <sup>5</sup>
	1.860	261.9	10 <sup>5</sup>
	1.970	262.8	10 <sup>5</sup>
	2.070	263.4	10 <sup>5</sup>
	2.170	263.8	10 <sup>5</sup>
	2.370	265.2	10 <sup>5</sup>
	2.480	266.1	10 <sup>5</sup>
	2.630	266.9	10 <sup>5</sup>
	2.750	267.5	10 <sup>5</sup>

**THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)**

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
	2.850	267.8	10 <sup>5</sup>
	2.970	269.1	10 <sup>5</sup>
	3.050	269.7	10 <sup>5</sup>
	3.130	270.0	10 <sup>5</sup>
	3.450	272.0	10 <sup>5</sup>
	3.630	273.0	10 <sup>5</sup>
CCl <sub>2</sub> F <sub>2</sub>	0.221	342.5	10 <sup>6</sup>
Dichlorodifluoromethane	0.427	344.3	10 <sup>6</sup>
	0.462	344.7	10 <sup>6</sup>
	0.655	346.6	10 <sup>6</sup>
	0.896	348.8	10 <sup>6</sup>
	0.931	349.0	10 <sup>6</sup>
	1.227	351.7	10 <sup>6</sup>
	1.489	354.4	10 <sup>6</sup>
	1.917	358.8	10 <sup>6</sup>
	2.399	363.7	10 <sup>6</sup>
	2.910	369.0	10 <sup>6</sup>
	3.289	373.0	10 <sup>6</sup>
	3.323	373.4	10 <sup>6</sup>
	3.585	376.2	10 <sup>6</sup>
	3.634	376.9	10 <sup>6</sup>
CCl <sub>4</sub>	-27.600	268.2	10 <sup>3</sup>
Carbon tetrachloride			
CHClF <sub>2</sub>	0.101	327.8	10 <sup>4</sup>
Chlorodifluoromethane	0.236	328.2	10 <sup>4</sup>
	0.280	329.4	10 <sup>4</sup>
	0.510	330.8	10 <sup>4</sup>
	0.560	331.5	10 <sup>4</sup>
	0.710	332.4	10 <sup>4</sup>
	0.810	332.9	10 <sup>4</sup>
	0.910	334.2	10 <sup>4</sup>
CHCl <sub>3</sub>	-31.700	258.2	10 <sup>3</sup>
Trichloromethane	0.101	466.2	10 <sup>2</sup>
CH <sub>2</sub> Cl <sub>2</sub>	0.101	394.8	10
Dichloromethane			
CH <sub>3</sub> Cl	0.101	366.2	10 <sup>5</sup>
Chloromethane			
CH <sub>4</sub>	0.400	167.6	10 <sup>5</sup>
Methane	0.620	168.3	10 <sup>5</sup>
	0.820	169.3	10 <sup>5</sup>
	1.030	170.5	10 <sup>5</sup>
	1.230	171.4	10 <sup>5</sup>
	1.430	172.1	10 <sup>5</sup>
	1.630	173.1	10 <sup>5</sup>
	1.830	174.0	10 <sup>5</sup>
	2.030	175.2	10 <sup>5</sup>
	2.220	176.4	10 <sup>5</sup>
	2.430	177.6	10 <sup>5</sup>
	2.630	178.6	10 <sup>5</sup>
	2.820	180.0	10 <sup>5</sup>



THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
CH <sub>2</sub> O	0.101	458.4	10
Methanol	0.101	461.2	10 <sup>5</sup>
	0.101	466.2	10 <sup>18</sup>
	0.600	469.2	10 <sup>19</sup>
	1.050	471.2	10 <sup>20</sup>
	2.030	476.7	10 <sup>16</sup>
	2.030	478.2	10 <sup>20</sup>
	3.000	482.2	10 <sup>21</sup>
	4.000	488.7	10 <sup>22</sup>
	4.980	494.7	10 <sup>22</sup>
	5.970	501.2	10 <sup>23</sup>
	6.960	507.7	10 <sup>23</sup>
C <sub>2</sub> H <sub>3</sub> Cl Chloroethane	0.101	374.1	10 <sup>5</sup>
C <sub>2</sub> H <sub>3</sub> F Fluoroethene	0.101	290.1	10 <sup>5</sup>
C <sub>2</sub> H <sub>3</sub> N Acetonitrile	0.101	497.0	10 <sup>6</sup>
C <sub>2</sub> H <sub>4</sub> F <sub>2</sub> 1,1-Difluoroethane	0.101	343.6	10 <sup>5</sup>
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> Acetic acid	-28.800 0.101	292.7 526.2	10 <sup>3</sup> 10 <sup>6</sup>
C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> Methyl formate	0.101	423.2	10
C <sub>2</sub> H <sub>5</sub> Br Ethyl bromide	0.101	422.2	10
C <sub>2</sub> H <sub>5</sub> Cl Ethyl chloride	0.101	399.2	10
C <sub>2</sub> H <sub>6</sub> Ethane	0.101	269.2	10 <sup>5</sup>
C <sub>2</sub> H <sub>6</sub> O Ethanol	0.101	464.1	10
	0.101	466.0	10 <sup>4</sup>
	0.101	471.5	10 <sup>17</sup>
	0.580	474.2	10 <sup>19</sup>
	0.980	471.0	10 <sup>2</sup>
	1.070	477.2	10 <sup>20</sup>
	1.540	481.7	10 <sup>20</sup>
	2.030	484.2	10 <sup>21</sup>
	2.520	486.7	10 <sup>21</sup>
	3.010	490.2	10 <sup>21</sup>
	3.500	494.2	10 <sup>22</sup>
C <sub>3</sub> H <sub>3</sub> N Acrylonitrile	0.101	489.0	10 <sup>5</sup>
C <sub>3</sub> H <sub>4</sub> Propadiene	0.101	346.2	10 <sup>5</sup>

THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
C <sub>3</sub> H <sub>4</sub> Propyne	0.101	356.8	10 <sup>5</sup>
C <sub>3</sub> H <sub>6</sub> Cyclopropane	0.101	350.7	10 <sup>5</sup>
C <sub>3</sub> H <sub>6</sub> Propene	0.101	325.6	10 <sup>5</sup>
C <sub>3</sub> H <sub>6</sub> O Acetone	0.101	454.5	10
	0.101	456.4	10 <sup>2</sup>
	0.101	458.7	10 <sup>13</sup>
	0.101	462.7	10 <sup>18</sup>
	0.980	462.6	10
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> Ethyl formate	0.101	428.5	10
C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> Methyl acetate	0.101	416.6	10
C <sub>3</sub> H <sub>8</sub> Propane	0.101	326.4	10 <sup>6</sup>
	0.302	332.8	10 <sup>4</sup>
	0.491	336.8	10 <sup>4</sup>
	0.715	339.1	10 <sup>4</sup>
	0.907	343.2	10 <sup>4</sup>
C <sub>3</sub> H <sub>8</sub> O 1-Propanol	0.101	487.4	10 <sup>4</sup>
	0.101	493.0	10 <sup>15</sup>
	0.101	495.7	10 <sup>18</sup>
C <sub>3</sub> H <sub>8</sub> O Isopropanol	0.101	473.0	10 <sup>6</sup>
C <sub>4</sub> H <sub>6</sub> 1,3-Butadiene	0.101	377.3	10 <sup>5</sup>
C <sub>4</sub> H <sub>8</sub> 1-Butene	0.101	371.0	10 <sup>5</sup>
C <sub>4</sub> H <sub>8</sub> <i>cis</i> -2-Butene	0.101	385.4	10 <sup>5</sup>
C <sub>4</sub> H <sub>8</sub> <i>trans</i> -2-Butene	0.101	379.7	10 <sup>5</sup>
C <sub>4</sub> H <sub>8</sub> 2-Methylpropene	0.101	369.6	10 <sup>5</sup>
C <sub>4</sub> H <sub>10</sub> Butane	0.101	377.6	10 <sup>5</sup>
C <sub>4</sub> H <sub>10</sub> 2-Methylpropane	0.101	361.0	10 <sup>5</sup>
C <sub>4</sub> H <sub>10</sub> O 1-Butanol	0.101	509.6	10 <sup>2</sup>
	0.101	511.9	10 <sup>4</sup>

THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
	0.101	513.2	10 <sup>13</sup>
	0.101	516.2	10 <sup>16</sup>
	0.101	518.2	10 <sup>18</sup>
	0.908	519.4	10 <sup>2</sup>
C <sub>4</sub> H <sub>10</sub> O Diethyl ether	-1.75	293.	10 <sup>2</sup>
	-1.520	402.7	10 <sup>4</sup>
	-1.220	407.6	10 <sup>4</sup>
	-1.120	409.2	10 <sup>4</sup>
	-1.000	410.2	10 <sup>4</sup>
	-0.740	413.4	10 <sup>4</sup>
	0.101	417.5	10 <sup>2</sup>
	0.101	425.7	10 <sup>19</sup>
	0.211	419.4	10
	0.415	420.3	10
	0.480	427.7	10 <sup>18</sup>
	0.500	421.1	10 <sup>2</sup>
	0.641	424.3	10 <sup>2</sup>
	0.777	426.3	10
	0.880	432.7	10 <sup>18</sup>
	1.000	428.4	10
	1.280	436.7	10
	1.366	433.6	10
	1.442	435.1	10 <sup>2</sup>
	1.575	437.2	10
	1.660	440.7	10 <sup>19</sup>
	1.865	441.2	10
	2.089	443.3	10
	2.450	450.7	10 <sup>21</sup>
	2.850	455.7	10 <sup>20</sup>
C <sub>4</sub> H <sub>10</sub> O Isobutanol	0.101	437.2	10
C <sub>4</sub> H <sub>11</sub> N Diethylamine	0.101	408.5	10
C <sub>5</sub> F <sub>12</sub> Perfluoropentane	0.101	381.5	10 <sup>6</sup>
	0.300	385.4	10 <sup>6</sup>
	0.500	388.7	10 <sup>6</sup>
	0.700	392.2	10 <sup>6</sup>
	0.890	396.4	10 <sup>6</sup>
	1.090	399.0	10 <sup>6</sup>
	1.280	403.1	10 <sup>6</sup>
	1.480	407.4	10 <sup>6</sup>
C <sub>5</sub> H <sub>8</sub> Cyclopentene	0.101	451.4	10 <sup>6</sup>
C <sub>5</sub> H <sub>10</sub> Cyclopentane	0.101	455.1	10 <sup>6</sup>
C <sub>5</sub> H <sub>10</sub> 1-Pentene	0.101	417.2	10 <sup>6</sup>
C <sub>5</sub> H <sub>12</sub> 2,2-Dimethylpropane	0.101	386.1	10 <sup>6</sup>

**THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)**

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
C <sub>5</sub> H <sub>12</sub> Isopentane	0.101	409.2	10
	0.101	411.7	10 <sup>7</sup>
C <sub>5</sub> H <sub>12</sub> Pentane	0.101	418.8	10 <sup>4</sup>
	0.101	426.2	10 <sup>18</sup>
	0.490	423.7	10 <sup>2</sup>
	0.880	429.1	10 <sup>2</sup>
	1.280	435.3	10 <sup>2</sup>
	2.600	451.2	10 <sup>6</sup>
C <sub>5</sub> H <sub>12</sub> O 1-Pentanol	0.101	551.7	10 <sup>4</sup>
C <sub>6</sub> F <sub>6</sub> Hexafluorobenzene	0.101	464.8	10
	0.101	467.9	10 <sup>6</sup>
	0.500	469.9	10 <sup>2</sup>
	0.570	474.1	10 <sup>6</sup>
	1.000	477.1	10 <sup>2</sup>
	1.050	480.4	10 <sup>6</sup>
	1.540	486.0	10 <sup>6</sup>
	2.030	494.2	10 <sup>6</sup>
C <sub>6</sub> F <sub>14</sub> Perfluorohexane	0.101	409.8	10 <sup>6</sup>
	0.300	414.4	10 <sup>6</sup>
	0.500	418.5	10 <sup>6</sup>
	0.700	422.3	10 <sup>6</sup>
	0.880	425.6	10 <sup>6</sup>
	1.050	430.3	10 <sup>6</sup>
	1.240	434.6	10 <sup>6</sup>
C <sub>6</sub> H <sub>5</sub> Br Bromobenzene	0.101	534.2	10 <sup>2</sup>
C <sub>6</sub> H <sub>5</sub> Cl Chlorobenzene	0.101	523.2	10 <sup>2</sup>
C <sub>6</sub> H <sub>6</sub> Benzene	-15.000	291.2	10 <sup>3</sup>
	0.101	498.9	10 <sup>2</sup>
	0.101	510.2	10 <sup>18</sup>
	0.490	502.2	10 <sup>2</sup>
	0.580	514.2	10 <sup>19</sup>
	0.980	509.2	10 <sup>2</sup>
	1.070	516.7	10 <sup>18</sup>
	1.470	513.8	10 <sup>2</sup>
	1.540	520.7	10 <sup>19</sup>
	2.030	525.7	10 <sup>19</sup>
	2.520	532.2	10 <sup>20</sup>
	3.010	537.7	10 <sup>17</sup>
3.500	544.7	10 <sup>18</sup>	
C <sub>6</sub> H <sub>7</sub> N Aniline	-30.000	272.2	10 <sup>3</sup>
	0.101	535.2	10 <sup>2</sup>
C <sub>6</sub> H <sub>10</sub> 1-Hexyne	0.101	465.2	10 <sup>6</sup>

**THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)**

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> -s)]
C <sub>6</sub> H <sub>12</sub> Cyclohexane	0.101	490.8	10 <sup>6</sup>
	0.300	493.1	10 <sup>2</sup>
	0.420	495.2	10 <sup>6</sup>
	0.720	499.7	10 <sup>6</sup>
	0.950	501.7	10 <sup>6</sup>
	0.980	502.1	10 <sup>2</sup>
	1.110	504.2	10 <sup>6</sup>
	1.350	506.2	10 <sup>6</sup>
	1.700	512.2	10 <sup>6</sup>
	2.160	518.2	10 <sup>6</sup>
C <sub>6</sub> H <sub>12</sub> Methylcyclopentane	0.101	476.1	10 <sup>6</sup>
	0.101	446.4	10 <sup>6</sup>
	0.101	453.5	10 <sup>2</sup>
	0.101	454.9	10 <sup>5</sup>
	0.101	459.2	10 <sup>13</sup>
	0.101	463.7	10 <sup>20</sup>
	0.290	465.2	10 <sup>15</sup>
	0.420	461.7	10 <sup>6</sup>
C <sub>6</sub> H <sub>14</sub> Hexane	0.490	459.3	10 <sup>2</sup>
	0.490	468.2	10 <sup>22</sup>
	0.760	466.7	10 <sup>6</sup>
	0.980	467.0	10 <sup>2</sup>
	0.980	475.2	10 <sup>23</sup>
	1.080	471.7	10 <sup>6</sup>
	1.120	478.2	10 <sup>15</sup>
	1.280	474.7	10 <sup>6</sup>
	1.420	475.7	10 <sup>6</sup>
	1.590	479.7	10 <sup>6</sup>
	1.600	486.2	10 <sup>16</sup>
	1.720	481.7	10 <sup>6</sup>
	1.960	487.7	10 <sup>17</sup>
	2.060	493.2	10 <sup>16</sup>
2.390	496.7	10 <sup>6</sup>	
2.570	501.2	10 <sup>16</sup>	
C <sub>6</sub> H <sub>14</sub> O 1-Hexanol	0.101	551.7	10 <sup>4</sup>
C <sub>7</sub> F <sub>8</sub> Octafluorotoluene	0.101	485.3	10
	0.490	489.7	10
	0.980	499.8	10
C <sub>7</sub> F <sub>16</sub> Perfluoroheptane	0.101	434.8	10 <sup>6</sup>
	0.230	436.9	10 <sup>6</sup>
	0.400	440.5	10 <sup>6</sup>
	0.570	444.4	10 <sup>6</sup>
	0.770	448.3	10 <sup>6</sup>
0.920	452.7	10 <sup>6</sup>	

THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	[nuclei/(cm <sup>3</sup> ·s)]
	1.070	456.1	10 <sup>6</sup>
	1.150	459.0	10 <sup>6</sup>
	1.280	461.3	10 <sup>6</sup>
C <sub>7</sub> H <sub>8</sub> Toluene	0.101	526.7	10 <sup>2</sup>
C <sub>7</sub> H <sub>14</sub> Methylcyclohexane	0.101	510.4	10 <sup>6</sup>
C <sub>7</sub> H <sub>16</sub> Heptane	0.101	486.9	10 <sup>6</sup>
	0.101	493.7	10 <sup>18</sup>
	0.294	489.2	10 <sup>6</sup>
	0.392	490.7	10 <sup>6</sup>
	0.490	493.7	10 <sup>6</sup>
	0.589	494.2	10 <sup>6</sup>
	0.736	498.7	10 <sup>6</sup>
	0.952	500.7	10 <sup>6</sup>
	1.275	505.2	10 <sup>6</sup>
	1.373	509.7	10 <sup>6</sup>
	1.570	512.7	10 <sup>6</sup>
	1.736	515.2	10 <sup>6</sup>
	1.805	516.7	10 <sup>6</sup>
	2.001	519.7	10 <sup>6</sup>
C <sub>7</sub> H <sub>16</sub> O 1-Heptanol	0.101	566.3	10 <sup>4</sup>
C <sub>8</sub> F <sub>18</sub> Perfluorooctane	0.101	457.0	10 <sup>6</sup>
	0.300	461.1	10 <sup>6</sup>
	0.500	467.1	10 <sup>6</sup>
	0.700	471.2	10 <sup>6</sup>
	0.890	476.9	10 <sup>6</sup>
	1.090	482.8	10 <sup>6</sup>
	1.190	484.1	10 <sup>6</sup>
C <sub>8</sub> H <sub>10</sub> Cyclooctane	0.101	560.7	10 <sup>6</sup>
C <sub>8</sub> H <sub>10</sub> 2,3-dimethylbenzene	0.101	508.2	10 <sup>2</sup>
C <sub>8</sub> H <sub>16</sub> 1-Octene	0.101	510.3	10 <sup>6</sup>
C <sub>8</sub> H <sub>18</sub> Octane	0.101	513.8	10 <sup>6</sup>
	0.377	519.3	10 <sup>4</sup>
	0.653	525.2	10 <sup>4</sup>
	0.929	528.6	10 <sup>4</sup>
	1.204	532.4	10 <sup>4</sup>
C <sub>8</sub> H <sub>18</sub> 2,2,4-Trimethylpentane	0.101	488.5	10 <sup>6</sup>
C <sub>8</sub> H <sub>18</sub> O 1-Octanol	0.101	586.0	10 <sup>4</sup>

**THE LIMITS OF SUPERHEAT OF PURE LIQUIDS (CONTINUED)**

<i>P</i> Substance	<i>T</i> [MPa]	<i>J</i> [K]	<i>S</i> [nuclei/(cm <sup>3</sup> .s)]
C <sub>9</sub> F <sub>20</sub> Perfluorononane	0.101	478.5	10 <sup>6</sup>
	0.300	484.4	10 <sup>6</sup>
	0.500	489.3	10 <sup>6</sup>
	0.700	493.3	10 <sup>6</sup>
	0.890	499.7	10 <sup>6</sup>
	1.090	505.7	10 <sup>6</sup>
C <sub>9</sub> H <sub>20</sub> Nonane	0.101	538.5	10 <sup>6</sup>
C <sub>10</sub> F <sub>22</sub> Perfluorodecane	0.101	497.1	10 <sup>6</sup>
	0.300	503.2	10 <sup>6</sup>
	0.500	508.6	10 <sup>6</sup>
	0.700	515.6	10 <sup>6</sup>
	0.890	521.2	10 <sup>6</sup>
	1.090	527.7	10 <sup>6</sup>
C <sub>10</sub> H <sub>22</sub> Decane	0.101	558.3	10 <sup>6</sup>
C <sub>12</sub> H <sub>10</sub> O Diphenylether	0.101	703.2	10 <sup>17</sup>
	0.101	708.7	10 <sup>19</sup>

THERMAL CONDUCTIVITY OF ROCKS

Rock	Temperature, °C	Conductivity Kcal·m·m <sup>-2</sup> ·h <sup>-1</sup> ·°C <sup>-1</sup>	Heat Capacity, cal·g <sup>-1</sup> ·°C <sup>-1</sup>
Granite	0	3.02	0.192
	50	2.81	—
	100	2.59	—
	200	2.34	0.228
	300	2.12	—
	400	—	0.258
Marble	118	1.44	0.21
	196	1.29	0.24
	245	1.19	—
	360	0.95	0.271
Dolomitic limestone	130	1.41	—
	181	1.37	—
	268	1.29	—
	377	1.15	—
Shale	0	1.65	0.17
	100	1.51	—
	120	1.33	—
	188	1.41	0.24
	304	1.26	0.245
Sandstone (quartzitic)	0	4.9	—
	100	3.82	0.26
	200	3.24	—



### TOTAL MONTHLY SOLAR RADIATION IN A CLOUDLESS SKY

Total radiation is the sum of the direct and scattered radiation that strikes the earth's surface. It is influenced by the degree of cloudiness, atmospheric transparency, duration of sunshine, and height of elevation at which the measurements are taken. Deviations from values in this table are bound to occur; however, it is believed that the deviations do not exceed  $\pm 10\%$  for the summer months and  $\pm 15\%$  for the winter months. The radiation units in this table are kcal/cm<sup>2</sup>.

$\varphi^\circ$	January	February	March	April	May	June	July	August	September	October	November	December
90 N	0	0	0.1	10.0	21.9	26.0	23.8	12.9	2.4	0	0	0
85	0	0	0.7	10.2	21.8	25.8	23.4	13.1	3.0	0	0	0
80	0	0	2.4	10.8	21.4	25.2	23.0	13.4	4.3	0.5	0	0
75	0	0.5	4.0	11.7	21.0	24.5	22.2	13.8	5.8	1.3	0	0
70	0	1.6	6.0	13.1	20.5	23.6	21.2	14.6	7.5	2.7	0.5	0
65	0.7	2.8	8.0	14.5	20.1	22.8	21.0	15.6	9.5	4.3	1.4	0.2
60	1.8	4.3	9.9	16.0	20.8	22.9	21.4	16.7	11.3	6.1	2.6	1.1
55	3.1	6.2	11.7	17.3	21.4	23.4	21.9	17.9	12.9	7.8	4.0	2.3
50	4.8	8.2	13.3	18.5	22.2	23.7	22.6	19.1	14.4	9.7	5.8	3.9
45	6.7	10.3	14.8	19.5	22.6	23.9	23.2	20.1	15.8	11.5	7.8	5.9
40	8.8	12.2	16.4	20.3	23.0	24.0	23.4	20.9	17.0	13.2	9.7	7.7
35	10.7	14.0	17.6	21.0	23.0	24.0	23.6	21.6	18.1	14.7	11.4	9.7
30	12.5	15.5	18.6	21.4	23.0	23.8	23.4	21.8	19.1	16.1	13.1	11.5
25	14.1	16.8	19.5	21.6	23.0	23.4	23.1	21.8	19.8	17.4	14.6	13.1
20	15.5	17.9	20.2	21.6	22.5	22.8	22.6	21.6	20.4	18.5	16.1	14.7
15	16.9	19.0	20.8	21.4	21.9	22.0	21.9	21.2	20.9	19.3	17.4	16.1
10	18.1	19.8	21.1	21.2	21.2	21.0	21.1	20.6	21.2	20.1	18.5	17.5
5	19.3	20.4	21.4	21.0	20.2	19.9	20.0	20.0	21.3	20.6	19.5	18.8
0	20.2	20.9	21.5	20.4	19.3	18.8	19.1	19.3	21.2	21.2	20.4	19.2
5S	20.1	21.4	21.4	19.9	18.3	17.6	17.9	18.3	20.8	21.4	21.8	21.0
10	22.0	21.8	21.1	19.2	17.7	16.3	16.3	17.3	20.4	21.4	21.8	22.0
15	22.6	22.0	20.6	18.3	16.0	14.9	15.4	16.1	19.7	21.3	22.4	22.9
20	23.2	22.0	20.0	17.2	14.7	13.4	13.8	14.9	18.9	21.0	22.6	23.6
25	23.6	22.0	19.4	16.0	13.0	12.0	12.6	13.6	18.0	20.6	23.0	24.1
30	23.9	21.8	18.6	14.9	11.9	10.6	11.1	12.1	17.0	20.1	23.0	24.6
35	24.0	21.3	17.6	13.6	10.4	9.0	9.6	10.6	15.9	19.5	23.0	25.0
40	24.0	20.6	16.4	12.2	8.7	7.3	8.1	9.0	14.3	18.7	22.8	25.2
45	24.0	19.9	15.2	10.7	7.1	5.5	6.3	7.3	13.4	17.7	22.4	25.2
50	23.6	18.9	13.8	9.2	5.4	3.8	4.6	5.5	12.0	16.6	21.8	25.0
55	23.2	17.8	12.3	7.5	3.8	2.3	3.0	3.8	10.3	15.4	21.2	24.6
60	22.6	16.6	10.8	5.6	2.4	1.0	1.6	2.3	8.5	14.1	21.0	24.4
65	22.4	15.3	9.1	3.9	1.1	0.1	0.4	1.0	6.7	12.6	20.8	24.5
70	22.6	14.2	7.3	2.2	0.1	0	0	0	5.0	11.4	21.0	24.9
75	23.2	13.4	5.7	0.9	0	0	0	0	3.5	10.4	21.2	25.4
80	24.0	12.8	4.3	0	0	0	0	0	2.1	9.7	21.9	26.0
85	24.6	12.4	2.9	0	0	0	0	0	0.9	9.2	22.4	26.6
90	24.9	12.3	1.7	0	0	0	0	0	0	9.0	22.6	27.0

## TRANSMISSION OF CORNING COLORED FILTERS

Supplied by R. G. Saxton

If  $I_0$  is the intensity of radiation entering a layer of some medium and  $I$  the intensity reaching the opposite surface, the ratio  $I/I_0$  is called the transmittance. In practice the ratio of intensity of radiation passing through a glass sample to that incident on its surface is often measured and plotted as transmission. The transmission is the result of two factors, the transmittance of the glass and the losses by reflection. These losses amount to about 4% for each glass-air surface; the transmission of a sample is about 92% of its transmittance. Since the reflection losses differ slightly with different samples, the correction is often determined and applied when the transmission is measured. Values in this table have been corrected for reflection losses.

The identifying glass number, CS number, color and properties, and nominal thickness for the Corning glasses in this table are:

Glass No.	CS	Color and properties	Nominal thickness
0160	0-54	Clear; Ultraviolet transmitting	2.0
2030	2-64	Red; Sharp cut	3.0
2403	2-58	Red; Sharp cut	3.0
2404	2-59	Red; Sharp cut	3.0
2408	2-60	Red; Sharp cut	3.0
2412	2-61	Red; Sharp cut	3.0
2418	2-62	Red; Sharp cut	3.0
2424	2-63	Red; Sharp cut	3.0
2434	2-73	Red; Sharp cut	3.0
2540	7-56	Black; IR transmitting; Visible absorbing	2.5
2550	7-57	Black; IR transmitting; Visible absorbing	2.0
2600	7-69	Black; IR transmitting; Visible absorbing	3.0
3060	3-75	Straw	2.0
3304	3-76	Dark amber	3.0
3307	3-77	Dark amber	3.0
3384	3-70	Yellow	3.0
3385	3-71	Yellow	3.0
3387	3-72	Straw	3.0
3389	3-73	Straw	3.0
3391	3-74	Straw	3.0
3480	3-66	Yellow; Sharp cut	3.0
3482	3-67	Yellow; Sharp cut	3.0
3484	3-68	Yellow; Sharp cut	3.0
3486	3-69	Yellow; Sharp cut	3.0
3718	3-94	Yellow	3.0
3750	3-79	Yellow; Yellow green fluorescing	5.0
3780	3-80	Yellow	2.0
3850	0-51	Clear; UV transmitting	4.0
3961	1-56	Bluish; IR absorbing; Visible transmitting	2.5
3962	1-57	Bluish; IR absorbing; Visible transmitting	2.5
3965	1-58	Bluish; IR absorbing; Visible transmitting	2.5
3966	1-59	Bluish; IR absorbing; Visible transmitting	2.5
4010	4-64	Green	4.0
4015	4-65	Yellow green	3.0
4060	4-67	Green	2.0
4084	4-68	Green	4.5
4303	4-72	Blue green	4.0
4305	4-71	Blue green	4.0
4308	4-70	Blue green	4.0
4309	4-69	Blue green	4.0
4445	4-74	Green	2.5
4602	1-75	Bluish; IR absorbing; Visible transmitting	3.0
4784	4-94	Blue green	5.0
5030	5-57	Blue	5.0
5031	5-56	Blue	4.5
5070	7-62	Amethyst	3.9
5071	7-63	Amethyst	3.9
5073	7-64	Amethyst	3.9
5113	5-58	Blue	4.0
5120	1-60	Smoky violet; Absorbs yellow	5.2
5300	4-106	Green	3.9
5330	1-64	Blue	4.5
5433	5-59	Blue	5.0
5543	5-60	Blue	5.0
5562	5-61	Blue	5.0
5572	1-61	Blue	5.0
5840	7-60	Black; UV transmitting; Visible absorbing	4.5
5850	7-59	Purple; UV transmitting; Visible absorbing	4.0
5860	7-37	Black; UV transmitting; Visible absorbing	5.0
5874	7-39	Black; UV transmitting; Visible absorbing	5.0
5900	1-62	Blue	5.5
5970	7-51	Black; UV transmitting; Visible absorbing	5.0
7380	0-52	Clear; UV transmitting	2.0
7740	0-53	Clear; UV transmitting	2.0
7905	9-30	Clear; UV transmitting; Long Range IR transmitting	2.0
7910	9-54	Clear; UV transmitting	2.0
8364	7-98	Gray	2.0
9780	4-76	Blue green	5.0
9782	4-96	Blue green	5.0
9788	4-97	Blue green	5.0
9830	4-77	Green	3.4
9863	7-54	Black; UV transmitting; Visible absorbing	3.0





















# TRANSMISSION OF WRATTEN FILTERS

Compiled by Allie C. Peed, Jr. for The Eastman Kodak Company

Data condensed from Kodak Wratten Filters for Scientific and Technical Use published by the Eastman Kodak Company, manufacturers of the filters.

The following pages give (1) percentage luminous transmittance at wave lengths from 400 to 700 $\mu$  at intervals of 10 $\mu$  for the standard illuminant "C" adopted by the International Commission of Illumination, (2) dominant wavelength in millimicrons, and (3) percentage of excitation purity. Values of wave length followed by "c" indicate the complementary wave lengths of purple filters which do not have a dominant wave length.

All colorimetric specifications are based on the 1931 standard ICI colorimetric and luminosity data.

The transmittance data are given as representing standard samples of the filters. They are intended only for the information of users in choosing filters which will meet their requirements. Values taken from the tables of data should not be used by research workers as representing precisely the absorption characteristics of a particular filter. If such precise data are needed, they should be determined for the particular filter being used.

Where the spectra extend into the ultraviolet this fact is indicated by an asterisk (\*) in the transmission tables immediately beneath the filter number, and quantitative data are not given. The manufacturer should be consulted for this information. Transmission in the ultraviolet of wave lengths less than 330 $\mu$  will be eliminated in the case of cemented filters, as glass absorbs ultraviolet radiation of wave lengths shorter than about 330 $\mu$ .

Stability ratings are given as three letter combinations following the filter description in the table below. In establishing the stability classifications each filter is exposed to a selected light source for a specific time interval. The following grading system is used to describe the result:

Class A — stable  
 Class B — relatively stable  
 Class C — somewhat unstable  
 Class D — unstable

The classification letters, for example, AAA, describe the stability to the following three exposure tests in this order:

1. Two weeks' exposure to daylight in a south window
2. Twenty-four hours' exposure to a "Fade-Ometer"
3. Two weeks' exposure at two feet from a 1000-watt tungsten lamp.

Filters are supplied in two forms: as lacquered gelatin film, or as a gelatin film cemented between pieces of optical glass. Filters in glass are cemented between sheets of plane-parallel glass, which is surfaced in quantities and is of sufficient accuracy for general photographic work, and for most scientific purposes.

Most Wratten Gelatin Filters are stocked in 2- or 3-inch squares. Stocks of 2- or 3-inch square filters cemented in glass are maintained only in filters usually used for general photographic work.

The booklet "Kodak Filters and Lens Attachments" gives more valuable information on this subject.

## FILTER DATA

No.	Description, use, and stability	No.	Description, use, and stability
	<b>Colorless</b>	25	A — Tricolor red for direct color separation. Contrast effects in commercial photography and in outdoor scenes. Two-color general viewing. Aerial infrared photography and haze cutting, AAA.
0	For compensating thickness of other gelatin filters in optical systems, AAA.		
1	Absorbs ultraviolet below 360 m $\mu$ , DDD.	26	Stereo red, AAA.
1A	Kodak Skylight Filter — Reduces excess bluishness in outdoor color photographs in open shade under a clear, blue sky, ACA.	29	Red color separation from transparencies and for the Kodak Fluorescence Process. Strong contrast effects. Copying blueprints. Tungsten tricolor projection, AAA.
	<b>Yellow</b>		
2B	Absorbs ultraviolet below 410 m $\mu$ , ACA.		
3	Light yellow, CCD.		
3N5	No. 3 plus 0.5 neutral density, AAA.	30	<b>Magentas and Violets</b>
4	Light yellow — Approximate correction on panchromatic materials for outdoor scenes, including sky, CCC.	31	Green absorption, BBC.
6	K1 — Light yellow — Partial correction outdoors, BBA.	32	Green absorption, CCA.
8	K2 — Yellow — Full correction outdoors on Type B panchromatic materials. Widely used for proper sky, cloud, and foliage rendering. Green separation for Fluorescence Process, AAA.	33	Minus green, CCD.
		34	Strong green absorption, CCB.
8N5	No. 8 plus 0.5 neutral density, AAA.	34A	Violet, CDD.
9	K3 — Deep yellow. Moderate contrast in outdoor photography (with black-and-white films), AAA.	35	Blue separation — Kodak Fluorescence Process, DCC.
11	X1 — Greenish yellow. Correction for tungsten light on Type B panchromatic materials; also for daylight correction with Type C panchromatic materials in making outdoor portraits, darkening skies, or lightening foliage, AAA.	36	Contrast in microscopy, CDD.
12	Minus blue. Haze cutting in aerial photography, AAA.	38	Dark violet, CCC.
13	X2 — Yellow green. Correction for Type C panchromatic materials in tungsten light, ABA.		<b>Blues and Blue-greens</b>
15	G — Deep yellow. Overcorrection in landscape photography. Contrast control in copying and in aerial infrared photography, AAA.	38A	Red absorption, BCA.
16	Blue absorption, AAB.	39	Red absorption. Increasing contrast in visual microscopy, BBB.
18A	Transmits ultraviolet and infrared only (glass), AAA.	40	Contrast control in printing motion-picture duplicates (glass) AAA.
	<b>Oranges and Reds</b>	44	Green for two-color photography (tungsten), CBC.
21	Blue and blue-green absorption, CBB.	44A	Minus red — Two-color general viewing, DDD.
22	Yellow-orange. For increasing contrast in blue preparations in microscopy. Mercury yellow, BAC.	45	Minus red, DDD.
23A	Light red. Two-color projection — contrast effects, BAB.	45A	Contrast in microscopy, DDD.
24	Red for two-color photography (daylight or tungsten). White-flame-arc tricolor projection, AAB.	46	Highest resolving power in visual microscopy, CDC.
		47	Blue projection (experimental), DDD.
		47B	Tricolor blue for direct color separation and from Kodak Ektacolor Film for Dye Transfer. Contrast effects in commercial photography. Tungsten and white-flame-arc tricolor projection, BBC.
		48	Tricolor blue for color separation from transparencies and from Kodak Ektacolor Film for Graphic Arts, BBB.
		48A	Green and red absorption, CBC.
		49	Green and red absorption, AAB.
		49B	Dark blue, BCB.
		50	Very dark blue, BBB.
		52	Very dark blue. Mercury violet, CCC.
			<b>Greens</b>
			Light green, AAB.

## TRANSMISSION OF WRATTEN FILTERS (Continued)

### FILTER DATA

No.	Description, use, and stability	No.	Description, use, and stability
53	Medium green, CCB	†86B	Yellowish. Photometric filter (visual), BCA.
	Very dark green, AAA.	†86C	Yellowish. Photometric filter (visual), AAA.
55	Stereo green, BBC.		<b>Light Balancing</b>
56	Very light green, CBC.	80A	For Kodachrome Film, Daylight Type, and photographic flood lamps, ABA.
57	Green for two-color photography (daylight), CBC.	81	Yellowish. For warmer color rendering.
57A	Light green, BBC.	81A	Yellowish. For Kodak Ektachrome Film, Type B, with photographic flood lamps.
58	Tricolor green for direct color separation. Contrast effects in commercial photography and microscopy, BBC.	81B	Yellowish. For warmer color rendering.
59	Green for tricolor projection (white-flame-arc), BBB.	81C	Yellowish. For Kodachrome Film, Type A, with flash lamps.
59A	Very light green, BBB.	81D	Yellowish. For Kodachrome Film, Type A, with flash lamps.
60	Green for two-color photography (tungsten), BDC.	81EF	Yellowish. For Kodak Ektachrome Film, Type B, with flash lamps.
61	Green color separation from transparencies and Kodak Ektacolor Film. Tricolor projection (tungsten), ABC.	82	Bluish. For cooler color rendering.
64	Red absorption (light), CDB.	82A	Bluish. For Kodachrome Film, Type A, with 3200 K lamps.
65	Red absorption, ADB.	82B	Bluish. For cooler color rendering.
65A	Red absorption, CCD.	82C	Bluish. For cooler color rendering.
66	Contrast effects in microscopy and medical photography, DDC.	83	Yellowish. For 16 mm Commercial Kodachrome Film and daylight exposure, BBB.
67A	Red absorption (light). Two-color projection, CDC.	85	Orange. For Type A Kodak color films and daylight exposure, BAA.
	<b>Narrow-band</b>	85B	Orange. For Kodak Ektachrome Film, Type B, and daylight exposure, BAB.
70	Dark red. Infrared photography. Color separation for Kodak Ektacolor Film (with tungsten), ABC.		<b>Miscellaneous</b>
72B	Dark orange-yellow, CCC.	79	Photographic sensitometry. Corrects 2360 K to 5500 K, AAA.
73	Dark yellow-green, ABB.	87	For infrared photography. Absorbs visual.
74	Dark green. Mercury green, BBC.	87C	Absorbs visual, transmits infrared.
75	Dark blue-green, ACC.	88A	For infrared photography. Absorbs visual.
76	Dark violet (compound filter), DDD.	89B	For infrared photography, AAA.
77	Transmits 546 m $\mu$ mercury line (glass plus gelatin), AAA.	90	Narrow-band viewing filter for judging brightness scale of scenes, CCD.
77A	Transmits 546 m $\mu$ mercury line (glass plus gelatin), AAA.	96	Neutral filters for controlling luminance, AAB.
	<b>Photometrics</b>	97	Dichroic absorption, AAA.
78	Bluish. Photometric filter (visual), BAB.	102	Correction filter for Barrier-layer photocell, ABA.
78AA	Bluish. Photometric filter (visual), BAA.	106	Correction filter for S-4 type photocell, AAA.
78A	Bluish. Photometric filter (visual), AAA.		
78B	Bluish. Photometric filter (visual), AAA.		
78C	Bluish. Photometric filter (visual), BAA.		
86	Yellowish. Photometric filter (visual), BBA.		
86A	Yellowish. Photometric filter (visual), AAA.		

Wave length	Percent transmittance												
	No. 0	No. 1	No. 1A	No. 2B	No. 3	No. 3N5	No. 4	No. 6	No. 8	No. 8N5	No. 9	No. 11	No. 12
400	88.0	85.0	59.0	19.0	—	—	—	7.40	—	—	—	—	—
10	88.5	85.5	76.0	48.0	—	—	—	8.32	—	—	—	—	—
20	88.9	86.0	82.0	67.0	—	—	—	10.4	—	—	—	0.16	—
30	89.3	86.5	84.6	75.3	0.36	—	—	13.5	—	—	—	0.29	—
40	89.6	87.0	86.0	80.0	1.78	—	—	18.9	—	—	—	0.56	—
50	89.8	87.4	86.8	83.0	11.5	1.59	—	27.6	—	—	—	1.32	—
60	89.9	87.8	87.2	85.2	38.0	9.40	6.9	39.0	0.25	0.16	—	4.00	—
70	90.1	88.2	87.5	86.7	68.0	18.5	42.0	52.3	5.50	2.0	1.78	12.0	—
80	90.3	88.5	87.3	88.1	80.8	23.5	74.0	65.8	19.0	6.3	8.31	26.0	—
90	90.4	88.7	86.8	88.8	85.2	25.5	84.7	76.8	41.0	13.2	20.7	43.7	—
500	90.5	88.9	86.3	89.5	86.9	26.3	87.5	83.5	63.5	20.0	34.5	55.0	1.50
10	90.6	89.1	85.5	89.9	87.8	26.7	88.5	87.0	78.0	24.3	48.8	60.0	17.3
20	90.7	89.3	84.8	90.3	88.4	27.0	89.1	88.4	84.1	26.7	62.0	60.2	55.0
30	90.7	89.5	84.3	90.5	89.0	27.2	89.4	89.0	86.5	28.0	76.0	57.8	77.8
40	90.8	89.7	84.0	90.6	89.5	27.5	89.6	89.4	87.7	28.6	83.8	54.2	86.0
50	90.8	89.9	83.9	90.7	89.8	27.8	89.8	89.7	88.4	29.0	87.0	50.0	88.4
60	90.9	90.1	84.1	90.8	90.1	27.9	90.0	89.9	88.8	29.3	88.3	44.8	89.4
70	90.9	90.2	84.8	90.9	90.4	28.0	90.2	90.1	89.2	29.5	88.8	38.9	89.7
80	90.9	90.3	86.0	90.9	90.6	28.4	90.4	90.3	89.5	29.6	89.1	33.1	90.1
90	91.0	90.4	87.4	91.0	90.7	29.0	90.6	90.5	89.8	29.8	89.3	27.6	90.3
600	91.0	90.5	88.5	91.1	90.8	29.5	90.8	90.6	90.1	29.9	89.5	22.7	90.4
10	91.0	90.5	89.5	91.2	90.9	29.5	90.9	90.7	90.3	29.6	89.7	19.0	90.5
20	91.0	90.6	90.2	91.3	91.0	29.3	91.0	90.8	90.5	29.4	89.8	14.9	90.7
30	91.0	90.6	90.6	91.3	91.0	29.1	91.1	90.9	90.7	29.1	89.9	11.4	90.9
40	91.1	90.7	90.8	91.4	91.1	29.0	91.2	91.0	90.9	28.8	90.0	9.10	90.9
50	91.1	90.7	91.0	91.4	91.2	20.4	91.3	91.1	91.0	28.9	90.1	8.05	91.0
60	91.1	90.8	91.1	91.5	91.3	29.6	91.4	91.2	91.1	29.2	90.1	7.50	91.1
70	91.1	90.8	91.1	91.5	91.4	29.8	91.5	91.2	91.2	29.4	90.2	7.05	91.2
80	91.1	90.9	91.1	91.6	91.5	30.0	91.5	91.3	91.3	29.5	90.2	6.50	91.2
90	91.1	90.9	91.1	91.7	91.6	30.2	91.6	91.4	91.4	29.7	90.3	6.10	91.2
700	91.1	91.0	91.1	91.8	91.7	31.0	91.6	91.3	91.5	30.2	90.3	6.20	91.3
Luminous transmit.	90.8	89.9	85.9	90.5	88.3	27.4	87.8	87.5	82.7	27.0	76.6	40.2	73.8
Dominant wave lgth.	571.0	575.0	498.0	570.0	569.5	570.5	569.5	570.3	571.8	572.0	574.4	550.3	576.1
Excitation purity.	0.8	1.5	1.2	5.7	50.0	56.3	64.0	44.7	85.2	84.0	91.4	60.7	97.8

\* Some transmission below 400 m $\mu$ . Consult the manufacturer.



## TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance												
	No. 13	No. 15	No. 16	No. 18A	No. 21	No. 22	No. 23A	No. 24	No. 25	No. 26	No. 29	No. 30	No. 31
400	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	48.6	13.8
20	—	—	—	—	—	—	—	—	—	—	—	47.4	14.5
30	—	—	—	—	—	—	—	—	—	—	—	48.5	16.4
40	0.18	—	—	—	—	—	—	—	—	—	—	50.1	25.5
50	0.50	—	—	—	—	—	—	—	—	—	—	49.4	42.7
60	1.35	—	—	—	—	—	—	—	—	—	—	43.0	50.2
70	4.08	—	—	—	—	—	—	—	—	—	—	26.5	40.4
80	11.0	—	—	—	—	—	—	—	—	—	—	13.8	22.6
90	23.5	—	—	—	—	—	—	—	—	—	—	5.00	8.20
500	39.0	—	—	—	—	—	—	—	—	—	—	0.63	1.85
10	50.8	—	—	—	—	—	—	—	—	—	—	—	0.12
20	55.2	1.00	—	—	—	—	—	—	—	—	—	—	—
30	56.5	16.0	3.00	—	—	—	—	—	—	—	—	—	—
40	55.0	52.1	22.0	—	—	—	—	—	—	—	—	—	—
50	51.0	70.7	48.0	—	2.50	—	—	—	—	—	—	—	—
60	46.0	84.3	69.5	—	29.0	0.25	—	—	—	—	—	—	—
70	39.2	87.5	79.5	—	65.0	19.0	—	—	—	—	—	0.10	—
80	32.0	88.7	84.0	—	80.6	60.0	11.0	—	—	—	—	10.0	—
90	25.1	89.3	86.3	—	85.4	81.0	47.0	4.55	—	—	—	45.0	—
600	18.2	89.7	87.8	—	87.3	87.0	69.6	37.3	12.6	2.90	—	76.0	0.63
10	13.5	90.0	89.0	—	88.1	88.5	82.7	72.3	50.0	30.0	—	87.4	26.0
20	9.60	90.1	89.6	—	88.7	89.0	85.8	82.9	75.0	63.2	10.0	89.5	67.2
30	6.40	90.2	90.0	—	89.0	89.5	87.2	86.4	82.6	78.9	45.3	90.2	84.0
40	3.66	90.3	90.2	—	89.5	89.8	87.9	87.8	85.5	84.0	71.4	90.5	88.1
50	2.20	90.4	90.3	—	89.9	90.0	88.5	88.5	86.7	86.1	82.7	90.7	89.8
60	1.58	90.5	90.4	—	90.2	90.1	89.0	89.0	87.6	87.2	86.6	90.8	90.2
70	1.74	90.6	90.5	—	90.4	90.2	89.4	89.3	88.2	88.1	88.4	90.9	90.4
80	2.62	90.6	90.6	—	90.5	90.3	89.6	89.7	88.5	88.5	89.4	91.0	90.5
90	3.55	90.7	90.7	—	90.5	90.4	89.8	89.9	89.0	88.9	90.0	91.1	90.7
700	4.48	90.7	90.8	0.25	90.6	90.5	90.0	90.2	89.3	89.2	90.3	91.1	90.8
	5.25	90.8	90.8	1.20	90.6	90.6	90.2	90.3	89.5	89.5	90.4	91.1	91.0
Luminous transmit.	34.5	66.2	57.7	0.0014	45.6	35.8	25.0	17.8	14.0	11.7	6.3	26.6	12.9
Dominant wave lgth.	542.0	579.3	582.7	700.0	588.9	595.1	602.7	610.6	615.1	619.0	631.6	498.6	513.1
Excitation purity.	57.5	99.0	99.3	100.0	99.9	99.9	100.0	100.0	100.0	100.0	100.0	62.4	81.9

Wave length	Percent transmittance												
	No. 32	No. 33	No. 34	No. 34A	No. 35	No. 36	No. 38	No. 38A	No. 39	No. 40	No. 44	No. 44A	No. 45
400	38.0	0.85	64.0	—	48.0	36.5	60.5	33.4	85.2	—	0.44	2.52	—
10	37.9	0.71	70.1	0.1	57.0	45.5	66.5	41.2	78.2	—	0.36	3.39	—
20	40.0	1.17	72.0	40.0	57.6	45.5	72.5	53.0	70.5	—	0.63	6.30	—
30	43.0	1.69	68.4	69.7	47.5	32.7	75.3	58.0	63.3	—	3.63	17.4	—
40	55.5	5.36	58.2	68.7	29.5	15.2	76.2	58.8	53.6	—	13.1	32.7	5.00
50	66.0	14.3	42.3	56.2	12.3	3.7	75.9	57.6	42.5	—	25.4	41.8	19.0
60	66.0	12.4	25.2	40.5	3.5	0.35	74.8	55.2	28.5	3.16	36.5	48.1	29.5
70	57.0	5.00	12.1	23.8	0.25	—	73.4	51.9	17.3	21.6	46.5	51.7	34.4
80	40.0	0.50	2.7	9.2	—	—	71.6	48.5	10.2	44.7	53.6	52.9	35.7
90	21.0	—	0.2	2.3	—	—	69.5	44.6	4.00	61.4	56.8	52.2	34.5
500	9.56	—	—	0.33	—	—	66.7	40.2	1.33	70.2	55.8	49.8	29.7
10	2.51	—	—	—	—	—	63.9	35.8	0.35	72.4	50.9	44.8	21.5
20	0.13	—	—	—	—	—	60.8	31.7	—	70.5	42.1	36.8	11.5
30	—	—	—	—	—	—	57.0	27.2	—	64.8	30.5	26.8	3.80
40	—	—	—	—	—	—	52.6	22.3	—	55.5	18.6	16.8	0.85
50	—	—	—	—	—	—	48.0	17.6	—	44.2	8.99	8.20	—
60	—	—	—	—	—	—	42.8	12.9	—	32.5	3.59	2.95	—
70	—	—	—	—	—	—	37.0	8.78	—	20.3	0.80	0.91	—
80	—	—	—	—	—	—	30.6	5.65	—	9.56	—	0.10	—
90	—	—	—	—	—	—	25.5	3.48	—	3.20	—	—	—
600	6.04	—	—	—	—	—	20.9	2.09	—	1.10	—	—	—
10	41.0	0.80	—	0.13	—	—	16.8	1.15	—	0.32	—	—	—
20	75.0	24.9	—	1.0	—	—	12.9	0.59	—	—	—	—	—
30	86.1	60.8	—	6.3	—	—	10.0	0.28	—	—	—	—	—
40	89.0	78.0	0.4	22.0	—	—	7.79	0.13	—	—	—	—	—
50	90.0	85.0	4.0	45.0	0.1	—	6.68	—	—	—	—	—	—
60	90.6	87.5	20.7	65.0	3.0	0.21	6.20	—	—	—	—	—	—
70	90.7	88.7	45.2	77.3	19.0	7.5	5.91	—	—	—	—	—	—
80	90.8	89.4	66.5	85.0	43.5	29.0	5.41	—	0.50	0.80	—	—	—
90	90.9	89.8	78.8	88.2	66.0	55.0	4.90	—	4.06	6.99	0.18	—	—
700	91.0	90.0	85.0	89.8	77.7	71.3	5.00	—	17.8	23.5	1.60	—	1.00
Luminous transmit.	12.5	5.2	1.3	2.9	0.45	0.25	42.5	17.3	1.2	33.6	15.6	14.4	5.2
Dominant wave lgth.	551.7	498.0	424.0	564.8	566.8	566.4	483.5	478.9	450.6	516.2	589.1	483.4	481.5
Excitation purity.	79.6	88.3	94.4	91.4	96.3	97.8	41.8	69.8	98.9	48.5	72.9	77.2	88.4

\* Some transmission below 400 mμ. Consult the manufacturer.

## TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance												
	No. 45A	No. 46	No. 47	No. 47B	No. 48	No. 48A	No. 49	No. 49B	No. 50	No. 52	No. 53	No. 54	No. 55
400	—	1.20	7.80	16.0	0.96	5.65	3.30	1.70	0.45	2.18	—	—	—
10	—	0.60	17.4	29.5	3.16	10.0	4.28	2.00	0.39	1.51	—	—	—
20	—	0.80	34.0	43.6	8.25	16.0	6.93	3.55	0.59	0.80	—	—	—
30	1.00	5.98	47.0	50.0	15.0	21.0	11.2	7.00	2.63	0.44	—	—	—
40	8.81	19.0	50.3	47.2	22.6	25.0	18.9	13.0	8.90	0.41	—	—	—
50	17.4	30.1	48.3	36.0	30.3	26.2	25.6	17.4	14.0	0.69	—	—	—
60	20.9	33.8	43.4	25.0	33.2	22.9	24.0	14.8	12.3	1.45	—	—	0.20
70	21.6	32.1	36.2	13.2	29.6	16.5	15.7	7.60	5.36	2.70	0.10	—	2.90
80	20.5	27.0	28.5	4.5	22.4	9.55	6.93	2.76	1.55	4.90	0.7	—	13.1
90	18.0	20.2	19.6	1.3	14.1	4.27	2.14	0.40	0.10	8.50	2.14	—	34.2
500	14.4	11.1	0.36	0.17	7.30	1.58	0.46	—	—	13.3	4.47	—	53.4
10	10.1	4.39	—	—	2.64	0.48	—	—	—	18.2	7.24	0.10	67.0
20	5.60	1.66	—	—	0.50	—	—	—	—	23.7	10.7	0.31	69.3
30	2.52	0.35	—	—	—	—	—	—	—	28.5	14.0	0.64	65.1
40	0.4	—	—	—	—	—	—	—	—	32.1	16.6	0.89	56.7
50	0.10	—	—	—	—	—	—	—	—	33.1	17.3	0.93	45.0
60	—	—	—	—	—	—	—	—	—	31.0	15.4	0.62	33.1
70	—	—	—	—	—	—	—	—	—	25.6	11.4	0.21	20.7
80	—	—	—	—	—	—	—	—	—	19.1	6.90	—	9.00
90	—	—	—	—	—	—	—	—	—	12.6	3.60	—	2.70
600	—	—	—	—	—	—	—	—	—	7.78	1.41	—	0.40
10	—	—	—	—	—	—	—	—	—	4.17	0.40	—	—
20	—	—	—	—	—	—	—	—	—	2.34	0.15	—	—
30	—	—	—	—	—	—	—	—	—	1.38	—	—	—
40	—	—	—	—	—	—	—	—	—	0.80	—	—	—
50	—	—	—	—	—	—	—	—	—	0.54	—	—	—
60	—	—	—	—	—	—	—	—	—	0.36	—	—	—
70	—	—	—	—	—	—	—	—	—	0.27	—	—	—
80	—	—	—	—	—	—	—	—	—	0.23	—	—	0.66
90	0.20	0.25	—	—	—	—	—	—	—	0.19	—	—	6.90
700	2.24	0.85	—	—	—	—	—	—	—	0.17	—	—	27.8
Luminous transmit.	2.8	2.4	2.8	0.78	1.86	0.88	0.69	0.36	0.26	20.1	9.0	0.032	31.4
Dominant wave lgth.	477.6	470.4	463.7	479.8	466.5	458.0	457.9	455.5	455.9	553.3	551.1	546.1	530.2
Excitation purity.	89.7	94.9	95.8	69.1	96.1	98.3	98.9	99.3	99.4	77.3	89.7	97.0	68.4

Wave length	Percent transmittance												
	No. 56	No. 57	No. 57A	No. 58	No. 59	No. 59A	No. 60	No. 61	No. 64	No. 65	No. 65A	No. 66	No. 67A
400	—	—	—	—	—	—	—	—	9.00	—	—	12.3	1.10
10	—	—	—	—	—	—	—	—	9.20	—	—	13.0	0.93
20	—	—	—	—	—	—	—	—	8.75	0.23	—	15.0	1.28
30	—	—	—	—	—	0.16	—	—	9.20	0.61	0.16	18.4	3.16
40	—	—	0.19	—	—	0.37	—	—	11.3	1.58	1.32	23.2	6.40
50	—	—	0.87	—	0.40	1.26	0.19	—	15.5	4.10	5.50	31.2	10.5
60	0.16	0.44	2.56	—	1.90	4.57	1.38	—	23.3	9.00	13.0	42.2	17.7
70	3.12	3.10	7.80	0.23	7.70	13.2	5.38	—	34.4	16.8	24.9	55.5	28.5
80	13.0	13.1	21.6	1.38	21.0	30.0	15.0	0.33	46.8	24.9	36.6	68.4	41.4
90	34.5	31.9	41.7	4.90	41.5	50.8	32.0	4.00	56.6	31.3	45.1	77.6	52.1
500	59.0	50.5	58.8	17.7	59.0	66.0	48.4	16.6	62.1	33.7	45.8	82.7	57.9
10	73.0	60.6	67.9	38.8	67.7	73.0	57.2	32.3	62.9	32.4	39.7	84.6	58.8
20	79.0	63.3	70.1	52.2	69.8	75.1	59.2	40.0	59.1	27.5	29.7	84.0	55.4
30	79.9	61.0	67.6	53.6	67.2	73.2	55.5	39.6	51.6	20.7	17.8	82.6	47.5
40	77.5	55.0	61.8	47.6	61.5	68.5	47.5	34.5	41.3	13.7	7.90	79.1	36.6
50	72.6	47.1	53.5	38.4	54.0	62.0	36.8	26.3	28.0	6.50	2.40	73.7	25.0
60	66.1	37.3	43.3	27.8	45.0	54.4	25.2	17.3	16.2	1.66	0.32	67.1	14.2
70	58.0	26.5	31.6	17.4	35.0	44.5	14.4	9.70	7.95	0.40	—	58.8	5.50
80	46.1	16.6	19.4	9.0	24.0	33.0	6.3	4.40	3.10	—	—	47.2	1.40
90	33.8	8.69	9.70	3.50	14.0	22.0	1.82	1.66	0.80	—	—	34.5	0.28
600	24.0	3.70	4.50	1.50	7.95	14.6	0.48	0.38	—	—	—	24.4	—
10	18.7	1.60	2.00	0.41	4.90	10.5	0.10	—	—	—	—	18.5	—
20	13.2	0.49	0.87	—	2.70	6.92	—	—	—	—	—	13.7	—
30	7.22	—	0.22	—	1.00	3.16	—	—	—	—	—	7.70	—
40	3.02	—	—	—	0.17	1.07	—	—	—	—	—	3.00	—
50	1.48	—	—	—	—	0.50	—	—	—	—	—	1.46	—
60	1.91	—	—	—	—	0.91	—	—	—	—	—	1.91	—
70	7.95	—	—	—	0.63	3.00	—	—	—	—	—	6.17	—
80	23.0	—	0.16	—	4.00	10.0	—	—	—	—	—	19.9	—
90	44.1	—	1.15	—	12.0	20.0	2.10	—	0.10	—	0.20	42.6	—
700	64.8	—	3.17	0.53	22.6	30.0	8.70	—	4.50	—	2.18	63.1	0.40
Luminous transmit.	52.8	32.5	37.2	23.7	38.7	45.8	26.1	16.8	25.0	9.6	9.8	58.3	22.4
Dominant wave lgth.	552.3	536.4	534.0	540.2	538.3	541.4	525.7	536.8	497.3	496.6	492.7	512.3	499.8
Excitation purity.	78.2	69.2	62.1	88.1	66.0	59.3	62.2	85.4	55.0	67.8	77.4	21.5	55.8

\* Some transmission below 400  $\mu$ . Consult the manufacturer.

## TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance											
	No. 70	No. 72B	No. 73	No. 74	No. 75	No. 76	No. 77	No. 77A	No. 78	No. 78AA	No. 78A	No. 78B
400	—	—	—	—	—	0.22	—	—	37.2	43.0	56.0	64.1
10	—	—	—	—	—	0.18	—	—	41.7	46.0	58.6	66.5
20	—	—	—	—	—	0.29	—	—	44.2	48.7	61.0	68.4
30	—	—	—	—	—	1.38	—	—	44.6	49.8	61.8	69.5
40	—	—	—	—	—	3.50	—	—	44.2	49.7	61.8	70.0
50	—	—	—	—	—	3.50	—	—	41.7	48.0	61.0	69.4
60	—	—	—	—	1.97	1.92	—	—	38.0	44.9	58.7	67.5
70	—	—	—	—	10.0	0.51	—	—	33.8	40.3	55.0	65.4
80	—	—	—	—	17.4	—	—	—	27.5	35.6	51.0	62.9
90	—	—	—	—	18.0	—	—	—	23.5	30.9	47.1	59.8
500	—	—	—	—	13.0	—	—	—	19.5	26.5	43.5	57.0
10	—	—	—	0.96	7.35	—	0.30	0.10	15.8	23.4	40.0	54.2
20	—	—	—	7.95	3.20	—	9.10	5.35	13.8	20.3	36.9	51.4
30	—	—	—	14.6	0.83	—	13.5	1.90	11.8	17.8	34.4	49.3
40	—	—	—	12.9	0.14	—	46.1	35.0	10.5	16.6	32.7	48.1
50	—	—	—	7.60	—	—	78.0	71.8	9.56	14.9	31.2	46.7
60	—	—	2.24	3.06	—	—	75.8	63.1	8.53	13.2	29.4	45.0
70	—	—	5.97	0.83	—	—	8.00	—	7.77	12.1	28.0	43.6
80	—	—	4.56	0.12	—	—	1.00	—	7.41	11.6	27.5	43.1
90	—	1.26	2.00	—	—	—	0.32	—	6.93	11.1	27.0	42.9
600	—	5.89	0.56	—	—	—	16.2	1.60	6.45	10.40	26.0	41.8
10	—	5.25	0.10	—	—	—	52.1	32.1	5.50	9.20	24.1	40.0
20	—	2.88	—	—	—	—	83.0	78.0	4.80	7.70	21.8	37.6
30	—	1.26	—	—	—	—	84.9	79.5	3.94	6.50	19.7	35.5
40	—	0.48	—	—	—	—	88.1	86.5	3.46	5.60	18.6	34.2
50	0.63	0.14	—	—	—	—	89.8	89.2	3.24	5.50	18.4	33.6
60	10.5	—	—	—	—	—	89.8	89.0	3.16	5.60	18.5	34.0
70	35.0	—	—	—	—	—	85.5	79.5	3.39	5.80	18.7	34.1
80	55.2	—	—	—	—	—	76.1	62.5	3.45	6.10	19.0	34.5
90	70.0	—	—	—	—	0.13	75.0	62.4	3.51	6.10	19.3	34.8
700	79.0	—	—	—	0.14	1.24	86.5	83.0	3.90	6.50	20.2	36.0
Luminous transmit.	0.31	0.74	1.3	4.0	1.9	0.046	32.3	25.5	10.7	15.8	31.6	46.7
Dominant wave lgth.	675.6	604.9	574.9	538.6	487.7	449.2	579.9	581.5	471.1	473.4	475.7	477.2
Excitation purity.	100.0	100.0	100.0	96.7	90.4	99.7	99.0	99.1	63.0	54.5	33.7	20.7

Wave length	Percent transmittance											
	No. 78C	No. 79	No. 80A	No. 81	No. 81A	No. 81B	No. 81C	No. 81D	No. 81EF	No. 82	No. 82A	No. 82B
400	74.9	24.0	67.6	77.7	65.1	55.1	46.1	38.2	30.7	83.0	80.1	76.7
10	76.6	26.0	73.1	78.1	65.9	55.8	46.6	38.4	31.5	83.7	80.8	78.0
20	77.9	29.0	76.8	79.0	67.6	57.7	49.0	41.0	34.3	84.6	81.6	79.2
30	78.9	31.0	7.77	80.5	70.2	61.0	52.5	45.5	38.6	85.1	82.2	79.7
40	79.4	32.2	76.5	81.9	72.8	64.5	57.2	50.0	43.2	85.4	82.4	79.7
50	79.5	32.7	73.0	83.0	74.8	67.2	60.5	53.9	47.4	85.4	82.4	79.2
60	79.3	31.4	69.0	83.7	76.0	69.1	63.0	56.5	50.2	85.0	81.7	78.0
70	78.6	28.8	63.6	84.3	77.1	70.6	64.2	58.1	52.0	84.6	80.7	76.3
80	77.8	25.6	57.6	84.6	77.8	71.3	65.0	59.0	53.0	84.0	79.3	74.4
90	76.7	22.2	51.3	84.9	78.3	71.8	65.7	60.0	54.0	83.3	78.0	72.1
500	75.5	19.3	45.2	85.3	78.6	72.6	66.4	60.8	55.4	82.6	76.6	70.2
10	74.2	16.8	39.4	85.4	79.0	72.9	66.5	61.1	56.2	82.0	75.3	68.3
20	73.0	14.2	34.2	85.5	79.5	73.2	67.0	61.6	57.0	81.4	74.0	66.5
30	72.1	12.7	30.0	86.0	80.4	74.5	68.8	62.5	59.5	81.0	73.1	65.5
40	71.5	11.8	27.1	86.5	81.5	76.0	71.0	66.1	62.7	80.8	72.7	65.0
50	70.7	11.0	24.8	86.8	82.3	77.0	72.0	67.3	64.5	80.6	72.4	64.5
60	69.8	9.76	23.5	87.0	82.6	77.6	72.5	68.0	65.3	80.4	71.8	63.8
70	69.0	8.81	22.6	87.1	82.7	77.8	72.7	68.3	65.8	80.2	71.5	63.2
80	68.8	8.50	22.6	87.1	82.8	78.0	73.0	68.5	66.0	80.2	71.5	63.2
90	68.6	8.29	23.2	87.4	83.1	78.2	74.0	69.5	66.5	80.3	71.7	63.4
600	68.0	7.56	23.7	87.6	84.0	79.1	75.6	72.0	68.1	80.2	71.5	63.0
10	66.7	6.45	23.2	88.1	85.0	81.0	78.5	75.0	71.6	79.3	70.3	61.5
20	65.0	5.13	21.0	88.8	86.1	83.1	80.8	78.0	74.7	78.4	68.5	59.0
30	63.8	4.17	18.2	89.2	87.0	84.2	82.1	79.8	77.0	77.5	66.9	56.9
40	63.0	3.47	15.8	89.4	87.4	85.1	83.0	80.8	78.4	76.8	65.5	55.0
50	62.7	3.16	14.5	89.5	87.7	85.6	83.5	81.5	79.2	76.5	64.8	54.1
60	63.0	3.09	13.8	89.8	88.0	86.0	84.1	82.1	80.1	76.2	64.6	53.7
70	63.3	3.16	13.4	90.0	88.2	86.5	84.8	83.0	80.9	76.1	64.5	53.7
80	63.4	3.16	12.7	90.1	88.5	87.0	85.5	83.7	81.8	76.1	64.4	53.5
90	63.6	3.16	11.7	90.3	89.0	87.5	86.1	84.6	82.9	76.2	64.2	53.4
700	65.0	3.31	11.5	90.5	89.2	88.0	86.8	85.5	84.0	77.1	64.6	54.1
Luminous transmit.	70.4	11.3	28.4	86.8	82.0	76.9	72.0	67.4	64.0	80.7	72.5	64.6
Dominant wave lgth.	479.8	474.8	471.7	576.7	577.5	577.8	577.4	579.5	579.0	477.5	476.6	475.6
Excitation purity.	6.8	52.8	45.9	2.9	6.0	8.7	10.7	14.7	19.0	3.0	6.3	10.2

\* Some transmission below 400 m $\mu$ . Consult the manufacturer.



## TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance												
	No. 82C	No. 83	No. 85	No. 85B	No. 86	No. 86A	No. 86B	No. 86C	No. 89B	No. 90	No. 96	No. 97	No. 102
400	73.4	13.5	6.0	1.59	0.50	8.00	20.0	44.0	—	—	4.28	—	1.12
10	75.0	13.1	18.0	9.32	0.81	12.2	26.1	55.0	—	—	4.91	—	0.96
20	76.4	13.5	28.4	15.5	1.55	16.7	31.6	62.0	—	—	5.50	—	0.89
30	77.2	14.1	33.4	19.0	2.88	21.5	37.5	66.6	—	—	6.17	—	0.96
40	77.2	15.6	36.2	20.8	5.50	27.8	44.0	70.8	—	—	6.92	—	1.23
50	76.6	17.8	38.1	22.1	9.10	34.2	50.1	74.3	—	—	7.50	—	1.86
60	75.2	21.0	40.4	24.3	13.5	40.4	55.4	76.8	—	—	7.81	—	3.23
70	73.2	25.5	43.0	27.5	17.8	45.0	59.5	78.7	—	—	8.15	0.22	6.45
80	70.7	30.2	45.3	30.9	21.3	48.7	62.5	80.2	—	—	8.47	0.43	14.0
90	68.1	35.8	47.2	34.3	24.5	51.2	64.6	81.2	—	—	8.60	0.39	21.6
500	65.7	43.5	48.9	38.3	26.8	52.8	66.0	81.7	—	—	8.73	0.15	30.7
10	63.5	46.3	49.2	40.7	27.9	53.4	66.4	81.9	—	—	8.85	—	41.4
20	61.5	47.2	48.2	40.6	28.6	53.7	66.6	82.0	—	—	8.90	—	51.3
30	59.9	48.3	48.3	40.7	30.4	55.0	67.6	82.4	—	—	9.01	—	59.4
40	59.1	49.6	49.2	41.6	32.5	56.5	69.0	83.0	—	—	9.07	—	64.2
50	58.3	51.8	51.0	43.2	35.0	58.5	70.2	83.5	—	—	9.20	—	66.7
60	57.2	56.5	55.8	47.1	41.2	63.0	73.0	84.6	—	9.00	9.30	—	66.3
70	56.2	65.0	64.5	56.0	53.0	70.9	78.1	86.8	—	30.5	9.20	—	63.0
80	56.1	75.5	75.0	68.1	67.5	79.0	84.0	88.9	—	34.3	9.19	—	58.0
90	56.0	83.0	83.0	78.1	76.5	85.2	87.5	89.9	—	25.2	9.54	—	51.9
600	55.0	87.3	87.2	85.0	85.0	88.1	89.3	90.6	—	16.1	9.64	—	45.2
10	53.0	89.3	88.9	88.0	88.1	89.8	90.3	91.0	—	11.3	9.73	—	37.8
20	50.2	90.4	90.0	89.6	89.6	90.5	90.7	91.1	—	7.40	9.56	—	30.5
30	47.4	90.8	90.5	90.3	90.4	90.8	90.9	91.2	—	2.91	9.27	—	25.0
40	45.2	91.0	90.7	90.7	90.7	91.1	91.1	91.3	—	0.76	9.10	—	20.6
50	44.1	91.1	90.9	90.9	91.0	91.2	91.2	91.4	—	0.29	9.07	—	17.5
60	43.6	91.3	91.0	91.0	91.1	91.3	91.3	91.5	—	0.41	9.00	—	15.2
70	43.5	91.5	91.0	91.2	91.2	91.4	91.4	91.6	—	2.30	9.13	—	13.7
80	43.1	91.5	91.0	91.3	91.3	91.4	91.5	91.6	0.10	9.52	9.08	0.44	12.8
90	42.8	91.5	91.0	91.3	91.3	91.5	91.6	91.6	1.58	28.5	9.21	5.02	12.1
700	43.5	91.5	91.0	91.3	91.3	91.5	91.6	91.6	11.2	51.9	9.52	18.7	12.0
Luminous transmit.	58.1	61.4	62.5	55.5	49.7	67.1	75.5	85.4	0.017	9.8	9.1	0.041	50.8
Dominant wave lgth.	477.2	581.5	587.7	585.7	585.7	581.7	579.6	577.6	700	583.1	572.4	555.0	564.9
Excitation purity.	14.5	55.4	30.3	48.0	69.7	37.1	24.1	9.0	100	100.0	12.1	48.0	80.0

Wave length	Percent transmittance												
	No. 106	CC-05R	CC-10R	CC-20R	CC-30R	CC-40R	CC-50R	CC-05B	CC-10B	CC-20B	CC-30B	CC-40B	CC-50B
400	—	81.0	73.0	61.5	51.6	42.5	36.4	87.0	85.5	82.2	80.2	77.0	74.1
10	—	81.0	72.4	60.0	50.0	40.0	33.9	87.5	86.4	84.0	82.5	80.3	78.4
20	0.10	81.0	72.0	58.6	48.2	38.2	31.9	87.7	87.2	85.0	84.0	82.2	80.7
30	0.20	81.1	71.6	57.7	47.0	36.8	30.5	88.0	87.5	85.3	84.3	82.5	81.1
40	0.35	81.2	71.5	57.2	46.4	36.0	29.7	88.1	87.5	85.0	83.5	81.3	79.8
50	0.58	81.4	71.6	57.2	46.4	36.1	29.6	88.1	87.2	83.9	81.9	78.7	76.6
60	0.98	81.7	72.4	58.5	47.5	37.5	31.0	87.9	86.4	82.5	79.5	75.9	72.9
70	1.5	82.3	73.7	60.6	49.9	40.0	33.6	87.5	85.3	80.3	76.2	72.0	67.9
80	2.3	82.8	74.9	62.0	52.0	42.5	35.9	87.0	84.0	77.8	72.5	67.5	62.7
90	3.5	83.2	75.8	63.5	53.9	44.8	37.9	86.2	82.4	74.2	68.3	62.3	56.6
500	5.2	83.3	76.6	64.6	55.2	46.1	39.4	85.2	80.5	71.2	63.8	56.7	50.1
10	7.7	83.0	76.1	64.0	54.5	46.0	38.5	84.4	78.6	67.7	58.7	51.0	44.5
20	10.7	82.4	74.9	61.5	51.6	42.5	35.0	83.5	77.0	64.0	54.4	46.0	38.6
30	15.1	81.6	73.5	59.4	48.5	38.5	31.5	82.6	75.2	61.5	50.7	41.6	34.1
40	20.2	81.2	72.5	57.8	46.5	36.6	29.4	82.1	73.9	59.5	48.3	39.0	31.3
50	25.7	81.1	72.4	57.1	45.6	35.6	28.7	81.5	73.0	58.0	46.6	36.9	29.5
60	31.0	81.4	72.8	58.0	46.9	36.4	29.7	81.4	72.7	57.5	45.9	35.9	28.6
70	35.6	82.5	74.5	60.6	49.2	39.2	32.7	81.4	73.0	57.9	46.3	36.1	28.7
80	43.2	83.9	77.3	65.0	54.6	45.0	38.6	81.9	73.9	59.3	47.9	37.8	30.5
90	53.8	85.7	80.7	71.0	61.8	53.5	47.6	82.7	75.1	61.6	50.3	40.8	33.4
600	65.6	87.6	84.0	77.0	70.5	64.0	58.7	83.4	76.3	63.5	53.0	43.5	36.0
10	77.0	89.0	86.5	82.0	77.8	73.0	69.8	83.6	76.7	64.5	54.6	44.7	37.8
20	82.8	90.0	88.9	86.2	83.5	80.8	78.3	83.5	76.5	64.3	54.4	44.3	37.5
30	86.0	90.6	89.9	88.1	87.2	85.1	84.2	83.2	76.6	63.1	53.2	42.5	35.6
40	87.6	91.1	90.5	89.8	89.2	88.0	87.5	82.8	74.5	61.6	51.5	40.2	33.7
50	88.7	91.2	90.8	90.5	90.3	89.5	89.2	82.5	74.0	60.6	49.5	38.4	31.8
60	89.5	91.3	91.1	90.8	90.6	90.4	90.1	82.5	73.8	60.1	49.0	37.7	31.0
70	90.0	91.4	91.3	91.0	90.9	90.8	90.7	82.3	73.3	59.6	48.2	36.5	30.0
80	90.5	91.6	91.5	91.2	91.1	91.0	91.1	82.0	72.8	58.6	47.2	35.4	29.0
90	90.8	91.7	91.7	91.4	91.4	91.3	91.1	81.9	72.5	58.1	47.2	35.4	29.0
700	91.0	91.9	91.9	91.5	91.5	91.4	91.2	82.2	73.0	58.5	47.5	35.6	29.0
Luminous transmit.	34.6	83.7	77.0	65.3	55.9	47.3	41.3	82.8	75.5	62.3	52.0	42.8	35.7
Dominant wave lgth.	589.4	605.0	597.8	604.2	605.8	605.5	608.5	459.0	462.0	460.0	461.0	463.2	462.5
Excitation purity.	95.2	2.0	4.7	8.5	12.3	17.3	21.4	2.8	6.3	13.2	20.2	27.7	34.2

\* Some transmission below 400 mμ. Consult the manufacturer.

## TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance											
	CC-05G	CC-10G	CC-20G	CC-30G	CC-40G	CC-50G	CC-05Y	CC-10Y	CC-20Y	CC-30Y	CC-40Y	CC-50Y
400	80.0	73.1	58.8	48.0	39.7	32.0	81.0	74.5	61.3	50.5	43.0	34.5
10	80.7	72.9	57.8	46.5	38.1	30.3	80.6	73.2	59.0	47.4	39.5	30.5
20	81.0	72.8	57.3	45.8	37.3	29.5	80.4	72.6	57.8	46.0	37.5	29.0
30	81.4	72.7	57.0	45.5	36.5	29.0	80.4	72.5	57.5	45.6	36.5	28.7
40	81.6	73.0	57.3	45.8	36.6	29.1	80.6	72.8	57.8	46.5	36.8	29.5
50	82.1	73.9	58.4	46.9	38.1	30.6	81.2	74.0	59.5	48.5	38.5	31.5
60	83.0	75.5	61.4	50.3	41.5	34.3	82.5	76.0	63.0	52.5	42.5	36.2
70	84.4	78.0	65.4	55.8	47.0	40.5	83.9	78.5	67.5	48.2	48.8	43.5
80	85.6	80.4	70.0	61.8	53.5	47.8	85.3	81.2	72.3	64.9	56.2	54.0
90	86.8	83.0	75.2	68.9	61.3	57.0	87.0	84.4	78.0	72.4	66.0	64.0
500	87.9	85.9	80.3	76.4	70.7	68.0	88.4	87.2	84.0	81.0	77.0	75.5
10	88.7	87.5	83.8	80.9	77.8	75.3	89.5	89.0	88.0	86.6	85.5	84.2
20	89.0	88.1	84.9	82.3	79.5	77.5	90.0	90.0	89.6	89.1	89.0	88.5
30	89.0	88.0	84.6	81.7	79.4	77.0	90.4	90.4	90.0	89.7	89.9	89.6
40	89.0	87.6	83.7	80.5	77.8	74.8	90.7	90.7	90.6	90.4	90.2	90.0
50	88.6	87.1	82.4	78.6	75.8	72.2	90.9	90.9	90.8	90.6	90.4	90.3
60	88.1	86.3	80.9	76.2	72.9	68.8	91.0	91.0	90.9	90.8	90.7	90.6
70	87.5	85.3	79.0	73.5	69.3	64.8	91.3	91.3	91.0	90.9	90.8	90.7
80	87.0	84.1	77.0	70.4	65.3	60.3	91.4	91.4	91.1	91.0	90.8	90.7
90	86.4	82.8	74.5	67.2	61.9	55.9	91.4	91.4	91.2	91.1	90.9	90.8
600	85.7	81.5	72.0	64.1	57.7	51.7	91.4	91.4	91.3	91.2	90.9	90.8
10	85.0	80.0	69.5	60.7	53.7	47.3	91.4	91.4	91.3	91.2	90.9	90.9
20	84.0	78.5	66.5	57.2	49.8	42.5	91.4	91.4	91.3	91.2	91.0	90.9
30	83.0	76.9	63.8	53.7	45.5	38.0	91.5	91.5	91.4	91.3	91.0	91.0
40	82.2	75.6	61.5	50.8	42.0	34.6	91.5	91.5	91.4	91.3	91.0	91.0
50	81.9	74.9	60.1	49.1	40.2	32.5	91.5	91.5	91.4	91.3	91.1	91.1
60	81.5	74.4	59.4	48.1	39.5	31.5	91.5	91.5	91.4	91.3	91.1	91.1
70	81.4	74.0	58.8	47.5	38.5	31.0	91.5	91.5	91.4	91.4	91.2	91.2
80	81.1	73.5	58.1	46.6	37.6	29.9	91.5	91.5	91.4	91.4	91.2	91.2
90	81.1	73.2	57.6	46.0	36.6	28.9	91.5	91.5	91.4	91.4	91.3	91.3
700	81.5	73.5	58.0	46.4	36.5	28.7	91.5	91.5	91.4	91.4	91.3	91.3
Luminous transmit.	87.2	84.5	77.8	72.2	67.7	63.3	90.4	90.1	89.1	88.2	87.4	86.9
Dominant wave lgth.	553.0	555.5	555.0	554.0	554.3	553.4	572.0	571.3	571.4	571.3	571.3	571.2
Excitation purity.	2.3	5.2	10.9	15.8	21.1	25.9	5.3	9.6	18.8	28.3	35.7	42.0

Wave length	Percent transmittance											
	CC-05M	CC-10M	CC-20M	CC-30M	CC-40M	CC-50M	CC-05C	CC-10C	CC-20C	CC-30C	CC-40C	CC-50C
400	87.6	86.6	85.6	84.2	82.3	80.9	87.3	86.0	83.9	82.3	80.4	78.8
10	88.2	87.7	86.6	85.7	84.6	83.6	88.2	87.5	85.2	84.5	83.4	82.7
20	88.6	88.0	87.0	85.9	85.2	84.4	88.7	88.1	86.5	86.0	85.3	84.8
30	88.7	88.0	86.9	85.6	84.4	83.6	89.0	88.6	87.5	87.0	86.3	85.9
40	88.7	87.9	86.0	84.7	82.5	81.4	89.3	89.0	87.7	87.3	86.6	86.1
50	88.6	87.5	84.9	82.8	80.0	78.1	89.5	89.1	87.8	87.5	86.6	86.0
60	88.4	86.5	83.1	80.0	76.1	73.7	89.6	89.1	87.7	87.3	86.4	85.7
70	87.8	85.2	80.8	76.4	71.3	68.0	89.7	89.0	87.5	87.0	85.8	85.2
80	87.0	83.6	77.9	72.1	65.8	61.7	89.7	89.0	87.2	86.5	85.3	84.3
90	86.0	81.8	74.4	67.0	60.0	55.0	89.7	89.0	87.0	86.0	84.4	83.4
500	85.0	79.7	70.5	61.7	53.7	48.1	89.6	89.0	86.5	85.2	83.5	82.3
10	83.8	77.5	66.7	56.5	47.7	41.6	89.6	88.7	86.0	84.4	82.4	80.8
20	82.7	75.3	63.4	52.0	42.8	36.3	89.5	88.5	85.2	83.5	81.1	79.2
30	81.8	73.7	60.5	48.6	39.0	31.9	89.4	88.0	84.3	82.4	79.6	77.3
40	81.3	72.5	58.6	46.6	36.7	29.8	89.2	87.5	83.4	81.0	77.7	75.0
50	81.2	72.2	58.0	46.0	36.0	29.1	88.9	87.0	82.3	79.0	75.3	72.2
60	81.5	72.8	58.3	46.5	36.7	29.7	88.5	86.1	80.5	76.7	72.7	69.0
70	82.5	74.6	60.5	49.8	40.2	32.3	88.0	85.0	78.5	74.0	69.3	65.0
80	84.0	77.3	64.9	55.6	46.2	39.0	87.5	83.8	76.1	70.9	65.4	60.5
90	85.8	80.8	70.6	63.3	54.9	48.7	87.0	82.5	73.9	67.5	61.6	55.8
600	88.0	84.5	77.1	71.6	64.9	59.9	86.4	81.0	71.2	64.1	57.6	51.3
10	89.3	87.0	82.2	79.2	74.9	70.7	85.5	79.5	68.5	60.4	53.4	36.2
20	90.2	88.9	86.1	84.1	81.4	79.2	84.5	77.9	65.5	56.7	49.2	42.3
30	90.6	90.0	88.7	87.4	86.0	84.5	83.8	76.3	62.7	53.1	45.0	38.0
40	90.8	90.5	90.0	89.3	88.7	87.6	83.3	75.1	60.8	50.4	42.0	34.9
50	91.0	90.7	90.5	90.2	90.0	89.7	82.8	74.4	59.5	48.8	40.2	32.9
60	91.1	91.0	90.8	90.4	90.4	90.4	82.5	74.0	58.5	48.0	39.4	32.0
70	91.2	91.2	91.0	91.0	90.7	90.7	82.4	73.6	57.9	47.2	38.6	31.0
80	91.3	91.3	91.2	91.1	91.0	91.0	82.0	73.0	57.5	46.0	37.5	29.9
90	91.4	91.4	91.4	91.3	91.3	91.3	82.0	72.8	57.4	45.5	36.7	29.1
700	91.5	91.5	91.5	91.5	91.5	91.5	82.5	74.0	58.5	46.4	37.3	29.8
Luminous transmit.	84.2	77.9	67.1	58.1	50.0	44.0	88.0	85.1	78.9	74.8	70.5	66.7
Dominant wave lgth.	541.0	547.5	551.2	550.0	550.3	551.2	489.2	487.5	486.5	486.2	486.1	485.5
Excitation purity.	3.5	7.4	14.4	21.5	28.3	34.0	1.6	4.1	8.9	12.8	17.5	20.2

\* Some transmission below 400  $\mu$ . Consult the manufacturer.

### TRANSMISSION OF WRATTEN FILTERS (Continued)

Wave length	Percent transmittance				Wave length	Percent transmittance			
	No. 87	No. 87C	No. 88A	No. 89B		No. 87	No. 87C	No. 88A	No. 89B
700	—	—	—	11.2	30	74.1	17.8	84.7	88.8
10	—	—	—	32.4	40	77.7	28.2	85.5	89.0
20	—	—	—	57.6	50	81.4	41.0	86.1	89.2
30	—	—	7.4	69.1	60	84.0	53.8	86.6	89.4
40	0.10	—	32.8	77.6	70	85.4	61.6	87.2	89.6
50	2.19	—	56.3	83.1	80	86.8	69.2	87.5	89.8
60	7.95	—	69.2	85.0	90	87.8	74.1	87.8	89.9
70	17.4	—	74.2	86.1	900	88.4	78.5	88.0	90.0
80	31.6	—	77.6	87.0	10	88.8	81.5	88.2	90.1
90	43.7	—	79.7	87.7	20	89.1	83.6	88.4	90.2
800	53.8	0.32	81.4	88.1	30	89.1	85.1	88.6	90.3
10	61.7	3.20	82.6	88.4	40	89.1	86.0	88.8	90.4
20	69.2	8.90	83.7	88.6	50	89.1	87.0	89.0	90.5

\* Some transmission below 400 m $\mu$ . Consult the manufacturer.



## ULTRAVIOLET SPECTRA OF COMMON LIQUIDS

The following tables present the UV spectra of some common solvents and other liquids. The data were obtained, using a 1.00-cm path-length cell, against a water reference.

### REFERENCES

1. Krieger, P. A., *High Purity Solvent Guide*, Burdick and Jackson, McGraw Park, IL, 1984.

#### ACETONE

Wavelength (nm)	Max absorbance
330	1.000
340	0.060
350	0.010
375	0.005
400	0.005

#### BENZENE

Wavelength (nm)	Max absorbance
278	1.000
300	0.020
325	0.010
350	0.005
400	0.005

#### ACETONITRILE

Wavelength (nm)	Max absorbance
190	1.000
200	0.050
225	0.010
250	0.005
350	0.005

#### 1-BUTANOL

Wavelength (nm)	Max absorbance
215	1.000
225	0.500
250	0.040
275	0.010
300	0.005

#### 2-BUTANOL

Wavelength (nm)	Max absorbance
260	1.000
275	0.300
300	0.010
350	0.005
400	0.005

#### CARBON TETRACHLORIDE

Wavelength (nm)	Max absorbance
263	1.000
275	0.100
300	0.005
350	0.005
400	0.005

#### *n*-BUTYL ACETATE

Wavelength (nm)	Max absorbance
254	1.000
275	0.050
300	0.010
350	0.005
400	0.005

#### CHLOROBENZENE

Wavelength (nm)	Max absorbance
287	1.000
300	0.050
325	0.040
350	0.020
400	0.005

***n*-BUTYL CHLORIDE**

Wavelength (nm)	Max absorbance
220	1.000
225	0.300
250	0.010
300	0.005
400	0.005

**CHLOROFORM**

Wavelength (nm)	Max absorbance
245	1.000
250	0.300
275	0.005
300	0.005
400	0.005

**CYCLOHEXANE**

Wavelength (nm)	Max absorbance
200	1.000
225	0.170
250	0.020
300	0.005
400	0.005

***o*-DICHLOROBENZENE**

Wavelength (nm)	Max absorbance
295	1.000
300	0.300
325	0.100
350	0.050
400	0.005

**CYCLOPENTANE**

Wavelength (nm)	Max absorbance
200	1.000
215	0.300
225	0.020
300	0.005
400	0.005

**DIETHYL CARBONATE**

Wavelength (nm)	Max absorbance
256	1.000
265	0.150
275	0.050
300	0.040
400	0.010

**DECAHYDRONAPHTHALENE**

Wavelength (nm)	Max absorbance
200	1.000
225	0.500
250	0.050
300	0.005
400	0.005

**DIMETHYL ACETAMIDE**

Wavelength (nm)	Max absorbance
268	1.000
275	0.300
300	0.080
350	0.005
400	0.005

**DIMETHYL FORMAMIDE**

Wavelength (nm)	Max absorbance
268	1.000
275	0.300
300	0.050
350	0.005
400	0.005

**2-ETHOXYETHANOL**

Wavelength (nm)	Max absorbance
210	1.000
225	0.500
250	0.200
300	0.005
400	0.005

**DIMETHYL SULFOXIDE**

Wavelength (nm)	Max absorbance
268	1.000
275	0.500
300	0.200
350	0.020
400	0.005

**ETHYL ACETATE**

Wavelength (nm)	Max absorbance
256	1.000
275	0.050
300	0.030
325	0.005
350	0.005

**1,4-DIOXANE**

Wavelength (nm)	Max absorbance
215	1.000
250	0.300
300	0.020
350	0.005
400	0.005

**DIETHYL ETHER**

Wavelength (nm)	Max absorbance
215	1.000
250	0.080
275	0.010
300	0.005
400	0.005

**ETHYLENE DICHLORIDE**

Wavelength (nm)	Max absorbance
228	1.000
240	0.300
250	0.100
300	0.005
400	0.005

**HEXADECANE**

Wavelength (nm)	Max absorbance
190	1.000
200	0.500
250	0.020
300	0.005
400	0.005

**ETHYLENE GLYCOL DIMETHYL ETHER (GLYME)**

Wavelength (nm)	Max absorbance
220	1.000
250	0.250
300	0.050
350	0.010
400	0.005

**HEXANE**

Wavelength (nm)	Max absorbance
195	1.000
225	0.050
250	0.010
275	0.005
300	0.005

**HEPTANE**

Wavelength (nm)	Max absorbance
200	1.000
225	0.100
250	0.010
300	0.005
400	0.005

**ISOBUTANOL**

Wavelength (nm)	Max absorbance
220	1.000
250	0.050
275	0.030
300	0.020
400	0.010

**METHANOL**

Wavelength (nm)	Max absorbance
205	1.000
225	0.160
250	0.020
300	0.005
400	0.005

**METHYL *t*-BUTYL ETHER**

Wavelength (nm)	Max absorbance
210	1.000
225	0.500
250	0.100
300	0.005
400	0.005

**2-METHOXYETHANOL**

Wavelength (nm)	Max absorbance
210	1.000
250	0.130
275	0.030
300	0.005
400	0.005

**METHYLENE CHLORIDE**

Wavelength (nm)	Max absorbance
233	1.000
240	0.100
250	0.010
300	0.005
400	0.005

**2-METHOXYETHYL ACETATE**

Wavelength (nm)	Max absorbance
254	1.000
275	0.150
300	0.050
350	0.005
400	0.005

**METHYL ETHYL KETONE**

Wavelength (nm)	Max absorbance
329	1.000
340	0.100
350	0.020
375	0.010
400	0.005

**METHYL ISOAMYL KETONE**

Wavelength (nm)	Max absorbance
330	1.000
340	0.100
350	0.050
375	0.010
400	0.005

***n*-METHYLPYRROLIDONE**

Wavelength (nm)	Max absorbance
285	1.000
300	0.500
325	0.100
350	0.030
400	0.010

**METHYL ISOBUTYL KETONE**

Wavelength (nm)	Max absorbance
334	1.000
340	0.500
350	0.250
375	0.050
400	0.005

**PENTANE**

Wavelength (nm)	Max absorbance
190	1.000
200	0.600
250	0.010
300	0.005
400	0.005

**METHYL *n*-PROPYL KETONE**

Wavelength (nm)	Max absorbance
331	1.000
340	0.150
350	0.020
375	0.005
400	0.005

**β-PHENETHYLAMINE**

Wavelength (nm)	Max absorbance
285	1.000
300	0.300
325	0.100
350	0.050
400	0.005

**1-PROPANOL**

Wavelength (nm)	Max absorbance
210	1.000
225	0.500
250	0.050
300	0.005
400	0.005

**PYRIDINE**

Wavelength (nm)	Max absorbance
330	1.000
340	0.100
350	0.010
375	0.010
400	0.005

**2-PROPANOL**

Wavelength (nm)	Max absorbance
205	1.000
225	0.160
250	0.020
300	0.005
400	0.010

**TETRAHYDROFURAN**

Wavelength (nm)	Max absorbance
212	1.000
250	0.180
300	0.020
350	0.005
400	0.005

**PROPYLENE CARBONATE**

Wavelength (nm)	Max absorbance
280	1.000
300	0.500
350	0.050
375	0.030
400	0.020

**TOLUENE**

Wavelength (nm)	Max absorbance
284	1.000
300	0.120
325	0.020
350	0.050
400	0.005

**1,2,4-TRICHLOROBENZENE**

Wavelength (nm)	Max absorbance
308	1.000
310	0.500
350	0.050
375	0.010
400	0.005

**2,2,4-TRIMETHYLPENTANE**

Wavelength (nm)	Max absorbance
215	1.000
225	0.100
250	0.020
300	0.005
400	0.005

**TRICHLOROETHYLENE**

Wavelength (nm)	Max absorbance
273	1.000
300	0.100
325	0.080
350	0.060
400	0.060

**WATER**

Wavelength (nm)	Max absorbance
190	0.010
200	0.010
250	0.005
300	0.005
400	0.005

**1,1,2-TRICHLOROTRIFLUOROETHANE**

Wavelength (nm)	Max absorbance
231	1.000
250	0.050
300	0.005
350	0.005
400	0.005

***o*-XYLENE**

Wavelength (nm)	Max absorbance
288	1.000
300	0.200
325	0.050
350	0.010
400	0.005



## UNITS, SYMBOLS, AND EQUATIONS FOR RADIOMETRIC AND PHOTOMETRIC QUANTITIES

Submitted by Abraham Abramowitz  
from Z-7.1-1967

### Radiometric Quantities (See Note at bottom of page)

Quantity*	Symbol*	Defining Equation**	Commonly Used Units	Symbol
Radiant energy	$Q, (Q_e)$		erg ‡ joule kilowatt-hour	J kWh
Radiant density	$w, (w_e)$	$w = dQ/dV$	‡ joule per cubic meter erg per cubic centimeter	$J/m^3$ $erg/cm^3$
Radiant flux	$\Phi, (\Phi_e)$	$\Phi = dQ/dt$	erg per second ‡ watt	$erg/s$ W
Radiant flux density at a surface				
Radiant exitance	$M, (M_e)$	$M = d\Phi/dA$	watt per square centimeter	$W/cm^2$
(Radiant emittance)†				
Irradiance	$E, (E_e)$	$E = d\Phi/dA$	‡ watt per square meter, etc.	$W/m^2$
Radiant intensity	$I, (I_e)$	$I = d\Phi/d\omega$ ( $\omega$ = solid angle through which flux from point source is radiated)	‡ watt per steradian	W/sr
Radiance	$L, (L_e)$	$L = d^2\Phi/d\omega^2(dA \cos\theta)$ $= dI/(dA \cos\theta)$ ( $\theta$ = angle between line of sight and normal to sur- face considered)	watt per steradian and square centimeter ‡ watt per steradian and square meter	$W \cdot sr^{-1} cm^{-2}$ $W \cdot sr^{-1} m^{-2}$
Emissivity	$\epsilon$	$\epsilon = M/M_{blackbody}$ ( $M$ and $M_{blackbody}$ are re- spectively the radiant exi- tance of the measured specimen and that of a blackbody at the same temperature as the speci- men)	one (numeric)	—

Note: The symbols for photometric quantities (see following table) are the same as those for the corresponding radiometric quantities (see above). When it is necessary to differentiate them the subscripts  $v$  and  $e$  respectively should be used, e.g.,  $Q_v$  and  $Q_e$ .

\*Quantities may be restricted to a narrow wavelength band by adding the word spectral and indicating the wavelength. The corresponding symbols are changed by adding a subscript  $\lambda$ , e.g.,  $Q_\lambda$  for a spectral concentration or a  $\lambda$  in parentheses, e.g.,  $K(\lambda)$ , for a function of wavelength.

\*\*The equations in this column are given merely for identification.

\*\*\* $\Phi_i$  = incident flux  
 $\Phi_a$  = absorbed flux  
 $\Phi_r$  = reflected flux  
 $\Phi_t$  = transmitted flux

†to be deprecated.

‡International System (SI) unit.

**UNITS, SYMBOLS, AND EQUATIONS FOR RADIOMETRIC AND PHOTOMETRIC QUANTITIES**  
(continued)

Quantity*	Symbol*	Photometric Quantities		
		Defining Equation**	Commonly Used Units	Symbol
Absorptance	$\alpha, (\alpha_v, \alpha_e)$	$\alpha = \Phi_d/\Phi_i^{***}$	one (numeric)	—
Reflectance	$\rho, (\rho_v, \rho_e)$	$\rho = \Phi_r/\Phi_i^{***}$	one (numeric)	—
Transmittance	$\tau, (\tau_v, \tau_e)$	$\tau = \Phi_t/\Phi_i^{***}$	one (numeric)	—
Luminous energy (quantity of light)	$Q, (Q_v)$	$Q_v = \int_{380}^{760} K(\lambda) Q_e \lambda d\lambda$	lumen-hour ‡lumen-second (talbot)	lm · h lm · s
Luminous density	$w, (w_v)$	$w = dQ/dV$	‡lumen-second per cubic meter	lm · s · m <sup>-3</sup>
Luminous flux	$\Phi, (\Phi_v)$	$\Phi = dQ/dt$	‡lumen	lm
Luminous flux density at a surface Luminous exitance (Luminous emittance)†	$M, (M_v)$	$M = d\Phi/dA$	lumen per square foot	lm/ft <sup>2</sup>
Illumination (illuminance)	$E, (E_v)$	$E = d\Phi/dA$	footcandle (lumen per square foot) ‡lux (lm/m <sup>2</sup> ) phot (lm/cm <sup>2</sup> )	fc lx ph
Luminous intensity (candlepower)	$I, (I_v)$	$I = d\Phi/d\omega$ ( $\omega$ = solid angle through which flux from point source is radiated)	‡candela (lumen per steradian)	cd
Luminance (photometric brightness)	$L, (L_v)$	$L = d^2\Phi/d\omega (dA \cos\theta)$ $= dI/(dA \cos\theta)$ ( $\theta$ = angle between line of sight and normal to surface considered)	candela per unit area stilb (cd/cm <sup>2</sup> ) nit (‡cd/m <sup>2</sup> ) footlambert (cd/πft <sup>2</sup> ) lambert (cd/πcm <sup>2</sup> ) apostilb (cd/πm <sup>2</sup> )	cd/in <sup>2</sup> , etc. sb nt fL L asb
Luminous efficacy	$K$	$K = \Phi_v/\Phi_e$	‡lumen per watt	lm/W
Luminous efficiency	$V$	$V = K/K_{\text{maximum}}$ ( $K_{\text{maximum}}$ = maximum value of $K(\lambda)$ function)	one (numeric)	—

**ILLUMINATION CONVERSION FACTORS**

1 lumen = 1/680 lightwatt	1 watt-second = 1 joule = 10 <sup>7</sup> ergs
1 lumen-hour = 60 lumen-minutes	1 phot = 1 lumen/cm <sup>2</sup>
1 footcandle = 1 lumen/ft <sup>2</sup>	1 lux = 1 lumen/m <sup>2</sup>

Number of → Multiplied by ↘	Footcandles	*Lux	Phots	Milliphots
Equals Number of ↓				
Footcandles	1	0.0929	929	0.929
*Lux	10.76	1	10,000	10
Phot	0.00108	0.0001	1	0.001
Milliphot	1.076	0.1	1,000	1

\*The International System (SI) unit.



**VALUES FOR THE LANGEVIN FUNCTION  $\mathcal{L}(u)$**   
**Compiled by Allen L. King**

Because of random thermal rotations a dipole or dipole-like element ordinarily has an average dipole moment of zero. If it is placed in an orienting field  $F$  however it tends to align itself with the field so that the average component of the dipole moment parallel to the field equals  $p$ . Classically, if the system is in thermal equilibrium,

$$\bar{p} = p_0(\coth u - 1/u) = p_0\mathcal{L}(u)$$

Here  $p_0$  is the permanent moment (electric or magnetic) of the dipole, and  $\mathcal{L}(u)$  is the Langevin function of the argument  $u$  which equals  $Fp_0/kT$ . The following table gives values of  $\mathcal{L}(u)$ . Note that for  $u \ll 1$ ,  $\mathcal{L}(u) \approx u/3$ ; for  $u \gg 1$ ,  $\mathcal{L}(u) \approx (u - 1)/u$ .

$(u)$	0	1	2	3	4	5	6	7	8	9	10	Diff.
0.0	.0000	.0033	.0066	.0100	.0133	.0166	.0200	.0233	.0267	.0300	.0333	33
0.1	.0333	.0366	.0400	.0433	.0466	.0499	.0532	.0566	.0599	.0632	.0665	33
0.2	.0665	.0698	.0731	.0764	.0797	.0830	.0863	.0896	.0928	.0961	.0994	33
0.3	.0994	.1027	.1059	.1092	.1125	.1157	.1190	.1222	.1255	.1287	.1319	32.5
0.4	.1319	.1352	.1384	.1416	.1448	.1480	.1512	.1544	.1576	.1608	.1640	32
0.5	.1640	.1671	.1703	.1734	.1766	.1797	.1829	.1860	.1891	.1922	.1954	31
0.6	.1954	.1985	.2016	.2046	.2077	.2108	.2139	.2169	.2200	.2230	.2261	31
0.7	.2261	.2291	.2321	.2351	.2381	.2411	.2441	.2471	.2500	.2530	.2559	30
0.8	.2559	.2589	.2618	.2647	.2677	.2706	.2735	.2763	.2792	.2821	.2850	29
0.9	.2850	.2878	.2906	.2935	.2963	.2991	.3019	.3047	.3075	.3103	.3130	28
1.0	.3130	.3158	.3185	.3213	.3240	.3267	.3294	.3321	.3348	.3375	.3401	27
1.1	.3401	.3428	.3454	.3481	.3507	.3533	.3559	.3585	.3611	.3636	.3662	26
1.2	.3662	.3688	.3713	.3738	.3763	.3789	.3813	.3838	.3863	.3888	.3912	25
1.3	.3912	.3937	.3961	.3985	.4010	.4034	.4057	.4081	.4105	.4129	.4152	24
1.4	.4152	.4175	.4199	.4222	.4245	.4268	.4291	.4314	.4336	.4359	.4381	23
1.5	.4381	.4404	.4426	.4448	.4470	.4492	.4514	.4535	.4557	.4578	.4600	22
1.6	.4600	.4621	.4642	.4663	.4684	.4705	.4726	.4747	.4767	.4788	.4808	21
1.7	.4808	.4828	.4849	.4869	.4889	.4908	.4928	.4948	.4967	.4987	.5006	20
1.8	.5006	.5026	.5045	.5064	.5083	.5102	.5120	.5139	.5158	.5176	.5194	19
1.9	.5194	.5213	.5231	.5249	.5267	.5285	.5303	.5321	.5338	.5356	.5373	18
2.0	.5373	.5390	.5408	.5425	.5442	.5459	.5476	.5493	.5509	.5526	.5543	17
2.1	.5543	.5559	.5575	.5592	.5608	.5624	.5640	.5656	.5672	.5687	.5703	16
2.2	.5703	.5719	.5734	.5750	.5765	.5780	.5795	.5810	.5825	.5840	.5855	15
2.3	.5855	.5870	.5885	.5899	.5914	.5928	.5943	.5957	.5971	.5985	.5999	14.5
2.4	.5999	.6013	.6027	.6041	.6055	.6068	.6082	.6096	.6109	.6122	.6136	14
2.5	.6136	.6149	.6162	.6175	.6188	.6201	.6214	.6227	.6240	.6252	.6265	13
2.6	.6265	.6277	.6290	.6302	.6314	.6327	.6339	.6351	.6363	.6375	.6387	12
2.7	.6387	.6399	.6411	.6422	.6434	.6446	.6457	.6469	.6480	.6492	.6503	12
2.8	.6503	.6514	.6525	.6536	.6547	.6558	.6569	.6580	.6591	.6602	.6612	11
2.9	.6612	.6623	.6634	.6644	.6655	.6665	.6675	.6686	.6696	.6706	.6716	10.5
3.0	.6716	.6726	.6736	.6746	.6756	.6766	.6776	.6786	.6796	.6805	.6815	10
3.1	.6815	.6824	.6834	.6843	.6853	.6862	.6872	.6881	.6890	.6899	.6908	9
3.2	.6908	.6917	.6926	.6935	.6944	.6953	.6962	.6971	.6980	.6988	.6997	9
3.3	.6997	.7006	.7014	.7023	.7031	.7040	.7048	.7056	.7065	.7073	.7081	8.5
3.4	.7081	.7089	.7097	.7106	.7114	.7122	.7130	.7138	.7145	.7153	.7161	8
3.5	.7161	.7169	.7177	.7184	.7192	.7200	.7207	.7215	.7222	.7230	.7237	8
3.6	.7237	.7245	.7252	.7259	.7267	.7274	.7281	.7288	.7295	.7302	.7310	7
3.7	.7310	.7317	.7324	.7331	.7337	.7344	.7351	.7358	.7365	.7372	.7378	7
3.8	.7378	.7385	.7392	.7398	.7405	.7412	.7418	.7425	.7431	.7438	.7444	7
3.9	.7444	.7450	.7457	.7463	.7469	.7476	.7482	.7488	.7494	.7501	.7507	6

## X-RAY WAVELENGTHS

J. A. Bearden

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### THE W $K\alpha_1$ WAVELENGTH STANDARD

A wavelength standard should possess characteristics which permit its ready redetermination in other laboratories by different techniques. Considering all of the factors involved in the selection of a wavelength standard, the W  $K\alpha_1$  line is superior to any other x-ray or  $\gamma$ -ray wavelength. Its advantages as the x-ray wavelength standard are discussed in *Review of Modern Physics* Vol. 39, page 82 (1967).

$$\lambda W K\alpha_1 = 0.2090100 \text{ \AA} \pm 5 \text{ ppm.}$$

This numerical value of the wavelength of the W  $K\alpha_1$  line is used to define the *x-ray wavelength standard* by the relation

$$\lambda(W K\alpha_1) = 0.2090100 \text{ \AA}^*.$$

This is a new unit of length which may differ from the angstrom by  $\pm 5$  ppm (probable error), *but as a wavelength standard it has no error*. In order to clearly indicate that this unit is not exactly an angstrom, it has been designated  $\text{\AA}^*$ .

Wavelengths tabulated normally refer to the pure element in its solid form. However, there are many instances in which such data are not available. For example, rare gases are of necessity almost always used in the gaseous form, while the rare-earth elements were customarily used in the form of salts.

In high precision work there is some ambiguity as to exactly what feature of a line profile should be taken to be the "true wavelength." In double-crystal work the line peak is usually employed. In crystallography the centroid is widely used; in photographic work with visual observation of the plates, there is involved some subjective criterion of the observer which it is difficult to define precisely. In this survey the peak of the line profile has been adopted as the standard criterion.

In the study of the X-ray literature, the wavelengths of a number of lines were noted which appeared inconsistent with the remaining data. A Moseley-type diagram was constructed, and if the value was clearly outside estimated probable error, it was assumed that an experimental or typographical error had occurred, and the interpolated value was listed in the table. Such cases are marked with a dagger ( $\dagger$ ) as a superscript to the wavelength. For elements of atomic number 85 through 89 and 91, there are no measured lines of the  $K$  series and very few of other series except for 88 radium and 91 protactinium. Likewise there are very few measurements for 43 technetium and 54 xenon. In these cases, interpolated values are listed for the more prominent lines and marked with a dagger ( $\dagger$ ).

X-RAY WAVELENGTHS

X-ray wavelengths in Å\* units and in keV. The probable error (p.e.) is the error in the last digit of wavelength. Designation indicates both conventional Siegbahn notation (if applicable) and transition, e.g.,  $\beta_1 L_{II}M_{IV}$  denotes a transition between the  $L_{II}$  and  $M_{IV}$  levels, which is the  $L\beta_1$  line in Siegbahn notation.

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
<b>3 Lithium</b>				<b>4 Beryllium</b>				<b>19 Potassium (Cont.)</b>				<b>20 Calcium (Cont.)</b>			
$\alpha KL$	228.	1	0.0543	114.	1	0.1085	$\eta L_{II}M_I$	47.24	2	0.2625	40.46	2	0.3064		
<b>5 Boron</b>				<b>6 Carbon</b>				$\beta_1$			35.94	2	0.3449		
$\alpha KL$	67.6	3	0.1833	44.7	3	0.277	$l L_{III}M_I$	47.74	1	0.25971	40.96	2	0.3027		
<b>7 Nitrogen</b>				<b>8 Oxygen</b>				$\alpha_{1,2} L_{III}M_{IV,V}$			36.33	2	0.3413		
$\alpha KL$	31.6	4	0.3924	23.62	3	0.5249	$M_{II,III}N_I$	692	9	0.0179	525.	9	0.0236		
<b>9 Fluorine</b>				<b>10 Neon</b>				<b>21 Scandium</b>				<b>22 Titanium</b>			
$\alpha_{1,2} KL_{II,III}$	18.32	2	0.6768	14.610	3	0.8486	$\alpha_2 KL_{II}$	3.0342	1	4.0861	2.75216	2	4.50486		
$\beta KM$				14.452	5	0.8579	$\alpha_1 KL_{III}$	3.0309†	1	4.0906	2.74851	2	4.51084		
<b>11 Sodium</b>				<b>12 Magnesium</b>				$\beta_{1,2} KM_{II,III}$	2.7796	2	4.4605	2.51391	2	4.93181	
$\alpha_{1,2} KL_{II,III}$	11.9101	9	1.0410	9.8900	2	1.25360	$\beta_3 KM_{IV,V}$	2.7634	3	4.4865	2.4985	2	4.9623		
$\beta KM$	11.575	2	1.0711	9.521	2	1.3022	$\eta L_{II}M_I$	35.13	2	0.3529	30.89	3	0.4013		
$L_{II,III}M$	407.1	5	0.03045	251.5	5	0.0493	$\beta_1 L_{II}M_{IV}$	31.02	2	0.3996	27.05	2	0.4584		
$L_1L_{II,III}$	376	1	0.0330	317	1	0.0392	$l L_{III}M_I$	35.59	3	0.3483	31.36	2	0.3953		
<b>13 Aluminum</b>				<b>14 Silicon</b>				$\alpha_{1,2} L_{III}M_{IV,V}$	31.35	3	0.3954	27.42	2	0.4522	
$\alpha_2 KL_{II}$	8.34173	9	1.48627	7.12791	9	1.73938	<b>23 Vanadium</b>				<b>24 Chromium</b>				
$\alpha_1 KL_{III}$	8.33934	9	1.48670	7.12542	9	1.73998	$\alpha_2 KL_{II}$	2.50738	2	4.94464	2.293606	3	5.40551		
$\beta KM$	7.960	2	1.5574	6.753	1	1.8359	$\alpha_1 KL_{III}$	2.50356	2	4.95220	2.28970	2	5.41472		
$L_{II,III}$	171.4	5	0.0724	135.5	4	0.0915	$\beta_{1,2} KM_{II,III}$	2.28440	2	5.42729	2.08487	2	5.94671		
$L_1L_{II,III}$	290.	1	0.0428				$\beta_3 KM_{IV,V}$	2.26951	6	5.4629	2.07087	6	5.9869		
<b>15 Phosphorus</b>				<b>16 Sulfur</b>				$\beta_{3,4} L_1M_{II,III}$	21.19†	9	0.585	18.96	2	0.654	
$\alpha_2 KL_{II}$	6.160†	1	2.0127	5.37496	8	2.30664	$\eta L_{II}M_I$	27.34	3	0.4535	24.30	3	0.5102		
$\alpha_1 KL_{III}$	6.157†	1	2.0137	5.37216	7	2.30784	$\beta_1 L_{II}M_{IV}$	23.88	4	0.5192	21.27	1	0.5828		
$\beta KM$	5.796	2	2.1390				$l L_{III}M_I$	27.77	1	0.4465	24.78	1	0.5003		
$\beta_1 KM$				5.0316	2	2.4640	$\alpha_{1,2} L_{III}M_{IV,V}$	24.25	3	0.5113	21.64	3	0.5728		
$\beta_2 KM$				5.0233	3	2.4681	$M_{II,III}M_{IV,V}$	337.	9	0.037	309.	9	0.040		
$L_{II,III}M$	103.8	4	0.1194				<b>25 Manganese</b>				<b>26 Iron</b>				
$l, \eta L_{II,III}M_I$				83.4	3	0.1487	$\alpha_2 KL_{II}$	2.10578	2	5.88765	1.939980	9	6.39084		
<b>17 Chlorine</b>				<b>18 Argon</b>				$\alpha_1 KL_{III}$	2.101820	9	5.89875	1.936042	9	6.40384	
$\alpha_2 KL_{II}$	4.7307	1	2.62078	4.19474	5	2.95563	$\beta_{1,2} KM_{II,III}$	1.91021	2	6.49045	1.75661	2	7.05798		
$\alpha_1 KL_{III}$	4.7278	1	2.62239	4.19180	5	2.95770	$\beta_3 KM_{IV,V}$	1.8971	1	6.5352	1.7442	1	7.1081		
$\beta KM$	4.4034	3	2.8156				$\beta_{3,4} L_1M_{II,III}$	17.19	2	0.721	15.65	2	0.792		
$\beta_{1,2} KM_{II,III}$				3.8860	2	3.1905	$\eta L_{II}M_I$	21.85	2	0.5675	19.75	4	0.628		
$\eta L_{II}M_I$	67.33	9	0.1841	55.9†	1	0.2217	$\beta_1 L_{II}M_{IV}$	19.11	2	0.6488	17.26	1	0.7185		
$l L_{III}M_I$	67.90	9	0.1826	56.3†	1	0.2201	$l L_{III}M_I$	22.29	1	0.5563	20.15	1	0.6152		
<b>19 Potassium</b>				<b>20 Calcium</b>				$\alpha_{1,2} L_{III}M_{IV,V}$	19.45	1	0.6374	17.59	2	0.7050	
$\alpha_2 KL_{II}$	3.7445	2	3.3111	3.36166	3	3.68809	$M_{II,III}M_{IV,V}$	273.	6	0.045	243.	5	0.051		
$\alpha_1 KL_{III}$	3.7414	2	3.3138	3.35839	3	3.69168	<b>27 Cobalt</b>				<b>28 Nickel</b>				
$\beta_{1,2} KM_{II,III}$	3.4539	2	3.5896	3.0897	2	4.0127	$\alpha_2 KL_{II}$	1.792850	9	6.91530	1.661747	8	7.46089		
$\beta_3 KM_{IV,V}$	3.4413	4	3.6027	3.0746	3	4.0325	$\alpha_1 KL_{III}$	1.788965	9	6.93032	1.657910	8	7.47815		
								$\beta_{1,2} KM_{II,III}$	1.62079	2	7.64943	1.500135	8	8.26466	
								$\beta_3 KM_{IV,V}$	1.60891	3	7.7059	1.48862	4	8.3286	
								$\beta_{3,4} L_1M_{II,III}$	14.31	3	0.870	13.18	1	0.941	
								$\eta L_{II}M_I$	17.87	3	0.694	16.27	3	0.762	
								$\beta_1 L_{II}M_{IV}$	15.666	8	0.7914	14.271	6	0.8688	
								$l L_{III}M_I$	18.292	8	0.6778	16.693	9	0.7427	
								$\alpha_{1,2} L_{III}M_{IV,V}$	15.972	6	0.7762	14.561	3	0.8515	
								$M_{II,III}M_{IV,V}$	214.	6	0.058	190.	2	0.0651	





X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV						
39 Yttrium (Cont.)						40 Zirconium (Cont.)						43 Technetium				44 Ruthenium			
$\beta_4 KN_{IV,V}$	0.72776	5	17.036	0.68901	5	17.994	$\alpha_2 KL_{II}$	0.67932 <sup>†</sup>	3	18.2508	0.647408	5	19.1504						
$\beta_4 LI_{M_{II}}$	6.0186	3	2.0600	5.6681	3	2.1873	$\alpha_1 KL_{III}$	0.67502 <sup>†</sup>	3	18.3671	0.643083	4	19.2792						
$\beta_3 LI_{M_{III}}$	5.9832	3	2.0722	5.6330	3	2.2010	$\beta_3 KM_{II}$	0.60188 <sup>†</sup>	4	20.599	0.573067	4	21.6346						
$\gamma_{2,3} LI_{N_{II,III}}$	5.2830	3	2.3468	4.9536	3	2.5029	$\beta_1 KM_{III}$	0.60130 <sup>†</sup>	4	20.619	0.572482	4	21.6568						
$\eta LI_{M_I}$	7.0406	3	1.76095	6.6069	3	1.87654	$\beta_3 KN_{II,III}$	0.59024 <sup>†</sup>	5	21.005	0.56166	3	22.074						
$\beta_1 L_{III}M_{IV}$	6.2120	3	1.99584	5.8360	3	2.1244	$\beta_6^{II} KM_{IV}$				0.5680	2	21.829						
$\gamma_6 L_{II}N_I$	5.8754	3	2.1102	5.4977	3	2.2551	$\beta_6^I KM_V$				0.56785	9	21.834						
$\gamma_1 L_{II}N_{IV}$				5.3843	3	2.3027	$\beta_4$				0.56089	9	22.104						
$l L_{III}M_I$	7.3563	3	1.68536	6.9185	3	1.79201	$\beta_4 L_{II}M_{IV}$				4.5230	2	2.7411						
$\alpha_2 L_{III}M_{IV}$	6.4558	3	1.92047	6.0778	3	2.0399	$\beta_3 LI_{M_{III}}$				4.4866	3	2.7634						
$\alpha_1 L_{III}M_V$	6.4488	2	1.92256	6.0705	2	2.04236	$\gamma_{2,3} LI_{N_{II,III}}$				3.8977	2	3.1809						
$\beta_6 L_{III}N_I$	6.0942	3	2.0344	5.7101	3	2.1712	$\eta L_{II}M_I$				5.2050	2	2.38197						
$\beta_{2,16}$				5.5863	3	2.2194	$\beta_1 L_{II}M_{IV}$	4.8873 <sup>†</sup>	8	2.5368	4.62058	3	2.68323						
$M_{II}M_{IV}$	81.5	2	0.1522	76.7	2	0.1617	$\gamma_6 L_{II}N_I$				4.2873	2	2.8918						
$M_{II}N_I$	46.48	9	0.267				$\gamma_1 L_{II}N_{IV}$				4.1822	2	2.9645						
$M_{III}M_V$				80.9	3	0.1533	$l L_{III}M_I$				5.5035	3	2.2528						
$M_{III}N_I$	48.5	2	0.256				$\alpha_2 L_{III}M_{IV}$				4.85381	7	2.55431						
$M_{III}M_{IV,V}$	86.5	2	0.1434				$\alpha_1 L_{III}M_V$	5.1148 <sup>†</sup>	3	2.4240	4.84575	5	2.55855						
$\zeta M_{IV,V}N_{II,III}$	93.4	2	0.1328	82.1	2	0.1511	$\beta_6 L_{III}N_I$				4.4866	3	2.7634						
$M_{IV,V}O_{II,III}$				70.0	4	0.177	$\beta_{2,16} L_{III}N_{IV,V}$				4.3718	2	2.8360						
41 Niobium						42 Molybdenum						45 Rhodium				46 Palladium			
$\alpha_2 KL_{II}$	0.75044	1	16.5210	0.713590	6	17.3743	$\alpha_2 KL_{II}$	0.617630	4	20.0737	0.589821	3	21.0201						
$\alpha_1 KL_{III}$	0.74620	1	16.6151	0.709300	1	17.47934	$\alpha_1 KL_{III}$	0.613279	4	20.2161	0.585448	3	21.1771						
$\beta_3 KM_{II}$	0.66634	3	18.6063	0.632872	9	19.5903	$\beta_3 KM_{II}$	0.546200	4	22.6989	0.521123	4	23.7911						
$\beta_1 KM_{III}$	0.66576	2	18.6225	0.632288	9	19.6083	$\beta_1 KM_{III}$	0.545605	4	22.7236	0.520520	4	23.8187						
$\beta_3^{II}$				0.62107	5	19.963	$\beta_2^{II} KN_{II}$	0.53513	5	23.168									
$\beta_2 KN_{II,III}$	0.65416	4	18.953	0.62099	2	19.9652	$\beta_2 KN_{II,III}$	0.53503	2	23.1728	0.510228	4	24.2991						
$\beta_4 KN_{IV,V}$	0.65318	5	18.981				$\beta_6^{II} KM_{IV}$	0.54118	9	22.909									
$\beta_6^{II} KM_{IV}$				0.62708	5	19.771	$\beta_6^I KM_V$	0.54101	9	22.917									
$\beta_6^I KM_V$				0.62692	5	19.776	$\beta_4 KN_{IV,V}$	0.53401	9	23.217	0.5093	2	24.346						
$\beta_4 KN_{IV,V}$				0.62001	9	19.996	$\beta_6 KM_{IV,V}$				0.51670	9	23.995						
$\beta_4 LI_{M_{II}}$	5.3455	3	2.3194	5.0488	3	2.4557	$\beta_4 L_{II}M_{II}$	4.2888	2	2.8908	4.0711	2	3.0454						
$\beta_3 LI_{M_{III}}$	5.3102	3	2.3348	5.0133	3	2.4730	$\beta_3 LI_{M_{III}}$	4.2522	2	2.9157	4.0346	2	3.0730						
$\gamma_{2,3} LI_{N_{II,III}}$	4.6542	2	2.6638	4.3800	2	2.8306	$\gamma_{2,3} LI_{N_{II,III}}$	3.6855	2	3.3640	3.4892	2	3.5533						
$\eta L_{II}M_I$	6.2109	3	1.99620	5.8475	3	2.1202	$\eta L_{II}M_I$	4.9217	2	2.5191	4.6605	2	2.6603						
$\beta_1 L_{II}M_{IV}$	5.4923	3	2.2574	5.17708	8	2.39481	$\beta_1 L_{II}M_{IV}$	4.37414	4	2.83441	4.14622	5	2.99022						
$\gamma_6 L_{II}N_I$	5.1517	3	2.4066	4.8369	2	2.5632	$\beta_1 L_{II}N_I$	4.0451	2	3.0650	3.8222	2	3.2437						
$\gamma_1 L_{II}N_{IV}$	5.0361	3	2.4618	4.7258	2	2.6235	$\gamma_1 L_{II}N_{IV}$	3.9437	2	3.1438	3.7246	2	3.3287						
$l L_{III}M_I$	6.5176	3	1.90225	6.1508	3	2.01568	$l L_{III}M_I$	5.2169	3	2.3765	4.9525	3	2.5034						
$\alpha_2 L_{III}M_{IV}$	5.7319	3	2.1630	5.41437	8	2.28985	$\alpha_2 L_{III}M_{IV}$	4.60545	9	2.69205	4.37588	7	2.83329						
$\alpha_1 L_{III}M_V$	5.7243	2	2.16589	5.40655	8	2.29316	$\alpha_1 L_{III}M_V$	4.59743	9	2.69674	4.36767	5	2.83861						
$\beta_6 L_{III}N_I$	5.3613	3	2.3125	5.0488	5	2.4557	$\beta_6 L_{III}N_I$	4.2417	2	2.9229	4.0162	2	3.0870						
$\beta_{2,16} L_{III}N_{IV,V}$	5.2379	3	2.3670	4.9232	2	2.5183	$\beta_{2,16} L_{III}N_{IV,V}$	4.1310	2	3.0013	3.90887	4	3.17179						
$M_{II}M_{IV}$	72.1	3	0.1718	68.9	2	0.1798	$\beta_{10} LI_{M_{IV}}$				3.7988	2	3.2637						
$M_{II}N_I$	38.4	3	0.323	35.3	3	0.351													
$M_{III}M_V$	33.1	2	0.375																
$M_{III}N_I$	78.4	2	0.1582	74.9	1	0.1656													
$M_{III}M_{IV,V}$	40.7	2	0.305	37.5	2	0.331													
$\gamma M_{III}N_{IV,V}$	34.9	2	0.356																
$\zeta M_{IV,V}N_{II,III}$	72.19	9	0.1717	64.38	7	0.1926													
$M_{IV,V}O_{II,III}$	61.9	2	0.2002	54.8	2	0.2262													



X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
45 Rhodium (Cont.)				46 Palladium (Cont.)				49 Indium (Cont.)				50 Tin (Cont.)			
$\beta_1 L_I M_V$				3.7920	2	3.2696	$\beta_1 K M_{III}$	0.454545	4	27.2759	0.435236	5	28.4860		
$M_{II} N_{II,III}$				20.1	2	0.616	$\beta_2 K N_{II,III}$	0.44500	1	27.8608	0.425915	8	29.1093		
$M_{II} M_{IV}$	59.3	1	0.2090	56.5	1	0.2194	$K O_{II,III}$	0.44374	3	27.940	0.42467	3	29.195		
$M_{II} N_I$	28.1	2	0.442	26.2	2	0.474	$\beta_1^{II} K M_{IV}$	0.45098	2	27.491	0.43184	3	28.710		
$M_{II} N_{IV}$				22.1	1	0.560	$\beta_1^I K M_V$	0.45086	2	27.499	0.43175	3	28.716		
$M_{II} M_V$	65.5	1	0.1892	62.9	1	0.1970	$\beta_4 K N_{IV,V}$	0.44393	4	27.928	0.42495	3	29.175		
$M_{II}^I N_I$	29.8	1	0.417	27.9	1	0.445	$\beta_4 L_I M_{II}$	3.50697	9	3.5353	3.34335	9	3.7083		
$\gamma M_{III} N_{IV,V}$	25.01	9	0.496	23.3 <sup>†</sup>	1	0.531	$\beta_3 L_I M_{III}$	3.46984	9	3.5731	3.30585	3	3.7500		
$\zeta M_{IV,V} N_{II,III}$	47.67	9	0.2601	43.6	1	0.2844	$\gamma_{2,3} L_I N_{II,III}$	2.9800	2	4.1605	2.8327	2	4.3768		
$M_{IV,V} O_{II,III}$	40.9	2	0.303	37.4	2	0.332	$\gamma_4 L_I O_{II,III}$	2.9264	2	4.2367	2.7775	2	4.4638		
							$\eta L_{II} M_I$	3.98327	9	3.11254	3.78876	9	3.27234		
47 Silver				48 Cadmium				$\beta_1 L_{II} M_{IV}$	3.55531	4	3.48721	3.38487	3	3.66280	
$\alpha_2 K L_{II}$	0.563798	4	21.9903	0.539422	3	22.9841	$\gamma_8 L_{II} N_I$	3.24907	9	3.8159	3.08475	9	4.0192		
$\alpha_1 K L_{III}$	0.5594075	6	22.16292	0.535010	3	23.1736	$\gamma_1 L_{II} N_{IV}$	3.16213	4	3.92081	3.00115	3	4.13112		
$\beta_3 K M_{II}$	0.497685	4	24.9115	0.475730	5	26.0612	$l L_{III} M_I$	4.26873	9	2.90440	4.07165	9	3.04499		
$\beta_1 K M_{III}$	0.497069	4	24.9424	0.475105	6	26.0955	$\alpha_2 L_{III} M_{IV}$	3.78073	6	3.27929	3.60891	4	3.43542		
$\beta_2 K N_{II,III}$	0.487032	4	25.4564	0.465328	7	26.6438	$\alpha_1 L_{III} M_V$	3.77192	4	3.28694	3.59994	3	3.44398		
$\beta_3 K M_{IV,V}$	0.49306	2	25.145				$\beta_4 L_{III} N_I$	3.43606	9	3.60823	3.26901	9	3.7926		
$\beta_4 K N_{IV,V}$	0.48598	3	25.512				$\beta_{2,15} L_{III} N_{IV,V}$	3.33838	3	3.71381	3.17505	3	3.90486		
$\beta_4 L_I M_{II}$	3.87023	5	3.20346	3.68203	9	3.36719	$\beta_3 L_{III} O_I$	3.324	4	3.730	3.1564	3	3.9279		
$\beta_3 L_I M_{III}$	3.83313	9	3.23446	3.64495	9	3.40145	$\beta_{10} L_I M_{IV}$	3.27404	9	3.7868	3.12170	9	3.9716		
$\gamma_3 L_I N_{II}$	3.31216	9	3.7432	3.1377	2	3.9513	$\beta_3 L_I M_V$	3.26763	9	3.7942	3.11513	9	3.9800		
$\gamma_3 L_I N_{III}$	3.30635	9	3.7498				$M_{II} M_{IV}$				47.3	1	0.2621		
$\eta L_{II} M_I$	4.4183	2	2.8061	4.19315	9	2.95675	$M_{II} N_I$				20.0	1	0.619		
$\beta_1 L_{II} M_{IV}$	3.93473	3	3.15094	3.73823	4	3.31657	$M_{II} N_{IV}$				16.93	5	0.733		
$\gamma_5 L_{II} N_I$	3.61638	9	3.42832	3.42551	9	3.61935	$M_{III} M_V$				54.2	1	0.2287		
$\gamma_1 L_{III} N_{IV}$	3.52260	4	3.51959	3.33564	6	3.71686	$M_{III} N_I$				21.5	1	0.575		
$l L_{III} M_I$	4.7076	2	2.6337	4.48014	9	2.76735	$\gamma M_{III} N_{IV,V}$				17.94	5	0.691		
$\alpha_2 L_{III} M_{IV}$	4.16294	5	2.97821	3.96496	6	3.12691	$M_{IV} O_{II,III}$				25.3	1	0.491		
$\alpha_1 L_{III} M_V$	4.15443	3	2.98431	3.95635	4	3.13373	$\zeta M_{IV,V} N_{II,III}$				31.24	9	0.397		
$\beta_4 L_{III} N_I$	3.80774	9	3.25603	3.61467	9	3.42994	$M_V O_{III}$				25.7	1	0.483		
$\beta_{2,15} L_{III} N_{IV,V}$	3.70335	3	3.34781	3.51408	4	3.52812									
$\beta_{10} L_I M_{IV}$	3.61158	9	3.43287	3.4367	2	3.6075	51 Antimony				52 Tellurium				
$\beta_3 L_I M_V$	3.60497	9	3.43917	3.43015	9	3.61445	$\alpha_2 K L_{II}$	0.474827	3	26.1108	0.455784	3	27.2017		
$M_{II} N_{II,III}$	18.8	2	0.658				$\alpha_1 K L_{III}$	0.470354	3	26.3591	0.451295	3	27.4723		
$M_{II} M_{IV}$	54.0	1	0.2295	52.0	2	0.2384	$\beta_3 K M_{II}$	0.417737	4	29.6792	0.400659	4	30.9443		
$M_{II} N_I$				22.9	2	0.540	$\beta_1 K M_{III}$	0.417085	3	29.7256	0.399995	5	30.9957		
$M_{II} N_{IV}$	20.66	7	0.600	19.40	7	0.639	$\beta_2 K N_{II,III}$	0.407973	5	30.3895	0.391102	6	31.7004		
$M_{III} M_V$	60.5	1	0.2048	58.7	2	0.2111	$K O_{II,III}$	0.40666	1	30.4875	0.38974	1	31.8114		
$M_{III} N_I$	26.0	1	0.478	24.5	1	0.507	$\beta_1^{II} K M_{IV}$	0.41388	1	29.9560					
$\gamma M_{III} N_{IV,V}$	21.82	7	0.568	20.47	7	0.606	$\beta_1^I K M_V$	0.41378	1	29.9632					
$M_{IV} O_{II,III}$				30.4	1	0.408	$\beta_4 K N_{IV,V}$	0.40702	1	30.4604					
$\zeta M_{IV,V} N_{II,III}$	39.77	7	0.3117	36.8	1	0.3371	$\beta_4 L_I M_{II}$	3.19014	9	3.8864	3.04661	9	4.0695		
$M_V N_I$	24.4	2	0.509				$\beta_3 L_I M_{III}$	3.15258	9	3.9327	3.00893	9	4.1204		
$M_V O_{III}$				30.8	1	0.403	$\gamma_{2,3} L_I N_{II,III}$	2.6953	2	4.5999	2.5674	2	4.8290		
$M_{IV,V} O_{II,III}$	33.5	3	0.370				$\gamma_4 L_I O_{II,III}$	2.6398	2	4.6967	2.5113	2	4.9369		
							$\eta L_{II} M_I$	3.60765	9	3.43661	3.43832	9	3.60586		
49 Indium				50 Tin				$\beta_1 L_{II} M_{IV}$	3.22567	4	3.84357	3.07677	6	4.02958	
$\alpha_2 K L_{II}$	0.516544	3	24.0020	0.495053	3	25.0440	$\gamma_8 L_{II} N_I$	2.93187	9	4.2287	2.79007	9	4.4437		
$\alpha_1 K L_{III}$	0.512113	3	24.2097	0.490599	3	25.2713	$\gamma_1 L_{II} N_{IV}$	2.85159	3	4.34779	2.71241	6	4.5709		
$\beta_3 K M_{II}$	0.455181	4	27.2377	0.435877	5	28.4440	$l L_{III} M_I$	3.88826	9	3.18860	3.71696	9	3.33555		
							$\alpha_2 L_{III} M_{IV}$	3.44840	6	3.59532	3.29846	9	3.7588		





X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
<b>57 Lanthanum (Cont.)</b>						<b>58 Cerium (Cont.)</b>						<b>61 Promethium (Cont.)</b>						<b>62 Samarium (Cont.)</b>					
$M_{\text{V}}O_{\text{II,III}}$				14.39	5	0.862	$\alpha_2 L_{\text{III}}M_{\text{IV}}$	2.2926	4	5.4078	2.21062	3	5.6084										
$N_{\text{IV,V}}O_{\text{II,III}}$	152.6	6	0.0812	144.4	6	0.0859	$\alpha_1 L_{\text{III}}M_{\text{V}}$	2.2822	3	5.4325	2.1998	2	5.6361										
<b>59 Praseodymium</b>						<b>60 Neodymium</b>						<b>63 Europium</b>						<b>64 Gadolinium</b>					
$\alpha_2 KL_{\text{II}}$	0.348749	2	35.5502	0.336472	2	36.8474	$\alpha_2 KL_{\text{II}}$	0.303118	2	40.9019	0.293038	2	42.3089										
$\alpha_1 KL_{\text{III}}$	0.344140	2	36.0263	0.331846	2	37.3610	$\alpha_1 KL_{\text{III}}$	0.298446	2	41.5422	0.288353	2	42.9962										
$\beta_3 KM_{\text{II}}$	0.304975	5	40.6529	0.294027	3	42.1665	$\beta_3 KM_{\text{II}}$	0.264332	5	46.9036	0.25534	2	48.555										
$\beta_1 KM_{\text{III}}$	0.304261	4	40.7482	0.293299	2	42.2713	$\beta_1 KM_{\text{III}}$	0.263577	5	47.0379	0.25460	2	48.697										
$\beta_2 KN_{\text{II,III}}$	0.29679	2	41.773	0.2861 <sup>†</sup>	1	43.33	$\beta_2 KN_{\text{II,III}}$	0.256923	8	48.256	0.24816	3	49.959										
$\beta_4 L_{\text{I}}M_{\text{II}}$	2.2550	4	5.4981	2.1669	3	5.7216	$\beta_2 KN_{\text{II,III}}$	0.255645	7	48.497	0.24687	3	50.221										
$\beta_3 L_{\text{I}}M_{\text{III}}$	2.2172	3	5.5918	2.1268	2	5.8294	$KO_{\text{II,III}}$				0.25275	3	49.052										
$\gamma_2 L_{\text{I}}N_{\text{II}}$	1.8791	4	6.598	1.8013	4	6.883	$\beta_5 KM_{\text{IV,V}}$				1.8540	2	6.6871										
$\gamma_4 L_{\text{I}}N_{\text{III}}$	1.8740	4	6.616	1.7964	4	6.902	$\beta_4 L_{\text{I}}M_{\text{II}}$	1.9255	2	6.4389	1.8150	2	6.8311										
$\gamma_4 L_{\text{I}}O_{\text{II,III}}$	1.8193	4	6.815	1.7445	4	7.107	$\beta_3 L_{\text{I}}M_{\text{III}}$	1.8867	2	6.5713	1.5331	2	8.087										
$\eta L_{\text{II}}M_{\text{I}}$	2.512	3	4.935	2.4094	4	5.1457	$\gamma_2 L_{\text{I}}N_{\text{II}}$	1.5961	2	7.7677	1.5297	2	8.105										
$\beta_1 L_{\text{II}}M_{\text{IV}}$	2.2588	3	5.4889	2.1669	2	5.7216	$\gamma_4 L_{\text{I}}N_{\text{III}}$	1.5903	2	7.7961	1.4839	2	8.355										
$\gamma_6 L_{\text{II}}N_{\text{I}}$	2.0205	4	6.136	1.9355	4	6.406	$\gamma_4 L_{\text{I}}O_{\text{II,III}}$	1.5439	1	8.0304	2.0494	1	6.0495										
$\gamma_1 L_{\text{II}}N_{\text{IV}}$	1.9611	3	6.3221	1.8779	2	6.6021	$\eta L_{\text{II}}M_{\text{I}}$	2.1315	2	5.8166	1.8468	2	6.7132										
$\gamma_8 L_{\text{II}}O_{\text{I}}$	1.9362	4	6.403	1.8552	5	6.683	$\beta_1 L_{\text{II}}M_{\text{IV}}$	1.9203	2	6.4564	1.6412	2	7.5543										
$l L_{\text{III}}M_{\text{I}}$	2.7841	4	4.4532	2.6760	4	4.6330	$\gamma_6 L_{\text{II}}N_{\text{I}}$	1.7085	2	7.2566	1.5924	2	7.7858										
$\alpha_2 L_{\text{III}}M_{\text{IV}}$	2.4729	3	5.0135	2.3807	3	5.2077	$\gamma_1 L_{\text{II}}N_{\text{IV}}$	1.6574	2	7.4803	1.5707	2	7.894										
$\alpha_1 L_{\text{III}}M_{\text{V}}$	2.4630	2	5.0337	2.3704	2	5.2304	$\gamma_8 L_{\text{II}}O_{\text{I}}$	1.6346	2	7.5849	1.5644	2	7.925										
$\beta_6 L_{\text{III}}N_{\text{I}}$	2.1906	4	5.660	2.1039	3	5.8930	$\gamma_6 L_{\text{II}}O_{\text{IV}}$	1.6282	2	7.6147	2.3122	2	5.3621										
$\beta_{2,16} L_{\text{III}}N_{\text{IV,V}}$	2.1194	4	5.850	2.0360	3	6.0894	$l L_{\text{III}}M_{\text{I}}$	2.3948	2	5.1772	2.0578	2	6.0250										
$\beta_7 L_{\text{III}}O_{\text{I}}$	2.0919	4	5.927	2.0092	3	6.1708	$\alpha_2 L_{\text{III}}M_{\text{IV}}$	2.1315	2	5.8166	2.0468	2	6.0572										
$\beta_{10} L_{\text{I}}M_{\text{IV}}$	2.1071	4	5.884	2.0237	3	6.1265	$\alpha_1 L_{\text{III}}M_{\text{V}}$	2.1209	2	5.8457	1.8054	2	6.8671										
$\beta_9 L_{\text{I}}M_{\text{V}}$	2.1004	4	5.903	2.0165	3	6.1484	$\beta_6 L_{\text{III}}N_{\text{I}}$	1.8737	2	6.6170	1.7455	2	7.1028										
$\gamma M_{\text{III}}N_{\text{IV,V}}$	10.998	9	1.1273	10.505	9	1.180	$\beta_{2,16} L_{\text{III}}N_{\text{IV,V}}$	1.8118	2	6.8432	1.7203	2	7.2071										
$\beta M_{\text{IV}}N_{\text{VI}}$	13.06	2	0.950	12.44	2	0.997	$\beta_7 L_{\text{III}}O_{\text{I}}$	1.7851	2	6.9453	1.7130	2	7.2374										
$\zeta M_{\text{V}}N_{\text{III}}$	17.38	4	0.714	16.46	4	0.753	$\beta_8 L_{\text{III}}O_{\text{IV,V}}$	1.7772	2	6.9763	1.7315	3	7.160										
$\alpha M_{\text{V}}N_{\text{VI,VII}}$	13.343	5	0.9292	12.68	2	0.978	$\beta_{10} L_{\text{I}}M_{\text{IV}}$	1.7993	3	6.890	1.7240	3	7.192										
$N_{\text{IV,V}}N_{\text{VI,VII}}$	113.	1	0.1095	107.	1	0.116	$\beta_9 L_{\text{I}}M_{\text{V}}$	1.7916	3	6.920	1.4807	3	8.373										
$N_{\text{IV,V}}O_{\text{II,III}}$	136.5	4	0.0908	128.9	7	0.0962	$L_{\text{I}}O_{\text{IV,V}}$				8.844	9	1.402										
<b>61 Promethium</b>						<b>62 Samarium</b>						<b>65 Terbium</b>						<b>66 Dysprosium</b>					
$\alpha_2 KL_{\text{II}}$	0.324803	4	38.1712	0.313698	2	39.5224	$\alpha_2 KL_{\text{II}}$	0.283423	2	43.7441	0.274247	2	45.2078										
$\alpha_1 KL_{\text{III}}$	0.320160	4	38.7247	0.309040	2	40.1181	$\alpha_1 KL_{\text{III}}$	0.278724	2	44.4816	0.269533	2	45.9984										
$\beta_3 KM_{\text{II}}$	0.28363 <sup>†</sup>	4	43.713	0.27376	2	45.289	$\beta_3 KM_{\text{II}}$	0.24683	2	50.229	0.23862	2	51.957										
$\beta_1 KM_{\text{III}}$	0.28290 <sup>†</sup>	3	43.826	0.27301	2	45.413																	
$\beta_2 KN_{\text{II,III}}$	0.2759 <sup>†</sup>	1	44.94	0.2662	1	46.58																	
$KO_{\text{II,III}}$				0.26491	3	46.801																	
$\beta_5 KM_{\text{IV,V}}$				0.27111	3	45.731																	
$\beta_4 L_{\text{I}}M_{\text{II}}$				2.00095	6	6.1963																	
$\beta_3 L_{\text{I}}M_{\text{III}}$	2.0421	4	6.071	1.96241	3	6.3180																	
$\gamma_2 L_{\text{I}}N_{\text{II}}$				1.66044	6	7.4668																	
$\gamma_4 L_{\text{I}}N_{\text{III}}$				1.65601	3	7.4867																	
$\gamma_4 L_{\text{I}}O_{\text{II,III}}$				1.60728	3	7.7137																	
$\eta L_{\text{II}}M_{\text{I}}$				2.21824	3	5.5892																	
$\beta_1 L_{\text{II}}M_{\text{IV}}$	2.0797	4	5.961	1.99806	3	6.2051																	
$\gamma_6 L_{\text{II}}N_{\text{I}}$				1.77934 <sup>*</sup>	3	6.9678																	
$\gamma_1 L_{\text{II}}N_{\text{IV}}$	1.7989	9	6.892	1.72724	3	7.1780																	
$\gamma_6 L_{\text{II}}O_{\text{IV}}$				1.6966	9	7.3076																	
$l L_{\text{III}}M_{\text{I}}$				2.4823	4	4.9945																	







X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
71 Lutetium (Cont.)				72 Hafnium (Cont.)				73 Tantalum (Cont.)				74 Tungsten (Cont.)			
$\beta_1 KM_{III}$	0.20231 <sup>†</sup>	3	61.283	0.19607 <sup>†</sup>	3	63.234	$KO_{II,III}$	0.184031	7	67.370	0.178444	5	69.479		
$\beta_2 KN_{II,III}$	0.1969 <sup>†</sup>	2	62.97	0.1908 <sup>†</sup>	2	64.98	$KL_I$				0.21592	4	57.42		
$KO_{II,III}$	0.19589	2	63.293				$\beta_1^{II} KM_{IV}$	0.188920	6	65.626	0.183264	5	67.652		
$\beta_3 KM_{IV,V}$	0.20084	2	61.732				$\beta_2^{II} KM_V$	0.188757	6	65.683	0.183092	7	67.715		
$\beta_4 L_I M_{II}$	1.44056	5	8.6064	1.39220	5	8.9054	$\beta_4 KN_{IV,V}$	0.18451	1	67.194	0.17892	2	69.294		
$\beta_5 L_I M_{III}$	1.40140	5	8.8469	1.35300	5	9.1634	$\beta_4 L_I M_{II}$	1.34581	3	9.2124	1.30162	5	9.5252		
$\gamma_2 L_I N_{II}$	1.1853	2	10.460	1.14442	5	10.8335	$\beta_5 L_I M_{III}$	1.30678	3	9.4875	1.26269	5	9.8188		
$\gamma_3 L_I N_{III}$	1.17953	4	10.5110	1.13841	5	10.8907	$\gamma_2 L_I N_{II}$	1.1053	1	11.217	1.06806	3	11.6080		
$\gamma_4 L_I O_{II}$				1.10376	5	11.2326	$\gamma_3 L_I N_{III}$	1.09936	4	11.2776	1.06200	6	11.6743		
$\gamma_4 L_I O_{II,III}$	1.1435	1	10.8425	1.10303	5	11.2401	$\gamma_4 L_I O_{II}$	1.06544	3	11.6366	1.02863	3	12.0530		
$\eta L_{II} M_I$	1.5779	1	7.8575	1.52325	5	8.1393	$\gamma_4 L_I O_{III}$	1.06467	3	11.6451	1.02775	3	12.0634		
$\beta_1 L_{II} M_{IV}$	1.42359	3	8.7090	1.37410	5	9.0227	$\eta L_{II} M_I$	1.47106	5	8.4280	1.42110	3	8.7243		
$\gamma_6 L_{II} N_I$	1.2596	1	9.8428	1.21537	5	10.2011	$\beta_1 L_{II} M_{IV}$	1.32698	3	9.3431	1.281809	9	9.67235		
$\gamma_1 L_{II} N_{IV}$	1.22228	4	10.1434	1.17900	5	10.5158	$\gamma_6 L_{II} N_I$	1.1729	1	10.5702	1.13235	3	10.9490		
$\gamma_8 L_{II} O_I$	1.2047	1	10.2915	1.16138	5	10.6754	$\gamma_1 L_{II} N_{IV}$	1.13794	3	10.8952	1.09855	3	11.2859		
$\gamma_8 L_{II} O_{IV}$	1.1987	1	10.3431	1.15519	5	10.7325	$\gamma_8 L_{II} O_I$	1.1205	1	11.0646	1.08113	4	11.4677		
$l L_{III} M_I$	1.8360	1	6.7528	1.78145	5	6.9596	$\gamma_8 L_{II} O_{IV}$	1.11388	3	11.1306	1.07448	5	11.5387		
$\alpha_2 L_{III} M_{IV}$	1.63029	5	7.6049	1.58046	5	7.8446	$l L_{III} M_I$	1.72841	5	7.1731	1.6782	1	7.3878		
$\alpha_1 L_{III} M_{IV}$	1.61951	3	7.6555	1.56958	5	7.8990	$\alpha_2 L_{III} M_{IV}$	1.53293	2	8.0879	1.48743	2	8.3352		
$\beta_4 L_{III} N_I$	1.4189	1	8.7376	1.37410	5	9.0227	$\beta_1 L_{III} M_V$	1.52197	2	8.1461	1.47639	2	8.3976		
$\beta_{15} L_{III} N_{IV}$	1.3715	1	9.0395	1.32783	5	9.3371	$\beta_2 L_{III} N_I$	1.33094	8	9.3153	1.28989	7	9.6117		
$\beta_2 L_{III} N_V$	1.37012	3	9.0489	1.32639	5	9.3473	$\beta_{15} L_{III} N_{IV}$	1.28619	5	9.6394	1.24631	3	9.9478		
$\beta_7 L_{III} O_I$	1.34949	5	9.1873	1.30564	5	9.4958	$\beta_2 L_{III} N_V$	1.28454	2	9.6518	1.24460	3	9.9615		
$\beta_8 L_{III} O_{IV,V}$	1.34183	7	9.2397	1.29761	5	9.5546	$\beta_7 L_{III} O_I$	1.26385	5	9.8098	1.22400	4	10.1292		
$L_I M_I$				1.43025	9	8.6685	$\beta_8 L_{III} O_{IV,V}$	1.2555	1	9.8750	1.21545	3	10.2004		
$\beta_{10} L_I M_{IV}$	1.3430	2	9.232	1.29819	9	9.5503	$L_I M_I$				1.3365	3	9.277		
$\beta_8 L_I M_V$	1.3358	1	9.2816	1.29025	9	9.6090	$\beta_{10} L_I M_{IV}$	1.2537	2	9.889	1.21218	3	10.2279		
$L_I N_{IV}$	1.16227	9	10.6672	1.12250	9	11.0451	$\beta_8 L_I M_V$	1.2466	2	9.946	1.20479	7	10.2907		
$\gamma_{11} L_I N_V$	1.16107	9	10.6782	1.12146	9	11.0553	$L_I N_I$	1.11521	9	11.1173					
$L_I O_I$				1.10664	9	11.2034	$L_I N_{IV}$	1.08377	7	11.4398	1.0468	2	11.844		
$L_I O_{IV}$				1.10086	9	11.2622	$\gamma_{11} L_I N_V$	1.08205	7	11.4580	1.0458	1	11.856		
$L_{II} M_{II}$	1.53333	9	8.0858	1.48064	9	8.3735	$L_{II} N_{VI, VII}$	1.06357	9	11.6570					
$\beta_{17} L_{II} M_{III}$				1.43643	9	8.6312	$L_I O_I$	1.06771	9	11.6118	1.0317	3	12.017		
$L_{II} N_V$				1.17788	9	10.5258	$L_I O_{IV,V}$	1.06192	9	11.6752	1.0250	2	12.095		
$v L_{II} N_{VI}$				1.15830	9	10.7037	$L_{II} M_{II}$	1.43048	9	8.6671					
$L_{II} O_{II, III}$	1.2014	1	10.3198				$\beta_{17} L_{II} M_{III}$	1.3864	1	8.9428	1.3387	2	9.261		
$l L_{III} M_{II}$	1.7760	1	6.9810	1.72305	9	7.1954	$L_{II} M_V$	1.31897	9	9.3998	1.2728	2	9.741		
$s L_{III} M_{III}$				1.66346	9	7.4532	$L_{II} N_{II}$	1.1600	2	10.688	1.1218	3	11.052		
$L_{III} N_{II}$				1.35887	9	9.1239	$L_{II} N_{III}$	1.1553	1	10.7316	1.1149	2	11.120		
$L_{III} N_{III}$				1.35053	9	9.1802	$L_{II} N_V$	1.13687	9	10.9055					
$u L_{III} N_{VI, VII}$				1.30165	9	9.5249	$v L_{II} N_{VI}$	1.1158	1	11.1113	1.0771	1	11.510		
$L_{III} O_{II, III}$	1.34524	9	9.2163				$L_{II} O_{II}$	1.11789	9	11.0907					
$M_{III} N_I$				7.887	9	1.572	$L_{II} O_{III}$	1.11693	9	11.1001	1.0792	2	11.488		
$\gamma M_{III} N_V$	6.768	6	1.832	6.544	4	1.895	$l L_{III} M_{II}$	1.67265	9	7.4123	1.6244	3	7.632		
$\zeta_3$				9.686	7	1.2800	$s L_{III} M_{III}$	1.61264	9	7.6881	1.5642	3	7.926		
$\beta M_{IV} N_{VI}$	7.601	2	1.6312	7.303	1	1.6976	$L_{III} N_{II}$	1.3167	1	9.4158	1.2765	2	9.712		
$\zeta_1$				9.686	7	1.2800	$L_{III} N_{III}$	1.3086	1	9.4742	1.2672	2	9.784		
$\alpha M_V N_{VI, VII}$	7.840	2	1.5813	7.539	1	1.6446	$L_{III} N_V$	1.25778	4	9.8572	1.21868	5	10.1733		
$N_{IV} N_{VI}$	63.0	5	0.197				$u L_{III} N_{VI, VII}$	1.25778	4	9.8572	1.21868	5	10.1733		
$N_V N_{VI, VII}$	65.7	2	0.1886				$L_{III} O_{II, III}$	1.2601	3	9.839	1.2211	2	10.153		
73 Tantalum				74 Tungsten				$M_I N_{III}$	5.40	2	2.295	5.172	9	2.397	
$\alpha_2 K L_{II}$	0.220305	8	56.277	0.213828	2	57.9817	$M_I O_{II, III}$				4.44	2	2.79		
$\alpha_1 K L_{III}$	0.215497	4	57.532	0.2090100	Std	59.31824	$M_{II} N_I$				6.28	2	1.973		
$\beta_8 K M_{II}$	0.190890	2	64.9488	0.185181	2	66.9514	$M_{II} N_{IV}$	5.570	4	2.226	5.357	4	2.314		
$\beta_1 K M_{III}$	0.190089	4	65.223	0.184374	2	67.2443	$M_{III} N_I$	7.612	9	1.629	7.360	8	1.684		
$\beta_2^{II} K N_{II}$	0.185188	9	66.949	0.17960	1	69.031	$M_{III} N_{IV}$	6.353	5	1.951	6.134	4	2.021		
$\beta_8^I K N_{III}$	0.185011	8	67.013	0.179421	7	69.101	$\gamma M_{III} N_V$	6.312	4	1.964	6.092	3	2.035		
							$M_{III} O_I$	5.83	2	2.126	5.628	8	2.203		
							$M_{III} O_{IV,V}$	5.67	3	2.19					





X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
<b>77 Iridium (Cont.)</b>				<b>78 Platinum (Cont.)</b>				<b>79 Gold (Cont.)</b>				<b>80 Mercury (Cont.)</b>			
$\beta_8 L_{III}O_{IV,V}$	1.10585	3	11.2114	1.0724	2	11.561	$\gamma_8 L_I N_{II}$	0.90434	3	13.7095	0.87544	7	14.162		
$L_I M_I$	1.2102	2	10.245	1.16962	9	10.6001	$\gamma_8 L_I N_{III}$	0.89783	5	13.8090	0.86915	7	14.265		
$\beta_{10} L_I M_{IV}$	1.09702	4	11.3016	1.06183	7	11.6762	$\gamma'_4 L_I O_{II}$	0.86816	4	14.2809	0.84013	7	14.757		
$\beta_8 L_I M_V$	1.08975	5	11.3770	1.05446	5	11.7577	$\gamma_4 L_I O_{III}$	0.86703	4	14.2996	0.83894	7	14.778		
$L_I N_I$	0.9766	2	12.695	0.9455	2	13.113	$\eta L_{II} M_I$	1.20273	3	10.3083	1.1640	1	10.6512		
$L_I N_{IV}$	0.9459	2	13.108				$\beta_1 L_{II} M_{IV}$	1.08353	3	11.4423	1.04868	5	11.8226		
$\gamma_{II} L_I N_V$	0.9446	2	13.126	0.9143	2	13.560	$\gamma_8 L_{II} N_I$	0.95559	3	12.9743	0.92453	7	13.410		
$L_I O_{IV,V}$	0.9243	3	13.413				$\gamma_8 L_{II} N_{IV}$	0.92650	3	13.3817	0.89646	5	13.8301		
$L_I O_I$				0.8995	2	13.784	$\gamma_8 L_{II} O_I$	0.90989	5	13.6260	0.87995	7	14.090		
$L_I O_{IV}$				0.8943	1	13.864	$\gamma_4 L_{II} O_{IV}$	0.90297	3	13.7304	0.87319	7	14.199		
$L_I O_V$				0.8934	1	13.878	$\lambda L_{III} M_I$	1.45964	9	8.4939	1.4216	1	8.7210		
$L_{II} M_{II}$	1.2502	3	9.917	1.213	1	10.225	$\alpha_2 L_{III} M_{IV}$	1.28772	3	9.6280	1.25264	7	9.8976		
$\beta_{17} L_{II} M_{III}$	1.2069	2	10.273	1.1667	1	10.6265	$\alpha_1 L_{III} M_V$	1.27640	3	9.7133	1.24120	5	9.9888		
$L_{II} M_V$	1.1489	2	10.791	1.1129	2	11.140	$\beta_8 L_{III} N_I$	1.11092	3	11.1602	1.07975	7	11.4824		
$L_{II} N_{II}$	1.0120	2	12.251	0.9792	2	12.661	$\beta_{18} L_{III} N_{IV}$	1.07188	5	11.5667	1.04151	7	11.9040		
$L_{II} N_{III}$	1.0054	3	12.332	0.97173	4	12.7588	$\beta_8 L_{III} N_V$	1.07022	3	11.5847	1.03975	7	11.9241		
$\nu L_{II} N_{VI}$	0.97161	6	12.7603	0.93931	5	13.1992	$\beta_1 L_{III} O_I$	1.04974	8	11.8106	1.01937	7	12.1625		
$L_{II} O_{III}$	0.96979	5	12.7843				$\beta_8 L_{III} O_{IV,V}$	1.04044	3	11.9163	1.00987	7	12.2769		
$t L_{III} M_{II}$	1.4930	3	8.304	1.4530	2	8.533	$L_I M_I$	1.13525	5	10.9210	1.0999	2	11.272		
$s L_{III} M_{III}$	1.4318	2	8.659	1.3895	2	8.923	$\beta_{10} L_I M_{IV}$	1.02789	7	12.0617	0.9962	2	12.446		
$L_{III} N_{II}$	1.16545	5	10.6380	1.1310	2	10.962	$\beta_8 L_I M_V$	1.02063	7	12.1474	0.9871	2	12.560		
$L_{III} N_{III}$	1.1560	3	10.725	1.1226	2	11.044	$L_I N_I$	0.9131	1	13.578	0.8827	2	14.045		
$u L_{III} N_{VI,VII}$	1.11145	4	11.1549	1.07896	5	11.4908	$L_I N_{IV}$	0.88563	7	13.999					
$L_{III} O_{II,III}$	1.10923	6	11.1772	1.0761	3	11.521	$\gamma_{II} L_I N_V$	0.88433	7	14.020	0.85657	7	14.474		
$M_I N_{III}$	4.631 <sup>†</sup>	9	2.677	4.460	9	2.780	$\beta_1 O_I$	0.87074	5	14.2385	0.8452	2	14.670		
$M_{II} N_{IV}$	4.780	4	2.594	4.601	4	2.695	$L_I O_{IV,V}$	0.86400	5	14.3497	0.8350	2	14.847		
$M_{III} N_I$	6.669	9	1.859	6.455	9	1.921	$L_{II} M_{II}$	1.1708	1	10.5892	1.1387	5	10.888		
$M_{III} N_{IV}$	5.540	5	2.238	5.357	5	2.314	$\beta_{17} L_{II} M_{III}$	1.12798	5	10.9915	1.0916	5	11.358		
$\gamma M_I N_V$	5.500	4	2.254	5.319	4	2.331	$L_{II} M_V$	1.0756	2	11.526					
$M_{III} O_I$				4.876	9	2.543	$L_{II} N_{III}$	0.9402	2	13.186	0.90894	7	13.640		
$M_{III} O_{IV,V}$	4.869	9	2.546	4.694	8	2.641	$\nu L_{II} N_{VI}$	0.90837	5	13.6487	0.87885	7	14.107		
$\zeta_2 M_{IV} N_{II}$	8.065	5	1.5373	7.790	5	1.592	$L_{II} O_{II}$	0.90746	7	13.662	0.8784	1	14.114		
$M_{IV} N_{III}$	7.645	8	1.622	7.371	8	1.682	$L_{II} O_{III}$	0.90638	7	13.679	0.8758	1	14.156		
$\beta M_{IV} N_{VI}$	6.038	1	2.0535	5.828	1	2.1273	$t L_{III} M_{II}$	1.41366	7	8.7702	1.3746	2	9.019		
$\zeta_1 M_V N_{III}$	8.021	4	1.5458	7.738	4	1.6022	$s L_{III} M_{III}$	1.35131	7	9.1749	1.3112	2	9.455		
$\alpha_2 M_V N_{VI}$	6.275	3	1.9758	6.058	3	2.047	$L_{III} N_{II}$	1.09968	7	11.2743	1.0649	2	11.642		
$\alpha_1 M_V N_{VII}$	6.262	1	1.9799	6.047	1	2.0505	$L_{III} N_{III}$	1.09026	7	11.3717	1.0585	1	11.713		
$M_V O_{III}$				5.987	9	2.071	$u L_{III} N_{VI,VII}$	1.04752	5	11.8357					
$N_{IV} N_{VI}$	50.2	1	0.2470	48.1	2	0.258	$u' L_{III} N_{VI}$				1.01769	7	12.1826		
$N_V N_{VI,VII}$	52.8	1	0.2348	50.9	1	0.2436	$u L_{III} N_{VII}$				1.01674	7	12.1940		
							$L_{III} O_{II,III}$	1.0450	2	11.865					
							$L_{III} O_{II}$				1.01558	7	12.2079		
							$L_{III} O_{III}$				1.01404	7	12.2264		
							$L_{III} P_{II,III}$	1.03876	7	11.9355					
$\alpha_2 K L_{II}$	0.185075	2	66.9895	0.179958	3	68.895	$M_I N_{III}$	4.300	9	2.883					
$\alpha_1 K L_{III}$	0.180195	2	68.8037	0.175068	3	70.819	$M_{II} N_{IV}$	4.432	4	2.797					
$\beta_1 K M_{II}$	0.159810	2	77.580	0.155321	3	79.822	$M_{III} N_I$	6.259	9	1.981	6.09	2	2.036		
$\beta_1 K M_{III}$	0.158982	3	77.984	0.154487	3	80.253	$M_{III} N_{IV}$	5.186	5	2.391					
$\beta_2^{II} K N_{II}$	0.15483	2	80.08	0.15040	2	82.43	$\gamma M_{III} N_V$	5.145	4	2.410	4.984 <sup>†</sup>	2	2.4875		
$\beta_2^I K N_{III}$	0.154618	9	80.185	0.15020	2	82.54	$M_{III} O_I$	4.703	9	2.636					
$K O_{II,III}$	0.153694	7	80.667	0.14931	2	83.04	$M_{III} O_{IV,V}$	4.522	6	2.742					
$K L_I$	0.18672	4	66.40				$\zeta_1 M_{IV} N_{II}$	7.523	5	1.648					
$\beta_8^{II} K M_{IV}$	0.158062	7	78.438				$M_{IV} N_{III}$	7.101	8	1.746	6.87	2	1.805		
$\beta_1^I K M_V$	0.157880	5	78.529				$\beta M_{IV} N_{VI}$	5.624	1	2.2046	5.4318 <sup>†</sup>	9	2.2825		
$\beta_8 K M_{IV,V}$				0.15353	2	80.75	$\zeta_1 M_V N_{III}$	7.466	4	1.6605					
$\beta_4 K N_{IV,V}$	0.154224	5	80.391	0.14978	2	82.78	$\alpha_2 M_V N_{VI}$	5.854	3	2.118					
$\beta_4 L_I M_{II}$	1.10651	3	11.2047	1.07222	7	11.5630									
$\beta_8 L_I M_{III}$	1.06785	9	11.6103	1.03358	7	11.9953									



X-Ray Wavelengths  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV		
79 Gold (Cont.)				80 Mercury (Cont.)				81 Thallium (Cont.)				82 Lead (Cont.)			
$\alpha_1 M_V N_{VII}$	5.840	1	2.1229	5.6476 <sup>†</sup>	9	2.1953	$L_{II} N_{III}$	0.87996	5	14.0893	0.85192	7	14.553		
$M_V O_{III}$	5.767	9	2.150				$L_{II} N_V$				0.8382	2	14.791		
$N_{IV} N_{VI}$	46.8	2	0.265	45.2 <sup>†</sup>	3	0.274	$v L_{II} N_{VI}$	0.85048	5	14.5777	0.82327	7	15.060		
$N_V N_{VI, VII}$	49.4	1	0.2510	47.9 <sup>†</sup>	3	0.259	$L_{II} O_{II}$	0.8490	1	14.604					
							$L_{II} O_{III}$				0.8200	1	15.120		
							$i L_{III} M_{II}$	1.34154	5	9.2417	1.30767	7	9.4811		
							$s L_{III} M_{III}$	1.27807	5	9.7007	1.24385	7	9.9675		
							$L_{III} N_{II}$				1.01040	7	12.2705		
							$L_{III} N_{III}$	1.0286	1	12.053	1.0005	1	12.392		
							$u L_{III} N_{VI, VII}$	0.9888	1	12.538	0.96133	7	12.8968		
$\alpha_2 K L_{II}$	0.175036	2	70.8319	0.170294	2	72.8042	$L_{III} O_{II}$	0.98738	5	12.5566	0.9586	1	12.934		
$\alpha_1 K L_{III}$	0.170136	2	72.8715	0.165376	2	74.9694	$L_{III} O_{III}$	0.98538	5	12.5820	0.9578	1	12.945		
$\beta_3 K M_{II}$	0.150980	6	82.118	0.146810	4	84.450	$L_{III} P_{II, III}$	0.97926	5	12.6607	0.95118	7	13.0344		
$\beta_1 K M_{III}$	0.150142	5	82.576	0.145970	6	84.936	$M_{II} N_{III}$	4.013	9	3.089	3.872	9	3.202		
$\beta_2^{II} K N_{II}$	0.14614	1	84.836	0.14212	2	87.23	$M_{II} N_I$				4.655	8	2.664		
$\beta_2^I K N_{III}$	0.14595	1	84.946	0.14191	1	87.364	$M_{II} N_{IV}$	4.116	4	3.013	3.968	5	3.124		
$K O_{II, III}$	0.14509	1	85.451	0.141012	8	87.922	$M_{III} N_I$	5.884	8	2.107	5.704	8	2.174		
$K P$				0.1408	1	88.06	$M_{III} N_{IV}$	4.865	5	2.548	4.715	3	2.630		
$\beta_3 K M_{IV, V}$	0.14917	1	83.114				$\gamma M_{III} N_V$	4.823	4	2.571	4.674	1	2.6527		
$\beta_2^{II} K M_{IV}$				0.14512	2	85.43	$M_{III} O_I$				4.244	9	2.921		
$\beta_2^I K M_V$				0.14495	3	85.53	$M_{II} O_{IV, V}$	4.216	6	2.941	4.069	6	3.047		
$\beta_4 K N_{IV, V}$	0.14553	2	85.19	0.14155	3	87.59	$\zeta_1 M_{IV} N_{II}$	7.032	5	1.763	6.802	5	1.823		
$\beta_4 L_I M_{II}$	1.03918	3	11.9306	1.0075	1	12.306	$M_{IV} N_{III}$				6.384	7	1.942		
$\beta_3 L_I M_{III}$	1.00062	3	12.3904	0.96911	7	12.7933	$\beta M_{IV} N_{VI}$	5.249	1	2.3621	5.076	1	2.4427		
$\gamma_2 L_I N_{II}$	0.84773	5	14.6251	0.8210	2	15.101	$M_{IV} O_{II}$	5.196	9	2.386	5.004	9	2.477		
$\gamma_1 L_I N_{III}$	0.84130	4	14.7368	0.8147	1	15.218	$\zeta_1 M_V N_{III}$	6.974	4	1.778	6.740	3	1.8395		
$\gamma'_4 L_I O_{II}$	0.81308	5	15.2482	0.78706	7	15.752	$\alpha_2 M_V N_{VI}$	5.472	2	2.2656	5.299	2	2.3397		
$\gamma_4 L_I O_{III}$	0.81184	5	15.2716	0.7858	1	15.777	$\alpha_1 M_V N_{VII}$	5.460	1	2.2706	5.286	1	2.3455		
$\eta L_{II} M_I$	1.12769	3	10.9943	1.09241	7	11.3493	$M_V O_{III}$				5.168	9	2.399		
$\beta_1 L_{II} M_{IV}$	1.01513	4	12.2133	0.98291	3	12.6137	$N_V N_{VI, VII}$	46.5	2	0.267	45.0	1	0.2756		
$\gamma_3 L_{II} N_I$	0.89500	4	13.8526	0.86655	5	14.3075	$N_{VI} O_{IV}$	115.3	2	0.1075	102.4	1	0.1211		
$\gamma_1 L_{II} N_{IV}$	0.86752	3	14.2915	0.83973	3	14.7644	$N_{VII} O_V$	113.0	1	0.10968	100.2	2	0.1237		
$\gamma_3 L_{II} O_I$	0.8513	2	14.564	0.82365	5	15.0527	$N_{VII} O_V$	117.7	1	0.10530	104.3	1	0.1189		
$\gamma_4 L_{II} O_{IV}$	0.8442	2	14.685	0.81683	5	15.1783									
$L_{II} P_I$				0.81583	5	15.1969									
$i L_{III} M_I$	1.38477	3	8.9532	1.34990	7	9.1845									
$\alpha_2 L_{III} M_{IV}$	1.21875	3	10.1728	1.18648	5	10.4495									
$\alpha_1 L_{III} M_V$	1.20739	4	10.2685	1.17501	2	10.5515	$\alpha_2 K L_{II}$	0.165717	2	74.8148	0.16130 <sup>†</sup>	1	76.862		
$\beta_4 L_{III} N_I$	1.04963	5	11.8118	1.0210	1	12.143	$\alpha_1 K L_{III}$	0.160789	2	77.1079	0.15636 <sup>†</sup>	1	79.290		
$\beta_{13} L_{III} N_{IV}$	1.01201	3	12.2510	0.98389	7	12.6011	$\beta_3 K M_{II}$	0.142779	7	86.834	0.13892 <sup>†</sup>	2	89.25		
$\beta_3 L_{III} N_V$	1.01031	3	12.2715	0.98221	7	12.6226	$\beta_1 K M_{III}$	0.141948	3	87.343	0.13807 <sup>†</sup>	2	89.80		
$\beta_1 L_{III} O_I$	0.99017	5	12.5212	0.9620	1	12.888	$\beta_2^{II} K N_{II}$	0.13817	1	89.733	0.13438 <sup>†</sup>	2	92.26		
$\beta_3 L_{III} O_{IV, V}$	0.98058	3	12.6436	0.9526	1	13.015	$\beta_2^I K N_{III}$	0.13797	1	89.864	0.13418 <sup>†</sup>	2	92.40		
$L_I M_I$	1.0644	2	11.648	1.0323	2	12.010	$K O_{II, III}$	0.13709	1	90.435					
$\beta_{10} L_I M_{IV}$	0.96389	7	12.8626	0.9339	2	13.275	$\beta_3 K M_{IV, V}$	0.14111	1	87.860					
$\beta_3 L_I M_V$	0.95675	7	12.9585	0.9268	1	13.377	$\beta_4 K N_{IV, V}$	0.13759	2	90.11					
$L_I N_I$	0.8549	1	14.503	0.82859	7	14.963	$\beta_4 L_I M_{II}$	0.97690	4	12.6912	0.9475	3	13.086		
$L_I N_{IV}$	0.83001	7	14.937	0.80364	7	15.427	$\beta_3 L_I M_{III}$	0.93855	3	13.2098	0.9091	3	13.638		
$\gamma_{11} L_I N_V$	0.82879	5	14.9593	0.80233	9	15.453	$\gamma_2 L_I N_{II}$	0.79565	3	15.5824	0.772	1	16.07		
$L_I N_{VI, VII}$				0.7884	1	15.725	$\gamma_3 L_I N_{III}$	0.78917	5	15.7102					
$L_I O_I$	0.8158	1	15.198	0.7897	1	15.699	$\gamma'_4 L_I O_{II}$	0.76198	3	16.2709					
$L_I O_{IV, V}$	0.80861	5	15.3327	0.78257	7	15.843	$\gamma_4 L_I O_{III}$	0.76087	3	16.2947					
$L_{II} M_{II}$	1.0997	1	11.274	1.0644	2	11.648	$\gamma_{13} L_I P_{II, III}$	0.75690	3	16.3802					
$\beta_{17} L_{II} M_{III}$	1.05609	7	11.7397	1.0223	1	12.127	$\eta L_{II} M_I$	1.05856	3	11.7122					
$L_{II} M_V$	1.00722	5	12.3093	0.9747	1	12.720	$\beta_1 L_{II} M_{IV}$	0.951978	9	13.0235	0.9220	2	13.447		
$L_{II} N_{II}$	0.882	2	14.057	0.8585	3	14.442	$\gamma_3 L_{II} N_I$	0.83923	5	14.7732					







*X-Ray Wavelengths*  
TABLE A (Continued)

Designation	Å*	p.e.	keV	Å*	p.e.	keV	Designation	Å*	p.e.	keV	Å*	p.e.	keV										
<b>91 Protactinium (Cont.)</b>						<b>92 Uranium (Cont.)</b>						<b>91 Protactinium (Cont.)</b>						<b>92 Uranium (Cont.)</b>					
$\gamma_2 L_{II}N_{II}$	0.6239	1	19.872	0.605237	9	20.4847	$M_{IV}O_{II}$	3.691	2	3.359	3.576	1	3.4666										
$\gamma_3 L_{II}N_{III}$	0.6169	1	20.098	0.598574	9	20.7127	$\zeta_1 M_{V}N_{III}$	5.092	2	2.4350	4.946	2	2.507										
$\gamma'_4 L_{II}O_{II}$				0.576700	9	21.4984	$\alpha_2 M_{V}N_{VI}$	4.035	3	3.072	3.924	1	3.1595										
$\gamma_4 L_{II}O_{II,III}$	0.5937	1	20.882	0.57499	9	21.562	$\alpha_1 M_{V}N_{VII}$	4.022	1	3.0823	3.910	1	3.1708										
$\gamma_5$				0.5706	1	21.729	$N_{I}O_{III}$				10.09	7	1.229										
$\eta L_{II}M_I$	0.8295	1	14.946	0.80509	2	15.3997	$N_{II}P_{II}$				8.81	7	1.41										
$\beta_1 L_{II}M_{IV}$	0.74232	5	16.702	0.719984	8	17.2200	$N_{II}P_{III}$				8.76	7	1.42										
$\gamma_5 L_{II}N_I$	0.6550	1	18.930	0.63557	2	19.5072	$N_{II}P_I$				10.40	7	1.192										
$\gamma_1 L_{II}N_{IV}$	0.63358 <sup>†</sup>	9	19.568	0.614770	9	20.1671	$N_{III}O_V$				12.90	9	0.961										
$\gamma_6 L_{II}O_I$				0.60125	5	20.621	$N_{IV}N_{VI}$				31.8	1	0.390										
$\gamma_6 L_{II}O_{IV}$	0.6133	1	20.216	0.594845	9	20.8426	$N_{V}N_{VI,VII}$				34.8	1	0.357										
$L_{II}P_{IV}$				0.59203	5	20.942	$N_{IV}O_{IV}$				43.3	2	0.286										
$l L_{III}M_I$	1.0908	1	11.366	1.06712	2	11.6183	$N_{VI}O_V$				42.1	2	0.295										
$\alpha_2 L_{III}M_{IV}$	0.94482 <sup>†</sup>	5	13.1222	0.922558	9	13.4388	$N_{I}P_{IV,V}$				8.60	7	1.44										
$\alpha_1 L_{III}M_V$	0.93284	5	13.2907	0.910639	9	13.6147																	
$\beta_6 L_{III}N_I$	0.8079	1	15.347	0.78838	2	15.7260	<b>93 Neptunium</b>						<b>94 Plutonium</b>										
$\beta_{15} L_{III}N_{IV}$				0.756642	9	16.3857	$\beta_4 L_{II}M_{II}$	0.72671	2	17.0607	0.70620	2	17.5560										
$\beta_2 L_{III}N_V$	0.7737	1	16.024	0.754681	9	16.4283	$\beta_2 L_{II}M_{III}$	0.68920 <sup>†</sup>	9	17.989	0.66871	2	18.5405										
$\beta_7 L_{III}O_I$	0.7546	2	16.431	0.73602	6	16.845	$\gamma_2 L_{II}N_{II}$	0.5873	5	21.11	0.57068	2	21.7251										
$\beta_8 L_{III}O_{IV,V}$	0.7452	2	16.636	0.726305	9	17.0701	$\gamma_2 L_{II}N_{III}$	0.5810	5	21.34	0.564001	9	21.9824										
$L_{III}P_I$				0.72521	5	17.096	$\gamma'_4 L_{II}O_{II}$				0.5432	1	22.823										
$L_{III}P_{IV,V}$				0.72240	5	17.162	$\gamma_4 L_{II}O_{II,III}$	0.5585	5	22.20	0.5416	1	22.891										
$\beta_{10} L_{II}M_V$	0.7088	2	17.492	0.68760	5	18.031	$\eta L_{II}M_I$	0.7809	2	15.876	0.7591	1	16.333										
$\beta_9 L_{II}M_V$	0.7018	1	17.667	0.681014	8	18.2054	$\beta_1 L_{II}M_{IV}$	0.698478	9	17.7502	0.67772	2	18.2937										
$L_{II}N_{IV}$				0.59096	5	20.979	$\gamma_5 L_{II}N_I$	0.616	1	20.12	0.5988	1	20.704										
$\gamma_{11} L_{II}N_V$				0.58986	5	21.019	$\gamma_1 L_{II}N_{IV}$	0.596498	9	20.7848	0.578882	9	21.4173										
$\gamma_{11} L_{II}O_{IV,V}$				0.5725	1	21.657	$\gamma_8$				0.5658	1	21.914										
$\beta_{17} L_{II}M_{III}$				0.74503	5	16.641	$\gamma_6 L_{II}O_{IV}$	0.57699	5	21.488	0.55973	2	22.1502										
$L_{II}N_{III}$				0.6228	1	19.907	$l L_{III}M_I$	1.0428	6	11.890	1.0226	1	12.124										
$v L_{II}N_{VI}$				0.6031	1	20.556	$\alpha_2 L_{III}M_{IV}$	0.901045	9	13.7597	0.88028	2	14.0842										
$L_{III}O_{III}$				0.59728	5	20.758	$\alpha_1 L_{III}M_V$	0.889128	9	13.9441	0.86830	2	14.2786										
$L_{II}P_{II,III}$				0.5930	2	20.906	$\beta_8 L_{III}N_I$	0.769	1	16.13	0.75148	2	16.4983										
$l L_{III}M_{II}$				1.0347	1	11.982	$\beta_{15} L_{III}N_{IV}$				0.7205	1	17.208										
$s L_{III}M_{III}$				0.9636	1	12.866	$\beta_2 L_{III}N_V$	0.736230	9	16.8400	0.71851	2	17.2553										
$L_{III}N_{II}$				0.78017	9	15.892	$\beta_7 L_{III}O_I$				0.7003	1	17.705										
$L_{III}N_{III}$				0.7691	1	16.120	$\beta_8 L_{III}O_{IV,V}$	0.70814	2	17.5081	0.69068	2	17.9506										
$u L_{III}N_{VI,VII}$				0.738603	9	16.7859	$\beta_{10} L_{II}M_{IV}$				0.6482	1	19.126										
$L_{III}O_{II}$				0.7333	1	16.907	$\beta_9 L_{II}M_V$				0.6416	1	19.323										
$L_{III}O_{III}$				0.7309	1	16.962	$u L_{III}N_{VI,VII}$				0.7031	1	17.635										
$L_{III}P_{II,III}$				0.72426	5	17.118	<b>95 Americium</b>																
$M_{II}N_{II}$				2.92	2	4.25	$\beta_4 L_{II}M_{II}$	0.68639	2	18.0627													
$M_{II}N_{III}$				2.753	8	4.50	$\beta_2 L_{II}M_{III}$	0.64891	2	19.1059													
$M_{II}O_{II}$				2.304	7	5.38	$\gamma_2 L_{II}N_{II}$	0.5544	2	22.361													
$M_{II}P_{III}$				2.253	6	5.50	$\beta_1 L_{II}M_{IV}$	0.657655	9	18.8520													
$M_{II}N_I$	3.441	5	3.603	3.329	4	3.724	$\gamma_1 L_{II}N_{IV}$	0.561886	9	22.0652													
$M_{II}N_{IV}$	2.910	2	4.260	2.817	2	4.401	$\gamma_6 L_{II}O_{IV}$	0.54311	2	22.8282													
$M_{II}O_{IV}$	2.527	4	4.906	2.443	4	5.075	$l L_{III}M_I$	1.0012	6	12.384													
$M_{III}N_I$	4.450	4	2.786	4.330	2	2.863	$\alpha_2 L_{III}M_{IV}$	0.860266	9	14.4119													
$M_{III}N_{IV}$	3.614	2	3.430	3.521	2	3.521	$\alpha_1 L_{III}M_V$	0.848187	9	14.6172													
$\gamma M_{III}N_V$	3.577	1	3.4657	3.479	1	3.563	$\beta_6 L_{III}N_I$	0.73418	2	16.8870													
$M_{III}O_I$	3.245	9	3.82	3.115	7	3.980	$\beta_{15} L_{III}N_{IV}$	0.70341	2	17.6258													
$M_{III}O_{IV,V}$	3.038	2	4.081	2.948	2	4.205	$\beta_2 L_{III}N_V$	0.701390	9	17.6765													
$\zeta_2 M_{IV}N_{II}$	5.193	2	2.3876	5.050	2	2.4548	$\beta_8 L_{III}O_{IV,V}$	0.67383	2	18.3996													
$M_{IV}N_{III}$				4.625	5	2.681																	
$\beta M_{IV}N_{VI}$	3.827	1	3.2397	3.716	1	3.3367																	



TABLE B. Wavelengths in numerical order of the emission lines and absorption edges.

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.10723	1 92 U	<i>K</i>	Abs. Edge	115.62	0.1408	1 82 Pb	<i>KP</i>	88.06	
0.10744	1 92 U		<i>KO<sub>II,III</sub></i>	115.39	0.140880	5 82 Pb	<i>K</i>	Abs. Edge	88.005
0.10780	2 92 U	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	115.01	0.141012	8 82 Pb		<i>KO<sub>II,III</sub></i>	87.922
0.10818	1 92 U	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	114.60	0.14111	1 83 Bi	<i>Kβ<sub>5</sub></i>	<i>KM<sub>IV,V</sub></i>	87.860
0.10837	1 92 U	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	114.40	0.14141	2 89 Ac	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	87.67
0.11069	1 92 U	<i>Kβ<sub>5</sub></i>	<i>KM<sub>IV,V</sub></i>	112.01	0.14155	3 82 Pb	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	87.59
0.11107	2 91 Pa	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	111.62	0.14191	1 82 Pb	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	87.364
0.11129	2 91 Pa	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	111.40	0.141948	3 83 Bi	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	87.343
0.111394	5 92 U	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	111.300	0.14212	2 82 Pb	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	87.23
0.112296	4 92 U	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	110.406	0.142779	7 83 Bi	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	86.834
0.11307	1 90 Th	<i>K</i>	Abs. Edge	109.646	0.14399	3 87 Fr	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	86.10
0.11322	1 90 Th		<i>KO<sub>II,III</sub></i>	109.500	0.14495	1 81 Tl	<i>K</i>	Abs. Edge	85.533
0.11366	2 90 Th	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	109.08	0.14495	3 82 Pb	<i>Kβ<sub>5</sub><sup>I</sup></i>	<i>KM<sub>V</sub></i>	85.53
0.114040	9 90 Th	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	108.717	0.14509	1 81 Tl		<i>KO<sub>II,III</sub></i>	85.451
0.11426	1 90 Th	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	108.511	0.14512	2 82 Pb	<i>Kβ<sub>5</sub><sup>II</sup></i>	<i>KM<sub>IV</sub></i>	85.43
0.114345	8 91 Pa	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	108.427	0.14512	2 88 Ra	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	85.43
0.11523	2 91 Pa	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	107.60	0.14553	2 81 Tl	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	85.19
0.116667	9 90 Th	<i>Kβ<sub>5</sub></i>	<i>KM<sub>IV,V</sub></i>	106.269	0.14595	1 81 Tl	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	84.946
0.11711	2 89 Ac	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	105.86	0.145970	6 82 Pb	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	84.936
0.11732	2 89 Ac	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	105.67	0.14614	1 81 Tl	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	84.836
0.117396	9 90 Th	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	105.609	0.146810	4 82 Pb	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	84.450
0.118268	3 90 Th	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	104.831	0.14798	3 86 Rn	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	83.78
0.12029	3 88 Ra	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	103.07	0.14896	3 87 Fr	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	83.23
0.12050	3 88 Ra	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	102.89	0.14917	1 81 Tl	<i>Kβ<sub>5</sub></i>	<i>KM<sub>IV,V</sub></i>	83.114
0.12055	2 89 Ac	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	102.85	0.14918	1 80 Hg	<i>K</i>	Abs. Edge	83.109
0.12143	2 89 Ac	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	102.10	0.14931	2 80 Hg		<i>KO<sub>II,III</sub></i>	83.04
0.12358	5 87 Fr	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	100.33	0.14978	2 80 Hg	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	82.78
0.12379	5 87 Fr	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	100.16	0.150142	5 81 Tl	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	82.576
0.12382	3 88 Ra	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	100.13	0.15020	2 80 Hg	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	82.54
0.12469	3 88 Ra	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	99.43	0.15040	2 80 Hg	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	82.43
0.125947	3 92 U	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	98.439	0.150980	6 81 Tl	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	82.118
0.12698	5 86 Rn	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	97.64	0.15210	2 85 At	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	81.52
0.12719	5 86 Rn	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	97.47	0.15294	3 86 Rn	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	81.07
0.12719	5 87 Fr	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	97.47	0.15353	2 80 Hg	<i>Kβ<sub>5</sub></i>	<i>KM<sub>IV,V</sub></i>	80.75
0.12807	5 87 Fr	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	96.81	0.153593	5 79 Au	<i>K</i>	Abs. Edge	80.720
0.129325	3 91 Pa	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	95.868	0.153694	7 79 Au		<i>KO<sub>II,III</sub></i>	80.667
0.13052	4 85 At	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	94.99	0.154224	5 79 Au	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	80.391
0.13069	5 86 Rn	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	94.87	0.154487	3 80 Hg	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	80.253
0.13072	4 85 At	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	94.84	0.154618	9 79 Au	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	80.185
0.130968	4 92 U	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	94.665	0.15483	2 79 Au	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	80.08
0.13155	5 86 Rn	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	94.24	0.155321	3 80 Hg	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	79.822
0.132813	2 90 Th	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	93.350	0.15636	1 84 Po	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	79.290
0.13418	2 84 Po	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	92.40	0.15705	2 85 At	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	78.95
0.13432	4 85 At	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	92.30	0.157880	5 79 Au	<i>Kβ<sub>5</sub><sup>I</sup></i>	<i>KM<sub>V</sub></i>	78.529
0.134343	9 91 Pa	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	92.287	0.158062	7 79 Au	<i>Kβ<sub>5</sub><sup>II</sup></i>	<i>KM<sub>IV</sub></i>	78.438
0.13438	2 84 Po	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	92.26	0.15818	1 78 Pt	<i>K</i>	Abs. Edge	78.381
0.13517	4 85 At	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	91.72	0.15826	1 78 Pt		<i>KO<sub>II,III</sub></i>	78.341
0.136417	8 89 Ac	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	90.884	0.15881	2 78 Pt	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	78.069
0.13694	1 83 Bi	<i>K</i>	Abs. Edge	90.534	0.158982	3 79 Au	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	77.984
0.13709	1 83 Bi		<i>KO<sub>II,III</sub></i>	90.435	0.15920	1 78 Pt	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	77.878
0.13759	2 83 Bi	<i>Kβ<sub>4</sub></i>	<i>KN<sub>IV,V</sub></i>	90.11	0.15939	1 78 Pt	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	77.785
0.137829	2 90 Th	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	89.953	0.159810	2 79 Au	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	77.580
0.13797	1 83 Bi	<i>Kβ<sub>2</sub><sup>I</sup></i>	<i>KN<sub>III</sub></i>	89.864	0.160789	2 83 Bi	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	77.1079
0.13807	2 84 Po	<i>Kβ<sub>1</sub></i>	<i>KM<sub>III</sub></i>	89.80	0.16130	1 84 Po	<i>Kα<sub>2</sub></i>	<i>KL<sub>II</sub></i>	76.862
0.13817	1 83 Bi	<i>Kβ<sub>2</sub><sup>II</sup></i>	<i>KN<sub>II</sub></i>	89.733	0.16255	3 78 Pt	<i>Kβ<sub>5</sub><sup>I</sup></i>	<i>KM<sub>V</sub></i>	76.27
0.13892	2 84 Po	<i>Kβ<sub>3</sub></i>	<i>KM<sub>II</sub></i>	89.25	0.16271	2 78 Pt	<i>Kβ<sub>5</sub><sup>II</sup></i>	<i>KM<sub>IV</sub></i>	76.199
0.14014	2 88 Ra	<i>Kα<sub>1</sub></i>	<i>KL<sub>III</sub></i>	88.47	0.16292	1 77 Ir	<i>K</i>	Abs. Edge	76.101

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
0.163019	5 77 Ir	<i>KO</i> <sub>II,III</sub>	76.053	0.190381	4 78 Pt	<i>Kα</i> <sub>2</sub>	65.122
0.16352	2 77 Ir	<i>Kβ</i> <sub>4</sub>	75.821	0.1908	2 72 Hf	<i>Kβ</i> <sub>2</sub>	64.98
0.163675	3 78 Pt	<i>Kβ</i> <sub>1</sub>	75.748	0.190890	2 73 Ta	<i>Kβ</i> <sub>3</sub>	64.9488
0.163956	7 77 Ir	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	75.619	0.191047	2 77 Ir	<i>Kα</i> <sub>1</sub>	64.8956
0.16415	1 77 Ir	<i>Kβ</i> <sub>2</sub> <sup>II</sup>	75.529	0.19585	5 71 Lu	<i>K</i>	63.31
0.164501	3 78 Pt	<i>Kβ</i> <sub>3</sub>	75.368	0.19589	2 71 Lu	<i>KO</i> <sub>II,III</sub>	63.293
0.165376	2 82 Pb	<i>Kα</i> <sub>1</sub>	74.9694	0.195904	2 77 Ir	<i>Kα</i> <sub>2</sub>	63.2867
0.165717	2 83 Bi	<i>Kα</i> <sub>2</sub>	74.8148	0.19607	3 72 Hf	<i>Kβ</i> <sub>1</sub>	63.234
0.167373	9 77 Ir	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	74.075	0.196794	2 76 Os	<i>Kα</i> <sub>1</sub>	63.0005
0.16759	2 77 Ir	<i>Kβ</i> <sub>5</sub> <sup>II</sup>	73.980	0.19686	4 72 Hf	<i>Kβ</i> <sub>3</sub>	62.98
0.16787	1 76 Os	<i>K</i>	73.856	0.1969	2 71 Lu	<i>Kβ</i> <sub>2</sub>	62.97
0.16798	1 76 Os	<i>KO</i> <sub>II,III</sub>	73.808	0.20084	2 71 Lu	<i>Kβ</i> <sub>6</sub>	61.732
0.16842	2 76 Os	<i>Kβ</i> <sub>4</sub>	73.615	0.201639	2 76 Os	<i>Kα</i> <sub>2</sub>	61.4867
0.168542	2 77 Ir	<i>Kβ</i> <sub>1</sub>	73.5608	0.20224	5 70 Yb	<i>K</i>	61.30
0.168906	6 76 Os	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	73.402	0.20226	2 70 Yb	<i>KO</i> <sub>II,III</sub>	61.298
0.16910	1 76 Os	<i>Kβ</i> <sub>2</sub> <sup>II</sup>	73.318	0.20231	3 71 Lu	<i>Kβ</i> <sub>1</sub>	61.283
0.169367	2 77 Ir	<i>Kβ</i> <sub>3</sub>	73.2027	0.202781	2 75 Re	<i>Kα</i> <sub>1</sub>	61.1403
0.170136	2 81 Tl	<i>Kα</i> <sub>1</sub>	72.8715	0.20309	4 71 Lu	<i>Kβ</i> <sub>2</sub>	61.05
0.170294	2 82 Pb	<i>Kα</i> <sub>2</sub>	72.8042	0.2033	2 70 Yb	<i>Kβ</i> <sub>2</sub>	60.89
0.17245	1 76 Os	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	71.895	0.20739	2 70 Yb	<i>Kβ</i> <sub>5</sub>	59.782
0.17262	1 76 Os	<i>Kβ</i> <sub>5</sub> <sup>II</sup>	71.824	0.207611	1 75 Re	<i>Kα</i> <sub>2</sub>	59.7179
0.17302	1 75 Re	<i>K</i>	71.658	0.20880	5 69 Tm	<i>K</i>	59.38
0.17308	1 75 Re	<i>KO</i> <sub>II,III</sub>	71.633	0.20884	8 70 Yb	<i>Kβ</i> <sub>1</sub>	59.37
0.173611	3 76 Os	<i>Kβ</i> <sub>1</sub>	71.413	0.20891	2 69 Tm	<i>KO</i> <sub>II,III</sub>	59.346
0.17362	2 75 Re	<i>Kβ</i> <sub>4</sub>	71.410	0.2090100	Std. 74 W	<i>Kα</i> <sub>1</sub>	59.31824
0.174054	6 75 Re	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	71.232	0.2096	1 70 Yb	<i>Kβ</i> <sub>3</sub>	59.14
0.17425	1 75 Re	<i>Kβ</i> <sub>2</sub> <sup>II</sup>	71.151	0.2098	2 69 Tm	<i>Kβ</i> <sub>2</sub>	59.09
0.174431	3 76 Os	<i>Kβ</i> <sub>3</sub>	71.077	0.213828	2 74 W	<i>Kα</i> <sub>2</sub>	57.9817
0.175036	2 81 Tl	<i>Kα</i> <sub>2</sub>	70.8319	0.21404	2 69 Tm	<i>Kβ</i> <sub>6</sub>	57.923
0.175068	3 80 Hg	<i>Kα</i> <sub>1</sub>	70.819	0.215497	4 73 Ta	<i>Kα</i> <sub>1</sub>	57.532
0.17766	1 75 Re	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	69.786	0.21556	2 69 Tm	<i>Kβ</i> <sub>1</sub>	57.517
0.17783	1 75 Re	<i>Kβ</i> <sub>5</sub> <sup>II</sup>	69.719	0.21567	1 68 Er	<i>K</i>	57.487
0.17837	1 74 W	<i>K</i>	69.508	0.21581	3 68 Er	<i>KO</i> <sub>II,III</sub>	57.450
0.178444	5 74 W	<i>KO</i> <sub>II,III</sub>	69.479	0.21592	4 74 W	<i>KL</i> <sub>I</sub>	57.42
0.178880	3 75 Re	<i>Kβ</i> <sub>1</sub>	69.310	0.21636	2 69 Tm	<i>Kβ</i> <sub>4</sub>	57.304
0.17892	2 74 W	<i>Kβ</i> <sub>4</sub>	69.294	0.2167	2 68 Er	<i>Kβ</i> <sub>2</sub>	57.21
0.179421	7 74 W	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	69.101	0.220305	8 73 Ta	<i>Kα</i> <sub>2</sub>	56.277
0.17960	1 74 W	<i>Kβ</i> <sub>2</sub> <sup>II</sup>	69.031	0.22124	3 68 Er	<i>Kβ</i> <sub>5</sub>	56.040
0.179697	3 75 Re	<i>Kβ</i> <sub>3</sub>	68.994	0.222227	3 72 Hf	<i>Kα</i> <sub>1</sub>	55.7902
0.179958	3 80 Hg	<i>Kα</i> <sub>2</sub>	68.895	0.22266	2 68 Er	<i>Kβ</i> <sub>1</sub>	55.681
0.180195	2 79 Au	<i>Kα</i> <sub>1</sub>	68.8037	0.22291	1 67 Ho	<i>K</i>	55.619
0.183092	7 74 W	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	67.715	0.22305	3 67 Ho	<i>KO</i> <sub>II,III</sub>	55.584
0.183264	5 74 W	<i>Kβ</i> <sub>5</sub> <sup>II</sup>	67.652	0.22341	2 68 Er	<i>Kβ</i> <sub>3</sub>	55.494
0.18394	1 73 Ta	<i>K</i>	67.403	0.2241	2 67 Ho	<i>Kβ</i> <sub>2</sub>	55.32
0.184031	7 73 Ta	<i>KO</i> <sub>II,III</sub>	67.370	0.227024	3 72 Hf	<i>Kα</i> <sub>2</sub>	54.6114
0.184374	2 74 W	<i>Kβ</i> <sub>1</sub>	67.2443	0.22855	3 67 Ho	<i>Kβ</i> <sub>6</sub>	54.246
0.18451	1 73 Ta	<i>Kβ</i> <sub>4</sub>	67.194	0.229298	2 71 Lu	<i>Kα</i> <sub>1</sub>	54.0698
0.185011	8 73 Ta	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	67.013	0.23012	2 67 Ho	<i>Kβ</i> <sub>1</sub>	53.877
0.185075	2 79 Au	<i>Kα</i> <sub>2</sub>	66.9895	0.23048	1 66 Dy	<i>K</i>	53.793
0.185181	2 74 W	<i>Kβ</i> <sub>3</sub>	66.9514	0.23056	3 66 Dy	<i>KO</i> <sub>II,III</sub>	53.774
0.185188	9 73 Ta	<i>Kβ</i> <sub>2</sub> <sup>II</sup>	66.949	0.23083	2 67 Ho	<i>Kβ</i> <sub>2</sub>	53.711
0.185511	4 78 Pt	<i>Kα</i> <sub>1</sub>	66.832	0.2317	2 66 Dy	<i>Kβ</i> <sub>2</sub>	53.47
0.18672	4 79 Au	<i>KL</i> <sub>I</sub>	66.40	0.234081	2 71 Lu	<i>Kα</i> <sub>2</sub>	52.9650
0.188757	6 73 Ta	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	65.683	0.23618	3 66 Dy	<i>Kβ</i> <sub>6</sub>	52.494
0.188920	6 73 Ta	<i>Kβ</i> <sub>5</sub> <sup>II</sup>	65.626	0.236655	2 70 Yb	<i>Kα</i> <sub>1</sub>	52.3889
0.18982	5 72 Hf	<i>K</i>	65.31	0.23788	2 66 Dy	<i>Kβ</i> <sub>1</sub>	52.119
0.190089	4 73 Ta	<i>Kβ</i> <sub>1</sub>	65.223	0.23841	1 65 Tb	<i>K</i>	52.002



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
0.23858	3 65 Tb	<i>KO</i> <sub>II,III</sub>	51.965	0.315816	2 58 Ce	<i>Kβ</i> <sub>1</sub>	39.2573
0.23862	2 66 Dy	<i>Kβ</i> <sub>3</sub>	51.957	0.316520	4 58 Ce	<i>Kβ</i> <sub>3</sub>	39.1701
0.2397	2 65 Tb	<i>Kβ</i> <sub>2</sub>	51.68	0.31844	5 57 La	<i>K</i>	38.934
0.241424	2 70 Yb	<i>Kα</i> <sub>2</sub>	51.3540	0.31864	2 57 La	<i>KO</i> <sub>II,III</sub>	38.909
0.244338	2 69 Tm	<i>Kα</i> <sub>1</sub>	50.7416	0.31931	2 57 La	<i>Kβ</i> <sub>4</sub> <sup>I</sup>	38.828
0.24608	2 65 Tb	<i>Kβ</i> <sub>1</sub>	50.382	0.320117	7 57 La	<i>Kβ</i> <sub>2</sub>	38.7299
0.24681	1 64 Gd	<i>K</i>	50.233	0.320160	4 61 Pm	<i>Kα</i> <sub>1</sub>	38.7247
0.24683	2 65 Tb	<i>Kβ</i> <sub>3</sub>	50.229	0.324803	4 61 Pm	<i>Kα</i> <sub>2</sub>	38.1712
0.24687	3 64 Gd	<i>KO</i> <sub>II,III</sub>	50.221	0.32546	2 57 La	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	38.094
0.24816	3 64 Gd	<i>Kβ</i> <sub>2</sub>	49.959	0.32563	2 57 La	<i>Kβ</i> <sub>6</sub> <sup>II</sup>	38.074
0.249095	2 69 Tm	<i>Kα</i> <sub>2</sub>	49.7726	0.327983	3 57 La	<i>Kβ</i> <sub>1</sub>	37.8010
0.252365	2 68 Er	<i>Kα</i> <sub>1</sub>	49.1277	0.328686	4 57 La	<i>Kβ</i> <sub>3</sub>	37.7202
0.25275	3 64 Gd	<i>Kβ</i> <sub>5</sub>	49.052	0.33104	1 56 Ba	<i>K</i>	37.452
0.25460	2 64 Gd	<i>Kβ</i> <sub>1</sub>	48.697	0.33127	2 56 Ba	<i>KO</i> <sub>II,III</sub>	37.426
0.25534	2 64 Gd	<i>Kβ</i> <sub>3</sub>	48.555	0.331846	2 60 Nd	<i>Kα</i> <sub>1</sub>	37.3610
0.25553	1 63 Eu	<i>K</i>	48.519	0.33229	2 56 Ba	<i>Kβ</i> <sub>4</sub> <sup>II</sup>	37.311
0.255645	7 63 Eu	<i>KO</i> <sub>II,III</sub>	48.497	0.33277	1 56 Ba	<i>Kβ</i> <sub>2</sub>	37.257
0.256923	8 63 Eu	<i>Kβ</i> <sub>2</sub> <sup>I</sup>	48.256	0.336472	2 60 Nd	<i>Kα</i> <sub>2</sub>	36.8474
0.257110	2 68 Er	<i>Kα</i> <sub>2</sub>	48.2211	0.33814	2 56 Ba	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	36.666
0.260756	2 67 Ho	<i>Kα</i> <sub>1</sub>	47.5467	0.33835	2 56 Ba	<i>Kβ</i> <sub>6</sub> <sup>II</sup>	36.643
0.263577	5 63 Eu	<i>Kβ</i> <sub>1</sub>	47.0379	0.340811	3 56 Ba	<i>Kβ</i> <sub>1</sub>	36.3782
0.264332	5 63 Eu	<i>Kβ</i> <sub>3</sub>	46.9036	0.341507	4 56 Ba	<i>Kβ</i> <sub>3</sub>	36.3040
0.26464	5 62 Sm	<i>K</i>	46.849	0.344140	2 59 Pr	<i>Kα</i> <sub>1</sub>	36.0263
0.26491	3 62 Sm	<i>KO</i> <sub>II,III</sub>	46.801	0.34451	1 55 Cs	<i>K</i>	35.987
0.265486	2 67 Ho	<i>Kα</i> <sub>2</sub>	46.6997	0.34611	2 55 Cs	<i>Kβ</i> <sub>2</sub>	35.822
0.2662	1 62 Sm	<i>Kβ</i> <sub>2</sub>	46.57	0.348749	2 59 Pr	<i>Kα</i> <sub>2</sub>	35.5502
0.269533	2 66 Dy	<i>Kα</i> <sub>1</sub>	45.9984	0.354364	7 55 Cs	<i>Kβ</i> <sub>1</sub>	34.9869
0.27111	3 62 Sm	<i>Kβ</i> <sub>5</sub>	45.731	0.355050	4 55 Cs	<i>Kβ</i> <sub>3</sub>	34.9194
0.27301	2 62 Sm	<i>Kβ</i> <sub>1</sub>	45.413	0.357092	2 58 Ce	<i>Kα</i> <sub>1</sub>	34.7197
0.27376	2 62 Sm	<i>Kβ</i> <sub>3</sub>	45.289	0.3584	5 54 Xe	<i>K</i>	34.59
0.274247	2 66 Dy	<i>Kα</i> <sub>2</sub>	45.2078	0.36026	3 54 Xe	<i>Kβ</i> <sub>2</sub>	34.415
0.27431	5 61 Pm	<i>K</i>	45.198	0.361683	2 58 Ce	<i>Kα</i> <sub>2</sub>	34.2789
0.2759	1 61 Pm	<i>Kβ</i> <sub>2</sub>	44.93	0.36872	2 54 Xe	<i>Kβ</i> <sub>1</sub>	33.624
0.278724	2 65 Tb	<i>Kα</i> <sub>1</sub>	44.4816	0.36941	2 54 Xe	<i>Kβ</i> <sub>3</sub>	33.562
0.28290	3 61 Pm	<i>Kβ</i> <sub>1</sub>	43.826	0.370737	2 57 La	<i>Kα</i> <sub>1</sub>	33.4418
0.283423	2 65 Tb	<i>Kα</i> <sub>2</sub>	43.7441	0.37381	1 53 I	<i>K</i>	33.1665
0.28363	4 61 Pm	<i>Kβ</i> <sub>2</sub>	43.713	0.37523	2 53 I	<i>Kβ</i> <sub>2</sub>	33.042
0.28453	5 60 Nd	<i>K</i>	43.574	0.375313	2 57 La	<i>Kα</i> <sub>2</sub>	33.0341
0.2861	1 60 Nd	<i>Kβ</i> <sub>2</sub>	43.32	0.383905	4 53 I	<i>Kβ</i> <sub>1</sub>	32.2947
0.288353	2 64 Gd	<i>Kα</i> <sub>1</sub>	42.9962	0.384564	4 53 I	<i>Kβ</i> <sub>3</sub>	32.2394
0.293038	2 64 Gd	<i>Kα</i> <sub>2</sub>	42.3089	0.385111	4 56 Ba	<i>Kα</i> <sub>1</sub>	32.1936
0.293299	2 60 Nd	<i>Kβ</i> <sub>1</sub>	42.2713	0.389668	5 56 Ba	<i>Kα</i> <sub>2</sub>	31.8171
0.294027	3 60 Nd	<i>Kβ</i> <sub>3</sub>	42.1665	0.38974	1 52 Te	<i>KO</i> <sub>II,III</sub>	31.8114
0.29518	5 59 Pr	<i>K</i>	42.002	0.38974	1 52 Te	<i>K</i>	31.8114
0.29679	2 59 Pr	<i>Kβ</i> <sub>2</sub>	41.773	0.391102	6 52 Te	<i>Kβ</i> <sub>2</sub>	31.7004
0.298446	2 63 Eu	<i>Kα</i> <sub>1</sub>	41.5422	0.399995	5 52 Te	<i>Kβ</i> <sub>1</sub>	30.9957
0.303118	2 63 Eu	<i>Kα</i> <sub>2</sub>	40.9019	0.400290	4 55 Cs	<i>Kα</i> <sub>1</sub>	30.9728
0.304261	4 59 Pr	<i>Kβ</i> <sub>1</sub>	40.7482	0.400659	4 52 Te	<i>Kβ</i> <sub>3</sub>	30.9443
0.304975	5 59 Pr	<i>Kβ</i> <sub>3</sub>	40.6529	0.404835	4 55 Cs	<i>Kα</i> <sub>2</sub>	30.6251
0.30648	5 58 Ce	<i>K</i>	40.453	0.40666	1 51 Sb	<i>KO</i> <sub>II,III</sub>	30.4875
0.30668	2 58 Ce	<i>KO</i> <sub>II,III</sub>	40.427	0.40668	1 51 Sb	<i>K</i>	30.4860
0.30737	2 58 Ce	<i>Kβ</i> <sub>4</sub> <sup>I</sup>	40.337	0.40702	1 51 Sb	<i>Kβ</i> <sub>4</sub> <sup>I</sup>	30.4604
0.30816	1 58 Ce	<i>Kβ</i> <sub>2</sub>	40.233	0.407973	5 51 Sb	<i>Kβ</i> <sub>2</sub>	30.3895
0.309040	2 62 Sm	<i>Kα</i> <sub>1</sub>	40.1181	0.41378	1 51 Sb	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	29.9632
0.31342	2 58 Ce	<i>Kβ</i> <sub>5</sub> <sup>I</sup>	39.558	0.41388	1 51 Sb	<i>Kβ</i> <sub>6</sub> <sup>II</sup>	29.9560
0.31357	2 58 Ce	<i>Kβ</i> <sub>6</sub> <sup>II</sup>	39.539	0.41634	2 54 Xe	<i>Kα</i> <sub>1</sub>	29.779
0.313698	2 62 Sm	<i>Kα</i> <sub>2</sub>	39.5224	0.417085	3 51 Sb	<i>Kβ</i> <sub>1</sub>	29.7256

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.417737	4 51 Sb	$K\beta_3$	$KM_{II}$	29.6792	0.546200	4 45 Rh	$K\beta_3$	$KM_{II}$	22.6989
0.42087	2 54 Xe	$K\alpha_2$	$KL_{II}$	29.458	0.5544	2 95 Am	$L_{\gamma_2}$	$L_{II}N_{II}$	22.361
0.42467	3 50 Sn		$KO_{II,III}$	29.195	0.5572	1 94 Pu	$L_{II}$	Abs. Edge	22.253
0.42467	1 50 Sn	$K$	Abs. Edge	29.1947	0.5585	5 93 Np	$L_{\gamma_4}$	$L_{IO_{II,III}}$	22.20
0.42495	3 50 Sn	$K\beta_4^I$	$KN_{IV,V}$	29.175	0.5594075	6 47 Ag	$K\alpha_1$	$KL_{III}$	22.16292
0.425915	8 50 Sn	$K\beta_2$	$KN_{II,III}$	29.1093	0.55973	2 94 Pu	$L_{\gamma_6}$	$L_{II}O_{IV}$	22.1502
0.43175	3 50 Sn	$K\beta_3^I$	$KM_V$	28.716	0.56051	1 44 Ru	$K$	Abs. Edge	22.1193
0.43184	3 50 Sn	$K\beta_3^{II}$	$KM_{IV}$	28.710	0.56089	9 44 Ru	$K\beta_4$	$KN_{IV,V}$	22.104
0.433318	5 53 I	$K\alpha_1$	$KL_{III}$	28.6120	0.56166	3 44 Ru	$K\beta_2$	$KN_{II,III}$	22.074
0.435236	5 50 Sn	$K\beta_1$	$KM_{III}$	28.4860	0.561886	9 95 Am	$L_{\gamma_1}$	$L_{II}N_{IV}$	22.0652
0.435877	5 50 Sn	$K\beta_3$	$KM_{II}$	28.4440	0.563798	4 47 Ag	$K\alpha_2$	$KL_{II}$	21.9903
0.437829	7 53 I	$K\alpha_2$	$KL_{II}$	28.3172	0.564001	9 94 Pu	$L_{\gamma_3}$	$L_{IN_{III}}$	21.9824
0.44371	1 49 In	$K$	Abs. Edge	27.9420	0.5658	1 94 Pu	$L_{\gamma_8}$	$L_{II}O_I$	21.914
0.44374	3 49 In		$KO_{II,III}$	27.940	0.56785	9 44 Ru	$K\beta_3^I$	$KM_V$	21.834
0.44393	4 49 In	$K\beta_4^I$	$KN_{IV,V}$	27.928	0.5680	2 44 Ru	$K\beta_3^{II}$	$KM_{IV}$	21.829
0.44500	1 49 In	$K\beta_2$	$KN_{II,III}$	27.8608	0.5695	1 92 U	$L_I$	Abs. Edge	21.771
0.45086	2 49 In	$K\beta_3^I$	$KM_V$	27.499	0.5706	1 92 U	$L_{\gamma_{13}}$	$L_I P_{II,III}$	21.729
0.45098	2 49 In	$K\beta_3^{II}$	$KM_{IV}$	27.491	0.57068	2 94 Pu	$L_{\gamma_2}$	$L_{IN_{II}}$	21.1251
0.451295	3 52 Te	$K\alpha_1$	$KL_{III}$	27.4723	0.572482	4 44 Ru	$K\beta_1$	$KM_{III}$	21.6568
0.454545	4 49 In	$K\beta_1$	$KM_{III}$	27.2759	0.5725	1 92 U		$L_I O_{IV,V}$	21.657
0.455181	4 49 In	$K\beta_3$	$KM_{II}$	27.2377	0.573067	4 44 Ru	$K\beta_3$	$KM_{II}$	21.6346
0.455784	3 52 Te	$K\alpha_2$	$KL_{II}$	27.2017	0.57499	9 92 U	$L_{\gamma_4}$	$L_I O_{III}$	21.562
0.46407	1 48 Cd	$K$	Abs. Edge	26.7159	0.576700	9 92 U	$L_{\gamma_4}'$	$L_I O_{II}$	21.4984
0.465328	7 48 Cd	$K\beta_2$	$KN_{II,III}$	26.6438	0.57699	5 93 Np	$L_{\gamma_6}$	$L_{II}O_{IV}$	21.488
0.470354	3 51 Sb	$K\alpha_1$	$KL_{III}$	26.3591	0.578882	9 94 Pu	$L_{\gamma_1}$	$L_{II}N_{IV}$	21.4173
0.474827	3 51 Sb	$K\alpha_2$	$KL_{II}$	26.1108	0.5810	5 93 Np	$L_{\gamma_8}$	$L_{IN_{III}}$	21.34
0.475105	6 48 Cd	$K\beta_1$	$KM_{III}$	26.0955	0.585448	3 46 Pd	$K\alpha_1$	$KL_{III}$	21.1771
0.475730	5 48 Cd	$K\beta_3$	$KM_{II}$	26.0612	0.5873	5 93 Np	$L_{\gamma_2}$	$L_{IN_{II}}$	21.11
0.48589	1 47 Ag	$K$	Abs. Edge	25.5165	0.58906	1 43 Te	$K$	Abs. Edge	21.0473
0.4859	9 47 Ag	$K\beta_4$	$KN_{IV,V}$	25.512	0.589821	3 46 Pd	$K\alpha_2$	$KL_{II}$	21.0201
0.487032	4 47 Ag	$K\beta_2$	$KN_{II,III}$	25.4564	0.58986	5 92 U	$L_{\gamma_{11}}$	$L_{IN_V}$	21.019
0.490599	3 50 Sn	$K\alpha_1$	$KL_{III}$	25.2713	0.59024	5 43 Tc	$K\beta_2$	$KN_{II,III}$	21.005
0.49306	2 47 Ag	$K\beta_6$	$KM_{IV,V}$	25.145	0.59096	5 92 U		$L_{IN_{IV}}$	20.979
0.495053	3 50 Sn	$K\alpha_2$	$KL_{II}$	25.0440	0.5919	1 92 U	$L_{II}$	Abs. Edge	20.945
0.497069	4 47 Ag	$K\beta_1$	$KM_{III}$	24.9424	0.59203	5 92 U		$L_{II}P_{IV}$	20.942
0.497685	4 47 Ag	$K\beta_3$	$KM_{II}$	24.9115	0.5930	2 92 U		$L_{II}P_{II,III}$	20.906
0.5092	1 46 Pd	$K$	Abs. Edge	24.348	0.5937	1 91 Pa	$L_{\gamma_4}$	$L_{IO_{II,III}}$	20.882
0.5093	2 46 Pd	$K\beta_4$	$KN_{IV,V}$	24.346	0.594845	9 92 U	$L_{\gamma_6}$	$L_{II}O_{IV}$	20.8426
0.510228	4 46 Pd	$K\beta_2$	$KN_{II,III}$	24.2991	0.596498	9 93 Np	$L_{\gamma_1}$	$L_{II}N_{IV}$	20.7848
0.512113	3 49 In	$K\alpha_1$	$KL_{III}$	24.2097	0.59728	5 92 U		$L_{II}O_{III}$	20.758
0.516544	3 49 In	$K\alpha_2$	$KL_{II}$	24.0020	0.598574	9 92 U	$L_{\gamma_8}$	$L_{IN_{III}}$	20.7127
0.51670	9 46 Pd	$K\beta_5$	$KM_{IV,V}$	23.995	0.5988	1 94 Pu	$L_{\gamma_8}$	$L_{II}N_I$	20.704
0.520520	4 46 Pd	$K\beta_1$	$KM_{III}$	23.8187	0.60125	5 92 U	$L_{\gamma_8}$	$L_{II}O_I$	20.621
0.521123	4 46 Pd	$K\beta_3$	$KM_{II}$	23.7911	0.60130	4 43 Tc	$K\beta_1$	$KM_{III}$	20.619
0.53395	1 45 Rh	$K$	Abs. Edge	23.2198	0.60188	4 43 Tc	$K\beta_3$	$KM_{II}$	20.599
0.53401	9 45 Rh	$K\beta_4^I$	$KN_{IV,V}$	23.217	0.6031	1 92 U	$L_V$	$L_{II}N_{VI}$	20.556
0.535010	3 48 Cd	$K\alpha_1$	$KL_{III}$	23.1736	0.605237	9 92 U	$L_{\gamma_2}$	$L_{IN_{II}}$	20.4847
0.53503	2 45 Rh	$K\beta_2$	$KN_{II,III}$	23.1728	0.6059	1 90 Th	$L_I$	Abs. Edge	20.464
0.53513	5 45 Rh	$K\beta_3^{II}$	$KN_{II}$	23.168	0.60705	8 90 Th	$L_{\gamma_{13}}$	$L_I P_{II,III}$	20.424
0.5365	1 94 Pu	$L_I$	Abs. Edge	23.109	0.6083	1 90 Th		$L_I O_{IV,V}$	20.383
0.539422	3 48 Cd	$K\alpha_2$	$KL_{II}$	22.9841	0.61098	4 90 Th	$L_{\gamma_4}$	$L_I O_{III}$	20.292
0.54101	9 45 Rh	$K\beta_3^I$	$KM_V$	22.917	0.61251	4 90 Th	$L_{\gamma_4}'$	$L_I O_{II}$	20.242
0.54118	9 45 Rh	$K\beta_3^{II}$	$KM_{IV}$	22.909	0.6133	1 91 Pa	$L_{\gamma_6}$	$L_{II}O_{IV}$	20.216
0.5416	1 94 Pu	$L_{\gamma_4}$	$L_I O_{III}$	22.891	0.613279	4 45 Rh	$K\alpha_1$	$KL_{III}$	20.2161
0.54311	2 95 Am	$L_{\gamma_8}$	$L_{II}O_{IV}$	22.8282	0.6146	1 90 Th		$L_I O_I$	20.174
0.5432	1 94 Pu	$L_{\gamma_4}'$	$L_I O_{II}$	22.823	0.614770	9 92 U	$L_{\gamma_1}$	$L_{II}N_{IV}$	20.1671
0.545605	4 45 Rh	$K\beta_1$	$KM_{III}$	22.7236	0.6160	1 90 Th		$L_{IN_{VI,VII}}$	20.128



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.616	1 93 Np	$L_{\gamma_5}$	$L_{II}N_I$	20.12	0.67383	2 95 Am	$L\beta_5$	$L_{III}O_{IV,V}$	18.3996
0.6169	1 91 Pa	$L_{\gamma_3}$	$L_I N_{III}$	20.098	0.67491	4 90 Th	$L_{\gamma_5}$	$L_{II}N_I$	18.370
0.617630	4 45 Rh	$K\alpha_2$	$KL_{II}$	20.0737	0.67502	3 43 Tc	$K\alpha_1$	$KL_{III}$	18.3671
0.61978	1 42 Mo	$K$	Abs. Edge	20.0039	0.67538	5 88 Ra	$L_{\gamma_3}$	$L_I N_{III}$	18.357
0.62001	9 42 Mo	$K\beta_1^I$	$KN_{IV,V}$	19.996	0.6764	1 88 Ra		$L_{II}O_{III}$	18.330
0.62099	2 42 Mo	$K\beta_2$	$KN_{II,III}$	19.9652	0.67772	2 94 Pu	$L\beta_1$	$L_{II}M_{IV}$	18.2937
0.62107	5 42 Mo	$K\beta_3^{II}$	$KN_{II}$	19.963	0.6780	1 88 Ra		$L_{II}O_{II}$	18.286
0.6228	1 92 U		$L_{II}N_{III}$	19.907	0.67932	3 43 Tc	$K\alpha_2$	$KL_{II}$	18.2508
0.6239	1 91 Pa	$L_{\gamma_2}$	$L_I N_{II}$	19.872	0.6801	1 88 Ra	$L_{\gamma_8}$	$L_{II}O_I$	18.230
0.62636	9 90 Th	$L_{\gamma_{11}}$	$L_I N_V$	19.794	0.681014	8 92 U	$L\beta_9$	$L_I M_V$	18.2054
0.62692	5 42 Mo	$K\beta_5^I$	$KM_V$	19.776	0.68199	5 88 Ra	$L_{\gamma_2}$	$L_I N_{II}$	18.179
0.62708	5 42 Mo	$K\beta_6^{II}$	$KM_{IV}$	19.771	0.68639	2 95 Am	$L\beta_4$	$L_I M_{II}$	18.0627
0.6276	1 90 Th		$L_I N_{IV}$	19.755	0.6867	1 94 Pu	$L_{III}$	Abs. Edge	18.054
0.6299	1 90 Th	$L_{II}$	Abs. Edge	19.683	0.6874	1 88 Ra		$L_I N_I$	18.036
0.62991	9 90 Th		$L_{II}P_{IV}$	19.682	0.68760	5 92 U	$L\beta_{10}$	$L_I M_{IV}$	18.031
0.6312	1 90 Th		$L_{II}P_{II,III}$	19.642	0.68883	1 40 Zr	$K$	Abs. Edge	17.9989
0.6316	1 90 Th		$L_{II}P_I$	19.629	0.68901	5 40 Zr	$K\beta_4$	$KN_{IV,V}$	17.994
0.632288	9 42 Mo	$K\beta_1$	$KM_{III}$	19.6083	0.68920	9 93 Np	$L\beta_3$	$L_I M_{III}$	17.989
0.63258	4 90 Th	$L_{\gamma_6}$	$L_{II}O_{IV}$	19.599	0.68993	4 40 Zr	$K\beta_2$	$KN_{II,III}$	17.970
0.632872	2 42 Mo	$K\beta_3$	$KM_{II}$	19.5903	0.69068	2 94 Pu	$L\beta_5$	$L_{III}O_{IV,V}$	17.9506
0.63358	9 91 Pa	$L_{\gamma_1}$	$L_{II}N_{IV}$	19.568	0.6932	1 88 Ra		$L_{II}N_V$	17.884
0.63557	2 92 U	$L_{\gamma_5}$	$L_{II}N_I$	19.5072	0.69463	5 88 Ra	$L_{\gamma_1}$	$L_{II}N_{IV}$	17.849
0.63559	4 90 Th	$L_{\gamma_3}$	$L_I N_{III}$	19.507	0.6959	1 40 Zr	$K\beta_5$	$KM_{IV,V}$	17.815
0.6356	1 90 Th		$L_{II}O_{III}$	19.506	0.698478	9 93 Np	$L\beta_1$	$L_{II}M_{IV}$	17.7502
0.6369	1 90 Th		$L_{II}O_{II}$	19.466	0.7003	1 94 Pu	$L\beta_7$	$L_{III}O_I$	17.705
0.63898	5 90 Th	$L_{\gamma_8}$	$L_{II}O_I$	19.403	0.701390	9 95 Am	$L\beta_2$	$L_{III}N_V$	17.6765
0.64064	9 90 Th	$L_V$	$L_{II}N_{VI}$	19.353	0.70173	3 40 Zr	$K\beta_1$	$KM_{III}$	17.6678
0.6416	1 94 Pu	$L\beta_9$	$L_I M_V$	19.323	0.7018	1 91 Pa	$L\beta_9$	$L_I M_V$	17.667
0.64221	4 90 Th	$L_{\gamma_2}$	$L_I N_{II}$	19.305	0.70228	4 40 Zr	$K\beta_3$	$KM_{II}$	17.654
0.643083	4 44 Ru	$K\alpha_1$	$KL_{III}$	19.2792	0.7031	1 94 Pu	$L_{II}$	$L_{III}N_{VI,VII}$	17.635
0.6445	1 88 Ra	$L_I$	Abs. Edge	19.236	0.70341	2 95 Am	$L\beta_{15}$	$L_{III}N_{IV}$	17.6258
0.64513	5 88 Ra	$L_{\gamma_{13}}$	$L_I P_{II,III}$	19.218	0.7043	1 88 Ra		$L_{II}N_{III}$	17.604
0.6468	1 88 Ra		$L_I O_{IV,V}$	19.167	0.70620	2 94 Pu	$L\beta_4$	$L_I M_{II}$	17.5560
0.647408	5 44 Ru	$K\alpha_2$	$KL_{II}$	19.1504	0.70814	2 93 Np	$L\beta_6$	$L_{III}O_{IV,V}$	17.5081
0.64755	5 90 Th		$L_I N_I$	19.146	0.7088	2 91 Pa	$L\beta_{10}$	$L_I M_{IV}$	17.492
0.6482	1 94 Pu	$L\beta_{10}$	$L_I M_{IV}$	19.126	0.709300	1 42 Mo	$K\alpha_1$	$KL_{III}$	17.47934
0.64891	2 95 Am	$L\beta_3$	$L_I M_{III}$	19.1059	0.71029	2 92 U	$L\beta_3$	$L_I M_{III}$	17.4550
0.64965	5 88 Ra	$L_{\gamma_4}$	$L_I O_{III}$	19.084	0.713590	6 42 Mo	$K\alpha_2$	$KL_{II}$	17.3743
0.65131	5 88 Ra	$L_{\gamma_4}'$	$L_I O_{II}$	19.036	0.71652	9 87 Fr	$L_{\gamma_1}$	$L_{II}N_{IV}$	17.303
0.6521	1 90 Th		$L_{II}N_V$	19.014	0.71774	5 88 Ra	$L_{\gamma_5}$	$L_{II}N_I$	17.274
0.65298	1 41 Nb	$K$	Abs. Edge	18.9869	0.71851	2 94 Pu	$L\beta_2$	$L_{II}N_V$	17.2553
0.65313	3 90 Th	$L_{\gamma_1}$	$L_{II}N_{IV}$	18.9825	0.719984	8 92 U	$L\beta_1$	$L_{II}M_{IV}$	17.2200
0.65318	5 41 Nb	$K\beta_4$	$KN_{IV,V}$	18.981	0.7205	1 94 Pu	$L\beta_{15}$	$L_{III}N_{IV}$	17.208
0.65416	4 41 Nb	$K\beta_2$	$KN_{II,III}$	18.953	0.7223	1 92 U	$L_{III}$	Abs. Edge	17.165
0.6550	1 91 Pa	$L_{\gamma_5}$	$L_{II}N_I$	18.930	0.72240	5 92 U		$L_{III}P_{IV,V}$	17.162
0.657655	9 95 Am	$L\beta_1$	$L_{II}M_{IV}$	18.8520	0.7234	1 90 Th	$L\beta_9$	$L_I M_V$	17.139
0.6620	1 90 Th		$L_{II}N_{III}$	18.729	0.72426	5 92 U		$L_{III}P_{II,III}$	17.118
0.6654	1 88 Ra	$L_{\gamma_{11}}$	$L_I N_V$	18.633	0.72521	5 92 U		$L_{III}P_I$	17.096
0.66576	2 41 Nb	$K\beta_1$	$KM_{III}$	18.6225	0.726305	9 92 U	$L\beta_5$	$L_{III}O_{IV,V}$	17.0701
0.66634	3 41 Nb	$K\beta_3$	$KM_{II}$	18.6063	0.72671	2 93 Np	$L\beta_4$	$L_I M_{II}$	17.0607
0.6666	1 88 Ra		$L_I N_{IV}$	18.600	0.72766	5 39 Y	$K$	Abs. Edge	17.038
0.66871	2 94 Pu	$L\beta_3$	$L_I M_{III}$	18.5405	0.72776	5 39 Y	$K\beta_4$	$KN_{IV,V}$	17.036
0.6707	1 88 Ra	$L_{II}$	Abs. Edge	18.486	0.72864	4 39 Y	$K\beta_2$	$KN_{II,III}$	17.0154
0.6714	1 88 Ra		$L_{II}P_{II,III}$	18.466	0.7301	1 90 Th	$L\beta_{10}$	$L_I M_{IV}$	16.981
0.6724	1 88 Ra		$L_{II}P_I$	18.439	0.7309	1 92 U		$L_{III}O_{III}$	16.962
0.67328	5 88 Ra	$L_{\gamma_6}$	$L_{II}O_{IV}$	18.414	0.73230	5 91 Pa	$L\beta_3$	$L_I M_{III}$	16.930
0.67351	9 89 Ac	$L_{\gamma_1}$	$L_{II}N_{IV}$	18.408	0.7333	1 92 U		$L_{III}O_{II}$	16.907

X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.73418	2 95 Am	$L\beta_6$	$L_{III}N_I$	16.8870	0.78292	2 38 Sr	$K\beta_1$	$KM_{III}$	15.8357
0.7345	1 39 Y	$K\beta_6$	$KM_{IV,V}$	16.879	0.78345	3 38 Sr	$K\beta_2$	$KM_{II}$	15.8249
0.73602	6 92 U	$L\beta_7$	$L_{III}O_I$	16.845	0.7858	1 82 Pb	$L\gamma_4$	$L_I O_{III}$	15.777
0.736230	9 93 Np	$L\beta_2$	$L_{III}N_V$	16.8400	0.78593	1 40 Zr	$K\alpha_1$	$KL_{III}$	15.7751
0.738603	9 92 U	$L\alpha$	$L_{III}N_{VI,VII}$	16.7859	0.78706	7 82 Pb	$L\gamma_4'$	$L_I O_{II}$	15.752
0.73928	9 86 Rn	$L\gamma_1$	$L_{II}N_{IV}$	16.770	0.78748	9 84 Po	$L\gamma_1$	$L_{II}N_{IV}$	15.744
0.74072	2 99 Y	$K\beta_1$	$KM_{III}$	16.7378	0.78838	2 92 U	$L\beta_6$	$L_{III}N_I$	15.7260
0.74126	3 39 Y	$K\beta_3$	$KM_{II}$	16.7258	0.7884	1 82 Pb		$L_I N_{VI,VII}$	15.725
0.74232	5 91 Pa	$L\beta_1$	$L_{II}M_{IV}$	16.702	0.7887	1 83 Bi	$L_{II}$	Abs. Edge	15.719
0.74503	5 92 U	$L\beta_{17}$	$L_{II}M_{III}$	16.641	0.78903	9 89 Ac	$L\beta_1$	$L_{II}M_{IV}$	15.713
0.7452	2 91 Pa	$L\beta_5$	$L_{III}O_{IV,V}$	16.636	0.78917	5 83 Bi	$L\gamma_3$	$L_I N_{III}$	15.7102
0.74620	1 41 Nb	$K\alpha_1$	$KL_{III}$	16.6151	0.7897	1 82 Pb		$L_I O_I$	15.699
0.747985	9 92 U	$L\beta_4$	$L_I M_{II}$	16.5753	0.79015	1 40 Zr	$K\alpha_2$	$KL_{II}$	15.6909
0.75044	1 41 Nb	$K\alpha_2$	$KL_{II}$	16.5210	0.79043	3 83 Bi	$L\gamma_6$	$L_{II}O_{IV}$	15.6853
0.75148	2 94 Pu	$L\beta_5$	$L_{III}N_I$	16.4983	0.79257	4 90 Th	$L\beta_4$	$L_I M_{II}$	15.6429
0.7546	2 91 Pa	$L\beta_7$	$L_{III}O_I$	16.431	0.79257	4 90 Th	$L\beta_{17}$	$L_{II}M_{III}$	15.6429
0.754681	9 92 U	$L\beta_2$	$L_{III}N_V$	16.4283	0.79354	3 90 Th	$L\beta_2$	$L_{III}M_V$	15.6237
0.75479	3 90 Th	$L\beta_3$	$L_I M_{III}$	16.4258	0.79384	5 83 Bi		$L_{II}O_{III}$	15.6178
0.756642	9 92 U	$L\beta_{15}$	$L_{III}N_{IV}$	16.3857	0.79539	5 90 Th	$L\beta_{15}$	$L_{III}N_{IV}$	15.5875
0.75690	3 83 Bi	$L\gamma_{13}$	$L_I P_{II,III}$	16.3802	0.79565	3 83 Bi	$L\gamma_2$	$L_I N_{II}$	15.5824
0.7571	1 83 Bi	$L_I$	Abs. Edge	16.376	0.79721	9 83 Bi	$L\alpha$	$L_{II}N_{VI}$	15.552
0.7579	1 90 Th		$L_{II}M_V$	16.359	0.7973	1 83 Bi	$L\gamma_8$	$L_{II}O_I$	15.551
0.75791	5 83 Bi		$L_I O_{IV,V}$	16.358	0.8022	1 83 Bi		$L_I N_I$	15.456
0.7591	1 94 Pu	$L\eta$	$L_{II}M_I$	16.333	0.80233	9 82 Pb	$L\gamma_{11}$	$L_I N_V$	15.453
0.7607	1 90 Th	$L_{III}$	Abs. Edge	16.299	0.80273	5 88 Ra	$L\beta_3$	$L_I M_{III}$	15.4449
0.76087	9 90 Th		$L_{III}P_{IV,V}$	16.295	0.8028	1 88 Ra	$L_{III}$	Abs. Edge	15.444
0.76087	3 83 Bi	$L\gamma_4$	$L_I O_{III}$	16.2947	0.80364	7 82 Pb		$L_I N_{IV}$	15.427
0.76198	3 83 Bi	$L\gamma_4'$	$L_I O_{II}$	16.2709	0.8038	1 88 Ra		$L_{III}P_{II,III}$	15.425
0.7625	2 90 Th		$L_{III}P_{II,III}$	16.260	0.8050	1 88 Ra		$L_{III}P_I$	15.402
0.76289	9 85 At	$L\gamma_1$	$L_{II}N_{IV}$	16.251	0.80509	2 92 U	$L\eta$	$L_{II}M_I$	15.3997
0.76338	5 90 Th		$L_{III}P_I$	16.241	0.80627	5 88 Ra	$L\beta_5$	$L_{III}O_{IV,V}$	15.3771
0.7641	5 83 Bi		$L_I N_{VI,VII}$	16.23	0.8079	1 91 Pa	$L\beta_6$	$L_{III}N_I$	15.347
0.7645	2 84 Po	$L\gamma_6$	$L_{II}O_{IV}$	16.218	0.8081	1 81 Tl	$L_I$	Abs. Edge	15.343
0.76468	5 90 Th	$L\beta_5$	$L_{III}O_{IV,V}$	16.213	0.8082	1 90 Th		$L_{III}N_{III}$	15.341
0.765210	9 90 Th	$L\beta_1$	$L_{II}M_{IV}$	16.2022	0.80861	5 81 Tl		$L_I O_{IV,V}$	15.3327
0.76857	5 88 Ra	$L\beta_9$	$L_I M_V$	16.131	0.81163	9 90 Th		$L_I M_I$	15.276
0.769	1 93 Np	$L\beta_6$	$L_{III}N_I$	16.13	0.81184	5 81 Tl	$L\gamma_4$	$L_I O_{III}$	15.2716
0.7690	1 90 Th		$L_{III}O_{III}$	16.123	0.81308	5 81 Tl	$L\gamma_4'$	$L_I O_{II}$	15.2482
0.7691	1 92 U		$L_{III}N_{III}$	16.120	0.81311	2 83 Bi	$L\gamma_1$	$L_{II}N_{IV}$	15.2477
0.76973	5 38 Sr	$K$	Abs. Edge	16.107	0.81375	5 88 Ra	$L\beta_1$	$L_{II}M_{IV}$	15.2358
0.7699	1 91 Pa	$L\beta_4$	$L_I M_{II}$	16.104	0.8147	1 82 Pb	$L\gamma_3$	$L_I N_{III}$	15.218
0.76989	5 38 Sr	$K\beta_4$	$KN_{IV,V}$	16.104	0.81538	5 82 Pb	$L_{II}$	Abs. Edge	15.2053
0.77081	3 38 Sr	$K\beta_2$	$KN_{II,III}$	16.0846	0.8154	2 37 Rb	$K\beta_4$	$KN_{IV,V}$	15.205
0.7713	1 90 Th		$L_{III}O_{II}$	16.074	0.81554	5 37 Rb	$K$	Abs. Edge	15.2023
0.772	1 84 Po	$L\gamma_2$	$L_I N_{II}$	16.07	0.8158	1 81 Tl		$L_I O_I$	15.198
0.7737	1 91 Pa	$L\beta_2$	$L_{III}N_V$	16.024	0.81583	5 82 Pb		$L_{II}P_I$	15.1969
0.77437	4 90 Th	$L\beta_7$	$L_{III}O_I$	16.0105	0.8162	1 88 Ra	$L\beta_7$	$L_{III}O_I$	15.190
0.77546	5 88 Ra	$L\beta_{10}$	$L_I M_{IV}$	15.988	0.81645	3 37 Rb	$K\beta_2$	$KN_{II,III}$	15.1854
0.7764	1 38 Sr	$K\beta_5$	$KM_{IV,V}$	15.969	0.81683	5 82 Pb	$L\gamma_6$	$L_{II}O_{IV}$	15.1783
0.77661	5 90 Th	$L\alpha$	$L_{III}N_{VI,VII}$	15.964	0.8186	1 88 Ra	$L\alpha$	$L_{III}N_{VI,VII}$	15.146
0.77728	5 83 Bi	$L\gamma_{11}$	$L_I N_V$	15.951	0.8190	2 90 Th		$L_{III}N_{II}$	15.138
0.77822	9 89 Ac	$L\beta_8$	$L_I M_{III}$	15.931	0.8200	1 82 Pb		$L_{II}O_{III}$	15.120
0.77954	5 83 Bi		$L_I N_{IV}$	15.904	0.8210	2 82 Pb	$L\gamma_2$	$L_I N_{II}$	15.101
0.78017	9 92 U		$L_{III}N_{II}$	15.892	0.8219	1 37 Rb	$K\beta_5$	$KM_{IV,V}$	15.085
0.7809	2 93 Np	$L\eta$	$L_{II}M_I$	15.876	0.82327	7 82 Pb	$L\alpha$	$L_{II}N_{VI}$	15.060
0.78196	5 82 Pb	$L_I$	Abs. Edge	15.855	0.82365	5 82 Pb	$L\gamma_8$	$L_{II}O_I$	15.0527
0.78257	7 82 Pb		$L_I O_{IV,V}$	15.843	0.8248	1 83 Bi		$L_{II}N_{III}$	15.031



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.82789	9 87 Fr	$L\beta_3$	$L_{III}M_{III}$	14.976	0.87088	5 88 Ra	$L\beta_6$	$L_{III}N_{VI}$	14.2362
0.82790	8 90 Th	$L\beta_6$	$L_{III}N_{VI}$	14.975	0.8722	1 80 Hg	$L_{II}$	Abs. Edge	14.215
0.82859	7 82 Pb		$L_{I}N_{I}$	14.963	0.87319	7 80 Hg	$L\gamma_6$	$L_{II}O_{IV}$	14.199
0.82868	2 37 Rb	$K\beta_1$	$KM_{III}$	14.9613	0.87526	1 38 Sr	$K\alpha_1$	$KL_{III}$	14.1650
0.82879	5 81 Tl	$L\gamma_{11}$	$L_{I}N_{V}$	14.9593	0.87544	7 80 Hg	$L\gamma_2$	$L_{I}N_{II}$	14.162
0.82884	1 39 Y	$K\alpha_1$	$KL_{III}$	14.9584	0.8758	1 80 Hg		$L_{II}O_{III}$	14.156
0.82921	3 37 Rb	$K\beta_3$	$KM_{II}$	14.9517	0.8784	1 80 Hg		$L_{II}O_{II}$	14.114
0.8295	1 91 Pa	$L\eta$	$L_{II}M_{I}$	14.946	0.8785	1 36 Kr	$K\beta_1$	$KM_{III}$	14.112
0.83001	7 81 Tl		$L_{I}N_{IV}$	14.937	0.87885	7 80 Hg	$L\nu$	$L_{II}N_{VI}$	14.107
0.83305	1 39 Y	$K\alpha_2$	$KL_{II}$	14.8829	0.8790	1 36 Kr	$K\beta_3$	$KM_{II}$	14.104
0.8338	1 90 Th		$L_{II}M_{II}$	14.869	0.87943	1 38 Sr	$K\alpha_2$	$KL_{II}$	14.0979
0.8344	9 83 Bi		$L_{II}N_{II}$	14.86	0.87995	7 80 Hg	$L\gamma_8$	$L_{II}O_{I}$	14.090
0.8350	2 80 Hg		$L_{I}O_{IV,V}$	14.847	0.87996	5 81 Tl		$L_{II}N_{III}$	14.0893
0.8353	1 80 Hg	$L_I$	Abs. Edge	14.842	0.88028	2 94 Pu	$L\alpha_2$	$L_{III}M_{IV}$	14.0842
0.83537	5 88 Ra	$L\beta_2$	$L_{III}N_{V}$	14.8414	0.88135	9 85 At	$L\beta_3$	$L_{I}M_{III}$	14.067
0.83722	5 88 Ra	$L\beta_{15}$	$L_{III}N_{IV}$	14.8086	0.8827	2 80 Hg		$L_{I}N_{I}$	14.045
0.8382	2 82 Pb		$L_{II}N_{V}$	14.791	0.88433	7 79 Au	$L\gamma_{11}$	$L_{I}N_{V}$	14.020
0.83894	7 80 Hg	$L\gamma_4$	$L_{I}O_{III}$	14.778	0.88563	7 79 Au		$L_{I}N_{IV}$	13.999
0.83923	5 83 Bi	$L\gamma_6$	$L_{II}N_{I}$	14.7732	0.8882	2 81 Tl		$L_{II}M_{II}$	13.959
0.83940	9 87 Fr	$L\beta_1$	$L_{II}M_{IV}$	14.770	0.889128	9 93 Np	$L\alpha_1$	$L_{III}M_{V}$	13.9441
0.83973	3 82 Pb	$L\gamma_1$	$L_{II}N_{IV}$	14.7644	0.8931	1 78 Pt	$L_I$	Abs. Edge	13.883
0.84013	7 80 Hg	$L\gamma_4'$	$L_{I}O_{II}$	14.757	0.8934	1 78 Pt		$L_{I}O_{V}$	13.878
0.84071	5 88 Ra	$L\beta_4$	$L_{I}M_{II}$	14.7472	0.89349	9 85 At	$L\beta_1$	$L_{II}M_{IV}$	13.876
0.84130	4 81 Tl	$L\gamma_3$	$L_{I}N_{III}$	14.7368	0.8943	1 78 Pt		$L_{I}O_{IV}$	13.864
0.8434	1 81 Tl	$L_{II}$	Abs. Edge	14.699	0.89500	4 81 Tl	$L\gamma_5$	$L_{II}N_{I}$	13.8526
0.8438	1 88 Ra	$L\beta_{17}$	$L_{II}M_{III}$	14.692	0.89646	5 80 Hg	$L\gamma_1$	$L_{II}N_{IV}$	13.8301
0.8442	2 81 Tl	$L\gamma_6$	$L_{II}O_{IV}$	14.685	0.89659	4 78 Pt	$L\gamma_4$	$L_{I}O_{III}$	13.8281
0.8452	2 80 Hg		$L_{I}O_{I}$	14.670	0.89747	4 78 Pt	$L\gamma_4'$	$L_{I}O_{II}$	13.8145
0.84773	5 81 Tl	$L\gamma_2$	$L_{I}N_{II}$	14.6251	0.89783	5 79 Au	$L\gamma_3$	$L_{I}N_{III}$	13.8090
0.848187	9 95 Am	$L\alpha_1$	$L_{III}M_{V}$	14.6172	0.89791	3 83 Bi	$L\beta_9$	$L_{I}M_{V}$	13.8077
0.8490	1 81 Tl		$L_{II}O_{II}$	14.604	0.8995	2 78 Pt		$L_{I}O_{I}$	13.784
0.85048	5 81 Tl	$L\nu$	$L_{II}N_{VI}$	14.5777	0.8996	2 84 Po	$L\beta_5$	$L_{III}O_{IV,V}$	13.782
0.8512	1 88 Ra		$L_{III}N_{III}$	14.566	0.901045	9 93 Np	$L\alpha_2$	$L_{III}M_{IV}$	13.7597
0.8513	2 81 Tl	$L\gamma_8$	$L_{II}O_{I}$	14.564	0.90259	5 79 Au	$L_{II}$	Abs. Edge	13.7361
0.85192	7 82 Pb		$L_{II}N_{III}$	14.553	0.90297	3 79 Au	$L\gamma_6$	$L_{II}O_{IV}$	13.7304
0.85436	9 86 Rn	$L\beta_3$	$L_{I}M_{III}$	14.512	0.90434	3 79 Au	$L\gamma_2$	$L_{I}N_{II}$	13.7095
0.85446	4 90 Th	$L\eta$	$L_{II}M_{I}$	14.5099	0.90495	4 83 Bi	$L\beta_{10}$	$L_{I}M_{IV}$	13.7002
0.8549	1 81 Tl		$L_{I}N_{I}$	14.503	0.90638	7 79 Au		$L_{II}O_{III}$	13.679
0.85657	7 80 Hg	$L\gamma_{11}$	$L_{I}N_{V}$	14.474	0.90742	5 88 Ra	$L\eta$	$L_{II}M_{I}$	13.6630
0.858	2 87 Fr	$L\beta_2$	$L_{III}N_{V}$	14.45	0.90746	7 79 Au		$L_{II}O_{II}$	13.662
0.8585	3 82 Pb		$L_{II}N_{II}$	14.442	0.90837	5 79 Au	$L\nu$	$L_{II}N_{VI}$	13.6487
0.860266	9 95 Am	$L\alpha_2$	$L_{III}M_{IV}$	14.4119	0.90894	7 80 Hg		$L_{II}N_{III}$	13.640
0.8618	1 88 Ra		$L_{III}N_{II}$	14.387	0.9091	3 84 Po	$L\beta_3$	$L_{I}M_{III}$	13.638
0.86376	5 79 Au	$L_I$	Abs. Edge	14.3537	0.90989	5 79 Au	$L\gamma_8$	$L_{II}O_{I}$	13.6260
0.86400	5 79 Au		$L_{I}O_{IV,V}$	14.3497	0.910639	9 92 U	$L\alpha_1$	$L_{III}M_{V}$	13.6147
0.8653	2 36 Kr	$K\beta_4$	$KN_{IV,V}$	14.328	0.9131	1 79 Au		$L_{I}N_{I}$	13.578
0.86552	1 36 Kr	$K$	Abs. Edge	14.3244	0.9143	2 78 Pt	$L\gamma_{11}$	$L_{I}N_{V}$	13.560
0.86605	9 86 Rn	$L\beta_1$	$L_{II}M_{IV}$	14.316	0.9204	1 35 Br	$K$	Abs. Edge	13.470
0.8661	1 36 Kr	$K\beta_2$	$KN_{II,III}$	14.315	0.92046	2 35 Br	$K\beta_2$	$KN_{II,III}$	13.4695
0.86655	5 82 Pb	$L\gamma_6$	$L_{II}N_{I}$	14.3075	0.9220	2 84 Po	$L\beta_1$	$L_{II}M_{IV}$	13.447
0.86703	4 79 Au	$L\gamma_4$	$L_{I}O_{III}$	14.2996	0.922558	9 92 U	$L\alpha_2$	$L_{III}M_{IV}$	13.4388
0.86752	3 81 Tl	$L\gamma_1$	$L_{II}N_{IV}$	14.2915	0.9234	1 83 Bi	$L_{III}$	Abs. Edge	13.426
0.86816	4 79 Au	$L\gamma_4'$	$L_{I}O_{II}$	14.2809	0.9236	1 77 Ir	$L_I$	Abs. Edge	13.423
0.86830	2 94 Pu	$L\alpha_1$	$L_{III}M_{V}$	14.2786	0.92413	4 83 Bi		$L_{III}P_{II,III}$	13.4159
0.86915	7 80 Hg	$L\gamma_3$	$L_{I}N_{III}$	14.265	0.9243	3 77 Ir		$L_{I}O_{IV,V}$	13.413
0.87074	5 79 Au		$L_{I}O_{I}$	14.2385	0.92453	7 80 Hg	$L\gamma_5$	$L_{II}N_{I}$	13.410
0.8708	2 36 Kr	$K\beta_5$	$KM_{IV,V}$	14.238	0.9255	1 35 Br	$K\beta_5$	$KM_{IV,V}$	13.396

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
0.925553	9 37 Rb	$K\alpha_1$	$KL_{III}$	13.3953	0.96788	2 90 Th	$L\alpha_2$	$L_{III}M_{IV}$	12.8096
0.92556	3 83 Bi	$L\beta_9$	$L_{III}O_{IV,v}$	13.3953	0.96911	7 82 Pb	$L\beta_3$	$L_{II}M_{III}$	12.7933
0.92650	3 79 Au	$L\gamma_1$	$L_{II}N_{IV}$	13.3817	0.96979	5 77 Ir		$L_{II}O_{III}$	12.7843
0.9268	1 82 Pb	$L\beta_9$	$L_{II}M_{V}$	13.377	0.97161	6 77 Ir	$L\nu$	$L_{II}N_{VI}$	12.7603
0.92744	3 77 Ir	$L\gamma_4$	$L_{II}O_{III}$	13.3681	0.97173	4 78 Pt		$L_{II}N_{III}$	12.7588
0.92791	5 78 Pt	$L\gamma_3$	$L_{II}N_{III}$	13.3613	0.97321	5 83 Bi		$L_{III}N_{III}$	12.7394
0.92831	3 77 Ir	$L\gamma_4'$	$L_{II}O_{II}$	13.3555	0.97409	3 77 Ir	$L\gamma_8$	$L_{II}O_I$	12.7279
0.92937	5 84 Po	$L\beta_2$	$L_{III}N_{V}$	13.3404	0.9747	1 82 Pb		$L_{II}M_{V}$	12.720
0.92969	1 37 Rb	$K\alpha_2$	$KL_{II}$	13.3358	0.9765	3 76 Os	$L\gamma_{11}$	$L_{II}N_{V}$	12.696
0.9302	2 83 Bi		$L_{III}O_{III}$	13.328	0.9766	2 77 Ir		$L_{II}N_I$	12.695
0.9312	2 84 Po	$L\beta_{16}$	$L_{III}N_{IV}$	13.314	0.97690	4 83 Bi	$L\beta_4$	$L_{II}M_{II}$	12.6912
0.9323	2 83 Bi		$L_{III}O_{II}$	13.298	0.9772	3 76 Os		$L_{II}N_{IV}$	12.687
0.93279	2 35 Br	$K\beta_1$	$KM_{III}$	13.2914	0.9792	2 78 Pt		$L_{II}N_{II}$	12.661
0.93284	5 91 Pa	$L\alpha_1$	$L_{III}M_{V}$	13.2907	0.97926	5 81 Tl		$L_{III}P_{II,III}$	12.6607
0.93327	5 35 Br	$K\beta_3$	$KM_{II}$	13.2845	0.9793	1 81 Tl	$L_{III}$	Abs. Edge	12.660
0.9339	2 82 Pb	$L\beta_{10}$	$L_{II}M_{IV}$	13.275	0.97974	1 34 Se	$K$	Abs. Edge	12.6545
0.93414	5 78 Pt	$L_{II}$	Abs. Edge	13.2723	0.97992	5 34 Se	$K\beta_2$	$KN_{II,III}$	12.6522
0.9342	2 78 Pt	$L\gamma_6$	$L_{II}O_{IV}$	13.271	0.97993	5 89 Ac	$L\alpha_1$	$L_{III}M_{V}$	12.6520
0.93427	5 78 Pt	$L\gamma_2$	$L_{II}N_{II}$	13.2704	0.9801	1 36 Kr	$K\alpha_1$	$KL_{III}$	12.649
0.93505	5 83 Bi	$L\beta_7$	$L_{III}O_I$	13.2593	0.98058	3 81 Tl	$L\beta_5$	$L_{III}O_{IV,v}$	12.6436
0.93505	5 83 Bi	$Lu$	$L_{III}N_{VI,VII}$	13.2593	0.98221	7 82 Pb	$L\beta_2$	$L_{III}N_{V}$	12.6226
0.93855	3 83 Bi	$L\beta_3$	$L_{II}M_{III}$	13.2098	0.98280	5 83 Bi		$L_{III}N_{II}$	12.6151
0.93931	5 78 Pt	$L\nu$	$L_{II}N_{VI}$	13.1992	0.98291	3 82 Pb	$L\beta_1$	$L_{II}M_{IV}$	12.6137
0.9402	2 79 Au		$L_{II}N_{III}$	13.186	0.98389	7 82 Pb	$L\beta_{18}$	$L_{III}N_{IV}$	12.6011
0.9411	1 78 Pt	$L\gamma_8$	$L_{II}O_I$	13.173	0.9841	1 36 Kr	$K\alpha_2$	$KL_{II}$	12.598
0.94419	5 83 Bi		$L_{II}M_{V}$	13.1310	0.9843	1 34 Se	$K\beta_6$	$KM_{IV,v}$	12.595
0.9446	2 77 Ir	$L\gamma_{11}$	$L_{II}N_{V}$	13.126	0.98538	5 81 Tl		$L_{III}O_{III}$	12.5820
0.94482	5 91 Pa	$L\alpha_2$	$L_{III}M_{IV}$	13.1222	0.9871	2 80 Hg	$L\beta_9$	$L_{II}M_{V}$	12.560
0.9455	2 78 Pt		$L_{II}N_I$	13.113	0.98738	5 81 Tl		$L_{III}O_{II}$	12.5566
0.9459	2 77 Ir		$L_{II}N_{IV}$	13.108	0.9877	2 78 Pt	$L\gamma_6$	$L_{II}N_I$	12.552
0.9475	3 84 Po	$L\beta_4$	$L_{II}M_{II}$	13.086	0.9888	1 81 Tl	$Lu$	$L_{III}N_{VI,VII}$	12.538
0.95073	5 82 Pb	$L_{III}$	Abs. Edge	13.0406	0.98913	5 83 Bi	$L\beta_{17}$	$L_{II}M_{III}$	12.5344
0.95118	7 82 Pb		$L_{III}P_{II,III}$	13.0344	0.9894	1 75 Re	$L_I$	Abs. Edge	12.530
0.951978	9 83 Bi	$L\beta_1$	$L_{II}M_{IV}$	13.0235	0.9900	1 75 Re		$L_{IO_{IV,v}}$	12.524
0.9526	1 82 Pb	$L\beta_6$	$L_{III}O_{IV,v}$	13.015	0.99017	5 81 Tl	$L\beta_7$	$L_{III}O_I$	12.5212
0.95518	4 83 Bi	$L\beta_2$	$L_{III}N_{V}$	12.9799	0.99085	3 77 Ir	$L\gamma_1$	$L_{II}N_{IV}$	12.5126
0.95559	3 79 Au	$L\gamma_5$	$L_{II}N_I$	12.9743	0.99178	5 89 Ac	$L\alpha_2$	$L_{III}M_{IV}$	12.5008
0.9558	1 76 Os	$L_I$	Abs. Edge	12.972	0.99186	5 76 Os	$L\gamma_3$	$L_{II}N_{III}$	12.4998
0.95600	3 90 Th	$L\alpha_1$	$L_{III}M_{V}$	12.9687	0.99218	3 34 Se	$K\beta_1$	$KM_{III}$	12.4959
0.95603	5 76 Os		$L_{IO_{IV,v}}$	12.9683	0.99249	5 75 Re	$L\gamma_4$	$L_{IO_{III}}$	12.4920
0.95675	7 81 Tl	$L\beta_9$	$L_{II}M_{V}$	12.9585	0.99268	5 34 Se	$K\beta_3$	$KM_{II}$	12.4896
0.95702	5 83 Bi	$L\beta_{15}$	$L_{III}N_{IV}$	12.9549	0.99331	3 83 Bi	$L\beta_6$	$L_{III}N_I$	12.4816
0.9578	1 82 Pb		$L_{III}O_{III}$	12.945	0.99334	5 75 Re	$L\gamma_4'$	$L_{IO_{II}}$	12.4813
0.95797	3 78 Pt	$L\gamma_1$	$L_{II}N_{IV}$	12.9420	0.9962	2 80 Hg	$L\beta_{10}$	$L_{II}M_{IV}$	12.446
0.9586	1 82 Pb		$L_{III}O_{II}$	12.934	0.9965	1 75 Re		$L_{IO_I}$	12.442
0.95931	5 77 Ir	$L\gamma_3$	$L_{II}N_{III}$	12.9240	0.99805	5 76 Os	$L\gamma_2$	$L_{II}N_{II}$	12.4224
0.95938	8 76 Os	$L\gamma_4$	$L_{IO_{III}}$	12.923	1.0005	1 82 Pb		$L_{III}N_{III}$	12.392
0.96033	8 76 Os	$L\gamma_4'$	$L_{IO_{II}}$	12.910	1.0005	9 83 Bi		$L_{II}M_I$	12.39
0.96133	7 82 Pb	$Lu$	$L_{III}N_{VI,VII}$	12.8968	1.00062	3 81 Tl	$L\beta_3$	$L_{II}M_{III}$	12.3904
0.9620	1 82 Pb	$L\beta_7$	$L_{III}O_I$	12.888	1.00107	5 76 Os	$L\gamma_6$	$L_{II}O_{IV}$	12.3848
0.96318	7 76 Os		$L_{IO_I}$	12.8721	1.0012	6 95 Am	$L_I$	$L_{III}M_I$	12.384
0.9636	1 92 U	$L_5$	$L_{III}M_{III}$	12.866	1.0014	1 76 Os	$L_{II}$	Abs. Edge	12.381
0.96389	7 81 Tl	$L\beta_{10}$	$L_{II}M_{IV}$	12.8626	1.0047	2 76 Os		$L_{III}O_{III}$	12.340
0.96545	3 77 Ir	$L\gamma_2$	$L_{II}N_{II}$	12.8418	1.00473	5 88 Ra	$L\alpha_1$	$L_{III}M_{V}$	12.3397
0.96708	4 77 Ir	$L\gamma_6$	$L_{II}O_{IV}$	12.8201	1.0050	2 76 Os	$L\nu$	$L_{II}N_{VI}$	12.337
0.9671	1 77 Ir	$L_{II}$	Abs. Edge	12.820	1.0054	3 77 Ir		$L_{II}N_{III}$	12.332
0.9672	2 84 Po	$L\beta_6$	$L_{III}N_I$	12.819	1.00722	5 81 Tl		$L_{II}M_{V}$	12.3093



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV	
1.0075	1 82 Pb	$L\beta_4$	$L_{II}M_{II}$	12.306	1.04500	3 33 As	$K\beta_2$ $KN_{II,III}$	11.8642
1.00788	5 76 Os	$L\gamma_8$	$L_{II}O_I$	12.3012	1.0458	1 74 W	$L\gamma_{II}$ $L_{II}N_V$	11.856
1.0091	1 80 Hg	$L_{III}$	Abs. Edge	12.286	1.0468	2 74 W	$L_{II}N_{IV}$	11.844
1.00987	7 80 Hg	$L\beta_6$	$L_{III}O_{IV,V}$	12.2769	1.04752	5 79 Au	$L\mu$ $L_{III}N_{VI,VII}$	11.8357
1.01031	3 81 Tl	$L\beta_2$	$L_{III}N_V$	12.2715	1.04868	5 80 Hg	$L\beta_1$ $L_{II}M_{IV}$	11.8226
1.01040	7 82 Pb		$L_{III}N_{II}$	12.2705	1.0488	1 33 As	$K\beta_6$ $KM_{IV,V}$	11.822
1.0108	1 75 Re	$L\gamma_{II}$	$L_{II}N_V$	12.266	1.04963	5 81 Tl	$L\beta_6$ $L_{III}N_I$	11.8118
1.0112	1 90 Th	$L_s$	$L_{III}M_{III}$	12.261	1.04974	8 79 Au	$L\beta_7$ $L_{III}O_I$	11.8106
1.0119	1 75 Re		$L_{II}N_{IV}$	12.252	1.05446	5 78 Pt	$L\beta_9$ $L_{II}M_V$	11.7577
1.0120	2 77 Ir		$L_{II}N_{II}$	12.251	1.05609	7 81 Tl	$L\beta_{17}$ $L_{II}M_{III}$	11.7397
1.01201	3 81 Tl	$L\beta_{16}$	$L_{III}N_{IV}$	12.2510	1.05693	5 76 Os	$L\gamma_6$ $L_{II}N_I$	11.7303
1.01404	7 80 Hg		$L_{III}O_{III}$	12.2264	1.05723	5 86 Rn	$L\alpha_1$ $L_{III}M_V$	11.7270
1.01513	4 81 Tl	$L\beta_1$	$L_{II}M_{IV}$	12.2133	1.05730	2 33 As	$K\beta_1$ $KM_{III}$	11.7262
1.01558	7 80 Hg		$L_{III}O_{II}$	12.2079	1.05783	5 33 As	$K\beta_2$ $KM_{II}$	11.7203
1.01656	5 88 Ra	$L\alpha_2$	$L_{III}M_{IV}$	12.1962	1.0585	1 80 Hg	$L_{III}N_{III}$	11.713
1.01674	7 80 Hg	$L\mu$	$L_{III}N_{VII}$	12.1940	1.05856	3 83 Bi	$L\eta$ $L_{II}M_I$	11.7122
1.01769	7 80 Hg	$L\mu'$	$L_{III}N_{VI}$	12.1826	1.06099	5 75 Re	$L\gamma_1$ $L_{II}N_{IV}$	11.6854
1.01937	7 80 Hg	$L\beta_7$	$L_{III}O_I$	12.1625	1.0613	1 73 Ta	$L_I$ Abs. Edge	11.682
1.02063	7 79 Au	$L\beta_9$	$L_{II}M_V$	12.1474	1.06183	7 78 Pt	$L\beta_{10}$ $L_{II}M_{IV}$	11.6762
1.0210	1 82 Pb	$L\beta_5$	$L_{III}N_I$	12.143	1.06192	9 73 Ta	$L_I O_{IV,V}$	11.6752
1.02175	5 77 Ir	$L\gamma_5$	$L_{II}N_I$	12.1342	1.06200	6 74 W	$L\gamma_3$ $L_{II}N_{III}$	11.6743
1.0223	1 82 Pb	$L\beta_{17}$	$L_{II}M_{III}$	12.127	1.06357	9 73 Ta	$L_I N_{VI,VII}$	11.6570
1.0226	1 94 Pu	$L_I$	$L_{II}M_I$	12.124	1.0644	2 82 Pb	$L_{II}M_{II}$	11.648
1.02467	5 74 W	$L_I$	Abs. Edge	12.0996	1.0644	2 81 Tl	$L_I M_I$	11.648
1.0250	2 74 W		$L_I O_{IV,V}$	12.095	1.06467	3 73 Ta	$L\gamma_4$ $L_I O_{III}$	11.6451
1.02503	5 76 Os	$L\gamma_1$	$L_{II}N_{IV}$	12.0953	1.0649	2 80 Hg	$L_{III}N_{II}$	11.642
1.02613	7 75 Re	$L\gamma_3$	$L_{II}N_{III}$	12.0824	1.06544	3 73 Ta	$L\gamma_4'$ $L_I O_{II}$	11.6366
1.02775	3 74 W	$L\gamma_4$	$L_I O_{III}$	12.0634	1.06712	2 92 U	$L_I$ $L_{III}M_I$	11.6183
1.02789	7 79 Au	$L\beta_{10}$	$L_{II}M_{IV}$	12.0617	1.06771	9 73 Ta	$L_I O_I$	11.6118
1.0286	1 81 Tl		$L_{III}N_{III}$	12.053	1.06785	9 79 Au	$L\beta_3$ $L_{II}M_{III}$	11.6103
1.02863	3 74 W	$L\gamma_4'$	$L_I O_{II}$	12.0530	1.06806	3 74 W	$L\gamma_2$ $L_{II}N_{II}$	11.6080
1.03049	5 87 Fr	$L\alpha_1$	$L_{III}M_V$	12.0313	1.06899	5 86 Rn	$L\alpha_2$ $L_{III}M_{IV}$	11.5979
1.0317	3 74 W		$L_I O_I$	12.017	1.07022	3 79 Au	$L\beta_2$ $L_{III}N_V$	11.5847
1.03233	5 75 Re	$L\gamma_2$	$L_{II}N_{II}$	12.0098	1.07188	5 79 Au	$L\beta_{15}$ $L_{III}N_{IV}$	11.5667
1.0323	2 82 Pb		$L_{II}M_I$	12.010	1.07222	7 80 Hg	$L\beta_4$ $L_{II}M_{II}$	11.5630
1.03358	7 80 Hg	$L\beta_3$	$L_{II}M_{III}$	11.9953	1.0723	1 78 Pt	$L_{III}$ Abs. Edge	11.562
1.0346	9 83 Bi		$L_{II}M_{II}$	11.98	1.0724	2 78 Pt	$L\beta_6$ $L_{III}O_{IV,V}$	11.561
1.0347	1 92 U	$L_I$	$L_{III}M_{II}$	11.982	1.07448	5 74 W	$L\gamma_6$ $L_{II}O_{IV}$	11.5387
1.03699	9 75 Re	$L\gamma_6$	$L_{II}O_{IV}$	11.956	1.0745	1 74 W	$L_{II}$ Abs. Edge	11.538
1.0371	1 75 Re	$L_{II}$	Abs. Edge	11.954	1.0756	2 79 Au	$L_{II}M_V$	11.526
1.03876	7 79 Au		$L_{III}P_{II,III}$	11.9355	1.0761	3 78 Pt	$L_{III}O_{II,III}$	11.521
1.03918	3 81 Tl	$L\beta_4$	$L_{II}M_{II}$	11.9306	1.0767	1 75 Re	$L_{II}N_{III}$	11.515
1.0397	1 75 Re		$L_{II}O_{III}$	11.925	1.0771	1 74 W	$L\nu$ $L_{II}N_{VI}$	11.510
1.03973	5 76 Os		$L_{II}N_{III}$	11.9243	1.07896	5 78 Pt	$L\mu$ $L_{III}N_{VI,VII}$	11.4908
1.03974	2 35 Br	$K\alpha_1$	$KL_{III}$	11.9242	1.0792	2 74 W	$L_{II}O_{III}$	11.488
1.03975	7 80 Hg	$L\beta_2$	$L_{III}N_V$	11.9241	1.07975	7 80 Hg	$L\beta_6$ $L_{III}N_I$	11.4824
1.04000	5 79 Au	$L_{III}$	Abs. Edge	11.9212	1.08009	9 90 Th	$L_I$ $L_{III}M_{II}$	11.4788
1.0404	1 75 Re	$L\nu$	$L_{II}N_{VI}$	11.917	1.08113	4 74 W	$L\gamma_8$ $L_{II}O_I$	11.4677
1.04044	3 79 Au	$L\beta_6$	$L_{III}O_{IV,V}$	11.9163	1.08168	3 78 Pt	$L\beta_7$ $L_{III}O_I$	11.4619
1.04151	7 80 Hg	$L\beta_{15}$	$L_{III}N_{IV}$	11.9040	1.08205	7 73 Ta	$L\gamma_{II}$ $L_{II}N_V$	11.4580
1.0420	1 75 Re		$L_{II}N_I$	11.899	1.08353	3 79 Au	$L\beta_1$ $L_{II}M_{IV}$	11.4423
1.04230	5 87 Fr	$L\alpha_2$	$L_{III}M_{IV}$	11.8950	1.08377	7 73 Ta	$L_{II}N_{IV}$	11.4398
1.0428	6 93 Np	$L_I$	$L_{III}M_I$	11.890	1.0839	1 75 Re	$L_{II}N_{II}$	11.438
1.04382	2 35 Br	$K\alpha_2$	$KL_{II}$	11.8776	1.08500	5 85 At	$L\alpha_1$ $L_{III}M_V$	11.4268
1.04398	5 75 Re	$L\gamma_8$	$L_{II}O_I$	11.8758	1.08975	5 77 Ir	$L\beta_9$ $L_{II}M_V$	11.3770
1.0450	2 79 Au		$L_{III}O_{II,III}$	11.865	1.09026	7 79 Au	$L_{III}N_{III}$	11.3717
1.0450	1 33 As	$K$	Abs. Edge	11.865	1.0908	1 91 Pa	$L_I$ $L_{III}M_I$	11.366

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.0916	5 80 Hg	$L\beta_{17}$	$L_{II}M_{III}$	11.358	1.13687	9 73 Ta	$L_{II}N_V$	10.9055	
1.09241	7 82 Pb	$L\eta$	$L_{II}M_I$	11.3493	1.13707	3 77 Ir	$L\beta_{18}$	10.9036	
1.09388	5 75 Re	$L\gamma_6$	$L_{II}N_I$	11.3341	1.13794	3 73 Ta	$L\gamma_1$	10.8952	
1.09671	5 85 At	$L\alpha_2$	$L_{III}M_{IV}$	11.3048	1.13841	5 72 Hf	$L\gamma_3$	10.8907	
1.09702	4 77 Ir	$L\beta_{10}$	$L_I M_{IV}$	11.3016	1.1387	5 80 Hg	$L_{II}M_{II}$	10.888	
1.09855	3 74 W	$L\gamma_1$	$L_{II}N_{IV}$	11.2859	1.1402	1 71 Lu	$L_I$	Abs. Edge	10.8740
1.09936	4 73 Ta	$L\gamma_3$	$L_I N_{III}$	11.2776	1.1405	1 76 Os	$L\beta_5$	$L_{III}O_{IV,V}$	10.8711
1.0997	1 81 Tl		$L_{II}M_{II}$	11.274	1.1408	1 76 Os	$L_{III}$	Abs. Edge	10.8683
1.0997	1 72 Hf	$L_I$	Abs. Edge	11.274	1.14085	3 77 Ir	$L\beta_3$	$L_I M_{III}$	10.8674
1.09968	7 79 Au		$L_{III}N_{II}$	11.2743	1.14223	5 78 Pt	$L\beta_4$	$L_I M_{II}$	10.8543
1.0999	2 80 Hg		$L_I M_I$	11.272	1.1435	1 71 Lu	$L\gamma_4$	$L_I O_{II,III}$	10.8425
1.10086	9 72 Hf		$L_I O_{IV}$	11.2622	1.14355	5 78 Pt	$L\beta_6$	$L_{III}N_I$	10.8418
1.10200	3 78 Pt	$L\beta_2$	$L_{III}N_V$	11.2505	1.14386	2 83 Bi	$L\alpha_1$	$L_{III}M_V$	10.8388
1.10303	5 72 Hf	$L\gamma_4$	$L_I O_{III}$	11.2401	1.14442	5 72 Hf	$L\gamma_2$	$L_I N_{II}$	10.8335
1.10376	5 72 Hf	$L\gamma_4'$	$L_I O_{II}$	11.2326	1.14537	7 76 Os	$L\mu$	$L_{III}N_{VI,VII}$	10.8245
1.10394	5 78 Pt	$L\beta_3$	$L_I M_{III}$	11.2308	1.1489	2 77 Ir		$L_{II}M_V$	10.791
1.10477	2 34 Se	$K\alpha_1$	$K L_{III}$	11.2224	1.14933	8 76 Os	$L\beta_7$	$L_{III}O_I$	10.7872
1.1053	1 73 Ta	$L\gamma_2$	$L_I N_{II}$	11.217	1.1548	1 72 Hf	$L_{II}$	Abs. Edge	10.7362
1.1058	1 77 Ir	$L_{III}$	Abs. Edge	11.212	1.15519	5 72 Hf	$L\gamma_6$	$L_{II}O_{IV}$	10.7325
1.10585	3 77 Ir	$L\beta_5$	$L_{III}O_{IV,V}$	11.2114	1.1553	1 73 Ta		$L_{II}N_{III}$	10.7316
1.10651	3 79 Au	$L\beta_4$	$L_I M_{II}$	11.2047	1.15536	1 83 Bi	$L\alpha_2$	$L_{III}M_{IV}$	10.73091
1.10664	9 72 Hf		$L_I O_I$	11.2034	1.1560	3 77 Ir		$L_{III}N_{III}$	10.725
1.10882	2 34 Se	$K\alpha_2$	$K L_{II}$	11.1814	1.15781	3 77 Ir	$L\beta_1$	$L_{II}M_{IV}$	10.7083
1.10923	6 77 Ir		$L_{III}O_{II,III}$	11.1772	1.15830	9 72 Hf	$L\nu$	$L_{II}N_{VI}$	10.7037
1.11092	3 79 Au	$L\beta_6$	$L_{III}N_I$	11.1602	1.1600	2 73 Ta		$L_{II}N_{II}$	10.688
1.11145	4 77 Ir	$L\mu$	$L_{III}N_{VI,VII}$	11.1549	1.16107	9 71 Lu	$L\gamma_{11}$	$L_I N_V$	10.6782
1.1129	2 78 Pt		$L_{II}M_V$	11.140	1.16138	5 72 Hf	$L\gamma_8$	$L_{II}O_I$	10.6754
1.1137	1 73 Ta	$L_{II}$	Abs. Edge	11.132	1.16227	9 71 Lu		$L_I N_{IV}$	10.6672
1.11386	4 84 Po	$L\alpha_1$	$L_{III}M_V$	11.1308	1.1640	1 80 Hg	$L\eta$	$L_{II}M_I$	10.6512
1.11388	3 73 Ta	$L\gamma_6$	$L_{II}O_{IV}$	11.1306	1.16487	4 75 Re	$L\beta_9$	$L_I M_V$	10.6433
1.11489	3 77 Ir	$L\beta_7$	$L_{III}O_I$	11.1205	1.16545	5 77 Ir		$L_{III}N_{II}$	10.6380
1.1149	2 74 W		$L_{II}N_{III}$	11.120	1.1667	1 78 Pt	$L\beta_{17}$	$L_{II}M_{III}$	10.6265
1.11508	4 90 Th	$L\zeta$	$L_{III}M_I$	11.1186	1.16719	5 88 Ra	$L\zeta$	$L_{III}M_I$	10.6222
1.11521	9 73 Ta		$L_I N_I$	11.1173	1.16962	9 78 Pt		$L_I M_I$	10.6001
1.1158	1 73 Ta	$L\nu$	$L_{II}N_{VI}$	11.1113	1.16979	8 76 Os	$L\beta_2$	$L_{III}N_V$	10.5985
1.11658	5 32 Ge	$K$	Abs. Edge	11.1036	1.1708	1 79 Au		$L_{II}M_{II}$	10.5892
1.11686	2 32 Ge	$K\beta_2$	$KN_{II,III}$	11.1008	1.17167	5 76 Os	$L\beta_{15}$	$L_{III}N_{IV}$	10.5816
1.11693	9 73 Ta		$L_{II}O_{III}$	11.1001	1.17218	5 75 Re	$L\beta_{10}$	$L_I M_{IV}$	10.5770
1.11789	9 73 Ta		$L_{II}O_{II}$	11.0907	1.1729	1 73 Ta	$L\gamma_5$	$L_{II}N_I$	10.5702
1.1195	1 32 Ge	$K\beta_5$	$KM_{IV,V}$	11.0745	1.17501	2 82 Pb	$L\alpha_1$	$L_{III}M_V$	10.5515
1.11990	2 78 Pt	$L\beta_1$	$L_{II}M_{IV}$	11.0707	1.17588	1 33 As	$K\alpha_1$	$K L_{III}$	10.54372
1.1205	1 73 Ta	$L\gamma_8$	$L_{II}O_I$	11.0646	1.17721	5 75 Re	$L\beta_6$	$L_{III}O_{IV,V}$	10.5318
1.12146	9 72 Hf	$L\gamma_{11}$	$L_I N_V$	11.0553	1.1773	1 75 Re	$L_{III}$	Abs. Edge	10.5306
1.1218	3 74 W		$L_{II}N_{II}$	11.052	1.17788	9 72 Hf		$L_{II}N_V$	10.5258
1.12250	9 72 Hf		$L_I N_{IV}$	11.0451	1.17796	3 77 Ir	$L\beta_6$	$L_{III}N_I$	10.5251
1.1226	2 78 Pt		$L_{III}N_{III}$	11.044	1.17900	5 72 Hf	$L\gamma_1$	$L_{II}N_{IV}$	10.5158
1.12548	5 84 Po	$L\alpha_2$	$L_{III}M_{IV}$	11.0158	1.17953	4 71 Lu	$L\gamma_3$	$L_I N_{III}$	10.5110
1.12637	6 76 Os	$L\beta_9$	$L_I M_V$	11.0071	1.17955	7 76 Os	$L\beta_3$	$L_I M_{III}$	10.5108
1.12769	3 81 Tl	$L\eta$	$L_{II}M_I$	10.9943	1.17958	3 77 Ir	$L\beta_4$	$L_I M_{II}$	10.5106
1.12798	5 79 Au	$L\beta_{17}$	$L_{II}M_{III}$	10.9915	1.17987	1 33 As	$K\alpha_2$	$K L_{II}$	10.50799
1.12894	2 32 Ge	$K\beta_1$	$KM_{III}$	10.9821	1.1815	1 75 Re	$L\mu$	$L_{III}N_{VI,VII}$	10.4931
1.12936	9 32 Ge	$K\beta_3$	$KM_{II}$	10.9780	1.1818	1 70 Yb	$L_I$	Abs. Edge	10.4904
1.1310	2 78 Pt		$L_{III}N_{II}$	10.962	1.1827	1 70 Yb		$L_I O_{IV,V}$	10.4833
1.13235	3 74 W	$L\gamma_5$	$L_{II}N_I$	10.9490	1.1853	1 70 Yb	$L\gamma_4$	$L_I O_{II,III}$	10.4603
1.13353	5 76 Os	$L\beta_{10}$	$L_I M_{IV}$	10.9376	1.1853	2 71 Lu	$L\gamma_2$	$L_I N_{II}$	10.460
1.13525	5 79 Au		$L_I M_I$	10.9210	1.18610	5 75 Re	$L\beta_7$	$L_{III}O_I$	10.4529
1.13532	3 77 Ir	$L\beta_2$	$L_{III}N_V$	10.9203	1.18648	5 82 Pb	$L\alpha_2$	$L_{III}M_{IV}$	10.4495



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV	
1.1886	1 70 Yb	$L_I O_I$	10.4312	1.254054	9 32 Ge	$K\alpha_1$	$KL_{III}$	9.88642
1.18977	7 76 Os	$L_{II} M_V$	10.4205	1.2553	1 73 Ta	$L_{III}$	Abs. Edge	9.8766
1.1958	1 31 Ga	$K$	10.3682	1.2555	1 73 Ta	$L\beta_5$	$L_{III} O_{IV,V}$	9.8750
1.19600	2 31 Ga	$K\beta_2$	10.3663	1.25778	4 73 Ta	$L\mu$	$L_{III} N_{VI,VII}$	9.8572
1.19727	7 76 Os	$L\beta_1$	10.3553	1.258011	9 32 Ge	$K\alpha_2$	$KL_{II}$	9.85532
1.1981	2 31 Ga	$K\beta_5$	10.348	1.25917	5 75 Re	$L\beta_4$	$L_I M_{II}$	9.8463
1.1985	1 71 Lu	$L_{II}$	10.3448	1.2596	1 71 Lu	$L\gamma_5$	$L_{II} N_I$	9.8428
1.1987	1 71 Lu	$L\gamma_6$	10.3431	1.2601	3 73 Ta		$L_{III} O_{II,III}$	9.839
1.20086	7 76 Os	$L_{III} N_{II}$	10.3244	1.26269	5 74 W	$L\beta_3$	$L_I M_{III}$	9.8188
1.2014	1 71 Lu	$L_{II} O_{II,III}$	10.3198	1.26385	5 73 Ta	$L\beta_7$	$L_{III} O_I$	9.8098
1.20273	3 79 Au	$L\eta$	10.3083	1.2672	2 74 W		$L_{III} N_{III}$	9.784
1.2047	1 71 Lu	$L\gamma_8$	10.2915	1.26769	5 70 Yb	$L\gamma_1$	$L_{II} N_{IV}$	9.7801
1.20479	7 74 W	$L\beta_9$	10.2907	1.2678	2 69 Tm	$L\gamma_3$	$L_I N_{III}$	9.779
1.20660	4 75 Re	$L\beta_2$	10.2752	1.2706	1 68 Er	$L_I$	Abs. Edge	9.7574
1.2069	2 77 Ir	$L\beta_{17}$	10.273	1.2728	2 74 W		$L_{II} M_V$	9.741
1.20739	4 81 Tl	$L\alpha_1$	10.2685	1.2742	2 69 Tm	$L\gamma_2$	$L_I N_{II}$	9.730
1.20789	2 31 Ga	$K\beta_1$	10.2642	1.2748	1 83 Bi	$L_I$	$L_{II} M_{II}$	9.7252
1.20819	5 75 Re	$L\beta_{15}$	10.2617	1.2752	2 68 Er	$L\gamma_4$	$L_I O_{II,III}$	9.722
1.20835	5 31 Ga	$K\beta_3$	10.2603	1.27640	3 79 Au	$L\alpha_1$	$L_{III} M_V$	9.7133
1.2102	2 77 Ir	$L_I M_I$	10.245	1.2765	2 74 W		$L_{III} N_{II}$	9.712
1.2105	1 83 Bi	$L_S$	10.2421	1.27807	5 81 Tl	$L_S$	$L_{III} M_{III}$	9.7007
1.21218	3 74 W	$L\beta_{10}$	10.2279	1.281809	9 74 W	$L\beta_1$	$L_{II} M_{IV}$	9.67235
1.213	1 78 Pt	$L_{II} M_{II}$	10.225	1.2829	5 84 Po	$L_I$	$L_{III} M_I$	9.664
1.21349	5 76 Os	$L\beta_6$	10.2169	1.2834	1 30 Zn	$K$	Abs. Edge	9.6607
1.21537	5 72 Hf	$L\gamma_5$	10.2011	1.28372	2 30 Zn	$K\beta_2$	$KN_{II,III}$	9.6580
1.21545	3 74 W	$L\beta_5$	10.2004	1.28448	3 77 Ir	$L\eta$	$L_I M_I$	9.6522
1.2155	1 74 W	$L_{III}$	10.1999	1.28454	2 73 Ta	$L\beta_2$	$L_{III} N_V$	9.6518
1.21844	5 76 Os	$L\beta_4$	10.1754	1.2848	1 30 Zn	$K\beta_5$	$KM_{IV,V}$	9.6501
1.21868	5 74 W	$L\mu$	10.1733	1.28619	5 73 Ta	$L\beta_{15}$	$L_{III} N_{IV}$	9.6394
1.21875	3 81 Tl	$L\alpha_2$	10.1728	1.28772	3 79 Au	$L\alpha_2$	$L_{III} M_{IV}$	9.6280
1.22031	5 75 Re	$L\beta_3$	10.1598	1.2892	1 69 Tm	$L_{II}$	Abs. Edge	9.6171
1.2211	2 74 W	$L_{III} O_{II,III}$	10.153	1.28989	7 74 W	$L\beta_5$	$L_{III} N_I$	9.6117
1.22228	4 71 Lu	$L\gamma_1$	10.1434	1.29025	9 72 Hf	$L\beta_9$	$L_I M_V$	9.6090
1.22232	5 70 Yb	$L\gamma_3$	10.1431	1.2905	2 69 Tm	$L\gamma_5$	$L_{II} O_{IV}$	9.607
1.22400	4 74 W	$L\beta_7$	10.1292	1.2927	1 75 Re	$L\beta_{17}$	$L_{II} M_{II}$	9.5910
1.2250	1 69 Tm	$L_I$	10.1206	1.2934	2 76 Os		$L_{II} M_{II}$	9.586
1.2263	3 69 Tm	$L_I O_{IV,V}$	10.110	1.29525	2 30 Zn	$K\beta_{1,3}$	$KM_{II,III}$	9.5720
1.2283	1 75 Re	$L_{III} N_{III}$	10.0933	1.2972	1 72 Hf	$L_{III}$	Abs. Edge	9.5577
1.22879	7 70 Yb	$L\gamma_2$	10.0897	1.29761	5 72 Hf	$L\beta_5$	$L_{III} O_{IV,V}$	9.5546
1.2294	2 69 Tm	$L\gamma_4$	10.084	1.29819	9 72 Hf	$L\beta_{10}$	$L_I M_{IV}$	9.5503
1.2305	1 75 Re	$L_{II} M_V$	10.0753	1.30162	5 74 W	$L\beta_4$	$L_I M_{II}$	9.5252
1.23858	2 75 Re	$L\beta_1$	10.0100	1.30165	9 72 Hf	$L\mu$	$L_{III} N_{VI,VII}$	9.5249
1.24120	5 80 Hg	$L\alpha_1$	9.9888	1.30564	5 72 Hf	$L\beta_7$	$L_{III} O_I$	9.4958
1.24271	3 70 Yb	$L\gamma_6$	9.9766	1.3063	1 70 Yb	$L\gamma_5$	$L_{II} N_I$	9.4910
1.2428	1 70 Yb	$L_{II}$	9.9761	1.30678	3 73 Ta	$L\beta_3$	$L_I M_{III}$	9.4875
1.2429	2 78 Pt	$L\eta$	9.975	1.30767	7 82 Pb	$L_I$	$L_{III} M_{II}$	9.4811
1.24385	7 82 Pb	$L_S$	9.9675	1.3086	1 73 Ta		$L_{III} N_{III}$	9.4742
1.24460	3 74 W	$L\beta_2$	9.9615	1.3112	2 80 Hg	$L_S$	$L_{III} M_{III}$	9.455
1.2453	1 70 Yb	$L_{II} O_{II,III}$	9.9561	1.31304	3 78 Pt	$L\alpha_1$	$L_{III} M_V$	9.4423
1.24631	3 74 W	$L\beta_{15}$	9.9478	1.3146	1 68 Er	$L\gamma_3$	$L_I N_{III}$	9.4309
1.2466	2 73 Ta	$L\beta_9$	9.946	1.3153	2 69 Tm	$L\gamma_1$	$L_{II} N_{IV}$	9.426
1.2480	2 76 Os	$L\beta_{17}$	9.934	1.31610	7 83 Bi	$L_I$	$L_{II} M_I$	9.4204
1.24923	5 70 Yb	$L\gamma_8$	9.9246	1.3167	1 73 Ta		$L_{III} N_{II}$	9.4158
1.2502	3 77 Ir	$L_{II} M_{II}$	9.917	1.31897	9 73 Ta		$L_{II} M_V$	9.3998
1.25100	5 75 Re	$L\beta_6$	9.9105	1.3190	1 67 Ho	$L_I$	Abs. Edge	9.3994
1.25264	7 80 Hg	$L\alpha_2$	9.8976	1.3208	3 67 Ho		$L_I O_{IV,V}$	9.387
1.2537	2 73 Ta	$L\beta_{10}$	9.889	1.3210	2 68 Er	$L\gamma_2$	$L_I N_{II}$	9.385

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.3225	2 67 Ho	$L\gamma_4$	$L_{II}O_{II,III}$	9.374	1.3948	1 70 Yb	$L\beta_7$	$L_{III}O_I$	8.8889
1.32432	2 78 Pt	$L\alpha_2$	$L_{III}M_{IV}$	9.3618	1.3983	2 67 Ho	$L\gamma_8$	$L_{II}O_I$	8.867
1.32639	5 72 Hf	$L\beta_2$	$L_{III}N_V$	9.3473	1.40140	5 71 Lu	$L\beta_8$	$L_{II}M_{III}$	8.8469
1.32698	3 73 Ta	$L\beta_1$	$L_{II}M_{IV}$	9.3431	1.40234	5 76 Os	$L\alpha_2$	$L_{III}M_{IV}$	8.8410
1.32783	5 72 Hf	$L\beta_{15}$	$L_{III}N_{IV}$	9.3371	1.4067	3 68 Er	$L\gamma_5$	$L_{II}N_I$	8.814
1.32785	7 76 Os	$L\eta$	$L_{II}M_I$	9.3370	1.41366	7 79 Au	$Lt$	$L_{II}M_{II}$	8.7702
1.33094	8 73 Ta	$L\beta_6$	$L_{III}N_I$	9.3153	1.41550	5 70 Yb	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	8.7588
1.3358	1 71 Lu	$L\beta_9$	$L_{II}M_V$	9.2816	1.41640	7 66 Dy	$L\gamma_3$	$L_{II}N_{III}$	8.7532
1.3365	3 74 W		$L_{II}M_I$	9.277	1.4174	2 67 Ho	$L\gamma_1$	$L_{II}N_{IV}$	8.747
1.3366	1 75 Re		$L_{II}M_{II}$	9.2761	1.4189	1 71 Lu	$L\beta_5$	$L_{II}N_I$	8.7376
1.3386	1 68 Er	$L_{II}$	Abs. Edge	9.2622	1.42110	3 74 W	$L\eta$	$L_{II}M_I$	8.7243
1.3387	2 74 W	$L\beta_{17}$	$L_{II}M_{III}$	9.261	1.4216	1 80 Hg	$Ll$	$L_{II}M_I$	8.7210
1.3397	3 68 Er	$L\gamma_6$	$L_{II}O_{IV}$	9.255	1.4223	1 65 Tb	$L_I$	Abs. Edge	8.7167
1.340083	9 31 Ga	$K\alpha_1$	$KL_{III}$	9.25174	1.42278	7 66 Dy	$L\gamma_2$	$L_{II}N_{II}$	8.7140
1.3405	1 71 Lu	$L_{III}$	Abs. Edge	9.2490	1.4228	3 65 Tb		$L_{III}O_{IV,v}$	8.714
1.34154	5 81 Tl	$Lt$	$L_{III}M_{II}$	9.2417	1.42359	3 71 Lu	$L\beta_1$	$L_{II}M_{IV}$	8.7090
1.34183	7 71 Lu	$L\beta_5$	$L_{III}O_{IV,v}$	9.2397	1.4276	2 65 Tb	$L\gamma_4$	$L_{II}O_{II,III}$	8.685
1.3430	2 71 Lu	$L\beta_{10}$	$L_{II}M_{IV}$	9.232	1.43025	9 72 Hf		$L_{II}M_I$	8.6685
1.34399	1 31 Ga	$K\alpha_2$	$KL_{II}$	9.22482	1.43048	9 73 Ta		$L_{II}M_{II}$	8.6671
1.34524	9 71 Lu		$L_{III}O_{II,III}$	9.2163	1.4318	2 77 Ir	$Ls$	$L_{III}M_{III}$	8.659
1.34581	3 73 Ta	$L\beta_4$	$L_{II}M_{II}$	9.2124	1.43290	4 75 Re	$L\alpha_1$	$L_{III}M_V$	8.6525
1.34949	5 71 Lu	$L\beta_7$	$L_{III}O_I$	9.1873	1.4334	1 69 Tm	$L_{III}$	Abs. Edge	8.6496
1.34990	7 82 Pb	$Ll$	$L_{III}M_I$	9.1845	1.4336	3 69 Tm	$L\beta_9$	$L_{II}M_V$	8.648
1.35053	9 72 Hf		$L_{III}N_{III}$	9.1802	1.4349	2 69 Tm	$L\beta_5$	$L_{III}O_{IV,v}$	8.641
1.35128	3 77 Ir	$L\alpha_1$	$L_{III}M_V$	9.1751	1.435155	7 30 Zn	$K\alpha_1$	$KL_{III}$	8.63886
1.35131	7 79 Au	$Ls$	$L_{III}M_{III}$	9.1749	1.43643	9 72 Hf	$L\beta_{17}$	$L_{II}M_{III}$	8.6312
1.35300	5 72 Hf	$L\beta_3$	$L_{II}M_{III}$	9.1634	1.439000	8 30 Zn	$K\alpha_2$	$KL_{II}$	8.61578
1.3558	2 69 Tm	$L\gamma_5$	$L_{II}N_I$	9.144	1.44056	5 71 Lu	$L\beta_4$	$L_{II}M_{II}$	8.6064
1.35887	9 72 Hf		$L_{III}N_{II}$	9.1239	1.4410	3 69 Tm	$L\beta_{10}$	$L_{II}M_{IV}$	8.604
1.36250	5 77 Ir	$L\alpha_2$	$L_{III}M_{IV}$	9.0995	1.44396	5 75 Re	$L\alpha_2$	$L_{III}M_{IV}$	8.5862
1.3641	2 68 Er	$L\gamma_1$	$L_{II}N_{IV}$	9.089	1.4445	1 66 Dy	$L_{II}$	Abs. Edge	8.5830
1.3643	2 67 Ho	$L\gamma_3$	$L_{II}N_{III}$	9.087	1.44579	7 66 Dy	$L\gamma_6$	$L_{II}O_{IV}$	8.5753
1.3692	1 66 Dy	$L_I$	Abs. Edge	9.0548	1.45233	5 70 Yb	$L\beta_3$	$L_{II}M_{III}$	8.5367
1.3698	2 67 Ho	$L\gamma_2$	$L_{II}N_{II}$	9.051	1.4530	2 78 Pt	$Lt$	$L_{III}M_{II}$	8.533
1.37012	3 71 Lu	$L\beta_2$	$L_{III}N_V$	9.0489	1.45964	9 79 Au	$Ll$	$L_{III}M_I$	8.4939
1.3715	1 71 Lu	$L\beta_{15}$	$L_{III}N_{IV}$	9.0395	1.4618	2 67 Ho	$L\gamma_5$	$L_{II}N_I$	8.481
1.37342	5 75 Re	$L\eta$	$L_{II}M_I$	9.0272	1.4640	2 69 Tm	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	8.468
1.37410	5 72 Hf	$L\beta_1$	$L_{II}M_{IV}$	9.0227	1.4661	1 70 Yb	$L\beta_5$	$L_{III}N_I$	8.4563
1.37410	5 72 Hf	$L\beta_6$	$L_{III}N_I$	9.0227	1.47106	5 73 Ta	$L\eta$	$L_{II}M_I$	8.4280
1.37459	7 66 Dy	$L\gamma_4$	$L_{II}O_{II,III}$	9.0195	1.4718	2 65 Tb	$L\gamma_3$	$L_{II}N_{III}$	8.423
1.3746	2 80 Hg	$Lt$	$L_{III}M_{II}$	9.019	1.47266	7 66 Dy	$L\gamma_1$	$L_{II}N_{IV}$	8.4188
1.38059	5 29 Cu	$K$	Abs. Edge	8.9803	1.4735	2 76 Os	$Ls$	$L_{III}M_{III}$	8.414
1.38109	3 29 Cu	$K\beta_2$	$KM_{IV,v}$	8.9770	1.47565	5 70 Yb	$L\beta_1$	$L_{II}M_{IV}$	8.4018
1.3838	1 70 Yb	$L\beta_9$	$L_{II}M_V$	8.9597	1.4764	2 65 Tb	$L\gamma_2$	$L_{II}N_{II}$	8.398
1.38477	3 81 Tl	$Ll$	$L_{III}M_I$	8.9532	1.47639	2 74 W	$L\alpha_1$	$L_{III}M_V$	8.3976
1.3862	1 70 Yb	$L_{III}$	Abs. Edge	8.9441	1.4784	1 64 Gd	$L_I$	Abs. Edge	8.3864
1.3864	1 73 Ta	$L\beta_{17}$	$L_{II}M_{III}$	8.9428	1.48064	9 72 Hf		$L_{II}M_{II}$	8.3735
1.38696	7 70 Yb	$L\beta_5$	$L_{III}O_{IV,v}$	8.9390	1.4807	3 64 Gd		$L_{II}O_{IV,v}$	8.373
1.3895	2 78 Pt	$Ls$	$L_{III}M_{III}$	8.923	1.4835	1 68 Er	$L_{III}$	Abs. Edge	8.3575
1.3898	1 70 Yb		$L_{III}O_{II,III}$	8.9209	1.4839	2 64 Gd	$L\gamma_4$	$L_{II}O_{II,III}$	8.355
1.3905	1 67 Ho	$L_{II}$	Abs. Edge	8.9164	1.4848	3 68 Er	$L\beta_5$	$L_{III}O_{IV,v}$	8.350
1.39121	5 76 Os	$L\alpha_1$	$L_{III}M_V$	8.9117	1.4855	5 68 Er	$L\beta_9$	$L_{II}M_V$	8.346
1.3915	1 70 Yb	$L\beta_{10}$	$L_{II}M_{IV}$	8.9100	1.48743	2 74 W	$L\alpha_2$	$L_{III}M_{IV}$	8.3352
1.39220	5 72 Hf	$L\beta_4$	$L_{II}M_{II}$	8.9054	1.48807	1 28 Ni	$K$	Abs. Edge	8.33165
1.392218	9 29 Cu	$K\beta_{1,3}$	$KM_{II,III}$	8.90529	1.48862	4 28 Ni	$K\beta_5$	$KM_{IV,v}$	8.3286
1.3923	2 67 Ho	$L\gamma_8$	$L_{II}O_{IV}$	8.905	1.49138	3 70 Yb	$L\beta_4$	$L_{II}M_{II}$	8.3132
1.3926	1 29 Cu	$K\beta_2$	$KM_{II}$	8.9029	1.4930	3 77 Ir	$Lt$	$L_{III}M_{II}$	8.304



X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.4941	3 68 Er	$L\beta_7$	$L_{III}O_I$	8.298	1.60891	3 27 Co	$K\beta_8$	$KM_{IV,V}$	7.7059
1.4941	3 68 Er	$L\beta_{10}$	$L_{I}M_{IV}$	8.298	1.61264	9 73 Ta	$L_s$	$L_{III}M_{III}$	7.6881
1.4995	2 78 Pt	$L_I$	$L_{III}M_I$	8.268	1.61951	3 71 Lu	$L\alpha_1$	$L_{II}M_V$	7.6555
1.500135	8 28 Ni	$K\beta_{1,s}$	$KM_{II,III}$	8.26466	1.6203	2 67 Ho	$L\beta_3$	$L_I M_{III}$	7.6519
1.5023	1 65 Tb	$L_{II}$	Abs. Edge	8.2527	1.62079	2 27 Co	$K\beta_{1,s}$	$KM_{II,III}$	7.64943
1.5035	2 65 Tb	$L\gamma_6$	$L_{II}O_{IV}$	8.246	1.6237	2 67 Ho	$L\beta_8$	$L_{III}N_I$	7.6359
1.5063	2 69 Tm	$L\beta_8$	$L_I M_{III}$	8.231	1.62369	7 66 Dy	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.6357
1.5097	2 65 Tb	$L\gamma_8$	$L_{II}O_I$	8.212	1.6244	3 74 W	$L_I$	$L_{III}M_{IV}$	7.6324
1.51399	9 68 Er	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	8.1890	1.6271	1 63 Eu	$L_{II}$	Abs. Edge	7.6199
1.5162	2 69 Tm	$L\beta_6$	$L_{III}N_I$	8.177	1.6282	2 63 Eu	$L\gamma_6$	$L_{II}O_{IV}$	7.6147
1.5178	1 75 Re	$L_s$	$L_{III}M_{III}$	8.1682	1.63029	5 71 Lu	$L\alpha_2$	$L_{III}M_{IV}$	7.6049
1.51824	7 66 Dy	$L\gamma_6$	$L_{II}N_I$	8.1661	1.63056	5 75 Re	$L_I$	$L_{III}M_I$	7.6036
1.52197	2 73 Ta	$L\alpha_1$	$L_{III}M_V$	8.1461	1.6346	2 63 Eu	$L\gamma_8$	$L_{II}O_I$	7.5849
1.52325	5 72 Hf	$L_\eta$	$L_{II}M_I$	8.1393	1.63560	5 70 Yb	$L_\eta$	$L_{II}M_I$	7.5802
1.5297	2 64 Gd	$L\gamma_8$	$L_I N_{III}$	8.105	1.6412	2 64 Gd	$L\gamma_6$	$L_{II}N_I$	7.5543
1.5303	2 65 Tb	$L\gamma_1$	$L_{II}N_{IV}$	8.102	1.6475	2 67 Ho	$L\beta_1$	$L_{II}M_{IV}$	7.5253
1.5304	2 69 Tm	$L\beta_1$	$L_{II}M_{IV}$	8.101	1.6497	1 65 Tb	$L_{III}$	Abs. Edge	7.5153
1.53293	2 73 Ta	$L\alpha_2$	$L_{III}M_{IV}$	8.0879	1.6510	2 65 Tb	$L\beta_6$	$L_{III}O_{IV,V}$	7.5094
1.5331	2 64 Gd	$L\gamma_2$	$L_I N_{II}$	8.087	1.65601	3 62 Sm	$L\gamma_8$	$L_I N_{II}$	7.487
1.53333	9 71 Lu	$L_I$	$L_{II}M_{II}$	8.0858	1.6574	2 63 Eu	$L\gamma_1$	$L_{II}N_{IV}$	7.4803
1.5347	2 76 Os	$L_I$	$L_{III}M_{II}$	8.079	1.657910	8 28 Ni	$K\alpha_1$	$KL_{III}$	7.47815
1.5368	1 67 Ho	$L_{III}$	Abs. Edge	8.0676	1.6585	2 65 Tb	$L\beta_7$	$L_{III}O_I$	7.4753
1.5378	2 67 Ho	$L\beta_6$	$L_{III}O_{IV,V}$	8.062	1.6595	2 67 Ho	$L\beta_4$	$L_I M_{II}$	7.4708
1.5381	1 63 Eu	$L_I$	Abs. Edge	8.0607	1.66044	6 62 Sm	$L\gamma_2$	$L_I N_{II}$	7.467
1.540562	2 29 Cu	$K\alpha_1$	$KL_{III}$	8.04778	1.661747	8 28 Ni	$K\alpha_2$	$KL_{II}$	7.46089
1.54094	3 77 Ir	$L_I$	$L_{III}M_I$	8.0458	1.66346	9 72 Hf	$L_s$	$L_{III}M_{III}$	7.4532
1.5439	1 63 Eu	$L\gamma_4$	$L_I O_{II,III}$	8.0304	1.6673	3 65 Tb	$L\beta_{10}$	$L_I M_{IV}$	7.436
1.544390	9 29 Cu	$K\alpha_2$	$KL_{II}$	8.02783	1.6674	5 61 Pm	$L_I$	Abs. Edge	7.436
1.5448	2 69 Tm	$L\beta_4$	$L_I M_{II}$	8.026	1.67189	4 70 Yb	$L\alpha_1$	$L_{III}M_V$	7.4156
1.5486	3 67 Ho	$L\beta_{10}$	$L_I M_{IV}$	8.006	1.67265	9 73 Ta	$L_I$	$L_{III}M_{II}$	7.4123
1.5616	1 68 Er	$L\beta_3$	$L_I M_{III}$	7.9392	1.6782	1 74 W	$L_I$	$L_{III}M_I$	7.3878
1.5632	1 64 Gd	$L_{II}$	Abs. Edge	7.9310	1.68213	7 66 Dy	$L\beta_6$	$L_{III}N_I$	7.3705
1.5642	3 74 W	$L_s$	$L_{III}M_{III}$	7.926	1.6822	2 66 Dy	$L\beta_8$	$L_I M_{III}$	7.3702
1.5644	2 64 Gd	$L\gamma_6$	$L_{II}O_{IV}$	7.925	1.68285	5 70 Yb	$L\alpha_2$	$L_{III}M_{IV}$	7.3673
1.5671	2 67 Ho	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.911	1.6830	2 65 Tb	$L\beta_{2,15}$	$L_{III}N_{I,V}$	7.3667
1.5675	2 68 Er	$L\beta_6$	$L_{III}N_I$	7.909	1.6953	1 62 Sm	$L_{II}$	Abs. Edge	7.3132
1.56958	5 72 Hf	$L\alpha_1$	$L_{III}M_V$	7.8990	1.6963	2 69 Tm	$L_\eta$	$L_{II}M_I$	7.3088
1.5707	2 64 Gd	$L\gamma_8$	$L_{II}O_I$	7.894	1.6966	9 62 Sm	$L\gamma_6$	$L_{II}O_{IV}$	7.308
1.5779	1 71 Lu	$L_\eta$	$L_{II}M_I$	7.8575	1.7085	2 63 Eu	$L\gamma_6$	$L_{II}N_I$	7.2566
1.5787	2 65 Tb	$L\gamma_8$	$L_{II}N_I$	7.8535	1.71062	7 66 Dy	$L\beta_1$	$L_{II}M_{IV}$	7.2477
1.5789	1 75 Re	$L_I$	$L_{III}M_{II}$	7.8525	1.7117	1 64 Gd	$L_{III}$	Abs. Edge	7.2430
1.58046	5 72 Hf	$L\alpha_2$	$L_{III}M_{IV}$	7.8446	1.7130	2 64 Gd	$L\beta_6$	$L_{III}O_{IV,V}$	7.2374
1.58498	7 76 Os	$L_I$	$L_{III}M_I$	7.8222	1.7203	2 64 Gd	$L\beta_7$	$L_{III}O_I$	7.2071
1.5873	1 68 Er	$L\beta_1$	$L_{II}M_{IV}$	7.8109	1.72103	7 66 Dy	$L\beta_4$	$L_I M_{II}$	7.2039
1.58837	7 66 Dy	$L\beta_5$	$L_{III}O_{IV,V}$	7.8055	1.72305	9 72 Hf	$L_I$	$L_{III}M_{II}$	7.1954
1.58844	9 70 Yb		$L_{II}M_{II}$	7.8052	1.7240	3 64 Gd	$L\beta_9$	$L_I M_V$	7.192
1.5903	2 63 Eu	$L\gamma_3$	$L_I N_{III}$	7.7961	1.72724	3 62 Sm	$L\gamma_1$	$L_{II}N_{IV}$	7.178
1.5916	1 66 Dy	$L_{III}$	Abs. Edge	7.7897	1.7268	2 69 Tm	$L\alpha_1$	$L_{III}M_V$	7.1799
1.5924	2 64 Gd	$L\gamma_1$	$L_I N_{IV}$	7.7858	1.72841	5 73 Ta	$L_I$	$L_{III}M_I$	7.1731
1.5961	2 63 Eu	$L\gamma_2$	$L_I N_{II}$	7.7677	1.7315	3 64 Gd	$L\beta_{10}$	$L_I M_{IV}$	7.160
1.59973	9 66 Dy	$L\beta_9$	$L_I M_V$	7.7501	1.7381	2 69 Tm	$L\alpha_2$	$L_{III}M_{IV}$	7.1331
1.6002	1 62 Sm	$L_I$	Abs. Edge	7.7478	1.7390	1 60 Nd	$L_I$	Abs. Edge	7.1294
1.6007	1 68 Er	$L\beta_4$	$L_I M_{II}$	7.7453	1.7422	2 65 Tb	$L\beta_6$	$L_{III}N_I$	7.1163
1.60447	7 66 Dy	$L\beta_7$	$L_{III}O_I$	7.7272	1.74346	1 26 Fe	$K$	Abs. Edge	7.11120
1.60728	3 62 Sm	$L\gamma_4$	$L_I O_{II,III}$	7.714	1.7442	1 26 Fe	$K\beta_6$	$KM_{IV,V}$	7.1081
1.60743	9 66 Dy	$L\beta_{10}$	$L_I M_{IV}$	7.7130	1.7445	4 60 Nd	$L\gamma_4$	$L_I O_{II,III}$	7.107
1.60815	1 27 Co	$K$	Abs. Edge	7.70954	1.7455	2 64 Gd	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	7.1028

X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
1.7472	2 65 Tb	$L\beta_4$	$L_{II}M_{III}$	7.0959	1.9255	2 63 Eu	$L\beta_4$	$L_{II}M_{II}$	6.4389
1.75661	2 26 Fe	$K\beta_{1,2}$	$KM_{II,III}$	7.05798	1.9255	5 59 Pr	$L_{II}$	Abs. Edge	6.439
1.7566	1 68 Er	$L\eta$	$L_{II}M_I$	7.0579	1.9355	4 60 Nd	$L\gamma_5$	$L_{II}N_I$	6.406
1.7676	5 61 Pm	$L_{II}$	Abs. Edge	7.014	1.936042	9 26 Fe	$K\alpha_1$	$KL_{II}$	6.40384
1.7760	1 71 Lu	$L\zeta$	$L_{III}M_{II}$	6.9810	1.9362	4 59 Pr	$L\gamma_8$	$L_{II}O_I$	6.403
1.7761	1 63 Eu	$L_{III}$	Abs. Edge	6.9806	1.939980	9 26 Fe	$K\alpha_2$	$KL_{II}$	6.39084
1.7768	3 65 Tb	$L\beta_1$	$L_{II}M_{IV}$	6.978	1.94643	3 62 Sm	$L\beta_6$	$L_{III}N_I$	6.3693
1.7772	2 63 Eu	$L\beta_5$	$L_{III}O_{IV,V}$	6.9763	1.9550	2 69 Tm	$L\zeta$	$L_{III}M_I$	6.3419
1.77934	3 62 Sm	$L\gamma_6$	$L_{II}N_I$	6.968	1.9553	3 58 Ce	$L\gamma_3$	$L_I N_{III}$	6.3409
1.78145	5 72 Hf	$L\zeta$	$L_{III}M_I$	6.9596	1.9559	6 61 Pm	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	6.339
1.78425	9 68 Er	$L\alpha_1$	$L_{III}M_V$	6.9487	1.9602	3 58 Ce	$L\gamma_2$	$L_I N_{II}$	6.3250
1.7851	2 63 Eu	$L\beta_7$	$L_{III}O_I$	6.9453	1.9611	3 59 Pr	$L\gamma_1$	$L_{II}N_{IV}$	6.3221
1.7864	2 65 Tb	$L\beta_4$	$L_I M_{II}$	6.9403	1.96241	3 62 Sm	$L\beta_3$	$L_I M_{III}$	6.318
1.788965	9 27 Co	$K\alpha_1$	$KL_{III}$	6.93032	1.9730	2 65 Tb	$L\eta$	$L_{II}M_I$	6.2839
1.7916	3 63 Eu	$L\beta_9$	$L_I M_V$	6.920	1.9765	2 65 Tb	$L\alpha_1$	$L_{III}M_V$	6.2728
1.792850	9 27 Co	$K\alpha_2$	$KL_{II}$	6.91530	1.9780	5 57 La	$L_I$	Abs. Edge	6.268
1.7955	2 68 Er	$L\alpha_2$	$L_{III}M_{IV}$	6.9050	1.9830	4 57 La	$L\gamma_4$	$L_I O_{II,III}$	6.252
1.7964	4 60 Nd	$L\gamma_3$	$L_I N_{III}$	6.902	1.9875	2 65 Tb	$L\alpha_2$	$L_{III}M_{IV}$	6.2380
1.7989	9 61 Pm	$L\gamma_1$	$L_{II}N_{IV}$	6.892	1.9967	1 60 Nd	$L_{III}$	Abs. Edge	6.2092
1.7993	3 63 Eu	$L\beta_{10}$	$L_I M_{IV}$	6.890	1.99806	3 62 Sm	$L\beta_1$	$L_{II}M_{IV}$	6.2051
1.8013	4 60 Nd	$L\gamma_2$	$L_I N_{II}$	6.883	2.00095	6 62 Sm	$L\beta_4$	$L_I M_{II}$	6.196
1.8054	2 64 Gd	$L\beta_6$	$L_{III}N_I$	6.8671	2.0092	3 60 Nd	$L\beta_7$	$L_{III}O_I$	6.1708
1.8118	2 63 Eu	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	6.8432	2.0124	5 58 Ce	$L_{II}$	Abs. Edge	6.161
1.8141	5 59 Pr	$L_I$	Abs. Edge	6.834	2.015	1 68 Er	$L\zeta$	$L_{III}M_I$	6.152
1.8150	2 64 Gd	$L\beta_3$	$L_I M_{III}$	6.8311	2.0165	3 60 Nd	$L\beta_9$	$L_I M_V$	6.1484
1.8193	4 59 Pr	$L\gamma_4$	$L_I O_{II,III}$	6.815	2.0205	4 59 Pr	$L\gamma_5$	$L_{II}N_I$	6.136
1.8264	2 67 Ho	$L\eta$	$L_{II}M_I$	6.7883	2.0237	4 58 Ce	$L\gamma_8$	$L_{II}O_I$	6.126
1.83091	9 70 Yb	$L\zeta$	$L_{III}M_{II}$	6.7715	2.0237	3 60 Nd	$L\beta_{10}$	$L_I M_{IV}$	6.1265
1.8360	1 71 Lu	$L\zeta$	$L_{III}M_I$	6.7528	2.0360	3 60 Nd	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	6.0894
1.8440	1 60 Nd	$L_{II}$	Abs. Edge	6.7234	2.0410	4 57 La	$L\gamma_3$	$L_I N_{III}$	6.074
1.8450	2 67 Ho	$L\alpha_1$	$L_{III}M_V$	6.7198	2.0421	4 61 Pm	$L\beta_3$	$L_I M_{III}$	6.071
1.8457	1 62 Sm	$L_{III}$	Abs. Edge	6.7172	2.0460	4 57 La	$L\gamma_2$	$L_I N_{II}$	6.060
1.8468	2 64 Gd	$L\beta_1$	$L_{II}M_{IV}$	6.7132	2.0468	2 64 Gd	$L\alpha_1$	$L_{III}M_V$	6.0572
1.84700	9 62 Sm	$L\beta_6$	$L_{III}O_{IV,V}$	6.7126	2.0487	4 58 Ce	$L\gamma_1$	$L_{II}N_{IV}$	6.052
1.8540	2 64 Gd	$L\beta_4$	$L_I M_{II}$	6.6871	2.0494	1 64 Gd	$L\eta$	$L_{II}M_I$	6.0495
1.8552	5 60 Nd	$L\gamma_8$	$L_{II}O_I$	6.683	2.0578	2 64 Gd	$L\alpha_2$	$L_{III}M_{IV}$	6.0250
1.8561	2 67 Ho	$L\alpha_2$	$L_{III}M_{IV}$	6.6795	2.0678	5 56 Ba	$L_I$	Abs. Edge	5.996
1.85626	3 62 Sm	$L\beta_7$	$L_{III}O_I$	6.679	2.07020	5 24 Cr	$K$	Abs. Edge	5.9888
1.86166	3 62 Sm	$L\beta_9$	$L_I M_V$	6.660	2.07087	6 24 Cr	$K\beta_5$	$KM_{IV,V}$	5.9869
1.86990	3 62 Sm	$L\beta_{10}$	$L_I M_{IV}$	6.634	2.0756	3 56 Ba	$L\gamma_4$	$L_I O_{II,III}$	5.9733
1.8737	2 63 Eu	$L\beta_6$	$L_{III}N_I$	6.6170	2.0791	5 59 Pr	$L_{III}$	Abs. Edge	5.963
1.8740	4 59 Pr	$L\gamma_3$	$L_I N_{III}$	6.616	2.0797	4 61 Pm	$L\beta_1$	$L_{II}M_{IV}$	5.961
1.8779	2 60 Nd	$L\gamma_1$	$L_{II}N_{IV}$	6.6021	2.08487	2 24 Cr	$K\beta_{1,3}$	$KM_{II,III}$	5.94671
1.8791	4 59 Pr	$L\gamma_2$	$L_I N_{II}$	6.598	2.0860	2 67 Ho	$L\zeta$	$L_{III}M_I$	5.9434
1.8821	3 62 Sm	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	6.586	2.0919	4 59 Pr	$L\beta_7$	$L_{III}O_I$	5.927
1.8867	2 63 Eu	$L\beta_3$	$L_I M_{III}$	6.5713	2.1004	4 59 Pr	$L\beta_9$	$L_I M_V$	5.903
1.8934	5 58 Ce	$L_I$	Abs. Edge	6.548	2.101820	9 25 Mn	$K\alpha_1$	$KL_{III}$	5.89875
1.89415	5 70 Yb	$L\zeta$	$L_{III}M_I$	6.5455	2.1039	3 60 Nd	$L\beta_6$	$L_{III}N_I$	5.8930
1.89643	5 25 Mn	$K$	Abs. Edge	6.5376	2.1053	5 57 La	$L_{II}$	Abs. Edge	5.889
1.8971	1 25 Mn	$K\beta_5$	$KM_{IV,V}$	6.5352	2.10578	2 25 Mn	$K\alpha_2$	$KL_{II}$	5.88765
1.89743	7 66 Dy	$L\eta$	$L_{II}M_I$	6.5342	2.1071	4 59 Pr	$L\beta_{10}$	$L_I M_{IV}$	5.884
1.8991	4 58 Ce	$L\gamma_4$	$L_I O_{II,III}$	6.528	2.1103	3 58 Ce	$L\gamma_5$	$L_{II}N_I$	5.8751
1.90881	3 66 Dy	$L\alpha_1$	$L_{III}M_V$	6.4952	2.1194	4 59 Pr	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	5.850
1.91021	2 25 Mn	$K\beta_{1,3}$	$KM_{II,III}$	6.49045	2.1209	2 63 Eu	$L\alpha_1$	$L_{III}M_V$	5.8457
1.9191	1 61 Pm	$L_{III}$	Abs. Edge	6.4605	2.1268	2 60 Nd	$L\beta_3$	$L_I M_{III}$	5.8294
1.91991	3 66 Dy	$L\alpha_2$	$L_{III}M_{IV}$	6.4577	2.1315	2 63 Eu	$L\eta$	$L_{II}M_I$	5.8166
1.9203	2 63 Eu	$L\beta_1$	$L_{II}M_{IV}$	6.4564	2.1315	2 63 Eu	$L\alpha_2$	$L_{III}M_{IV}$	5.8166



X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
2.1342	2 56 Ba	$L_{\gamma_2}$	$L_{II}N_{III}$	5.8092	2.3913	2 53 I	$L_{\gamma_4}$	$L_{IO_{II,III}}$	5.1848
2.1387	2 56 Ba	$L_{\gamma_2}$	$L_{IN_{II}}$	5.7969	2.3948	2 63 Eu	$L_I$	$L_{III}M_I$	5.1772
2.1418	3 57 La	$L_{\gamma_1}$	$L_{II}N_{IV}$	5.7885	2.40435	6 56 Ba	$L_{\beta_{2,15}}$	$L_{III}N_{IV,v}$	5.1565
2.15877	7 66 Dy	$L_I$	$L_{III}M_I$	5.7431	2.4094	4 60 Nd	$L_{\eta}$	$L_{II}M_I$	5.1457
2.166	1 58 Ce	$L_{III}$	Abs. Edge	5.723	2.4105	3 57 La	$L_{\beta_3}$	$L_{IM_{III}}$	5.1434
2.1669	3 60 Nd	$L_{\beta_4}$	$L_{IM_{II}}$	5.7216	2.4174	2 55 Cs	$L_{\gamma_6}$	$L_{II}N_I$	5.1287
2.1669	2 60 Nd	$L_{\beta_1}$	$L_{II}M_{IV}$	5.7216	2.4292	1 54 Xe	$L_{II}$	Abs. Edge	5.1037
2.1673	5 55 Cs	$L_I$	Abs. Edge	5.721	2.442	9 90 Th		$M_{IO_{III}}$	5.08
2.1701	2 58 Ce	$L_{\beta_7}$	$L_{III}O_I$	5.7132	2.443	4 92 U		$M_{II}O_{IV}$	5.075
2.1741	2 55 Cs	$L_{\gamma_4}$	$L_{IO_{II,III}}$	5.7026	2.4475	2 53 I	$L_{\gamma_{2,3}}$	$L_{IN_{II,III}}$	5.0657
2.1885	3 58 Ce	$L_{\beta_9}$	$L_{IM_V}$	5.6650	2.4493	3 57 La	$L_{\beta_4}$	$L_{IM_{II}}$	5.0620
2.1906	4 59 Pr	$L_{\beta_6}$	$L_{III}N_I$	5.660	2.45891	5 57 La	$L_{\beta_1}$	$L_{II}M_{IV}$	5.0421
2.1958	5 58 Ce	$L_{\beta_{10}}$	$L_{IM_{IV}}$	5.646	2.4630	2 59 Pr	$L_{\alpha_1}$	$L_{III}M_V$	5.0337
2.1998	2 62 Sm	$L_{\alpha_1}$	$L_{III}M_V$	5.6361	2.4729	3 59 Pr	$L_{\alpha_2}$	$L_{III}M_{IV}$	5.0135
2.2048	1 56 Ba	$L_{II}$	Abs. Edge	5.6233	2.4740	1 55 Cs	$L_{III}$	Abs. Edge	5.0113
2.2056	4 57 La	$L_{\gamma_5}$	$L_{II}N_I$	5.621	2.4783	2 55 Cs	$L_{\beta_9}$	$L_{IM_V}$	5.0026
2.2087	2 58 Ce	$L_{\beta_{2,15}}$	$L_{III}N_{IV,v}$	5.6134	2.4823	4 62 Sm	$L_I$	$L_{III}M_I$	4.9945
2.21062	3 62 Sm	$L_{\alpha_2}$	$L_{III}M_{IV}$	5.6090	2.4826	2 56 Ba	$L_{\beta_6}$	$L_{III}N_I$	4.9939
2.2172	3 59 Pr	$L_{\beta_3}$	$L_{IM_{III}}$	5.5918	2.4849	2 55 Cs	$L_{\beta_7}$	$L_{III}O_I$	4.9893
2.21824	3 62 Sm	$L_{\eta}$	$L_{II}M_I$	5.589	2.4920	2 55 Cs	$L_{\beta_{10}}$	$L_{IM_{IV}}$	4.9752
2.2328	2 55 Cs	$L_{\gamma_3}$	$L_{IN_{III}}$	5.5527	2.49734	5 22 Ti	$K$	Abs. Edge	4.96452
2.2352	2 65 Tb	$L_I$	$L_{III}M_I$	5.5467	2.4985	2 22 Ti	$K\beta_5$	$KM_{IV,v}$	4.9623
2.2371	2 55 Cs	$L_{\gamma_2}$	$L_{IN_{II}}$	5.5420	2.50356	2 23 V	$K\alpha_1$	$KL_{III}$	4.95220
2.2415	2 56 Ba	$L_{\gamma_1}$	$L_{II}N_{IV}$	5.5311	2.50738	2 23 V	$K\alpha_2$	$KL_{II}$	4.94464
2.253	6 92 U		$M_{IP_{III}}$	5.50	2.5099	1 52 Te	$L_I$	Abs. Edge	4.9397
2.2550	4 59 Pr	$L_{\beta_4}$	$L_{IM_{II}}$	5.4981	2.5113	2 52 Te	$L_{\gamma_4}$	$L_{IO_{II,III}}$	4.9369
2.2588	3 59 Pr	$L_{\beta_1}$	$L_{II}M_{IV}$	5.4889	2.5118	2 55 Cs	$L_{\beta_{2,15}}$	$L_{III}N_{IV,v}$	4.9359
2.261	1 57 La	$L_{III}$	Abs. Edge	5.484	2.512	3 59 Pr	$L_{\eta}$	$L_{II}M_I$	4.935
2.2691	1 23 V	$K$	Abs. Edge	5.4639	2.51391	2 22 Ti	$K\beta_{1,3}$	$KM_{II,III}$	4.93181
2.26951	6 23 V	$K\beta_5$	$KM_{IV,v}$	5.4629	2.5164	2 56 Ba	$L_{\beta_3}$	$L_{IM_{III}}$	4.9269
2.2737	1 54 Xe	$L_I$	Abs. Edge	5.4528	2.527	4 91 Pa		$M_{II}O_{IV}$	4.906
2.275	3 57 La	$L_{\beta_7}$	$L_{III}O_I$	5.450	2.5542	5 53 I	$L_{II}$	Abs. Edge	4.8540
2.282	3 57 La	$L_{\beta_9}$	$L_{IM_V}$	5.434	2.5553	2 56 Ba	$L_{\beta_4}$	$L_{IM_{II}}$	4.8519
2.2818	3 58 Ce	$L_{\beta_6}$	$L_{III}N_I$	5.4334	2.5615	2 58 Ce	$L_{\alpha_1}$	$L_{III}M_V$	4.8402
2.2822	3 61 Pm	$L_{\alpha_1}$	$L_{III}M_V$	5.4325	2.5674	2 52 Te	$L_{\gamma_{2,3}}$	$L_{IN_{II,III}}$	4.8290
2.28440	2 23 V	$K\beta_{1,3}$	$KM_{II,III}$	5.42729	2.56821	5 56 Ba	$L_{\beta_1}$	$L_{II}M_{IV}$	4.82753
2.28970	2 24 Cr	$K\alpha_1$	$KL_{III}$	5.41472	2.5706	3 58 Ce	$L_{\alpha_2}$	$L_{III}M_{IV}$	4.8230
2.290	3 57 La	$L_{\beta_{10}}$	$L_{IM_{IV}}$	5.415	2.58244	8 53 I	$L_{\gamma_1}$	$L_{II}N_{IV}$	4.8009
2.2926	4 61 Pm	$L_{\alpha_2}$	$L_{III}M_{IV}$	5.4078	2.5926	1 54 Xe	$L_{III}$	Abs. Edge	4.7822
2.293606	3 24 Cr	$K\alpha_2$	$KL_{II}$	5.405509	2.5932	2 55 Cs	$L_{\beta_6}$	$L_{III}N_I$	4.7811
2.3030	3 57 La	$L_{\beta_{2,15}}$	$L_{III}N_{IV,v}$	5.3835	2.618	5 90 Th		$M_{II}O_{IV}$	4.735
2.304	7 92 U		$M_{IO_{III}}$	5.38	2.6203	4 58 Ce	$L_{\eta}$	$L_{II}M_I$	4.7315
2.3085	3 56 Ba	$L_{\gamma_6}$	$L_{II}N_I$	5.3707	2.6285	2 55 Cs	$L_{\beta_3}$	$L_{IM_{III}}$	4.7167
2.3109	3 58 Ce	$L_{\beta_3}$	$L_{IM_{III}}$	5.3651	2.6388	1 51 Sb	$L_I$	Abs. Edge	4.6984
2.3122	2 64 Gd	$L_I$	$L_{III}M_I$	5.3621	2.6398	2 51 Sb	$L_{\gamma_4}$	$L_{IO_{II,III}}$	4.6967
2.3139	1 55 Cs	$L_{II}$	Abs. Edge	5.3581	2.65710	9 53 I	$L_{\gamma_6}$	$L_{II}N_I$	4.6660
2.3480	2 55 Cs	$L_{\gamma_1}$	$L_{II}N_{IV}$	5.2804	2.66570	5 57 La	$L_{\alpha_1}$	$L_{III}M_V$	4.65097
2.3497	4 58 Ce	$L_{\beta_4}$	$L_{IM_{II}}$	5.2765	2.6666	2 55 Cs	$L_{\beta_4}$	$L_{IM_{II}}$	4.6494
2.3561	3 58 Ce	$L_{\beta_1}$	$L_{II}M_{IV}$	5.2622	2.67533	5 57 La	$L_{\alpha_2}$	$L_{III}M_{IV}$	4.63423
2.3629	1 56 Ba	$L_{III}$	Abs. Edge	5.2470	2.6760	4 60 Nd	$L_I$	$L_{III}M_I$	4.6330
2.3704	2 60 Nd	$L_{\alpha_1}$	$L_{III}M_V$	5.2304	2.6837	2 55 Cs	$L_{\beta_1}$	$L_{II}M_{IV}$	4.6198
2.3764	2 56 Ba	$L_{\beta_9}$	$L_{IM_V}$	5.2171	2.6879	1 52 Te	$L_{II}$	Abs. Edge	4.6126
2.3790	4 57 La	$L_{\beta_6}$	$L_{III}N_I$	5.2114	2.6953	2 51 Sb	$L_{\gamma_{2,3}}$	$L_{IN_{II,III}}$	4.5999
2.3806	2 56 Ba	$L_{\beta_7}$	$L_{III}O_I$	5.2079	2.71241	6 52 Te	$L_{\gamma_1}$	$L_{II}N_{IV}$	4.5709
2.3807	3 60 Nd	$L_{\alpha_2}$	$L_{III}M_{IV}$	5.2077	2.71352	9 53 I	$L_{\beta_9}$	$L_{IM_V}$	4.5690
2.3869	2 56 Ba	$L_{\beta_{10}}$	$L_{IM_{IV}}$	5.1941	2.7196	5 53 I	$L_{III}$	Abs. Edge	4.5587
2.3880	5 53 I	$L_I$	Abs. Edge	5.192	2.72104	9 53 I	$L_{\beta_{10}}$	$L_{IM_{IV}}$	4.5564

X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
2.7288	3 53 I	$L\beta_7$	$L_{III}O_I$	4.5435	3.04661	9 52 Te	$L\beta_4$	$L_{IM_{II}}$	4.0695
2.740	3 57 La	$L\eta$	$L_{II}M_I$	4.525	3.068	5 90 Th	$M_{III}$	Abs. Edge	4.041
2.74851	2 22 Ti	$K\alpha_1$	$KL_{III}$	4.51084	3.0703	1 20 Ca	$K$	Abs. Edge	4.0381
2.75053	8 53 I	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	4.5075	3.0746	3 20 Ca	$K\beta_5$	$KM_{IV,v}$	4.0325
2.75216	2 22 Ti	$K\alpha_2$	$KL_{II}$	4.50486	3.07677	6 52 Te	$L\beta_1$	$L_{II}M_{IV}$	4.02958
2.753	8 92 U		$M_{II}N_{III}$	4.50	3.08475	9 50 Sn	$L\gamma_5$	$L_{II}N_I$	4.0192
2.762	1 21 Sc	$K$	Abs. Edge	4.489	3.0849	1 48 Cd	$L_I$	Abs. Edge	4.0190
2.7634	3 21 Sc	$K\beta_5$	$KM_{IV,v}$	4.4865	3.0897	2 20 Ca	$K\beta_{1,3}$	$KM_{II,III}$	4.0127
2.77595	5 56 Ba	$L\alpha_1$	$L_{III}M_v$	4.46626	3.094	5 83 Bi	$M_I$	Abs. Edge	4.007
2.7769	1 50 Sn	$L_I$	Abs. Edge	4.4648	3.11513	9 50 Sn	$L\beta_9$	$L_{IM_v}$	3.9800
2.7775	2 50 Sn	$L\gamma_4$	$L_I O_{II,III}$	4.4638	3.11513	9 51 Sb	$L\beta_6$	$L_{III}N_I$	3.9800
2.7796	2 21 Sc	$K\beta_{1,3}$	$KM_{II,III}$	4.4605	3.115	7 92 U		$M_{III}O_I$	3.980
2.7841	4 59 Pr	$L_I$	$L_{III}M_I$	4.4532	3.12170	9 50 Sn	$L\beta_{10}$	$L_{IM_{IV}}$	3.9716
2.78553	5 56 Ba	$L\alpha_2$	$L_{III}M_{IV}$	4.45090	3.131	3 90 Th		$M_{III}O_{IV,v}$	3.959
2.79007	9 52 Te	$L\gamma_5$	$L_{II}N_I$	4.4437	3.1355	2 56 Ba	$L_I$	$L_{III}M_I$	3.9541
2.817	2 92 U		$M_{II}N_{IV}$	4.401	3.1377	2 48 Cd	$L\gamma_2$	$L_{IN_{II}}$	3.9513
2.8294	5 51 Sb	$L_{II}$	Abs. Edge	4.3819	3.1473	1 49 In	$L_{II}$	Abs. Edge	3.9393
2.8327	2 50 Sn	$L\gamma_{2,3}$	$L_{IN_{II,III}}$	4.3768	3.14860	6 53 I	$L\alpha_1$	$L_{II}M_v$	3.93765
2.83672	9 53 I	$L\beta_5$	$L_{III}N_I$	4.3706	3.15258	9 51 Sb	$L\beta_3$	$L_{IM_{III}}$	3.9327
2.83897	9 52 Te	$L\beta_9$	$L_{IM_v}$	4.3671	3.1557	1 50 Sn	$L_{III}$	Abs. Edge	3.9288
2.84679	9 52 Te	$L\beta_{10}$	$L_{IM_{IV}}$	4.3551	3.1564	3 50 Sn	$L\beta_7$	$L_{III}O_I$	3.9279
2.85159	3 51 Sb	$L\gamma_1$	$L_{II}N_{IV}$	4.34779	3.15791	6 53 I	$L\alpha_2$	$L_{II}M_{IV}$	3.92604
2.8555	1 52 Te	$L_{III}$	Abs. Edge	4.3418	3.16213	4 49 In	$L\gamma_1$	$L_{II}N_{IV}$	3.92081
2.8627	3 56 Ba	$L\eta$	$L_{II}M_I$	4.3309	3.17505	3 50 Sn	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	3.90486
2.8634	3 52 Te	$L\beta_7$	$L_{III}O_I$	4.3298	3.19014	9 51 Sb	$L\beta_4$	$L_{IM_{II}}$	3.8364
2.87429	9 53 I	$L\beta_3$	$L_{IM_{III}}$	4.3134	3.217	5 82 Pb	$M_I$	Abs. Edge	3.854
2.88217	8 52 Te	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	4.3017	3.22567	4 51 Sb	$L\beta_1$	$L_{II}M_{IV}$	3.84357
2.884	5 92 U	$M_{III}$	Abs. Edge	4.299	3.245	9 91 Pa		$M_{III}O_I$	3.82
2.8917	4 58 Ce	$L_I$	$L_{III}M_I$	4.2875	3.24907	9 49 In	$L\gamma_5$	$L_{II}N_I$	3.8159
2.8924	2 55 Cs	$L\alpha_1$	$L_{III}M_v$	4.2865	3.2564	1 47 Ag	$L_I$	Abs. Edge	3.8072
2.9020	2 55 Cs	$L\alpha_2$	$L_{III}M_{IV}$	4.2722	3.2670	2 55 Cs	$L_I$	$L_{II}M_I$	3.7950
2.910	2 91 Pa		$M_{II}N_{IV}$	4.260	3.26763	9 49 In	$L\beta_9$	$L_{IM_v}$	3.7942
2.91207	9 53 I	$L\beta_4$	$L_{IM_{II}}$	4.2575	3.26901	9 50 Sn	$L\beta_6$	$L_{III}N_I$	3.7926
2.92	2 92 U		$M_{II}N_{II}$	4.25	3.27404	9 49 In	$L\beta_{10}$	$L_{IM_{IV}}$	3.7868
2.9260	1 49 In	$L_I$	Abs. Edge	4.2373	3.27979	9 53 I	$L\eta$	$L_{II}M_I$	3.7801
2.9264	2 49 In	$L\gamma_4$	$L_I O_{II,III}$	4.2367	3.283	9 90 Th		$M_{III}O_I$	3.78
2.93187	9 51 Sb	$L\gamma_5$	$L_{II}N_I$	4.2287	3.28920	6 52 Te	$L\alpha_1$	$L_{III}M_v$	3.76933
2.934	8 90 Th		$M_{II}N_{III}$	4.23	3.29846	9 52 Te	$L\alpha_2$	$L_{III}M_{IV}$	3.7588
2.93744	6 53 I	$L\beta_1$	$L_{II}M_{IV}$	4.22072	3.30585	3 50 Sn	$L\beta_3$	$L_{IM_{III}}$	3.7500
2.948	2 92 U		$M_{III}O_{IV,v}$	4.205	3.30635	9 47 Ag	$L\gamma_3$	$L_{IN_{III}}$	3.7498
2.97088	9 52 Te	$L\beta_5$	$L_{III}N_I$	4.1732	3.31216	9 47 Ag	$L\gamma_2$	$L_{IN_{II}}$	3.7432
2.97261	9 51 Sb	$L\beta_9$	$L_{IM_v}$	4.1708	3.3237	1 49 In	$L_{III}$	Abs. Edge	3.7302
2.97917	9 51 Sb	$L\beta_{10}$	$L_{IM_{IV}}$	4.1616	3.324	4 49 In	$L\beta_7$	$L_{III}O_I$	3.730
2.9800	2 49 In	$L\gamma_{2,3}$	$L_{IN_{II,III}}$	4.1605	3.3257	1 48 Cd	$L_{II}$	Abs. Edge	3.7280
2.9823	1 50 Sn	$L_{II}$	Abs. Edge	4.1573	3.329	4 92 U		$M_{II}N_I$	3.724
2.9932	2 55 Cs	$L\eta$	$L_{II}M_I$	4.1421	3.333	5 92 U	$M_{IV}$	Abs. Edge	3.720
3.0003	1 51 Sb	$L_{III}$	Abs. Edge	4.1323	3.33564	6 48 Cd	$L\gamma_1$	$L_{II}N_{IV}$	3.71686
3.00115	3 50 Sn	$L\gamma_1$	$L_{II}N_{IV}$	4.13112	3.33838	3 49 In	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	3.71381
3.0052	3 51 Sb	$L\beta_7$	$L_{III}O_I$	4.1255	3.34335	9 50 Sn	$L\beta_4$	$L_{IM_{II}}$	3.7083
3.006	3 57 La	$L_I$	$L_{III}M_I$	4.124	3.346	5 81 Tl	$M_I$	Abs. Edge	3.705
3.00893	9 52 Te	$L\beta_3$	$L_{IM_{III}}$	4.1204	3.35839	3 20 Ca	$K\alpha_1$	$KL_{III}$	3.69168
3.011	2 90 Th		$M_{II}N_{IV}$	4.117	3.359	5 83 Bi	$M_{II}$	Abs. Edge	3.691
3.0166	2 54 Xe	$L\alpha_1$	$L_{III}M_v$	4.1099	3.36166	3 20 Ca	$K\alpha_2$	$KL_{II}$	3.68809
3.02335	3 51 Sb	$L\beta_{2,15}$	$L_{III}N_{IV,v}$	4.10078	3.38487	3 50 Sn	$L\beta_1$	$L_{II}M_{IV}$	3.66280
3.0309	1 21 Sc	$K\alpha_1$	$KL_{III}$	4.0906	3.42551	9 48 Cd	$L\gamma_5$	$L_{II}N_I$	3.61935
3.0342	1 21 Sc	$K\alpha_2$	$KL_{II}$	4.0861	3.43015	9 48 Cd	$L\beta_9$	$L_{IM_v}$	3.61445
3.038	2 91 Pa		$M_{III}O_{IV,v}$	4.081	3.43606	9 49 In	$L\beta_5$	$L_{III}N_I$	3.60823



X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
3.4365	1 19 K	<i>K</i>	Abs. Edge	3.6078	4 49 In	<i>L</i> <sub>α1</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>V</sub>	3.28694	
3.4367	2 48 Cd	<i>L</i> β <sub>10</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>IV</sub>	3.6075	6 49 In	<i>L</i> α <sub>2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV</sub>	3.27929	
3.437	1 46 Pd	<i>L</i> <sub>I</sub>	Abs. Edge	3.607	5 80 Hg	<i>M</i> <sub>II</sub>	Abs. Edge	3.277	
3.43832	9 52 Te	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	3.60586	9 50 Sn	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	3.27234	
3.43941	4 51 Sb	<i>L</i> α <sub>1</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>V</sub>	3.60472	2 46 Pd	<i>L</i> β <sub>9</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>V</sub>	3.2696	
3.441	5 91 Pa		<i>M</i> <sub>III</sub> <i>N</i> <sub>I</sub>	3.603	2 46 Pd	<i>L</i> β <sub>10</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>IV</sub>	3.2637	
3.4413	4 19 K	<i>K</i> β <sub>6</sub>	<i>KM</i> <sub>IV,V</sub>	3.6027	3.80774	9 47 Ag	<i>L</i> β <sub>6</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>I</sub>	3.25603
3.44840	6 51 Sb	<i>L</i> α <sub>2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV</sub>	3.59532	3.808	4 90 Th		<i>M</i> <sub>IV</sub> <i>O</i> <sub>II</sub>	3.256
3.4539	2 19 K	<i>K</i> β <sub>1,3</sub>	<i>KM</i> <sub>II,III</sub>	3.5896	3.8222	2 46 Pd	<i>L</i> γ <sub>6</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>I</sub>	3.2437
3.46984	9 49 In	<i>L</i> β <sub>2</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>III</sub>	3.57311	3.827	1 91 Pa	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	3.2397
3.478	5 80 Hg	<i>M</i> <sub>I</sub>	Abs. Edge	3.565	3.83313	9 47 Ag	<i>L</i> β <sub>2</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>III</sub>	3.23446
3.479	1 92 U	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>V</sub>	3.563	3.834	4 83 Bi		<i>M</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.234
3.4892	2 46 Pd	<i>L</i> γ <sub>2,3</sub>	<i>L</i> <sub>I</sub> <i>N</i> <sub>II,III</sub>	3.5533	3.835	5 44 Ru	<i>L</i> <sub>I</sub>	Abs. Edge	3.233
3.492	5 82 Pb	<i>M</i> <sub>II</sub>	Abs. Edge	3.550	3.87023	5 47 Ag	<i>L</i> β <sub>4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II</sub>	3.20346
3.497	5 92 U	<i>M</i> <sub>V</sub>	Abs. Edge	3.545	3.87090	5 18 A	<i>K</i>	Abs. Edge	3.20290
3.5047	1 48 Cd	<i>L</i> <sub>III</sub>	Abs. Edge	3.5376	3.872	9 82 Pb		<i>M</i> <sub>I</sub> <i>N</i> <sub>III</sub>	3.202
3.50697	9 49 In	<i>L</i> β <sub>4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II</sub>	3.53528	3.8860	2 18 A	<i>K</i> β <sub>1,3</sub>	<i>KM</i> <sub>II,III</sub>	3.1905
3.51408	4 48 Cd	<i>L</i> β <sub>2,15</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	3.52812	3.88826	9 51 Sb	<i>L</i> λ	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	3.18860
3.5164	1 47 Ag	<i>L</i> <sub>II</sub>	Abs. Edge	3.5258	3.892	9 83 Bi		<i>M</i> <sub>I</sub> <i>N</i> <sub>II</sub>	3.185
3.521	2 92 U		<i>M</i> <sub>III</sub> <i>N</i> <sub>IV</sub>	3.521	3.8977	2 44 Ru	<i>L</i> γ <sub>2,3</sub>	<i>L</i> <sub>I</sub> <i>N</i> <sub>II,III</sub>	3.1809
3.52260	4 47 Ag	<i>L</i> γ <sub>1</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.51959	3.904	5 83 Bi	<i>M</i> <sub>III</sub>	Abs. Edge	3.176
3.537	9 90 Th		<i>M</i> <sub>II</sub> <i>N</i> <sub>I</sub>	3.505	3.9074	1 46 Pd	<i>L</i> <sub>III</sub>	Abs. Edge	3.17298
3.55531	4 49 In	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	3.48721	3.90887	4 46 Pd	<i>L</i> β <sub>2,15</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	3.17179
3.557	5 90 Th	<i>M</i> <sub>IV</sub>	Abs. Edge	3.485	3.910	1 92 U	<i>M</i> α <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VII</sub>	3.1708
3.55754	9 53 I	<i>L</i> λ	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	3.48502	3.915	5 77 Ir	<i>M</i> <sub>I</sub>	Abs. Edge	3.167
3.576	1 92 U		<i>M</i> <sub>IV</sub> <i>O</i> <sub>II</sub>	3.4666	3.924	1 92 U	<i>M</i> α <sub>2</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI</sub>	3.1595
3.577	1 91 Pa	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>V</sub>	3.4657	3.932	6 83 Bi		<i>M</i> <sub>III</sub> <i>O</i> <sub>IV,V</sub>	3.153
3.59994	3 50 Sn	<i>L</i> α <sub>1</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>V</sub>	3.44398	3.93473	3 47 Ag	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	3.15094
3.60497	9 47 Ag	<i>L</i> β <sub>9</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>V</sub>	3.43917	3.936	5 79 Au	<i>M</i> <sub>II</sub>	Abs. Edge	3.150
3.60765	9 51 Sb	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	3.43661	3.941	1 90 Th	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	3.1458
3.60891	4 50 Sn	<i>L</i> α <sub>2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV</sub>	3.43542	3.9425	5 45 Rh	<i>L</i> <sub>II</sub>	Abs. Edge	3.1448
3.61158	9 47 Ag	<i>L</i> β <sub>10</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>IV</sub>	3.43287	3.9437	2 45 Rh	<i>L</i> γ <sub>1</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.1438
3.614	2 91 Pa		<i>M</i> <sub>III</sub> <i>N</i> <sub>IV</sub>	3.430	3.95635	4 48 Cd	<i>L</i> α <sub>1</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>V</sub>	3.13373
3.61467	9 48 Cd	<i>L</i> β <sub>6</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>I</sub>	3.42994	3.96496	6 48 Cd	<i>L</i> α <sub>2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV</sub>	3.12691
3.61638	9 47 Ag	<i>L</i> γ <sub>6</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>I</sub>	3.42832	3.968	5 82 Pb		<i>M</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.124
3.616	5 79 Au	<i>M</i> <sub>I</sub>	Abs. Edge	3.428	3.98327	9 49 In	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	3.11254
3.629	5 45 Rh	<i>L</i> <sub>I</sub>	Abs. Edge	3.417	4.013	9 81 Tl		<i>M</i> <sub>I</sub> <i>N</i> <sub>III</sub>	3.089
3.634	5 81 Tl	<i>M</i> <sub>II</sub>	Abs. Edge	3.412	4.0162	2 46 Pd	<i>L</i> β <sub>6</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>I</sub>	3.0870
3.64495	9 48 Cd	<i>L</i> β <sub>2</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>III</sub>	3.40145	4.022	1 91 Pa	<i>M</i> α <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VII</sub>	3.0823
3.679	2 90 Th	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>V</sub>	3.370	4.0346	2 46 Pd	<i>L</i> β <sub>2</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>III</sub>	3.0730
3.68203	9 48 Cd	<i>L</i> β <sub>4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II</sub>	3.36719	4.035	3 91 Pa	<i>M</i> α <sub>2</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI</sub>	3.072
3.6855	2 45 Rh	<i>L</i> γ <sub>2,3</sub>	<i>L</i> <sub>I</sub> <i>N</i> <sub>II,III</sub>	3.3640	4.0451	2 45 Rh	<i>L</i> γ <sub>6</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>I</sub>	3.0650
3.691	2 91 Pa		<i>M</i> <sub>IV</sub> <i>O</i> <sub>II</sub>	3.359	4.047	1 82 Pb	<i>M</i> <sub>III</sub>	Abs. Edge	3.0632
3.6999	1 47 Ag	<i>L</i> <sub>III</sub>	Abs. Edge	3.35096	4.058	5 43 Te	<i>L</i> <sub>I</sub>	Abs. Edge	3.055
3.70335	3 47 Ag	<i>L</i> β <sub>2,15</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	3.34781	4.069	6 82 Pb		<i>M</i> <sub>III</sub> <i>O</i> <sub>IV,V</sub>	3.047
3.716	1 92 U	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	3.3367	4.0711	2 46 Pd	<i>L</i> β <sub>4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II</sub>	3.0454
3.71696	9 52 Te	<i>L</i> λ	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	3.33555	4.071	5 76 Os	<i>M</i> <sub>I</sub>	Abs. Edge	3.045
3.718	3 90 Th		<i>M</i> <sub>III</sub> <i>N</i> <sub>IV</sub>	3.335	4.07165	9 50 Sn	<i>L</i> λ	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	3.04499
3.7228	1 46 Pd	<i>L</i> <sub>II</sub>	Abs. Edge	3.33031	4.093	5 78 Pt	<i>M</i> <sub>II</sub>	Abs. Edge	3.029
3.7246	2 46 Pd	<i>L</i> γ <sub>1</sub>	<i>L</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.3287	4.105	9 83 Bi		<i>M</i> <sub>III</sub> <i>O</i> <sub>I</sub>	3.021
3.729	5 90 Th	<i>M</i> <sub>V</sub>	Abs. Edge	3.325	4.116	4 81 Tl		<i>M</i> <sub>II</sub> <i>N</i> <sub>IV</sub>	3.013
3.73823	4 48 Cd	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	3.31657	4.1299	5 45 Rh	<i>L</i> <sub>III</sub>	Abs. Edge	3.0021
3.740	9 83 Bi		<i>M</i> <sub>I</sub> <i>N</i> <sub>III</sub>	3.315	4.1310	2 45 Rh	<i>L</i> β <sub>2,15</sub>	<i>L</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	3.0013
3.7414	2 19 K	<i>K</i> α <sub>1</sub>	<i>KL</i> <sub>III</sub>	3.3138	4.1381	9 90 Th	<i>M</i> α <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VII</sub>	2.9961
3.7445	2 19 K	<i>K</i> α <sub>2</sub>	<i>KL</i> <sub>II</sub>	3.3111	4.14622	5 46 Pd	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	2.99022
3.760	9 90 Th		<i>M</i> <sub>V</sub> <i>P</i> <sub>III</sub>	3.298	4.151	2 90 Th	<i>M</i> α <sub>2</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI</sub>	2.987
3.762	5 78 Pt	<i>M</i> <sub>I</sub>	Abs. Edge	3.296	4.15443	3 47 Ag	<i>L</i> α <sub>1</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>V</sub>	2.98431

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
4.16294	5 47 Ag	$L\alpha_2$	$L_{III}M_{IV}$	2.97821	4.6542	2 41 Nb	$L\gamma_{2,3}$	$L_{I}N_{II,III}$	2.6638
4.180	1 44 Ru	$L_{II}$	Abs. Edge	2.9663	4.655	8 82 Pb		$M_{II}N_{I}$	2.664
4.1822	2 44 Ru	$L\gamma_1$	$L_{II}N_{IV}$	2.9645	4.6605	2 46 Pd	$L\eta$	$L_{II}M_{I}$	2.6603
4.19180	5 18 A	$K\alpha_1$	$KL_{III}$	2.95770	4.674	1 82 Pb	$M\gamma$	$M_{III}N_{V}$	2.6527
4.19315	9 48 Cd	$L\eta$	$L_{II}M_{I}$	2.95675	4.686	1 78 Pt	$M_{III}$	Abs. Edge	2.6459
4.19474	5 18 A	$K\alpha_2$	$KL_{II}$	2.95563	4.694	8 78 Pt		$M_{III}O_{IV,V}$	2.641
4.198	1 81 Tl	$M_{III}$	Abs. Edge	2.9535	4.703	9 79 Au		$M_{III}O_{I}$	2.636
4.216	6 81 Tl		$M_{III}O_{IV,V}$	2.941	4.7076	2 47 Ag	$Ll$	$L_{III}M_{I}$	2.6337
4.236	5 75 Re	$M_{I}$	Abs. Edge	2.927	4.715	3 82 Pb		$M_{III}N_{V}$	2.630
4.247	2 45 Rh	$L\beta_6$	$L_{III}N_{I}$	2.9229	4.719	1 42 Mo	$L_{II}$	Abs. Edge	2.6274
4.244	9 82 Pb		$M_{III}O_{I}$	2.921	4.7258	2 42 Mo	$L\gamma_1$	$L_{II}N_{IV}$	2.6235
4.2522	2 45 Rh	$L\beta_5$	$L_{I}M_{III}$	2.9157	4.7278	1 17 Cl	$K\alpha_1$	$KL_{III}$	2.62239
4.260	5 77 Ir	$M_{II}$	Abs. Edge	2.910	4.7307	1 17 Cl	$K\alpha_2$	$KL_{II}$	2.62078
4.26873	9 49 In	$Ll$	$L_{III}M_{I}$	2.90440	4.757	5 82 Pb	$M_{IV}$	Abs. Edge	2.606
4.2873	2 44 Ru	$L\gamma_5$	$L_{II}N_{I}$	2.8918	4.764	5 83 Bi	$M_{V}$	Abs. Edge	2.603
4.2888	2 45 Rh	$L\beta_4$	$L_{I}M_{II}$	2.8908	4.780	4 77 Ir		$M_{II}N_{IV}$	2.594
4.300	9 79 Au		$M_{I}N_{III}$	2.883	4.79	2 76 Os		$M_{I}N_{III}$	2.59
4.304	5 42 Mo	$L_{I}$	Abs. Edge	2.881	4.815	5 74 W	$M_{II}$	Abs. Edge	2.575
4.330	2 92 U		$M_{III}N_{I}$	2.863	4.823	3 83 Bi		$M_{IV}O_{II}$	2.571
4.355	1 80 Hg	$M_{III}$	Abs. Edge	2.8469	4.823	4 81 Tl	$M\gamma$	$M_{III}N_{V}$	2.571
4.36767	5 46 Pd	$L\alpha_1$	$L_{III}M_{V}$	2.83861	4.8369	2 42 Mo	$L\gamma_5$	$L_{II}N_{I}$	2.5632
4.369	1 44 Ru	$L_{III}$	Abs. Edge	2.8377	4.84575	5 44 Ru	$L\alpha_1$	$L_{III}M_{V}$	2.55855
4.3718	2 44 Ru	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	2.8360	4.85381	7 44 Ru	$L\alpha_2$	$L_{III}M_{IV}$	2.55431
4.37414	4 45 Rh	$L\beta_1$	$L_{II}M_{IV}$	2.83441	4.861	1 77 Ir	$M_{III}$	Abs. Edge	2.5505
4.37588	7 46 Pd	$L\alpha_2$	$L_{III}M_{IV}$	2.83329	4.865	5 81 Tl		$M_{III}N_{IV}$	2.548
4.3800	2 42 Mo	$L\gamma_{2,3}$	$L_{I}N_{II,III}$	2.8306	4.869	9 77 Ir		$M_{III}O_{IV,V}$	2.546
4.3971	1 17 Cl	$K$	Abs. Edge	2.81960	4.876	9 78 Pt		$M_{III}O_{I}$	2.543
4.4034	3 17 Cl	$K\beta$	$KM$	2.8156	4.879	5 40 Zr	$L_{I}$	Abs. Edge	2.541
4.407	5 74 W	$M_{I}$	Abs. Edge	2.813	4.8873	8 43 Tc	$L\beta_1$	$L_{II}M_{IV}$	2.5368
4.4183	2 47 Ag	$L\eta$	$L_{II}M_{I}$	2.8061	4.909	1 83 Bi	$M\beta$	$M_{IV}N_{VI}$	2.5255
4.432	4 79 Au		$M_{II}N_{IV}$	2.797	4.911	5 90 Th		$M_{IV}N_{III}$	2.524
4.433	5 76 Os	$M_{II}$	Abs. Edge	2.797	4.913	1 42 Mo	$L_{III}$	Abs. Edge	2.5234
4.436	1 43 Te	$L_{II}$	Abs. Edge	2.7948	4.9217	2 45 Rh	$L\eta$	$L_{II}M_{I}$	2.5191
4.44	2 74 W		$M_{I}O_{II,III}$	2.79	4.9232	2 42 Mo	$L\beta_{2,15}$	$L_{III}N_{IV,V}$	2.5183
4.450	4 91 Pa		$M_{III}N_{I}$	2.786	4.946	2 92 U	$M\zeta_1$	$M_{V}N_{III}$	2.507
4.460	9 78 Pt		$M_{I}N_{III}$	2.780	4.952	5 81 Tl	$M_{IV}$	Abs. Edge	2.504
4.48014	9 48 Cd	$Ll$	$L_{III}M_{I}$	2.76735	4.9525	3 46 Pd	$Ll$	$L_{III}M_{I}$	2.5034
4.4866	3 44 Ru	$L\beta_3$	$L_{I}M_{III}$	2.7634	4.9536	3 40 Zr	$L\gamma_{2,3}$	$L_{I}N_{II,III}$	2.5029
4.4866	3 44 Ru	$L\beta_5$	$L_{III}N_{I}$	2.7634	4.955	4 76 Os		$M_{II}N_{IV}$	2.502
4.518	1 79 Au	$M_{III}$	Abs. Edge	2.7439	4.955	5 82 Pb	$M_{V}$	Abs. Edge	2.502
4.522	6 79 Au		$M_{III}O_{IV,V}$	2.742	4.984	2 80 Hg	$M\gamma$	$M_{III}N_{V}$	2.4875
4.5230	2 44 Ru	$L\beta_4$	$L_{I}M_{II}$	2.7411	5.004	9 82 Pb		$M_{IV}O_{II}$	2.477
4.532	2 83 Bi	$M\gamma$	$M_{III}N_{V}$	2.735	5.0133	3 42 Mo	$L\beta_3$	$L_{I}M_{III}$	2.4730
4.568	5 90 Th		$M_{III}N_{I}$	2.714	5.0185	1 16 S	$K$	Abs. Edge	2.47048
4.571	5 83 Bi		$M_{III}N_{IV}$	2.712	5.020	5 73 Ta	$M_{II}$	Abs. Edge	2.470
4.572	5 83 Bi	$M_{IV}$	Abs. Edge	2.711	5.0233	3 16 S	$K\beta_x$	$KM$	2.4681
4.575	5 41 Nb	$L_{I}$	Abs. Edge	2.710	5.031	1 41 Nb	$L_{II}$	Abs. Edge	2.4641
4.585	5 73 Ta	$M_{I}$	Abs. Edge	2.704	5.0316	2 16 S	$K\beta_1$	$KM$	2.46404
4.59	2 83 Bi		$M_{IV}P_{II,III}$	2.70	5.0361	3 41 Nb	$L\gamma_1$	$L_{II}N_{IV}$	2.4618
4.59743	9 45 Rh	$L\alpha_1$	$L_{III}M_{V}$	2.69674	5.043	5 76 Os	$M_{III}$	Abs. Edge	2.458
4.601	4 78 Pt		$M_{II}N_{IV}$	2.695	5.0488	3 42 Mo	$L\beta_4$	$L_{I}M_{II}$	2.4557
4.60545	9 45 Rh	$L\alpha_2$	$L_{III}M_{IV}$	2.69205	5.0488	5 42 Mo	$L\beta_5$	$L_{III}N_{I}$	2.4557
4.620	5 75 Re	$M_{II}$	Abs. Edge	2.684	5.050	2 92 U	$M\zeta_2$	$M_{IV}N_{II}$	2.4548
4.62058	3 44 Ru	$L\beta_1$	$L_{II}M_{IV}$	2.68323	5.076	1 82 Pb	$M\beta$	$M_{IV}N_{VI}$	2.4427
4.625	5 92 U		$M_{IV}N_{III}$	2.681	5.092	2 91 Pa	$M\zeta_1$	$M_{V}N_{III}$	2.4350
4.630	1 43 Tc	$L_{III}$	Abs. Edge	2.6780	5.1148	3 43 Tc	$L\alpha_1$	$L_{III}M_{V}$	2.4240
4.631	9 77 Ir		$M_{I}N_{III}$	2.677	5.118	1 83 Bi	$M\alpha_1$	$M_{V}N_{VII}$	2.4226



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
5.130	2 83 Bi	$M\alpha_2$	$M_V N_{VI}$	2.4170	5.6445	3 38 Sr	$L\gamma_{2,3}$	$L_I N_{II,III}$	2.1965
5.145	4 79 Au	$M\gamma$	$M_{III} N_V$	2.410	5.6476	9 80 Hg	$M\alpha_1$	$M_V N_{VII}$	2.1953
5.1517	3 41 Nb	$L\gamma_5$	$L_{II} N_I$	2.4066	5.650	5 73 Ta	$M_{III}$	Abs. Edge	2.194
5.153	5 81 Tl	$M_V$	Abs. Edge	2.406	5.6681	3 40 Zr	$L\beta_4$	$L_I M_{II}$	2.1873
5.157	5 80 Hg	$M_{IV}$	Abs. Edge	2.404	5.67	3 73 Ta		$M_{III} O_{IV,V}$	2.19
5.168	9 82 Pb		$M_V O_{III}$	2.399	5.682	4 76 Os	$M\gamma$	$M_{III} N_V$	2.182
5.172	9 74 W		$M_I N_{III}$	2.397	5.704	8 82 Pb		$M_{III} N_I$	2.174
5.17708	8 42 Mo	$L\beta_1$	$L_{II} M_{IV}$	2.39481	5.7101	3 40 Zr	$L\beta_6$	$L_{III} N_I$	2.1712
5.186	5 79 Au		$M_{III} N_{IV}$	2.391	5.724	5 76 Os		$M_{III} N_{IV}$	2.166
5.193	2 91 Pa	$M\zeta_2$	$M_{IV} N_{II}$	2.3876	5.7243	2 41 Nb	$L\alpha_1$	$L_{III} M_V$	2.16589
5.196	9 81 Tl		$M_{IV} O_{II}$	2.386	5.7319	3 41 Nb	$L\alpha_2$	$L_{III} M_{IV}$	2.1630
5.2050	2 44 Ru	$L\eta$	$L_{II} M_I$	2.38197	5.756	1 39 Y	$L_{II}$	Abs. Edge	2.1540
5.217	5 39 Y	$L_I$	Abs. Edge	2.377	5.767	9 79 Au		$M_V O_{III}$	2.150
5.2169	3 45 Rh	$L_I$	$L_{III} M_I$	2.3765	5.784	1 15 P	$K$	Abs. Edge	2.1435
5.230	1 41 Nb	$L_{III}$	Abs. Edge	2.3706	5.796	2 15 P	$K\beta$	$KM$	2.1391
5.234	5 75 Re	$M_{III}$	Abs. Edge	2.369	5.81	2 76 Os		$M_{II} N_I$	2.133
5.2379	3 41 Nb	$L\beta_{2,15}$	$L_{III} N_{IV,V}$	2.3670	5.81	1 78 Pt	$M_V$	Abs. Edge	2.133
5.245	5 90 Th	$M\zeta_1$	$M_V N_{III}$	2.364	5.828	1 78 Pt	$M\beta$	$M_{IV} N_{VI}$	2.1273
5.249	1 81 Tl	$M\beta$	$M_{IV} N_{VI}$	2.3621	5.83	2 73 Ta		$M_{III} O_I$	2.126
5.2830	3 39 Y	$L\gamma_{2,3}$	$L_I N_{II,III}$	2.3468	5.83	1 77 Ir	$M_{IV}$	Abs. Edge	2.126
5.286	1 82 Pb	$M\alpha_1$	$M_V N_{VII}$	2.3455	5.8360	3 40 Zr	$L\beta_1$	$L_{II} M_{IV}$	2.1244
5.299	2 82 Pb	$M\alpha_2$	$M_V N_{VI}$	2.3397	5.840	1 79 Au	$M\alpha_1$	$M_V N_{VII}$	2.1229
5.3102	3 41 Nb	$L\beta_3$	$L_I M_{III}$	2.3348	5.8475	3 42 Mo	$L\eta$	$L_{II} M_I$	2.1202
5.319	4 78 Pt	$M\gamma$	$M_{III} N_V$	2.331	5.854	3 79 Au	$M\alpha_2$	$M_V N_{VI}$	2.118
5.340	5 90 Th	$M\zeta_2$	$M_{IV} N_{II}$	2.322	5.8754	3 39 Y	$L\gamma_5$	$L_{II} N_I$	2.1102
5.3455	3 41 Nb	$L\beta_4$	$L_I M_{II}$	2.3194	5.884	8 81 Tl		$M_{III} N_I$	2.107
5.357	4 74 W		$M_{II} N_{IV}$	2.314	5.885	2 75 Re	$M\gamma$	$M_{III} N_V$	2.1067
5.357	5 78 Pt		$M_{III} N_{IV}$	2.314	5.931	5 75 Re		$M_{III} N_{IV}$	2.090
5.36	1 80 Hg	$M_V$	Abs. Edge	2.313	5.962	1 39 Y	$L_{III}$	Abs. Edge	2.0794
5.3613	3 41 Nb	$L\beta_6$	$L_{III} N_I$	2.3125	5.9832	3 39 Y	$L\beta_3$	$L_I M_{III}$	2.0722
5.37216	7 16 S	$K\alpha_1$	$K L_{III}$	2.30784	5.987	9 78 Pt		$M_V O_{III}$	2.071
5.374	5 79 Au	$M_{IV}$	Abs. Edge	2.307	6.008	5 37 Rb	$L_I$	Abs. Edge	2.063
5.37496	8 16 S	$K\alpha_2$	$K L_{II}$	2.30664	6.0186	3 39 Y	$L\beta_4$	$L_I M_{II}$	2.0600
5.378	1 40 Zr	$L_{II}$	Abs. Edge	2.3053	6.038	1 77 Ir	$M\beta$	$M_{IV} N_{VI}$	2.0535
5.3843	3 40 Zr	$L\gamma_1$	$L_{II} N_{IV}$	2.3027	6.0458	3 37 Rb	$L\gamma_{2,3}$	$L_I N_{II,III}$	2.0507
5.40	2 73 Ta		$M_I N_{III}$	2.295	6.047	1 78 Pt	$M\alpha_1$	$M_V N_{VII}$	2.0505
5.40655	8 42 Mo	$L\alpha_1$	$L_{III} M_V$	2.29316	6.05	1 77 Ir	$M_V$	Abs. Edge	2.048
5.41437	8 42 Mo	$L\alpha_2$	$L_{III} M_{IV}$	2.28985	6.058	3 78 Pt	$M\alpha_2$	$M_V N_{VI}$	2.047
5.4318	9 80 Hg	$M\beta$	$M_{IV} N_{VI}$	2.2825	6.0705	2 40 Zr	$L\alpha_1$	$L_{III} M_V$	2.04236
5.435	1 74 W	$M_{III}$	Abs. Edge	2.2811	6.073	5 76 Os	$M_{IV}$	Abs. Edge	2.042
5.460	1 81 Tl	$M\alpha_1$	$M_V N_{VII}$	2.2706	6.0778	3 40 Zr	$L\alpha_2$	$L_{III} M_{IV}$	2.0399
5.472	2 81 Tl	$M\alpha_2$	$M_V N_{VI}$	2.2656	6.09	2 80 Hg		$M_{II} N_I$	2.036
5.4923	3 41 Nb	$L\beta_1$	$L_{II} M_{IV}$	2.2574	6.092	3 74 W	$M\gamma$	$M_{III} N_V$	2.035
5.4977	3 40 Zr	$L\gamma_6$	$L_{II} N_I$	2.2551	6.0942	3 39 Y	$L\beta_6$	$L_{III} N_I$	2.0344
5.500	4 77 Ir	$M\gamma$	$M_{III} N_V$	2.254	6.134	4 74 W		$M_{III} N_{IV}$	2.021
5.5035	3 44 Ru	$L_I$	$L_{III} M_I$	2.2528	6.1508	3 42 Mo	$L_I$	$L_{III} M_I$	2.01568
5.537	8 83 Bi		$M_{III} N_I$	2.239	6.157	1 15 P	$K\alpha_1$	$K L_{III}$	2.0137
5.540	5 77 Ir		$M_{III} N_{IV}$	2.238	6.160	1 15 P	$K\alpha_2$	$K L_{II}$	2.0127
5.570	4 73 Ta		$M_{II} N_{IV}$	2.226	6.162	8 83 Bi		$M_{IV} N_{III}$	2.012
5.579	1 40 Zr	$L_{III}$	Abs. Edge	2.2225	6.173	1 38 Sr	$L_{II}$	Abs. Edge	2.0085
5.584	5 79 Au	$M_V$	Abs. Edge	2.220	6.2109	3 41 Nb	$L\eta$	$L_{II} M_I$	1.99620
5.5863	3 40 Zr	$L\beta_{2,15}$	$L_{III} N_{IV,V}$	2.2194	6.2120	3 39 Y	$L\beta_1$	$L_{II} M_{IV}$	1.99584
5.59	1 78 Pt	$M_{IV}$	Abs. Edge	2.217	6.259	9 79 Au		$M_{III} N_I$	1.981
5.592	5 38 Sr	$L_I$	Abs. Edge	2.217	6.262	1 77 Ir	$M\alpha_1$	$M_V N_{VII}$	1.9799
5.624	1 79 Au	$M\beta$	$M_{IV} N_{VI}$	2.2046	6.267	1 76 Os	$M\beta$	$M_{IV} N_{VI}$	1.9783
5.628	8 74 W		$M_{II} O_I$	2.203	6.275	3 77 Ir	$M\alpha_2$	$M_V N_{VI}$	1.9758
5.6330	3 40 Zr	$L\beta_3$	$L_I M_{III}$	2.2010	6.28	2 74 W		$M_{II} N_I$	1.973

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
6.2961	3 38 Sr	$L\gamma_6$	$L_{II}N_I$	1.96916	7.101	8 79 Au	$M_{IV}N_{III}$	1.746	
6.30	1 76 Os	$M_V$	Abs. Edge	1.967	7.11	1 73 Ta	$M_V$	Abs. Edge	1.743
6.312	4 73 Ta	$M_\gamma$	$M_{III}N_V$	1.964	7.12542	9 14 Si	$K\alpha_1$	$KL_{III}$	1.73998
6.33	1 75 Re	$M_{IV}$	Abs. Edge	1.958	7.12791	9 14 Si	$K\alpha_2$	$KL_{II}$	1.73938
6.353	5 73 Ta		$M_{III}N_{IV}$	1.951	7.168	1 36 Kr	$L_{II}$	Abs. Edge	1.7297
6.3672	3 38 Sr	$L\beta_3$	$L_I M_{III}$	1.94719	7.250	5 36 Kr		$L_{II}N_{III}$	1.710
6.384	7 82 Pb		$M_{IV}N_{III}$	1.942	7.252	1 73 Ta	$M\alpha$	$M_V N_{VI, VII}$	1.7096
6.387	1 38 Sr	$L_{III}$	Abs. Edge	1.9411	7.264	5 36 Kr	$L\beta_3$	$L_I M_{III}$	1.707
6.4026	3 38 Sr	$L\beta_4$	$L_I M_{II}$	1.93643	7.279	5 36 Kr	$L\gamma_8$	$L_{II}N_I$	1.703
6.4488	2 39 Y	$L\alpha_1$	$L_{III}M_V$	1.92256	7.30	2 73 Ta		$M_V O_{III}$	1.700
6.455	9 78 Pt		$M_{III}N_I$	1.921	7.303	1 72 Hf	$M\beta$	$M_{IV}N_{VI}$	1.6976
6.4558	3 39 Y	$L\alpha_2$	$L_{III}M_{IV}$	1.92047	7.304	5 36 Kr	$L\beta_4$	$L_I M_{II}$	1.697
6.47	1 36 Kr	$L_I$	Abs. Edge	1.915	7.3183	2 37 Rb	$L\alpha_1$	$L_{III}M_V$	1.69413
6.490	1 76 Os	$M\alpha$	$M_V N_{VI, VII}$	1.9102	7.3251	3 37 Rb	$L\alpha_2$	$L_{III}M_{IV}$	1.69256
6.504	1 75 Re	$M\beta$	$M_{IV}N_{VI}$	1.9061	7.3563	3 39 Y	$L_I$	$L_{III}M_I$	1.68536
6.5176	3 41 Nb	$L_I$	$L_{III}M_I$	1.90225	7.360	8 74 W		$M_{III}N_I$	1.684
6.5191	3 38 Sr	$L\beta_3$	$L_{III}N_I$	1.90181	7.371	8 78 Pt		$M_{IV}N_{III}$	1.682
6.521	4 83 Bi	$M\zeta_1$	$M_V N_{III}$	1.901	7.392	1 36 Kr	$L_{III}$	Abs. Edge	1.6772
6.544	4 72 Hf	$M_\gamma$	$M_{III}N_V$	1.895	7.466	4 79 Au	$M\zeta_1$	$M_V N_{III}$	1.6605
6.560	5 75 Re	$M_V$	Abs. Edge	1.890	7.503	1 34 Se	$L_I$	Abs. Edge	1.6525
6.585	5 83 Bi	$M\zeta_2$	$M_{IV}N_{II}$	1.883	7.510	4 36 Kr	$L\beta_3$	$L_{III}N_I$	1.6510
6.59	1 74 W	$M_{IV}$	Abs. Edge	1.880	7.5171	3 38 Sr	$L\eta$	$L_{II}M_I$	1.64933
6.6069	3 40 Zr	$L\eta$	$L_{II}M_I$	1.87654	7.523	5 79 Au	$M\zeta_2$	$M_{IV}N_{II}$	1.648
6.6239	3 38 Sr	$L\beta_1$	$L_{II}M_{IV}$	1.87172	7.539	1 72 Hf	$M\alpha$	$M_V N_{VI, VII}$	1.6446
6.644	1 37 Rb	$L_{II}$	Abs. Edge	1.8661	7.546	8 68 Er	$M_\gamma$	$M_{III}N_V$	1.643
6.669	9 77 Ir		$M_{III}N_I$	1.859	7.576	3 36 Kr	$L\beta_1$	$L_{II}M_{IV}$	1.6366
6.729	1 75 Re	$M\alpha$	$M_V N_{VI, VII}$	1.8425	7.60	1 68 Er		$M_{III}N_{IV}$	1.632
6.738	1 14 Si	$K$	Abs. Edge	1.8400	7.601	2 71 Lu	$M\beta$	$M_{IV}N_{VI}$	1.6312
6.740	3 82 Pb	$M\zeta_1$	$M_V N_{III}$	1.8395	7.612	9 73 Ta		$M_{III}N_I$	1.629
6.7530	1 14 Si	$K\beta$	$KM$	1.83594	7.645	8 77 Ir		$M_{IV}N_{III}$	1.622
6.755	3 37 Rb	$L\gamma_8$	$L_{II}N_{IV}$	1.83532	7.738	4 78 Pt	$M\zeta_1$	$M_V N_{III}$	1.6022
6.757	1 74 W	$M\beta$	$M_{IV}N_{VI}$	1.8349	7.753	5 35 Br	$L_{II}$	Abs. Edge	1.599
6.768	6 71 Lu	$M_\gamma$	$M_{III}N_V$	1.832	7.767	9 35 Br	$L\beta_{3,4}$	$L_I M_{II, III}$	1.596
6.7876	3 37 Rb	$L\beta_3$	$L_I M_{III}$	1.82659	7.790	5 78 Pt	$M\zeta_2$	$M_{IV}N_{II}$	1.592
6.802	5 82 Pb	$M\zeta_2$	$M_{IV}N_{II}$	1.823	7.817	3 36 Kr	$L\alpha_{1,2}$	$L_{III}M_{IV, V}$	1.5860
6.806	9 74 W		$M_{IV}O_{II}$	1.822	7.8362	3 38 Sr	$L_I$	$L_{III}M_I$	1.58215
6.8207	3 37 Rb	$L\beta_4$	$L_I M_{II}$	1.81771	7.840	2 71 Lu	$M\alpha$	$M_V N_{VI, VII}$	1.5813
6.83	1 74 W	$M_V$	Abs. Edge	1.814	7.865	9 67 Ho	$M_\gamma$	$M_{III}N_{IV, V}$	1.576
6.862	1 37 Rb	$L_{III}$	Abs. Edge	1.8067	7.887	9 72 Hf		$M_{III}N_I$	1.572
6.8628	2 38 Sr	$L\alpha_1$	$L_{III}M_V$	1.80656	7.909	2 70 Yb	$M\beta$	$M_{IV}N_{VI}$	1.5675
6.8697	3 38 Sr	$L\alpha_2$	$L_{III}M_{IV}$	1.80474	7.94813	5 13 Al	$K$	Abs. Edge	1.55988
6.87	1 73 Ta	$M_{IV}$	Abs. Edge	1.804	7.960	2 13 Al	$K\beta$	$KM$	1.55745
6.87	2 80 Hg	$\delta$	$M_{IV}N_{III}$	1.805	7.984	5 35 Br	$L_{III}$	Abs. Edge	1.5530
6.89	2 76 Os		$M_{III}N_I$	1.798	8.021	4 77 Ir	$M\zeta_1$	$M_V N_{III}$	1.5458
6.9185	3 40 Zr	$L_I$	$L_{III}M_I$	1.79201	8.0415	4 37 Rb	$L\eta$	$L_{II}M_I$	1.54177
6.959	5 35 Br	$L_I$	Abs. Edge	1.781	8.065	5 77 Ir	$M\zeta_2$	$M_{IV}N_{II}$	1.5373
6.974	4 81 Tl	$M\zeta_1$	$M_V N_{III}$	1.778	8.107	1 33 As	$L_I$	Abs. Edge	1.5293
6.983	1 74 W	$M\alpha_1$	$M_V N_{VII}$	1.7754	8.1251	5 35 Br	$L\beta_1$	$L_{II}M_{IV}$	1.52590
6.9842	3 37 Rb	$L\beta_3$	$L_{III}N_I$	1.77517	8.144	9 66 Dy	$M_\gamma$	$M_{III}N_{IV, V}$	1.522
6.992	2 74 W	$M\alpha_2$	$M_V N_{VI}$	1.7731	8.149	5 70 Yb	$M\alpha$	$M_V N_{VI, VII}$	1.5214
7.005	9 74 W		$M_V O_{III}$	1.770	8.239	8 75 Re		$M_{IV}N_{III}$	1.505
7.023	1 73 Ta	$M\beta$	$M_{IV}N_{VI}$	1.7655	8.249	7 69 Tm	$M\beta$	$M_{IV}N_{VI}$	1.503
7.024	8 70 Yb	$M_\gamma$	$M_{III}N_V$	1.765	8.310	4 76 Os	$M\zeta_1$	$M_V N_{III}$	1.4919
7.032	5 81 Tl	$M\zeta_2$	$M_{IV}N_{II}$	1.763	8.321	9 34 Se	$L\beta_{3,4}$	$L_I M_{II, III}$	1.490
7.0406	3 39 Y	$L\eta$	$L_{II}M_I$	1.76095	8.33934	9 13 Al	$K\alpha_1$	$KL_{III}$	1.48670
7.0759	3 37 Rb	$L\beta_1$	$L_{II}M_{IV}$	1.75217	8.34173	9 13 Al	$K\alpha_2$	$KL_{II}$	1.48627
7.09	2 73 Ta		$M_{IV}O_{II, III}$	1.748	8.359	5 76 Os	$M\zeta_2$	$M_{IV}N_{II}$	1.4831



*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
8.3636	4 37 Rb	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	1.48238	10.254	6 64 Gd	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.2091	
8.3746	5 35 Br	<i>L</i> α <sub>1,2</sub>	1.48043	10.294	1 34 Se	<i>L</i> <sub>I</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	1.2044	
8.407	1 34 Se	<i>L</i> <sub>II</sub>	Abs. Edge	10.359	9 31 Ga	<i>L</i> β <sub>3,4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II,III</sub>	1.197	
8.470	9 70 Yb		<i>M</i> <sub>III</sub> <i>N</i> <sub>I</sub>	10.40	7 92 U		<i>N</i> <sub>II</sub> <i>P</i> <sub>I</sub>	1.192	
8.48	1 69 Tm	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.462	10.4361	8 32 Ge	<i>L</i> α <sub>1,2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV,V</sub>	1.18800
8.486	9 65 Tb	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.461	10.46	3 64 Gd	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.185
8.487	5 69 Tm	<i>M</i> ν	Abs. Edge	10.48	1 70 Yb	<i>M</i> ζ	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.183	
8.573	8 74 W		<i>M</i> <sub>IV</sub> <i>N</i> <sub>III</sub>	1.446	10.505	9 60 Nd	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.180
8.592	3 68 Er	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.4430	10.711	5 63 Eu	<i>M</i> <sub>IV</sub>	Abs. Edge	1.1575
8.60	7 92 U		<i>N</i> <sub>I</sub> <i>P</i> <sub>IV,V</sub>	1.44	10.734	1 33 As	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	1.1550
8.601	5 68 Er	<i>M</i> <sub>IV</sub>	Abs. Edge	1.4415	10.750	7 63 Eu	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.1533
8.629	4 75 Re	<i>M</i> ζ <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.4368	10.828	5 31 Ga	<i>L</i> <sub>II</sub>	Abs. Edge	1.1450
8.646	1 34 Se	<i>L</i> <sub>III</sub>	Abs. Edge	1.4340	10.96	3 63 Eu	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.131
8.664	5 75 Re	<i>M</i> ζ <sub>2</sub>	<i>M</i> <sub>IV</sub> <i>N</i> <sub>II</sub>	1.4310	10.998	9 59 Pr	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.1273
8.7358	5 34 Se	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	1.41923	11.013	5 63 Eu	<i>M</i> ν	Abs. Edge	1.1258
8.76	7 92 U		<i>N</i> <sub>I</sub> <i>P</i> <sub>III</sub>	1.42	11.023	2 31 Ga	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	1.1248
8.773	1 32 Ge	<i>L</i> <sub>I</sub>	Abs. Edge	1.4132	11.072	1 33 As	<i>L</i> <sub>I</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	1.1198
8.81	7 92 U		<i>N</i> <sub>I</sub> <i>P</i> <sub>II</sub>	1.41	11.07	7 90 Th	<i>N</i> <sub>II</sub> <i>P</i> <sub>I</sub>	1.120	
8.82	1 68 Er	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.406	11.100	1 31 Ga	<i>L</i> <sub>III</sub>	Abs. Edge	1.1169
8.844	9 64 Gd	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.402	11.200	7 30 Zn	<i>L</i> β <sub>3,4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II,III</sub>	1.1070
8.847	5 68 Er	<i>M</i> ν	Abs. Edge	1.4013	11.27	1 62 Sm	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.0998
8.90	2 73 Ta		<i>M</i> <sub>IV</sub> <i>N</i> <sub>III</sub>	1.393	11.288	5 62 Sm	<i>M</i> <sub>IV</sub>	Abs. Edge	1.0983
8.929	1 33 As	<i>L</i> β <sub>3,4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II,III</sub>	1.3884	11.292	1 31 Ga	<i>L</i> α <sub>1,2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV,V</sub>	1.09792
8.962	4 74 W	<i>M</i> ζ <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.3835	11.37	1 68 Er	<i>M</i> ζ	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.0901
8.965	4 67 Ho	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.3830	11.47	3 62 Sm	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.081
8.9900	5 34 Se	<i>L</i> α <sub>1,2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV,V</sub>	1.37910	11.53	1 58 Ce	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.0749
8.993	5 74 W	<i>M</i> ζ <sub>2</sub>	<i>M</i> <sub>IV</sub> <i>N</i> <sub>II</sub>	1.3787	11.552	5 62 Sm	<i>M</i> ν	Abs. Edge	1.0732
9.125	1 33 As	<i>L</i> <sub>II</sub>	Abs. Edge	1.3587	11.56	5 90 Th	<i>N</i> <sub>II</sub> <i>O</i> <sub>IV</sub>	1.072	
9.20	2 67 Ho	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.348	11.569	1 11 Na	<i>K</i>	Abs. Edge	1.07167
9.211	9 63 Eu	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.346	11.575	2 11 Na	<i>K</i> β	<i>K</i> <i>M</i>	1.0711
9.255	1 35 Br	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	1.3396	11.609	2 32 Ge	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	1.0680
9.316	4 73 Ta	<i>M</i> ζ <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.3308	11.862	1 30 Zn	<i>L</i> <sub>II</sub>	Abs. Edge	1.04523
9.330	5 73 Ta	<i>M</i> ζ <sub>2</sub>	<i>M</i> <sub>IV</sub> <i>N</i> <sub>II</sub>	1.3288	11.86	1 67 Ho	<i>M</i> ζ	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.0450
9.357	6 66 Dy	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.3250	11.9101	9 11 Na	<i>K</i> α <sub>1,2</sub>	<i>K</i> <i>L</i> <sub>II,III</sub>	1.04098
9.367	1 33 As	<i>L</i> <sub>III</sub>	Abs. Edge	1.3235	11.965	2 32 Ge	<i>L</i> <sub>I</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	1.0362
9.40	7 90 Th		<i>N</i> <sub>I</sub> <i>P</i> <sub>III</sub>	1.319	11.983	3 30 Zn	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	1.0347
9.4141	8 33 As	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	1.3170	12.08	4 57 La	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.027
9.44	7 90 Th		<i>N</i> <sub>I</sub> <i>P</i> <sub>II</sub>	1.313	12.122	3 29 Cu	<i>L</i> β <sub>3,4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II,III</sub>	1.0228
9.5122	1 12 Mg	<i>K</i>	Abs. Edge	1.30339	12.131	1 30 Zn	<i>L</i> <sub>III</sub>	Abs. Edge	1.02201
9.517	5 31 Ga	<i>L</i> <sub>I</sub>	Abs. Edge	1.3028	12.254	3 30 Zn	<i>L</i> α <sub>1,2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV,V</sub>	1.0117
9.521	2 12 Mg	<i>K</i> β	<i>K</i> <i>M</i>	1.3022	12.43	2 66 Dy	<i>M</i> ζ	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	0.998
9.581	2 32 Ge	<i>L</i> β <sub>3</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>III</sub>	1.2941	12.44	2 60 Nd	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	0.997
9.585	1 35 Br	<i>L</i> <sub>I</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	1.2935	12.459	5 60 Nd	<i>M</i> <sub>IV</sub>	Abs. Edge	0.9951
9.59	2 66 Dy	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.293	12.597	2 31 Ga	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	0.9842
9.600	9 62 Sm	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	1.291	12.68	2 60 Nd	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	0.978
9.640	2 32 Ge	<i>L</i> β <sub>4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II</sub>	1.2861	12.737	5 60 Nd	<i>M</i> ν	Abs. Edge	0.9734
9.6709	8 33 As	<i>L</i> α <sub>1,2</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>IV,V</sub>	1.2820	12.75	3 56 Ba	<i>M</i> γ	<i>M</i> <sub>III</sub> <i>N</i> <sub>IV,V</sub>	0.973
9.686	7 72 Hf	<i>M</i> ζ <sub>2</sub>	<i>M</i> <sub>IV</sub> <i>N</i> <sub>II</sub>	1.2800	12.90	9 92 U		<i>N</i> <sub>III</sub> <i>O</i> <sub>V</sub>	0.961
9.686	7 72 Hf	<i>M</i> ζ <sub>1</sub>	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	1.2800	12.953	2 31 Ga	<i>L</i> <sub>I</sub>	<i>L</i> <sub>III</sub> <i>M</i> <sub>I</sub>	0.9572
9.792	6 65 Tb	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	1.2661	12.98	2 65 Tb	<i>M</i> ζ	<i>M</i> <sub>V</sub> <i>N</i> <sub>III</sub>	0.955
9.8900	2 12 Mg	<i>K</i> α <sub>1,2</sub>	<i>K</i> <i>L</i> <sub>II,III</sub>	1.25360	13.014	1 29 Cu	<i>L</i> <sub>II</sub>	Abs. Edge	0.95268
9.924	1 32 Ge	<i>L</i> <sub>II</sub>	Abs. Edge	1.2494	13.053	3 29 Cu	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	0.9498
9.962	1 34 Se	<i>L</i> η	<i>L</i> <sub>II</sub> <i>M</i> <sub>I</sub>	1.2446	13.06	2 59 Pr	<i>M</i> β	<i>M</i> <sub>IV</sub> <i>N</i> <sub>VI</sub>	0.950
10.00	2 65 Tb	<i>M</i> α	<i>M</i> <sub>V</sub> <i>N</i> <sub>VI,VII</sub>	1.240	13.06	1 30 Zn	<i>L</i> <sub>I</sub>	Abs. Edge	0.9495
10.09	7 92 U		<i>N</i> <sub>I</sub> <i>O</i> <sub>III</sub>	1.229	13.122	5 59 Pr	<i>M</i> <sub>IV</sub>	Abs. Edge	0.9448
10.175	1 32 Ge	<i>L</i> β <sub>1</sub>	<i>L</i> <sub>II</sub> <i>M</i> <sub>IV</sub>	1.2185	13.18	2 28 Ni	<i>L</i> β <sub>3,4</sub>	<i>L</i> <sub>I</sub> <i>M</i> <sub>II,III</sub>	0.941
10.187	1 32 Ge	<i>L</i> <sub>III</sub>	Abs. Edge	1.2170	13.288	1 29 Cu	<i>L</i> <sub>III</sub>	Abs. Edge	0.93306

*X-Ray Wavelengths*  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV		
13.30	6 83 Bi	$N_{I}P_{II,III}$	0.932	18.8	2 47 Ag	$M_{I}N_{II,III}$	0.658		
13.336	3 29 Cu	$L_{\alpha_{1,2}}$	0.9297	18.96	4 24 Cr	$L_{\beta_{3,4}}$	0.654		
13.343	5 59 Pr	$M_{\alpha}$	0.9292	19.11	2 25 Mn	$L_{\beta_1}$	0.6488		
13.394	5 59 Pr	$M_{\nu}$	Abs. Edge	0.9257	19.1	1 52 Te	$M_{III}N_I$	0.648	
13.57	2 64 Gd	$M_{\zeta}$	0.914	19.40	7 48 Cd		$M_{II}N_{IV}$	0.639	
13.68	2 30 Zn	$L_{\eta}$	0.906	19.44	5 57 La	$M_{\zeta}$	$M_{\nu}N_{III}$	0.638	
13.75	4 58 Ce	$M_{\beta}$	0.902	19.45	1 25 Mn	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.6374	
13.8	1 90 Th		0.897	19.66	5 53 I	$M_{IV,v}$	Abs. Edge	0.631	
14.02	2 30 Zn	$L_I$	0.884	19.75	4 26 Fe	$L_{\eta}$	$L_{II}M_I$	0.628	
14.04	2 58 Ce	$M_{\alpha}$	0.883	20.0	1 50 Sn		$M_{II}N_I$	0.619	
14.22	2 63 Eu	$M_{\zeta}$	0.872	20.1	2 46 Pd		$M_I N_{II,III}$	0.616	
14.242	5 28 Ni	$L_{II}$	Abs. Edge	0.8706	20.15	1 26 Fe	$L_I$	$L_{III}M_I$	0.6152
14.271	6 28 Ni	$L_{\beta_1}$	0.8688	20.2	1 51 Sb		$M_{III}N_I$	0.612	
14.3018	1 10 Ne	$K$	Abs. Edge	0.866889	20.47	7 48 Cd	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.606
14.31	3 27 Co	$L_{\beta_{3,4}}$	0.870	20.64	4 56 Ba	$M_{\zeta}$	$M_{\nu}N_{III}$	0.601	
14.39	5 58 Ce		0.862	20.66	7 47 Ag		$M_{II}N_{IV}$	0.600	
14.452	5 10 Ne	$K_{\beta}$	$KM$	0.8579	20.7	1 24 Cr	$L_{III}$	Abs. Edge	0.598
14.51	5 57 La	$M_{\beta}$	$M_{IV}N_{VI}$	0.854	21.19	5 23 Va	$L_{\beta_{3,4}}$	$L_I M_{II,III}$	0.585
14.525	5 28 Ni	$L_{III}$	Abs. Edge	0.8536	21.27	1 24 Cr	$L_{\beta_1}$	$L_{II}M_{IV}$	0.5828
14.561	3 28 Ni	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.8515	21.34	5 52 Te		$M_{IV}O_{II,III}$	0.581
14.610	3 10 Ne	$K_{\alpha_{1,2}}$	$KL_{II,III}$	0.8486	21.5	1 50 Sn		$M_{III}N_I$	0.575
14.88	5 57 La	$M_{\alpha}$	$M_{\nu}N_{VI,VII}$	0.833	21.64	3 24 Cr	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.5728
14.90	2 29 Cu	$L_{\eta}$	$L_{II}M_I$	0.832	21.78	5 52 Te		$M_{\nu}O_{III}$	0.569
14.91	4 62 Sm	$M_{\zeta}$	$M_{\nu}N_{III}$	0.831	21.82	7 47 Ag	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.568
15.286	9 29 Cu	$L_I$	$L_{III}M_I$	0.8111	21.85	2 25 Mn	$L_{\eta}$	$L_{II}M_I$	0.5675
15.56	1 56 Ba	$M_{IV}$	Abs. Edge	0.7967	22.1	1 46 Pd		$M_{II}N_{IV}$	0.560
15.618	5 27 Co	$L_{II}$	Abs. Edge	0.7938	22.29	1 25 Mn	$L_I$	$L_{III}M_I$	0.5563
15.65	4 26 Fe	$L_{\beta_{3,4}}$	$L_I M_{II,III}$	0.792	22.9	2 48 Cd		$M_{II}N_I$	0.540
15.666	8 27 Co	$L_{\beta_1}$	$L_{II}M_{IV}$	0.7914	23.32	1 8 O	$K$	Abs. Edge	0.5317
15.72	9 56 Ba		$M_{IV}O_{III}$	0.789	23.3	1 46 Pd	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.531
15.89	1 56 Ba	$M_{\nu}$	Abs. Edge	0.7801	23.62	3 8 O	$K_{\alpha}$	$KL$	0.5249
15.91	5 56 Ba		$M_{IV}O_{II}$	0.779	23.88	4 23 Va	$L_{\beta_1}$	$L_{II}M_{IV}$	0.5192
15.915	5 27 Co	$L_{III}$	Abs. Edge	0.7790	24.25	3 23 Va	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.5113
15.93	4 52 Te	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.778	24.28	5 50 Sn	$M_{IV,v}$	Abs. Edge	0.511
15.972	6 27 Co	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.7762	24.30	3 24 Cr	$L_{\eta}$	$L_{II}M_I$	0.5102
15.98	5 51 Sb		$M_{II}N_{IV}$	0.776	24.4	2 47 Ag		$M_{\nu}N_I$	0.509
16.20	5 56 Ba		$M_{\nu}O_{III}$	0.765	24.5	1 48 Cd		$M_{III}N_I$	0.507
16.27	3 28 Ni	$L_{\eta}$	$L_{II}M_I$	0.762	24.78	1 24 Cr	$L_I$	$L_{III}M_I$	0.5003
16.46	4 60 Nd	$M_{\zeta}$	$M_{\nu}N_{III}$	0.753	25.01	9 45 Rh	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.496
16.693	9 28 Ni	$L_I$	$L_{III}M_I$	0.7427	25.3	1 50 Sn		$M_{IV}O_{II,III}$	0.491
16.7	1 24 Cr	$L_I$	Abs. Edge	0.741	25.50	9 44 Ru		$M_{II}N_{IV}$	0.486
16.92	4 51 Sb	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.733	25.7	1 50 Sn		$M_{\nu}O_{III}$	0.483
16.93	5 50 Sn		$M_{II}N_{IV}$	0.733	26.0	1 47 Ag		$M_{III}N_I$	0.478
17.19	4 25 Mn	$L_{\beta_{3,4}}$	$L_I M_{II,III}$	0.721	26.2	2 46 Pd		$M_{II}N_I$	0.474
17.202	5 26 Fe	$L_{II}$	Abs. Edge	0.7208	26.72	9 52 Te	$M_{\zeta}$	$M_{IV,v}N_{II,III}$	0.464
17.26	1 26 Fe	$L_{\beta_1}$	$L_{II}M_{IV}$	0.7185	26.9	1 44 Ru	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.462
17.38	4 59 Pr	$M_{\zeta}$	$M_{\nu}N_{III}$	0.714	27.05	2 22 Ti	$L_{\beta_1}$	$L_{II}M_{IV}$	0.4584
17.525	5 26 Fe	$L_{III}$	Abs. Edge	0.7074	27.29	1 22 Ti	$L_{II,III}$	Abs. Edge	0.4544
17.59	2 26 Fe	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.7050	27.34	3 23 Va	$L_{\eta}$	$L_{II}M_I$	0.4535
17.6	1 52 Te		$M_{II}N_I$	0.703	27.42	2 22 Ti	$L_{\alpha_{1,2}}$	$L_{III}M_{IV,v}$	0.4522
17.87	3 27 Co	$L_{\eta}$	$L_{II}M_I$	0.694	27.77	1 23 Va	$L_I$	$L_{III}M_I$	0.4465
17.94	5 50 Sn	$M_{\gamma}$	$M_{III}N_{IV,v}$	0.691	27.9	1 46 Pd		$M_{III}N_I$	0.445
17.9	1 24 Cr	$L_{II}$	Abs. Edge	0.691	28.1	2 45 Rh		$M_{II}N_I$	0.442
18.292	8 27 Co	$L_I$	$L_{III}M_I$	0.6778	28.13	5 48 Cd	$M_{IV,v}$	Abs. Edge	0.4408
18.32	2 9 F	$K_{\alpha}$	$KL$	0.6768	28.88	8 51 Sb	$M_{\zeta}$	$M_{IV,v}N_{II,III}$	0.429
18.35	4 58 Ce	$M_{\zeta}$	$M_{\nu}N_{III}$	0.676	29.8	1 45 Rh		$M_{III}N_I$	0.417
18.8	1 51 Sb		$M_{II}N_I$	0.658	30.4	1 48 Cd		$M_{IV}O_{II,III}$	0.408



X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV
30.8	1 48 Cd	$M_{\text{V}}O_{\text{III}}$	0.403	49.4	1 79 Au	$N_{\text{V}}N_{\text{VI,VII}}$	0.2510
30.82	5 47 Ag	$M_{\text{IV}}$ Abs. Edge	0.4022	49.5	1 90 Th	$N_{\text{VI}}O_{\text{IV}}$	0.2505
30.89	3 22 Ti	$L_{\text{II}}M_{\text{I}}$	0.4013	50.0	1 90 Th	$N_{\text{VII}}O_{\text{V}}$	0.2479
30.99	1 7 N	$K$ Abs. Edge	0.4000	50.2	1 77 Ir	$N_{\text{IV}}N_{\text{VI}}$	0.2470
31.02	2 21 Sc	$L_{\text{II}}M_{\text{IV}}$	0.3996	50.3	1 52 Te	$M_{\text{III}}M_{\text{V}}$	0.2465
31.14	5 47 Ag	$M_{\text{V}}$ Abs. Edge	0.3981	50.9	1 78 Pt	$N_{\text{V}}N_{\text{VI,VII}}$	0.2436
31.24	9 50 Sn	$M_{\text{IV,V}}N_{\text{II,III}}$	0.397	51.3	1 38 Sr	$M_{\text{II}}N_{\text{I}}$	0.2416
31.35	3 21 Sc	$L_{\text{III}}M_{\text{IV,V}}$	0.3954	51.9	1 76 Os	$N_{\text{IV}}N_{\text{VI}}$	0.2388
31.36	2 22 Ti	$L_{\text{II}}M_{\text{I}}$	0.3953	52.0	2 48 Cd	$M_{\text{II}}M_{\text{IV}}$	0.2384
31.60	4 7 N	$K\alpha$ $KL$	0.3924	52.2	1 51 Sb	$M_{\text{III}}M_{\text{V}}$	0.2375
31.8	1 92 U	$N_{\text{IV}}N_{\text{VI}}$	0.390	52.34	7 44 Ru	$M_{\text{IV,V}}N_{\text{II,III}}$	0.2369
32.3	2 44 Ru	$M_{\text{II}}N_{\text{I}}$	0.384	52.8	1 77 Ir	$N_{\text{V}}N_{\text{VI,VII}}$	0.2348
33.1	2 41 Nb	$M_{\text{II}}N_{\text{IV}}$	0.375	53.6	1 38 Sr	$M_{\text{III}}N_{\text{I}}$	0.2313
33.5	3 47 Ag	$M_{\text{IV,V}}O_{\text{II,III}}$	0.370	54.0	2 74 W	$N_{\text{II}}N_{\text{IV}}$	0.2295
33.57	9 90 Th	$N_{\text{IV}}N_{\text{VI}}$	0.3693	54.0	1 47 Ag	$M_{\text{II}}M_{\text{IV}}$	0.2295
34.8	1 92 U	$N_{\text{V}}N_{\text{VI,VII}}$	0.357	54.2	1 50 Sn	$M_{\text{III}}M_{\text{V}}$	0.2287
34.9	2 41 Nb	$M_{\text{III}}N_{\text{IV,V}}$	0.356	54.7	2 76 Os	$N_{\text{V}}N_{\text{VI,VII}}$	0.2266
35.13	2 21 Sc	$L_{\text{II}}M_{\text{I}}$	0.3529	54.8	2 42 Mo	$M_{\text{IV,V}}O_{\text{II,III}}$	0.2262
35.13	1 20 Ca	$L_{\text{II}}$ Abs. Edge	0.3529	55.8	1 74 W	$N_{\text{IV}}N_{\text{VI}}$	0.2221
35.3	3 42 Mo	$M_{\text{II}}N_{\text{I}}$	0.351	55.9	1 18 A	$L_{\text{II}}M_{\text{I}}$	0.2217
35.49	1 20 Ca	$L_{\text{III}}$ Abs. Edge	0.34931	56.3	1 18 A	$L_{\text{III}}M_{\text{I}}$	0.2201
35.59	3 21 Sc	$L_{\text{II}}M_{\text{I}}$	0.3483	56.5	1 46 Pd	$M_{\text{II}}M_{\text{IV}}$	0.2194
35.63	1 20 Ca	$L_{\text{II,III}}$ Abs. Edge	0.34793	57.0	2 37 Rb	$M_{\text{II}}N_{\text{I}}$	0.2174
35.94	2 20 Ca	$L_{\text{II}}M_{\text{IV}}$	0.3449	58.2	1 73 Ta	$N_{\text{IV}}N_{\text{VI}}$	0.2130
36.32	9 90 Th	$N_{\text{V}}N_{\text{VI,VII}}$	0.3414	58.4	1 74 W	$N_{\text{V}}N_{\text{VII}}$	0.2122
36.33	2 20 Ca	$L_{\text{III}}M_{\text{IV,V}}$	0.3413	58.7	2 48 Cd	$M_{\text{III}}M_{\text{V}}$	0.2111
36.8	1 48 Cd	$M_{\text{IV,V}}N_{\text{II,III}}$	0.3371	59.3	1 45 Rh	$M_{\text{II}}M_{\text{IV}}$	0.2090
37.4	2 46 Pd	$M_{\text{IV,V}}O_{\text{II,III}}$	0.332	59.5	3 74 W	$N_{\text{V}}N_{\text{VI}}$	0.208
37.5	2 42 Mo	$M_{\text{III}}N_{\text{I}}$	0.331	59.5	2 37 Rb	$M_{\text{III}}N_{\text{I}}$	0.2083
38.4	3 41 Nb	$M_{\text{II}}N_{\text{I}}$	0.323	60.5	1 47 Ag	$M_{\text{III}}M_{\text{V}}$	0.2048
39.77	7 47 Ag	$M_{\text{IV,V}}N_{\text{II,III}}$	0.3117	61.1	2 73 Ta	$N_{\text{V}}N_{\text{VI,VII}}$	0.2028
40.46	2 20 Ca	$L_{\text{II}}M_{\text{I}}$	0.3064	61.9	2 41 Nb	$M_{\text{IV,V}}O_{\text{II,III}}$	0.2002
40.7	2 41 Nb	$M_{\text{III}}N_{\text{I}}$	0.305	62.2	1 44 Ru	$M_{\text{II}}M_{\text{IV}}$	0.1992
40.9	2 45 Rh	$M_{\text{IV,V}}O_{\text{II,III}}$	0.303	62.9	1 46 Pd	$M_{\text{III}}M_{\text{V}}$	0.1970
40.96	2 20 Ca	$L_{\text{II}}M_{\text{I}}$	0.3027	63.0	5 71 Lu	$N_{\text{IV}}N_{\text{VI}}$	0.197
42.1	2 92 U	$N_{\text{VI}}O_{\text{V}}$	0.295	64.38	7 42 Mo	$M_{\text{IV,V}}N_{\text{II,III}}$	0.1926
42.1	1 19 K	$L_{\text{II,III}}$ Abs. Edge	0.2946	65.1	7 70 Yb	$N_{\text{IV}}N_{\text{VI}}$	0.190
42.3	2 82 Pb	$N_{\text{IV}}N_{\text{VI}}$	0.293	65.5	1 45 Rh	$M_{\text{III}}M_{\text{V}}$	0.1892
43.3	2 92 U	$N_{\text{VI}}O_{\text{IV}}$	0.286	65.7	2 71 Lu	$N_{\text{V}}N_{\text{VI,VII}}$	0.1886
43.6	1 46 Pd	$M_{\text{IV,V}}N_{\text{II,III}}$	0.2844	67.33	9 17 Cl	$L_{\text{II}}M_{\text{I}}$	0.1841
43.68	1 6 C	$K$ Abs. Edge	0.28384	67.6	3 5 B	$KL$	0.1833
44.7	3 6 C	$K\alpha$ $KL$	0.277	67.90	9 17 Cl	$L_{\text{III}}M_{\text{I}}$	0.1826
44.8	1 44 Ru	$M_{\text{IV,V}}O_{\text{II,III}}$	0.2768	68.2	3 90 Th	$O_{\text{III}}P_{\text{IV,V}}$	0.1817
45.0	1 82 Pb	$N_{\text{V}}N_{\text{VI,VII}}$	0.2756	68.3	1 44 Ru	$M_{\text{III}}M_{\text{V}}$	0.1814
45.2	3 80 Hg	$N_{\text{IV}}N_{\text{VI}}$	0.274	68.9	2 42 Mo	$M_{\text{II}}M_{\text{IV}}$	0.1798
45.2	1 51 Sb	$M_{\text{II}}M_{\text{IV}}$	0.2743	69.3	5 70 Yb	$N_{\text{V}}N_{\text{VI,VII}}$	0.179
46.48	9 39 Y	$M_{\text{II}}N_{\text{I}}$	0.267	70.0	4 40 Zr	$M_{\text{IV,V}}O_{\text{II,III}}$	0.177
46.5	2 81 Tl	$N_{\text{V}}N_{\text{VI,VII}}$	0.267	72.1	3 41 Nb	$M_{\text{II}}M_{\text{IV}}$	0.1718
46.8	2 79 Au	$N_{\text{IV}}N_{\text{VI}}$	0.265	72.19	9 41 Nb	$M_{\text{IV,V}}N_{\text{II,III}}$	0.1717
47.24	2 19 K	$L_{\text{II}}M_{\text{I}}$	0.2625	72.7	9 68 Er	$N_{\text{IV}}N_{\text{VI}}$	0.171
47.3	1 50 Sn	$M_{\text{II}}M_{\text{IV}}$	0.2621	74.9	1 42 Mo	$M_{\text{III}}M_{\text{V}}$	0.1656
47.67	9 45 Rh	$M_{\text{IV,V}}N_{\text{II,III}}$	0.2601	76.3	7 68 Er	$N_{\text{V}}N_{\text{VI,VII}}$	0.163
47.74	1 19 K	$L_{\text{III}}M_{\text{I}}$	0.25971	76.7	2 40 Zr	$M_{\text{II}}M_{\text{IV}}$	0.1617
47.9	3 80 Hg	$N_{\text{V}}N_{\text{VI,VII}}$	0.259	76.9	2 35 Br	$M_{\text{II}}N_{\text{I}}$	0.1613
48.1	2 78 Pt	$N_{\text{IV}}N_{\text{VI}}$	0.258	78.4	2 41 Nb	$M_{\text{III}}M_{\text{V}}$	0.1582
48.2	1 90 Th	$N_{\text{VI}}O_{\text{V}}$	0.2572	79.8	3 35 Br	$M_{\text{III}}N_{\text{I}}$	0.1554
48.5	2 39 Y	$M_{\text{III}}N_{\text{I}}$	0.256	80.9	3 40 Zr	$M_{\text{III}}M_{\text{V}}$	0.1533

X-Ray Wavelengths  
TABLE B (Continued)

Wavelength Å*	p.e. Element	Designation	keV	Wavelength Å*	p.e. Element	Designation	keV	
81.5	2 39 Y	$M_{II}M_{IV}$	0.1522	157.	3 30 Zn	$M_{II,III}M_{IV,V}$	0.079	
82.1	2 40 Zr	$M\zeta$	$M_{IV,V}N_{II,III}$	0.1511	2 56 Ba	$N_{IV}O_{III}$	0.07796	
83.	1 66 Dy		$N_{IV,V}N_{VI,VII}$	0.149	5 29 Cu	$M_{II}$	Abs. Edge 0.0777	
83.4	3 16 S	$L\iota, \eta$	$L_{II,III}M_I$	0.1487	2 56 Ba		$N_{IV}O_{II}$ 0.07590	
85.7	2 38 Sr		$M_{II}M_{IV}$	0.1447	2 56 Ba		$N_{V}O_{III}$ 0.07530	
86.	1 65 Tb		$N_{IV,V}N_{VI,VII}$	0.144	3 35 Br		$M_I M_{III}$ 0.0753	
86.5	2 39 Y		$M_{III}M_{IV,V}$	0.1434	5 29 Cu	$M_{III}$	Abs. Edge 0.0747	
91.4	2 38 Sr		$M_{III}M_{IV,V}$	0.1357	1 13 Al	$L_{II,III}$	Abs. Edge 0.07278	
91.5	2 37 Rb		$M_{II}M_{IV}$	0.1355	5 13 Al		$L_{II,III}M$ 0.0724	
91.6	1 83 Bi		$N_{VI}O_{IV}$	0.1354	3 29 Cu		$M_{II,III}M_{IV,V}$ 0.072	
93.2	1 83 Bi		$N_{VII}O_V$	0.1330	5 90 Th		$O_{IV,V}O_{II,III}$ 0.068	
93.4	2 39 Y	$M\zeta$	$M_{IV,V}N_{II,III}$	0.1328	1 55 Cs		$N_{IV}O_{III}$ 0.06746	
94.	1 15 P	$L_{II,III}$	Abs. Edge	0.132	3 35 Br		$M_I M_{II}$ 0.0672	
96.7	2 37 Rb		$M_{III}M_{IV,V}$	0.1282	1 28 Ni	$M_{III}$	Abs. Edge 0.06581	
97.2	8 66 Dy		$N_{IV,V}O_{II,III}$	0.128	1 55 Cs		$N_{IV}O_{II}$ 0.06574	
98.	1 62 Sm		$N_{IV,V}N_{VI,VII}$	0.126	3 35 Br		$M_{IV}N_{III}$ 0.0654	
100.2	2 82 Pb		$N_{VI}O_V$	0.1237	1 55 Cs		$N_{V}O_{III}$ 0.06515	
102.2	4 65 Tb		$N_{IV,V}O_{II,III}$	0.1213	2 28 Ni		$M_{II,III}M_{IV,V}$ 0.0651	
102.4	1 82 Pb		$N_{VI}O_{IV}$	0.1211	2 35 Br	$M\zeta_2$	$M_{IV}N_{II}$ 0.06488	
103.8	4 15 P		$L_{II,III}M$	0.1194	2 35 Br	$M\zeta_1$	$M_V N_{III}$ 0.06437	
104.3	1 82 Pb		$N_{VII}O_V$	0.1189	1 12 Mg	$L_I$	Abs. Edge 0.06284	
107.	1 60 Nd		$N_{IV,V}N_{VI,VII}$	0.116	5 27 Co	$M_{II,III}$	Abs. Edge 0.061	
108.0	2 38 Sr	$M\zeta_2$	$M_{IV}N_{II,III}$	0.1148	1 16 S		$L_I L_{II,III}$ 0.061	
108.7	1 38 Sr	$M\zeta_1$	$M_V N_{III}$	0.1140	6 27 Co		$M_{II,III}M_{IV,V}$ 0.058	
109.4	3 35 Br		$M_{II}M_{IV}$	0.1133	1 53 I	$N_{IV,V}$	Abs. Edge 0.0552	
110.6	5 29 Cu	$M_I$	Abs. Edge	0.1121	1 3 Li	$K$	Abs. Edge 0.05475	
111.	1 4 Be	$K$	Abs. Edge	0.111	1 34 Se	$M_V$	Abs. Edge 0.05443	
112.0	6 63 Eu		$N_{IV,V}O_{II,III}$	0.1107	1 3 Li	$K\alpha$	$KL$ 0.0543	
113.0	1 81 Tl		$N_{VI}O_V$	0.10968	2 34 Se		$M_V N_{III}$ 0.0538	
113.	1 59 Pr		$N_{IV,V}N_{VI,VII}$	0.1095	1 26 Fe	$M_{II,III}$	Abs. Edge 0.0538	
113.8	3 35 Br		$M_{III}M_{IV,V}$	0.1089	5 26 Fe		$M_{II,III}M_{IV,V}$ 0.051	
114.	1 4 Be	$K\alpha$	$KL$	0.1085	249.3	1 12 Mg	$L_{II}$	Abs. Edge 0.04973
115.3	2 81 Tl		$N_{VI}O_{IV}$	0.1075	250.7	1 12 Mg	$L_{III}$	Abs. Edge 0.04945
117.4	4 62 Sm		$N_{IV,V}O_{II,III}$	0.1056	251.5	5 12 Mg		$L_{II,III}M$ 0.04929
117.7	1 81 Tl		$N_{VII}O_V$	0.10530	273.	6 25 Mn		$M_{II,III}M_{IV,V}$ 0.045
123.	1 14 Si	$L_{II,III}$	Abs. Edge	0.1006	290.	1 13 Al		$L_I L_{II,III}$ 0.0428
126.8	2 37 Rb		$M_{IV}N_{III}$	0.0978	309.	9 24 Cr		$M_{II,III}M_{IV,V}$ 0.040
127.8	2 37 Rb	$M\zeta_2$	$M_{IV}N_{II}$	0.0970	317.	1 12 Mg		$L_I L_{II,III}$ 0.0392
128.7	2 37 Rb	$M\zeta_1$	$M_V N_{III}$	0.0964	337.	9 23 V		$M_{II,III}M_{IV,V}$ 0.0368
128.9	7 60 Nd		$N_{IV,V}O_{II,III}$	0.0962	376.	1 11 Na		$L_I L_{II,III}$ 0.03299
135.5	4 14 Si		$L_{II,III}M$	0.0915	399.	5 35 Br	$N_I$	Abs. Edge 0.0311
136.5	4 59 Pr		$N_{IV,V}O_{II,III}$	0.0908	405.	5 11 Na	$L_{II,III}$	Abs. Edge 0.0306
137.0	5 30 Zn	$M_{II}$	Abs. Edge	0.0905	407.1	5 11 Na		$L_{II,III}M$ 0.03045
142.5	1 13 Al	$L_I$	Abs. Edge	0.08701	417.	5 17 Cl	$M_I$	Abs. Edge 0.0297
143.9	5 30 Zn	$M_{III}$	Abs. Edge	0.0862	444.	5 53 I	$O_I$	Abs. Edge 0.0279
144.4	6 58 Ce		$N_{IV,V}O_{II,III}$	0.0859	525.	9 20 Ca		$M_{II,III}N_I$ 0.0236
144.4	3 37 Rb		$M_I M_{III}$	0.0859	692.	9 19 K		$M_{II,III}N_I$ 0.0179
152.6	6 57 La		$N_{IV,V}O_{II,III}$	0.0812				



# Index

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The most efficient way to use this index is to look for the pertinent *property* (e.g., vapor pressure, entropy), *process* (e.g., disposal of chemicals, calibration), or *general concept* (e.g., units, radiation). Most primary entries are subdivided into several secondary entries, e.g., under heat capacity there are 17 secondary entries such as air, metals, water, etc. Primary entries will be found for certain *classes of substances*, such as alloys, elements, organic compounds, refrigerants, semiconductors, etc. Primary entries are also given for the individual chemical elements and for a few compounds such as water and carbon dioxide. However, only the most important tables are listed under these substances. Therefore, the user will find in most cases that it is best to look first for the property of interest, then examine the table or tables that are referenced.

Entries in boldface type are the titles of tables as they appear in the Table of Contents.

The reference given for each index term is the inclusive pages of the pertinent table (e.g., **8-45** to 55). The introduction to each table describes the method of ordering the substances within that table.

The editor would be grateful for comments and suggestions on this index.

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